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Space Environmental testing at GSFC

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Solar Absorptance measurements (α)

- **AZ-Tek LPSR-300**
  - **Total hemispherical reflectance**
  - **250nm-2800nm**
  - **1” dia samples**

LPSR-300

- **Perkin-Elmer Lambda-19**
  - **Total hemispherical Reflectance**
  - **250-2500nm**
  - **Center/side mount integrating sphere**

$$\alpha(\theta) = 1 - \frac{\int_0^\infty R(\lambda,\theta)S(\lambda)d\lambda}{\int_0^\infty S(\lambda)d\lambda}$$

Lambda-19

Solar Absorptance measurements (α)

- **New Instrumentation (coming soon)**
- **Cary 5000**
  - **200-2500nm**
  - **Diffuse Reflectance Attachment**

Emittance measurements (ε_n ε_H)

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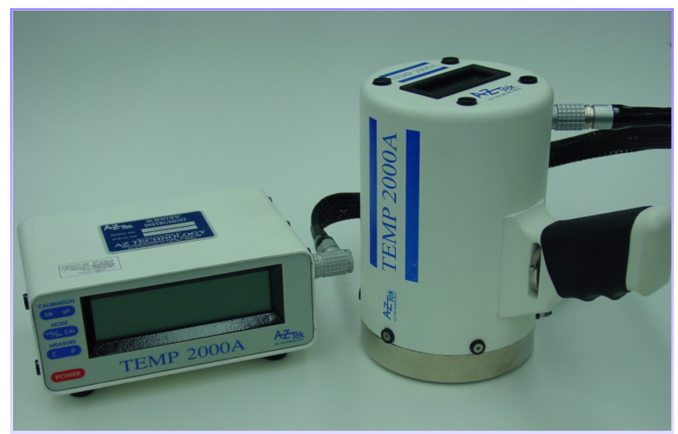
- **Gier-Dunkel DB-100**
  - **IR reflectance 4-40µm**
  - **1” dia samples**
  - **Must be grey & Lambertian**

- **Az-Tek Temp 2000A**
  - **IR Reflectance 3-35µm**
  - **Normal & Hemispherical emittance**
  - **Must be grey & Lambertian**



Emittance measurements (ε_n ε_H)

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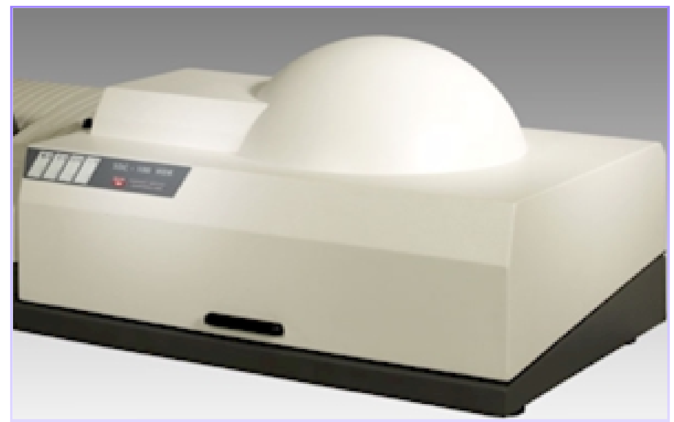
Nicolet Magna 760 FTIR

