PCOS and COR Strategic Technology Portfolio

For more information about these technologies visit our Technology Database (http://www.astrostrategictech.us)
Technology Development Module with a pair of parabolic-hyperbolic X-ray mirror segments

**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)
150-mm X-ray grating wafer patterned with nine samples of experimental Level-2 backside structures

**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)
30/40-GHz bowtie planar antenna design for Cosmic Microwave Background (CMB) polarimetry

**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)
25-pixel Hydra readout before absorber deposition for X-ray microcalorimeters

**Significance:** Transition-Edge Sensor (TES) superconducting microcalorimeters offer energy resolution that enables the European Space Agency (ESA) ATHENA X-ray observatory, and may enable future missions such as the Lynx X-ray flagship mission concept

**Project Title:** Advanced X-ray Microcalorimeters: TES Microcalorimeters

**PI:** Caroline Kilbourne (GSFC)
Gold:Erbium (Au:Er) “waffle” sensor targeting Lynx main array requirements

**Significance:** Magnetically-Coupled Microcalorimeters (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)
Deterministic polishing of X-ray optics mandrel in Zeeko machine

**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)
Custom coating mask with varying holes corrects entire X-ray optic in one exposure

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)
Support structure for X-ray mirror shell

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

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

PI: Stephen Bongiorno (MSFC)
Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) grating coated

**Significance:** High-quality X-ray optics such as gratings enable future missions

**Project Title:** Advanced X-ray Optics: Mirror Coatings

**PI:** David Broadway (MSFC)
Innovative methods of fabricating lightweight, high-resolution, low-cost space-borne optics, e.g. using polyimide aerogel

**Significance:** Low-cost, lightweight, high-quality X-ray optics may enable many future missions

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

**PI:** David Broadway (MSFC)
Adjustable X-ray mirror sample, with front reflective surface shown on left, and electrode control side on right

**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)
0.5-megapixel X-ray CCDs, front-illuminated (left) and back-illuminated (right); back-illuminated offers better low-energy response

**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)
Digital Micro-mirror Device (DMD) window replaced with 2-µm-thick nitrocellulose membrane

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

**Project Title:** Development of DMDs for Far-UV Applications

**PI:** Zoran Ninkov (RIT)
μMUX/SMuRF readout deployed on Keck telescope at South Pole

Significance: High-density readout may enable large focal planes in future space missions

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

PI: Josef Frisch (SLAC)
Sample electronics box with Transition Edge Sensor (TES) microcalorimeter detectors, microwave multiplexers, and support electronics

**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)
Active gasp-gap heat switches used in continuous adiabatic demagnetization refrigerator (CADR) cooling system

**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)
Through-wafer via allowing connection of 2D superconducting detectors to cold readout electronics

Significance: This new technique 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)
100-mm convex SISTINE secondary mirror over-coated at JPL

**Significance:** May enable or enhance future far-UV missions

**Project Title:** High-Performance, Stable, and Scalable UV Aluminum Mirror Coatings Using Atomic Layer Deposition (ALD)

**PI:** John Hennessy (JPL)
Large Area Plasma Processing System (LAPPS) reactor at NRL, used for removing oxidation from aluminum optics prior to coating

**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-UV Astronomical Instrument Applications

**PI:** Manuel Quijada (GSFC)
Buttressed (top) and unbuttressed Transition-Edge-Sensor (TES) bolometer devices

**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)
1.9-THz 4-pixel frequency-multiplied chain for Stratospheric Terahertz Observatory 2 (STO-2, launched Dec 2016)

**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)
Harris 1.5-m ULE® Advanced Mirror Technology Development (AMTD) mirror

**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)
Curved grooves with 4° blaze ruled on flat grating (top) with EUV measurement (bottom)

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)
Superconducting QUantum Interference Device (SQUID) amplifier for 100-mK 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)
Substrates with light shields for next-generation electrostatically activated microshutter arrays

**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 detector with sapphire input window, bialkali cathode, and pair of 54-mm, 20-µm-pore ALD borosilicate Multi-Channel Plates (MCP)

**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)
Portable X-ray Spectrometer/Electron Beam Ion Trap (XRS/EBIT) for specialized experiments

**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)
Radiation-testing Atomic Layer Deposition (ALD) coatings

**Significance:** Detectors baselined by SHIELDS, HabEx, LUVOIR, and ground facilities are fabricated using ALD coatings

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

**PI:** Shouleh Nikzad (JPL/Caltech)
2×2 array of Timepix readout chips for Multi-Channel Plate detectors

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 Multi-Channel Plates (MCPs) and Timepix4 readouts

PI: John Vallerga (UC Berkeley)
Chip carrier with printed circuit board for wiring (left), and die of 20 DFB devices indium die-bonded to copper chip carrier (right)

**Significance:** This technology provides 4.7-THz local oscillators (LOs), enabling far-IR/sub-mm missions such as the balloon-borne Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory (GUSTO)

**Project Title:** Raising the Technology Readiness of 4.7-THz local oscillators

**PI:** Qing Hu (MIT)
UHV system built at ASU for fluoride Plasma-Enhanced Atomic Layer Deposition (PEALD) mirror coatings

**Significance:** High-reflectance UV coatings would vastly improve system throughput for photon-starved UV astronomy; this system attempted to develop advanced technique for depositing high-reflectance UV coatings

**Project Title:** Improving UV Coatings and Filters using Innovative Materials Deposited by ALD

**PI:** Paul Scowen (ASU)