

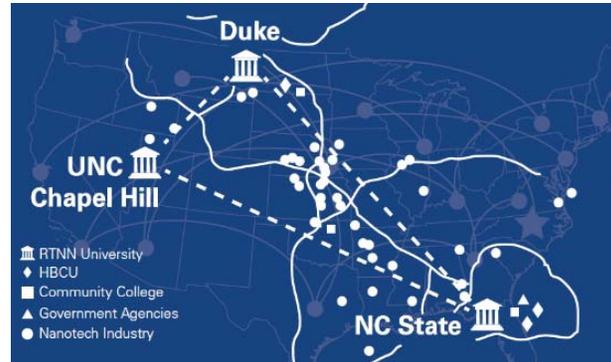
### **RTNN Executive Committee:**

Jacob Jones (NC State), David Berube (NC State),  
Nan Jokerst (Duke), Mark Walters (Duke),  
Carrie Donley (UNC-Chapel Hill), & Jim Cahoon (UNC-Chapel Hill)



THE UNIVERSITY  
of NORTH CAROLINA  
at CHAPEL HILL

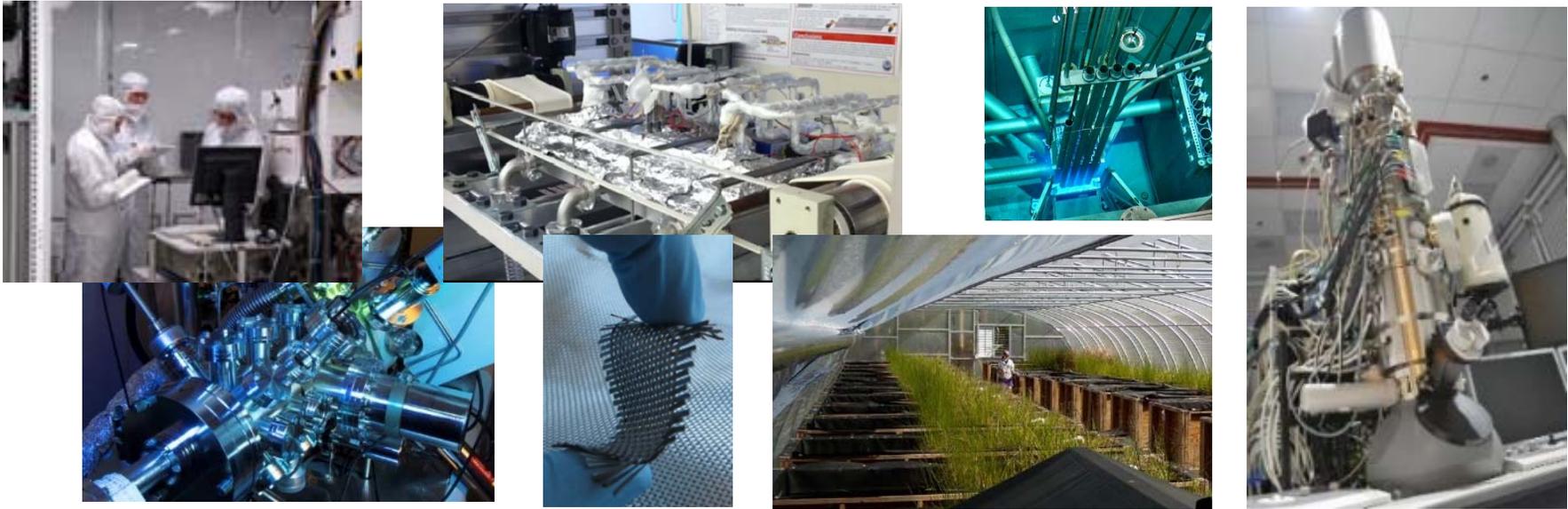
# ***The RTNN is an Innovation Hub that enables nanotech discovery, education, commercialization, and workforce development***



## Some Distinguishing Goals:

1. Dramatically **enhance access** of external industry, government, and academic researchers to university core nanotechnology facilities by **lowering barriers to use** of facilities e.g. cost, distance, and awareness
2. Develop new nanotechnology **tools, education, outreach, and workforce training** programs for industry, government, academics, students, and K-12
3. **Evaluate** the user base and the user program to institutionalize effective programs and drive change.

# RTNN Core Facilities



## **By the numbers**

**Core Facilities:** 9 core user facilities across 3 universities

**Tools:** >200 characterization and fabrication tools across >40,000 ft.<sup>2</sup> of space

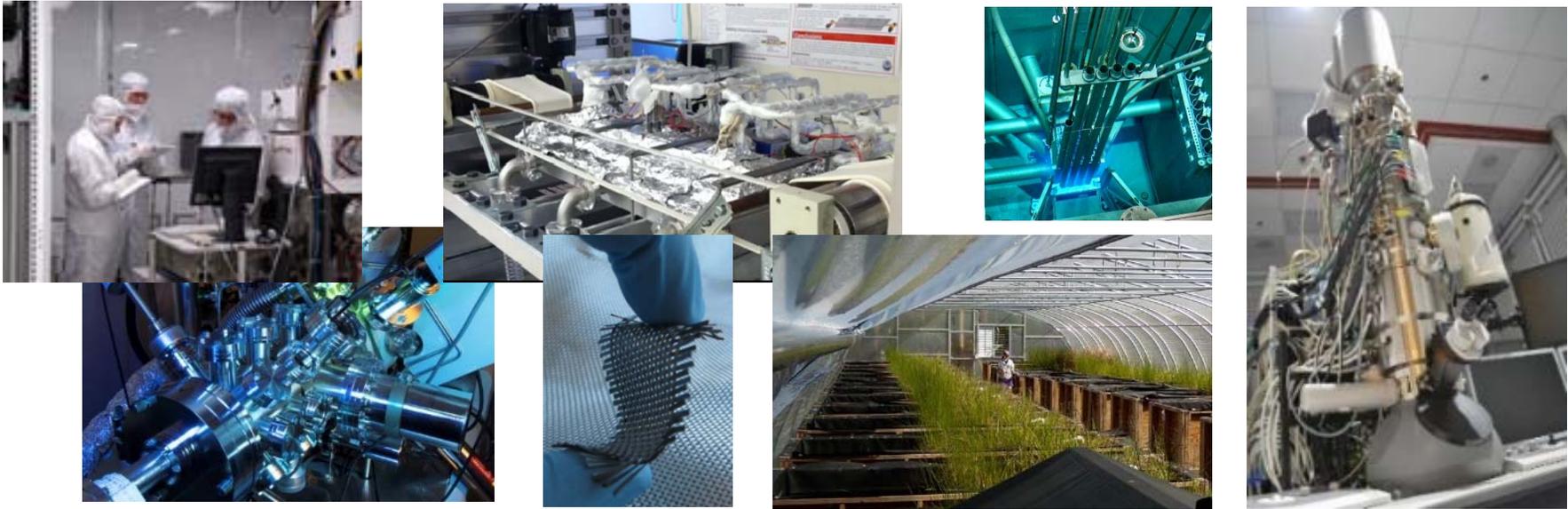
**Personnel:** 45+ technical staff to assist/create/develop