Transmittance 2-30µm

SOC-100 Hemispherical Directional Reflectometer

Nicolet FTIR



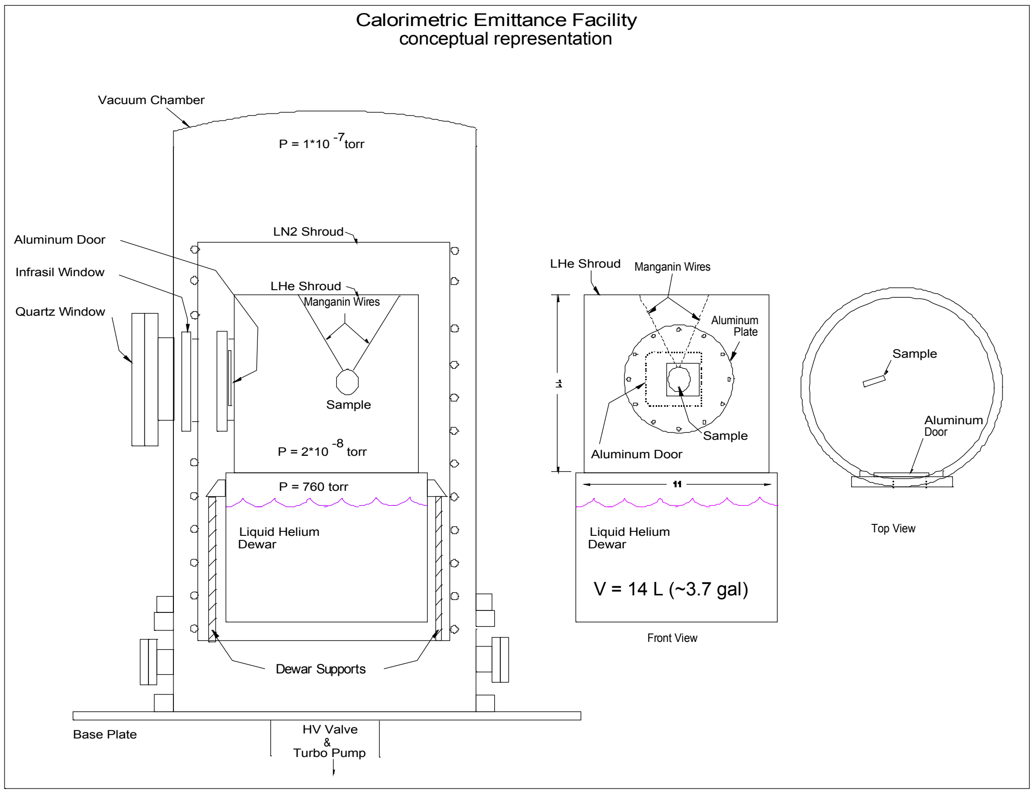
SOC-100

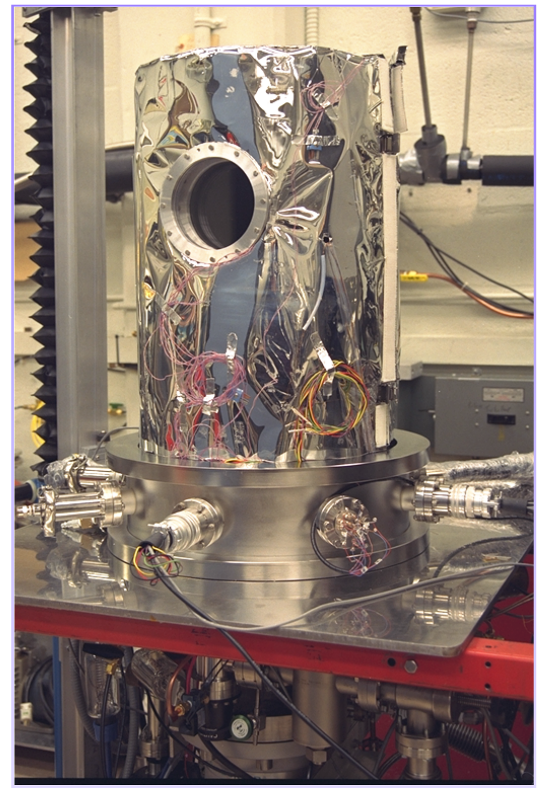
$$\varepsilon_T(\theta,\phi,\lambda) = 1 - \frac{\int_0^{\pi/2}\int_0^{\pi/2}\int_0^{\infty} \rho(\theta,\phi,\lambda)\frac{8\pi hc}{\lambda^5\left(e^{hc/\lambda Tk}-1\right)}\,d\lambda\, d\phi\, d\theta}{\int_0^{\infty}\frac{8\pi hc}{\lambda^5\left(e^{hc/\lambda Tk}-1\right)}}$$

$$\varepsilon_h = 2\int_0^{\pi/2} \varepsilon_t(\theta,\phi,\lambda)\sin(\theta)\cos(\theta)\,d\theta$$

Transient Calorimetric Technique ε_H

- **Total hemispherical emittance from 30°K - 350°K**
- **Vacuum: < 3×10^{-7} torr**
- **Sample Size: 1.5" dia A1100 Aluminum with embedded Silicon Diode Sensor**





