

The Orwell Astronomical Society (Ipswich) 'All-sky' Fireball Camera, 1976-86

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Spectacular fireball recorded by the camera on 23 April 1984 between 20:02:00 and 20:54:00 UT.

Abstract

From 1976 until 1986, the Orwell Astronomical Society, Ipswich (OASI) operated a fireball camera on nearly every clear night, providing coverage of most of the heavens. The camera was operated by an ingenious arrangement of electromechanical controls, which was developed throughout the period in question to support increasing automation and performance; the technology employed reflects an era before the embedded processor became ubiquitous. In total, on its retiring, the camera had recorded almost 650 hours of exposures of the night sky, capturing images of numerous meteors, fireballs and several unexplained objects. The original images from the camera were negatives; unfortunately, archiving and retention of these, and of the associated prints, was less than ideal, and many potentially interesting images have degraded or been lost completely with the passage of time¹. This report describes the evolution of the camera and highlights the most impressive surviving images.

Beginnings

On 12 May 1976, OASI purchased a 35mm Zorki 4K camera (figure 1) and two lenses from a member of the Society, Mrs. P. Maxfield of 31 Cumberland St, Woodbridge, for the sum of £10. The lenses were a standard 50mm lens and a Spiratone 0.15x fisheye afocal lens (figure 2) which could be attached to the front of the 50mm lens giving an effective focal length of around 7.5mm and a 180°, “all-sky” view. Unfortunately, the Spiratone lens had suffered somewhat before OASI purchased it: the front surface had been exposed to dew causing the anti-reflection coating to develop “spots” and there were large scratches on the very vulnerable outer surface of the dome (figure 3, arrowed). In practice, however, the impairments didn’t cause visible image degradation.



Figure 1. Zorki 4K camera with 50 mm lens.



Figure 2. Spiratone fisheye lens.



Figure 3. Scratches on the front surface of the Spiratone lens.

Initially, the Director of the Meteor and Fireball section of OASI, Mr. David Barnard (1958-2005), used the camera on an *ad-hoc* basis. In December 1977, the Society offered the equipment for loan to anyone with a dark-sky garden and the ability and willingness to operate an all-sky camera on as

¹ Two instances, from many possible, of the demise of images are as follows. Fireballs were observed visually as follows and noted in the camera log as being captured in the frames specified:

- 25 November 1981 at 20:32, frame 17-15. The negative has degraded in the intervening years and no longer shows a discernible fireball trail.
- 12 March 1982 at 19:37:40, frame 21-23. Unfortunately, the frame is no longer available.

many clear nights as possible, from dusk to dawn! At the time, I was on 24-hour callout for work and was thus able to run the camera into the late night/early morning, so I accepted the challenge.

A major drawback of an all-sky lens is that it is photographically “slow”, meaning that it can record only bright objects. The Zorki camera and Spiratone lens could capture only exceptionally bright meteors: its limiting magnitude was not established with certainty, but was brighter than magnitude -3; hence, the camera was known as a “fireball camera”². Additionally, it produced a very small image, displaying the entire night sky as approximately only 20mm in diameter, thus fireball tracks were minute, requiring study under a magnifying glass!

Initial Operation

I mounted the camera in an old wooden mantle clock case³, with the lens just protruding through a thin metal plate on top. The plate through which the lens protruded benefitted from a dew heater constructed from a pair of 18 Watt resistors⁴. The wooden case in turn was mounted on a platform screwed to the roof of the garden shed (figure 4) at 83 Fountains Road, Ipswich⁵ (figure 5). The property was located in a high-density housing estate and, although initially there were relatively few street or domestic lights in the vicinity, there were, nonetheless, sufficient to cause fogging of the image.



Figure 4. Mount for the all-sky camera on the top of the garden shed.

I intended that the camera would form part of the British Fireball Network under the directorship of Dr. K. B. Hindley of the BAA. The anticipated benefit of membership was that the BAA would provide films, processing and forms for recording operation of the camera but, in practice, this did not happen.

I began exposure of my first film on 18 September 1978 and, when it was fully exposed, sent it to the BAA for development and analysis. An enthusiastic response from Dr. Hindley provided great encouragement. However, two years later, by September 1980, I was disappointed with the feedback from the Association and decided instead to develop films myself and report results to the British Meteor Society (of which I was a member).

² On 12 August 1982, I observed a bright meteor (magnitude -3) whilst operating the camera. I had just begun to expose frame 23-22 at the time and immediately terminated the exposure, after only two minutes duration. The film did not record the meteor, indicating that the limiting magnitude was brighter than -3.

³ Unfortunately, no photograph survives of the camera, lens and mounting.

⁴ The heater ran at 12v and drew 390mA, i.e. dissipated approximately 5 Watts.

⁵ Coordinates 52° 2.144' N, 1° 7.974' E (WGS84).

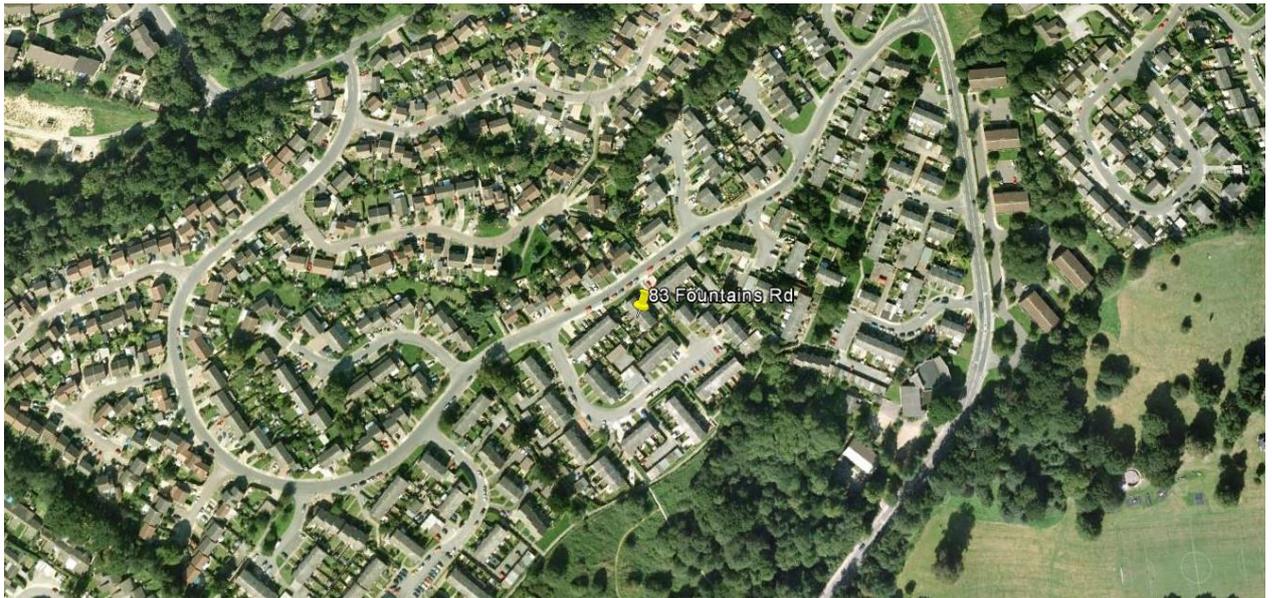


Figure 5. High-density housing around Fountains Road.

To minimise fogging of the image, I took exposures between the hours of evening and morning astronomical twilight⁶ (when the sky was fully dark). This meant that an early start was possible in winter, but few frames could be exposed in summer. I relied on a chart of twilight start/end times provided by the BAA to help plan the observing schedule. The moon caused considerable light pollution and exposures had to be curtailed during moonlit nights. In addition, as the camera did not initially benefit from an automatic rain cover, sometimes the lens got wet! At this time, the camera was fully manual and standard operating practice was as follows:

1. Assess sky conditions at the beginning of the evening. Consult the BAA twilight chart and consider the phase of the moon.
2. If sky conditions were acceptable, mount the camera on its platform on the roof of the shed.
3. Open the camera shutter and lock it open (on the “B” stop).
4. After approximately one hour, release the shutter, wind on the film, and open the shutter again.
5. Repeat the process until it was time to retire for the evening, or weather conditions deteriorated.
6. Log the start and stop times for each image and record any other pertinent notes.

My logs show that it took approximately 10 seconds to close the shutter, advance the film and open the shutter again, and around five minutes to remove the camera from its case, rewind a completed film, load a new film, replace the camera and start a new exposure.

Initially I purchased individual rolls of film but, to reduce costs, I eventually moved to buy bulk cans of film (30 metres) from advertisers in *Exchange and Mart* and *Amateur Photographer*. In the pitch black of a darkroom⁷ (figure 6) constructed in the loft of my house, I took film off the bulk roll and wound it by hand (using a bulk film loader – figure 7) onto empty cassettes for use by the camera.

⁶ Astronomical twilight occurs when the Sun is 18° below the nominal horizon.

⁷ Much of the equipment in the darkroom was homemade or considerably home-modified.

Using this method, I crammed as much film as possible into a cassette, enabling 42 or more frames to be obtained from each one.



Figure 6. The darkroom in the loft of 83 Fountains Road, Ipswich.



Figure 7. Hand operated bulk film loader.

Generally (except where noted to the contrary below), I used Ilford FP4 film developed in Paterson's *Acutol* at 20°C with intermittent agitation in a spiral tank, producing an effective rating of ASA 100.

A Close Encounter (Almost...)

The most famous British "UFO encounter", the so-called "Rendlesham Forest incident"⁸ (just outside RAF Woodbridge, only a few miles from the site of the camera), allegedly took place on 26 December 1980 at about 03:00⁹. The camera was operating on 25 December 1980, and the log indicates a limiting magnitude 5 with 9/10 cloud cover and moonlight. Unfortunately, I switched the camera off just after midnight, at 00:15. How close was I to capturing a UFO on film?!

Beginnings Of Automation

In early March 1981, I introduced an Omron electro-mechanical timer, (similar to that shown in figure 8) to activate a shutter release servo. The latter was implemented as an electric motor with gearbox, mounted inside the wooden mantle case and running at about 0.1 rev/sec, driving two cams. One cam (inside the case) operated micro switches which stopped the motor shaft at precise angles of rotation, while the other cam, outside the box, pressed a cable release for the camera. Push-buttons controlled the motor to open or close the shutter. The push-buttons were mounted in a control box situated inside the shed and connected to the camera box by a long umbilical cord, made from a redundant telephone handset cable. The film, of course, still had to be wound on manually.



Figure 8. An Omron timer.

In operation, with the camera positioned on the shed roof and the film wound on, the timer was set for a delay to close the shutter (if it was opened manually), or to both open and close the shutter, in

⁸ See, for example, Jenny Randles, *UFO: Crash Landing? Friend or Foe? - True Story of the Rendlesham Forest Close Encounter*, Cassell, 1998.

⁹ All times in this report are given in 24-hour format and refer to UT (Universal Time).

fully automatic mode. Automation enabled more exposures to be made, especially after midnight when I would typically go to bed. During winter months, the timer enabled lengthy exposures of many hours.

By 22 March 1981, I had fitted a rotating shutter to the camera. This was made from white 2mm thick plastic sheet, painted matt black (it looked like a pair of butterfly wings!) It was glued to the spindle of a motor¹⁰ (with electro-mechanical speed governor) salvaged from a discarded portable cassette player. The motor was mounted outside the mantle case, adjacent to the heated metal plate, and the blades of the shutter spun just over the top of the lens. The shutter chopped the trail left by a passing object such as a fireball into a series of dots. The rotation speed of the shutter was 5 rev/sec, creating 10 breaks per second in the trailed image: the speed of a moving object could thus be calculated. An additional benefit was that the shutter reduced by approximately 50% the light reaching the camera meaning that image capture time could be increased and fogging decreased. I found too that dotted trails were much easier to spot when checking negatives.



Figure 9. Rotating shutter.

¹⁰ The motor operated from 6v DC, drawing 950mA running and 1200mA stalled.

