

IMPROVING DETECTION LIMITS ON HIGH CONTRAST IMAGING : THE PACO ALGORITHM PERFORMANCES

First results on a small survey

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COBREX

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Introduction

THESIS : Exoplanet detection with high contrast imaging

- Reprocess the entire SPHERE archive
- Use of a new algorithm : PACO
- Test bed on a small sample of close and young solar-type stars

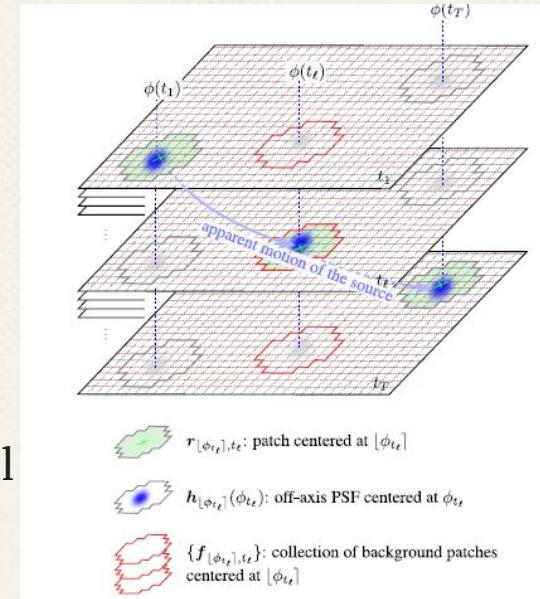
The PACO algorithm

Algorithm developed to process HCI observation (PAatch COvariance, Flasseur et al. 2018)

- Statistical data-driven modelling of noise at local scale
- Provide statistically-based SNR maps following $N(0,1)$
- No PSF subtraction step

We used robust PACO ASDI (Flasseur et al. 2020ab)

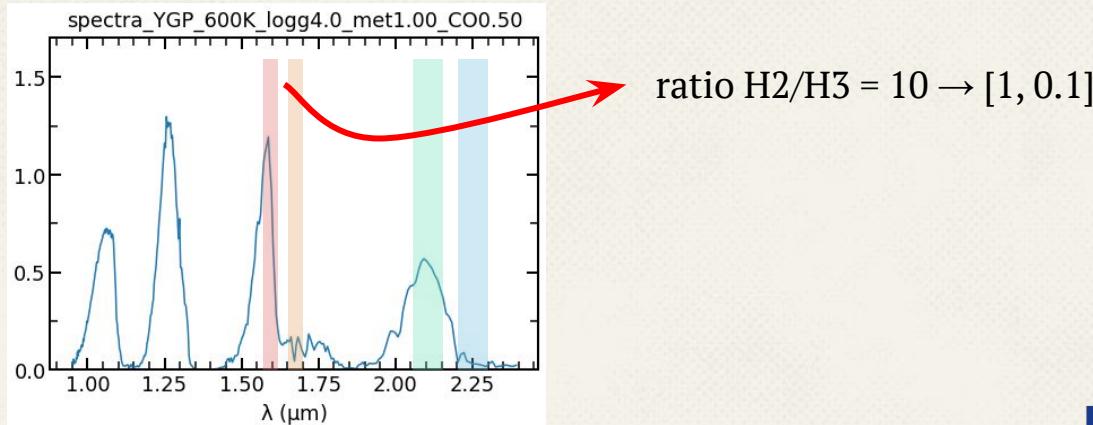
- Robustness to bad frames
- ASDI allow better noise estimation and optimal spectral combination following a prior



Priors creation for PACO ASDI

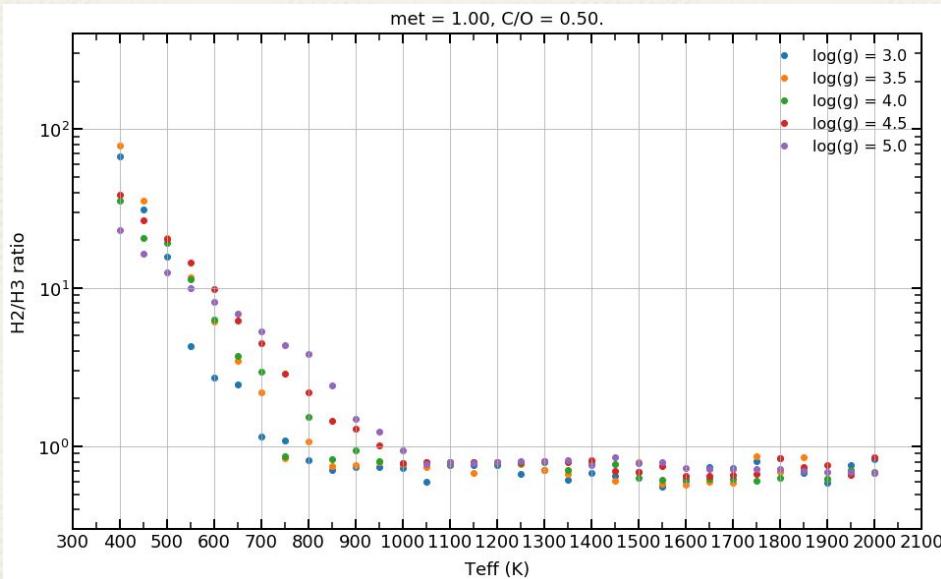
Priors are used to optimally combine multi wavelength data following weights → spectral priors, maximize snr of sources

