Journal for Occultation Astronomy

2012–01 FORMERLY OCCULTATION NEWSLETTER

Highlights and Minutes of the 29th IOTA Annual Meeting – July 16-17, 2011

Sierra College, Rocklin, CA – by Richard Nugent, Executive Secretary

The 29th annual meeting of the International Occultation Timing Association was held on Saturday and Sunday July 16-17, 2011 at Sierra College in Rocklin, California. This location was chosen to coincide with the occultation of the binary asteroid 90 Antiope covering a 120-km wide path that covers northern California a few hours before sunrise on July 19, 2011.

Positive chords were obtained and the results are posted at the asteroid occultation results page:

http://www.asteroidoccultation.com/observations/results/Data2011/20110719_AntiopeLook6.gif

The meeting location was kindly hosted by Dave Kenyon of Sierra College who also hosted IOTA's 21st annual meeting in 2003. The final meeting schedule, and most of the presentation files, are located as links from Brad Timerson's North American Observations web site:

http://www.asteroidoccultation.com/observations/NA/2011Meeting/

http://www.asteroidoccultation.com/observations/NA/2011Meeting/Presentations/

Persons participating in the meeting included:

- President Dr. David Dunham and Dr. Joan Dunham from Maryland,
- Vice President Paul Maley, Chuck Herald from Texas,
- Dr. Eberhard Bredner, IOTA-ES Secretary, from Germany
- Tony George from Oregon,
- Steve Preston from Washington
- Dan Davidson, Ted Swift, Richard Nolthenius, Walt Morgan, Derek Breit, Danny Falla, Sandy Bumgarner from California,
- Roger Venable from Georgia,
- Scotty Deganhardt from Tennessee,
- Derald Nye from Arizona

Video Internet Conference (EVO) Attendees: Steve Messner, Ted Blank, Brad Timerson, Chris Douglass, John Grismore, Terry Redding, IOTA Treasurer Chad Ellington, IOTA Executive Secretary Richard Nugent, Ernie Iverson, Richard Wilds, Dave Gault, Aart Olsen, Bruce Berger, Jan Manek, Dave Herald, Steve Conard, Bruce Holenstein, Wolfgang Rothe, Rob Robinson, Hristo Pavlov, Bob Sandy, Wayne Warren, Jr., Jonathan Bradshaw, Ned Smith, Henry Sielski, Rafael Chavez, John Talbot.

Journal for
Occultation Astronomy

Dear reader,

Mobile big telescopes?

That is an alternate possibility to record extreme faint stars being occulted by much fainter Trans-Neptunian-Objects or minor-planets.

Why we are doing this?

Although a lot of observatories are spread all over Europe and the USA occultation paths don't move to the observer – rather the observer must be prepared to move to the event as a possible result of a last-minute-prediction. If this happens it becomes necessary to switch from a fixed 16" telescope to a portable 12" Meade or 11" Celestron with the possible result that the occultation will be unobservable.

That is one of the reasons why American members are building "giant portable" scopes, and IOTA-ES is trying to do the same in spite of a few more problems European members have to move big-mass-instruments across borders to reach a 1600 km distant path – being no problem within the US regarding the distance.

But the European concept has one advantage: Their telescope can well be dis- and reassembled to be easily sent to very distant continents by airplane – especially when no observatory is available there… For further information about the newest equipment acquisition of IOTA/ES please refer to my article: "A portable 20 inch" telescope".

In Iran a very active group of young occultation observers formed the IOTA-Middle-East-section in 2010 and held its 2nd international workshop in November. Eberhard Riedel was invited as a guest speaker and reports about his experiences in Iran.

On this workshop Arya Sabouri, 2nd vice president of IOTA/ME, presented an ambitious project to solve timing problems with modern but readily available equipment. His article in this issue will hopefully induce some discussion on this important matter and lead to further cooperation and development.

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In this issue:

Writing articles for JOA:

The rules below should be regarded while writing an article; using them will greatly facilitate the production and layout of ON!

If your article does not conform to these rules, please correct it.

There are 3 different possibilities for submitting articles:

- pdf-articles (must be editable – these can be converted)
- unformatted Word *.doc-files containing pictures/graphs or their names (marked red: <figure_01>) at the desired position(s)
- *.txt-files must contain at the desired position the name of each graph/picture

The simplest way to write an article is just use Word as usual and after you have finished writing it, delete all your format-commands by selecting within the push-down-list "STYLE" (in general it's to the left of FONT & FONTSIZE) the command "CLEAR FORMATTING". After having done this you can insert your pictures/graphs or mark the positions of them (marked red: <figure_01>) within the text.

txt-files: Details, that should be regarded

- Format-commands are forbidden
- In case of pictures, mark them within the text like <picture001> where they should be positioned

Name of the author should be written in the 2nd line of the article, right after the title of the article; a contact e-mail address (even if just of the national coordinator) should be given after the author's name.

IMPORTANT:Use only the end-of-line command (press ENTER) if it's really necessary (new paragraph, etc.) and not when you see it's the end of the line!

Sending articles to JOA:

Each country / state has a coordinator who will translate your article to English – if necessary.

In case there is no one (new country) please send a mail to the editorial staff at: **info@occultations.info**

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9:01AM – Meeting start – Introductions

President Dr. David Dunham opened the meeting and welcomed everyone. Dunham then asked the attendees to introduce themselves. All present at Sierra College walked in front of the webcam and introduced themselves. Then all EVO attendees with microphones introduced themselves.

Dave Kenyon of Sierra College welcomed back IOTA for this year's meeting.

Business meeting:

IOTA Treasurer Chad Ellington presented the income and expense report. A summary of the year's bank balances are:

Starting Balance:	**$7,089.65**	**2010, Dec 4**
Ending Balance:	**$6,305.00**	**2011, Jul 11**
Net Decrease in Balance:	**$ 784.65**	

New Server: Currently a new web site is being investigated for IOTA business. Chad showed a screen shot of the proposed new format of the business page which included links to all archived ON's (Occultation Newsletter, renamed JOA) and allowing for payment for subscriptions to ON/JOA. The old site, www.occultations.org was being paid for by Art Lucas and Lucas has suggested we move everything elsewhere to stabilize IOTA business needs.

A Google group website is currently up and running for accessing past ON/JOA issues and IOTA business. The URL is http://groups.google.com/group/iota.us. All users and access would be approved by Chad, as he would maintain the site. In this scenario, users would be able to customize their access page such as having links to the asteroid predictions, lunar graze events, software programs, IOTA-ES, RASNZ, Euraster, weather forecasts, etc.

David Dunham motioned the group to accept the financial report as presented. All attendees agreed.

This year's presentation of the annual Homer F. Daboll Award was made by the Award Committee Chair Dr. Terry Redding. The Homer F. Daboll award is given annually to an individual in recognition of significant contributions to Occultation Science. "Occultation Science" is limited to actual IOTA research: total and grazing occultations, asteroid occultations and solar eclipses.

Homer F. DaBoll had a long history with IOTA until his death on March 10, 1990. DaBoll was born on May 22, 1920. He led numerous grazing occultation expeditions in the Chicago area spanning 3 decades, from the 1960's to 1990. He was the first ever editor of Occultation Newsletter for 16 years from its first issue in 1974 thru early 1990 when health reasons forced him to pass on the Editorial duties to Joan Dunham. DaBoll was the person who came up with the acronym IOTA, International Occultation Timing Association. Members of IOTA have always held Homer DaBoll in the highest regard for his numerous contributions to occultation observations, expeditions, ON, and his many other volunteer efforts.

This year's committee received 14 nominations. The Committee's main objective in selecting an award recipient was to reach a consensus and not choosing someone by a majority vote. The rules allow any person to be considered for the award except for current IOTA Officers and Committee members.

The 2011 Homer F. Daboll award recipient was Scotty Deganhardt from Columbia, Tennessee for his long time contributions to IOTA including the design and development of the multi video station deployments (Mighty Mini's). These have become the standard for spreading out and maximizing coverage for asteroid events. Scotty broke all records with his December 11, 2008 occultation observations of 135 Hertha in which he obtained an unprecedented 14 chords!

Scotty described how he came up with the idea of the Mighty Mini concept. In his garage one day he found a half binocular in his toolbox. It was left there 15 years earlier as he used the other ½ to make a telescope finder. He decided to try and use it as a lens for a video system and after experimenting and "tweaking it along" the "Mighty Mini" was born. The rest is history.

Dunham suggested since there is a backlog of persons entitled to receive the Homer Daboll Award, that a 2nd award can also be given annually perhaps under a different name.

Brad Timerson has been researching the acquisition of a single IOTA dedicated domain to host most if not all IOTA web sites. Currently we have different sites for the business pages, lunar occultation/graze pages, annual meeting minutes, and other pages. The scattering of this important IOTA information could lead to problems if a server ceases to exist/have problems (as was the case for Nugent's IOTA meeting minutes pages earlier this year). Brad found a server LibiHost.com, http://www.libihost.com/index.php which offers an excellent rate for non-profit organizations.

- Features: http://www.libihost.com/plan.php?p=21
- Price: $ 4.95 per month, $ 49.50 per year
- Local contact person for service, specific hosting plan for non-profits

And by luck, the person managing this server is located a mere 20 miles from Brad. One advantage of having our own domain would be shorter URL's. A username/password can be set up for paid IOTA members for the business pages. Brad will continue exploring this important task for IOTA.

Executive Secretary Richard Nugent presented a summary of the minutes for last year's 2010 meeting held in Boston, MA. Earlier this year Nugent had to move the annual meeting minutes pages (covering years 1998-present) to Derek Breit's poyntsource.com server. The person whose server hosted the IOTA minutes website passed away in March 2011 and along disappeared the web pages. The current location for IOTA annual meeting minutes from 1998-present is:

http://www.poyntsource.com/Richard/IOTA_Annual_Meetings.htm

Vice President Paul Maley talked about the status of the recently formed IOTA Middle East Section, IOTA/ME. Their web address is http://www.iota-me.com/. Their current focus is to foster and spread knowledge and observing in occultation research, especially lunar occultations. Many members have telescopes and their 1st meeting last November 17-19, 2010 in Gonbad Iran had 74 attendees. Paul has contributed 5 articles to their newsletter, Dunham has contributed articles also. They plan to expand their membership with observers from Iraq and Afghanistan.

