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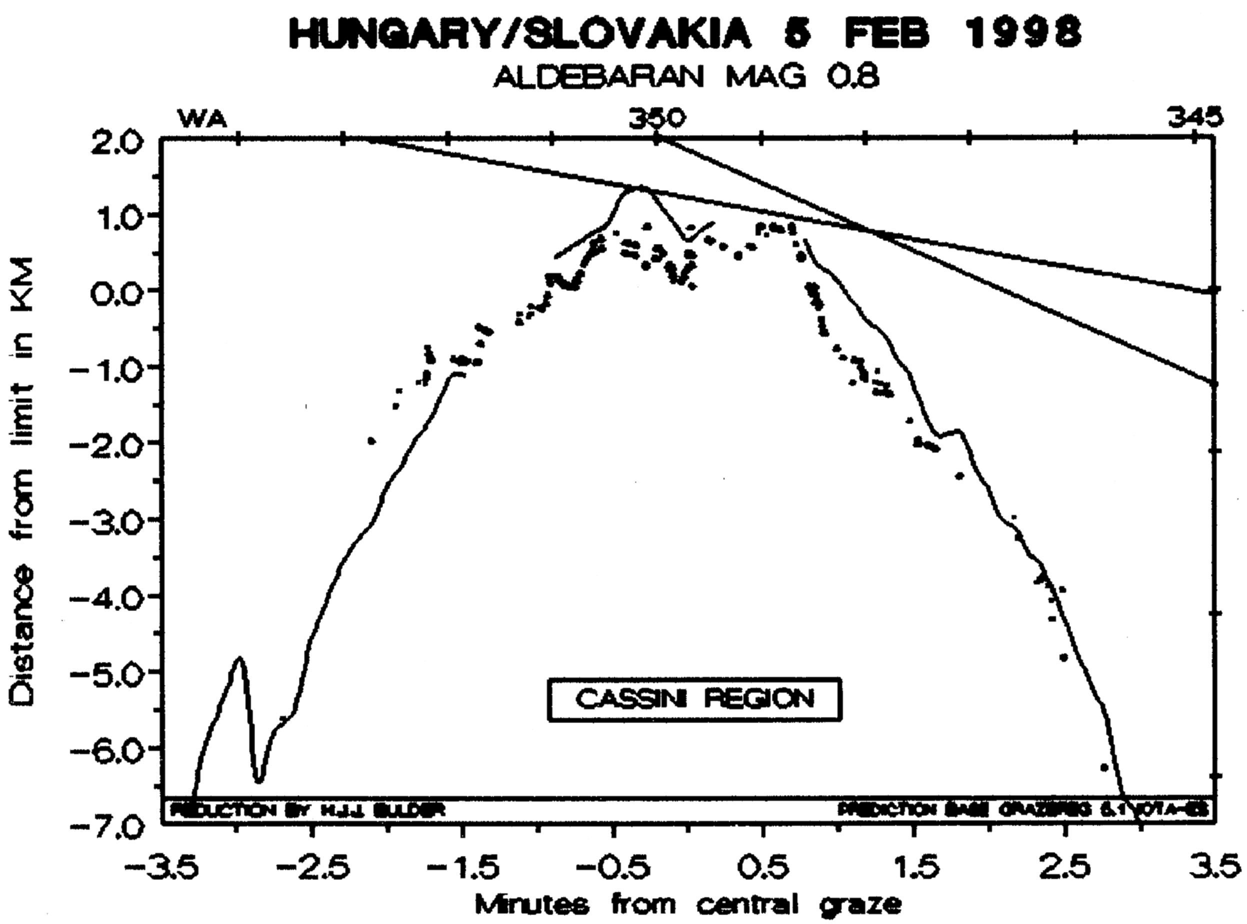

FIGUUR 3

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For subscription purposes, this is the third issue of 1997.
(The previous issue stated in error that it was the fourth issue. It was the second issue of 1997.)

On the cover: A double graze of Aldebaran sent in by Henk J. J. Bulder. Observers in Sopron Hungary were: Sandor Szabo, Otto Farago, Stoeger - Lovranich, Vlasich - Ternai, Petyus - Kalmar, Toth - Lendvai, Nyari Szabolcs, Spanyi-kaposi, Posztobanyi-tordai, Tepliczkiek, Tuboly-karoly-horvath-molr, Sarneczky-varnai, Kovago Gabor. Observers in Rimavska Sobota, Slovakia were: P. Kusnirak, J. Koza, J. Vana, M. Bujdos, P. Dolinsky, D. Toth, G. Vince, M. Arbet, J. Kovac, D. Lorenc, L. Smelcer, P. Zeleny, J. Micikova, L. Pastorek

International Occultation Timing Association, Inc. (IOTA)

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Memberships include the *Occultation Newsletter* and annual predictions and supplements. Memberships are US$30.00 per year for USA, Canada, and Mexico; and US$35.00 per year for all others. Observers from Europe and the British Isles should join the European Service (IOTA/ES). See the inside back cover for more information.

IOTA Publications

Although the following are included in membership, nonmembers will be charged for:

- Local Circumstances for Appulses of Solar System Objects with Stars predictions US$1.00
- Graze Limit and Profile predictions US$1.50 per graze.
- Papers explaining the use of the above predictions US$2.50
- IOTA Observer's Manual US$5.00

Asteroidal Occultation Supplements will be available for US$2.50 from the following regional coordinators:

- **South America**--Orlando A. Naranjo; Universidad de los Andes; Dept. de Fisica; Mérida, Venezuela
- **Europe**--Roland Boninsegna; Rue de Mariembourg, 33; B-6381 DOURBES; Belgium or IOTA/ES (see back cover)
- **Southern Africa**--M. D. Overbeek; Box 212; Edenvale 1610; Republic of South Africa
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- **Japan**--Toshiro Hirose; 1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan
- **All other areas**--Jim Stamm; (see address at left)

ON Publication Information

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ESOP XVII
European Symposium on Occultation Projects

De Haan, Belgium
28 August - 2 September 1998
Edwin Goffin

The seventeenth European Symposium on Occultation Projects (ESOP XVII) will be held from 28 August through 2 September 1998 in De Haan, Belgium, under the auspices of the European Section of the International Occultation Timing Association (IOTA/ES) and with the support of the "Vereniging Voor Sterrenkunde" (VVS, the Flemish astronomical association) and Urania, Volkssterrenwacht van Antwerpen (the Public Observatory of Antwerp).

The symposium is open to everyone and encompasses all facets of occultations: lunar, planetary and asteroidal, and also phenomena involving satellites and solar eclipses.

An invitation was sent by mail to a number of potential participants, based on their presence at earlier ESOP meetings. It is also available on the World Wide Web. The ESOP home page will be maintained by Tom Alderweireldt, the URL is: **http://www.ping.be/~pin01622/esop-xvii/index.shtml**. ι

Attention Eclipse Enthusiasts

Bryan Brewer
bryanb@earthview.com

The Earth View Eclipse Network (http://www.earthview.com/) announces the immediately availability of a new Eclipse list server aimed at facilitating responsible email communication among eclipse enthusiasts worldwide.

Target Audience: eclipse chasers, astronomers, photographers, educators and the general public interested in eclipses--all are encouraged to subscribe.

Intended Uses: share ideas, stories, links, and photographs; ask questions and receive answers about the history and science of eclipses; discuss travel plans to view eclipses; and eclipse news in general.

To Subscribe: send an email to **listproc@hydra.carleton.ca** with the following first line of the message (not the subject line):

subscribe eclipse YourFirstName YourLastName

Support: Barry McClarnon, of Ottawa, Ontario, administers the list server.

Additional Information:
http://www.earthview.com/resources/mailinglist.htm or contact Bryan Brewer, bryanb@earthview.com, phone 206-527-3168 Seattle, WA, USA. ι

Good GPS Position Measurements in "Stand Alone" Mode

Experiences and Recommendations
Wolfgang Rothe, wrothe@t-online.de

Introduction

A permanent problem for all occultation observers is the position measurement of the observation site at home or during expeditions. Generally we have to consider that observations are necessary in different countries with very different circumstances (infrastructure, available maps, different map datum, security, density of landmarks etc.). So position measurements based on the GPS (Global Positioning System) can solve this problem globally as indicated by its name.

Unfortunately the possible accuracy of GPS measurements is affected by:

- artificial falsification of transmitted GPS signals because of military reasons, called selective availability (S/A)
- current available satellite geometry
- propagation effects due to atmospheric attenuation, propagation time delay and reflections
- technical features and software used in the given GPS unit.

Without any doubt: The best method is the use of differential GPS measurement (DGPS) to avoid or to minimise errors. But this method requires more sophisticated (and more expensive) equipment and a point with "well known position" for the base station located "nearby".

