INSTITUTE FOR ELECTRONICS AND NANOTECHNOLOGY

OVERVIEW

ERIC VOGEL, IEN DEPUTY DIRECTOR

OLIVER BRAND, IEN EXECUTIVE DIRECTOR

HTTP://WWW.IEN.GATECH.EDU

CREATING THE NEXT®

GEORGIA TECH – FACTS AND FIGURES

Total GT Students: 32,718

Total GT Instructional Faculty: 2,389

Largest Engineering College in the U.S.

Undergraduates	8,780
Master's	3,103
Doctorate	2,245
Faculty	493
Annual Research Expenditures	~$272M

GEORGIA TECH – RANKINGS

2018 BEST COLLEGES U.S. News & WORLD REPORT RANKINGS

#4 Undergraduate Engineering College

#8 Graduate Engineering College

#8 Public University in the Country for Undergraduate Studies

TEN Undergraduate Engineering Programs Ranked in the **Top 5**

ELEVEN Graduate Engineering Programs Ranked in the **Top 10**

#1 Bachelor Engineering Degrees Awarded to Minority Students

-ASEE/Diverse: Issues in Higher Education

#3 Doctorate Engineering Degrees Awarded to Minority Students

-American Society for Engineering Education (ASEE)

OFFICE OF THE PRESIDENT
ÁNGEL CABRERA

Georgia Tech

- **Executive Vice President for Research** — **CHAOUKI ABDALLAH**
  - Vice President & Director, EI² — **KAREN FITE (interim)**
  - Vice President & Director, GTRI — **JAMES HUDGENS**
  - V.P. & General Manager, GTRC — **JILDA GARTON**
  - Executive Director, Industry Relations — **GEORGE WHITE (interim)**
  - VP Interdisciplinary Research — **RAHEEM BEYAH**
  - VP Research Operations — **ROB BUTERA**
- **Provost & Exec. Vice Pres. Academic Affairs** — **RAFAEL L. BRAS**
  - Vice Provost Enrollment Services — **PAUL KOHN**
  - Vice Provost International Initiatives — **YVES BERTHELOT**
  - Vice Provost Undergrad Education — **COLIN POTTS**
  - Vice Provost Graduate Education and Faculty Affairs — **BONNIE FERRI**
  - Vice Provost Learning Excellence and Dean of Libraries — **C. MURRAY-RUST**
- **Exec. Vice Pres. Finance and Administration** — **JAMES FORTNER (interim)**
  - Campus Operations

INTERDISCIPLINARY RESEARCH INSTITUTES

Faculty, Students, Centers/Lab, IRI Core Staff

COLLEGES

6 Colleges:
Architecture,
Business,
Computing,
Engineering,
Liberal Arts,
Sciences

INTERDISCIPLINARY RESEARCH INSTITUTES

Georgia Tech

BIOENGINEERING AND BIOSCIENCE

Parker H. Petit Institute for Bioengineering & Bioscience

ELECTRONICS AND NANOTECHNOLOGY

Institute for Electronics and Nanotechnology

ENERGY AND SUSTAINABLE INFRASTRUCTURE

Strategic Energy Institute

Brook Byers Institute for Sustainable Systems

MATERIALS

Institute for Materials

CYBER SECURITY

Institute for Information Security and Privacy

MANUFACTURING, TRADE, & LOGISTICS

Georgia Tech Manufacturing Institute

RENEWABLE BIOPRODUCTS

Renewable Bioproducts Institute

PEOPLE AND TECHNOLOGY

Institute for People and Technology

ROBOTICS

Institute for Robotics and Intelligent Machines

BIG DATA

Institute for Data Engineering and Science

NATIONAL SECURITY

Georgia Tech Research Institute

INTERDISCIPLINARY RESEARCH INSTITUTES

Georgia Tech's Interdisciplinary Research Institutes strategically define and nurture transformative interdisciplinary research by:

Establishing and continually refining a technical vision and strategy that will impact the current and future needs of our stakeholders and customers. Articulation of national and international thought leadership.

Enabling and supporting inclusive and active communities of interdisciplinary GT researchers to take risks in developing early-stage ideas and to help build and sustain teams that will enable the creation of and response to large-scale multi-investigator extramural funding opportunities.

Being an effective focal point for interactions with external partners. This includes coordinating visits with industry and government leaders, developing and supporting external partnerships, and assisting faculty with commercialization and economic development.

Developing and maintaining research space, core facilities and administrative infrastructure necessary to enable world-class interdisciplinary research at GT.

IEN VISION AND MISSION

VISION: The Institute for Electronics and Nanotechnology enables research, development and deployment of nanotechnology and nanoscience solutions to challenges of global significance.

MISSION:

- IEN provides a focal point of information, facilities & infrastructure for **all nanotechnology and nanoscience** research at Georgia Tech.
- IEN facilitates innovation in **micro-/nano-enabled electronics & photonics** by catalyzing and translating research, connecting Georgia Tech researchers, companies & government agencies, and preparing the workforce.

INSTITUTE FOR ELECTRONICS & NANOTECHNOLOGY
BY THE NUMBERS

Visibility & Thought Leadership

- 60+ faculty in 10 centers & programs
- 6 new centers/programs seeded in past 3 years
- 160+ companies served through centers & core facilities
- 6000+ individuals reached by outreach activities per year

Research Enablement

- 18 interdisciplinary proposals supported over past 4 years
- 190+ faculty enabled by IEN activities
- 1 annual Meindl Distinguished Lecture & Technical Exchange Conf.
- 30+ seminars & short courses per year

Education & Outreach

- 5000+ newsletter subscribers
- 500+ undergraduate/graduate students trained per year
- 25 faculty groups housed in IEN buildings (Pettit & Marcus)
- 1 coordinating office for NSF NNCI program