**Principal Faculty:** 100+ faculty working in related nanotechnology areas

**Use in Year 1:** >1,100 users in year one; >52,000 annual hours of collective use

**Diversity:** >50% facility use by non-traditional disciplines including Biology, Biomedical Engineering, Textile Engineering, Agriculture, Soil Science, Forest Biomaterials, Plant & Microbial Biology, ...>15% facility use by external users

# RTNN Core Facilities



## Nanofabrication

- **SMIF** (Director: Jokerst, 6 staff) - comprehensive nanofabrication and characterization facility
- **NNF** (Director: Muth, 4 staff) – nanofabrication facility
- **CHANL** (Director: Donley, 4 staff) – nanofabrication and analytical facility
- **Zeis** and **TexLabs** (Director: Rust) - textile processing shared facilities and education

## Environmental

- **CEINT** (Director: Wiesner) - environmental mesocosms to evaluate the effects of nanomaterials on environment

## Characterization

- **AIF** (Director: Jones, 7 staff) - characterization facility for both hard and soft materials with *in situ* expertise
- **DMRSC** (Director: Spicer) - Magnetic Resonance Spectroscopy Center
- **PULSTAR** (Director: Hawari, 12 staff) - neutron imaging and diffraction, neutron activation, and positron beams

# RTNN Reaches New Communities and Users

New engagement programs to address known barriers:

Cost, distance, awareness

*Free use for new, non-traditional users*

*Nanotechnology MOOC (Coursera)*

*Desktop scanning electron microscope*

*Electron Microscopes in K-12 Classrooms*

*K-12 tours and hands-on demos (e.g. NanoDays)*

*REU+ activities, links undergrads to facilities*

*Workshops for specific communities*

Community college teachers

Industry and business

*Peer-to-peer student networks*

Graduate student peer-to-peer staff



## K-12 & Outreach:

*> 1,800 people reached in first year*

STEM clubs, summer camps, classrooms

*> 50% from underrepresented groups*

Women in STEM, Minorities in STEM



# Free-Use of Facilities Program

## **Goal**

- Encourage facility use by new, non-traditional users
- Facilitate cutting-edge, transformative research

## **Provide funding for facility use and materials costs**

- Up to \$1,000 (at internal rate)
- Rolling applications

## **Types of projects**

- Proof-of-principle studies
- Specialized characterization or fabrication not currently funded
- Individual or group class projects



# Free-Use of Facilities Program

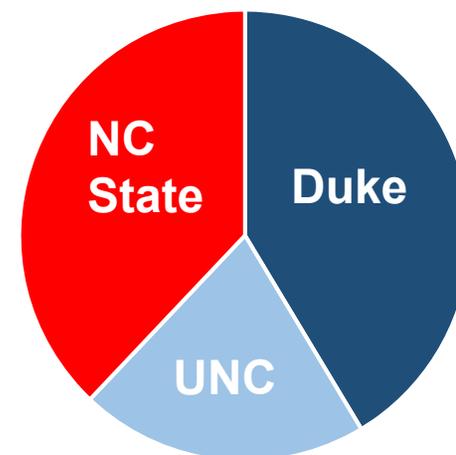
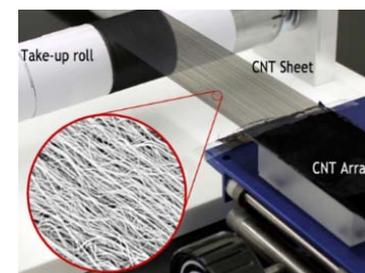
**29 projects selected (~\$27k value of access)**

## **Non-traditional users**

- Start-up companies
- HBCU
- Non R1 universities
- High school students and classrooms

## **Positive feedback**

- “Making these facilities accessible is critical for a small startup, where dollars are limited but enthusiastic users are not.”
- “The results may be instrumental in forming key ideas in a future grant proposal.”

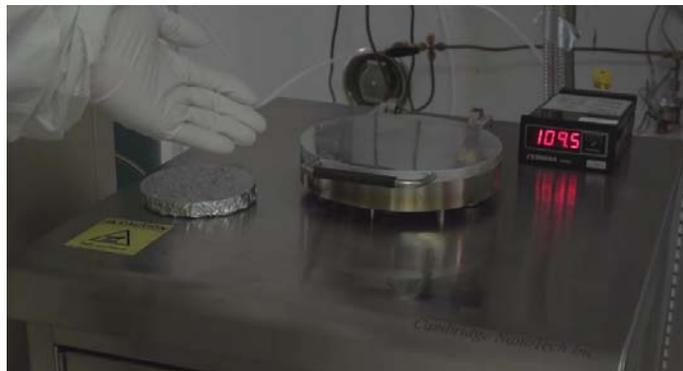


# Massive Open Online Course (MOOC)

## *Nanotechnology: A Maker's Course*



- Provide educational foundation in nano-fabrication and -characterization
- Easy to understand, scientific explanations
- In-lab demonstrations of state-of-the-art equipment
- Demo video on next slide!

