**AN INNOVATIVE LIGHT SCATTERING TECHNIQUE FOR CHARACTERIZING MARTIAN SOIL.** V. Backman[1], K. Chen[1], M.P. Ulmer[1], B.W. Wessels[1], M.S. Robinson[1], [1]Northwestern University, 2145 Sheridan Road, Evanston IL 60208, v-backman@northwestern.edu.

**Introduction:** Utilizing a propriety technique we have designed and prototyped a new remote sensing instrument called the Light Scattering Spectroscopy Micro-Organism Probe (LSSMOP) [1,2,3,4]. This instrument detects DNA, protein, and virus-like organisms as well as gives basic morphologic information at the scale of 30-300 nm. This instrument is ideally suited for characterizing martian geologic samples as part of a landed science payload. Not only does the LSSMOP directly address key exobiology science goals, it can be used to characterize grain sizes and shapes of geologic materials over a broad range of scales. The basic design parameters include a mass of 2 kg, peak power of 100 Watts in 10-second bursts, with up to 10 measurements per day. The duty cycle between samples is ~1 hr with a data rate of 10bit/sec-100bits/sec. Currently the LSSMOP is at a TRL-3 for the basic instrument and with proper funding, it will be at TRL-6 by 2006. The experiment is designed for longevity and can readily measure up to 10 samples per day. To acquire a reading the LSS requires a sample area of only 1 $mm^2$ to 1 $cm^2$ that is located within 3 mm of the probe. The reading can be made in a few minutes and thus does not interfere with other science operations onboard a lander or rover. We are currently testing the prototype on a variety of martian analog samples (basalt, sandstone, mudstone, siltstone) and meteorites to establish detection levels and operational limits.

**Background:** Visible light scattering spectroscopy (LSS) is useful for remote real-time analysis of the nanometer-scale structure of materials including inorganic materials and biological cells and tissues. In LSS, static light scattering from an object is recorded for multiple wavelengths and its spectrum is analyzed to obtain the structural information about the object. Potentially, LSS can be used to probe the submicron/nanometer-scale structure of tissues and cells obtained for diagnostic purposes, to analyze bioengineered tissues, to analyze sub-micron bio-particles and organisms including viruses in a massively parallel manner for the purposes of identifying harmful biological agents, to study the roughness of the surfaces of non-biological materials, e.g. solids, as well as their interior.

The major advantage of LSS is its ability to provide information regarding the structure of materials at scales as small as few tens of nanometers. Visualization of such small objects is impossible with optical microscopy, because the required resolution is below the diffraction limit. According to the Rayleigh criterion of diffraction-limited resolution, objects cannot be resolved when their sizes or separation between the objects are less than, approximately, half of the wavelength of light used to image the objects. However, LSS does not attempt to *visualize* these small objects. Whereas the resolution of a light microscope is limited to ~$\lambda/2$, with $\lambda$ the wavelength of light, characteristic spectral features of light scattered by particles smaller than $\lambda/10$ can be distinguished. Only when the size of a particle becomes *much smaller* than the wavelength does the particle behave as a Rayleigh scatterer and its characteristic spectral features disappear. We are in the process of extending the LSS methods to the UV to bring the resolution down to ~20 nm, which is compatible to the size of many macromolecular complexes.

**References:** [1] Backman V, et al., (2000) *Nature*, 406, 35-36. [2] Backman V, V. et al. (2001) *IEEE J. Sel. Top. Quant. Elect.*, **7**, 887-894. [3] Backman V, R. et al. (1999) *IEEE J Sel Top Quant. Elec.*, 5, 1019. [4] Backman V, et al. (2002) *Progress Biomed. Optics Imaging*, **3**, 101-110.

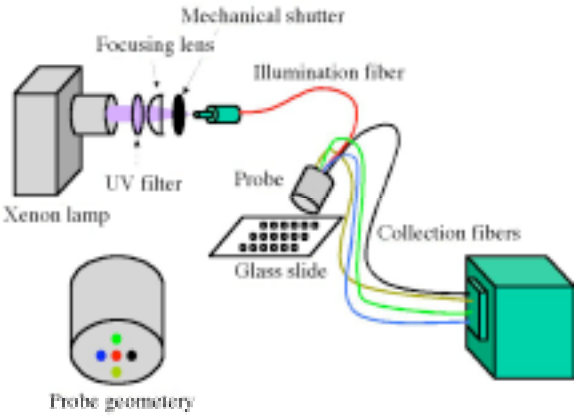


Figure 1 Fiber-optic LSS probe size = 5mm.