Wide-band Millimeter and Sub-Millimeter Wave Radiometer Instrument to Measure Tropospheric Water and Cloud Ice (TWICE)

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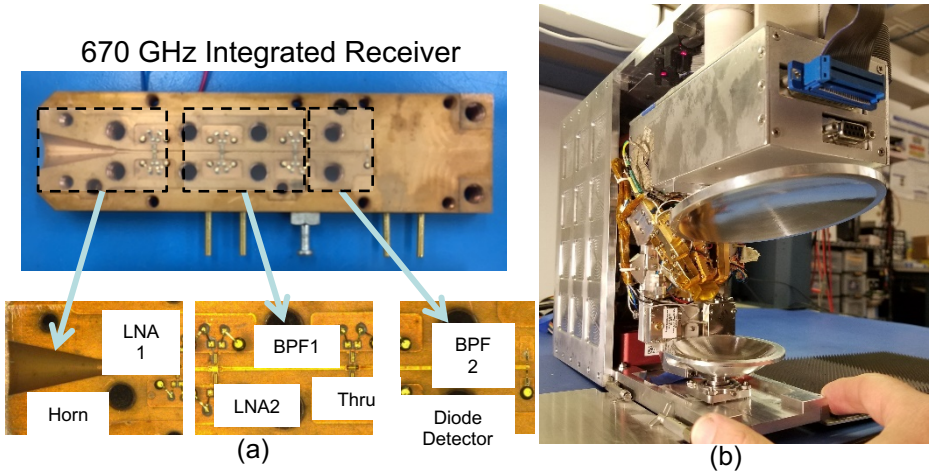
Objective

- Develop, fabricate, and test a wide-band millimeter and sub-millimeter wave radiometer instrument to measure tropospheric water and cloud ice.
- Develop capability to measure upper-tropospheric water vapor, cloud ice particle size distribution, and water content at a variety of local times.
- Reduce the size, mass, and power consumption of space-borne millimeter and sub-millimeter wave radiometers to enable deployment on a 6U-Class satellite platform.



(a) TWICE 670-GHz integrated receiver; (b) TWICE instrument for a 6U CubeSat.

Accomplishments

- Developed, fabricated and tested a multi-frequency, wide-band millimeter and sub-millimeter wave instrument with 16 channels, i.e. 4 frequencies near 118 GHz for temperature profiling, 4 frequencies near each of 183 GHz and 380 GHz for water vapor profiling at different altitude ranges, as well as 240, 310, 670 and 850 GHz for ice particle sizing.
- Demonstrated measurement capability at a level that meets science requirements for simultaneous retrievals of cloud ice particle effective diameter, ice water content, water vapor and temperature profiles.
- Developed and demonstrated for the first time LNA-based direct-detection receivers at 240, 310, 670 and 850 GHz.
- Demonstrated 1/f-noise reduction by 19 dB in sub-millimeter wave receivers leading to significant improvement in receiver performance.
- Demonstrated more than 650% reduction in mass and more than 800% reduction in both volume and power consumption per channel, as compared to the commercial 883 GHz radiometer flown on IceCube.
- The new capabilities of the TWICE instrument that fit within a ~3U volume enable the measurement of ice particle size and total amount of ice in high clouds on a global basis, along with water vapor and temperature profiles at relevant atmospheric altitudes.

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TRL_{in}= 3 **TRL_{out}= 5**