



# Research Triangle Nanotechnology Network: An Interdisciplinary Innovation Hub

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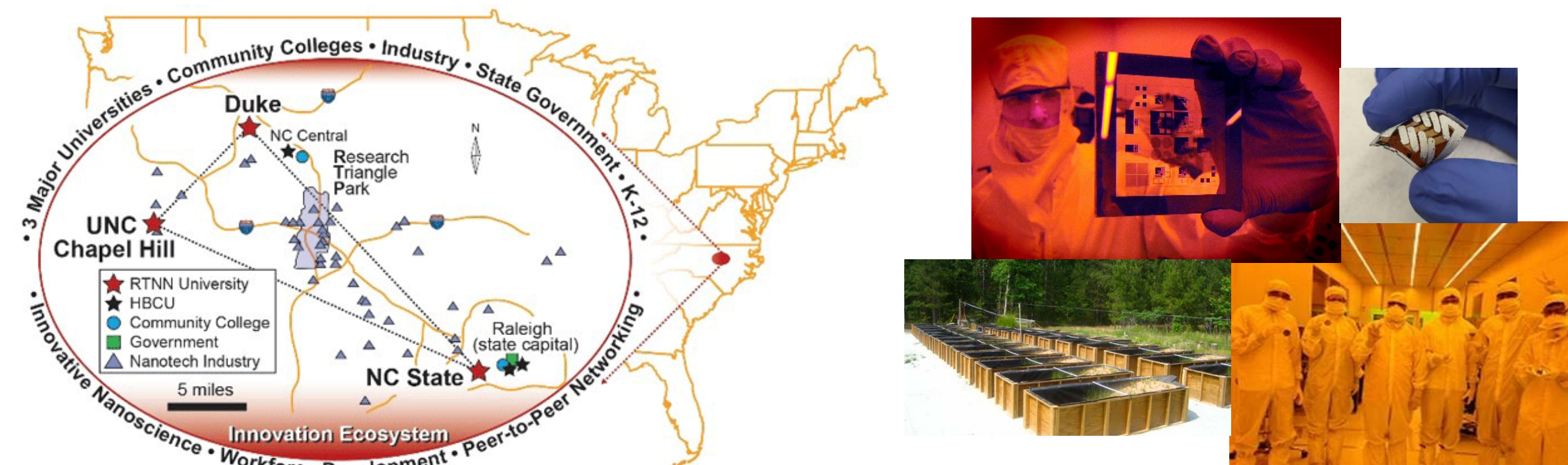
A site in the **National Nanotechnology Coordinated Infrastructure (NNCI)** supported by Grant No. ECCS-1542015.



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## Overview

RTNN serves as an **interdisciplinary innovation hub** for transformative nanotechnology research, fabrication, commercialization, and education by leveraging the capabilities and expertise of **9 user facilities** at research universities in the Research Triangle.

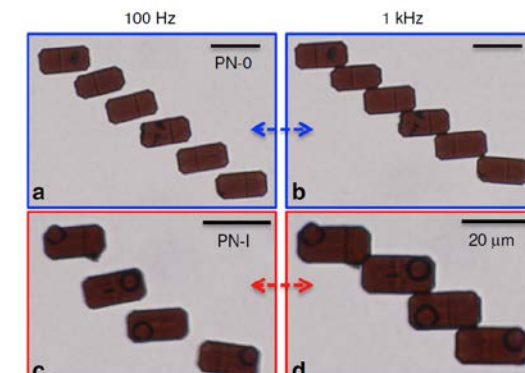


## Core Strengths

- Turn-key and dynamic facilities**
  - >1,300 users and >55,000 hours of collective use annually
  - >39 new tools introduced into facilities since 2016
- Unique capabilities**
  - Bio-processing bays, functionalization of fibers and textiles, hot embosser, X-ray and neutron imaging, positron annihilation lifetime spectroscopy, *in situ* microscopy and diffraction, mesocosms
- Well-supported faculty research in nanotechnology**
- Large non-traditional, multidisciplinary user community**
- Well-established user base in traditional technologies**
- Expertise in emerging needs and capabilities**
  - Non-traditional characterization and fabrication (e.g. soft, bio-based, and flexible materials)
- Capacity for technology transfer**
  - Research Triangle Park, 4<sup>th</sup> largest nano-metro area in the U.S., NC State's Centennial Campus
- Quantitative social science research**

