HITACHI
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SCANNING ELECTRON MICROSCOPE

SU3800/SU3900

INSTRUCTION MANUAL

(User's Operation/Maintenance Edition)

Please read through this manual carefully and store it in a safe place.

- Please thoroughly understand safety instructions and warnings in this manual before using the instrument.
- Instructions in this manual and in warning labels must be strictly obeyed.
- Keep this manual close at hand to ensure that it is accessible whenever needed.

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Hitachi High-Tech Corporation

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PREFACE

Thank you very much for purchasing the SU3800/SU3900 scanning electron microscope.
The SU3800/SU3900 scanning microscope (hereafter abbreviated as SU3800/SU3900) is designed for observing/evaluating specimens prepared for the system by means of an electron beam accelerated at 300 V to 30 kV.
In this manual, the functions and maintenance of this product are explained for the person who has received training of electron microscope operations. Supervision is required when a person who has not received such technical training.
Before attempting operation, be sure to read this manual carefully together with the instruction manuals accompanying the accessories you purchased. Please acquaint yourself with the SU3800/SU3900 and its accessories of proper use.
After reading this instruction manual, keep it in a safe place near the instruction so that it can be referred to whenever needed.

ABOUT THIS MANUAL

- The SU3800/SU3900 comprises of a main unit and optional accessories.
  This instruction manual includes descriptions of the outline, functions, operations and maintenance procedures of the SU3800/SU3900 main unit.
  For each optional accessory of the SU3800/SU3900, refer to the relevant accompanying instruction manual.
- This instruction manual consists of the following six chapters.
  - Chapter 1 SYSTEM SPECIFICATIONS AND INSTALLATION REQUIREMENTS (installation requirements, items to be prepared by user, etc.)
  - Chapter 2 FUNCTIONS (including descriptions of control knobs and switches)
  - Chapter 3 OPERATION (including operational procedures for image observation, and image data saving/output)
  - Chapter 4 MAINTENANCE (including maintenance procedures for each part, troubleshooting, and action to take on occurrence of power failure, etc.)
  - Chapter 5 REPLACEMENT PARTS
- This manual contains the operating and maintenance instructions and cautionary matters for the SU3800/SU3900.
- First of all, be sure to read the “IMPORTANT” and “GENERAL SAFETY GUIDELINE” chapters at the beginning of this manual for ensuring safety in operation of the SU3800/SU3900.

IMPORTANT

Leakage X-Ray Radiation from This Instrument

In the SU3800/SU3900, the effective dose equivalent of leakage X-ray radiation is 0.1 μSv/hour under its actual operating conditions, which satisfies the requirement specified in the IEC 61010-1 Ed.3:2010. In the ICRP recommendations, it is stated that electron microscopes, along with home television sets (cathode ray tube type), fall into a category of potential radiation sources that could produce undesired byproduct X-rays. It is therefore required to ensure safety with sufficient care in operation of the SU3800/SU3900.
To be on the safe side, please observe the following cautionary instructions.

(1) Use the instrument properly according to the application purposes and procedures specified in the manual, catalog, and other accompanying technical documents.
(2) Do not remove any protective external parts from the instrument or mount any unspecified parts.
(3) Do not modify the instrument to disable its safety mechanisms.
(4) Since laws and regulations regarding prevention of radiation damage may be revised in time, the user is required to meet the revisions of the regulations properly to use the instrument.

Radiation Hazard due to Laser Beam

The Super Multi drive incorporated in the personal computer (PC) of this instrument is equipped with a laser light source. The PC is designed to meet the safety standards specified in industrial standards such as the International Electrotechnical Commission (IEC) 60825-1. The laser device arrangement conforms to the Class-1 Laser Device Standards stipulated in the Federal Regulations of the U.S.A. Under the normal operating conditions, laser radiation harmful to human health will not leak out of this instrument. However, to be on the safe side, please observe the following cautionary instructions.

- Do not open the panel of the laser device. There are no user-serviceable components in the laser device.
- For any laser light source, the user is not allowed to make control adjustment.
- Be sure to leave repair of the instrument to our service engineers.
- Never remove any cover from the instrument while power is connected to it.

IMPORTANT

Warranty on Product

Hitachi High-Tech Corporation warrants the SU3800/SU3900 to be free from defects in material and manufacturing workmanship under normal use within the product specifications indicated in this manual and under conditions given below. This warranty is void if the instrument is not used in accordance with the instruction manual.

(1) Scope of Warranty
Any parts that were proved by Hitachi High-Tech Corporation to be defective in design or workmanship during the warranty period will be repaired without charge. A substitute part may be used for repair, or replacement with an equivalent product may be made instead of repair. System components that are upgraded frequently for improvement may not be available in original versions at the time of replacement. Repair or replacement after the warranty period is available at charge.

(2) Warranty Area
Within the country where this instrument has been delivered.

(3) Warranty Period
One year from the date of installation.

(4) Exclusions from Warranty
Note that the following cases are excluded from the scope of warranty even if they occur within the warranty period.

(a) Failure due to operation at a place not meeting the installation requirements specified by Hitachi High-Tech Corporation.
(b) Failure due to power supply voltage/frequency other than specified by Hitachi High-Tech Corporation or due to power failure.
(c) Corrosion or deterioration of the piping/tubing due to impurities contained in gas, air or cooling water supplied by the user.
(d) Corrosion of the electric circuits or deterioration of the optical elements due to highly corrosive gas atmosphere such as chlorine gas.
(e) Failure due to use of hardware, software, or spare parts other than supplied by the Hitachi High-Tech Corporation.
(f) Failure due to improper handling or maintenance by the user.
(g) Failure due to maintenance or repair performed by any person other than a service representative authorized by Hitachi High-Tech Corporation, or detachment or modification of parts performed by the user.
(h) Failure due to relocation or transport not approved by the Hitachi High-Tech Corporation after initial installation.
(i) Failure due to acts of God, including fire, earthquake, storm, flood, lightning, social disturbance, riot, crime, insurrection, terrorism, war (declared or undeclared), radioactive pollution, contamination with harmful substances, etc.
(j) Failure of consumables or parts that have reached the end of specified useful life.
(k) Failure due to continued use of any part that has reached the end of its specified service life.

(l) Failure due to disassembly, modification, or relocation not approved by Hitachi High-Tech Corporation.

(m) After disposal of this instrument, or after its resale without prior approval from Hitachi High-Tech Corporation.

(n) Failure due to use not described in the manual or improper repair not approved by Hitachi High-Tech Corporation.

(o) Failure of parts excluded from the warranty in the instruction manual or other documents.

(p) Failure of the personal computer used in the system, or damage to the OS, application software, or data due to power interruption or momentary voltage drop caused by lightning or the like.

(q) Failure of the personal computer in the system, or damage to the OS, application software, or data due to disconnection of the main power to the personal computer without performing the specified normal shutdown procedure.

(r) Failure of the hardware, or damage to the OS, application software or data due to computer virus infection.

(5) Limitations on Warranty

(a) Any express or implied warranties other than the explicit conditions indicated in (1) above are excluded from this warranty.

(b) Any other express or implied warranties of merchantability or fitness for a particular purpose are not included in this warranty.

(c) No liability is assumed for direct or indirect damages arising out of explicit or implied warranties.

(d) Oral or written information or advice given by our dealers, distributors, agents or employees without our express permission shall not create a warranty or in any way increase the scope of this warranty.

IMPORTANT

Installation, Relocation, and After-sales Technical Service

(1) Installation and Relocation

(a) The customer must not install the instrument.
To ensure the safety and high accuracy operation of instrument, Hitachi High-Tech Corporation service engineer who is trained and qualified by Hitachi High-Tech will carry out the installation.

(b) Before installation of this instrument, the user is requested to make preparations and to notify the sales or service engineer of Hitachi High-Tech Corporation for satisfying the installation requirements according to this manual.

(c) When relocation of this instrument becomes necessary after initial installation (delivery), please notify the sales or service engineer of Hitachi High-Tech Corporation to avoid possible troubles due to relocation. (Relocation service will be provided on a chargeable basis.)

(2) After-sales Service

(a) For after-sales technical service, contact the sales or service representative of Hitachi High-Tech Corporation.

(b) After the warranty period, maintenance, inspection, etc. are available through a contract.

(c) For 10 years after the delivery, its maintenance can be provided to ensure operation of the instrument.
Even when more than 10 years have elapsed after delivery, maintenance will basically be provided as long as the relevant units and parts are available. Note, however, that this statement does not represent any extension of the above-mentioned useful life of the instrument.

Disposal of Instrument

In the present design, this instrument does not use materials that would directly cause environmental disruption. Note, however, that the environmental protection laws and directives may be revised or amended. Therefore, be sure to consult with the sales or service engineer of Hitachi High-Tech Corporation when planning disposal of this instrument or its parts.

Lithium batteries are used in the personal computer of this instrument. When disposing of the lithium batteries, strictly follow the relevant laws and regulations regarding industrial waste disposal and environmental protection.

Service Life of Instrument

This instrument has a service life of 10 years after the date of its initial use (installation), which is estimated under the condition that periodic maintenance/checkup, replacement of life-limited parts, and repair of worn parts are carried out as specified in this instruction manual. When more than the service life have elapes after delivery, perform the safety check-up by our sales or service representative of Hitachi High-Tech Corporation (with charge). In case of operating the insturument after elapes of service life, it can cause of malfuction of instrument and risk of safety. Please note that safety check-up is unable to perform due to operating condition or instrument installation condition.
In addition, purchasing a new instument may need to consider due to the result of the safety check-up.

Technical Seminars and Training for Customers

To ensure safety and high accuracy in operation of the instrument, technical seminars and training courses are available at Hitachi High-Tech Corporation's facilities or your site. For further information, contact the sales representative of Hitachi High-Tech Corporation. (The technical seminars and customer training courses are available on a chargeable basis.)

IMPORTANT

Other Precautions

Disclaimer of Liability for Industrial Properties of Third Party

Hitachi High-Tech Corporation does not assume any liability for a third party's complaint regarding infringement of any patent rights or industrial properties with respect to products manufactured through use of the equipment supplied by Hitachi High-Tech Corporation or its related companies or application of said instrument.

Handling of Chemicals

(1) The user is responsible for following relevant legal standards and regulations in the handling, storage and discarding of chemicals to be used for cleaning this instrument.
(2) Chemicals shall be handled, stored, and disposed of, as instructed by respective suppliers.

Substances of very high concern

Hitachi High-Tech Corporation investigates the substances of very high concern (SVHCs) (REACH regulation (EC) No.1907/2006) content in the products based on the information which is provided in that supply chain.
The SVHC which is found to contain in the products is as follows;

The substance name: lead
CAS registry No.: 7439-92-1

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IMPORTANT

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A "png_get_copyright" function is available, for convenient use in "about" boxes and the like:

```
printf("%s",png_get_copyright(NULL));
```

Also, the PNG logo (in PNG format, of course) is supplied in the files "pngbar.png" and "pngbar.jpg (88x31) and "pngnow.png" (98x31).

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Glenn Randers-Pehrson
glennrp at users.sourceforge.net
March 26, 2015

◆zlib (1.2.3)

/* zlib.h -- interface of the 'zlib' general purpose compression library version 1.2.3, July 18th, 2005

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Jean-loup Gailly Mark Adler
jloup@gzip.org madler@alumni.caltech.edu

*/

◆libtiff（4.0.3）

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IMPORTANT

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User Manual Addendum for WEEE

Information for Users on WEEE (Only for EU countries)

This symbol is in compliance with the Waste Electrical and Electronic equipment directive 2002/96/EC (WEEE).
This symbol on the product indicates the requirement NOT to dispose the equipment as unsorted municipal waste, but use the return and collection systems available.

Information on Disposal for Users.

1. In the European Union

   If you need to discard this product or discard user serviceable parts:
   Please contact your Hitachi High-Tech office in the European Union or distributor who will inform you of the recycle of the product.
   You might be charged for the costs arising from take-back and recycling.

2. In other Countries outside the EU

   If you wish to discard this product, please contact your local authorities and ask for the correct method of disposal.

If you want to find our Hitachi High-Tech office in the European Union, you can find at https://map.hitachi-hightech.com/

⚠GENERAL SAFETY GUIDE

⚠Safety Alert Symbols and Signal Words

The warnings for human safety is indicated and described in the following alert headings that is consisted by the safety alart symbol [⚠], [WARNING] and [CAUTION].

	: This is a safety alert symbol. Safety alert symbol used for calling attention to a potential hazard that could cause personal injury. To prevent possible hazards or injury, be sure to follow the safety precautions preceded by this symbol.
⚠ WARNING	: Indicates a potentially hazardous situation which, if not avoided, will or can result in death or serious injury.
⚠ CAUTION	: Indicates a hazardous situation which, if not avoided, will or can result in minor or moderate injury.

Other safety precautions or useful reminders are indicated by the following signal words.

NOTICE	: Indicates a potentially hazardous situation which, if not avoided, will or can result in damage to the product or property, serious failures in the instrument, damage to data, or environmental pollution, though personal injury may not be incurred.
NOTE	: Indicates explanations about the proper use of the product to avoid minor damage and obtain the maximum performance and functionality.

Common Safety Precautions

Precautions Prior to Use

- Follow the precautions and instructions stated on the warning labels attached on the instrument and those contained in all the accompanying instruction manuals. Failure to do so could result in fatal/serious injury or damage to the instrument due to an electric shock or fire.

- Absolutely avoid modifying the product, using non-specified parts, or using the instrument with safety devices detached, as it could be hazardous.

- When using a chemical such as reagent for the instrument, it shall be handled properly, referring to the information about material characteristics and handling (SDS).

- When using a chemical such as a reagent, you are responsible for proper ventilation of the room. Inadequate ventilation could endanger human health.

- Keep in mind that the hazard warnings in the manuals or on the product cannot cover every possible case, as it is impossible to predict and evaluate all circumstances beforehand. Always be alert and use your common sense.

- If an abnormality such as unusual noise, odor or smoke occurs during operation of the instrument, immediately shut down the power supply and take proper safety measures as required. Then, contact our sales or service representative.

- Follow the precautions and instructions stated on the instruction manual of each manufacturer for the option devices.

- In case of the emergency stop, turn OFF the key switch on the LED panel and power OFF the Main breaker at the rear side of the main unit.

- The power is supplied to the instrument by connecting the power cable to the power cable connector. Please remove the power cable from the power cable connector when failure is occurred.

- Please use the dedicated cable that is connected during installation. Do not exchange or divert the power cable.

Be sure to observe the cautionary instructions mentioned above. Failure to do so may result not only in improper specimen observation and evaluation, but also in personal injuries.

Common Safety Precautions (Continued)

Installation, Maintenance, and Relocation

- Upon final delivery of the product after completion of its installation, the user is requested to check that there are no lost standard accessories.
  If the instrument is operated with any one of the standard parts missing, a failure may occur, resulting in a hazardous condition.
  If any item is missing or damaged or if you have any question, consult a service engineer or our sales representative.

- The maintenance and checkup procedures to be performed by the user are only those described in this manual. Before performing the maintenance and checkup procedures described in the manual, attain a clear understanding of them.
  Maintenance other than those described in this manual must be performed by our service engineers.
  A failure to observe the above can result in instrument malfunctions or personal injuries.

- Replace the life-limited parts with new ones at intervals specified in this manual. If the instrument is operated without replacing a life-limited part, a failure can occur, resulting in a hazardous condition. For maintenance that is intended to be performed by service engineers, contact a service engineer or our sales representative of Hitachi High-Tech Corporation.

Common Safety Precautions (Continued)

Warning and Caution Messages That Are Not Mentioned in the Instruction Manual

Shown below are the cautionary instructions not contained elsewhere in this manual.

⚠ WARNING

- Accident due to Continuous Use under Abnormal condition

If the instrument is used continuously under abnormal condition of instrument, electric shock or fire will be occurred. Shut down the power supply immediately as soon as an abnormality condition is found such as unusual noise, odor, or fuming occurs during operation of the instrument. Then, take proper safety measures as required and notify a service engineer of Hitachi High-Tech Corporation.

- Fuming and Ignition due to Inappropriate Operation

This instrument is equipped with protective devices such as fuses, overcurrent detectors, electric leakage detectors, and alarm indicators. If a protective device is activated, contact a service engineer of Hitachi High-Tech Corporation.
Power on the instrument again without proper elimination can cause of unexpected dangers such as fuming or ignition.

- Electric Shock due to Improper Grounding

Insufficient grounding of the instrument can cause of incorrect operation leading to electric shock. Do not touch the grounding wire. The grounding wire of the instrument shall be carried out by a service engineer.

(Chapter 1 Specification and installation requirements)

Common Safety Precautions (Continued)

Shown below are the cautionary instructions not contained elsewhere in this manual.

⚠ CAUTION

- Fatigue due to Long Hours of Operation

Looking at the monitor over an extended period may lead to eyestrain or body fatigue. Recommended to take a break of 10 to 15 minutes per hour during operation.
In addition, please prepare a proper table and chairs by referring to the SEMI standard or other standard for the operation.

Safety Indications in This Manual

Shown below are the cautionary instructions contained in this manual and the section numbers corresponding to them.

⚠ WARNING

- Burns due to contacting with compressor (Option)

In case of operating the compressor for long hours, the discharge pipe of the compressor will be high temperature. Beware of contacting with the discharge pipe of compressor. It can cause burn your hands.

(Chapter 4 Maintenance)

- Cautions of high pressure of compressor (Option)

Beware of high pressure
Will splash wastewater.
It can damage your eyes due to splashing the wastewater into your eyes. Make sure to decrease the pressure and gradually rotate the drain valve.

(Chapter 4 Maintenance)

- Caution for handling the rotary pump oil

- Oil is used in the rotary pump (option) of this instrument.
- Wear the polyethylene gloves when using the liquid.
- Avoid inhaling the vapor from the liquid over a long time.
- Use the liquid in a well-ventilated place.
- Do not swallow the liquid.

Safety Indications in This Manual

⚠ CAUTION

- High temperature (Electron gun)

Beware of high temperature (About 90℃)
Can cause burn.
Wait over 30 minutes for cooling down after introducing air when replacing the filament.

(Chapter 4 Maintenance)

- Injury upon lifting heavy unit

Injury upon lifting heavy unit
Rotary pump (28 kg), weight (26 kg) are heavy objects.
Muscle strain or back injury. Use lifting aids and proper lifting techniques by two or more persons when removing or replacing. In addition, only the service engineers are allowed to perform this work.
Weight shall be described in the service manual.

(Chpater 1 Specification and installation requirements)

- Injury upon lifting heavy unit (Main unit)

The main unit (SU3800:520kg, SU3900: 780kg) is a heavy object.
Use fixing tools during the shipment. In addition, only the service engineers are allowed to perform this work.
Weight shall be described in the service manual.

(Chpater 1 Specification and installation requirements)

- Damage on specimen

Can cause damaging the specimen due to contacting to the objective lens. Set the specimen size properly.

(Chapter 3 Operation)

Safety Indications in This Manual (Continued)

⚠ CAUTION

- Injury while opening the electron gun part

When lifting the entire electron gun unit, be sure to hold it in two hands and move it until it stops. Releasing the hand in the middle carries the risk of injury such as finger getting caught.

(Chapter 4 Maintenance)

- Injury due to damaging the cover

Can cause injury due to damaging the cover. Do not lean or sit on the cover.

(Chapter 4 Maintenance)

- Injury your hands or fingers due to contacting with filament component

Can cause injury your hands or fingers due to contacting with filament component
Do not touch the tip of the filament.

(Chapter 4 Maintenance)

- Electric Shock due to High voltage

Voltage up to AC 100V to 240V, DC 30 kV are used inside this instrument. When touching the inside parts or circuit of the main unit area, the control area and the power supply area, it can cause death or severe injury by receiving an electric shock. Do not remove the cover.

(Chapter 4 Maintenance)

- Moving parts inside

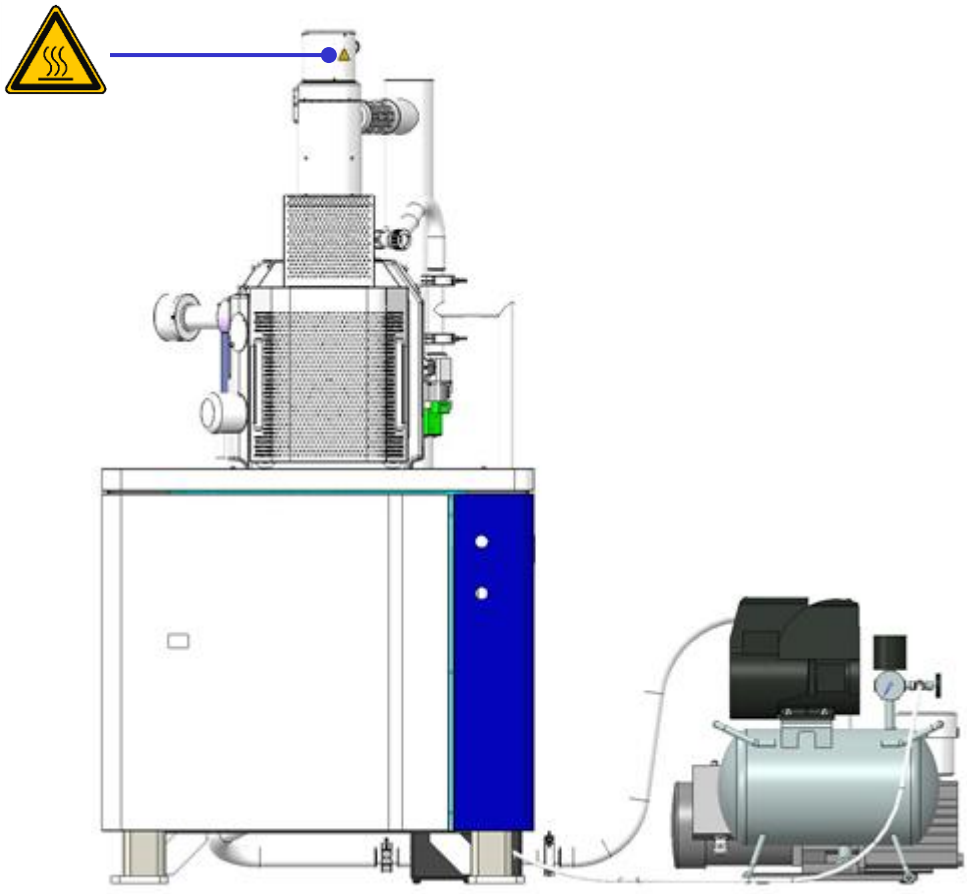
Keep hands, finger or hair clear from the moving parts.
Do not touch the moving parts while moving the Z stage.

(Chapter 3 Operation)

Warning and Caution Labels on Instrument

Pages SAFETY - 9 to 18 show warning and caution labels that are affixed to the SU3800/SU3900.
Confirm the actual WARNING and CAUTION labels attached on the instrument.
The labels should be checked periodically and cleaned so that they can be viewed clearly from a safe distance.
If warning labels fade and become difficult to read due to deterioration with age, contact our service representative of Hitachi High-Tech Corporation for replacement.

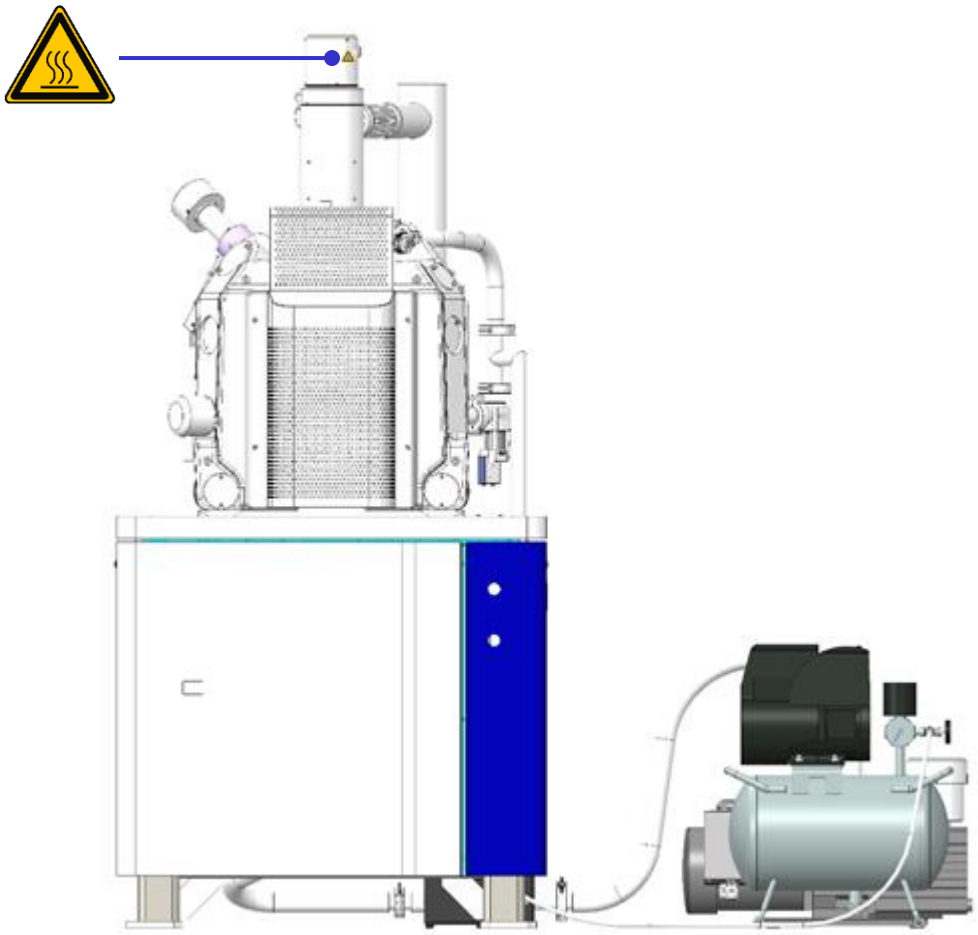
(6)



Main Unit (SU3800: Front view)

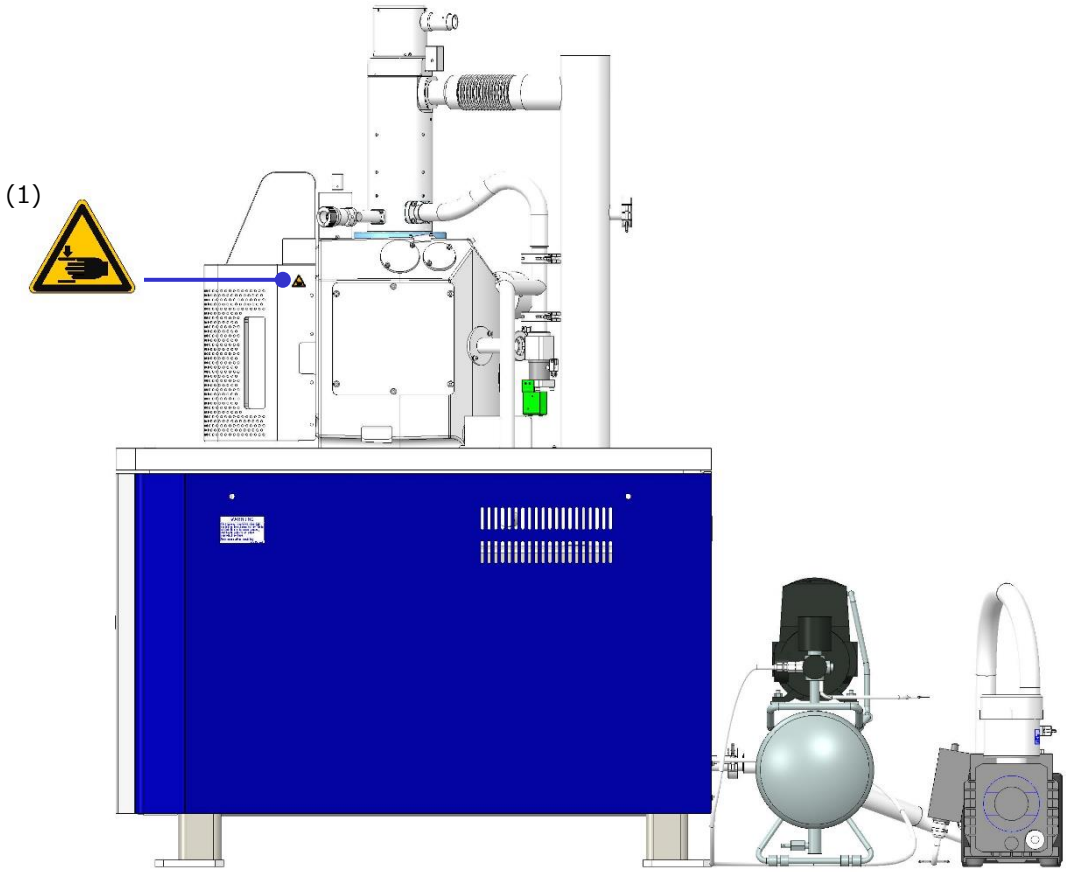
Warning and Caution Labels on Instrument

(6)



Main Unit (SU3900: Front view)

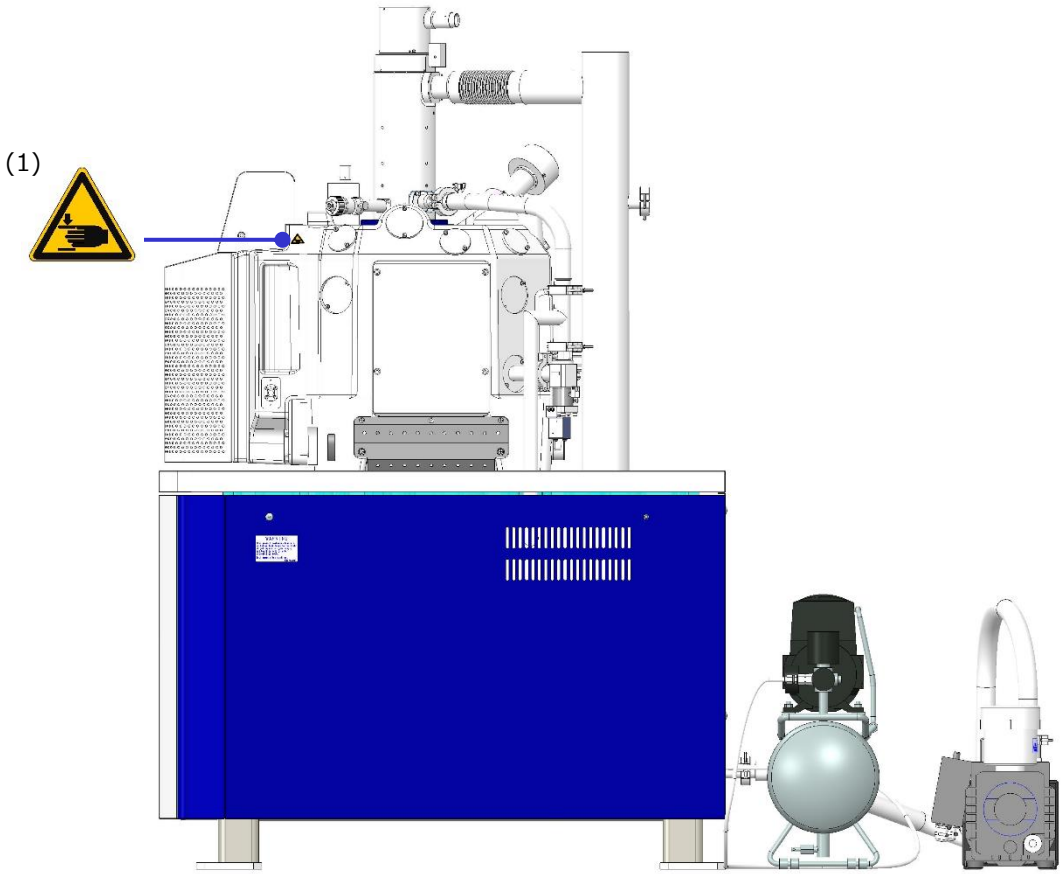
Warning and Caution Labels on Instrument (Continued)



Main Unit (SU3800: Right Side View)

Locations of WARNING and CAUTION Labels on Main Unit

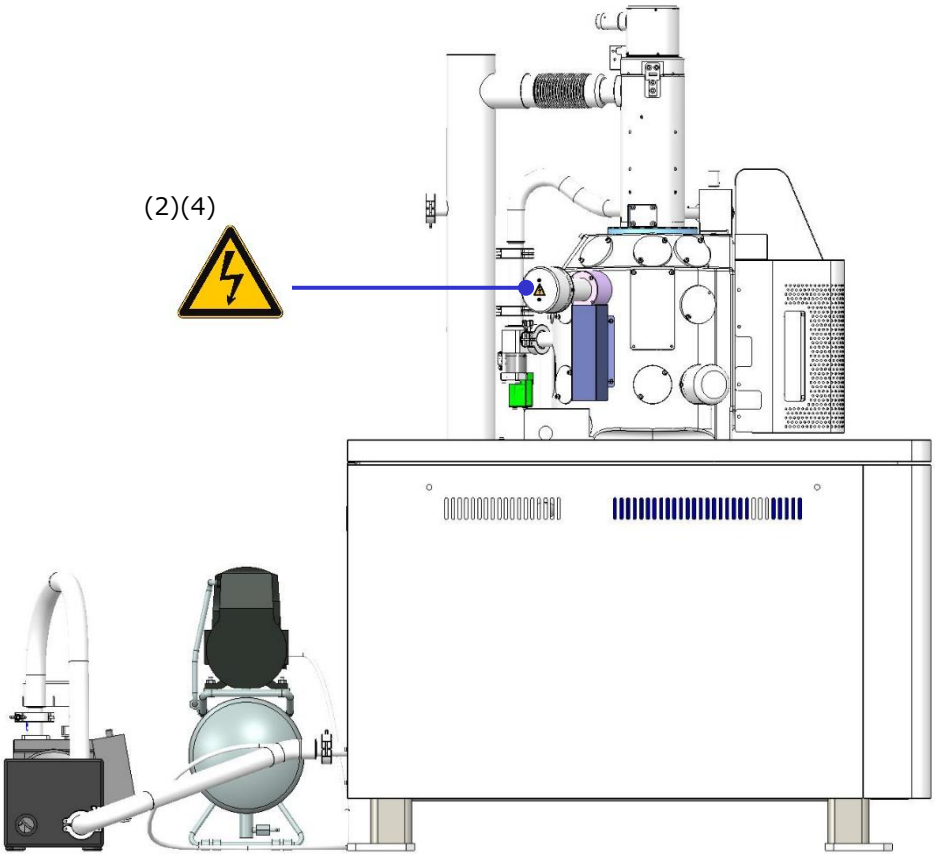
Warning and Caution Labels on Instrument (Continued)



Main Unit (SU3900: Right Side View)

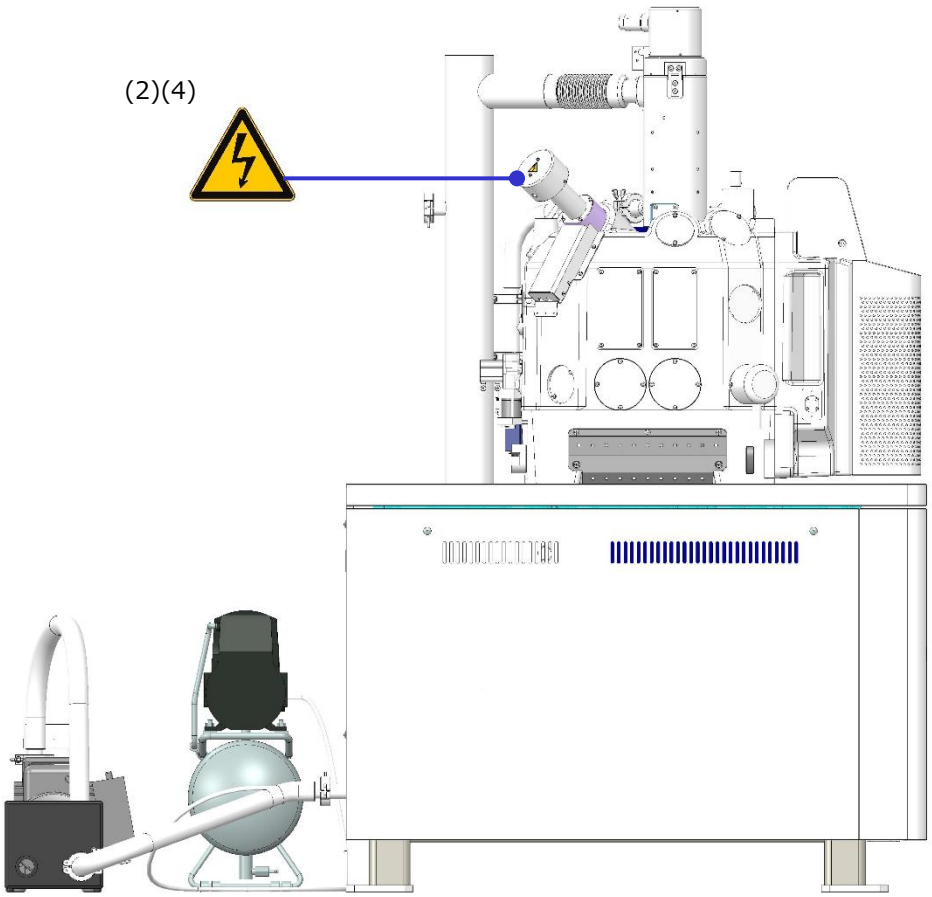
Locations of WARNING and CAUTION Labels on Main Unit

Warning and Caution Labels on Instrument (Continued)



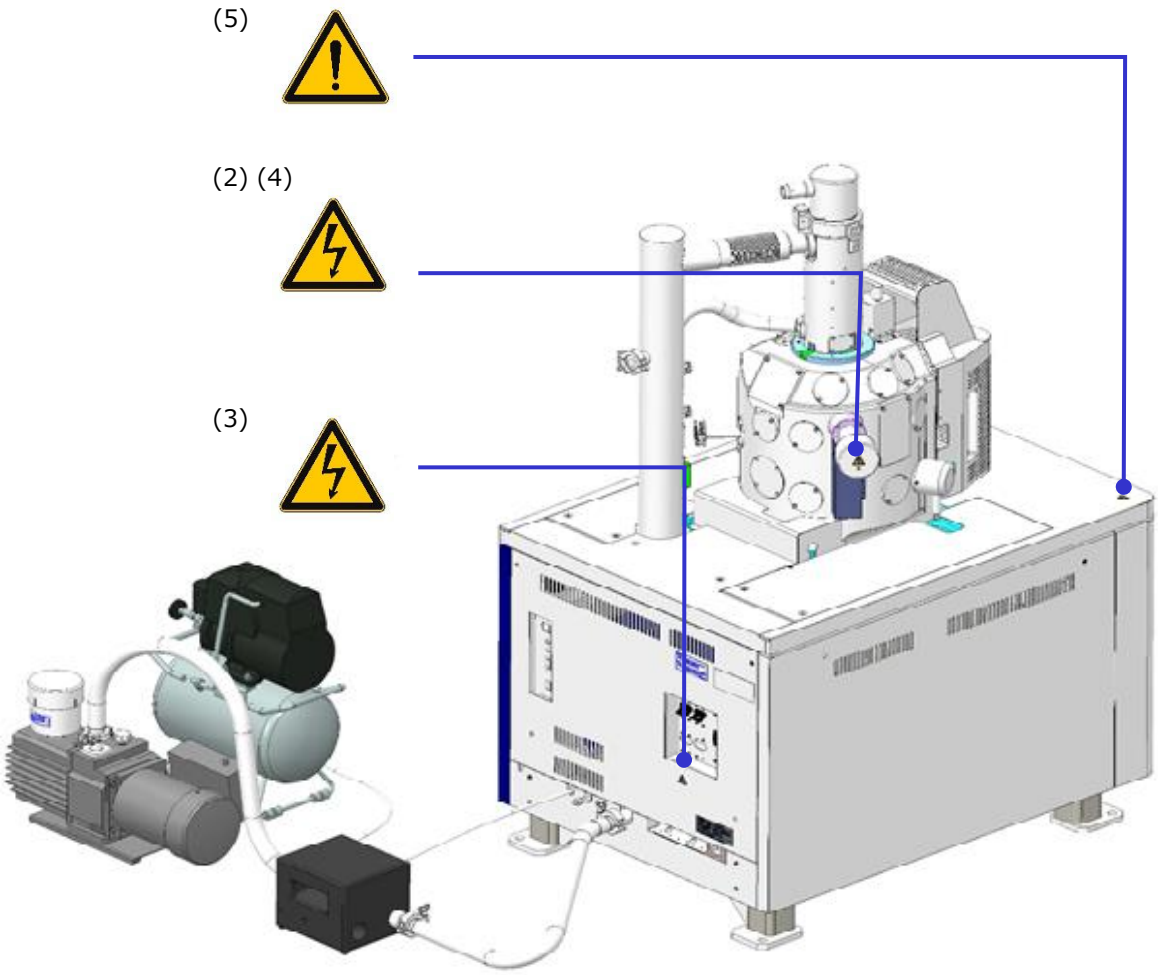
Main Unit (SU3800: Left side view)
Locations of WARNING and CAUTION Labels on Main Unit

Warning and Caution Labels on Instrument (Continued)



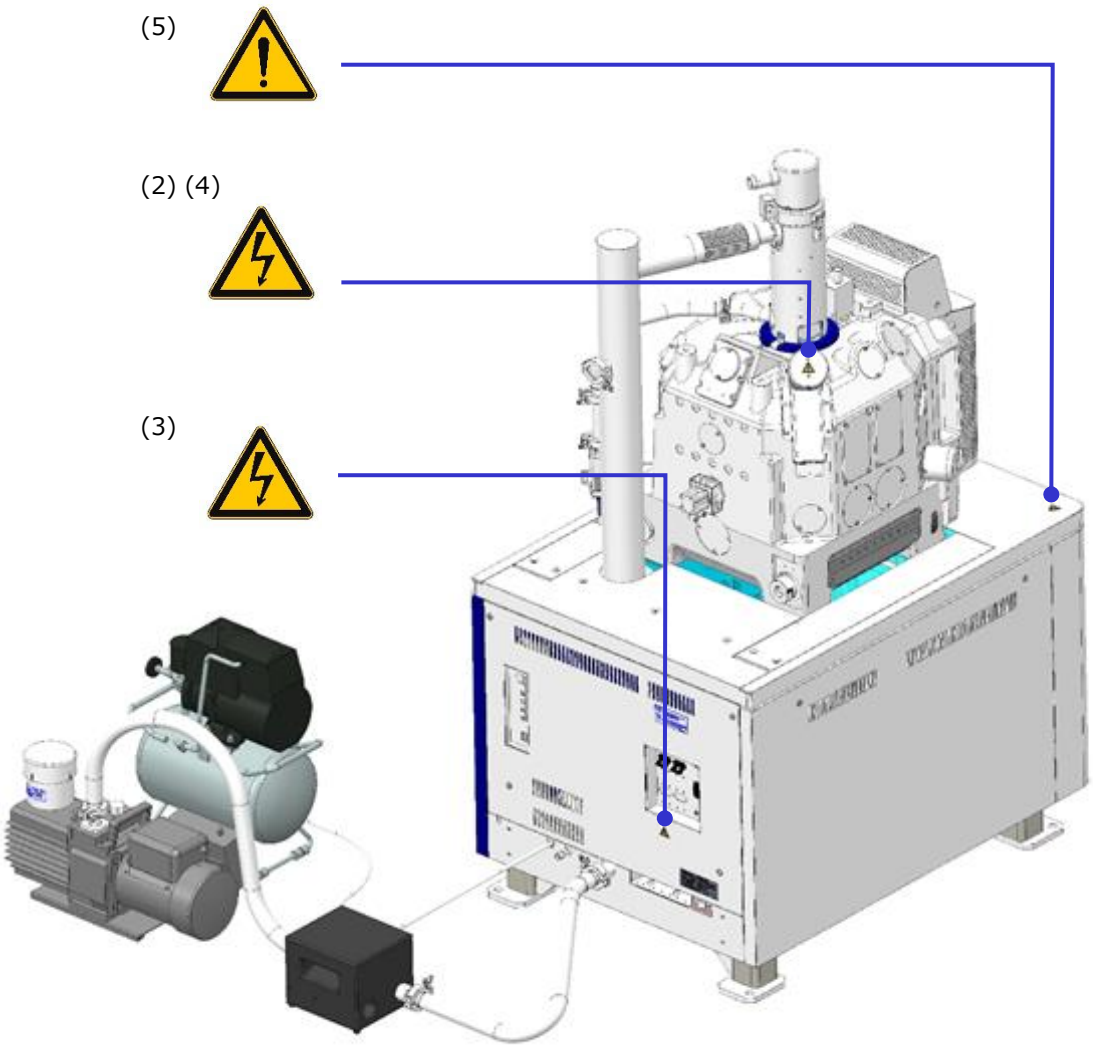
Main Unit (SU3900: Left side view)
Locations of WARNING and CAUTION Labels on Main Unit

Warning and Caution Labels on Instrument (Continued)



Main Unit (SU3800: Rear view)
Locations of WARNING and CAUTION Labels on Main Unit

Warning and Caution Labels on Instrument (Continued)



Main Unit (SU3900: Rear view)
Locations of WARNING and CAUTION Labels on Main Unit

Warning and Caution Labels on Instrument (Continued)

Contents of each labels are described as below.

(1)		Pinch point hazards. Can cause injury. Keep hands clear when opening or closing the stage. P/N 548-6624
(2)		Hazardous Voltage (1,000 V) Can cause death or severe injury. Turn HV off before removing this cover. Only a service engineer is allowed to perform this work. Do not remove the cover. P/N 458-6621
(3)		Hazardous Voltage (AC 100 to 240 V) Can cause death or severe injury. Turn HV off before removing this cover. Only a service engineer is allowed to perform this work. Do not remove the cover. P/N 458-6621
(4)		Hazardous Voltage (10 kV) Can cause death or severe injury. Turn HV off before removing this cover. Only a service engineer is allowed to perform this work. Do not remove the cover. P/N 458-6621
(5)		Caution Can cause injury due to damaging the cover. Do not sit or lean to the cover. P/N 458-6625
(6)		High Temperature (About 90℃) Can cause of burn your hands due to contacting to the filament after the SEM observation. Leave the filament for more than 30 minutes or more after the observation before performing the filament replacement. P/N 458-6622

Other safety guidelines

⚠ CAUTION

- **Power Interruption**

  On occurrence of a power interruption or a momentary power voltage drop due to lightning, etc., the PC of this instrument may become faulty or the system software, application software, or data may be damaged.
  It is recommended to employ an uninterruptible AC power supply unit in consideration of voltage drops.

- **Power Supply**

  Make sure that the power supply for the SU3800/SU3900 is single-phase AC 100 to 240 V, 1.5 kVA (50 or 60 Hz).

  Use a ground terminal having a grounding resistance of 100 Ω or less.
  Additionally, the grounding terminal must not be shared with any other electrical devices. Be sure to ground the instrument independently.

Other Safety Guidelines (Continued)

⚠ CAUTION

- **Other Applications on Computer**

  Never install any application software, other than those that have undergone an operational check by us, into the personal computer of this instrument. Otherwise, an unpredictable screen may be displayed, the instrument may be adversely affected or the instrument system may function abnormally. Malfunction of the system due to installation of any other application software is out of the scope of the warranty.

- **Power supply to personal computer (PC)**

  In case of shutting down the PC or application software forcibly an unsaved data will be deleted.
  Exit all operatable application software before shutting down the PC.

- **Ethernet connection (main unit and PC)**

  The main unit and control PC are connected with Ethernet cable. A port (RJ-45-J interface), which is at the network controller on the board in PC, is used only for the Ethernet. The main unit and control PC are communicating entire time during use. When the network does not connect properly, reduction of communication speed, interruption of communication or interfere with the system operation is occurred. When the main unit and control PC are connected, be sure the followings.
  - The connection of Ethernet cable is only use for the main unit and control PC. (Directly connect the main unit and the PC) Do not use a hub or any network device between the connections.
  - Use the network cable which is based on category 5 (Cat 5) standards.
  - For a company internal network or any local network (LAN) connection, additional network controller is needed. Be sure to separate the main unit port and LAN port.
  - Use the port at the network controller on board in PC which is used for the connection between the main unit and the control PC. In case of using additional network controller, reduction of communication speed or interruption of communication is possibly occurred, especially, using the adapter to convert from USB port to network port.

Other Safety Guidelines (Continued)

⚠ CAUTION

Network Connection

The PC is equipped with an Ethernet port for network connection. Sufficient knowledge on the network environment is required for network connection via Ethernet. Proceed with connection upon consulting the network supervisor.

- Cable connection to the Ethernet port will be performed by an authorized installer or our service representative. Contact our sales or service representative.
- When connecting the PC to a network, be sure to run a computer virus program. For further information, refer to “Protection against Computer Viruses” in this chapter.
- The Ethernet cable is not supplied, so the customer must prepare a suitable one.
- Utmost care should be taken when changing the PC pre-settings for network connection. If the settings required for system operation are changed, the system may fail to operate normally.
- Do not install an unspecified software program for network connection. Otherwise, it may adversely affect the system preventing it from operating normally.
- To connect to a particular network or if you request a connection service, contact our sales or service representative.
- Since the Ethernet port is used in a case where an external device such as an EDX is connected through the optional external communication interface, a hub for branching will have to be prepared for connection to other than the external unit. Consult our sales representative since certain external units are standard-equipped with such a hub.
- Establishing a network connection using the Microsoft-TCP/IP protocol requires an IP address. Secure such an address by consulting the network administrator. Connecting to an external device, such as an EDX, requires another IP address for the device.

About PC Freezing

If the PC freeze (the mouse and the keyboard won’t work) for some reason, on the keyboard press the [Ctrl], [Alt] and [Delete] keys simultaneously, and shut down the system by following the instructions that appears in the dialog box (software resetting). After that, close Windows normally, turn off the main unit, and restart it. If this condition occurs, any data up to that point will be lost. If the PC fails to restart after a software reset operation, verify that the hard disk access indicator light is off, and press the Power button for a long time to turn it off forcibly. Since turning off power when the hard disk is still running can damage the hard disk and disable to PC from starting, this technique should be used only as a last resort.

Other Safety Guidelines (Continued)

⚠ CAUTION

- Protection against Computer Viruses

  If any program/data is damaged suddenly or an unexpected operation/screen is encountered, it may cause lie in the condition that the PC is infected with a computer virus. Computer viruses are malicious programs that sneak into computers to cause misbehavior or damage to data. A software program designed to offer protection against computer viruses is called an anti-virus or vaccine program.

  Computer virus infection may spread via network communication, program downloading, exchangeable storage media such as USB memory, or communication with infected PC. Never use a program or storage media that is suspected to contain a virus.

  In case of using a program or storage media that is suspected to contain a virus, be sure to carry out virus-scanning inspection. However, some kinds of anti-virus programs cannot eradicated particular viruses. It is therefore advisable to periodically save a backup data of hard disk. The use is requested to prepare an anti-virus program and carry out virus removal on the user's own responsibility.

Other Safety Guidelines (Continued)

⚠ CAUTION

- Data Backup

  On occurrence of a system failure or wrong operation, data stored in the PC or hard disk or others may be damaged or destroyed. It is therefore advisable to periodically save important data such as image data from the PC or the hard disk to storage media such as an external hard disk.

- Update program of Windows

  Microsoft periodically distributes a new update program of Windows for increasing the security level or improving the liability. Updating a new program by connecting a PC to network and maintaining the PC at the latest condition are recommended.
  However, functions of PC can be unstable due to the update program or applying the update program. In such a case, uninstall the updated program. It is therefore advisable to periodically save important data such as image data as a backup.

(For Korea only)
(한국대상)

Information about the attached chemical substances
부속화학물질에 관한 정보

The attached chemical substances listed below do not correspond to the standard of classification of the harmful factor under the laws of Korea.
첨부된 아래의 리스트의 화학물질은 산업안전보건법 시행 규칙 별표 11 의 2 제 1 호에 따라 유해인자의 분류기준에 해당하지 않습니다.

Table Chemical substances for SEM/TEM/STEM/FIB,etc.
SEM/TEM/STEM/FIB,etc. 용 화학물질

No.	Part No.	Product Name 품명	Notes 비고	Attached Presence 첨부 유무
1	50E-1991	Vacuum Grease (Electron Grease)		Yes / No 유 / 무
2	539-0454	Vacuum Grease (Electron Grease)		Yes / No 유 / 무
3	539-2132	Vacuum Grease (Electron Grease)		Yes / No 유 / 무
4	757-2859	Fomblin YVAC3 Grease		Yes / No 유 / 무
5	585-4267	Fomblin YVAC3 Grease		Yes / No 유 / 무
6	G465016	Fomblin YVAC3 Grease		Yes / No 유 / 무
7	575-0399	Barrierta Grease		Yes / No 유 / 무
8	536-9850	Barrierta Grease		Yes / No 유 / 무
9	575-1587	Barrierta Super IS/V		Yes / No 유 / 무
10	01E-4385	Demnum S-65		Yes / No 유 / 무
11	420-1255	Oil Compound KS-64		Yes / No 유 / 무
12	754-4603	Silicon Oil SH 200		Yes / No 유 / 무
13	872-0165	Apiezon Grease		Yes / No 유 / 무
14	G465003	Apiezon Grease		Yes / No 유 / 무
15	01E-5707	FD-20		Yes / No 유 / 무
16	G465055	KDL Grease		Yes / No 유 / 무

PREFACE

IMPORTANT

⚠ GENERAL SAFETY GUIDE

1. Specification and installation requirements

2. Function

3. Operation

4. Maintenance

5. Replacement parts

Appendix

1. Specification and installation requirements

This chapter describes the specifications and installation requirement of the Model SU3800/SU3900.

1.1 Specifications

1.1.1 Resolution

Secondary electron image resolution
: 3.0 nm (30 kV accelerating voltage, WD* = 5 mm, High vacuum mode)
: 15.0 nm (1 kV accelerating voltage, WD* = 5 mm, High vacuum mode)
Back scattered electron image resolution
: 4.0 nm (30 kV accelerating voltage, WD* = 5 mm, Variable pressure mode)
* WD (Working Distance)

1.1.2 Magnification

Photo Magnification : ×5 to ×300,000
(The lowest magnification depends on WD and scan speed)

1.1.3 Electron optics system

(1)	Electron source:	Pre-centered cartridge type tungsten hairpin filament
(2)	Accelerating voltage (Vacc):	0.3 to 30 kV
(3)	Gun bias:	Self-bias + Continuous change of Fixed bias
(4)	Beam alignment:	Electromagnetic two-stage deflection (Common use with blanking while image is in the freeze condition)
(5)	Lens system:	3-stage electromagnetic lens reduction optical system
(6)	Objective aperture:	Objective aperture (Four-hole are available and it is changeable from the atmospheric condition 20, 40, 80, 150 μm)
(7)	Astigmatism correcting unit:	Electromagnetic 8-pole method (X, Y)
(8)	Scanning coil:	Two-stage electromagnetic deflection method
(9)	Electrical shifting of field of view (Image shift):	±75 μm (WD = 10 mm)
(10)	X-ray analysis position:	WD = 10 mm
(11)	Detectors:	SE detector (Second electron detector) (Standard) BSE detector (Back scattered electron detector) (Standard) UVD detector (Ultra Variable-Pressure Detector) (Option)

EDS detector (Energy dispersive x-ray analyzer (External option)
Electron backscatter diffraction detector (EBSD) (External option)

NOTE: The amount of image shift is varied depending on WD.

1.1.4 Specimen stage

(1) Drive method: 5-axis motor drive
(2) Movable range (SU3800): X-axis 0 to 100 mm
Y-axis 0 to 50 mm
Z-axis 5 to 65 mm
R-axis (Rotation) 360° continuous
T-axis (Tilt) -20° to +90°
Movable range (SU3900): X-axis 0 to 150 mm
Y-axis 0 to 150 mm
Z-axis (WD) 5 to 85 mm
R-axis (Rotation) 360° continuous
T-axis (Tilt) -20° to +90°
(3) All area observation specimen size:
(SU3800) 127 mm diameter,
(SU3900) 203 mm diameter
(4) Maximum specimen size: (SU3800) 200 mm diameter,
(SU3900) 300 mm diameter
(5) Maximum specimen height: (SU3800) 80 mm
(SU3900) 130 mm
(The Minimum WD is 10 mm when mounting the above specimen)
(6) Maximum specimen weight: (SU3800) 2 kg
(SU3900) 5 kg (only X/Y-axes are available)
(7) Specimen exchange : Draw out method (Standard)
Load lock method (Option)

NOTE: The specimen stub is not included in the maximum height and weight of the specimen.

NOTE: For the load lock method (option), maximum specimen size, maximum specimen height and maximum specimen weight are different from the draw out method.

1.1.5 Image display

(1) Display method
Display the paused image on the PC (All scanning speed)
(2) Monitor for observing
23 inch 16:9 wide LCD
(Display pixels: 1,920 × 1,080)
(3) Image display mode
Large display mode: 1,280 × 960 pixels
2 display mode: 640 × 480 pixels
(4) Scanning mode
Fast scan
Slow scan
Reduce scan
High definition capture
Integration capture
Charge up suppression scan (CS scan)
(5) Capture mode
High definition capture
Frame integration capture
CSS capture
(6) Scanning mode
Fast scan: Fast (1 type)
Slow scan: Slow 1 to Slow 6 (6 types)
SC scan: CSS1 to CSS 6 (6 types)
Reduce scan: Reduce 1 and 3 (2 types)
(7) Auto tuning functions
Auto Brightness & Contrast Control（ABCC）
Auto Focus Control（AFC）
Auto Astigmatism correction & Auto Focus Control (ASF)
Auto Filament Saturation (AFS)
Auto Beam Alignment (ABA)
Auto start
Auto beam adjustment
Auto optical axis alignment
Auto beam brightness
Intelligent Filament Technology (IFT, Extend the filament life-time due to auto filemant control)
(8) Signal/image processing functions
Signal mixing function
BSE image recovery function
Live Image Processing function (Gamma, Tone curve and brightness adjustment)
(9) Image data saving
Size of saving image: 640 × 480, 1,280 × 960, 2,560 × 1,920, 5,120 × 3,840
File format: BMP, TIFF, JPEG

(10) Saving image data management:　SEM Date Manager (Option)
(11) Auto data display
Comment, auto increment No., Accelerating voltage, WD value, detector name, magnification, date, time, micron marker, data display with image, Black the background, Translucence
(12) Data input
Text, number and mark can input on the image by keyboard operation.
In addition, circle, rectangle, arrow mark, dimension, dimension line can draw on the image by the mouse operation.
(13) Signal output　:　NTSC monochrome signal (BNC)

1.1.6 Vacuum system

(1)	Method:	Fully automatic pneumatic-valve system
(2)	Vacuum gauge:	Pirani gauge
(3)	Ultimate vacuum status:	1.5×10−3 Pa or less
(4)	Vacuum setting range:	6 to 650Pa (26 steps)
(5)	Vacuum pump:	Turbo molecular pump (TMP) 260L/s 1 unit Rotary pump (RP) 1 unit Only the Rotary pump of the following recommended specification can be used. Recommended specification: 135L/min (50Hz), 162L/min (60Hz)
(6)	Air compressor:	1 unit (Option) Only the air compressor which pressure range is 0.34 to 0.49 MPa can be used.

1.1.7 Protections

Protections for power interruption, water outrage, electric leakage and decreasing the vacuum condition are equipped.

1.1.8 Size and weight

Size and weight	(Width)	× (Depth)	× (Height)	(Mass)
Main unit (SU3800)	780 (W)	×1,060 (D)	× 1,530 (H)	: 520 kg
Main unit (SU3900)	780 (W)	×1,060 (D)	× 1,620 (H)	: 780 kg
Rotary pump (Recommended)	526 (W)	× 225 (D)	× 306 (H)	: 28 kg
Air compressor (Recommended)	400 (W)	× 225 (D)	× 550 (H)	: 18 kg
Weight	160 (W)	× 200 (D)	× 134 (H)	: 26 kg
Table (Recommended)	1,200 (W)	× 700 (D)	× 630 to 1290 (H)	: 34 kg
				(Unit: mm)

NOTE: The cables are not included.

1.1.9 Other functions

Raster roataion
Dynamic focus/Tilt compensation
Image improvement function
Overlay function
IPI (which transfers an image to Image Pro)
DBC interface (Standard)
Preset magnification
Stage position navigation fucntion (SEM MAP)
Beam marking function
Report function

1.2 Installation requirement

1.2.1 General

The sites and conditions mentioned below must be avoided.

(1) Room located in the vicinity of transformer substation
(2) Room located in the vicinity of elevator
(3) Location near electric equipment consuming high power (e.g., electric furnace) or it power supply
(4) Location near spark discharge or high-frequency apparatus
(5) Room filled with gas which corrodes metals
(6) Place exposed to direct sunlight or strong draft
(7) Dusty place
(8) Location subjected to severe vibrations
(9) Using ground wire in common with other electric equipment
(10) Location adjacent to radio or sound wave source
(11) Windy place
(12) Location near railway

1.2.2 Ambient conditions

(1) Room temperature: 15℃ to 30℃
Temperature fluctuation should be 5.0℃ or less during operation of the instrument.
(2) Humidity: 60%RH or less
The instrument should be operated in an air-conditioned room. (Without condensation)
(3) Altitude: 2,000 m or less

NOTE:
- Only gradual temperature changes are allowed. Sudden fluctuations are not tolerated. For high-magnification observation, choose an environment that is not subject to extensive temperature change.
- In case wind such as the air conditioning directly hits an instrument, image disturbance due to temperature change can be occurred. Avoid the airflow when capturing a high resolution SEM image.
- If an instrument is installed on a high altitude place, contact to our service representative of Hitachi High-Tech Corporation.

