Shaped Pupil Coronagraph: Disk Science Mask Experimental Verification and Testing

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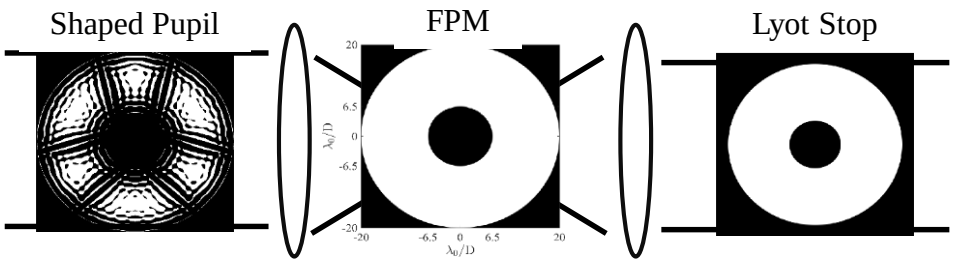
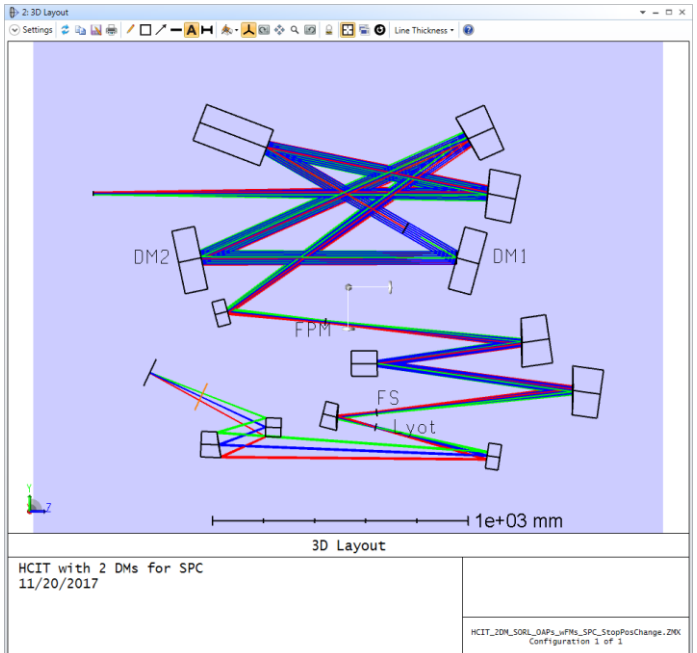
Outline

- **Shaped Pupil Coronagraph – Disk Science (Wide Field of View)**
  - Description of the Coronagraph and Testbed
- **Testbed Results:**
  - EFC and Best Contrast
  - WFE Sensitivity
- **Wide Field of View Considerations**
  - Probe Amplitude
  - Influence Function and Transfer Function
  - Plate Scale Error

SPC—Disk Science Testbed Layout

- **Shaped Pupil—Disk Science Coronagraph Essential Elements:**
  - 2 deformable mirrors
  - Focal plane occulting mask
  - Lyot stop