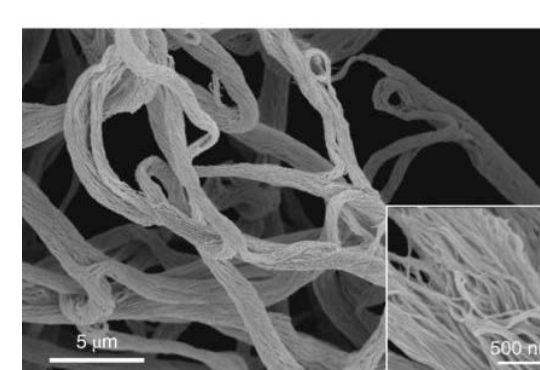
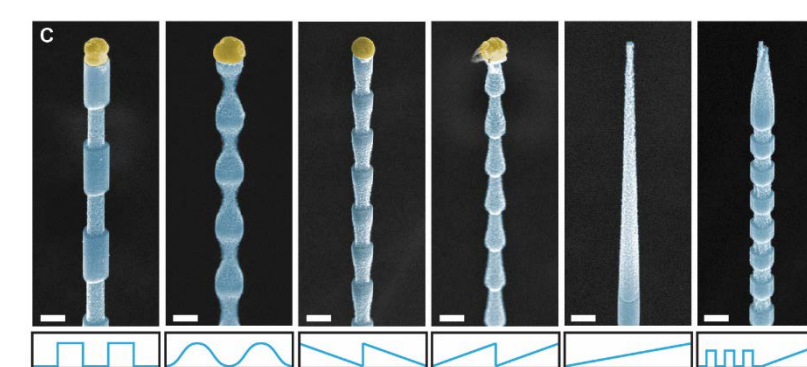
## Nano-Technical Focus Areas

- Interfaces, Metamaterials, Fluidics, and Heterogeneous Integration**
- Organic and Inorganic 1- and 2-D Nanomaterials**
- Nanomaterials for Biology and Environmental Assessment**
- Textile Nanosciences and Flexible Integrated Systems**



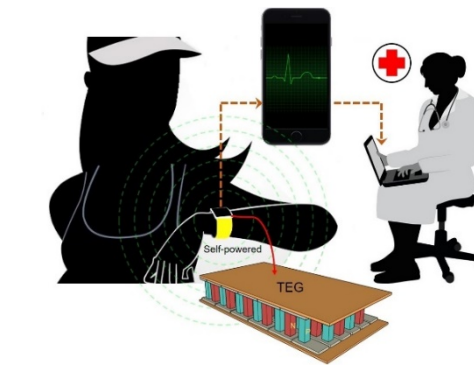
Dynamically reconfigurable active thin film silicon microparticles

