

# RICH Spherical Mirror Reflectivity Tests

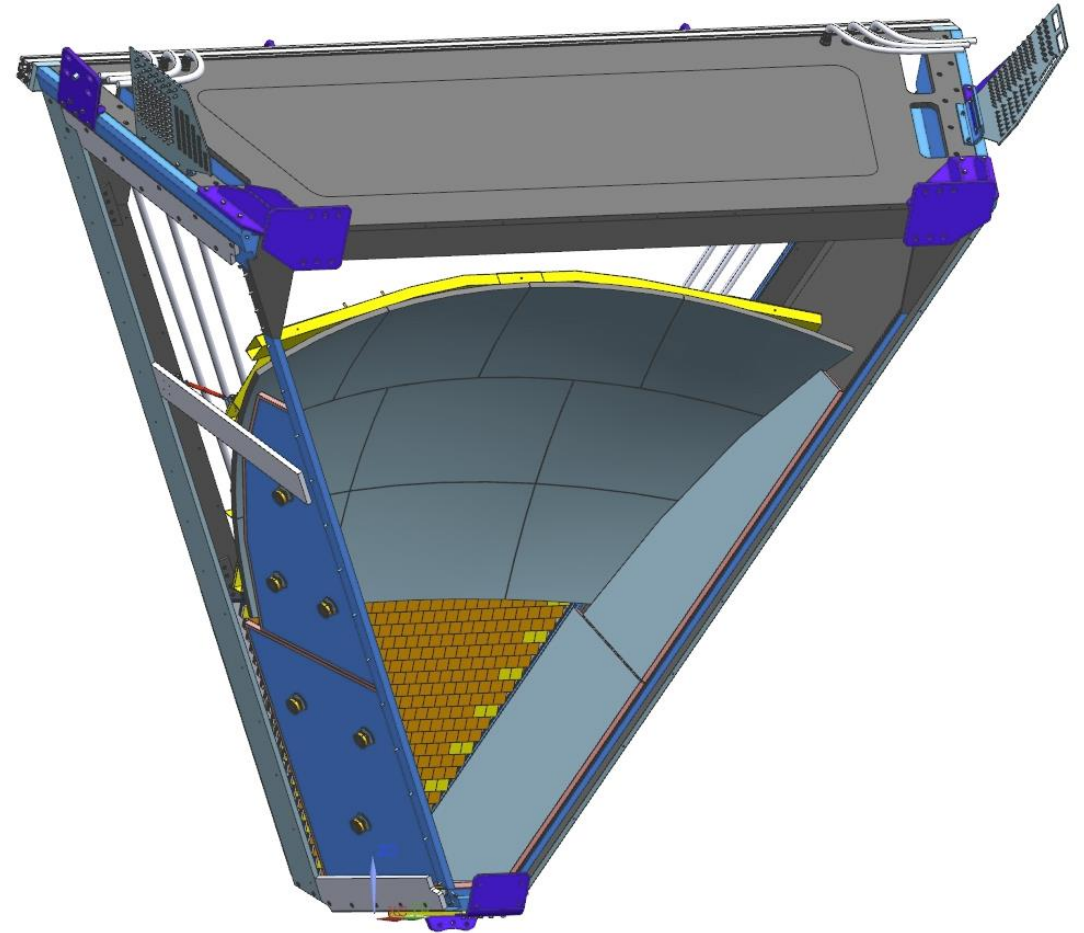
Tyler Lemon

Detector Support Group

August 30, 2017

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# RICH Spherical Mirrors

- 10 carbon-fiber reinforced polymer (CFRP) mirrors.
- Reflects Cherenkov light generated by particles with incident angles from  $12^\circ - 35^\circ$  from beamline into MAPMTs.
  - Reduces cost of RICH by decreasing number of MAPMTs needed.
- Ideal specifications for mirrors:
  - Radius of curvature = 2.7 m
    - Verified using CMM in 2016
  - Reflectivity = 90%

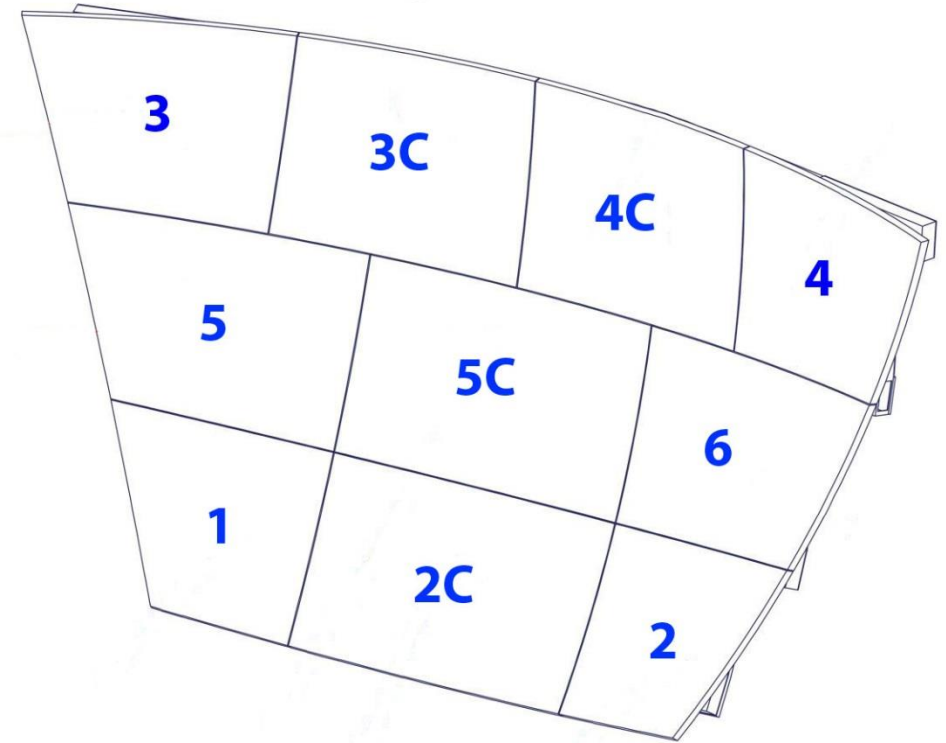
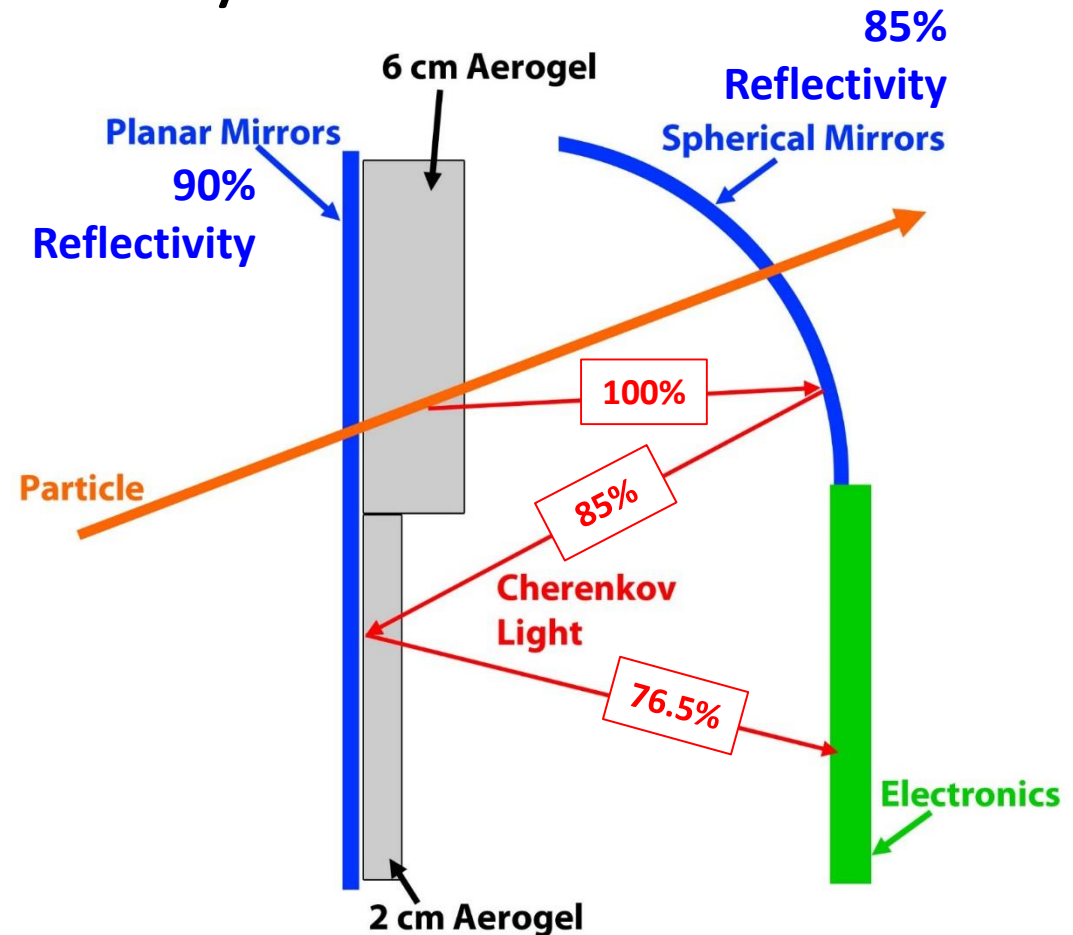


