Optical & Environmental Performance of Durable Silver Mirror Coatings Fabricated at LLNL

Presented to the Mirror Days
Huntsville 2004

Jesse Wolfe and Dave Sanders

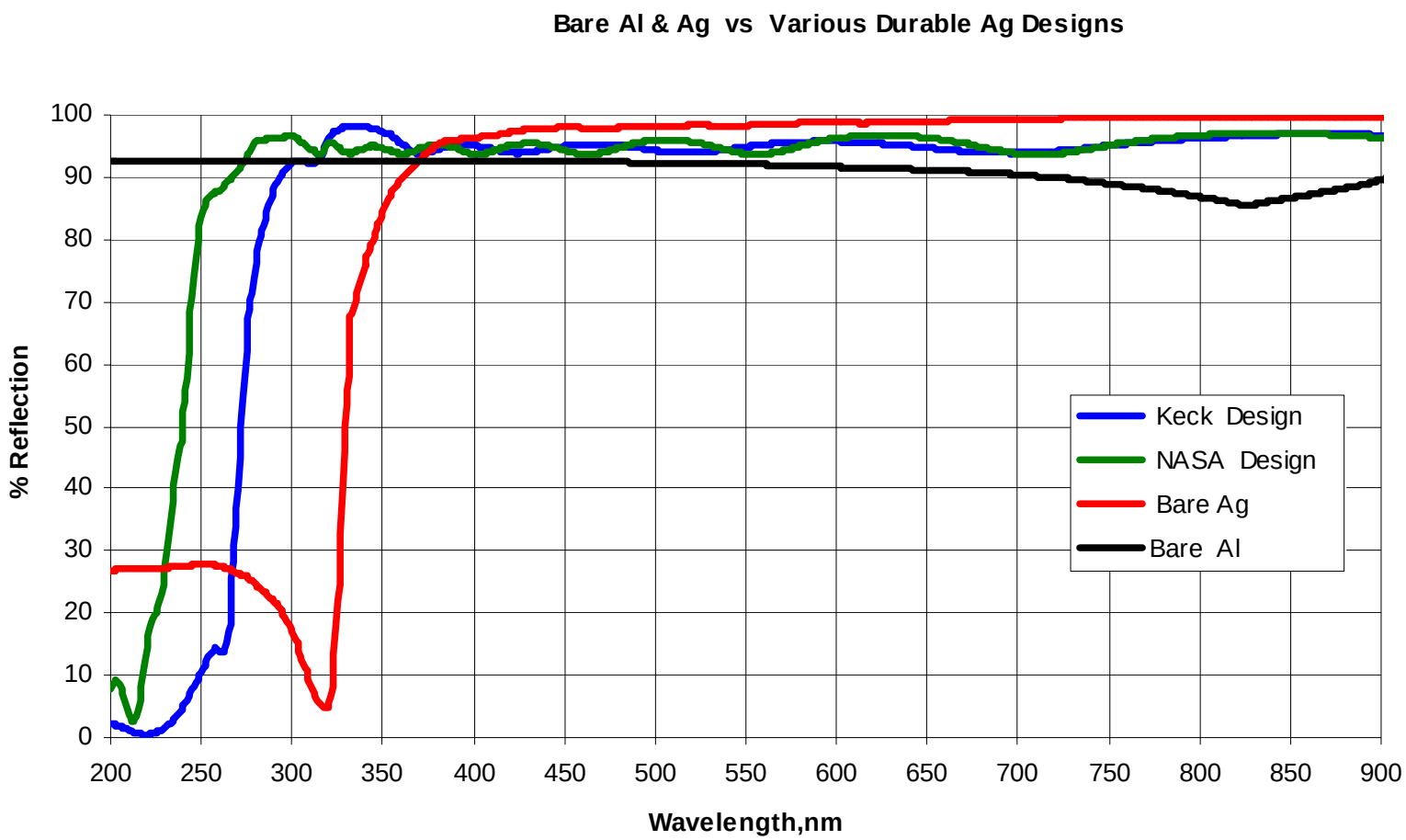
Lawrence Livermore Laboratory

Currently Used Silver and Aluminum Coatings Have Inadequate Durability. LLNL Has Developed a More Durable Coating.

