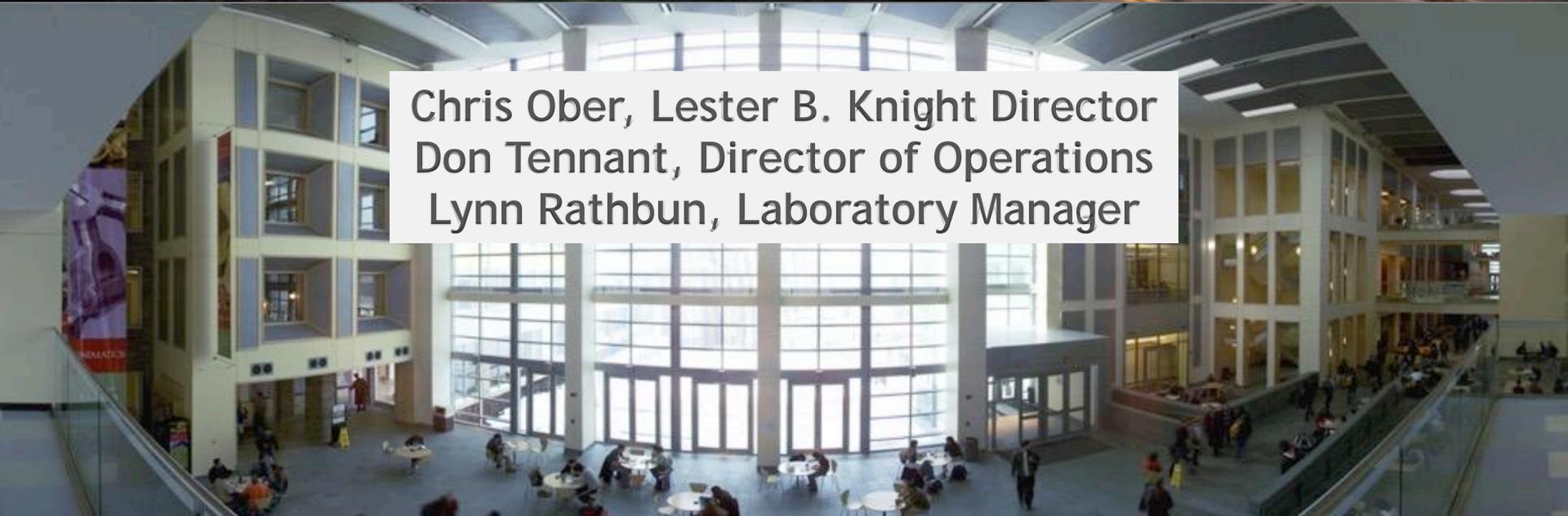


Celebrating 40 years!

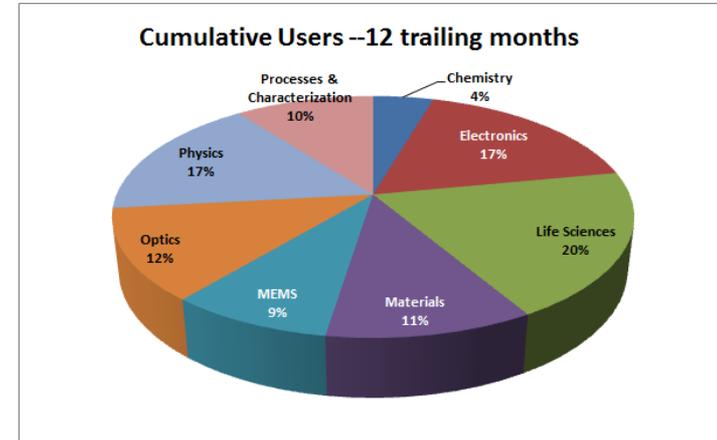


Chris Ober, Lester B. Knight Director
Don Tennant, Director of Operations
Lynn Rathbun, Laboratory Manager