1.2.3 Power supply

(1) Single phase AC 100 V to 240V, 1.5kVA, 50/60 Hz (Main unit)
The power supply shall be continuously on. The fluctuation of voltage 90 V to 250 V is acceptable.

NOTE: Only power supply voltage change that is time-wise gradual is tolerated; sudden fluctuations must be avoided.

(2) The maximum distance from the main unit to the switchboard on the wall is 5 m. (The length of the input AC cable is 5 m)
(3) The tip of connector for the AC cable is M5 3-line crimp terminal.
(4) Make sure to provide an exclusive open and close device (The device shall be installed into the switchboard by customer).

1.2.4 Ground terminal

The grounding wire must be connected to the ground in a condition with a maximum grounding resistance of 100Ω. Any grounding terminal used should not be shared with other pieces of electrical equipment and should be grounded on an exclusive basis (sharing can potentially cause image distortion and system malfunction).

NOTE: If the grounding terminal shares with other pieces of electrical equipment, it can cause of image disturbance or failure of instrument.

⚠ CAUTION: Electric shock due to improper grounding
Insufficient grounding of the instrument can cause not only incorrect operation but also lead to electric shock. Do not touch the grounding wire. The grounding wire to the instrument shall be carried out by our service representative.

1.2.5 Compressed air

Set the pressure range from 0.4 to 0.5 MPa (Gauge) when using compressed air supplied within the facility instead of using an air compressor. Since any entrained water or oil may lead to erosion of an electromagnetic solenoid valve or an air valve, locate an appropriate filter.

1.2.6 Stray magnetic field

Image disturbance will be negligible when the stray magnetic field conditions shown in Table 1-2-1 and 1-2-2 are satisfied at the instrument installation place. Before proceeding to installation, check the stray magnetic field conditions as required. Make sure that the conditions shown in the tables are satisfied.
If there is large-sized, magnet clutch or power cable for other equipment in the vicinity of this instrument, abrupt variation in current or magnetic field may take place. Avoid installing the instrument in such a location. If the instrument is installed in an environment having intense stray magnetic fields, the scanning electron beam is forced to tremble due to the magnetic fields, causing abnormal expansion, shrinkage, distortion, unintentional shift, or whisker noise during imaging.
Because a scanning mode in synchronization with the power supply is normally used for the recording of SEM image, the tolerance of the system with respect to stray magnetic fields is defined based on the impact of stray magnetic fields on system performance in a power supply-synchronized scanning mode. In a power supply-synchronized scanning mode, the way in which image distortion appears can vary depending on whether stray magnetic field components are in or out of synch with the power supply frequency. Image distortions due to power-synchronous stray magnetic field (AC magnetic field) normally take the form of gradual image distortion, expansion, or shrinkage, whereas image distortions due to a power-asynchronous stray magnetic field (DC magnetic field fluctuations) appear in the form of image shifting or whisker noise. Also, if the DC components of the stray magnetic field (DC magnetic field) change gradually as a function of time, the problem occurs as if the image was flowing. For this reason, the system tolerance with respect to the stray magnetic field of power frequency components, that with respect to power supply asynchronous components, and that with respect to time-wise change (drift) can vary.
Given below are the allowable values stipulated under the resolution guaranteeing conditions (high resolution observation condition), and under conditions different from these. Image disturbance may occur even if the stray magnetic field at the site satisfies the allowable values give in Tables below.
In general, the effect of a stray magnetic field (waving of scanning electron beam) is inversely proportional to the square root of the accelerating voltage, and nearly proportional to the working distance.

Allowable stray magnetic field (SU3800)

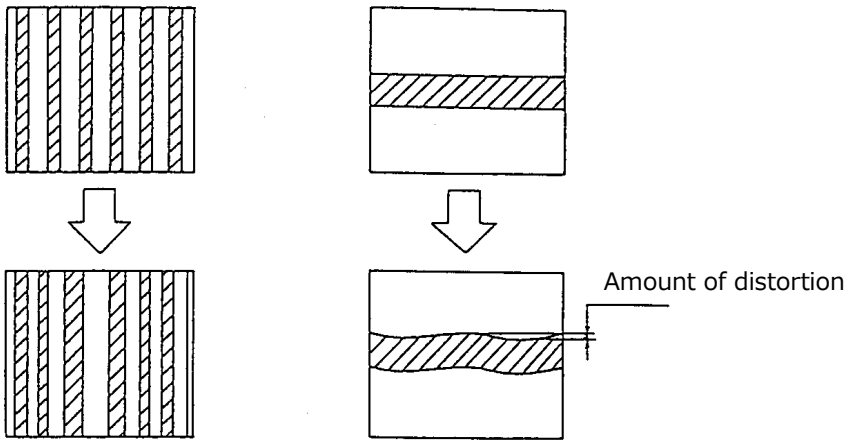
	Accelerating voltage	Working distance	Magnification	AC magnetic field (rms value)	DC magnetic field variation (peak to peak)
Allowable value	1 kV	5.0 mm	x 20,000	180 nT (horizontal) 250 nT (vertical)	210 nT (horizontal) 280 nT (vertical)
	30 kV	5.0 mm	x100,000	180 nT (horizontal) 380 nT (vertical)	200 nT (horizontal) 430 nT (vertical)

nT [Nanotesla]

Allowable stray magnetic field (SU3900)

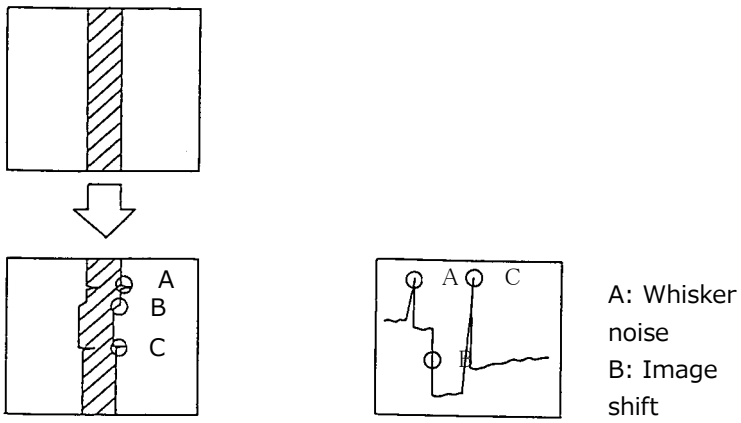
	Accelerating voltage	Working distance	Magnification	AC magnetic field (rms value)	DC magnetic field variation (peak to peak)
Allowable value	1 kV	5.0 mm	x20,000	150 nT (horizontal) 260 nT (vertical)	160 nT (horizontal) 300 nT (vertical)
	30 kV	5.0 mm	x100,000	200 nT (horizontal) 550 nT (vertical)	220 nT (horizontal) 650 nT (vertical)

nT [Nanotesla]



(a) Image expansion/contraction (b) Image distortion

Effect of Stray Magnetic Field Componenet Synchronous with Power Frequency (AC amgnetic field)



(a) Appearance of image disturbance (b) DC magnetic field variation

Effect of Stray magnetic Field Component Asynchronous with Power Frequency (DC magnetic field variation)

NOTE:
- The power frequency synchronous component (AC magnetic field) is in rms value. To evaluate in peak-to-peak value, the allowable value will be 2.8 times the rms value.
- The DC magnetic field fluctuation stands for a rapid change in stray magnetic field with time lapse. A gradual and moderate change with time lapse is handled as a temporal change (draft). Change of stray magnetic fluctuation (drift) indicate the differences maximum and minimum values for the gradual change (for one minutes) of magnetic field of selected time (for one minute). Allowable DC magnetic field is the value when the wave of image due to stray magnetic field is 0.2 mm under the specified condition (Capture time: 80 seconds).
  The allowable AC magnetic field is the value at the prescribed image disturbance (expansion/contraction or bending of image) of 0.5 mm and at the specified magnification.
- The allowable DC magnetic field variation is the value at the prescribed image disturbance (Image shift or whisker noise) of 0.2 mm and at the specified magnification.
- The DC component of stray magnetic field without fluctuation does not cause swaying of the electron beam, and will not affect the image if the amount is around several ten μT.
- The allowable values in Tables are the ones under the resolution guaranteeing conditions. In general, the longer the WD or the lower the accelerating voltage, the more the electron beam is susceptible to stray magnetic field effect.
- If the allowable values in Tables are exceeded, the stray magnetic field must be reduced by one of the countermeasures below:
  ・Try a different installation location
  ・Provide a magnetic shielding box
  ・Provide an active magnetic field canceller

1.2.7 Vibration

The floor vibration of the installation site should be measured prior to installing the SU3800/SU3900. When the measured values are satisfied the following Tables, no image trouble will occur. When the instrument is installed on the location in a reinforced concrete or steel frame building and satisfies the table value, generally effect of vibration will be minimized.

- No vibration source such as large mechanical tools in vicinity
- No vibration source such as public transportation (such as train)
- Installation location is not the first floor

Allowable vibration (SU3800)

Allowable value (Low frequency)		
Frequency	X, Y	Z
2.0 Hz	1.5 μmp-p or less	10.0 μmp-p or less
3.0 Hz	1.6 μmp-p or less	5.0 μmp-p or less
5.0 Hz	3.0 μmp-p or less	2.0 μmp-p or less
8.0 Hz	2.0 μmp-p or less	1.5 μmp-p or less
10.0 Hz	1.3 μmp-p or less	3.0 μmp-p or less

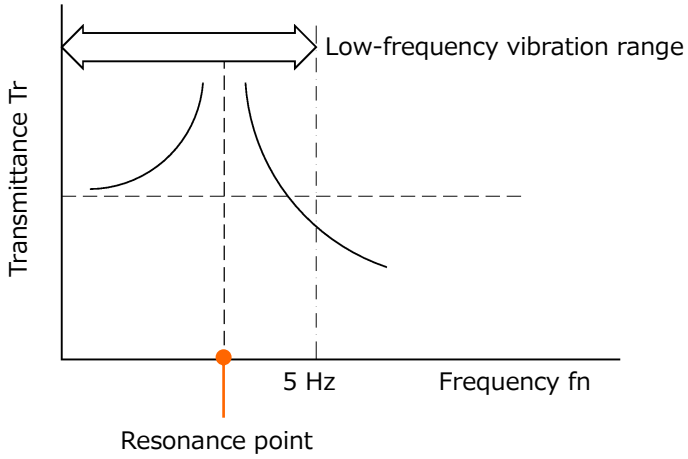
Allowable vibration (SU3900)

Allowable value (Low frequency)		
Frequency	X, Y	Z
2.0 Hz	1.5 μmp-p or less	12.0 μmp-p or less
3.0 Hz	3.0 μmp-p or less	8.0 μmp-p or less
5.0 Hz	2.5 μmp-p or less	1.0 μmp-p or less
8.0 Hz	2.5 μmp-p or less	1.0 μmp-p or less
10.0 Hz	5.5 μmp-p or less	2.0 μmp-p or less

The allowable amplitude is determined so that image deviation will not exceed 0.2 mm on a micrograph taken at a magnification of x100,000.
Figure shows the relation between the frequency of floor vibration and the vibration transmittance of the instrument. The vibration transmittance is maximum at the resonance point (approximately 1.6 Hz) of the anti-vibration mount incorporated in the instrument. Therefore, the allowable amplitude is minimum at this point.

NOTE:
- A sine wave should be used for vibration measurement. If other than a sine wave, measurement should be made with each frequency components concentrated a t a dominant frequency level.
- For the ultra-low frequency vibration of less than 1 Hz sufficient vibration dampening cannot be attained with the technology available today.
- The 1 Hz to 10 Hz area is interpolated with the direct lines that tie the tolerance values.

- The above-mentioned allowable vibration is measured with a 5 mm of specimen size. The larger specimen, the more susceptible to the effect of vibration and the lower the allowable amplitude.
- Contact a Hitachi High-Tech Corporation in case of assuming the vibration that exceed the allowable vibration. (In case of assuming the vibration problems, measure the vibration prior to installing the instrument)



Frequency of floor vibration and vibration transmittance

1.2.8 Power line noise and electric field noise

Image trouble will occur when such equipment as given in Table or its power line is installed nearby or, even if distant from the instrument, it is a heavy-duty type. To determine where to install the system, therefore, check for any source of interference noise to prevent such image troubles.

In case equipment energized by power of a frequency different from the commercial frequency employed on the SU3800/SU3900 or the power line for it is located nearby, scan synchronization with power frequency will become ineffective. Such a location should be avoided.

External Noise Sources

Classification		Noise Source	Source Equipment
Small-sized electric equipment (general/home electrical appliance)	Electric equipment having contacts	Electric discharge (spark, arc)	Flasher (neon sign, ornamental electric bulb), relay, electromagnetic contactor, thermostat (warmer, heater, refrigerator, iron), cash register
	Equipment utilizing commutator motor	Electric discharge (spark, arc) sliding contact	Electric drill, dental engine, motor for sewing machine, vacuum cleaner, electric food mixer, electric shaver, electric massager
	Electric discharge tube	Glow discharge	Neon discharge tube, high-pressure mercury arc lamp
	Controller using semiconductor	Phase controller (transient noise)	Thyristor dimmer, inverter
Glow discharge	High-frequency industrial equipment	Unnecessary radiation*	High-frequency industrial heater, high-frequency electric welder, microwave oven
	High-frequency medical equipment	Unnecessary radiation*	VHF/UHF fulgurates, electric scalpel
	Equipment utilizing ultrasonic wave	Unnecessary radiation*	Flaw detector, depth sounder, fish-finder, ultrasonic cleaner
Power equipment	Power cable (transmission/distribution line)	High voltage, large current	Induction of commercial frequency (electrostatic induction, electromagnetic induction, current leaking in ground)
		Electric discharge (corona, arc)	Corona, poor insulator, poor contact due to corroded metal (arc discharge)
	Electric railroad/train	Electric discharge (spark, arc)	Trolley wire, internal equipment, rectifier
		Reflection	From car body
Internal combustion engine	Automobile	Electric discharge	Ignition system
		Others	Dynamo, voltage regulator, wiper, horn, winker
Wireless communication equipment	Large-power transmission equipment	Signal emission*	Broadcasting equipment, radar
		Unnecessary emission	High-frequency transmitter

* Signal that is required in the relevant system but can become a disturbance for other systems.

1.2.9 Disturbance by sound waves

Sound waves (vibrations of air) will adversely affect the instrument regardless of whether their frequency is high or low, causing image trouble. To prevent this, confirm before installation that no sonic disturbance source is located nearby.

If there is any sonic disturbance source in the vicinity of the instrument, then check for noise level. The influence of noise on SEM images differs depending on its frequency. Table shows the relation between the frequency and allowable sound pressure level (C-characteristic) at the installation site for the SU3800/SU3900.

In general, the sound pressure level decreases as the noise frequency increases, and the noise frequency varies depending on the sonic disturbance source. It is therefore necessary to carry out noise frequency analysis at the installation site to determine the effect of noise (at practical magnification) in each case. In case the noise frequency coincides with the resonance frequency of the instrument, image trouble may occur at 58 dB or more even when the frequency is 150 Hz or less.

Allowable sound pressure level (C-characteristic): SU3800/SU3900

Frequency : f (Hz)	Allowable noise level
f≦ 150	75 dB or less
150≦f≦ 800	65 dB or less
800≦f≦2,000	54 dB or less

NOTE: The representative value at the noise level where this instrument is generated in recorded below under the normal operating position, without buzzer sound and no other noise except the instruments' is described below.

Normal operation : 42 dB

Pump air : 50dB

Air compressor operation : 57 to 60 dB (Use an optional compressor)

1.2.10 Caution on disturbance by electromagnetic wave

Although this instrument does not intentionally produce electromagnetic waves, such waves are slightly emitted from electronic circuitry in the instrument. Equipment that may be adversely affected by electromagnetic noise therefore must not be installed near the instrument. Besides, this instrument may incur image disturbance and malfunction upon receiving external electromagnetic noise. The room in which this instrument has been installed must be controlled so that the following electric apparatus* will not be brought into the room.

* Apparatus that emits radio waves such as specific low-power equipment including cellular phones, transceivers and cordless phones.

The following is a statement of notice about EMC for EU area.
This instrument has suited class A of EN standard EN61326-1 (2013). Do not set up this instrument near the equipment that is influenced data by the electromagnetic radiation noise in this standard allowance value.

The following is a statement of notice about EMC for Korea.
A 급 기기 (산업, 과학용기재)
이 기기는 업무용(A 급)으로 전자파적합등록을 한 기기오니 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

1.2.11 Calorific value

The calorific value of equipment may be required for air-conditioning design of the SEM installation room.
This value can be calculated from the power consumption P [kW] of equipment by the following equation.

Calorific value [kcal/h] = 0.24 × P × 3,600

The SU3800/SU3900 have the following power consumption and calorific value.

Power consumption: 1.5 [kW]
Calorific value: 1,296 [kcal/h]

NOTE: When additional equipment such as EDS is installed, its calorific value should be calculated by the above formula and added to that of this instrument.

1.2.12 Site requirement

(1) Space required

A room of about 2.6 × 2.4 m is required.

(2) Dimensions of entrance

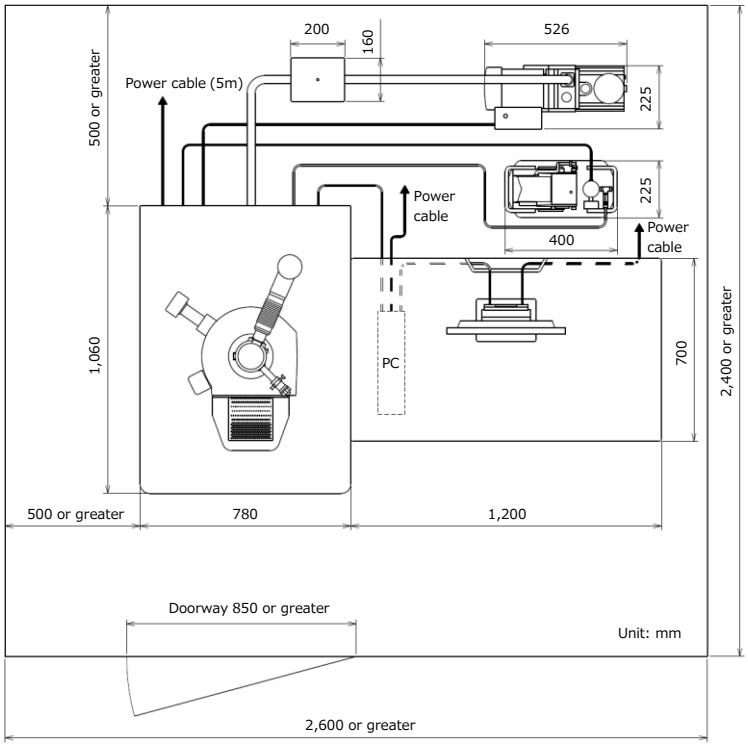
0.85 m (W) × 1.7 m (H) or more

(3) Durability of floor

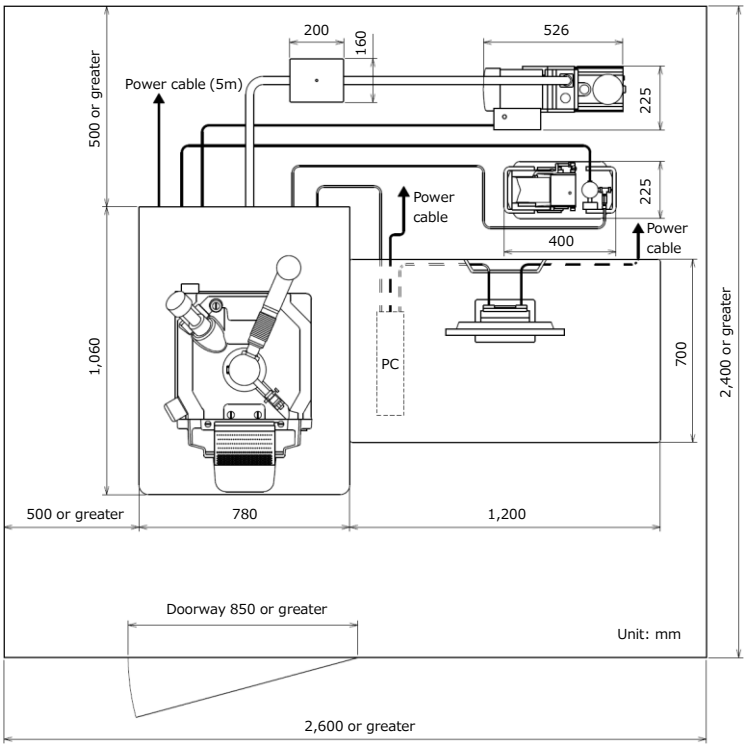
Floor strength (N/m^2) / 3 ≥ quantity of all facilities (kg) × 9.8 / floor area (m^2)

(4) Others

See following Figure for system layout.



Layout (SU3800)



Layout (SU3900)

⚠ WARNING: The main units (SU3800:520 kg, SU3900: 780 kg) are heavy objects. It can cause of injury by trumbling the heavy object due to earthquake or other. Recommended to use fixing tools after installation of the instrument. Relocation of the instrument is carried out by our service engineers only and the customer is not allowed to perform the relocation of the instrument.

⚠ WARNING: The weight weighs about 26 kg.
Careless lifting of this unit could result in injury. Lifting should be carried out by two persons or by using a forklift or the like.
The weight must be moved by a service engineer trained and certified by Hitachi High-Tech Corporation only. The customer should not attempt relocation.

⚠ CAUTION: Can cause injury due to damaging the cover of the main unit.
Do not sit or lean to the cover.

NOTE: A maintenance space of 500 mm or more is required at the left of the main unit.

1.3 Customer-supplied items

Prepare the items as shown in the following table prior to the installation.

Customer-supplied items

Product Name	Quantity	Note
Ethanol	500 mL	Cleaning/ultrasonic-cleaning of parts
Polyethylene gloves	1 box	Handling the vacuuming parts
Specimen vapor deposition system	1 set	Metal vapor deposition on specimen surfaces/aperture vacuum baking (cleaning)
Ion sputtering system	1 set	Specimen metal coating
Tungsten basket	1 piece	Vapor deposition equipment filaments
Gold wire	1 piece	Specimen vapor deposition target
Ultrasonic cleaning system	1 set	Cleaning of components
Aluminum foil	1 piece	Storing cleaned components
Desiccator or a dry storage box	1 unit	The storage of specimen and filaments
Optical microscope	1unit	Verifying specimens
Conducting two-side tape	1 roll	Fixing large specimens/for quick fixing (for low magnification)
Conducting bonding agent (paste)	20 g	Fixing specimens (for high magnification)
Bond	1 piece	Fixing wet specimens
Tweezer	1 set	Handling specimens and parts
Blower	1 piece	Cleaning of parts
Polishing paste	1 box	Cleaning of parts

*The following products are recommended.

- Polishing paste: PIKAL(paste), NIHON MARYO KOGYO Co., Ltd.

2. Function

This chapter describes the hardware configuration and software of the Model SU3800/SU3900 Scanning electron microscope.
The following Figure shows the external view of SU3800 and SU3900.

External view of SU3800

External view of SU3900

2.1 Parts name

2.1.1 External view of main unit

Figure shows the external view of the main unit (Front and Top of the specimen chamber).

SU3800 SU3900

External view (Front)

External view (Top of the specimen chamber)

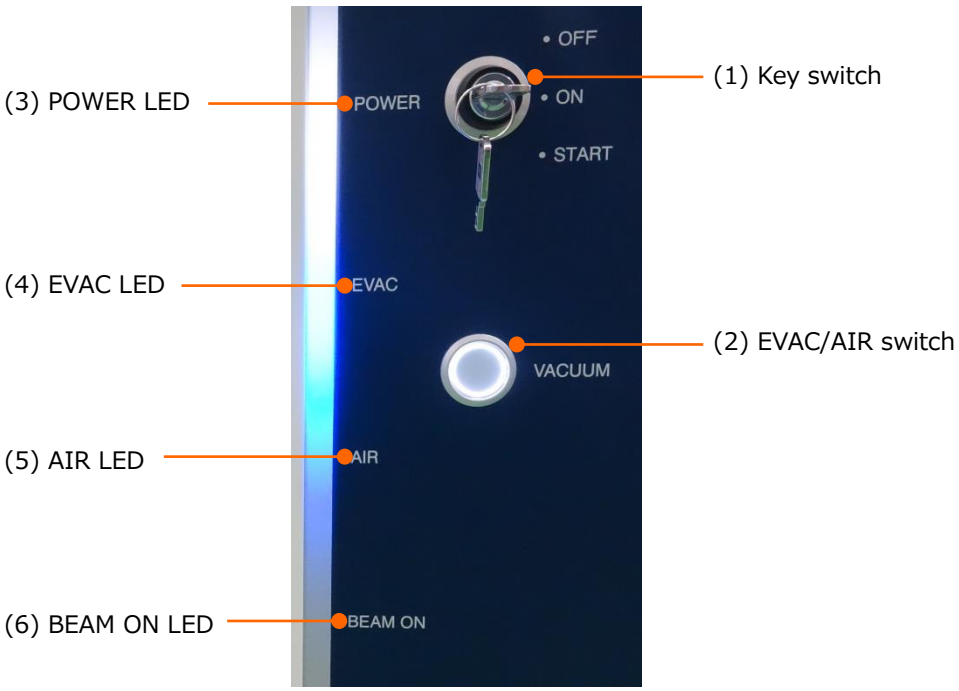
(1) LED panel
Indicate the power and specimen chamber conditions.

(2) Objective aperture
Switch the aperture by rotating the dial for adjusting the current, which applies to the specimen.

(3) BSE detector insertion mechanism
Insert or extract the BSE detector. BSE detector is inserted by rotating the knob to clockwise and the BSE detector is extracted by rotating the knob to counterclockwise.
The present status of BSE detector can be confirmed by the LED. When the detector is inserted, OUT LED is ON and when the detector is extracted, OUT LED is ON. When the detector is in the middle, the both LEDs will be blinking.

2.1.2 LED panel

Figure shows the LED panel.



(1) Key switch: Power ON the instrument by rotating the key until START position. The key will be stopped at the ON position. Power OFF the instrument by rotating the key to the previous position.

(2) EVAC/AIR switch: Switch between EVAC (pump air) Air (vent air) conditions by pressing the button. Normally, select the EVAC or Air by the operation program.

(3) POWER LED: The Power of the instrument. The white LED will be ON by powering ON the instrument.

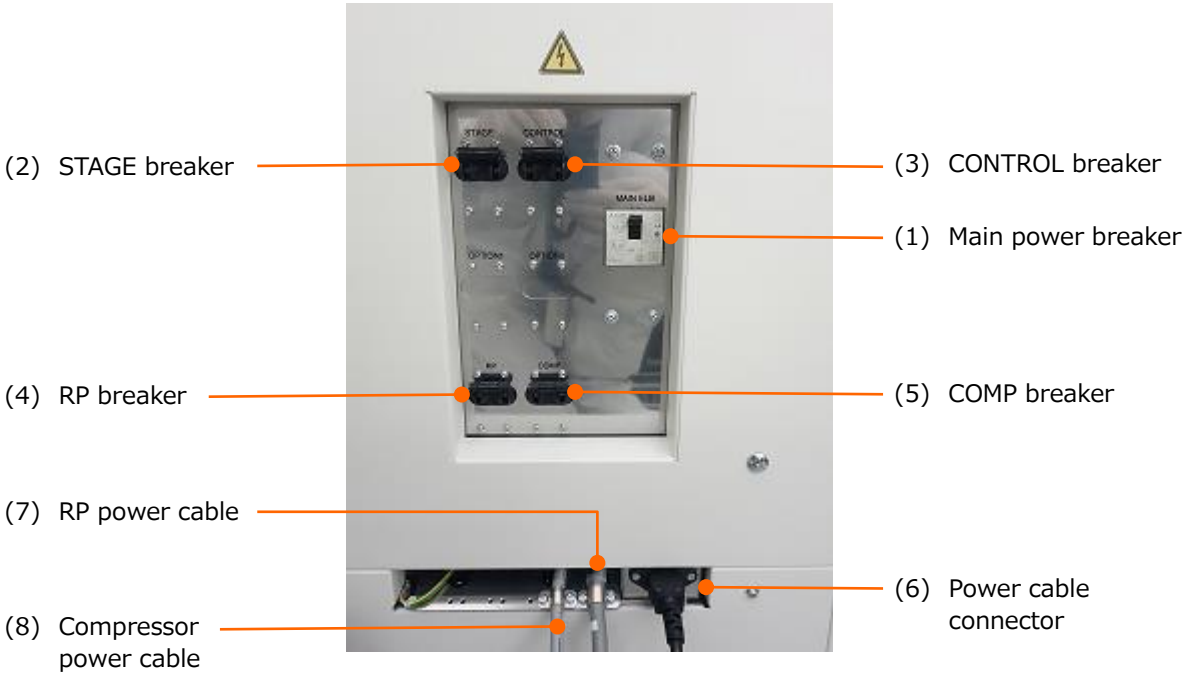
(4) EVAC LED: Specimen chamber condition LED. The LED is lit in blue color when the specimen chamber is in the vacuum condition and the LED is blinking while pumping air from the specimen chamber.

(5) AIR LED: Specimen chamber condition LED. The LED is lit in orange color when the specimen chamber is in the atmospheric condition and the LED is blinking while venting air from the specimen chamber.

(6) BEAM ON LED: This LED indicates the specimen chamber condition. The LED is lit in green color when the specimen chamber is in the atmospheric condition and the LED is blinking while venting air to the specimen chamber. In addition, the LED color will be changed according to the condition of specimen chamber.

2.1.3 Switchboard

Figure shows the switchboard (At the rear side of the main unit).



Switch board (Rear side of the main unit)

(1) Main power breaker: The breaker for the Main power. Power ON the breaker for starting up the instrument and power OFF the breaker for shutting down the instrument.

(2) STAGE breaker: The breaker for the stage power. Power ON the breaker for the normal use. Power OFF the breaker when shutting down the instrument completely.

(3) CONTROL breaker: The breaker for the instrument control power. Power ON the breaker for the normal use. Power OFF the breaker when shutting down the instrument completely.

(4) RP breaker: The breaker for the rotary pump power. Power ON the breaker for the normal use. Power OFF the breaker when shutting down the instrument completely.

(5) COMP breaker: The breaker for the compressor power. Power ON the breaker for the normal use. Power OFF the breaker when shutting down the instrument completely. (Only when an optional compressor is used.)

(6) Power cable connector: The connector for connecting the power cable of the instrument.

(7) RP power cable: Power cable of the rotary pump.

(8) Compressor power cable: Power cable of the compressor. (Only when optional compressor is used.)

2.2 Input device

2.2.1 Trackball (Option)

(1) Trackball: Move the field of view to the same direction of rotating the ball. The direction can be reversed.

(2) Direction switch: Turn the switch to the X side. The field of view moves to the horizontal direction (X) only by rotating the trackball.
Turn the switch to the Y side. The field of view moves to the vertical direction (Y) only by rotating the trackball.
When set the switch in the middle, the field of view moves to the direction of rotating the ball.

2.2.2 Joystick (Option)

The external view of Joystick.

The Joystick is available as an option. The Joystick operations is same as the Trackball except the X, Y switch.
If both the Trackball and Joystick are equipped, the both devices can be used simultaneously.

2.2.3 Manual operation panel (Option)

The external view of Manual operation panel.

(2) Image shift operation area (5) Function operation area (4) Image adjustment area

(1) Magnification operation area (3) Astigmatism correction and axis alignment area (6) Focus adjustment area

(1) Magnification operation area

MAGNIFICATION knob: Change the magnification. Increase the magnification by rotating the knob clockwise.

LOW MAG button: Set to the lowest magnification under the current observation condition.

(2) Image shift operation area

IMAGE SHIFT X and Y knobs: Move the field of view by the image shift (Move the electron beam position).

(3) Astigmatism correction and axis alignment area

STIGMATOR/ALIGNMENT X and Y knobs:

Perform the astigmatism correction and alignment.
Perform the astigmatism correction while STIGMATOR LED is ON in blue color. When the ALIGNMENT LED is blinking in blue color, alignment can be performed.

MODE button: Activate the [Align] mode. The [Aperture alignment] mode is activated by clicking. The mode can be switched at the each time of clicking the button.

(4) Image adjustment area

CONTRAST knob: Control the image contrast.

BRIGHTNESS knob: Control the image brightness.

AUTO button: Control the brightness and contrast automatically (ABCC).

(5) Function operation area

SCAN1 to SCAN3 buttons:	Select a scan speed. The allocation of the speeds for the each buttons are the same as the three scan buttons on the control panel.
RUN/FREZ button:	Stop/Pause the scanning.
CAPT button:	Capture an image.
DIS1, DIS2 button:	Switch the target for performing the brightness and contrast adjustment under the 2-screen mode.

(6) Focus adjustment area

FOCUS COARSE/FINE knobs:	Adjust the focus of electron beam. Select the COARSE for rough alignment and FINE for fine adjustment. The amount of focusing is linked to the rotating amount of knob so, the higher magnification the more detailed adjustment is enable.
AUTO button:	Execute the Auto focus correction (AFC).

2.3 GUI operation screen

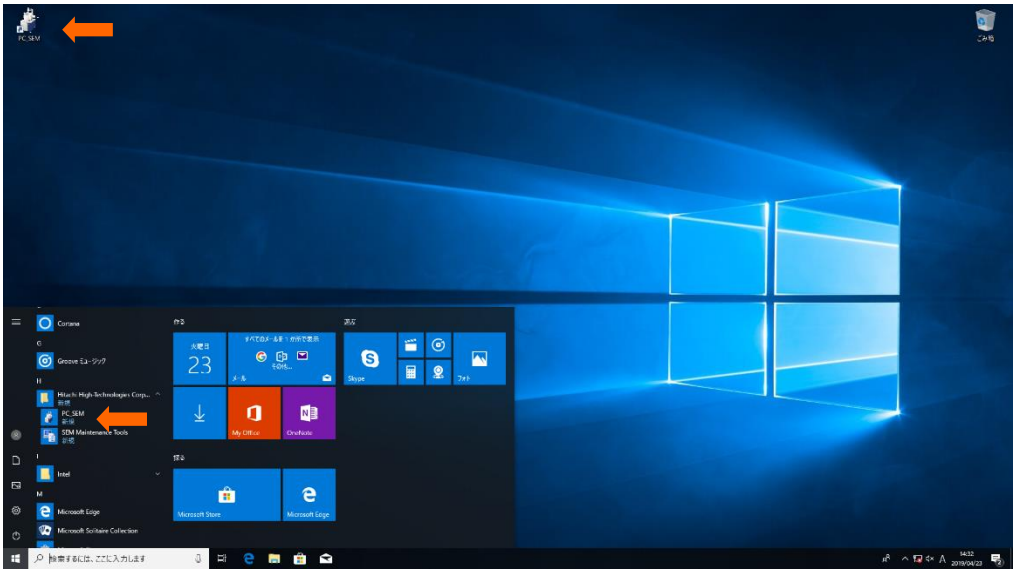
2.3.1 Startup of SU3800/SU3900 operation program

Startup the operation program according to the following procedures.

1. Startup the instrument by turning ON the key switch at the front of the main unit.
2. Startup the PC.
3. Startup the installed operation program of SU3800/SU3900.

   Startup the program by double-clicking the 

icon on the desktop or from the Start menu.

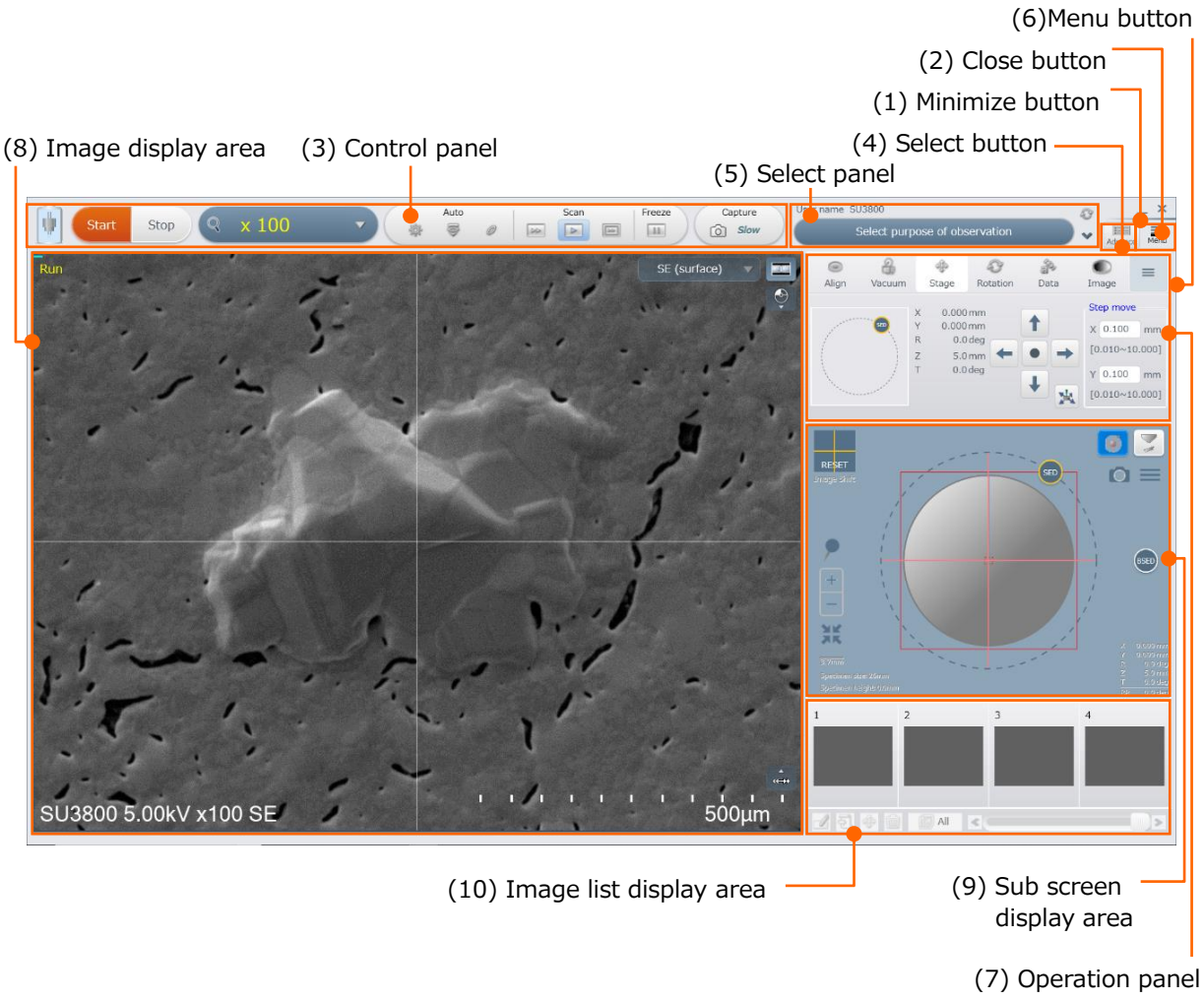


4. Login window is displayed. Enter the user name and password then, click the Start button for starting up the operation program.

When the first time of starting-up the operation program after installation, enter the user name [SU3800 (or SU3900)] and click [Start] button.
Password is not set for the user name of the system administrator. Setting the password by the user is recommended depending on the requirement.
After setting the user name and password and click the [Start] button.
System administrator shall register or delete the user name. The password can be set and change on the [User account] dialog while logging in by each user name.

2.3.2 SU3800/SU3900 main window

Following figure shows the main window for the SU3800/SU3900.

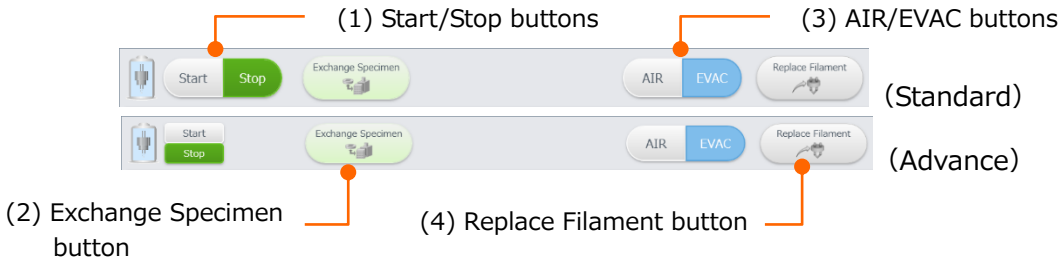


(1) Minimize button
Iconize the present window and place it on the taskbar.
(2) Close button
Exit the operation program.
(3) Control panel
The buttons which operate the main functions for SEM operation are arranged.
(4) Select button
Select a display mode from [Standard] or [Advance] on the control panel.
(5) Select panel
Select an item from the observation purpose, scan speed selection, electron beam status display or setting menu short cut and display the selected item. Refer to the 2.3.4 for details.
(6) Menu button
Select various settings and tool etc. Refer to the 2.3.5 for details.
(7) Operation panel
Customize the display items. Refer to the 2.3.6 for details.
(8) Image display area
Display the observing SEM image. In addition, status, signal select box, mouse operation setting button are arranged. See 2.3.7 for details.
(9) Sub screen display area
Display the images of SEM MAP, the chamber scope (option) and the Stage. See 2.3.8 for details.
(10) Image list display area
Display the thumbnail list of saved or captured images. See 2.3.9 for details.

2.3.3 Control panel

Operation buttons for the image observation and recording are arranged. The operation buttons are different when the beam is ON or OFF.

<When the beam is OFF>

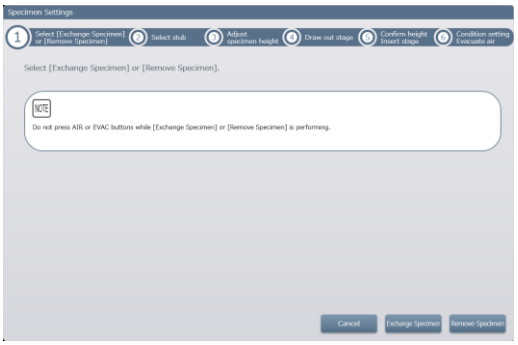


(1) Start/Stop buttons

Beam is ON and start the observation by clicking the [Start] button.

(2) Exchange Specimen button

Click the [Exchange Specimen] button while exchanging the specimen. Exchange a specimen according to the dialog instructions.

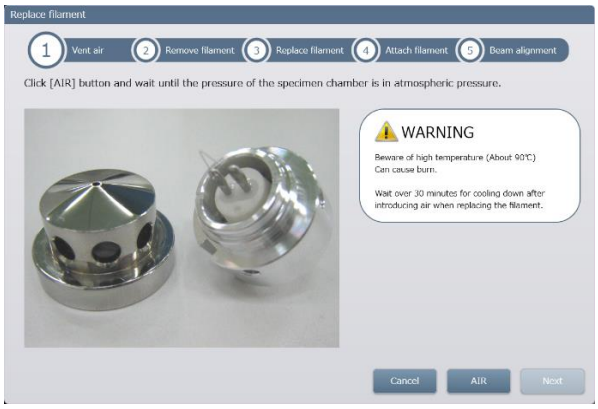


(3) AIR/EVAC buttons

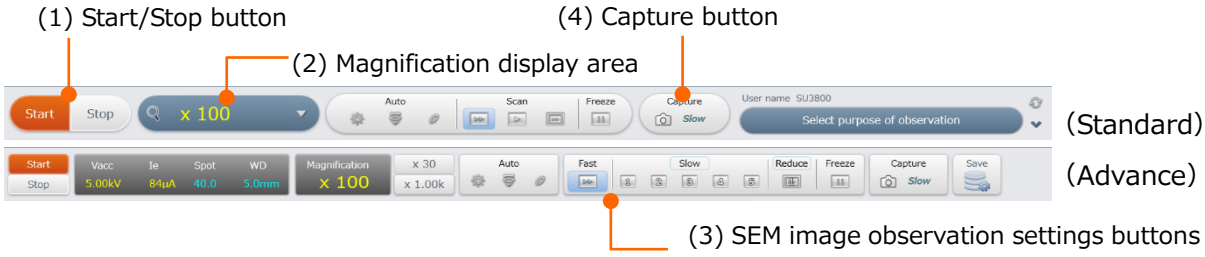
- AIR button :Vent air to the specimen chamber.
- EVAC button :Pump air from the specimen chamber.

(4) Replace Filament button

Click the [] button for replacing the filament. Replace the filament according to the dialog instruction.



<When the beam is ON>



(1) Start/Stop buttons

Beam is OFF and finish the observation.

(2) Magnification display area

Display the magnification. Change the magnification by dragging the mouse on this display.

In addition display the magnification list and select the magnification by clicking the magnification split button (▽).

(3) SEM image observation settings buttons

Click the each button and perform the following operations.

(a) Auto Brightness & Contrast Control button ()

Control the brightness and contrast of the SEM image automatically.

(b) Auto Focus Control button ()

Control the focus of SEM image automatically.

(c) Auto astigmatism correction/auto focus control button ()

Correct the astigmatism and control the focus of the SEM image automatically.

(d) Fast button ()

Set the scan speed to Fast.

(e) Slow button ( / )
Set the scan speed to Slow.

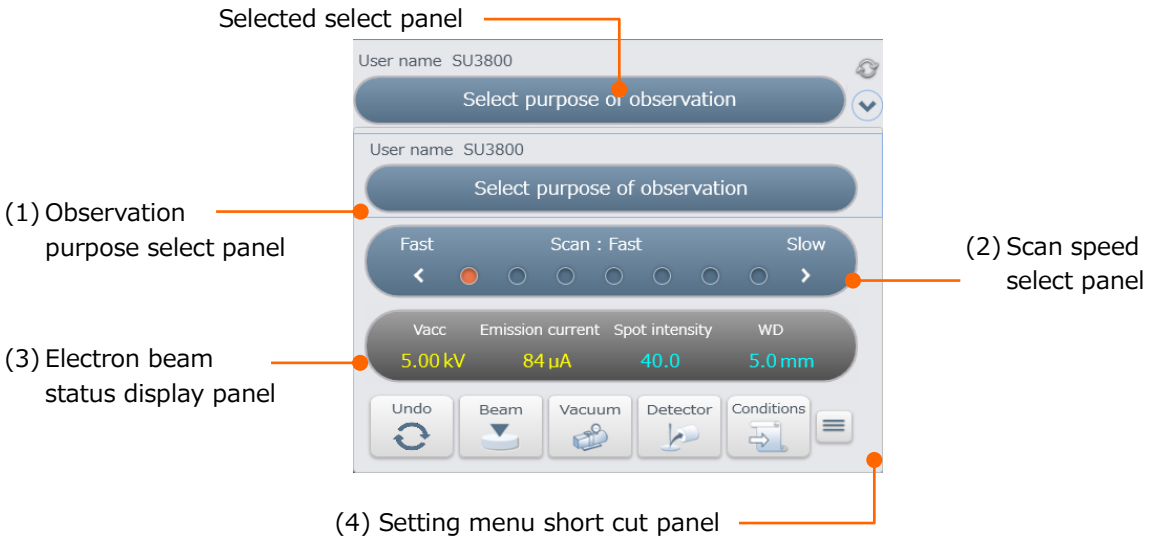
(f) Reduce button ()
Set the scan speed to Reduce.

(g) Run/Freeze button ()
Pause the scanning. Restart to scan by clicking the button.

(4) Capture button
Capture a SEM image.

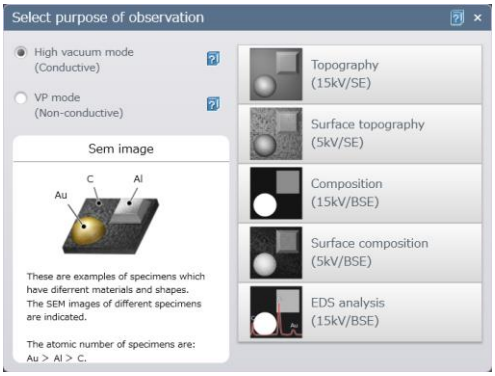
2.3.4 Select panel

Expand a list and display the four items by clicking the split button. Select an item for displaying on the select panel. Display one item from observation purpose select panel, scan speed select panel, electron beam status display panel, setting menu short cut panel in this select panel. The item can be switched by clicking the button on the select panel.



2.3.4.1 Observation purpose select panel

Click the select panel and select an optimal observation condition for each vacuum mode.



2.3.4.2 Scan speed select panel

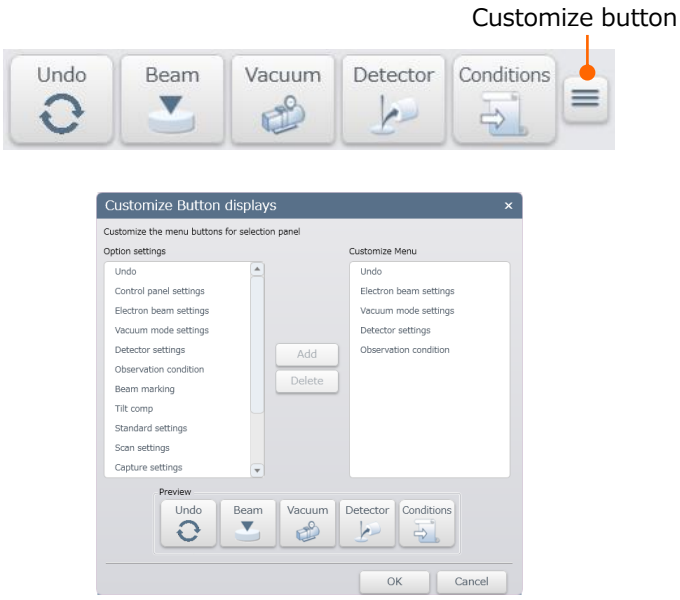
Select a scan speed from 7 speed types (Fast, Slow1 to Slow6) by clicking the select panel.

2.3.4.3 Electron beam status display panel

Display the accelerating voltage, emission current, spot intensity and WD for the electron beam. In addition, electron beam settings can be performed by clicking the select panel.

2.3.4.4 Setting menu short cut panel

The menu buttons for arranging on the panel can be customized by each user. Up to 5 menu buttons can be displayed by selecting from the menu.



2.3.5 Setting menu

Click the menu button on the main window and select items for setting. These items can be displayed on the settings menu short cut on the select panel.

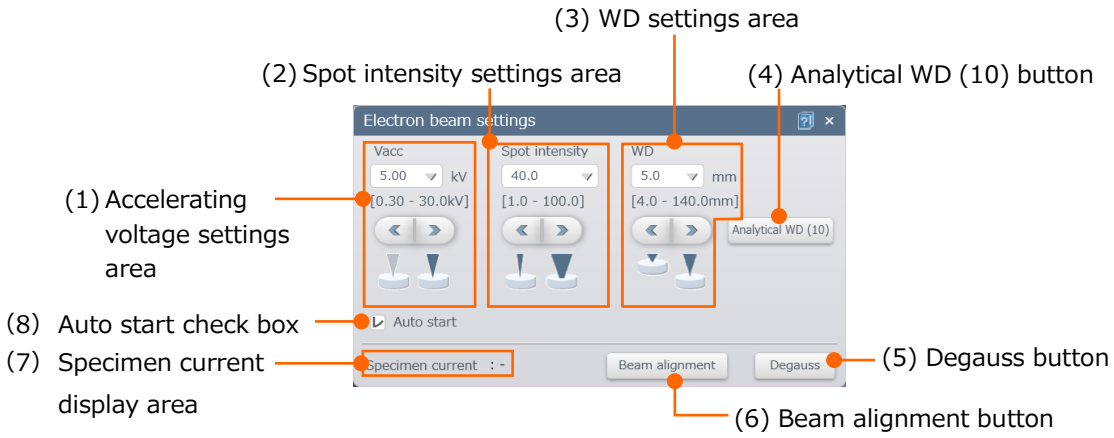
2.3.5.1 [Undo]

The operation condition can be set to the previous condition. The following four functions can be set to the previous condition.

- AFC
- ASFC
- ABCC
- Stage move

2.3.5.2 [Electron beam settings]

Set the electron beam related settings.



(1) Accelerating voltage settings area
Select the accelerating voltage. Enter the value in the text box or select a value from the pull down list. In addition, the value can be set by 0.1 kV step with the fine adjustment button.

(2) Spot intensity settings area
Select the spot intensity. Enter the value in the text box or select a value from the pull down list. In addition, the value can be set by 0.1 kV step with the fine adjustment button.

(3) WD settings area
Set the focus position of the electron beam. Enter the value in the text box or select a value from the pull down list. In addition, the value can be set by 0.1 kV step with the fine adjustment button.

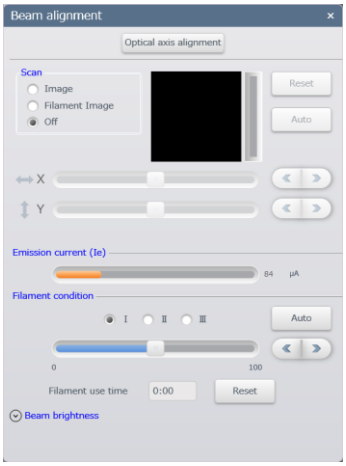
(4) Analysis WD (10) button
Set the WD to 10 mm. This button can be used for the EDS analysis.

(5) Degauss button
Eliminate the residual magnetic field of objective lens.

NOTE: The specimen stub assemble of standard attachment is designed for observing a Click [Degauss] button for the following status.

- After focus is greatly changed.
- Before performing the axis alignment (electromagnetic alignment) of the electron optical system.

(6) Beam alignment button
Align the beam. Refer to the 3.4.5 Details of axis alignment method.



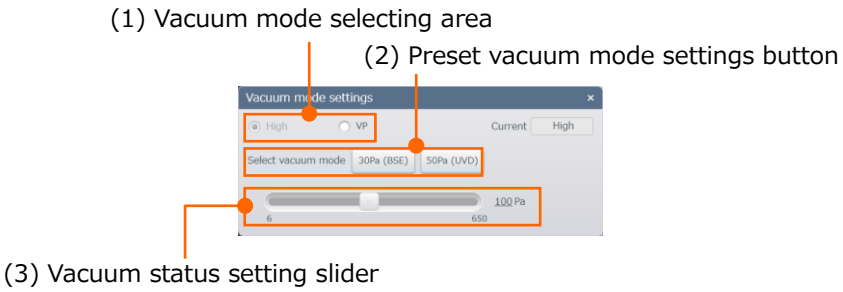
(7) Specimen current display area
The specimen current value is displayed.
Display of the specimen current value

- The specimen current is generated due to the absorbed electron of the primary electron of landing current on the specimen. The part of primary electron emits from the specimen as the back scattered electron or second electron. Thus, the specimen landing current is different than the specimen current.
- Specimen current is varied depending on the specimen condition, specimen mounting method, vacuum status or other even if the optical system condition is the same.
- Note that the displayed specimen current value is measured by a simple current measurement system as for reference value.

(8) Auto start check box
When check box is ON , the Auto start function (ABCC→AFC) will be performed when the beam is ON.

2.3.5.3 [Vacuum mode settings]

Switch the vacuum mode between [VP] and [High].



(1) Vacuum mode selecting area
Switch the vacuum mode between the VP mode and the High vacuum mode.

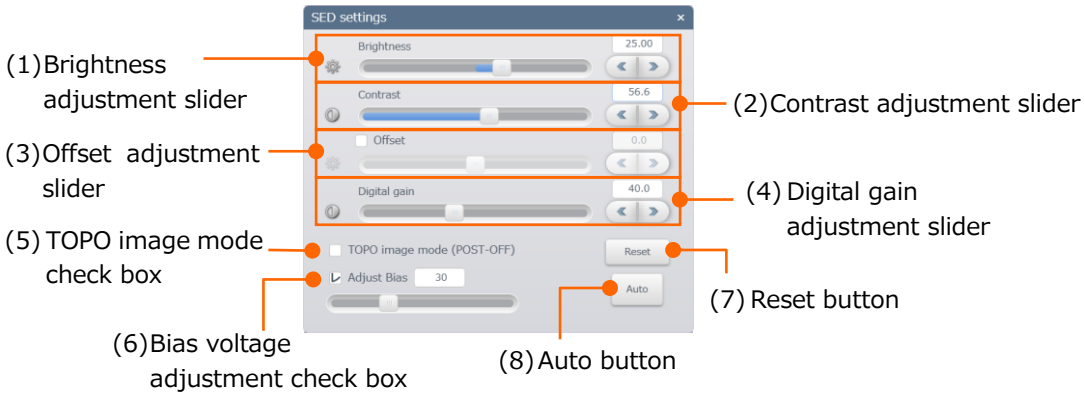
(2) Preset vacuum mode settings button
Set the pressure value of the VP mode BSE image observation vacuum status (30 Pa, recommended value) and the UVD image observing vacuum status (50 Pa, recommended value).

(3) Vacuum status setting slider
Set or display the pressure value for the [VP] mode. The value from 6 to 650 Pa are available. It can be set in 26 steps.

2.3.5.4 [Detector settings]

Set the presently used detector conditions.

- SE detector



(1) Brightness adjustment slider
Adjust the brightness of SE image by entering the brightness value in the box or moving the slider. In addition, the value can be set by 0.64 step with the fine adjustment button.

(2) Contrast adjustment slider
Adjust the contrast of SE image by entering the contrast value in the box or moving the slider. In addition, the value can be set by 0.6 step with the fine adjustment button.

(3) Offset adjustment slider
Set the offset amount of the brightness on the SEM image by enabling the check box. Enter the offset value in the text box or moving the slider. In addition, the value can set by 0.5 step with the fine adjustment button

(4) Digital gain adjustment slider
Enhance the contrast of SE image digitally. Adjust the digital gain by entering the digital gain value or moving the slider. In addition, the value can be set by 0.5 step with the fine adjustment button.

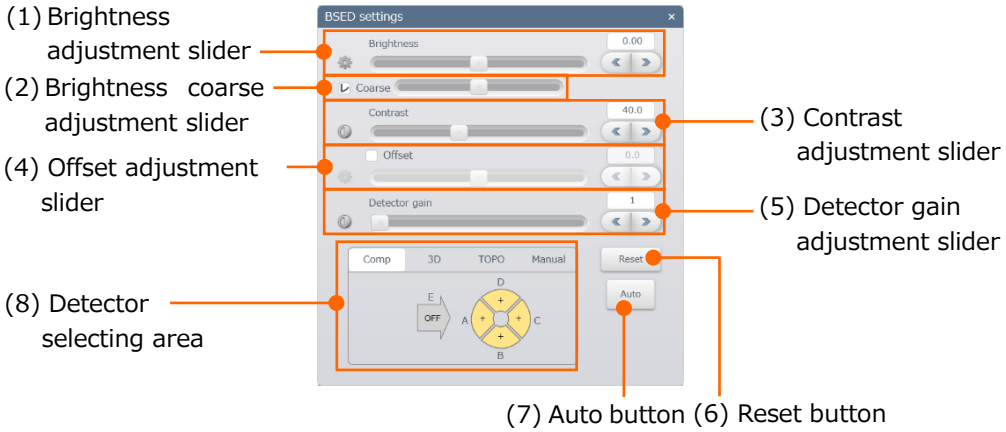
(5) TOPO image mode (POST-OFF) check box
Turn OFF the HV of SE detector and switch to the TOPO mode for the SEM image by enabling the check box. SE detector detects BSE and the image is displayed. The topographical image of the specimen by viewing from the detector direction can be observed. Set OFF the check box for the normal observation.

(6) Bias voltage adjustment check box
Change the bias voltage value within the 0 to 100 by enabling the check box. Set the value for obtaining the maximum brightness. In addition, the bias voltage is possible to improve the obtaining efficiency of SEs.

(7) Reset button
Set the setting of SE image brightness, contrast offset, digital gain to the initial condition.

(8) Auto button
Execute ABCC.

- BSE detector



(1) Brightness adjustment slider

Adjust the brightness of BSE image by entering the brightness value in the box or moving the slider. In addition, value can be set by 0.02 step with the fine adjustment button.

(2) Brightness coarse adjustment slider

Perform the coarse adjustment of the brightness for BSE image while enabling the check box (Coarse). Adjust the brightness by moving the slider.

(3) Contrast adjustment slider

Adjust the contrast of the BSE image by entering the value in the text box or moving the slider. In addition, the value can be set by 0.5 step with the fine adjustment button.

(4) Offset adjustment slider

Set the offset amount of the brightness on the BSE image by enabling the check box. Set the offset value by entering the value in the text box or moving the slider. In addition, the value can be set by 0.5 step with the fine adjustment button.

(5) Detector gain adjustment slider

Adjust the detector gain of BSE image by 4 steps. Adjust the detector gain by entering the gain value in the box or moving the slider. In addition, the value can be set by 1 step with the fine adjustment button.

(6) Reset button

Set the settings of the brightness of BSE image, contrast, offset, detector gain to the initial conditions.

(7) Auto button

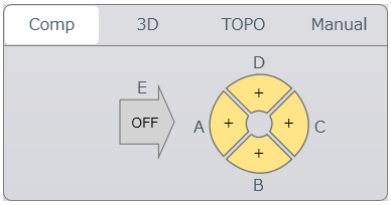
Execute the ABCC.

(8) Detector selecting area

Select a BSE detector setting (observation mode). Select the tab at the upper area.

(a) Composition mode

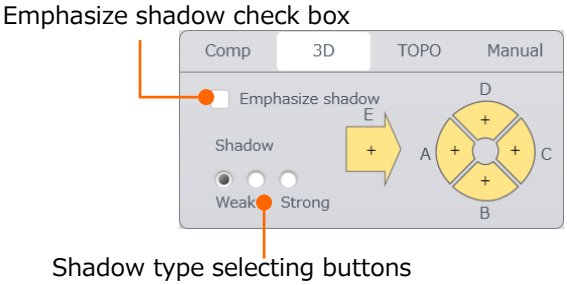
Observe the composition image of the specimen.



