AFTA HLC Results

HLC Design 20140623-139

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AFTA HLC Run

- New design (20140623-139) from Dwight Moody optimized for ease of manufacturing at JPL Micro Devices Lab and higher throughput
  - nearly flat & hard-edged, nearly-opaque (~0.05% intensity transmission) r = 2.6 λ/D spot
  - dichroic has limited radial extent
  - “dimple” in dichroic at center of mask designed for Zernike low order wavefront sensor (fed by reflection off occulter)
  - lower DM strokes and improved throughput
  - slightly worse (~2x-3x) low-order aberration sensitivity (design was optimized for above factors more than sensitivity; could be optimized further)
  - This design will be fabricated for HCIT testing
- Broadband EFC over 522.5 – 577.5 nm, λ_c = 550 nm
- Field stop radius = 10.5 λ_c/D
- Sensing & control over r = 2.4 – 10.5 λ_c/D region using 9 wavelengths in a system *without jitter*
- Two separate EFC runs, both with polarization
  - sense & control in X channel, evaluate in X and Y
  - sense & control simultaneously in X & Y (about equivalent to no polarizer)
- Jitter & star added to final dark hole solution (multiple tilts propagated through system)

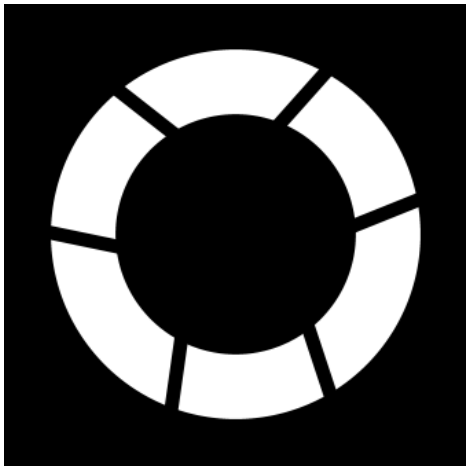
Summary of Results

- Can be used at 550 nm without polarization filtering
  - 2 x 10^{-9} mean contrast between 3 - 3.5 λ/D with 0.4 mas RMS jitter
  - 3x-4x worse contrast than using a single polarization
  - May need polarization filtering at other passbands due to increase in polarization aberrations
- Fairly low jitter sensitivity
  - Contrast with 1.6 mas RMS and 1 mas star jitter is only 3x worse than with no jitter or resolved star