Synthesis of 3-dimensional silicon nanostructures



Genetically encoded lipid-polypeptide hybrid nanomaterials

Low-power wearable systems for continuous monitoring of environment and health



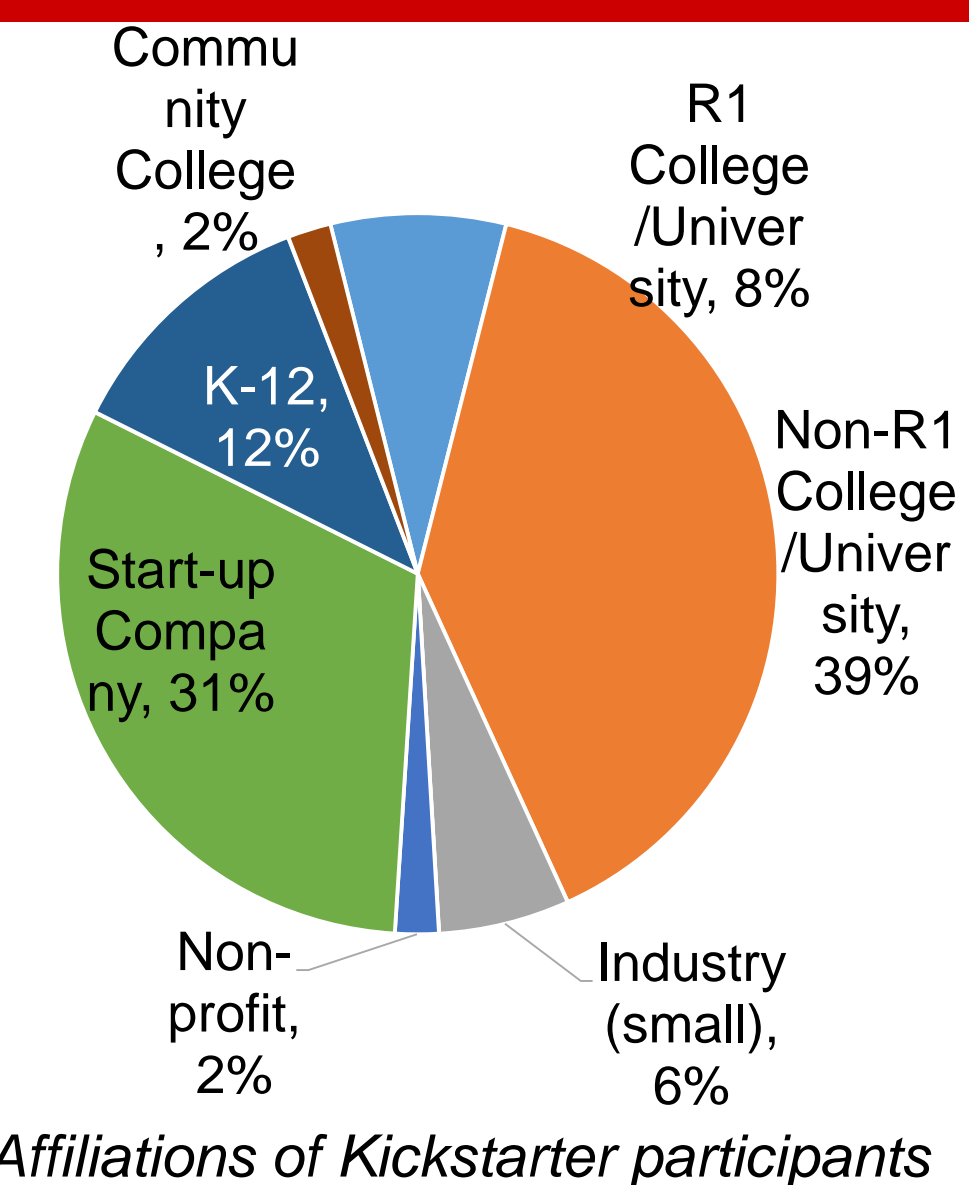
## Building the User Base

### Kickstarter Program

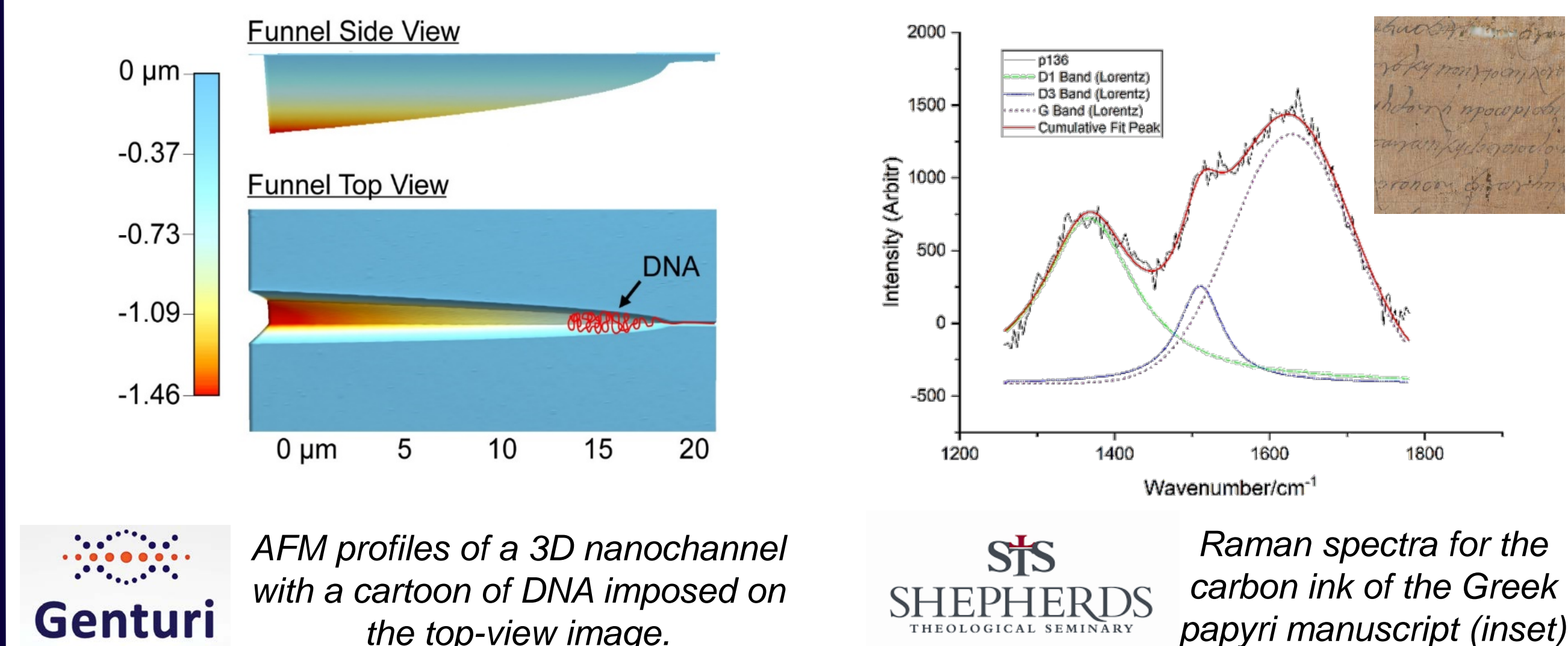
- Provide *free* access to facilities to new, non-traditional users
- 52 projects** and (>1,100 hours of use)

*"...there's a small group of us that are out trying to develop new ideas and kind of unconventional ways to do things. So I'm already telling them about [the Kickstarter Program]."*

*"Making these facilities accessible is critical for a small startup, where dollars are limited but enthusiastic users are not."*

