VFTS XI Meeting

High Contrast Imaging of Massive Stars

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Tenerife

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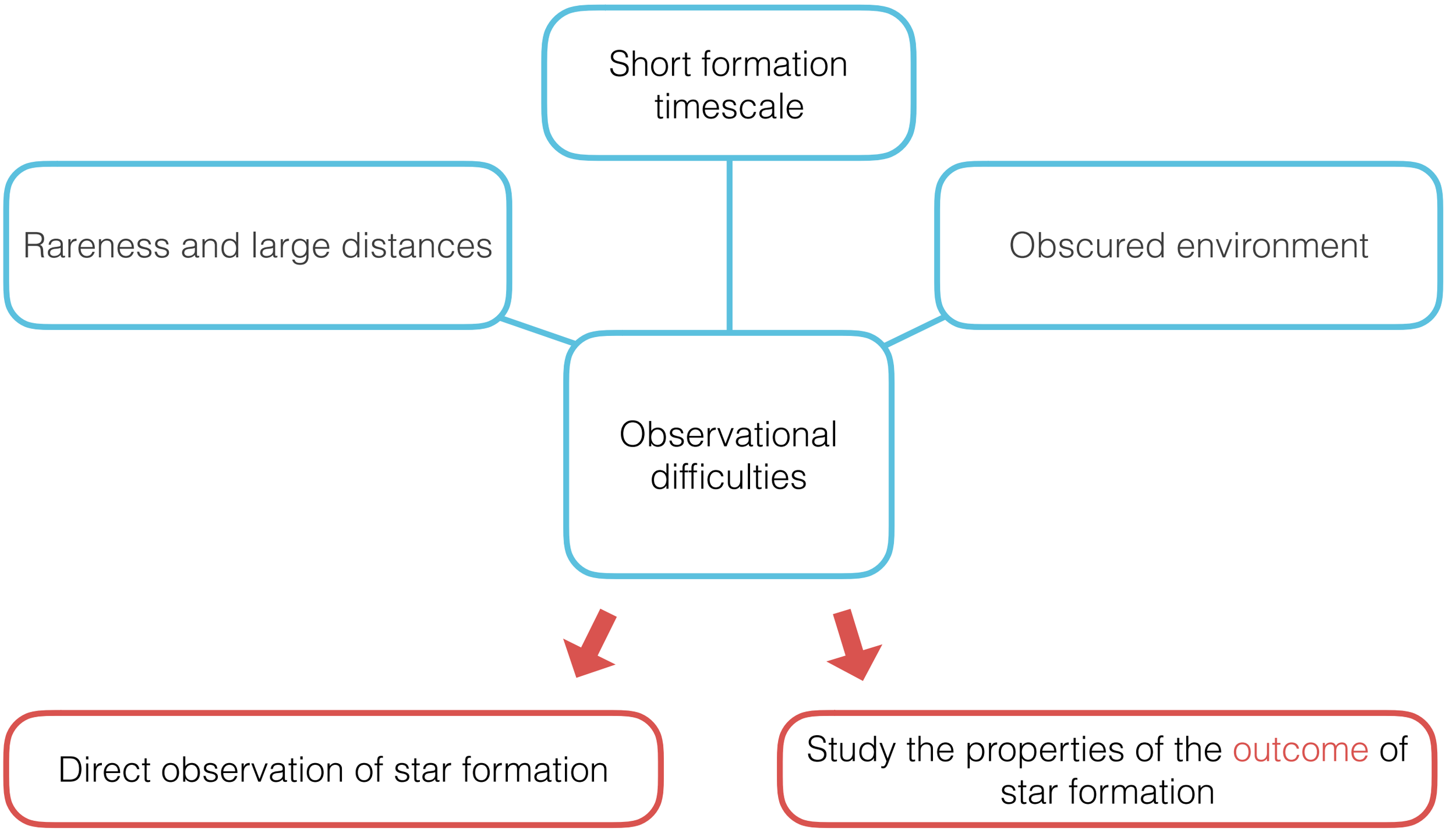
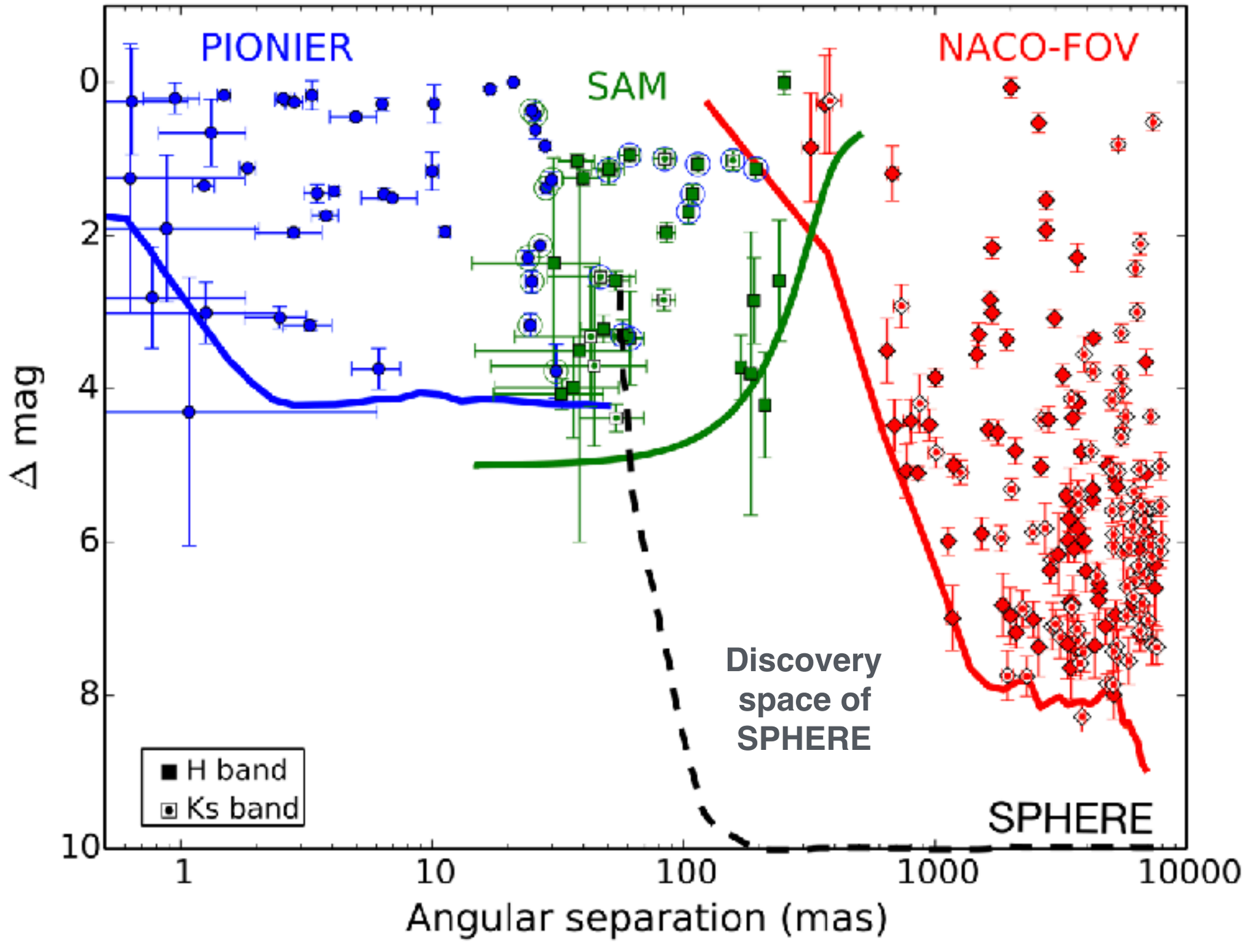
Massive Star Formation

Massive Star Formation Problems



Previous study

SMaSH+ (Sana et al, 2014)



From Sana et al, 2014

The Carina High-contrast Imaging Project of massive Stars (CHIPS)

