Brookhaven National Laboratory

U.S. DEPARTMENT of ENERGY

Mirror Reflectivity Measurements at Small Mirror Test Stand

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ePIC pfRICH General Meeting

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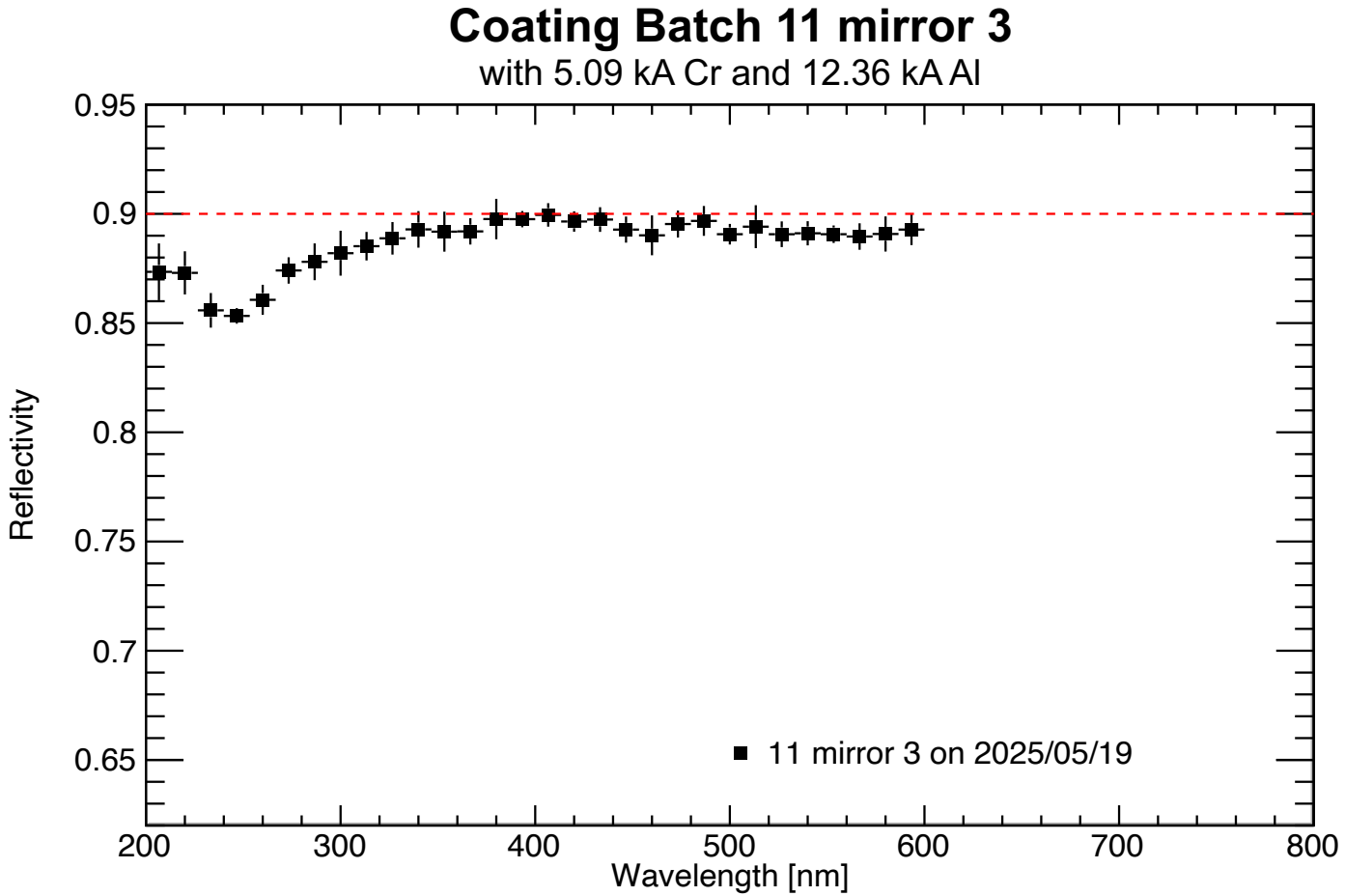
Overview

- Performed direct light measurement.
- Continued to take small mirror reflectivity measurements.
  - Coating batch 11: mirror 3, aka reference mirror (cross-check)
  - Coating batch 55: 6 mirrors (new)
    - Add SiO_2 protection layer
  - Coating batch 56: 5 mirrors of 6 (new)
- Checked the beam spot image
  - Verified whether any saturated pixels were present
- Attempted to clean the camera to publication standards
  - but, the result was not ideal.

Small Mirror Reflectivity Results – Ref.

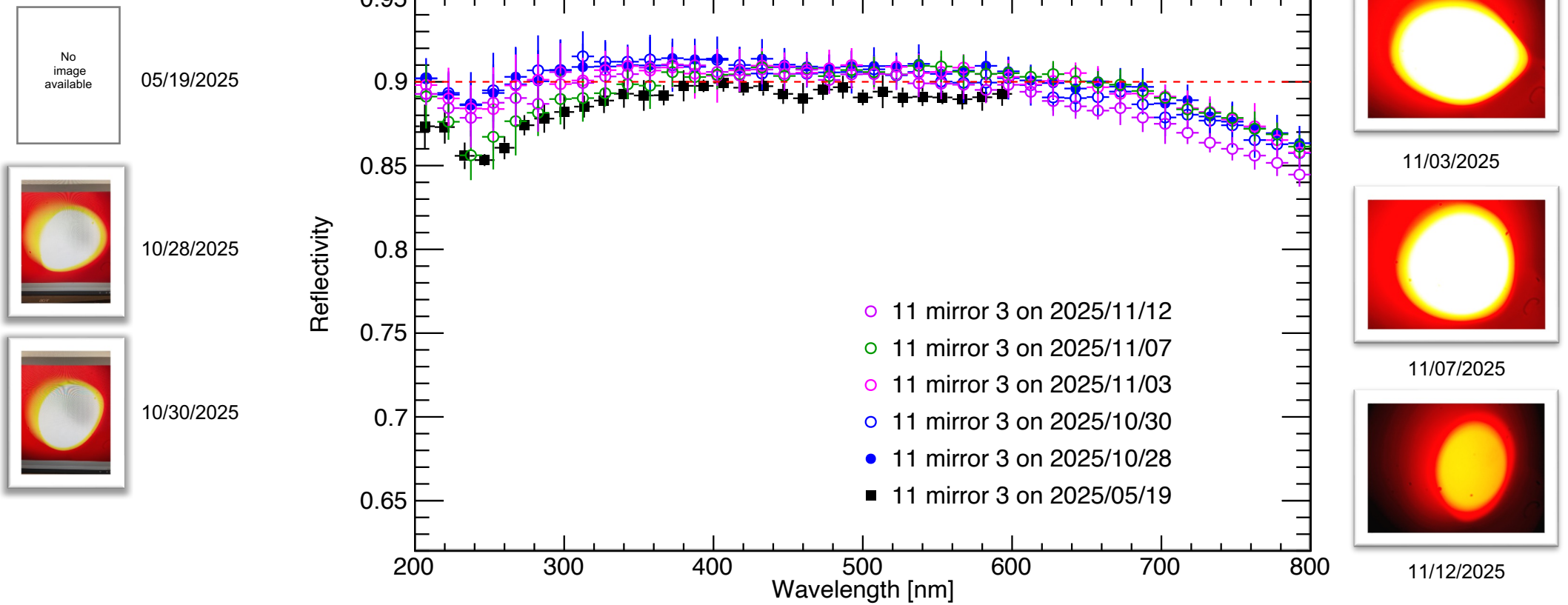
No image available

11 3
05/19/2025



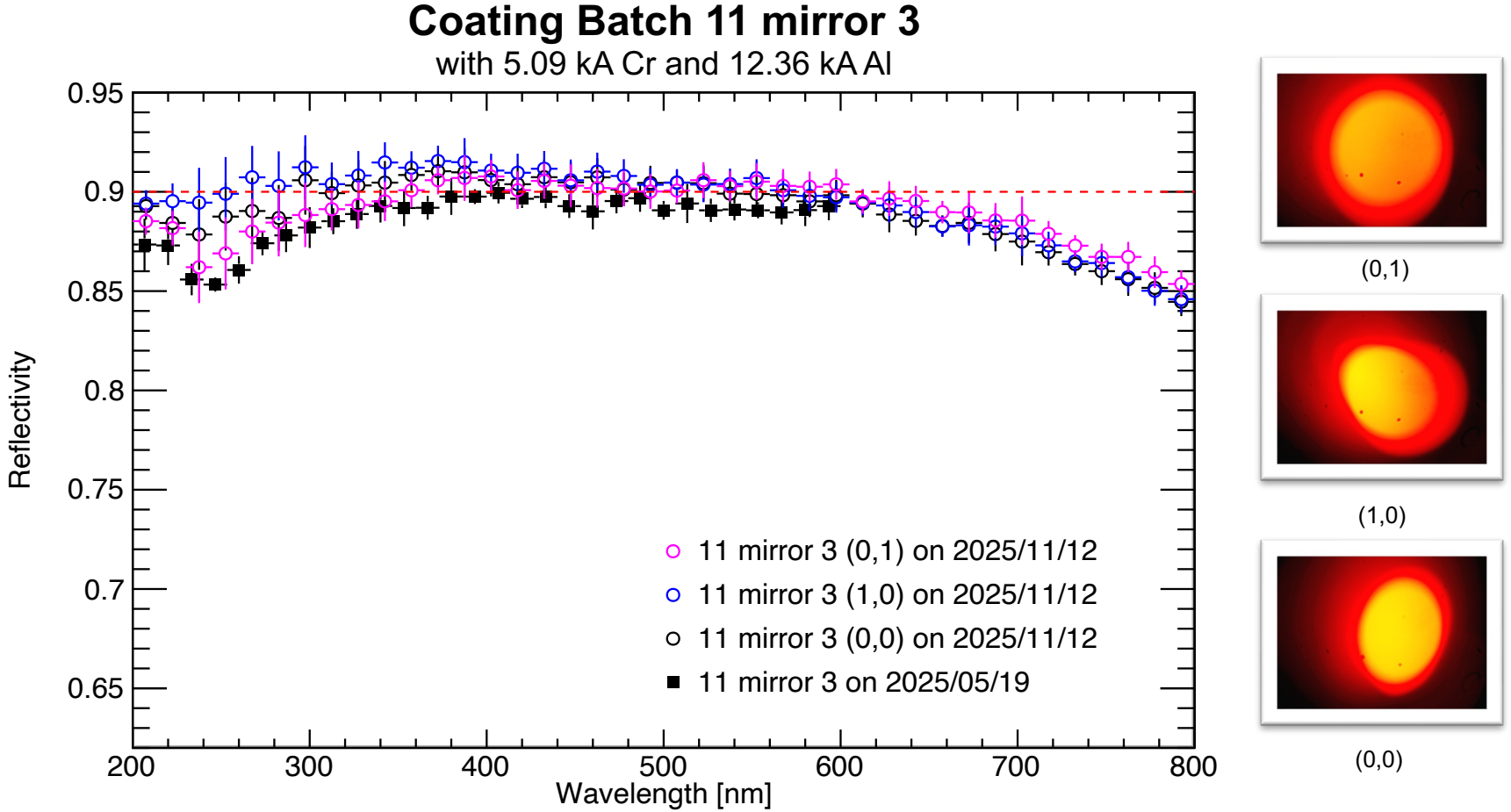
The reflectivity of Coating Batch 11, Mirror 3, is used as the reference.

Small Mirror Reflectivity Results – Ref.



Re-measured the reflectivity of Coating Batch 11, Mirror 3 since new lamp was installed.
Shown beam spot image with short exposure time and new measurements are consistent.