(b) 3D mode

Image which emphasizes the roughness of specimen surface can be observed.

The following shows the polarity of element.

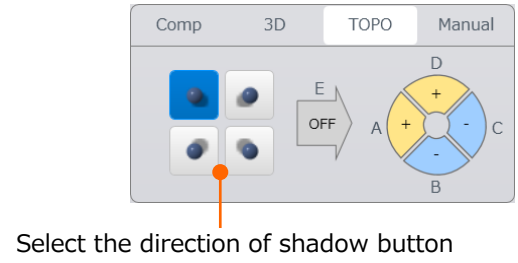


- Emphasize shadow check box
  Emphasize the shadow of the observing image.
- Shadow type selecting buttons
  Select the intensity of shadow.

(c) TOPO mode

The TOPO image with the different direction of the light source can be obtained.

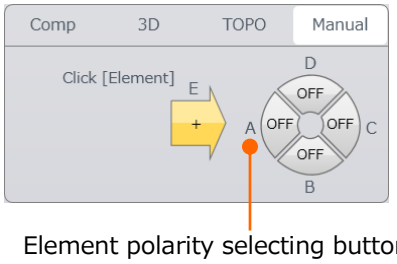
The following shows the polarity of element.



- Select the direction of shadow button
  Select the direction of shadow.

(d) Manual mode

Select the polarity of each element.



Element polarity selecting buttons

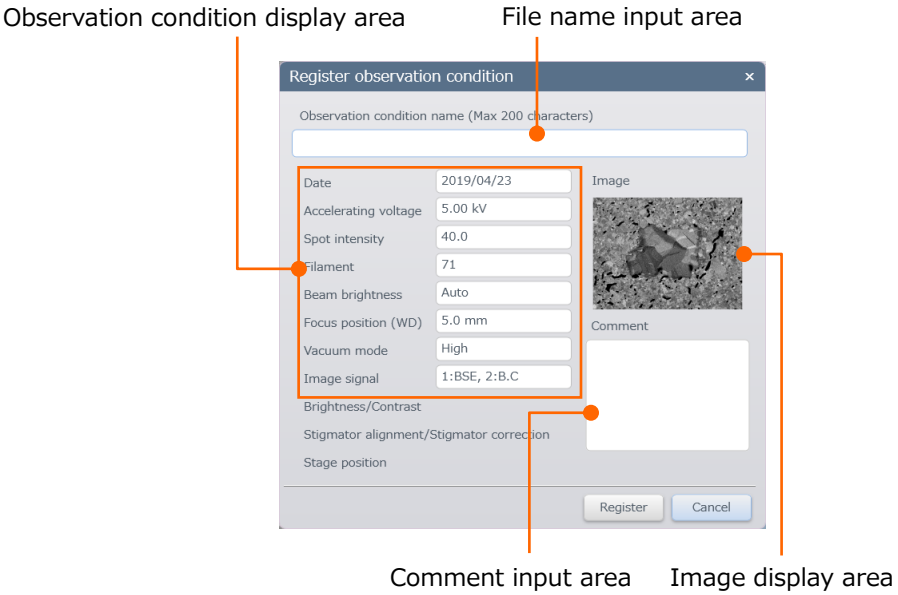
- Element polarity selecting button

  Select the polarity of each element in order to +/−/OFF by clicking each element button.

2.3.5.5 [Condition Register/load]

Register or load the observation condition.

(1) Register the observation condition



- File name input area

  Enter the file name of the observation condition. Up to 200 characters can be entered in the file name.

- Register button

  Register the file for the observation condition.

- Comment input area

  Comment can be input.

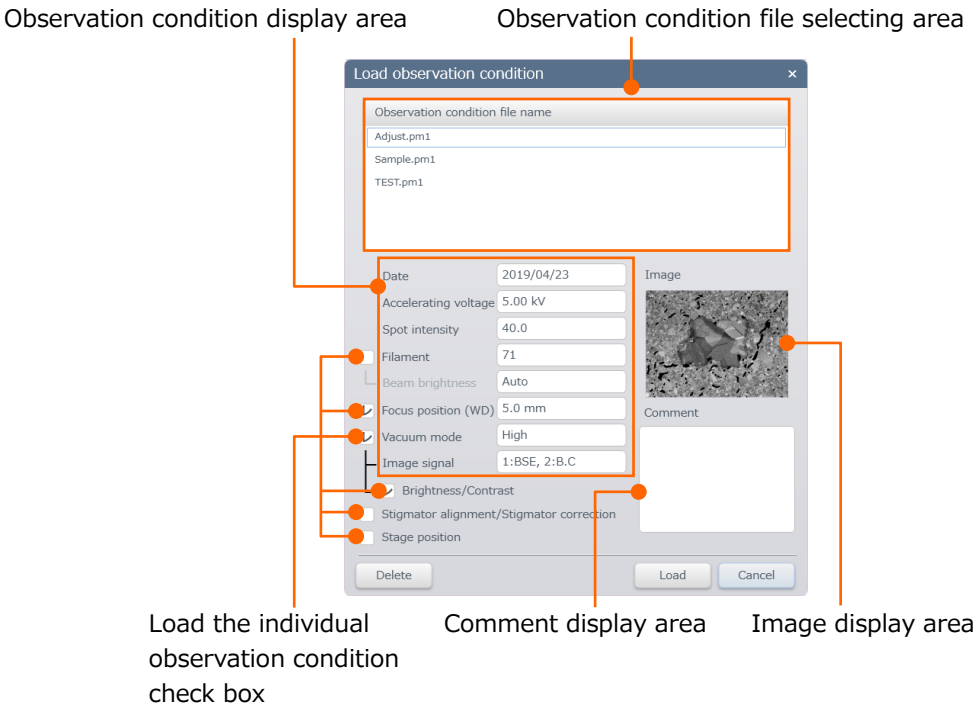
- Observation condition display area

  Display the present observation condition.

- Image display area

  Display the present SEM image.

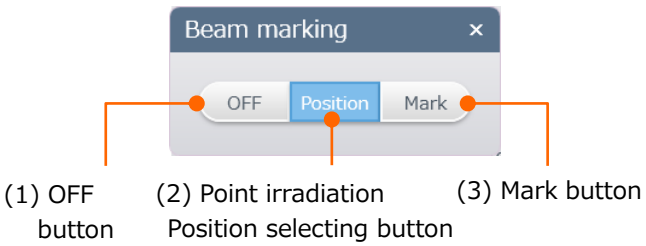
(2) Load the observation condition



- Observation condition file selecting area
  Select an observation condition file by clicking [Load] button after selecting a condition. In addition, delete the condition by clicking [Delete] button after selecting a condition.
- Observation condition display area
  Display the saved observation condition.
- Delete button
  Delete the saved observation condition.
- Load button
  Load the saved observation condition.
- Load the individual observation condition check box
  Load the selected condition by enabling the check boxes.

2.3.5.6 [Beam marking]

Perform the point irradiation on the selected position by the electron beam.



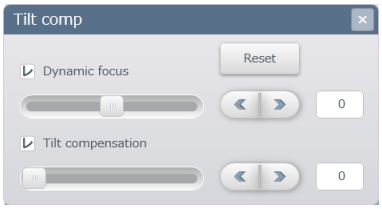
(1) OFF button
Set OFF the beam marking mode.

(2) Point irradiation position selecting button
Cross marker is displayed on the image. Move the point irradiation position by dragging the cross marker.

(3) Mark button
Irradiate the electron beam to the selected point.

2.3.5.7 [Tilt compensation]

When the specimen is observed from the oblique direction, shifting the focus and magnification can be occurred. This Tilt compensation can correct the shift of focus and magnification.

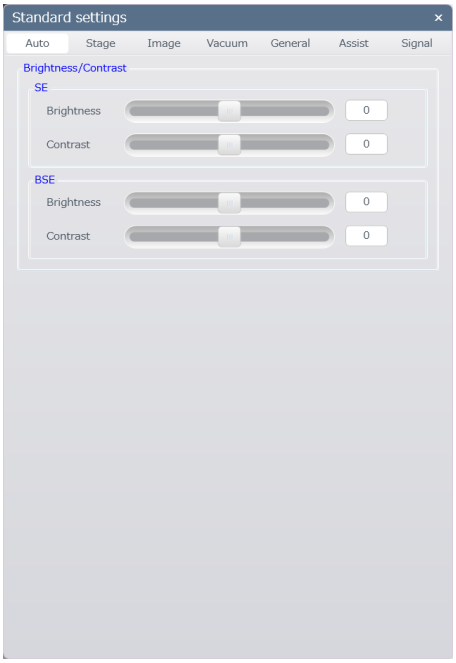


2.3.5.8 [Standard settings]

Set the each function.

(1) [Auto] tab

Set the control level of automatic brightness and contrast. The adjustment level can be set individually. The standard value is 0 and the value can be set by ±5 step.



(2) [Stage] tab

Set the stage related settings.

- Motor drive ON/OFF
  Set ON/OFF the motor drive stage function.
- Reverse direction
  The operation will be reversed by enabling the Mouse, Step move and Constant move or Trackball and Joystick check boxes.
- Adjust the Trackball and Joystick speed
  Adjust the slider to set the stage speed for the Trackball and Joystick.
- Coordinate
  Set the standard coordinate for the stage move.
  Coordinate on the specimen [Specimen]:
  Set the Home position to [0, 0] where the center of the specimen holder.
  Coordinate on the stage [Stage]:]
  Set home position to the bottom left of the specimen holder and center of the specimen holder will be [40, 25] for SU3800 and [100, 75] for SU3900.
- Specimen size settings
  Display the [Specimen stub list settings] dialog. Select a size of specimen size from the list in the specimen exchange dialog.

- Z focus link
  Focus will be adjusted automatically when moving the Z position while the Z focus link is activated. In addition, the focus is automatically adjusted and the degauss will be executed when checking ON the [Execute degauss automatically after Z movement is completed] check box.
- Z minimum step
  Set the minimum step move of the Z to 0.01 mm.
- Eucentric
  Activate the Eucentric rotation/tilting by enabling the check box.

(3) [Image] tab

Set the settings of image display.

- Preset magnification

  Two types of magnification can be set to the preset magnification. The value can be set by entering in the text box or selecting from the pulldown list. When entering the value in the text box, apply the value by pressing the Enter key.

  In addition, the present magnification can be set in the preset magnification by clicking [Current Mag.] button.

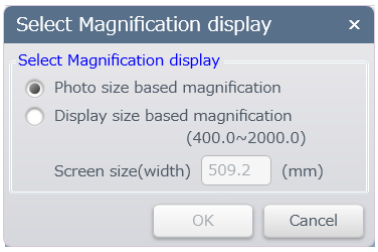
- Micron marker

  Select [Variable length] for changing the length of micron marker depending on the magnification.

  [Fix length]: When fixing the length of micron marker.

- Select Magnification display

  Select magnification display from photo size based magnification and display size based magnification.



- Display magnification unit

  Enable the check box for displaying the magnification in k when the value is more than x1,000.

- Set the image list window

  Set the default size when opening the image viewer.

(4) [Vacuum] tab

Set the vacuum mode of the instrument startup.

- [Previous pressure value] mode
  The instrument will be started-up with the vacuum mode that is previously set when exiting the operation program.
- [High] mode
  Startup the instrument with the high vacuum mode.
- [VP] mode
  Start up the instrument with the VP mode. The pressure from 6 to 650 Pa are available. Set the value by the slider.

(5) [General] tab

Set the general settings.

- Intelligent Filament Technology (IFT)
  Set ON or OFF the auto control function for the filament.
- WD rotation correction
  Correct the rotation of the observing image automatically due to the change of the WD.
- Scan indicator
  Set ON/OFF the display of the scan indicator.
  Scan indicator is displayed when the scan speed which is slower than the Slow3.
- IPI
  Set ON or OFF the IPI transfer function.
- Select the GUI language
  Japanese or English are available. The SU3800/SU3900 operation program must be restarted for applying the language.

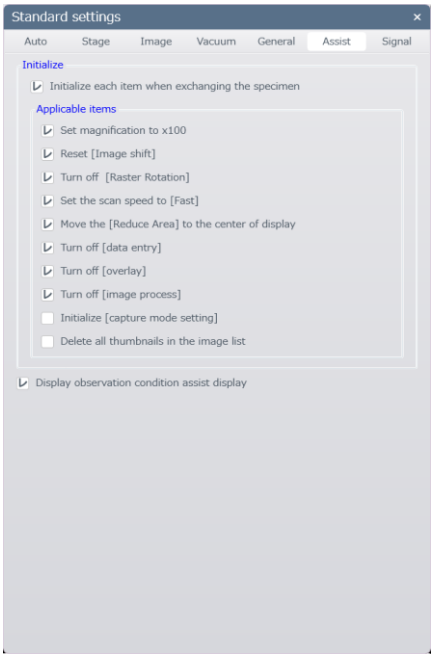
- Initialize the settings
  Each setting will be set to the value of shipping condition.
- User settings
  Register the login user or delete the password.
- Pop-up tips
  Display/hide the pop-up tips.

(6) [Assist] tab

Set the following items when exchanging a specimen.

- Set the following item when exchanging a specimen.
  Set ON or OFF this function.
- Set the magnification at x100
  Set the magnification at x100.
- Reset the image shift
  Set the image shift position to the center.
- Set OFF the raster rotation
  Set OFF the raster rotation while maintaining the setting data.
- Set scan speed to [Fast]
  Set the scan speed to [Fast].
- Move the Reduce Area to the center of the image
  Set the Reduce Area to the center of the image.
- Set OFF the data input
  Delete the input length, angle and text that are input at the operation panel > Data tab.
- Set OFF the overlay
  Set OFF the overlay. Loaded image will be remained.

- Set OFF the image processing
  Set OFF the brightness inversion, gamma correction, tone curve of the Image on the Operation panel. The setting data of gamma correction and tone curve will be remained.
- Initialize the capture mode setting
  Set the capture mode settings to the shipping condition.
- Delete all thumbnails in the image list
  Delete all thumbnails in the image list. However, the image which is protected will not be deleted.
- Display the observation condition assist display
  Display the observation condition assist display after the specimen exchange sequence is finished.



(7) [Signal] tab

Set the signal settings of the image display area.

- Use AUX1

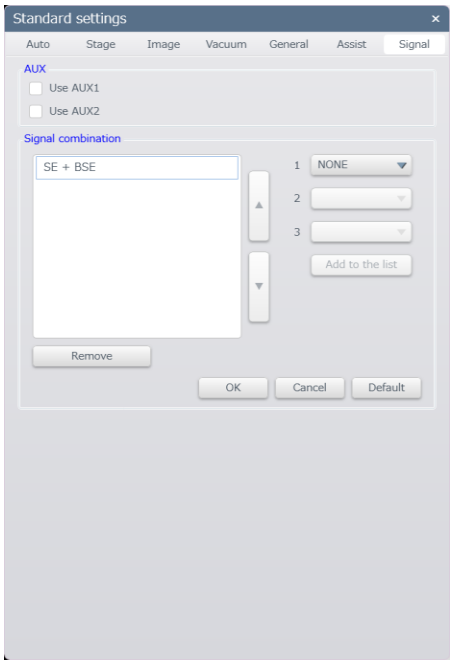
  Set ON the AUX1 when connecting to the external input terminal. Display the AUX1 in the observation signal selecting button on the image display area.

- Use AUX2

  Set ON the AUX2 when connecting to the external input terminal. Display the AUX2 in the observation signal selecting button on the image display area.

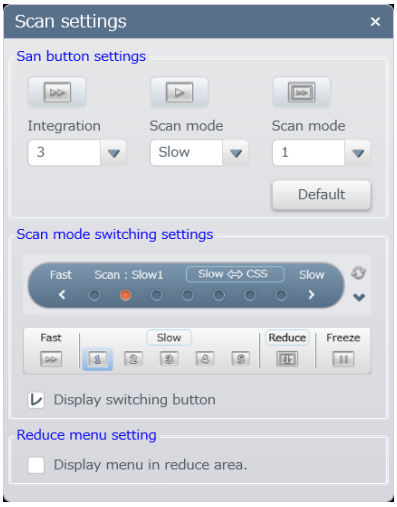
- Signal mixing combination

  Add the signal condition to the observation signal selecting button on the image display area.



2.3.5.9 [Scan settings]

Set the scan button, scan speed selecting panel and reduce Area.



(1) Set the scan setting buttons

Set the settings of the scan button.

- Integration number of frames

  Set the integration number of frames in the Fast scan.
- Set the type of scan (Slow button)

  Set the observation mode during the Slow scan. Slow/CSS are available.

NOTE:
- In the CS scanning, signals are integrated by repeating horizontal scanning at high speed and then moves to the next vertical scanning section. Compare to slow scanning, the dual-time of the electron beam on the specimen is shorter, thus it can prevent the anomalous contrast due to charge up.
- The image may be shifted to the horizontal direction with the detector (BSE detector etc.) that has narrow frequency bandwidth. In this case, select the Slow scan.

- Scan mode (Reduce button)

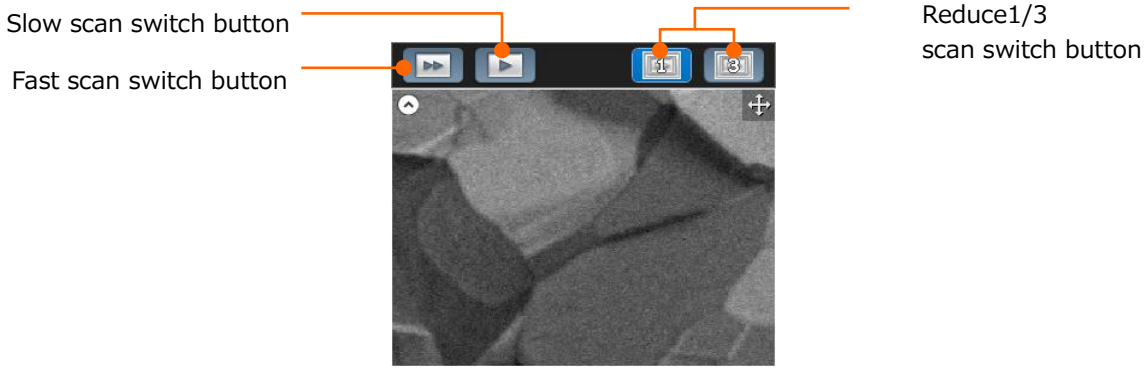
  Set the scan mode 1 or 3 during the Reduce scan.

(2) Select the scan mode

Display the Slow ⇔ CSS, Reduce1 ⇔ Reduce3 buttons are displayed on the scan speed selecting panel by enabling the [Display switching button] check box. Switch the scan mode between Slow and CS scan, Reduce1 and Reduce3 scans during the observation.

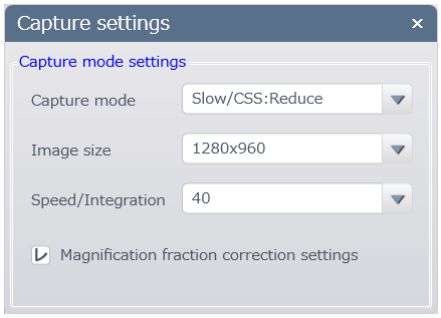
(3) Reduce menu settings

Display the Fast, Slow, Reduce1, Reduce3 scan switching button in the reduce menu by enabling the [Display menu in reduce area.] check box.



2.3.5.10 [Capture settings]

Set the function settings.



(1) Capture mode settings

Switch the capture mode while scanning. The following 4 scan modes are available.

Displayed scan:	Pause and save the observing image.
Slow/CSS:Reduce:	Capture the image with Slow/CS Scan.
Fast:	Perform the frame integration with Fast scan.
Slow1:Integration:	Perform the frame integration with Slow1 scan.

(2) Image size

Set the image size for capturing. The four image sizes that are 640×480, 1,280×960, 2,560×1,920, and 5,120×3,840 pixels are available.

Cannot select the [Image size] when [Displayed scan] is set for the scan type.

NOTE: 5,120×3,840 pixels must be selected for the [Slow/CSS:Reduce] capture mode.

(3) Speed/Integration

Set the capturing speed and number of frame for integration. Set to the Fast for the Slow/CSS (Reduce) scan type, and set number of frames for integration for the Slow1: Integration.

Cannot select an image size when setting the displaying image for the scan type.

(4) Magnification fraction correction settings

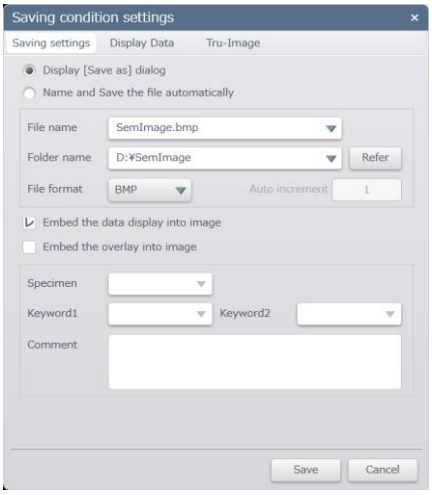
The fraction of magnification value due to the focusing while saving an image will be corrected by enabling the check box.

2.3.5.11 [Saving condition settings]

Set the image saving, data display, image and Tru-Image settings.

(1) Saving settings tab

Set the saving destination, file name, file information etc. while saving an image file.

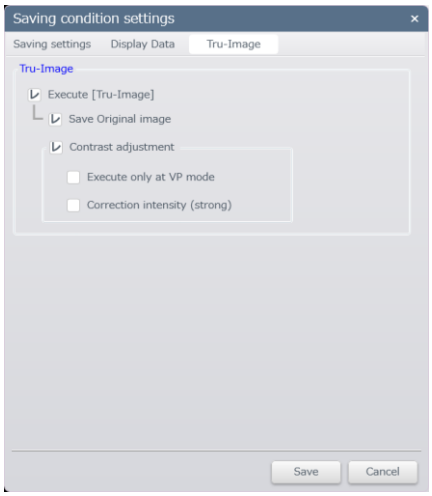


(2) Display Data tab

Set the data display settings (The function for displaying the observation condition on an image).

(3) Tru-Image tab

Set the Tru-Image settings.



2.3.5.12 [Maintenance]

Instrument information of SU3800/SU3900 can output as a file by utilizing the SEM Maintenance Tool.

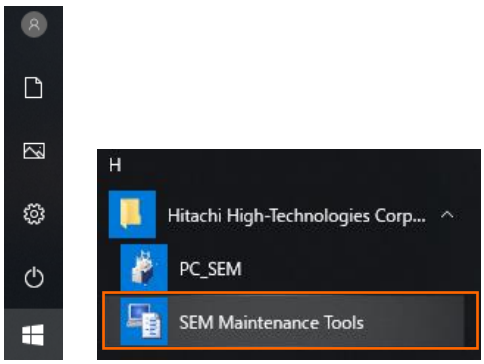
This maintenance tool is only for a service engineer of Hitachi High Tech Corporation. Use this function when our service engineer request to perform.

(1) Startup the SEM Maintenance Tool

SEM Maintenance Tool can be started-up in two methods. Startup this tool depending on the situation.

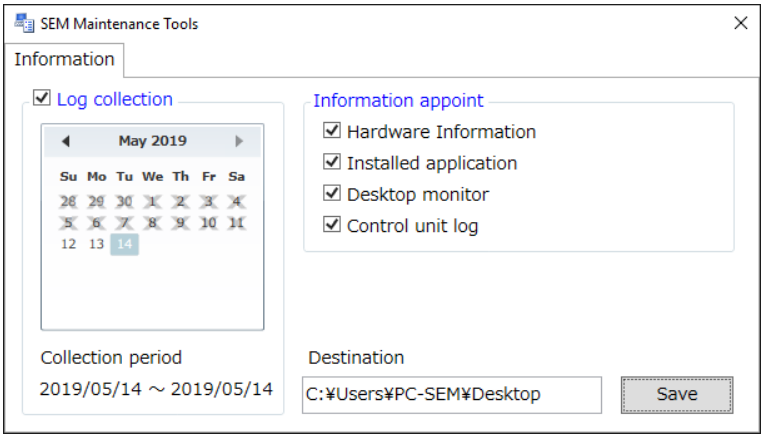
(a) If the SU3800/SU3900 operation program does not startup.

Select Windows Menu > [All applications] > [Hitachi High-Technologies Corporation] > [SEM Maintenance Tools].

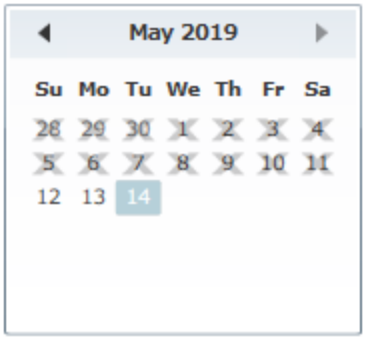


(b) Startup via SU3800/SU3900 operation program
Select [Menu]> [Maintenance]> [SEM maintenance tools]. Then, the SEM Maintenance Tools window will be displayed.

(2) SEM Maintenance Tool window



(a) Log collection checkbox
Select the date in the displayed log collection calendar. The date which does not have any information in the instrument indicates in X mark and unable to select. Press and hold the Ctrl or Shift for selecting multiple dates.



(b) Hardware information checkbox
Collect the information of the OS, Plug & Play and monitor.

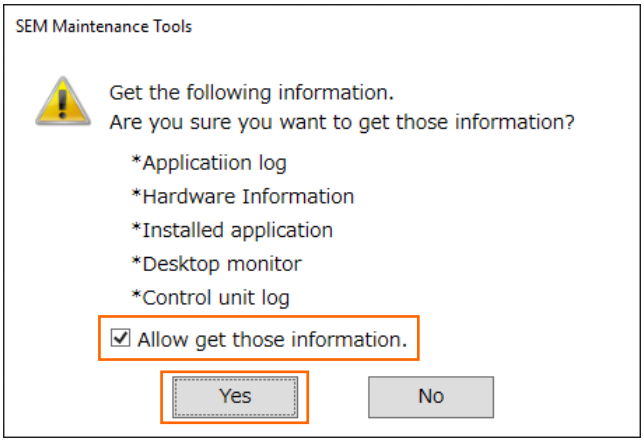
(c) Application information checkbox
Collect the information of the PC model, BIOS, PC application

(d) Desktop screen check box
Obtain the screenshot of the desktop screen.

(e) Control unit log
Obtain the log information of the control unit.

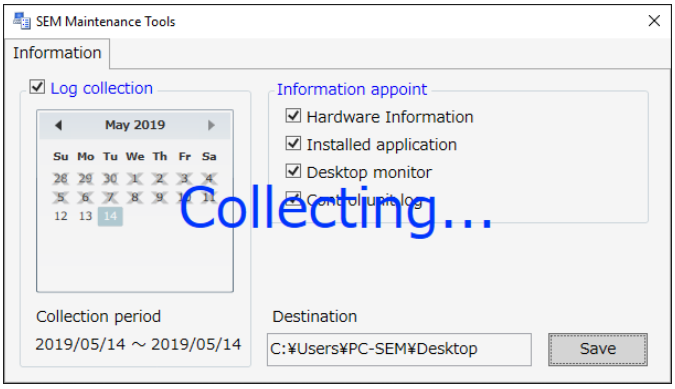
(3) Saving destination

The following saving confirmation dialog is displayed by defining the saving destination and clicking the [Save] button. Enable the [Allow get those information] check box then, click [Yes].



NOTE: The data is saved in the desktop folder.
The instrument information such as the folder pass name or file name may include personal information. Make sure the information whether collecting the information or not before enabling the check box.

The following dialog is displayed while collecting the information. Please wait until the saving completes.



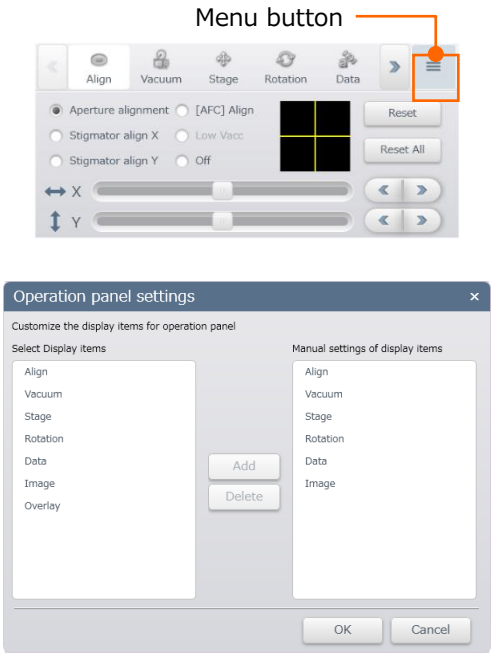
A compressed file is created with the file name of [YYYYMMDDhhmmss (Present setting time of PC).zip] after the information is collected.

2.3.5.13 [Version information]

Display the version information.

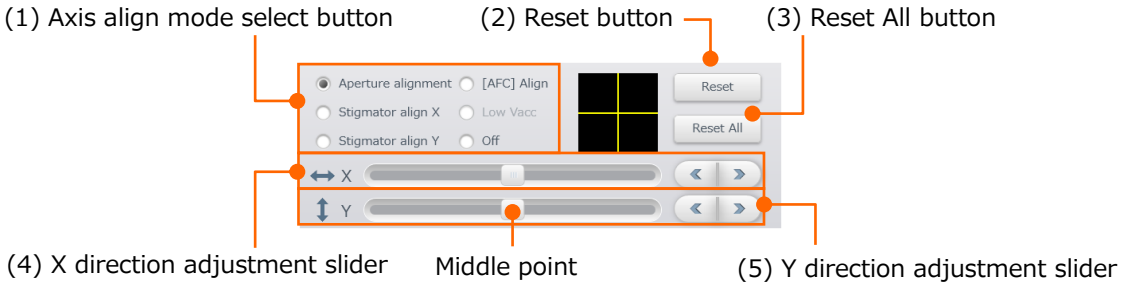
2.3.6 Operation panel function

The displayed items can be customized for each users by clicking the menu button.
Select items from the seven items that are Align, Vacuum, Stage, Rotation, Data, Image and Overlay for displaying the items on the operation panel.



2.3.6.1 [Align] tab

Align the axes of electron optical system in the [Align] tab.



(1) Axis align mode select button
Select the mode from the aperture alignment, Stigmator align X, Stigmator align Y, [AFC] Align and Low Vacc mode.

NOTE: Set the accelerating voltage at 1.5 kV or less then, Low Vacc mode is selectable.

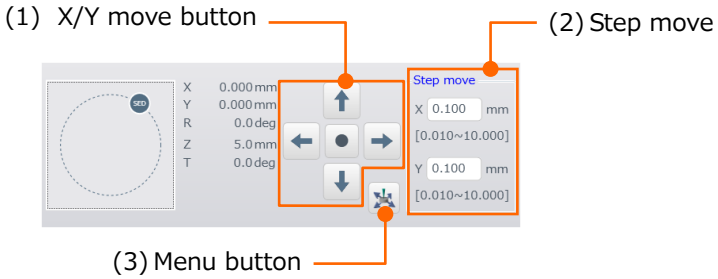
(2) Reset button
Set the adjusting item to the center point.
(3) Reset All button
Set the all axes alignment items to the center point.
(4) X direction adjustment slider
Align the axis of the X direction by moving the slider. In addition step adjustment can be performed by the fine adjustment button.
(5) Y direction adjustment slider
Align the axis of the Y direction by moving the slider. In addition step adjustment can be performed by the fine adjustment button.

2.3.6.2 [Vacuum] tab

Set the Vacuum mode or vacuum status during the SEM observation in [Vacuum] tab.

2.3.6.3 [Stage] tab

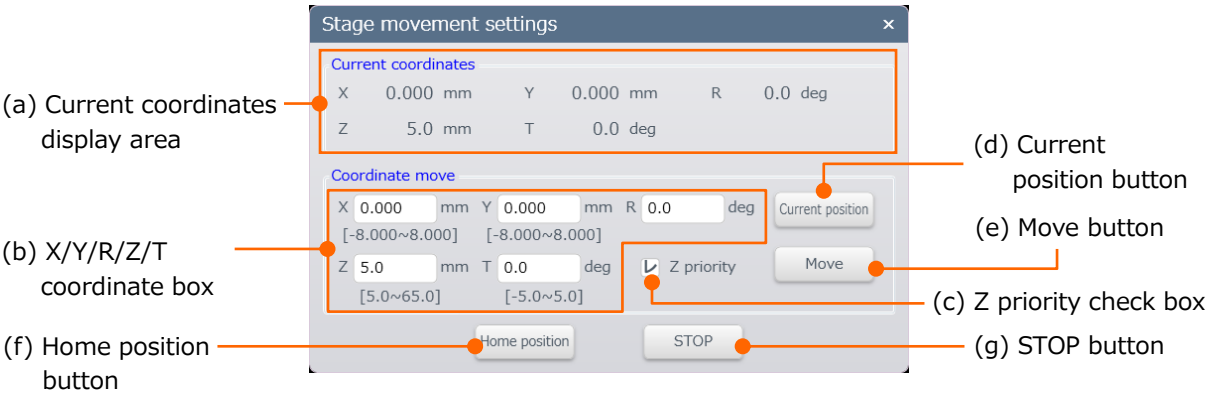
Move the specimen stage.



(1) X/Y move button
X/Y axes move button enable to move the stage by 1 step. In addition, the move the stage of X/Y continuously by pressing and holding the button. The stage move to the center by press the  button.
(2) Step move
Set the amount of one step move.

(3) Menu button

Display the stage move setting dialog.



(a) Current coordinates display area

Display the current stage positions (X, Y, R, Z, T).

(b) X/Y/R/Z/T coordinate box

Enter the desired coordinate of each axis. Enter the value and press [Move] button to move the stage.

(c) Z priority check box

The movable range of Z or T axis is limited by the other axis. The stage is moved by prioritize the Z or T axis and move the other axis within the movable range.

(d) Current position button

Load the current coordinates of the X, Y and R axes.

(e) Move button

Move the stage to the coordinate that is entered in the [X/Y/R/Z/T coordinate box].

(f) Home position button

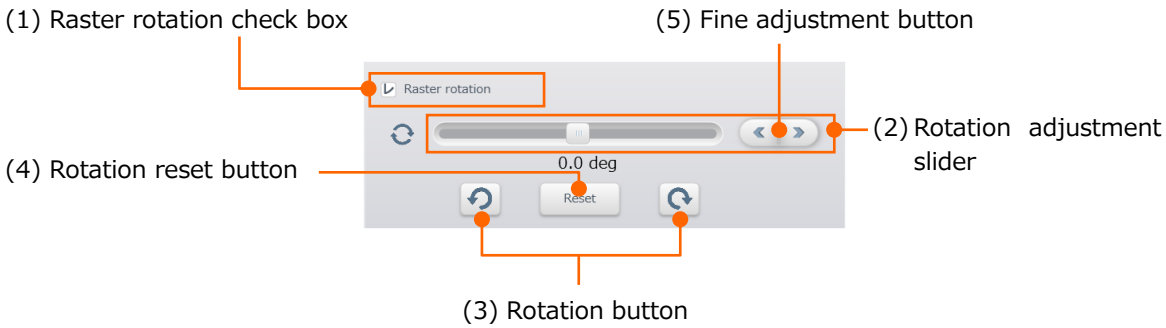
Move the stage to the home position (X, Y=0 mm, Z=the lowest position, R,T＝0°).

(g) STOP button

Stop the stage move forcibly while moving the stage.

2.3.6.4 [Rotation] tab

Rotate the displayed image by rotating the scanning direction of electron beam.



(1) Raster rotation check box
Activate the Raster Rotation function by enabling the check box.

(2) Rotation adjustment slider
Rotate the displayed image by moving the slider. The rotation range from -200.0 to + 200.0 degree are available.

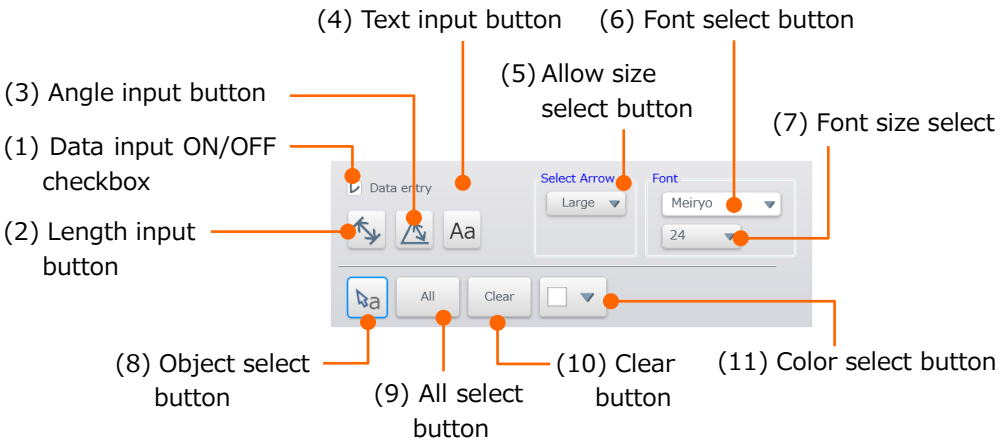
(3) Rotation button
Rotate the scanning direction to clockwise or counterclockwise by 45 degree.

(4) Rotation reset button
Reset the rotation angle to 0 degree.

(5) Fine adjustment button
Set the value by 0.1 degree step with the fine adjustment button.

2.3.6.5 [Data] tab

Input the length, angle and text on the displayed image in the [Data] tab.



(1) Data input ON/OFF checkbox
Set ON of OFF the input the data.

(2) Length input button
Input the length. Press the left button on the mouse at the starting point and release the button at the end point.

(3) Angle input button
The smaller angle of two lines will be input by clicking the left button on the mouse.

(4) Text input button
Input text. Place a text box by clicking a mouse on the displayed image.

(5) Allow size select button
Change the allow size indicating in the length input.

(6) Font select button
Select a font of the text.

(7) Font size select button
Select a font size of the text.

(8) Object select button
Select the input length, angle or textbox. The selected object will be highlighted in blue color.

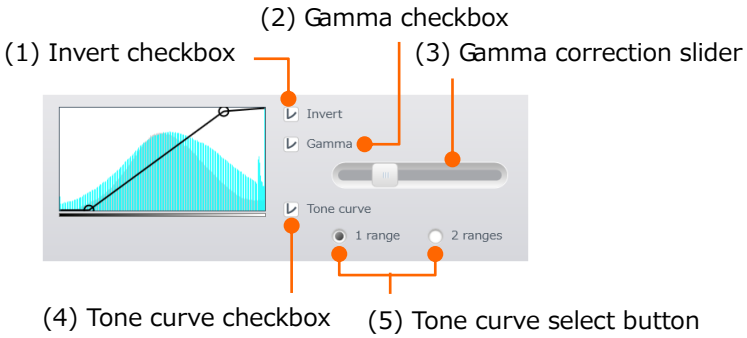
(9) All select button
Select all objects on the displayed image.

(10) Clear button
Clear the selected objects.

(11) Color select button
Change the object color.

2.3.6.6 [Image] tab

Perform the SEM image brightness invert processing and Brightness control in [Image] tab.



(1) Invert checkbox
Set ON or OFF the brightness invert function by enabling the checkbox.
Invert the brightness of SEM image (White/Black).

(2) Gamma checkbox
Set ON or OFF the Gamma correction function by enabling the checkbox.

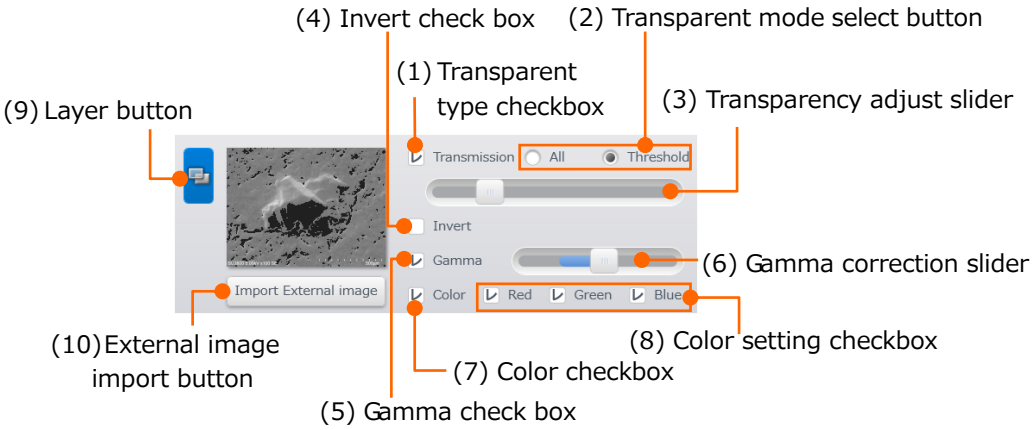
(3) Gamma correction slider
Change the gamma correction value by moving the slider.

(4) Tone curve checkbox
Set ON or OFF the Torn curve by enabling the checkbox.

(5) Tone curve select button
Select the 1 area emphasize or 2 area emphasize.

2.3.6.7 [Overlay] tab

Overlay the desired image on the SEM image.



(1) Transparent type checkbox
Set ON or OFF the transparent function by enabling the checkbox.

(2) Transparent mode select button
Switch the all or threshold transparent areas.
All: Entire image will be transparent.
Threshold: The black area of image will be transparent.

(3) Transparency adjust slider
Change the transparency level by the slider.

(4) Invert checkbox
Set ON or OFF the brightness invert function by the checkbox.
Invert the brightness of layered images (White/Black).

(5) Gamma checkbox
Set ON or OFF the Gamma correction by the checkbox.

(6) Gamma correction slider
Adjust the correction amount of Gamma by the slider.

(7) Color checkbox
Activate the color setting function of the layered image by enabling the checkbox.

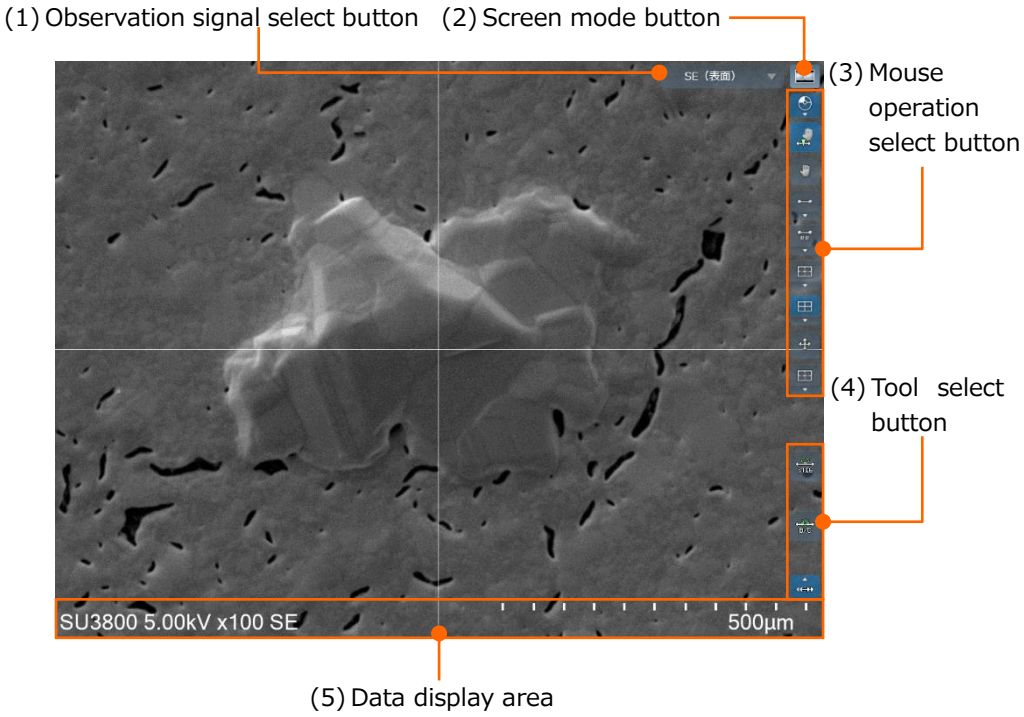
(8) Color setting checkbox
Apply the selected color on the image.

(9) Layer button
Layer the selected image to the selected frame.

(10) External image import button
Select an external image for layering.

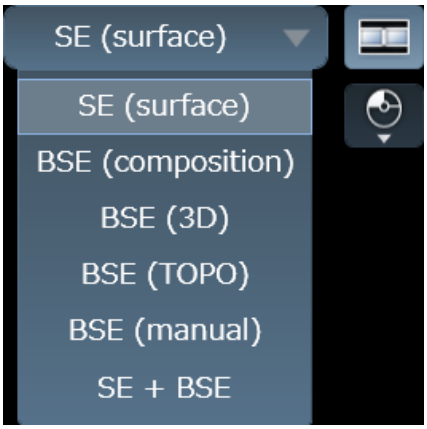
2.3.7 Image display area

Display the SEM observation image. The observation signal selection, image processing with the mouse operation on the image or other operations are possible.



(1) Observation signal select button

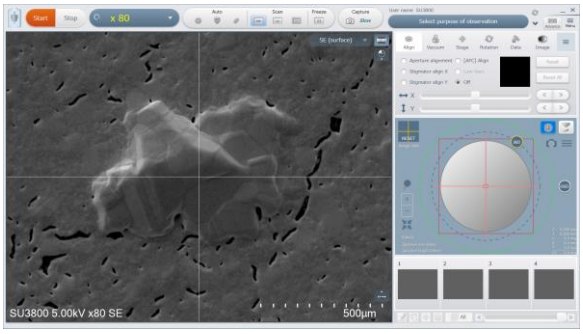
Display the selectable signals by clicking the button.



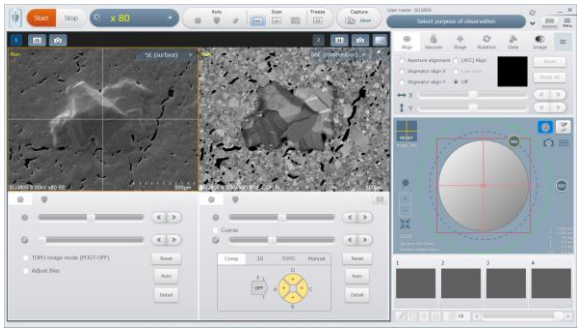
(2) Screen mode button

Switch the screen mode between 1 screen mode and 2 screen mode.

(1 screen mode)



(2 screen mode)



(3) Mouse operation select button

-  Mouse operation button.

  The mouse operation button function will be display and mouse operation can be enabled by clicking the mouse operation button. Display the each mouse operation buttons by clicking the pulldown button.

-  Focus or RISM button

  Change the mouse icon on an image to the FOCUS＆RISM mode. Adjust the focus by dragging the mouse and move the FOV by double-clicking the mouse.

-  RISM button

  Change the mouse icon on an image to the RISM mode. Move the FOV by double-clicking or dragging the mouse.

-  Stage rotation (Horizontal)

  Line up the FOV to horizontal direction on the image by rotating the R axis of stage. The guide line  is displayed on the image. The guide line will extend by dragging the left and right circles. Align the area to the guide and the R axis of stage will rotate.

  When dragging the circle and move to the image display area, the mouse operation will be deactivated.

-  Stage rotating (Vertical) button
  Line up the FOV to the vertical direction on the image by rotating the R axis of stage.
  The guide line  is displayed on the image. The guide line will extend by dragging the top and bottom circles. Align the area to the guide and the R axis of stage will rotate. When dragging the circle and move to the image display area, the mouse operation will be deactivated.
-  Raster Rotation (Horizontal) button
  Rotate the FOV with mouse operation.
  The guide line  is displayed on the image. The guide line will extend by dragging the left and right circles. Align the area to the guide and the FOV will rotate due to the RR function.
  When dragging the circle and move to the image display area, the mouse operation will be deactivated.
-  Raster Rotation (Vertical) button
  Rotate the FOV with mouse operation.
  The guide line  is displayed. The guide line will extend by dragging the top and bottom circles. Align the area to the guide. The FOV will rotate due to RR function.
  When dragging the circle and move to the image display area, the mouse operation will be deactivated.
-  Cross-marker
  Display the cross-marker on an image.
  The cross point will move by dragging the center of the cross-marker. In addition, the color of the cross-marker can be changed by clicking the split button (▼).
-  Center marker
  Display the cross-marker on the image.
  The center maker cannot be moved. However the color of the center maker can be changed by clicking the split button (▼).
-  Stage move button
  Display the stage move button on an image.
  Stage can be moved by operating each button. Click the mouse and move the stage by

steps. The amount of step can be set on the step move dialog. Press and hold the mouse for moving the stage constantly.

(4) Tool select button

-  Astigmatism correction

  Correct the astigmatism correction by the mouse operation. The stigmator adjustment slider are displayed. The top slider indicates the X, the bottom slider indicates Y.

  Move the sliders to adjust the stigmator.

-  Brightness and Contrast adjustment

  Adjust the brightness and contrast by the mouse operation. The brightness and contrast adjustment sliders are displayed. The top slider indicates the brightness, the bottom slider indicates contrast.

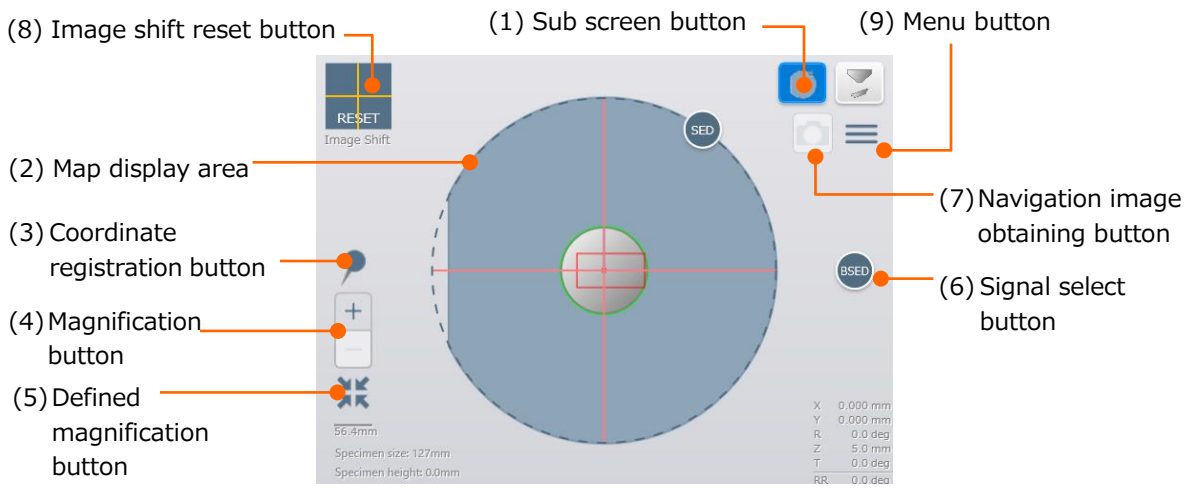
  Move the slider to adjust the brightness and contrast.

(5) Data display area

Display the observation condition.

2.3.8 Sub screen display area

Display the SEM MAP, chamber scope (option) or stage image.



(1) Sub screen button

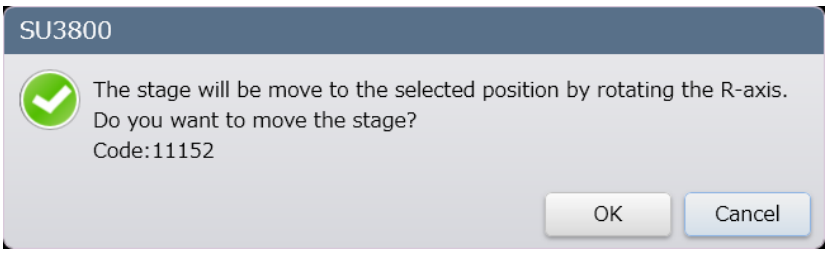
Select a function for displaying on the sub screen.

(2) Map display area

Indicate the present specimen stub with gray color. X and Y axes are moved by dragging the Map display area.

The red square frame indicates the XY axes movable range. Click the desired point within the frame, move the X and Y axes will be moved so that the selected point will be the center of the FOV.

The green circle frame indicates the movable range while rotating the R axis. The following message will be displayed by clicking the desired point. The stage of X, Y and R axes will be moved to the center of FOV by clicking the [OK] button.



(3) Coordinate registration button

Register the observing stage coordinate. The stage can move to the registered coordinate.

(4) Magnification button

Change the magnification of the MAP display area.

(5) Defined magnification button

The magnification of the Map display area will be set to the defined magnification. Set the magnification in the [SEM MAP setting] dialog.

(6) Signal select button
Select a detection signal for displaying on the image display area.
SED, BSED, UVD are available under the High vacuum mode and BSED and UVD are available under the High vacuum and VP mode.

NOTE: EDS icon is displayed while EDS detector is equipped. This EDS icon indicates the EDS detector and specimen positions.

(7) Navigation image obtaining button
Obtain the observing SEM image as a Navigation image as well as the position information on the Map area.

NOTE: The observing SEM image cannot be obtained when the magnification is higher than x2,000 or number of obtained images reach to 40.

(8) Image shift reset button
Reset the image shift amount.
(9) Menu button
Set the SEM MAP settings.
(a) Navigation image management
Display [Navigation image management] dialog as shown in the following figure.

 : Move button
Move the stage to the position where the selected navigation image is obtained.

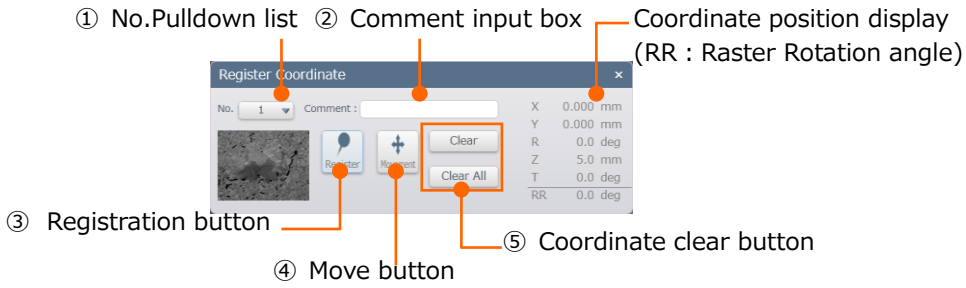
NOTE: The move button cannot be used in the navigation image which is added by the external image import.

 : Delete button
Delete the selected Navigation image.

: All select button
Select all Navigation images.

(b) Coordinate registration

Display [Register Coordinate] dialog.



① Number (No.) Pulldown list

Select the registered coordinate number.

② Comment input box

Input the comment of the selected coordinate number.

③ Registration button

Register the observed stage coordinate.

④ Move button

Move the stage to the position that is selected coordinate number at ①.

⑤ Coordinate clear button

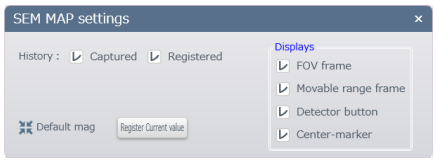
Clear the coordinate of selected number by pressing [Clear] button. In addition, all coordinates can be cleared by pressing [Clear All] button.

(c) Import an external image

A camera image of the specimen for observing, an optical microscope image, or simple drawing can be loaded and used as a navigation image. Perform the 3 point alignment according to the instruction on the display.

(d) SEM MAP settings.

Set the SEM MAP settings.

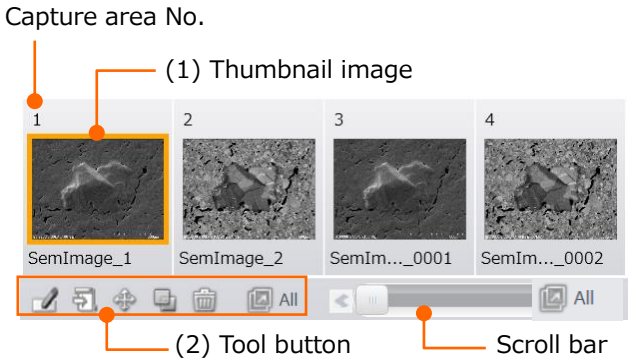


(e) Save the SEM MAP image

Save the present SEM MAP as an image. However, the frame of the FOV and detector button, center marker will not be displayed.

2.3.9 Image list display area

The captured and saved will be reduced and displayed in the list.

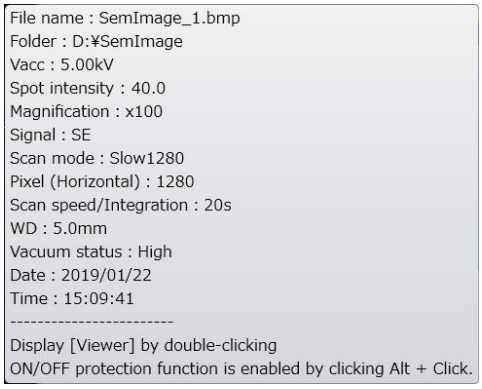


(1) Thumbnail image

Reduce and display the captured image.

The image will be enlarged by double-clicking on the thumbnail image.

The image detailed information will be pop-up by placing on the mouse cursor on the thumbnail.



Yellow frame is displayed by clicking the thumbnail image and the image will be selected condition. Thus, the selected image can be operated with the tool button.

(2) Tool button

Perform the following operations.


: Rename

Change and save the selected image file name. When multiple images are selected, change and save the file in order to the selected capture area number.


: Observation condition registration

Register the observation condition of selected capturing image.


: Move

Move the stage to the stage coordinate of the selected image. This function cannot be performed when multiple images are selected.

 : Overlay

Transfer the selected image to the overlay function.

 : Delete

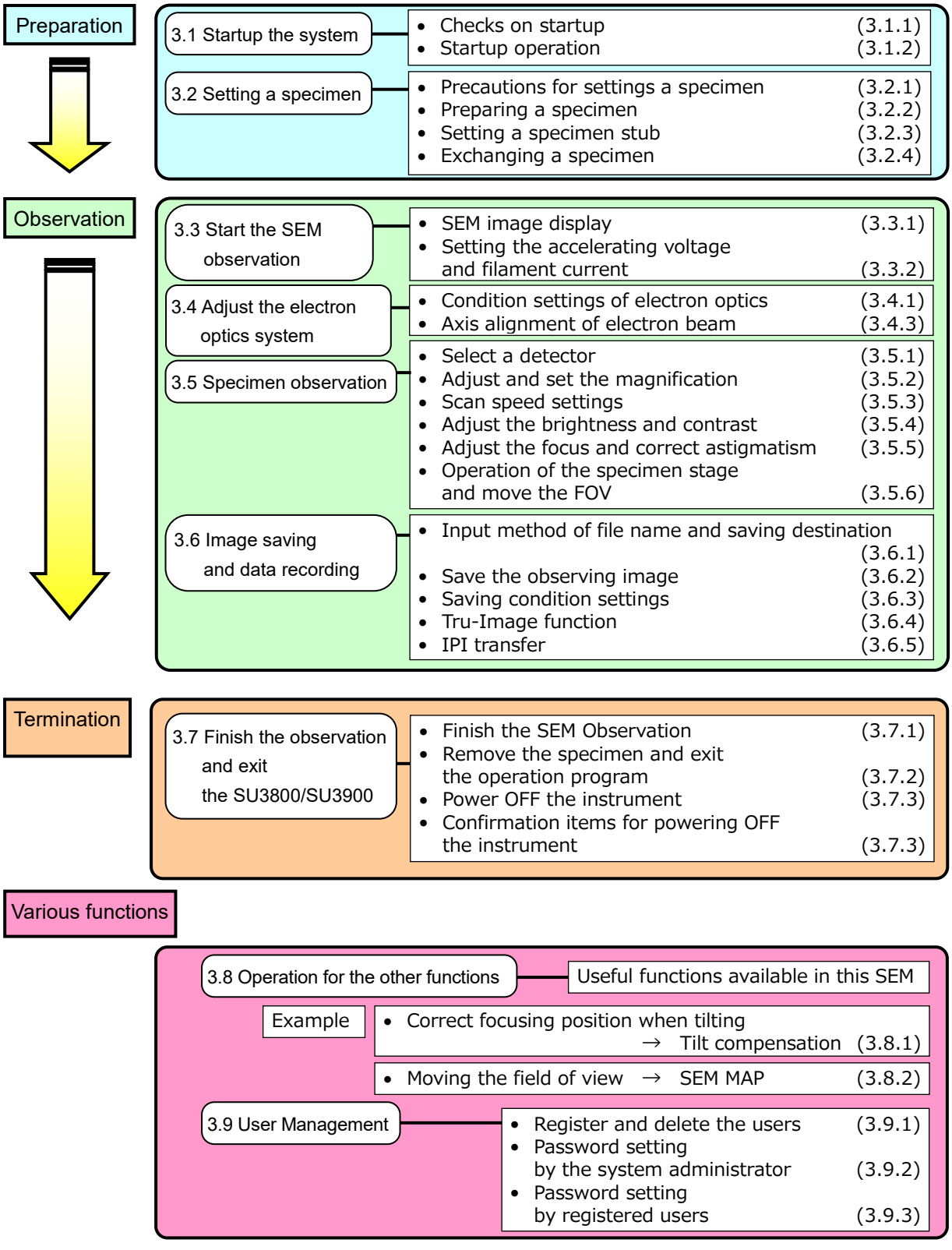
Delete the original selected image from the saving destination and the reduced image from the thumbnail list.

: Select All

Select all images in the thumbnail list.

3. Operation

This chapter describes the operation of SU3800/SU3900.
The following shows the basic operation flow of SU3800/SU3900. Refer to the each items for details.

