

# First Flight of an Almost All-CMOS 183 GHz Limb-Sounding Spectrometer System Aboard the ReckTangLE Ballooncraft

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This abstract discusses a compact and low-power 183 GHz heterodyne spectrometer instrument that is almost entirely implemented in CMOS technology except for a single InP preamplifier MMIC. The 1.1W and 0.5 Kg spectrometer system is intended for both Earth and planetary science applications enabling limb-sounding of H<sub>2</sub>O from compact CubeSat and SmallSat platforms.

The spectrometer's RF front-end employs an 28nm system-on-chip (SoC) device containing a 183 GHz receiver, integrated 183 GHz phase-locked loop to provide the LO, integrated IF amplification and an integrated digital processor connected to many sensors and tuning knobs (bias and varactors) for calibration purposes. External to the receiver SoC a single 35nm InP MMIC low-noise amplifier (LNA) is placed in front of the CMOS receiver to maintain reasonable receiver noise temperatures.  $T_{\text{sys}}$  of the CMOS receiver alone is above 2000K while  $T_{\text{sys}}$  with the InP amplifier is on the order of 500K when operated at room temperature. A second 65nm CMOS chip provides the back-end processing for the spectrometer instrument. This chip contains a high-speed 3b analog-to-digital converter (ADC) and a 4096-channel wideband FFT processor, and SRAM based accumulator along with several sub-processors that perform analog calibration and timing adjustment tasks on the ADC. The chip also contains a USB2.0 interface allowing it to directly interface with a PC or spacecraft computer. While the ADC is capable of operation up to 6 GS/s it was operated at 1.5 GS/s in this instrument as the CMOS receiver's integrated IF only offers 750 MHz of bandwidth.

The full CMOS spectrometer instrument was integrated into the payload of a small hand-launched high-altitude ballooncraft called the "Reck-Tang Limb-sounding Experiment" (ReckTangLE) which was launched on Oct 17 2019 and performed several spectroscopic soundings of H<sub>2</sub>O in the upper stratosphere over the southwestern United States.

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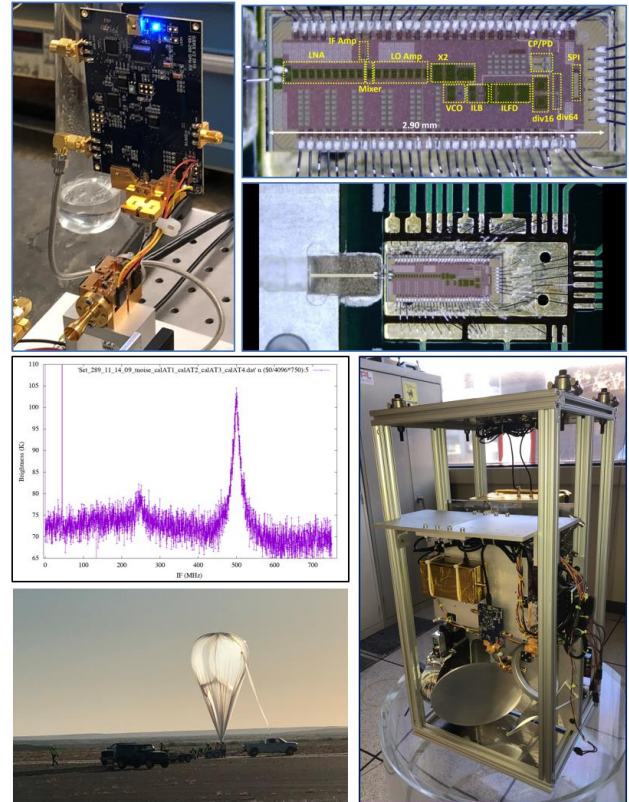


Fig. 1. Overview of the 183 GHz almost all-CMOS spectrometer instrument and integration on board a ballooncraft.

## REFERENCES

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