Brookhaven National Laboratory

U.S. DEPARTMENT of ENERGY

Synergistic Activities: Mirror Testing and QA for pfRICH

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01/21/2026

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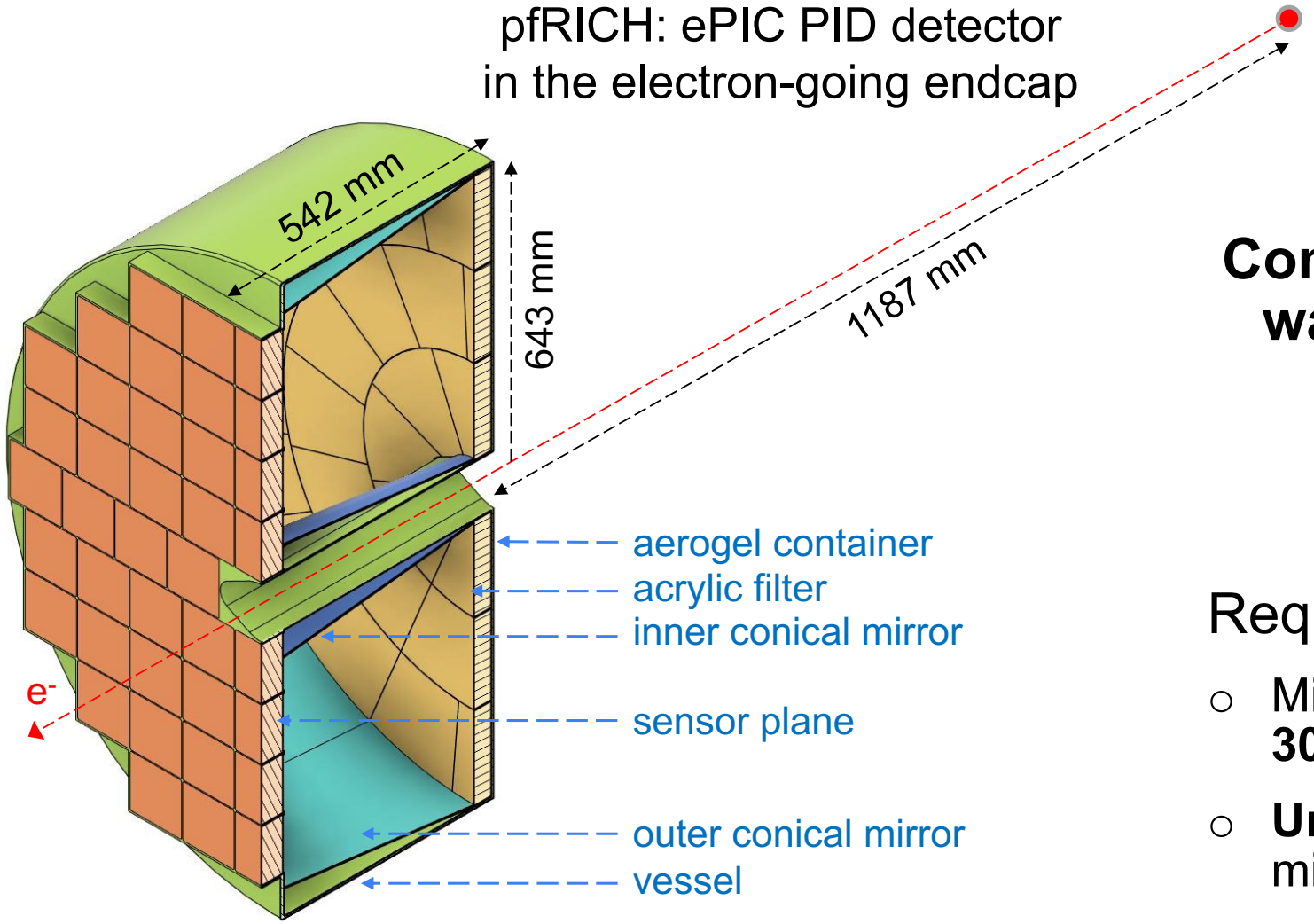
January 2026 ePIC Collaboration Meeting − PID Cross-Cutting Working Group Workfest

Introduction – Mirror for pfRICH

pfRICH: ePIC PID detector
in the electron-going endcap



Conical mirrors along cylindrical walls direct Cherenkov photons onto HRPPD sensor plane, ensuring **high acceptance**.

