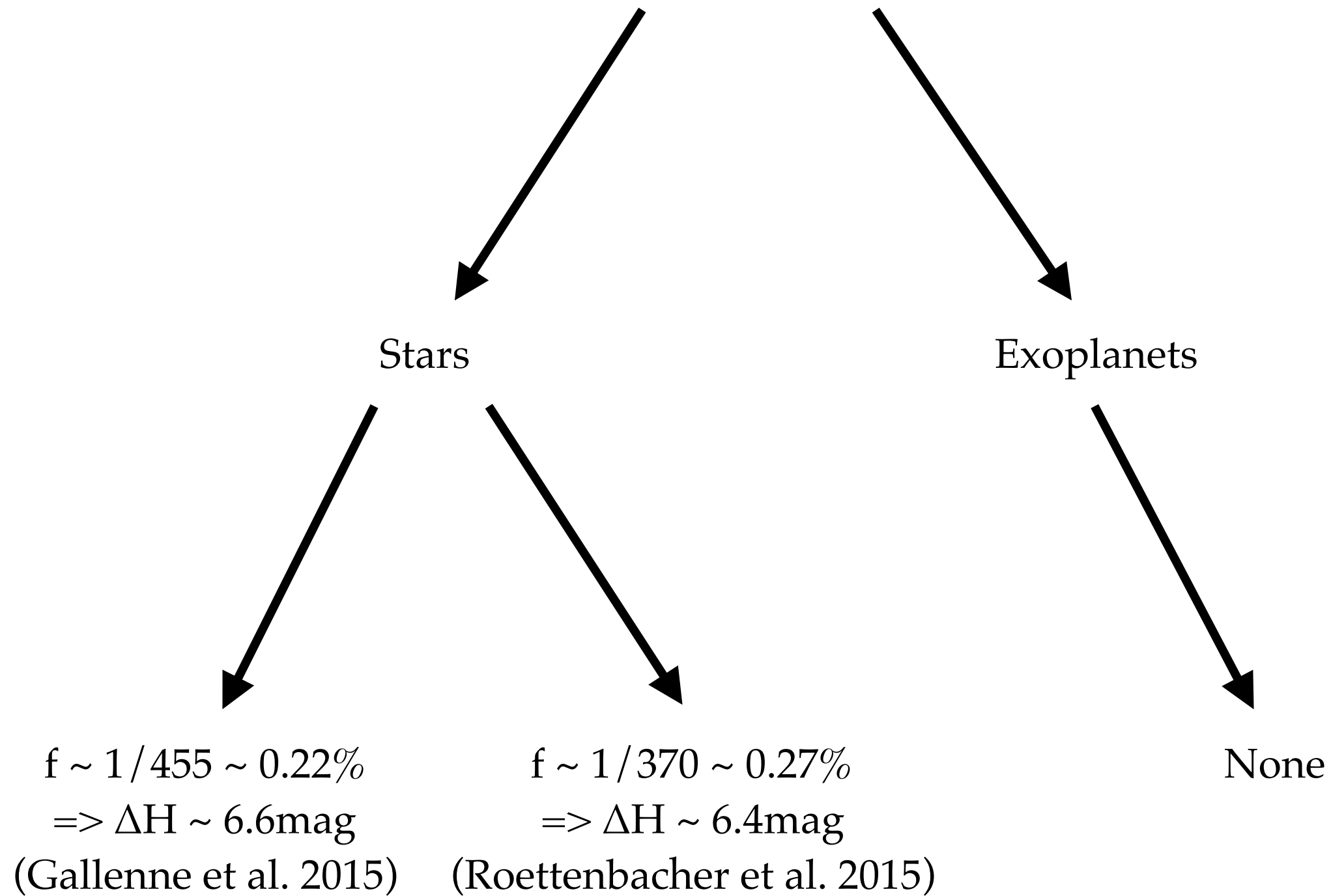


Detection limits with PIONIER, MIRC and GRAVITY

Alexandre Gallenne
(ESO Chile)



What is the faintest companion we detected so far from interferometry?



Main limitations?

Telescopes size

Telescopes baselines

Instrument
sensitivity and
dynamic range

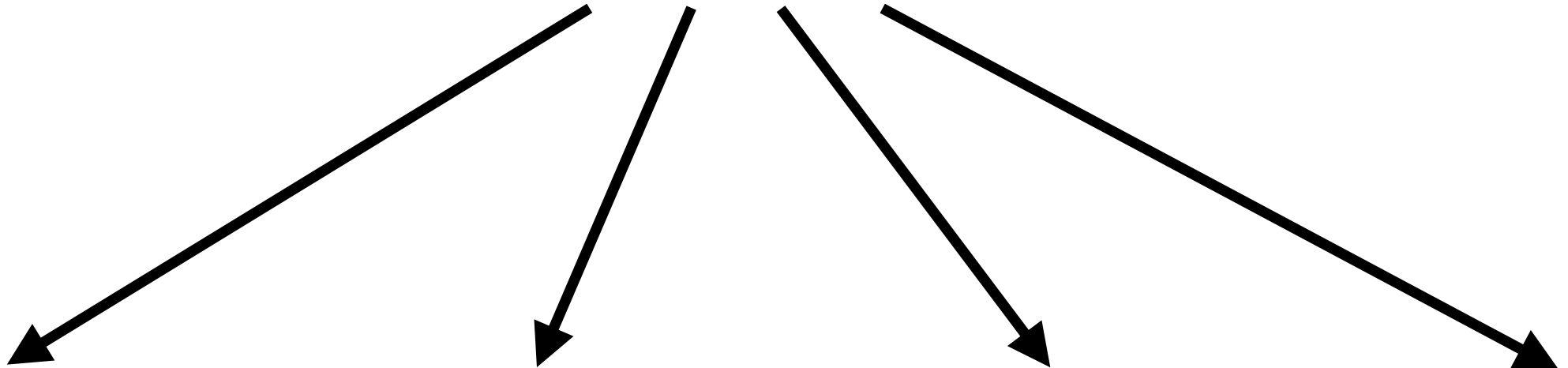
Interferometer
stability

Higher SNR

More simultaneous
data, better (u,v)
coverage

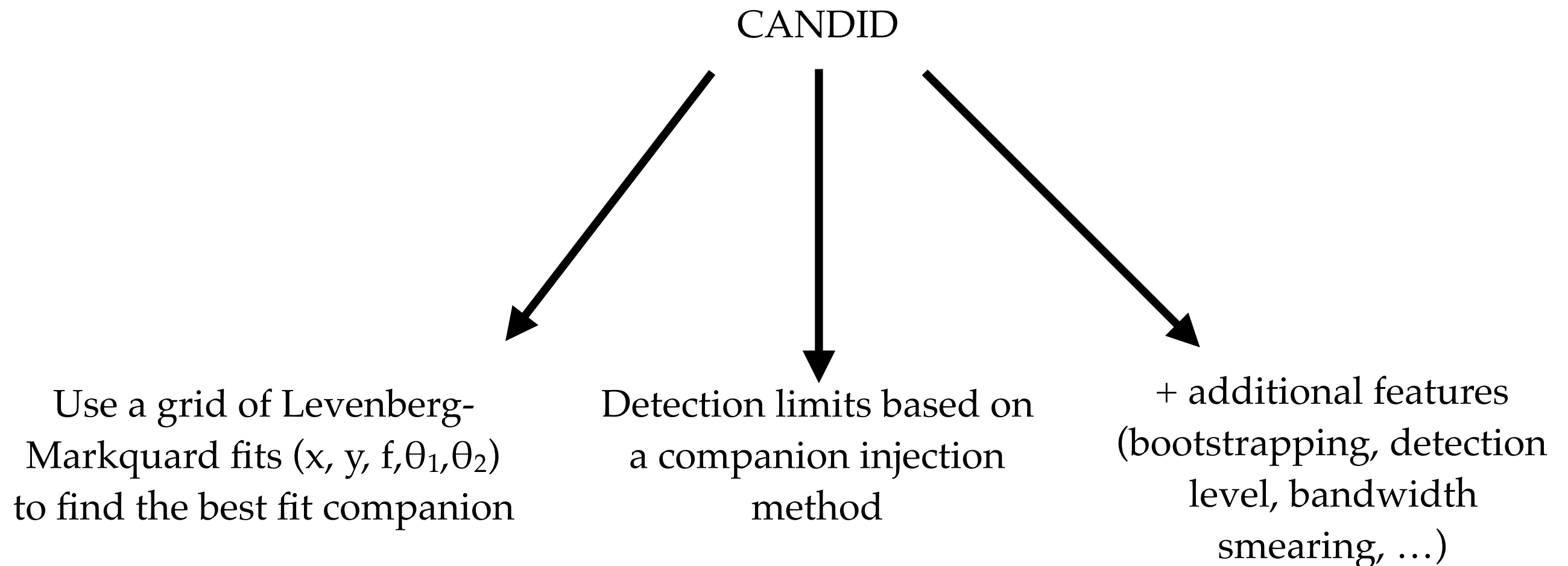
Fainter magnitude
limits and higher
contrasts

No vibrations, no
polarization effect,
...



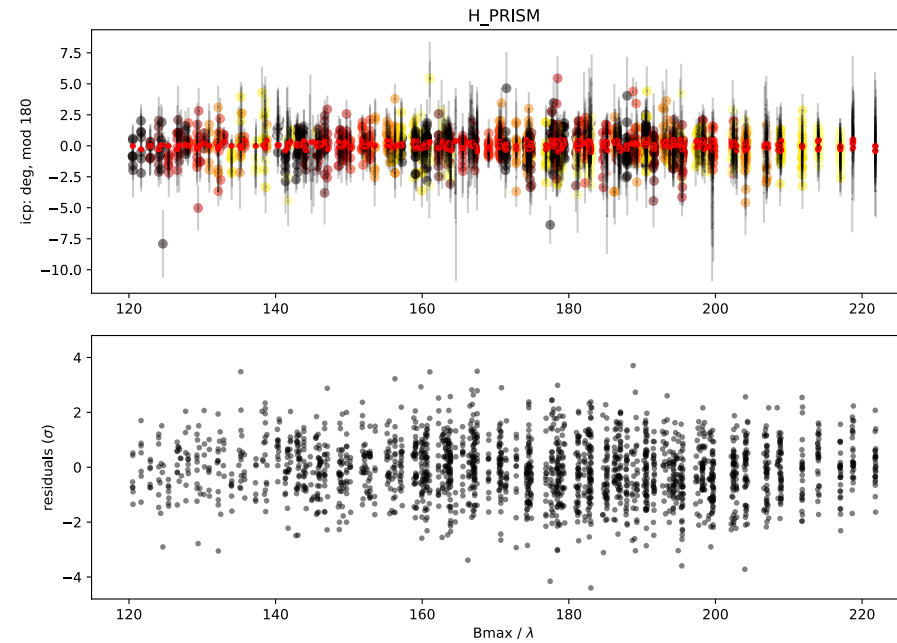
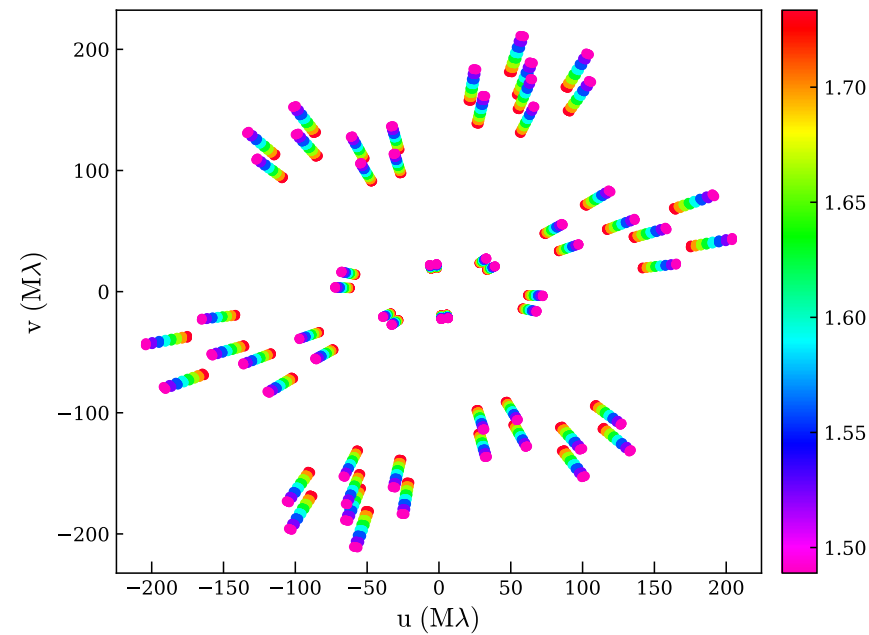
Detection limits of companions

- We use the CANDID tool (Companion Analysis and Non-Detection in Interferometric Data) —> Gallenne et al. (2015, A&A, 579, A68)

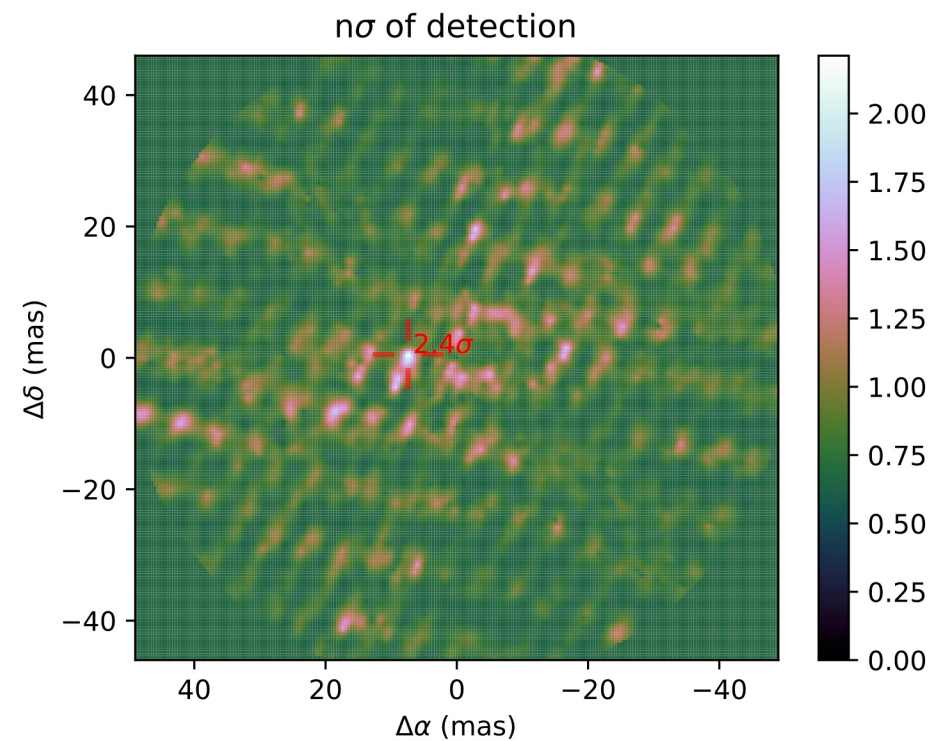
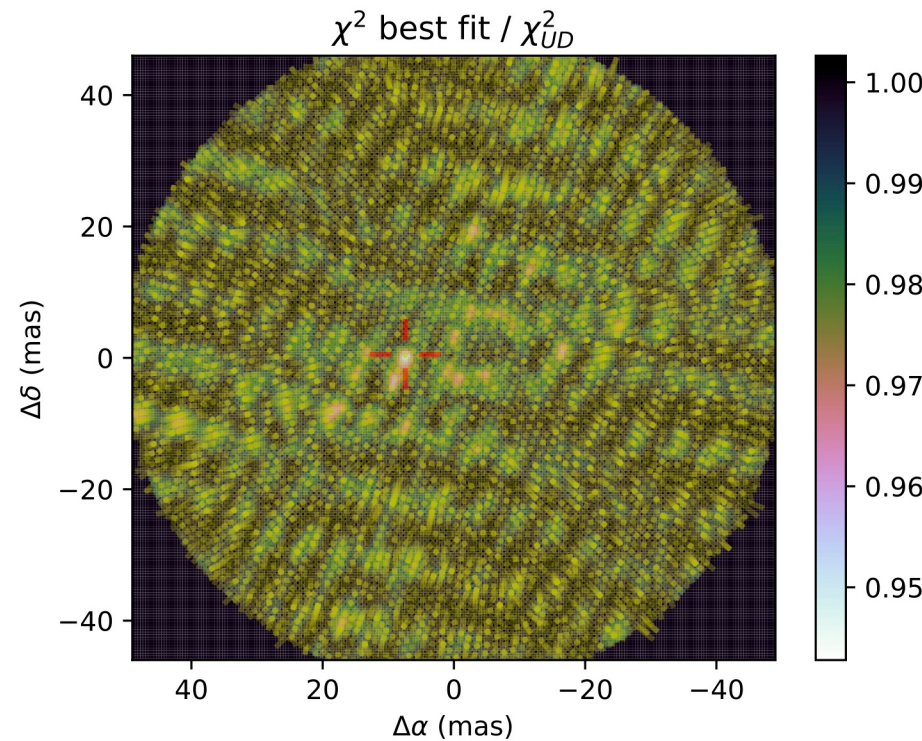


