# CCD Observations of Meteor Showers

**Mariusz Wiśniewski**

Warsaw University Observatory,
Al. Ujazdowskie 4, 00-478 Warszawa, Poland
mwisniew@astrouw.edu.pl

**Abstract**

The preliminary results of using a CCD camera for meteor observations are described. The data were collected during 21 nights between April 22 and August 13 at Ostrowik Station of the Warsaw University Observatory. During the first 17 nights we used the Cousins *I* filter. During these nights we captured 31 meteors. Observations made during four nights near the Perseid maximum were performed with the rotating shutter and without any filter. During these nights we captured 17 meteors.

## 1 Introduction

The instrument and CCD camera which were used for meteor observations were part of my Master's Thesis. The main aim of this work is the construction of a small instrument called the *MicroTelescope (MiT)* which can be used for continuous monitoring all stars visible to the naked eye. This kind of instrument could be also useful for meteor observations because has very wide field of view and good limiting magnitude.

The data described in this report were collected during 21 nights between April 22 and August 13 at Ostrowik Station of the Warsaw University Observatory. We are still working on obtaining good photometry of stars on very wide field of view pictures.

Figure 1: *The MicroTelescope (MiT): CCD Camera, 4.5 mm lens and I filter.*

# 2 MicroTelescope (MiT)

The project is called the *MicroTelescope (MiT)* because the instrument is the smallest usable telescope in astronomy, even smaller than the CCD camera itself. This is unique nowadays, when gigantic telescope mirrors several meters across are built.

The lens we used comes from a CCTV camera. This type of lens has a very short focal length and is very fast. The *MiT* lens is for cameras with CCD chips no bigger than 1/2″ (12.5mm) and has a focal length of $f = 4.5$ mm and $f/1.4$.

The camera connected to this telescope (but more accurate is to say that telescope is connected to the camera) is the cheapest product of Santa Barbara Instrument Group: model *SBIG ST237A*. The CCD chip has a size of $657 \times 493$ pixels. It was sponsored by Princeton University.

The *MiT* telescope, shown in Figure 1, has a $60° \times 40°$ field of view and is controlled under Linux by a C program written by the author. Each frame is a 653kB `FITS` format image.

During observations, we mounted a Cousins $I$ filter in front of the lens. $I$ means infrared, from one of the most popular photometric systems in astronomy ($U$, $B$, $V$, $R$, $I$). Near the maximum of the Perseid shower we decided to mount the instrument under the rotating shutter and take off the filter.

# 3 Observations

## 3.1 Observations with the $I$ filter

Table 1: *Observations with the $I$ filter.*

| year | month | day | number of frames | $T_{eff}$ [h] | number of meteors |
|---|---|---|---|---|---|
| 2002 | 04 | 22/23 | 272 | 3.40 | 1 |
| 2002 | 05 | 01/02 | 229 | 2.87 | 0 |
| 2002 | 05 | 02/03 | 333 | 4.17 | 2 |
| 2002 | 05 | 03/04 | 386 | 4.83 | 2 |
| 2002 | 05 | 07/08 | 68 | 0.85 | 0 |
| 2002 | 05 | 12/13 | 383 | 4.79 | 0 |
| 2002 | 06 | 05/06 | 234 | 2.93 | 1 |
| 2002 | 06 | 12/13 | 98 | 1.23 | 0 |
| 2002 | 07 | 05/06 | 114 | 1.43 | 0 |
| 2002 | 07 | 12/13 | 135 | 1.69 | 0 |
| 2002 | 07 | 13/14 | 282 | 3.53 | 0 |
| 2002 | 08 | 01/02 | 353 | 4.42 | 2 |
| 2002 | 08 | 03/04 | 169 | 2.11 | 4 |
| 2002 | 08 | 04/05 | 293 | 3.66 | 5 |
| 2002 | 08 | 06/07 | 32 | 0.40 | 3 |
| 2002 | 08 | 07/08 | 345 | 4.31 | 7 |
| 2002 | 08 | 08/09 | 264 | 3.30 | 4 |
| Total | | 17 | 3990 | 49.92 | 31 |

From April 22 to August 8 we made observations during 17 nights. Detailed information about these observations is shown in Table 1. The *MiT* collected a total of 3990 frames during

49.92 hours of effective observation time. The CCD readout time of the *SBIG ST237A* is 10 seconds. In accordance with Murphy's laws, the majority of bright meteors occurred during this "dead time", which was very frustrating during the Perseid maximum.

