Self Calibrating Multiple Systems

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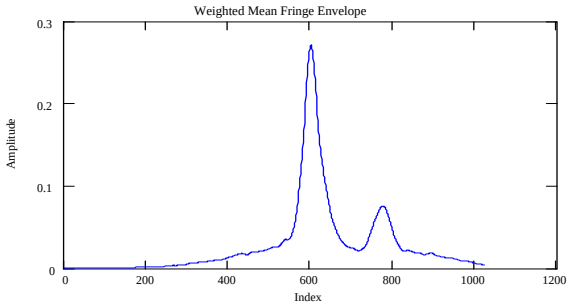
Project overview

- Find hierarchical triple systems where:
  - the close binary and the wide component are at a suitable separation to create two fringe packets
  - the wide component would be a good calibrator for the close binary
- Orbits derived for these binaries will give mutual inclinations between the close and wide orbit



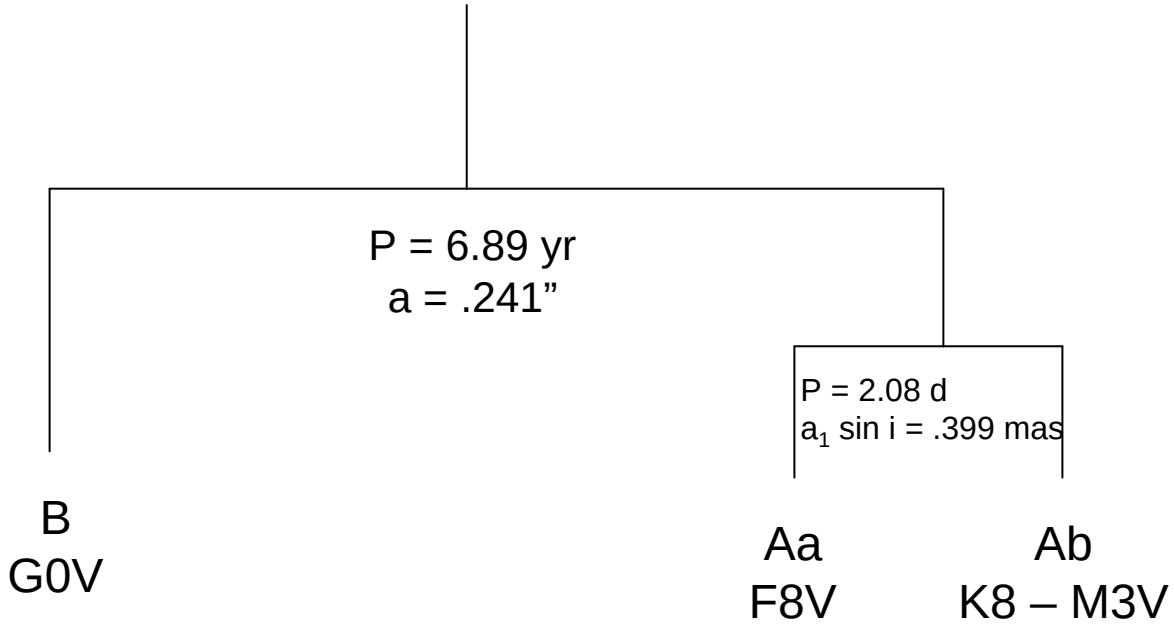
Current Progress

- Main target list
  - HD 3196 = 13 Ceti: Orbit fit almost finished
  - HD 35411 = η Ori: Orbit not yet giving reasonable physical results
  - HD 129132, 157482, & 206901: data reduction in progress
  - HD 98353 & 107259: not enough data yet

