

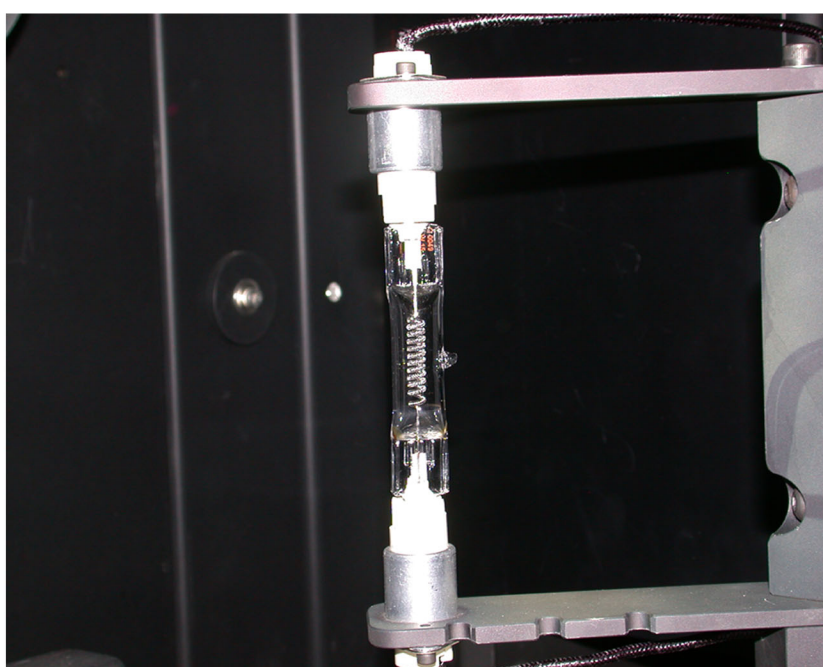
Improving Reflectance Retrieval: Methodology and Results

Stuart A. Biggar, Kurtis J. Thome and Jeremy T. Dobler
Remote Sensing Group, College of Optical Sciences
The University of Arizona

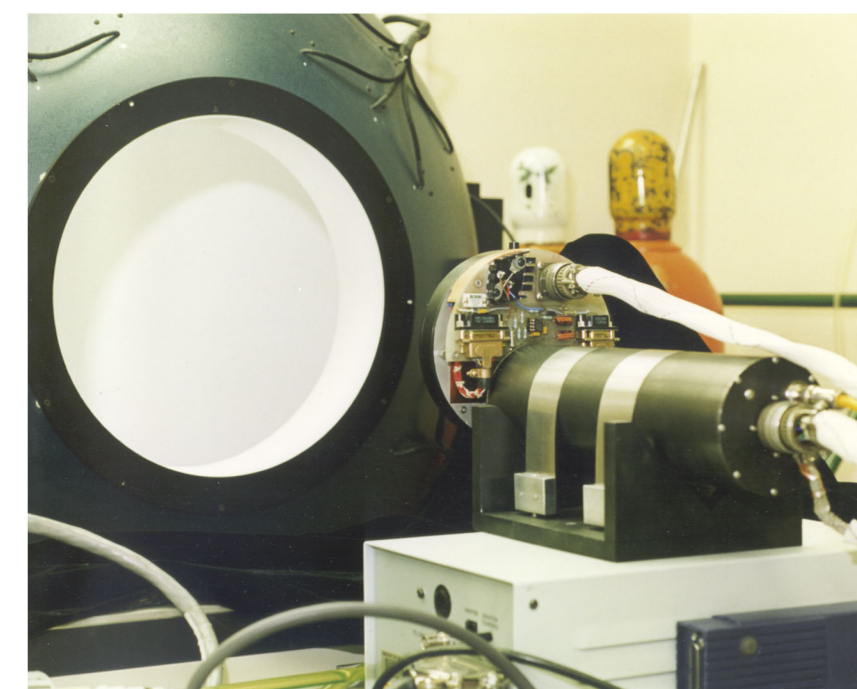
Our group at the University of Arizona has been using a reflectance-based method for vicarious calibration of MODIS and MISR and other optical sensors such as ETM+, ALI, ASTER, Hyperion, MASTER, and MAS. We normally work at sites such as Railroad Valley, NV, Ivanpah Playa, CA, and White Sands Missile Range, NM. We have compared many sensors using the reflectance-based method. We are working now to improve our measurements of reflectance.

