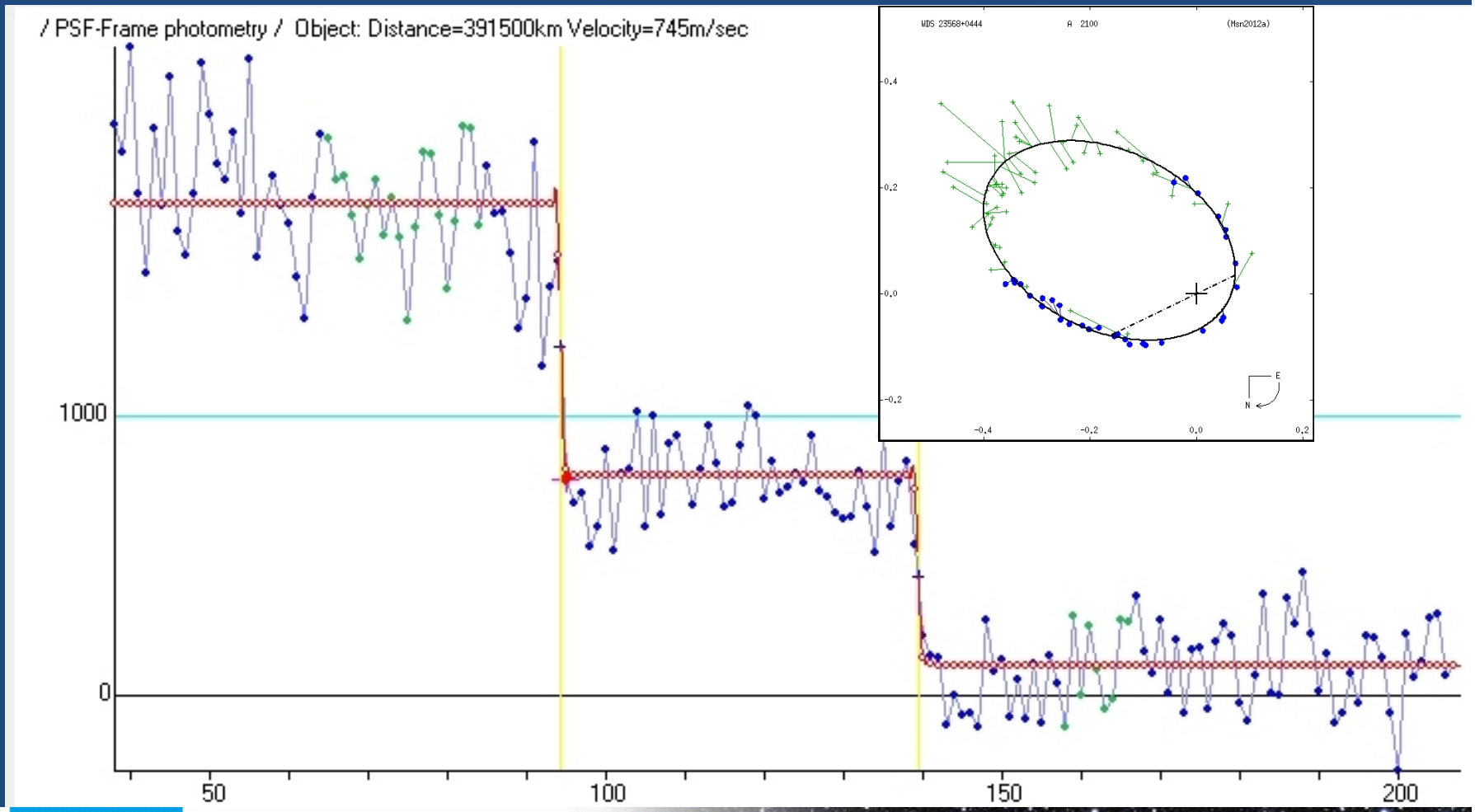
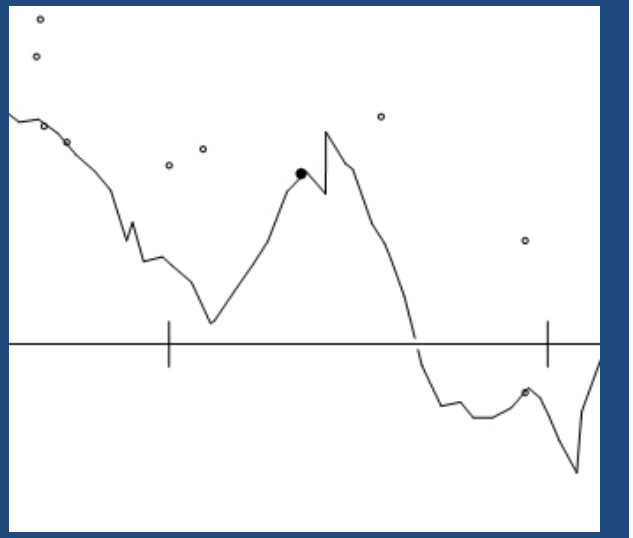
Video recording and analysing lunar occultations of double stars



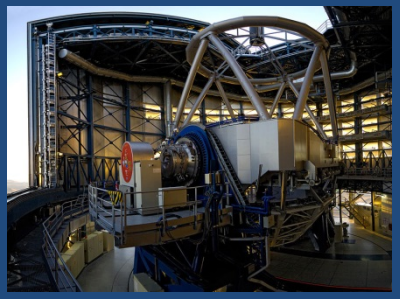
IOTA's lunar occultations programme



- Time occultations of single and multiple stars
- Determine the lunar limb profile (Kaguya)
- Estimate uncertainties in the stellar reference frame
- Double stars – Position Angle, separation, magnitude difference
- Discover new double stars

Recommended hardware

- Long focal length telescope – good contrast
- Sturdy mount and good quality drive
- Barlow lens
- Video camera – 25 fps – integration OFF (not colour)
- Video time and date inserter – GPS 1PPS receiver
- Computer with PC video card or USB capture device



Recommended software

- *VirtualDub*
- *AAVrec*
- Lossless Codec (*Lagarith*)
- *Occult*
- *OccultWatcher*
- IOTA-ES *Lunar Occultations* add-in
- *Tangra*
- *LiMovie*
- *AviSynth*

Occultation predictions

- *Occult*
- *OccultWatcher* (IOTA-ES *Lunar Occultations* add-in)
- Known and suspected double stars

Lunar Occultations

2233 D	Wed 14 Aug, 21:09	5.5	100	-	07 Aug, 10:04 new
184579 d	Thu 15 Aug, 23:11	7.9	100	-	07 Aug, 10:04 new
2733 d	Sun 18 Aug, 00:29	6.8	100	-	07 Aug, 10:04 new
163087 d	Mon 19 Aug, 01:21	8.5	100	-	07 Aug, 10:04 new
163899 d	Mon 19 Aug, 22:30	8.8	100	-	07 Aug, 10:04 new