See figure 10 below; it is frame 12-30¹¹, taken at some point during the eight days 22-29 March 1981¹². It was logged as “general view” (i.e. did not capture anything of particular interest); however, it shows well the motor and boss of the shutter as the mushroom-shaped object at the centre bottom. The difference between areas of the image swept by the shutter and those not swept is obvious! (The blades of the shutter were flimsy and I could not make them large enough to completely cover the lens in a satisfactory manner.) Note also that, at this stage, I did not employ a permanent horizon mask and domestic lighting was a significant and ever-present problem. A red insert at the top of the image shows the cardinal points: these are the same for all subsequent images. Note the E-W reversal!

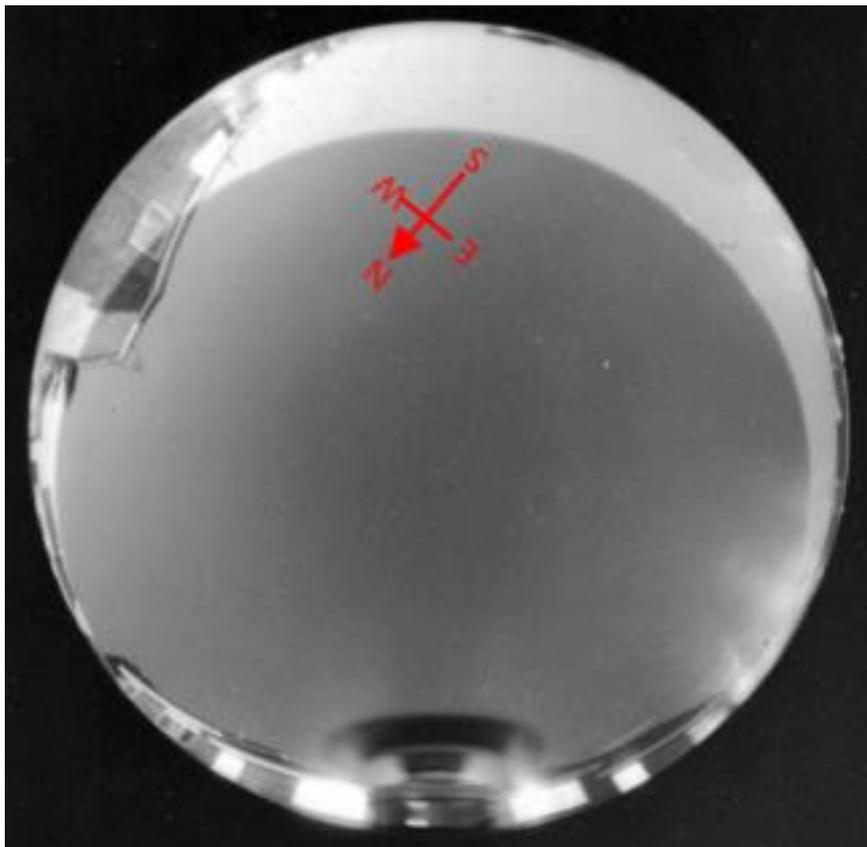


Figure 10. Frame 12-30, exposed at some time during the period 22-29 March 1980.

When analysing the images, initially I loaded them one at a time into a slide mount and projected onto a screen to search for anything of interest. This was a very tedious process! Later, I purchased a second-hand microfiche viewer with a large glass screen. In fact, the screen was broken (this was the reason for the sale), so I replaced it with a hand-ground glass plate approximately 60cm square. I could pass a strip of film through the machine relatively quickly: however, the analysis of images remained a tedious undertaking!

¹¹ This shorthand notation, employed throughout the document, means frame 30 of film 12.

¹² The log does not show frame numbers for the film, but the entire roll was exposed between the dates specified.

Further Improvements And Results

By the end of May 1981, I constructed the first horizon mask. This consisted of thin plastic sheet, painted black and shaped to prevent lights from upstairs windows in neighbouring houses shining directly onto the camera. (I left the roofs of the buildings un-masked in order to allow better orientation of any frames of interest). This first attempt needed more work, and I did not use it regularly.

Figure 11 shows a typical image captured at this time; it is frame 15-15, taken 00:00:00 – 03:08:00 (188 minutes exposure) on 02 August 1981. Star trails and Polaris (circled) are visible. Conditions were logged as 0/10 cloud and magnitude 6 transparency.

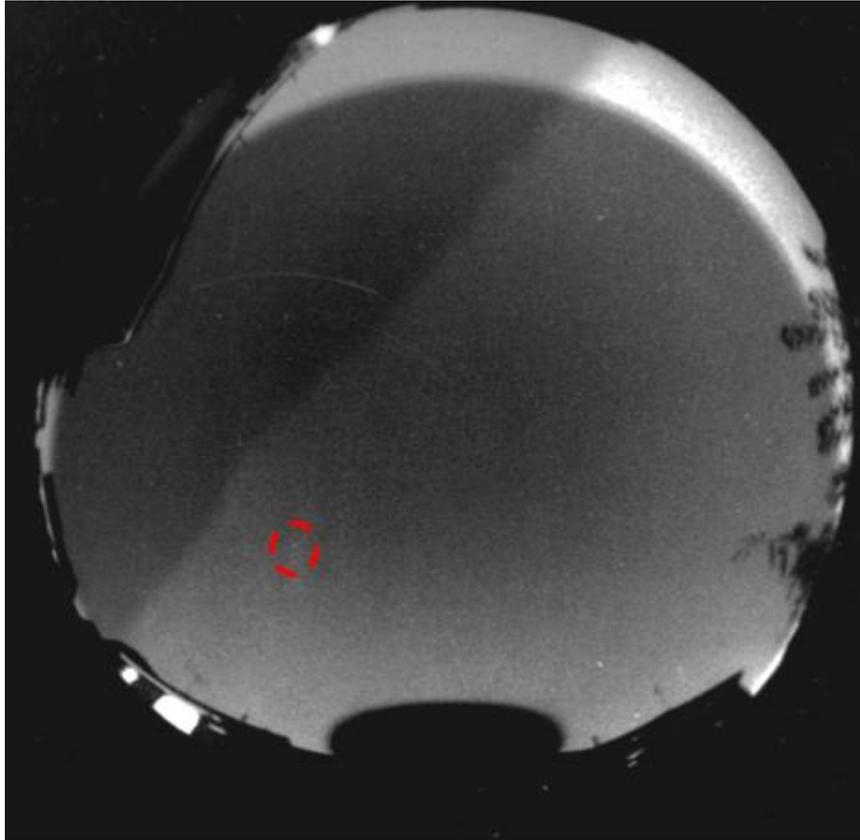


Figure 11. Frame 15-15, taken 02 August 1981.

Figure 12 shows frame 17-15, taken 25 November 1981, 19:42:15-21:25:20. Sky conditions were recorded as magnitude 4, cloud cover 0/10. Although the negative has been badly scratched in the intervening years, it still shows the faint curved trail of a fireball just above the boss; the fireball was observed visually at 20:32.

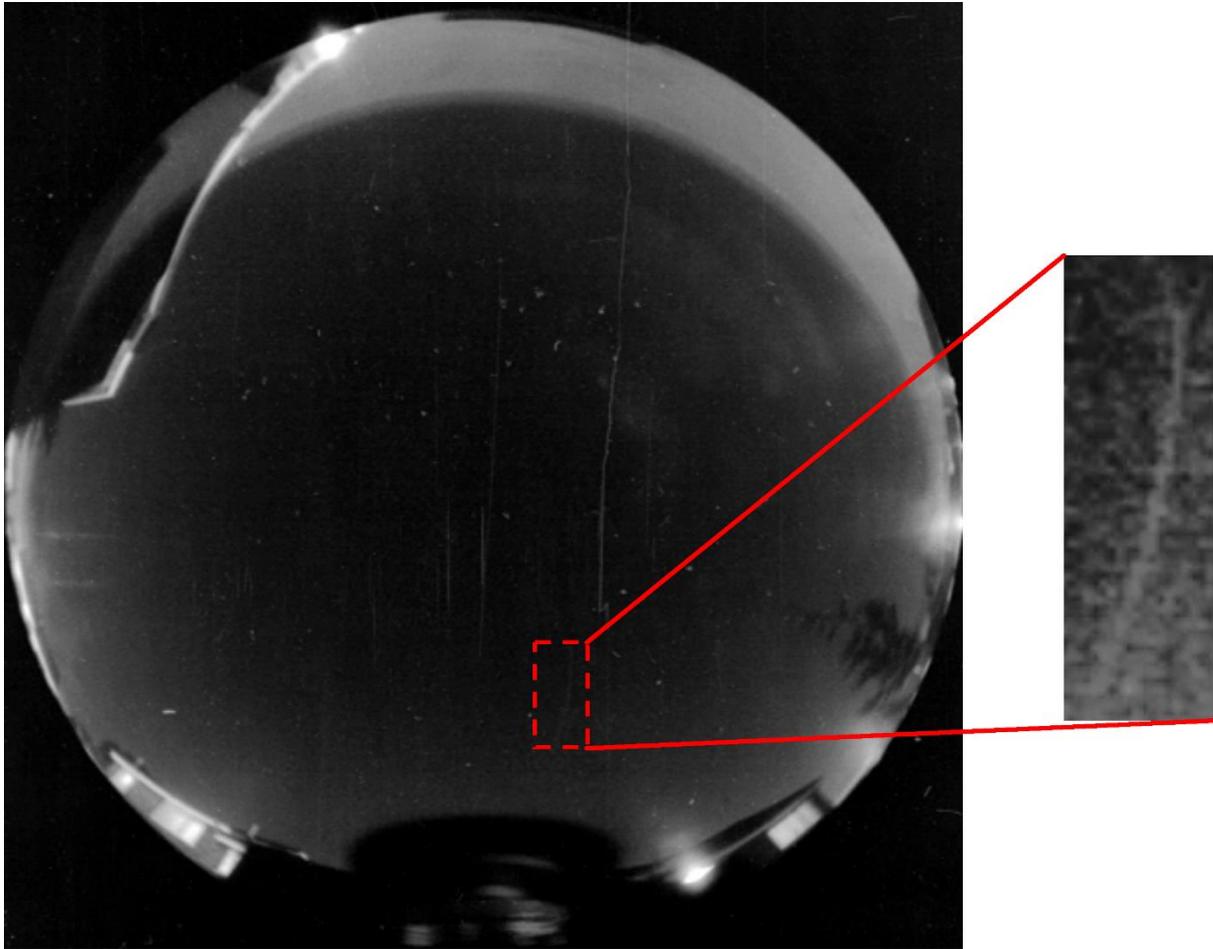


Figure 12. Frame 17-15. Faint fireball.

In November 1981 I tested the effectiveness of the rotating shutter on trails left by firework rockets. This revealed some limitations: a bright trail could create afterglow resulting in an image on film comprising a single, unbroken line. Figure 13 shows frame 17-38, taken 05 November 1981, 18:49:10-19:05:55 with 10/10 cloud, clearly illustrating the effect.



Figure 13. Frame 17-38. Fireworks demonstrate the limitations of the rotating shutter.

The moon could create significant fogging of the image. Figure 14 shows frame 25-42, taken on 22 December 1982, 19:29:55-23:09:30. Sky conditions were recorded as magnitude 3, cloud cover 0/10. A six-day old moon set just before the end of the exposure and caused considerable fogging: compare the sky brightness with figure 12.