Current Work

1. Work is being performed to automate reflectance measurements using LED based radiometers.
2. The current method for obtaining surface reflectance uses an Analog Spectral Devices (ASD) spectrometer.
3. Although automation would not be able to replace the current method, it allows continuity of data when personnel are not present at the calibration sites.
4. Retrieval of accurate reflectance data requires both laboratory and field work.



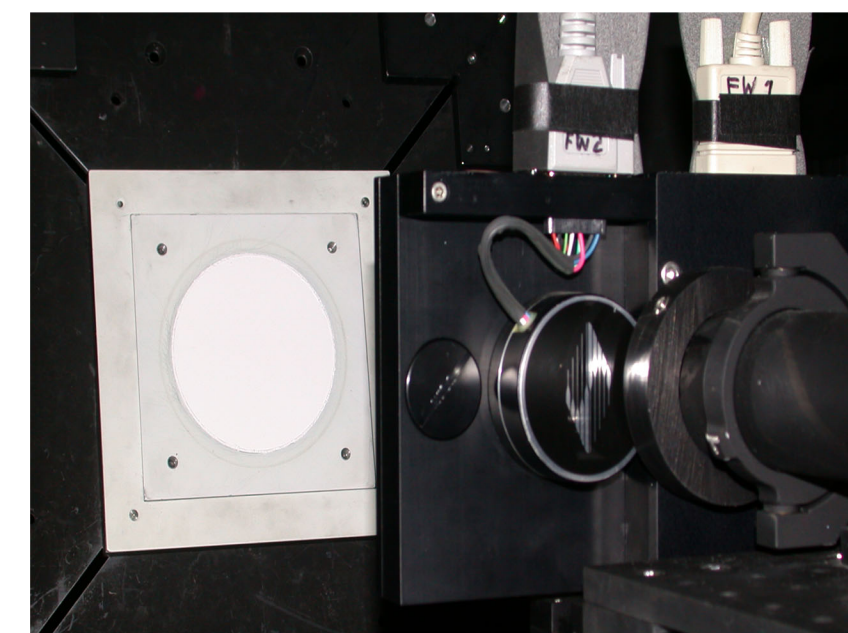
DXW Lamp Source Used for BRDF Measurements