This article describes how one can measure position using a GPS unit in "stand alone" mode and how to check the accuracy of these measurements. Such measurements can be interesting

- to find a reliable position without expensive DGPS equipment and without other aid
- to find the "well known position" for a DGPS base station without other aid.

Possible measurement accuracy and recommendations are given. The acceptance of recommendations will be better when the reason for them are known. So the reasons and some background information are provided. The basis for this article is my own personal experience using the cheap handheld unit GPS45 made by GARMIN, but this is not intended to be an advertisement for GARMIN; other GPS products may be suitable to the same or higher degree. On the other hand there may be GPS equipment which is useless for our purposes. All measurements were made in Berlin, Germany, at about 13.5 degrees east and 52.5 degrees north.

I used the following for evaluation of results:

1. Internal TRACKLOG mode of GPS45, maximum storage of 768 single measurement points, selected time interval between 10 and 120 seconds. After measurement was made data transfer to PC via serial interface using software GARLINK EasyNav Communications, Version A.02.00, developed by EasyNav, available via 100012.2021@compuserve.com. This mode allows one to collect data without use of a computer under field conditions, but there is the limitation of 768 measurement points.

2. Real time data transfer to PC via NMEA mode of GPS45 (protocol version 0183.2). This mode transfers about 1800 single measurements per hour and creates a (primary) file about 1 MB / hour. I used the TERMINAL software from Windows 3.1 to receive the data flow via serial interface. This mode is better for measurements at several positions for expeditions and/or for more detailed studies.

3. In order to analyse the data sets I have written two TurboPascal (Version 7.0) programs:

The first program analyses the tracklog data and gives the average values, the standard deviation of data set and a graphic display of the measurement point cluster.

The other program analyses the NMEA data. It also gives the average values, the standard deviation of the data set, and a graphic display of the measurement point cluster. The NMEA data flow contains a lot of other parameters, and so it was possible to create diagrams for "estimated position error (EPE)", altitude above sea level, estimated altitude errors, satellite positions, satellite signal quality (see also attached plots). Altitude measurements are not considered in this article.

I thank Paul Maley for detailed discussions and for the suggestion to write this article.

Possible Accuracy based on own Experiences

Unobstructed horizon conditions (down to 5 to 10 degrees elevation) for the GPS antenna:

- A single measurement may deviate about 100 or more meters from true position
- Measurement time (data collection) of 2 hours: The measured averaged position did not deviate more than about 10 meters from the true position in any direction, regardless of the fact that the 1-sigma-dispersion of the collected data set is on the order of +/- 20 to 35 meters.
- Average of the averages of several data collection periods: The 1-sigma-dispersion of the averages is on the order of +/- 3 meters. I think that the accuracy of the average of the averages has the same order.

Partially shielded conditions for the GPS antenna:

- I found that a single measurement may deviate more than several hundred meters from true position up to (800 meters)
- Measurement time (data collection) of 2 hours: The measured averaged position deviates up to 100 meters from the true position, the 1-sigma-dispersion of the collected data set can increase up to +/- 150 meters.
- Average of the averages of several data collection periods: The 1-sigma-dispersion of the averages is on the order of +/- 30 meters. I think that the accuracy of the average of the averages has the same order.

Values above for shielded conditions are valid for a position where nearly the half sky is visible. For this situation, time periods occur (up to an hour or more) where GPS measurements are impossible or they are interrupted because of "poor satellite coverage" (low number of satellites and/or very bad satellite geometry, see attached plots). I think this situation is nearly the worst case for GPS measurements regardless of the fact that it is an excellent place (half the sky is visible from my balcony) for astronomical observations.

General Recommendations for Stand Alone GPS Measurements and Reasons for It

1. Give the GPS antenna an unobstructed horizon

An unobstructed horizon is the most important, simplest and most effective aid to achieve the best satellite geometry at any time and minimises the resulting position error due to non-optimum satellite geometry. Use a pole or other simple mechanical support to elevate the GPS antenna or the whole GPS unit to yield the best possible view of the sky for the GPS measurements. The attached plots illustrate the bad influence of site shielding on the measurement dispersion and errors.

2. Avoid reflecting objects

Large metallic objects (e.g. transmission towers, metal fences, metal buildings) may cause reflections of GPS signal radio waves. Reflected waves have a longer propagation path than directly received waves and this fact results in additional measurement errors. Water surfaces can reflect radio waves too. If a lake is in the vicinity of your observation point, place the GPS antenna such that it can not "see" the water surface.

3. Collect GPS data as long as possible, each data block for 1 or 2 hours and containing about 60 single measurements per hour

When there is a limited time budget, e.g. during expeditions, the whole time of stay at the observation point should be used for GPS measurements. Therefore the first activity after arrival should be the activation of GPS measurement. The time duration is required in order to exclude S/A effects and geometric effects by averaging over as long a time period as possible. Data collection should be done using the internal memory of the GPS unit and/or interface, laptop, and transfer program. Of course, manual data reading and documentation is possible but involves a question of man power. There is no advantage to collect data more often than once per minute.

4. Sketch the neighborhood of the observation site. Mark the exact observation point, the exact GPS measurement point and durable landmarks including the distances between all them; then, mark the northern direction.

This documentation is necessary for offset calculation between the measured point and the actual observation point (if the measured point is different) and to reproduce all circumstances if later investigation is required. Measure the required distances with an accuracy better than 1 meter.

5. Evaluate / criticise the results as soon as possible

We can evaluate a given GPS measurement series only by looking at the result, not by looking at just the circumstances.

I have a look at the shape of the measured "position cloud" of each series. An nonsymmetric shape and large excursions indicate influence of site shielding, bad satellite geometry (and maybe reflections from a certain direction). Some points may deviate several hundred (!!) meters from average, especially under shielded antenna conditions.

Calculate the average and the dispersion of the first series. 3x Sigma describes the deviation from the average, valid for 95 % of single measurements if data collection was made for 2 hours (to average the S/A effect). My experiences show that the average of a 2-hour-series never deviates more than 1x Sigma limit of this series from the true position. This was checked using landmarks with very exact known co-ordinates (error of several decimeters only). If the value Sigma meets the requirements of the given observation, the result (average of one series) can be used.

If this value of dispersion does not meet the requirements then you must measure more series (e.g. five), calculate the average and the dispersion of each series, and then calculate the average and the dispersion of the averages. The dispersion of the averages should be significantly (more than 3 to 5 times) lower than the dispersion of each series. If the value 3x sigma (dispersion of the averages) meets the requirements of the given observation, the result (average of the averages) can be used.

It is not recommended to use visual averaging using the graphic track display of the GPS unit. The reasons are: bad resolution and bad visual weighting due to the following facts. First, not only are the measured single positions (points) displayed but also the connection lines between them; second, multiple measured positions cannot be recognised.

This evaluation may be difficult for a layman, but I do not see a way to avoid it.

6. If necessary, repeat the position measurements under improved conditions

If the evaluation of the results did not meet the required accuracy, repeat the measurements with a better antenna location in case of obstacles or use another GPS unit or an alternative position measurement method (map method included). Ask a friend with good experience and/or better equipment for help.

A repetition of measurement can be required not only for averaging of several series but also if the satellite geometry during the first series was too bad. An optimal satellite coverage is not guaranteed at any time. Sometimes a reduced number of usable GPS satellites is offered due to the "unhealthy" state of one or several satellites. A measurement can be impossible sometimes under shielded conditions.

7. Record the map datum

When locating the site, you will first use a topographic map. The map datum describes a system of parameters for approximation of the irregular shape of the earth for a given region. Different map datums give different values for the position of the same terrestrial point. The difference can reach several hundred meters. Normally GPS units allow the user to select a suitable map datum. Use the international datum WGS-84 when you have any doubt. (This is normally the IOTA standard map datum). Report the datum used under all conditions. The conversion between different map systems is a matter for experts who collect observation results.

8. Watch for possible unexpected effects due to Selective Availability (S/A)

The S/A is designed to reduce the accuracy of GPS real time measurements for "normal" (non-military) users because of military reasons. There are very different opinions about the degree, time dependence, and possible averaging of S/A, and sometimes it seems to be a matter of belief.

I have made a lot of GPS measurements under different conditions since April 1996. <u>Always I found that when using an antenna location free of obstructions, an averaging time of 2 or more hours is enough to get averages with a deviation of some tenths of arc seconds from the "true" position</u>. The influence of effects other than S/A can be considerably higher.

Generally all experiences are based in the past. We cannot be sure absolutely that the experiences referring to S/A are valid forever. The S/A is a man-made effect and the "man" can create an unexpected new S/A mode with long-term bias or so. So we have to watch possible new S/A effects. A home-staying observer should make GPS measurements for his well known position especially during important astronomical expeditions in order to recognise new S/A effects. Then plan to repeat GPS measurements time and again with unobstructed horizon conditions.