Requirements:

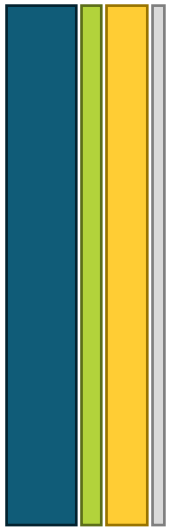
- Mirror reflectivity of **≥ 90%** over the **300–600 nm** wavelength range.
- **Uniform coating quality** across large mirror surfaces.

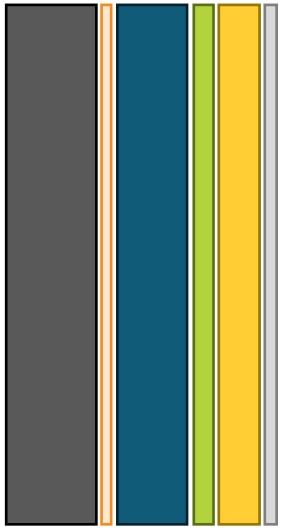
Mirror Coating at SBU

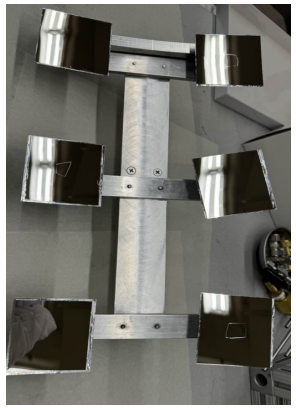
Coating Stack:

⇒ Lexan + Cr + Al + SiO_2

⇒ Carbon fiber + Lexan + Cr + Al + SiO_2

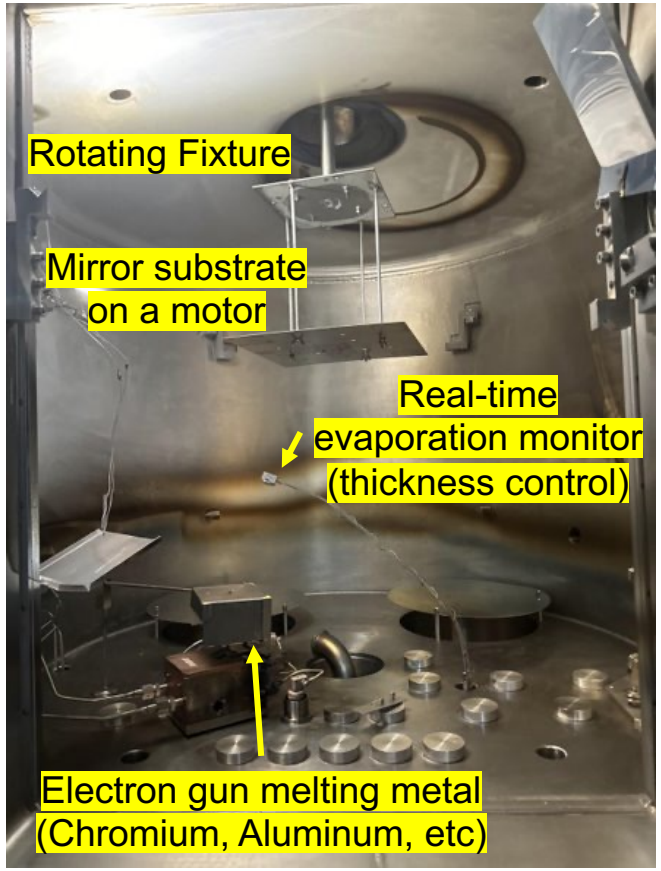






6 samples per batch

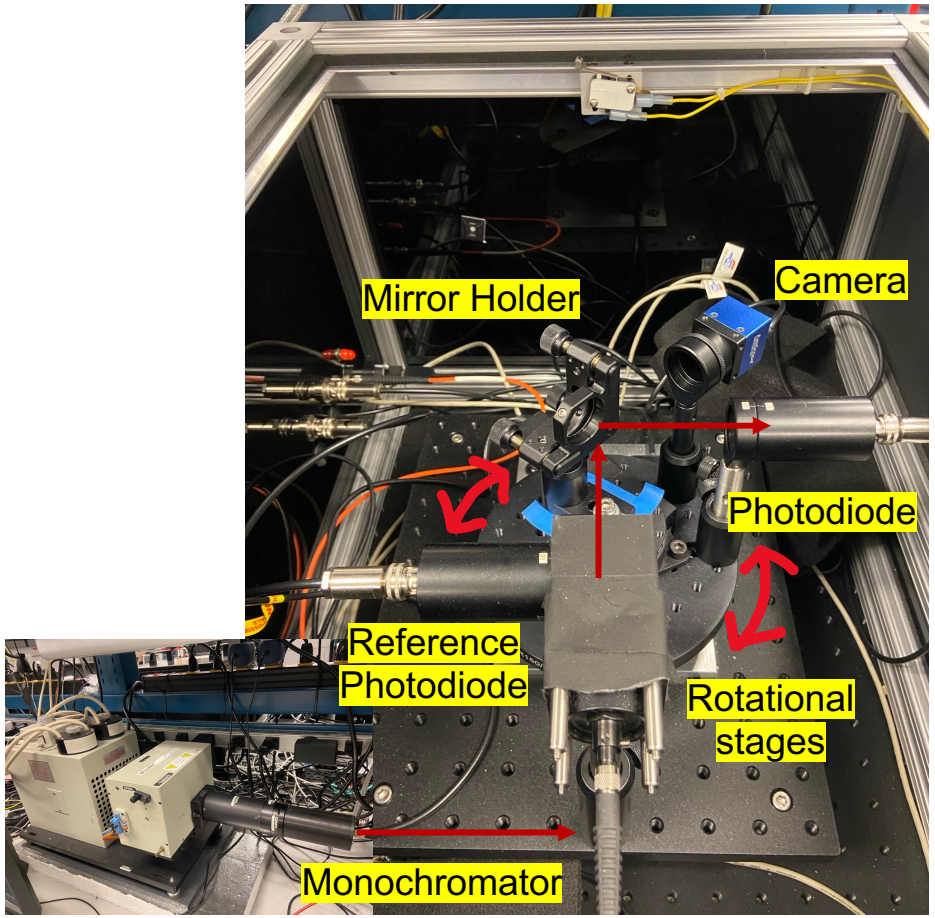
- Carbon Fiber (CF): substrate
- Epoxy: Adhesion layer btw CF and Lexan
