

Unveiling new stellar companions from the PIONIER exozodi survey: follow up

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ABSTRACT— In 2012, we have conducted a survey of nearby main sequence stars with VLTI/PIONIER to search for the presence of circumstellar dust. Here we focus on the use of the closure phases and the square visibilities in a combined way to search for faint companions in the whole sample (92 stars). In this process, we found 4 new stellar companions, on which we conducted a follow up in 2014. This follow up allows us to confirm three of the four detections (the case of HD202730 is not clear at this point), and to detect another new companion.

1. Search method

$$\chi_{comb}^2 = \sum_k \frac{(V_{mod,k,\lambda}^2 - V_{data,k,\lambda}^2)^2}{\sigma_{V^2,k,\lambda}^2} + \sum_k \frac{(CP_{mod,k,\lambda} - CP_{data,k,\lambda})^2}{\sigma_{CP,k,\lambda}^2}$$

- Compute a binary model and compare it to data both for closure phase (CP) and squared visibilities (V^2) using a χ^2 test
- Same method as in Absil et al. (2011), but...
- Discriminate between companion & disk
 - Detection in V^2 only → disk
 - Detection in CP only → to be checked
 - Detection in CP + V^2 → companion
- Provide better systematic rejection of false positive detection

2. Results from the first search: 2012

Name	Date	Significance for CP+ V^2 (σ)	Spect. type	Best position in the FoV		Best fit Contrast (%)
				$\delta\theta$ (mas)	PA (deg)	
HD4150	17-12-12	7.7	AoIV	90.5±2.2	-84.0±2.2	2.3±0.4
HD16555	18-12-12	105.3	A6V	78.7±1.6	-40.9±0.3	51.3±4.3
HD29388	16-12-12	111.9	A6V	11.1±0.2	-71.6±0.05	3.0±0.2
HD202730	24-07-12	12.2	A5V	61.7±1.2	21.4±0.8	87.4±14.1

- 4 A-type binaries previously unknown
- De Rosa et al. (2013): $33.8 \pm 2.6\%$ of A type stars are visual binaries with separations ~0.4-140 arcsec.
- This work: 4 of 31 A type stars are binaries (< 0.1 arcsec)
- Increases the total occurrence rate to 47% of visual binaries

3. Follow-up : 2014

Name	Date	Significance for CP+ V^2 (σ)	Spect. type	Best position in the FoV		Best fit contrast (%)
				$\delta\theta$ (mas)	PA (deg)	
HD4150	17-12-12	7.7	AoIV	90.5	-84.0	2.3±0.4
	08-08-13	29.3		96.8	-99.2	4.1±0.4
	12-10-14	15.0		98.5	68.2	4.1±0.5
HD16555	18-12-12	105.3	A6V	78.7	-40.9	51.3±4.3
	12-10-14	843.9		-53.9	154.1	64.8±5.0
HD29388	16-12-12	111.9	A6V	11.1	-71.6	3.0±0.2
	12-10-14	65.3		12.7	48.2	2.7±0.3
HD202730	24-07-12	12.2	A5V	61.7	21.4	87.4±14.1
	12-10-14	< 3.1		--	--	< 1.3
HD219402	13-10-14	8.6	A3V	59.5	-74.9	20.9±4.8