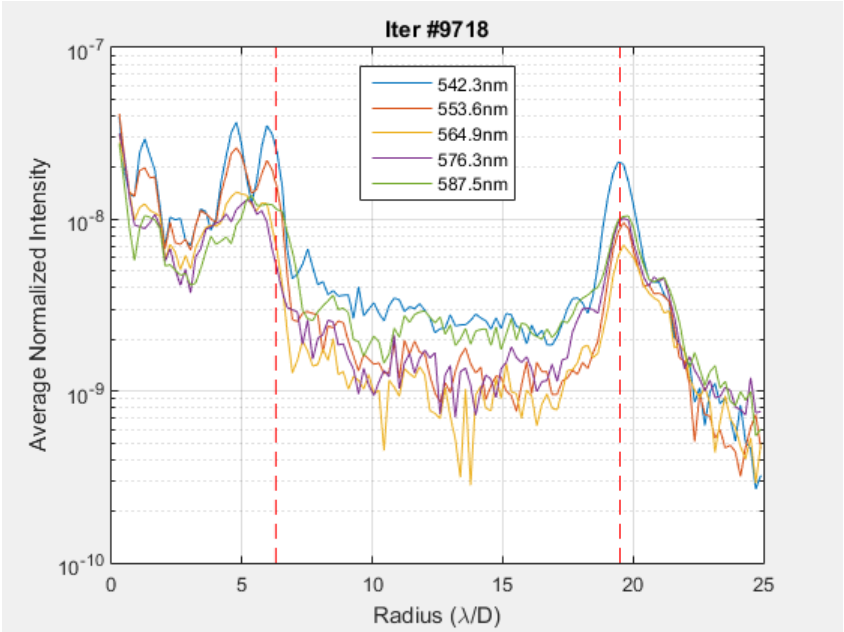


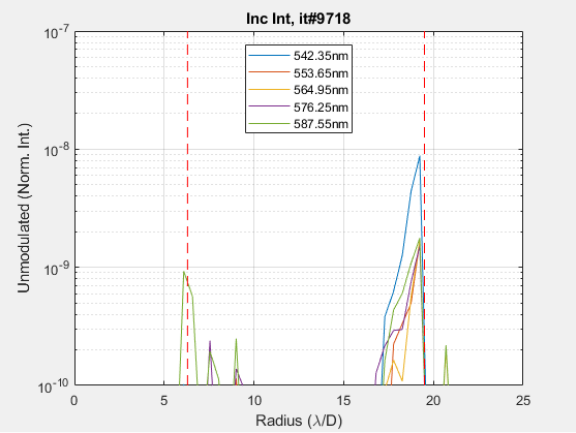


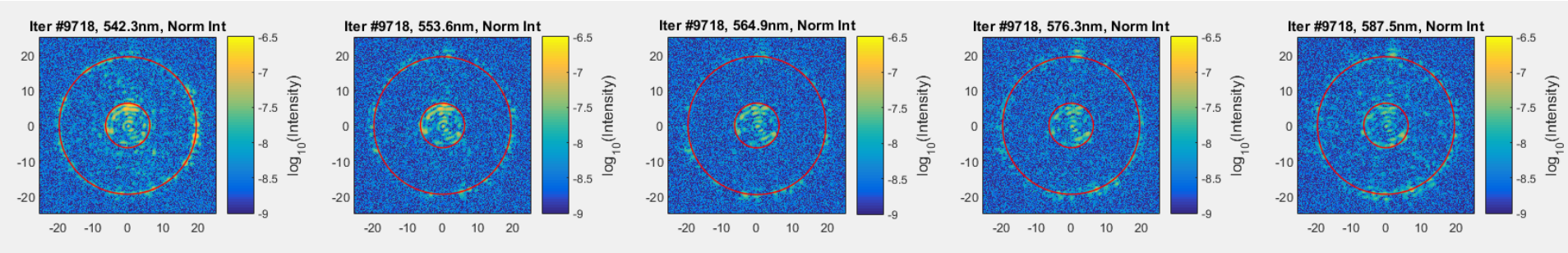
Best Contrast

Contrast

	lam/D			
Band	6.3 - 7.3	7.3 - 18.5	18.5 - 19.5	6.3 - 19.5
542	2.19E-08	2.96E-09	2.28E-08	5.95E-09
554	1.38E-08	1.47E-09	8.15E-09	2.71E-09
565	6.16E-09	1.13E-09	5.90E-09	1.87E-09
576	6.76E-09	1.61E-09	9.80E-09	2.74E-09
588	1.62E-08	2.53E-09	1.10E-08	4.03E-09
Total	1.30E-08	1.94E-09	1.15E-08	3.46E-09

