NC STATE

NANOFABRICATION FACILITY

Grand Re-Opening

January 8, 2018 | 3:00pm

Monteith Research Center, Room 136
Refreshments to be served

Please RSVP to Dr. Phil Barletta: pbarlet@ncsu.edu

nnf.ncsu.edu

NNF
NCSU NANOFABRICATION FACILITY

RTNN

Welcome to the “New” NNF

January 8, 2018

Dr. Phil Barletta
NNF Director of Operations

pbarlet@ncsu.edu
3-1976

NNF Strategic Plan

- **Goal 1:** Proactive approach to safety
  - –Instill a safety-first mindset in the staff and users
  - –Collaborate with health and safety personnel at the University level
- **Goal 2:** Exceptional technical performance
  - –Talented and dedicated staff
  - –Emphasis on equipment uptime
  - –Constantly looking to expand capabilities
- **Goal 3:** Growing customer base
  - –Retention of current customers by consistent performance
  - –Active recruitment of new users
- **Goal 4:** Engagement with the local community
  - –Including NCSU, other universities, and local companies
  - –More than just a business relationship

Dr. Philip Barletta, NNF Director of Operations

- Ph.D., Materials Science (2006)
  - North Carolina State University
  - Studied under Dr. Salah Bedair
- M.S., Materials Science (1999)
  - North Carolina State University
  - Studied under Dr. Jerry Cuomo
- B.S., Materials Science (1996)
  - Wilkes University

Work Experience

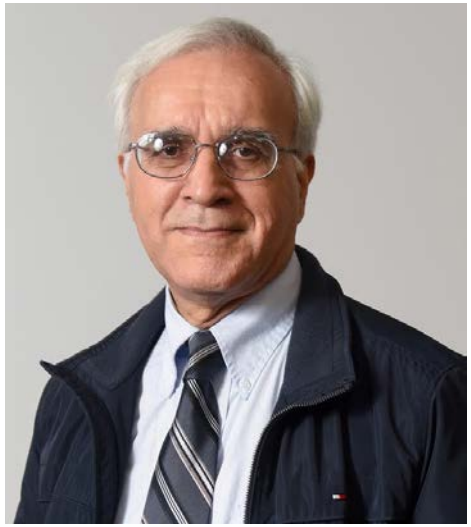
- Program Manager, Micross AIT (2016-2017)
- Research Engineer/Engineering Manager, RTI International (2006-2016)
- Senior Scientist, Dot Metrics Technologies (2005-2006)
- Process Engineer, Litespec Optical Fiber (1999-2000)

New NNF Staff

- Greg Allion, our new lithography engineer, started 8/14
- Was recruited from the University of Michigan, where he had 15 years of experience with optical and e-beam lithography
- Also has significant wafer bonding experience
- Experience in processing development consulting for local startups

- Jim Mitchell is the newest member of our team, having started 9/11
- Specializes in semiconductor equipment repairs
- Was recruited from Cree, and has 34 years experience working on all semiconductor equipment, primarily lithography tools

NNF Veterans (1)



- Marcio Cerullo is our Laboratory Manager
- Started at NNF in 2006
- Fourteen years experience at AT&T Bell Laboratories
- Also worked at Tompkins Research Corp and Tyco Electronics
- B.S., M.S. University of Sao Paolo, Brazil

- Nicole Hedges is our Business and Education Manager
- Started at NNF in 2009
- Four years experience at GE Global Research Center
  - –Worked extensively with MEMS and microfluidics
- B.S. Georgia Tech, M. Engr. U. of Michigan

NNF Veterans (2)

- Jeff Ricker-Hagler is our Hardware Engineer
- Started at NNF in 2016
- Ten years with GE as Nuclear Reactor Inspector
- Also worked with Wolfspeed and The Nonwovens Institute at NCSU
- AAS Nuclear Technology

- Sharon Guidry is our Accounting Technician
- Started at NNF in 2014
- Experience as Executive Assistant and Business Consultant with Nationwide Insurance
- Educational background from Wake Tech Community College

Undergraduate hires

Andrew Squires

Anne Corbett

Zach Ledford

- NNF will have three undergraduate students helping out in the Spring 2018 semester
- Welcome Andrew, Anne, and Zach!