AFTA HLC Design

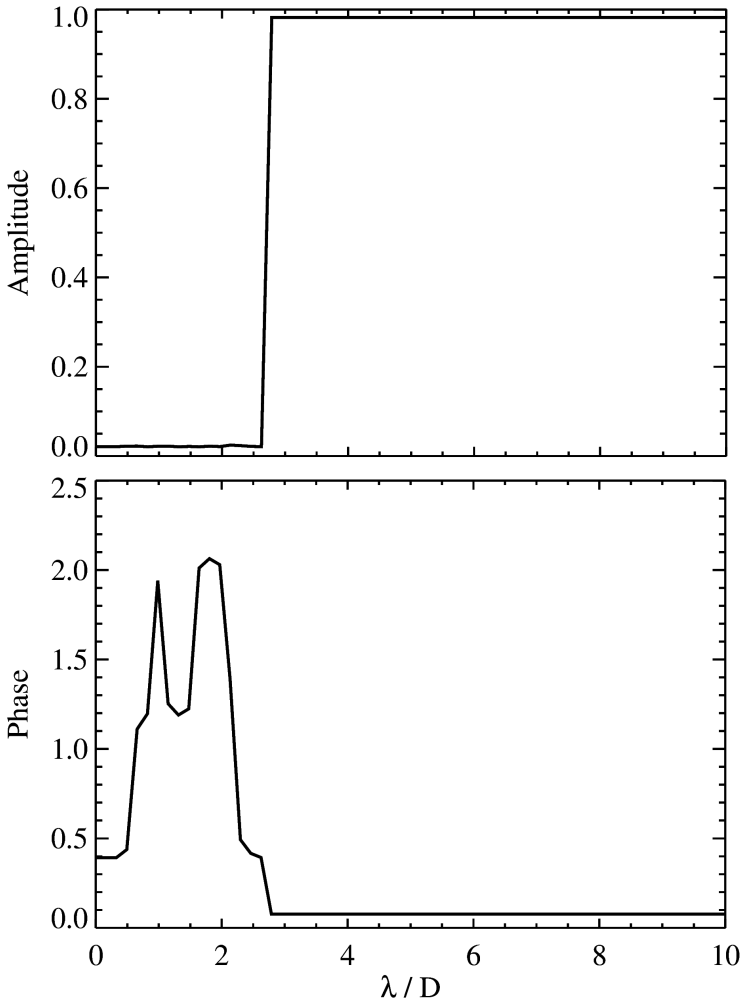
DM 1 DM 2

Total stroke = 231 nm

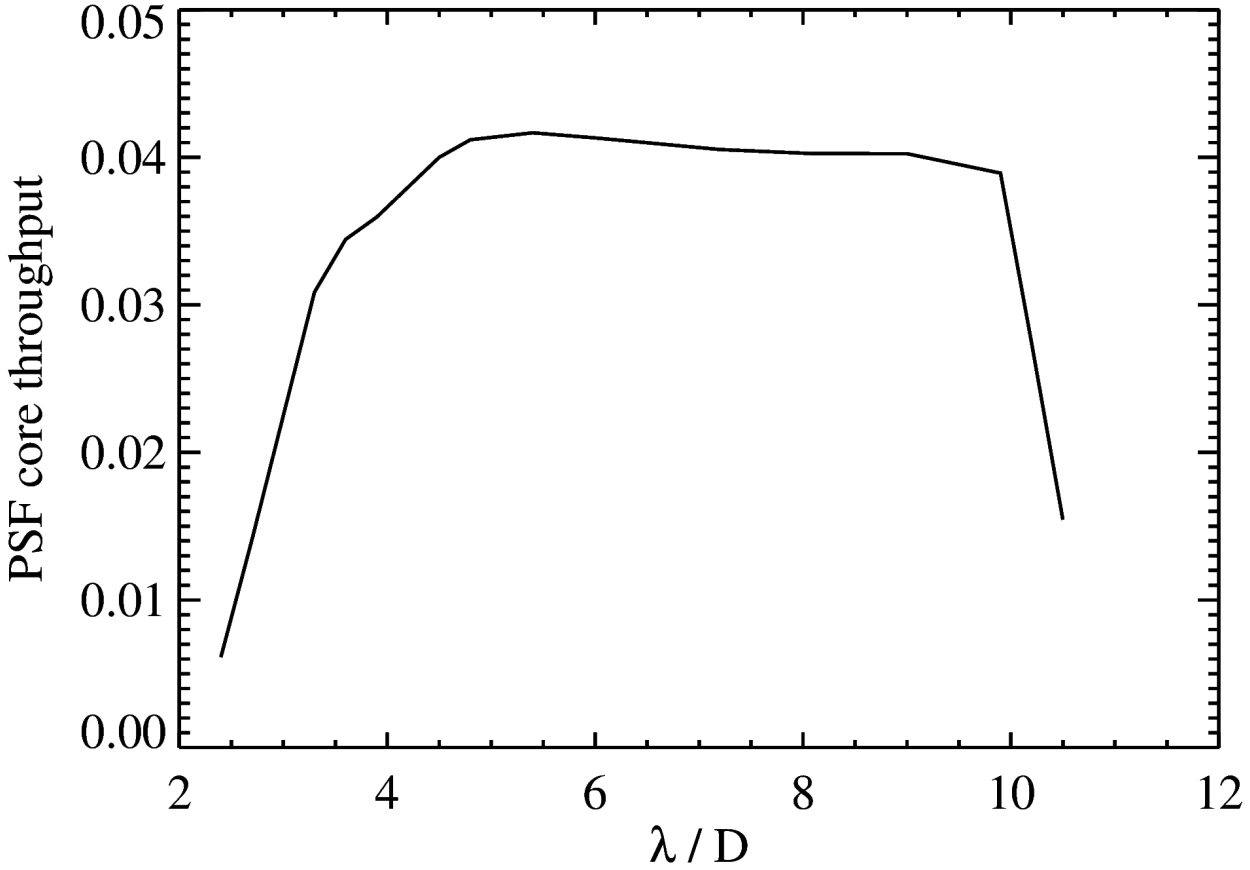


Lyot stop

Occulter (@ 550 nm)



