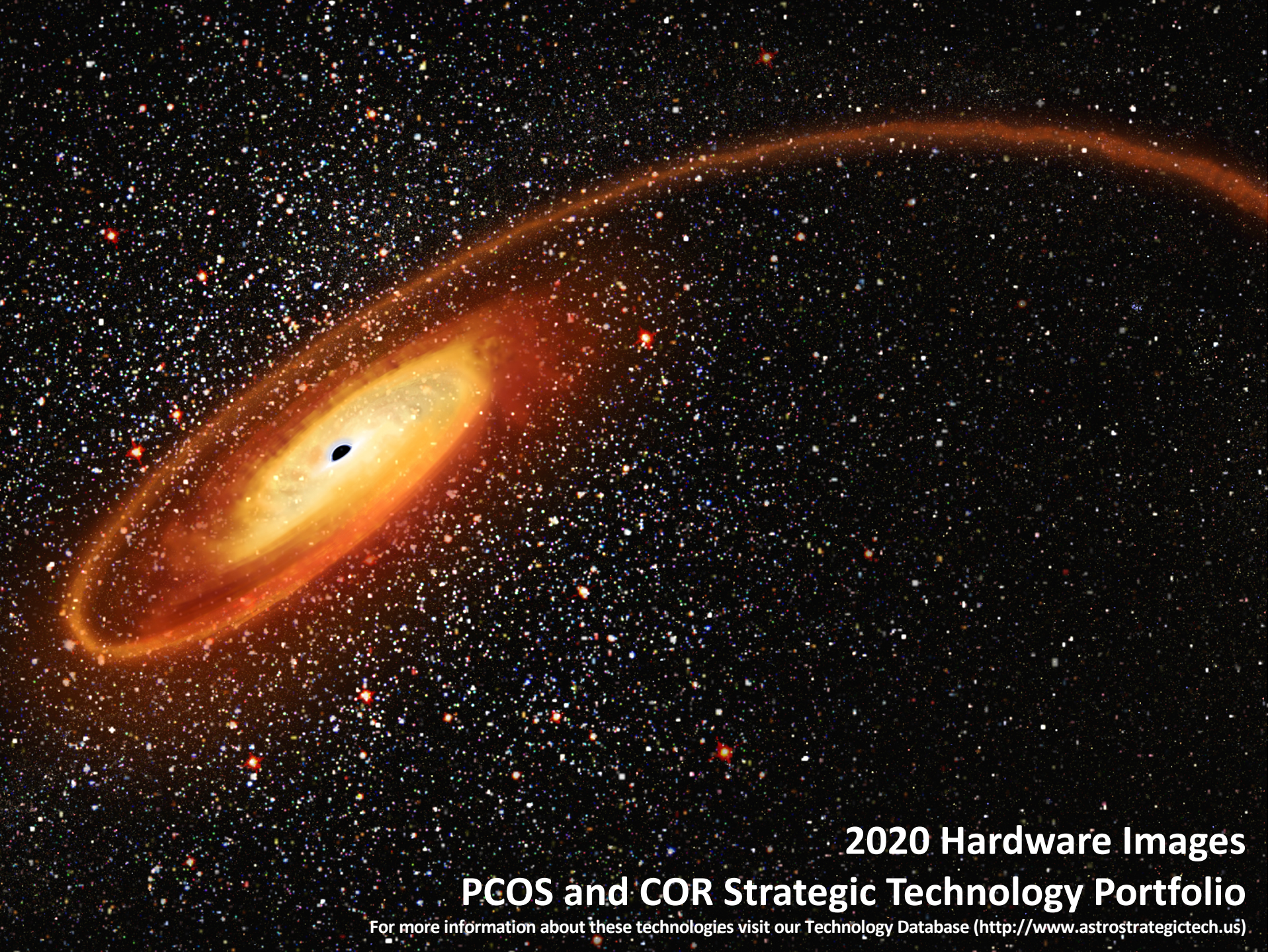
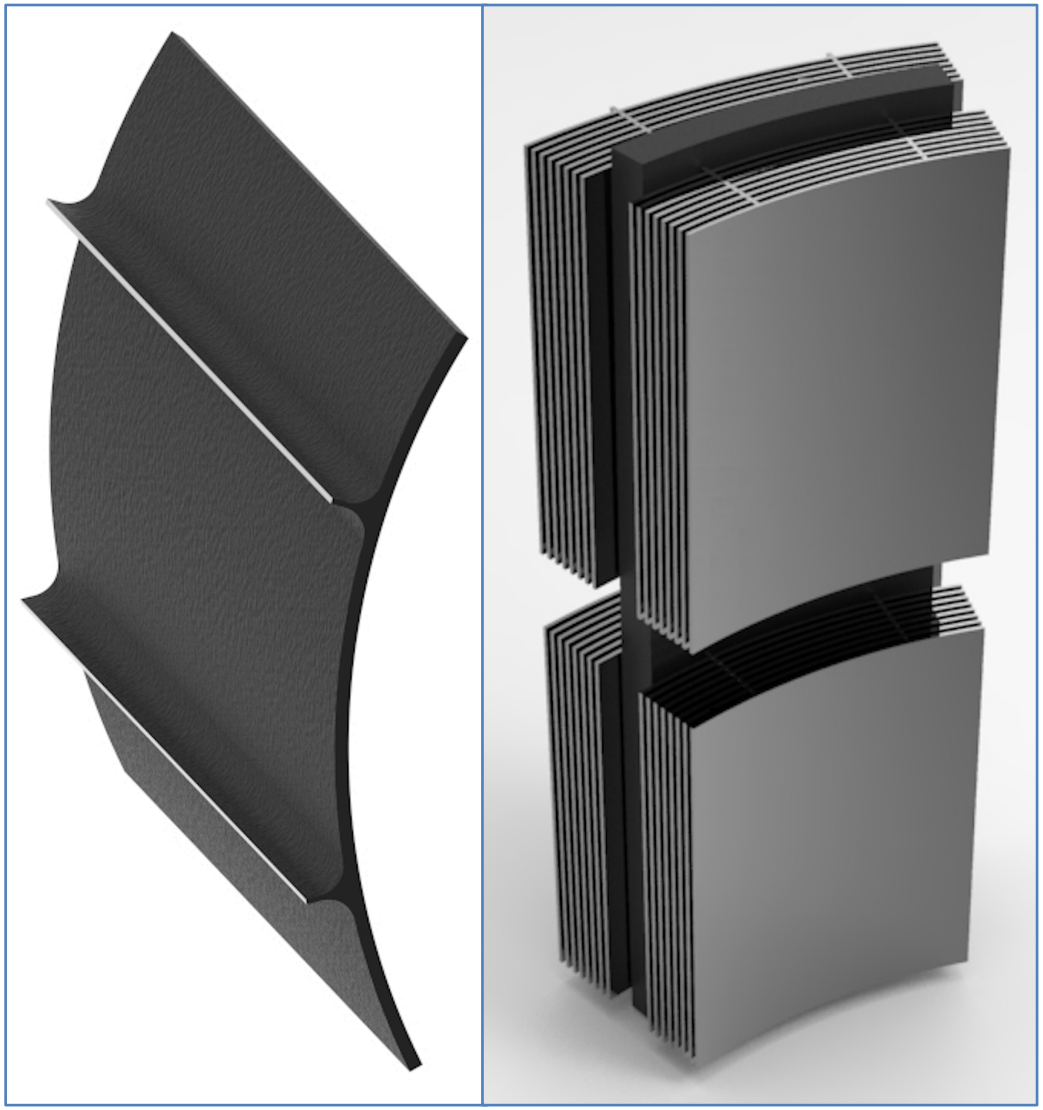


2020 Hardware Images
PCOS and COR Strategic Technology Portfolio

For more information about these technologies visit our Technology Database (http://www.astrostrategictech.us)

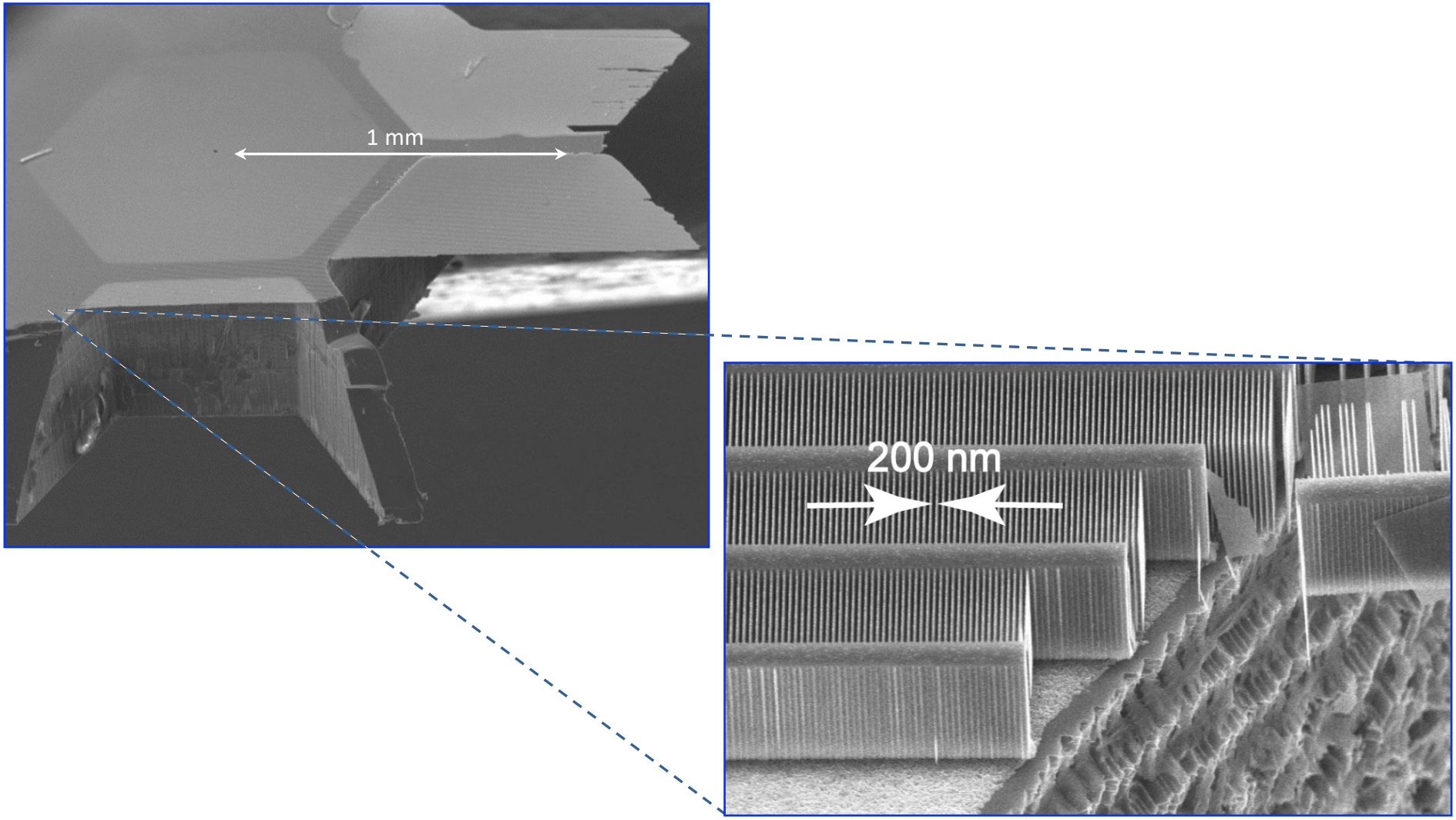


Single X-ray mirror segment with mounting ridges plus stacked segments with support panel

Significance: World-class thin grazing-angle X-ray mirror technology; baselined for Lynx X-ray flagship mission concept

Project Title: Next Generation X-ray Optics: High Resolution, Light Weight, and Low Cost

PI: Zhang, William (GSFC)

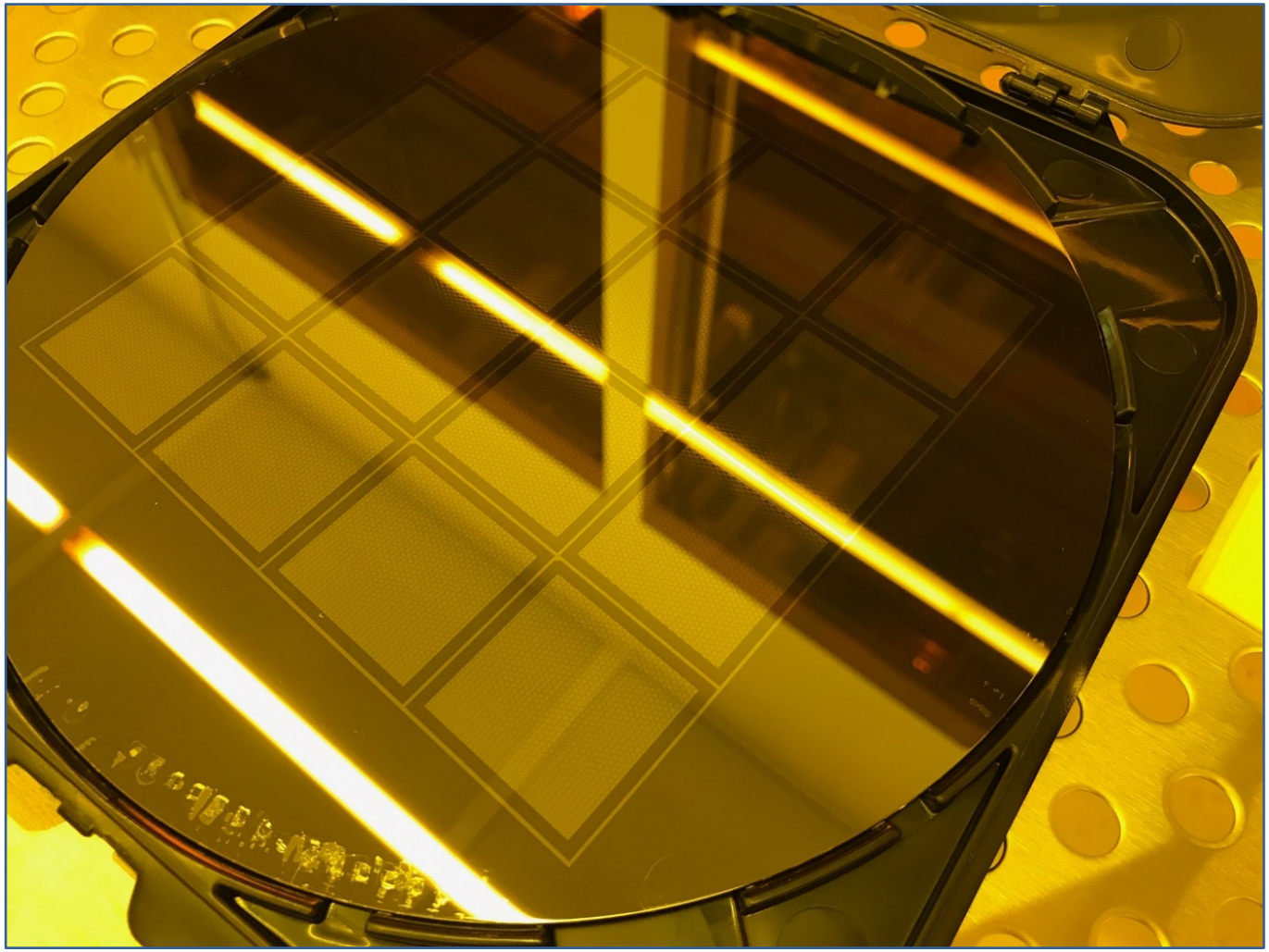


Scanning Electron Microscope (SEM) images of cleaved freestanding Critical-Angle Transmission (CAT) grating

Significance: Highest-resolution X-ray transmission grating technology; baselined for Lynx X-ray flagship mission concept

Project Title: High Resolution and High Efficiency X-ray Transmission Grating Spectrometer

PI: Mark Schattenburg (MIT Kavli Institute for Astrophysics and Space Research)

