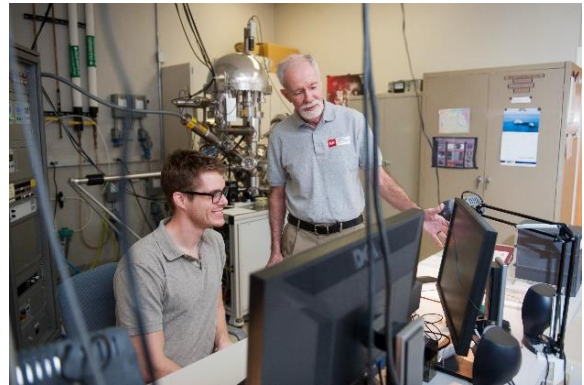


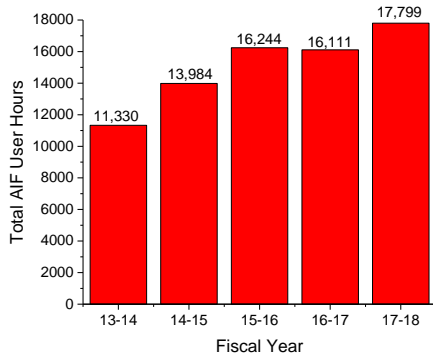
**Mission and Capabilities**

The AIF is NC State’s primary shared facility for materials characterization with a mission to enable and lead state-of-the-art research through acquisition, development, maintenance, training, and access to major analytical and materials characterization instrumentation. Through the support of engaged faculty and experienced staff, the AIF supports state-of-the-art scanning and transmission electron microscopes, X-ray scattering and spectroscopy instruments, mass spectrometry, scanning probe and Raman microscopy, laser scanning microscopy, nanoindentation and extensive sample preparation facilities. Some of the extraordinary capabilities of these instruments include chemically-sensitive atomic-scale imaging, extreme-resolution SEM of insulating and soft materials, *in situ* high temperature and electric-field-dependent X-ray diffraction, cryogenic SEM of biological and soft materials, low-temperature TEM and *in situ* microscopy during heating, electrical current, immersion in fluids, and in flowing gases (to name a few). The AIF is positioned within the College of Engineering and is named an NC State Core Facility by the Office of Research and Innovation (ORI).

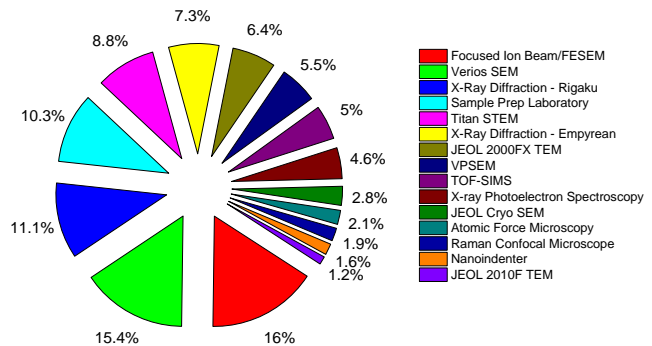


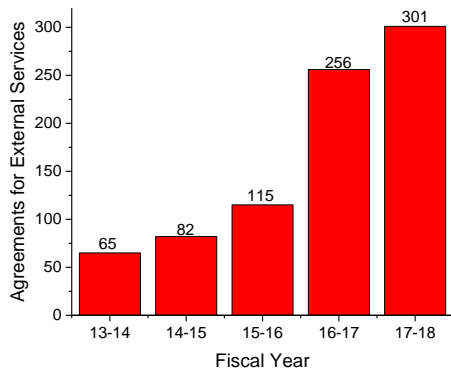
**Usage**

In FY18, the AIF was accessed by **145 NC State Principal Investigators (PIs)** at NC State and **407 users from those groups, who are mostly students and postdocs**. These individuals come from the **Colleges of Agriculture and Life Sciences, Natural Resources, Engineering, Sciences, Textiles, and Veterinary Medicine**. In addition, the AIF supported materials characterization services for **153 unique external government, industrial, and other academic researchers** through managing **301 active contracts** (up from 256 contracts in FY 17, 115 in FY 16, and 82 in FY 15). Overall, the AIF provided **17,799 lab user hours** in FY18 (up from 16,111 in FY 17 and 11,330 in FY 14), representing a 57% increase over 4 years. 27% of AIF users are external to the university, demonstrating our service to researchers from North Carolina and around the world.

