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NANOTECHNOLOGY EDUCATION:

Building a State-wide Innovation Network for Graduate Education

Robert Geer

Senior Vice President

Chief Operating Officer

SUNY Polytechnic Institute

Topics

- A few comments on STEM opportunities and skills and the growth of nanotech degrees/concentrations
- CNSE degree program components
- CNSE's co-location strategy for graduate education infrastructure
- A NYS Innovation-education ecosystem for nanotech research, education, workforce development, and economic development
- Leveraging infrastructure across the NSE pipeline

The rise of STEM careers…

Employment in STEM fields is projected to grow by 26 percent, adding about 2.1 million new jobs between 2010 and 2020.

STEM majors earn the **highest starting salaries** of any profession, $62,000.

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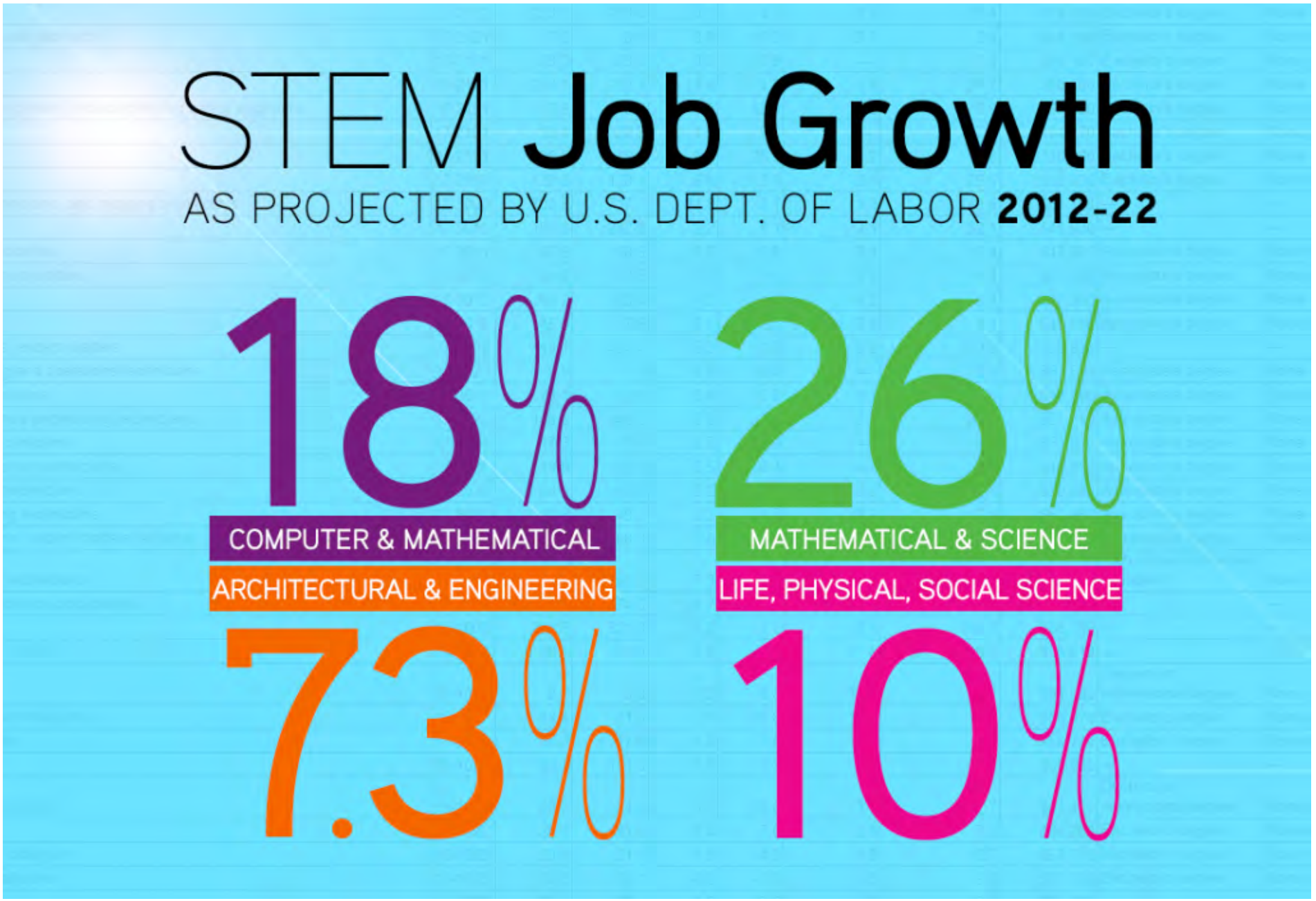
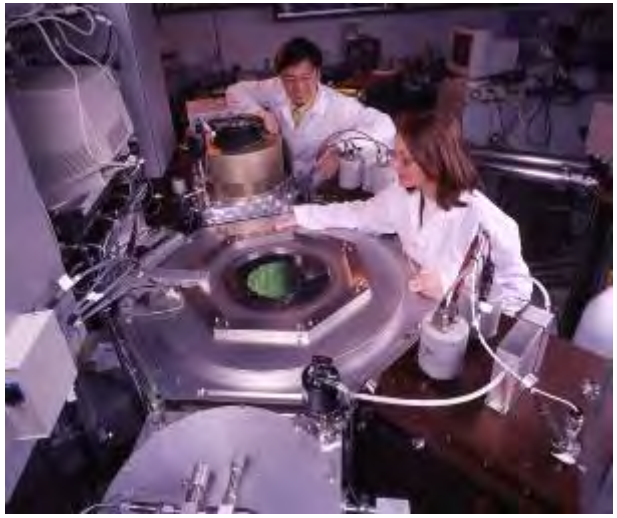


The College of Nanoscale Science and Engineering



CNSE Academic Goal

"…to provide a comprehensive education in the emerging interdisciplinary fields of nanoscale science and engineering."

