ASD FieldSpec FR Calibration
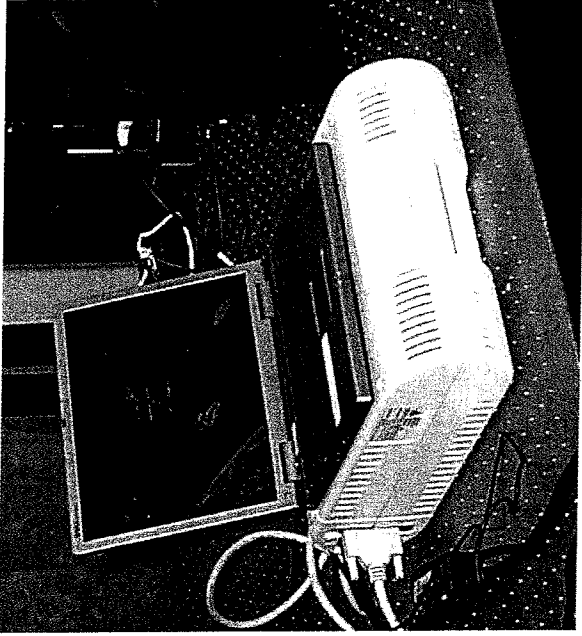
Setup and Techniques

Prepared by

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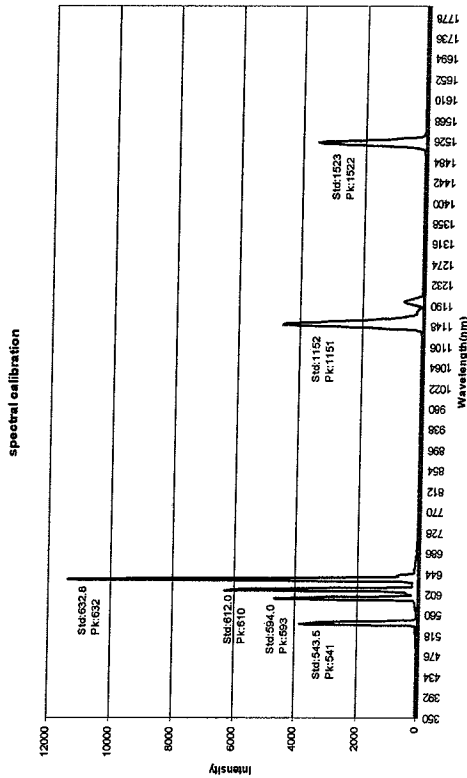# ASD FieldSpec FR Spectroradiometer

- Designed for collection of spectral data in the field

- Range is 350 to 2500 nanometers

- Measures spectral reflectance, radiance, and irradiance

- Fiber optic bundle carries light to three internal spectrometers

- UV/VIS/NIR silicon array covers about 350 to 950 nm with ~1.4 nm sample interval

- Two NIR/MWIR spectrometers cover 900 to 1850 nm and 1700 to 2500 nm with a sampling interval of about 2 to 3 nm

- Control and data storage with laptop computer

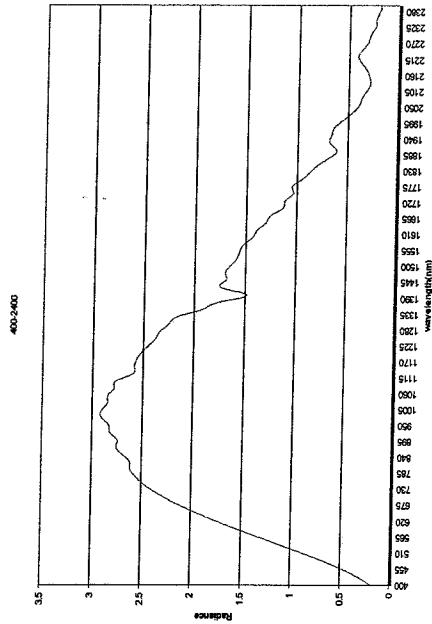- Interchangeable foreoptics provide flexibility in field of view