Core Facilities

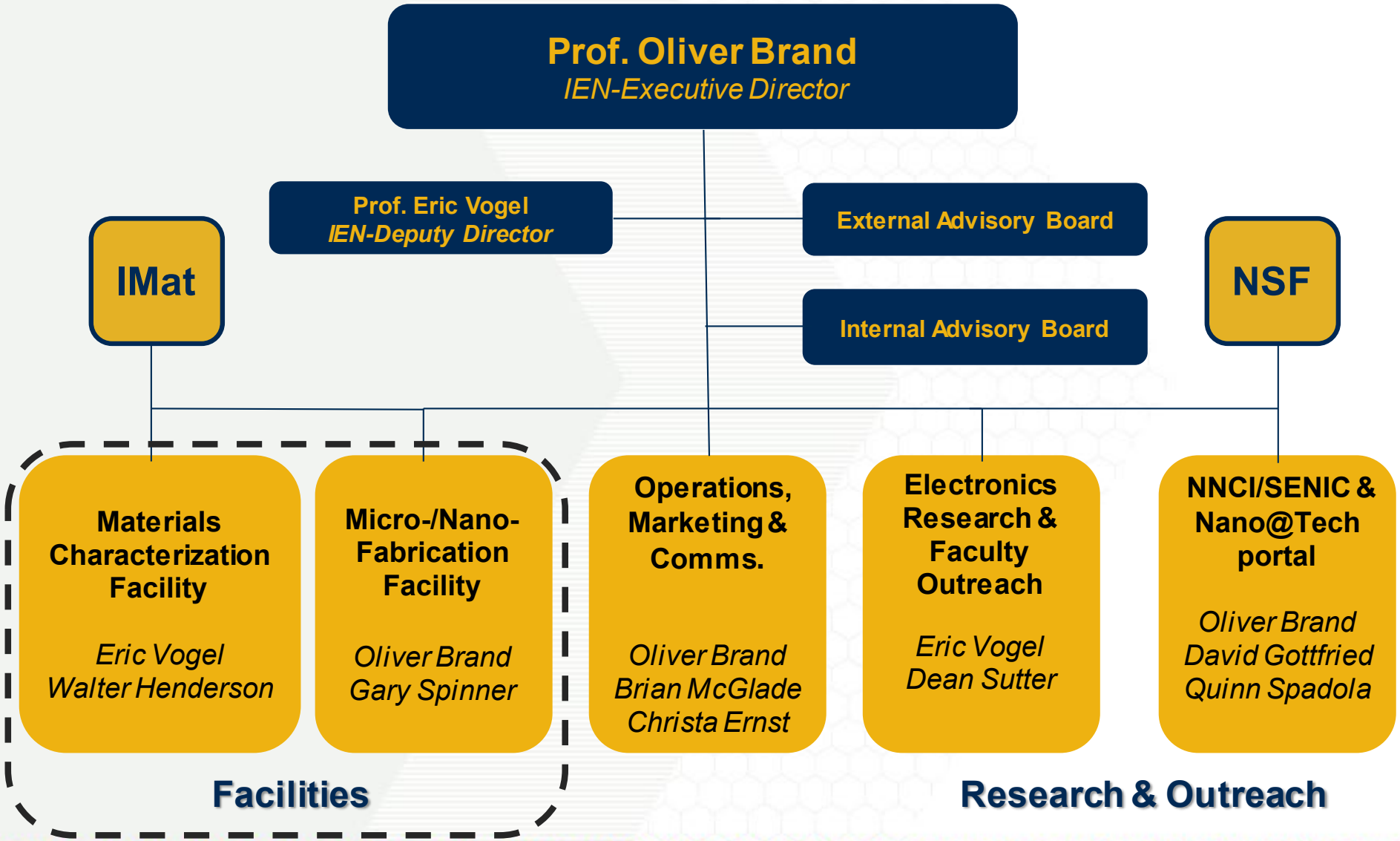
- 850+ annual users in core facilities
- 150 GT faculty groups using core facilities
- 900+ publications and 33 patents/invention disclosures over 2 years
- 1700+ active SUMS users using 40+ core labs

INSTITUTE FOR ELECTRONICS & NANOTECHNOLOGY

ORGANIZATION

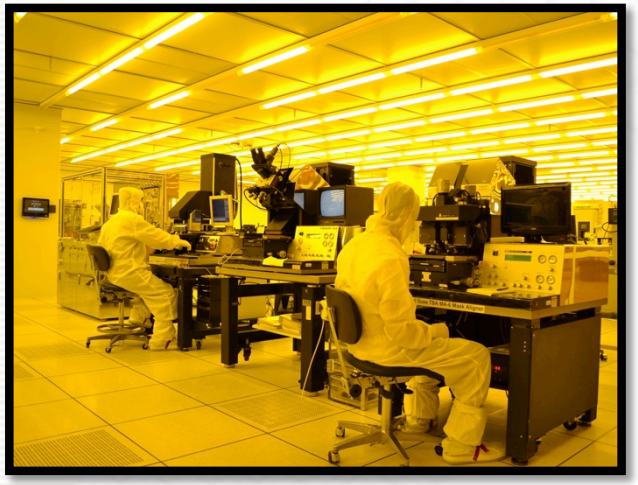
INSTITUTE FOR ELECTRONICS & NANOTECHNOLOGY

ORGANIZATION



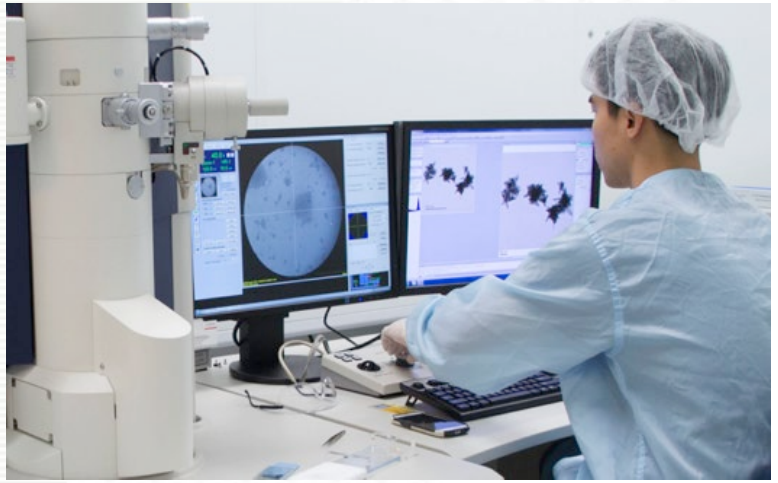
MICRO-/NANO- FABRICATION FACILITY

- Contact: gary.spinner@ien.gatech.edu or paul.joseph@ien.gatech.edu
- 200+ tools available to GT users and non-GT users from academia, industry and government agencies on an hourly basis
- ~25,000 sq. ft. of finished cleanroom space
- > 400 users per year (80% internal, 20% external)
- > 25,000 annual usage hours