David Dunham presented the current status of IOTA publications. One way the activity of a scientific organization can be realized by the amount of publications in refereed journals. Since last December 2010, the following publications involving occultations/eclipses has appeared:

"Constraints on Charon's orbital elements from the double stellar occultation of 2008 June 22", The Astronomical Journal, Vol. 141, pp. 67-83, 2011 February. Authors: B. Sicardy, G. Bolt, J. Broughton, T. Dobosz, D. Gault, S. Kerr, F. B´ nard, E. Frappa, J. ecacheux, A. Peyrot, J.-P. Teng-Chuen-Yu, W. Beisker, Y. Boissel, D. Buckley, F. Colas, C. de Witt, A. Doressoundiram, F. Roques, T. Widemann, C. Gruhn, V. Batista, J. Biggs, S. Dieters, J. Greenhill, R. Groom, D. Herald, B. Lade, S. Mathers, M. Assafin, J. I. B. Camargе, R. Vieira-Martins, A. H. Andrei, D. N. da Silva Neto, F. Braga-Ribas, and R. Behrend

"Combining asteroid models derived by lightcurve inversion with asteroidal occultation silhouettes", Icarus, 2011, in press.. Authors: Josef urech, Mikko Kaasalainen, David Herald, David Dunham, Brad Timerson, Josef Hanuš, Eric Frappa, John Talbot, Tsutomu Hayamizu, Brian Warner, Frederick Pilcher, and Adrián Galád, The analysis of over 40 asteroidal occultations observed from 1977 to 2010, combined with lightcurve inversion models, is described. This important paper is now available at http://astro.troja.mff.cuni.cz/projects/asteroids3D/download/durech_et_al_2011_occ_paper.pdf

"Obituary: Thomas C. Van Flandern (1940-2009), Bulletin of the American Astronomical Society, Vol. 43, p. 23, 2011 June. Authors: David Dunham and Victor Slabinski, It is available at: http://aas.org/baas/obits/obit?Full_Name=Tom_C._Van%20Flandern&Date=2009-01-09

"A New Double Star from an Asteroidal Occultation: UCAC2 41168613", Journal of Double Star Observations, Vol. 7, No. 2, pp. 129-132, April 1, 2011. Authors: Tony George, Brad Timerson, Kerry Coughlin, and Roc Fleishman, The results of the occultation of UCAC2 41168613 by (675) Ludmilla observed on 2010 October 20 from Baja California Sur, Mexico, are described. Available at http://www.jdso.org/volume7/number2/George_67_70.pdf

"TYC 2255-01354-1 duplicity discovery from asteroidal occultation by (790) Pretoria", Journal of Double Star Observations, Vol. 7, No. 3, pp.172-177, July 1, 2011. Authors: Tony George, Brad Timerson, Bill Cooke, Scott Degenhardt, David W. Dunham, Steve Messner, Robert Suggs, Roger Venable, and Wayne H. Warren, Jr., The results of the occultation of TYC 2255-01354-1 by (790) Pretoria observed on 2009 July 19 from Minnesota, Tennessee, Alabama, and Georgia are described. Available here: http://www.jdso.org/volume7/number3/George_34_39.pdf

"HIP 46249 duplicity discovery from asteroidal occultation by (160) Una", Journal of Double Star Observations, Vol. 7, No. 3, pp. 178-182, July 1, 2011. Authors: Tony George, Brad Timerson, Tom Beard, Ted Blank, Ron Dantowitz, Jack Davis, Dennis di Cicco, David W. Dunham, Mike Hill, Aaron Sliski, and Red Sumner, The results of the occultation of HIP 46249 by (160) Una observed on 2011 January 24 from Nevada and Massachusetts are described. Available here: http://www.jdso.org/volume7/number3/George_40_44.pdf

"Towards A Unified Definition Of Solar Limb During Central Eclipses And Daily Transits", International Journal of Modern Physics D, World Scientific polishing Company, June 14, 2011. Authors: Cosantino Sigismondi, Andrea Raponi, Cyril Bazin, Richard Nugent. A new simple criterion to define the timing of the Sun's photosphere's disappearance/reappearance from Baily's Beads is modified. Available at:

http://arxiv.org/PS_cache/arxiv/pdf/1106/1106.2197v1.pdf

2012 RASC Observer's Handbook – Lunar occultation material has been prepared by Dave Herald and Eberhard Riedel. Jim Stamm is working on the asteroidal occultation list. Dunham mentioned they are behind schedule with this, but hope to finish and submit late next week to the new RASC handbook editor.

2011 Astronomical Calendar, Guy Ottewell, The "Occultations" chapter is written by Secretary Richard Nugent and lists occultation events visible with naked eye and binoculars, both by the Moon and asteroids.

The new Journal of Occultation Astronomy had seen 2 issues since it's replacing of the Occultation Newsletter. The first issue was published near the time of the last meeting, December 2010. The second issue was published in April, and the third issue is being assembled. Two papers submitted to ON but never published will finally be published in the third issue of JOA.

Paul Maley presented the status of possible funding for IOTA. He has been communicating with Bill Merline of the Southwest Research Institute (SWRI) in Colorado. The amount of actual funding is unclear but may be in the range of several thousand dollars. This would be for actual expenses only (such as airfare, rental car, hotel) and only for selected persons for selected asteroid events. The aim is to start a professional-amateur collaboration for asteroid events. If IOTA can show its worthiness and acquire excellent data on a few choice events, this may lead to future but limited funding.

Paul has identified several candidate events for this process:

704 Interamnia	November 11, 2011	
57 Mnemosyne	March 11, 2012	California
63 Ausonia	March 21, 2012	California to Texas
185 Eunike	August 3, 2012	Baja Mexico
52 Europa	August 12, 2012	Maine, Nova Scotia
856 Backlunda	September 17, 2012	Florida
111 Ate	October 5, 2012	South Florida
521 Brixia	October 22, 2012	California to Dakotas
168 Sibyla	November 25, 2012	Central Florida

Another proposal does not entail any funding for new occultation data. Instead it seeks to combine existing photometric data with existing asteroid occultation data to get better sizes/shapes of asteroids, using the KOALA method. IOTA help is sought in finding and interpreting existing occultation data and, what's more, the occultation data will contribute to key new science results, leading to better understanding of asteroid sizes, shapes, densities and compositions.

Business Meeting closed. 12:15PM Lunch Break

1:35PM Technical Session Starts

Dr. Terry Redding gave his experiences in coordinating observers for the occultation of 217 Eudora on May 29, 2011. He routinely collaborates with Tom Campbell of Tampa, FL. Terry presents occultation reports monthly to the Palm Beach Astronomical Society located in West Palm Beach, Florida. He described the timeline on how he decided to attempt the event, how he contacted observers and how observers and interested parties (including the local CBS affiliate) expressed interest in trying this important event.

The timeline of events included:

May 9th 5 observers were committed

May 11th a school science teacher joined the group

May 13th South Florida Science Museum expressed interest

May 16th Science Museum offered canned material from IOTA for CBS (TV station) and a camera, KIWI GPS for their C-14.

May 17th Science Museum advised against using the C-14 telescope citing poor tracking and little prospect of seeing "anything"

May 18th 18 stations committed

May 19th pre-point method prepared and shared

May 22nd Science Museum commits to one station

May 23rd local club member announces he has 2 Mighty Minis, PC164C camera and 2 Canon camcorders.

May 24th a club member falls off a ladder and suffered brain damage and was taken to intensive care.

May 27th Final instructions for observers

May 29th Event – a miss was recorded for most stations. IOTA members know this better than anyone so Terry had to explain the statistical nature of the predictions regardless of how accurate they maybe.

David Dunham discussed on changing a large deployment at the last minute in connection with the 2011 May 29 217 Eudora event. With the prediction looking very good, Dunham planned a series of Mighty Minis. He and Joan Dunham chose central Florida to try 9 stations covering the path center and the north uncertainty zone. Things to consider were the weather – the rainy season starts in Florida in May and most days have thunderstorms in the afternoons. He had a Plan B depending on daily weather uncertainties while watching Occult Watcher station updates.

The Dunhams used a paper copy of the Florida DeLorme Gazetteer (detailed road atlas) on their flight comparing Google maps to see where the path limits crossed several roads they might use. No internet was available on the flight and it Dunham says it would have made the process more difficult. Delays and clouds only allowed time to set up 5 video stations plus one additional station. One station was skipped due to clouds in the area. And another site the camcorder battery died before the occultation!

The result was a 1.3-path width north shift causing 5 misses and one positive chord – the northernmost station. Steve Preston had advised that this star might have duplicity and had proper motion discrepancies between catalogs. At the time of this annual meeting Paul Maley had 2 videos of possible events and would ask Tony George to analyze them.

Just 5 nights after the Eudora occultation on June 3rd, an occultation by the relatively small

asteroid 1166 Sakuntala was predicted for the northeast USA with large uncertainties. Dunham spread six stations across the zone, with 4 recording the star (10.5-mag PPM 719647) – all misses. As luck would have it, Bruce Berger recorded an occultation in between Dunham's station's 3 and 6 which were 25km apart !!

Tony George presented a list of IOTA publications on the discovery of new double stars published in the Journal of Double Star Observations, JDSO. From January 2010 to July 2010, four (4) papers were published in JDSO reporting new double stars discovered from occultations. The target stars that showed duplicity were:

TYC 4677-00696-1 occulted by 1048 Feodosia on 2008 November 18, separation unknown – visual observation

UCAC2 41168613 occulted by 675 Ludmilla on 2010 October 20, Sep = 28.3 ± 2.0 mas

TYC 2255-01354-1 occulted by 790 Pretoria on 2009 July 19, Sep = 144.8 ±0.4 mas

HIP 46249 occulted by 160 Una on 2011 January 24, Sep = 6.5 ± 1.1 mas

The occultation by 1048 Feodosia was a visual observation made by Alan Whiteman. He made such a careful high quality observation that Dave Herald agreed that Alan did in fact observed a drop in brightness due to duplicity of the star.

A portion of Alan's actual report is reproduced below:

"At 04:28:01.0 the magnitude 10.1 target star TYC 4677-00696-1 crisply faded but did NOT disappear. It remained at least as bright as magnitude 12.9 GSC 4677-806 located 1.7' northeast. This failure to dim the predicted 4.7 magnitudes completely surprised me and resulted in a very long reaction time that I estimated to be 0.75 seconds. (This estimate is on the tape, a couple of minutes after the event.) I .. (made) .. a conscious effort to compare the magnitudes of the two stars during the brief occultation.] Transparency was excellent and the seeing was fair since the 1.8" double star Alpha Psc was only occasionally split at 366x. Nevertheless, the stars looked crisp at the ultra low power used to monitor the asteroid occultation. I observed the asteroid 54 minutes after the event, when it had moved 18" away from the target star, and the asteroid was barely visible with direct vision at 366x. So the asteroid was as faint as it should be. The asteroid could not have been seen with the ultra low power of only 45x used during the occultation. Therefore the object which was at least magnitude 12.9 during the asteroid occultation must have been a companion star."

Tony showed the light curves of the published occultation events showing the step events in brightness. Tony reminded everyone to carefully analyze their light curves for anything that might look like anything other than a perfect drop in brightness as this may need further analysis.

Two more reports are in progress (not published):

3UC197-115375 occulted by 336 Lacadiera on 2009 April 16
TYC 2322-01054 occulted by 695 Bella on 2010 August 31

The 336 Lacadiera event light curve indicates a fourth component of a previously known triple star system, making it a quadruple star system. This is an example of an event with very unequal star magnitudes. This report is still in progress. The 695 Bella event light curve found a component so close to the primary star that the secondary occultation was barely detectable. This is an example of an event with very unequal star magnitudes. This report is also still in progress.

Paul Maley reported on the 2011 April 1, 554 Peraga Occultation Expedition to Iraq 3/20/11-4/2/11. This was the 1st ever successful recorded asteroid occultation from Iraq. He arrived in Erbil, Iraq and worked with amateur astronomers of Kurdistan. Paul showed a few slides of the living conditions and interesting sites in the area including the Korek Observatory which houses a radio telescope plus 1.5 and 3.5 meter optical telescopes. The domes housing these telescopes were attacked and had huge holes in them. The government removed the telescope mirrors and they were relocated and able to be saved.

Paul located an observing site in the town of Shaqlawa in the mountains. One of the local amateur astronomers brought a donated 6-inch refractor. Another scope used was a donated 8-inch Meade LX-200 that Paul used. The observers on this event assisting Paul were Azhy Hasan and Rojgar Hamid. They successfully recorded a 5-second occultation D = 18:53:14.5UT, R = 18:53:19.5UT. Three other chords were obtained. Richard Nugent analyzed Paul's data and created a YouTube video for the Iraqi participants. It is located here:

http://www.youtube.com/watch?v=fzGY4gV9iTo

Walt Morgan presented to David Dunham and Dr. Eberhard Bredner the first IOTA-VTI GPS timing units just recently manufactured. This new unit fills the gap and replaces the discontinued KIWI unit. The web site for more information and ordering is http://www.videotimers.com/. Walt gave a demo of the 12V powered device which has a built in GPS receiver thus it's a single box unit.

