Lunar Impact Flashes – the how

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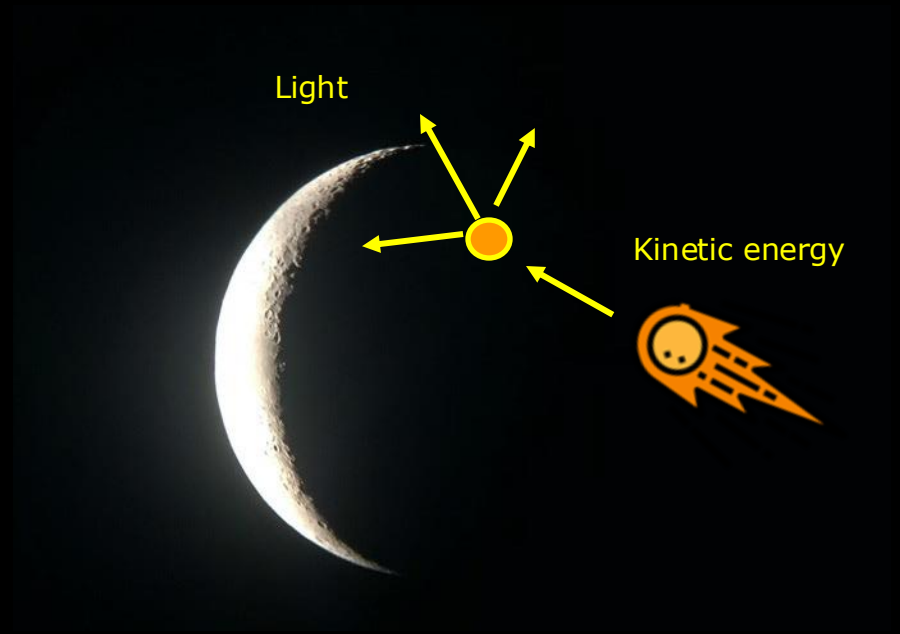
What do we see?



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

LRO image. Credit:
NASA/GSFC/ASU

Quick reminder on 'why' – Flux density, impact processes…

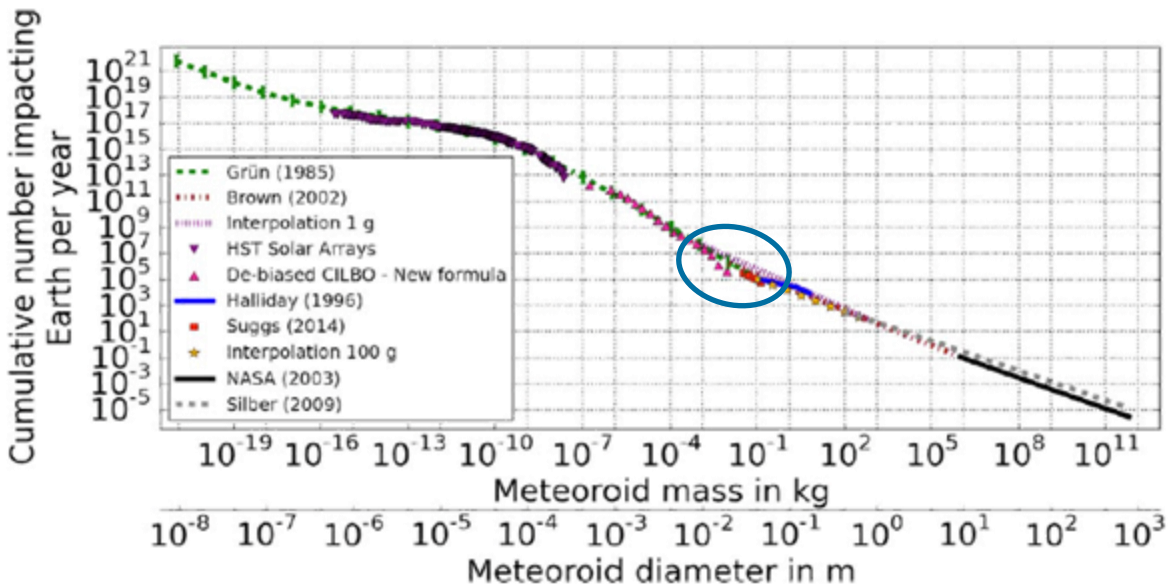
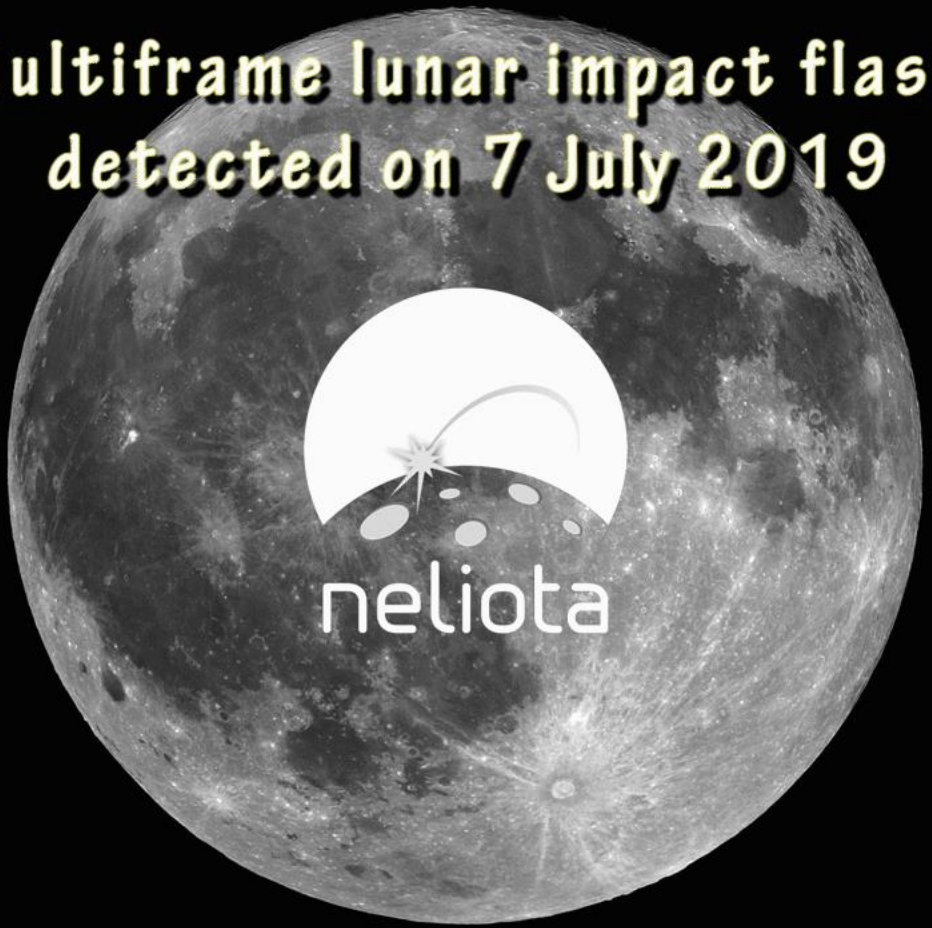