<u>Summary</u>

A position error of +/- 10 meters or less can be achieved under good conditions using GPS stand alone mode.

Recommendations for stand alone GPS measurements are:

1. Place the GPS antenna with as unobstructed a horizon as possible
2. Avoid the vicinity of reflecting objects
3. Collect GPS data as long as possible, about 60 single measurements per hour
4. Sketch the neighbourhood of the observation site for offset calculation and in case you have to return to resurvey days, months or even years later
5. Evaluate/criticise the results as soon as possible
6. If necessary, repeat the position measurements under improved conditions
7. Record the map datum used
8. Watch for possible unexpected effects due to S/A

These recommendations include the case of where it is impossible to get suitable GPS results under certain circumstances.

Explanation of Plots:

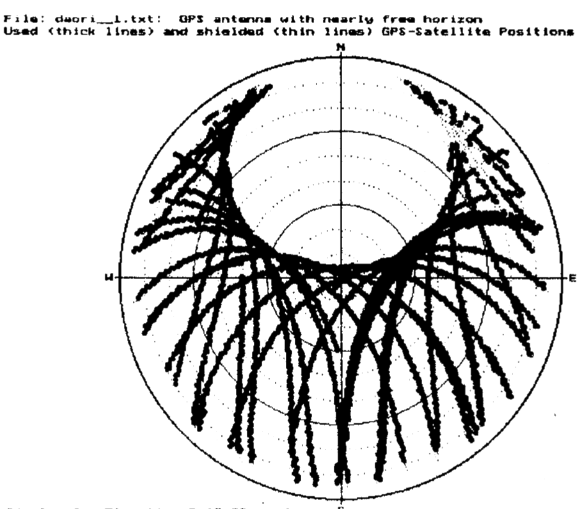
The plots illustrate the influence of site shielding on the dispersion of GPS measurements. Measurement series of about 16 hours are used for this demonstration.

The letter designation below describes the position of the GPS antenna:

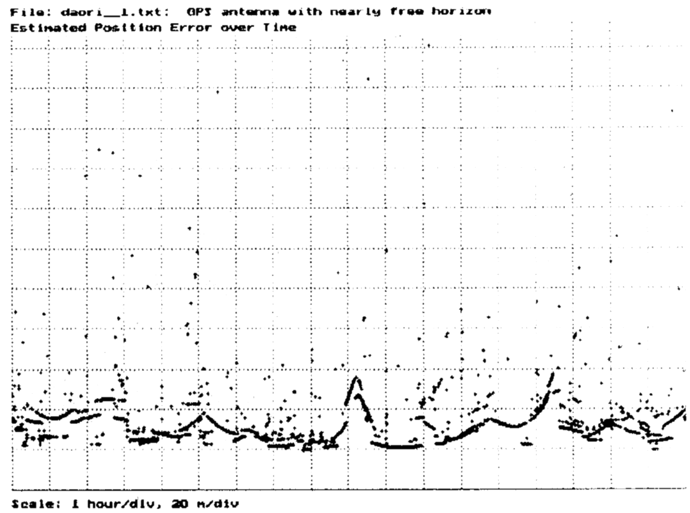
Plots A- Obstruction free horizon down to about 5 degrees elevation

Plots B- Antenna position shielded by a house corner, about 75 % of sky is visible
Plots C- Antenna position shielded by a house wall, about 45 % of sky is visible

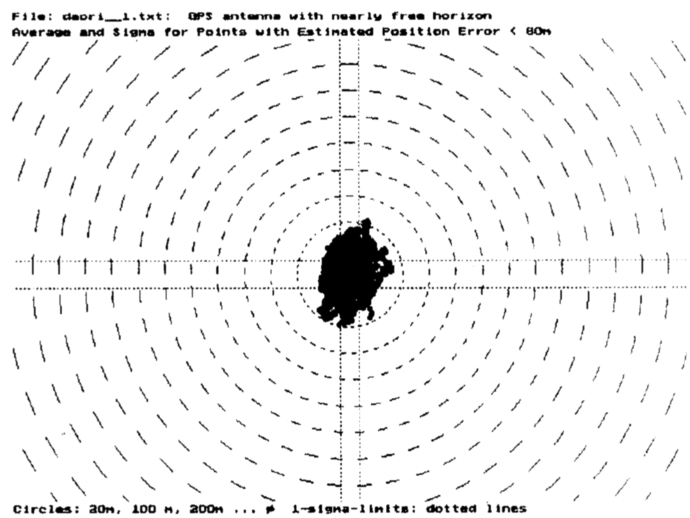
The figures are related to the special content:
Plots -1 Sky view; thick points indicate that satellite positions with enough signal quality were used; thin points indicate offered but shielded satellite positions. Insulated points in the north-western area of plot C-3 may be caused by radio wave reflections due to neighboring houses
Plots -2 Estimated position error (EPE) over time as indicated by the GPS unit. This diagram demonstrates the change of EPE due to the change of geometric satellite arrangement and/or new selection of satellites by the GPS unit. Insulated points may be caused by local interference and satellite losses due to non-ideal (non-isotropic) antenna pattern.
A-2: Note the permanent change between good and very good satellite geometry resulting in a permanent low EPE.
B-2: Note the higher change and average level of EPE. This series ends after 16 hours.
C-2: Note the very high EPE, the strong changes of EPE and interruptions of measurements due to too low a number of visible satellites. Good satellite geometry was never available.
Plots -3 Typical "cloud" of measured points in one series. Note the increased dispersion for shielded antenna positions.
Plots -4 Average of the averages of several series (for this demonstration, more than 20 series were used for each position). The center of plot A-4 is the reference point (true position) for plot B-4 and plot C-4 (offsets of several meters are corrected). You can see the bad influence of shielding and the large bias between true position (marked by a thick point) and the average of the averages at plot C-4.



