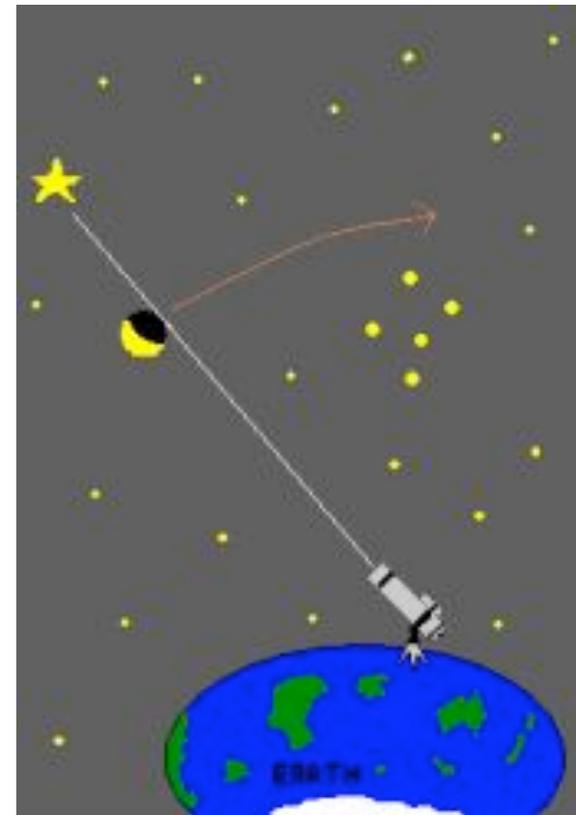


# Asteroid Occultation Observations: They are Fun (and Addictive)

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Big Bear, CA  
May 19, 2009



# So what is an occultation?

It's all geometry, and has no physics significance..

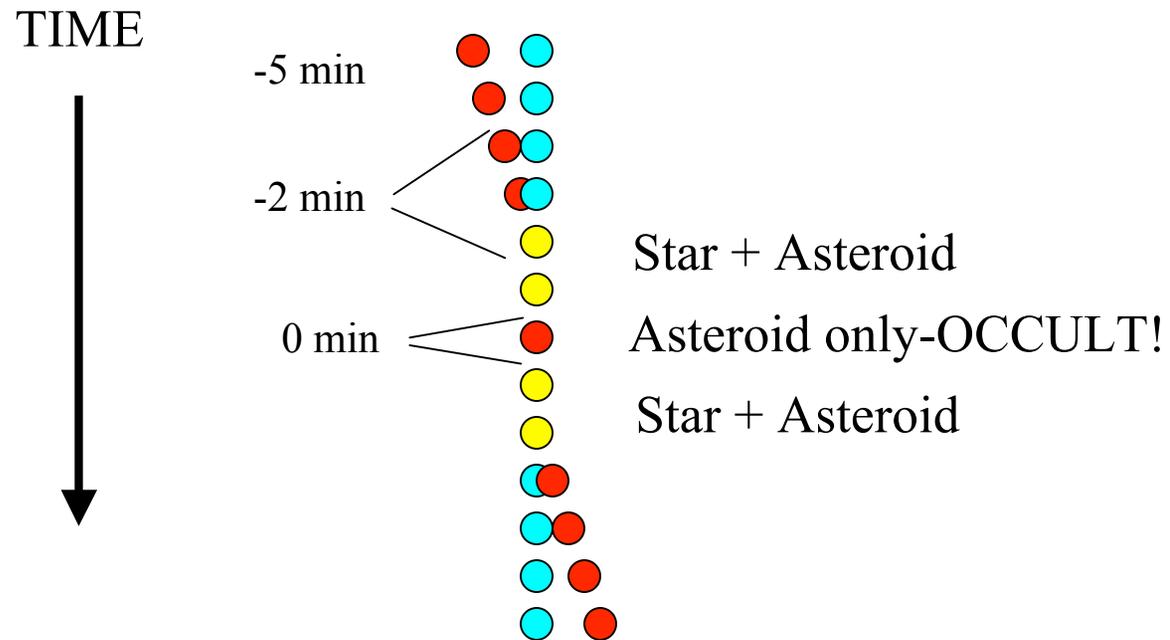
Occultation is the line-up of observer, asteroid, and star

...Asteroid passes in front of the star, blocking it from view

...Shadow (faint) of asteroid passes across the earth

# What does an occultation “look” like?

Note--apparent size of asteroid or star is around  $10E-2$  a-s  
ie., much smaller than resolution or seeing for most scopes



## Occultation Observation...

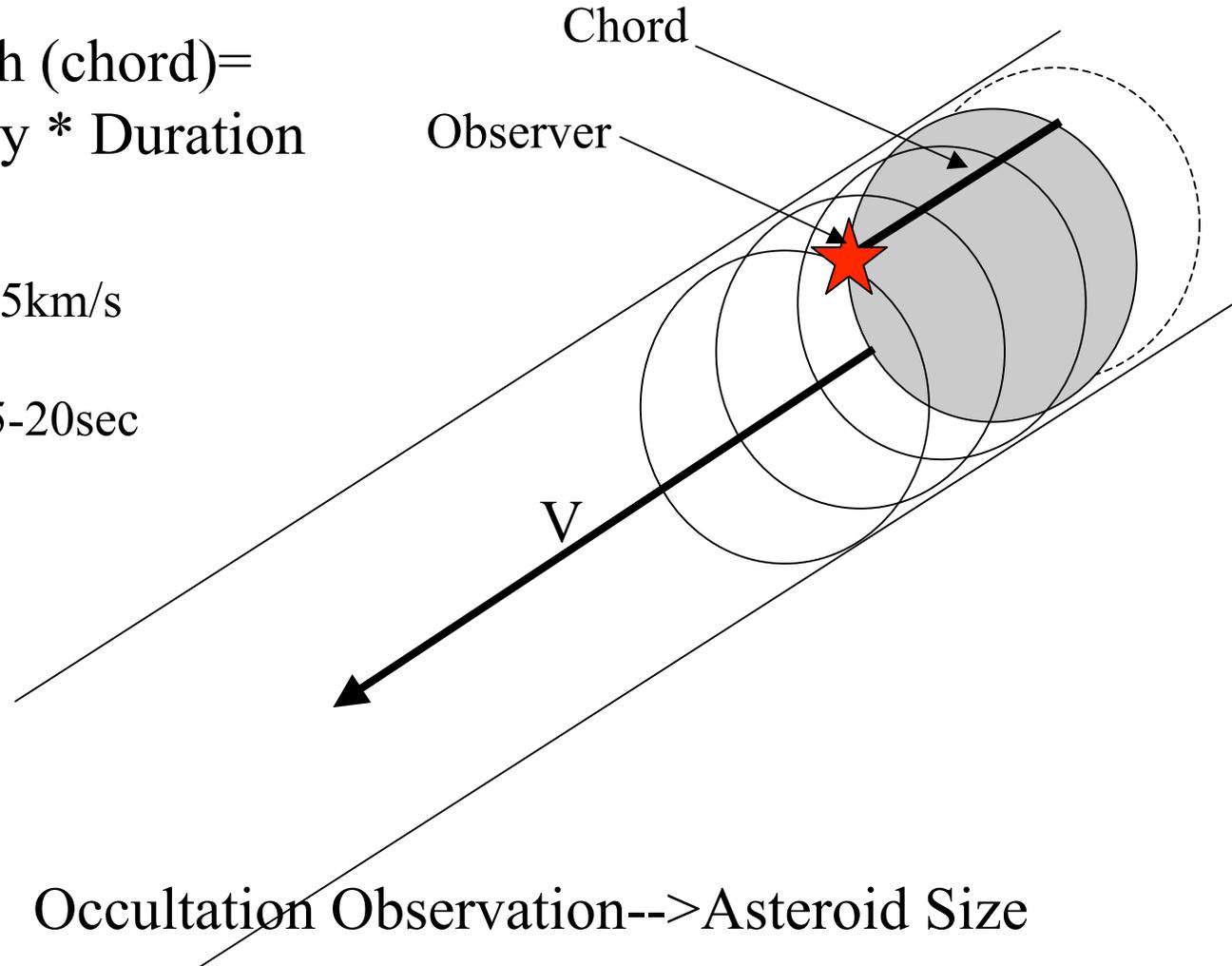
...Duration of event gives chord of asteroid

...multiple chords give size and shape (of one cross-section)

