THE CALIBRATION TARGET FOR THE MARS 2020 SHERLOC INSTRUMENT. T. G. Graff [1], R. Bhartia[2], L. W. Beegle[2], V. D. Tran[1], R. H. Weiner[1], M. J. Calaway[1], D. H. Garrison[1], M. D. Fries[3], K. N. Davis[3], A. S. Burton[3], A. J. Ross[3], and C. L. Smith[4], [1]Jacobs, NASA/JSC, Houston, TX 77058 (*trevor.g.graff@nasa.gov*), [2]NASA Jet Propulsion Laboratory, California Institute of Technology, [3]NASA JSC, [4]Natural History Museum, London.

Introduction: The Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC) instrument is a Deep Ultraviolet (DUV) native fluorescence and resonance Raman spectrometer that that will conduct science investigations from the Mars 2020 Rover [1-3]. SHERLOC enables non-contact, spatially resolved, and highly sensitivity detection and characterization of organics and minerals in the Martian surface and near subsurface. It utilizes a DUV laser to generate characteristic Raman and fluorescence photons from a target/area of interest. The laser is co-boresighted to a context imager and integrated into an autofocusing/scanning optical system that allows correlation of spectral signatures to visible sample surface features. In addition to the combined spectroscopic and macro imaging component of the instrument, SHERLOC also integrates a camera system called WATSON (Wide Angle Topographic Sensor for Operations and eNgineering), which is used for engineering, operations, and science imaging. The instrument analysis will support assessment of the aqueous history of the landing site, detect the presence and preservation of potential biosignatures, and support sample selection for caching and future Earth return.

SHERLOC consists of three separate assemblies, 1) the SHERLOC Turret Assembly (STA) mounted on the robotic arm turret, 2) the SHERLOC Body Assembly (SBA) located inside the rover chassis, and 3) the SHERLOC Calibration Target (SCT) mounted on the extension bracket for the elbow joint of the robotic arm (Fig. 1). The SCT project is led by the Astromaterials Research and Exploration Science (ARES) Division at the Johnson Space Center (JSC). Here we report the SCT design, target materials, and status.

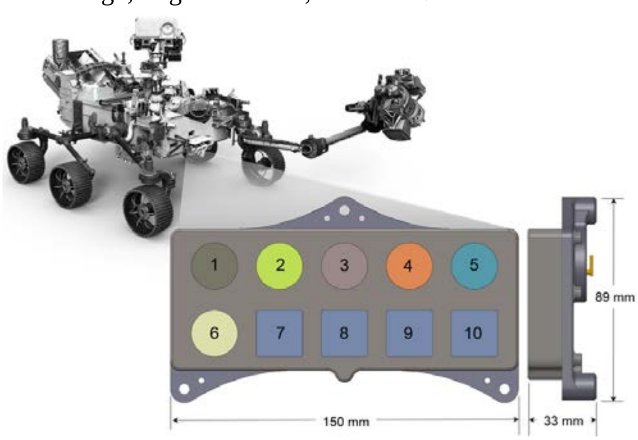

Figure 1: SCT design and position on the rover.

Calibration Target Design: The SCT is 150 x 89 x 33 mm and has a mass of ~437 grams. Three mounting locations interface with the extension bracket placing the assembly forward-facing on the front of the rover (Fig. 1). This configuration allows the STA, through discrete rover arm movements, to access and analyze the each of the SCT targets. The SCT has ten individual targets locations; six accommodate 25 mm round (20 mm exposed) hard targets of various thickness, and four 20 x 20 mm square openings which expose a portion of space suit material retained by a soft goods sub-assembly (Fig. 2). A small thermal subassembly allows heating of three targets to reduce contamination risk. The design utilizes compressed wave springs to hold individual targets and sub-assemblies in place. A cover plate protects the targets and will be removed before flight.

Target Materials: The top target row consists of five targets used for SHERLOC calibration including Raman and fluorescence spectral accuracy, response curve, ambient light reflection, spectral mapping, and laser parameters. The bottom target row consists of the selected suite of space suit materials, that also function as secondary calibration targets. The following lists the target functions/materials (numbers correspond to identified locations in Fig. 1):

1: Sapphire Disk with AlGaN coating (264 nm)
2: Diffusil Diffuser (opaque fused silica glass)
3: Mars Meteorite Slice (SAU008,13)
4: Intensity Target (maze pattern on silica glass)
5: Sapphire Disk with AlGaN coating (340 nm)
6a: Polycarbonate Spacesuit Visor Material
6b: Geocache Coin (printed opal glass; 6a backing)
7: Vectran (soft goods material)
8: Orthofabric (soft goods material)
9: Teflon (soft goods material)
10: Coated Teflon (soft goods material)

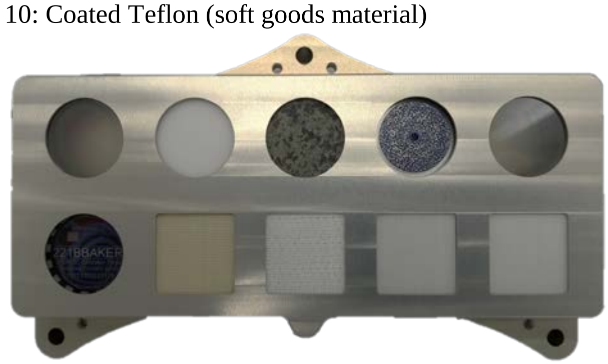

Figure 2: SCT Flight Model.