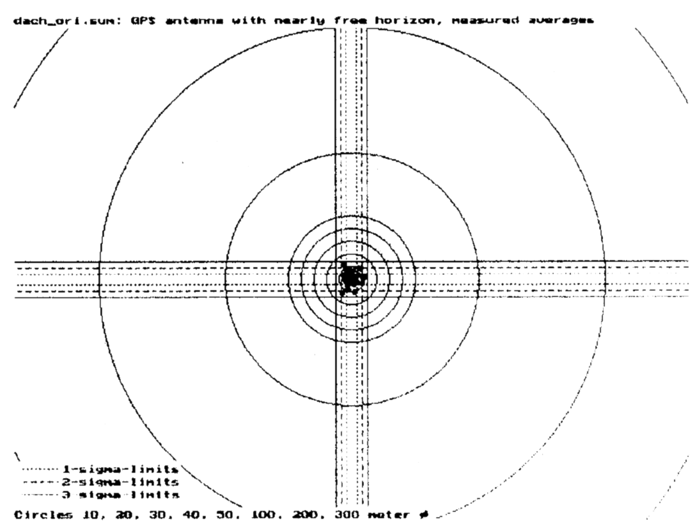
Plot A-1



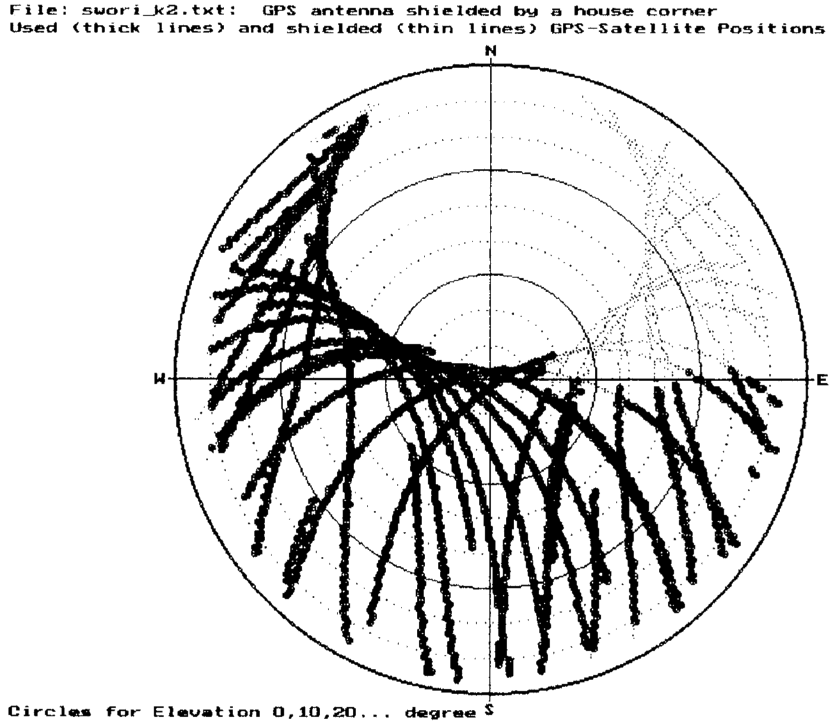
Plot A-2



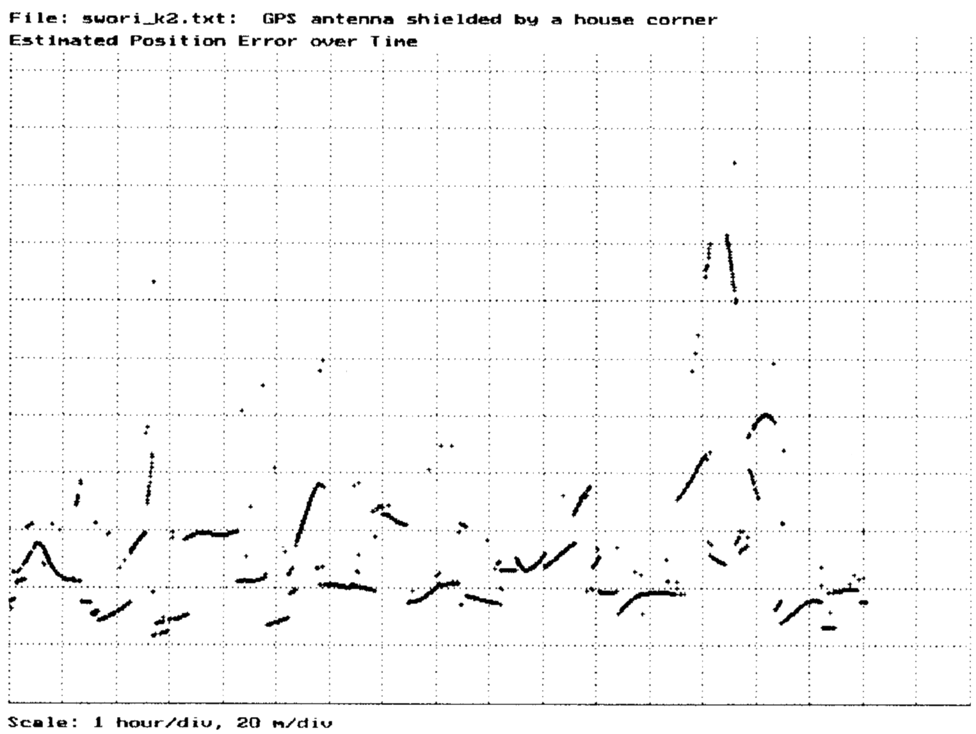
Plot A-3



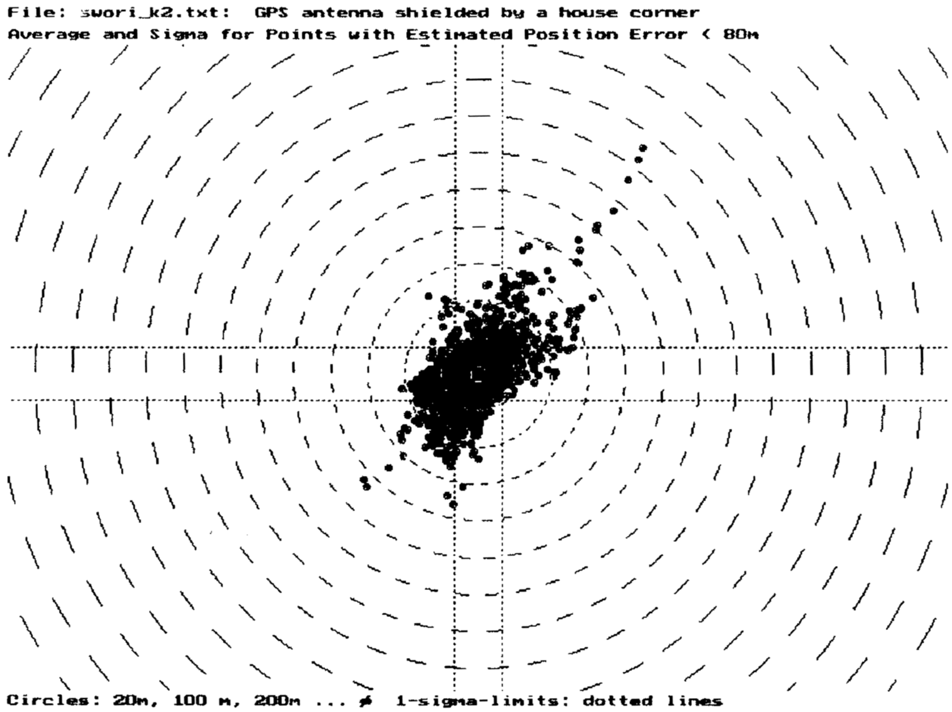
Plot A-4



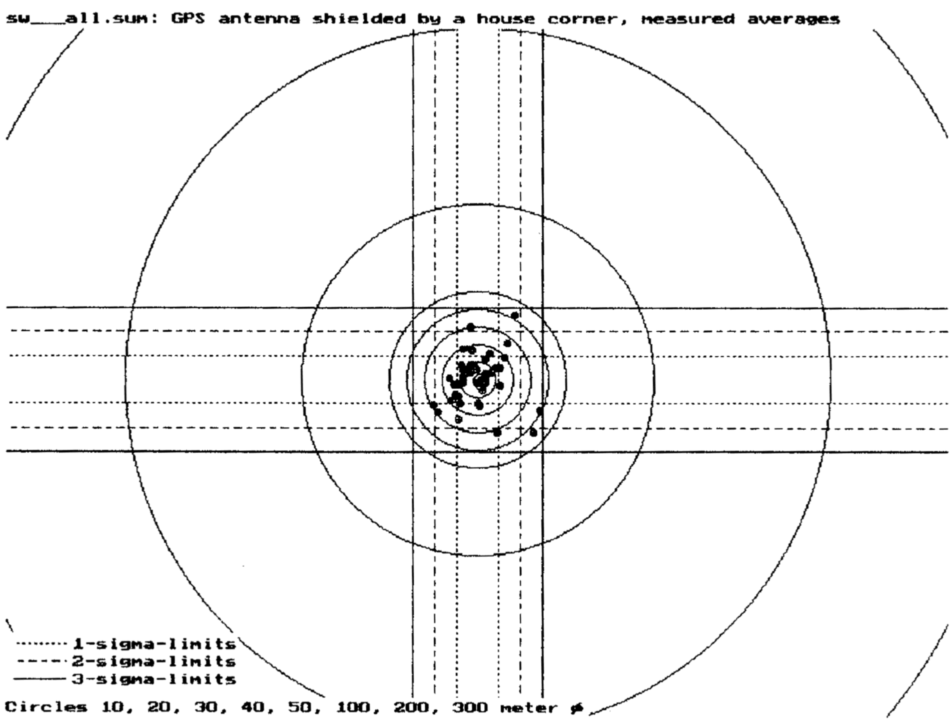
Plot B-1



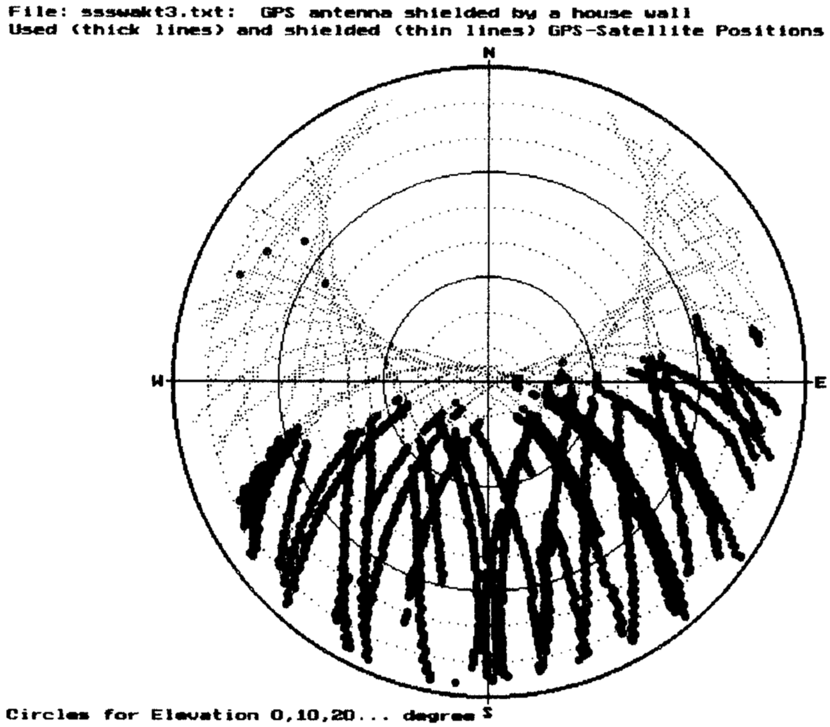
Plot B-2



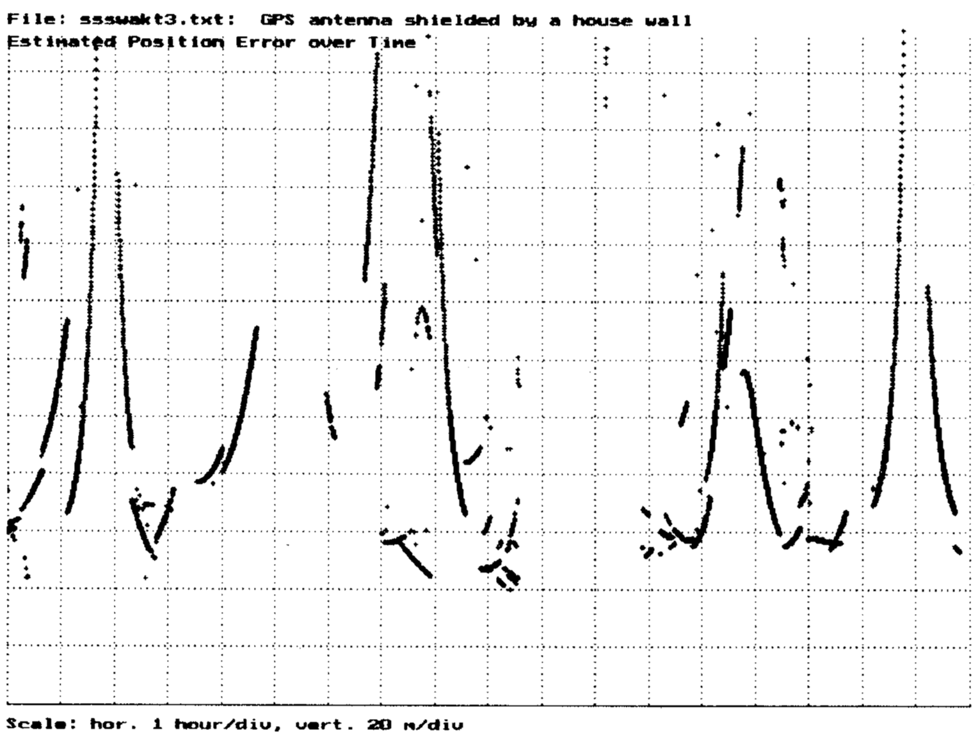
Plot B-3



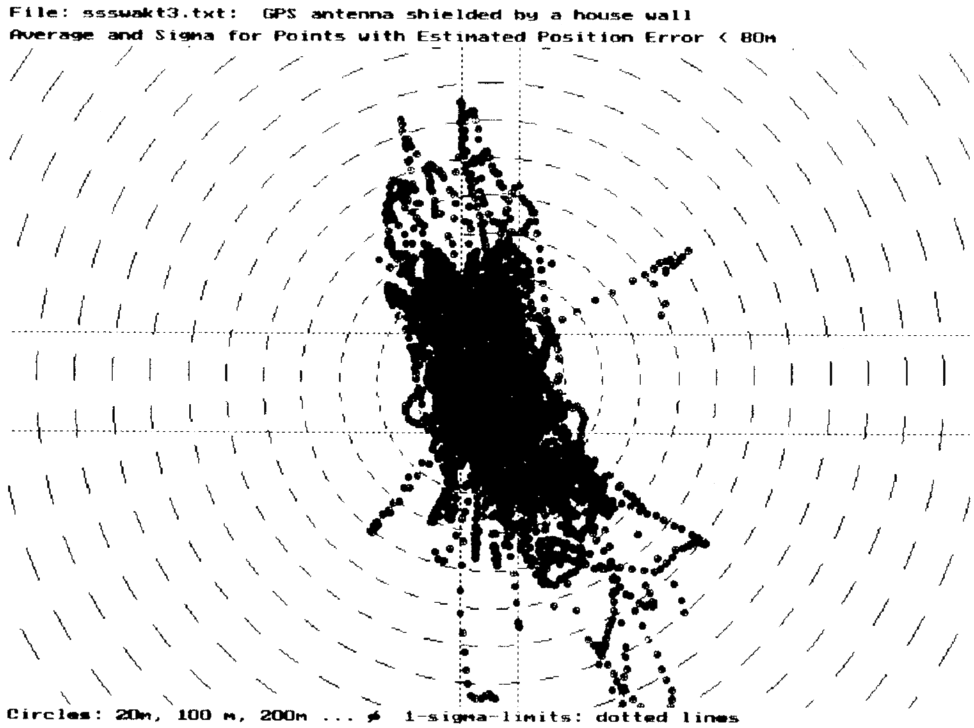
Plot B-4



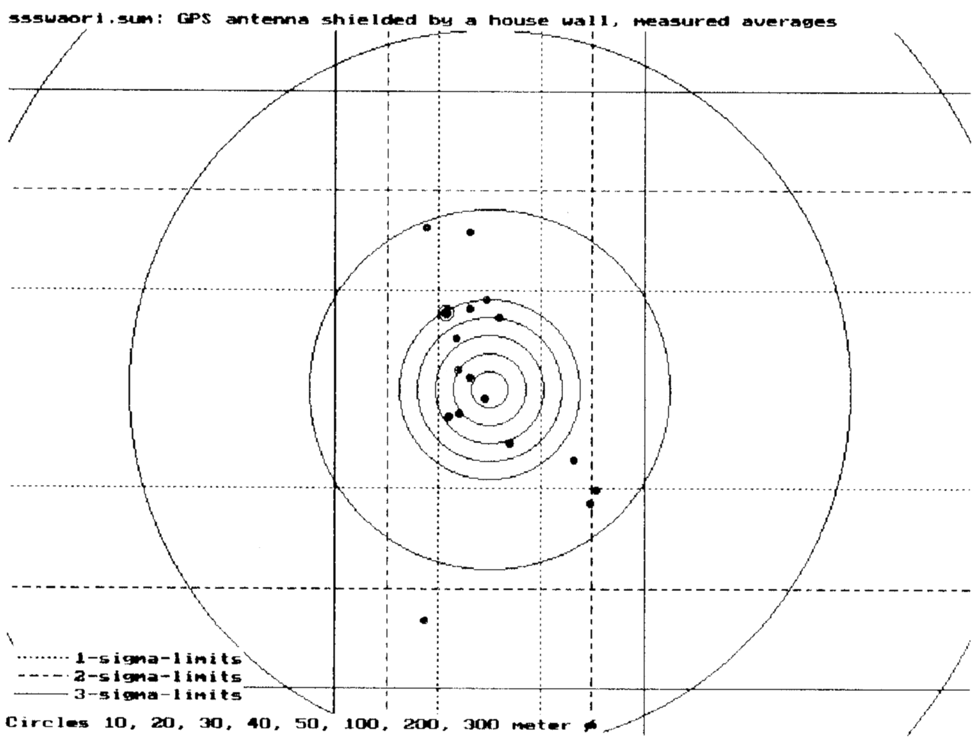
Plot C-1



Plot C-2



Plot C-3



Plot C-4

Preliminary Results of PHEMU97: A Joint Effort

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Abstract

Several first time observers of mutual events participated in PHEMU97 project of Bureau des Longitudes (BDL) so far. One of them, Jan Van Gestel, a Belgian amateur, used a C8 telescope in combination with a ST-8 camera. His effort resulted in some 19 frames per minute, which were reduced into a light curve by the author. This paper describes the joint effort in getting these preliminary results. Some experimentation is described to get the best result out of the frames and a suggestion for further improvement is given.

Motivation to Observe and Equipment Used

June 7 1997, a discussion among friends revealed Jan was not planning to observe any phemu events, since he thought his ST-8 camera would yield too few images to be of any scientific value. The author twisted Jan's arm into trying anyway, since getting a few images is better than getting none at all. The effort would certainly be better than any visual observation, I expected. This was later confirmed by project leader Jean-Eudes Arlot of BDL.

Emailing Jan after the July 8-9 events, yielded he had fallen asleep waiting for the events. July 25, Jan was more alert and consequently more successful. He got his first 860 frames for 2 consecutive events, Ganymede Eclipsing Europa (3E2) and Ganymede Occulting Europa (3O2). He used an 8 inch Celestron telescope in his 4 meter dome in Geel, Belgium. It took him about an hour or so to install his ST-8 including cooling, computer, software, etc. The chip was cooled down to some -6 °C. He had set a small window to get all four satellites downloaded to his computer. Integration time was set at 0.2 seconds. This resulted in about 19 frames every minute for the 3E2 event. Integration time for 3O2 was set at 0.5 seconds yielding 17 frames per minute. Jan used a diaphragm in front of his C8 for this second event. This way the seeing would be better, Jan expected.