Fig. 10. All used flux density models in one plot including the estimated errors.

Multiframe lunar impact flash detected on 7 July 2019



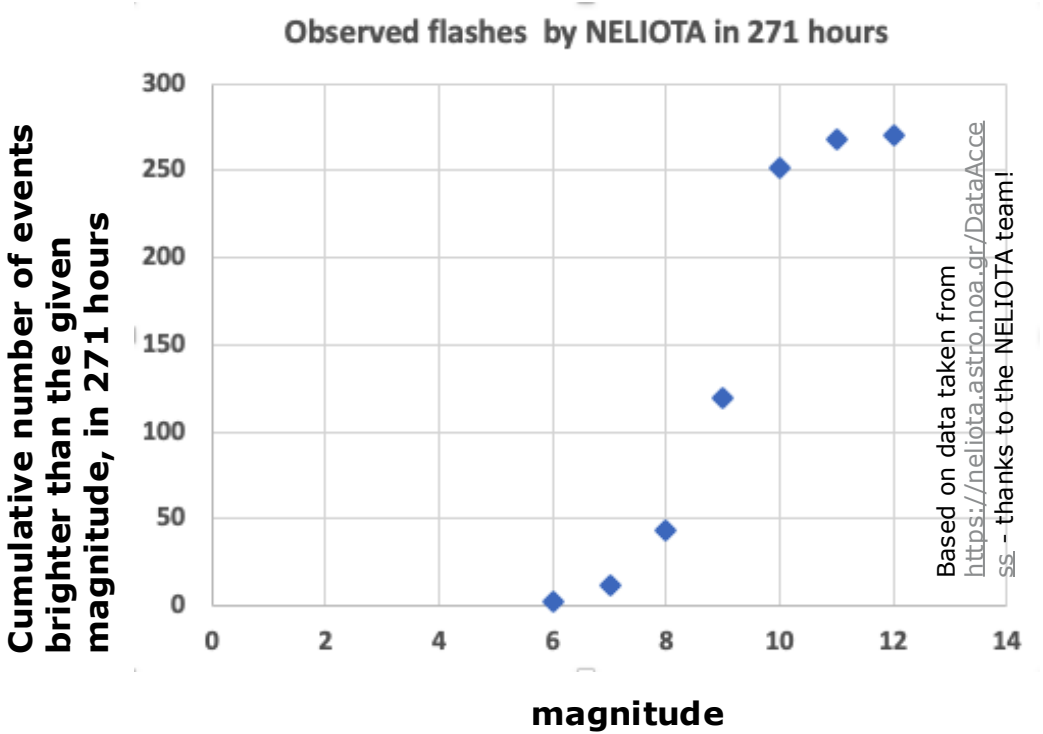
http://users.uoa.gr/~alliakos/neliota%20film/MF%20flash%20190707.gif

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 (10 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 analyse 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!

How many do 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, later 12”

