A COMPACT INTEGRATED RAMAN SPECTROMETER, CIRS, FOR FINE-SCALE DEFINITIVE MINERALOGY IN VENUS EXPLORATIONS. Alian Wang[1], Jie Wei[1], James Lambert[2], Ian Hutchinson[3], [1]Dept. Earth and Planetary Sciences and McDonnell Center for Space Sciences, Washington University in St. Louis, [2]Jet Propulsion Laboratory, [3]University of Leicester, UK; [4]Max Planck Institute for Solar System Research, Germany. (alianw@levee.wustl.edu).

Raman for Venus mission: pros and corns: Among the terrestrial planetary bodies, we have the least knowledge about Venus. There isn't any meteorite that can be remotely assigned to a Venus origin. The geochemical data from Venera and Vega landing sites suggest a basaltic crust, but rich in incompatible elements (K, Th, U) similar to alkali-rich terrestrial oceanic island [1]. Venus has the youngest surface built through recent volcanic activities. With a dense atmosphere of high pressure and temperature near surface, Venus has the most interesting atmosphere-surface interactions. These features make ***the definitive characterization of molecular species at Venus surface to be an absolute necessity for any Venus landing mission.***

Raman spectroscopy probes fundamental vibrations of molecules that produce finger-print spectral patterns with sharp peaks. In that sense, planetary Raman spectroscopy is very powerful. On the other hand, Raman scattering phenomenon is intrinsically weak. It requires carefully crafted optical configurations with high efficiency optical and opto-electronic components, in order to obtain high Raman signal strength and to reduce instrument noises.

Through two decades of studies of extraterrestrial materials and tests in the laboratory and in natural geologic settings, we have come to a conclusion regarding the best configuration for a planetary Raman system to satisfy the need of fine-scale definitive mineralogy, i.e., the configuration of MMRS and CIRS. CIRS is currently supported by MatISSE to reach TRL 6 in 2016. It is based on the mature technologies of MMRS [2], developed through PIDDP, MIDP and field tested in an ASTEP project.

In terms of engineering, MMRS / CIRS configuration uses the simplest, most mature, and optically most effective techniques (continuous wave, low power 532 nm laser, visible optics, conventional CCD). The robustness and Raman efficiency of this configuration was demonstrated through the 2014 field test on Zoe rover over 50 km traverse at Atacama Desert.

Science Return vs. beam size, *f* number, efficiency: Through twenty years' Raman spectroscopic study of extraterrestrial samples, we can conclude that many extremely important science would normally be revealed by minor and trace components in a geological entity, which would be the case during Venus surface exploration. Because of that reason, we believe that CIRS/MMRS type of Raman system is advantageous over a remote-Raman system. Not only because of its µm sized sampling spot would enable the Raman signals from minor and trace species ***not-to-be*** covered by those from abundant major phases in a 300 µm -1 mm sampling spot, but also because its ***f/2*** optical system provides ***85-3420*** times Raman photons collectivity than an ***f/10-70*** optical system of normally proposed remote-Raman for planetary missions. In addition, we have to balance the high power density of a pulse laser used by a remote Raman over the low duty cycle (0.1%) and over the threat in sample over-heating. All of our publications that demonstrated wide planetary applications of Raman spectroscopy [3-8] have used *in-situ* green Raman systems, e.g., an MMRS / CIRS type of instrumental configuration.

Current status of CIRS: after one year development support by the MATISSE program, a prototype of CIRS was built and preliminary tests were done. Further optimization is in progress.

CIRS / MMRS for a Venus lander: CIRS and MMRS represent two flexible configurations to be selected by various types of Venus missions. They both work in visible spectral range (532-675 nm), thus allow the laser excitation and Raman photon collection through a transparent window (fused silica or sapphire). While keeping the ***f/2*** optics, CIRS has a front optics with long working distance that will enable Raman measurements to be made behind a window, while Venus surface/subsurface sample could be delivered onto the window from outside of a sealed lander. It can also directly analyze the samples that will be delivered into the sealed lander. In both ways, CIRS / MMRS can generate 100 spectra (spots) in less an hour.

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