



HARVARD UNIVERSITY  
Faculty of Arts and Sciences



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John A. Paulson School of Engineering and  
Applied Sciences



# Harvard University: *Center for Nanoscale Systems*

*NNCI Annual Meeting  
Spring FY17*





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*Epicenter for Nanoresearch at Harvard: LABORATORY FOR  
INTEGRATED SCIENCE AND ENGINEERING*



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## FY17 Activities

- **CNS** is a one-stop shop for all things “Nano”
- **CNS** is a important regional, nanoscience community resource
- **CNS** have initiated new training and educational programs to engage larger numbers of undergraduates, non-traditional, and underserved external users, in nanofabrication, advanced characterization and advanced imaging techniques.
- **CNS** has developed a number of new experimental platform expanding our experimental capabilities; (example, Scanning probe spectroscopy platforms.)
- **CNS** offered support for new faculty recruiting and hosting an array of distinguished visitors.



**Robert Westervelt**  
Director



**William L. Wilson**  
Executive Director



Center for  
Nanoscale  
Systems  
Harvard University



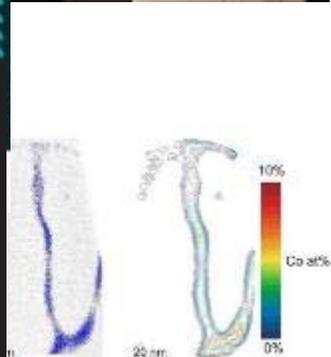
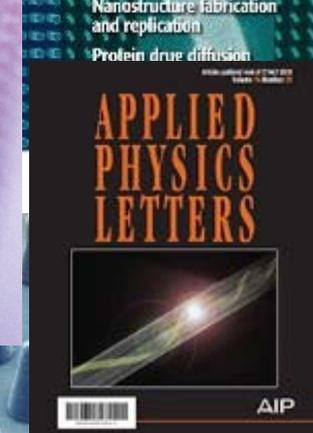
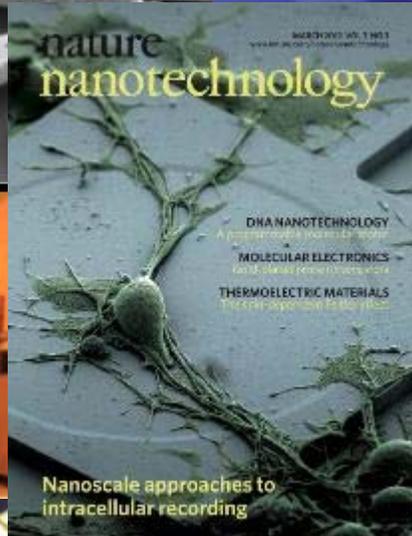
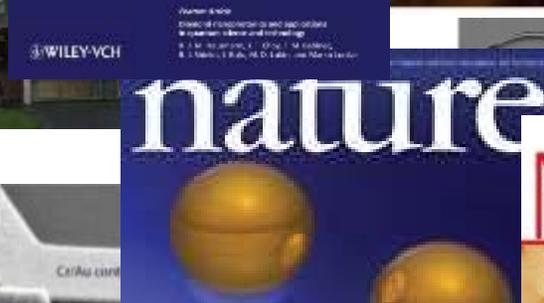
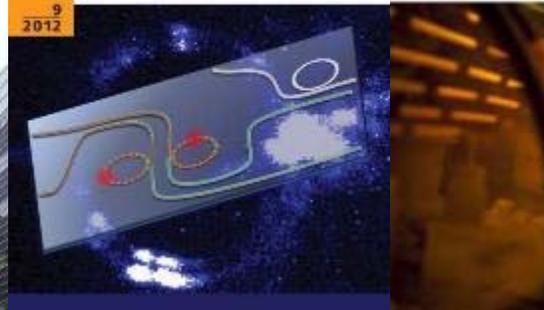
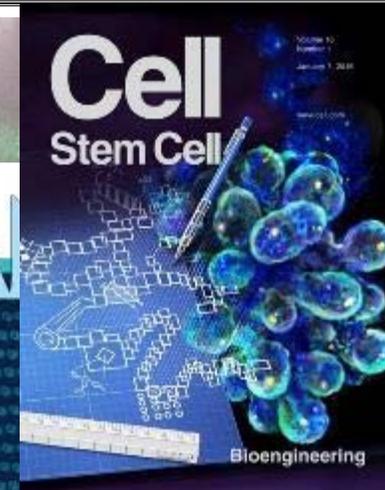