Diagram of spherical mirror assembly with mirror names.

# Reflectivity Test

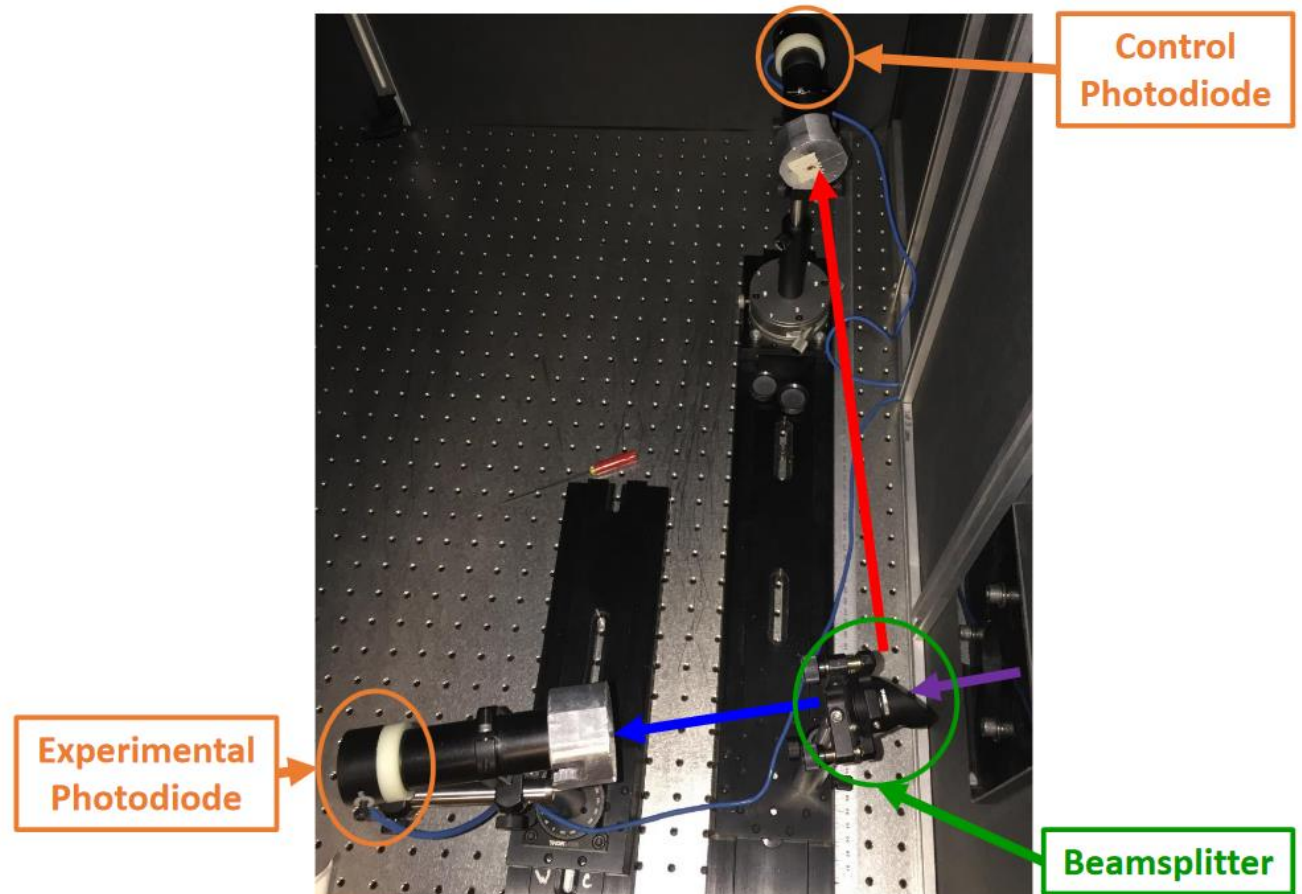
- Reflectivity of mirrors must be confirmed to meet 90% specification.
  - Poor reflectivity of spherical mirrors leads to loss of Cherenkov light.
- Mirrors tested in EEL 108A test station.



Sketch showing Cherenkov light reflected by RICH's mirrors into MAPMTs.

# Reflectivity Test Station

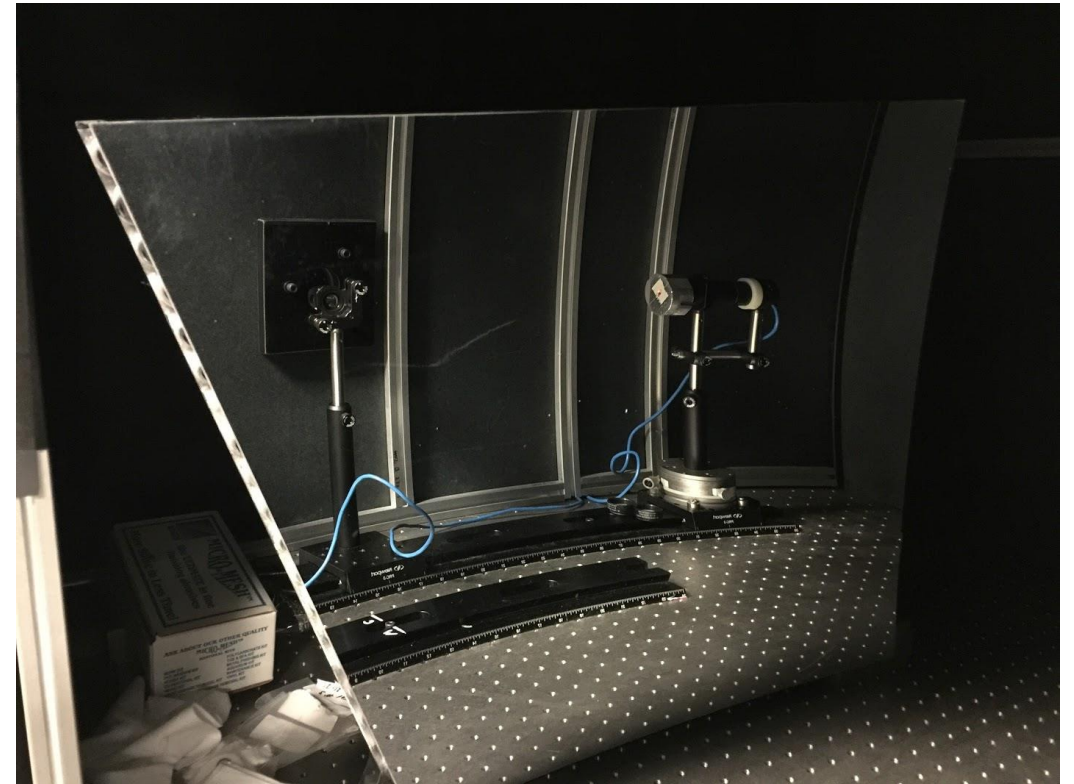
- See previous DSG presentations for detailed overview.
  - [Reflectivity Test Station Calculations](#)
  - [Reflectivity Test Station Error Propagation](#)
- Monochromator
  - Outputs light at user-set wavelength ( $\lambda$ )
  - Used  $300 \text{ nm} \leq \lambda \leq 650 \text{ nm}$
  - Results from 300 – 420 nm discarded.
    - Low end of monochromator output, resulting in bad data.
- Beamsplitter
- Two photodiodes



Components of test station inside dark box.