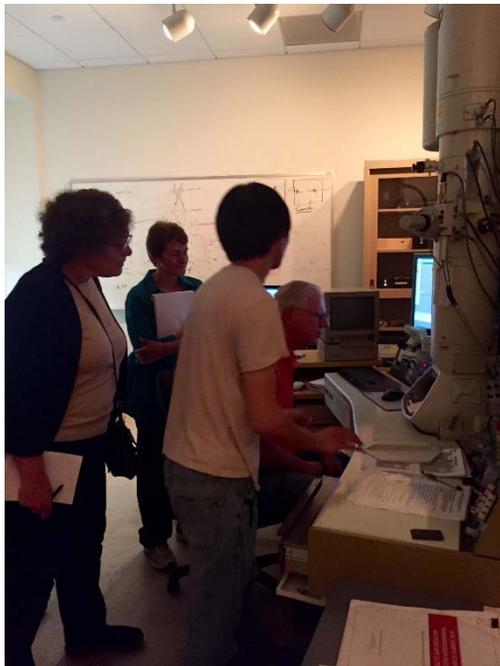




# Community College Workshop

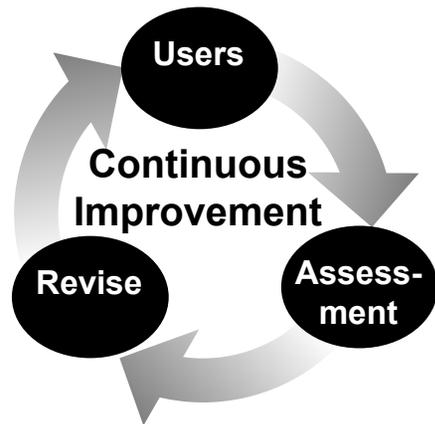
*Provide nanotechnology teaching materials to community college educators*

*Hands-on learning experiences*

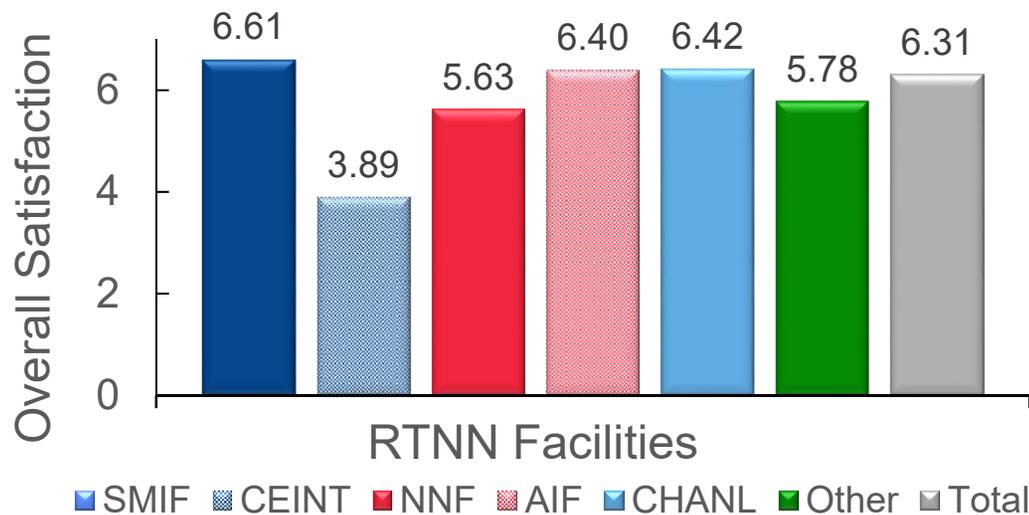


*“...gave me exposure to nanotechnology and sophisticated equipment and materials that most community college educators never encounter.”*

# Evaluation of the User Experience



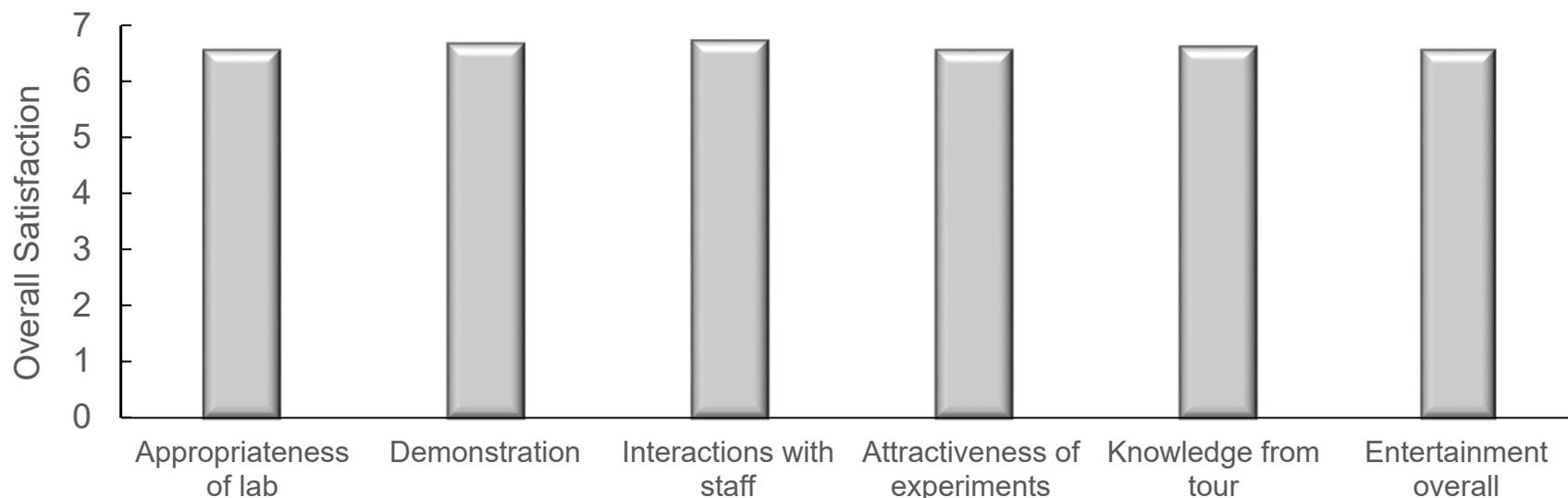
- Evaluation of user programs will **drive change**
- Determine, e.g., the effectiveness of **free use program** at recruiting long-term (returning) users
- IRB approval at all three institutions so we can undertake research on our users; user interviews with the social science team



Lab	N	SD
SMIF (Duke)	50	0.53
CEINT (Duke)	3	2.59
NNF (NC State)	22	1.30
AIF (NC State)	65	1.08
CHANL (UNC)	18	0.47
Other	3	1.58
<b>Total</b>	<b>161</b>	<b>1.06</b>

Note:  $F(5, 155) = 7.16, p = 0.000$

# Satisfaction Level for Outreach/Engagement



## ***Positive feedback***

- “The crew at CHANL was great...They were able to connect to middle schoolers without using the complex chemistry and physics needed to understand what was really occurring in the demonstrations. ”
- “...overall we had a fantastic time. We connected with researchers and staff and the students were fully engaged.”
- “Thank you for truly making us feel a part of the experience...”

