For more information about these technologies visit our Technology Database (http://www.astrostrategictech.us)
Mechanical engineering meta-shell test with aluminum structural shell, 54 glass test segments, 216 spacers, and 432 epoxy bonds

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

**Project Title:** High-Resolution and Lightweight X-ray Optics for the X-ray Surveyor

**PI:** Zhang, William (GSFC)
X-ray Critical-Angle Transmission (CAT) gratings during optical alignment

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

**Project Title:** Development of a CAT Grating Spectrometer

**PI:** Mark Schattenburg (MIT Kavli Institute for Astrophysics and Space Research)
Large-format antenna-coupled bolometer arrays for Cosmic Microwave Background (CMB) polarimetry

**Significance:** Developing antenna designs providing sensitivity, stability, and minimized particle susceptibility for bands required by the Inflation Probe, enabling identification of Inflation instants after the Big Bang

**Project Title:** Planar Antenna-Coupled Superconducting Detectors for CMB Polarimetry

**PI:** James Bock (JPL/Caltech)
Candidate demonstration model Transition-Edge Sensors (TESs) array for the ATHENA X-ray Integral Field Unit (X-IFU)

**Significance:** TES microcalorimeters offer energy resolution for the European ATHENA mission

**Project Title:** Providing enabling and enhancing technologies for a demonstration model of the ATHENA X-IFU

**PI:** Caroline Kilbourne (GSFC)
Mounted adjustable cylindrical X-ray mirror showing piezo cells and wiring

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

**Project Title:** Development of 0.5-Arc-second Adjustable Grazing-Incidence X-ray Mirrors for the SMART-X Mission Concept

**PI:** Paul Reid (SAO)
Students working on REXIS, a student-built instrument deployed on the OSIRIS-REx mission to Asteroid Bennu, that deployed with directly deposited filter on its X-ray CCDs

**Significance:** X-ray detectors operate far better when filters allow X-ray photons through and block longer wavelength light

**Project Title:** Directly-Deposited Blocking Filters for X-ray Imaging Detectors

**PI:** Mark Bautz (MIT Kavli Institute for Astrophysics and Space Research)
Detecting tripped micro-mirrors in Digital Micro-mirror Device (DMD) during vibration and shock testing done as part of flight qualification

**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)
1.5-m mirror blank after grinding and polishing

**Significance:** Deep-core manufacturing enables 4-m-class mirrors such as planned for the HabEx exoplanet observatory concept with significantly lower cost and risk

**Project Title:** Advanced Mirror Technology Development (AMTD) for Very Large Space Telescopes

**PI:** H. Philip Stahl (MSFC)
1.5-m mirror with strip heaters placed at 120° intervals on its outside, and 18 thermocouples on its back and sides, as well as measuring the ambient temperature

**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)
Delta-doped Electron-Multiplied CCD detectors (EMCCD) deployed at Palomar

**Significance:** Advanced detectors developed by this project are 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)
100 mm polyimide anode used for 100×100 mm² Multi-Channel Plate (MCP) detector

**Significance:** Large-format low-noise detectors may enable future far-UV missions

**Project Title:** Development of 100×100 mm² photon-counting UV detectors

**PI:** John Vallerga (UC Berkeley)
90-GHz feedhorn-coupled focal plane array for performing Cosmic Microwave Background (CMB) measurements

**Significance:** CMB measurements may enable identification of the “Inflation” cosmologists believe may have occurred instants after the Big Bang

**Project Title:** High Efficiency Feedhorn-Coupled TES-based Detectors for CMB Polarization

**PI:** Edward Wollack (GSFC)
Measuring scattered light in prototype Laser Interferometer Space Antenna (LISA) telescope

Significance: The LISA gravitational-wave observatory crucially depends on collecting laser light from a remote spacecraft, millions of km away

Project Title: Telescope Development for the LISA Mission

PI: Jeffrey Livas (GSFC)
Prototype laser oscillator and pre-amplifier for lasers enabling the Laser Interferometer Space Antenna (LISA) gravitational-wave observatory

**Significance:** LISA crucially depends on lasers to allow interferometric measurement of the multi-million-km distance between the three spacecraft; technology readiness level (TRL) of 5 is needed for infusion into the mission

**Project Title:** Demonstration of a TRL-5 Laser System for LISA

**PI:** Jordan Camp (GSFC)
GRACE Follow-On photo-receivers integrated into testbed as part of phasemeter development for the Laser Interferometer Space Antenna (LISA) gravitational-wave (GW) observatory

**Significance:** LISA needs a phasemeter system to allow interferometric measurement of the multi-million-km distance between the three spacecraft

**Project Title:** Phase Measurement System Development for Interferometric GW Detectors

**PI:** William Klipstein (JPL)
Biasless 1.9-THz triplers developed for multi-pixel Local Oscillator (LO)

**Significance:** This high-resolution multi-pixel far-IR detector technology may enable or enhance future missions

**Project Title:** A Far-IR Heterodyne Array Receiver for C+ and OI Mapping

**PI:** Imran Mehdi (JPL)
484-pixel 350-mm Kinetic Inductance Detector (KID) array

**Significance:** Polarization-sensitive arrays in the far-IR can provide critical information on the role of magnetic fields in galaxy formation and evolution, and star formation in our galaxy and nearby galaxies

**Project Title:** KID Imaging Arrays for Far-IR Astrophysics

**PI:** Jonas Zmuidzinas (JPL)
Atomic Layer Deposition (ALD) reactors at JPL used for developing advanced UV coatings

**Significance:** High-reflectivity, high-uniformity, wide-bandpass UV coatings are key for astrophysics and exoplanet studies

**Project Title:** UV Coatings, Materials and Processes for Advanced Telescope Optics

**PI:** Bala K. Balasubramanian (JPL)
Test box for characterizing AC- and DC-biased Transition-Edge Sensors (TESs)

**Significance:** AC-biased TESs and Frequency Division Multiplexing are ATHENA’s baseline readout architecture

**Project Title:** Technology Development for an AC-Multiplexed Calorimeter for ATHENA

**PI:** Joel Ullom (NIST)
Four X-ray reflection gratings aligned into a single module for testing

**Significance:** X-ray reflection gratings enable high throughput, high spectral resolving power below 2 keV, a spectral band holding major astrophysics interest

**Project Title:** Reflection Grating Modules: Alignment and Testing

**PI:** Randall McEntaffer (PSU)