- Lexan: substrate
- Cr: Adhesion layer btw Lexan and Al
- Al: Reflective layer
- SiO_2: Protective coating



Evaporator Exterior

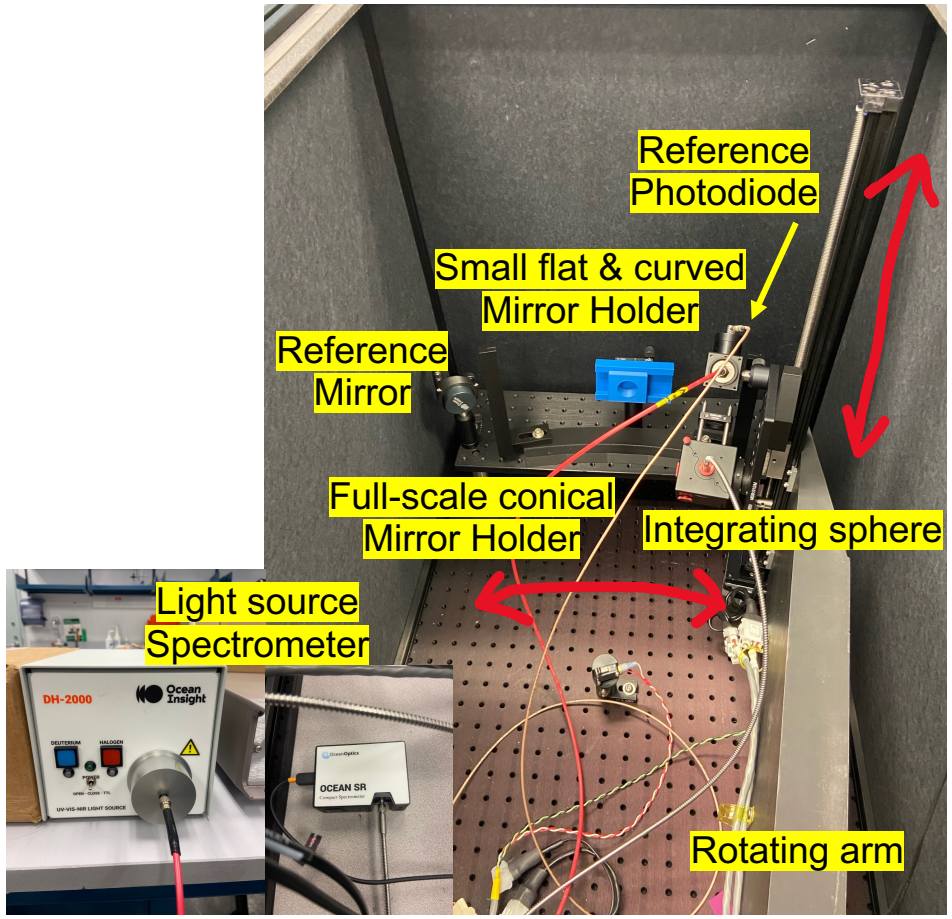
Two Mirror Test Stands at BNL

Small Mirror Test Stand



(200−800 nm)