MIRC

- Cepheid T Vul, $H = 4.4\text{mag}$, $2 \times 15\text{mn}$ on target:

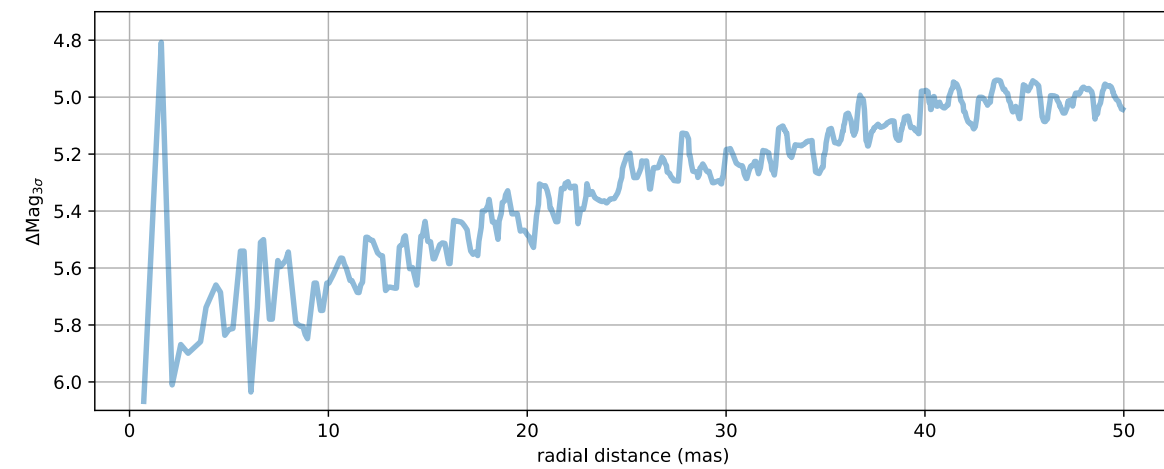
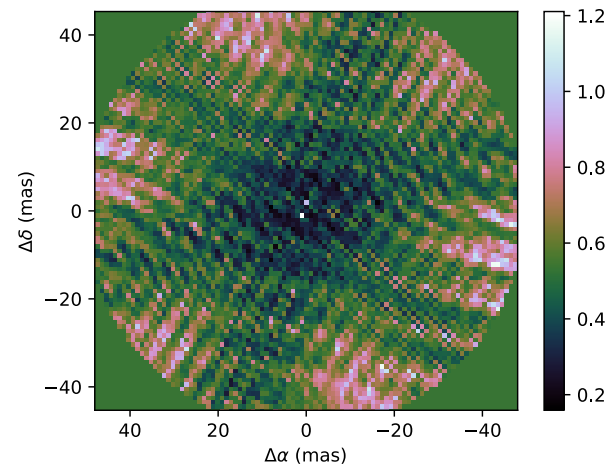


- $\sigma_{\text{median}} = 1^\circ$
- $\sigma_{\text{min}} = 0.3^\circ$
- $\sigma_{\text{max}} = 5^\circ$

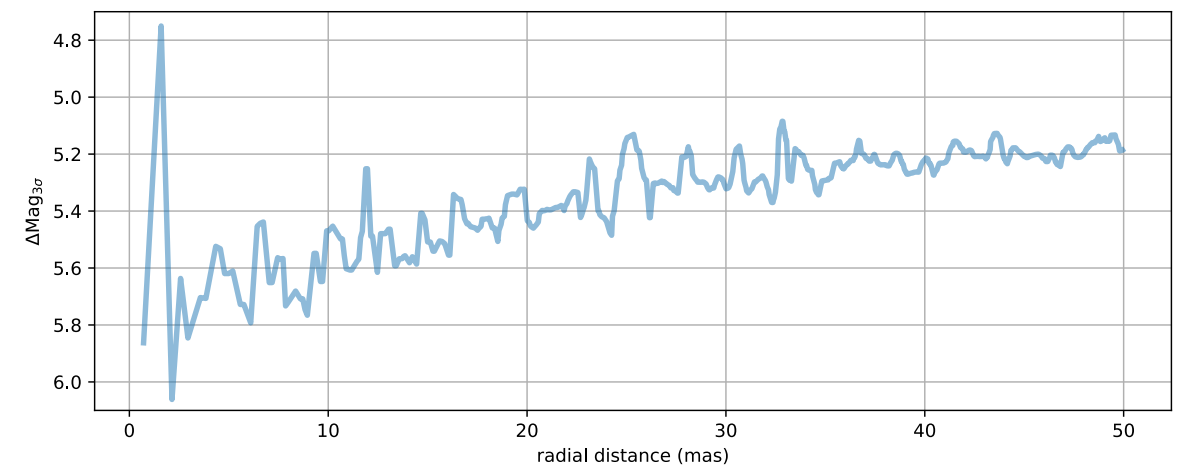
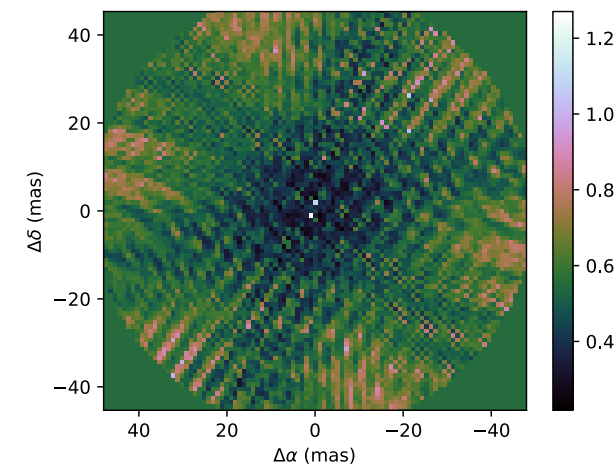


No companion
detected $> 3\sigma$

MIRC



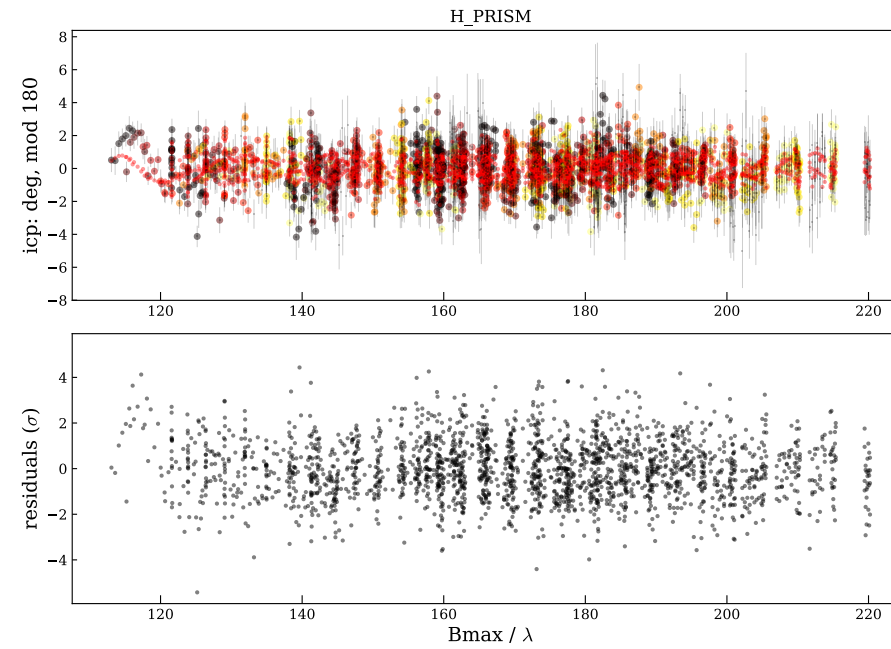
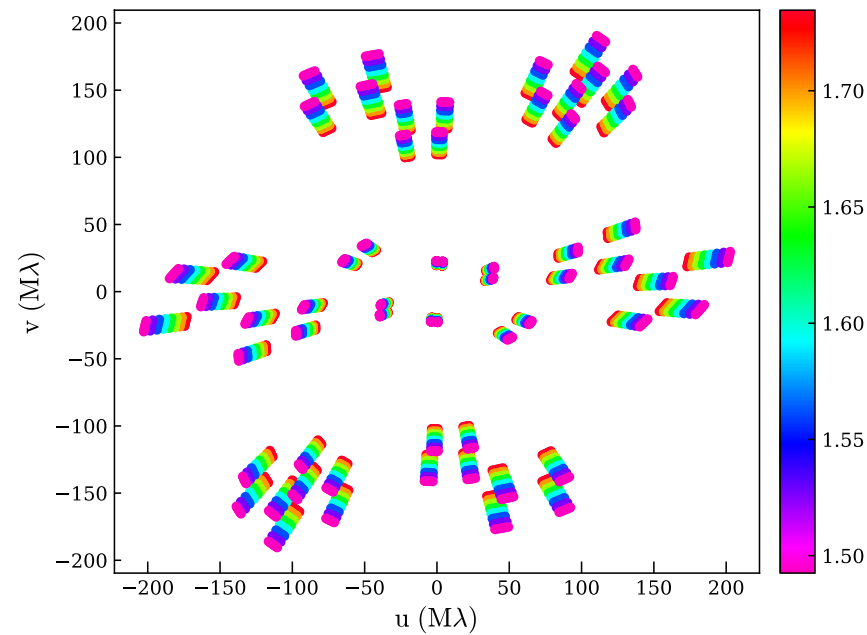
CP only



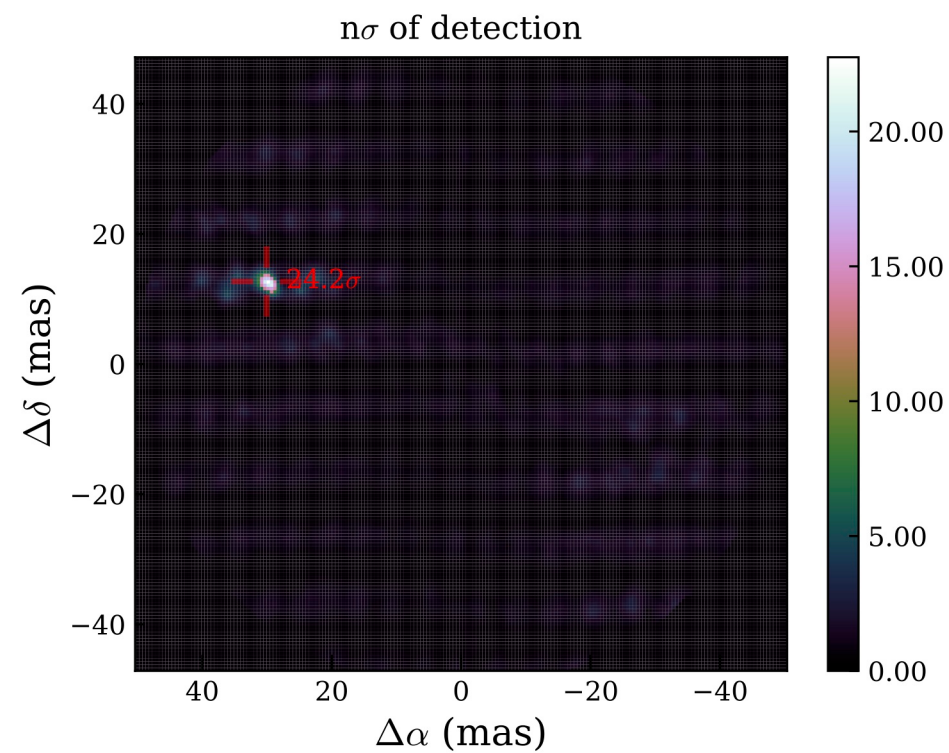
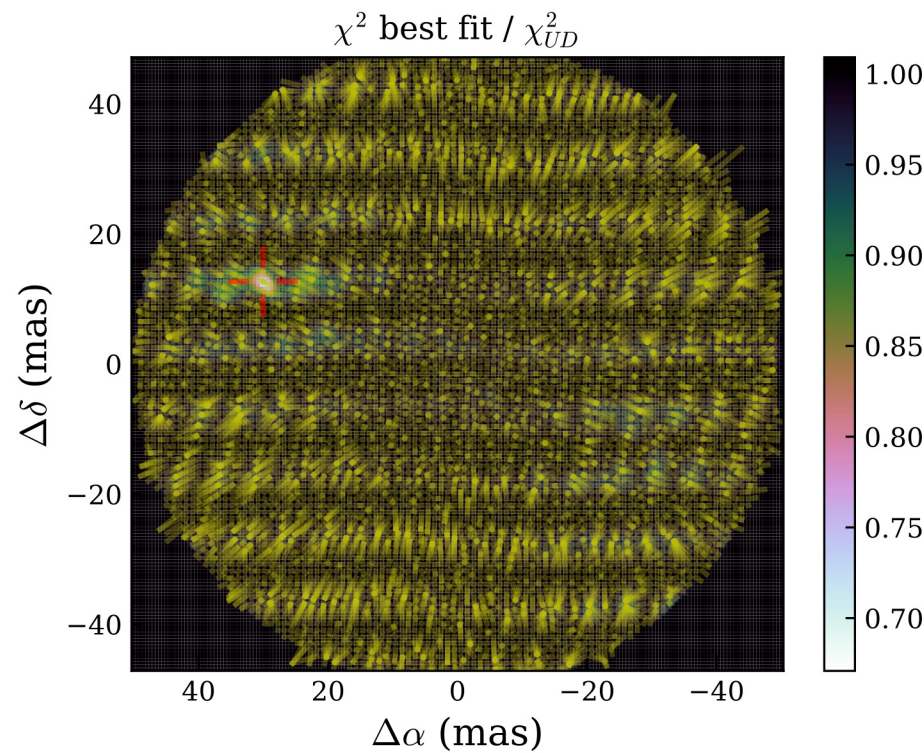
All observables

MIRC

- Cepheid AW Per, $H = 4.8\text{mag}$, $2 \times 15\text{mn}$ on target:



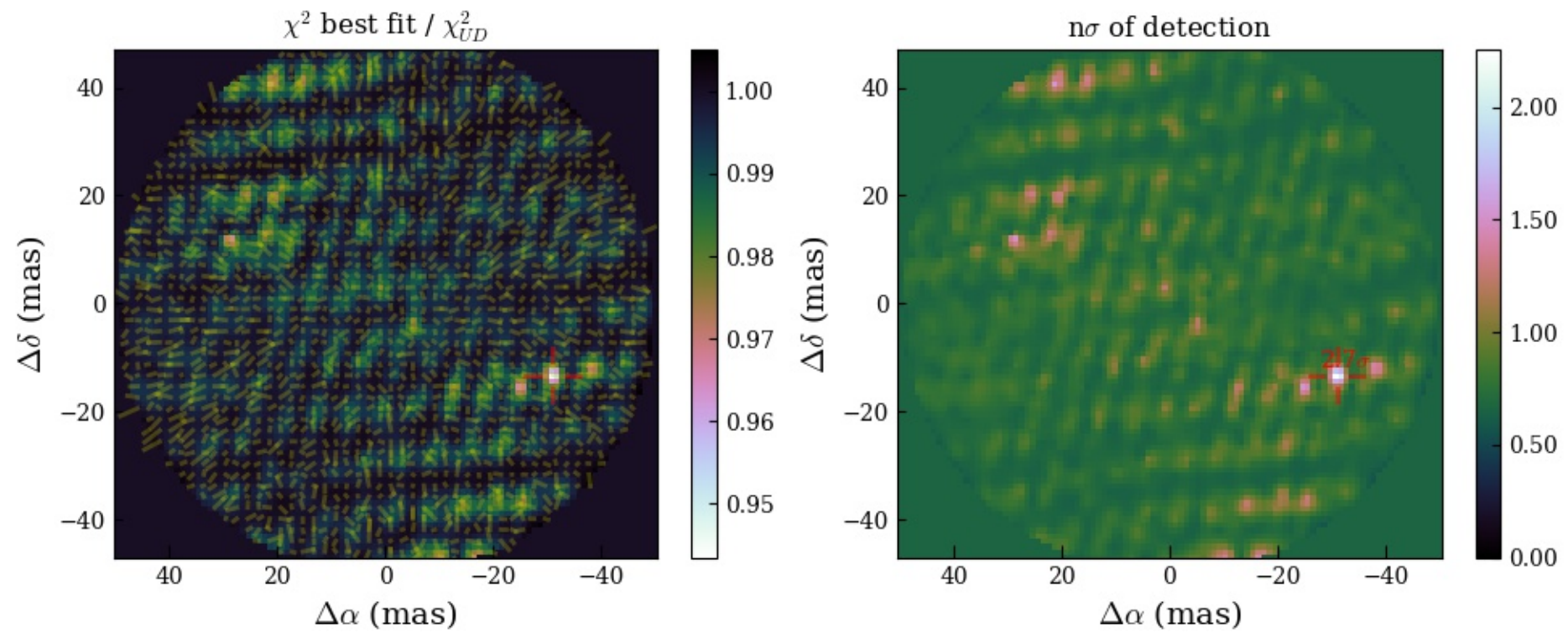
- $\sigma_{\text{median}} = 0.8^\circ$
- $\sigma_{\text{min}} = 0.3^\circ$
- $\sigma_{\text{max}} = 2.9^\circ$



- $\rho = 33\text{mas}$
- $f = 1.3\%$ ($\Delta H = 4.7\text{mag}$)
- detection level: 24σ

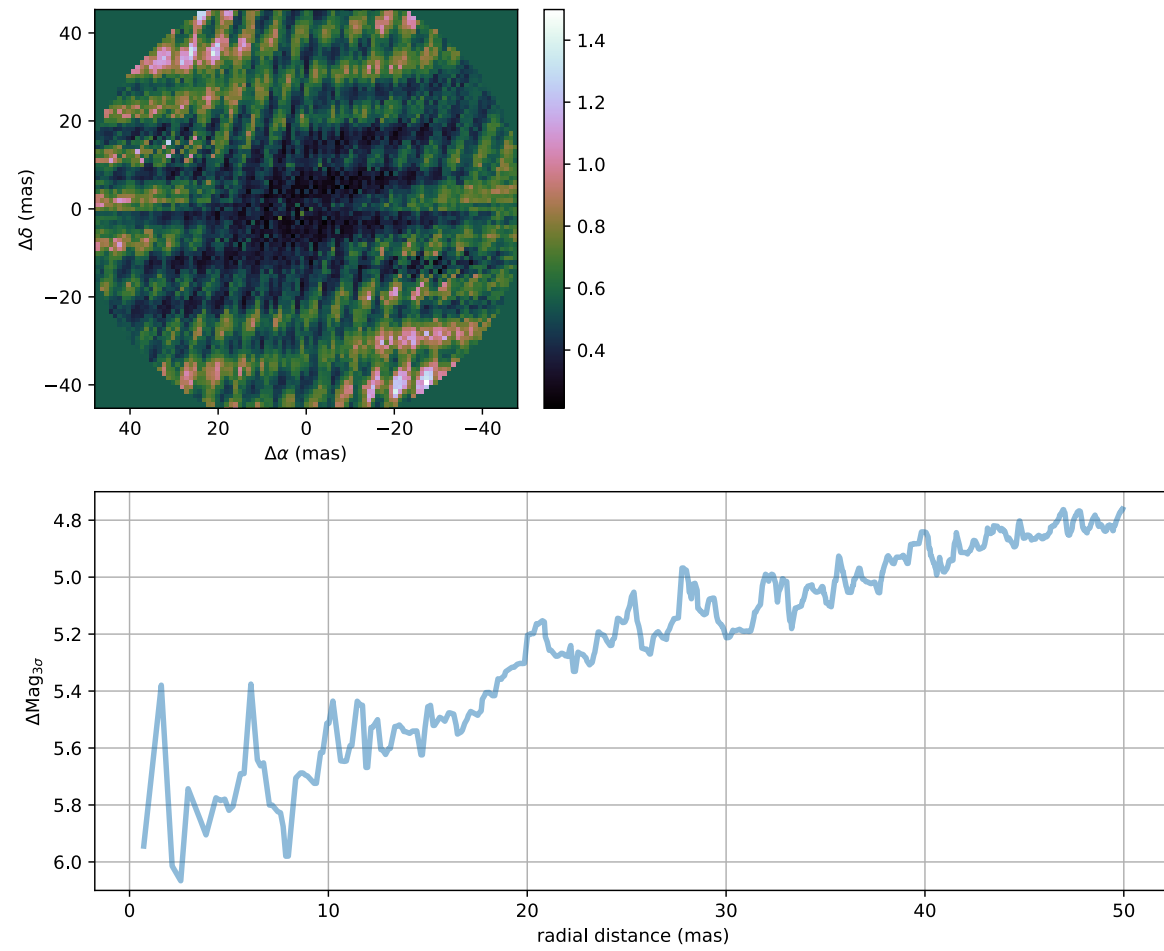
MIRC

- Analytically removed the companion to estimate unbiased detection limits:

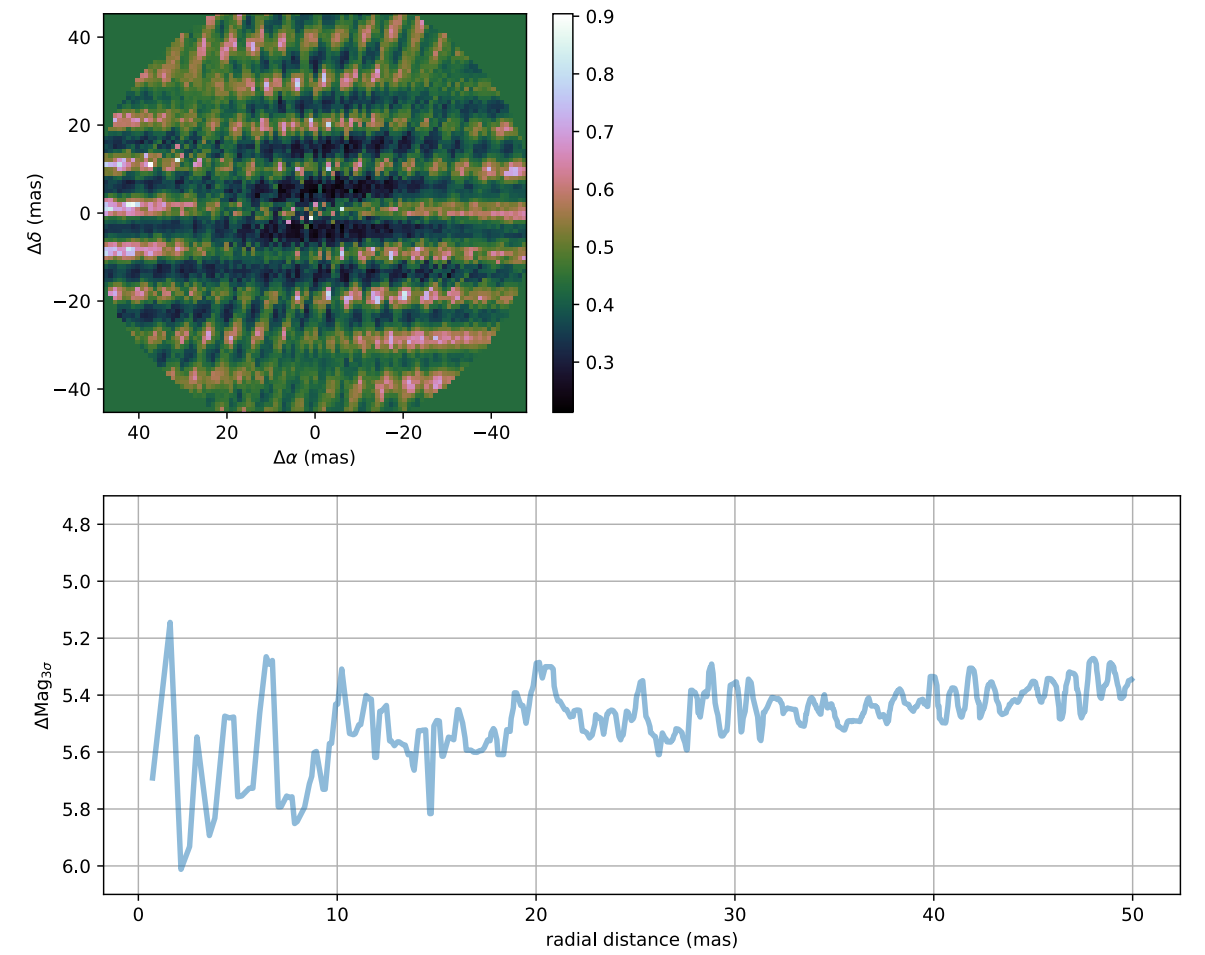


No companion
detected $> 3\sigma$

MIRC



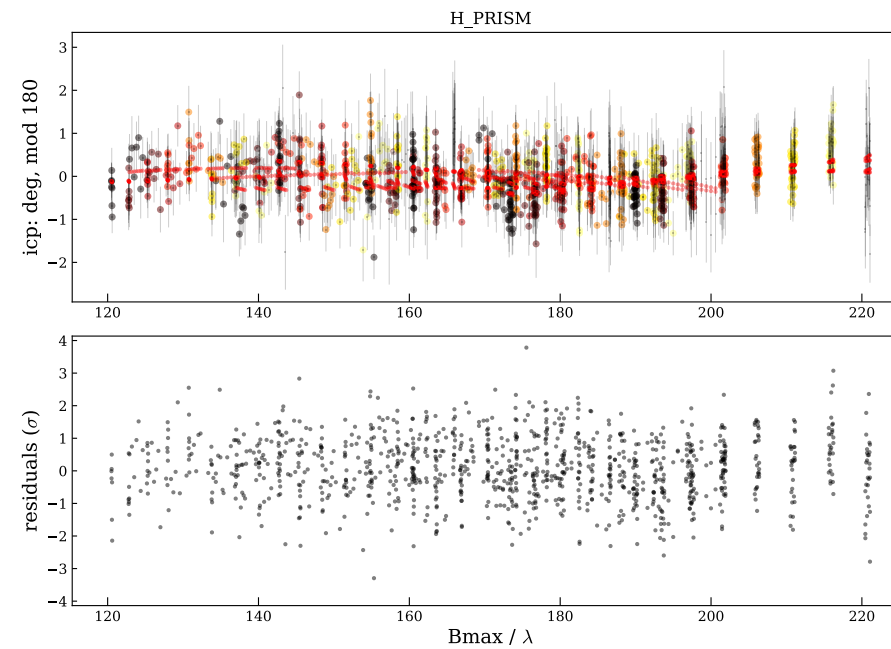
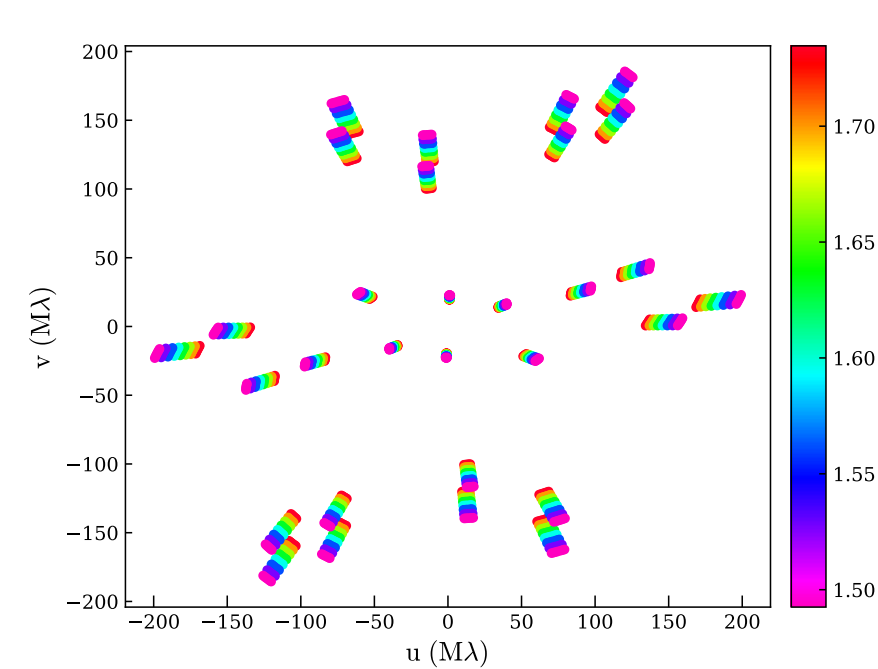
CP only



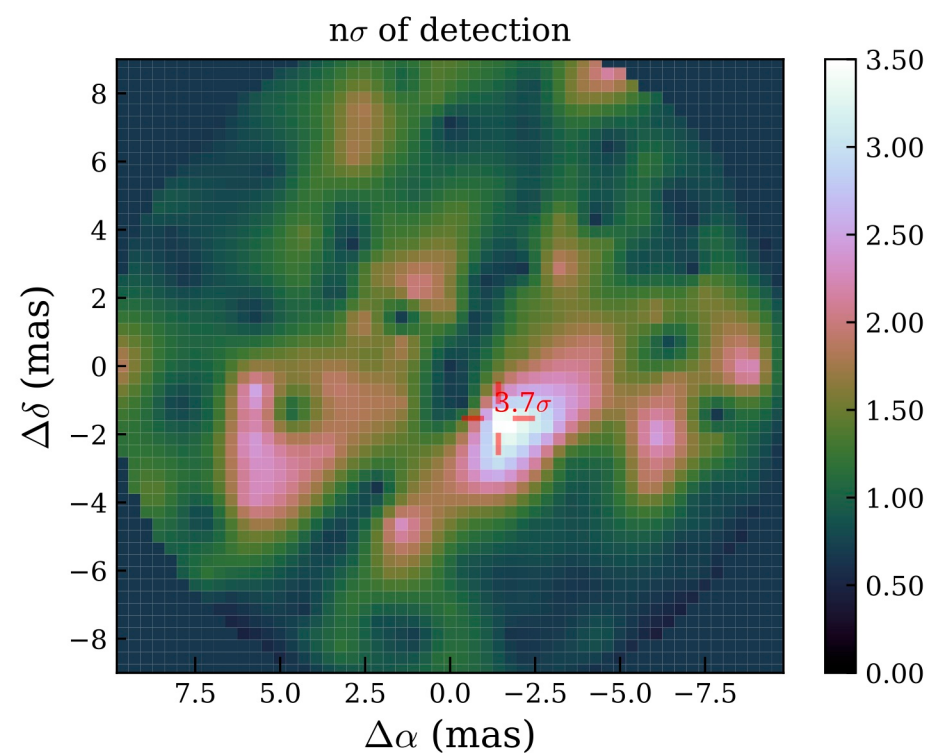
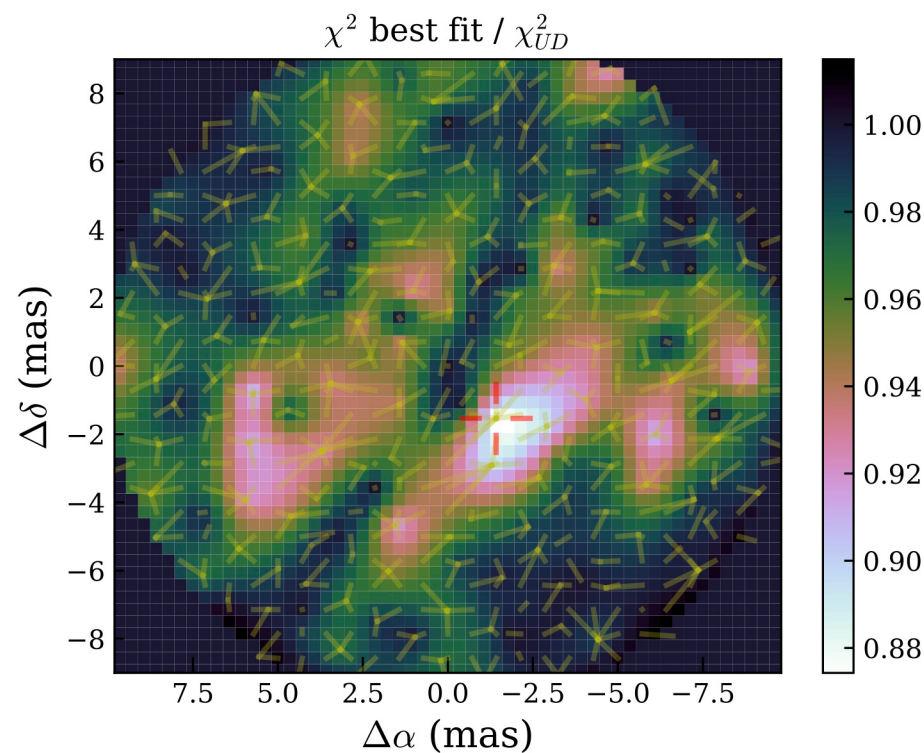
All observables