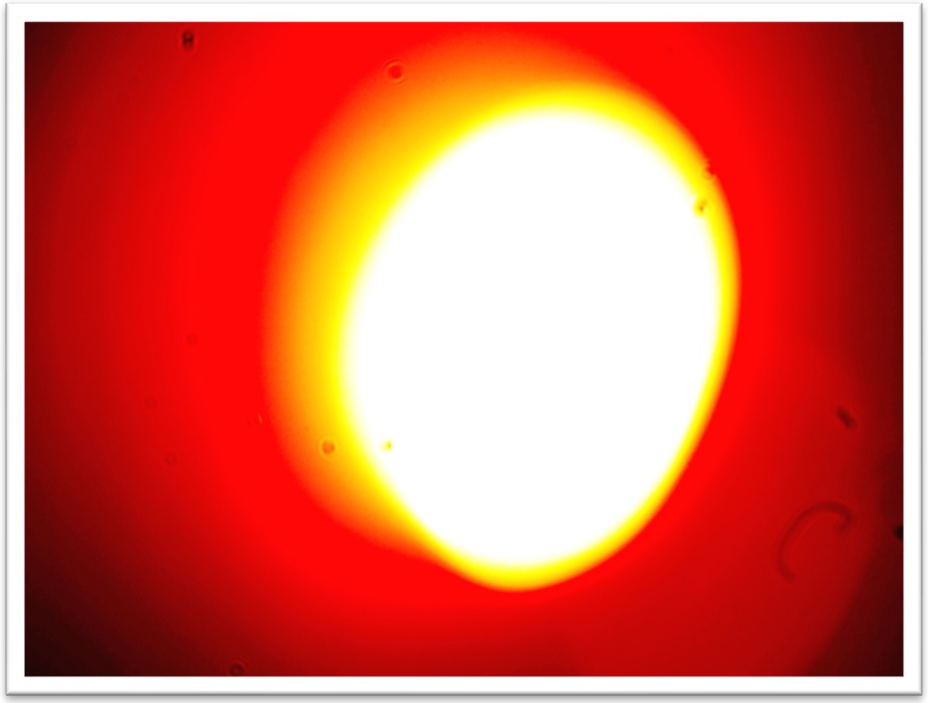
Small Mirror Reflectivity Results – Ref.



Scanned a small area of Coating Batch 11, Mirror 3, which is known to have surface distortions.
Images differ in shape and brightness: These variations impact reflectivity results, particularly at low wavelengths.

Beam Spot Profile w/ Coating Batch 11 3

Coating Batch 11 3



Laser spot

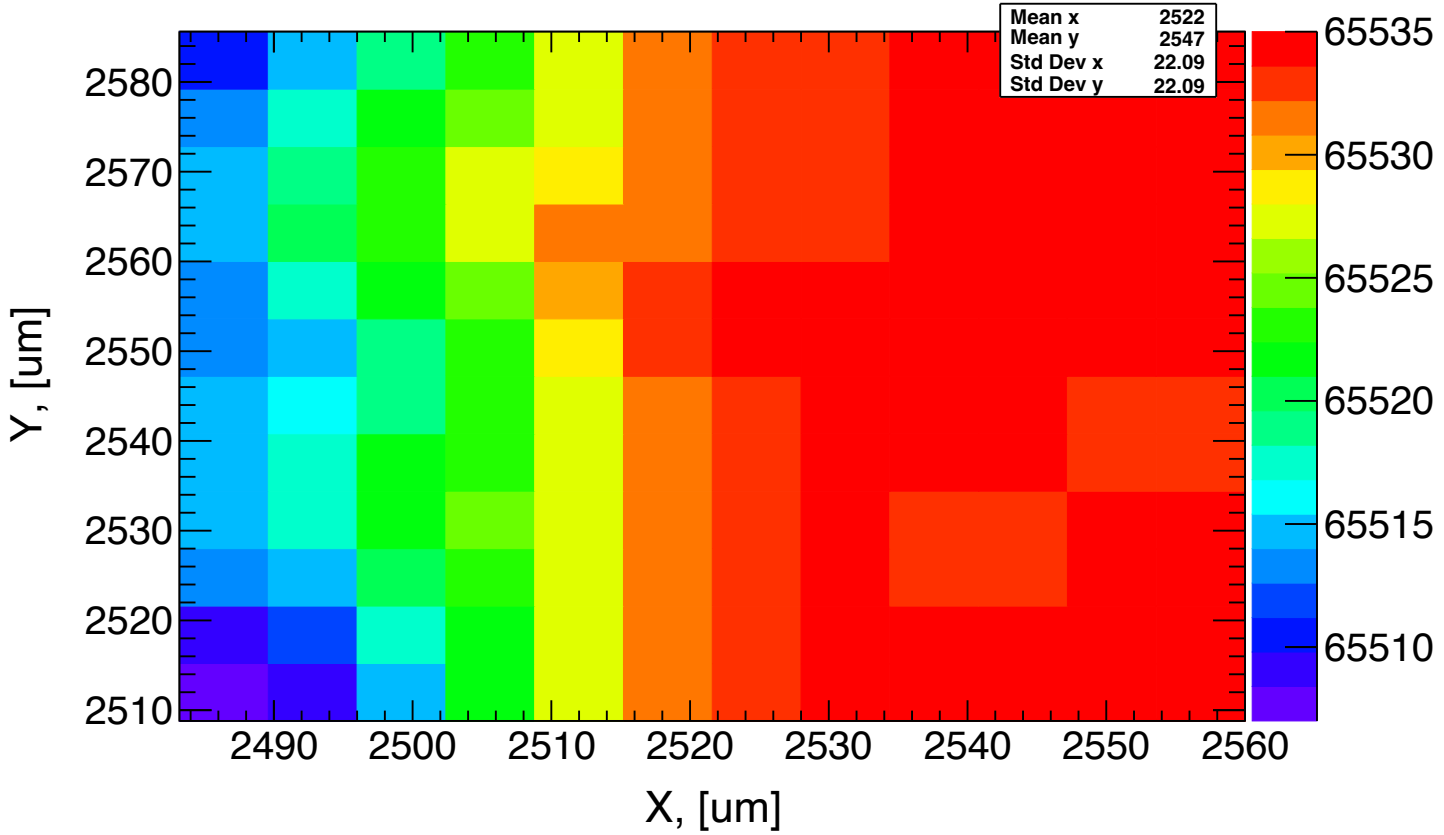
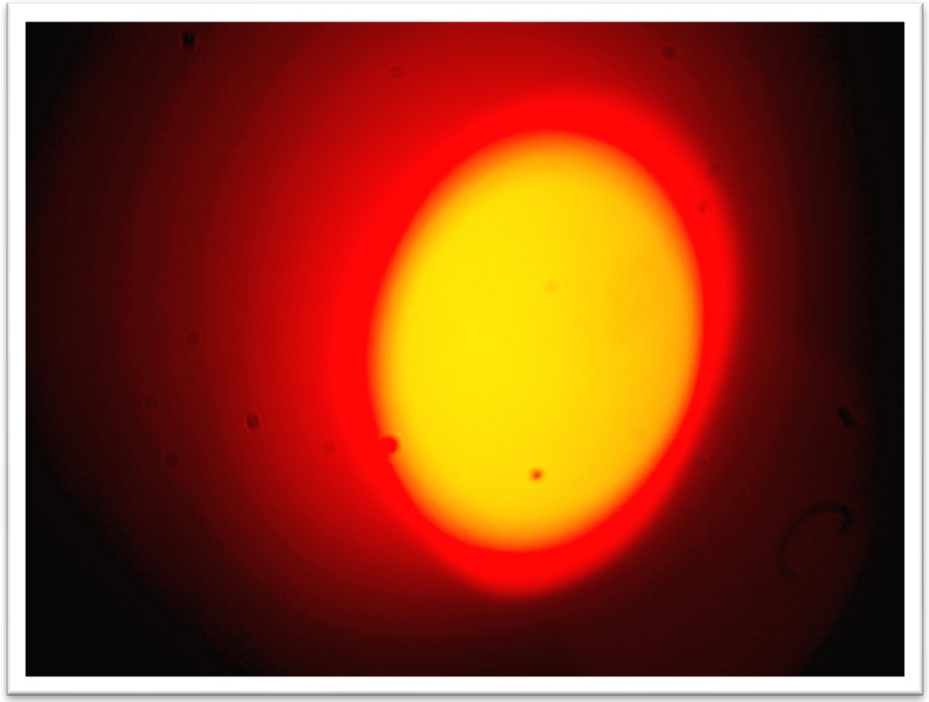


Image shown with original exposure settings and it contains saturated pixels (maximum 16-bit value: 65,535)

Beam Spot Profile w/ Coating Batch 11 3

Coating Batch 11 3



Laser spot

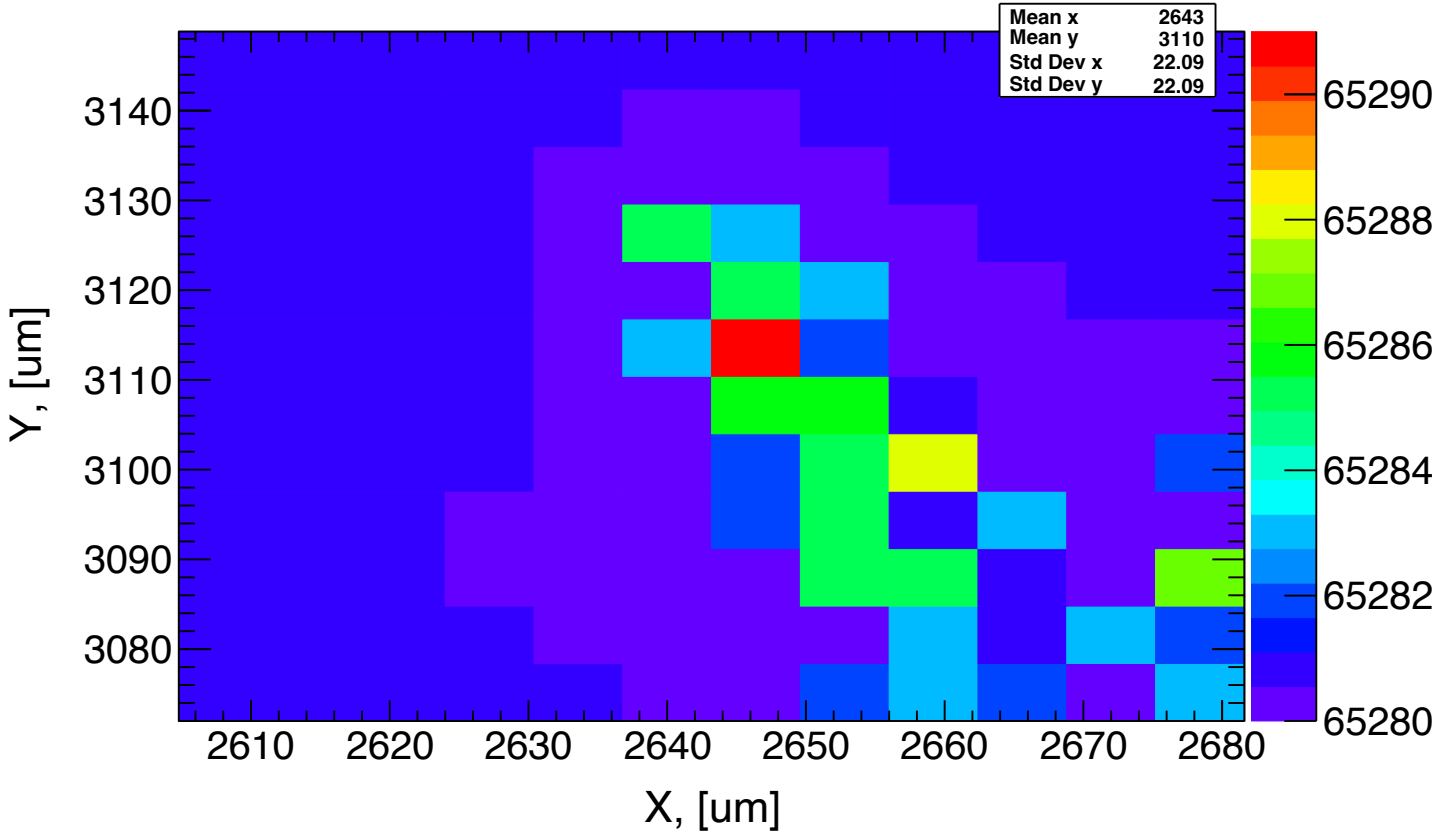
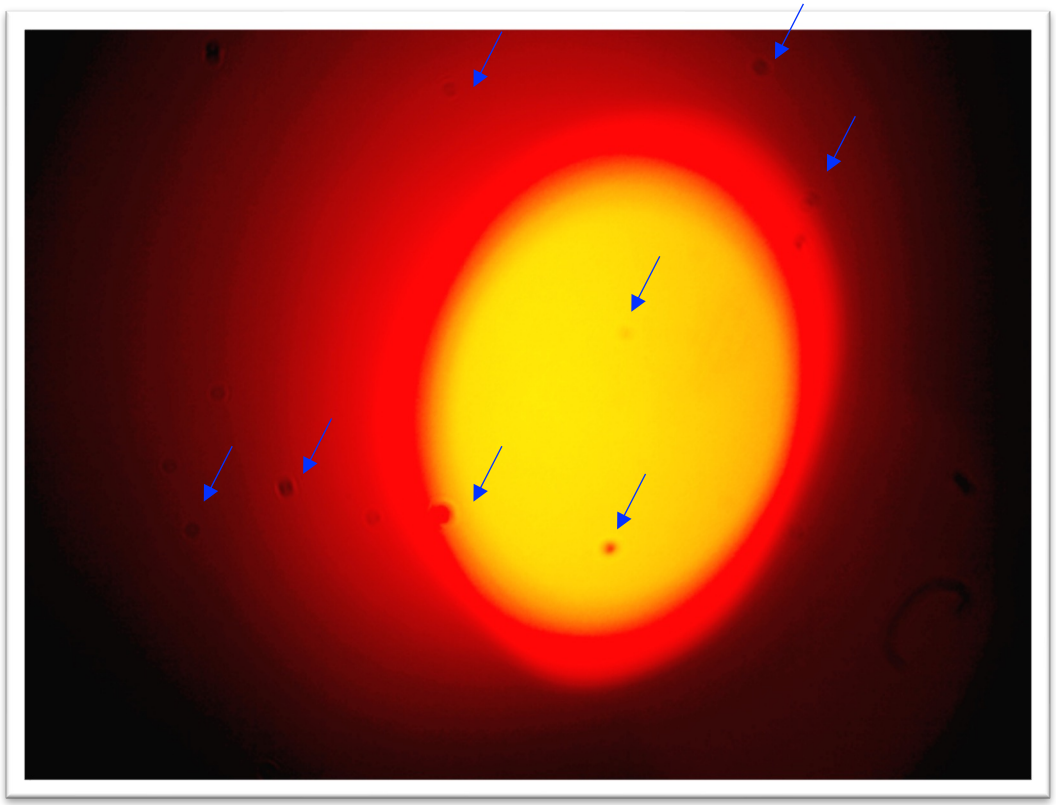