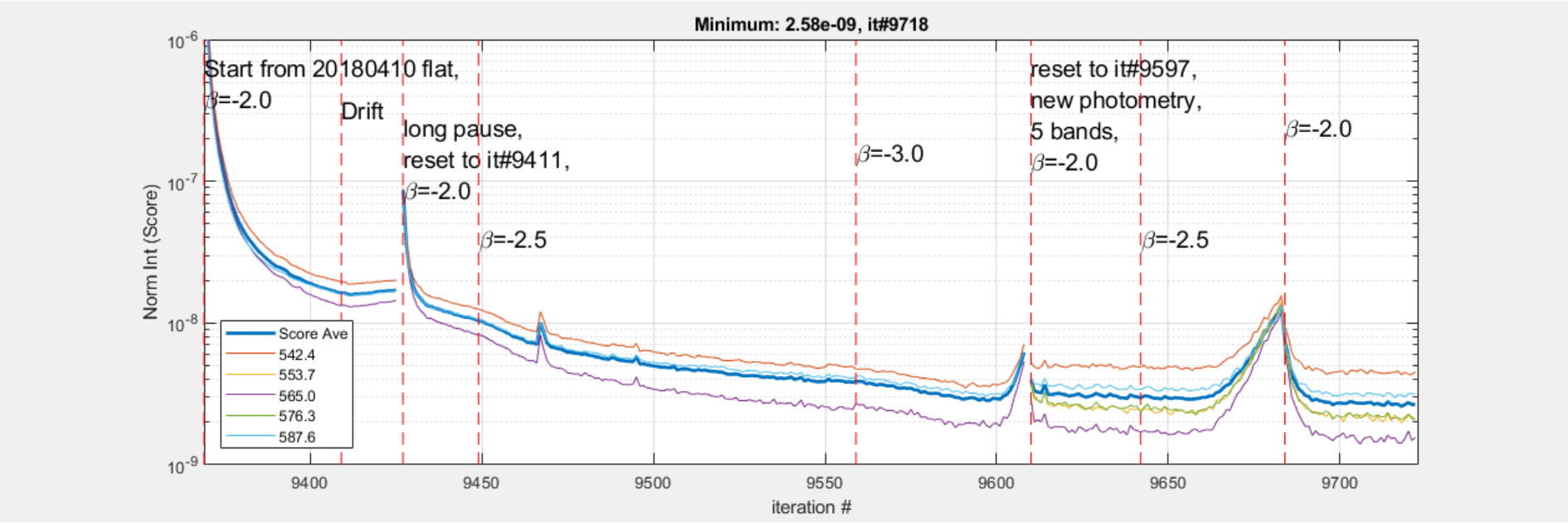




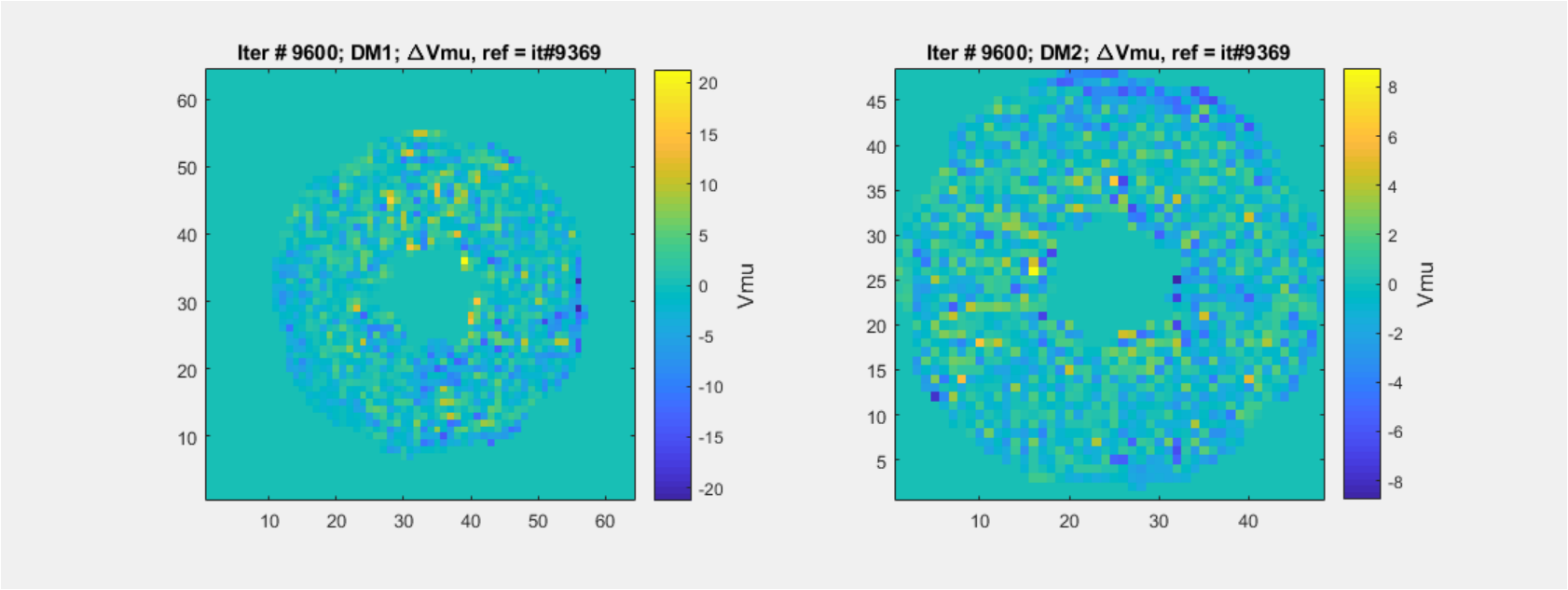


EFC Convergence

- **Relax Regularization Parameter, β**