Calorimetric Facility

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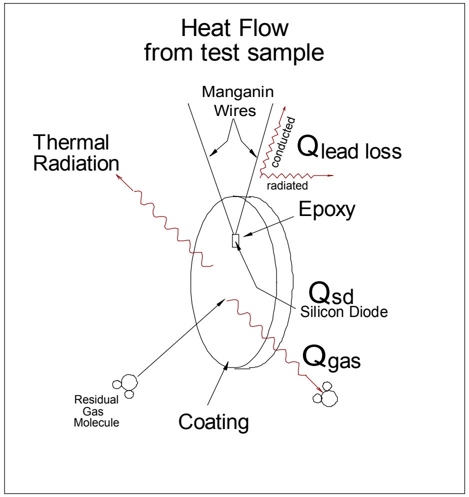
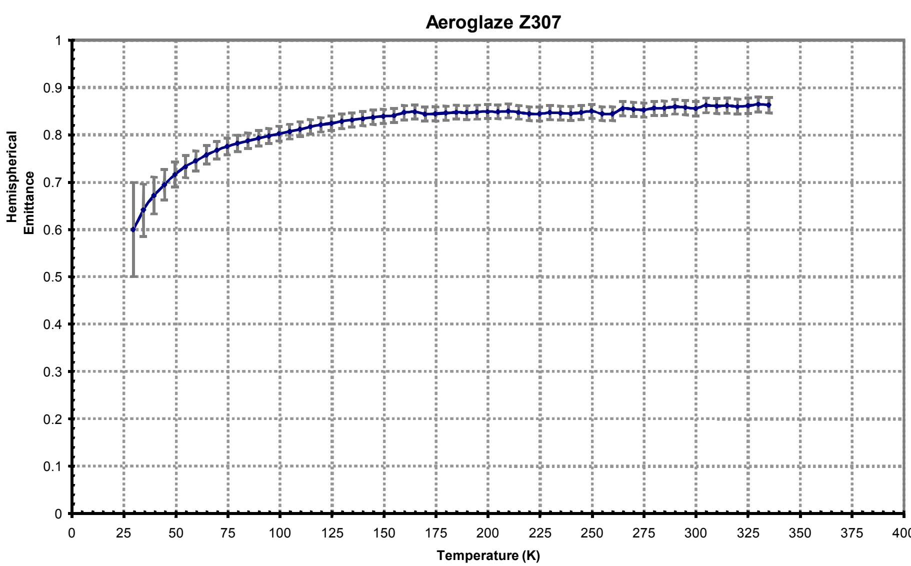
Transient Calorimetric Technique ε_H



$$\varepsilon_h = \frac{-mCp\dfrac{\Delta T}{\Delta t} - m_c Cp_c \dfrac{\Delta T}{\Delta t} - Q_{tc} - Q_{gas} + Q_{sd} + a\varepsilon(Ts)\sigma Ts^4}{a\sigma T^4}$$

Where:

- σ : Stefan-Boltzmann constant
- Cp : specific heat of substrate
- Δt : time increment
- Cp_c : specific heat of coating
- Q_{tc} : residual gas heat loss
- a : surface area of coating
- Ts : temperature of shroud of the shroud
- m : mass of the Aluminum substrate
- ΔT : temperature increment
- m_c : mass of coating
- Q_{tc} : manganin supports wires heat loss
- Q_{sd} : heat input from silicon diode
- T : temperature of substrate
- $\varepsilon(Ts)$: coating emittance at the temperature