# Communicating with the Public

## *Nanotechnology resources for the public*

- **Clearinghouse** of crowd-sourced information on nanotechnology and nanoscience innovation, research, and education
- **Public Alert Program** to assist the media in reporting nanotechnology events by providing remarks from experts to help contextualize these events.
- **Nanohype blog**: contemporary topics in nanotechnology

## *Social media campaign*

- **Raising awareness** through multiple distinct platforms
- Facebook, Twitter, LinkedIn
- In development: newsletter, Snapchat with geotags, Instagram



**@RTNNsocial**



# EXTRA SLIDES



# Research Triangle Nanotechnology Network

<http://www.rtnn.org>



*The RTNN is an  
Innovation Hub that  
enables nanotech  
discovery, education,  
commercialization, and  
workforce development*

**NC STATE**  
UNIVERSITY

**Duke**  
UNIVERSITY



THE UNIVERSITY  
of NORTH CAROLINA  
at CHAPEL HILL

# Large Non-Traditional User Community

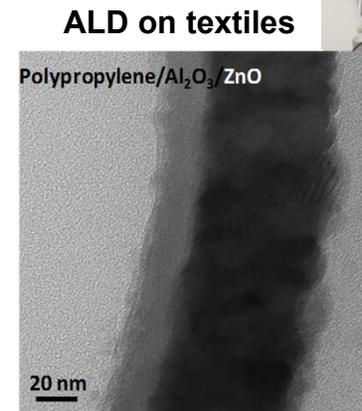
Designed intersection of traditional and non-traditional areas – *fosters breakthroughs*

**Non-traditional user communities (>50% of users)**

**Soft, wet, bio-based, flexible materials**

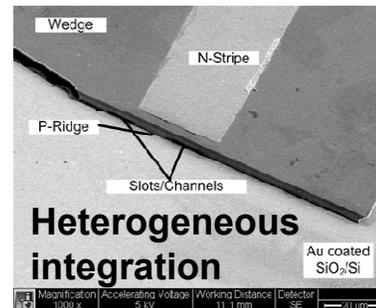
- Forest Biomaterials
- Tissue Engineering
- Biomedical Nanoparticles
- Textiles
- Environmental Engineering (CEINT)
- Marine, Earth, and Atmospheric Sciences
- Food, Bioprocessing, and Nutrition Sciences

Biochemical Conversion of Cellulose to Bio-Plastic

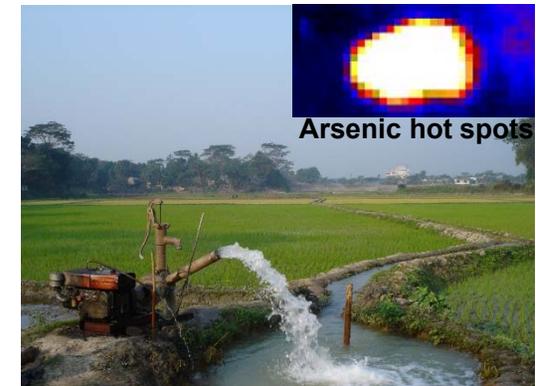


**Traditional user communities**

- 2D and 3D materials
- Semiconductors, esp. GaN-based
- Heterogeneous Integration
- Metamaterials
- Photonics, Photovoltaics
- Fluidics

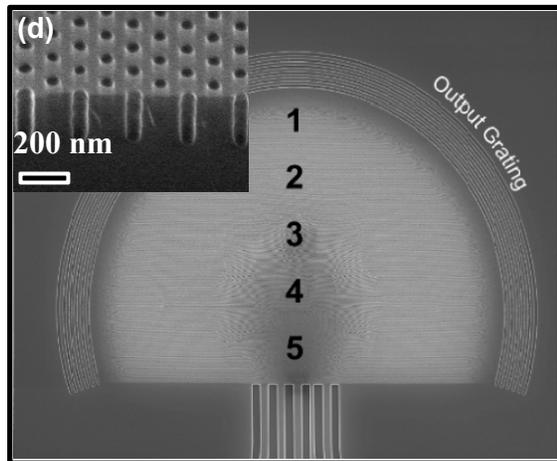


Controlling Arsenic uptake, storage, and release in Bangladesh rice fields

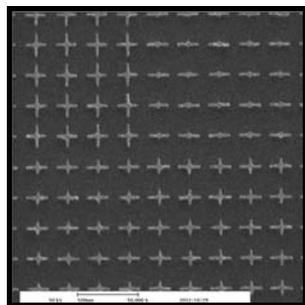


# Nano Technical Focus Strengths

## Interfaces, Metamaterials, Fluidics, and Heterogeneous Integration

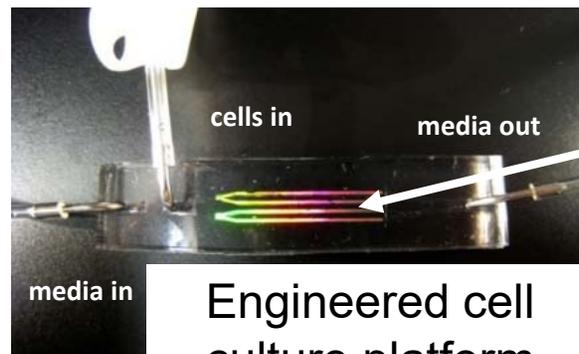
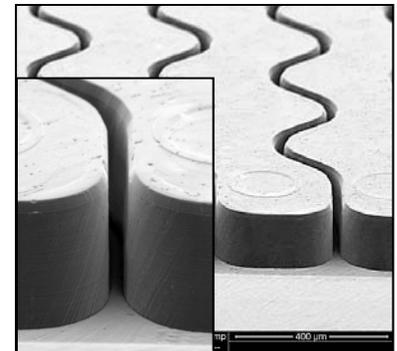
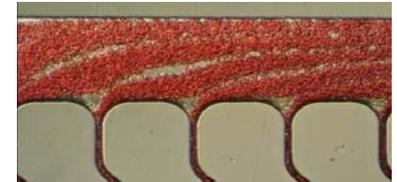