CHIPS

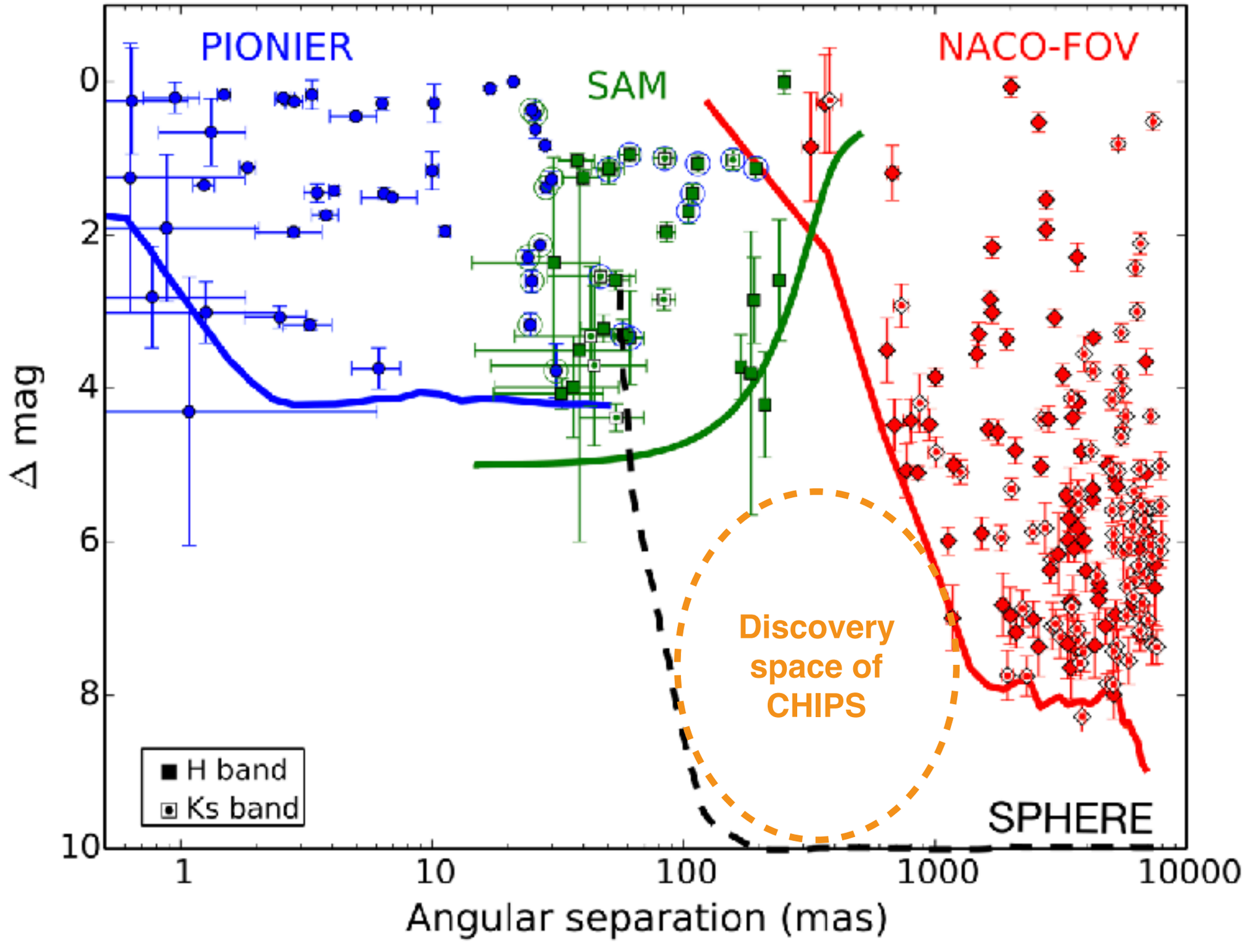
- Closest massive star region

- Multiplicity properties of 84 massive O and WR type stars

- Goal: find faint & low mass companions

- VLT/SPHERE in IRDIS/IFS modes

SMaSH+ (Sana et al, 2014)



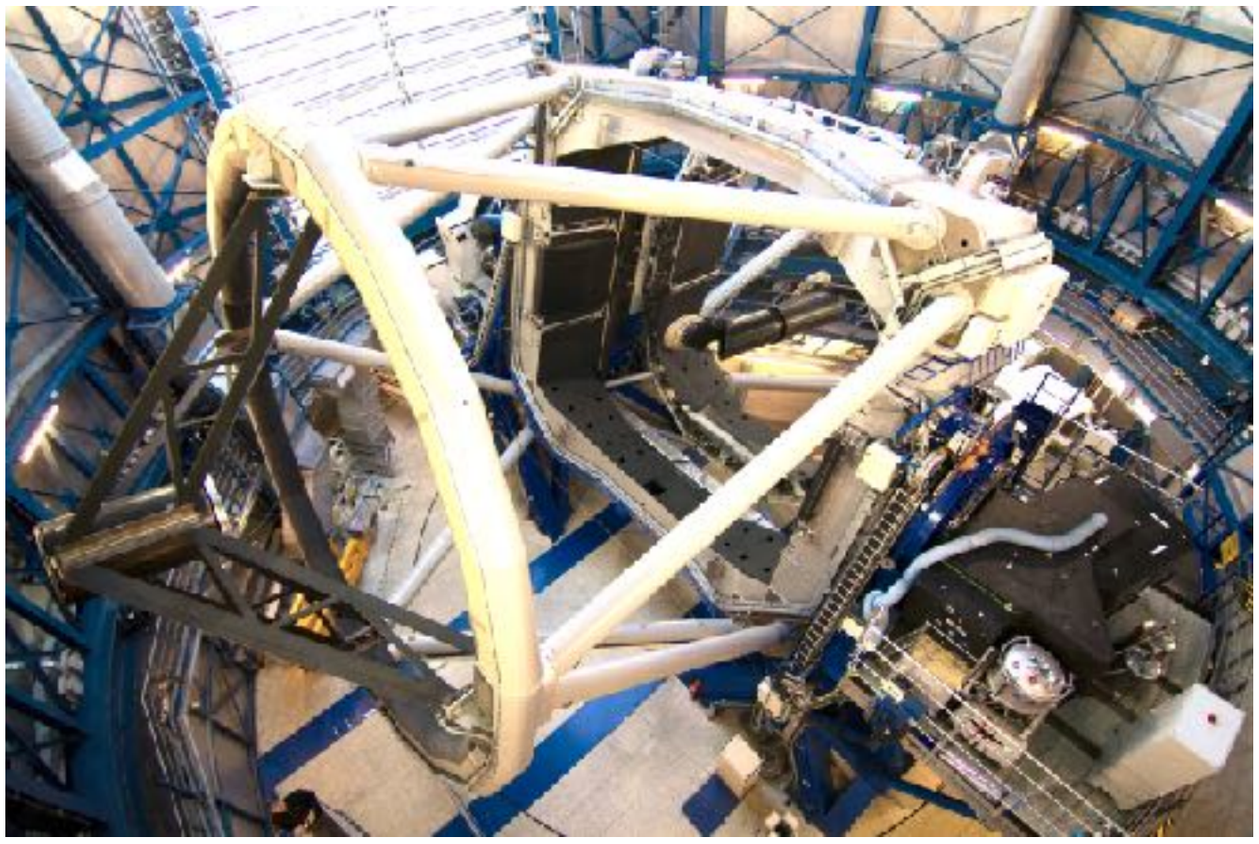
From Sana et al, 2014

The Data

SPHERE

- Extreme AO system coronagraphic facility

	IFS	IRDIS
Spectral Range (μm)	0.95-1.75	0.95-2.32
FOV (arcsec^2)	1.73	11
Pixel Scale (marcsec)	7.4	12.25
Bands	Y-J-H	K
Spectral resolution	50	350