4. The disappearance of HD202730

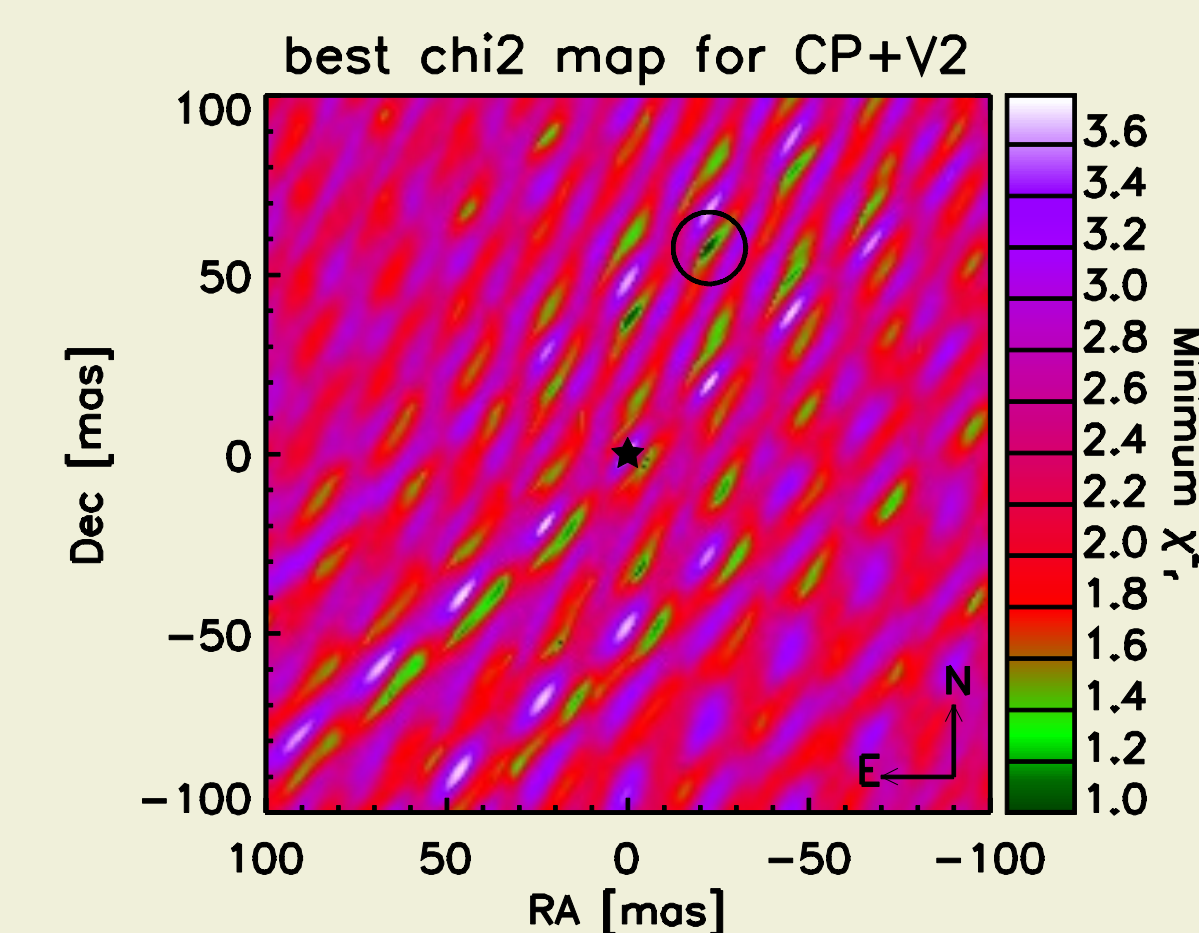


Fig. 1: χ^2 map for the 2012 CP + V^2 , showing the best position for the companion in the PIONIER FoV