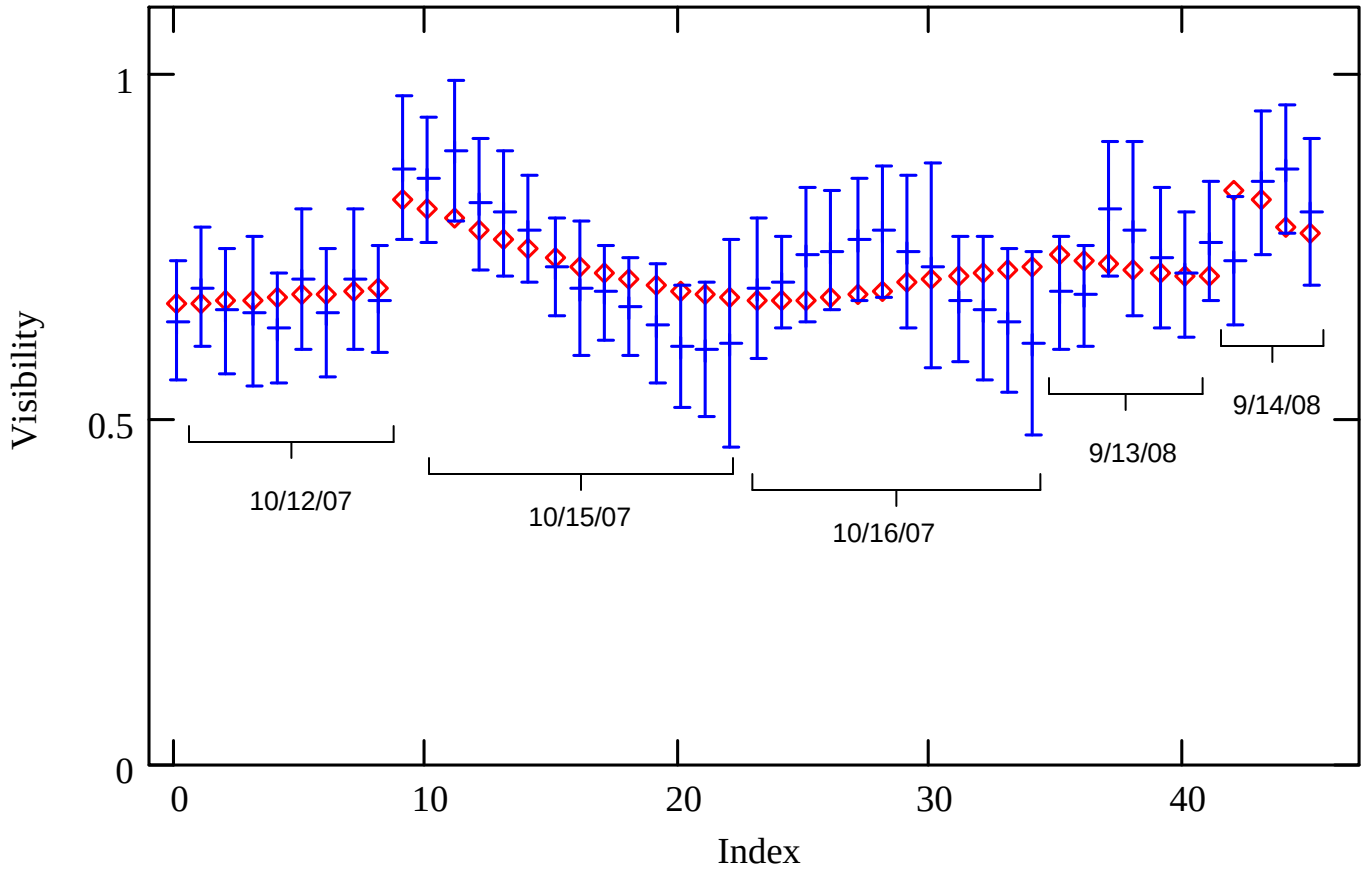
Current Progress

- Auxiliary targets:
  - Last season, bracketed observations of 2 targets were conducted when their SFPs were too far apart to observe simultaneously
  - This led to an expansion of my target list to include targets with a larger separation between components
  - 40 new targets found using A. Tokovinin's "Multiple Star Catalog"

HD 3196 (13 Ceti)

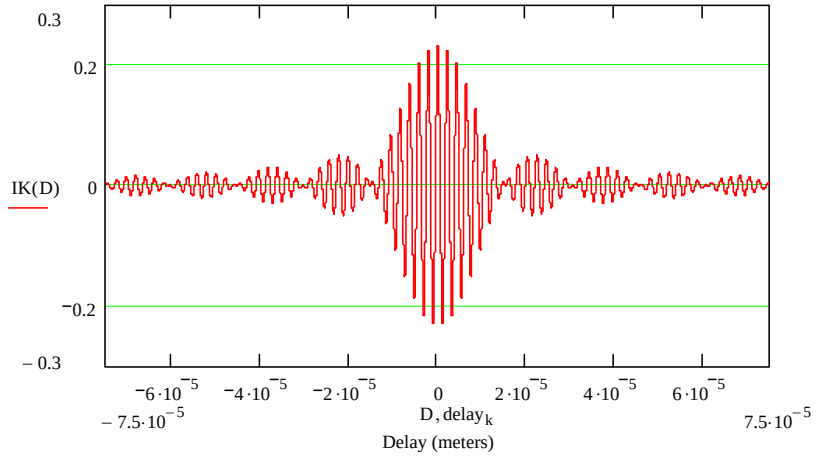


HD 3196 (13 Ceti)

