

Mission and Capabilities

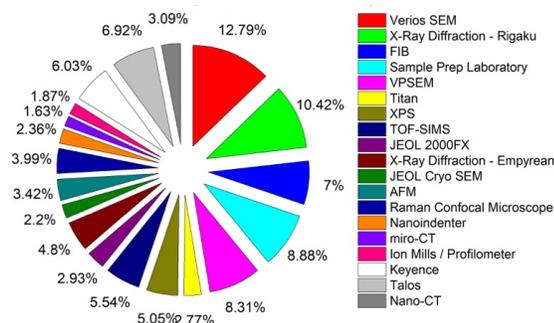
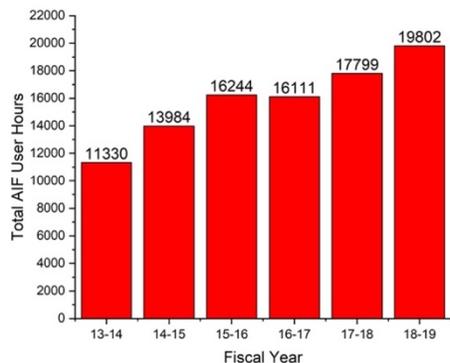
The AIF is NC State’s primary shared facility for materials characterization with a mission to enable and lead state-of-the-art research through acquisition, development, maintenance, training, and access to major analytical and materials characterization instrumentation. Through the support of engaged 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, nano-microscope (nano-CT) system, micro-CT system, 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).

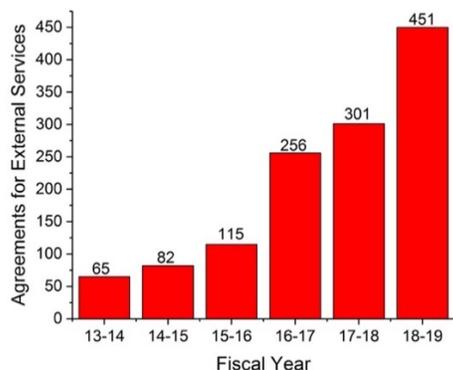


Usage

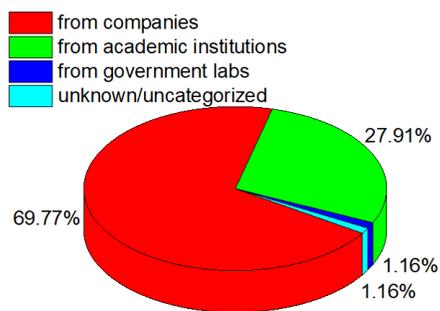
In FY19, the AIF was accessed by **174 NC State Principal Investigators (PIs)** at NC State and **435 users from those groups, who are mostly students and postdocs**. These individuals come from the **Colleges of Agriculture and Life Sciences, Natural Resources, Engineering, Sciences, Textiles, and Veterinary Medicine**. In addition, the AIF supported materials characterization services for **122 unique external government, industrial, and other academic researchers** through managing **451 active contracts** (up from 301 contracts in FY18, 256 in FY 17, 115 in FY 16, and 82 in FY 15). Overall, the AIF provided **19,802 lab user hours** in FY19 (up from 17,799 in FY 18, 16,111 in FY 17, 16,244 in FY 16, 13,984 in FY 15, and 11,330 in FY 14), representing a ~75% increase over 5 years. ~21.9% of AIF users are external to the university, demonstrating our service to researchers from North Carolina and around the world.

Distribution of the 19802 hours across the AIF laboratories and instruments.



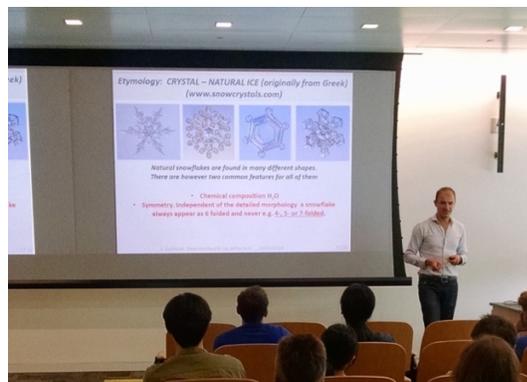
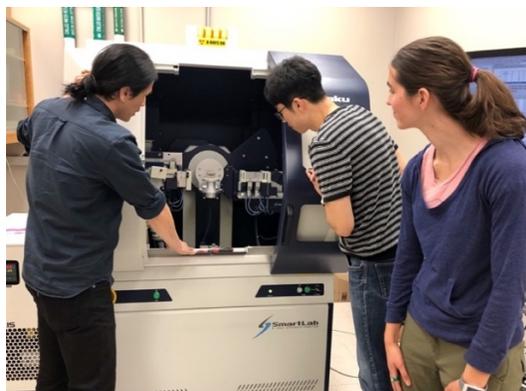