- CNSE Academic Mission Statement

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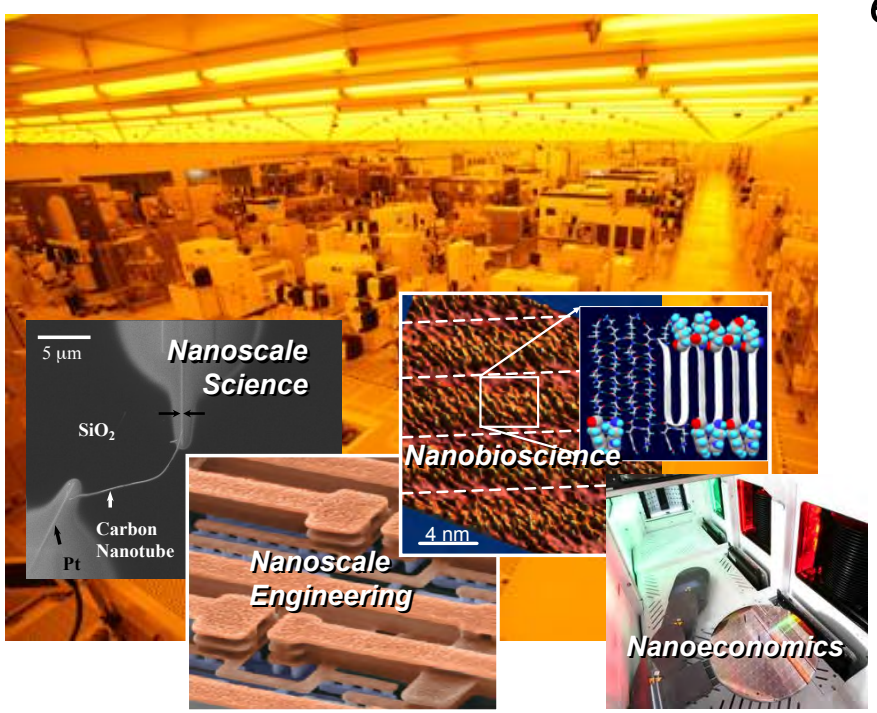
CNSE Cross-Disciplinary Focus

CNSE is dedicated to nanotechnology with constellations in:

Nanoscience
Nanoengineering
Nanobioscience
Nanoeconomics



Vision *Leverage combined resources to establish effective partnerships that will enable pioneering nanoscale research, education, and innovation.*

Mission *Create a financially and technically competitive environment to empower the nanotechnology industry with manufacturing advantages through vertically integrated partnerships.*

2003: CNSE initiates the *MS and PhD* programs in *Nanosciences and Nanoengineering*.

2006: CNSE creates separate MS/PhD programs in *Nanoscale Science* and in *Nanoscale Engineering*

2009: CNSE creates a comprehensive *Bachelor of Science* program in *Nanoscale Science*

2009: CNSE and UAlbany School of Business develop *MBA program* with elective *track in nanotechnology*

2010: CNSE announces launch of *Bachelor of Science* program in *Nanoscale Engineering*

2011: CNSE and SUNY Downstate Medical Center partner to launch the first *MD/PhD* program for research physicians in *nanoscale medicine*

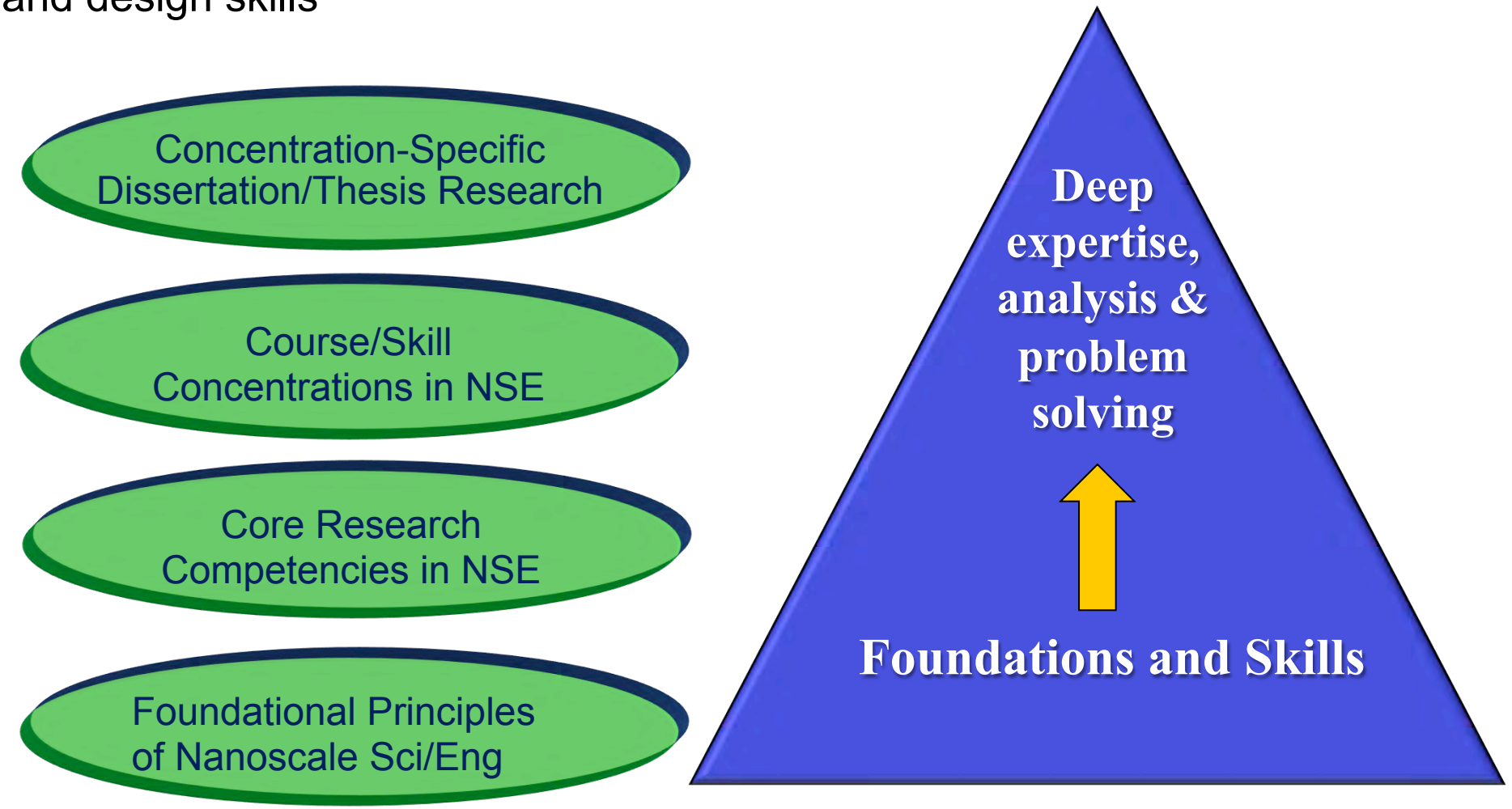
2015: CNSE to launch *MD/PhD* and *BS* programs in *Nanobioscience*

