Mirror Reflectivity Measurements at Small Mirror Test Stand

Jihee Kim (jkim11@bnl.gov), Jan Vanek (UNH), and Zhoudunming Tu (BNL)
Brookhaven National Laboratory

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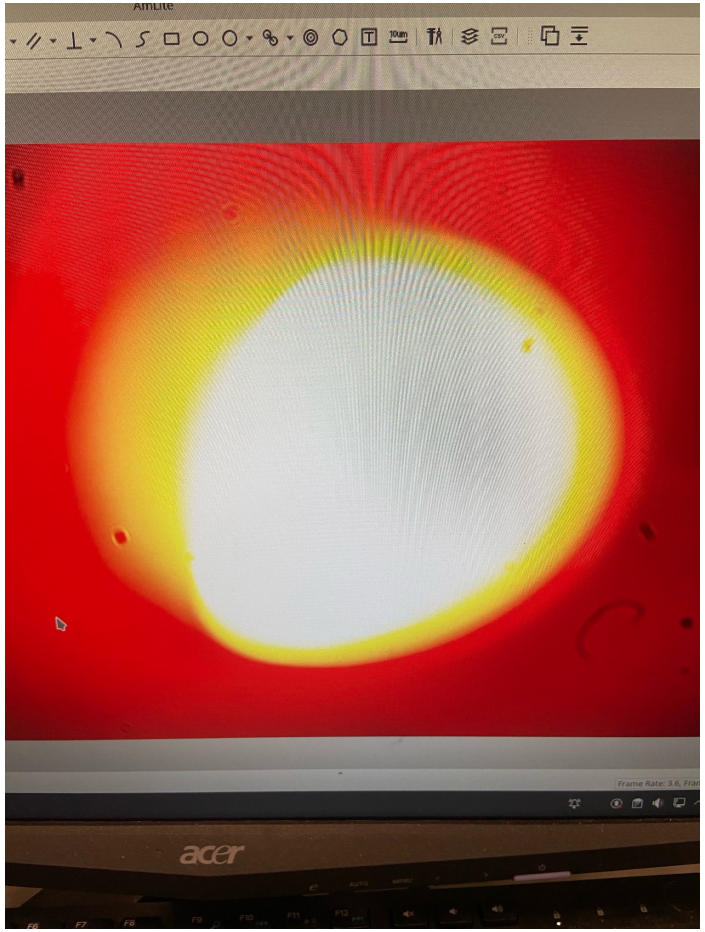
ePIC pfRICH Engineering/Design Meeting

Overview

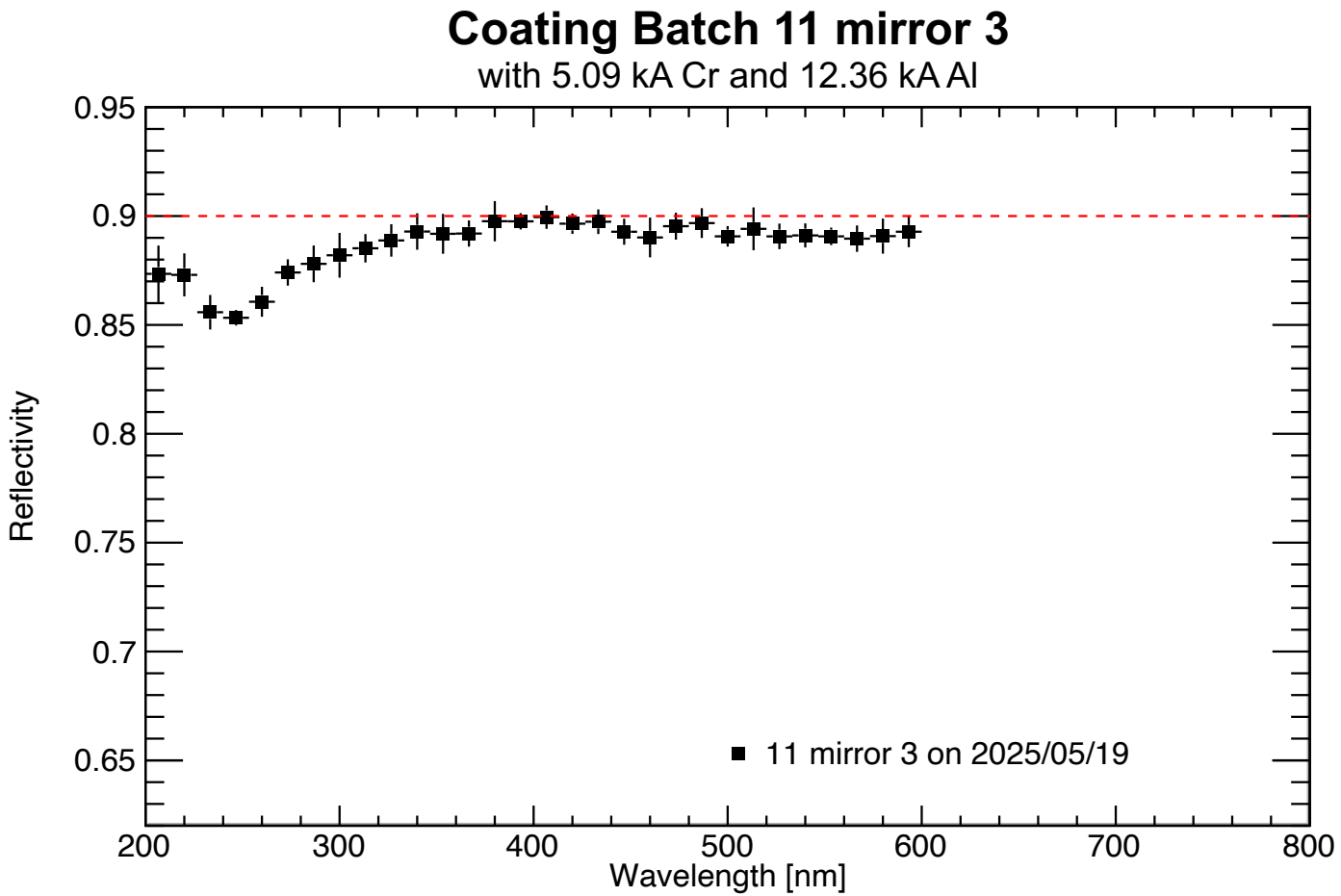
- Made sure that iris of monochromator is fully opened.
- Performed new direct light measurement.
- Performed small mirror reflectivity measurements.
  - Coating batch 11: 1 mirror with 5.09 kA Cr and 12.36 kA Al (cross-check)
    - 11 mirror 3 (aka reference mirror)
  - Coating batch 53: 6 mirrors with 5.04 kA Cr and 20.22 kA Al (new)
  - Coating batch 37: 2 mirrors with 4 kA Cr and 17.01 kA Al (cross-check)
  - Round reference mirrors: OceanInsight (new) and ThorLabs (cross-check)
- Added mirror reflectivity result as a matrix in eic/epic repository
- Made comparisons of ThorLabs with previous measurements.

Coating Batch 11 Mirror 3 Alignment

- Alignment image appeared distorted.
- The mirror surface showed slight distortion (my reflection appeared a bit warped).
- This is known.

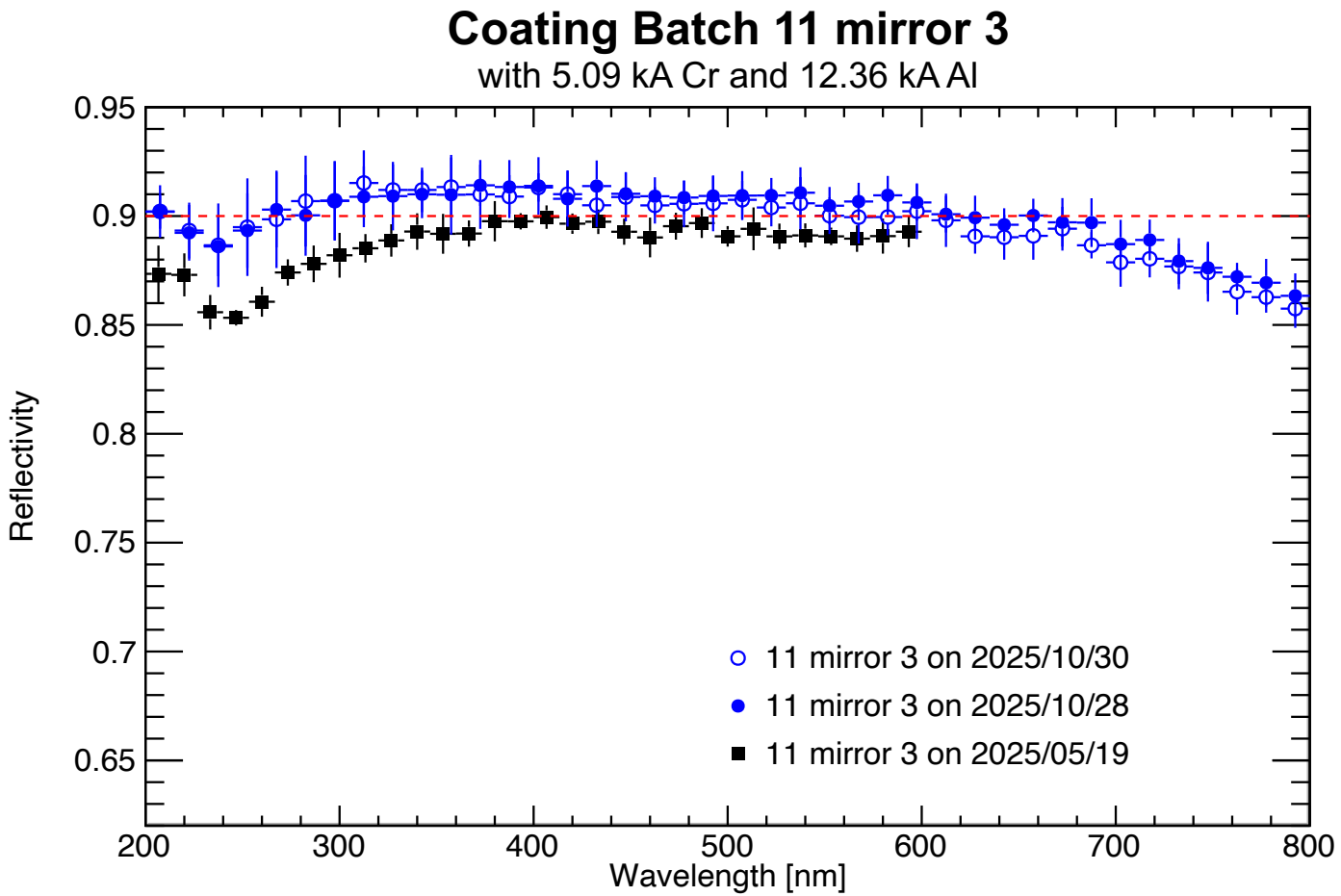


Small Mirror Reflectivity Results – Ref.