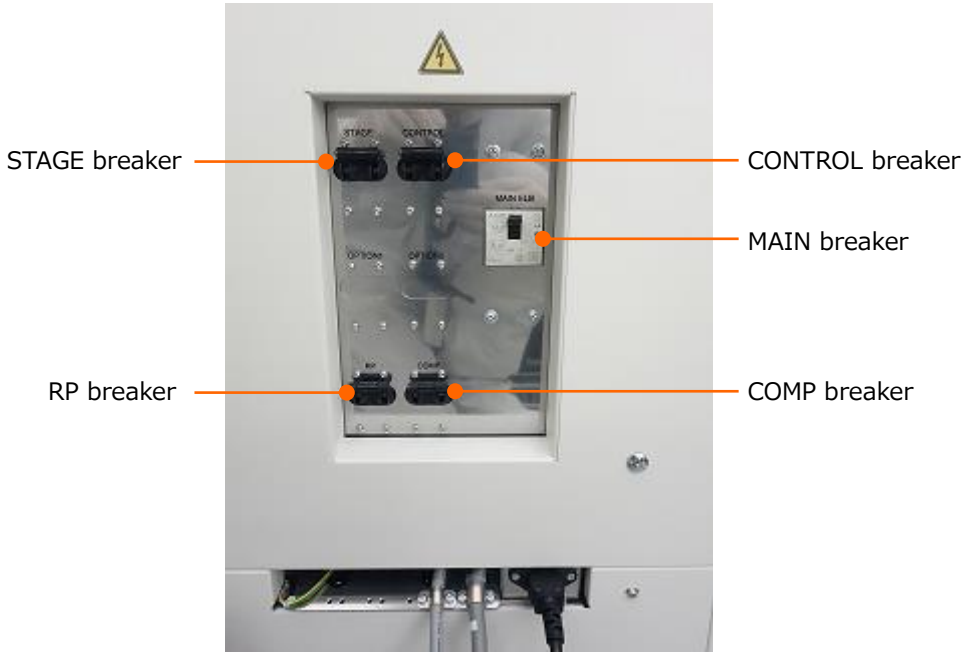


3.1 Startup the system

3.1.1 Checks on startup

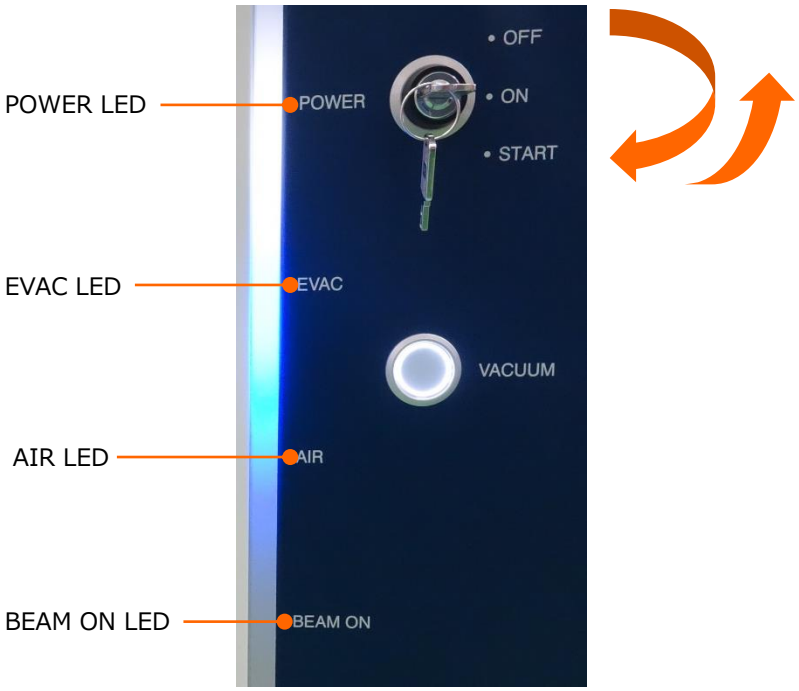
Perform the followings before starting up the system.

(1) Check the quantity and quality of the rotary pump oil.
(2) Check if flexible tube between the rotary pump and main unit are appropriately connected.
(3) Check if the drain cock of the compressor is firmly closed.
(4) Check if the compressor valve is released.
(5) Check if the switchboard breaker at the customer site is ON.
(6) Check if all switchboard breakers of the instrument at the rear side of the main unit are ON.



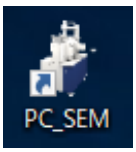
3.1.2 Startup operation

(1) Insert the key to the LED panel. Rotate the key to the START position and release it. The key is stop at the ON position by rotating to the START position then, the instrument will be started.
The column unit will be ready when the EVAC LED (Blue) is ON from blinking and buzzer sounds.



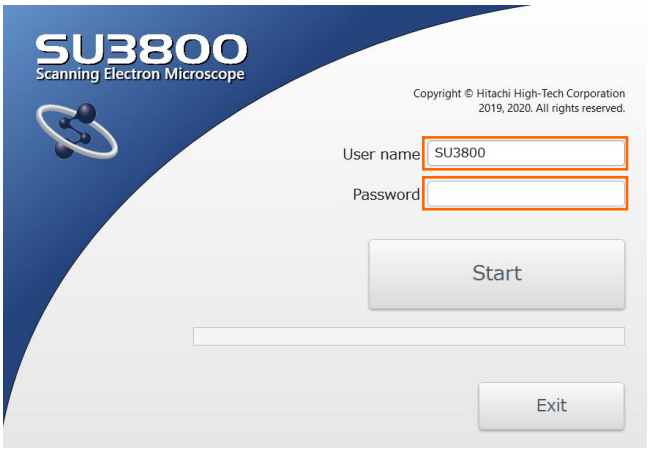
NOTE: When the specimen chamber was in the atmospheric condition (AIR condition) at the last shut down, the instrument will start up with the specimen chamber in the atmospheric condition.
In this time, the AIR LED (Orange) is blinking. When the condition to exchange a specimen is possible, the LED and buzzer are ON. The specimen chamber must be in the vacuum condition for observing a specimen. Check if the specimen stage is completely inserted and start to pump air from the specimen chamber.

(2) Startup the SEM operation program on the PC. Double click the PC_SEM icon.

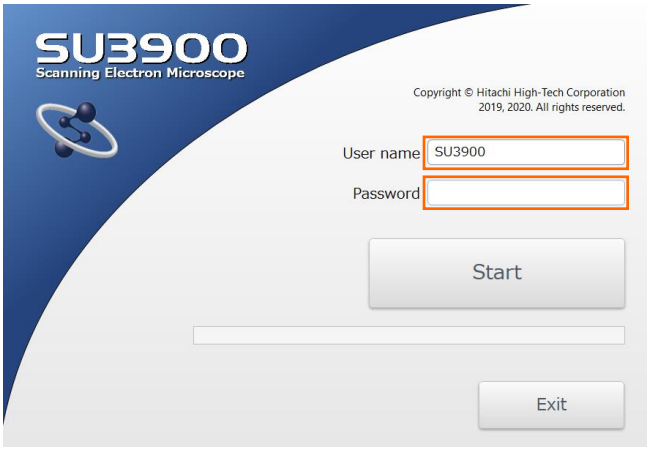


(3) Enter the user name and password in the displayed dialog and click the start button.
The user name and password under the shipping condition are displayed in the below.
User name (for SU3800) :SU3800
User name (for SU3900) :SU3900
Password : None

NOTE: Desired login name and password can be set.
The user registration is recommended to perform before operating the instrument.

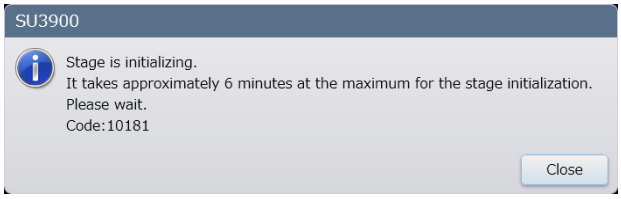


SU3800



SU3900

(4) The stage initialization starts. The dialog below will be displayed.
After completion of the initialization, the SEM operation window will open.



3.2 Setting a specimen

This section describes the specimen setting method. In addition, the differences of the setting method between SU3800 and SU3900 are described.

3.2.1 Precautions for settings a specimen

Note the followings for setting a specimen on the specimen stub.

NOTE:
- Wear clean gloves for handling the specimen or specimen stub.
- Select an appropriate size of specimen stub. If the inappropriate specimen stub is selected, the protection of specimen cannot be performed and specimen or instrument can be damaged.
- When using the double-sided conductive adhesive tape to the stub, cut the tape as least as possible for reducing outgassing. The use of double-sided adhesive tape can also cause specimen drift.
- Avoid using an excessive amount of conductive paste to fix a specimen on the specimen stub. Ensure that the paste has dried before setting the specimen holder on the specimen stage. Too much paste can release a large quantity of gas into the vacuum, which can cause the vacuum level to decline and result in contamination.
- Blow adequately an excessive powder of specimen with a blower after mounting the specimen on the double-sided conductive adhesive tape. An unfixed specimen can cause contamination in the column, results in image disturbance.
- Mounting a specimen containing an excessive amount of water can cause contamination in the column. Reduce the water and oil to least amount before setting the specimen holder on the specimen stage.

3.2.2 Preparing a specimen

The method of specimen preparation varies with different materials. Listed below are typical preparation methods for various types of specimens.

(1) Conductive specimen: Metals etc.
These types of specimen scan be observed and analyzed without preparation.

(2) Non-conductive specimen: Semiconductors, fibers or polymeric materials etc.
These types of specimen can be observed an analyzed using the VP mode or a low accelerating voltage without prior treatment. When observing a specimen at high magnification, mount the specimen onto a stub, coat the specimen with a metal coating (such as ion sputtering and magnetron-sputtering), and then observe in the high-vacuum mode.

(3) Biological specimen

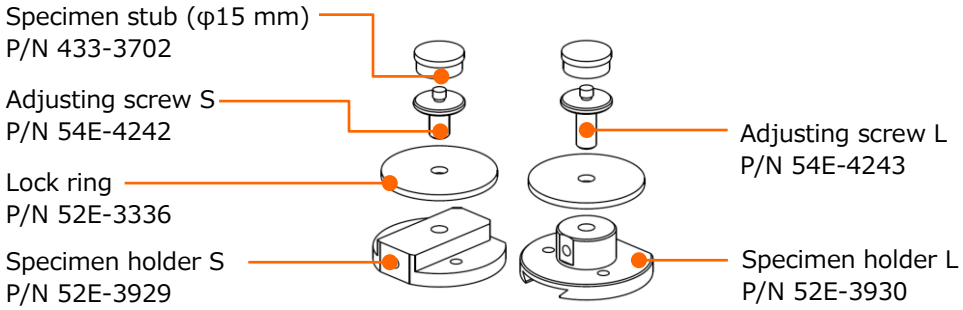
Specimens such as plants and insects with low content water can be observed and analyzed in the VP mode without prior treatment. When observing a specimen at high magnification or a specimen with high content water, coat the specimen with a metal coating and observed in the high-vacuum mode after the pre-treatment (fixation, dehydration, critical point drying or freeze drying).

3.2.3 Setting a specimen stub

The shape of specimen holder are diffenrent in SU3800 and SU3900, which are described in this section.

SU3800

Three types of specimen holder and two types of adjusting screw are attached in the SU3800. Select a specimen holder and adjusting screw depending on the observation target.
Fix the specimen stub by combining the adjusting screw (S or L), lock ring and specimen holder (S or L) as shown in the Figure.
The 80 mm specimen holder is for a specimen with large height.
Adhere the specimen to the specimen holder.
Make sure to fix the adjusting screw while pressing the lock ring to the specimen holder for fixing it firmly.

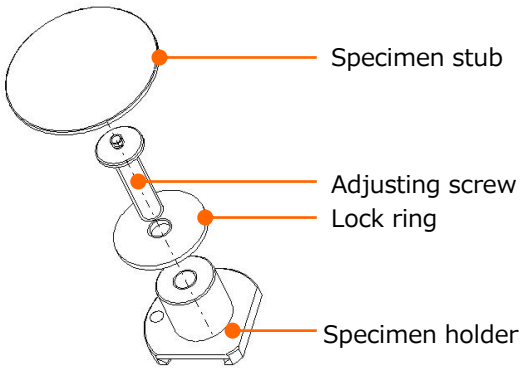


SU3900

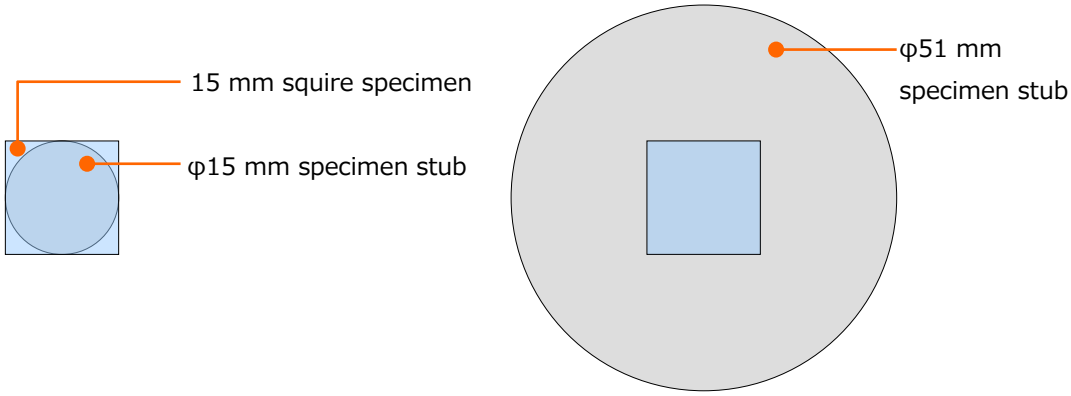
Three types of specimen holder and five types of adjusting screw are attached in the SU3900. Various combinations of the specimen holders and adjusting screws are available as shown in the table below. Select an appropriate combination depending on the height of observing specimen.

Specimen height	Specimen holder	Specimen holder P/N	Adjusting screw	Adjusting screw P/N
0 to 14 mm	Holder L (Height 24 mm)	52E-4726	Adjusting screw 46 mm	52E-4724
14 to 28 mm	Holder L (Height 24 mm)	52E-4726	Adjusting screw 32 mm	52E-4723
28 to 38 mm	Holder L (Height 24 mm)	52E-4726	Adjusting screw 18 mm	52E-4722
8 to 42 mm	Holder S (Height 12 mm)	52E-4725	Adjusting screw 18 mm	52E-4722
42 to 46 mm	Holder S (Height 12 mm)	52E-4725	Adjusting screw 14 mm	52E-4721
46 to 50 mm	Holder S (Height 12 mm)	52E-4725	Adjusting screw 10 mm	52E-4720
55 to 130 mm	Specimen stub for 130 mm	52E-4774	–	–

Combine the adjusting screw, lock ring and specimen holder then fix specimen stub to the adjusting screw as shown in figure below.
Make sure to fix adjusting screw while pressing the lock ring to the specimen holder for fixing it firmly.
The 130 mm specimen holder is for a specimen with large height. Adhere the specimen to the specimen holder.



NOTE: The attached specimen stub is round shape. Select an appropriate specimen stage, which can fit entire specimen when setting an angular shape specimen.
If inappropriate specimen stub is selected, the protection of specimen cannot be performed and the specimen or instrument can be damaged. For an example, the diagonal line will be 21 mm for the 15 mm square shaped specimen. The specimen cannot fit in the φ 15 mm specimen stub. Thus, select the φ 51 mm specimen stub for fitting the entire specimen.



NOTE: The specimen stub assemble of standard attachment is designed for observing a specimen with light weight. When observing a heavy specimen that is more than 200 g while tilting, use a specimen holder for heavy weight (option).

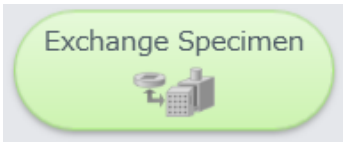
3.2.4 Exchanging a specimen

The following describes the specimen exchange procedures.

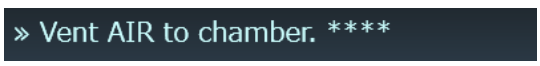
(1) Stop the observation by clicking the [Stop] button if the SEM observation is performed.

(2) Extract the BSE detector that is placed at right bottom of the objective lens.
If the BSE detector is inserted, rotate the operation handle of BSE detector to the OUT side until the end.
When the BSE detector is inserted, the IN LED in the BSE detector operation panel is ON. The both IN and OUT LEDs are blinking while the BSED is moving and the OUT LED is ON when the BSED is in the extracted position.

(3) Click the [Exchange Specimen] button.
Vent air to the specimen chamber. It takes few minutes to complete.



When the specimen chamber is in the atmospheric condition, AIR LED in the LED panel is ON and buzzer sounds three times.
The present status is displayed at the upper left on the image display area while venting air to the specimen chamber.



Specimen set dialog is displayed.

(4) Exchange a specimen according to the [Specimen Settings] dialog.
The specimen can be exchanged by 6 steps.
Step 1: [Select [Exchange Specimen] or [Remove Specimen]]
Step 2: [Select stub]
Step 3: [Adjust specimen height]
Step 4: [Draw out stage]
Step 5: [Confirm height, Insert stage]
Step 6: [Condition setting, Evacuate air]

Step 1: [Select [Exchange Specimen] or [Remove Specimen]
Select [Exchange specimen] in the [Specimen Settings] dialog and click [Next] button.

Step 2: [Select stub]
Select a specimen stub from the list in the left side of the [Specimen Settings] dialog.
Click [Specimen stub list settings] at the bottom left of the [Specimen Settings] dialog for adding or deleting a specimen stub.
If the size of prepared specimen stub cannot be identified. Confirm the size by comparing with the actual size that is displayed on the center of [Specimen Settings] dialog.

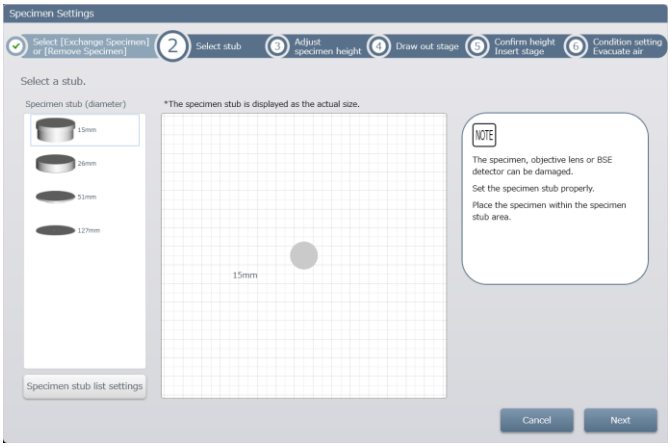
⚠ Caution: Can cause damaging the specimen due to contacting to the objective lens. Set the specimen size properly.

NOTE: The specimen and LCD monitor might be damaged if the specimen stub collides to the LCD monitor. Keep the proper distance when comparing them.

NOTE: Make sure to select a proper specimen size. The specimen, objective lens or BSED will be damaged due to collision when the specimen size is set incorrectly.

NOTE: Movable range of stage X and Y axes are limited within the set specimen stub diameter size.
The movable range is limited by calculating the safety range of Z and tilt axes depending on the set specimen size and height.

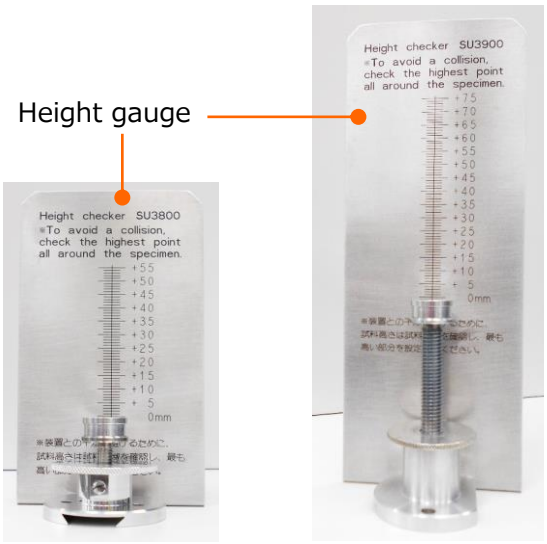
Select a specimen stub size then click [Next].



Step 3: [Adjust specimen height]

Refer to the figure that is displayed on [Specimen Settings] dialog, set the top of specimen surface at 0 mm with the attached height gauge by adjusting the adjusting screw. Fix the adjusting screw with the lock ring after adjusting the height.

When multiple specimens are mounted, adjust the height with a tallest specimen.



SU3800 SU3900

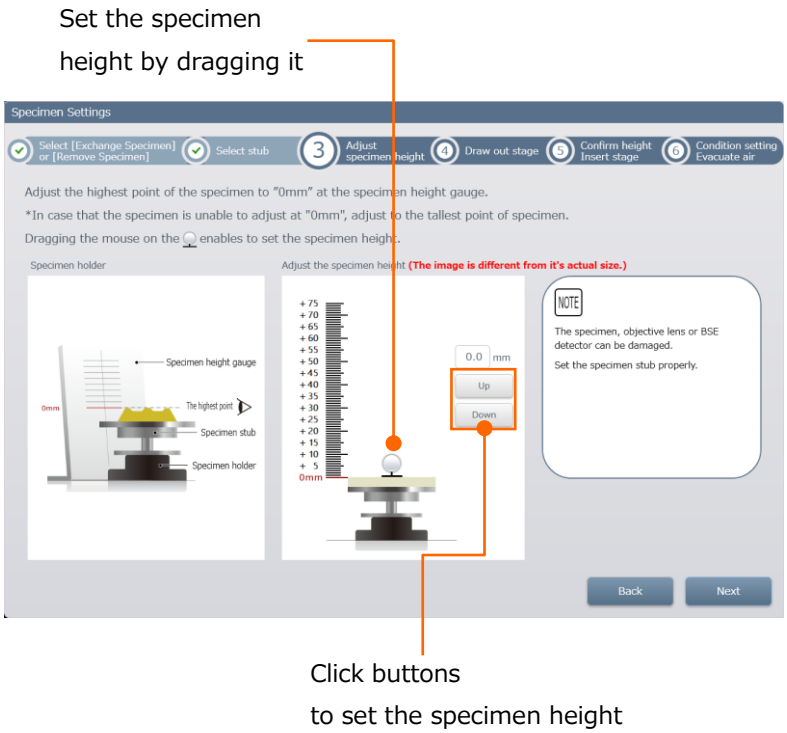
If the specimen height cannot be set at 0 mm, read and set the specimen height with the specimen height gauge. The maximum height of specimen height gauge is +55 mm in SU3800 and +55 mm in SU3900.

When the specimen height exceeds the maximum height in the combination of specimen stub, adjusting screw and specimen holder, fix a specimen on the 51 mm (H=80) specimen stub in SU3800 or the 130 mm specimen stub in SU3900. Enter the specimen height to 0 mm in the [Specimen Settings] dialog. Click [Up]/[Down] buttons or drag the ○ mark with the mouse.

NOTE: Make sure to set the proper specimen height in [Specimen Settings] dialog. The specimen, objective lens or BSED will be damaged by collusion while tilting the specimen or setting the stage Z at small value if the specimen size is set improperly. Movable range of stage X and Y axes are limited depending on the set specimen stub diameter size.

NOTE: The movable range is limited by calculating the safety range of Z and tilt axis depending on the specimen size and height.

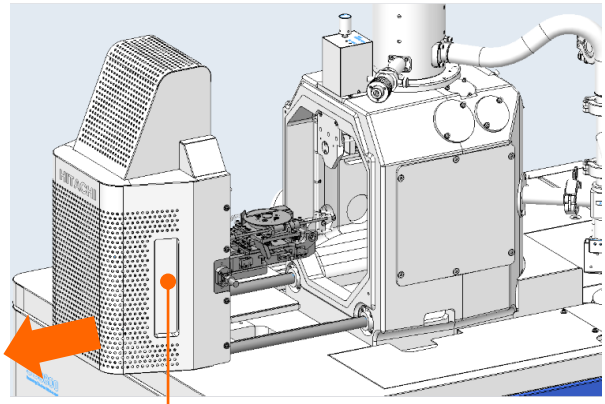
Set the specimen height and click [Next] button.



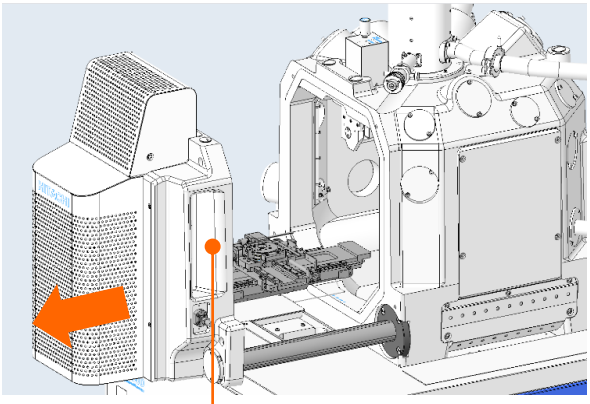
Step 4: [Draw out the stage]

Specimen stage can be pulled out when the specimen chamber is in the atmospheric condition.

Hold the both side of handles and slowly draw out the stage until the end.



SU3800



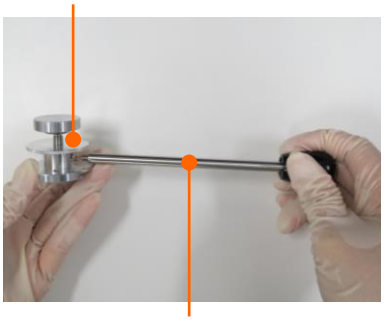
SU3900

Remove the specimen holder from the stage if the specimen holder is mounting. The specimen holder removing method is different between SU3800 and SU3900.

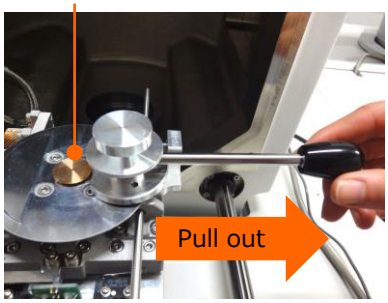
SU3800

Attach the attached specimen exchange rod to the side of specimen holder (S or L). Remove the specimen by pulling the specimen exchange rod to the right side of the instrument.

Screw part at the side of the specimen holder



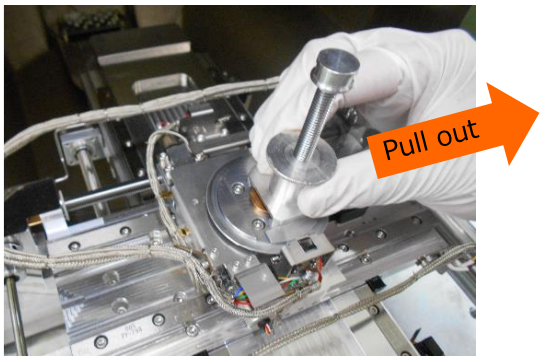
Dovetail part of the stage



SU3900

Hold the specimen holder with your fingers and slowly pull out the specimen to the right side of the instrument.

Make sure to wear clean gloves for handing the specimen, specimen stub or specimen chamber.



When removing the specimen holder, confirm that the specimen stage is drawn out completely and click [Stage Motion] button on [Specimen Settings] dialog. When the stage is completely drawn out, the [Stage Motion] button is enabled.

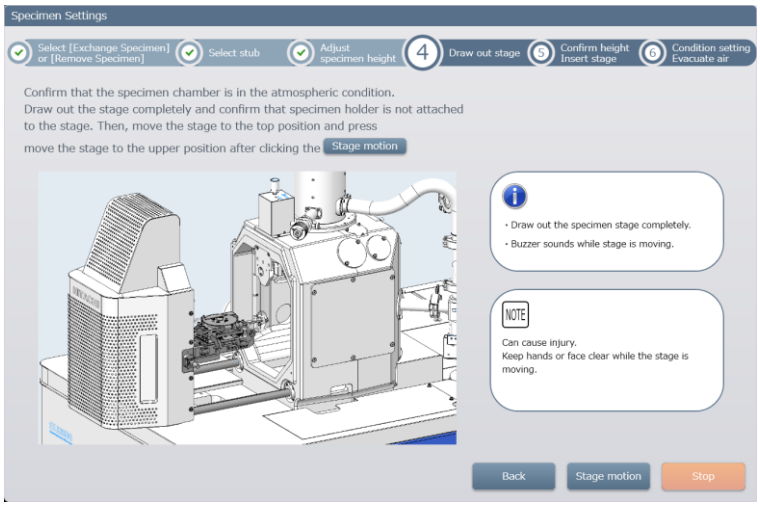
The stage will move to the top position depending on the specimen height. The buzzer sounds while stage is moving.

⚠ Caution: Keep hands, finger or hair clear from the moving parts. Do not touch the moving parts while moving the Z stage.

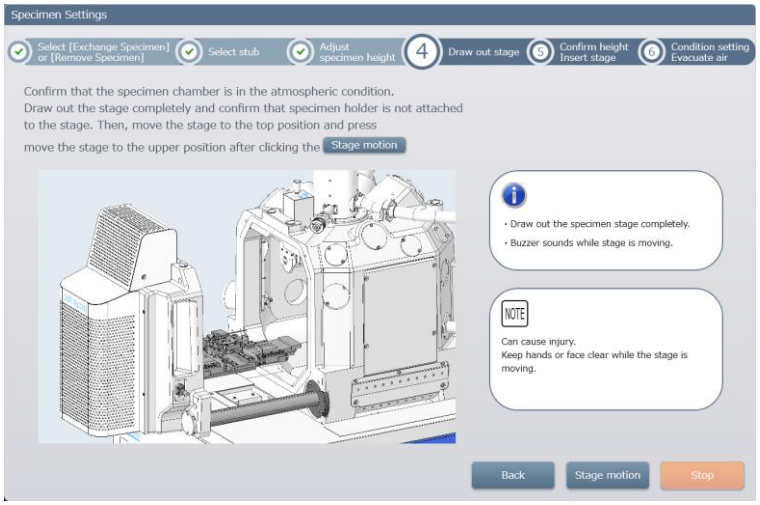
When the stage is moving to the top position buzzer is stopped and the [Specimen Settings] dialog is switched to the [Confirm height, Insert stage] dialog. Move to the step 5.

NOTE:
- Stage can be stopped by pressing [Stop] button while stage is moving. Press the [Back] button and move to the previous step for selecting a specimen stub or setting the specimen height.
- The specimen, objective lens or BSED will be damaged by contacting while tilting the specimen or setting the stage Z at small value if the specimen stub or height are set improperly.

⚠ Caution: The specimen damage due to misoperation of the customers is not warranted with or without the warranty period.



SU3800



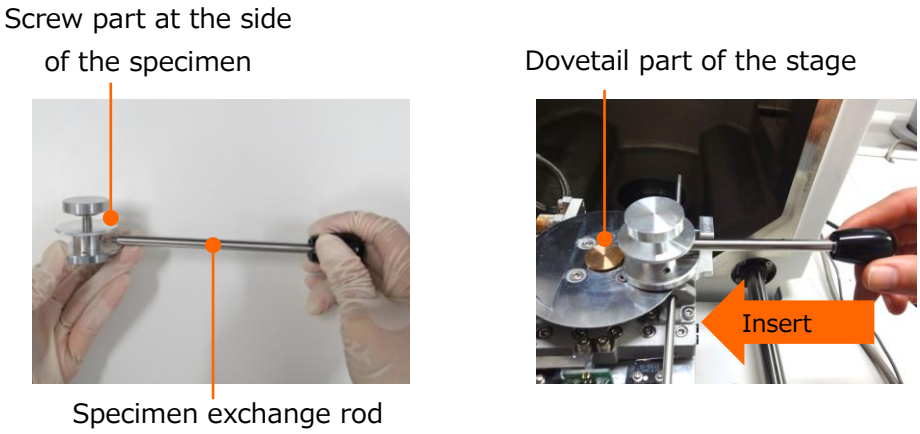
SU3900

Step 5: [Confirm height, Insert stage]

Attach the prepared specimen holder to the stage when the stage is stopped. The specimen holder setting method of SU3800 and SU3900 are different.

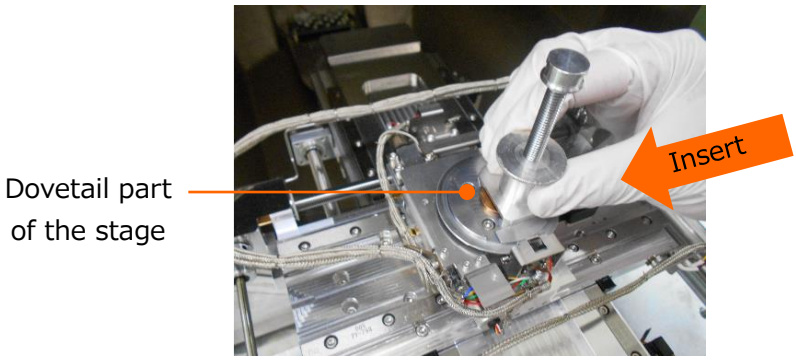
SU3800

Attach the specimen exchange rod to the side of specimen holder (S or L). Hold the specimen exchange rod and insert the notch part on the Bottom of the specimen holder to the stage projection part. Remove the specimen exchange rod after setting the specimen holder.



SU3900

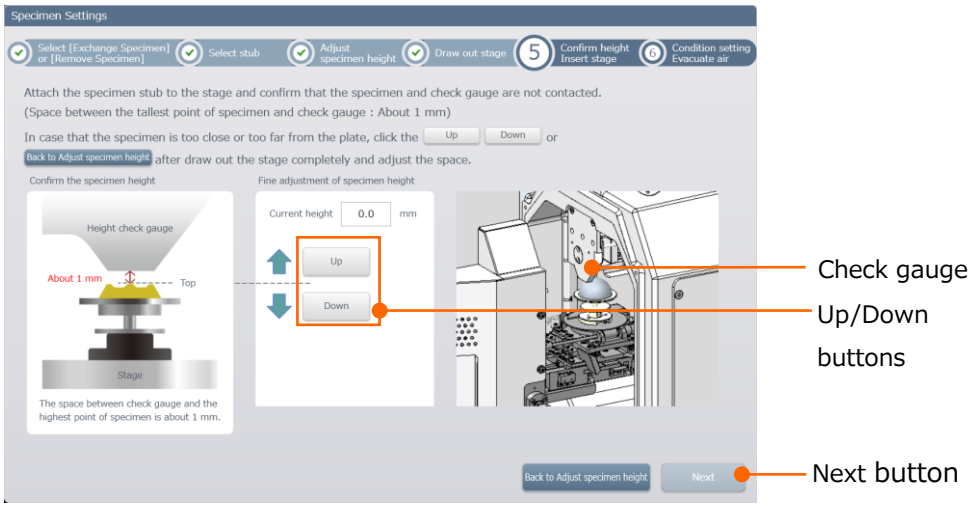
Hold the specimen holder with your fingers and straightly insert the notch part on the bottom of the specimen holder to the stage projection part.
Make sure to wear gloves for handing the specimen, specimen stub or specimen chamber.

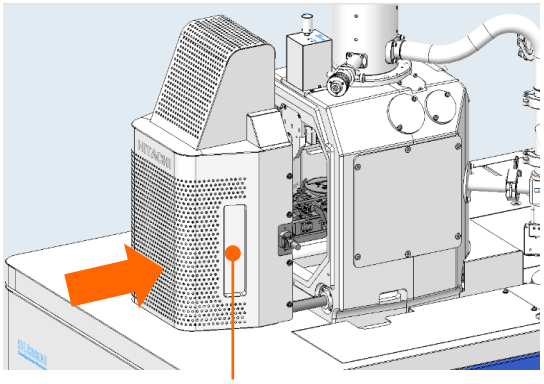


When the specimen holder is removed, hold the handles of the stage at the both side and slowly insert the specimen stage to the specimen chamber. Refer to the [Specimen Settings] dialog and confirm that space between the specimen and check gauge are approximately 1 mm without contacting the specimen to the check gauge.
The specimen height is properly set when the space between the specimen and check gauge is approximately 1 mm. Insert the stage to the specimen chamber.
If the specimen and check gauge are contacting or the space between the specimen and check gauge is more than 1 mm, click [Up]/[Down] on [Specimen Settings] dialog or enter a value in the specimen height setting box. In this time, the specimen height that is set at Step 2 will be changed automatically.
Click [Up]/[Down] button and specimen height is changed by 0.5 mm steps. Value of specimen height setting box can be entered by 0.5 mm pitch.
Fine adjustment of specimen height can be set within the 0 to +55 mm in SU3800 and 0 to +75 mm in SU3900.

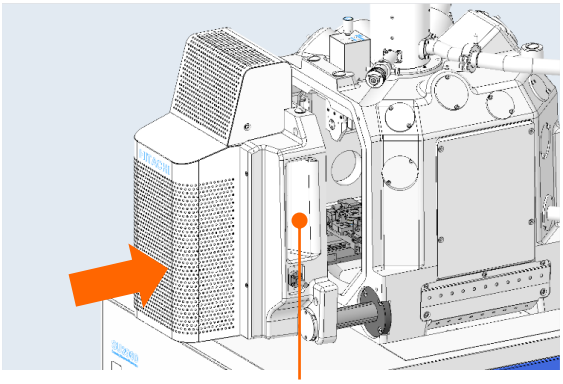
⚠ Caution: Can cause injury of your hands when inserting the specimen stage. Hold the handle and slowly insert the specimen stage.

When stage is inserted into the specimen chamber, the [Next] button is enabled. Click the [Next] button.





SU3800



SU3900

Insert the specimen stage

Step 6: [Condition setting, Evacuate air]

Set the observation condition on the [Specimen Settings] dialog.
Three observation condition setting methods are available. Select a desired setting method from three tabs in the [Specimen Settings] dialog.

[Manual setting] tab

Vacuum mode setting, stage position settings and electron beam settings can be performed.
In the vacuum mode settings, the pressure value of the specimen chamber in the vacuum condition can be set. When the VP mode is selected, pressure of the specimen chamber during the observation can be set.
In the stage position settings, Z-axis coordinate when the observation is started can be set.

- Observation Z 5 mm:
  Move the stage where the optimal height for observing. (Z=5 mm)
- EDS Z 10 mm:
  Move the stage where the optimal height for analysis. (Z=10 mm)

The electron beam settings can be possible when the [Set the observation conditions] check box is ON.
In addition, this setting can be performed in the [Menu] > [Vacuum mode settings] > [Electron beam settings].

[Observation purpose] tab

Preset setting of observation depending on the observation purpose can be set in the tab. In addition, the stage Z will be moved to the 10 mm when selecting the element analysis. This setting can be performed at [Menu] > [Select purpose of observation].

[Observation condition] tab

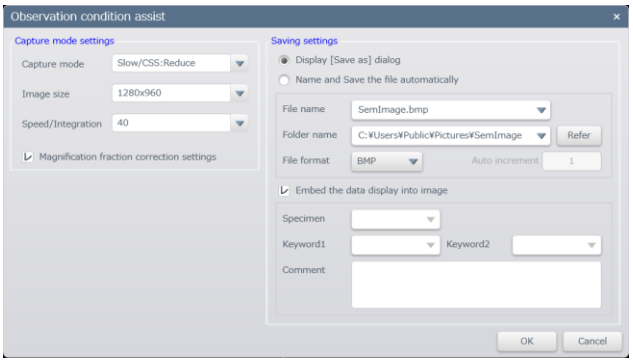
The previously registered observation can be loaded and set in this tub. In addition, this setting can be performed by selecting [Menu]> [Observation condition] > [Load].
In addition, the stage X and Y move to the home position and the Z moves to 5 mm when stage movable range of the loaded observation condition is out of the movable range. This setting can be performed at [Menu] > [Observation condition].

NOTE: Make sure to set the specimen height properly in the [Specimen Settings]. The specimen, objective lens or BSED will be damaged due to collusion when the specimen size is set improperly.

When setting the observation condition, click the [EVAC] button on the bottom right of the [Specimen Settings] dialog for pumping air from the specimen chamber.
In the condition of shipping, the [Observation condition assist] dialog will be displayed by clicking the EVAC button. The [Capture mode settings] and the [Saving settings] can be performed.

[Capture mode settings]
File format or saving folder of captured image can be set. In addition, this setting can be performed by clicking the [Capture settings] in the [Menu].

[Saving settings]
The file format or saving folder of capturing image can be set. In addition, this setting can be performed by selecting [Saving condition settings] in the [Menu].



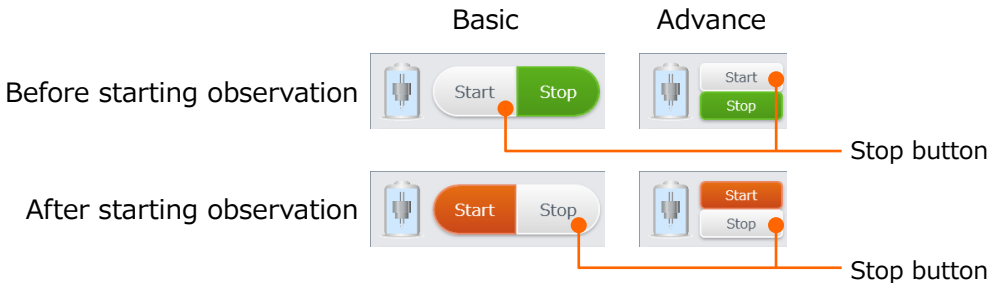
EVAC LED (Blue) in the LED panel is blinking while pumping air from the specimen chamber. When the specimen chamber is in the vacuum status, EVAC LED is ON and buzzer sounds. The message of “Ready to start observation” is displayed at upper left of the display area.

3.3 Start the SEM observation

3.3.1 SEM image display

Electron beam is irradiated and SEM image which brightness and focus are controlled is displayed on the image display area by clicking [Start] button in the control panel. In this time the [Start] button is indicated in orange color.

NOTE: The [Start] or [Stop] button is indicated in gray color (Deactivated status) and the SEM observation cannot be performed while pumping air from the specimen chamber or the specimen chamber is in the atmospheric condition.
In this condition, wait until the specimen chamber is reaches to the vacuum condition and the [Start] button is enabled.



3.3.2 Setting the accelerating voltage and filament current

Set the accelerating voltage and filament current depending on the observing specimen or observation purpose.

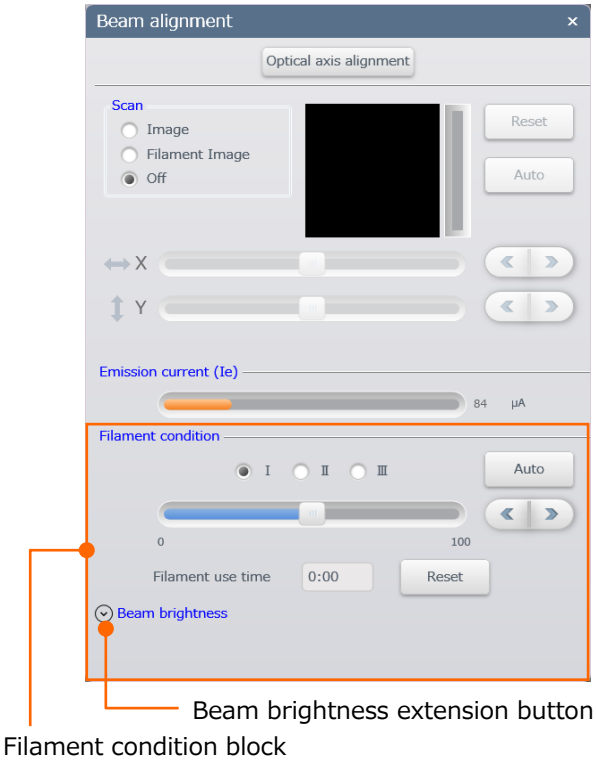
- Set the [Filament]

  Display [Beam alignment] dialog by clicking [Beam alignment] on [Electron beam settings] dialog. Select [Ⅰ], [Ⅱ] or [Ⅲ] in the [Filament condition] block and set the filament current by clicking [Auto] button. Filament current increase from [Ⅰ] to [Ⅲ]. Filament setting [Mid] of the previous model (SU3500) is equivalent to [Ⅰ] of the SU3800/SU3900. The [Ⅰ] is recommended for the normal observation. Select [Ⅱ] for high magnification and high contrast observation. Select [Ⅲ] for more high contrast observation. However the filament lifetime is shorten.

  Set filament current when replacing the filament or setting the filament to [Ⅰ], [Ⅱ] or [Ⅲ]. In addition, the filament current can be set manually by moving the slider.

Filament current and image quality

Change factor and influence on image	Filament current Low ⇨ High
S/N ratio of image	Low → High
Irradiation current	Low → High
Filament lifetime	Long → Short
Brightness	Dark → Bright



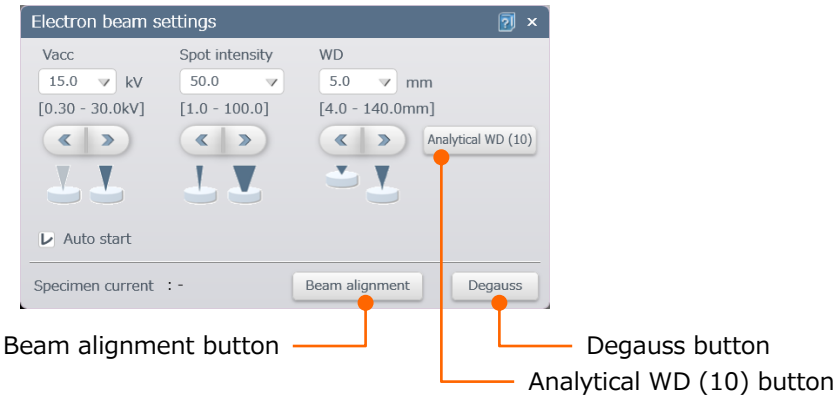
Brightness of the captured image can be controlled by adjusting the emission current in the [Beam brightness] function. Click the extension button of the beam brightness and the beam brightness settings menu will be displayed. Beam brightness value can be adjusted manually by selecting [Manual] in the [Beam brightness] block. Set the value from 0 to 100 by moving the slider. Set at the large value for setting the emission current to the large and small value for setting the emission current to small value. Select [Auto] for the normal observation.

NOTE : In addition to the filament current setting, enhance the beam brightness for the low accelerating voltage observation or X-ray analysis with large emission current. However, the optical axis may be shifted when setting at the larger value. In this case, perform the optical axis alignment.

3.4 Adjust the electron optics system

3.4.1 Condition settings of electron optics

Set the focus position (WD) [Working distance] of electron beam, spot intensity [Spot] and objective aperture depending on the observation specimen and observation purpose.
Display [Electron beam settings] dialog by clicking [Select panel] > [Electron beam condition display] panel or select [Menu] > [Electron beam settings].
Set the focus point (WD) [Working distance] of the electron beam and [Spot intensity] depending on the observation specimen and observation purpose. Fine adjustment can be performed with the spin button by 0.1 step or enter the value directly into the combo box by 0.1 step (Define the value by pressing the Enter key).



The following settings or adjustment can be performed in the electron beam settings dialog.

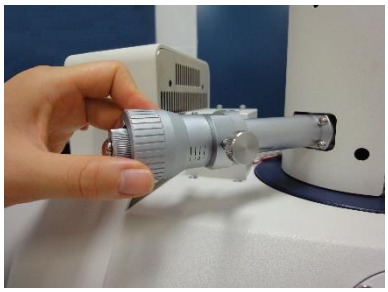
- Analytical WD (10) button
  Set the focus position (WD) of electron beam for EDs analysis or other observation. In this function, only the focus position (WD) of electron beam is set. The Z axis of specimen stage will not be moved.
- Degauss button
  Eliminate residual magnetic field of the objective lens. When focus is greatly changed, the accuracy of WD display and magnification will be degraded due to the residual magnetic field. Perform the degauss function in the following condition.
  - When the focus is greatly changed.
  - Before performing the axis alignment of optical system (Electromagnetic alignment).
- Beam alignment button
  Display [Beam alignment] dialog by clicking the button.

3.4.2 Objective aperture settings

Select an aperture number by rotating the aperture select knob of objective aperture.
The below table shows the diameter of each aperture.

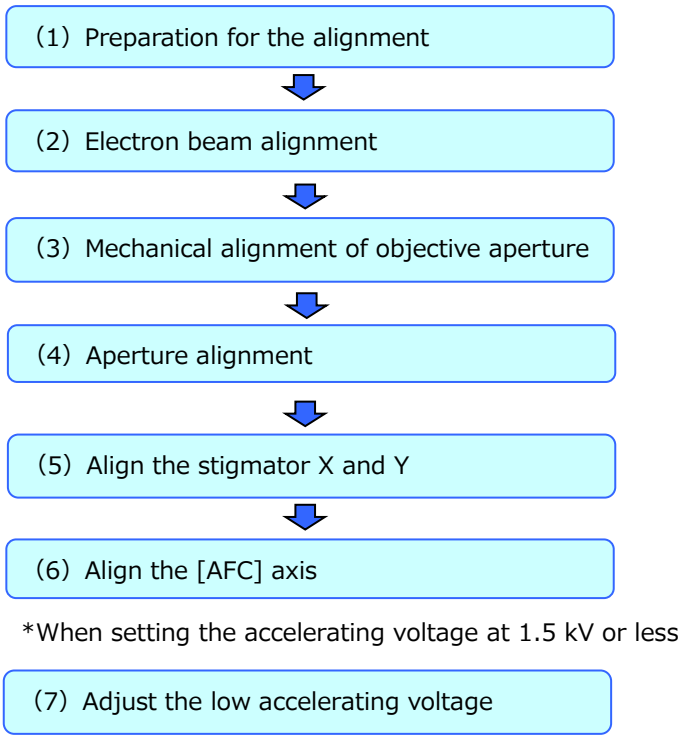
No.	μm
1	150
2	80
3	40
4	20

The electron beam will not go through the aperture by setting at No.0, which is aperture open condition.



3.4.3 Axis alignment of electron beam

Axis alignment of electron optics system is required for obtaining the best performance of the instrument.
The following shows the axis alignment procedures. Perform the required adjustment after exchanging the filament or changing the observation condition.



NOTE: Perform the alignment while observing an image.

3.4.4 Requirement of axis alignment

The following shows the required alignment items at each condition.

- After replace the filament:
  Perform the alignment of (1) to (5).
- When the objective aperture position is changed:
  Perform the alignment of (3) to (5).
- When the accelerating voltage or spot intensity is changed:
  Perform the alignment of (4) and (5).
- When the accuracy of AFC is deteriorated:
  Perform the alignment of (6).
- When the accelerating voltage is set to 1.5 kV or less:
  Perform the alignment in order to (7), (3), (4) and (5).

3.4.5 Details of axis alignment method

(1) Preparation operation for the alignment

The following operations must be performed before the axis alignment.

(a) Set an attached calibration specimen or a conductive specimen which has topographical surface.

(b) Set to the high vacuum mode.

(c) Set the specimen chamber in vacuum condition by pump air.

(d) Set the objective aperture number for normal use (except “0” (Aperture open)).

(e) Set the condition as below.

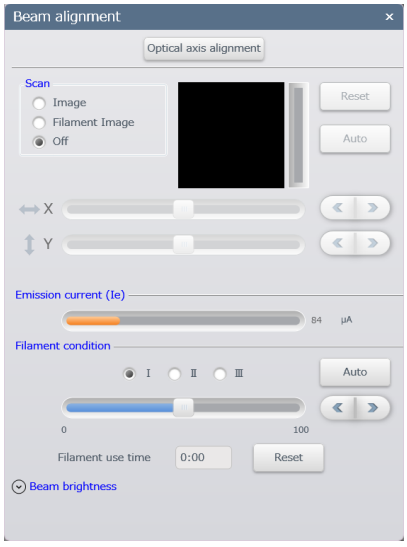
- Accelerating voltage : Accelerating voltage for normal use
- Spot intensity : Value for normal use
- WD : 5 mm (Specimen exchange position)
- Magnification : x100

(f) Click the [Start] button.

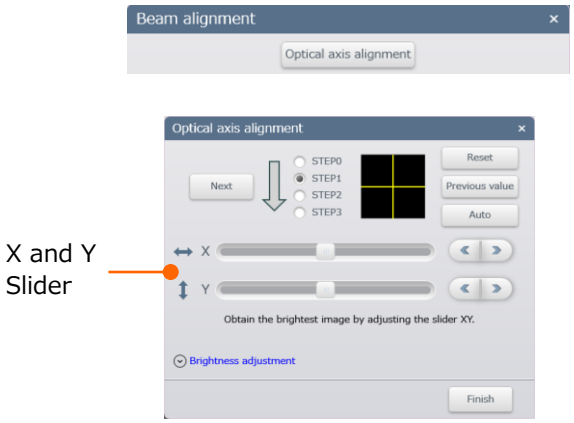
(2) Electron beam alignment

Adjust the electron beam to go through the center of electromagnetic lens and aperture.

Display the [Beam alignment] dialog by selecting [Menu] > [Electron beam settings].



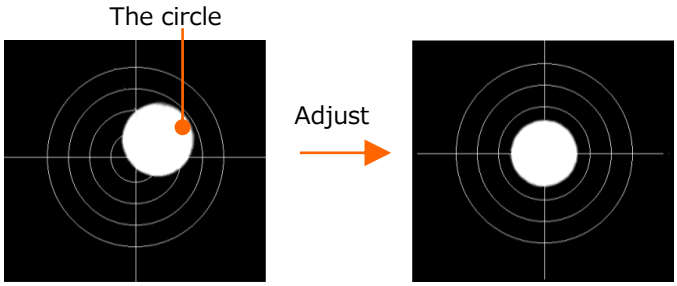
Click the [Optical axis alignment] button and display the [Optical axis alignment] dialog.



(a) Click the STEP1 radio button.
Adjust the X and Y sliders so the image becomes the brightest or click the [Auto] button.

(b) Click the STEP2 radio button.
Adjust the X and Y sliders so the circle is in the center or click the [Auto] button.

(c) Click the STEP3 radio button.
Adjust the X and Y sliders so the circle is in the center or click the [Auto] button.



(d) Click the [Finish] button and close the [Optical axis alignment] dialog.

NOTE:
- If the image does not display while setting the contrast at maximum, click the [Reset] button and perform the beam alignment.
- If the focus is greatly shifted from specimen surface, the circle image may be distorted or chipped. In this case, adjust the center of bright area to the center of the display and release the beam alignment then, focus on the specimen and perform the beam alignment again. In case that the circle is chipped or is not displayed when adjusting it to the center of image while performing the beam alignment, perform the mechanical alignment according to the (3) Mechanical alignment of objective aperture procedures.

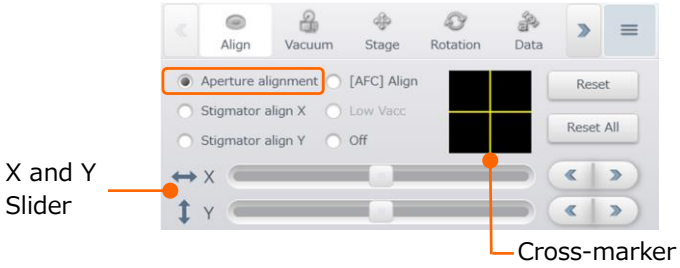
(3) Mechanical alignment of objective aperture

Adjust the mechanical alignment of objective aperture so that the electron beam goes through the center of the objective aperture.

NOTE: The beam alignment may be shifted when performing the objective aperture is changed. In this time, perform the mechanical alignment of objective aperture.

(a) Display the [Electron beam settings] dialog and select the [Beam alignment] button.

(b) Select the [Aperture alignment].



NOTE: Press the [MODE] button on the manual operation panel (option) and the aperture alignment mode will be activated.

(c) Click the [Reset] button and reset the [Aperture alignment].

(d) Select the [Off] button.

(e) Set the magnification to x100.

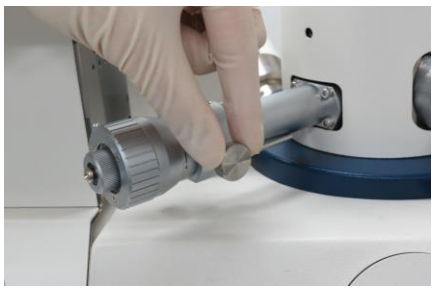
(f) Select an objective aperture number for normal use.

(g) Adjust the brightness and contrast.

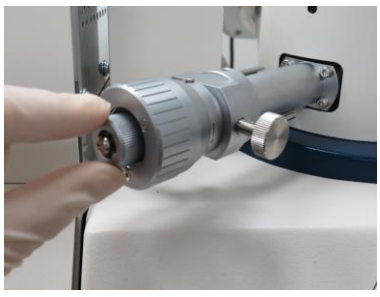
(h) Adjust the X and Y knobs of objective aperture knob to obtaining the brightest image.

NOTE: Make sure to rotate the objective aperture X and Y knobs while monitoring. When the image becomes darker, rotate the knobs to the previous position.

NOTE: If the objective aperture is set at No.0 such as after the filament exchange, perform the procedure of (g) to (h) at each number in order from No.1.



X direction



Y direction

(4) Aperture alignment

Perform the [Aperture alignment] so that the electron beam goes through the center of the objective aperture. Perform this alignment when accelerating voltage or spot intensity is change. Resolution of image may be degraded due to shifting the FOV while changing the focus without this alignment.

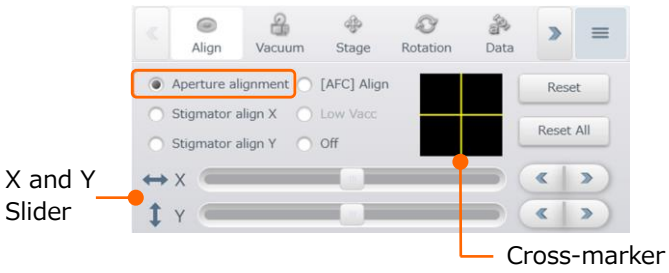
(a) Observe the characteristic area on the image at x1, 000 to 5,000.
(b) Correct the focus and astigmatism of the image.

NOTE: It is important to adjust the focus property for performing the aperture alignment accurately.

NOTE: The aperture alignment cannot be performed accurately under the low magnification (several hundred magnification). Set the magnification more than x1,000.

NOTE: Set the scan speed to Red1 for high vacuum, to Red3 (Set the detector gain at high) or Red1 (Set the detector gain at low) for VP mode.

(c) Click [Operation panel] > [Align] tab.
(d) Select the [Aperture alignment].
The mode will be in the aperture alignment mode and image will be moved periodically.



NOTE: The aperture alignment mode can be activated manually by clicking the [MODE] button on the manual operation panel (option).

(e) Adjust the X and Y sliders so the image movement is minimized. In addition, the image movement can be minimized by dragging the cross-marker. When adjusting by the knobs, adjust the X knob for the X direction and Y knob for the Y direction and X and Y knobs for diagonal direction.

NOTE: Set the scan speed at Red1 for VP mode.

(f) Increase the magnification and perform the previous Step (e) operation again.
(g) When alignment completes, select the [Off].

(5) Stigmator align X, Y

Perform [Stigmator align X, Y.] for minimizing the image move during the astigmatism correction.

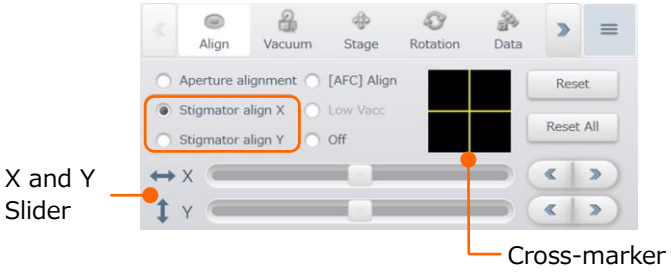
(a) Observe a characteristic area of specimen at x1, 000 to 5,000.

(b) Adjust the focus and correct the astigmatism.

(c) Click [Operation panel] > [Axial] tab.

(d) Select the [Stigmator align X].

The mode will be in the Stigmator alignment mode and image will be moved periodically.



(e) Adjust the X, Y slider to minimize the image move. In addition, this adjustment can be performed by dragging the cross-marker. When adjustment is performed with the STIGMATOR/ALIGNMENT X、Y knob on the manual operation panel, rotate the X knob when the image is moving to the X direction, rotate the Y knob when the image is moving to the Y direction and rotate a little bit in both X and Y knobs when the image is moving to the diagonal direction.

(f) Select the [Stigmator align Y] to minimize the image move.

NOTE: Set the scan speed at Red1 for the low vacuum mode.

NOTE: Aperture alignment may be shifted when Stigmator alignment is performed. Align the stigmator of X and Y, and align the aperture again when the aperture position is shifted.

(g) When the alignment completes, select the [Off].

(6) Perform the [AFC Align.]

Perform [AFC Align.] for improve the accuracy of AFC.

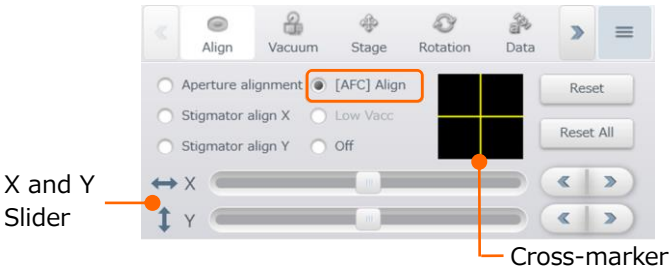
(a) Observe a characteristic area of specimen at x1, 000 to 5,000.

(b) Correct the focus and astigmatism of the image.

(c) Click [Operation panel] > [Axial] tab.

(d) Select the [[AFC] Align].

The mode will be in the AFC alignment mode and image will be moved periodically.



