

Lunar impact flashes (LIF)

Why and how?

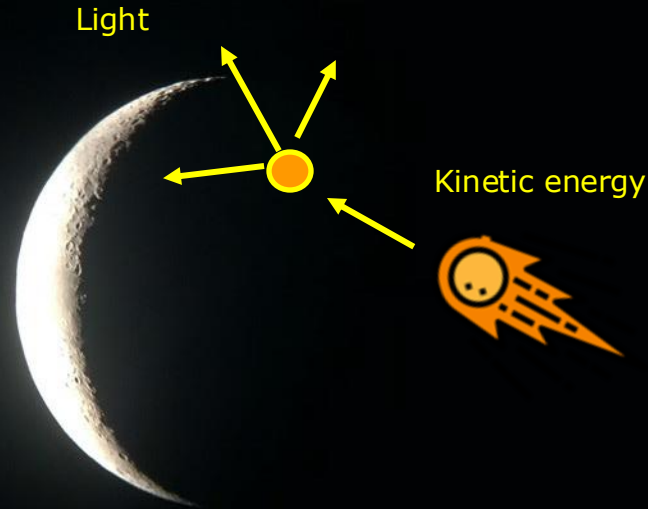
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CLUPI technical manager, Space Exploration Institute, CH

Detlef.Koschny@tum.de

What do we see?



$$E_{lum} = \mu \frac{1}{2} mv^2 \text{ where } \mu: \text{ luminous efficiency}$$



Impact flash - 01 Mar 2017
(Credit: NELIOTA/ESA)



LRO image. Credit:
NASA/GSFC/ASU

Why? – Flux densities and cratering processes

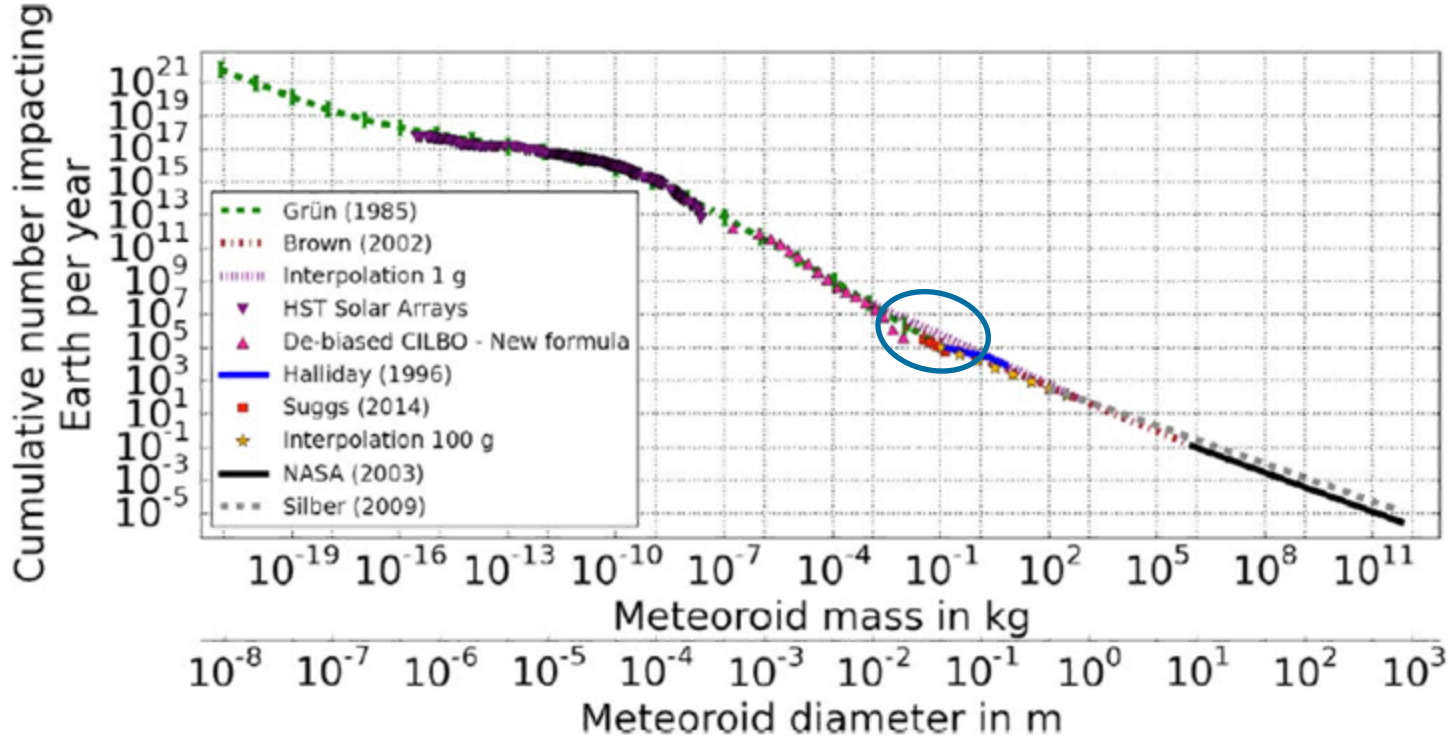


Fig. 10. All used flux density models in one plot including the estimated errors.



Contents lists available at ScienceDirect
 Planetary and Space Science
 journal homepage: www.elsevier.com/locate/psas