Large Mirror Test Stand
(w/ Small Mirror)



(180−900 nm)

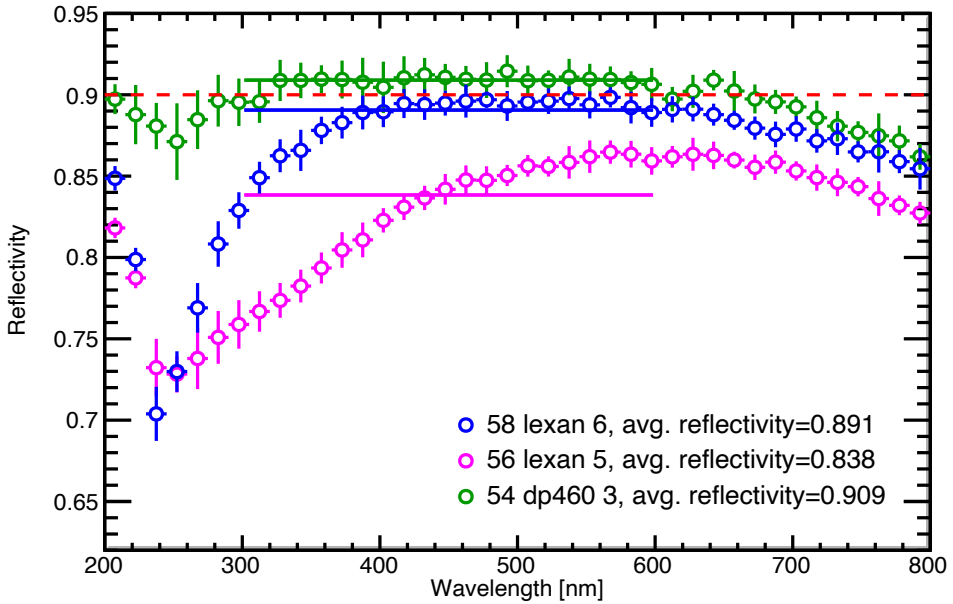
Capabilities in Mirror Testing and QA

Versatile testing lab (BNL/SBU) with 3D printing capability

- **Fully in-house workflow**: same team responsible for mirror coating and testing
- **Mirror size coverage**: small samples to large, full-scale mirrors
- **Mirror geometries**: flat and curved (conical) mirrors
- **Multi-parameter scanning capability**:
  - Reflection angle
  - Wavelength
  - Two-dimensional position (2D)
  - 2D surface mapping relative to nominal conical shape (*to be implemented*)

Highlights of Key Results

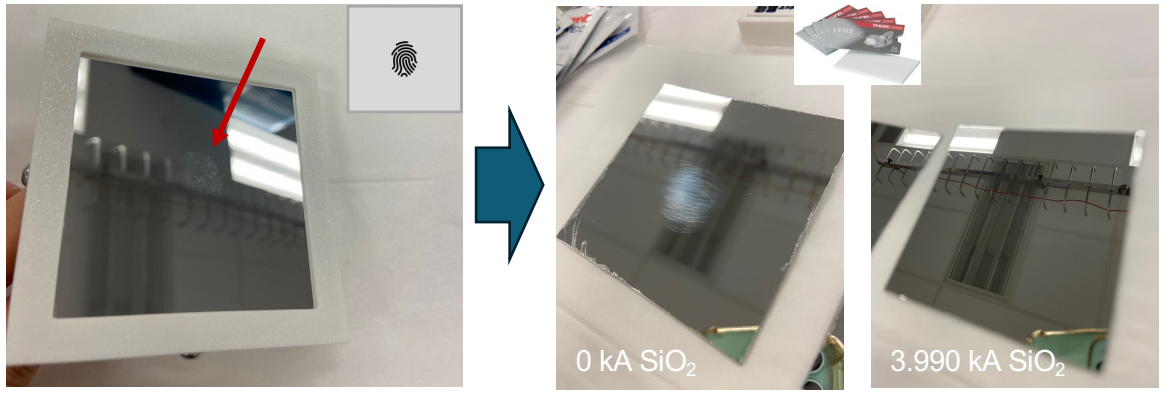
Reflectivity Measurement



Coating Batch	Coating Total Thickness Cr [kA]	Al [kA]	SiO_2 [kA]	Reflectivity
58	4.004	16.032	1.599	**89.1 %**
56	4.003	16.027	3.990	**83.8 %**
54	4.01	16.00	0.000	**90.9 %**

89 % reflectivity achieved with SiO_2 protection layer.
A thinner SiO_2 layer is expected to yield **≥ 90 % reflectivity**.

