



National Aeronautics and
Space Administration

Lessons Learned from 20+ Years of ISS Imaging

Presenter: Sara Schmidt

Crew Earth Observations (CEO) Payload Lead

Earth Science and Remote Sensing (ESRS) Group

Virtual Session 21:

Artemis Orbital Observation Science

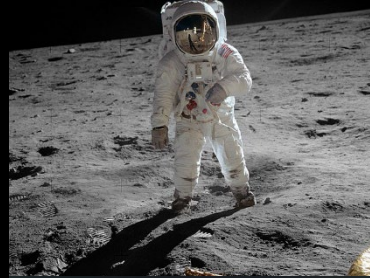
December 5, 2023

Timeline of Astronaut Photography

MERCURY & GEMINI
December 1960 – November 1966



APOLLO PROGRAM
January 1967 – December 1972



SPACE SHUTTLE PROGRAM
April 1981 – July 2011



ISS CREW EARTH OBSERVATIONS (CEO)
November 2000 – Present

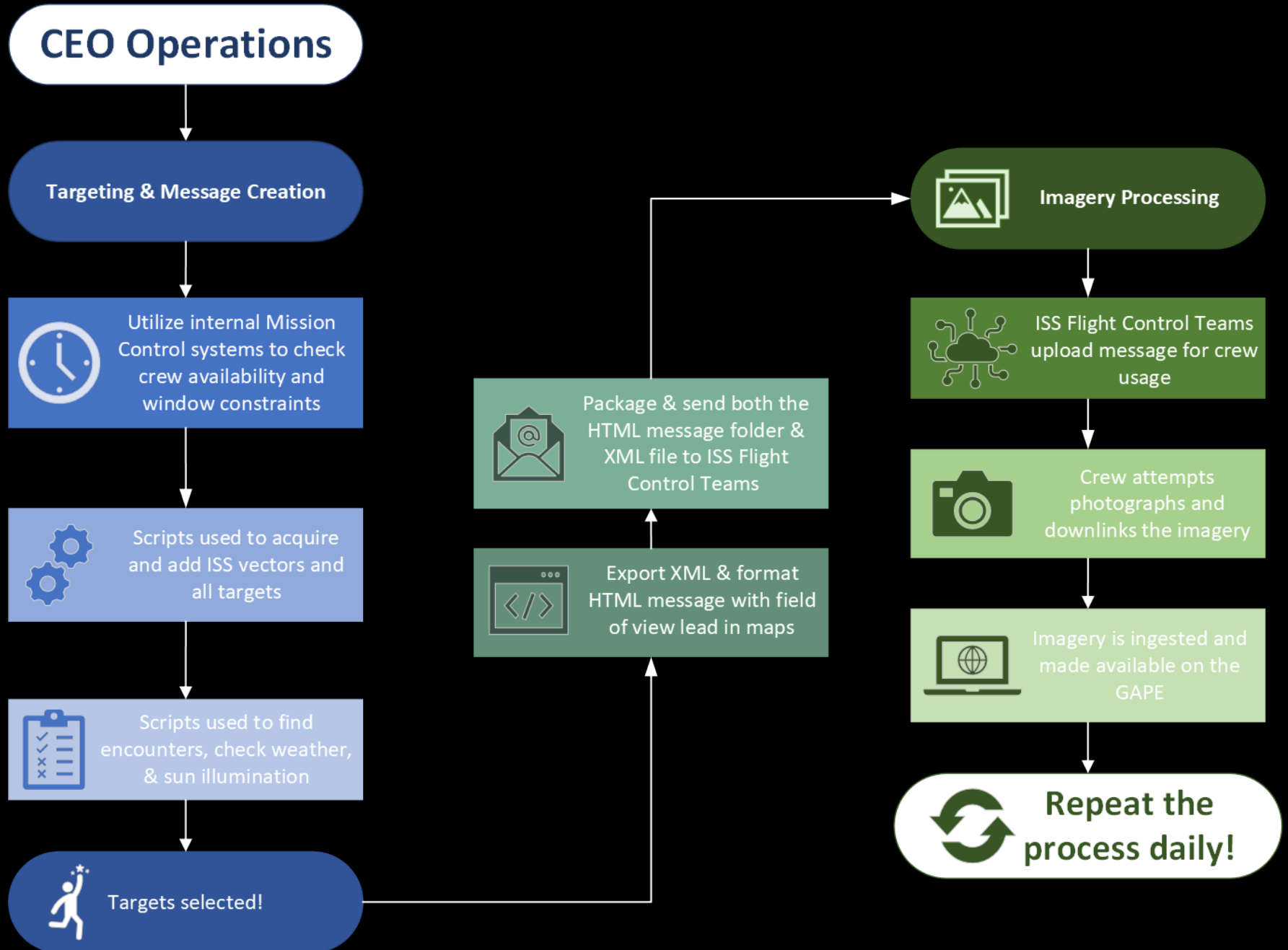


What is Crew Earth Observations (CEO)?

- Crew members on the ISS using digital handheld cameras to photograph Earth
- CEO Team at JSC provides targeting details for each ground or atmospheric site of interest
- Sites are provided by:
 - Science and education study request
 - International Disaster Charter Activations
 - NASA Public Affairs Office
 - Crew members
 - ISS Program Science Office
 - NASA HQ



CEO Workflow



Operational Improvements & Lessons Learned

- Improvements continue to be made each year
- Scripting capabilities
 - ISS Vectors
 - Encounters
 - Sun illumination
 - Weather constraints
