

TOLIMAN

Peter Tuthill
Chris Betters
Conaire Deagan
Louis Desgoits
Ben Pope
Kieran Larkin
Adam Taras

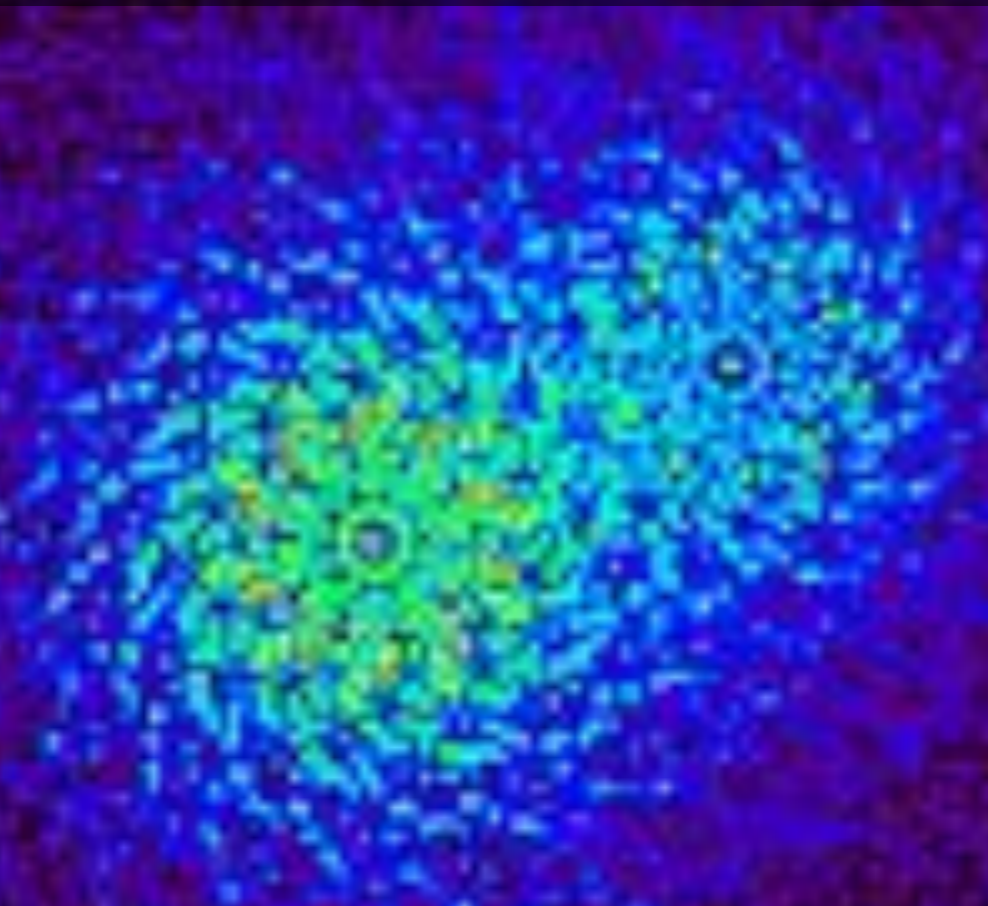


Universiteit
Leiden



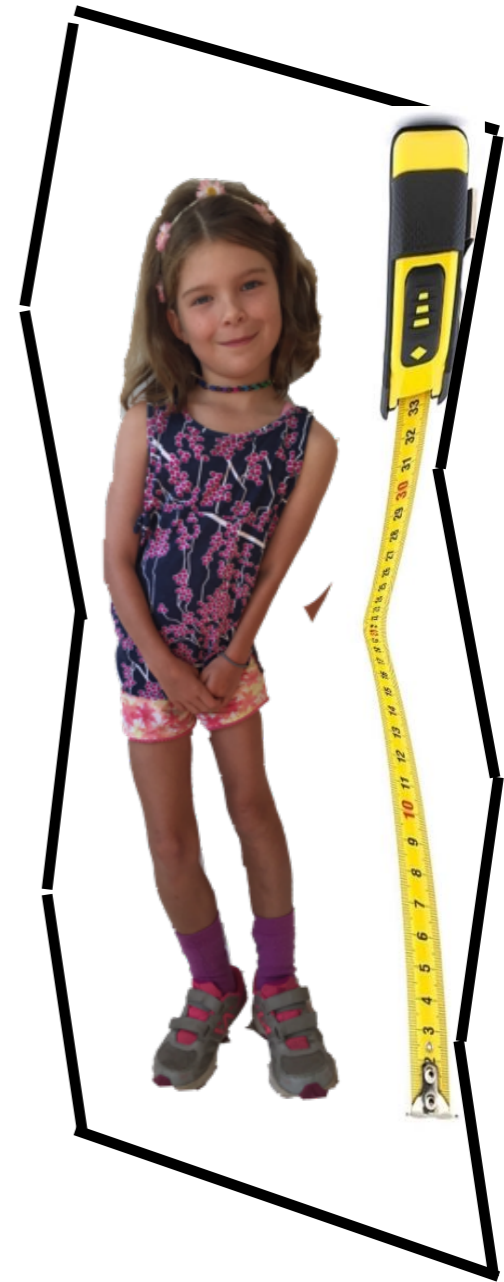
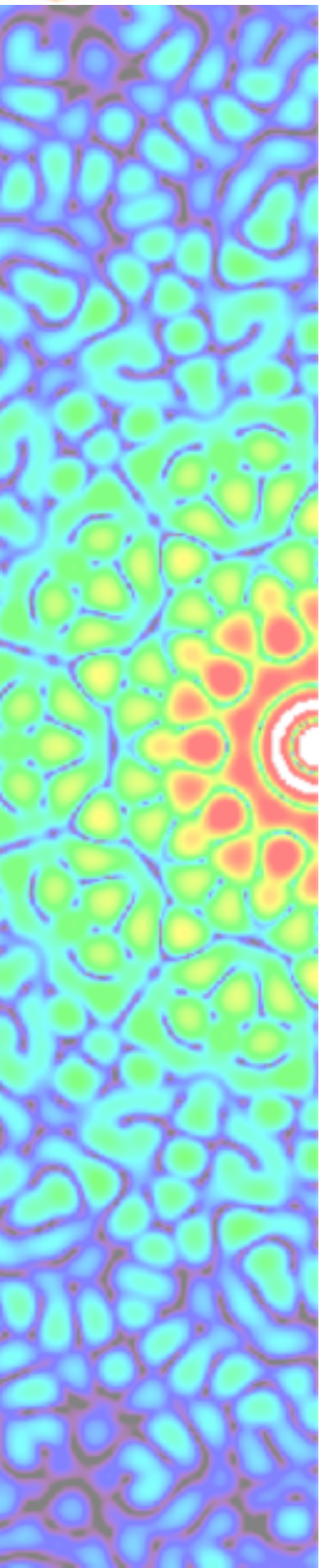
TOLIMAN

Telescope for Orbit Locus Interferometric
Monitoring of our Astronomical Neighbourhood



- Is there an Earth Analog in Alpha Cen?
- 1 Earth Mass, 0.5-2yr orbit, A or B

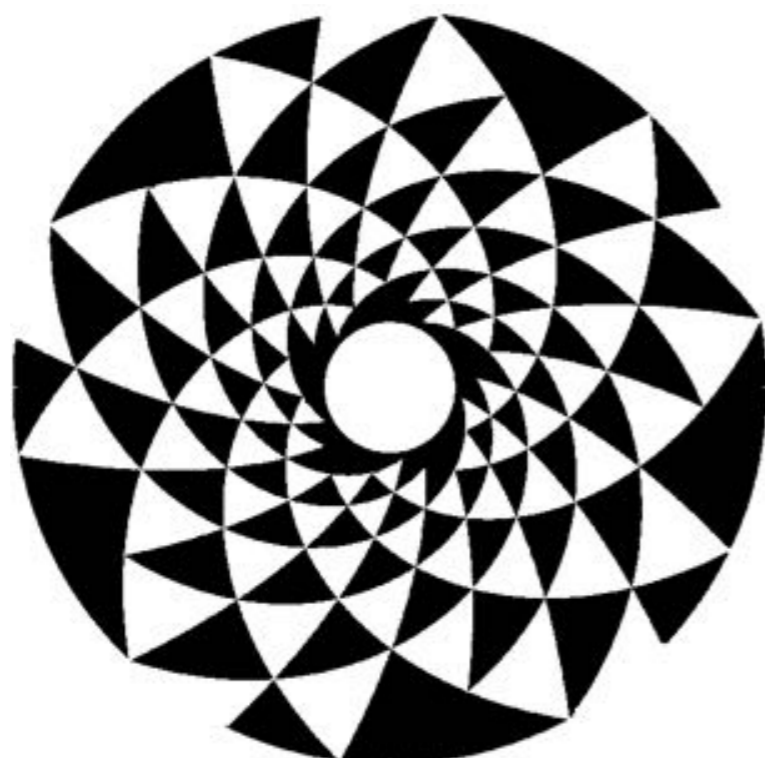
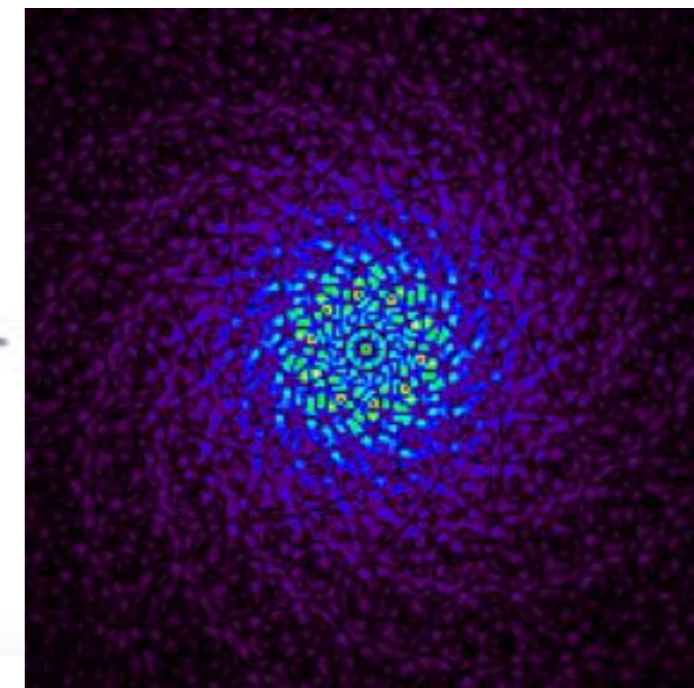
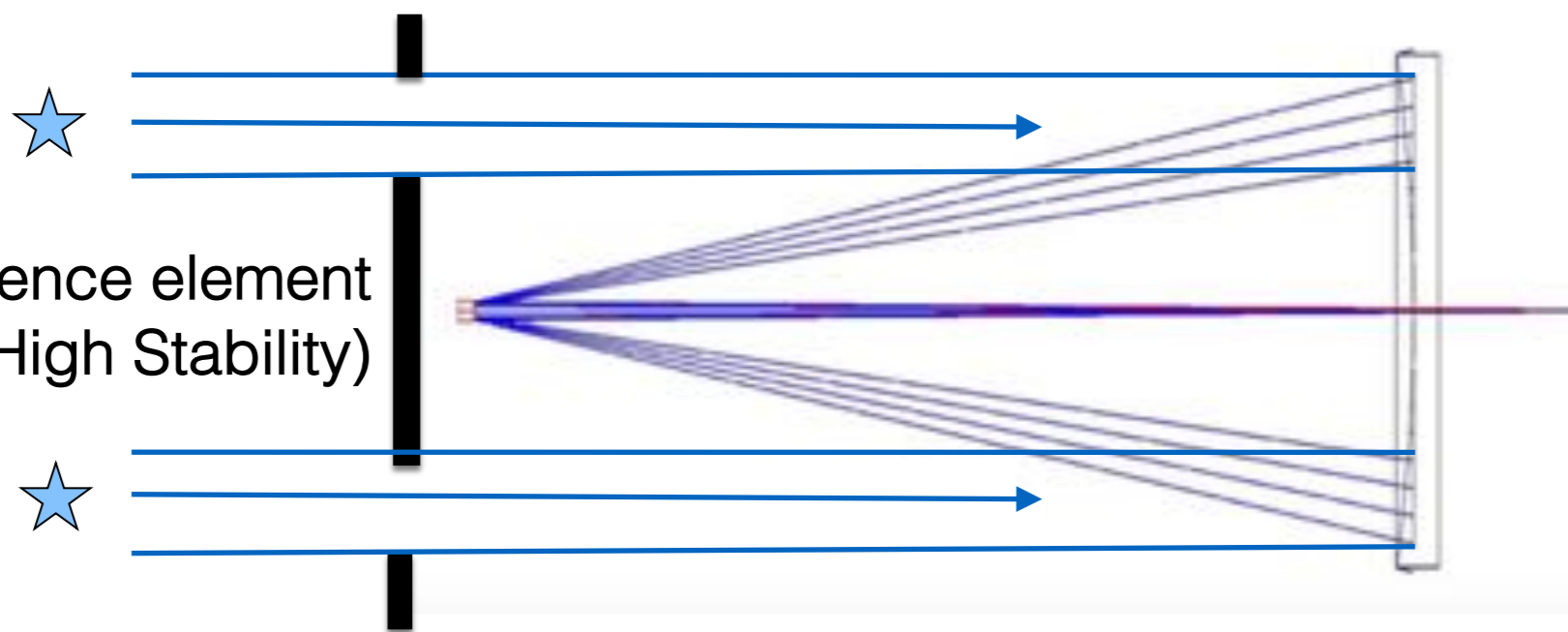
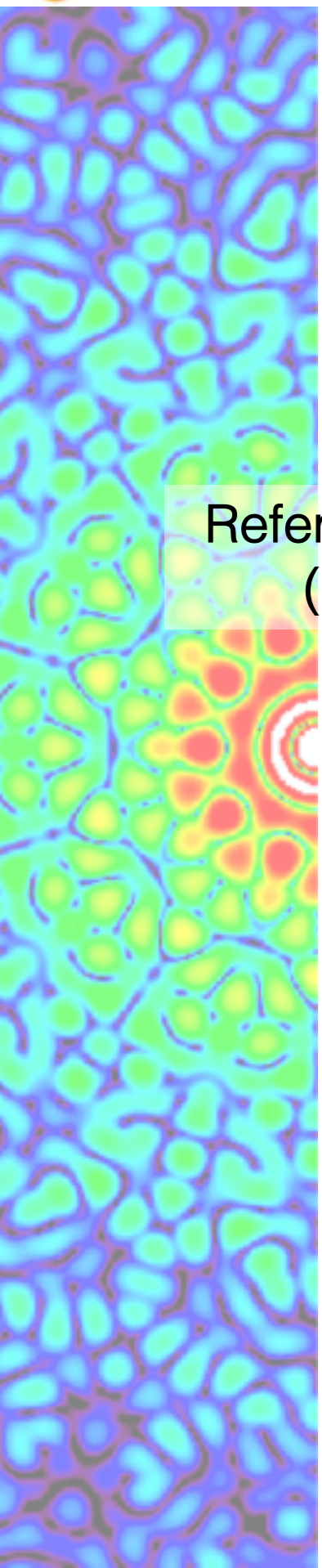
Optical distortions don't matter if they bend both your ruler and your object...