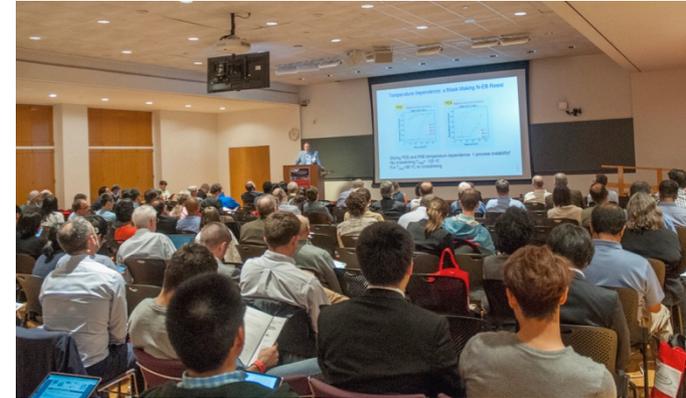
Cornell Nanoscale Facility

- 2017 is CNF's 40th Anniversary as an NSF funded User Facility
- We house \$40M of nanofabrication tools in a 17,000 sq ft clean room in Duffield Hall
- 23 (20.7 FTE) scientific and technical staff
- Backgrounds include: Physics, Materials Science, Electrical Engineering, Chemical Engineering, Biology
- 4 administrative staff support on-site users
- 15 NNCI Technical Experts among staff
- By NNCI definitions: 53% Non-traditional users



CNF 40th Anniversary Meeting & Workshop

- Held September 14th – 15th 2017
- 290 Attendees; 27 Sponsors
- 12 Invited Speakers from academia, government and industry
- 80 student posters; 5 student awards
- Topics included IOT; Machine learning; Using biology as fab of future; Uses of technology for societal benefit; 2D materials; Polymers; (and more)
- Panel Discussion “Past Impact and Future Impact”
- Lectures available on the CNF web site.



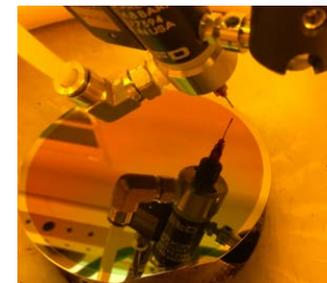
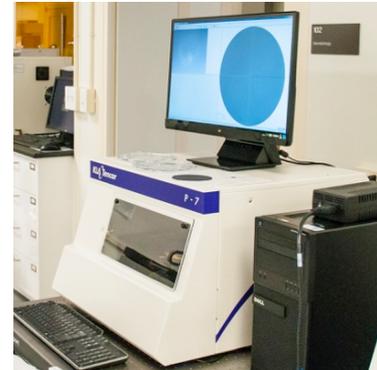
CNF 40th Anniversary Meeting & Workshop

- Workshop
- Future Fab in Biosciences; Future Enabling Technologies ; Trends in Nanoscience
 - Post Moore's Law Scaling
 - C as the new Si
 - Sensors and signal transduction
 - Digital agriculture
 - Integration with living systems – goal sets length scale
- Comments focused on:
 - Biology
 - New materials
 - Integrated design – heterointegration



New Tool and Process Highlights: Tools

- New KLA-Tencor P7 Profilometer
- EverBeing EB-6 Electrical Probe Station
- Bruker QUANTAX 200 EDS – x-ray spectrometer for elemental mapping
- Metricon Prism Coupler
- Edge Bead Removal System



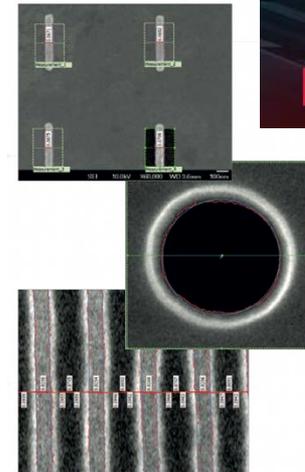
New Tool and Process Highlights: Coming Soon

- **OEM Group Endeavor ML Dual Cathode S-Gun Piezoelectric Deposition system (Sc-AlN) (1Q 2018)**
- **Newly designed YES image reversal vacuum oven with redundant valving (4Q 2017)**



