Harvard CNS:

LISE:Cambridge

SEC:Allston

National Nanotechnology Coordinated Infrastructure

NSF

Robert Westervelt
Director - PI

William L. Wilson
Executive Director – *Co*-PI

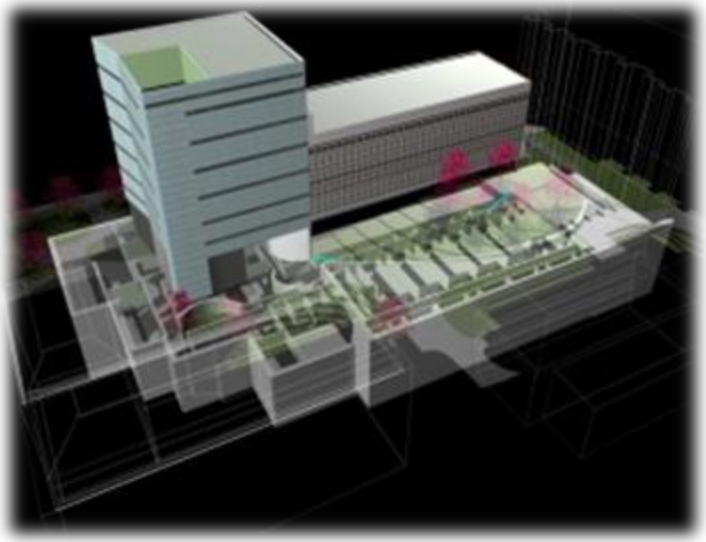
Center for Nanoscale Systems
Harvard University
FAS • SEAS

CNS Overview:

- ***CNS*** serves as a one-stop shop for all things "Nano and Quantum" (almost fully self-use).
- ***CNS*** serves as an important regional, nanoscience community resource. (we are a *"Fully open"* facility)
- ***CNS*** evolves to support the primary research and innovation thrusts within the *Harvard* and *"Cambridge"* regional research community.
- ***CNS*** have initiated new training and educational programs to engage larger numbers of undergraduates, non-traditional, and underserved external users, in nanofabrication, advanced characterization and advanced imaging techniques.
- ***CNS*** is developing a number of new experimental platforms expanding our experimental capabilities; (example, LEEM, LT-Scanning probe spectroscopy platforms, 2D Assembly infrastructure, etc.)
- ***CNS*** has a core research focus on Quantum Networking and Integrated Photonics in thin film NLO Materials
- ***CNS*** is a hub for prototyping/advanced development for Start-up companies and is establishing alliances with local incubators technology, *(~18% of our Userbase).*

What are examples of programs developed under **NNCI** that will be sustainable, independent of any continued **NSF** renewal funding, and what strategies or sources will be used to support them?

- Staff Support (*bandwidth support*)
- Technology Incubator Collaboration / Start-up Bootcamp:
- Technology Platform Development (*Packaging / Materials*)
- **CNS** Spring Seminar Series:
- **CNS** Scholars:
- **REU** program:
- **REV** program:
- *Quantum Noir*:
- **Next:** *NanoFabrication Boot Camp:*
- **Next:** *Quantum Noir 2026*



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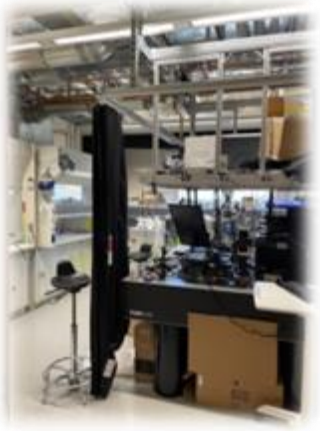
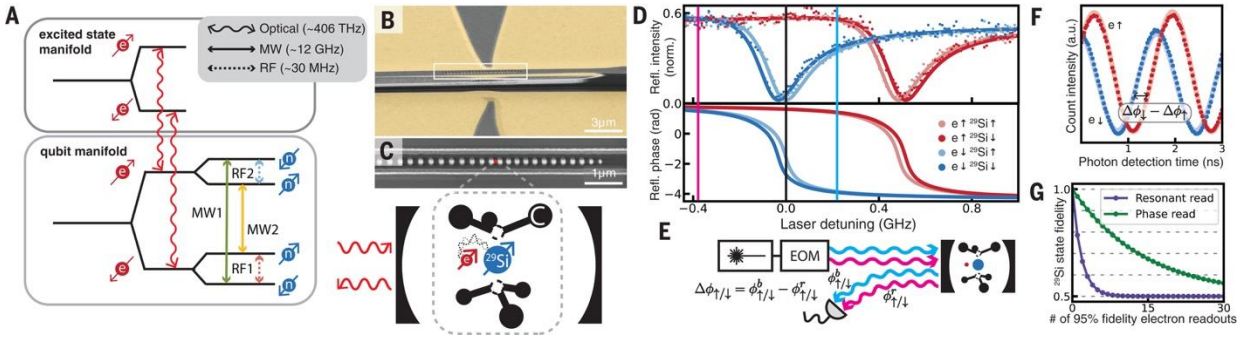
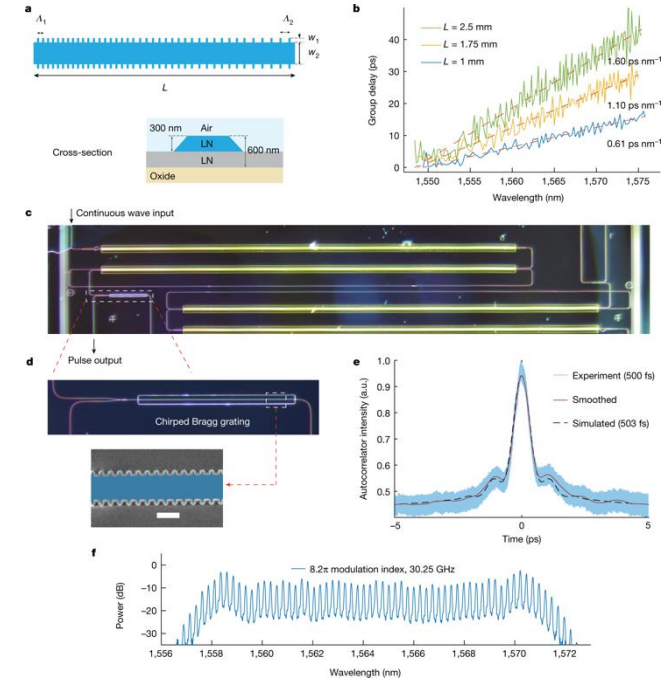
Industry Partner Initiatives:

Quantum Networking: QFab



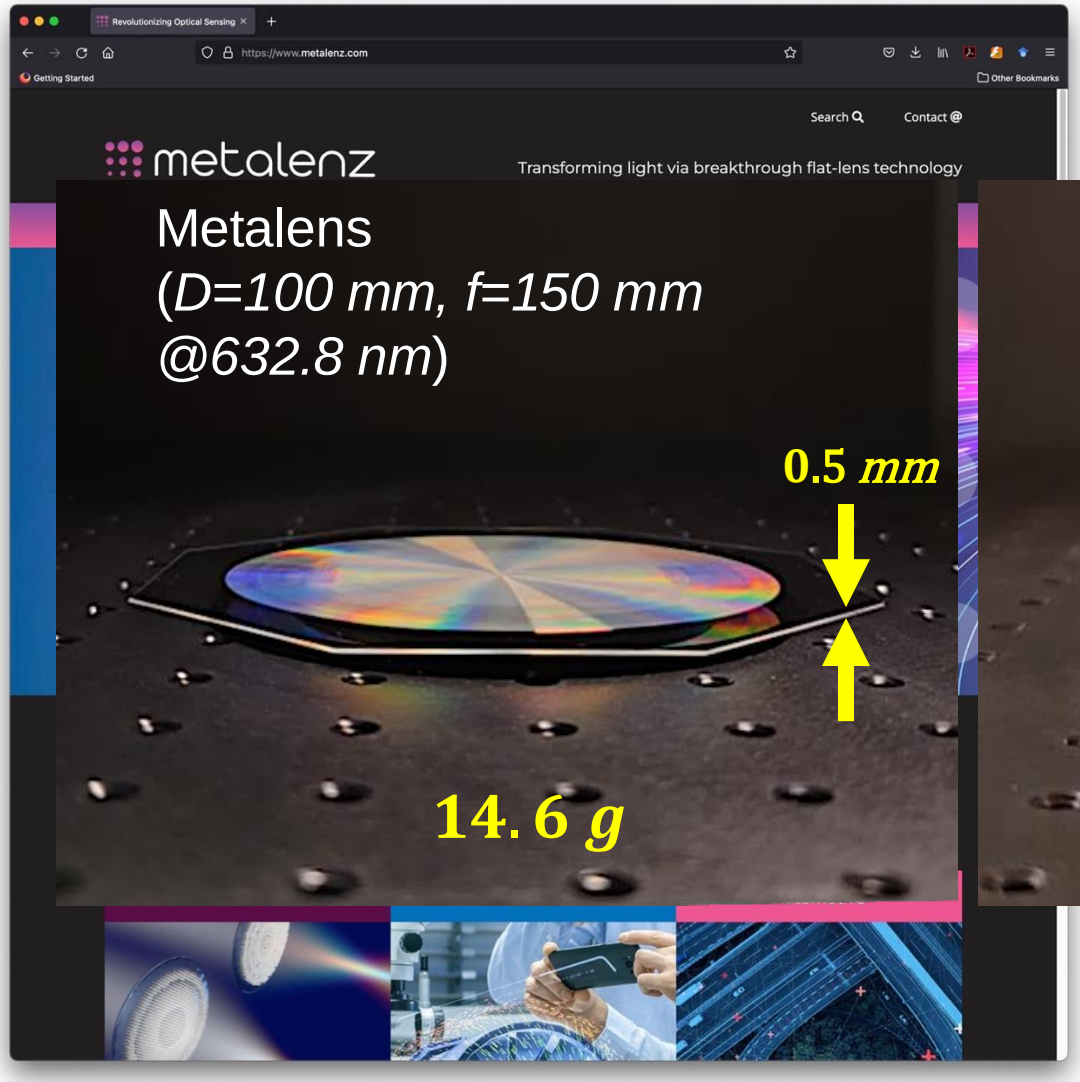
- Integrated Quantum Photonics
- Quantum Repeaters
- Quantum Sources
- Quantum Devices

