

# Exo-planet direct detection and characterisation with HARMONI – the first light integral field spectrograph for the E-ELT



**E-ELT**

Niranjan Thatte  
On behalf of the  
HARMONI consortium



**VLT**

Special thanks to C. Verinaud, A. Carlotti, T. Fusco, K. Dohlen, D. Mouillet, B. Pope & M. Tecza

# PREAMBLE

- HARMONI is a work-horse first light E-ELT spectrograph with a broad range of science programmes
  - limited in special capabilities for exo-planet observations.
- Main driver is follow-up spectroscopy of SPHERE, GPI, SCExAO detected planets, at low ( $R \sim 500$ ) and medium ( $R \sim 3500$ ) spectral resolving power.
  - would be nice to do more (esp. close-in planets)
- Not fed by extreme AO (just SCAO with M4-M5), and no ADC

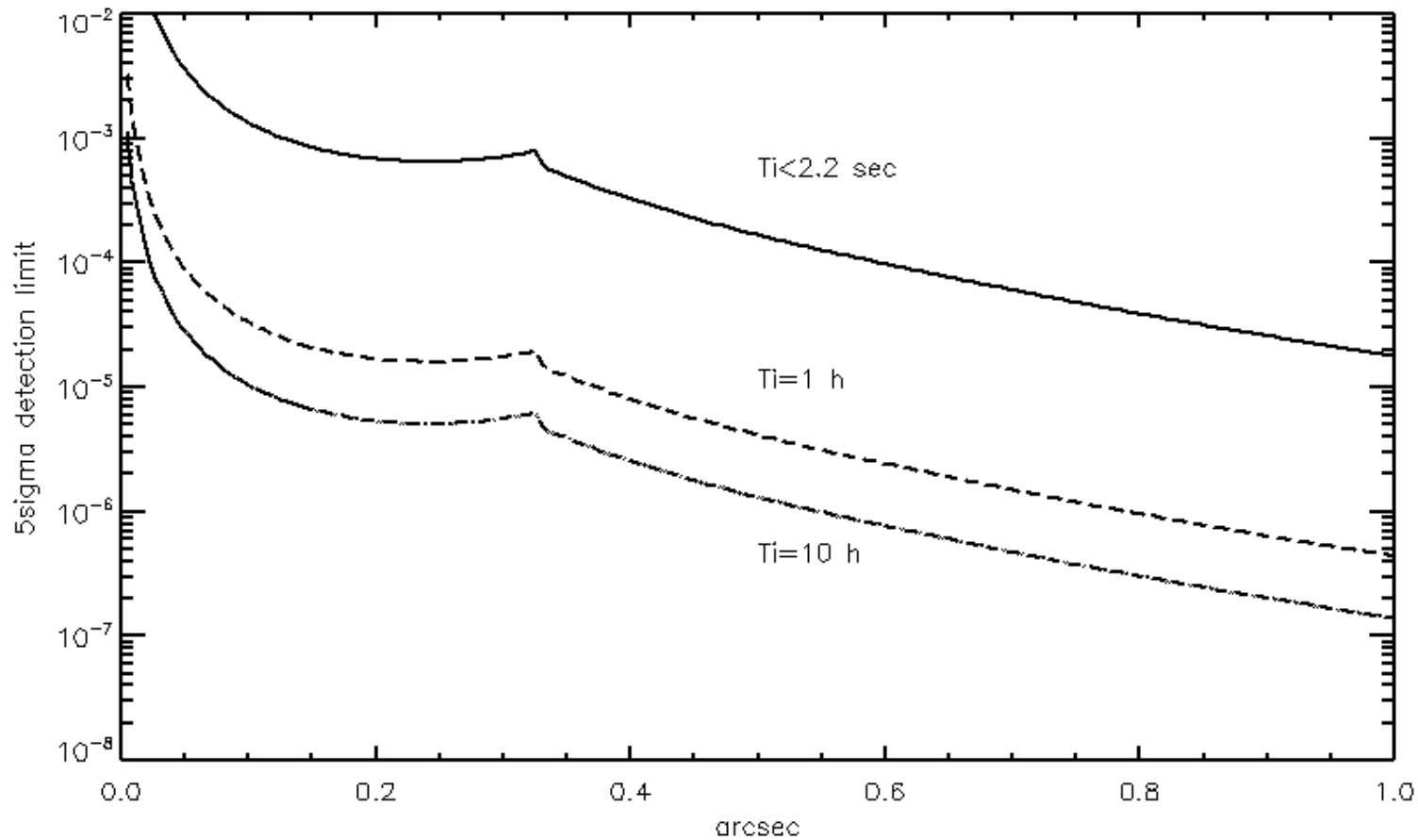


# KEY POINTS

- HARMONI can perform crucial on-sky tests of some key issues (e.g. atmospheric speckle lifetime)
  - help us build a better PCS
- Calibrating and correcting NCPA will be key to achieving good performance
- Simple, monochromatic computation
- Polychromatic issues
- Conclusions



# ATMOSPHERIC SPECKLE LIFETIMES

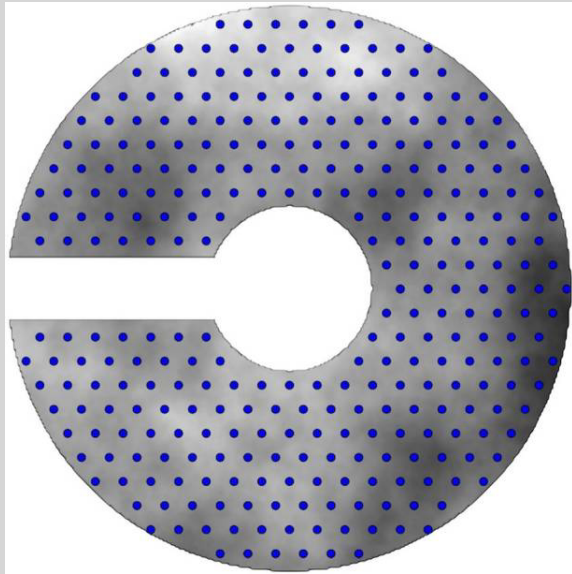


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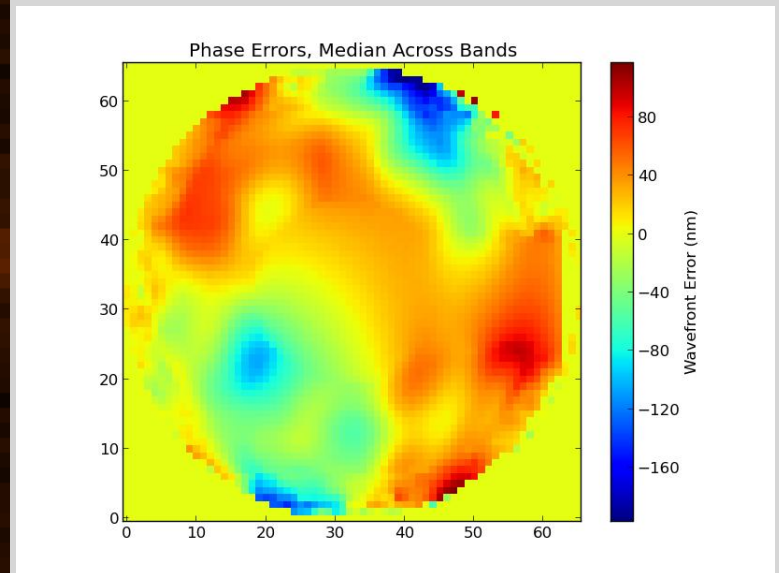
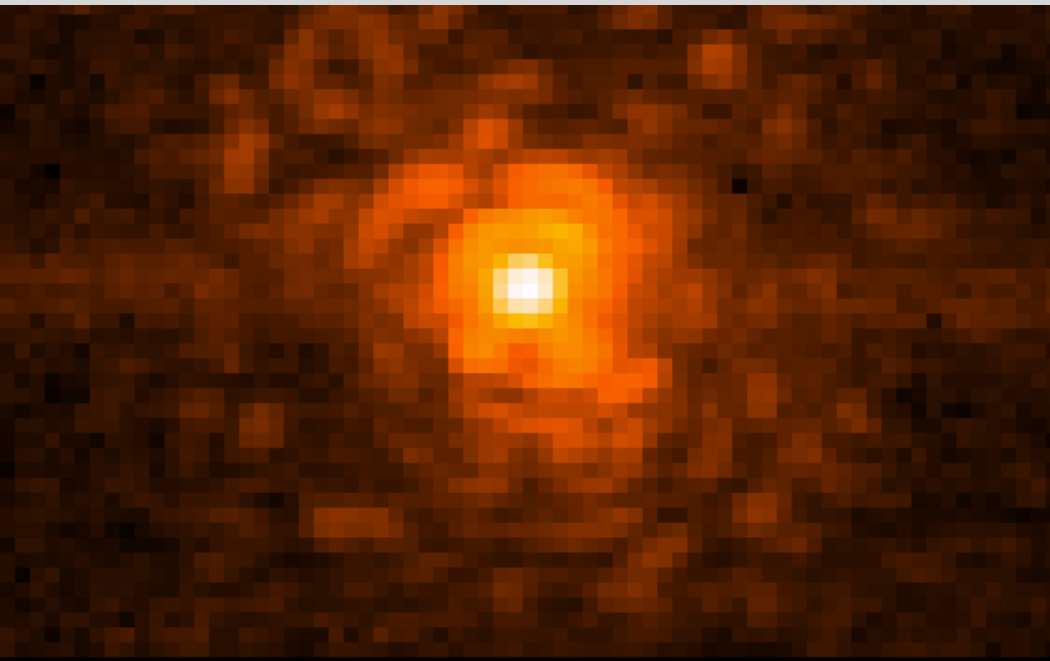
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# NCPA USING KERNELPHASE



