

VORTEX

Hitting the diffraction limit
with the VORTEX project

Olivier Absil

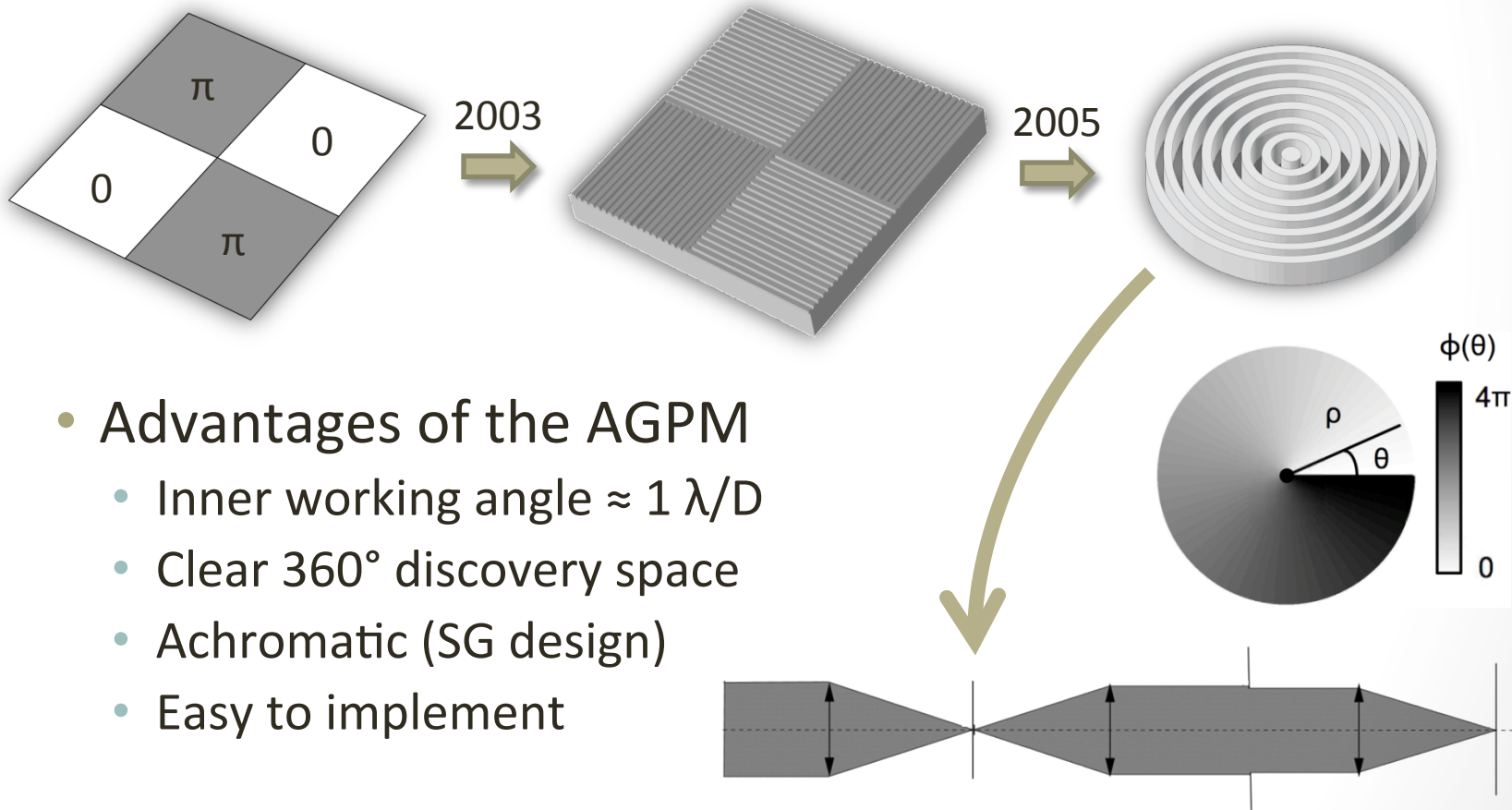
FNRS Research Associate

University of Liège



The birth of a concept

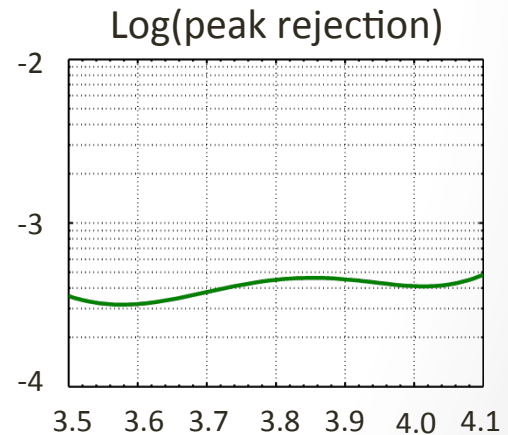
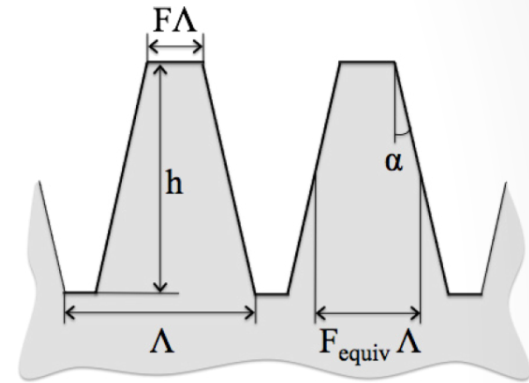
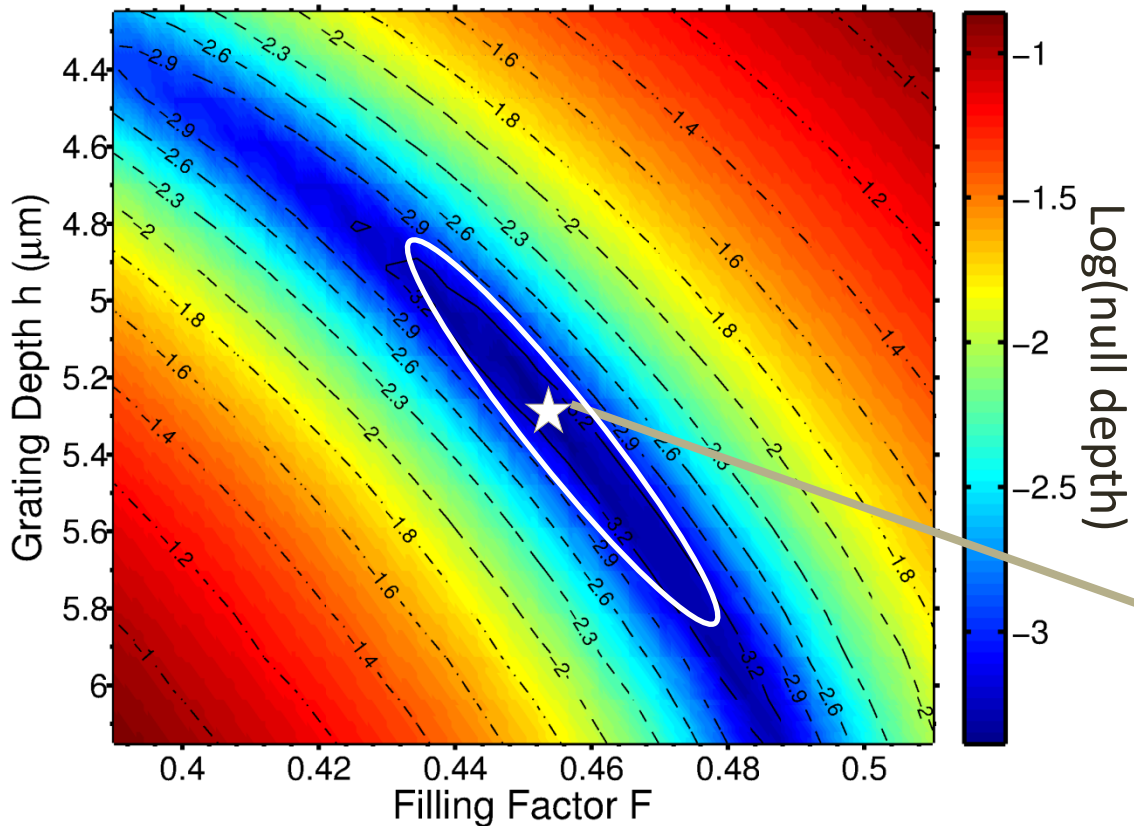
- FQPM \rightarrow sub-wavelength gratings \rightarrow Annular Groove PM



- Advantages of the AGPM
 - Inner working angle $\approx 1 \lambda/D$
 - Clear 360° discovery space
 - Achromatic (SG design)
 - Easy to implement

Grating design/optimization

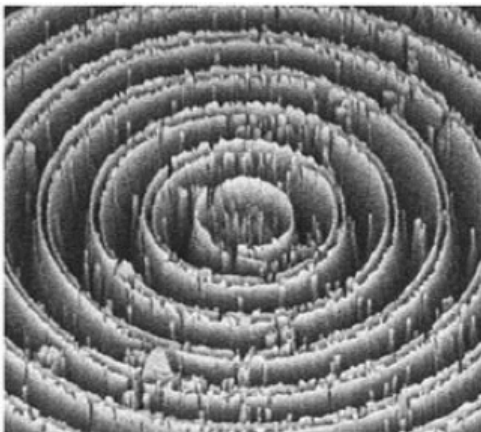
L band. Period = $1.42 \mu\text{m}$, angle = 3.00°