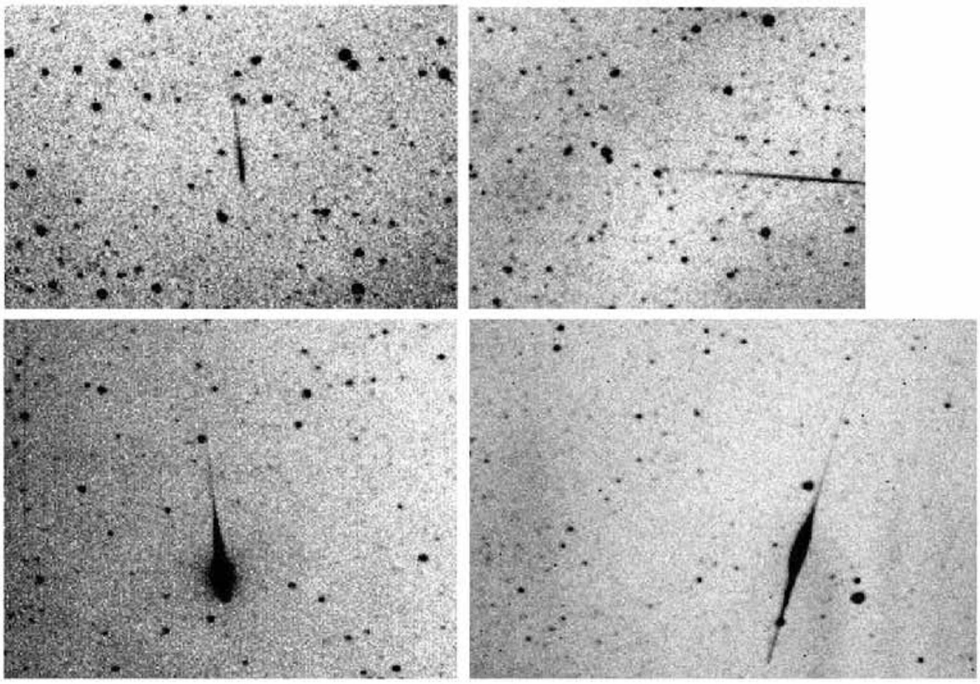

Figure 2: *Meteors: 1) 2002 Aug. 02 at 22:12:03 UT; 2) 2002 Aug. 05 at 23:49:20 UT; 3) 2002 Aug. 02 at 02:09:52 UT and Iridium on 2002 Aug. 03 at 19:33:52 UT.*

The true number of captured meteors could be even higher due to the fact that during the observations without a rotating shutter it is difficult to distinguish meteors from satellites or planes. Only when the trail is visible on two consecutive frames we can be sure that it is a satellite. Sometimes trails only look like meteors. For example the fourth picture in Figure 2 is an Iridium flare because is ideally symmetrical and has a visible trail long before (or after) the flash. Clouds on figures are visible as black shadows.

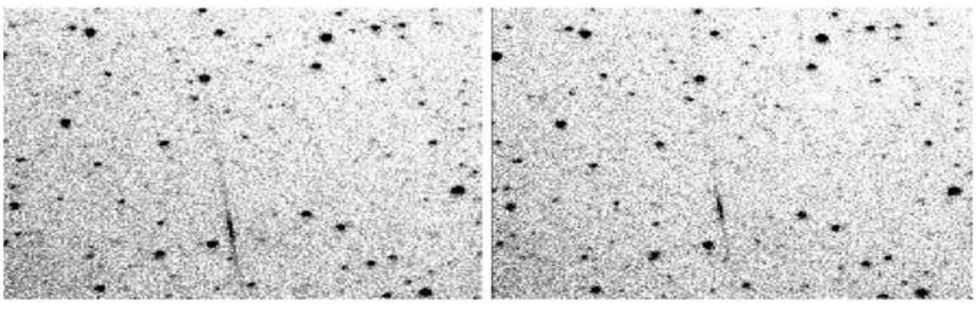

Figure 3: *Meteor with trail 2002 August 04 at 23:51:18 and 23:52:13 UT.*

One of the strangest objects was collected on 2002 August 4. In Figure 3 it is shown in two consecutive frames taken at 23:51:18 and 23:52:13 UT. The trail is clearly visible in both frames. Is almost impossible that two satellites flew exactly along the same track, no more than one minute one after another. Thus we suppose that this was meteor with a bright, at least half minute trail.