Concept  
F. Martinache,  
P. Tuthill  
Implementation  
B. Pope

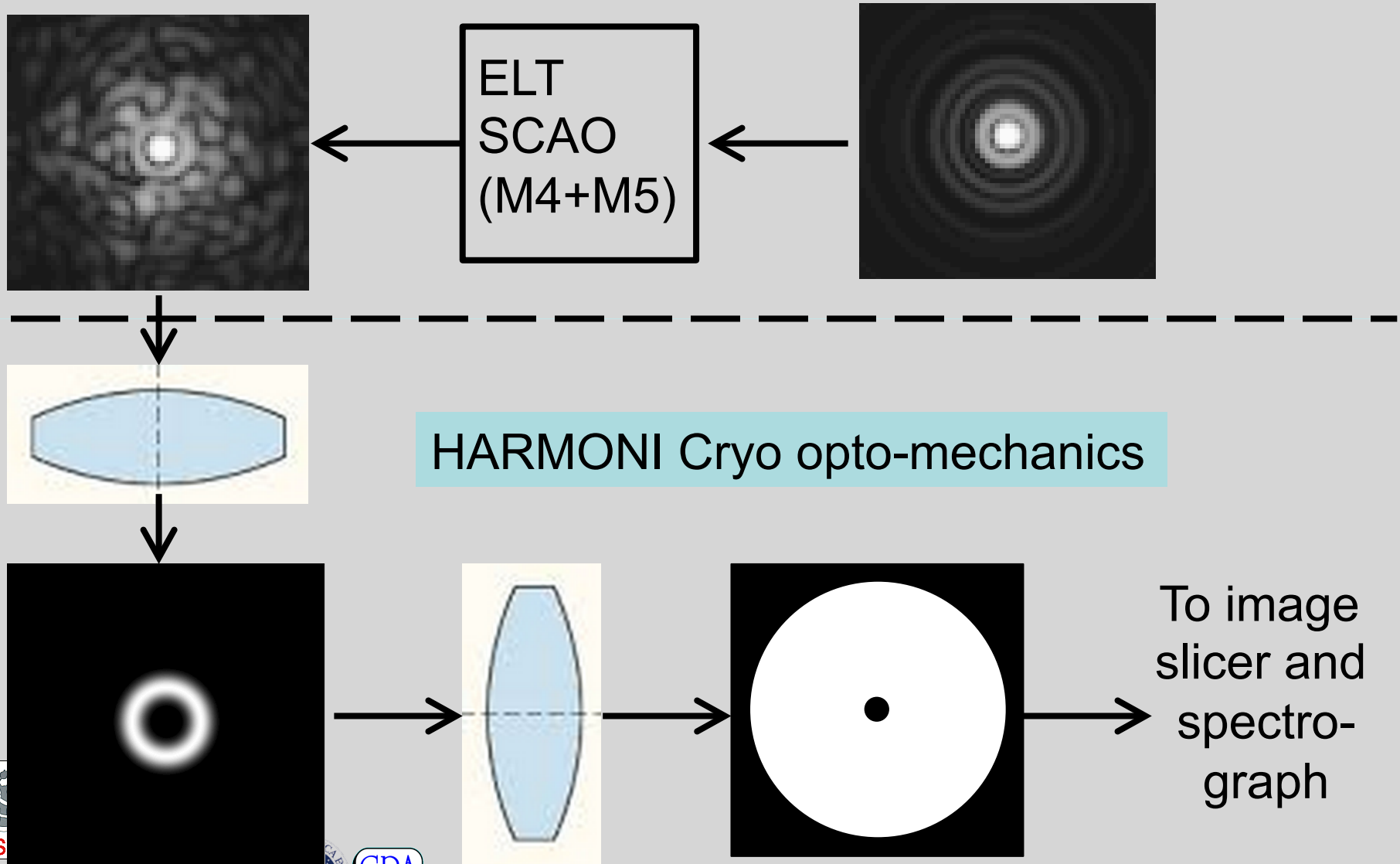