Electrostatic charge testing

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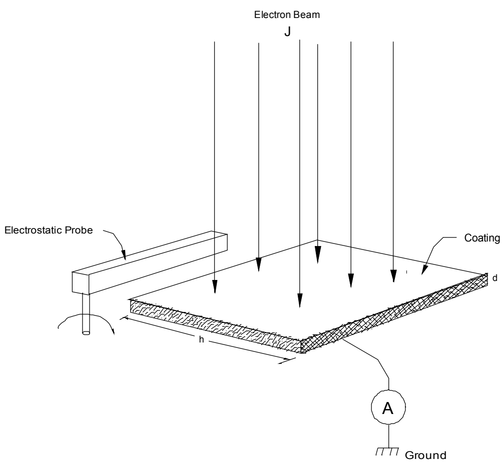
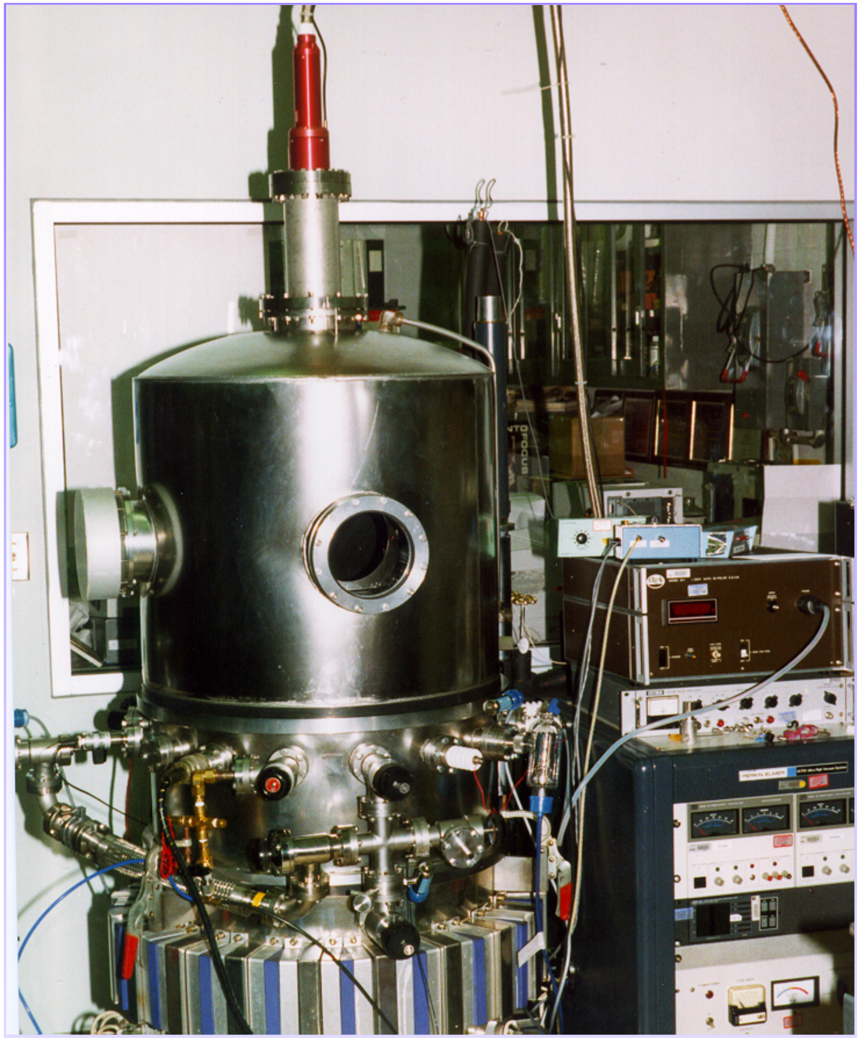
- Simulates Space charge Environment
- Sample size: 6x6 inch
- Temperature Range: -150˚C to +100˚C
- Electron Energy: 500eV- 20KeV
- Kimball physics EFG-9
- Beam Current: 10nA/cm^2
- Contactless Electrostatic probe
  - Trek 341B: 0-10Kv
- Coating Electrical Conductivity





Electrostatic Test Chamber

UV degradation testing

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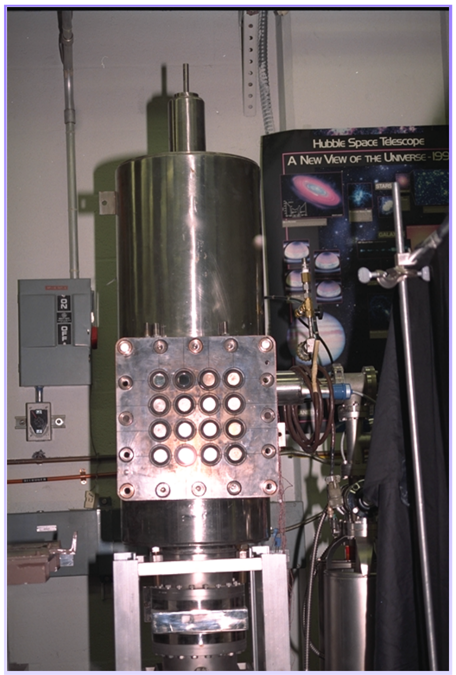
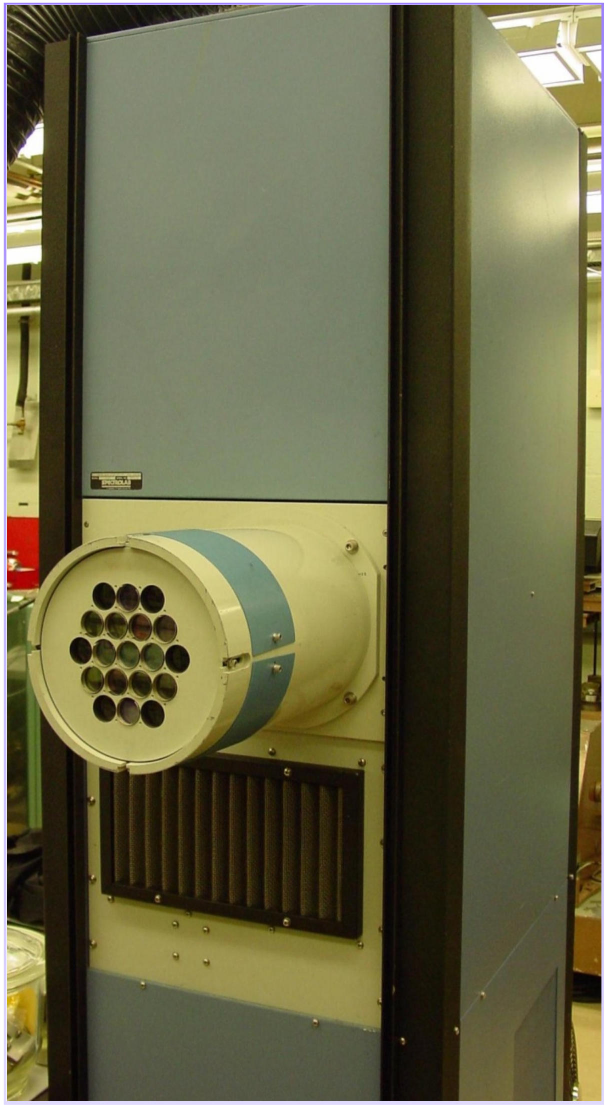
- 14 samples 1” dia, plus one reference
- 0.5 – 2 equivalent suns (250-3000nm)
- Water cooled samples
- In-situ relative reflectance measurements
- Degradation as a function of UV exposure
  - 250-2400nm