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Occultation prediction for OW.LunarOcc
E. Longitude -  1 36 27.9,  Latitude  53 50 15.5,  Alt.  164m;  Telescope dia 20cm;  dMag 3.0

       day  Time    P   Star  Sp  Mag  Mag     % Elon Sun  Moon   CA    PA  VA  AA Libration    A    B    RV   Cct   durn R.A. (J2000)  Dec   Mdist   SV
 y   m  d  h  m  s      No  D     v    r V  ill      Alt Alt Az   o     o   o   o   L     B    m/o m/o  "/s    o    sec  h  m   s    o  m  s   Mm   m/s
13 Aug 14 20  9 47 D    2233cG8  5.5        54+  95  -5 13 208  19S  174 157 160 -5.1  -0.8 +1.5-3.6 .103  -76.7      15 38 54.6 -19 18  7 371.1 806.9
   R2233 = 41 Librae
      2233 is double: AB 5.57 8.80 0.44" 107.2
      2233 is a close double. Observations are highly desired
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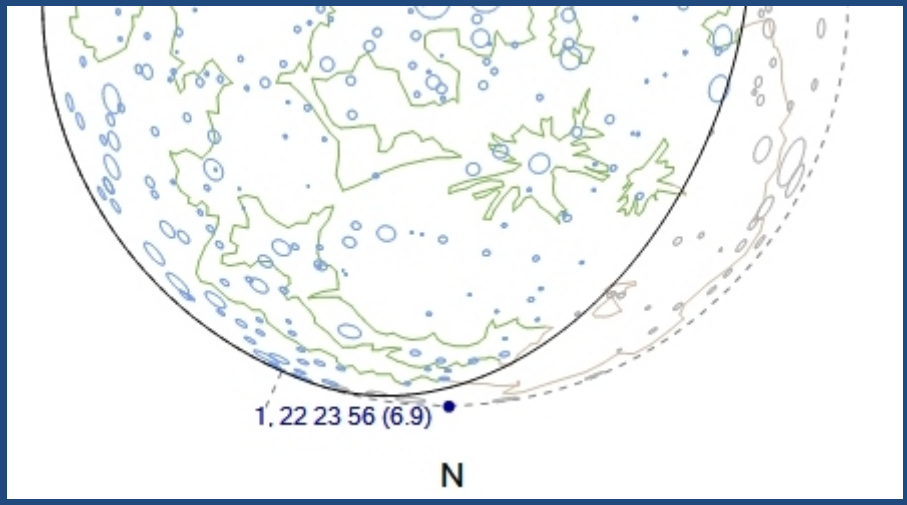
Recording an occultation



- Switch on VTI
- Locate star (D) or lunar limb (R)
- Check VTI
- Check *VirtualDub* 'Autoincrement after capture'
- Run *VirtualDub* Capture (Lossless Codec)
- Check for any dropped frames
- Backup the recording!

Image Saturation

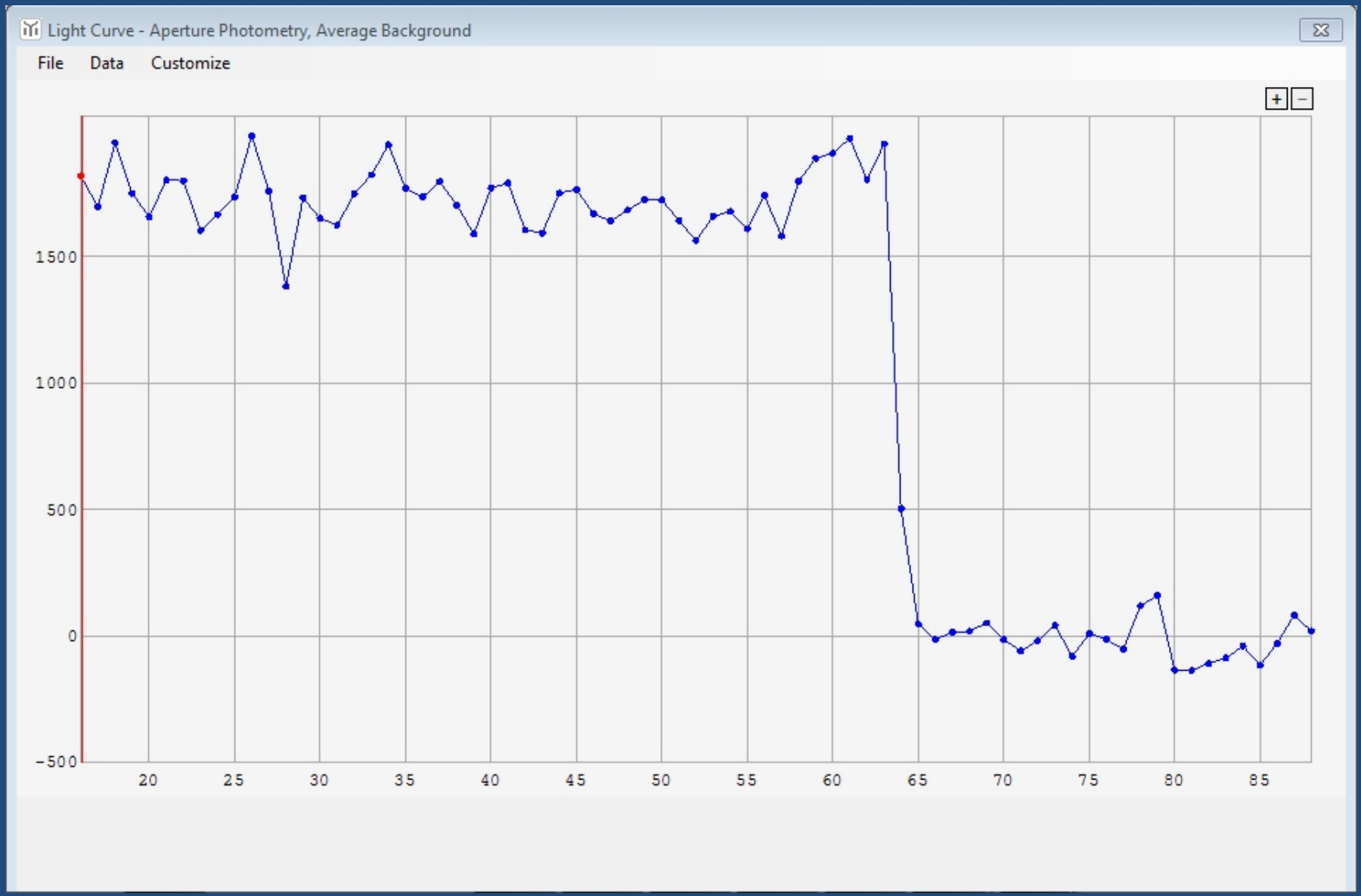
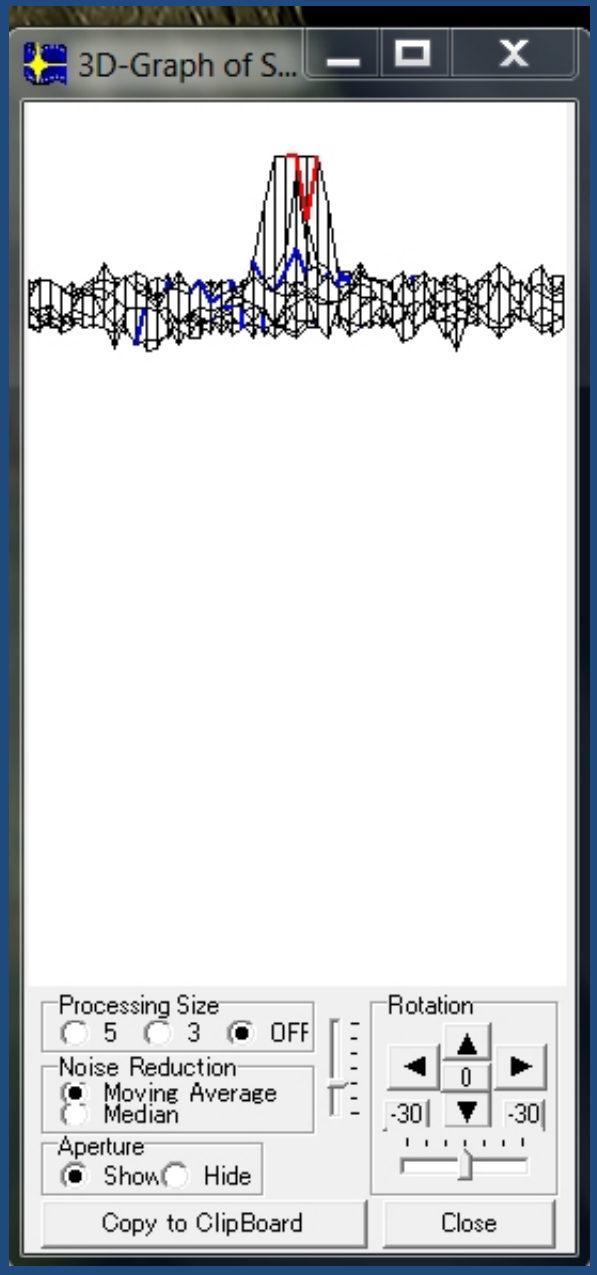