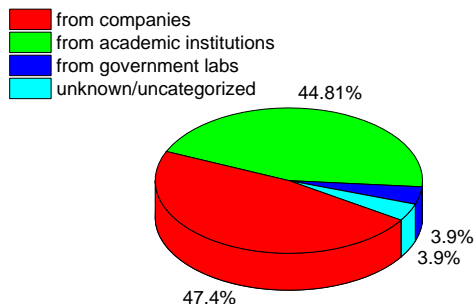


*Distribution of the 17,799 hours across the AIF laboratories and instruments.*



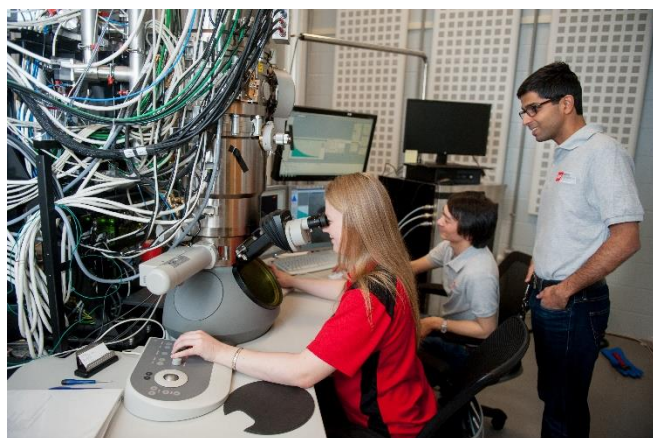


*Distribution of the 153 unique external users by institution type*



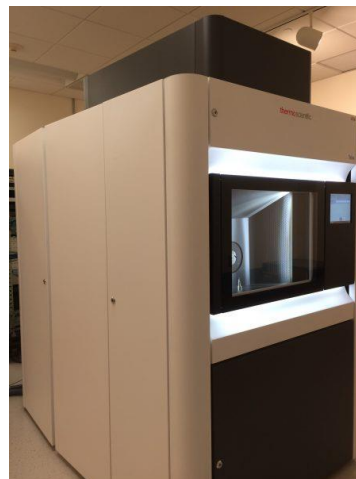
### Education and Engagement

The AIF is heavily involved in student training/education and engagement with the community. During FY18, the AIF offered **42 training** workshops, short courses, and other major in-lab events for hands-on training and learning on topics including vacuum technology, SEM, TEM, XRD, surface analysis, and sample preparation. Some examples include Vacuum Technology, XRD, SEM, and FIB short courses. New courses were created this FY including a Confocal Raman Spectroscopy and Ultramicrotomy Short Courses. In November of 2017, the AIF partnered with Malvern PANalytical to host a 1.5-day workshop on non-ambient diffraction; the workshop was attended by over 50 individuals from across the country. The AIF also contributes to numerous NC State for-credit courses through laboratory demonstrations and hands-on exercises for both undergraduate and graduate students. In FY18, the AIF gave over **74 tours** for visitors, industry researchers, and classrooms. The AIF engages with and enhances the missions of other research centers on campus, for example the Research Triangle Nanotechnology Network (RTNN), Center for Dielectrics and Piezoelectrics (CDP), and PowerAmerica, to provide short courses and workshops specialized for those constituencies, and proposal development to support such activities. The AIF staff and capabilities are featured in an RTNN-designed online course on the Coursera platform (<https://www.coursera.org/learn/nanotechnology>), a course which has been viewed by over 17,000 individuals and over 6,000 enrolled learners. AIF staff members helped to organize the annual Carolina Science Symposium in November of 2017, an event that attracts over 100 researchers. The AIF also programmed a “Cool Science” symposium during hot afternoons in the summer. The first one was held in August of 2017 and the second in July of 2018.