Recent Improvements to NNF (1)

- Recognition as a University Core Facility
  - Interaction with the Office of Research, Innovation, and Economic Development (ORIED)
  - Regularly scheduled meetings with Assistant Vice Chancellor Jon Horowitz
  - NNF gets significant support, but also more scrutiny
- Increased staffing
  - Three new hires in the last four months
  - Six total technical staff, plus part-time accounting technician and one temporary employee (through January 31)
  - Three undergrad student hires for Spring 2018 semester
- Investment in infrastructure
  - Air handler upgrade ($6.4 mil) – second floor completed November 2017
  - Thermals loop ($3-4 mil)
- Emphasis on upgrading documentation procedures
  - SOPs, maintenance logbooks, PM schedules, equipment tracking

Recent Improvements to NNF (2)

- $1 mil+ investment in new instrument capabilities

Atomic Layer Deposition (ALD)

III-V plasma etcher

Rapid Thermal Processor

Direct-write laser lithography

Particle measurement

- Lasair III Particle Measurement Instrument purchased to verify lab cleanliness
- Measurements will be logged every month
- December 2017 measurements verify that we have a Class 100 (ISO 5) cleanroom

Heidelberg room				
	N/m^3	N/m^3	N/m^3	**N/m^3**
≥0.1 µm	2896	10560	3532	**5663**
≥0.2 µm	1695	3037	1907	**2213**
≥0.3 µm	1130	1201	1413	**1248**
≥0.5 µm	600	424	494	**506**
≥1 µm	247	141	247	**212**
≥5 µm	0	0	35	**12**

Class 1	*Class 10*	*Class 100*	*Class 1000*
N/m^3	*N/m^3*	*N/m^3*	*N/m^3*
1000	10,000	100,000	1,000,000
237	2370	23,700	237,000
102	1020	10,200	102,000
35	352	3,520	35,200
8	83	832	8320
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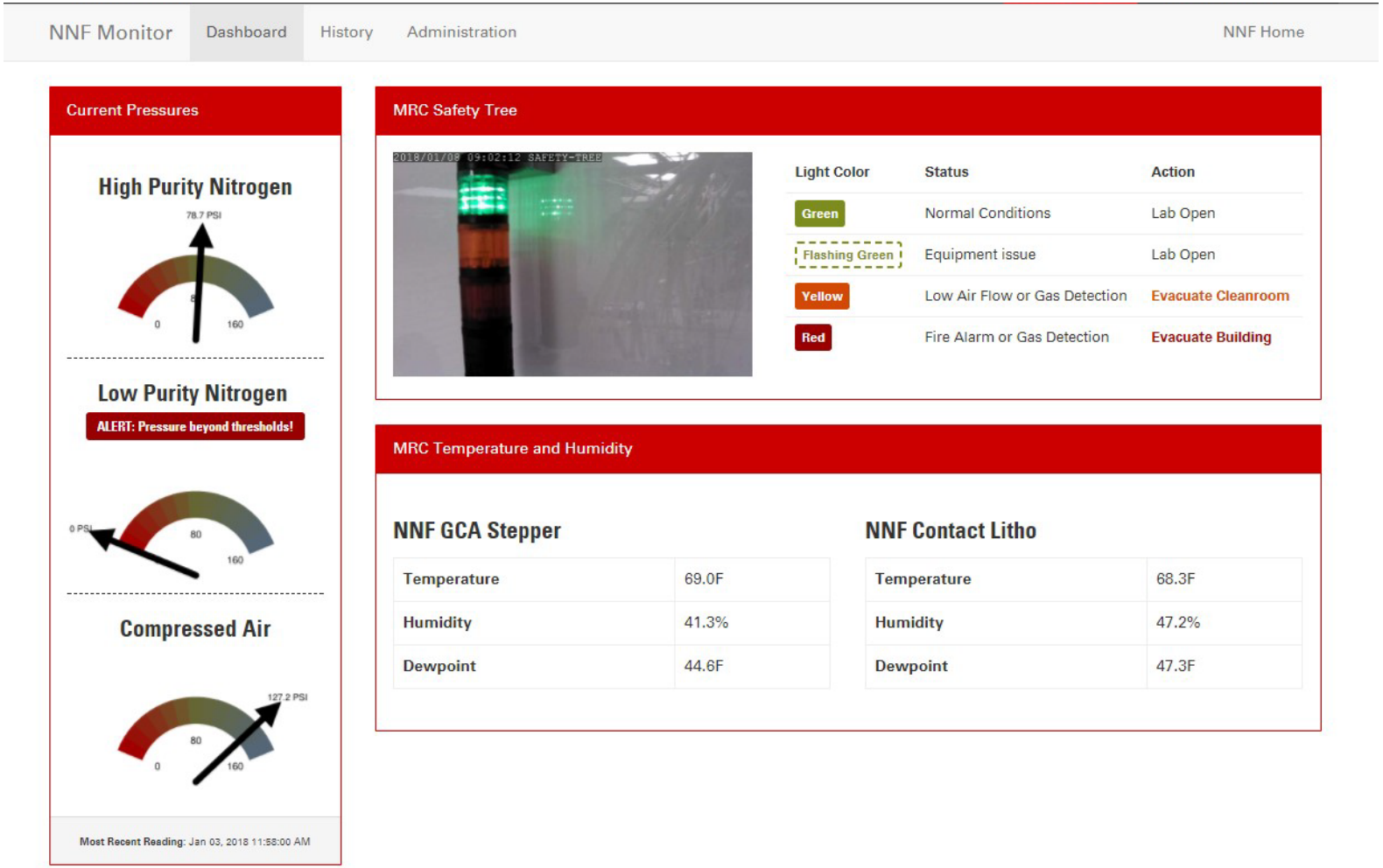
Temperature/humidity monitoring