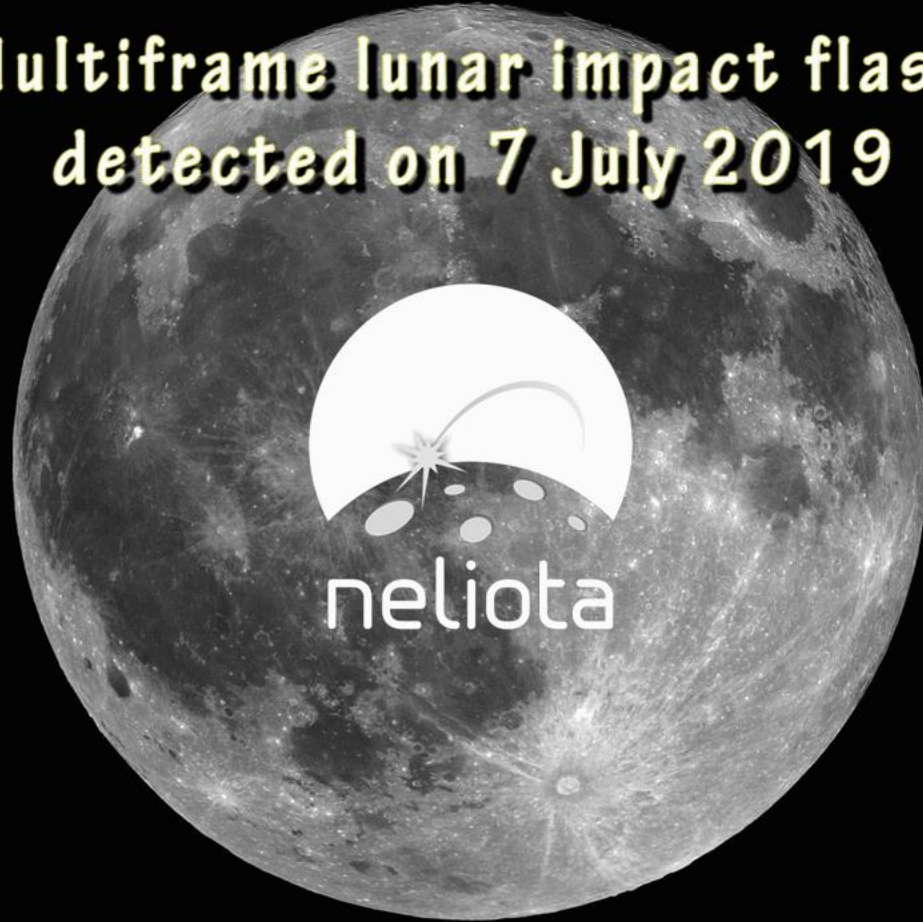



Mass accumulation of earth from interplanetary dust, meteoroids, asteroids and comets

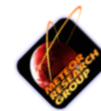
Gerhard Drolshagen^{a,*}, Detlef Koschny^{a,b}, Sandra Drolshagen^c, Jana Kretschmer^c, Björn Poppe^d
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Multiframe lunar impact flash
detected on 7 July 2019



<http://users.uoa.gr/~alliakos/neliota%20fil%20m/MF%20flash%20190707.gif>



Observing procedure in a nutshell

- 1. Take as big a telescope as you have, hopefully with little in-field straylight**
- 2. Mount a sensitive camera which can record with high frame rate (20 fps or faster – most use video rate) – make sure you have some magnitude calibration (see later)**
- 3. Point it to the non-sunlit side (henceforth called the ‘dark side’) of the Moon – coordinate with other observers if possible**
- 4. Use a detection software and press start – or: record on video if you have enough memory space**
- 5. If using e.g. the ‘Flash Detection Software’ (see later) – run some scripts over the acquired data, see whether there is a flash – be happy!**
- 6. If using video – use a software that can analyze the data – FDS in demo mode, LunarScan, ALFI (again see later)**
- 7. Inform Brian Cudnik (ALPO), Tony Cook (BAA), J. Madiedo (MIDAS), post on lunar-impacts@groups.io**
- 8. Hope that somebody else has seen it too!**

Observing programmes / setups

A night sky photograph featuring a bright crescent moon in the center. The moon is partially obscured by a faint, glowing nebula or cloud of gas. The background is a deep, dark blue, and the foreground shows the dark silhouette of a horizon or landscape.

- ❑ 50 cm RCOS telescopes
- ❑ 2 to 3 stations in the US

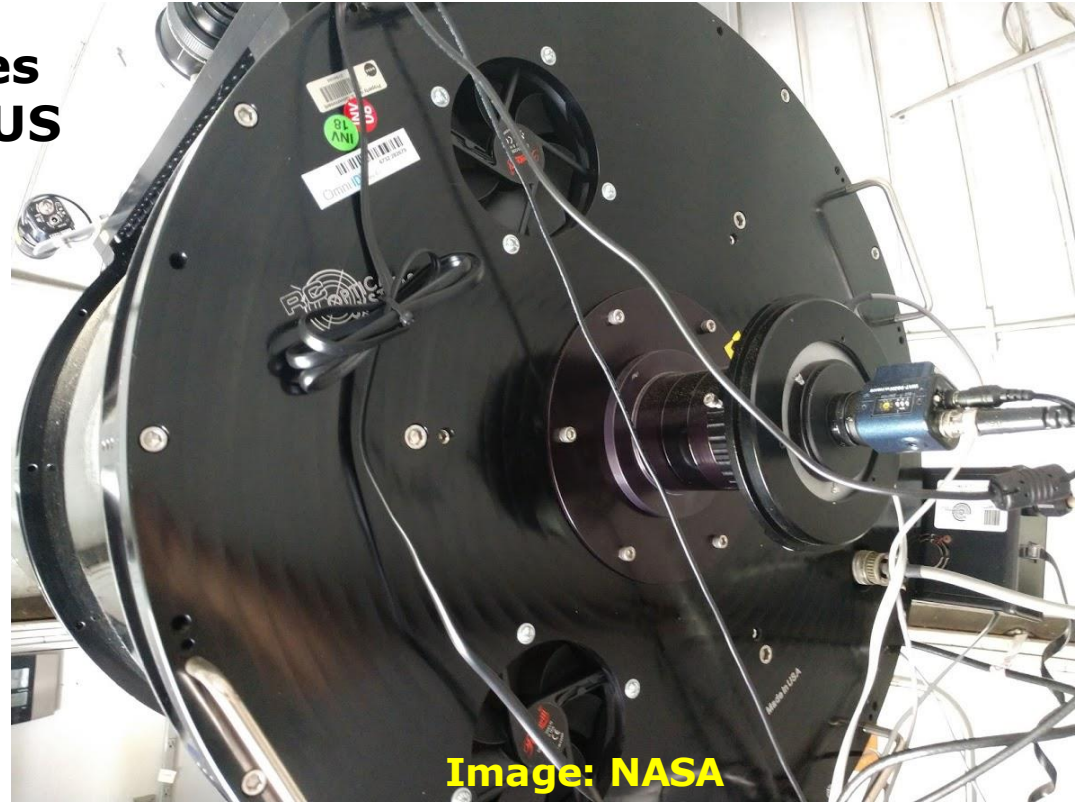
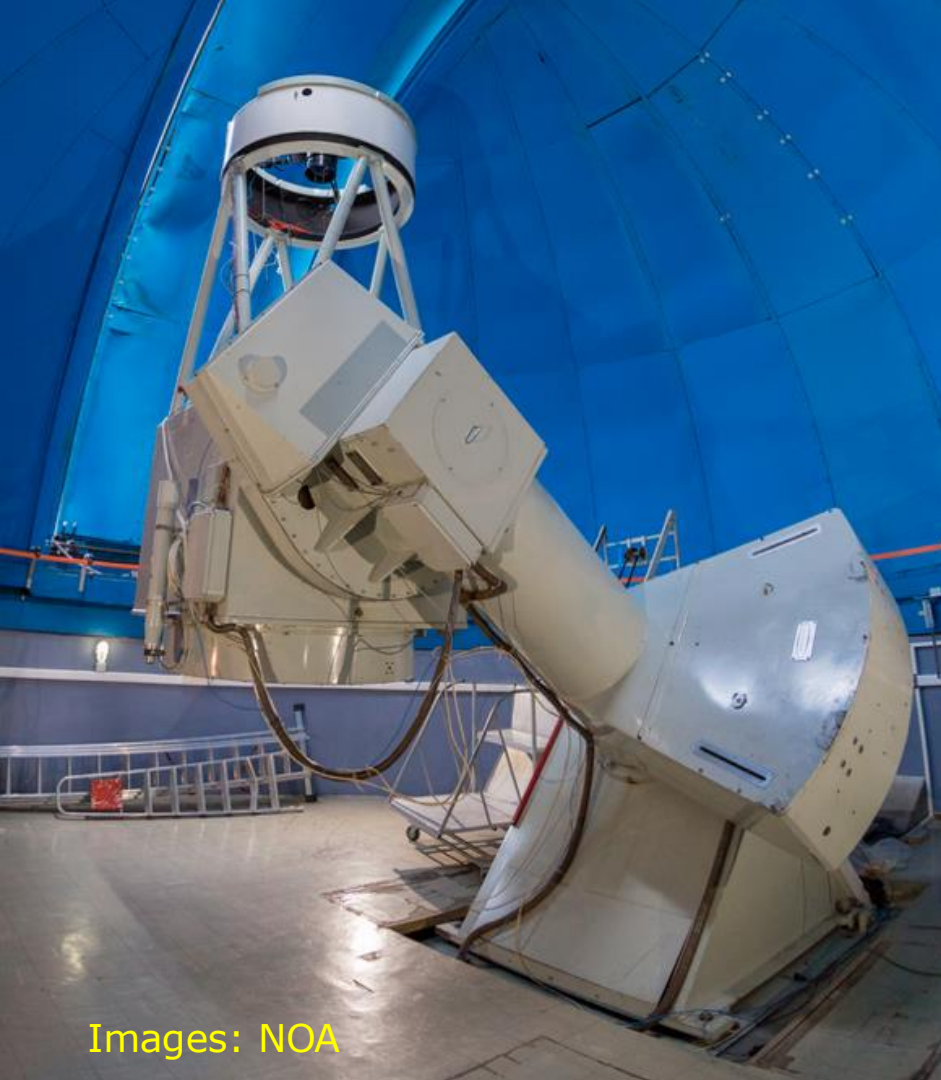