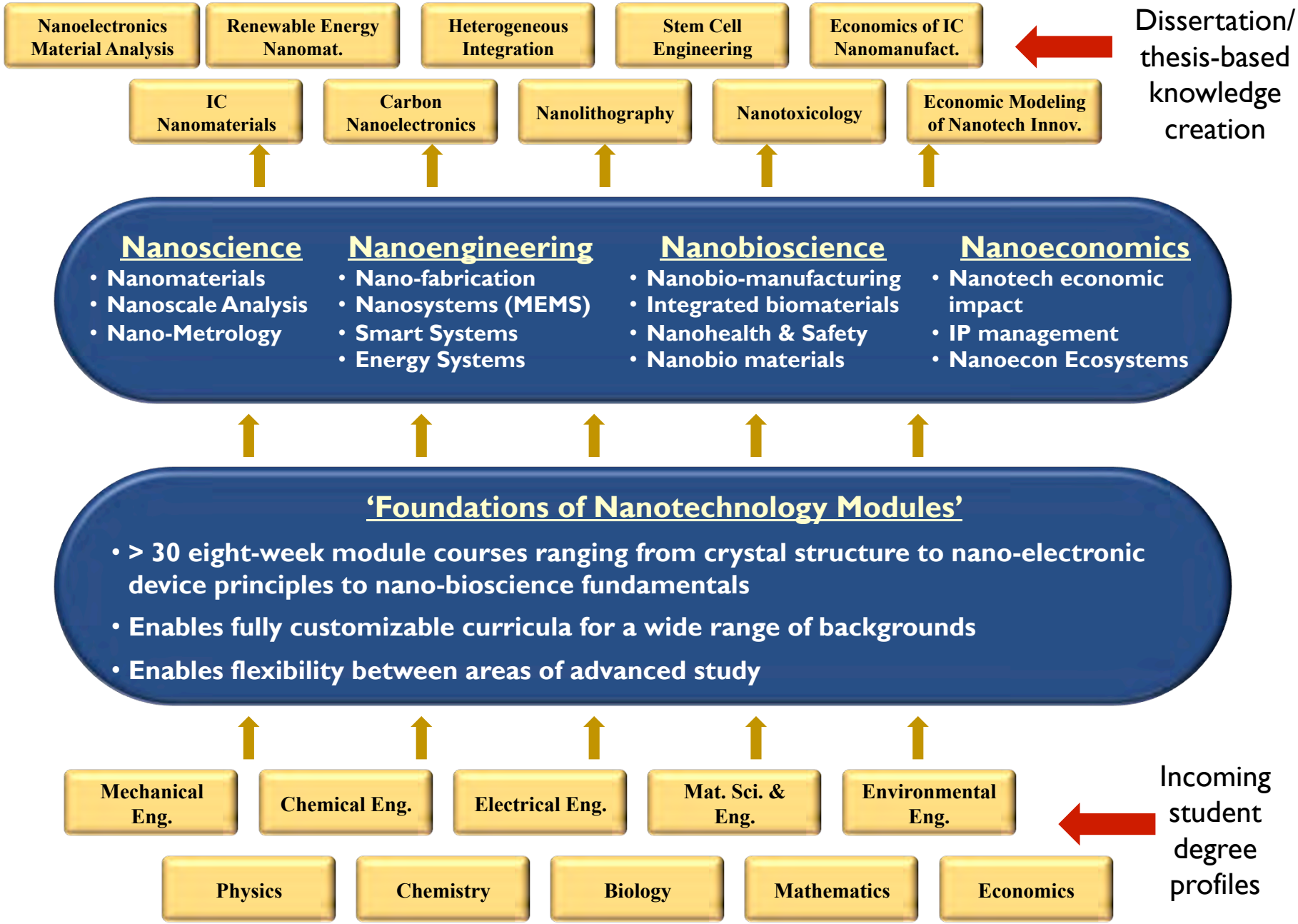
Graduate Study in Nanoscale Science & Engineering

- Since ~ 2000
  - > 150 Masters-level programs
  - > 50 Doctoral-level programs
  - > 30 UG-level programs
- Most common recipes
  - NSE-specific tracks/concentrations to existing degree programs
  - Joint-institution degrees
- Challenges
  - Disciplinary expertise (breadth vs depth)
  - Pedagogical base (truly 'nano-specific', connective)
  - Research infrastructure (tools of the trade – expensive)

Graduate Study in Nanoscale Science & Engineering

Nanoscale Science/Engineering curricula coherently integrate CNSE's NanoFab Complex to develop critical interdisciplinary science, engineering, and design skills




Nanoelectronics Material Analysis
Renewable Energy Nanomat.
Heterogeneous Integration
Stem Cell Engineering
Economics of IC Nanomanufact.
Dissertation/ thesis-based knowledge creation
IC Nanomaterials
Carbon Nanoelectronics
Nanolithography
Nanotoxicology
Economic Modeling of Nanotech Innov.
Nanoscience
• Nanomaterials
• Nanoscale Analysis
• Nano-Metrology
Nanoengineering
• Nano-fabrication
• Nanosystems (MEMS)
• Smart Systems
• Energy Systems
Nanobioscience
• Nanobio-manufacturing
• Integrated biomaterials
• Nanohealth & Safety
• Nanobio materials
Nanoeconomics
• Nanotech economic impact
• IP management
• Nanoecon Ecosystems
'Foundations of Nanotechnology Modules'
• > 30 eight-week module courses ranging from crystal structure to nano-electronic device principles to nano-bioscience fundamentals
• Enables fully customizable curricula for a wide range of backgrounds
• Enables flexibility between areas of advanced study
Mechanical Eng.
Chemical Eng.
Electrical Eng.
Mat. Sci. & Eng.
Environmental Eng.
Physics
Chemistry
Biology
Mathematics
Economics
Incoming student degree profiles