Scratch Test



Place a fingerprint at the center, where mirror reflectivity is measured.

Clean the fingerprint using optical cleaning tissue

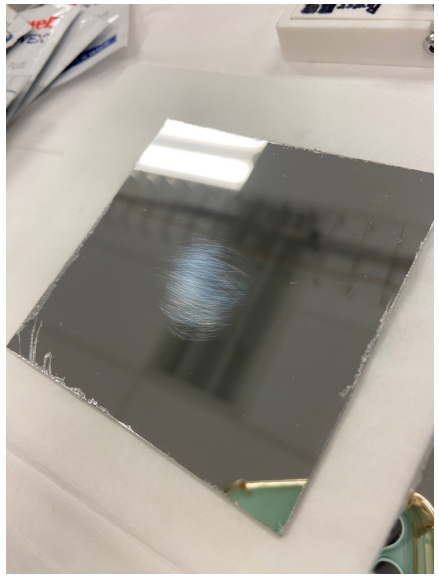
See backup: reflectivity results

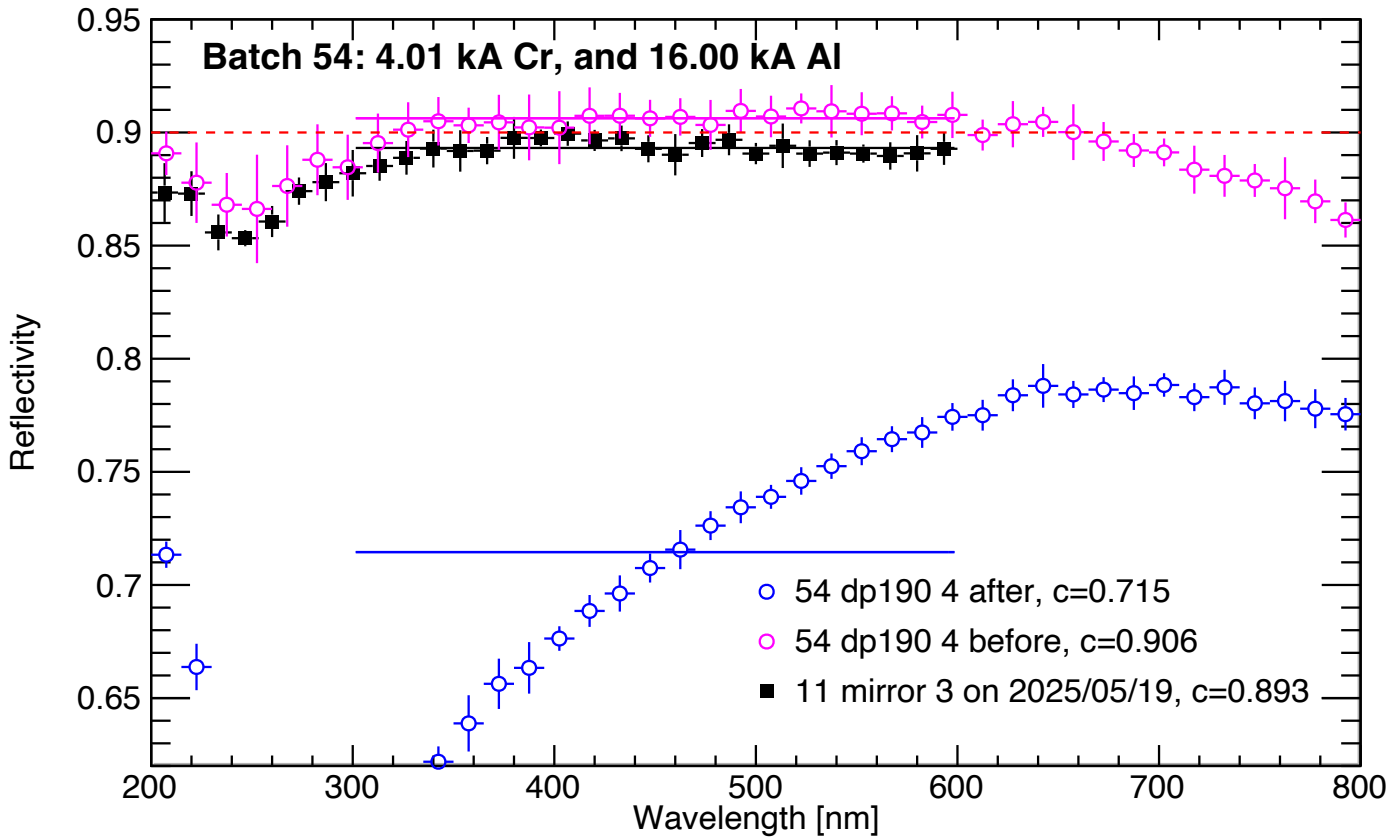
Coating Batch	Coating Total Thickness Cr [kA]	Al [kA]	SiO_2 [kA]	Reflectivity Change
58	4.004	16.032	1.599	**-1.0 %**
56	4.003	16.027	3.990	**-0.4 %**
54	4.01	16.00	0.000	**-19 %**