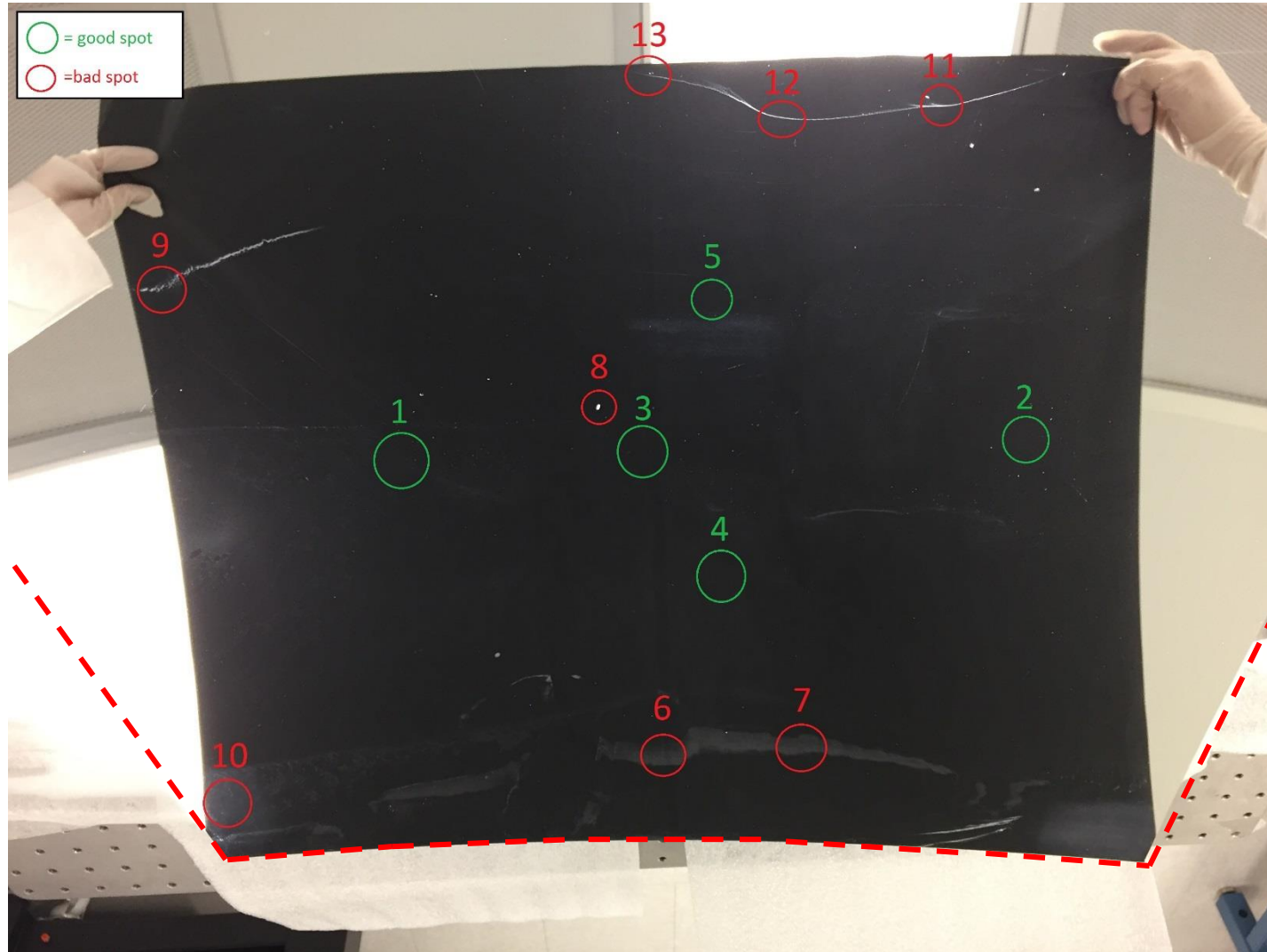
# Spherical Mirrors 3 and 4

- Received at JLab after final coating on June 16, 2017.
- Both mirrors had areas that looked smudged and scratched.
  - Poor surface quality caused by issues with fabrication process.
  - Prompted all spherical mirrors to be sent back to fabricators, Composite Mirrors Application, Inc. (CMA), for rework.
- Mirrors 3 and 4 remained at JLab to be tested with reflectivity test station.



Spherical mirror 3 in reflectivity test station's dark box.

# Mirror 3 Reflectivity Test Spots



## NOTES:

- Black sheet held over mirror to be able to see scratches and smudges on surface.
- Red, dashed line marks edges of mirror.

# Mirror 3 Reflectivity Results

Spot #	Visual Quality of Spot	Reflectivity [%]
1	GOOD	89
2	GOOD	87
3	GOOD	89
4	GOOD	87
5	GOOD	89
6	BAD	83
7	BAD	82
8	BAD	73
9	BAD	84
10	BAD	77
11	BAD	84
12	BAD	86
13	BAD	84

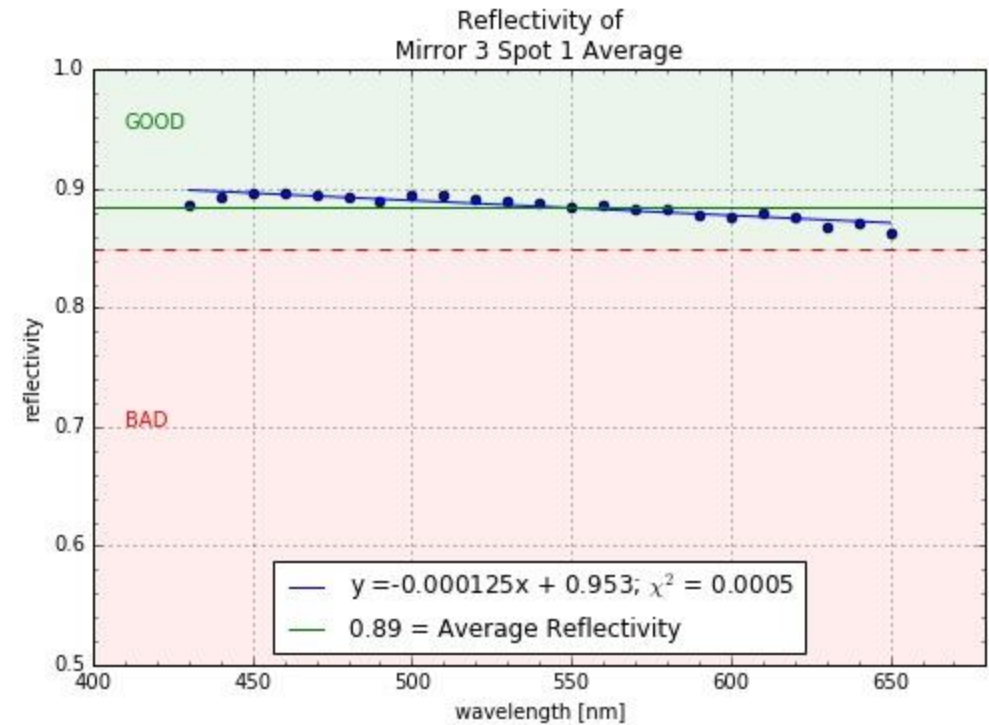
**NOTE:**  
**Alignment on scratches may not have been precise enough to get bad reflectivity result.**