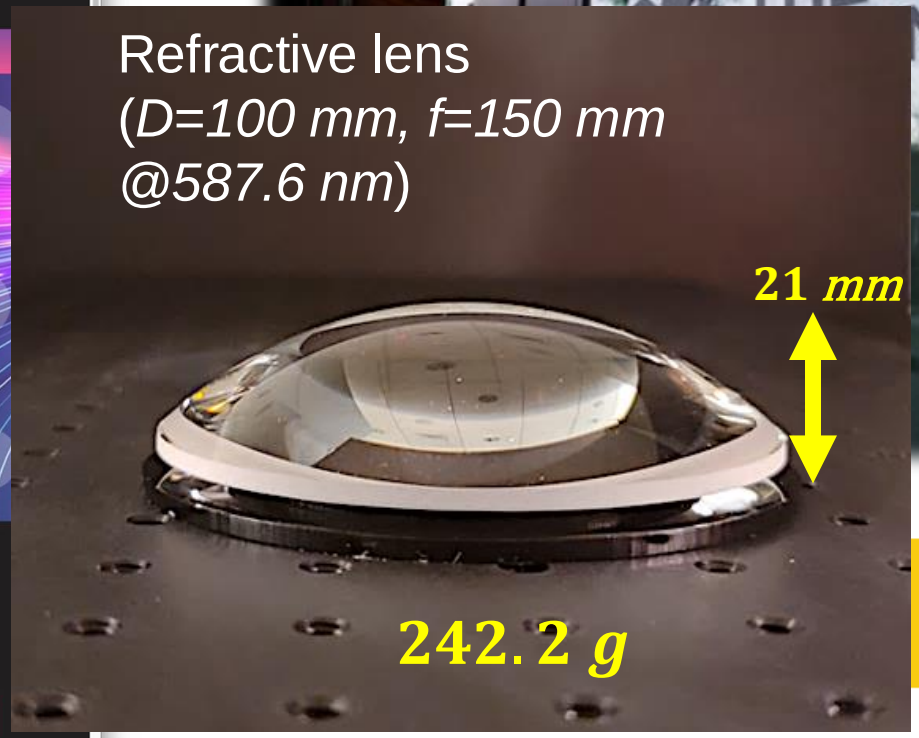




Goal: Bandwidth support / Lab future proofing

Outreach: *Start-up Industry Support*





- Incubator engagement ongoing
- Start-up Bootcamp to return (Spring 2025)

metalenz

Driving the Evolution of 3D Machine Vision Solutions with **Metasurface Optics.**

HARVARD UNIVERSITY

Harvard University spin out (Capasso Lab)

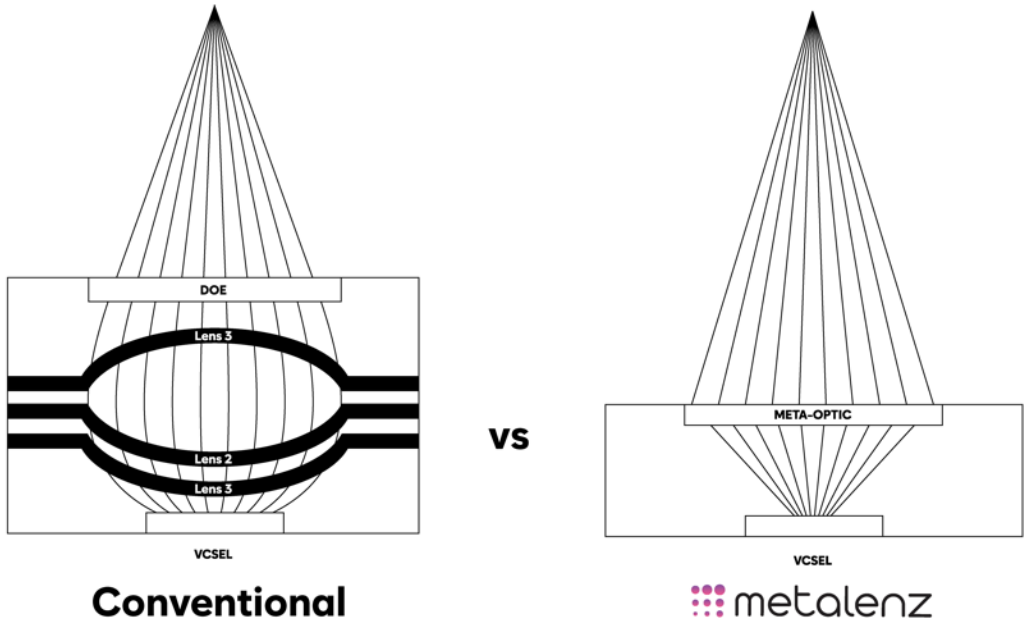
- Fabless optical semiconductor company since 2016.
- Based in Boston with >40 employees.
- Launched world's first metasurface optics in 2022.
- **Launching world's simplest, secure facial recognition in 2024.**

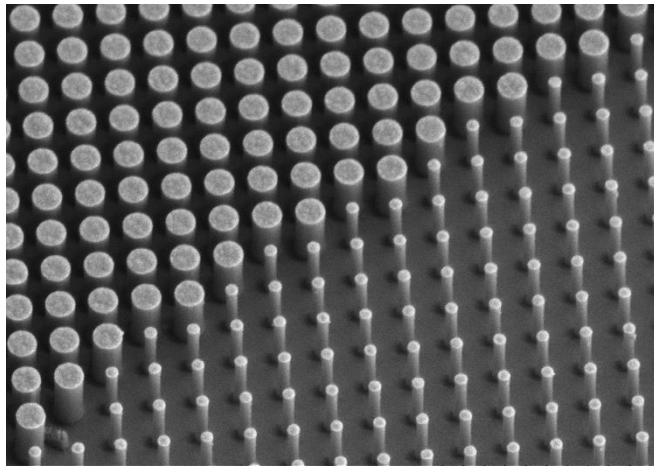
Consumer Devices, Next-gen Biometrics, Auto and IoT

