A Radar and Spectrometer Instrument Prototype for Planetary Science at Millimeter and Submillimeter-Wave Frequencies

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A main objective of planetary science is to decipher the history of our solar system including Earth by observing space objects such as planets, asteroids and comets. Millimeter and submillimeter-wave radars and spectrometers are valuable observation tools which provide physical, chemical and morphological information about planetary objects. GAISR (Gas And Ice Spectrometer Radar) is an instrument concept currently being matured as a laboratory prototype instrument for probing the dynamics and composition of cometary jets. GAISR will operate in three channels: a 95 GHz radar and 270 and 560 GHz spectrometers sharing the same RF back-end and achieving a high level of integration. We intend to address several technical aspects of this low-mass and low-power instrument, including the common local oscillator chain and mixer stages, the quasi-optical feed system as well as the calibration load.

The LO chain starts with a Ka band synthesizer realized in 65 nm CMOS technology followed by a Tripler that delivers W-band power to the rest of the chain through a 4-way splitter.

Here, we emphasize on the two spectrometer channels: The 270 GHz tripler as well as the 270 and 560 GHz mixers are developed in-house by JPL using state-of-the-art Schottky diode technology. The noise temperature of each mixers is extracted by the mean Y-factor measurements (hot and cold) using a calibrated test setup.

Based on these results, the ongoing works aims to integrate custom intermediate frequency (IF) low noise amplifiers (LNAs) within the mixer blocks. This approach aims to reduce the conversion loss between the mixers and the LNAs as well as to optimize the packaging of the system resulting respectively in lower noise temperature (thus better sensitivity) and more compactness.