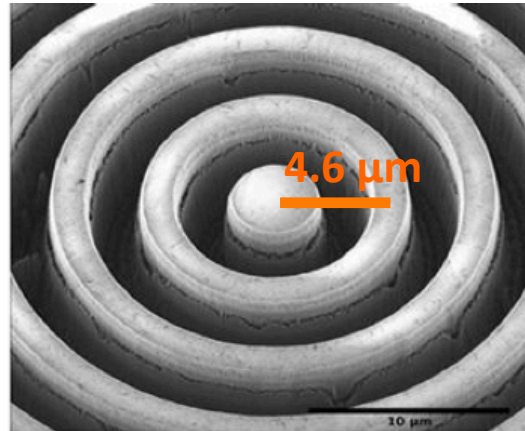
Etching on CVD diamond

- Nanoimprint lithography + dry plasma etching
 - N band (grating period = $4.6\ \mu\text{m}$)
 - L band (grating period = $1.4\ \mu\text{m}$)

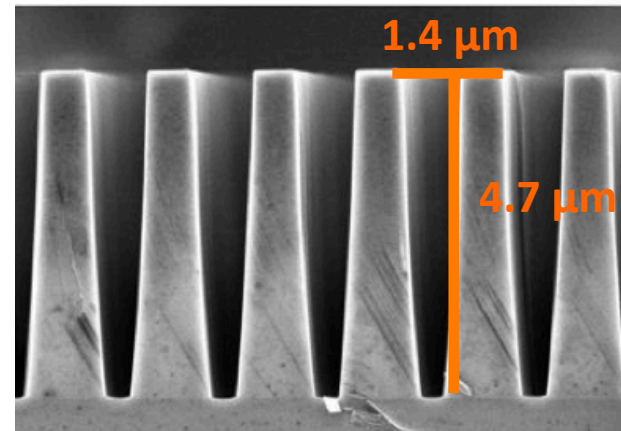
N band (Nov 2009)



N band (Feb 2012)



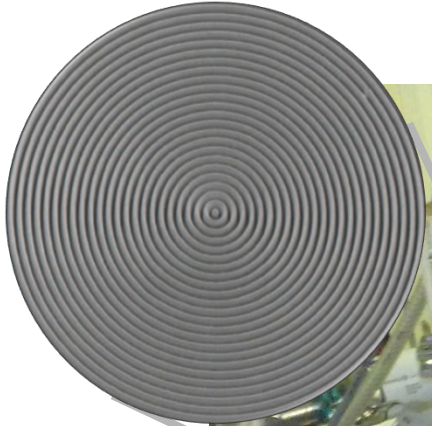
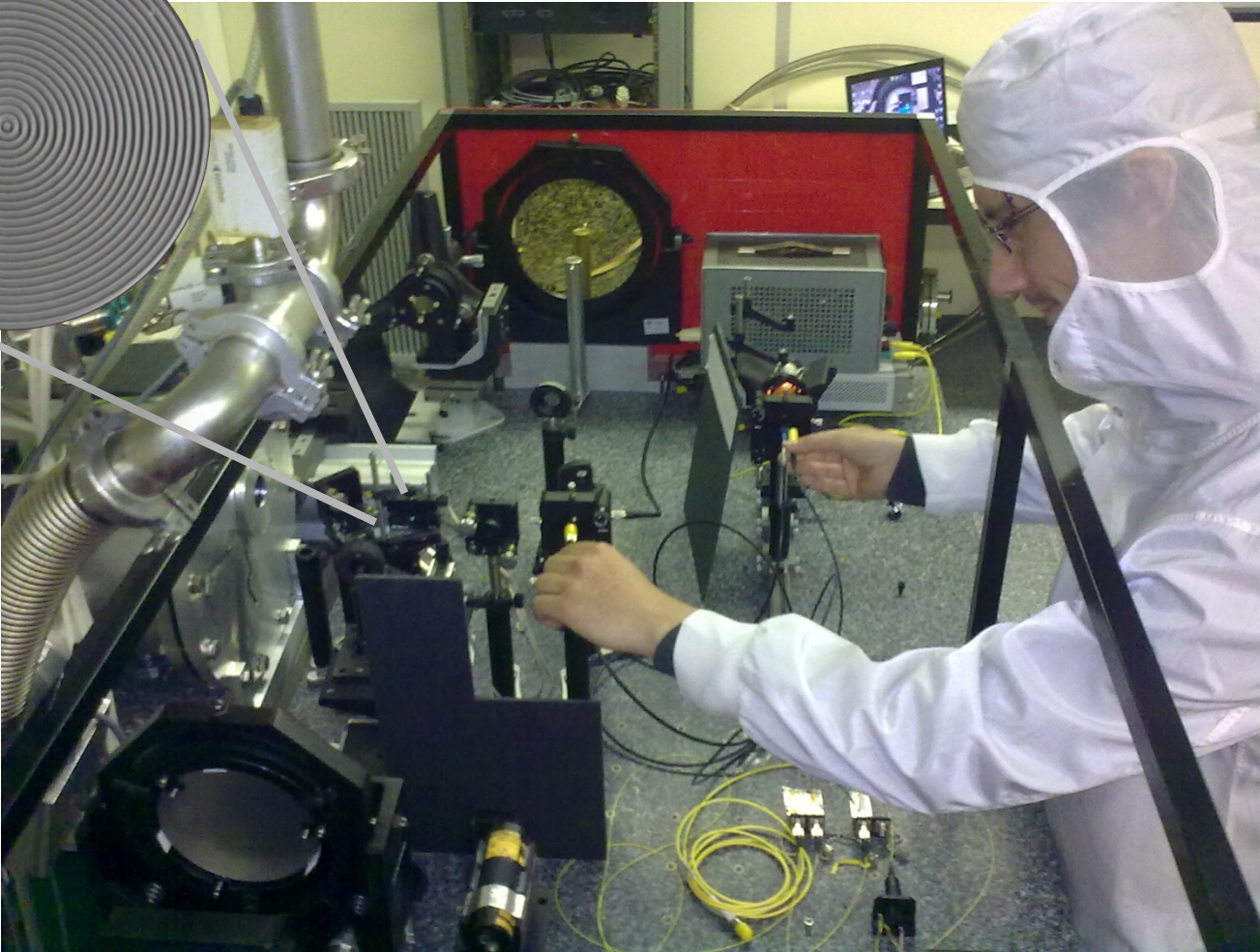
L band (Sep 2012)



- Parameters close to optimal ... need to test!

Setting up the bench

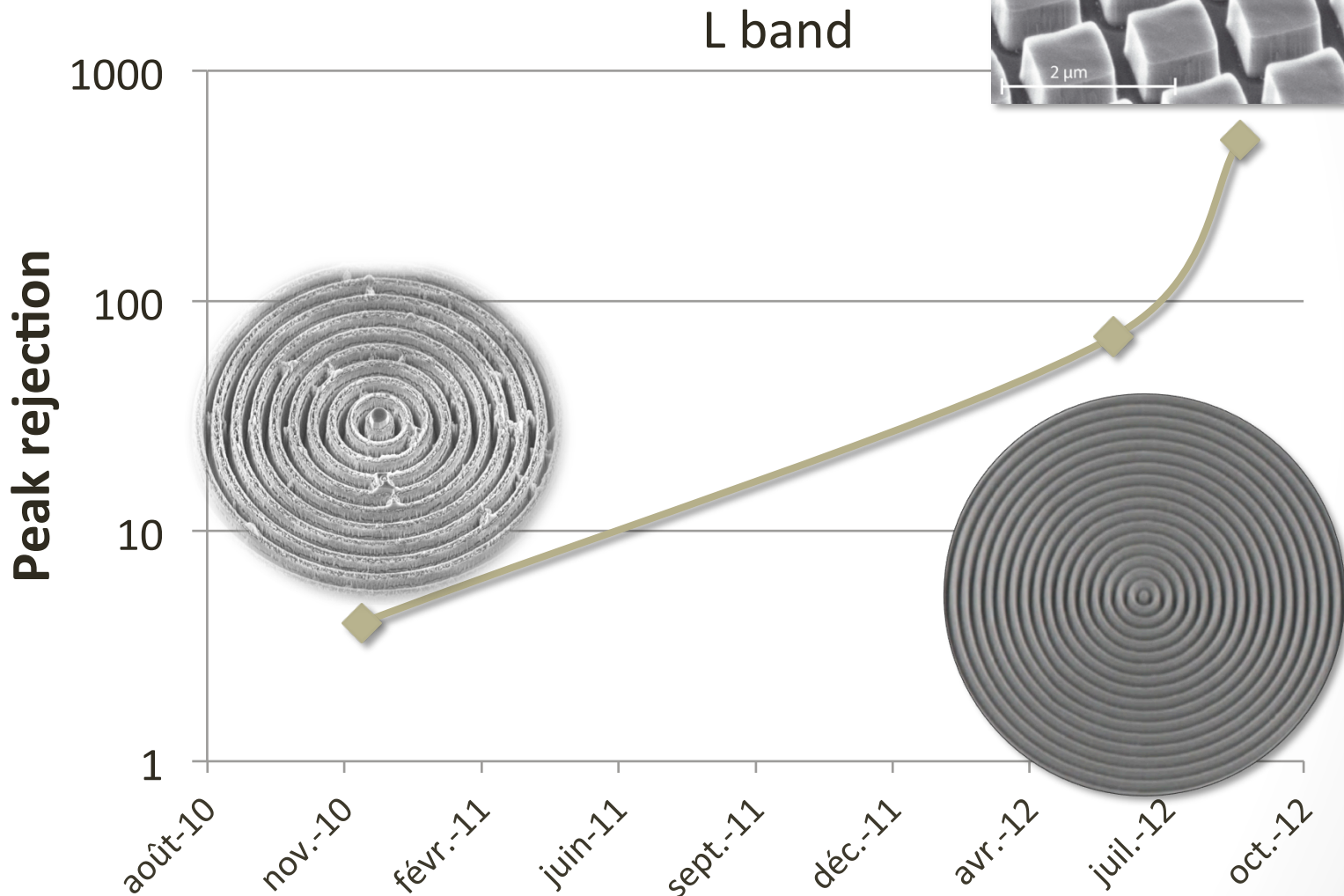
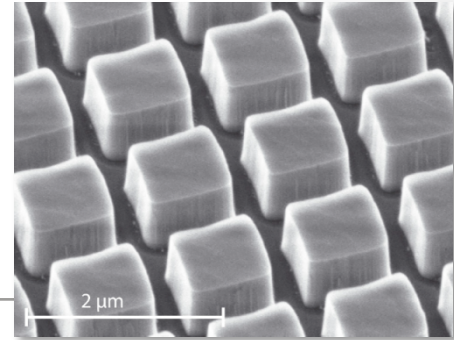
“Yacadire” @ Paris-Meudon