New Tools and Processes: Upgrades

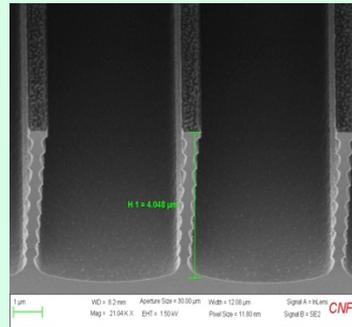
- JEOL JBX 6300 Ebeam (Beta) Scripting Language Interface
- Cadence Software Design Suite
- GenISys ProSEM added for SEM analytics



New Process Highlights

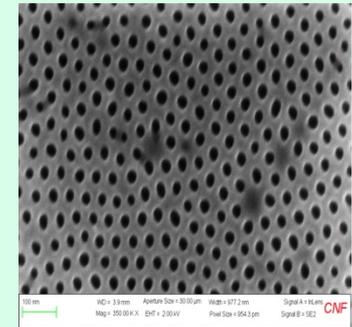
Nanoimprint for Deep Si Etching

UV-NIL (UV curable resist) Microresist Technology (mr-XNIL26) using Nanonex NX-2500 & Plasmatherm SLR DRIE



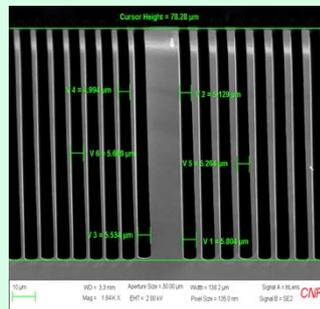
Block Co-Polymer process

Polystyrene/PMMA system (P8205-SMMA) for quasi-periodic 29nm holes



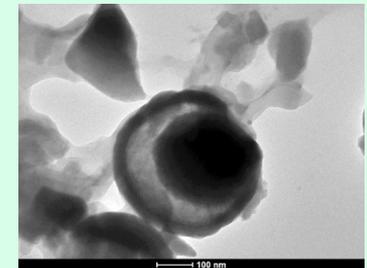
Deep Germanium Etch

Bosch process adapted to etching of Germanium
Applications to Xray Optics



Nano particle Production and Coating

Nanoparticles solution phase synthesis TiO₂, Pt with controlled size (50nm - 10μm)



ALD Coating with Al₂O₃

New Capabilities: NanoBiotechnology Merger

- **NBTC Core Characterization facilities managed by CNF**
- **NanoParticle Characterization:** Malvern Zeta Sizer, Malvern NanoSight
- **Planar Measurement:** EP3 NanoFilm Ellipsometer, DekTak profilometer, Rame Hart Contact Angle Goniometer
- **Thin Films:** SCS Parylene Labcoter, CHA Mark50 Evaporator, Samco UV Ozone Cleaner
- **Cantilever Fabrication:** Baltec 8" Critical Point Dryer,
- **μFluidics:** Olympus Inverted Microscope

NBTC Equipment is Now Managed by CNF, CCMR, and the BRC Imaging Facility

We Welcome New & Former Users!

FOR ACCESS AND TRAINING CONTACT:

*Biotechnology Resource Center
(Imaging and Cell Culture Mini-Courses)
<https://cores.lifesciences.cornell.edu/userdev/newuser.php>*

*Cornell Center for Materials Research
(Imaging and Material Analysis)
<http://www.ccmr.cornell.edu/facilities/becoming-a-cmr-facility-user/>*

*Cornell NanoScale Science & Technology Facility
(Particle and Surface Analysis)
http://cnf.cornell.edu/cnf_steps_secondfloor.html*

The CNF recently assumed many tools and some lab space from the Nanobiotechnology Center. CNF has created a new second floor training procedure for researchers who would like to use these tools. See the URL above.

