EO/IR Calibration and Characterization Workshop

18-20 March 2008
Tucson, AZ

Tuesday, March 18

8:00 a.m. **Registration**
Continental Breakfast

8:30 a.m. **Welcome**
Jim Wyant, Dean of College of Optical Sciences, The University of Arizona

Introduction to the Workshop
Randy Jost, USU/Space Dynamics Laboratory

9:00 a.m. **Measurement Uncertainty Half Day Workshop**
Greg Wilson, ATK

Abstract: Our half day workshop is an introduction to uncertainty analysis that presents the basic statistical background along with examples relevant to the EO/IR community. Topics covered include statistical definitions of uncertainty, Root Sum Squared (RSS) roll up within an uncertainty budget, error models and error bars, a discussion of Root Mean Squared Error (RMSE), the Law of Propagation of Uncertainty, and the Taylor series method. The general theory is presented in a mathematical framework, and examples are used to clarify the theory.

10:00 a.m. **Refreshment Break**
Participant Discussions

10:20 a.m. **PART 2 - Measurement Uncertainty Half Day Workshop**
Greg Wilson, ATK

12:00 p.m. **Lunch Provided**
Participant Discussions

1:00 p.m. **PART 3 - Measurement Uncertainty Half Day Workshop**
Greg Wilson, ATK

2:15 p.m. **Development of an Optical Properties Lab Book for the AFRL/RX Optical Measurements Facility**
William Lynn, General Dynamics Advanced Information Systems

Abstract: As part of the Signature Measurements and Standards Group (SMSG) Task 18 effort, we are preparing a draft laboratory handbook, or “lab book” that documents the measurement procedures, instrument error characterization, and quality control procedures used at the AFRL/RX Optical Measurements Facility (OMF) located at Wright-Patterson AFB, OH. The lab book is largely based on the RCS Range Book as outlined in “Radar Cross Section (RCS) Certification for Static and Dynamic RCS Measurement Facilities,” Range Commanders Council Document 804-01, Volume I. The lab book is web-based is available to all the OMF staff on the AFRL/RX network. We are currently populating the critical (priority 1) components and tailoring them to OMF specific needs.

3:00 p.m. **Refreshment Break**
Participant Discussions

3:20 p.m. **Introduction to Breakout Group Activity**
Randy Jost, USU/Space Dynamics Laboratory

3:45 p.m. **Breakout Groups**

5:00 p.m. **Conclude for the day**

Wednesday, March 19

8:00 a.m. **Continental Breakfast**
Participant Discussions

8:30 a.m. **Polarization and Calibration Issues**
Russell Chipman, The University of Arizona

Abstract: Polarization effects are now recognized to play a critical role as a tool for improving remote sensing retrievals of surface and atmospheric properties. For instance, many man-made objects have different polarization characteristics than natural objects. Polarization has also become an issue in the radiometric characterization of sensors because of improvements in overall sensitivity, increased optical complexity, wider fields-of-view, and larger focal planes. Newer sensors are susceptible to polarization effects resulting from stray light as well as from the inherent design, meaning that understanding the causes of polarization and developing the tests needed to measure the sensor's polarization sensitivity becomes more important. This talk will discuss polarization effects in optical systems and calibrating systems taking into account polarization.

10:00 a.m. **Refreshment Break**
Participant Discussions

10:20 a.m. **Status of NIST-led Infrared Spectral Reflectance Intercomparison**
Leonard Hanssen, NIST

Abstract: NIST has organized a nationwide Intercomparison for infrared spectral reflectance. 25 participants representing government agencies, contractors, equipment manufacturers, measurement service laboratories, and standards laboratories are taking part. The intercomparison samples are of both specular and diffuse types, high and low reflectance, as well as with spectral structure, forming a set of 6. The measured property is near-normal reflectance over the infrared spectral range of approximately 2.5 to 14 microns. A complete sample set is measured by NIST and provided to each participant. Upon return of the sample sets, NIST will remeasure them to check for any change due to contamination, etc. Although not yet complete, partial results are available and will be discussed.

11:05 a.m. **Certification Needs Flexibility for Changing Technology and Challenges**
Stephen C. Bennett, Ball Aerospace & Technologies Corp

Abstract: Establishing standards and certification processes for EO/IR calibration labs will bring benefits to customers from better calibrations and to the labs from increased credibility and recognition. However, these standards and processes must allow for enough flexibility to accommodate increased scrutiny when unexpected results arise from advancing technology. They must also allow for reduced testing when requirements, funds or schedule do not require it. This talk will support this thesis by discussing examples from SBUV/2, TOMS, OMI and OMPS. These Ozone-measuring instruments all use a common technique that compares atmospheric radiances with a solar-irradiated on-board diffuser. The two more recent instruments have higher spectral and spatial resolutions that reveal sensitivity to fine structure in the goniometric response of the diffuser that was unobserved on the earlier instruments.

11:50 a.m. **Lunch Provided**
Participant Discussions

12:50 p.m **An ISO17025-Based Documentation Standard for EO/IR Systems and Facilities**
Randy J. Jost, USU/Space Dynamics Laboratory

Abstract: This presentation will present a draft of an approach for the documentation of EO/IR measurement activities. The draft is based upon the ISO 17025 standard and covers the activities that need to occur to document all aspects of facility operation, with an emphasis on those items critical to good calibration and characterization. The presentation is meant to outline what the draft is (a documentation standard based on internationally accepted standards) and is not (a mandatory range certification program). While this document has its roots in the efforts that went into setting up the current RCS range certification program, this document is not intended to fill that role at the present time.

