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Geoscientific Instrumentation Methods and Data Systems Discussions

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Interactive Comment

Interactive comment on "A double-station meteor camera setup in the Canary Islands – CILBO" *by* D. Koschny et al.

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Detailed reply to referee #02 comments to the paper "A double-station meteor camera setup...'

1. First paragraph of referee comments, sentence "... quantitative results, such as a a table giving observed orbital parameters...'

==> We have added Table 4 listing the orbits of 51 Geminids. We give the mean and standard deviation of all orbital parameters and compare to Toth et al. and SonotaCo data. Added text "Table 4 shows the individual orbits and mean values, compared to other values found in the literature. It can be seen that the system produces results as

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expected." at the end of the paragraph "Using the double-station data..."

2. Second to fifth paragraph - "... A late-peaked light curve... oversimplify the situation." and "Instead, quantifying the F-parameter... would be more appropriate".

===> We have reworked a number of sections in the paper to follow the referees suggestions.

(a) Section 5, paragraph starting with "Plotting the light curve..." - added the following text to explain how the light curve was measured: "To obtain the F-factor, we use the sum images showing the complete meteor. The position of the meteor in the image is known from the *.inf file recorded by the detection software. A semi-automated software cuts out a 10 pixel wide stripe around the meteor image. After subtraction of a background area around the meteor, the pixel values perpendicular to the direction of flight are summed up. The beginning and end point of the meteor are defined as those positions where the meteor flux is 25 % of the peak flux. The software presents the results graphically to a user who has to visually inspect the correctness of the result and accept it."

(b) We exchanged Figure 10 with two histogram plots showing the distribution of the F-factor.

(c) We found only one paper with F-factors of the Geminids, Koten et al. 2004 (also mentioned by the referee). We compare our values with those of Koten in the text: "In Figure 10 we plot a histogram showing the distribution of the F-factor for all Geminids and all sporadic meteors observed during the three nights of 13 - 15 Dec 2011. We find a mean value for the Geminids of 0.53 ± 0.14, which is consistent with e.g. Koten et al. 2004, who find a value of 0.58 ± 0.02. A more detailed interpretation of the obtained F-factor is beyond the scope of this paper."

3. 6th paragraph of referee comments, "... add more details to the system...":

==> In the section 'Figure 2 shows a photograph...' we added at the end: "The lens

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images the sky onto the entrance aperture of a second-generation image intensifier (DEP XX-1700). The intensifier has a spectral responsivity from about 350 to 850 nm. It is fibre-coupled to a CCD, which is read out via a Toshiba Teli CS8310Bi PAL video camera. The PAL format has 576 x 768 pixel2; 25 full frames are read out per second with 8 bit dynamical accuracy. With the given field of view the pixel scale is 2.3'.". We updated the given field of view to the precise values of 22 x 28 deg2." I.e. we added the requested spectral sensitivity, the pixel scale and the dynamical range.

4. 7th paragraph of referee comments, '... MetRec software gives an estimate of the magnitude...'

==> We updated a paragraph in Section 2.4: "With the pointing information and the time of a meteor event, MetRec will generate position measurements of each detected event in right ascension and declination. The given position is the photometric centre of the meteor in each single frame where the meteor was detected. MetRec automatically estimates the magnitude of the meteor in each individual frame. The way this is determined is that the sum of the pixel values in a given aperture is compared to the pixel values of the reference stars marked with the previously mentioned tool 'RefStars'. While a color correction is performed, MetRec does not properly handle changes in image brightness towards the corner of the images. The magnitudes are therefore not extremely accurate; we expect the typical error bars for bright events to be ± 1 mag."

We also added text to the section explaining how the pointing direction is determined: "The cameras point in a fixed direction in azimuth and elevation. Using the tool 'RefStars' from the MetRec software suite, we have determined the pointing position of the cameras to sub-pixel accuracy. This is done by manually matching stars in the field of view with reference stars on a star map. From the matches and the time of the image used, RefStars computes the necessary pointing information for the camera. If the camera position is fixed, this needs to be done once. Due to very small changes in the mounting, this process needs to be repeated typically every few months. The

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transformation from pixels to celestial coordinates is done by a 3-rd order polynomial fit. Typically 50-100 stars are used for the fit, using 2 to 3 reference images, resulting in root-mean-square residuals of typically below 1'."

Concerning the determination of the light curve: see comment 1 (a).

Concerning the flux computation: We added a section "The *.flx files store information on the computed meteoroid flux for a given stream. This is a functionality of the MetRec software: Every minute the grabbed image is analysed for the number and brightness of the stars in the field of view. From that an estimate of the limiting magnitude is continuously produced. The viewing geometry in space is computed from the pointing direction of the camera. Assuming typical values of the magnitude distribution for shower meteors, the flux of the particles in km-2s-1 is computed. The data is uploaded regularly to the beta-version of the MetRec FluxViewer at http://vmo.estec.esa.int/flx."

The ambiguous sentence "However, the produced flux information..." has been deleted, it is misleading.

Detailed comments by referee:

Abstract

- The first three sentences were deleted. They were not re-introduced in the introduction section as it wasn't clear to us where we should put them.

- Updated the second sentence to "Image-intensified video cameras one camera on Tenerife, one on La Palma, monitor the same volume of the atmosphere. They are located in automated roll-off roofs" (mentioning image-intensifiers).

- We added the parentheses in 'For bright meteors (typically 0 mag or brighter), ...'

Section 1

- Thanks for the positive comment!

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- In sentence "The light can be recorded..." replaced 'means' with 'cameras'.

- "the" was removed from '... allows observation by radar systems'.

- For the reference about the 'global meteoroid complex' we added Baggaley et al. 1994 and Campbell-Brown + Jones 2006.

Section 2.1

- 'was supposed to fulfil' has been replaced with 'must fulfil'

- A scale bar was added to Figure 1.

Section 2.2

- repeat of 'camera' was fixed.

Section 2.3

- replaced 'a second camera...' with 'spectral camera'

Section 2.4

- The section was restructured - we kept the short paragraph summarizing the complete operations, then, as suggested, comes the text "The following paragraphs describe... in more detail." We moved the paragraph on how the roof and the cameras are controlled to later.

- 'MetRec is reading the real-time...' was updated to 'MetRec reads the real-time..."

- 'Signal-to-Noise' was changed to 'signal-to-noise'

- False detections when sky is bright - indeed we operate the camera until the Moon is 40 deg (configurable) distance from the center of the field of view. We added test in Section 2.4 to explain: "The scheduler computes the distance of the field of view of the main camera to the center of the field of view as a function of time. To avoid damaging the intensifier, the system is switched off when the Moon gets closer than

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40° (configurable) to the center of the field of view. The spectral camera points more to the North compared to the zero-order camera, so it is always safe."

- Comment by referee 'Describe how the camera pointing position is found...'. We have updated the paragraph starting with 'The cameras point in a fixed direction...' to read like this: "The cameras point in a fixed direction in azimuth and elevation. Using the tool 'RefStars' from the MetRec software suite, we have determined the pointing position of the cameras to sub-pixel accuracy. This is done by manually matching stars in the field of view with reference stars on a star map. From the matches and the time of the image used, RefStars computes the necessary pointing information for the camera. If the camera position is fixed, this needs to be done once. Due to very small changes in the mounting, this process needs to be repeated typically every few months. The transformation from pixels to celestial coordinates is done by a 3-rd order polynomial fit. Typically 50-100 stars are used for the fit, using 2 to 3 reference images, resulting in root-mean-square residuals of typically below 1'."

- 'On Tenerife, a second camera...' - this sentence was omitted.

- Thanks for the positive comment on the serial port interface.

- 'Sky temperature' indeed is the temperature of the sky, not the wind temperature. We added '...measured via an infrared thermopile sensor' after the mentioning of the sky temperature to make it clearer.

- 'In the morning, the control software shuts down the system...' replaces '.. will start shutting down...'

- '...allows the trained user to judge whether the system functioned correctly that night' now replaces '... whether everything went ok.'

- Comment to part (b): we added 'which switches the cameras and the image intensifiers on and off ' behind the NuDAM controller.

Section 3 . - We replaced '... for each meteor ...' with 'For each frame where a meteor

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was detected ... is measured and stored' to make it clear that one measurement per frame exists.

Section 4

- Clarification of number of meteors - we have updated these numbers as a repeated detailed analysis showed that our initial estimate was too conservative. We record between 60 and 130 meteors per night, with 800 - 3000 per month.

- Updated sentence 'To give a first impression of the results this setup is capable of producing, we have analysed ...' (replaced 'science' with 'results' and 'is capable to produce' with 'is capable of producing'.

- The reference to the Fleming et al. 1993 paper was added. We also refer to Beech and Murray 2003 now.

- The orbital parameters of the analyzed Geminids are now given in Table 5, with comparison to other literature values (Toth et al. 2011). We kept the 3-D visualisation.

- We completely revised the section on the F-factor, changing the message to just presenting the values and comparing them to other papers rather than drawing conclusions. We have replaced the scatterplot of the F-factor with two histograms showing the distribution for Geminids and sporadics. We give the average and error bars and compare to literature.

Section 5

- 'The system has been operational for about two years now' replaces 'one year'

- '...first scientific results...' was replaced with '...some preliminary results...'

- rephrased (a) to 'The reliability of the setup could still be improved. Normally the system is working well, but there are times where the opening and/or closing of the roof does not happen within the expected time, leading to errors...'

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- 'relieving strain...' was implemented.

- Before the 'lessons learnt' we added a summary of the scientific results:

"To illustrate the capabilities of the setup, we analysed three nights of observations from 13-15 Dec 2011 during the Geminid meteor stream. We have obtained 51 Geminid orbits and the orbital parameters are consistent with other literature (Toth et al. 2011). From the light curve, we measured the F-factor (Fleming et al. 1993) to be 0.53$\pm$0.14, consistent with e.g. Koten et al. 2004, who find a value of 0.58$\pm$0.02."

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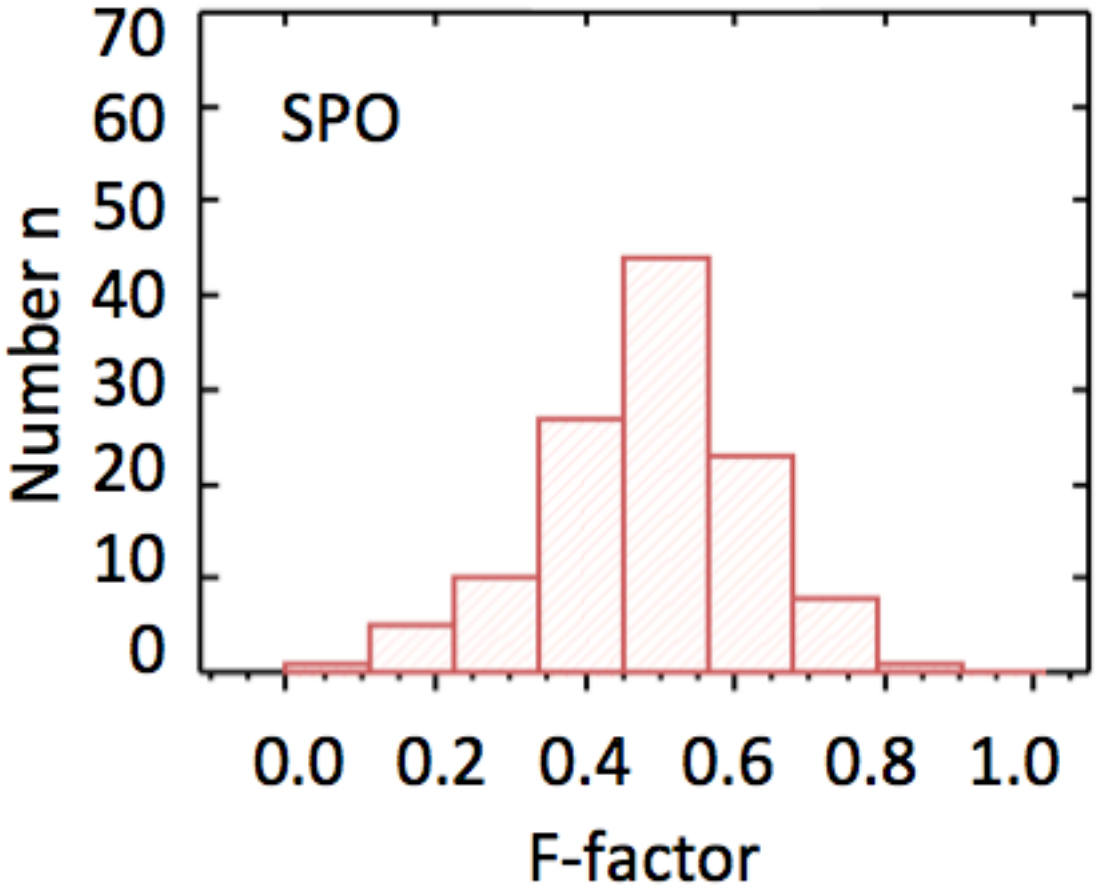

Fig. 1.

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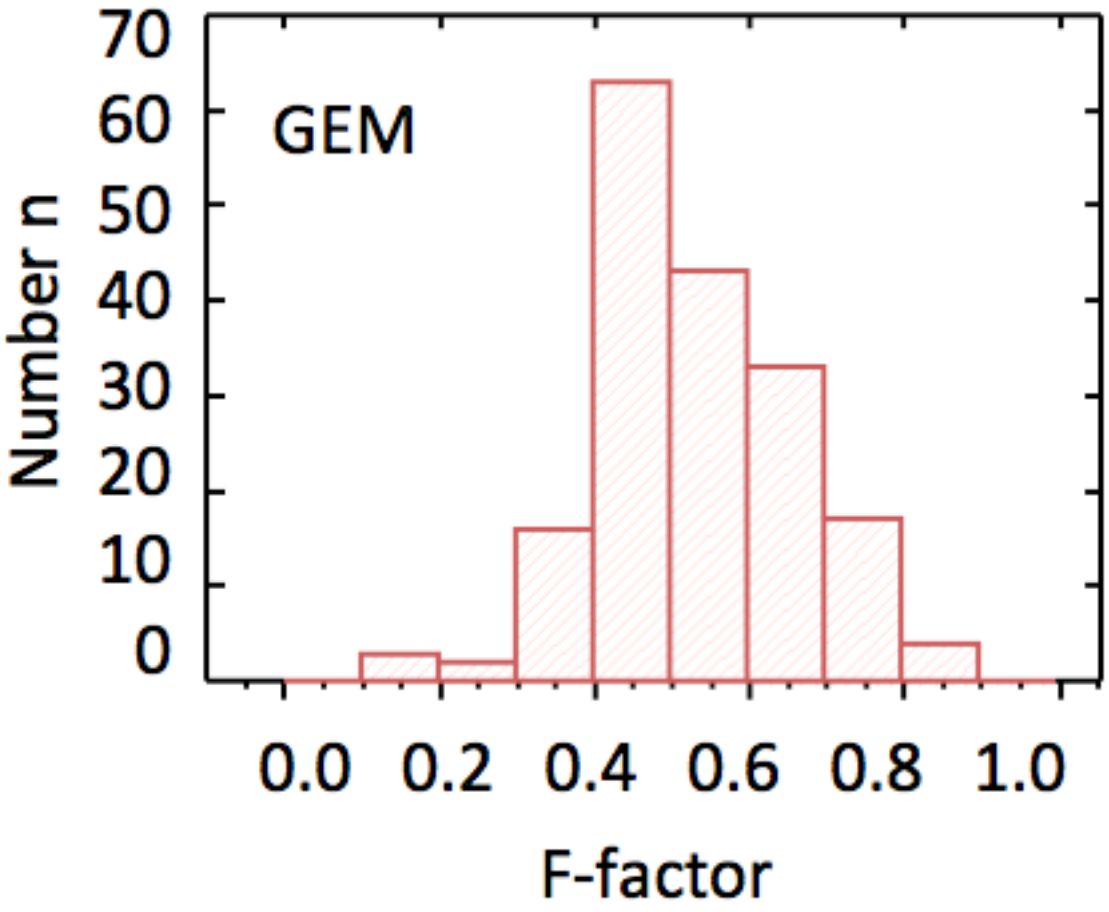

Fig. 2.

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