Image Saturation



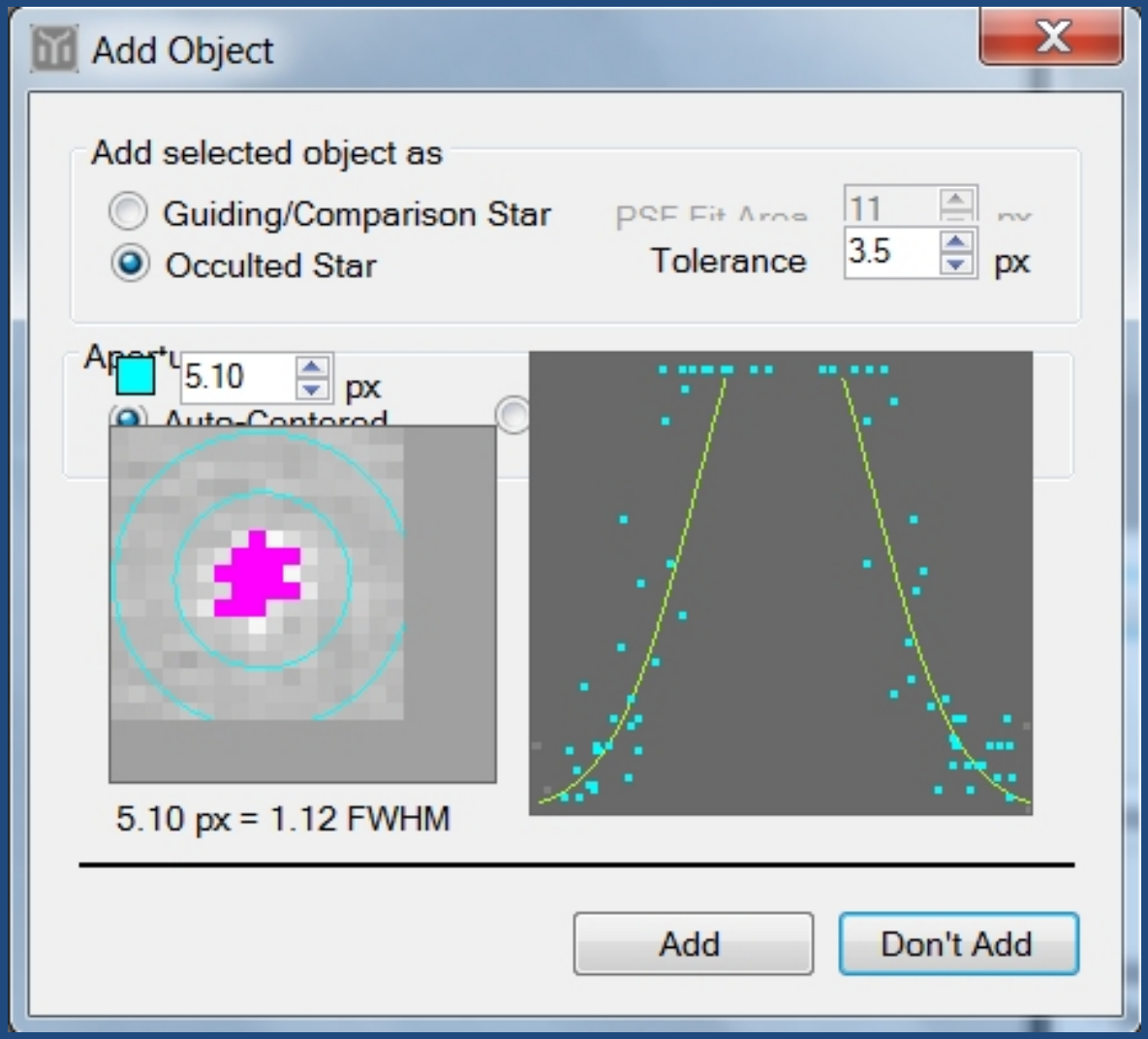


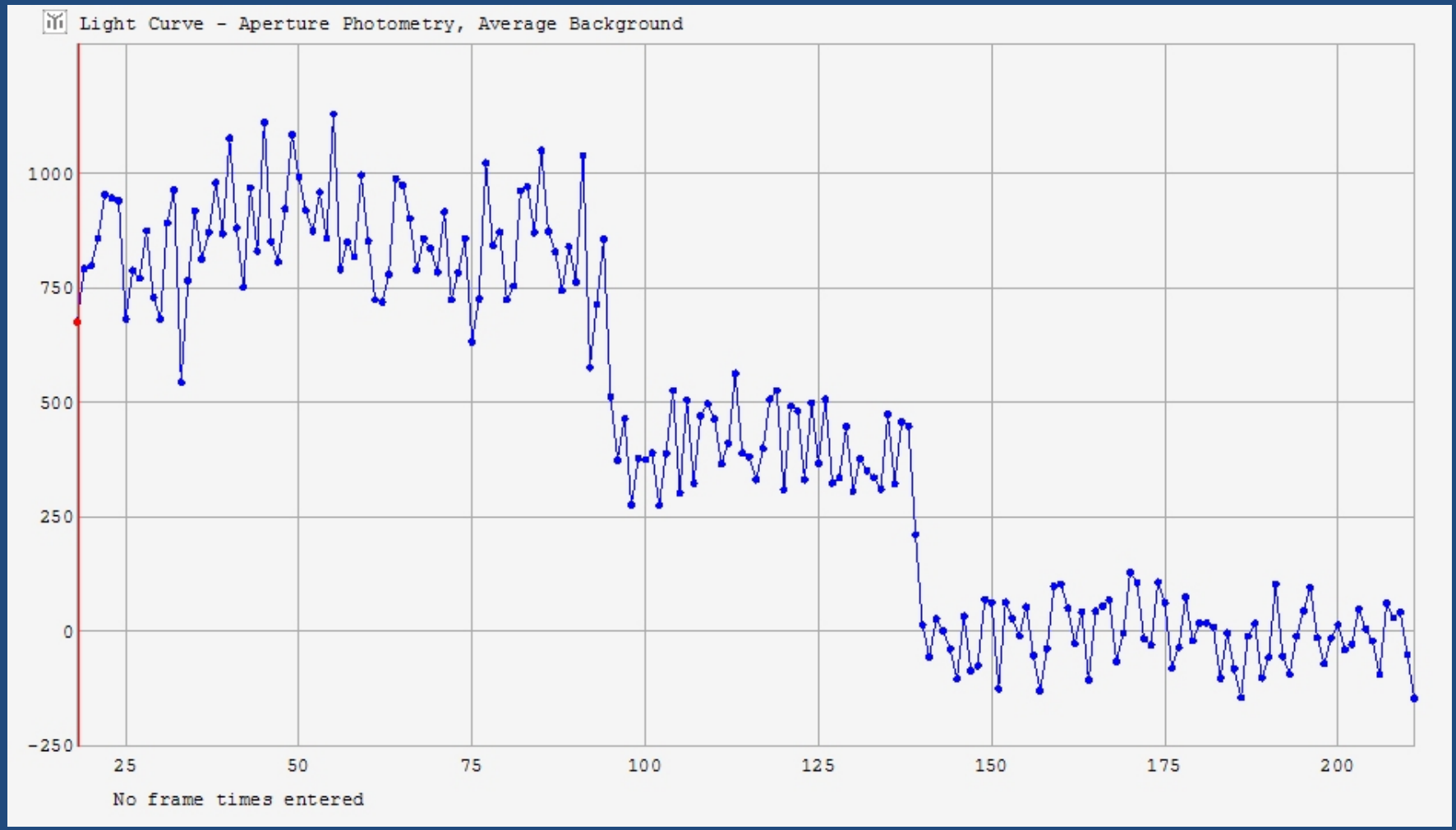
Image Saturation

- The step might not be detected
- Take a short test recording and check with *LiMovie* or *Tangra*
- Reduce the gain setting on the video camera
- Stop down the telescope aperture

