

Time-resolved Raman spectroscopy for Mars exploration: insights from a laboratory analogue of the Mars2020 SuperCam instrument

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NASA will send a new rover to Mars in 2020 with a scientific payload that includes the SuperCam instrument. SuperCam is a suite of four co-aligned instruments including laser Induced Breakdown Spectroscopy (LIBS), time-resolved Raman and fluorescence spectroscopy, Visible and Near-Infrared spectroscopy (VISIR), and high resolution color Remote Micro-Imaging (RMI). Time-resolved Raman spectroscopy will be performed at a distance up to several meters using a 4 ns pulsed Nd:YAG laser (532 nm, 10 Hz, 10 mJ/pulse), a 110 mm telescope and an intensified 100 ns gated ICCD detector. This multi-purpose instrument suite will allow characterization of the elemental composition (LIBS) as well as the structure and mineralogy (Raman, VISIR) of minerals and putative organic targets with textural information (RMI). Here, this instrument will be presented in terms of methodology and main scientific objectives.

At IMPMC Paris, we set up a unique homemade time-resolved Raman spectrometer equipped with a microscope allowing *in situ* Raman mapping and analyses, and a telescope allowing remote measurements. Because weight, volume, temperature and shock resistance are not restrictions in the lab, the IMPMC instrument relies on a 1.5 ns pulsed Nd:YAG laser (532 nm, 10 to 2000 Hz, 1 mJ/pulse), a 200 mm telescope and an intensified gated (down to 0.5 ns gate) ICCD detector.

Preliminary experiments showed that SuperCam will allow documentation of both Raman and fluorescence signals. Time resolution is extremely powerful to extract the Raman signal from mineral fluorescence even in the case of highly fluorescent targets (like clays, some carbonates or phosphates, ruby...). Thanks to the excellent synchronization between the laser and the ICCD, sub-nanosecond time-resolution can be achieved in the laboratory and makes possible the analysis (and removal) of organic fluorescence which have a very short (ns) decay lifetimes compared to most mineral fluorescences (decay lifetimes commonly in ms).