SUPERCAM REMOTE MICRO-IMAGER ON MARS 2020. O. Gasnault[1], S. Maurice[1], R. C. Wiens[2], S. Le Mouélic[3], W. W. Fischer[4], P. Caïs[5], K. McCabe[2], J.-M. Reess[6], and C. Virmontois[7], [1]IRAP (Univ. Toulouse, 31400, France - ogasnault@irap.omp.eu), [2]LANL, Los Alamos, USA, [3]LPG-Nantes, France, [4]Caltech, Pasadena, USA, [5]LAB, Bordeaux, France, [6]LESIA, Meudon, France, [7]CNES, Toulouse, France.

Introduction: SuperCam is an instrument comprising a Laser Induced Breakdown Spectrometer (LIBS), a Raman spectrometer, an infrared spectrometer, and a Remote Micro-Imaging (RMI). These four subsystems are coaligned and operate at remote distances, in sequence, on the same target. SuperCam was selected to be on-board the next NASA mobile rover on Mars (project Mars 2020), which will be built and operated by the Jet Propulsion Laboratory [1, 2, 3].

SuperCam benefits from the heritage of ChemCam [4, 5] and the experience acquired with more than two years of operations on Mars Science Laboratory.

Science goals: The ChemCam RMI has proven the importance of clear high-resolution images to get the context and the precise locations of the spectroscopic analysis spots [6, 7]. The most frequent use of RMI with SuperCam on Mars 2020 will be the same.

These cameras are at the rear of a 110 mm diameter telescope that provides an effective spatial resolution better than 60 µm at 1.5 m (2 pixels at best focus) in a small field-of-view of the order of 20 mrad. The secondary mirror of the telescope can move to get the right focus from 1.4 m to infinity.

Used independently of other measurements, RMI will provide long distance images, with the possibility to do small mosaics for analyzing specific outcrop geometry, such as the presence of bedding or contacts between units. Given the high resolution, layer facies can be analyzed over scales of a few centimeters up to distances of several 100 m. Coupled with SuperCam passive spectroscopy, this will allow long-range identification of key targets for broad geological interests, or for tactical goals.

At shorter distances, RMI resolves individual sand-size grains allowing detailed texture investigations. This will be particularly important when SuperCam will be used for rock identification using LIBS, Raman, and infrared. The texture provided by the RMI and by the other cameras on-board will fulfil this analysis by determining the rock type (e.g., sedimentary *vs.* igneous) and the grain size (e.g., porphyritic *vs.* aphanitic).

While ChemCam's RMI is panchromatic, the SuperCam RMI will return color images (Fig. 1), which will enable comparison with mineralogical data and help the interpretation of morphological nuances (e.g. red dust *vs.* dark iron oxides). Color imaging will require a radiometric calibration and dedicated targets on the rover deck.

Technical description: The panchromatic 1 million pixel CCD (coupled charged device) is replaced by a color 4 million pixel CMOS (Complementary Metal-Oxide Semiconductor) following a successful research and development program conducted at CNES (French space agency). Similar sensors already flew on Spot-6.

Sensor. For SuperCam, the CMV4000 device with a Bayer filter from CMOSIS was selected. Its optical area (11.26 mm) is comparable to ChemCam CCD (14.34 mm), allowing the use of the same optical path than in ChemCam for a similar field-of-view.

Resolution. The CMOS pixels are 5.5 µm, while the telescope resolution covers a 15 µm area at the focal plane. As in a typical Bayer filter several pixels of different colors are illuminated, providing color images with the same resolution as ChemCam.

Focus. The focus requirement for RMI is similar to the requirement for LIBS, which is ±0.5% of the actual distance [5]. This is obtained with a continuous wave laser, while the focus stage is moving. An alternative consist in analyzing the quantity of information in the image on-board. This is achieved by computing the deviation from the mean signal level in a small subframe, a standard deviation, or the entropy. The former is working very well with ChemCam RMI on a 85x85 pixel centered subframe, which includes the LIBS pit (submillimeter size).

Pointing. SuperCam will use the pointing capability of the rover mast with targets defined in the mosaics returned by the engineering cameras. It is also planned to use the AEGIS (Autonomous Exploration for Gathering Increased Science) software [8, 9] in fine-scale mode: A RMI image is acquired and sent to the ground; The science team locates targets of interests (veins, nodules, laminae, etc.) within the image frame of reference; The next day, a new image is acquired and is used by the onboard computer to redirect SuperCam to the precise location.

In summary, the synergy of SuperCam components give access to a broad range of investigations (Fig. 2).

References: [1] Mustard J.F. et al. (2013) *DPS 45*, Abstract #211.17. [2] Schulte M.D. and Meyer M.A. (2013) *AGU Fall Meet.*, Abstract #P44B-02. [3] Maurice S. et al. (2015) *LPS XLVI,* this issue.