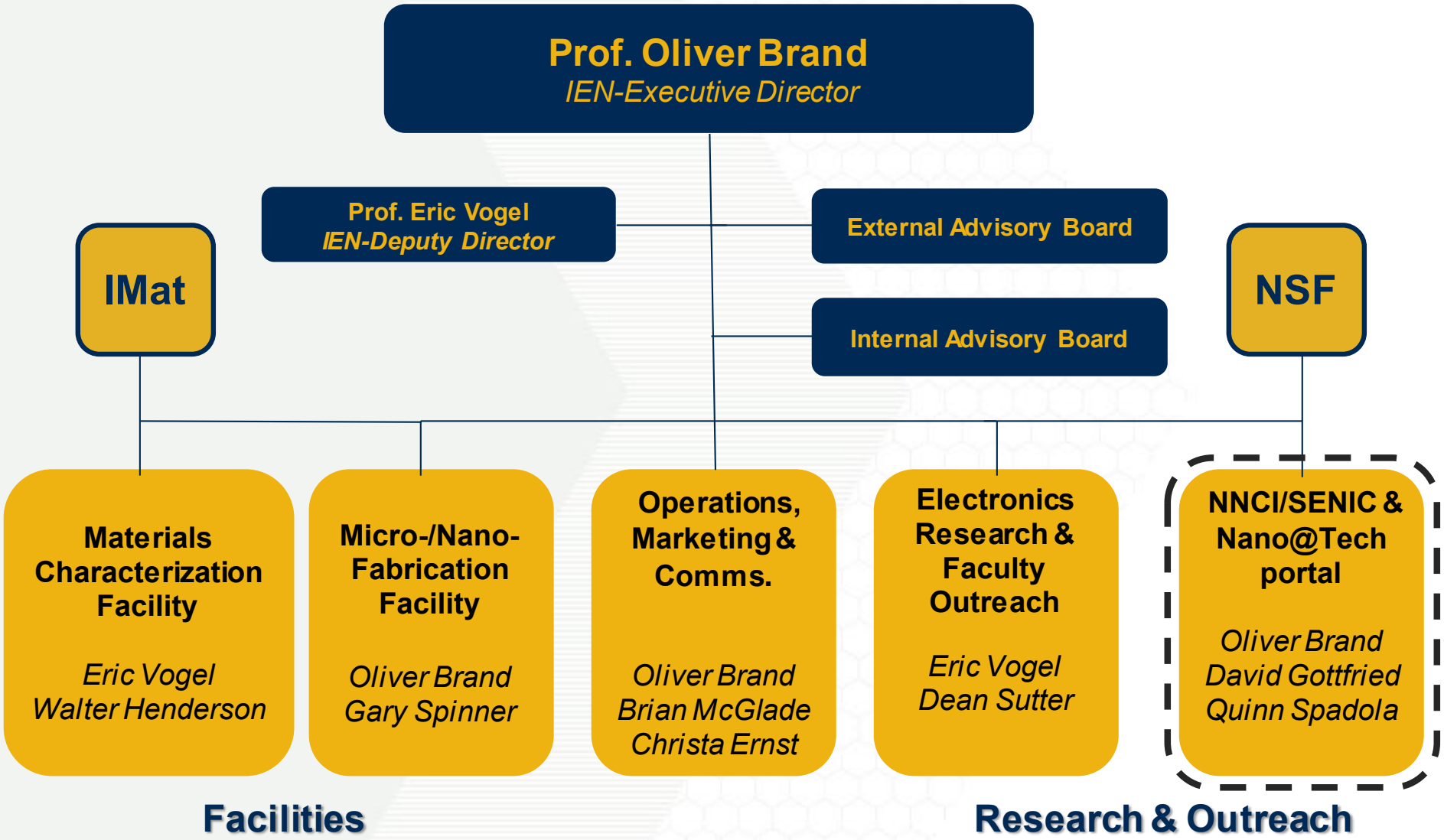
MATERIALS CHARACTERIZATION FACILITY (WITH THE INSTITUTE FOR MATERIALS)

- Contact: walter.henderson@ien.gatech.edu
- 20+ tools available to GT users and non-GT users from academia, industry and government agencies on an hourly basis
- ~7,500 sq. ft. of microscopy space
- > 400 users per year (80% internal, 20% external)
- > 15,000 annual usage hours

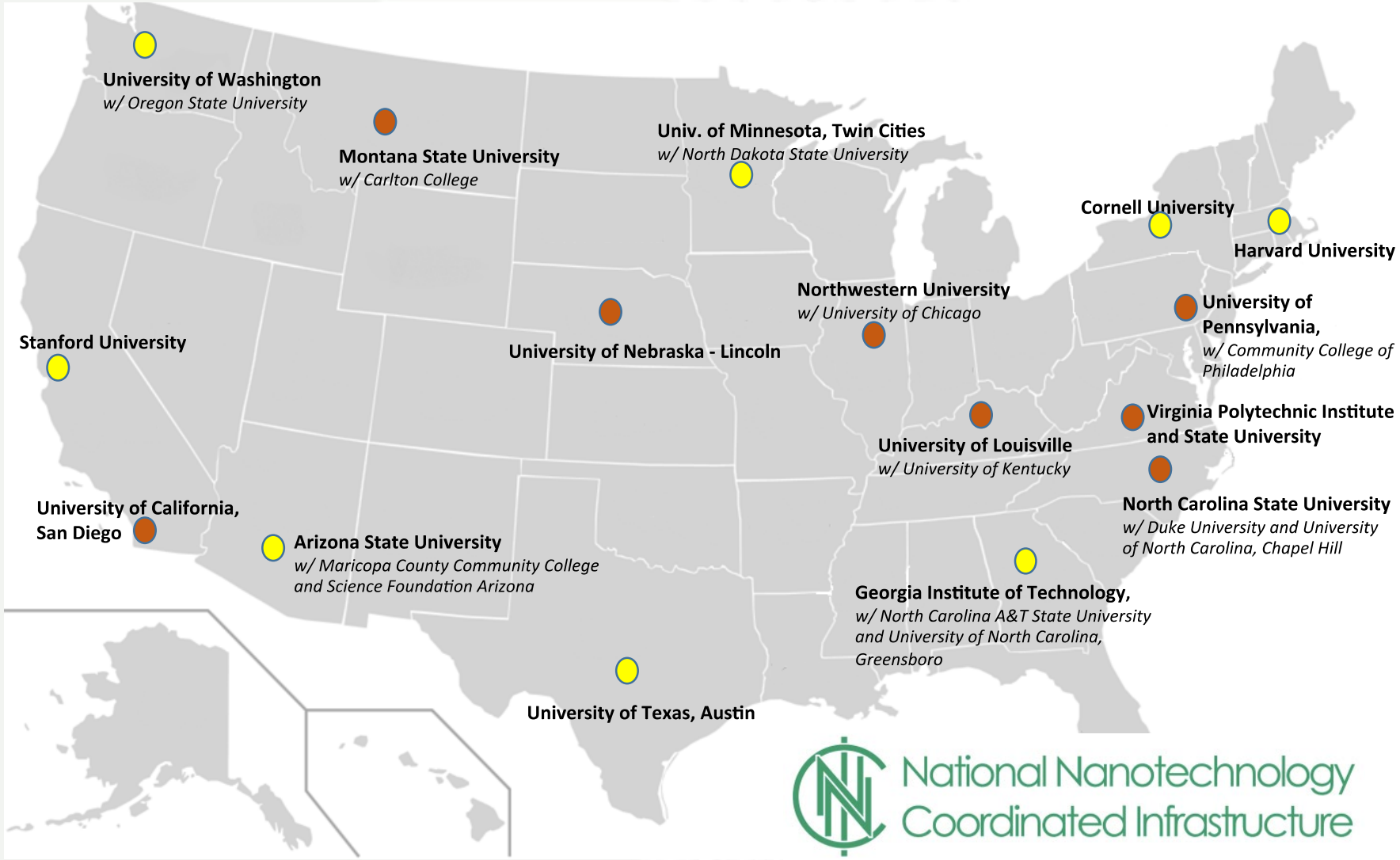


INSTITUTE FOR ELECTRONICS & NANOTECHNOLOGY

ORGANIZATION



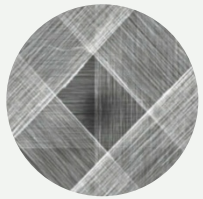
NATIONAL NANOTECHNOLOGY COORDINATED INFRASTRUCTURE (NNCI)