Test setup – 13 cm Refraktor

And the camera:
QHY 174
1920 x 1200 px, 5.86 um
11.3 mm * 7.0 mm

Test setup – 6” Refraktor


Detection software

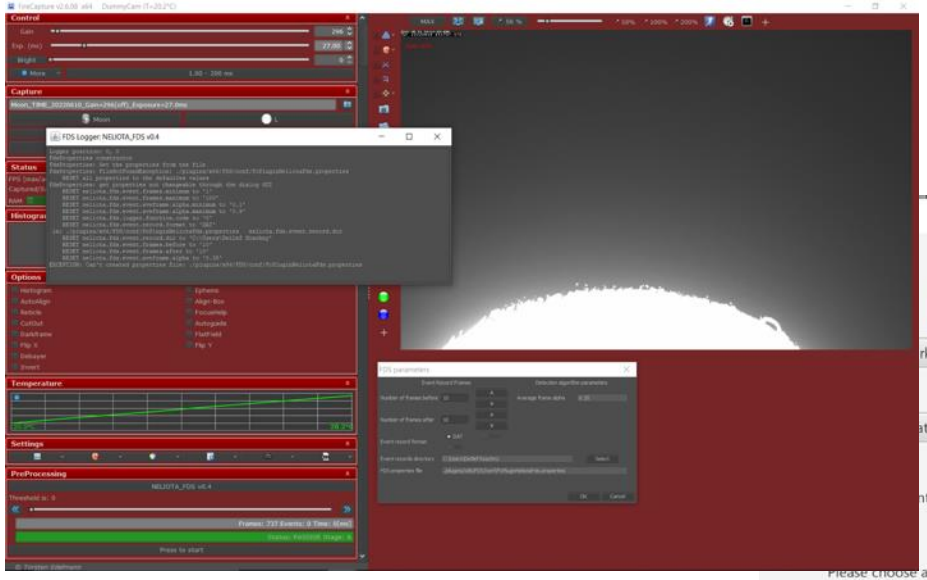
Flash Detection Software

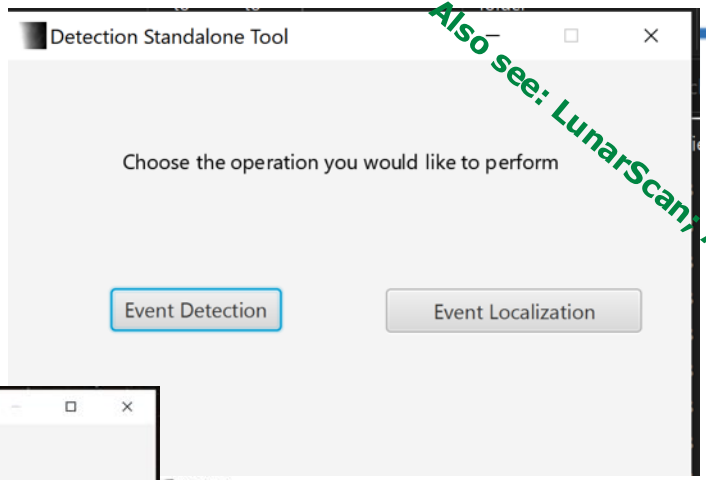
The Flash Detection Software (FDS) is a tool for detecting impact flashes on the Moon. This software can be used by any amateur or professional astronomer performing planetary observations with video cameras or fast-frame CMOS/CCDs for data processing and flagging all potential flash events. The ultimate 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/