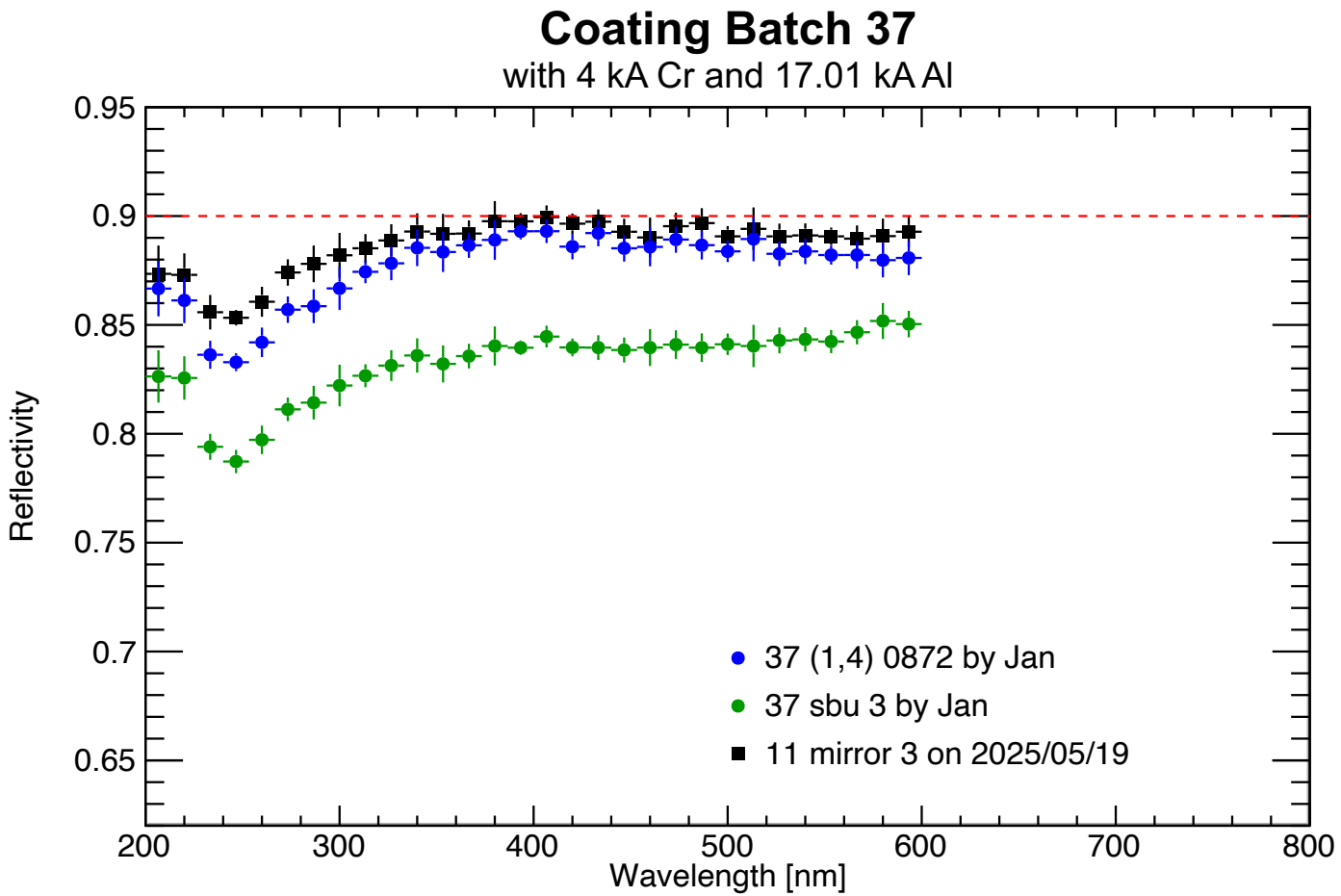
The reflectivity of Coating Batch 11, Mirror 3, is used as the reference.

Small Mirror Reflectivity Results – Ref.



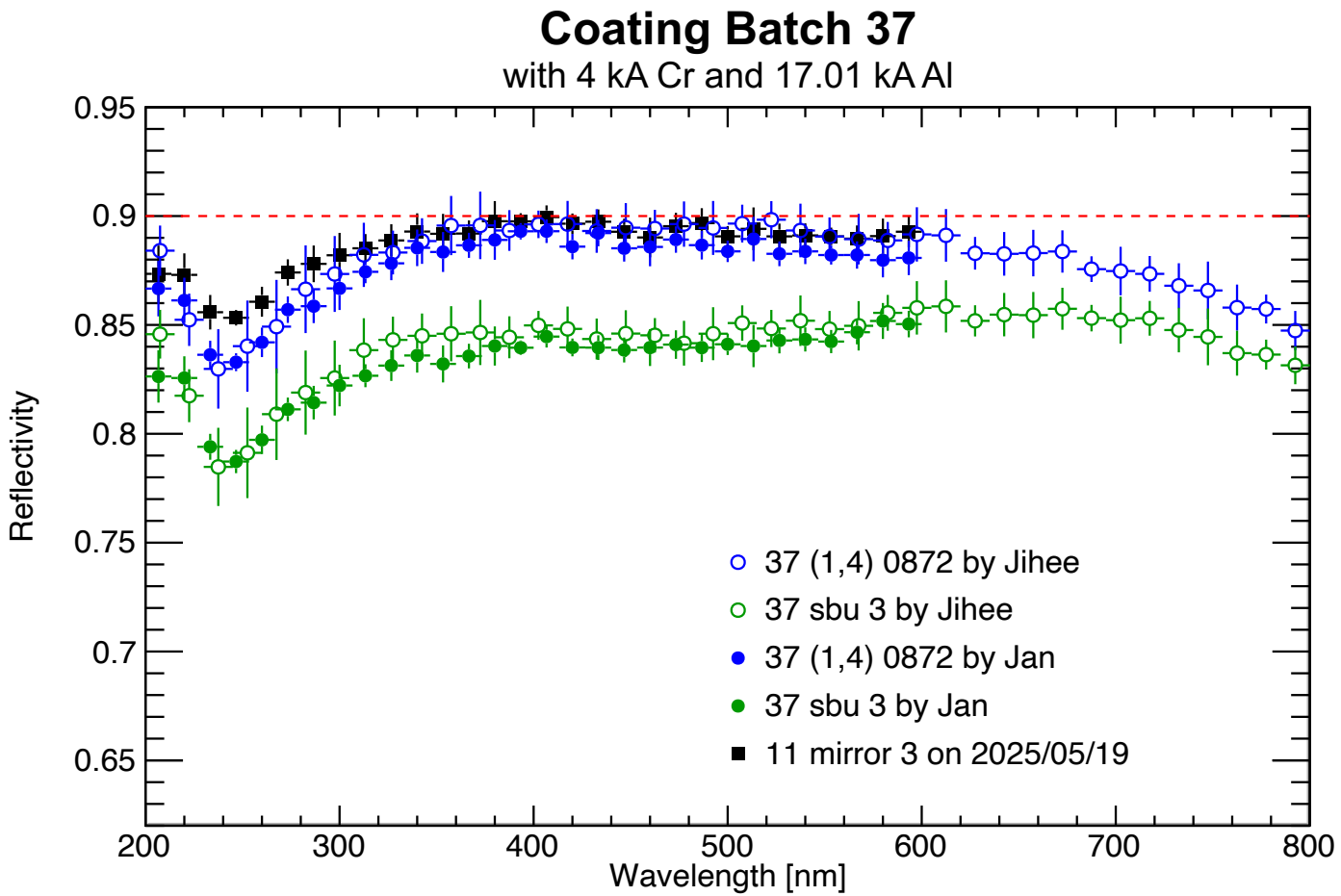
Re-measured the reflectivity of Coating Batch 11, Mirror 3 since new lamp was installed
It turned out that mirror reflectivity of Coating Batch 11, Mirror 3 got better?