Path Length (chord)=  
Velocity \* Duration

Velocity~15km/s

Duration~5-20sec



## Methods of determining size/shape of asteroids

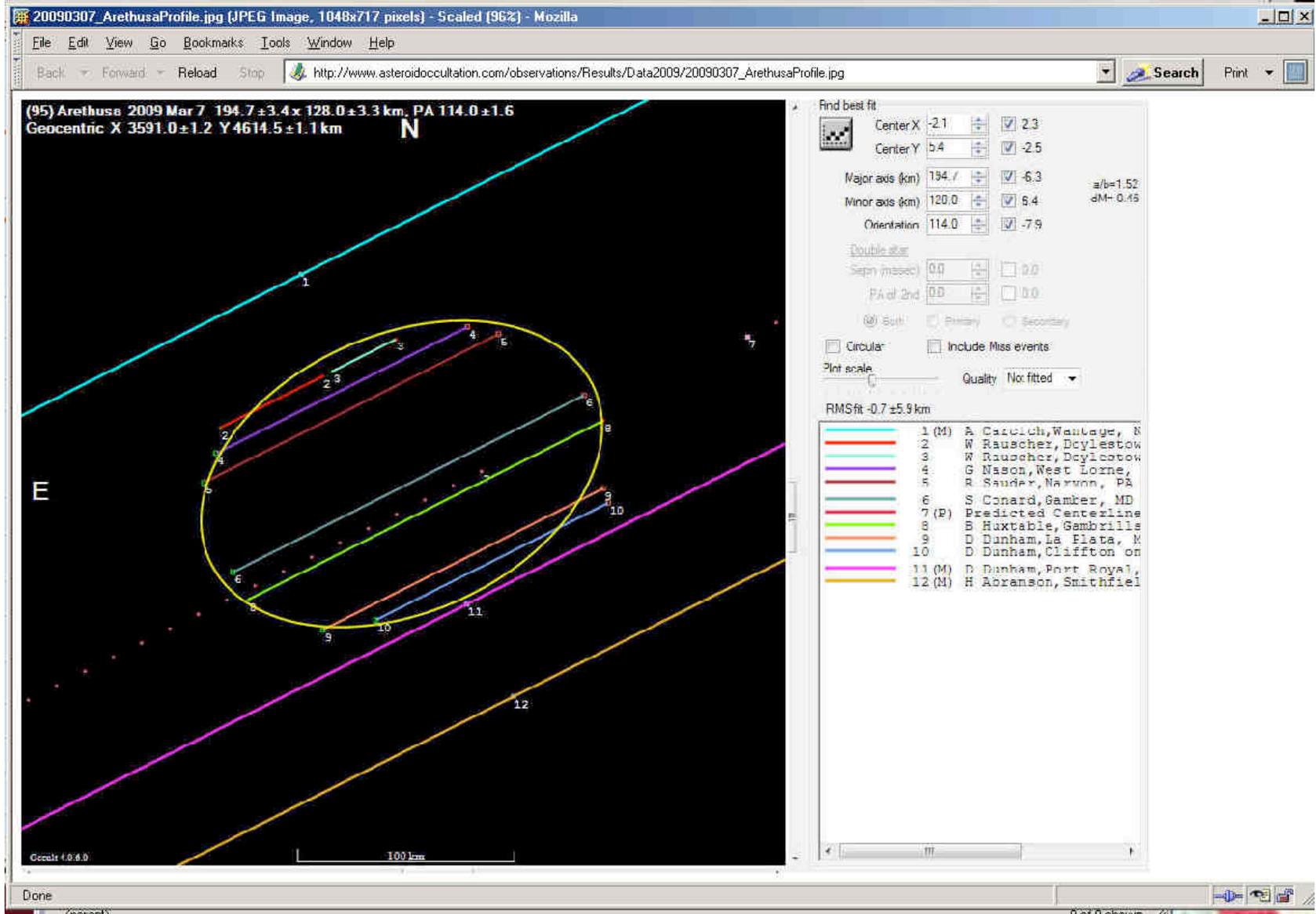
Light curves (can derive shape, but not size)

Radar (nearby only)

Multi-telescope interferometry (new)

Space probe fly-by (expensive, rare)

Stellar-asteroid occultation observation



Arethusa

# Occultation observation requirements..

## Predict location and time of occultation

location/path to within tens of miles

timing to tens of seconds

## Must be able to observe dimming

dimming usually >25-50%

fast (<0.1 sec)

## Must be able to measure duration (UTC even better)

events last 30 sec

may be in error or have additional events

## Where to find occultation predictions:

Prediction web sites

Newsletters (e.g., Dunham, Breit)

Sky & Telescope listings

Use OccultWatcher (Freeware), tailors time and place,  
and helps map where on the path to observe



The screenshot displays the OccultWatcher software interface. The main window is titled "Occult Watcher, ver. 3.2 - Barnesville (UTC -04:00)". It features a menu bar with "Synchronise now", "Configuration", "Add-ins", and "Help". The main content area is divided into two sections: "My Events" and "All Events".

**My Events:**

Asteroid Name	Event Date, loc.time	Magn.	Rank	Travel Dist.	Last Updated
(1512) Dulu	Fri 10 Apr, 02:28	11.8	69	36 mi S	09 Mar, 19:35
(255) Oppavia	Thu 30 Apr, 01:44	12.8	42	22 mi S	16 Mar, 14:02 **
(159) Aemilia	Fri 01 May, 23:40	11.0	97	13 mi SW	20 Mar, 18:06

**All Events:**

Asteroid Name	Event Date, loc.time	Magn.	Rank	Travel Dist.	Last Updated
(25569) 1999 XE192	Sun 05 Apr, 01:48	10.0	1	117 mi NE	29 Mar, 19:35
(8160) 1990 MG	Wed 08 Apr, 05:53	8.3	2	21 mi N	29 Mar, 19:35
(12839) 1997 FB2	Thu 09 Apr, 23:02	11.1	3	77 mi N	14 Mar, 19:35
(140) Siwa	Sun 12 Apr, 05:55	12.4	35	107 mi N	16 Mar, 19:35
(62137) 2000 SH7	Tue 14 Apr, 02:40	12.9	1	18 mi S	14 Mar, 19:35
(420) Bertholda	Tue 21 Apr, 06:01	12.7	49	304 mi NW	06 Apr, 19:35
(9) Metis ***	Wed 22 Apr, 22:12	10.9	86	1025 mi SW	16 Mar, 19:35
(94) Aurora	Tue 28 Apr, 20:49	11.3	96	34 mi SW	20 Mar, 19:35
(617) Patroclus **	Wed 29 Apr, 03:36	13.4	34	843 mi NW	29 Mar, 19:35
(780) Armenia	Thu 30 Apr, 04:48	12.2	91	110 mi NE	20 Mar, 19:35
2002 GP32	Mon 04 May, 04:58	13.9	1	6016 mi S	20 Mar, 19:35

Below the event lists is a graphical representation of the occultation path, showing the 1-sigma zone (red), shadow (teal), and 2 & 3-sigma limits (yellow). The current event is highlighted: **(1512) Dulu occults TYC 0275-00523-1**. The event time is 02:28:59, and the constellation is Virgo. The position is in the 1-sigma zone, <1 mi outside the shadow path. The error in time is 8 sec. The star altitude is 38° SW, and the sun altitude is -40°. The moon altitude is 34° S, and the moon distance is 34°. The maximum duration is 7.1 sec, the magnitude drop is 3.3 m, the combined magnitude is 11.8 m, and the star magnitude is 11.9 m. There are currently 4 announced stations for this event, and 1 of them is yours. The interface includes links for "Show online map with stations", "View details on the web", "Save 'Google Earth' kml file", and "View station sorts". The last updated time is 04/06/2009 6:26:21 PM.

The "Event Info" window is open, showing details for the selected event:

Star	Asteroid	Event	Previous Observations	Prediction Updates
Name		TYC 0275-00523-1		
Constellation		Virgo		
RA (h)		11h 42m 51.7s		
DE (deg)		+03° 18' 56.0"		
RA (h) J2000		11h 42m 21.2s		
DE (deg) J2000		+03° 22' 13.2"		
Mag V		11.9		
Mag R		11.6		
NOMAD1		0933-0235155		
USNO-B1		0933-0231788		
UCAC2		32872890		
Tycho-2		0275-00523-1		
RAJ2000		175.5882900 deg		
Equinox		J2000		
Epoch		2000.000		

Star data from Simbad & Visier <http://simbad.u-strasbg.fr/simbad/>

OccultWatcher Main Window

Explorer Reader 4.0 VirtualDub Shortcut to ...

[IOTA Updates] (1512) Oulu occults TYC 0275-00523-1, Fri 10 Apr. 02:28, 38° SW

Map Satellite Hybrid

Street View Preferred Sites

Map data ©2009 Tele Atlas - Tangier Sound

Asteroid Name	Color
(1512) Oul	Red
(255) Opp	Green
(159) Aem	Blue

**My Events**

**All Events:**

- (25569) 199
- (8160) 199
- (12839) 199
- (140) Siv
- (62137) 200
- (420) Ber
- (9) Met
- (94) Aur
- (617) Pat
- (780) Arn
- 200

Position: In the 1-s  
There are currently 1 of them is yours.

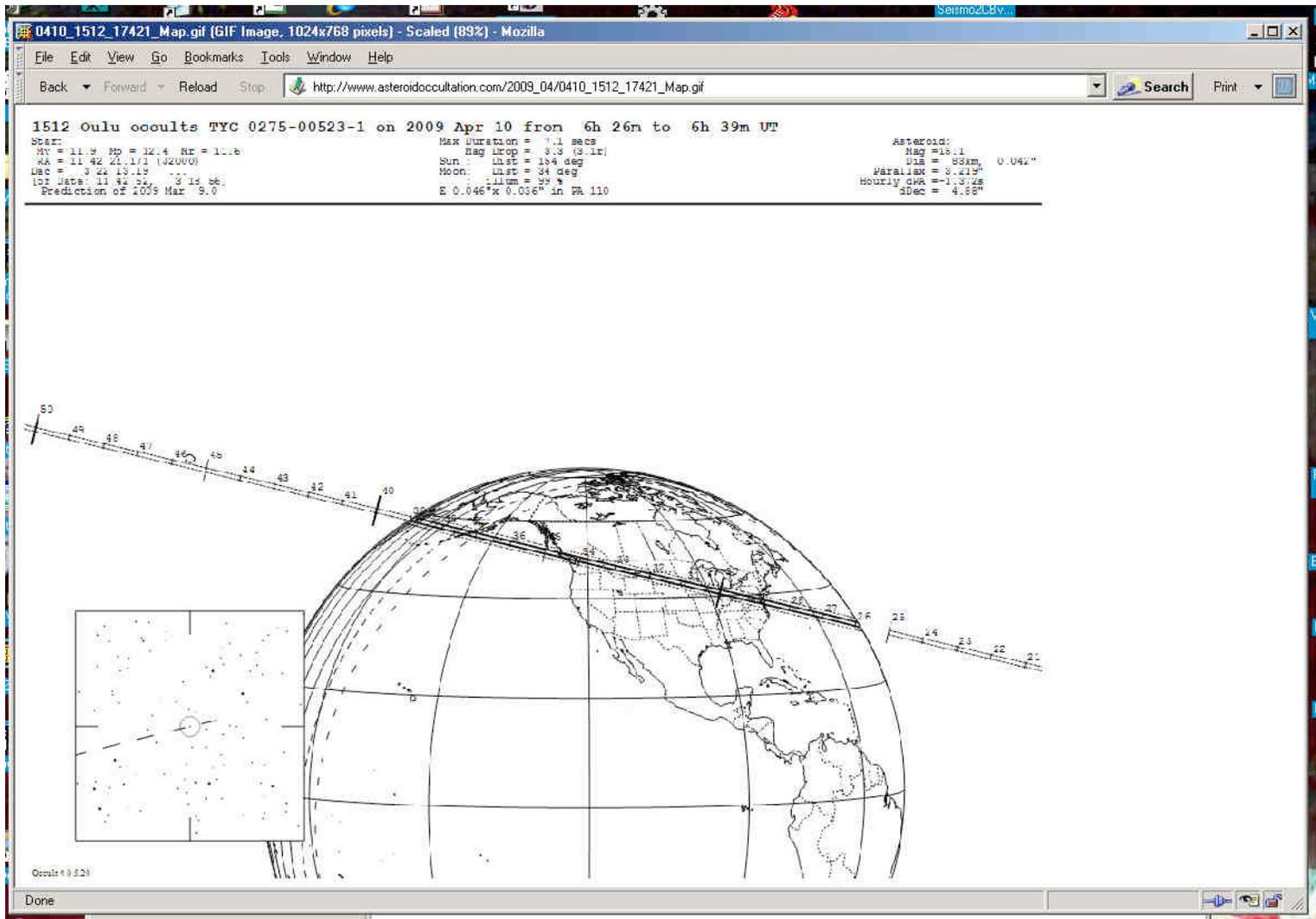
Observing locations currently announced by other observers:  
1 = Home; 2 = Oisen Urbana IL; 3 = Menke J Barnesville, MD; 6 = Home

Right click on the map to define another observing site or click on your already announced observing site to edit it.  
Left click on the map to enter a street view mode. Then click on the street view marker to open up the street view window.