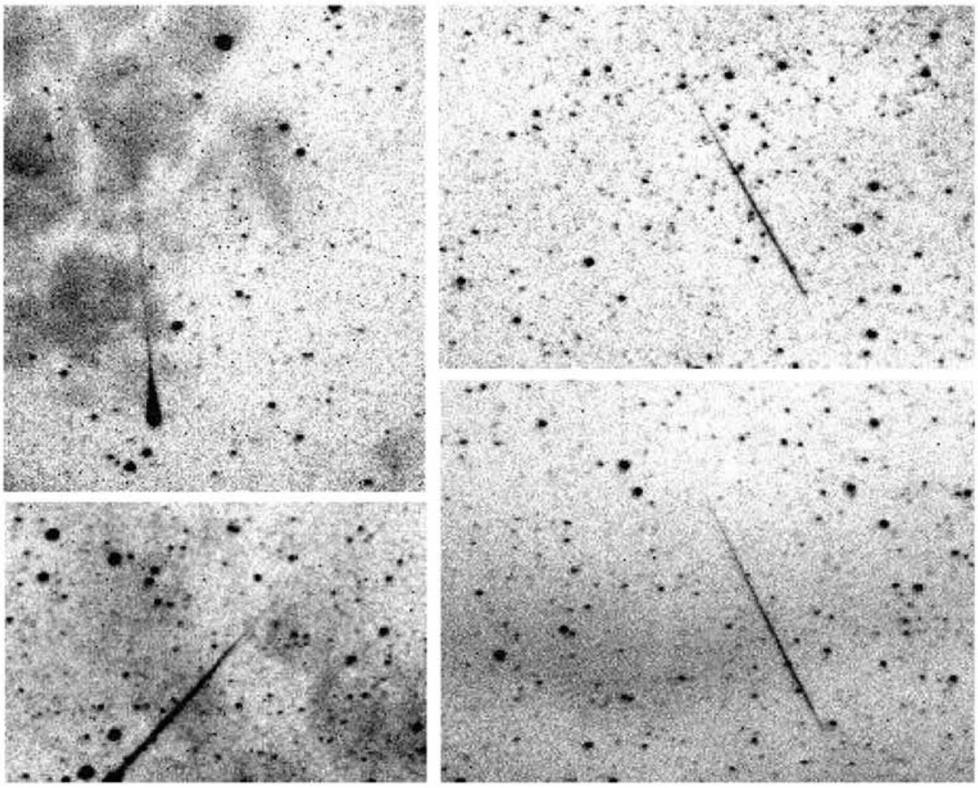

Figure 4: *The meteors: 1) 2002 Aug. 06 at 23:48:35 UT; 2) 2002 Aug. 07 at 22:53:02 UT; 3) 2002 Aug. 07 at 21:13:32 UT; 4) 2002 Aug. 07 at 22:48:27 UT.*

