ISBN 978-2-87355-024-4

Proceedings of the International Meteor Conference
La Palma, Canary Islands, Spain
20–23 September, 2012

Published by the International Meteor Organization 2013
Edited by Marc Gyssens and Paul Roggemans

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Editing team and Organization

Publisher: The International Meteor Organization
Editors: Marc Gyssens and Paul Roggemans
Typesetting: LaTeX 2_ε (with styles from Imolate 2.4 by Chris Trayner)

Printed in Belgium

Legal address: International Meteor Organization, Mattheessensstraat 60, 2540 Hove, Belgium

Distribution

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Calculating video meteor positions in a narrow-angle field with AIP4Win software—Comparison with the positions obtained by SPOSH cameras in a wide-angle field

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We present an alternative way to calculate the positions of meteors captured in a narrow video field with a Watec camera and a 28 mm aspherical lens (FOV 11°) by using Astronomical Image Processing for Windows, V2, a classic astrometry and photometry software. We have calculated positions for two Perseid meteors in Lyra which were recorded in August 2010, at Mt. Parnon, Greece. We then compare our astrometry position results with the results obtained by SPOSH cameras (FOV 120°) for the same meteors.

1 Introduction

Video recordings of meteors have great advantages compared to the traditional photographic records. Excellent results are obtained with software especially developed for video meteor observing, such as MetRec and UFOCapture/Analyzer/Orbit. On the other hand, high-resolution double-station photographic data from cameras equipped with a rotating shutter for meteor velocity measurement can also be of excellent quality and lead to valid orbit calculations.

In general, orbit computations for meteors require an accurate value for the pre-atmospheric velocity of the meteor, taking into account the atmospheric deceleration due to drag and other forces. The Astronomical Image Processing for Windows software (Berry and Burnell, 2006) or AIP4Win for short, can very well handle astrometric calculations for source positions, but cannot produce heliocentric orbit calculations.

Figure 1 – The observing site and set-up.

Figure 2 – A SPOSH camera with a rotating shutter at Mt. Parnon.

2 The site and time of observations

Our observations were made at Mt. Parnon, Greece (altitude 1420 m), in August 2010, during the SPOSH campaign in Greece (Margonis, 2010a; 2010b). The SPOSH data were aquired at Mt. Mainalon Station by Anastasios Margonis (TUB) and at Mt. Parnon Station by Stephan Elgner. The distance between the SPOSH and the Watec cameras at Mt. Parnon observing station was 20 meters (Figures 1 and 2).

3 Method

The set-up for our observations included a Watec 902 H2-Ultimate video camera and a Nikon 28 mm $f/1.8$ DSLR lens on a field tripod (Figure 1). UFOCapture software was used for video capturing. A DCF-77 radio clock was used in order to synchronize the laptop computer clock with UT time.

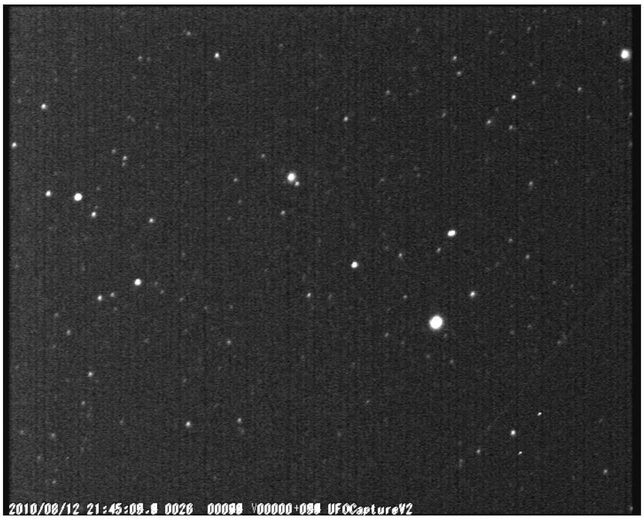

Figure 3 – Aiming at Lyra ($FOV \approx 11°$).

We were aiming at the constellation of Lyra (Figure 3), where we captured two meteors.

The first Perseid meteor was captured at 2010 August 12, $21^h45^m01^s$ UT (Meteor 1), and the second one at 2010 August 12, $22^h44^m36^s$ UT (Meteor 2).

First, we produced `.bmp` files for all the video frames using freeware software. By visual inspection of the `.bmp` files, we chose those with the best quality, in which the meteor trail was clear enough for astrometry calculations. We picked three frames for each meteor.