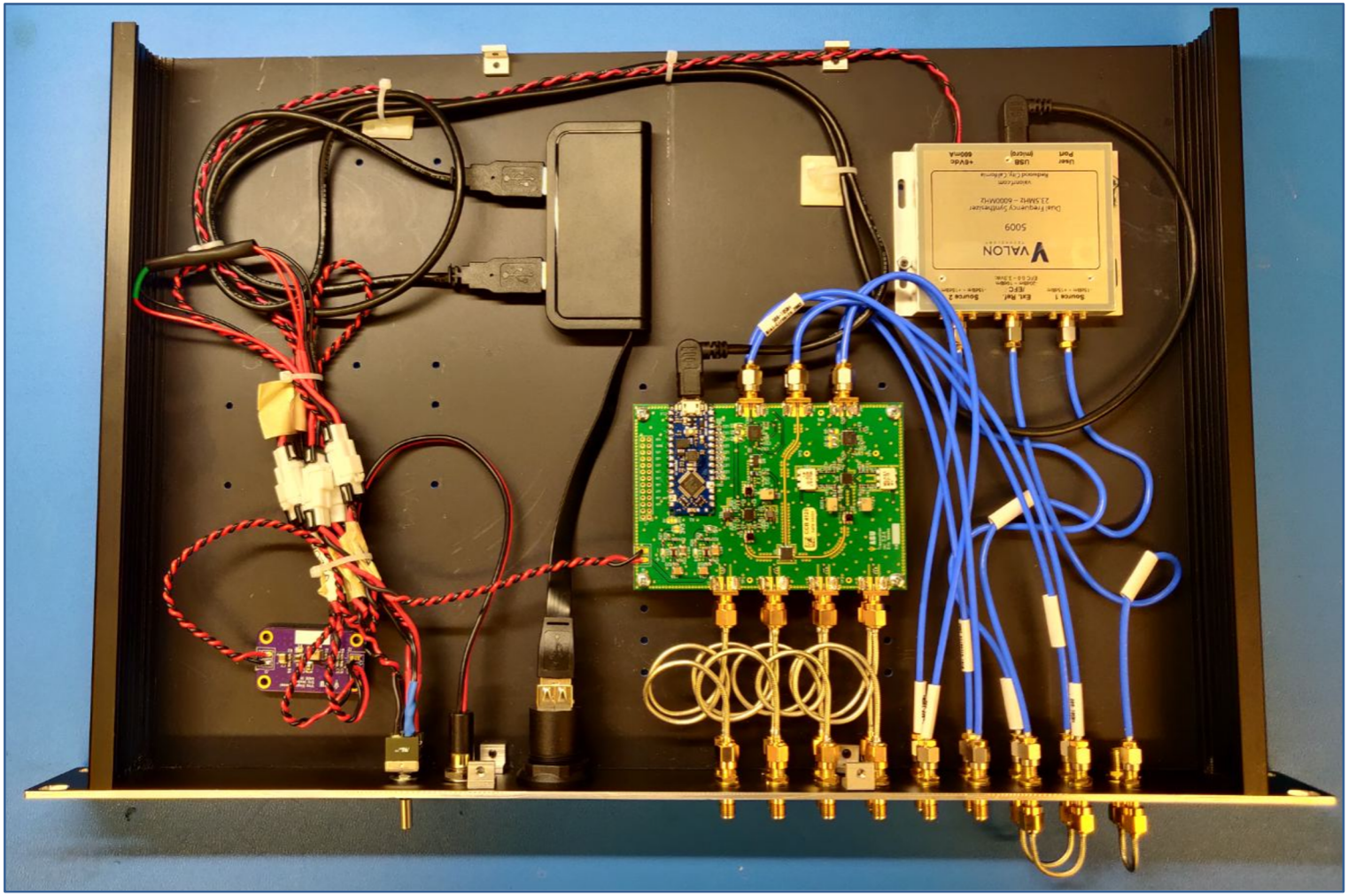


200-mm wafer patterned with 16 ARCUS-style Critical-Angle Transmission (CAT) gratings

Significance: Enhances manufacturability of highest-resolution X-ray transmission grating technology; baselined for Lynx X-ray flagship mission concept

Project Title: Readying X-ray Gratings and Optics for Space Applications: Manufacturability and Alignment

PI: Randall Smith (SAO)

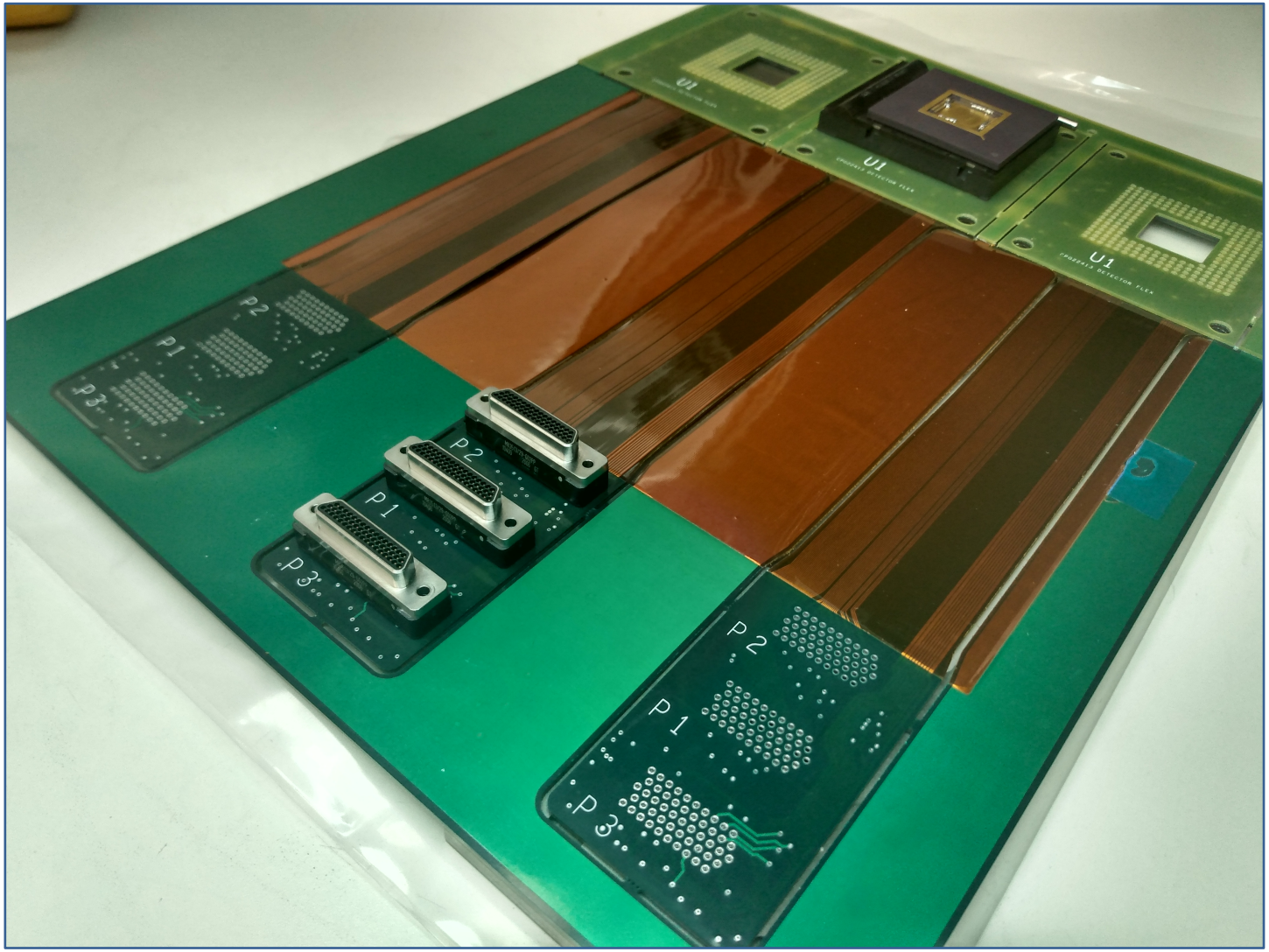


Auxiliary boards for reading out superconducting resonators with resonant frequencies from 0.1 – 8 GHz, implemented for ground-based Toltec experiment

Significance: Fast readouts are crucial for large focal plane arrays in future missions

Project Title: Development of Low-Power FPGA-based Readout Electronics for Superconducting Detector Arrays

PI: Philip Mauskopf (ASU)



One of three assembled low-noise detector boards in a panel

Significance: Low-noise detectors are crucial for future missions

Project Title: A Single-Photon-Sensing and Photon-Number-Resolving Detector for NASA Missions

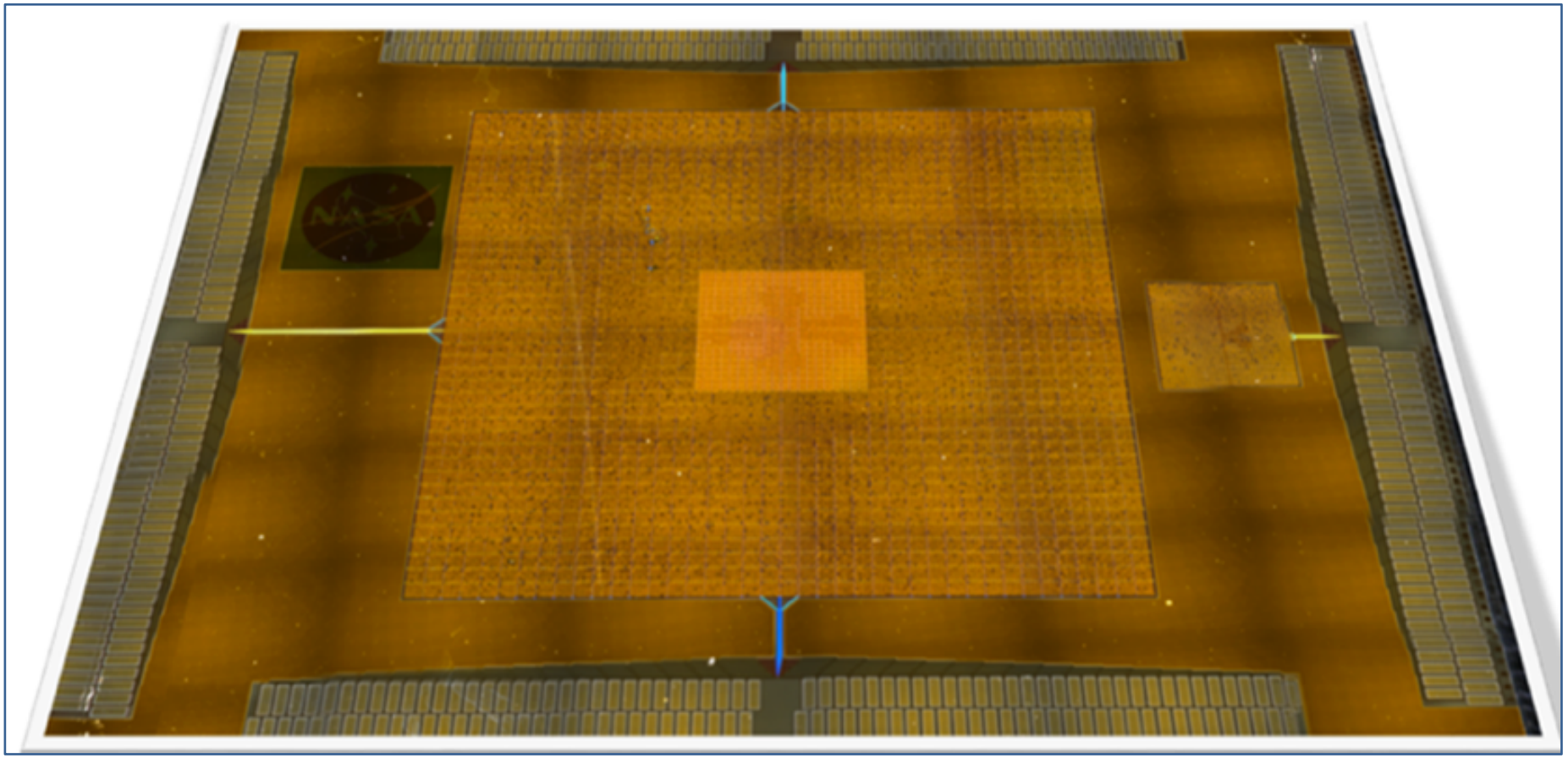
PI: Don Figer (RIT)

Field-testing detectors in BICEP ground array (Antarctica)

Significance: CMB polarimetry is crucial for identifying echoes of the Big Bang

Project Title: Superconducting Detectors for Cosmic Microwave Background (CMB) Polarimetry in PICO

PI: Roger O'Brient (JPL/Caltech)

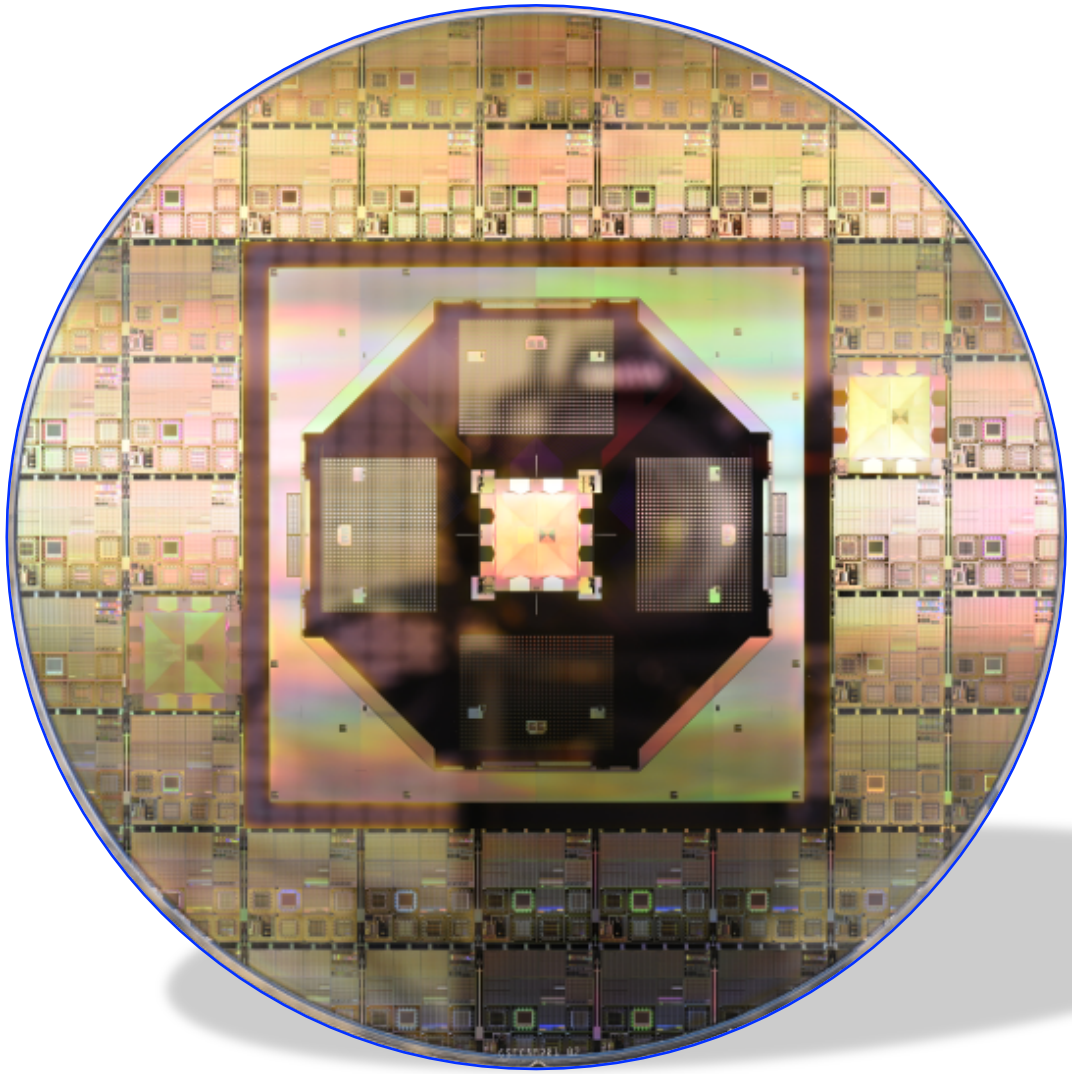


First prototype Lynx Transition-Edge-Sensor (TES) arrays with 25 absorbers

Significance: High-resolution TES microcalorimeters may enable future X-ray missions such as Lynx

Project Title: Advanced X-ray Microcalorimeters: TES Microcalorimeters

PI: Caroline Kilbourne (GSFC)

