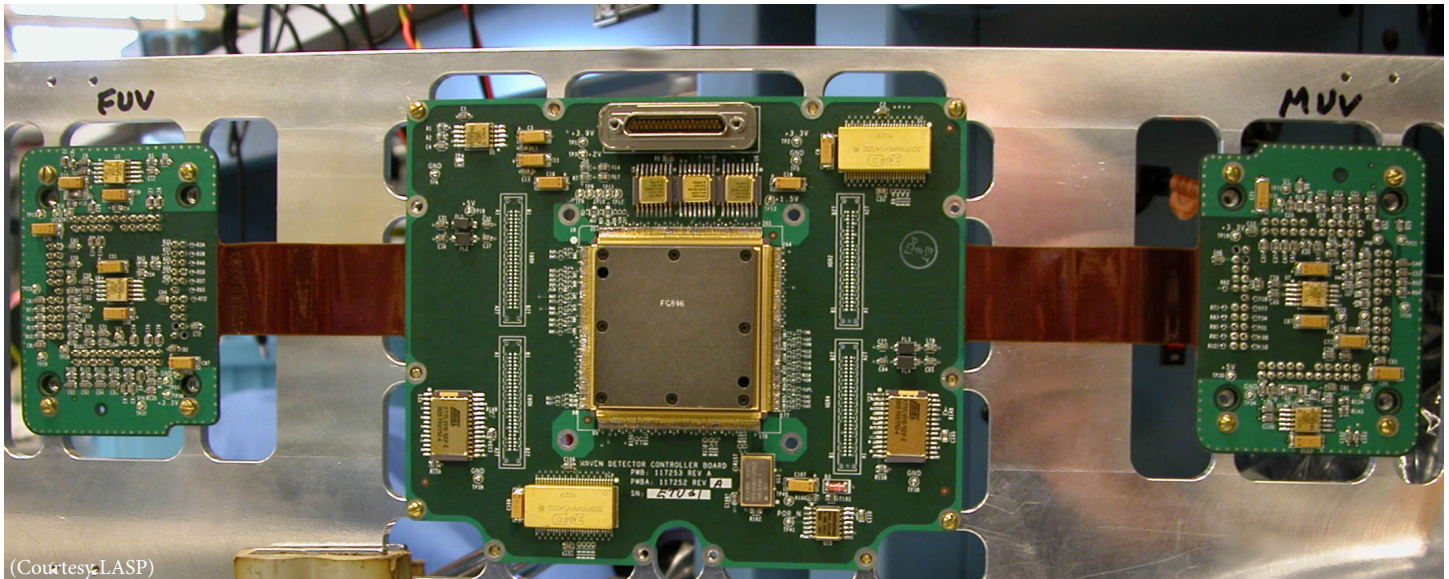


Electrical Engineering Group

Digital, analog, power, ASIC, FPGA, and embedded systems design



MAVEN RS IUVS Dual Imager Board Assembly

Dual 1-Megapixel CMOS imagers (with <10 e⁻ RMS readout noise) convert far and medium ultraviolet photons to electrical signals. The dedicated FPGA provides independent control with configurable readout areas, non-linear binning, and semi-log compression.

The Electrical Engineering (EE) Group at LASP has a broad range of technical expertise in the design, development, and test of space flight electrical systems. Engineers work closely with mission science, systems engineering, project management, and other engineering disciplines to ensure that the desired scientific data is collected, processed, and transmitted accurately. Systems are designed to be flexible so that in-flight adjustments can be made to maximize scientific returns. The EE Group consistently produces reliable spaceflight systems on time, on budget, and to specification. Recent designs include imaging detector electronics, fields and particle detection electronics, FPGA-based DSP algorithms and embedded processors, motion control systems, and full microcontroller systems.

