

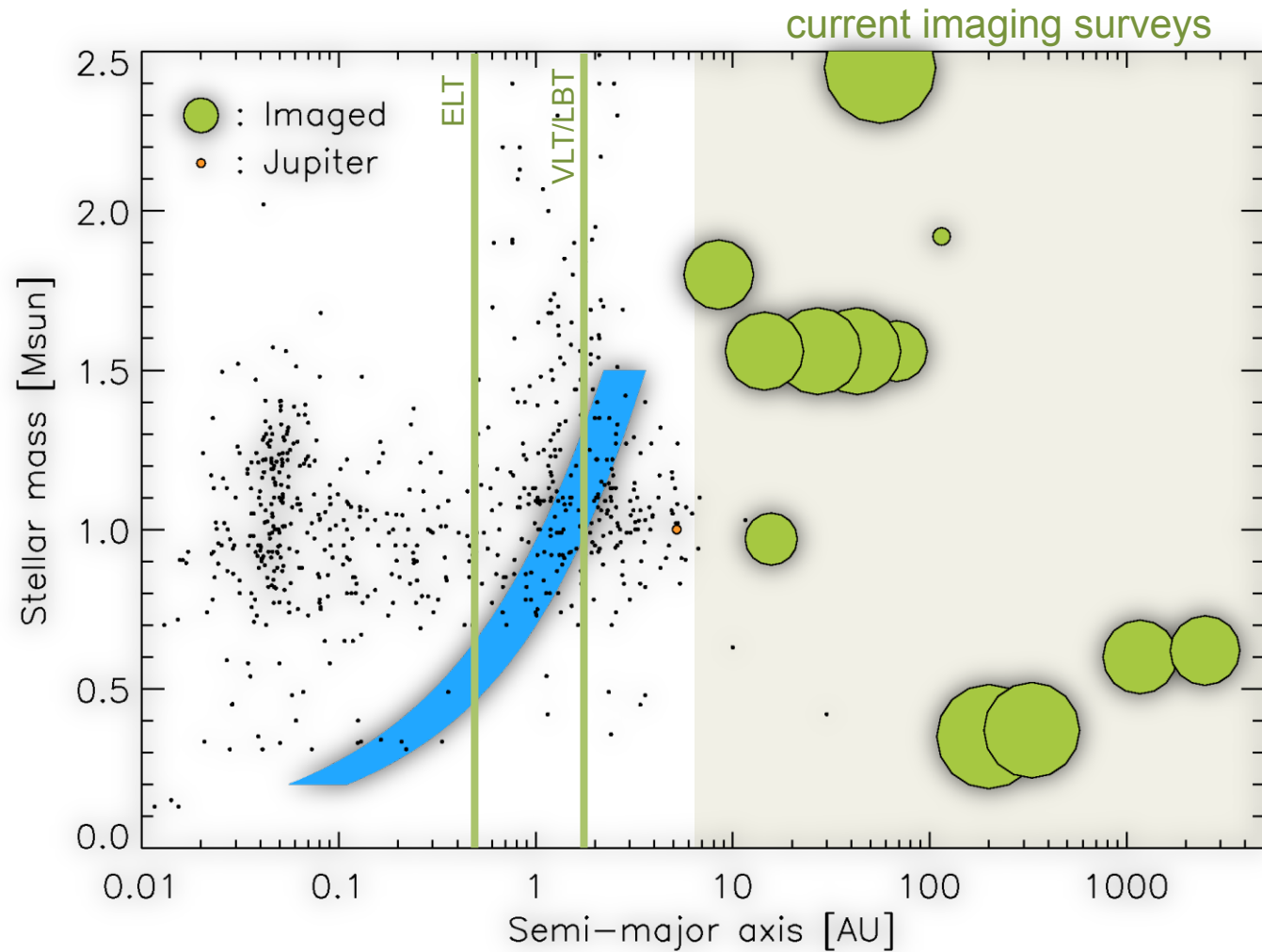
Direct exoplanet imaging with small-angle VORTEX coronagraphs

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O. Absil, P.-A. Absil, P. Baudoz, B. Carlomagno, C. Delacroix, V. Christiaens, P. Forsberg, J. Girard, C. Gomez Gonzalez, S. Habraken, P. Hinz, E. Huby, A. Jolivet, M. Karlsson, D. Mawet, J. Milli, E. Pantin, P. Piron, G. Ruane, E. Serabyn, J. Surdej, M. Van Droogenbroeck, E. Vargas Catalan, and O. Wertz

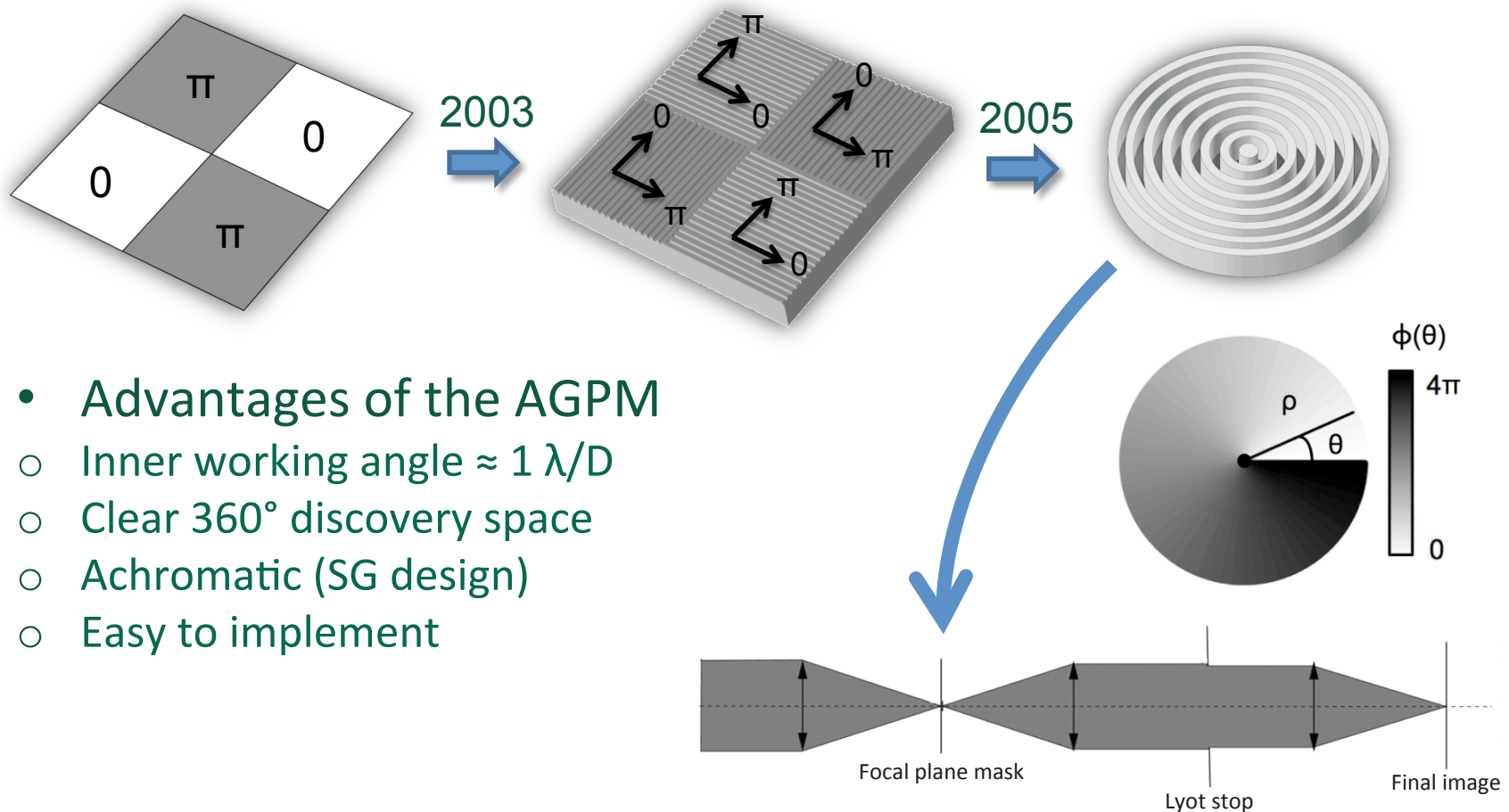


Which planets?



