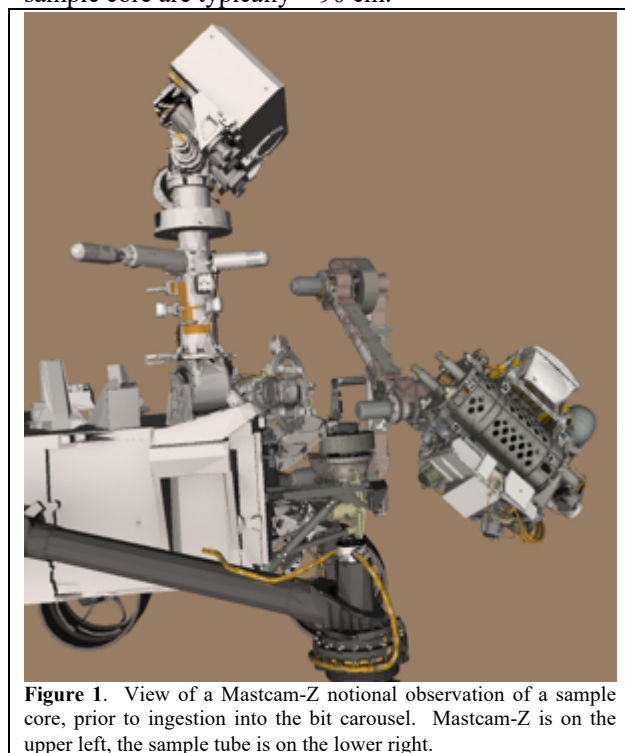


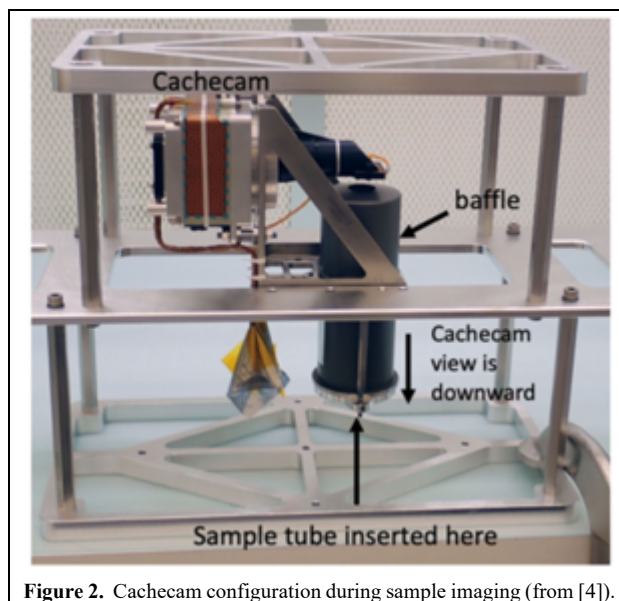
**MARS 2020 SAMPLE CORE IMAGING.** J. N. Maki<sup>1</sup>, J. F. Bell III<sup>2</sup>, C. Donaldson<sup>3</sup>, N. Ruoff<sup>1</sup>, A. Culver<sup>1</sup>, T. Green<sup>1</sup>, A. Lidawer<sup>1</sup>, M. Lambert<sup>1</sup>, J. Van Beek<sup>1</sup>, N. Williams<sup>1</sup>, J. Ryan<sup>1</sup>, C.D.K. Herd<sup>4</sup>, J. Carsten<sup>1</sup>, R. Howson<sup>3</sup>, E. Jensen<sup>3</sup>, <sup>1</sup>Jet Propulsion Laboratory/California Institute of Technology, Pasadena, CA (Contact: [Justin.N.Maki@jpl.nasa.gov](mailto:Justin.N.Maki@jpl.nasa.gov)), <sup>2</sup>Arizona State Univ., Tempe, AZ; <sup>3</sup>Malin Space Science Systems, San Diego, CA, <sup>4</sup>Dept. of Earth and Atmospheric Sciences, Univ. of Alberta, Edmonton, Canada.

**Introduction:** The Mars 2020 *Perseverance* rover mission is currently in the process of identifying, documenting, and caching a set of Martian samples for possible return to Earth by a follow-on mission [1]. During the sampling process [2], the individual samples are cored from a rock and subsequently imaged by the Mastcam-Z [3] and Cachecam [4] cameras prior to tube sealing and subsequent storage. Images from these two cameras provide information about the texture and color of the sample and form an important component of the sample documentation data set.

**Mastcam-Z Imaging Configuration:** The Mastcam-Z images of the core are acquired prior to the sample tube insertion into the sample handling system (Figure 1). The sample tube is illuminated by Martian daylight (direct sun and diffuse illumination). Because the illumination angles depend on the rover orientation time of day, the Mastcam-Z image illumination conditions vary from sample to sample and do not always include a fully-illuminated core (partial shadowing). The Mastcam-Z is typically autofocused and autoexposed on the sample core. Distances from the camera to the sample core are typically ~ 90 cm.