If you have any questions regarding the NBTC closure, please contact Brian Bowman at nbtinfo@cornell.edu

CNF
Cornell NanoScale
Science and Technology Facility



CHA Mark 50 Evaporator

- E-beam thin film deposition system*
- Lift-off or conformal metal deposition with up to fifty-seven 4-inch wafer capacity
- Heated substrate option provides temperature range 20-500°C
- Metals available include:
Ag, Al, Au, Cr, Ta, Ti, Pt, Ni, Cu, Ta, SiO₂, Ge

What Is It?



*This plate full of holes is a **Planetary Evaporator Wafer Holder** for the CHA evaporator.*

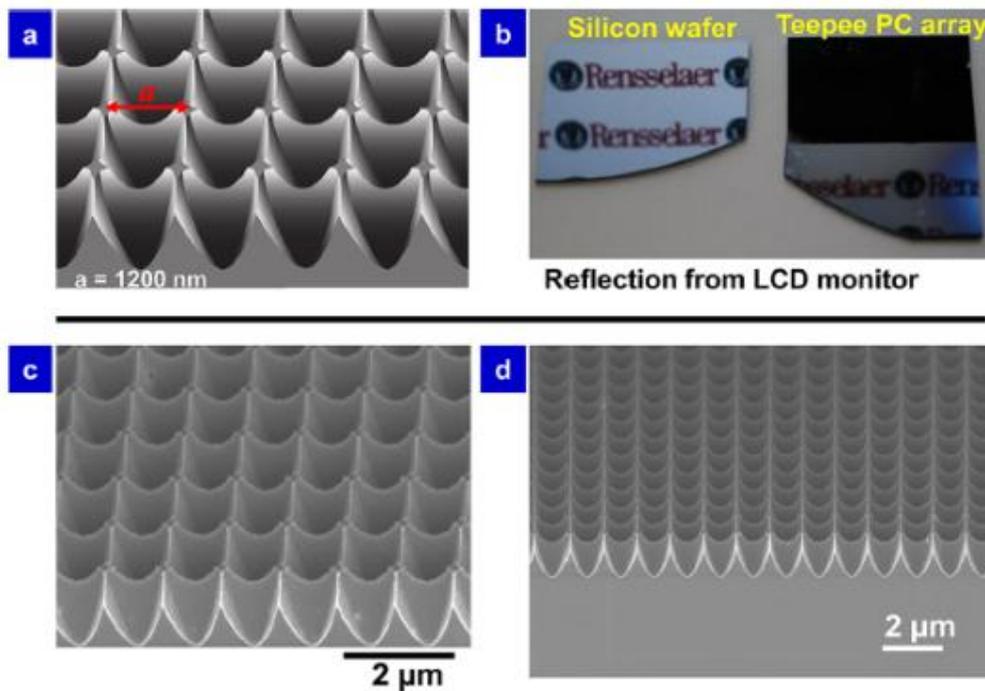
The holder makes it easy for researchers to deposit metal layers on up to fifty-seven 4" or twenty-four 6" wafers at a time.

** See posters further down this hallway that explain electron beams and thin films!*

Research Highlight:

Nanostructures Enable More Efficient Light Harvesting

In **ACS Nano**, the Lin group at Rensselaer Polytechnic Institute in collaboration with researchers at the University of Toronto and National Chiao-Tung University used the Cornell Nanoscale Facility to create a teepee-like photonic crystal (PC) structure on crystalline silicon (c-Si) designed to fulfill two critical criteria in solar energy harvesting through a (i) its Gaussian-type gradient-index profile for excellent antireflection and (ii) near-orthogonal energy flow and vortex-like field concentration via the parallel-to-interface refraction effect inside the structure for enhanced light trapping. Depending on PC thickness, the capture of weakly absorbing wavelengths is significantly increased and angular dependence measurements show that the high absorption is sustained over a wide angle range ($\theta_{inc} = 0-60^\circ$) for teepee-like PC structures.