The birth of a concept

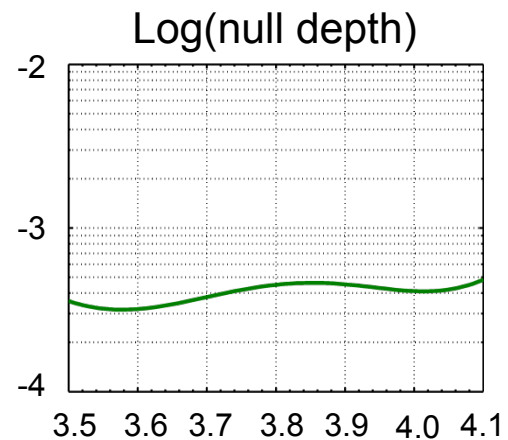
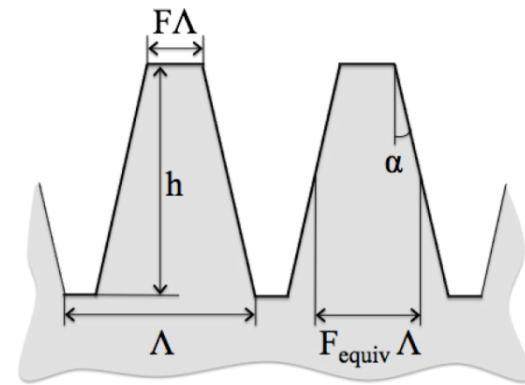
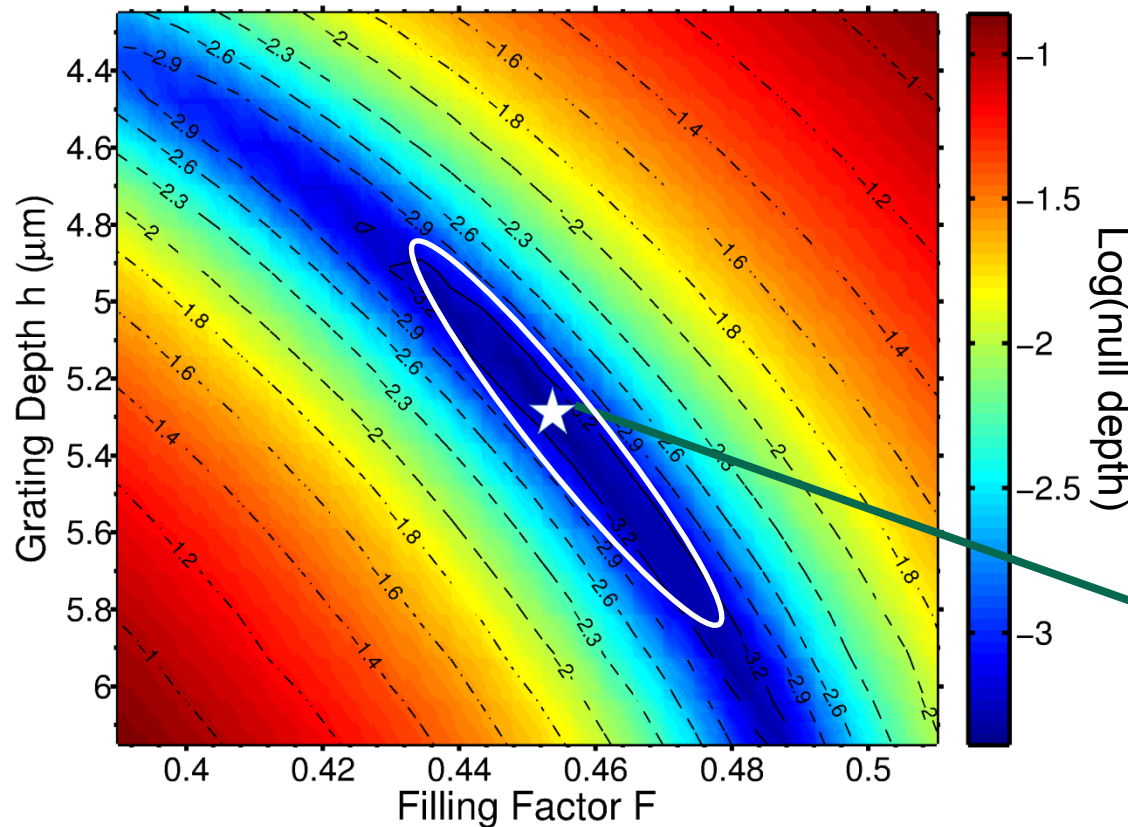
- FQPM \rightarrow sub-wavelength gratings \rightarrow Annular Groove PM



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

Grating design/optimization

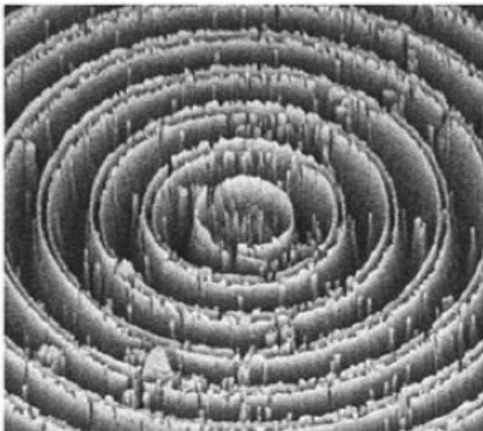
L band. Period = $1.42 \mu\text{m}$, angle = 3.00°



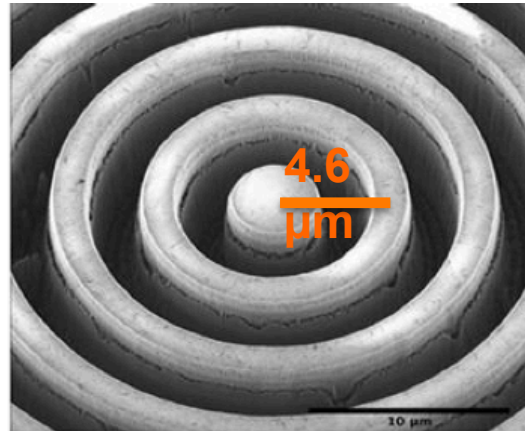
Etching on synthetic diamond

- Inductively coupled plasma etching
 - N band (grating period = $4.6\ \mu\text{m}$)
 - L band (grating period = $1.4\ \mu\text{m}$)

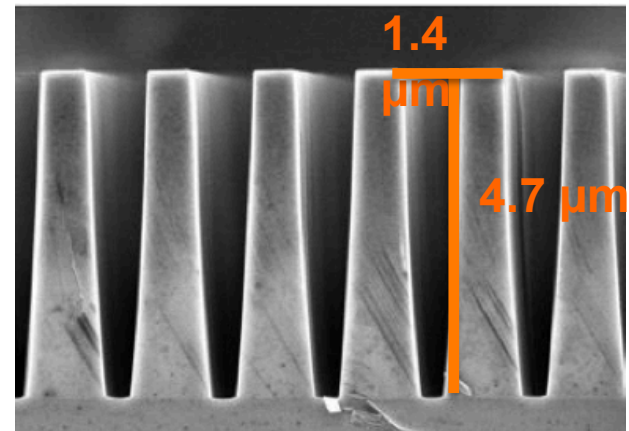
N band (Nov 2009)



N band (Feb 2012)