Small Mirror Reflectivity Results – #37



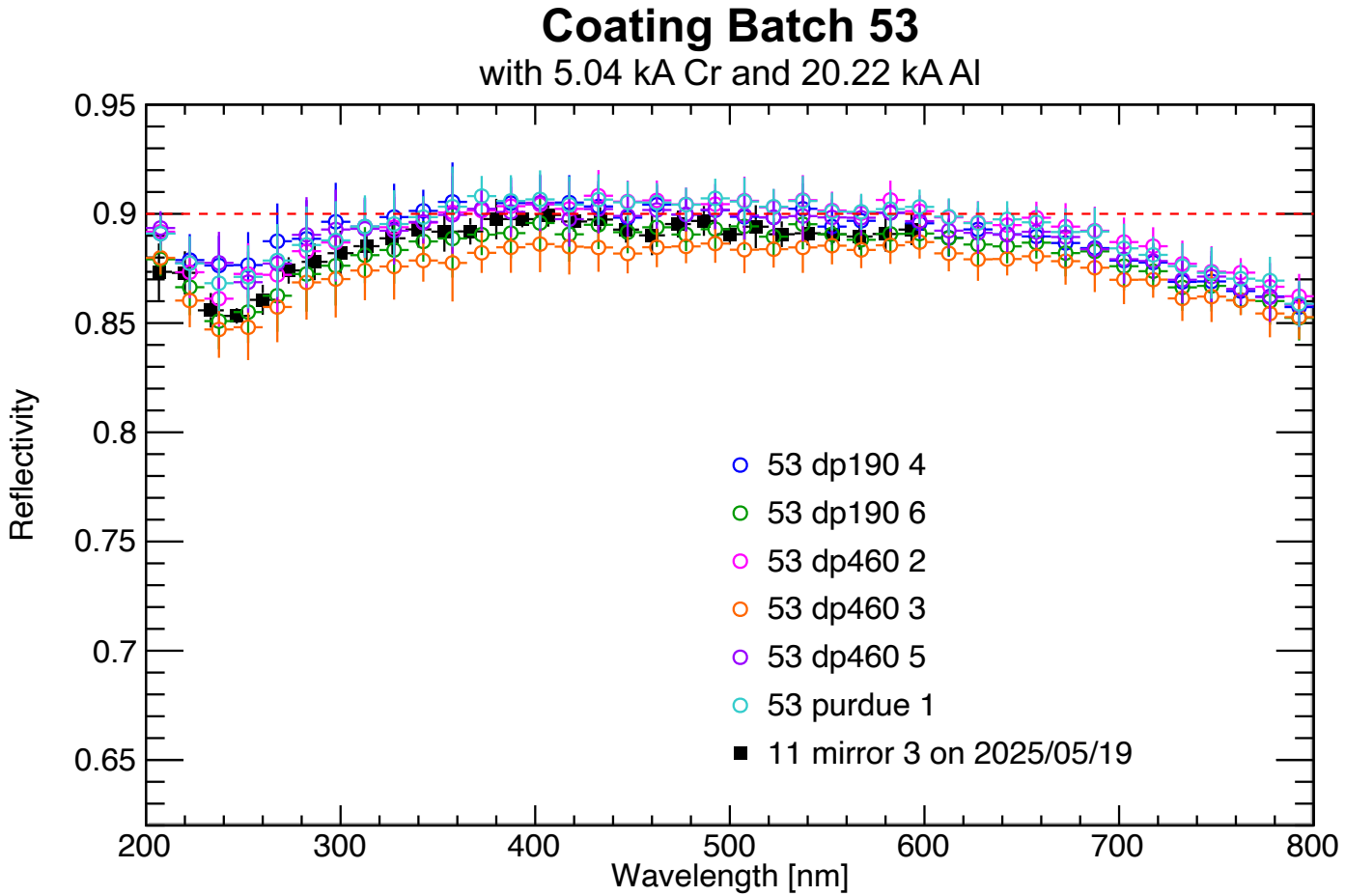
Picked two mirror samples of Coating Batch 37 before lamp started having issue
(Jan reported Coating Batch 37 measurements on May 19, 2025)

Small Mirror Reflectivity Results – #37



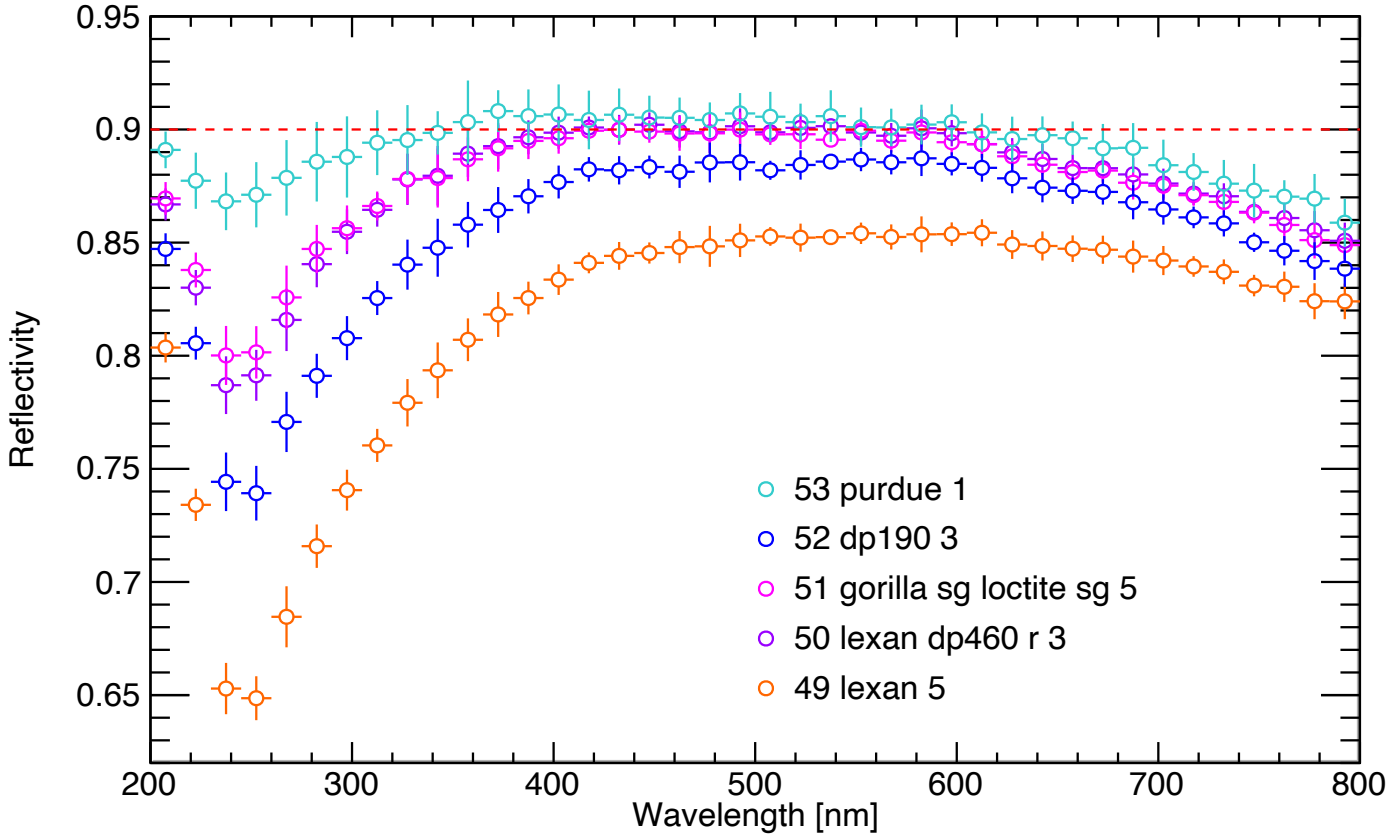
New measurements are slightly higher, but they are in a good agreement with previous results.

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.

Coating Summary So Far



Coating Batch	Coating Thickness Cr [kA]	Al [kA]
53	5.04	20.22
52	5.75	23
51	5.29	21
50	5.51	22.02
49	6.01	23.99

Picked the best mirror reflectivity (to me) per coating batch and listed coating information, respectively.