# Mirror 3, Spot 1



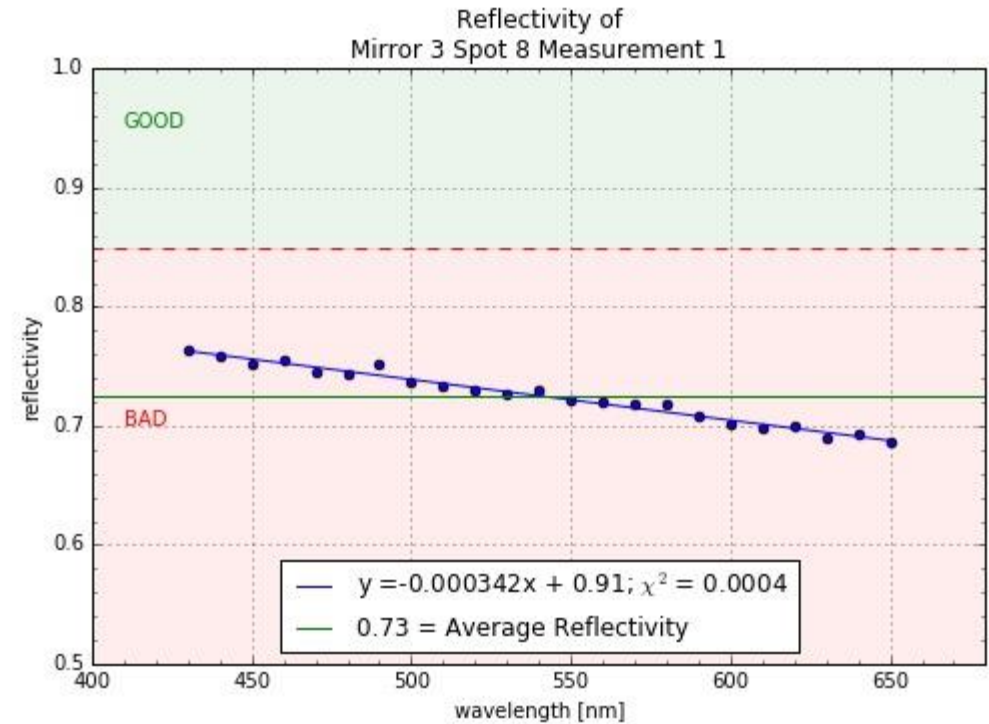
Close-up of Mirror 3, Spot 1 from overview photo



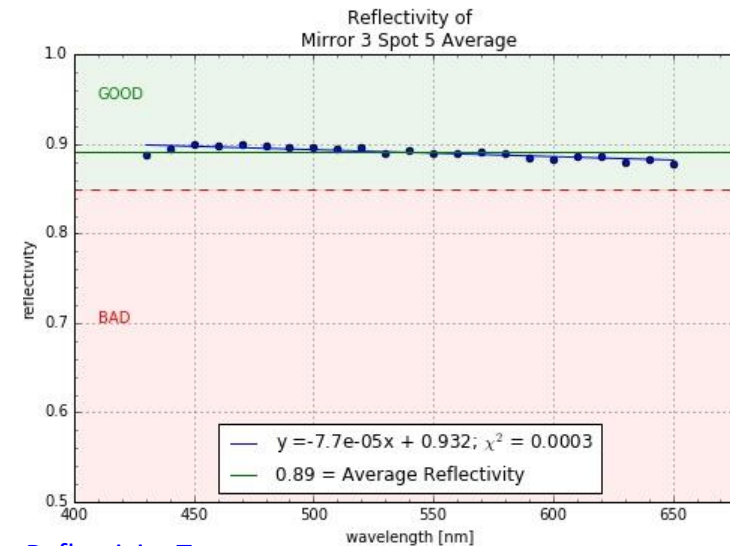
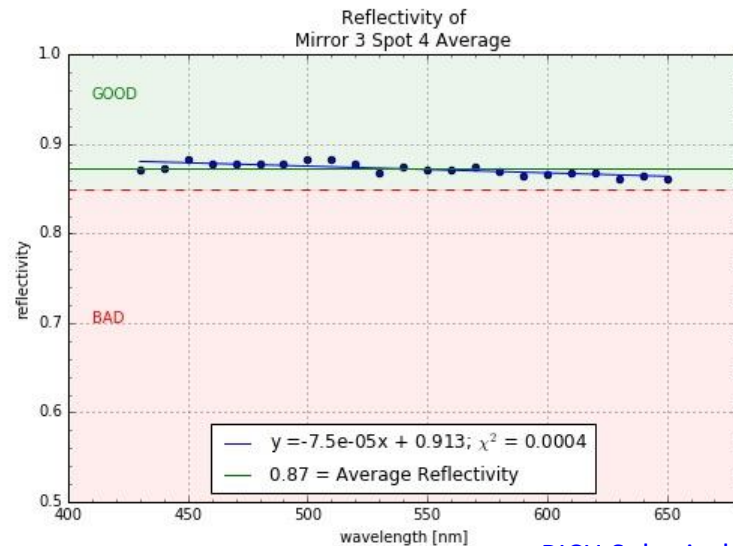
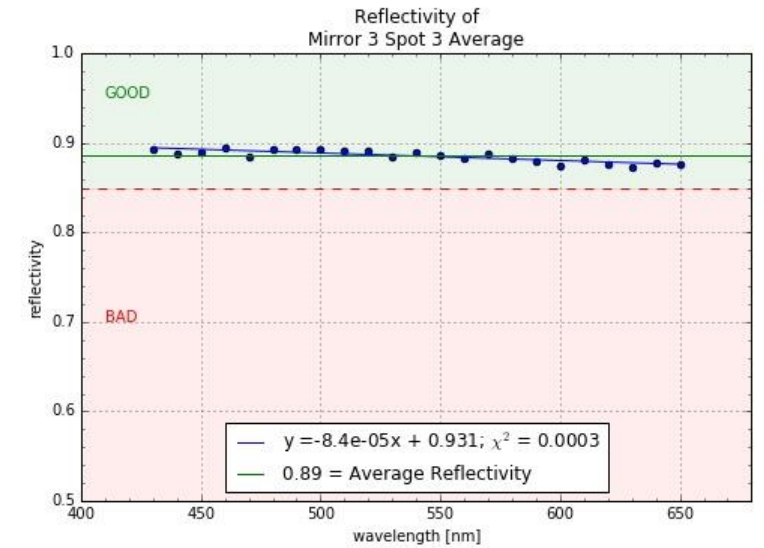
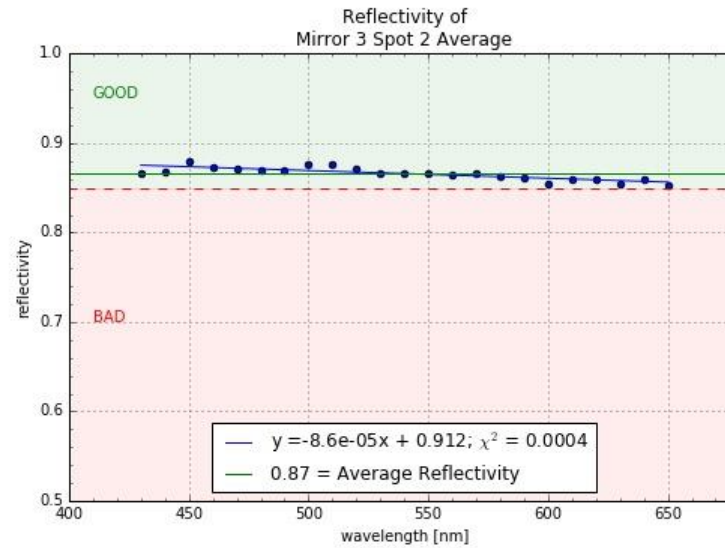
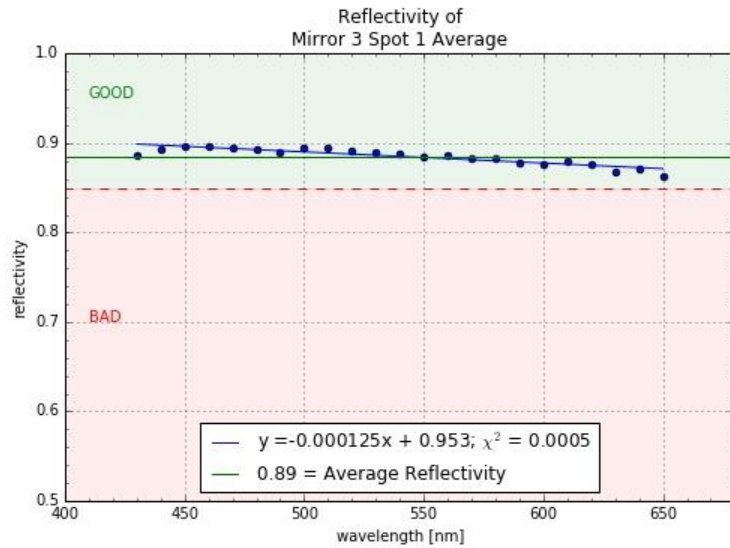
# Mirror 3, Spot 8



