INITIAL MASTCAM-Z MULTISPECTRAL VISIBLE/NEAR-INFRARED OBSERVATIONS OF MARS 2020 PERSEVERANCE ROVER CALIBRATION TARGETS. J.R. Johnson[1], J.F. Bell III[2], K.M. Kinch[3], J. Kristensen[3], M. Merusi[3], M.B. Madsen[3], O.B. Jensen[3], J. Joseph[4], L. Mehall[2], M. Rice[5], E. Jensen[6], E. Cloutis[7], J. I. Núñez[1], J. Maki[12], R. Wiens[8], S. Maurice[9], A. Cousin[9], P. Beck[10], J.A. Manrique[11], F. Rull[11], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, jeffrey.r.johnson@jhuapl.edu, [2]Arizona State University, [3]NBI, Univ. Copenhagen, [4]Cornell University, [5]Western Washington Univ., [6]Malin Space Science Systems, [7]University of Winnipeg, Canada, [8]Los Alamos National Lab., [9]IRAP, Toulouse, France, [10]IPAG, Grenoble, France, [11]University of Valladolid, Spain, [12]Jet Propulsion Lab.

Introduction: Directly after landing, the Mars 2020 rover Perseverance will begin a Surface Operations Transition (SOX) phase, during which initial visible/near-infrared (VISIR) observations will be acquired of the Mastcam-Z and SuperCam calibration targets by the Mastcam-Z multispectral stereo imaging system. By the time of the conference, such measurements should have been made and will be compared to laboratory spectra of the targets.

Mastcam-Z description. Mastcam-Z [1] includes a pair of focusable, 4:1 zoomable cameras that provide broadband red/green/blue and narrowband 440-1020 nm color imaging with fields of view from 25.6°×19.2° (26 mm focal length at 283 μrad/pixel) to 6.2°×4.6° (110 mm focal length at 67.7 μrad/pixel). Each Mastcam-Z camera consists of zoom, focus, and filter wheel mechanisms and a 1648×1214 pixel charge-coupled device detector (1600x1200 active pixels) and electronics. The two Mastcam-Z cameras are mounted with a 24.4 cm stereo baseline and 1.65° toe-in on a camera plate ~2 m above the surface on the rover's Remote Sensing Mast (RSM), which controls azimuth and elevation actuation.

Calibration. Initial Mastcam-Z SOX imaging will verify camera performance such as the pre-flight bias and dark current, multispectral characterization of the calibration targets (prior to significant dust accumulation), and characterization of the geometric, focus, and zoom performance of the cameras as a function of object distance and camera temperature, including imaging of geometric fiducial targets on the rover deck. Mastcam-Z image calibration will involve conversion to radiance and relative reflectance via use of flat field images and observations of the Mastcam-Z calibration targets [1-2].

Mastcam-Z calibration targets. Mastcam-Z uses two deck-mounted radiometric calibration targets to validate camera performance, provide an estimate of local irradiance, and allow conversion of image data to units of relative reflectance on a tactical timescale (**Figs. 1-2**). The primary target consists of a gold-plated aluminum base, eight magnets mounted in the base, eight ceramic color and grayscale patches mounted over the magnets, four concentric, ceramic grayscale rings and a central aluminum shadow post (gnomon) painted with an IR-black paint. The magnets are expected to keep the central area of each patch relatively free of Martian magnetic dust. The Mastcam-Z secondary calibration target is an aluminum shelf carrying seven vertically mounted ceramic color and grayscale chips and seven identical, but horizontally mounted ceramic chips. The secondary target is intended to augment the calibration-related information derived from the primary target.