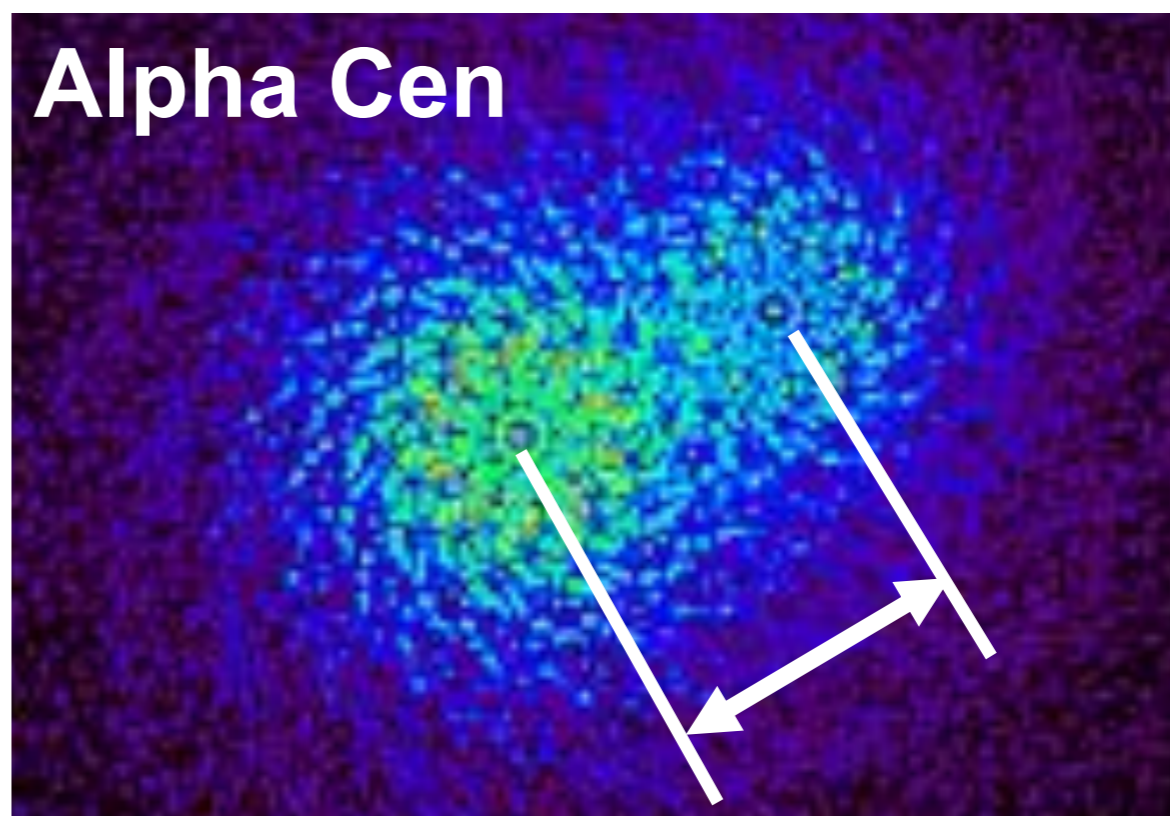
Original concept empowering TOLIMAN

Diffractive-pupil pupil mask

Monitor the binary with a diffractive ruler made of starlight!

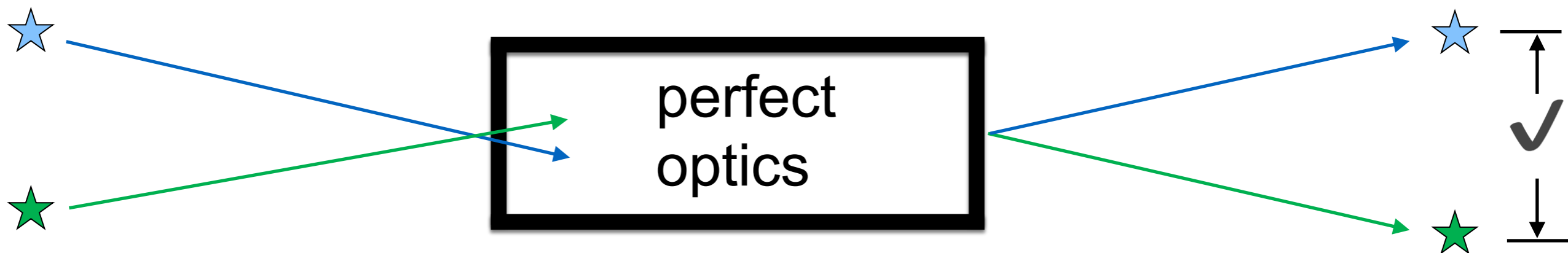


Diffractive Pupil ($0 / \pi$)

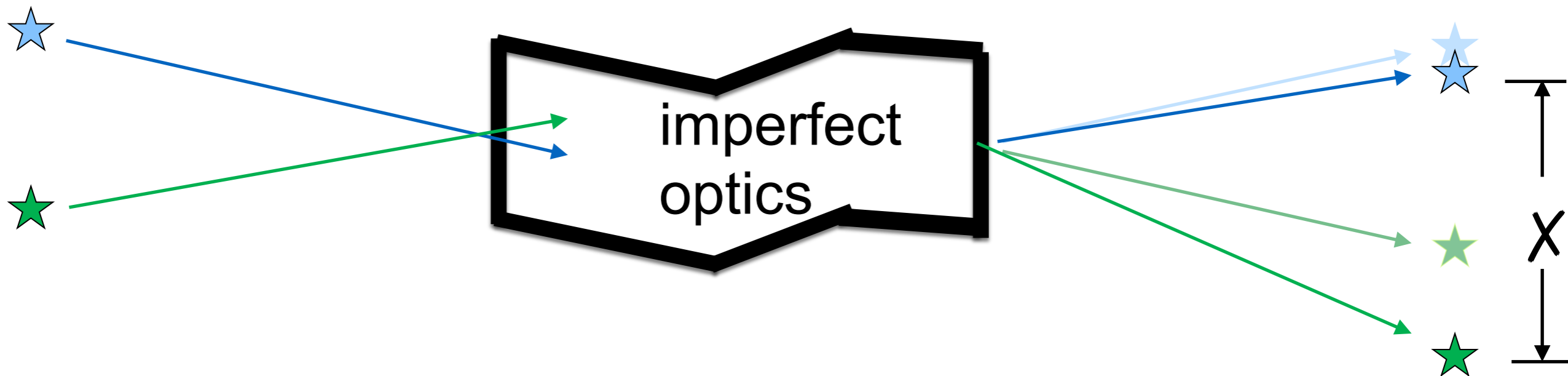


Fundamental principle: Diffractive Pupils

1. *The basic problem*

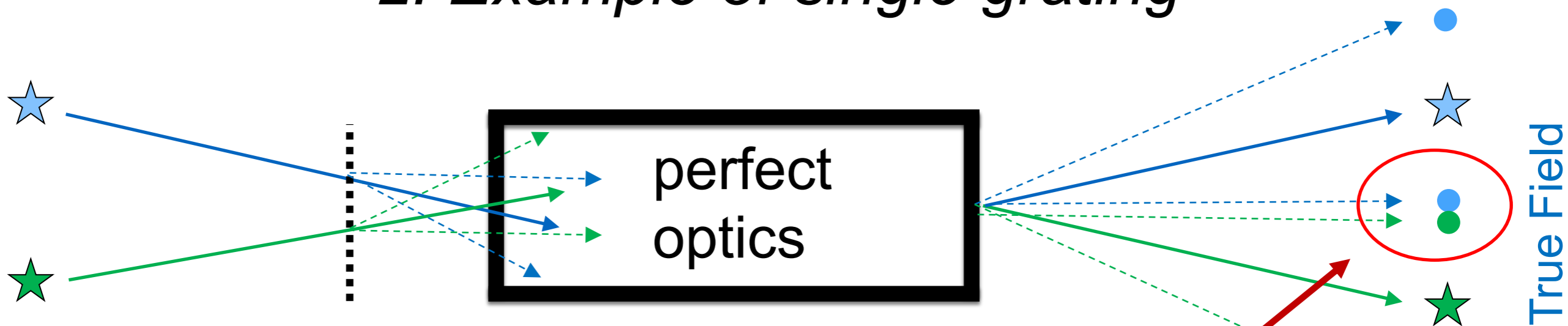


Distortion in the image field caused by unstable optical errors causes us to register the wrong apparent separation for the binary



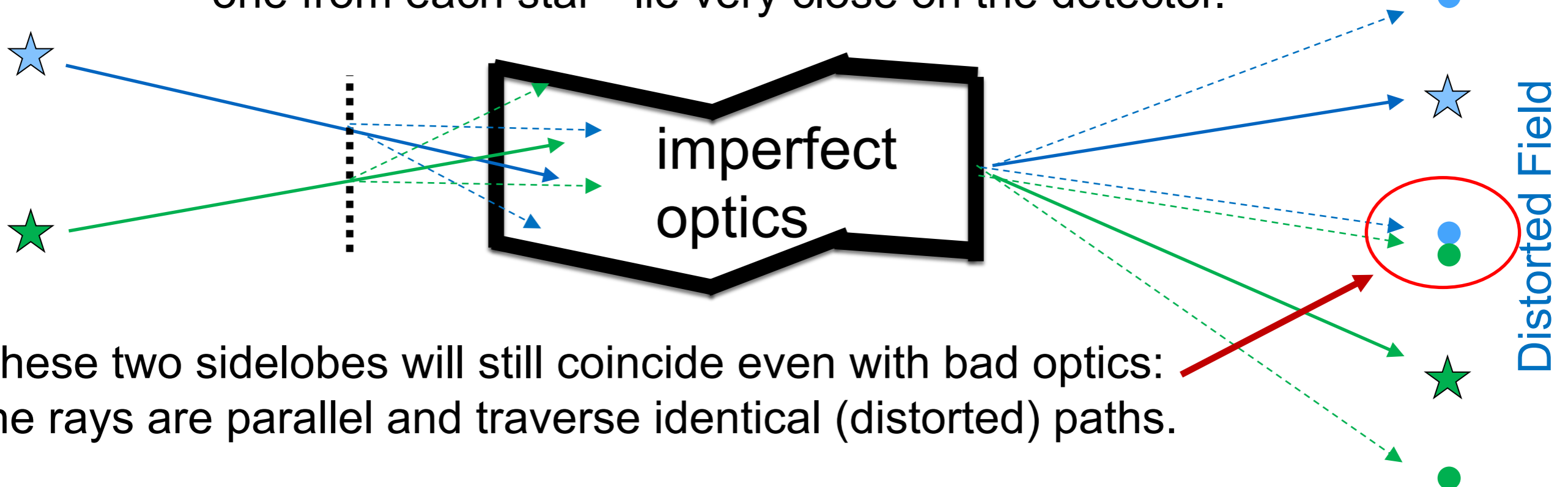
Fundamental principle: Diffractive Pupils

