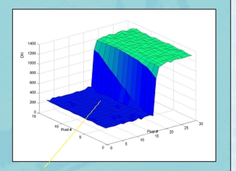
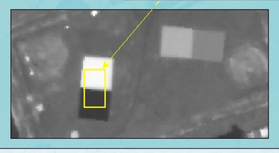
Stennis Space Center
Verification and Validation Capabilities

Spatial Response

Edge Response of Tarps

Reflective Tarp Edge Target





Concrete Edge Target

Purpose: Measure spatial response of 1-meter GSD class systems
Reflectance: ~50% and ~4% reflective painted rectangles
Dimensions: 4 rectangles, 10 m x 20 m each
Total Dimensions: 20 m x 40 m
Orientation: North-South and East-West orientation

Tri-bar Target Array

Concrete Radial Edge Target

- 130 m radial target > 90° arc angle
- ~4 m thick tapered to < 10 cm

Reflectance Radiometry

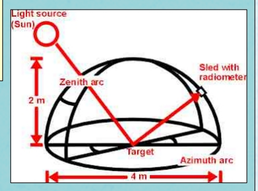
ASD Measuring Tarps

Analytical Spectral Devices

Purpose: Analytical Spectral Devices (ASDs) used to calculate accurately target reflectance values used to validate imager radiance values
Spectral Range: 350 - 2500 nm
Sensors: One 512-element photodiode array and two thermoelectrically cooled, extended-range InGaAs photodiodes
Sampling Interval: 1.4 nm from 350 - 1000 nm; 2 nm from 1000 - 2500 nm
Spectral Resolution: 3 nm @ 700 nm; 10 nm @ 1500 nm; 10 nm @ 2100 nm
Number of Channels: 512 channels
Wavelength Accuracy: +/-1 nm

Purpose: Measure BRDF effects of target surface
Spectral Radiometer: GER
Zenith Range: 180° sampled every 15°
Azimuthal Range: 180° sampled every 30°

Goniometer



NIST Characterized Spectralon© Panels

Reflective Tarps

- Tarp Panel 1 - 3.5%
- Tarp Panel 2 - 22%
- Tarp Panel 3 - 34%
- Tarp Panel 4 - 52%

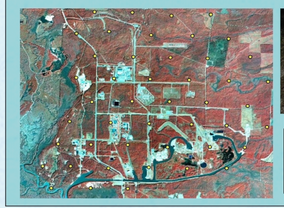
Purpose: Tarp panels form four 20-meter edges to measure the modulation transfer function (MTF) for panchromatic and multispectral imaging systems with ground sampling distances of 1 meter or less
Tarps' highly stable spectral reflectance can be utilized in the characterization of multispectral and hyperspectral sensors
Degradation Tracking: 60 square witness samples, 30.5 cm x 30.5 cm, document the status of the tarps at each use

Positional Accuracy

IKONOS Observed Geolocational Accuracy

	Product	Resampling	MTFC	Band	Mean Error: Mean Error	Mean Error: STD	Mean Error: Total RMS	Circular Error 90%
Stennis Space Center, MS	Std. Mag.	CC	On	Pan	3.87	0.51	3.91	1.06
	Std. Mag.	CC	On	Blue	4.48	1.39	4.69	3.06
	Std. Mag.	CC	On	Green	4.46	1.49	4.70	3.34
	Std. Mag.	CC	On	Red	4.40	1.36	4.61	3.12
	Std. Mag.	CC	On	NIR	4.34	1.35	4.54	2.79
	Std. Orig.	CC	On	Pan	3.57	0.63	3.62	1.38
	Std. Orig.	CC	On	Blue	3.10	1.00	3.26	2.58
	Std. Orig.	CC	On	Green	3.17	1.16	3.36	2.84
	Std. Orig.	CC	On	Red	3.50	1.15	3.68	2.79
	Std. Orig.	CC	On	NIR	3.31	0.97	3.45	2.62
	Std. Orig.	CC	Off	Pan	0.99	0.44	1.09	1.39
	Std. Orig.	NN	Off	Pan	0.95	0.48	1.06	1.36
	Std. Orig.	NN	On	Pan	1.00	0.49	1.11	1.50