SuperCam calibration targets. The SuperCam Calibration Target (SCCT) comprises a suite of 36 targets to be used for calibration of images and to assist with mineral identification, chemometric calculations, and spectral references to evaluate the health of the instrument [5] (**Figs. 1,3**). The visible diameter of each target is 8 mm. The SCCT is located at a distance of ~1.56 m from the RSM, such that a Mastcam-Z pixel at 26 mm focal length will provide a pixel scale of ~0.44 mm on the SCCT targets. Black, white, red, green, and cyan color samples (shown as targets numbered 1-5 in Fig. 5) include the same type of embedded magnets used by Mastcam-Z (44/11 mm inner/outer diameter). A variety of geologic samples are mainly in the form of sintered powders [9], seven of which exhibit variable VISIR albedos and spectral features of interest that will be monitored during the mission. These include a chert sample with hematite (#8), calcite (#9), ferrosilite (#10), orthoclase ("orthose"; #12), clinopyroxene (#13), enstatite (#16), and a serpentine-bearing sample (#17).

Planned observations during SOX. During the first ~25 sols of the mission, pre-planned activities conducted during SOX include multispectral observations of the Mastcam-Z and SuperCam calibration targets in the same scene (e.g., Fig. 1) nominally on Sol 2 and ~Sol 14 (in support of a martian target calibration). Multispectral images of the Mastcam-Z targets at a zoom setting of 63 mm will nominally occur on Sol 3.

Laboratory spectra. Samples of the calibration target materials were observed in the laboratory under a variety of incidence, emission, and phase angles to provide VISIR spectra for comparison to observations acquired on Mars. **Figures 4 and 5** show lab spectra for Mastcam-Z and SuperCam targets of interest, respectively, at original spectral resolution and convolved to Mastcam-Z bandpasses [10].

Future work. Mastcam-Z multispectral observations of its calibration targets will be paired with every multispectral surface observation to enable calibration

to relative reflectance [1-2]. Mastcam-Z multispectral observations of the SuperCam calibration target will be acquired less frequently, mainly to assist in monitoring dust deposition on the targets. SuperCam VISIR reflectance observations of its calibration targets (Fig. 5) will be acquired as the mission proceeds [cf., 6-7] to monitor the stability of the instrument.

References: [1] Bell, J, this conf.; Bell, J. Space Sci. Rev., 2021; [2] Kinch, K., Space Sci. Rev, 2020; [3] Wiens, R., Space Sci. Rev., 2021; [4] Maurice, S., Space Sci. Rev., 2021; [5] Manrique, J., Space Sci. Rev., 216, 8 (2020), 1-27; [6] Fouchet, T., this conf.; [7] Wiens, R. et al., this conf.; [8] https://mastcamz.asu.edu/mars-in-full-color/; [9] Cousin, A. in prep, 2021; [10] Hayes, A, Space Sci. Rev., 2021.

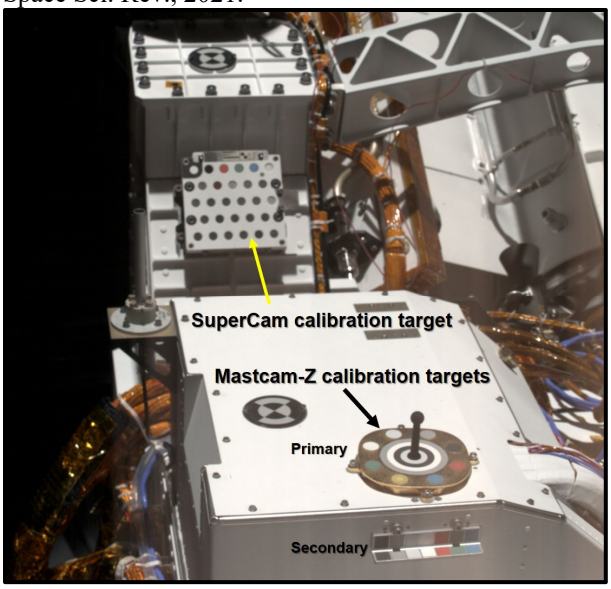

Figure 1. Portion of Mastcam image acquired during System Thermal Test showing the calibration targets for SuperCam and Mastcam-Z (primary and secondary) [2] on the Perseverance rover deck.