2D SOI nanostructured metamaterial

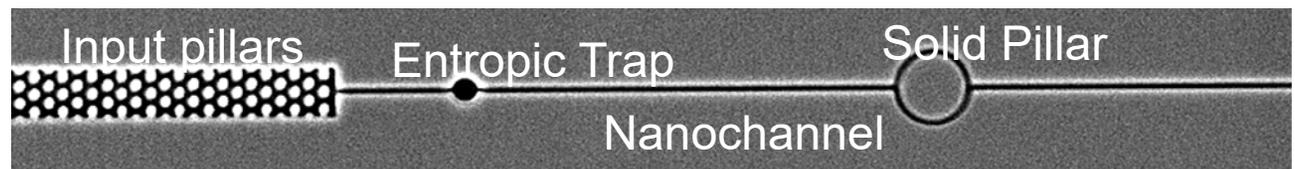


3D stacked nanostructured metamaterial

A microfluidic chip for the isolation of circulating tumor cells from whole blood.



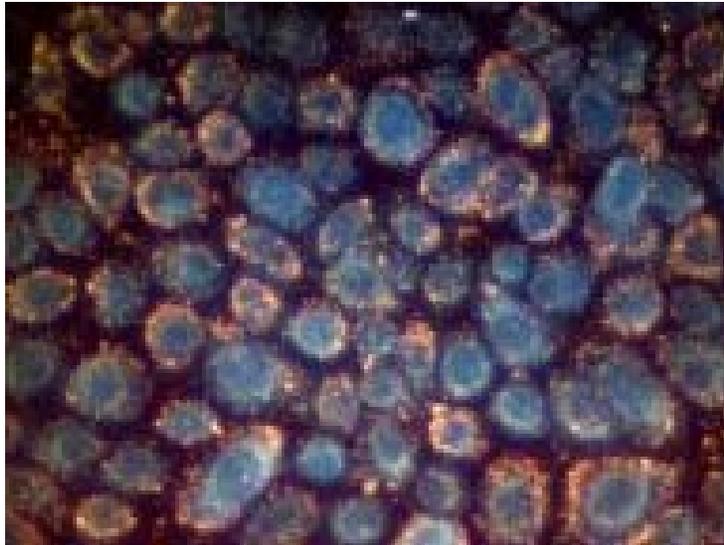
Engineered cell culture platform



50 nm x 50 nm nanochannel on a nanofluidic chip made via imprinting and used for transporting single DNA molecules.

# Nano Technical Focus Strengths

## Nanomaterials for Biology and Environmental Assessment

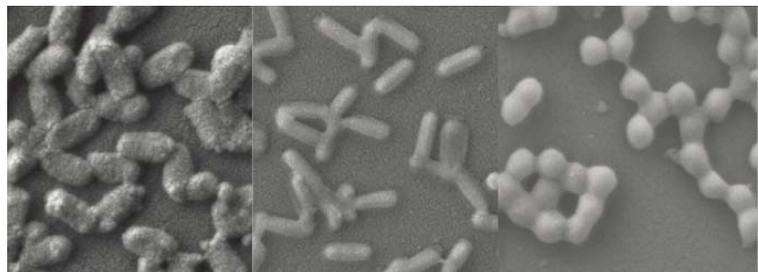


Nanoshell photo-assisted therapy for cancer treatment

CEINT Mesocosm Boxes

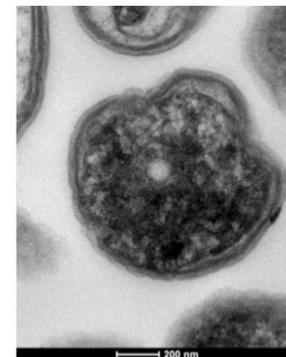


CEINT will be made newly available to external users through the RTNN

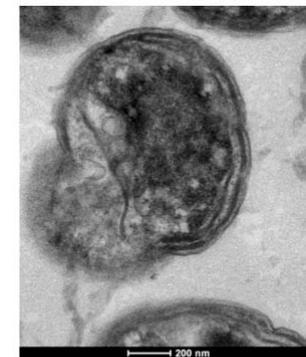


Nanoparticle drug delivery

Affect of Ag nanoparticles on *Nitrosomonas europaea*



Control

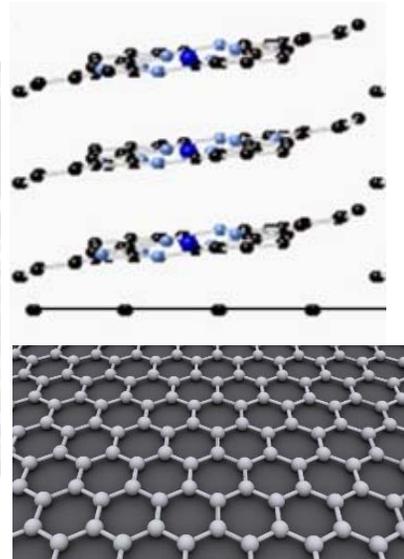
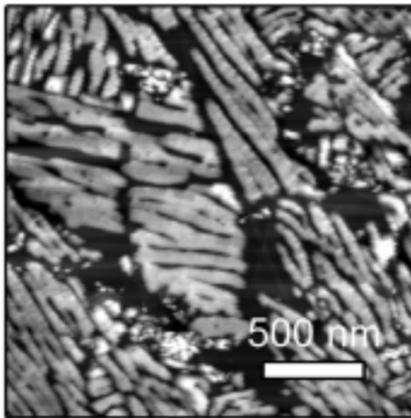