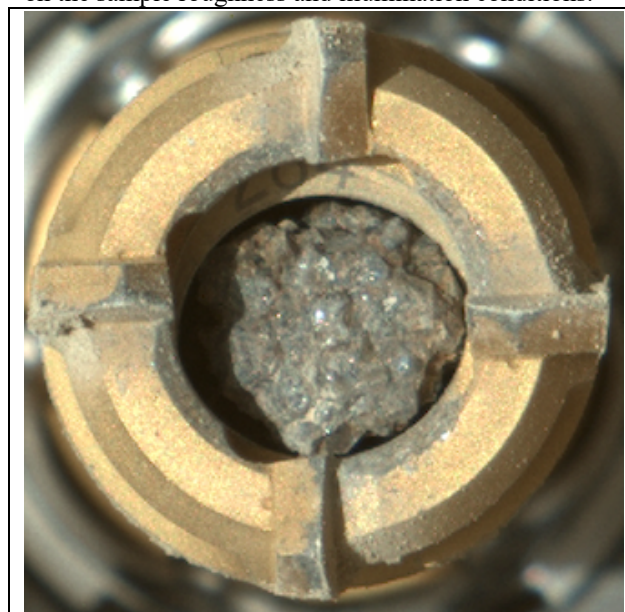


**Cachecam Imaging Configuration:** After the sample tube is ingested into the sample handling system, the sample tube is presented to the Vision Station (Figure 2), where the Cachecam camera illuminates the sample tip with an LED (light emitting diode) illuminator. Unlike the Mastcam-Z images, because of the fixed position of the Cachecam LED illuminator, the lighting conditions are consistent between Cachecam images of the samples. The sample is moved towards the Cachecam in ~ 10 mm incremental steps. An autoexposed image is acquired at each step and the image is sent back to Earth for analysis. The resulting set of Cachecam images comprise a Z-stack (focus stack) of the sample core. Cachecam Z-stack image acquisition is typically performed twice per sample: before and after a volume probe operation. The volume probe operation can sometimes move a sample core slightly within the tube.

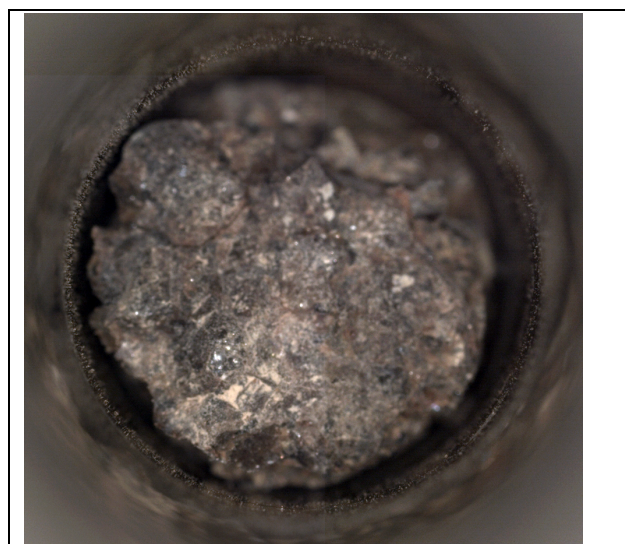


**Sample Core Images:** The Mastcam-Z and Cachecam images are qualitatively similar. At a maximum zoom of 110mm focal length, the Mastcam-Z image scale on the sample core tip is ~ 60 microns/pixel (Figure 3). Cachecam image scale on the core tip is ~ 13 microns/pixel at full resolution (Figure 4). Although the Cachecam images have a ~ 5x finer pixel scale, due to the limited depth of field (+/- 5 mm) of the Cachecam and large (~10 mm) step size of the Cachecam Z-stacks,

the resulting image spatial resolution is somewhat coarser than 13 microns/pixel, and the Mastcam-Z images can sometimes provide more detail depending on the sample roughness and illumination conditions.



**Figure 3.** Mastcam-Z image (110 mm) of the *Coulettes* sample core tip (Sol 271). The sample core is ~ 13 mm in diameter.



**Figure 4.** Cachecam image of the *Coulettes* sample core tip (Sol 271). The sample core is ~ 13 mm in diameter.

**Current Status:** Early in the mission Cachecam images of the sample cores were acquired in low-resolution mode (4x downsampled), yielding a pixel scale of ~ 50 microns/pixel, sufficient for operational verification purposes. The subsequent decision to acquire these images in high-resolution mode (13 microns/pixel) was informed by their potential scientific value; these

images are the only means of documenting the base of each core prior to possible return to Earth.



**Figure 5.** Cachecam image of a sealed sample tube containing the *Coulettes* sample (Sol 271)

**Acknowledgments:** The authors would like to acknowledge the efforts of the entire *Perseverance* Development and Operations Teams.

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