Crop the video with *VirtualDub*

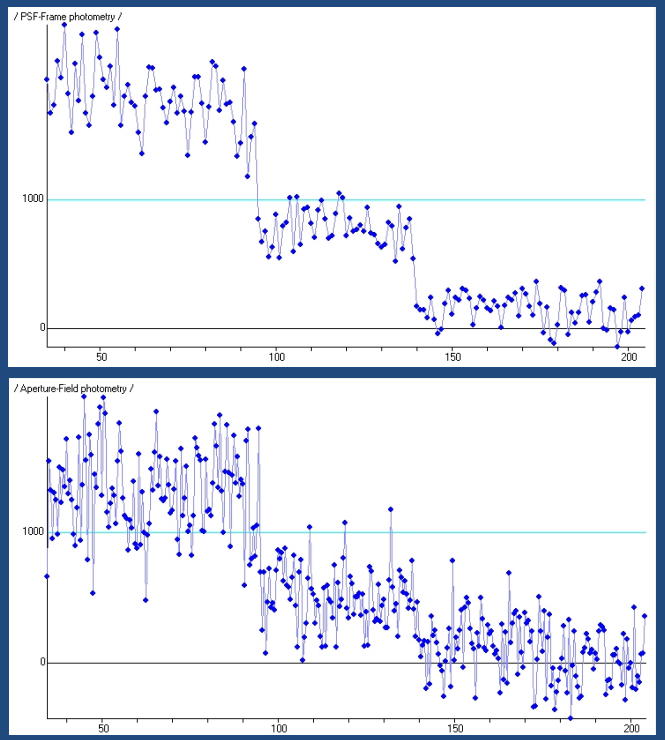
Analysing the disappearance of double star XZ 13791 and XZ 113062 2013 Apr 19

Magnitudes 9.9 and 10.2, separation 0.8”, PA 136.6



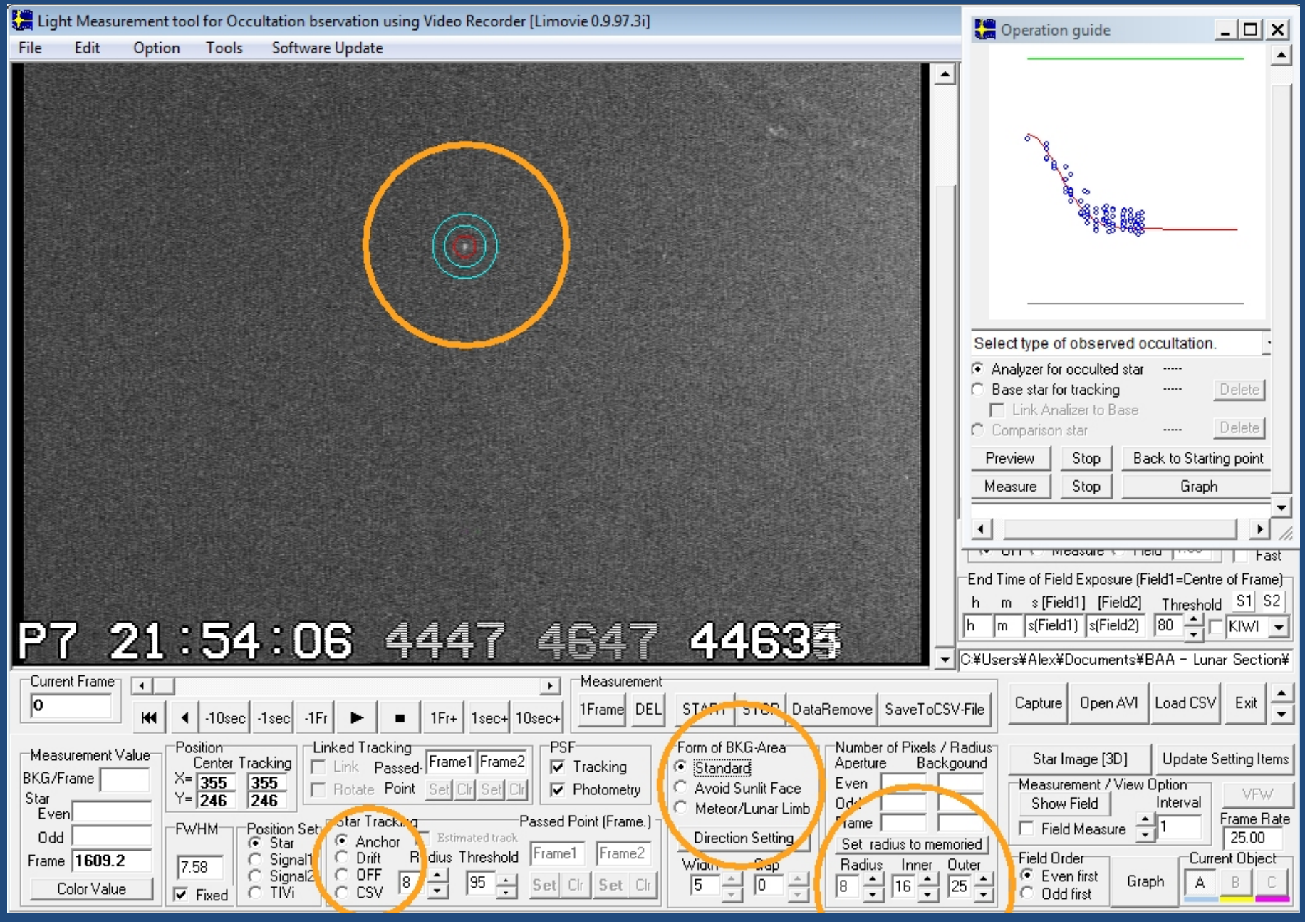
Video frames, fields and gamma

- 25 frames per second (0.04s)
- 50 fields per second (0.02s)
- Signal to Noise ratio (SNR)
- Gamma 0.45 to 1.0
- *AviSynth*