(e) Adjust the X and Y sliders for minimizing the image move. The image move can be minimized by dragging the cross-marker. When adjustment is performed with the STIGMATOR/ALIGNMENT X、Y knob on the manual operation panel, rotate the X knob when the image is moving to the X direction, rotate the Y knob when the image is moving to the Y direction and rotate a little bit in both X and Y knobs when the image is moving to the diagonal direction.

(f) When the alignment completes, select [Off].

(7) Adjust for the low accelerating voltage (1.5 kV or less)

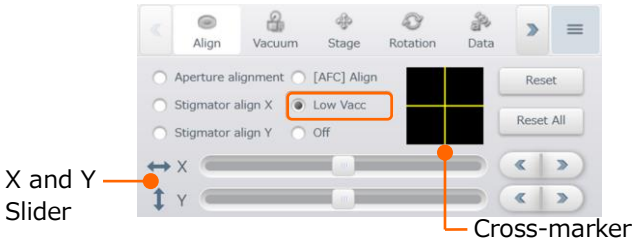
Align the electron beam axis when setting the accelerating voltage to 1.5 kV or less.

(a) Observe an image under the magnification at x100.

(b) Click the Operation panel > [Align] tub.

(c) Select [Low Vacc].

The mode will be in the low accelerating voltage alignment mode and image will be moved periodically.



(d) Adjust the X and Y sliders for minimizing the image move. The image move can be minimized by dragging the cross-marker. When adjustment is performed with the STIGMATOR/ALIGNMENT X、Y knob on the manual operation panel, rotate the X knob when the image is moving to the X direction, rotate the Y knob when the image is moving to the Y direction and rotate a little bit in both X and Y knobs when the image is moving to the diagonal direction.

(e) Set the magnification at x1, 000 to 5,000 and adjust the X and Y slider so the image move is minimized.

(f) When the adjustment completes, select [Off].

NOTE: Perform the mechanical alignment of objective aperture when the alignment completes.

3.5 Specimen observation

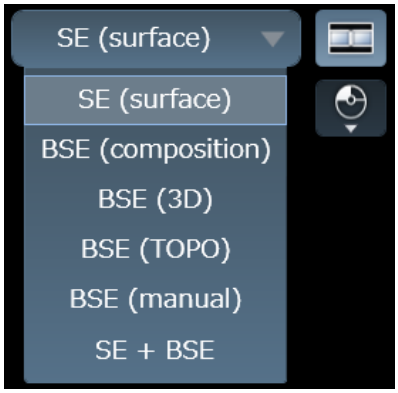
This section describes the specimen observation procedures.

3.5.1 Select a detector

Second electron detector (SE detector), Back scattered electron detector (BSED) and Ultra Variable-pressure Detector (UVD) (Option) are available.

NOTE: The observing image FOV will be shifted few μm when changing the detector while observing an image with the high magnification due to the characteristic of detector.

The detecting signal can be selected from the list that is displayed by clicking the observation signal select button on the upper right of the image display area. In addition, the signal can be selected by clicking the detector button on the SEM MAP.
To display the mixed image of multiple signals, simultaneous display of different signals or 2-screen display is possible in this instrument. This section describes the observation under the condition of 1-screen mode without mixed signals.



Characteristic of signal for each detector is described in the following Table. Select a detector as your observation purpose.

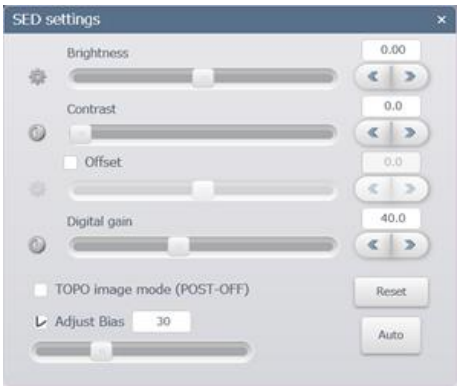
Detector	Character	Application
SE (Secondary Electron)	High resolution Superior in surface information Strong edge contrast Easily Charged-up Cannot use in VP mode	Effective for the specimen surface observation
BSE (Back Scattered electron)	Superior in composition information Weak edge contrast Charge-up is small Possible to observe in VP mode	Effective for the observation while suppressing the edge contrast, composition observation or charge-up suppression.

3.5.1.1 Secondary electron detector (SED)

Select the [SE [surface]] by clicking the observation signal select button at the upper right of the image display area. The SE detector is enabled and the SE image is displayed.
When performing the detail settings of SE detector, display the [SED settings] dialog by selecting from the [Menu] > [Detector Settings].

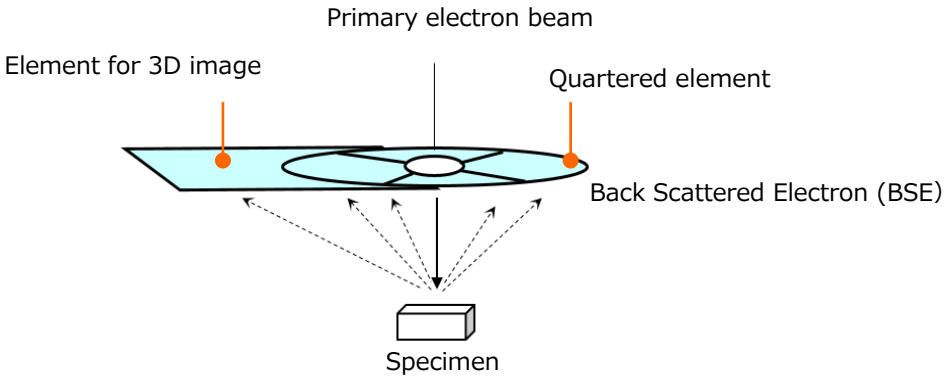
NOTE:
- The SED is designed for the high vacuum mode. The detector other than the SED is automatically selected when the VP mode is selected.
- SED applies high voltage to the signal detection part. Cannot use SED under the VP mode because, discharge is occurred at this area.

Control the brightness and contrast of SE image. The brightness and contrast on an image can be improved and enhanced for the image with is few SE signals, by adjusting the offset (Brightness) and digital gain (Contrast).
Observation of topographic image while the high voltage of SE detector is OFF is possible by enabling [TOPO image mode (POST-OFF)] check box.
Adjustment of bias voltage is possible by enabling [Adjust Bias] check box. Effect of signal detection can be changed between 0 to 100 by the bias voltage adjustment. Set at 30 for normal use.



3.5.1.2 Back scattered electron detector (BSED)

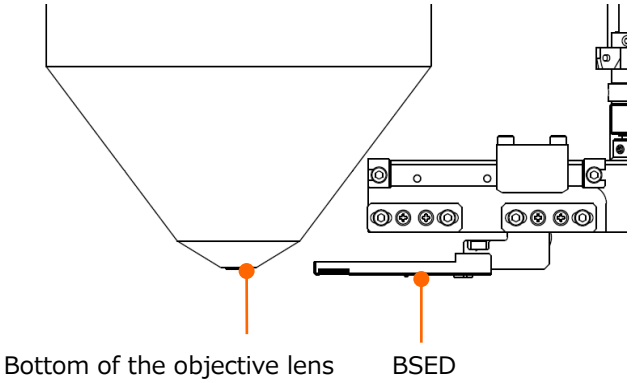
Select a signal from the [BSE (composition)], [BSE (3D)], [BSE (TOPO)], [BSE (Manual)] from the observation signal select button at the upper right of the image display area. The BSE detector will be enabled and BSE image will be displayed. In the VP mode, the BSE detector will be selected automatically.
Detect the back scattered electrons by the BSE detector which is placed under the objective lens. The BSE detector consists of quartered donut shaped element with a primary electron beam passage hole and an element for 3D imaging that detects low-angle back scattered electrons. Display the 3D, composition and topography (TOPO) image by calculating the detected signals of each element. In addition polarity of each element can be set manually (Manual).



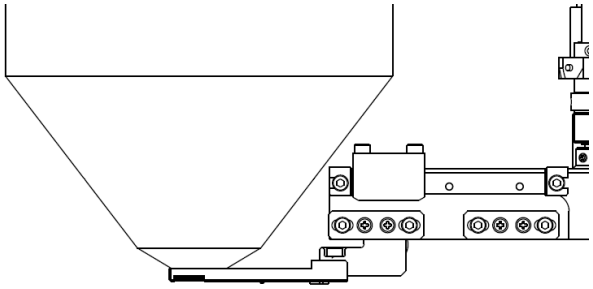
NOTE: Semiconductor element is used for the BSE detector. Please beware of the followings for preventing from the semiconductor element or specimen damage.

- Make sure to adjust the specimen according to [Exchange Specimen] for exchanging a specimen. If the specimen height is higher than the set value, the element can be damaged due to collision of the specimen and the semiconductor element when stage is moving.
- Extract the BSED from the position at the right bottom of the objective lens for preventing from damaging of semiconductor element when BSED is not used.
- Set the WD to 5 mm or more for preventing the collision of the specimen and detection elements.

Following figure shows the left side view of the specimen chamber.
The BSED has a mechanism of sliding to the horizontal direction. Thus, inserting or extracting from the right bottom of the objective lens is possible. Insert the BSED to the right under the objective lens for the BSED image observation. In addition, extract the BSED from the right under the objective lens when BSED is not used.



Extract the BSED



Insert the BSED

(1) Insertion mechanism of BSED

Insert the BSED for observing a BSE image. Insert or extract the BSED by operating a handle at the upper area of the specimen chamber. Refer to the LED display for confirming the BSED condition.

NOTE:
- If the BSED is not inserted, a BSE image cannot be observed. Confirm that the BSED is inserted for observing a BSE image.
- Rotate the handle slowly to the IN or OUT side until it is stopped.

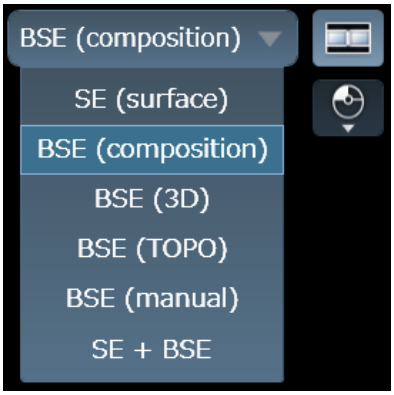
Extract (OUT LED is ON)

Middle (IN and OUT LEDs are ON)

Insert (IN LED is ON)

(2) BSED settings

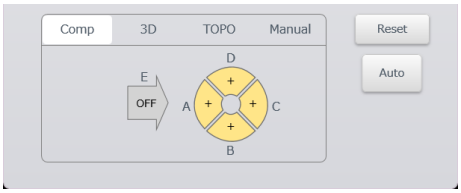
Select the [BSE (Composition)], the [BSE (3D)] or the [BSE (TOPO)] from the observation signal select button on the image display area depending on the observation purpose. The observing image that is obtained by the BSED can be displayed.



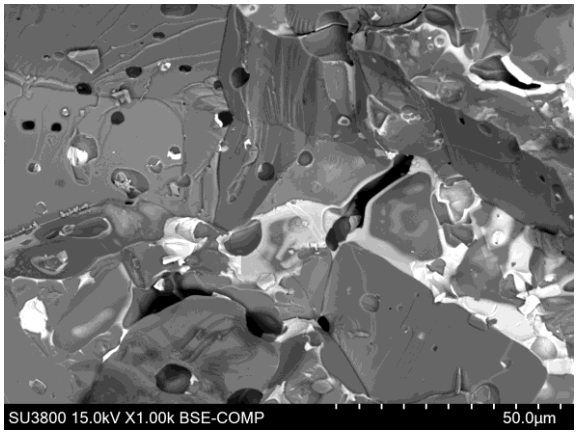
Details settings of the BSED can be performed from the [Menu] > [Detector Settings].

(a) [Composition] mode

Select the [BSE (composition)] from the observation signal select box or select [Comp] on [BSED settings] dialog. Display the BSED image with contrast that reflects the specimen composition distribution information.



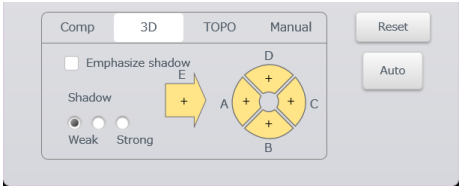
Comp mode



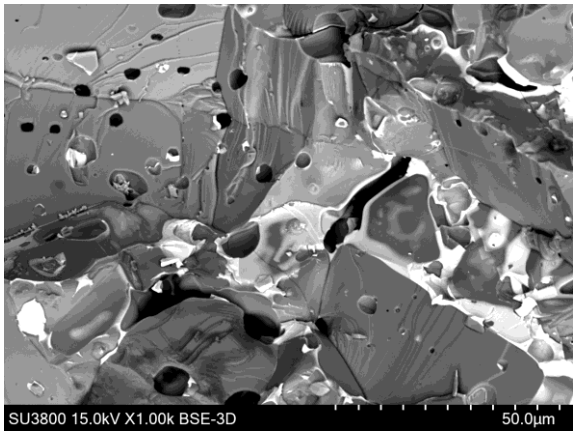
BSE image (Composition mode)

(b) 3D mode

Select the [BSE (3D)] from the observation signal or select 3D in the [BSED settings] dialog. Display a stereoscopic BSE image that is mixing the topographic information into the composition information of the specimen surface. Enhance the shadow of the observation image or change the volume of shadow.



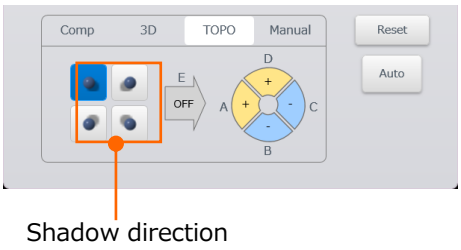
3D mode



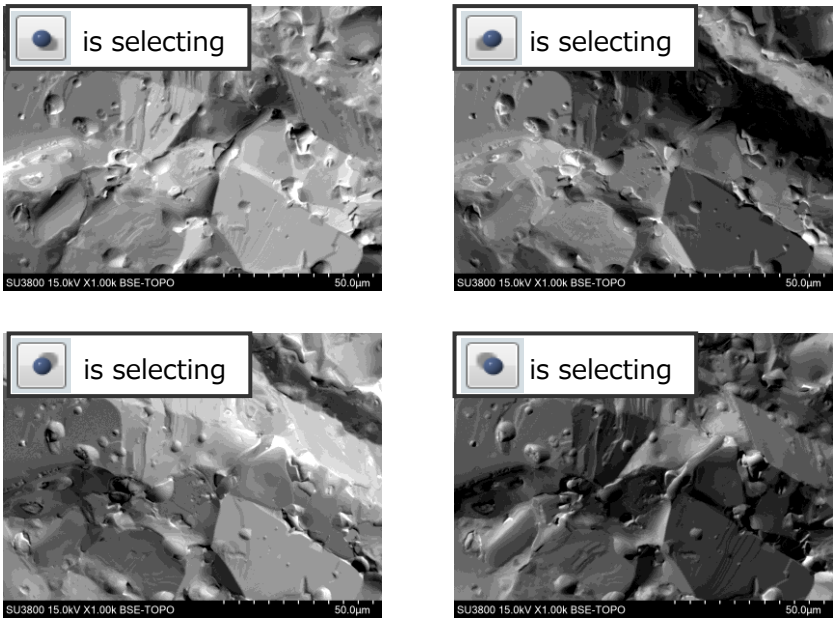
BSE image (3D mode)

(c) TOPO mode

Select BSE (TOPO) from the observation signal select box or select TOPO in the [BSED settings] dialog. Display a shadow image due to the signal differences of detecting element. Switch the direction of shadow by clicking the shadow direction selecting button depending on the observation purpose.



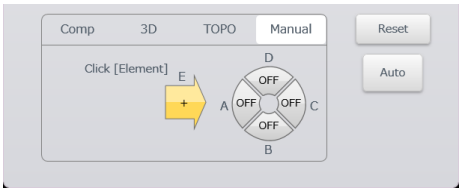
TOPO mode



BSE image (TOPO mode)

(d) [Manual] mode

Select [BSE (manual)] from the observation signal select box or select [Manual] in the [BSED settings] dialog. +(Non-invert)/ -(Invert)/OFF are available for each element.



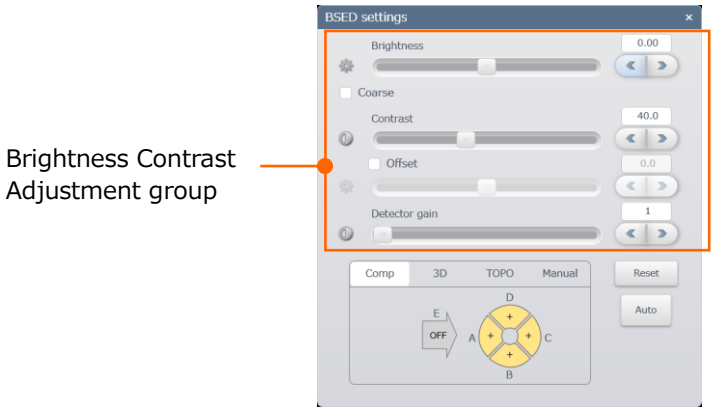
Manual mode

(3) Brightness button

Adjust the brightness and contrast of BSE image. The offset (brightness) and digital gain (contrast) can be enhanced when the image has few BSE signals and, weak brightness and contrast.

Gain for the BSED can be adjusted by 4 steps. Set the detector gain at 1 when the image contrast is strong and the detecting amount of BSE is high and set the detector gain at 4 when the image contrast is weak and the detecting amount of BSE is low.

NOTE: When [Detector gain] is high, observation image will be shifted to the side way in the Fast scan due to the characteristic of detector. Select slow scan or increase the spot intensity for setting the lower value of detector gain.



3.5.1.3 Other detectors (option)

The image of selected detector can be obtained by selecting a detector other than SE/BSE in the select box on the image display area.

3.5.2 Adjust and set the magnification

Adjust and set the magnification by the following method.

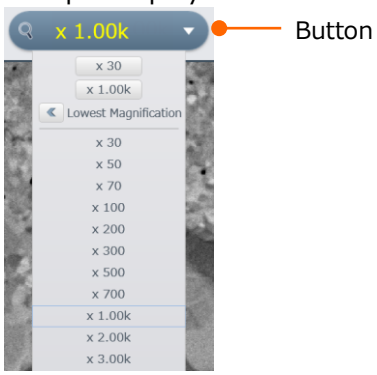
3.5.2.1 Adjustment and setting methods of magnification

(1) Adjust by mouse wheel
Minimize or enlarge the image by rotating the mouse wheel to the front or back on the image display area.

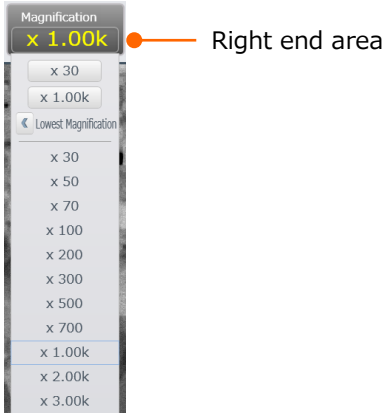
(2) Adjustment with mouse operation on the magnification display area
Press and hold the mouse on the [Control panel] > [Magnification display area] and move the mouse to the right for enlarge the magnification and move the mouse to the left for minimize the magnification.

(3) Select the magnification from the pull down list and set the value
Display the pull down list by clicking the magnification display area button (Right end area for displaying the details) and select magnification from the pull down list and set the value.

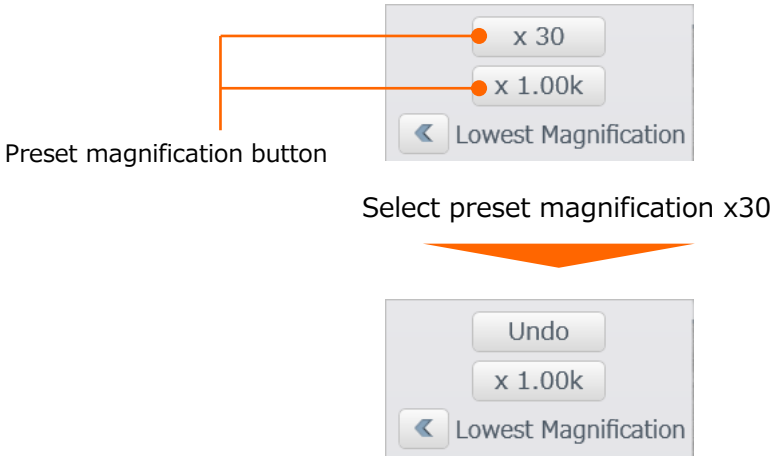
<Simple display>



<Detail display>



(4) Select the preset magnification from the pull down list and set the value
Set the magnification as a button by the two preset magnification button. The display will be [Undo] when clicking the preset magnification button and the display will be the previous magnification when clicking the button again.



3.5.2.2 Details settings of magnification

Display [Standard settings] dialog by selecting [Menu] > [Standard settings] > [Display Image]. Set the setting related to the image display.

3.5.2.3 Precaution for the minimum magnification and minimum magnification observation

(1) Minimum magnification range

Following table shows the minimum magnification for each observation condition. The minimum magnification is limited depending on the focus position (WD) and accelerating voltage.

Minimum magnification for each observation condition

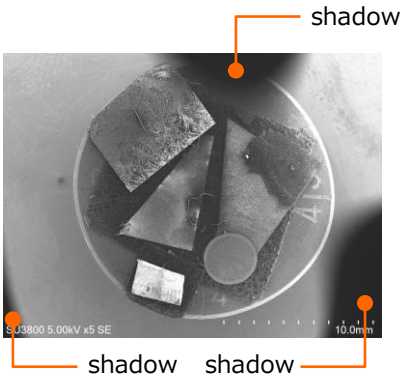
Accelerating voltage (kV)	WD (mm)							
	4.0 to		9.5 to		13.5 to		19.5 to	
	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow
30.0 to 28.1	80	60	45	35	37	30	27	21
28.0 to 26.1	80	55	45	35	35	27	27	20
26.0 to 24.1	80	55	42	35	35	27	25	19
24.0 to 22.1	75	50	42	32	32	25	25	19
22.0 to 20.1	65	50	42	30	30	25	23	18
20.0 to 18.1	65	47	40	30	30	23	23	17
18.0 to 16.1	65	45	35	27	30	21	21	16
16.0 to 14.1	60	42	35	27	27	20	20	15
14.0 to 12.1	60	42	32	25	25	19	19	14
12.0 to 10.1	55	37	30	23	23	18	17	13
10.0 to 8.1	45	35	27	20	21	16	16	12
8.0 to 6.1	42	30	23	18	18	15	14	11
6.0 to 4.1	35	27	20	16	15	13	12	10
4.0 to 2.1	35	25	20	14	15	11	12	9
2.0 to 0.3	35	25	20	14	15	11	12	9

Accelerating voltage (kV)	WD (mm)							
	29.5 to		39.5 to		49.5 to		55.5 to	
	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow
30.0 to 28.1	20	15	15	12	13	10	12	9
28.0 to 26.1	19	15	15	11	12	9	12	8
26.0 to 24.1	18	14	14	11	12	9	11	8
24.0 to 22.1	18	14	14	11	12	9	11	8
22.0 to 20.1	17	13	13	10	11	8	10	8
20.0 to 18.1	16	12	13	10	11	8	10	7
18.0 to 16.1	15	12	12	9	10	8	10	7
16.0 to 14.1	14	11	11	9	10	7	9	7
14.0 to 12.1	14	10	11	8	9	7	9	6
12.0 to 10.1	13	10	10	8	8	6	8	6
10.0 to 8.1	11	9	9	7	7	6	7	5
8.0 to 6.1	10	8	8	6	7	5	7	5
6.0 to 4.1	9	7	7	6	6	5	6	5
4.0 to 2.1	9	6	7	5	6	5	6	5
2.0 to 0.3	9	6	7	5	6	5	6	5

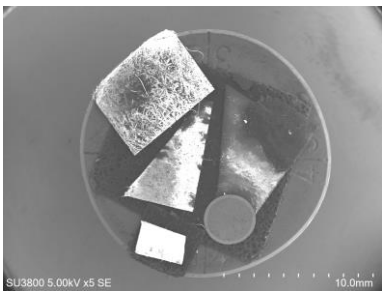
(2) Precaution for low magnification observation

- Shadow of the aperture

  In the condition of the previous table indicating in light grey color, the shadow as shown in following figure is appeared under the low accelerating voltage and low magnification observation while selecting the objective aperture No.3 or No.4. This shadow is appeared because the electron beam interferes the objective lens and orifice unit. The occurrence of shadow can be decreased by selecting a larger objective aperture (No.1 or No.0).



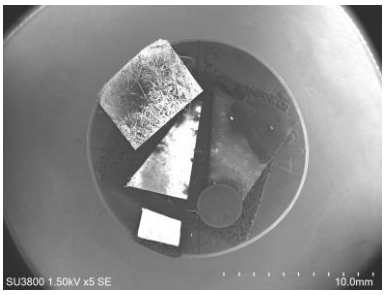
With shadow (No.4)



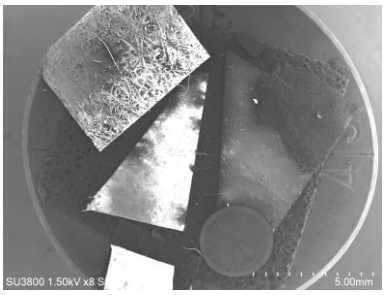
Without shadow (No.0)

The observation condition of light or dark gray color is suitable for searching an observation view due to larger field of view. Select a large objective aperture (No.1 or No.0) for the observation.

In addition the dark gray color range, the field of view may be chipped in circle under the low accelerating voltage and low magnification observation. It is occurred due to large deflection angle of electron beam for displaying the specimen image with low magnification.

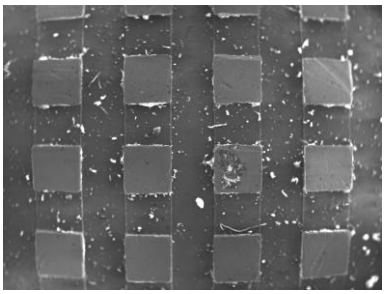


With shadow



Without shadow

- Effect of blur on image under the low magnification observation
  The surrounding area of image may be blurred by observing an image when observing at low magnification and selecting the objective aperture No.1 or No.0 even if the image is focused.
  This burr can be reduced by selecting a smaller objective aperture.



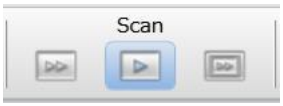
3.5.3 Scan speed settings

This section describes the scan speed settings during the specimen observation.

3.5.3.1 Scan speed settings

Fast, Slow1 to Slow6, CSS1 to 6, Reduce1 or Reduce3 are available for the scan speed. Switch a scan speed on the scan speed select panel on the select panel depending on the observation condition.

The Fast scan, Slow scan、Reduce scan can be selected on the control panel.



NOTE: Noise on an image may be appeared due to the combination of scan speed and observation condition.

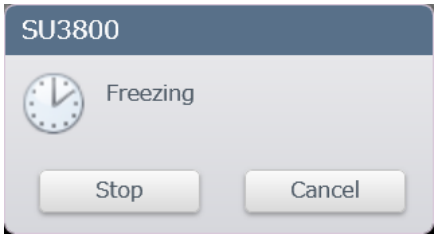
(1) Run/Freeze button

Stop or restart the scan operation by the Run/Freeze 

button on the control panel.

Click the Freeze button during the observation, scan the image until the end of the frame then stop the scan. [Going to freeze] is displayed on the upper left of the image display area until the scanning is stopped. When the scan is finished, the display at the upper left of the image becomes [Freeze] and the [Freeze] button will changed to [Run] button. Restart the observation by clicking the [Run] button while the observation is stopping. In this time, [Run] is displayed at the upper left of the image display area and the [Run] button changes to the [Freeze] button.

The following dialog is displayed by clicking the Freeze button when the scan speed is Slow3 or slower than CSS3. Click the [Stop] button and scan will stop immediately. Freeze operation will be canceled and the condition will be the observation condition by clicking [Cancel] button.



Run/Freeze button is arranged at the upper area of the image display area and control panel under the 2 screen mode. Perform the Scan/Stop operation to all displays by clicking the Run/Freeze button on the control panel. Perform the Scan/Stop operation to the selected display by clicking the Run/Freeze button at the upper area of the image display area.

NOTE: Electron beam does not irradiate on the specimen under the Freeze condition. However, either screen is in the observation condition, the electron beam irradiates on the specimen. Beware of the affection of the contamination or a specimen that is easily charged-up.

(2) Fast scan

This scan is used for searching a field of view under the SED observation. In addition, this scan is suitable for a specimen which is easily charged-up. The image quality may be improved by the frame interval average processing (recursive filtering). The higher number of integration frames the higher quality of image can be obtain. However, the afterimage will be displayed longer, the traceability of moving the FOV and the focusing operation will be deteriorated. Set the number of integration frames on [Scan Settings] dialog.

The table shows the scan time of each frame in the fast scan.

Fast scan times (Unit: ms/Frames)

Scan speed	Screen mode	
	2 screens (640×480)	1 screen (1,280×960)
Fast	Approximately 40/33	Approximately 80/67

(Power frequency 50 Hz/60 Hz)

NOTE: Uniformity of left and center of the image is deteriorated in the fast scan comparing with slow scan. User the slow scan when accuracy is required such as the measurement.

(3) Slow scan (Slow1/2/3/4/5/6)

Slow1 and Slow2 are suitable for BSE image with VP mode or searching a field of view under the high vacuum SE image observation. Searching a field of view with better quality of image is possible because scanning the image slower than the fast scan.

The Slow3 to Slow6 can be used for confirming a high quality image. This scan is suitable for confirming an image after searching a field of view or after the focus/astigmatism correction. The speed is difficult to be disturbed by the Power frequency.

The following table shows the scan time of each frame in the slow scan.

Slow1/2/3/4/5/6 scan times (Unit: s/frame)

Scan speed	Screen mode	
	2 screens (640×480)	1 screen (1,280×960)
Slow1	Approximately 0.5	Approximately 1
Slow2	Approximately 2	Approximately 4
Slow3	Approximately 10/8	Approximately 20/16
Slow4	Approximately 20/16	Approximately 40/32
Slow5	Approximately 40/32	Approximately 80/64
Slow6	Approximately 80/64	Approximately 160/128

(Power frequency 50 Hz/60 Hz for the value of Slow3 to Slow6)

NOTE: Slow1 and Slow2 are not the frame power synchronization. Disturbance of power frequency effects on an image under the condition of the High magnification, low accelerating voltage, or long WD.

(4) CS scan (CSS1/2/3/4/5/6)

In the CS scan, repeatedly scan to the horizontal direction and integrate the signal then, move to the vertical direction position. Abnormal contrast due to the charge-up can be suppressed because duel time of the electron beam is disparate on the scanning line comparing with the slow scan. The effect is applied between Fast scan and Slow scan. The image will be updated slowly from the top in the slow scan while the scanning. Therefore, it seems same as the Slow scan. The scan can be identified by the name of button.

The following table shows the scan time of each frame on CS scan. The slower speed, more number of integration frames is set. Thus, the image quality will be improved. The scanning speed in horizontal direction is the same in all speed.

CSS scan times (Unit: s/frame)

Scan speed	Screen mode	
	2 screens 640×480)	1 screen（1,280×960)
CSS1	Approximately 1	Approximately 2
CSS2	Approximately 2	Approximately 5
CSS3	Approximately 5.0/4.2	Approximately 10/8.4
CSS4	Approximately 10/8.4	Approximately 20/17
CSS5	Approximately 20/17	Approximately 40/33
CSS6	Approximately 40/33	Approximately 80/66

(Power frequency 50 Hz/60 Hz for the value of CSS3 to CSS6)

NOTE:
- The image may be shifted to the horizontal direction in the detector (BSED etc.) that is narrow frequency band. In this time, perform the observation with slow scan.
- The blur on CS scan image may be larger comparing to the Slow scan image when the image is wobbling due to the floating AC magnetic field.

(5) Reduce scan (Reduce1/3)

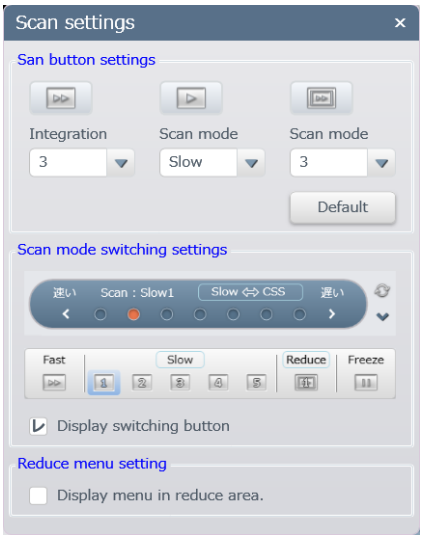
The scan is used for the focus/astigmatism correction. In this scan, improve the image quality by scanning slower than the Fast scan and image display speed by reducing the observation area. The observation area can be moved by dragging the mouse.

Reduce1: This mode is used for high vacuum second electron image or focus/astigmatism correction of BSE image analysis under the VP mode. Reduce the area of vertical and horizontal direction and speed up the scanning.

Reduce3: This mode is used for focus/astigmatism correction of BSE image under the VP mode. The observation area size is the same as the Reduce1. However, the scan speed is slightly slower than Reduce1 so that the detector with narrow frequency band is possible as BSE detector.

3.5.3.2 Detail settings of scan

Display [Scan settings] dialog by clicking the capture button on the control panel or selecting [Menu] > [Scan settings]. The setting of the scan button, scan speed selecting panel and Reduce menu can be performed.
Default values of integration number of frames and scan mode is set by clicking [Default] button.

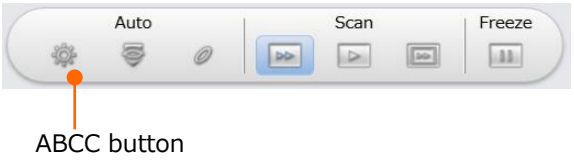


3.5.4 Adjust the brightness and contrast

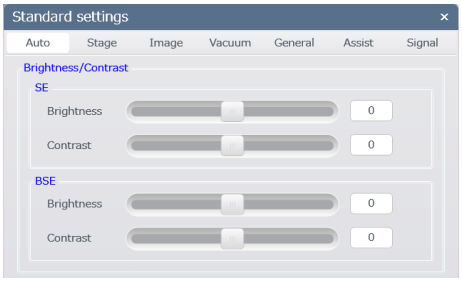
Brightness and contrast of image can be set manually. The setting can be performed manually by referring to the observing image histogram.

(1) Auto adjustment

Click the ABCC button on the control panel for setting the brightness and contrast value.



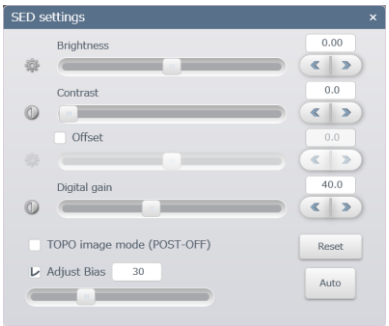
The correction volume of brightness/contrast can be set at [Auto] tab in [Standard settings] dialog.



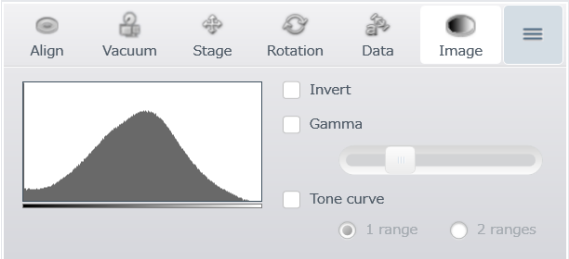
(2) Manual setting

(a) Detector settings dialog

[Detector settings] dialog is displayed by selecting [Menu] > [Detector settings]. Use the slider in the dialog and set the volume of brightness and contrast.

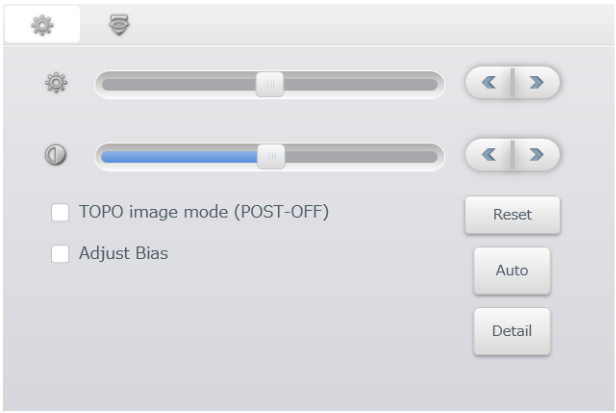


The histogram data of presently observing image can be monitored by displaying the [Image] tab on the operation panel. Refer to the data for manual setting.



(b) Adjustment in the Brightness tab

In the 2 screen mode, the brightness adjustment tab at the bottom of the image display area is displayed. Move the slider to adjust the image brightness and contrast. In addition, the step adjustment can be performed by clicking the fine adjustment button.



When SED is selected

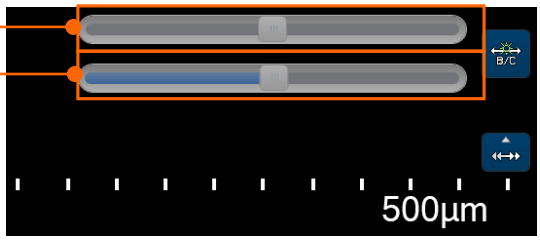
When BSED is selected

(c) Set at the image display area

In the 1 screen mode, display the sliders of brightness and contrast in the image display area by clicking  button at the bottom right of the image display area. Set the volume brightness and contrast by the sliders.

Brightness Adjustment slider

Contrast Adjustment slider

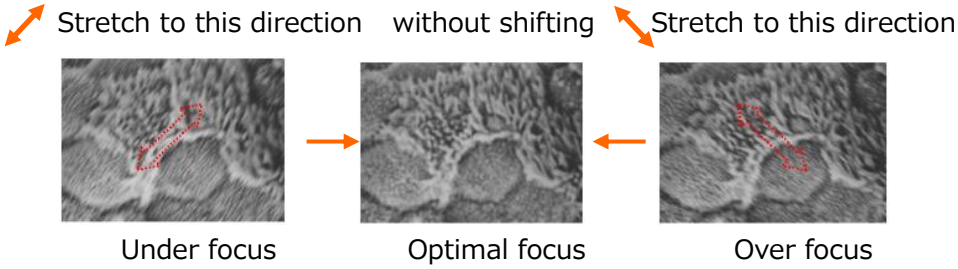


3.5.5 Adjust the focus and correct astigmatism

The focus and astigmatism can be set automatically or manually.

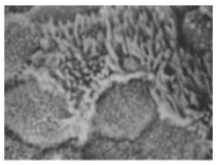
3.5.5.1 Setting procedure of focus and astigmatism correction

1. Make sure the axes alignment items before performing the settings.
2. Set the scan speed to the Reduce1 for high vacuum mode, Reduce3 (When setting the BSED gain at high value) or Reduce1 (When setting BSED gain at low value) for VP mode.
3. Set the magnification at higher than the desired magnification (x1,000 or more) and adjust the focus for confirming the stretching direction of the observing image.
   ⇒The sharpest image can be obtained in the optimal focus position (WD) under the condition without astigmatism. In the condition with astigmatism, the image will be blurred in the optimal focus position (WD) and the image will be stretched under or over focus position (WD).

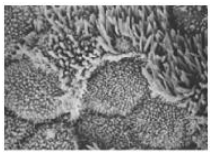


NOTE: The stretching direction of image can be defined by finding a structure with circler shape and clear edge around the FOV.
Effect of damage or contamination can be received while performing the high magnification observation or adjustment in the same FOV. When observing a specimen which is sensitive for electron beam damage or has contamination, set the spot intensity at small value or, perform the adjustment at the area other than desired FOV, move to the desired FOV and quickly setting the focusing then capture an image.

4. Adjust the focus and minimize the blur of image.
5. Adjust the astigmatism correction for obtaining a sharpest image.
6. Adjust the focus again. The settings of focus and astigmatism correction is completed if the image is not shifted and blurred concentrically. If the image is stretched, perform the procedures of 3 to 5.
7. Confirm the image in the scan speed that is slower than Slow3.



Before adjustment



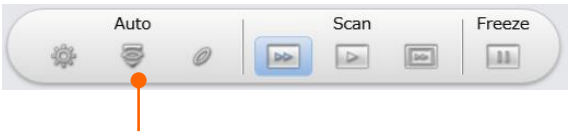
After adjustment

3.5.5.2 Focus correction

The focus can be set automatically or manually.

(1) Auto correction

Click the AFC button on the control panel for setting the focus.



AFC button

Coarse mode and Fine mode are available in the AFC that is automatically selected by the setting magnification.

Coarse mode is selected for magnification at x5,000 or less and an image can be visible even if the image cannot be observed by searching the entire area of WD. Therefore, it takes time to obtain an image and the accuracy is degraded comparing to the Fine mode.

Fine mode is selected for magnification at more than x5,000. The area of searching is narrow and the focus of image will be corrected from the condition of image that is visible.

If WD of specimen is already known, focus can be set in the short time by setting the focus position (WD) with the value and setting the magnification at x5,000 or higher in the Fine mode.

NOTE: Accuracy of focus correction is affected by the surface structure of specimen. The function may not perform correctly when the specimen surface is flat and does not have fine structure or the specimen has low contrast or is easily charged-up.

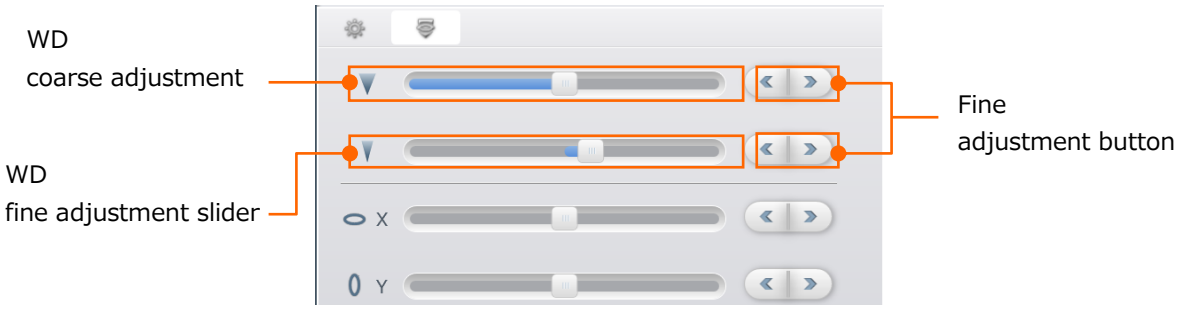
(2) Manual adjustment

(a) Set at the Focus/astigmatism correction tab

Display the Focus/astigmatism correction tab in the lower on the image display area in the 2-screen mode. The focus can be adjusted by moving the slider.

When set the slider to the right side, the WD is shorter and WD is longer by setting the slider to the left side. In addition, fine adjustment can be performed by clicking the fine adjustment button.

Move the Coarse slider for coarse adjustment and move the Fine slider for fine adjustment.



(b) Adjustment with mouse operation

Click the  button at the upper right of image display area and the mouse icon will be Focus or RISM mode (). Set the focus by dragging operation on the image. When set the slider to the right side, the WD is shorter and WD is longer by setting the slider to the left side.

Only fine focus adjustment is performed when setting the focus with the mouse operation. The fine adjustment can be performed after performing the AFC.

3.5.5.3 Astigmatism correction

(1) Auto correction

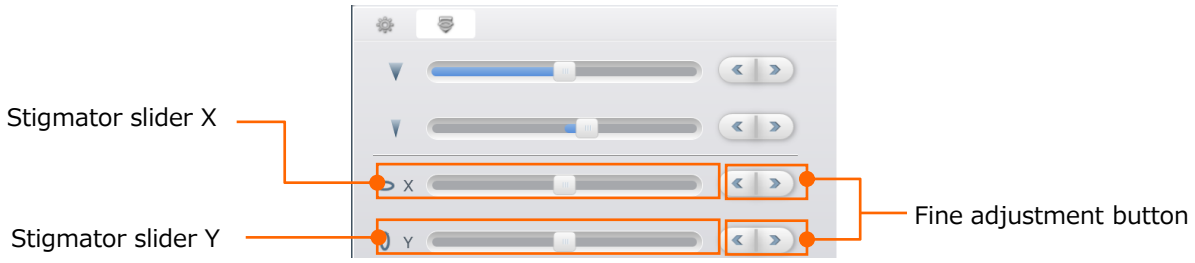
The astigmatism can be set by clicking the ASFC button. This function will be performed optimistically under the magnification at x5,000 or more.

NOTE:
- Accuracy of ASFC will be effected by the surface structure of specimen. The function may not perform correctly when the specimen surface is flat and does not have fine structure or the specimen has low contrast or is easily charged-up.
- If the setting of [[AFC] Align] is not performed correctly, the accuracy of AFC and ASFC are deteriorated. In this case, perform the [[AFC] Align] adjustment.

(2) Manual adjustment

(a) Adjustment on the Focus/Astigmatism correction tab

Display the [Focus/Astigmatism correction] tab at the bottom of the image display area in the 2 screen mode. The focus can be adjusted by moving the slider. The WD will be shorter when moving the slider to the right side and longer when moving the slider to the left. In addition, fine adjustment can be performed by clicking the fine adjustment button. Set the value for obtaining a sharp image by operating the stigmator slider X and Y.

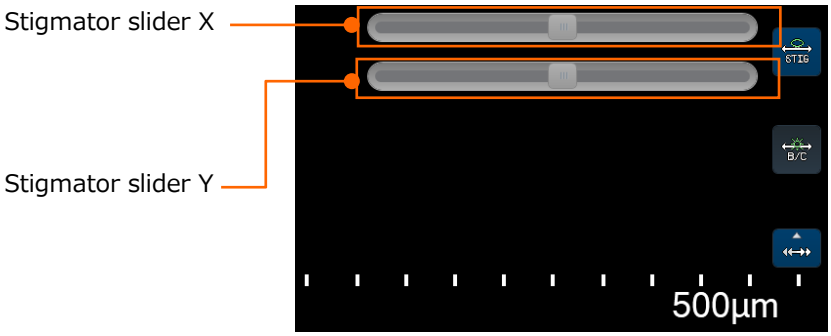


(b) Set in the image display area

Click the 

button in the tool select button at bottom right of the image display area under the 1 screen mode and the stigmator adjustment slider will be displayed on the image display area.

Adjust the stigmator by the slider.



3.5.6 Operation of the specimen stage and move the FOV

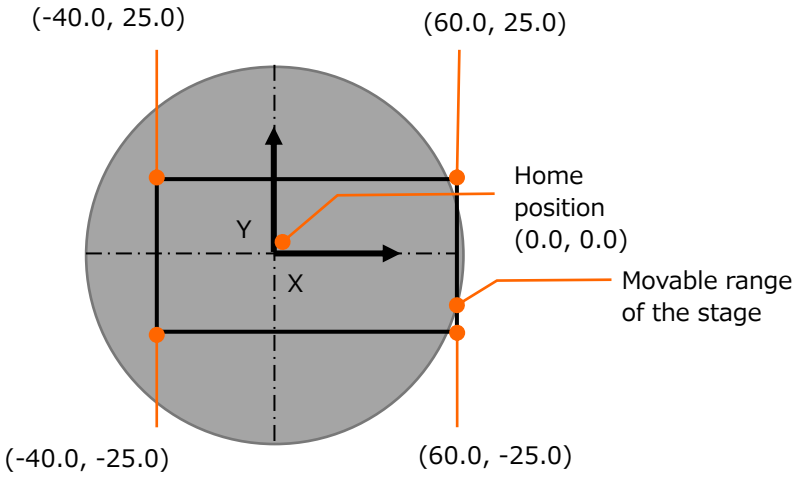
The specimen stage consists of 5-axes motor. This section describes the methods of specimen stage operation and moving the FOV.

3.5.6.1 Description of the coordinate value

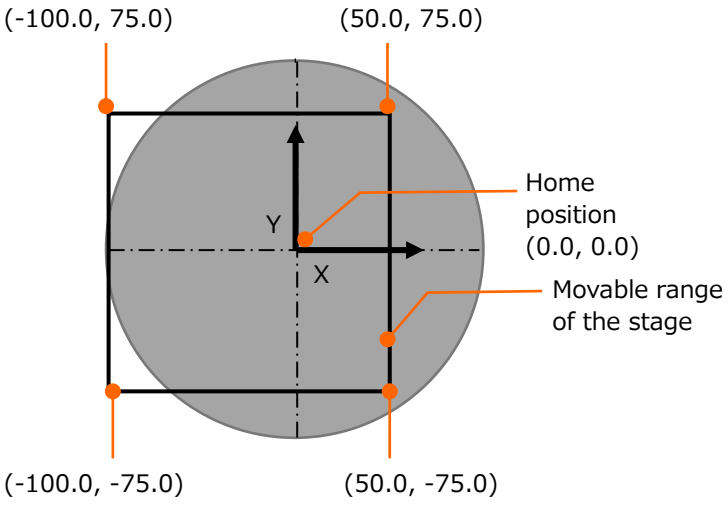
Two type of methods of displaying the coordinate on the specimen and displaying the coordinate of the stage are available in the X and Y coordinate.

(1) Relationship between the specimen coordinate and the stage coordinate

Following figure shows the relation of both coordinate system in the φ 127 mm specimen stub on SU3800 and φ203 mm specimen stub on SU3900. In the specimen coordinate, define the center of the specimen stub as a home position (X=0 mm, Y=0mm). In the stage coordinate, define the center of specimen stub is (X=40 mm, Y=25 mm) for SU3800 and (X=100 mm, Y=75 mm) for SU3900.

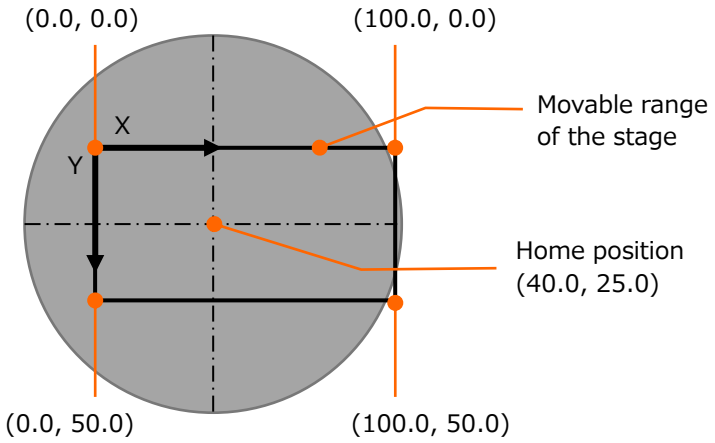


SU3800/φ127 mm

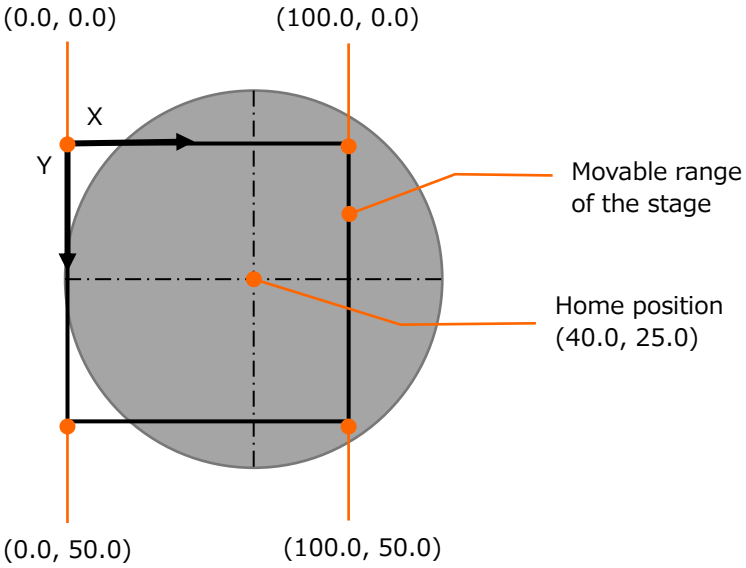


SU3900/φ203 mm

Specimen coordinate



SU3800/φ127 mm

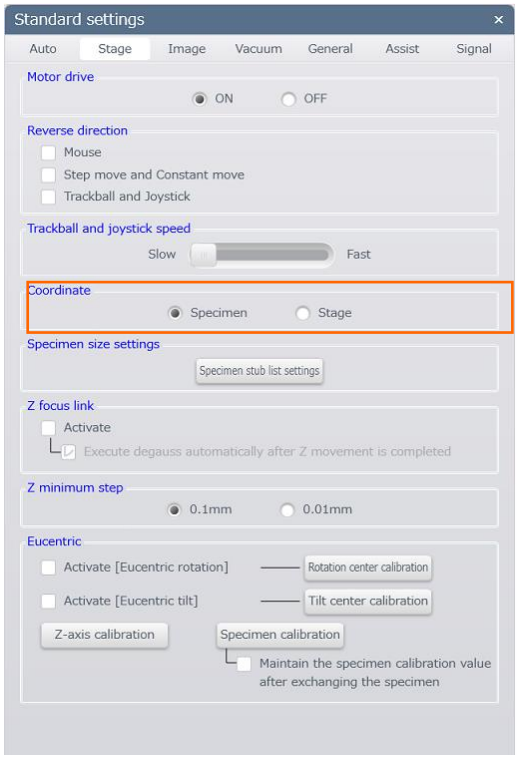


SU3900/φ203 mm

Stage coordinate

(2) Set the coordinate system

Select [Menu] > [Standard settings] > [Stage] and display [Standard settings] dialog as shown in the following figure. Select either the [Specimen] or [Stage] in the [Coordinate] group.



3.5.6.2 Movable range and specimen exchange position for each axes

The following table shows the movable range and specimen exchange position for each axes.

<SU3800>

Axes	Movable range (Stage coordinate)	Movable range (Specimen coordinate)	Specimen exchange position (Stage coordinate)	Specimen exchange position (Specimen coordinate)
X	0 to 100 mm	-40 to +60 mm	40 mm	0 mm
Y	0 to 50 mm	-25 to +25 mm	25 mm	0 mm
R	0 to 360° (Continuous rotation)	0 to 360° (Continuous rotation)	0°	0°
T	−20 to 90°	−20 to 90°	0°	0°
Z	5 to (65 - specimen height [mm]) mm	5 to (65 - specimen height [mm]) mm	Minimum point	Minimum point

<SU3900>

axes	Movable range (Stage coordinate)	Movable range (Specimen coordinate)	Specimen exchange position (Stage coordinate)	Specimen exchange position (Specimen coordinate)
X	0 to 150 mm	-100 to +50 mm	100 mm	0 mm
Y	0 to 150 mm	-75 to +75 mm	75 mm	0 mm
R	0 to 360° (Continuous rotation)	0 to 360° (Continuous rotation)	0°	0°
T	−20 to 90°	−20 to 90°	0°	0°
Z	5 to (85 - specimen height [mm]) mm	5 to (85 - specimen height [mm]) mm	Minimum point	Minimum point

The movable range of X, Y, T and X are limited to smaller than the table value when the specimen stub size is large.
Table shows the movable range of X and Y axes for each specimen stub size. This movable range will be limited automatically depending on the specimen stub size or detectors. Thus, as long as the setting the correct information, the movable range will be within the safety range.

Movable range of X and Y axes (Stage coordinate) for each specimen stub size

<SU3800>

Specimen stub size	X axes movable range	Y axes movable range	Standard attachment
φ15 mm	32.0 to 48.0	17.0 to 33.0	○
φ26 mm	26.5 to 53.5	11.5 to 38.5	○
φ51 mm	14.0 to 66.0	0.0 to 50.0	○
φ51 mm (H80 mm)	14.0 to 66.0	0.0 to 50.0	○
φ127 mm	0.0 to 100.0	0.0 to 50.0	○
φ200 mm	40.0 to 70.0	7.0 to 44.0	–

<SU3900>

Specimen stub size	X axes movable range	Y axes movable range	Standard attachment
φ15 mm	92.0 to 108.0	67.0 to 83.0	○
φ26 mm	86.5 to 113.5	61.5 to 88.5	–
φ51 mm	74.0 to 126.0	49.0 to 101.0	○
φ102 mm	48.5 to 150.0	23.5 to 126.5	○
φ102 mm (H130 mm)	48.5 to 150.0	23.5 to 126.5	○
φ127 mm	36.0 to 150.0	11.0 to 139.0	–
φ203 mm	0.0 to 150.0	0.0 to 150.0	○
φ300 mm	39.0 to 105.0	30.0 to 120.0	–

3.5.6.3 Movable and observation ranges of the specimen stage and the limitation due to optional detector

(1) Specimen stub size and stage movable range

Specimen stage movable range will be limited by the specimen stub size. The movable range is set according to the following standard.

(a) For SU3800

The movable range covers the range of the specimen stub size when the specimen stub size of φ51 mm or less. When the specimen stub size is larger than φ51 mm, the movable range is limited so that the edge of the specimen does not contact to the objective lens, or other detector in the specimen chamber.

(b) For SU3900

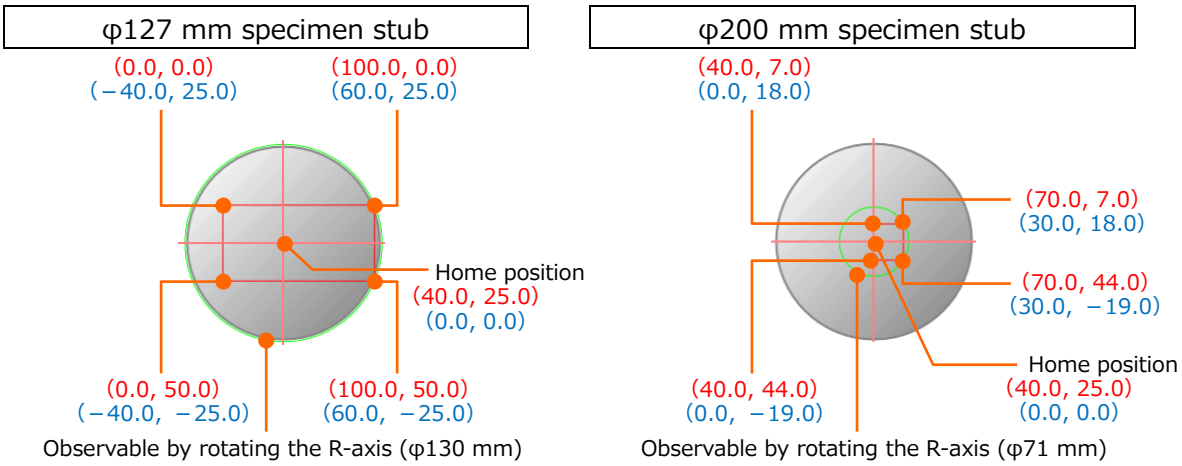
The movable range covers the range of the specimen stub size when the specimen stub size of φ127 mm or less. When the specimen stub size is larger than φ127 mm, the movable range is limited so that the edge of the specimen does not contact to the objective lens, or other detector in the specimen chamber.

NOTE: The movable range is limited automatically depending on the setting value of the specimen stub size.

(2) Observation range

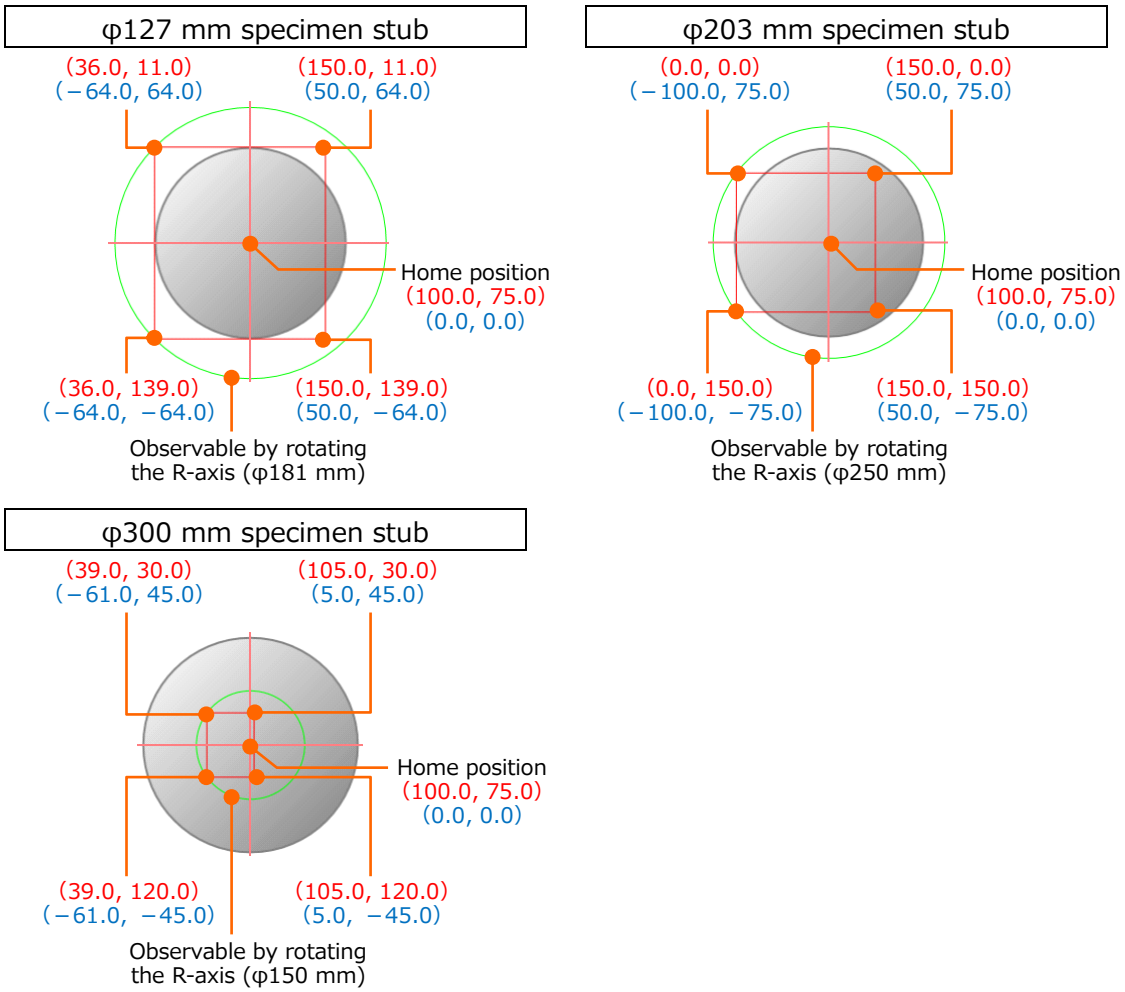
Figure shows the observation range in the X and Y directions for each specimen stub size. In the SU3800, Observation for entire area is possible by utilizing the R axes adding to the X and Y directions in the φ127 mm of the specimen stub size or less. In the SU3900, Observation for entire area is possible by utilizing the R axes adding to the X and Y directions in the φ203 mm of the specimen stub size or less. In case of the specimen stub exceeds the size, the area for observation will be limited. Please select a specimen stub, which is suitable for the specimen size.