2. Example of single grating

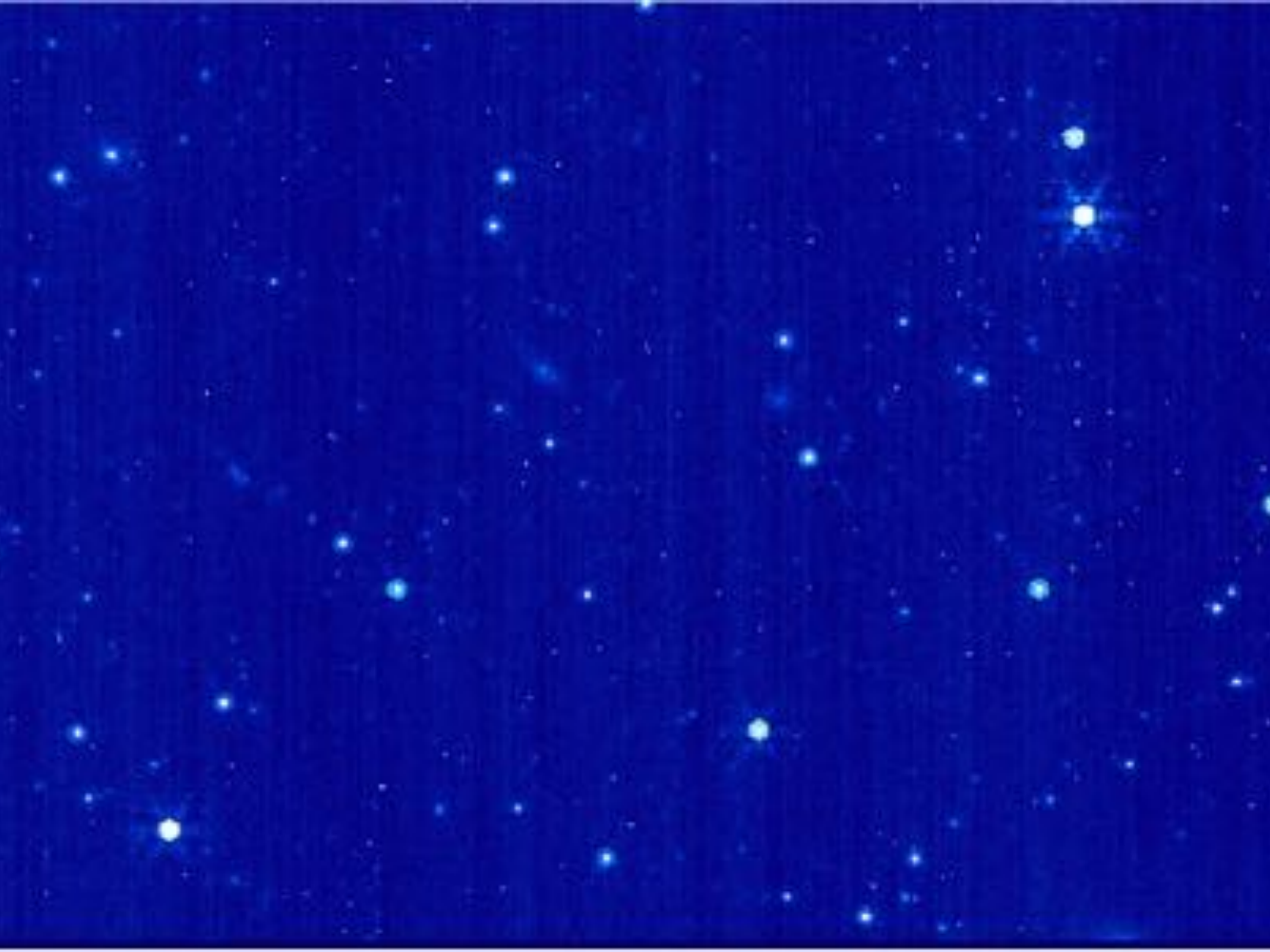


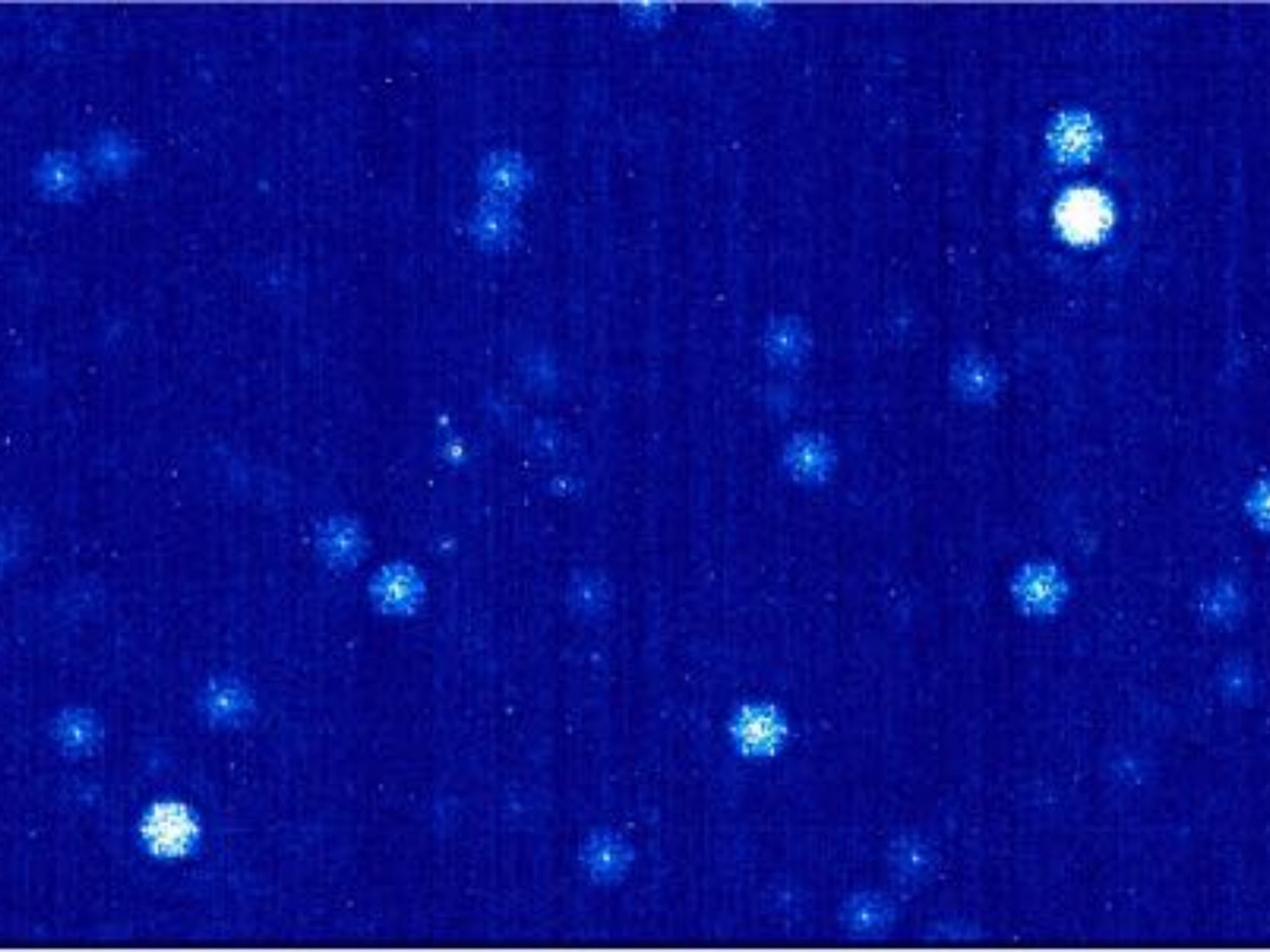
Insert a grating *upstream of the entire optical system* that diffracts light into 2 sidelobes.

The grating spacing is chosen so that two sidelobes – one from each star - lie very close on the detector.

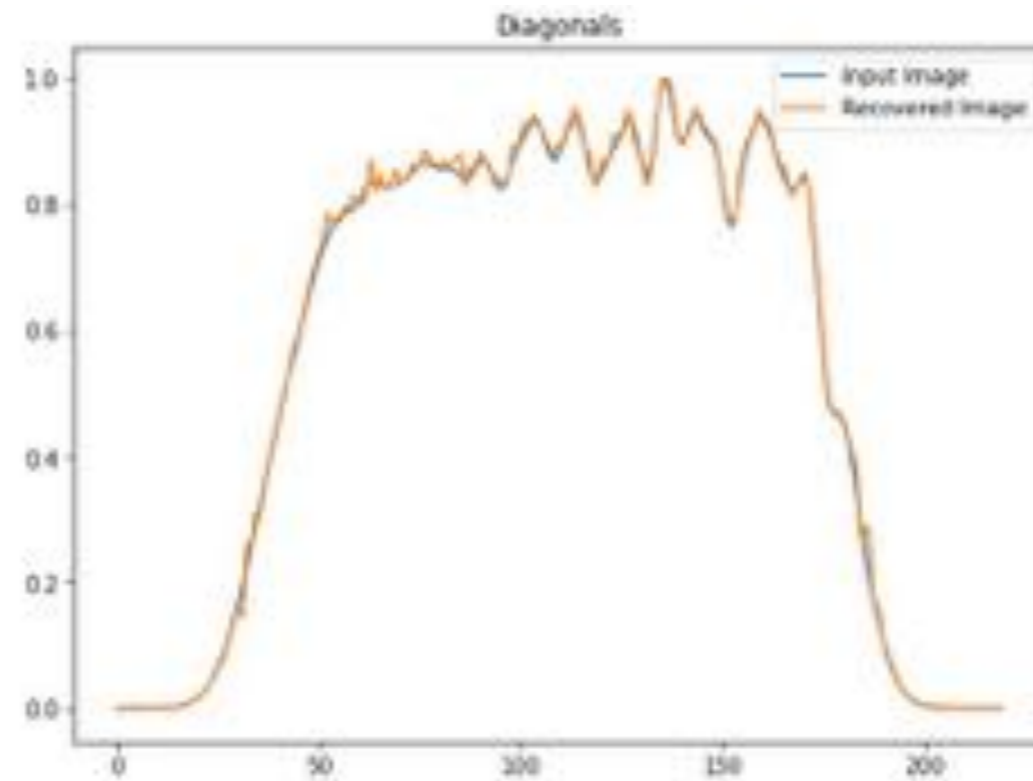


These two sidelobes will still coincide even with bad optics: the rays are parallel and traverse identical (distorted) paths.