Components of Calibration

RADIOMETRIC

SPECTRAL

LINEARITY

Correlation coefficient: 0.99988
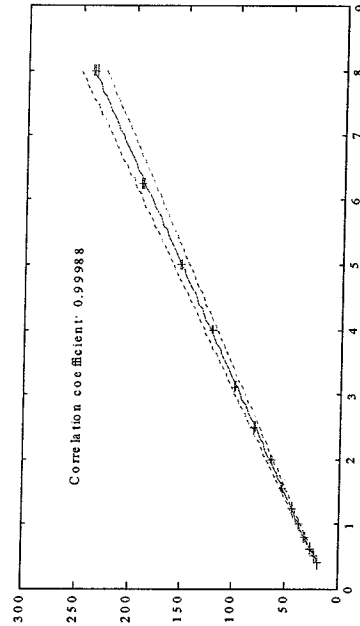
- Spectral: Intrinsic wavelength standards
  - Lasers
  - Discharge lamps
- Radiometric: NIST secondary standard
- Linearity
- Field of View (FOV)

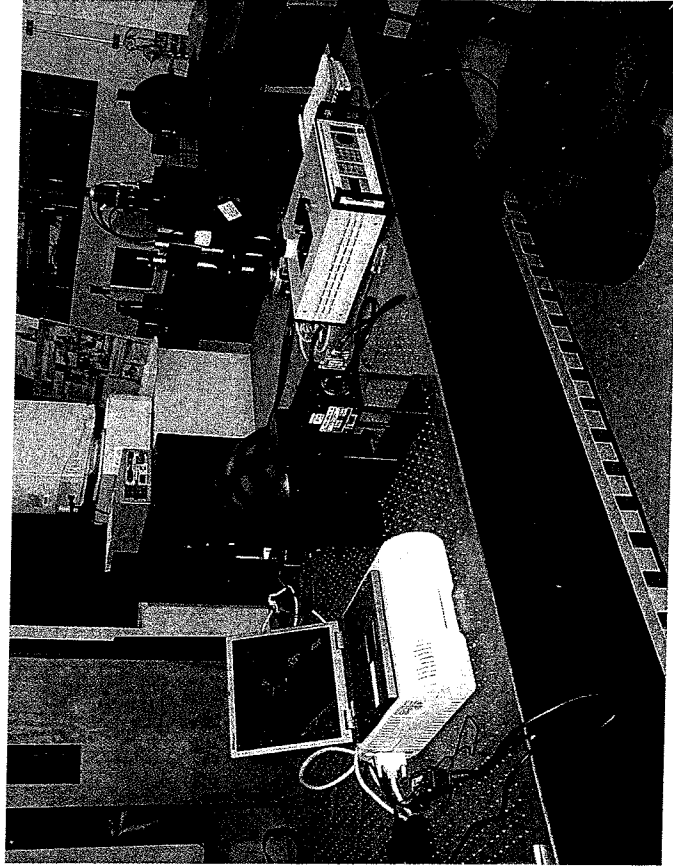# Equipment List

- NIST calibrated integrating sphere
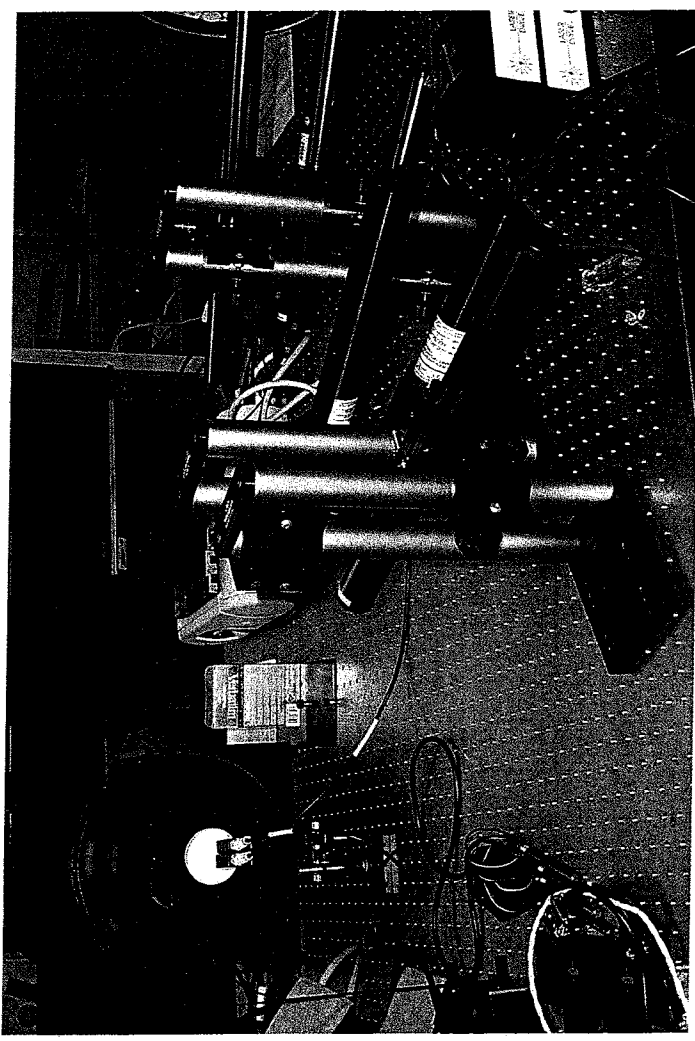
- NIST sphere is equivalent to a secondary radiance standard