Walt told about the history of timing accuracy and how the IOTA-VTI came to be. It was designed by Tony Barry and Dave Gault, active members of the Western Sydney Amateur Astronomy Group (WSAAG), in Australia Earlier this year Tony and Dave assigned their rights in IOTA-VTI to IOTA, the intent being to allow IOTA to assure its members of the continuing availability of a precision video time insertion device. Toward that end, IOTA subsequently granted a license to Video Timers to manufacture and market IOTA-VTI. One condition of the license is that IOTA is to receive a royalty for each unit sold.

The engineer for Video Timers is Sandy Bumgarner, well-known to IOTA members for his work with video systems, especially the manual gain modification of many PC164C cameras. Walt (an active IOTA member for over 35 years, and IOTA Vice-president for Occultation Services for a decade after the 1983 incorporation) has worked closely with Sandy. Together they have transferred the excellent system created by Tony and Dave to a rugged printed circuit board-based design. It's nice looking, too!

The resulting device is well-matched to the demands of timing occultations: it is easy to use; it is rugged enough for field use; it produces legible characters in any lighting; its high-sensitivity GPS achieves accurate geographic fixes and it has been demonstrated to reliably produce accurate millisecond timing. The first deliveries of the production version of IOTA-VTI were at the IOTA annual meeting. Anyone who chooses to buy one there will not incur shipping and handling charge, and, as a special offer, Video Timers will absorb the California sales tax. The total price for units delivered at the meeting will therefore be $249.

Steve Preston talked about star position issues as they affect asteroid occultation path predictions. The two main issues affecting star positions are proper motions and if the target is a double/multiple star. When a double star is suspected, the following sources are checked to see if the target might be a double: Washington Double Star Catalog (WDS), Interferometric Catalog and previous occultation records. If an orbital solution is not available for a known multiple star, then the path uncertainties would generally be invalid since path shifts may be much greater than the path statistics.

Proper Motions will be affected by multiple stars and their orbital motions. When Steve sees a large discrepancy, he'll flag it and note it in the prediction. Older epoch observations carrying lower weights and the Hipparcos catalog with it's short term baselines used for proper motion calculations can cause issues in the star positions and thus present errors in path predictions. Steve will do a full evaluation on duplicity and proper motion statistics if it is known that if the asteroid event will be widely observed. Steve advises that if you see a notation about the star position in the prediction, be cautious and ask for more information before observing.

Brad Timerson summarized the database of 2011 asteroid occultations through June 30, 2011 in North America. Compared to previous year's 6-month data, the total number of observations was down, but this is still only halfway through the year. Single chord observations make the most reports, but multiple chord observations are on the rise. Brad discussed 4 events that had inversion models (photoelectric analysis of light curves):

24 January	160	Una	6+ New Double Star
26 January	11	Parthenope	11+
19 February	7	Iris	6+
22 April	17	Thetis	4+

For the 160 Una event, David Dunham's chord on Occult's elliptical fit appeared to be off compared to the other chords. When the inversion model was overlaid on the fit, Dunham's chord fit nearly perfectly with the light curve model of the asteroid's shape. With the upcoming Antiope event on July 19 it was postulated on what the size/shape of this binary asteroid will show.

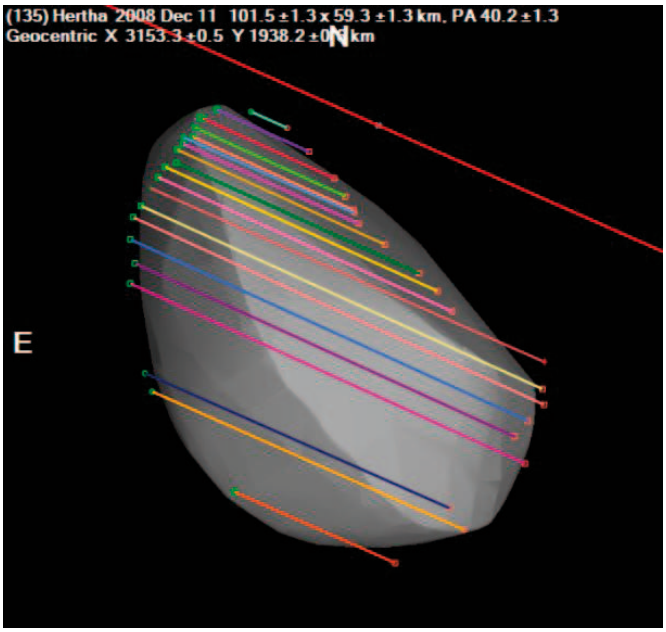
Hristo Pavlov presented his comprehensive occultation analysis program Tangra. He mentioned a few pros and cons compared to LiMovie, Tangra doesn't support lunar events while LiMovie does. LiMovie reads only AVI formatted video files while Tangra reads nearly any video format. This feature alone of Tangra minimizes any loss of data in converting a video file to AVI format as LiMovie requires.

Hristo showed example light curves of the photometry methods (aperture and PSF) Tangra uses to analysis light curves. He then showed a demo of the program and it's flexibility of uses and parameters in processing videos. Tangra has the feature of allowing integrating of frames which is similar to using a frame integrating/averaging camera such as the StellaCam. Another highly useful feature is a built in brightness and contrast adjustments plus the use of custom filters to process data.

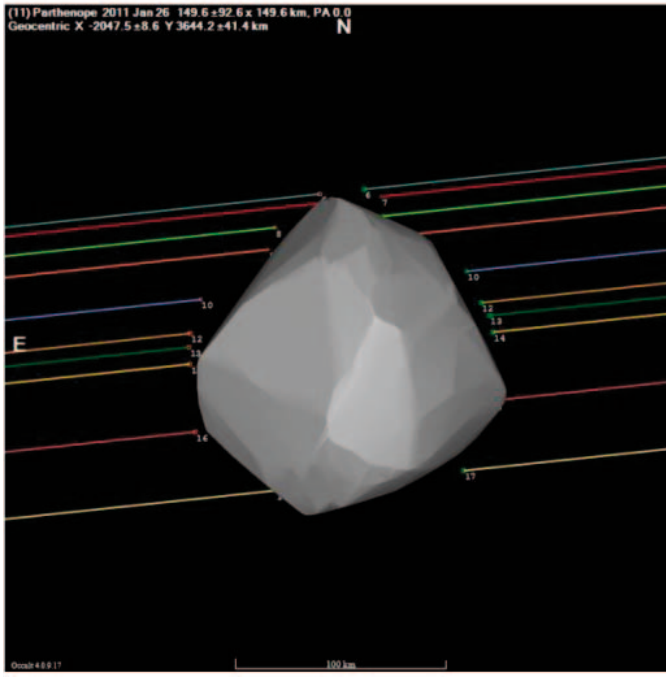
Tangra's astrometry functions allow 0.2 pixel (0.3arc-sec) accuracy. Currently it can accept the following star catalogues: UCAC2, UCAC3 or NOMAD. The reduction process is simple. Take a video of a known field and identify at least 3 stars. Hristo demonstrated the astrometry function on a Near Earth Asteroid (NEA) and a comet. The program was recently used to provide accurate positions of Comet Hartley.

Dave Herald presented a summary of the best asteroid occultation events over the past 2 years. From 2008 on the total number of asteroid events has continued to grow with over 200 observed events in the years 2008-2010. In 2010 for example, Japan had 25 events, but the smallest land area and Australasia had smaller population with 50 events. The US had 106 events and Europe had 51 events for 2010.

Double star discoveries result in ranges of separations of 0.1" – 0.001" with uncertainties in the range of 1-3 mas. In the past 2 months nine double stars have been discovered.



Parthenope Inversion Model



Dave showed profiles of several of the successful events starting with 234 Barbara over Florida and Europe in Nov. 2009. 472 Roma occulted Oph (m = +2.7) on July 8, 2010 over northern Europe and had 222 observers, the most ever (26 produced chords, 27 observations not used and 142 misses). Due to the large asteroid and small star size issue, light curves showed more gradual D's and R's producing a non-consistent size/shape result. Other profiles showed:

790 Pretoria	Jul 19, 2009
449 Hamburga	Sep 9, 2009
216 Kleopatra	Dec 24, 2009 (cigar shaped asteroid)
81 Terpischore	Dec 25, 2009
80 Sappho	Jun 4, 2010
16 Psyche	Aug 21, 2010 (had a timing issue with one chord)
695 Bella	Aug 31, 2010
96 Aegle	Oct 29, 2010
93 Minerva	Dec 24, 2010
212 Medea	Jun 8, 2011
160 Una	Jan 24, 2011
11 Parthenope	Jun 26, 2011

Dave then presented results of a comparison of asteroid occultations and their light curve inversion models from a paper published in Icarus this year. The co-authors of the paper were:

Josef Durech, Mikko Kaasalainen, David Herald, David Dunham, Brad Timerson, Josef Hanus, Eric Frappa, John Talbot, Tsutomu Hayamizu, Brian D. Warner, Frederick Pilcher, Adrian Galad.

With GPS millisecond timing asteroid occultations provide the highest resolution of the object's profile down to about 1-km except for space

probe encounters.. This however is the projected profile toward Earth at the time of the occultation (snap-shot). An issue with occultations is the slight rotation of the asteroid as it's shadow crosses one side of the Earth to another. With careful analysis of light curves over several complete phases of their rotation (which can take years), 3D inversion models of the asteroid can be generated. An important consideration in deriving these models is the magnitude variation which depends on the axis facing Earth which can be 0.15 magnitudes and larger. Inversion models can derive a shape of an asteroid, but not it's size.

Occultation profiles can with combined with inversion models. If the 3D model is generated for the orientation at the time of an occultation, it can be matched to check on the accuracy of the inversion model.

Dave showed comparison overlays of occultation and inversion models on the some recent occultations: 515 Amherstia 2011 Apr 18 and 135 Hertha 2008 Dec 11:

The comparison of Hertha occultation (colored lines) and inversion model (gray ellipsoid) is shown:

The Parthenope comparison had matching issues at the 10 o'clock and 2 o'clock positions (chords 10, 12-14, 17):

Other inversion models/occultation comparisons shown were:

3 Juno	1979 Dec 11
5 Astraea	2008 Jun 6
17 Thetis	2007 Apr 21
88 Thisbee	1981 Oct 7 and 2007 Feb 21
372 Palma	2007 Jan 26 and 2009 Sep 10
925 Alphonsina	2003 Dec 15 and 2003 Dec 22

From EVO, Dave Gault asked "Has there been any instance of an inversion model , and an occultation model, of an asteroid that has been visited by a space craft?"

Dave Herald replied "Not to the best of my knowledge." Dave then demonstrated how one could us their cursor on an inversion model and drag it to any orientation.

6PM Meeting adjourned – exactly on schedule!

9:05 AM Sunday July 17 – Technical Sessions continue

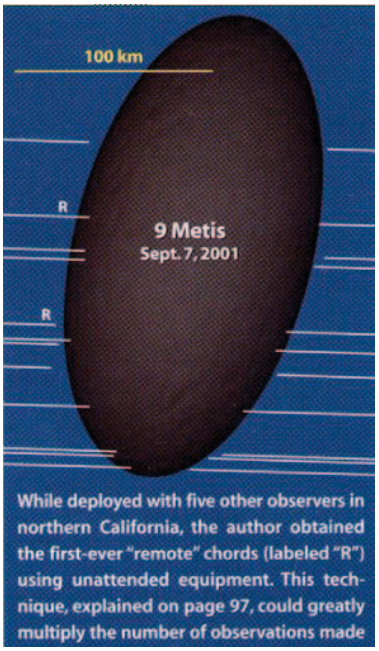
David Dunham talked about the history of multi-station deployments. In the 1990's he realized that the equipment is doing all the work, and maybe he should be somewhere else making an additional observation. On November 12, 1998 for the graze of Omicron Leonis, he set up a 5-inch clock driven telescope at Delta, Pennsylvania and left a student here to adjust it. He then set up another telescope 0.5 km away to record the event. When he came back, he was excited to see the system recorded multiple occultations of the star. He asked the student, "Did you make any adjustments?" The student replied "No". David said, "At least, you were there to protect the equipment". The student responded, "Actually, it was the other way around. Whenever a car drove by, I hid behind the telescope box."