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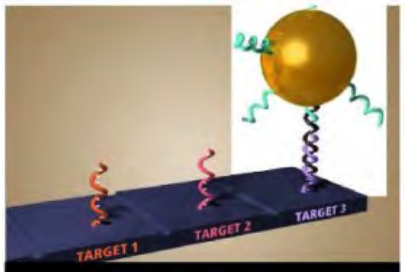
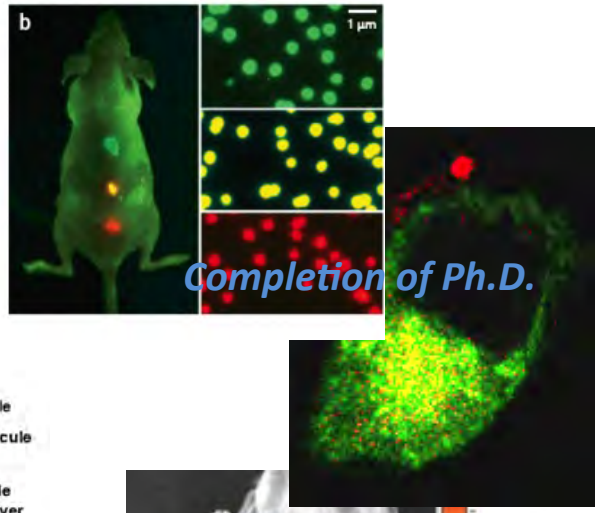
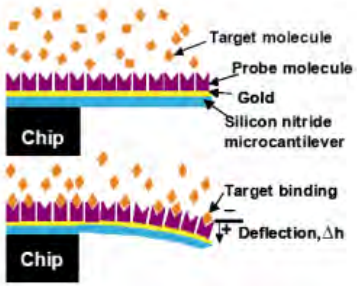
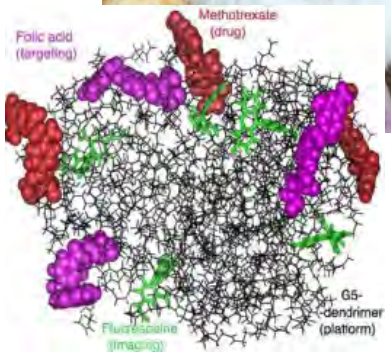
CNSE SUNY/Downstate MD/PhD Program

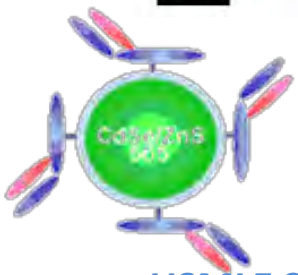




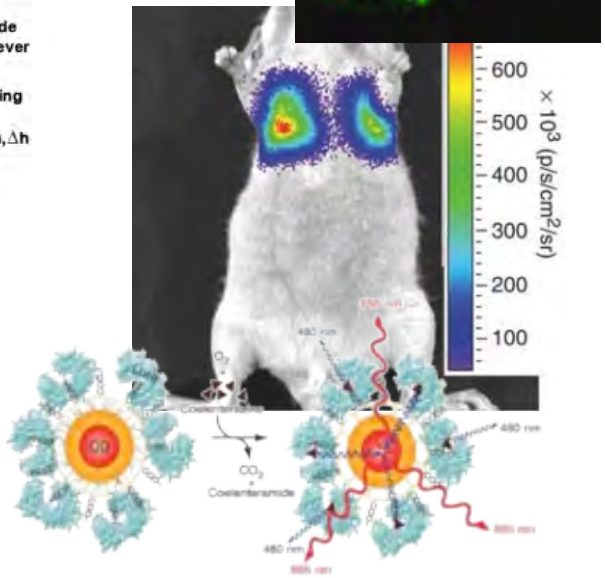
Completion of Ph.D.

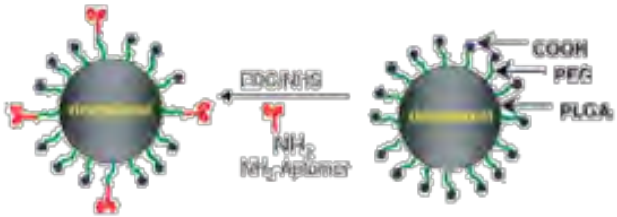






USMLE Step 1





Early detection **Imaging** **Therapy**

Source: Piotr Grodzinski, Ph.D., Director, NCI Nanotechnology Alliance, National Cancer Institute