2 ppm Citrate AgNP

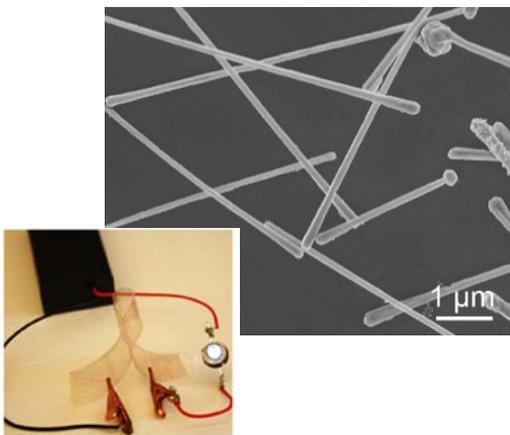
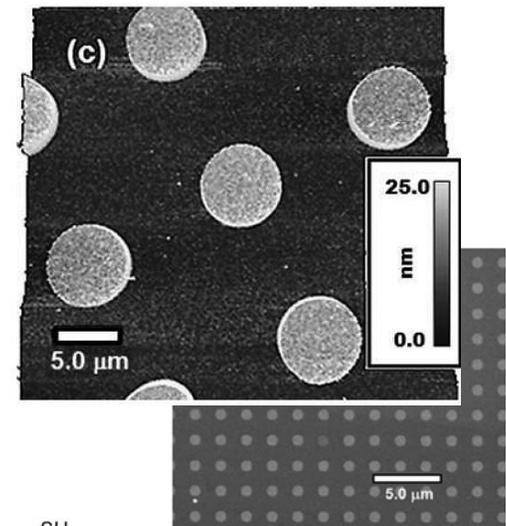
TEM Images of *Nitrosomonas europaea*

# Nano Technical Focus Strengths

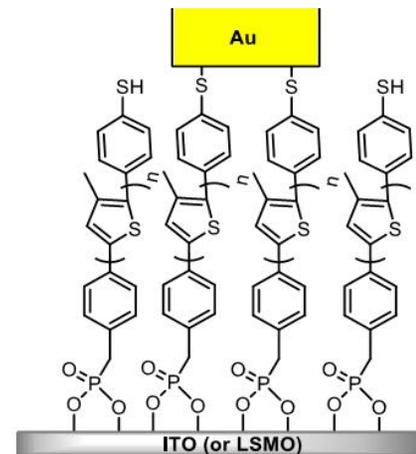
## Organic and Inorganic 1- and 2-D Nanomaterials



Hybrid graphene-carbon 2D electronics



1D copper nanowires for transparent 2D electrodes

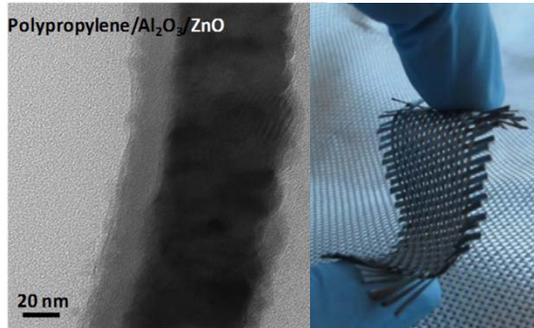


Molecular electronics using conjugated assemblies

# Nano Technical Focus Strengths

## Textile Nanosciences and Flexible Integrated Systems

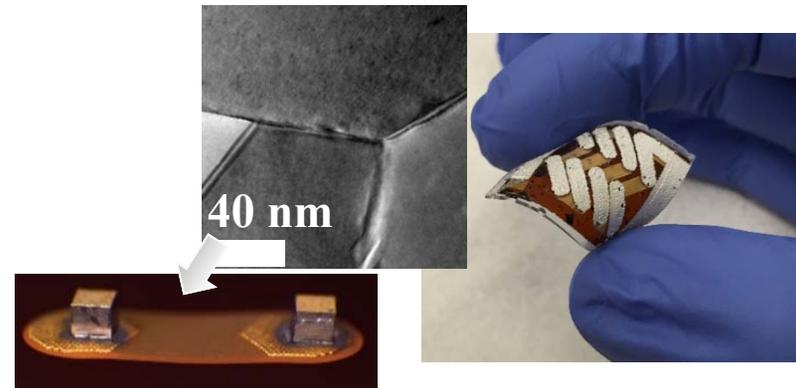
*The Textiles industry in the U.S. employs 500,000 workers – significant opportunity for economic growth for the nation*



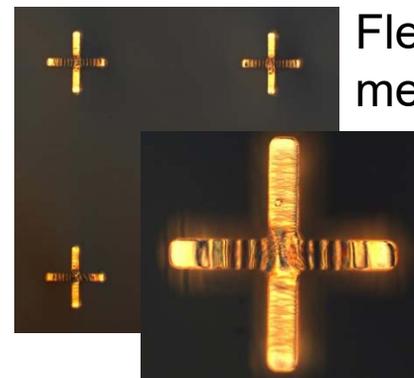
Conductive textiles via atomic layer deposition (ALD)



High-throughput ALD on textiles (roll-to-roll)



Thermoelectric nanocomposites energy harvester integrated into a polyimide/PDMS based package on a flexible substrate



Flexible metamaterials

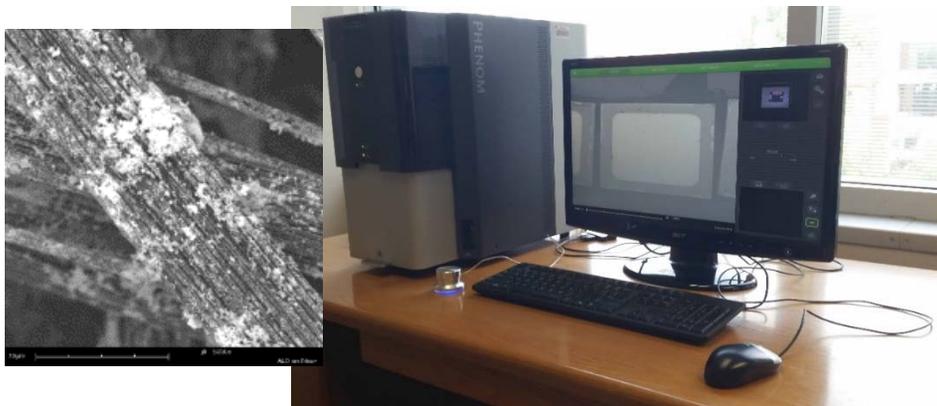
# Remote Access of Facilities

## Classes collect samples and send to facility

- Interactive, student-led presentation
  - On-site or remote

## Desktop scanning electron microscope

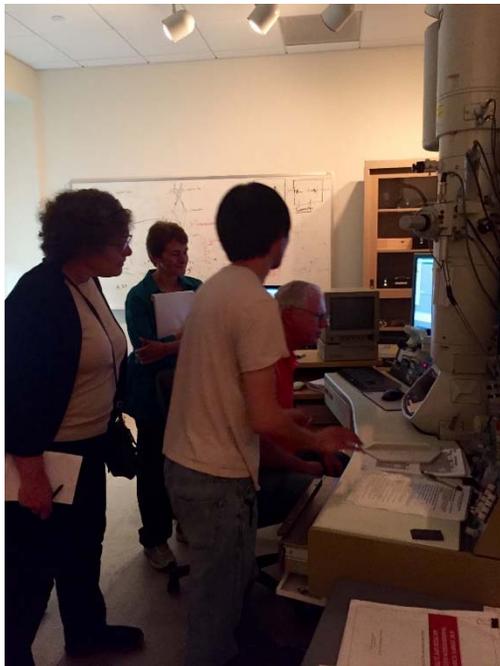
- Take to classrooms
- Students drive microscope