We choose to build our spectral priors based on Exo-Rem model (~10 000 spectra at R=500, Charnay et al. 2019)

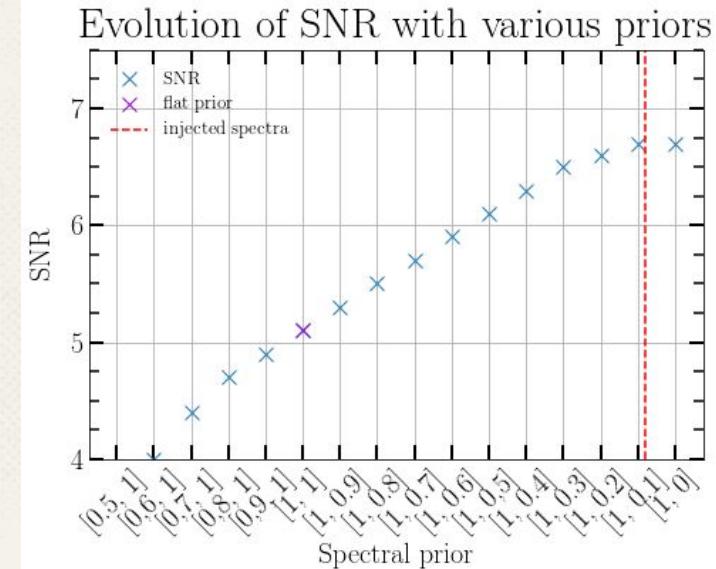


IRDIS spectral priors

Exploring the spectral diversity



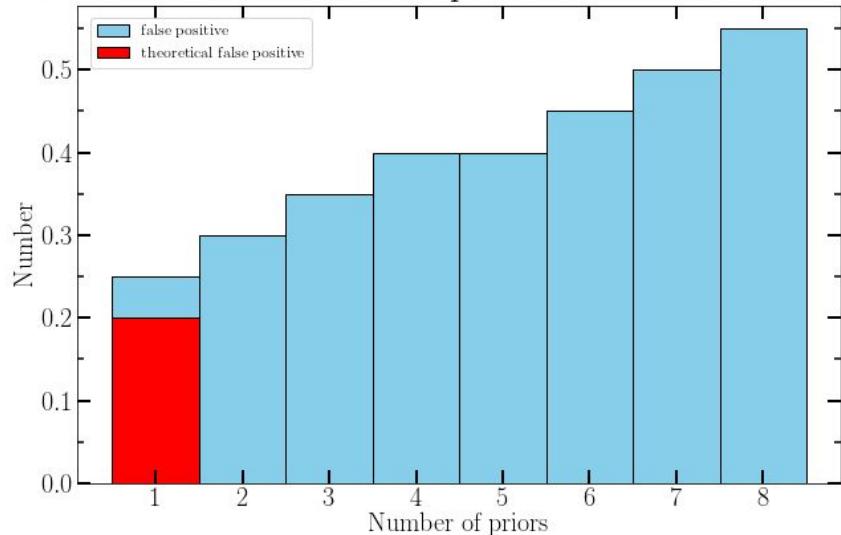
Study the sensibility of PACO to various number of priors with fake injected planet of various spectral types