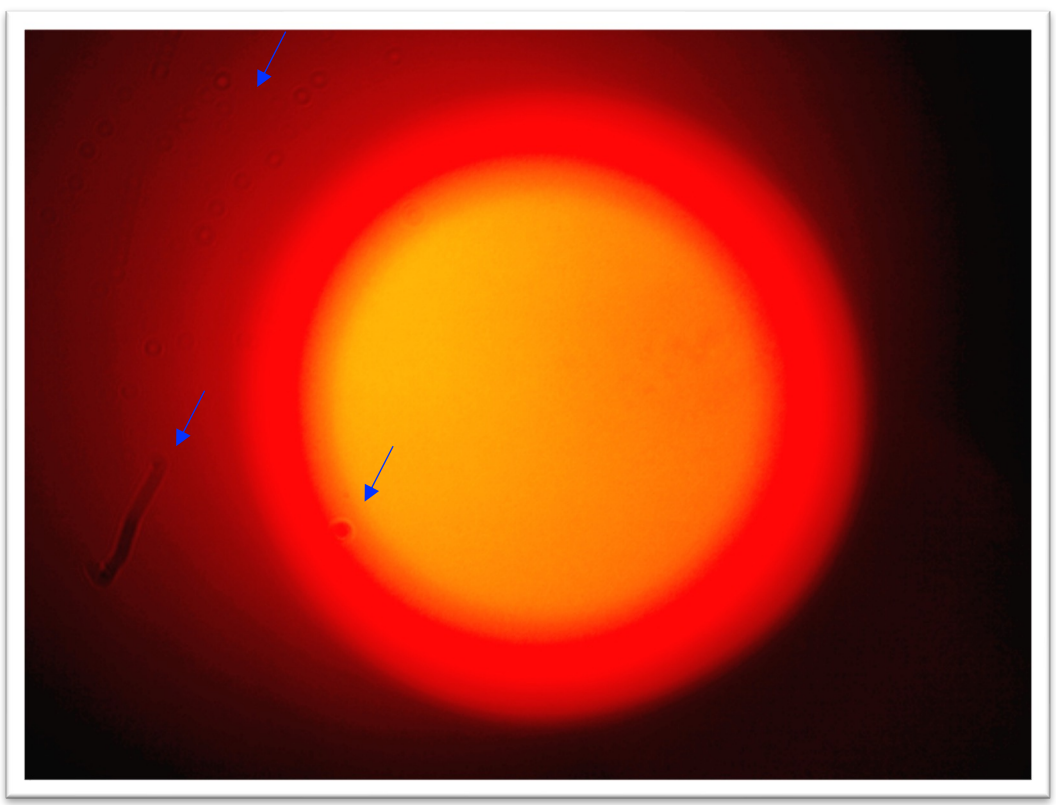
Image shown with reduced exposure time, and no saturated pixels present (all values below the 16-bit maximum of 65,535)

Beam Spot Image

Coating Batch 11 3

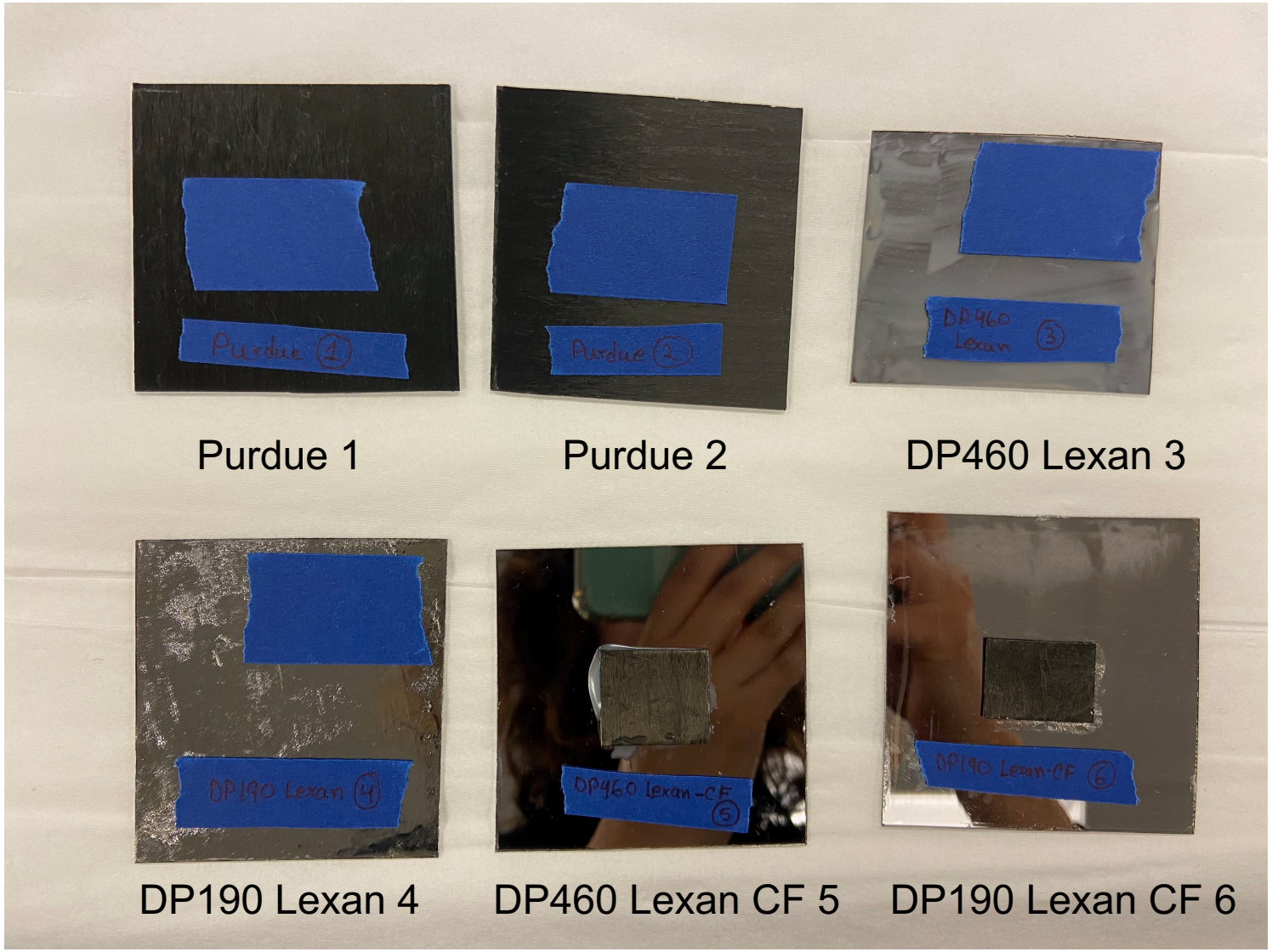


Coating Batch 55 Purdue 1

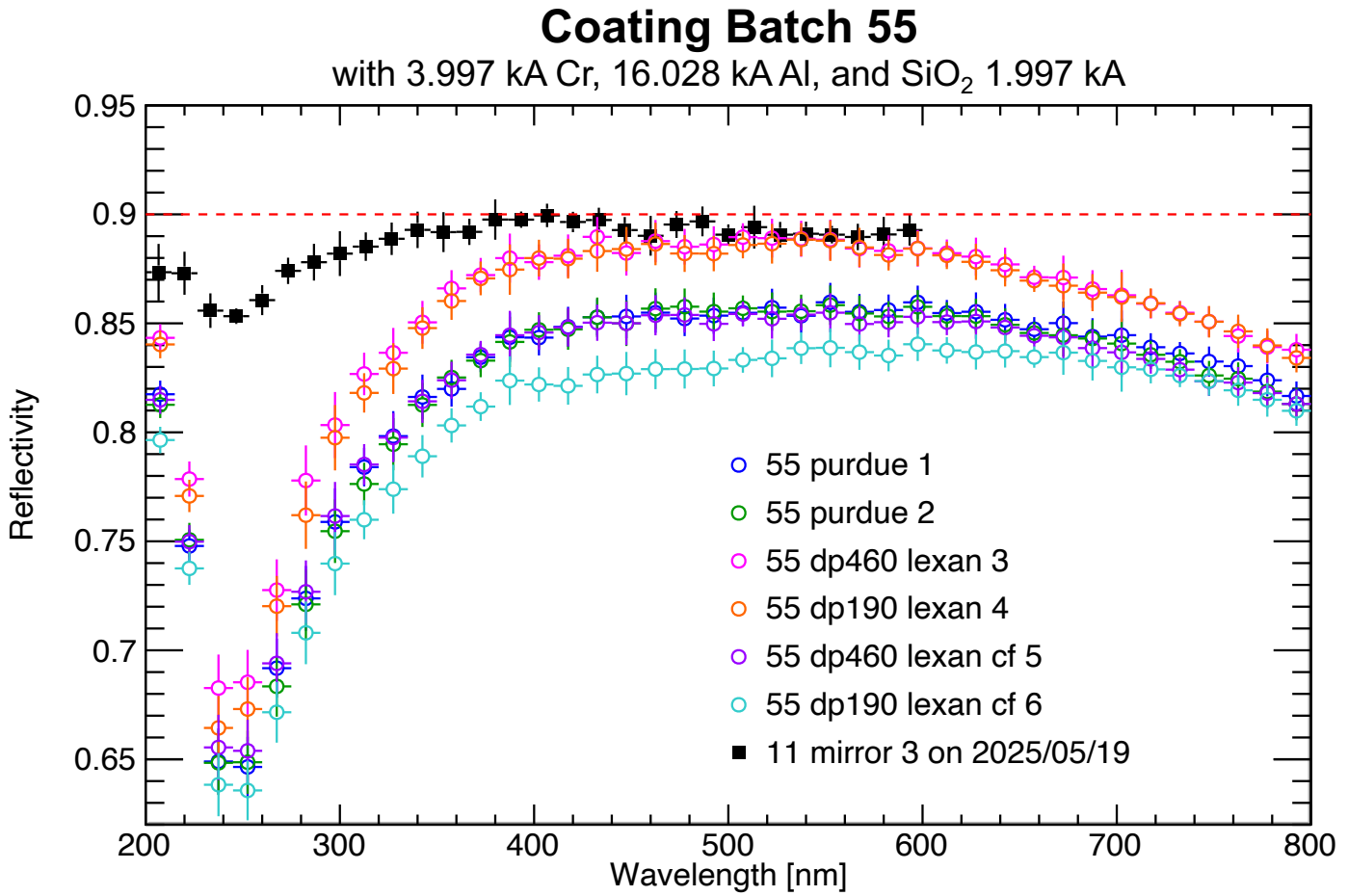


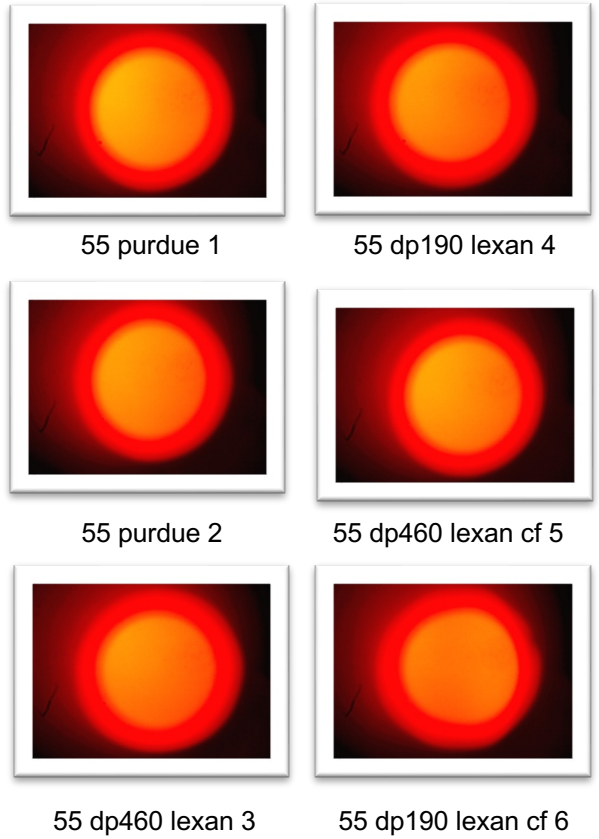
Attempted to clean the camera to publication standards, but the result was not ideal.
Need lint-free materials (clothes/tissues) to avoid leaving fibers. (thanks to Alexander)