Degraded Aluminum after 1.5 years

LLNL Protected Silver after 1.5 years

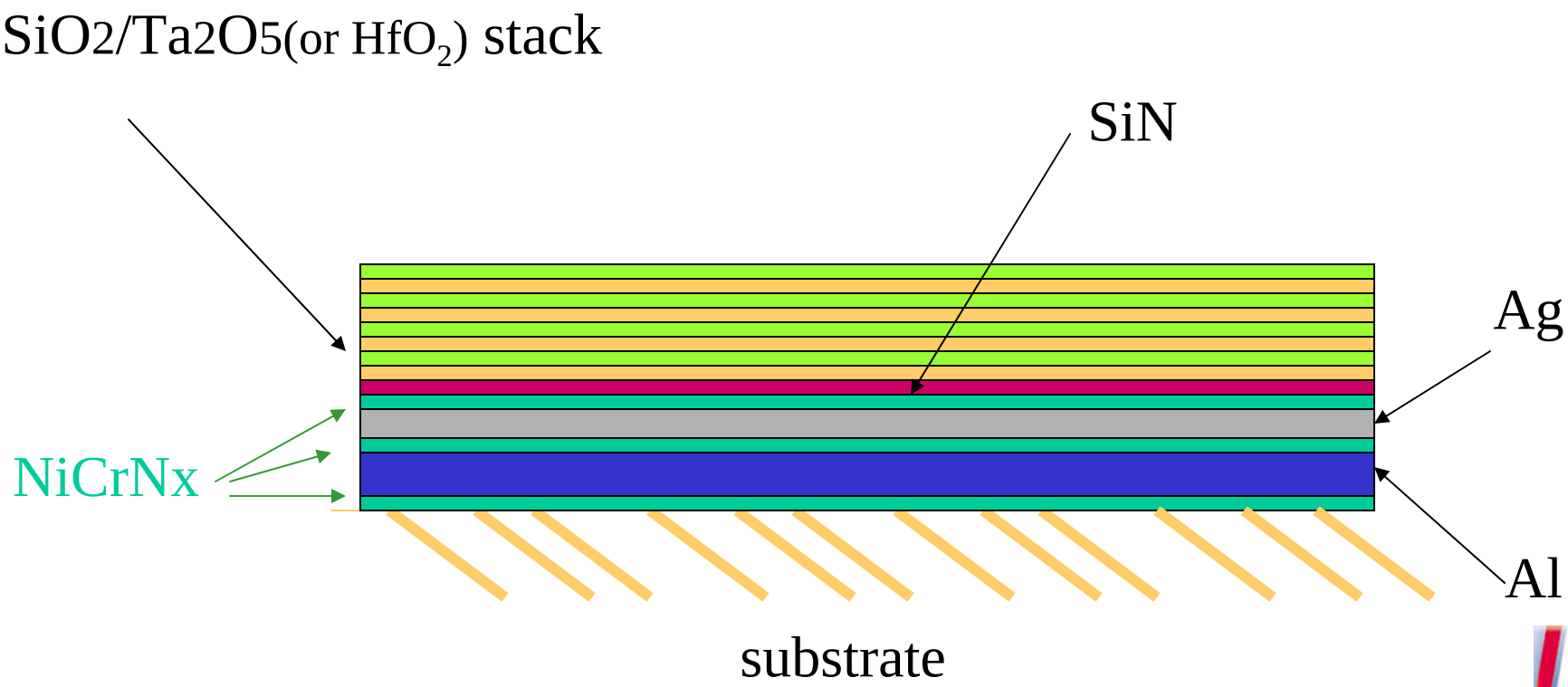
Comparison of Mirror Coatings



Proposed Solution: Durable Silver

- Based on low emissivity window coatings
- Further developed for NIF mirrors
- Fabricated using:
  - Low pressure/ long throw
  - Pulsed DC magnetron sputtering
  - Uniformity modeling program
  - Financial necessity required development of ability to coat larger substrates with smaller sources

Coatings Are Formulated for Specific Applications

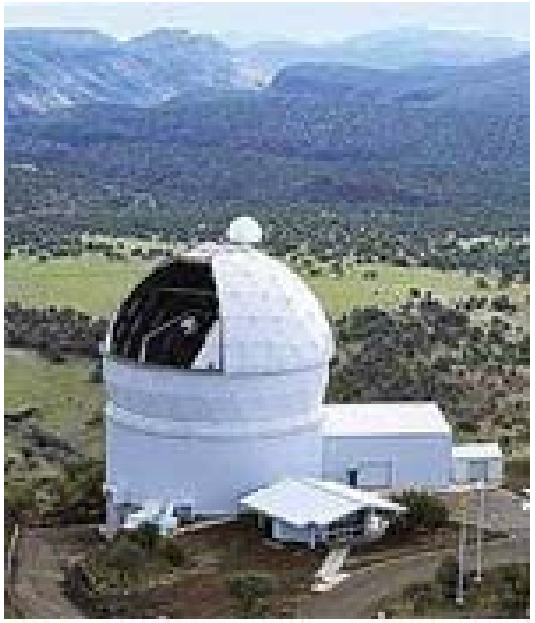


Our Current Coating Chamber 4’ x 4’ x 5’