Mulitsedes System



Spectrolab X25 Solar Simulator

UV degradation Testing

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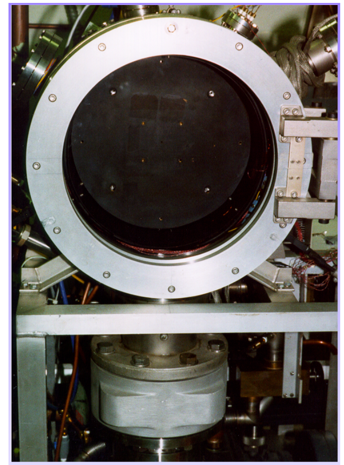
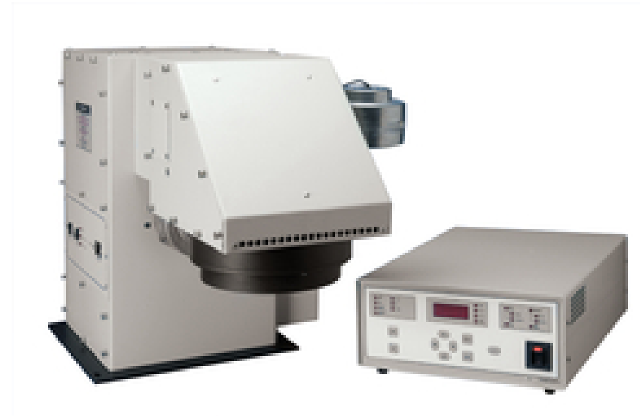
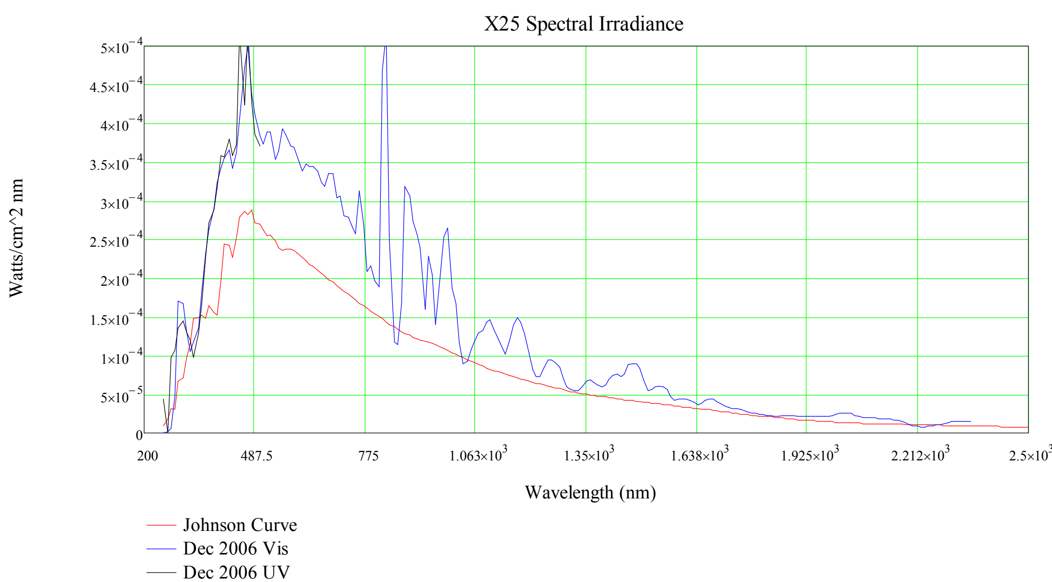
- **Sample size: 8”x8” max**
- **UV grade quartz window**
- **Solar Simulation 0.5 – 2 suns**
- **Reflectance measured externally**