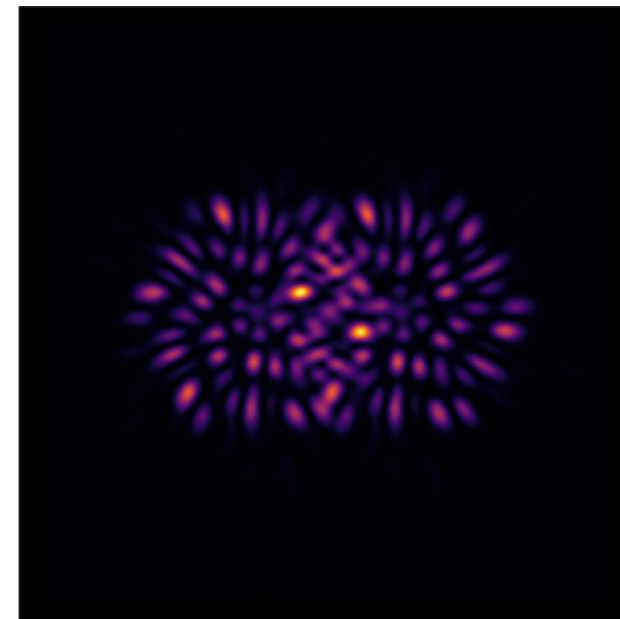
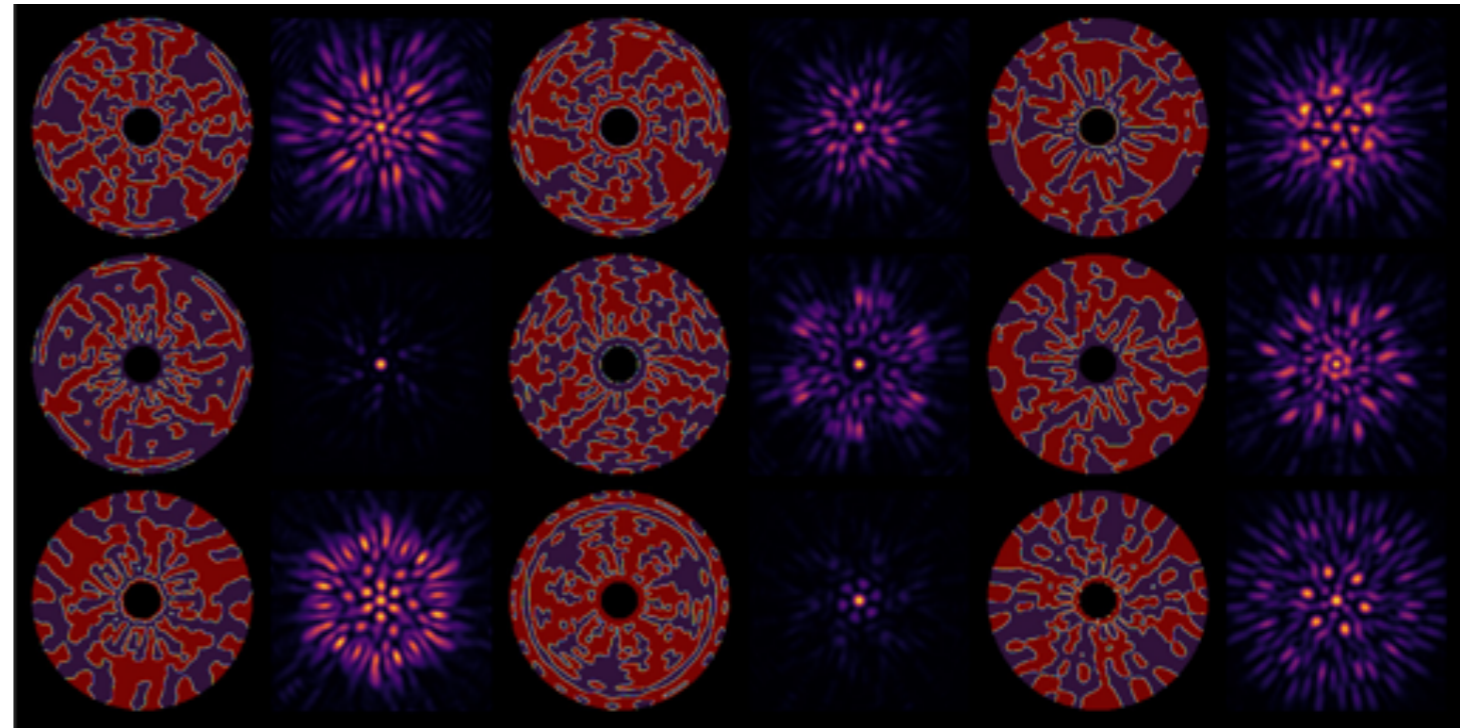
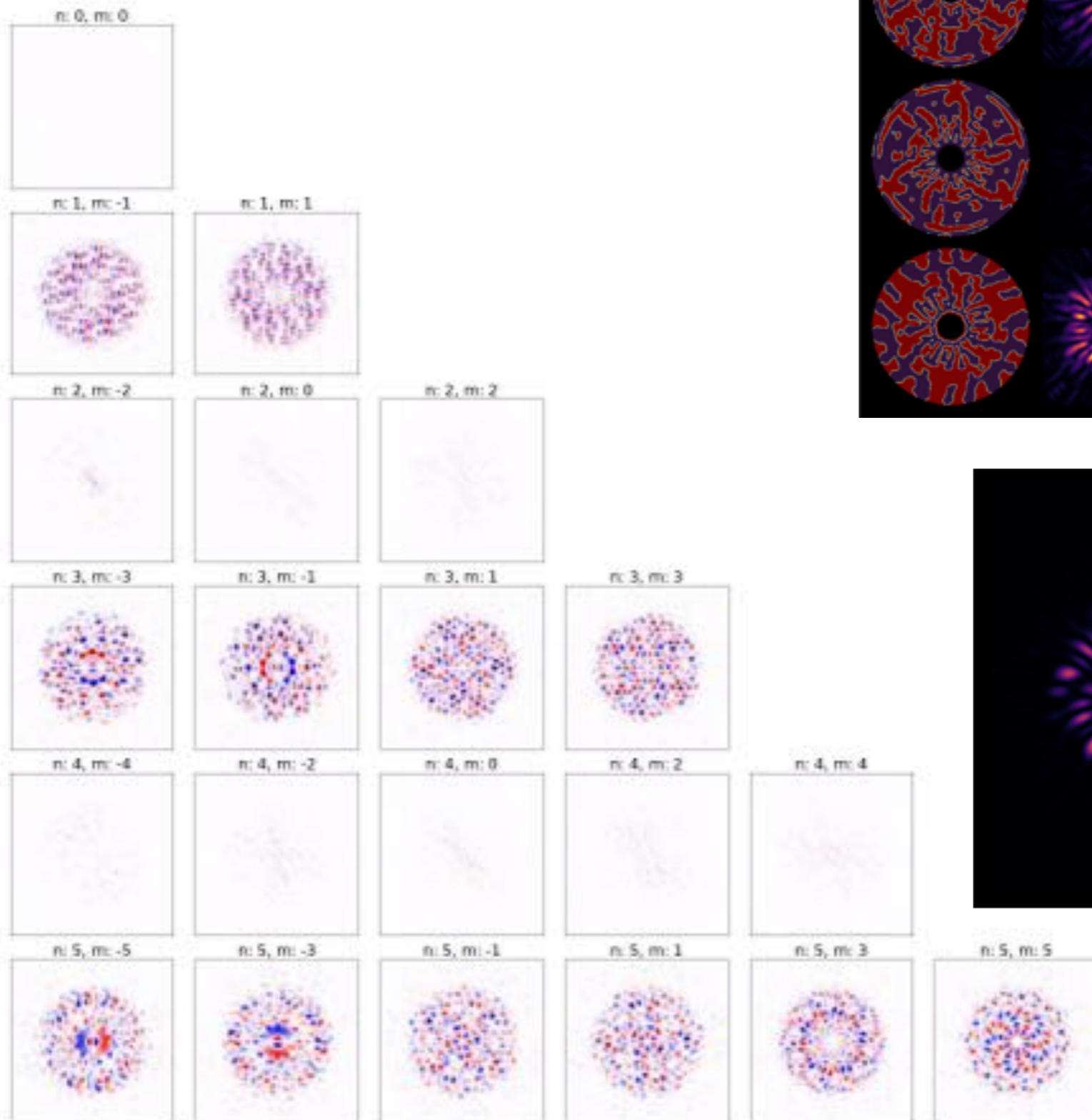