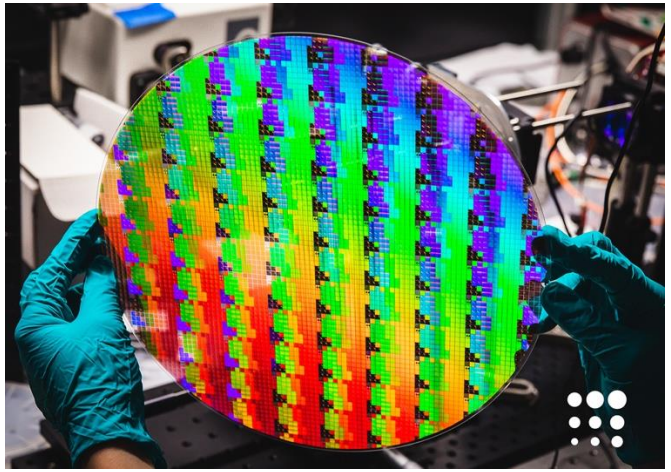
NEOTRIBE TDK TDK VENTURES 3M intel capital M VENTURES foothill ventures APPLIED Ventures global brain SGINNOVATE BRAEMAR ENERGY VENTURES

Metasurface Optics

- Abrupt phase changes in x, y and z
- Multiple functions in one surface
- Fully customizable platform
- Planar optical system
- Control over all information in light







Manufacturing Process

- Enables optics manufacturing in semi foundries
- Single semiconductor layer
- All standard semiconductor materials

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Major Meta-optics Product Milestones

HARVARD UNIVERSITY

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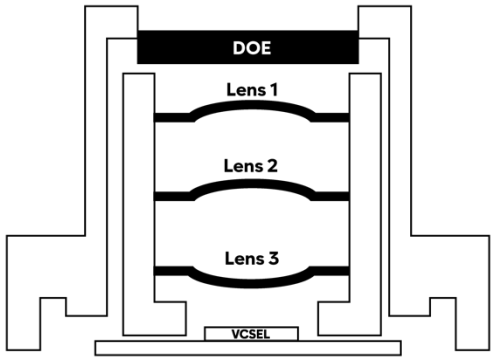
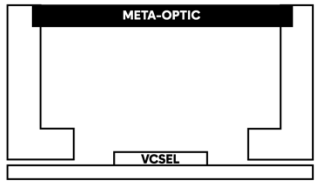
Conventional





- Single metasurface optic replaces multiple traditional optics
- Dot patterns with higher precision & contrast
- Improved light capture on image sensors

2022

Adopted by ST Micro

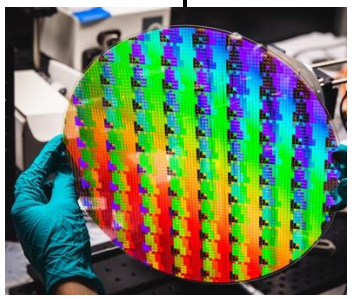
Used in all FlightSense ToF modules

Millions shipped

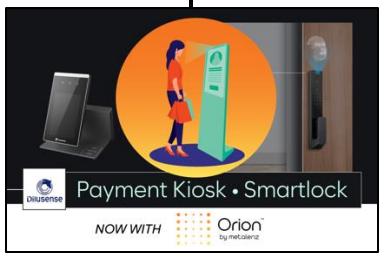
Teardown id's tech in Samsung S23 & Pixel 8

2023

Optics released to MP with UMC



DiLuSense adopts Structured Light Projector for next-gen Face ID Module



2024

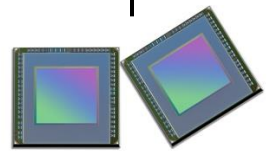
Polar ID Face Unlock demonstrated at MWC

Polar ID by metalenz

android

Qualcomm snapdragon

Samsung's Vizion 931 confirmed as sensor for Polar ID



ISOCELL Vizion 931

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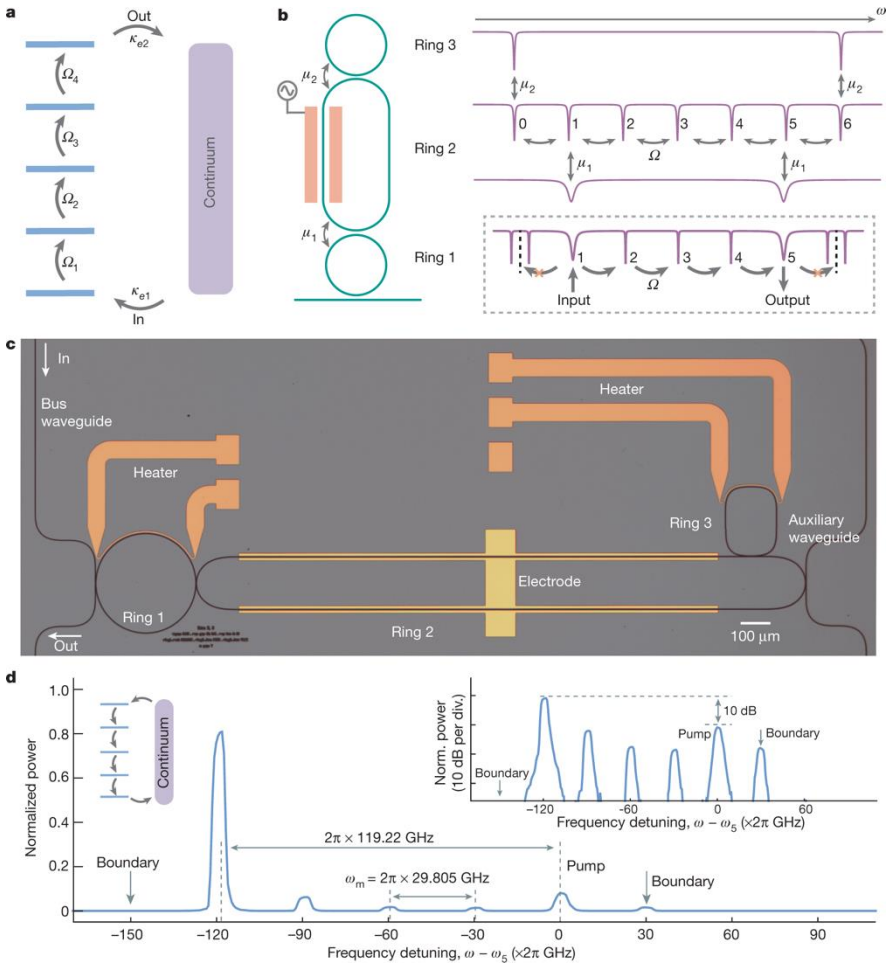
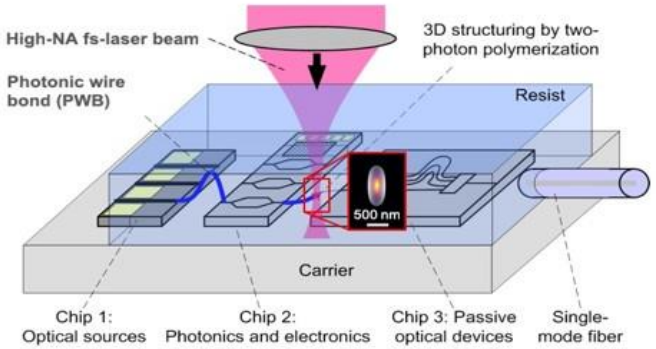
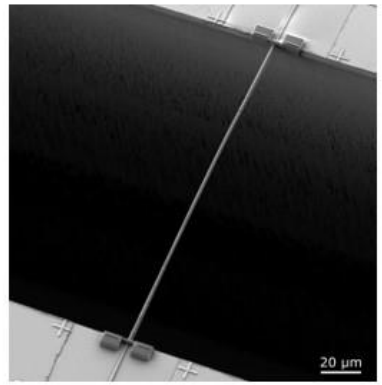
Backend Processing Development: (*MRI Supported)*