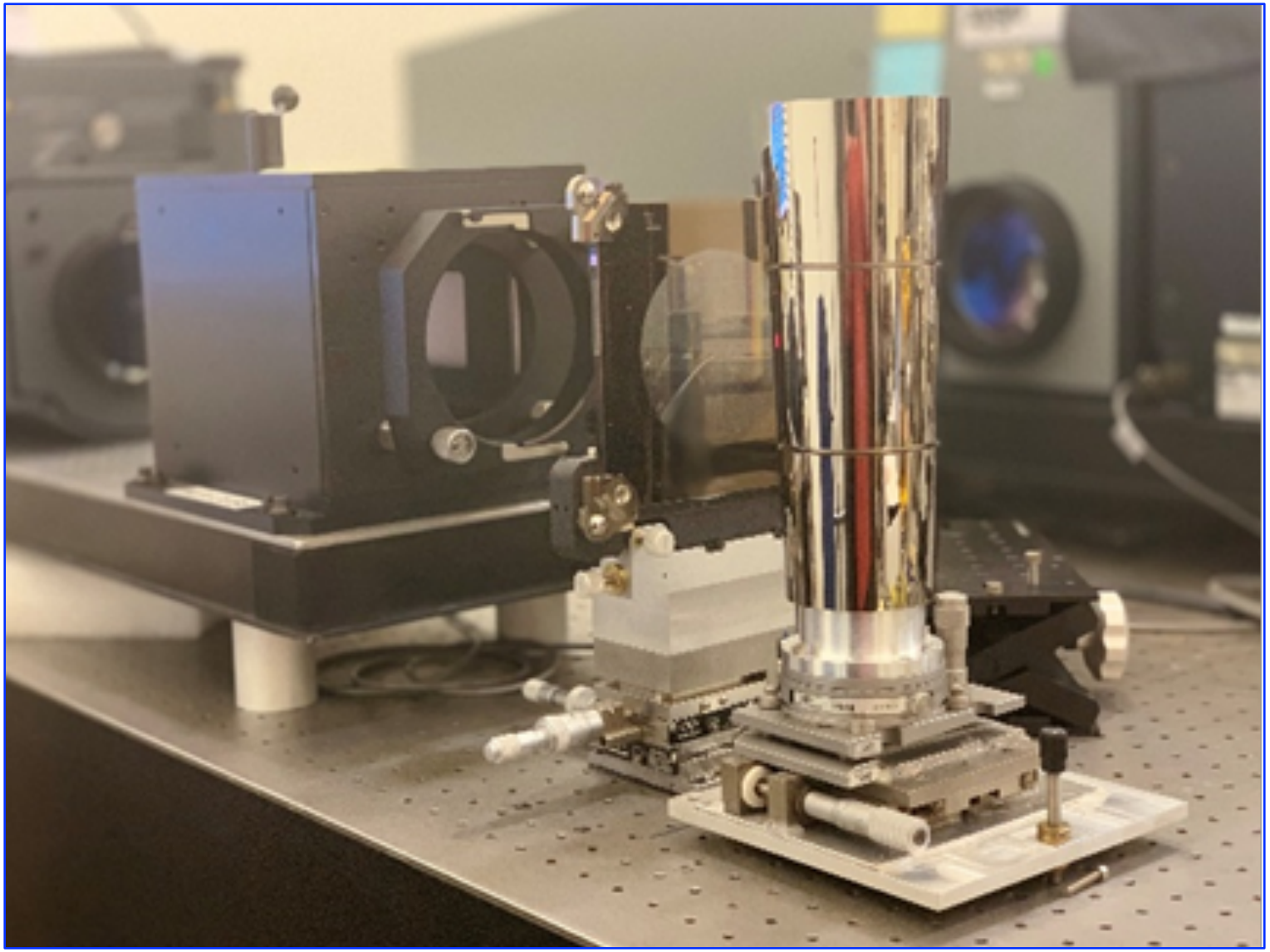


8” wafer with 4” Magnetically-Coupled Microcalorimeter (MMC) X-ray detector core

Significance: MMCs offer energy resolution that may enable future X-ray missions such as the Lynx X-ray flagship mission concept

Project Title: MMC Arrays for X-ray Astrophysics

PI: Simon Bandler (GSFC)

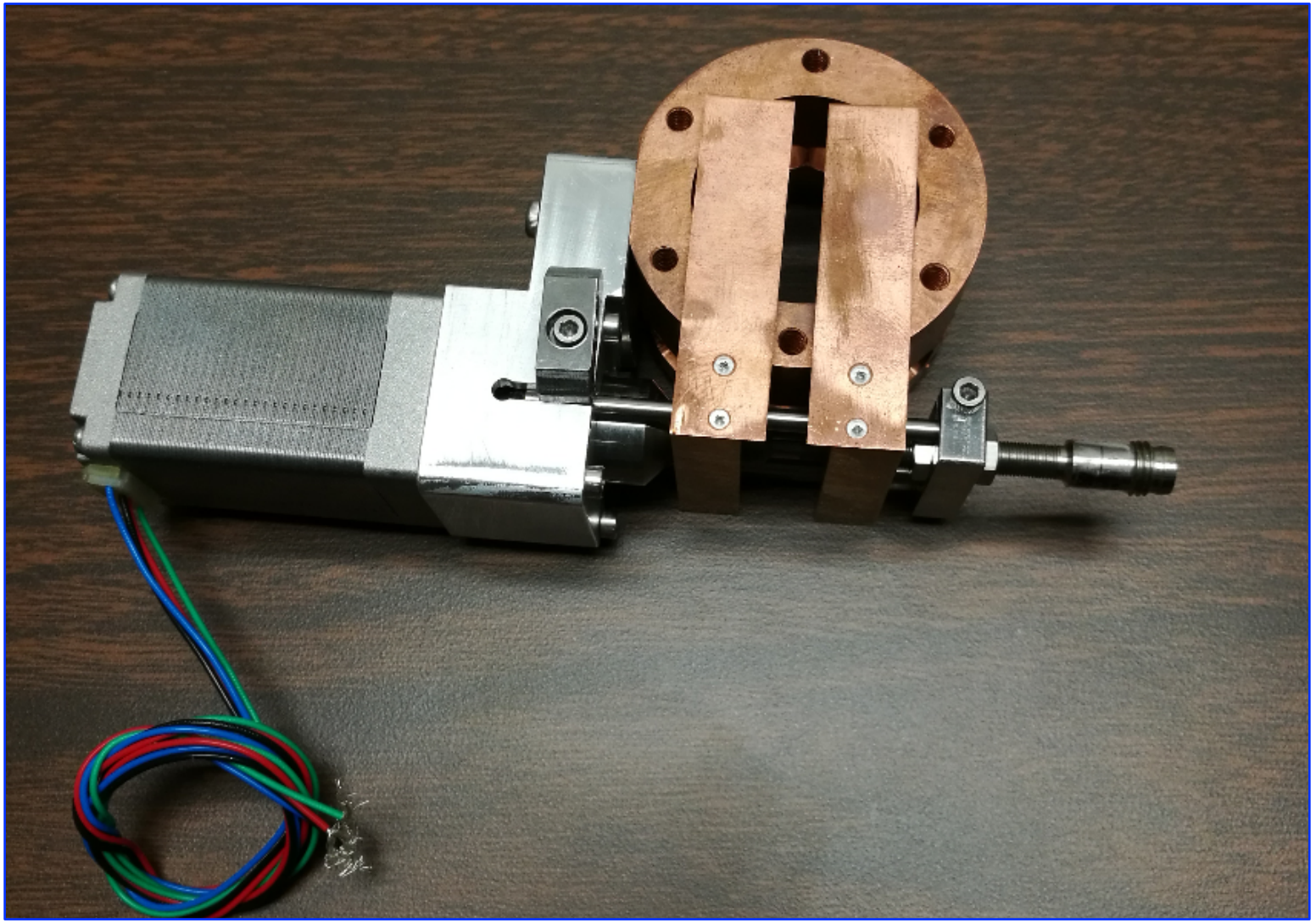


High-resolution metrology to measure polished X-ray optic mandrel

Significance: High-quality X-ray optics may enable or enhance future Astrophysics missions

Project Title: Advanced X-ray Optics: Computer-Controlled Polishing of High-Quality Mandrels

PI: Jacqueline Davis (MSFC)



Active slit for differential deposition used to correct X-ray-optic figure errors

Significance: High-quality X-ray optics may enable or enhance future Astrophysics missions

Project Title: Advanced X-ray Optics: Differential Deposition for Figure Correction in X-Ray Optics

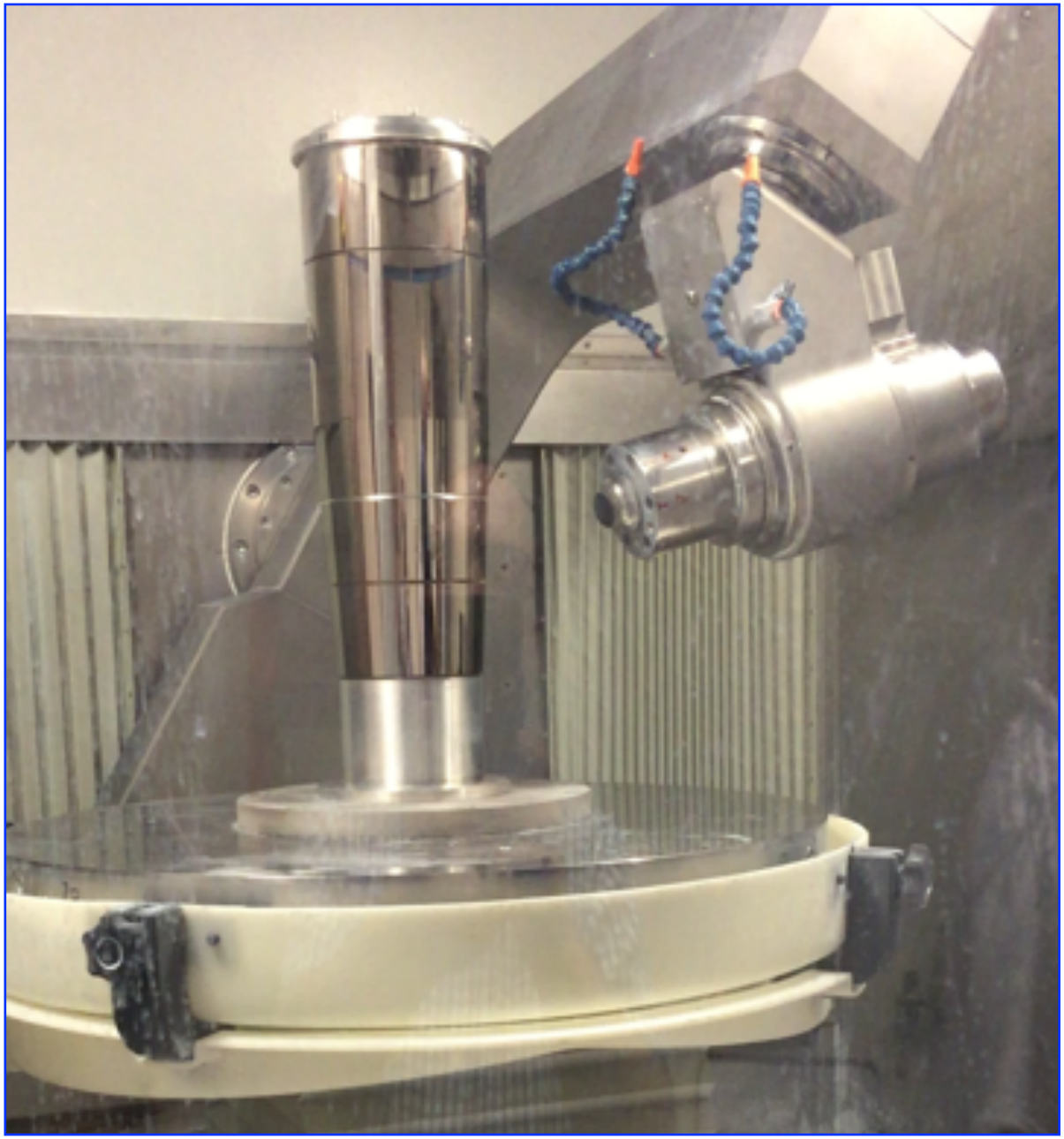
PI: Kiranmayee Kilaru (MSFC)

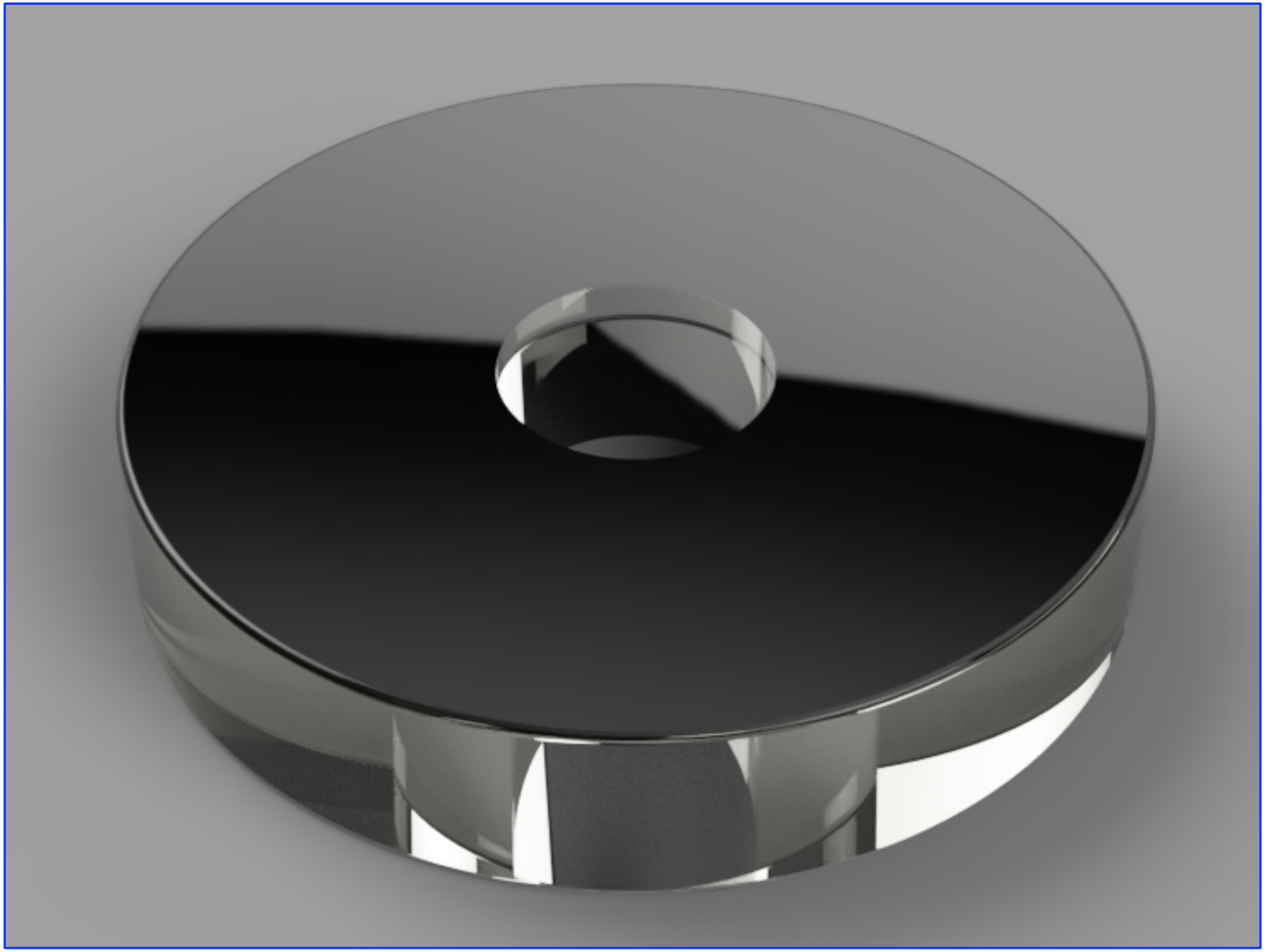
X-ray optic mandrel being polished

Significance: High-quality X-ray optics may enable or enhance future Astrophysics missions

Project Title: Advanced X-ray Optics: Full-Shell Direct Polishing

PI: Stephen Bongiorno (MSFC)



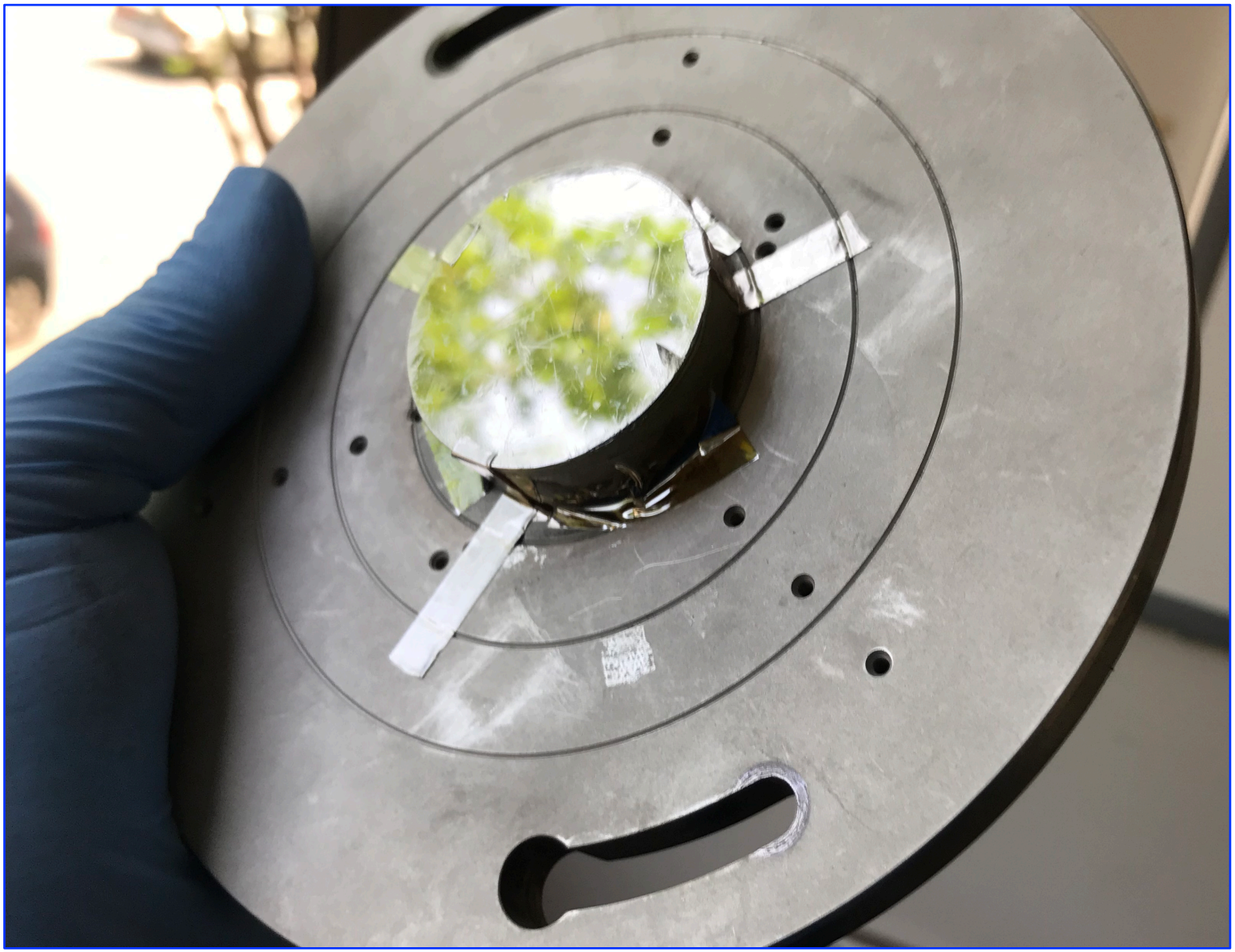


Hi-C primary Extreme-UV (EUV) multilayer mirror

Significance: High-quality EUV and X-ray optics may enable or enhance future Astrophysics missions

