A CMOS-Based 90 – 105 GHz Pulsed-Echo Spectrometer: New Approaches for Highly-Mobile and Low-Power *in situ* Chemical Detections

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Abstract—Cavity enhanced pure rotational spectroscopy has long been a potent laboratory tool for the elucidation of structure and dynamics in isolated molecular systems where sensitive pulsed-echo techniques are routinely performed up to frequencies as high ~50 GHz. Although the associated narrow linewidths (~800kHz), wide-bandwidth (often >10 GHz), and long optical path lengths have long been identified as a desirable combination for sensitive and specific gas sensing, the unaccommodating size and power requirements of traditional microwave optics/electronics are unsuitable for the stringent demands required for *in situ* deployment. Additionally, efforts to drive pulsed-echo techniques into millimeter and submillimeter wavelength regimes, where the size of optics can be reduced without suffering large diffraction losses, have failed largely due to inefficiencies of injecting radiation into the resonant optical cavity.

Recent pursuits at the Jet Propulsion Laboratory to realize compact, low-power devices capable of *in situ* chemical detections on extra-terrestrial objects have found success in calling upon novel transmitter and receiver sources built from CMOS architectures commonly employed in the high-speed communications industry. Combining custom low-power integrated circuit chipsets with novel antennae embedded optical devices allows for the realization of cavity based instruments where *all* source and detection electronics are hosted by a single 4in. x 4in. printed circuit board. The current talk will present a full system description of this miniaturized CMOS-based pulsed-echo rotational spectrometer, which has an operational bandwidth (90-105 GHz) that includes many astrophysically relevant target compounds, along with future plans to extend the bandwidth to other wavelength regions.