Surface Optics Corporation Protected Silver Coatings For Large Optics

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Large Optics & Silver Coatings

- SOC's method for coating large optics
  - E-beam evaporation
  - Deposition source on movable stage
  - Ion assisted deposition (IAD)
    - Reactive compounds (nitrides, oxides)
    - High density coatings
- Silver coatings
  - LLNL patented silver coating (based on sputtering)

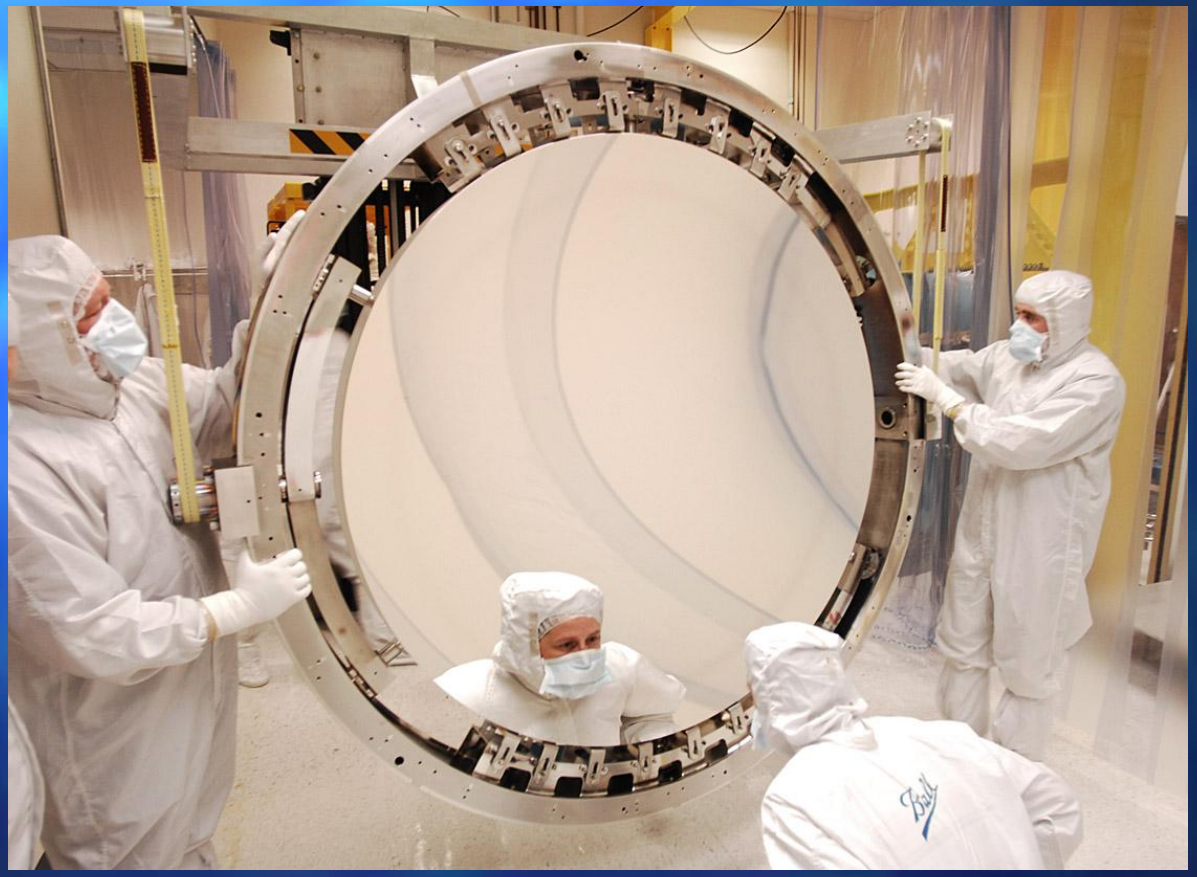
Government Funded R&D Mirror Coating Projects at SOC