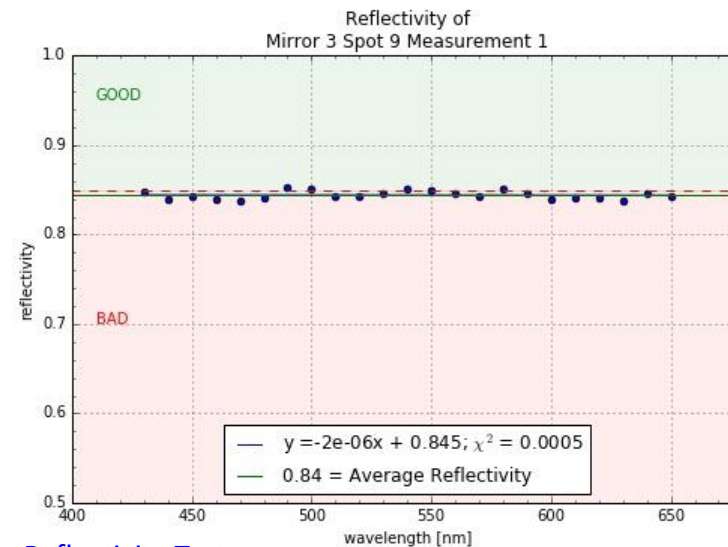
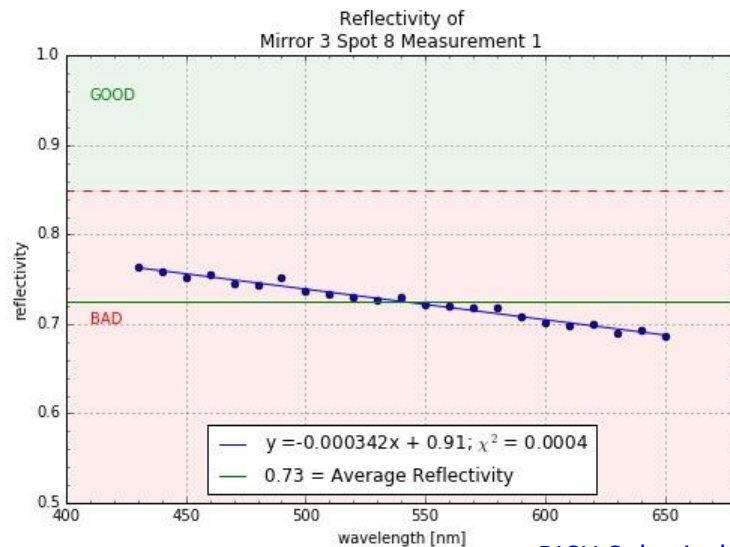
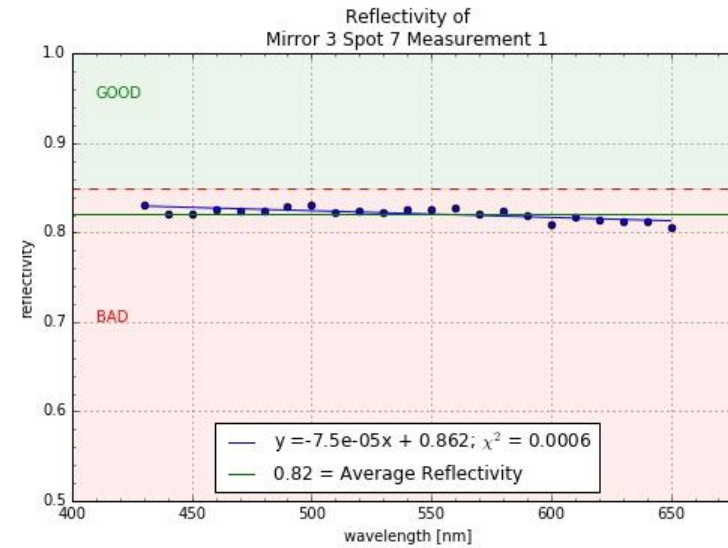
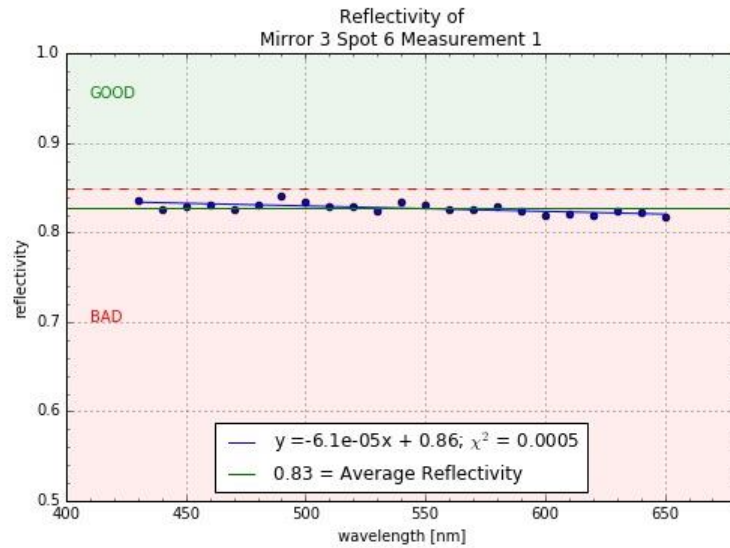
Close-up of Mirror 3, Spot 8 from overview photo



