NASA Lunar Meteoroid Impact/LADEE Online Workshop

Tools, Tips and Techniques for Amateur Astronomers

By George Varros
Equipment

- Celestron 9.25” SCT f10, CGEM mount
  - Originally used a Celestron 8” f5 NGT CG-5 (FOV 23’x14’)
- Watec 902 H2 Ult, Antares .5X reducer (FOV 19’x12’)
  - Originally used a Stellacam II (Watec 120n)
- KIWI OSD video time inserter (discontinued)
- Sony TRV740 Digital8 NTSC video to DV-AVI converter
- PC Laptop; 64 GB Mini SD
- Craterlet by Craig Stark to record AVIs
- Lunarscan 1.53 by Pete Gural – scan for impact events
- Nudger the Lunar Auto-Guider by George Varros

Minimum System Requirements - NASA Meteoroid Environment Office (MEO)
Celestron C8 NGT f/5
Stellacam II (2007)
Celestron CGEM 9.25
Watec 902H2 Ult with .5x reducer

System had 3 main components:

1) Telescope system
2) Video system (camera, gps, converter)
3) PC for video recording and analysis
The video system

- Watec 902 H2 Ult
- 25 ft video cable
- GPS receiver 12 ft cable
- IEEE 1394 Firewire Input to computer
- NTSC/Digital converter Sony Digital8 TRV740
- Video Time Inserter VTI
- Power

Note: cheap cables and power adapters can be a source of noise and extensive troubleshooting. Only use high quality power adaptors and expensive high quality cables.
Video gear in a kit, make it easy for yourself

The video system, along with the telescope, can be run from a 12V car battery and inverter for 5 hrs.

Without an observatory, it becomes necessary to limit the time spent on equipment setup while allowing versatility and protection against the elements.
Computer and external 2 TB drive

MacBook Pro, Bootcamp/Win 7

2 TB Iomega HD (replaced with SanDisk 64 GB micro SD)

MacBook Pro can be powered by a 12V car battery
Video Camera

Watec 902 H2 Ult
.0001 lux @ f1.4, 1/2 inch
Sony EX-view HAD sensor
costs ~ $330.00


Stellacam EX discontinued
Stellacam II discontinued (Watec 120n)

Note: 1/3 inch HAD EX sensor might work. Less expensive, less sensitive and more noisy.
Dr. Dunham used PC-23 and 5.5 inch SCT for the first lunar impact recordings!
Video Time Inserter

IOTA-VTI  3 models from $245 - $350 USD
   – replaces the discontinued KIWI OSD
      http://videotimers.com/home.html

Europe – PIC-OSD.com GPSBOXSPRITE2
      http://www.blackboxcamera.com/pic-osd/sprite.htm

Audio WWV can be used if a VTI is not available

A VTI will pay for its self fairly quickly in saved time and frustration.
NTSC to Digital converters

Canopus ADVC-55 with IEEE1394 Firewire output port costs ~ $160
- small and compact unit, works extremely well, highly recommended
- converts NTSC to 720 X 480 DV-AVI (Digital Video – Audio Video Interleave)
  http://www.grassvalley.com/products/advc55

I’m using a Sony TRV740 Handycam or Sony GV-D800 Watchman
both convert NTSC to 720 X 480 DV-AVI with IEEE1394/Firewire output

Digital video camera recorder with NTSC input and video pass-through capabilities using IEEE1394/Firewire output

Other NTSC to Digital input cards that provide 720x480 resolution at 30 fps (25 fps PAL).
Equipment Setup

Thermally acclimate telescope for an hour
Set up mount, run power cable, rough alignment
Load weights, telescope, video gear, balance load
Refine polar alignment run telescope
Hook video feed to PC, check video, GPS timestamp
Find suitable star and focus, set lunar tracking rate
Position moon in FOV, align
Record AVI 10-20 seconds of dark frame video
Record AVI
Monitor and correct pointing when necessary
Run auto-guide software

After run is complete, analyze video with LunarScan
Original MEO target field of view for flux measurements

This has changed for LADEE. Use a wider field of view but keep the illuminated surface out of the field of view. See Dr. Suggs’ presentation for more specific information.
2007 Lyrids, MEO impact event #45 April 22, 2007

Celestron 8” NGT f5 reflector 1000mm fl
StellaCam II
2007 Lyrid radiant generated with LunarScan
Celestron 8” NGT f5 reflector 1000mm fl
StellaCam II
Celestron 8” NGT f5 reflector 1000mm fl
StellaCam II
MEO Impact Event #170, April 28, 2009