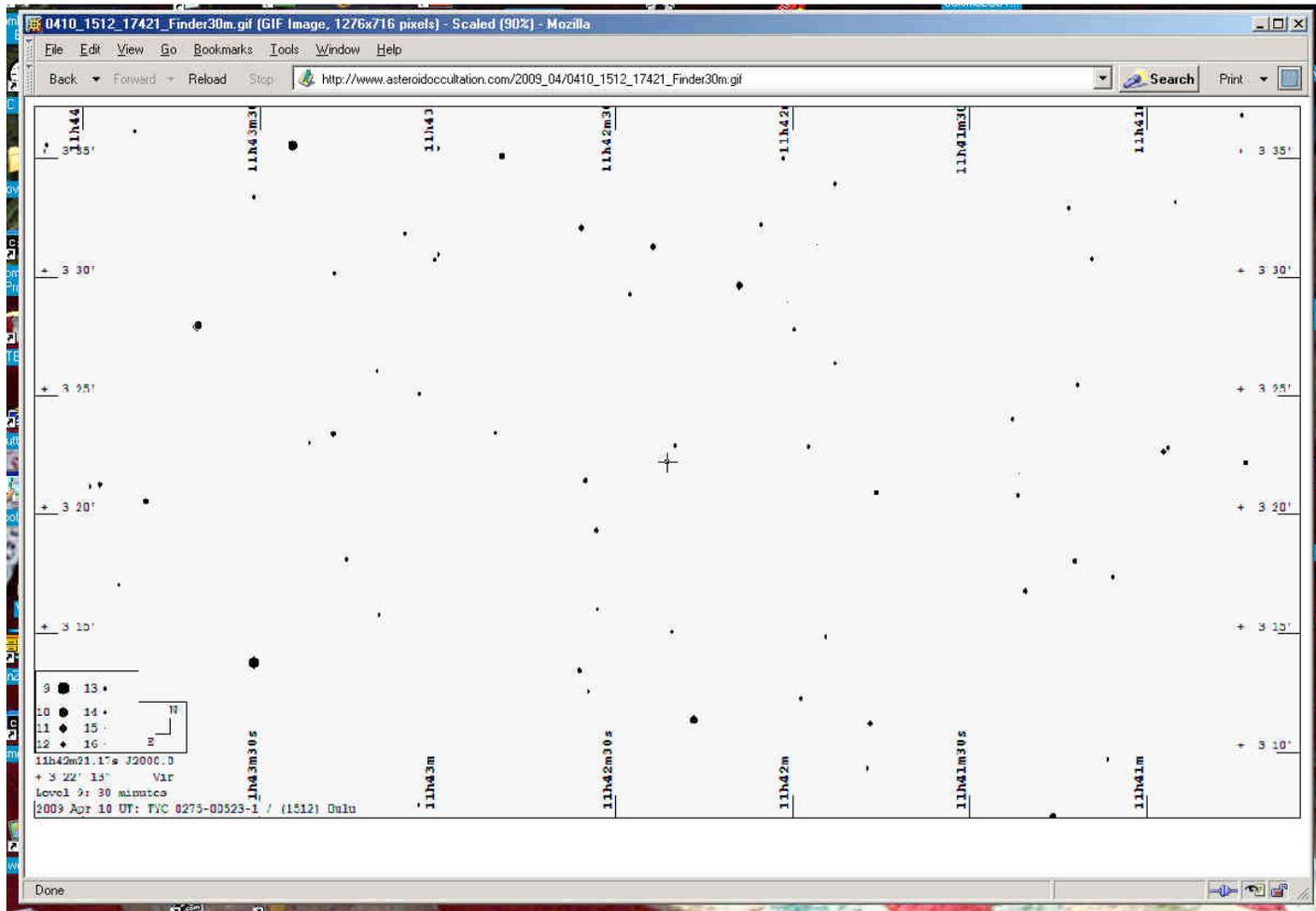
Last updated on 04/06/2009 6:28:21 PM

Graphical Plop

## Occult Watcher Mapping functions



Steve Preston Site--Occultation Path map



Steve Preston Site-Star Map

So, measuring a 12mag star should be easy, right?

Pushing the envelope on moon, alt & az, twilight, etc  
means star may be hard to find

Portable setups increase difficulty of acquiring  
and tracking target

Little time for practice--occultations only 0-4x per month

No second tries--mess up one step and you've lost the opportunity

Absolute deadline for preparation--it happens when it happens



And timing a 30 sec event should be easy, right?

Aha, but with  $<0.1$  sec resolution, too?.....

Objects are often faint 12-13 mag, hard to get good S/N

Scintillation effects strong at under one second speed

Difficult to get/use accurate UTC time to  $<1$  sec

Windows computer programs cannot do  $<1$  sec UTC

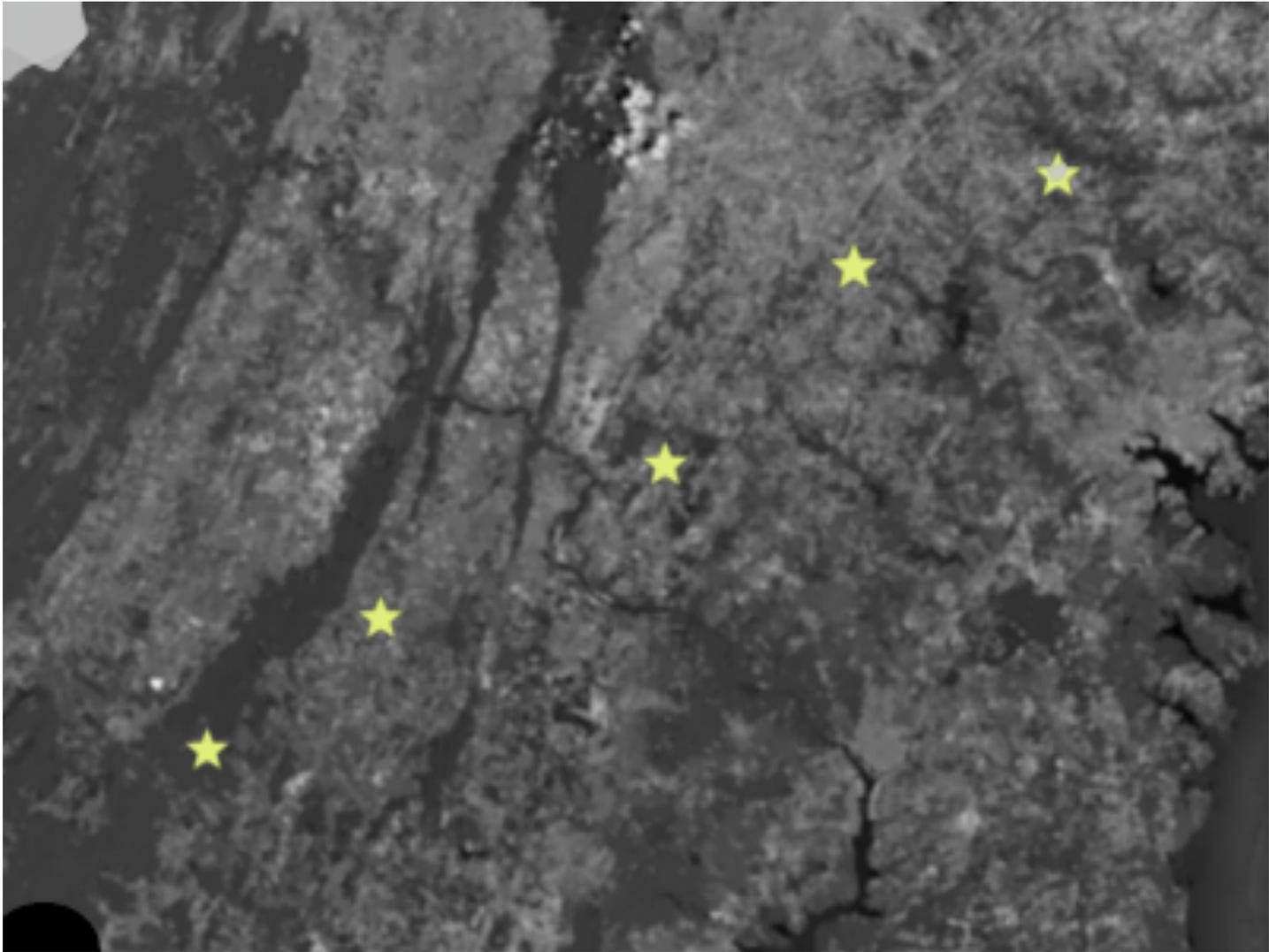
Want automatic, permanent recording of time and event



And then there is Mother nature..

always ready to help out...