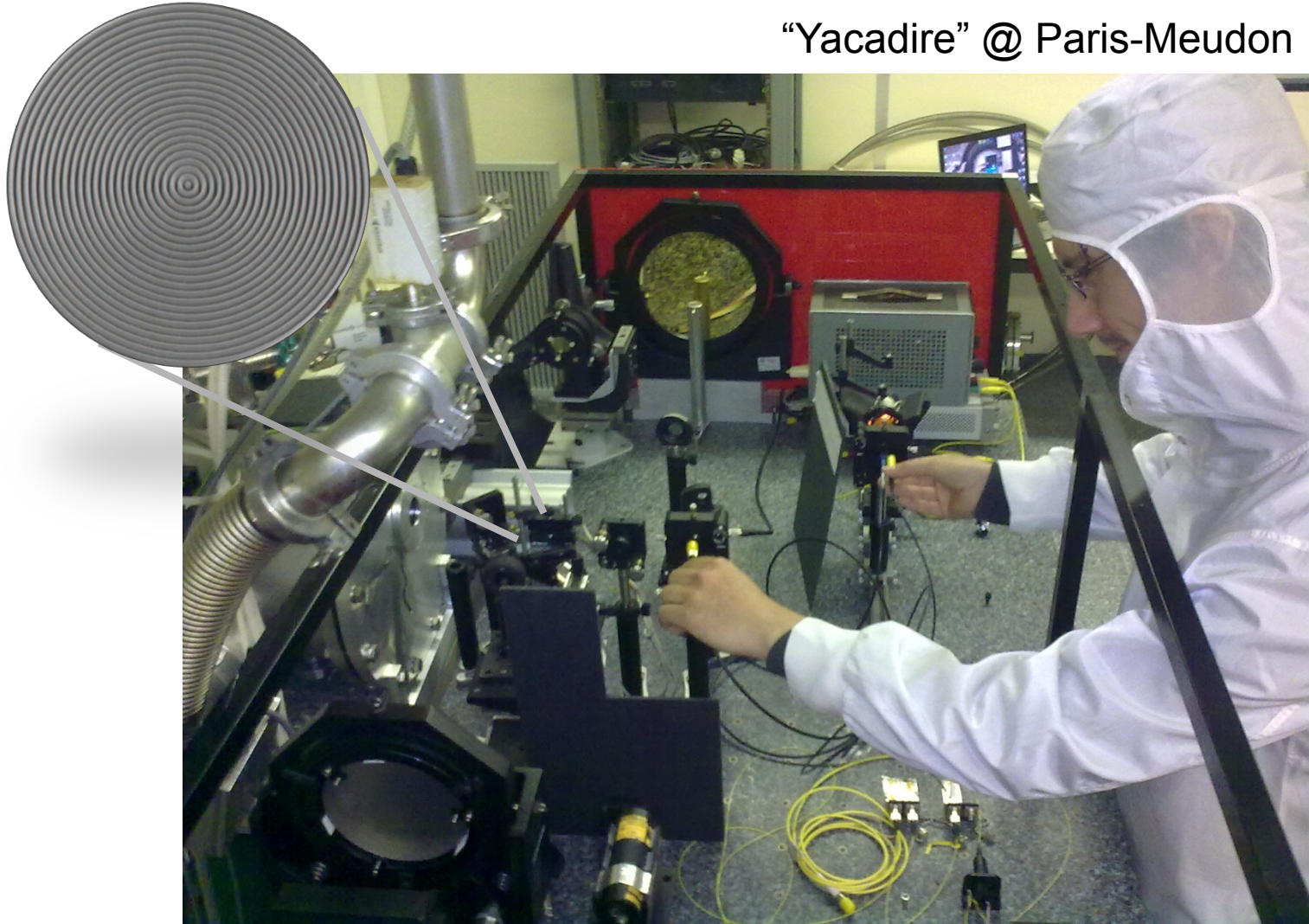
L band (Sep 2012)



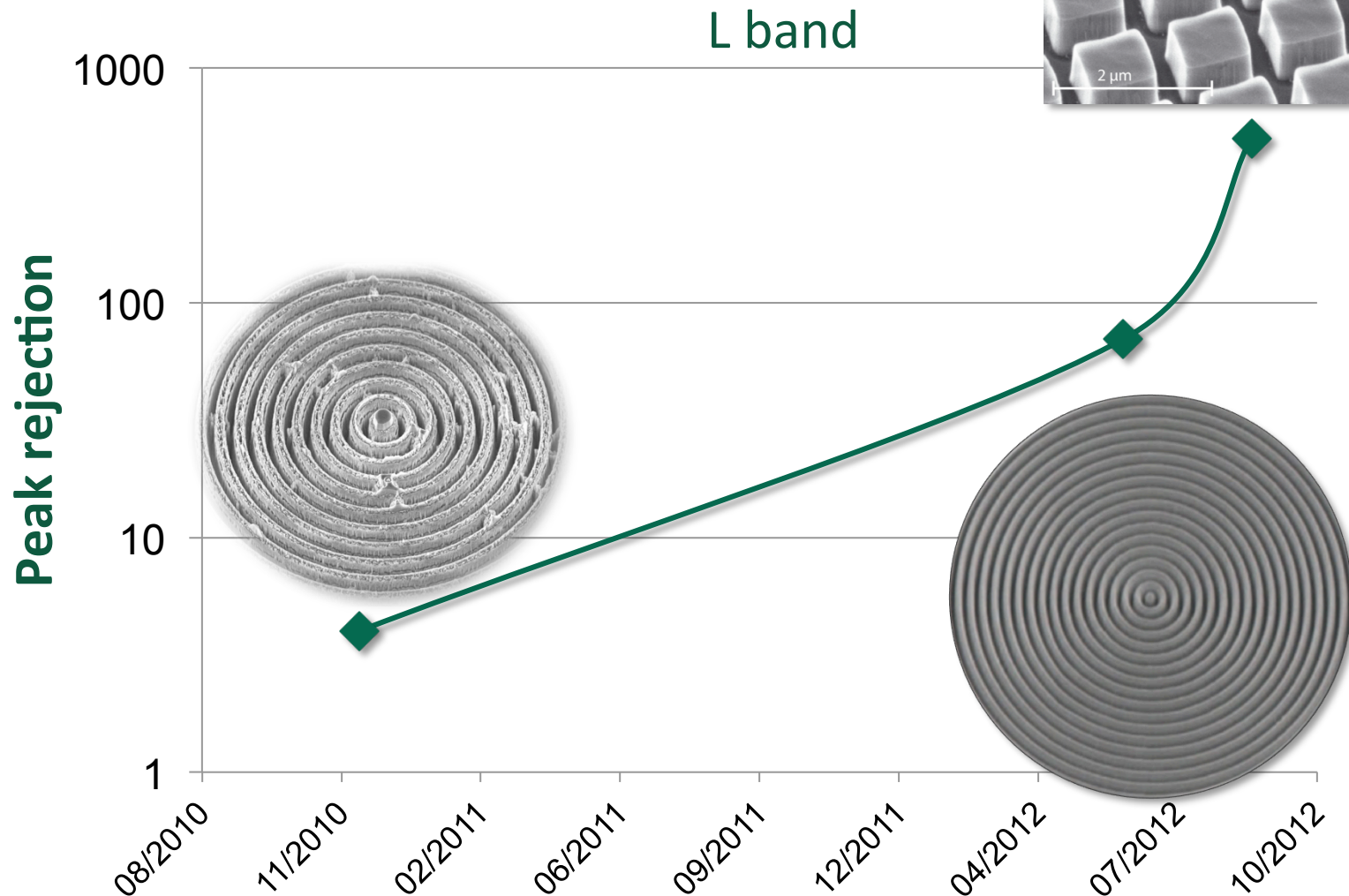
- Parameters close to optimal ... need to test!