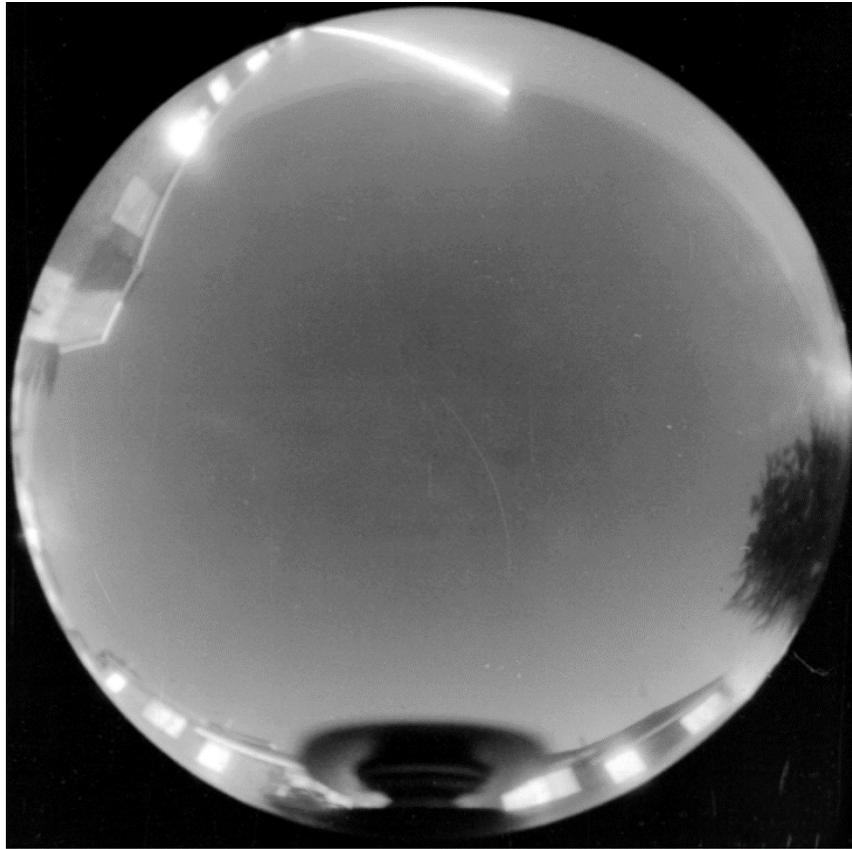


Figure 14. Frame 25-42, taken 22 December 1982.

A New Camera

On 14 March 1983, I installed a replacement (secondhand) camera¹³. This was a Zenit "B" with a 58mm, f2.8, Helios primary lens (see figure 15). The existing Spiratone afocal lens was mounted on the front of the Helios lens using an adapter fabricated by OASI member Martin Cook. The new lens assembly was slightly faster than the old and produced an image on the film slightly larger at 23mm diameter. I also installed a new rotating shutter assembly.

The following day, new street lights were installed in the neighbourhood increasing background illumination. However, that very night a fireball was recorded on frame 28-29, which ran from 22:36:30-05:00:00 hrs (383 minutes 30 seconds) – see figure 16. Once again there is no horizon mask. Sky conditions are recorded as limiting magnitude 5, 0/10 cloud, however there are no star trails in the image. What appear to be scratches are, I think, aircraft trails. Note that the fireball trail, although exhibiting several flares, including a large terminal event, does not show evidence of breaks caused by the rotating shutter.



Figure 15. The Zenit "B" camera.

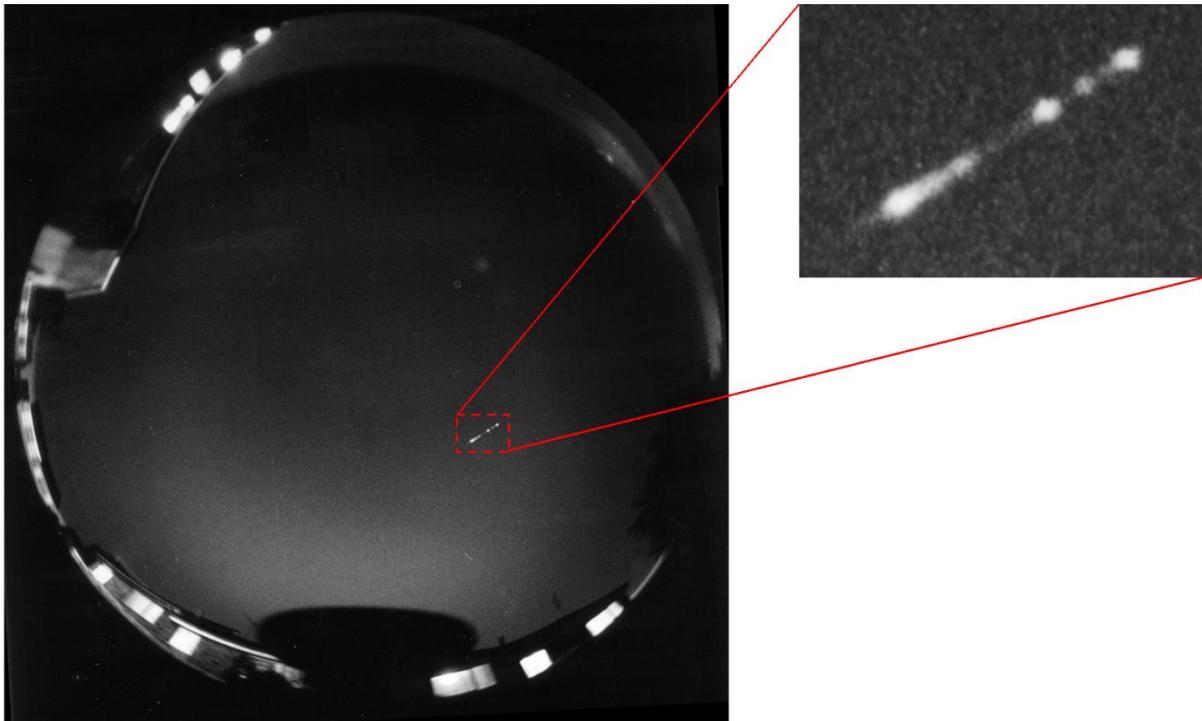


Figure 16. Frame 28-29. Fireball recorded 15 March 1983.

¹³ The old Zorki "4" was returned to the OASI equipment curator.

Further Automation And Other Improvements

One of the more significant problems with an automated (or semi-automated) camera is that while it is running unattended, the weather can change significantly over a short period of time, resulting in the equipment becoming wet. Over the years of operation up to 1983, the front surface of the lens of the OASI fireball camera became wet many times, causing further deterioration of the non-reflective coating already marked by scratches.

In May 1983, I addressed the problem with further automation. I constructed a device to close a cover¹⁴ over the camera lens and rotating shutter in the event of rain. (The shutter was located close to the lens so the easiest solution was a large cover to protect both, rather than a smaller cover for the lens alone.) I fabricated a rain sensor from a plastic sheet (about 50x25mm) with a double spiral of wire attached to it, the conductors separated by about 2mm. The sensor was attached to the top of the camera case. Rain landing on the sheet caused current to flow between the conductors, triggering a two-transistor switch, mounted inside the case, which in turn powered a six volt DC electric motor, controlled by cams and micro switches, to close the shutter and terminate the exposure. Unfortunately, there was no way to record when closure occurred, so the termination times of exposures truncated by rain were unknown. In practice, a heavy dew would also cause the cover to activate.

I conducted various experiments, trying higher speed films and different developing solutions in an effort to increase the speed of the system enabling it to capture more events. It was often necessary to greatly enlarge an image during analysis and it was essential therefore to use films with a small grain. At best, I could achieve a speed rating of around 3200 ASA without degrading the resolution of the film unacceptably.

¹⁴ Continuing the spirit of ingenuity, the cover was in fact the drip tray of a flower pot!

Unfortunately, in the early 1980s the housing estate around Fountains Road was enlarged and this contributed to an increase in general background illumination of the sky. Matters were compounded by ever-increasing air traffic, with the camera recording many aircraft strobe lights. Figure 17 illustrates the problem. It shows frame 32-19, a 38 minute exposure on 28 October 1983, taken between 19:10:30 and 19:49:00 using Ilford HP5 film triple-developed in Ilford *Microphen* to give a speed rating of 3200 ASA. Sky conditions are recorded as magnitude 5, 9/10 to 5/10 cloud cover. The image shows some star trails, many aircraft strobe lights and much fogging due to background illumination.

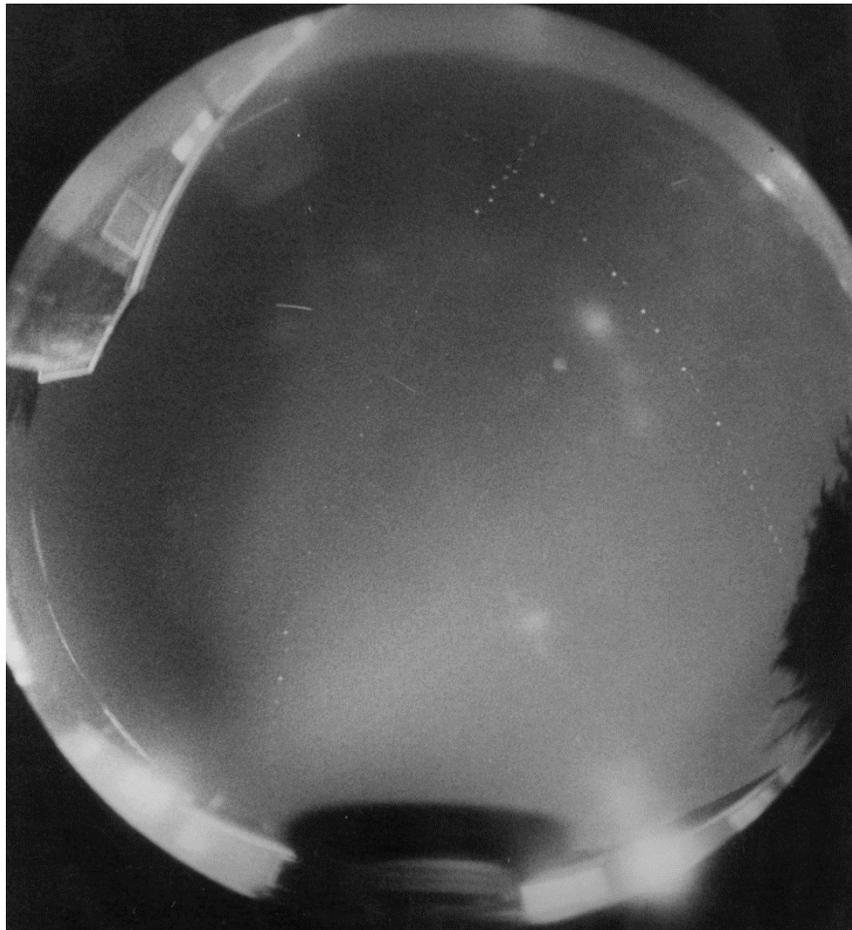


Figure 17. Frame 32-19 showing the combined effects of increased street-lighting, domestic lighting and aircraft strobe lights.

Towards the end of November 1983, I made a further attempt to mask the problem of domestic lighting around the horizon by fixing a shaped, plastic, artificial horizon around the edge of the camera case. Figure 18 shows the benefit thus achieved. It is frame 34-34 taken on 30 November 1983, 18:01:25-18:41:35. The film used was Ilford HP5 (400 ASA) developed in Paterson *Acuspeed* for 17 minutes at 22°C, push-processed to give an effective rating of approximately 1250 ASA. Sky conditions are recorded as magnitude 5, 0/10 cloud. The horizon mask eliminates some of the domestic lights and Polaris (circled) is easily visible but it is clear that a better profile is required!

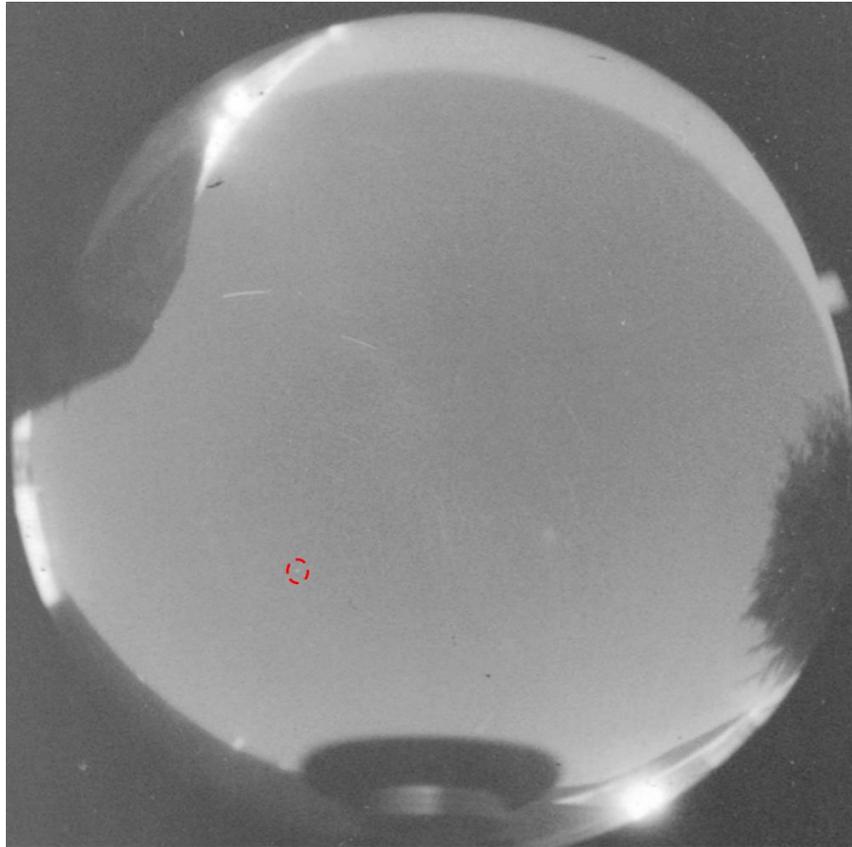


Figure 18. Frame 34-34, illustrating the benefits of a horizon mask (although clearly leaving room for further improvement!)