HLC Effective Throughput



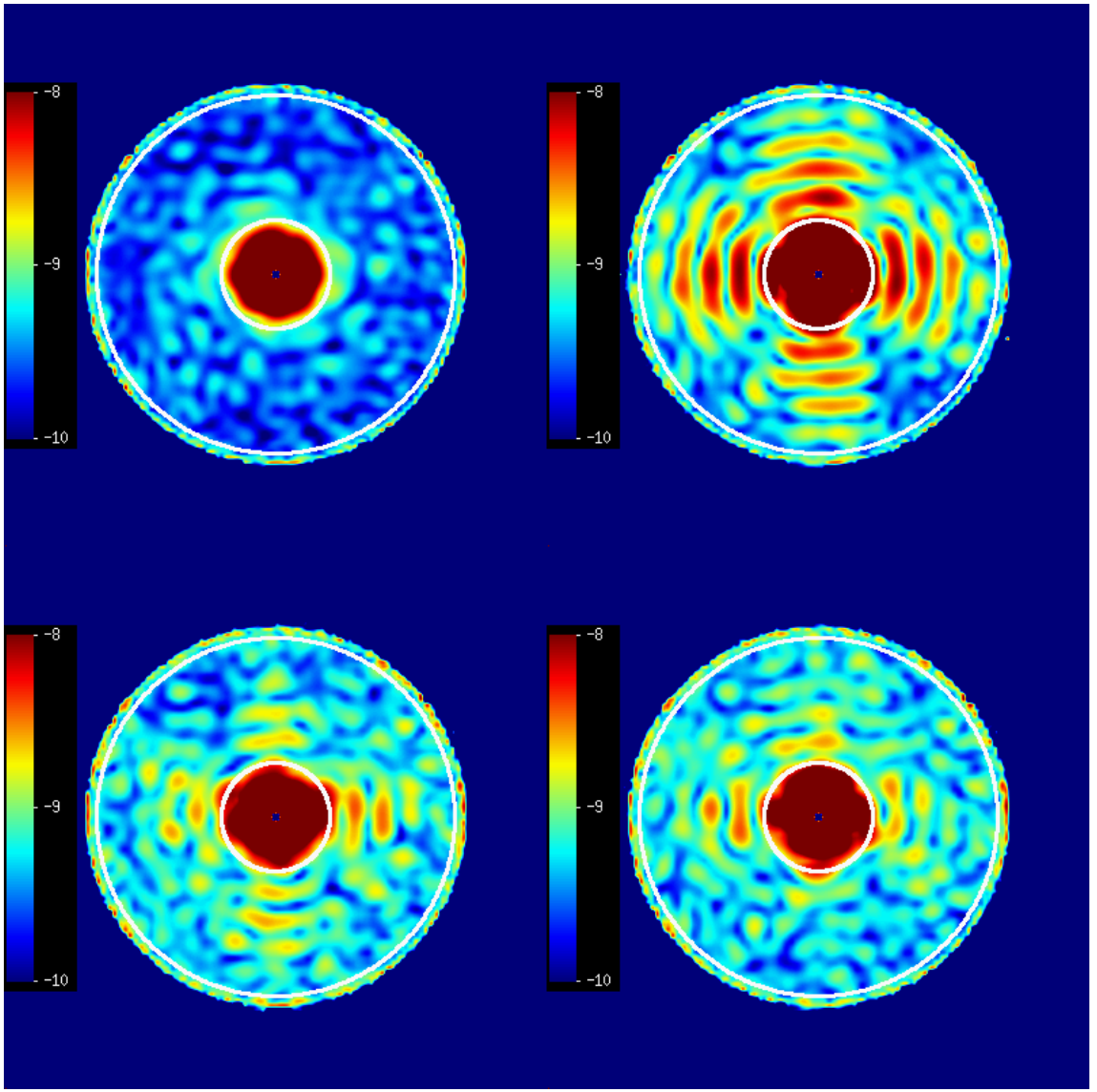
PSF Throughput = Flux inside off-axis (planet) PSF FWHM region / Flux at AFTA primary
(for AFTA without a coronagraph this is 0.34)
Peak relative throughput = 0.043 / 0.34 = 0.13 (previous version was 0.10)
Off-axis (planet) PSF FWHM region covers 0.0021 arcsec^2
(for AFTA without a coronagraph this is 0.00165 arcsec^2)