Two Primary Cores: Nanofabrication / Nanoscale Characterization  
Enabling scientific excellence



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## Focus and Logistics



### *The Mission at CNS:*

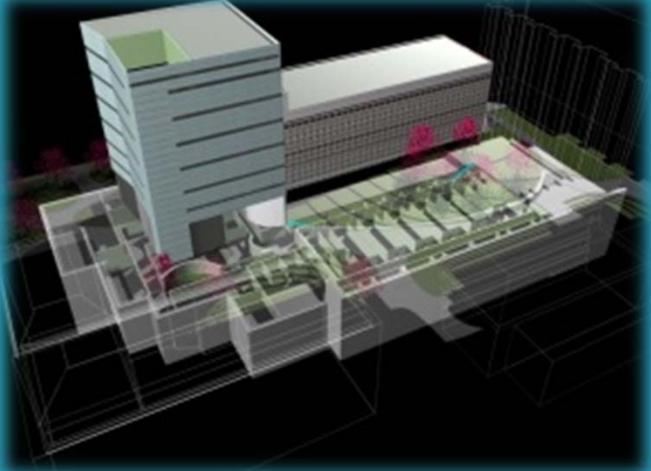
To evolve and nurture one of the most comprehensive nanotechnology research communities in the world. Supporting the development of new materials and devices.

#### **Nanofabrication**

- Component driven
- Complete lithography tool set
- Non-traditional materials
- Multiple length-scales

#### **Electron Microscopy/Analysis**

- Advanced Tools
- Core expertise in CryoTEM
- Atom Probe tomography



#### **LABORATORY FOR INTEGRATED SCIENCE AND ENGINEERING (LISE):**

- ❖ 10000 ft<sup>2</sup> Cleanroom
- ❖ 6000 ft<sup>2</sup> Hi-resolution EM Imaging Suites
- ❖ 3000 ft<sup>2</sup> Cell Culture Lab
- ❖ Soft lithography/BioMaterials Lab
- ❖ Optical Spectroscopy Lab
- ❖ Scanning Probe Microscopy Lab