- Current status of cleanroom conditions can be found at **www.nnf.ncsu.edu/monitor**

NNF contributions to NCSU community (and beyond)

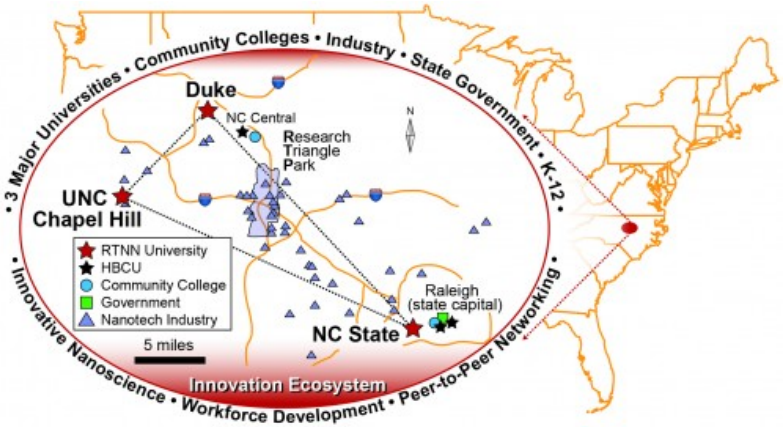
- NNF supported 107 individual users in 2016-2017
  - –92 NCSU
  - –15 external
- These users worked a total of 8422 hours across 93 projects
- NNF contributed to **$4.9 million** worth of funded projects for NCSU investigators
- With your help, we can push these numbers even higher in 2017-2018
  - –We will also start tracking publications written that contain NNF work

Cleanroom courses

- ECE 442, ECE 739, and MSE 335 will continue to be offered in NNF
- Starting in Fall 2018, ECE 442 and ECE 739 will move out of the main cleanroom (MRC 240) into MRC 106
- However, the Spring 2018 offering will still be held in the main cleanroom
  - –NNF staff will be teaching lab
  - –Lab sessions will be held Thursday afternoon and all day Friday
- Please respect the staff's time when they are engaged in a teaching activity for the course

NNF participation in RTNN

- NNF, along with AIF (NCSU), SMIF (Duke), and CHANL (UNC), is part of the Research Triangle Nanotechnology Network (RTNN)
- RTNN is one of sixteen NSF-funded National Nanotechnology Coordinated Infrastructure (NNCI) sites
- The role of the RTNN is to enhancing access to university resources by overcoming common barriers
  - –Awareness
  - –Cost
  - –Distance



Next six months

- Removal of UHV MOCVD tool
  - –Will open up space in the lab
  - –Big thanks to Dr. Bill Kiether for leading this task
- Increased capabilities
  - –Image reversal oven, spin-coating track system, hot piranha bath, spin-on glass
- Revisit the Equipment Sharing Programs
  - –Many faculty have generously donated equipment to NNF over the last several years
  - –Protocol for how to handle such “faculty-owned” tools in shared facility needs to be formalized
  - –Dr. Barletta will be reaching out to faculty for discussion and input
- NNF staff to attend individual PI research group meetings
  - –Please speak up if you would like us to join a group meeting of yours!