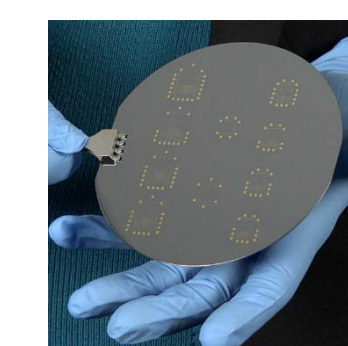


### Selected Participant Results

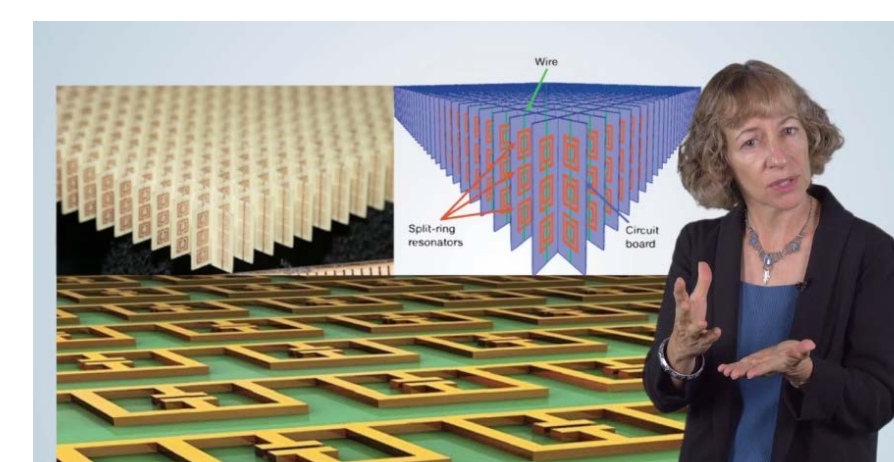


### Nanotechnology: A Maker's Course

- Massive Open Online Course** (hosted on Coursera)
- Educational foundation in nano-fabrication and characterization
- Demonstrations of state of the art equipment
- Since September 2017 launch:**  
**>21,000 visitors; >9,000 enrolled**



*"I like the speaker very much, I hope I can be a scientist like her."*



Introductory lecture on nanofabrication



Demo of energy-dispersive X-ray spectroscopy

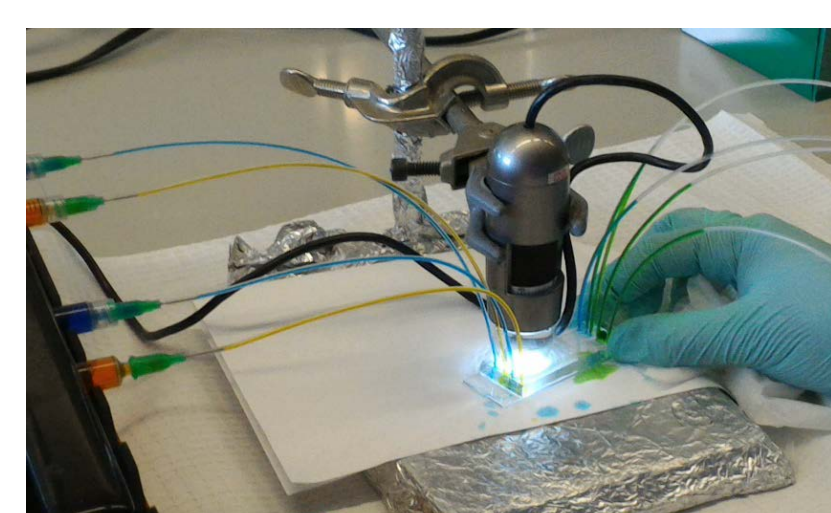


Photolithography demo in the clean room

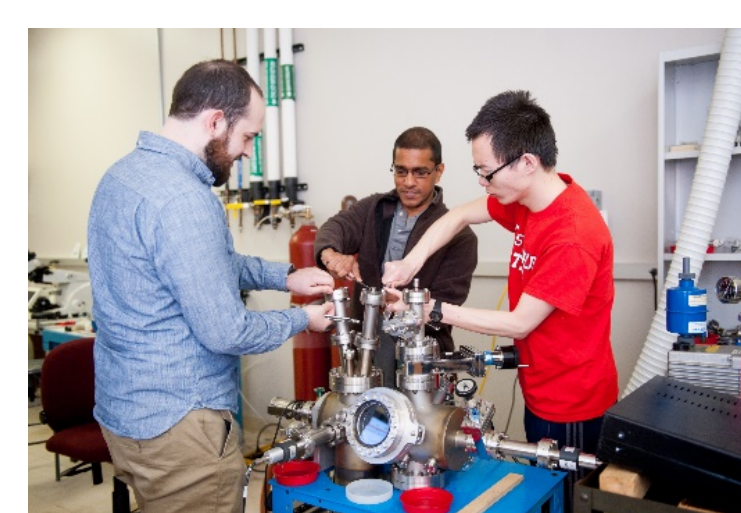
[www.coursera.org/learn/nanotechnology](http://www.coursera.org/learn/nanotechnology)

