1-1-2003

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Space Dynamics Laboratory

Infrared Systems
Sensor Calibration
Spacecraft Systems
Hyper-spectral Systems
Cryogenics
Data Compression
SOL is a recognized world leader in the calibration of infrared electro-optical instrumentation. SOL has three portable calibration systems adaptable to apertures from 6" (152 mm) to 16" (406 mm) and capable of spatial, spectral, and radiometric calibration in the 1 to 30 micrometer wavelength region. Our calibration systems are fully NIST traceable and can be employed at SOL or at remote sites. SOL has calibrated over 30 sensors using these systems. SOL recently added a large-aperture, strategic scene generation and infrared calibration facility to be operational by 2001.

Sensor Calibration

SDL specializes in micro- and nano-spacecraft tailored to specific mission needs. SDL has designed and built several micro-satellites and is developing a new family of micro-spacecraft systems.
and other hyperspectral imaging technologies, data processing techniques, and subsystems. One example showcasing SDL's hyperspectral imaging expertise is the Geostationary Imaging Fourier Transform Spectrometer (GIFTS). GIFTS was selected as the next Earth-observing mission, Earth Observing 3, under NASA's New Millennium Program. Using large-area format focal plane arrays and new data processing technologies, GIFTS brings revolutionary measurement approaches to Earth system science. With over 32,600 sensors, GIFTS will provide more detailed information than today's one-sensor weather observation instruments. These measurements have the potential for extensive improvements in weather prediction accuracy, providing up-to-the-minute information on severe weather systems and atmospheric pollutants. The GIFTS flight demonstration is planned in 2003.

Cryogenics

SDL has been involved in the design and operation of cryogenic systems for the cooling of infrared instruments for over 40 years. These systems have provided the cooling for ground-based instruments as well as sensor systems aboard balloons, sounding rockets, the space shuttle, and satellites. SDL engineers use a variety of cryogens including solid and liquid nitrogen, solid and liquid argon, liquid neon, solid hydrogen, deuterium, and liquid and supercritical helium. The highly successful Cryogenic Infrared Radiance Instrumentation for Shuttle (CIRRIS-1A) sensor suite is one example of SDL's use of liquid helium as a cryogen.
The Space Dynamics Laboratory (SDL) Research Environment.

Over the past four decades, the Space Dynamics Laboratory (SDL) has placed sophisticated sensors on more than 400 research payloads ranging from aircraft and sounding rocket-born sensors to space experiments, satellite systems, and instrumentation suites. Our core capabilities include development, fabrication, and operation of infrared and visible sensors, passive and active cryogenic systems, upper atmospheric sensors, micro- and nano-satellites and subsystems, electro-optics, target detection and tracking systems, and environmental monitoring instrumentation. SDL also offers state-of-the-art data compression, terabyte-class data processing, infrared calibration services, mission operations support, and data visualization and analysis.

SDL has the state-of-the-art facilities necessary to take programs from concept through delivery to mission operation. They include a comprehensive machine shop, class 100 clean rooms, integration high bays, environmental test facilities, and laboratories for full optical, mechanical, and electrical system design and assembly.

SDL's broad experience includes the science, engineering, and management support that is required to bring programs to successful completion. External funding for the lab has averaged over $25 million/year for nearly a decade. Current year funding is in excess of $60 million.

The value that SDL places on advanced research and higher education is evident in the programs are managed by SDL's University Relations Branch of the Research Division. SDL offers undergraduate and graduate students extensive hands-on experience and research opportunities. The lab also provides generous support for USU faculty to carry out science and engineering research. This year SDL will contributed nearly $1,000,000 dollars to support the library, university research, various student activities, and the arts.

With USU's renewed emphasis on space research and technology, SDL has greater responsibility than ever to ensure that USU maintains its place as one of the nation's premier space-grant universities. SDL's Enabling Technologies program sponsored proof-of-concept research grants in areas of strategic importance to SDL, such as heat transfer technology, damping composites, sensor filters, plasma frequency probes, and data compression.

Key Research Thrust Areas

Sensor Systems
  Electro-optical systems, hyperspectral & hyper-temporal systems, active & passive sensors, thermal management technologies, and advanced structures
Calibration
Technologies to increase productivity & accuracy of calibration, and methods for hyperspectral calibration

Science
Solar physics, atmospheric physics, experimental upper atmospheric plasma physics, and space plant growth

Spacecraft
Advanced spacecraft systems and advanced structures

Data Exploitation
Data compression, data visualization, data mining, data fusion, and target identification, discrimination, recognition, & extraction

Tomorrow Fellowships
SDL offers Tomorrow Ph.D. Fellowships to help support research in space engineering and related sciences and technologies. The Fellowships are competitively selected based upon applicants’ scholastic achievements and potential contributions to SDL’s strategic research thrusts. In an effort to attract the best student in the nation, each Fellowship carries an annual stipend of up to $30,000 and is renewable for up to three years.