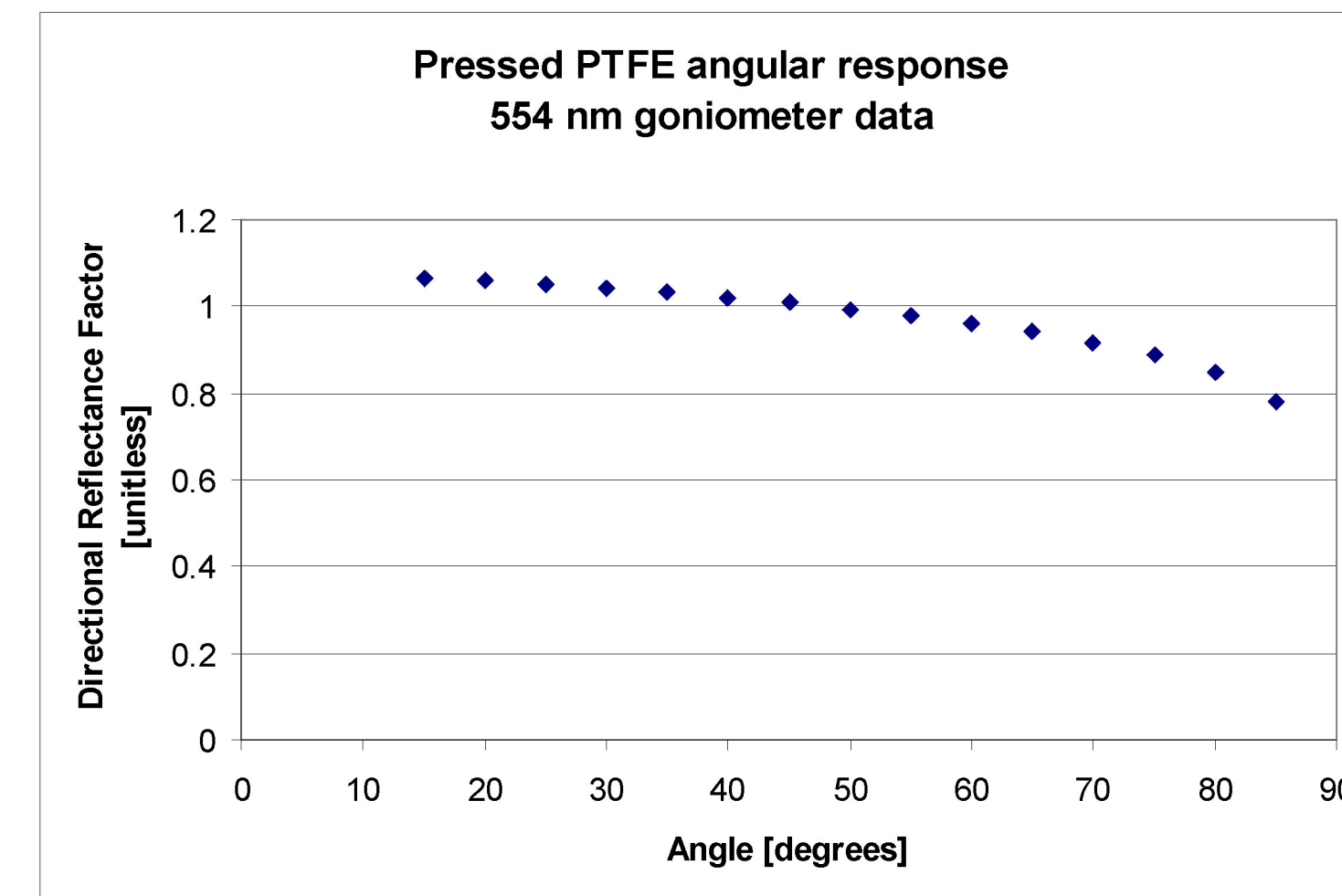
VNIR Transfer Radiometer Calibrated with NIST FEL Lamp and Spectralon Panel