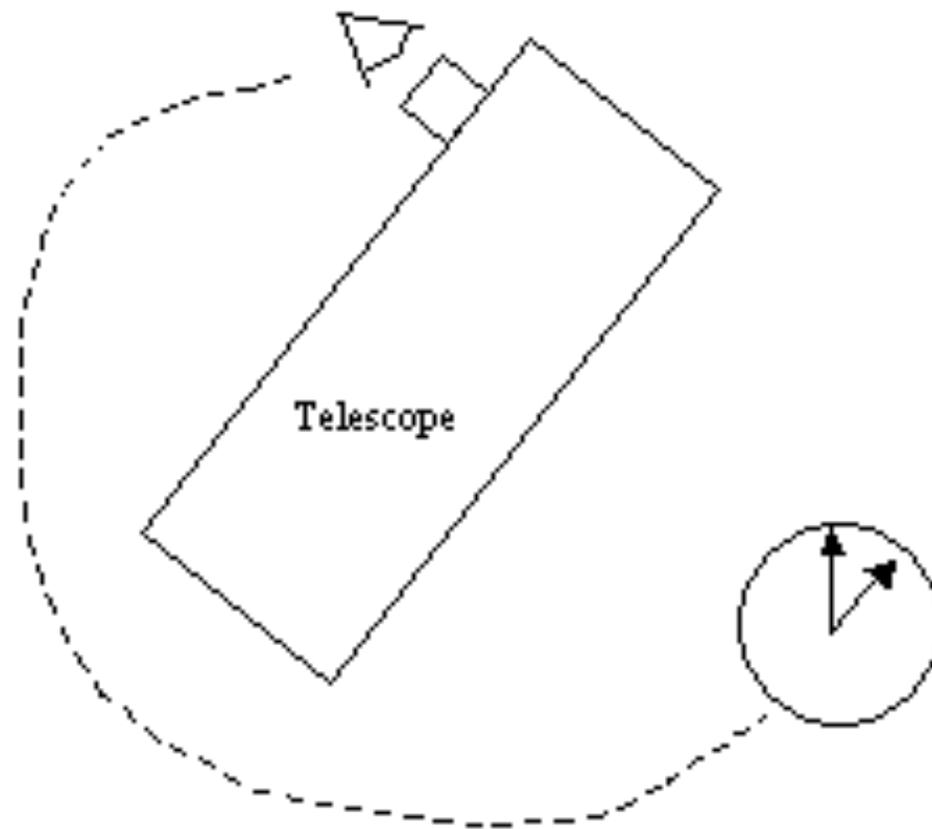
# Methods of Observation

<b>Detector Type</b>	<b>Telescope</b>	<b>Mounting</b>	<b>Timing</b>
Visual (eye)	Small	GoTo	Radio
CCD Camera*	Big	Non-GoTo	WWV
Video Camera		Non-Tracking	Stopwatch
Photometer			GPS