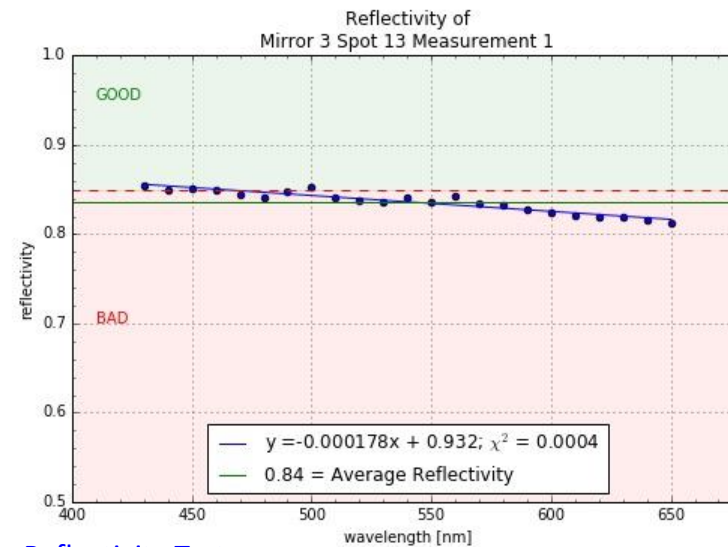
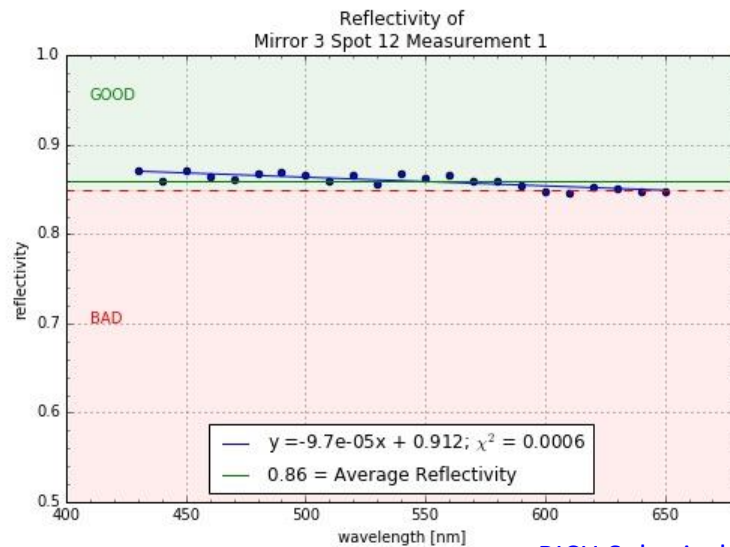
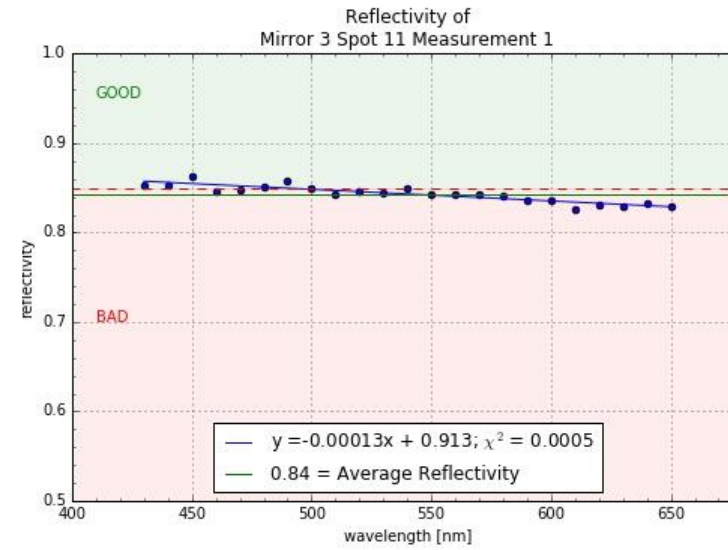
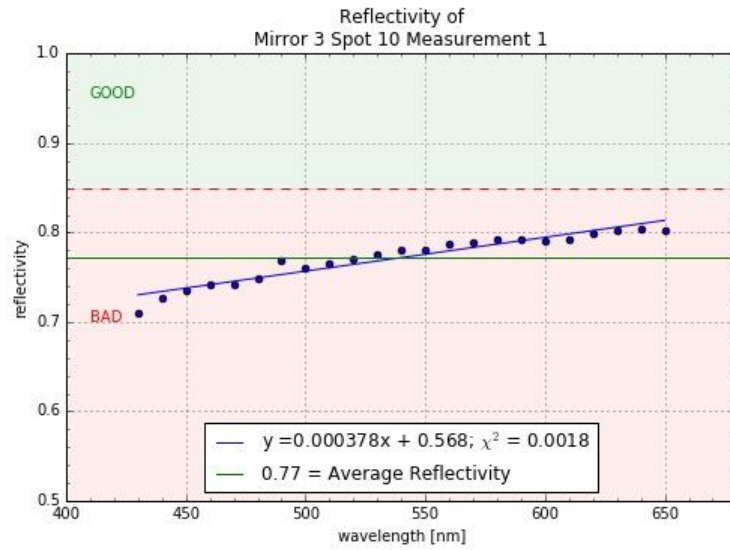
# Mirror 3 Reflectivity Results: Spots 1 – 5



# Mirror 3 Reflectivity Results: Spots 6 – 9



# Mirror 3 Reflectivity Results: Spots 10 – 13



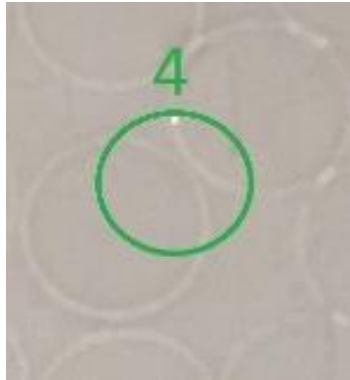
# Mirror 4 Reflectivity Test Spots



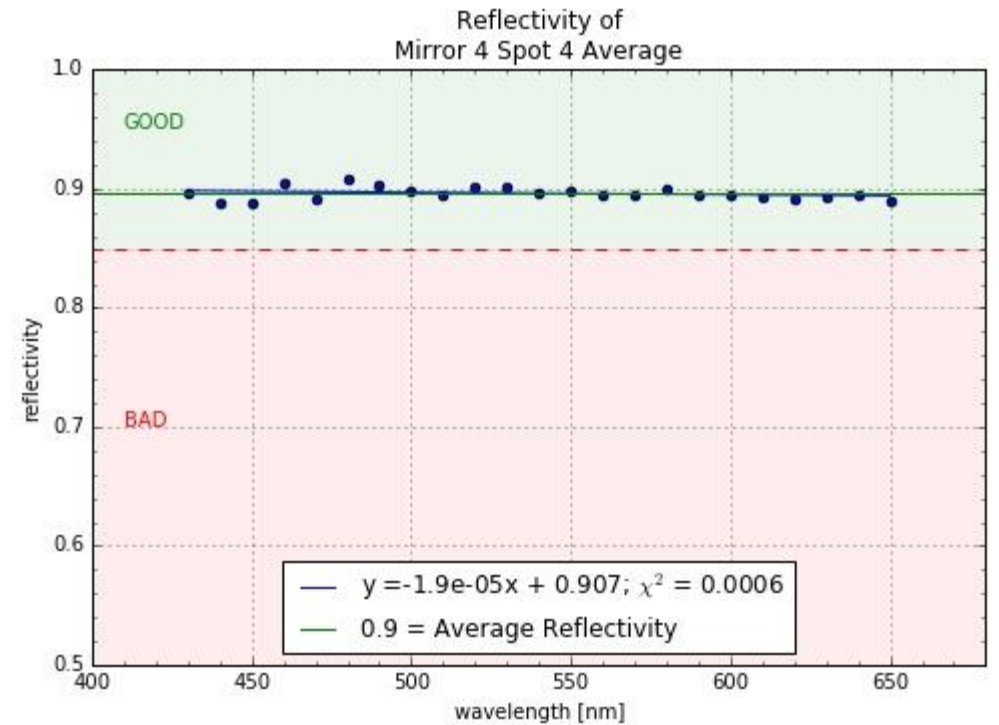
# Mirror 4 Reflectivity Results

Spot #	Visual Quality of Spot	Reflectivity [%]
1	GOOD	88
2	GOOD	80
3	BAD	81
4	GOOD	90
5	GOOD	89
6	BAD	77
7	BAD	62
8	BAD	67
9	BAD	67
10	BAD	81
11	BAD	76