- Multiple HeNe lasers

- Sphere controller

- ASD FieldSpec FR spectroradiometer

- Portable laptop computer

- Precision 3-axis positioner

- MATLAB® software

Spectral Setup

- Use intrinsic spectral sources
- Six different wavelengths
- All HeNe lasers
- Beams directed into sphere
- No beams directly on baffle

Spectral Calibration

Stennis Space Center
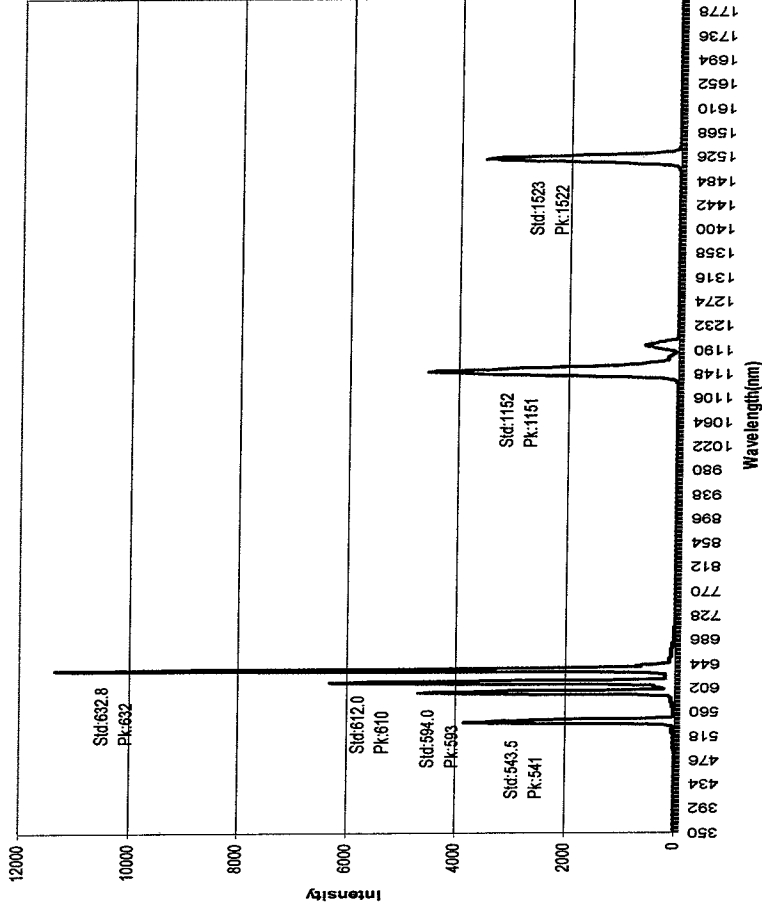
- Take raw DN data with laser input to sphere