- AFRL - $850k; High-Energy Laser Coatings On Polymer Membranes
- NASA - $700k; Non-Tarnishing Silver for Space Telescopes
- MDA - $1.1M; X-Ray Hardened Mirror Coatings for Missile Interceptors
- NASA – $170k Large Optical Mirror-Filter for Laser Communication
- Thick Silicon Cladding For Optical Finishing ($400k)

Examples of SOC Space Flight Coatings

- Kepler Space Telescope Primary Mirror (1.5-m)
- M^3 (Moon Mineralogy Mapper)
- Cloud Sat (2-meter RF Reflector)
- WMAP Reflector (Microwave Anisotropy Probe)
- EchoStar (6, 3-meter reflectors)
- Chandra Observatory (collimator plates)

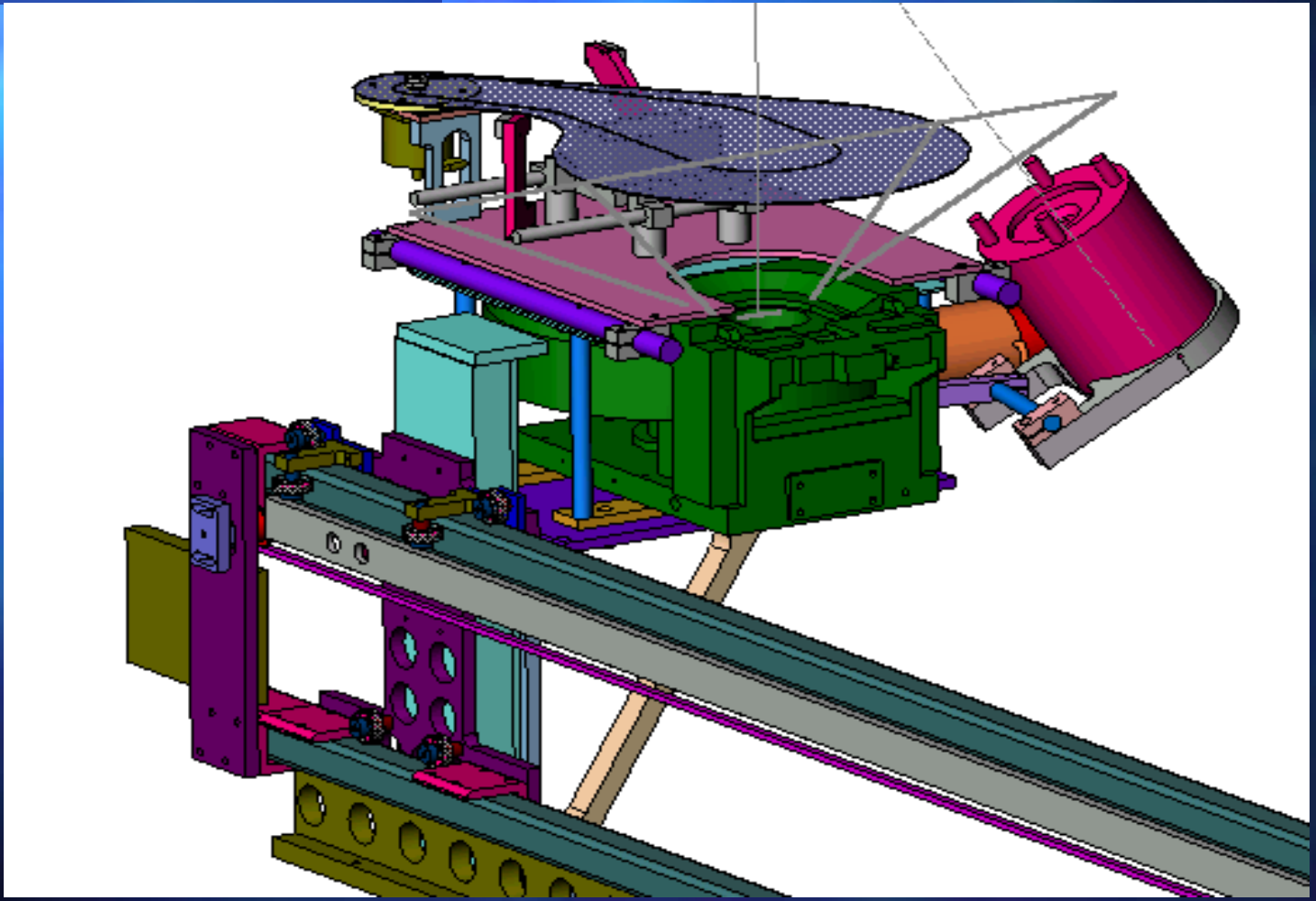
Kepler Primary Mirror



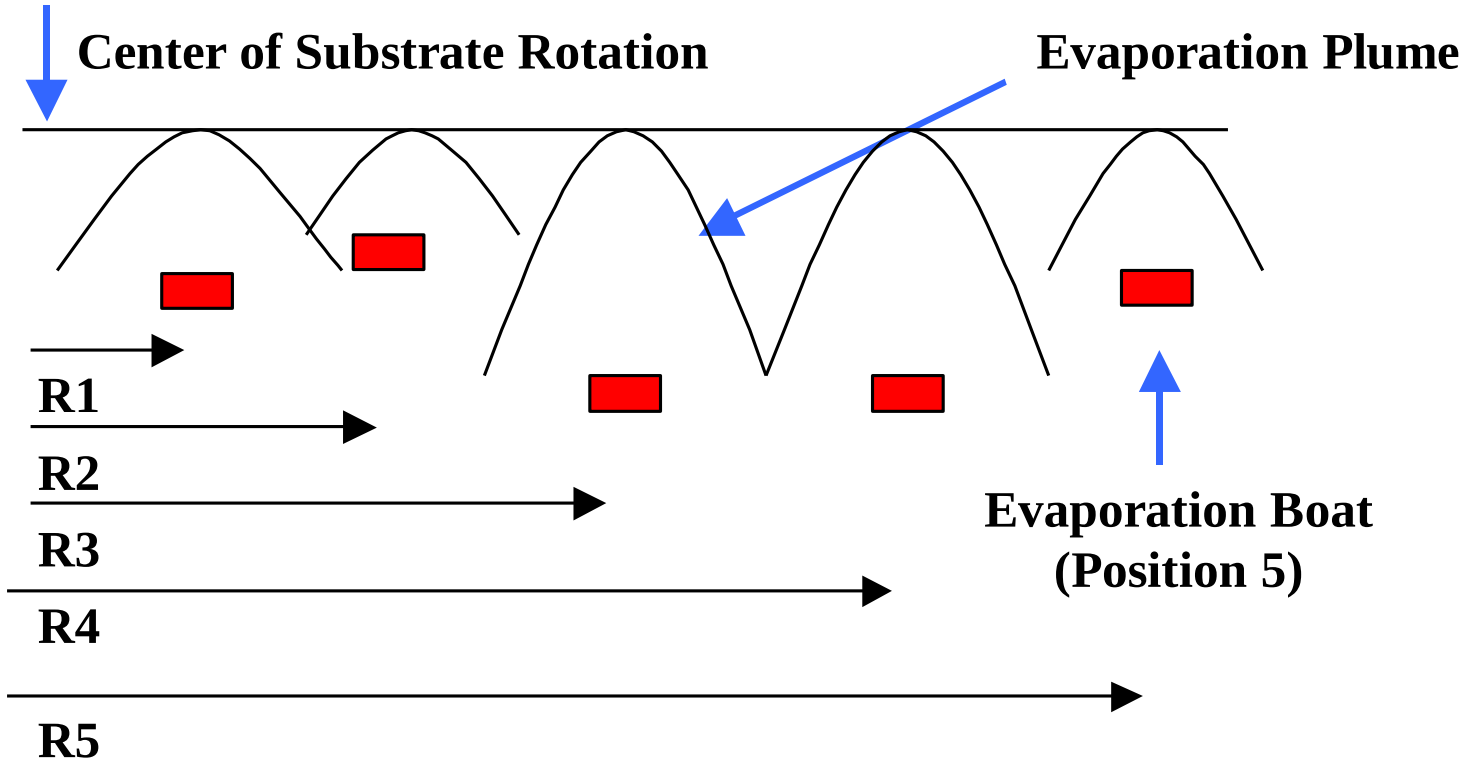
Kepler Mirror – Inspection

SOC's 3.3-meter Vacuum Chamber

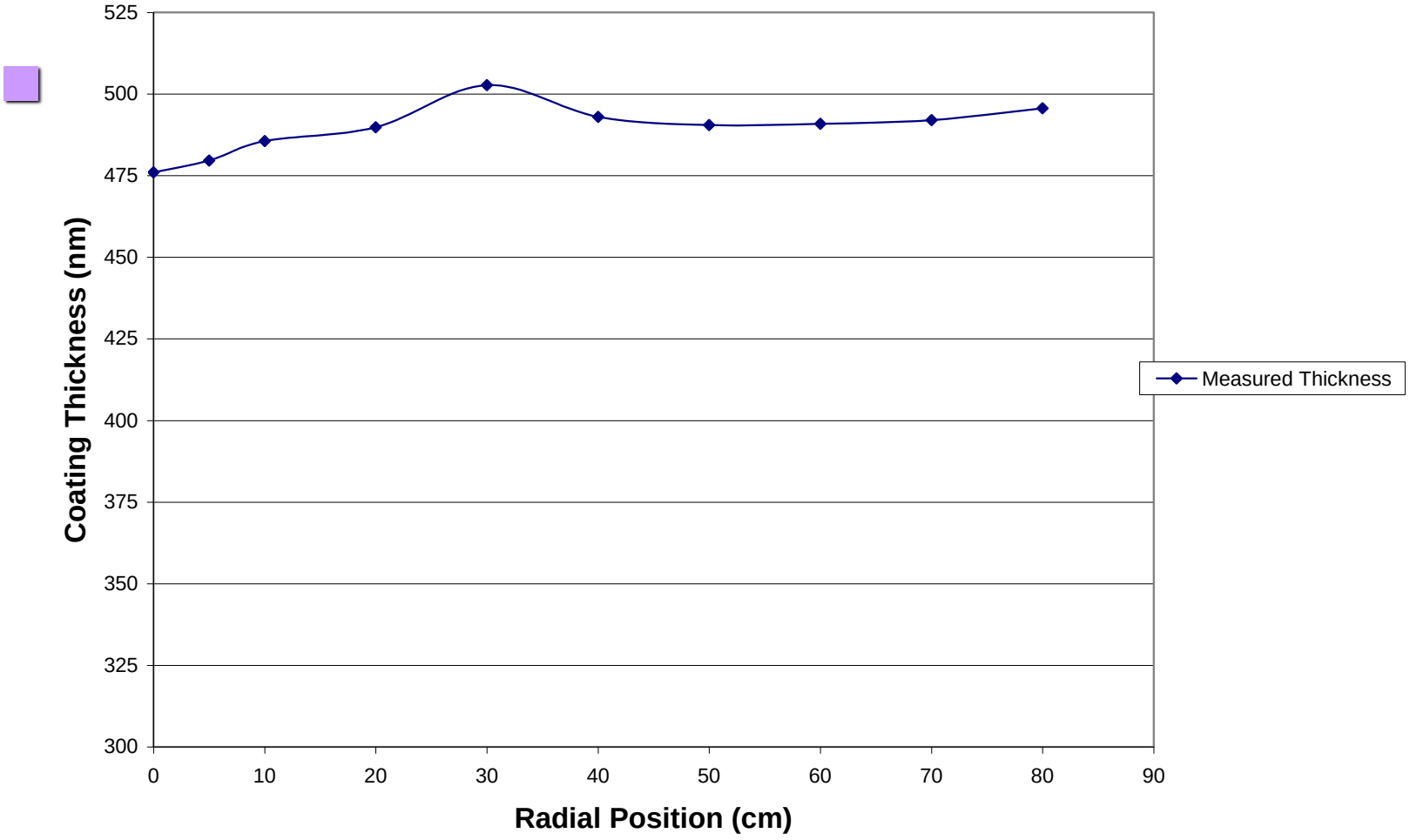