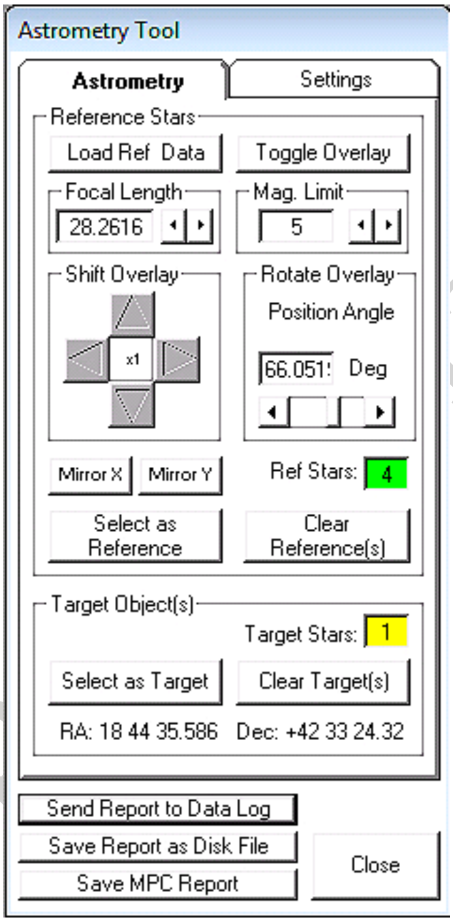

Figure 4 – The AIP astrometry tool.

Then we opened the `.bmp` files with the AIP4WIN software included in the *Handbook of Astronomical Image Processing* (Berry and Burnell, 2006) and initiated the astrometry processing operation (Figure 4). The images were astrometrically reduced using standard techniques, based on our previous experience from asteroid astrometry reductions (Tsamis, 2011). As a reference star catalog we used Guide Star Catalog 1.1, included in the MEGASTAR software. As reference stars for the astrometric calculations for Meteor 1, we used α, δ, ϵ, and ζ Lyrae. For the astrometric calculations for Meteor 2, we used α, γ, δ, and λ Lyrae (Figure 5).

4 AIP4Win astrometric results

The astrometry with AIP4WIN produced the results shown in Table 1).

Table 1 – Astrometry position results for Meteors 1 and 2.

Fr.	Time (UT)	α	δ
	Meteor 1		
1	$21^h45^m05^s.00 \pm 1^s$	$18^h31^m56^s.313$	$+41°37'50''.39$
2	$21^h45^m05^s.05 \pm 1^s$	$18^h30^m16^s.801$	$+40°35'32''.51$
3	$21^h45^m05^s.10 \pm 1^s$	$18^h27^m16^s.585$	$+39°36'17''.10$
	Meteor 2		
1	$22^h44^m36^s.40 \pm 1^s$	$19^h12^m44^s.757$	$+36°01'06''.86$
2	$22^h44^m36^s.45 \pm 1^s$	$19^h08^m27^s.064$	$+35°34'15''.47$
3	$22^h44^m36^s.50 \pm 1^s$	$19^h05^m52^s.255$	$+34°31'39''.95$

An example of the full astrometry report in the log file generated by AIP4WIN can be seen in Table 2.

5 The SPOSH data and analysis

The SPOSH camera is a flexible and sensitive system designed for imaging meteors not only from Earth observations but also from space probes orbiting the Earth or other planets (Christou et al., 2012). In Tables 3 and 4, we present the results of the SPOSH data analysis for Meteors 1 and 2, respectively.

6 Conclusions

We argue that the astrometric results for meteors derived in this way are of good quality since the value of the residuals in α and δ are not bad at all; in most of our observations; they are in the order of $18''$ (rms) and $40''$ (rms), respectively.