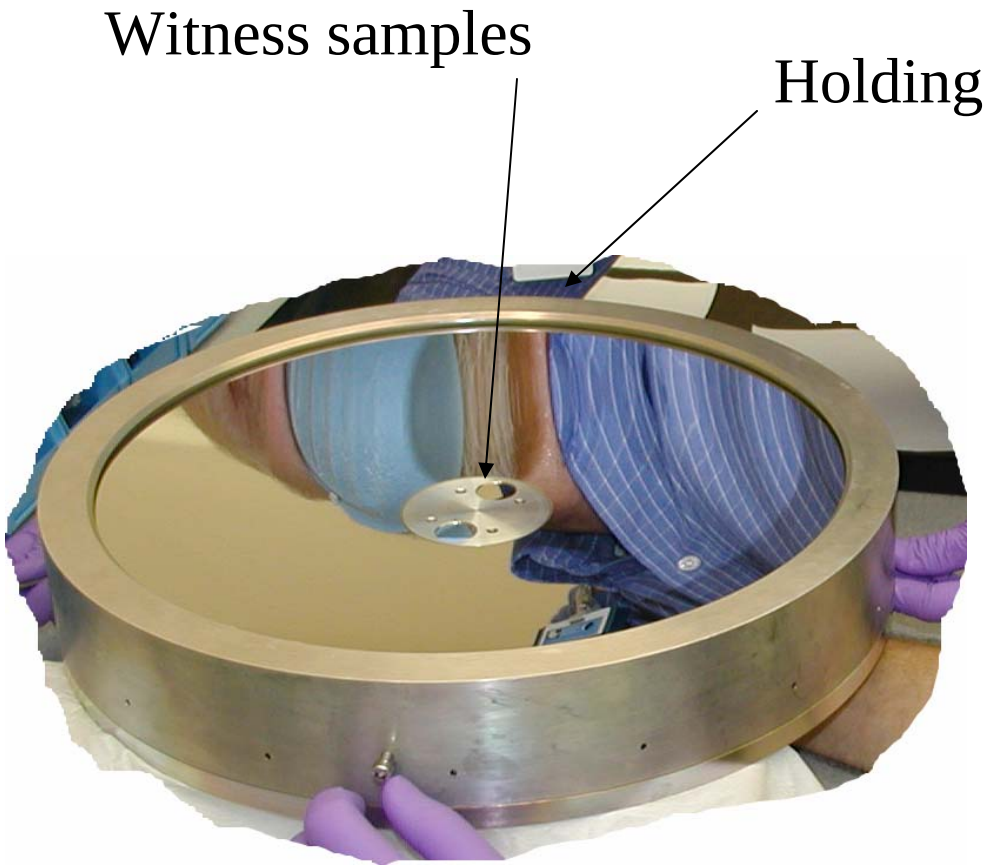
Experience

- National Ignition Facility
- Keck Telescope
- NASA / Lockheed (International Space Station)
- South African Large Telescope (S.A.L.T.)
- Hobby-Eberly Telescope (H.E.T)
- Las Campanas
- Smithsonian/Harvard
- L.S.S.T.