This experience led him to try another event. On 1998 Nov. 26, after Thanksgiving dinner, he drove about 10 miles south of home and set up an 8-inch SCT with video to record a marginal grazing occultation. Then he set up another telescope 200 meters north and observed the graze visually there. The video station recorded three events, the first unattended mobile video occultation observation, as far as he knew. Two nights later, he had another success with a better graze, of 4th-mag. c Piscium at Assateague Island, Maryland.

For asteroid events a much longer time planning is needed. In prepoint planning, RA difference times need to compensate for the 10-second difference between sidereal and solar rate. David's first successful attempt for an asteroid occultation was the occultation of 6.0 mag SAO 78349 by 9 Metis on September 7, 2001 in the Sacramento Valley. He set up a remote station in Orland, CA and drove some 20 miles to set up a 2nd manned station. When he returned to the remote station, the camcorder battery had died, luckily after the occultation !! The profile was published in Sky and Telescope for March 2002.:

David then showed a list of 26 successful remote observations from Sep 2001 through Feb 2008. During the time period 2002-2008, Roger Venable led the way in the development of multi-station deployments and authored Chapter 10 of the IOTA Manual on this topic. One clever idea Roger used was to program a VCR to start recording near to the time of the occultation to save on tape and power requirements.

In 2008, Scotty Degenhardt came on board and turned the occultation community upside down with his army of Mighty Mini remote video stations. After several failures, Scotty's first successful multi-station event was 135 Hertha on December 11, 2008. He had an unprecedented 14 successful hits from 14 remote video stations !! Scotty's Mighty Minis can reach mag. 9.5 and even 10.0 under ideal conditions. Scotty's arsenal also includes the Orion 80mm short tube refractor reaching m=11.0, and the "Mighty-Maxi" and the Orion 120mm short tube refractor, reaching m=12.0. To simplify the start of recordings, Scotty now uses programmable remotes to start them.



While deployed with five other observers in northern California, the author obtained the first-ever "remote" chords (labeled "R") using unattended equipment. This technique, explained on page 97, could greatly multiply the number of observations made

David showed slides of his multi-station efforts to record the m = +2.7 star by 472 Roma on July 8, 2010 where he had 4 stations. Others included: 16 Psyche on August 21, 2010, where he had acquired 5 chords, 695 Bella on August 31, 2010, with 8 chords and 2 misses, (Paul Maley had 2 chords).

The Bella all nighter success was extremely exhausting for David, he developed an ear infection as his plane landed home in Maryland, then the flu and after 2 weeks went to a Doctor. He had thyroiditis and his recovery took 6 weeks and he wasn't back to 100% for a few months. Multi-station deployments is an extreme sport, and IOTA needs younger folks to help out!!

Bruce Holenstein and Russ Genet updated IOTA on the Alt-Az Initiative project. This is a major undertaking in designing and building an affordable 1-meter class portable telescope. This telescope is expected to cost about the same as a C-14, have a 30 minute setup time and reach 2.5 magnitudes fainter than a 14-inch aperture. This would allow occultation targets not previously reachable, such as TNO's, KBO's Pluto occultations, etc. Needless to say, deep-sky enthusiasts are also very excited about this project.

Russ Co-chaired the Light Bucket Astronomy Conference Dec 31, 2010-Jan 2, 2011 in Hawaii and gathered ideas from touring the large Gemini and Canada France Hawaii Telescopes. A prototype of the 1-meter telescope was used at the RTMC astronomy Expo May 28/29, 2011 at Big Bear, CA:

They are currently working on the design of a 1.5meter portable telescope. It will weigh less than 400 pounds (880 kg), and be transportable on any road with a trailer.

The design and building of such a large portable telescope will require new technologies. Russ has applied for grant money to facilitate the continuation of this project.

Bruce took over the presentation and discussed new technologies needed. This included the mirror fabrication process to produce a strong lightweight mirror, non-vacuum coatings and mounts to make these telescopes ultra portable.

The group is also investigating various fast cameras for occultations, spectroscopy, astrometry and other uses. Frame rates of cameras being evaluated range from 30 fps to several hundred fps.

In addition active primary/secondary mirrors are being investigated for utilizing adaptive optics technologies. One such method is using an electrostatic charge to create deformations on the mirrors.

Bruce indicated one of his main interests in this project is using high frame rate cameras on stars for occultations. This is to measure scintillation effects and determine stellar diameters. Scotty then told the group that Richard Berry has come up with a method to do high precision astrometry on an 8-inch telescope with a fast fame rate CCD camera when the star and asteroid are on the same frame. A variation of this method was used in the 1990's called "last minute CCD astrometry". With a meter-size telescope and a fast frame rate camera, high precision astrometry is of special interest to occultation observers to modify path predictions.

The Alt-Az website is http://www.AltAzInitiative.org and the discussion group is - http://groups.yahoo.com/group/AltAzInitiative

David Dunham next showed a summary of remaining occultation events for 2011. These are from the 2011 RASC Observer's Handbook. One missed event not in the handbook is the occultation of a m = +5.1 star, HIP 16322 (4 Tau) by 1693 Hertzsprung over south Florida. David also showed a list of remaining grazes for 2011 also straight from the Handbook.

David then showed major events from the Observer's Handbook tables he's now compiling for 2012. The best asteroid event is of the m = +2.7 star HIP 72622 by 363 Padua on September 16. The event is in daylight over the US but occurs in darkness over Africa. David referred Steve Preston's page listing "Best Worldwide Events for 2012".

Paul Maley talked about a proposed expedition for the 363 Padua asteroid event on September 16, 2012. This 2.7 mag star is the brightest event for 2012. Most of the path is in daylight over the US, the best viewing is in West Africa. The duration is short, 2.1 seconds with a 12.1 magnitude drop. Possible concerns is that the star might be a double/spectroscopic binary. The low elevation of 22 deg will make it difficult plus the event occurs just 1 hour after sunset.

The event is daylight over south Florida (Tampa and West Palm area) where IOTA observer's Tom Campbell and Terry Redding live. The path also goes over Washington State where other IOTA observers are located. The solar elongation is about 51 degrees. Tom Campbell mentioned he would experiment with an IR bandpass filter with an 8-inch telescope. At the date of the meeting, he doesn't have results to report yet.

Paul is planning an expedition that would have a maximum of 8 persons mainly due to safety and transportation limitations. Paul has the details on his website: http://www.eclipsetours.com/padua.html

David Dunham reported on the grazing occultation expedition of Eta Gem (m=+3.7) to central Arizona about 50 miles west of Phoenix on 2011 April 10. For this graze the attended (human) stations failed while the remote video stations all worked! David showed Google maps of the locations of the 5 stations. This graze had the typical problems: strong rainstorms earlier that day, jammed tapes in camcorders, etc. The end tally was Machines: 3, Humans: 0. David has an article on this expedition in JOA Vol 1 No. 3, page 9.

Lunch Break 12:50 PM

1 PM Technical Session Continues

David Dunham shared a few videos: An asteroid occultation from one of his Mighty Minis, and the Eta Gem Graze from April 2011 including a spectacular step event due to the star's giant size. David showed the most recent issue of JOA mentioning Kazuhisha Miyashita's article on "Measurement Region of LiMovie for Occultation by Earth-Lit Lunar Limb".

Dr. Eberherd Bredner is the IOTA European Section Secretary and came all the way from Germany. He said a few words about his occultation experiences with the IOTA ES. He brought and presented the ESOP (European Section on Occultation Projects) conference poster and stickers, and invited attendees to Berlin next month August 26-31st for the meeting. Eberhard said that he was glad to be with us at the IOTA meeting and able to try to observe the Antiope occultation.

Dave Kenyon showed a few things the Astronomy Dept is doing at Sierra College. They have an all sky camera (part of a network over northern California/Nevada) that does frame comparisons every 0.03 sec. This camera system was designed for meteors and other transient events but it also picks up birds, planes and other false objects. Typically the cameras pick up a few real events per month. A recent event was captured and Dave had used software he wrote to determine the true triangulated position of the object as projected on Earth.

Francois Colas briefly presented his research on TNO occultations. Unfortunately at the meeting his computer died and his powerpoint file wasn't available.

Dave Gault and Tony Barry presented their talk on the new IOTA-VTI as given at the 5th Trans-Tasman Symposium on Occultations 2011 May 26-27. Dave and Barry developed the IOTA-VTI and licensing to avoid availability gaps for a VTI for occultation work. From their website:

"IOTA-VTI is a rugged, reliable, ready-to-go unit, deriving precision time from an internal GPS receiver. The ABS enclosure is about five inches square and two inches high.

IOTA-VTI is compatible with both NTSC (30 frames/second) and PAL (25 frames/ second) video formats. Selection of format is via an internal switch that will be set to the buyer's preference, but which can be easily changed.

IOTA-VTI has been tested extensively, both on a bench and in the field, so we are confident it will meet your need for precision timing of video signals."

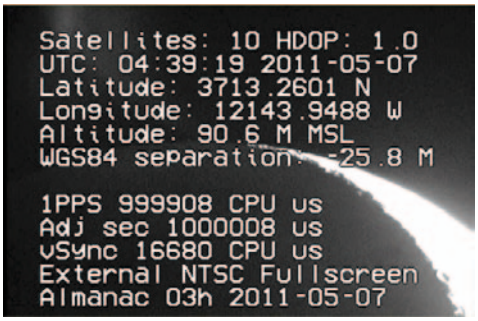
The IOTA-VTI features include:

- PAL/NTSC compatible
- Will work without a camera connected
- LED to confirm that a camera is connected.
- Internal built in sensitive GPS
- Characters have a drop-shadow style – viewable against say, the lunar bright limb
- Comprehensive Data Quality Assurance system
- GPS Almanac Management System
- Licensed to IOTA to prevent untimely withdrawl
- Price US $249 + shipping

Can be ordered now

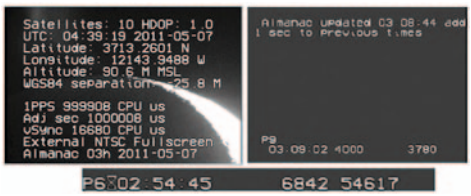
The time frame from prototype to demo unit was 8 months. Initial quality assurance tests compared to the older KIWI connected to a PC with Garmin 18x LVC GPS demonstrated timestamp accuracy consistent with these devices. Dave showed shots of the Position screen,

Time screen, Full screen and TV safe modes.



Position Screen:

The Time Screen has large easy to see time information:



*The unit also has a dedicated screen for GPS Almanac Management System (GPS-AMS) showing diagnostics and information regarding satellites and degree of precision as shown below:

The unit also performs constant Data Quality Assurance (DQA):

- The IOTA-VTI samples the serial data and the 1pps from the GPS every second
- 5 tests every second + 1 test sequentially over an hour
- Overall policy is to 'squawk' loudly on error
- Reports on status of satellite fix

The units are available now and be purchased directly from the website: http://www.videotimers.com

Unit size is about 2 x 5 inches:

Dave says the almanac takes 10-15 minutes to create from a fresh start. He suggested running a connection outside your car window while driving to the occultation site, and switch to video cables upon arrival.

Tony asked if units could be sent to Iran/Iraq. United States policy is that no electronic items can be sent to Iran. Dave mentioned that he sent a PC-164 camera to Atila from Australia with no security problems so it might be done that way.

Bruce Berger, working with John Broughton and David Dunham presented the design and specifications of the "Ultra-Portable Telescope for Occultation Expeditions" i.e., suitcase telescope.

