

Establishing UCF as an anchor institution for research and education in advanced semiconductor technologies and nanofabrication

Sasan Fathpour

CREOL, The College of Optics and Photonics
& Department of Electrical and Computer Engineering
University of Central Florida

fathpour@creol.ucf.edu

CECS Dean Advisory Board Meeting

University of Central Florida

April 23, 2022

UCF President's 2021-2022 Strategic Investment Program

Academic Excellence Fund

- To support big ideas and longer-term innovations that will have a substantial impact
- Seven million in recurring central funds and \$21 million in central non-recurring funds will be invested, plus unit matching funds

Jump Start Fund

- Invests in one-time projects or purchases to amplify UCF's impact
- Proposals could include requests for research infrastructure, facilities renovations under \$2 million, equipment, temporary staff, etc.
- A total of \$5 million of central university non-recurring funds

Importance of Nanofabrication Cleanroom Facilities

- There is arguably no STEM infrastructure as impactful as a versatile micro/nanofabrication cleanroom facilities
- There is a strong correlation between university research ranking in STEM fields and the capabilities of their cleanroom facilities
- For example, the 16 primary facilities that form the NSF-supported National Nanotechnology Coordinated Infrastructure (NNCI) include Stanford, Georgia Tech, Cornell, UT Austin, and Arizona State amongst others
- At top research universities, cleanroom facilities are truly multiuser (tens to over 100 PIs) and multidisciplinary and synergize different colleges and department programs

Status of Cleanrooms at UCF

- Centrally-operated cleanrooms are known as one of the best catalysts to synergize research among faculty from different colleges and department programs
- UCF currently has three cleanroom facilities spread across three colleges (COP, CECS and COS)
- These previously balkanized facilities are now unified under a shared umbrella and are utilized by over 25 internal PIs and several external users including local industry
- The UCF central cleanroom facility is directly operated and funded by the UCF Office of Research and administered by a joint faculty committee, comprised of three members from each of the three involved colleges
- The fees collected from the users amount to roughly 20% of the operation cost of the center

Shortcomings and Future Plans of Cleanrooms at UCF

- Equipment capabilities are limited or worn out
- Staff support is limited
- The UCF administration has agreed to establish a new 10,000 sq. ft. in the first floor of the to-be-built Research II Building
- The building has the second highest priority in the university masterplan

Why Not take Advantage of the UCF President Initiative?

Response to UCF President's 2021-2022 Strategic Investment Program

- **Name of co-PIs:**
- **College of Optics and Photonics:** Sasan Fathpour, Peter Delfyett, Patrick LiKamWa, and Kyle Renshaw
- **College of Engineering and Computer Science:** Reza Abdolvand, Parag Banerjee, Hyoung Jin Cho, Kevin Coffey, Kris Davis, Xun Gong, Tengfei Jiang, Swaminathan Rajaraman, Tania Roy, and Kalpathy Sundaram
- **College of Sciences:** Robert Peale, Enrique del Barco, Debashis Chanda, Arkadiy Lyakh, and Masahiro Ishigami

The combined research funding received during the past 3 years by the 19 listed co-PIs on this proposal is more than \$18.5M

Two Funded “Cleanroom” Proposals (Total of ~ \$7,000,000)

Academic Excellence Program

- **Cleanroom Equipment Budget** (Total of \$1,785,000 nonrecurring fund from UCF):
 - Advanced Electron-Beam Lithography System (\$1,700,000 with \$1,495,000 from UCF)
 - E-Beam Evaporator System for Metal Deposition (\$280,000 with \$260,000 from UCF)
 - Plasma-Enhanced Chemical Vapor Deposition (PECVD) Chamber (\$255,000 with \$30,000 from UCF)
- **Six UCF Faculty Positions** (\$1,150,000 recurring salaries and \$3,800,000 startup fund):
 - More details later
- **Two Cleanroom Technical Staff Positions** (\$250,000 recurring salaries from UCF):
 - Manager of UCF’s Nanofabrication Cleanroom Facilities
 - Equipment Maintenance Engineer

Jump Start Program

- **Equipment Acquisition:** A direct-write (maskless) photolithography tool (\$534,000 with \$430,000 from UCF)

Major Equipment to Be Acquired



Raith EBPG5150 Plus - Ultra High Performance e-Beam Writer



AJA International's ATC Series e-Beam Evaporator



DWL 66+ maskless photolithography system from Heidelberg, Inc.