Laboratory Measurement of Reflectance Standards

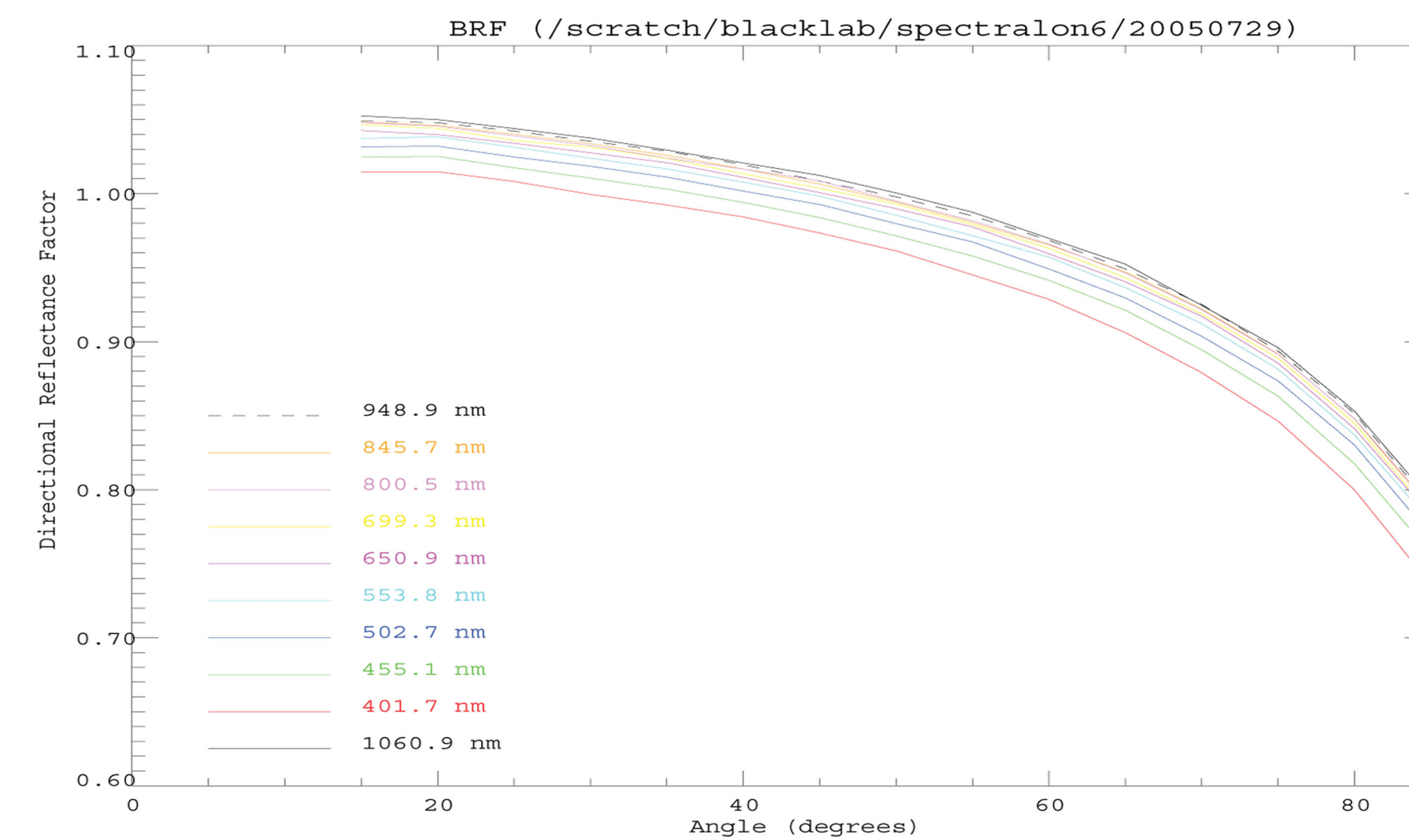
- The reference is a pressed polytetrafluoroethylene (PTFE) disc
- Finely powdered PTFE is pressed to a density of 1g/cm³ with 1 cm thickness
- Pressed PTFE reflectance is taken from NIST published values
- Angular measurements of the reference are taken with a goniometer with sample viewed at normal with varying incidence angle.
- Data are taken at a series of wavelengths covering 400 - 2400 nm with filter radiometers (Silicon trap detector and Indium Antimonide detector)
- Data are fit, numerically integrated, and normalized to the NIST value