This design allows the suitcase telescope to be road and airline transportable on using a new alt-azimuth mount. The design requirements called for the telescope to be inexpensive, lightweight, compact, has a ground hugging profile, and a minimum FOV of least 20 arc-minutes. Currently the telescope has a 10" f/4 aperture with a 50mm finder. The whole telescope fits in a suitcase.

Pointing the telescope is simplified by the large 5 x 7 deg FOV from the C-90 finder. The FOV of the telescope with a Watec 120N camera is 23.6 arc-min. John uses a mini DVR to identify stars from a prepoint chart. John showed video frames of the occultation of 194 Prokne from May 13, 2011. The telescope recorded a high quality 17.82 sec occultation. John shipped the telescope to Bruce in Boston for additional use/testing.

David Dunham had borrowed the telescope setup for the meeting for the attendees to see:

Bruce knows someone in his area that knows about fabrication. The plan is to have this person's students come up with a possible mass production design for manufacture.

Walt Morgan showed a live demonstration of the IOTA-VTI with a camcorder pointed at the wall with output to personal DVD recorder/player. Being indoors, the 4 satellites needed for accurate time were not acquired. This condition is noted by the hourglass on the top image above-left of the 23:08:03 time.

Walt showed some screen shots of the IOTA-VTI unit in action from the website and explained the meaning of each line of text. Three (3) satellites only provides a 2-dimensional fix and four (4) satellites provides the desired 3-dimensional fix. Six types of errors are possible with the unit. Users are referred to the on-line manual for explanation and solution of these error codes.

In the Spring 2011, prototype #4 of the unit was sent by Dave Gault to Gerhard Dangl in Austria. Gerhard ran his Exposure Time Analyzer (ETXA). The results were consistent and times produced by the new unit were deemed accurate.

Antiope update: Dunham and Preston discussed weather updates for the 90 Antiope occultation for the following night.

Bill Merline from the South West Research Institute provided an astrometry update for the components of 90 Antiope for the occultation. He was at Keck in Hawaii the previous week and checked for duplicity of the target star (there was none detected). The FOV was too small with the Keck telescopes for an astrometric position since there are no reference stars visible. Bill showed the Keck images of the two asteroid components as they should appear 30 minutes away from the predicted orientation:

The July 19 prediction from the French team was PA ~ 26 deg, Sep ~ 168 KM, Current Keck observations predict PA ~ 21 deg, Sep ~ 145 km. Separations are center to center between the two components.

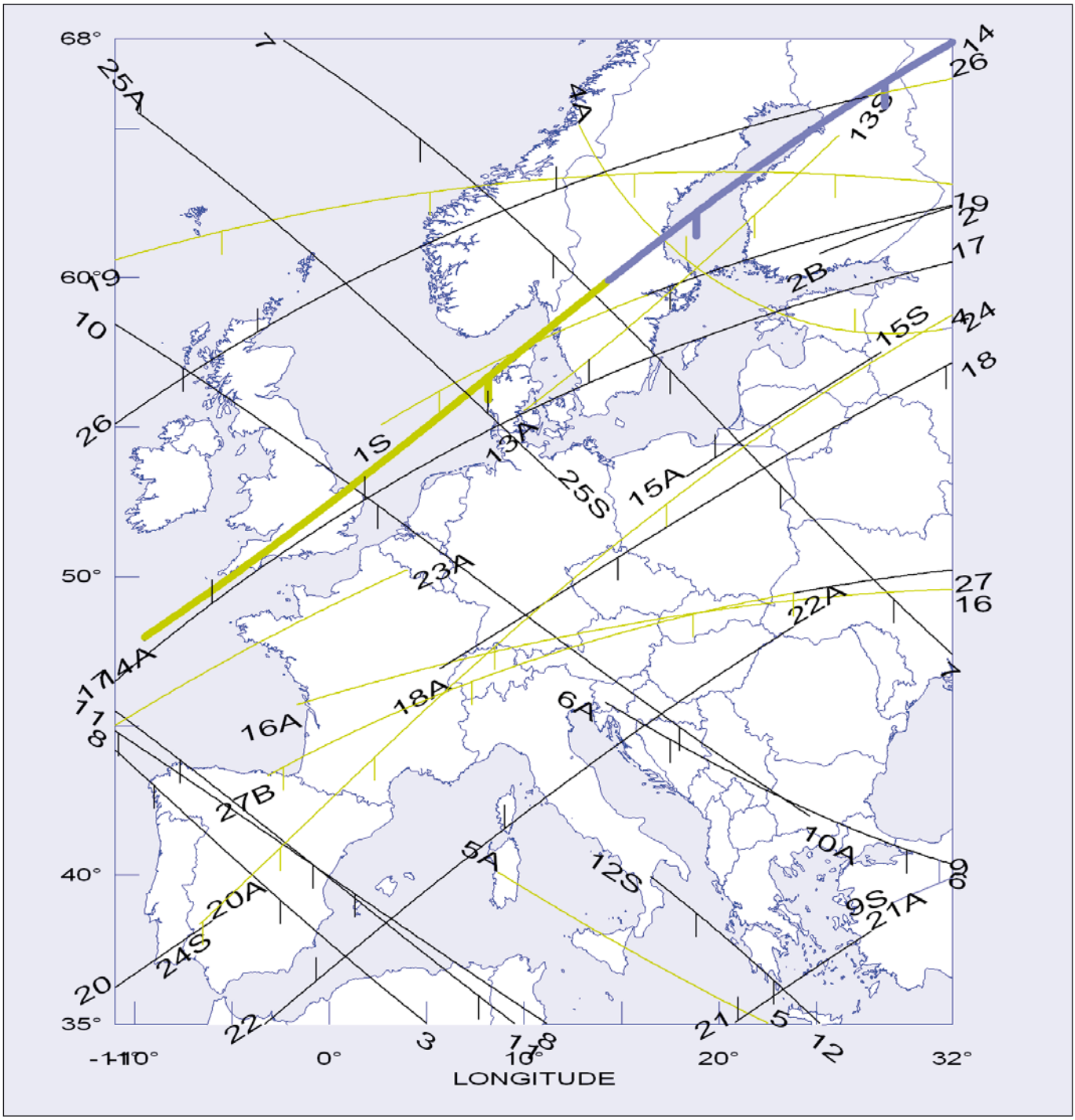
Bill discussed briefly funding possibilities. The large Keck telescopes with adaptive optics can't measure the sizes of asteroid satellites because they are so small. Their positions however can be predicted which can be used by IOTA for positioning of telescopes to catch these satellite occultations.

The meeting unofficially adjourned at 5:30PM and the group talked about station plans for the Antiope occultation, weather updates and continued their discussions.

Journal for Occultation Astronomy

European Grazes of Bright Stars in 2012

Eberhard Riedel



The GRAZPREP-map shows the 27 grazing occultation events of stars brighter or equal 5.0 mag. taking place in Europe this year. The black lines indicate grazes at the dark lunar limb at night, the yellow lines show grazes on the sunlit limb of the moon at night and the blue lines are grazes in daylight.

The table lists the details for each event. The time in UT as well as the longitude and latitude values refer to the westernmost appearance of a limit line in the map.
Double or variable star data is given in the rightmost columns including separations and position angles.

NO.	Y-M-D	USNO	SAOPPM D	MAG	%SNL	L.	WUT	LONG	LAT	STAR NAME	MAG1	MAG2
1	**Jan 27**	ZC 3501	128374	5.0	19+	N	16 16.7	02	55	19 TX Psc	5.0	5.2
2	**Feb 03**	ZC 817	77184T	4.9	82+	N	15 21.2	25	61	114 o Tau	5.6	5.6
3	**Feb 6**	ZC 1158	97120K	5.0	96+	N	03 06.9	–11	44	74 m Gem	6.0	6.0
4	**Feb 15**	ZC 2290	184014L	2.3	44–	S	05 14.8	12	65	7 delta Sco (Dschubba)	3.0	5.0
5	**Feb 18**	ZC 2759	187504	3.5	14–	S	04 03.9	08	40	36 37 xi2 Sgr		
6	**Feb 18**	ZC 2757	187498	5.0	14–	N	04 08.9	14	46	36 xi1 Sgr		
7	**Mar 5**	ZC 1341	98267Y	4.3	92+	N	23 31.9	–02	68	65 alpha Cnc (Acubens)	5.1	5.1
8	**Mar 28**	ZC 752	76920K	4.6	31+	N	22 20.5	–11	45	102 iota Tau	5.4	5.4
9	**Mar 29**	ZC 847	77336J	3.0	38+	S	12 05.6	28	39	123 zeta Tau	3.2	5.2
10	**Apr 25**	ZC 847	77336J	3.0	17+	N	20 26.3	-11	58	123 zeta Tau	3.2	5.2
11	**Apr 26**	ZC 995	78423B	4.1	25+	N	20 24.8	–11	46	18 nu Gem	4.3	6.0
12	**Apr 29**	ZC 1341	98267Y	4.3	54+	N	17 44.9	16	40	65 alpha Cnc (Acubens)	5.1	5.1
13	**Jul 15**	ZC 628	76532K	4.9	15–	N	00 24.1	10	56	50 omega Tau	5.0	7.0
14	**Jul 15**			–1.7	15–	N	02 1.6	–09	48	Jupiter		
15	**Jul 17**	ZC 915	77911L	4.6	4–	S	01 39.8	18	53	62 chi 2 Ori	5.5	6.3
16	**Sep 13**	ZC 1341	98267Y	4.3	10–	N	03 05.3	–01	46	65 alpha Cnc (Acubens)	5.1	5.1
17	**Sep 27**	ZC 3320	146210T	5.0	95+	S	23 41.6	–11	46	63 kappa Aqr (Situla)	6.1	6.1
18	**Oct 6**	ZC 894	77705V	4.4	62–	N	21 17.6	05	47	54 chi1 Ori		
19	**Oct 7**	ZC 915	77911L	4.6	61–	N	02 15.1	–11	61	62 chi2 Ori	5.5	6.3
20	**Oct 19**	ZC 2547	185660X	4.9	24+	S	20 35.8	–11	36	58 Oph	5.1	6.9
21	**Nov 16**	ZC 2633	186497T	3.8	11+	S	17 10.5	20	35	13 mu Sgr	4.1	7.0
22	**Nov 17**	ZC 2814	162413V	4.9	20+	S	17 36.4	–03	35	43 d Sgr	5.8	5.8
23	**Nov 18**	ZC 2969	163481I	3.0	30+	N	20 42.0	–11	45	9 beta Cap (Dabih major)	3.5	4.8
24	**Nov 19**	ZC 3093	164182	4.5	41+	N	17 10.1	–06	38	13 nu Aqr		
25	**Dec 10**	ZC 2029	158401	4.9	13–	S	07 10.0	–10	66	40 H. ET Vir	4.9	5.0
26	**Dec 18**	ZC 3320	146210T	5.0	35+	S	18 42.4	–11	55	63 kappa Aqr (Situla)	6.1	6.1
27	**Dec 19**	ZC 3453	128186V	5.0	45+	N	19 49.1	–03	43	8 kappa Psc	5.7	5.7

Journal for Occultation Astronomy

IOTA/ME's 2nd International Workshop of Astronomical Occultations

A report · Eberhard Riedel

Between November 15 and 17 the new Middle East section of IOTA, founded in 2010, held its 2nd International Workshop of Astronomical Occultations in Dezful, Iran. A group of young and fully ambitious amateur astronomers were in charge of preparing and holding this major event concerning the scientific programme as well as several topics of cultural interest. Thus the importance and size of this workshop can well be compared to the one of the European Symposiums on Occultation Projects held once per year.

About 55 attendants from all parts of Iran formed an enviably young auditorium. Besides the Iranian speakers a few international experts had been invited on different subjects. Dave Gault from Australia, Paul Maley, USA, and John Talbot from New Zeeland were remotely present by video conference. I was the only foreign guest speaker to attend in person. IOTA/ME was so generous to fully invite me and to give me an unforgettable time in Iran. My personal attendance in Iran also helped to find out more about the present state of knowledge, skill and equipment of the workshop visitors.

