Search for companions with PIONIER : "the exozodi sample"

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Context : why searching for companions in the exozodi sample ?

➤ Stars especially chosen to be WITHOUT companions

➤ Hard to know if the IR excess is caused by a disk or a companion

➤ Possibility to extract/refine some statistics ?

➤ Lot of data available ➔ just need a student to search in…

Which limitations to PIONIER view ?

➤ The use of single mode fibers :

• FWHM estimated to 400 mas ;

➤ Overlapping of the fringe packets
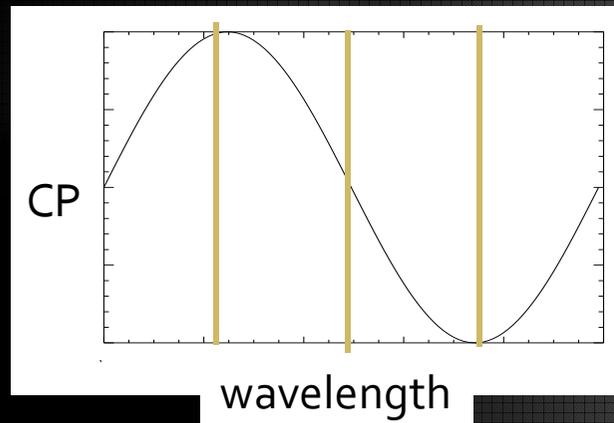associated to the star and the companion
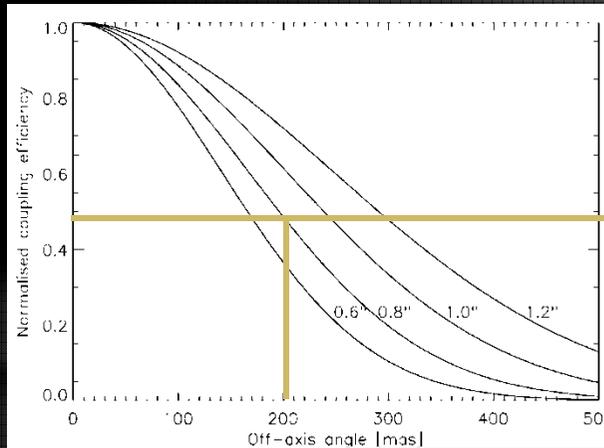
• B = 40m ➜ ≈ 100 mas;

➤ Good spectral sampling

• Period ~ $\lambda^2/B\Delta\theta > 4\Delta\lambda$

• B = 40m ➜ ≈ 85 mas

➤ Use 100 mas as a FoV

CP

wavelength

4 spectral channels

Which method to use ?

- Compute a binary model
- Compare model and data for each position (x,y) and for each contrast r in a given range ➜ a cube $\chi^2(x,y,r)$
- Doing this for CP, V2 and both

$$\chi^2_{comb} = \sum_k \frac{\left(V^2_{mod,k,\lambda} - V^2_{data,k,\lambda}\right)^2}{\sigma^2_{V^2,k,\lambda}} + \sum_k \frac{\left(CP_{mod,k,\lambda} - CP_{data,k,\lambda}\right)^2}{\sigma^2_{CP,k,\lambda}}$$

- Minimizing the cube
- Same method as O.A (2011) BUT...