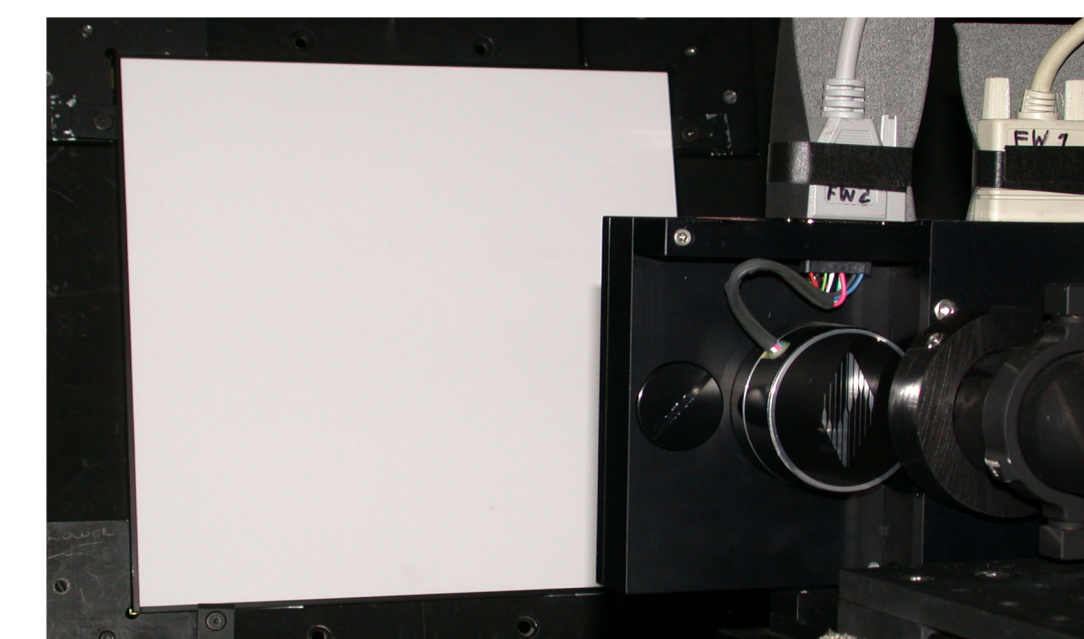
BRDF Measurement Facility with PTFE Reference



- Field reference panel is a Labsphere Spectralon panel about 18" on a side
- Field panel is measured on the goniometer in same geometry as reference
- The ratio of radiometer measurements times the PTFE reflectance gives the panel reflectance



Field Panel Measurement Showing Reduced Blue Reflectance (UV exposure and contamination)



BRDF Measurement Facility with Calibrated Spectralon Panel

Estimated Uncertainty of Laboratory Reflectance Measurements

Estimated Uncertainty of PTFE Reference (laboratory)	< 2000 nm	2000-2500 nm
NIST measurement of PTFE	0.2%	0.2%
Reproducibility of PTFE reference (NIST)	0.5%	1.0%
Integration of goniometric data (NIST)	0.5%	0.5%
Fitting to polynomial function (NIST)	0.1%	0.1%
Radiometer system noise (lab)	0.3%	0.3%
Goniometer angle error (0.1° at 60° incidence)	0.1%	0.1%
Source variations (lab)	0.1%	0.1%
Temperature variations (lab)	0.5%	0.2%
RSS	1.1%	1.4%

