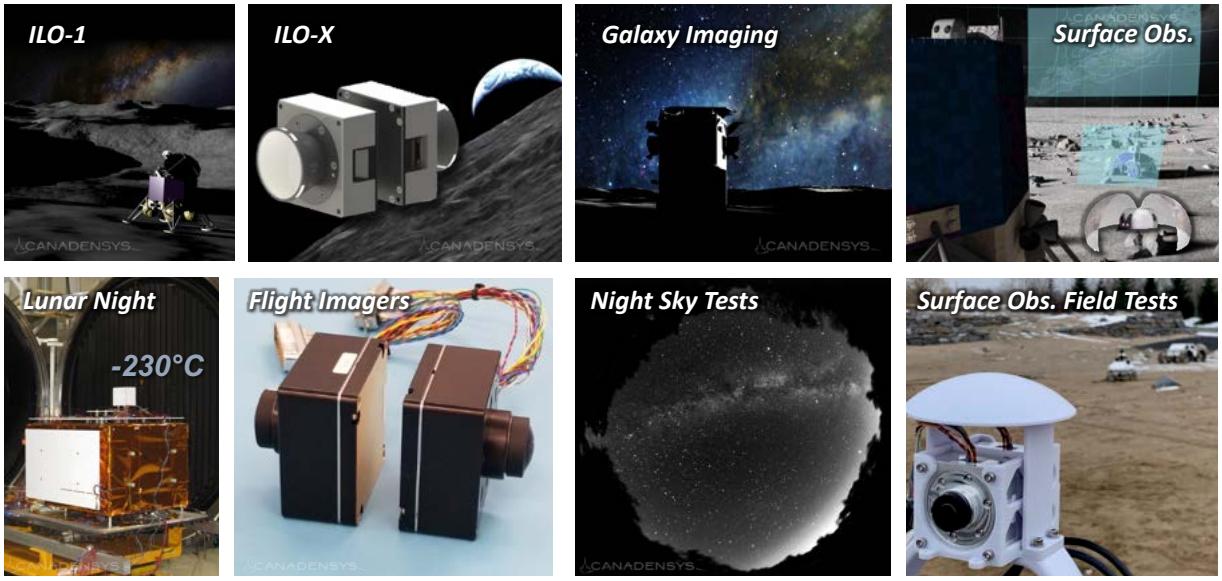
ILO-X Payload Summary

The ILO-X is a precursor to the ILOA flagship lunar south pole observatory, ILO-1. The ILO-X instrument is manifested on NASA's 2021/22 CLPS lander mission which is being led by commercial lander provider Intuitive Machines, where it will perform a number of observation and technology validation experiments ahead of the larger ILO-1 observation and communications mission which is planned to follow 1-2 years later. ILO-X's primary objectives are to (i) capture a first image of the Milky Way Galaxy Center (MWGC) from the surface of the Moon, both for societal interest as well as validating key elements of ILO-1's optics and electronics, (ii) capture additional images of the celestial sphere throughout the lunar day, and (iii) capture imagery of the lunar surface around the lander, including the terrain and surrounding landscape out to the horizon as well as activities of surface assets that are anticipated to be deployed from the lander.

A key driver for the ILO-X payload was miniaturization, ensuring that lunar and celestial observation capabilities could still be delivered from the earliest commercial lunar landers, despite tight size, mass and power constraints. The payload, which leverages several years of technology advancement by ILOA, Canadensys and the Canadian Space Agency, is currently undergoing flight build and is scheduled for flight integration with the Intuitive Machines' M1 (IM1) lander in 2021.



The ILO-X instrument features two main imagers:

- **Wide FOV Imager:**
  - Circular FOV with full angle of 186°
  - Pixel resolution of ~0.06° per pixel
  - Bayer colour detector, circular image diameter 3000 pixels
  - Near-horizontal orientation to capture both lunar surface activity and lunar sky at certain times
- **Narrow FOV Imager:**
  - Rectangular FOV, approx. 60° x 80°
  - Pixel resolution of 0.02° per pixel
  - Bayer colour detector, 3000 pixels x 4000 pixels

  - Approx. 60° elevation relative to local south horizon, fixed azimuth angle over course of mission. Final fixed azimuth set 1 week prior to launch to optimize for celestial calendar.
  - Baffle for stray light mitigation – both from sun and lunar surface
- **Common features**
  - Fixed FOV with respect to lander (no scanning mechanisms - size, mass & power constraints)
  - Programmable exposure times
  - Bit depth of 8, 10 or 12 bits per pixel
  - Onboard processing as well as 32 GB data storage per imager
  - Images can be stored as jpg or raw
  - Thumbnails help verify which images should be downloaded in full resolution (data limit)
  - HDR and image stacking processing options available onboard (i.e. prior to download)

The IM1 lunar landing site is at 24.5 degrees N, with longitude ranging from 50°W to 50°E depending on final launch month. The duration of the nominal lander mission is a single lunar day (14 days at the IM1 latitude), although both imagers feature lunar night survival capabilities and could support multiple lunar days of operation if the lander can also survive, for power and data link provision. At this time none of the commercial landers are baselining lunar night survival on their first missions, but partial survival may still be achieved. Currently it is assumed that the IM1 / ILO-X mission will occur between October 2021 and March 2022.

Communications remains a constraint for many of the modern, smaller lunar landers, and total downlink data volume available for ILO-X on the IM1 mission is heavily constrained. The expected number of images returned to earth varies depending on resolution and quality of imaging in the initial commissioning phase, but is anticipated to be in the range of 30 to 100 images.

While the ILO-X imagers have fixed orientations following landing, the portions of the celestial sphere that will be visible at different times during the mission will be well known prior to launch. An observation opportunity exists for astronomers collaborating with ILOA to request priority portions of the celestial sphere to be downloaded and/or receive specific onboard image processing (e.g. resolution, exposure / stacking, specific timing etc.)

Data management policies are being explored to allow the handling of such requests, as well as the ability to quarantine specified images for a sufficient period prior to releasing to the larger astronomy community to ensure enough time for ILOA researchers to access, analyze and publish results.