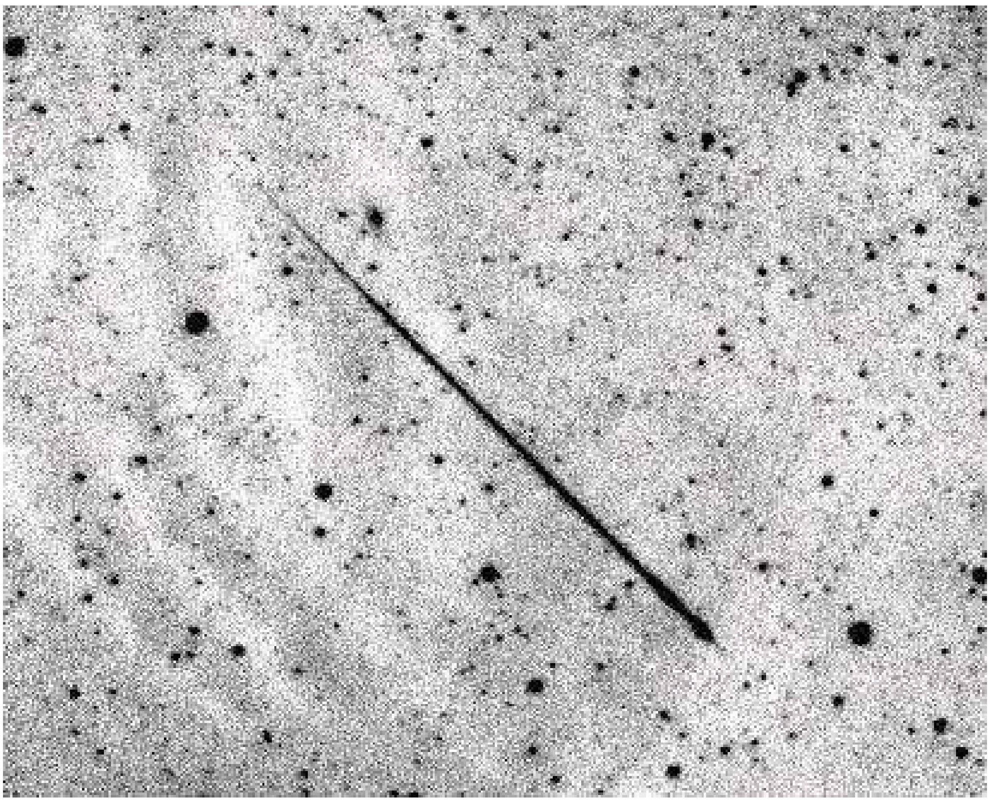

Figure 5: *The meteor occurred on 2002 Aug. 09 at 00:34:16 UT.*

The majority of meteors were captured in August during the Astronomical Camp of the *Comets and Meteors Workshop (CMW)*; for more details see (Trofimowicz, 2003). Almost all of them were Perseids but sometimes we also captured sporadics, like the third meteor in Figure 4. The first meteor in Figure 6 was captured in quite a bright sky when none of observers could start visual observations. This proves the power of CCD observations!