Coating Batch #55 Mirror Samples



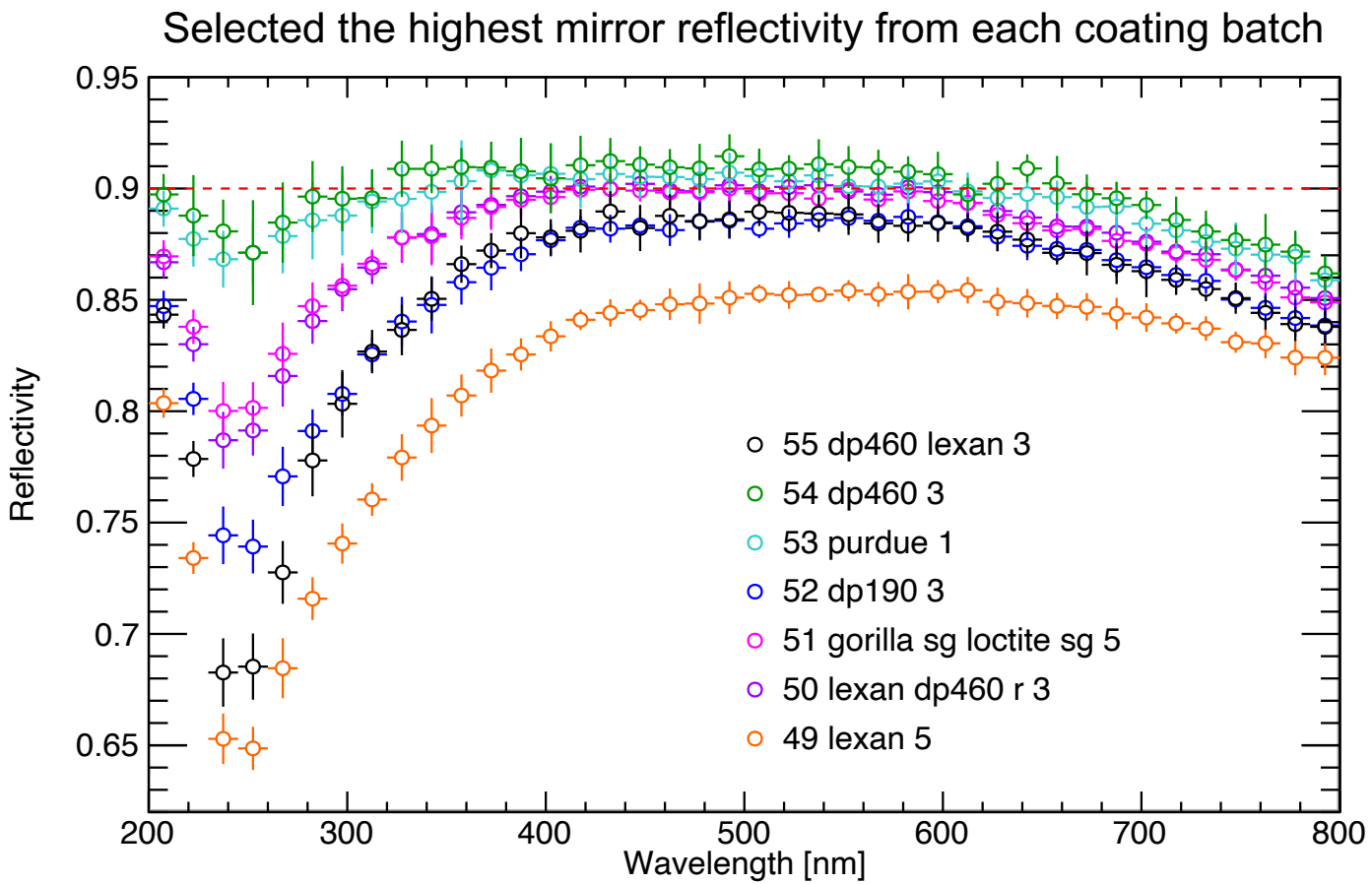
Small Mirror Reflectivity Results – #55





Coating Batch 55 mirrors show mixed reflectivity results —
lexan substrate shows the best, while others are lower (Lexan-CF and purdue substrate).

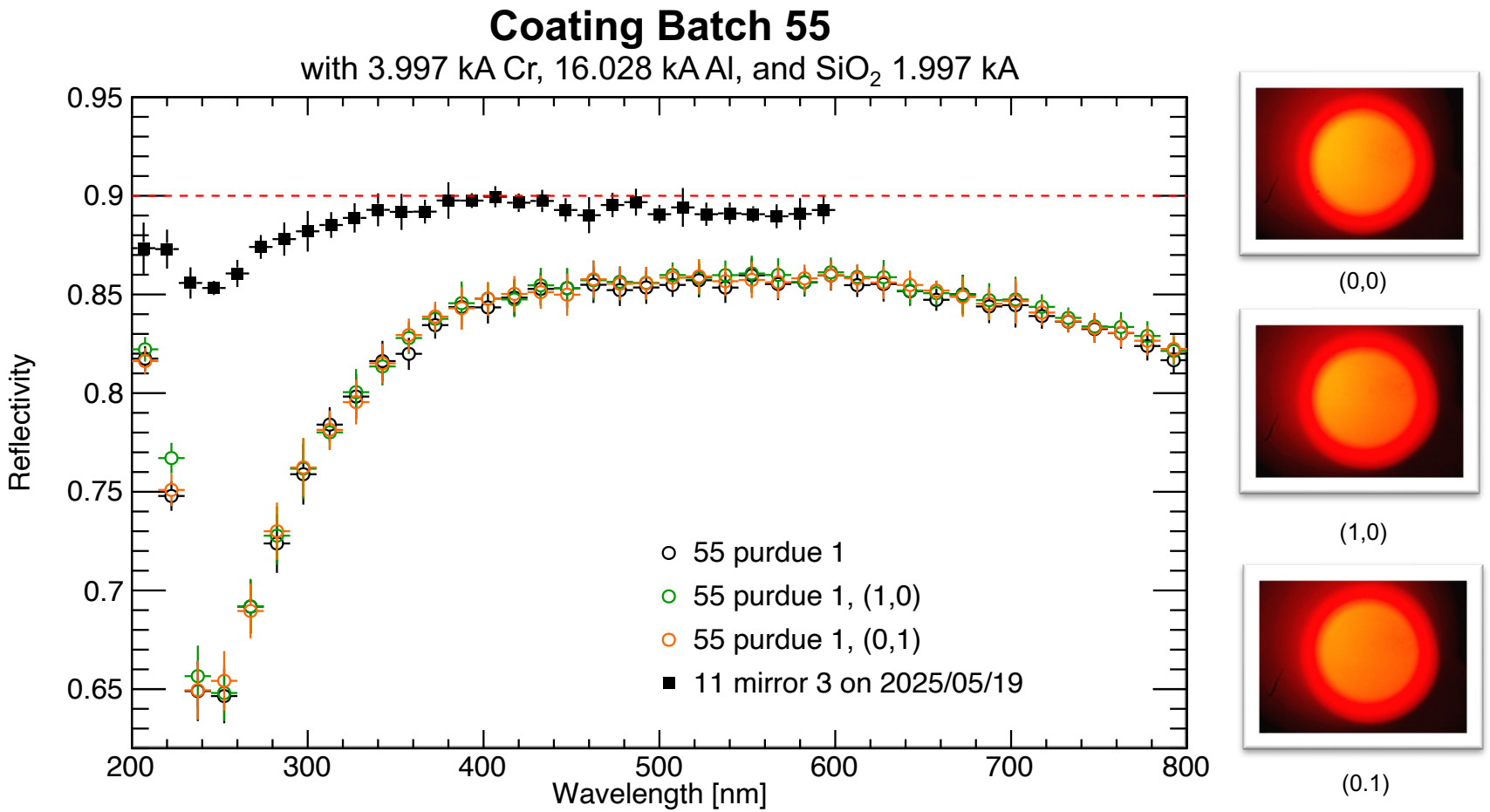
Mirror Coating Summary So Far



Coating Batch	Coating Total Thickness Cr [kA]	Al [kA]	SiO_2 [kA]
55	3.997	16.028	1.997
54	4.01	16.00	0
53	5.04	20.22	0
52	5.75	23	0
51	5.29	21	0
50	5.51	22.02	0
49	6.01	23.99	0

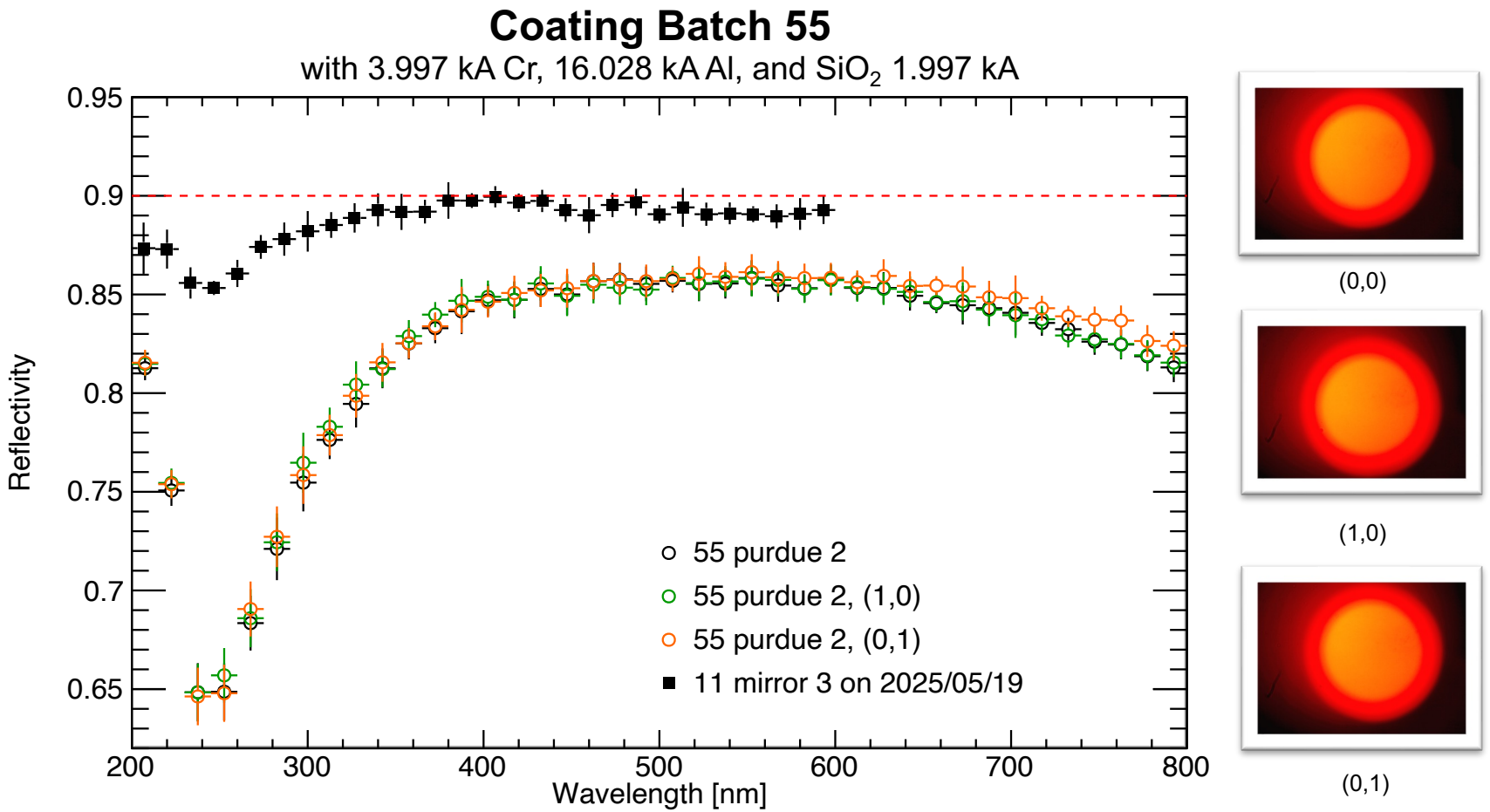
Adding a SiO_2 protection layer (while keeping Cr and Al thickness unchanged from Batch 54) reduces overall reflectivity by ~2-3%. This reduction is particularly significant at low wavelengths.