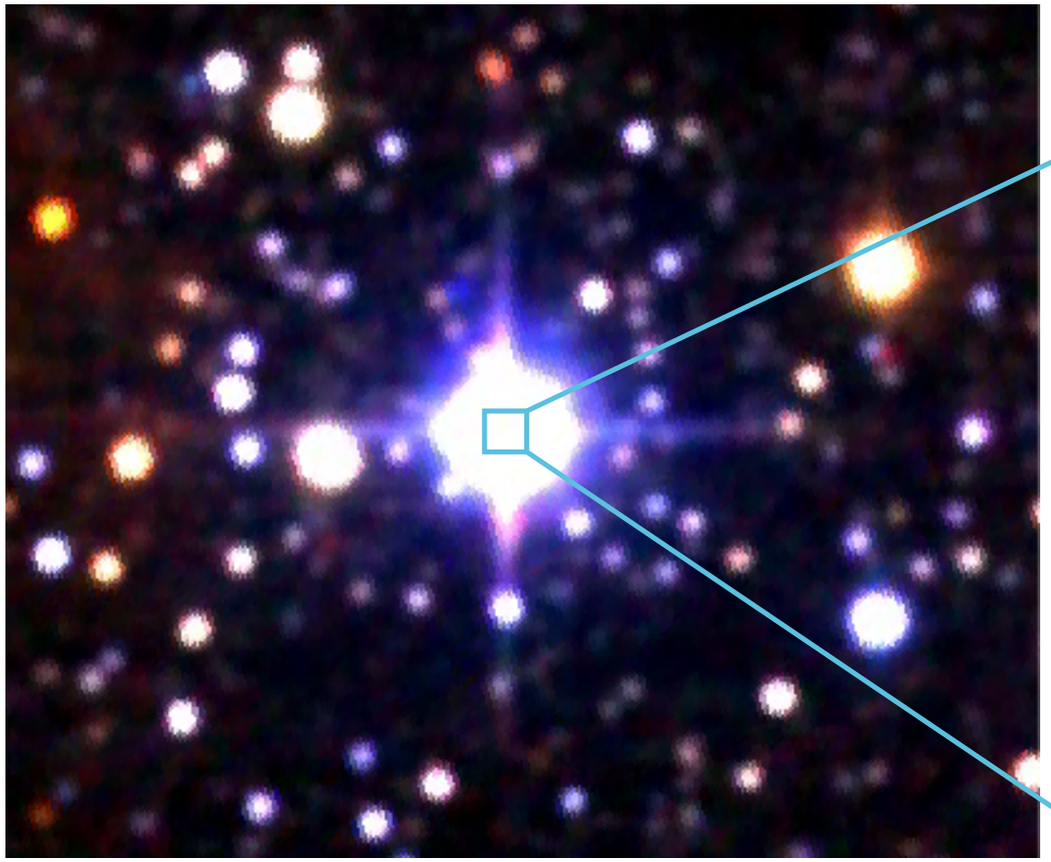


VLT Unit Telescope 3 with SPHERE installed, credit: ESO/J.Girard

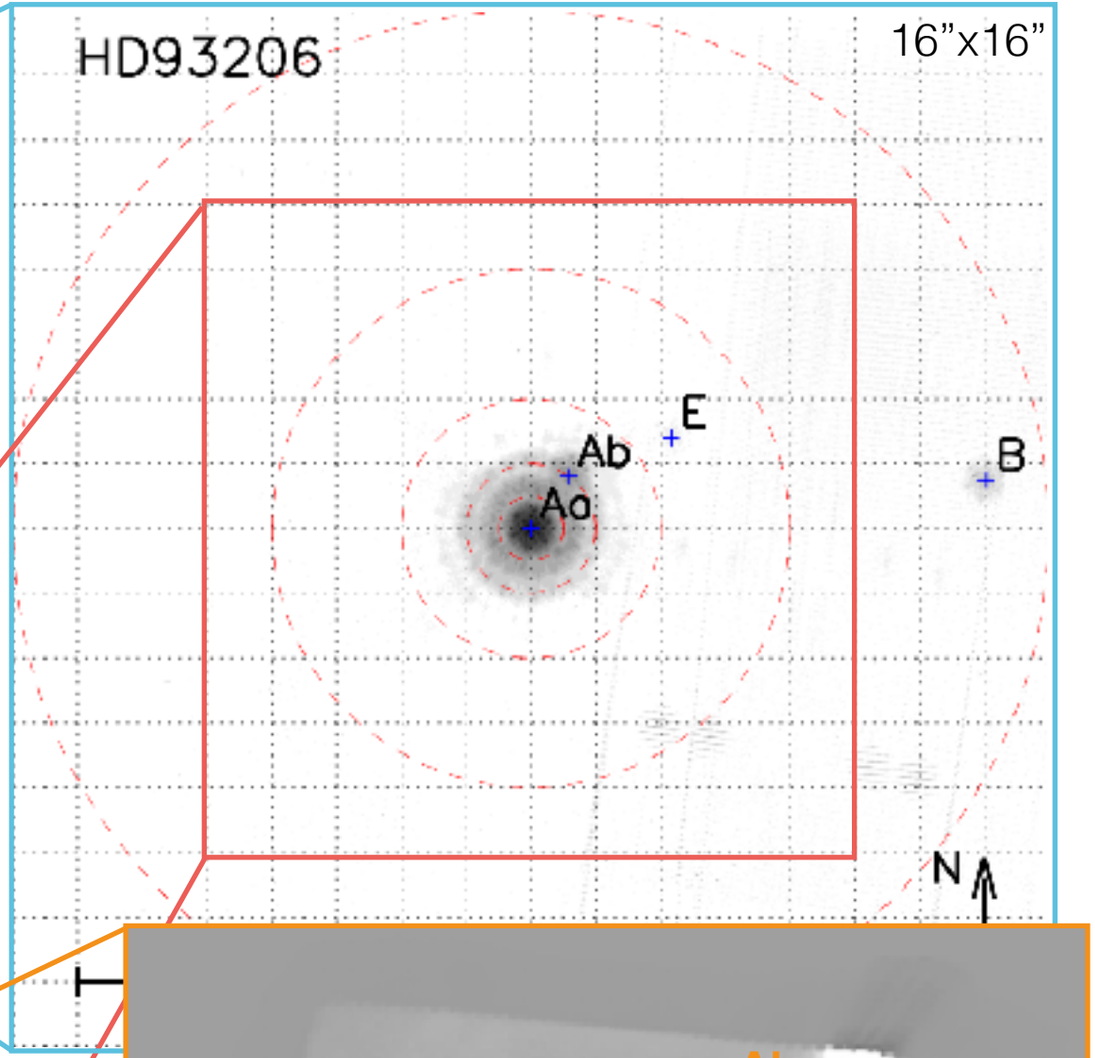
➡ 4D data cube + PSF: 2D coordinates, wavelengths, rotation angle

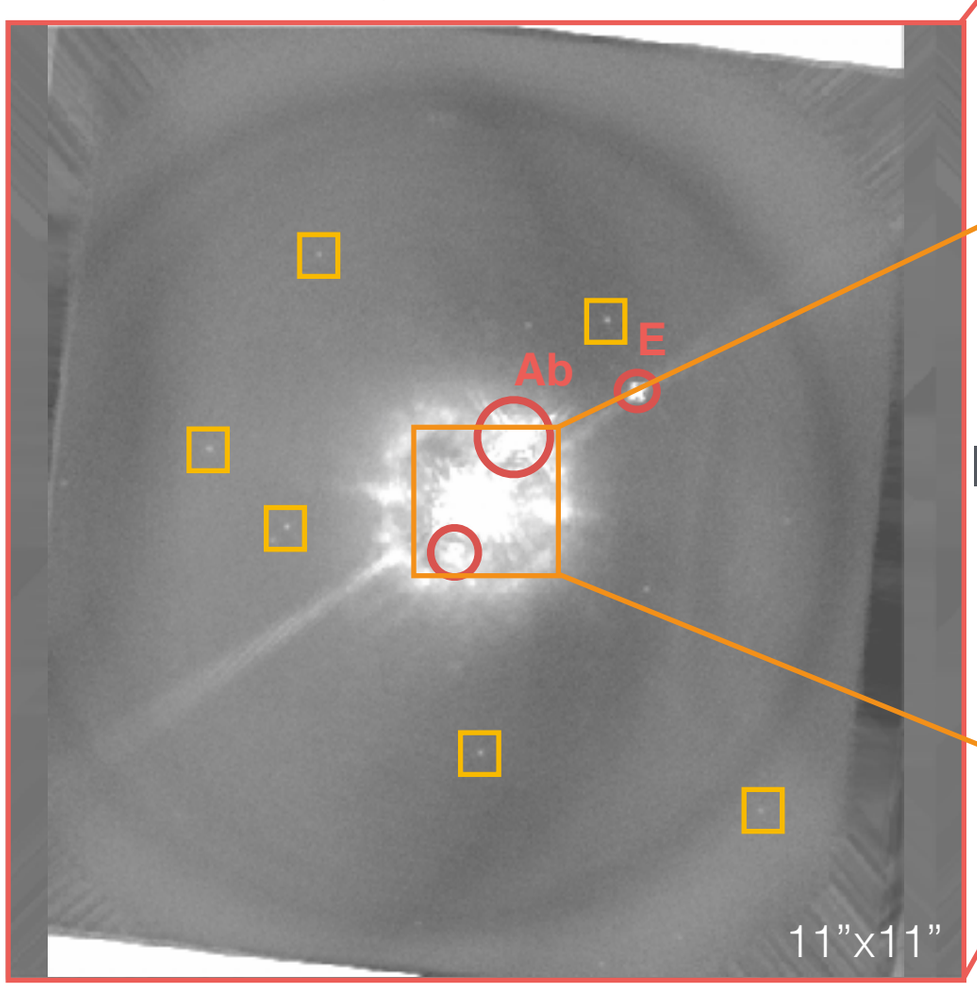
Data analysis

QZ Car (HD 93206)