Later events even yielded 25 frames per minute using updated software in combination with an optimized orientation of the satellite plane (parallel to pixel rows), which allowed for further downsizing the download area.

Reduction

Jan used software of Herbert Raab [ref.1] to get some preliminary data from the frames (figure 1). Although he got a curve, Jan was quite worried about the high noise in it. Since I'm not familiar with this software, I was not able to advice him, so, I proposed to send me the frames. Because I was not able to read the ST-8 format, Jan conveniently converted them to comma separated text files after he had performed dark current and flat field correction. All values were offset 100 to avoid any negative values.

I processed them with software based on the BDL method of reduction [ref.2][ref.3], including some movement correction routines, as I described at previous ESOP meetings [ref.4]. Basically this method boils down to positioning two embracing windows around both the object of interest and the reference object and summing the gray values within those 4 windows.

For the first event, 3E2, the light of satellite III was taken as reference. The first trial, without correcting for proper motion of satellite III in relation to satellite II, already resulted in a less noisy curve (figure 2).

Background Analysis, the Key to Further Improvement

Analyzing the background of the object of interest, satellite II, can tell a lot about things that are wrong. In general we can say that things are ok when this background shows a flat noise.

When we look at this background in the first trial (figure 3) we can see a peculiar pattern. This pattern with high noise towards both ends can be explained for by the proper motion of satellite II in relation to satellite III. Some light of satellite II is leaking into the background window due to this motion, which turned out to be 3 pixels from begin to end. When corrected for this motion, the background of satellite II improved (figure 4).

Varying the window sizes yielded no further improvement. It turned out the estimated window sizes were perfect. In case the size is too small you will see the background behave like the event itself (figure 5). It simply means the background contains part of the object. In case the windows are too large you will see, especially when objects get very close together, light of the adjacent object leaking into the background (figure 6 shows towards the end increased noise due to light leaking from satellite III). Using round in stead of square windows to determine the flux, improves the situation, especially in this case.

The final curve (figure 7) very well agrees with predictions (predicted maximum at 22:32:42 UT and predicted flux drop 0.33). Figure 8 shows the result for event 3O2 on the same date (predicted maximum at 23:50:59 UT and predicted flux drop 0.228). It looks as if the real maximum appeared somewhat earlier and flux drop certainly is much deeper. In this case the joint light of satellites III and II is compared with light of satellite IV (Satellite I could not be used because it exceeded the frame limits part of the time).

Suggestion

Reducing events like this, where objects to be measured are very close together, will introduce some interference noise. When the smeared light of the objects could be restored into its original position, this situation improves dramatically. Consequently the dimension of measuring windows could be smaller, which would eliminate the interference noise. To reach such a situation, some kind of deconvolution would be needed. In this respect the method described by P. Magain et. al. [ref.5] looks very promising. However, lacking the necessary software and time prevented trying this approach.

References

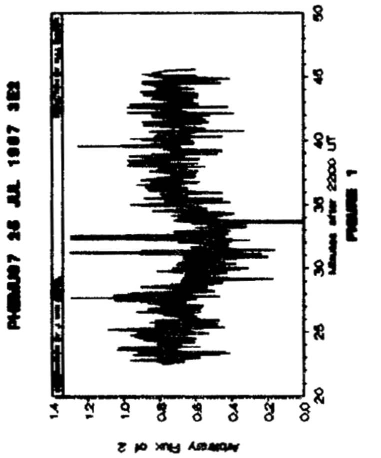
[1] Astrometrica 3.1A (DOS version), © 1993-1996, Herbert Raab, Schrammlstr. 8, A-4050 Traun, Austria

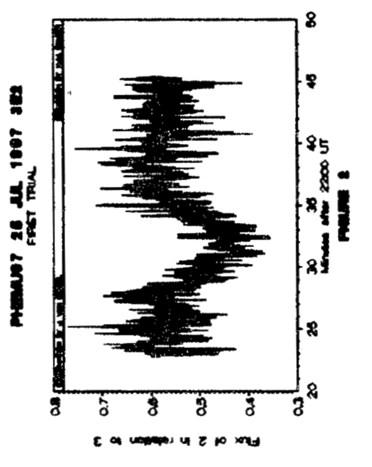
[2] "L'Observation Video des Phenomenes Mutuels", J-E.Arlot et. al. Note Technique PHEMU91 No.16, janvier 1991

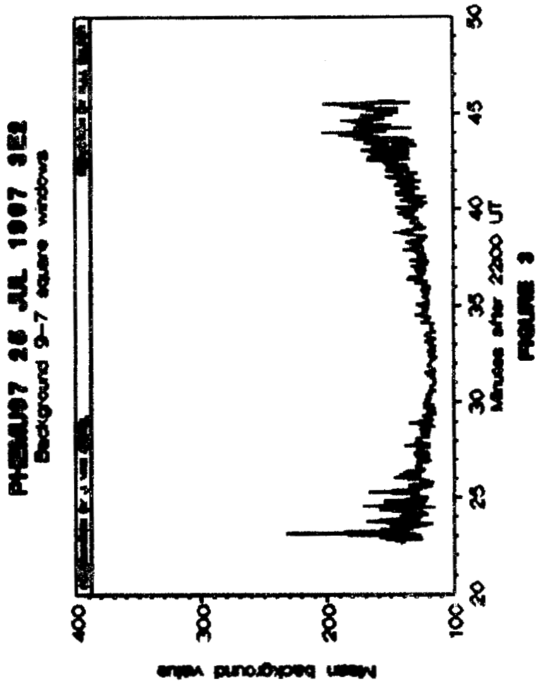
[3] "L'Observation des Phenomenes Mutuels avec une cible CCD", F. Colas, Note Technique PHEMU91 No.18, janvier 1991

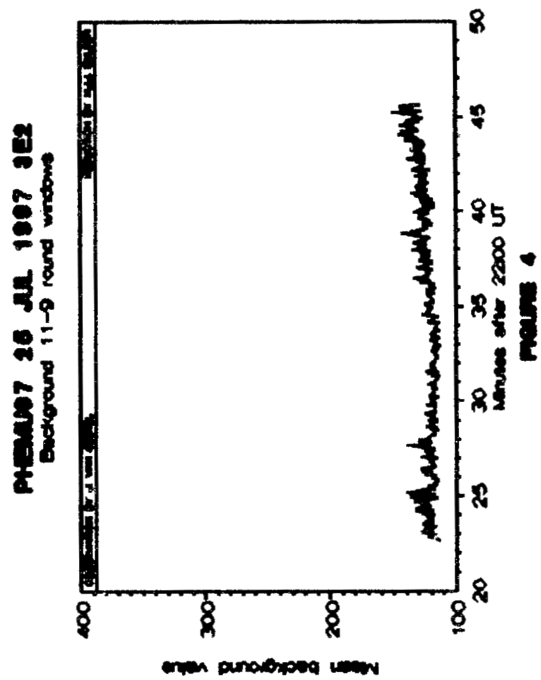
[4] "Experiences with Digital Data Reduction of Video Tapes", H. J. J. Bulder, Annales de Physique, Colloque C1, suppl. au no.1, vol.21, fevrier 1996

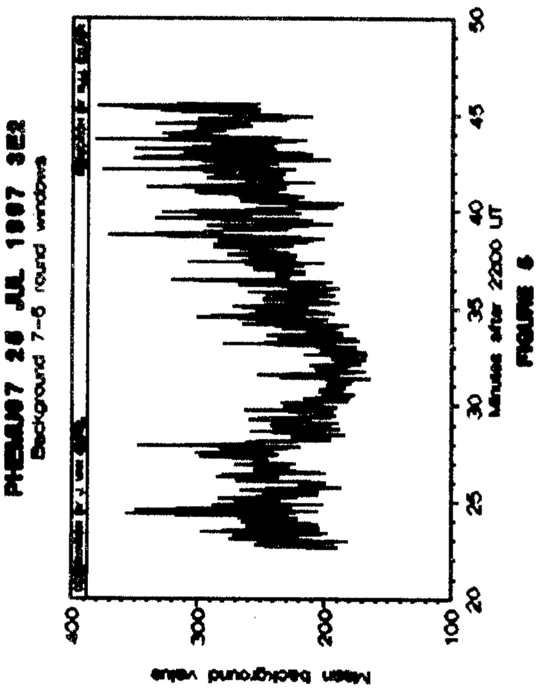
[5] "Deconvolution with Correct Sampling", P. Magain et. al., The Messenger, No. 88, June 1997