Image: NASA

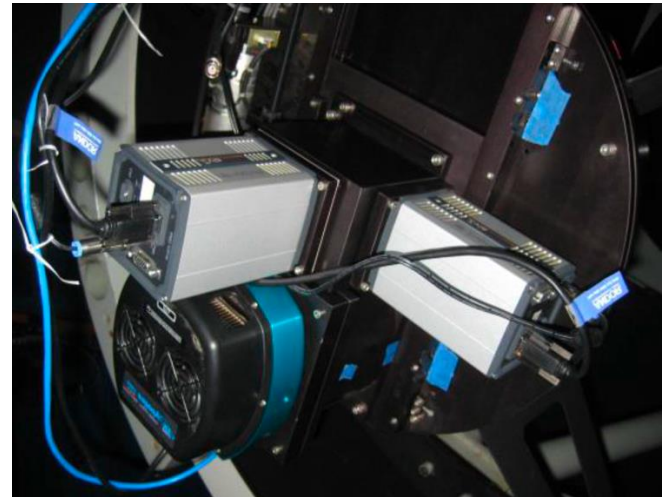


Images: NOA

Observing programmes – ESA/NELIOTA



- ❑ <https://neliota.astro.noa.gr>
- ❑ 2017 – 2023
- ❑ Two cameras with di-chroic
- ❑ 187 impacts in 278 hours