<SU3800>



Observation range in X and Y direction for each specimen stub size on SU3800 (when option detector is not equipped).
(Coordinate in ( ) Red : Stage coordinate, Blue : Specimen coordinate)

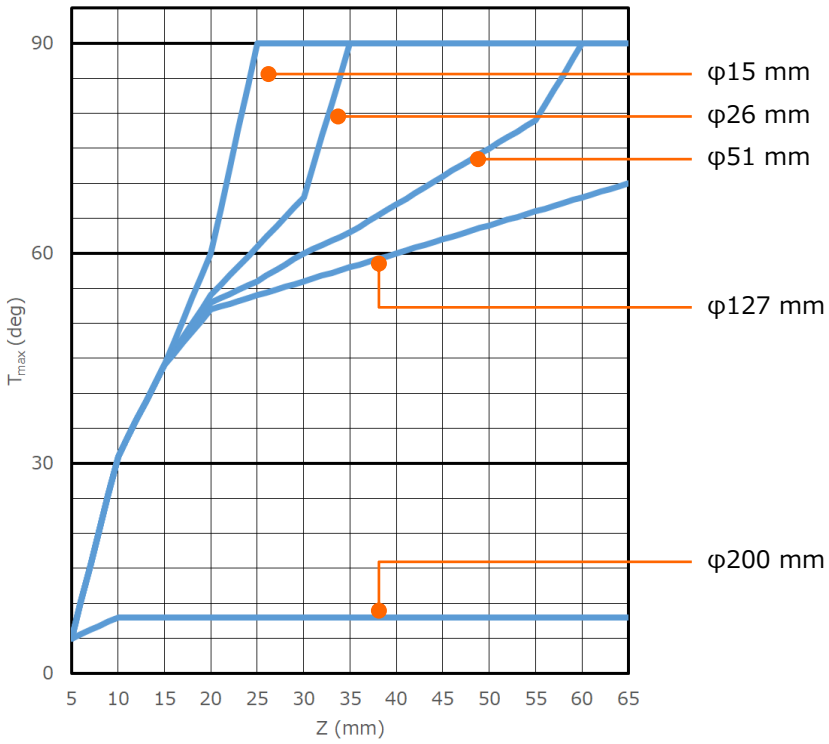
<SU3900>



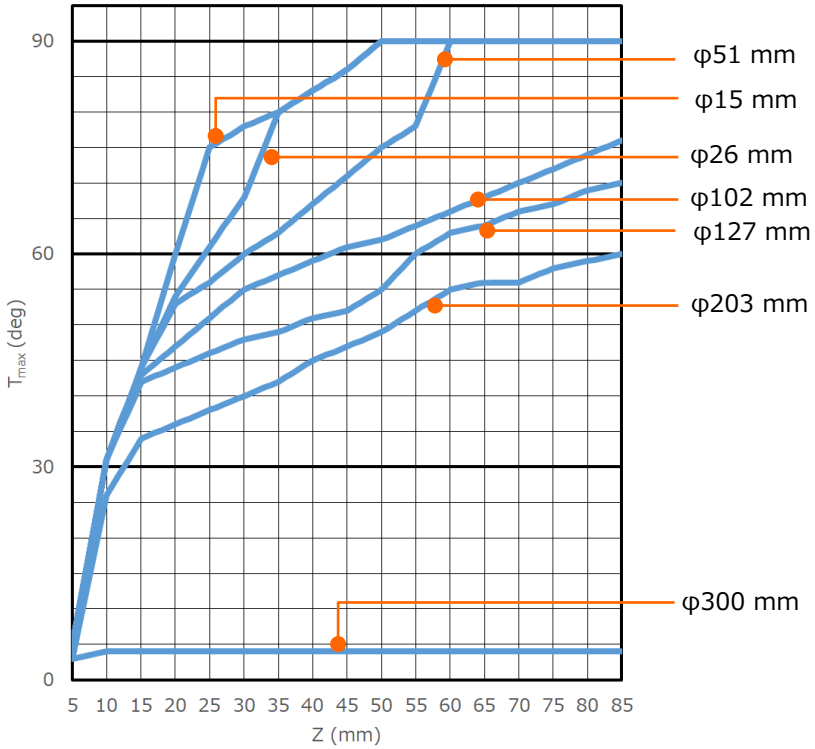
Observation range in X and Y direction for each specimen stub size on SU3900 (when option detector is not equipped).
(Coordinate in ( ) Red : Stage coordinate, Blue : Specimen coordinate)

The following figure shows the T-axis movable range on the X-axis depending for the each specimen size. The T-axis movable range will be calculated by setting the Z-axis coordinate value and the value will be displayed on the stage R/Z/T display on the sub screen display area. Please set the coordinate of the T-axis within the range.

<SU3800>

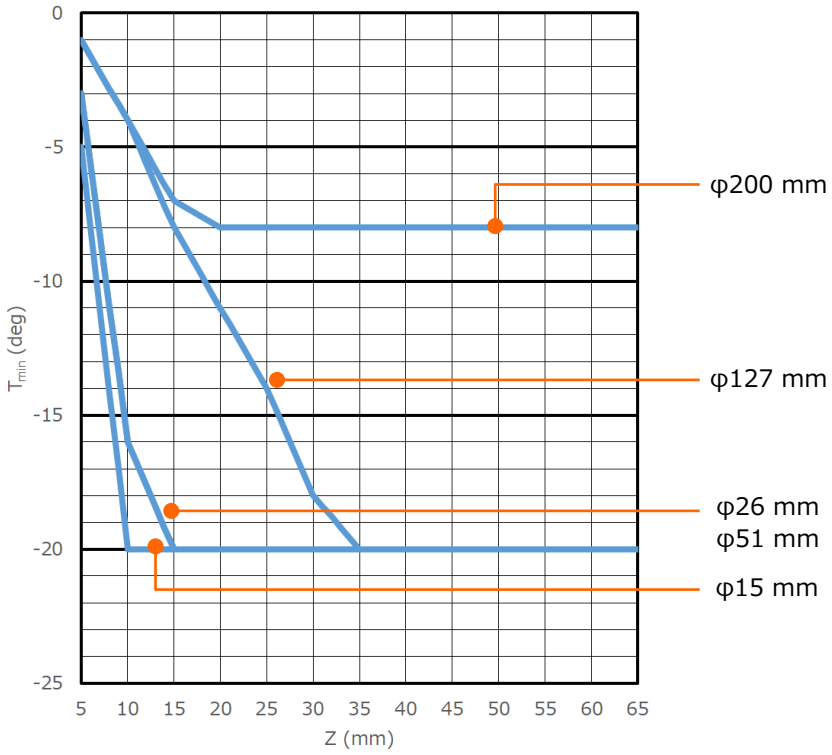


<SU3900>

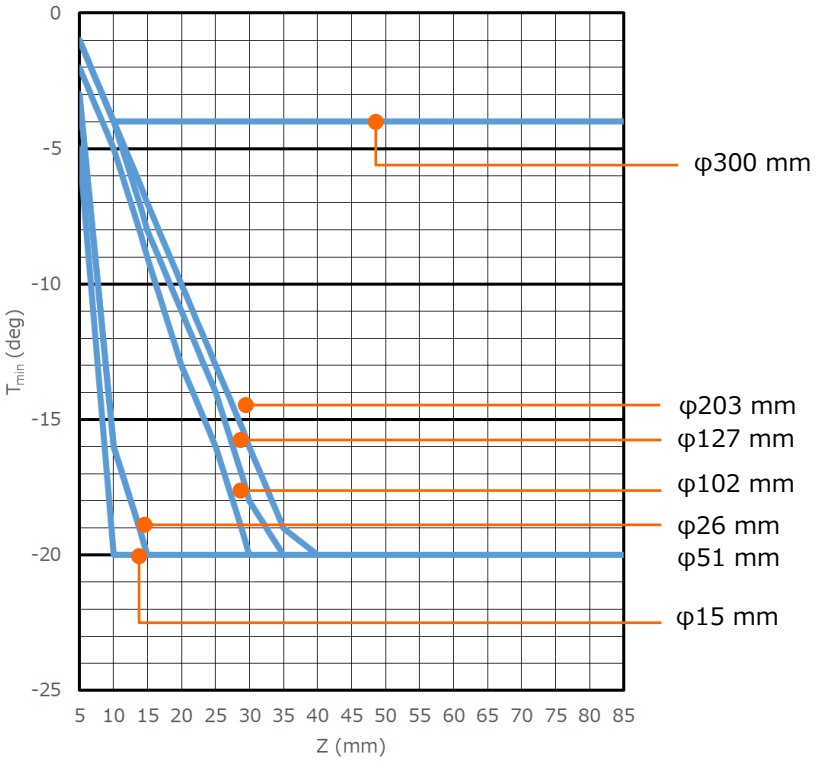


Tilt axis movable range to the Z-axis coordinate
(Plus tilting angle direction, specimen height 0 mm)

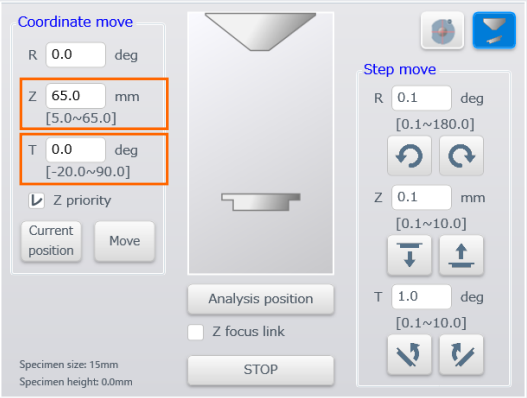
<SU3800>



<SU3900>



Tilt axis movable range to the Z-axis coordinate
(Minus tilting angle direction, specimen height 0 mm)



3.5.6.4 Outline of the operation

The stage operation can be performed by the following methods.

- Operate it on the [Stage movement settings] (5 axes) dialog or on [Operation panel] > [Stage] tab.
- Operate it on the Sub screen display area > Stage R/Z/T display (R axes)
- Operate it with the mouse operation (X/Y/R axes) on the image
- Operate it with the stage move (X/Y/R axes) by the SEM MAP function
- Operate it manually (X/Y axes) by the trackball (option) or joystick (option)

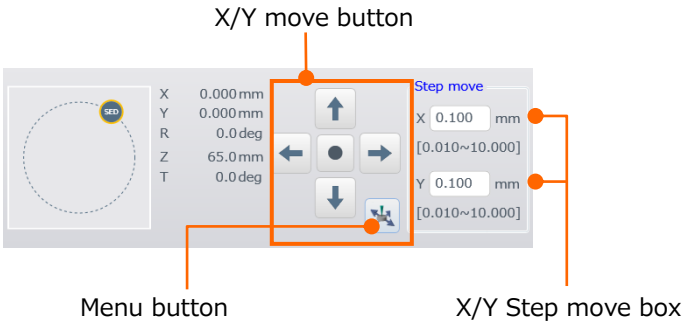
  In addition, the following assist function is available for the stage operation.
- Image navigation function
- Camera Navigation function (option)

3.5.6.5 X, Y and R axes operation

Operation of the X, Y and R axes can be performed by the following methods.

(1) Operation in [Stage] tab (X/Y axes)

Enter the moving amount value and clicking the X and Y move button, the stage will be moved to the entered step move value. Input range of step move for X and Y axes are 0.01 to 10.00 mm. The stage moves continuously by pressing and holding the button.



(2) Operation by [Stage movement settings] dialog (Coordinate value select) (X/Y/R axes)

Display [Stage movement settings] dialog by clicking the menu button in [Stage] tab. Enter the coordinate in the X, Y, R coordinate box and press [Enter] key or, click [Move] button.

Click [STOP] button for stopping the stage while moving.

Input range of R coordinate is 0 to 359.9°.

NOTE : Do not click the [Move] button repeatedly while stage is moving. The error of the [Stop] button may occurred.

(3) Operation in Sub screen > Stage R/Z/T (R/Z/T axes)

Move the stage by entering the value in the step move box and clicking the step button. The stage moves continuously by pressing and holding the button.

Stage is moved to the selected coordinate by entering the coordinate value in the R coordinate box and press Enter key or clicking [Move] button.

Input range of R coordinate is 0 to 359.9°.

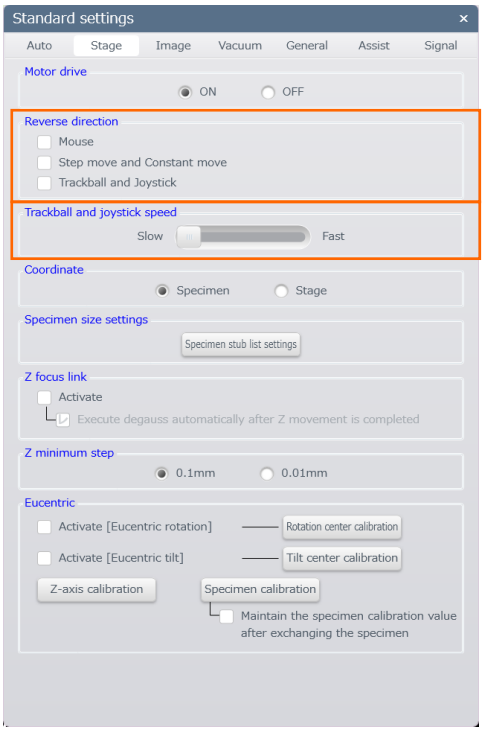
(4) Mouse operation on an image (X/Y/R axes)

The stage can be moved to the desired direction, the selected position within the image or the center of image by operating the mouse on the observing image.

(5) Manual operation by trackball (option) (X/Y axes)

The stage move to the direction of rotating the ball.

- Moving amount of stage for the rotating amount of ball is linked to the magnification of the image. Thus, the moving amount of the stage is larger in the lower magnification.
- Moving amount of stage for the rotating amount of ball can be set in 4 steps by the slider in the [Standard settings] dialog > [Stage] tab > Trackball/Joystick speed group.
- The stage move is limited in the horizontal direction (X direction) by switching to the X side. The stage move is limited in the vertical direction (Y direction) by switching to the Y side.
- The rotating direction of ball can set in the reverse direction to the moving direction of the image. Enable the [Trackball and Joystick] check box in [Standard settings] dialog > [Stage] tab > [Reverse direction] group.



(6) Manual operation with the Joystick (option) (X/Y axes)

The Joystick (option) will move as the Trackball (option) except the direction switch.

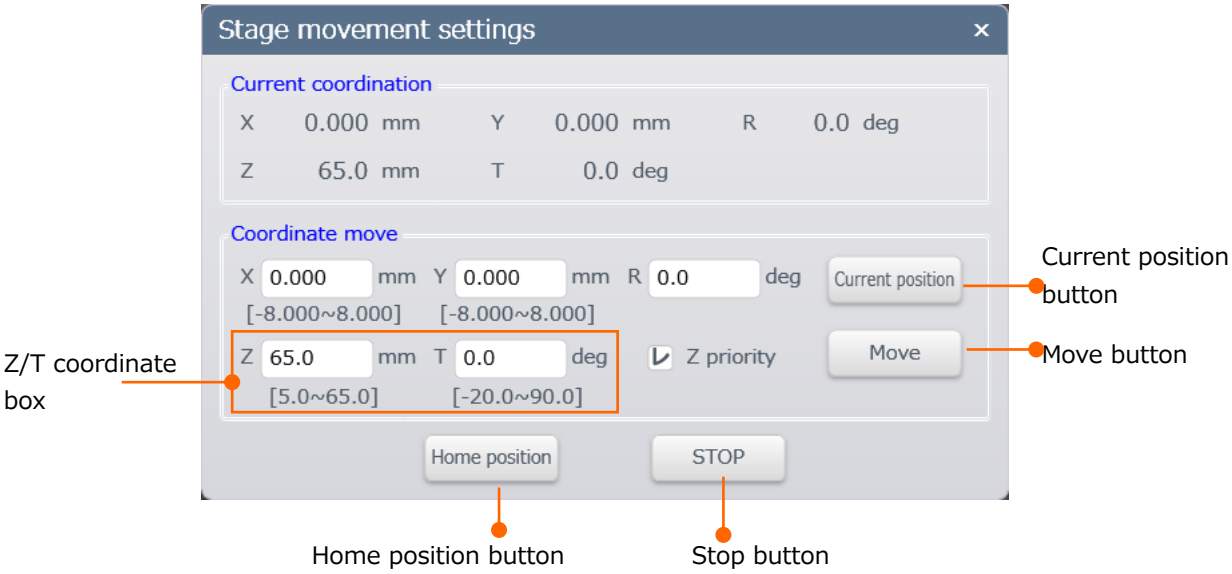
3.5.6.6 Z and Tilt axes operation

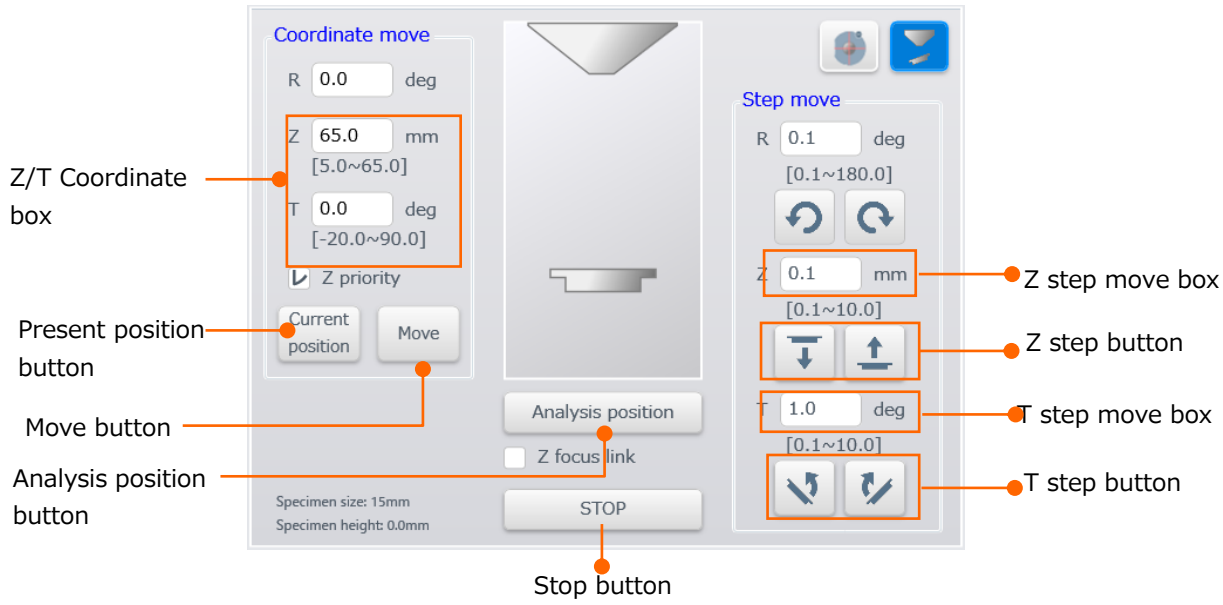
Z and Tilt axes can be operate as the following method.

(1) Display [Stage movement settings] dialog by clicking the [Stage movement settings] > [Stage] tab > Menu  button. Enter the coordinate values in the Z and T axes coordinate boxes and press Enter or click the [Move] button.
Click the [STOP] button for stopping the stage while moving.

(2) Operation of Stage R/Z/T (Z/T axes) in the Sub screen
Z/T axes can be moved by step when entering the step value in the step move box and clicking the step button.
Stage moves to the selected coordinate by entering the coordinate value in the Z/T coordinate box and pressing the Enter key or clicking the [Move] button.

(3) Move to the analysis position
Stage Z axes move to the analysis position (Z=10 mm) by clicking the [Analysis position] button.





NOTE:
- Make sure to set the specimen stub size, height and detector correctly. The objective lens, the BSED placing at right bottom of the objective lens or specimen can be damaged.
- Do not click the [Move] button repeatedly while stage is moving. The error of the [STOP] button may occurred.

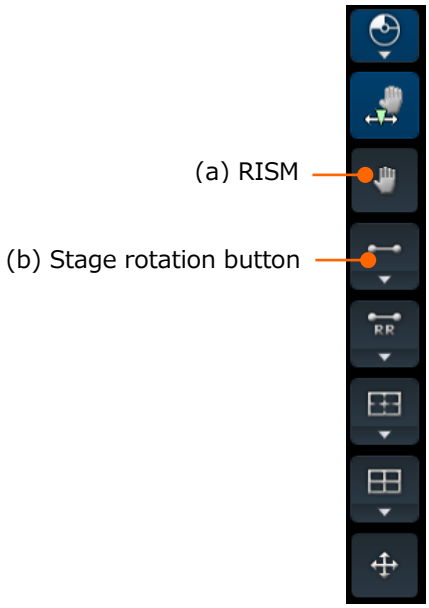
3.5.6.7 Move the FOV by mouse operation or manual operation panel (option)

Stage can be moved to the desired direction, the selected position within the image or the center of the image by performing the mouse operation on the image.
In addition, the image shift which is limiting the X and Y axes move can be performed by rotating the knob in the manual operation panel (option).

(1) Move the FOV by mouse operation

FOV can be moved by operating the mouse on the image.

The function button is extended by clicking the button. Select a function.



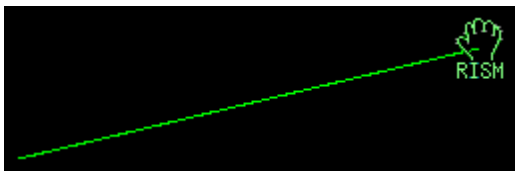
(a) RISM button

Move the stage by double-clicking or dragging the mouse on the image.

Double click the mouse at the desired position and the stage will move to the position where selecting position in the center of image.

In addition, press and hold the left button of the mouse at the desired position on the image and release the button at the moving destination. Then, the position where the button is pressed is moved to the position where the button is released.

The green indicating the moving pass is displayed while dragging the mouse.



NOTE: Mechanical move of stage cannot be performed within the movable range of image shift. The present moving amount of image shift can be confirmed by the cross-maker on the SEM MAP.

(b) Stage rotation button

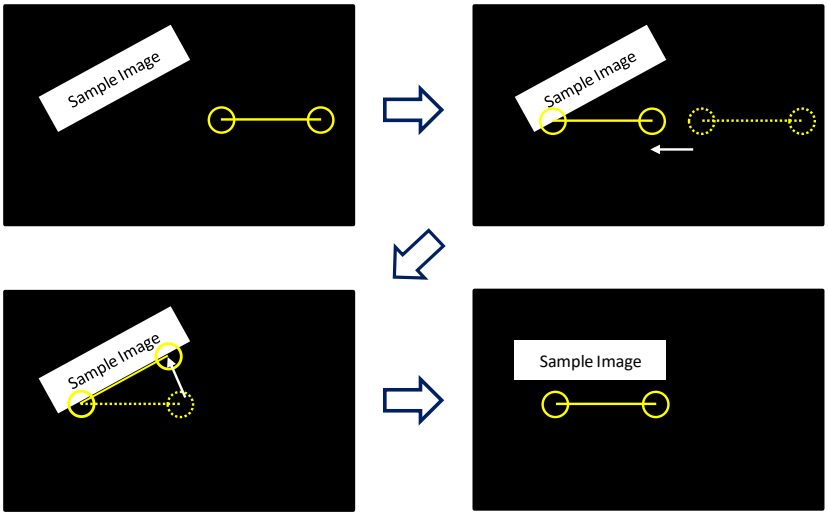
Rotate the stage R axes and tilted structure on the image to horizontal or vertical.

- Set to horizontal

  The guide line  is displayed by clicking  at the bottom of the stage rotation button and select  .

  Align a circle of guide line to the tilted structure on the image. The tool will move when dragging the straight area of guide line.

  Then, drag the other circle area and align the straight line of tool to the tilted structure. When release the mouse button, the stage or R axes will rotate so that the structure becomes horizontal.



When dragging the circle and move to out of the image display area, the mouse operation will be deactivated.

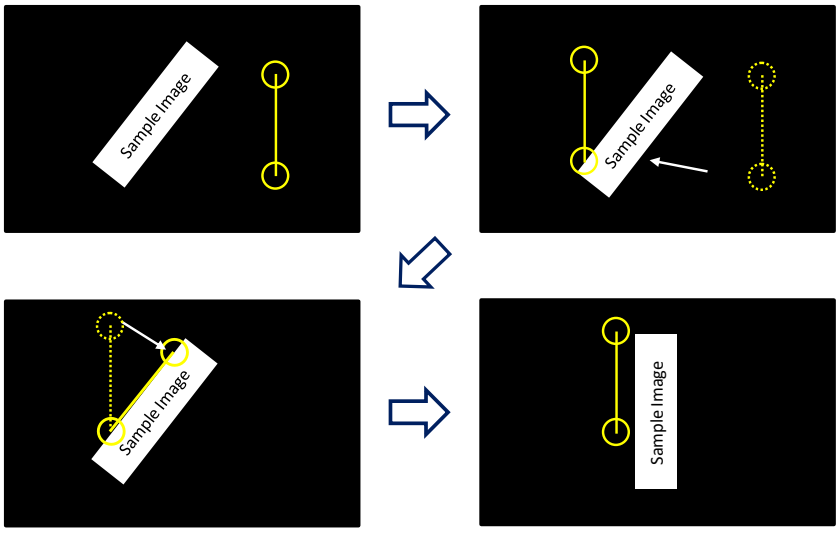
When return to the previous position, click the [Menu] > [Undo] > [Move Stage] to return to the previous condition. (Cannot return to the condition before the previous condition)

- Set to vertical

  Guide line is displayed by clicking the button at the stage rotation button and select .

  Align a circle of guide line to the tilted structure on the image. The tool will move when dragging the straight area of guideline, 

  Then, drag the other circle area and align the straight line of tool to the tilted structure. The stage R axes is moved so that the structure becomes vertical by releasing the mouse button.



When dragging the circle and move to out of the image display area, the mouse operation will be deactivated.

When return to the previous position, click the [Menu] > [Undo] > [Move Stage] to return to the previous condition. (Cannot return to the condition before the previous condition)

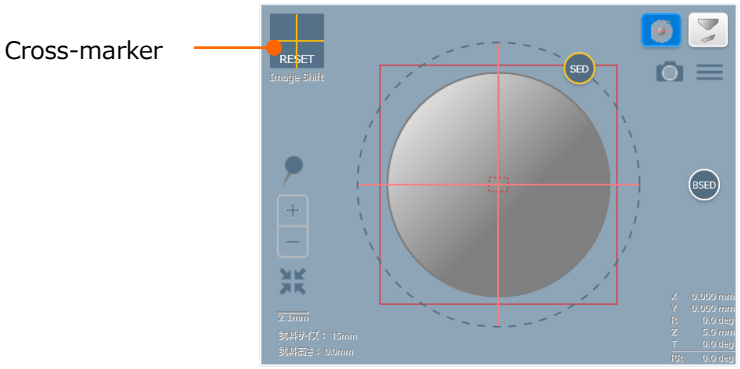
(2) Move the FOV by manual operation panel (Option)

It can be used for moving the FOV during the high magnification observation. Move the FOV by shifting the irradiation position of electron beam by rotating the IMAGE SHIFT knob on the operation panel.

The FOV moves to the X direction by rotating the X knob and Y direction by rotating the Y knob.

NOTE:
- Mechanical move of stage will not be performed.
- Buzzer sounds when exceeding the movable range of image shift.

The moving amount of image shift can be confirmed by the cross-marker on the SEM MAP. In addition, the image shift will be rest to the center of the movable range by clicking the RESET button.



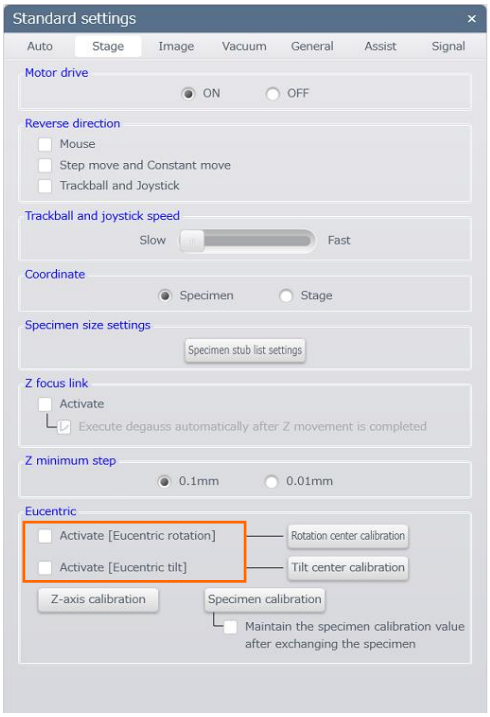
3.5.6.8 Eucentric rotation/Tilt function and calibration operation

The Eucentric rotation function is capable of observing the previous FOV by calculating the X and Y coordinates that can observe the previous FOV after the rotation and moving the X and Y coordinates while rotating the stage.
The Eucentric rotation function is capable of observing the previous FOV by calculating the X and Y coordinates that can observe the previous FOV after the tilting and moving the X and Y coordinates while tilting the stage.
Several calibrations are required for enabling the both functions.

(1) Eucentric operation settings

Control the stage so that the stage moves to the previous FOV when rotating the stage by enabling [Activate [Eucentric rotation]] check box in the [Standard settings] dialog > [Stage] tab.

Control the stage so that the stage moves to the previous FOV when tilting the stage by enabling [Activate [Eucentric tilt]] check box in the [Standard settings] dialog > [Stage] tab.



(2) Calibration operation

Correct the following due to the differences for operating the Eucentric rotation and tilting function properly.

(a) Measure and correct the shifting amount of rotation center and beam irradiating position.

(b) Measure and correct the shifting amount of tilting center and beam irradiating position.

(c) Correct the differences of shifting amount of both center axes due to the Z-axis move.

(d) Measure and correct the shift of tilting center and beam irradiating position due to changing the specimen height during the specimen exchange

The correction operation of (a) to (c) is preformed before shipment. However, performance of Eucentric function may be deteriorated due to beam irradiating position is shifted and electron beam axes alignment. In this case, preform the calibration operation.

(d) is performed for correcting the Eucentric performance deterioration due to changing the specimen height during the specimen exchange. Perform the specimen exchange procedure when accuracy of Eucentric function is required.

(3) Required calibration operation for each specimen exchange

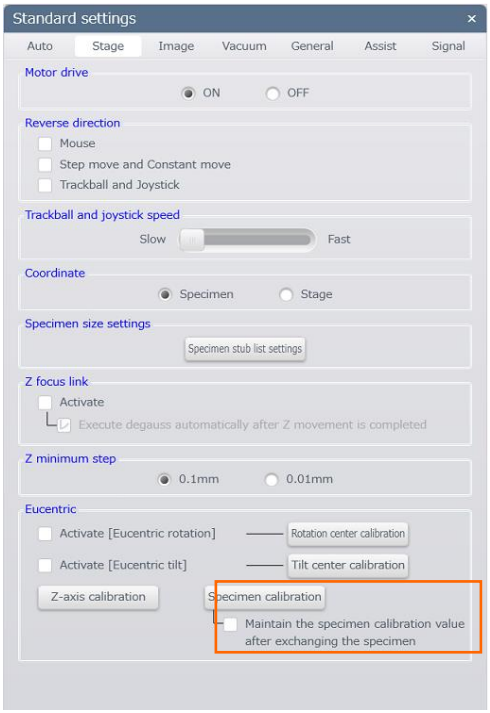
If the specimen height is different with the standard value, the rotation or tilt center will be shifted when tilting the specimen. Measure and correct the specimen height at the each time of specimen exchange for operating the Eucentric function accurately.

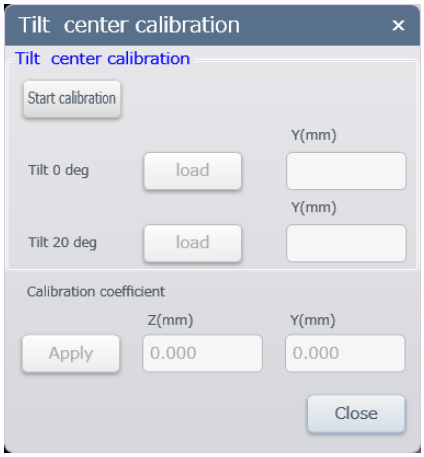
NOTE: The calibration is not required when the accuracy of Eucentric rotation in the tilting condition is not required.

1. Insert the specimen stub (SU3800: φ127 mm or less, SU3900: φ203 mm or less) and set at Z＝10 mm, Tilt＝0° and R＝0°. Confirm that the movable range of Tilt axes is more than 20°.
   Search a target structure around the center of the specimen stub.

NOTE:
- Confirm that the WD is set at WD＝10 mm. If the position is greatly shifted, set the specimen again.
- Set the Z longer when the movable range of Tilt axes is smaller than 20°.

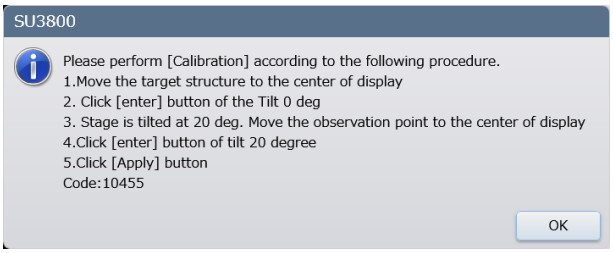
2. Display the [Standard settings] dialog from [Menu] > [Standard settings] > [Stage]. Click the [Specimen calibration] button in the [Stage].
   ⇒[Tilt center calibration] dialog is displayed.





NOTE: When enabling the [Maintain the specimen calibration value after exchanging the specimen] check box, the correction value will be kept using after exchanging the specimen. If the specimen height is not changed such as a wafer sample, the correction is not required.

3. Click the [Start calibration] button.
   ⇒The confirmation message for the operation method is displayed.



4. Click OK button
5. Move the target structure to the center of the display with the magnification around x500 and click [load] button at Tilt 0 deg.
   ⇒The stage will tilt to 20°.
6. When the stage moves, move the target structure to the center of display by operating the stage X and Y and click [load] button at Tilt 20 deg.
   ⇒ [Calibration coefficient] is calculated and displayed.
   This value is the shifting amount of specimen height from the standard position.
7. Close the dialog by clicking [Apply] button and then, [Close] button.

(4) Calibration operation when performance is deteriorated

The following calibration does not required normally. Perform the followings when the performance of Eucentric function is deteriorated.

NOTE:
- User the φ15 mm, φ26 mm or φ32 mm specimen stub for the calibration. The calibration cannot be performed in the other specimen stub.
- Use a specimen stub which does not mount a specimen and set the specimen height at 0 mm in the [Exchange Specimen] sequence for the calibration. The calibration cannot be performed in the other specimen height.

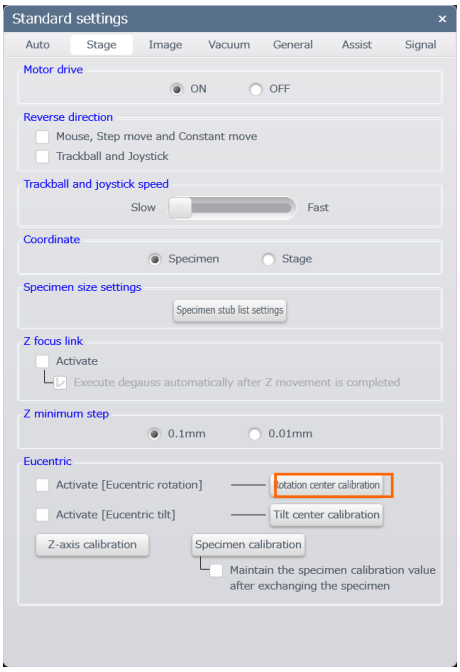
(a) Rotate center calibration

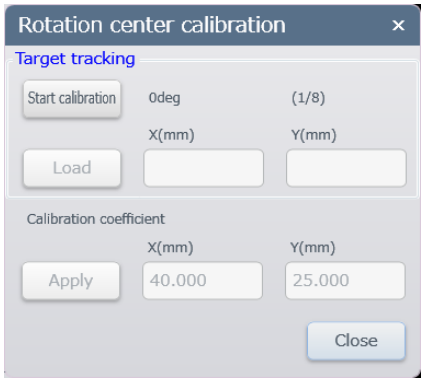
Measure and correct the shifting amount of rotation center and beam irradiation position.

1. Insert the specimen and set to Z＝10 mm, T＝0° and R＝0°. Search a target structure around the center of the specimen stub.

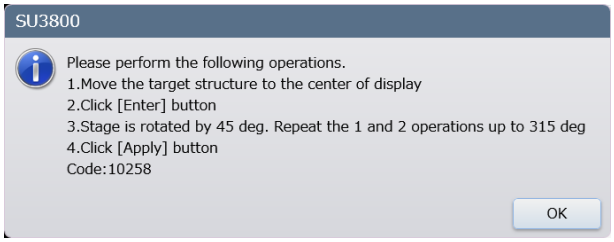
NOTE: Confirm that the WD is set at WD＝10 mm. If the position is greatly shifted, set the specimen again.

2. Display the [Standard settings] dialog from [Menu] > [Standard settings] > [Stage]. Click the [Rotation center] button in the [Stage] tab.
   ⇒ [Rotation center calibration] dialog is displayed.





3. Click the [Start calibration] button.
   ⇒The confirmation message for the operation method is displayed.



4. Click [OK] button.
5. Move the target structure to the center of the image with the magnification around x500 by operating the stage X and Y then, click [Load].
   ⇒Stage will rotate to 45°.
6. Move the target structure to the center of the image with the magnification around x500 by operating the stage X and Y when stage is moved and click [Load].
   ⇒Stage will rotate to 45° more.

NOTE: The target structure will shifted from the center of the display but within approximately 300 μm.

7. Move the target structure to the center of the image and click [Load] again.
   ⇒Stage will rotate by 45°.
8. When the stage rotating angle is 315°, click [Load] button.
   ⇒ [Calibration coefficient] is calculated and displayed.
   The value indicates rotation center on the stage coordinate and it is normally at the position around X = 60±1 mm and Y = 25±1 mm.
9. Click the [Apply] button and close the dialog.

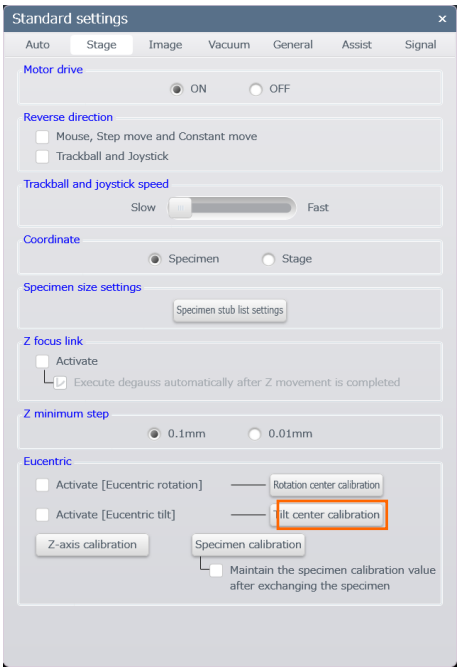
(b) Tilt center calibration

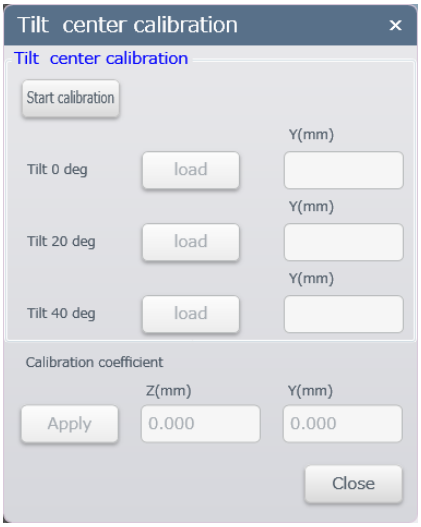
Measure and correct the shifting amount of tilt center and beam irradiating position.

1. Insert a specimen and set to Z=30 mm, Tilt = 0° and R = 0°. Search a target structure around the center of the specimen stub.

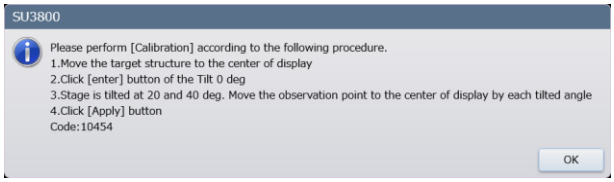
NOTE: Confirm that the WD is set at WD = 30 mm. If the position is greatly shifted, set the specimen again.

2. Display the [Standard settings] dialog from [Menu] > [Standard settings] > [Stage]. Click the [Tilt center calibration] button in [Stage] tab.
   ⇒ [Tilt center calibration] dialog is displayed.





3. Click [Start calibration] button.
   ⇒The confirmation message for the operation method is displayed.



4. Click the [OK] button
5. Move the target structure to the center of the display with the magnification around x500 by operation the stage X and Y and click the [load] button a the Tilt 0 deg.
   ⇒The stage will tilt to 20°.
6. When the stage moves, move the target structure to the center of display by operating the stage X and Y and click the [load] button at Tilt 20 deg.
   ⇒The stage will tilt to 40°.
7. When the stage moves, move the target structure to the center of display by operating the stage X and Y and click the [load] button at Tilt 40 deg.
   ⇒[Calibration coefficient] is calculated and displayed. This value indicates the shifting amount of specimen height from the standard position.
8. Close the dialog by clicking the [Apply] button and then, click the [Close] button.

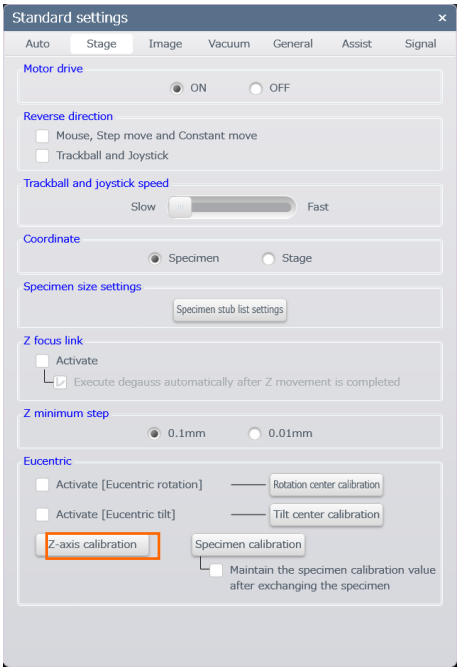
(c) Z axes calibration

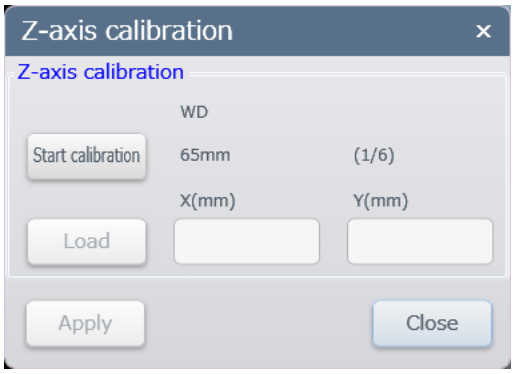
Perform the measurement and correction of the center axes moving amount differences due to moving the stage Z.

1. Insert a specimen and set to Z = 10 mm, R = 0° and T = 0°. Search a target structure around the center of the specimen stub.

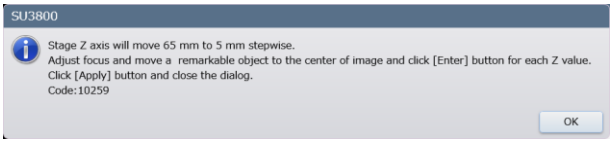
NOTE: Confirm that the WD is set at WD = 10 mm. If the position is greatly shifted, set the specimen again.

2. Display the [Standard settings] dialog from [Menu] > [Standard settings] > [Stage]. Click the [Z-axes calibration] button in [Stage] tab.
   ⇒ [Z-axes calibration] dialog is displayed.





3. Click [Start calibration] button
   ⇒The confirmation message for the operation method is displayed.



4. Click OK button.
   ⇒Z axes of stage moves to 65 mm on SU3800 and 85 mm on SU3900.
5. Correct the focus after the stage is moved. Operate the stage X and Y, move the target structure with magnification around x500 to the center of image then, click [Load] button.
   ⇒Z axes of stage moves to 50 mm on SU3800 and 60 mm on SU3900.
6. Then repeatedly correct the focus on the image and move the target structure to the center of the image then, click the [Load] button.
   ⇒The stage Z axes moves to 35 mm, 20 mm, 10 mm and 5 mm.
7. When the stage Z axes is 5 mm, click the [Load] button.
   ⇒ [Calibration coefficient] is calculated and displayed.
8. Close the dialog by clicking the [Apply] button and then, click the [Close] button.

3.5.6.9 Stop the stage move

If the selected stage position is incorrect, click the [STOP] button while stage is moving.

NOTE: Do not click the [Move] button repeatedly while stage is moving. The error of the [STOP] button may occurred.

Stage can move to the previous position after the stage is moved for selecting the coordinate by selecting the [Menu] > [Undo] > [Move Stage] (Cannot move to the position before the previous position). It can be used for performing the coordinate select move.

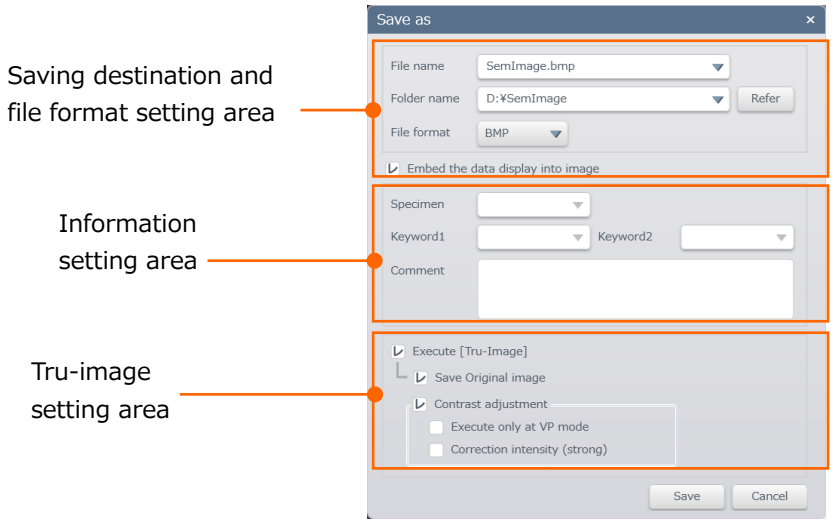
3.6 Image saving and data recording

Observation image can be saved as an image file (bit map format, TIFF format, JPEG format). The saved image will be displayed on the image list display area.

NOTE: A text data, which is the same as the file name will be saved while saving the image data. The observation condition will be recorded in the file when saving an image. Thus, please do not delete the file.

3.6.1 Input method of file name and saving destination

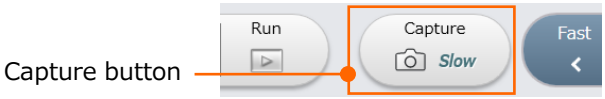
The following dialog will be displayed for saving an image file.
The saving destination for the image file, file name, file information can be set. The list of text that is previously used can be displayed by clicking ▼ button at the text input box and select a text from the list.



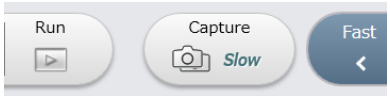
- Saving destination and file format setting area
  Set a file, the folder names and a file format.
  The contents of data that is embedded in the bottom of the image is saved by checking ON the [Embed the data display into image] checkbox.
- Information setting area
  Sample, keyword, comment can be entered.
- Tru-image setting area
  Perform the Tru-image function depending on the observation condition while capturing or saving an image by checking ON the [Execute [Tru-Image]] checkbox.

3.6.2 Save the observing image

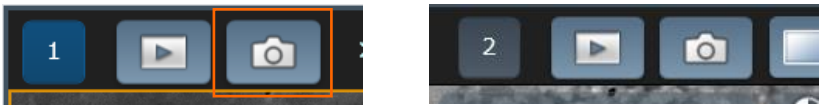
Start to scan or capture the image by clicking the [Capture] button on the control panel or Camera icon at the upper of the image display area (when selecting the 2 screen mode). This function can be performed by clicking the [CAPT] button on the Manual operation panel (option).



Capture condition under 1 screen mode



Capture condition under 2 screen mode



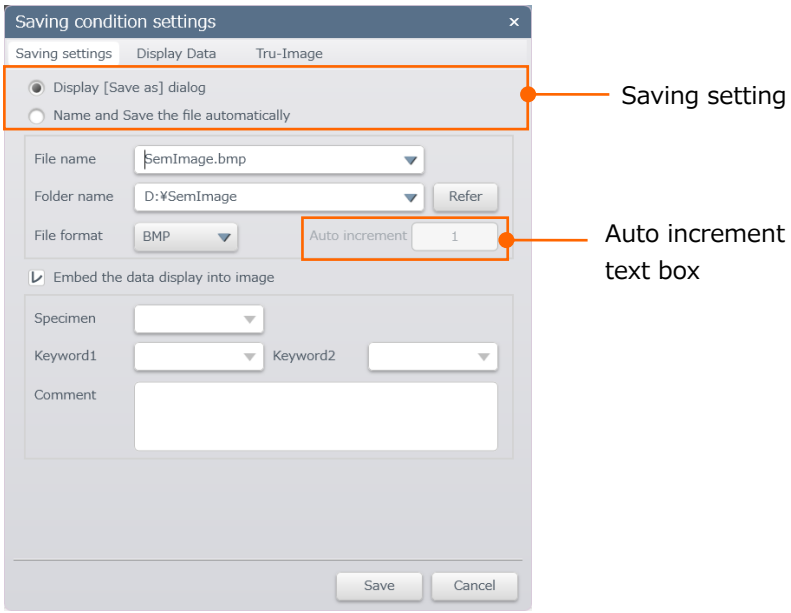
Camera icon button at the upper of image display area (2 screen mode)

3.6.3 Saving condition settings

Set the image saving, data display and Tru-image settings.

(1) Saving settings

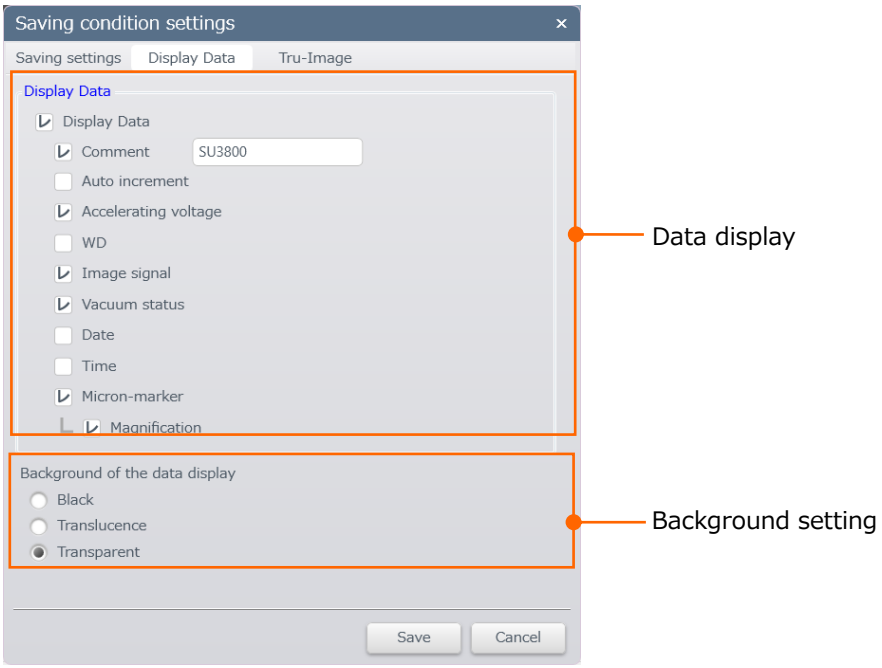
Display [Saving settings] tab in the [Saving condition settings] by selecting [Menu] > [Saving condition settings] > [Saving settings] button. The saving image file or the file information can be set in advance. The method of setting the saving destination or inputting the file name is same as the 3.6.1 Input method of file name and saving destination.



- Saving settings
  (a) When selecting the [Display [Save as] dialog], [Save as] dialog is displayed while saving an image. Enter the saving destination and information for each time.
  (b) When [Name and Save the file automatically] is selected, the saving destination and information can be entered in advance. A serial number automatically is added automatically and the image is saved after capturing. The initial number can be set at the [Auto increment] text box.

(2) [Data display] settings

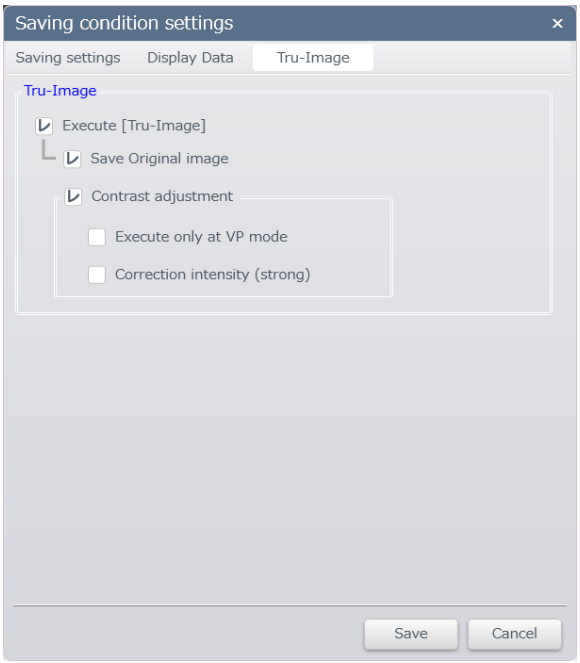
Display the [Data display] tab on the [Saving condition settings] dialog by selecting [Menu] > [Saving condition settings] > [Data display] button for setting the data display (Function for displaying an observation condition on the image).



- Data display
  Display/hide the data. The data can be displayed or hidden by checking ON or OFF the checkbox.
- Background setting
  Set the background of the data display.

(3) [True-Image] setting

Display the [Tru-Image] tab in [Saving condition settings] dialog by clicking [Menu] > [Saving condition settings] > [Image enhance]. Set the Tru-Image processing. The processing method will be described in the next section.



3.6.4 Tru-Image function

The [Tru-Image] is capable of recovering from the deterioration of contrast or blur of image due the electron optical system under the high magnification observation. Perform the Tru-Image function and save the image file depending on the observation condition (Accelerating voltage, WD, spot intensity, image size and magnification).

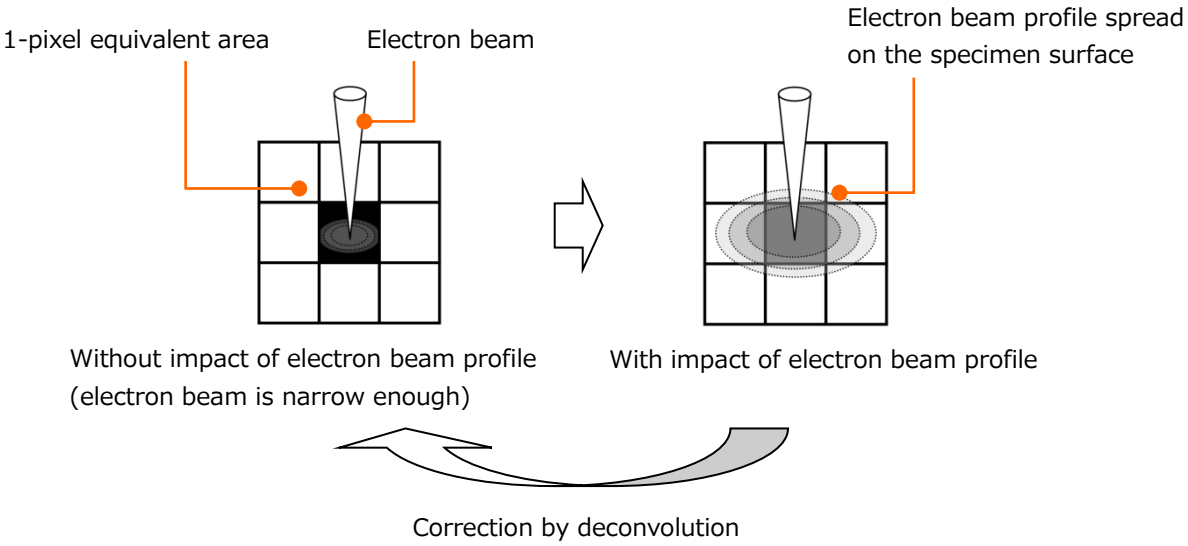
NOTE: The image (original image) without processing may be output as a processed image under the condition of low magnification, high accelerating voltage and short WD in the Tru-Image function due to the blur on the original image is small.

The [Freeze Tru-Image] is indicated at the upper left on the image of freeze condition when Tru-Image is performed.

(1) Principles of the Tru-Image

Tru-Image is possible to recover the blue on image that is generated due to the electron optical system under the high magnification observation and the deterioration of contrast.

The Tru-Image function will execute the image processing and save an image file depending on the observation condition (Accelerating voltage, WD, stop intensity, image size, magnification) while capturing the image.

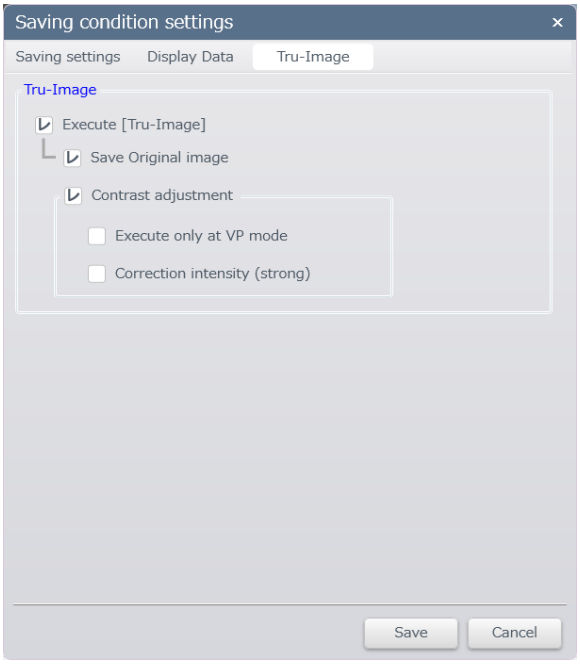


(2) How to use the Tru-Image Function

The Tru-Image can be set the setting in the [Saving condition settings] dialog in advance or set the setting in the [Save as] dialog.

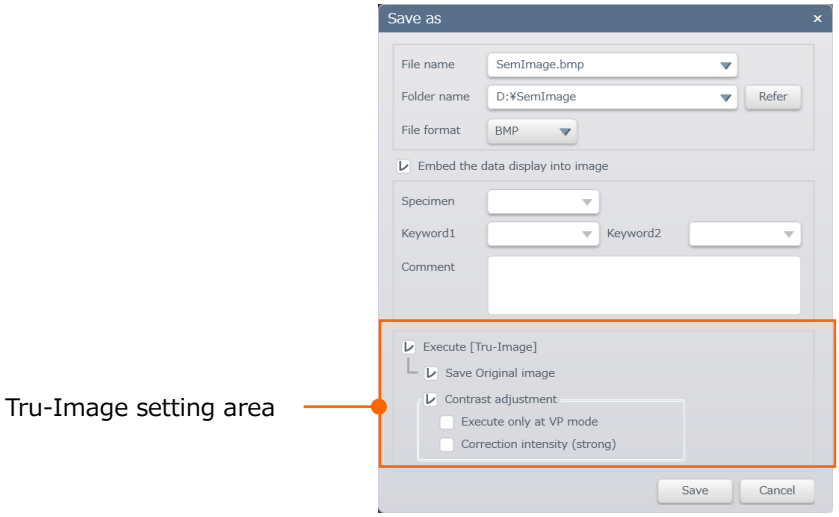
(a) Save condition settings dialog

- [Execute [Tru-Image]
  When checking ON the check box, the Tru-Image will be executed when capturing an image.
- [Save Original image]
  Check ON the check box and save an original image file as well as the Tru-Image file. The [_raw] will be added to the Tru-image file name on the original data file. Only the Tru-Image file will be saved when checking OFF the check box.
- [Contrast adjustment]
  When checking ON the check box, contrast on the image will be enhanced when performing the Tru-Image.
  When checking ON the [Execute only at VP mode] check box, correct the contrast on the image only when the condition is in the VP mode that is deterioration of contrast is easily occurred due to the beam dispersion.
  The intensity of the contrast correction can be increased by checking ON the [Contrast intensity (strong)] check box.