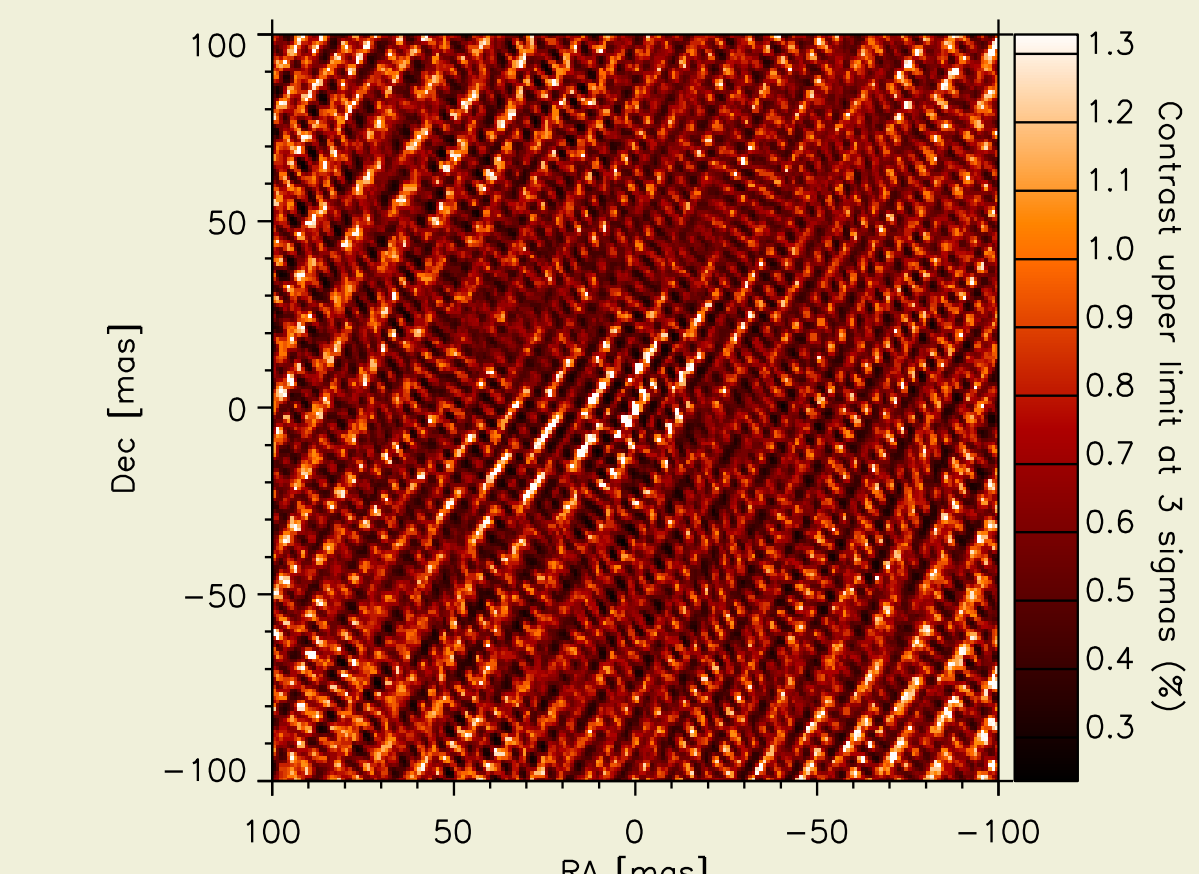


Fig. 3: Contrast upper limit at 3 sigma in the PIONIER FoV for the 2014 data

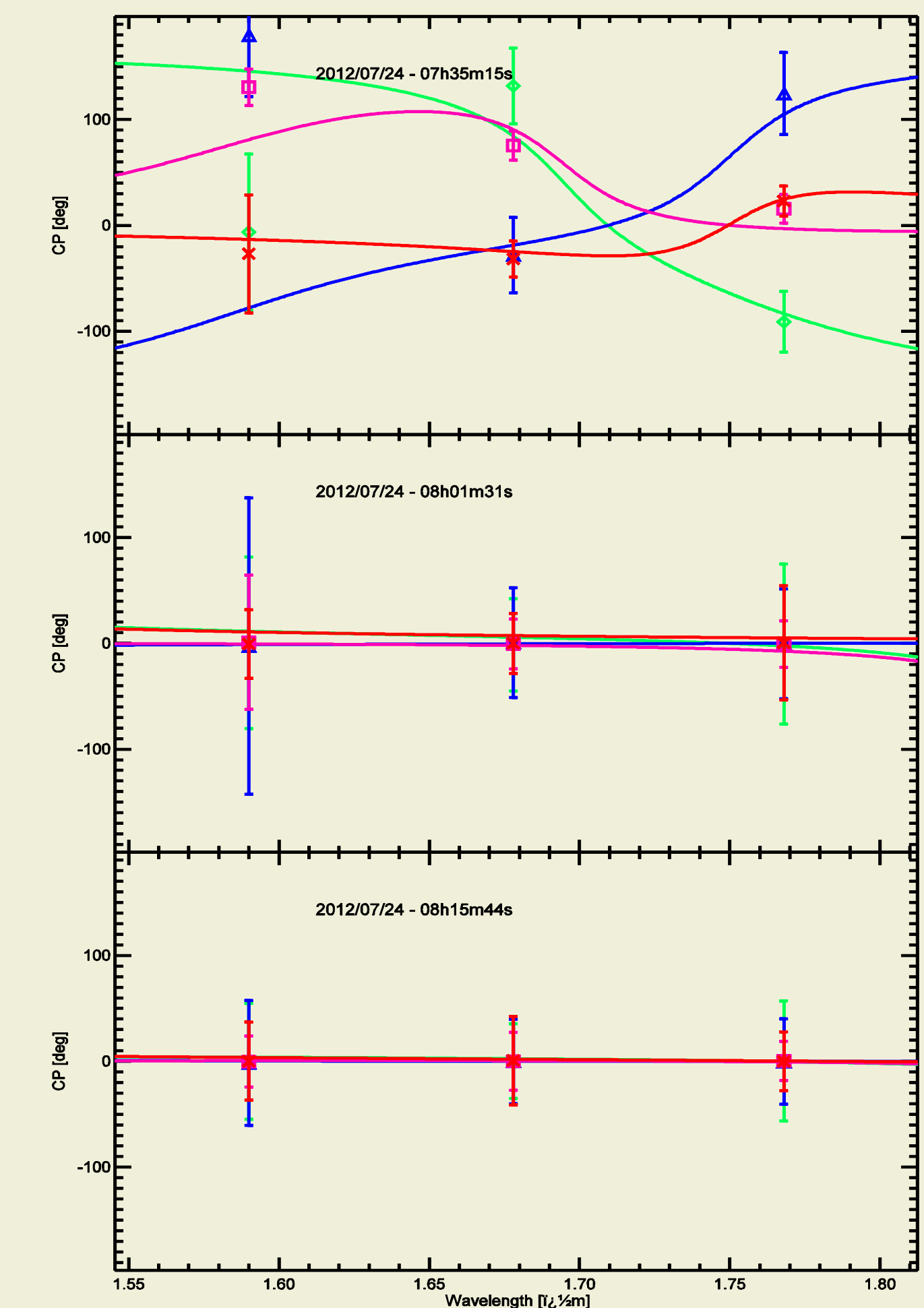


Fig. 2: CP as a function of wavelength on the four PIONIER triplets (=colors) in the 2012 data, and best fit model

- Orbital analysis using the Pearce et al. (2015) model