- Determine wavelength ASD measures for each intrinsic standard

- Locally generated MATLAB code fits Gaussian to peaks and provides center wavelength and FWHM

- Calculate ASD deviations from accepted standard wavelengths

spectral calibration

Std:632.8 Pk:632

Std:612.0 Pk:610

Std:594.0 Pk:593

Std:543.5 Pk:541

Std:1152 Pk:1151

Std:1523 Pk:1522

Intensity

Wavelength(nm)

Radiometric and Linearity Setup

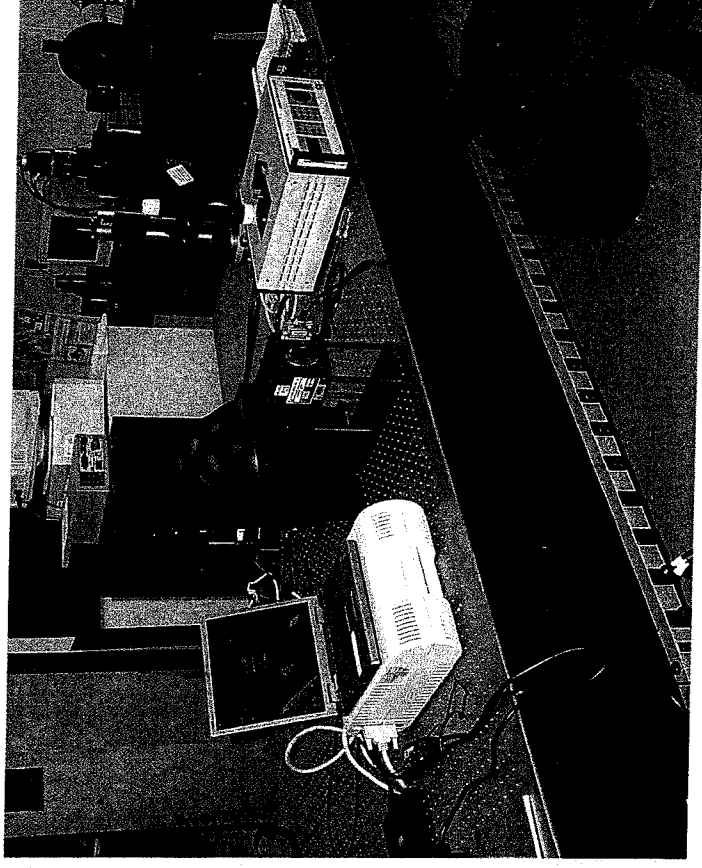- ASD powered up for 1.5 hours before taking data