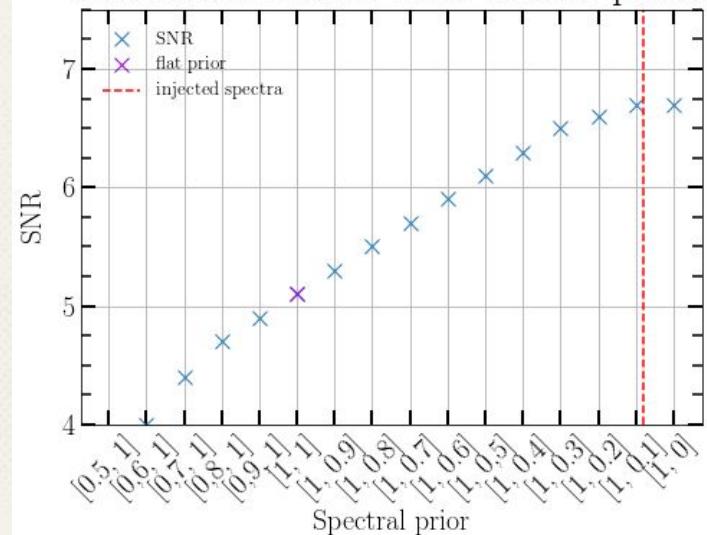
IRDIS spectral priors

Impact on false positive rate of adding prior

Normalized number of false positive with threshold = 5.0

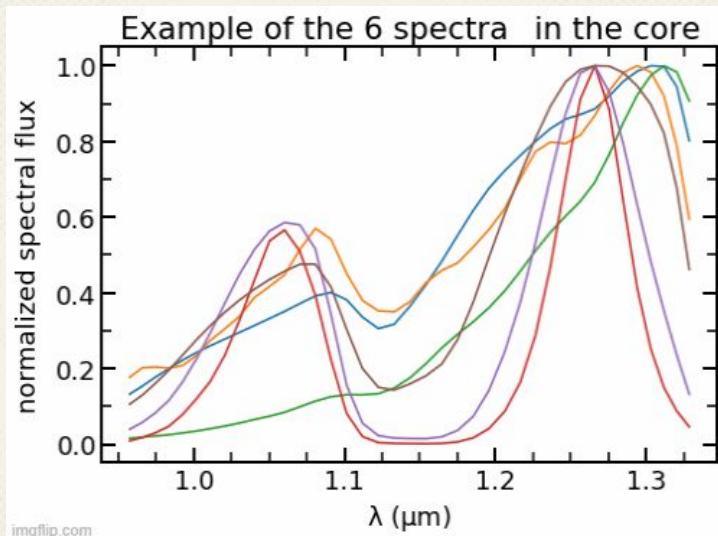


Evolution of SNR with various priors

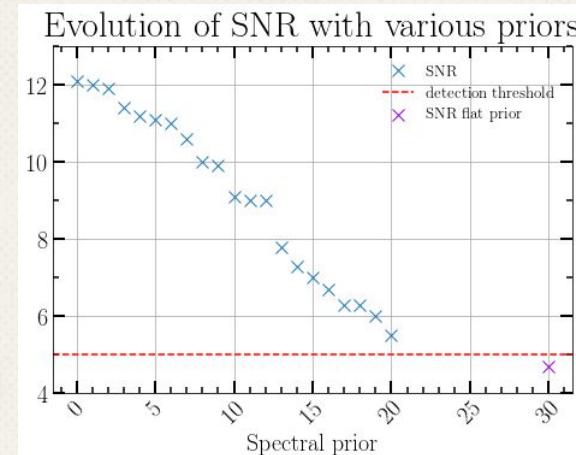
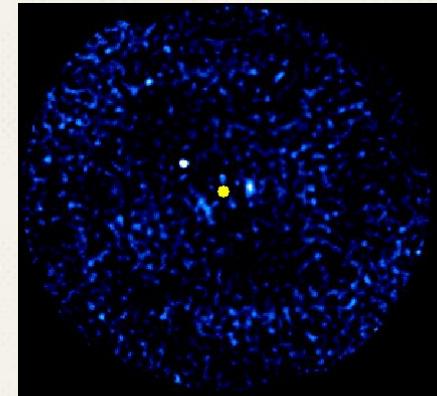


IFS spectral priors

Euclidian based method to explore the spectral diversity



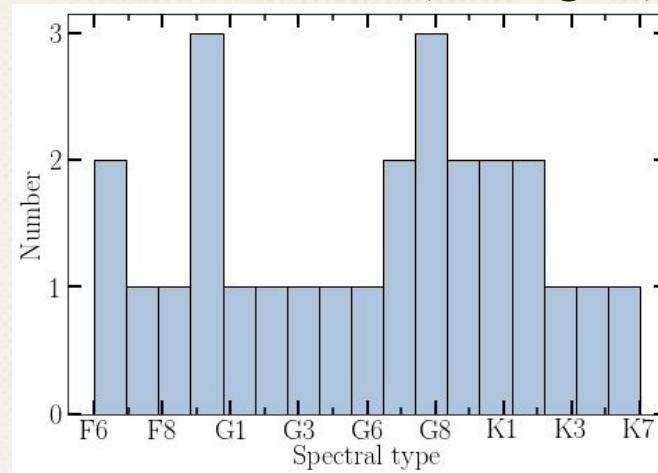
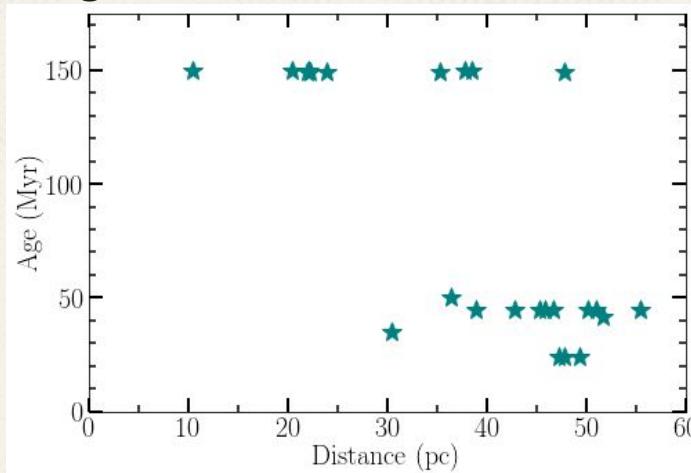
HD206893 b
2017-07-13
YJ band