- Companion may have left the FoV of PIONIER
- Semi major axis > 0.93 AU, no constraint on eccentricity

5. The new detection : HD219402

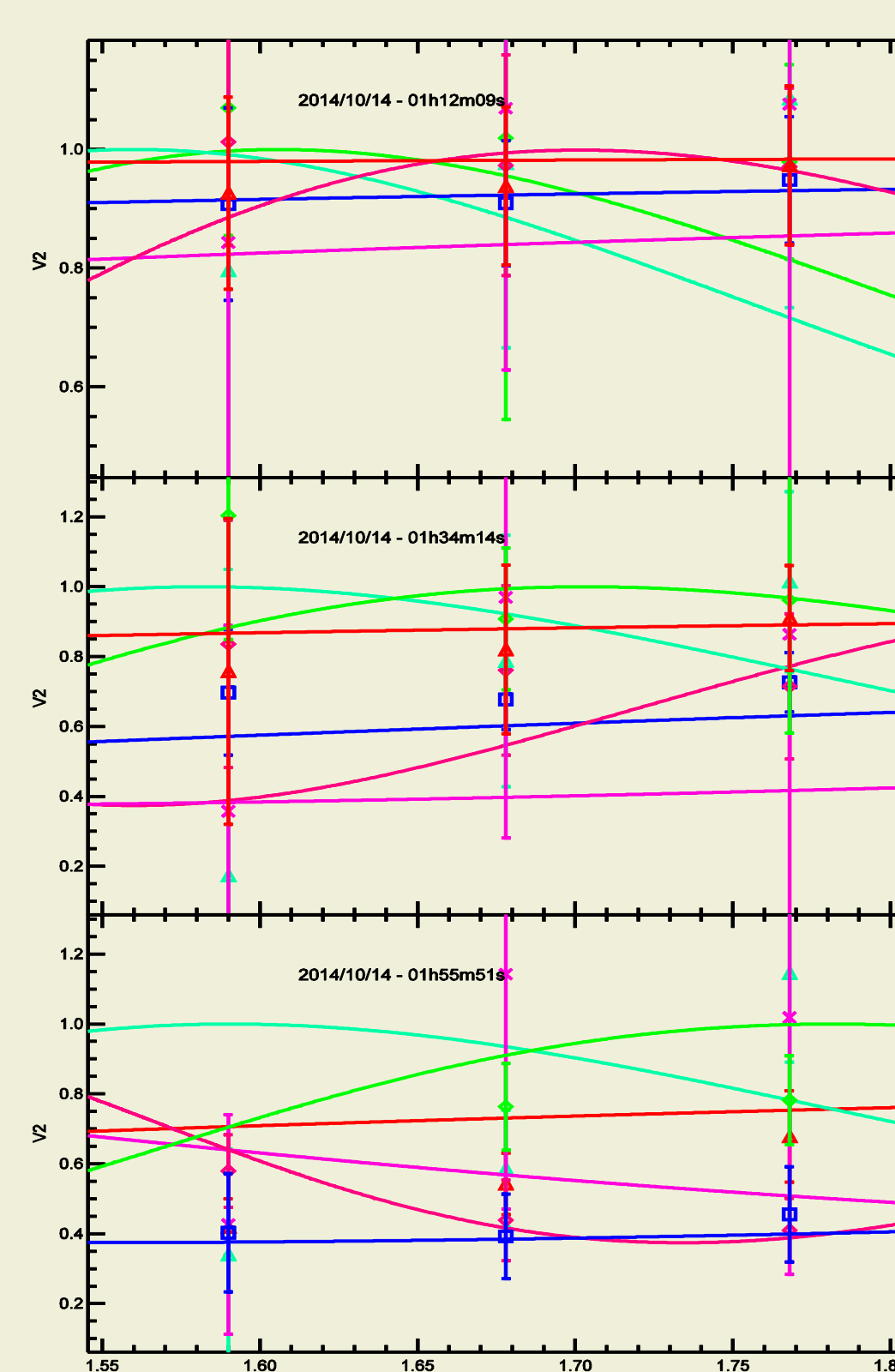


Fig. 4: V^2 as a function of wavelength on the six PIONIER baselines (=colors) for the three collected OBs, and best-fit model