MIRC

- Cepheid RT Aur, $H = 4\text{mag}$, $1 \times 15\text{mn}$ on target:

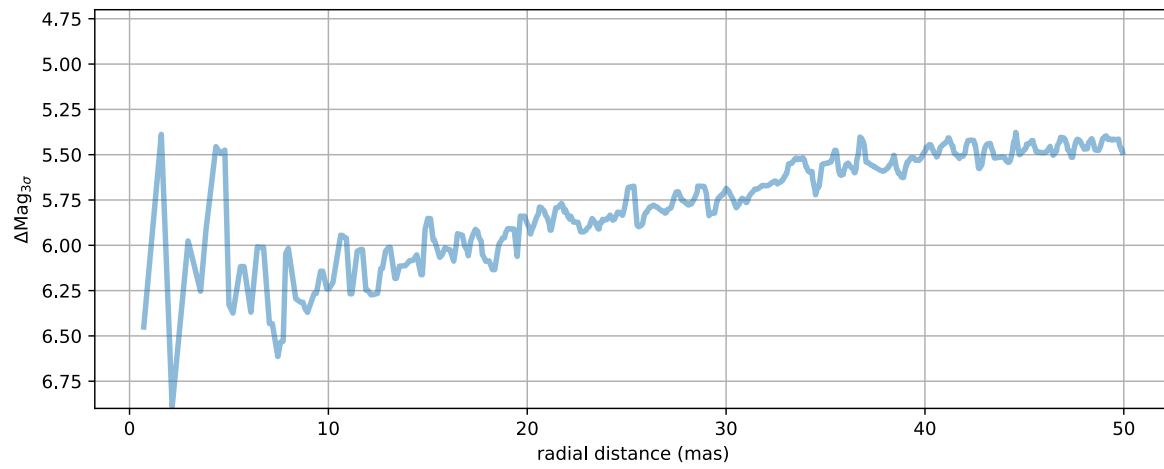
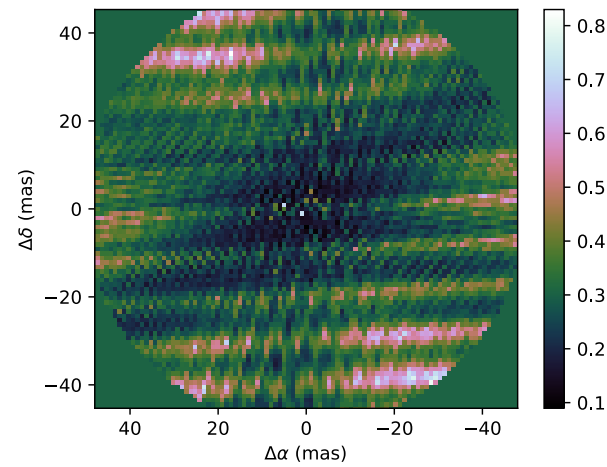


- $\sigma_{\text{median}} = 0.6^\circ$
- $\sigma_{\text{min}} = 0.2^\circ$
- $\sigma_{\text{max}} = 1.5^\circ$

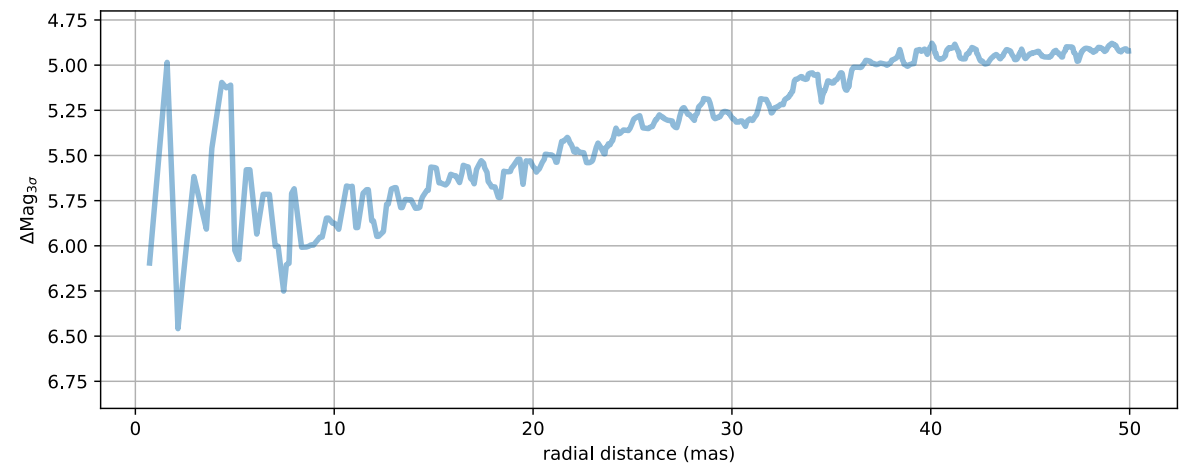
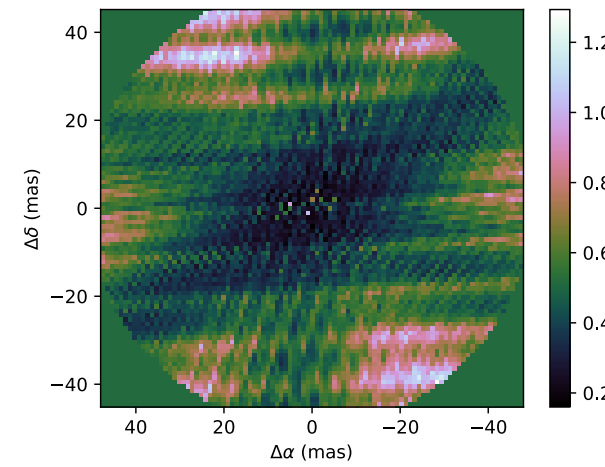


- $\rho = 2\text{mas}$
- $f = 0.22\%$ ($\Delta H = 6.6\text{mag}$)
- detection level: 3.7σ

MIRC



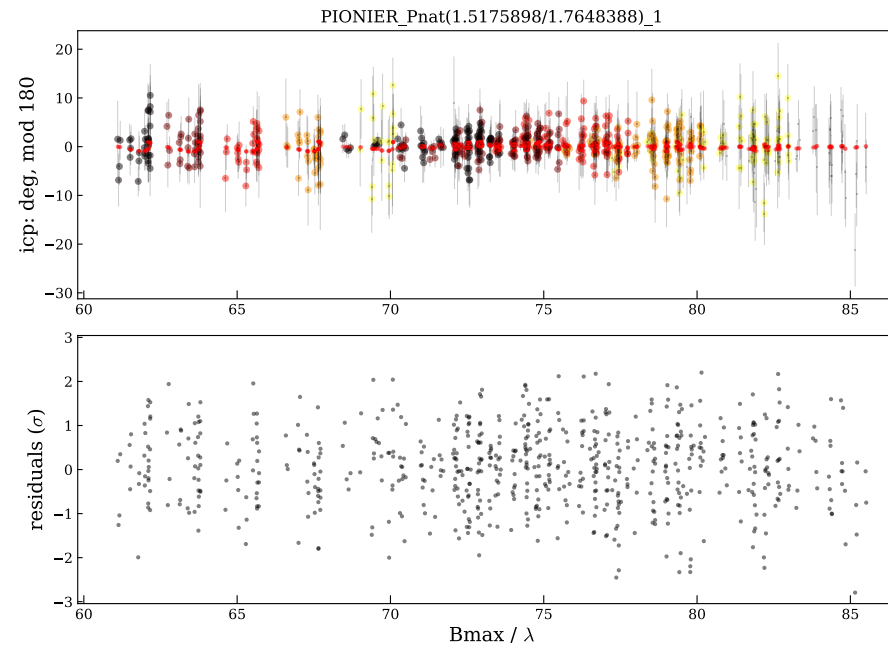
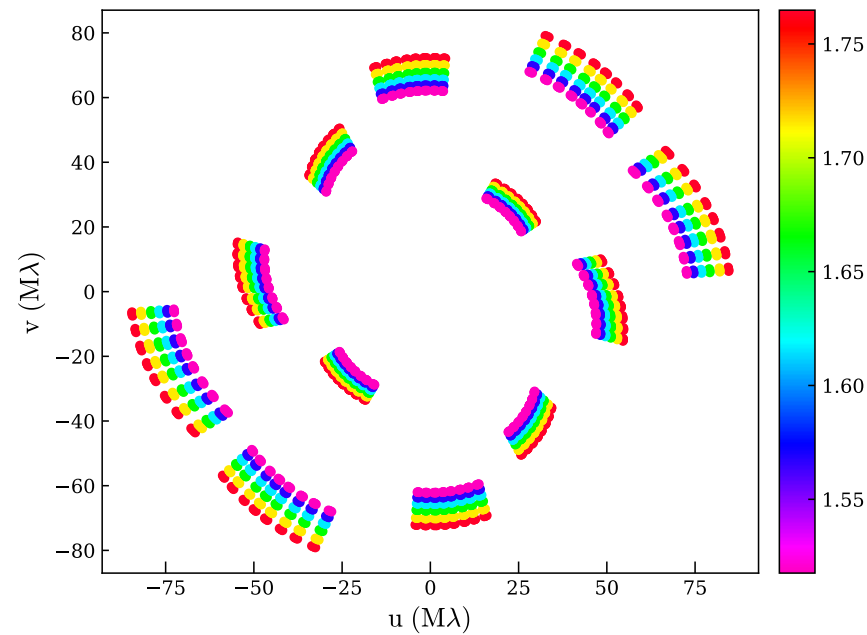
CP only



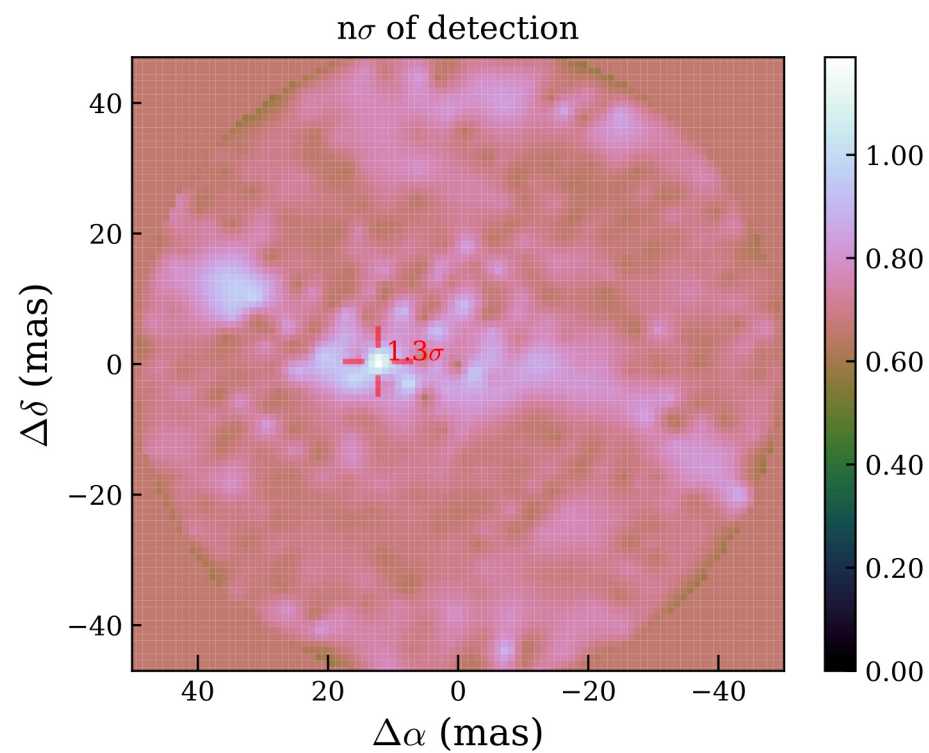
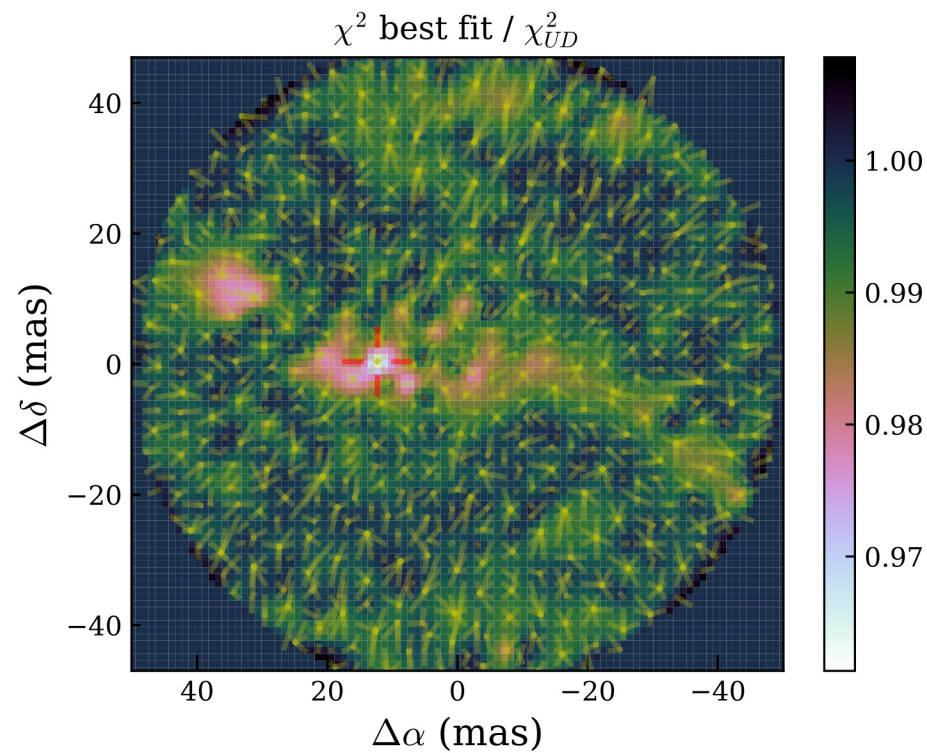
All observables