National Nanotechnology Coordinated Infrastructure

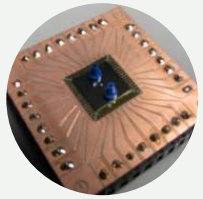
SENIC Southeastern Nanotechnology Infrastructure Corridor

NANO@TECH

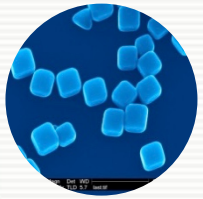


GTMI: Nanomanufacturing

SEI: Nano for energy



IEN: Nanoelectronics



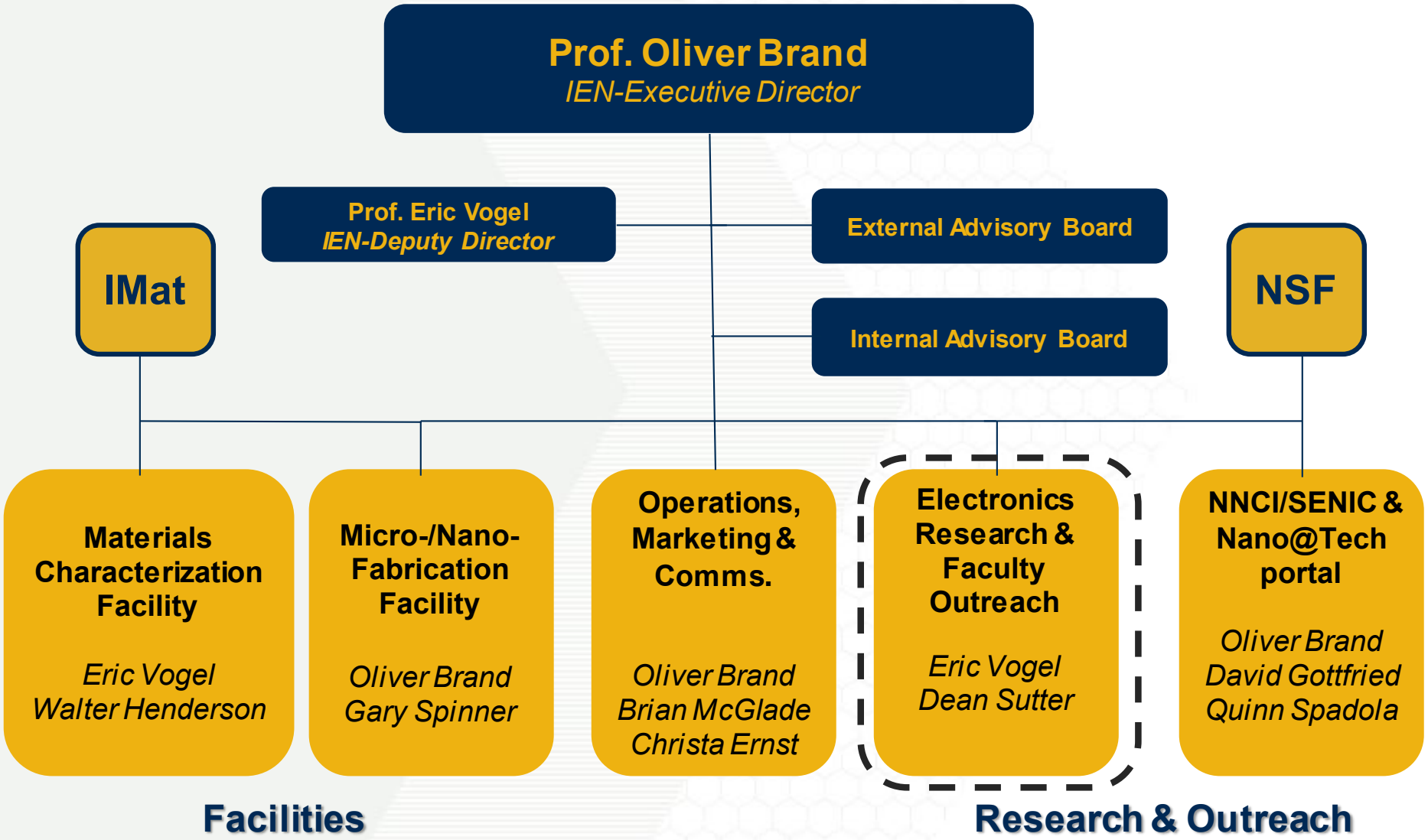
IMat: Nanomaterials

IBB: Bionanotechnology

- Support cross-IRI nanoscale science and engineering research
- Coordinate campus-wide nanoscale science and engineering education and outreach efforts
- Provide a communications portal for all nanoscale science and engineering activity at GT
- Manage activities related to our roles in SENIC and as the coordinating office for NNCI

INSTITUTE FOR ELECTRONICS & NANOTECHNOLOGY

ORGANIZATION

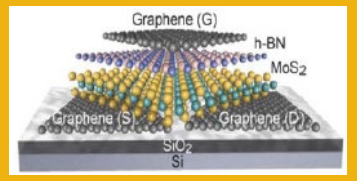


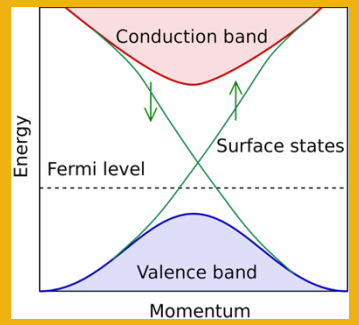
VISION FOR IEN ELECTRONICS & PHOTONICS RESEARCH