Observing programmes - MIDAS

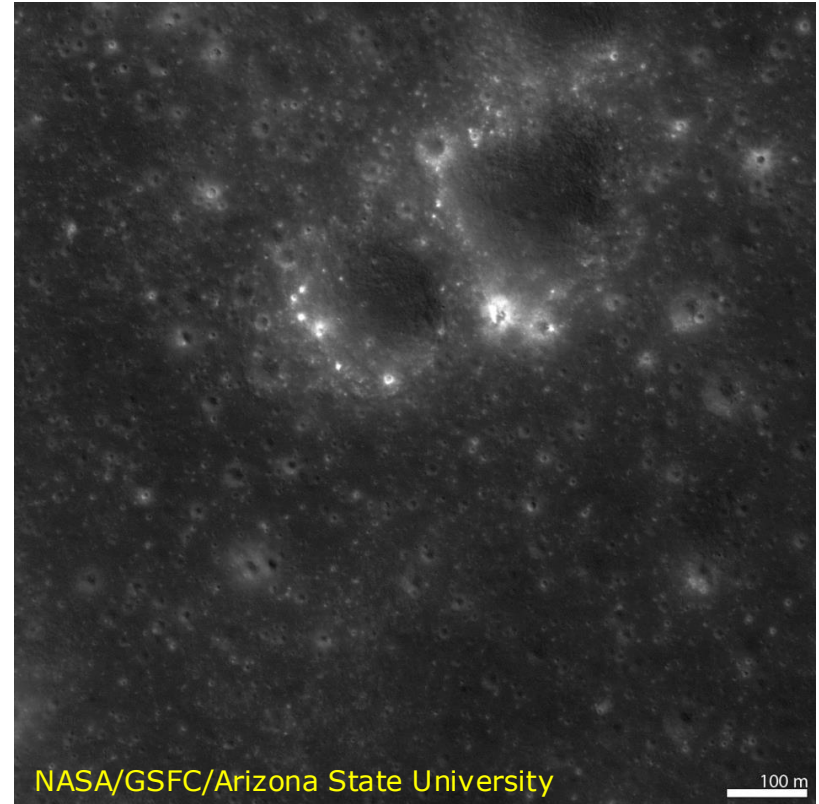


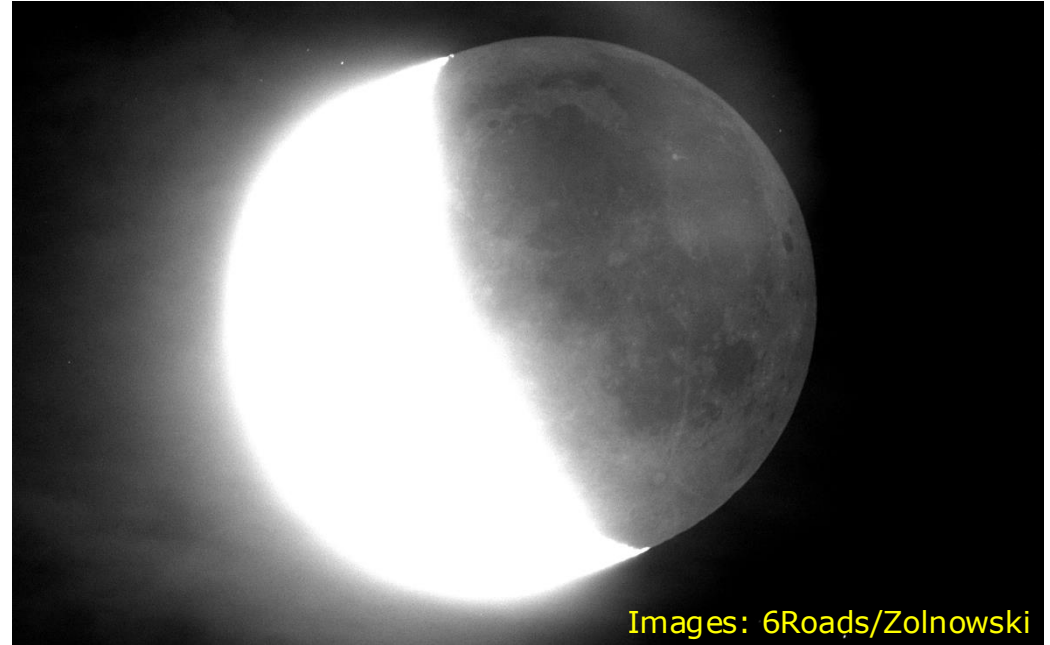
- 14" telescopes
- Several stations
- Status tbd



Image: Madiedo

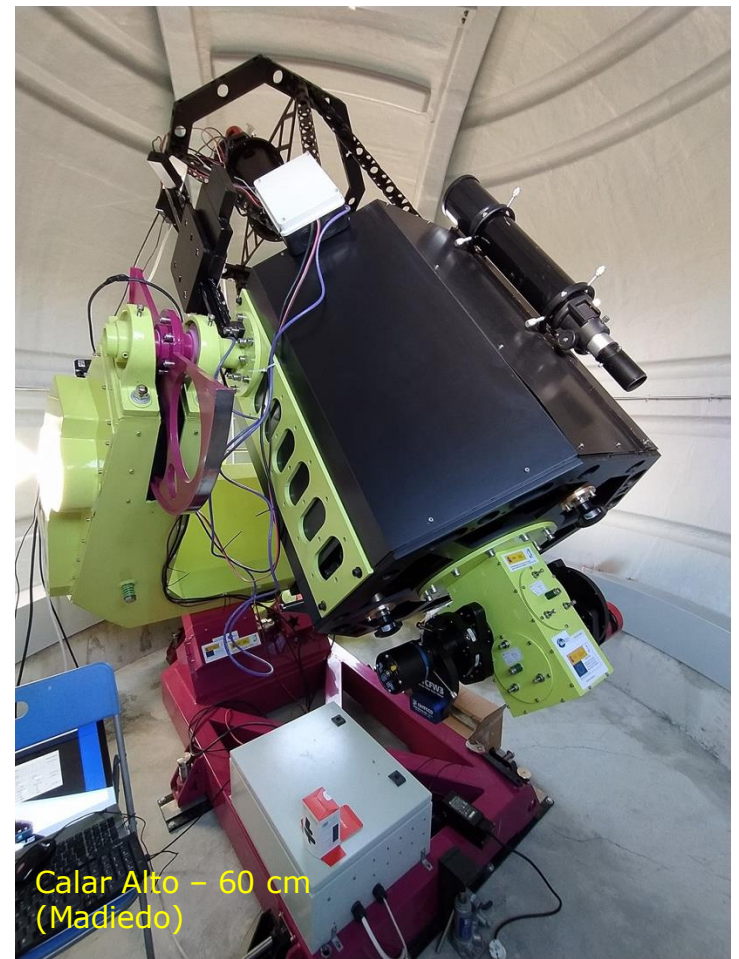
The longest flash so far





Images: 6Roads/Zolnowski

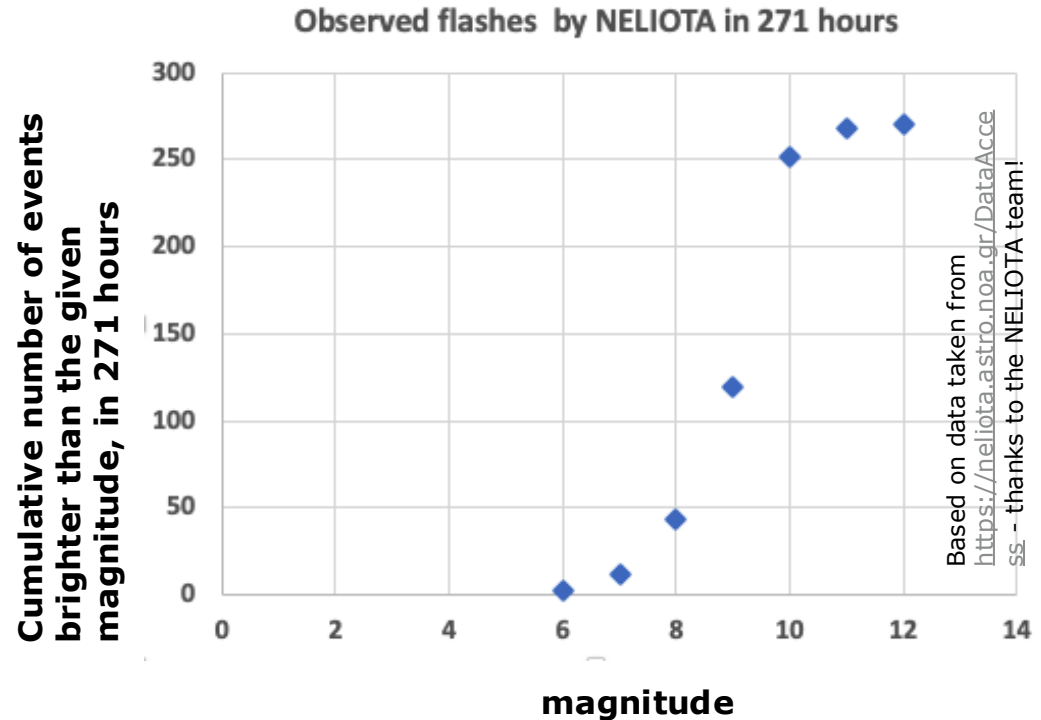
More?



How many flashes to we expect?



- ❑ **Brighter than 8 mag:
48 in 271 hours
=> 1 / 5.6 hours**
- ❑ **Brighter than 9 mag:
119 in 271 hours
=> 1 / 2.3 hours
(10" to 12" aperture?)**
- ❑ **Note: More during showers, less during sporadics only**



My setups - 10" Newton, 12"



Test setup – refractor 13 cm, 15 cm

And the camera:

QHY 174

1920 x 1200 px, 5.86 μ m

11.3 mm * 7.0 mm



Detection software

A night sky photograph featuring a crescent moon and a faint, diffuse galaxy or nebula. The text "Detection software" is overlaid in a bright yellow, bold font on the left side of the image. The background is dark blue and black, with some dark silhouettes of trees or structures on the right and bottom edges.