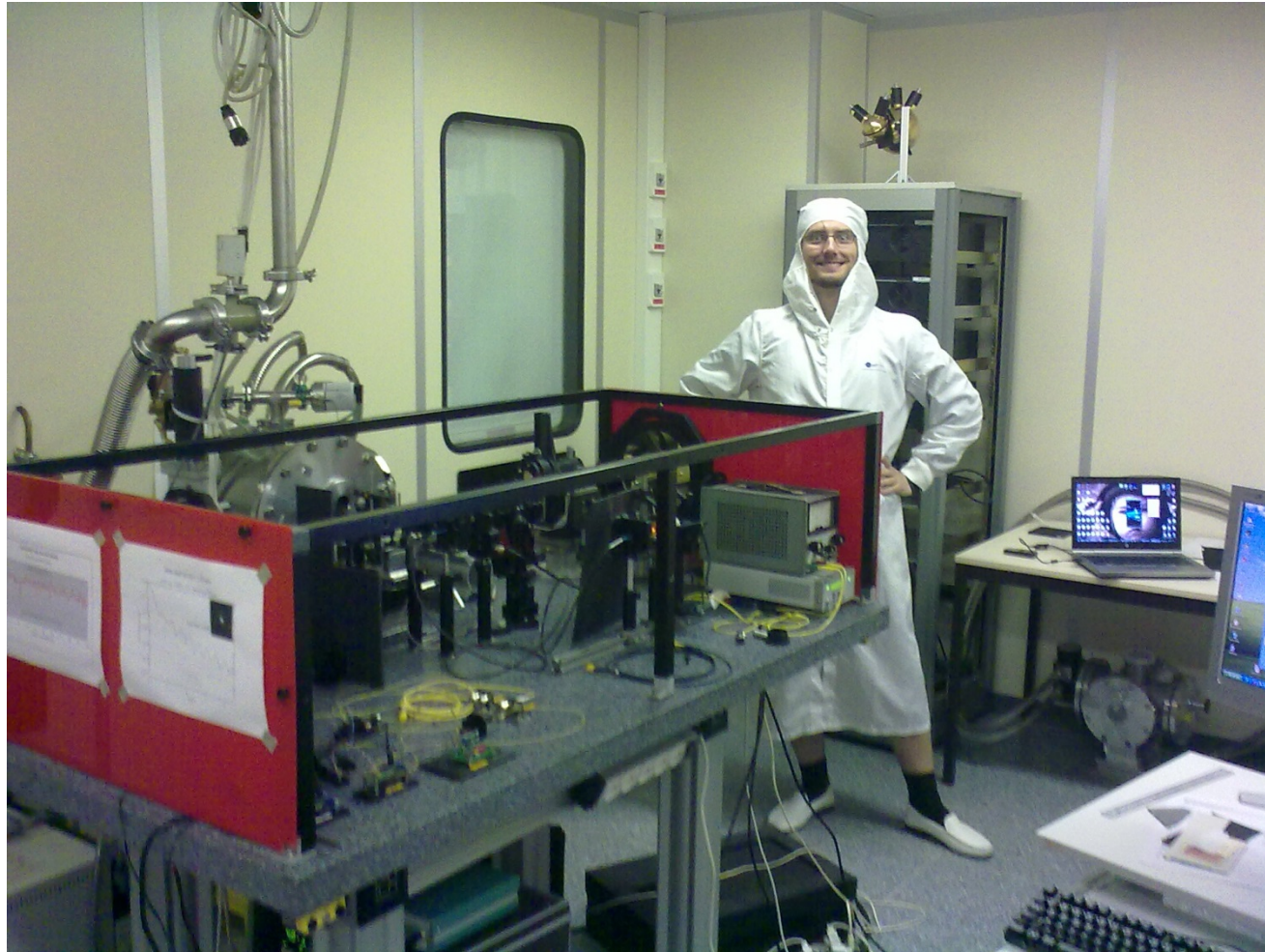
Anguish...



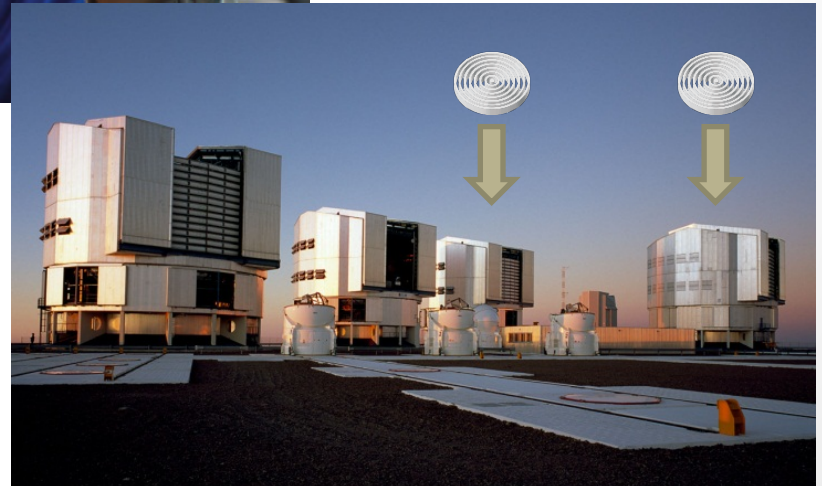
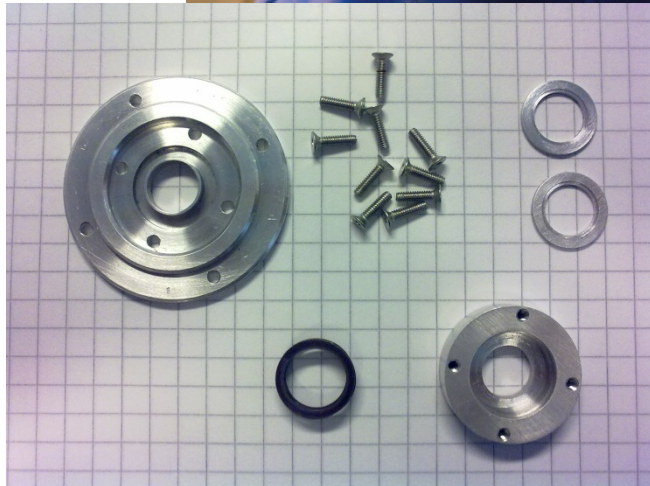
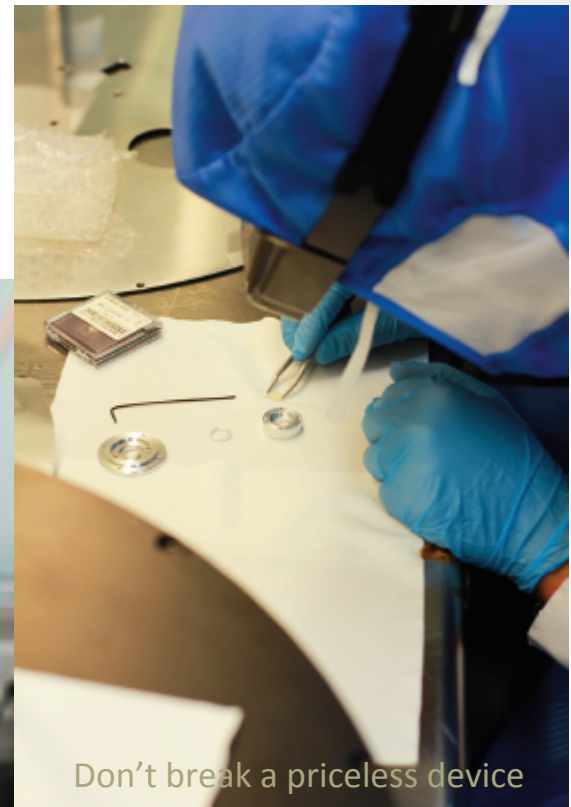
High performance



Bliss!