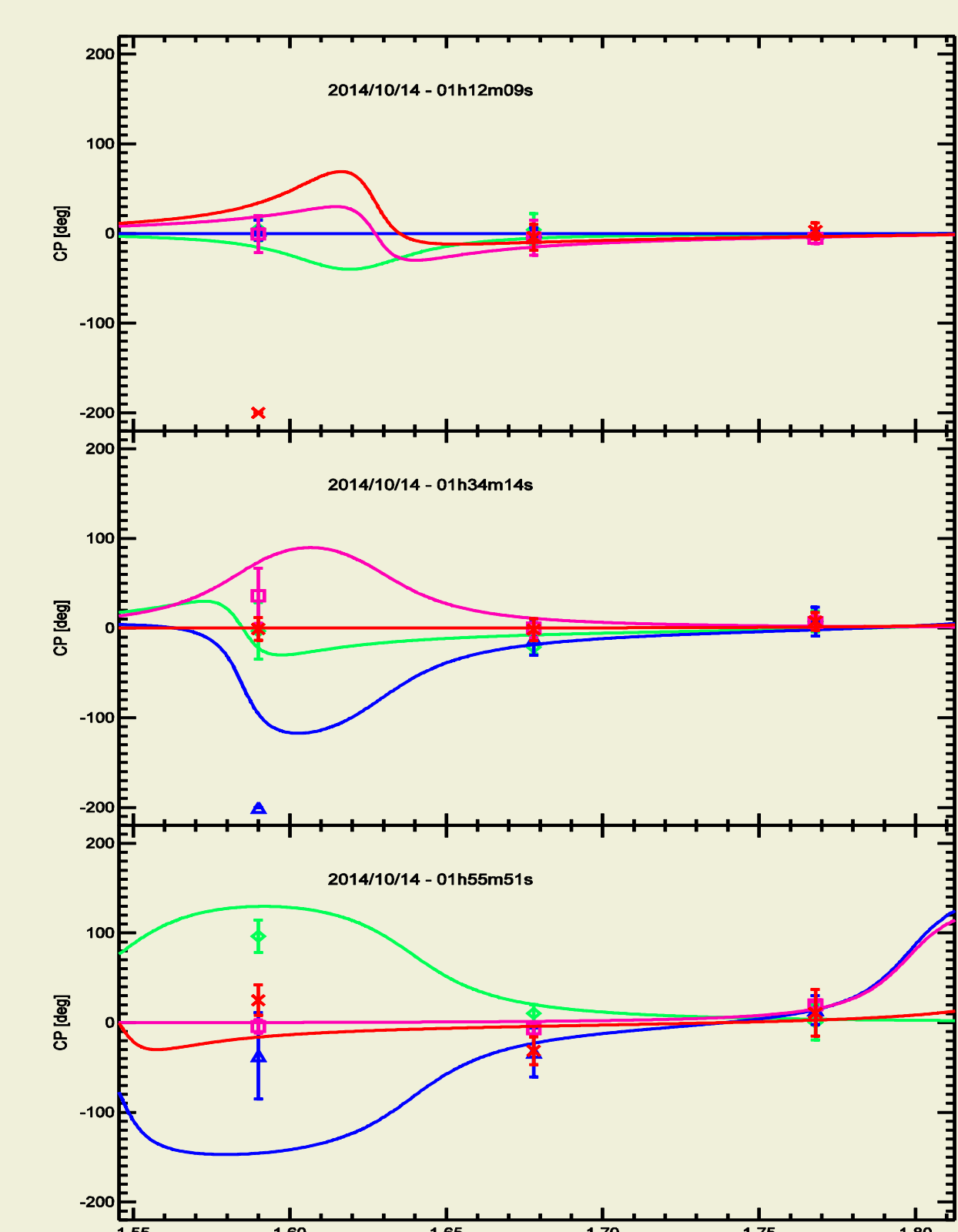


Fig. 5: CP as a function of wavelength on the four PIONIER triplets (=colors) for the three collected OBs, and best-fit model

6. Conclusion

- 3/4 confirmed binaries (w/ orbital motion), 1 new binary
- Revised binary statistics for A-types stars, but a gap remains in the 0.1 - 0.4 arcsec regime for A-type visual binaries