HLC Post-EFC with Polarization

0.4 mas RMS jitter, 1.0 mas star

X channel (WFS/C in X)

Y channel (WFS/C in X)



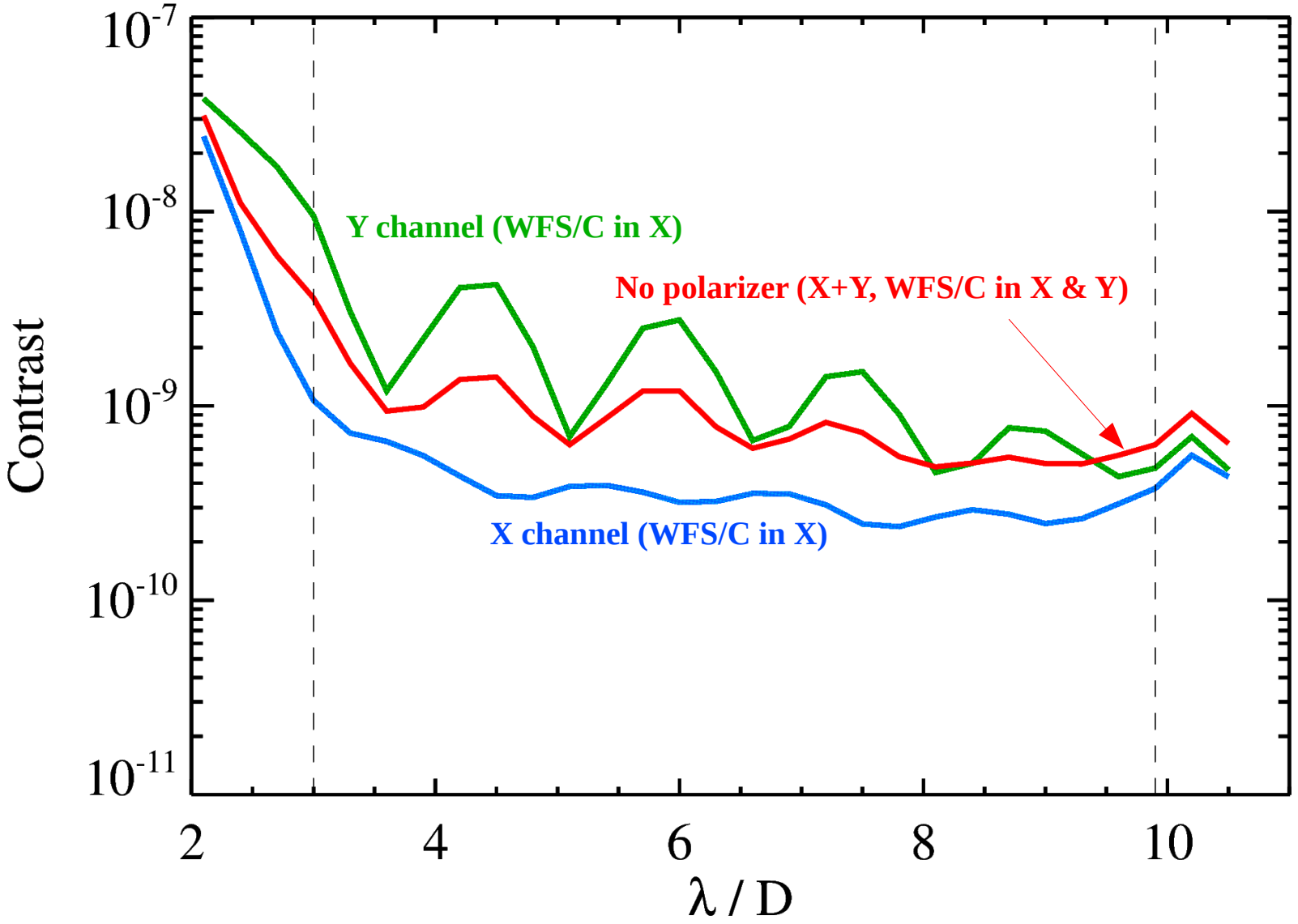
Circles are
r = 3 & 9.9 λ/D

X channel (WFS/C in X & Y)