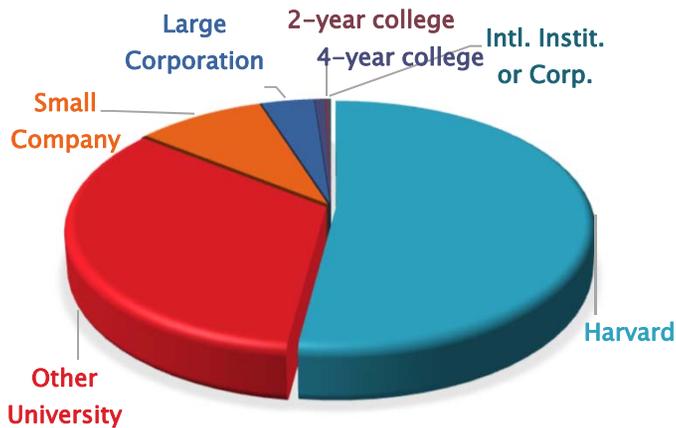


# General User Statistics

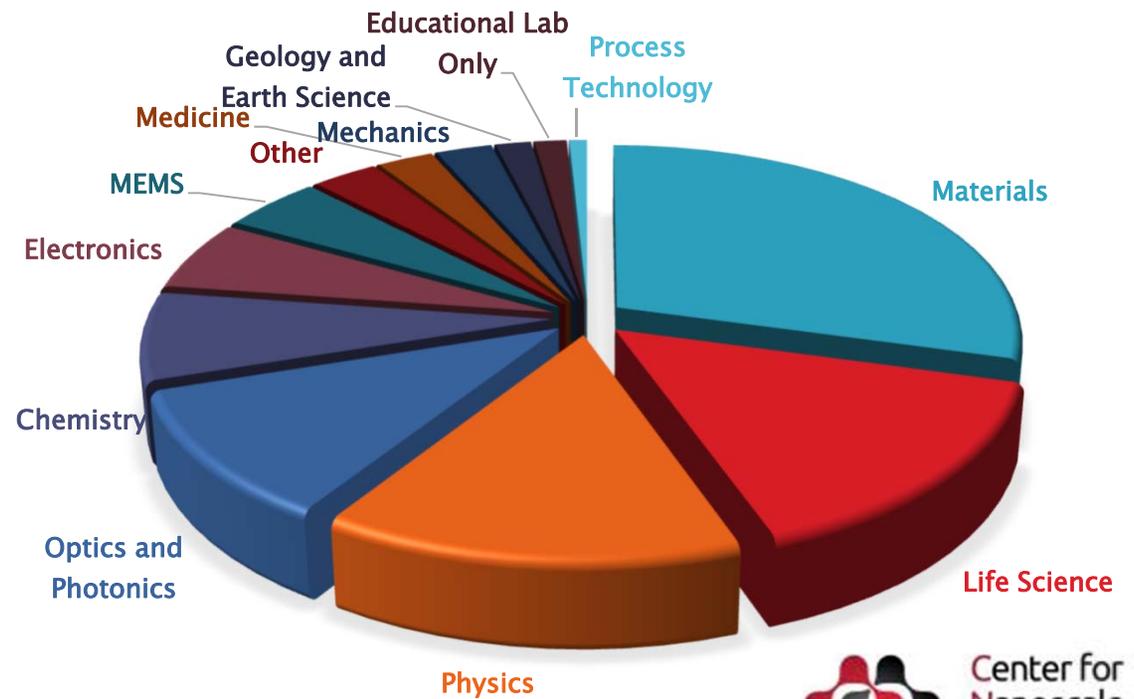


- >1600 current users
- >195,000 hours of use
- >30 fulltime Staff
- Multidisciplinary userbase

### USERS BY INSTITUTION



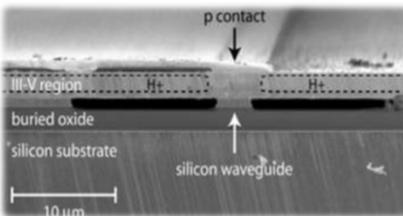
### USERS BY DISCIPLINE





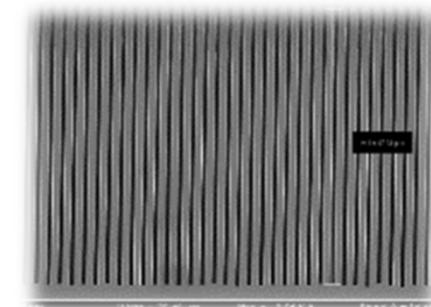
# Our Mission at CNS:

We curate one of the most comprehensive developmental nanotechnology tool sets in the world.



## Nanofabrication

- Component driven
- Complete lithography tool set
- **Unique materials**
- **Multi-scale (nm - Micron)**
- **Soft Lithography**



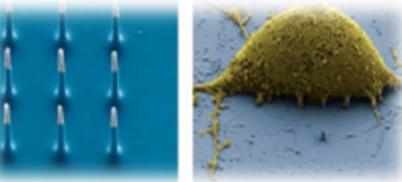
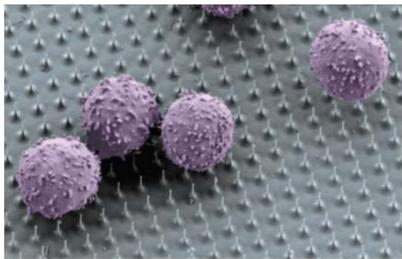
*We ensure we have the tools to optimize flexibility and encourage innovation!!*