(b) [Save as] dialog

When the [Display [Save as] dialog] dialog is selected in the [Saving condition settings] dialog, the [Save as] dialog will be displayed at the each time of capturing and select whether to perform the Tru-Image or not.



(3) Notes and restriction on the Tru-Image Function

(a) Notes on the Tru-Image function

- The Tru-Image function does not grantee the improvement of the measurement accuracy or resolution.
- The shape of the edge on the specimen structure for the Tru-Image may be different than the original image. Therefore, the measurement result of the Tru-Image may be different from the original image when performing the measurement function or resolution measurement, which use the auto reorganization function. In case of concerning the effect on observation, do not perform the Tru-Image.
- The specimen structure may be different from the original structure on the image (artifact) depending on the specimen structure.
- When checking ON the [Contrast adjustment] check box, The contrast on the captured image may strongly enhanced when performing the Tru-Image. In this case, please check OFF the check box.
- In case that the contrast on the original image is strong, contrast on the image may be decreased when performing the Tru-Image. In this case, please check ON the [Contrast intensity (strong)] check box or check OFF the [Contrast adjustment].
- The effect of Tru-Image function may be difficult to notice when the contrast on the original image is not optimal condition.

(b) Limitations on the Tru-Image function

The Tru-Image processing cannot be performed for the following images:

- When the captured image size is 2,560 × 1,920 pixels or more.
- When the image was saved in Reduce scan mode

3.6.5 IPI transfer

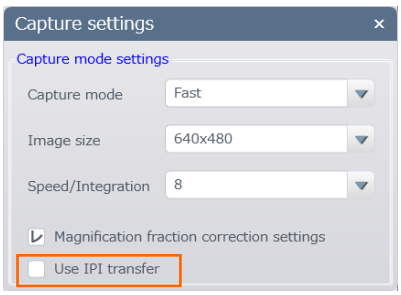
Image data can be transferred to the Image-Pro (option) which is manufactured by Media Cybernetics when saving or capturing an image.

(1) Setting of the IPI transfer

Selected from [Menu] > [Standard settings] > [General] dialog and open the [General] on the [Standard settings] dialog. Turn ON the [IPI transfer] check box.

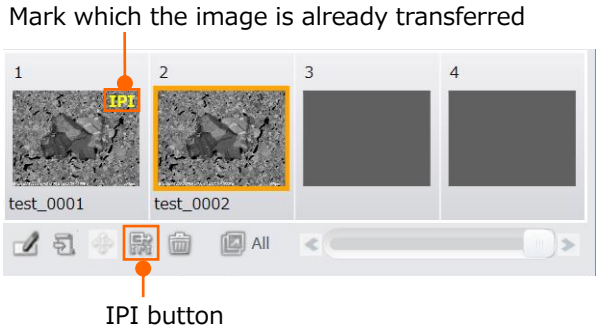
(2) Transfer the observing image to Image-Pro

An image can be transferred to the Image-Pro when capturing an image by checking ON the [Use IPI transfer] in the [Capture settings] dialog.



(3) Transfer the saved image to Image-Pro

Select an image form the image list display area and click the IPI button. A mark indicating the transferred image is displayed on the thumbnail image.



3.7 Finish the observation and exit the SU3800/SU3900

Perform the following procedures for finishing the observation and exiting the SU3800/SU3900.

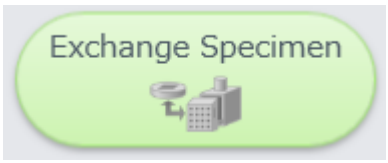
3.7.1 Finish the SEM observation

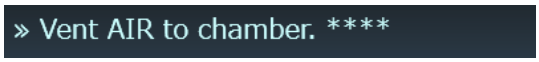
1. Close all windows.
2. Click the [Stop] button on the control panel for finishing the observation.

Observation status　　Stop status

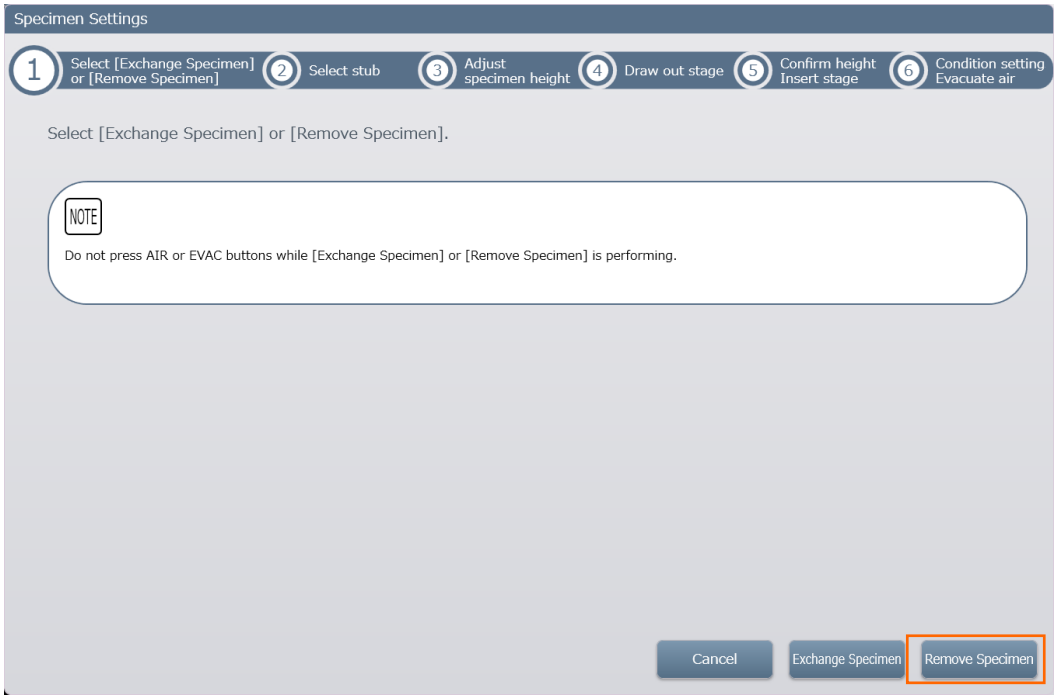
3.7.2 Remove the specimen and exit the operation program

1. Click the [Exchange Specimen] button.
   The [Specimen Settings] dialog is displayed and the air will be vented to the specimen chamber. It takes few seconds until the specimen chamber reaching to in the atmospheric condition.
   ⇒When the specimen chamber is in the atmospheric condition, AIR LED at the LED panel is ON from blinking and buzzer sounds three times.
   The progress status is indicated in the upper left on the image display area while venting air to the specimen chamber.

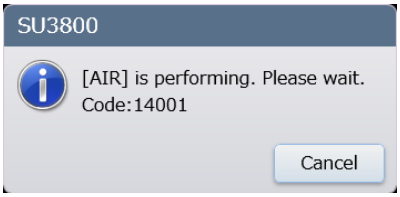




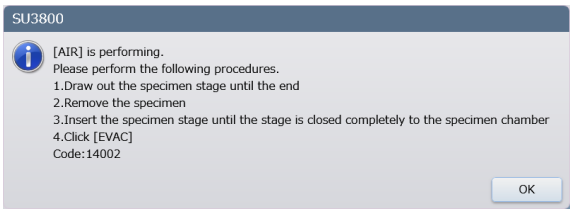
2. Click the [Remove Specimen] button on the [Specimen Setting] dialog.

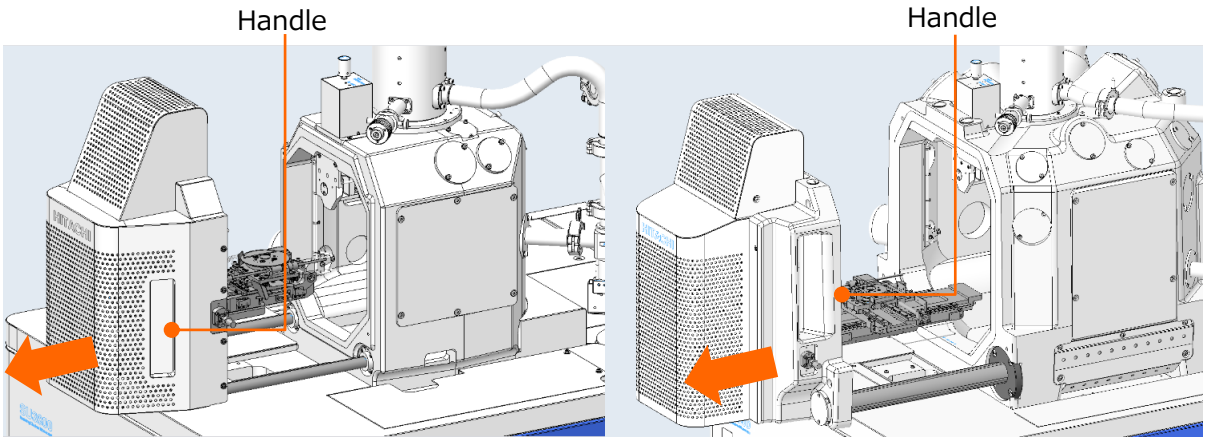


The following message is displayed while the [AIR] processing. It takes few minutes until the specimen chamber reaches to the atmospheric condition.



3. The following message is displayed when the specimen chamber is in the atmospheric condition. Draw out the specimen stage until the end and remove the specimen. Then, click the [OK] button.





4. Hold the handles of the specimen stage and slowly insert the specimen stage.
   Pump air from the specimen chamber by clicking the [Control panel] > [EVAC] button or pressing the EVAC/AIR switch on the LED panel.
5. When the specimen chamber is in the vacuum condition, exit SU3800/SU3900 by clicking the Close button.

3.7.3 Power OFF the instrument

Power OFF the instrument by rotating the key switch on the LED panel.

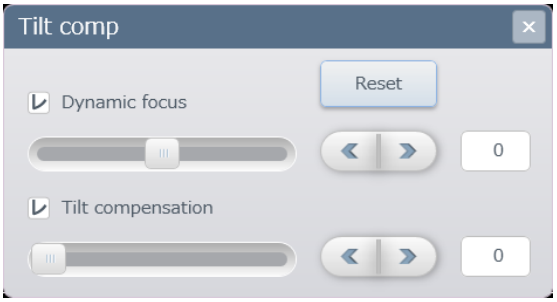
3.7.4 Confirmation items for powering OFF the instrument

Power OFF the SU3800/SU3900 by rotating the key switch.
If the instrument will not be shutdown, power OFF the main breaker at the rear side of the main unit. To shut down the instrument completely, power OFF the main breaker at the rear side of the main unit.
When re-starting the instrument, power ON the main breaker and rotate the key switch.

3.8 Operation for the other functions

3.8.1 Tilt compensation

The tilt compensation is possible to correct the change of focus position and magnification while tilting the specimen.
Display the [Tilt comp] dialog from the [Menu] > [Tilt comp].



(1) Dynamic focus
The area of focusing is limited when tilting the specimen. This function is possible to correct the shifting of focusing on the tilting direction. Set the raster rotation angle to 0 for performing this function.
Turn ON the [Dynamic focus] check box and move the focus slider to the center (0). Adjust the focus on the center of the image then, adjust the focus again on the entire image by moving the slider.
The slider can be moved by 5 steps when clicking the right and left slider knobs, and the slider can be moved by 1 step by clicking the fine adjustment button of the slider at the right side.
However, this value does not correspond to the specimen tilting angle.
The focus value will be (0) by moving to the center of the slier and the value range is -100 to +100.

NOTE: The adjustment value is different depending on the magnification, specimen height and accelerating voltage. When changing the observation condition, the adjustment shall be performed again. In addition, the adjustment of focusing may be difficult in the fast scan mode.

(2) Tilt compensation

When tilting the specimen, the image of tilting direction (Y direction) may display as it is shrank due to viewing the specimen from the diagonal direction. This function is possible to correct the deterioration on the image.

Enable the [Tilt compensation] check box and adjust the tilting angle with the slider or enter a value.

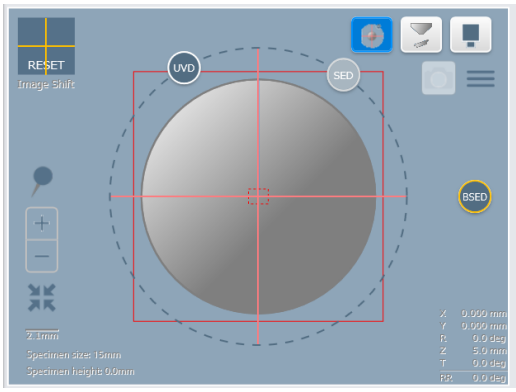
The slider can be moved by 5 steps when clicking the right and left slider knobs, and the slider can be moved by 1 step when clicking the fine adjustment button of the slider at the right side. However, this value corresponds to the tilting angle of the specimen. The correction value will be (0) by moving the slier to the most left side and the value range is 0 to 70.

NOTE: When the specimen has the topographic structure surface, the gap of the specimen surface is enhanced and the artificial image may be obtained by performing the tilt compensation function.

3.8.2 SEM MAP

The SEM MAP is capable of navigating the observation position (Present observation position display/stage moving operation). In addition, the positional relationship of a directive detector (SED etc.) can be displayed and the detector signal can be switched.

This section describes the coordinate registration function, Navigation function by utilizing the SEM image and the Navigation function by utilizing an external image. Refer to the 2.3.8 Sub screen display area regarding the basic operation method.



(1) Coordinate registration function

Register the stage coordinate by clicking the coordinate registration button at the desired position on the stage. Recover the X, Y and R coordinates and raster rotation by utilizing the registered position.

A marker that indicate the registered coordinate will be displayed on the SEM MAP window. Display the [Register Coordinate] dialog by selecting [Menu] > [Register coordinate]. The displayed window (the selected window in the 2 screen mode) will be displayed in the thumbnail display area as a thumbnail image during coordinate registration. The number can be registered from 1 to 100.

(a) Move to the registered point

Select a coordinate No. from the pulldown list on the [Register coordinate] dialog and click the [Movement] button.

(b) Clear the registered point

Clear the point by selecting the number of the registered point from the pulldown list and click [Clear] button in the [Register coordinate] dialog.

Click [Clear All] button for clearing the all registered points.

(2) ImageNavi function

Move the stage to the position where the desired position is center of the image by registering the presently observing specimen image in the low magnification (Captured SEM image) and selecting an observing point.

When clicking the ImageNavi image obtain button, the presently observing SEM image will be obtained as a Navigation image and displayed in the SEM MAP window.

NOTE: The image cannot be loaded when the image which magnification is more than x2,000 or the number of loading image is more than 40.

(3) Navigation function by utilizing an external image

Camera image of the observing specimen, optical microscope image or simple figure can be loaded and used as a navigation image.

(a) Load an external image

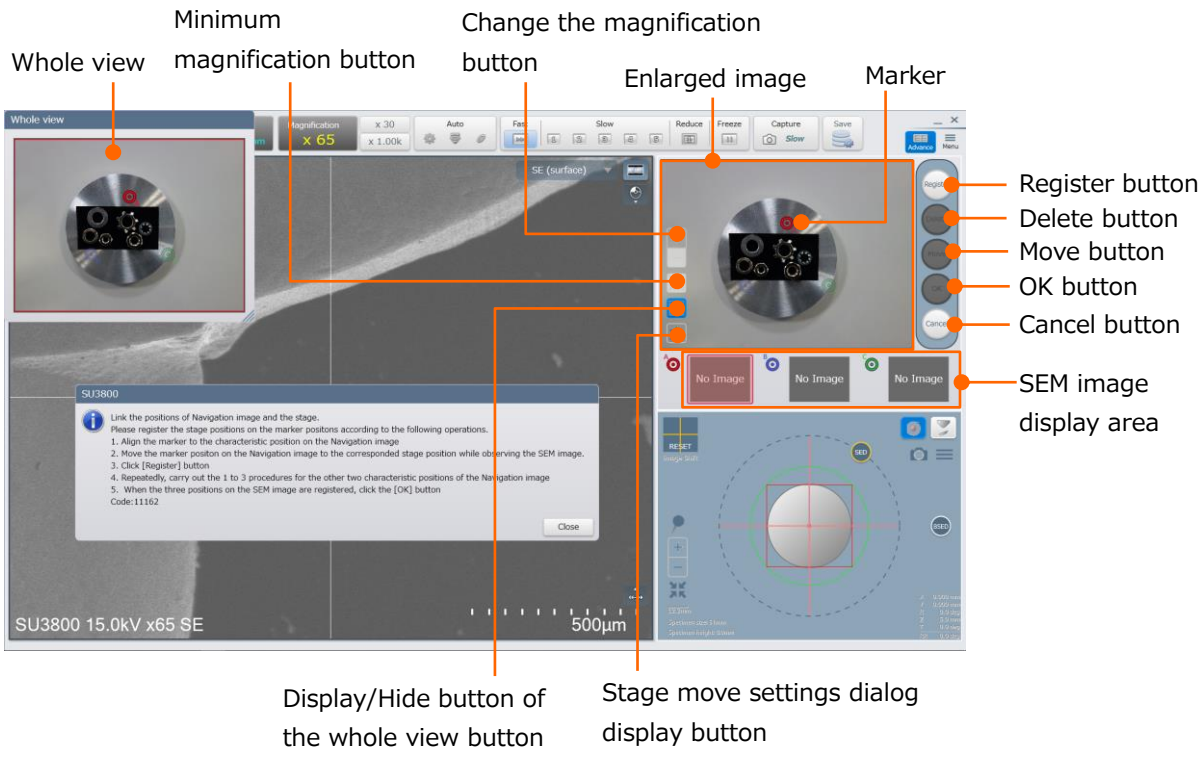
Display [Select image file] dialog by selecting [Menu] > [Load external image]. Select and load a navigation image.

The BMP (.bmp), JPEG (.jpg, .jpeg), TIFF (.tif, .tiff), PNG (.png), GIF (.gif) formats are available.

(b) 3 point alignment

Perform the 3 point alignment for linking the position of the Navigation image and the observing specimen.

The display will be switched to the display as shown in the following figure after the image is loaded.



- Whole view
  Display the navigation image. The red frame indicates the area, which is displaying in the enlarged display. Drag the red frame and move the enlarged image area.
- Enlarged image
  Display the navigation image. In addition, display the [Change the magnification] button, the [Minimum magnification] button, [Display/Hide] button of the whole view or marker.
  The magnification can be changed by operating the mouse wheel on the enlarged image.
- Change the magnification button
  Change the magnification of the enlarged image.
- Minimum magnification button
  Set the magnification of the enlarged image to the minimum magnification.
- Display/Hide button of the whole view button
  Display or Hide the whole view.
- Stage move settings dialog display button
  Display the stage move setting dialog.
- Marker
  The marker for the alignment operation.
  Three type of maker that is A (Red), B (Blue), C (Green) are available.
- SEM image display area
  Display the SEM image at the each marker position when clicking the register button. Click the SEM image and display the each marker position on the navigation image.
- [Register] button
  Link the positions between the marker position and the present stage position.
- [Delete] button
  Delete the link of the marker position and the stage position.
- [Move] button
  Move the stage to the selected marker position.
- [OK] button
  Finish the 3 point alignment.
- [Cancel] button
  Cancel the 3 point alignment.

Perform the 3 point alignment according to the following procedures.

1. Drag the marker A (red) on the enlarged image and move it to the characteristic position on the navigation image.
2. While confirming the SEM image, move the FOV that is corresponding to the marker A (red) position on the navigation image by operating the Stage X and Y axes. Display the center marker on the SEM image and layer the cross position to the positon of the marker A (red).
3. Click the [Register] button
   Link the marker position and the stage position. SEM image when clicking at the marker position is displayed on the SEM image display area. In addition, the marker, which indicates the registered position on the SEM MAP is displayed.
4. Perform the procedures of 1 to 3 on the marker B (Blue) and the marker C (green) as well.
   Accuracy of the 3 point alignment can be improved when the space between the marker positions are set far as possible.
5. When all marker positions are registered, click the [OK] button.
   The navigation image will be displayed on the map display area.

NOTE: Cannot use the Image shift function while 3 point alignment is performing.

3.8.3 Register and load the observation condition

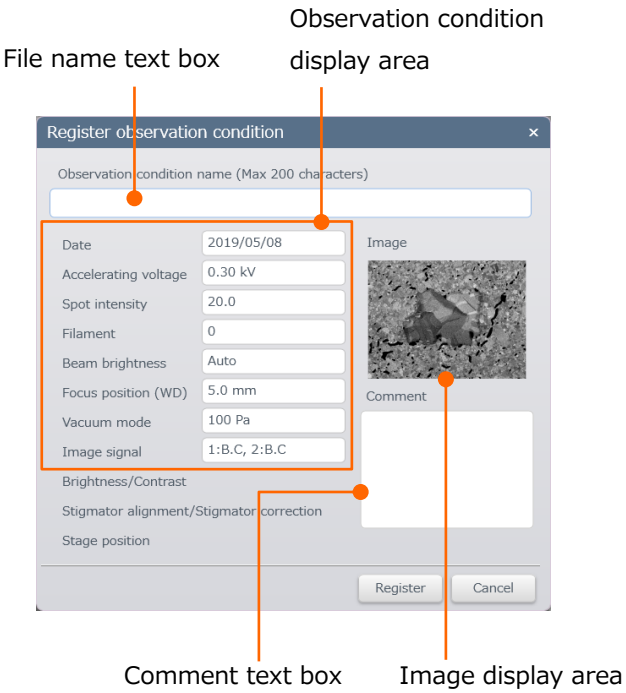
Electron optical system or observation condition can be set. The registered observation condition can be loaded and reproduced.

(1) Observation condition for registering and loading

Observation condition	Details
Accelerating voltage	Save the accelerating voltage
Spot intensity	Save the spot intensity
Filament	Save the filament current value
Beam brightness	Save the beam brightness setting and value (only for the Manual).
Focus position (WD)	Save the focus position (WD) value
Vacuum mode	Save the pressure value (only for the VP mode) and vacuum mode
Image signal	Save the detector type for displaying on the image display area
Brightness/Contrast	Save the value of image brightness and contrast
Astigmatism correction/ Stigmator alignment	Save the value of astigmatism correction and stigmator alignment
Stage position	Save the present stage coordinate

(2) Register the observation condition

1. Display [Register observation condition] dialog by clicking the [Menu] > [Observation condition] > [Register].

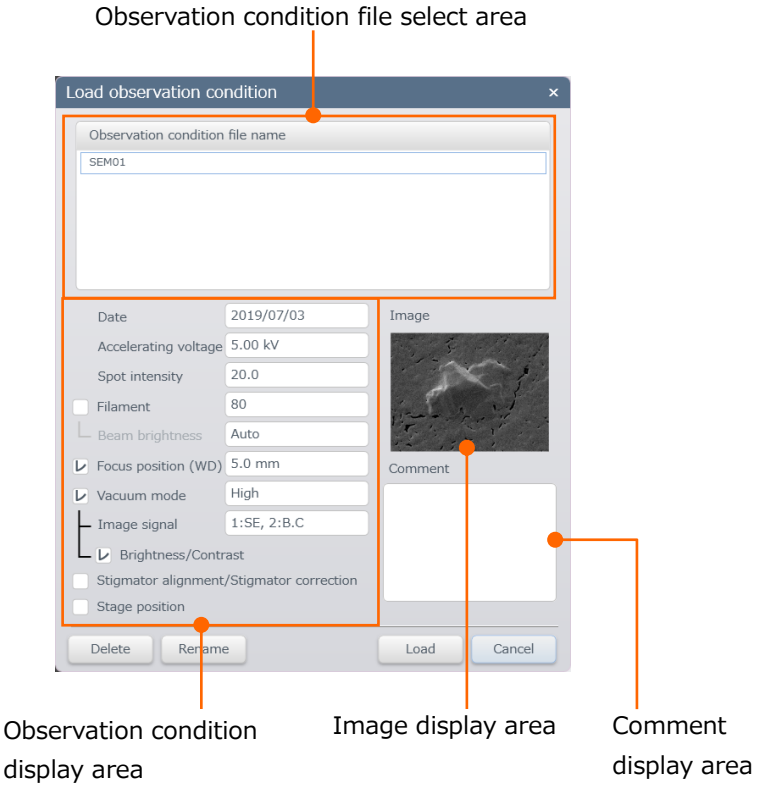


2. The observation condition at the time of displaying the [Register observation condition] dialog is displayed in the observation condition display area. In addition, the observing SEM image is displayed on the image display area. Enter the [Observation condition name] and [Comment] then, click the [Register] button.

(3) Load the observation condition

In the event of becoming the instrument condition inappropriate, to register the present observation condition as a backup before loading the observation condition is recommended.

1. Display [Load Observation condition] dialog by selecting [Menu] > [Observation condition] > [Load].



2. The registered observation conditions files are displayed in the observation condition file name select area. Select a file for loading.
3. Enable the check box of the desired condition at the observation condition display area.

NOTE: When the filament is replaced, the electron optical system condition will be changed. Set OFF the [Stigmator alignment/Stigmator correction] check box and [Filament].

4. Click [Load] button
   ⇒Set the recorded observation condition.

(4) Delete the observation condition

1. Click the [Menu] > [Observation condition] > [Load] and display the [Load observation condition] dialog.
2. The registered observation condition files are displayed in the observation condition file name select area. Select a file.
3. Click the [Delete] button.
4. Confirmation message will be displayed. Click the [OK] button.
   ⇒The selected observation condition file will be deleted.

(5) Delete the observation condition

1. Click the [Menu] > [Observation condition] > [Load] and display the [Load observation condition] dialog.
2. The registered observation condition files are displayed in the observation condition file name select area. Select a file to rename.
3. Click the [Rename] button.
4. The dialog will be displayed. Enter the file name and click the [OK] button.
   ⇒The selected observation condition file will be renamed.

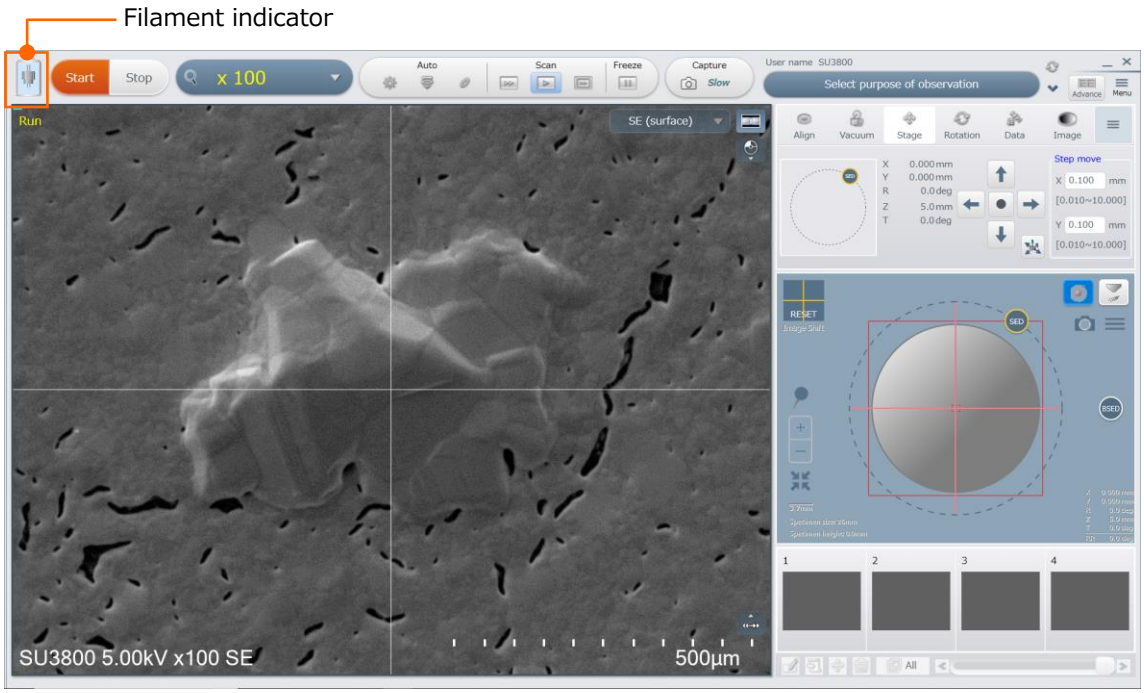
3.8.4 Intelligent Filament Technology function

Intelligent Filament Technology (Intelligent Filament Technology, IFT) is possible to stabilize the probe current and extend the filament lifetime by controlling the filament current constantly and maintaining the optimal condition.
Display the [Standard settings] by selecting the [Menu]> [Standard settings]> [General]. Check ON the [Automatic filament control] check box and the IFT will be enabled. The IFT check box is ON when shipping from the factory.

The lifetime of the filament is depending on the each filament, usage condition of the instrument or frequency of use. Total lifetime of the filament may be shorten under the VP-mode. Thus, the lifetime of the filament is excluded from the scope of warranty.

3.8.5 Filament indicator

Filament indicator indicates the estimated time for replacing the filament.



Condition	Preparing	Blue 1	Blue 2	Green	Red	Unavailable
Remaining	-	100% to 75%	75% to 50%	50% to 25%	25% or less	0%
Filament indicator						
Remark	When the filament is replaced	-	-	-	-	-

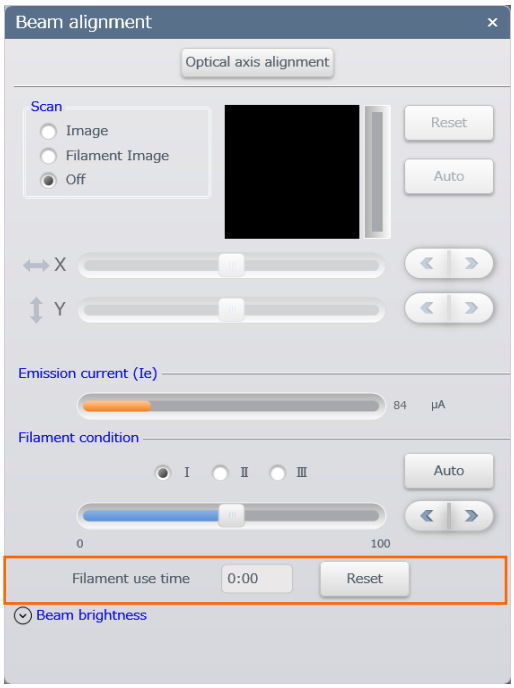
Set to the beam ON condition for approximately 5 minutes after replacing the filament ([Preparing] is displayed). However, the normal SEM observation can be performed.

About the filament indicator

- Filament indicator display will changed depending on each filament, usage condition of the instrument or frequency of use. Please use the filament indicator as for a reference.
- The filament indicator may not be displayed correctly when the filament is not replaced according to the filament replacement sequence, a new filament is used or a filament, which is not the specified by Hitachi High-Tech Corporation is used.
- The filament indication with 0% will be displayed when the filament is burned out or filament current setting is inappropriate.

3.8.6 Filament use time display function

The total use time of beam ON condition is displayed by this function.
The [Filament use time] is displayed at the [Filament condition] block on the [Beam alignment] dialog.
Click the reset button at the [Beam alignment] dialog for resetting the filament use time.
In addition, the filament use time will be reset when replacing the filament (See the 4.2.1 Exchange the filament).



NOTE : The maximum time for the filament use time is 9999 hours 59 minutes. When the time is exceeded to the maximum value, the time will be set to 0:00 automatically.

3.9 User management

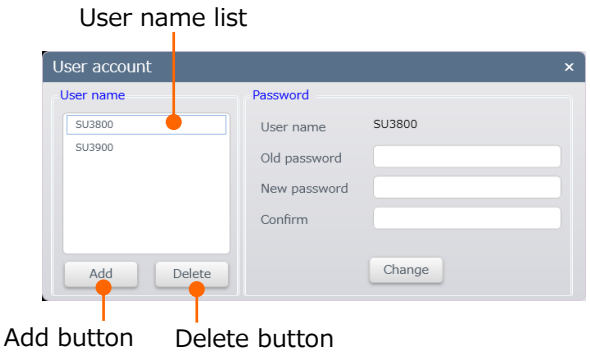
The instrument user can be restricted by setting the user name and password for SU3800/SU3900 operation program.
The instrument can startup with the user name [SU3800] (No password) in the SU3800 and user name [SU3900] (No password) in the SU3900 in the default condition. This user name is defined for a system administrator.

NOTE:
- The user name of [SU3900] cannot be the system administrator in the SU3800 as well as the user name of [SU3800] in the SU3900.
- Enter the user name or password within 8 letters or numbers.

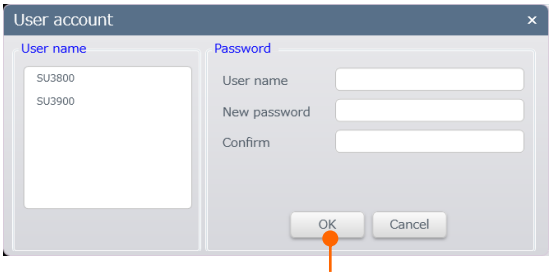
3.9.1 Register and delete the users

Display [Standard settings] by selecting [Menu] > [Standard settings] > [General]. [User account] dialog is displayed by clicking [Login settings] button in [General] tab.

NOTE: The login setting button will be displayed when entering the user name [SU3800] in the SU3800 and [SU3900] in the SU3900.



- User registration
  The display will be switched to dialog of Figure by clicking [Add] button on [User account] dialog. Enter the user name into the [User name] text box and a new password to the [New password] and [Confirm] text boxes then, click OK button.



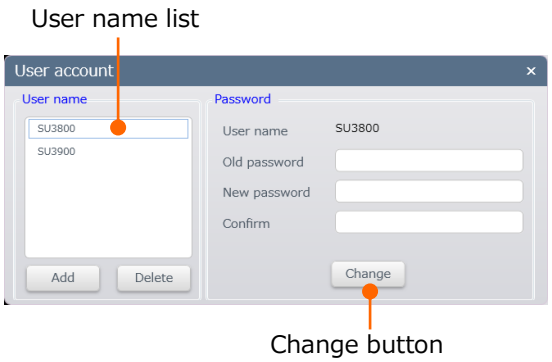
- Delete the user
  Select a user name in the User name list and click [Delete] button. The confirmation message will be displayed. Click the [OK] button.

3.9.2 Password setting by the system administrator

Password settings of all users can be performed in the [User account] dialog when staring-up the SU3800 or SU3900 by the system administrator which user name of [SU3800] or [SU3900].

NOTE: The user registration operation cannot be performed without the password of the [SU3800]/[SU3900] as an administrator.

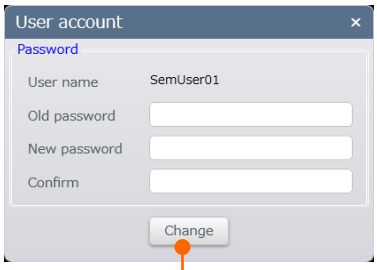
Select the [Menu] > [Standard settings] > [General settings] and display the [Standard settings] dialog. The [User account] dialog is displayed by clicking the [Login setting] button in the [General] tab.



- Set and change the password
  Select a user name in [User name] list for setting the password. Enter the [New password] and [Confirm] text boxes then, click [Change] button.
- Delete the password
  Select a user name in [User name] list for deleting the password. Leave the [New password] and [Confirm] text boxes blank then, click [Change] button.

3.9.3 Password setting by registered users

When starting up the SU3800/SU3900 operation program by a registered user, password can be change or delete in [User account] dialog.
Select the [Menu] > [Standard settings] > [General settings] and display the [Standard settings] dialog. [User account] dialog is displayed by clicking [Password settings] button in [General] tab.



The user name, which is presently logging-in the SU3800/SU3900 operation program, is displayed.

NOTE: Cannot add or delete the user name. Refer to the 3.9.1 Register and delete the users.

- Set a new password
  Enter a new password in [New password] and [Confirm] text boxes and click [Change] button.
- Change the password
  Enter the present password in [Old password] text box and enter a new password in [New password] and [Confirm] text boxes then click [Change] button.
- Delete the password
  Enter the present password in [Old password] text box and leave [New password] and [Confirm] text boxes blank then click [Change] button.

4. Maintenance

Please note the followings for performing the maintenance of instrument.

(1) Read through the maintenance procedures contained in this manual, and then carry out maintenance as described.

(2) Avoid dissembling/reassembling or repairing any part that is not described in the maintenance procedures.

4.1 Daily operational maintenance

Periodic maintenance check items for proper operation are shown in below table. Perform maintenance according to this table. For maintenance items that are supposed to be performed by our service engineer of the Hitachi High-Tech Corporation.

NOTE: Only perform the maintenance, which is described in this instruction manual. Please thoroughly understand the contents of the instruction manual before performing the maintenance. Only the service engineers of Hitachi High-Tech Corporation are allowed to perform the instrument maintenance. If the maintenance is not performed according to the above, it can cause of damaging of instrument or injury.

Periodical maintenance and inspection items

* “U” indicates the user, “S” indicates the service engineer.

No.	Frequency	Maintenance and inspection items	Respon sibility		Remarks
			U	S	
1	Every day (Daily)	(1) Amount of oil for the rotary pump	○	–	
2	1/week	(1) Cleaning of instrument exterior Main unit, console tabel, monitor, keyboard, mouse	○	–	
3	1/month	(1) Checkup the connecting and tightening condition of vacuum pipe between the rotary pump to the main unit.	○	–	
4	1/6 month	(1) Exchange the rotary pump oil	○	○	
		(2) Exchange the oil mist trap element of the rotary pump	○	○	

Periodical maintenance and inspection items
* “U” indicates the USER, “S” indicates the service engineer.

No.	Frequency	Maintenance and inspection items	Respon-sibility		Remarks
			U	S	
5	1/year	(1) Replace the objective aperture plate	○	○	
		(2) Replace the Single aperture mesh 0.7 (For Orifice aperture)	–	○	
		(3) Replace the Single aperture mesh 1.0 (For Condensor lens aperture)	○	○	
		(4) Replace the Single aperture mesh 0.2 (For Condensor lens aperture)	○	○	
		(5) Replace the Leak valve (LV1, LV3) and element of the needle valve (NV)	–	○	
		(6) Appy some grease on the Specimen stage X and Y axes ball-bearing.	–	○	
		(7) Appy some grease on the feed screw of the Z axis on specimen stage.	–	○	
		(8) Appy some grease on the R axis worm gear of the specimen stage	–	○	
		(9) Apply some grease on the T axis gears of specimen stage	–	○	
		(10) Apply some grease on the stage drawer rail	–	○	
		(11) Apply some oil to the X, Y and Z axes splinesof the specimen stage	–	○	
		(12) Check up the tightning condition of each specimen stage screw.	–	○	
6	1/3 years	(1) Replace the Scintillator	–	○	
		(2) Replace the Pirani gauge	–	○	
		(3) Replace the rotary encoder (Magnification) (Manual operation panel) (Option)	–	○	
7	1 /4 years	(1) Replace the DC motor R	–	○	
		(2) Replace the TMP	–	○	
8	1 /5 years	(1) Replace the Photomultiplier R6249	–	○	
		(2) Replace the Rotary pump	–	○	
		(3) Replace the R encorder (other) (Manual operation panel) (Option)	–	○	
		(4) Replace the Relay	–	○	
		(5) Replace the pulse motor (For Needle valve unit)	–	○	
		(6) Repalce the batteries (Control unit)	–	○	
		(7) Replace the fan	–	○	
		(8) Replace the potentiometer (T axis)	–	○	

4.2 Maintenance of electron optical column

This section describes the maintenance of the electron optics system.

4.2.1 Exchange the filament

Burning out the filament can be considered when an image is not displayed or emission current is not flown. Check the filament and exchange the filament.

1. Stop the observation by clicking [Stop] button if performing the SEM observation.

2. Display the [Replace filament] dialog by clicking the [Replace filament] button on the control panel. Perform the following five steps according to the instruction.
   Step1: Vent air
   Step2: Remove filament
   Step3: Replace filament
   Step4: Attach filament
   Step5: Beam alignment

⚠ CAUTION: The filament part becomes high temperature after the SEM observation. Beware of high temperature (About 90℃)
It can cause burn. Wait over 30 minutes for cooling down after introducing air when replacing the filament.

⚠ CAUTION: When lifting the entire electron gun unit, be sure to hold it in two hands and move it until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.

⚠ CAUTION: Can cause injury due to damaging the cover. Do not lean or sit on the cover.

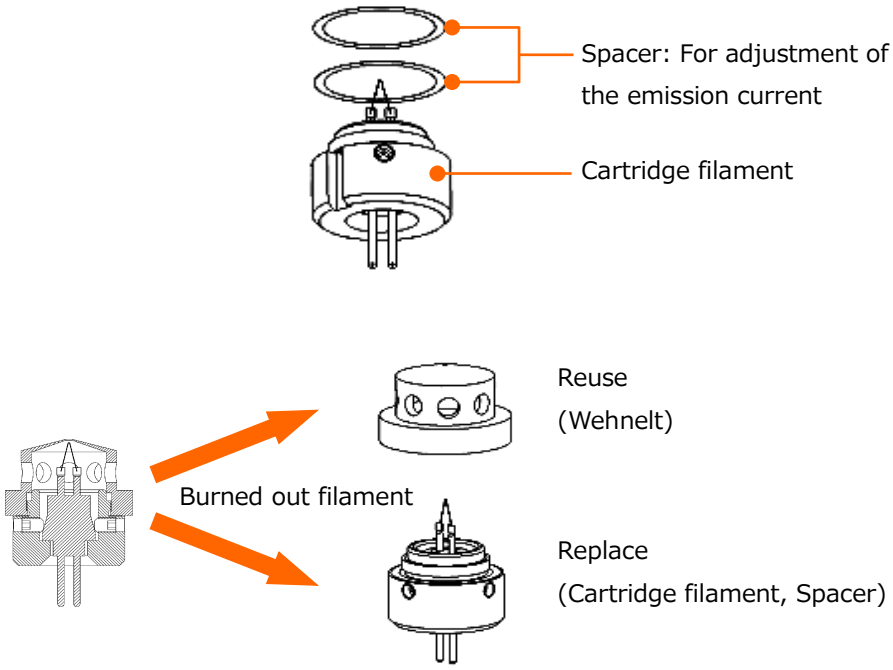
NOTE: Be sure to ware clean gloves when replacing the filament. Do not leave fingerprints on the internal vacuum parts for preventing gas degassing.

⚠ CAUTION: It can cause injury your hands or fingers due to contacting with filament component. Do not touch the tip of the filament

NOTE: Remove the polishing paste completely. If the polishing paste is remained, the emission current will be fluctuated and resulting in the SEM image distortion such as change of the brightness.

NOTE: Remove the dust or remaining fiber completely. If the dust or remaining fiber is attached inside of the electron gun, the emission gas will be generated, resulting in deterioration of the instrument performance.

NOTE: Make sure to attach spacers.
Spacers to adjust the height of each filament are attached to the cartridge filament. Make sure to install these spacers when exchanging the cartridge filament.



Details of cartridge filament assemble

The component of used cartridge filament assemble can be recycle. Please contact our service engineer of Hitachi High-Tech Corporation.

NOTE: Make sure that the O-ring is equipped in the groove before closing the electron gun unit.

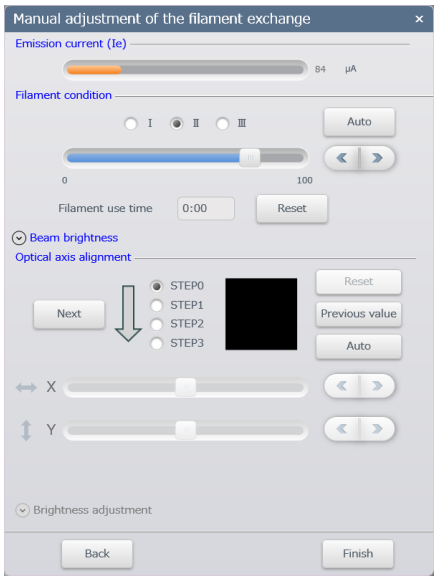
NOTE: If the dust or remaining fiber is attached inside of the electron gun, the emission gas will be generated, resulting in degrading of the instrument performance.

3. Step5: Beam alignment
   Perform the electron beam alignment. The Auto and Support mode are available for performing the beam alignment.
   Perform the alignment by the one of method from 4 to 6.

[Replace filament] dialog / Step5: Beam alignment

4. Auto mode
   Perform the alignment automatically by utilizing the attached calibration specimen. This mode should be used for the normal operation.
   Perform the alignment according to the [Replace filament] dialog.
   However, select a number of objective aperture other than the No.0 (Open).
   Remove the calibration specimen when the alignment is finished.

5. Support mode
   Perform the alignment manually by utilizing the attached calibration specimen or a selected specimen according to the [Replace filament] dialog. When you do not have a calibration specimen, perform the support mode.
   Perform the alignment according to the [Replace filament] dialog.
   However, select a number of objective aperture other than the No.0 (Open).
   When the support mode is selected, the observation will be started and the [Manual adjustment of the filament exchange] dialog will be displayed. Refer to the 3.3.2 Setting the accelerating voltage and filament current and adjust the filament condition or beam brightness as required.
   Then, refer to the 3.4.5 Details of axis alignment method and align the axis.



6. Manual mode
   Perform the alignment under the desired observation condition.
   Click the [Close] button on the [Replace filament] dialog.
   Refer to the 3.4.3 Axis alignment of electron beam and align the beam axis.

Filament replacement is finished.

NOTE: The auto alignment cannot be performed properly when dust is subjected on the surface of the calibration specimen.
If the dust is subjected on the specimen surface, clean the surface of the specimen with organic solvents.
Make sure that the specimen surface is free from the dust while storing.

4.2.2 Maintenance of the objective aperture

Repalce the objective aperture every year.
However, replacement of objective aperture is reuqried within one year when the astigmatism is occurred due to the use of objective aperture.

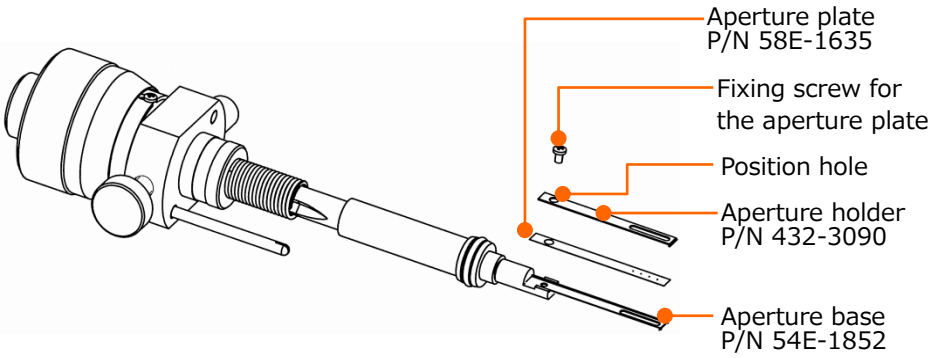
1. Stop the observation if performing the SEM observation by clicking [Stop] button.

2. Vent air to the specimen chamber.
   Click [AIR] button on the control panel or press [EVAC/AIR] switch.
   ⇒It takes a few minutes to complete. When the specimen chamber is in the atmospheric condition, the AIR on the LED panel is ON.
3. Set the objective aperture to the [0] position (Release the aperture). Fix the W-point screw that is fixing the feed mechanism component of the objective aperture with hexagon wrench.

4. Remove the feed mechanical component of objective aperture.

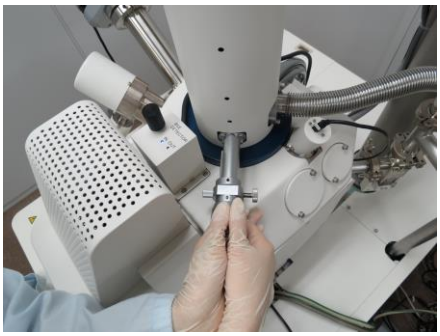
5. Remove the fixing screw that is fixing the objective aperture plate with a precision screw driver.

6. Remove the aperture plate with tweezers and place a new aperture plate (or one that has been baked in vacuum deposition equipment). If the aperture holder or aperture base is dirty, clean it with a bamboo stick, cotton swab, polishing paste or organic solvent.



7. Mount the aperture plate and aperture holder on the aperture base then, fix them with the fixing screw.

8. Make sure that the surrounding or objective aperture is free from dust. Set the objective aperture to [0] position (Release the aperture) and insert the objective aperture feed mechanism component to the previous position.



NOTE: If the objective aperture is inserted to the [0] position, the aperture base will bent.

9. Fix the W-point screw with the hexagonal wrench to secure the objective aperture feed mechanism component.

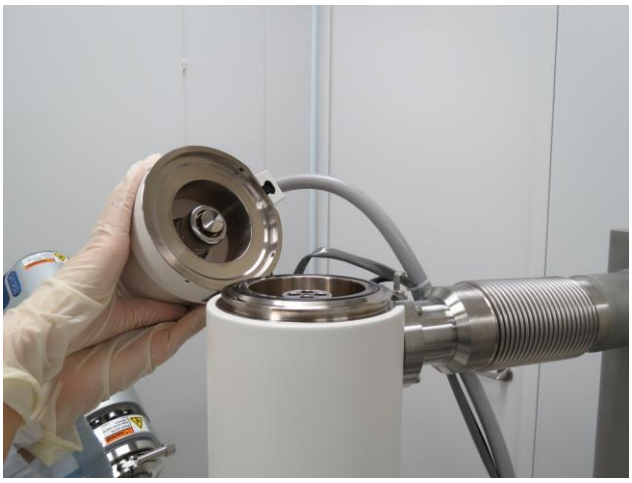
10. Pump air from the specimen chamber by clicking the [EVAC] button on the control panel or pressing the [EVAC/AIR] switch in the front of the instrument. It takes a few minutes to complete.

The maintenance procedures of the objective aperture is finished.
When the specimen chamber is in the vacuum condition, align the objective aperture axis.

4.2.3 Maintenance of the condenser aperture

1. Stop the observation if performing the SEM observation by clicking [Stop] button.

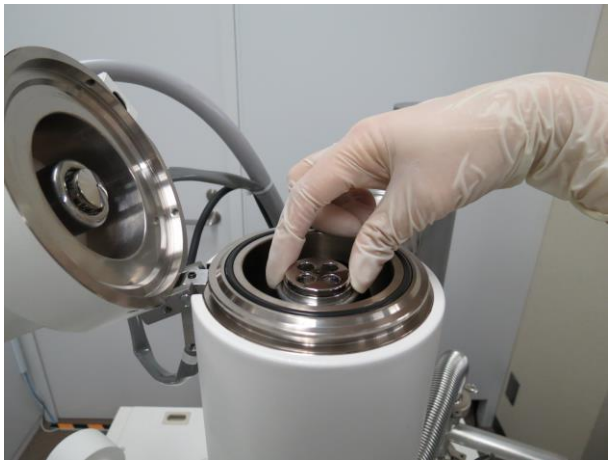
2. Vent air to the specimen chamber.
   Click [AIR] button on the control panel or press the [EVAC/AIR] switch.
   ⇒It takes a few minutes to complete. When the specimen chamber is in the atmospheric condition, AIR LED on the LED panel is ON
3. Lift the entire electron gun unit toward left and tilt it.



⚠ CAUTION: When lifting the entire electron gun unit, be sure to hold it in two hands and move it until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.

NOTE: Be sure to ware clean gloves when replacing the filament. Do not leave fingerprints on the internal vacuum parts for preventing gas degassing.

4. Rotate the equipped anode counterclockwise and remove it.



5. Pull out the condenser aperture unit.

6. Refer to the configuration figure of condenser lens, loosen the pipe and pipe holder and remove the aperture plate.
7. Attach a new aperture pate. Assemble the condenser aperture unit.
   Make sure that the new condenser aperture is free from dust or dirt and has holes with good processing status by confirming with an optical microscopy.

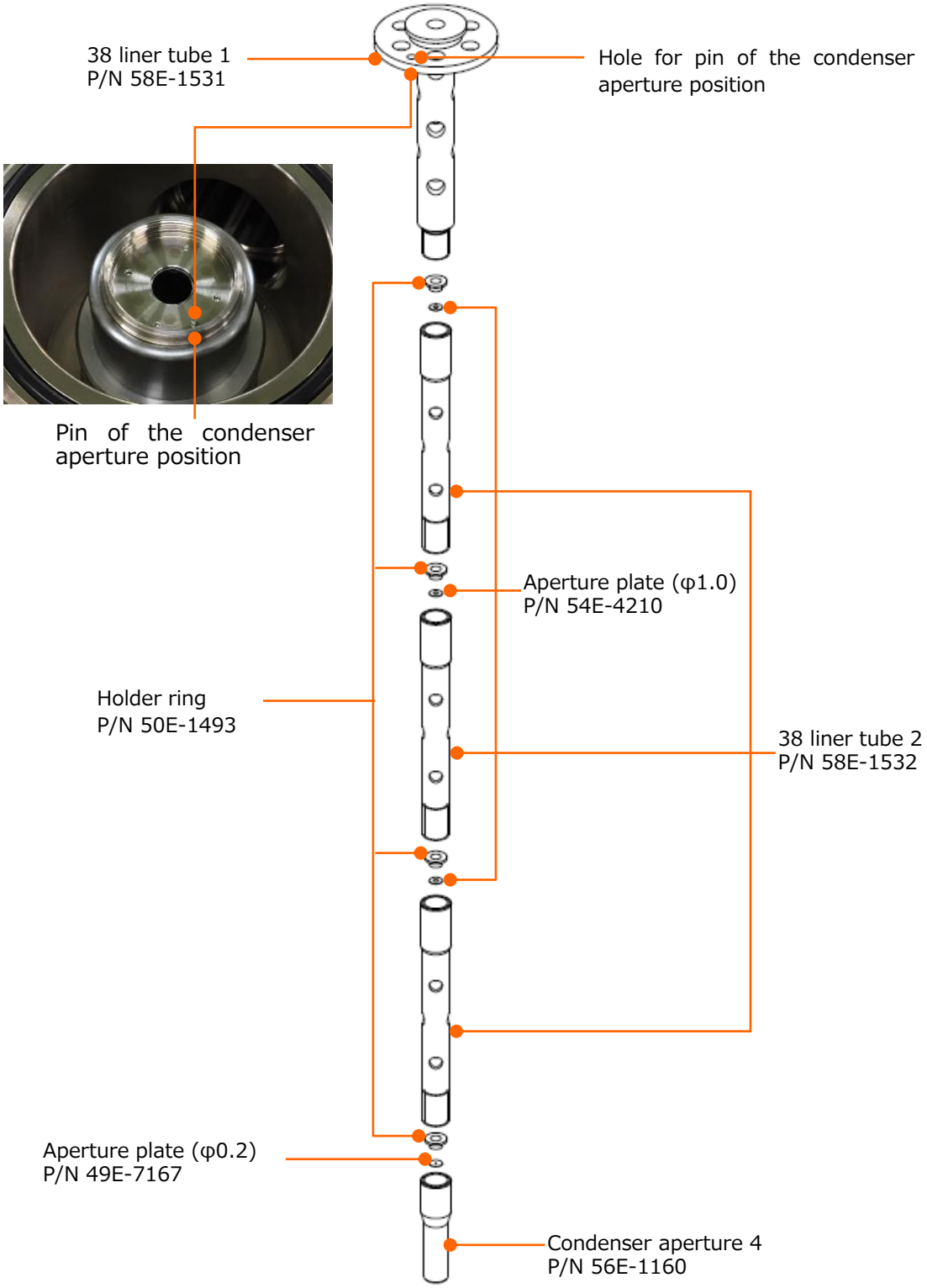
NOTE: The condenser aperture unit consists of four aperture plates. In addition, the hole diameter of the bottom aperture plate differ from the other aperture plates. Make sure to equip a proper plate for each position.

8. Remove dust or dirt by spray or blower after the unit is assembled.
9. Perform step 3 to 6 in the reverse order to mount the condenser aperture unit.

NOTE: When equipping the assemble into the instrument, adjust it to the pin of the condenser aperture position of the main unit.

10. Pump air from the specimen chamber.
    Click the [EVAC] button on the control panel or press [EVAC/AIR] switch at the front of the instrument. It takes a few minutes to complete.

The maintenance of condenser aperture and objective aperture are finished.
Start the SEM observation and align the electron beam axis.



4.2.4 Ultrasonic cleaning with organic solvent

NOTICE: When handling organic solvents (volatile solvents), take the following points into consideration to avoid the danger of injury or explosion caused by ignition.

(1) Volatile solvents should be handled at a place which is well ventilated and is well away from flame.

(2) If volatile solvent is excessively inhaled, dyspnea (difficulty in breathing) may be caused. If volatile solvent is swallowed or gets onto the skin or into the eyes, the symptoms of polyneuritis including anesthesia and ataxia (difficulty in walking) may develop. So use a gas mask for organic gas, plus an inhaler, safety goggles, protective gloves, protective boots, etc. as the occasion demands or in consideration of conditions.

To clean the wehnelt and anode plate, use the accompanying polishing paste. After that, perform ultrasonic cleaning with organic solvent to clean off the polishing paste. Before performing ultrasonic cleaning, be sure to read the cautions described at the end of this instruction manual.

1. Supply water into the wash-basin of the ultrasonic cleaner up to 10 to 20% of its capacity
2. Fill organic solvent into a beaker to about half of its capacity.
3. Put parts, which have been cleaned with polishing paste, into the beaker.
4. Place the beaker in the wash-basin of the ultrasonic cleaner.
5. Turn on the cleaner and clean the parts for 2 to 3 minutes.
6. After the ultrasonic cleaning, remove the parts from the beaker and let the organic solvent evaporate.

4.3 Maintenance of rotary pump

The service life of the rotary pump varies depending on the condition of use. Perform inspection periodically depending on the condition of use, so that the instrument can be used without failures and a longer service life can be ensured.
It is recommended that the rotary pump oil and the oil mist trap element be replaced once every six months.

NOTE: The rotary pump is a life-limited part. Replace it with a new one after 5 years has passed from the start of use. If the motor reaches the end of its service life, it may generate abnormally high heat or cause fuming.

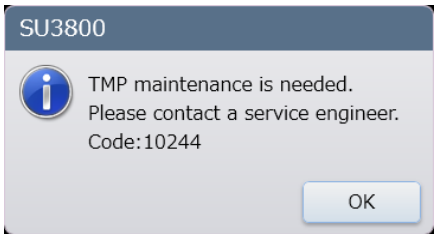
NOTE: When disposing of rotary pump oil, refer to the instruction manual of rotary pump and properly dispose of it.

4.4 Maintenance of the compressor (option)

The periodical maintenance of compressor is required. Please refer to the instruction manual of compressor and perform the maintenance as described otherwise, the decreasing the performance or shortening the lifetime of the instrument can be occurred.

4.5 Maintenance of the turbo molecular pump

The maintenance of the turbo molecular pump (TMP) using in this instrument every 4 year is recommended. A message for notifying the maintenance will be displayed, after four years has passed. Please contact a service engineer.



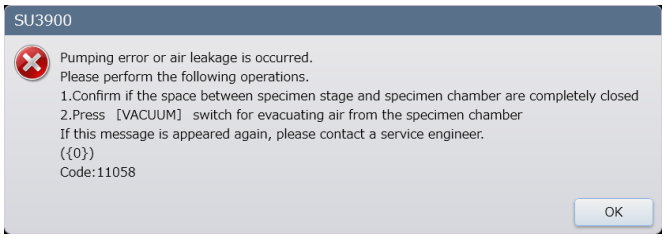
4.6 Trouble shooting

4.6.1 When the vacuum system does not work normally

If the evacuation system does not work, or the evacuation sequence does not run, perform the following checks.

(1) Check if any error is indicated on the screen.
If the LED panel is blinking in red, or a buzzer is sounding, it is possible that an error has occurred. Check if an error message is indicated on the PC operation screen. If an error message is displayed, perform the relevant remedy described in the Error Code List provided at the end of the instruction manual.

NOTE: The buzzer will be stopped by pressing the EVAC/AIR switch.



(2) Check if any foreign object is stacked between the specimen stage and specimen chamber.
In case that the specimen stage does not adhered to the specimen chamber properly, the specimen chamber cannot reach to the vacuum pressure. Confirm and remove if any foreign object is stacked between the specimen stage and the specimen chamber. At this time, check the value of [Current vacuum] that is displayed on the [Vacuum mode settings] dialog and make sure that the value becomes decreased. Confirm that the pressure of the specimen chamber reaches to the setting vacuum value under the VP mode or pressure of the specimen chamber reaches to the [High] under the High vacuum mode.

(3) When VP mode is set, set the vacuum condition to [High] and pump air from the specimen chamber by pressing the [EVAC/AIR] switch.

(4) If a unit has equipped attached (e.g. objective lens aperture unit), detach the unit, clean and grease on the O-ring then, attach the unit and pump air from the specimen chamber again.

(5) If the specimen is not dry, outgas from the specimen may generate resulting in a longer evacuation time.

(6) If you do not find any failure mentioned above, contact a service engineer.

4.6.2 The emission current does not flow normally

If the emission current does not properly flow during observation, perform the following checks.

(1) Click [Auto] on the [Filament condition] in [Beam alignment] dialog to check if the emission current flows. If the emission current does not flow, check that the filament is in the proper position and whether the filament is burned out or not.