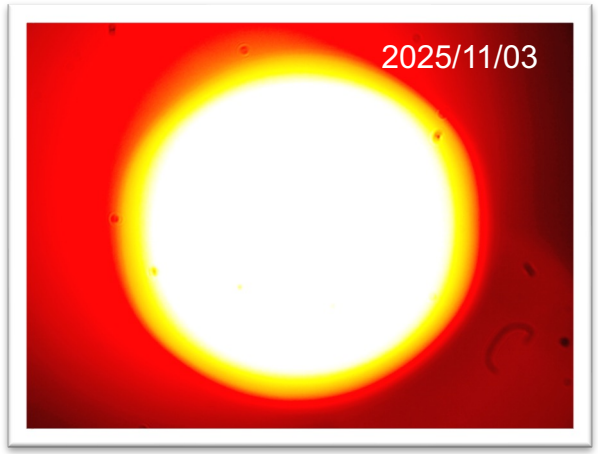
SiO_2 protection layer showed **no visible scratches**, with **a reflectivity loss of ≤ 1%** regardless of thickness.

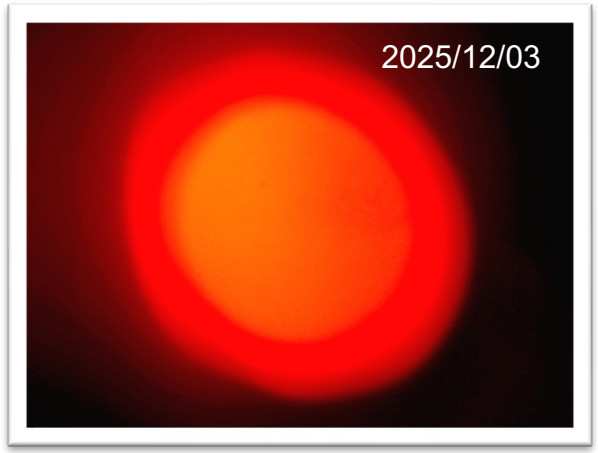
Backup Slides

Small Mirror Reflectivity Results – #54



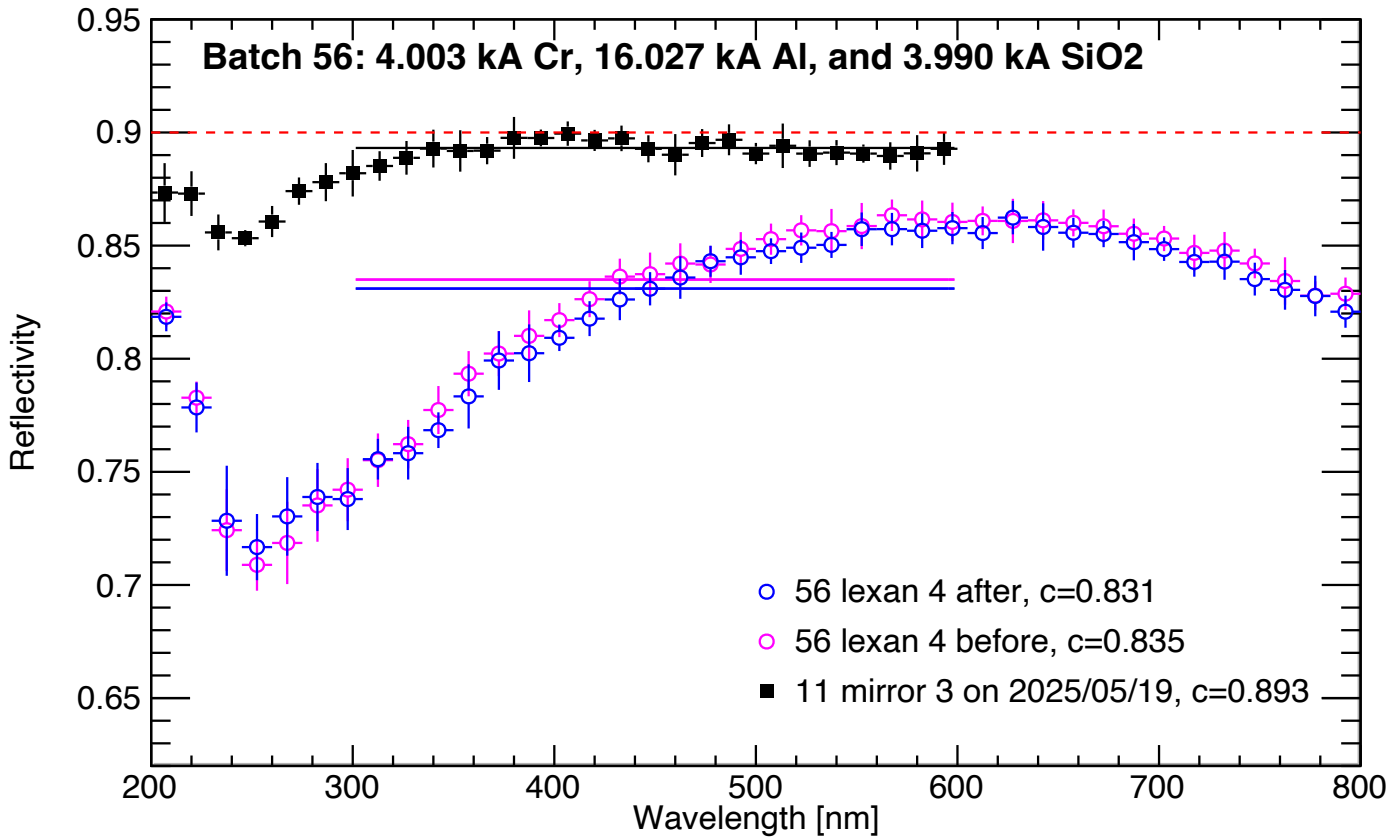


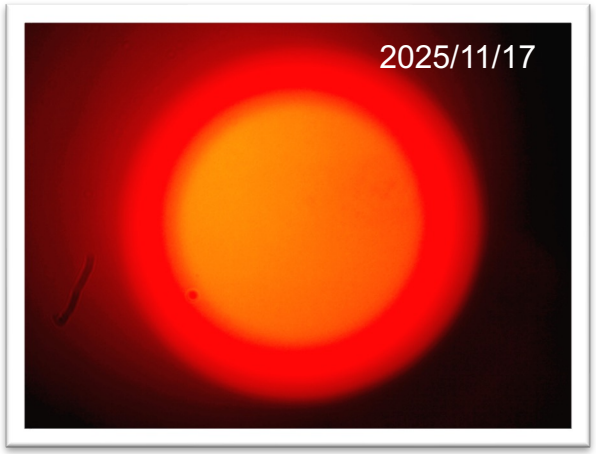


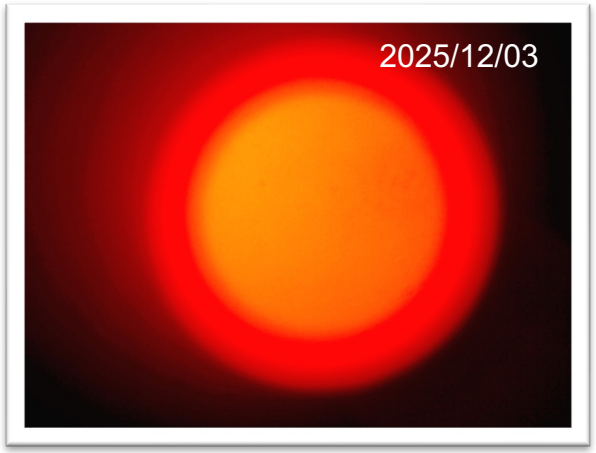


Sample without SiO_2 layer showed visible scratches.
Reflectivity decreased significantly by 19 %.