Leybold Vacuum Chamber



Oriel 1600W



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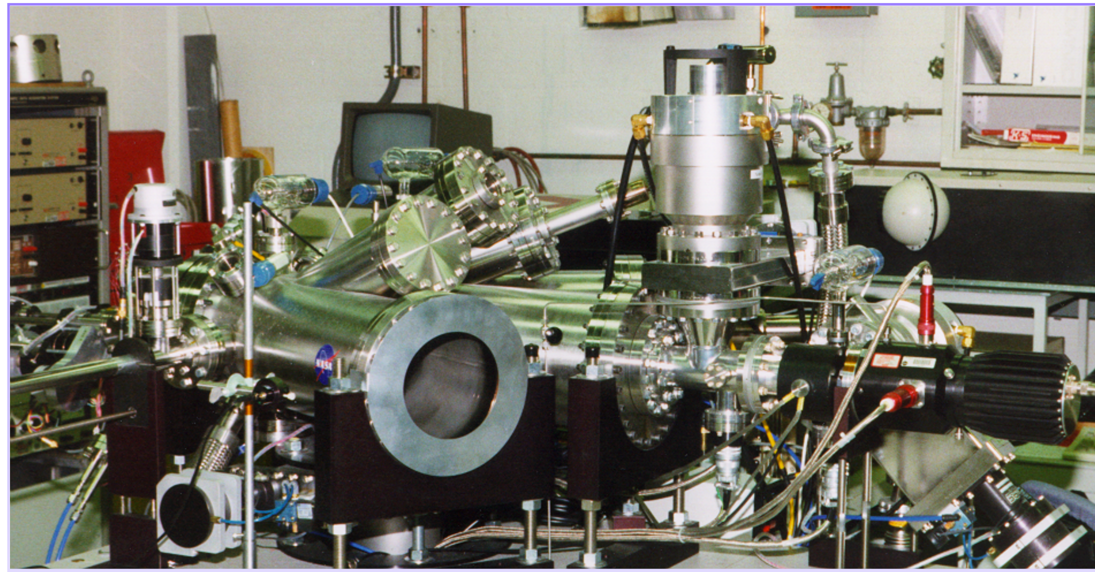
Solar Wind Facility

- Simulation of low energy p^+ , e^- & UV at the GEO environment

- Proton Beam
  - Kimball Physics IMG-31
  - 2KeV –5 KeV
  - 1.0nA/cm^2 (6x10^{9}p$^+$/s-cm^2)



- Electron Beam
  - Kimball Physics EFG-9
  - 500eV 20KeV
  - 10nA/cm^2

- Full Spectrum Solar Simulation
  0.5 – 2.0 equivalent suns

- In-situ absolute reflectance measurements
  - 12 samples
  - Lambda 9 plus center mount vacuum integrating sphere
  - 250nm – 2200nm