# Community College Workshop

*Provide nanotechnology teaching materials to community college educators*

*Hands-on learning experiences*

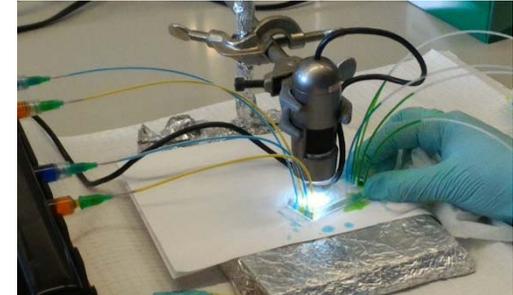


*“Gave me exposure to nanotechnology and sophisticated equipment and materials that most community college educators never encounter.”*

# Technical Workshops and Short Courses

## *Specialized workshops*

- Provide opportunities to discover new equipment and techniques



## *Short courses*

- In-depth information on specific analysis or fabrication techniques available in facilities
- Hands-on component



*Year 1*

*35 Workshops*

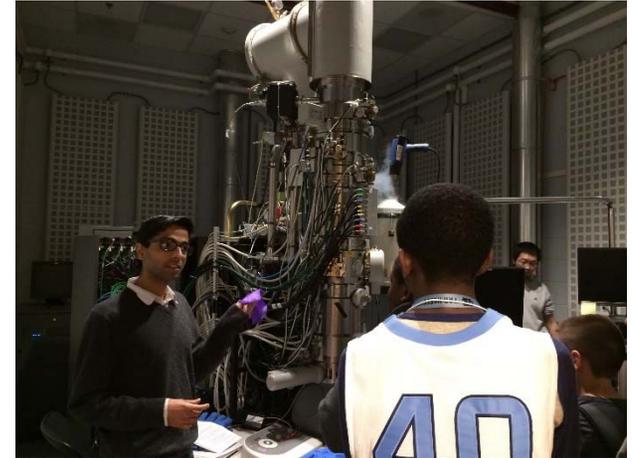
*> 200 Participants*



# Facility Tours and Demonstrations

*Equipment in action*

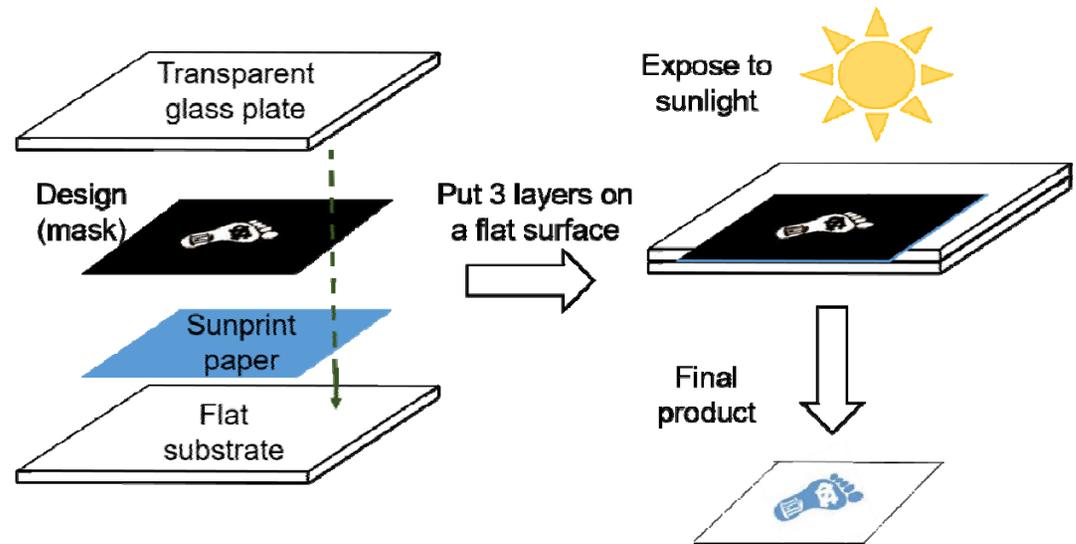
*Interactive events*



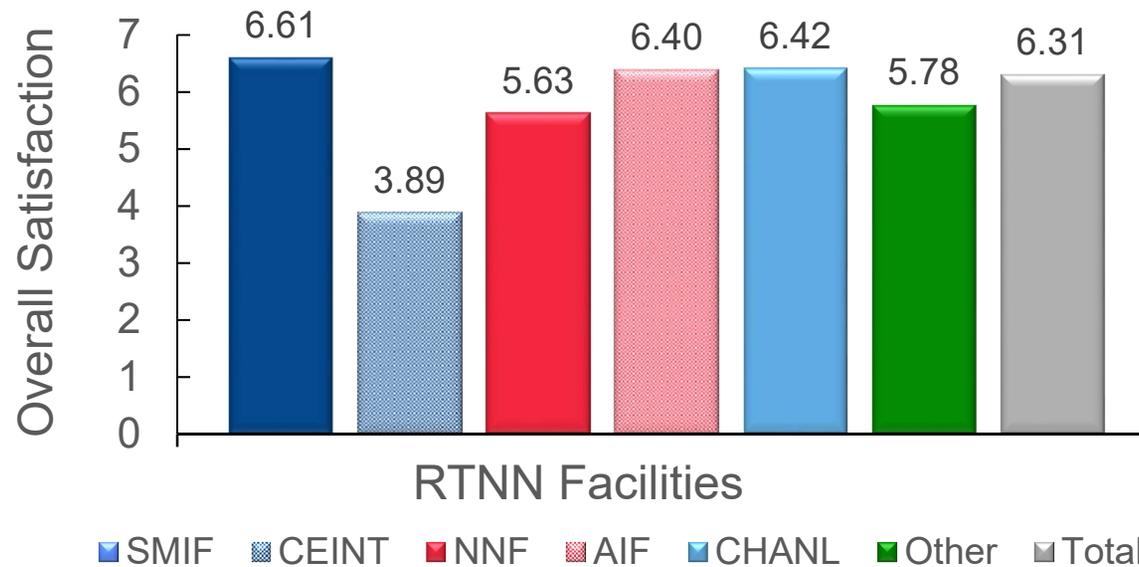
# Lesson Plan Development

## *Incorporation of cutting edge science into the classroom*

- Hit specific STEM educational standards
  - North Carolina
  - Next Generation Science Standards
- Focused for different grade levels
- Shared at SciREN teacher networking event