[4] Wiens R.C. et al. (2012) *Space Sci. Rev.*, 10.1007/s11214-012-9902-4. [5] Maurice S. et al. (2012) *Space Sci. Rev.*, 10.1007/s11214-012-9912-2. [6] Le Mouélic S. et al. (2014) *Icarus, in press*, 10.1016/j.icarus.2014.05.030. [7] Langevin Y. et al. (2013) *LPSC XLIV*, Abstract #1227. [8] Estlin T. et al. (2013) *AGU Fall Meet.*, Abstract #P51G-1801. [9] Altinok A. et al. (2014) *LPS XLV*, Abstract #2871. [10] Sautter V. et al. (2015) *LPS XLVI*, this issue.

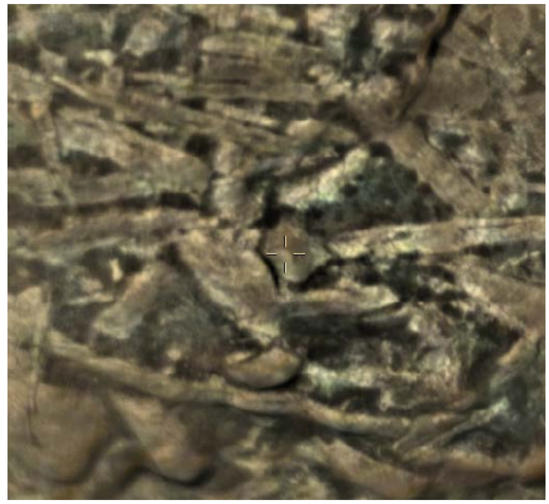

Fig. 1: Combined ChemCam RMI and MSL Mast-Cam images of the target Harrison (Sol 514), showing the expected products for SuperCam RMI. The cross shows the location of the laser sampling on a high-Si crystal [10], different than the composition returned by the dark cement around. Image publicly released in Photojournal as PIA17768 (credits: NASA, JPL-Caltech, LANL, CNES, IRAP, LPGNantes, CNRS, IAS, MSSS).

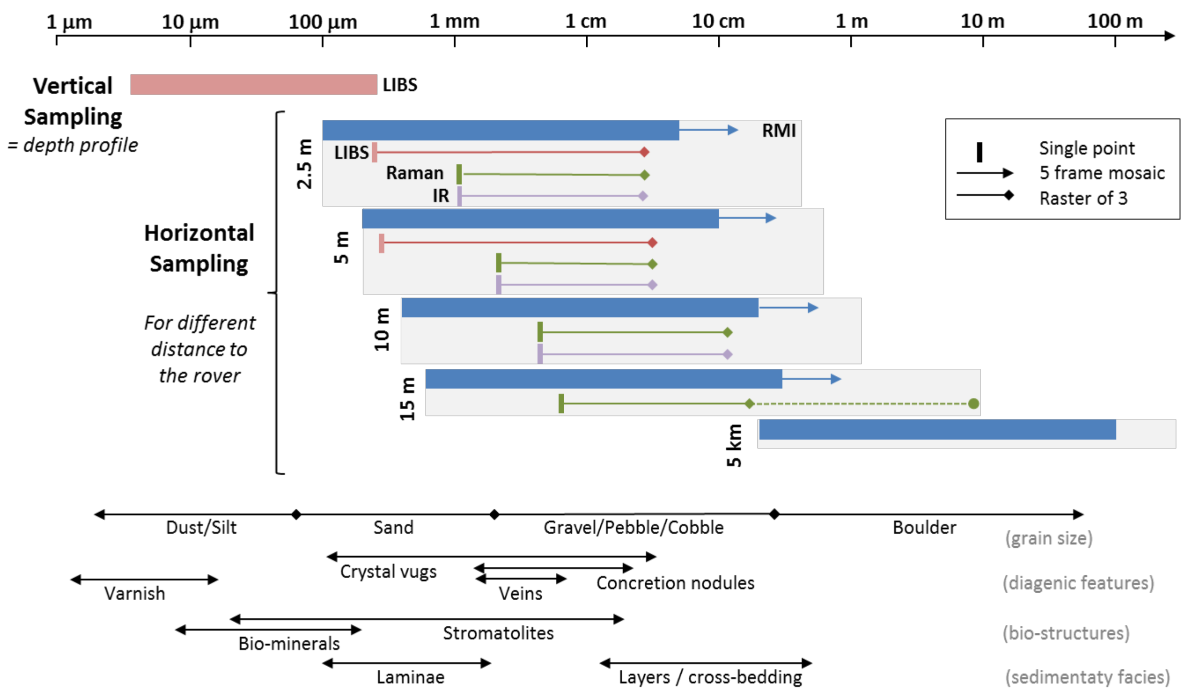

Fig. 2: The different scales of SuperCam suite investigation. For each distance, the blue scale bar extends from the effective spatial resolution to the field-of-view of the RMI image. The arrow to the right illustrate to coverage by mosaicking. The sampling area by LIBS, Raman and IR is shown by a vertical bar, and the measurement is repeated in a series of points (raster shown with the horizontal lines). The science investigations for each scale are listed in the bottom. In addition, images taken within 15 m can be used for analyzing features such as wind abrasion or open cracks for determining recent or current environmental conditions (wind direction, frost action, etc.).