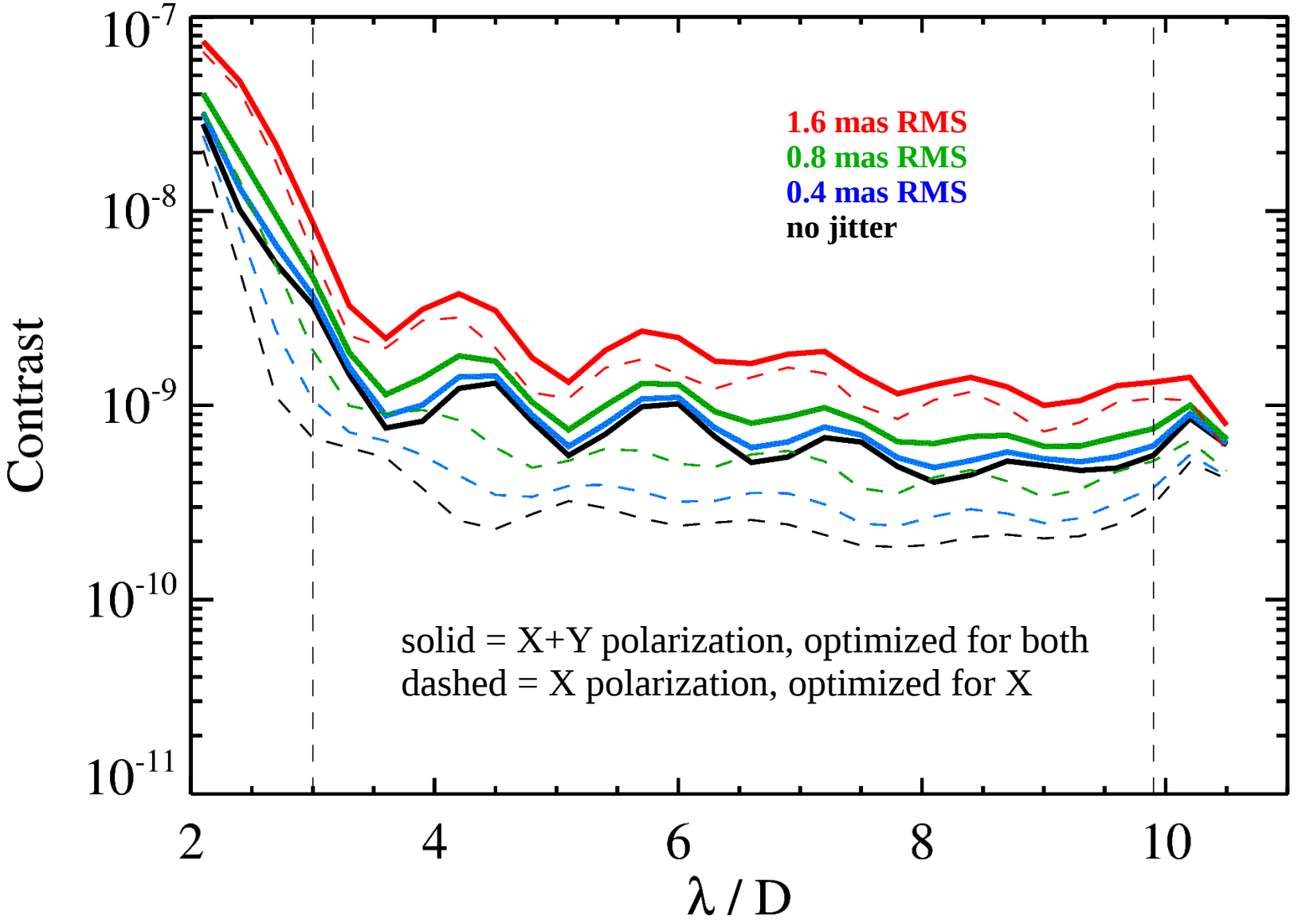
Y channel (WFS/C in X & Y)