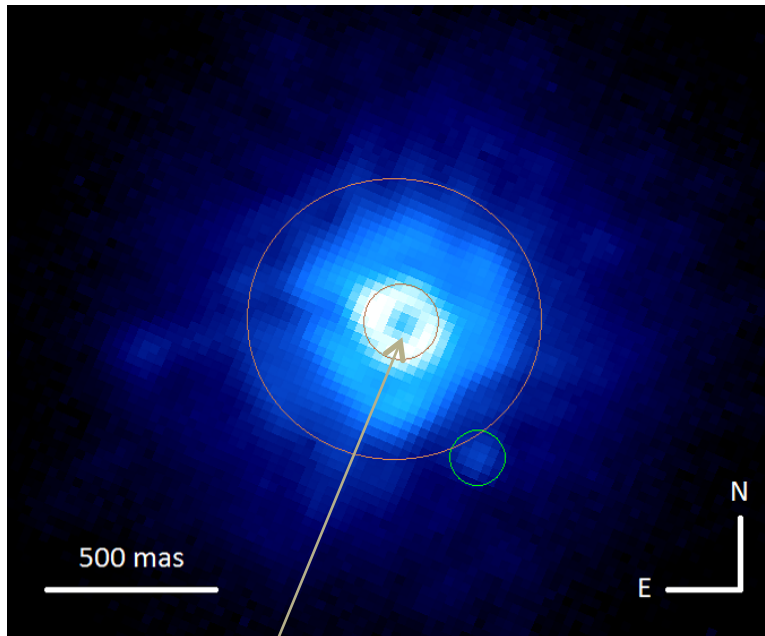


Installation at VLT



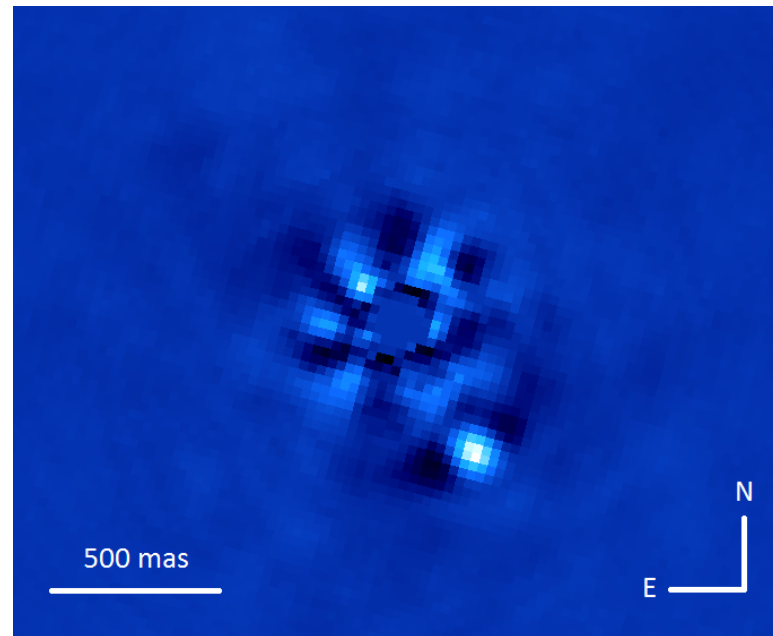
NACO: science demonstration

Raw image of β Pic

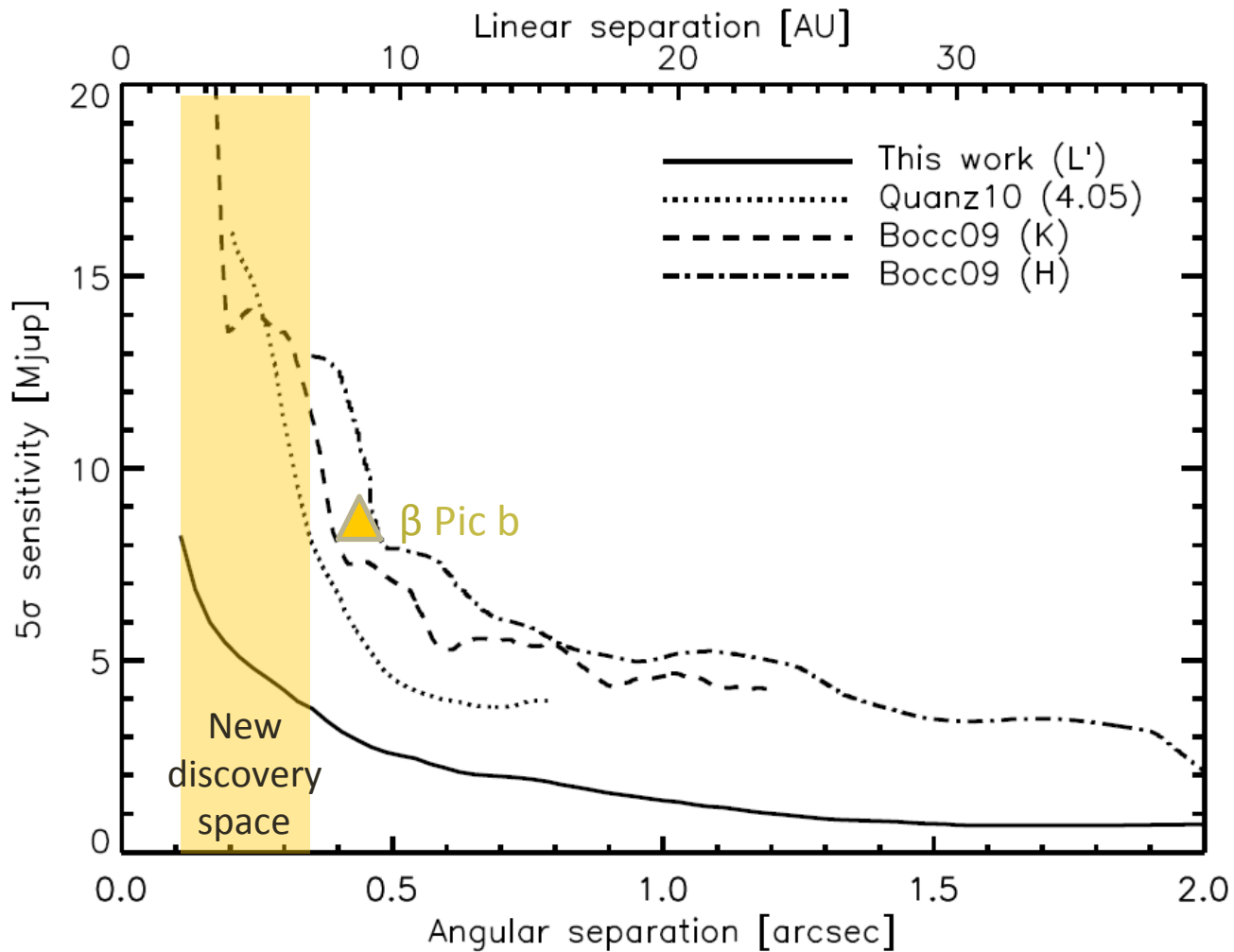


Peak rejection $\sim 50:1$

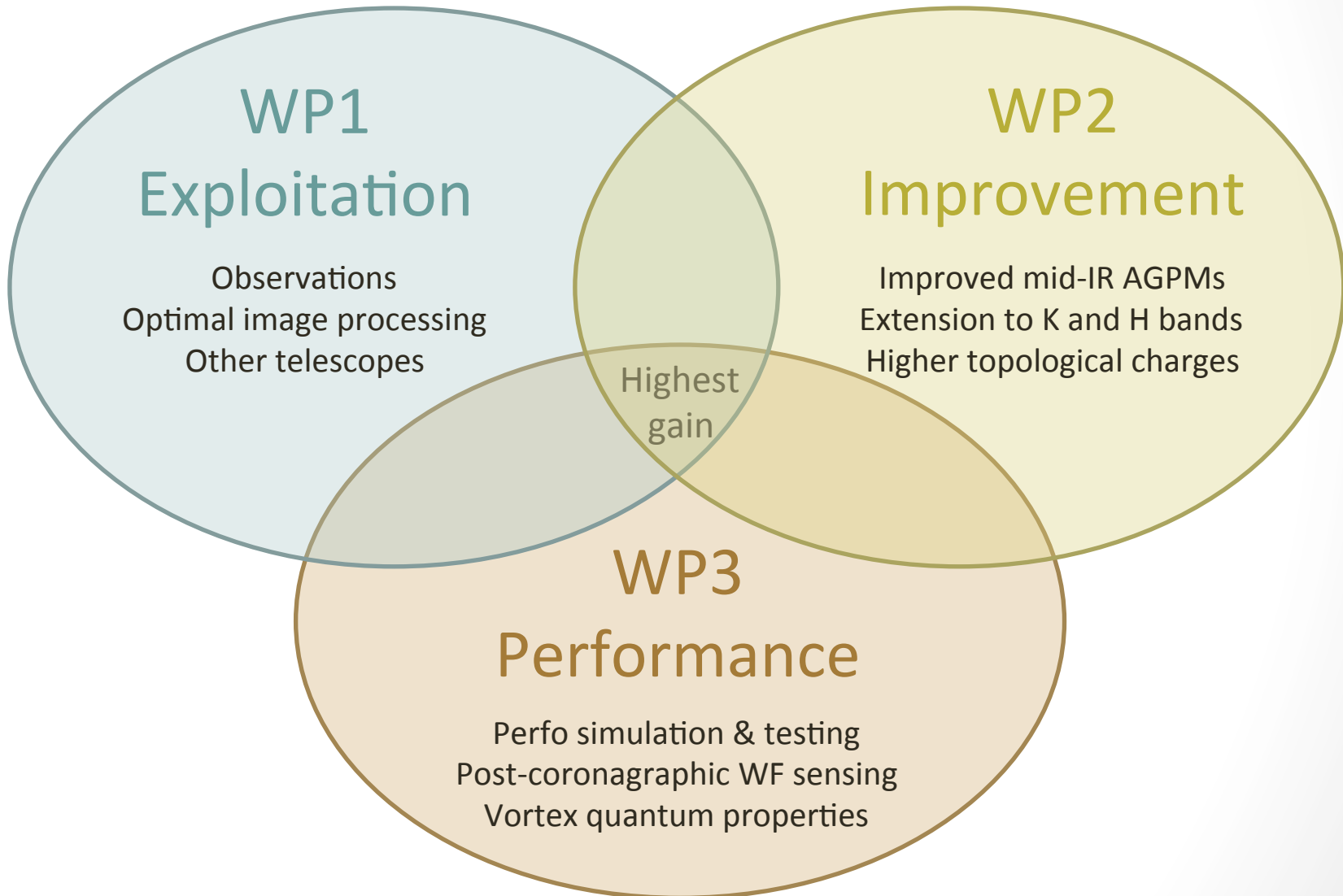