The PSF in-built spectrometer: performance



Principled numerical optimisation of the Pupil



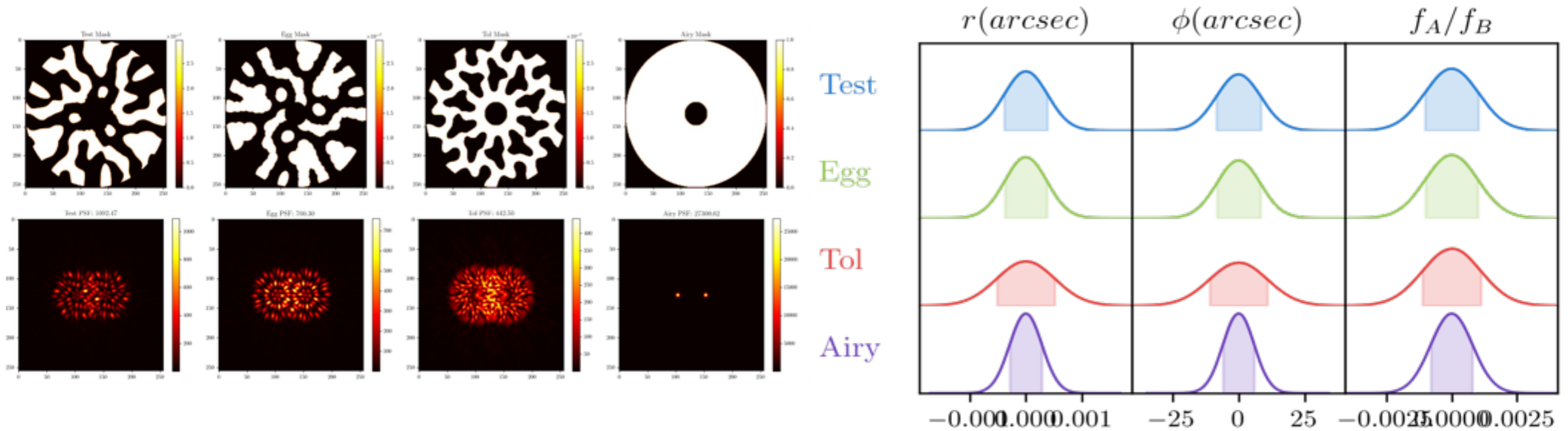
3-fold

5-fold

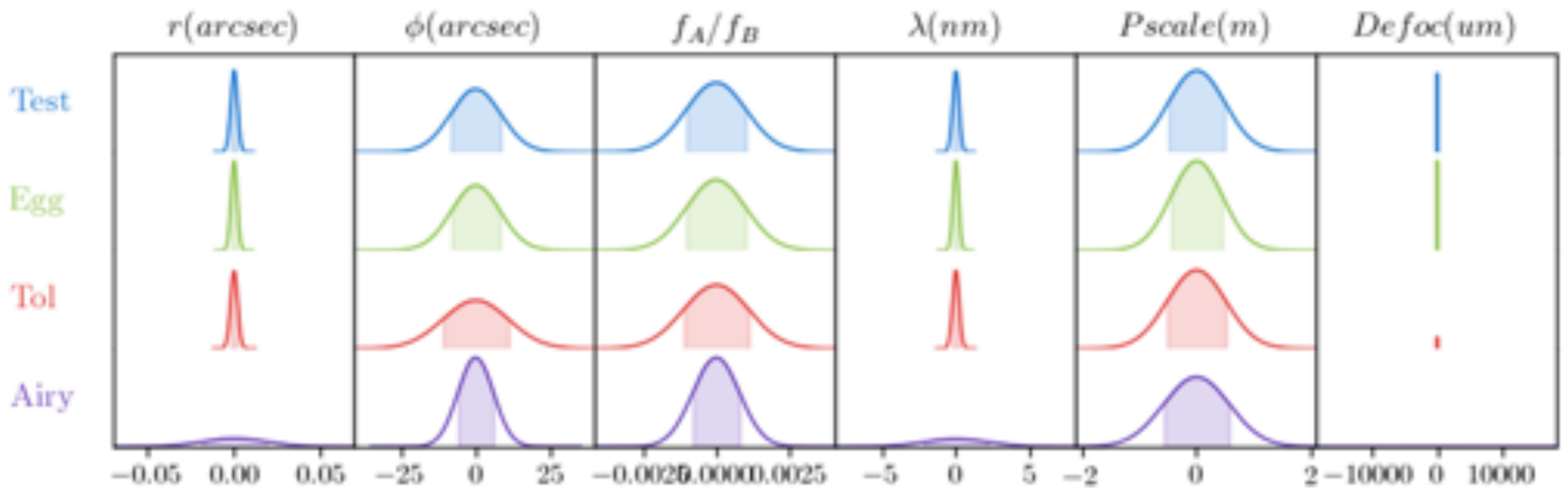
7-fold



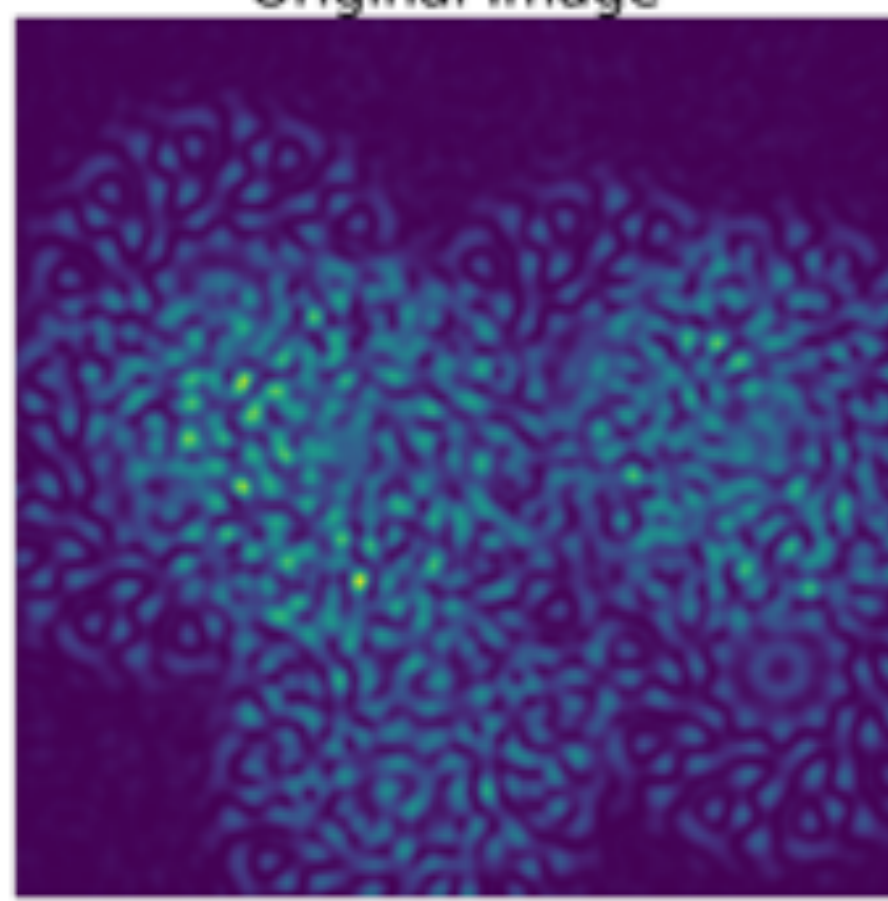
Posteriors: Separation, field angle, flux ratio



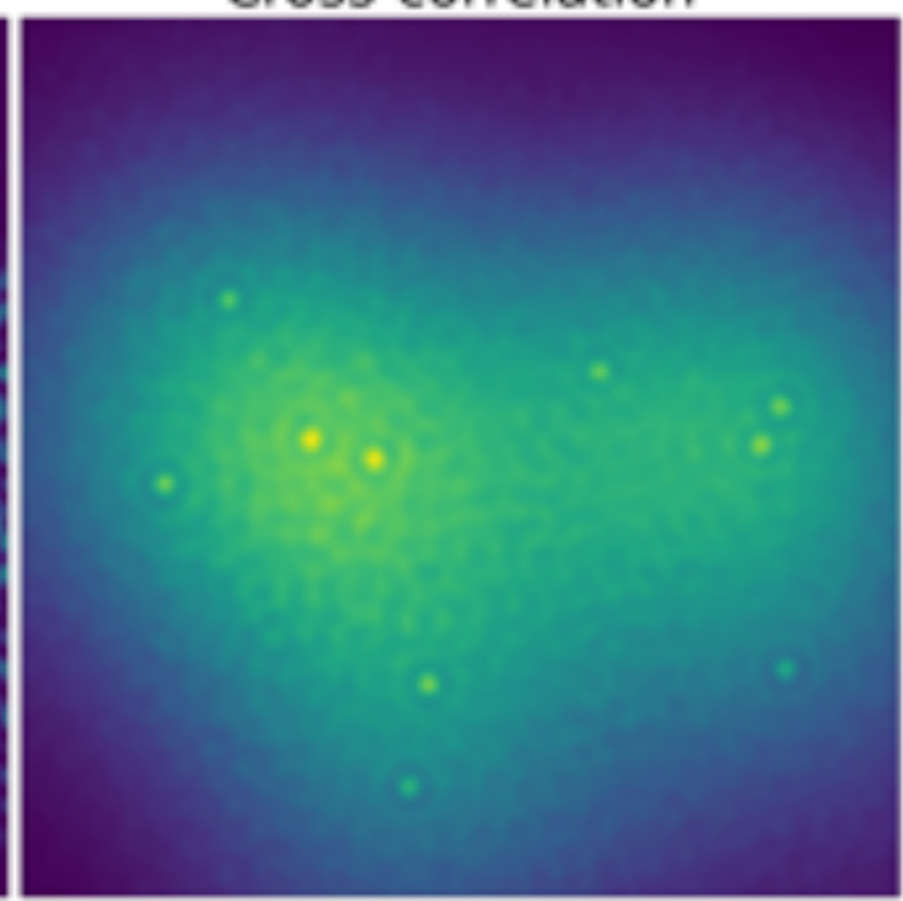
Posteriors: Adding wavelength, plate scale, defocus