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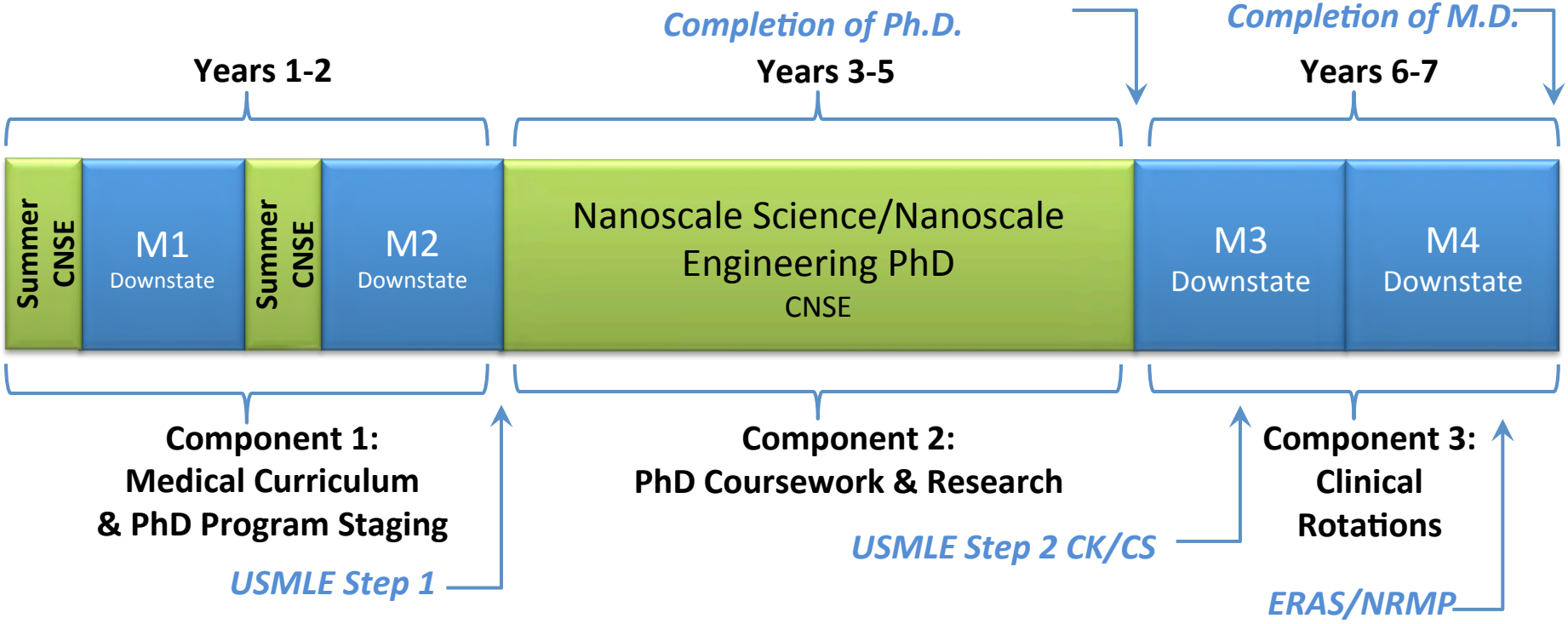
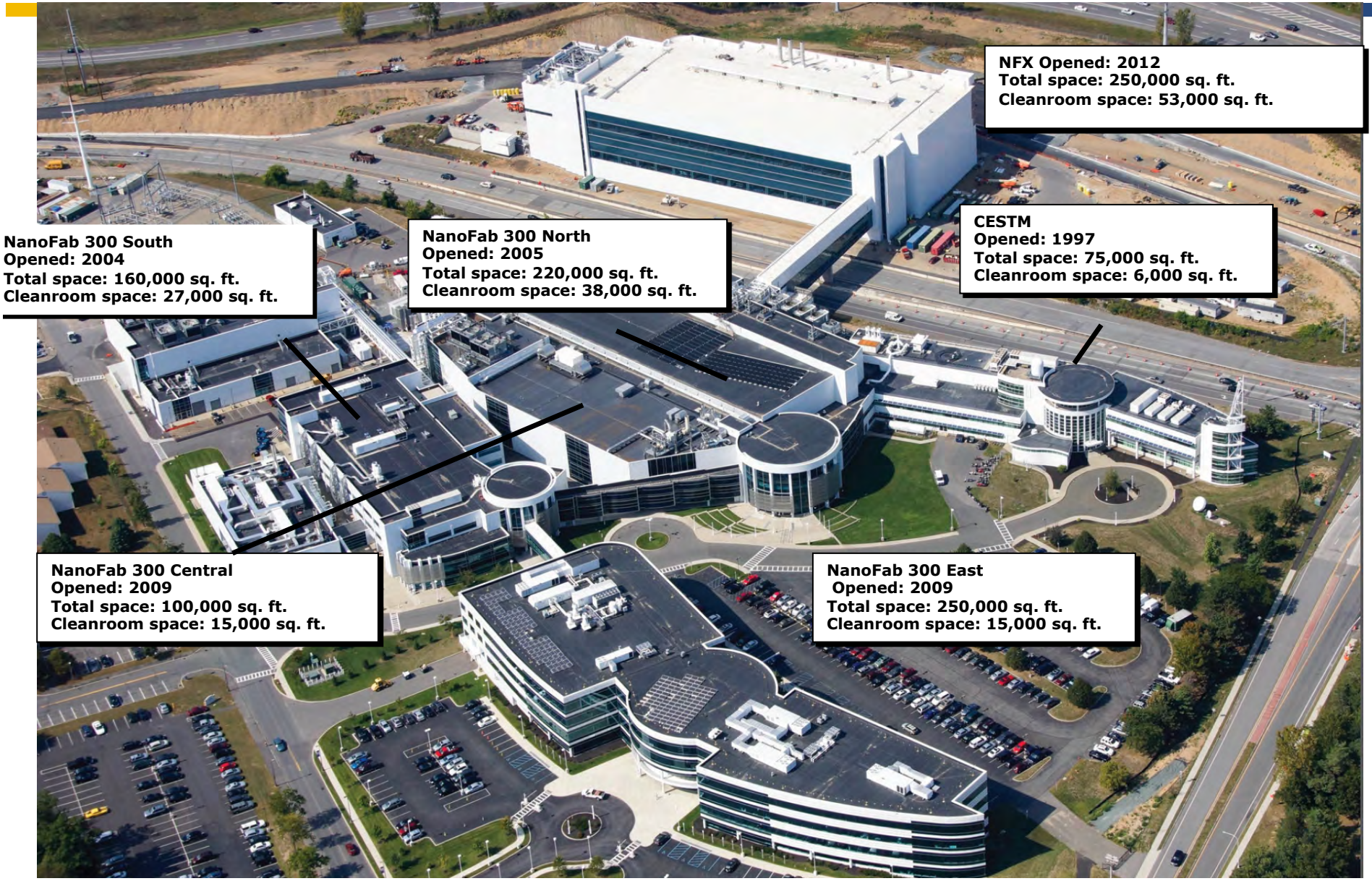
CNSE SUNY/Downstate MD/PhD Program