The presented topics on the 3 days covered the whole range of occultation astronomy and related subjects even though the points of most interest were sometimes surprising. For his topic 'Using a star atlas and a telescope in order to find faint stars' the well known Iranian amateur astronomer Kazem Kookaram used most time to explain the polar alignment of the telescope rather than the problems of finding and pinpointing the correct star in the star field (which I had expected). Actually, as I was told later, the polar alignment seems to be more of a problem yet to most amateurs than working with star charts where much more experience exists already.

Another problem of the work of the Iranian amateur astronomer friends was discussed after a long report about 'Needed techniques to have a successful teamwork in an observing project'. For logistic and other reasons joint expeditions to observe grazing or asteroidal occultations are yet hard to organize in Iran. The coordination between the different observing groups in this big country was said to yet be improved.

Dave Gault was not available via video stream as later was Paul Maley due to Dave's remote location in Australia away from broad band internet, so he had recorded his reports on video which were projected in the lecture hall along with his presentation, only interrupted for the translation into Farsi. Among other things like the use of the LiMovie


software he presented the Kiwi-OSD timing equipment and explained in detail the way precise visual timings can be made with it. He believed that this timing system consists of parts all of them available in Iran so therefore would be a reasonable recommendation especially for this country. It only runs under MS-DOS on older machines he thought would also be present in Iran.

Actually the precise timing on occultation expeditions is one of the major technical problems in Iran since none of the internationally broadcasted time signals can be received anywhere.

Not just I was surprised to later find out in a highly interesting contribution of Aria Saboori, a mechatronic expert, that he developed a timing technique by use of modern present day PCs and additional equipment that he believes to be easier to achieve and to handle as well as to be more precise in timing than the Kiwi-OSD (refer to his article in this issue of JOA).

In my contribution I tried to provide more understanding about the theory of grazing occultations as well as information about the preparation of the observation of these events. In the past a few graze reports were published in Iran that showed problems of timing as well as of positioning. The use of my GRAZPREP-software could be explained in detail which I hope to help in the future in finding the best observing site. The software is also useful to more easily detect apparently false timings that are not related to the lunar profile.

Concerning the ongoing value of observations of grazing occultations I pointed out that with the very precise Kaguya-lunar limb features already given in the predictions it should be a new observing policy to choose a position where the apparent stellar path is expected to get close to flat lunar terrain for a longer time. For one thing many blink- and flash events can be expected there. On the other side in these areas the terrain data or the stellar position can be most likely improved.

Paul Maley gave an introduction on asteroidal occultations in theory and practice. He could be seen and heard directly over video stream (oovoo) and thus could command his power point presentation himself. One interesting goal he presented is internationally combined observations of asteroidal occultations in order to determine the 3-dimensional structures of asteroids that revolve or are projected differently along an extended occultation path. As a first attempt for such an observation including Iranian astronomers he suggested the occultation by Rosa on April 15 this year.

John Talbot took his main effort to explain a method of reporting observed occultations mainly by use of the Occult software. In the chosen way as a frontal presentation it seemed hard for a few attendants to fully understand all necessary details. More explanations will be needed in the future as well as an international agreement on a sufficient but simple reporting tool for all kinds of occultations. The price the attendants had to pay can be compared to ESOP prices. The side program of this workshop was remarkable though. All accommodations were of a high standard and the included delicious meals (lunch and dinner) were offered in a very good restaurant. The highlight of the cultural program was a trip to the nearby ancient city of Susa which is one of the oldest known settlements in the world, probably founded in 4200 BC. Due to time constraints I was not able to take part in the complete cultural program.

Much more than I know it from all ESOPs I attended the IOTA/ME-workshop attracted much public attention. The organizers used the presence of many amateur astronomers to address the public. So before the workshop there was a major presentation on general astronomical topics in front of some 200 mostly teenage school children where I also was asked to give a lecture. Two warm receptions of the local political and Cultural Heritage authorities belonged to the program, one before the beginning right after our landing at the airport in Ahwaz and one on the last evening of the workshop. Here it became noticeable how much honoured the authorities felt by the organisation of this event and the presence of so many interested amateur astronomers. I myself received very warm words of gratitude for my visit and contribution and took the chance in a short speech to show my gratitude in return, offering further support for Iranian amateurs by observers throughout the world regardless of any frontiers.

Also not common to ESOPs, a TV team was present at the workshop most of the time and recorded quite a few interviews. Iran is lucky to have his Channel 4 which is totally committed to science topics. Atila Poro, the president of IOTA/ME, as well as Mohammad Reza Norouzi, the 1st vice president, have good connections to this channel and appear there regularly on astronomical issues. Due to this good contact also a report about this workshop was possible.

Thanks to Atila Poro, who mainly organized this workshop, and Miss Farzane Momenpoor, both English teacher and amateur astronomer, who as a translator did a superb job in filling the language gap between the workshop attendents and me and who also served as my permanent guide in Iran, I had an unforgettable and precious time in this country meeting many wonderful and interesting people. I hope for an ongoing close contact between the Iranian observers and all other parts of IOTA.

Journal for Occultation Astronomy

Multi-System-Timing Method

Arya Sabouri · IOTA/ME, TEHRAN, IRAN · aryas86@yahoo.com

Up to now, various methods of observation event timing have been presented. Visual methods, sound recording, time keeping by assistants, using stopwatches, combinational methods etc. yet, the best of these methods are combinational methods which are able to show image, time, voice and data of devices simultaneously such as GPS, or in other words show them with micro-second delay which in engineering sciences nowadays is called a real time system. Observers extract its information either simultaneously or after a review of a movie and even after transferring images by common formats such as MPEG or AVI using image processing software.

A few years ago, these methods were very expensive and technically complicated and thus inaccessible for observers without knowledge in computer sciences, so that their use was not widespread due to the lack of technical experts. Capable devices like the Kiwi OSD and its applications were presented about 18 years ago based on the DOS operating system. Kiwi OSD needs devices to be connected to the computer by means of computer ports like in heavy and simple old laptops, and it needs astronomers with engineering experience to remove this deficiency to be able to achieve an accurate timing and valuable results.

But nowadays after removing many technical problems we can see that operating systems like Windows can be used as real time operating systems if they are supported by devices with appropriate processing power. These are systems with an i3 core processor and higher as currently used in robotic and new industrial systems. The Linux operating system on the other side whose development started about 7 years ago as an open source project with a low volume software core, was always introduced as a real time operating system on various types of computers. User convenience with these modern operating systems in comparison to the old DOS environment, as well as the versatility of processing software and image recording techniques led to much less use of DOS in scientific projects in the world these days.

Today the most accurate CNC devices in the world are equipped with Linux and Windows. Therefore the author believes that using DOS is no longer recommendable for occultation work and other astronomical issues due to the costs.

In addition to the lack of support of DOS in today's computers, also current IT knowledge does not show the need of DOS. Users are also more willing to use new technologies. According to software engineering courses about operating system training we know that DOS is an operating system with much more delay and a much weaker processing compared to Windows and Linux. Therefore, DOS in today's technology has more time error and delay than other operating systems. Furthermore, at least today in Iran, the majority of astronomers and observation groups are equipped with powerful laptops with powerful processing cores that are common in the world.

Now, if you are supposed to take your laptop to an observation night, you should better take a light laptop with a powerful processor to do the timing and connect all devices directly to the laptop by means of open source software and modern processor capabilities instead of using an old heavy laptop with a weak operating system.

In timing methods such as those used in the Kiwi system, additional hardware is needed since other equipment such as CCD and GPS has to be connected to the laptop. Then both the image and the timing overlap and the shared file can be shown on the screen through the ports of the laptop.

If you take a look at cameras in security industries (except industrial networks which need the use of many cameras and some cards and software to synchronize time and image), in many new digital technologies that use 1 or 2 cameras, there are no additional interface cards needed. Since most modern computers' processors, image and graphic cards and mother boards transfer data with a very high speed (unless your computer is infected) you can experience real time systems with good quality.

Accessories like VTI cards have various noises and delays such as thermal noise that occurs at the low temperature of observation nights. There is a delay in information release, including cable delay and delay in transferring data between card and computer system, etc. Compared to this the use of the embedded system has less noise and less delay when cameras, CCDs (note: most of modern CCDs are connected to the laptop directly via USB port), GPS active antennas etc. are directly connected to the laptop ports allowing viewing the data on the desktop. Since these devices are thus connected to an embedded system they have proper time synchronization. Recording the desktop data from the desktop by different image recording software products (most of them are free and open source) you will be able to simply make a complete movie of the observation event with its timing. I have used about 6 MB large instant demo software in my tests which is free of charge. This software has 2 percent image drops approximately (according to the information provided by the manufacturer). But there exists even more powerful software with a size of about 100 MB available on the internet that is also being used for cinema movies having a lower image drop rate when reviewing these films. It works on different graphic formats like MPEG and AVI.

In addition to accurate timing there is software that allows you to process the image data for drawing light curves, reduce camera noise, separate objects, etc. for both scientific and art purposes. This method considerably reduces human errors that existed in old timing methods due to the use of film. Also, there are different websites that offer GPS virtual clock. e.g. www.leapsecond.com.

You can use virtual GPS on your desktop to overcome problems of GPS data disconnection due to events such as a sudden cloudy sky and other complications. Of course, today most GPS devices and GPS active antennas connecting to the laptop have virtual GPS, so in case of a disconnection of the satellite's transmission data it continues counting the time using the internal crystal itself and again continues the timing by the satellite data when the GPS antenna is reactivated.

Considering all of the above, it seems using user friendly methods is very important. So, from the author's point of view it is suggested to test this method in an experimental phase. The multi system timing method is more economical and more accurate regarding the technological development concerning both hardware and software.

In the beginning I named this method 'Arya Sabouri Timing Method A.S.T.M', but then I decided not to take a person's name and rather present it as an Open Source project. So I changed the name to 'Multi System Timing Method M.S.T.M' and added a developer's name section to the end of this article. I hope that with assistance of other amateur astronomers from all over the world we can make this method as creative and complete as we can. I ask all developers to add their names to this list.