An alternative to the horizon mask was simply to operate the camera in the early hours of the morning, when the problem of domestic lighting was much reduced. Figure 19 illustrates the benefit of early-hours operation: it is frame 35-15, taken on 03 December 1983, 03:15:20-03:49:55 on HP5 film developed in Paterson *Acuspeed*. Sky conditions are recorded as magnitude 6, 0/10 cloud. Note that even in the unmasked horizon areas there are no domestic lights! This is representative of the best image that I could achieve with the camera around this date.

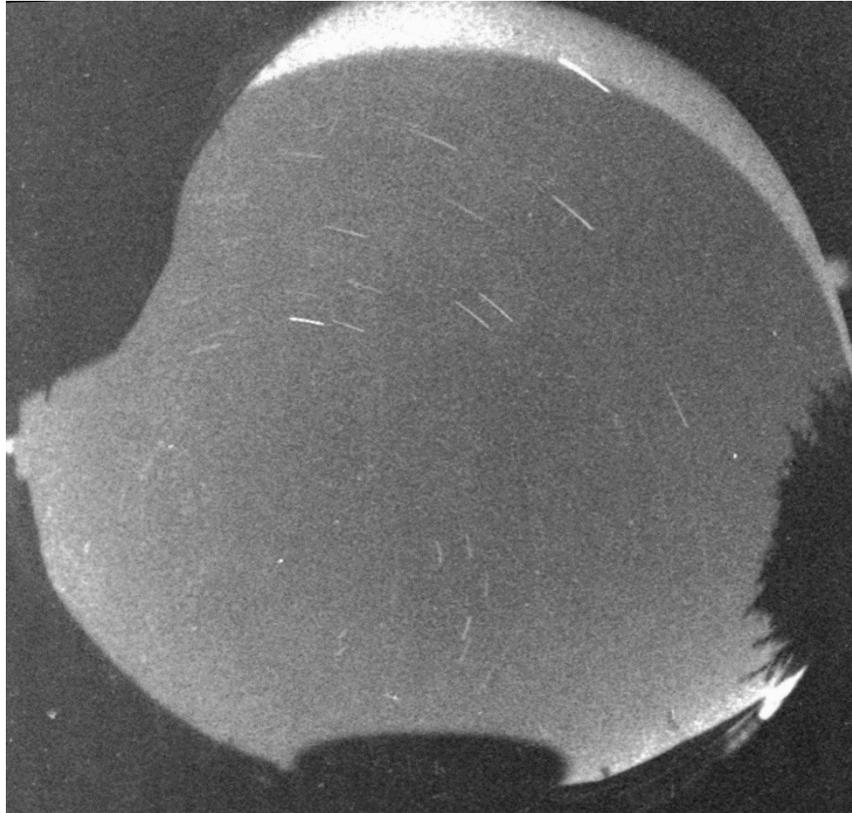


Figure 19. Frame 35-15, taken in the early hours of the morning.

On 13 December 1983, I fitted an improved horizon mask which effectively eliminated all direct illumination by domestic lighting. (Of course, scattered light from domestic sources remained an issue.) The benefit of banishing domestic lighting rapidly became apparent when, three weeks later, the camera recorded its first “good” fireball trail with many breaks formed by the rotating shutter. Figure 20 shows the image; it is frame 37-34, taken 22:27:30-06:42:00 on 05-06 January 1984 (with automatic end of exposure). The film was Ilford HP5 developed in Paterson *Acuspeed*. The very long exposure (eight and a quarter hours!) shows that the new horizon mask effectively banished domestic lighting. The arc of Polaris is clearly visible with the fireball trail just to the south.

There are around 23 breaks in the fireball trail which, at 10 breaks per second, means that the trail represents approximately 2½ seconds of travel. The object would have been visible for much longer to the naked eye (more sensitive than the film).

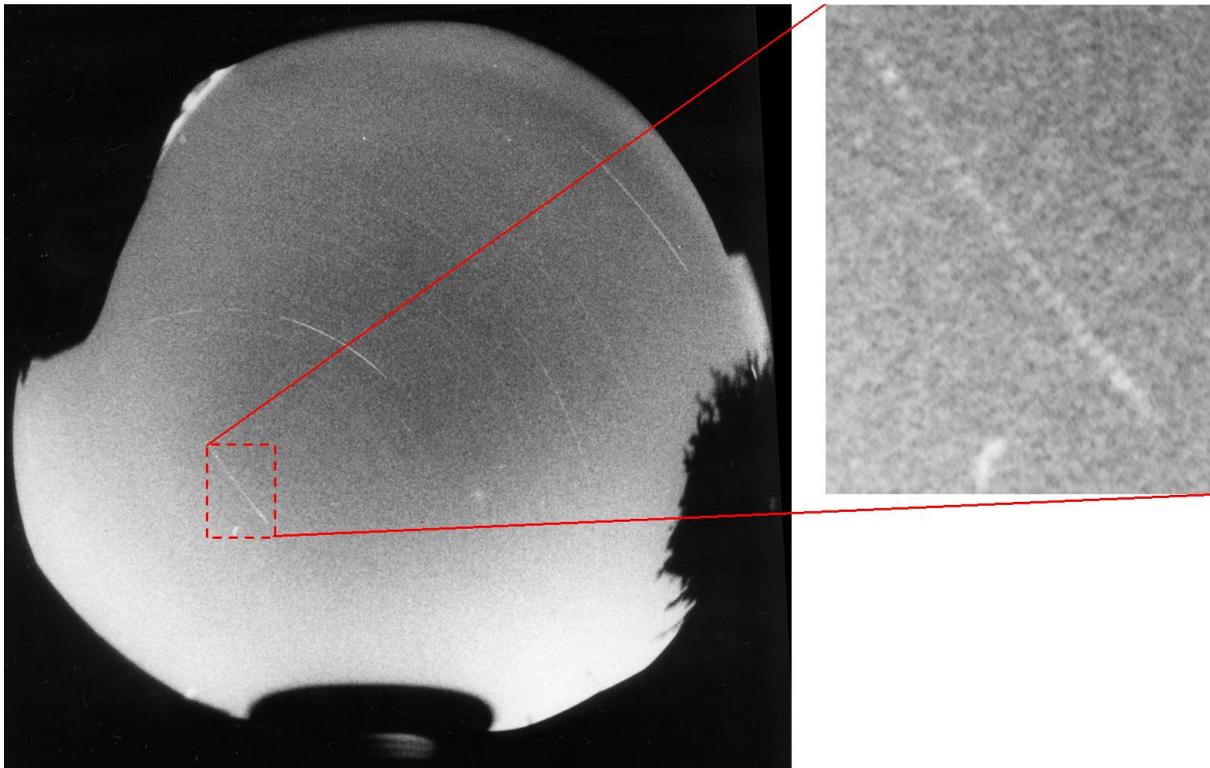


Figure 20. Frame 37-34, taken 05-06 January 1984, showing a fireball trail just south of Polaris.

Various factors conspired to limit the performance of the camera, for example wind shake and vibration, imperfect focus and atmospheric. The combined effect was to produce images of both star trails and fireballs with appreciable thickness. (Fireball trails would, in any case, in general have a noticeable thickness.) When a fireball trail was interrupted by the rotating shutter, examination under high magnification revealed a characteristic pattern of alternating light and dark banding (as above, right-hand image).

Figure 21 provides further confirmation of the benefit of the horizon mask. It shows frame 38-36, taken on 29 January 1984, 21:04:15-22:06:05. Sky conditions are recorded as limiting magnitude 4, 0/10 cloud. This one-hour image taken during a typical winter evening shows that the horizon shield largely eliminated domestic glare.

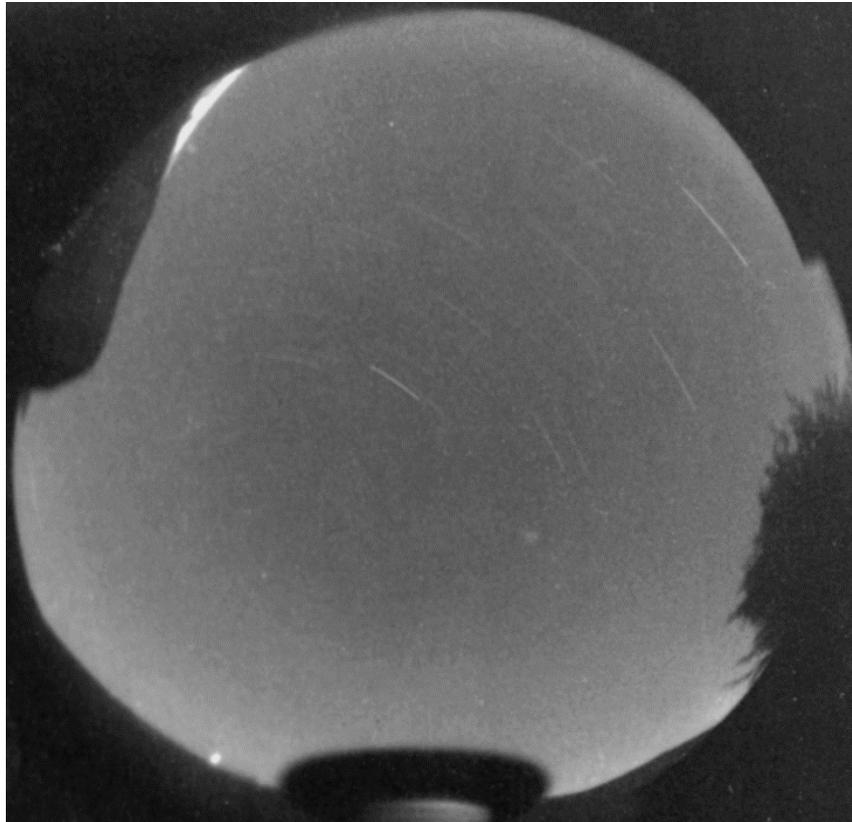


Figure 21. Frame 38-36, taken 29 January 1984. The horizon shield effectively eliminated direct illumination from domestic lighting.

Collaboration

On the evening of 23 April 1984, I recorded sky conditions as limiting magnitude 3 and 0/10 cloud. The image from the camera that night shows no star trails but a superb image of a fireball – see figure 22, frame 40-04, taken 20:02:20-20:54:02 on the evening in question¹⁵. The object was photographed also by a fireball camera run by the Royal Greenwich Observatory (Herstmonceux) and by one run by Hans Betlem at a fireball station in Elsloo, Holland¹⁶ (see figure 23). The object, which appeared at 20:27 UT, was recorded at magnitude -14 (brighter than the full moon!)