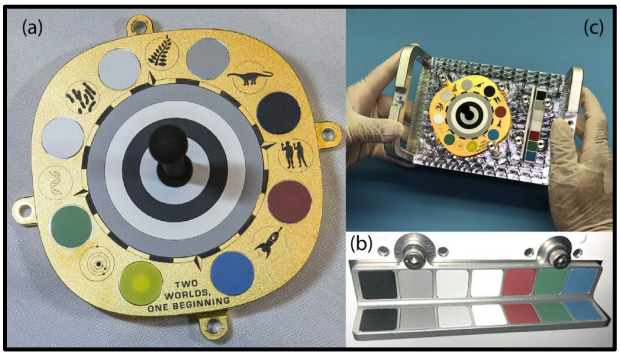

Figure 2. (a) Mastcam-Z primary radiometric calibration target. Target base is ~9.8x9.8cm; (b) secondary target is ~8cm long; "shelf" is ~1.6cm wide; (c) Inspection photo. (a) Niels Bohr Institute, Copenhagen; (b, c) NASA/JPL-Caltech/ASU [8].

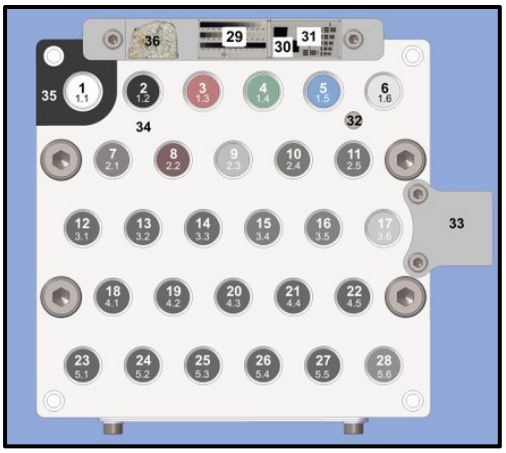

Figure 3. Schematic diagram showing numbered layout of SuperCam calibration targets [5,9]; cf. Figs. 1,5. Visible portion of targets is 8 mm in diameter.

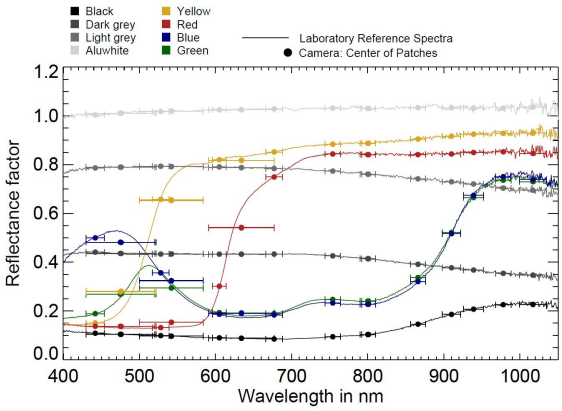

Figure 4. Laboratory spectra of Mastcam-Z calibration targets (i=0°, e=58°) at full spectral resolution (lines) and convolved to Mastcam-Z bandpasses (circles) [1-2].

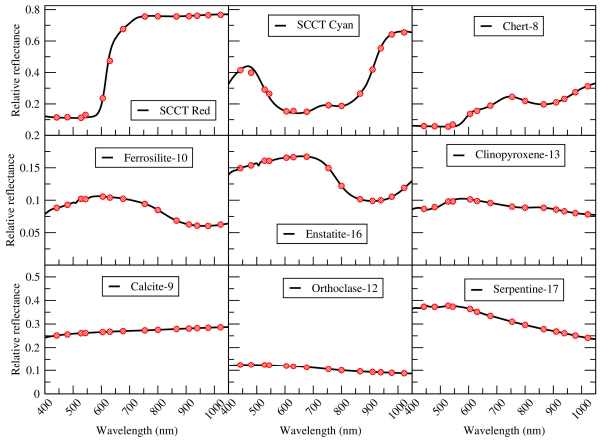

Figure 5. Laboratory spectra of selected SuperCam calibration targets (i=0°, e=30°) at full spectral resolution (lines) and convolved to Mastcam-Z bandpasses (circles) [3-5]. Numbers correspond to SuperCam targets in Fig. 3.