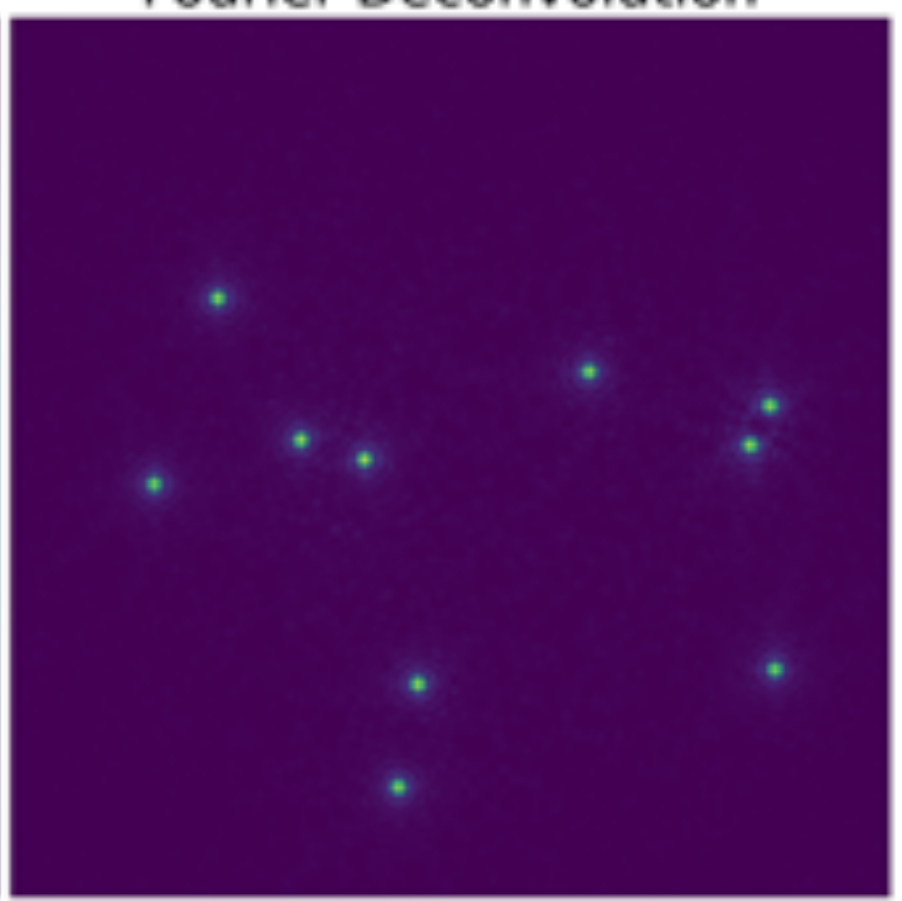
Original Image



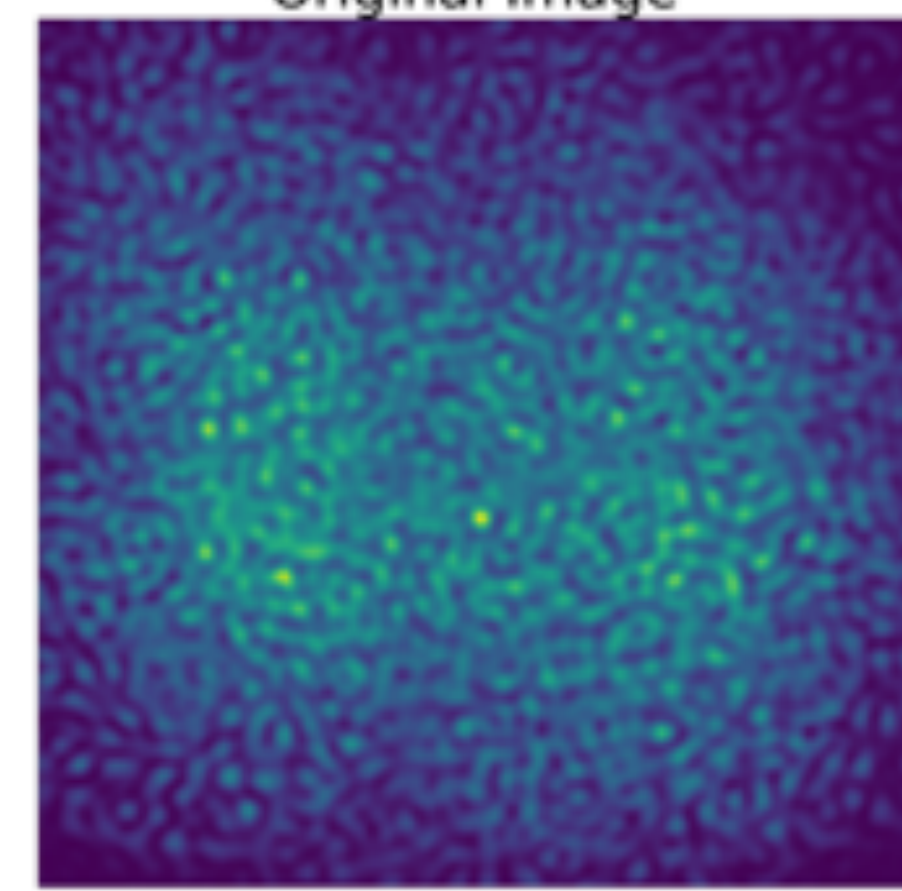
Cross-correlation



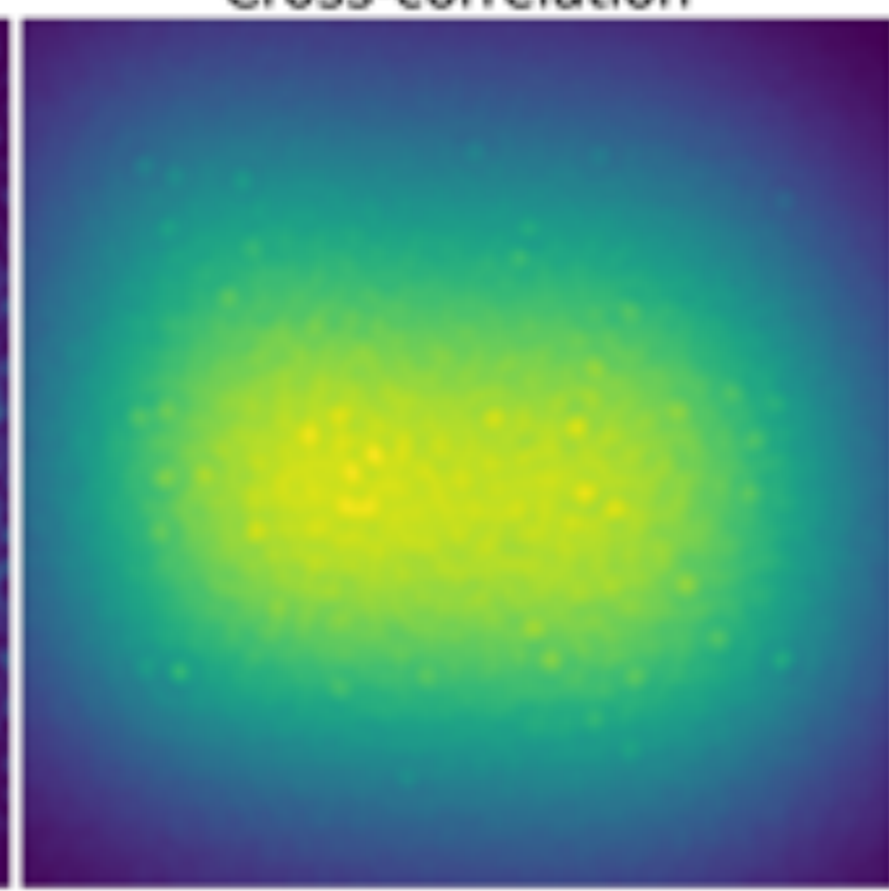
Fourier Deconvolution



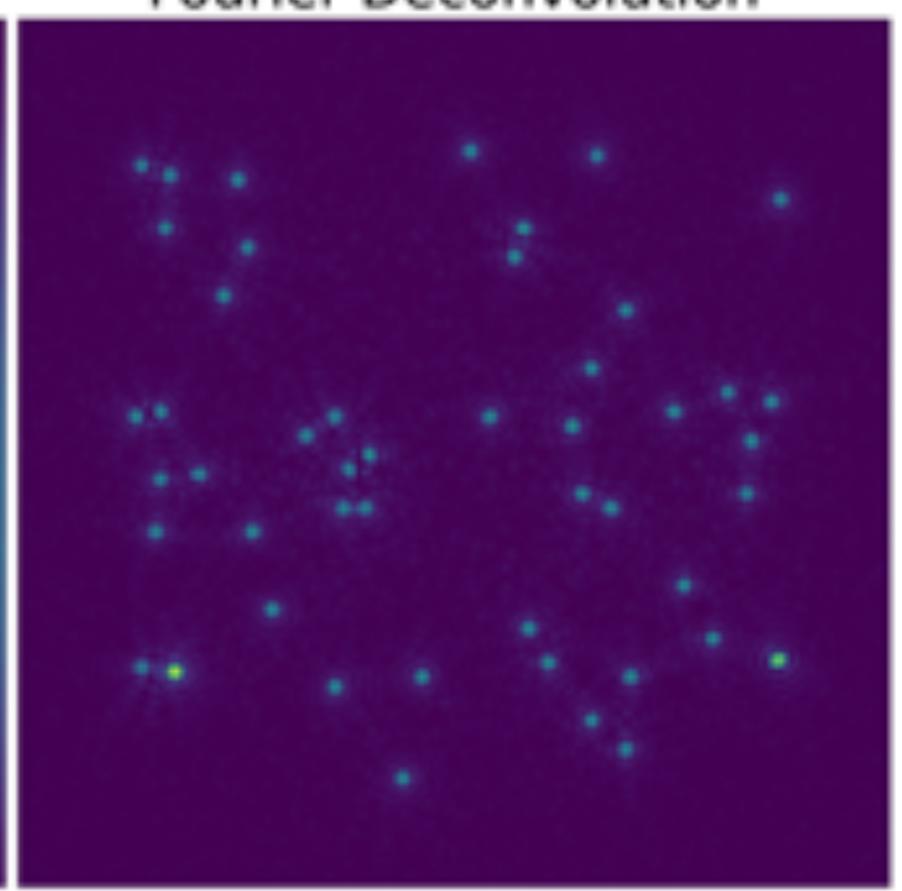
Original Image



Cross-correlation



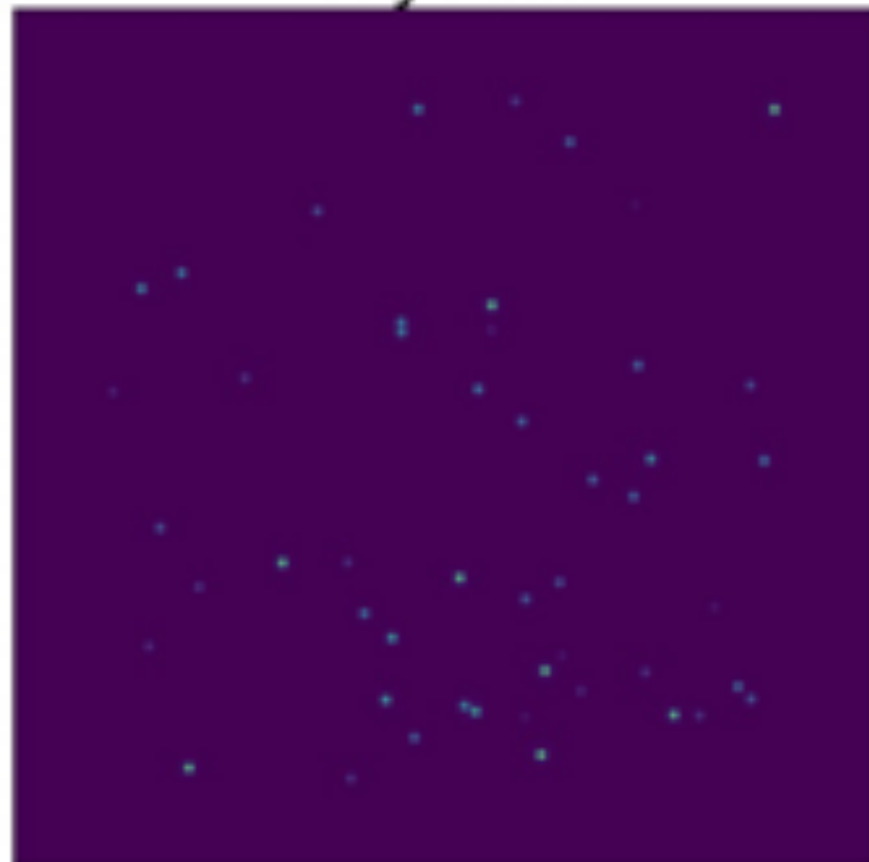
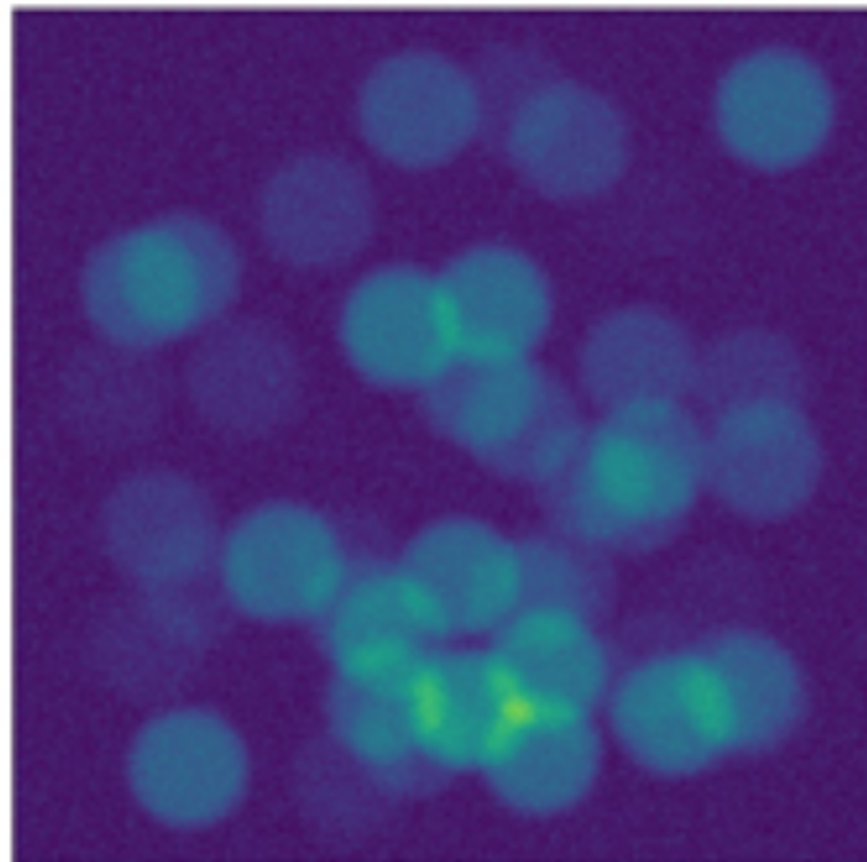
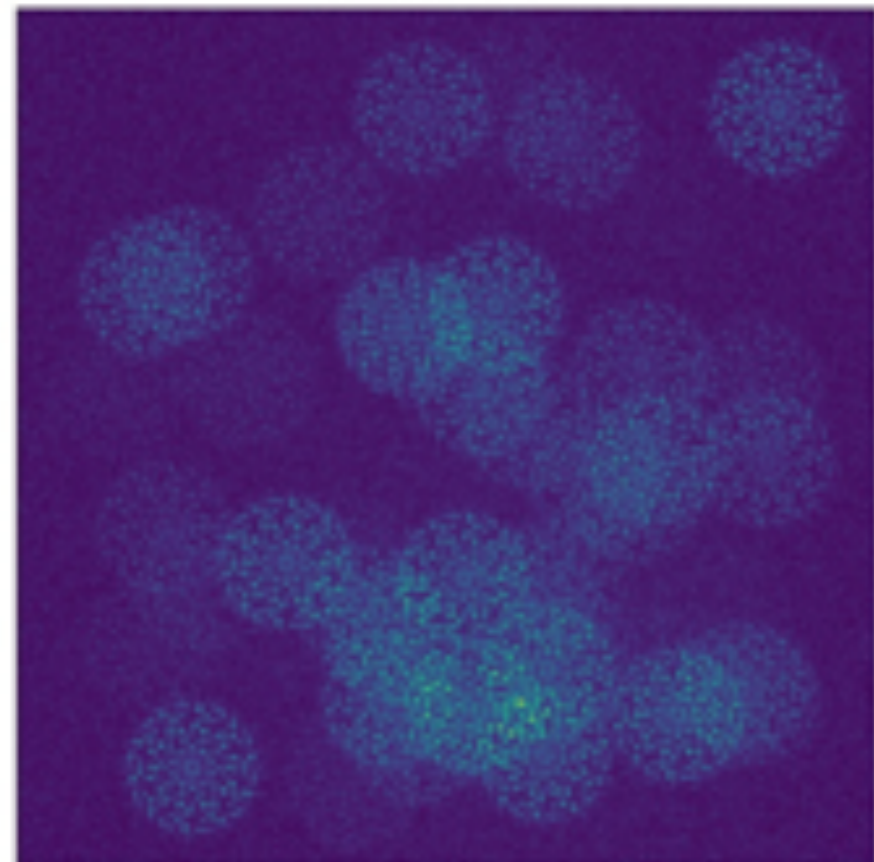
Fourier Deconvolution