### Technical workshops and short courses

- Exposure to cutting-edge equipment and techniques
- Hands-on learning experiences prepare participants for use
- 2017-2018: 31 events, >250 participants**



Microfluidic device created during a workshop



Participants working on a vacuum system



Community college educators gowning for clean room entry

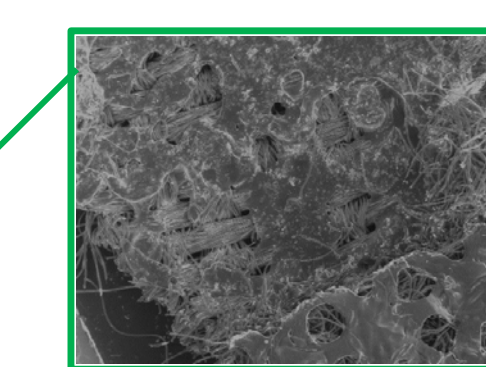
## K-12 Engagement

- Immersive lab experiences** with hands-on time using tools
- Remote connections** to instruments, students, and staff in the facilities
- Classroom visits** with portable SEM
- Lesson plans** linked to educational standards
- Partnerships** with Girl Scouts and local libraries
- NanoDays:** lab tours, demos, and hands-on activities

Micrographs of a student sample: a Bandaid



Light Microscope



Scanning Electron Microscope



Middle school students using the portable SEM in their classroom



Girls Scouts learn how to operate an SEM during Girls STEM Day @ Duke



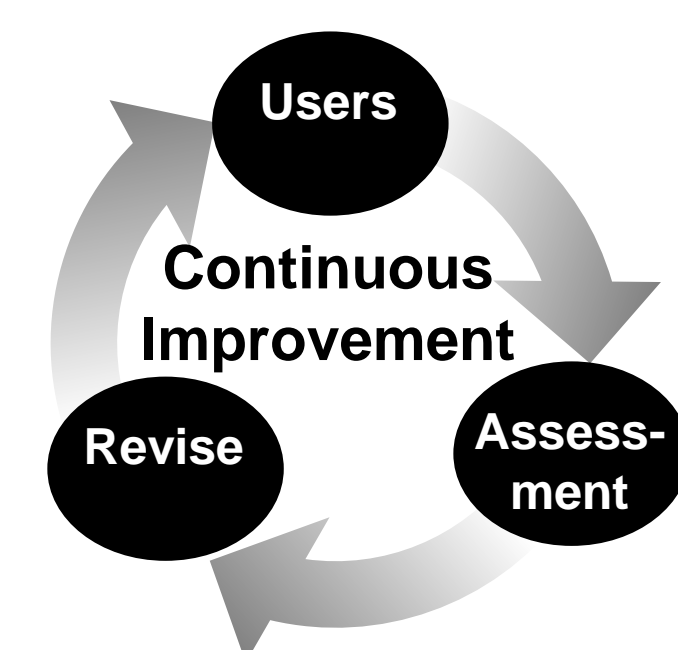
Kids try various nano activities at the Chapel Hill Public Library on National Nanotechnology Day