Celestron 8” NGT f5 reflector 1000mm fl
Watec 902 H2 Ultimate
Unconfirmed impact candidate Dec 18, 2007
Unconfirmed impact candidate Aug 9, 2008
Unconfirmed impact candidate Jan 3, 2009

-80.6; 41.1 N 85km north of Lavoisier
MEO Impact Event #100  March 13, 2008
Lunarscan capture of MEO event #100
Lunarscan detection screen
Impact Event video fields

Characteristics (after splitting video frames into odd/even fields):

Appears stellar when image is zoomed, light distribution is brightest in center although atmospheric turbulence may distort event

Found on two or more sequential video fields or frames

First video field should be the brightest, each successive field dimmer than previous
Cosmic ray events
Cosmic ray events

Characteristics:

Single bright rows, columns or pixels

Brightness distribution not like a star

Video frame may have multiple artifacts

I’ve only found them on one video frame, but sometimes on both odd and even fields
Cosmic ray events

Multiple artifacts in single video frame
Impact event

Brighter in center, similar to star

Cosmic Ray

Single rows, columns or pixels
Auto Guiding

Unless your lunar tracking rate is perfect, it is necessary to maintain accurate pointing using the hand controller or by implementing auto-guiding.

Auto-guiding saves vast amounts of time and helps stabilize video for Lunarscan analysis.

Nudger the Lunar Auto-Guider freely available at http://www.lunarimpacts.com/

Uses ASCOM drivers to control telescope pointing http://ascom-standards.org

Locks on to earthshine illuminated features on the shadowed lunar surface such as Aristarchus

Uses Pulse-guide commands to “nudge” the scope

Requires no additional video input – uses a screen capture technique to watch the window that is recording the video such as Craterlet
Nudger “Diag” link displays device capabilities. Mount must be able to “Pulse Guide”.

ASCOM Supported Devices
http://ascom-standards.org/

ACP Observatory Control Software telescope hub
Astro-Electronic FS-2 telescope controller
Astrometric Instruments Maestro
AstroOptik research telescopes
Astro-Physics GTO mounts
Celestron NexStar 60GT, 80Gt, 114GT, 130GT, 4GT, 5, 5i, 8, 8i, 8 GPS, 9.5 GPS, 11 GPS, CGE 800, CGE 925, CGE 1100, CGE 1400, Advanced C5-SGT, C6-RGT, C8-SGT, C8-NGT, C9 1/4-SGT, C10-NGT, Ultima 2000, 76GT, 102GT, Advanced C11-SGT, C20, and NS8i-SE. (Current firmware required!)
COMSOFT PC-TCS controlled telescopes
DFM Engineering research-grade telescopes
EQ-MOD Stepper Controller
FocusMax telescope hub
Gemini controller (Level 4 only!)
Generic LX200 type (many emulations such as Bartels, FS2)
MaxPoint telescope hub
Meade LX200, LX200GPS, and Autostar (Meade specific features supported)
Paramount (via TheSky™)
Plain Old Telescope Hub (POTH) with Dome control
Optical Guidance Systems research-grade telescopes
Orion Intelliscope series
ServoCAT
SkyCommander
Takahashi Temma
Telescope Simulator (included in Platform)
Vixen SkySensor 2000 PC
Vixen Sphinx
Wireless computer-to-telescope connections are useable. However, they require batteries and will run out of power at inconvenient times.

Use a cable, it is easier to deal with and more reliable.

BlueStar Adaptor can use normal USB connection

USB to serial – DB9 to RJ22 Celestron
Useful links

NASA Meteoroid Environment Office (MEO)
   http://www.nasa.gov/offices/meo/home/index.html

Lunar Impacts, FAQ, Minimum system requirements @ NASA MEO
   http://www.nasa.gov/centers/marshall/news/lunar/

Yahoo! Lunar Impacts Group
   http://groups.yahoo.com/neo/groups/lunar-impact/info

Lunarscan 1.53  http://www.lunarimpacts.com/

Nudger the Lunar Auto Guider 1.0.0.22  http://www.lunarimpacts.com/

ASCOM Telescope drivers  http://ascom-standards.org/

Stefano Sposetti, 143-Gnosca, Switzerland – Excellent detailed documented observations of lunar meteoroid impacts, definitely worth reading!
   http://www.sposetti.ch/
Figure 2. Detection of the impact flash (August, 1, 2013 at 02:21:55 UT) recorded simultaneously by Lena (left image) with a 130mm refractor, Manna (middle image) with a 200mm reflector and Sposetti (right image) with a 150mm refractor.

Flash located in the same position (layers superimposed of the frame by Sposetti and Lena)