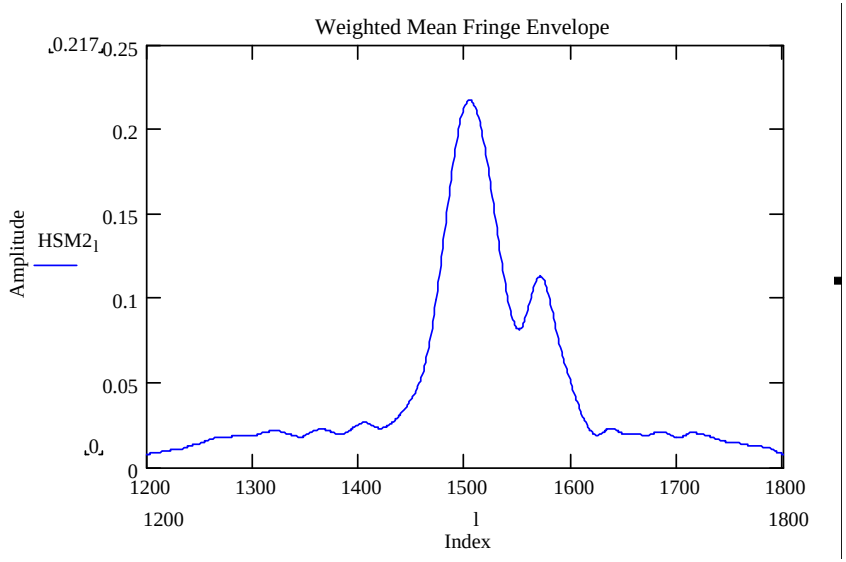


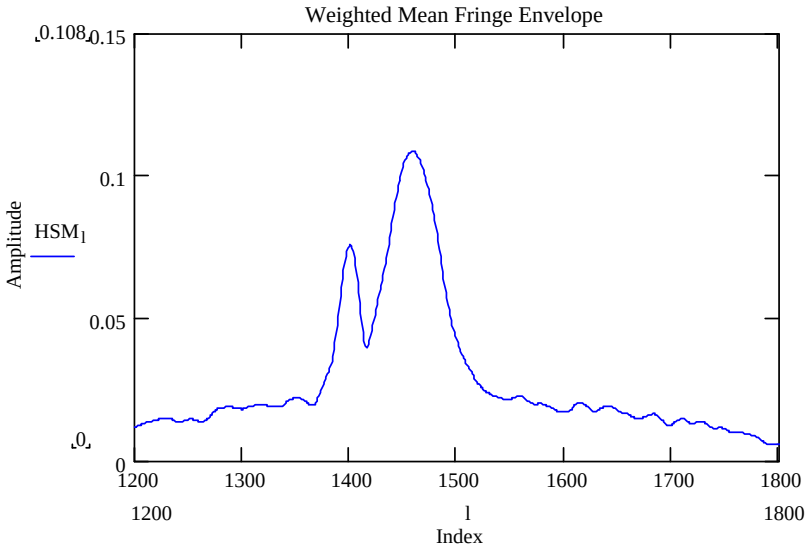
HD 3196 (13 Ceti)

- Systematics present on data from nights 10/15/07 & 10/16/07
- Explanation: interference between secondary fringe packet with side lobe(s) of the primary fringe
- Based on the wide orbit from the Multiple Star Catalog, the secondary should lie right in the area of the first side lobe



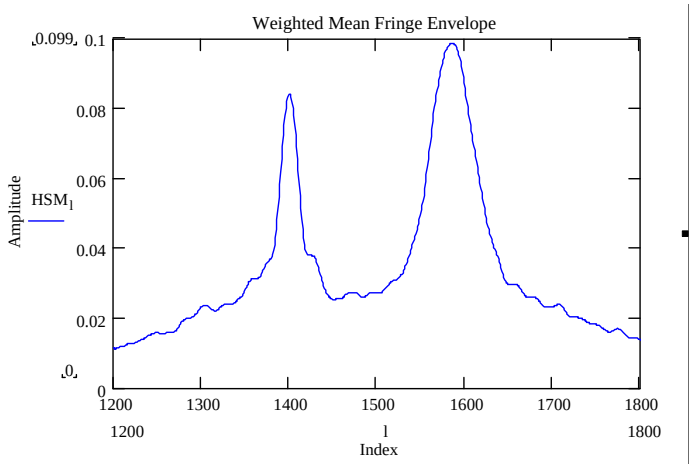
HD 3196 (13 Ceti)