Setting up the bench

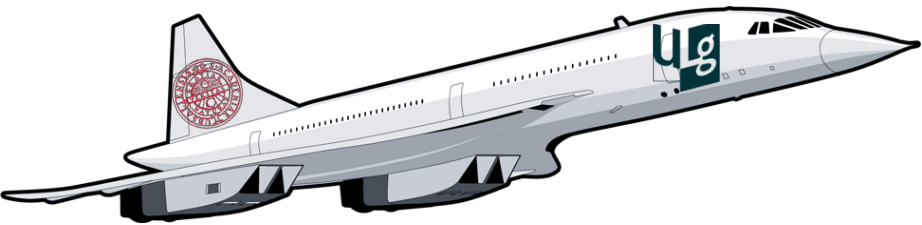
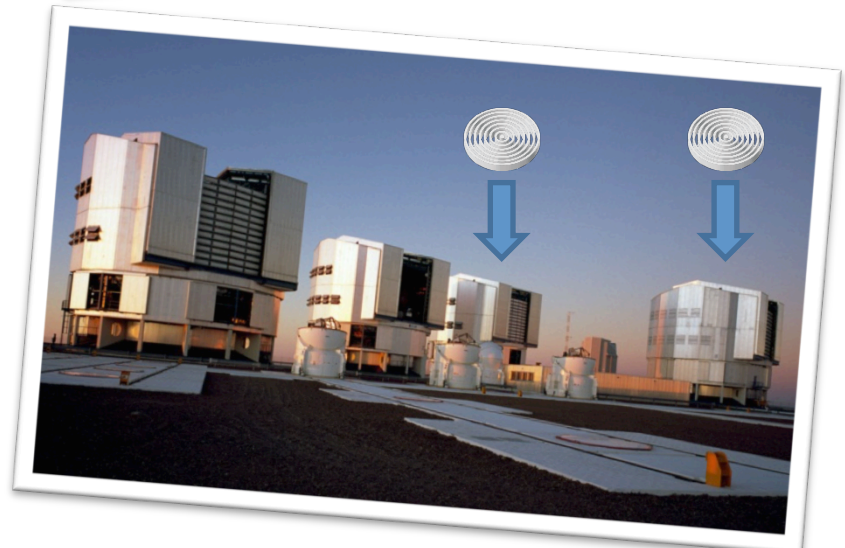
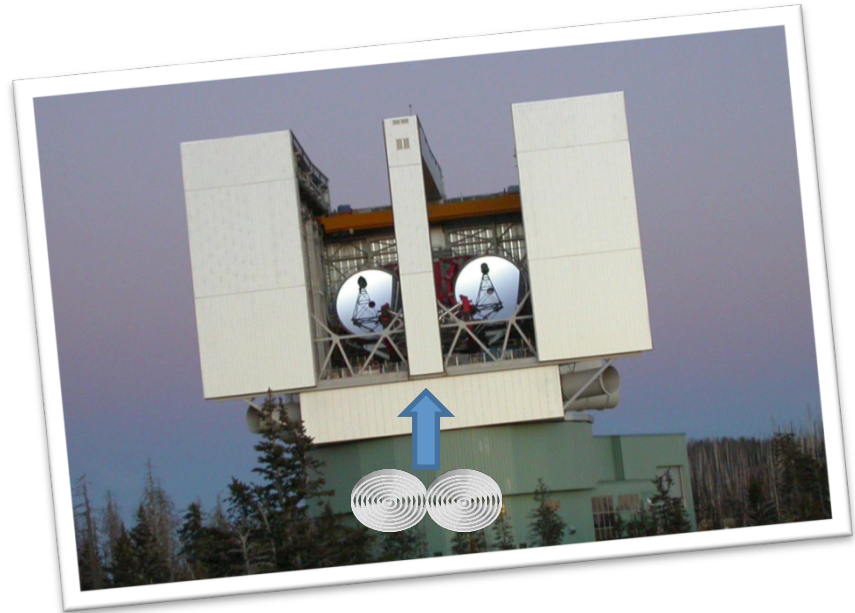
“Yacadire” @ Paris-Meudon



