

## **Technical Session**

### **Remote Sensing and Calibration of Astronomical Data**

Assessing the precision and accuracy of radiometric measurements of astrophysical sources.

- Inter-comparison of ground-test and in-orbit data
- Methods and techniques for identifying and controlling measurement bias (systematic uncertainties)
- Reliability of astrophysical standards
- Inter-calibration of astronomical observing platforms
- Establishing reliable secondary / transfer standards
- Sensor calibration and characterization for astronomy

**1:20**

### **The Relative Calibration System for WFIRST LED Lessons**

Ray Wright, Gregory Wirth – Ball Aerospace; Phil Scott – USU/Space Dynamics Laboratory; Maxime Rizzo – Conceptual Analytics

ABSTRACT: NASA's Wide-Field Infrared Survey Telescope (WFIRST) is a space-based observatory currently under design and initial stages of fabrication, targeted to launch in the mid-2020s. The U.S. National Academy of Science's Astro2010 decadal survey identified WFIRST as the highest-priority mission to investigate three fundamental problems in astronomy: the dark energy content of the Universe, the evolution of the high-redshift galaxy and quasar population, and the demographics of exoplanets in our own galaxy. Ball Aerospace is currently developing the mechanical/optical assembly for WFIRST's key imager, the Wide Field Instrument. With its leading-edge mosaic of IR detectors, this imager will provide a field of view over 100 times greater than the competing instruments on the Hubble Space Telescope, thus opening an exciting new era in sky surveys from space. To achieve the mission's ambitious science objectives, WFI must observe celestial objects over an exceptional range of brightness with extraordinary photometric precision. Ball Aerospace and Utah State University's Space Dynamics Laboratory (SDL) are collaborating to design and build an onboard light source system capable of helping WFI meet these stringent photometric performance requirements. This Relative Calibration System (RCS) generates light matched to the wavelengths of each of the imager's six filters, illuminating the WFI Focal Plane Assembly (FPA) with temporally stable illumination at six logarithmically-spaced signal levels. Measuring these light levels will define a detector response ratio we'll use to define a transfer standard relating faint objects to bright ones. This talk will highlight the engineering methods we've employed to select the sources for use in the calibration system, some unexpected consequences of these choices, the lessons learned from the trade studies, and what challenges lie ahead in completing the RCS.

**1:40**

### **The All-sky Visible and Infrared Astronomical Catalog Encompass 3.0: Motivation, Creation, and Validation**

Jennifer Simmerer, Thomas Murdock, Leah Roach, Ryan Hartzell – Frontier Technology Inc.; Brian Muccioli – BAE Systems

ABSTRACT: Celestial objects captured in a sensor field-of-view can be used for in-situ sensor calibration and for navigation. One of the limitations on this approach is that the prediction of what objects will be visible to sensors can be highly inaccurate when sensor spectral bands do not match published stellar survey spectral bands. FTI presents Encompass v3.0, a compiled catalog of all known stars, galaxies, globular star clusters, and nebulae detectable in the visible, near-infrared, and mid-infrared portions of the electromagnetic spectrum across the entire sky. Proprietary physics-based modeling techniques enable Encompass users to create radiometrically and astrometrically relatively accurate astronomical inventories to suit a wide range of detector technologies. Derived from the Hubble Space Telescope's Guide Star Catalog version 2.3 and the AllWISE extension of the space-based Wide-field Infrared Survey Explorer, the star catalog contains nearly 1 billion astronomical objects detectable with visible-wavelength sensors (complete to 20 mag at 0.6 um) and nearly 750 million astronomical

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objects detectable with infrared-wavelength sensors (complete to 17 mag at 3  $\mu\text{m}$ ) over the whole sky. Object positions are accurate to 2  $\mu\text{rad}$  (0.4 arcsec) at all brightness ranges and the catalog supports physics-based spectral modeling for any mission passband between 0.4 and 20  $\mu\text{m}$ . Catalogs in derived custom passbands were validated against published astronomical surveys APASS, GLIMPSE, and DIRBE and found to be accurate to better than 0.5 mag--sufficient to determine whether sources will be visible for mission planning purposes. Encompass supports derived program catalogs filtered by brightness and position as well as calibration and reference catalogs filtered to custom source densities. We discuss the challenges of working with a large data set, outline the validation process, and present validation results.