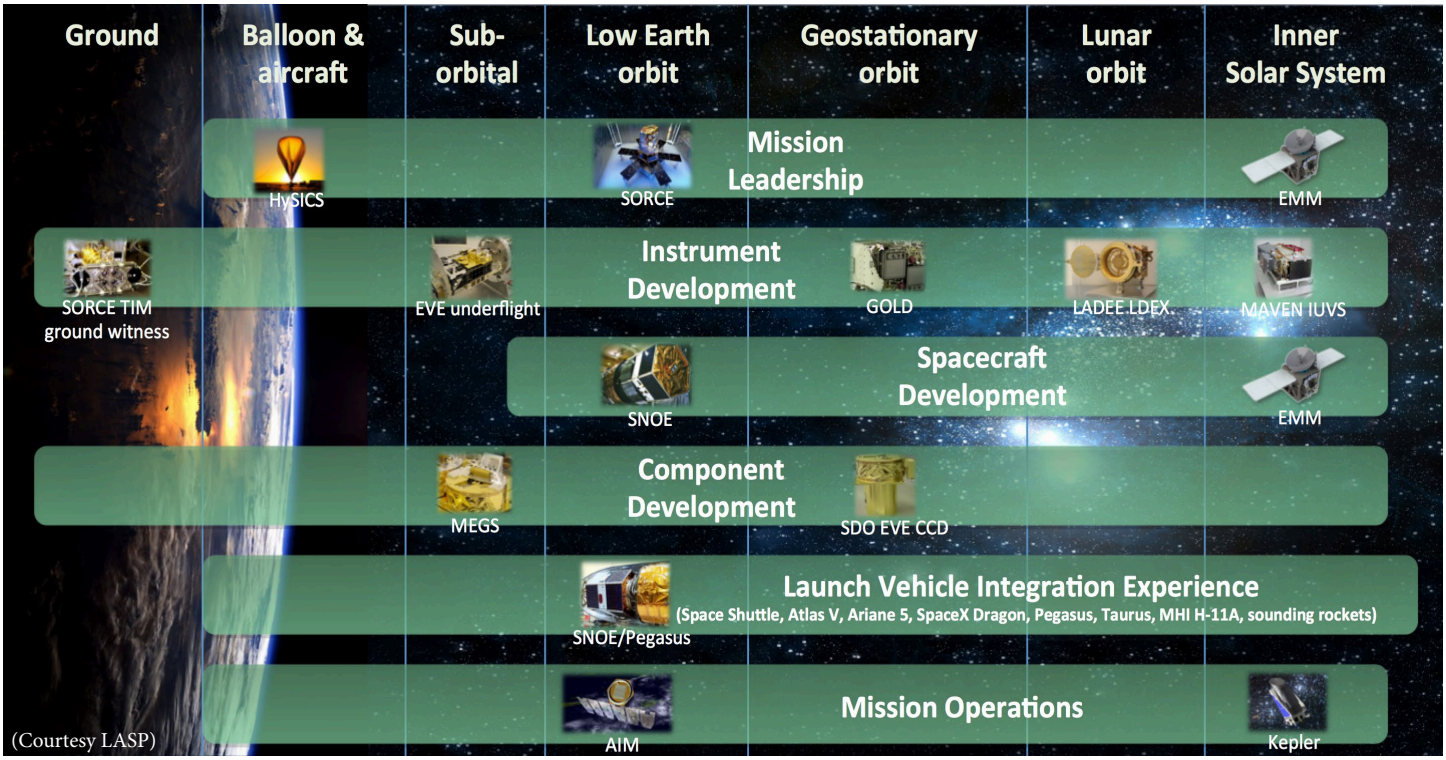
Systems Engineering

Integrating Project Management, Science, Engineering, and Mission Operations

Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**



Systems Engineering Experience

LASP is a full-cycle space research institute, combining all aspects of space exploration through our expertise in science, engineering, mission operations, data analysis, and education. Systems engineering at LASP is a key to our success, linking scientific objectives to engineering implementation.

We do more than build spaceflight systems. By fully understanding the objectives first and using our experience to intelligently flow down these needs, we tailor each mission, spacecraft, and instrument to meet the objectives in the most effective way. We have a proven history of building the correct system to comprehensively meet mission needs.

LASP has successfully implemented systems engineering on many fronts:

- Performing systems engineering functions at every level of the supply chain, from mission-level, to instrument-provider-level, to component supplier (mission list: http://lasp.colorado.edu/home/missions-projects/)
  - **Mission-level**—EMM, GOLD, Glory, SME, SORCE, AIM, and SNOE; CubeSats: CSSWE, and MinXSS-1 & 2
  - **Instrument-level**—A wide variety of remote sensing and in-situ instrument builds, most still on-orbit and producing science data: ADP (MMS); IUVS and EUV (MAVEN); LDEX (LADEE); TCTE (STP-Sat3); EVE (SDO); CIPS and CDE (AIM); REPT (Van Allen Probes); TIM, SIM, SOLSTICE, and XPS (SORCE); SEE (TIMED); MASCS (MESSENGER); PPS (Voyager 1 & 2); EXIS (GOES-16 & 17); SIM and TIM (TSIS-1); GOLD UVS; EXI and EMUS (EMM)
  - **Component-level**—High voltage power supplies (HVPS), Digital Signal Processors (DSP), microprocessor units (MU), high precision mechanisms and control systems, detector developments, sun sensors, and magnetometers are a few examples
  - **Pointing platforms—**Glory, TSIS, CLARREO
- Integration experience with various launch vehicles and platforms, including the ISS, Space Shuttle, Atlas V, Ariane 5, SpaceX Dragon, Pegasus, Taurus, high-altitude balloons, aircraft, and sounding rockets; MHI H-IIA underway
- Designing systems for multiple environments, including ground, balloons, airplanes, sub-orbital rockets, low Earth orbiting, geostationary, moon-orbiting, and interplanetary environments
- Vast experience on NASA, NOAA, and Air Force contracts as well as commercial and academic partnerships
- Experience in international development efforts and projects