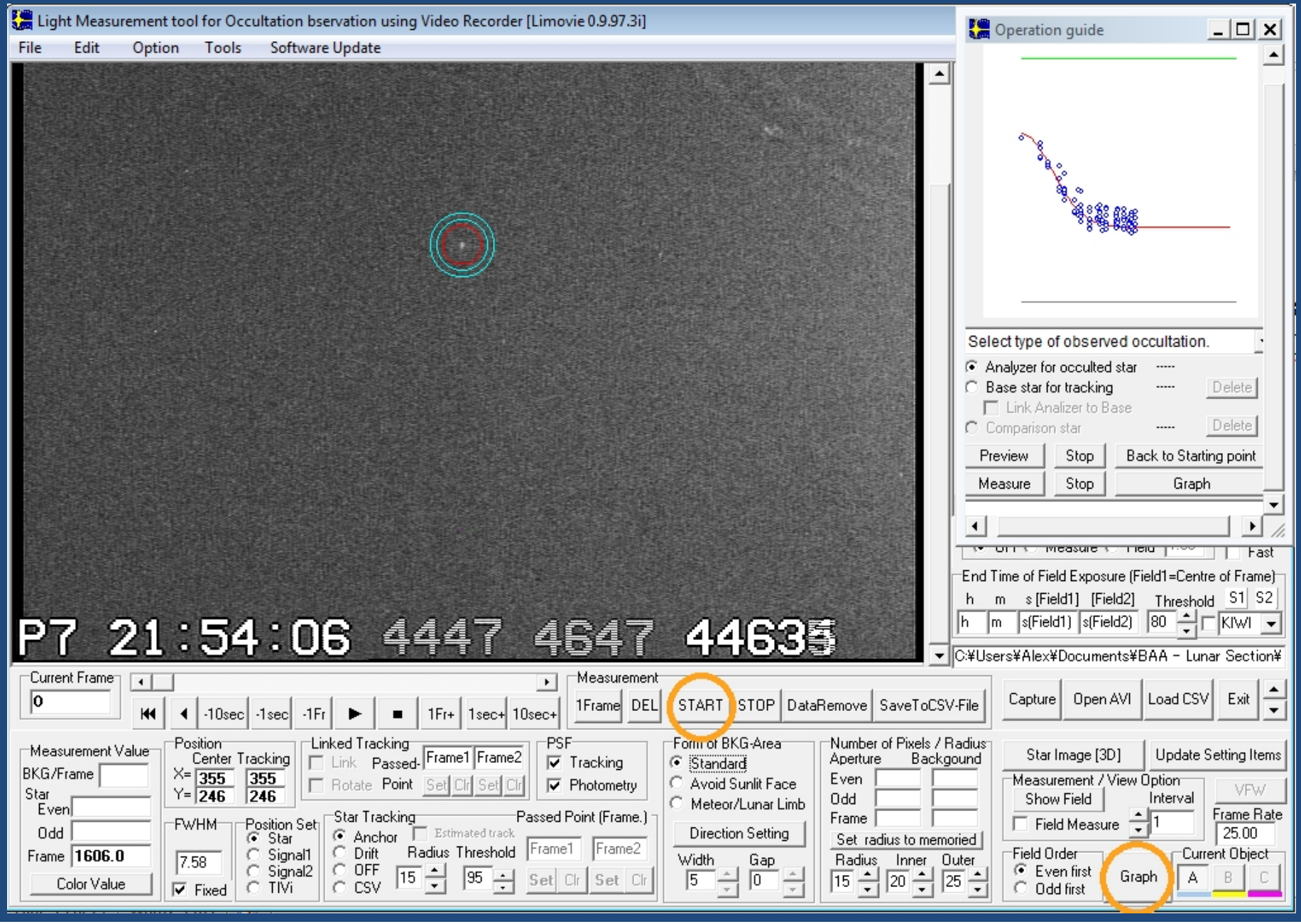


Video field order (Even – Odd)