Electrical Engineering Capabilities

Power Systems

- Low power, low voltage, low noise DC/DC conversion
- Point of load converters
- High voltage, low current, low noise detector supplies for photomultiplier tubes and image intensifiers
- Motor drivers: H-bridge and linear designs for stepper, DC torque, and brushless DC motors

Analog Design

- Sensor interfaces: CCDs, CMOS imagers, photodiodes, PMTs, MCPs, particle detectors, bolometers, electric and magnetic field detectors, solid state radiation detectors
- Low noise, high performance amplifiers: sensitivity to femtoamp with photodiodes, tens of electrons with CCD and CMOS imagers, single photon counting with MCP and PMTs

- Signal bandwidths of sub-Hertz to 50 MHz
- Custom ADC design to 24 bit resolution
- Custom ASIC with 6-channel, femtoamp photo-current measurements, low power, 20-bit internal ADC

Digital Design

- Microcontroller and microprocessor system design (8-bit to 32-bit)
- Memory system design (ROM, SRAM, Flash, SDRAM)
- FPGA-based digital systems

FPGA Design

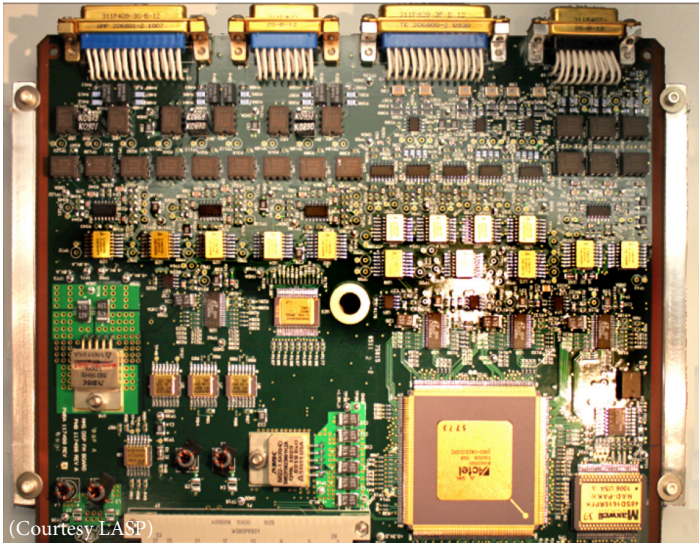
- More than 30 FPGA designs flown on ten different missions from Mercury to Pluto
- Multiple designs delivered and currently awaiting launch on seven different missions
- Designs span wide range of complexity from simple “glue logic” designs to full-featured system-on-a-chip designs with embedded processors for Class A/B programs
- Experience producing low cost, high reliability solutions for sounding rocket and CubeSat applications that utilize error correction and redundancy logic to allow low cost FPGAs to be used in place of more expensive rad-hard FPGAs
- Experience with broad range of Actel/Microsemi and Xilinx radiation hardened and radiation tolerant FPGAs
- Design of high reliability embedded processors, state machines, communication interfaces (SpaceWire, GRDDP, MIL-STD-1553), and memory controllers (SDRAM, Flash, Serial EEPROM) for space radiation environments
- Verification of high reliability FPGA designs, using various simulation, code coverage analysis, and timing analysis tools—including comprehensive self-checking test benches

with automated constrained random stimulus generation and external component models

- Extensive library of space proven DSP algorithms for FPGA designs that provide higher performance while using less power than traditional software DSP solutions, including digital filters, lossless image compression algorithms, and Fourier transforms