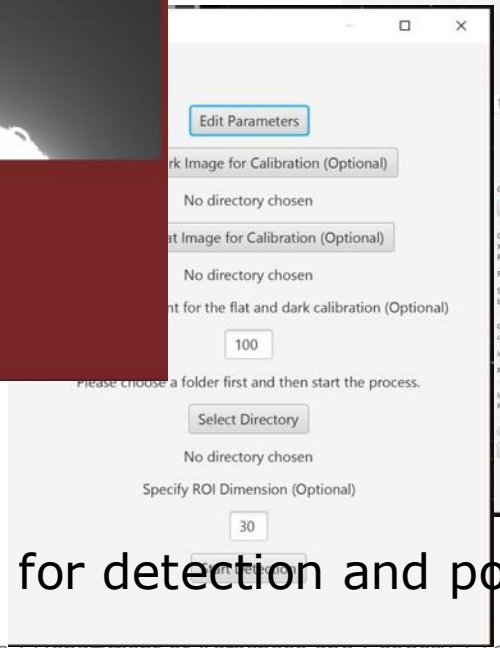
Flash Detection Software

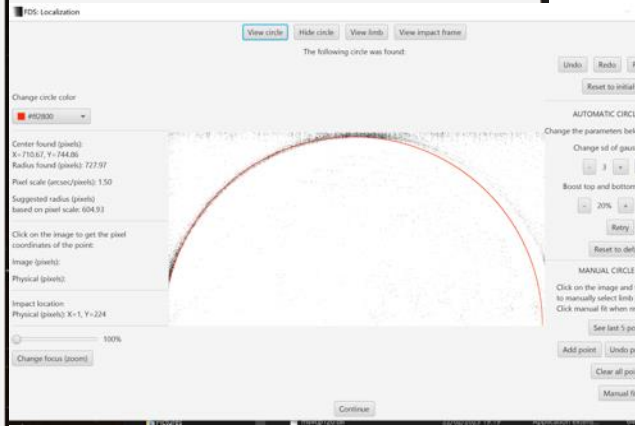
”Real-time” quick and dirty detection





Also see: LunarScan, ALFI

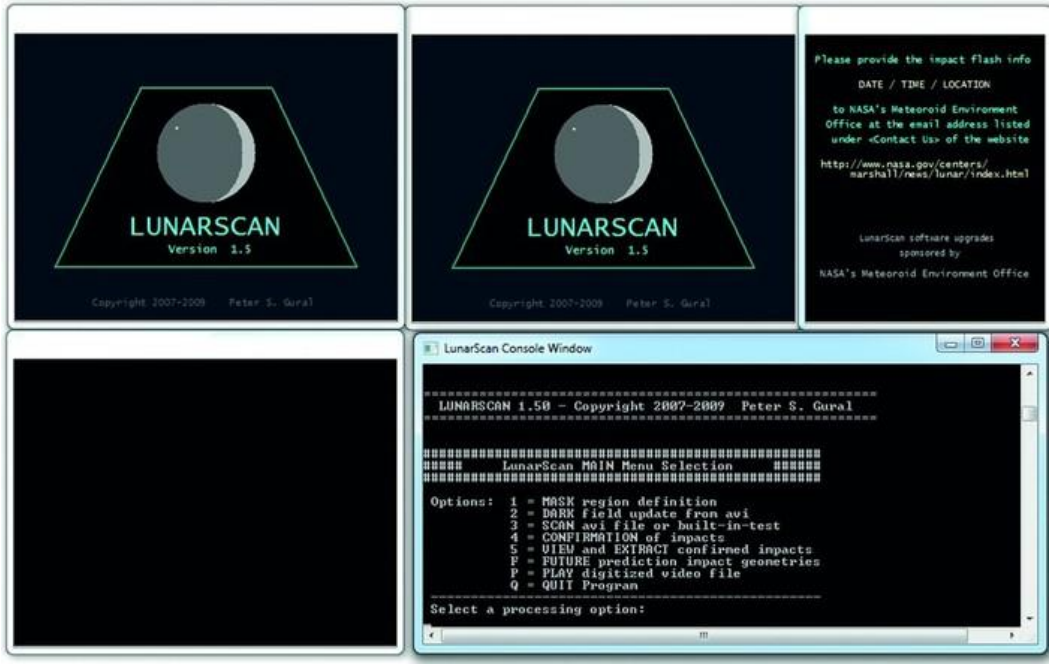




”Stand-alone” tool for detection and position determination

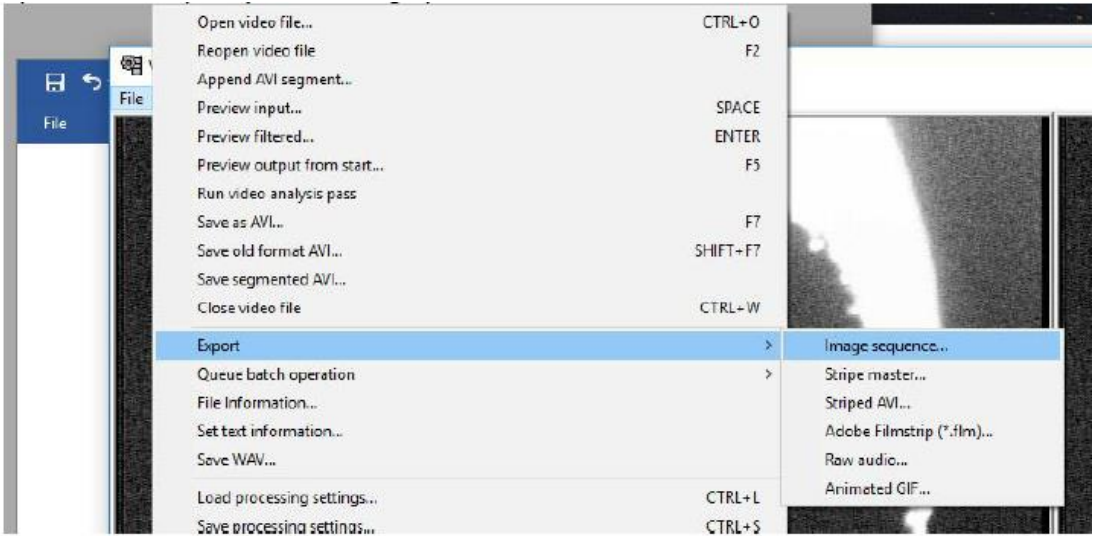
LunarScan

- **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/marshall/news/lunar/index.html.“