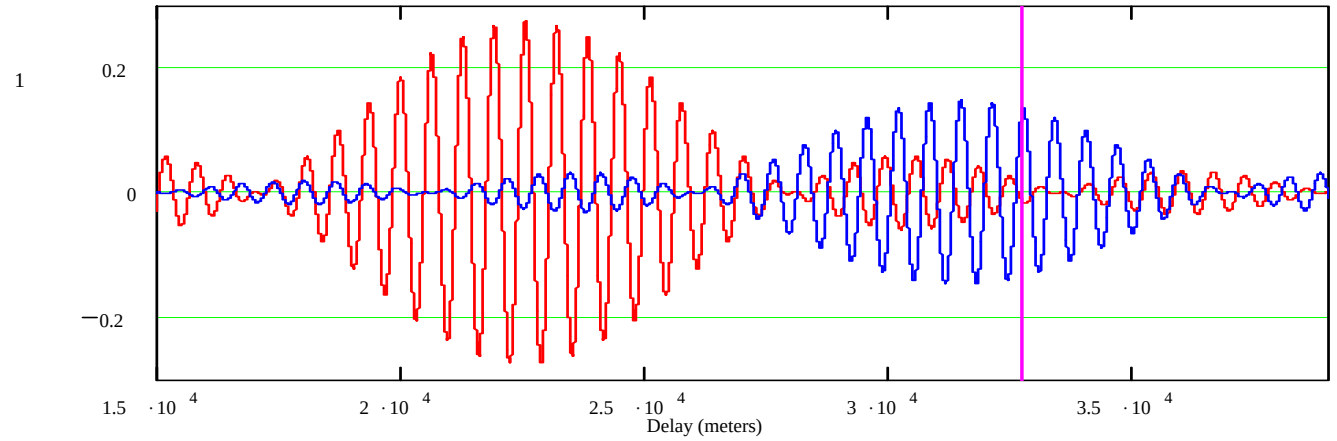
Systematics in data
(10/15 & 10/16)

No systematics in data
(10/12)



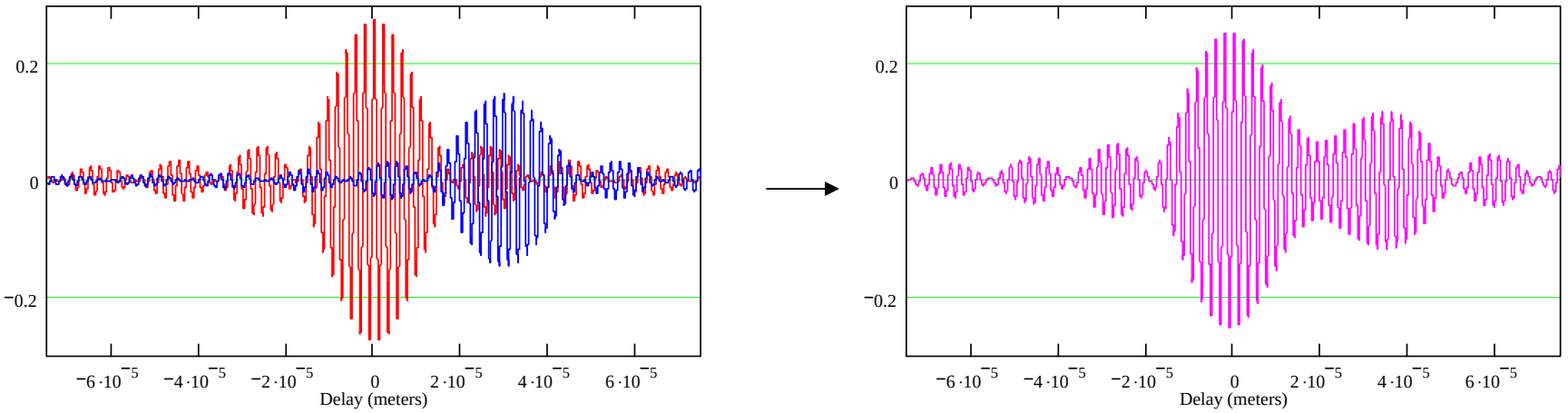
Fringe Interference on 10/15/07

- Over the interval during which data were taken, the secondary moves about 2/3 of the distance between fringes (not fringe packets), relative to the primary
  - From destructive interference, through a null, to constructive interference