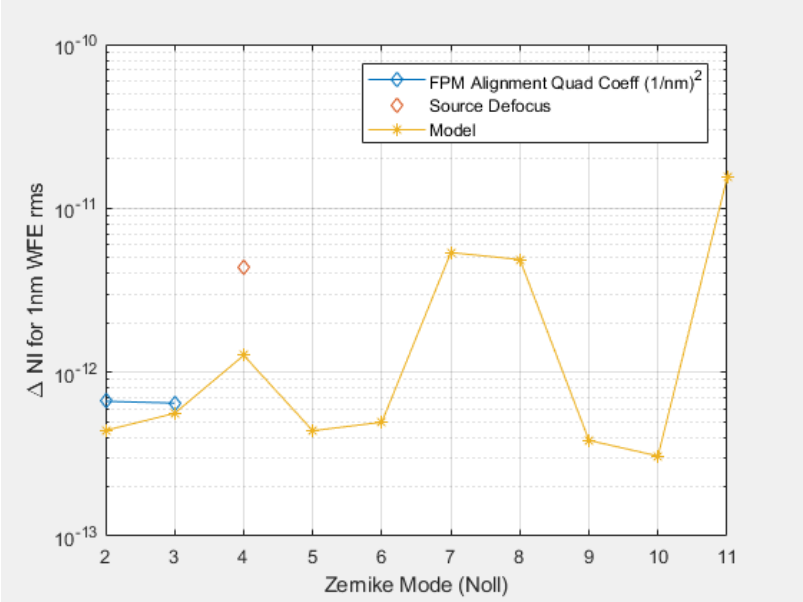
Δ DM At Best Contrast



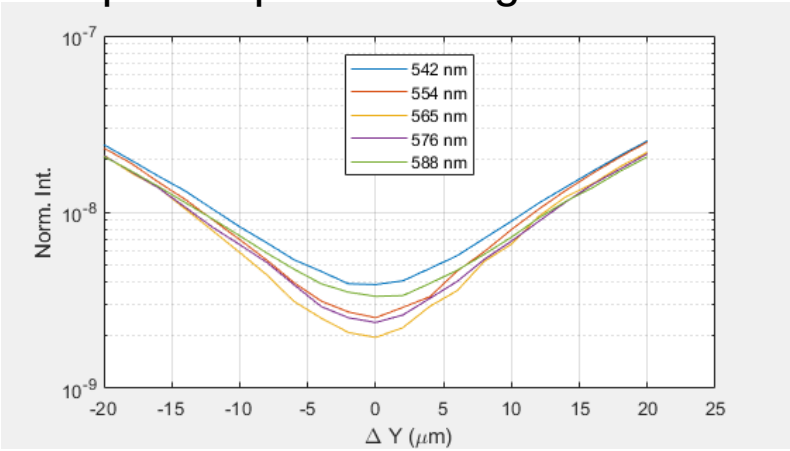
- rms Δ DM1 = 4.3 Vmu
- rms Δ DM2 = 1.9 Vmu