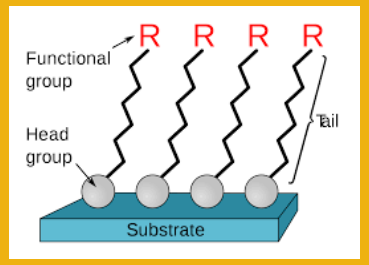
Georgia Tech

Micro-/Nano- Electronics and Photonics: Physics to Applications

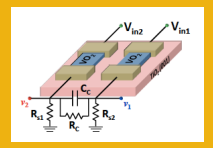
Physics, Materials, Processes

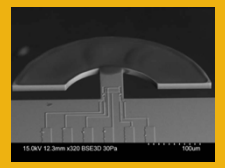


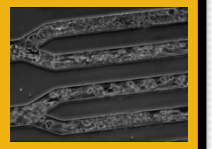


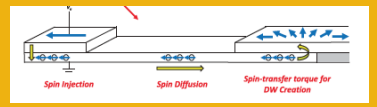


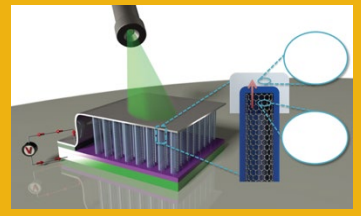
Devices, Components, Interconnects



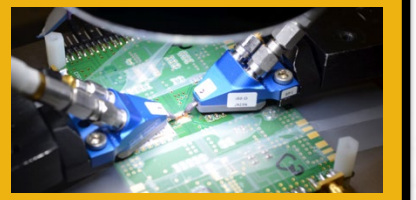


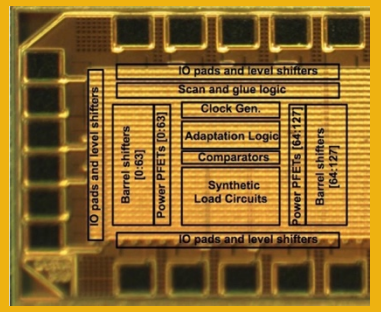


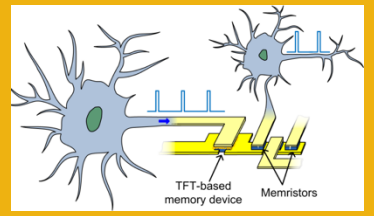




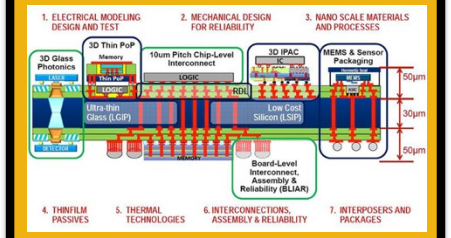
Circuits, Architectures

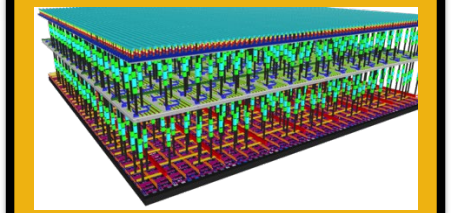


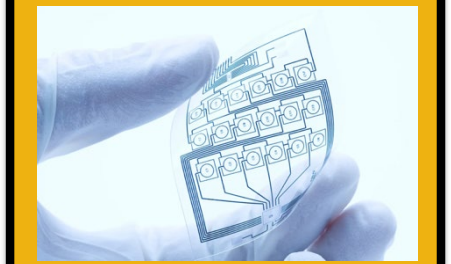




System Integration







Applications

IEN ELECTRONICS/PHOTONICS CENTER/PROGRAM DEVELOPMENT AND SUPPORT

Seeding Phase

- Annual research seed grant RFP
- Peer evaluated similar to NSF process
- 1-2 awards per year at $75k/year for 3 years

New RFP Annually

Growth Phase

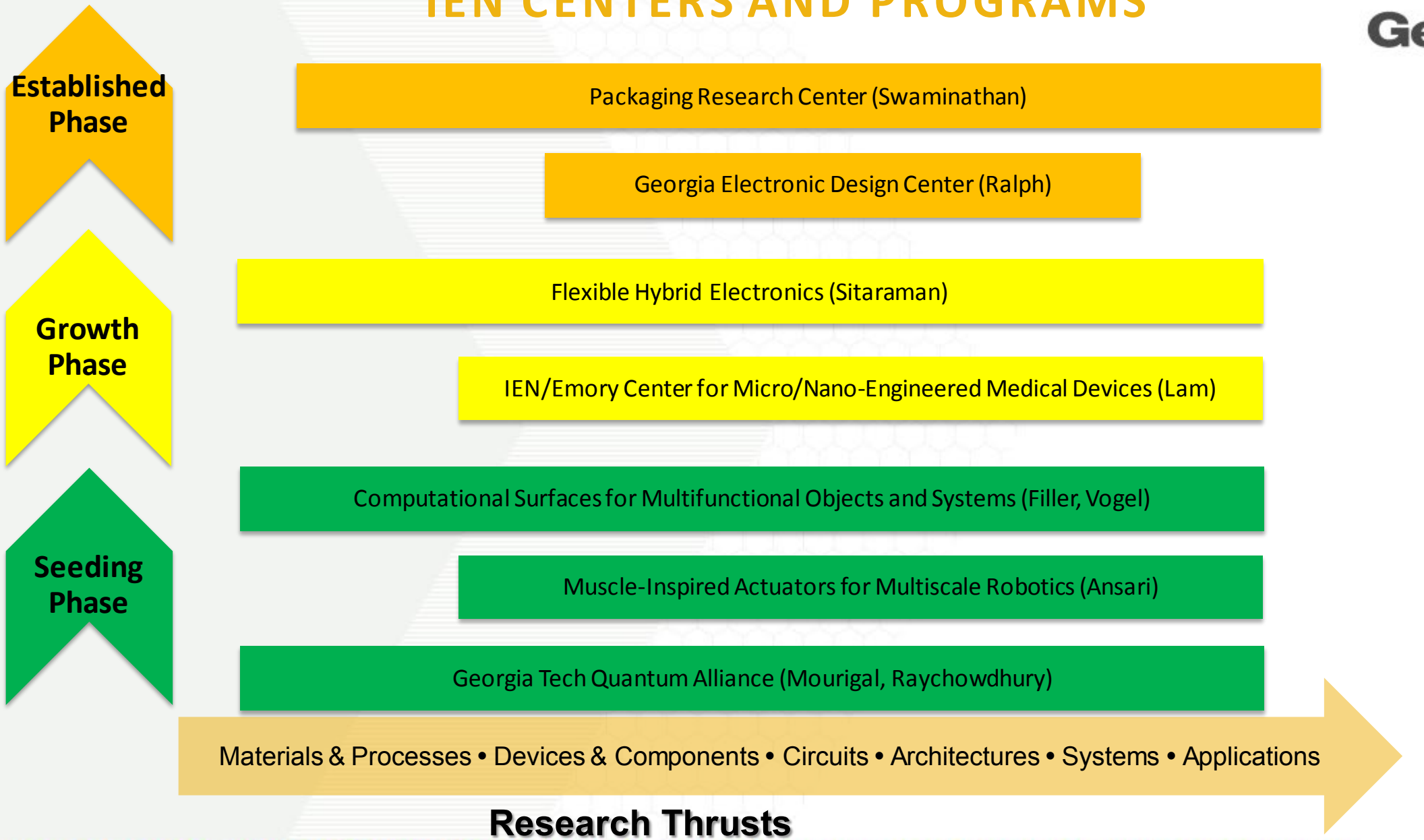
- Transitioning from seed funding to personnel support
- Establishing of center vision/mission, faculty membership, etc.
- Growth of research portfolio

Established Phase

- Administrative & finance support in line with center/program $
- Support for core facility staff
- Partial Support for research faculty

Annual reporting/evaluation at all stages to provide feedback & possibility of sun-setting

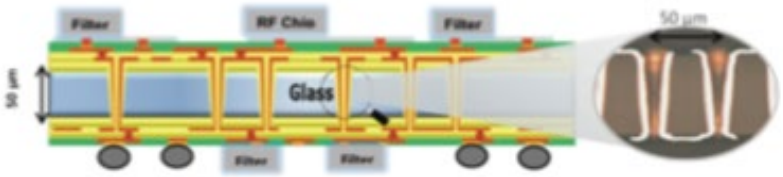
IEN CENTERS AND PROGRAMS



3D SYSTEMS PACKAGING RESEARCH CENTER

The PRC develops system-on-package integration strategies with a focus on glass for a wide variety of core technologies.

