MARS 2020 MASTCAM-Z PDS4 DATA ARCHIVE. L. K. Mehall[1], E. Cisneros[1], J.F. Bell III[1], K. N. Paris[1], D. Wellington[1], E.H. Jenson[2], J.N. Maki[3], A.G. Hayes[4], K. Kinch[5], and the Mastcam-Z Team. [1]Arizona State Univ., Tempe, AZ; [2]Malin Space Science Systems, Inc., San Diego, CA; [3]JPL/Caltech Pasadena, CA; [4]Cornell Univ., Ithaca, NY; [5]Univ. of Copenhagen, Denmark.

Introduction: The Mastcam-Z imaging investigation onboard the Mars 2020 Rover consists of two identical area-array digital cameras. Unlike previous rover imagers, Mastcam-Z cameras have ~3:1 zoom telephoto lenses that permit imaging at focal lengths from approximately 34 to 100 mm. This zoom capability will significantly enhance the stereoscopic imaging performance for both science and operations support. Each camera also has an eight-position filter wheel, enabling it to acquire: Bayer pattern red, green, and blue (RGB) color images, multi-spectral images from ~440 to 1000 nm, and solar images in two wavelengths using neutral density coated filters [1]. See Table 1.

Data Acquisition: A Digital Electronics Assembly (DEA) with flash memory, for each camera, is incorporated within the rover allowing the cameras to acquire and store images. Flight software and hardware enable images to be processed both into and out of flash memory. Full-frame images, sub-framed images, thumbnail images, compressed video Groups of Pictures (GOPs) and focus merge (z-stack) products can be stored in each DEA. During nominal operations, a full resolution image is written to the DEA then processed into the requested format for downlink. Raw data can then be returned in four formats: (1) Color JPEG images and thumbnails, (2) Losslessly-compressed images, (3) Compressed color videos, and (4) Raw 11-bit images [1,2].

Table 1: Mastcam-Z Filter Bandpasses and Half-Width Half Maximum (HWHM) Values. ND5 is 10^{-5} neutral density coating for solar imaging (ND6 is 10^{-6}) [3].

Mastcam-Z Filter Wavelengths & Bandpasses

Filter	$\lambda_{eff} \pm$ HWHM (nm)	Filter	$\lambda_{eff} \pm$ HWHM (nm)
L0 (Broadband)	590 ± 88	R0 (Broadband)	590 ± 88
L0 (Red Bayer)	640 ± 44	R0 (Red Bayer)	640 ± 44
L0 (Green Bayer)	554 ± 38	R0 (Green Bayer)	554 ± 38
L0 (Blue Bayer)	495 ± 37	R0 (Blue Bayer)	495 ± 37
L1	805 ± 10	R1	805 ± 10
L2	751 ± 10	R2	867 ± 10
L3	676 ± 10	R3	908 ± 10
L4	600 ± 10	R4	937 ± 10
L5	527 ± 10	R5	975 ± 10
L6	445 ± 10	R6	1013 ± 10
L7	590 ± 88, ND6	R7	880 ± 10, ND5

Data Products: The Mastcam-Z team at Arizona State University will archive all Mastcam-Z Raw Level 0 (L0) data products. All Partially Processed Level 1A (L1A) and Calibrated Level 1B (L1B) data products will be generated using the required calibration and processing algorithms (Figure 1), then added to the archive. This includes all thumbnail images, even in instances when the parent image is not received on Earth. The archive will also include all Mastcam-Z data products from calibration, ATLO, and Cruise. Additionally, every instance where the same image was returned with a different compression scheme or file type, will be included in the archive [4].

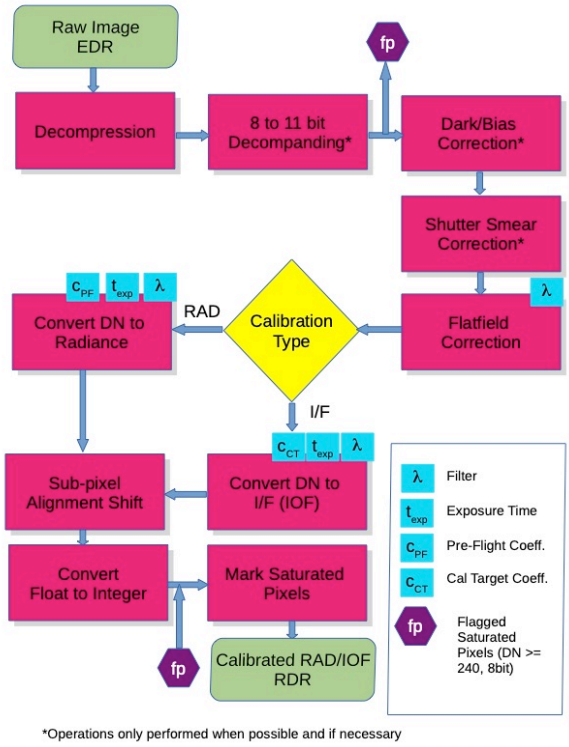

Figure 1: Flow chart describing calibration pipeline for Mastcam-Z data [4].