- Sphere port set to open away from operator

- Probe with appropriate foreoptic positioned normal to port and centered

- Room lights off for minimum stray light

- No reflective surfaces near output port

Radiometric Setup
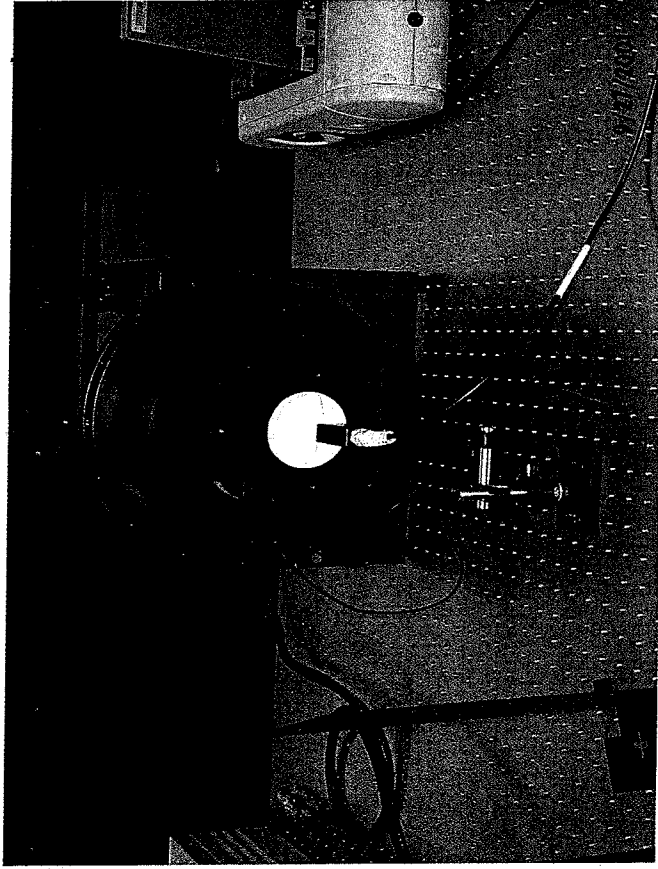
- Entrance aperture of probe close to but not inside port output plane

- Probe is well centered

- Note edge of internal baffle

- Field of view should be considerably less than 40° to ensure total area seen is fully on the baffle surface

Datasets Required

- NIST calibration at 30.0 mW/cm^2*sr

- Equivalent to about 50% of maximum output from sphere

- Linearity requires data collection at 100%, 75%, 50%, 25%, and 10% of max

- Least squares linear fit to these points

- Use data from 50% for radiometric calibration coefficient calculation
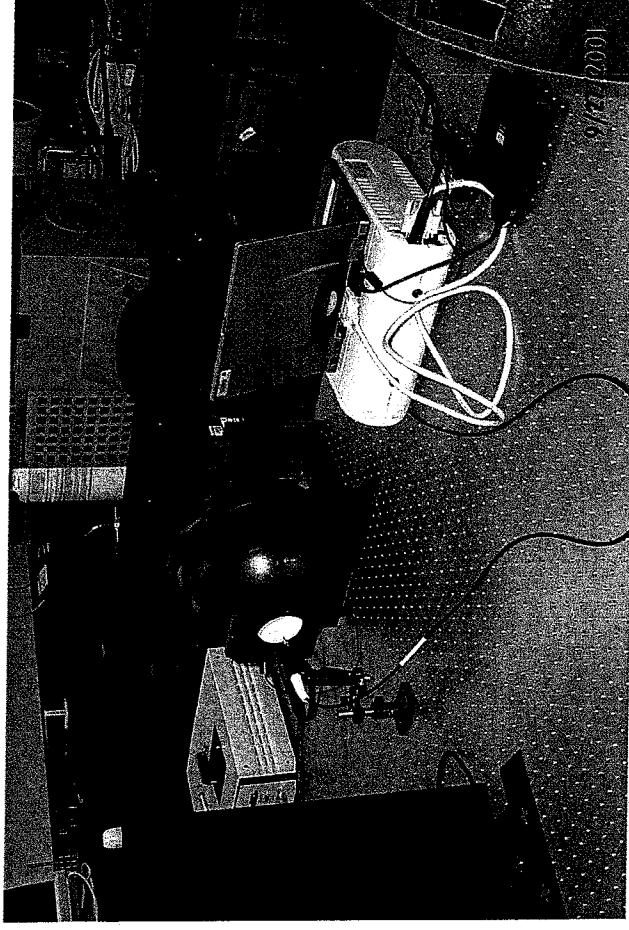
Data Files