Director: Madhavan Swaminathan



30-50μm glass core 3D package

Core Technologies

1. Design
2. Materials
3. Devices
4. Electronic Substrates
5. Photonic Substrates
6. High-temp Electronics
7. Power Electronics
8. Sensing Electronics
9. RF and mm-Wave Electronics
10. EMI Design & Materials
11. Interconnections & Assembly

D&D Test Vehicles

- Communication Electronics
  - Electronics
  - Photonics
  - mm-Wave
- Power Electronics
- Sensor Electronics

Sub-System Integration

SOP

Georgia Tech approach from basic technologies to functional modules to system integration.

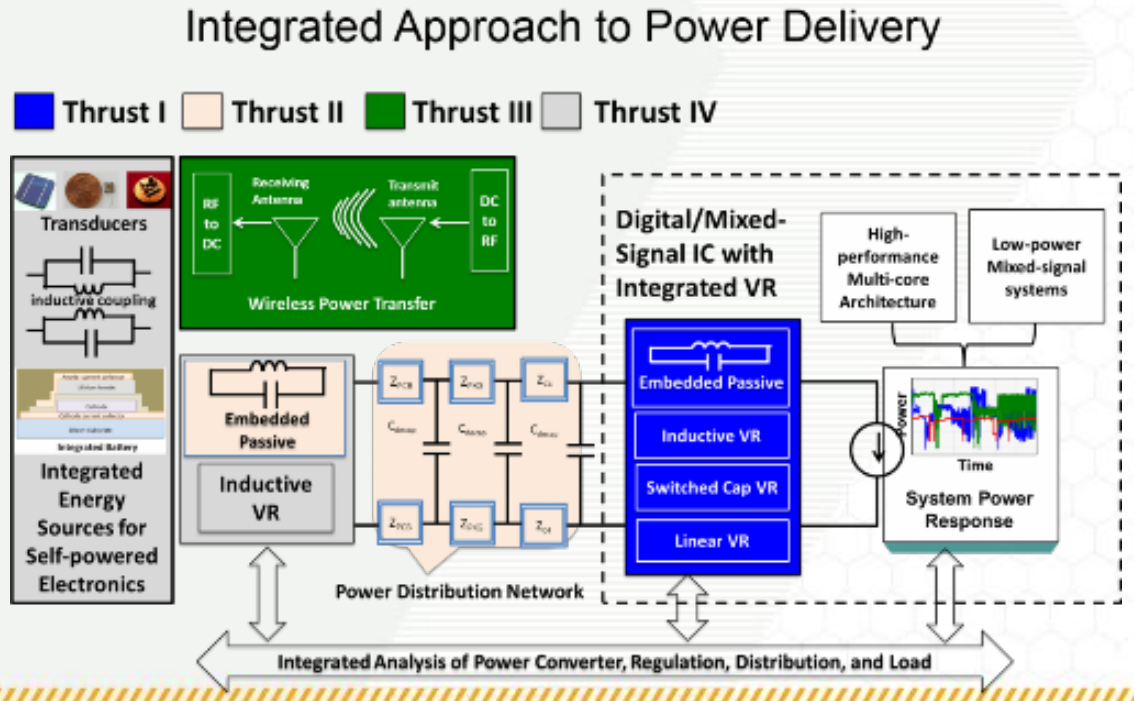
UNITED STATES	EUROPE	CHINA	JAPAN
Brewer Sci - Polymers	HC Starck – Capacitors	JCET – Bumping	Ajinomoto – Dry Film
Corning – Glass	Schott – Glass	KOREA	Asahi Glass – Glass
Rogers – Dielectrics	Atotech – Plating	Fusei Menix – Lamination	MGC – Laminates
Applied Materials – PVD, CVD Tools	EVG – Spray Coating	Gigalane – RF	TOK – Photopolymer
Coherent – Laser	Suss – Laser Via	TAIWAN	Asahi Glass – TPV
K&S – TCB Bonder	Nanium – Bumping	Unimicron – 2.5D	Disco – Dicing
MKS – Plasma Etching	TDK-Epcos – RF	ASE – Assembly	Mitsubishi Electric – Laser
SSEC – Cleaning		TSMC – User	Ushio – Lithography
Tango – PVD Tools			NGK/NTK – 2.5D
QualiTau – Assembly			Shinko – 2.5D
AVX – Passives			Namics – Underfill
Ciena – Opto			
Global Foundries			
IBM – High Perf.			
Qualcomm – All			
TE – Opto			
TI – Passives			

Materials | Tools | Substrates | Assembly | Users

CENTER FOR CO-DESIGN OF CHIP, PACKAGE, SYSTEM (COMBINED WITH PRC)

C3PS conducts leading edge research that aims to increase the performance, efficiency and capabilities of future computing systems for both commercial and defense applications a cross-disciplinary through the co-design of the chip, the package, and the system.

Director: Madhavan Swaminathan



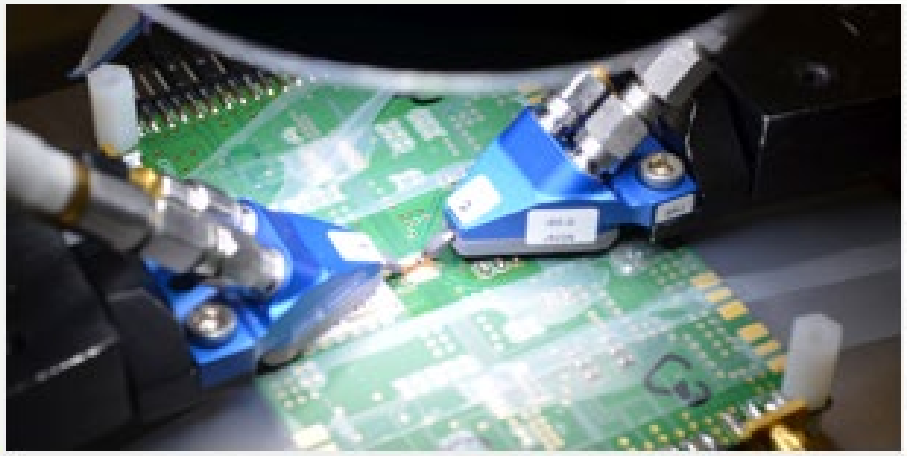
Georgia Tech Georgia Electronic Design Center
Institute for Electronics and Nanotechnology

Georgia Tech

The GEDC is a cross-disciplinary Electronics and Photonics center focused on the synergistic development of **high-speed electronic and photonic components and signal processing** to achieve breakthrough system performance for both Industry and Government.