Post-processed image



Sensitivity to inner planets

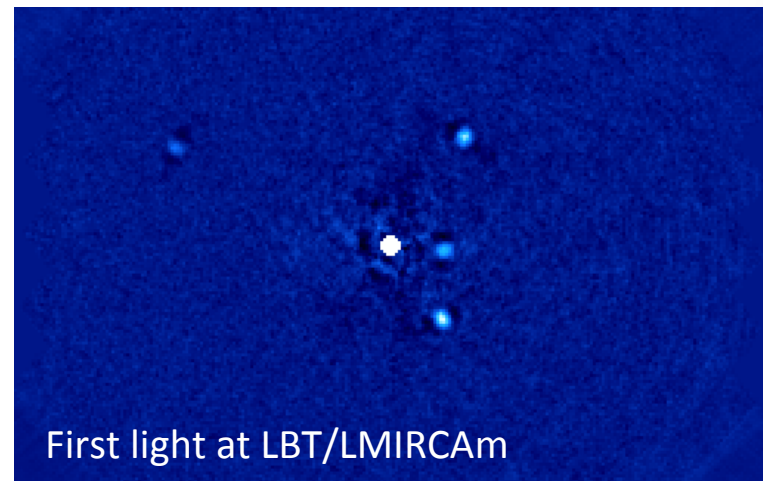
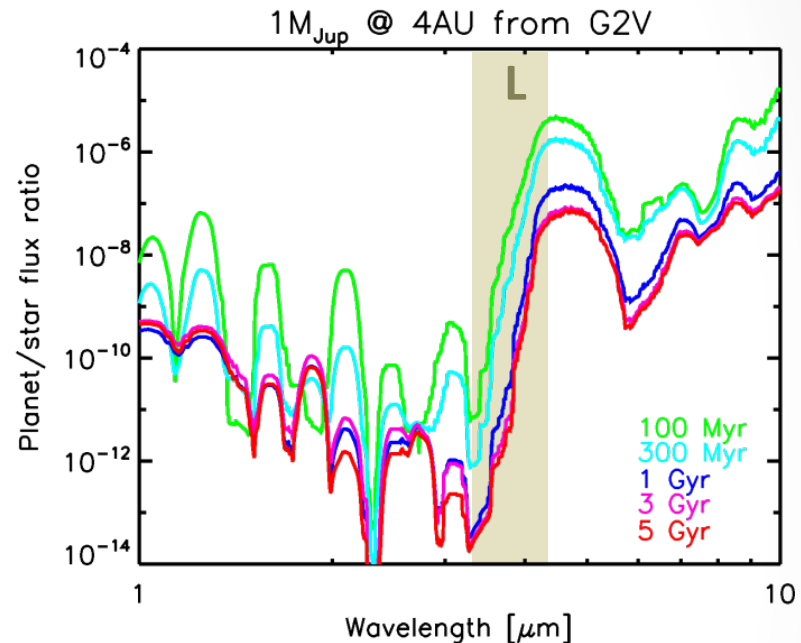


The VORTEX project (2013-2018)

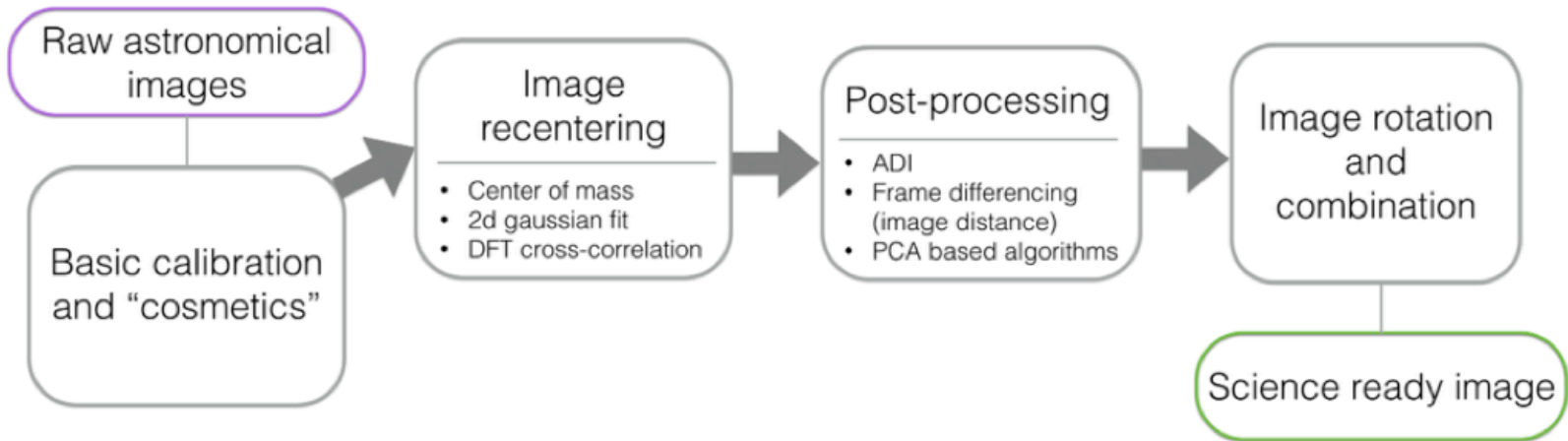
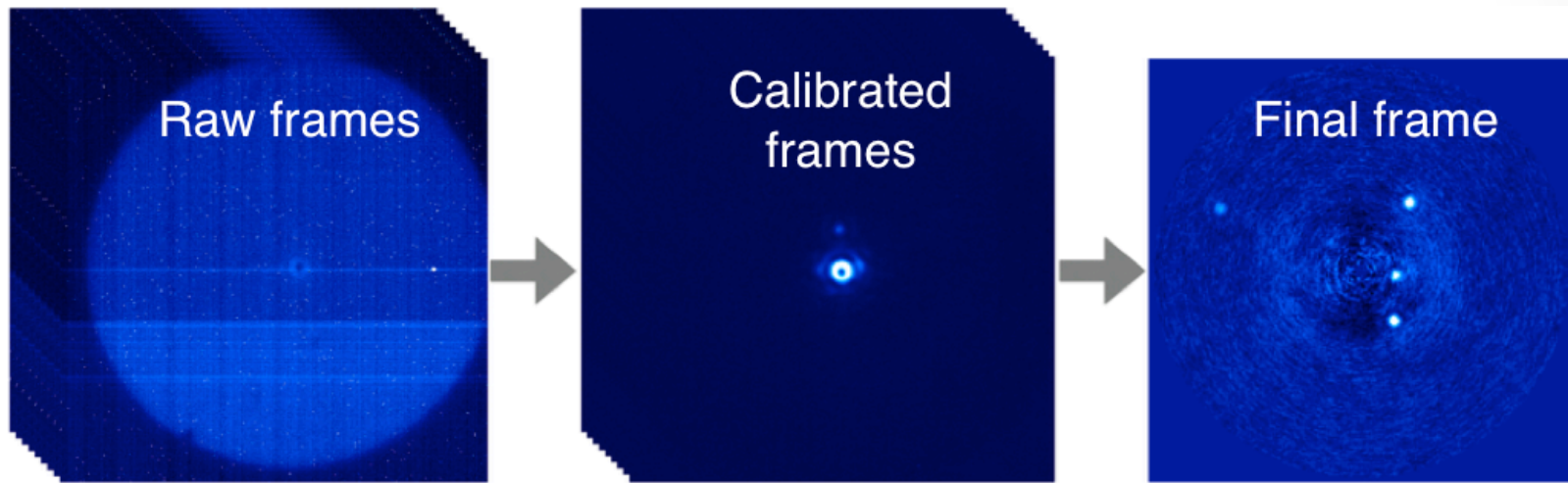