Distribution of the 122 unique external users by institution type



Education and Engagement

The AIF is heavily involved in student training/education and engagement with the community. During FY19, the AIF offered **43 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 January 2019, the AIF hosted a two-day Raman Spectroscopy Tutorial. The theory of Raman spectroscopy and their working principles were provided, including details on spectral fitting procedures. The course was completed by several examples of application of Raman spectroscopy on ceramic, semiconductor and polymeric samples. 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 FY19, the AIF gave over **70 tours** for visitors, industry researchers, and classrooms. The AIF engages with and enhances the missions of other research centers on campus to provide short courses and workshops specialized for those constituencies, and proposal development to support such activities. One of our staff members, Fred Stevie, was a lecturer at Lehigh Microscopy School in summer 2018. This is the considered to be the most prestigious school of its type and is also the longest running microscopy school (49 years and counting). It has been attended by over six thousand students. Fred taught in the Focused Ion Beam (FIB) Instrumentation and Applications Course at the school. He is also working with two of the other instructors on a new FIB book. AIF staff members helped to organize the annual Carolina Science Symposium in November of 2018, an event that attracted over 75 researchers, and 19 vendors. The AIF also programmed a “Cool Science” symposium on the topic of “Time-resolved X-ray diffraction for materials science” during a hot afternoon in the summer with ~50 attendees from NC State, UN-CH, NC A&T, UNCG, UNC-Wilmington, Duke, University of Virginia, Clemson University and several local companies.



New Instrumentation and Upgrades

The AIF acquires new instruments regularly. In March 2019, a new ***Zeiss Xradia 510 Versa X-ray Nano-microscope (nano-CT) System*** was delivered. It was acquired through an NSF Major Research Instrumentation (MRI) award by Prof. Jacque Cole (see article on this award [here](#)) from the Joint Department Biomedical Engineering at NC State and UNC-Chapel Hill. The system uses X-rays to visualize and measure the internal structure of many types of objects without having to cut them open. Another new instrument was acquired in the Summer 2019, a ***Leica ACE900 Freeze Fracture System*** by Prof. Candace Haigler in Crop Science and Plant Biology Department, using funds made available from Department of Energy (DOE). The Freeze Fracture System is used for sample preparation of biological and non-biological materials. AIF also is home to a ***Bruker SkyScan 1174 microCT system***. This compact micro-CT can be used to image a variety of samples in three-dimensions with down to 10-micron spatial resolution. A suite of software tools is included with the system for complex image reconstruction, processing, and analysis.



Assessment

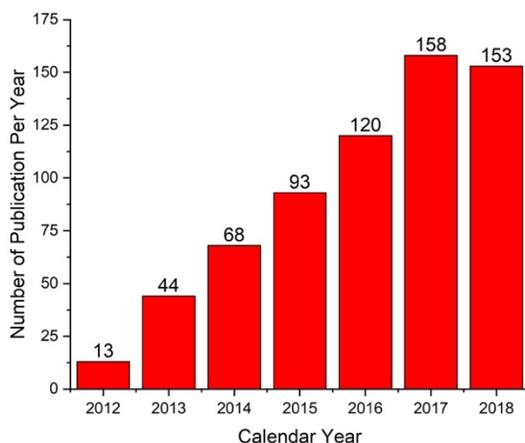
AIF users are annually surveyed by an external evaluator (as part of the RTNN project), allowing us to determine the level of satisfaction of AIF users with the facility. Notably, 98.9% of users would come back again for future work (N=183). Overall satisfaction ratings were 6.34 out of 7.0 (SD=1.15, N=183) with similar satisfaction levels for staff and physical facilities. We acknowledge Prof. David Berube for the assessment.

Organizational Innovation

In FY19, we continue ***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 dissemination of our AIF Newsletter ([link here](#) to access recent newsletters). The AIF newsletter is now sent to ***over 2,900 individuals***. Each month, AIF features “***User Spotlight***”, where selected users’ backgrounds and projects are introduced and primary instrument(s) they are using for the research are discussed. In FY2019, [Yusuke Mukai](#) (PhD student in Fiber Polymer Science), [Dr. Stephen Furst](#) (CEO of Smart Material Solutions, Inc.), [Ryan Schoell](#) (PhD student in Nuclear Engineering), [Amanda Volk](#) (PhD student in CBE), [Alex Hsain](#) (PhD student in MSE), [Javier Brumos](#) (Postdoc in PMB), and [Dr. Kate Marusak](#) (Protochips) were featured. These individuals were from diverse disciplinary backgrounds and career trajectories, and are brought together through their utilizing instruments at AIF.