# Mirror 4, Spot 4



Close-up of Mirror 4, Spot 4 from overview photo

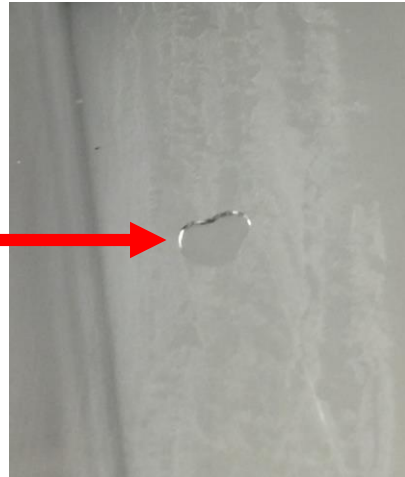




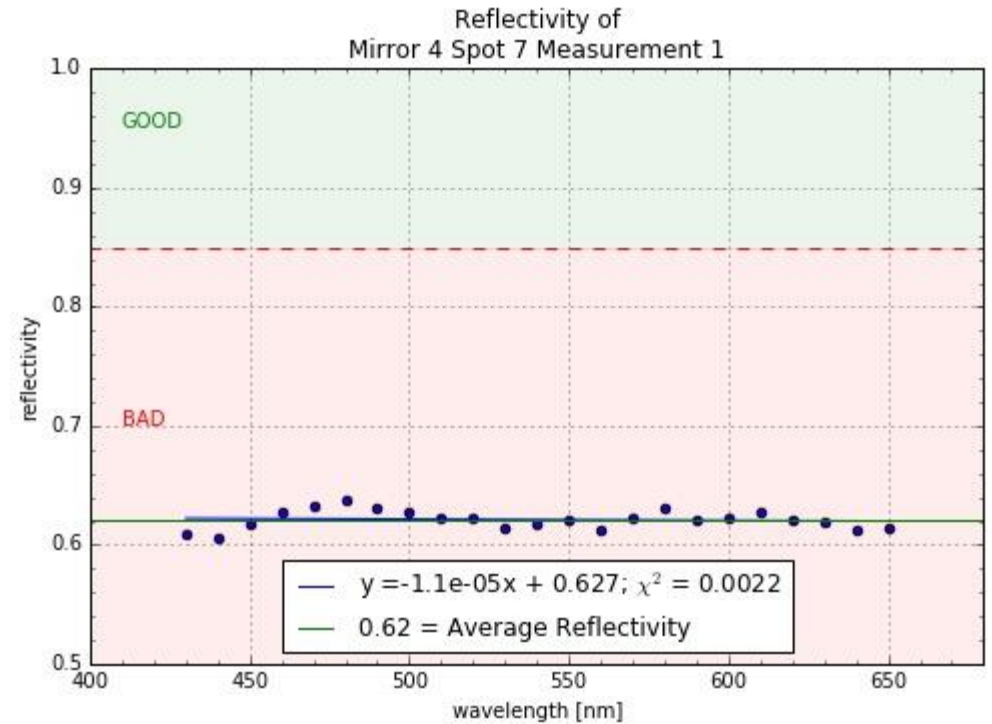
# Mirror 4, Spot 7



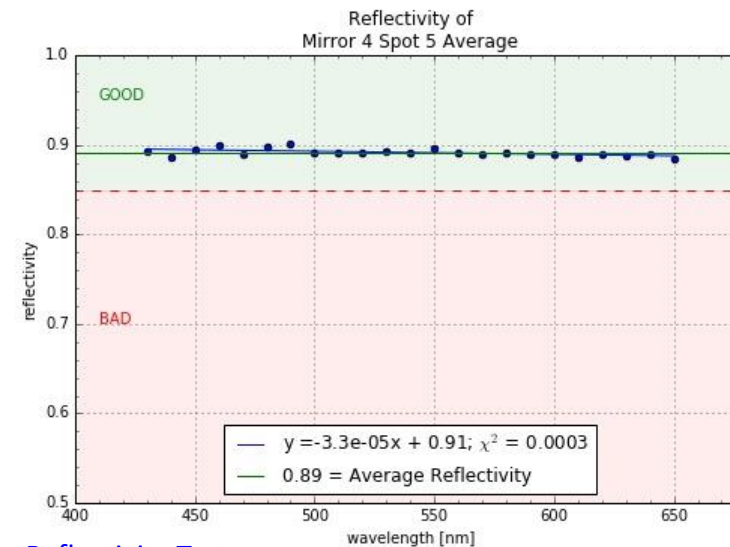
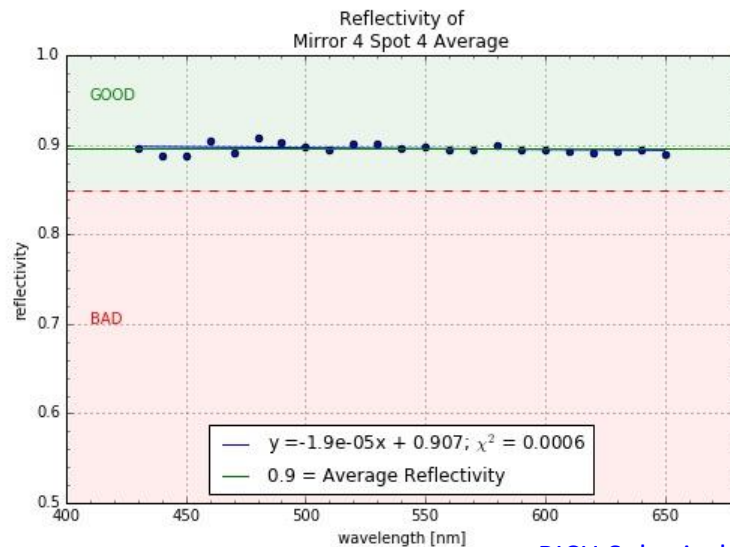
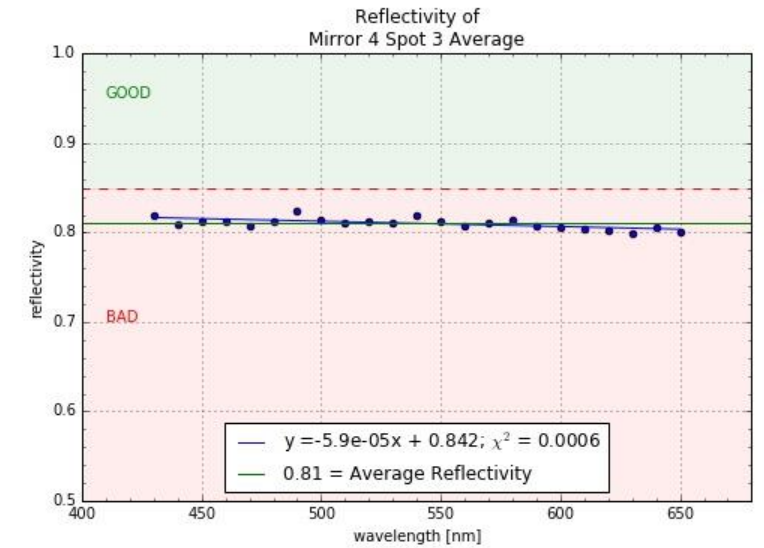
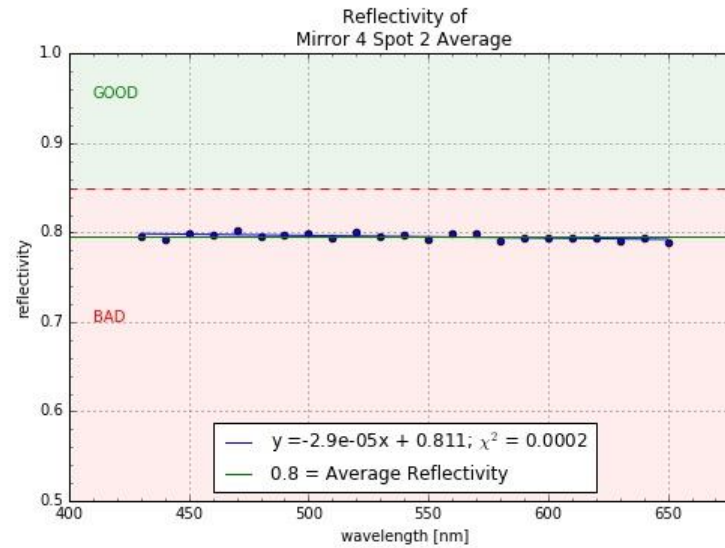
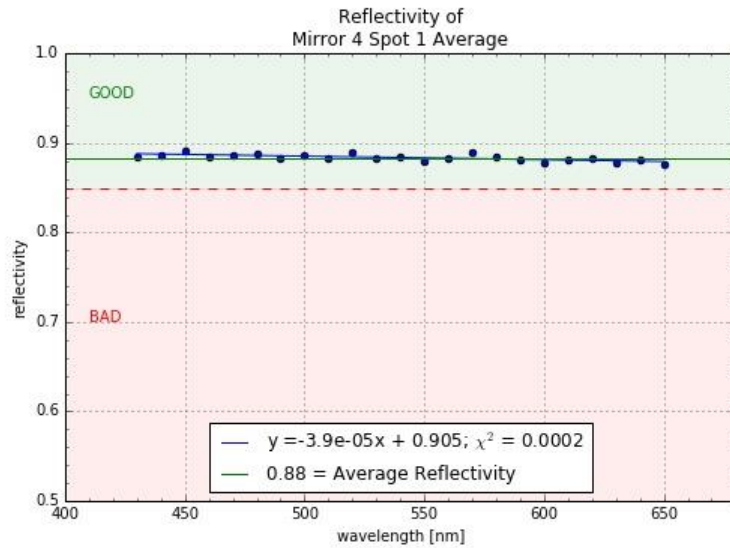
Close-up of Mirror 3, Spot 7 from overview photo