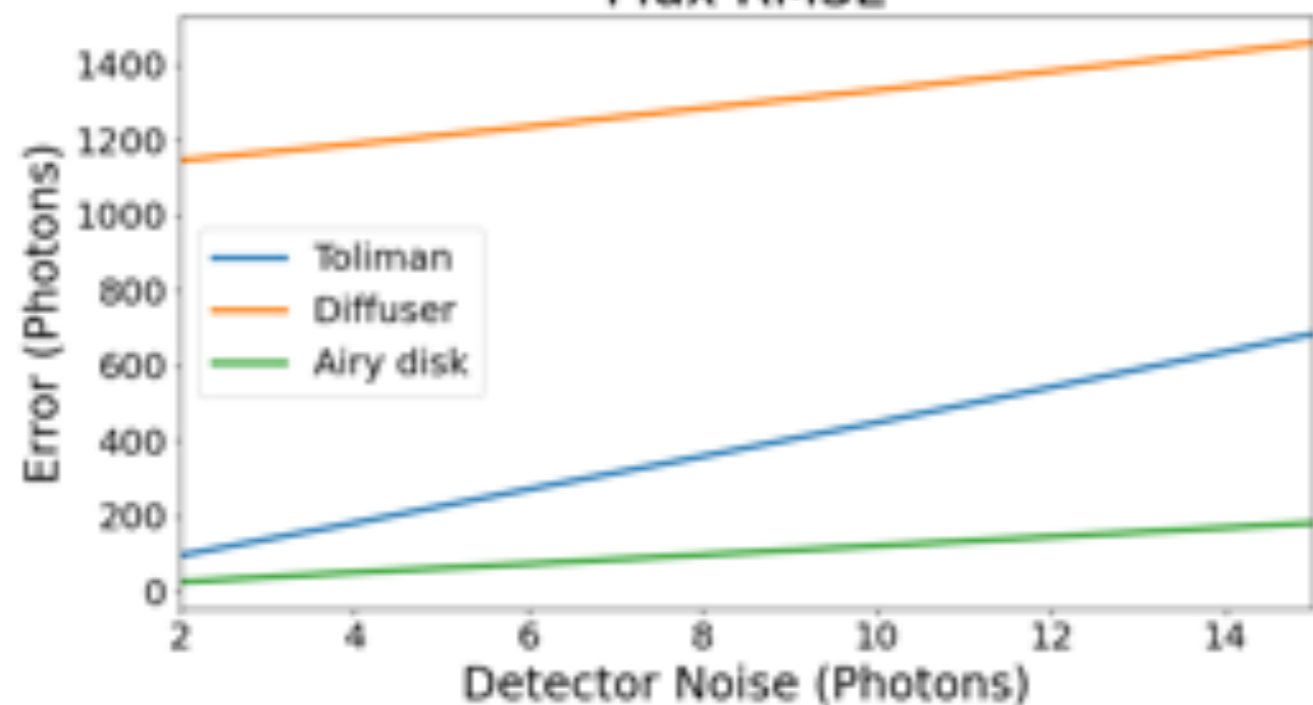
Toliman

Diffuser

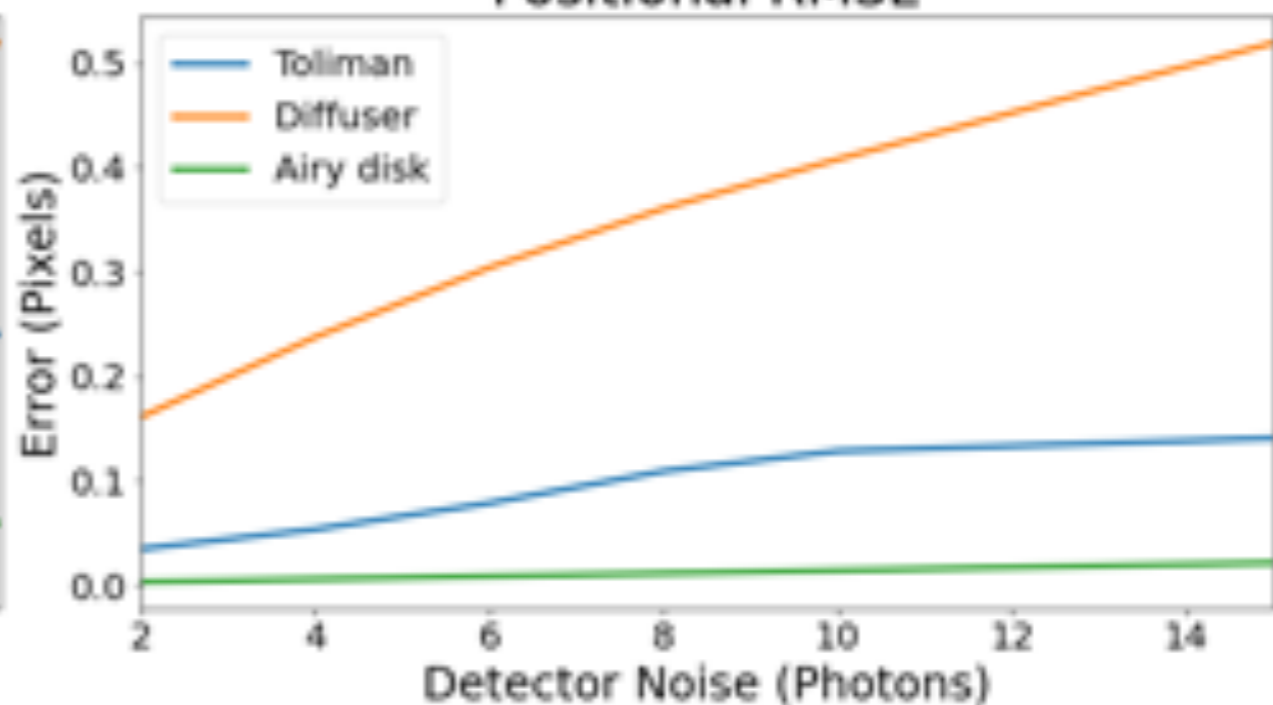
Airy disk



Flux RMSE



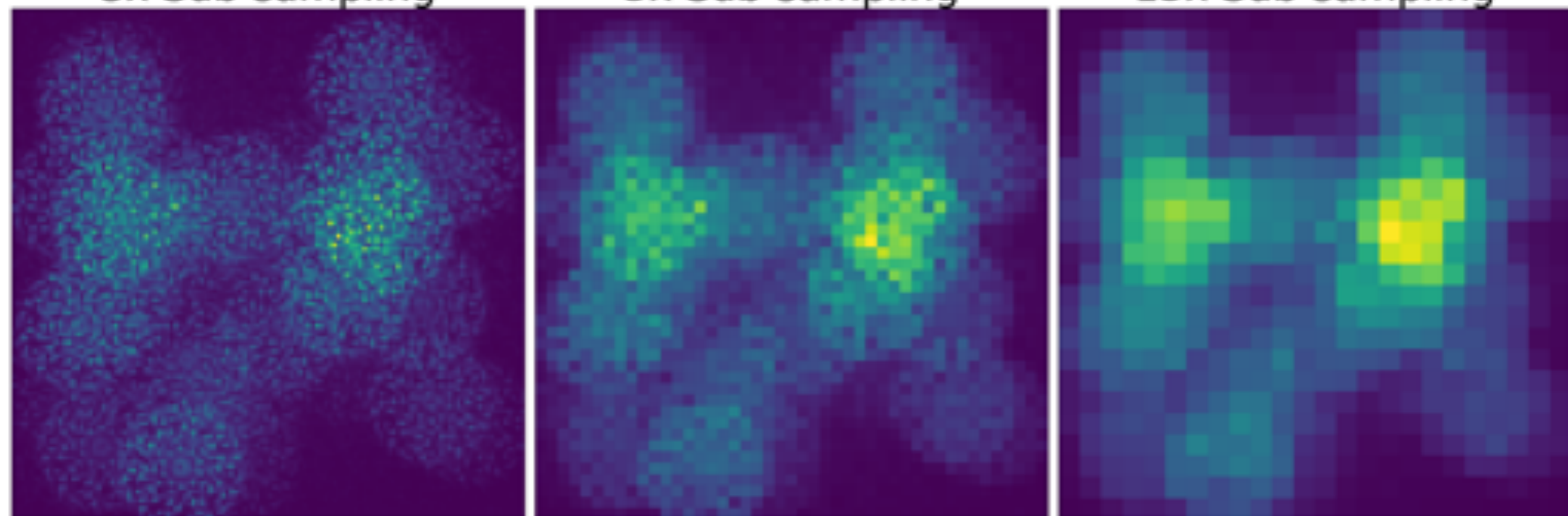
Positional RMSE



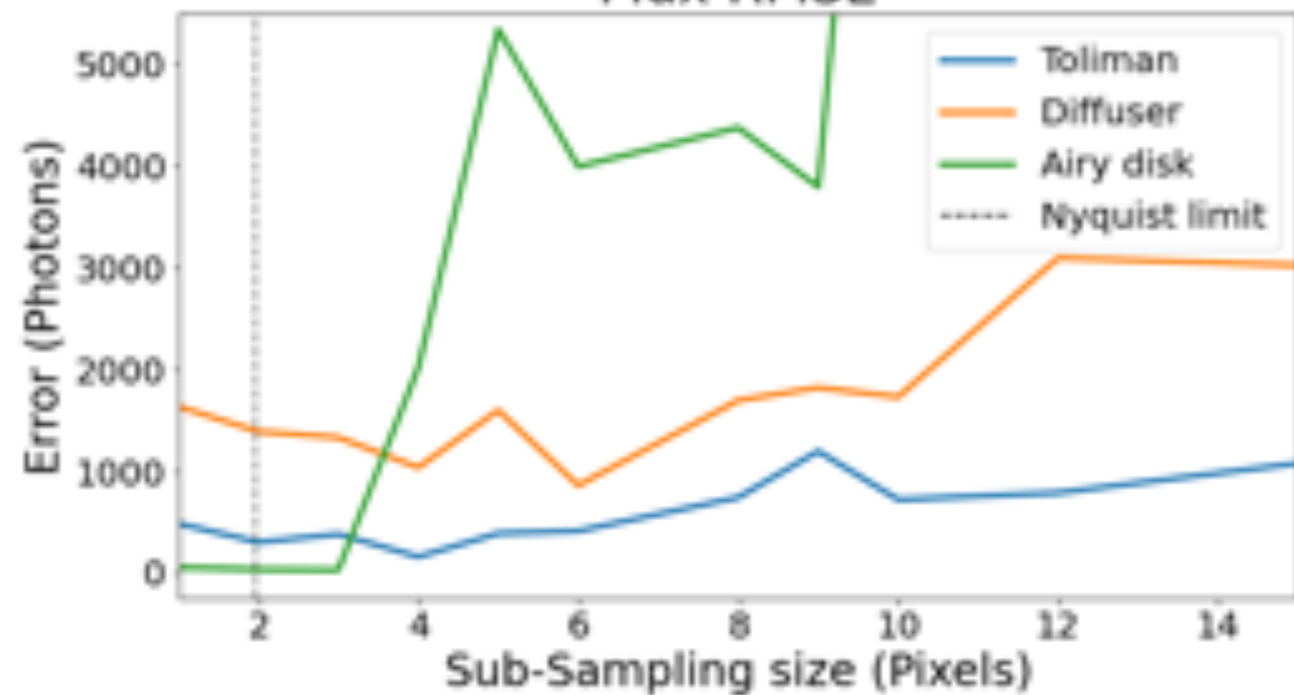
3x Sub-sampling

5x Sub-sampling

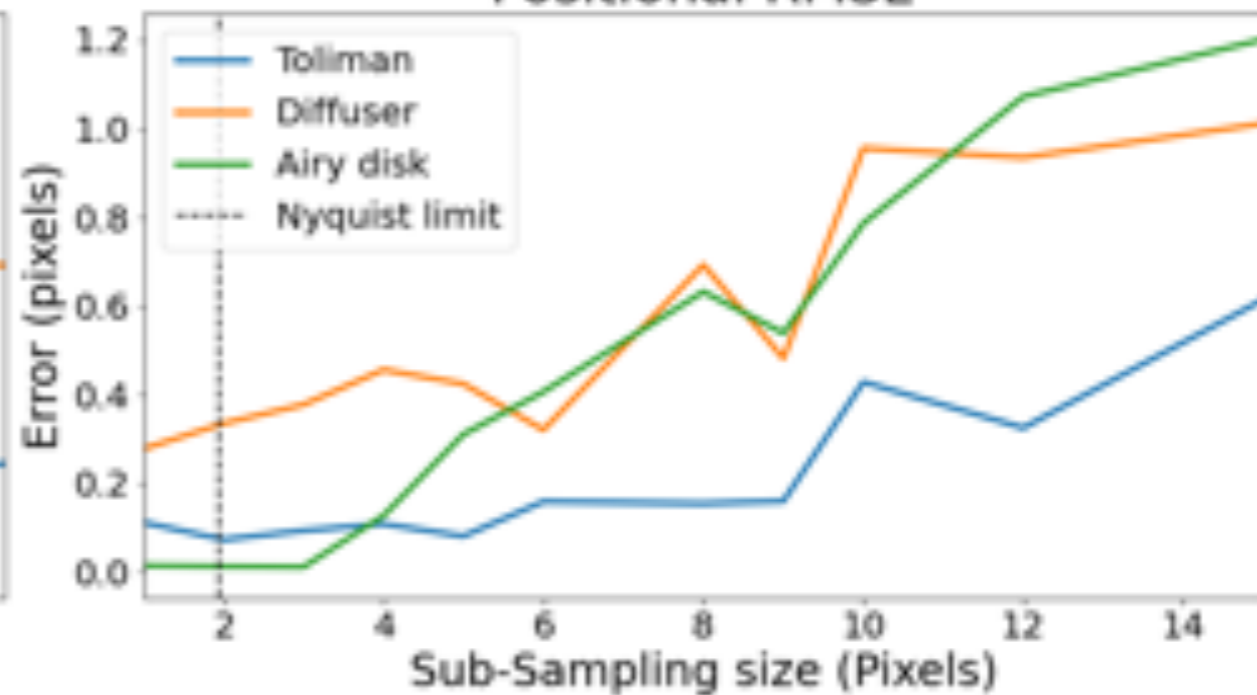
15x Sub-sampling