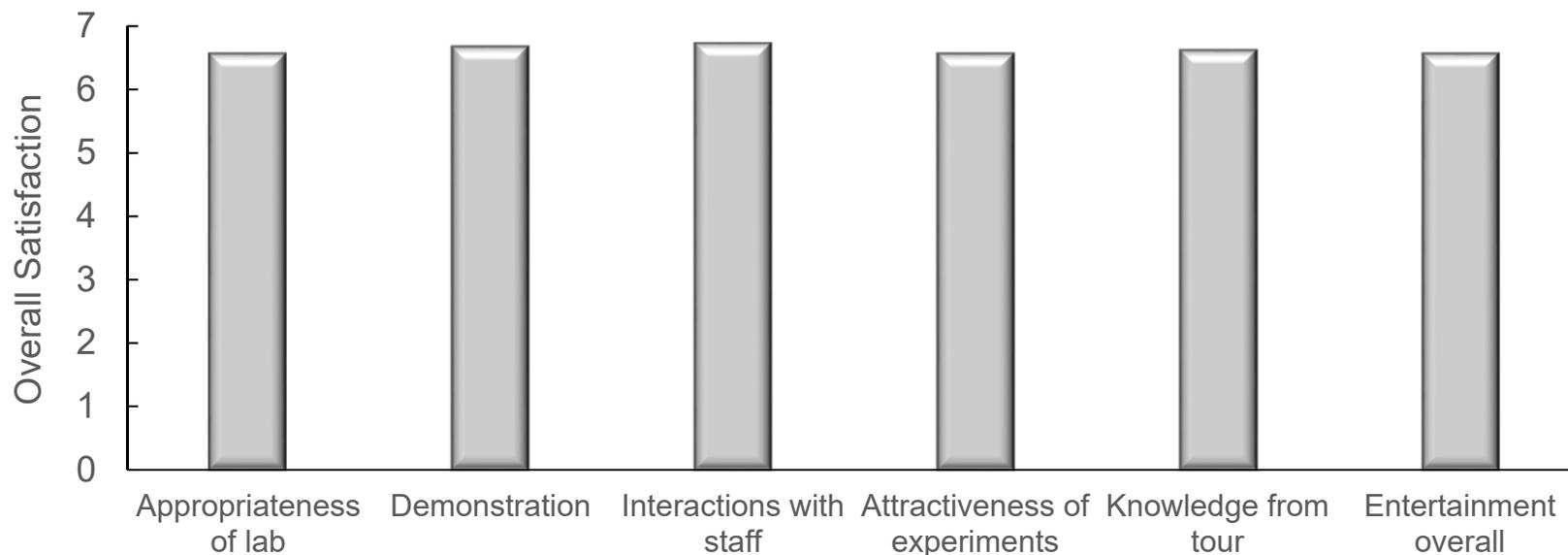
# Satisfaction Level by RTNN Facility



Facility	Satisfaction	N	SD
SMIF (Duke)	6.61	50	0.53
CEINT (Duke)	3.89	3	2.59
NNF (NC State)	5.63	22	1.30
AIF (NC State)	6.40	65	1.08
CHANL (UNC)	6.42	18	0.47
Other	5.78	3	1.58
<b>Total</b>	<b>6.31</b>	<b>161</b>	<b>1.06</b>

Note:  $F(5, 155) = 7.16, p = 0.000$

# Satisfaction Level for K-12 Outreach

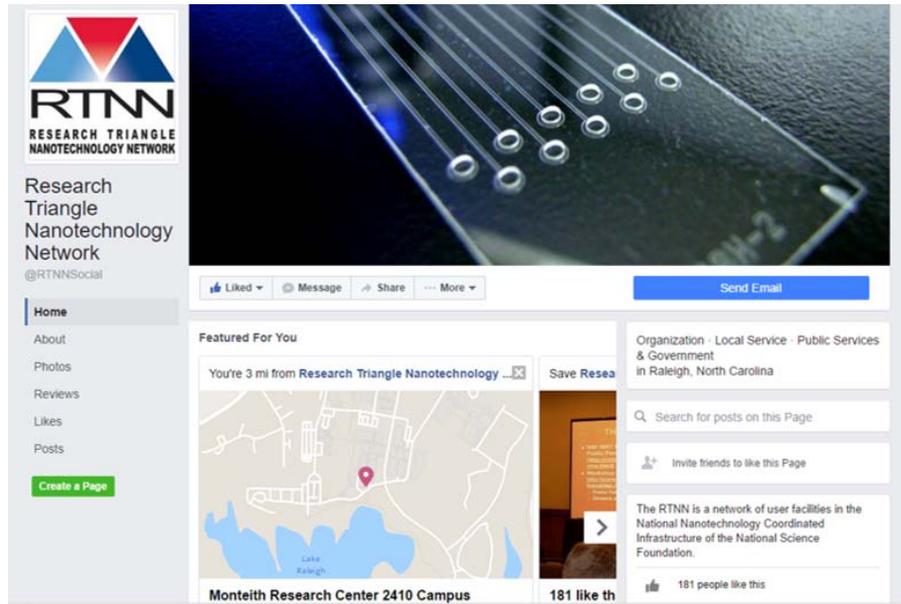


## ***Positive feedback***

- “The crew at CHANL was great...They were able to connect to middle schoolers without using the complex chemistry and physics needed to understand what was really occurring in the demonstrations. ”
- “...overall we had a fantastic time. We connected with researchers and staff and the students were fully engaged.”
- “Thank you for truly making us feel a part of the experience...”

# Social Media Campaign

*Raising awareness through multiple, distinct platforms*



@RTNNSocial

LinkedIn

*In development: newsletter, Snapchat with geotags, Instagram*