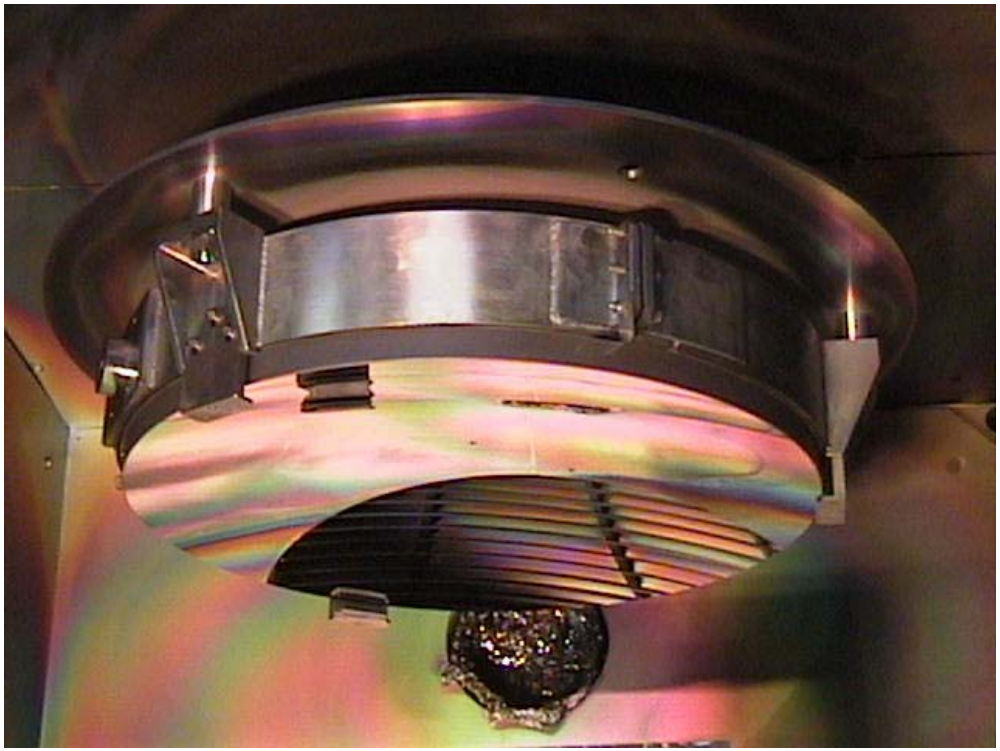
23” Diameter HET Mirror After Coating While Still in Holding Fixture