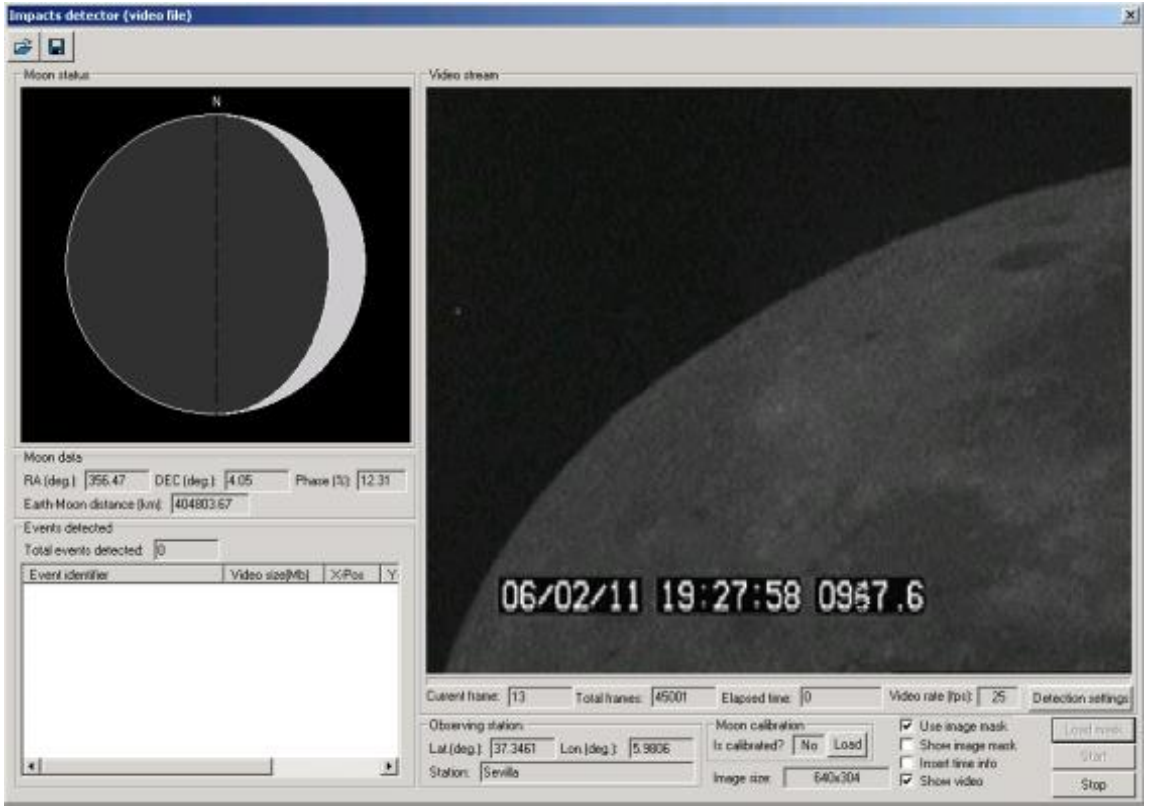
ALFI

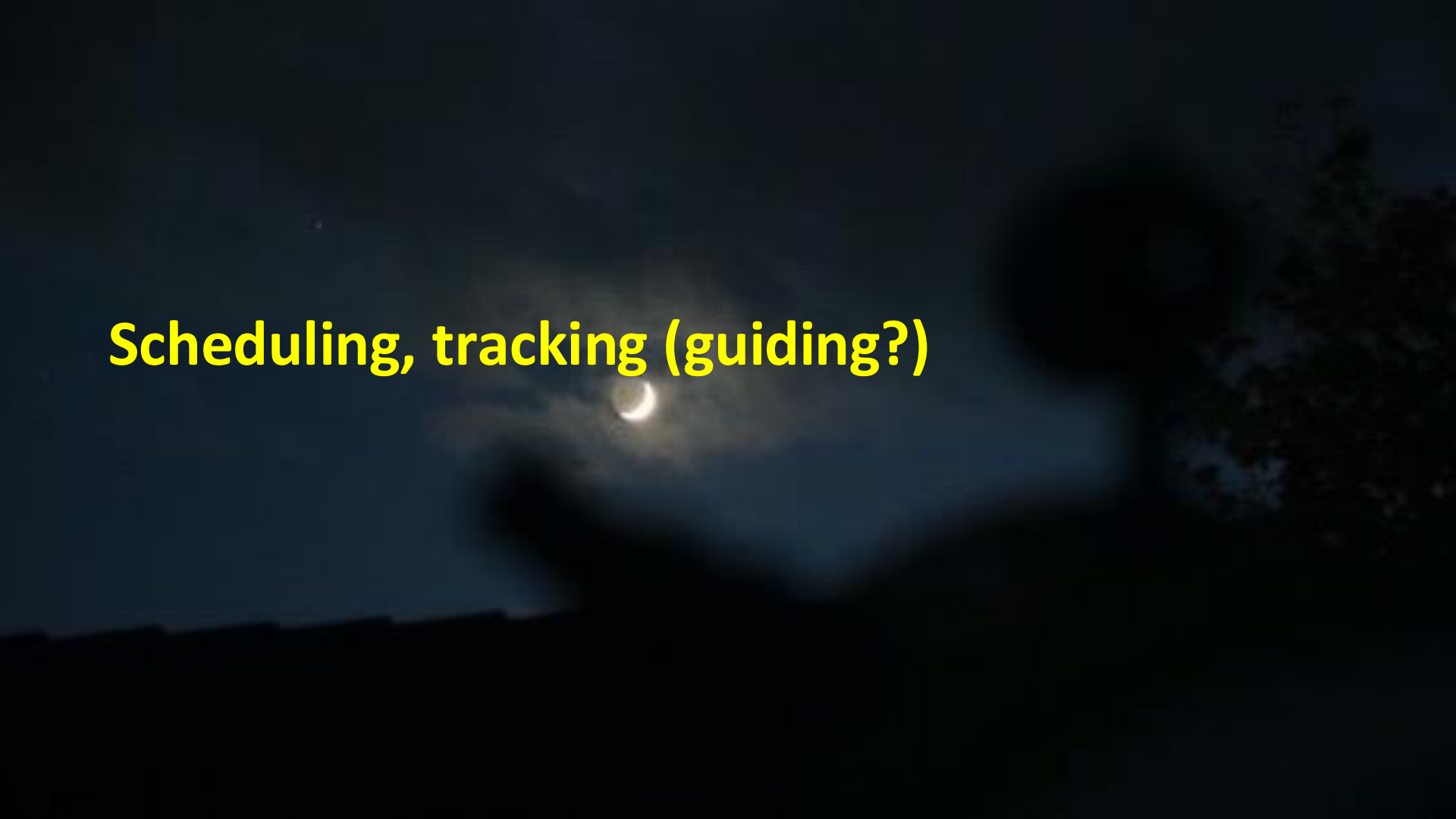
- Windows software, requires data as sequence of bmp files
- https://users.aber.ac.uk/atc/alfi.htm



MIDAS

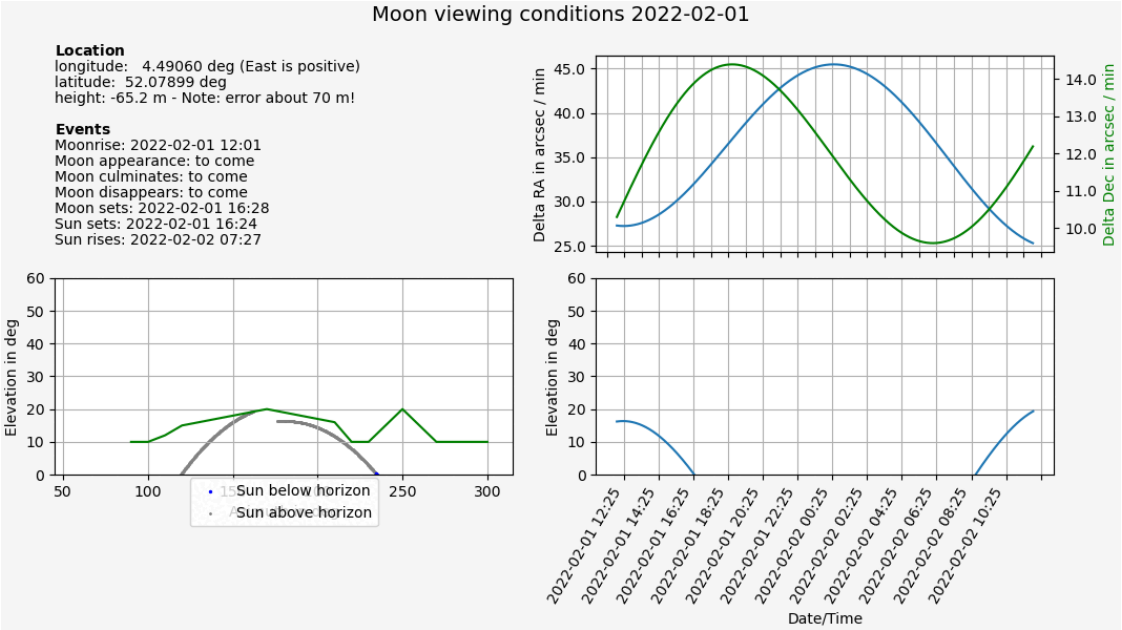
- Windows-based
- Used by Spanish team
- Not freely available (when I last asked)