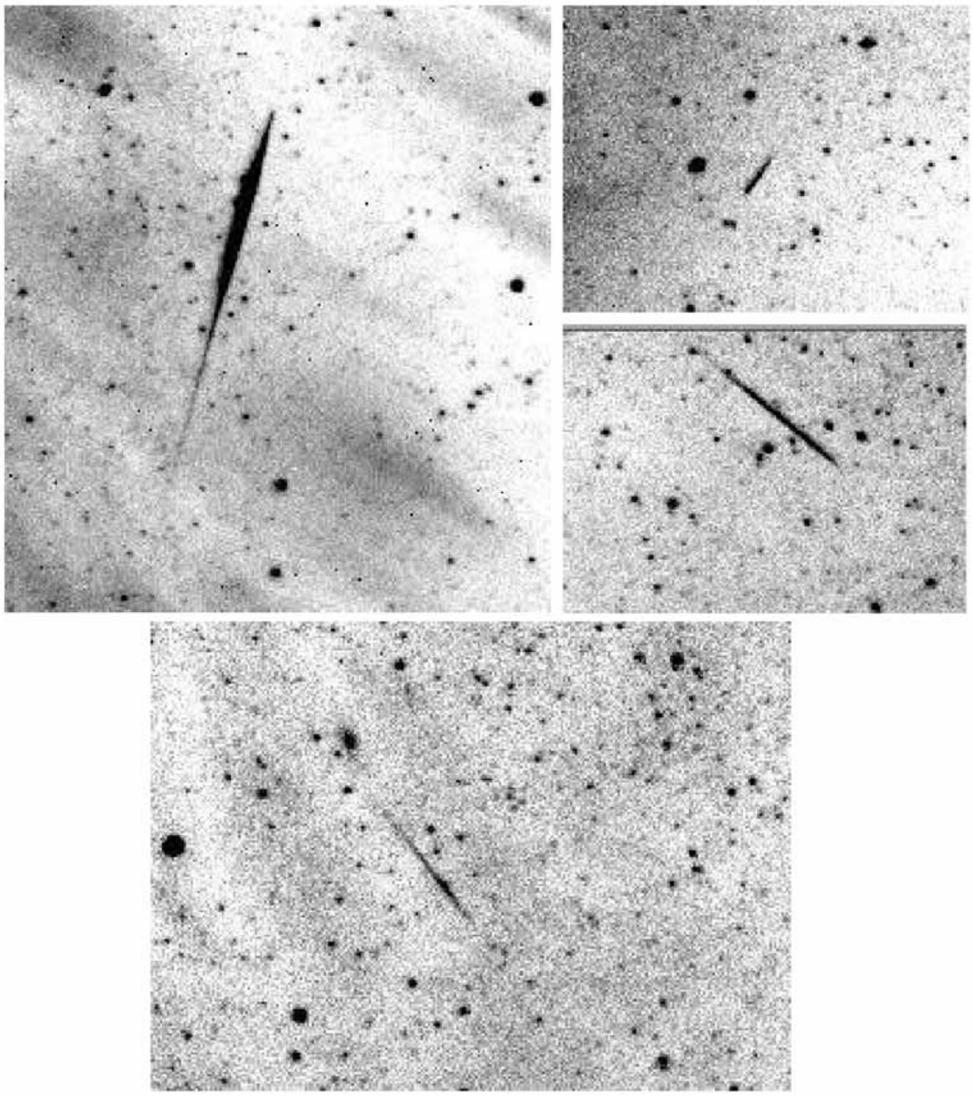

Figure 6: *Meteors: 1) 2002 Aug. 08 at 19:37:02 UT; 2) 2002 Aug. 09 at 00:09:30 UT; 3) 2002 Aug. 08 at 01:29:16 UT; 4) 2002 Aug. 09 at 00:36:06 UT.*

## 3.2 Observations with shutter

Infrared filters absorb a significant fraction of light and so are not good for meteor observation (though necessary for monitoring the stars). Near the Perseid shower maximum we decided that meteor observation during this night could give more valuable astronomical data than stellar photometry. We removed the filter and put the telescope under the photographic station build by Andrzej Skoczewski and Piotr Kędzierski (Figure 7). The rotating shutter improves the contrast of the frames because it reduces the light from the stars.

Table 2: *Observations with the shutter.*

| year | month | day | number of frames | $T_{eff}$ [h] | number of meteors |
|---|---|---|---|---|---|
| 2002 | 08 | 10/11 | 264 | 3.67 | 2 |
| 2002 | 08 | 11/12 | 264 | 3.67 | 6 |
| 2002 | 08 | 12/13 | 372 | 5.17 | 8 |
| 2002 | 08 | 13/14 | 67 | 0.93 | 1 |
| Total | | 4 | 967 | 13.44 | 17 |

From August 10 to 13 we made observations on all nights. Detailed information about these observations is shown in Table 2. The *MiT* collected a total of 967 frames during 13.44 hours of effective time and captured 17 meteors. We were fortunate because during the maximum the sky was clear above Ostrowik.

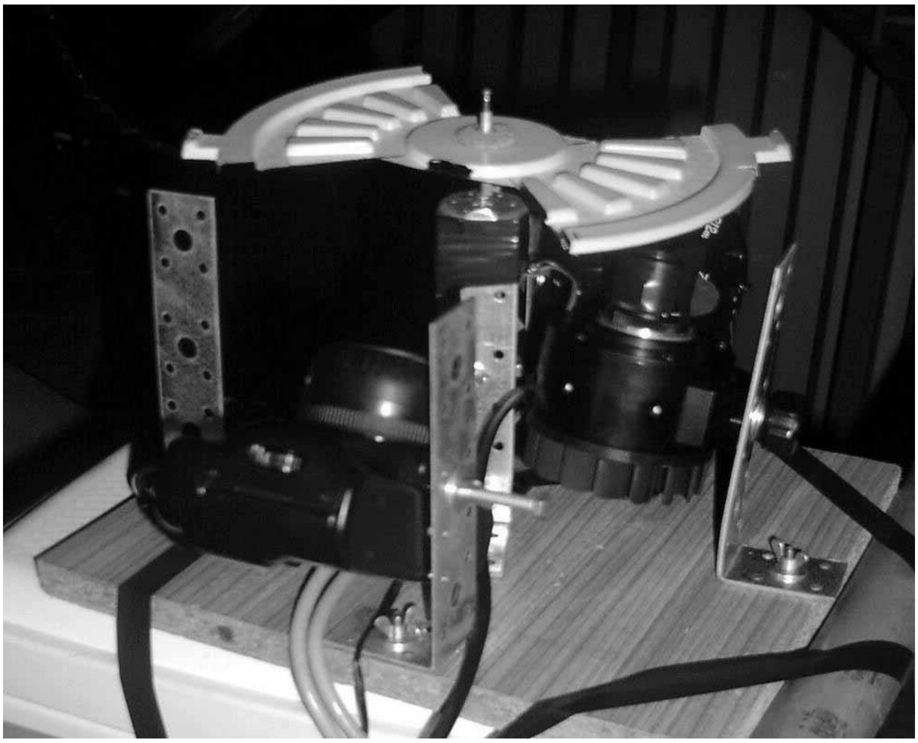

Figure 7: *The photo-CCD mount.*

The *MiT* works even better than ordinary film cameras under the same shutter because it gives usable data in real time and can also observe during periods of thin cloud or bright sky. During periods of low meteor activity the observations using the CCD camera are very economic because we need not buy and develop photographic film.

An example of this is the first meteor in Figure 8. This occurred in a cloudy sky. The film cameras had been waiting for better weather conditions but the CCD camera had been working without a break. There are also a few bright stars visible in this frame, but even without them we would have been able to determine the meteor's coordinates knowing the exposure time and using the positions of the stars determined in previous frames.

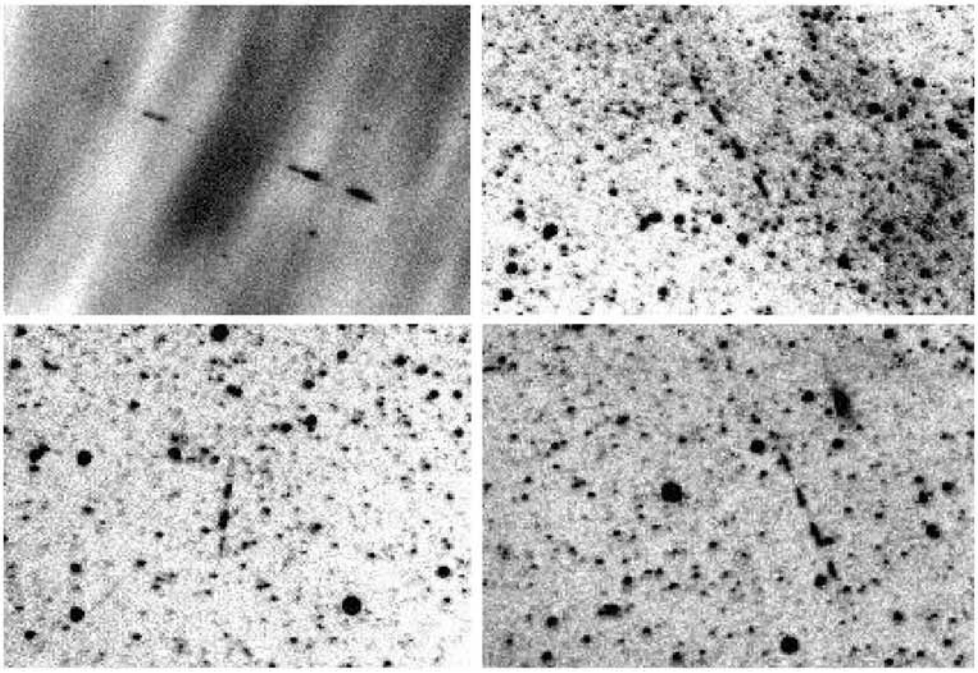

Figure 8: *Meteors: 1) 2002 Aug. 11 at 23:57:34 UT; 2) 2002 Aug. 13 at 00:10:46 UT; 3) 2002 Aug. 12 at 22:22:31 UT; 4) 2002 Aug. 13 at 00:58:35 UT.*

Information about all captured meteors is collected in Table 3.

# 4 Conclusions

CCD cameras have high sensitivity in infrared light. Even with poor weather they can see more than a naked eye observer. They can observe at least an hour longer per night when the sky is too bright for visual and film observations.

Our shutter rotates 12 times per second and has two blades which give 24 breaks per second. Usually meteors last less than one second and thus all captured meteor images are cut only a few times.