Small Mirror Reflectivity Results – #56

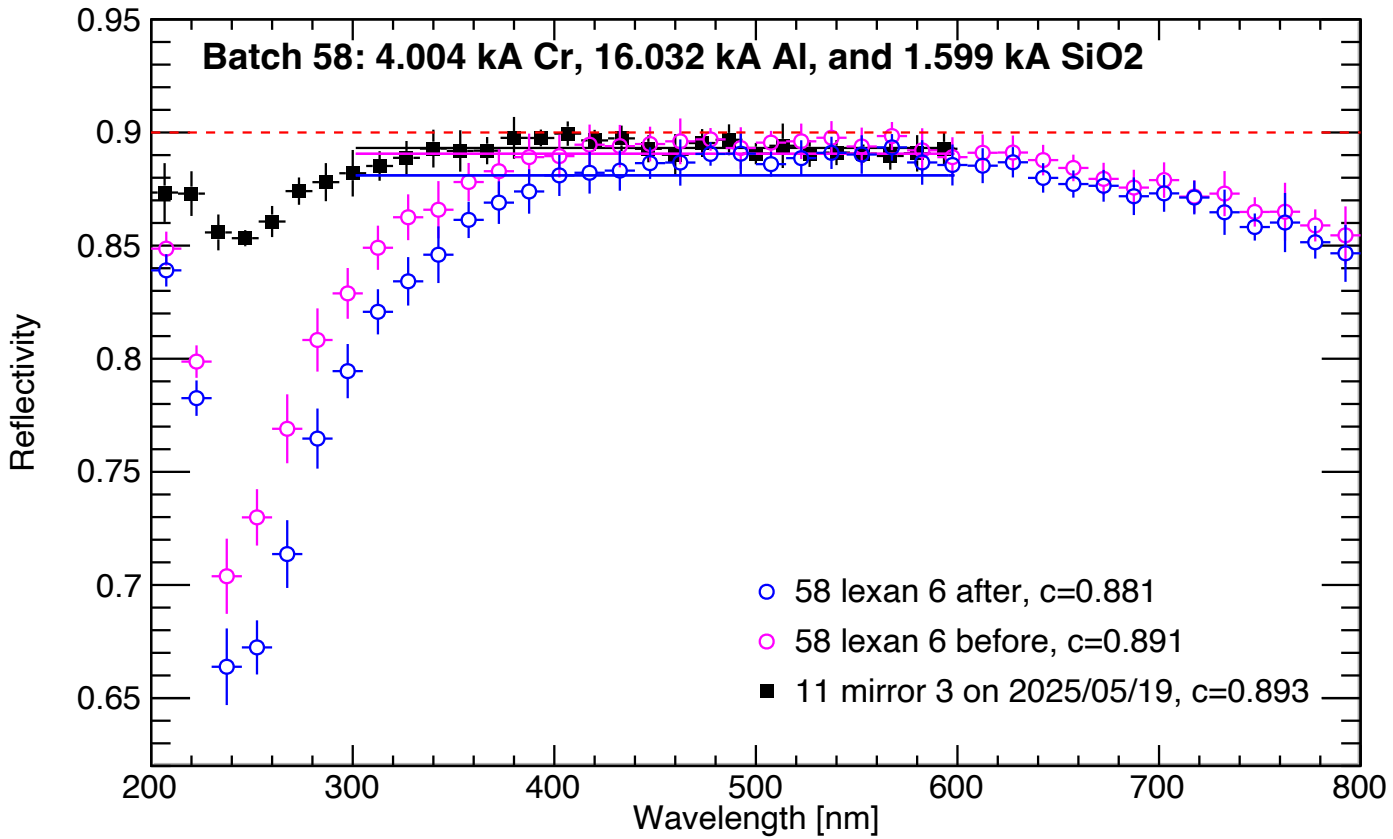


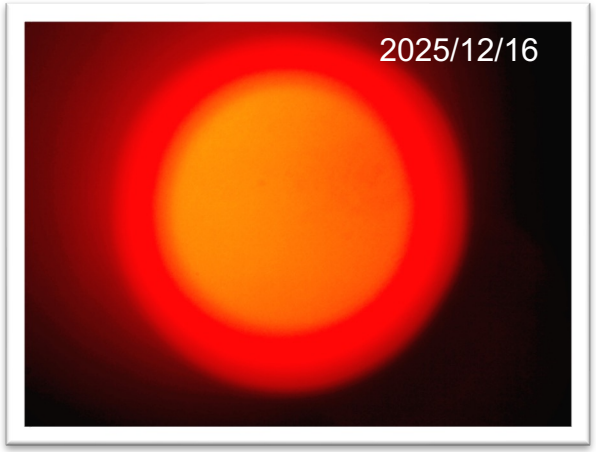




No visible scratches observed.
Reflectivity decreased slightly by 0.4 %.

Small Mirror Reflectivity Results – #58





No visible scratches observed.
Reflectivity decreased by 1 %.