COLLEGE OF NANOSCALE SCIENCE & ENGINEERING

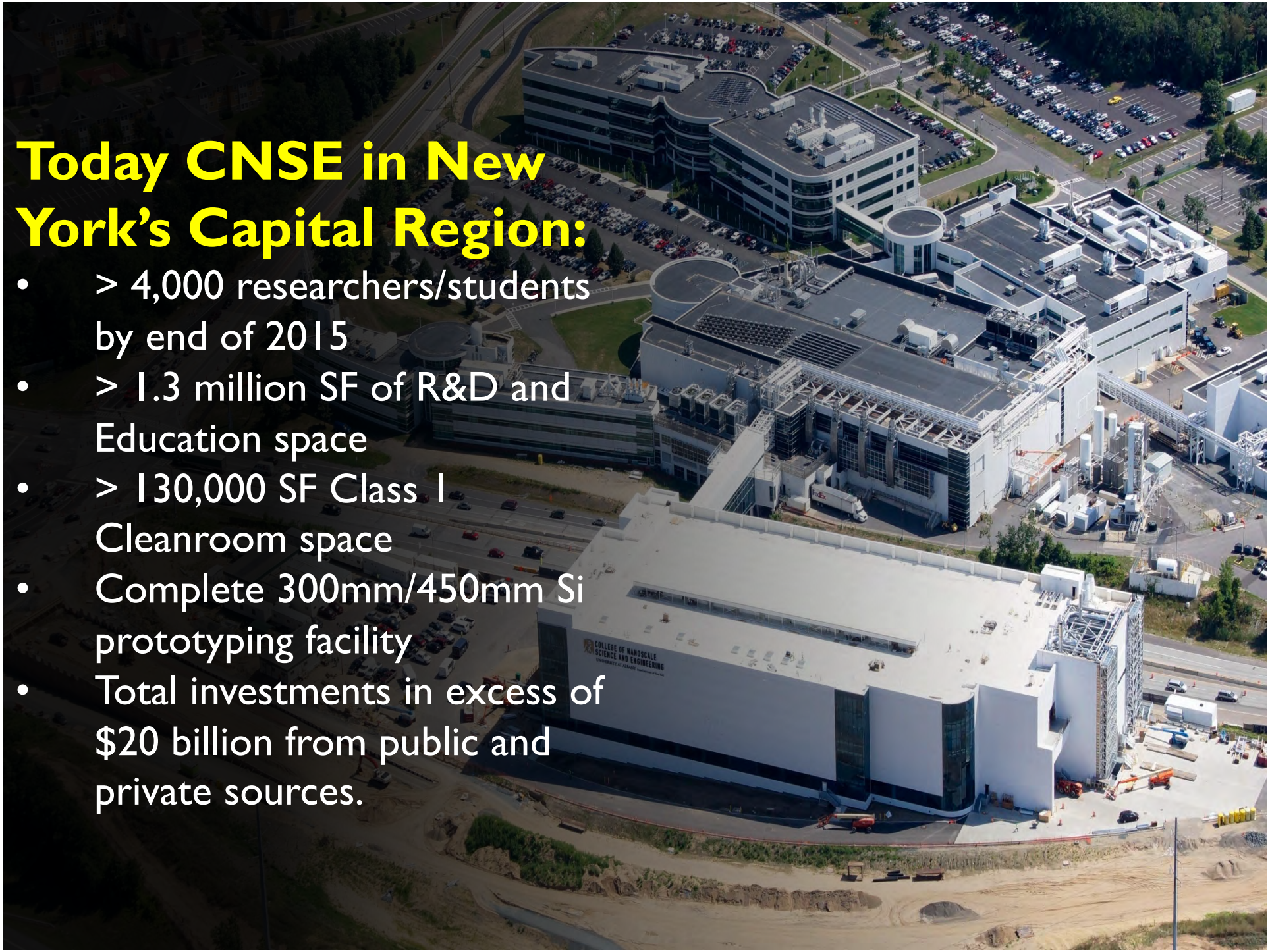
SUNY DOWNSTATE Medical Center



CNSE's Co-location Approach for Graduate Research Infrastructure



Shared-Use, Co-Location Model



Today CNSE in New York's Capital Region:

- > 4,000 researchers/students by end of 2015
- > 1.3 million SF of R&D and Education space
- > 130,000 SF Class 1 Cleanroom space
- Complete 300mm/450mm Si prototyping facility
- Total investments in excess of $20 billion from public and private sources.

An Open IC Innovation Eco-System

Over 300 Industry Partners

Integrated Device Manufacturers

SAMSUNG
intel
IBM
GLOBALFOUNDRIES
tsmc
ST

Equipment Suppliers

EVG
APPLIED MATERIALS
TOKYO ELECTRON
Lam RESEARCH
ASML
FEI Explore. Discover. Resolve.

Materials & Site Services Partners

CH2MHILL
CORNING
DOW
ATOTECH
Living. Improved daily.
MATHESON
ask. . .The Gas Professionals
DUPONT
The miracles of science
M+W GROUP

Industry Consortia

SEMATECH
Accelerating the next technology revolution.
G450C
common platform
semi
ISMI
F450C

Small Medium Enterprises (SME)

DARPA
AFRL
U.S. DEPARTMENT OF ENERGY
Massachusetts Institute of Technology
Raytheon
Avalanche Technology

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Clean Energy

U.S. PHOTOVOLTAIC MANUFACTURING CONSORTIUM

PVMC

R&D, Technology Transfer and Technology Deployment

SUNY POLYTECHNIC INSTITUTE

Current PVMC Members & Supply Partners

PVMC, Inc. Confidential

New York's innovation-education ecosystem

CNSE+SUNYT – The SUNY Polytechnic Institute

- **Merger between SUNY CNSE and SUNYIT to create a new degree granting institution**
- **Merger will create a first of its kind SUNY polytechnic research university**
- **New PhD, MS, BS and nanotech workforce training programs will be established in Utica and integrated with CNSE programs**

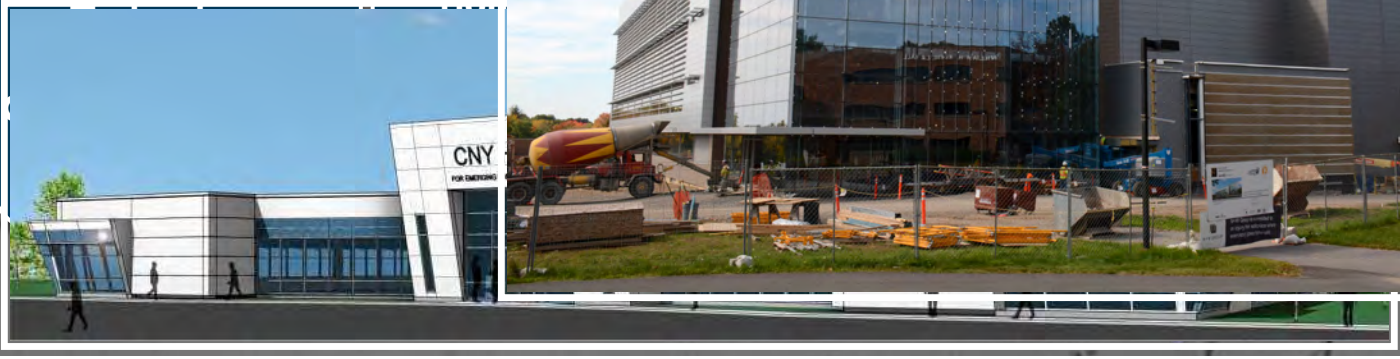
Solar City's 1 GW PV Manufacturing Facility