This level of astrometric precision could be the strong point in using a good-quality lens with a medium or narrow FOV and dedicated general astrometry software for meteor positions. In contrast, wide-angle lenses are more vulnerable to geometrical distortions, especially at the edges of the FOV. On the other hand, many more meteors can be captured with a wide FOV. Nev-

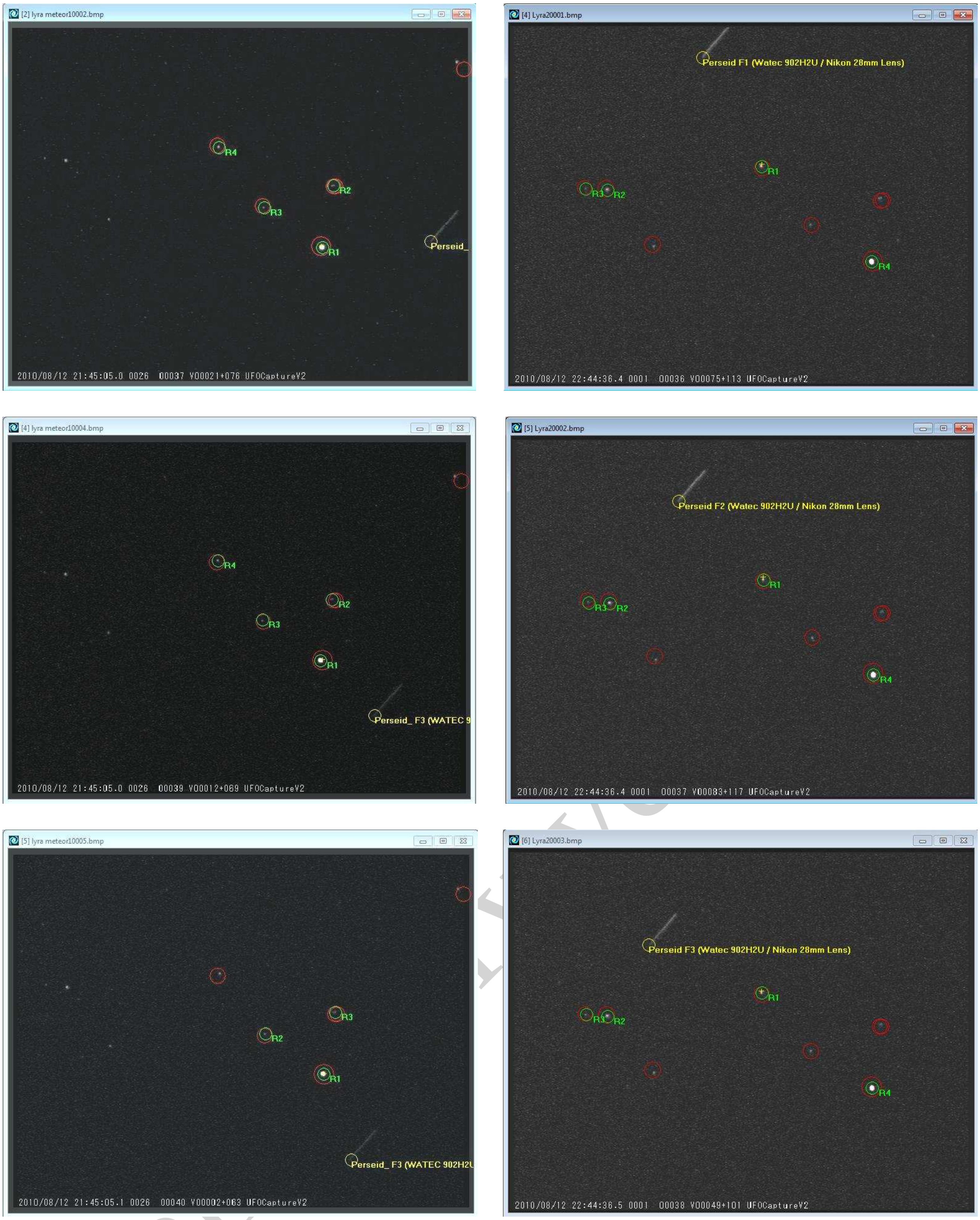

Figure 5 – Astrometry targets and reference stars for Meteors 1 and 2.

ertheless, the weak point in this approach is a time-consuming step-by-step analysis of the data and the lack of automated astrometry and orbit calculation procedures, which can be found in modern video meteor recording and analysis software, like MetRec.

7 Acknowledgements

We would like to thank the IMO Council and Ellinogermaniki Agogi School for their financial support to one of us (V.T.) for his participation at the 2012 IMC.