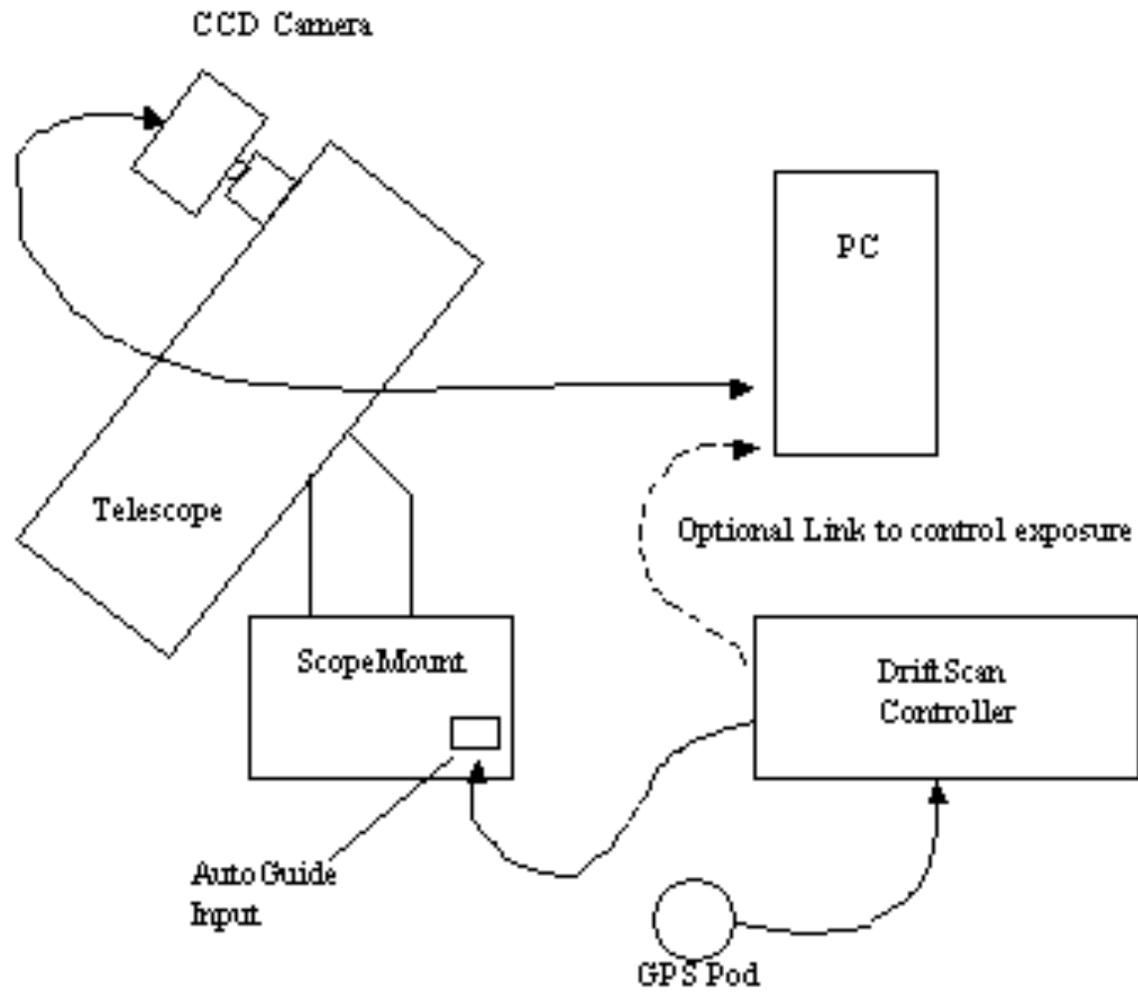
 = most common

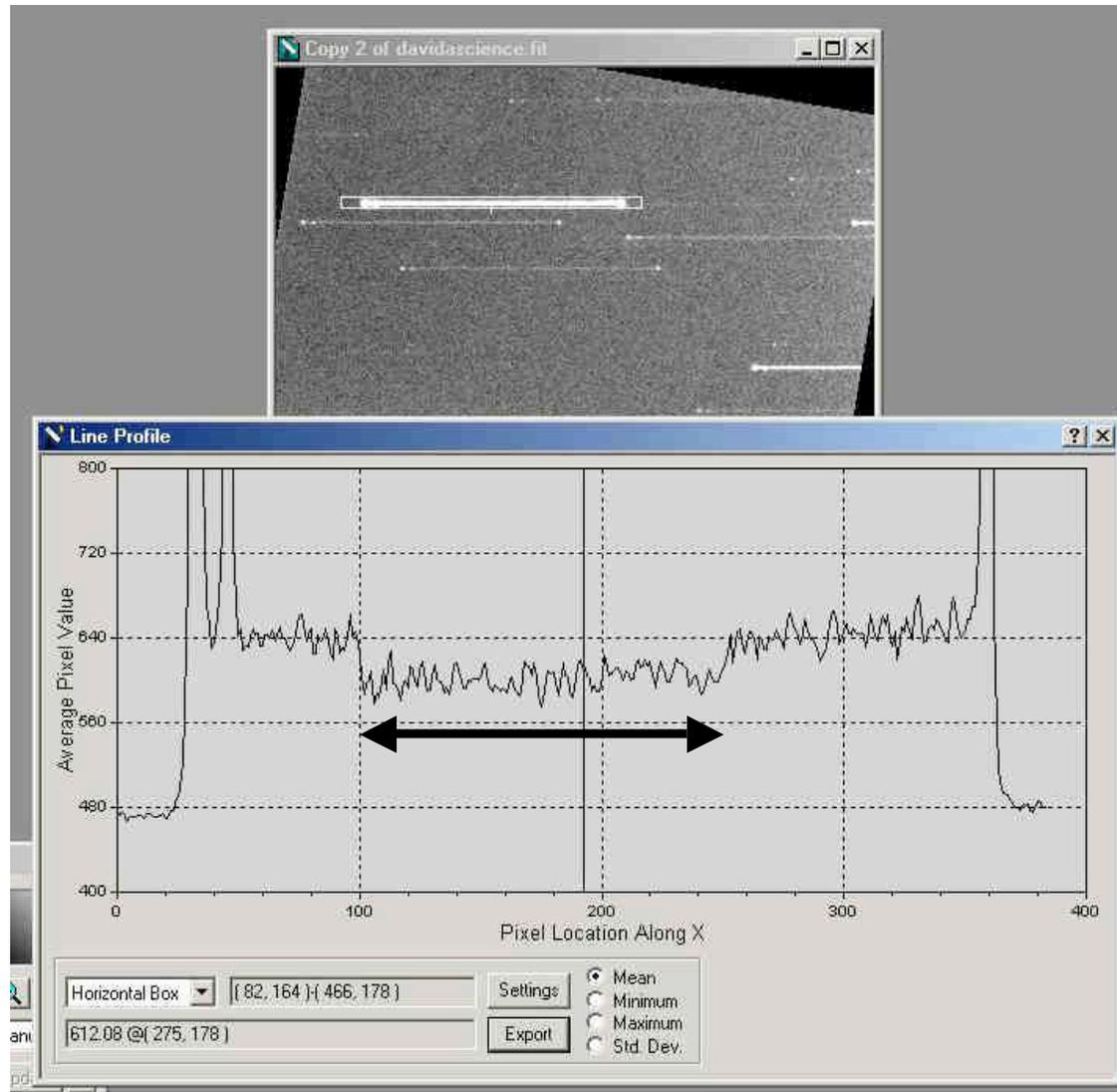
\* Drift Scan

## Visual Occultation Setup



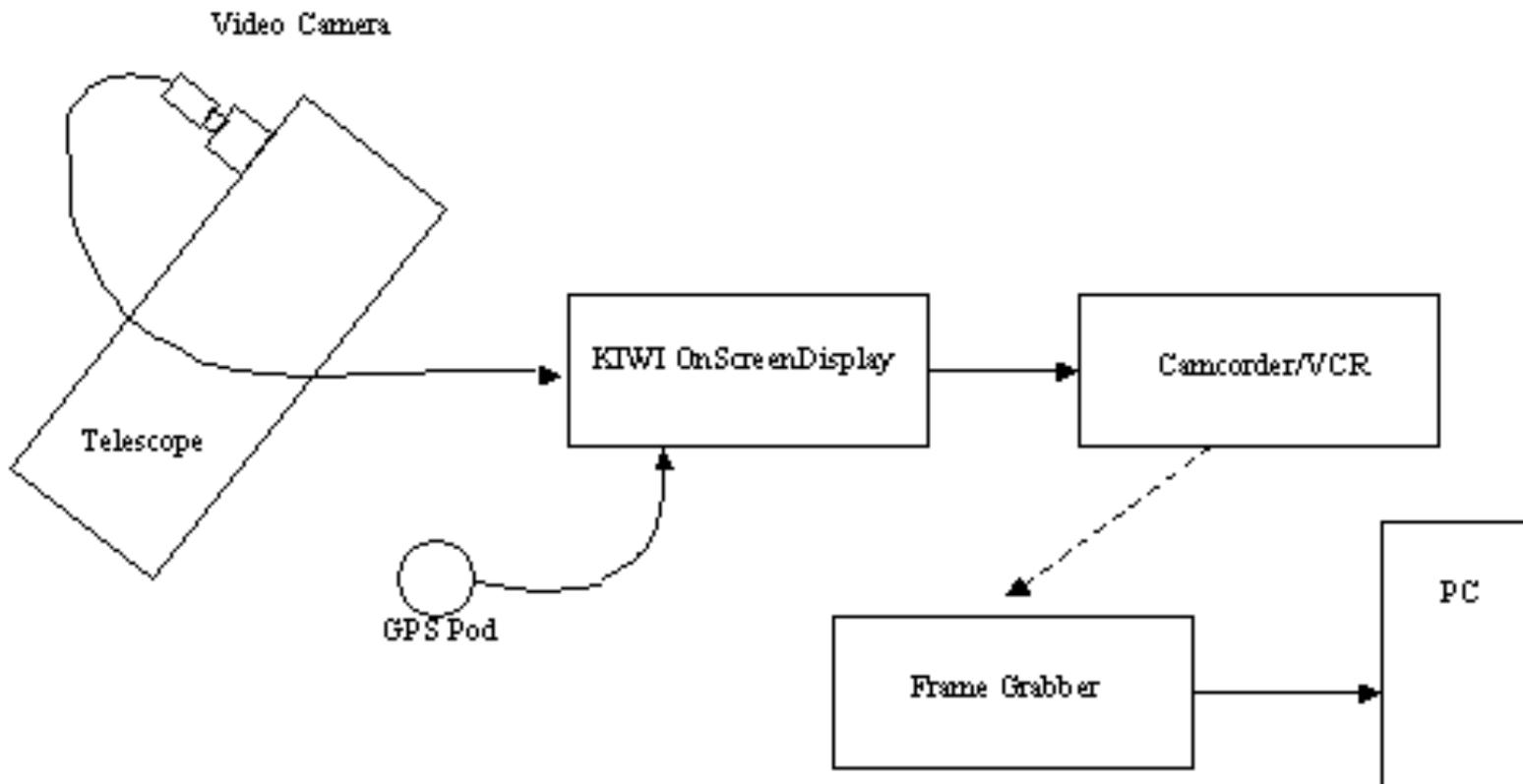
# CCD DriftScan/GPS Occultation Setup





Davida Drift Scan Result

## Video/GPS Occultation Setup





### Video Characteristics:

60 fields/sec-30frames/sec

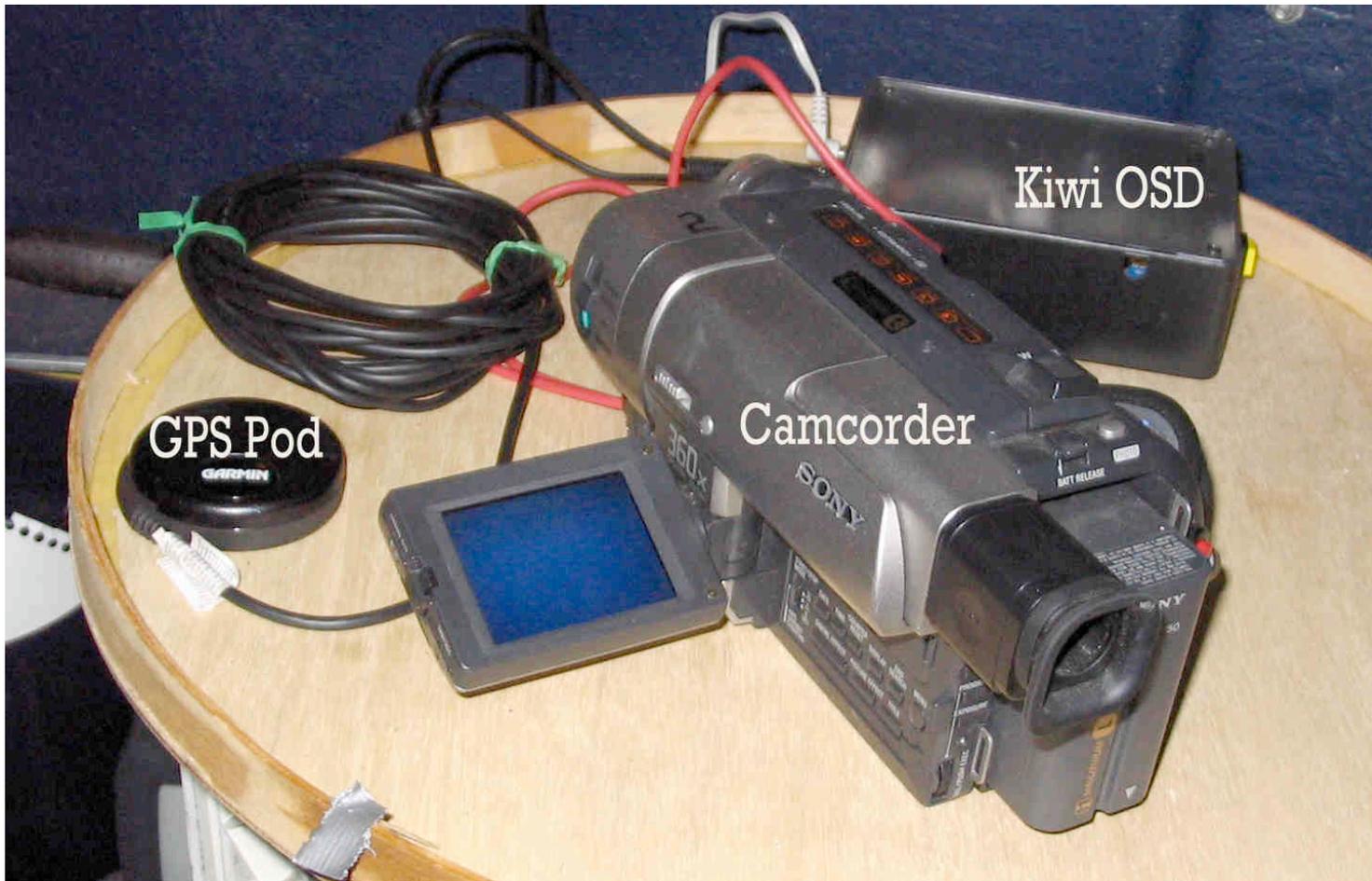
small board cameras through integrating cameras (x128=2 sec)

no cooling (short exposures)