Photonic Wire Bonder (PWB) System -Vanguard Symphony 1000

NSF-MRI funding ($ 999 K, PI-Prof. Marco Loncar/Dr. JD Deng)





SEM picture of a photonic wire bridging a LNTF waveguide and an optical fiber

Vanguard Symphony 1000 Includes two units:

Sonata-1000 (PWB-3D laser writing system) and Reprise-1000(PWB-packaging system)

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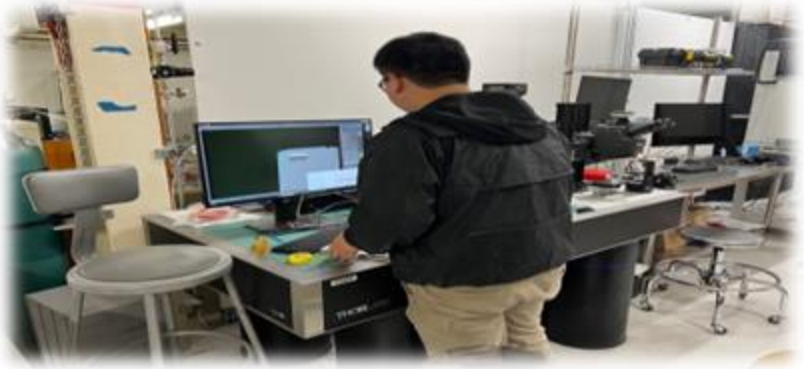
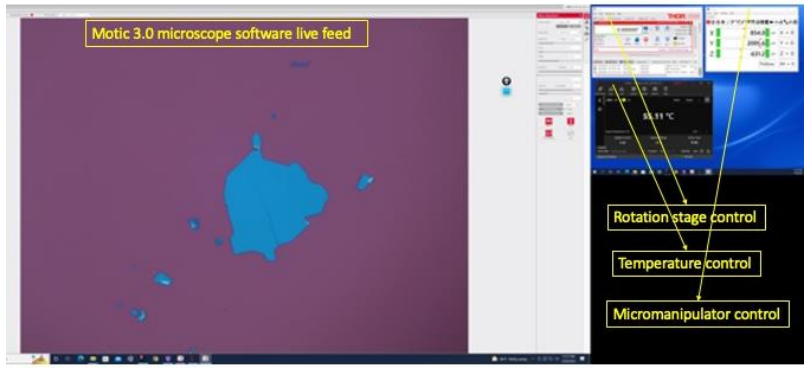
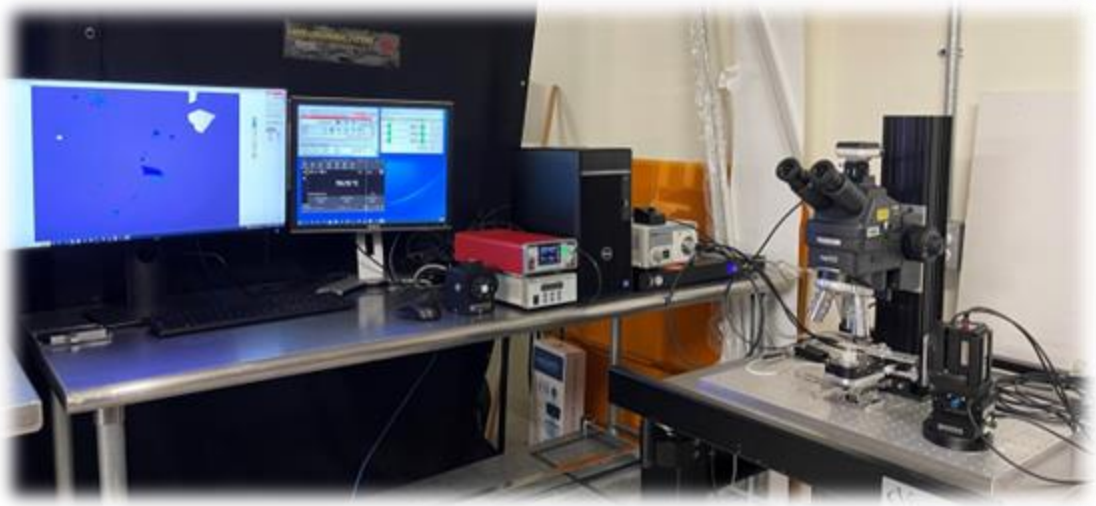
Quantum Materials Infrastructure Development