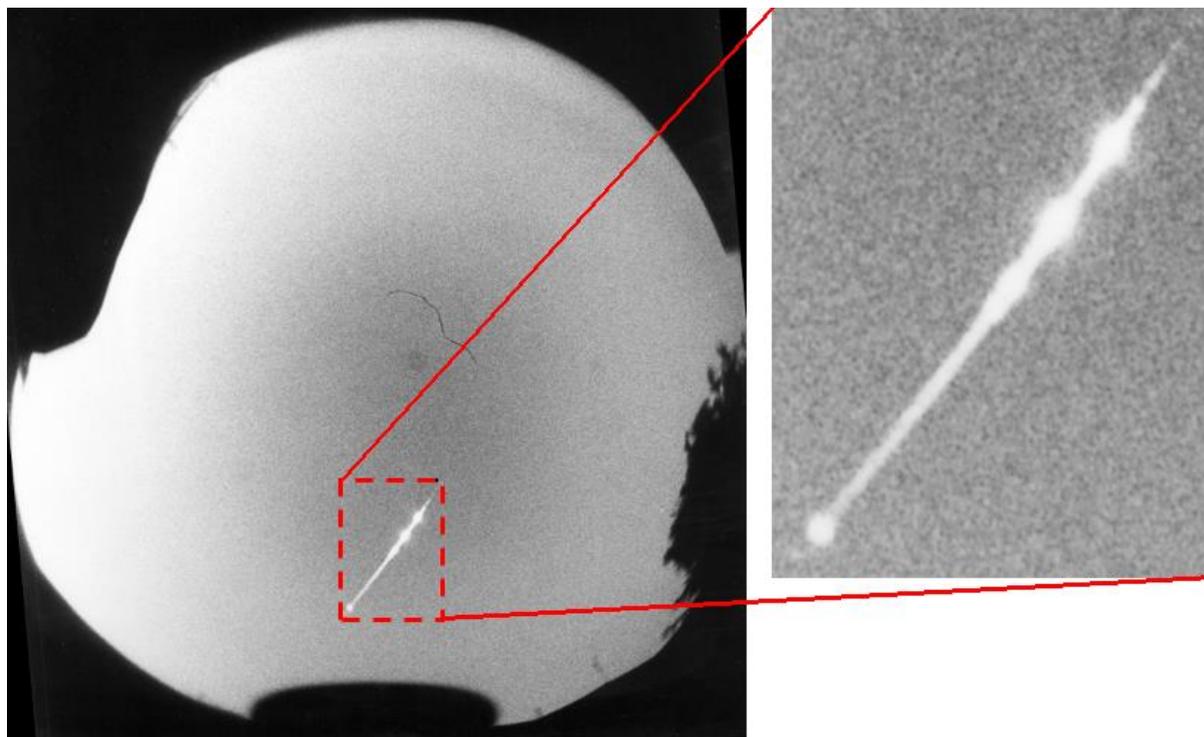


Figure 22. Frame 40-04, taken 23 April 1984. A magnitude -14 fireball.

Using the three images, staff at the RGO were able to compute an approximate track for the fireball; this was broadly from south to north off the Suffolk coast – see figure 24, from the *OASI Newsletter* for August 1984. Using this information, it is possible to interpret figure 22 as follows. The fireball entered the Earth's atmosphere approximately at the zenith, and quickly created three initial flares. It rapidly travelled north until, ultimately, frictional heating was so intense as cause it to disintegrate in a large terminal flare (to the bottom left of the image). Although the train

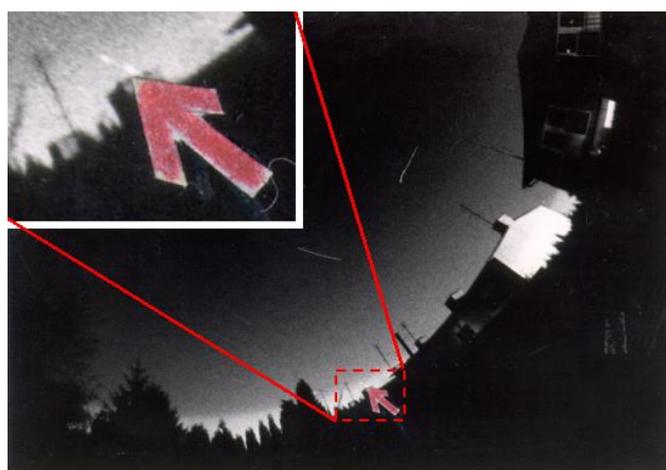


Figure 23. The image by Hans Betlem. The fireball is visible just above the rooftops.

¹⁵ The image is also reproduced on the front sheet of this report.

¹⁶ Some 350 km distant from Ipswich.

initially exhibits gaps associated with the rotating shutter, these are not present after the first flare, indicating that the train thereafter was persistent due to ionisation.

Even though the original image has a large defect near the centre of the negative (possibly a stray fibre) it was still deemed good enough to grace the front cover of the October 1984 edition of *Popular Astronomy* (figure 25).

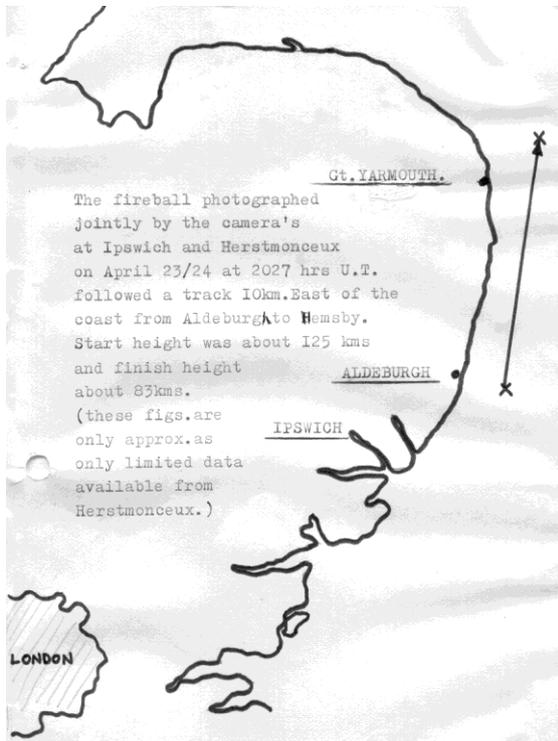


Figure 24. Page from the OASI Newsletter for August 1984 describing the path of the fireball.

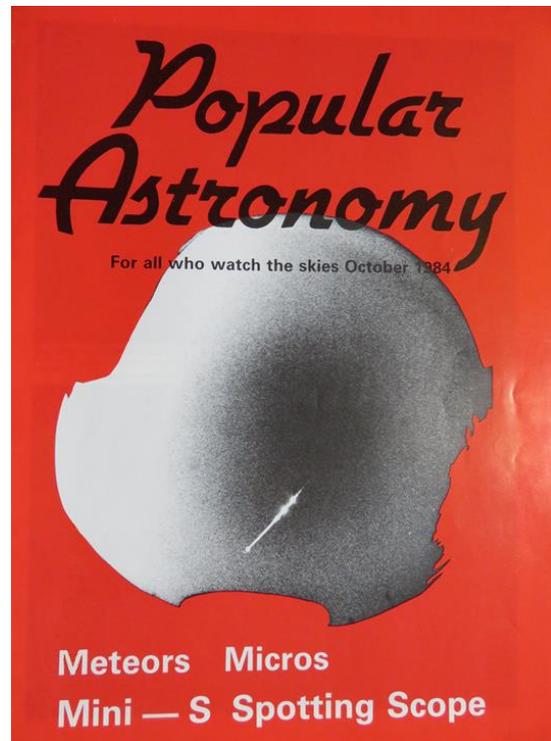


Figure 25. Front cover of *Popular Astronomy*, October 1984.

A Mystery

Figure 26 shows frame 46-01, taken on 24 December 1984, 19:18:47-20:26:38. Sky conditions are recorded as limiting magnitude 5, 0/10 cloud. The large trail at the bottom of the picture is a mystery. It exhibits no breaks, indicating that either it was a very bright object moving slowly or a fast moving object (fireball) with a prominent train. There were no reported incidents. Fogging of the film by poor handling is also obvious! (The moon was below the horizon.)

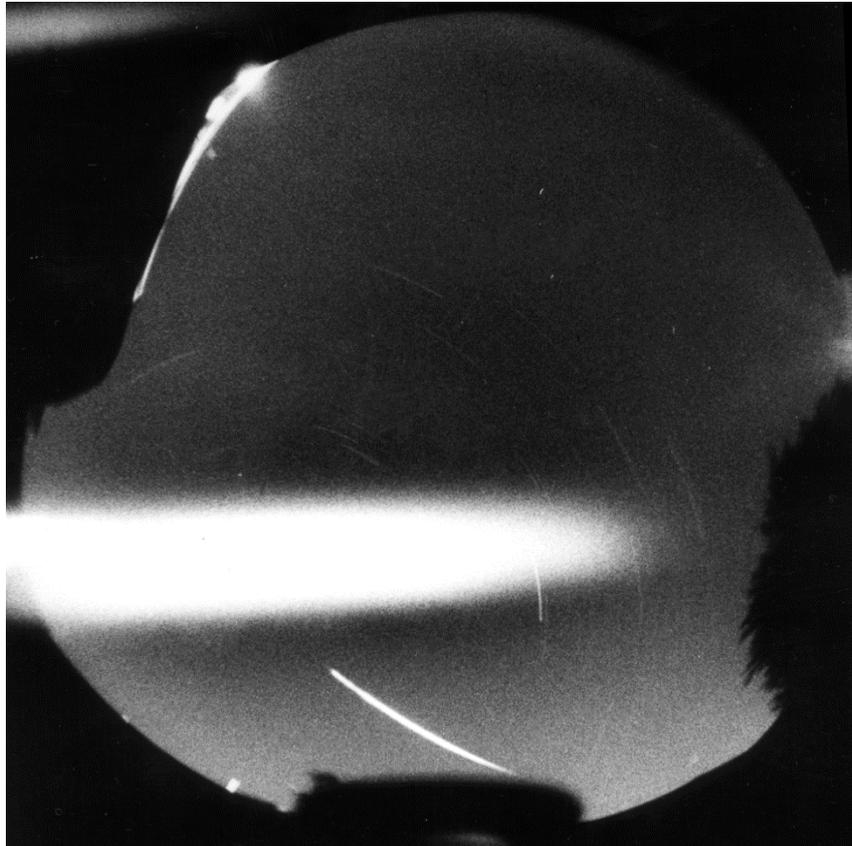


Figure 26. Frame 46-01, taken 24 December 1984. The object at the bottom of the image is a mystery.

A New Camera And Full Automation

In May 1985, I installed a new camera and lens (figure 27). The camera was a Minolta XG-M, fitted with an external, aftermarket, electric motor drive. The lens was a Sigma 16mm f2.8 fisheye. The new equipment enabled full automation of the system and for this I employed another, second-hand Omron electro-mechanical timer to set the exposure time. Once started, the camera would expose successive frames until the end-of-night timer expired and terminated the session or rain was detected in which case the cover would close and operation was terminated prematurely. In order to time exposures accurately, I modified an electronic calculator (similar to that shown in figure 28) with time display and a built in thermal paper dot matrix printer so that it printed the time when the camera shutter was opened. This represented the final, most sophisticated version of the system and, in practice, it worked well.



Figure 27. Minolta XG-M camera and Sigma fisheye lens. For all-sky use, the lens “hood” was removed.

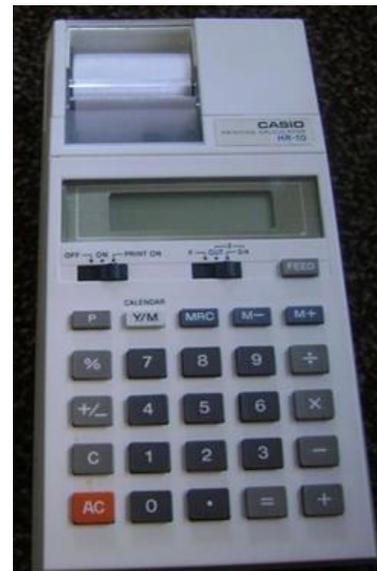


Figure 28. Calculator similar to that used to log exposure times.

Standard practice for using the system was as follows:

1. Look outside to check the weather.
2. If stars were visible and there was minimal prospect of rain, check times of twilight.
3. Once the sky was sufficiently dark, place the camera in its case on the platform on top of the shed.
4. Arrange the long, umbilical, electric cable to reach to the control box, safe inside the shed.
5. Check the number of frames of film left in the camera.
6. Switch on the various power supplies.
7. Set the exposure timer with reference to the number of frames left on the film, the phase of the moon, etc. Typically, exposures were around 30 minutes' duration.
8. Set the stop timer to terminate operations at the end of astronomical twilight.
9. Start the system. The camera would run until the stop timer expired or rain was detected.
10. The following morning, dismount the camera case from its platform and store in the shed ready for the next clear night.
11. Change the film when necessary (at least every couple of nights use).