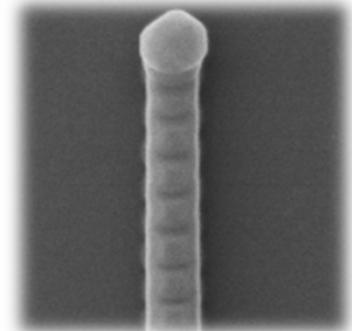
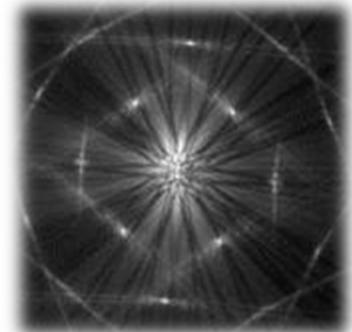
## Our Mission at CNS:

We are evolving one of the most comprehensive nanotechnology imaging resources in the world.



### Electron Microscopy/Ion Imaging

- High-Res Tools
- Core expertise in CryoTEM
- Atom probe



*We have the tools to support High-performance electron microscopy of hard and soft systems.*





# CNS Research: Peer Benchmarks



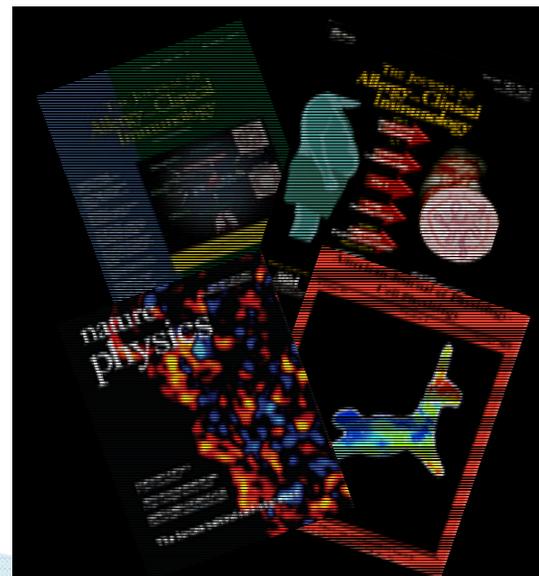
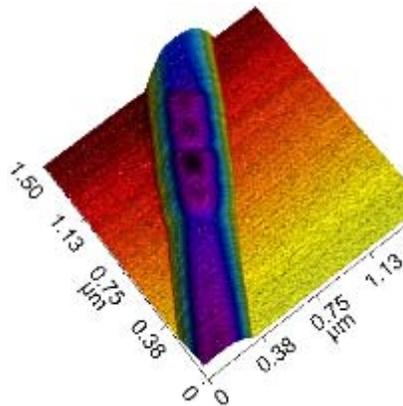
*\*CNS efforts Drive impactful research!*

