Introduction: The first ShadowCam Planetary Data System (PDS) release is scheduled for 01 March 2024. Onboard the Korea Pathfinder Lunar Orbiter (KPLO, also known as Danuri), ShadowCam has taken many high-resolution images (>10,000) inside permanently shadowed regions (PSRs). The PDS archive includes dark calibration images, star images, Moon/Earth images, stereo pairs, lunar terrain illuminated by earthshine, equatorial analogs, and many nominal ShadowCam observations in PSRs. The archive also includes a software interface specification (SIS) to document all of the data formats, labels, and other information necessary to use the ShadowCam PDS data.

Mission Phases: This first data release includes the cruise and commissioning mission phases and the first two months of the primary mission (August 2022 - March 2023). The cruise phase covers all images from launch on 04 August 2022 through 31 December 2022. The Commissioning phase includes 01 January 2023 through 31 January 2023, and the Primary phase includes the 11 months from 01 February 2023 through 31 December 2023. Data starting on 01 January 2024 will be from the KPLO extended mission.

Observation Types: ShadowCam images were acquired during the cruise phase and in orbit for uses beyond nominal PSR imaging. Dark images are regularly taken at line rates ranging from the minimum to the maximum values that ShadowCam supports at as many focal plane temperatures as possible in both time delay integration (TDI) sensor directions [1]. The dark images are acquired during lunar night on the farside. During night over the nearside, earthshine observations are acquired [2]. There are also a small number of observations that were intended to be dark observations but were “contaminated” with earthshine, resulting in visible terrain. During the cruise phase, many Earth and Moon images were acquired with the Lunar Terrain Imager (LUTI) [3]; ShadowCam acquired ride-along observations during those opportunities. These ride-along observations are useful for stray light characterization. Star scans of the Pleiades cluster were also taken during the cruise phase and once during the commissioning phase. Some are full-length images, while others were divided into smaller strips. These were acquired in both TDI directions to help with geometric calibration. Stereo pairs have also been acquired [4]. Pairs within ~5° of the poles use pitch slews, and areas further from the poles use roll slews to acquire the stereo parallax. DTM s generated from some of these stereo pairs will be released in a future PDS release [4]. The secondary lighting conditions in PSRs result in images that are sometimes difficult to interpret due to the drastic difference between direct lighting from the Sun (~ point source) and the diffuse lighting from reflections off nearby topography (broad, narrow source). Many equatorial PSR analog observations were acquired when the KPLO orbit was near the terminator. These analog observations can be compared with directly illuminated Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) images to see how the lighting difference affects the interpretation of landforms.

Data Products Generated: For each ShadowCam image, an assortment of primary and ancillary data products are produced and released to PDS alongside PDS 4 labels:
- Raw image, 8-bit ISIS cube
- Small browse image
- Full-resolution image, 8-bit Cloud-Optimized GeoTIFF (COG)
- Histogram CSV (256 8-bit bins)
- Calibrated image, 32-bit ISIS cube
- Full-resolution image, 32-bit COG
- Histogram CSV (radiance values in 256 bins)
- Small calibrated and stretched browse image
- TDI smear map of the area, 32-bit COG

Figure 1: Portion of a raw image (M012728826S) showing the six columns with lead-in and bias pixels (top). The same portion of the calibrated product with the non-scene columns removed (bottom).
- TDI smear map of the area, ISIS cube
- TDI smear map of the shadowed area, 32-bit COG
- TDI smear map of the shadowed area, ISIS cube
- Uncontrolled map-projected product, 32-bit COG
- Uncontrolled map-projected 8-bit stretched product, 8-bit COG

**Release Frequency:** ShadowCam data will be released to PDS every three months after this initial release. The next release of ShadowCam data will be in June 2024, covering April, May, and June 2023.

**Image Features:** ShadowCam data is read from the TDI sensor in six channels (Fig. 1). Each channel reads out two lead-in pixels, eight bias pixels, 512 scene pixels, and two lead-out pixels, resulting in an image width of 3,144 pixels. The calibrated product does not include the non-scene pixels, resulting in an image width of 3,072 pixels (Fig. 1). When viewing ShadowCam data, any terrain with direct solar illumination will be saturated. In the calibrated product, this saturation is represented by the high instrument saturation (HIS) special pixel value defined by ISIS and the PDS label. There can also be areas where saturated columns do not quite hit the maximum 8-bit digital number (DN) in the raw data, and these appear as bright lines at channel edges. Due to both single event upsets (SEUs) and data loss when transmitting to the ground, ShadowCam images can have missing data or corruption. Any missing data is replaced with 0 DN values, which are represented as low instrument saturation (LIS) special pixel values in the calibration process. An algorithm using the bias columns in the raw data detects corruption, and a data quality flag is set if any corruption is detected. During the primary mission, both padding and corruption were mostly in the January to February 2023 time frame as X-band downlink issues were being worked out. There is some small amount of padding and corruption that still occurred after that time, but it is a small percentage of the dataset (<0.6% of the images are affected). The data quality flags contained in the ISIS and PDS labels indicate problematic images to the user. Even in cases where some corruption exists, it is most often limited to a small portion of the image, leaving the bulk of the image data intact (Fig. 2).

**Data Portal:** Public access to the ShadowCam data release is primarily via the PDS system. However, a custom data portal is available via the ShadowCam Science Operations Center (SOC). This tool enables the searching of ShadowCam alongside other lunar datasets managed by the SOC team [5]. When using the data portal, the products link to product view pages where you can browse the full-resolution data directly from a web browser, dynamically stretch the raw bit depth products, see colorized smear maps, and more (Fig. 3) [6].

**Figure 2:** This 4-byte on/off repeated pattern from M030569340S is the typical appearance of missing or corrupt data. The pattern is due to the memory interleaving that takes place on the instrument.

**Conclusion:** The ShadowCam data release provides a new view into PSRs and comes with products to help make this critical data set as useful to the community as possible. As the extended mission progresses, additional data will be released quarterly with the same ancillary products available. The PDS search tool or the data portal at the ShadowCam SOC can be used to find and download ShadowCam data products.


**Figure 3:** Screenshot of the data portal view page for ShadowCam showing some the features available such as the full-resolution image viewer and interactive context map.