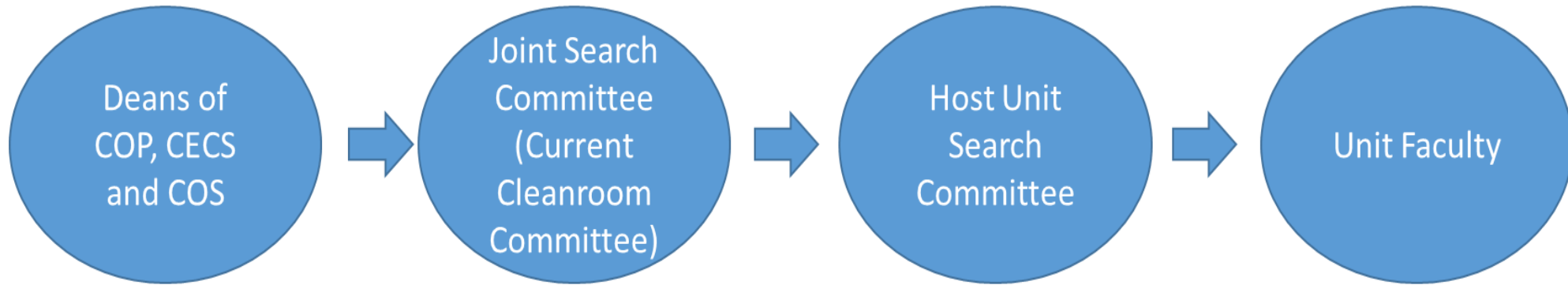
Example Fields That Can Flourish

- **College of Computer-Engineering and Computer Science (CECS):** Nanoelectronics, Nanomaterials science and engineering, Microbatteries and MEMS (micro-electromechanical systems)
- **College of Optics and Photonics:** Integrated photonics, Nanophotonics, Optoelectronics, biophotonics, Photovoltaics, Plasmonics and Metamaterials
- **College of Sciences:** Low-dimensional solid-state physics, Nanoscience
- **Explored Areas of Hire:** Next-generation computing, Topological electronics and photonics, Integrated space photonics and electronics, Integrated quantum photonics and communication, Optical interconnects and heterogeneous electronic-photonic integrated circuits, Novel metamaterials and nano-devices

Faculty Hires in Next-Generation Computing Hardware

| Faculty Position Description | Anticipated Areas of Expertise | Department/Unit | Hiring Completion Date |
|---|--|---|------------------------|
| Endowed Chair in Nanophotonics for Optical Computing | Optical artificial neural networks; Analog optical computing hardware; Optic-enabled deep learning; Optical convolutional accelerators | CREOL, COP | August 2023 |
| Tenure-Track Assistant Professor in Quantum-Optic Computing | Optical quantum computing devices and circuits; Integrated quantum photonics; Large-scale quantum photonic circuits | CREOL, COP | August 2024 |
| Tenure-Track Assistant Professor in Neuromorphic Computing | Neuromorphic electronic computing; Neuromorphic integrated circuits for big data and artificial intelligence; Nanoelectronics for machine learning | Electrical & Computer Engineering, CECS | August 2023 |
| Tenure-Track Assistant Professor in Nanomaterials for Computing | Novel nanomaterials for artificial learning; Quantum materials and devices; Metamaterials for deep learning; Novel materials for spintronics | Materials Science & Engineering, CECS | August 2023 |
| Tenure-Track Assistant Professor in Spintronic Computing | Neuromorphic spintronics; Spintronic quantum computing; Spintronic integrated circuits; Scalable spin-based devices | Physics, COS | August 2023 |
| Tenure-Track Assistant Professor in Superconductor Computing | Superconductor quantum computing; High-temperature superconducting circuits; Large-scale Josephson junction circuits | Physics, COS | August 2024 |

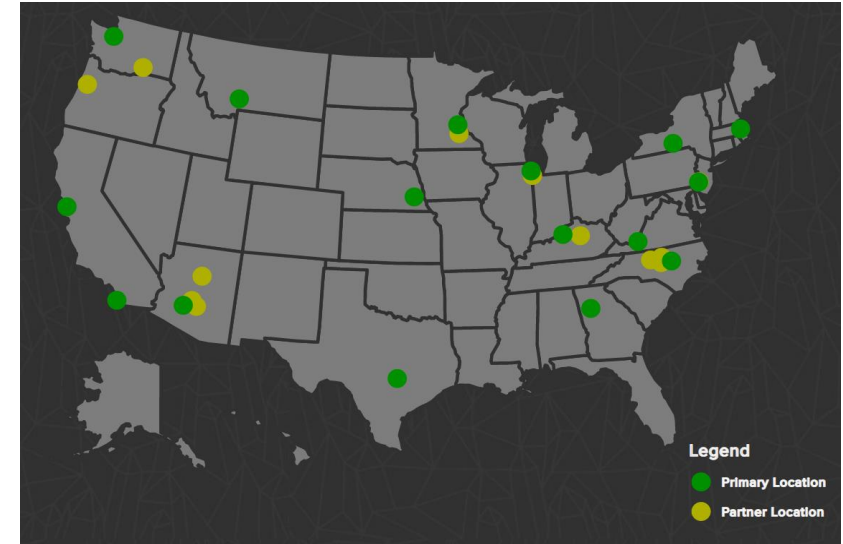
Plan for Dean and Committee Oversight



- **Joint Search Committee:** There are three members in this committee, who represent each college and are appointed by the Deans. Currently, they are S. Fathpour (COP), R. Abdolvand (CECS) and R. Peale (COS)
- It was proposed that the PI (S. Fathpour) serves as the chair of the Joint Search Committee

Regional and National Impacts

- Improved standing nationwide and enhance the university's future chances in attracting talent in all areas related to advanced semiconductor science and technologies
- The new 6 faculty positions constitute more than 20% increase in research-active faculty members that utilize cleanroom facility
- Complementing local partnerships such as those with SkyWater/BRIDG and FiconTEC
- Combined regional synergic activities in the advanced semiconductor technologies can potentially make Central Florida a national hub for next-generation semiconductor industry



Map of NNCI sites in the US, stressing no presence in the State of Florida