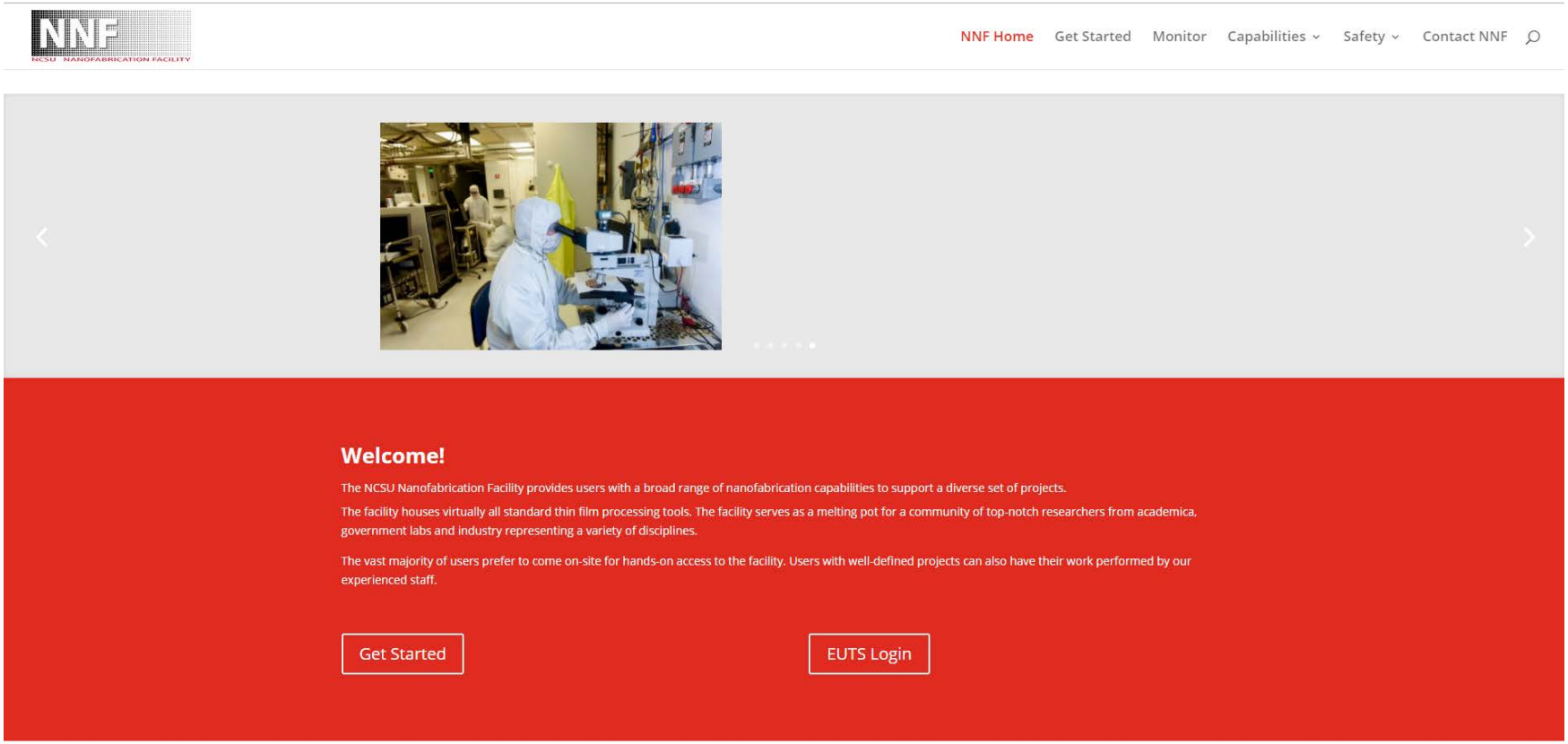
After-hours work policy

- NNF hours will be 8am – 8pm Monday-Friday
  - –At least one NNF staff member will be present during those hours
  - –All standard processes are available to users
- Weekend work in NNF will be allowed if and only if all of the following conditions are met:
  - –Users are NCSU students or employees
  - –At least two NNF-certified users are present at all times; i.e. “the buddy system”
  - –The user, the buddy, and the work to be done ***has been approved, in advance, by Dr. Barletta***
  - –No acids or hazardous/flammable gasses are to be used
- Additional critical need situations will be handled on a case-by-case basis
  - –Please coordinate in advance with Dr. Barletta