High performance



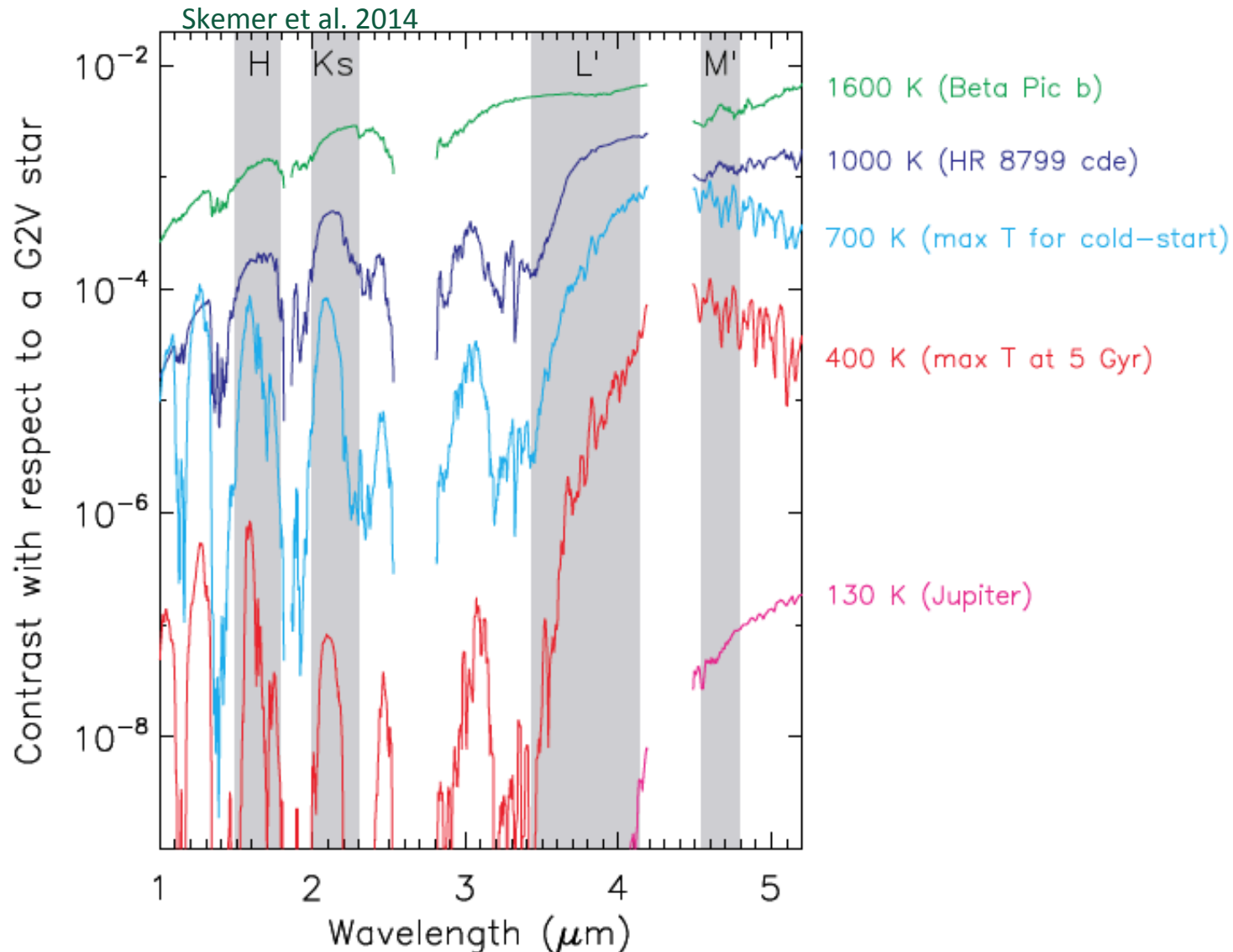
Installation at VLT, LBT, and Keck



Installation at VLT, LBT, and Keck

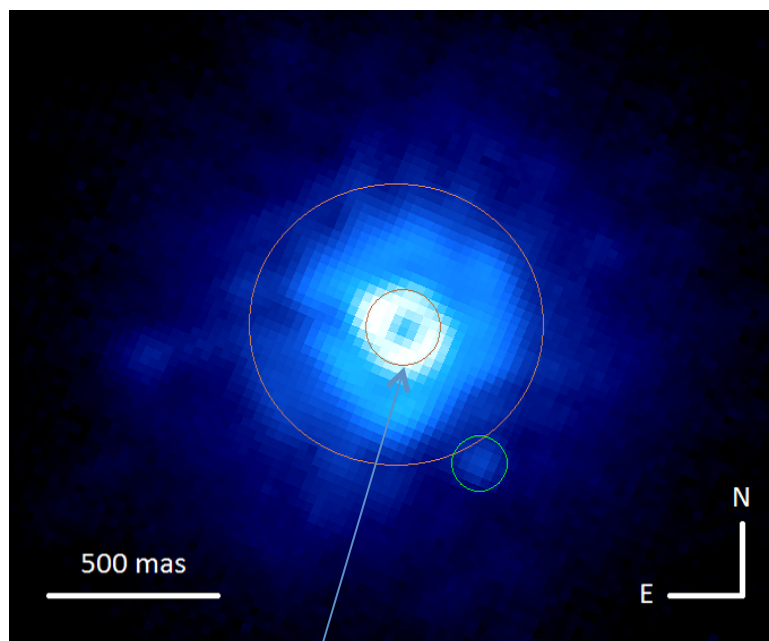


Scientific exploitation

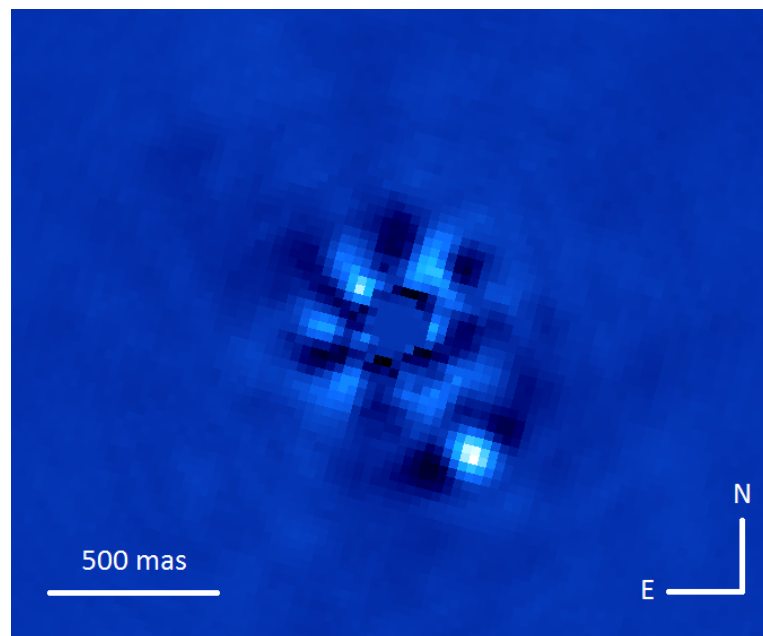


NACO: science demonstration

Raw image of β Pic

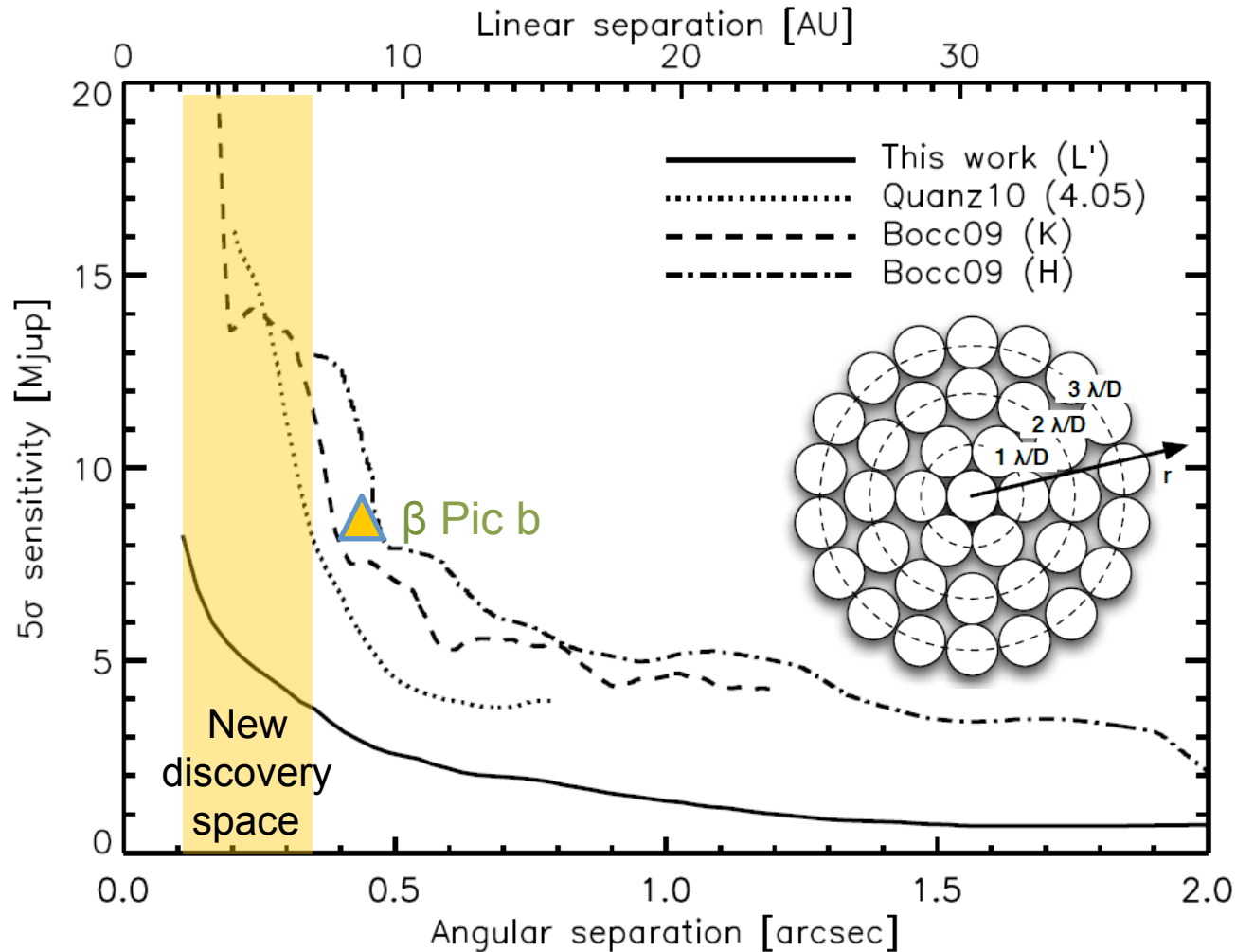


Post-processed image