Currently SDL supports four Ph.D. students. Daniel P. Stormont and Allan McInnes, ECE, are researching autonomous mobile robots and small spacecraft systems, respectively. Nicholas Alley, MAE, is designing unmanned aerial vehicles. Brian Lundberg, Physics, is studying magneto-hydrodynamics models of solar activity.

Internships
Each year SDL offers summer internships to students majoring in electrical engineering, mechanical engineering, chemical engineering, computer science, and/or physics. Since the program began in 2000, SDL has hosted sixteen students from several of the country’s most prestigious universities.

Working directly with SDL engineers and USU faculty, interns gain valuable job experience, learn about cutting-edge technologies, and receive opportunities to meet leading figures in their fields.

Example SDL / Faculty Collaboration
USU Faculty and Staff use facilities at SDL for research instrumentation assembly, testing, and teaching of technology and it’s applications. In return, SDL relies heavily on faculty to provide state-of-the-art expertise and consultation.

LADA (Dr. Gail Bingham, SDL Chief Scientist and USU Research Professor)
SDL is currently working with the Russian Institute of Biomedical Problems to develop a small, low-cost growth chamber to grow fresh vegetables and other plants on the Russian segment of the International Space Station (ISS). Students mentored by SDL scientists designed, built and tested the LADA instrument before it launched in September 2002.

A new project is underway to modify and enhance the existing growth chamber system to include space soil physics experiments. Ninety percent of this project is being completed by students. USU students currently involved with this project range from biology students to electrical engineers. The students not only gain experience in their specific fields but also interact with other disciplines to obtain a
broader view of the requirements of the chamber and the technical considerations involved with this project. Students will meet weekly with Dr. Bingham and work side-by-side on developing the new chamber.

Figure 1: SDL Plant Growth Chamber located on the International Space Station and the Student Team that Helped Develop the System.

**E-Winds (Dr. Charles Swenson, Associate Professor, ECE)**

E-Winds, a NASA-funded program, was launched June 30, 2003 from Wallops Flight Facility aboard four separate rockets. A USU/SDL team built eight out of eleven of the E-Winds science instruments as well as a majority of the telemetry hardware used for the mission.

The E-Winds mission objective was to measure the time history of nighttime E-Region neutral winds and discover how they relate to the formation and descent of intermediate ion layers. The E-Winds instruments also made measurements of the composition of the ion layers after they had descended below ~120 km.

During the rocket flights, absolute plasma density was measured primarily by a Plasma Frequency Probe (PFP) and Plasma Sweeping Probe (PSP) instrument combination provided by USU/SDL. The PFP/PSP instrument suite is commonly referred to as the Plasma Impedance Probe (PIP). In a secondary science mission role, the PIP also measured plasma collisional frequencies, ion-ion resonance characteristics, and plasma temperature. As a backup plasma density measurement technique, and a means of data comparison, a Direct Current Probe (DCP) instrument was included in the USU/SDL science instrumentation package.

Innovations USU/SDL brought to E-Winds mission include an improved control theory model of the PIP, a digital hardware implementation that provides improved accuracy and performance of the PIP, and an integration of several science instruments into a single, multi-platform design.

**FPMU (Dr. Charles Swenson, Associate Professor, ECE)**

In 2001, USU/SDL began work on the challenging Floating Potential Measurement Unit (FPMU) program. Sponsored by NASA's Johnson Space Center, USU/SDL designed the FPMU instrument to monitor surface charging of the International Space Station (ISS) and the space environment parameters that affect it. The FPMU will be used throughout every major ISS configuration change to ensure astronaut safety during Extra Vehicular Activity (EVA), or spacewalks.
USU/SDL built four FPMU units, the first of which was delivered for integration in December 2002. A successful System Acceptance Review was held October 10, 2003 at SDL, clearing the way for delivery of the additional three units to Kennedy Space Center. Additionally, an SDL-developed FPMU ground station will be shipped to JSC. Launch to the ISS is scheduled for the second space shuttle flight after reactivation of the shuttle launch schedule.

The FPMU project was a high priority, short-time line effort for NASA. To ensure the reliability and quality of the FPMU instruments, USU/SDL worked closely with NASA to conduct quality testing and underwater deployment procedures.

The NASA Silver Snoopy logo is being attached to the FPMU because of its importance in enhancing crew safety. The Space Flight Awareness Silver Snoopy Award itself is a prestigious award presented to individuals for outstanding performance in contributing to flight safety and mission success. The Snoopy emblem reflects NASA and industry's sense of responsibility and continuing concern for astronaut flight safety and is a link between the astronaut corps and members of the NASA/industry work team.

Figure 2: Student and technician work on FPMU
In a class 100 clean environment

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