- Message format
 - Microsoft Word
 - HTML
 - Automatic generation of imagery

Amman, Jordan at night

Initial Encounter	Closest Approach	Lens(es)	Look Angle from Nadir	Type
20:27:00 GMT	20:27:23 GMT	180, 400 mm	5 degrees left of track	City at night

SCIENCE Site: Photograph Amman, Jordan, at night for a night light study of urban areas to track the response to the coronavirus outbreak and the decrease in human activity due to the global pandemic. To avoid motion blur, attempt to track Earth's relative motion with the camera.

Visual Cues: Amman is northeast of the Dead Sea and east of the Jordan River and the illuminated Mediterranean coast near Israel.

Recommended camera settings:
Mode: M (manual)
Shutter speed: 100
Aperture: 2.8
ISO: 25600
sw Body Focus Mode: M (manual)

Please click images below for high resolution version

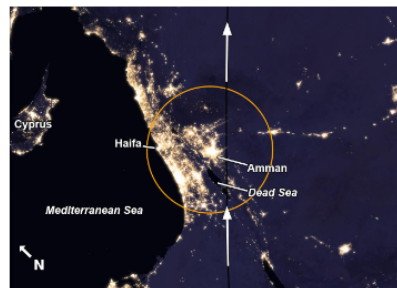


Figure 14 - Look left of track for Amman, Jordan at night

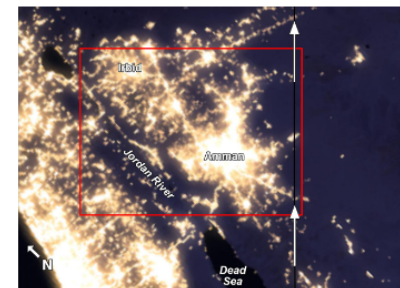


Figure 15 - Annotated satellite image showing orbit track (white arrows) and target area (red box)

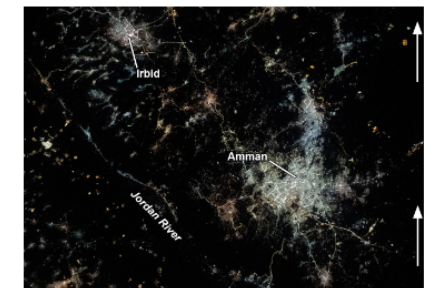


Figure 16 - Zoom of the red box target area shown in Figure 15 (ISS065-E-439637, 10/01/2021, 70mm)