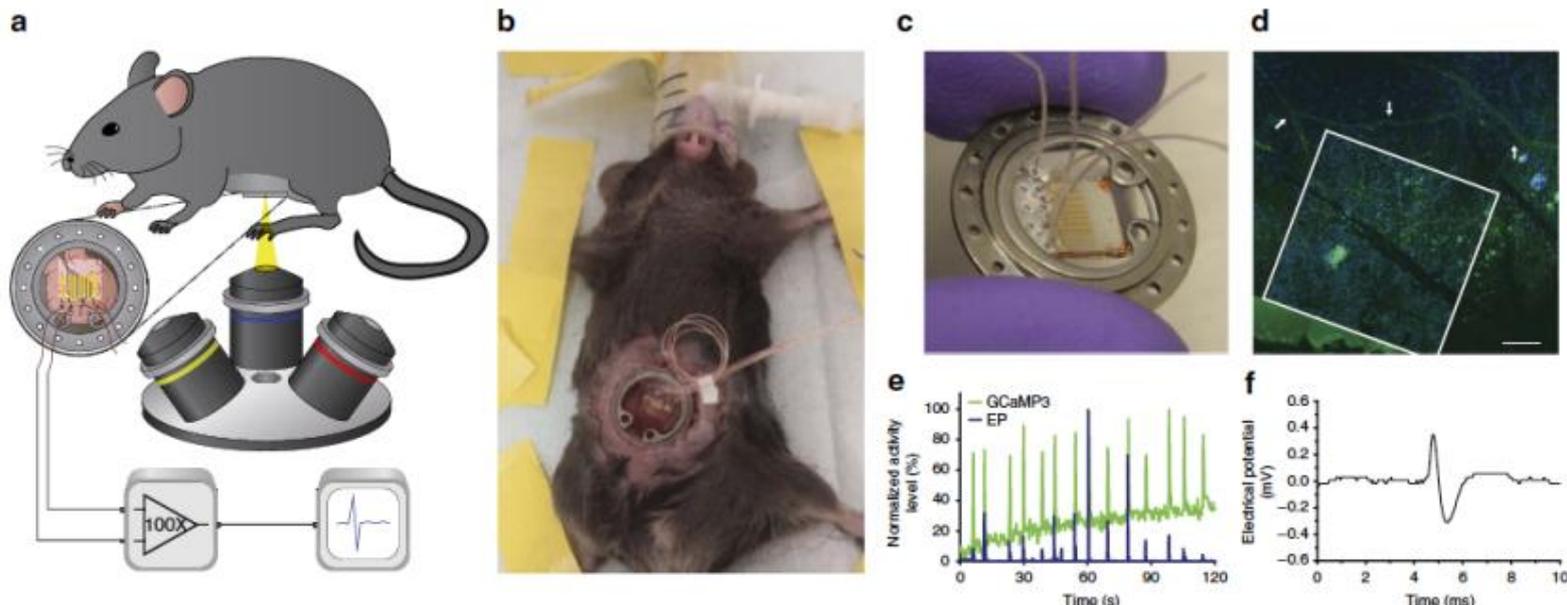


Received IEEE
Pioneer Award in
Nanotechnology

ACS Nano 2016,
10, 6116-6124

Research Highlight: Enteric Nervous System

In **Nature Communications**, the Shen group and colleagues at Cornell University in a highly collaborative project with researchers from Duke University, the Johns Hopkins University and the Howard Hughes Medical Institute used the Cornell Nanoscale Facility to create a graphene sensor on an abdominal window made from borosilicate glass for surgical implantation. The enteric nervous system (ENS) is a major division of the nervous system and vital to the gastrointestinal (GI) tract and its communication with the rest of the body. Unlike the brain and spinal cord, relatively little is known about the ENS in part because of the inability to directly monitor its activity in live animals. In this study researchers integrated a transparent graphene sensor with a customized abdominal window for simultaneous optical and electrical recording of the ENS in vivo. The implanted device captured ENS responses to neurotransmitters, drugs and optogenetic manipulation in real time.