Once the camera was set running, I generally did not then record sky transparency or cloud cover for each image. Although the new camera used the full 35mm frame, the field of view was reduced to 150°x100°.

The extra speed of the Sigma lens gave immediate benefit and the best images obtained with the equipment are presented below. The first fireball was recorded by the new equipment on 28 May 1985 – see figure 29, showing frame 50-06, exposed on Ilford HP5 film, 22:15:52-22:46:07, with conditions recorded as limiting magnitude 4, 0/10 cloud cover, moon above the horizon). Once again there is no hints of breaks in the train associated with the rotating shutter.

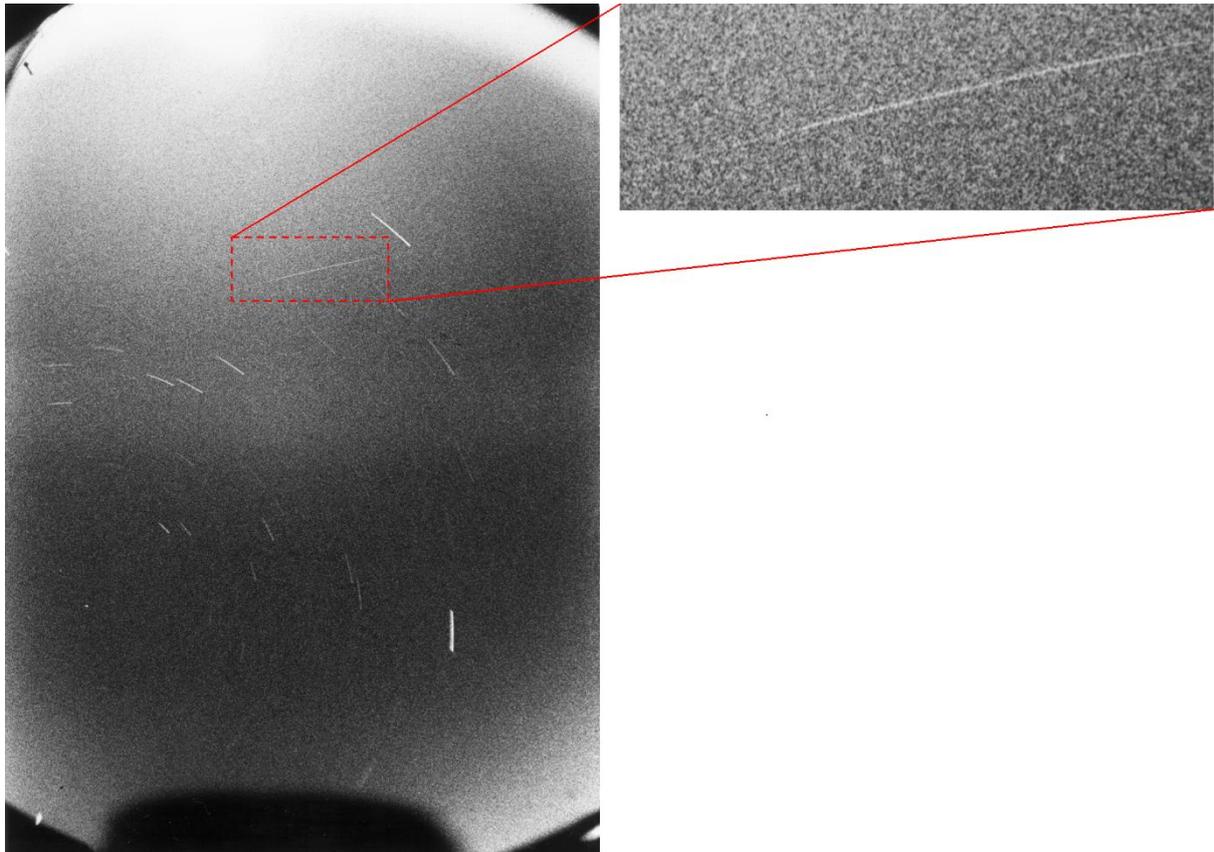


Figure 29. Fireball captured on frame 50-06, taken 28 May 1985.

The faster lens could record much fainter events, and so the “fireball camera” could now properly be called a “meteor camera”! Figure 30 illustrates the point. It shows frame 52-30, taken 24 July 1985, 00:18:05-00:48:21. The Milky Way is clearly visible running vertically through the centre of the image and nearby is the train of a fast meteor with widely spaced breaks caused by the rotating shutter.

The increased speed of the lens, coupled with increased automation, enabled the taking of more frames, showing more detail with less background fogging, and an increase in the number of objects logged.

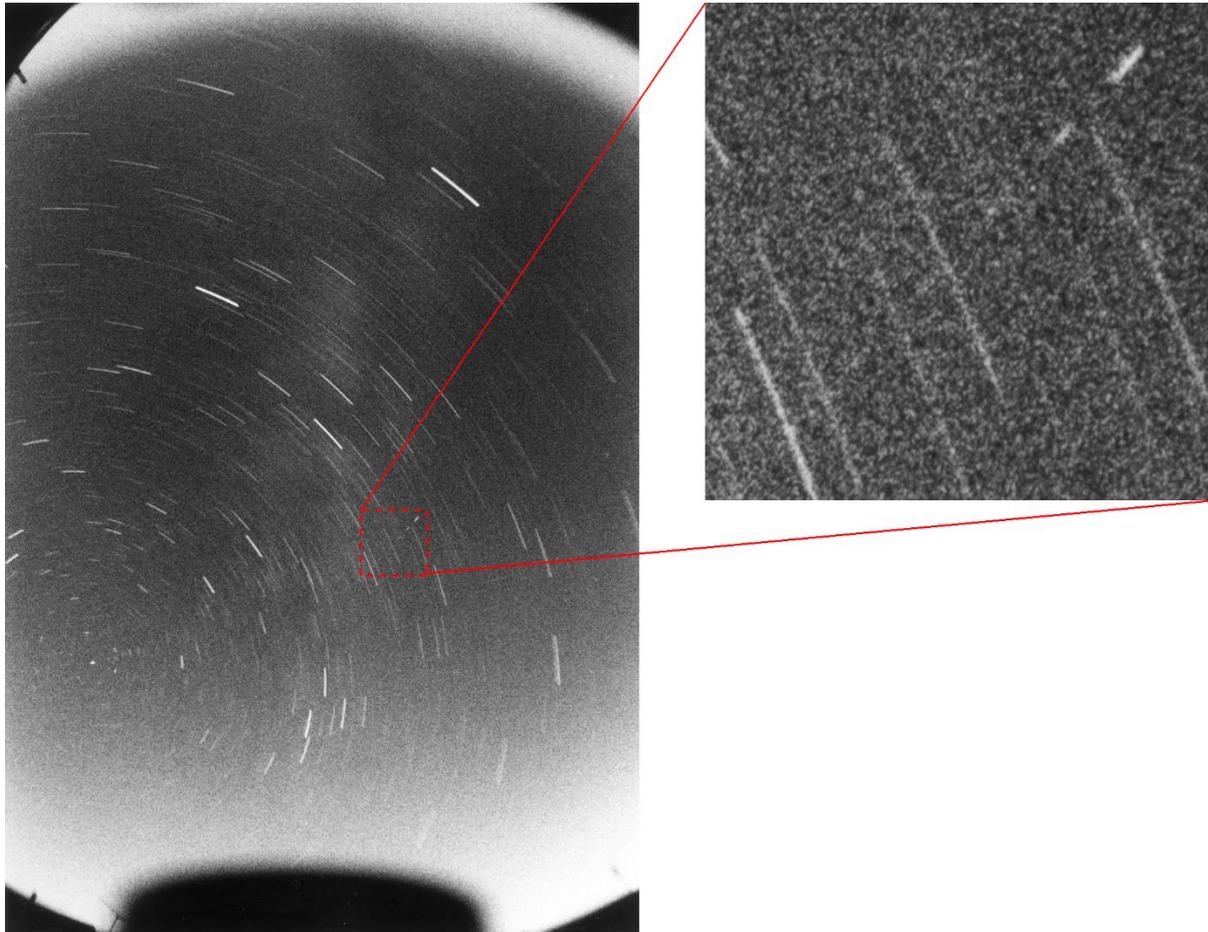


Figure 30. The Milky Way and a fast meteor captured in frame 52-30, taken 24 July 1985.

Figure 31 shows frame 53-32, taken on 09 August 1985, 22:30:12-23:00:25. It shows Polaris to the bottom left with two fast moving meteors to the left of it running top to bottom.

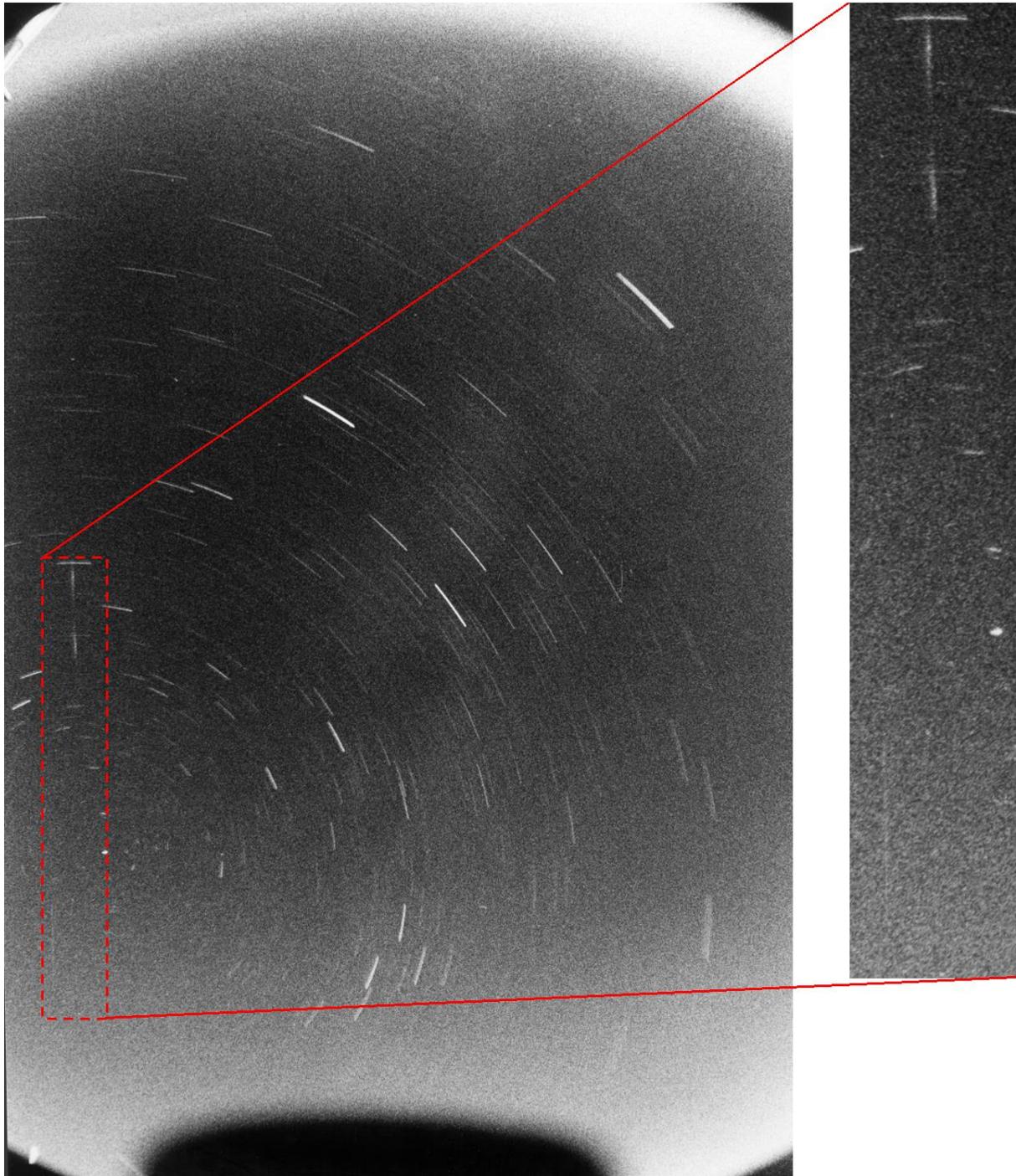


Figure 31. Two fast meteors captured in frame 53-32, taken 09 August 1985.