Electron Gun & IAD Platform



Coating Approach - ~30 plume positions, 3-cm steps



Coating Uniformity



LLNL & Kepler Coating Design

Basic Protected Silver

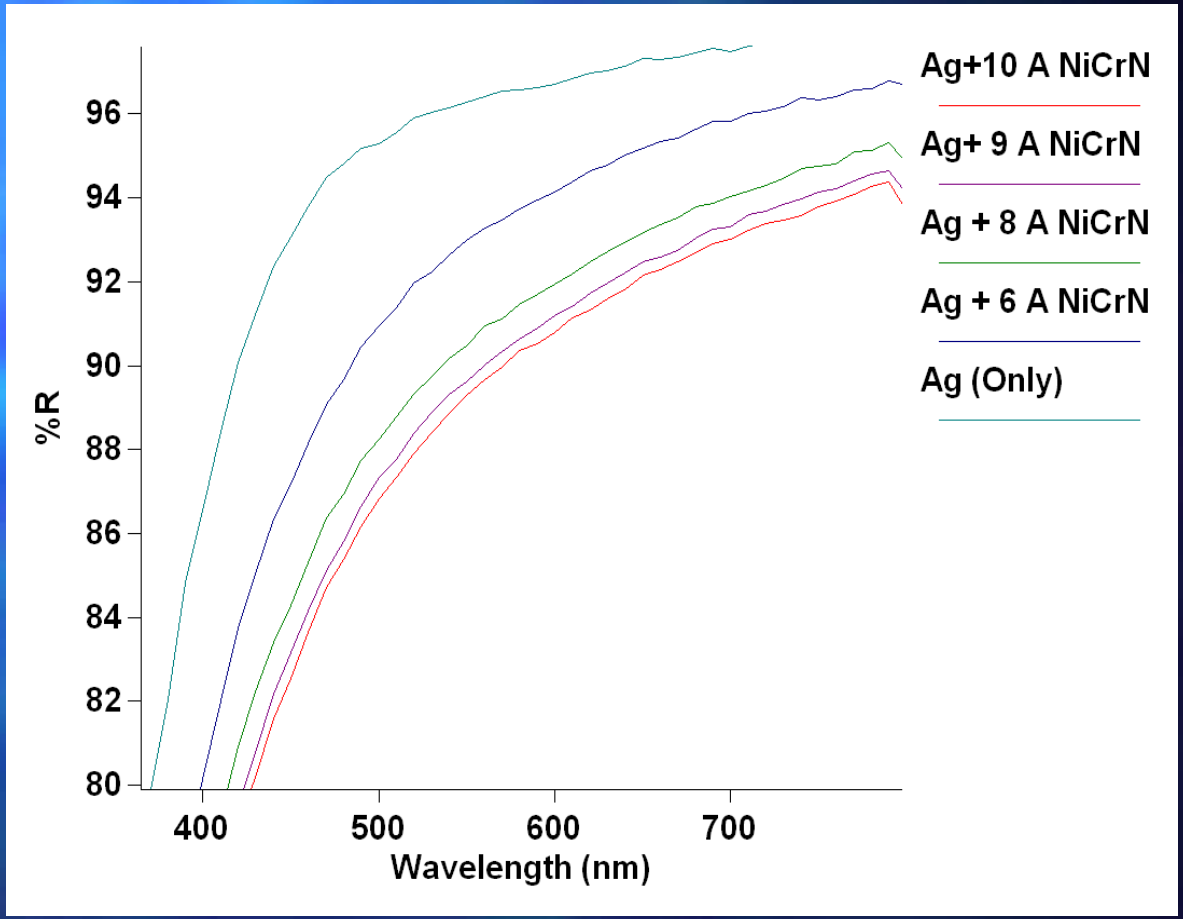
Si_3N_4
$Ni\text{-}CrN_x$
Ag
$Ni\text{-}CrN_x$
Mirror Surface