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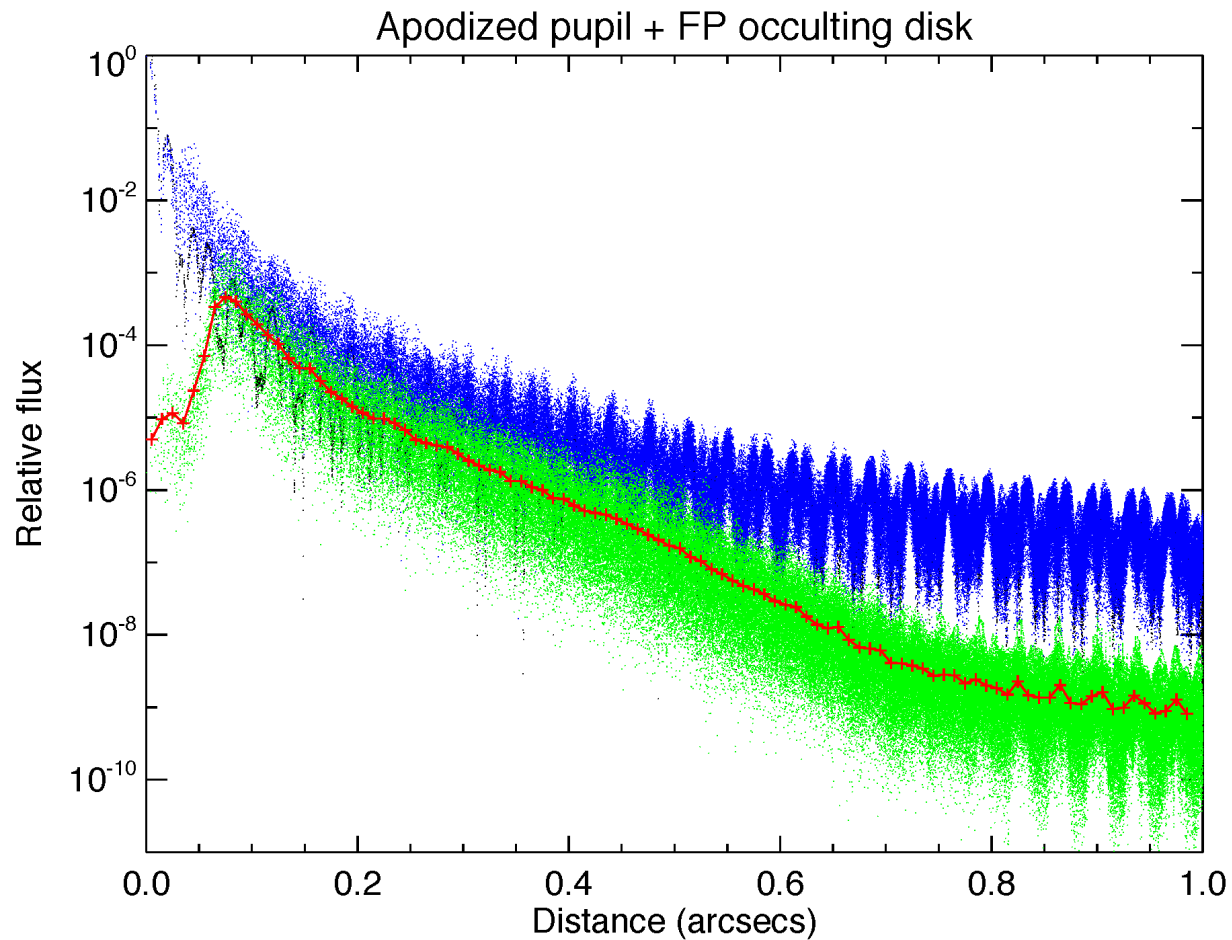