Solar Wind Facility

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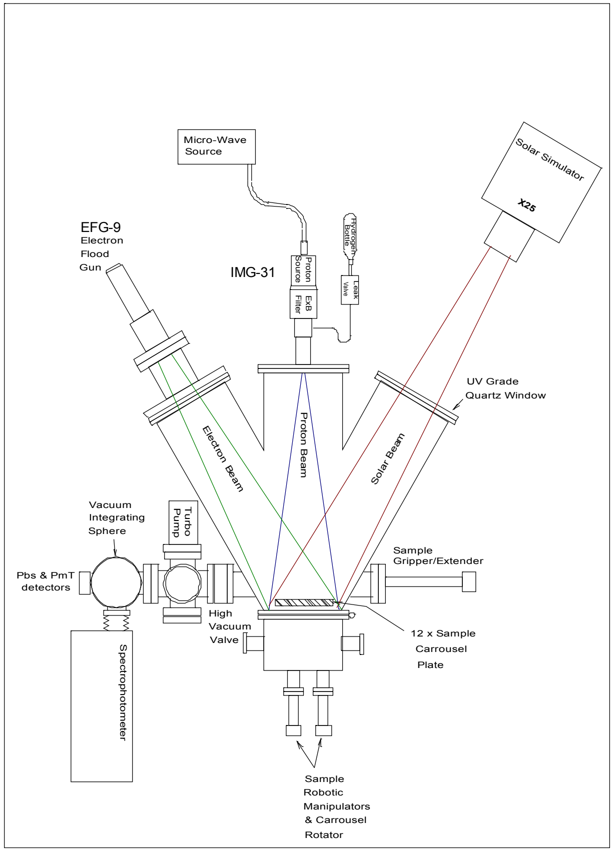
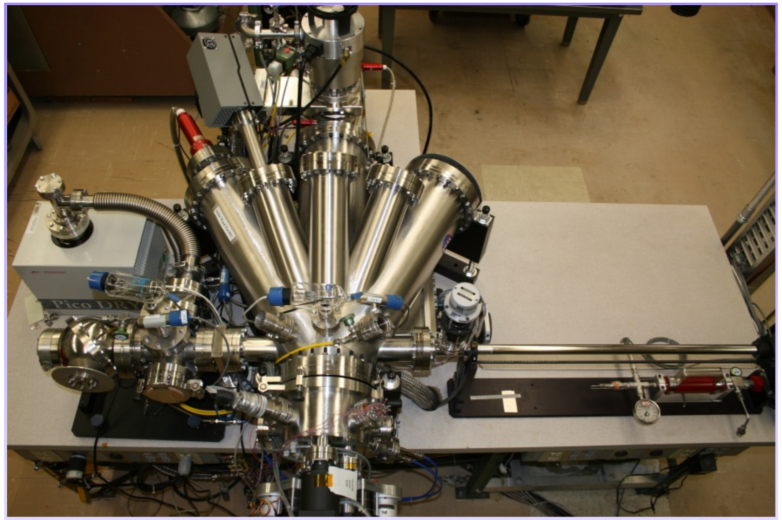