WFE Sensitivity

- **Model State 2e-9**



Shaped Pupil Mask Alignment Error



Defocus Sensitivity By Wave & FOV

- Defocus Sensitivity Measure Vs Model
- Testbed Defocus By Actuating the Source
- Testbed State: Mean Contrast = 4.3e-9
- Model State: 2e-9

Measure

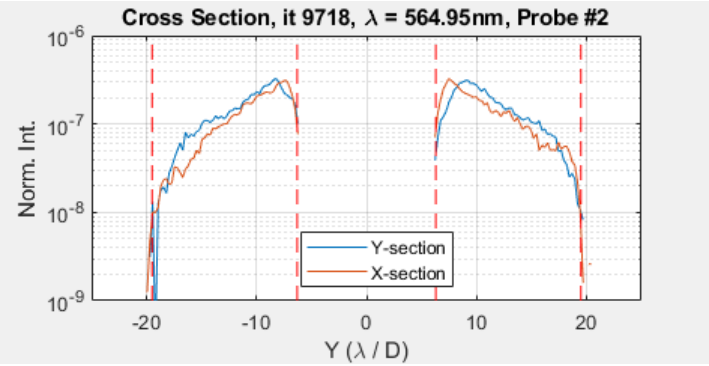
	542	554	565	576	588
6.3 - 7.3	1.33E-11	2.04E-11	5.38E-11	1.09E-10	2.12E-10
7.3 - 18.5	2.59E-12	1.44E-12	1.97E-12	2.88E-12	4.70E-12
18.5 - 19.5	2.91E-11	7.22E-12	2.21E-12	8.35E-13	1.18E-12
6.3 - 19.5	5.97E-12	2.84E-12	4.06E-12	6.87E-12	1.26E-11

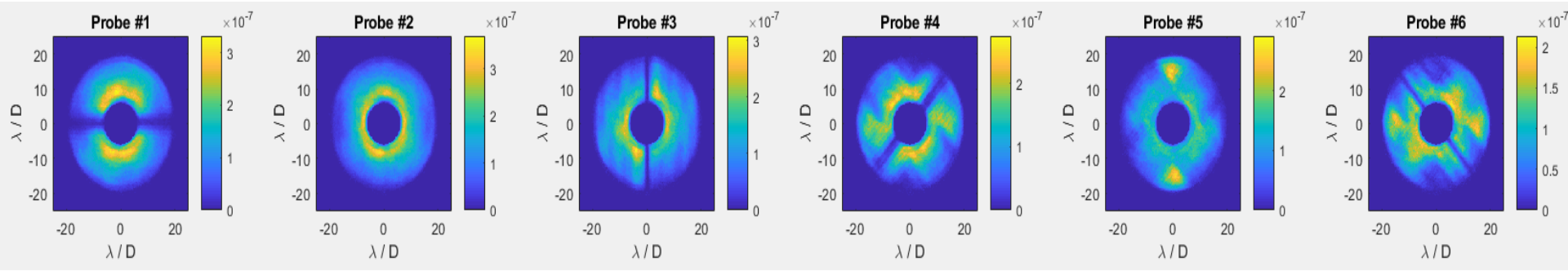
Model

	542	554	565	576	588
6.3 - 7.3	1.28E-12	2.52E-12	7.57E-12	2.08E-11	4.74E-11
7.3 - 18.5	4.09E-13	3.59E-13	4.40E-13	6.48E-13	1.01E-12
18.5 - 19.5	2.29E-12	5.17E-13	2.53E-13	2.70E-13	2.19E-13
6.3 - 19.5	6.56E-13	4.64E-13	7.06E-13	1.42E-12	2.79E-12