Nature Communications, | 7:11800 | DOI: 10.1038/ncomms11800 |

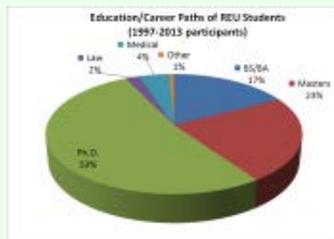
Education and Outreach Activity

REU

- Since 1990
- Five CNF REU students (summer 2017)
 - 11 additional REUs adopted from other programs



- Longitudinal tracking of NNUN/NNIN/NNCI REU students since 1997
 - Continuing project
 - Cooperation appreciated
 - 53% Ph.D. achieved



International

- Cooperative programs with the National Institute for Materials Science and the Nanotechnology Platform-Japan
 - Since 2008
- 6 NNCI REU “alumni” to NIMS for summer
 - Separate NSF Funding
 - From 5 different NNCI Sites



- 4 Nanotech Platform students to NNCI Sites, coordinated by Cornell
 - Texas, Louisville, RTNN, ASU

Thank You!

Nanooze

Nanooze in Print

- Science “news magazine” with nano emphasis
- Issue 15: Environment
- >100,000 copies per issue printed
 - Distributed at CNF/NCI events
 - Distributed by others at events
 - Direct mailed in classroom packs to over 2000 classrooms
- Over 1.5 Million total copies distributed (14 issues)



Nanooze at DisneyWorld

- NSF supplement to update Nanooze exhibit at Disney World into the NSF Disney Science Portal
- 100s of thousands of visitors per year



Nanooze On-line

www.nanooze.org

- Blog
- Interviews
- Articles



Education and Outreach: Community Activities

Partner with NYS 4-H for content distribution and on-campus events



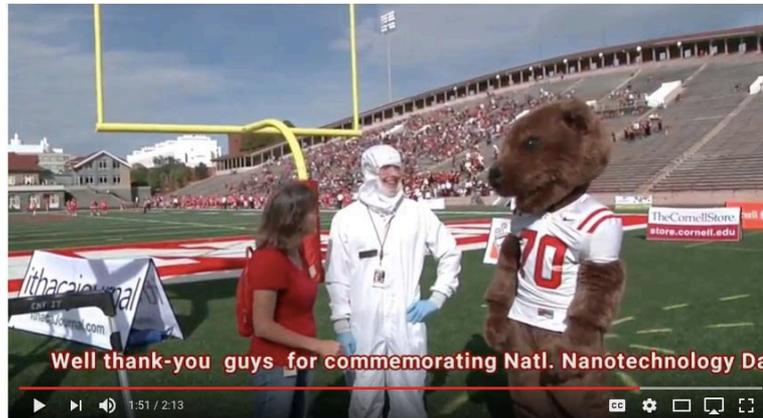
CNF's TCN Short Course

- Introductory nanotechnology mini-course offered semiannually.