Director: Stephen Ralph

- Integrated photonics with high speed electronics
- Machine Learning in wideband systems
- Short reach optical systems
- Adaptive Wireless (kHz to THz) systems
- Power efficient wideband electronic systems



AIM photonics
SHAPING THE 21ST CENTURY WITH THE POWER OF LIGHT

Georgia Tech joins AIM Photonics

Aim Photonics is an Institute for Manufacturing Innovation initiated by the White House to enhance manufacturing in strategic technologies within the United States. AIM Photonics focuses on advancing all aspects developing the national infrastructure needed to support a sustainable integrated photonics manufacturing base in the US. Aim Photonics is supported by >$100M from the federal government and will harness the vast infrastructure of the silicon electronics industry and create new packaging and test capabilities to enable deployment of large scale photonic circuits. Prof. Ralph has teamed with Raytheon, Harris, Lockheed Martin, UCSB and UVA to develop "Analog RF Photonics" within an integrated photonics platform. This

FLEXIBLE HYBRID ELECTRONICS

Flexible Hybrid Electronics conducts leading edge research related to combining silicon integrated circuits with flexible materials.

Director: Suresh Sitaraman

GT Flexible Hybrid Electronic Manufacturing Technologies

NEXTFLEX

America's Flexible Hybrid Electronics Manufacturing Institute

CENTER FOR MICRO/NANO-ENGINEERED MEDICAL DEVICES

Georgia Tech

Comprised of IEN faculty and Emory physician faculty, our Center leverages and develops micro/nano-devices to address medical problems that will directly affect the clinical practice of medicine

Directors: Wilbur Lam and Oliver Brand

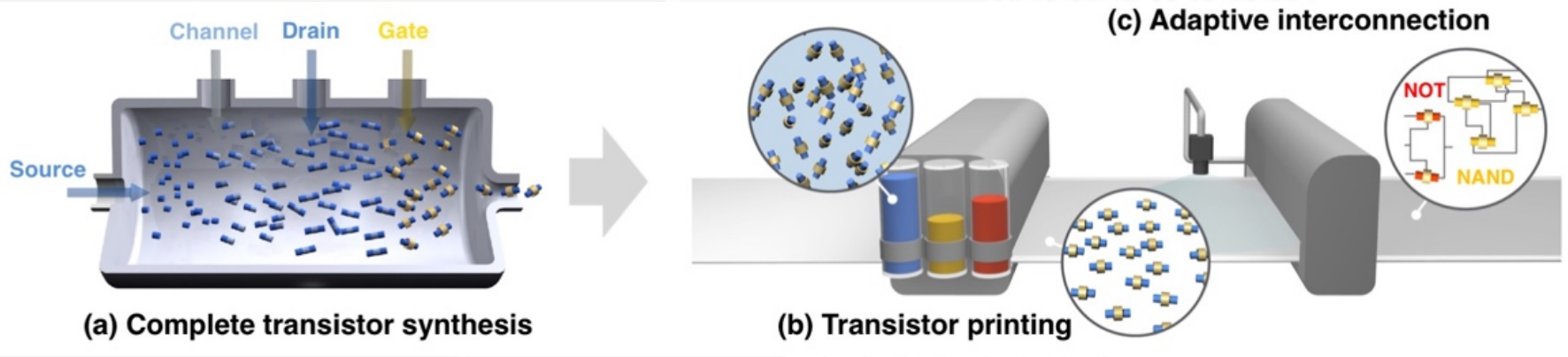
Center led to successful NIH U54 funding of the Atlanta Center for Microsystems Engineered Point-of-Care (POC) Technologies (ACME POCT),1 of 4 NIH-funded Centers as part of the POC Technologies Research Network, which is devoted to fostering the invention, development, translation, and commercialization of “microsystems-based” point-of-care (POC) diagnostic technologies (PIs: Lam, Brand, Martin)

COMPUTATIONAL SURFACES FOR MULTIFUNCTIONAL OBJECTS AND SYSTEMS

COSMOS enables the manufacturing of application specific integrated circuitry at a scale orders of magnitude beyond the state-of-the-art.

Directors: Michael Filler and Eric Vogel

Technology Opportunities: (1) Printed electronics with integrated active devices, **(2)** On-demand integrated circuit manufacturing, **(3)** Autonomous, disposable, wireless smart dust, **(4)** High speed AR/VR displays, **(5)** etc.