WP1: Scientific exploitation

- L-band = sweet spot for exoplanet imaging
- Complementary to XAO near-IR imagers → characterization
- Access to new parameter space → targeted surveys
- New perspectives on more telescopes (Keck coming soon)

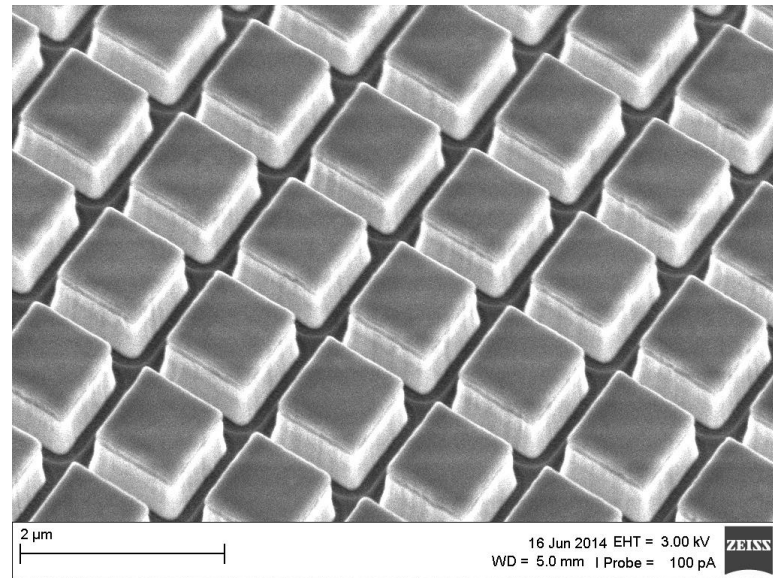
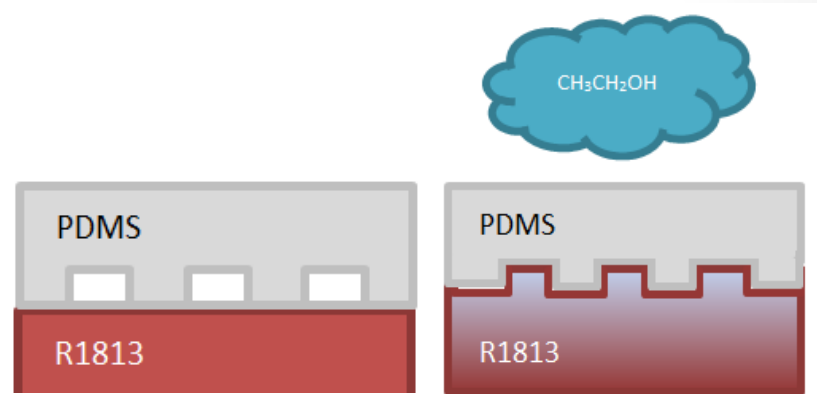


WP1: image processing



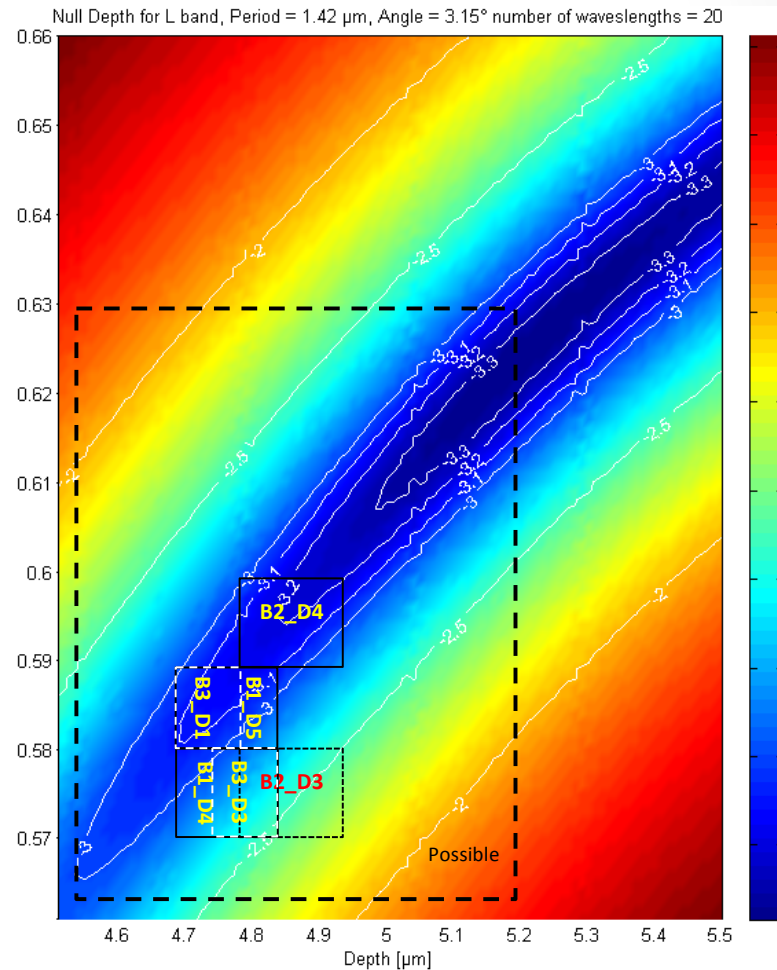
WP2: manufacturing

- Better control of grating parameters
 - Solvent-assisted micro-moulding replaces NIL
 - All etching recipes further optimised
 - Steeper side walls
- New L-band AGPMs etched, currently tested
- Improvement of AR performance
- Etching tests for K-band AGPMs to start soon



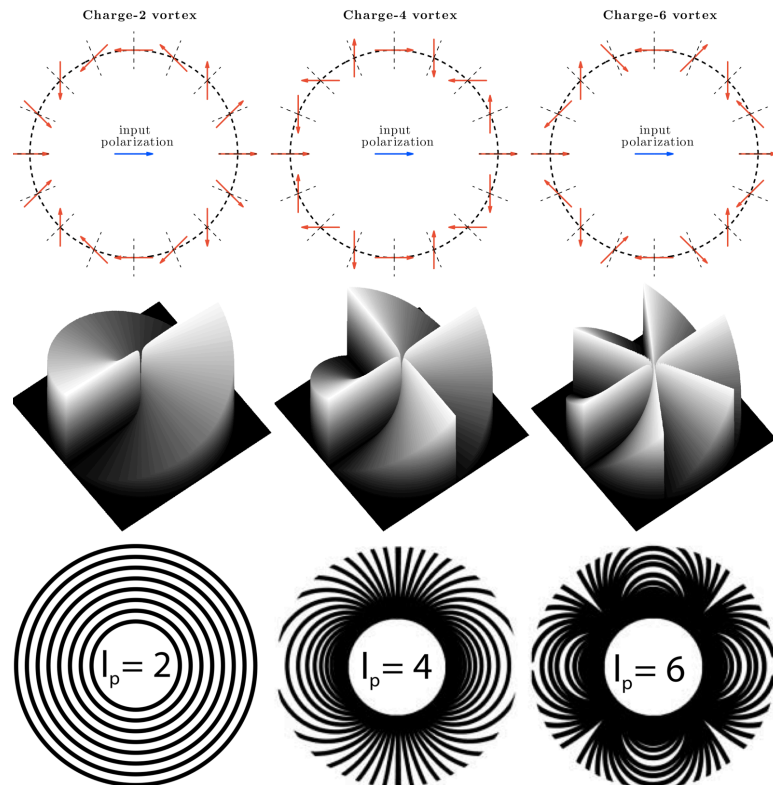
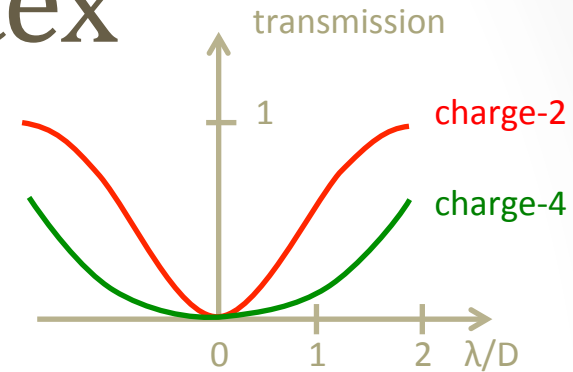
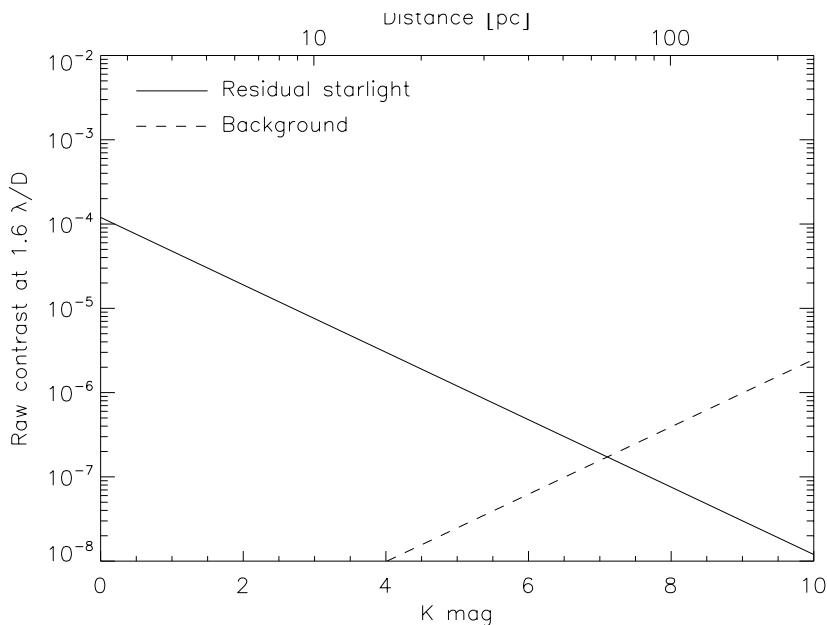
WP2: charge-2 vortex (AGPM)