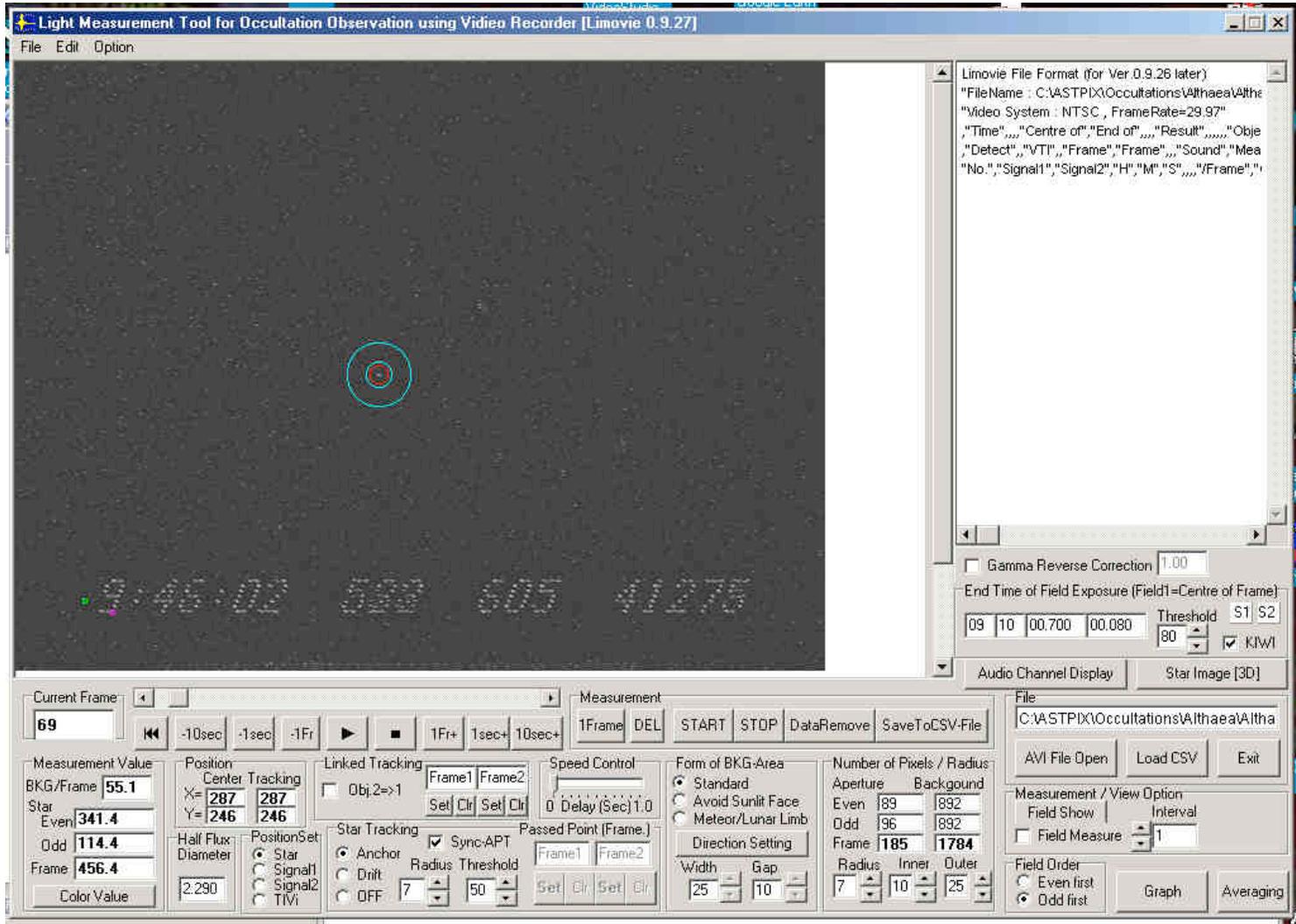
most are autoexposure, a few are manual

\$25-1000

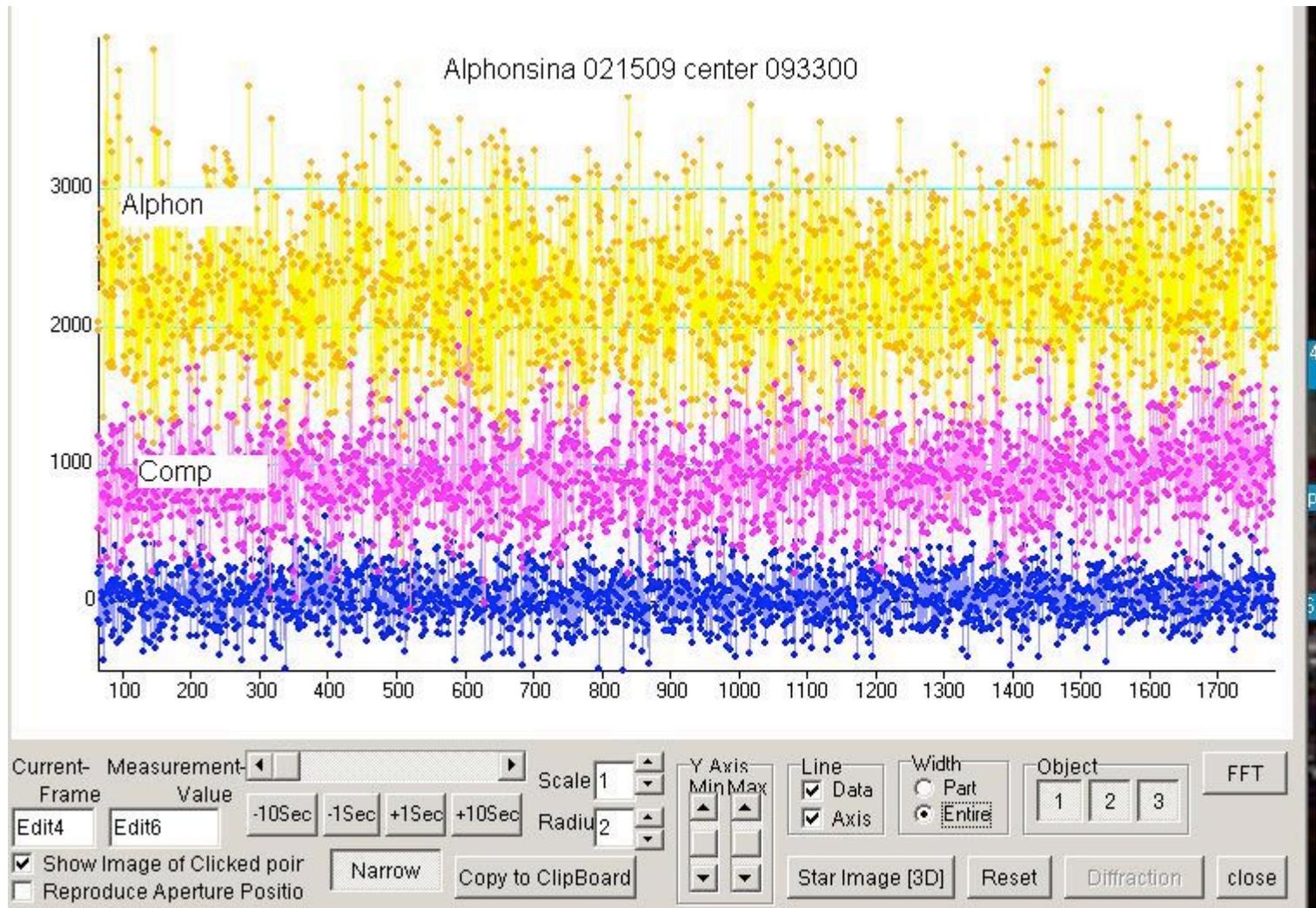
most are analog, convert to 8bit with frame grabber