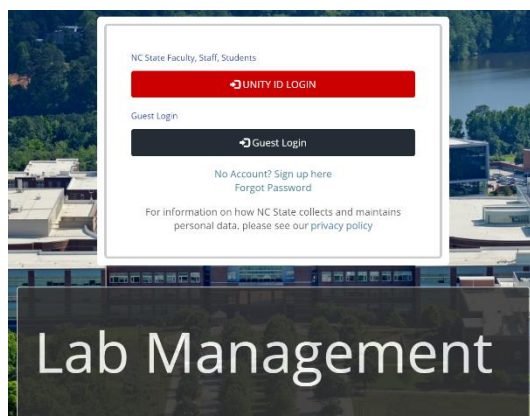
## New Instrumentation and Upgrades

The AIF acquires new instruments regularly. In the past year, for example, we started to commission a new [\*FEI Talos Transmission Electron Microscope\*](#), which was acquired through an NSF Major Research Instrumentation (MRI) award by Prof. James LeBeau (see article on his award [here](#)). In the summer of 2018, the NSF MRI program awarded funds to acquire a *\$IM X-ray nanotomography (nano-CT) instrument* which will be located in the AIF; the PI of this award is Prof. Jacques Cole from the Department of Biomedical Engineering and an interview with Dr. Cole about this instrument is available [here](#). Two other new instruments were acquired in the Spring 2018 semester, a [\*Keyence VKx1100 Confocal Laser Scanning Microscope\*](#) and a new [\*Bruker Hysitron TI980 Triboindenter\*](#) using funds made available from the College of Engineering. A new *Benchtop X-ray CT system*, which was acquired through the RTNN, has also just arrived at AIF. Several other upgrades include a CMOS-based *electron backscatter diffraction EBSD detector* in the Verios, enabling an order of magnitude improved data collection speed, an upgrade made possible through start-up funding to Prof. Victoria Miller in the Department of MSE, and an *energy dispersive EDS detector* in VPSEM. An *electron microscope pixel array detector EMPAD* was added to the Titan, which is 100 times faster compared to conventional detector, enabling 4D STEM imaging. A new *cathodoluminescence (CL) detector* was added to CryoSEM instrument to allow high spatial resolution CL imaging and a wide spectra range, which was made possible through a project awarded to Prof. Elizabeth Dickey in the Department of MSE. Finally, we moved our sample preparation laboratory from EB-1 to MRC in the Spring 2018 semester and brought in several new instruments in the process including *Vitrobot sample preparation for Cryo-electron microscopy*.



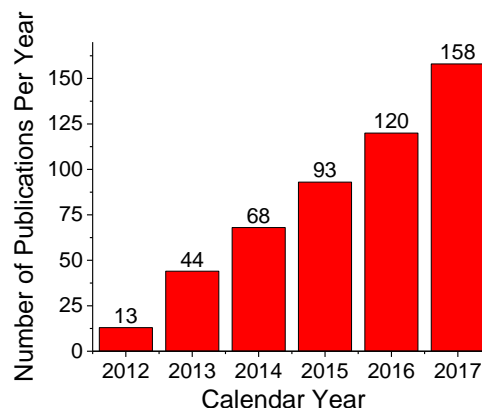
## Organizational Innovation

In FY18, we developed better ways of *communicating with our customers and stakeholders*, including the release of a *newly designed website* (<https://www.aif.ncsu.edu/>), development of our presence on *LinkedIn* (<https://www.linkedin.com/in/aif-nc-state-university/>), and transition to a professional emailing service for dissemination of our AIF Newsletter (link [here](#) to access recent newsletters). The AIF newsletter is now sent to *over 2,500 individuals!* Finally, we deployed a new *Lab Management system* through the Mendix platform in collaboration with the Office of Information Technology (OIT) and ORI to manage all aspects of our shared facility's business. The new system was released in July of 2017 and has enabled significant increases in efficiency and transparency. In the new system, training, reservation calendars, logging, and billing are all interlinked; and all approvals and processing is done electronically and integrated within NC State's business systems. The new system is available [here](#) and support and FAQ located [here](#). AIF credits much of this success to the involvement of folks across campus and the hard work and persistence of Jack Foster in OIT and Anna Ragsdale in AIF. Finally, we documented the *entire history of AIF, dating back to 1923*, which is summarized in a document available [here](#).



## Research Outputs and Impact

The AIF was authorized to work on **202 unique 5-account projects** in FY18, representing an impact to over **>\$20M in annual research expenditures** and **>\$98M in research awards** on campus. Users of the AIF published over **158 peer-reviewed technical publications** (full list [here](#)) in the calendar year 2017 (up from 120 in 2016, 93 in 2015, 68 in 2014, and 44 in 2013). Many of these publications receive national attention through news media or recognition in scientific communities. For example, papers titled, “[Sequential Actuation of Shape-Memory Polymers through Wavelength-Selective Photothermal Heating of Gold Nanospheres and Nanorods](#)” and “[Additive manufacturing of an iron-based bulk metallic glass larger than the critical casting thickness](#)”, were highlighted in the respective NC State press releases, [gold sequential unfolding](#) and [metallic glass alloys](#). Graduate students and postdocs also win national awards based on their research conducted in the AIF; for example, this year Weizong Xu won the the Microanalysis Birks Award for his contribution at last year's national Microscopy and Microanalysis conference. The AIF awarded two “[Best Paper](#)” awards this past year. The two recipients were Katherine Marusak from the group of [Prof. Joseph Tracy \(MSE\)](#) for [a publication in Chemistry of Materials on size and composition control of nanoparticles](#) and Nathalia Oriz from the group of [Prof. Gufeng Wang \(Chemistry\)](#) for [work published in The Journal of Physical Chemistry C on growth of Pd on gold nanorods](#).