Flash Detection Software

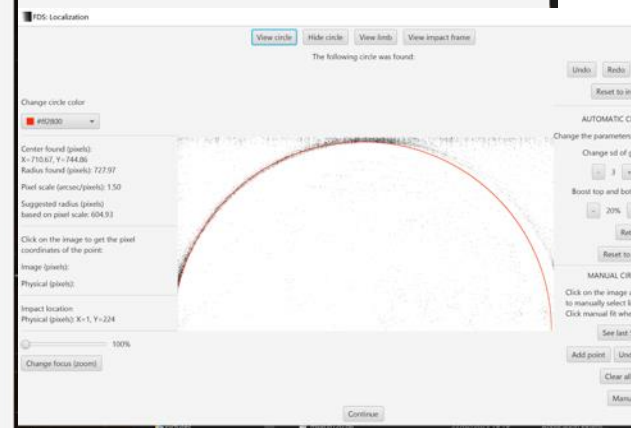
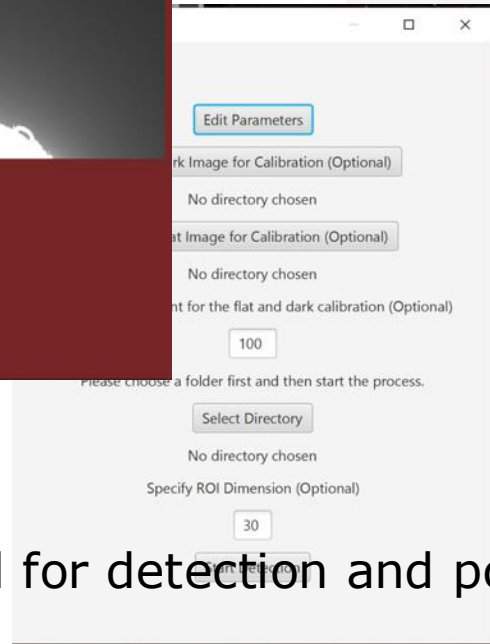
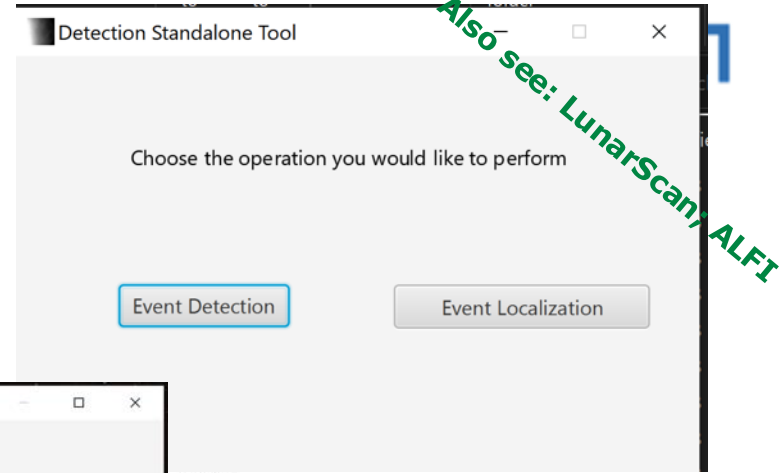
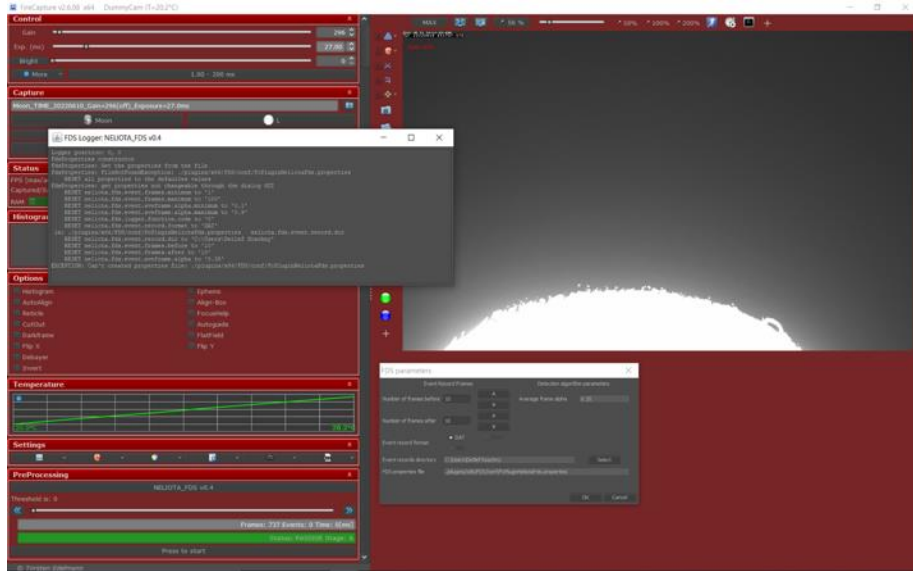
[Home](#) / [Flash Detection Software](#)

The Flash Detection Software (FDS) is a tool for detecting impact flashes on the Moon. This software can be used by any amateur or professional astronomer performing planetary observations with video cameras or fast-frame CMOS/CCDs for data processing and flagging all potential flash events. The ultimate goal is to encourage and increase the observations of impact flashes from both professional and amateur astronomers and to enable verification of impact flashes from multiple sites. The software was developed and tested for lunar impact flash observations, however, its use on planets (e.g. Jupiter, Mars) is encouraged.