Three targets additionally serve unique education and public outreach purposes. The Mars meteorite, a slice of Sayh al Uhaymir 008 (SaU008) collected in Oman in 1999, will represent the first piece of Mars to be returned to the planet's surface (Fig. 3a). The intensity target design incorporates an intricate maze (Fig. 3b), and the clear polycarbonate space suit visor material is backed by a distinctive Geocaching trackable marker (Fig. 3c).

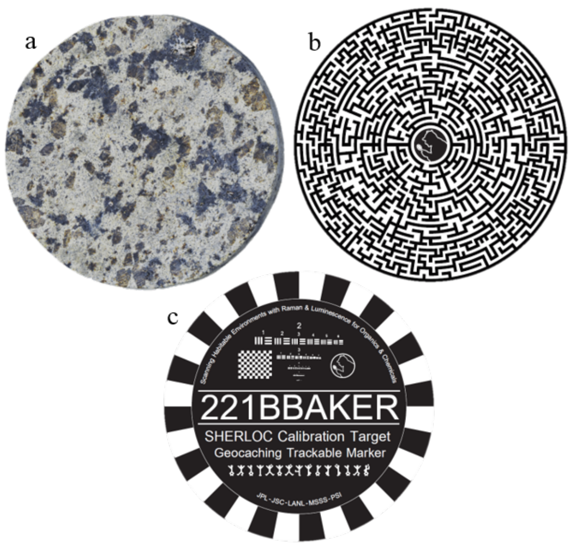

Figure 3: Images of the (a) Mars Meteorite, (b) Intensity Target Maze, and (c) Geocaching Trackable Marker.

The space suit materials on the SCT represent a unique materials experiment coordinated with the JSC Advanced Space Suits Lab. Human missions to Mars may require radical changes in the approach to extravehicular (EVA) suit design. A major challenge is the balance of building a suit robust enough to complete multiple EVAs under intense ultraviolet light exposure without losing mechanical strength or compromising the suit's mobility. This SCT experiment will provide in-situ spectral and observational analysis of space suit material degradation in the Martian environment. In addition, a simultaneous ground test will expose the same materials in a Mars environmental chamber and periodically test the chemical changes compared to mechanical strength.

Cleaning and Assembly: To achieve Mars 2020 and SHERLOC cleaning and contamination control standards, the JSC ARES curation cleanroom facilities, expertise, and best practices were utilized (Fig 4a). All SCT metallic components, hard targets, soft good targets, and handing tools were cleaned and verified to meet or exceed established requirements. Assembly occurred in a dedicated ISO Class 5 laboratory that was monitored for particulates, as well as inorganic and organic airborne molecular contamination.

Three SCTs have been assembled as of January 2019 including the Engineering Model (EM), the Flight Model (FM), and the Flight Spare (FS). The EM was used for assembly fit-checks and as a mass simulator for dynamics testing. A fourth SCT will be assembled as a Curation Model (CM), following the same cleaning and assembly protocols, and will be stored at JSC with other Mars 2020 components for future analysis and referral. Only the FM and FS include the Mars meteorite target, the EM and CM include a terrestrial basalt in that target location.

Testing and Validation: The FM and FS have successfully completed both random vibration and shock testing in each of the three component axes at JSC's Energy Systems Test Area (Fig 4b). Additionally, the FM and FS have successfully completed thermal function testing, high-resolution imaging and optical inspection, and bake out requirements. Thermal vacuum testing is scheduled to occur with the SHERLOC instrument at JPL, along with final verification and validation.

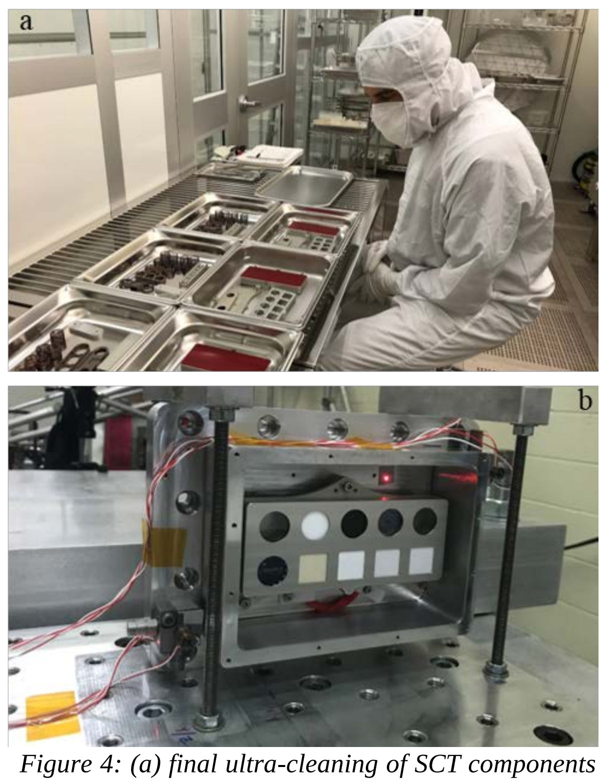

Figure 4: (a) final ultra-cleaning of SCT components in JSC Genesis Lab and (b) SCT shock testing setup.

References: [1] Beegle, L. W. et al. (2017) 48th LPSC, 2839, [2] Beegle, L. W. et al. (2015) IEEE, 90, 1-11, [3] Beegle, L. W. et al. (2014) International GeoRaman Conference, 5101.