## Assessment

AIF users are annually surveyed by an external evaluator (as part of the RTNN project), allowing us to determine the level of satisfaction of AIF users with the facility. Notably, 100% of users would come back again for future work (N=157). Overall satisfaction ratings were 6.39 out of 7.0 (SD=1.08, N=154) with similar satisfaction levels for staff and physical facilities. We acknowledge [Prof. David Berube](#) for the assessment.

## Personnel

A total of 10 technical and business staff members (~8 FTEs) staff the facility with three tenured faculty members serving in director-level leadership roles and undergraduate students working as research assistants. The technical staff are experienced, collaborative, energetic, and student/training focused. This past year, Tanzania Ray was hired as AIF's new Business Officer, in charge of the fiscal aspects of the facility. She was most recently a Budget Specialist in the College of Agriculture and Life Sciences at NC State where she provided support for the Administrative Directors, Rate Administrator for all of CALS Service Center Facilities, and ensured financial compliance to University policies. This past year, Anna Ragsdale was promoted to the SHRA position of University Program Associate and Dr. Ching-Chang Chung was promoted to an EHRA staff position carrying the title of X-ray Laboratory Manager. Two undergraduate students worked in AIF in the summer of 2017, Maeve Sedivy (TECS) and Nicholas Rinz (TECS), and graduate student Kasra Darabi and undergraduate Daniel Flint are assisting in the lab in summer 2018. An AIF/RTNN staff member, Phillip Strader, won an inaugural national award from the National Nanotechnology Coordinated Infrastructure (NNCI) in the category of User Support; this award acknowledges the significant efforts by NNCI site staff who endeavor to provide excellent service and support to all network users. Associate Director Melissa Pasquinelli was elevated to ACS Fellow in 2018

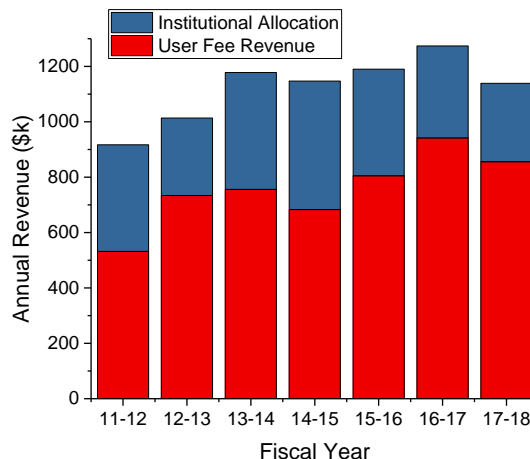
and won the [2018 Award for Excellence in Teaching by the UNC Board of Governors](#). Associate Director Jim LeBeau received the distinction of University Faculty Scholar. Director Jacob Jones won the NC State College of Engineering George H. Blessis Outstanding Undergraduate Advisor Award.

### Finances and Business

The AIF operates as a cost-recovery center, managing ~\$1.2M in annual expenditures across 22 different university accounts. The largest fraction of expenses are recovered from user fees (\$856k, or ~75%), with support also provided by the College of Engineering and ORI. Note that these numbers do not include support for equipment acquisitions.

**Operational support from the university is critical** to maintain a state-of-the-art facility, enable quality training of students and researchers, and offer competitive user rates for research activities. **Service contracts for the instruments** constitute a major portion of the annual expenditures (approximately \$400k), and this number will grow as new instruments come online and the factory warranty

periods of newly commissioned instruments terminate. Though large, this is a necessary expense to minimize downtime of instruments critical to the research enterprise and minimize the volatility of maintenance costs. As these expenses grow, we aim to grow facility usage concurrently (by both internal and external researchers) in order to maintain our competitive user rates.



### Outlook

This is an exciting time for the AIF and the research being performed within our facility. We have had significant instrument acquisitions enabled by active PIs and funds made available from the College of Engineering and ORI. The growth of impact to the users is noted in the rising number of usage hours and rising number of publications that acknowledge the AIF. In the summer of 2015, we created a strategic plan with goals to enrich *on-campus research*, strengthen relations with *external communities*, build the *next-generation infrastructure*, and enhance *operational and organizational excellence*. In the three years since developing that plan, we have made significant and measurable progress. As we move forward, we expect that AIF contributes to more diverse disciplinary work including new services to soft matter and biological researchers. We are already doing work behind-the-scenes to enable this growth. Our AIF advisory board will meet again in the Fall of 2018. If you are interested in joining or providing input to the AIF, please let us know. We welcome your input and engagement!

**Visit us or contact us at:** <http://www.aif.ncsu.edu>, <https://www.linkedin.com/in/aif-nc-state-university/>

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