Also notable, the Mars 2020 rover deck will include two calibration targets for use in the Mastcam-Z calibration of radiance factor (IOF). A primary calibration target, similar to those used on the Mars Science Laboratory and the Mars Exploration Rovers, will be imaged, near-in-time, for most multi-filter image sequences and used in nominal calibration processes. While a secondary (L-bracket) calibration target (Figure 2) will be imaged occasionally and used

as a crosscheck for the primary calibration target and for dust monitoring [5].

Labels: The PDS4 implementation uses XML (eXtensible Markup Language) for all labels. These PDS4 XML labels will be generated and included in the Mastcam-Z Archive. Additionally, all ODL (Object Description Language) labels, which are functionally equivalent to PDS3 labels, will be created and added to the archive (Figure 3). This process will allow for a smooth transition for data users during the changeover from PDS3 to PDS4.

Data Access: All Mastcam-Z data products will be validated and archived with the PDS, and released to the public according to the predetermined data release schedule.

References:

[1] Bell, J.F., et al., (2014). *Internat. Workshop on Instrum. for Plan. Missions* Abstract #1151. [2] Malin, M.C. et al. (2013). *Mars Science Laboratory Project Software Interface Specification (SIS)*. [3] Bell, J.F. et al., (2018). *MARS 2020 Project Mast Cameras Zoom (Mastcam-Z) Calibration Plan* JPL D 101345. [4] Bell, J.F. et al., (2017) *The Mars Science Laboratory Curiosity rover Mastcam instruments: Preflight and in-flight calibration, validation, and data archiving.* Earth and Space Science, 4(7), 396-452. [5] Bell, J.F. et al., *Mars 2020 Mastcam-Z Investigation Experiment Operations Plan (EOP) v3.1,* (2018) JPL D-101346.

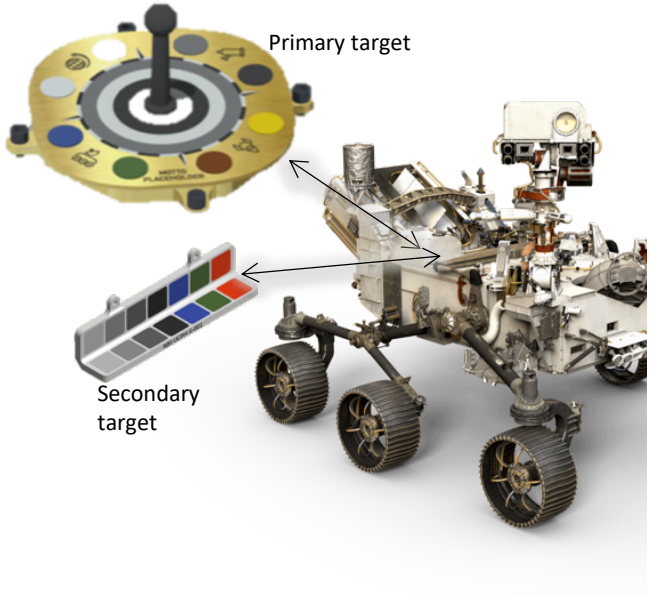

Figure 2: Location of Mastcam-Z Calibration Targets

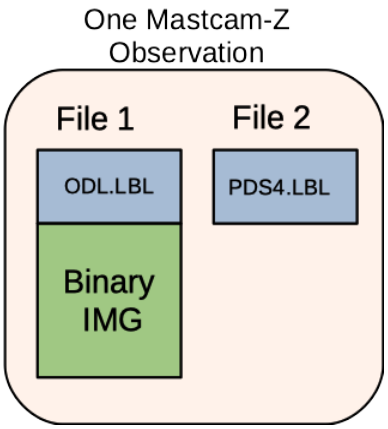

Figure 3. A single Mastcam-Z archived product will contain image data with the attached ODL label as well as a separate PDS4 XML label.