<https://kryoneri.astro.noa.gr/en/flash-detection-software/>

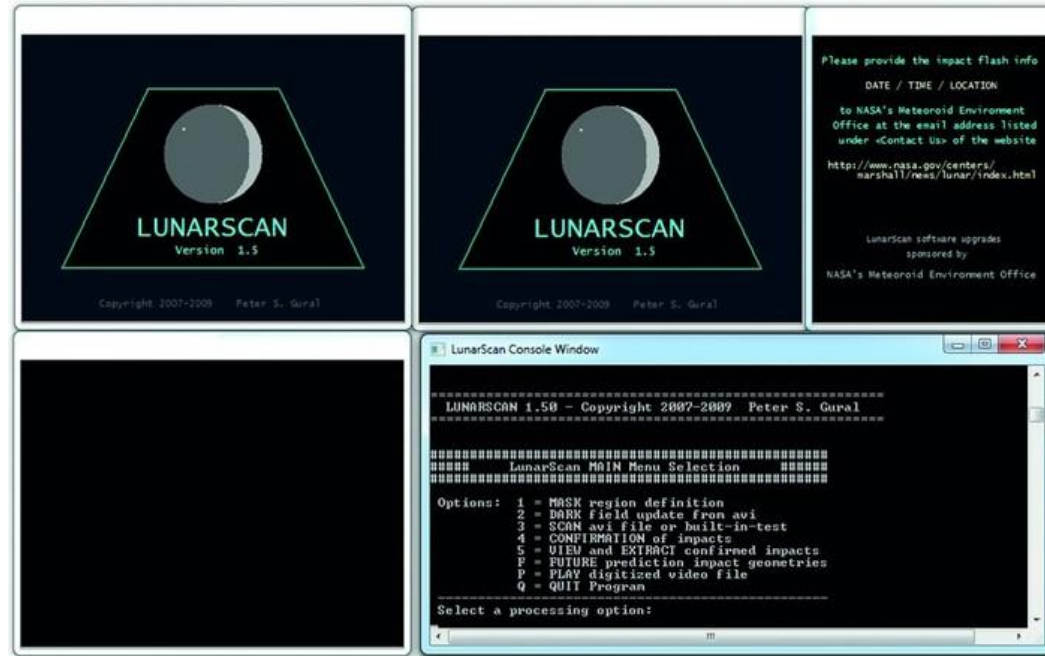
Flash Detection Software

“Real-time” quick and dirty detection

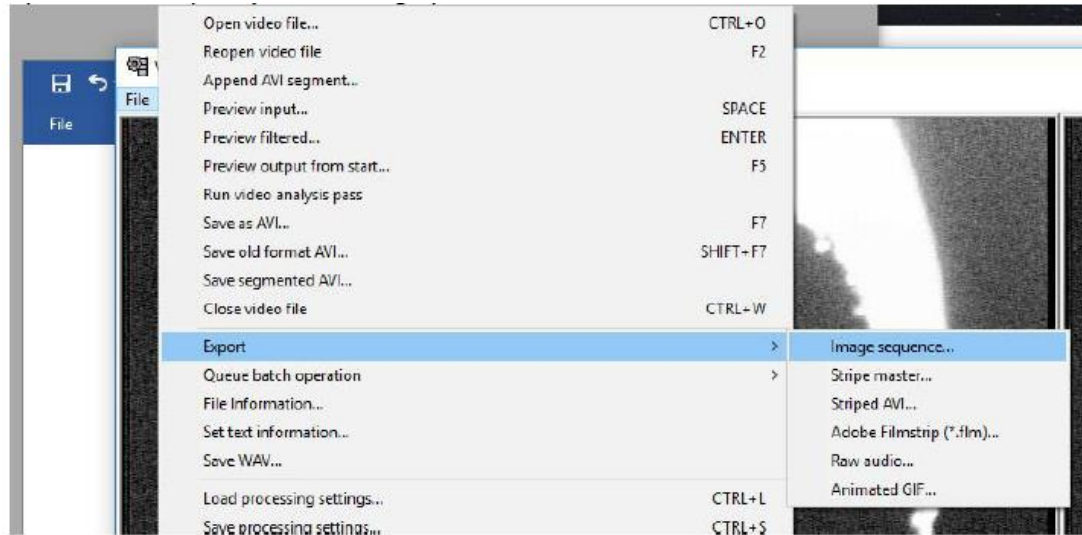


“Stand-alone” tool for detection and position determination

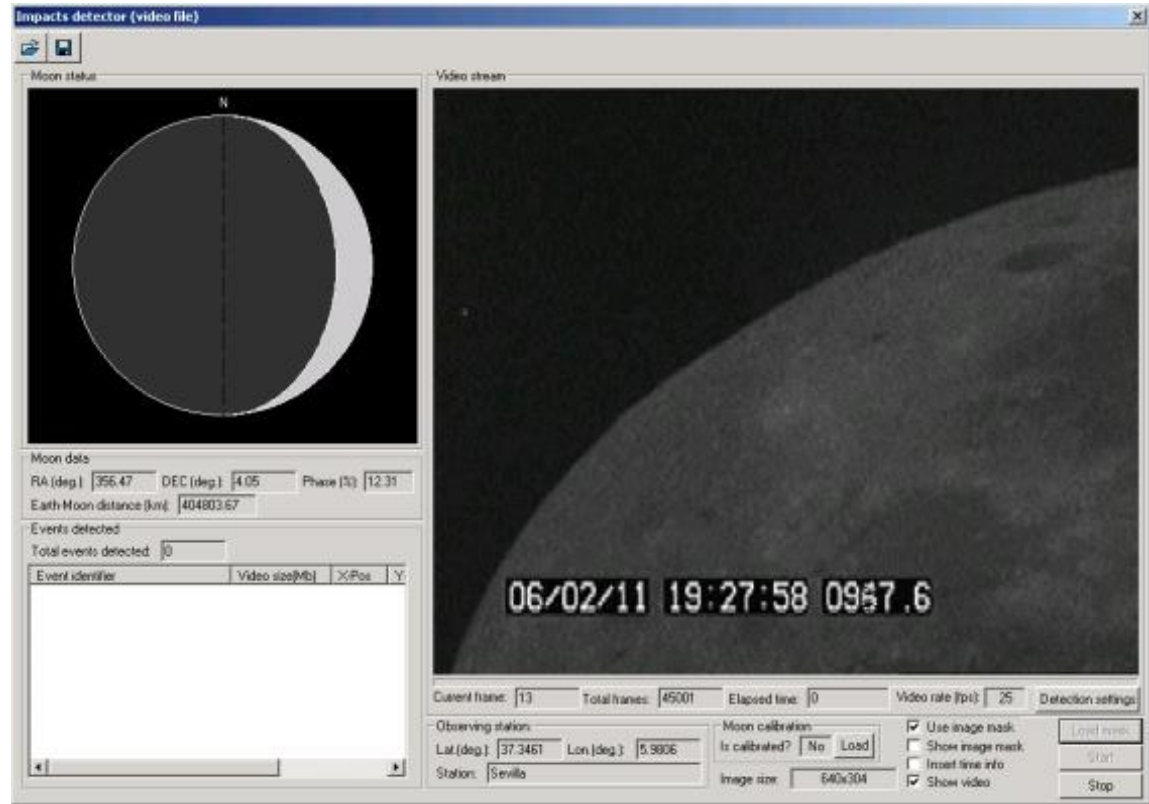
- ❑ DOS-based software to analyse video up to 720 px x 576 px
- ❑ <http://www.lunarimpacts.com/lunarscan15.zip>
- ❑ Note: “The software is free under the condition that you provide impact flash observations (date/time/location) to NASA's Meteoroid Environment Office at the e-mail address listed under "Contact Us" at http://www.nasa.gov/centers/mars_hall/news/lunar/index.html.”