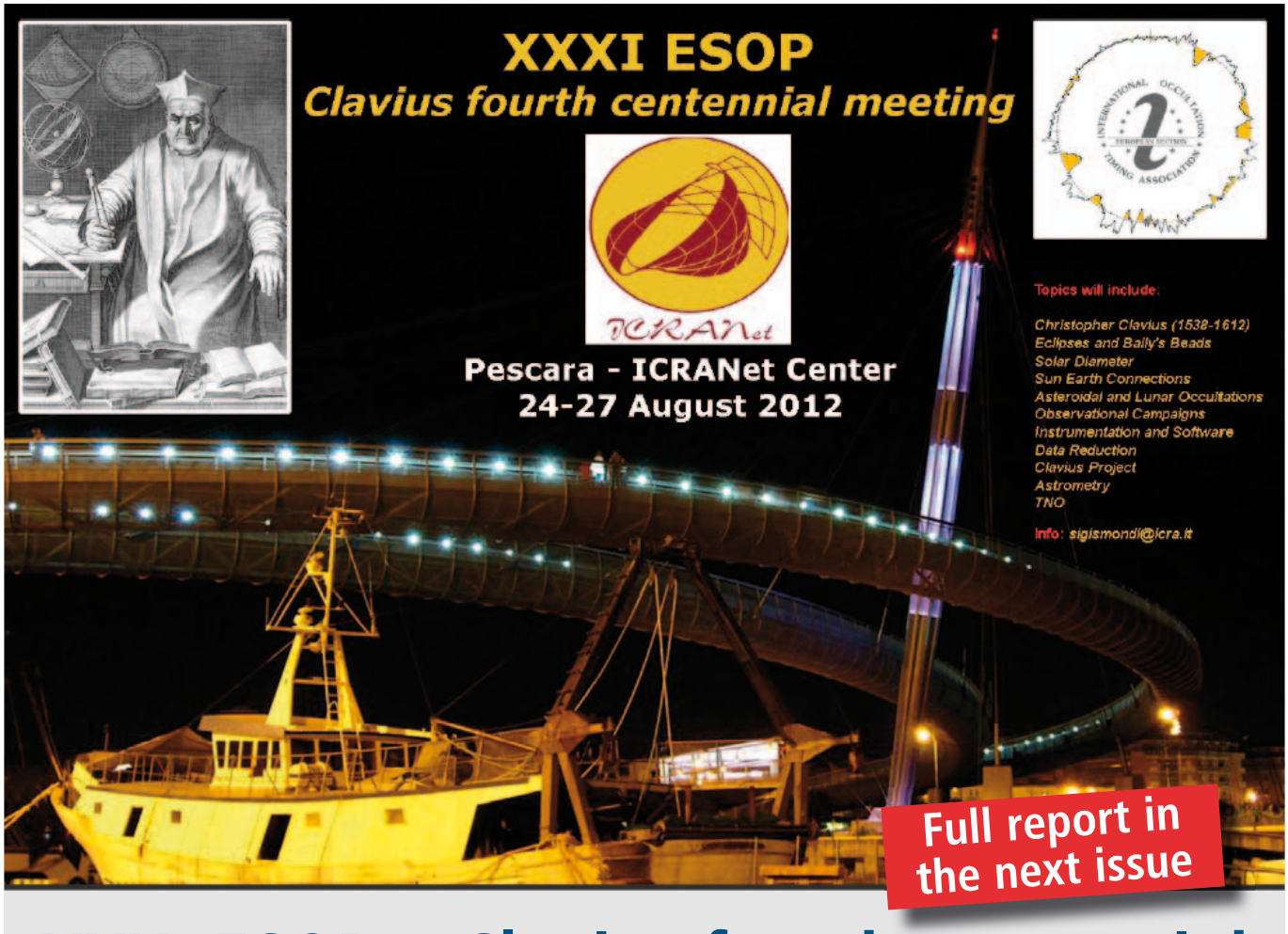
Furthermore, in order to have a convenient accuracy, I ask all observation groups to use this method besides other methods to help us reveal all probable errors and make it a modern and precise timing system.

M.S.T.M Developer people:
Arya Sabouri – IOTA-ME – Iran- December 2011

To use this method the following steps are recommended:

1. Connect the camera or CCD to the laptop via USB port or proper converter.
2. Connect the GPS USB or the GPS active antenna to the laptop.
3. Open virtual GPS.
4. Set the telescope on the target.
5. Start the image recording with the software on the desktop showing the information of points 1 to 4.
6. Connect to the internet, if a GPRS modem is available to set the time more accurately and use international time.
7. Connect a microphone to the laptop, since this system is able to record sounds.
8. Observe carefully and simultaneously and have the computer working process controlled by a friend or assistant.
9. At the end of the observation stop the software and save the movie in your favorite format.
10. Review the movie and make an observation report with time to time movie inspection and the recorded timings.
11. Publish the movie on a website for others for training and further inspection.

* Before starting, set your laptop clock with several precise sources.



XXXI ESOP – Clavius fourth centennial meeting – Registration Fee

The registration fee is 100 Euro until February, 29th 2012. Afterwards the registration fee will be 125 Euro. NOTE: the registration fee is applied also to the accompanying persons.

Registration fee covers: coffee-breaks, 1 dinner, 1 tour Fossacesia-Lanciano-Guardiagrele.

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Journal for Occultation Astronomy

A Portable 20"-Telescope

Hans-Joachim Bode

All over the years IOTA-ES received a lot of donations (mostly given by German members) resulting from the fact that this funding leads to a reduction of the German tax.

Regarding this amount of money several discussions took place in the past considering what to do with it, until a few years ago it was decided to buy 3 of the camera-systems being in development at Paris-University – but this project never came to an end …

This lead to the decision of Bruno Sicardy (Paris) to buy several extreme sensitive CCD-Cameras (RAPTOR, each at a price of about 5,000 Euros).

Our budget had a limit of about this size, so only one RAPTOR might have been purchased – but the company producing RAPTOR stopped its production last year!

Of course there are two possibilities to get the maximum of light:

- a highly sensitive CCD-Camera or
- a larger mirror.

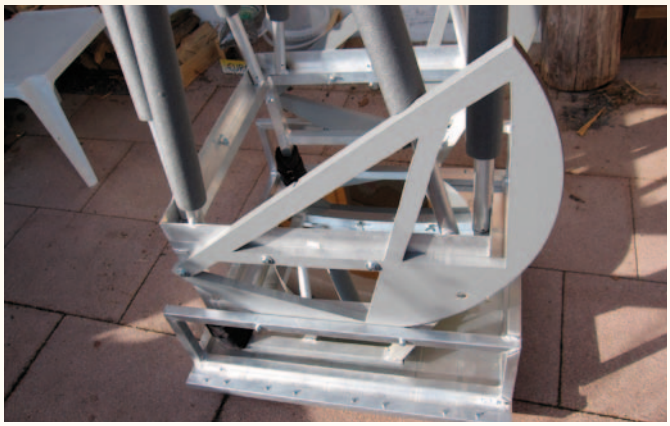
The development of CCD-Cameras is still going on so there is a good chance that there will be a highly sensitive and inexpensive system in the future. On the other hand the prices for large telescopes will not go down as much as prices for electronics. The disadvantage of bigger scopes is their weight especially when there is a need to travel with the telescope. In general this means that one has to optimize this system by using the 3 parameters electronics, mirror-size (function of weight) and money…

Michael Busse and I were talking about this situation and we decided to have a close look at presently advertised used telescopes. We knew that single 20"-mirrors can cost about 5,000 Euros – and we were lucky: An Amateur in southern Germany wanted to sell his 20"-Dobson-Telescope! It needed just a few talks on the phone to fix conditions and price: 3,300 Euros! The mounting is made of aluminium and can be dis- and reassembled within 15 minutes. The total weight is less than 45 kilograms and it looks like we can put it in our wooden transport-box (100 x 70 x 60 cm) for transportation to distant observation-sites like Sicily, Namibia, etc.

Michael will install a computer-controlled ALT/AZ motor drive and add my 110 mm/1:5 refractor as finder-scope. All this should be ready until end of March, so the first light of the 20"-Dobson will be the Ouaoar-occultation on April 17 where Michael and Andreas plan to travel to southern Spain to record this event.

Future events:

For everybody who is interested to record TNO-occultations or similar events this instrument will be available for a limited period of time. In this case it is necessary to sign and pay for a transport-insurance-contract. The user will have to arrange the transport from us to his address. Anyone wanting to use the Dobson is requested to work with it first during an introduction-workshop.



Journal for Occultation Astronomy

Measuring the position of the center of the Sun at the Clementine Gnomon in Santa Maria degli Angeli

Costantino Sigismondi, Galileo Ferraris Institute and ICRA International Center for Relativistic Astrophysics, Rome.

Abstract:

The Clementine Gnomon in the Basilica of Santa Maria degli Angeli has been realized in 1702 with the aim to measure the variation of the obliquity of the Earth axis along the forthcoming centuries. Since then the church and the instrument undergone several restorations and the original conditions of the pinhole changed.

The measurements of the position of the image in the days before and of the 2011 winter solstice with respect to the original markers compared with the ephemerides gives us the North-South correction for the position of the pinhole to be restored.

Introduction:

The Clementine Gnomon is a solar meridian telescope dedicated to solar astrometry operating as a giant pinhole dark camera, being the basilica of Santa Maria degli Angeli the dark room. This instrument built in 1701-1702 by the will of pope Clement XI by Francesco Bianchini (1662-1729) gives solar images free from distortions, excepted atmospheric refraction, because the pinhole is optics less. Similar historical instruments are in Florence (Duomo, by Toscanelli and Ximenes), Bologna (San Petronio, by Cassini), Milan (Duomo, by De Cesaris) and Palermo (Cathedral, by Piazzi).[1] The azimut of the Clementine Gnomon has been referenced with respect to the celestial North pole, and it is 4'28.8"±0.6",[2, 4].

Local deviations from a perfect line and evaluation of ΔUT1:

Also the local deviations from a perfect line are known with accuracy better than 0.5 mm, by using a LASER beam.

Due to the velocity of the drift of the solar image up to 3 mm/s, these local deviations add time scatters up to 2 s to the above mentioned global eastward deviation, which attains a maximum delay of ~18 s at the winter solstice, with respect to the modern ephemerides time.

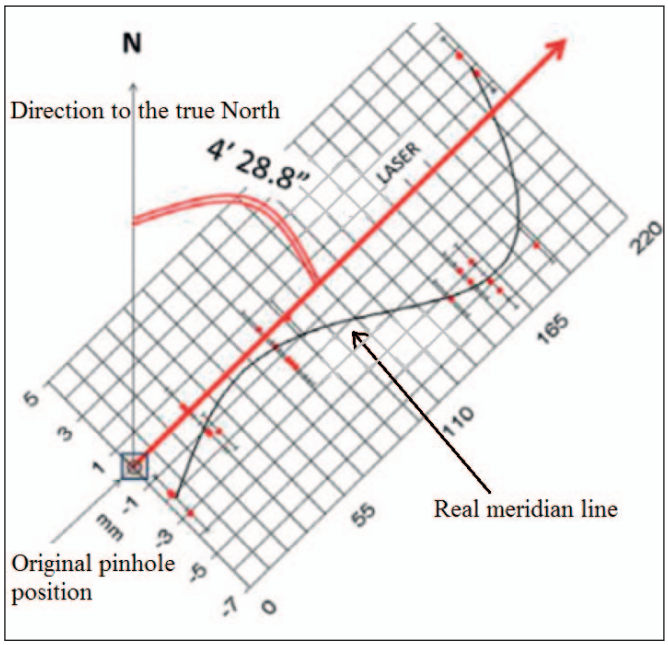


Fig. 1 Local deviation of the Clementine Line from the LASER line, and global deviation from the true North.

With these calibration data we used the Gnomon to measure the delay of the solar meridian transit with respect to the time calculated by the ephemerides. Since the ephemerides are computed with a constant Earth rotation rate, this difference is a direct measurement of UT1. The growth of this astronomical parameter is compensated by the insertion of a leap second ad the end of the year in order to keep the Universal Time close to astronomical phenomena within less than a whole second.

On December 31, 2008 at 23:59:59 there is one of those leap seconds leading to 23:59:60 before the new year's midnight 00:00:00, being ΔUT1~0.7 s at that date. ΔUT1 has been measured in that occasion with an accuracy of ±0.3 s. [2]

The reason of such limit in time accuracy is due to the effect of the atmospheric seeing.

Seeing, time resolution and statistical error on single transit timing

The warm air rising up near the external side of the pinhole produces turbulence. Since the circular pinhole used for the winter solstice 2011 is 1.6 cm of diameter, warm air vortices of such dimension are affecting the entire objective pupil, and therefore the image on the focal plane shakes as a whole.

Moreover the limit imposed by the diffraction is intriguingly similar to the one found by the seeing. For a pinhole of diameter d = 1.6 cm and for a light of wavelength λ = 550 nm, $\Delta\vartheta$ = 8.7 arcsec is the angular

resolution for point-like sources according to the Rayleigh resolution criterion ($\Delta\vartheta = 1.22 \cdot \lambda/D$).

In terms of time resolution, through the equation

$\Delta\vartheta = 15 \text{ arcsec} \cdot \cos\delta \cdot \Delta t$

where δ is the solar declination at the moment of the observation[3] we obtained a $\Delta\vartheta = 4.5$ arcsec which represents the better angular resolution achievable at the Clementine Gnomon under ordinary seeing conditions.