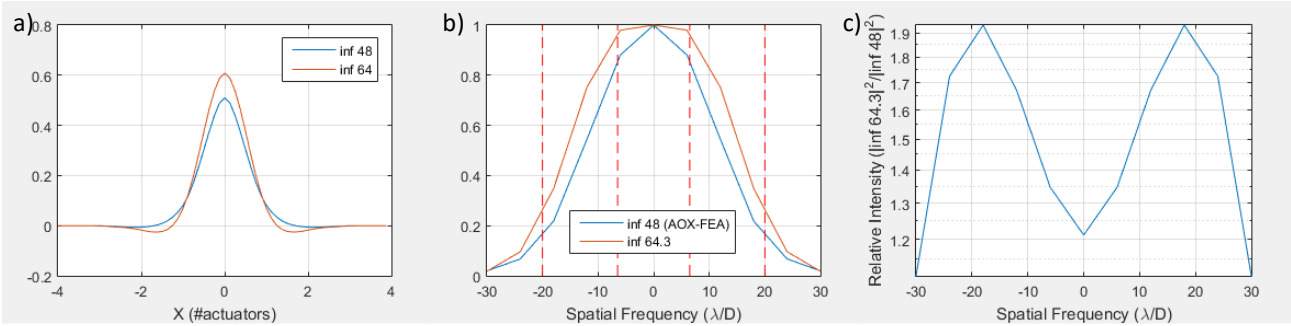
Wide FOV—Probe Amplitude

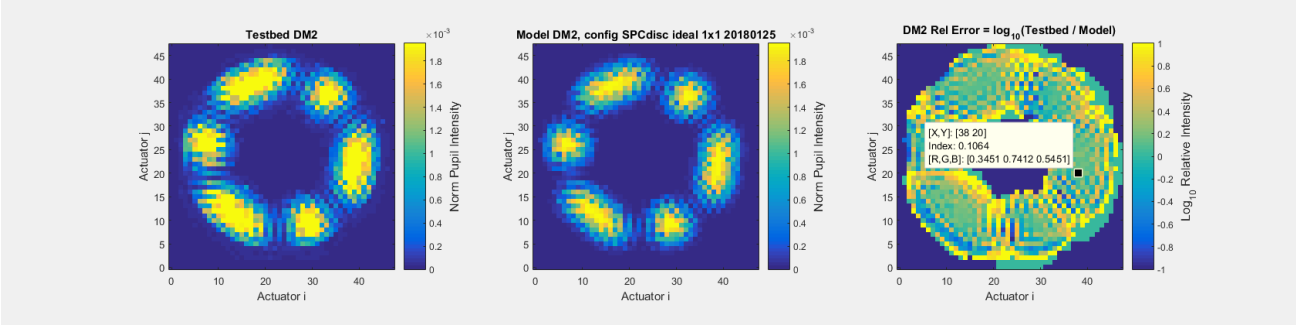
- **Pair-wise Probes For Electric Field Estimation**
- **Probe Amplitude Falls Off At Large FOV Angles**
  - Amplitude Envelope Is Fourier Transform Of Actuator Influence Function