- ❑ Windows software, requires data as sequence of bmp files
- ❑ <https://users.aber.ac.uk/atc/alfi.htm>



- ❑ Windows-based
- ❑ Used by Spanish team
- ❑ Not freely available (when I last asked)



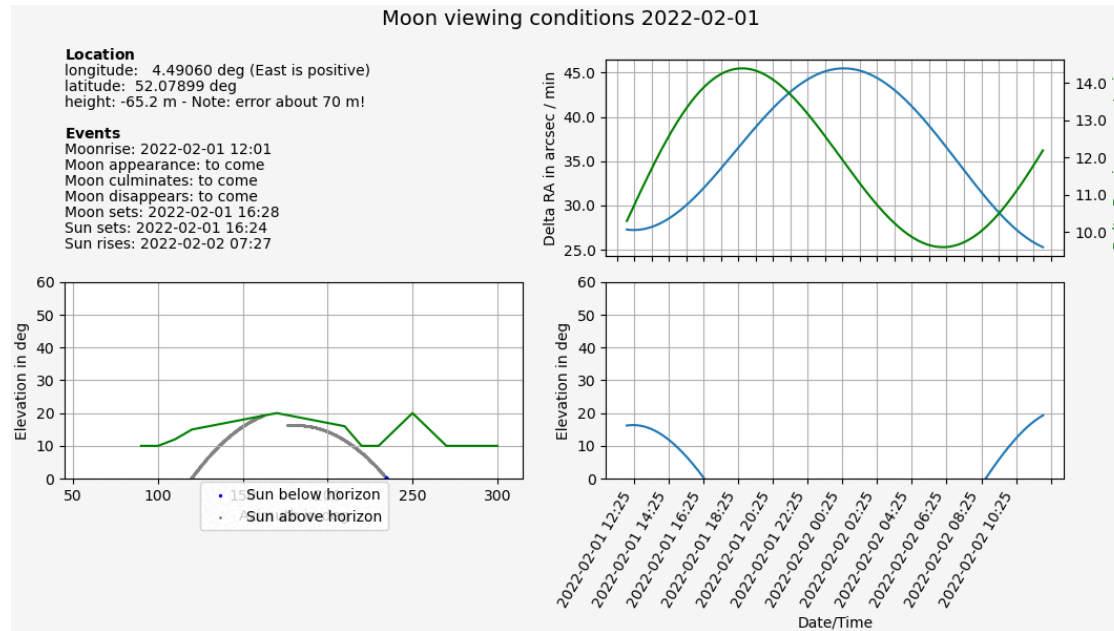
A night sky with a crescent moon and a star, with the text "Scheduling, tracking + guiding" overlaid in yellow. The background is dark blue and black, with a faint star visible in the upper left and a bright crescent moon in the center. The text is centered horizontally and vertically.

Scheduling, tracking + guiding

Dark sky / away from full Moon / elevation...



- A (still quite draft) Python script to visualize all this is here: <https://gitlab.com/dkoschny/moon>



Tracking or guiding

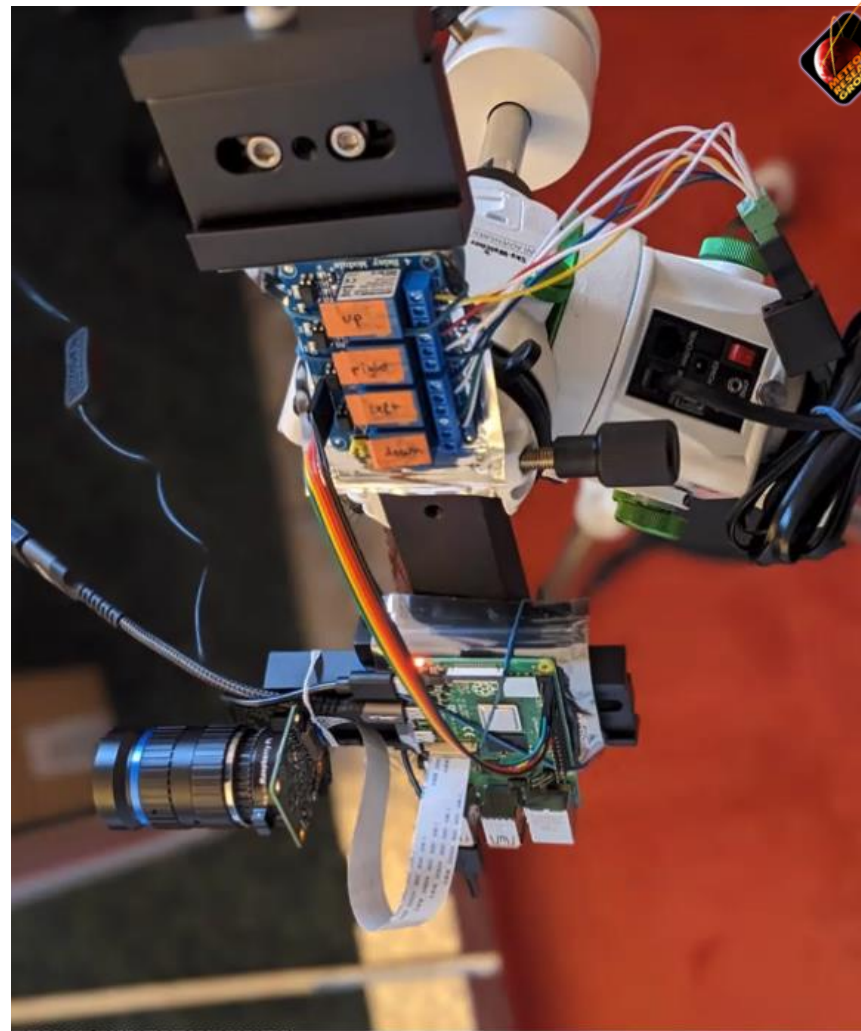
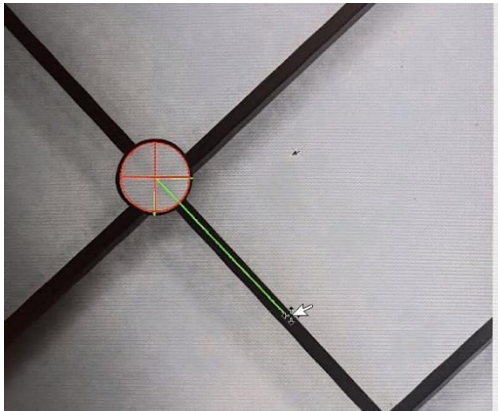


- ❑ Software to track the Moon exists – e.g. N.I.N.A., SkyTrack (<https://heavenscape.com/>).
- ❑ I wrote a Python script for ASCOM mounts <https://gitlab.com/dkoschny/moon>
- ❑ Tracking should work for well aligned mount

Guiding

Prototype guider
available:

- **RaspberryPI**
- **PI HD camera**
- **Lens**
- **relay board**
- **cable to ST-4 interface**