Small Mirror Reflectivity Results – #55 1



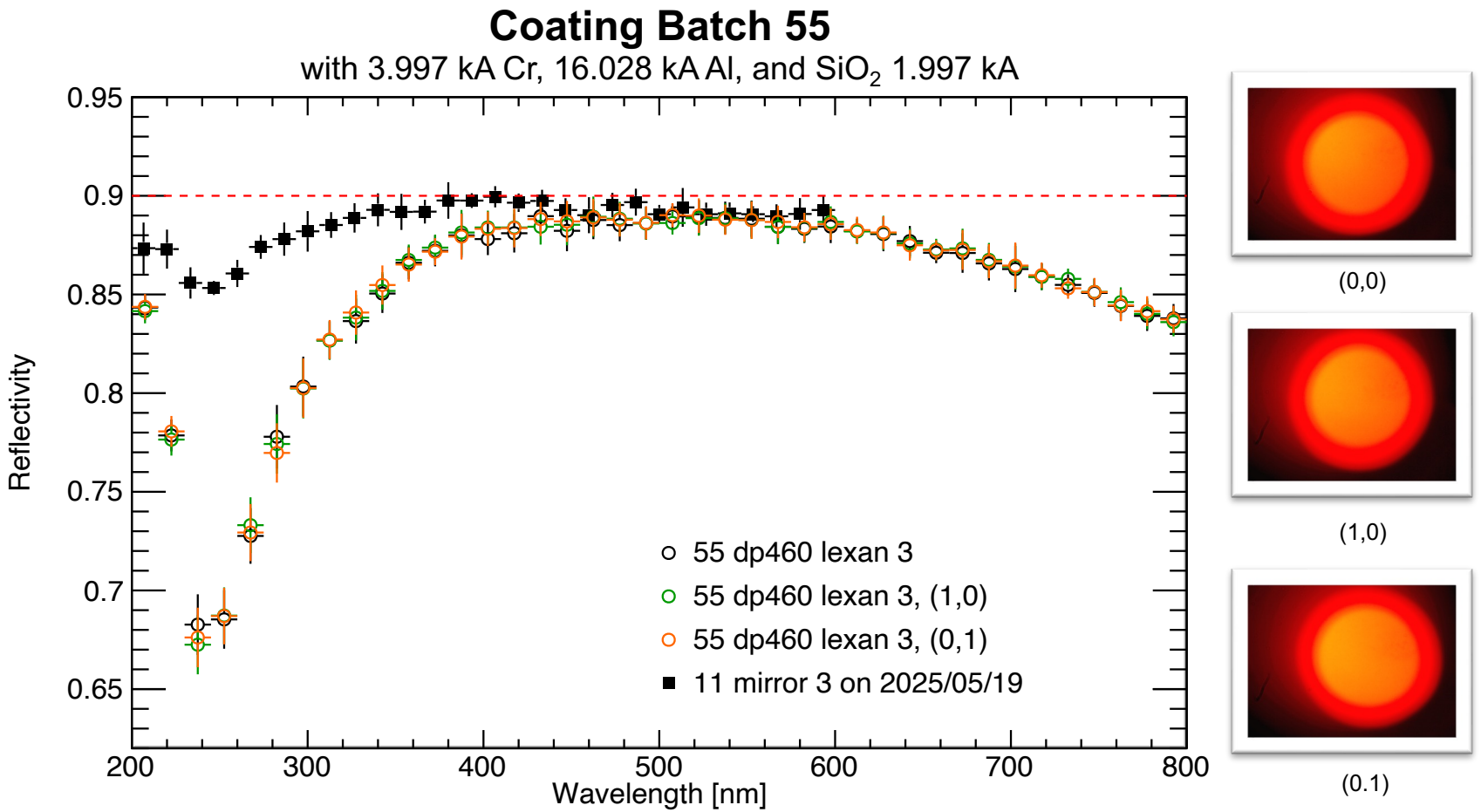
Reflectivity results were consistent across measurements.
Beam spot images showed nearly uniform appearance.

Small Mirror Reflectivity Results – #55 2



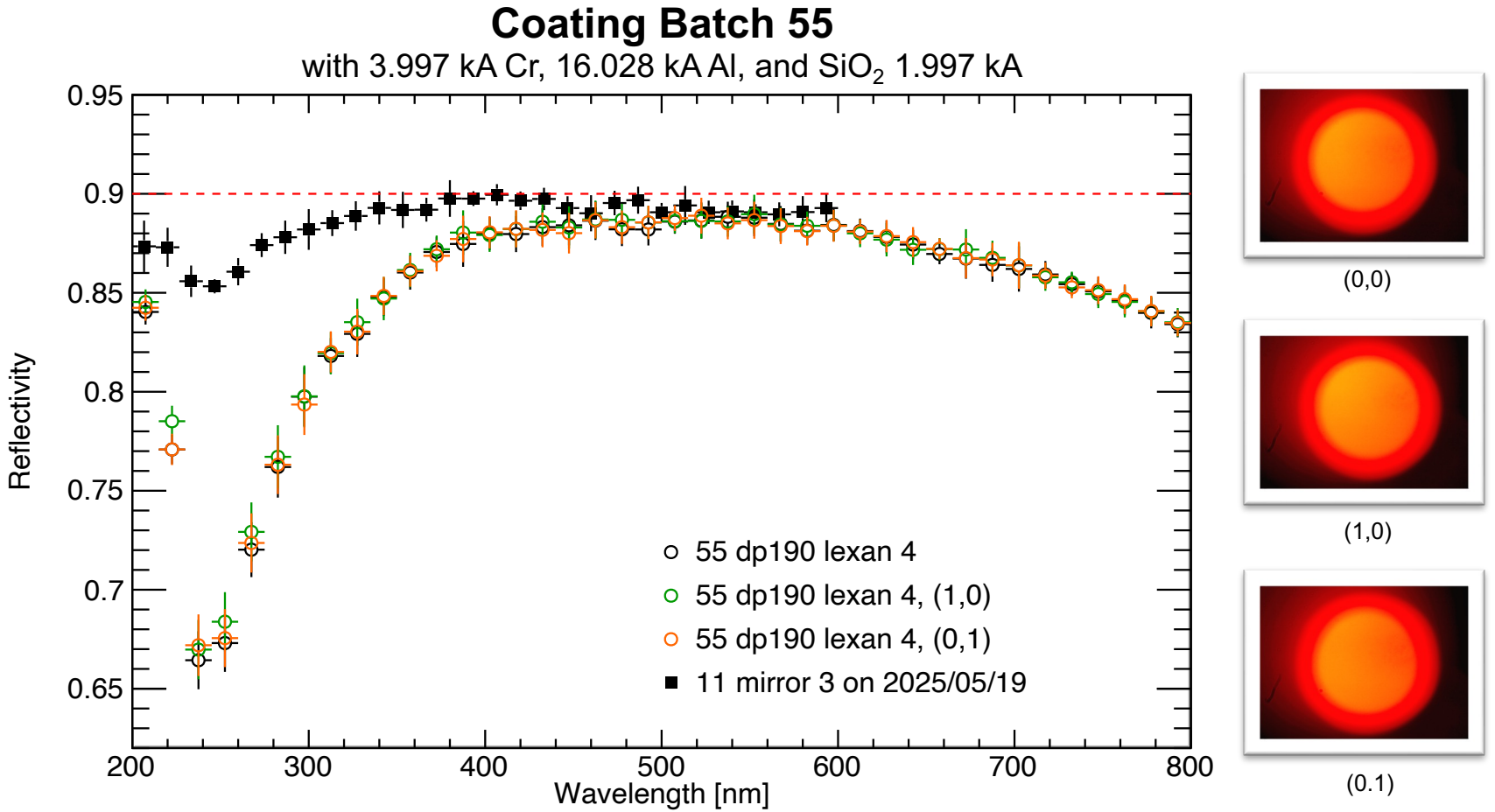
Reflectivity results were consistent across measurements.
Beam spot images showed nearly uniform appearance.

Small Mirror Reflectivity Results – #55 3



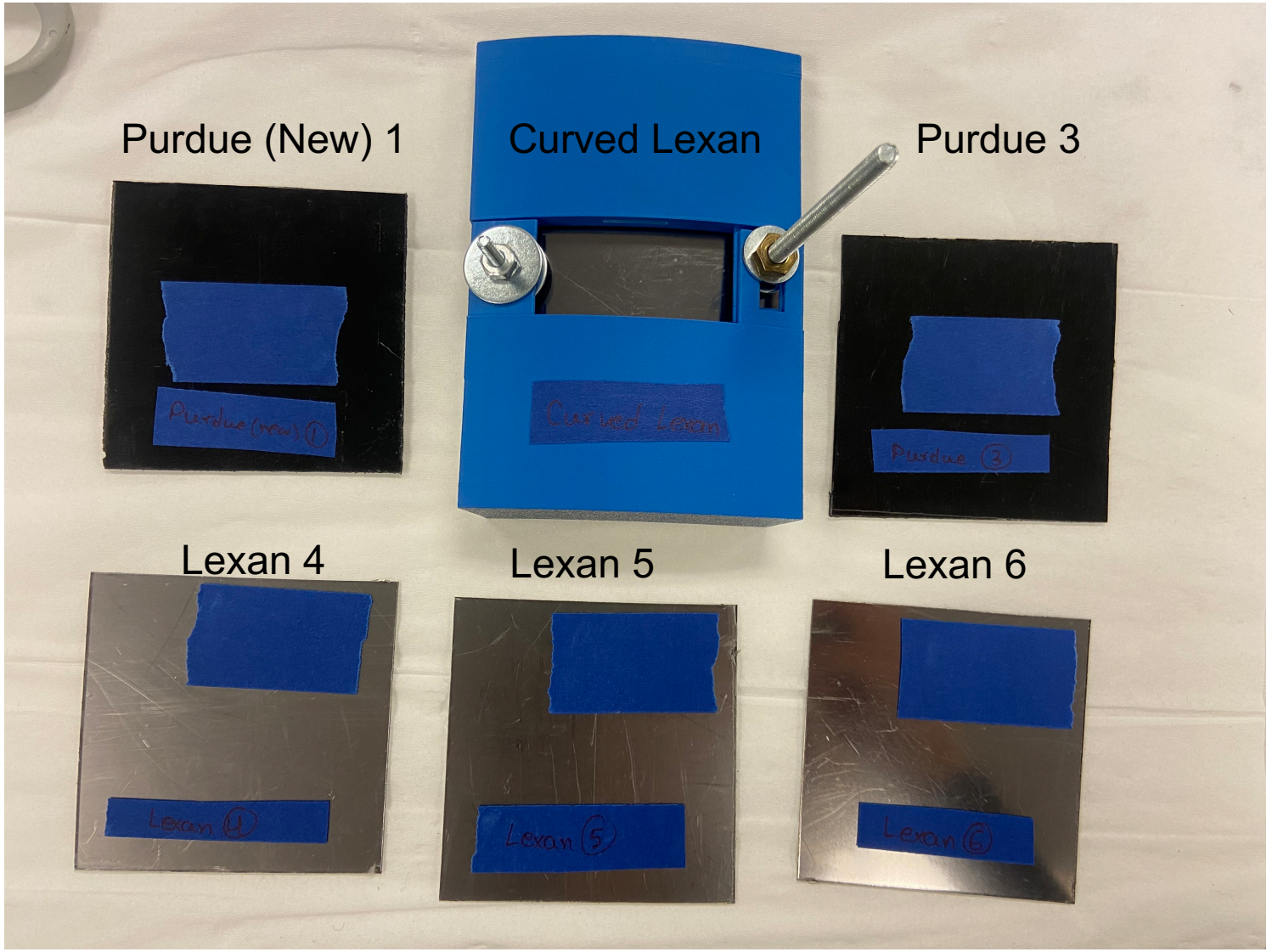
Reflectivity results were consistent across measurements.
Beam spot images showed nearly uniform appearance.