Wide FOV—Influence Function

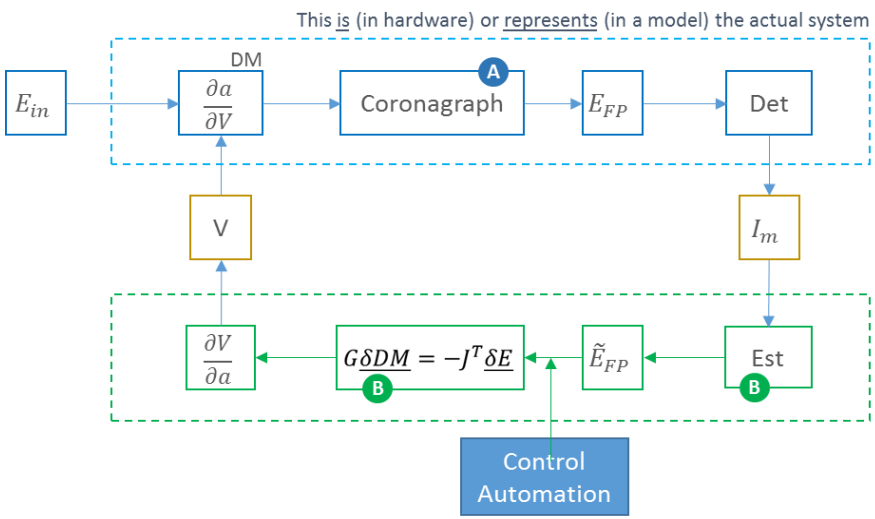




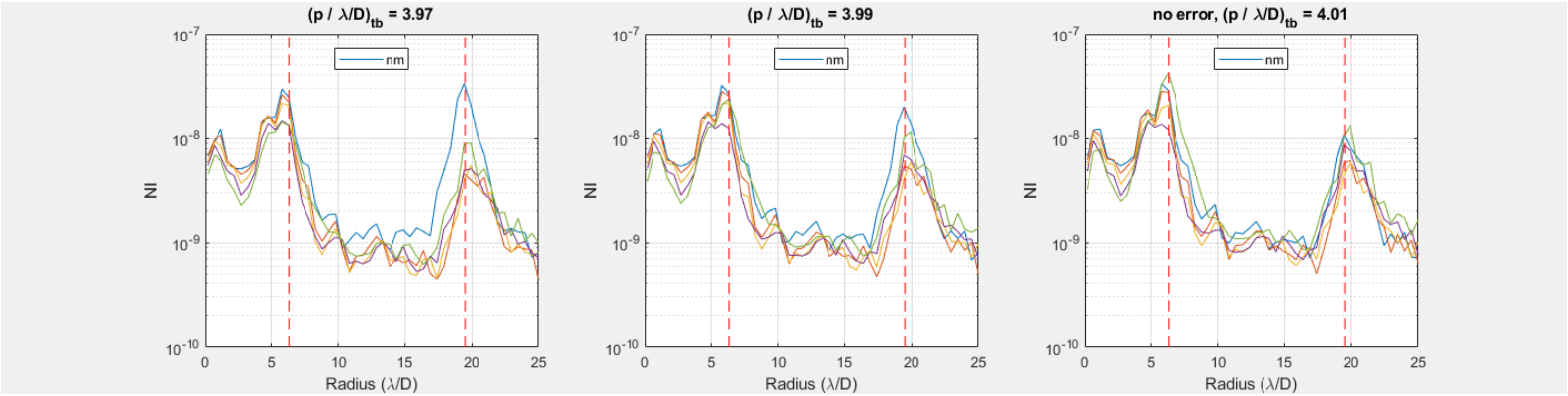
Why EFC Does Not Remove OWA Speckles?

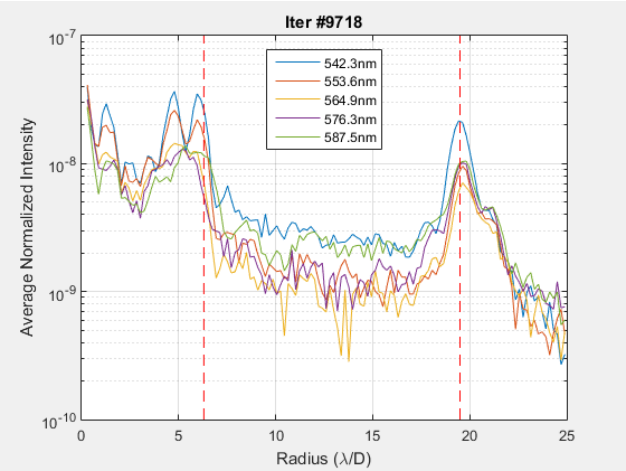
- **Maybe Plate Scale Error**
  - Plate Scale From DM Sinusoidal Modulation
  - 3.96 pix / λ/D in X
  - 4.07 pix / λ/D in Y
  - => Used 4.01 pix / λ/D For EFC

- **Knowledge Mismatch Model:**
  - "Testbed" Model => 3.97 pix / λ/D (for example)
  - EFC Model As Used With Testbed (4.01 pix / λ/D)