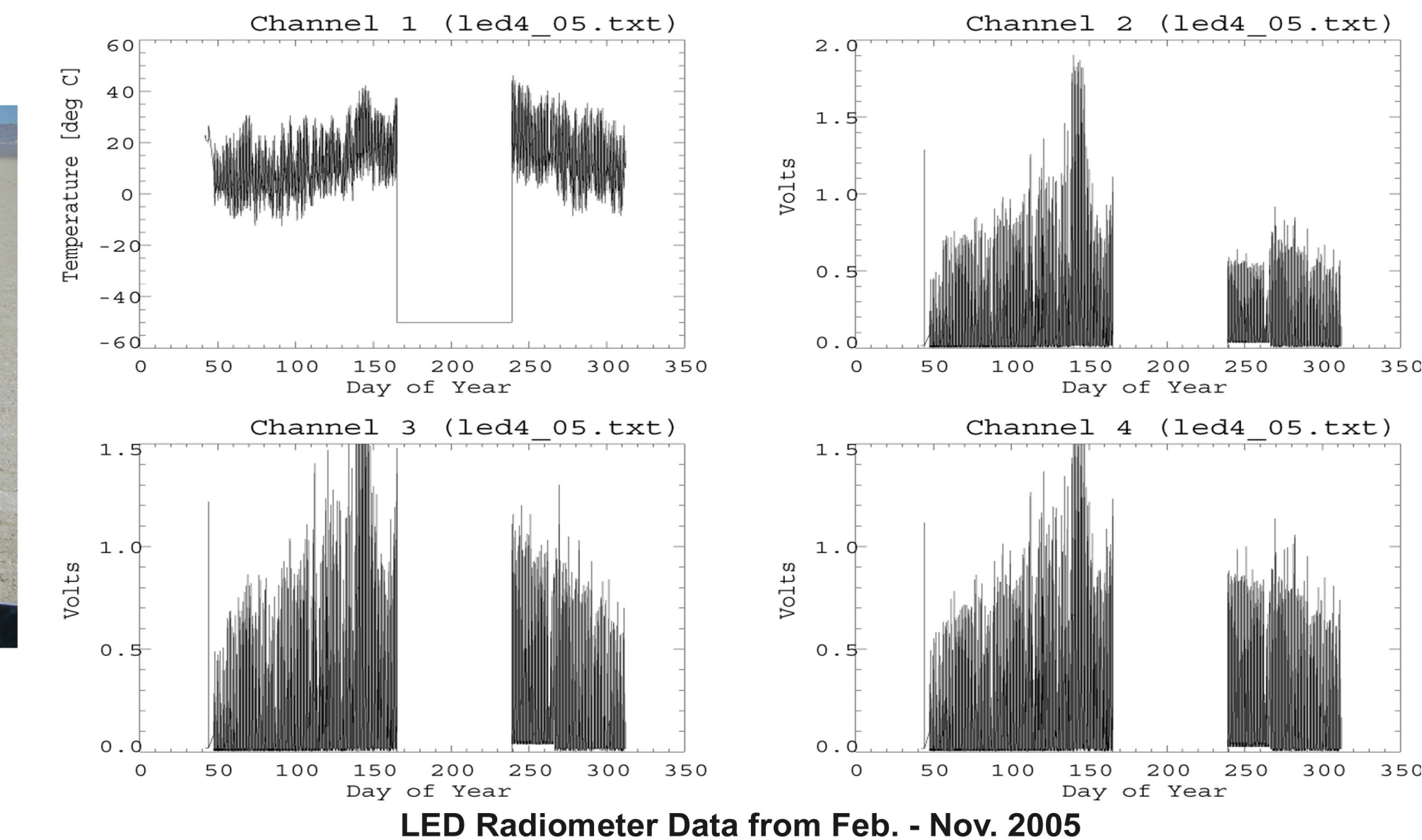
Estimated Uncertainty of Spectralon (laboratory)	< 2000 nm	2000-2500 nm
PTFE	1.1%	1.4%
Fitting to polynomial function	0.1%	0.1%
Goniometer angle error (0.1° at 60° incidence)	0.1%	0.1%
Radiometer system noise	0.3%	0.3%
Source variations	0.1%	0.1%
Temperature variations	0.5%	0.2%
RSS	1.3%	1.4%

Field Measurement of Surface Reflectance

- Field reference is the Spectralon panel
- Ratio measurement done with an Analytical Spectral Devices FieldSpec FR (350 -2500 nm)
- Measure the Spectralon, a 50% Spectralon panel, the surface and then Spectralon; Repeat for multiple transects of the field site
- Compute surface reflectance for solar illumination using solar zenith angle as an input to find reference reflectance and multiply by ratio of ASD measurements



Simultaneous Measurement of Panel with LED Radiometer and ASD - Inset Shows Similar Ground Measurements



LED Radiometer Data from Feb. - Nov. 2005

Conclusions and Future Work

- Uncertainty of field reflectance with the ASD is estimated at <2% in low atmospheric absorption regions
- Almost 2 years of prototype LED data has been collected at Railroad Valley, NV.
- Hand data reduction of LED data to reflectance, for recent dates, agrees with ASD results to within 5% on average
- We are developing software to expedite data analysis
- We are in proposal stage for improvements including an array of Silicon detector radiometers and an automated VNIR spectrometer