Analysing the disappearance of double star XZ 13791 and XZ 113062

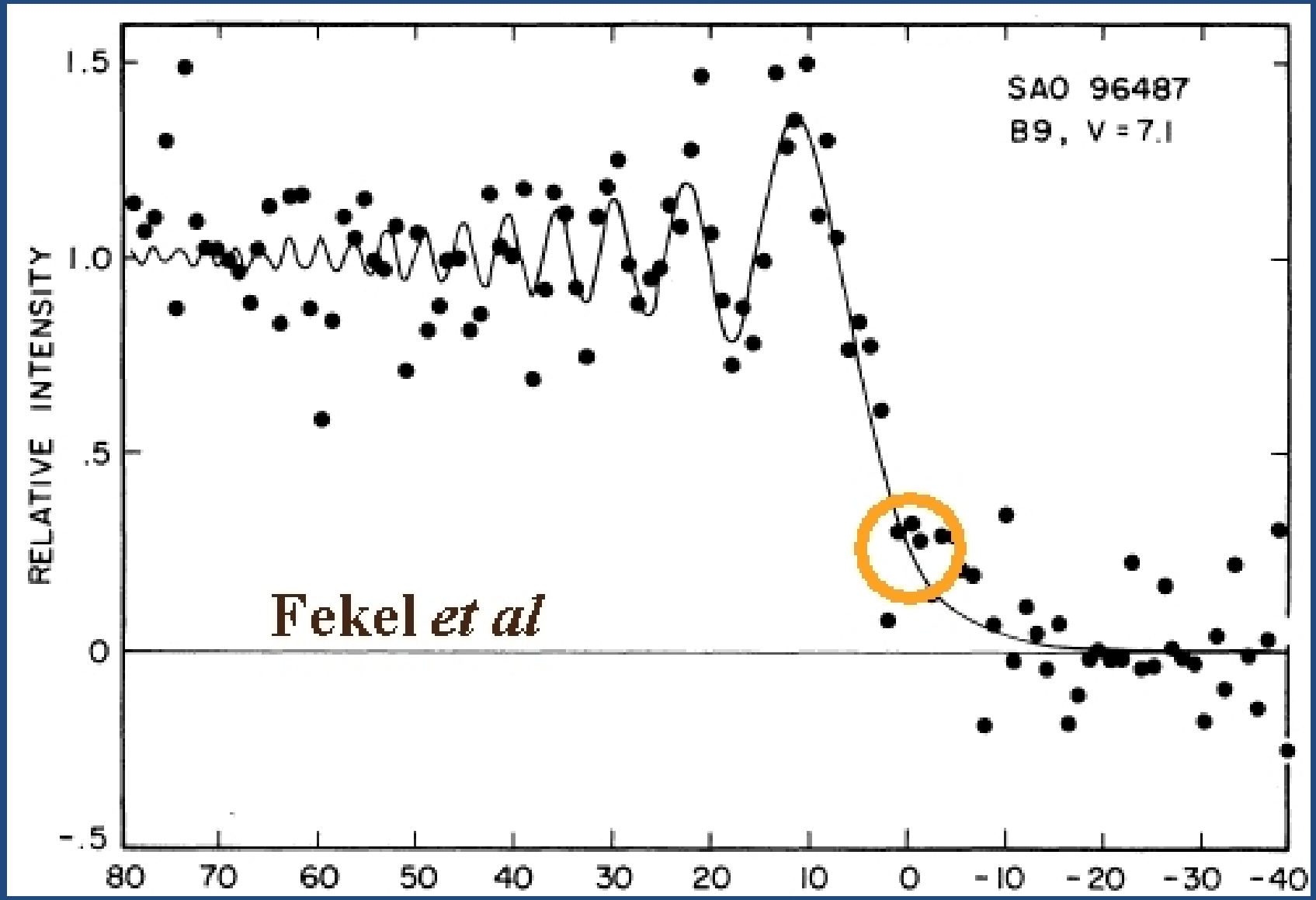


Analysing the disappearance of double star XZ 13791 and XZ 113062

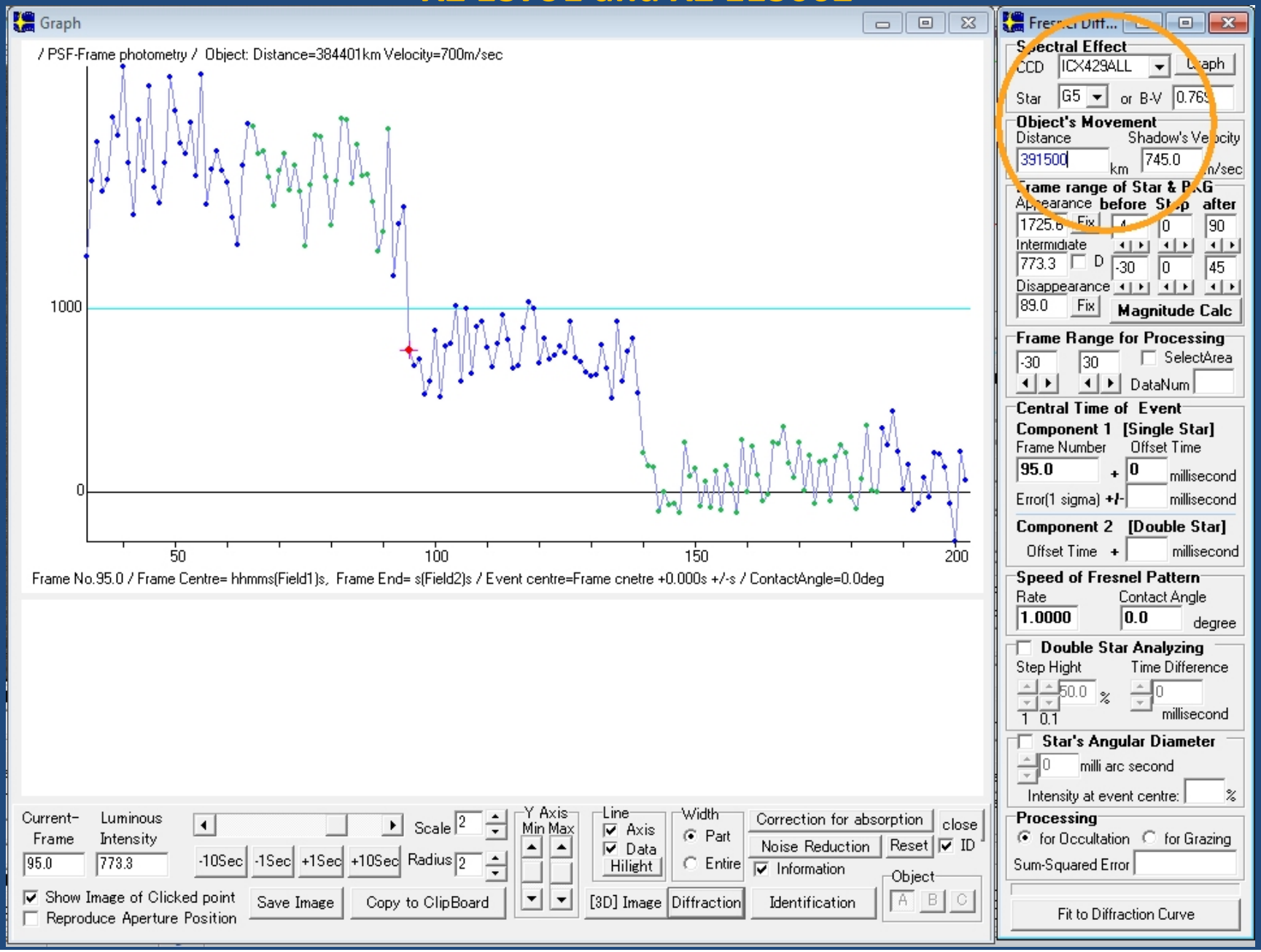


Analysing the disappearance of double star XZ 13791 and XZ 113062

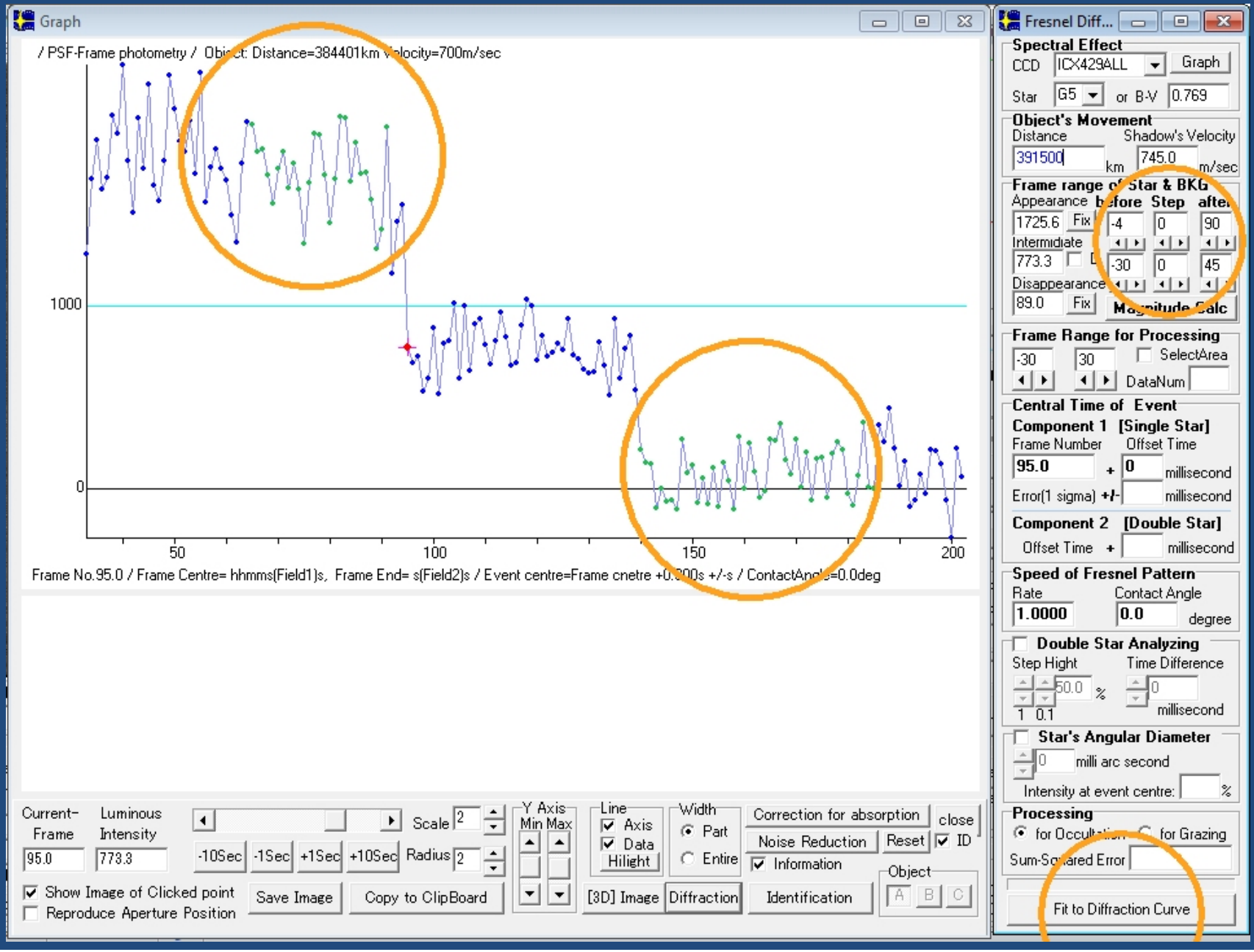
Fresnel Diffraction



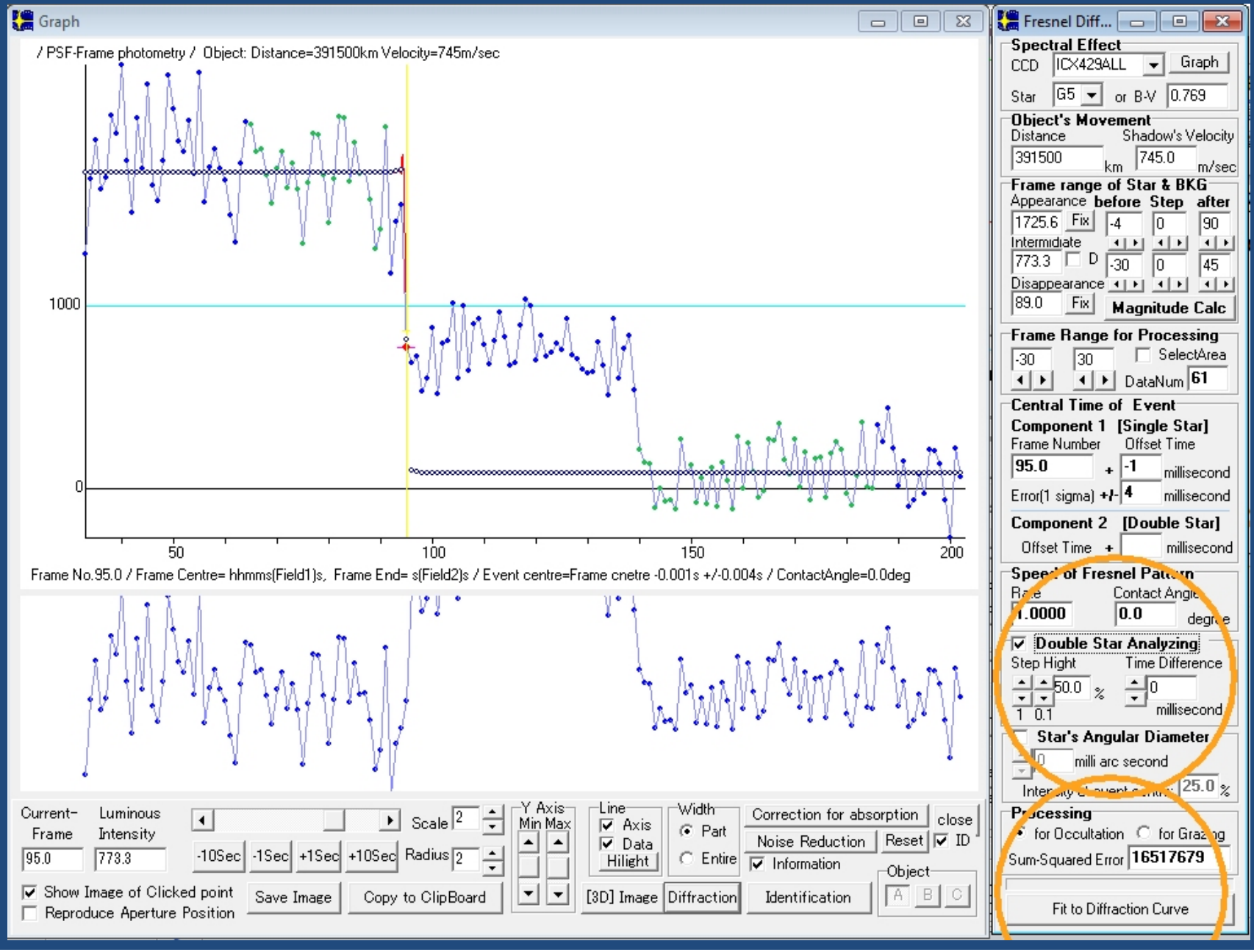
Analysing the disappearance of double star XZ 13791 and XZ 113062