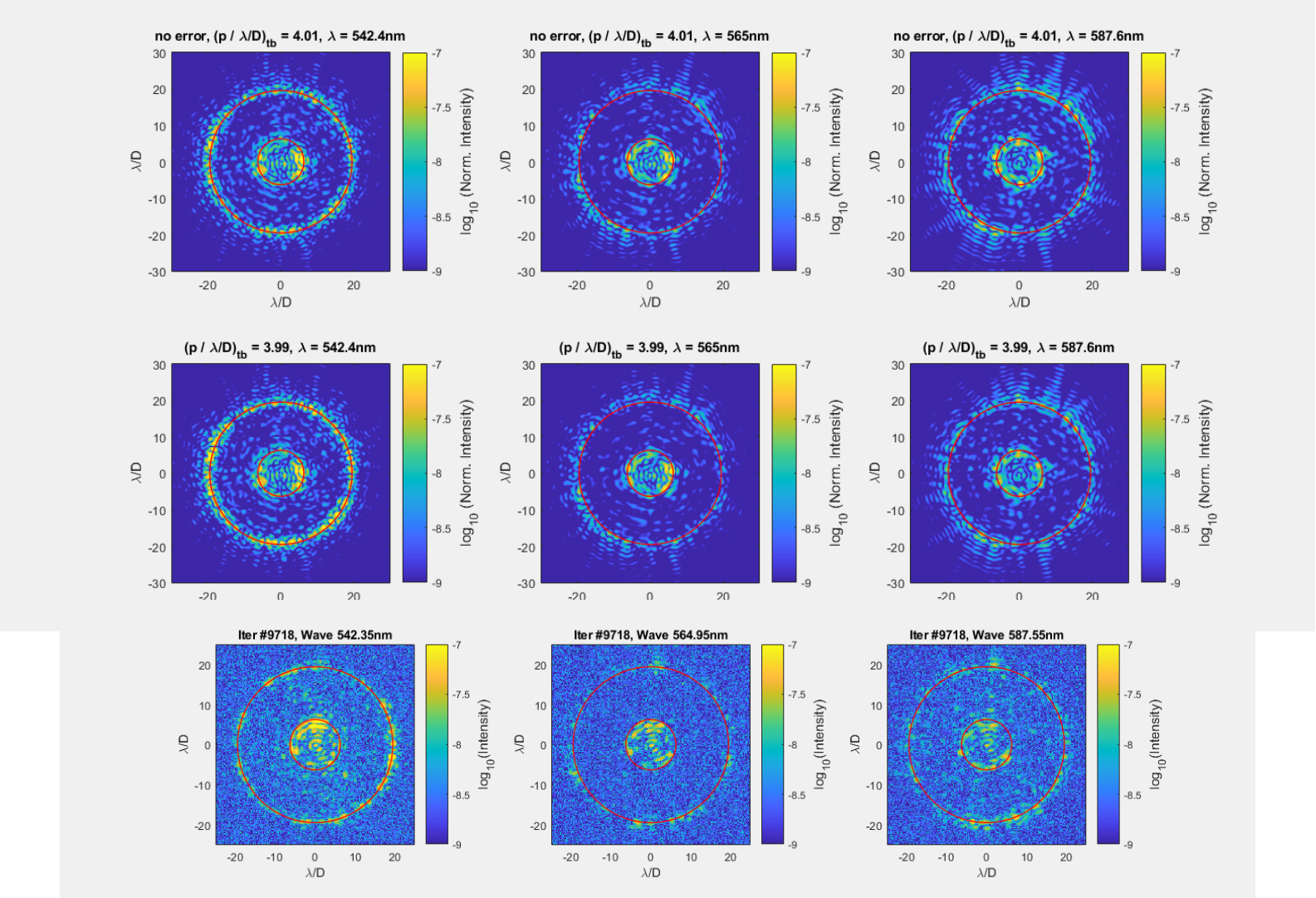
Effect of Plate Scale Error





Measured pix / λ/D:
Camera X: 3.962
Camera Y: 4.066

Image Comparison—Plate Scale Error



Conclusions

- Shaped Pupil—Disk Science Coronagraph Testbed Was Successful
  - 3.5e-9 10% Broadband Contrast
- Wide Field of View Challenges:
  - Probe Amplitude
  - Influence Function / Transfer Function
  - Plate Scale Calibration