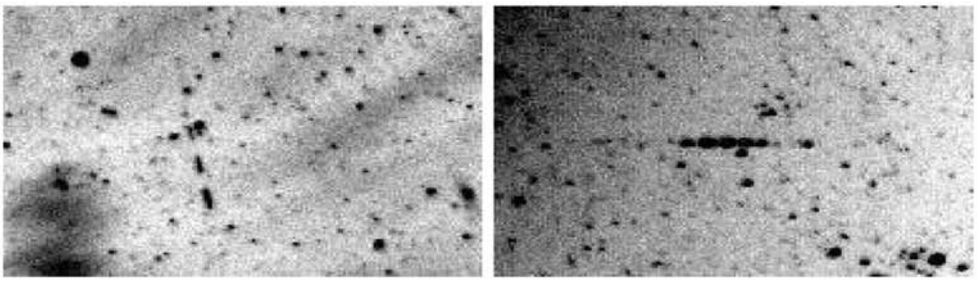

Figure 9: *The meteors occurred on 2002 August 13 at 01:22:38 and 01:36:14 UT.*

For the *MiT* optics and its CCD camera one pixel corresponds to $6'$ on the sky. To determine meteor velocity we must separate cut parts of the trail on the picture. Stars have a FWHM of around 2 pixels, so the minimal distance between parts of the trail should be 4 pixels =

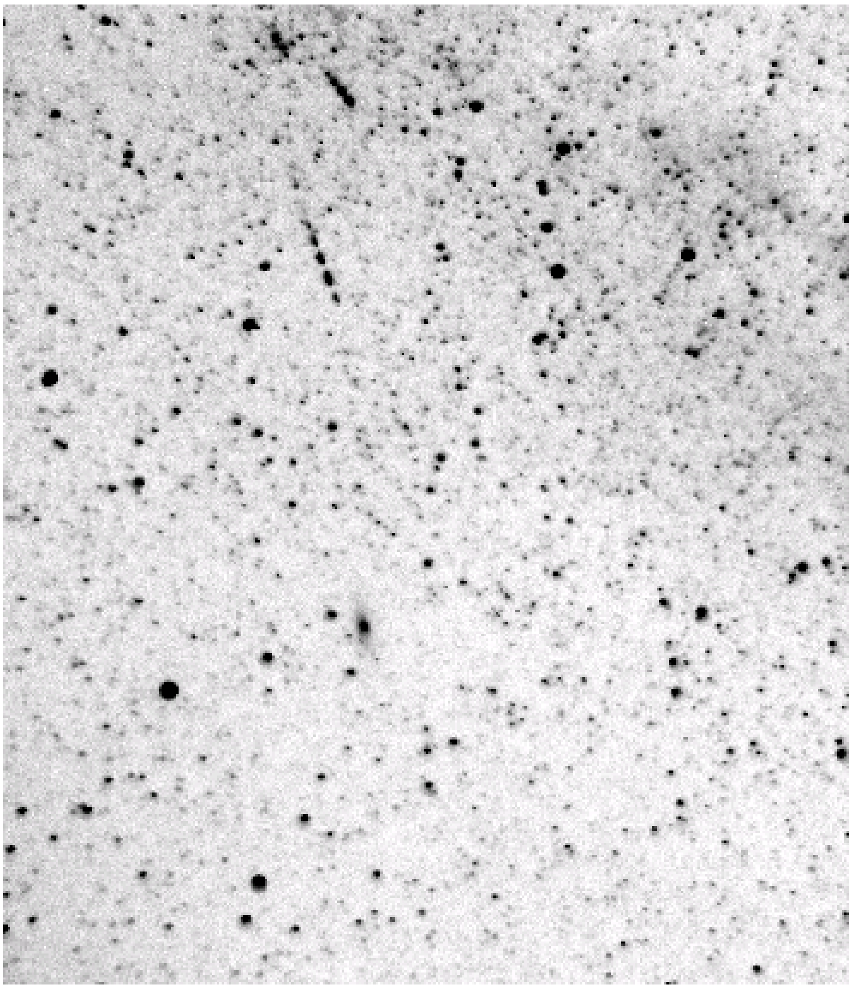

Figure 10: *Two Perseids within one frame: 2002 Aug. 12/13 23:51:26 UT. Note $\chi$ and h Per and M31 visible in this frame.*

$24' = 0.4°$. The minimal velocity which can be determined by our system is $0.4° \cdot 24 = 9.6°/s$. The second meteor on Figure 9 was very close to this limit.