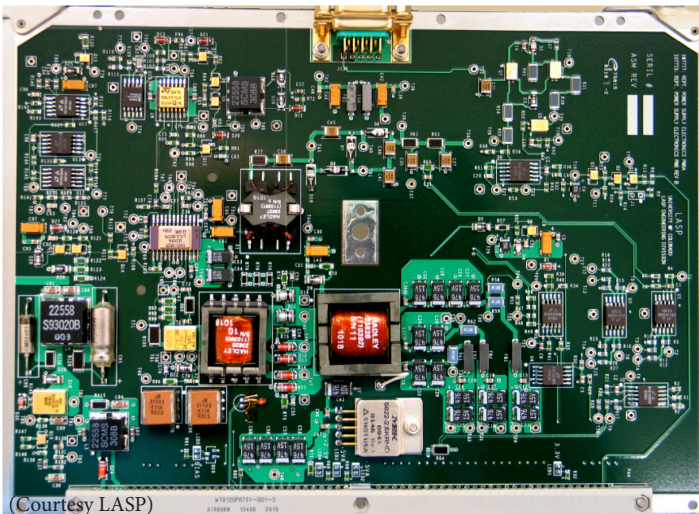
Control Systems

- Motion control to arc-second precision
- Spacecraft attitude control
- Temperature control to better than a tenth of a degree across S/C ground domains
- Power control and measurement to 1 mW



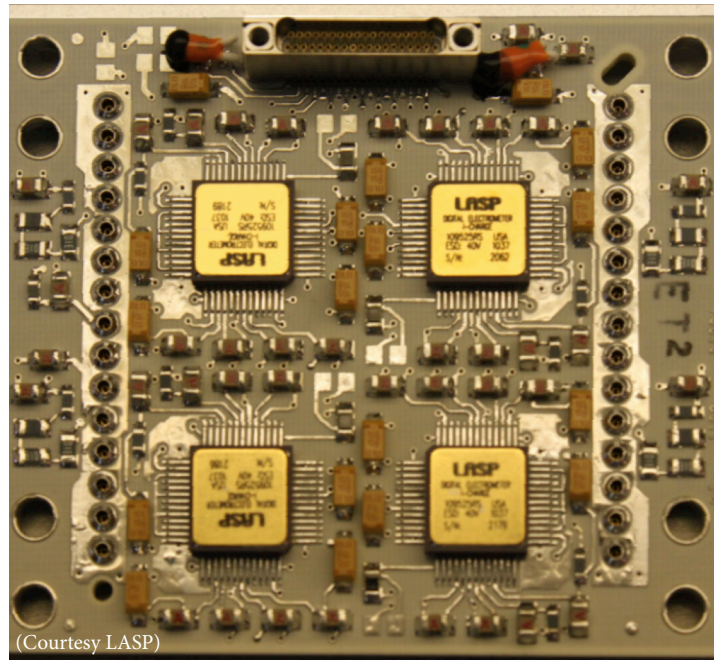
(Courtesy LASP)

MMS Fields DSP Board—18 Bessel filter channels sampled at up to 250kSps feed the FPGA performing nine simultaneous 1024 point FFTs at 16kHz along with other DSP operations.



(Courtesy LASP)

Van Allen Probes REPT Power Board—Custom magnetic feedback switch-mode power supply board provides 6 watts of power as $\pm 5V$, 3.3V, 2.5V and 320V.



(Courtesy LASP)

GOES EUVS-AB Detector Board—Four custom 6-channel ASICs on a 2" x 2" board provide femtoamp electrometers with 20-bit ADC measurements for the GOES-R EXIS extreme ultra-violet spectrometer in a custom, qualified 52-pin CQFP.

RF Systems

- Antenna design
- S-Band and X-Band transceiver design
- Active and passive RF spectrometers to 138 GHz

Printed Wiring Board Design

- Rigid and rigid-flex circuit board design to IPC-2220, including multi-layer with controlled impedance
- Assembly instructions, test and verification plans, final test documentation

Simulation, Verification, and Test

- "Test as you fly" philosophy leads to increased reliability in flight
- PSpice, Matlab, Simulink, Labview, IDL, Python, Modelsim, Hyperlinx tools used for simulation and system modeling

Parts Engineering

- Support for parts selection including screening to EEE-INST-002 (or other military screening qualifications) and radiation testing (TID and SEE)
- Fully compliant with government alerts and advisories including GIDEP

To read more about Electrical Engineering at LASP, visit <http://lasp.colorado.edu/home/engineering/eng-capabilities>, call Neil White at 303-492-7959, or email neil.white@lasp.colorado.edu.

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>.