Small Mirror Reflectivity Results – #55 4

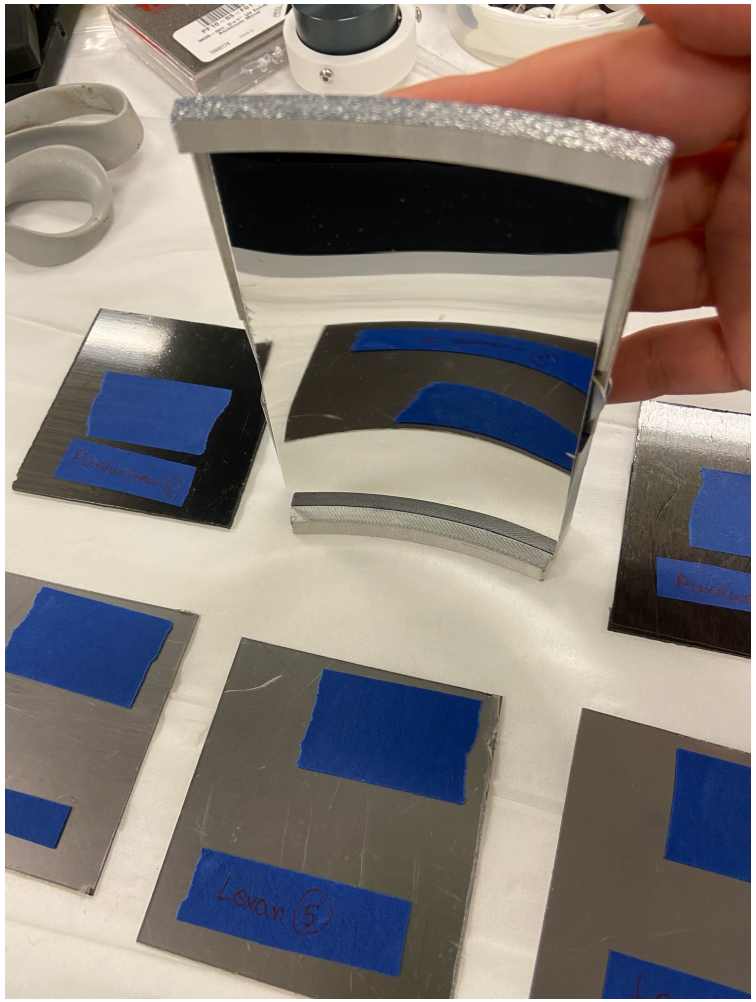


Reflectivity results were consistent across measurements.
Beam spot images showed nearly uniform appearance.

Coating Batch #56 Mirror Samples



Coating Batch #56 Mirror Samples



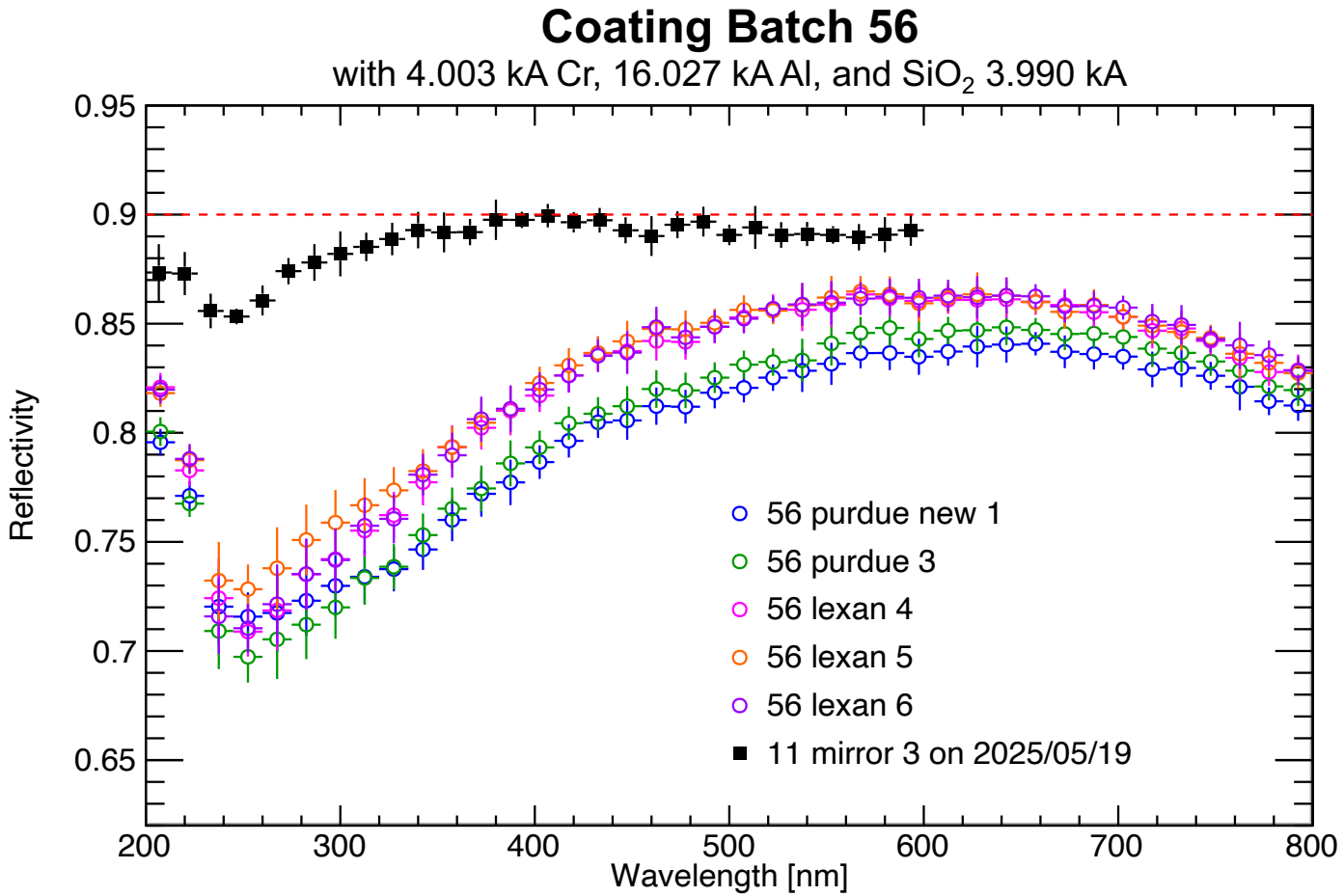
Curved small mirror sample

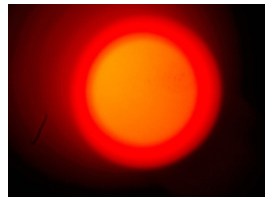
Haven’t tested it yet

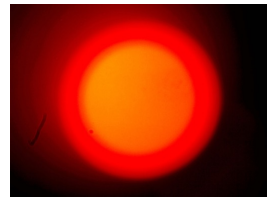
We need new mirror holder for this sample

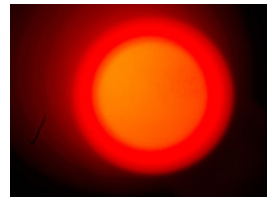
Maybe at small mirror test stand or large mirror test stand

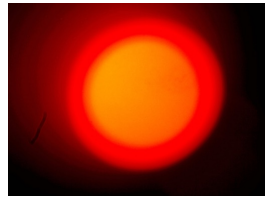
Small Mirror Reflectivity Results – #56




56 purdue new 1


56 lexan 4

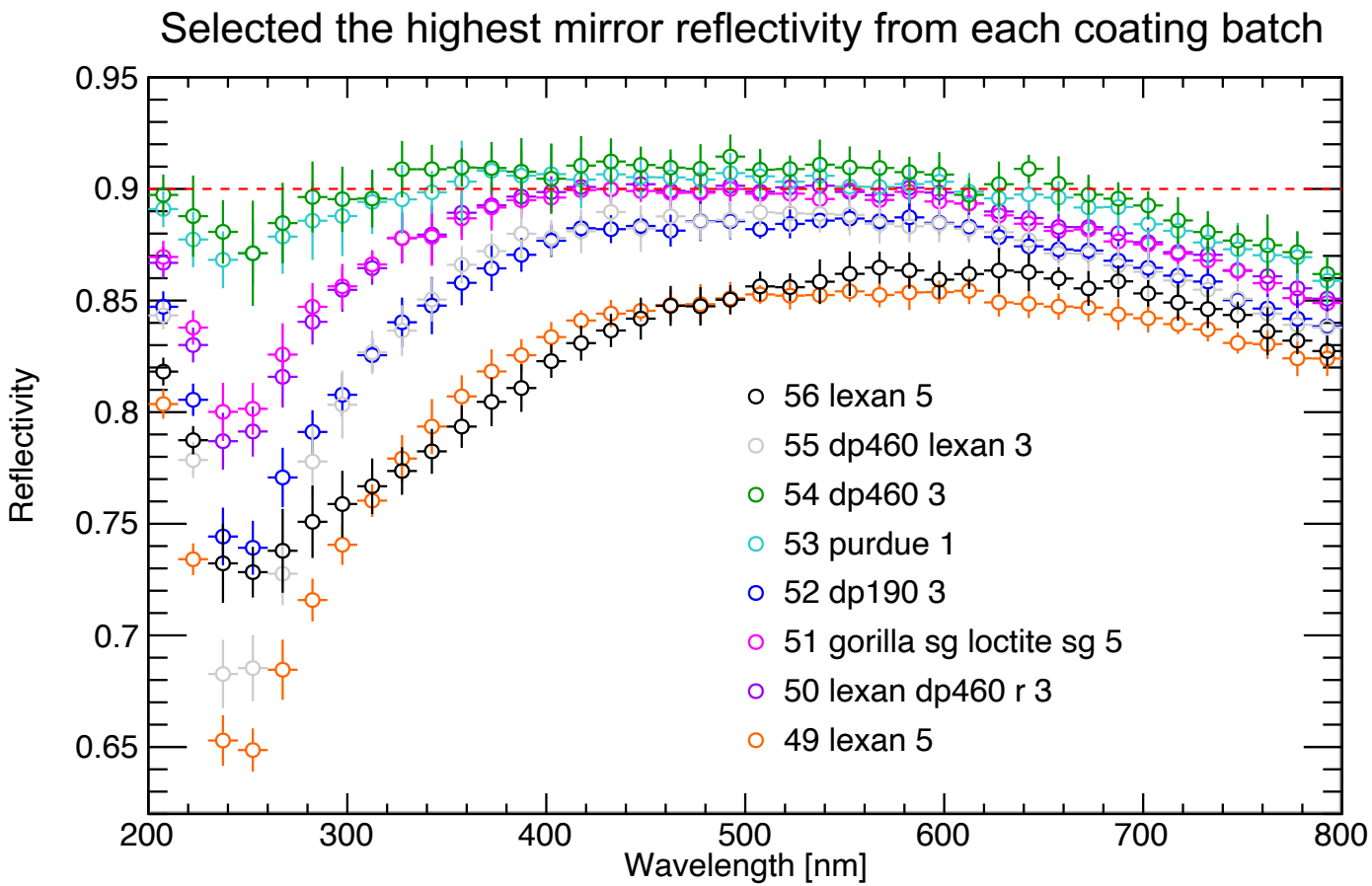

56 lexan 5


56 purdue 3


56 lexan 6

Coating Batch 56 mirrors show mixed reflectivity results — lexan substrate shows the best, while others are lower (purdue substrate). Overall, low reflectivity.