Protected & Enhanced

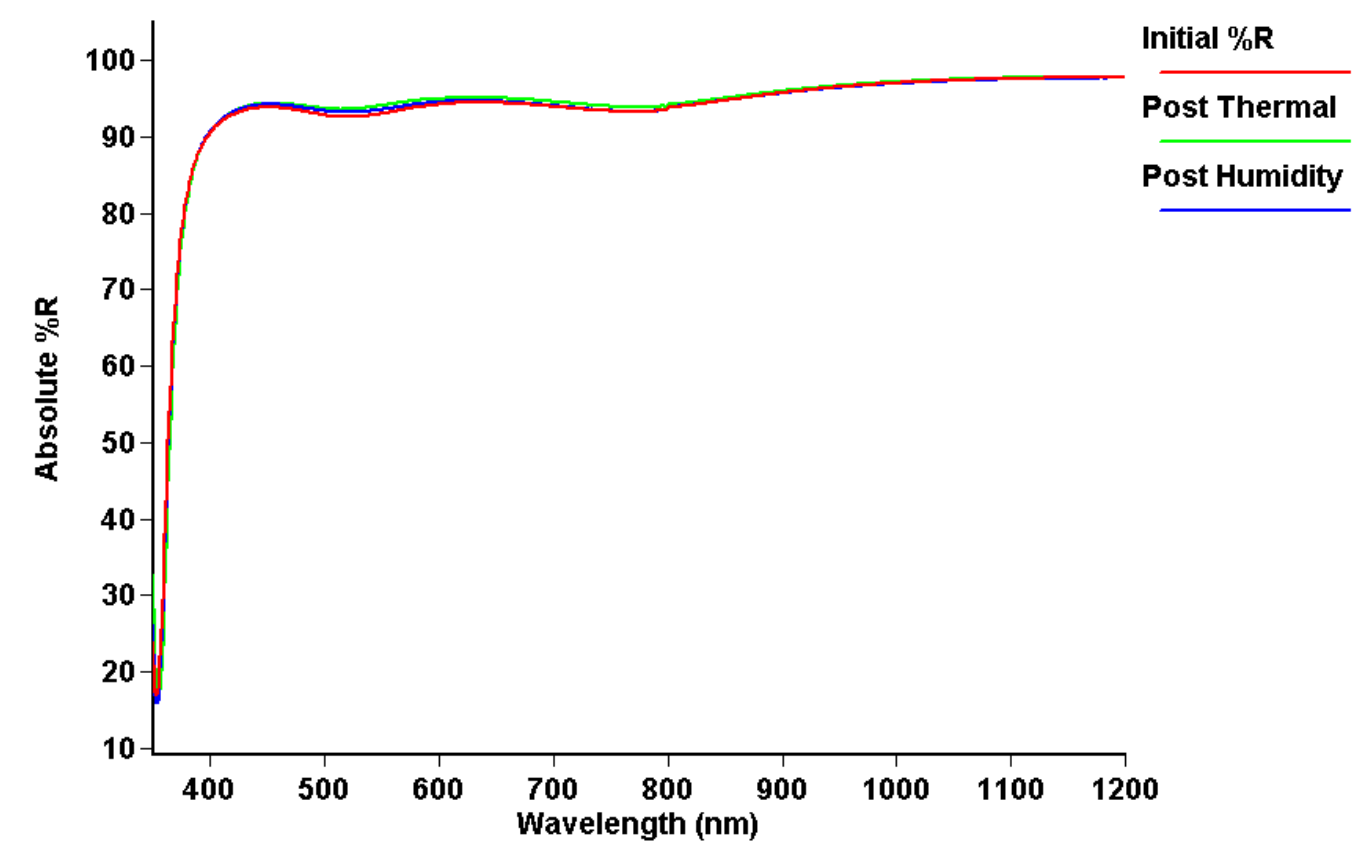
L-Oxide	Reflection Enhancement
H-Oxide	
L-Oxide	
H-Oxide	
L-Oxide	
Si_3N_4	Protected Ag
$Ni\text{-}CrN_x$	
Ag	
$Ni\text{-}CrN_x$	
Mirror Surface	