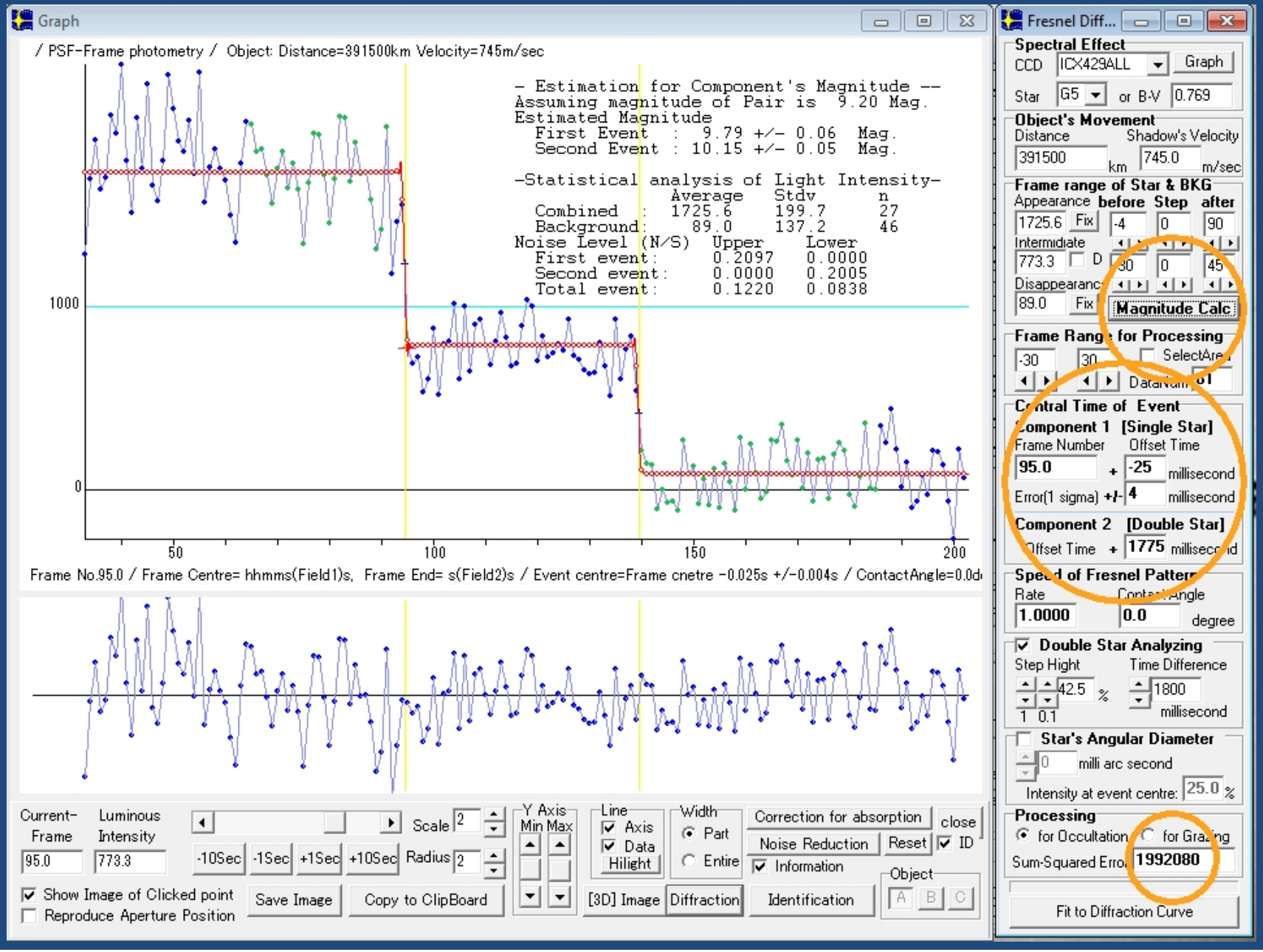
Analysing the disappearance of double star XZ 13791 and XZ 113062



Analysing the disappearance of double star XZ 13791 and XZ 113062



Analysing the disappearance of double star XZ 13791 and XZ 113062



Analysing the occultation of a double star

Timings

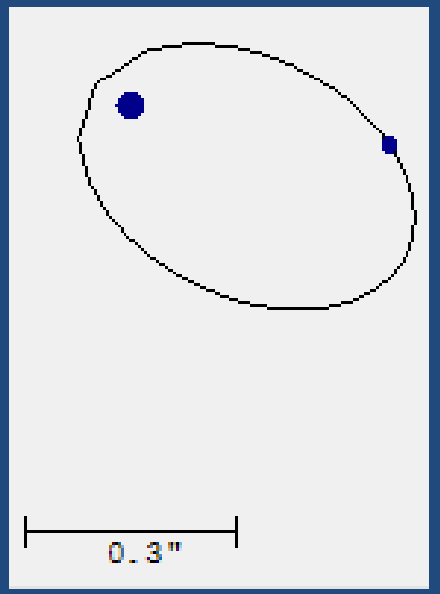
- Mid-point of frame
- 1st component: offset time (ms)
- 2nd component: offset time (ms) + interval
- Instrumental delay: Gerhard Dangl

