

Interest in Quantum Sensors at SLAC and collaborations with the community

SLAC Science / Quantum Sensors Relevance



High Energy Physics

- What is the nature of dark matter (dark sector, WIMPs) and dark energy?
- Did an inflationary expansion of the universe occur after the Big Bang?

Basic Energy Sciences

- Understand the molecular machinery of cells, viruses, and microbes
- Understand and control emergent phenomena in quantum materials
- Full characterization of extreme states of matter

Broad Scientific Application Areas

- Neuroscience, Medicine, Forensics, Astrophysics, Nuclear Safeguards, Precision Measurement

Quantum Science and Engineering

- Quantum sensing as part of a broad quantum science and engineering program

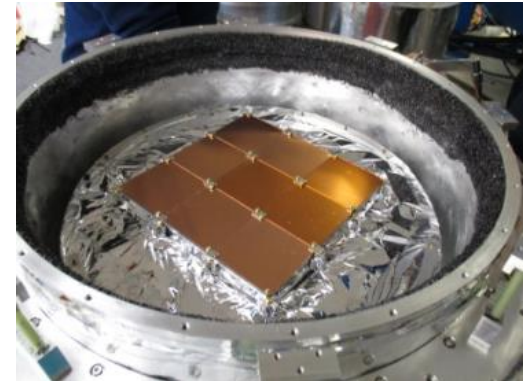
SLAC is interested in academic and industrial partnerships in these areas, and partnerships with other federal laboratories.

Cosmic Microwave Background

SLAC has a primary focus on CMB science

Programs

- CMB-S4
- Lead on BICEP-3
- BICEP-2, Keck, BICEP Array
- Simons Observatory



SLAC has a particular interest in quantum sensors and readout for CMB experiments

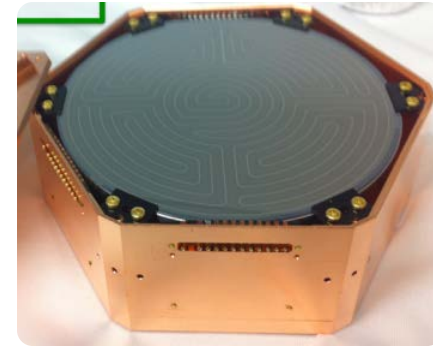
- Transition-edge sensors for CMB polarimeters
- dc SQUID design & development
- Microwave kinetic inductance detectors
- Microwave SQUIDs
- High performance RF control electronics
- Cryogenic test and receiver design / development

Collaboration with
ANL, LBNL, FNAL,
GSFC, JPL, NIST,
and many Universities

SLAC has a primary focus on dark matter science

Programs

- SuperCDMS
- LUX/LZ
- Light WIMP sensors
- DM Radio
- Heavy Photon Search
- Light Dark Matter Experiment