(2) If the value is small while the [Manual] check box is ON at [Beam brightness] on [Beam alignment] dialog, enable the [Auto] checkbox.

4.6.3 When an image is not displayed

If an image will not be displayed on the screen, or if it is difficult to focus the image, check the following.

(1) Confirm if specimen is loaded, the specimen is at the exchange position, the accelerating voltage and emission current are normal value, either SE (secondary electron) or BSE (backscattered electron) is selected as a detector or the spot intensity is set too low.

(2) Adjust contrast to the maximum.

(3) Open the objective lens movable aperture (set it to the 0 position). If an image is displayed, perform mechanical axial alignment and aperture alignment adjustments on the objective lens movable aperture.

(4) Click [Beam Adj. Auto] button in [Beam adjustment] dialog and perform the beam alignment.

(5) Confirm whether the BSE detector (Back scattered electron detector) is completely inserted/retracted.

(6) If an image is not displayed after performing as above, please contact a service engineer.

4.6.4 When the noise on image is large

Consider three possible causes for the noise on image.

(1) Snow nose that appears uniformly on image

This type of noise is mainly due to statistical fluctuation in density of primary, secondary or backscattered electrons. If appears when the probe current is too small, the secondary or backscattered electron emission efficiency of the specimen is too low, or the signal detection efficiency of the detector is too low. If this type of noise is conspicuous on image, check the following.

(a) Is the emission current too low?

Reset the accelerating voltage, the filament, and the gun bias.

(b) Is the spot intensity setting too low?

If the spot intensity is less than 30, it should be set to a level more than or equal to 30.

(c) Is the frame integration setting too low?

If you are using a FAST scanning speed, open the [Scan settings] dialog and check if the [Integration] setting for Fast 1 and Fast 2 is set at 1 or 2. If so, try setting to the higher number. The integration of 3 is recommended.

(d) Is the contrast setting too high?

Noise can occur when the contrast setting is too high. Lower the contrast, and adjust the dark parts by changing the brightness. Or, click the auto brightness.

(e) When the BSE detector is selected, check the setting of [BSE detector settings] dialog. If the contrast is too strong, set [Detector gain] at small value. If the contrast is too weak, set [Detector gain] at larger value. Select [COMP] for the observation mode.

When selecting the BSE detector, the efficiency of detection is degraded while focus position (WD) is long. In this case, adjust the stage position to shorter focus position. When the BSE detector is selected in the high vacuum mode, select SE detector.

(f) Display [Optical axis alignment] dialog and align the electron beam.

(2) When the electron beam or scintillator of SED is unstable, noise that takes the shapes of lateral stripes or trailing bright points may appear on images. If this type of noise is conspicuous, check the followings.

(a) Emission current is too small.

Set the accelerating voltage and filament again.

(b) Confirm the noise on an image while selecting the BSE detector. If noise does not appeared on an image, it is the problem of SE detector such as a specimen charge-up.

(3) Random noise appears due to partial charge-up of a specimen

Try observing another area of the specimen of the surface of the specimen stub. If this eliminates the noise, it appears that the charge-up was the problem. Either use conditions that minimize charge-up (using a low accelerating voltage or reducing the probe current) or perform appropriate specimen pre-treatment.

4.6.5 When astigmatism cannot be corrected

Check the following if astigmatism still remains at the maximum correction level.

(1) If the position of image is shifted, adjust the [Aperture alignment] in the [Align] tab on the operation panel.

(2) Use another opening of the objective aperture. If astigmatism can be corrected with the opening, the aperture may be contaminated. Replace the aperture of the objective aperture.

(3) If the image is shifted while correcting the astigmatism, adjust the stigmator align X, Y at the [Stigmator align] on [Align] tab.

In case the astigmatism be cannot corrected after performing the above operations, contact a service engineer.

4.6.6 When auto focus function does not work properly

(1) Execute the X, Y at [Stigmator align] and [Aperture alignment] in [Align] tab and check the image is not wobbling. If the image is wobbling, adjust each settings.

(2) If the observed specimen has no distinct surface structure, automatic adjustment may be difficult. In such a case, lower the magnification.

(3) Optimized result may not be obtained under the abnormal contrast due to charge-up.

4.6.7 When SU3800/SU3900 operation program does not startup

Check the following if the SEM operation program of the SU3800/SU3900 does not start up (the progress bar does not extend to the end after log in).

(1) Confirm if the vacuum system is activated.
Check whether any or both of the AIR and EVAC lamps on the LED panel are blinking or lit in steady state.
If both are not lit, or are blinking, it is possible that there is an abnormality in the vacuum system. If an error message is displayed, follow the instructions on the message.

(2) Check if the motor-driven stage is normally operating. After powering ON the system, the stage will move to the home position for mechanism initialization. If the motor is not normally running, restart the system. If the SU3800/SU3900 operation program does not start up even after a restart of the system, it is possible that there is an abnormality in the motor-driven stage. Contact a service engineer.

4.6.8 When the PC has hung up

If the PC has hung up during operation or if Windows has been frozen, shut down Windows and then restart the SEM.
Before shutdown, try saving data if there are any other open programs other than the SU3800/SU3900 operation program.

NOTE: Although it can be solved by restarting the operation program, note that the performance may become unstable. It is recommended to shut down the system.

1. Click the [Start] button on the Windows taskbar. When the Start menu is displayed, select [Power] and then [Shut down].

NOTE: The operation of the PC may differ depending on the type of the PC. Be sure to refer to the instruction manual accompanying the PC.

2. Wait until the PC is shut down.
   If the PC does not shut down even after a long period of time, long-press the power button of the PC to shut down forcibly.
3. Turn off the power switch located on the right side of the SEM unit.
4. Wait for about one minute, and then turn on the power switch.
5. Log on to Windows, and start the SU3800/SU3900 operation program.
6. If the SU3800/SU3900 operation program failed to be properly closed at the last session because it had been frozen, it is possible that the previous conditions may not be restored.

4.6.9 When error message is displayed

Two types of messages can be displayed on the SU3800/SU3900 operating screen: those indicating cautions about operations and those showing errors.
Each message has a number. If you are not sure about how to address a problem, refer to the Error Code List provided at the end of the instruction manual.

4.7 Recovery form power interruption and long-term shutdown procedures

1. Perform the daily shutdown procedure (Remove the specimen>EVAC>Power OFF the SEM).
2. Power OFF the main breaker of the switchboard on the rear side of the main unit.

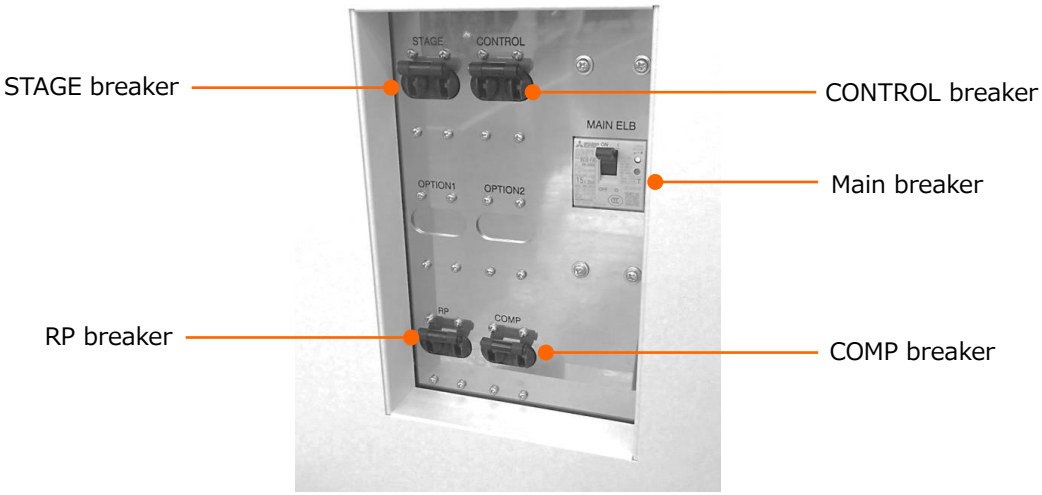
3. Pull out the power plug of the SEM from the outlet, and then power OFF the SEM.

4.8 Procedures after recovery form power interruption and startup after long-term shutdown

To start the system after recovery from a power interruption, perform the following procedure.

1. Power ON the power breaker on the switchboard of the customer's facility.
2. Power ON the main breaker of the switchboard on the rear side of the main unit.

NOTE: Make sure that the CONTROL, STAGE, RP, COMP breakers are ON.



3. Power ON the key switch at the front of the SEM unit and perform the normal startup procedure.

4.9 Maintenance of the optical system (Service engineer only)

The maintenance and adjustment for the optical axis of the electric optical system is important work related to the device performance.
If the instrument behaves any of the following conditions, request a service engineer to perform maintenance.

(1) The image disappears completely when the accelerating voltage is changed.
(2) The glare on the image stands out even if [Spot intensity] is enlarged.
(3) The most lightened spot exceeded the adjustable range in the STEP1 of [Optical axis alignment].
(4) Astigmatism is still significant during observation.

4.9.1 Maintenance of orifice unit

This section explains about maintenance for the orifice unit.

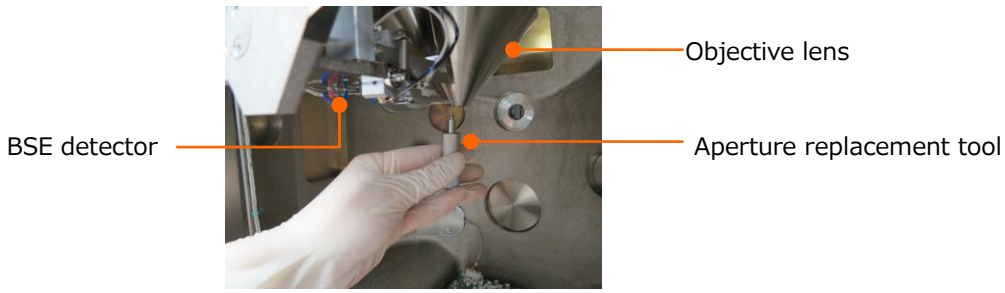
1. If a SEM observation is in process, end it. Click the [Stop] button.

2. Press [Home position] button in [Stage movement settings] dialog and move the stage to the specimen exchange position.

3. Vent air to the specimen chamber.
   Click AIR button in the control panel or press [EVAC/AIR] switch at the LED panel of the unit.
   ⇒It takes a few minutes to complete. When the specimen chamber is in the atmospheric condition, AIR on the LED panel is ON.
4. Draw out the stage.

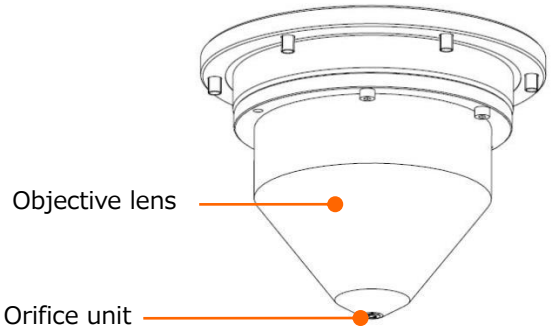
5. Rotate the knob of the BSE detector insertion mechanism counterclockwise and pull out the BSE detector.
   ⇒When the BSE detector is extracted completely, OUT light is ON.

6. Insert the aperture replacement tool through the stage opening into the specimen chamber and remove the orifice unit.

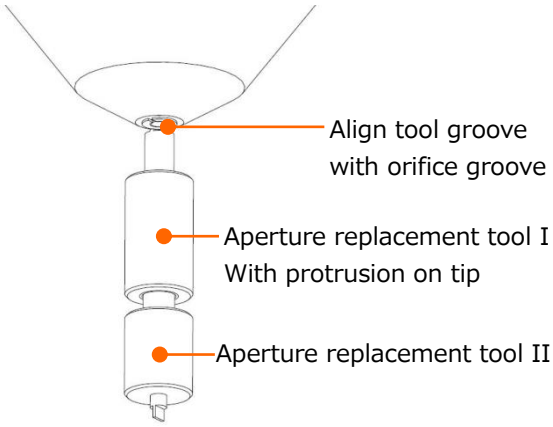


NOTE: When inserting your hand into the inside of the specimen chamber, be careful that your clothing is not caught in moving parts of the specimen stage such as gears and drive screws.

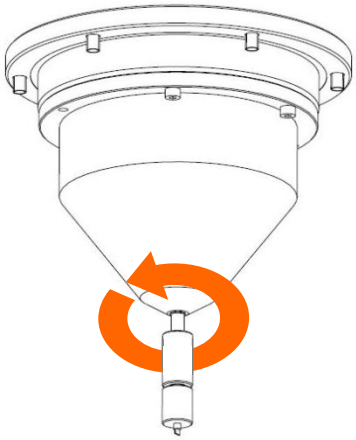
NOTE: Beware of damaging the SE detector or BSE detector in the specimen chamber while performing this maintenance.



a. Before Removal

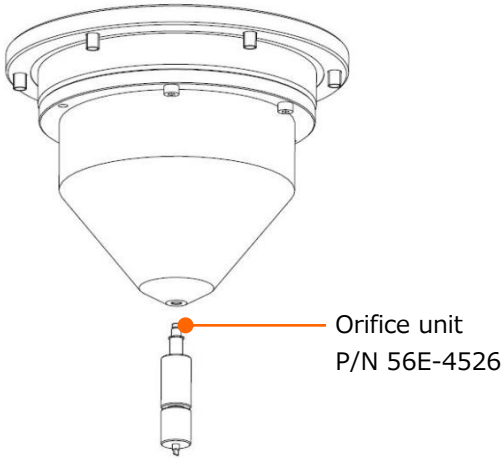


b. Aperture replacement tool and the orifice unit



Turn replacement tool counterclockwise

c. Turn the orifice unit and the tool together



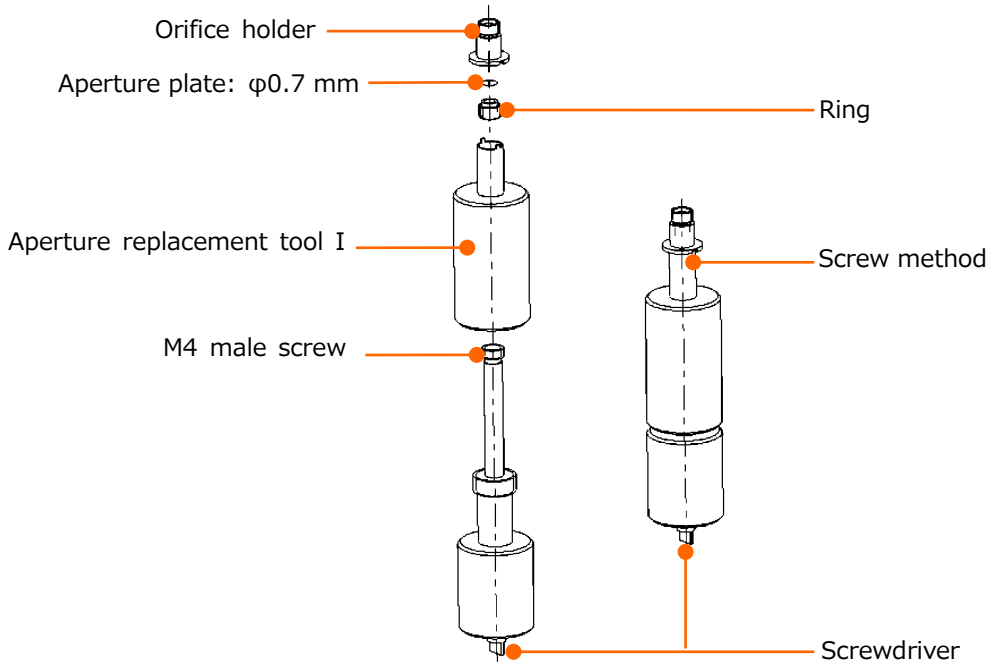
Pull out orifice unit and tool

d. Removal

To remove the orifice unit, first insert and screw the tip of the aperture replacement tool II (the M4 male screw) into the hole at the bottom surface of the objective lens while adjusting the projection part of the aperture replacement tool I to the groove on the circle ring at the bottom of the orifice unit. Rotate the aperture replacement tool I counterclockwise and remove the orifice unit.

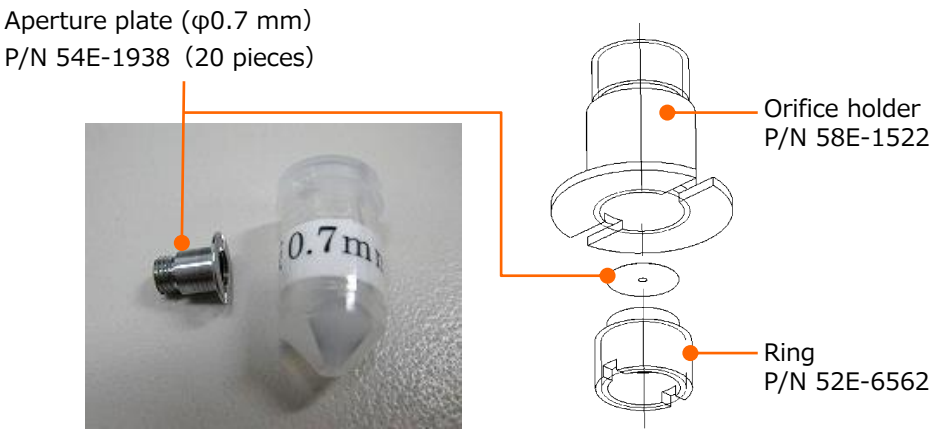
NOTE: Shock or scratch is subjected to the objective lens resulting in deterioration of the system performance. It should be replaced with great care. In addition, the objective lens must be free from dirt or dust.

NOTE: Avoid any damage to the SE detector or BSE detector in the specimen chamber.



Ordering a set of orifice unit: Orifice unit set P/N 54E-1919
Ordering a set of aperture replacement tools: Fixed aperture tools P/N 52E-6560

7. Set the screwdriver attached to the reverse side of the aperture replacement tool on the ring groove of the orifice unit, turn it counterclockwise, remove the ring, and take out the aperture plate (φ0.7 mm).



8. Clean the component except the aperture plate (φ0.7 mm) with cotton swab, attached bamboo sticks, and organic solvent. Perform ultrasonic cleaning to make sure no dirt is left.
9. Replace the single aperture mesh with a new one.
10. After the aperture is finished, perform Steps 6 to 7 in reverse to assemble the unit to the objective lens.

11. Insert the stage to the specimen chamber and pump air from the specimen chamber.
    Click the Control panel > [EVAC] button or press the [EVAC/AIR] switch at the LED panel of the main unit. It takes a few minutes to complete.

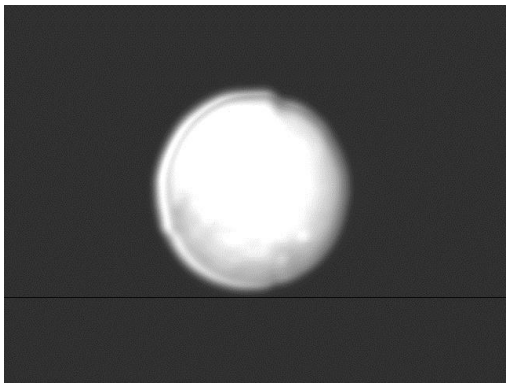
The maintenance of orifice unit is finished.

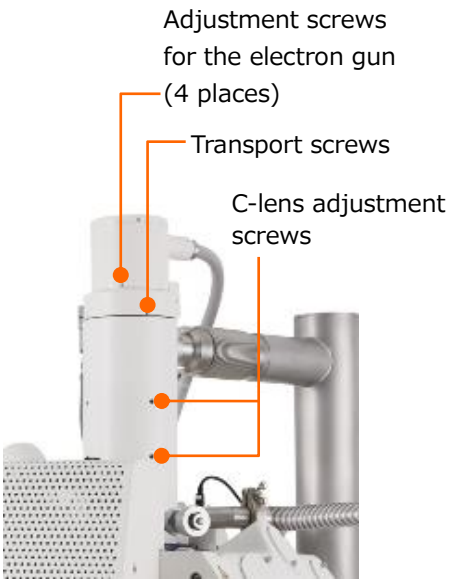
4.9.2 Maintenance of optical axis

A slight dispersion of the filament tips position in the cartridge filament could cause of the optical axis shifting. If the alignment range of the beam alignment is exceeded and alignment cannot be performed, check and align the optical axis according to the following procedures.

1. Select [STEP1] then click [Reset] button in the [Optical axis alignment] dialog. Select [STEP2] and [STEP3] then click [Reset] button as well.
2. Select [Filament Image] and click [Reset] in the [Beam alignment] dialog.

2. Set the accelerating voltage to 3 kV and set the spot intensity at 100 while [Filament Image] is selected (with an elliptic image is displayed) then, set the objective aperture to the No.0 (extract position).
3. Set the Filament condition to 100 and beam brightness to 0.
4. Adjust the position of the bright spot to center of the image display area with the M4 screw (M4 hex wrench) for the electron gun (See the below figure). Do not adjust transport screws or C-lens adjustment screws.





5. Fix adjustment screws for the electron gun when the image assumes the condition shown in above left figure. To avoid tightening with excess power, secure the screws diagonally a little at a time.
6. Close the [Beam alignment] dialog.

This concludes the electron gun position adjustment process. Confirm that the image is displayed normally when the accelerating voltage or the spot intensity is changed.

5. Replacement parts

This chapter describes the replacement parts and maintenance required parts of SU3800/SU3900.

5.1 Consumables parts

The consumables parts should be always be on hand in sufficient quantities for normal operation.

Consumables

Part No.	Part Name	Use	Remarks
50E-6159	Carbon sticker	Fix the specimen	20 pieces/set
58E-1635	Objective apertrue plate	Diameter of 0.02, 0.05, 0.08, 0.15 mm are available	1 pieces
54E-4210	Aperture plate (made of Mo)	For the condenser lens aperture	20 pieces/set
49E-7167	Aperture plate (made of Mo)	For the condenser lens aperture	20 pieces/set
54E-1938	Aperture plate (made of Mo)	For the objective fixed aperutre (Orifice)	20 pieces/set
51E-0240	Cartridge Filament	10 pieces/set	–

5.2 Life-limited parts

Following table lists parts with limited lifetime. They should be replaced on a predetermined cycle to ensure safety in operation of the instrument and maintain its performance. Replacement work shall be carry out by our service engineer. Please contact your nearest service representative for the replacement.

NOTE:
- The replacement term indicates the approximate lifetime of the part, and not the warranty period.
- Lifetime of replacement parts may change by the usage condition. However, replace them at their replacement term for planning maintenance. Do not carry out the replacement of the parts. Consult the nearest Hitachi service or service representative.

Life-limited parts (SU3800)

Part No.	Part name	Use	Replacement cycle
J386042	Photomultiplier R6249	SE detector	5 years
534-3841	Scintillator	SE detector	3 years
K433004	Pirani gauge bulb	Vacuum system	3 years
52E-4605	Rotary pump	Vacuum system	5 years
L479011	Element	Vacuum system (LV3)	1 year
L479010	Element	Vacuum system (LV1)	1 year
K591306	Stepping motor	Specimen stage (X, Y axes)	4 years
K591006	Geared pulse motor	Specimen stage (Z axis)	4 years
K591021	Stepping motor	Specimen stage (R axis)	4 years
K591304	Stepping motor	Specimen stage (T axis)	4 years
52E-6863	Universal joint	Specimen stage (X, Y axes)	4 years
L456868	O-ring AS568-278 FPM	Specimen stage	5 years
———	PC motor	PC	5 years
———	Hard disk	PC	3 years
———	Battery for PC	PC	2 years
K429012	Rotary encoder	Manual operation panel (option) (Magnification)	3 years
K429013	Rotary encoder	Manual operation panel (option) (Other)	5 years
K111250	Relay	Control system	5 years
K622142	DC power HWS150A-24/A	Control system	5 years
K622043	DC power HWS100A-24/A	Control system	5 years
K622148	DC power HWS150A-15/A	Control system	5 years
K622008	DC power HWS15A-15/A	Control system	5 years
K622019	DC power HWS50A-5/A	Control system	5 years
K622042	DC power HWS100A-15/A	Control system	5 years
L542181	FAN TUDC24D4	Control system	5 years
L542079	FAN MDS1225-24	TMP cooling system	5 years

Life-limited parts (SU3900)

Part No.	Part name	Use	Replacement cycle
J386042	Photomultiplier R6249	SE detector	5 years
534-3841	Scintillator	SE detector	3 years
K433004	Pirani gauge bulb	Vacuum system	3 years
52E-4605	Rotary pump	Vacuum system	5 years
L479011	Element	Vacuum system (LV3)	1 year
L479010	Element	Vacuum system (LV1)	1 year
K591305	Stepping motor	Specimen stage (X,Y axes)	4 years
K591307	Stepping motor	Specimen stage (T, Z axes)	4 years
58E-3138	R motor assemble	Specimen stage (R axis)	2 years
58E-3139	R encoder assemble	Specimen stage (R axis)	3 years
52E-6863	Universal joint	Specimen stage (X, Y axes)	4 years
58E-3066	Joint X assemble	Specimen stage (X axis)	4 years
58E-3061	Joint Y assemble	Specimen stage (Y axis)	4 years
L456872	O-ring AS568-282 FPM	Specimen stage	5 years
———	PC motor	PC	5 years
———	Hard disk	PC	3 years
———	Battery for PC	PC	2 years
K429012	Rotary encoder	Manual operation panel (option) (Magnification)	3 years
K429013	Rotary encoder	Manual operation panel (option) (Other)	5 years
K111250	Relay	Control system	5 years
K622142	DC power HWS150A-24/A	Control system	5 years
K622043	DC power HWS100A-24/A	Control system	5 years
K622148	DC power HWS150A-15/A	Control system	5 years
K622008	DC power HWS15A-15/A	Control system	5 years
K622019	DC power HWS50A-5/A	Control system	5 years
K622042	DC power HWS100A-15/A	Control system	5 years
L542181	FAN TUDC24D4	Control system	5 years
L542079	FAN MDS1225-24	TMP cooling system	5 years

5.3 Spare parts

The spare parts shown below shall be prepared when operating the instrument over a long time. Prepare them in sufficient quantities depending on the purpose of use.

Spare parts (SU3800)

Part No.	Part name	Remarks	Q'ty to use
58E-1400	Fuse for spare		1 set
433-3702	Specimen stub	15 mm diameter	–
52E-4020	Specimen stub	26 mm diameter	–
52E-4022	Specimen stub	51 mm diameter	–
52E-4070	Specimen stub	80 mm diameter	–
52E-4025	Specimen stub	127 mm diameter	–
54E-4242	Specimen holder screw	Size: S	–
54E-4243	Specimen holder screw	Size: L	–
52E-3336	Nut for specimen holder lock		–
52E-3929	Specimen holder	Size: S	–
52E-3930	Specimen holder	Size: L	–
L456825	O-ring AS568-235 FPM	For electron gun	1
L456711	O-ring AS568-012 FPM	For objective aperture	1
L456309	O-ring G70 FPM	Specimen chamber port	1
L456118	O-ring P24 FPM	Specimen chamber port	1
L456125	O-ring P35 FPM	Specimen chamber port	1
L456815	O-ring AS568-225 FPM	Specimen chamber port	10
L456827	O-ring AS568-237 FPM	Specimen chamber port	1
L456835	O-ring AS568-245 FPM	Specimen chamber port	2
L456859	O-ring AS568-269 FPM	Specimen chamber port	1
L456868	O-ring AS568-278 FPM	Specimen stage	1
G743002	Bamboo stick	For cleaning the vacuum system (10 sticks/pack)	–
———	Cloth	For cleaning the vacuum system	–
S269003	Aluminum foil	For cleaning the vacuum system	–
———	Vacuum grease	For vacuum sealing (Fixed part)	–
———	KDL grease	For specimen stage movable part	–
———	Ethanol	For cleaning the vacuum system	–
S263001	Polyethylene gloves	For handling the vacuum components	–

Spare parts (SU3900)

Part No.	Part name	Remarks	Q'ty to use
58E-1400	Fuse for spare		1 set
433-3702	Specimen stub	15mm diameter	–
52E-4022	Specimen stub	51mm diameter	–
52E-4024	Specimen stub	102mm diameter	–
52E-4770	Specimen stub	203mm diameter	–
52E-4720	Specimen holder screw	Length 10mm	–
52E-4721	Specimen holder screw	Length 14mm	–
52E-4722	Specimen holder screw	Length 18mm	–
52E-4723	Specimen holder screw	Length 32mm	–
52E-4724	Specimen holder screw	Length 46mm	–
52E-4728	Nut for specimen holder lock		–
52E-4725	Specimen holder	Size: S	–
52E-4726	Specimen holder	Size: L	–
L456825	O-ring AS568-235 FPM	For electron gun	1
L456711	O-ring AS568-012 FPM	For objective aperture	1
L456309	O-ring G70 FPM	Specimen chamber port	3
L456125	O-ring P35 FPM	Specimen chamber port	3
L456815	O-ring AS568-225 FPM	Specimen chamber port	10
L456818	O-ring AS568-228 FPM	Specimen chamber port	1
L456832	O-ring AS568-242 FPM	Specimen chamber port	1
L456835	O-ring AS568-245 FPM	Specimen chamber port	3
L456861	O-ring AS568-271 FPM	Specimen chamber port	1
58E-1236	O-ring AS568-253 FPM	Specimen chamber port	1
G743002	Bamboo stick	For cleaning the vacuum system (10 sticks/pack)	–
———	Cloth	For cleaning the vacuum system	–
S269003	Aluminum foil	For cleaning the vacuum system	–
———	Vacuum grease	For vacuum sealing (Fixed part)	–
———	KDL grease	For specimen stage movable part	–
———	Ethanol	For cleaning the vacuum system	–
S263001	Polyethylene gloves	For handling the vacuum components	–

Appendix

Appendix A Image quality

The followings are references for getting better imge quality.

Appendix A.1 Accelerating voltage

Accelerating voltage can be adjusted in [Electron beam settings] dialog. Select the appropriate value of accelerating voltage depending on the observing specimen or purpose.
In general, as the accelerating voltage increases, the resolution of secondary electron images improves. At the same time, however, the depth of penetration of the incident electron beam into the specimen expands resulting in increase of the amount of internal information. As a result, the contrast of the specimen surface decreases in relative terms, and this in some cases results in images of specimens that appear to be transparent.

Influence of Accelerating Voltage

Change factor and influence on image	Accelerating voltage Low ⇨ High	
Resolution	Low	High
Secondary electron signal	High	Low
Surface information	Topmost surface information	Surface information (including internal information)
Contamination	Easy to identify Hard to cause	Hard to identify Easy to cause
Charge-up	Low	High
Non-deposition observation	Easy	Difficult
Specimen damage	Low	High
Influence of floating magnetic field	High	Low
Generation of characteristic X-ray	2 to 3 times of excitation energy of X-ray	

NOTE: The possibility of charge-up, the availability of uncoated observation, and the degree of damage on a specimen are all subject to change depending on the type of specimen involved and the type of specimen pretreatment conducted.

Appendix A.2 Spot intensity

The spot intensity can be adjusted in [Electron beam settings] dialog. Select the appropriate value of spot intensity depending on the observing specimen or purpose by referring to the table below.
When the spot intensity is low, the resolution increases. However, the S/N ratio of images deceases. For low-magnification observation, the spot intensity should be set to high, and for high-magnification observation, it should be set to low.

Influence of Spot intensity

Change factor and influence on image	Spot intensity Low ⇨ High	
Irradiation current (A)	Low	High
Resolution	High	Low
Secondary electron signal	Low	High
S/N ratio of image	Low	High
Charge-up	Low	High
Specimen damage	Low	High

NOTE: Charge up may occur on non-conductive specimens.

Appendix A.3 Objective aperture

The diameter of the objective aperture is possible to change by rotating the aperture knob. Refer to the table below and select an appropriate aperture No. depending on the observation purpose of the specimen.
The smaller the aperture number, the larger the aperture diameter.
Select aperture No.3 or No.4 for the normal observation or high magnification observation.
Select aperture No.1 or No.2 for the low magnification observation or X-ray analysis that requires a high irradiation current on the specimen.
The surface condition of the objective aperture effects on the image quality especially, for the observation with the low accelerating voltage. Thus, periodical maintenance of the objective aperture is required.

Influence of Objective aperture

Change factor and influence on image	Aperture diameter Small ⇨ Large	
Depth of focus	Deep	Shallow
Irradiation current	Low	High
Resolution	High	Low

NOTE: Mechanical axis alignment of the objective aperture is required when switching the aperture No.

Appendix A.4 Working Distance

WD can be adjusted in [Electron beam settings] dialog. Select the appropriate value of WD depending on the observing specimen or purpose by referring to the table below.
A shorter WD improves resolution but decreases the focal depth. It also limits the tilt range of the specimen stage.

Influence of WD

Change factor and influence on image	WD Short ⇨ Long	
Resolution	High	Low
Focal depth	Shallow	Deep
Specimen tilt angle	Small	Large

NOTE: The longer the WD the greater is the sensitivity of the primary electron beam to floating magnetic fields. For this reason, in situation where a long WD is used, the floating magnetic field can produce image errors during high magnification imaging.

In VP mode, it is more likely than in high vacuum mode that some of the primary electrons irradiated onto a specimen and the backscattered electrons providing signals are scattered by residual gas molecules. This may result in a less than clear image. To ensure a clear image, the following settings may be required.

(1) Accelerating voltage
The accelerating voltage should be set as high as possible.

(2) Spot intensity
If image roughness is noticeable, the spot intensity should be increased.

(3) WD
In order to suppress the scattering of primary electron and back scattered electrons, the WD should be minimized as much as possible.

Influence of WD in VP mode

Change factor and influence on image	WD Short ⇨ Long	
Scattering of irradiating electron	Low	High
Scattering of backscattered electrons	Low	High

Appendix B User dependent operation condition memory

The operating condition just before shuuting down the insrument operation program area memorized and reproduced at the enst startup. The following lsit shows items momorized individually for SU3800/SU3900 login user name.

Settings stored for each login user name

Items	Contents
Operation panel display and arrangement	Display/hide of the operation panel, position of each tab
Electron beam setting dialog	Contents of the electron beam settings dialog
Scan setting dialog	Contents of the scan settings dialog
Capthre setting dialog	Contents of the capture settings dialog
Saving condition setting dialog	Contentsof Save, Data, Tru-Image tabs
Stage move setting dialog	Stepe move amount of X/Y/R axes
Raster rotation settings	Rotation angle (RR is set OFF at starting up)
Tilt compensation settings	Tilt compesation (Tilt compensation is set OFF at starting up)
BSE detector setting dialog	Shadow emphasis radio button, BSE 3D observation mode checkbox
Operation panel- data tab	Font type, size and color
Standard setting dialog	All settings except fo rthe follwoing Magnification display settings Motor drive ON/OFF settings
Position where a dialog is opened	Last position where a dialog was opened

Appendix C Error message list

The list shows the error messages that can be displayed while operating the SU3800/SU3900.

Code	Category	Error message	Remarks
10002	Error	Exceeding the input range. Please check the input range.	
10003	Error	Invalid characters are included. Please enter only numeric character.	
10004	Error	Invalid data. Please check the data.	
10005	Error	Exceeding the input range. Please check the input range.	
10006	Error	Remaining capacity of memory in the drive is insufficient. At least 550 MB is needed for starting up the operation program. Please delete unnecessary data files and try again.	
10011	Error	Cannot access to the file. Please check the file.	
10013	Error	Communication with image transfer is disconnected. Please check the connection of the image transfer.	
10014	Error	Cannot open the file or invalid data. Please check the file or data.	
10018	Error	Specimen stage has not been activated. Please power off then on the main switch.	
10019	Error	CameraNavi LED control unit has not been activated. Please power off then on the main switch.	
10020	Error	Chamber scope LED control unit has not been activated. Please restart the instrument according to the following procedures. 1.Shut down the PC 2.Power off the [EOC POWER] switch 3.Power on the [EOC POWER] switch.	
10031	Error	Electron gun unit has opened. Please close the electron gun unit.	
10072	Error	Relay motion of the electron gun control power supply error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
10073	Error	Electron gun control power error (+15V) Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	
10074	Error	Relay motion of the electron gun control power supply error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	
10075	Error	Electron gun control power supply error (Vacc) Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	
10076	Error	Electron gun control power supply error (Vfilament) Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	
10077	Error	Electron gun control power supply error (Vbias) Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
10078	Error	Electron gun control power supply error (Vbiasselect) Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	
10079	CriticalError	The electron gun interlock switch is activated. Please exit from the operation program and power off the main switch then, contact a service engineer.	
10080	Error	Over current protection of the electron gun is activated. Please confirm the filament setting.	
10081	Error	Over load protection of the POSTHV is activated. If this message is appeared again, please contact a service engineer.	
10082	Error	Relay motion of the POSTHV power supply error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Wait approximately 30 minutes 4.Power on the main switch If this message is appeared again, please contact a service engineer.	
10083	Error	Over load protection of the HV circuit for SED is activated. If this message is appeared again, please contact a service engineer.	
10149	Error	Stage error Stage is out of the maximum range (X-axis) . If this message is appeared again, please contact a service engineer.	
10150	Error	Stage error Stage is out of the minimum range (X-axis) . If this message is appeared again, please contact a service engineer.	
10151	Error	Stage error Stage is out of the maximum range (Y-axis) . If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
10152	Error	Stage error Stage is out of the minimum range (Y-axis) . If this message is appeared again, please contact a service engineer.	
10153	Error	Stage error Stage is out of the maximum range (Z-axis) . If this message is appeared again, please contact a service engineer.	
10154	Error	Stage error Stage is out of the minimum range (Z-axis) . If this message is appeared again, please contact a service engineer.	
10155	Error	Stage error Stage is out of the maximum range (T-axis) . If this message is appeared again, please contact a service engineer.	
10156	Error	Stage error Stage is out of the minimum range (T-axis) . If this message is appeared again, please contact a service engineer.	
10157	Error	Stage error Stage is out of the maximum range (R-axis) . If this message is appeared again, please contact a service engineer.	
10158	Error	Stage error Stage is out of the minimum range (R-axis) . If this message is appeared again, please contact a service engineer.	
10162	Error	Stage error Track ball or joy stick have been operating. Please stop operating the track ball or joy stick and wait until the stage is stop.	
10167	Error	Over run error X-axis (CCW side) of stage has overrun. In case the stage is not automatically recovered, please initialize the stage.	
10168	Error	Over run error X-axis (CW side) of stage has overrun. In case the stage is not automatically recovered, please initialize the stage.	

Code	Category	Error message	Remarks
10169	Error	Over run error Y-axis (CCW side) of stage has overrun. In case the stage is not automatically recovered, please initialize the stage.	
10170	Error	Stage over run at Y-axis. (CW side) If this message is appeared again, please contact a service engineer.	
10175	Error	Cannot move the stage. Please perform the following procedure. 1.Turn off and on the [STAGE] breaker 2.Confirm that the stage is stopped 3.Download the stage program again	
10194	Error	The stage OPEN/CLOSE sensor error Exit from the operation program. Power off and on the main switch off. If this message is appeared again, please contact a service engineer.	
10196	Error	Cannot move the stage. Please turn off and on the vacuum system power and stage power.	
10197	Error	LED control unit has not activated. Please restart the instrument according to the following procedures. 1.Turn off the PC 2.Power off the [EOC POWER] switch 3.Power on the [EOC POWER] switch If this message is appeared again, please contact a service engineer.	
10198	Error	[CameraNavi LED control unit] has not activated. Power off and on the main switch. If this message is appeared again, please contact a service engineer.	
10203	Error	Stage has inserted. The specimen will be damaged due to contacting the specimen chamber. Please open the specimen exchange chamber gate for inserting the stage.	
10205	Error	Cannot capture an image by the camera.	
10211	CriticalError	Vacuum system control power error Vacuum operation has stopped. Please turn OFF the [EVAC power] switch and contact a service engineer.	

Code	Category	Error message	Remarks
10212	Error	The observation condition may be out of the condition for adjusting the auto contrast. Please adjust the contrast manually or retry the auto contrast adjustment by the low magnification.	
10213	Error	The observation condition may be out of the condition for the auto contrast adjustment to work well. -Adjust contrast of each signal by selecting each signal button, then select MIXING and pushing an [Auto] button again.	
10214	Error	The user name is already used for the default. Please enter other user name.	
10215	Error	The user name has not registered. Please enter a valid user name.	
10216	Error	Password is incorrect. Please enter correct password.	
10217	Error	Cannot load the file. Please check the file.	
10219	Error	Time out. Restart the scanning.	
10220	Error	Time out. If this message is appeared again, please contact a service engineer.	
10222	Error	Time out. If this message is appeared again, please contact a service engineer.	
10223	Error	Cannot capture the image.	
10224	Error	Remaining capacity of drive is insufficient. More than ”” MB of remaining capacity is necessary.	
10226	Error	Remaining capacity of drive is insufficient.	
10232	Error	Cannot find the holder or cannot save the file because invalid character is included. Please re-select the holder name.	
10233	Error	Invalid character is included.	
10234	Error	The file name is invalid.	
10235	Error	Number of entered file name is exceeded the limitation value. Please enter the file name within 255 characters including the holder name.	
10236	Error	The user name is invalid.	
10237	Error	The specimen name is invalid.	
10238	Error	Keyword is invalid.	
10239	Error	Number of input data exceeds the limit. Please delete unnecessary data and input the data again.	

Code	Category	Error message	Remarks
10240	Error	New password and re-entered password are unmatched. Please check the password and enter again.	
10241	Error	Cannon delete the user name.	
10242	Error	Cannot save the file.	
10255	Error	Serial number is incorrect. Please enter correct serial number.	
10268	Error	[ABCC] error	
10269	Error	[AFC] error	
10271	Error	[Auto filament saturation] error	
10272	Error	[ABA] error	
10273	Error	Cannot find the optimal beam alignment position. Please confirm the filament setting value.	
10275	Error	Cannot find the optimal beam alignment position. The image of beam was not enough brightness or contrast. Set the spot size to 30 to 50 and try again.	
10276	Error	Cannot find the optimal beam alignment position. The optical axis may not be in the appropriate position. Perform the [Optical axis alignment] .	
10280	Error	The number of observation conditions are exceeded the limit (1000). Please delete the unnecessary conditions.	
10281	Error	Cannot perform the [Auto alignment]. Please perform the following operation and set the SEM condition. 1.Focus is improper→Focus to the range where the specimen can be seen or adjust the stage position 2.Aperture alignment value is around the adjustment limitation→Reset the aperture alignment and focus	
10282	CriticalError	Cannot perform the [Auto alignment]. Malfunction has occurred on the system. Please contact a service engineer. Error code=1	
10284	CriticalError	Cannot perform the [Auto alignment]. Malfunction has occurred on the system. Please contact a service engineer. Error code=3	
10285	CriticalError	Cannot perform the [Auto alignment]. Malfunction has occurred on the system. Please contact a service engineer. Error code=4	

Code	Category	Error message	Remarks
10286	CriticalError	Cannot perform the [Auto alignment]. Malfunction has occurred on the system. Please contact a service engineer. Error code=5	
10287	CriticalError	Cannot perform the [Auto alignment]. Malfunction has occurred on the system. Please contact a service engineer. Error code=6	
10288	CriticalError	Cannot perform the [Auto alignment]. Malfunction has occurred on the system. Please contact a service engineer. Error code=7	
10289	Error	Cannot perform the [Auto alignment]. Stigma alignment value or stigma correction value has set around the adjustment limitation value. Please perform the following operation. 1.Click [Default] button 2.Adjust the field of view 3.Perform [Auto stigma alignment]	
10290	Error	[ACAL] error The objective aperture has not been inserted. Insert the objective aperture and execute it again. If this message is displayed again, please perform the optical alignment manually.	
10291	Error	[Auto alignment] for the aperture error If this message is appeared again, please contact a service engineer.	
10292	Error	[Auto alignment] for the stigma error If this message is appeared again, please contact a service engineer.	
10293	Error	[Auto alignment] for the beam error Please align the beam manually from [Beam alignment]>[filament image]. If this message is appeared again, please contact a service engineer.	
10294	Error	Optical axis alignment error If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
10295	Error	Cannot perform the [Auto alignment]. Please align the [Optical axis alignment STEP2] and [STEP3] manually. If the manual adjustment is difficult, execute the auto alignment or contact a service engineer.	
10296	Error	Cannot perform the [Detection]. Please align the [Optical axis alignment STEP3] manually. If the manual adjustment is difficult, execute the auto alignment or contact a service engineer.	
10297	Error	Cannot perform [Auto alignment]. Please align the [Optical axis alignment STEP3] manually. If the manual adjustment is difficult, execute the auto alignment or contact a service engineer.	
10298	Error	Cannot perform [Auto alignment]. Please reset the optical axis alignment STEP2, and align the axis manually.	
10299	Error	［ACAL］error The objective aperture has not been aligned. Press the [Reset] button and adjust the objective aperture manually so the circular image is in the center.	
10300	Error	Cannot perform [Auto alignment].	
10301	Error	[AFS] has stopped because the emission current cannot be confirmed. Please check the filament.	
10318	Error	Number of entered file name is exceeded the limitation value. Please enter the file name within 255 characters including the holder name.	
10319	Error	Cannot register to the SEM Data Manager.	
10320	Error	Please enter user name.	
10331	Error	Cannot change the password because the base holder cannot be found.	
10332	Error	Cannot find the base folder. Please check the holder.	
10333	Error	Please select user name from the list.	
10339	Error	Cannot perform the Tru-image.	
10357	Error	Cannot find the ””.	
10359	Error	Cannot detect the camera device. (””)	
10360	Error	Cannot display the camera image.	
10361	Error	Cannot obtain a camera image. (””)	
10370	Error	Fail to load the area.	
10371	Error	Fail to load the image.	

Code	Category	Error message	Remarks
10372	Error	The number of saving area is exceeded the maximum number of (””). Please delete unnecessary saved area.	
10382	Error	Cannot load the image file.	
10409	Error	Cannot transfer the data because the data is exceeded the maximum amount. Please reduce the number of images.	
10411	Error	Cannot display the image. The maximum number of image for displaying is up to 16. Please close the unnecessary images.	
10412	Error	Cannot overwrite the data because the information is protected.	
10415	Error	Cannot delete the data because the information is protected.	
10416	Error	A protected information is selected. The information is unable to delete.	
10428	Error	The vacuum mode between destination file of registering and image are not matched. Please check the vacuum mode.	
10452	Error	Cannot execute [Calibration]. Please change the specimen stub size.	
10497	Error	Stage error Pull out the stage or wait until the stage is stopped. If this message is appeared again, please contact a service engineer.	
10498	Error	Stage error Stage has locked. Unlock the stage for moving the Z-axis . If this message is appeared again, please contact a service engineer.	
10499	Error	Stage error Stage has locked. Unlock the stage for moving the T-axis of stage. If this message is appeared again, please contact a service engineer.	
10500	Error	Stage lock error Cannot lock the stage Z-axis and T-axis of stage is moving or initialization of Z-axis and T-axis of stage has not completed. Please wait until the moving or initialization of stage is completed. If this message is appeared again, contact a service engineer.	
10506	Error	Time out Motor of detector has not functioned. Please check the motor of detector.	

Code	Category	Error message	Remarks
10507	Error	Over run error Z-axis (CCW side) of stage has overrun. In case the stage will not be recovered automatically, please initialize the stage.	
10508	Error	Over run error Z-axis (CW side) of stage has overrun. In case the stage will not be recovered automatically, please initialize the stage.	
10509	Error	Over run error T-axis (CCW side) of stage has overrun. In case that the stage will not be recovered automatically, please initialize the stage.	
10510	Error	Over run error T-axis (CW side) of stage has overrun. In case the stage will not be recovered automatically, please initialize the stage.	
10511	Error	Error Stage cannot be moved while the specimen exchange rod is inserted. Please pull out the specimen exchange rod.	
10512	Error	Stage error Malfunction of the stage motion (R-axis) has detected. Please check the parameter for R-axis DC motor or hardware.	
10513	Error	Stage error The stage (R-axis) has not functioned. Please check the parameter for R-axis DC motor or hardware.	
10514	Error	Stage error Malfunction of the stage motion (R-axis) has detected while the CW-axis is moving. Please check the parameter for R-axis DC motor or hardware.	
10515	Error	Stage error Malfunction of the stage motion (R-axis) has detected while the CCW-axis is moving. Please check the parameter for R-axis DC motor or hardware.	
10516	Error	Error Detector has inserted. Cannot initialize the stage while this detector is inserted. Please pull out the detector.	
10517	Error	Detector has inserted. Detectors which cannot be used simultaneously are inserted. Please pull out the detectors.	

Code	Category	Error message	Remarks
10520	Error	Cannot move the stage to the initializing position. Confirm the detector condition.	
10524	Error	Cannot initialize the stage. Power off and on the stage power. If this message is appeared again, please contact a service engineer.	
10566	Error	Although insertion or equipping an unknown option device was detected, the detector ports setting of SEM has not completed. Please extract the device and contact a service engineer.	
10602	Error	Cannot save the file.	
11007	Error	Fail to the auto alignment. Reset the optical axis alignment STEP3, and execute adjustment manually.	
11009	Error	Cannot transfer the image(s). Restart the PC. If this message is appeared again, please contact a service engineer.	
11010	Error	Cannot read the image. If this message is appeared again, please contact a service engineer.	
11011	Error	Cannot read some of the image(s), which remain not transferred. Please try again to transfer them. (The image(s) without IPI mark in the image list) If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
11012	Error	Cannot transfer the image. 1. Please carry out the following operations. (1) In case any image process is running on Image-Pro, wait until the process is completed. (2) Transfer the image. 2. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Restart the Image-pro. (2) Transfer the image. 3. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Remove and insert the LAN cable or reconnect the wireless LAN to the PC. (2) Transfer the image. 4. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Check the communication settings of Image-Pro. (2) Transfer the image. 5. If this message is appeared again after performing the above operation, please contact a service engineer.	
11013	Error	Some of the image(s) remain not transferred. 1. Please carry out the following operations. (1) In case any image process is running on Image-Pro, wait until the process is completed. (2) Transfer the image again. (the image(s) without IPI mark in the image list) 2. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Restart Image-Pro. (2) Transfer the image(s). 3. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Remove and insert the LAN cable or reconnect the wireless LAN to the PC. (2) Transfer the image(s). 4. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Check the communication settings of Image-Pro. (2) Transfer the image(s). 5. If this message is appeared again after performing the above operation, please contact a service engineer.	

Code	Category	Error message	Remarks
11014	Error	Cannot transfer the image. If this message is appeared again, please contact a service engineer.	
11015	Error	Cannot transfer the image(s), which remain not transferred. Please try again to transfer them. (the image(s) without IPI mark in the image list) If this message is appeared again, please contact a service engineer.	
11016	Error	Cannot transfer the image. 1. Please carry out the following operations. (1) In case any error message is appeared on the Image-Pro, carry out the operation according to the message. (2) Transfer the image. 2. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Restart Image-Pro. (2) Transfer the image. 3. If this message is appeared again, please contact a service engineer.	
11017	Error	Some of the image(s) remain not transferred. 1. Please carry out the following operations. (1) In case any error message is appeared on the Image-Pro, carry out the operation according to the message. (2) Transfer the image again. (the image(s) without IPI mark in the image list) 2. If this message is appeared again after performing the above operation, please carry out the following operations. (1) Restart Image-Pro. (2) Transfer the image(s). 3. If this message is appeared again, please contact a service engineer.	
11018	Error	Control unit versions are not matched. Please contact a device manager.	
11024	Error	Updating of control unit has failed. Turn off the main switch at the main unit and update the control unit again. If this message is appeared again, please contact a service engineer. Target unit : "" Error information : ""	
11025	Error	Operation can not be proceeded because "" is being edited.	

Code	Category	Error message	Remarks
11032	Error	This file name has already reserved by the Windows. Please select an other name and execute again.	
11033	Error	Recording has stopped because the file size is exceeded 4 GB.	
11035	Error	Cannot overwrite on the selected file because the file is used in the other application. Please exit the application or select an another filename.	
11036	Error	Recording has stopped because the image can not be loaded. Restart the operation program. If this message is appeared again, please contact a service engineer.	
11037	Error	Cannot initialize the read attribution of file. Please check the attribution of file.	
11038	Error	The connected device is not "".Please reconfirm the installer.	
11039	Error	Cannot load the image file. The image size exceeds 5120x5120. Please check the image size.	
11042	CriticalError	Electron gun control power supply error Please perform the following operations. 1.Exit from the operation program 2.Shut down the PC 3.Power off the main switch 4.Contact a service engineer	
11050	CriticalError	Vacuum system is set at the maintenance mode. Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 3.Contact a service engineer	
11051	CriticalError	Vacuum system control power +24V error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 3.Contact a service engineer Note that the main power will be shut down in about 3 minutes 30 seconds automatically.	
11052	CriticalError	Vacuum system control power +5V error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 3.Contact a service engineer	

Code	Category	Error message	Remarks
11053	CriticalError	Rotary pump has not activated or abnormality of the Vacuum system control power was detected. Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 3.Contact a service engineer Note that the main power will be shut down in about 3 minutes 30 seconds automatically.	
11054	CriticalError	TMP error Vacuum operation has stopped. Please perform the following operations. 1.Exit the operation program 2.Power off the main switch at the main unit 3.Wait about 30 minutes 4.Power on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11055	CriticalError	Pirani vacuum gauge error Please perform the following operations. 1.Exit from the operation program 2.Power off and on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11056	CriticalError	Cannot the specimen chamber to be atmospheric condition. Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 3.Check if the remaining gas amount and current are optimized 4.Power on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11057	CriticalError	Cannot the specimen exchange chamber to be atmospheric condition. Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 2.Check if the remaining gas amount and current are optimized 4.Power on the main switch at the main unit If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
11058	CriticalError	Pumping error or air leakage is occurred. Please perform the following operations. 1.Confirm if the space between specimen stage and specimen chamber are completely closed 2.Press [VACUUM] switch for evacuating air from the specimen chamber If this message is appeared again, please contact a service engineer.	
11059	CriticalError	Cannot reached to the setting pressure of specimen chamber. Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 2.Check if the remaining gas amount and current are optimized 4.Power on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11060	CriticalError	Pumping error or air leakage is occurred. Please perform the following operations. 1.Check if the specimen exchange chamber is firmly closed 2.Click [AIR] button and check if it is firmly closed to the specimen chamber without any space 3.Press [EVAC] or [OPEN] button on the specimen exchange chamber If this message is appeared again, please contact a service engineer.	
11061	CriticalError	Vacuum valve error Please perform the following operations. 1.Exit from the operation program 2.Power off and on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11062	CriticalError	Gate valve(XV) of specimen exchange device error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Contact a service engineer	
11063	CriticalError	Vacuum valve error Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch 3.Contact a service engineer	

Code	Category	Error message	Remarks
11064	CriticalError	Vacuum valve error Please perform the following operations. 1.Exit from the operation program 2.Power off and on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11065	Error	The specimen exchange rod is not pulled out completely. Please pull out the specimen exchange rod until stopped.	
11066	Error	Specimen chamber has opened. Please close the specimen chamber.	
11067	Error	Specimen exchange chamber is opened. Please close the specimen exchange chamber.	
11068	Error	The pressure of the compressed air has decreased. Please perform the following operation. ・In case of using an air compressor:Make sure the valve of outlet is opened. ・In case of using utility air:check the air supply system When the air pressure is recovered and system is in the vacuum condition, press [OK]. If this message is appeared again, please perform the following operation. 1.Exit the operation program. 2.Power off the main switch 3.Contact a service engineer.	
11069	Error	AIR or VP mode operation is prohibit due to interlock. Please release the interlock. In case of using the vacuum mode continuously, press [VACUUM] switch.	
11070	Error	Touch sensor is activated. Specimen and specimen stub have contacted to a check gauge or a specimen chamber. The Z-axis of specimen stage will move to the down side by 5 mm.	
11071	Error	Stage error The specimen stage is not in the exchange position. Move the stage to the specimen exchange position by pressing [SEC].	
11072	Error	Gate valve error The gate valve has open. Close the gate valve and press [VACUUM]. Pull out the specimen exchange rod if it is inserted.	

Code	Category	Error message	Remarks
11073	CriticalError	TMP cooling fan error Please perform the following operations. 1.Exit from the operation program 2.Power off and on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11077	Error	Cannot communicate with PC and SEM unit. Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch	
11078	Error	Cannot communicate with HV power unit. Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch	
11079	CriticalError	Vacuum system has not been activated. Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch	
11080	CriticalError	Overheat protection of the EODRV2 PCB is activated. Please perform the following operations. 1.Power off the [MAIN] switch 2.Wait approximately 30 minutes 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	
11081	CriticalError	Power supply fuse error Power off the [MAIN] switch and contact a service engineer.	
11084	Error	Execute it after starting the observation.	
11086	Error	[ASFC] error	
11090	Error	Cannot perform [Calibration]. [Calibration] can perform to the specimen when the stage can be tilted up to 20 deg.	
11092	Error	Unstable sensor status error. Exit SEM software, turn the [MAIN] switch off, and restart the microscope. When this message is shown again, contact a service engineer.	

Code	Category	Error message	Remarks
11093	Error	The stage position is out of the movable range. Stage will be initialized.	
11094	Error	Cannot use the same area name.	
11102	CriticalError	TMP temperature error Vacuum operation has stopped. Please perform the following operations. 1.Exit the operation program 2.Power off the main switch at the main unit 3.Wait about 30 minutes 4.Power on the main switch at the main unit If this message is appeared again, please contact a service engineer.	
11103	Error	X-axis motion error Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	
11104	Error	Y-axis motion error Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	
11105	Error	Z-axis motion error Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	

Code	Category	Error message	Remarks
11106	Error	T-axis motion error Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	
11107	Error	R-axis motion error Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	
11108	Error	Stage error Please restart the instrument according to the following procedures. 1.Exit from the operation program 2.Power off the [MAIN] switch 3.Power on the [MAIN] switch If this message is appeared again, please contact a service engineer.	
11109	Error	Touch sensor is activated. Specimen or specimen stub has contacted to a specimen chamber. Stage will be initialized by clicking the [OK] button.	
11110	Error	Touch sensor is activated. Please move the stage to retracted position and click the [Home position] button.	
11120	Error	Please check the connection status of Aztec.	
11121	Error	The registered number of sites has reached to the maximum number.	
11122	Error	The registered number of specimen has reached to the maximum number.	
11125	Error	The registered number of point analysis has reached to the maximum number.	
11139	Error	Stage free mode was selected at the last time of exiting the system. Move the stage to the home position for returning to the movable range limiting condition.	
11142	Error	The specimen exchange rod has not pulled out completely. Please pull out the specimen exchange rod until stopped.	

Code	Category	Error message	Remarks
11145	Error	Cannot initialize the stage while specimen exchange rod is inserting. Pull out the specimen exchange rod until the end. Exit the operation program by clicking the [Exit application] button and restart the operation program.	
11148	Error	Cannot move the stage to the selected Z-axis due to the present T-axis. Please set the stage Z-axis within the movable range.	
11149	Error	Cannot move the stage to the selected T-axis due to the present Z-axis. Please set the stage T-axis within the movable range.	
11157	CriticalError	The pressure of the compressed air for valve drive has been decreased.Please the following operation. 1. ・In case of using an air compressor : Make sure the valve of outlet is opened. ・In case of using utility air : Check the air supply system 2.Power OFF the main switch 3.Confirm that the air pressure is recovered 4.Power ON the main switch If the message is appeared again, please contact a service engineer.	
11164	CriticalError	TMP error Cannot communicate with TMP. Please perform the following operations. 1.Exit from the operation program 2.Power off the main switch at the main unit 3.Contact a service engineer	
11166	Error	［ACAL］error The objective aperture has not been inserted. Please perform the following operations. 1.Insert the objective 2.Display the [Filament exchange manual adjustment] dialog by clicking the [Support] button 3.Perform the beam alignment	
11167	Error	［ACAL］error The objective aperture has not been inserted. Please perform the following operations. 1.Insert the objective aperture 2.Display the [Filament exchange manual adjustment] dialog by clicking the [Support] button 3.Perform the beam alignment	

Code	Category	Error message	Remarks
11168	Error	Stage was stopped while the stage is moving to the home position. Make sure to move the stage to the home position when the touch sensor is activated.	
11169	Error	Cannot initialize the stage. Restart the operation program. If this message is appeared again, please contact a service engineer.	

Appendix D Notes on EDS analysis

Matters to be noted about system peak on elemental analysis using EDS (Energy Dispersive X-ray Analyzer) are described. The system peak is the peak appearing in the spectrum when X rays of elements contained outside the analysis part are detected due to the apparatus.
In the VP-mode, the system peak is caused when primary electron is scattered by colliding against gas molecules remaining in low vacuum atmosphere and irradiated on the sample or sample stub.
In case of using aluminum (Al) specimen stub, if the sample size is smaller than the stub, in the VP-mode, scattering primary electrons is irradiated on the stub, and Al is detected as the system peak. In that case, it is possible to prevent the detection of the Al peak by covering the stub with carbon tape, applying carbon paste, or using a carbon stub.
Characteristic X-ray of carbon is at the edge of the low energy (0.277 eV) on spectrum, and the influence on identification of contained elements is considered as minor. However, in this case carbon will increase as a system peak, so be careful when measuring carbon content.
This system peak rarely occurs in high vacuum mode.

SERVICE OFFICE LOCATIONS

(SEM, Nano-Probing System, (S)TEM, FIB, Peripheral Device)

Asia

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Note: The addresses and telephone numbers of the service offices listed above are subject to change without prior notice. In U.S.A., please contact the asterisked service office listed above if inquiries about the amount of the radiation dose emitted from the instrument arise.

As of October 11, 2018