# APODISED CORONAGRAPH





# MONOCHROMATIC CONTRASTS

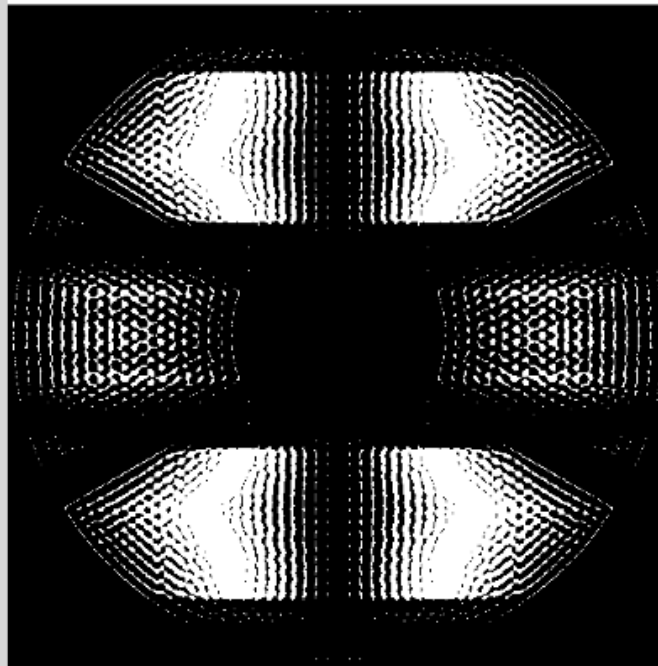


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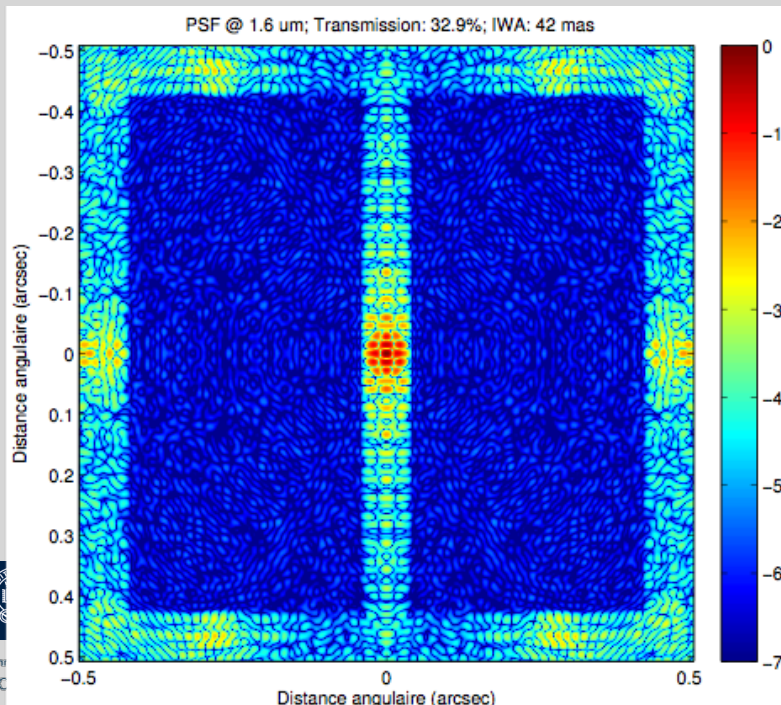