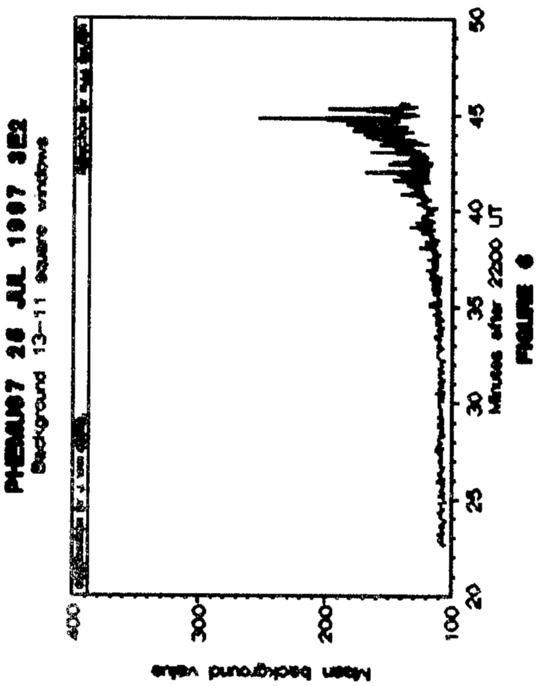


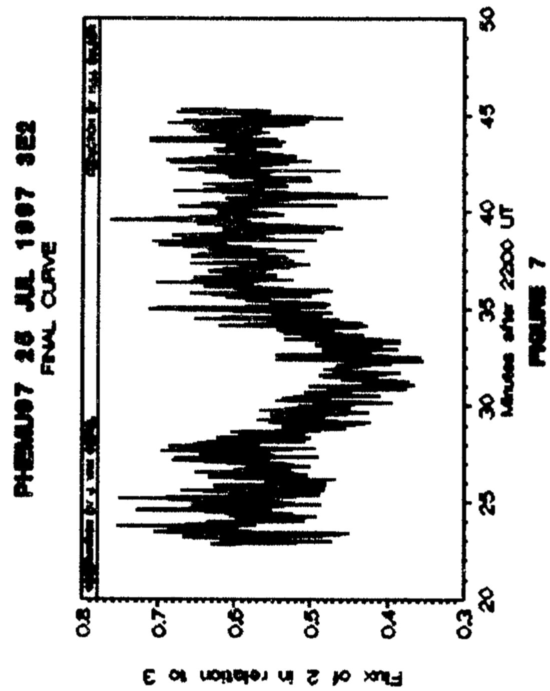


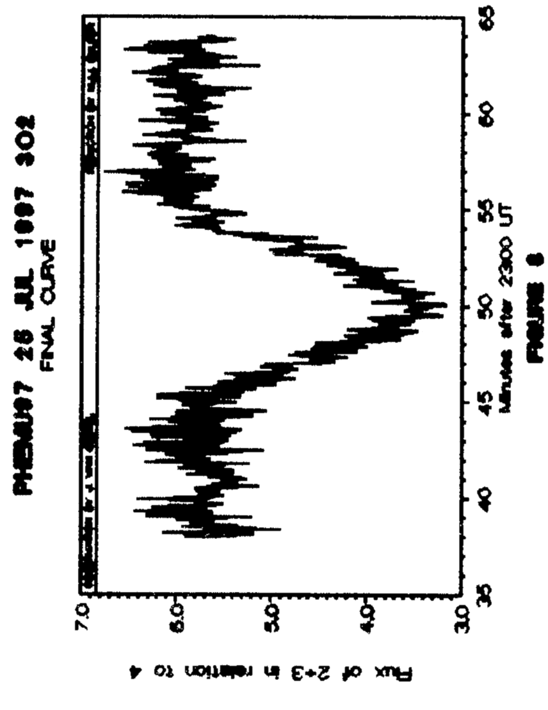





PHEMU97 28 JUL 1997 SE2
Background 7-6 round windows
Mean background value
Minutes after 2200 UT
FIGURE 5


PHEMU97 28 JUL 1997 SE2
Background 13-11 square windows
Mean background value
Minutes after 2200 UT
FIGURE 6


PHEMU97 28 JUL 1997 SE2
FINAL CURVE
Flux of 2 in relation to 3
Minutes after 2200 UT
FIGURE 7


PHEMU97 28 JUL 1997 SO2
FINAL CURVE
Flux of 2+3 in relation to 4
Minutes after 2300 UT
FIGURE 8

Discussion of Timing Accuracies from TV and Other Sources

From: Tom Harmon, Hartwood, VA, (email ko4ox@erols.com)

I have been playing with some interesting timing problems. In a close local area we have cable from two sources and satellite stuff from 3 sources, as well as over the air TV. I have measured between two houses a difference of over 1 second on identical CNN broadcasts. I have also measured almost 1/3 of a second variation in the WWV 10 MHZ broadcast. The number of up/down paths to get CNN to various locations is the major problem, but even if someone records CNN and WWV, the house next door may be totally different in total delays. My only reliable (?) time is coming from 60 kHz (WWVB) and/or averaging the daytime delays on HF WWV. I really wish there were an inexpensive radio for the 60 kHz time signals, it would sure make for more stable time reference. In a perfect world, we would all use portable cesium clocks. (I can dream, can't I?)

Another time error came from the distance from the WWV radio to the pick-up microphone and if more than 10 feet, that info should be recorded. Still another time error came from carrying a cam-corder around. When you make fast turns the gyroscope effect on the rotating head drum stretches or compresses time by forcing a tape speed change. This one is pretty small, but running around can generate +/- 40 milliseconds.

Tom Harmon

From: Joan and David Dunham
To: Rob Robinson; Dunham, David W.
Cc: DC Washington USNO Fiala, Alan; MA Cambridge MacRobert, A, S&T-SH; FL
Temple Ter. Campbell, Tom; MD Greenbelt Wayne Warren; ko4ox@erols.com
Subject: Re: FW: Timing from TV
Date: Tue, Mar 17, 1998 11:50PM

Rob,
At 05:44 PM 3/17/98 -0600, you wrote:
>> Another time error came from the distance from the WWV radio to
>> the pick-up microphone and if more then 10 feet, that info should be
>> recorded. Still another time error came from carrying a cam-corder
>
>Here again 10 feet? I don't think the lag could be measured except without sophisticated equipment. Over 100 feet
>maybe but not 10, or am I wrong?

The speed of sound is about 1,100 feet/second. For video timing, we prefer to keep "other" error sources well below the 0.03 second video time resolution. So if the "speed of sound" error is to be 0.01 second or less, then the distance from the WWV radio to the microphone should be 11 feet or less. A little more wouldn't hurt, but it would not be a good idea for this distance to be 30 ft. or 50 ft. (or if it is, then the sound delay must be applied to the timings).

David Dunham

From: Tom Campbell
To: Rob Robinson
Cc: Dunham, David W.; DC Washington USNO Fiala, Alan; MA Cambridge MacRobert, A, S&T-SH; MD Greenbelt Wayne Warren; Dunham, David & Joan, home
Subject: Re: FW: Timing from TV
Date: Wed, Mar 18, 1998 1:10AM

Hi Rob and all,
> I can understand, CNN having variances, in different localities, due to
> satellite feeds to cable providers, and the equipment that cable providers
> may be using, but I have NEVER heard of any variances in 10 MHz WWV,
> especially on the order of 1/3 of a second. This sounds more like a
> reaction time, rather than an actual measured variance.

I agree with Rob on this. I have done a lot of research on SW radio propagation. At 5, 10, and 15 MHZ of the WWV HF frequencies, you can have 1, 2, or 3 hops between the ionosphere and Earth and there will not be any significant change in time delay to the receiving station. The angle of incidence of each radio reflection is quite low and if you were to make a scale drawing of the curve of the Earth and the curve of the ionosphere, you can then clearly visualize that the angle of incidence of the radio signal is very low and the number of hops does not significantly change the distance the signal travels. The variances are often measured in microseconds and it takes a large number of these to add up to anything significant. Example: Video frame accuracy is 0.033 seconds or 33 milliseconds which is equal to 33,333 microseconds. Variations in SW radio wave propagation time delay are not nearly this large. A practical figure of radio propagation time delay is one millisecond for each 298 kilometers (185 statute miles) of great circle distance from the transmitter to the receiver. Information source: Beehler, Roger E. & Lombardi, Michael A. "NIST Special Publication 432, Time and Frequency Services". Washington, D.C.: U.S. Government Printing Office, 1991.