**> 4,900 people reached in Year 3**

**> 60% participation by girls and underrepresented minorities in STEM**

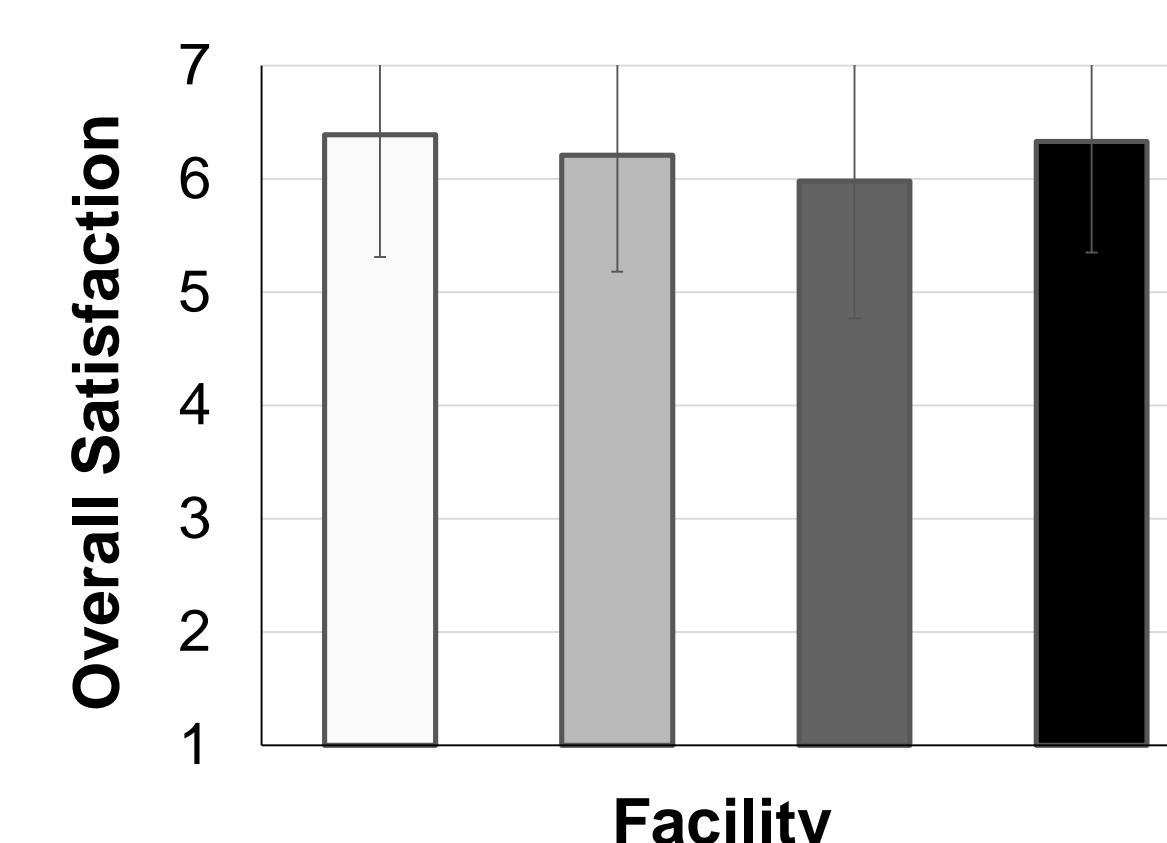
## Social and Ethical Implications of Nanotechnology

- Deep assessment**
  - Quantitative evaluation of user programs drives change
  - Evaluation determines, e.g., the effectiveness of **Kickstarter program** at recruiting participants as long-term users



### Overall Satisfaction in Facilities

- Measured on Likert scale (1-7) where 7 = very satisfied
- Satisfaction ratings at one facility did not meet peers'.
  - Led to a change in leadership, renovations, and restructuring of facility resulting in increased user satisfaction



### Nanotechnology resources for the public

- Social media** to communicate nanotechnology information effectively
- Clearinghouse** of crowd-sourced information on nanotechnology innovation, research, and education



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