Mirror Coating Summary So Far



Coating Batch	Coating Total Thickness Cr [kA]	Al [kA]	SiO_2 [kA]
56	4.003	16.027	3.990
55	3.997	16.028	1.997
54	4.01	16.00	0
53	5.04	20.22	0
52	5.75	23	0
51	5.29	21	0
50	5.51	22.02	0
49	6.01	23.99	0

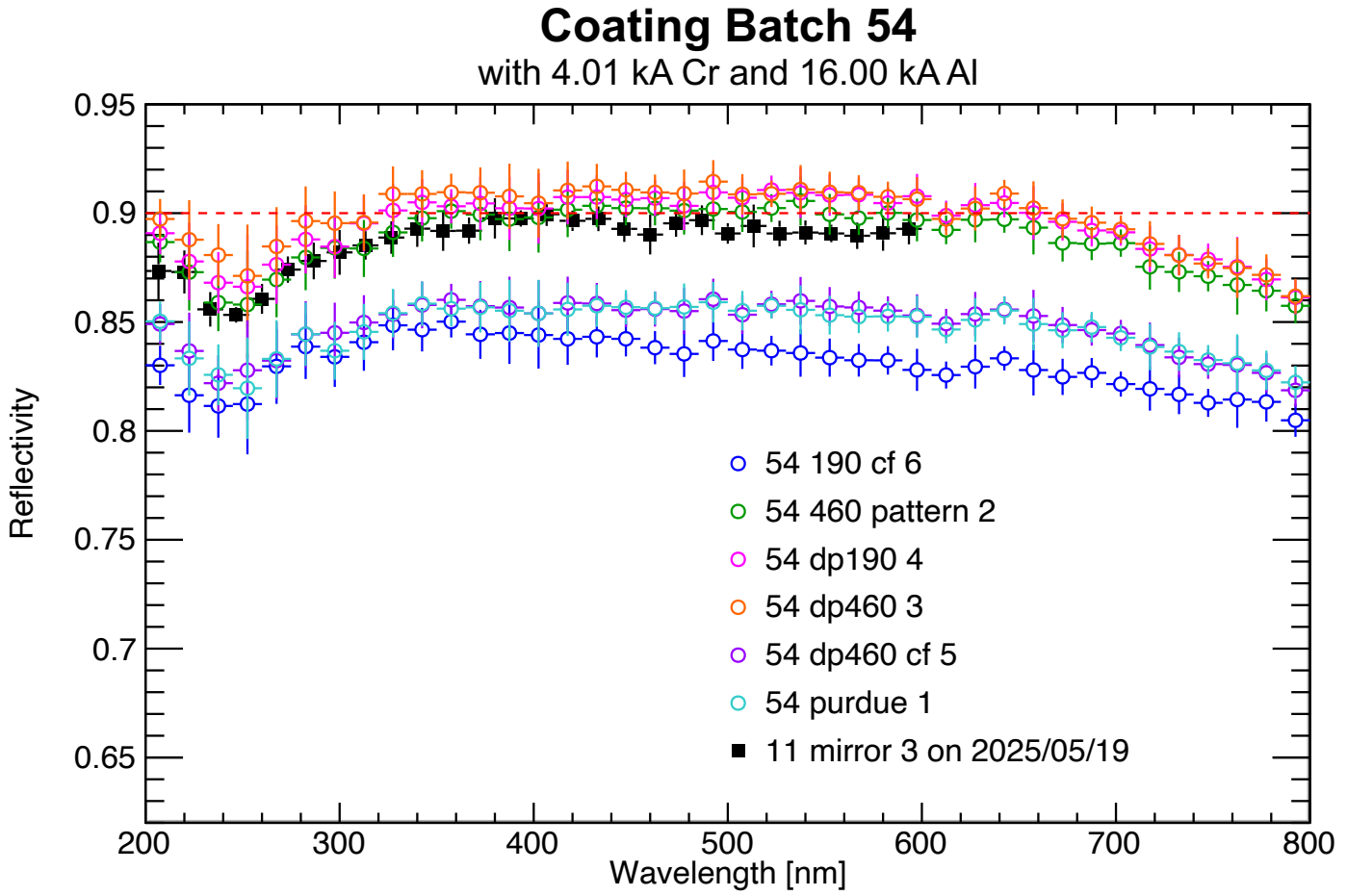
Adding thinker SiO_2 protection layer (while keeping Cr and Al thickness unchanged from Batch 54 and 55) reduces overall reflectivity. Batch #56 is a test ground for upper limit of SiO_2.

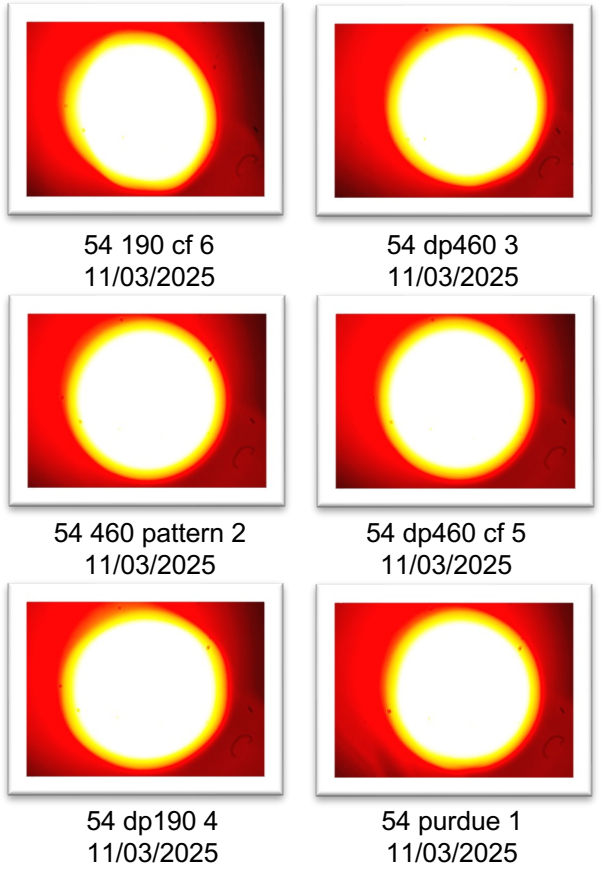
Summary

- New Batch 55 mirror reflectivity measurements were performed.
  - Added SiO_2 protection layer; Cr and Al thicknesses unchanged from Batch 54.
  - Overall reflectivity decreased by approximately 3%, with the largest reduction observed at shorter wavelengths.
  - The Lexan substrate demonstrated the highest reflectivity, while the carbon-fiber substrate showed lower performance.
  - Measurements taken from small scanned areas of the mirror samples showed consistent reflectivity results.
  - Beam-spot images displayed a nearly uniform appearance.
- New Batch 56 mirror reflectivity measurements were performed.
  - Added SiO_2 protection layer; Cr and Al thicknesses unchanged from Batch 54.
  - Overall reflectivity decreased. This result indicates the upper limits for SiO_2.
- To-Do: design new curved small mirror holder

Backup Slides

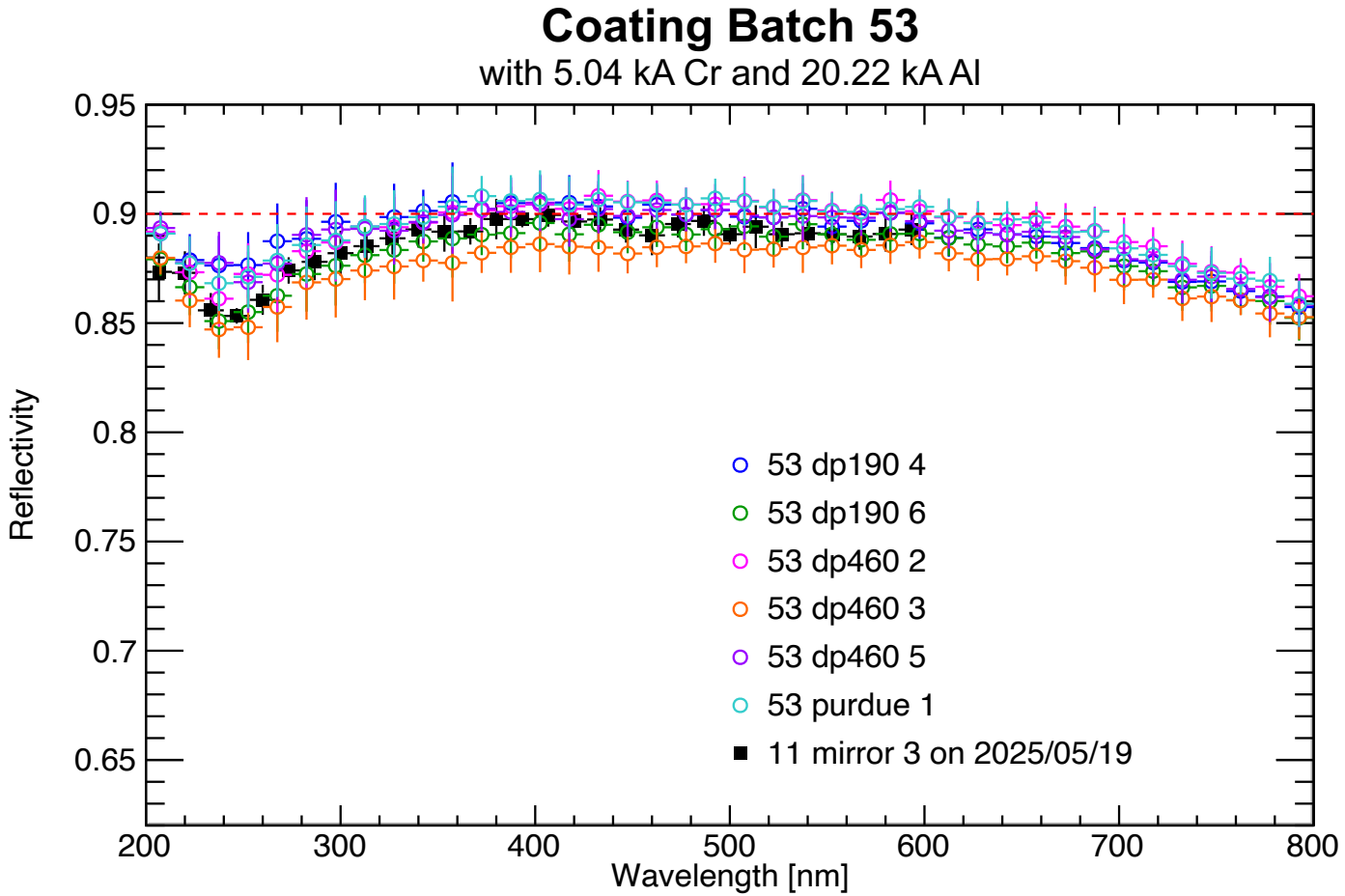
Small Mirror Reflectivity Results – #54





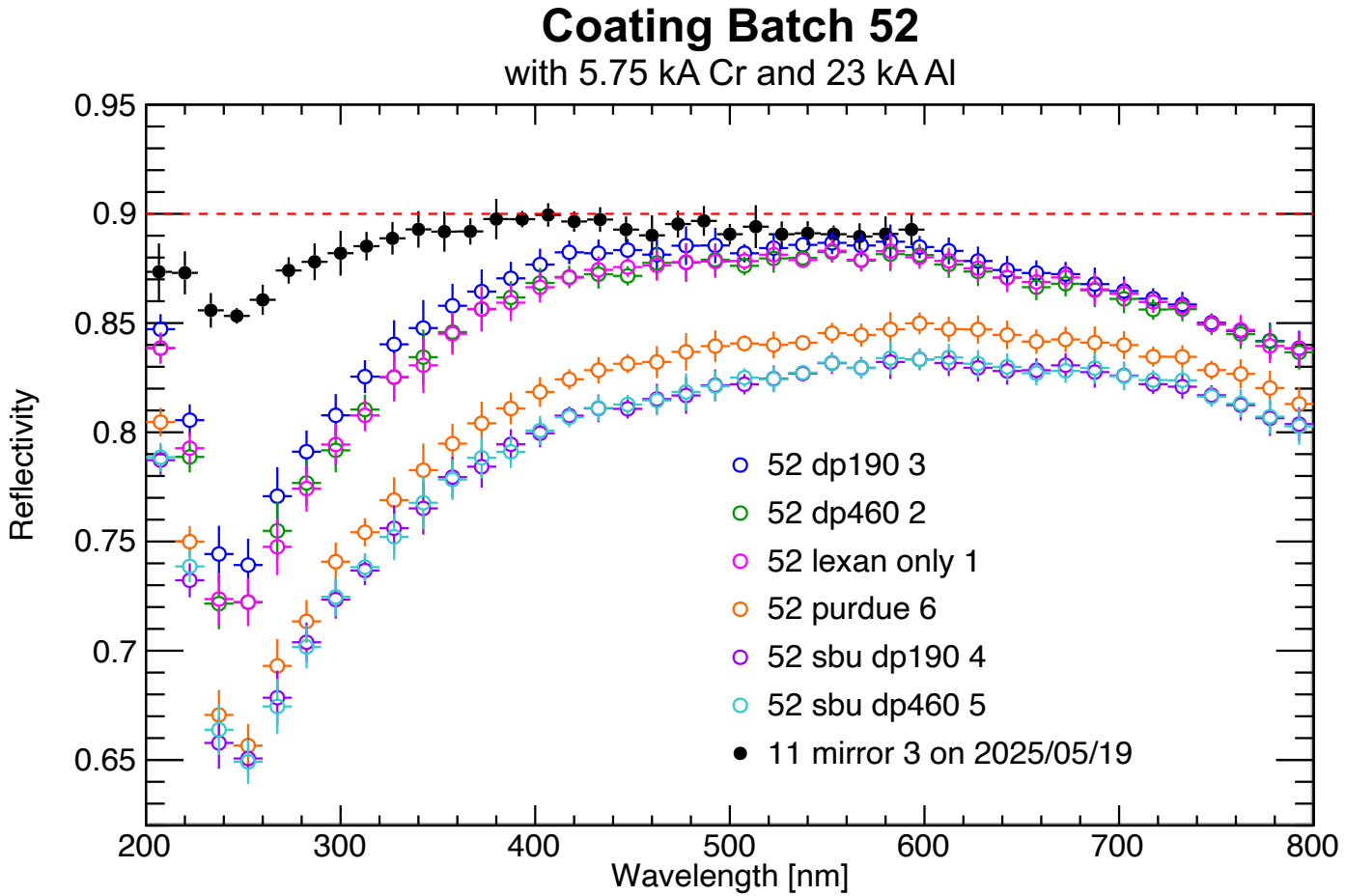
Coating Batch 54 mirrors show mixed reflectivity results — some nearly match Batch 53 or better, while others are lower (Lexan-CF and purdue substrate). Some mirrors were tightly fitted in the holder.