- All data recorded as raw data files

- Each has the format HEADER.XXXX, where HEADER is created by the operator and XXXX is a number auto-incremented by the FR

- Each file has wavelength scale in one column, DN in a second column

- Files converted to text files (*.txt) with the ViewSpecPro software before analysis

- Calibration Work Instruction details entries so that each experimental data sequence produces a spectrum that is the average of 25 separate readouts

- A total of 30 of these saved spectra is generated for each experimental setup

- First step in analysis is to average these 30 files at each wavelength

Data Files (continued)

- Averaging 25 readouts for one spectrum reduces noise

- Saving 30 spectra enables statistical calculation of SNR and further reduces noise

- Spectral calibration files of laser lines are analyzed to yield center wavelength and FWHM as measured by the ASD

- Corrections (offsets) are calculated from differences between standard wavelengths and those measured by the ASD

- Spectral radiance calibration coefficients are produced from raw digital numbers recorded and NIST file of spectral radiance from the sphere

- For verification of linearity, the raw spectra are first converted to spectral radiance via the calibration coefficients

- The resultant spectral radiance file is then integrated to yield total integrated radiance, which is used to derive a least squares fit to a line

Field of View Measurement
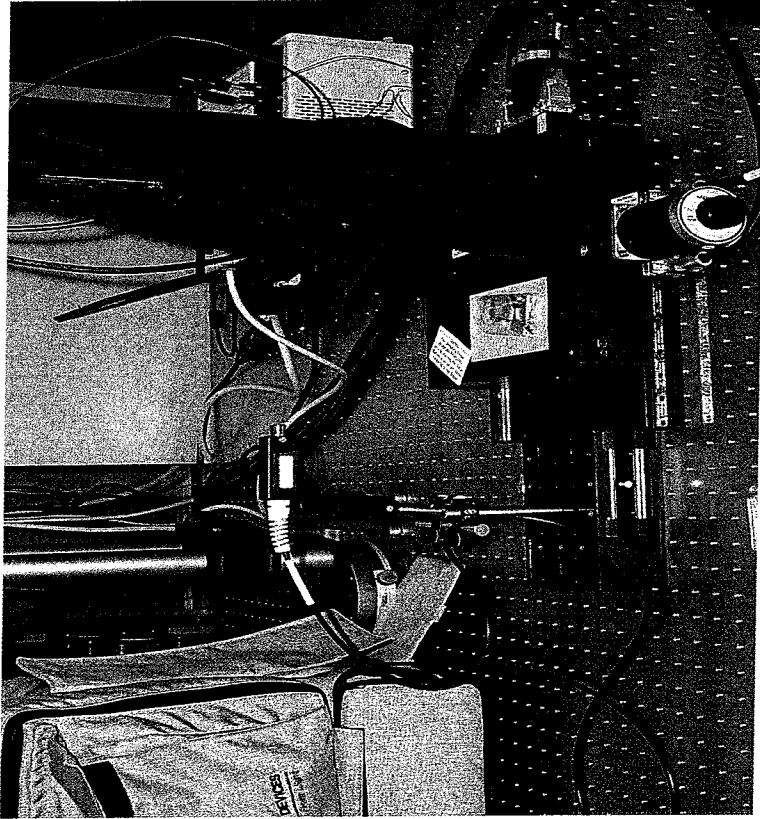
- Precision, automated three-axis positioner moves small grain of wheat bulb through field of view

- Room darkened

- ASD takes spectrum at each position

- Spectrum is integrated to yield overall intensity and plotted as function of position in the X,Z plane

- Angular FOV reconstructed from geometry

Summary

- **Field portable spectroradiometers play key role in validation and verification**

  - Ground truth data collection

  - Radiometer transfer for internal laboratory use

- **Calibration required under ISO9000**

- **Vendor calibrations not traceable**

- **In-house calibration highly desirable**

  - Traceability ensured

  - Equipment not subject to hazards of shipping

- **Instruments serve multiple purposes**

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