Research Outputs and Impact

The AIF was authorized to work on **213 unique 5-account projects** in FY19, representing an impact over \$23M in annual research activity and **>\$173M in research awards** on campus. Users of the AIF published over **153 peer-reviewed technical publications** (full list [here](#)) in the calendar year 2018 (virtually consistent with 158 in 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. The AIF awarded two “Best Paper” awards this past year. The two recipients were Zaynab Mahbooba from the group of Professor Ola Harrysson (ISE) for a publication in Applied Materials Today on “Additive manufacturing of an iron-based bulk metallic glass larger than the critical casting thickness” and Long Ye from the group of Harald Ade (Physics) for a publication in Nature Materials on “Quantitative relations between interaction parameter, miscibility and function in organic solar cells.”

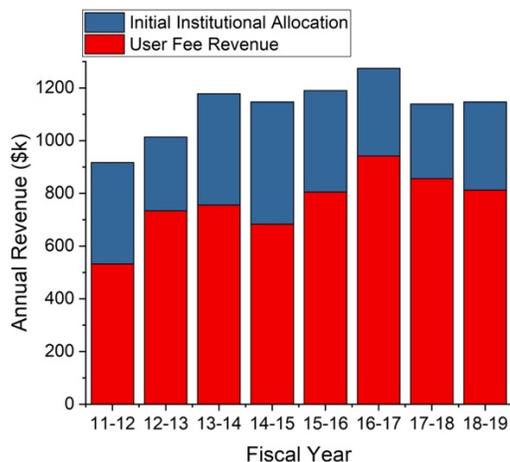


Personnel

A total of 13 technical and business staff members and postdocs staff the facility with two 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, AIF appointed Dr. Hsiao-Ying Shadow Huang, Associate Professor of Mechanical and Aerospace Engineering, as Associate Director. In this role, Dr. Huang leads the development and implementation of a strategic plan for AIF to better serve biological and life sciences researchers including, but not limited to, cryo-electron microscopy and associated sample preparation capabilities as well as other imaging and characterization needs that are synergistic with AIF’s current capabilities and directions. Dr. Chris Winkler was hired as AIF’s new TEM Lab Manager. After working for 5 years on a TEM in industry, Dr. Winkler went to Drexel University and received his PhD in 2012, largely utilizing TEM-based techniques. Since 2012, he has been the TEM lab manager at Virginia Tech. Dr. Winkler has hands-on experience with in situ electrical biasing, heating, cooling, irradiation, and tensile testing in the TEM, and is excited to work with the suite of holders housed within the AIF. Dr. Aaron Bell was hired as the Bio-EM Staff Scientist. Dr. Bell has over 15 years of EM experience, most recently as the Manager of the Neuropathology Brain Bank and Research Core in the Icahn School of Medicine in NYC. Dr. Bell’s past research interests have spanned several fields including left-right asymmetry determination utilizing protistan model systems, ciliary signal transduction, autism utilizing *Drosophila* models, parasitic nematodes in disease transmission, as well as neurodegenerative research using human tissue, 3D cell culture and mouse models. AIF Director, Dr. Jacob Jones, won the 2019 NC State Alumni Association Outstanding Research Award and was inducted into the Research Leadership Academy. This award recognizes faculty members for excellence in their field and commitment to the university’s research enterprise with an emphasis on collaborative leadership and mentoring. Phillip Strader won the National Nanotechnology Coordinated Infrastructure (NNCI) User Support Award. Phillip is an RTNN project scientist and an AIF lab manager. His nomination was particularly noteworthy because of his leadership in securing and commissioning new instruments and his thoughtful execution of the RTNN Kickstarter program.

Finances and Business

The AIF operates as a cost-recovery center, managing ~\$1.2M in annual expenditures across 23 different university accounts. The largest fraction of expenses are recovered from user fees (\$812k, or ~71%), 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 the cumulating publications that acknowledge the AIF. In the summer of 2018, the AIF initiated a strategic plan with goals to more substantially impact the biological and life sciences research communities. AIF capitalizes on investments such as cryo-SEM and cryo-TEM and develop a focused communication plan to disseminate awareness and knowledge of the new analytical capabilities as well as the new research opportunities emerging at the physical and life sciences intersection. We further enrich **on-campus research**, strengthen relations with **external communities**, build the **next-generation infrastructure**, and enhance **operational and organizational excellence**. In previous years, we have made significant and measurable progress in these areas. For example, we started new services to soft matter and biological researchers and it was recognized by the AIF advisory board (met in June of 2019). The advisory board had comment our significant growth and enhancement in research productivity, instrumentation infrastructure, and business operations. 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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