Additional Operations

- Private Astronaut Missions
- Artemis-I Launch
- CEO Special Sessions
 - Sequential targeting sessions of 8-16 consecutive targets
 - Evaluates time needed between targets
 - Requested during low solar illumination to resemble lunar environments
 - Message of targeting details formatted for offline viewing



Decades of Improvement & Collaboration



Earth Science Teams

Planetary Geologists
Meteorologists
Earth Scientists



Crew Office

Pre-flight training of crew members
Post-flight feedback from crew members

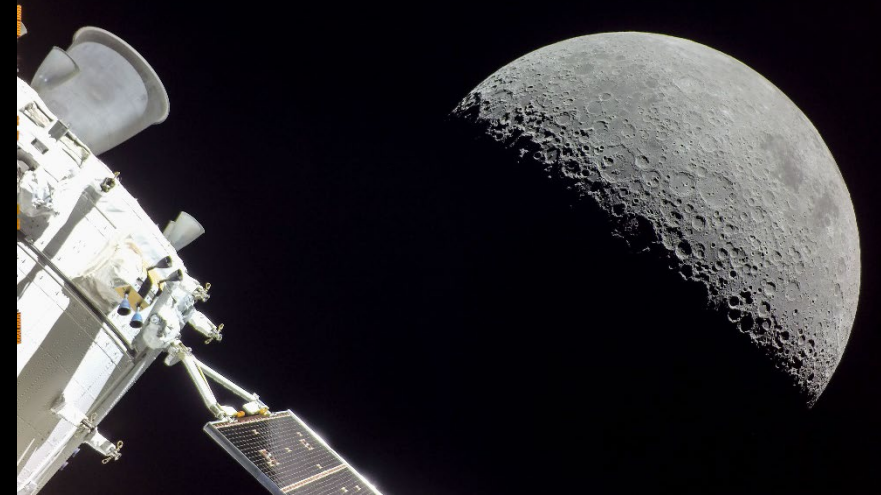


Imagery Teams

FOD Photo/TV camera and imagery trainings
Imagery downlinking

Crew Lunar Observations (CLO)

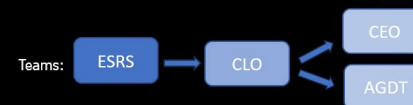
- CEO/ESRS team is leading development of Crew Lunar Observations (CLO) for Artemis II mission
- CLO will leverage the group's multi-decade legacy and expertise of handheld crew photography from space into a new domain of Earth and Moon photography from Orion