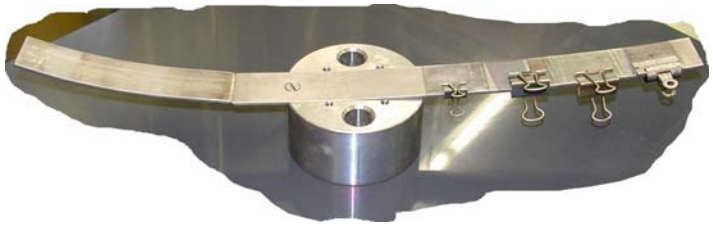


The HET at Mount Fowlkes

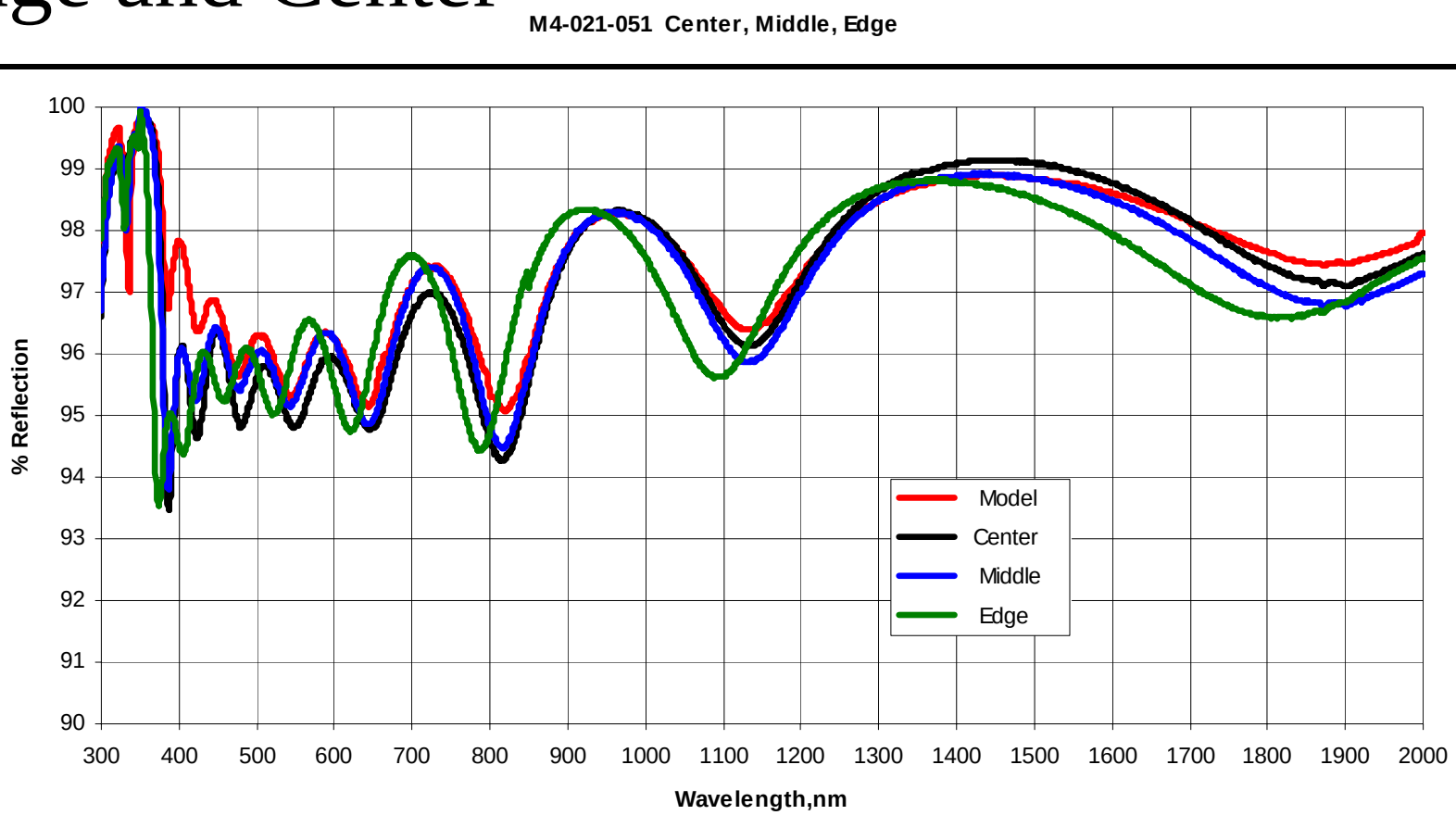


Coatings Can Be Applied Uniformly to Curved Surfaces

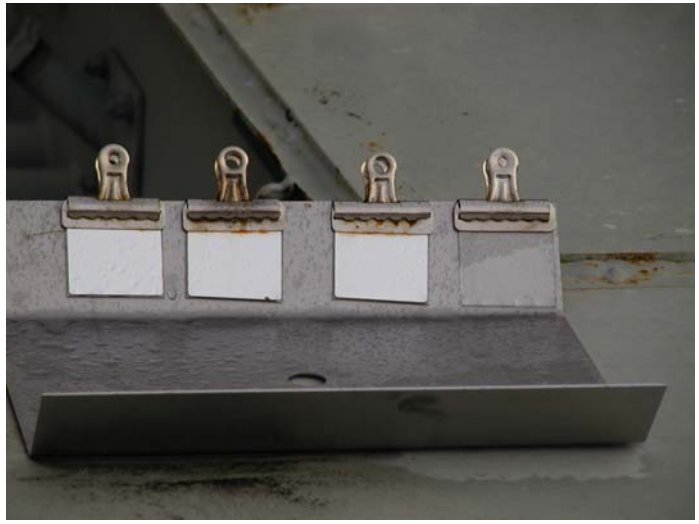




3% Thickness Uniformity Was Achieved With 2.5” Difference in Height Between Edge and Center