Figure 32 shows detail from frame 54-04, taken on 10 August 1985, 22:33:43-22:56:06, including a magnitude -1 meteor which I observed visually at 22:56:00.

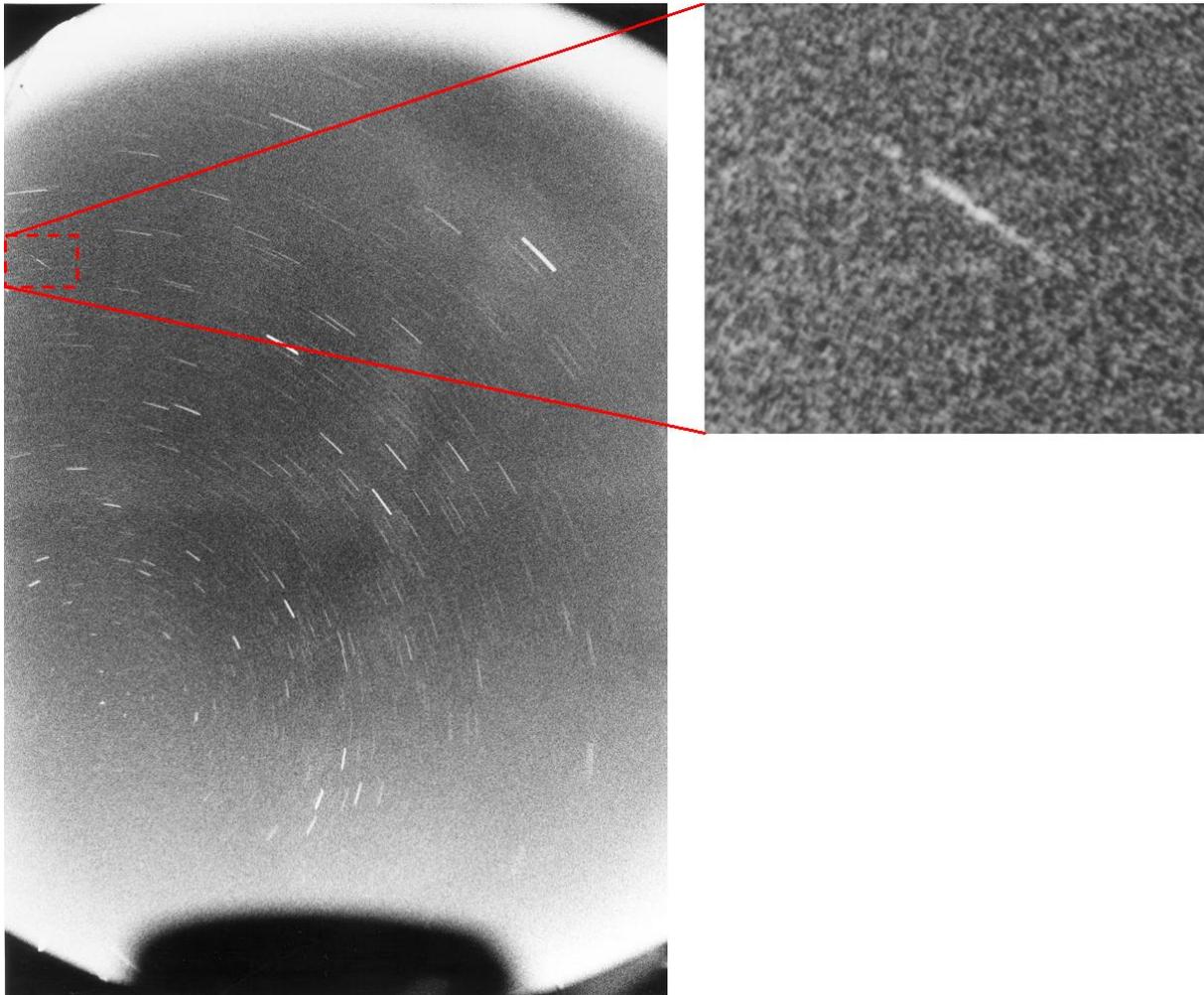


Figure 32. A magnitude -1 meteor, also observed visually. From frame 54-04, taken 10 August 1985.

Figure 33 shows frame 54-23, taken on 12 August 1985, 01:05:02-01:35:14. A long meteor trail cuts through the Milky Way.

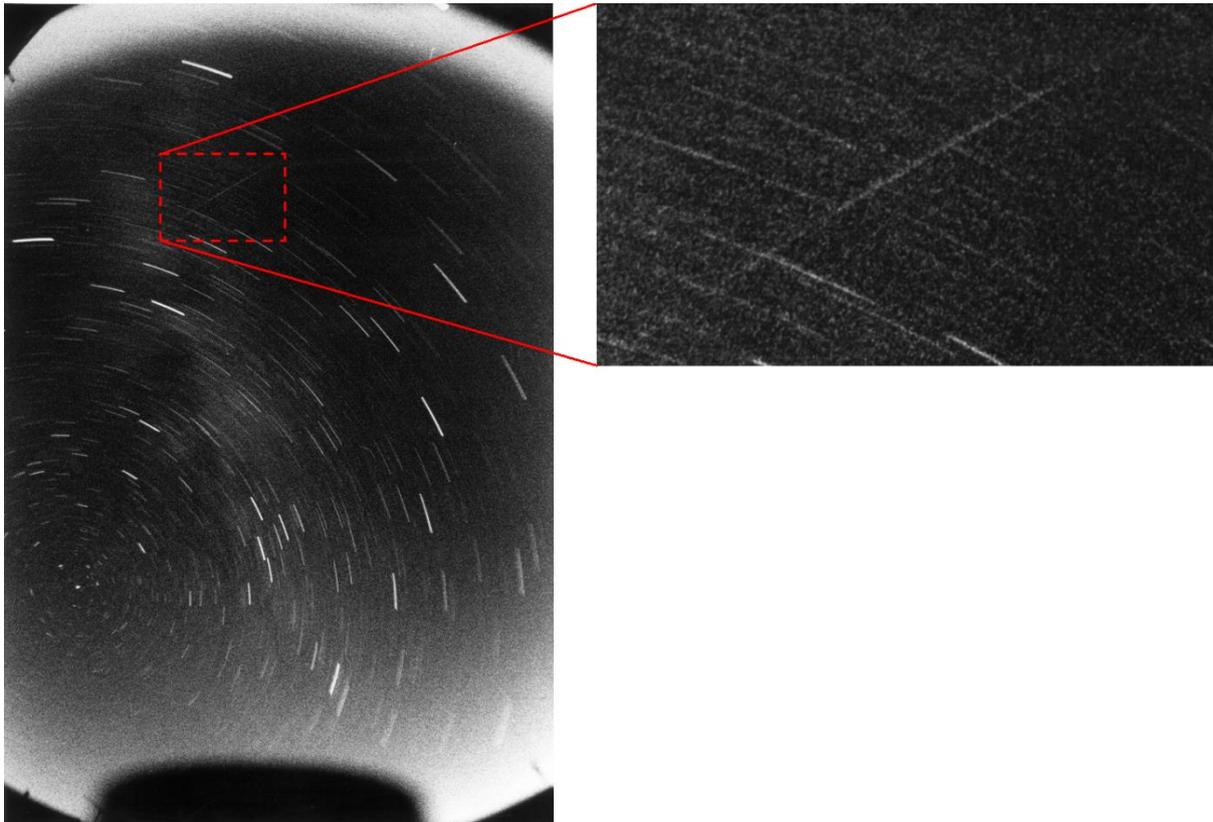


Figure 33. A meteor trail cuts through the Milky Way. From frame 54-23 (12 August 1985).

Figure 34 shows the very next exposure, frame 54-24 taken later the same morning 01:35:14-01:43:23. It shows a magnitude -4 meteor observed visually at 01:42:00. The meteor left a train, persisting for approximately five seconds, but this does not appear in the image. The short exposure and relatively dark background of this image represent the very best that I could achieve with the system.



Figure 34. A magnitude -4 meteor. Frame 54-24 (12 August 1985).

Figure 35 shows frame 54-26¹⁷ taken on 12 August 1985, 01:43:38-02:13:44. It shows two meteor trails (circled). Of course, the peak of the annual Perseid meteor shower occurs around 12 August!



Figure 35. Two meteors. Frame 54-26 (12 August 1985).

Unfortunately, at this time the practice of burning stubble was especially common in East Anglia, with the result that late summer skies were frequently polluted¹⁸. This, added to the ever increasing size of the high density housing estate with associated lighting, gave rise to ever decreasing visibility with frequently poor limiting magnitudes. Astrophotography with long exposures was becoming fraught...

¹⁷ The observing log shows that frame 54-25 was omitted and that only a few seconds elapsed between frames 54-24 and 54-26 during which time, perhaps, a problem occurred and the film was advanced manually.

¹⁸ It was not until 1993 that the practice was outlawed.

Figure 36 shows detail from frame 63-00, taken 10 November 1985, 17:33:00-18:03:02. It shows a faint, fast meteor.

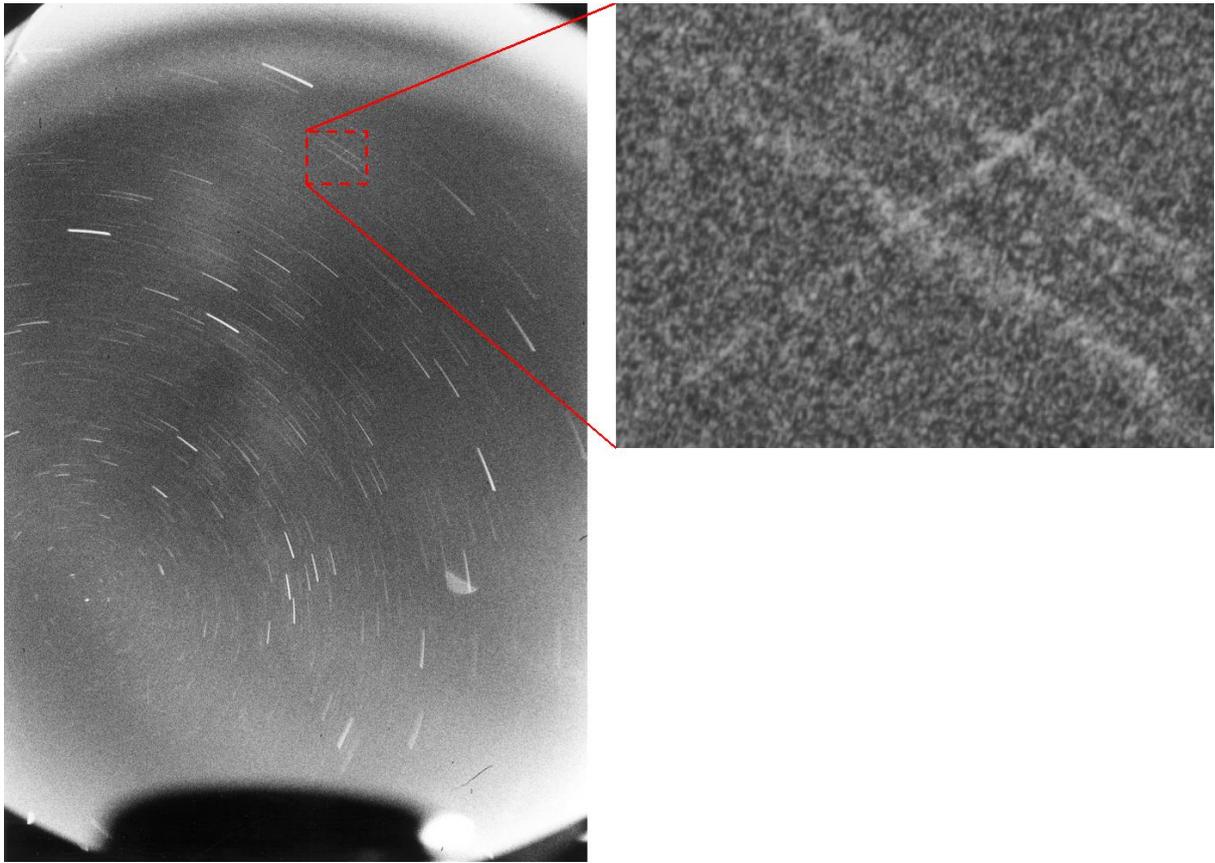


Figure 36. A faint, fast meteor. Frame 63-00 (10 November 1985).