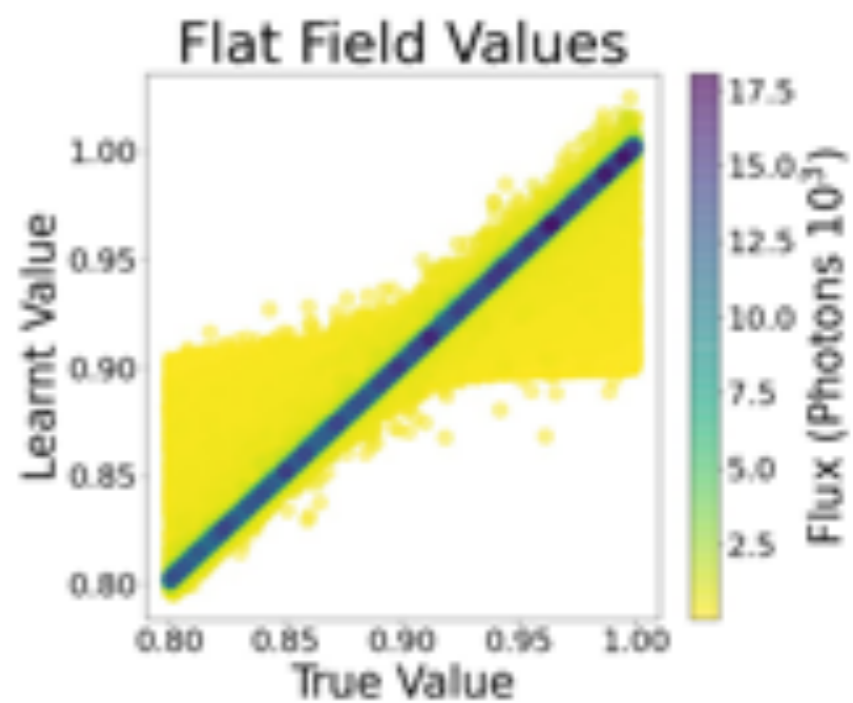
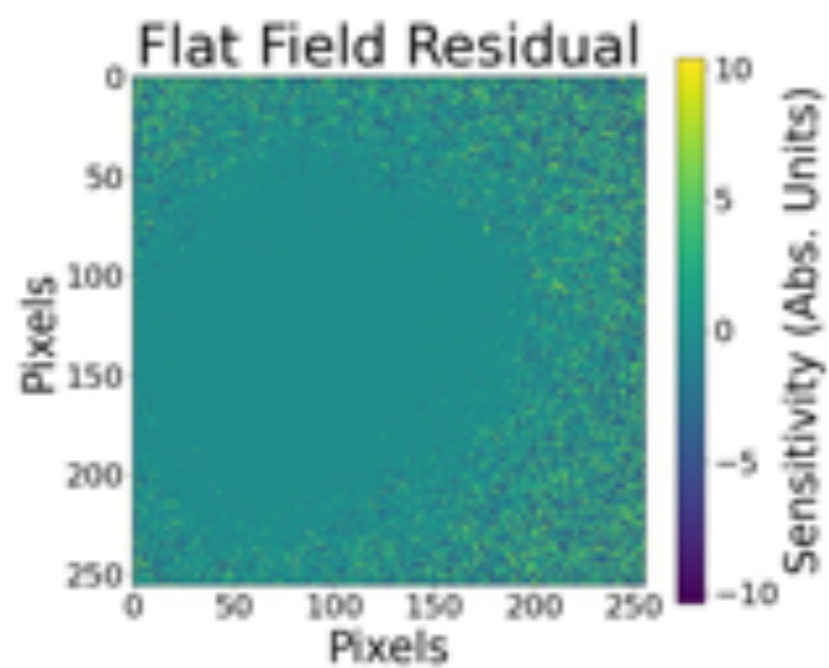
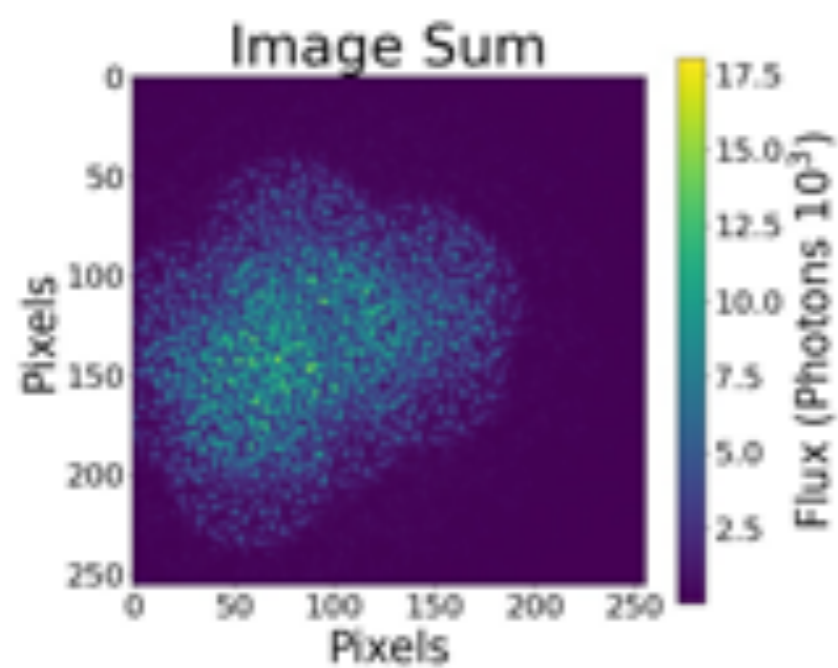


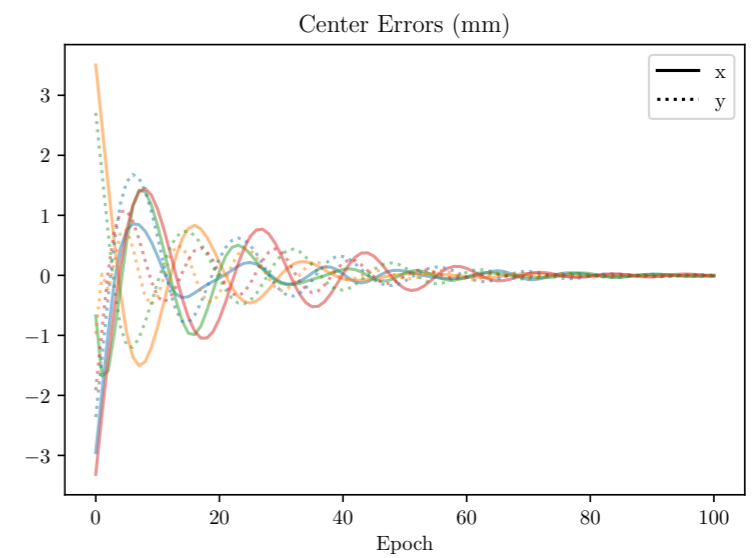
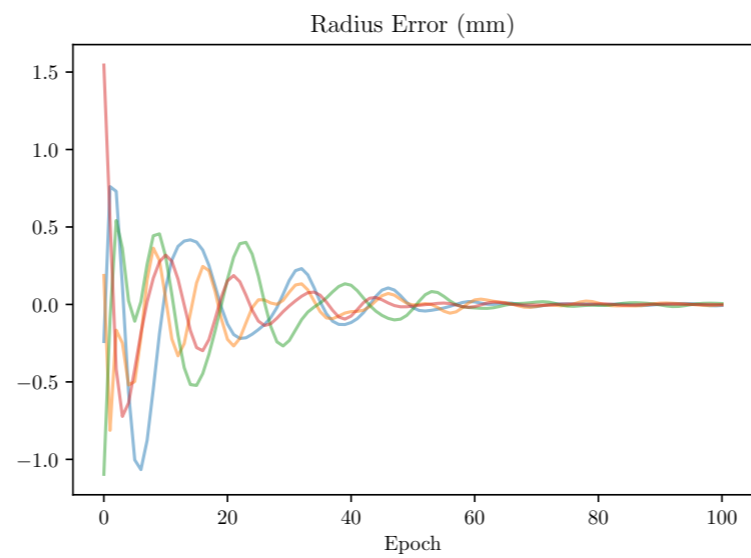
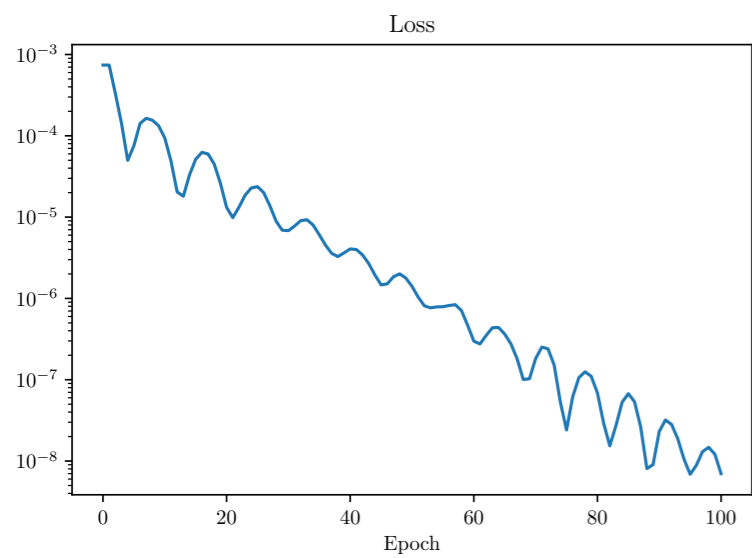
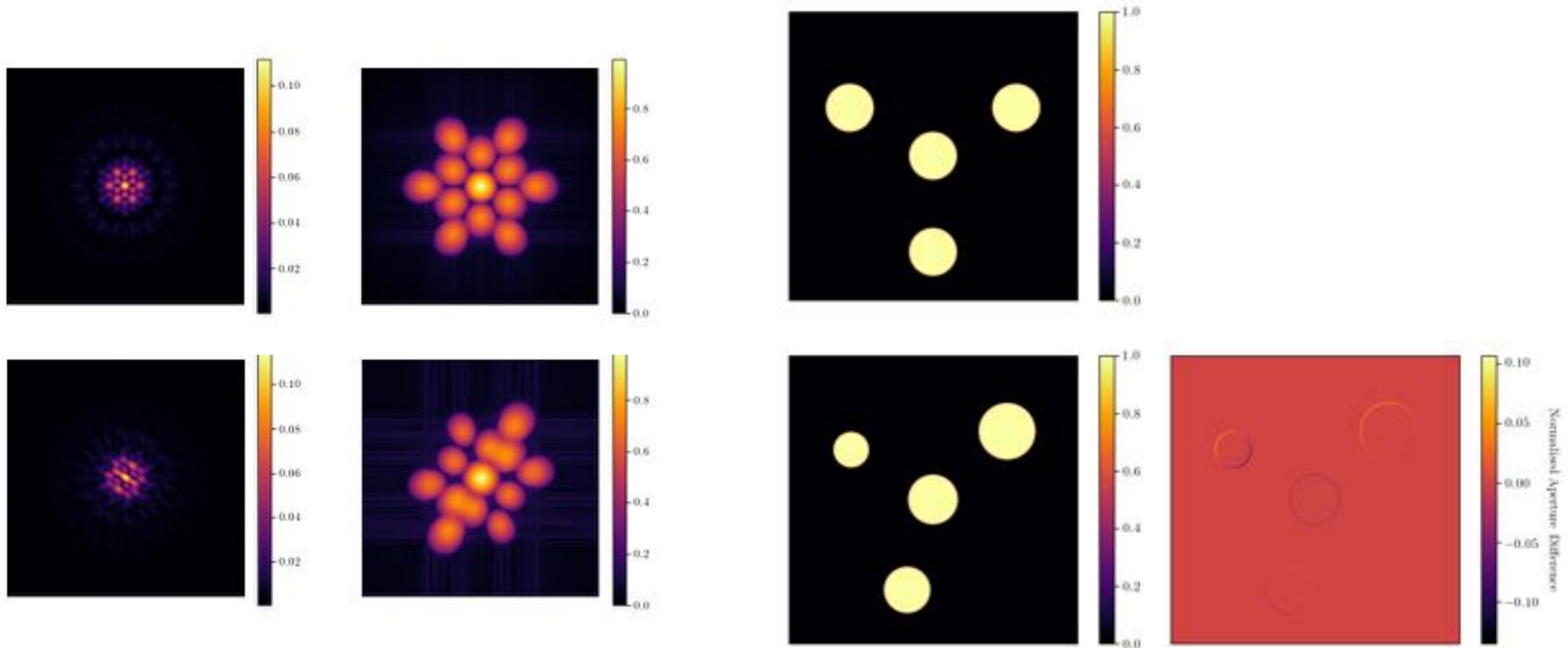
Flux RMSE



Positional RMSE







Normalized Aperture Difference