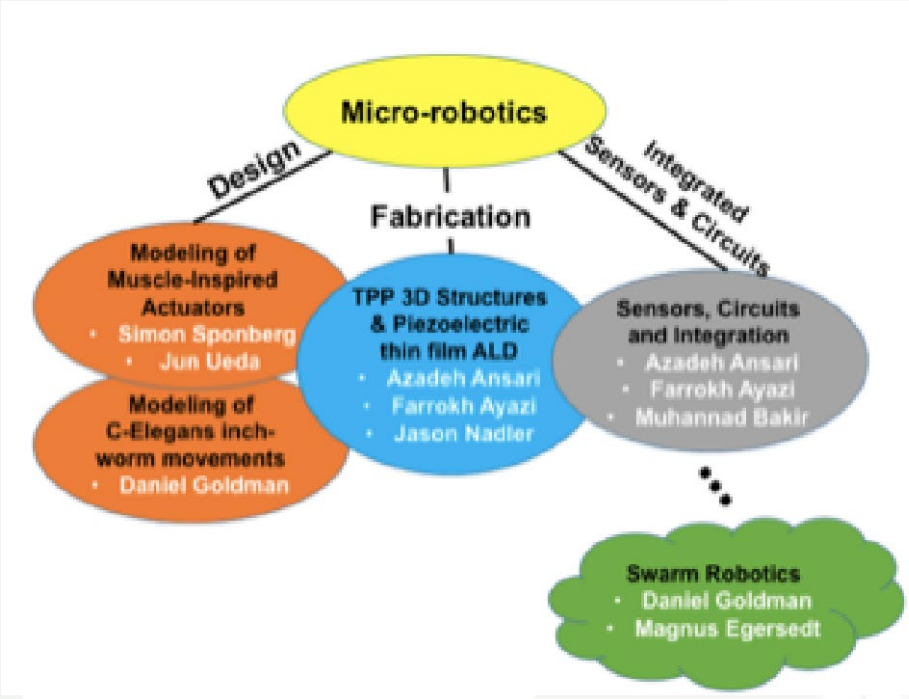
Other Key Faculty

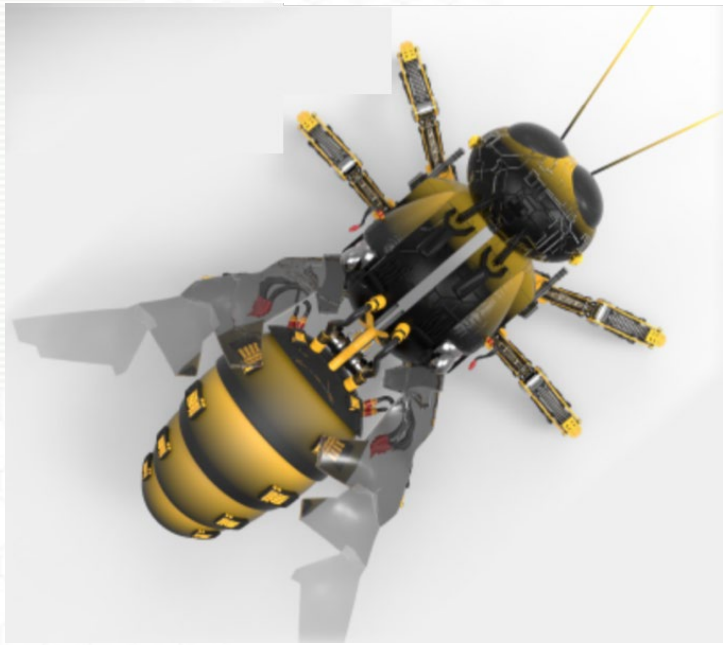
- Gregory Abowd
- Thad Starner
- Tom Conte
- Arijit Raychowdhury
- Manos Tentzeris

MUSCLE-INSPIRED ACTUATORS FOR MULTI-SCALE ROBOTICS

MIAMUR is focused on nano-scale 3D-printing and additive manufacturing, combined with MEMS fabrication technology to build cellular micro-actuators, sensors, and integrated circuits for micro-robotics applications.

Director: Azadeh Ansari





Other Key Faculty

- Jun Ueda
- Simon Sponberg
- Daniel Goldman
- Farrokh Ayazi
- Muhannad Bakir
- Jason Nadler
- Magnus Egersedt

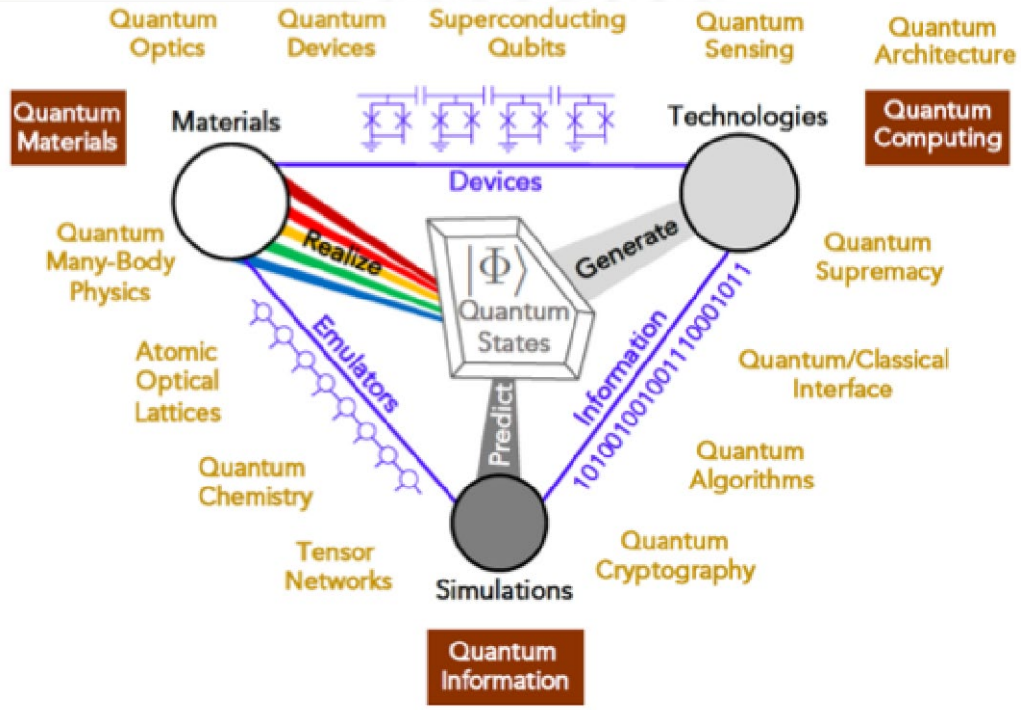
GEORGIA TECH QUANTUM ALLIANCE

Georgia Tech QUANTA enables quantum information processing through advances in technology, engineered systems, underlying materials, and computing architectures, models and algorithms.

Directors: Martin Mourigal (ECE) and Arijit Raychowdhury (Physics)

Georgia Tech QUANTUM ALLIANCE

Institute for Electronics and Nanotechnology



Other Key Faculty

- Ali Adibi
- John Cressler
- Glen Evenbly
- Zhigang Jiang
- Asif Khan
- Pete La Pierre
- Moin Queshri
- Carlos Silva
- Curtis Volin

IEN EVENTS (SELECTED TITLES)

Technical Seminars

- Plasma Processing of Thin Films
- ToF-SIMS: What is State-of-the-Art?
- Dielectrics for ICs and Packaging: Materials Used Today and Future Prospects
- Vacancies, Traps and Defects in Chemical Electronics
- Introduction to Low Flow Measurement and Control

Workshops

- Soft Lithography for Microfluidics
- Short Course on Microfabrication
- GTMI Internet of Things for Manufacturing Workshop

Nano@Tech Seminars

- Nanotechnology for Ultrasensitive and Noninvasive Diagnostics
- Metal Nanoparticles and Silica Structures: Self-Assembly and Shape Control
- IMU-on-a-Chip: MEMS and CMOS Microsystems
- Engineered Bionanocomposites for Biosensing and Bioelectronics
- The Role of Thermal Transport in Nanotechnology Applications
- Commercialization and Public Values Implications of Nanotechnology

NanoFANS

- Nano-Immuno Engineering
- Nano & Micro-Sensors in Disease Detection
- Current Trends in Ophthalmology

A SMALL SAMPLING OF IEN'S PARTNERS & SPONSORS

Georgia Tech

WAYS TO ENGAGE WITH IEN

- Contract with GT faculty for a one-on-one research project
- Become a member of an existing research center/program
  - Packaging Research Center (Swaminathan)
  - Georgia Electronic Design Center (Ralph)
  - Flexible Hybrid Electronics @ Tech (Sitaraman)
- Use IEN shared facilities; in person or remote
- Create an embedded lab; cleanroom space is available
- Become an IEN Sponsor

THANK YOU

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