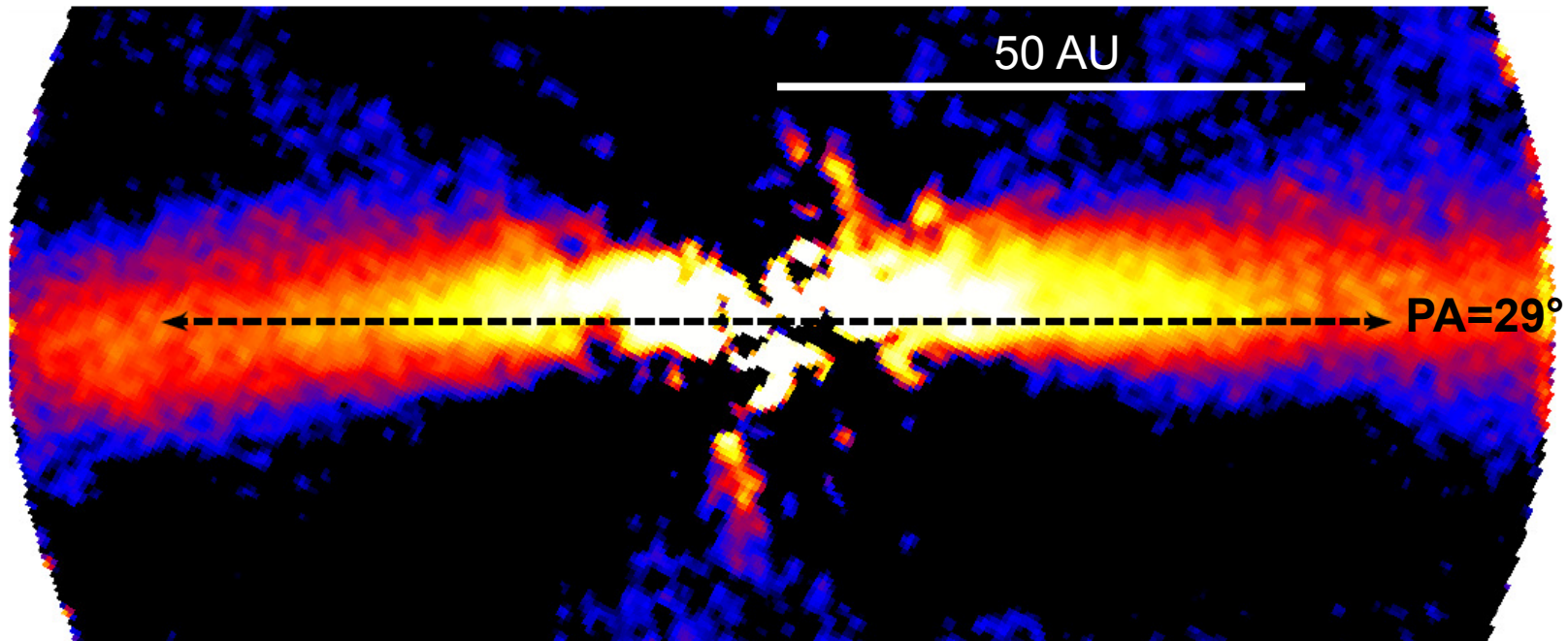
Peak rejection $\sim 50:1$

Sensitivity to inner planets



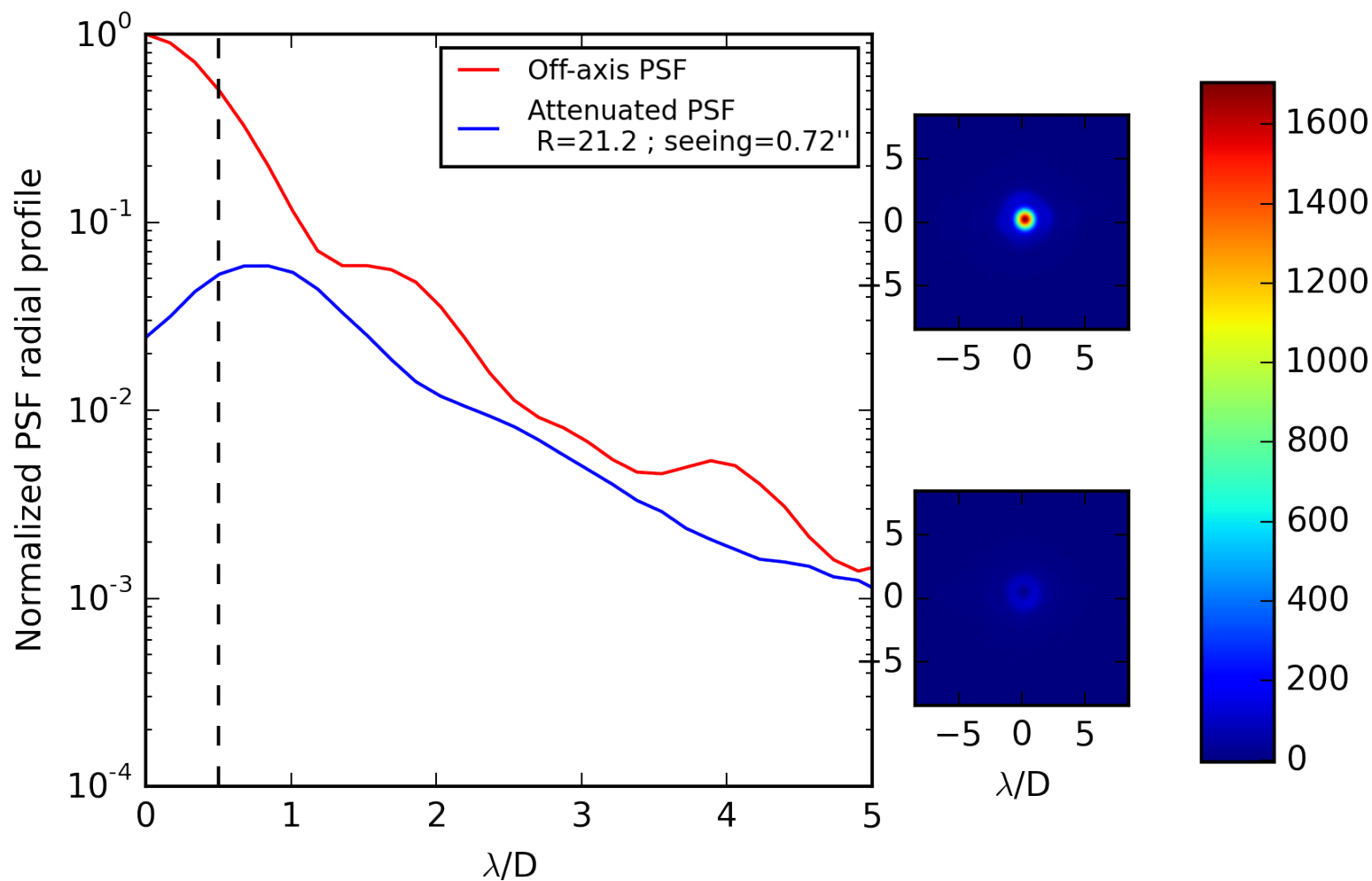
The β Pic disk at L band

- Warped, inner component
- Disk detected down to 10 AU (0.4")
- Spine offset and bowed (anisotropic scattering)

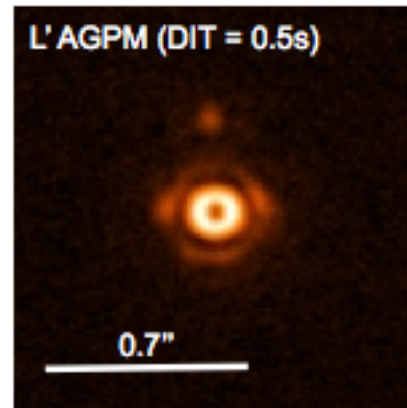
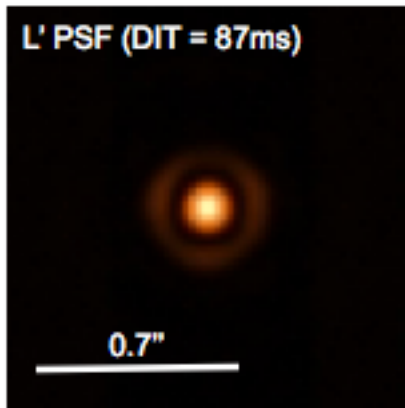