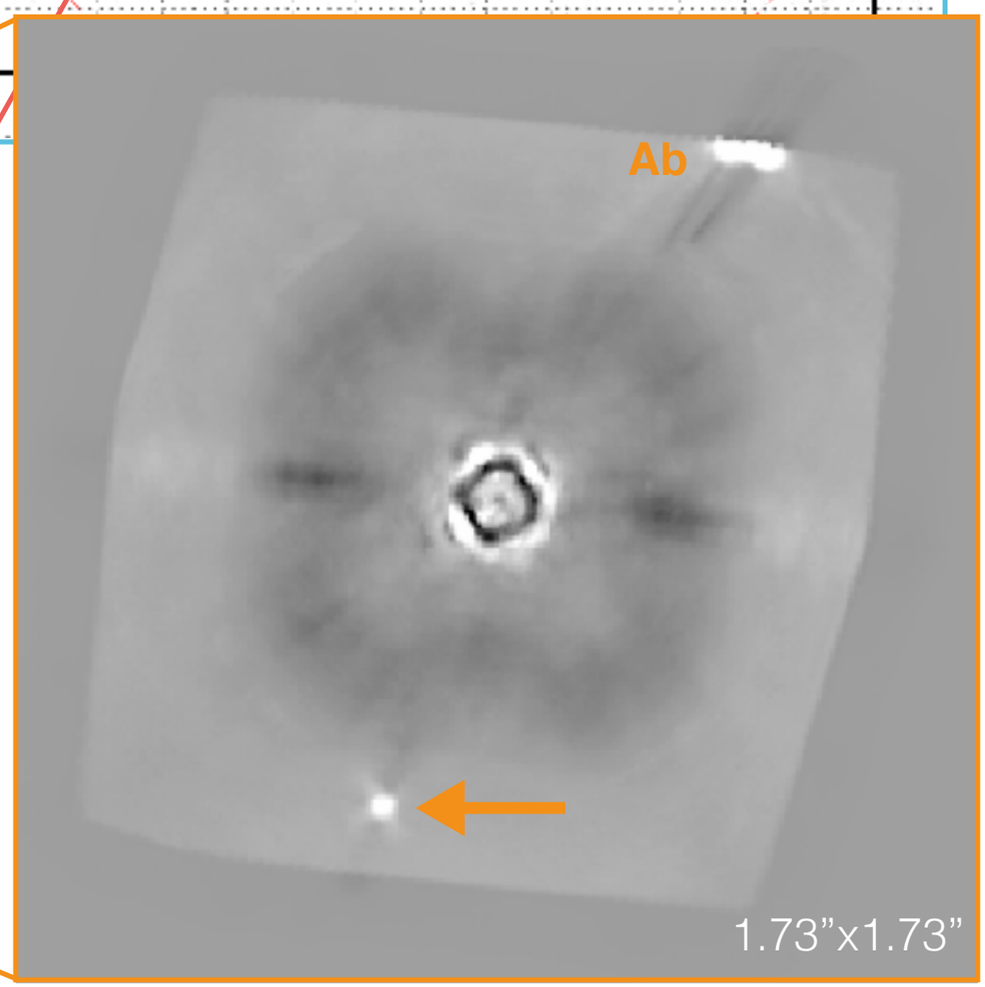
FOV = 5’, 2MASS



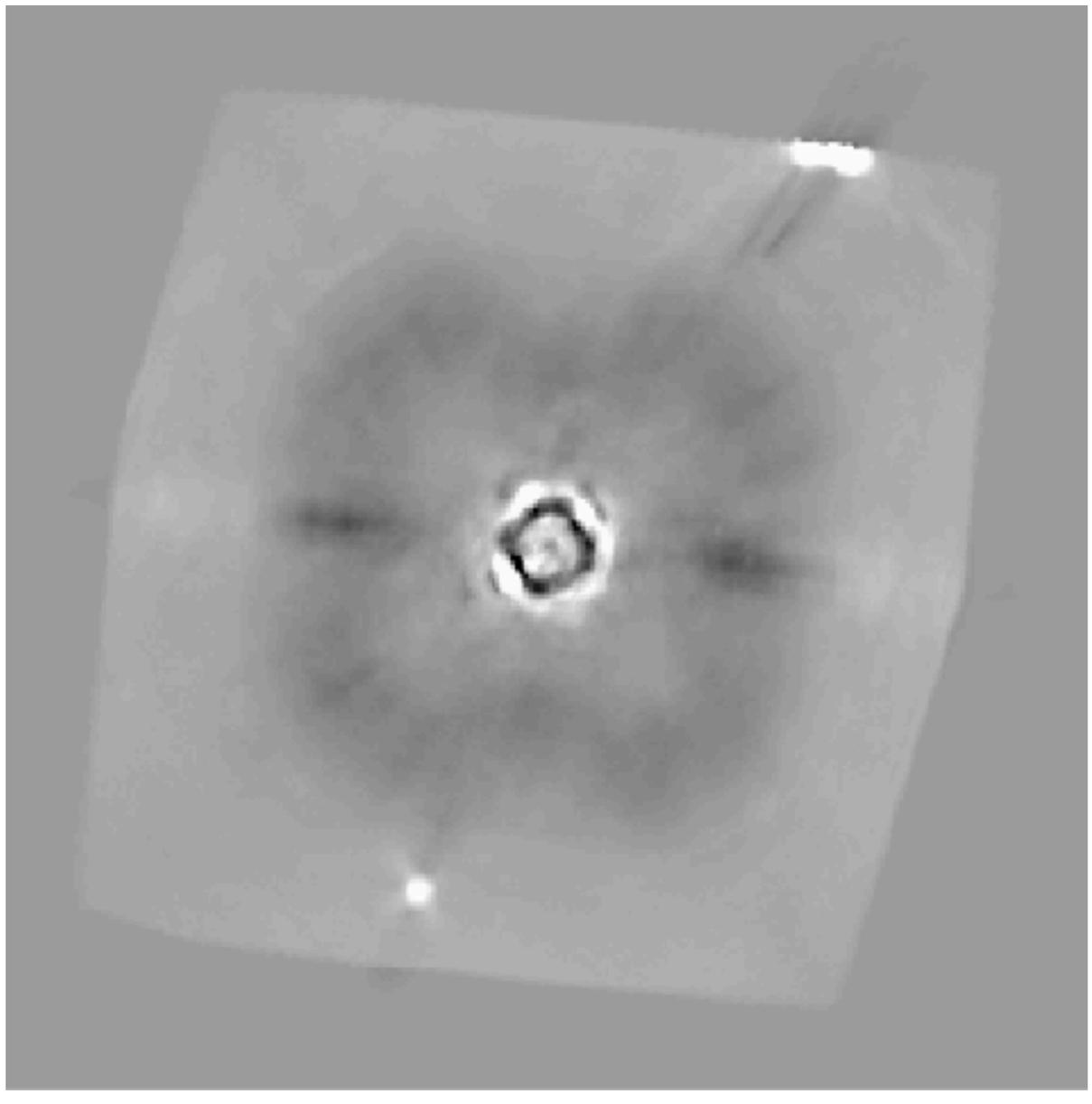


IRDIS

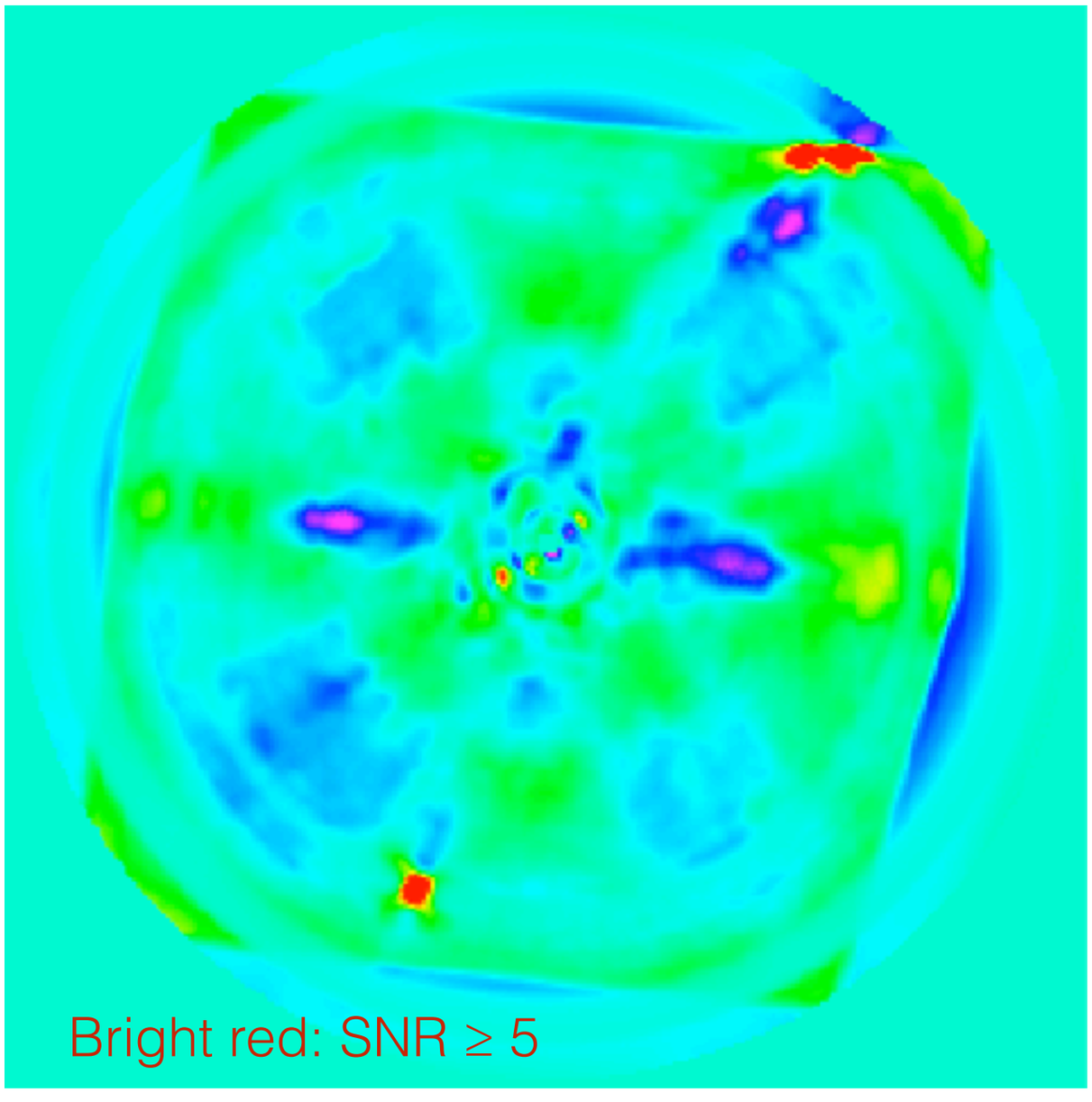
IFS



Detection method

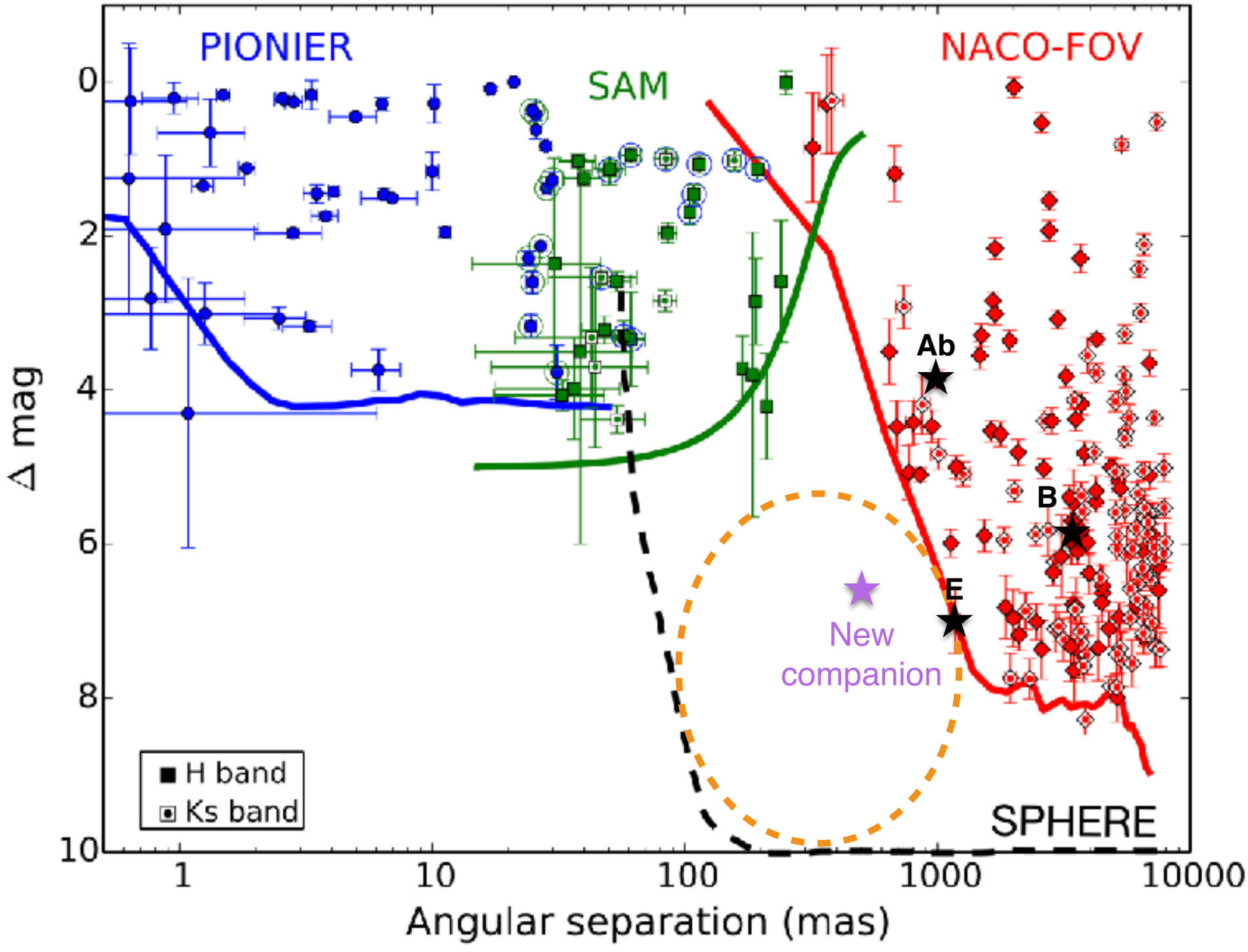