Project Title: Advanced X-ray Optics: Mirror Coatings

PI: David Broadway (MSFC)

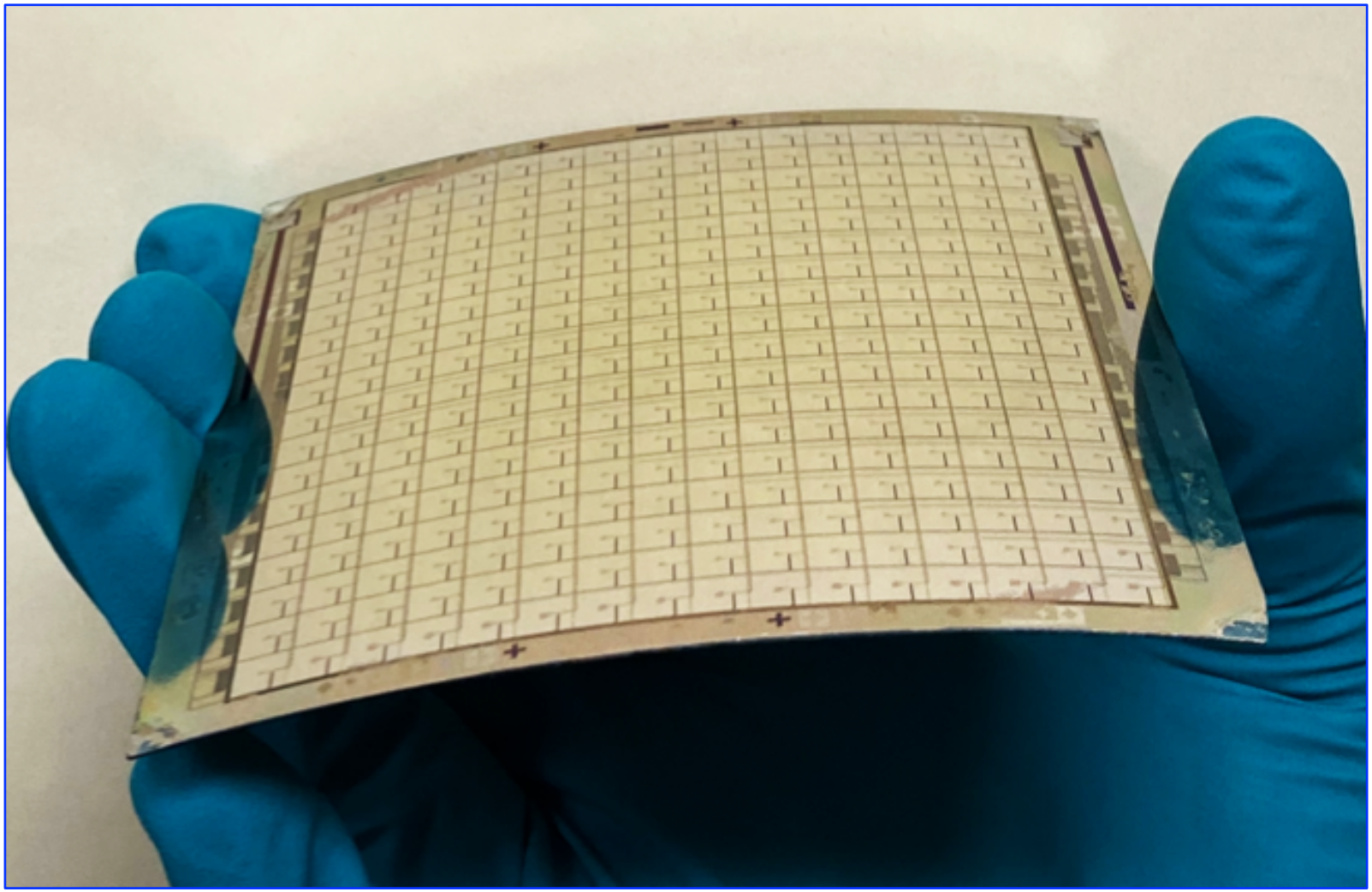


Lightweight polyimide aerogel optic

Significance: High-quality X-ray optics may enable or enhance future Astrophysics missions

Project Title: Advanced X-ray Optics: Hybrid X-Ray Optics by Additive Manufacturing

PI: David Broadway (MSFC)

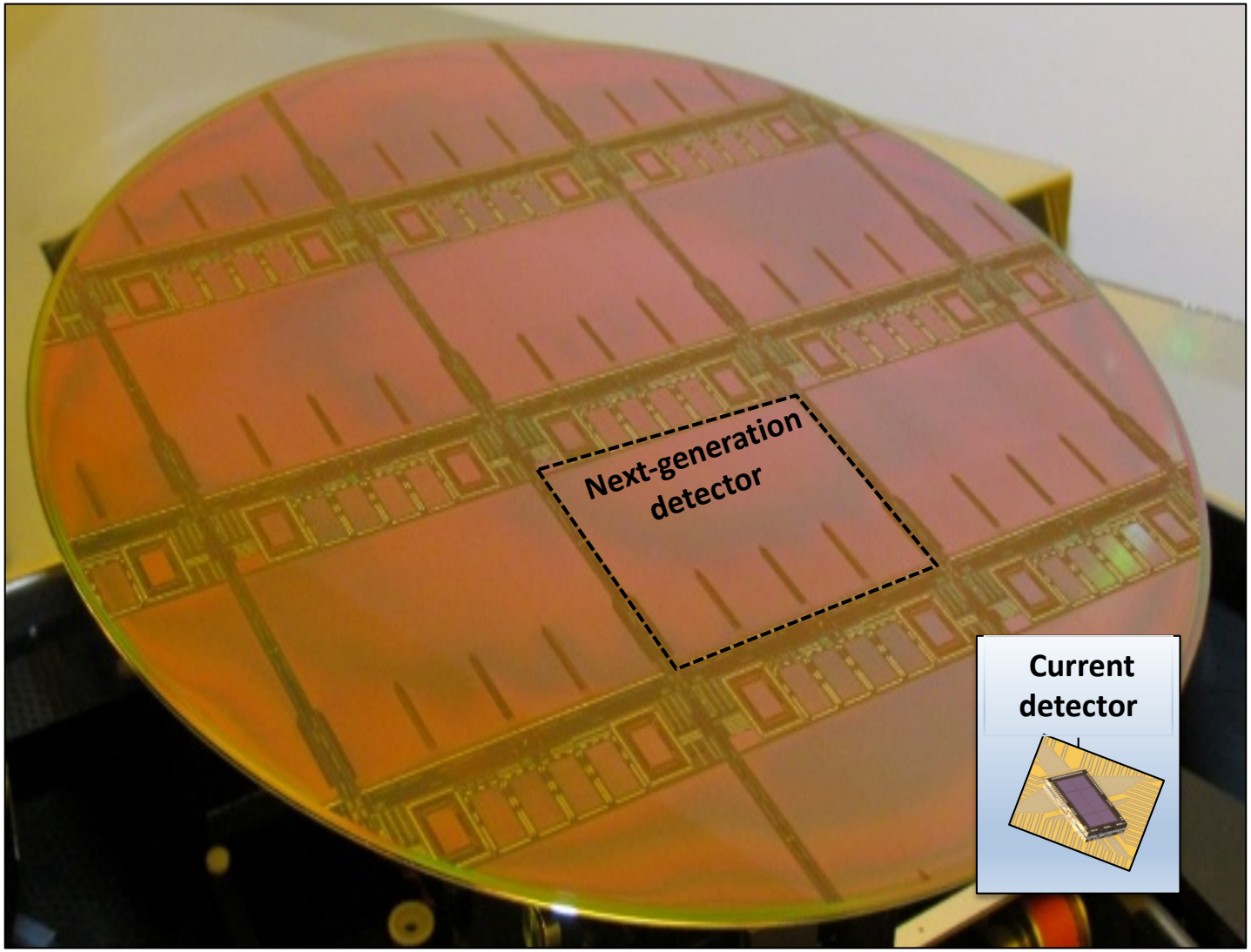


Back side of adjustable X-ray mirror segment with row-column addressing, electro-static-discharge (ESD) protection circuits, and piezo cells

Significance: Adjustable X-ray optics are a backup technology for the Lynx X-ray large mission concept

Project Title: Adjustable X-Ray Optics

PI: Paul Reid (SAO)

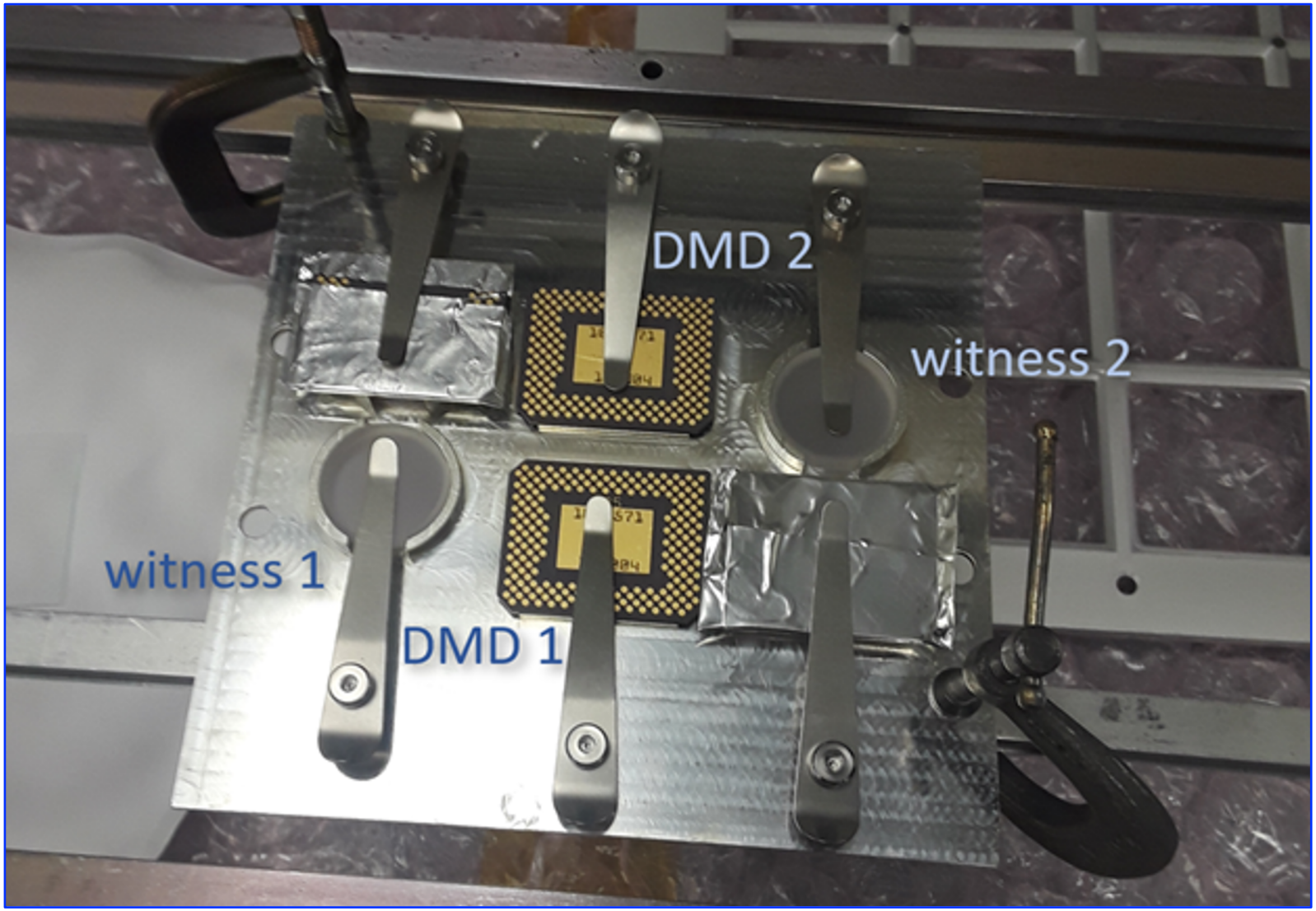


Six next-generation X-ray detectors on 200-mm wafer. Inset shows current, much smaller sensor

Significance: Advanced X-ray detectors may enable the Lynx large mission concept

Project Title: Toward Fast, Low-Noise, Radiation Tolerant X-ray Imaging Arrays for Lynx: Raising Technology Readiness Further

PI: Mark Bautz (MIT Kavli Institute for Astrophysics and Space Research)

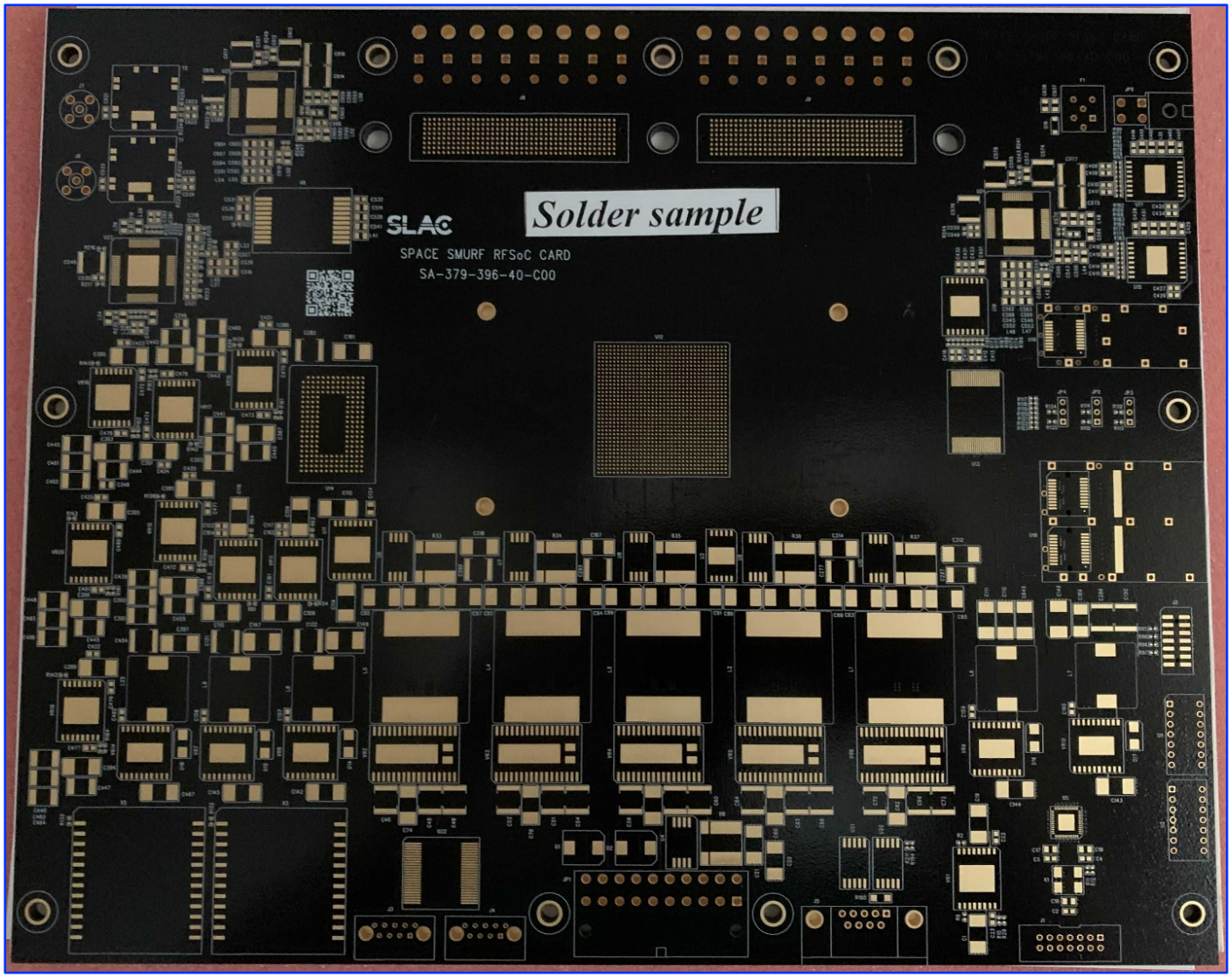


Commercially available Digital Micromirror Devices (DMDs) recoated for improved UV reflectance