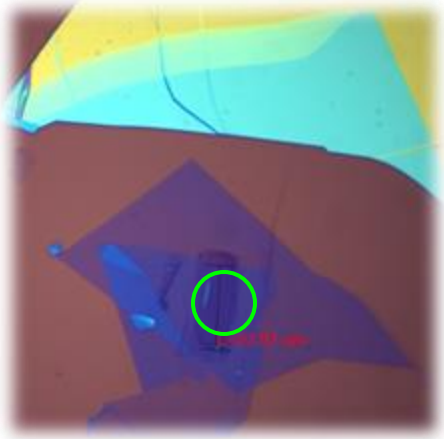
General Access 2D Assembly Platform:
(open to all users)
Currently building a Glovebox based system and



Software and interfaces







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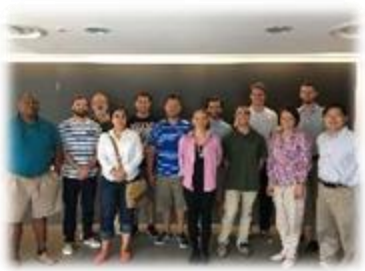
Harvard CNS Outreach: NNCI Enabled

REU – conventional program : but with project offerings from entire userbase, both internal and external



***REU PROGRAM** – Advanced research opportunities for Ugrads from external, 2 and 4yr institutions; added international students in FY19

Research **E**xperienc**e** **V**eterans – *staff serves as mentors*

(some interns carried through school year)

Fully Re-booted

CNS Staff also supporting the nano@Stanford Middle School Teacher program (NanoSIMST)

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Diversity Efforts: *Student Initiatives*

- Establishment of Student Chapter of NSBP at Harvard (officially supported by Physics and the University)
- Sister Chapter at MIT (plans for regional presence)

National Society of Black Physicists

VE RI TAS HARVARD / MIT

Greg Cunningham– **Harvard**
Nicole Taylor - **Harvard**

CNS Scholars (NNCI enabled)

*Prof. K. Dorsey – Smith College

Pheona Williams* – Harvard/MIT

Prof. R. Horton – Miss State University

Dr. Pia Sorenson – SEAS

Dr. Josh Burrow – Brown University

Prof. T. Brower-Thomas – Howard University

Prof. D. Simien – UAB

Doing Check-ins/Spin-ups

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*NSF Career Awardee

CAMPUS & COMMUNITY

Uncovering 'hidden curriculum' for those historically on outside

Quantum Noir fosters sense of community among individuals of color interested or involved in quantum science, nanoscience, engineering

Anne J. Manning | Harvard Staff Writer

June 21, 2024 ▪ 4 min read

Jada Emodogo arrived at the recent **Quantum Noir conference** knowing no one.

The incoming **Harvard Quantum Initiative** graduate student already knew she had an interest in the field. But that wasn't the same as feeling there may be a place for her in it.

"Being able to congregate with different professionals in the field gives me hope for the future, and it really affirms that what I want to do, and what I'm able to do, is right here," she said.

Emodogo, a recent Jackson State University graduate, was among more than

Howard computer engineering major Malcolm Bogroff asks a question at the

Broader Impacts Yr. 1: The primary goals of Quantum Noir and were all on display.

Created of a Community building event for folks in Quantum/Nanoscience and Engineering broadly cast.

- *Fully engaged attendees; Engaged dynamic speakers; robust discussions and a collaborative dynamic*

Executed an opportunity for Grad students and Postdoctoral researchers glean the frontier of Quantum/Nanoscience.

- *We exposed HBCU and MSI students to the key science , leaders and innovators of the relevant fields.*

We provided a Networking Opportunity for researchers and junior faculty of Color in the Quantum/Nano Space.

- *We connected innovators with tools and materials enabling their contributions.*

Created an opportunity for Junior Faculty to meet and Network with Federal Funders (NSF/DOE/DOD).

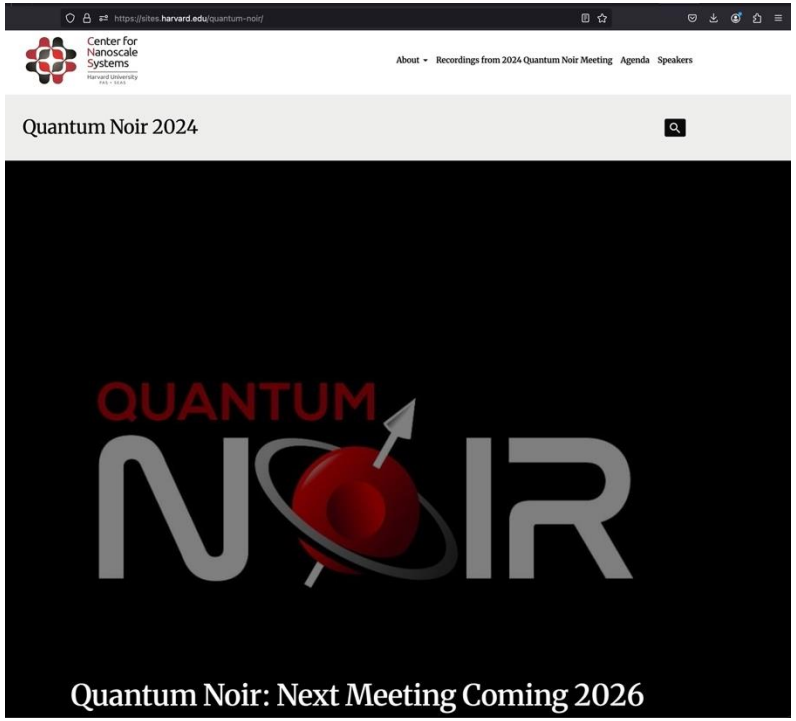
- *Focusing them on National priorities*

Held a dynamic session providing an opportunity for Quantum/ Nano Researchers to meet and Network with Entrepreneurs and VCs.