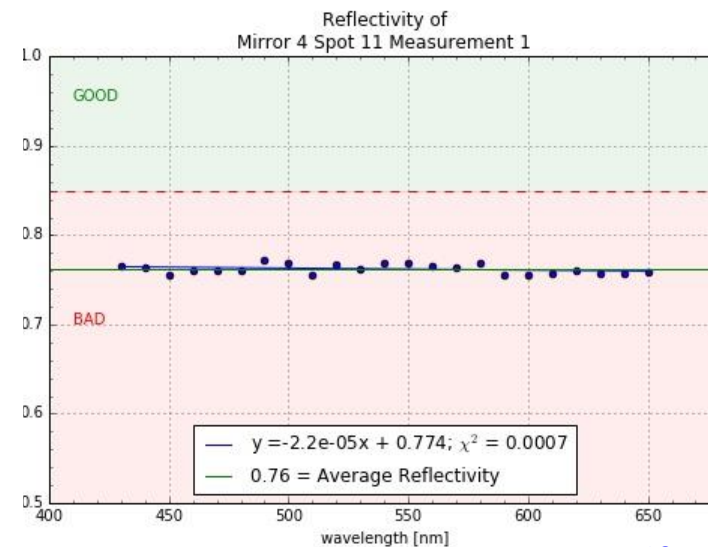
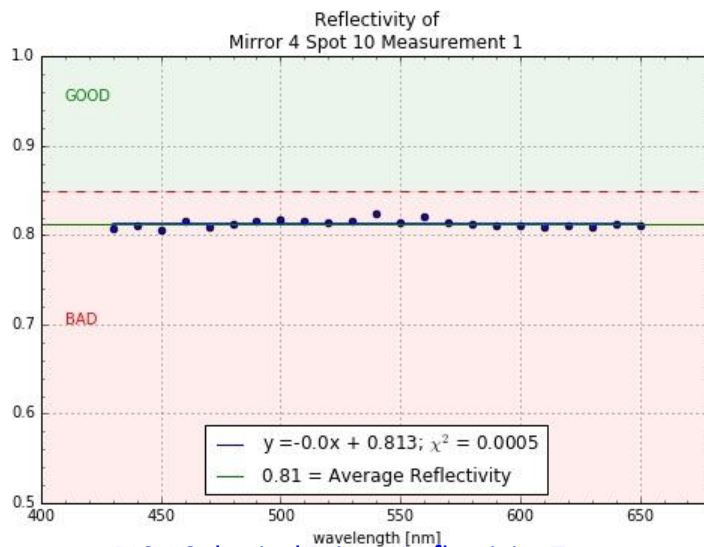
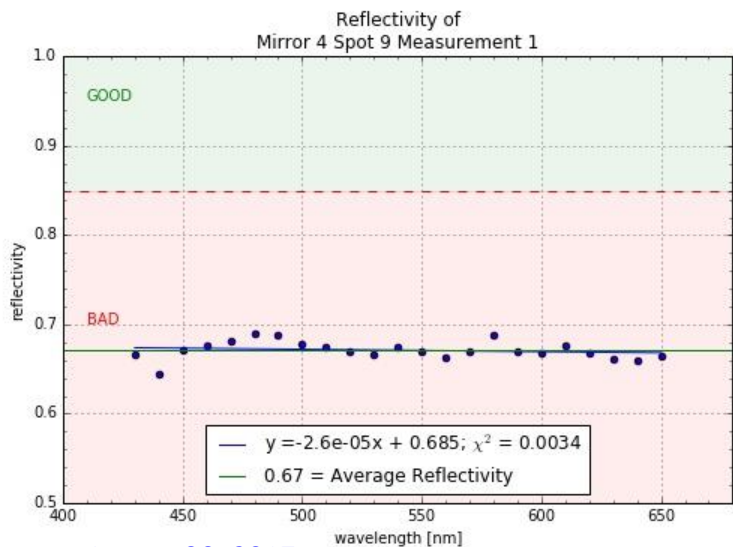
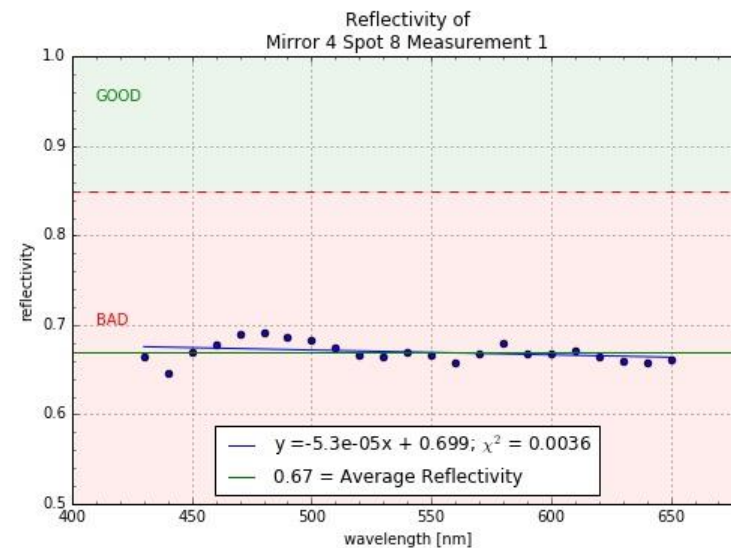
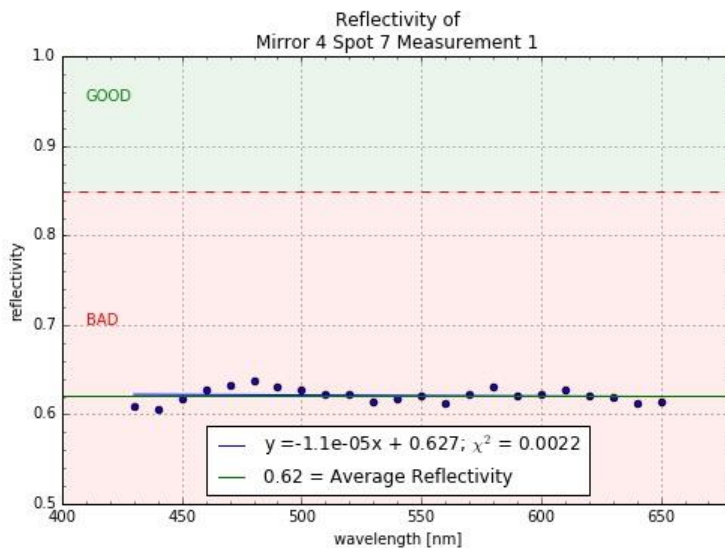
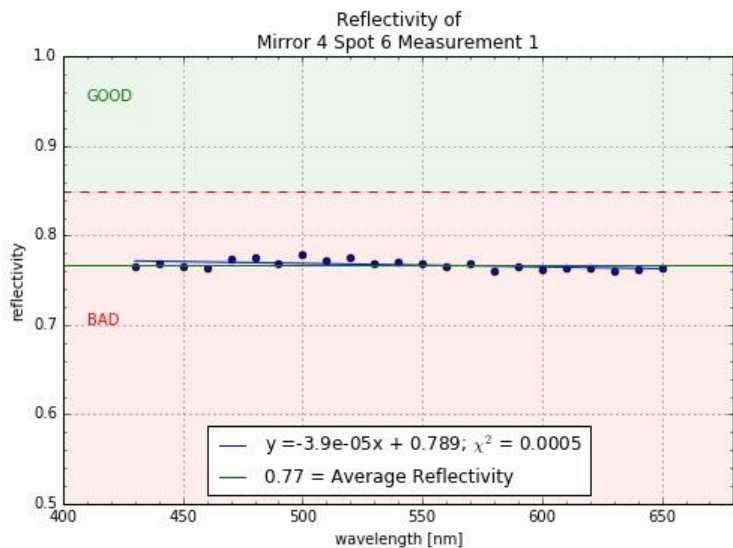
Pocket in reflective surface.  
Pocket is ~3 mm in size.



# Mirror 4 Reflectivity Results: Spots 1 – 5



# Mirror 4 Reflectivity Results: Spots 6 – 11



# Conclusion

- Good spots have reflectivity close to 90% specification.
  - Lower results could be due to:
    - Bad surface quality
    - Inherent error in test station alignment
- Bad spots have reflectivity ~85% or less.
  - Exceptions possibly due to alignment precision.
- Mirrors are being sent back to CMA for rework.
  - Large areas with bad surface will be fixed.
  - Mirrors 1, 2, 2C, 3C, 4C, 5, 5C, 6 at CMA.
  - Mirrors 3 and 4 shipped, will arrive August 30, 2017 at CMA.
  - After rework, mirrors go to Evaporated Coatings, Inc. for final reflective coating.

Thank you