Mirror Reflectivity Parameterization

- The best mirror reflectivity result was added to a matrix to *epic/compact/optical_materials.xml*.
- 53 purdue 1 data was shown.
- Created an issue (https://github.com/eic/epic/issues/974).
- Created pull request (https://github.com/eic/epic/pull/975).
- Assigned Alexander and Brian as reviewers.

```
<matrix name = "REFLECTIVITY_PFRICH_mirror" coldim="2" values="
  207.5*nm  0.89098
  222.5*nm  0.877347
  237.5*nm  0.868242
  252.5*nm  0.871153
  267.5*nm  0.878631
  282.5*nm  0.885751
  297.5*nm  0.88786
  312.5*nm  0.894157
  327.5*nm  0.895331
  342.5*nm  0.898498
  357.5*nm  0.903268
  372.5*nm  0.908119
  387.5*nm  0.905915
  402.5*nm  0.90662
  417.5*nm  0.904206
  432.5*nm  0.906525
  447.5*nm  0.90527
  462.5*nm  0.905159
  477.5*nm  0.904196
  492.5*nm  0.907093
  507.5*nm  0.905641
  522.5*nm  0.903252
  537.5*nm  0.905889
  552.5*nm  0.901025
  567.5*nm  0.90091
  582.5*nm  0.902174
  597.5*nm  0.903194
  612.5*nm  0.898724
  627.5*nm  0.895776
  642.5*nm  0.897481
  657.5*nm  0.896123
  672.5*nm  0.891675
  687.5*nm  0.891897
  702.5*nm  0.884201
  717.5*nm  0.881216
  732.5*nm  0.876046
  747.5*nm  0.872974
  762.5*nm  0.870306
  777.5*nm  0.86943
  792.5*nm  0.858807
  "/>
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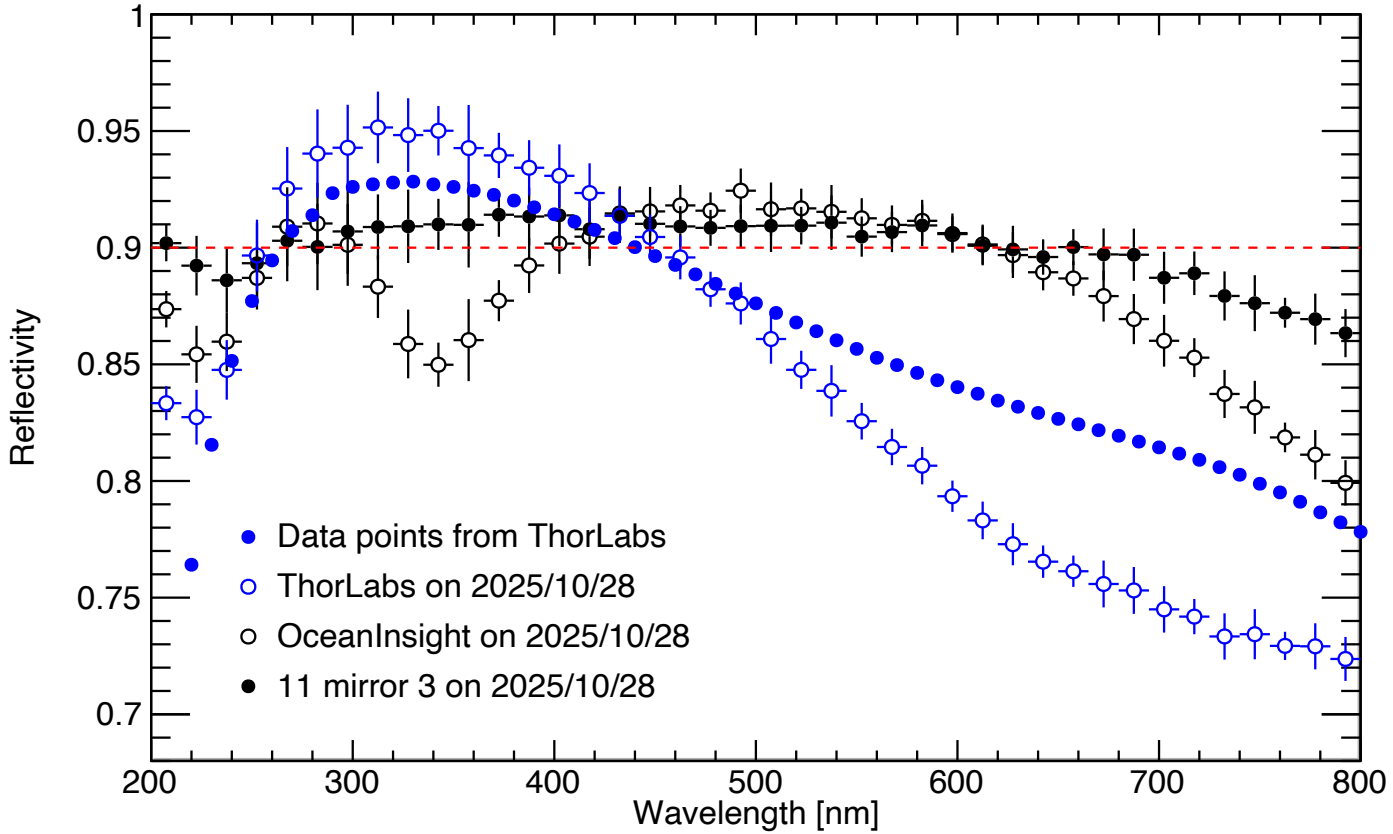
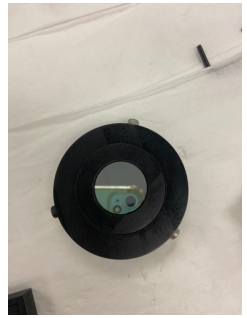
Small Round Mirror Reflectivity Results



Ocean Insight

ThorLabs



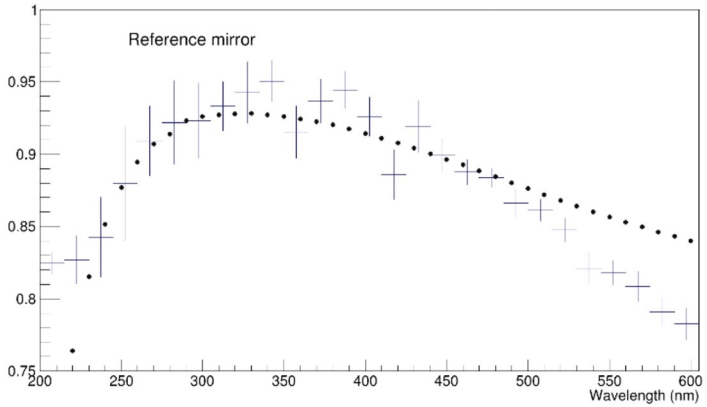
OceanInsight is reference mirror for large mirror test stand (white 3D printed mirror holder)
ThorLabs is reference mirror: mirror holder position moved to align (black 3D printed mirror holder)

Small Round Mirror Reflectivity Results

- Jan reported Thorlabs mirror on Oct 6, 2025

