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A Multi-Channel Tunable Laser Spectrometer for in Situ Measurement of Planetary Atmospheres

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A newly developed tunable laser spectrometer (TLS) capable of simultaneously measuring many of the key photochemical species in planetary atmospheres is presented. The instrument consists of a low-power (<10 mW) and low mass (<50 mg) vertical cavity emitting laser source and photodetector, a multi-pass optical cell to provide a long absorption path in a compact design, and laser driving and digital signal processing electronics. The sensor takes advantage of two key technological developments: 1) a patented multiple-pass optical cell design that uses small mirrors and dense spot patterns to give a long optical path with a small footprint; and 2) a low power and compact electronics system. Designs for Mars and Venus are mature, allowing for deployment on probe or balloon missions to either planet, and deployment on landed spacecraft at Mars. The instrument is immune to the corrosive sulfuric acid environment of Venus and is capable of operating at temperatures of up to at least 370 K; the instrument is ideal for an atmospheric balloon investigation at altitudes of 50 km or higher. The large diurnal temperature range of Mars is not a challenge, and the optical design is robust against dust contamination. The major advantage of this system over previously developed TLS instruments is the multichannel gas measuring capability, an increase in path length and sensitivity without an increase in mirror size, a dramatic decrease in mass and power, and the robust nature of the design in a hostile environment. Most of the instrument components and electronics are at TRL-6 with the combined system at TRL-5. The instrument is currently in field tests and will undergo environmental Mars testing for qualification to TRL-6 by then end of 2014. Current best estimates of total instrument mass and power are 750 mW and 1 kg, respectively.