G450C 450mm Si Development Center

Solar City 1GW PV Manufacturing Complex
Buffalo, NY

ANS/CNSE 3D IC Advanced Packaging Center

Information



COLLEGES OF NANOSCALE SCIENCE AND ENGINEERING
SUNY POLYTECHNIC INSTITUTE

ANDREW M. CUOMO
GOVERNOR

CNSE'S PHOTOVOLTAIC MANUFACTURING AND TECHNOLOGY DEVELOPMENT FACILITY (CNSE MDF) - ROCHESTER

COMPUTER CHIP COMMERCIALIZATION CENTER (QUAD-C) - UTICA

CNSE'S SOLAR ENERGY DEVELOPMENT CENTER - HALFMOON

BUFFALO HIGH-TECH MANUFACTURING INNOVATION HUB AT RIVERBEND - BUFFALO

CNSE'S CENTRAL NEW YORK HUB FOR EMERGING NANO INDUSTRIES - SYRACUSE

BUFFALO MEDICAL INNOVATION AND COMMERCIALIZATION HUB - BUFFALO

State-wide network of R&D and manufacturing innovation centers for research partnerships and experiential learning

ALBANY NANOTECH COMPLEX - ALBANY

BUFFALO INFORMATION TECHNOLOGIES INNOVATION AND COMMERCIALIZATION HUB - BUFFALO

CNSE'S SMART SYSTEM TECHNOLOGY AND COMMERCIALIZATION CENTER OF EXCELLENCE (CNSE STC)

MARCY NANOCENTER - UTICA

SMART CITIES TECHNOLOGY INNOVATION (SCiTI) CENTER AT KIERNAN PLAZA - ALBANY

WWW.SUNYCNSE.COM

Leveraging Infrastructure Across the Pipeline…

- **For every CNSE NanoFab scientist/researcher there are 14 additional people supporting their work as follows:**
  - 2 Engineers
  - 3 Specialized Equipment Technicians
  - 4 Facility Tech Support
  - 2 Professionals
  - 3 Skilled Trades
  - 14 Total

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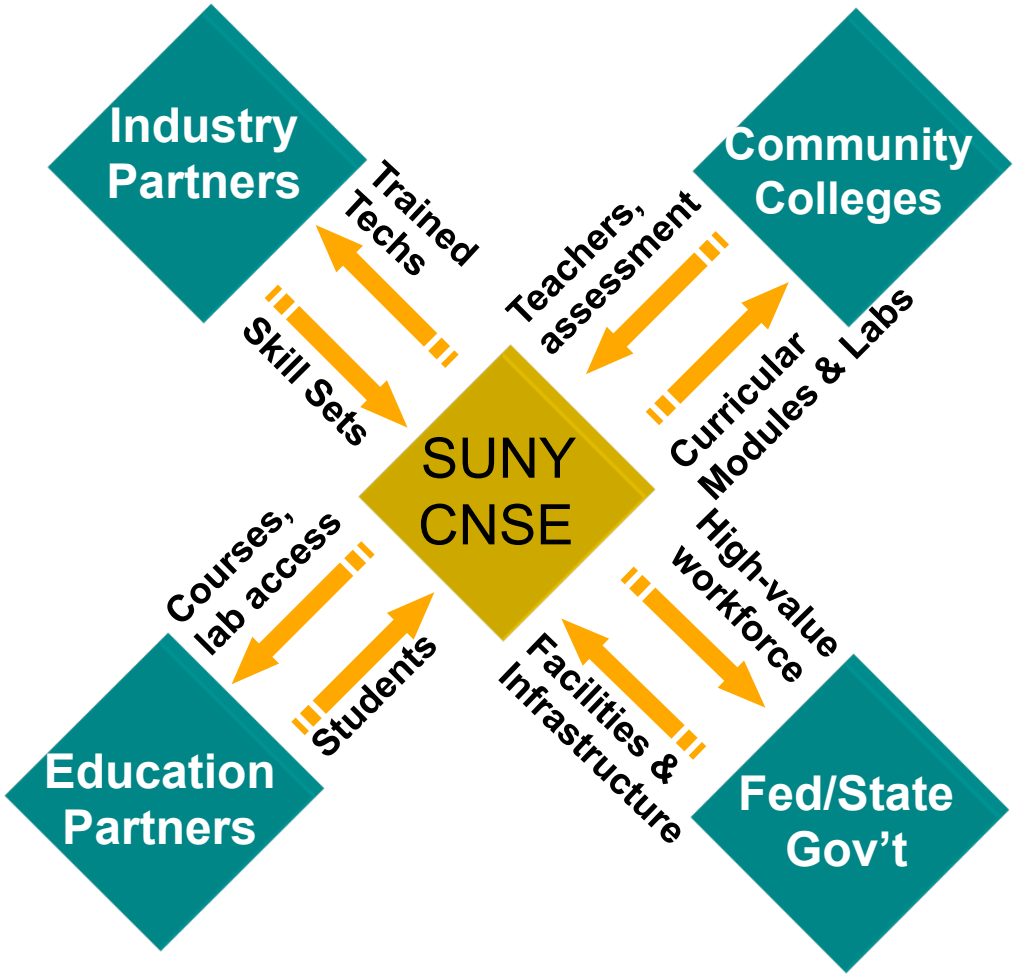
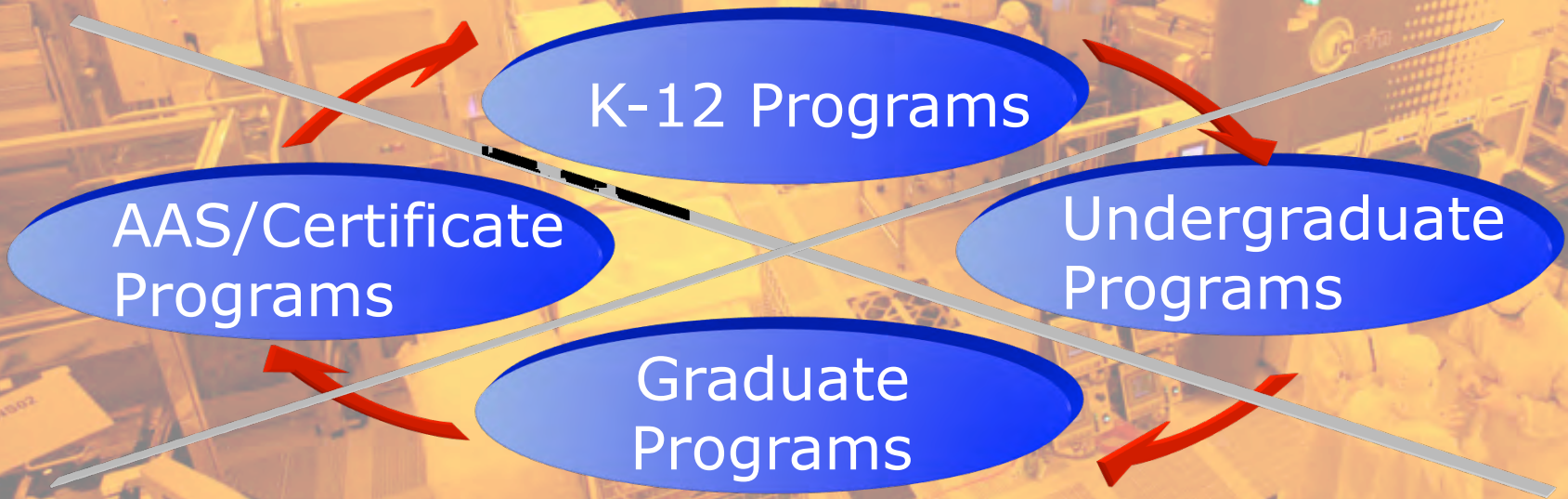
Complete Integration of Education with Nanotechnology R&D and Manufacturing



