Section 4.7 – Interferograms

Defocus

Defocus & Y-Tilt

$W_{020}$ -2 µm -1 µm 0 µm 1 µm 2 µm

Section 4.7 – Interferograms

Spherical Aberration

Spherical Aberration & Y-Tilt

$W_{020}$ -2 µm -1 µm 0 µm 1 µm 2 µm
Section 4.7 – Interferograms

Astigmatism

![Astigmatism Images]

Astigmatism & Y-Tilt

![Astigmatism & Y-Tilt Images]

\[ W_{020} \quad -2 \mu m \quad -1 \mu m \quad 0 \mu m \quad 1 \mu m \quad 2 \mu m \]

Section 4.7 – Interferograms

Coma

![Coma Images]

Coma & Y-Tilt

![Coma & Y-Tilt Images]

\[ W_{020} \quad -2 \mu m \quad -1 \mu m \quad 0 \mu m \quad 1 \mu m \quad 2 \mu m \]
Sampling a low frequency pattern accurately approximates the curve, but when high frequency patterns are sampled, the pattern is reduced to a lower frequency shape.
Aliasing

Hubble Telescope
Hubble Telescope

Ritchey-Chretien telescope with 2.4 m primary mirror.

Aberrations

Before Repairs       After Repairs
Reflective Null Corrector

Reflective null corrector converts incident spherical wave into a suitable shape to retro-reflect from the primary mirror

Reflective Null Alignment

Metal rods with rounded ends were used to set the spacing between the mirrors and the field lens. An interferometer is used to precisely locate the end of the rod through retro-reflection.
Rod Caps
Caps were placed on the ends of the rods to help make sure the rod was centered. The rod was visible through a small hole in the cap. The end of the cap had an anti-reflective coating applied to it.

Some of the anti-reflective coating in the neighbor of the hole had broken away.

Misalignment of Field Lens
Unfortunately, when locating the end of the rod for position the field lens, the operator got a retroreflection off the field cap instead of the rod. This ultimately led to a 1.3 mm displacement in the axial position of the field lens and an incorrect amount of spherical aberration in the reflective null corrector. This spherical aberration in turn was polished into the primary mirror.
Failure Report

These errors were identified by a team of independent scientists. Ultimately, corrective optics were developed and deployed based on the failure report and the image quality of the repaired telescope has led to unprecedented images of the universe.

Four-Step Algorithm

Phase Shift

\[ 0 \quad \pi/2 \quad \pi \quad 3\pi/2 \]
Wrapped Phase

$$\varphi(x, y) = \tan^{-1} \left( \frac{I_1(x, y) - I_0(x, y)}{I_1(x, y) - I_0(x, y)} \right)$$