- Discriminate between disks and companions
    ➡ if detection in the combined chi square + in CP and in V2 => companion
    ➡ if detection in V2 only => disk
    ➡ if detection in CP only => false positive or (?)
    ➡ better systematic rejection of the false positive (if detection in the closure phase but not in the square visibility, then the combined chi square shows generally no detection)
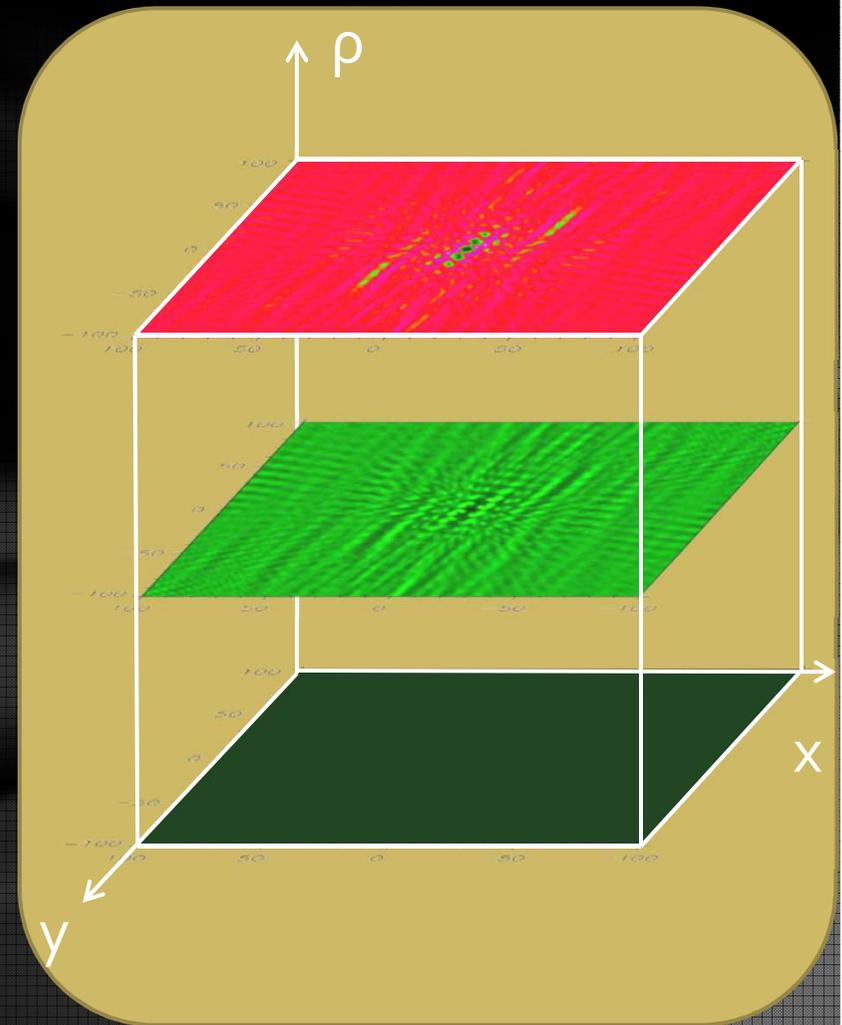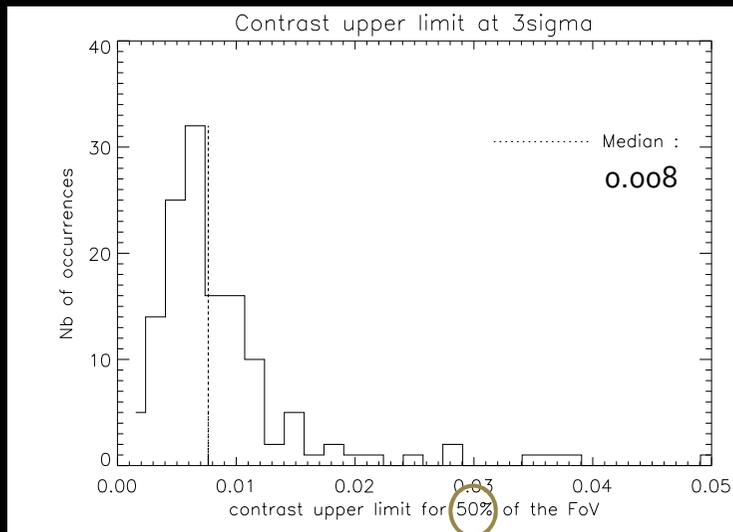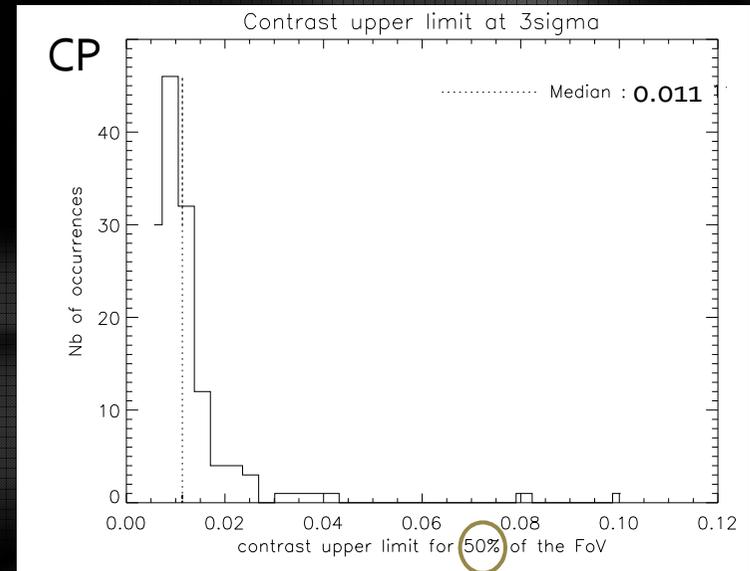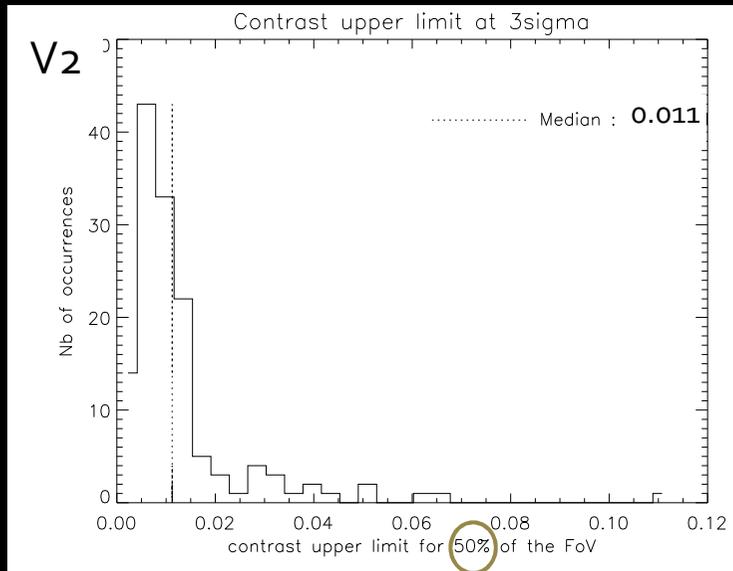
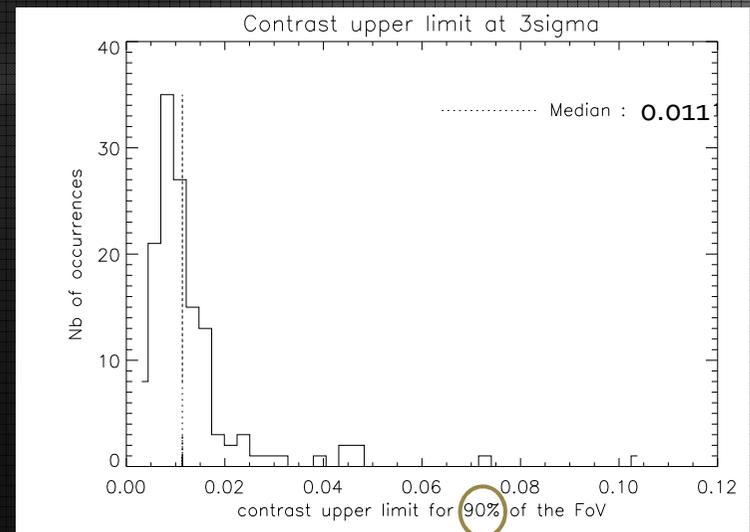# Which criterion of detection ?