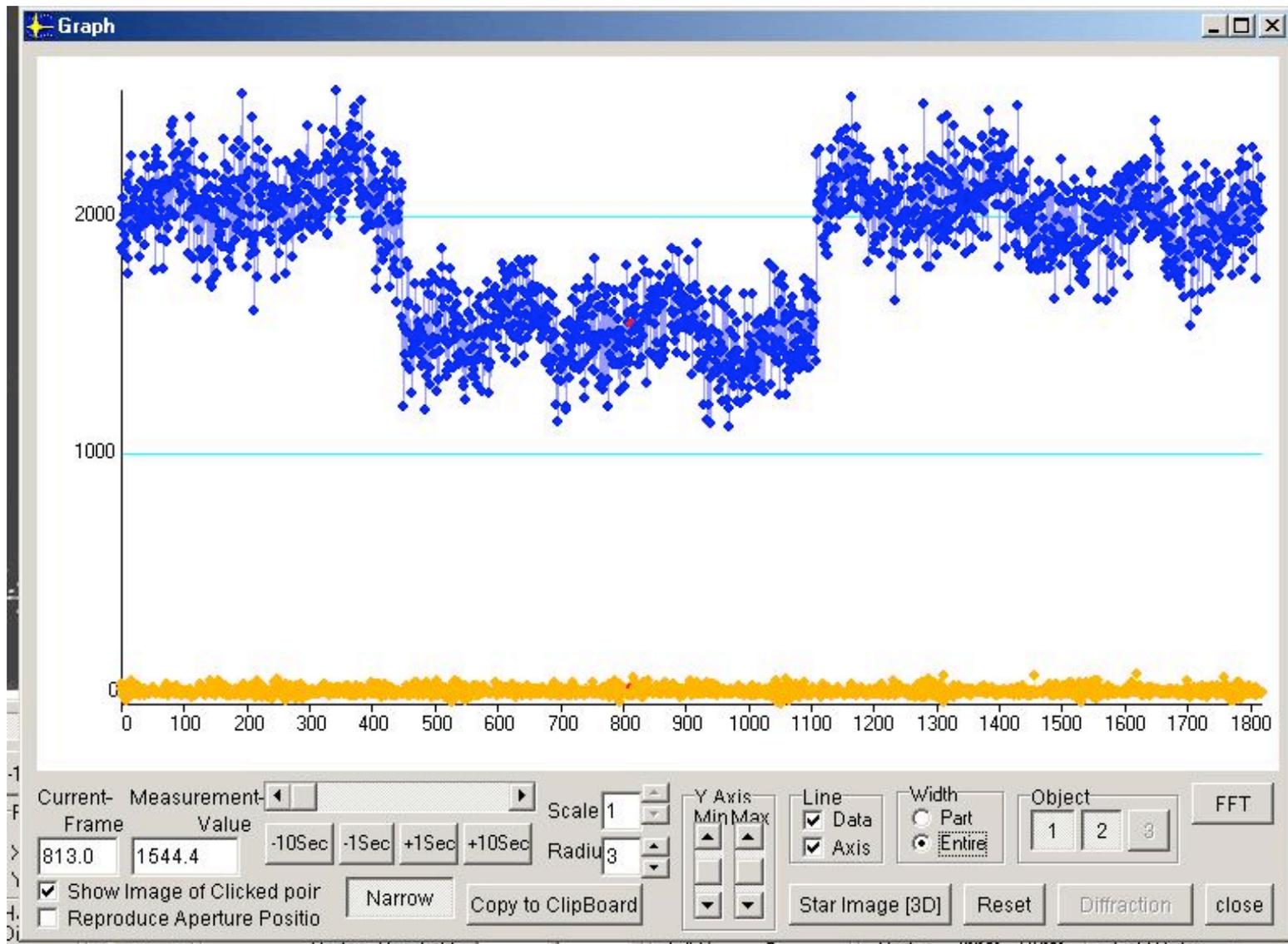
Video/GPS Setup using Camcorder



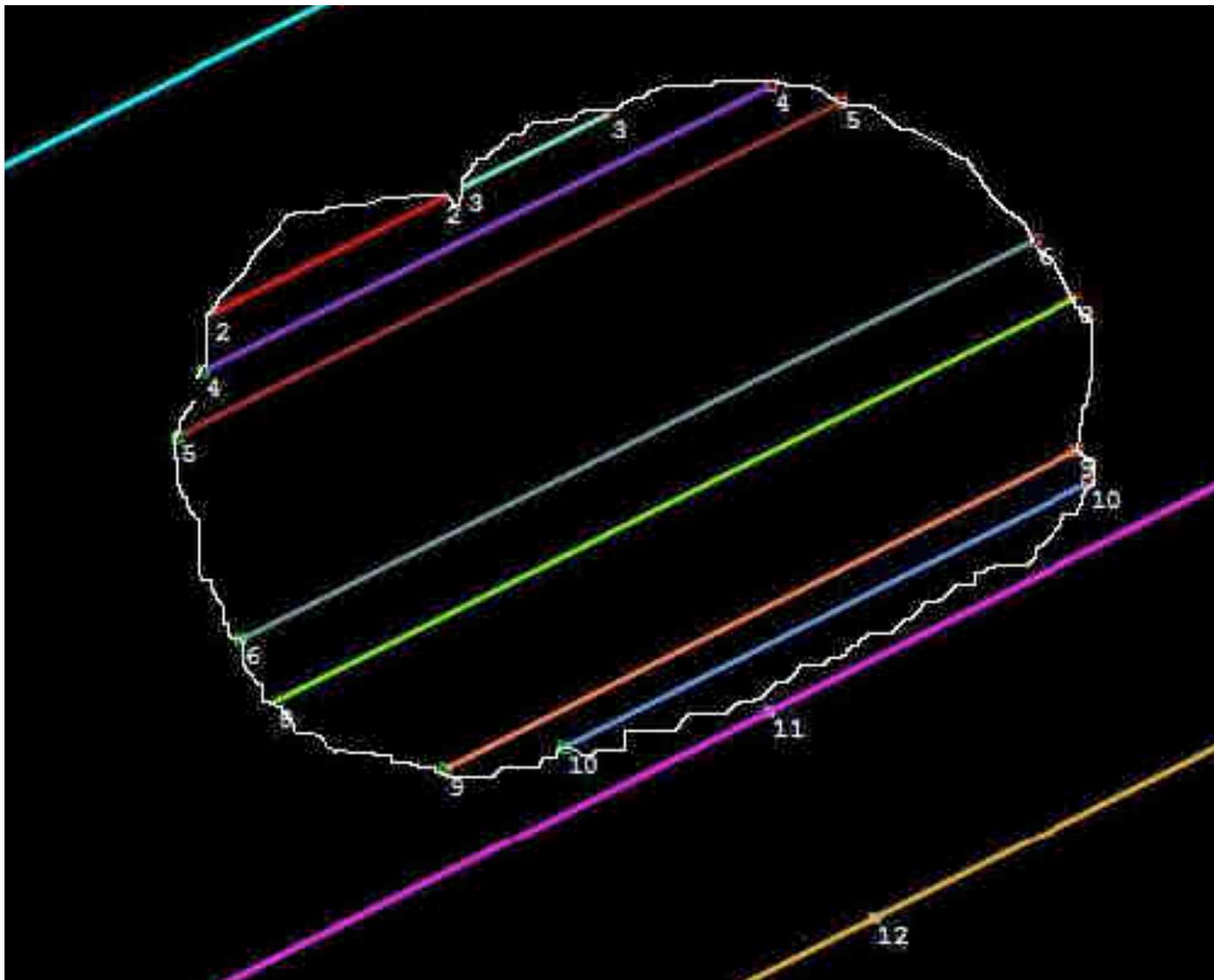
LiMovie Main Window



LiMovie Graph Function-miss (4AM)



LiMovie Graph Function-Davida Positive



Arethusa Hypothetical Shape

# The MightyMini and its variations

Scotty Degenhardt is a leading developer and user

Small Scope (2-3 inch) on tripod (no mount)

Video Camera with KIWI for gps timing

Recorder (camcorder, DVD, etc.)

## Advantages..

Wide field of view (1-2 deg)

Can do Pre-Pointing, then no drive

Reasonably sensitive (10-11 mag)

Very Portable (a few pounds)

Low power (easy battery supply)

Fast Setup

Cheap-can do multiple stations (~\$200)

## Complete portable occultation timing setup (air carryon)

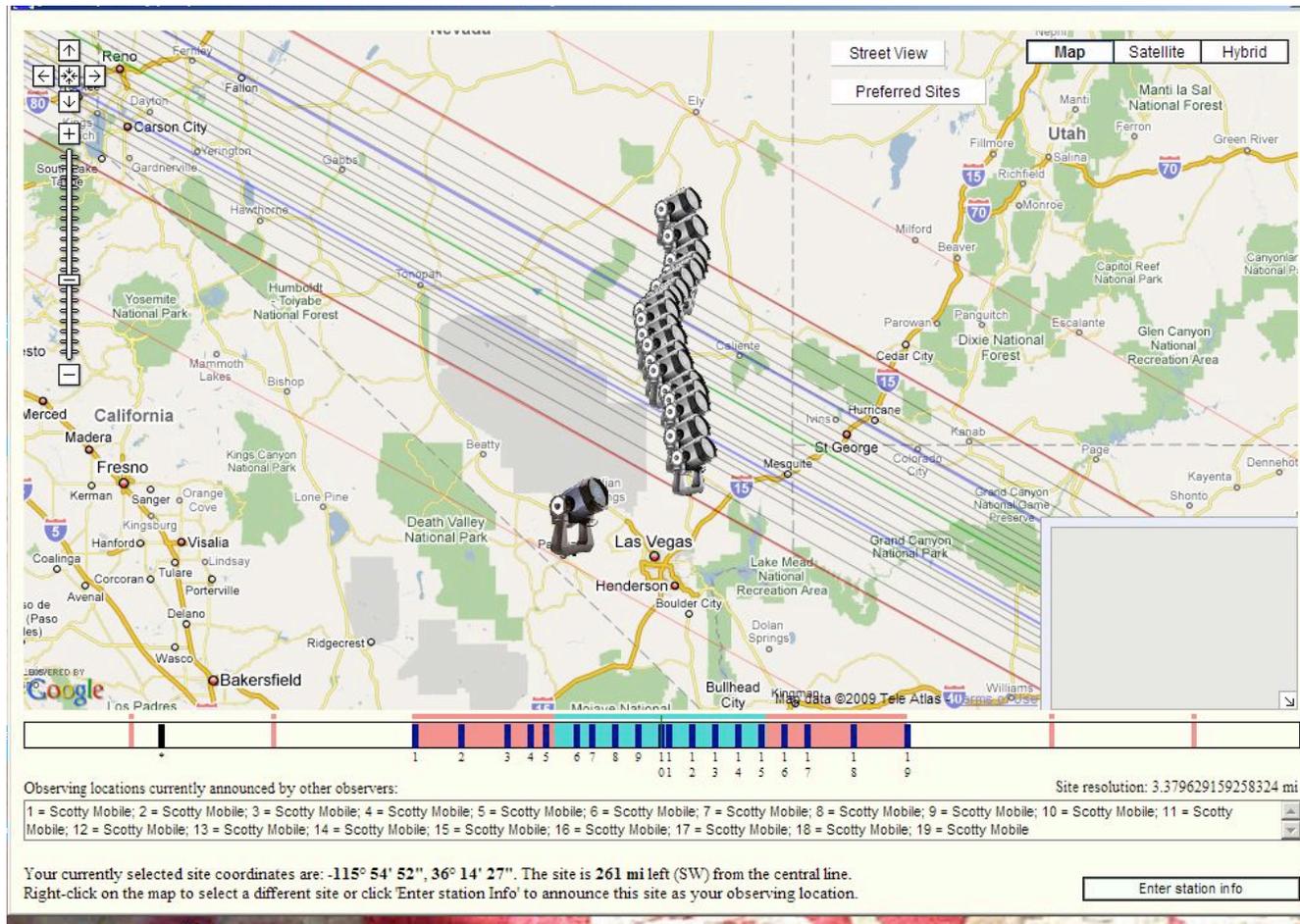


- Mighty Mini optics (half of a Tasco Essentials 10x50 binocular)
- PC164CEX-2 video camera
- MX-350 miniature tripod (collapses to 12")
- Canon ZR camcorder (digital VCR)
- 9 AA NiMH battery pack
- Prime focus adapter for lunar occultations
- Total weight: under 10 lbs
- Limiting magnitude = 10.2
- FOV = 3.2 x 2.4 degrees (using Owl FR)
- System designed by Scott Degenhardt

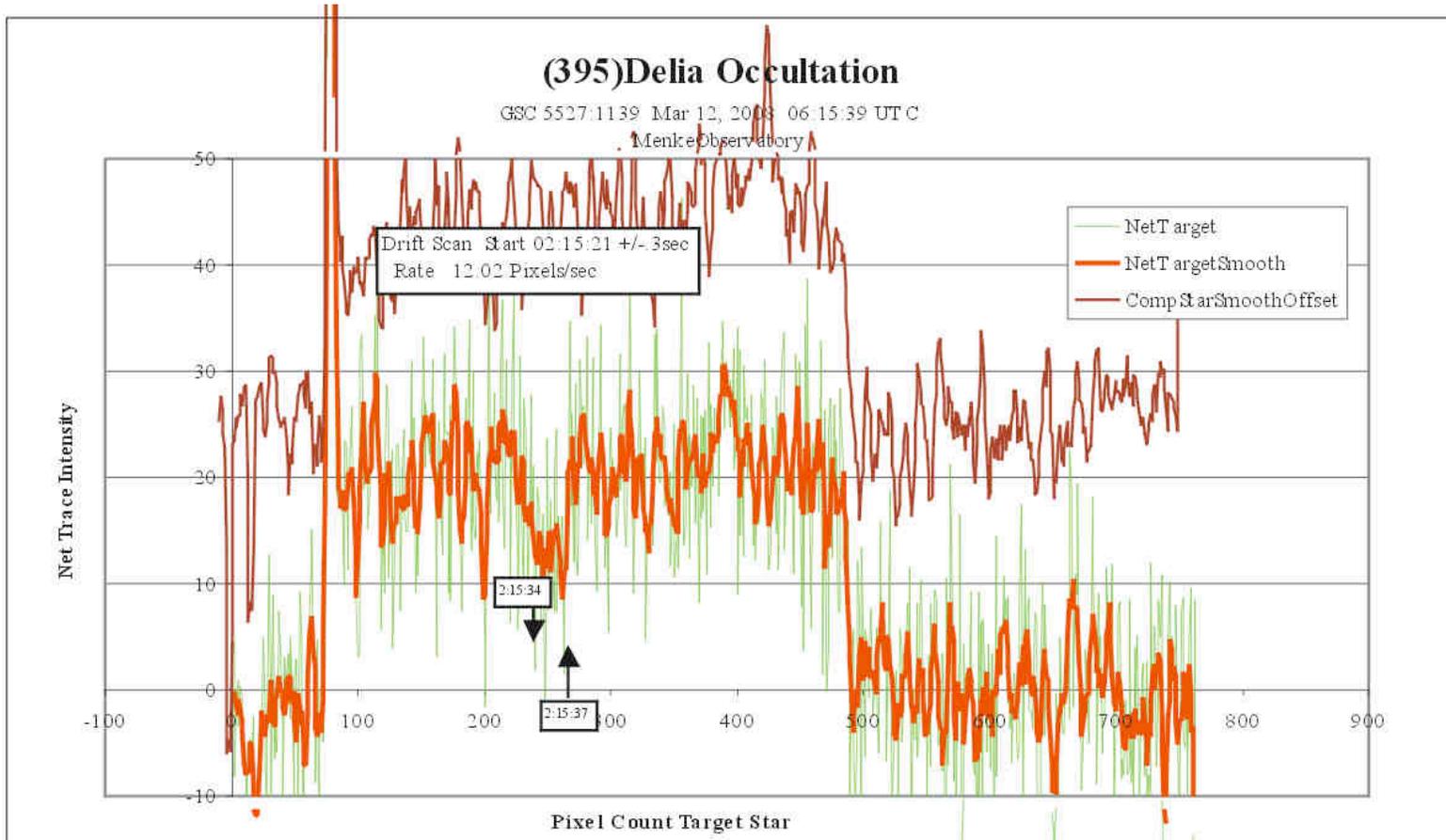
Scotty Degenhardt MightyMini Portable Station



Scotty with Six Stations Ready-to-go!