Scheduling, tracking (guiding?)

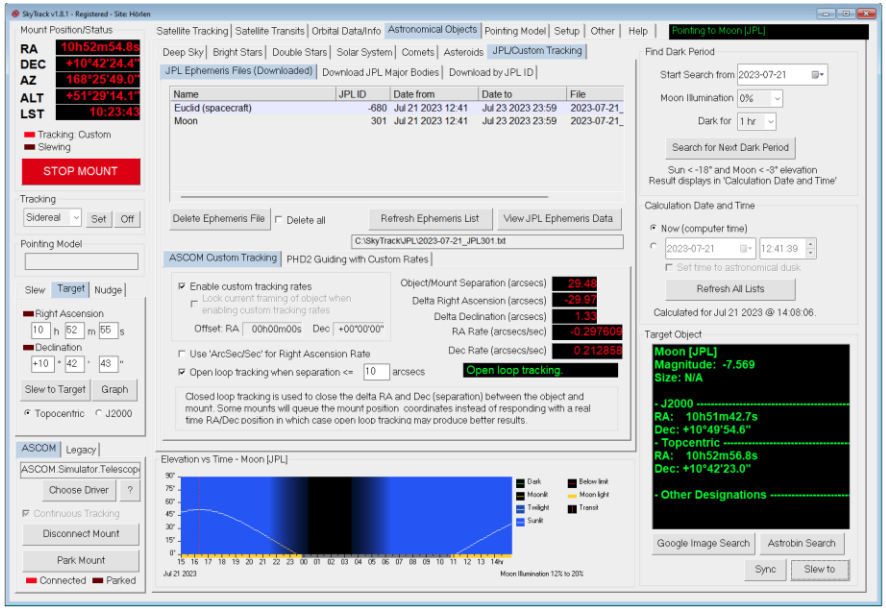
Dark sky / away from full Moon / elevation...