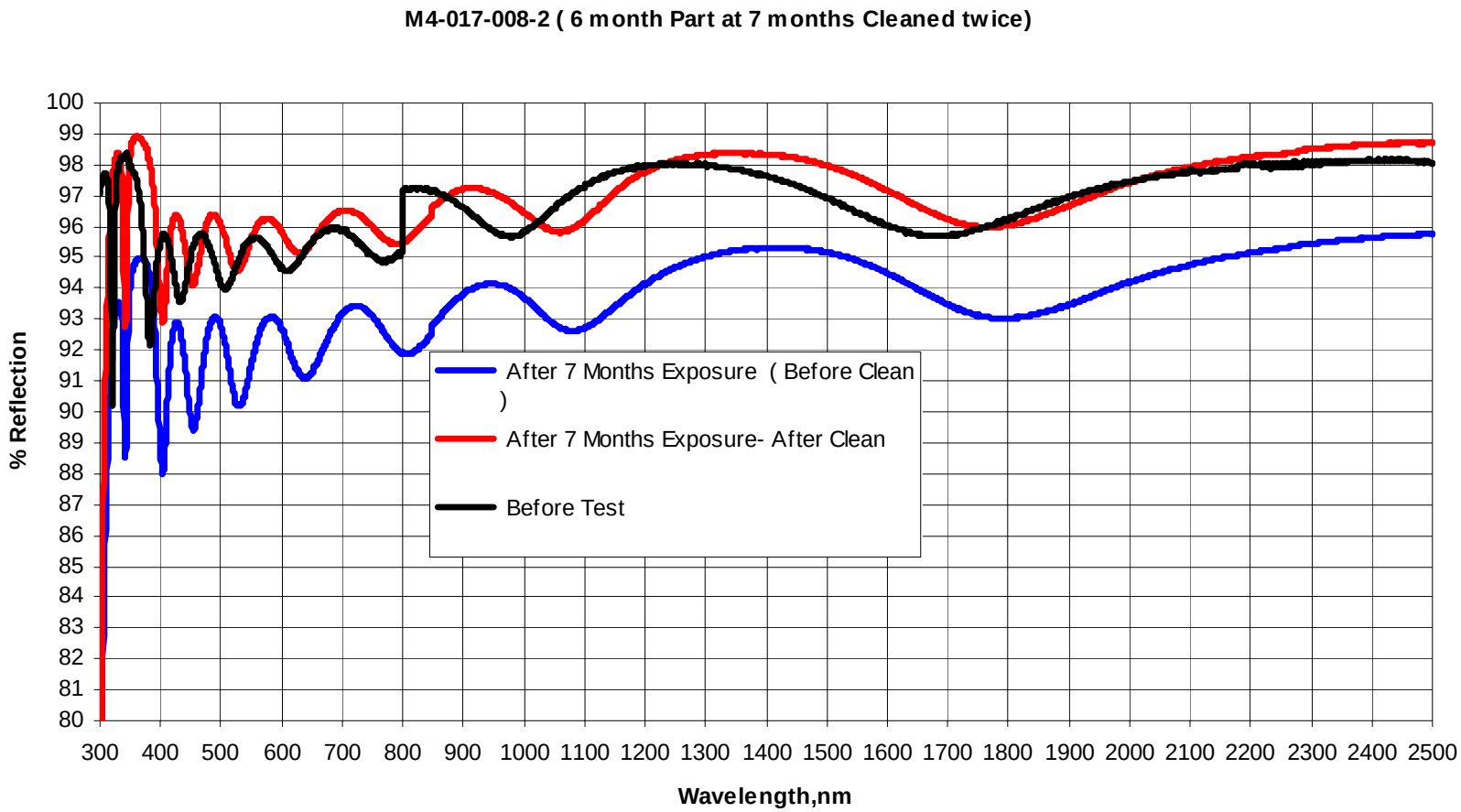


Our Accelerated Test Environment Is More Severe Than Most Actual Use Situations.