PIONIER (ATs)

- Cepheid YZ Car, H = 6mag, ~1h (8x8mn) on target

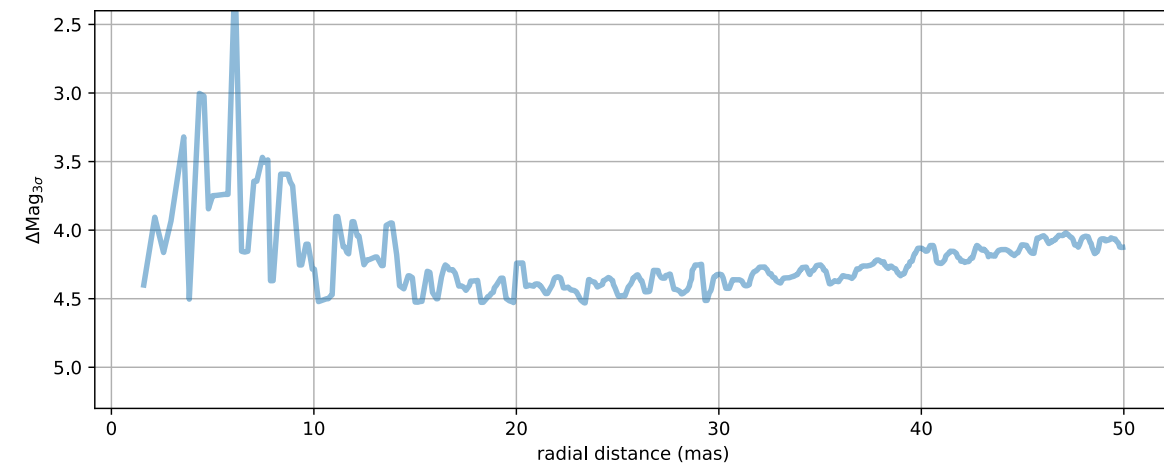
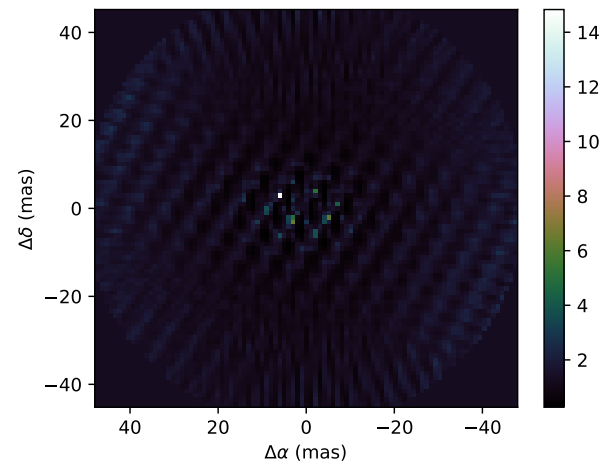


- $\sigma_{\text{median}} = 3.3^\circ$
- $\sigma_{\text{min}} = 0.9^\circ$
- $\sigma_{\text{max}} = 10^\circ$

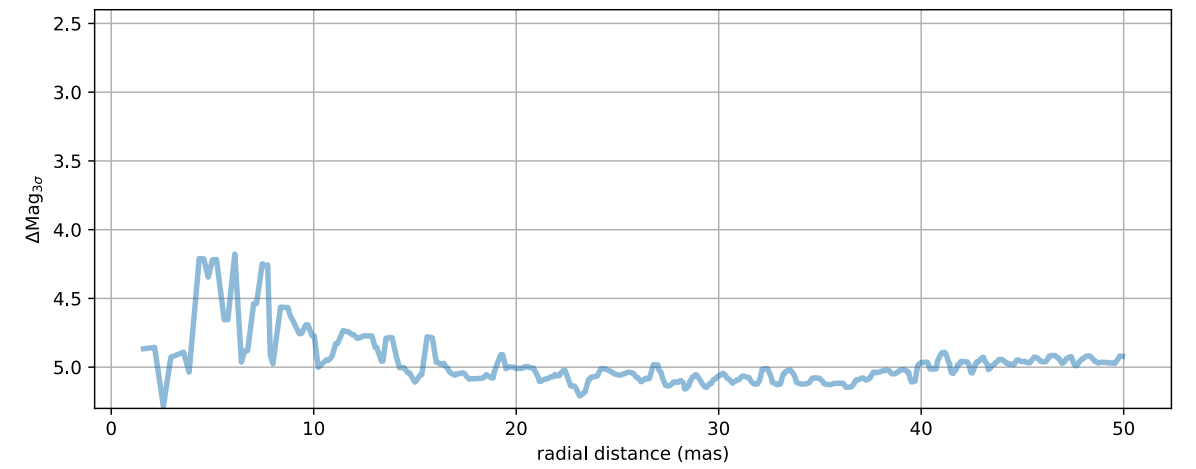
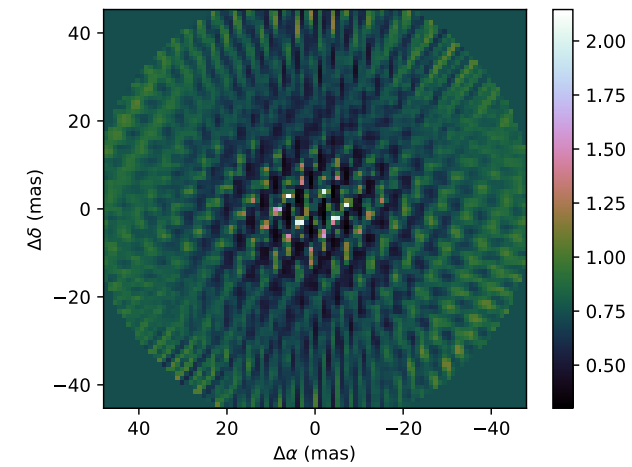


No companion
detected $> 3\sigma$

PIONIER (ATs)



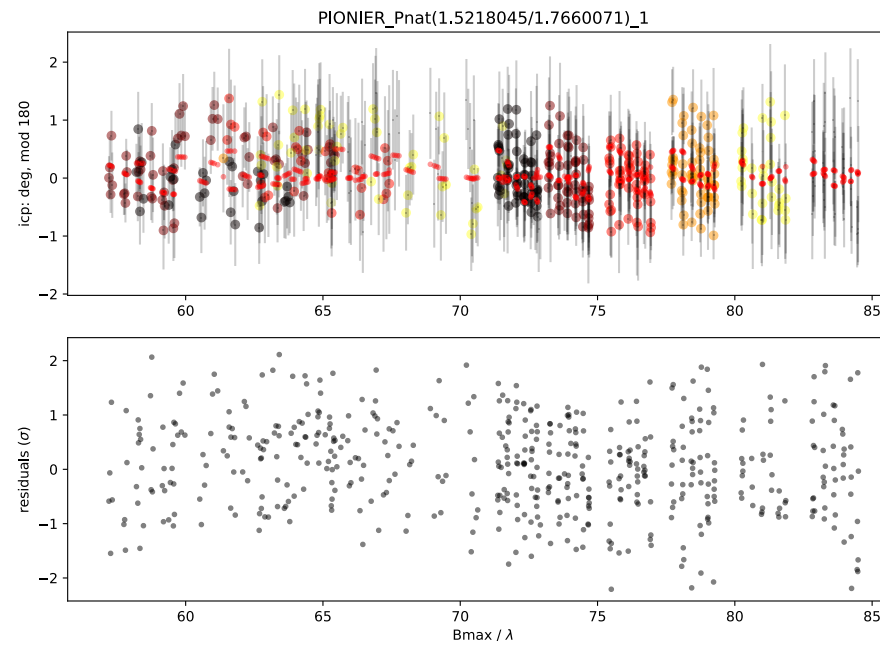
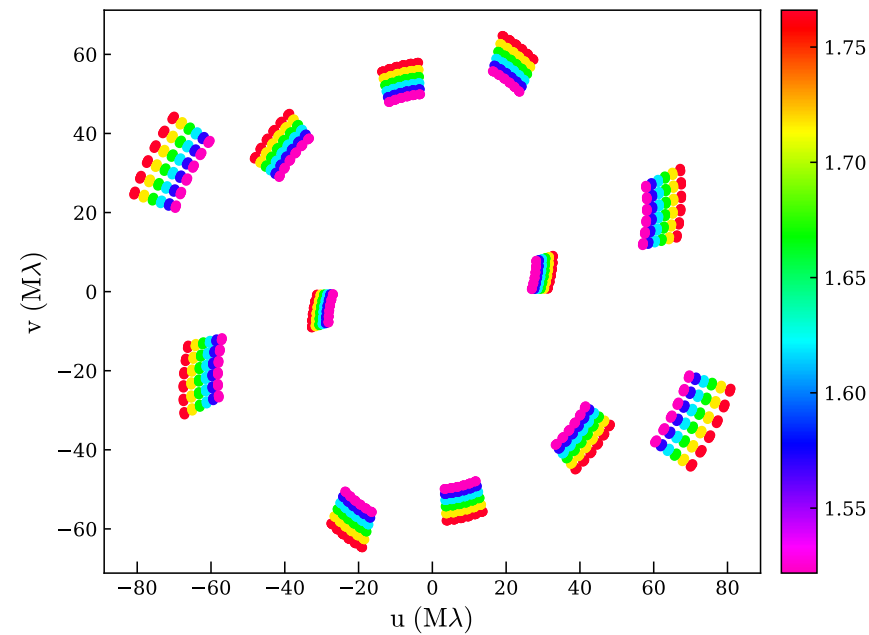
CP only



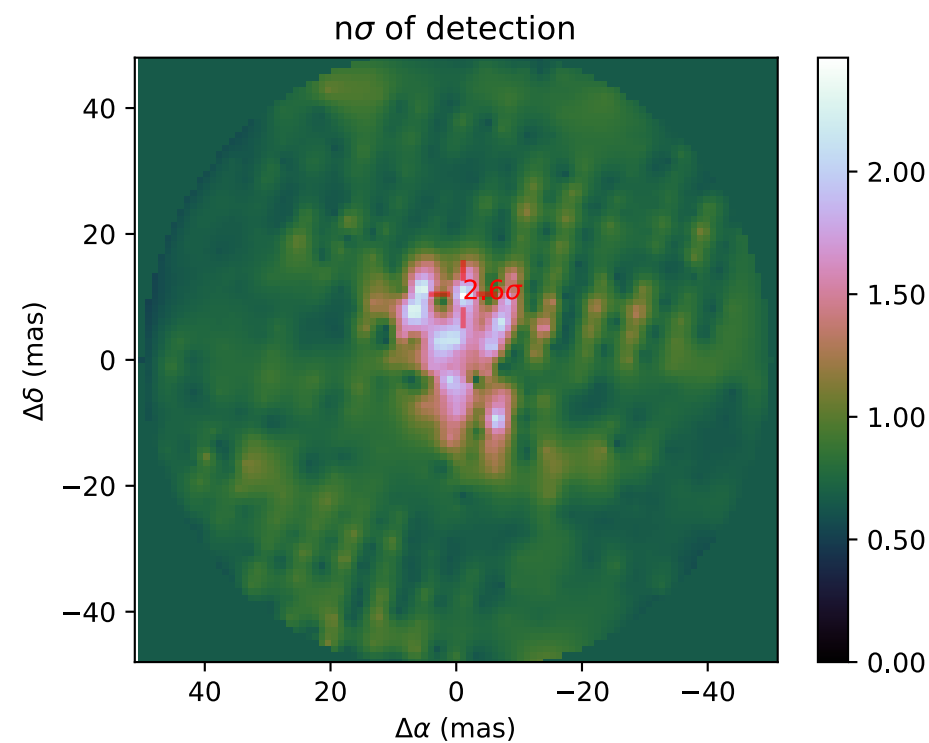
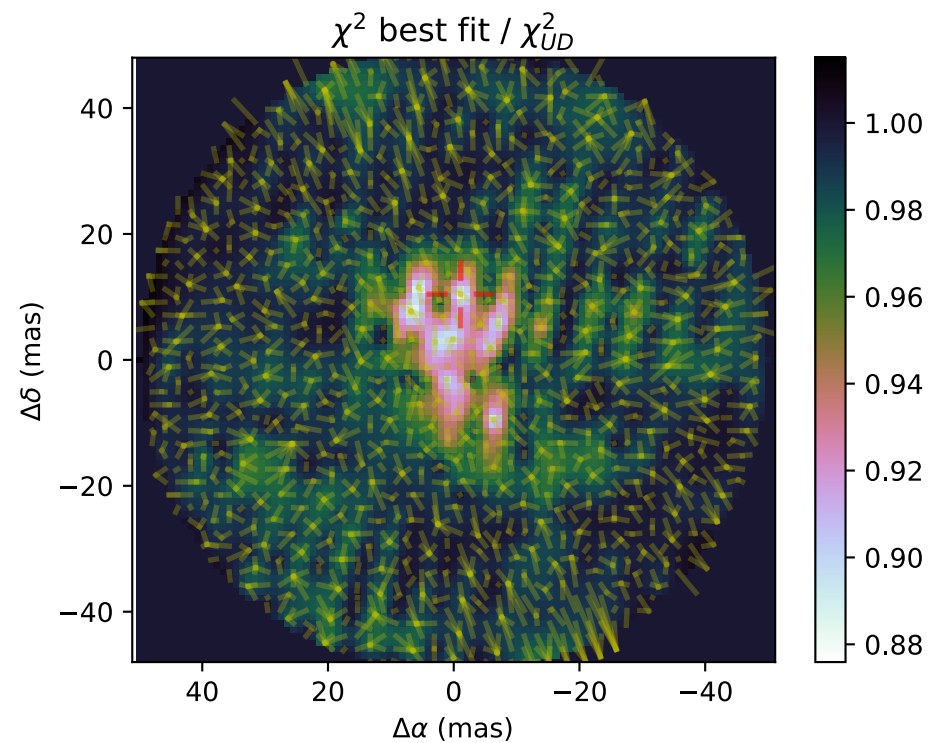
All observables

PIONIER (ATs)

- Cepheid β Dor, $H = 2.1\text{mag}$, $\sim 35\text{mn}$ (6x5mn) on target

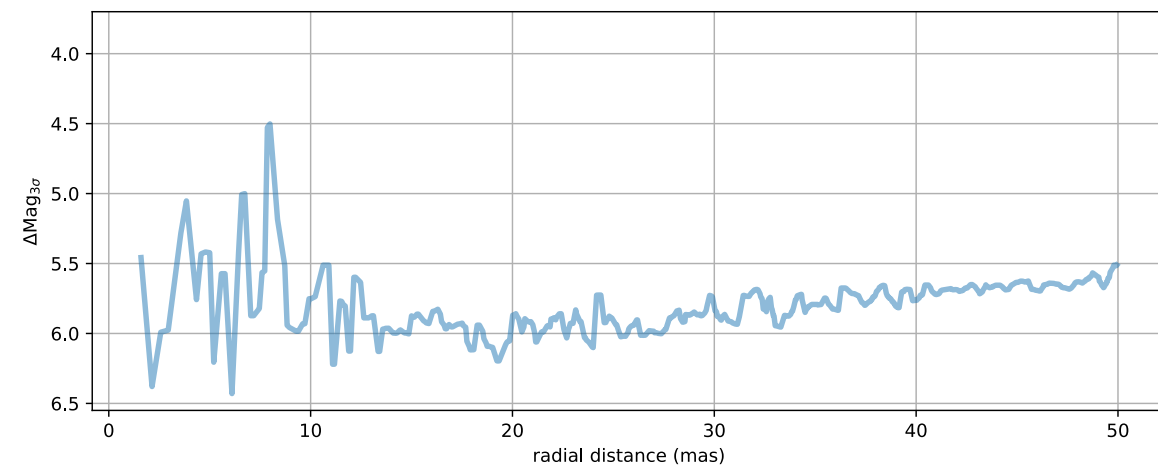
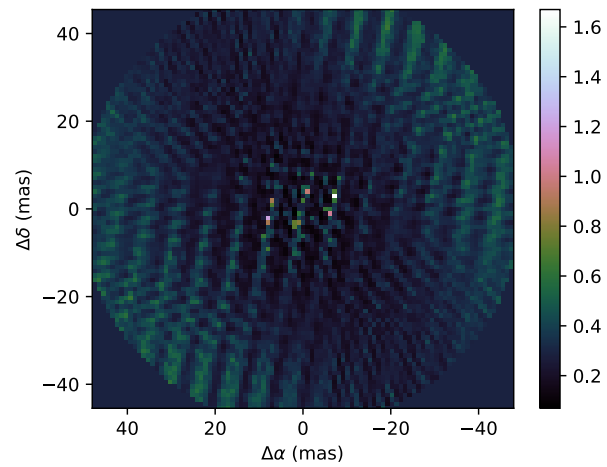