VISIR: science demonstration

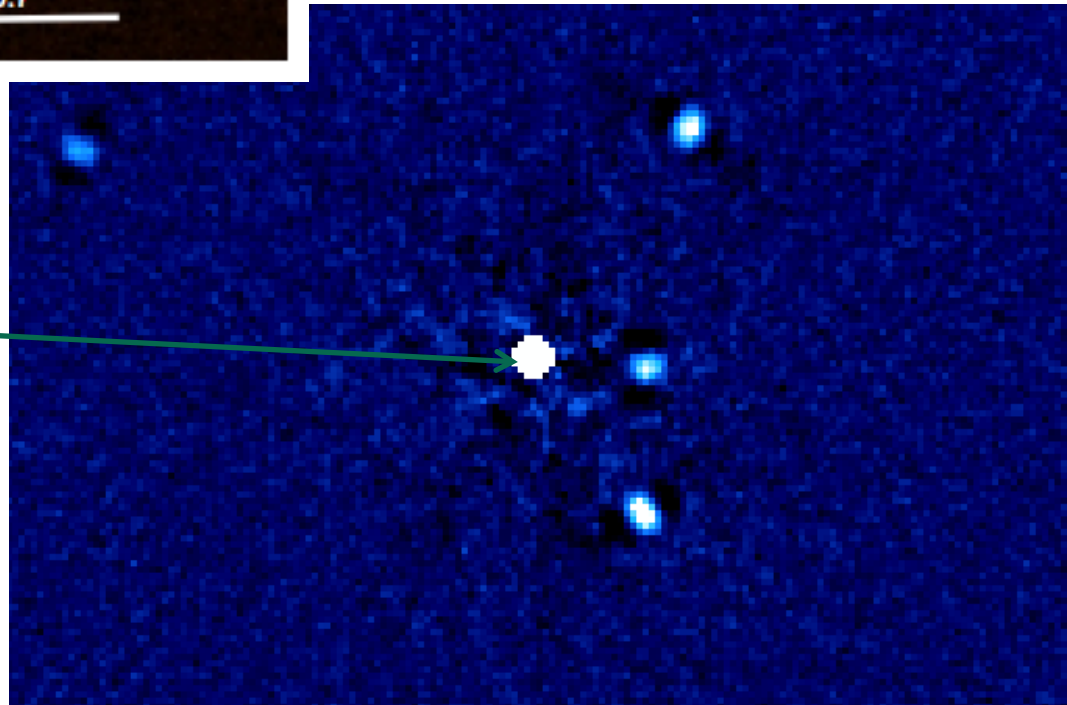
HD139063, NB-4QPM1 10.65 μ m



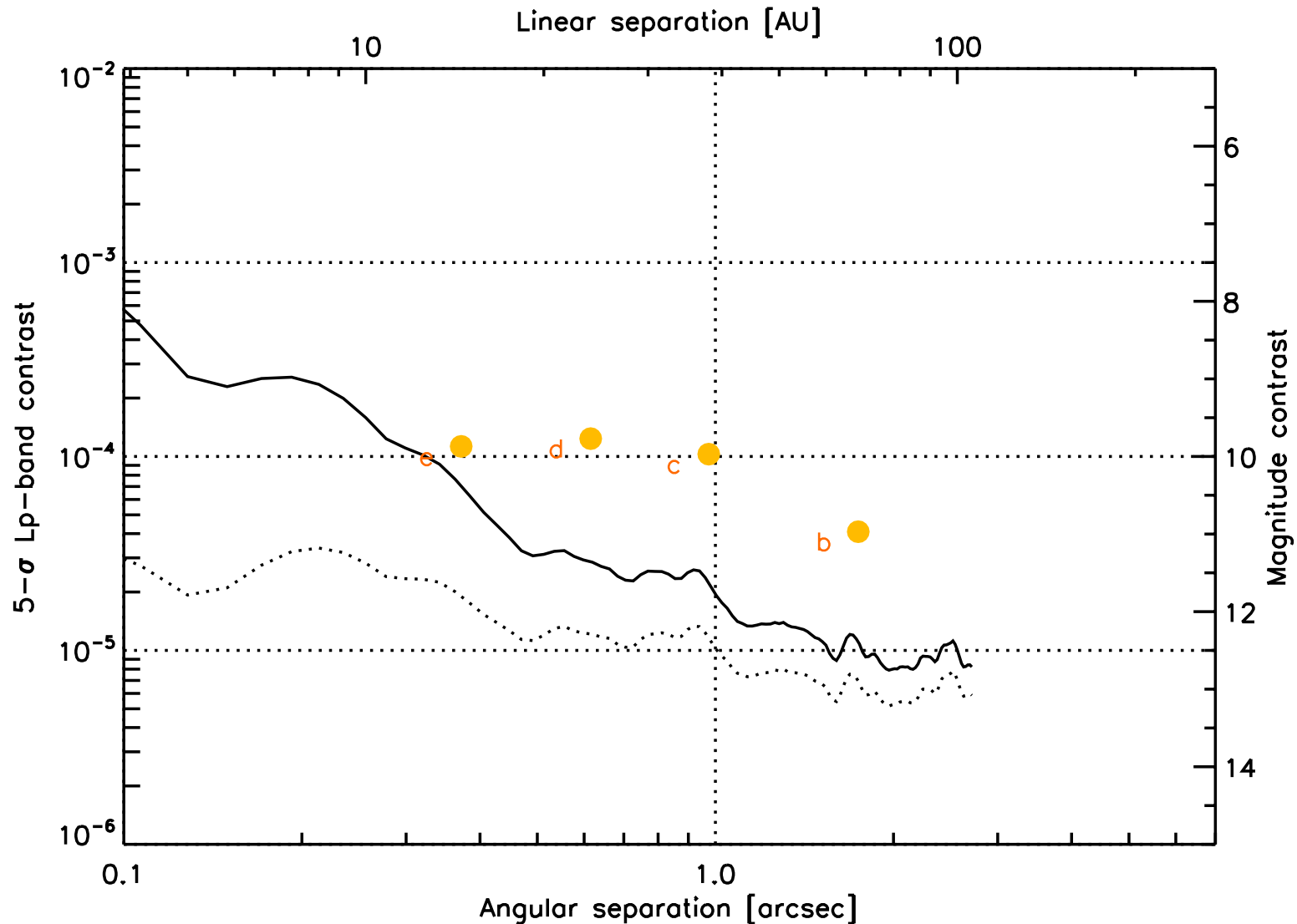
First light with LBT/LMIRCam



Peak rejection $\sim 35:1$
(far from optimal)

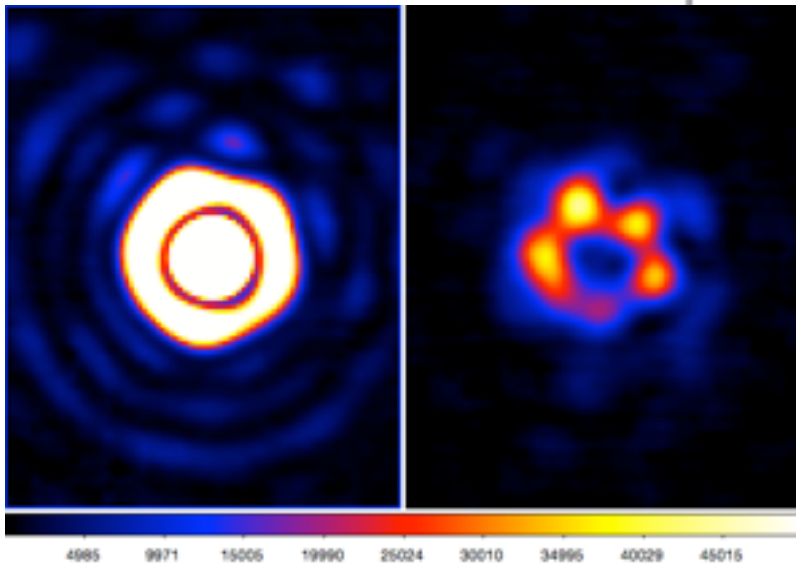
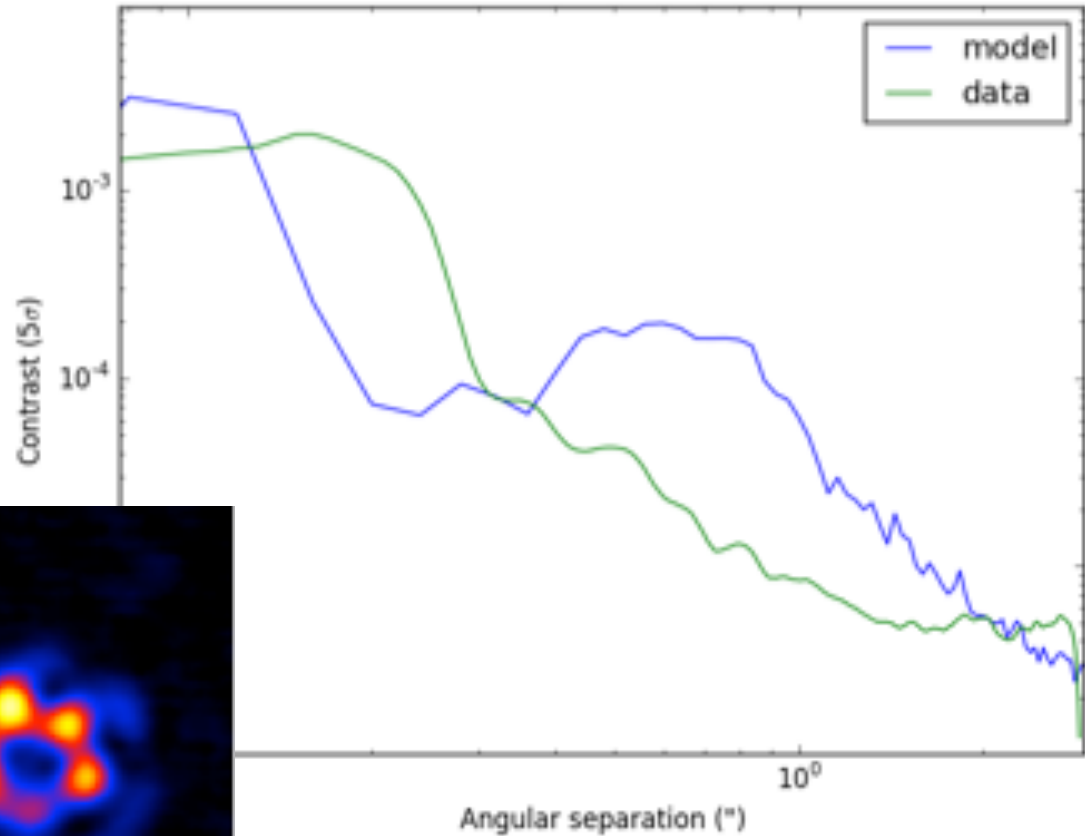