Significance: Replacing windows of commercial DMDs may enable far-UV multi-object spectrometry in future missions

Project Title: Development of DMDs for Far-UV Applications

PI: Zoran Ninkov (RIT)



Radio Frequency System-on-Chip (RFSoC) board allowing dense readout of large focal planes

Significance: High-density readout may enable large focal planes needed for future missions

Project Title: Advancing High-Density Readout Technology for Superconducting Sensor Arrays for Spaceflight

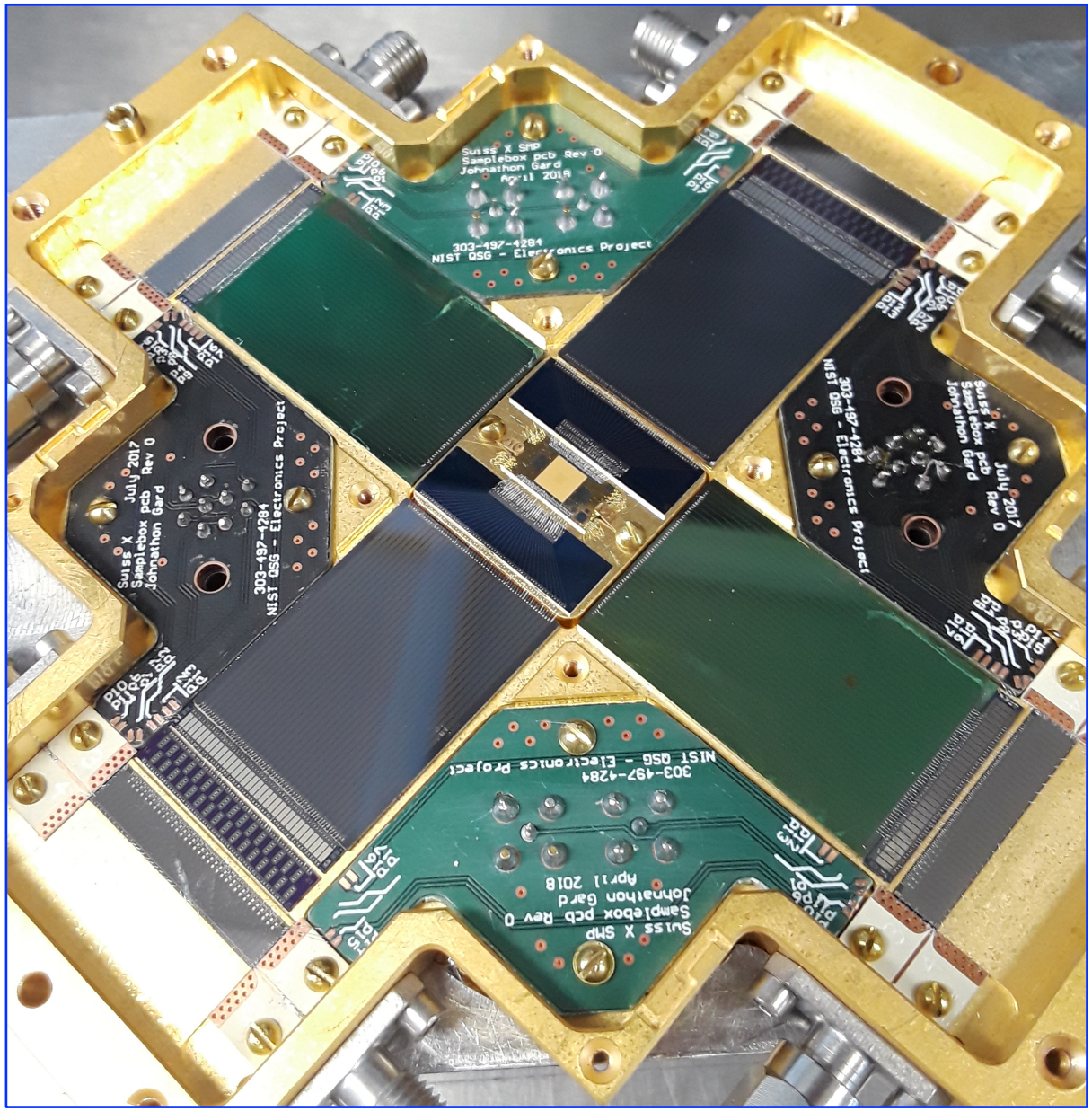
PI: Josef Frisch (SLAC)

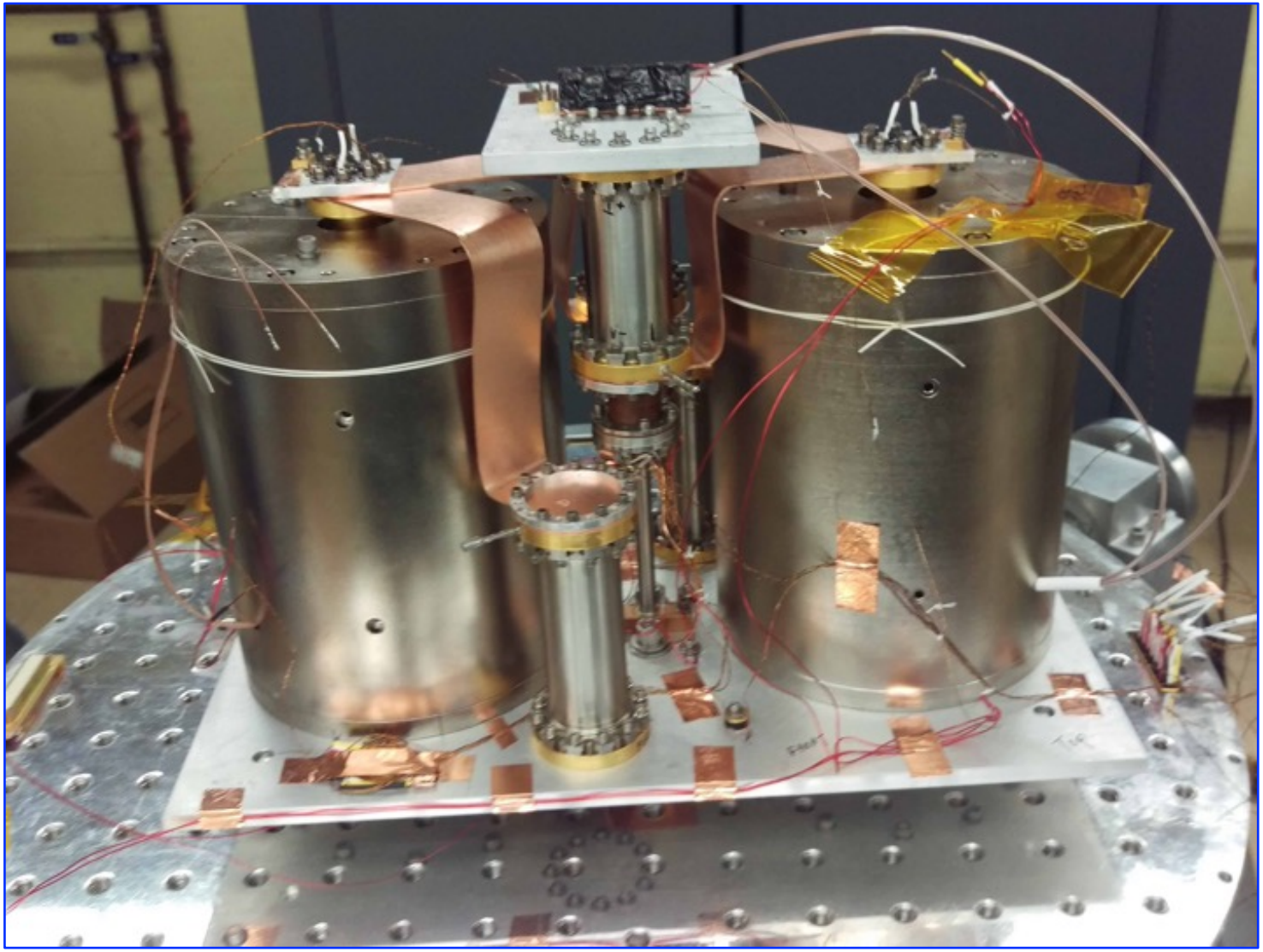
Measuring hydras for Transition-Edge Sensors (TESs) using micro-multiplexing

Significance: High-multiplexing-factor readouts may enable missions such as Lynx

Project Title: Technology development for Microwave Superconducting QUantum Interference Device (SQUID) multiplexing for the Lynx X-ray Observatory

PI: Douglas Bennett (NIST)



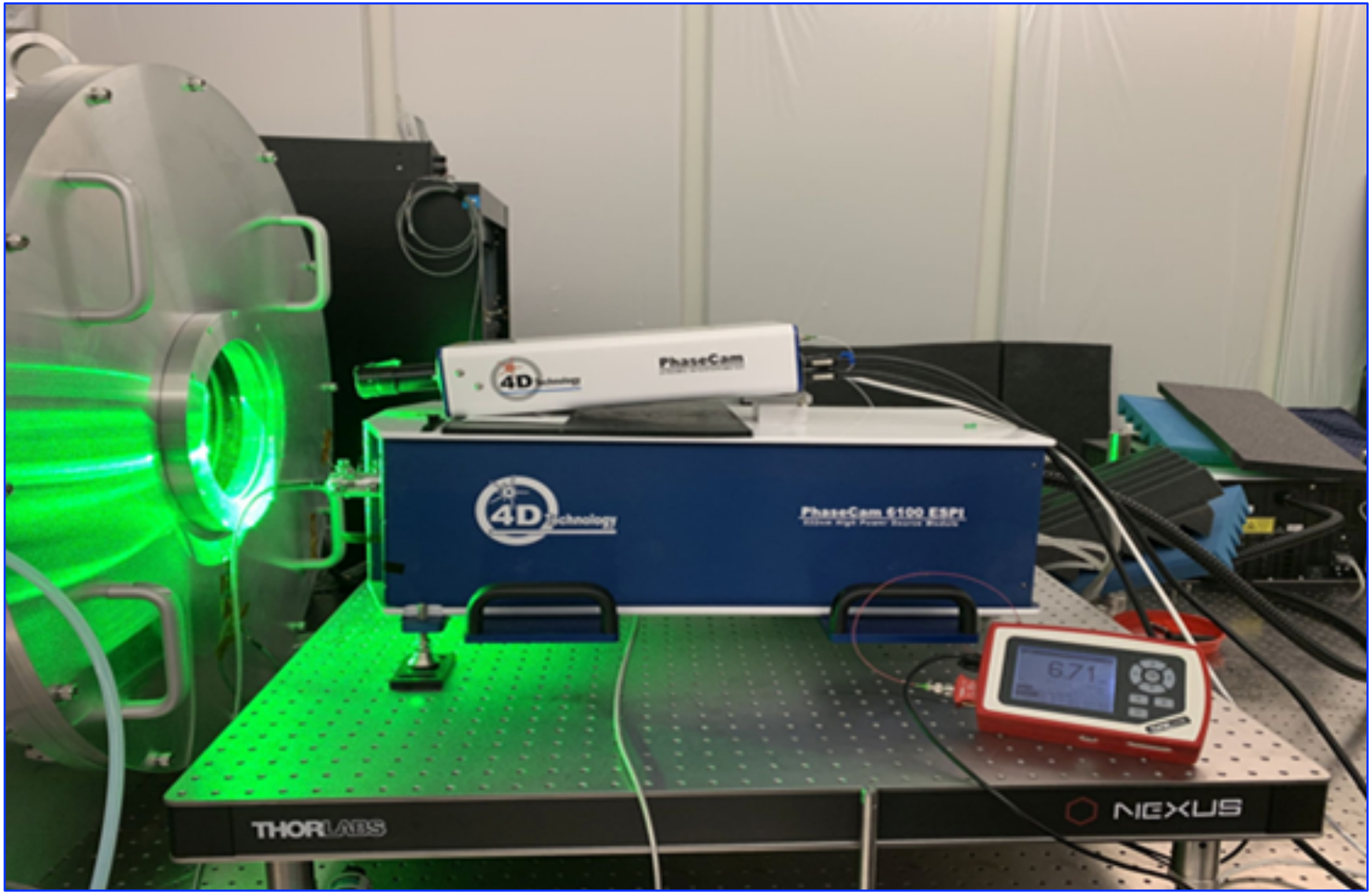


Two-stage 10K-to-4-K Continuous Adiabatic Demagnetization Refrigerator (CADR)

Significance: This advanced sub-Kelvin cooling technology has been baselined by Lynx, Origins, PICO, and GEP

Project Title: High-Efficiency Continuous Cooling for Cryogenic Instruments and sub-Kelvin Detectors

PI: James Tuttle (GSFC)

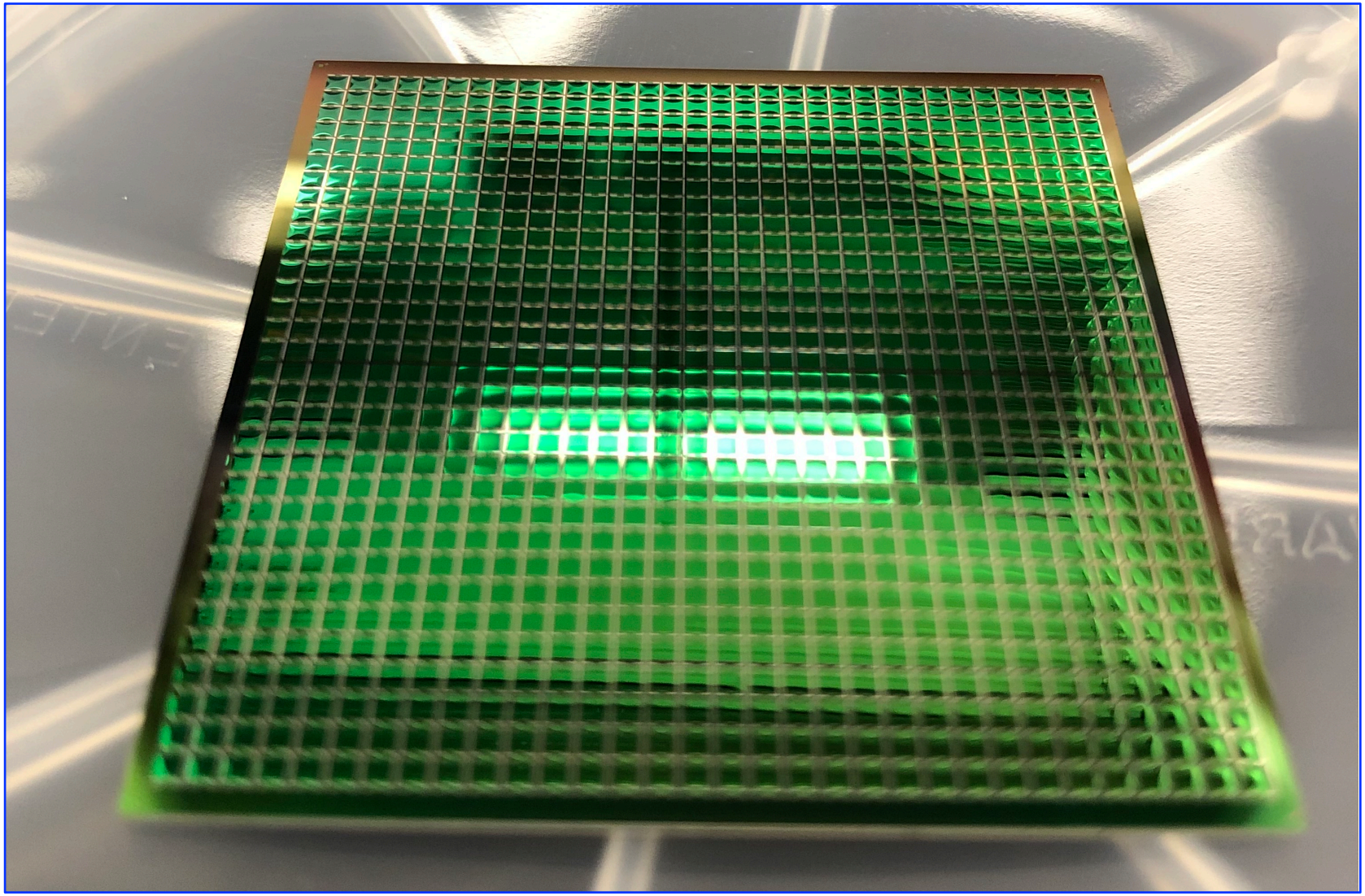


Speckle interferometer for ultra-precise measurements of non-reflective objects

Significance: Ultra-stability and -precision (~10 pm) may enable the HabEx and LUVOIR missions