45 GPS-Surveyed Geodetic Targets < 3 cm Accuracy



Forty-five, 2.44-meter outer 0.6-meter red center radius geodetic targets evenly spaced throughout site

76 GPS-Surveyed Road Intersection Points

17 A-Order GPS Monuments Onsite

31 Miles of GPS-Surveyed Roads

Trimble 4700 GPS

- Centimeter-level accuracy
- Sub-cm accuracies for static survey
- >8 hours from two camcorder batteries
- 18-channel receiver

NGS/NOAA-NDBC Operated CORS Site

Continuously Operating Reference Station provides carrier phase and code range measurements for added ease of post-processing GPS survey data

Trimble Pathfinder GPS

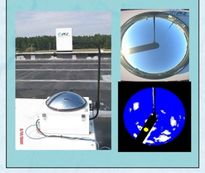
Purpose: Field portable real-time GPS survey
Accuracy: 10 m to submeter

Stationary Atmospheric Monitoring

Atmospheric Monitoring Station

- Live Web publishing
- Entirely automated

Total Sky Imager



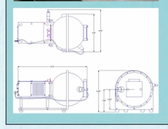
Cimel Sun Photometer

Channels: 440, 670, 870, 936, and 1020 nm
10 nm FWHM
FOV: 1.2°
Part of AERONET network

Multi-filter Rotating Shadow-band Radiometer

Lab Calibration

NIST Certified Integrating Spheres



Purpose: Calibration and characterization of spectral radiometers
Controls: Microprocessor-controlled integrating sphere calibration standard
Illumination: 150-W tungsten-halogen, reflectorized lamp with a motorized, computer-controlled, variable aperture
Temperature Range: 2000 to 3000K
Spectral Range: Calibrated from 300 to 2500 nm

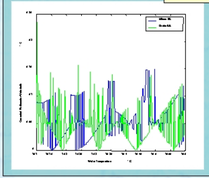
ESPEC Environmental Chamber

Purpose: Simulation of field conditions to validate instrument performance and to improve calibration
Temperature Range: -75 °C to 150 °C
Relative Humidity Range: 10% to 90%
Interior Dimensions: 32 ft^3

Mikron Water Bath Black Bodies

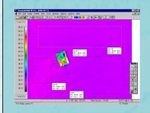
Purpose: Calibration of radiometers
Emitter Area: 12" x 12"
Temperature Range: 0 °C to 148.9 °C
Temperature Resolution: 0.01 °C ≤ 99.99 °C; 0.1 °C ≥ 100 °C
Stability: ± .04 °C for 8-hour period
Temperature Sensor: Precision Platinum

Mikron BB vs. Ice Chest BB



Thermal Radiometry

FLIR Systems SC2000: Thermal Camera

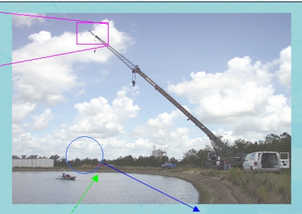


Purpose: Image float's influence on waterbody
Range: Thermal (8-12 µ)
Accuracy: 14-bit digitization with 0.1 °C NED, 240 x 320 pixel array
IFOV: Uncooled, 1.3 milliradian

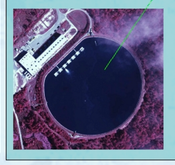
FTIR Spectropolarimeter

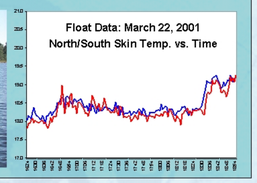
Purpose: Measure hyperspectral thermal data in two polarizations
Resolution: ~0.5 (cm^-1) in two polarizations
Range: 5000-600 (cm^-1) for KBr
Detector: Liquid N2 cooled MCT