Multiple Scotty Observing Sites Scheduled for May 20, 2009 (547) Praxedis Near Las Vegas



LiMovie-False Positive

Home • Gallery • **Dave Herald - Moons and asteroids** • Europa occults Ganymede - 2009 May 8 18h

[Main gallery page](#)

**Slideshow**

### Europa occults Ganymede - 2009 May 8 18h

Analyzed file name [AstroVideo4.avi] Photometry in each Frame

Frame No: 7.0 / Frame Center: hh:mm:ss(Field1)s, Frame End: s(Field2)s

**Description**   

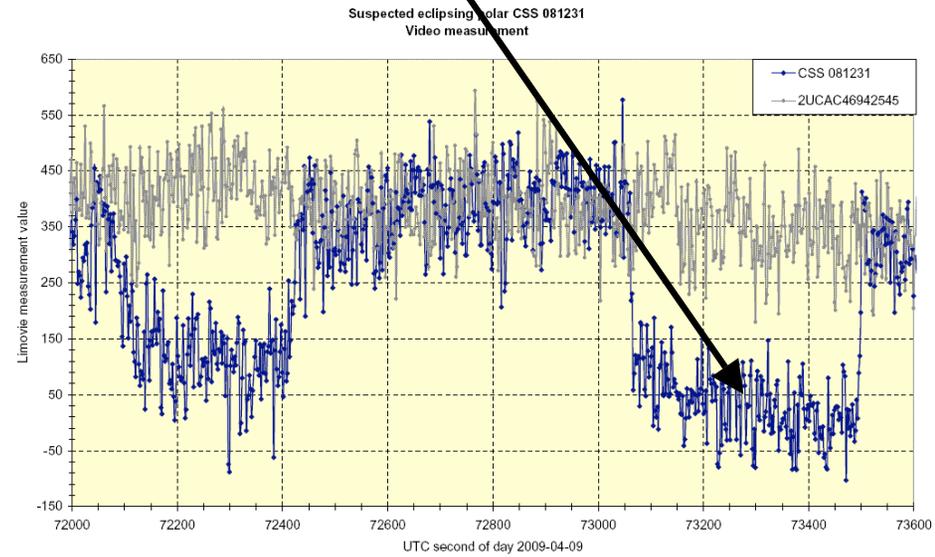
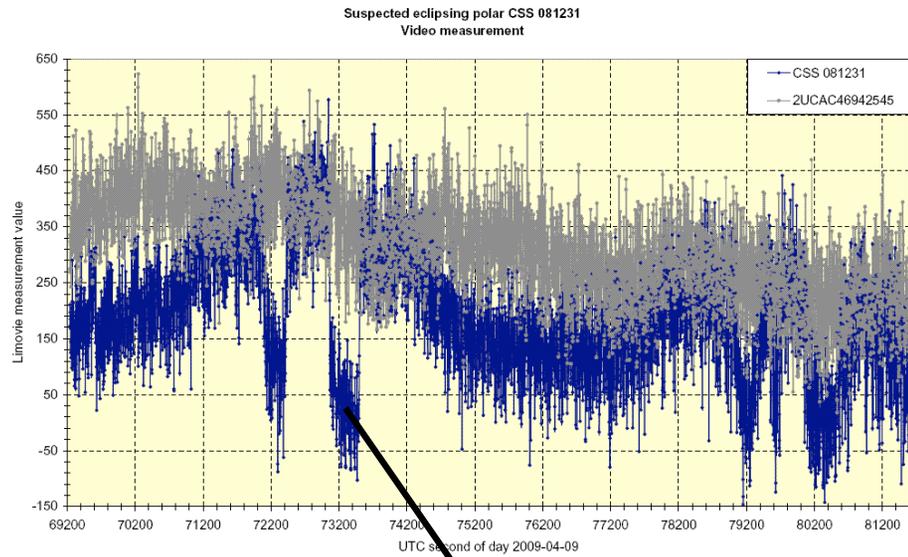
**Hits:**                    19

Light curve of the occultation of Ganymede by Europa. Light curve extends from 18h 3m 17.42s to 10m 57.23s. Europa is considerably smaller than Ganymede. In this event Europa 'transitted' Ganymede. The flat section during the flat section in the middle of the curve. The duration of the flat section is longer than predicted - which indicates Europa passed closer to the center of Ganymede than predicted. The fall and rise curves look to be quite symmetrical - being steeper near the central part of the occultation.

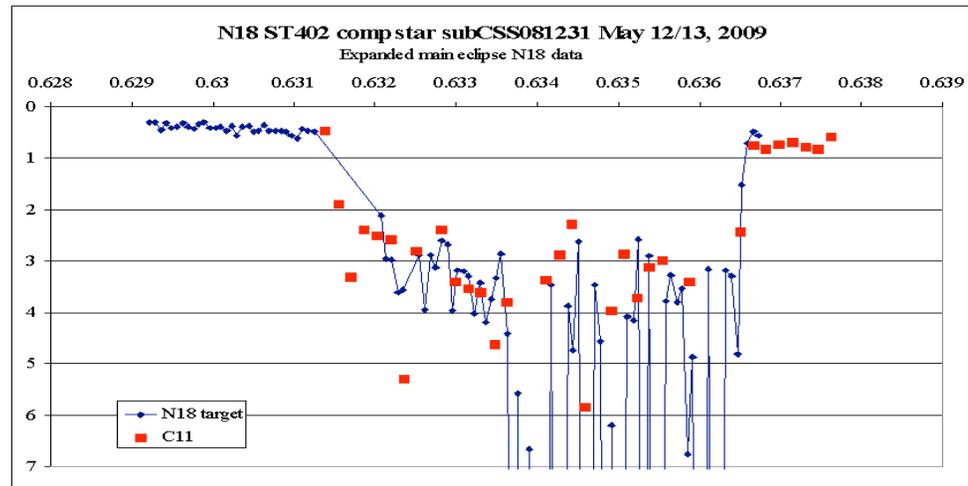
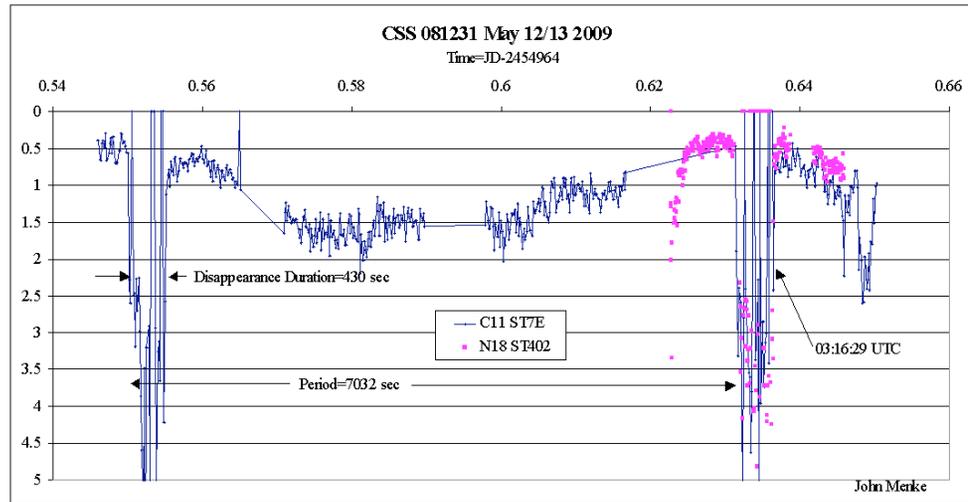
© 2009 ssa.iagmor.com

## David Herald Video (LiMovie) of Europa/Ganymede Event

Note: 14" Meade, polar mounted, and a Watec 120N+ video camera.



CSS 081231 Apr 9, 2009 Gerhard Dangl--2 sec integration video



CSS 081231 May 12/13,2009 Menke C11/ST7 and N18/ST402

# Occultation Madness...

Immediate observation results... "the rush"

Great break from routine work

Helps the old adrenaline flow

New skills, applicable to additional observing

Exciting new field, lots of energy and enthusiasm

A chance to use an observing system getting .01 a-s resolution!

Gratification--got a Positive!



One morning, observing an occultation....

So I am up at 4 AM.. Half hour to event time.. Half hour is shorter than my usual 60 minutes of tracking, but the scope is permanently mounted, and was 'Prewired" last night.. A Simple Synch on Spica and a GOTO to the target within 30' of a mag 5 star.. How hard could that be?? Well to start with, I have been using my ST80 and it's 1.98 x 1.48 degree FOV extensively and using the 12" scope and it's 24 x 17 arc minute FOV is no longer 'common'. And of course, 4:34:15 comes and goes and I would have missed the event by about 2 minutes because I broke my own rule and didn't allow enough time. One small detail..Event time is 5:34:15.. Just like it says on my chart.. Hell!.. I can do this! So I switch cameras to the integrating camera. Focus all the way in.. Nothing.. All the way out.. Nothing.. Heavy dew is everywhere, raining off the trees in my forest, so I check the corrector and.. lets just say it's wet.. So I am into the house, forgetting I have my knit 'Robber Mask' on with the two eye and one mouth holes.. Flashlight in hand, I trek into the bedroom to steal Wifey's hair dryer.. Next thing I know I have Wifey's Tasmanian Devil.. err.. Yorkshire Terrier ripping into various appendages with a vengeance because some hooded masked man with a flashlight is in the bedroom. Crash!.. Down I go.. On my back, wedged between the bed and the wall, 7 pound set of teeth on my chest.. "Honey! Where's the OFF switch!" "Don't hurt my dog!.. He's 'LITTLE' "!, she says.. Yeah.. A 'LITTLE' vicious SOB.. After stopping the blood flow, I dry the corrector, locate the target and all is well.. Integrating 32 fields.. Let's try less.. Worked my way down to real-time and could see it, but I went to 4 fields.. Good time resolution, high SNR.. About 1m 15 seconds to go, all the stars disappear, so I jump to the strategically placed hair dryer and whip out the flashlight to see how much dew needs to go away... the corrector is perfectly dry.. The target had set behind the ridge. And only a few short hours after I posted the Occultationist Humor - "Blew the Event".. So this event has been renamed.. This is No Longer, the Astarte Event.. It is now known as "The Great Metcalfia Warm-up" ! Derek <http://www.poyntsource.com/New/index.htm>