Derotated and wavelength collapsed image



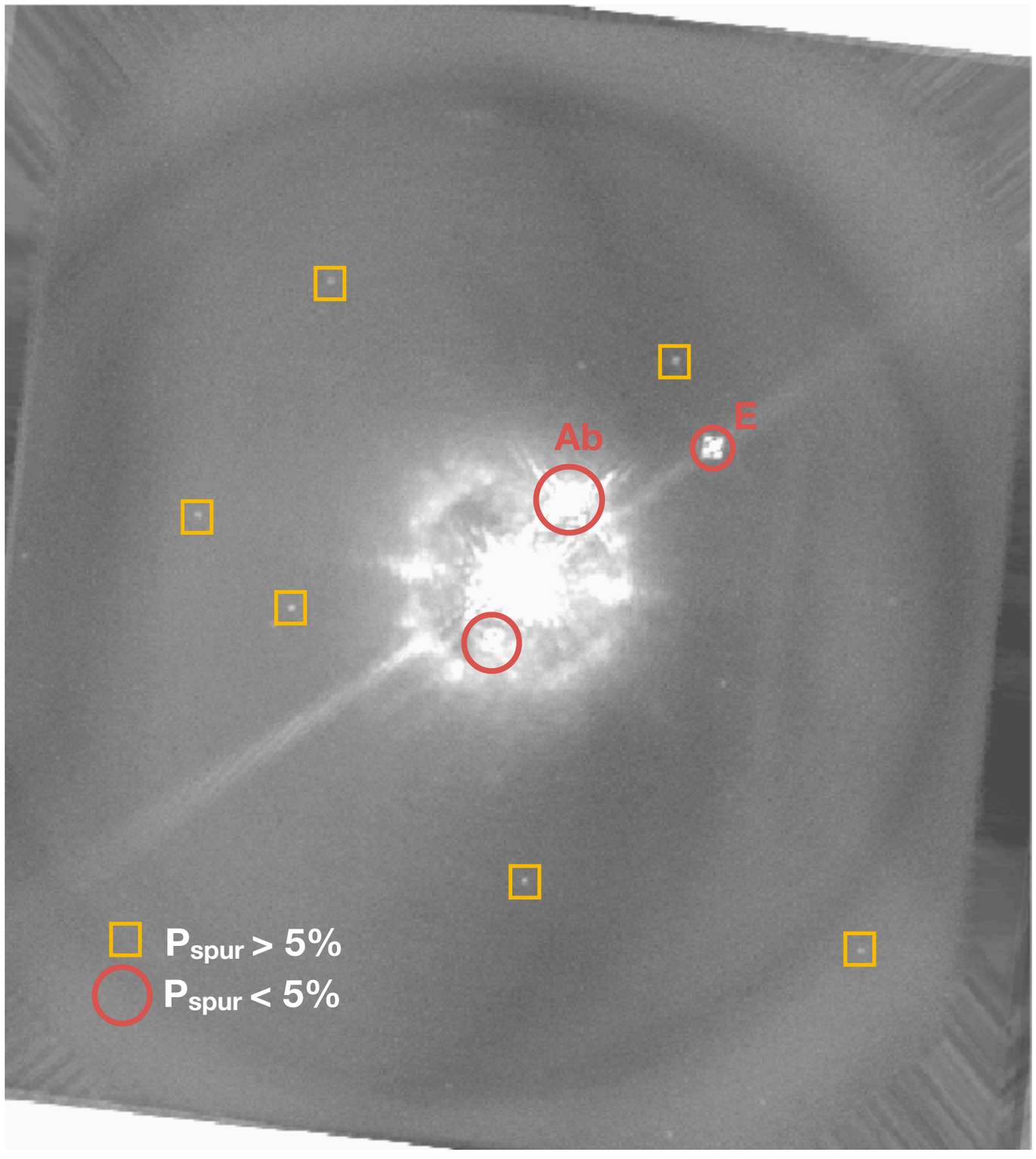
SNR map

SMaSH+ (Sana et al, 2014)



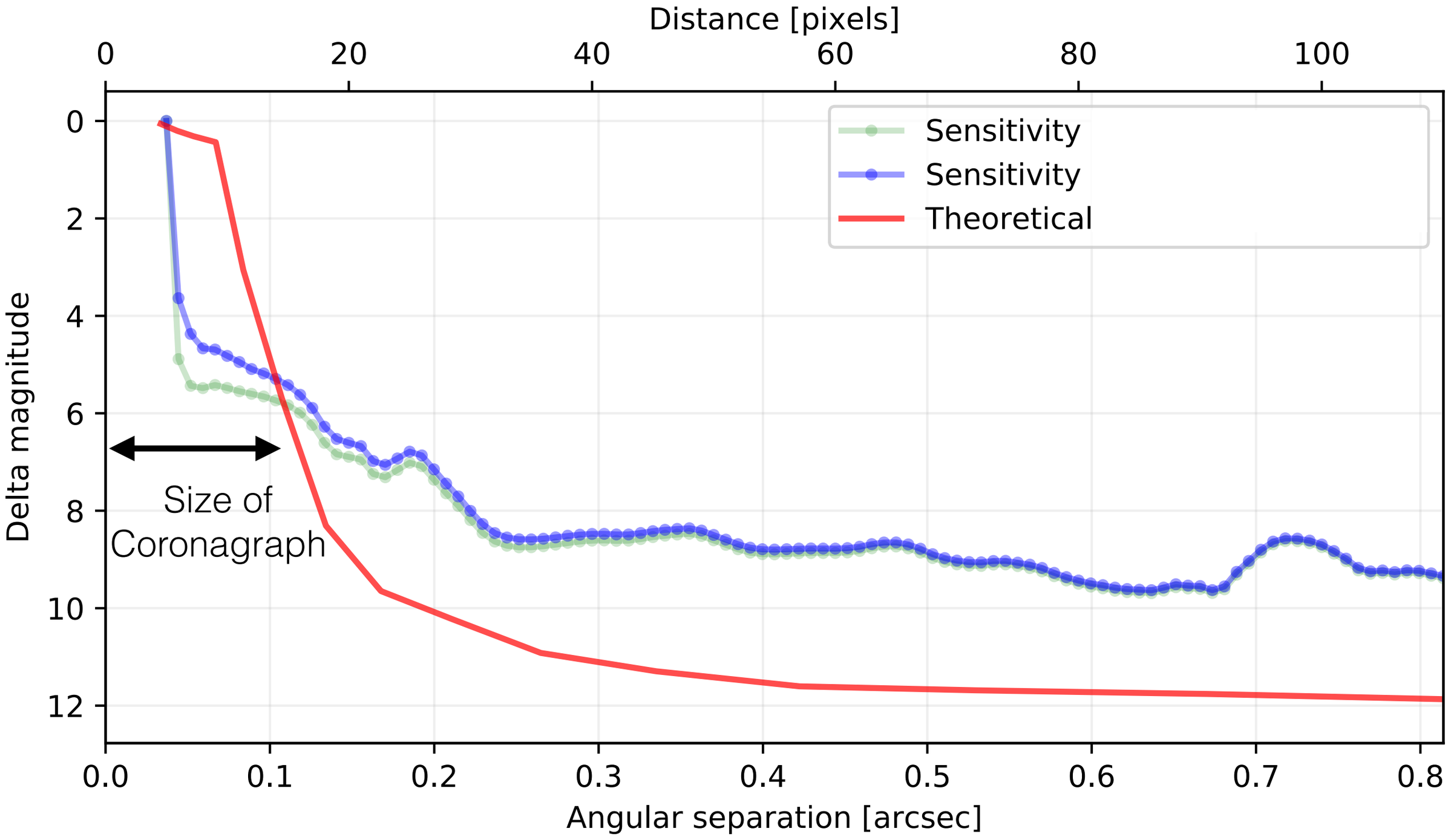
Adapted from Sana et al, 2014

IRDIS



Needs verification

Contrast Curves



Spectrum Extraction

Analysis Techniques

- ADI: Angular Differential Imaging
- SDI: Spectral Differential Imaging
- RDI: Reference star Differential Imaging