3σ, 4σ, something else?
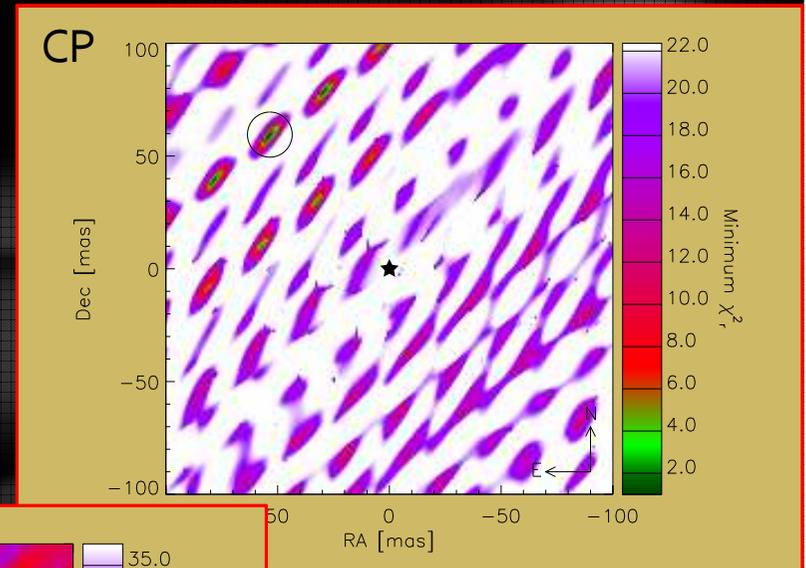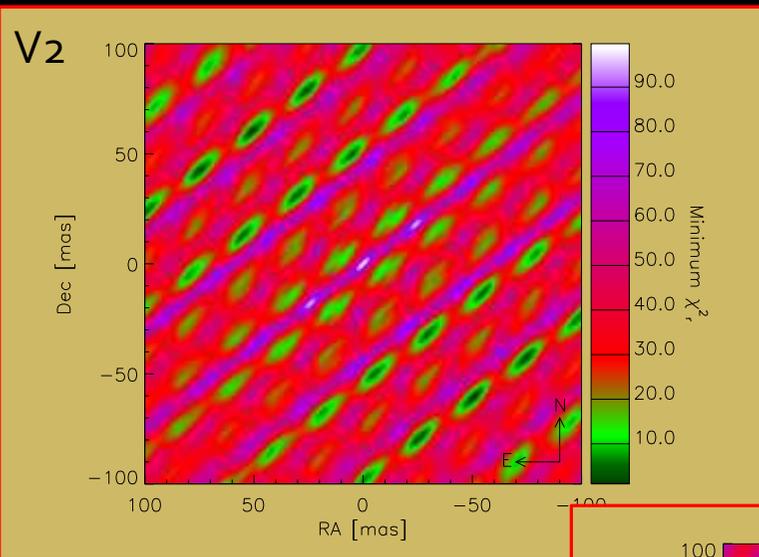