Solar Wind Facility Conceptual



Solar Wind Facility Vac Chamber

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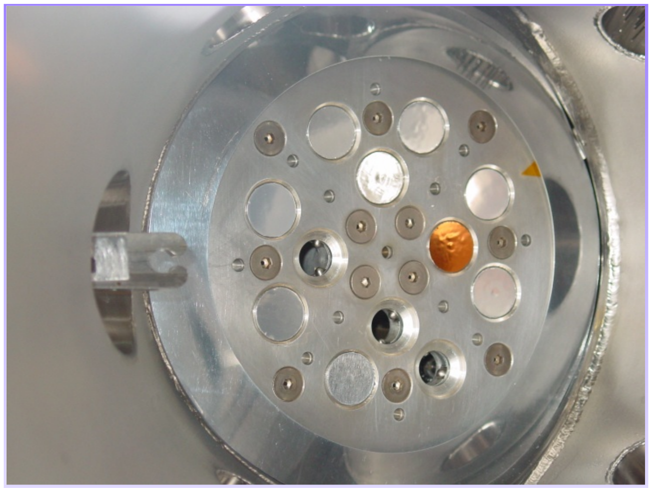
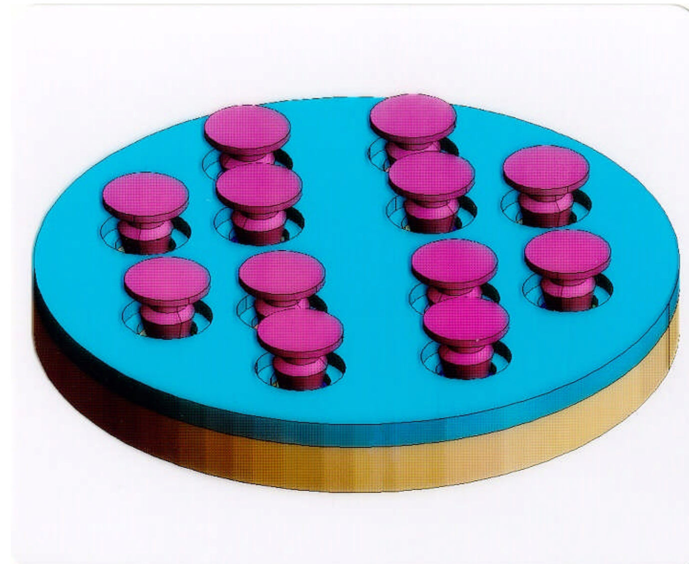
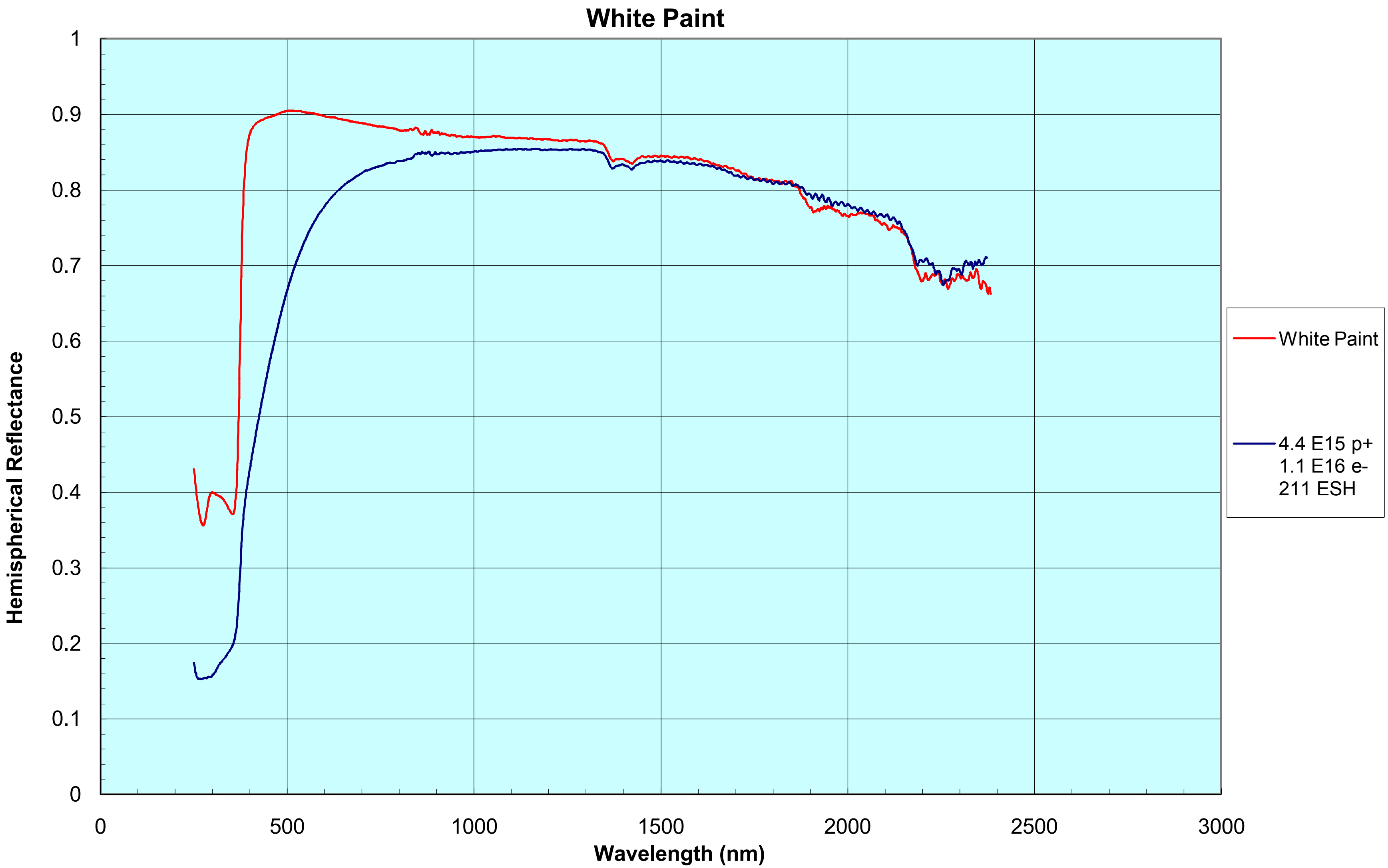
Solar Wind testing

Solar Wind Sample Carousel





Solar Wind testing



Thermal Coatings Committee

- BOL & EOL for thermal control coatings properties
- Based on environmental testing and flight data
- Committee Members: Lon Kauder
  Jack Triolo
  Ted Michalek
  Mark Hasagawa
  Ray Levesque
  Wanda Peters