National Aeronautics and Space Administration

Extremely Compact CMOS H_2O Detector

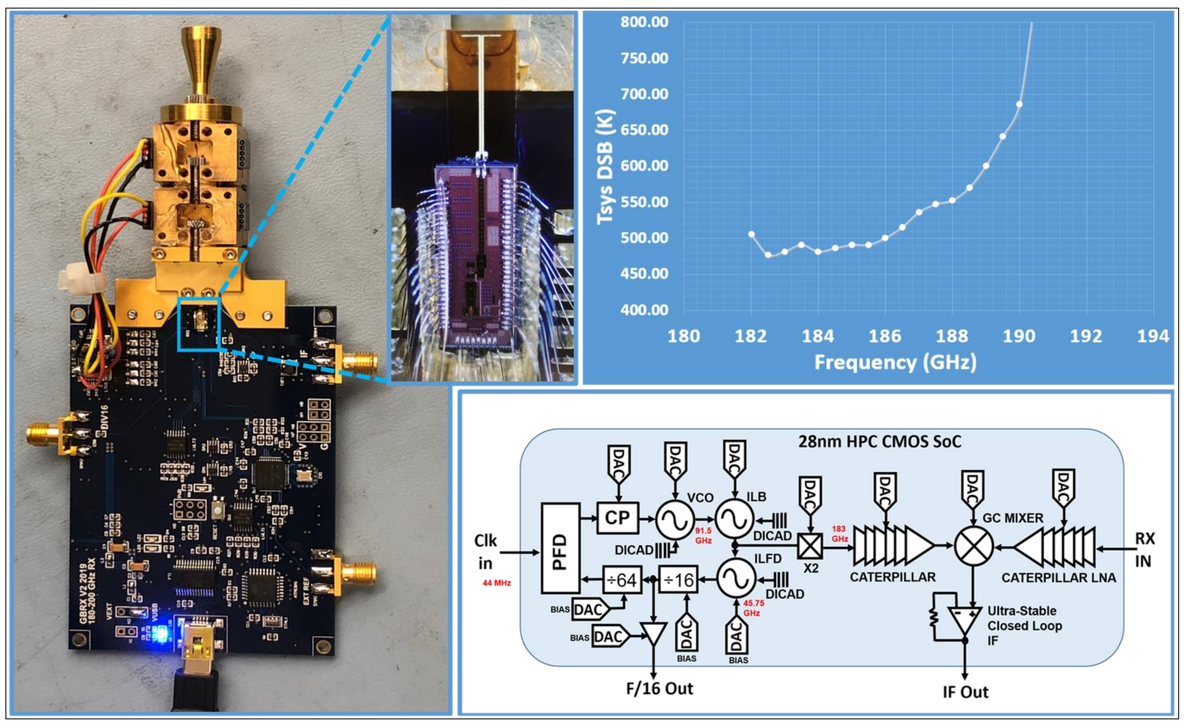
Principal Investigator: Adrian Tang
Co-Is: Frank Chang (UCLA)