Systems Engineering Capabilities

LASP performs comprehensive systems engineering. System engineers develop and manage requirements from initial concept through on-orbit operation, providing cohesion within the

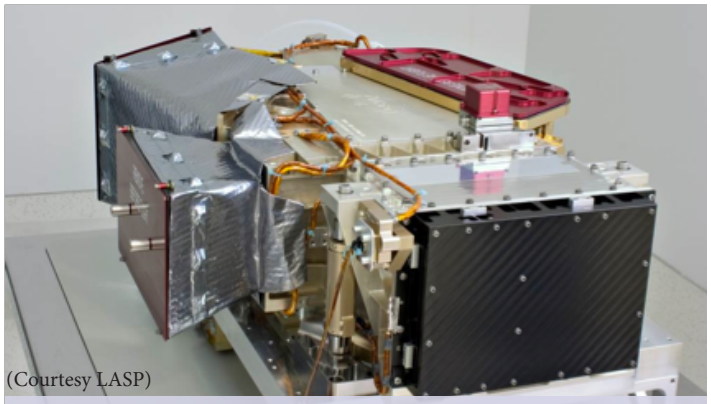
technical team. LASP system engineers typically start their careers in other areas and migrate into a systems engineering role after becoming domain experts in other fields. Beginning from a strong knowledge of the science mission goals, they optimize functional and physical compatibility of interfaces by carefully balancing developmental design trades against available technical resources (mass, power, volume, and data bandwidth).

Our successful flight programs share the core systems engineering principles of identifying, defining, and mitigating technical risk, along with establishing verification and validation paths for all system elements (hardware, software, facilities, personnel, and data).

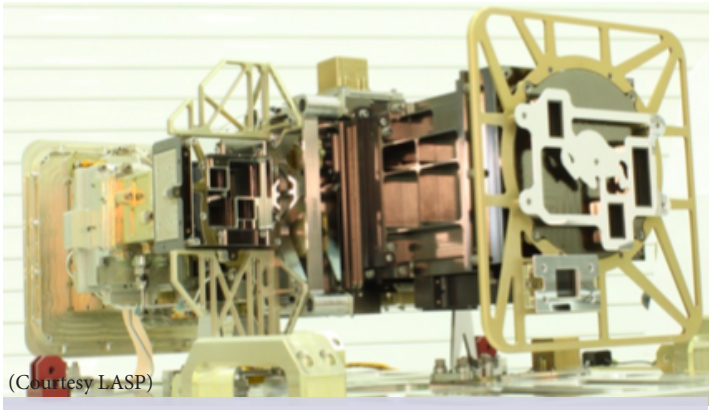
System engineers participate in concept design and follow the project through review, approval, fabrication, integration, testing, delivery, and on-orbit operations. End-to-end engagement is fundamental to LASP's continued success in building spacecraft and instruments.

The LASP systems engineering team is experienced in the areas of:

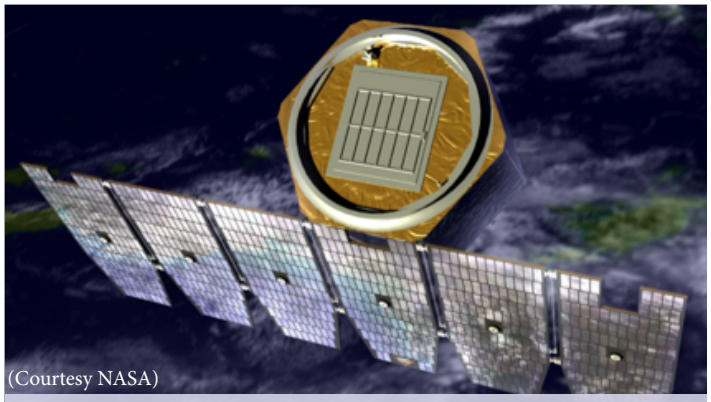
- Mission design
- Science requirements capture and flow down
- Spacecraft design
- Telemetry, tracking, and command (TT&C)
- Guidance, navigation, and control (GNC)
- Spacecraft fault management
- Embedded software systems
- Control architectures
- Optical, mechanical, thermal, and electrical design
- Mission operations
- Technical management and coordination
- System architecture and design process
- Requirements definition and management process
- Engineering trade studies
- Risk management
- Program organization
- Technical review
- Technical progress reporting
- Configuration management
- Anomaly management and resolution
- Technical resource management
- Interface management
- System integration and test
- Environmental testing
- System verification and validation
- Technical performance metrics
- Process developing and engineering
- Proposal development
- Business development


(Courtesy LASP)

MAVEN Imaging Ultraviolet Spectrograph (IUVS)


(Courtesy LASP)

GOES EUV and X-Ray Irradiance Sensors (EXIS)


(Courtesy NASA)

Aeronomy of Ice in the Mesosphere (AIM)

For more information about LASP systems engineering, visit: http://lasp.colorado.edu/home/engineering/eng-capabilities/systems/, or contact Nic Ferrington (nicolas.ferrington@lasp.colorado.edu) at 303-492-8155.

The Laboratory for Atmospheric and Space Physics (LASP) combines all aspects of space exploration through our expertise in science, engineering, mission operations, and data management. As an institute at the University of Colorado Boulder, LASP includes students throughout our activities. Learn more at http://lasp.colorado.edu.