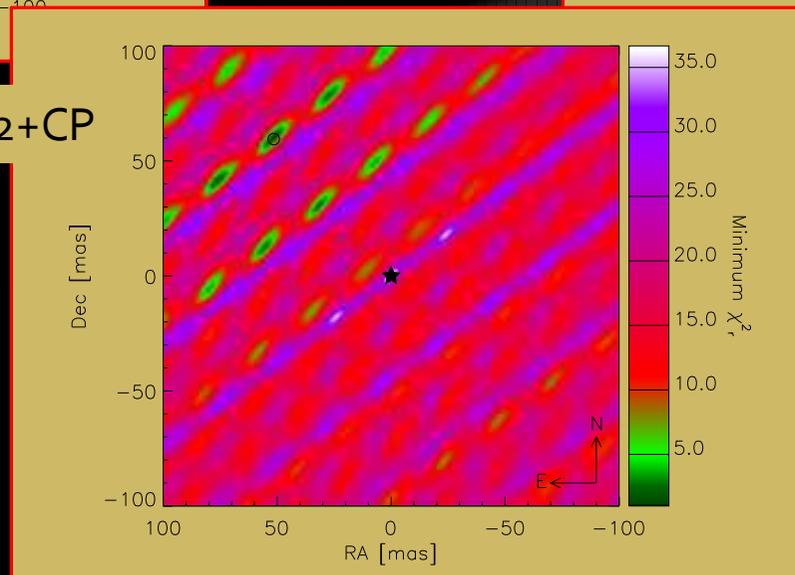
3σ seems OK…But…
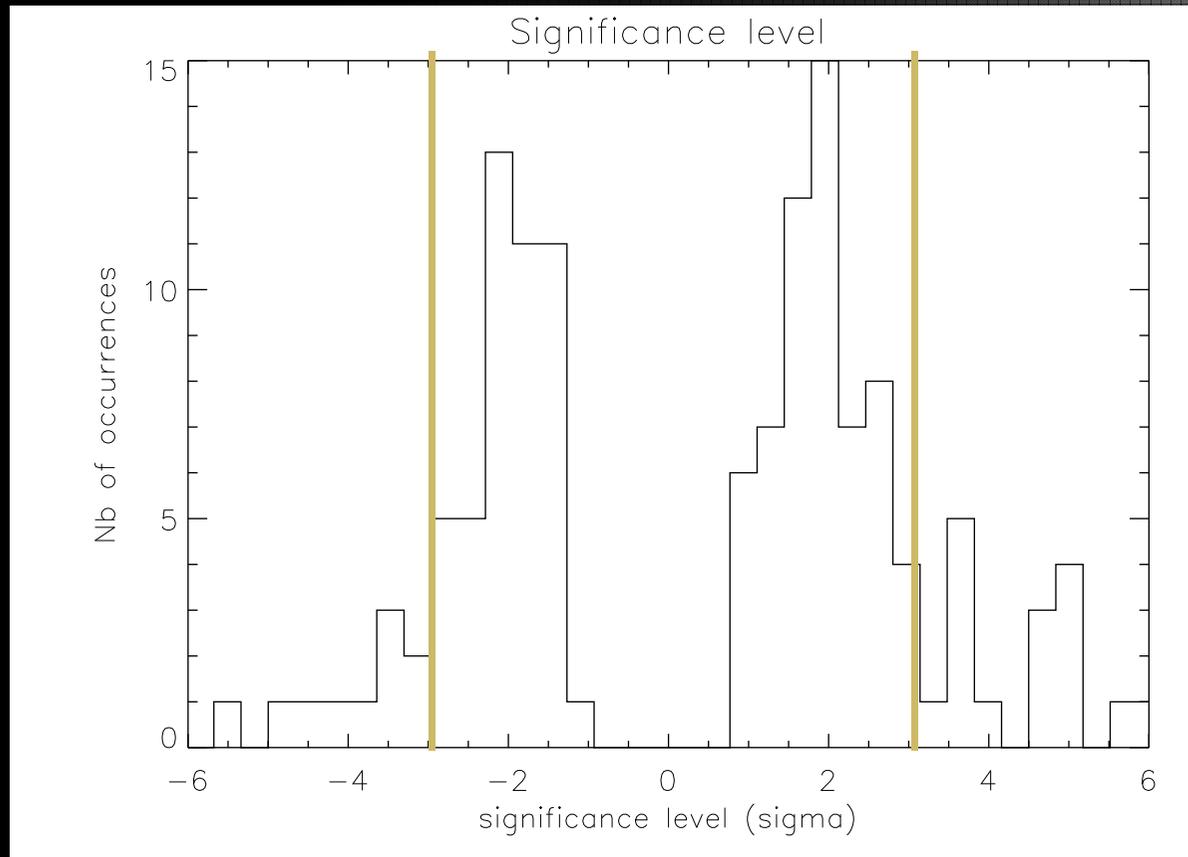
A word on the PIONIER sensitivity ?