HLC Post-EFC with Polarization

0.4 mas RMS jitter, 1.0 mas star

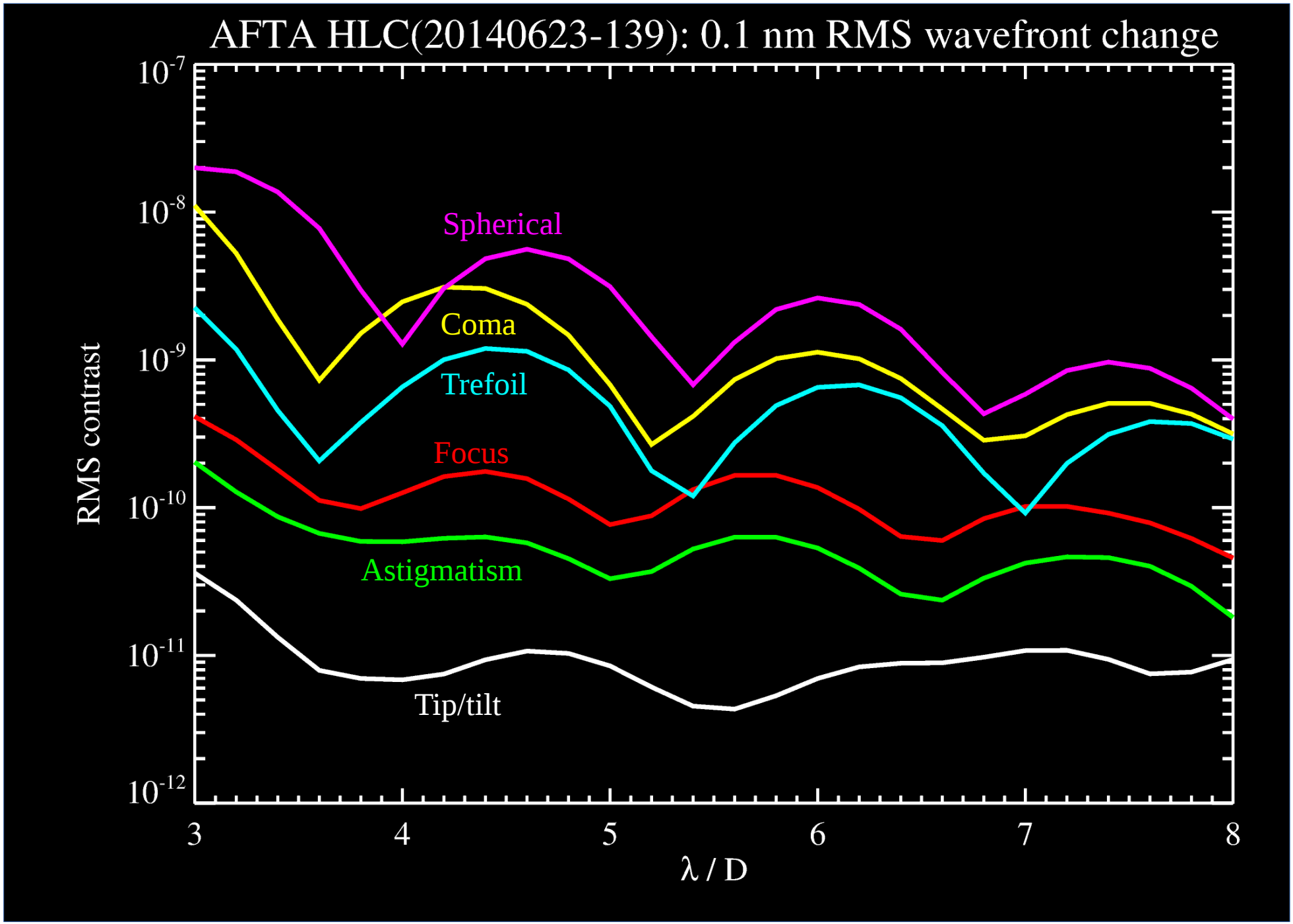


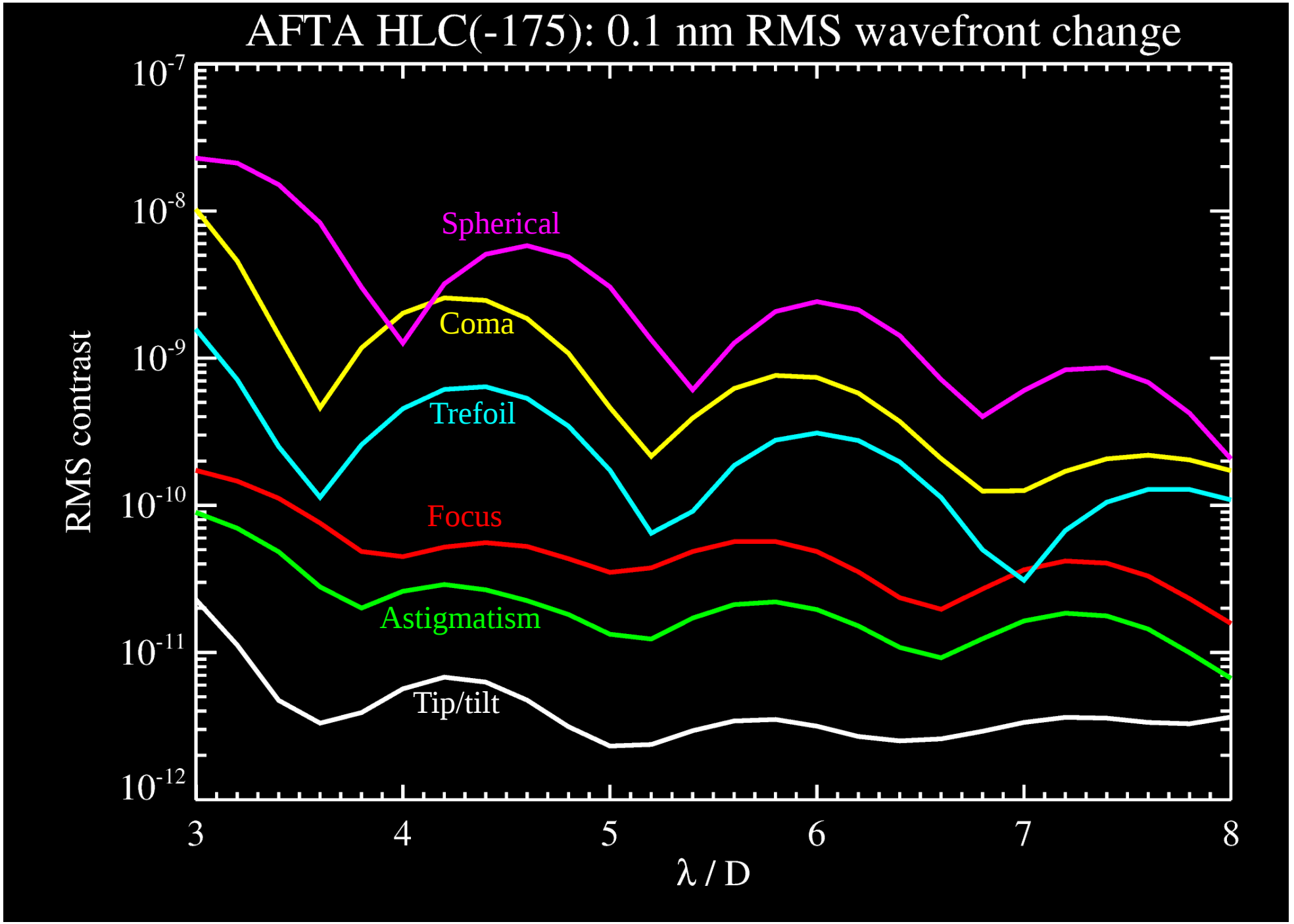
HLC Post-EFC with Polarization



Sensitivity Plots

- Plots for 550 nm (monochromatic)
- 100 pm of individual aberrations were inserted at the primary mirror and propagated through the system with no wavefront control
- The RMS of the difference between the aberrated and unaberrated intensity fields was computed in 0.4 λ/D-wide annuli of different radii
- Previous HLC design (-175) presented for comparison


AFTA HLC(20140623-139): 0.1 nm RMS wavefront change
RMS contrast
10-7
10-8
10-9
10-10
10-11
10-12
Spherical
Coma
Trefoil
Focus
Astigmatism
Tip/tilt
3
4
5
6
7
8
λ / D


AFTA HLC(-175): 0.1 nm RMS wavefront change
RMS contrast
10-7
10-8
10-9
10-10
10-11
10-12
Spherical
Coma
Trefoil
Focus
Astigmatism
Tip/tilt
3
4
5
6
7
8
λ / D