Figure 1: TCN Laboratory Activity

Nanoday
Mascot Race:
Cornell's
Touchdown
vs researcher

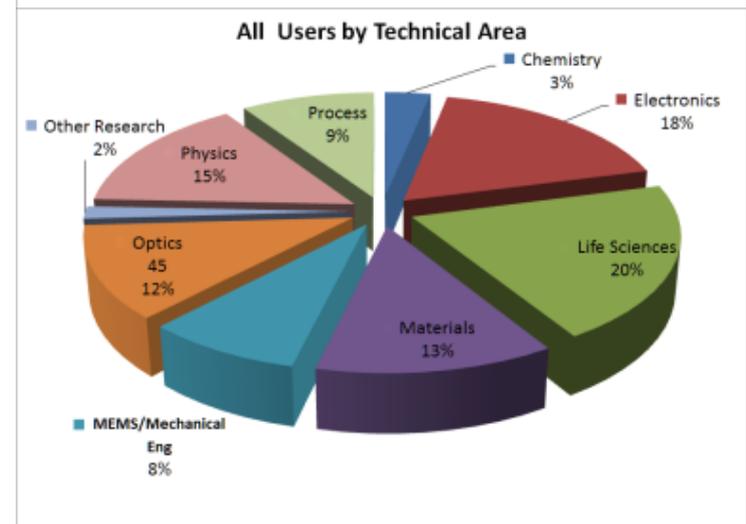
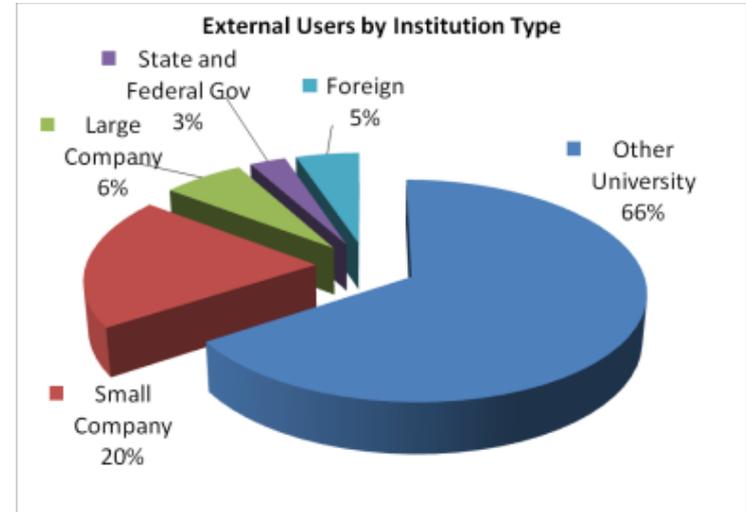


CNF Fellows and Ambassadors

- Students meeting the public and carrying out research for improved tool use

User Statistics: CNF

- 544 users last year
- 538 users to date this year
- ~40% external users
- 66% of external users are academic
- 20% external users from small companies and startups
- Largest user group is life sciences
- Followed by electronics, materials, physics and optics
- By NNCI definitions: 53% Non-traditional users
- \$1.4 million in new equipment



Partnerships & Commercialization

Company News:

- 4 start ups since NNCI award (18 months)
- NYS FuzeHub Manufacturing Innovation Grants;
 - 1 award (Xallent-CNF partnership)
 - 1 pending application
- 2 StartUp CNF Awards – NYS funds – e.g. Ultramend
- 2 Commercialization Foundry Partners
 - http://www.cnf.cornell.edu/cnf_stctoolmap.html
 - http://www.cnf.cornell.edu/cnf_novatitoolmap.html

Key Partnerships:

- JEOL – electron beam lithography
- GenlSys – CAD
- Oxford Instruments – Plasma Processing & ALD
- SÜSS – Alta Spray, SCIL
- PARADIM – NSF funded material innovation platform, a materials user facility



As an early start-up, every dollar counts and the CNF matching grant enables UltraMend to further our product development leveraging the CNF's usage-fee model enabling us to spend our money testing prototypes not on upfront capital equipment expenditures.

Regards, John Phillips

Network Activities

- Working closely with NNCI coordinating office at Georgia Tech
- Working group participation
 - **REU Working Group** - Chaired by Rathbun (CNF); Mallison (CNF) lends experience
 - **Reactive Ion Etching/Plasma Processing Working Group** - Chaired by Genova (CNF); workshop held at Cornell University on May 24-25, 2016; 12 NNCI sites attended.
 - **E-beam Lithography Working Group** - Cornell actively participates
- Sub-committee participation
 - **Global and Regional Interactions (GRI) Subcommittee**
 - CNF organizes NNCI international student activities
 - Ober and Tennant visiting NYS universities to communicate capabilities of NNCI
 - **Diversity Subcommittee**
 - Sharing best practices
 - At Cornell
 - Working with Engineering Diversity office to introduce underrepresented students to nanoscience
 - Building relationship with Morgan State University (Former Cornell ECE faculty member, M. Spencer, now Engineering Dean there)
 - Sending CNF ambassadors to NSBE and SHPE meetings to advertise NNCI and CNF
- Initiated ALD and SEM analysis software workshops and took part in those from other sites
 - Open to users and staff alike