Thermal Float on Stennis Pond



- Float employs 2 Heimann radiometers to measure skin surface temperature
- Additional Heimann measures cold sky temperature
- Two honeycomb black bodies calibrate radiometers during field exercises
- Thermocouple probe measures bulk water temperature





Heimann Radiometer

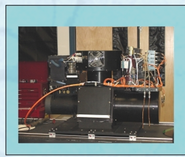
Spectral Response: 8- 14 µm
Accuracy: ±0.5 °C
Target Spot Size (@ 1 m): 10 cm
Long Term Stability: 1% over 1-year period
Response Time: 0.05-10.0 seconds

Ice Chest Portable Black Body

Purpose: Field Radiometer Calibration
Cone Material: Aluminum
Aperture Size: 2" (1.5" with reducer)
Depth of Cone: 6.73"
Cone Paint: ~.95 emissivity glossy black

In-flight Instruments

ATLAS: Airborne Terrestrial Applications Sensor



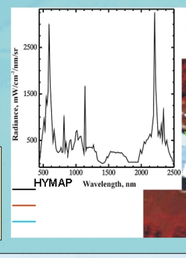
Spectral Range: 0.45 µm – 12.2 µm
FOV: 72°
Pixels: 640 ground scene pixels/ 3 calibration source pixels
Scan Rate: 6-50 scans/sec

CRIS: Coastal Research Imaging Spectrometer

Spectral Range: 0.4 µm – 0.8 µm
FOV: ~20°
Pixels: 1024 spatial/256 spectral
Scan Rate: 30 frames/sec

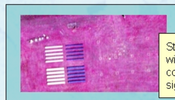
Hyperspectral Radiometry

Hyperspectral Active Targets

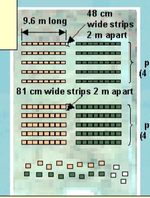


Purpose: Vicariously evaluate wavelength calibrations of airborne hyperspectral sensors
Design: 1500 W metal halide lamps

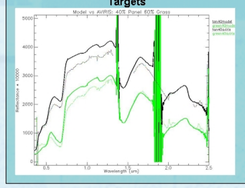
Hyperspectral Targets



Stripe array targets with known pixel fill, contrast, and signature



Spectral Response of Green and Tan Targets



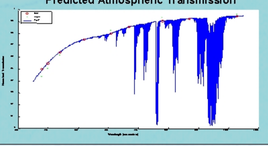
4' x 4' panels with multiple paint/ substrate combinations for weathering studies

Portable Atmospheric Monitoring

Reagan Sun Photometer

Purpose: Measure direct solar irradiance
Spectral Channels: Nine channels – one total solar and eight 10 nm bandwidth center wavelengths at 382, 400, 440, 521, 610, 671, 781, 870, 940, and 1030 nm

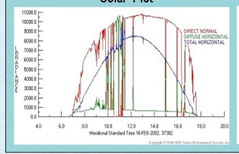
Reagan Sunphotometer Transmission
Predicted Atmospheric Transmission



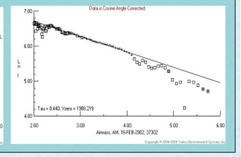
Multi-filter Rotating Shadow-band Radiometer

Purpose: Measure diffuse/ direct/horizontal solar irradiance
Spectral Channels: Seven channels – one total solar and six 10 nm bandwidth center wavelengths at 415, 500, 615, 673, 870, and 940 nm
Cosine response: <5% for 0-80 degree zenith angle; <1% with correction

Solar Plot

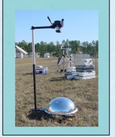


Langley Regression Plot



Radiosonde Balloon

Full Sky Imager



Portable Meteorology Station

Purpose: Record atmospheric measurements during field collects
Atmospheric Measurements: Temperature, humidity, pressure, and wind speed/direction sensors
Solar measurements: Pyrenometer, Pyroheliometer

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