Are there some new companions ?

HD16555

Are there some new companions ?

YES! 4 confirmed, 1 to be explored in more details (tbd with S. Borgniet)

| Name	Date	Significance (cp+v2) --σ	Significance cp --σ	Significance v2--σ	Best position In the FoV δθ (mas)	α (deg)	Best fit Contrast -- (%)
HD4150	17-12-12	4.11	8.82	4.73	89.56	39.53	2.46
	08-08-13	22.52	29.25	43.84	96.75	350.65	3.82
HD16555	18-12-12	106.20	8.04	219.17	78.69	49.27	48.50
HD29388	16-12-12	106.03	50.89	105.03	11.07	18.33	2.88
HD202730	24-07-12	11.47	8.58	21.02	61.74	111.15	87.69

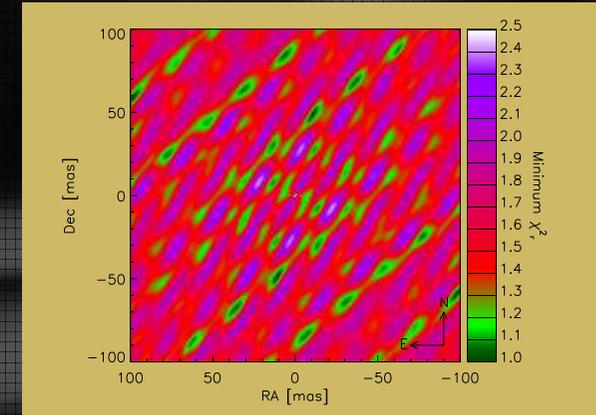**To be explored : HD224392**

The case of HD224392

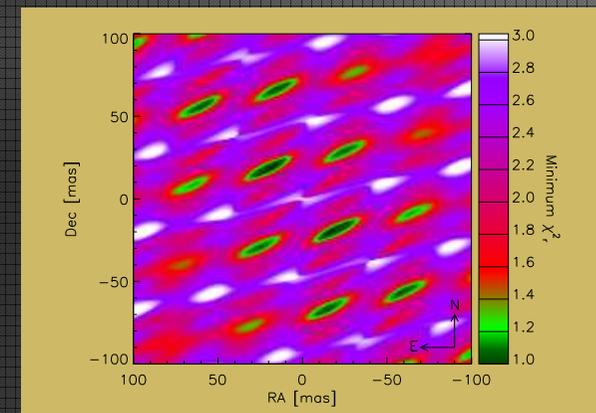26-07-2012 - detection level : 12.53σ - H band
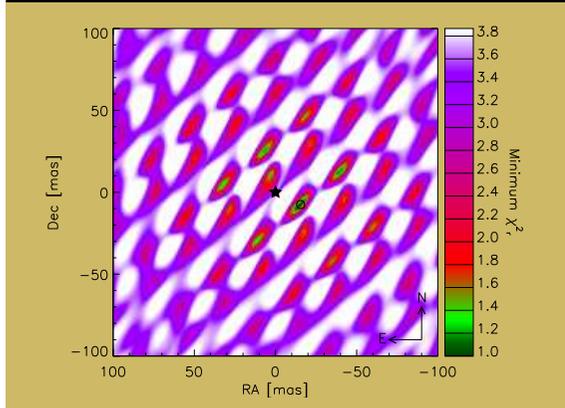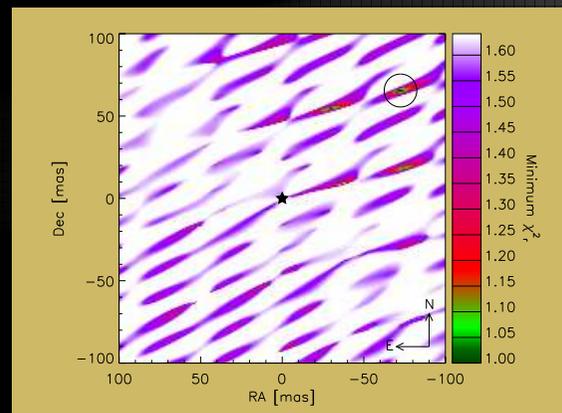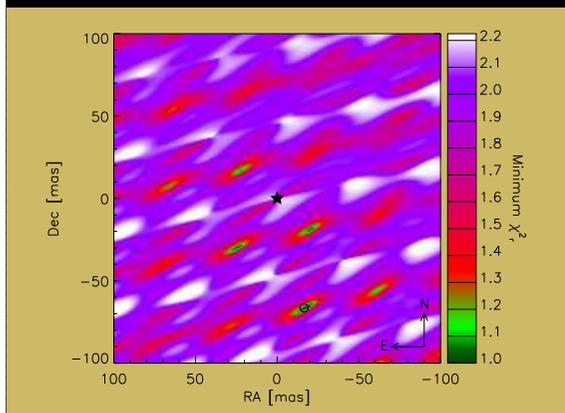