## CNS Citation Statistics, 2008-2017 (Harvard top 6 Users only)

# papers by CNS top 6: **1,053**

# of cites to these papers: **47,395**

Ave. cites per paper: **47.39**



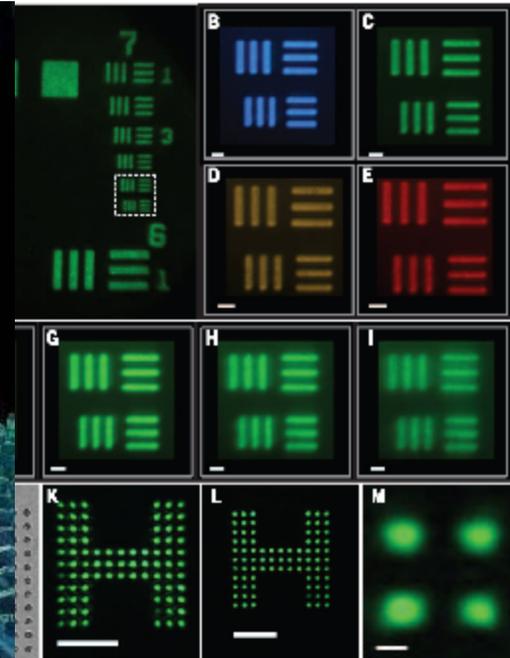
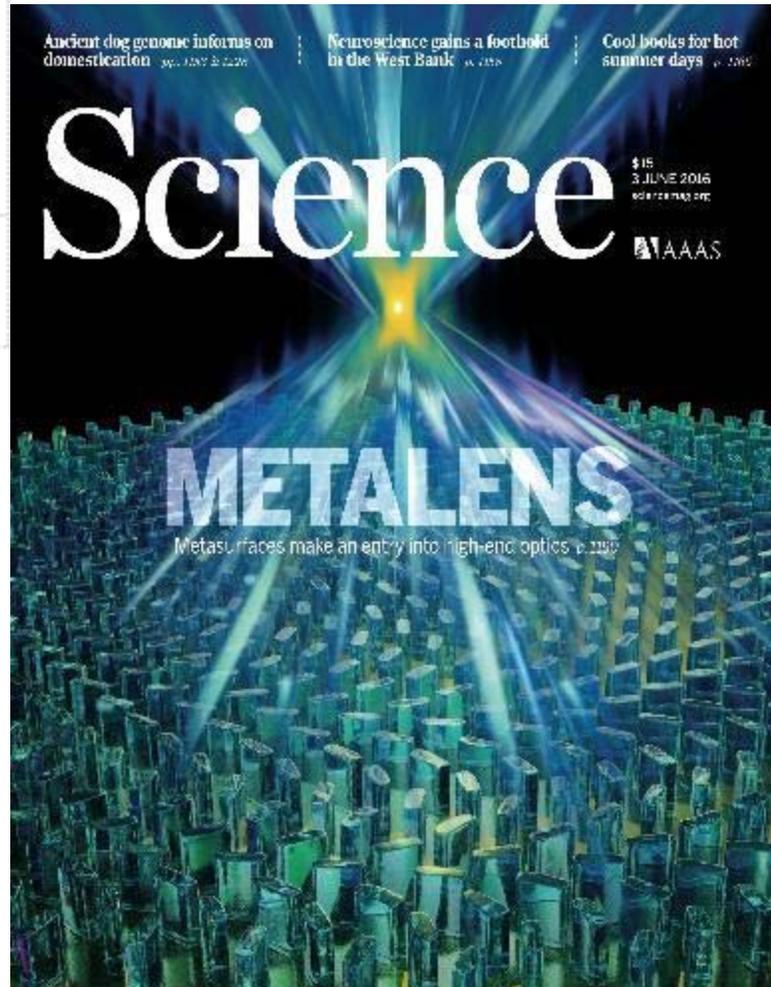
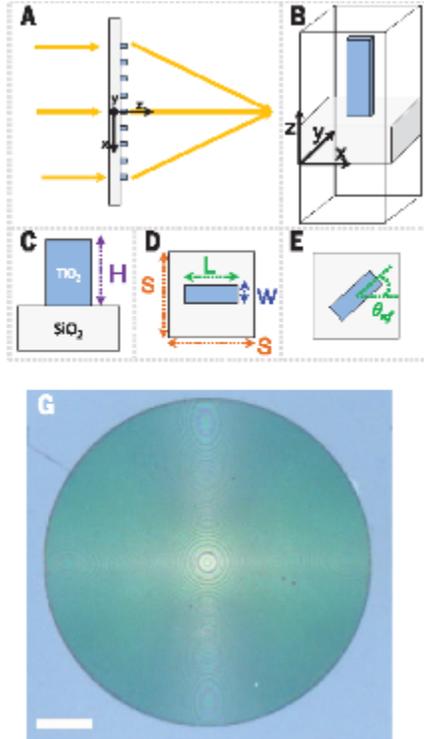


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# Example: $TiO_2$ "Nanofin" Meta Optics