Mini-survey : sample definition

All (23) young (< 150 Myr), close (<60 pc) solar type stars observed during the SPHERE/SHINE F150 (part of the SPHERE GTO survey, Desidera et al. 2021) survey with H23/JY filters

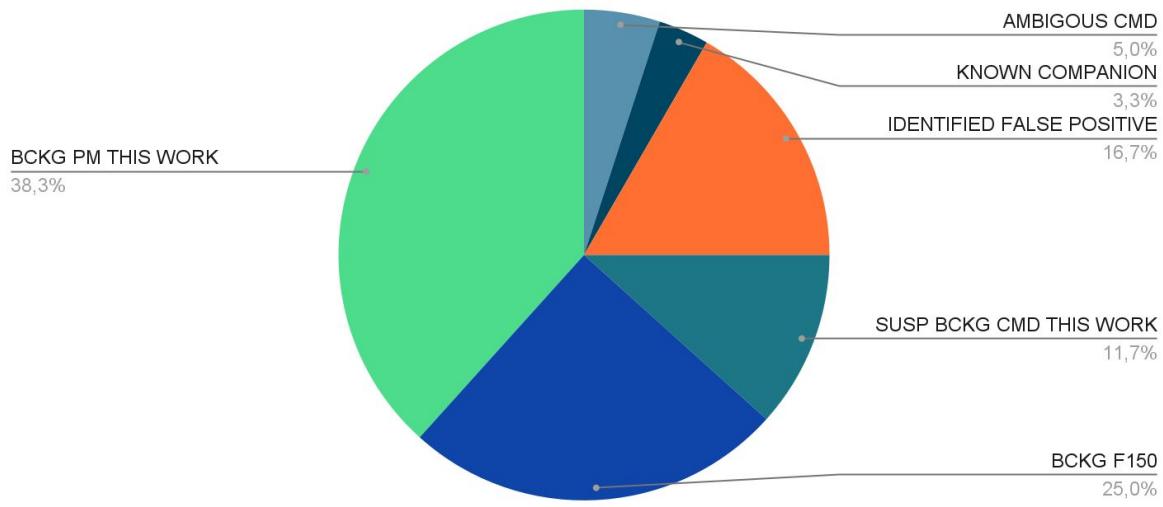
Designed as a test bed for the future massive reduction (all targets).



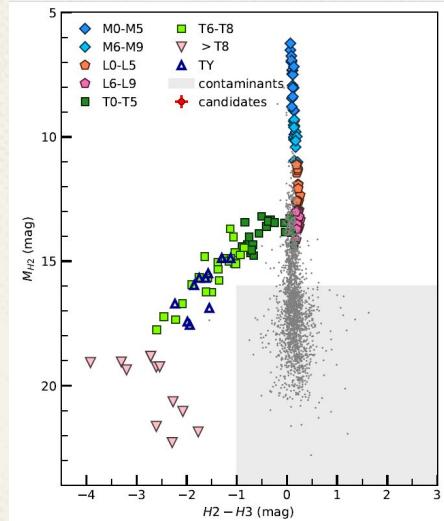
Results : IRDIS detection classification

60 (20 new) detections above 5 sigma; 40 datasets

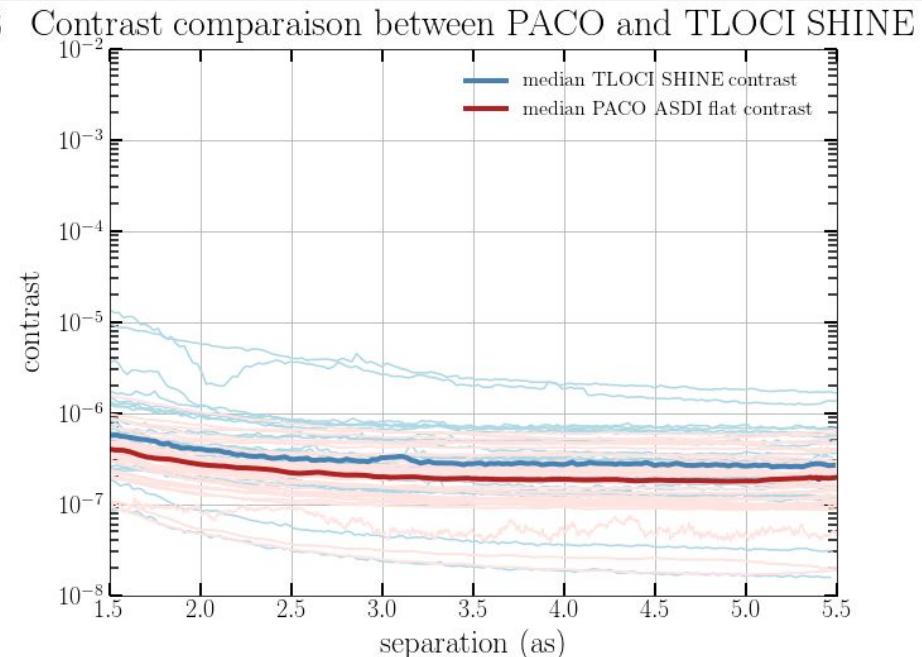
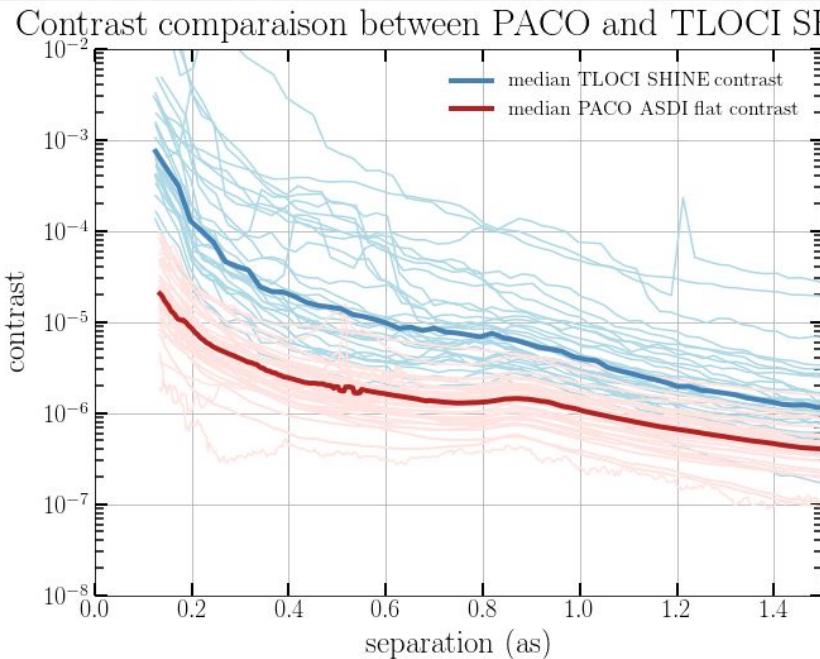
DETECTIONS ABOVE 5 SIGMA



10 false positives, 16 theoretical.
→ confirm gaussian noise behavior of PACO !

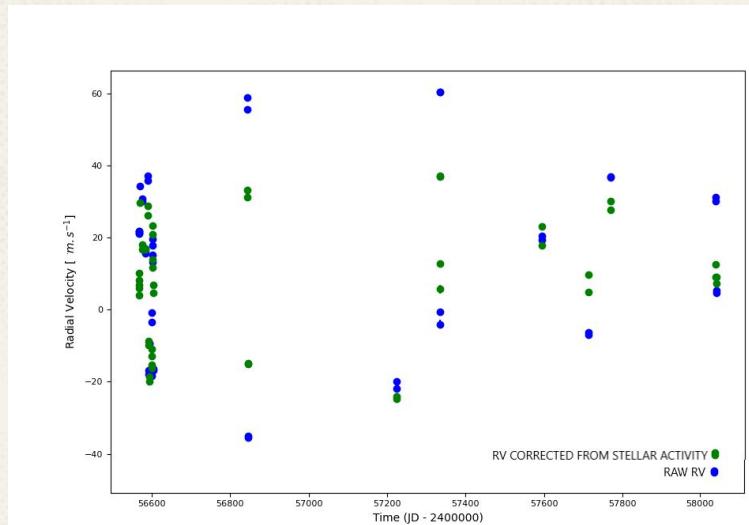


Results : IRDIS contrast comparison with SHINE F150

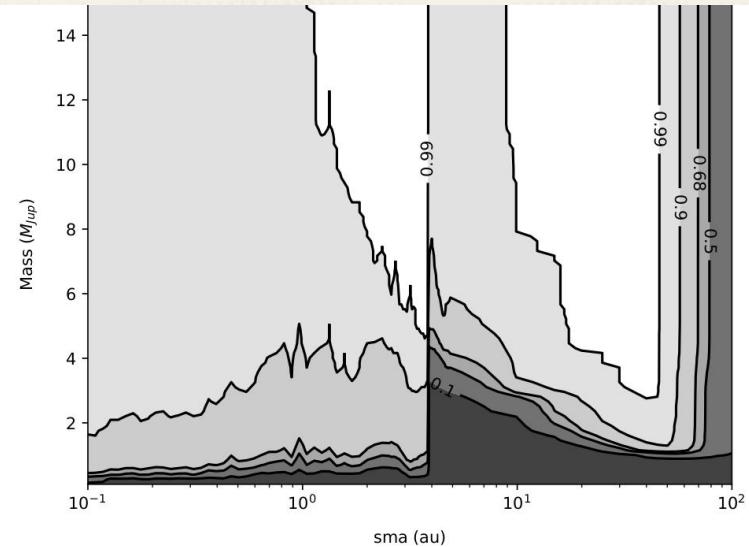


Results : detection limits using MESS2

HIP13402, 2016-10-14, H23 band, DI+RV combination

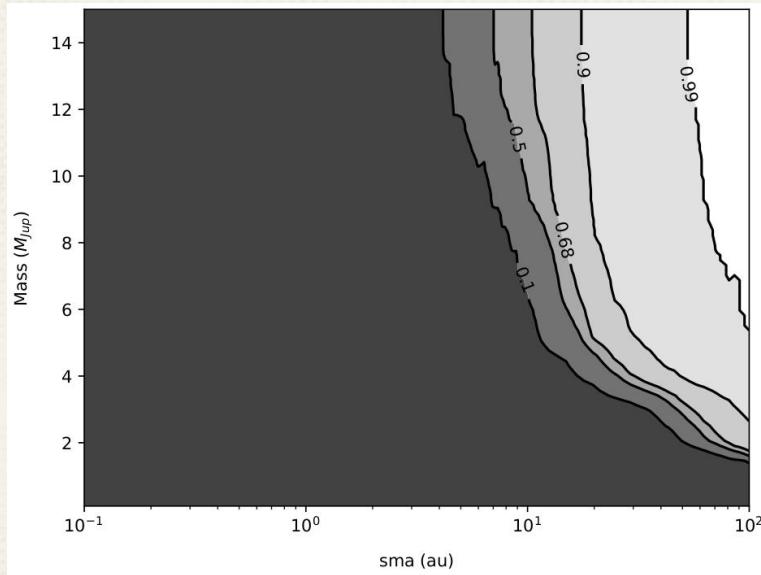


Grandjean et al, 2020

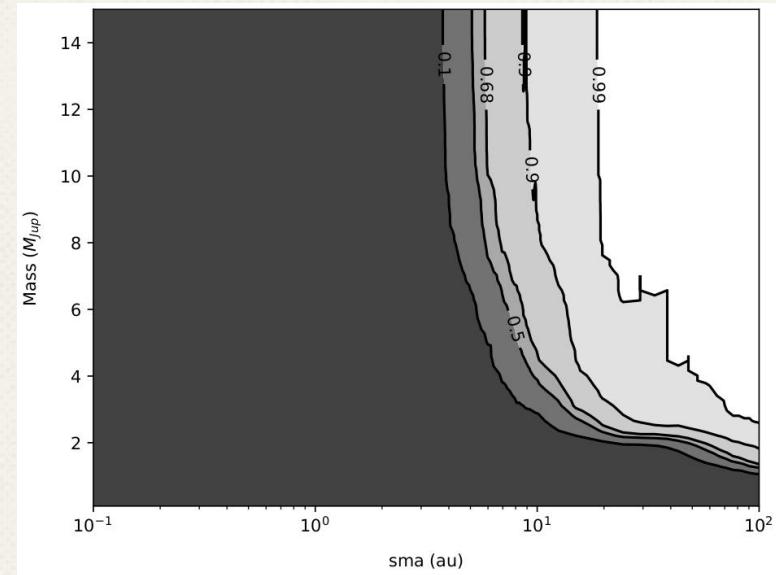