V2+CP
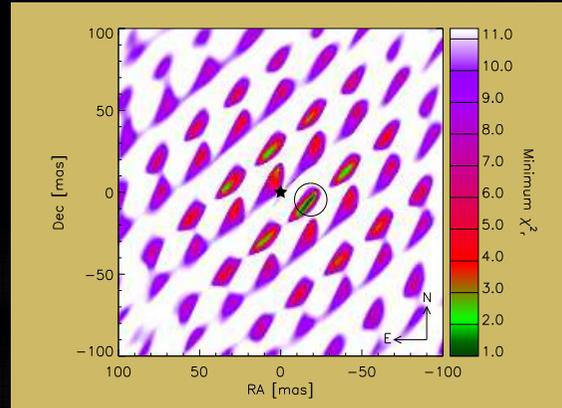
CP

V2

09-08-2013 – detection level : 5.96σ - K band... But where is the companion exactly?

Maybe the extent of the detection shows a disk?

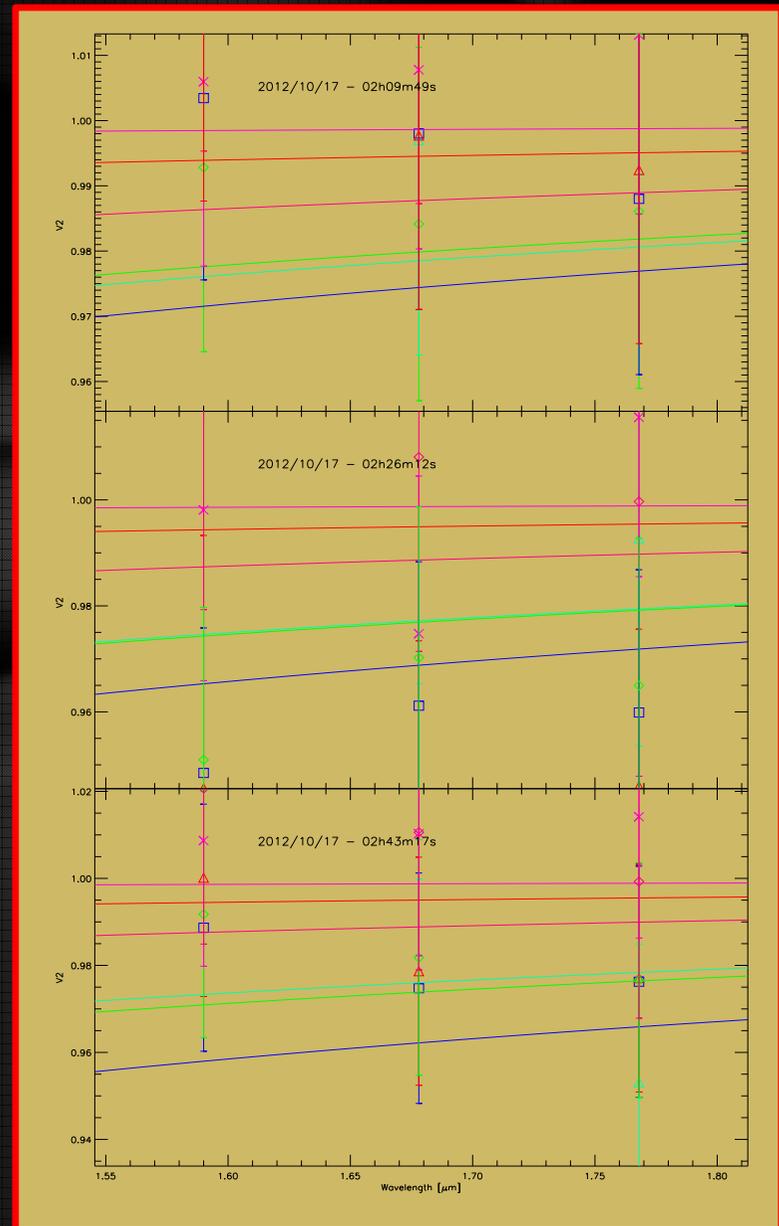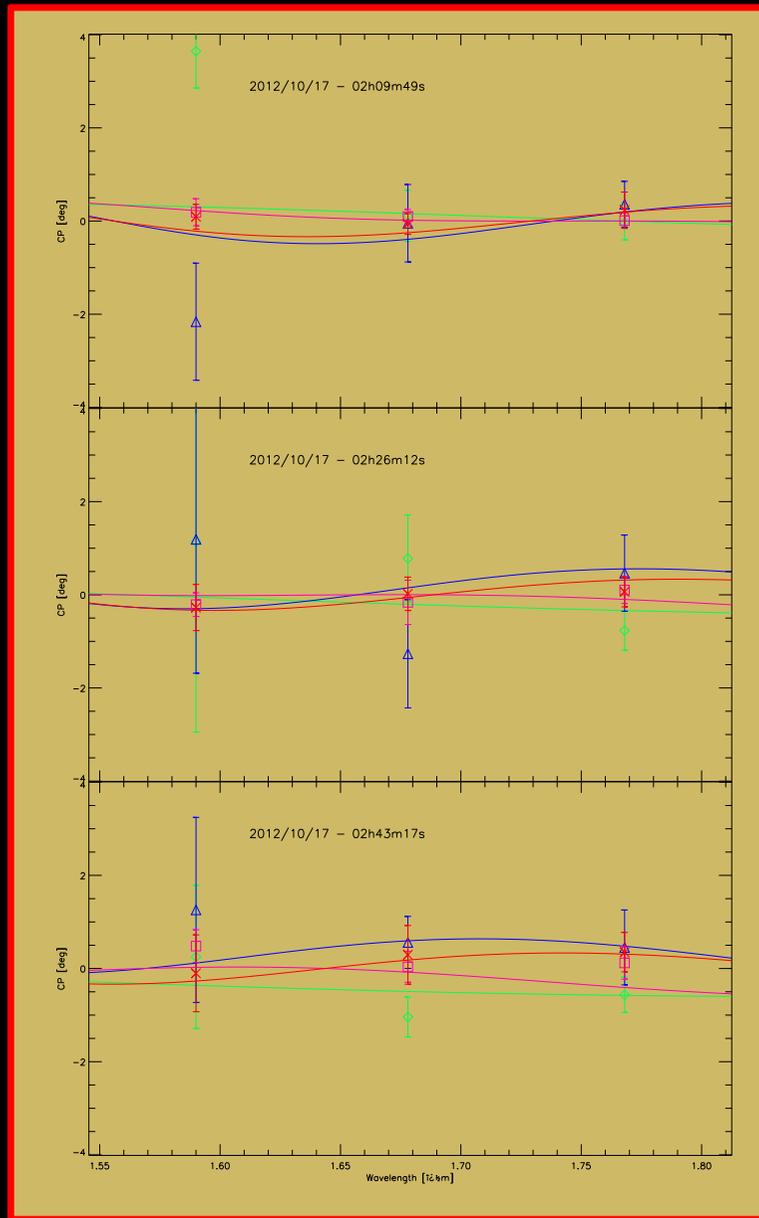# How could we conclude about the binaries in our neighborhood ?