Table 2 – A full astrometry report for Meteor 2 (frame 2) in AIP4Win.

```
Astronomical Image Processing Astrometry Tool

Target object(s): Perseid F2 (Watec 902H2U / Nikon 28mm Lens)
   REFERENCE STARS
     MegaStar
     Coordinates direct from the catalog.
     Coordinate epoch: 2000.0
Ref      RAS          DEC      Mcat   |     X       Y    Mpho  RArms  DErms
#   hh mm ss.sss +dd mm ss.ss         |  pixels  pixels        arcsec arcsec
R1  18 54 34.401 +36 59 47.94 09.60   |  390.402 225.492 15.98 +0.833 -1.874
R2  18 58 56.538 +32 41 22.53 03.20   |  151.229 263.050 15.86 -13.020 +29.272
R3  19 00 00.746 +32 08 44.08 04.90   |  118.069 262.253 17.50 +11.736 -26.385
R4  18 36 56.335 +38 47 01.54 00.10   |  561.696 378.696 14.18 +0.451 -1.013

TARGET OBJECT(S)
Target name      X       Y    Mpho    |       RAS          DEC      Mag
or number     pixels  pixels          |  hh mm ss.sss +dd mm ss.ss
Perseid F2 (W 258.082 098.052 16.55   |  19 08 27.064 +35 34 15.47 08.09

ASTROMETRIC SOLUTION
 Top left pixel:   (0, 0)
 Plate center X:   360.00 [pixels]
 Plate center Y:   288.00 [pixels]
 PA of +Y axis:    66.05 [degrees]
 Plate center RA:  18 50 47.834
 Plate center DEC: +36 03 20.17
 Focal length:     28.2616
 Residual in RA:    017.555 [arcsec rms]
 Residual in DEC:  039.466 [arcsec rms]
```

Table 3 – SPOSH Meteor details and orbital data for Meteor 1.

```
Calculated Orbit from Images 20100812_214505_dma.fits 20100812_214504_dpa.fits
UTC Date and Time (yyyy-mm-dd hh:mm:ss): 2010-08-12 21:45:05

TRAJECTORY
--------------------------------------------
Starting Height: 113.59
Ending Height: 105.25
Length of Trail: 17.32
Angle of Incidence: 26.56
Convergence Angle: 25.46

   RADIANT
--------------------------------------------
Apparent Radiant:
RA    =        47.647635 deg +-0.19583109
dec   =        57.268799 deg +-0.094911612
Observed Velocity:
v_app =        58.123676 km/s +-1.5805512
Pre-atmospheric velocity:
v_inf =       59.1929 km/sec +-0.19583109

Geocentric Radiant:
RA    =        48.671684 deg +-0.19719608
dec   =        56.962650 deg +-0.094108231
Geocentric Velocity: v_geo =  58.151761 km/s +-1.5852129
Heliocentric Velocity: v_hel = 39.920265 km/s +-1.5275707

   ORBIT
--------------------------------------------
Orbital Elements:
rp    =       0.94003691 AU +-0.00080288637
a     =        5.5714227 AU +-0.0015375618
ecc   =       0.83127525 deg +-0.42024737
inc   =        113.90662 deg +-0.22402975
lnode =        139.92513 deg +-1.4208847e-05
argp  =        147.21609 deg +-0.12390715
```

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Table 4 – SPOSH Meteor details and orbital data for Meteor 2.

```
Calculated Orbit from Images 20100812_224436_dma.fits 20100812_224435_dpa.fits
UTC Date and Time (yyyy-mm-dd hh:mm:ss): 2010-08-12 22:44:36

TRAJECTORY
--------------------------------------------
Starting Height: 113.43
Ending Height: 105.19
Length of Trail: 15.72
Angle of Incidence: 28.69
Convergence Angle: 24.97

   RADIANT
--------------------------------------------
Apparent Radiant:
RA    =        44.979950 deg +-0.15496794
dec   =        57.604688 deg +-0.10161045
Observed Velocity:
v_app =        50.833219 km/s +-0.49704262
Pre-atmospheric velocity:
v_inf =       52.0524 km/sec +-0.15496794

Geocentric Radiant:
RA    =        46.215676 deg +-0.16011865
dec   =        57.413607 deg +-0.10049634
Geocentric Velocity: v_geo =  50.865322 km/s +-0.50305840
Heliocentric Velocity: v_hel = 33.867090 km/s +-0.42591191

   ORBIT
--------------------------------------------
Orbital Elements:
rp    =       0.91031035 AU +-0.0024535446
a     =        1.4647434 AU +-0.012791021
ecc   =       0.37851888 deg +-0.044400544
inc   =        107.19981 deg +-0.34803444
lnode =        139.96576 deg +-1.7973713e-05
argp  =        129.04064 deg +-0.36552227
```

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