The method chosen for measuring the transit time with an expected accuracy of a few hundredths of second was described in a paper of 2006. [4] The strategy consisted to average the transit times of the preceding and proceeding limb on lines parallel and evenly spaced with respect to the meridian line. N lines and 2N contact times were determined each one with 1/30 s of accuracy through video inspection frame by frame. A final resolution on the averaged value of the central time calculated over the above N lines was expected to $1/\sqrt{N}$ times the accuracy of a single measurement, so with N = 30 lines 0.1 s should be attained.

But no convergence at all occurred having 30 lines and 30 supposedly independent determination of the central time. This was because the 30 determinations or the 30 transits above 30 parallel lines occurred over more than 5 minutes were not statistically independent one from another.

It means that the turbulent phenomena in the local atmosphere which affect the image have timescales which are comparable with the whole duration of the 30 measurements, and not only very rapid behavior ranging around the 20-50 Hz of typical frequency. The contributions of very rapid fluctuations over a long sampling time interval would be randomly averaged to zero.

The measurements of timing of Santa Maria degli Angeli did not attain the expected accuracy because the single timings were not Gaussian-like distributed, so their average did not converge as Gaussian data would do.

Studies conducted in Locarno and Paris with much greater telescopes (45 and 33 cm respectively) confirmed the non-Gaussian nature of the turbulent phenomena of the atmosphere, responsible of a tiny motion of the whole solar image during the time of a drift-scan transit (typically lasting 2 minutes and half).[8]

This fact implies that the average of N durations of consecutive transits does not converge with a Gaussian decreasing statistical dispersion proportional to $1/\sqrt{N}$.[5,7]

Therefore to validate a drift-scan measurement of the solar diameter a measurement of the drift of the solar center made in parallel by another large field (6 to 8 solar radii) instrument would be necessary.

Position of the actual pinhole

A simpler measurement to do in the Basilica at the moment of the meridian transit is the one on the position of the solar image with respect to the original marks of 1700.

This operation is complicate by the background illumination of the Basilica, which once (300 years ago) was darkened by tents during daytime observational sessions.

Nevertheless the lower contrast between the image and the background produces an error which is symmetrical for the northern and the southern limb of the Sun. Therefore this error does not affect the determination of the position of the center of the Sun.

The measure has been done as in the following.

Three sheets of papers have been attached to the floor next to the meridian line.

Fig. 2 Disposition of the white papers next to the meridian line. The approaching image of the Sun of December 21, 2011 is on the west (right) side of the meridian, the photo is taken in the direction of the pinhole.

When the transit occurred with a pencil the upper and the lower limbs were signed over the paper (in the image the papers are on the right side of the meridian line); also the central contact point position was evaluated.

After the position was calculated in terms of the original units of measurements: the 1/100 of the height of the original pinhole (20.344 m).

This unit of measurement allows to have directly the tangent of the zenithal angle of each limb.

The computation of solar ephemerides has been done by using the Ephemvga ephemeris program.[6]

The following tables resumes all our measurements:

Date December 2011	Transit time Obs. [±0.3 s]	Transit time Calc.	O-C [±0.3 s]	Pressure hPa	Air Temp °C
20	12:07:42.0	12:07:24.2	+17.8	1016	9
21	12:08:12.5	12:07:54.1	+18.4	1013	11
22		12:08:24.0		1017	11

Date Dec 2011	N limb Obs.	S limb Obs.	Center Obs.	Center Calc.	Center O-C mm
20	214.6657	220.0885	217.3494	217.3754	-5.29
21	214.7419	220.204	217.44525	217.4746	-5.97
22	214.7862	220.2015	217.46615	217.49544	-5.96

Air temperatures and pressure from Roma Urbe airport meteo station.

The unit of measure of the positions of the limbs is 1=203.44 mm, i.e. 1/100 of the height of the pinhole (as measured on Feb 2nd 2006 [4,11]). Each measurement has been computed from the lines traced on the paper, e.g. on Dec. 21 the Southern limb reached 4.15 mm above the 220 sign, so 220+4.15/203.44=220.204.

The image of the Sun covers 5.43 of such units, having a diameter of 1951 arcsec. Therefore the following equivalence is valid (having taken into account also the angular dimension of the pinhole of 67 arcsec):

1 arcsec = 0.55 mm

The correction of temperature and pressure corresponds to less than 0.2 mm.

The correction to the refraction formula (used at the first order i.e with the formula 60"·tan(z)), proportional to $\tan^3(z)$, it is about ~0.01 arcsec, i.e. less than 0.005 mm.

The error induced by the contrast, which changed from one day to the other, is assumed as the same on both limbs, and the central position was not affected by this effect.

The error induced by the [18.1±0.3] s of delay with respect to the true meridian transit is because the Sun is slightly lower than its maximum height at that moment, but its position along the line changes for less than 0.08 mm.

To compute the position of the solar center, the differential refraction for the Sun at ~24.7° above the horizon, has been also taken into account.

Conclusions:

The difference of 5.7±0.4 mm left between ephemerides and measured values is systematic.

It can be due either to

1. Different position of the center of the pinhole with respect to the 1702 original position.

In this case the pinhole had to be 5.7±0.4 mm northward than nowadays. This can be suggested by a figure published by the astronomer Francesco Bianchini (1703) who designed and realized the instrument. [9,10,11]

It's center D lays on the window's border AC. Right the actual position of the pinhole, as seen from the external side, is not on the border but more outward.

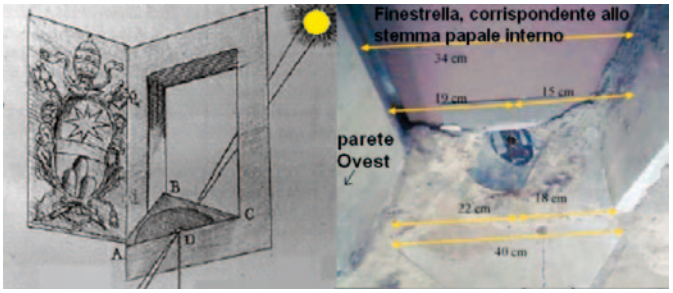


Fig. 3 Left: the original figure of Bianchini (1703) showing the solar pinhole.

2. Different height of the pinhole with respect to the original measurement, due to thermal expansion of the concrete of Diocletian Baths. In this case Bianchini could have measured the height of the pinhole in Summer time, when the air temperature was about 10° C higher than in the winter and the pinhole was slightly higher.

Assuming a typical thermal expansion coefficient of 10^{-5} /°C for the roman concrete (Opus Caementitium) for a 10 °C increase of temperature from winter to summer, we have for the 20 m wall of Diocletian Baths, where the pinhole is built-in, a raising of 2 mm.

With the inclination of 25° this corresponds to a 4.3 mm shift northward of the ending points of the meridian line. The thermal coefficient of the roman concrete is probably with a 30% uncertainty, and it can be derived by comparison with further summer time measurements.

Probably the height of the pinhole was measured in summer (1701 or 1702) and the marks on the meridian line were made consequently.

A forthcoming restoration will concern the pinhole, and the window in which it is located, that was opened to observe stellar transits as well.

The position of the pinhole will be chosen in order to reproduce correctly the measurements of the center of the Sun during the winter solstice when the graduation marks near the end point of the meridian line (215-220) are used as references.

The diameter of the pinhole will be restored to the original 20 mm, i.e. 1/1000 of the height of the pinhole.

The platform containing the pinhole will be realized in invar, and colored with white Titanium dioxide.

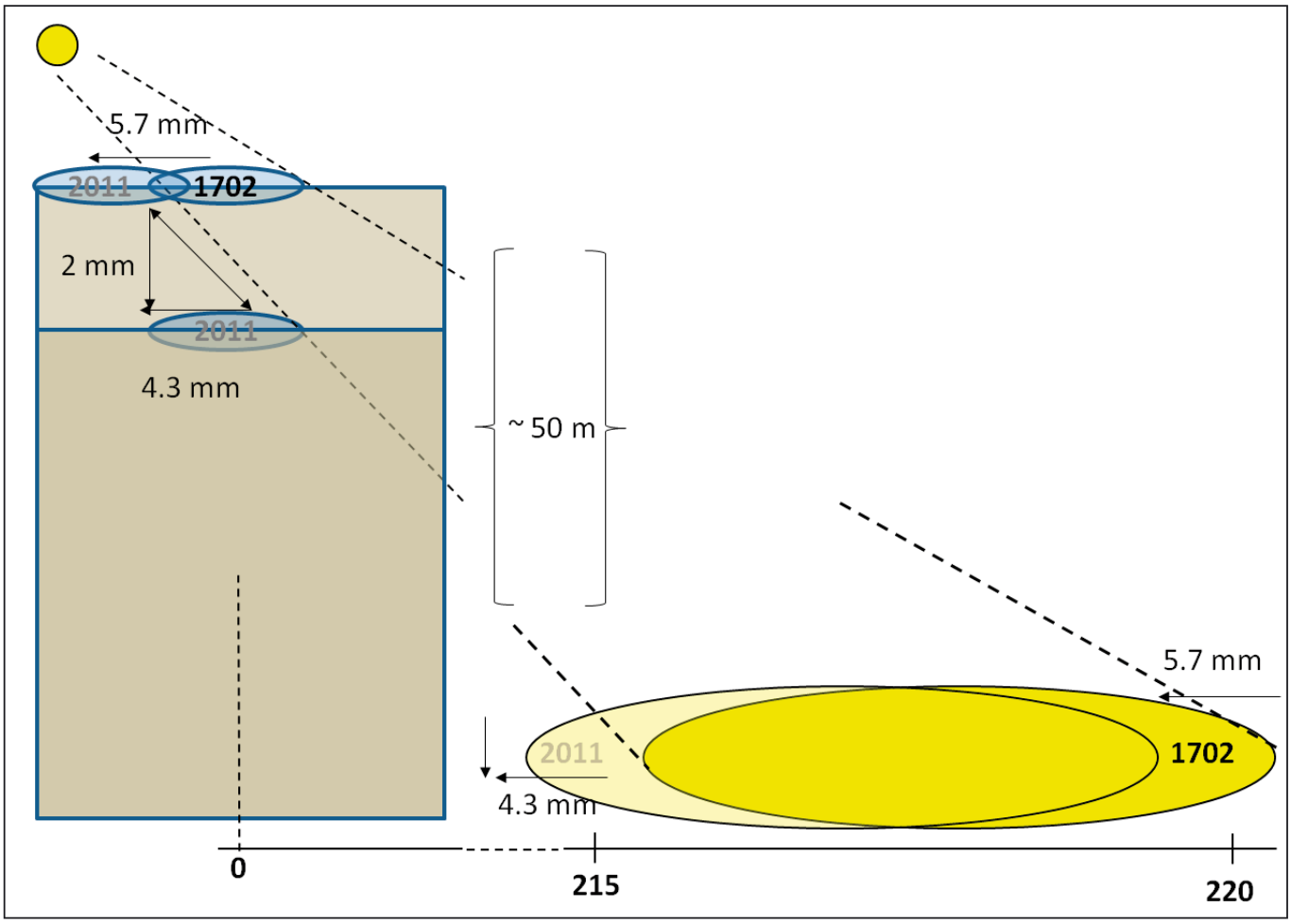


Fig. 4 A vertical shift of the pinhole position is due to the thermal expansion between winter 2011 and summer 1702 (or 1701), when the height of the pinhole could have been measured. An horizontal shift between 1702 and 2011 position is also possible. Both shifts bring the image backwards of some millimeters. The two effects are probably combined together.

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Journal for
Occultation Astronomy

IOTA's Mission

The International Occultation Timing Association, Inc. was established to encourage and facilitate the observation of occultations and eclipses. It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made.

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