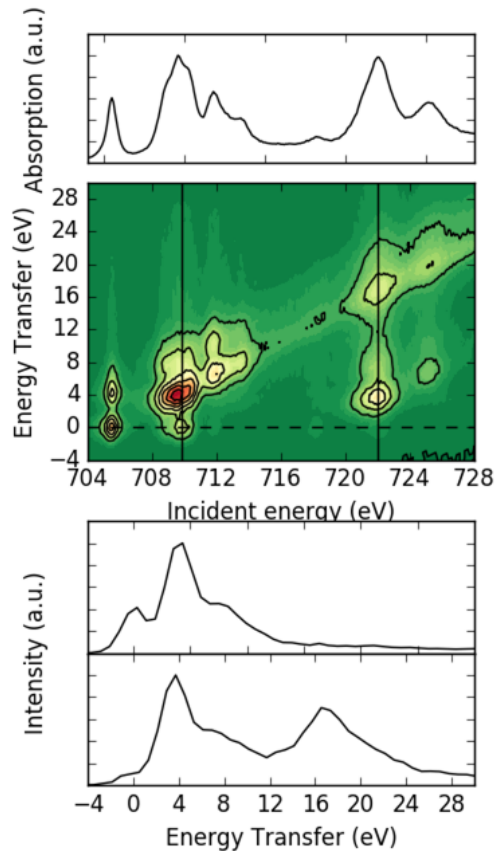


SuperCDMS SNOLab detectors

SLAC has a particular interest in quantum sensors for light dark matter

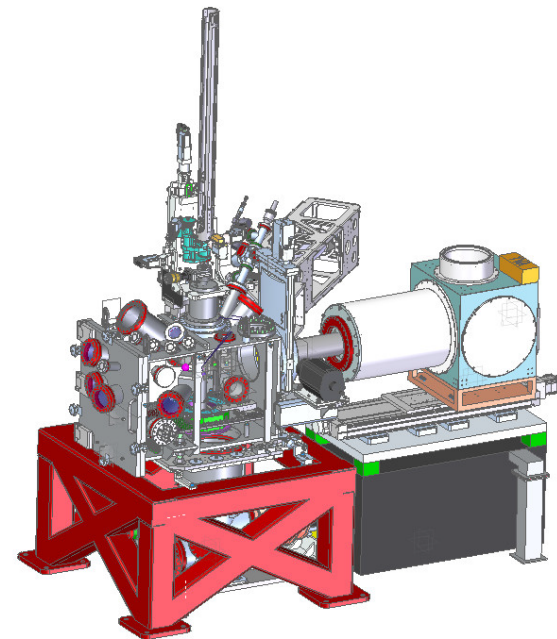
- Light WIMPs (e.g. recent measurement of electron-hole quantization in bulk crystal silicon: arXiv:1710.09335v1)
- Kinetic Inductance traveling wave parametric amplifiers
- Microwave SQUIDs below the quantum limit
- High performance RF control electronics
- Cold atom interferometers for dark sector measurements (with Stanford and FNAL)

Quantum sensors for x-ray light sources



TES bioinorganic spectroscopy
Of dilute $\text{Fe}(\text{CN})_6$ at SSRL BL10-1

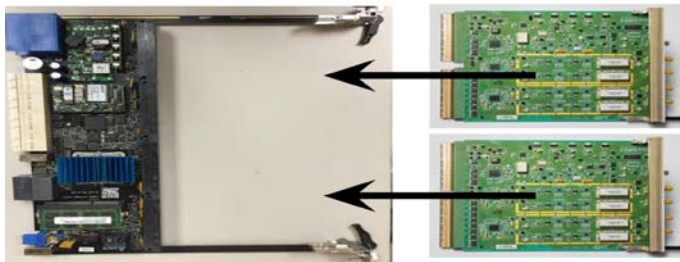
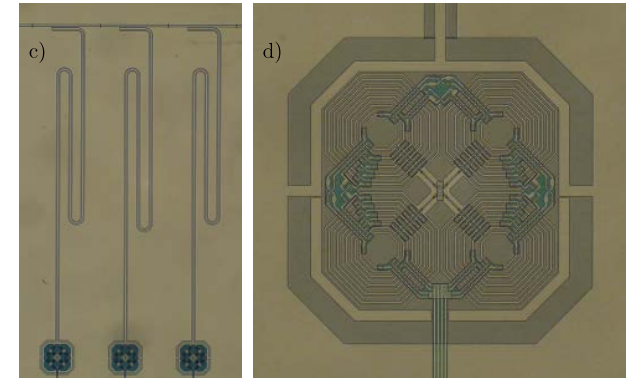
- What are the electron dynamics in the Kok cycle of Photosystem-II ?
- What is the oxidation state of the Fe-O bond in hemoglobin?



TES spectrometer in development for LCLS-II
Collaboration with NIST

Quantum RF control electronics

- RF electronics to control superconducting quantum sensor circuits
- The SMuRF electronics (SLAC Microresonator RF electronics) is flexible platform for the control of superconducting microwave circuits
- Interest in collaboration and providing capability to the community
- See Zeesh Ahmed talk



SLAC Microresonator RF (SMuRF) electronics. (LEFT) Carrier Card. Contains FPGA, memory, backplane connections. (RIGHT) Each carrier supports 2 AMC application cards. Designed for the flexible control of superconducting microwave circuits.