Small Mirror Reflectivity Results – #53



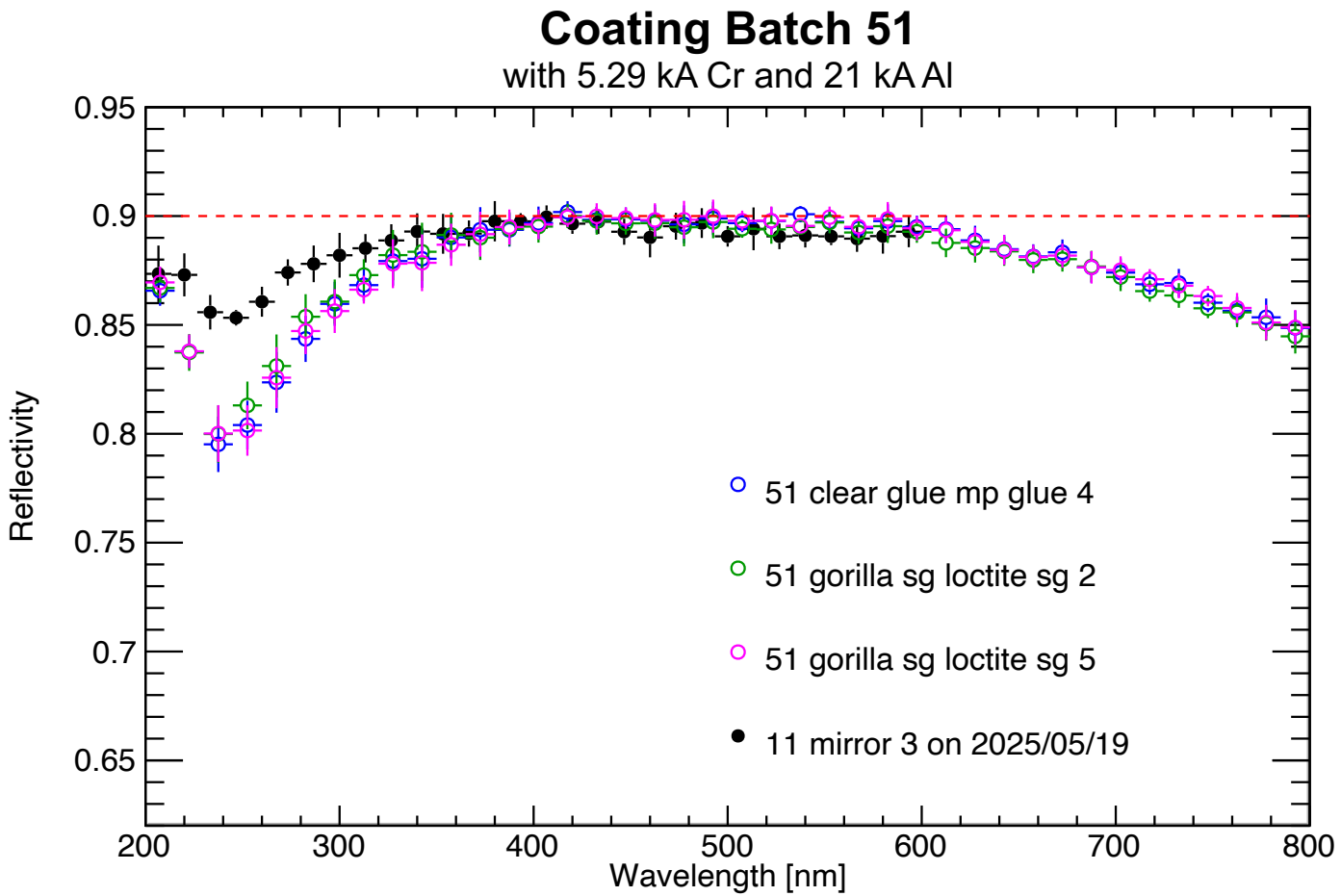
The mirrors from Coating Batch 53 achieved approximately **90% reflectivity** across the 350 – 650 nm range. Overall, these mirrors show **improved reflectivity** compared to previous batches.

Small Mirror Reflectivity Results – #52



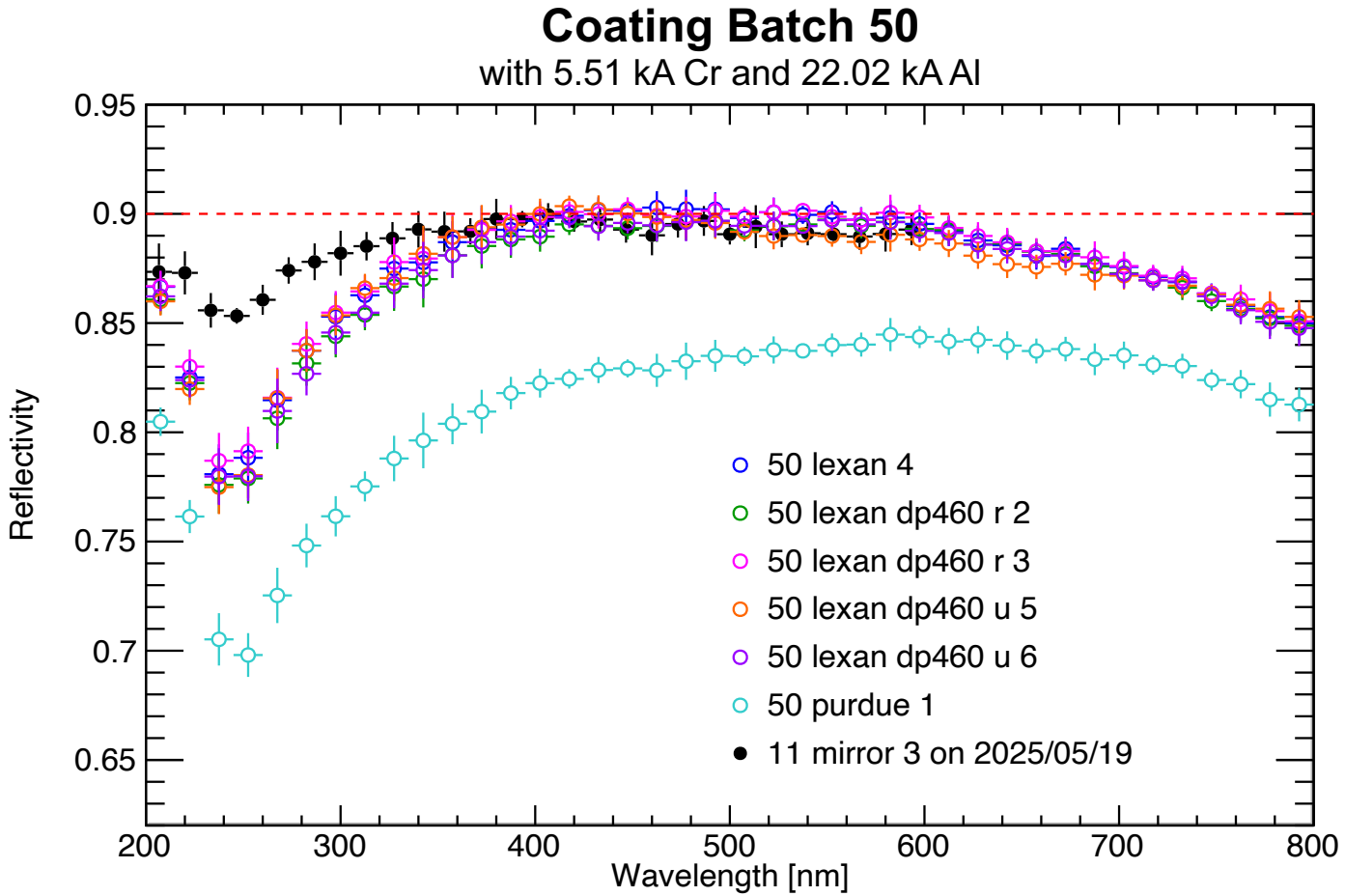
Coating Batch 52 mirrors show mixed reflectivity results — some nearly match the reference (within 1–2%), while others are lower (82–84%). Some mirrors were tightly fitted in the holder.

Small Mirror Reflectivity Results – #51



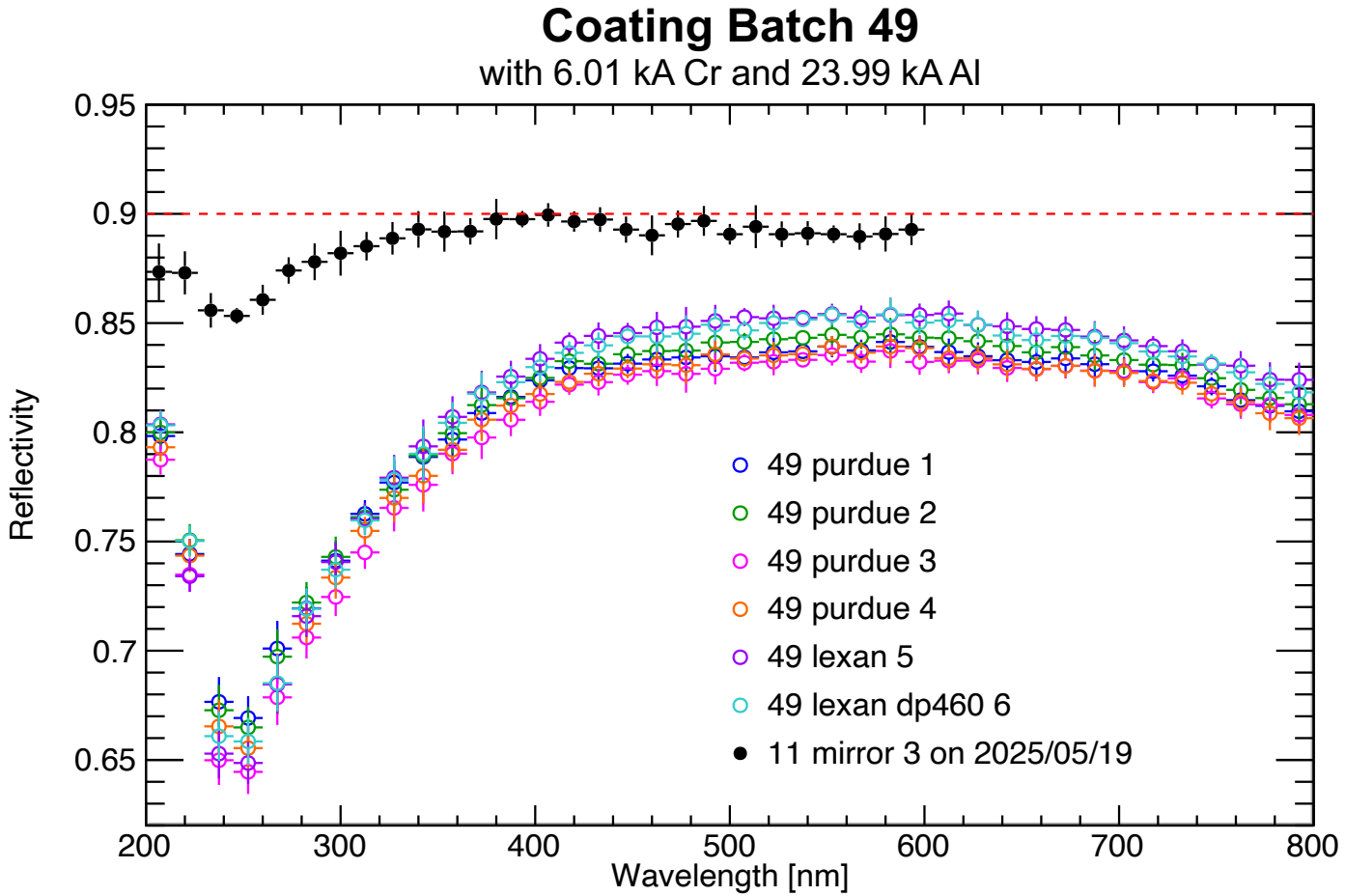
Mirrors from Coating Batch 51 exhibit approximately 90% reflectivity in the 400–600 nm range.

Small Mirror Reflectivity Results – #50



Mirrors from Coating Batch 50 show approximately 90% reflectivity across 400–600 nm, with *Purdue 1* as an exception.

Small Mirror Reflectivity Results – #49



The mirror from Coating Batch 49 reaches a maximum reflectivity of **85%**.