1:35 p.m **Multispectral Signature Measurements Consortium (MSMC) Web Site**
Jeff Burks, AFRL

Abstract: This presentation will provide a brief introduction to the use of the AFRL Virtual Distributed Laboratory environment to provide a secure collaboration environment for those participating in the development of calibration and characterization improvements for EO/IR systems.

Microsoft SharePoint for Range Books
B.L. Epling, SAIC

Abstract: This presentation describes the implementation of a Range Book in a Microsoft SharePoint environment. SharePoint is a portal-based collaboration and document management platform which can be used to host web sites, access shared workspaces and document libraries, as well as providing version control, wiki pages, blogs, task assignment, discussion boards, and search engines within a browser environment. This presentation will describe how the SharePoint features are used to support laboratory activities, including the Range Book development. This talk will review SharePoint capabilities and how they are being tailored to support the Range Book requirements in the IR Range.

AFRL RTD Calibration
Benjamin D. Booso, SAIC

Abstract: This presentation describes a proposed calibration procedure for characterizing the performance of a resistive temperature device (RTD). In order to achieve certification for the AFRL/RYS IR Range, the uncertainties associated with making temperature measurements will need to be explained. To that end, unique calibration coefficients for each RTD device will be determined rather than using nominal, published values.

3:05 p.m. **Refreshment Break**
Participant Discussions

3:20 p.m. **Breakout Groups**

5:00 p.m. **Conclude for the day**

Thursday, March 20

8:00 a.m. **Continental Breakfast**
Participant Discussions

8:30 a.m. **LSpec: An Automatic VNIR Vicarious Calibration Facility at Frenchman Flat, Nevada Test Site**
Mark Helmlinger, Northrop Grumman Space Technology

Abstract: Vicarious calibration technology, developed in the mid-1980's, has been used to establish the absolute radiometric calibration of on-orbit and in-flight sensors. Accurate calibration is essential to maximum exploitation. The traditional vicarious method requires a field team to collect surface and atmospheric measurements, coincident with a sensor overflight. With the recent creation of an autonomous calibration facility, the science of vicarious calibration has had its first major advancement. An autonomous facility makes continual measurements, without the need to deploy a field team. This simplifies the process, reduces the cost and manpower requirements for a project, and allows an archive of data to be used retrospectively, provided routine image collects are made of the site. Collects of the target site can also be made without intensive ground activities which may otherwise advertise asset overpass times and other characteristics. Since mid-November, 2006, the LSpec (LED Spectrometer) automatic facility has been making continual measurements of surface reflectances and atmospheric transmittances. The facility is located at Frenchman Flat, at the Nevada Test Site. Data are used to support sensors that acquire data at visible and near-infrared (VNIR) wavelengths. Spectral bandpasses of any width can be accommodated, as the hyperspectral top-of-atmosphere radiance products can be convolved with sensor-specific spectral response functions. The current site can support the calibration of sensors that have spatial resolutions of 100 m or less, although the concept can be extended to larger playas and thus sensors with larger footprints. This presentation will discuss the facility, present a validation of the concept, and provide information on data access.

9:15 a.m. **Improvement of Measurement Facilities via Inter-Laboratory Comparisons of Infrared Spectral Signature and Radiance Temperature in the Temperature Range of -50 °C to 500 °C**
Sergey Mekhontsev, NIST

Abstract: Since the last EO/IR workshop, the Advanced Infrared Radiometry and Imaging facility (AIRI) has achieved full temperature coverage of Infrared Spectral Radiance (spectral signature) and Radiance Temperature measurements across the temperature range of -50 °C to 1000 °C and the spectral range of 3.4 µm to 13.5 µm. Regular calibration services can be offered only after all quality documentation and procedures are completed. Presently, special tests are provided to support the immediate user needs.

We have prepared and calibrated a set of two transfer standard radiation sources and a transfer standard pyrometer, covering the temperature range -50 °C to 500 °C, which is currently being used for international comparisons with the primary national metrology laboratories of Germany (PTB), Great Britain (NPL) and Canada (NRC). The comparisons are performed using a round-robin scheme, in which the set is measured in turn by each participant of participants. This minimizes cost end and effort, as compared to a star scheme involving multiple sets. However, it does have an inherent risk of increased drift of one or several of the transfer standards, with possible loss of reliable data. To avoid this, we have transfer standards that provide two points of overlap: at 100 °C and 150 °C. Thus, the supplied pyrometer can test for the consistency of the two transfer standard sources, as well as test the pyrometer's own scale.

We intend to report preliminary results of the international comparisons, and propose to use the available equipment and procedures to carry an inter-laboratory comparison among interested EO/IR community members to assess and improve the quality of measurements and standardize the calibration procedures.

10:00 a.m. **Refreshment Break**
Participant Discussions

10:20 a.m. **Breakout Group Preparation**

12:00 noon **Lunch Provided**
Participant Discussions

1:00 p.m. **Breakout Groups - Wrap up**

2:00 p.m. **Reports from Breakout Groups**
Workshop Wrap up

3:30 p.m. **Workshop Conclusion**