Figure 37 shows frame 64-15, taken 14 November 1985, 02:36:31-03:06:07. A fast-moving meteor is visible (circled) just off the centre of the image. Note also that Polaris and the Milky Way are clearly visible.



Figure 37. A fast meteor. Frame 64-15 (14 November 1985).

Figure 38 shows frame 64-29, taken 07 December 1985, 21:22:34-21:52:43, showing a fast-moving fireball which I (and others) observed at 21:47:00, estimated at magnitude -6, bright yellow in colour. (We observed the object from Orwell Park Observatory while attempting to photograph Comet Halley using the 26cm Tomline Refractor¹⁹). The trail shows at least two probable terminal flares. Note also that a new terrestrial light has managed to “creep past” the horizon shield causing some reflections on the image. It also appears that the fireball itself was bright enough to cause internal reflections (see a parallel trail at right, circled, just to the left of the watermark). I forwarded a report of the observation to Robert Mackenzie of the British Meteor Society who suggested that, after the first flare, the fireball fragmented (there is evidence of glowing material in the gaps) and then became two objects travelling together with little evidence of rotation. He also advised that the image was slightly out of focus. (See Appendix 1 for the correspondence.) The problem with focus is probably either (a) systemic and a result of the rotating shutter causing a slight vibration, and/or (b) wind shake. There were no other reports of this event.

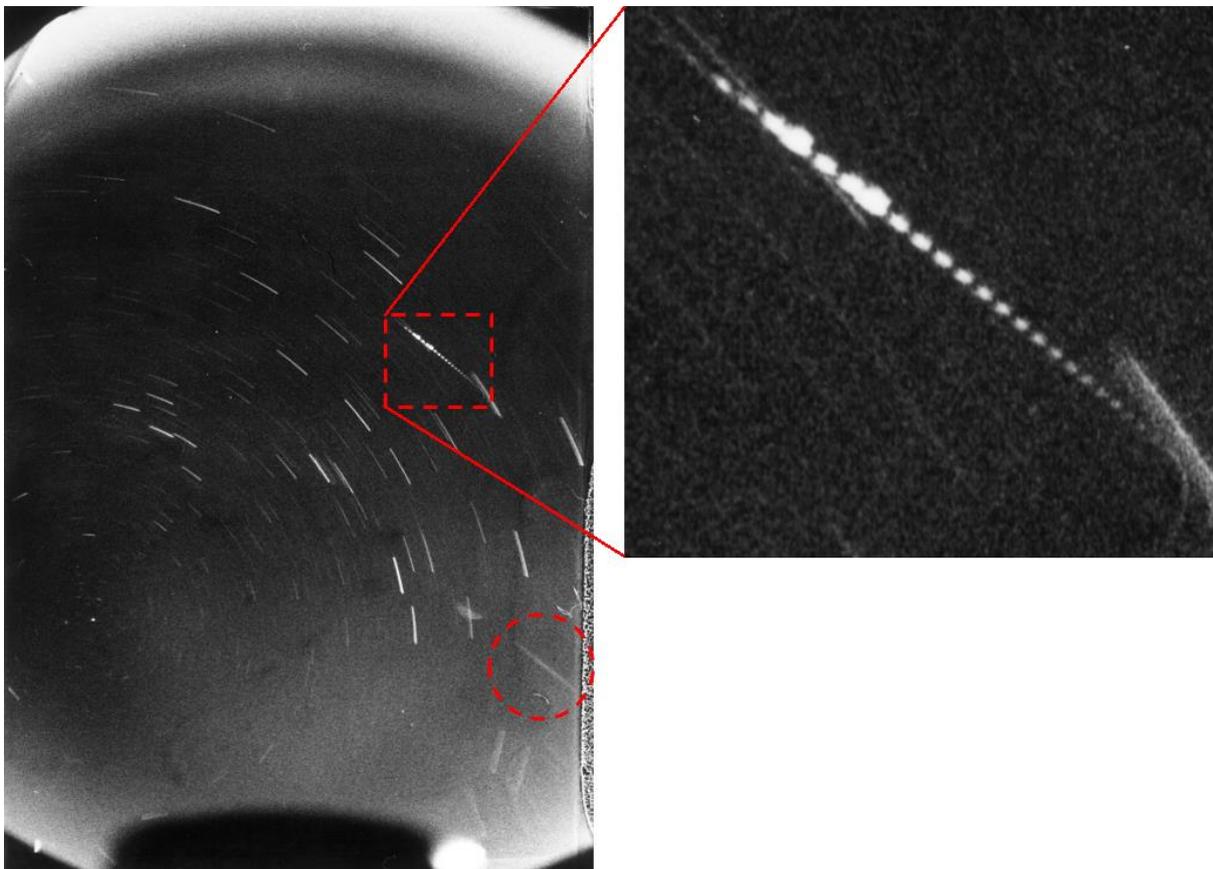


Figure 38. Fireball. Frame 64-29 (07 December 1985).

¹⁹ At the period in question, the telescope was generally referred to as the *Big Telescope*. It was named the *Tomline Refractor* by Dr. Allan Chapman at a ceremony on 18 May 2001.

Of course astronomers in the UK know all about the effect of clouds on observing! The meteor camera was also affected by cloud, which could cause dimming and breaks in star trails. Figure 39, from frame 65-08, taken 19 December 1985, 03:00:00-03:30:00, shows the effect. Polaris is to the bottom left of the image. Star trails are characterised by irregular dimming and breaks due to cloud, in contrast to the meteor trail (circled), distinguished by regular breaks due to the rotating shutter.



Figure 39. Passing clouds cause irregular breaks and dimming in star trails, in contrast to the regular breaks in the meteor trail. Detail from frame 65-08 (19 December 1985).

Figure 40, frame 66-21, taken 10 January 1986, 18:02:00-18:32:00, represents something of a mystery. There is a short, fast moving, meteor trail just to the right of Polaris. However, there are three further “mystery” trails, orientated approximately NE to SW, stretching across the entire sky. The breaks in the trails indicate that the three associated objects are fast-moving, although their direction of travel is unknown.



Figure 40. A meteor trail plus three mystery trails. Frame 66-21 (10 January 1986).

The top trail spans approximately two-thirds of the frame, the missing portion being to the SW. The transition between invisible and visible takes approximately one second (10 breaks). The middle trail, close to and parallel to the top one, is visible to the NE and SW of the frame but invisible in the middle; again, the transitions take approximately a second. Intriguingly, the middle trail transitions from visible to invisible at the same position in the sky where the top makes the opposite transition. The bottom trail again spans the full width of the frame NE - SW, apart from the middle where it is obscured by the boss of the rotating shutter (it is difficult to see in the SW due to the bright sky

there). Figure 41 presents an enlargement of the NE portion of the bottom trail. The objects responsible for the trails are moving far too fast to be high-flying jets or satellites and, at the time of writing (late 2015), remain a mystery.

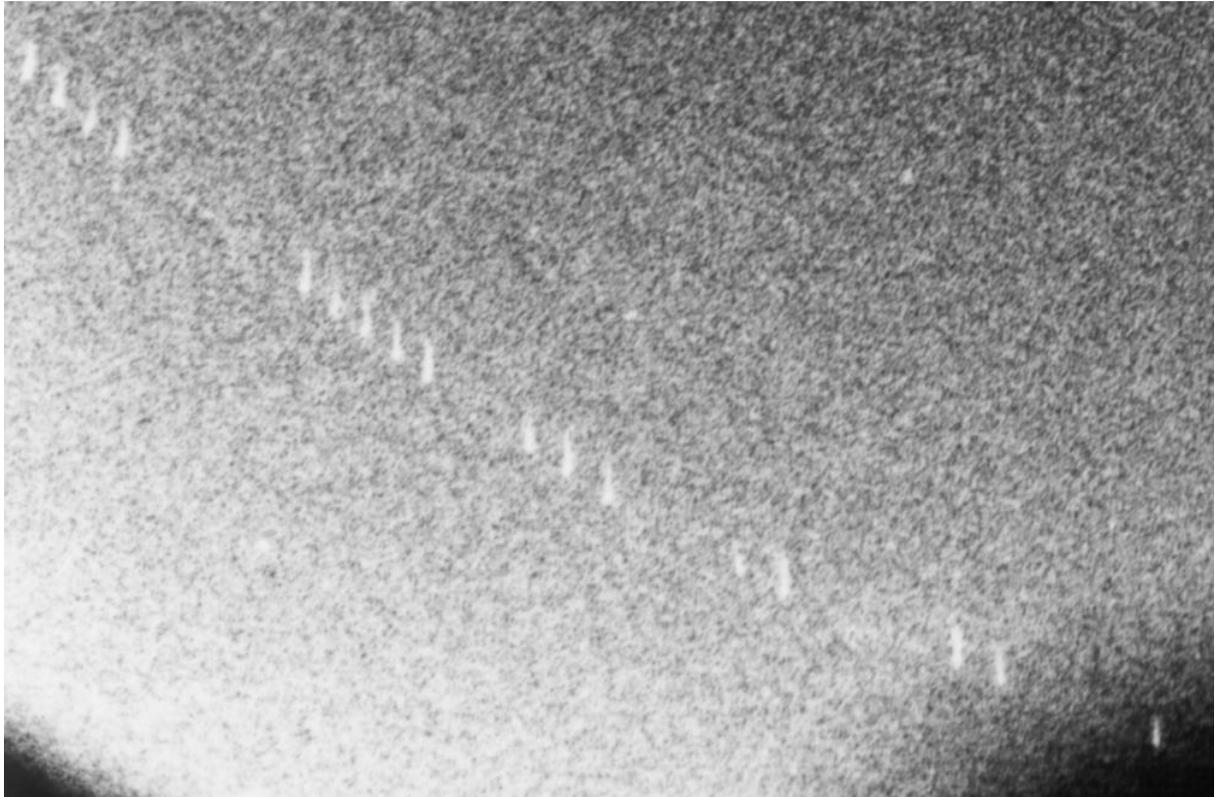


Figure 41. Close-up of “mystery” trails. Frame 66-21 (10 January 1986).

Figure 42, frame 67-08, taken 12 January 1986, 04:24:00– 04:54:00, shows a magnitude -10 fireball lasting for 8.4 seconds. I reported the observation to George Spalding, Director of the BAA Meteor Section; by considering reports from various observers he was able to deduce that the trail started approximately above Flamborough Head and proceeded in the direction of Gloucester.



Figure 42. Magnitude -10 fireball. Detail from frame 67-08 (12 January 1986).

End of the Project

In April 1986, together with former Chairman of OASI, Roy Cheesman, I travelled to Australia to observe Comet Halley. There, we enjoyed observing under ideal conditions, with utterly dark, crystal clear skies, the like of which I have not experienced elsewhere. Unfortunately, on my return home, the contrast was immediately obvious between the magnificent southern skies and the light-polluted, yellowish-grey skies above Ipswich. The increasing problem of light pollution, coupled with

poor air quality and the sheer amount of effort in taking the images, developing the films and above all, scanning manually the detail of each frame, meant that I decided to end the project. As a grand finale, I used, for the first time, a colour film (Agfa 1000) in the camera during the first half of May 1986. I logged a fireball track on the night of 07 May 1986 but, alas, the film is no longer available. This was my final attempt to improve the technology of the system.

After almost 650 hours of exposures, covering almost eight years, 2187 frames and 25 recorded events, I retired the camera.

This report is the only summary of the project and the results that it achieved. I write it (somewhat belatedly!) in the hope that it may interest anyone researching fireballs and the technology to observe them in the UK during the decade from the mid-1970s to the mid-1980s.

I would like to thank James Appleton for assistance in editing this report.

Alan Smith

Appendix – Correspondence With The BMS