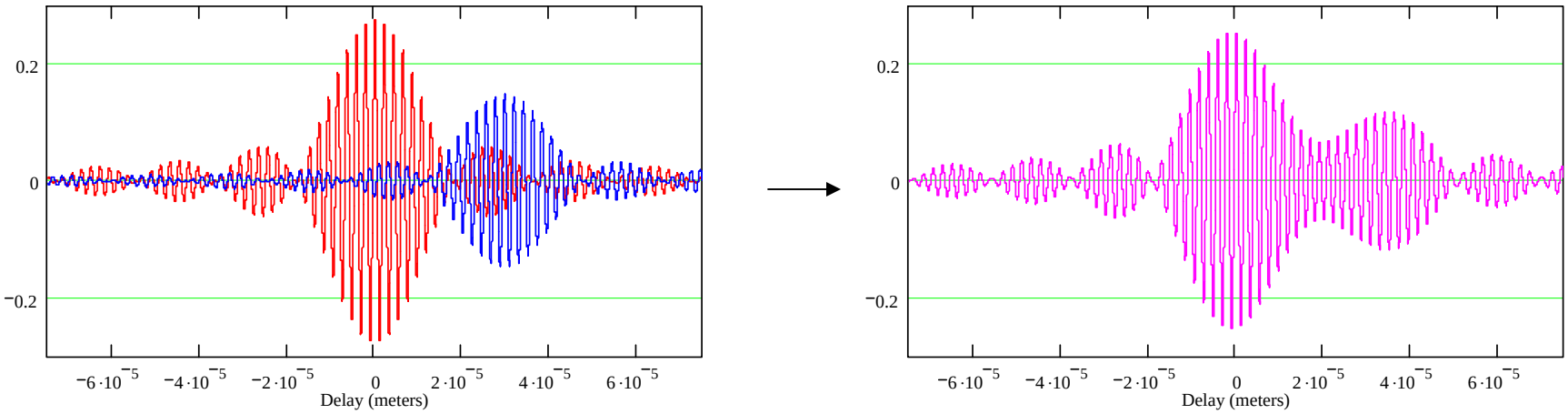
Correcting for visibilities

- Observed (uncorrected) visibilities from this data set:
  - $V_p = .252$, $V_s = .118$
- With fringes in this position visibilities of $V_p = .275$ & $V_s = .148$ will destructively interfere to give resulting visibilities of $V_p = .252$, $V_s = .118$



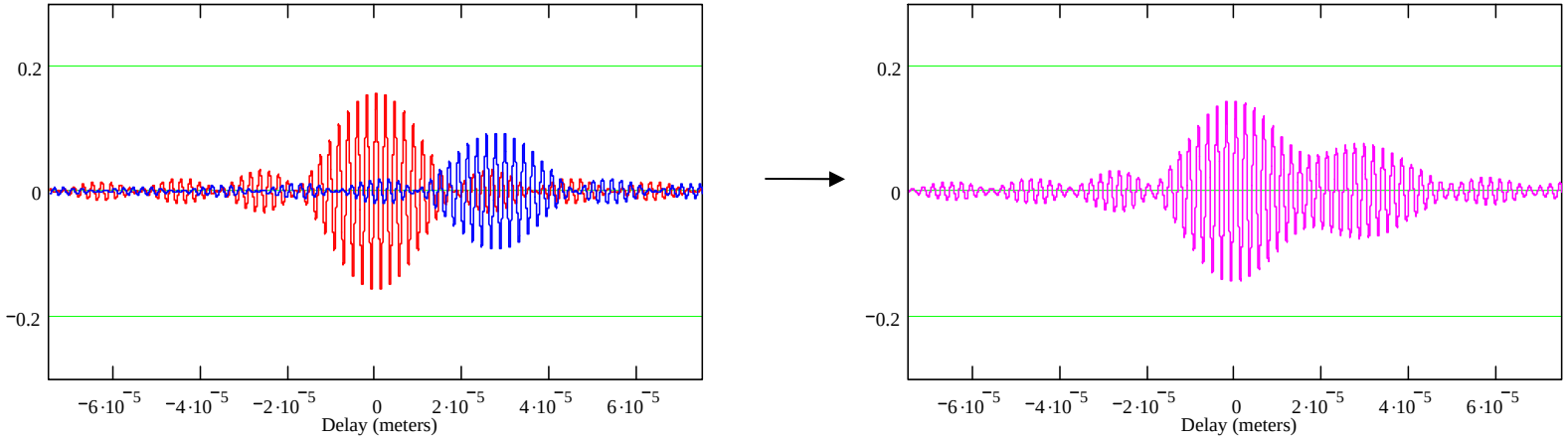
Correcting for visibilities

- This corresponds to the visibility ratio changing from an observed value of $V_p/V_s = 2.14$, to a corrected value of $V_p/V_s = 1.86$