Reference mirror measurement

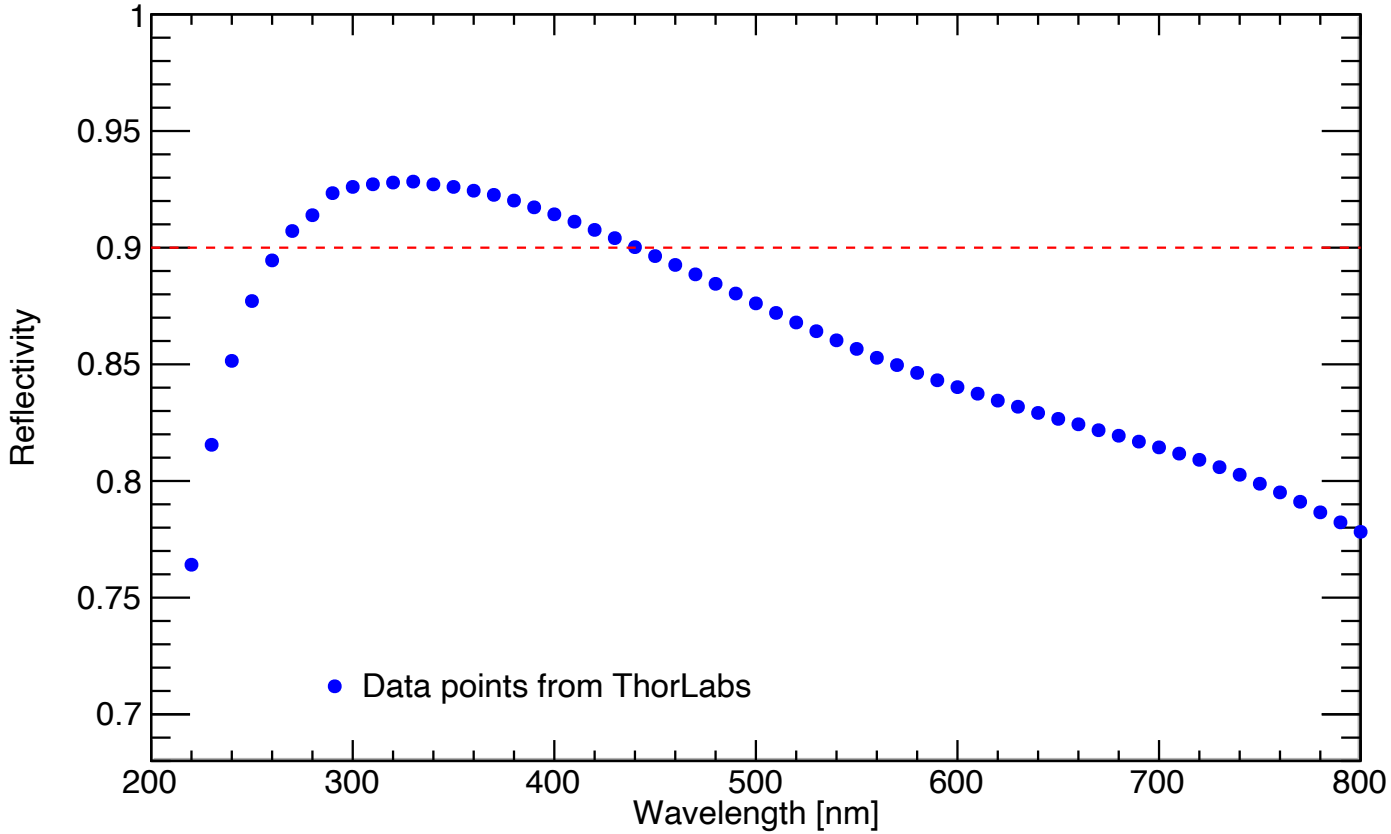
- Thorlabs mirror
- New lamp in monochromator
  - Re-measured reference mirror and direct light reference
- Checked and ensured good alignment after long downtime
- Observations
  - Very large errors compared to precious measurements
    - Need to determine what is going on
  - Overall shape looks OK



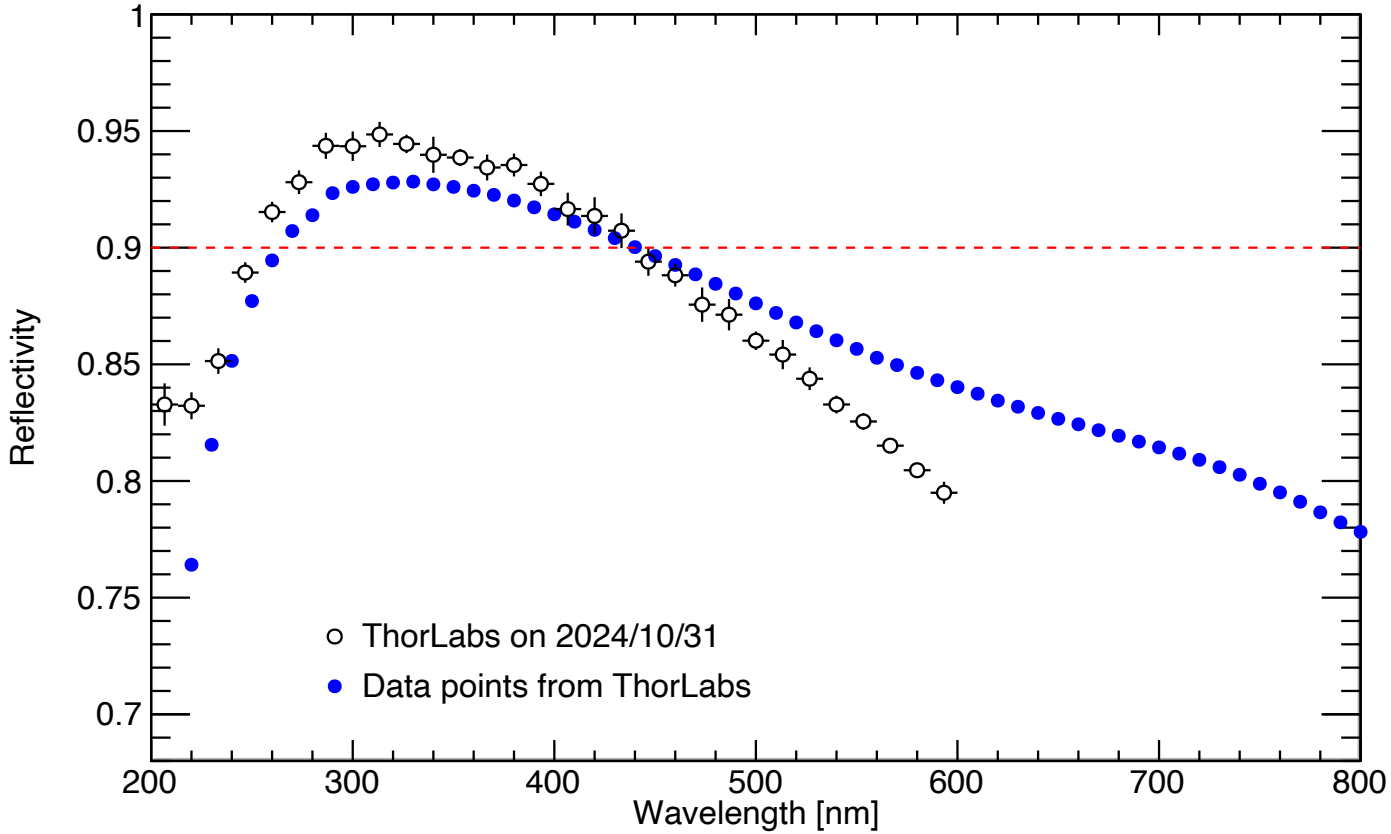
3

https://indico.bnl.gov/event/30127/contributions/114651/attachments/65340/112195/Mirror-20251006.pdf

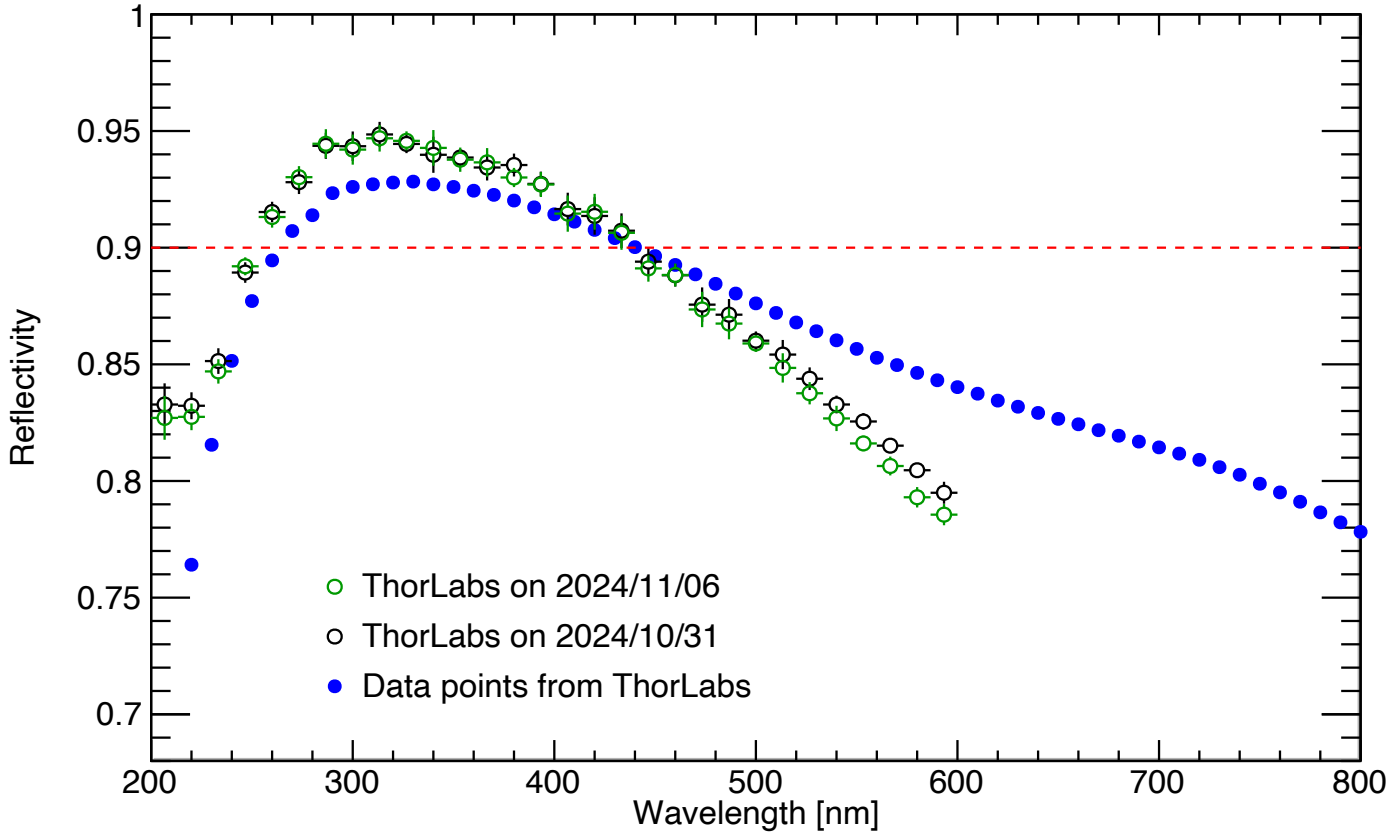
Comparison – ThorLabs Round Mirror



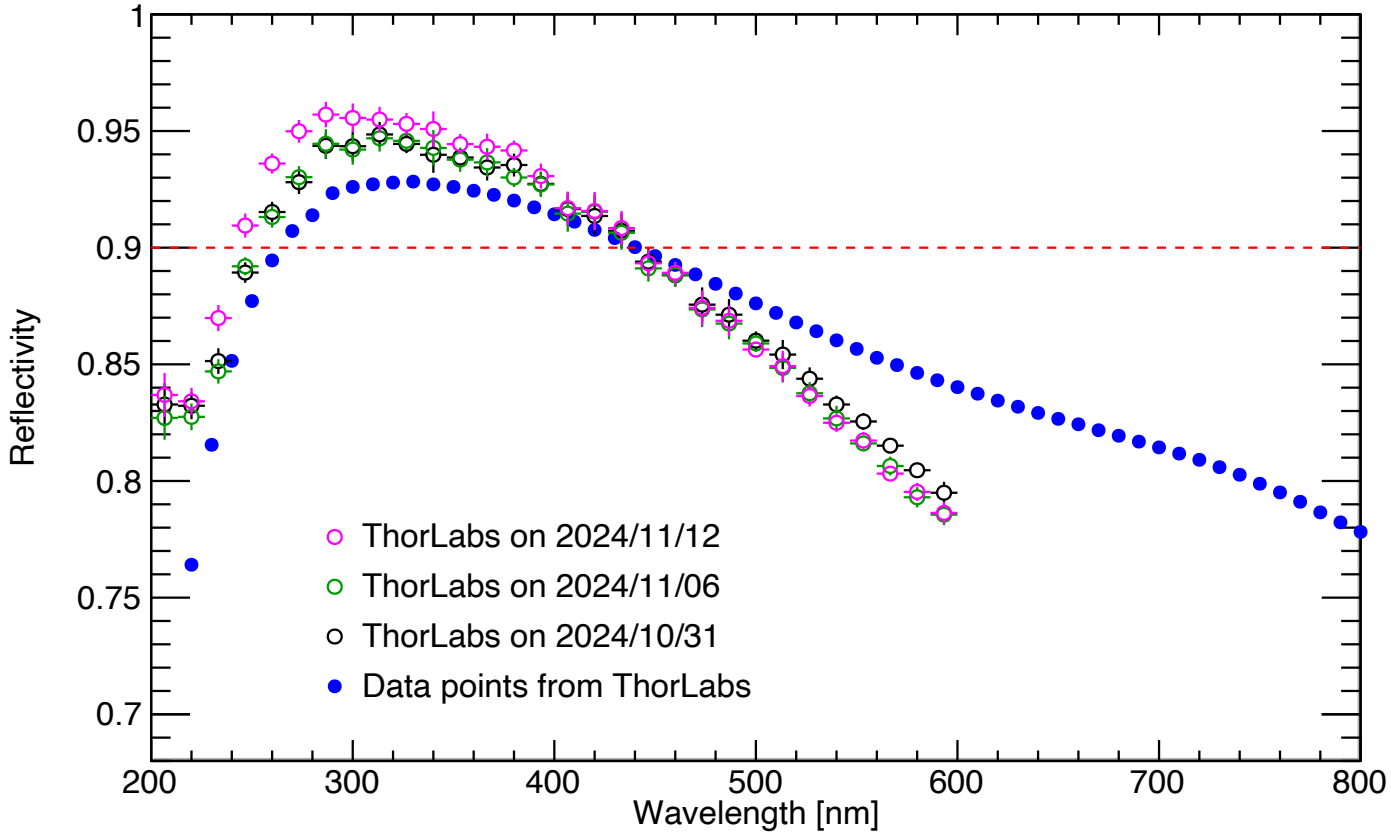
Comparison – ThorLabs Round Mirror



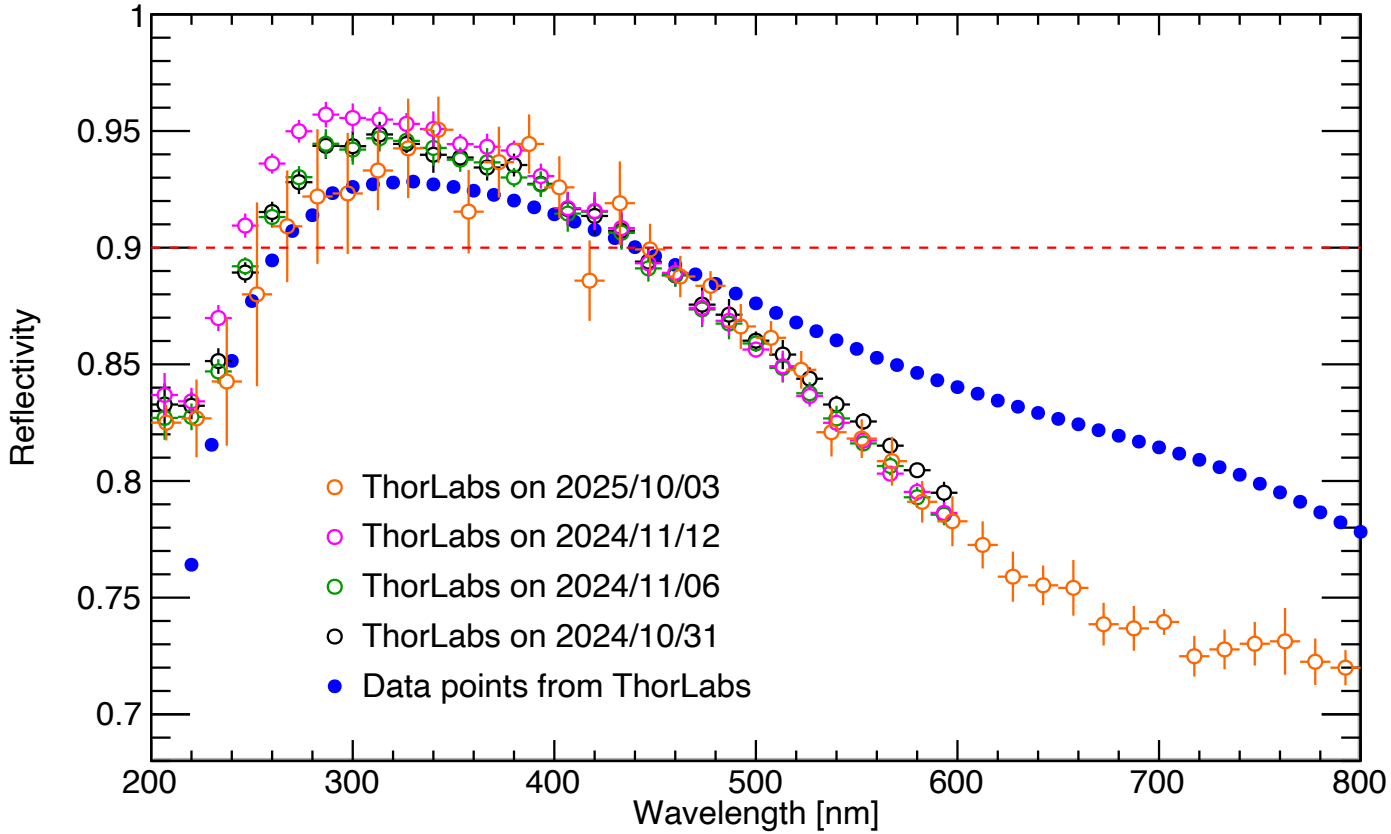
Comparison – ThorLabs Round Mirror



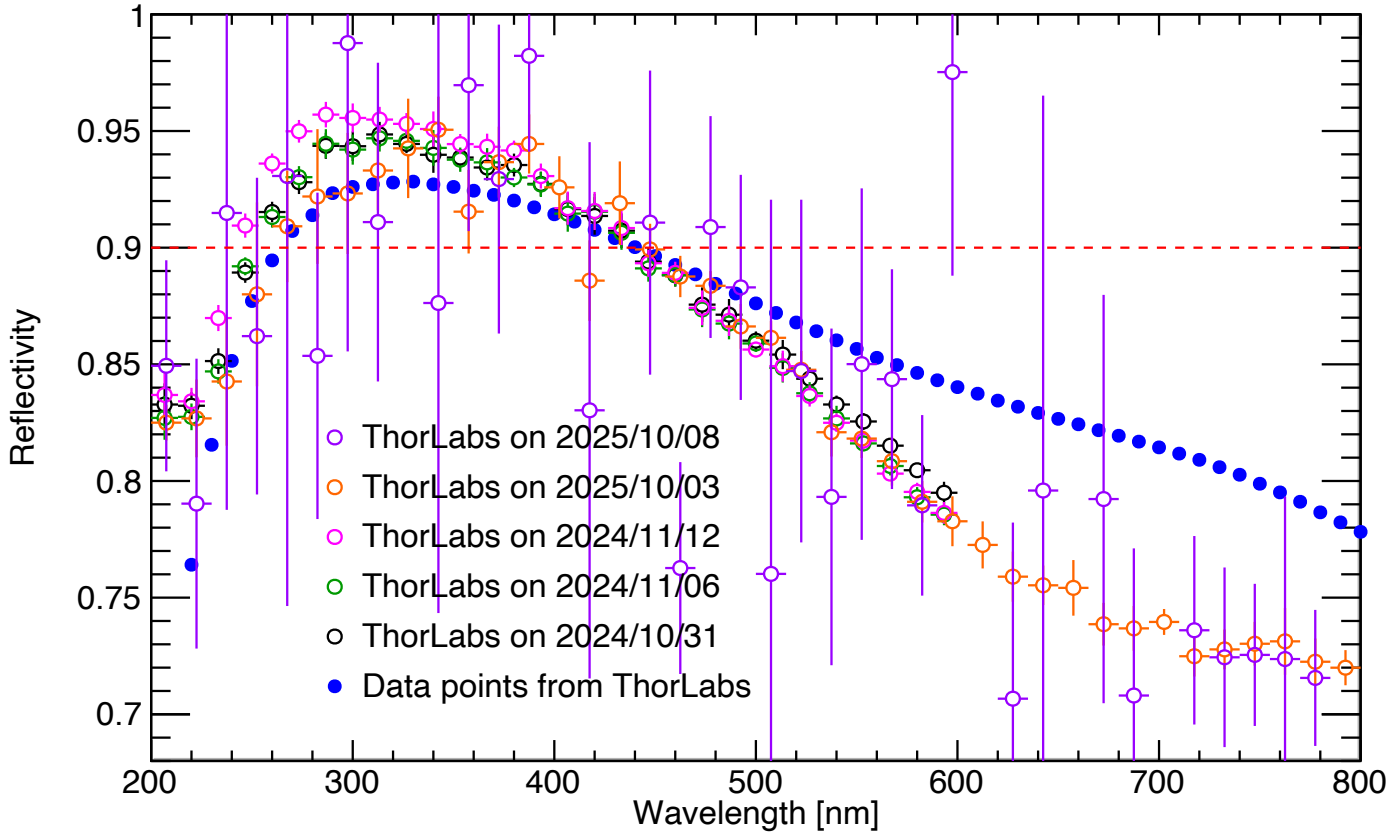
Comparison – ThorLabs Round Mirror



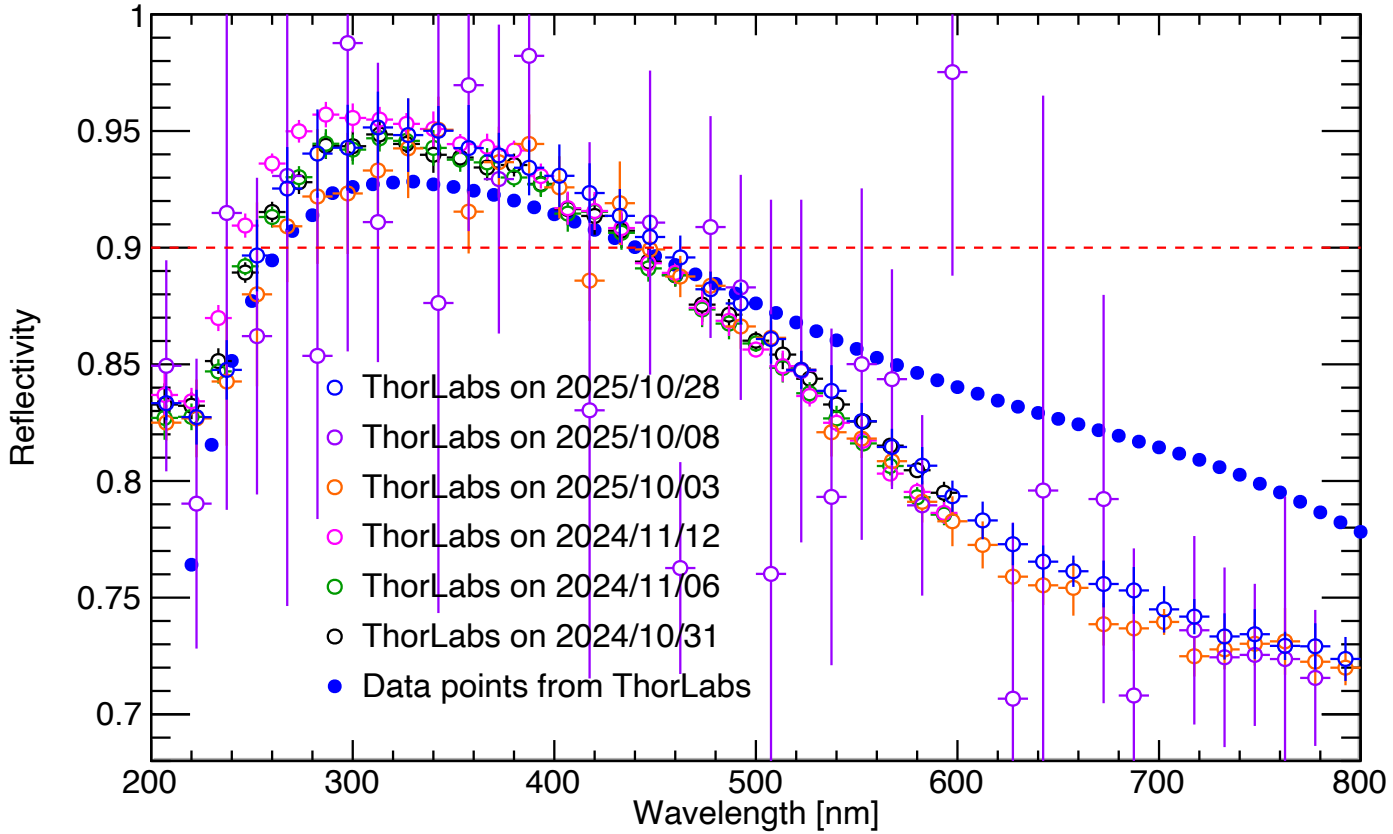
Comparison – ThorLabs Round Mirror



Comparison – ThorLabs Round Mirror



Comparison – ThorLabs Round Mirror



New measurement (open blue) is in a good agreement with previous results, but different from data sheet from ThorLabs

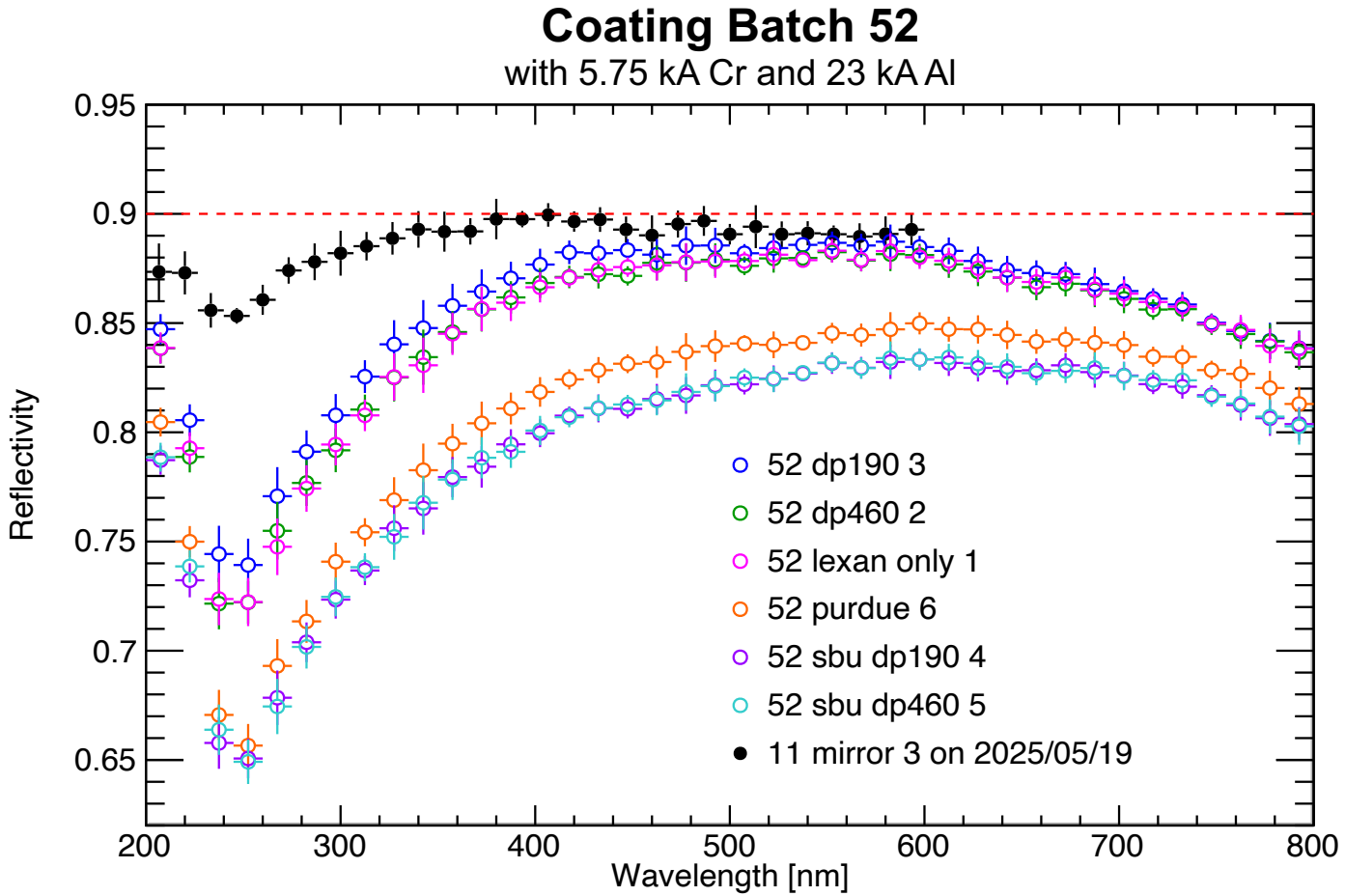
Summary and Next Plan

- New coating batch 53 mirror samples were tested. Looking good.
- From batch 49 to 53, we see improvement in mirror reflectivity clearly across wavelength and all 6 samples in batch are consistent.
- Mirror reflectivity result was added into epic repository.
- In addition to that, small round reference mirrors were tested.
  - Ocean Insight
    - Good to have for large mirror test stand, and observed a dip around 350 nm
  - ThorLab
    - New measurement is in a good agreement with previous results
    - Need to understand large errorbars and discrepancy when compared to data sheet from ThorLabs

- ❑ Look into current and past direct light measurements to check if they are consistent
- ❑ Look into past mirror reflectivity results of coating batch 11 mirror 3 (cross-check)
- ❑ Familiarize my self with entire measurement procedure for large mirror test stand

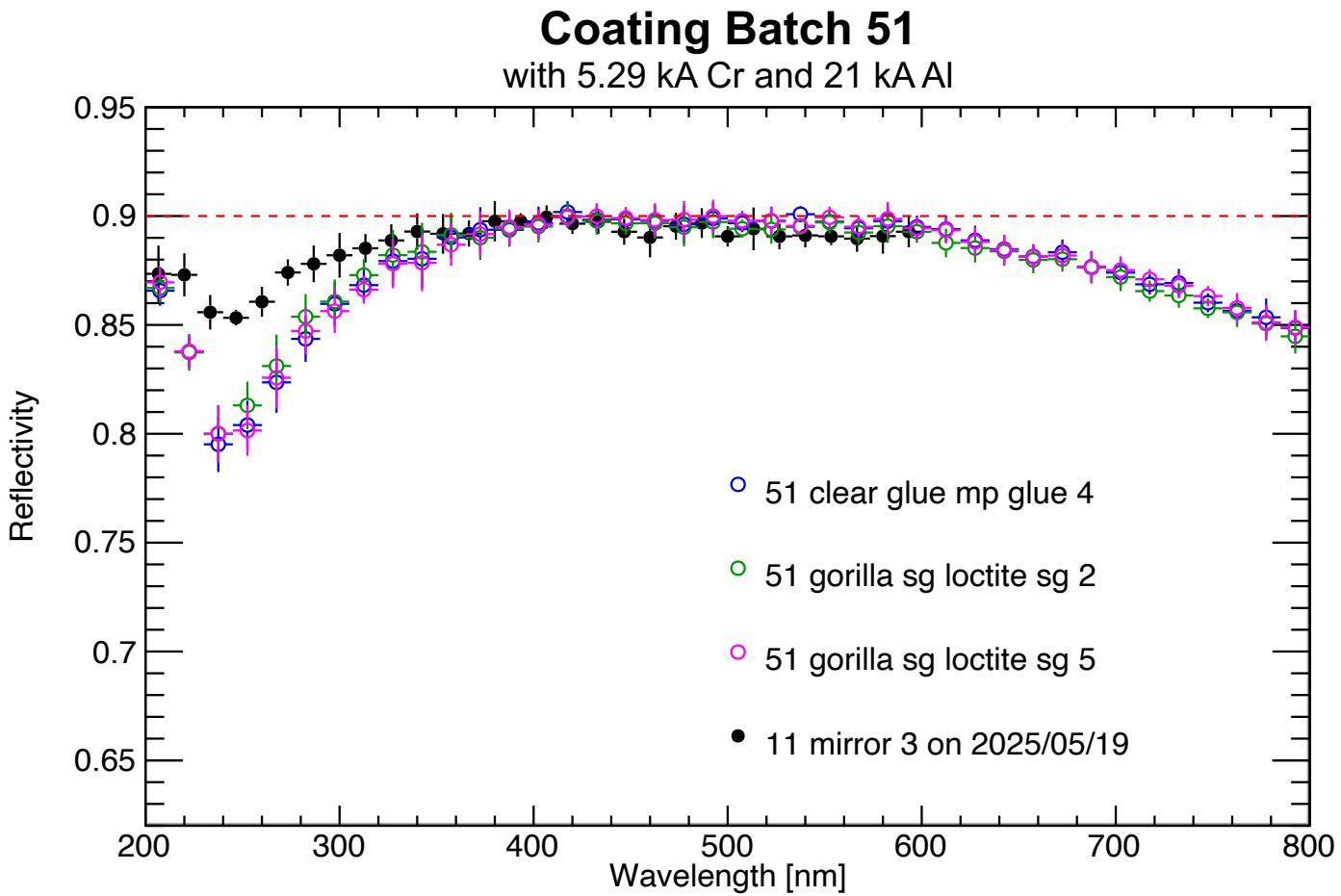
Backup Slides

Small Mirror Reflectivity Results – #52



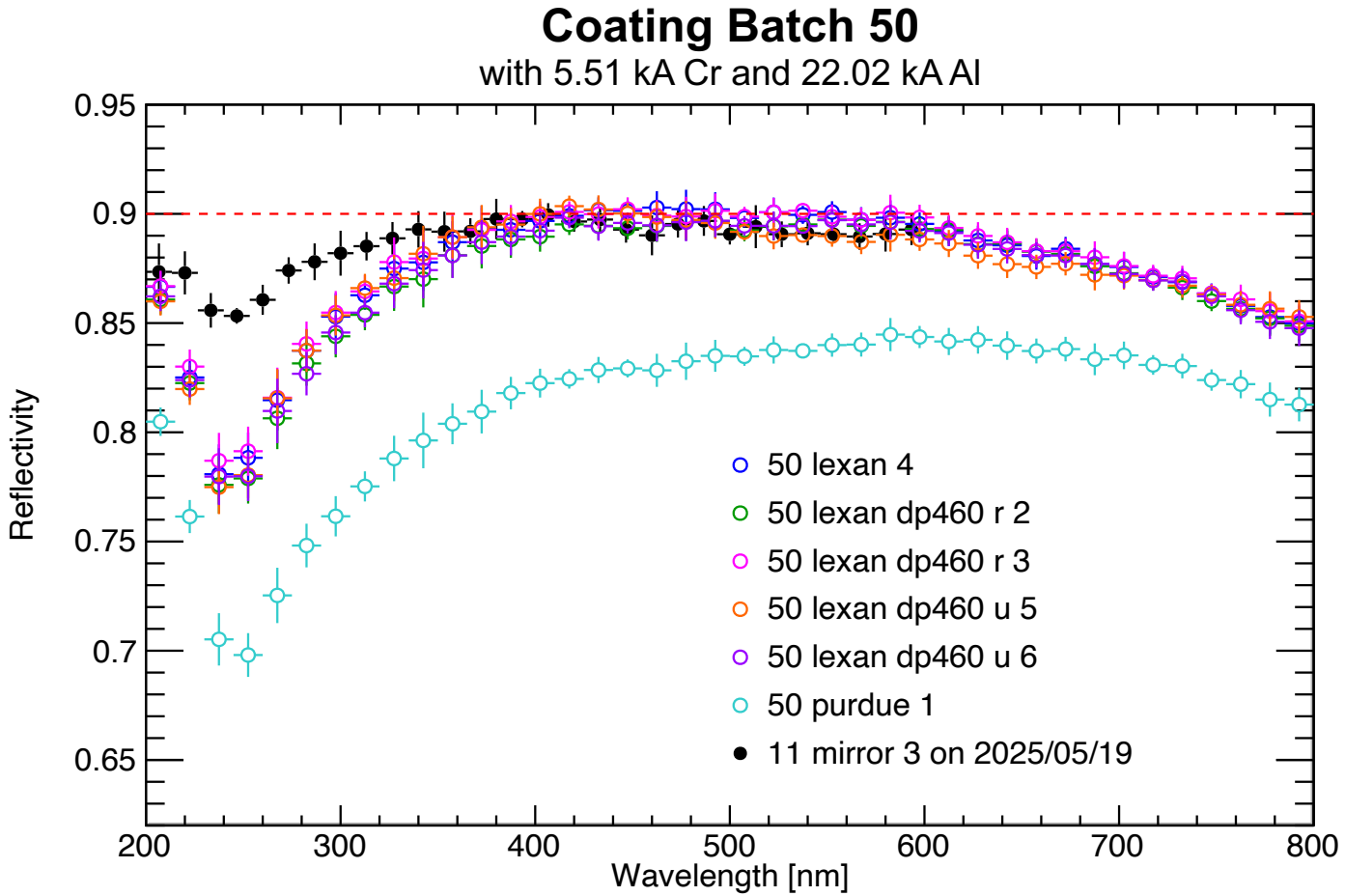
Coating Batch 52 mirrors show mixed reflectivity results — some nearly match the reference (within 1–2%), while others are lower (82–84%). Some mirrors were tightly fitted in the holder.

Small Mirror Reflectivity Results – #51



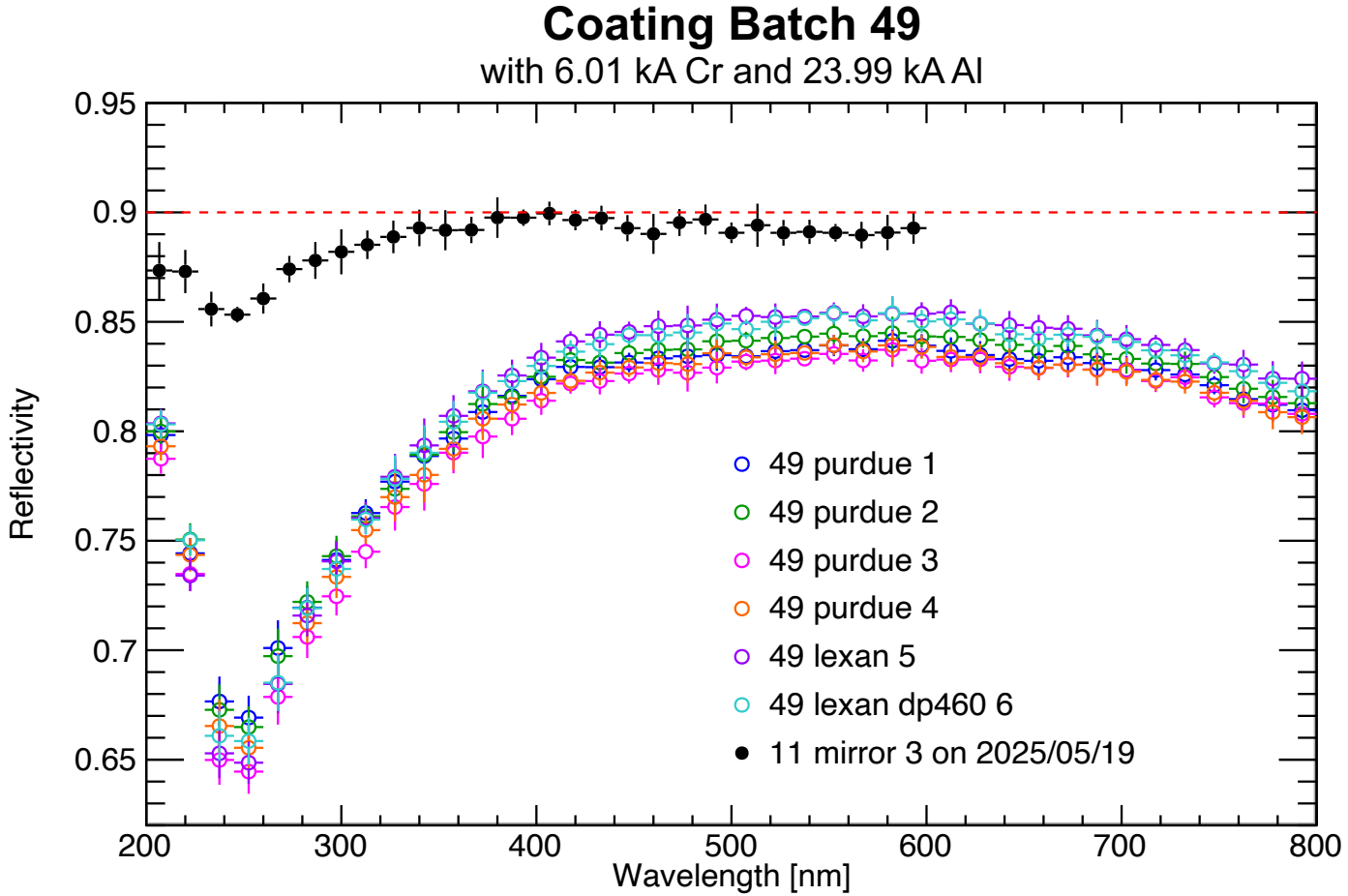
Mirrors from Coating Batch 51 exhibit approximately 90% reflectivity in the 400–600 nm range.

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%**.