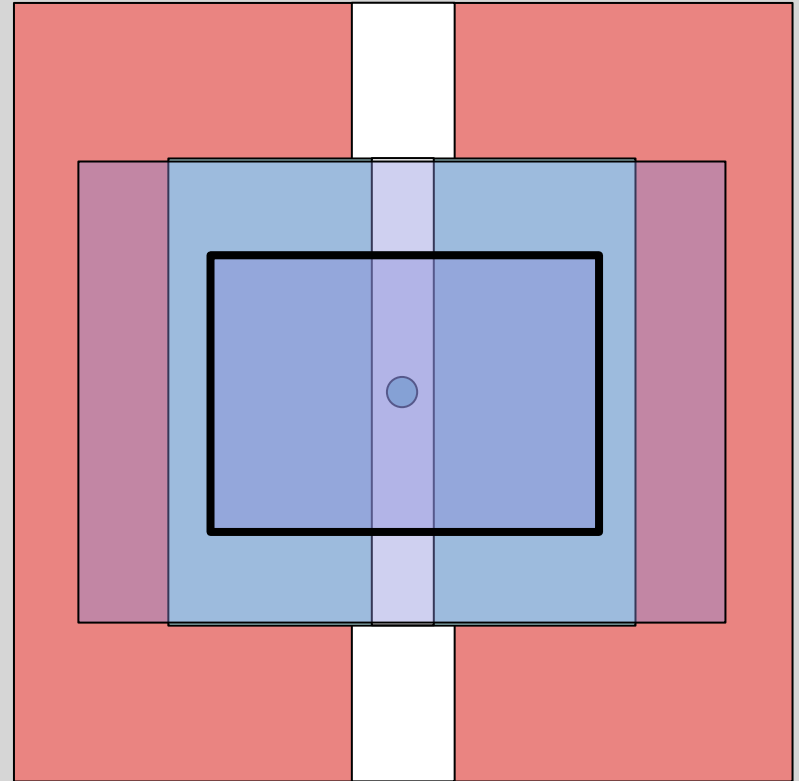
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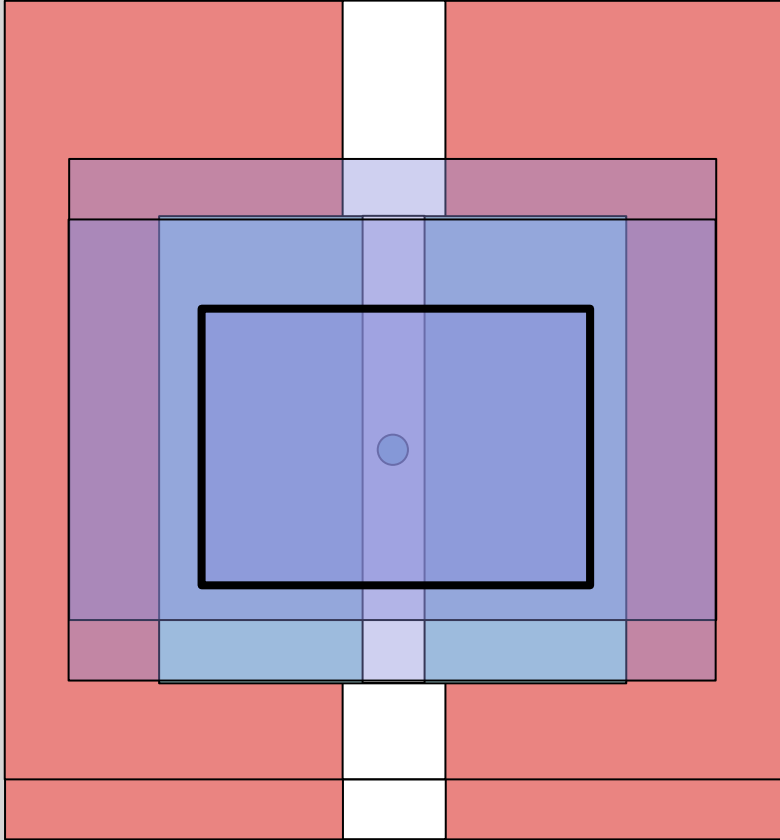
Mask ; Transmission: 32.9%; IWA: 42 mas @ 1.6 um