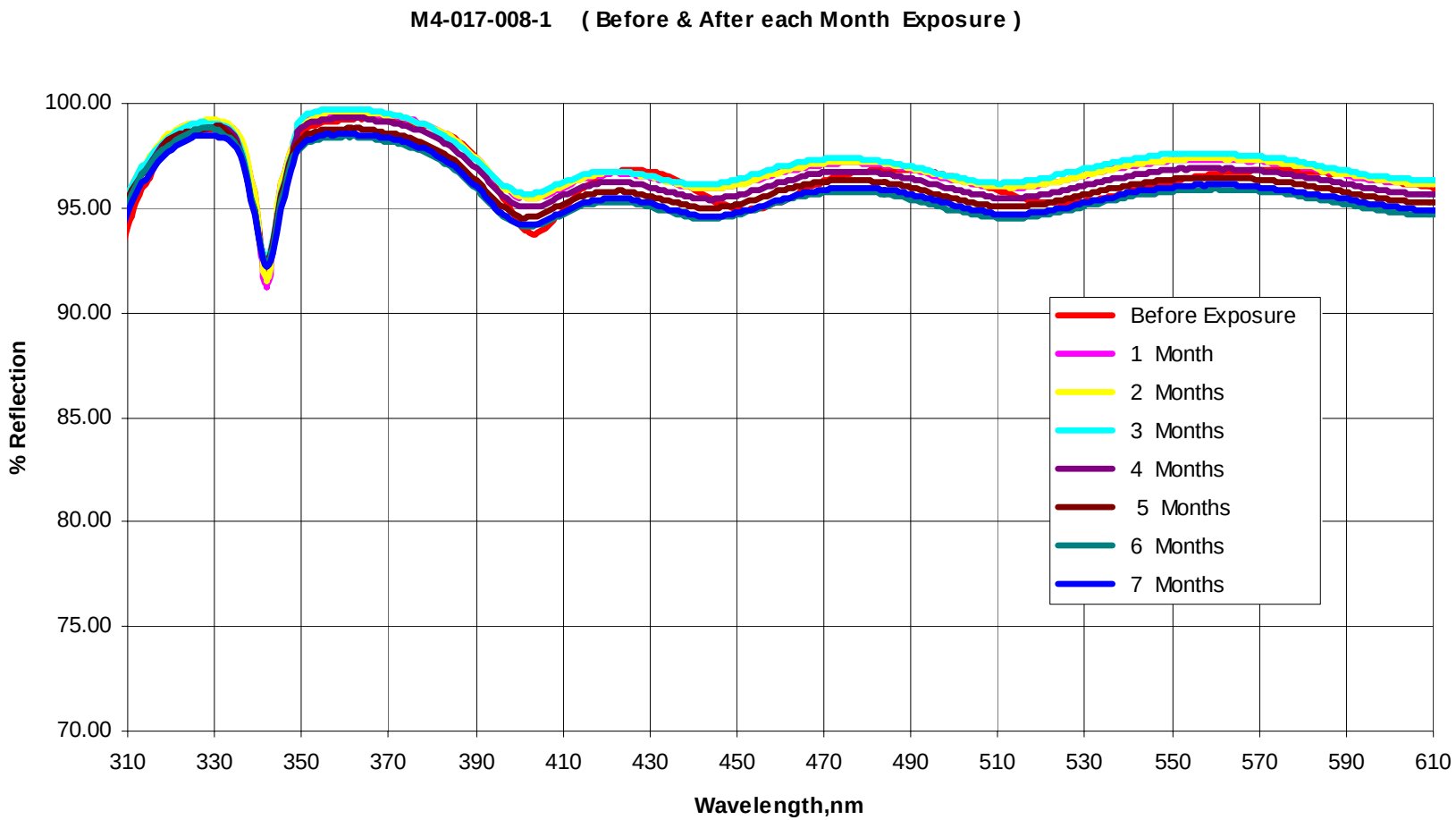


- Washed each month
- Washed after 6 months.
- To be washed after 1 year

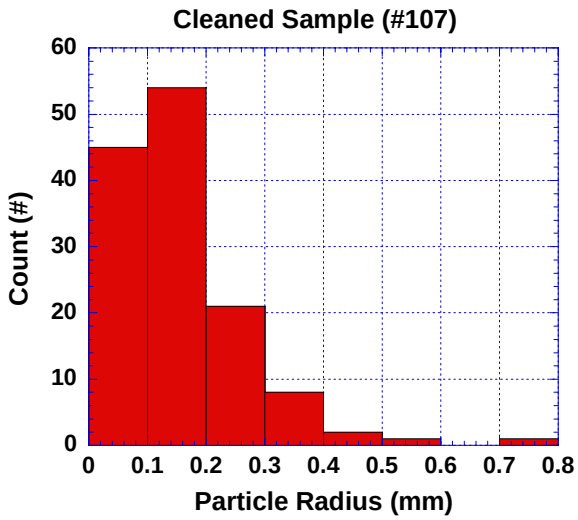
Reflectance Not Degraded After 7 Months Exposure With Two Intermediate Cleanings

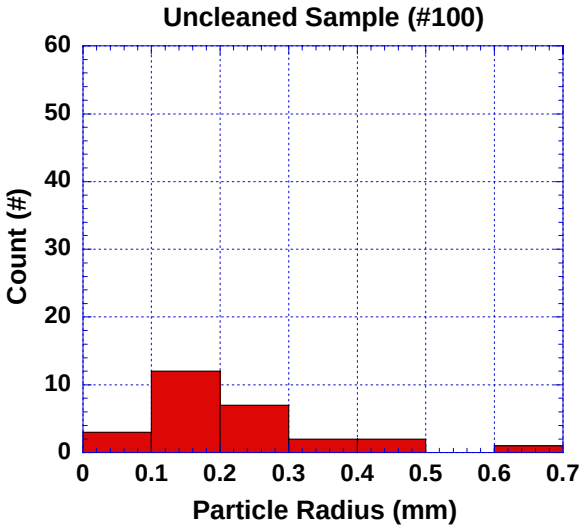


Reflectance Dropped Slightly With Monthly Aggressive Cleanings.