Results : detection limits using MESS2

HIP 1481, 2015-10-26, H23 band, DI only



HIP 1481, 2015-10-26 + 2016-09-18, H23
band, DI only

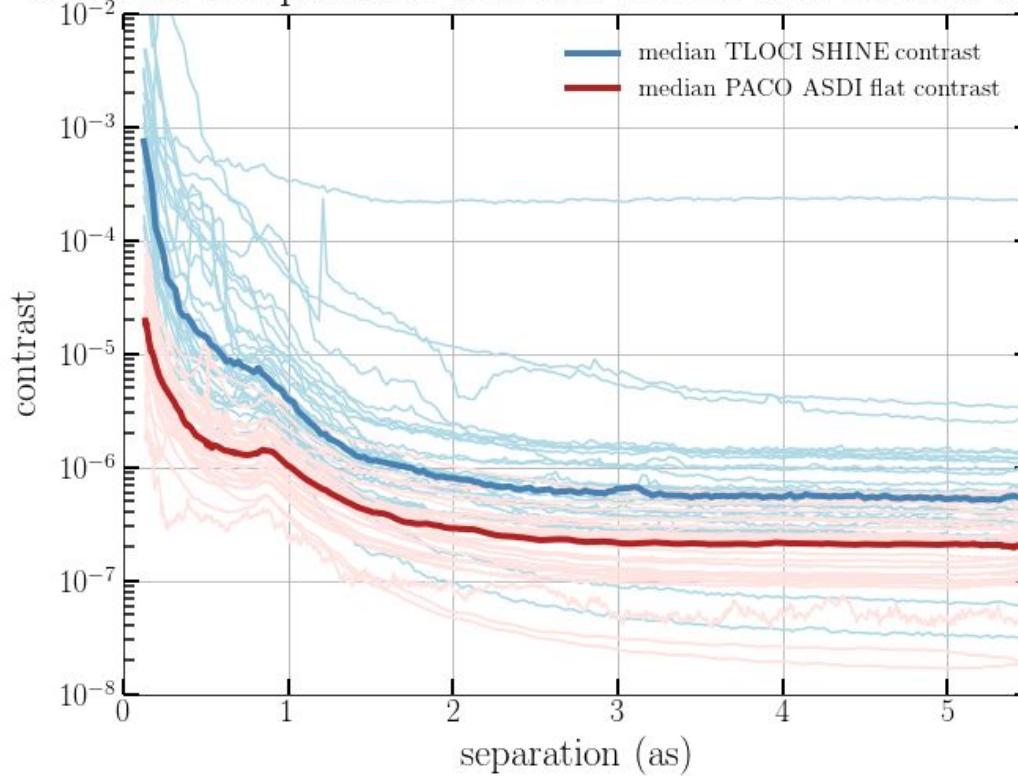


Forthcoming work

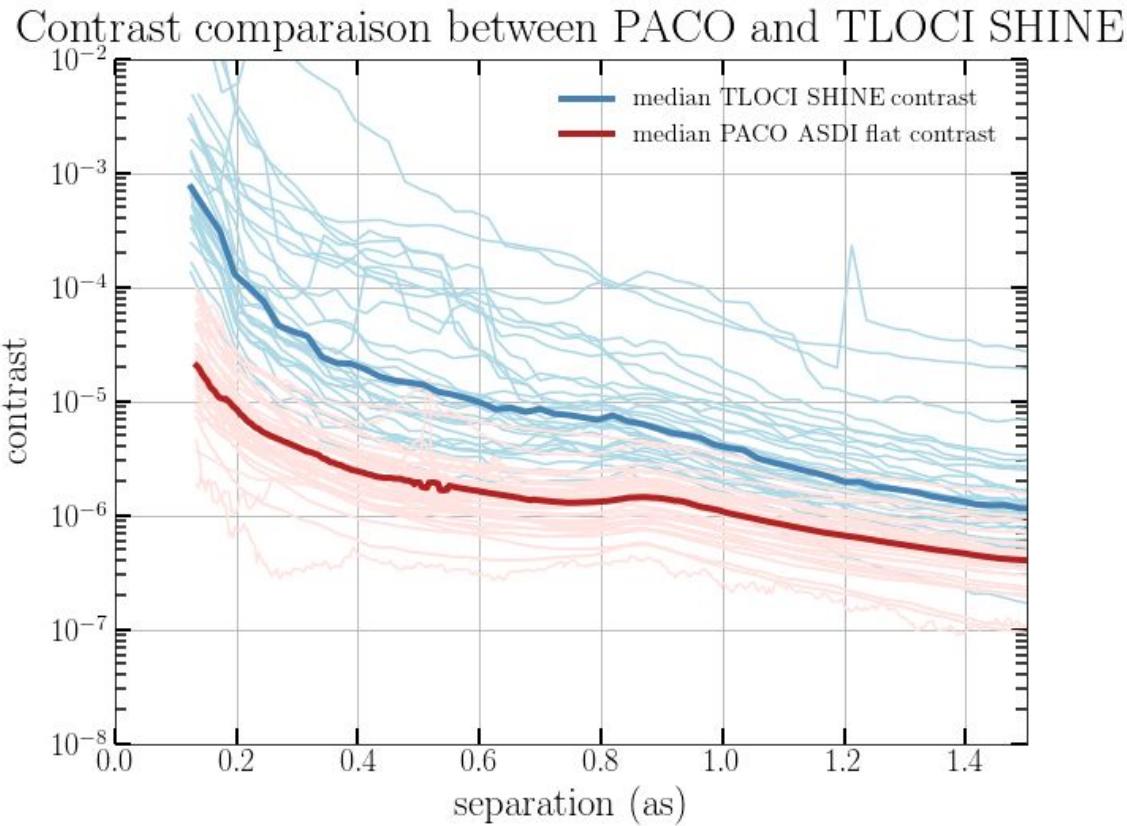
- PACO is the baseline algorithm to perform the F400 analysis
 - Re-analysis of the F150 IRDIS has begun
- The whole SPHERE archive

