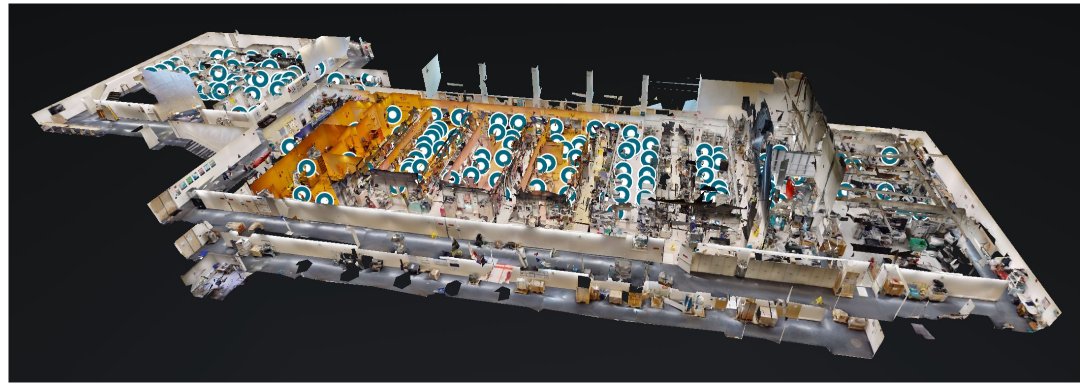


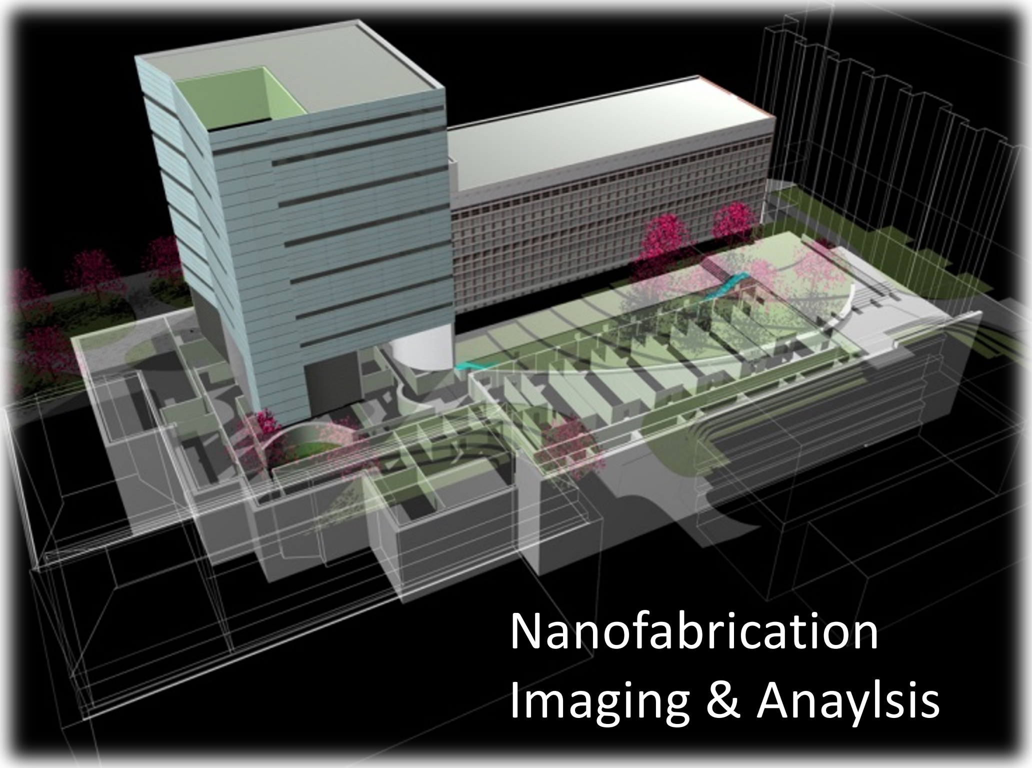
Center for Nanoscale Systems

http://CNS.FAS.Harvard.edu

Robert Westervelt (Director)
William Wilson (Executive Director)
Harvard University

Center for Nanoscale Systems

Laboratory for Integrated Science and Engineering



Science and Engineering Complex

Robert Westervelt
Director

William L. Wilson
Executive Director

Mission & Approach

Mission

To push the frontiers of nanotechnology in material synthesis, nanofabrication, imaging and analysis to advance quantum science and prototype new products.

Nanofabrication

Shape photonic and quantum systems from new materials.

Imaging & Analysis

Cryo-TEM, STEM, TEM's SEM's, FIB's, Atom Probe Tomography

CNS Facilities

Cleanroom (10,000 ft^2)
E-beam, optical, & soft lithography
TEM & SEM Imaging Suites
Scanning Probe Microscopy
Nonlinear optics Lab
Bioengineering Lab

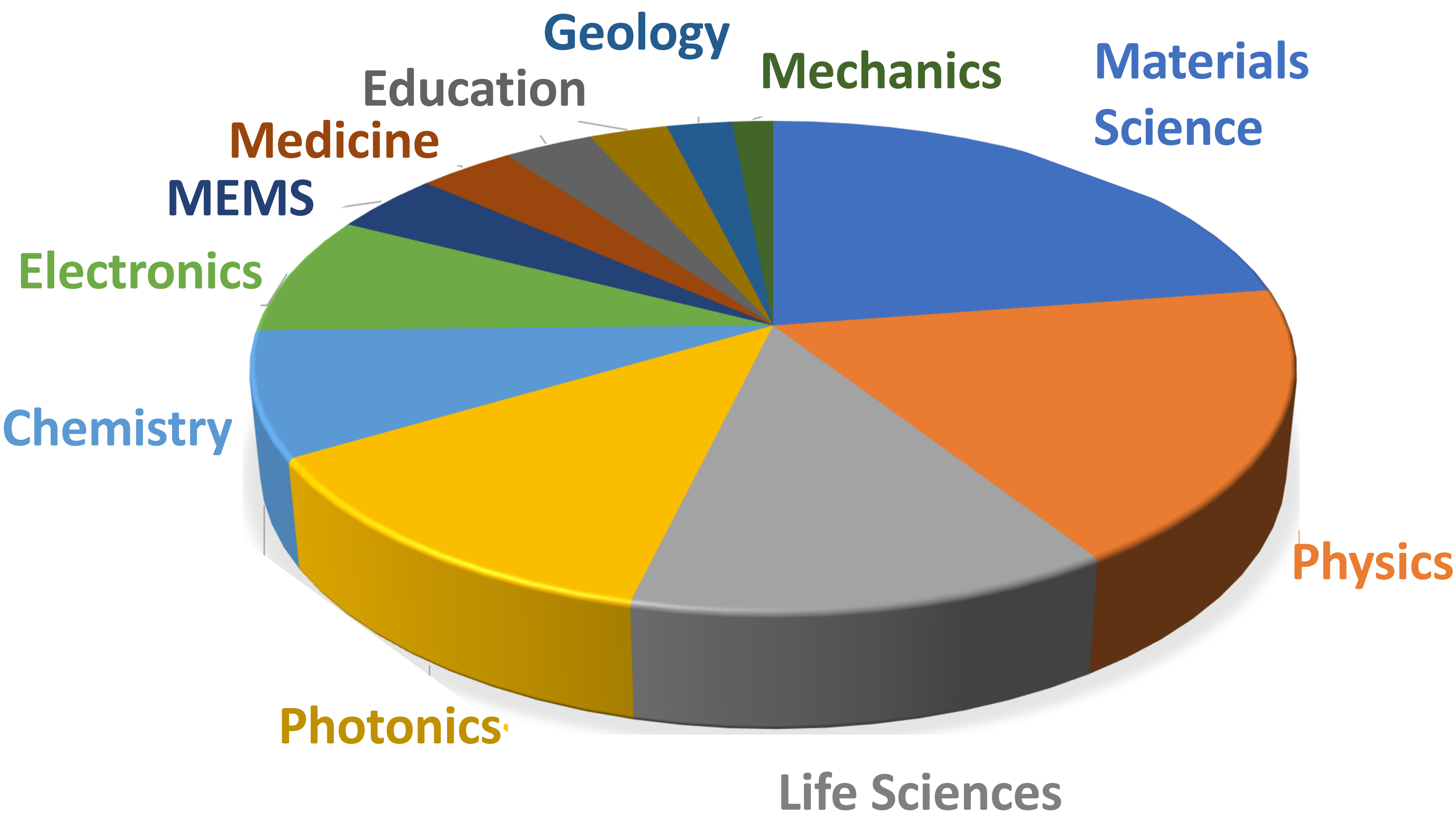
Center for Nanoscale Systems
Harvard University
FAS • SEAS

Virtual Tour of CNS

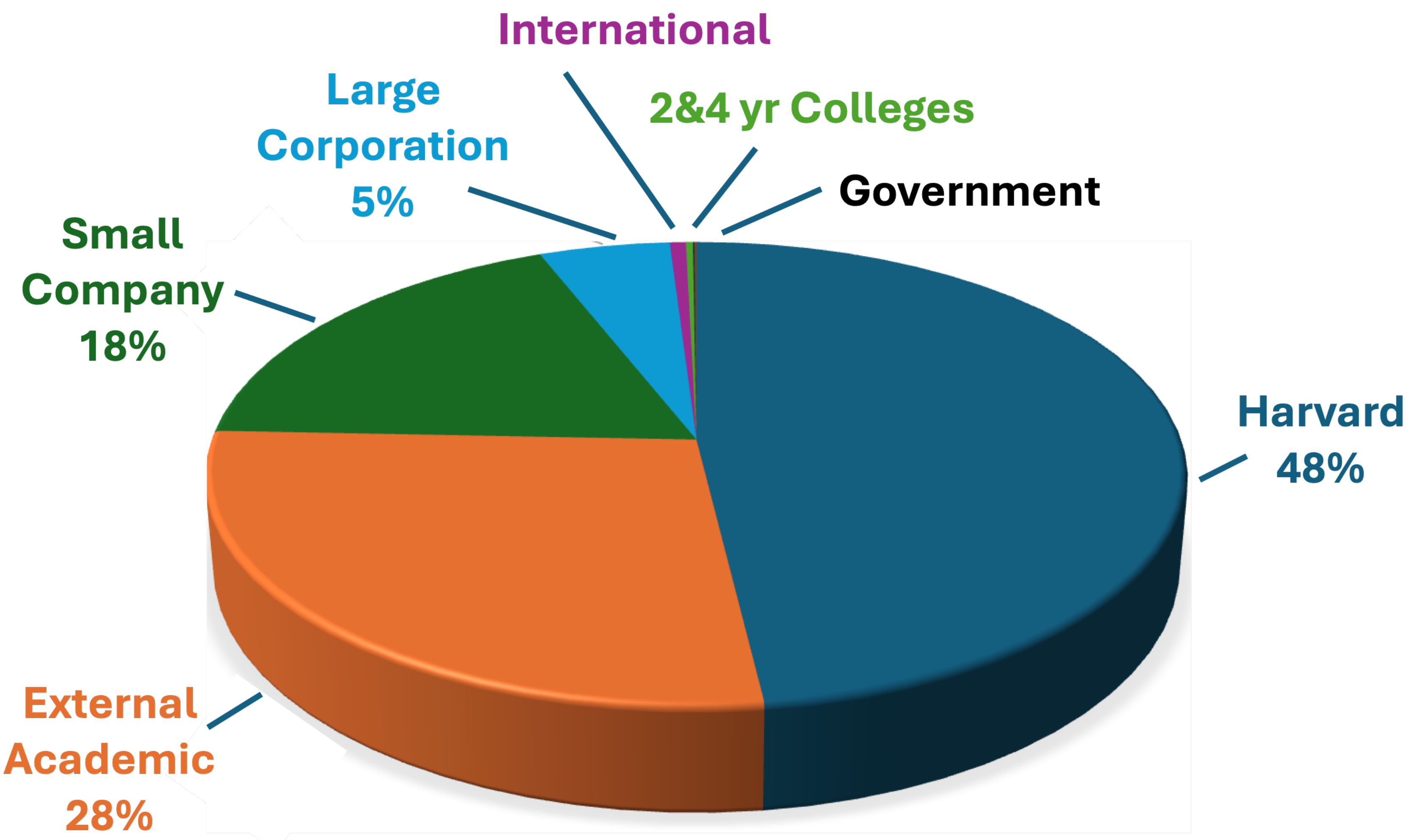
http://cns1.rc.fas.harvard.edu

The Center for Nanoscale Systems is an open shared-use facility at Harvard. Our focus is to advance the study, design, and fabrication of nanoscale structures and their integration into large and complex integrated systems.

CNS Users by Discipline

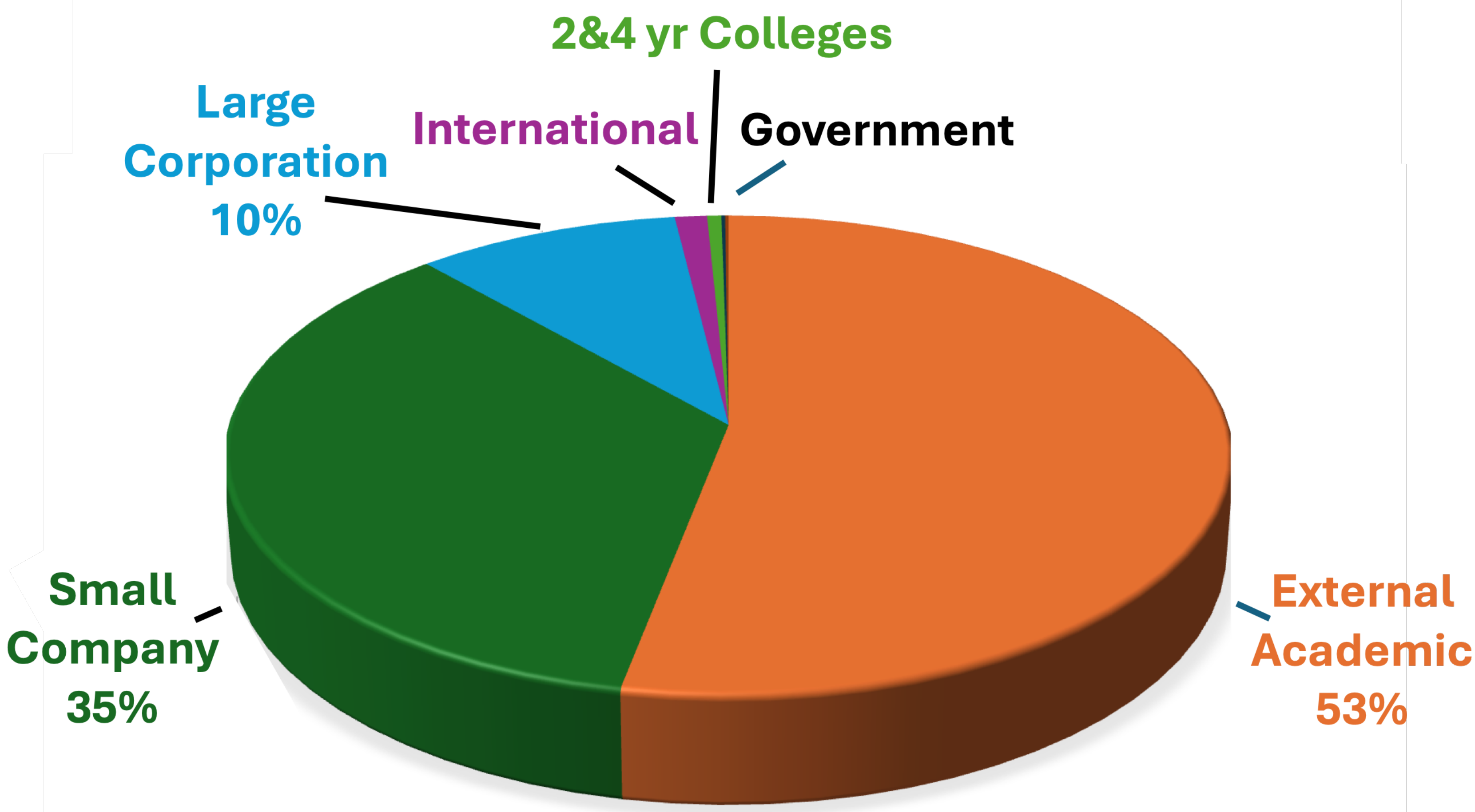


User Background



48% Harvard, 28% Ext. Academic, 22% Industrial

External User Distribution



CNS has served **377 Companies,** 68 were acquired, 22 whole companies acquired for a total **$8.029B**

CNS Research

Photonics

Diamond Photonics - Si-vacancy qubits

Thin-film Lithium Niobate – ultrafast signal processing

Meta-surface Photonics – multifunction flat optics

Quantum Materials and Devices

2D Material Heterostructures – graphene, TMD's

Topological Crystals

Quantum Information Processing

Quantum Networks

Photonic Control of Qubits

Bioengineering

Cryo-TEM

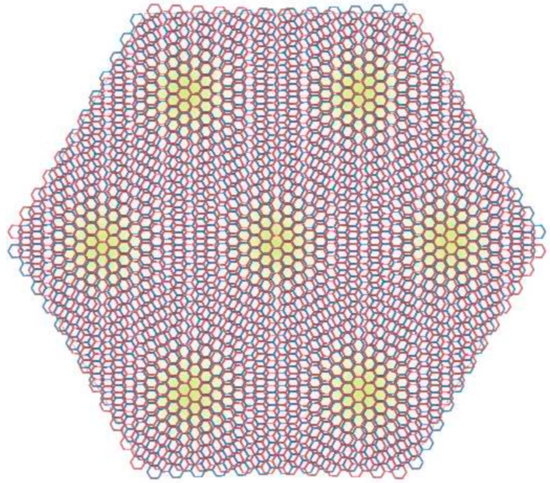
Cell Structure

CIQM CENTER for INTEGRATED QUANTUM MATERIALS

Twistronic Superconducting Graphene

Magic-Angle
Bilayer Graphene

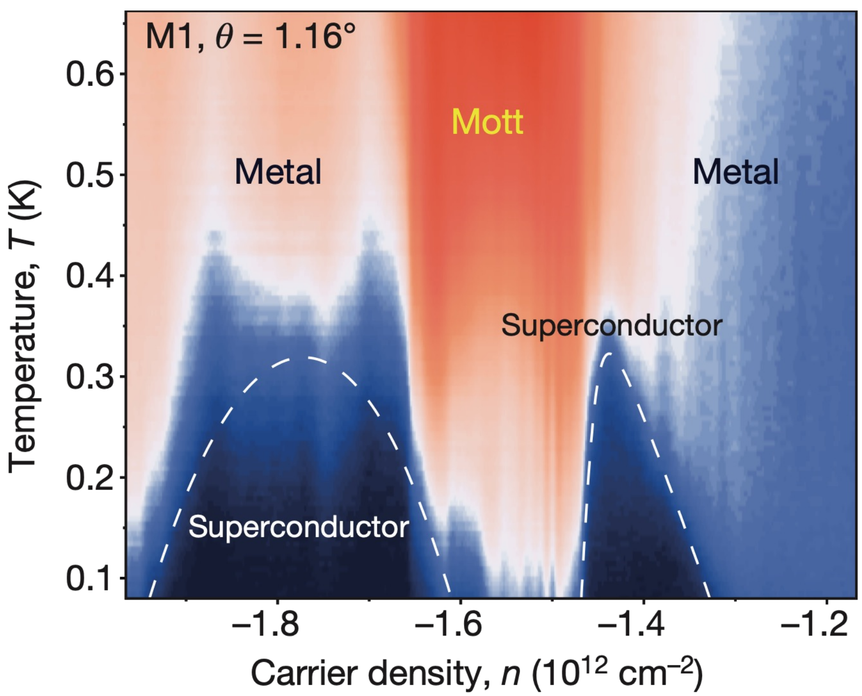
Moiré pattern

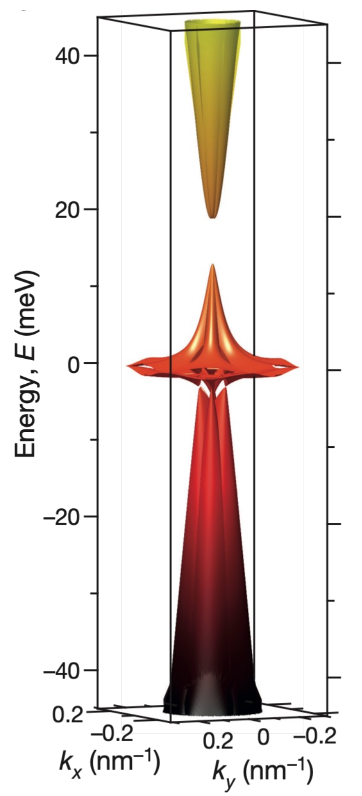


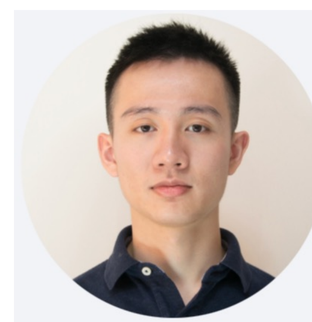
Pablo Jarillo-Herrero

2020 APS Buckley Prize
2020 Wolf Prize
with Allan MacDonald &
Rafi Bistritzer

flat energy bands → electronic correlations







Yuan Cao

2021 McMillan Award

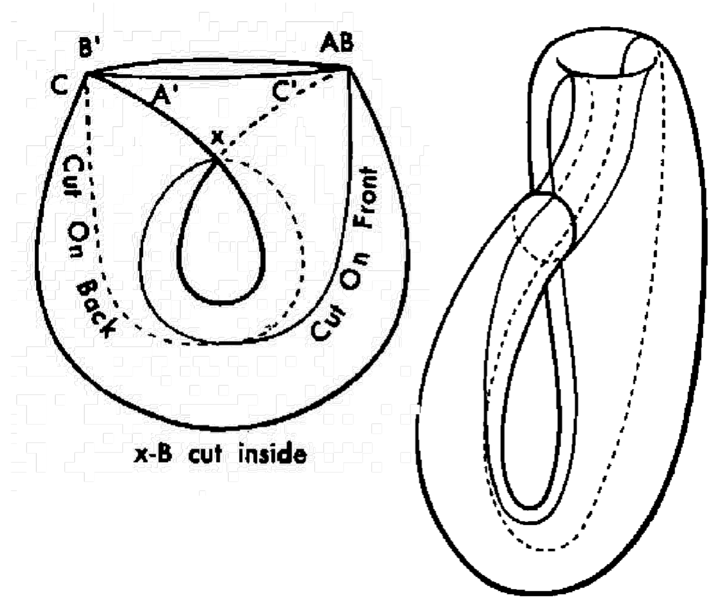
Y. Cao et al. Nature (2018) x 2

Topological Crystals & Qubits

Joe Checkelsky and Amir Yacoby

EXPERIMENTS IN TOPOLOGY

A topologist is interested in those properties of a thing that, while they are in a sense geometrical, are the most permanent—the ones that will survive distortion and stretching.

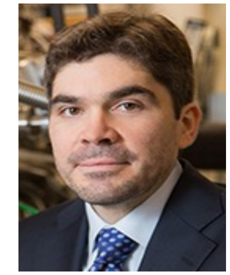


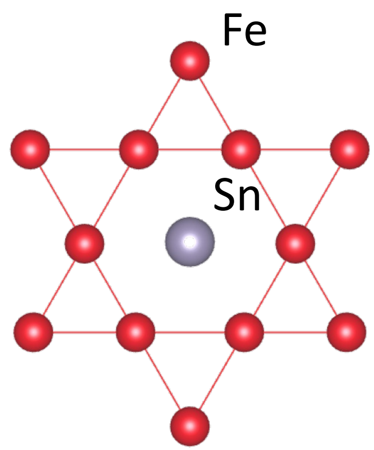
Mobius Shawl

Topological in Construction

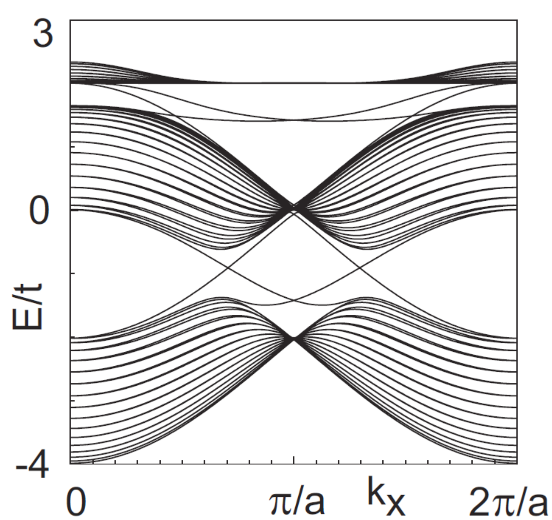
Fe_3Sn_2 – Kagome Metal

flat energy bands

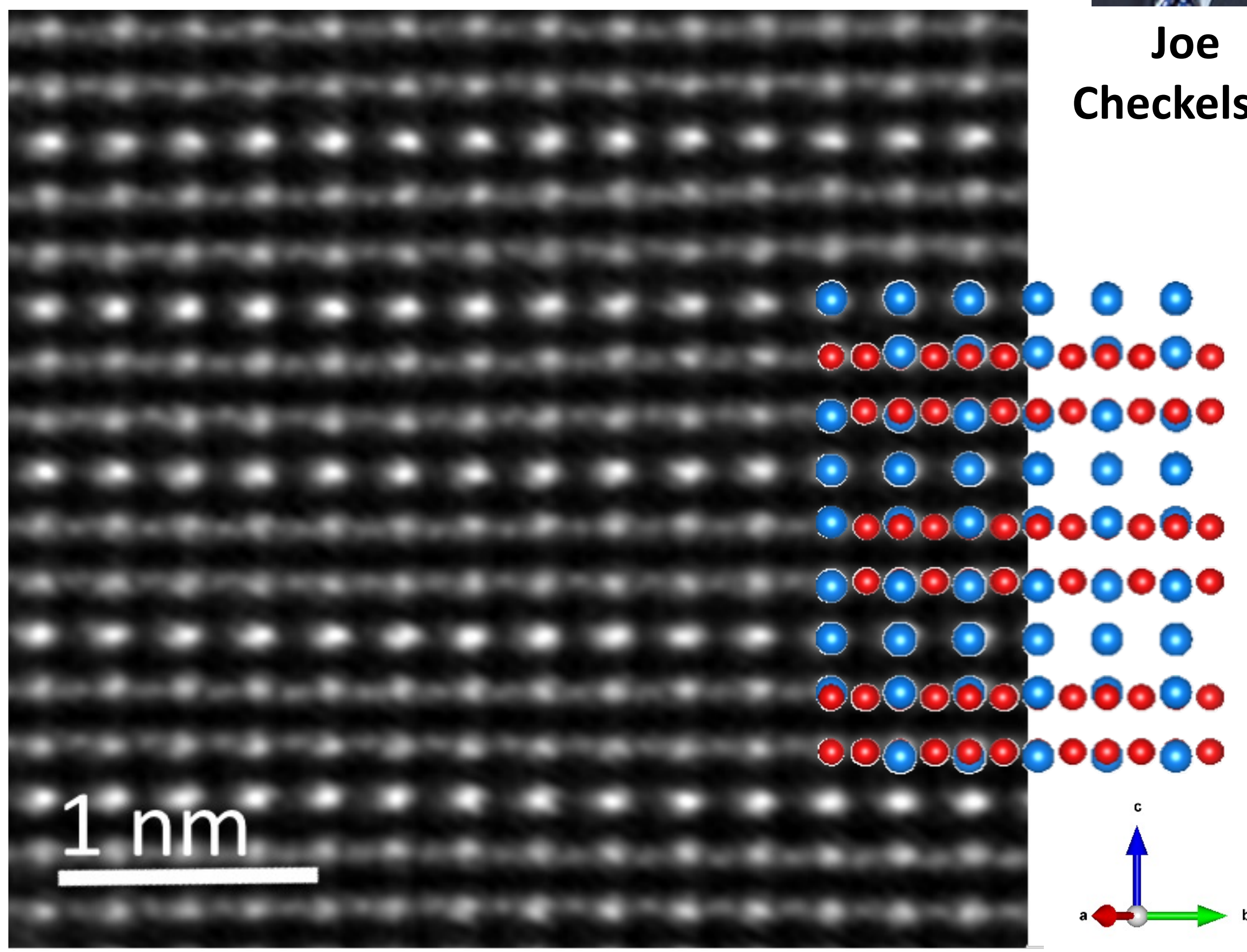




Kagome Bilayer



PHYSICAL REVIEW B **80**, 113102 (2009)
H.-M. Guo and M. Franz

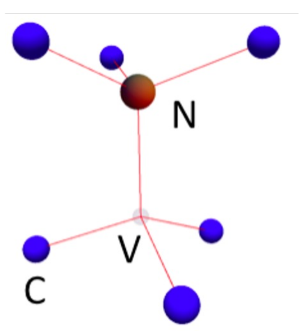


STEM Image theory

Ye, Bell, Fu, Comin, Checkelsky et al., Nature (2018).

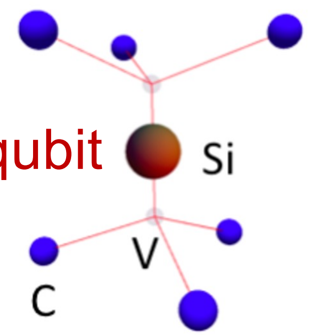
Quantum Networks with Single-Photon Quantum Emitters

color center qubits in diamond



NV center

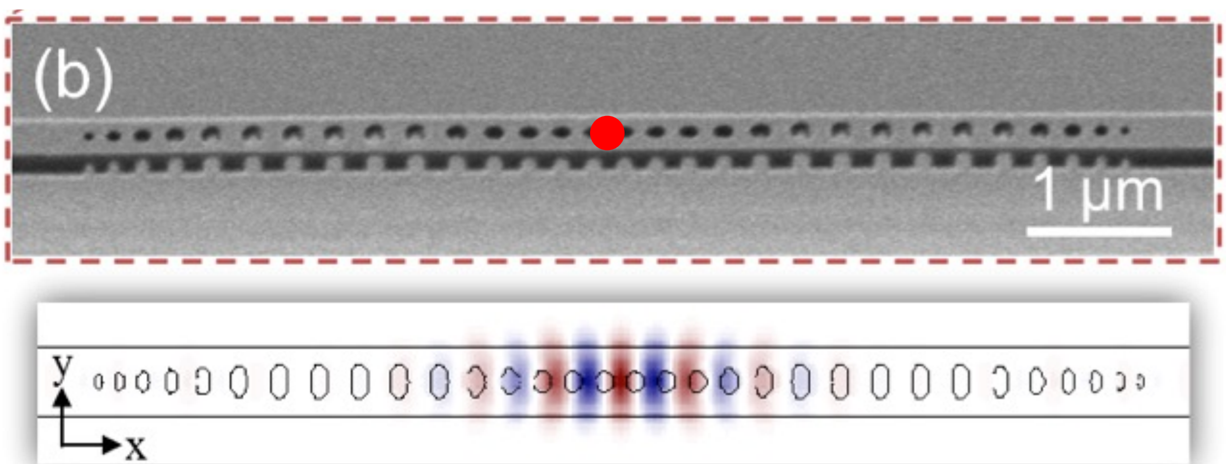
spin qubit



SiV center

to photon qubit

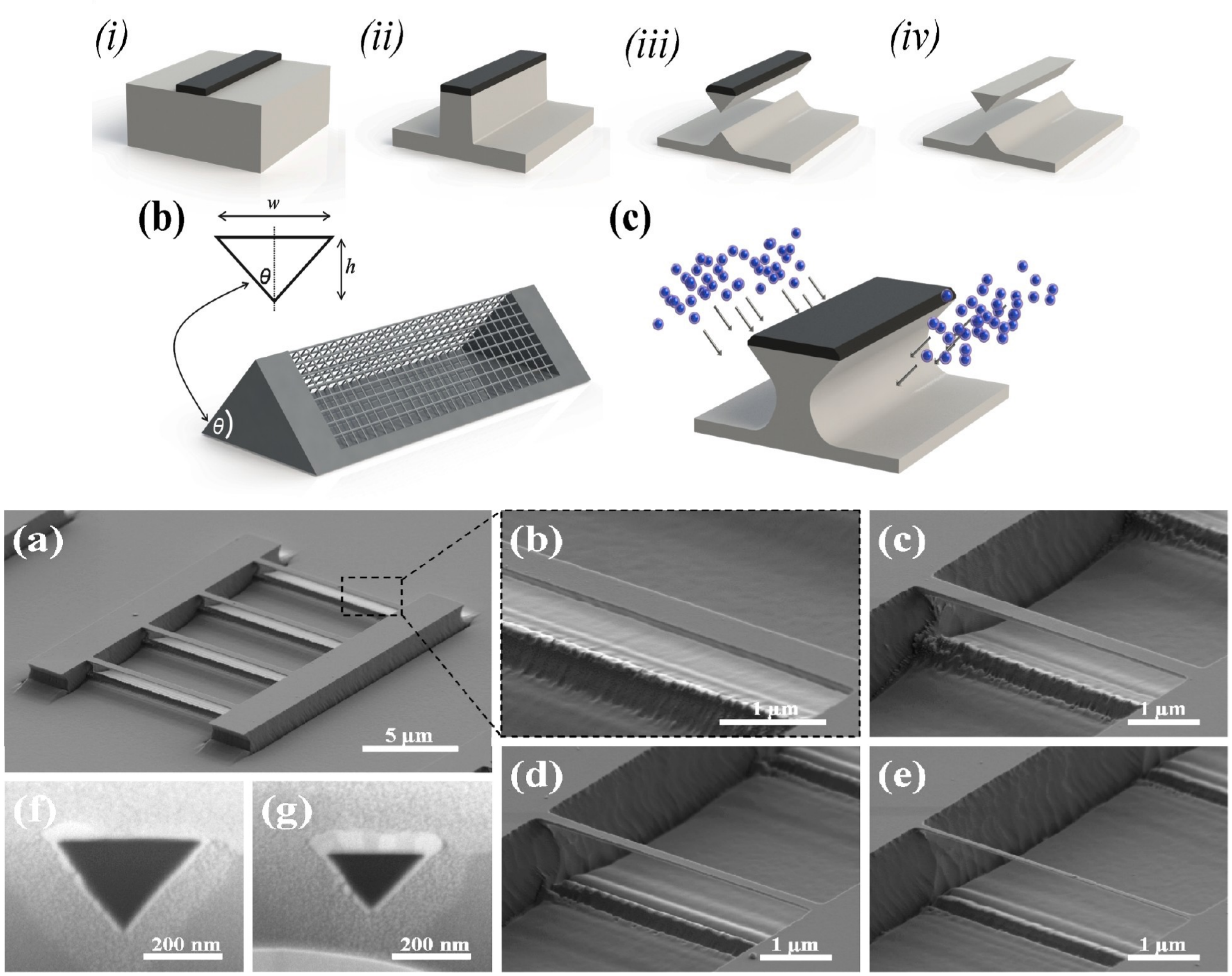
Quantum Network

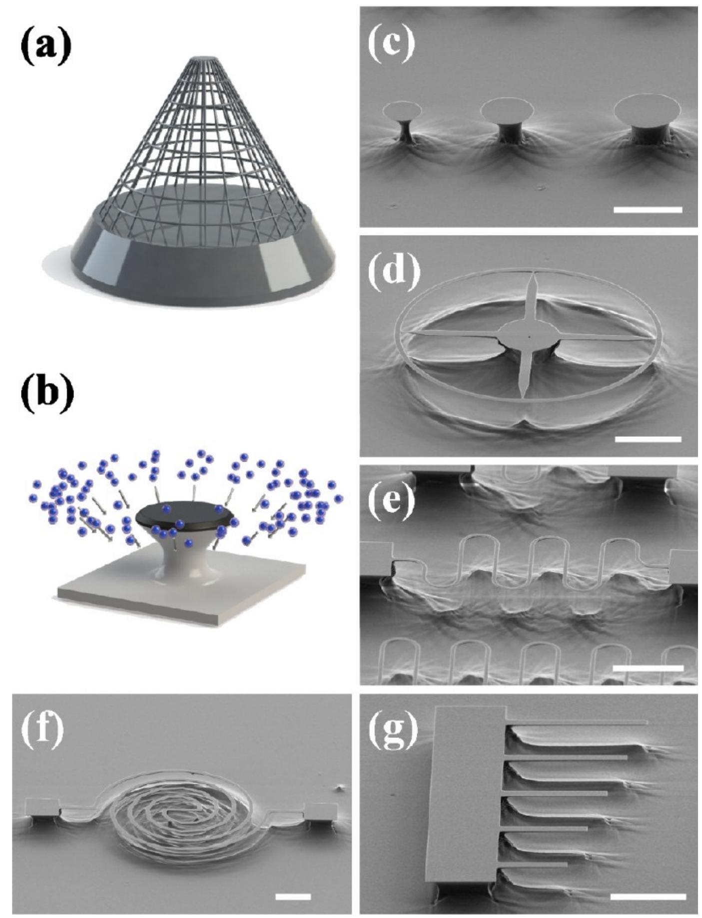


Diamond optical resonator with implanted SiV center

Quantum Infrastructure Development -

Diamond & Lithium Niobate Photonics for Quantum Networks





Pattern single crystal diamonds into free-standing optical resonators and waveguides to control color-center qubits in single-crystal diamond.

Amazon Web Services – strategic alliance

Marko Loncar & Mikhail Lukin

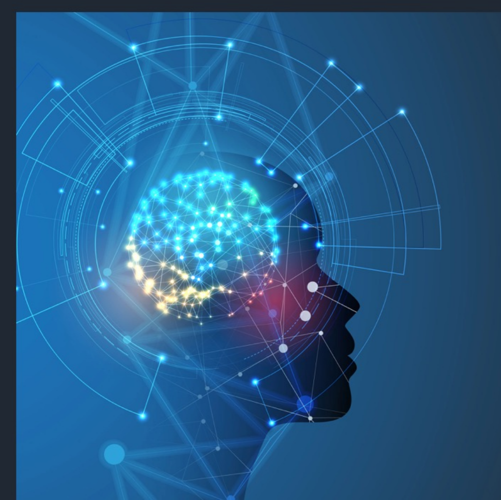
HYPERLIGHT

Lithium niobate photonic chips with 100 GHz bandwidth, 1 dB loss, and 1 V drive voltage

Enabling Next-Generation Photonics Applications with Performance and Scalability

DATA CENTERS

TELECOMMUNICATION NETWORKS

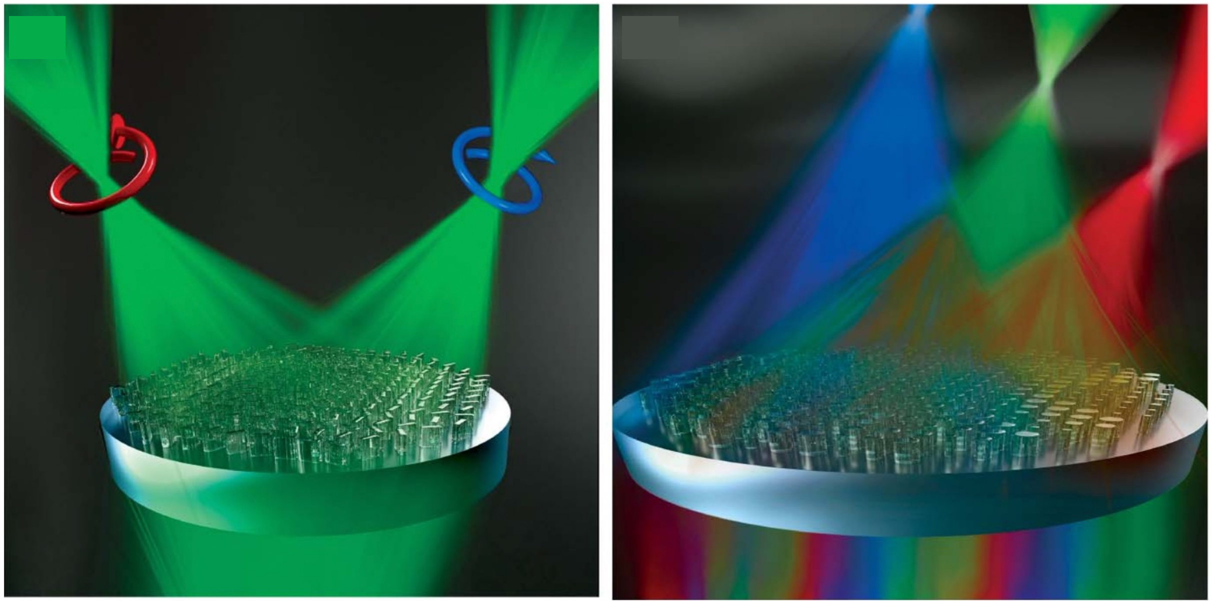


SENSORS

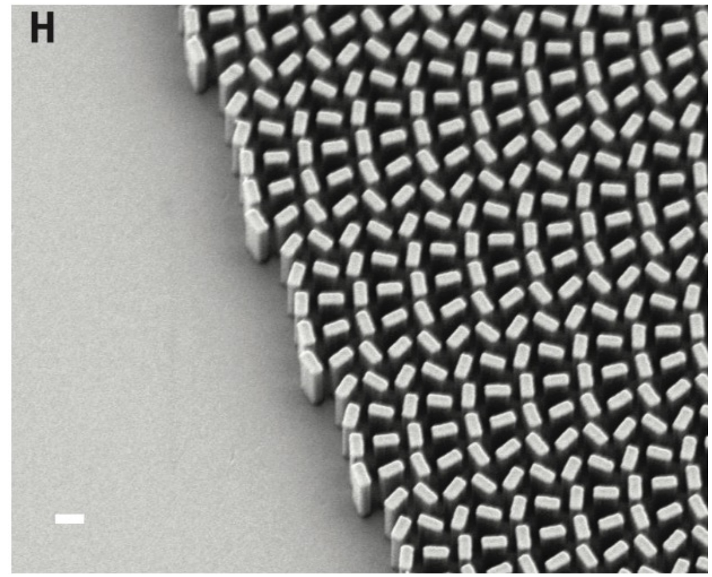
http://hyperlightcorp.com

Marko Loncar

Quantum Infrastructure Development – Flat Optics from Submicron Antennas



(left) Chiral flat optic lens that spatially separates and focuses light with left-hand and right-land circular polarization.
(right) Flat optic lens design that focuses red, green, and blue light to different spots.



SEM image of flat optics with TiO_2 elements (300 nm scale bar) (Khorasaninejad & Capasso 2017)

Federico Capasso

(Khorasaninejad & Capasso 2017)

metalenz

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http://www.metalenz.com

MENU

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Metalenz technology is produced at the wafer-scale using the same semiconductor foundries that make image sensors and illumination sources—disrupting the conventional supply chain.

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Federico Capasso

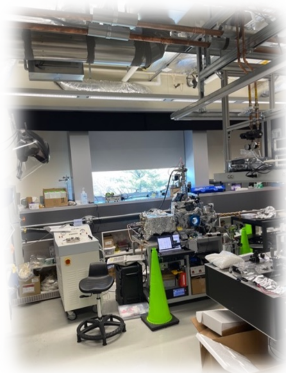
Industry Partner Initiatives

startup

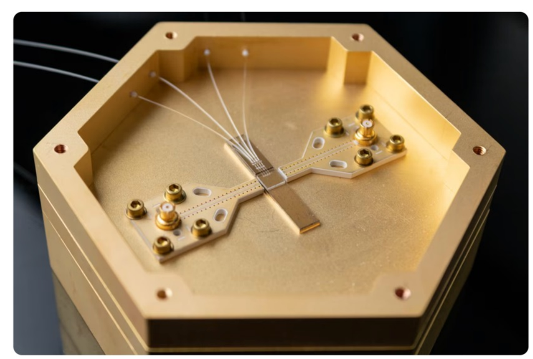
LIGHTSYNQ

acquired

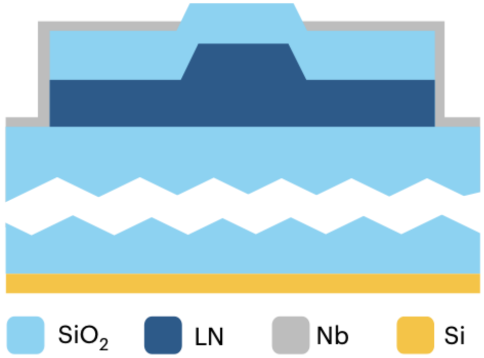
IONQ

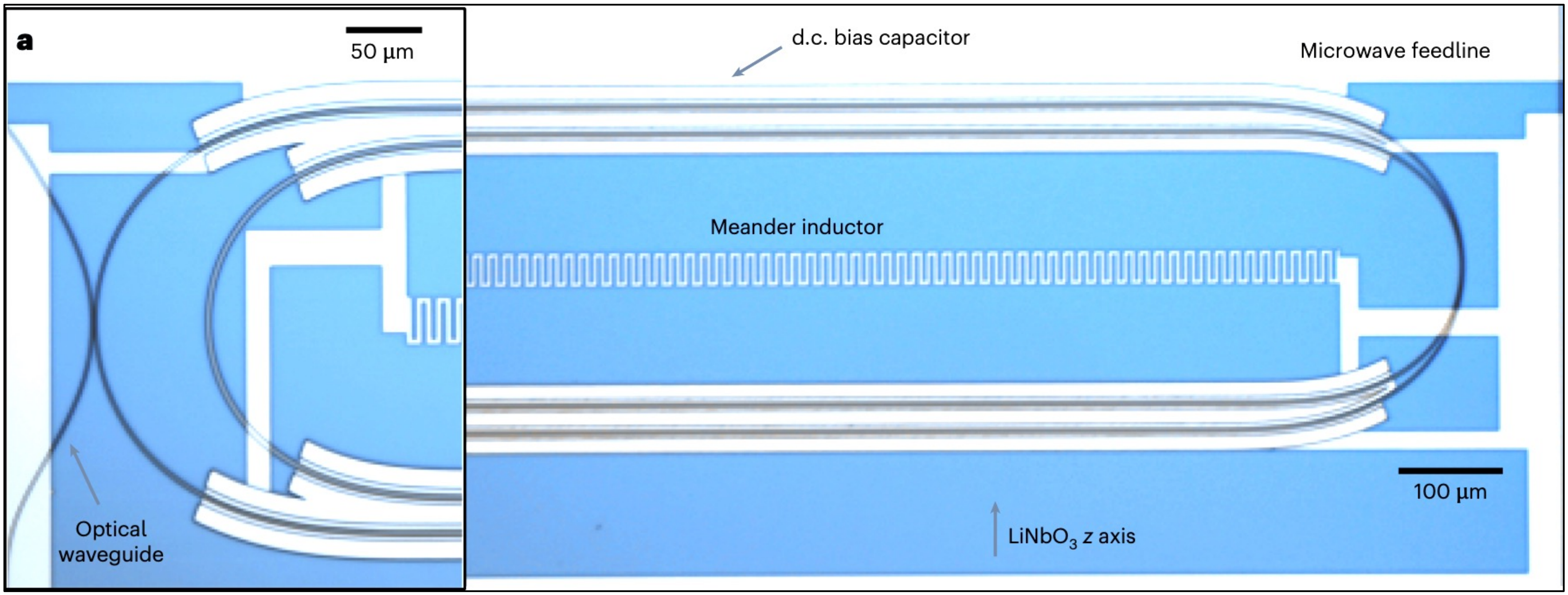


- Integrated Quantum Photonics
- Quantum Repeaters
- Quantum Sources
- Quantum Devices



Coherent Control of a Superconducting Qubit with Light

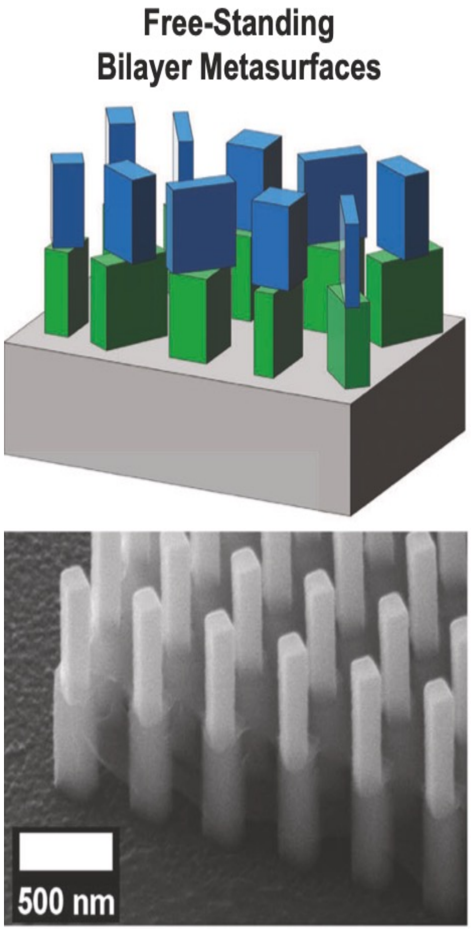




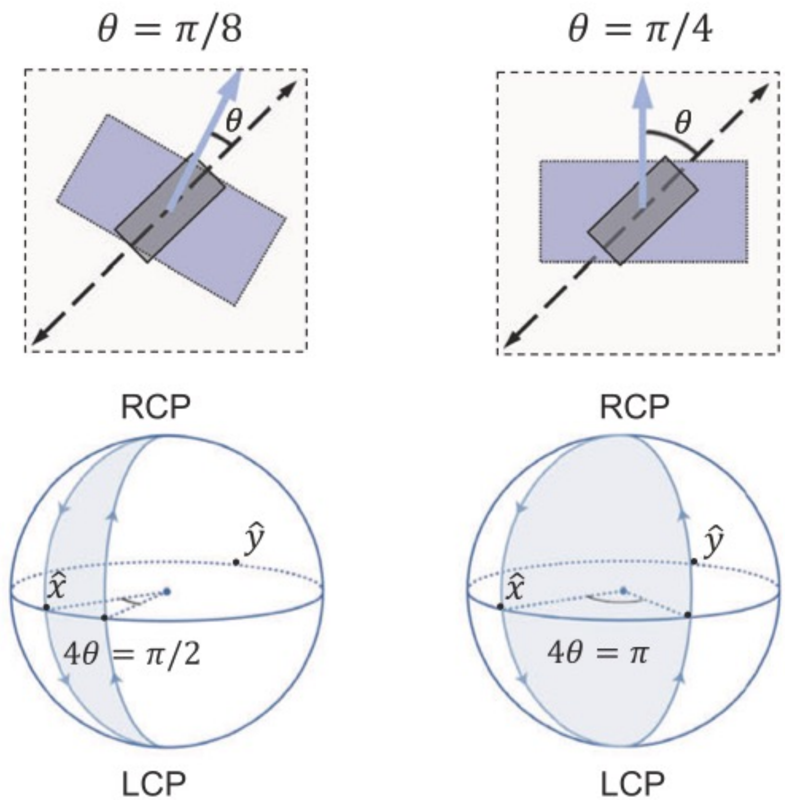
Optical micrograph of transducer with Nb LC resonator coupled to two racetrack hybrid lithium niobate resonators to coherently exchange energy between microwave and optical regimes.

Warner ... Loncar, Nature Physics **21**, 831 (2025).

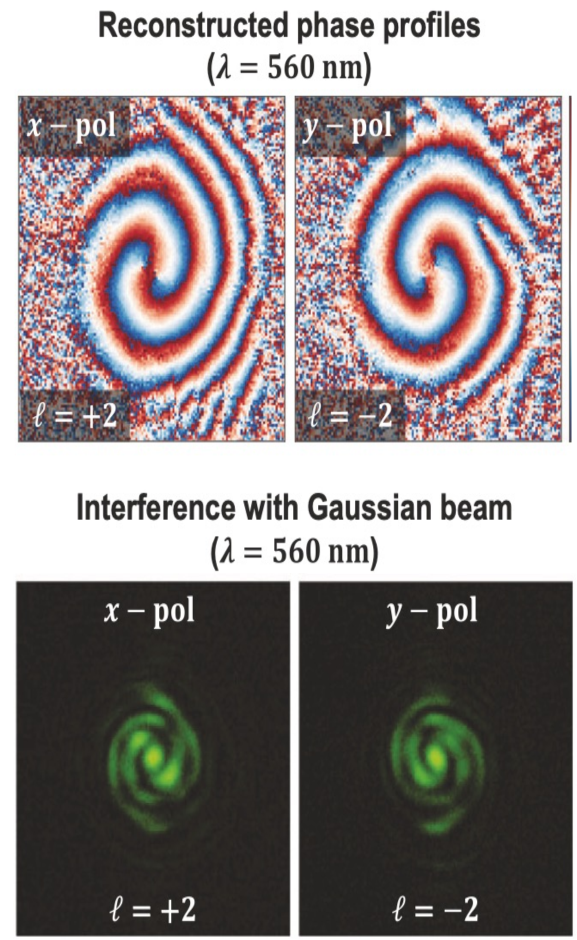
Optical Corkscrews from Topological Phase



metasurfaces - with a twist



Pancharatnam – Berry topological phase from twist

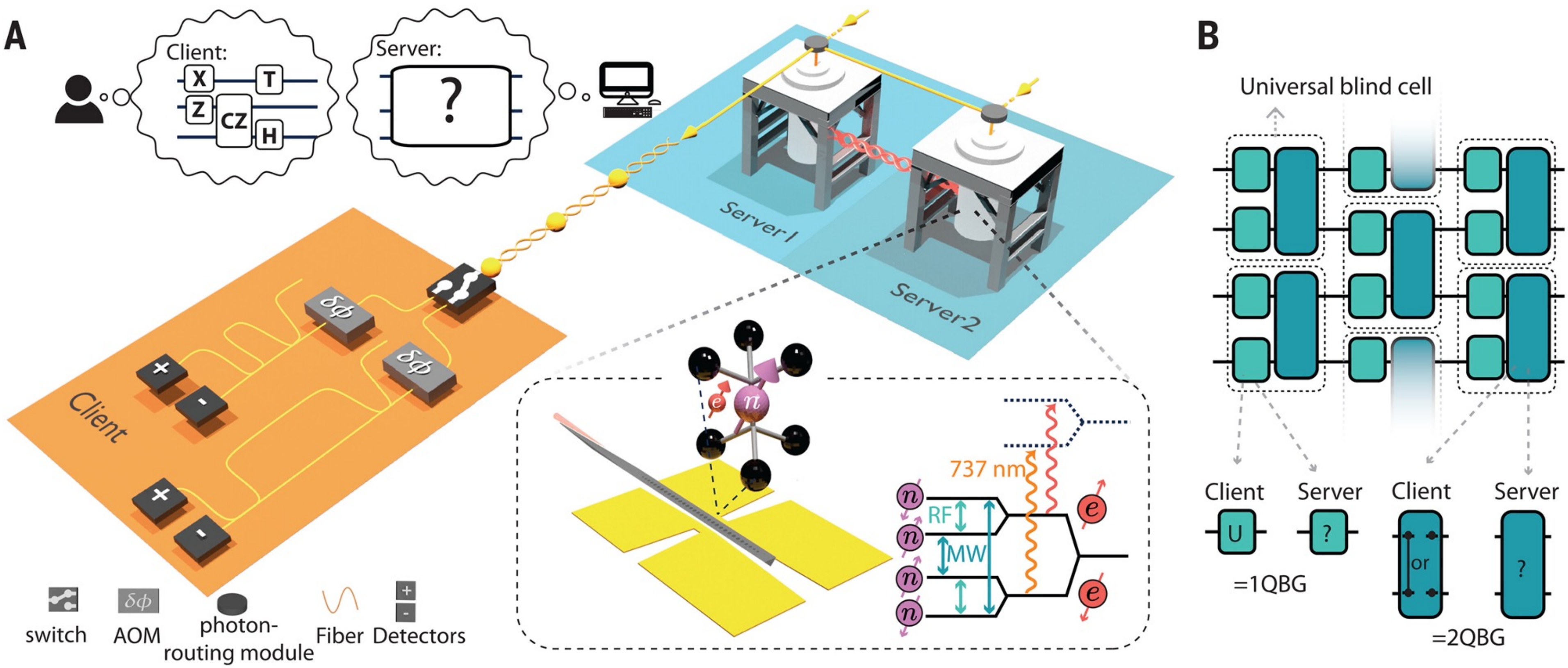


Optical corkscrew in simulations and data

Dorrah ... Capasso, Nature Commun. 16:3126 (2025)

Blind Quantum Computing - Solid State Qubits

Blind quantum computing allow clients to run algorithms on servers without giving out any information about the requested task. This demonstration is promising for quantum computing over larger distributed networks.



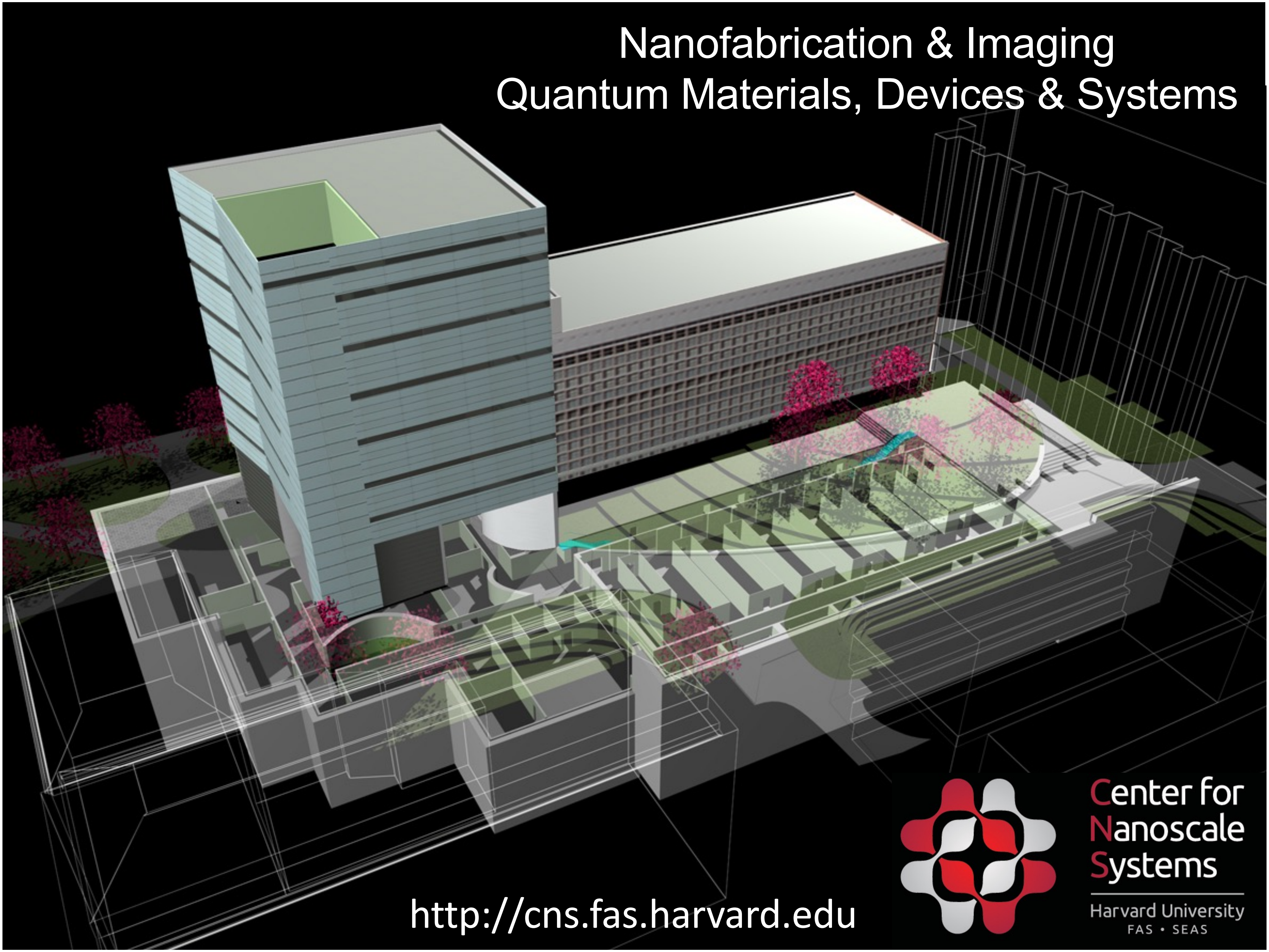
Schematic diagram of blind quantum computer: 2-node network of Si-V qubits.

Wei ... Park, Loncar, Lukin, Science **388**, 509 (2025).

Develop Workforce – CNS Harvard Courses

Harvard Courses

Chem 165
ES 100
ES 176
ES 177/277
ES 293
BE 128
MCB 68
AP 218
AP 291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