## Acknowledgments

This work was supported by the KBN grant number 2 P03D 022 22 to M. Wiśniewski.

### References

Trofimowicz A., (2003), in *Proceedings of the IMC 2002*, Frombork, Poland, eds. A. Olech, K. Złoczewski, K. Mularczyk, p. 21

Table 3: *The basic parameters of all captured meteors*

| Frame no. | Date | Time [UT] | Remarks |
|---|---|---|---|
| 0956 | 2002 04 23 | 00:50:42 | very bright |
| 1402 | 2002 05 02 | 22:12:03 | Fig. 2 (1) |
| 1508 | 2002 05 02 | 23:33:25 | |
| 1772 | 2002 05 03 | 18:42:00 | |
| 1913 | 2002 05 03 | 20:30:13 | |
| 1920 | 2002 05 03 | 20:35:36 | |
| 3373 | 2002 06 05 | 23:49:20 | Fig. 2 (2) |
| 3633 | 2002 08 01 | 23:03:03 | |
| 3829 | 2002 08 02 | 02:09:52 | Fig. 2 (3) |
| 4133 | 2002 08 03 | 21:11:58 | |
| 4216 | 2002 08 03 | 22:28:19 | |
| 4312 | 2002 08 03 | 23:57:22 | |
| 4355 | 2002 08 04 | 00:40:43 | |
| 4667 | 2002 08 04 | 22:48:04 | |
| 4729 | 2002 08 04 | 23:49:23 | |
| 4731 | 2002 08 04 | 23:51:18 | Fig. 3 (1) trail |
| 4732 | 2002 08 04 | 23:52:13 | Fig. 3 (2) trail |
| 4741 | 2002 08 05 | 00:00:42 | |
| 5139 | 2002 08 06 | 23:48:35 | Fig. 4 (1) |
| 5144 | 2002 08 06 | 23:53:10 | |
| 5229 | 2002 08 07 | 01:12:17 | |
| 5373 | 2002 08 07 | 21:13:32 | Fig. 4 (3) |
| 5472 | 2002 08 07 | 22:48:27 | Fig. 4 (4) |
| 5477 | 2002 08 07 | 22:53:02 | Fig. 4 (2) |
| 5525 | 2002 08 07 | 23:38:28 | |
| 5535 | 2002 08 07 | 23:47:52 | |
| 5645 | 2002 08 08 | 01:29:16 | Fig. 6 (3) |
| 5649 | 2002 08 08 | 01:32:56 | |
| 5736 | 2002 08 08 | 19:37:02 | Fig. 6 (1) |
| 6028 | 2002 08 09 | 00:09:30 | Fig. 6 (2) |
| 6055 | 2002 08 09 | 00:34:16 | Fig. 5 very long |
| 6057 | 2002 08 09 | 00:36:06 | Fig. 6 (4) |
| 6145 | 2002 08 10 | 21:14:44 | first under the shutter! |
| 6353 | 2002 08 11 | 01:46:08 | |
| 6452 | 2002 08 11 | 20:32:17 | |
| 6466 | 2002 08 11 | 20:50:30 | |
| 6501 | 2002 08 11 | 21:36:12 | |
| 6578 | 2002 08 11 | 23:17:11 | |
| 6602 | 2002 08 11 | 23:48:28 | |
| 6609 | 2002 08 11 | 23:57:34 | Fig. 8 (1) |
| 6780 | 2002 08 12 | 22:22:31 | Fig. 8 (3) |
| 6858 | 2002 08 12 | 23:51:26 | Fig. 10 |
| 6875 | 2002 08 13 | 00:10:46 | Fig. 8 (2) |
| 6879 | 2002 08 13 | 00:15:22 | |
| 6917 | 2002 08 13 | 00:58:35 | Fig. 8 (4) |
| 6938 | 2002 08 13 | 01:22:38 | Fig. 9 (1) |
| 6950 | 2002 08 13 | 01:36:14 | Fig. 9 (2) |
| 6959 | 2002 08 13 | 01:46:26 | |
| 7063 | 2002 08 13 | 19:18:23 | |