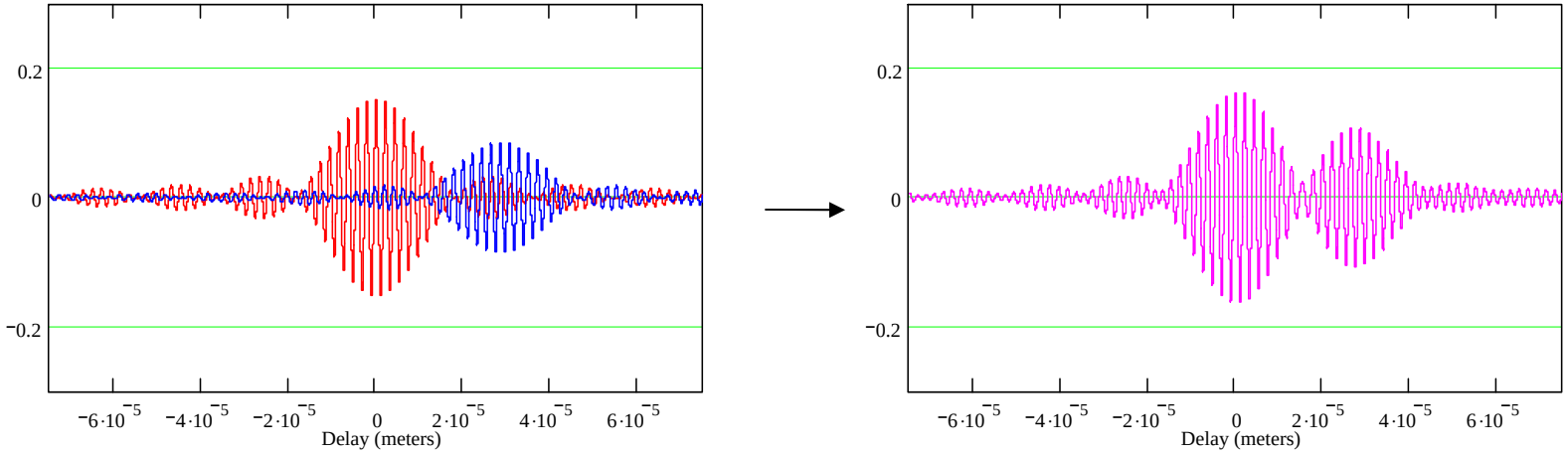


Fringe Interference on 10/16/07 (over 1.65 hrs)

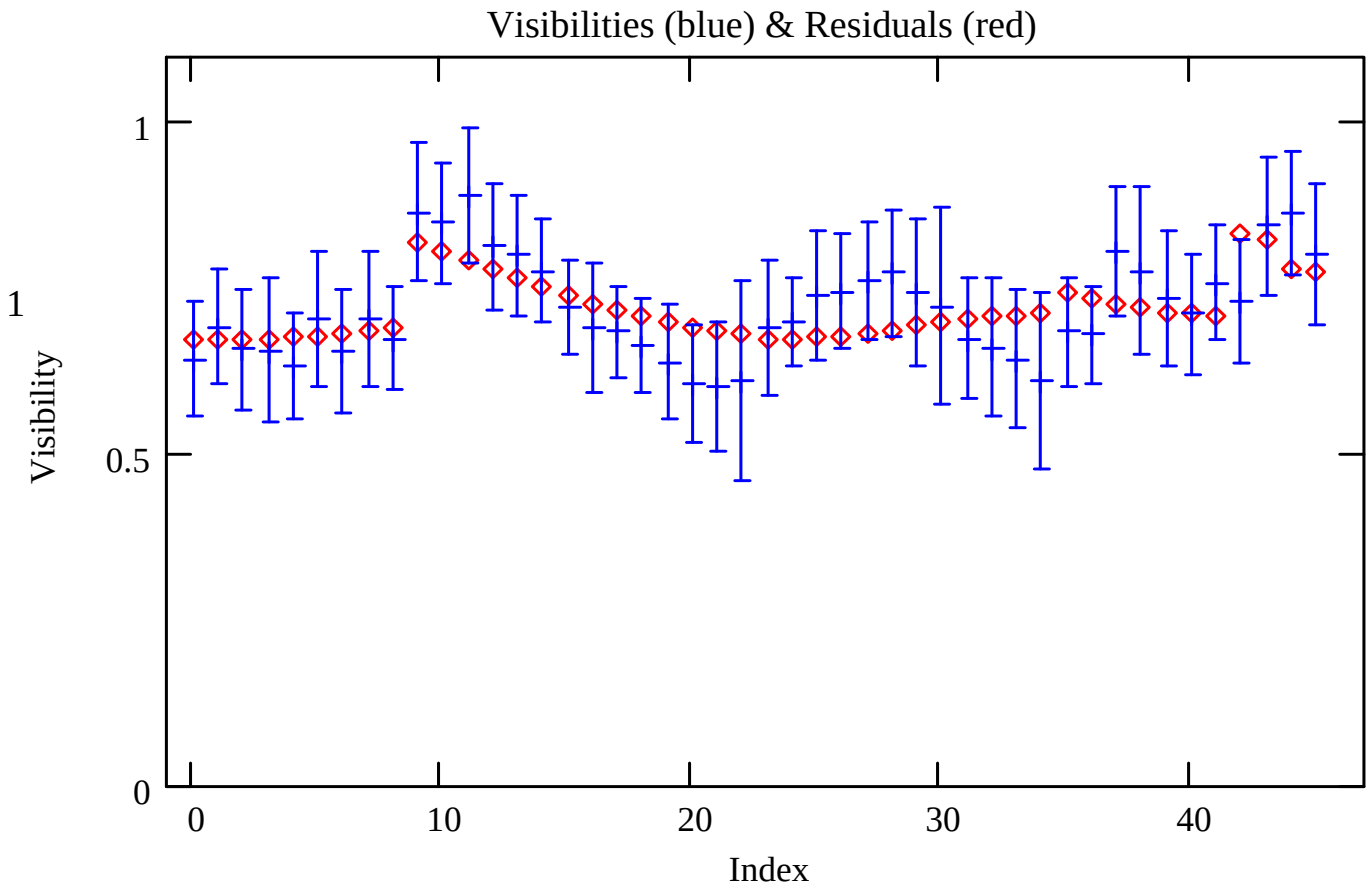
Start:



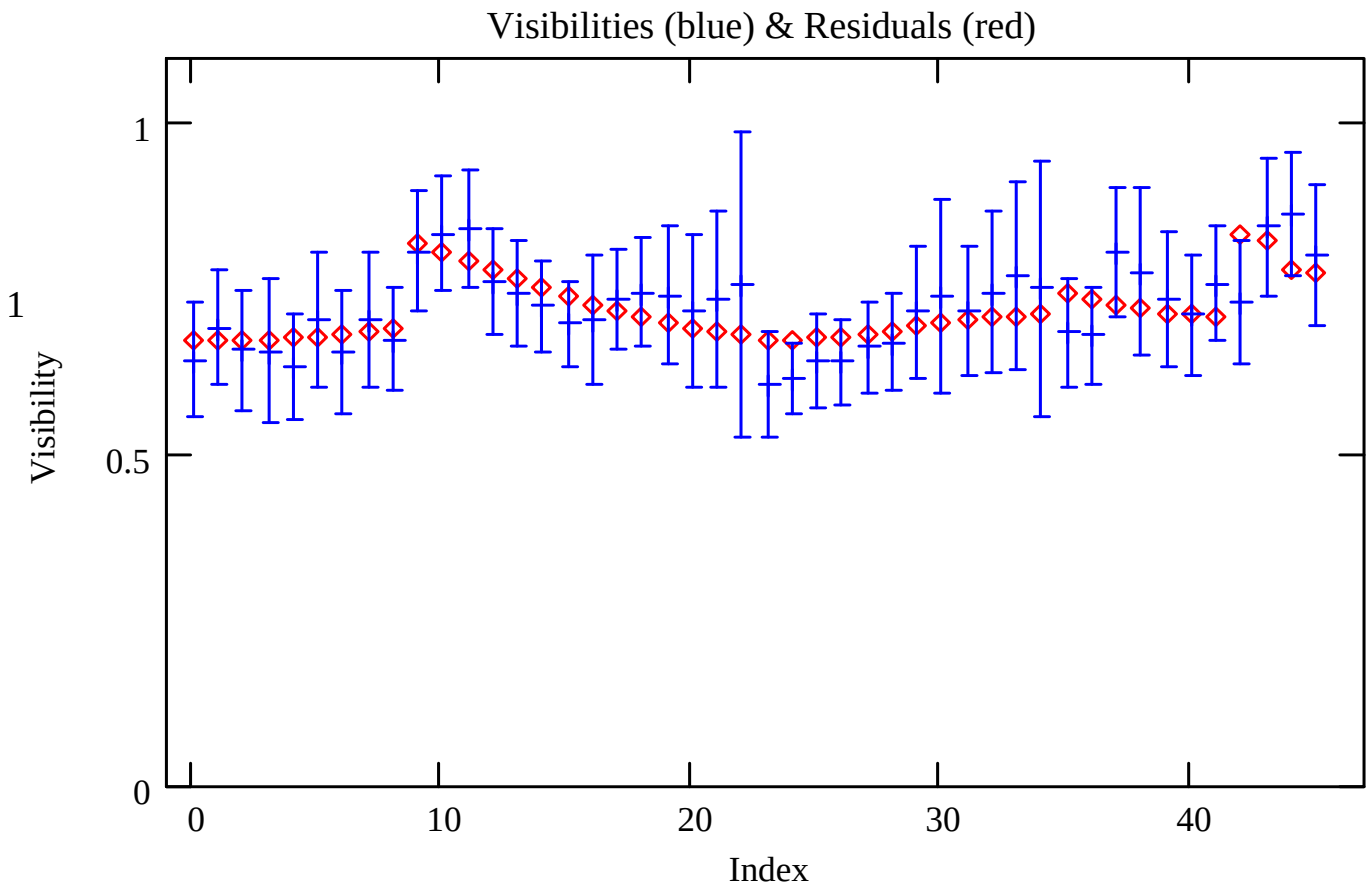
End:



Orbit Fit to Uncorrected Visibilities



Same Orbit with Corrected Visibilities



Orbit

- Fixed parameters:
  - P = 2.082 days
  - e = 0
  - $\omega = 0$
  - $\Theta_p = .262$ mas
  - $\Theta_s = .110$ mas
- Derived parameters:
  - $T_0 = 54711.265$ MJD
  - a = 1.76 mas
  - i = 80.5°
  - $\Omega = 92.0°$
  - $\Delta m_k = 1.85$
  - $\chi^2 = 14.3$

Results: $M_1 = 1.21\ M_\odot$, $M_2 = 0.36\ M_\odot$

Mutual Inclination: $\cos \phi = \cos i_{Close} \cos i_{Wide} + \sin i_{Close} \sin i_{Wide} \cos (\Omega_{Wide} - \Omega_{Close})$

$\phi = 72.5°$ (strongly argues against coplanarity)

η Ori

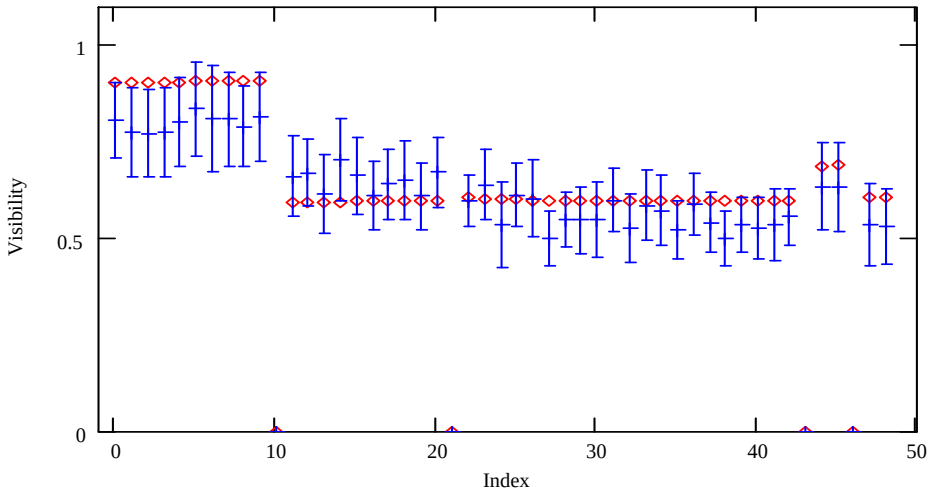
- Orbit fitting has been unsuccessful so far
  - α derived from orbit gives unreasonable masses for B stars
  - Using published masses from eclipsing orbit results in parallax that places the system outside of the Orion OB1 association

- Clearly, the η Ori data are experiencing the same systematic error as 13 Ceti

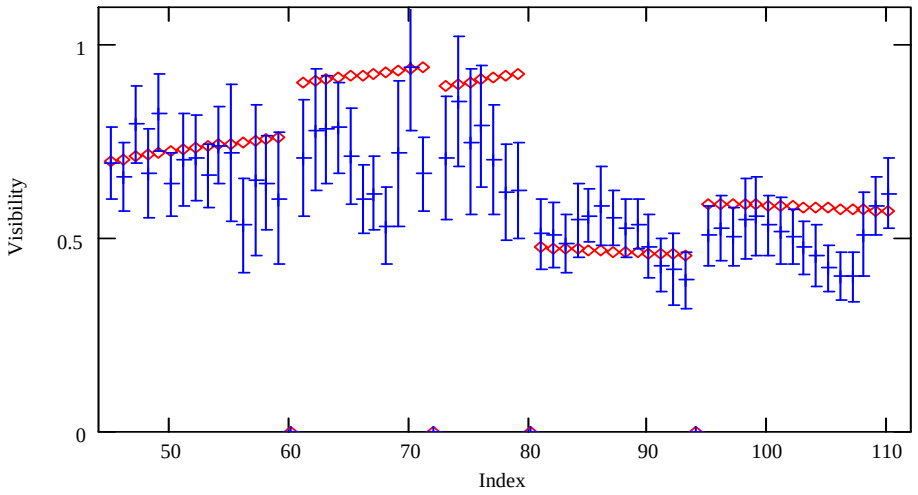
- Any data where the two fringe packets are very close together is subject to side-lobe biasing

η Ori Data

Calibrated V's with widely separated fringe packets



Calibrated V's with close fringe packets



Near-Term Work

- Revise HD 3196 orbit, with new corrected calibrated visibilities
- Correct for side-lobe interference in η Ori data, as well as data from other targets where this occurs, before attempting orbit-fitting
- Collect observations on auxiliary targets