- 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**



Magnitude calibration

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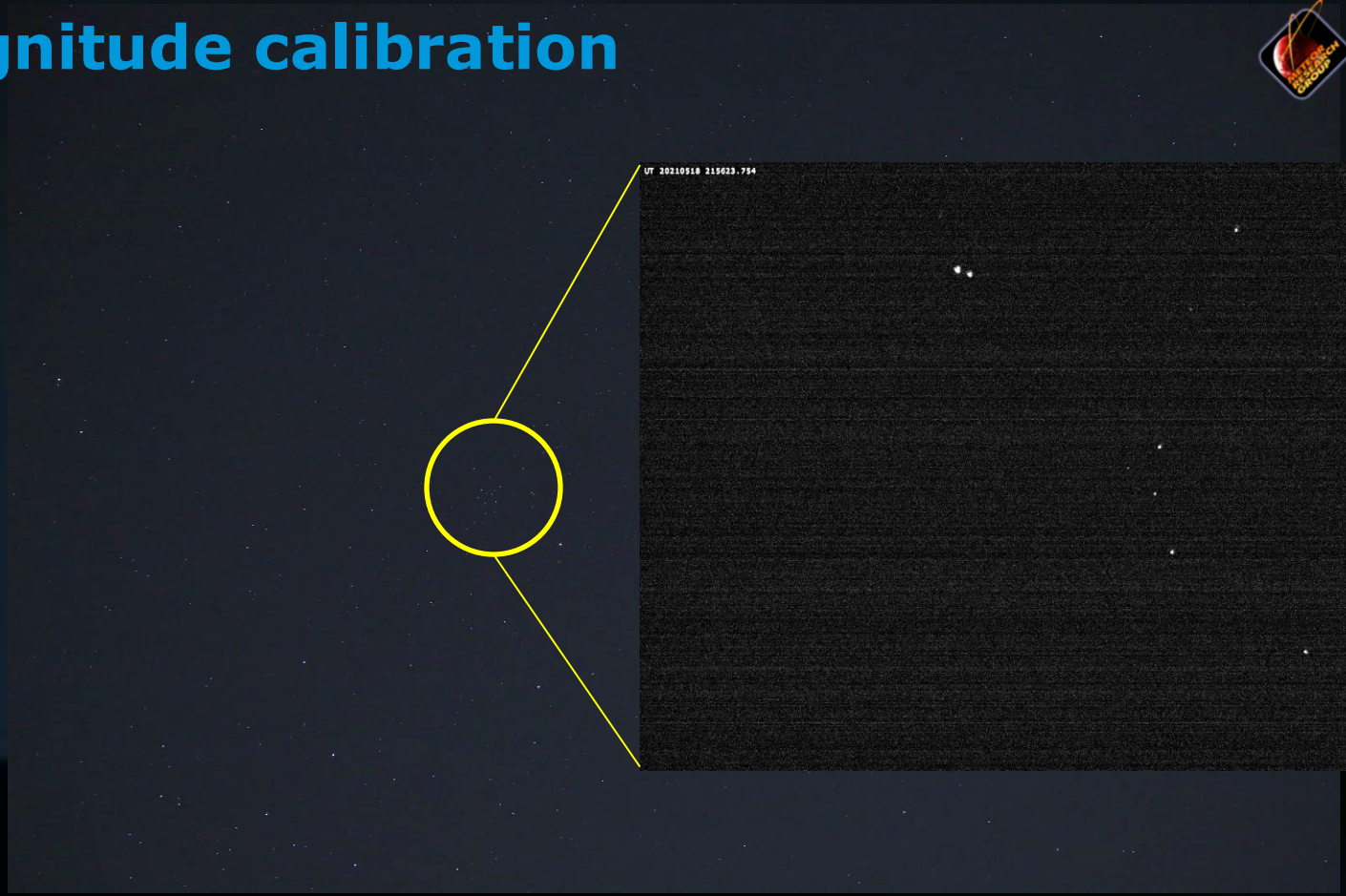
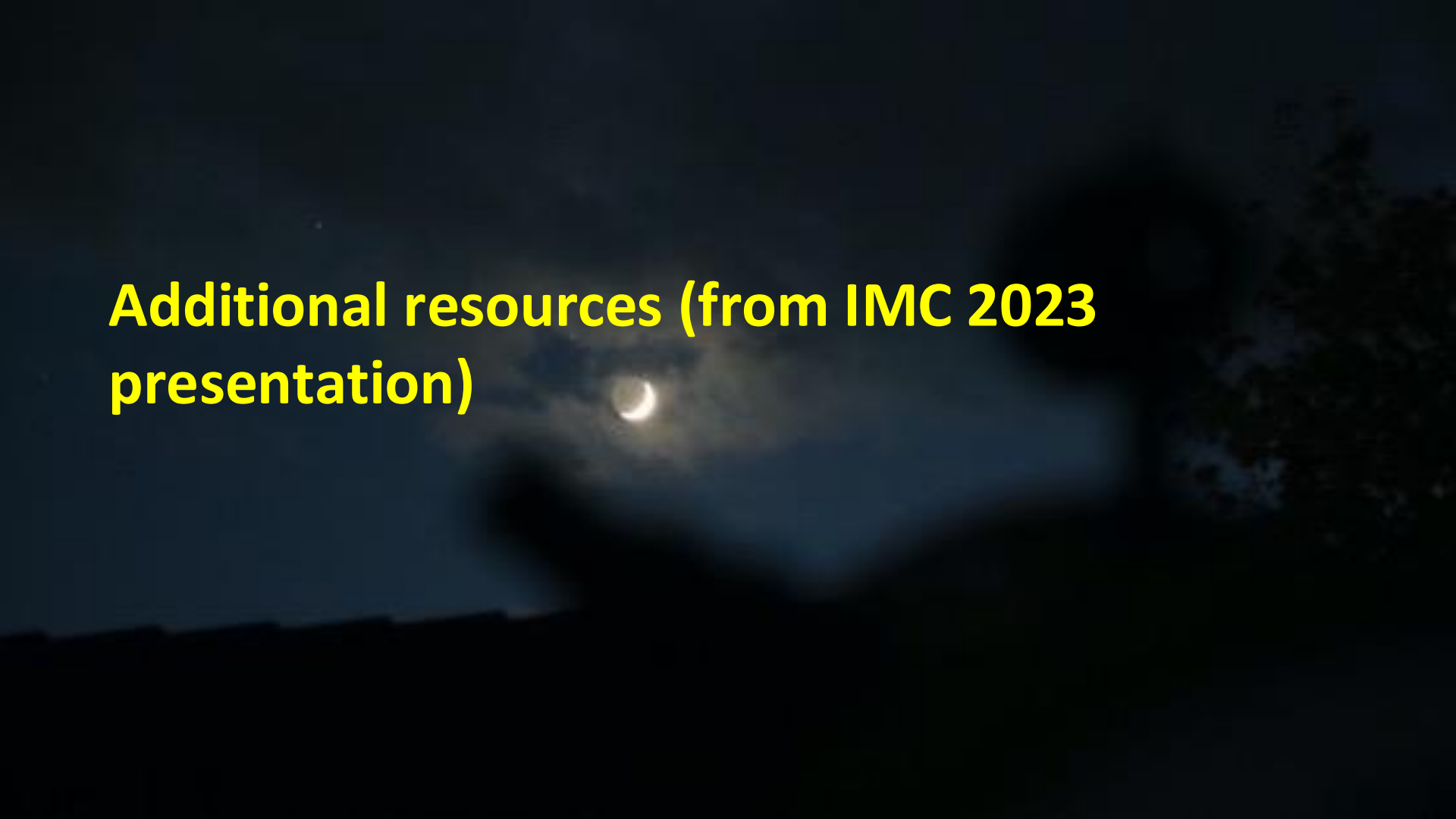


More on magnitude calibration

- NELIOTA uses photometric standard stars – but also uses two cameras with different filters to derive temperatures
- Might be overkill for single camera observations. The previous example was the summer beehive cluster; in winter I would use M45, Hyades…
- A standard list for targets is not (yet) there



Additional resources (from IMC 2023 presentation)

(Some) ongoing activities and web resources

- Four workshops related to the topic (and others) took place, funded via EuroPlanet (EU funding), see here: https://www.europlanet-society.org/europlanet-workshop-series-on-fireballs-and-their-detection/ - presentations are available there
- The ESA-funded NELIOTA project (https://neliota.astro.noa.gr) has been observing impact flashes for >6 years – but: funding has stopped a few months ago
- The ESA/ASI space mission LUMIO has just started science working groups – one is about citizen science, lead by Tony Cook, Aberysthwith University (no official web page yet, but see e.g. https://dart.polimi.it/lumio-call/)
- Detection s/w (plugin for FireCapture) is available for download (https://kryoneri.astro.noa.gr/en/flash-detection-software/ - not yet perfect, talk to me)
- A simulation tool developed by a Master's student at Univ. Oldenburg is available (https://gitlab.com/dkoschny/lif_simulation)
- A 'lunar guider' is under development at TU Munich, based on a Raspberry PI, controlling the ST-4 guide port available on most telescope mounts