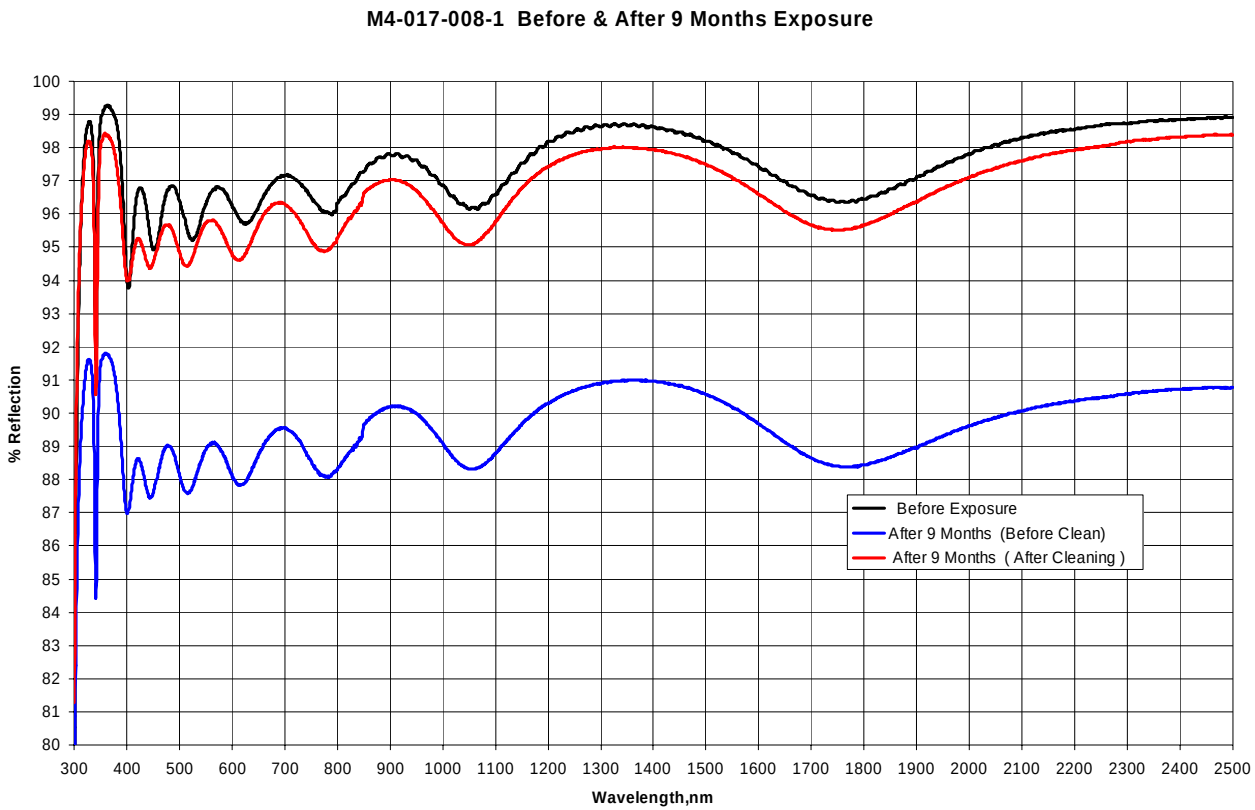


The Small Decrease in Reflectance May be Due to Pinholes. Their Number Increases with Aggressive Cleaning. (Note the Size Indicated is That of the Light Spots in a Photograph – The Actual Size of the Pinholes Remains to be Calibrated)





In Spite of the Pinholes, After 12 Aggressive Cleanings and 9 Months of Exposure, the Reflectance Is Only Slightly Diminished



Conclusions

- Coatings retain good reflectivity after 9 months exposure to outside exposure.
- While pinholes are evident in coating, they have minimal effect on reflectivity.
- Multiple harsh cleanings appear to increase number of pinholes – the influence on pinhole size remains to be determined.
- Further evaluations in actual use environments are being pursued.

Future Work Subject to Funding

- Modeling of Durability
- Removal of Known Absorption Peak at 10 Microns
- Further Enhancement of Wavelength Range and Durability