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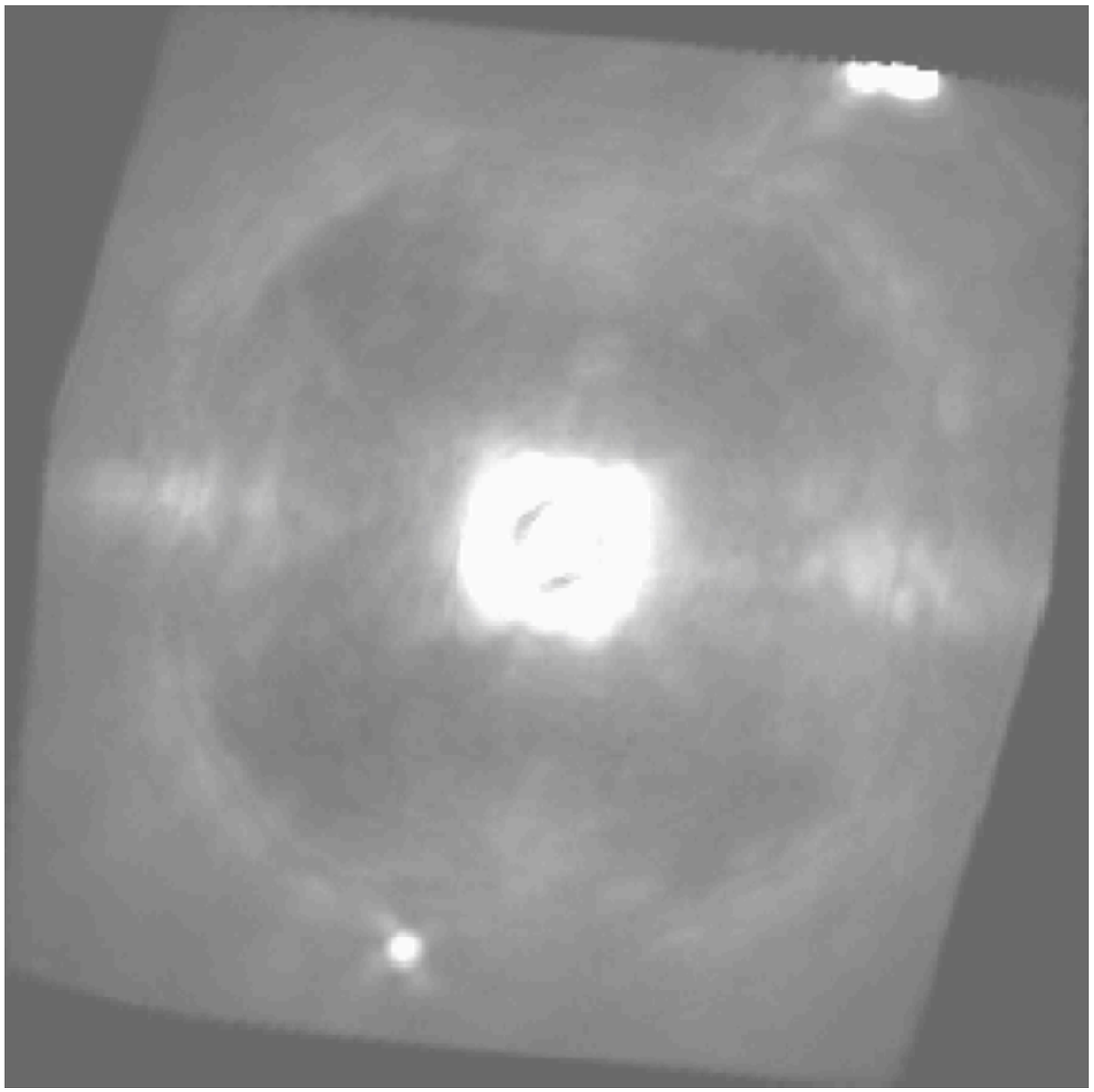
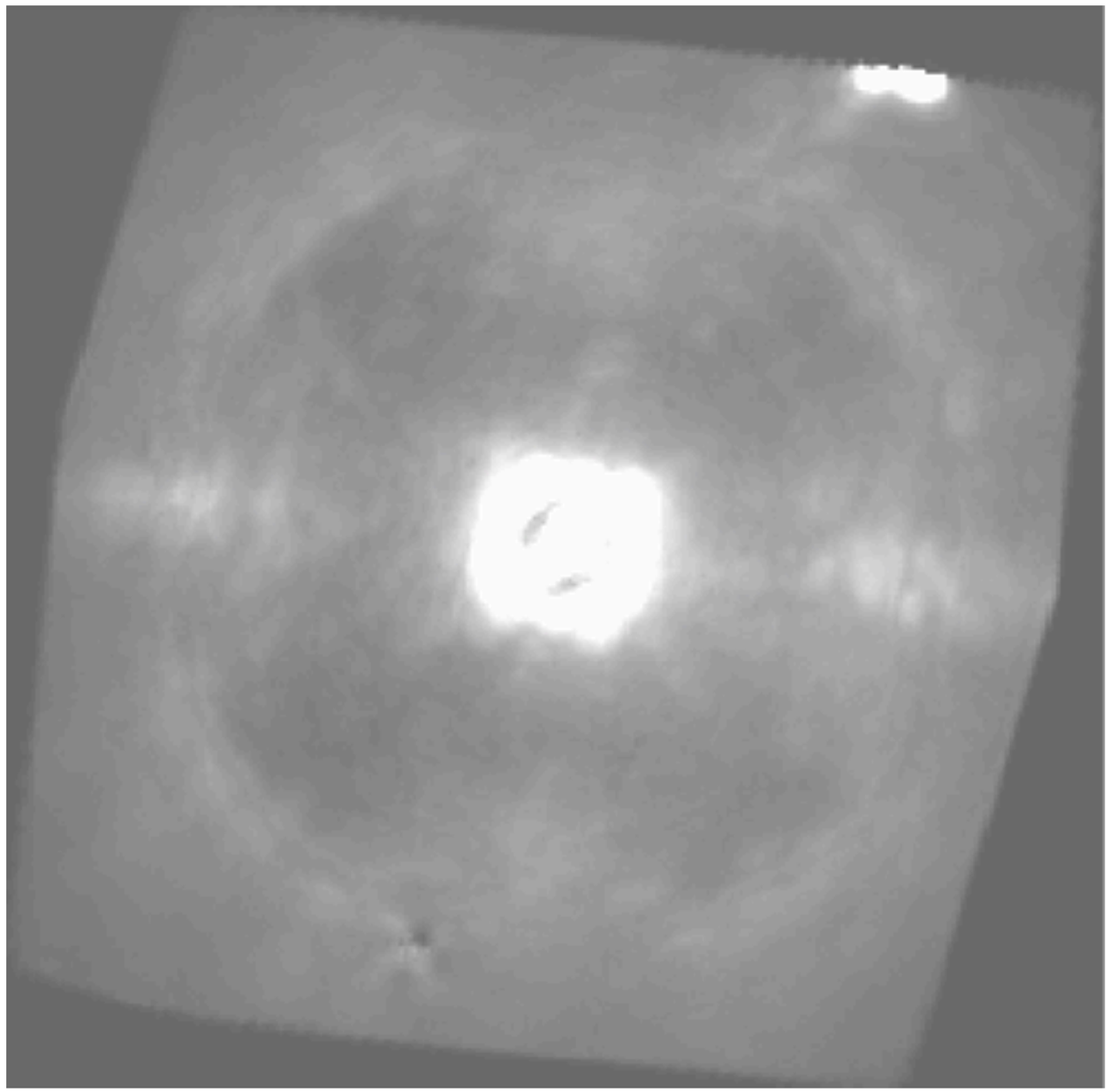
- ADI: Angular Differential Imaging
- SDI: Spectral Differential Imaging
- RDI: Reference star Differential Imaging
- PCA: Principal Component Analysis
  - ➡ Reference PSF subtraction
  - ➡ Spectrum Extraction: Negative fake companion & MCMC

Negative Fake Companion

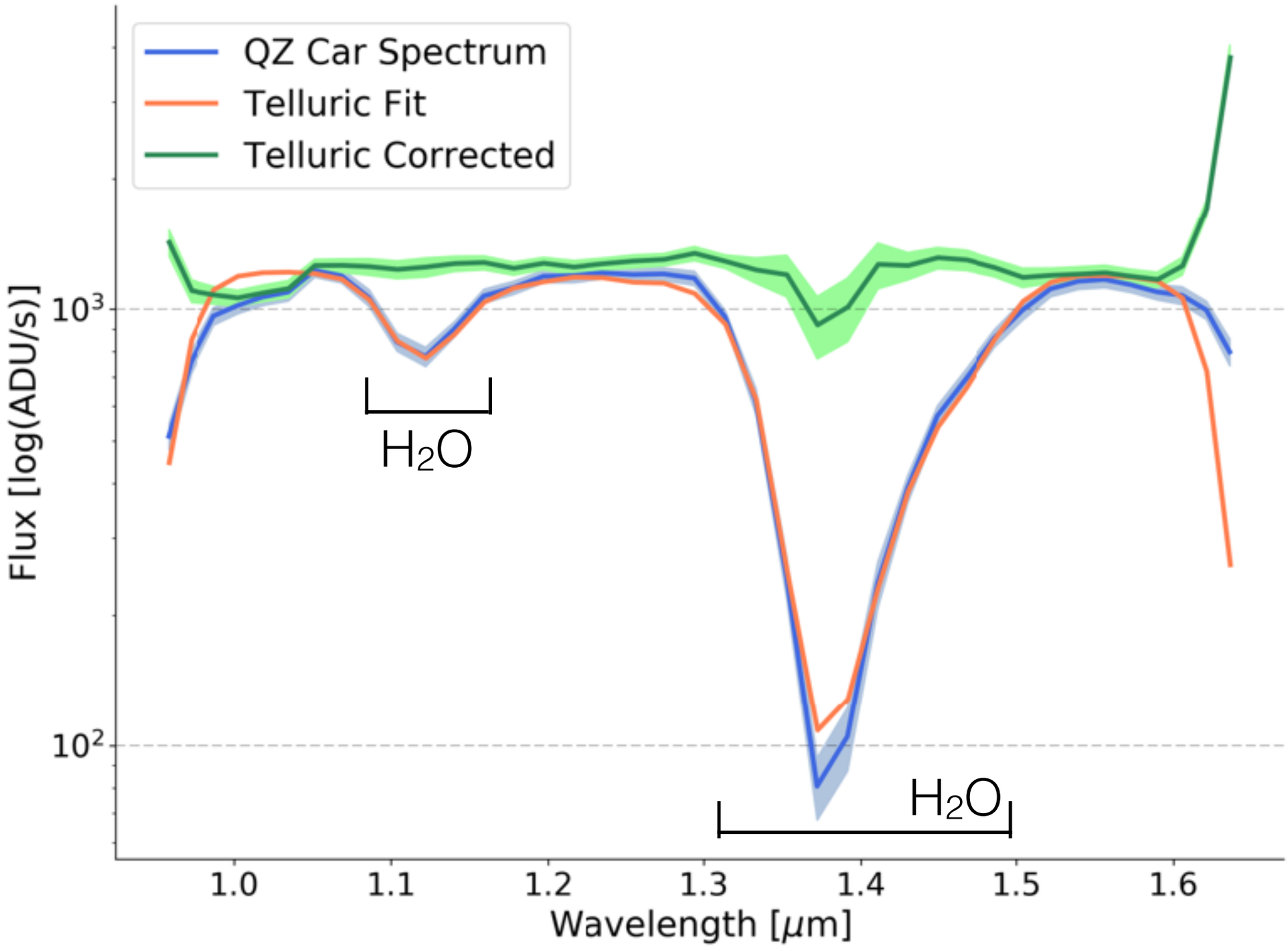


Collapsed image



NEGFC technique applied

PSF Fitting


QZ Car Spectrum
Telluric Fit
Telluric Corrected
Flux [log(ADU/s)]
10^3
10^2
H_2O
H_2O
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Wavelength [μm]