- Optimized L+M band AGPMs under study
 - Goal: 10^{-3} over whole L+M band
- Designs for shorter wavelengths (H-K) to be optimised after feedback from etching



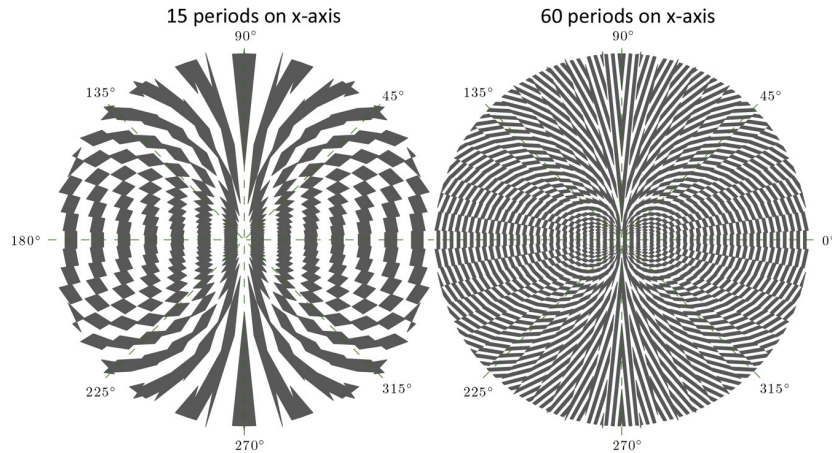
WP2: charge-4 vortex

- Rejection in θ^4
- Mandatory for near-infrared applications on ELTs

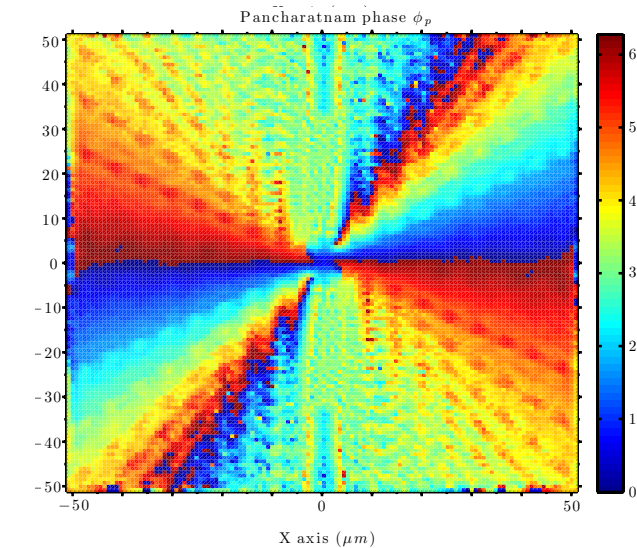
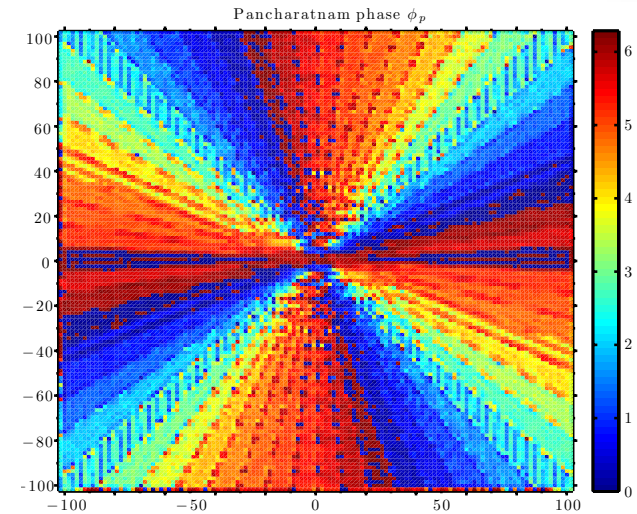
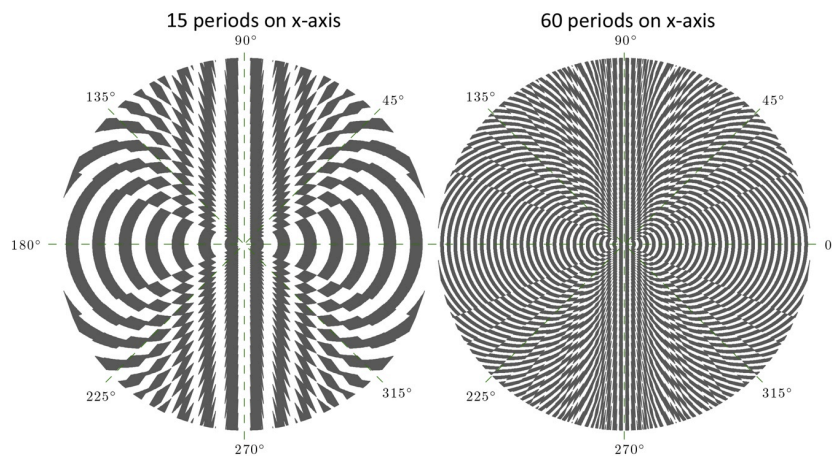