- $\sigma_{\text{median}} = 0.8^\circ$
- $\sigma_{\text{min}} = 0.2^\circ$
- $\sigma_{\text{max}} = 1.8^\circ$

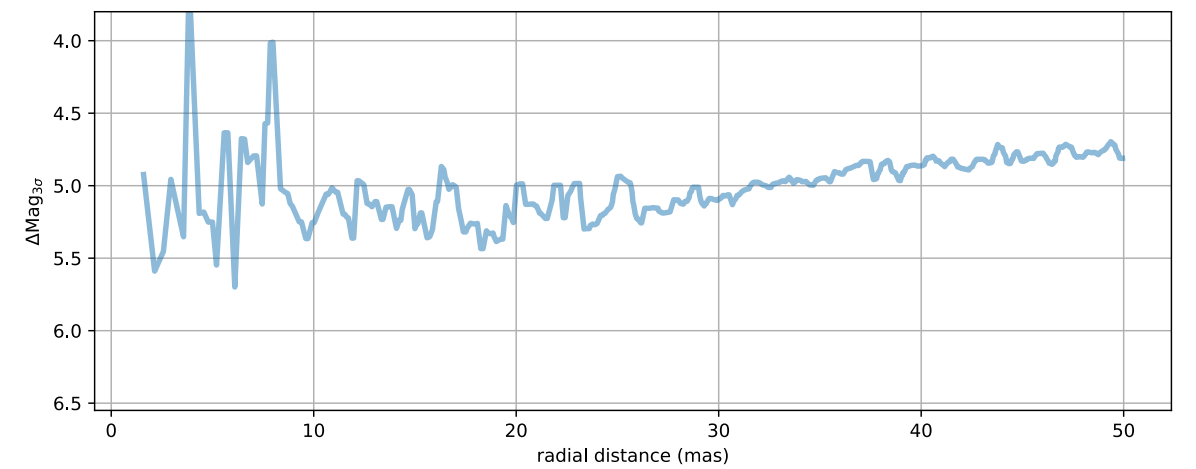
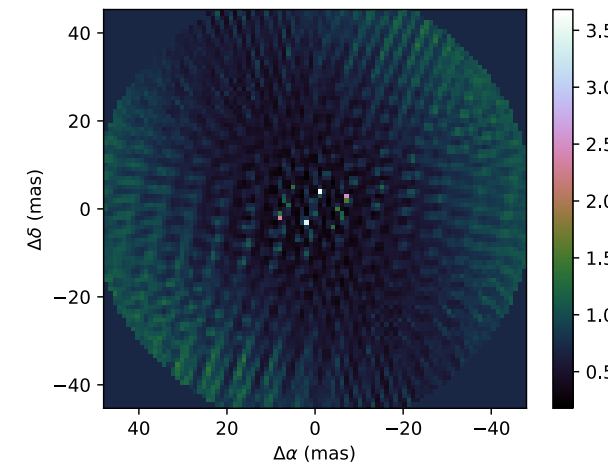


No companion
detected $> 3\sigma$

PIONIER (ATs)



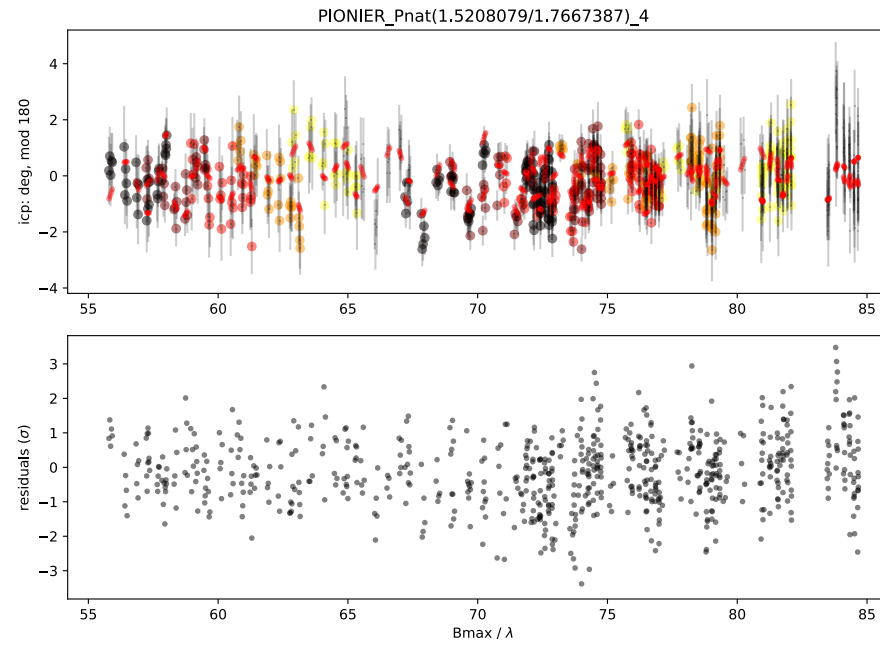
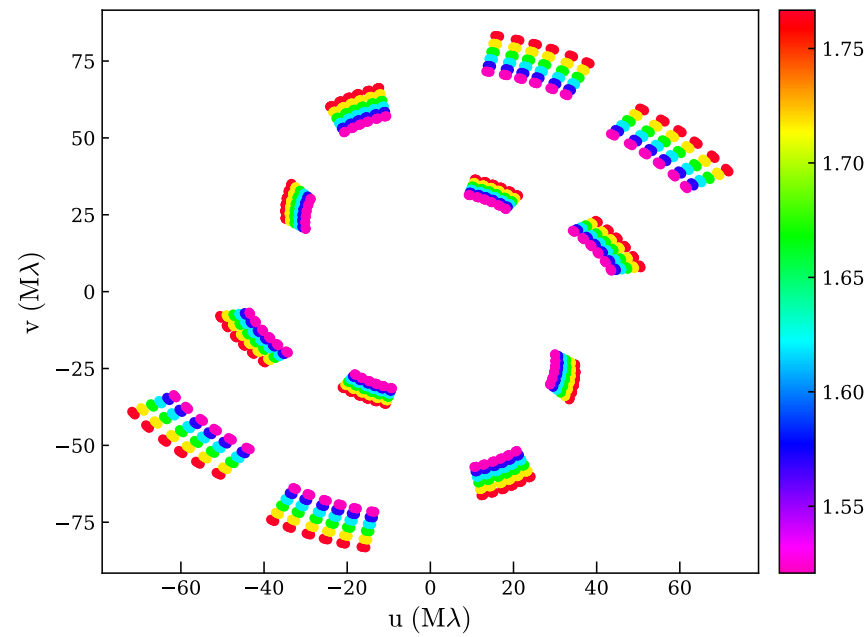
CP only



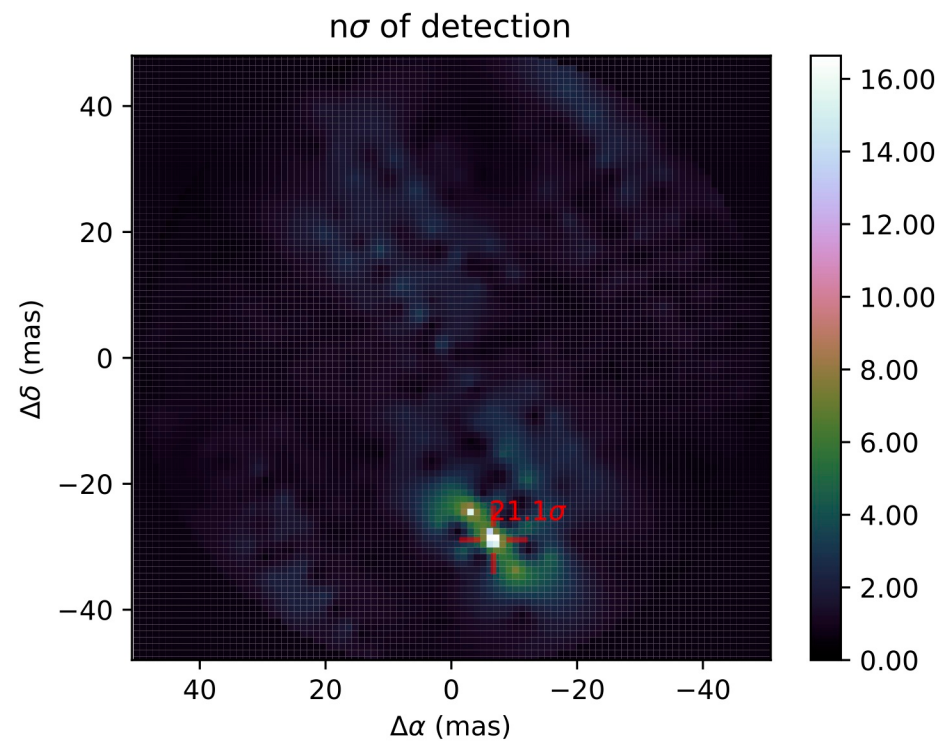
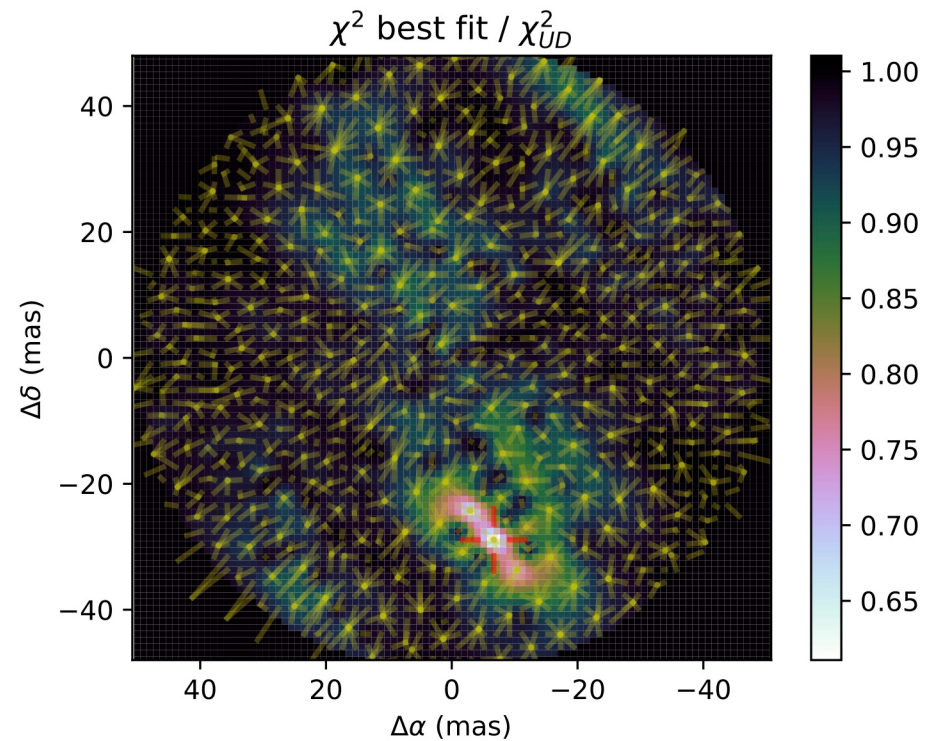
All observables

PIONIER (ATs)

- Cepheid AX Cir, $H = 3.9\text{mag}$, $\sim 35\text{mn}$ (6x5mn) on target

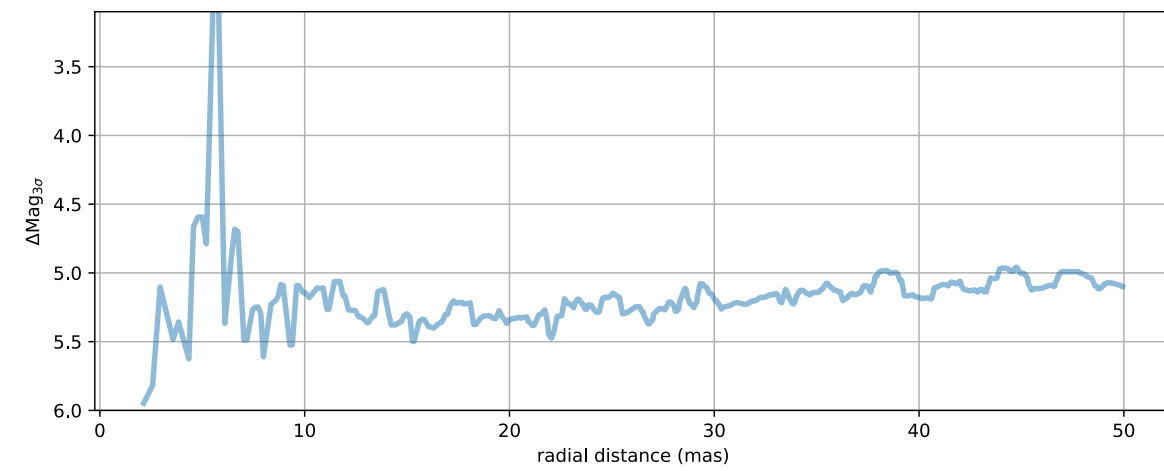
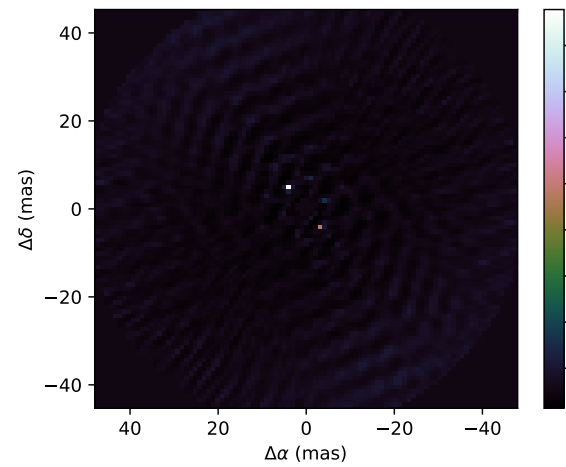


- $\sigma_{\text{median}} = 1.6^\circ$
- $\sigma_{\text{min}} = 0.6^\circ$
- $\sigma_{\text{max}} = 4.6^\circ$