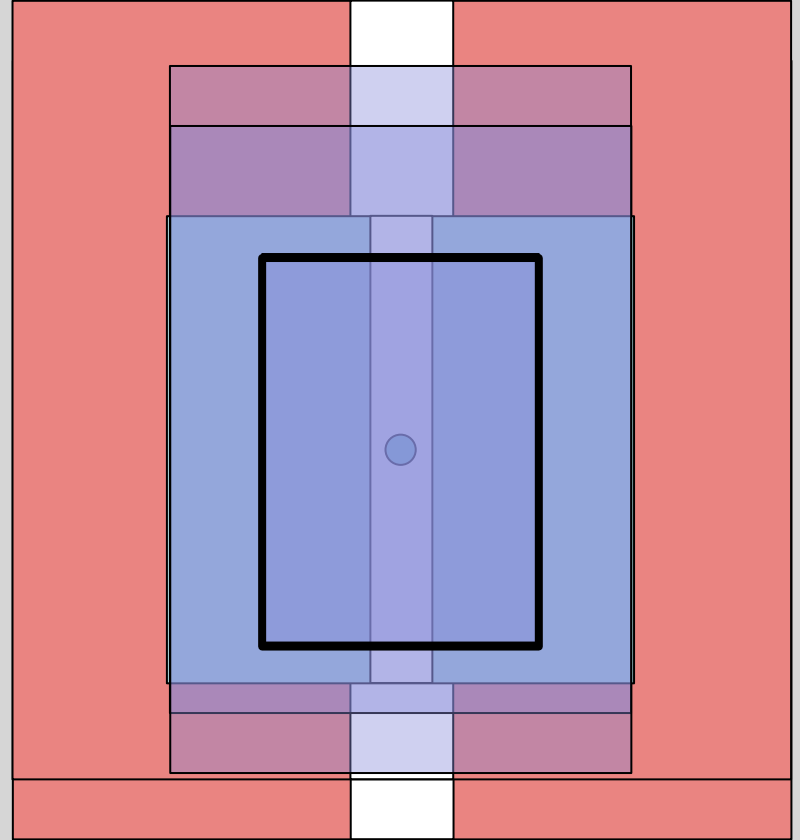
Work by A. Carlotti, with help of C. Verinaud & K. Dohlen



$0.514'' \times 0.366''$



0.514" × 0.366"



0.366" × 0.514"



Science & Technology Facilities Council  
UK Astronomy Technology Centre

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# PRELIMINARY CONCLUSIONS

- HARMONI can provide a serious follow-up capability in high contrast spectroscopy of directly imaged planets at  $R \sim 500$ ,  $R \sim 3500$ ,  $R \sim 10000$
- Integral field spectroscopy of disks (and jets) around young stars at  $R \sim 20000$
- Combination of SD + ADI post-processing of an apodised pupil imager with a focal plane occulting bar might provide good performance without too much specialised hardware
- Performance achievable with high contrast imaging spectroscopy with the ELT needs work!!