Program: Topic R&TD

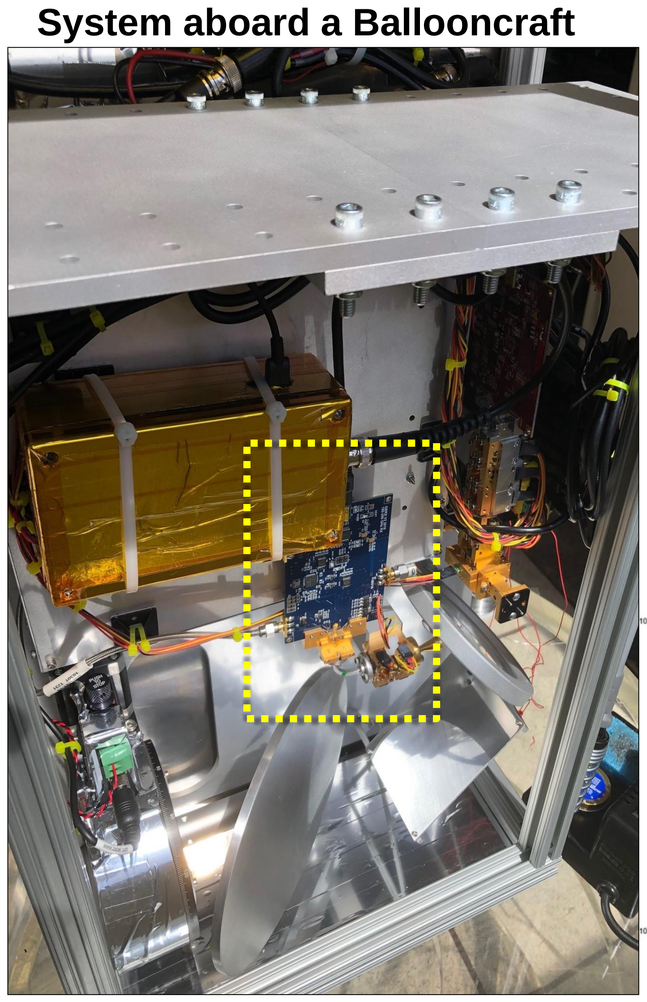
Project Objective:

The primary objectives of this effort are to develop an extremely compact and low power (<1Kg / <1W) CMOS heterodyne spectrometer/radiometer for H_2O detection and develop associated mm-wave packaging. The secondary objective is to augment the developed system with digital beam-steering capability for plume tracking and direction finding.