Nickel Chromium Nitride

- Thickness is critical for durability
- Thickness is difficult to control over large area
- Highly absorbing in blue and UV

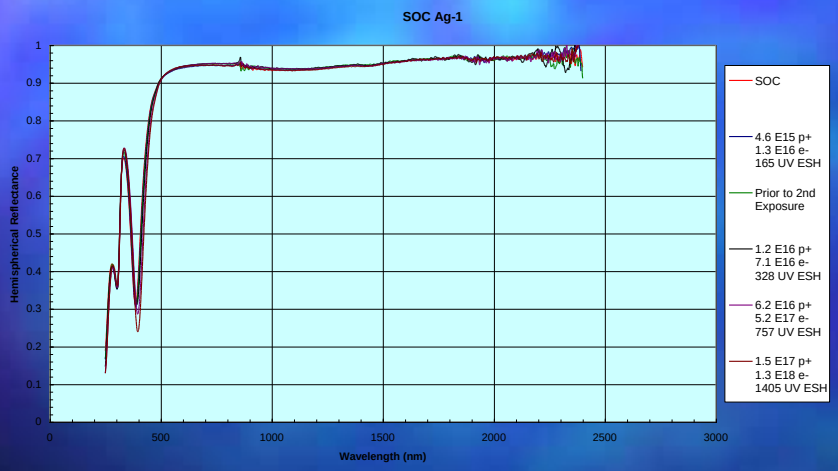


Enhanced Silver Reflectivity

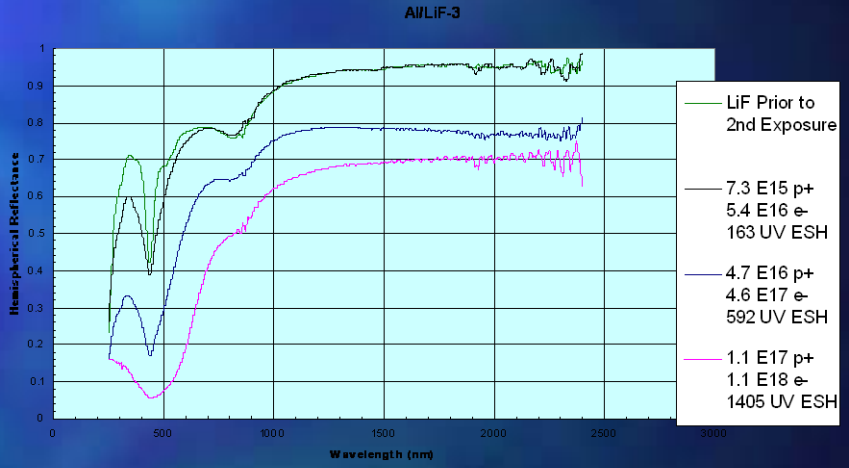


Space Radiation Test (GEO)

SOC - Silver Coating



LiF Standard



Limitations of Coating Design and Coating Method

- Hard to control thickness of NiCrNx over large area
- Too much NiCrNx leads to low reflectivity and too little leads to poor durability
- LLNL design requires exceptionally good vacuum
- SOC's coating method currently limited to optics less than 1,500 lbs
- Top loading system is awkward
- SOC's coating method points up and not down