- *Companies, (for example Atlantic Quantum, Inc.) focused on this branch of science.*

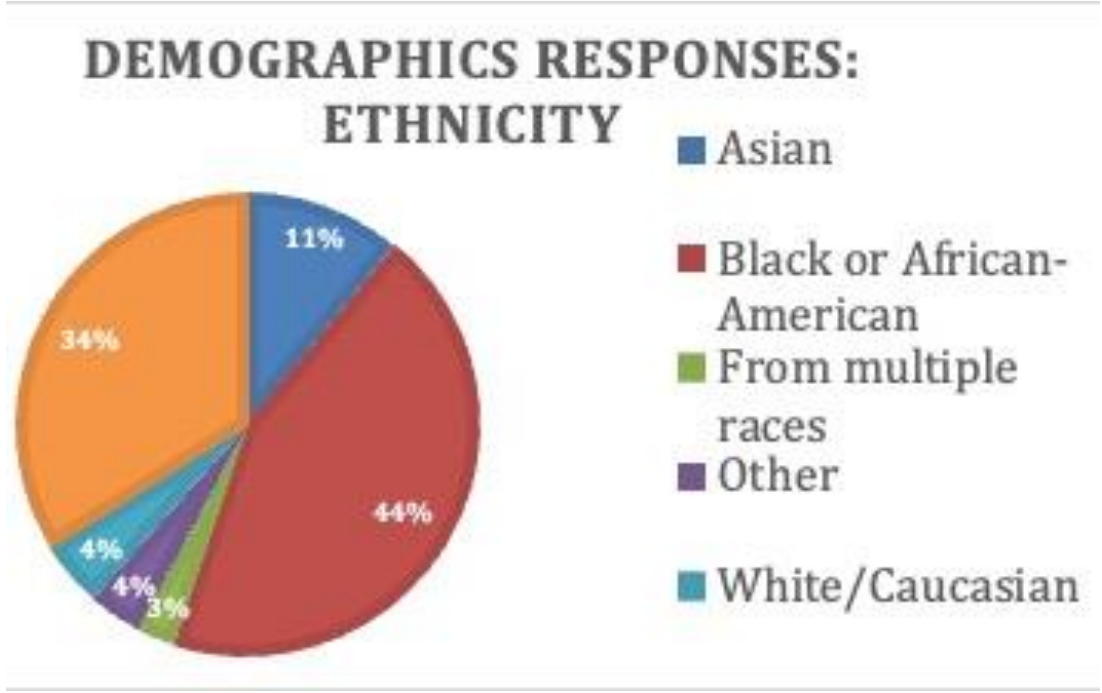
Integrating, diversifying, expanding, and optimizing the Quantum research community is key, we are leaving no one behind as we marshal and educate our nations human technical resources to take on the Quantum Challenge. Having the meeting in Cambridge allowed the Quantum PIs locally to provide a comprehensive overview of the state of the field in a number of areas; Logic, Networking, and Materials design. Importantly, it was clear that the meeting participants had been rarely exposed to this science. The Cambridge community hosts *World-class* research efforts in Quantum Materials, Quantum Computation, and Quantum Networking and number of local researchers at every level from both Harvard and MIT participated in this event. ***All talks and tutorials are being made available on the Quantum Noir website.***

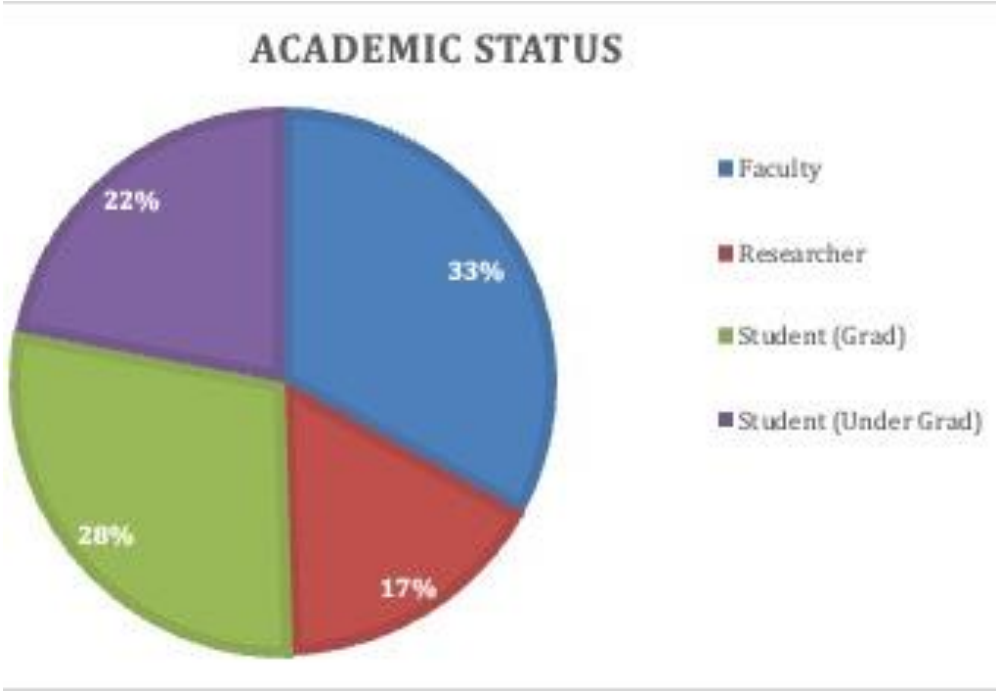
URL: Quantum-noir.org



Harvard CNS: Quantum Noir (stats)