> > Another time error came from the distance from the WWV radio to
> > the pick-up microphone and if more then 10 feet, that info should be
> > recorded. Still another time error came from carrying a cam-corder
> Here again . . . 10 feet? I don't think the lag could be measured except
> without sophisticated equipment. Over 100 feet maybe but not 10, or am I wrong?

The speed of sound is 1,130 feet per second at sea level under conditions of standard temperature and atmospheric barometric pressure. Again variations are not all that significant as long as you are still able to breathe :-o) For video occultation timing work, figure 1.1 millisecond of time delay for each one foot of separation of the microphone to the SW radio speaker. If you simply figure one millisecond for each one foot of sound travel, you will still be ok when factoring this time delay into your final reduced video time, for all practical purposes.

As for me I always factor in both the SW radio propagation delay to my station plus the sound delay into my final reduced times. This combined time delay value is often less than the time of one video frame. But here is the way I
feel about that: If video timing accuracy is +/- one video frame, I prefer that accuracy to be symmetrically centered on my final reduced video time.

I do agree that cable TV may not be an accurate time reference for video unless the actual number of uplinks/downlinks are known for each of the cable TV providers. My rough estimate is that it takes 0.25 seconds for each up/down satellite time delay.

Tom Campbell ι

Remote Video Stations

Tom Campbell

[This article was compiled from two email messages.]

I bought a 12 foot video cable from Radio Shack with the RCA phono plugs on both ends. And bought a few RCA to BNC adapters to use wherever required. You will need a few shorter video cables to hook up everything. Of course if you are using an AC powered VCR recording machine, the 50 foot cable will keep the AC powered equipment and the associated radio interference from the power invertor further away from your station where it interferes less with WWV reception. The following is the technique I used to minimize RF interference caused by the power invertor.

1. I cutoff the cigarette lighter plug, shortened the 12 V cord on the invertor to 30 inches, attached small battery clamps (Radio Shack) to the ends of the shortened DC power cord.

2. I next attached a short (two feet or less) 12 gauge stranded and insulated ground wire (the heavier gauge wire the better) to the metal case of the power invertor. Used a wire lug under one of the screws on the metal case to make the connection. I then attached a clamp to the other end of the ground wire.

3. Place the power invertor inside the engine compartment, attach the ground to the car chassis, and connect the invertor to the car battery (I use black and red clamps to indicate correct polarity).

4. The 50 foot extension I plug into the invertor has about 10 turns wrapped through and around a square shaped ferrite iron core located close to the AC power plug.

The principle of this is as follows: These electronic switching type power invertors do create a broad spectrum of radio frequency interference (RFI) that can really degrade the quality of your WWV time signal. The shorter the 12 V cord is going into the unit, the less RFI radiated. A solid ground to the car chassis prevents the unit from electrically "floating" and prevents the case of the invertor itself from emitting RFI. The ferrite choke on the AC extension cord blocks most remaining RFI noise from propagating along the extension cord. When you lower the hood of the engine compartment with just enough space for the AC extension cord, the entire engine compartment serves as an RFI shield.

If you have to use an inverter to power a 110 V AC VCR, small TV, etc., it is better to have separate 12 volt batteries. If you attempt to use the same battery for the source of AC power and to power the CCD camera as well as anything else that is 12 V DC powered, you will not only have a serious RF noise problem that affects shortwave WWV reception, but also potential damage to the sensitive CCD camera electronics.

The latter meaning possible damage due to 60 Hz ripple riding on the 12 V DC in the form of voltage spikes as well as the RFI component of this ripple that can enter the microcircuits of the CCD camera. Also if the 12 V DC cord to the inverter is long and/or the inverter is not grounded, the ground of the AC cord will float with a small AC voltage potential at both 60 Hz and RFI noise spikes. The ground side, or chassis, of the AC powered equipment will also float. Then a situation is created where RFI noise will propagate along the AC cord, the case of a table top VCR or TV set, and along the outer shields of the coaxial cables. This poor ground plane RFI noise may be only a few millivolts down to a few microvolts, but keep in mind the signal strength of a good shortwave WWV time signal is only a few microvolts at best.

It is best to use a separate small 12 V DC battery such as a "Portapack" or a garden tractor battery for your 12 V DC powered field equipment.

Your automobile battery can be used to power the inverter that powers all of your AC powered equipment. It is also best to ground the inverter to the car chassis with a heavy gauge ground wire with a good connection. (Attach the ground clamp to an engine bolt, a fender bolt, or someplace that is not coated with paint). Put the inverter under the engine compartment hood close to the car battery with its 12 V input leads cut as short as possible but still able to attach to the battery terminals with medium sized spring clamps. The metal engine enclosure serves as a very good RFI shield containing most of the RFI when the hood is lowered with just enough opening to allow room for the extension cord. Use a long AC extension cord (fifty feet with a third ground wire) to bring the AC power to the equipment that uses it.

Automobile cigarette lighter receptacles are a convenient place to get 12 V DC, but that source of 12 volts is noisier than the hookup I described due to the longer DC path the current takes to reach the inverter. Keep in mind that an inverter works by chopping the 12 V DC current. It uses heavy duty switching transistors to chop up the input current. The source of the RFI noise is this switching (chopping) of the DC input current and the longer the wire is to the inverter, the more this wire becomes a "noise antenna". If you are in a location where the shortwave WWV time signal is strong (very good signal to noise ratio), you can get by with using the cigarette lighter receptacle. But when the WWV signal is weak, which it often can be, any locally produced RFI can and will literally drown out the WWV time signal.

I forgot to mention in my last message that I use an off the shelf AC surge protector/RFI suppression device (the type used to protect PC home computers) between the power inverter and my AC extension cord. Most 12 V DC to 110 V AC power invertors have some built in RFI noise suppression, but I have discovered from experience that this extra RFI noise suppression does help. I run a separate short heavy duty ground wire to my car chassis from this surge protector for better grounding of the extension cord's ground wire. I also strongly recommend that all the AC powered devices be the type that has a third wire (a ground) so these grounds all get connected to the third (ground) wire of the extension cord. If some or all of your AC powered devices have only 2 wire cords (a polarized plug), in this case, test the system for noise; it may be ok as is. If not, then a separate ground wire may have to be bonded to the chassis of the VCR, TV, etc. (a wire under a screw head) and connected to the ground wire of the extension cord.

Sources of radio frequency interference are difficult to explain, understand, and know how to minimize, with fewer words than I have written above. I retired early from a 32 year career as a certified senior engineering technician (electronics). If you invest your time in reading my messages about RFI noise suppression and actually invest a small amount of time and money for the simple hardware needed for this noise suppression technique, you will gain by having a higher quality WWV time signal on the video tape sound track.

A reasonably clean recorded time signal is better for the purpose of audio triggering the video time insertion device from a played back minute tone for making video time insertion dubbed copies. The latter makes it possible for us to obtain single video frame timing accuracy of an occultation event when the tape is advanced frame by frame and reading the video time display on the frame where the event occurred.

Feel free to email me if you have any questions about RFI noise suppression or if you currently have a noise problem and need help in finding a solution. I'll be happy to share my applied learned skills with you. ɩ

Your graze profile could have been here.

International Occultation Timing Association, Inc. (IOTA)

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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Observers from Europe and the British Isles should join IOTA/ES, sending a Eurocheck for DM 40,00 to the account IOTA/ES; Bartold-Knaust Strasse 8; D-30459 Hannover, Germany; Postgiro Hannover 555 829-303; bank-code-number (Bankleitzahl) 250 100 30. German members should give IOTA/ES an "authorization for collection" or "Einzugs-Ermaechtigung" to their bank account. Please contact the secretary for a blank form. Full membership in IOTA/ES includes the supplement for European observers (total and grazing occultations) and minor planet occultation data, including last-minute predictions, when available. The addresses for IOTA/ES are:

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IOTA on the World Wide Web

(IOTA maintains the following web sites for your information and rapid notification of events.)

IOTA Administrative Site
http://www.inlandnet.net/~iota

This site contains information about the organization known as IOTA and provides information about joining IOTA and IOTA/ES, topics related to the *Occultation Newsletter*, and information about the membership--including the membership directory.

IOTA Asteroidal and Planetary Occultations Site
http://www.anomalies.com/iota/splash.htm

This site contains information on asteroidal and planetary occultations and the latest information on upcoming events and how to report them.

IOTA Lunar Occultations and Eclipses Site
http://www.sky.net/~robinson/iotandx.htm

This site contains information on lunar occultations and eclipses and the latest information on upcoming events. It also includes information explaining what occultations are and how to report them.

IOTA's Telephone Network

The Occultation Information Line at 301-474-4945 is maintained by David and Joan Dunham. Messages may also be left at that number. When updates become available for asteroidal occultations in the central USA, the information can also be obtained from either 708-259-2376 (Chicago, IL) or 713-480-9878 (Houston, TX).