Magnitude calibration



Magnitude calibration



Formsheet for observations

Before starting, check the following:

- Mount is aligned
- Mount set such that no pier flip will be needed during the observing run
- Mount has enough battery power, or is connected to power
- Cables routed such that over the full expected recording time they don't block the tracking
- Dew protection in place
- Recording computer has enough free disk space
- Recording computer has enough battery power (or is connected to power)
- No unnecessary processes are running in the background
- Computer clock is synchronized to [some time server](#). Time zone (UTC preferred): _____
- Telescope is aligned
- Telescope is in focus
- A recent magnitude calibration is existing

Configuration of this night

Camera	Make/type	Pixel size	IR-block filter on camera?	Extra filter?	Comments (e.g., cover glass removed)
Telescope	Make/type	R = Refractor, N = Newton, SC = Schmidt Cassegrain, O = other (specify)	Aperture in mm	Focal length in mm	Correctors, barlow?
Mount	Make/type		Azimuthal / equatorial	Guiding	
Software	Make/type		Version		
Recording	Frames/s	Exp. time in ms	Gain		
Begin time (UTC)					
End time (UTC)					
Transparency	(Scale: tbd)				
Seeing	(Scale: tbd)				

D. Koschny – AMM-HO-054/1.0, 29 Nov 2023



Sketch Moon with illuminated part, N-S and E-W orientation, and the field of the camera as seen on the monitor.

Record of events

Slews (note times, or say roughly how often)	
Clouds in front of Moon (note time slots, from – to)	
Other events (note times)	

Derived values

Total recorded time (end – begin – interruptions due to clouds or other)				
Comments:				

Useful for citizen science and professional observers => comments from WG requested - Contains check list and items to record

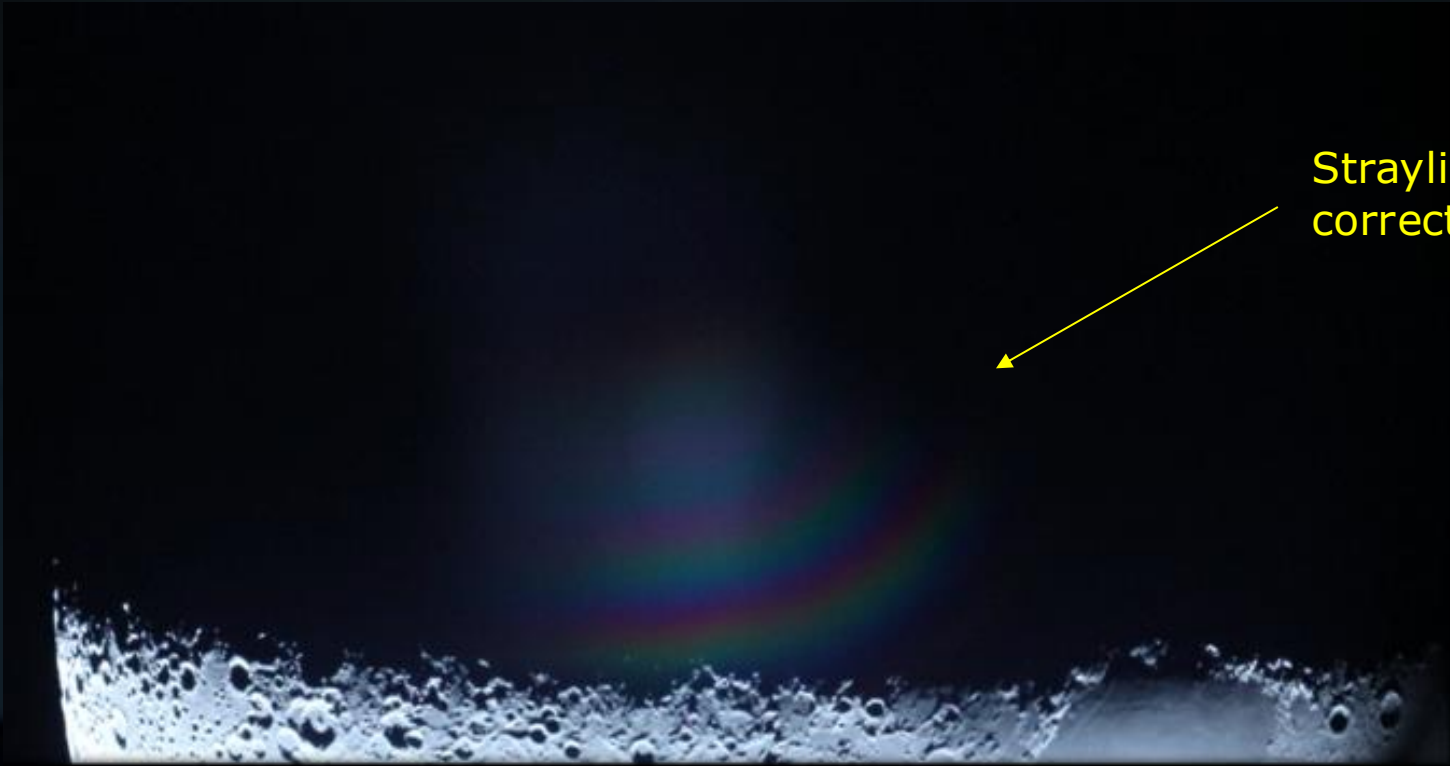
Important: effective observing time, observing area (as for meteor observers) https://www.asg.ed.tu.m.de/fileadmin/w00cip/lpe/_my_direct_uploads/TKO-FO-001_1_1_LIF_observing_log_2023-07-08.pdf

Lunar impact flashes – what needs to be done?



- ❑ Settings of camera – gain, exposure time – guidelines would be useful.
- ❑ Straylight
 - With my setup: up to two days *after* 50 % illumination seems ok – with refractor even longer!
 - NELIOTA stops before 50 %.
 - Don't use open truss systems.
 - Try “re-imaging” system, coronagraph-type optics. Proposed e.g. by Koschny (2005), Ground-based monitoring of Venus fireballs, Comp. meteor studies on terrestrial planets, 11-12 Nov 2005, Graz, Austria – and others.... – for the future
- ❑ Coma corrector introduced straylight and strange shadow effects
 - Should we use one or not? – Not clear to me.
 - Magnitude calibration must be done – needs procedure (e.g. point to open clusters)





Straylight due to
corrector lens system

**→ Straylight; frame rate; guiding... All a challenge
– optimize the instrumental setup!**

Small telescope – optimized instrument - science results



13 Aug 2023, during the
Perseid maximum.



<https://www.asg.ed.tum.de/en/lpe/research/near-earth-objects-and-impacts/lunar-impact-flashes/>



Post on Facebook, G. Palten:

<https://www.facebook.com/photo.php?fbid=6624084130958504&set=p.6624084130958504&type=3>