Project Title: Ultra-Stable Structures

PI: Babak Saif (GSFC)

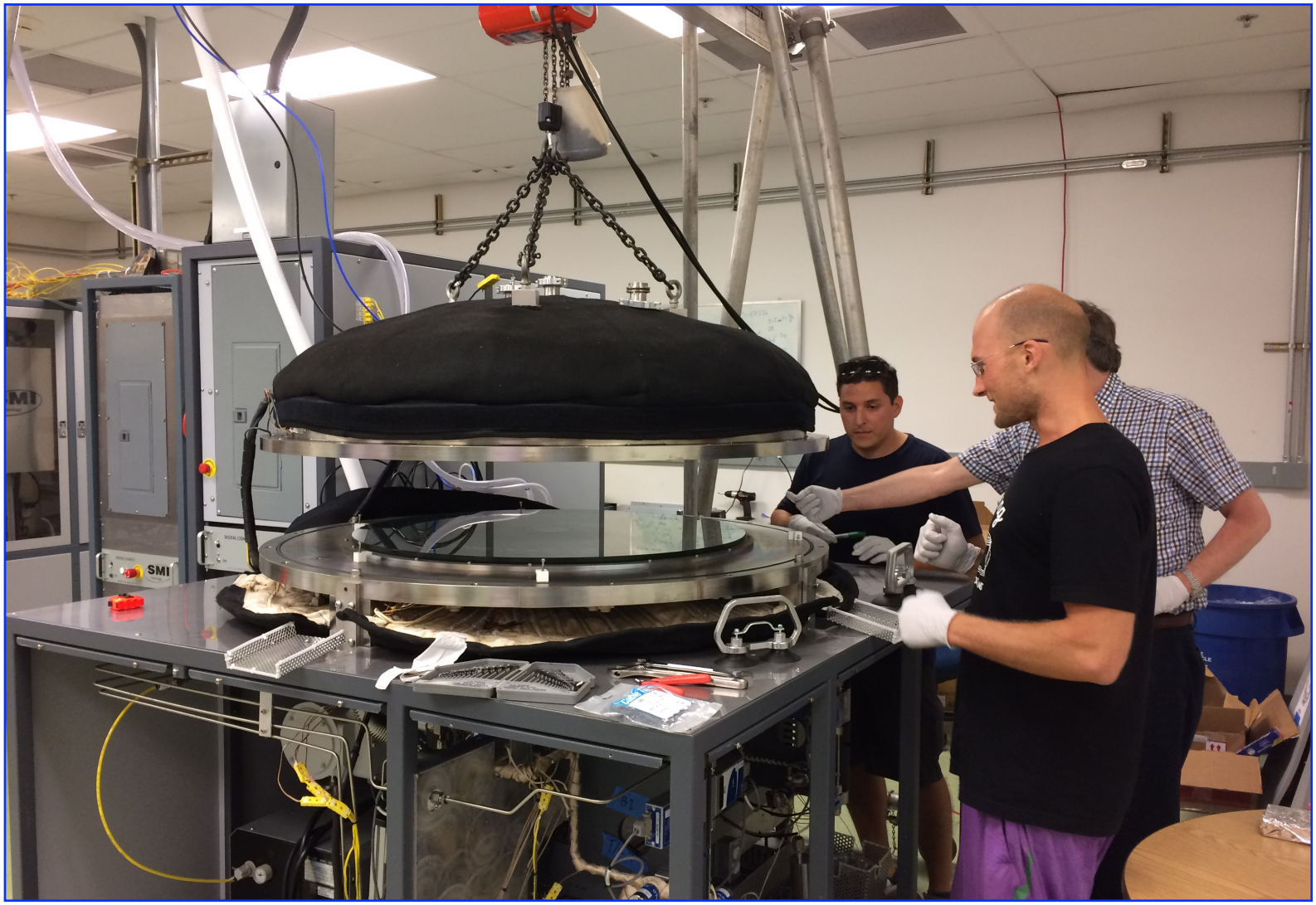


Advanced far-IR detector array

Significance: Advanced far-IR detectors may enable the Origins large mission concept

Project Title: Development of a Robust, Efficient Process to Produce Scalable, Superconducting Kilopixel Far-IR Detector Arrays

PI: Johannes Staguhn (JHU & GSFC)



Custom 0.9-m Atomic Layer Deposition (ALD) tool, developed to coat ground-based astronomical mirrors for ALD-protected silver

Significance: Advanced coatings may enable future far-UV missions

Project Title: High-Performance, Stable, and Scalable UV Aluminum Mirror Coatings Using ALD

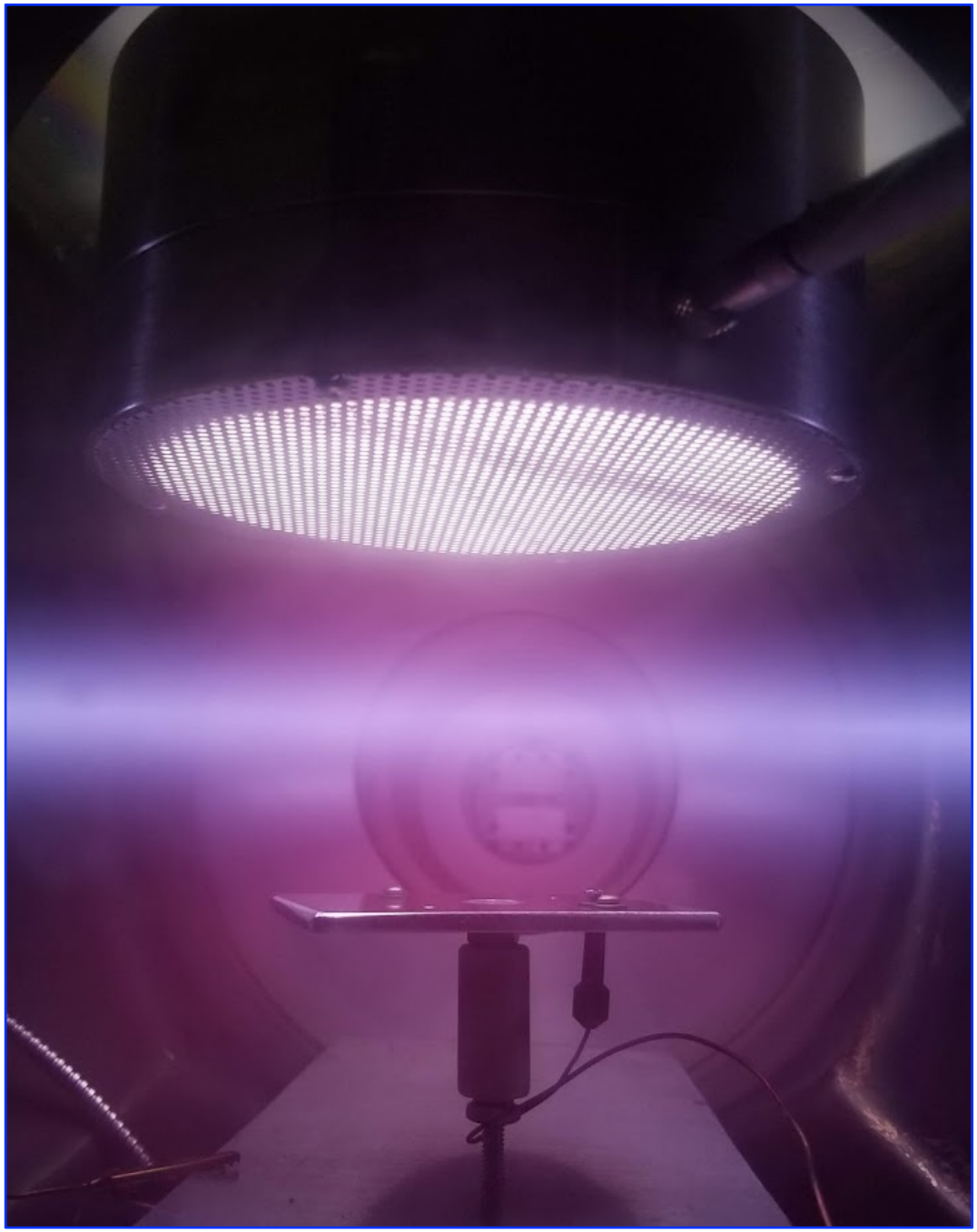
PI: John Hennessy (JPL)

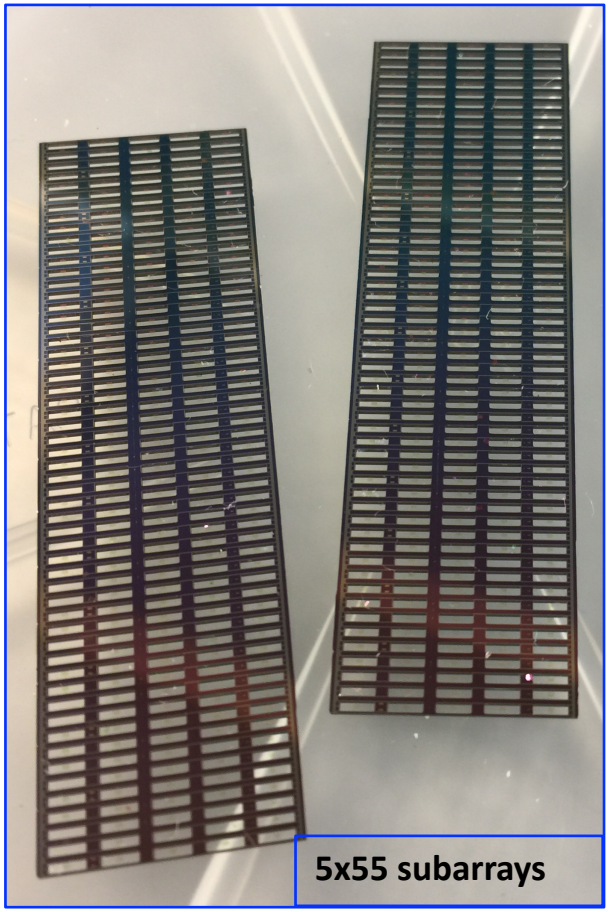
Large Area Plasma Processing System (LAPPS) at NRL used for removing oxidation from aluminum optics

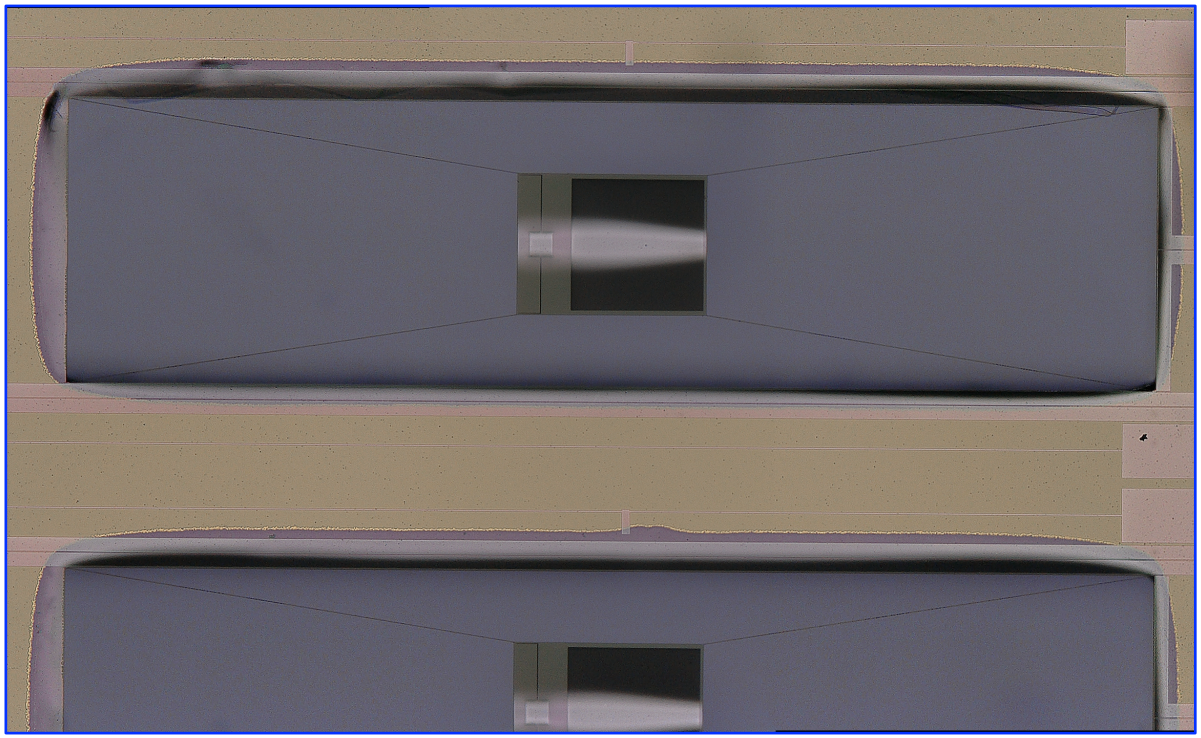
Significance: High far-UV reflectance is prevented by oxidation of aluminum mirrors; removing it may enable future far-UV missions

Project Title: E-Beam-Generated Plasma Etching for Developing High-Reflectance Mirrors for Far-Ultraviolet Astronomical Instrument Applications

PI: Manuel Quijada (GSFC)





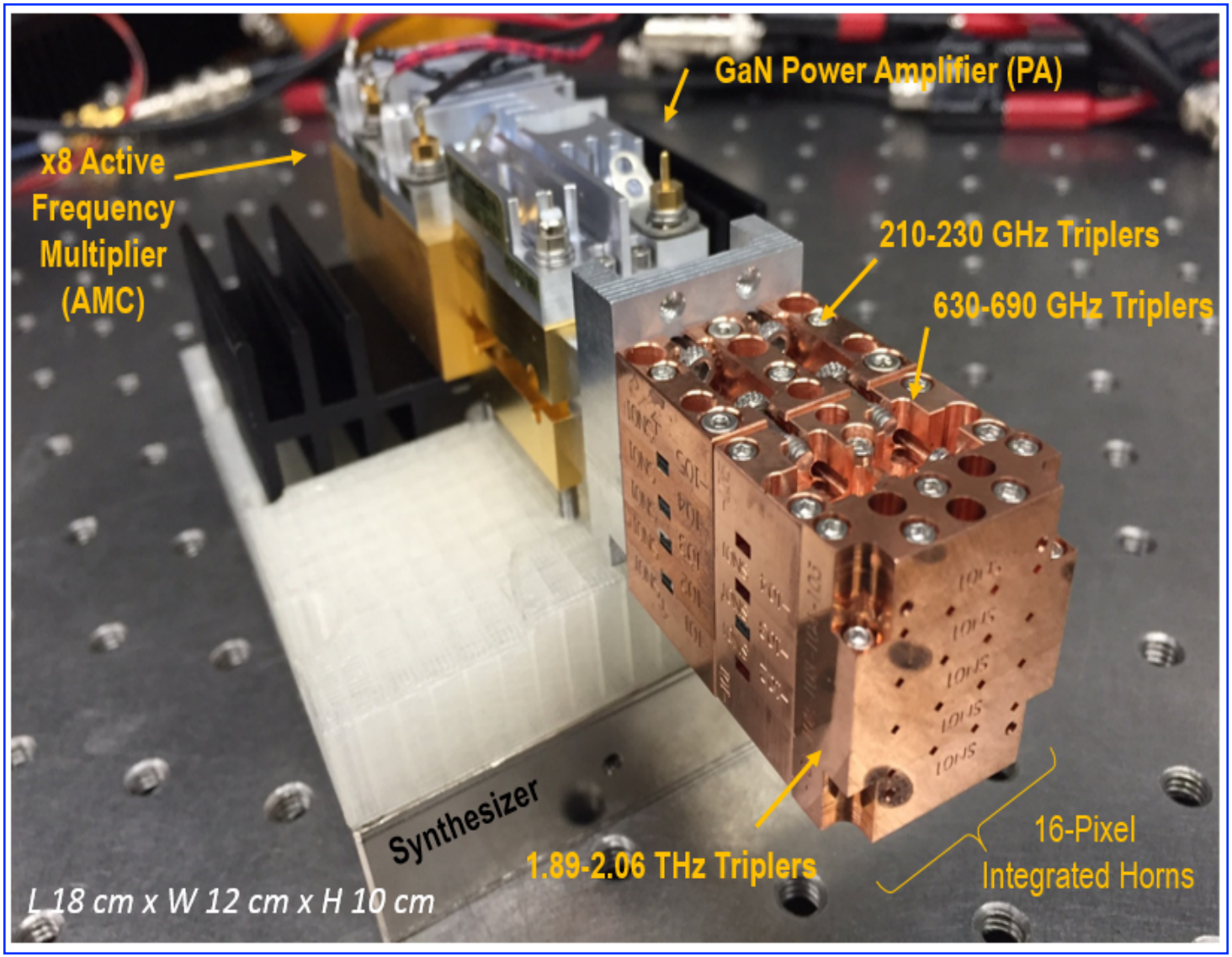


Initial Transition-Edge-Sensor (TES) bolometer fabrication

Significance: Extremely sensitive far-IR detectors may enable future missions

Project Title: Ultra-Sensitive Bolometers for Far-IR Space Spectroscopy at the Background Limit