WP2: charge-4 vortex

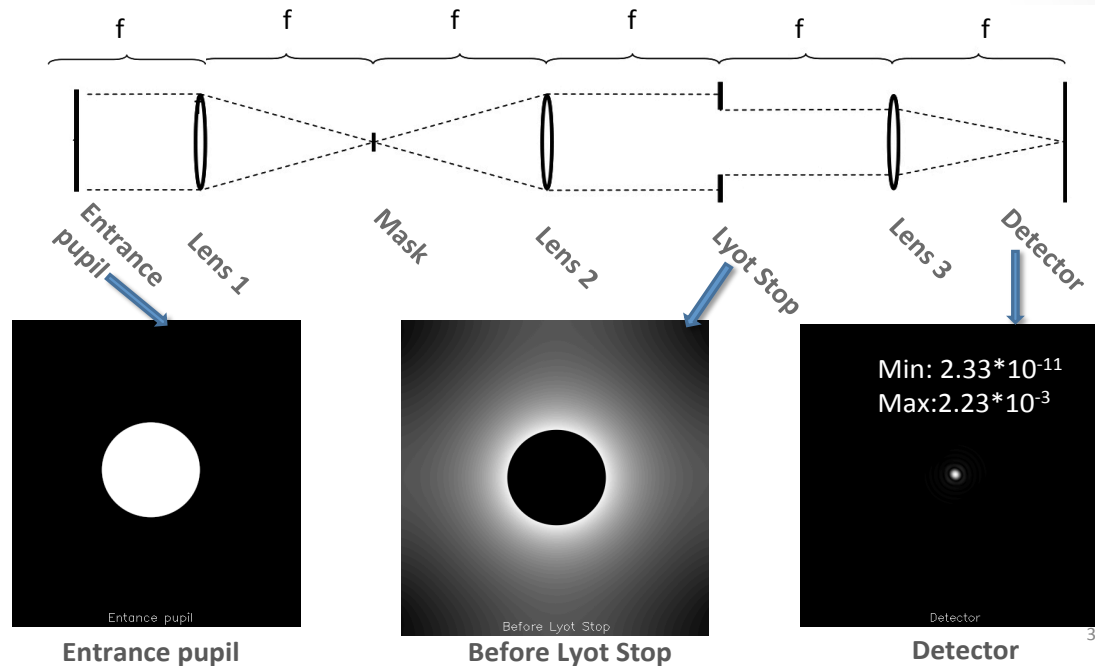
a) Construction with straight lines



b) Construction with curved lines



WP3: performance estimation



3D FDTD simulations

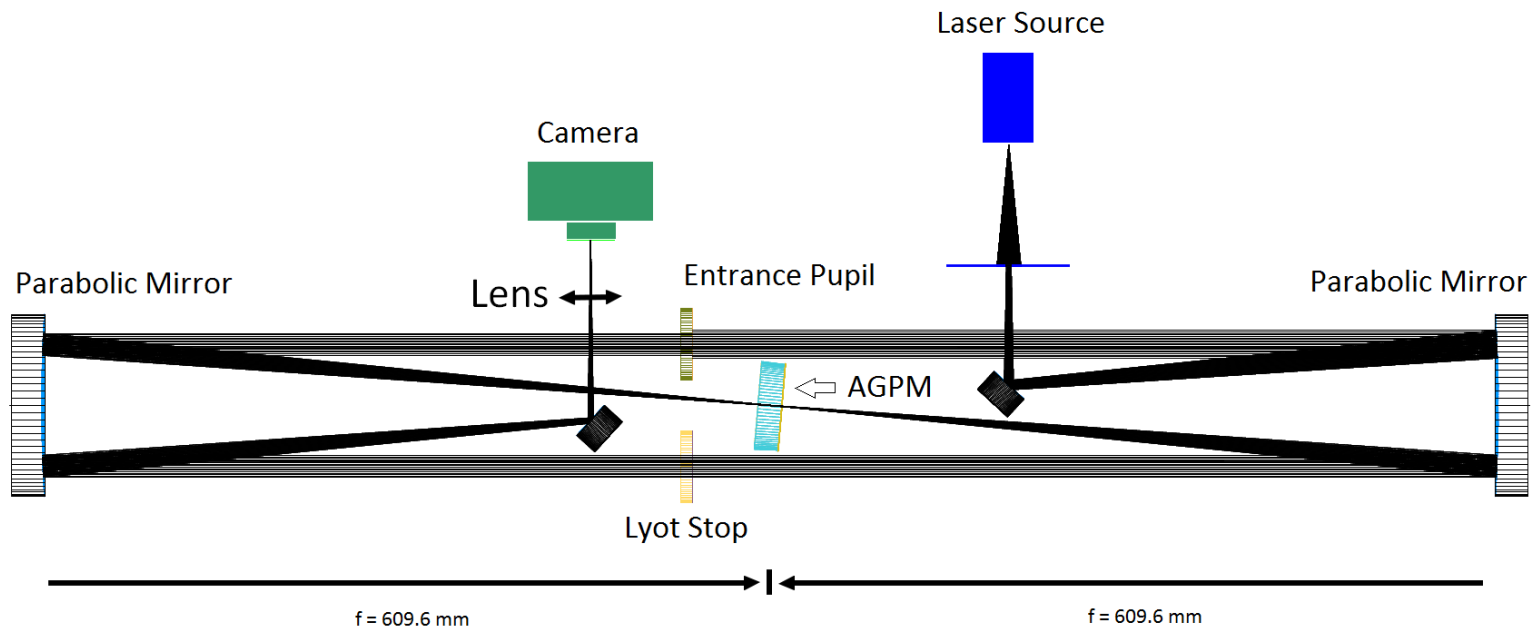
AO residuals + optical design

PROPER

Instantaneous rejection

WP3: performance testing

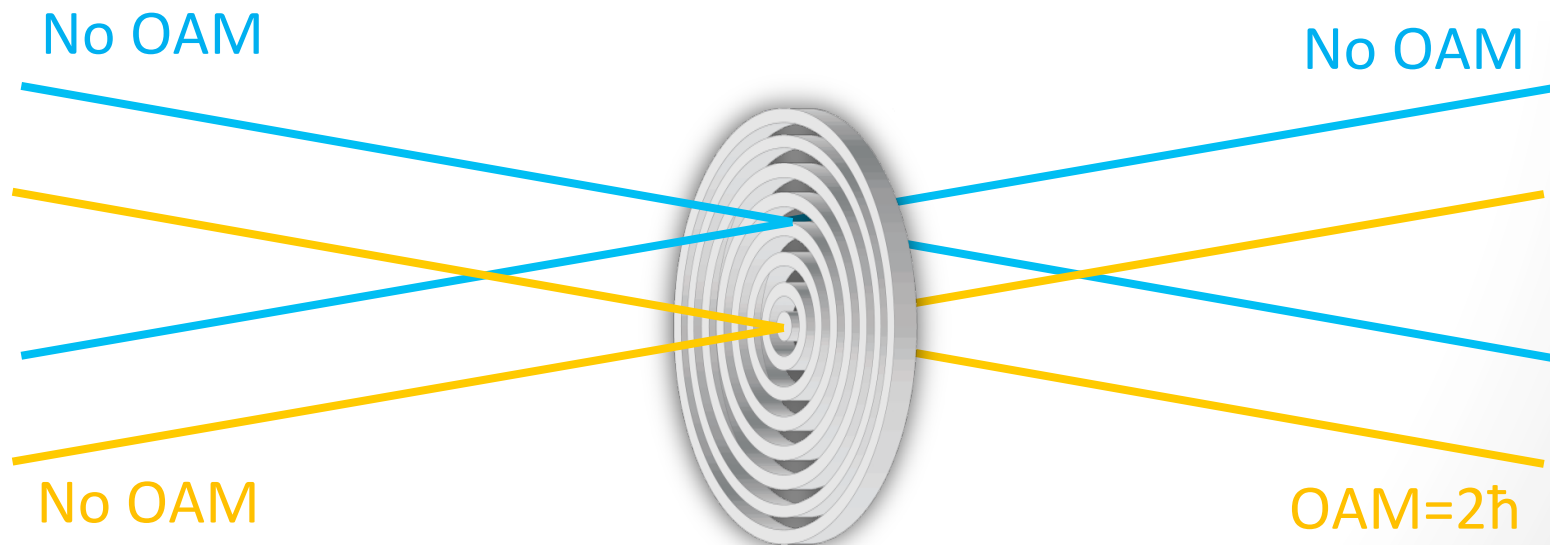
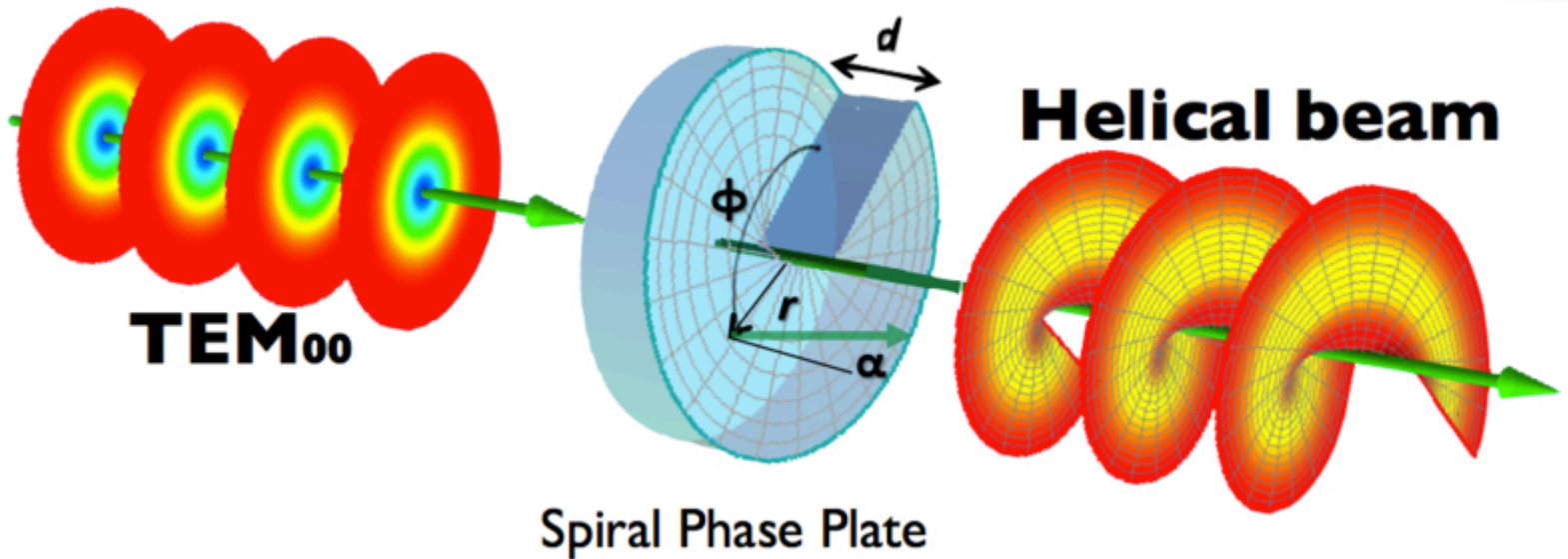
- VODCA: the Vortex Optical Demonstrator for Coronagraphic Applications
- AGPM testing + in-lab validation of new concepts



WP3: post-corono sensing

- At Lyot stop or on the science camera
- See talk by Elsa Huby this afternoon

WP3: quantum properties



Interested? Talk to us