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F. Capasso, et al





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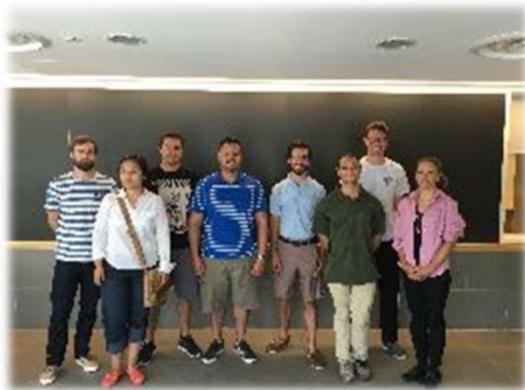
## REU / REV / CNS Scholars



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*First summer with new educational Initiatives; NNCI Enabled*

**REU** – conventional program but now locally managed  
**Research Experience Veterans** – *staff served as mentors*



**\*CNS SCHOLARS PROGRAM** – Advanced research opportunities for Grads, Post Docs, and Junior faculty from 2 and 4yr institutions

*\*The goal of Scholars is more “advanced” training, more sophisticated research opportunities with outside JR Faculty*





## *CNS* Hosting of Community Visitors



CNS has hosted a number of visitors both  
Local and international

- Potential Faculty Candidates
- Community Business Associations
- Management of other Core Facilities
- International Visitors
- Student Groups
- Local Companies- AMD / Draper Labs

\*Fidel Castro Díaz-Balart -  
(Vice-president of the Academy of Sciences of Cuba)





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## NSF / OTHER SYNERGIES



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Programs to engage life science users:  
Partnership with Catalyst offering  
instrumentation/ fabrication  
funding for Translational Bioscience  
Research using CNS

Partnership with NSF STC: CQIM, offering  
instrumentation/ complex fabrication  
expertise.



Sponsored by Reactor, a Harvard Catalyst program  
**Up to \$50,000 in pilot funding**

**FUNDING OPPORTUNITY**

**Big Ideas, Small Features:  
Utilizing Advanced Microscopic  
and Nanoscale Technologies**

Calling all researchers interested in utilizing state-of-the-art microscopes and/or nanoscale technologies at the Harvard Center for Biological Imaging (HCBI) and the Center for Nanoscale Systems (CNS) to innovate clinical healthcare.

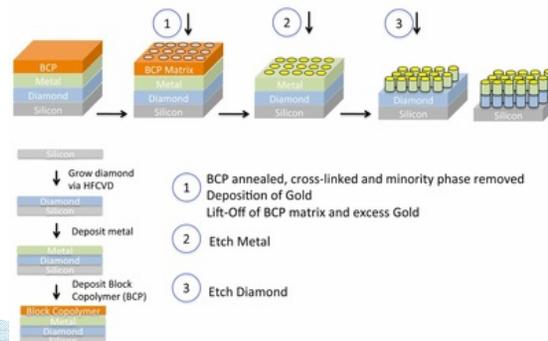
**TO LEARN MORE & APPLY**

**You *must* attend an educational event:**  
**April 4 or April 11**  
**2:30pm-5:30pm | Biological Laboratories, Cambridge**

**For more information & to register for an event:**  
[bit.ly/hcmicronano](http://bit.ly/hcmicronano)

Established in 2005, Harvard Catalyst | The Harvard Clinical and Translational Science Center is dedicated to improving human health by enabling collaboration and providing tools, training, and technologies to clinical and translational investigators. As a shared enterprise of the University, Harvard Catalyst is funded by the NIH, Harvard University, and its affiliated healthcare centers. Resources are freely available to all Harvard faculty and trainees, regardless of institutional affiliation or academic degree.

Nano-Sized Diamond Pillars: Approach 1





## Summary of our Laboratory Focus\*:

- ✓ Primary *Ecosystem* for all things Nano
- ✓ Nanofabrication – New Materials – Multi-lengthscale
- ✓ Tools shaping and processing of next generation materials
- ✓ Ultra-High Resolution Electron Microscopy (CryoTEM)
- ✓ Advanced Materials and Device characterization at the nanoscale

*We are an R&D resource to the entire nation  
and are expanding efforts locally and globally*





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Thank you!

CNS offices:  
All are welcome!!  
*We are ready to engage*