PI: C. Matt Bradford (JPL)

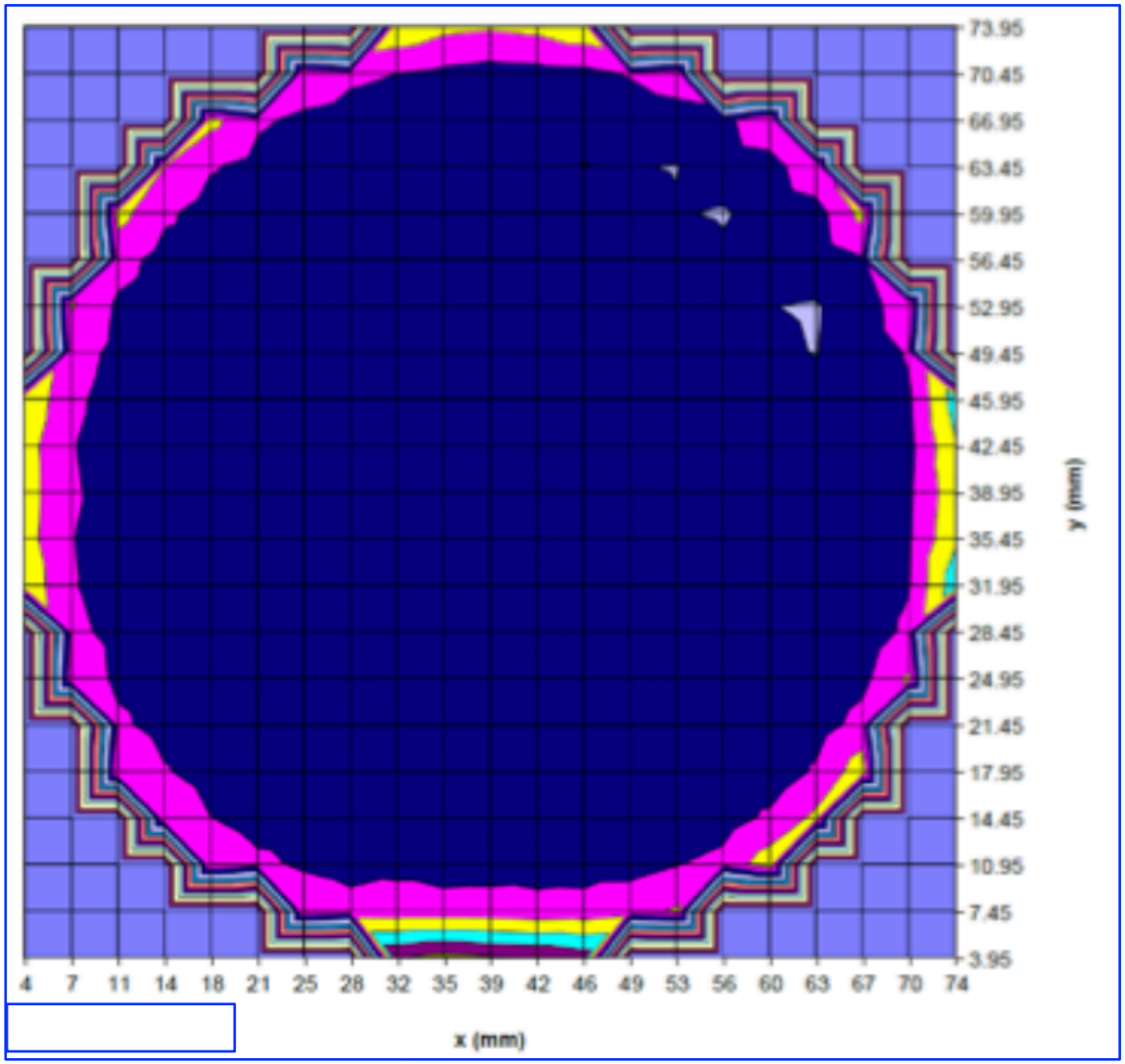


16-Pixel 1.9-2.06 THz Local Oscillator (LO) subsystem

Significance: Further development of this high-resolution far-IR detector technology to higher pixel numbers may enable or enhance future missions

Project Title: Development of High-Resolution Far-IR Arrays

PI: Imran Mehdi (JPL)



Growth uniformity of wafer yielding six usable sites for 1k×1k-pixel Linear-mode Avalanche Photodiode (LmAPD) detector

Significance: Ultra-low-noise detectors may enable spectroscopy of extrasolar planets

Project Title: Photon counting NIR LmAPD Arrays for Ultra-low Background Space Observations

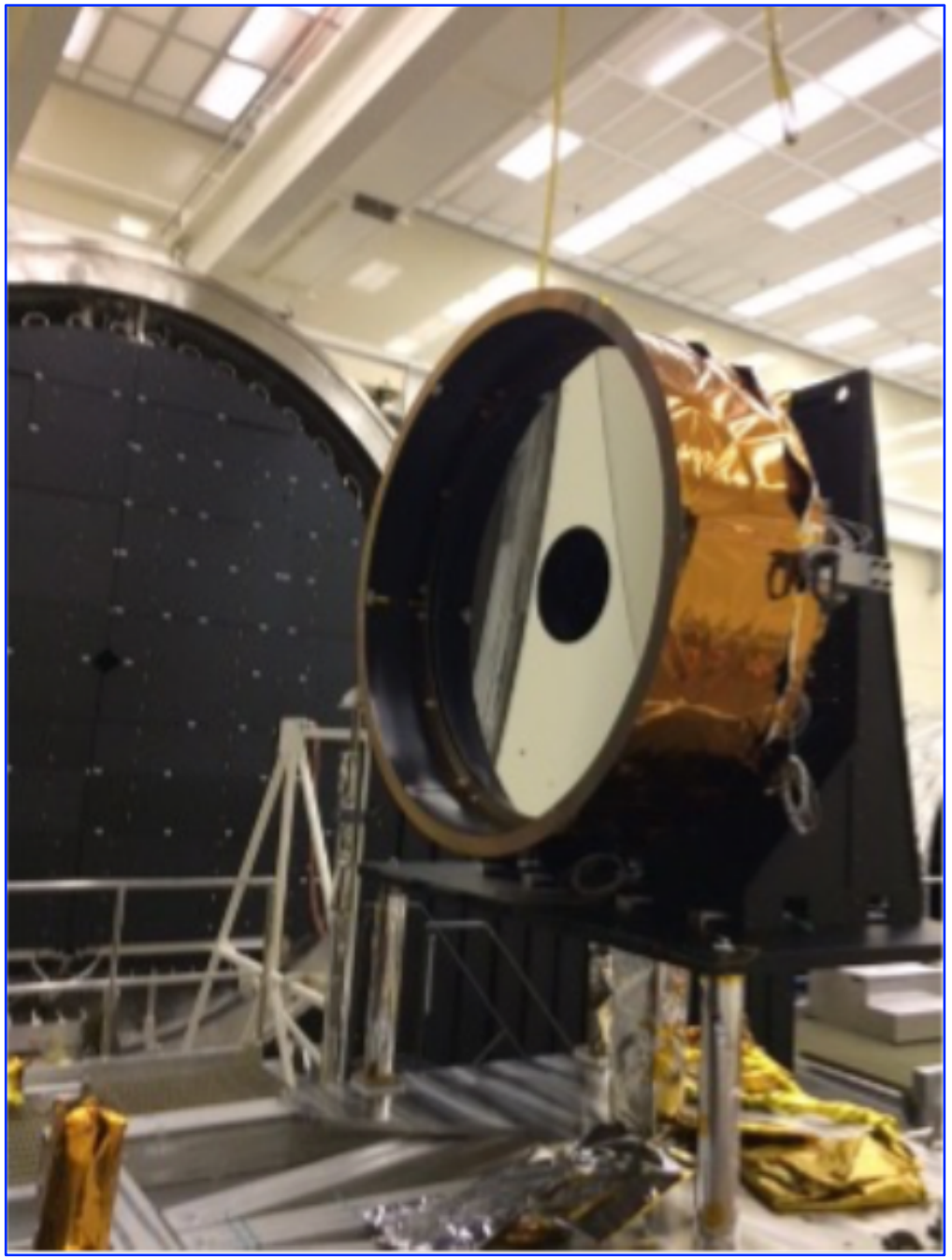
PI: Michael Bottom (U. of Hawaii)

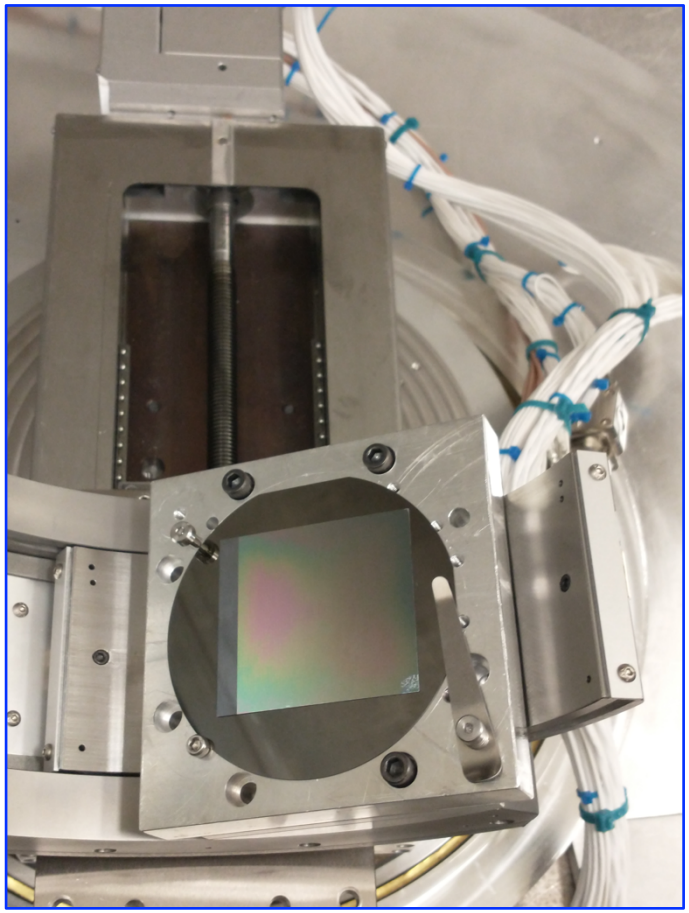
1.5-m Advanced Mirror Technology Development- (AMTD) 2 ULE® mirror in active thermal enclosure

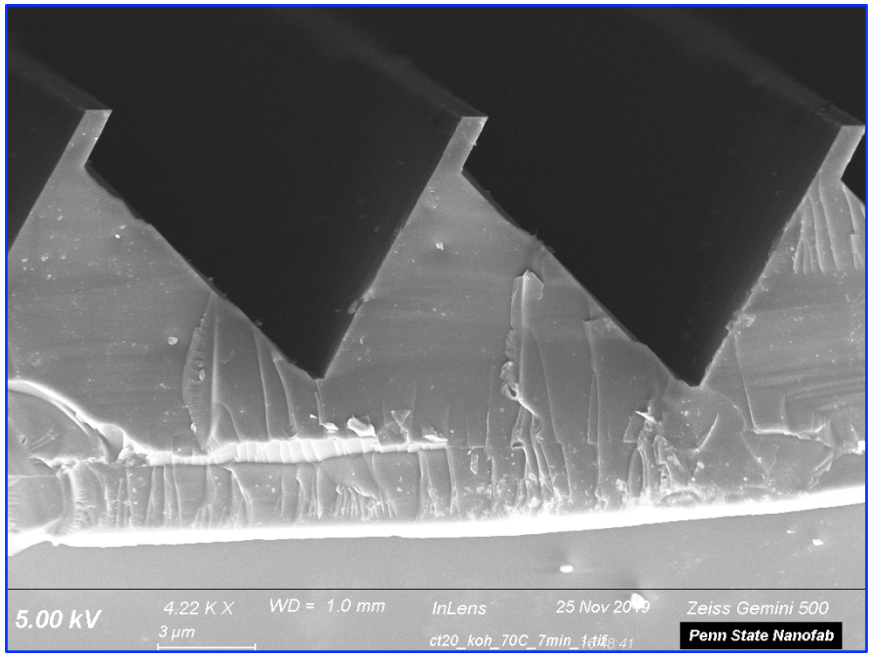
Significance: This technology may enable required ultra-stability (~10 pm) for HabEx and LUVOIR missions

Project Title: Predictive Thermal Control (PTC) Technology to enable Thermally Stable Telescopes

PI: H. Philip Stahl (MSFC)





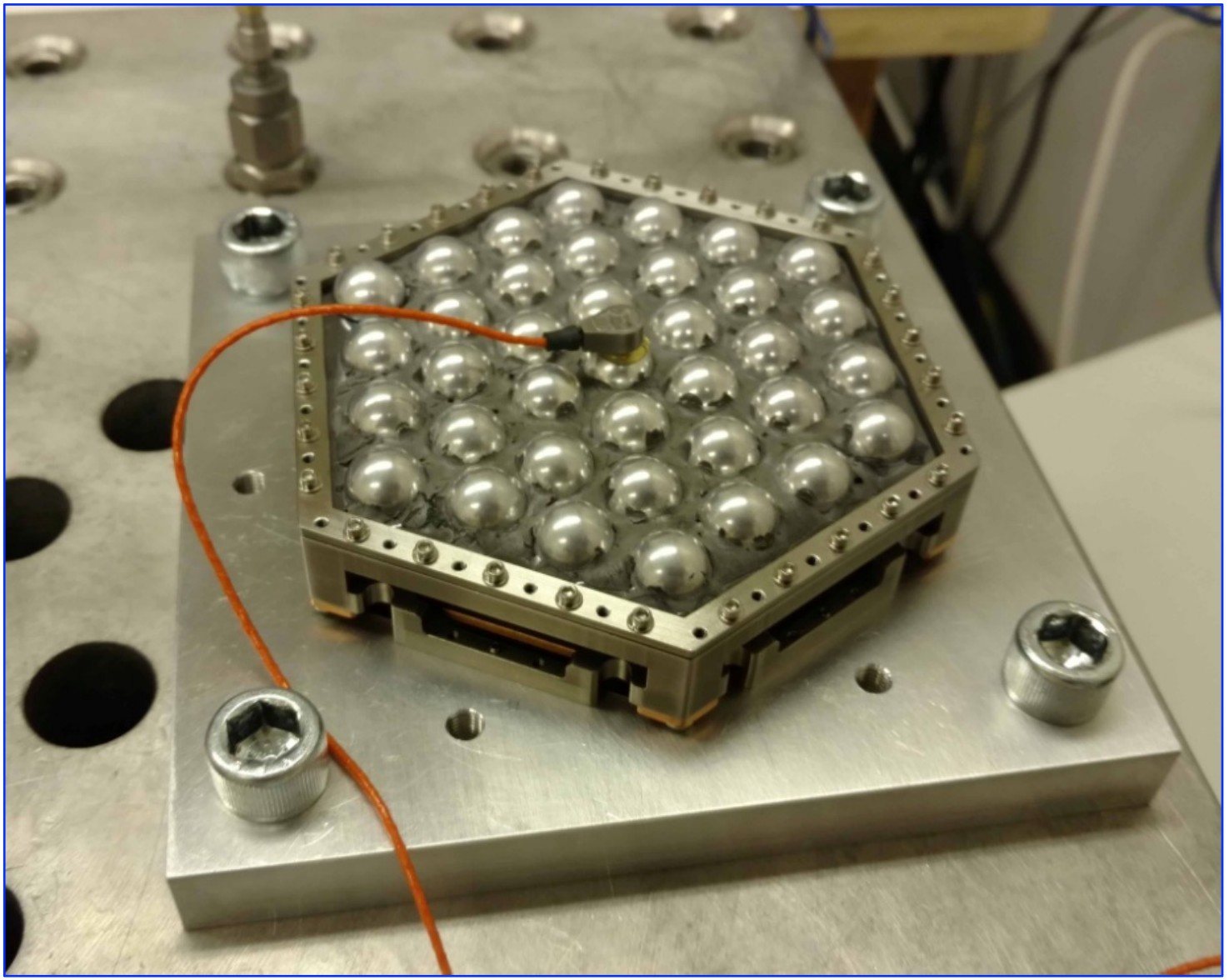


Protoflight CHESS echelle grating and Scanning Electron Microscope (SEM) image of ruled grating

Significance: May enable future UV/optical spectroscopic missions; enables current UV suborbital missions

Project Title: Electron-Beam-Lithography Ruled Gratings for Future UV/Optical Missions: High Efficiency and Low Scatter in the Vacuum UV

PI: Brian Fleming (U. of Colorado)