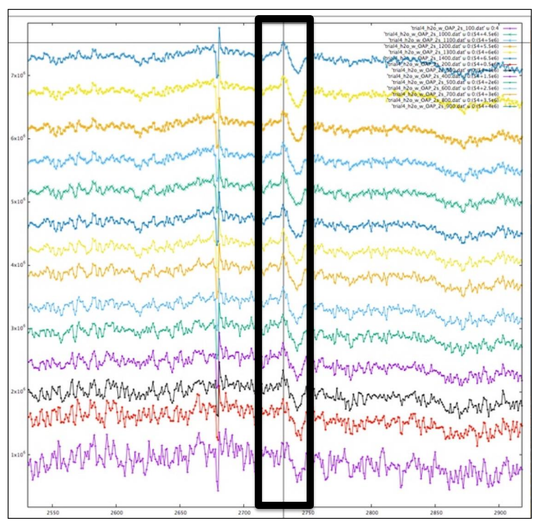
Developed Single Pixel System

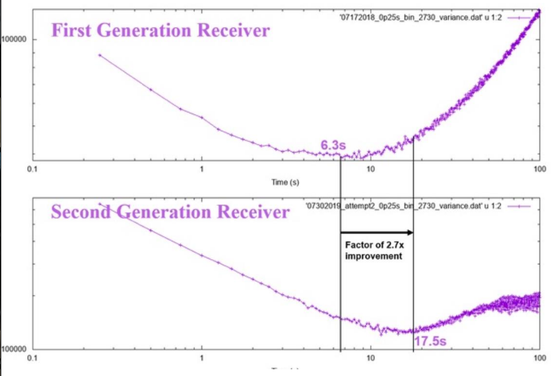


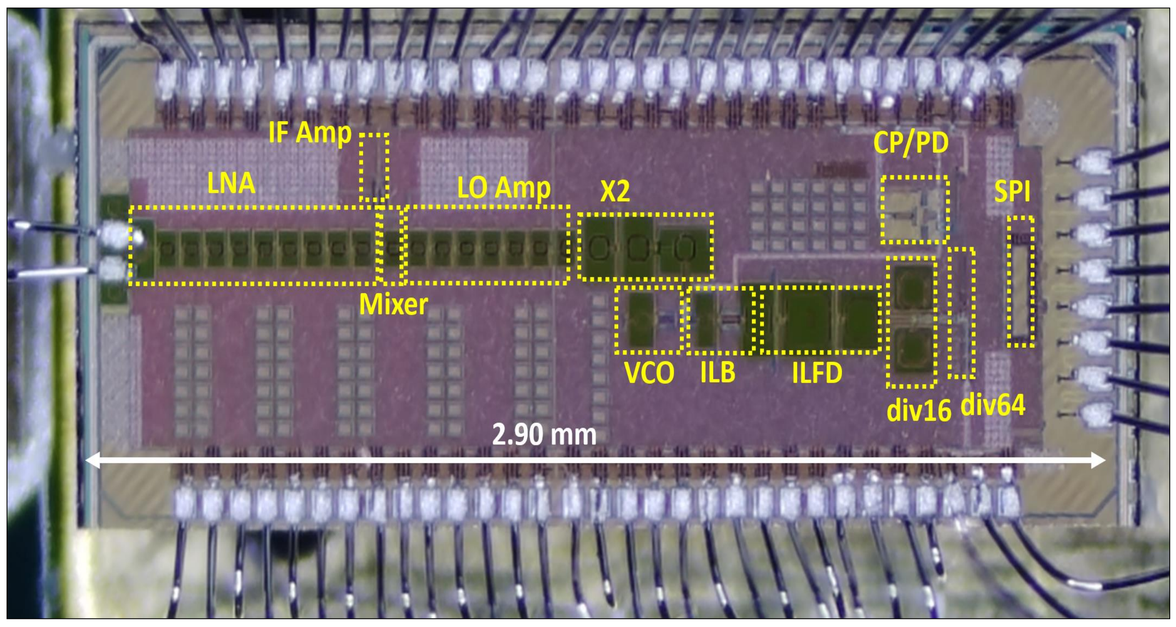
System aboard a Ballooncraft



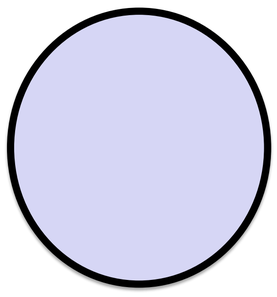
Lab Measurements







Actual Receiver



Characteristic	Performance
Technology	TSMC 28nm HP++
Noise Temperature	490K
Frequency Range	182-190 GHz
CMOS DC Power	460mW
Total Mass	232g
Allan Time	>15s
Preamp DC Power	20mW
Total DC Power	480mW

Benefits to NASA and JPL (or significance of results):

The demonstrated instrument is applicable to investigating water and volatiles on a comet surfaces, and investigating the presence of other molecules in other atmospheric studies of planets and their moons, as well as for studies of Earth's own atmosphere. It represents the smallest and lowest power microwave remote sensing instrument in JPL's portfolio.

Publications:

1. Y. Kim, Y. Zhang, T. Reck, D. Nemchick, G. Chattopadhyay, B. Drouin, M-C F. Chang and A. Tang, "A 183-GHz InP/CMOS-Hybrid Heterodyne-Spectrometer for Spaceborne Atmospheric Remote Sensing," in IEEE Transactions on Terahertz Science and Technology, vol. 9, no. 3, pp. 313-334, May 2019.
2. A. Tang, Y. Kim, T. Reck, G. Chattopadhyay, I. Mehdi, B. Drouin, K. Cooper, N. Livesey M-C F. Chang,"DDFS and ΣΔ Approaches for Fractional Frequency Synthesis in Terahertz Instruments", IEEE Trans. THz Sci. & Technology, Vol. 8 No. 4, pp 410-417, August 2018.
3. A. Tang, "Future THz Spectroscopic Instruments for Earth and Planetary Science ," in SPIE Defense and Commercial Sensing, 2018.
4. A. Tang, Y. Kim, T. Reck, Y. Tang, Y. Xu, G. Chattopadhyay, B. Drouin, M. Mehdi, M-C F. Chang, "A 177-205 GHz 249 mW CMOS-Based Integer-N Frequency Synthesizer Module for Planetary Exploration," in IEEE Transactions on Terahertz Science and Technology, vol. 8, no. 2, pp. 1-4
5. Deacon J. Nemchick, Brian J. Drouin **Adrian J. Tang**, Yanghyo Kim, Mau-Chung Frank Chang, "Sub-Doppler Spectroscopy With a CMOS Transmitter", in IEEE Transactions on Terahertz Science and Technology, vol. 8, no. 1, pp. 121-126

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Poster No.