User meeting schedules

- We will have user meetings twice a year
  - –These correspond with the spring and fall maintenance shutdowns
    - Spring meeting: April 9, 2018
    - Fall meeting: October 8, 2018
  - –User meeting will include the following:
    - Update from Dr. Barletta on lab operation
    - Presentation from EHS on a given safety topic
    - Student technical presentation
- Fall meeting will also be accompanied by lab cleanup
  - –All users are expected to contribute!
  - –Fall lab cleanup will be October 10, 2018

New NNF Webpage



- Updated NNF webpage located at **nnf.ncsu.edu**
- Same functionality as old webpage, with more user friendly design
- EUTS will continue to be used for logging in and billing until Mendix comes online for NNF (Summer/fall 2018)

NNF Twitter Page

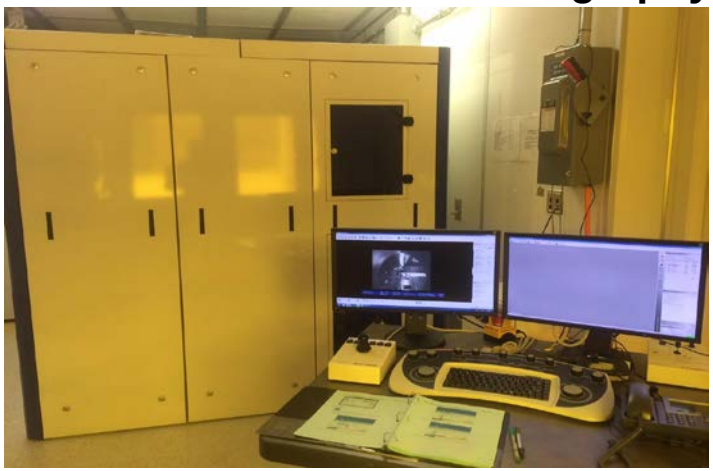
twitter

@NCStateNanoFab

- Will be used as a communication tool for NNF and its users
  - –Report NNF equipment/lab news
  - –Highlight work done in NNF
  - –Advertise success stories from NCSU PIs
  - –Promote seminars, short courses
  - –RTNN news
  - –Share any “cool” photos/videos of our work at NNF!

Under-utilized NNF tools

Raith 150 Two E-beam Lithography



- Feature sizes down to 20nm
- Specially designed sample holders: Pieces – 6” Wafers; rotate/tilt chuck
- Low kV exposure and imaging (SE detector with BSE detector option)
- Accelerating voltage up to 30kV
- Stitching and overlay accuracy of about 35nm

Nanoimprint Lithography

- High-throughput patterning of nanostructures
- Up to 2” diameter imprint area
- Variable time, temperature, pressure
  - T_{max} = 250°C, P_{max} = 70 bar
- Low cost, relatively simple alternative to optical and/or e-beam lithography

NNF Big Questions

Short/mid term

- What capabilities are we most sorely missing?
- Where are the gaps in staff expertise?
- What is the best way to reach local small companies?
- What sets us apart from competing facilities?
- What sources of funding are available to us?
- How do we handle high-dollar service contracts?

Long term

- Do we want to become a 24/7 operation?
- How can we expand our physical footprint?
- What do we envision for the NNF in five years? Ten years? Beyond that?

NNF Wish List

- Dicing saw
- Wafer bonder
- Filmetrics measurement tool
- RF sputter deposition
- Upgraded Si_3N_4 growth tool

Gentle Reminder

When publishing or presenting work that was supported by the NNF tools and/or staff, please be sure to acknowledge us:

This work was performed in part at the NCSU Nanofabrication Facility (NNF), a member of the North Carolina Research Triangle Nanotechnology Network (RTNN), which is supported by the National Science Foundation (Grant ECCS-1542015) as part of the National Nanotechnology Coordinated Infrastructure (NNCI).

This acknowledgement statement can be found on the NNF website:

nnf.ncsu.edu

Thank you!