BACKUP SLIDE : contrast

Contrast comparaison between PACO and TLOCI SHINE

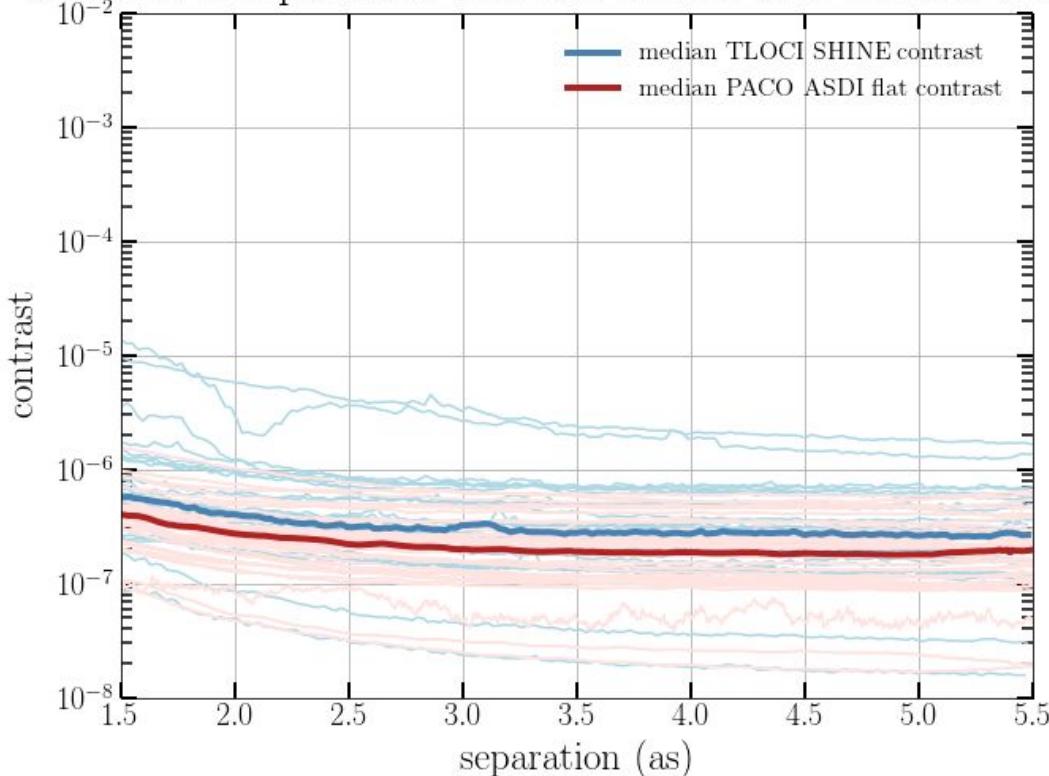


BACKUP SLIDE : contrast

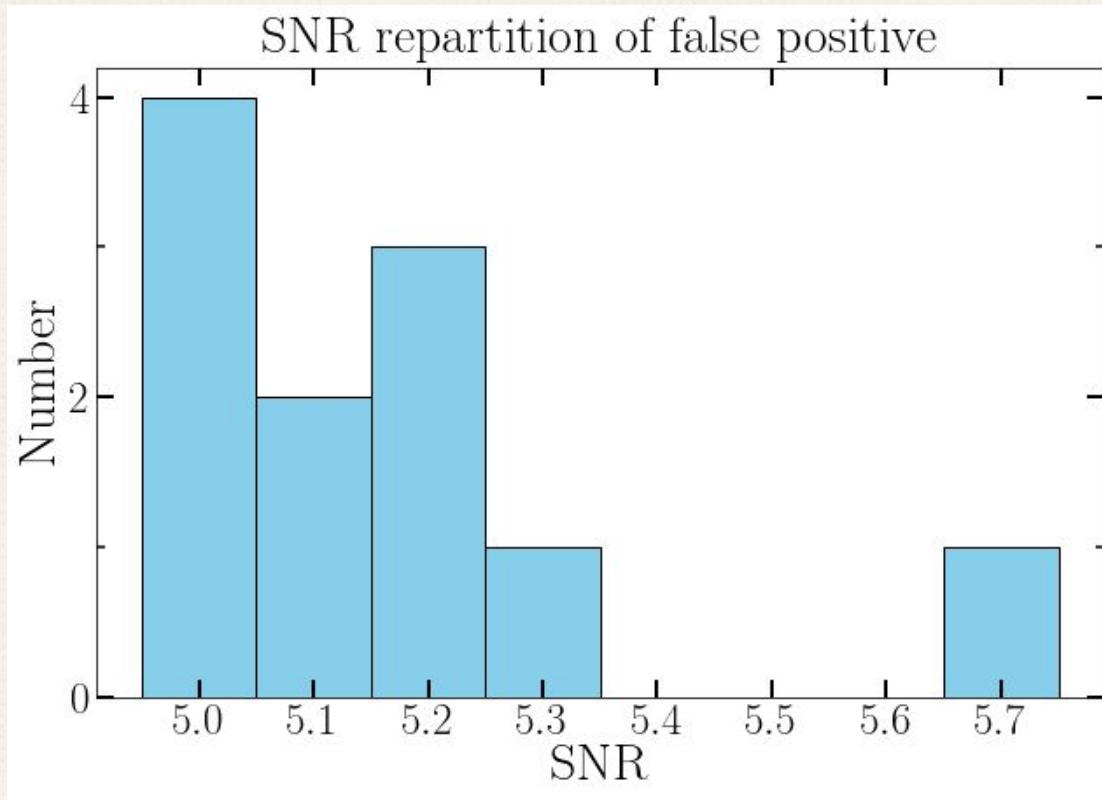


BACKUP SLIDE : contrast

Contrast comparaison between PACO and TLOCI SHINE



SNR of false positive



Contrast : All priors