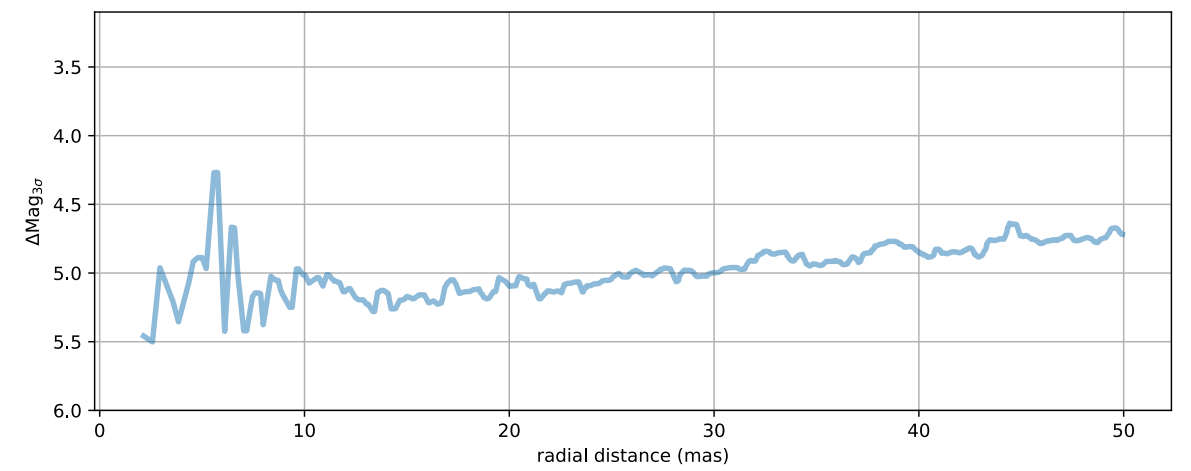
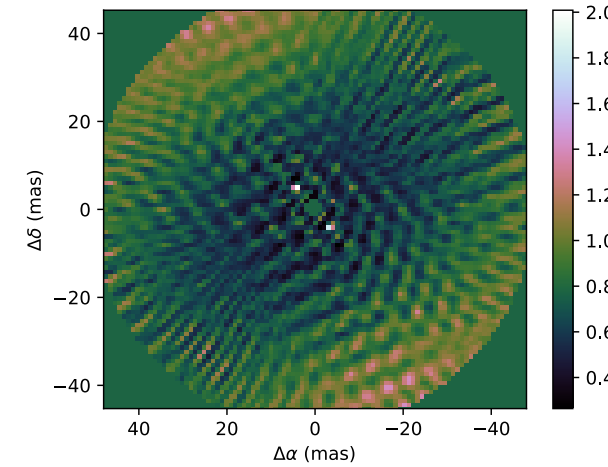


- $\rho = 30\text{mas}$
- $f=1\%$ ($\Delta H=4.8\text{mag}$)
- detection level: 21σ

PIONIER (ATs)



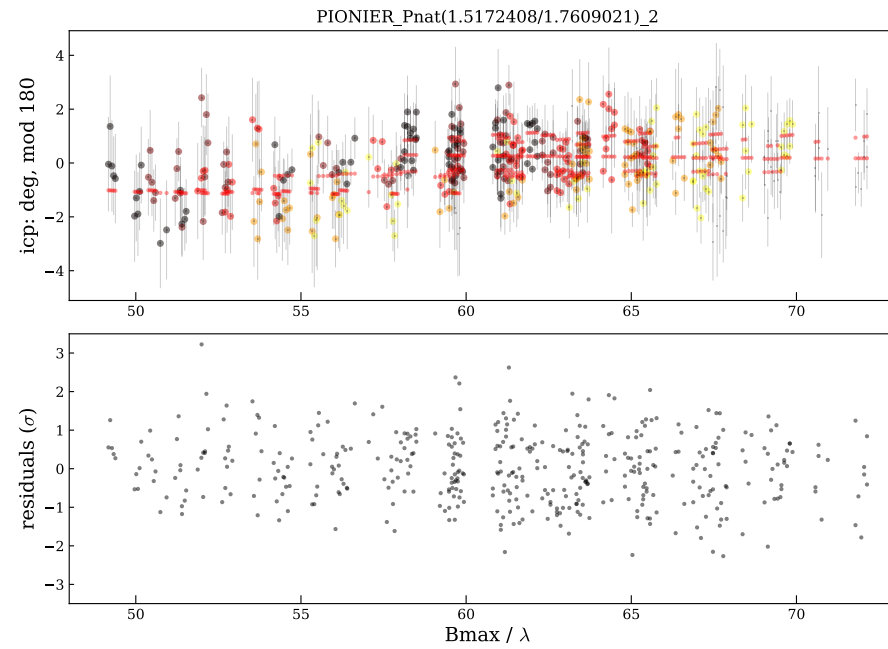
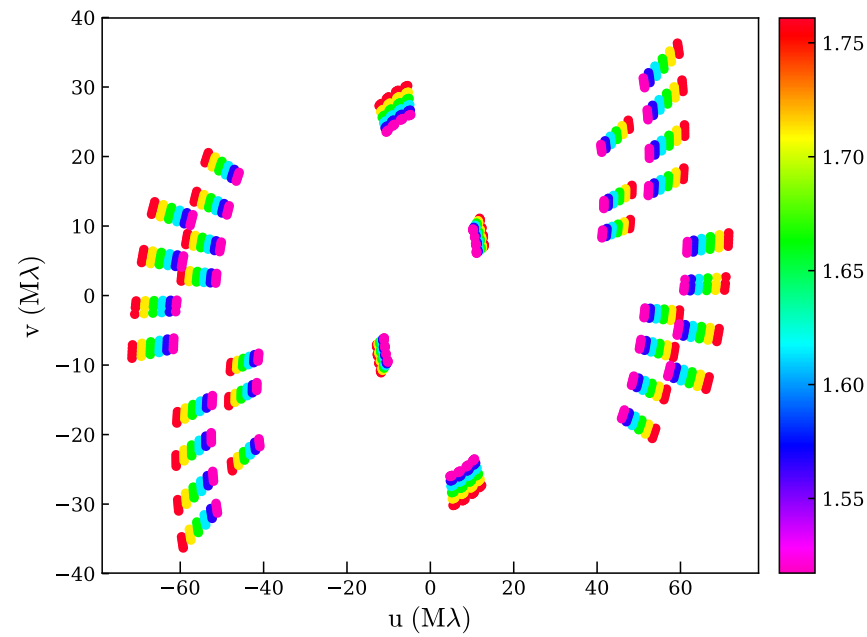
CP only



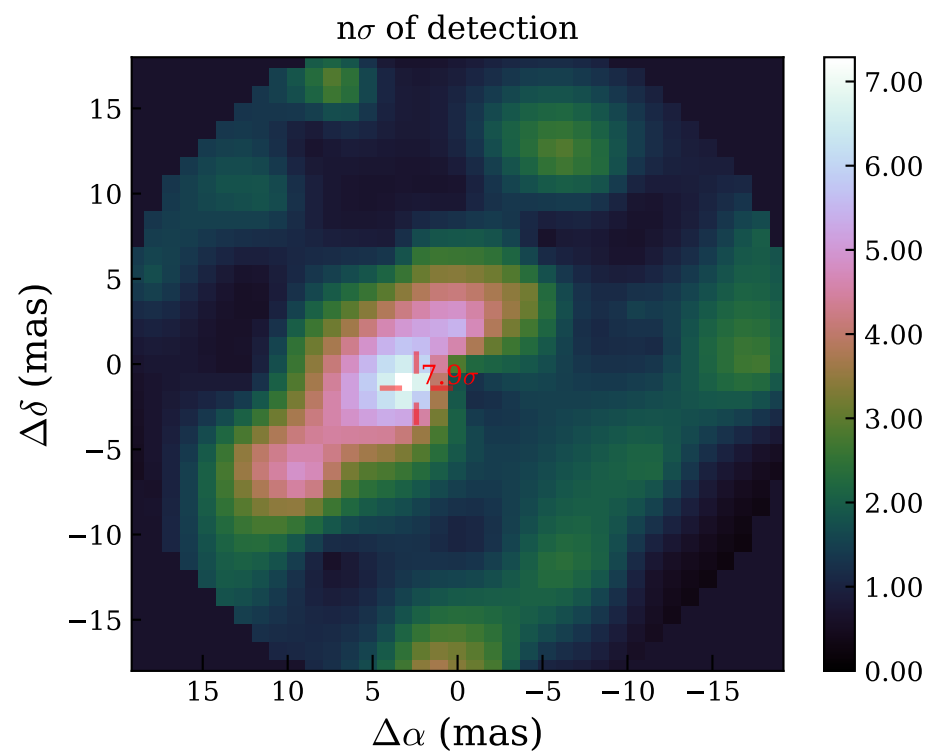
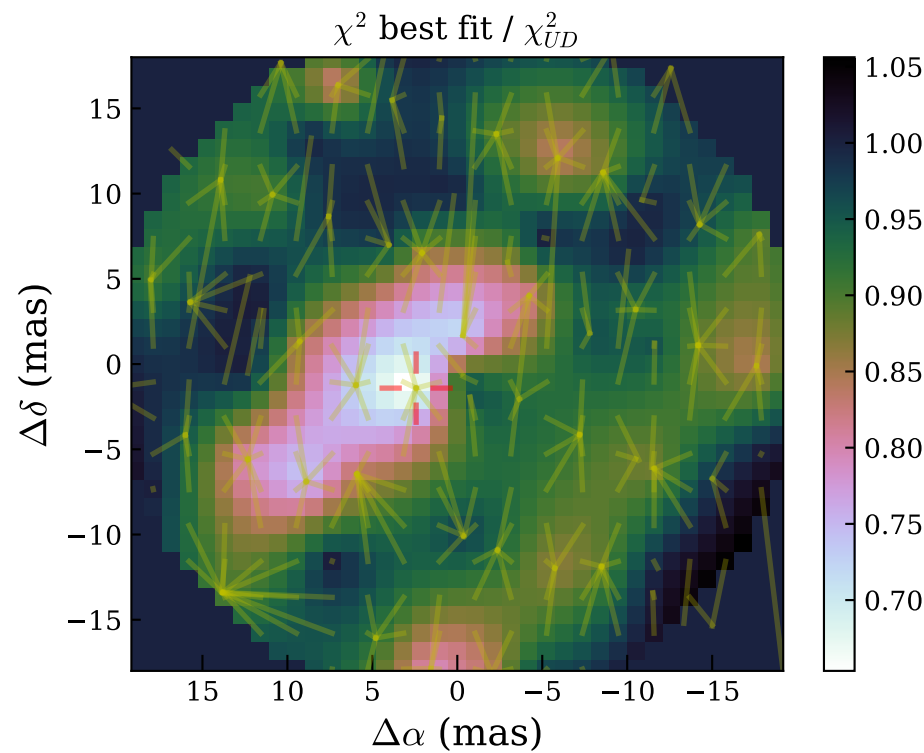
All observables

PIONIER (ATs)

- Cepheid S Mus, $H = 3.9\text{mag}$, $\sim 35\text{mn}$ (6x5mn) on target

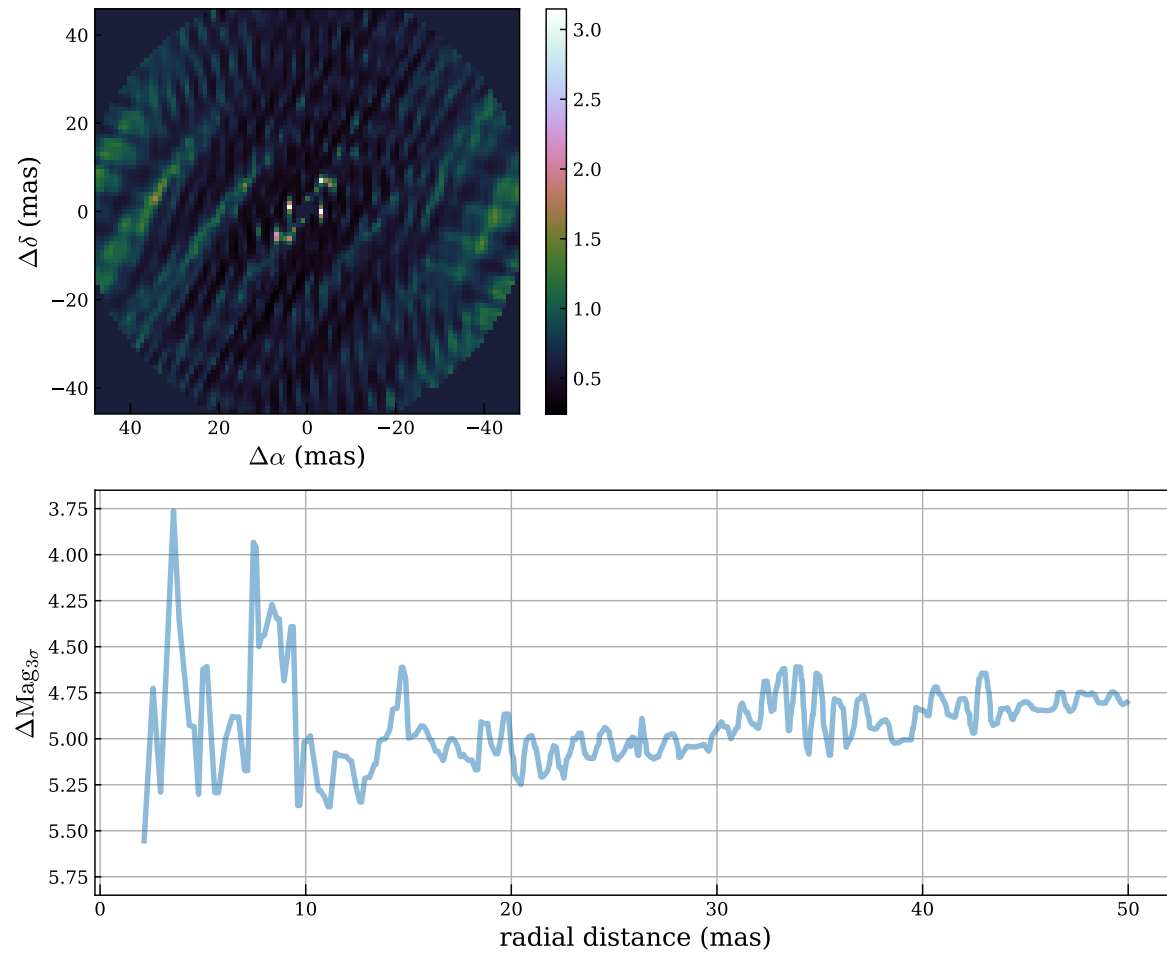


- $\sigma_{\text{median}} = 1.1^\circ$
- $\sigma_{\text{min}} = 0.4^\circ$
- $\sigma_{\text{max}} = 3.6^\circ$

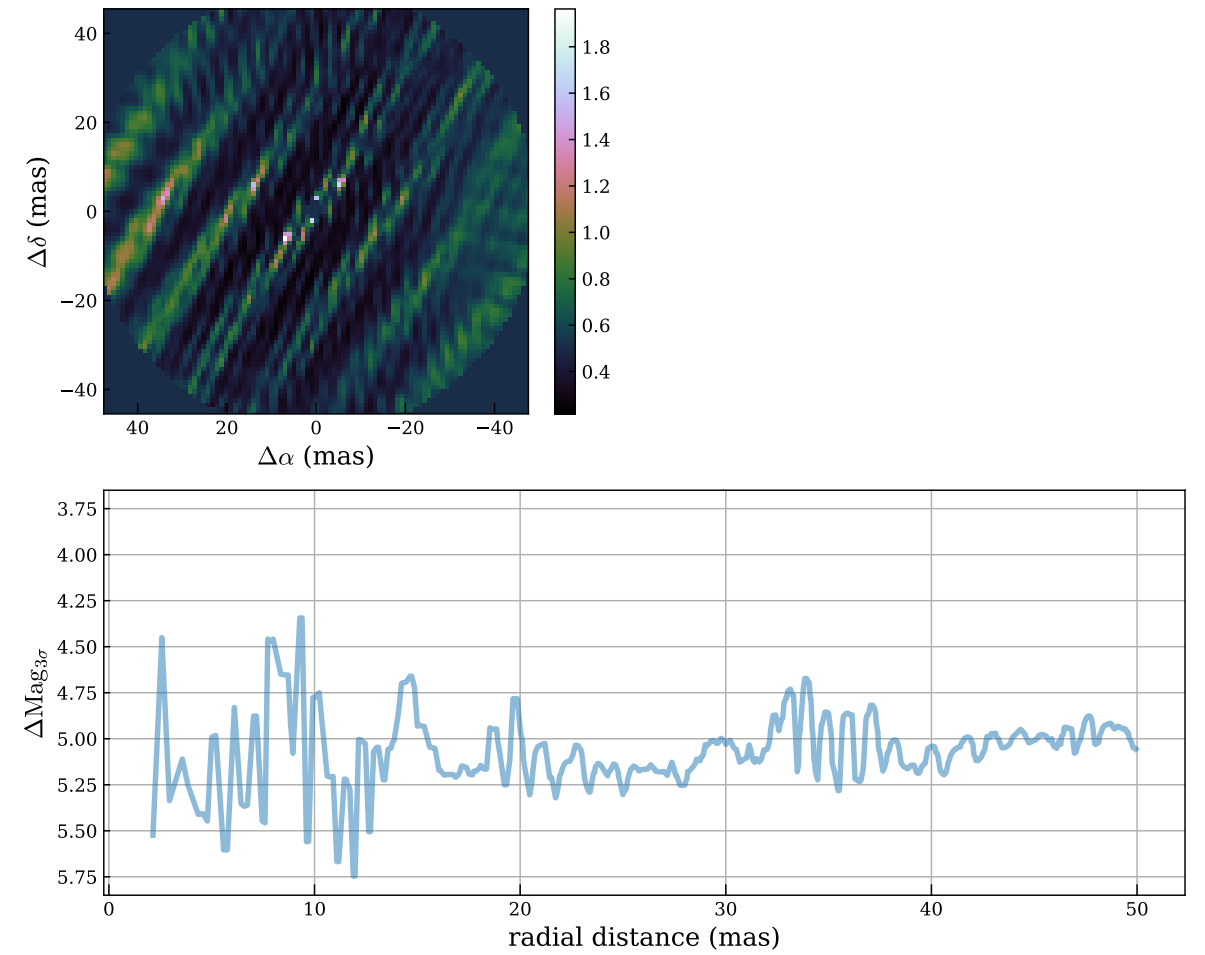


- $\rho = 2.8\text{mas}$
- $f=0.8\%$ ($\Delta H=5.2\text{mag}$)
- detection level: 7.8σ