109 Visiting registrants / ~140 attendees at the lectures each day. (All lectures open to the research community)





Supply Chain Consolidation

Enabling the optical foundry

semiconductor foundry

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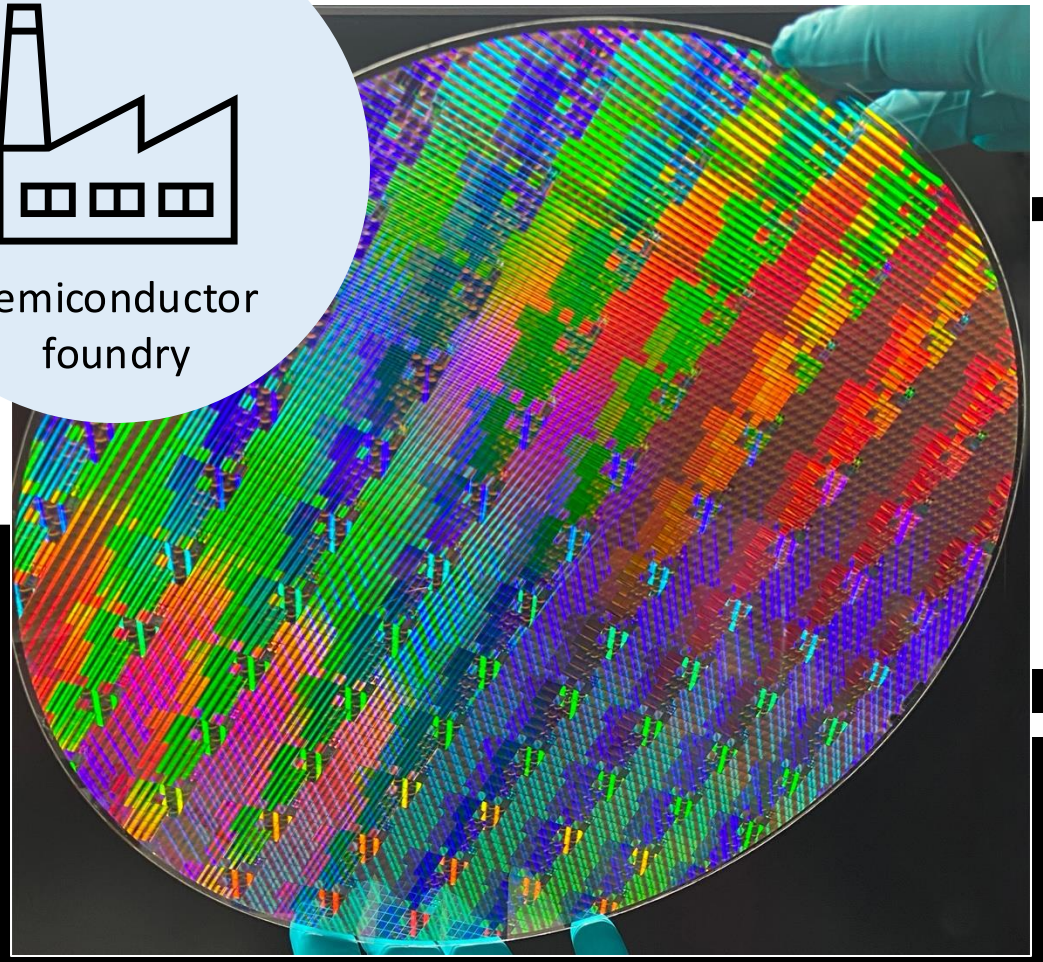
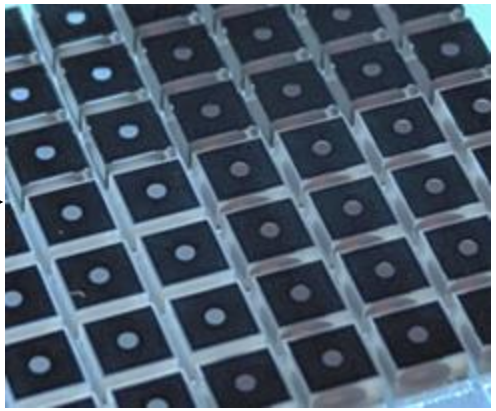
optic design file



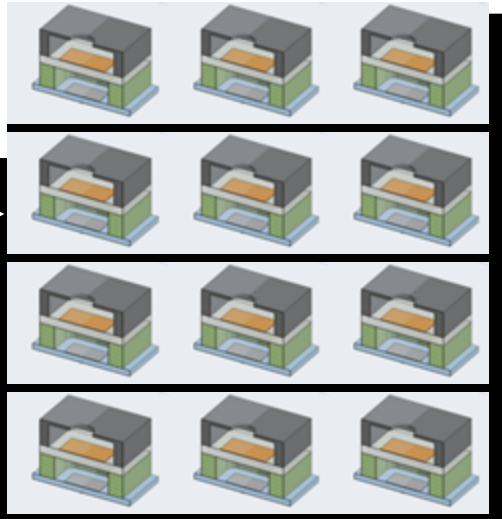
12-inch wafer ~7,000 meta-optics

Singulation



1000s of lens chips

Back-end integration



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