(Some) other ongoing activities and web resources

- NASA has been operating an impact flash observing programme since many years (https://www.nasa.gov/offices/meo/environments/lunar_detail.html)
- Additional activities within one of ESA's observational programme – Spain (http://www.meteoroides.net), Polish-led activities in preparation
- B. Cudnik from ALPO has set up an email group here: https://groups.io/g/lunar-impacts
- Obs. Nice is active – testing short-wave IR cameras, linking flashes to craters, more (https://sitweb.obs-nice.fr/fr/home-flash)
- British Astronomical Association (Anthony Cook): https://britastro.org/section_information_/lunar-section-overview/lunar-section-observation-activities/lunar-geological-change-detection/observing-lunar-impact-flashes
- Unione Astrofili Italy (Antonio Mercatali): http://luna.uai.it/index.php/Lunar_Impacts_Research_-_theory_for_observation
- ALPO, USA (Brian Cudnik): https://alpo-astronomy.org/lunarupload/lunimpacts.htm

Formsheet for observations

Lunar Impact Flash observing log *Date:*

Name:

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)			

Lunar Impact Flash observing log *Date:*

Name:

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)

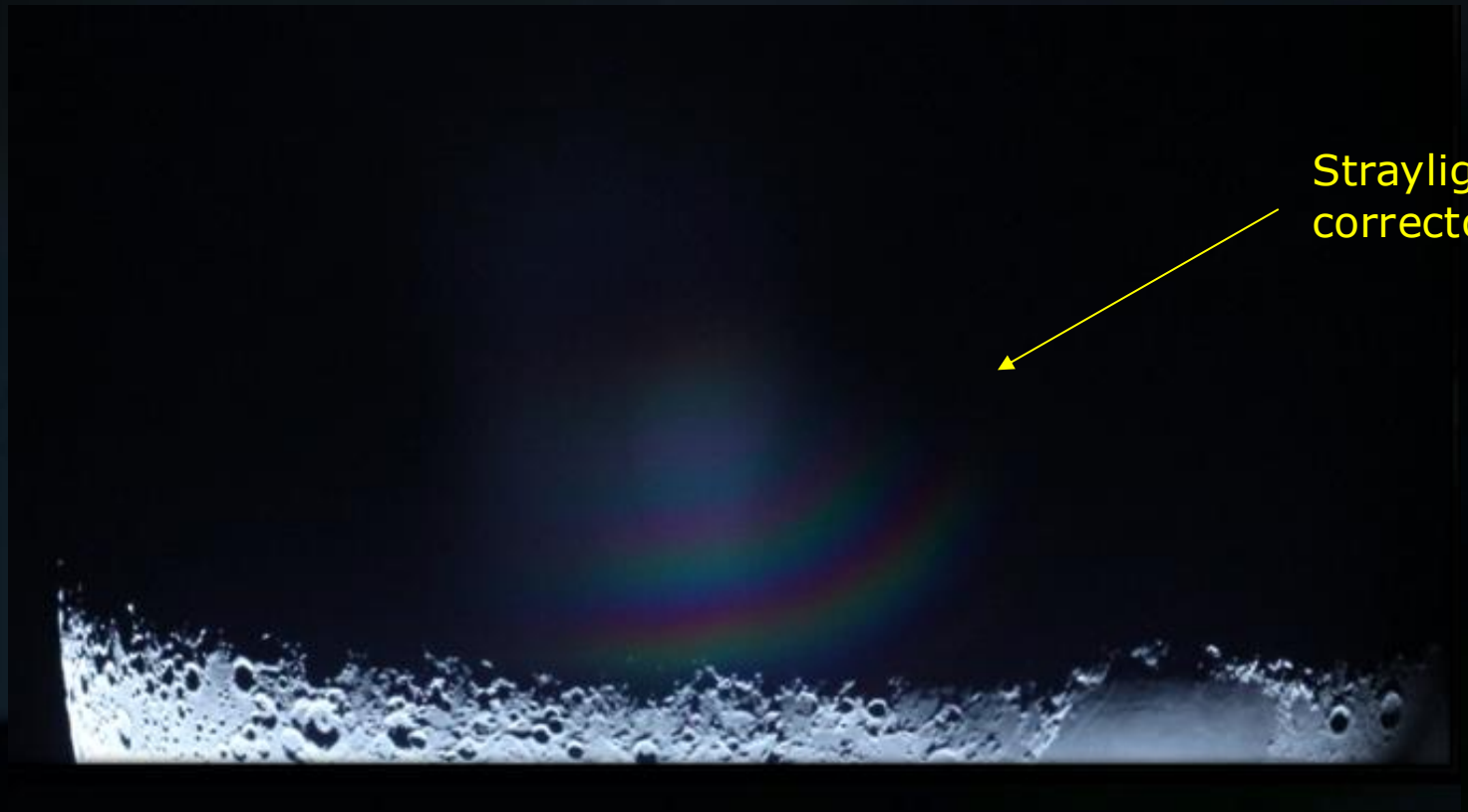
Some open points as presented by me at a Europlanet workshop in Feb 2022

Lunar impact flashes – what needs to be done?

Issues I found when trying it myself - #02:

- 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

Post on Facebook, G. Palten:
https://www.facebook.com/photo.php?fbid=6624084130958504&set=p.6624084130958504&type=3