PIONIER (ATs)



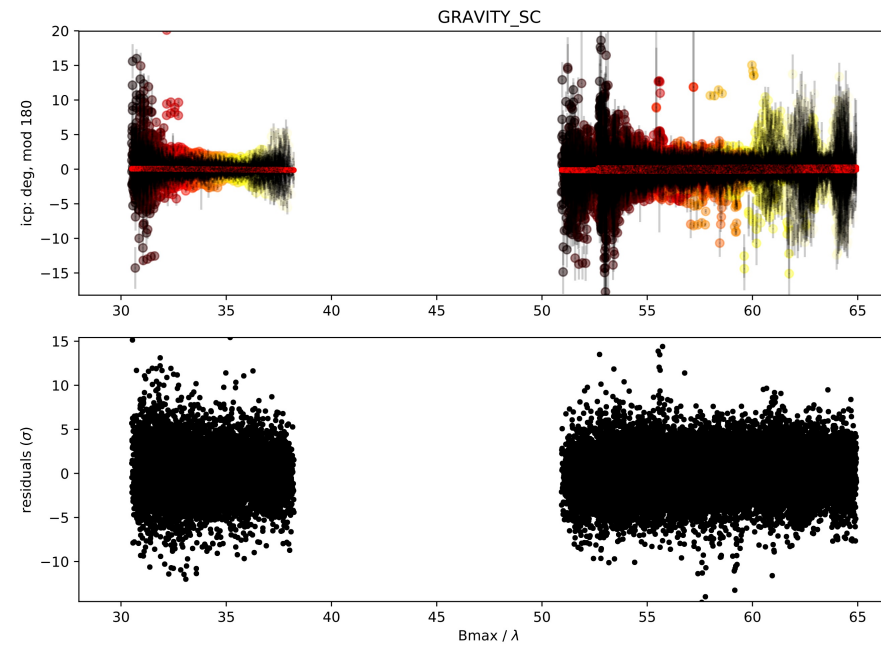
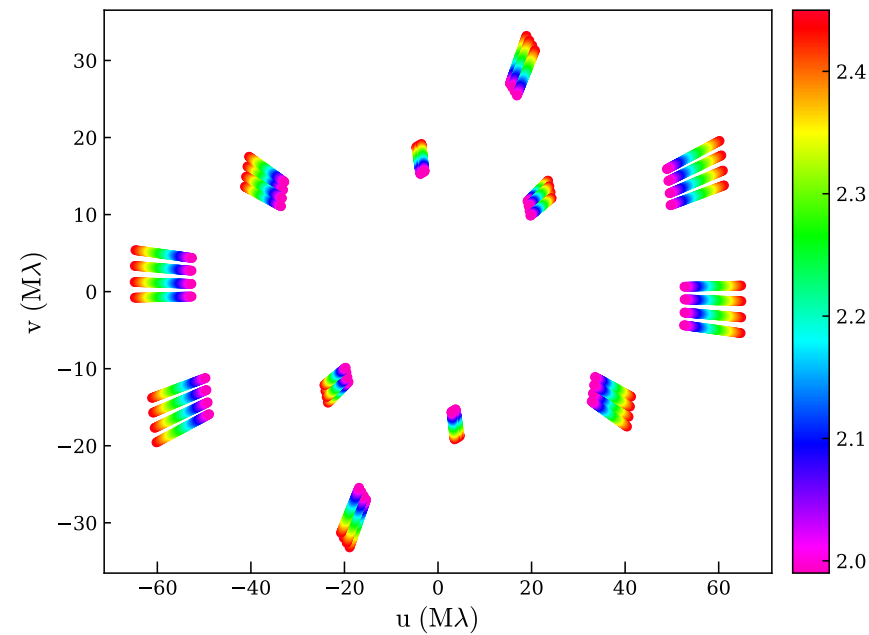
CP only



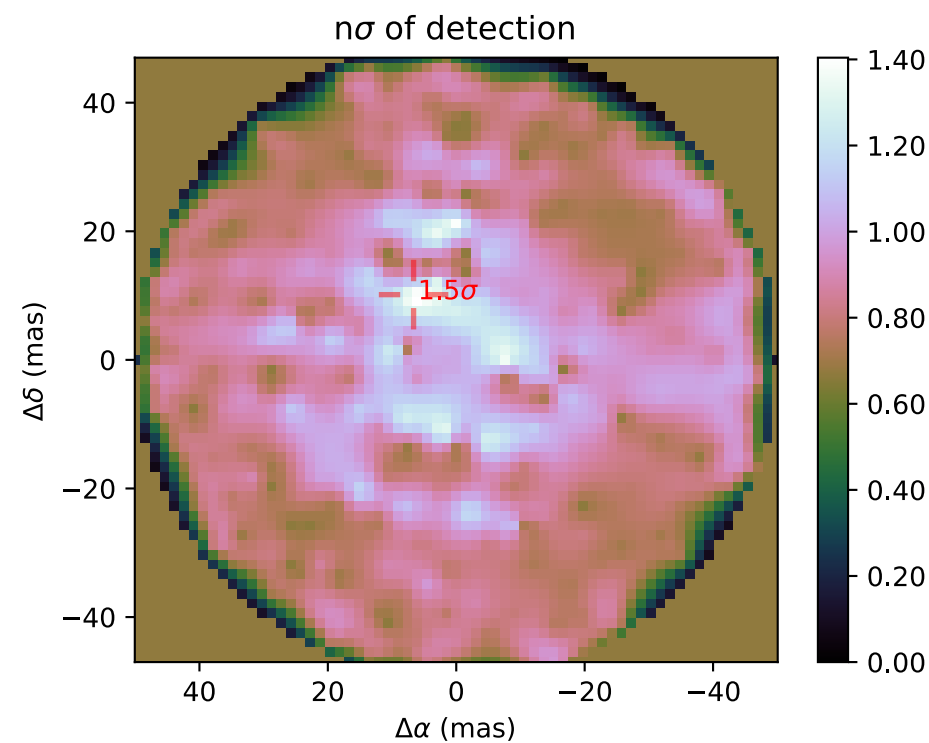
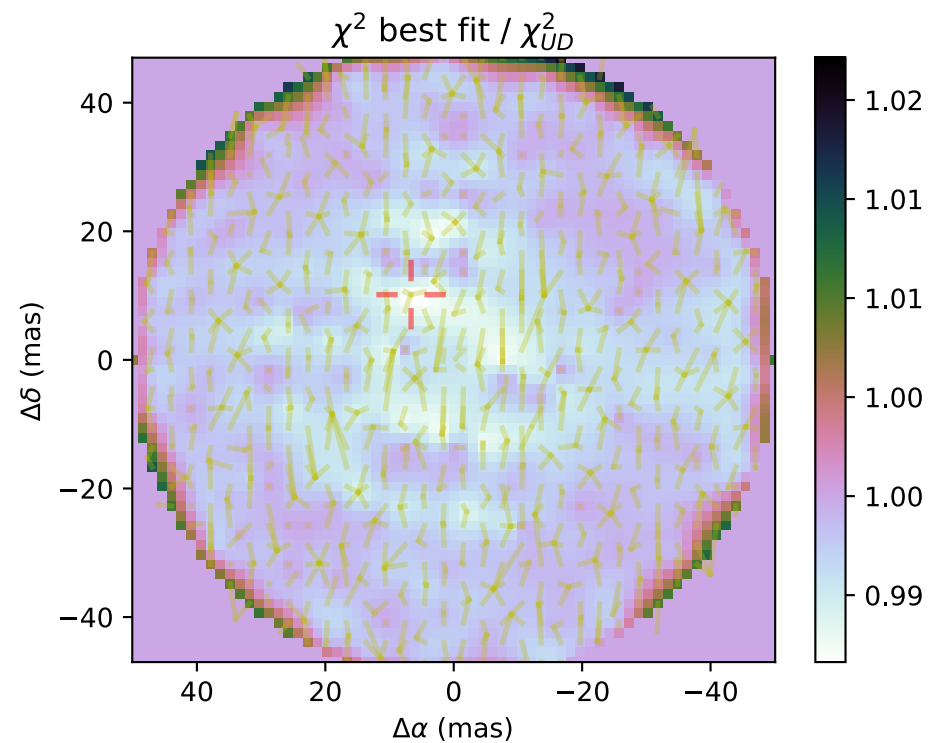
All observables

GRAVITY (ATs)

- Cepheid ℓ Car, $H = 1.2\text{mag}$, $\sim 20\text{mn}$ on target

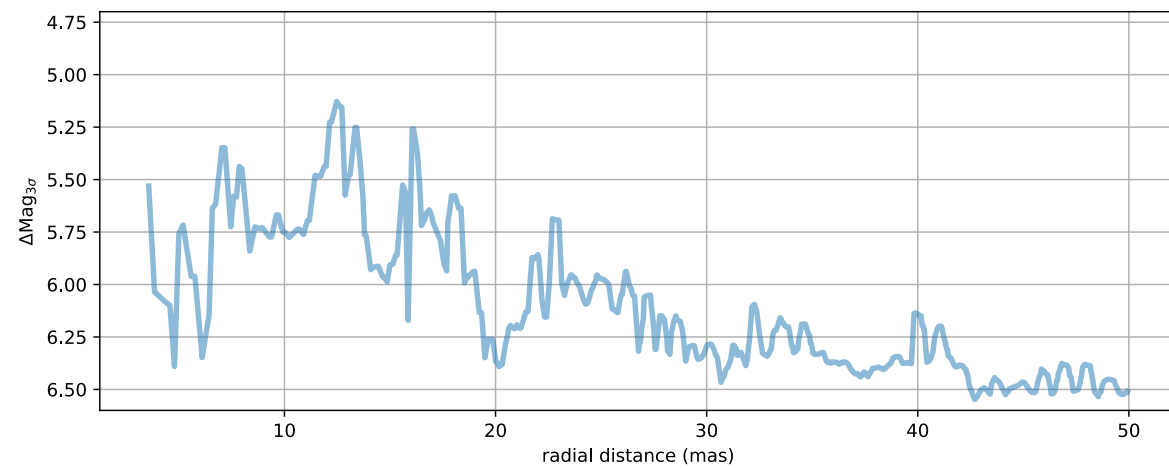
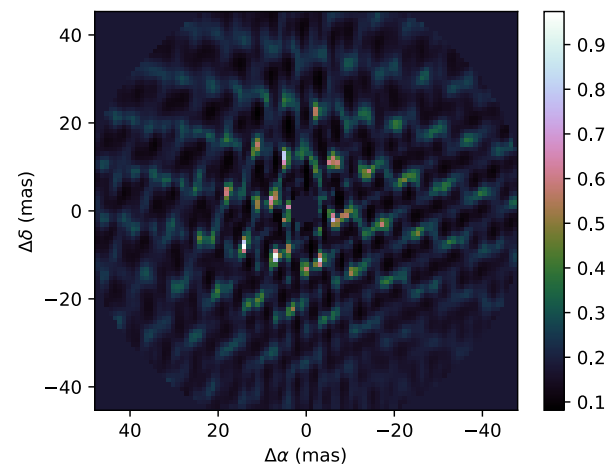


- $\sigma_{\text{median}} = 0.01^\circ$
- $\sigma_{\text{min}} = 0.001^\circ$
- $\sigma_{\text{max}} = 1^\circ$

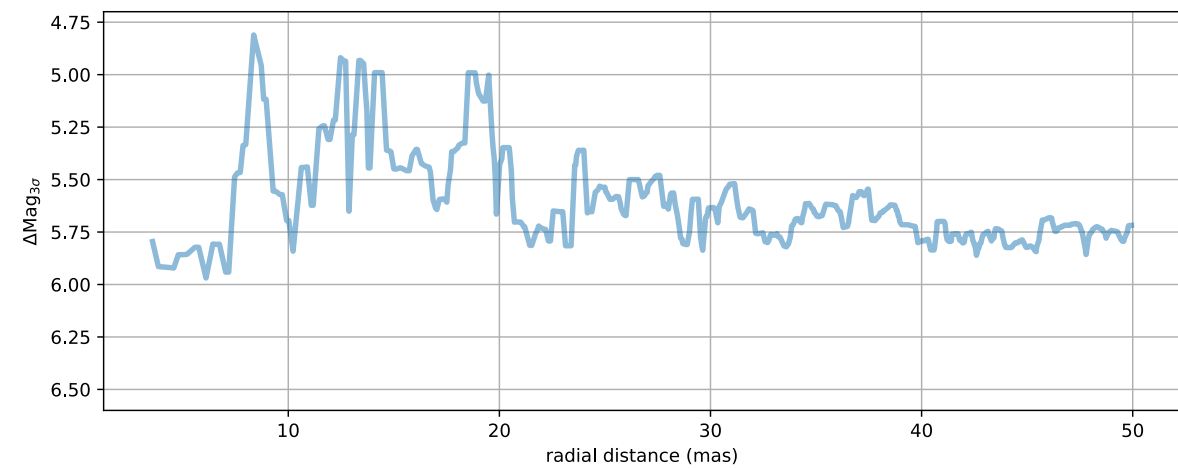
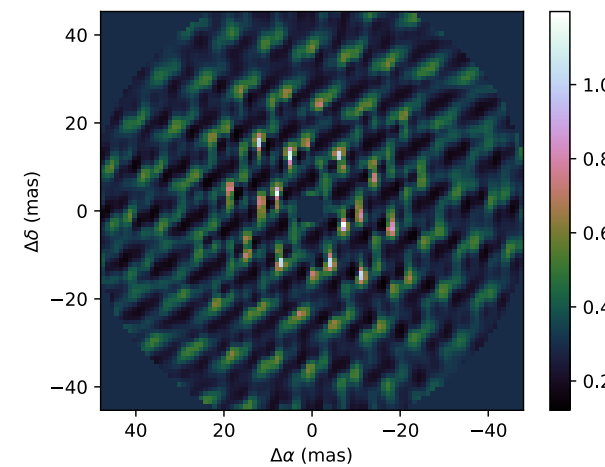


No companion
detected $> 3\sigma$

GRAVITY (ATs)



CP only



All observables

Overall detection limits

	Detection Limits
MIRC	6-6.5 mag ~ 0.3% ~ 1/300
PIONIER	5.5-6 mag ~ 0.5% ~ 1/200
GRAVITY	6-6.5 mag ~ 0.3% ~ 1/300