Multiplicity Results - IFS

Images	Visible companions (SNR > 5σ)	Candidates (5σ > SNR > 3σ)
28	6	12

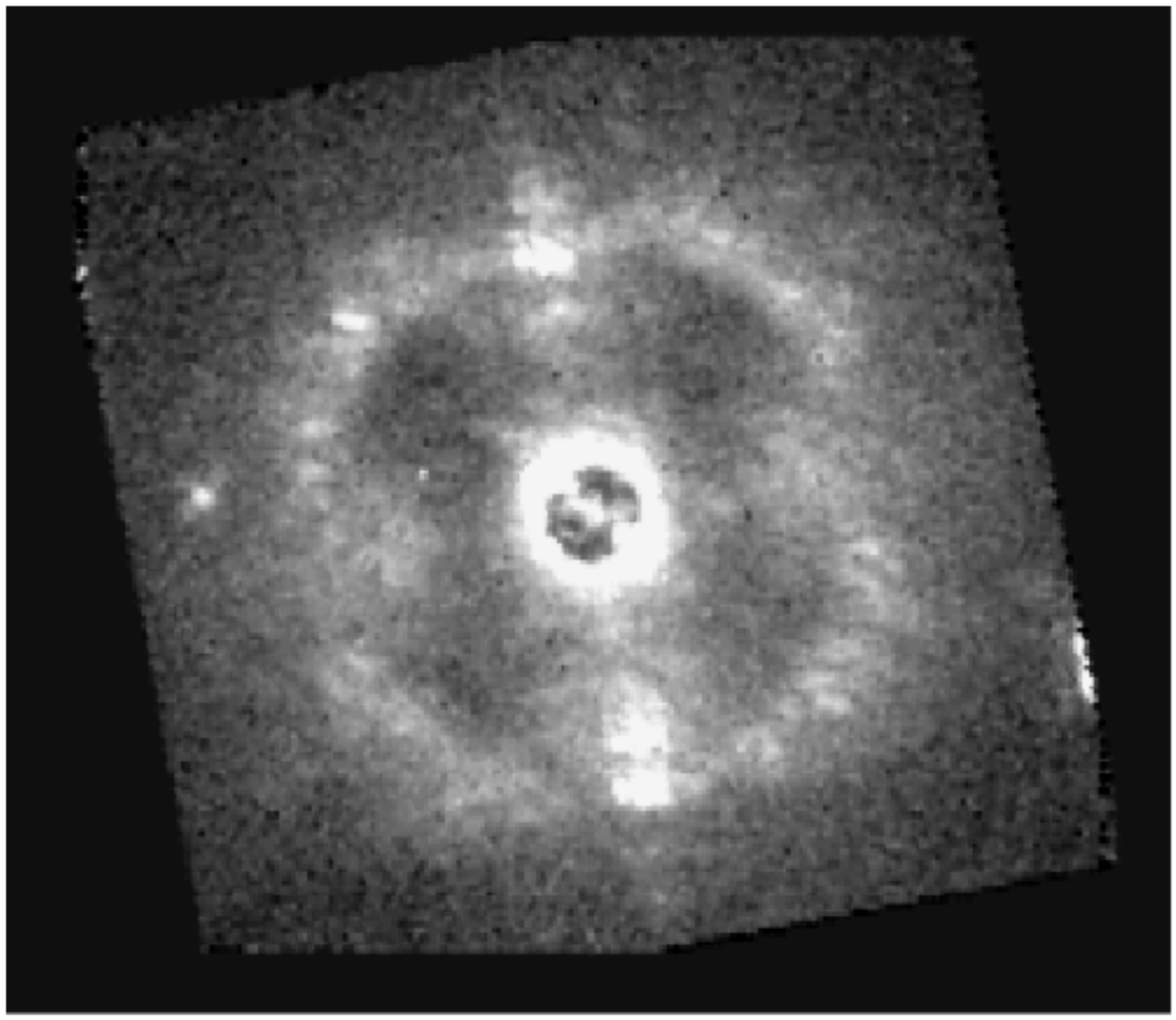
- Detection ratio ≃ 0.42 companions/star
- Expected ≃ 35 companions / 84 images

Further Work

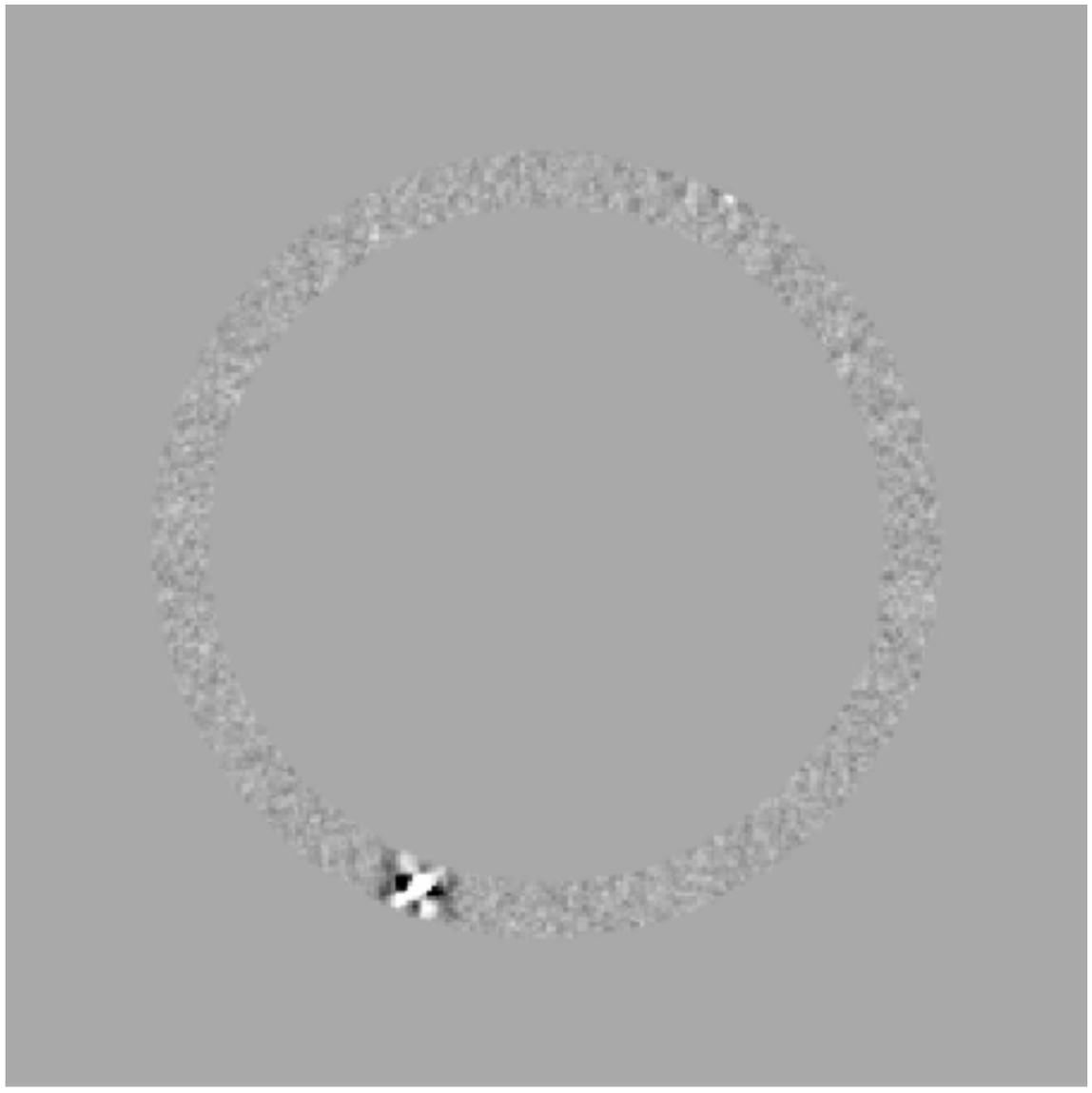
- Use FASTWIND to model QZ Car - the central 4-star system
- Characterise companion propreties
- Apply techniques to full dataset
- Obtain remaining 56 stars with SPHERE

➡ Use database to look for multiplicity properties

Analysis Techniques



Original image



Post-processed cube