Artemis II Crew Lunar Observations (CLO) Con Ops

NASA Lead: Kenton Fisher
ESRS Co-leads: Amber Turner & Sara Schmidt

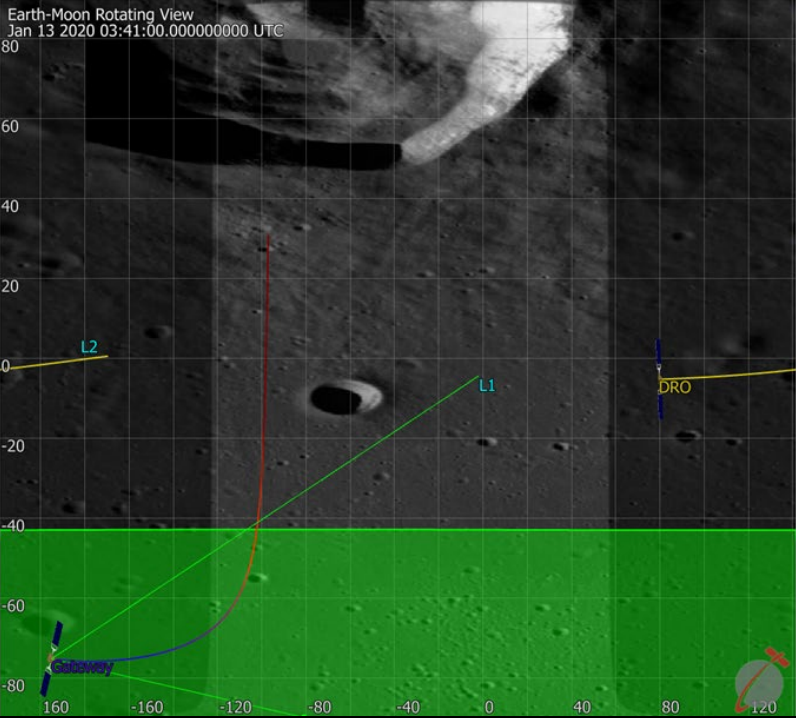
Earth Science and Remote Sensing Unit
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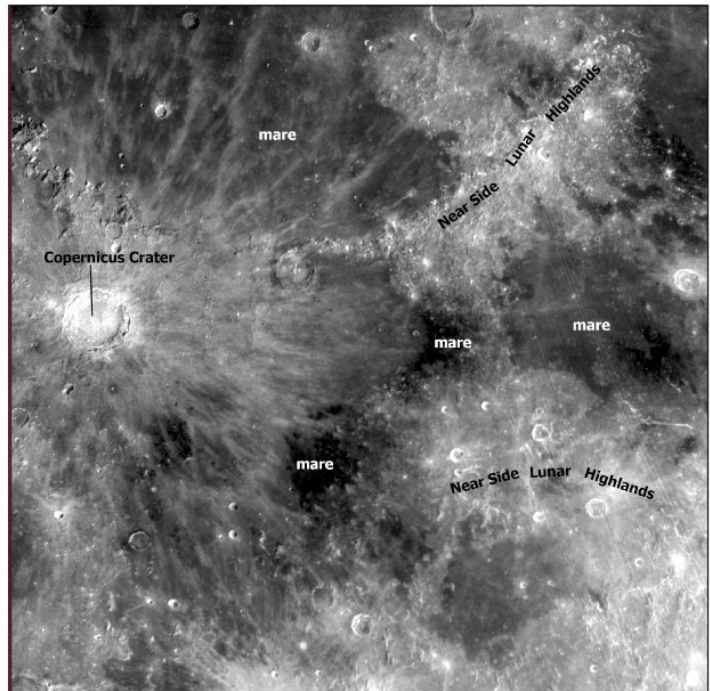


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CLO Targeting in Development

- Crew members in the Orion capsule will use digital handheld cameras to photograph the Lunar surface
- Sample target (left) showcases capabilities of targeting details and visualization using a 400 mm focal length and is for viewing example purposes only



Target 1: Copernicus Crater, Crater Rays, and Near Side Lunar Highlands

Visual Cues:

Copernicus Crater is on the Moon's Near Side in the **east** Oceanus Procellarum, just **south** of the Imbrium Basin (Mare Imbrium). This region of the moon is also part of the the Near Side Lunar Highlands - which are rugged and heavily cratered.

Copernicus Crater and the Near Side Lunar Highlands are distinguishable in imagery acquired by spacecraft (such as Orion and LRO), but also from the perspective of Earth's surface due to the abundance of bright felsic rocks (anorthosite) contrasting the dark, basaltic plains in this region (known as lunar mare).

Anorthosite rocks are high in plagioclase feldspar content, which are minerals that are characteristically white to light gray in color.

Data:

Image ID ART001E006115 was acquired on February 1, 2023 at 09:56:20 UTC by Orion's OpNav camera.

ART001E006115 has a resolution of 993 meters x 1378 meters. Grid cells for this image were not resampled.

ART001E006115 was georeferenced to an LROC WAC Global Morphology Mosaic using spline transformation for local positional accuracy.

Map Credit: NASA Earth Science and Remote Sensing Unit
Artemis II Crew Lunar Observations Team



NASA



NASA
ESA