First light with LBT/LMIRCam



First light with Keck/NIRC2

~50:1 peak starlight rejection, limited by AO correction, and Keck pupil obscuration

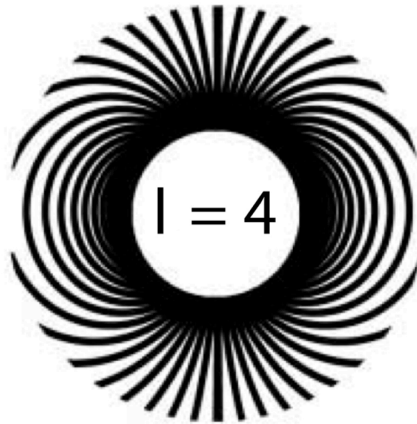
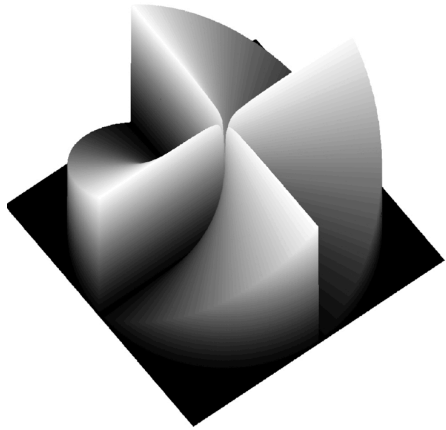


Prospects

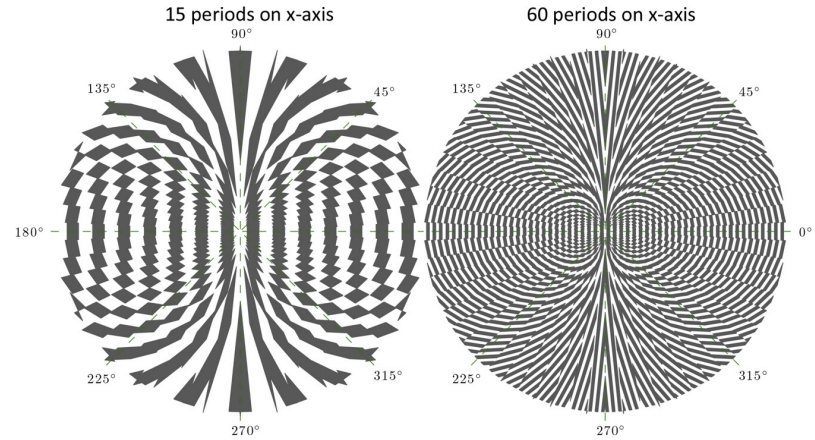
- Extension to shorter wavelengths (first K-band components recently etched)
- Extension to higher topological charges (trade some IWA for better resilience to pointing jitter)
- Combine the vortex with pupil-plane apodization (phase and/or amplitude)
- M-dwarf survey
- Protoplanets in transition disks
- Characterize new planets found by SPHERE and GPI

Charge-4 vortices for ELTs

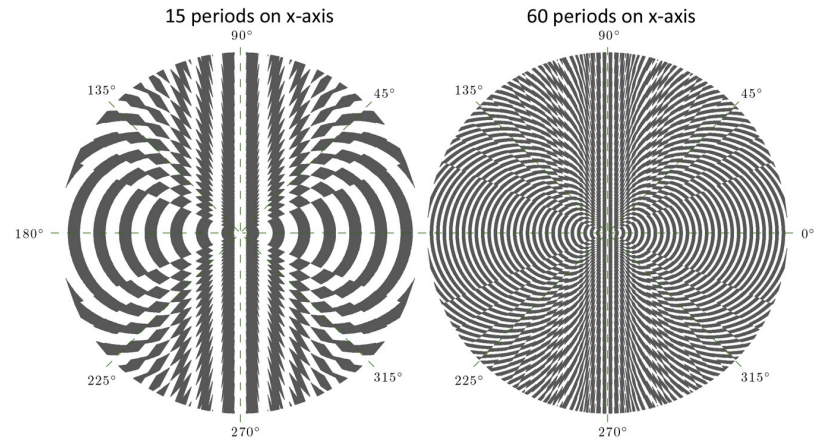
Charge-4 vortex



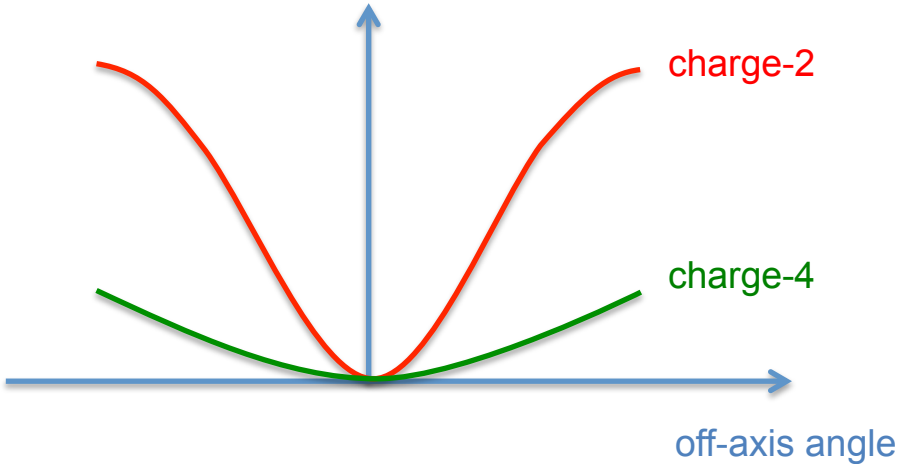
a) Construction with straight lines



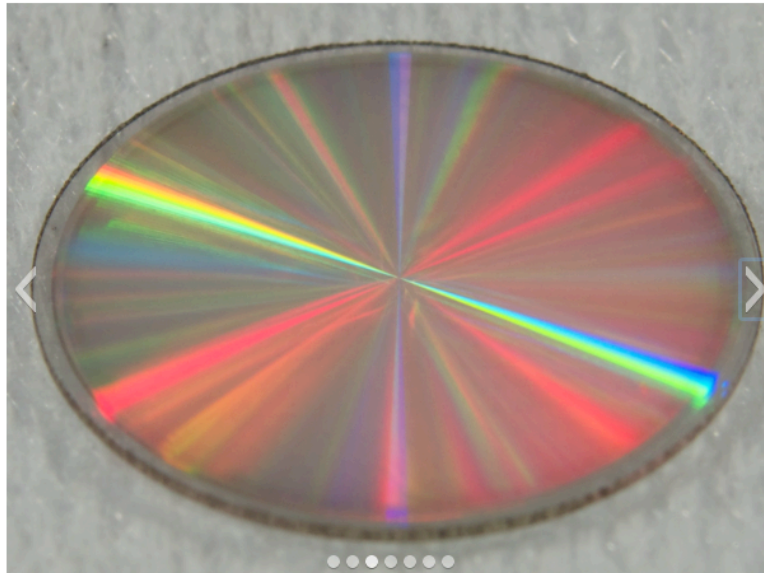
b) Construction with curved lines



transmission



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Latest news

- 2015-01-30: Two L-band AGPMs shipped to Caltech for Keck/NIRC2
- 2015-01-13: NACO+AGPM re-commissioned on UT1
- 2014-12-02: First K-band AGPM etched
- 2014-09-02: VORTEX annual meeting at Uppsala Universitet
- 2014-05-22: The VORTEX team joins the E-ELT/METIS project
- 2014-05-03: AGPM installation on Keck/NIRC2 approved
- 2013-10-21: AGPM first light on LBT/LMIR-Cam
- 2013-10-10: Kick-off of the VORTEX project

About VORTEX

The VORTEX project aims to advance the theory, manufacturing and exploitation of optical

Research topics

Exoplanets and disks
Image processing
Coronagraphic instruments

Funding & partners