Changing the Paradigm for STEM Education

- 'Learn by doing'…problem-based learning and skills training
- Intrinsically interdisciplinary
- Team-oriented and communications oriented
- Leverage infrastructure….remove "silos"



Ph.D./M.S.
Nanoscale Science
Nanoscale Engineering
Nanobioscience
Nanoeconomics

B.S.
Nanoscale Science
Nanoscale Engineering
(Capstone 300mm Fab Courses)

Doctoral Internship Programs:
IBM, TI, NIST,
TU Dresden, AMD,
GlobalFoundries
AMAT, TEL, Novellus,
Sematech

Technician-Level Programs
HVCC SMT Lab
FMCC Electrical Technology
Duchess CC IC Fab

Short courses, workshops:
Sematech Metrology Course
IC Fabrication & Yield Control Short Course
PV Manufacturing

Teacher Training & HS Programs:
Nanoelectronics HS curriculum
Cleanroom Shadowing
Research Immersion

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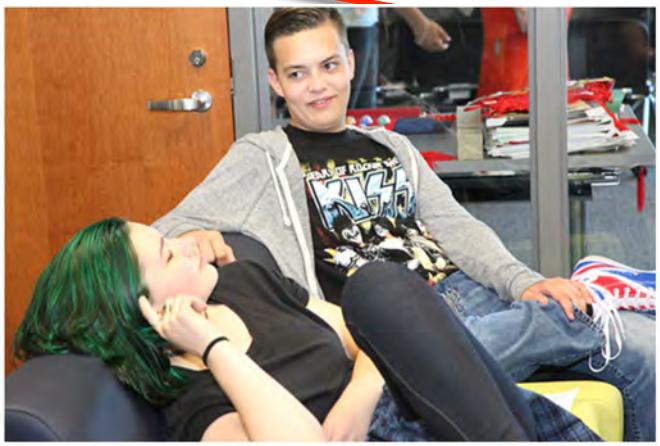
Community College Nano-electronics Internship Program: 2013-2014

- Fall 2013 Cohort (Phase I)
  - 12 interns (HVCC SMT Elec. Tech AAS, FMCC Elec. Tech AAS, SCCC Nanomaterials AAS)
  - 6 CSR Process operator slots at CNSE, 6 Fabrication Technician slots at Global Foundries Malta
- Spring 2014 Cohort (Phase I)
  - 12 interns (HVCC SMT Elec. Tech AAS, FMCC Elec. Tech AAS, SCCC Nanomaterials AAS)
  - 6 CSR Process operator slots at CNSE, 6 Fabrication Technician slots at Global Foundries Malta

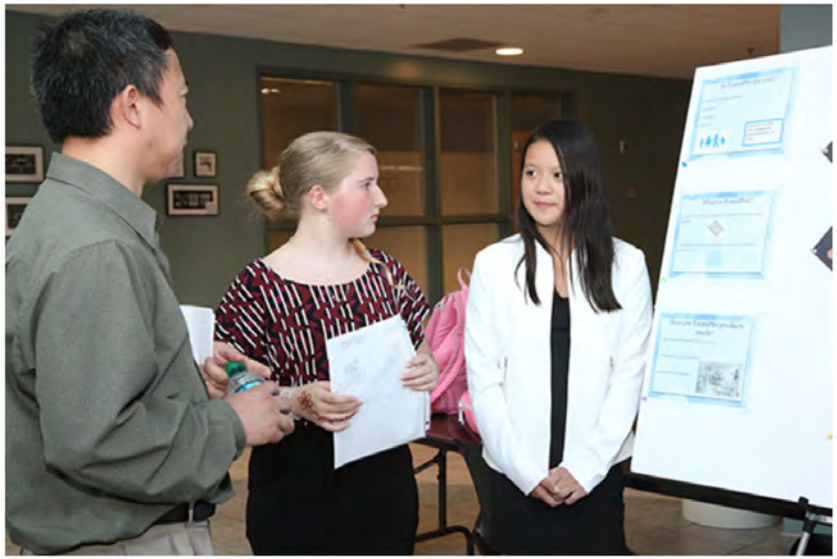
Don’t reinvent the wheel…Partner with the inventor…

In 2014 CNSE became host to the Tech Valley High School, a project-based science and engineering high school partnering with 26 school districts across eastern upstate New York

TechValley®
HIGH SCHOOL



Girls Inc. 'Eureka' Program @ CNSE



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Nano-AMPS Mentor Program

- NEATEC/NSF Mentor Program with ACSD Middle School Students
- 19 6th and 7th grade middle school students matched with CNSE graduate school mentors
- Participated in weekly activities at Doyle, Hackett and North Albany Middles Schools.
- Culminated in weeklong workshop at CNSE

Thanks for Your Attention!