- De Rosa et al. 2013 : 33.8±2.6% of A type star are binaries on a range of separation : 30-10000 AU (~0.4-140 arcsec)

- This study : 4 out of 101 stars were unknown binaries within 100 mas

- All of the detections were A type stars : 4 out of 30 A type stars were binaries (~13%)➜ Complete the survey of De Rosa

- The percentage of A type binaries in our neighborhood still needs to be refined

- Thanks to the sensitivity of PIONIER (~1% in contrast), we can conclude than the detection limit in terms of spectral type would be an M0 around A0 star to M7 around A5 star

Thank you for your attention!

CP/V2-Detection (HD16555)
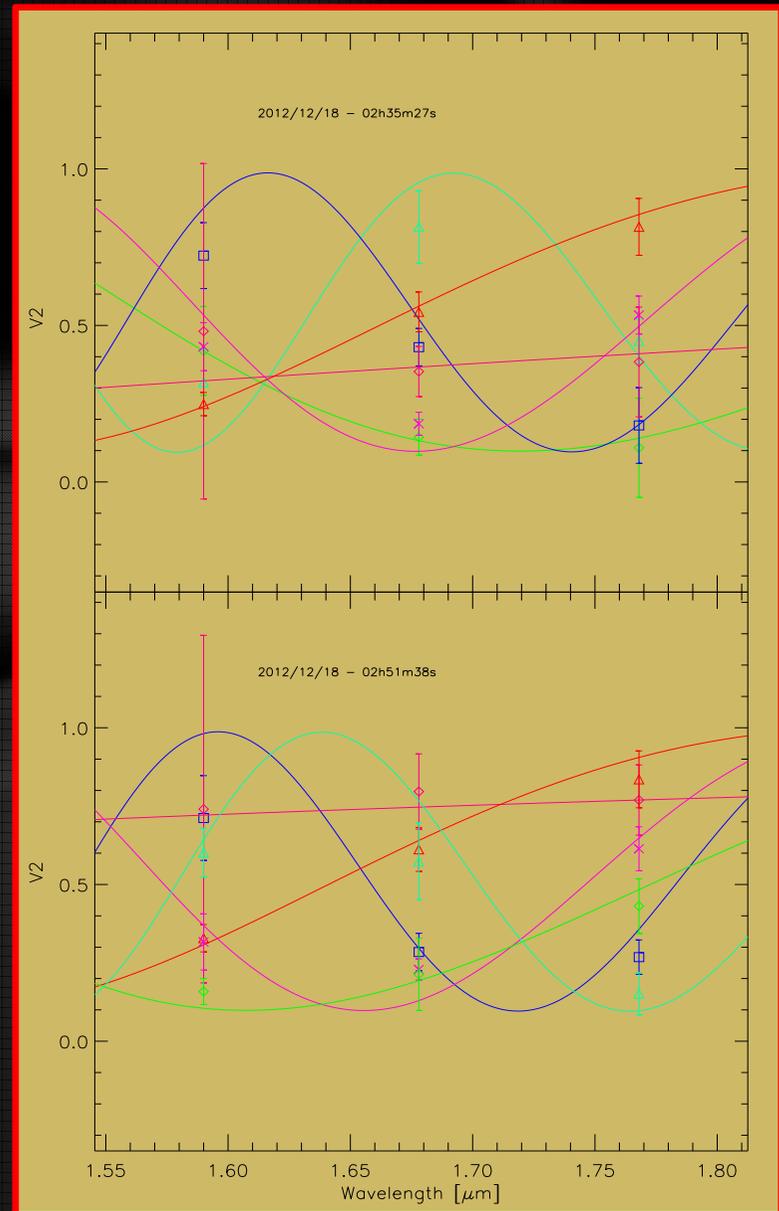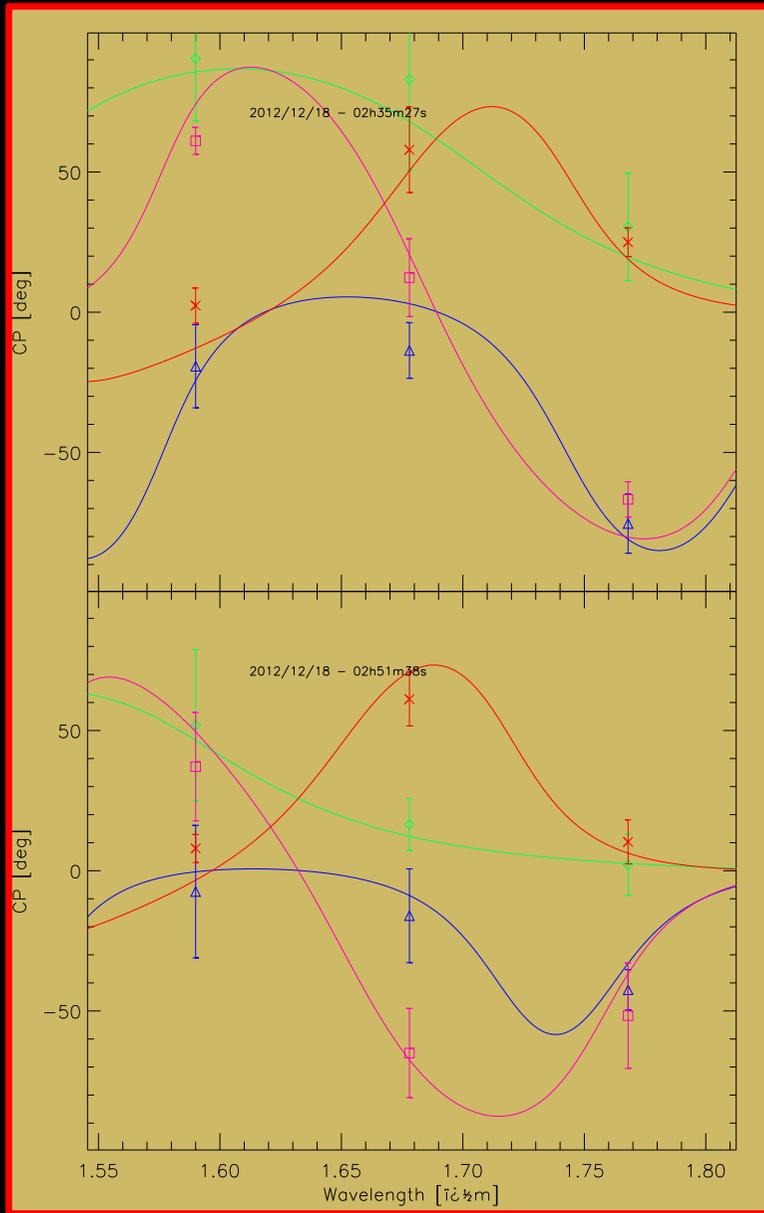
CP/V2-NON detection (HD3302)

CP/V2-FP detection (HD28355)