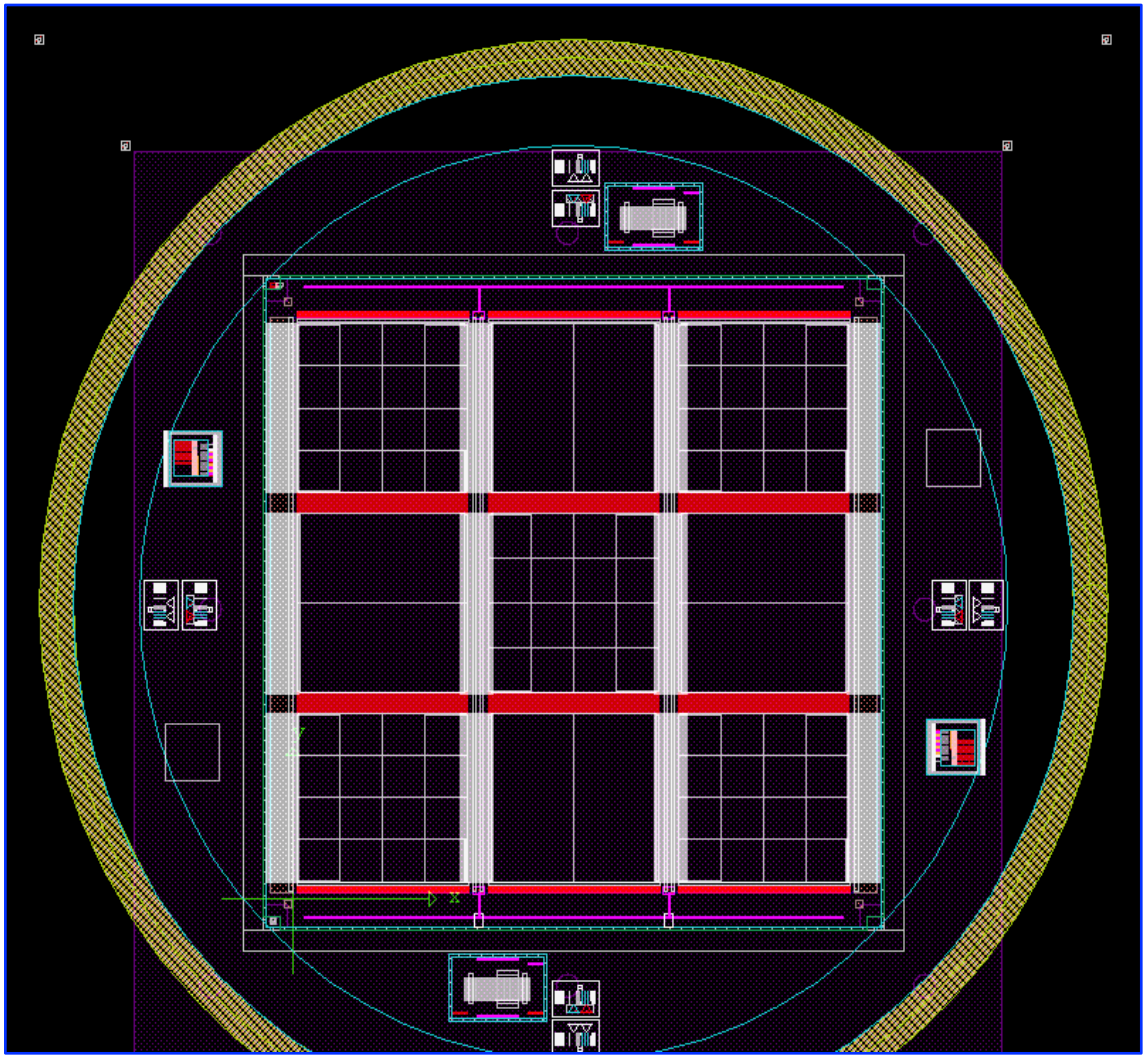


Mock array in vibration test

Significance: May enable future Cosmic Microwave Background (CMB) missions, e.g. LiteBIRD

Project Title: Technology Development for LiteBIRD and other CMB Missions

PI: Adrian T. Lee (UC Berkeley)

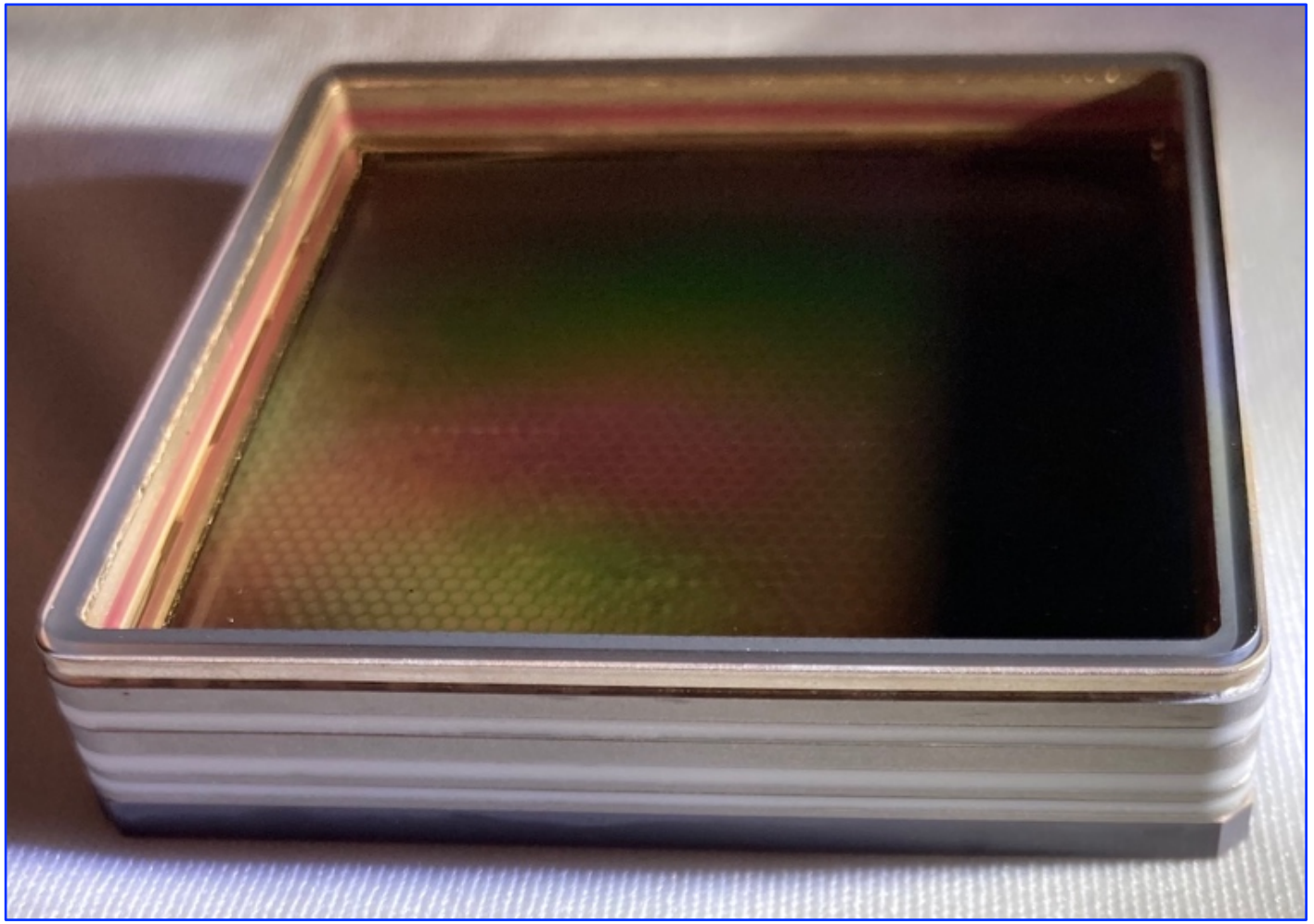


Mask layout for 734×348 microshutter array; small sections in sub-arrays consist of microshutters with various keystone structures

Significance: May enable sparse-field multi-object spectroscopy for e.g. LUVOIR, HabEx, CETUS, and/or AERIE

Project Title: Scalable Microshutter Systems for UV, Visible, and IR Spectroscopy

PI: Matt Greenhouse (GSFC)

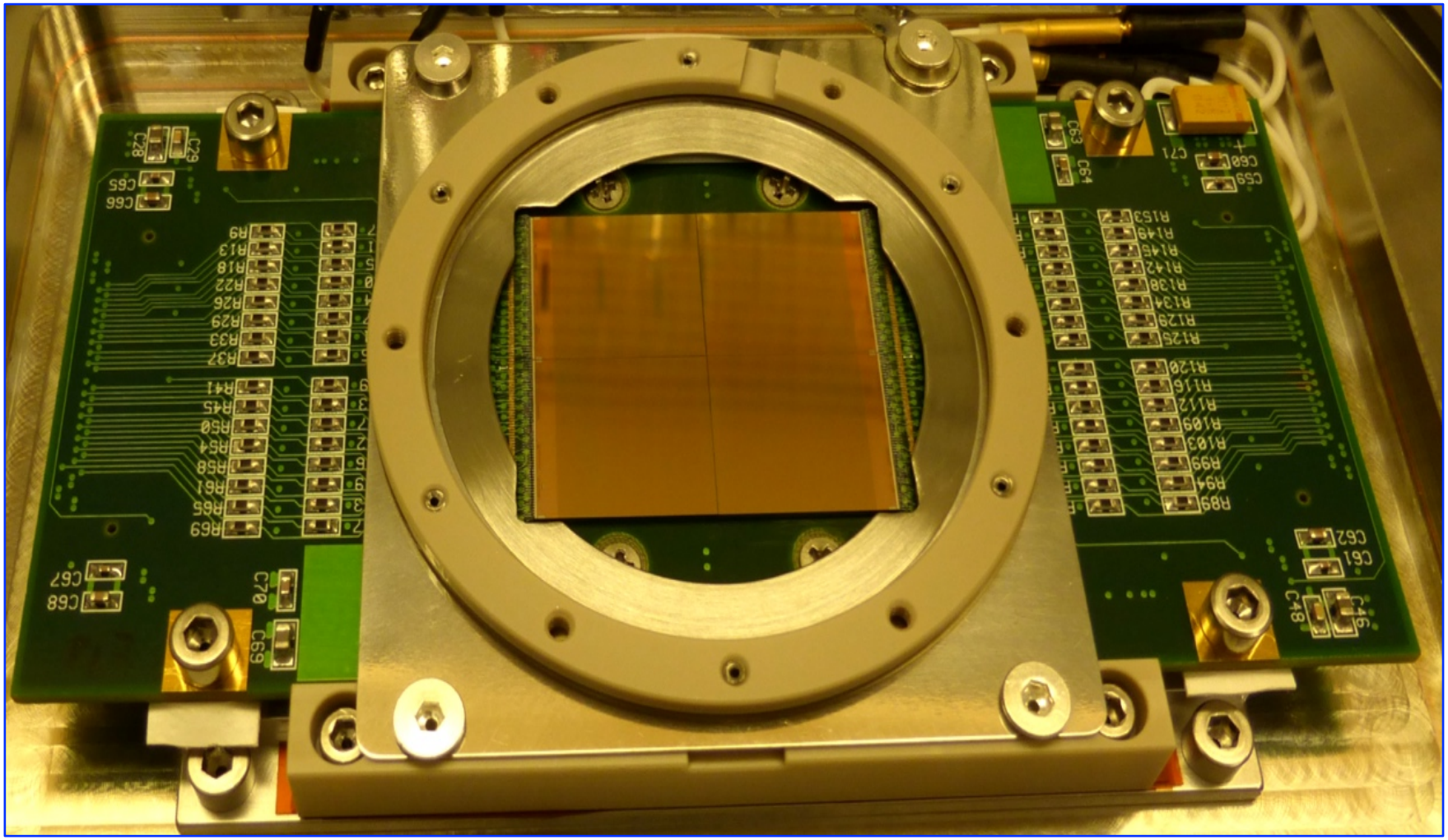


Planacon 50-mm sealed tube with sapphire input window, bialkali cathode, Atomic Layer Deposition (ALD) borosilicate Multi-Channel Plates (MCPs), and Low-Temperature Co-fired Ceramic (LTCC) XS anode

Significance: Baselined by HabEx, LUVOIR, and CETUS for UV/Visible light detection

Project Title: High-Performance Sealed-Tube Cross-Strip (XS) Photon-Counting Sensors for UV-Vis Astrophysics Instruments

PI: Oswald Siegmund (UC Berkeley)



Multi-Channel Plate (MCP) detector with 2×2 array of Timepix readout chips in the center

Significance: Four-side-buttable low-power readout chips may enable future far-UV missions with large focal planes

Project Title: Large-Format, High-Dynamic-Range UV detector using MCPs and Timepix4 readouts

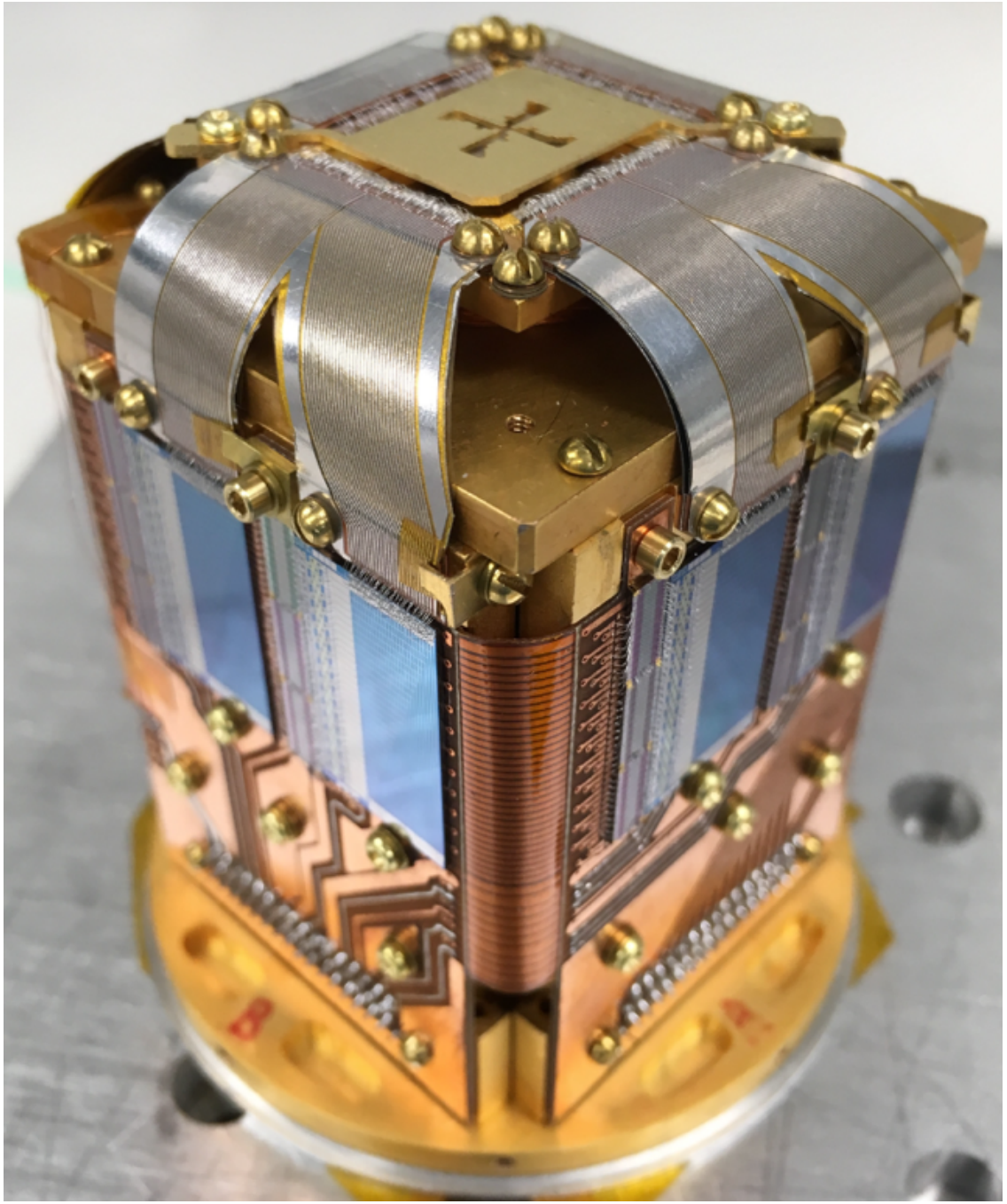
PI: John Vallerga (UC Berkeley)

NIST-developed 8-column × 32-row TDM “snout” package of detectors with readouts

Significance: Supports NASA X-ray observatories by developing similar instruments in ground-based labs, replicating conditions in astrophysical sources observed by spaceflight instruments, and observing them parametrically to help interpret space-based data

Project Title: Advanced X-ray Microcalorimeters: Lab Spectroscopy for Space Atomic Physics

PI: F. Scott Porter (GSFC)



2D Delta-Doped Electron-Multiplying Charge-Coupled Device (EMCCD) detector

Significance: Ultra-low-noise detectors were baselined by SHIELDS, HabEx, LUVOIR, and ground facilities

Project Title: Advanced FUV/UV/Visible Photon-Counting and Ultralow-Noise Detectors

PI: Shouleh Nikzad (JPL/Caltech)