Reporting the occultation of a double star

- Use Observations Report option in *Occult*
- Validate report with local coordinator
- Submit reports around Full Moon
- Total occultation report to lunoccult@iota-es.de
- Double star report to palbrl@clear.net.nz

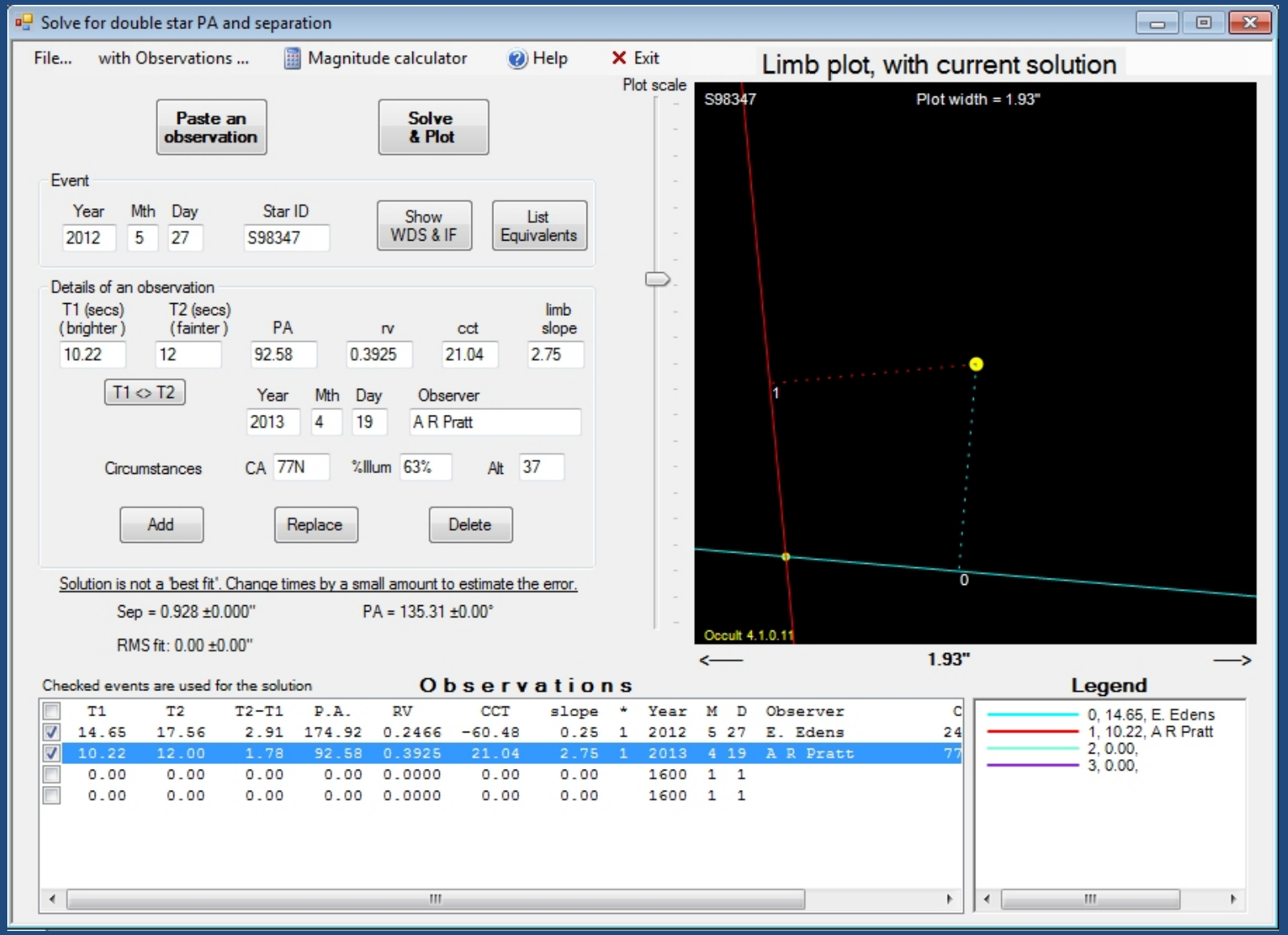
Estimating the position angle (PA) and separation of a double star

- Combine observations from 2 or more locations
- Within the same lunation
- Within 12 months?



- *Occult* – 'Solve for double star PA and separation'

Estimating the position angle (PA) and separation of a double star



Estimating the position angle (PA) and separation of a double star

Double star XZ 13791 and XZ 113062

Occult

2012/05/27 – 2013/04/19

PA	Separation (arcsec)
135.3	0.924

USNO Fourth Interferometric Catalog of Binary Stars

Date	PA		Sep
1991.92	138.2	.	0.941

Washington Double star Catalog

Y1	Y2	N	PA	PA	Sep	Sep
1910	1995	21	139	137	0.8	0.8

Published result - example

Double star XZ 32105

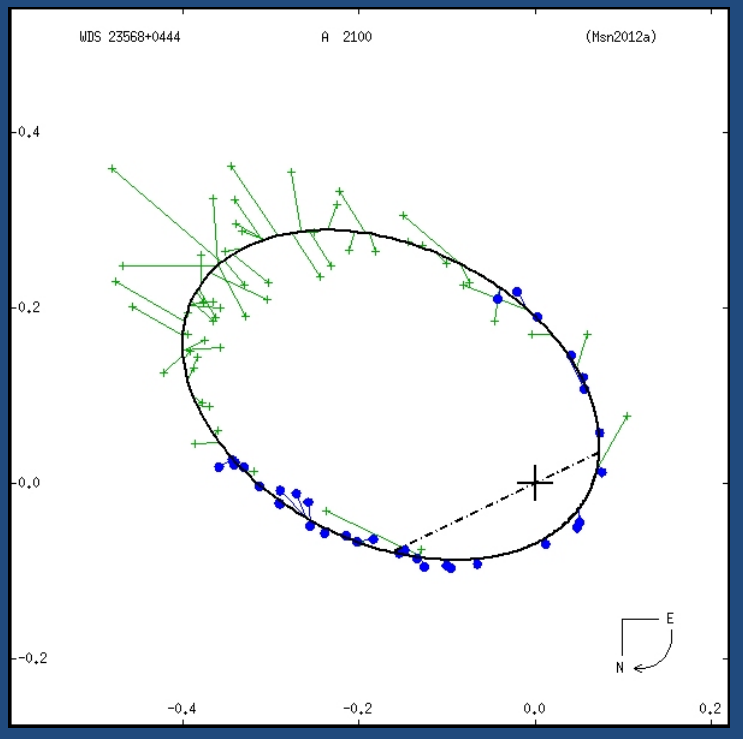
WDS name	XZ	RA Dec	PA	+/-	Sep.	+/-	Mag. diff.	Date	Observers	Note
A 2100	32105	23568+0444	260.67	1.42	0.366	0.010	1±0.3	2011.849 2011.924	AP DB	9

"Lunar Occultation Observations of Double Stars – Report #3" B. Loader *et al*
(*Journal of Double Star Observations*, Vol 8, No 4, Oct 1, 2012)

Washington Double Star Catalog

Y1	Y2	N	PA	PA	Sep	Sep
1909	2011	91	289	261	0.2	0.4

Period 88.95 years



Summary

- Investigate known and suspected double stars
- Estimate PA, separation and magnitude differences
- Discover previously unknown double stars

With acknowledgements and grateful thanks to…

- Jan Manek (IOTA total occultations coordinator for Europe)
- Brian Loader (IOTA double star coordinator)
- Dave Herald (author of *Occult*)
- Hristo Pavlov (author of *OccultWatcher)*

"This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory."