Diffuse Panel Studies

Conclusions

In the evaluation of new candidate materials for flight applications, considerations are given to
* optical performance (lambertian, spatially and spectrally uniform, high reflectance),
* static charge build-up,
* environmental stability (ruggedness, UV exposure, particle bombardment, etc.), and
* fabricability

ITO coated Spectralon appears to have produced a conductive material

Many other design issues remain

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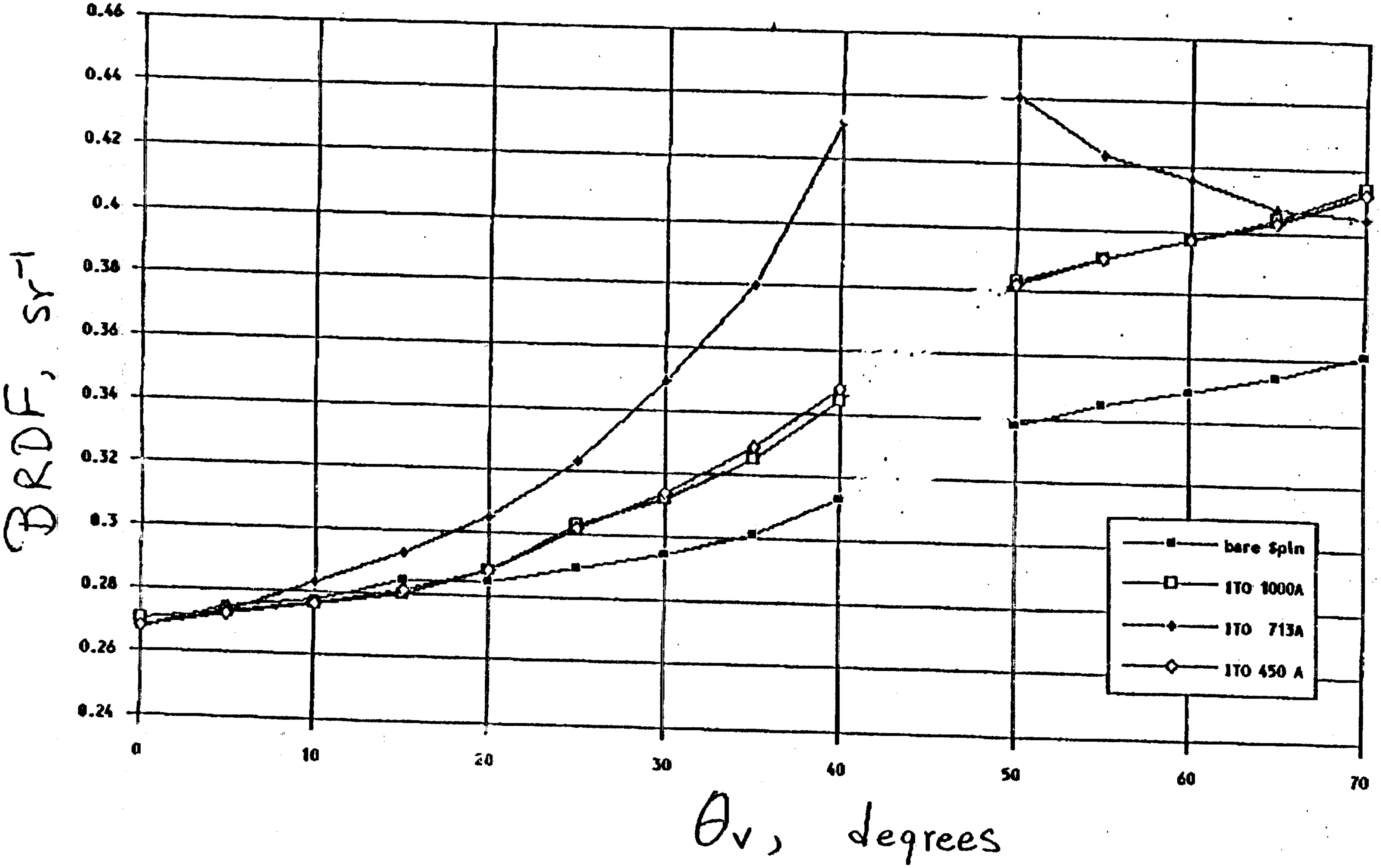
171302
N94-23606

TRW
Pete Jarecke
24 mar 92

ITO-Coated Spectralon

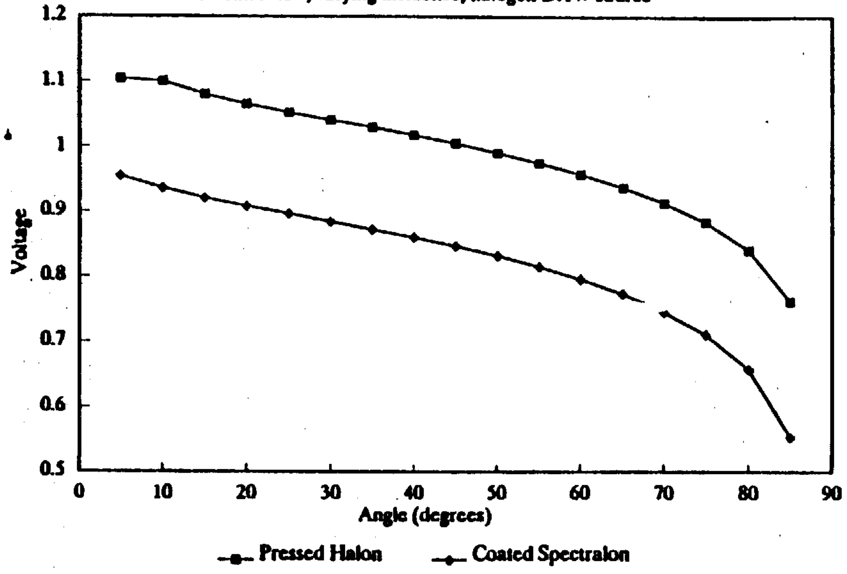


U of A
Stuart Biggar
20 Mar 92

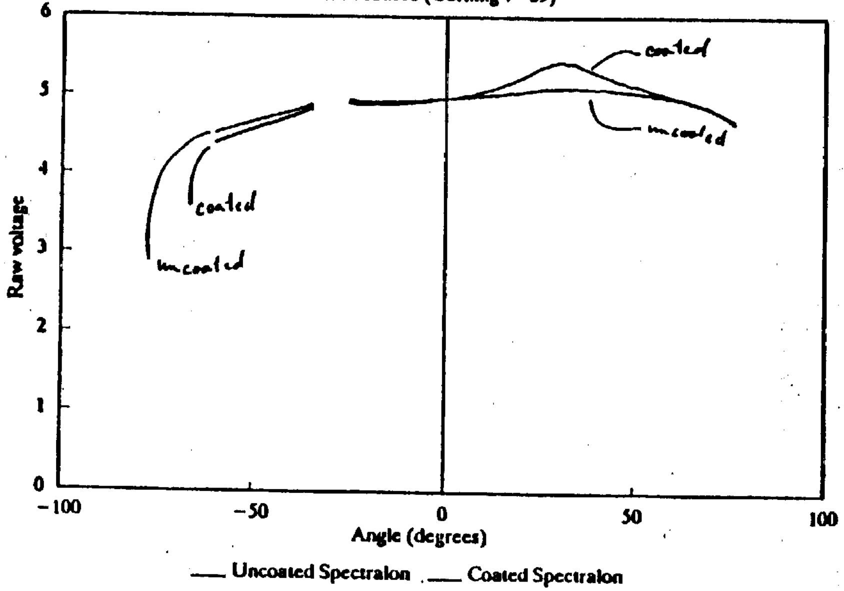
ITO - Coated
Spectralon
(1074Å layer)

Reflectance Factor, 450 nm

Normal view, varying incidence, halogen DXW source

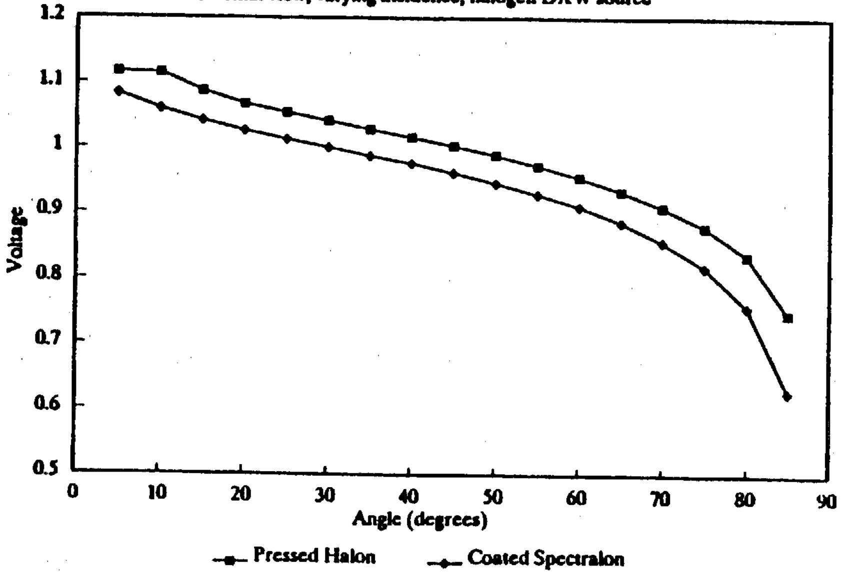


Raw voltages, −30 degree illumination, varying view
Filtered source (Corning 7−69)



Reflectance Factor, 650 nm

Normal view, varying incidence, halogen DXW source



Static Charge Data

Requirement

Materials exposed to the space environment cannot charge more than 100 V, and cannot be an electrostatic discharge source. If a charged particle detector is on the platform, the requirement may drop to 10 V. This requirement ensures that no charge arcing will occur which may affect the performance of other instruments, or the platform.

Charge data, V

Spectralon (pure PTFE, and carbon doped)
* Test results at 5 nA/ cm^2 current density, EOS simulated conditions

Energy (keV)	Requirement	sample 1 (ρ~99%)	sample 2 (ρ=94.75%)	sample 3 (ρ=77%)	ITO-Coated Spectralon
3	100	670	410	200	20 V
5	100	1600	1150	1100	
10	100	3260	2560	2320	
15	100	4647	4515	3150	

Resistivity data, Ω/cm^2

Requirement	Pure PTFE	YB-71 (ZOT)	ITO coated (713 Å)
10^{10}	10^{12}	10^{12}	10^{5}

Diode Dilemmas

Goal: Highest accuracy

- High QE trapped devices are accurate because no need to characterize!
- Continuity of pre-flight facility approach
  - but -
    - Trapping adds complexity with uncertain gain.
    - NIST relies on single-diode approach with reflectance characterization.

Goal: Single diode vendor

-$$$
  -but
    - Inversion layer (UDT) best for blue, different vendor required for red (unless A-UV technology proven)

Goal: Buy American

  -but
    -Hamamatsu wins 4 year stability study
    -Hamamatsu recognized standard for red, and used by NIST

on the other hand,
- international procurement difficult
- still have problem with blue channel.

Goal: Redundancy in Approach

- Precision provides evidence of accuracy in view of different degradation mechanisms.
- Perhaps rad-hard and high QE in red, with rad-hard biased and unbiased in blue fulfills this desire with advantage of single vendor.

Fidelity Interval Study

Conclusions

Determined calibration accuracy will not be limited by system noise (verify SNR specification)

Predict uncertainty for very low signal levels (those specified as “best effort”)

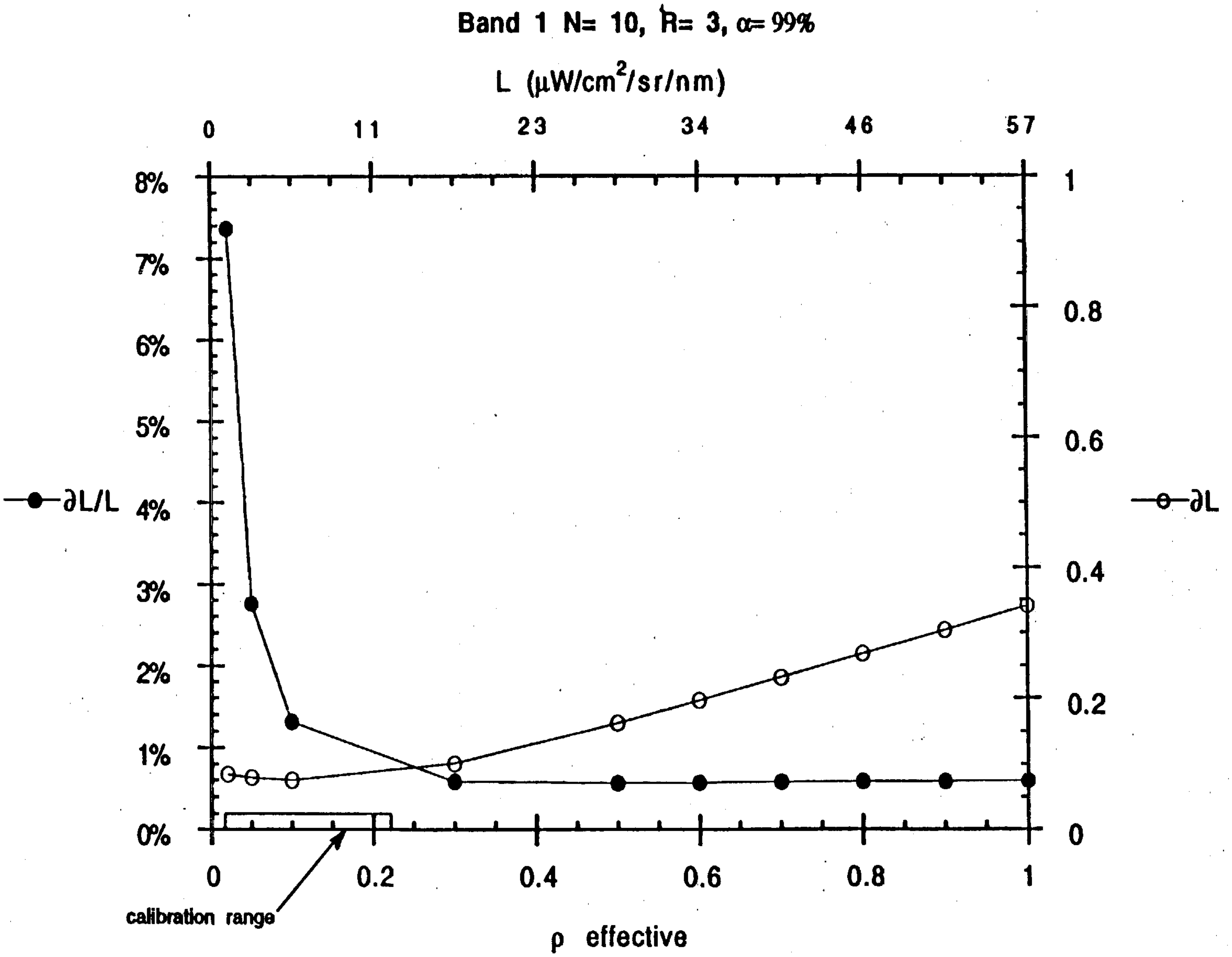
Allows tradeoff study involving calibration procedures versus accuracy
* Multiple radiometric levels required for calibration
* Radiometric levels must span range of instrument dynamic range for highest accuracy
* Sets limits for test plan (defines sufficient number of redundant measurements, etc.)

Defines the statistical tools to be used for uncertainty evaluation of calibration test data

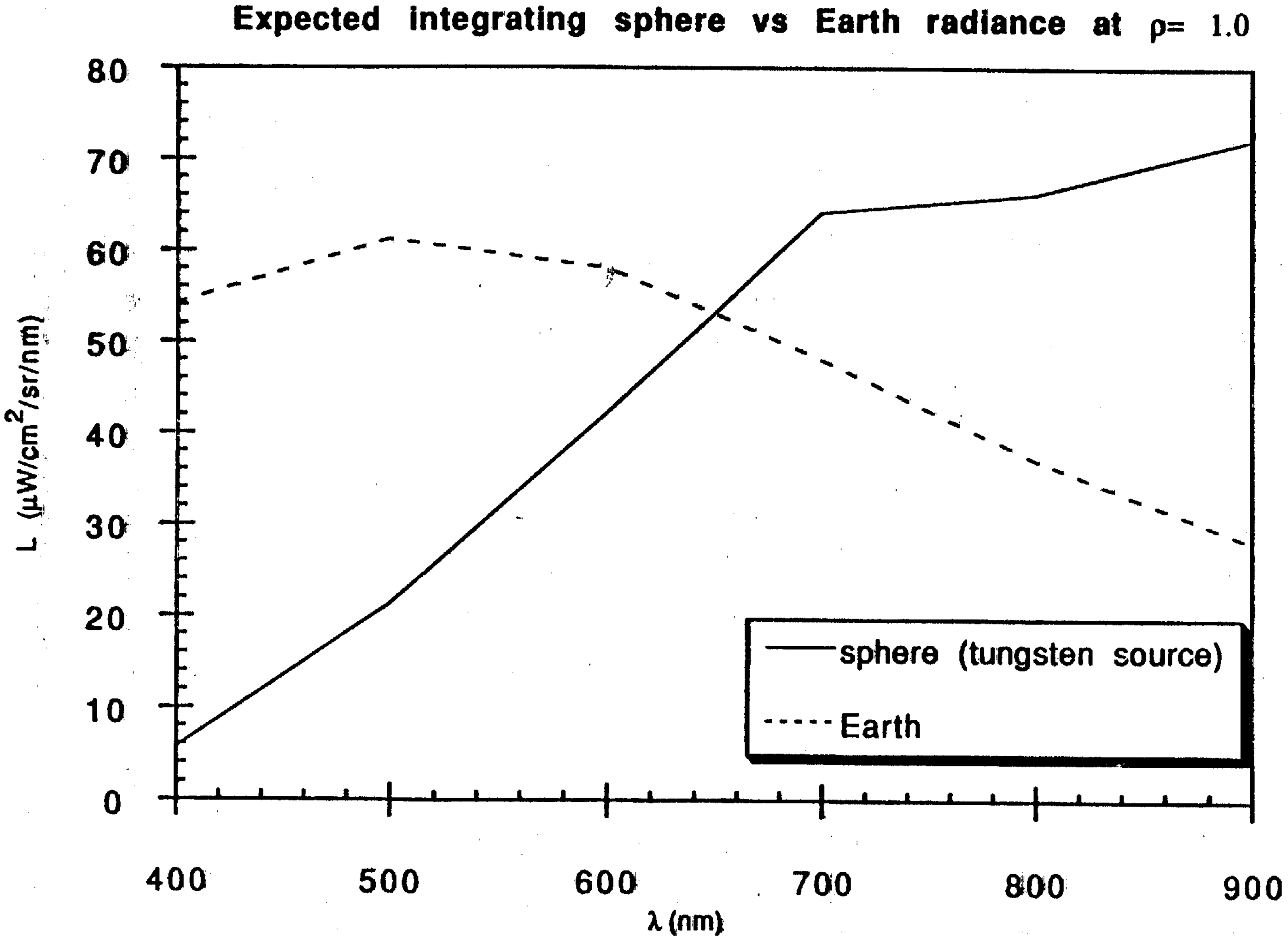
JPL

Uncertainty due to instrument noise: Relative and absolute radiance uncertainties

MISR Multi-angle Imaging Spectro-Radiometer



Fidelity Intervals: Calibration source versus expected maximum scene radiance



Expected integrating sphere vs Earth radiance at $\rho = 1.0$

Fidelity Interval

Simplified

For a well behaved system,

$$\left(\frac{t \cdot s}{\hat{G}^{-1}}\right)^2 \left(\frac{1}{S_{LL}}\right) \approx 0, \tag{1}$$

and

$$L_{u,l} = \hat{L} \pm (t \cdot \hat{G} \cdot s) \sqrt{1 + \frac{1}{N \cdot R} + \frac{(\hat{L} - \bar{L})^2}{S_{LL}}} \tag{2}$$

Given the estimated radiance, $\hat{L}$, the calibration parameters, $\hat{G}$, s, ν, N, R, $\bar{L}$, and S_{LL}, and a confidence level, α, we can calculate the limits, L_u and L_l, within which we expect the true radiance to lie with probability α.

Keypoints

Uncertainty minimum for
* small Student t value (lower stated confidence level)
* smaller gain slope, $\hat{G}$
* lower system noise, s
* sufficiently large N, number of radiometric levels, and R, repetitions
* mean of calibration radiance levels, $\bar{L}$, close to that to be estimated
* large spread in calibration radiance levels, S_{LL}

Fidelity Intervals

Statistical determination

Consider the calibration equation

$$L_\lambda = G(DN - DN_o)$$

where

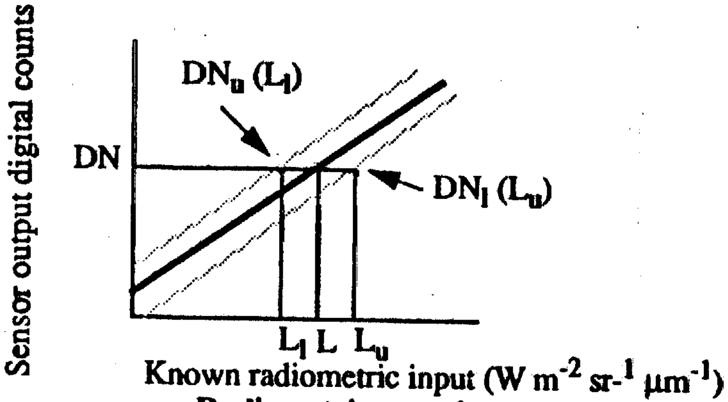
L_λ is the incoming spectral radiance incident on the entrance aperture, G is the gain coefficient in W m^{-2} sr^{-1} μm^{-1}, DN is the digital output counts when viewing a spectral radiance field, L_λ , DN_o is the digital counts when viewing a zero radiance field, and λ is wavelength.

A statistical determination of the coefficients G and DN_o will be made, along with their uncertainties, via an analyses such as that reported by
Barkstrom, Bruce R. Some thoughts on procedures for estimating measurement uncertainties in radiometric instruments. NASA Langley Research Center, September 1990.

C1-4

Example

These are the limits in radiance about the radiance estimated from the calibration regression, or the *fidelity intervals*



Radiometric transfer curve

On-Board Calibrator
(OBC)

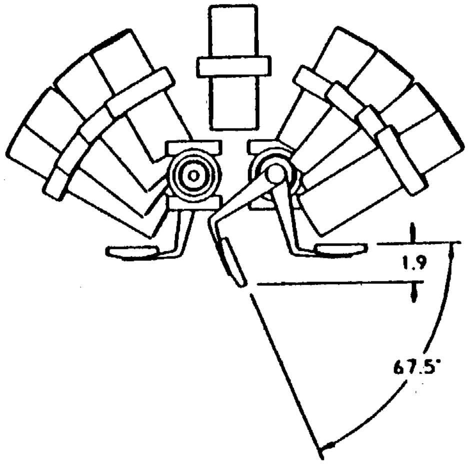
OBC elements

Two diffuse panels
- * deploy over the poles for solar reflection into the cameras

High QE diodes
- * assess panel stray-light/ shadowing
- * validate ground calibration
- * monitor panel degradation (initial post-launch)

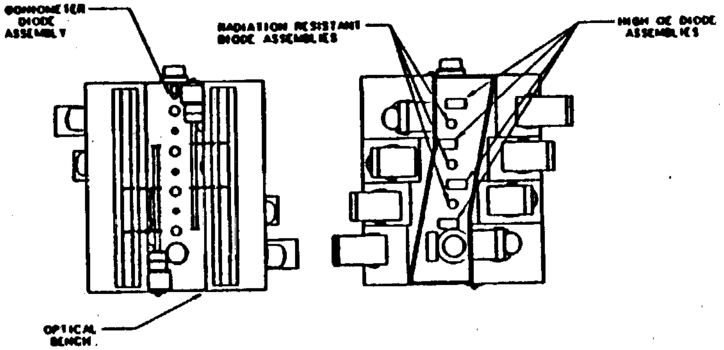
Radiation resistent diodes
- * improved stability over mission life
- * monitor panel degradation

Goniometer diode
- * angular characterization of diffuse panels using radiation resistent diodes

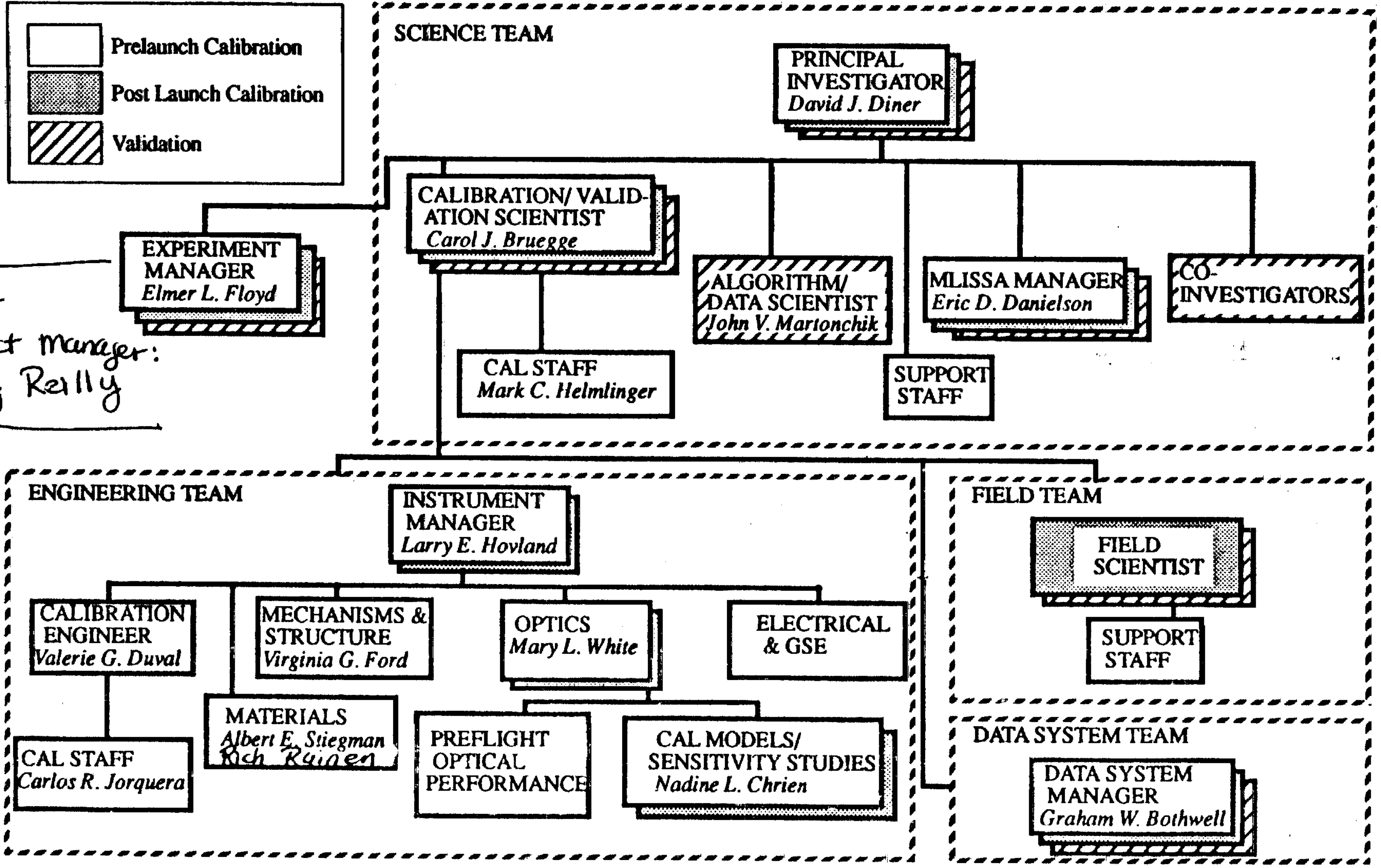


Utilization of OBC

Allows frequent (~monthly) calibrations
Calibrate the OBC during semi-annual ground calibration exercises



Calibration Support Team



- ☐ Prelaunch Calibration
- ▩ Post Launch Calibration
- ▨ Validation

2/92 -
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