Advanced Amplifier Front Ends for Submillimeter-Wave Sounders

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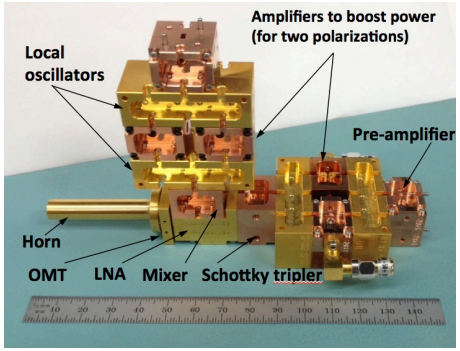
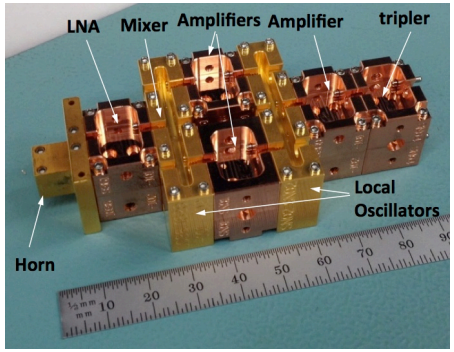
Objective

- Develop high electron mobility transistor (HEMT) amplifier-based heterodyne radiometers to provide high sensitivity at millimeter and submillimeter wavelengths with high spectral resolution for molecular line detection.
- Performance goals are:
  - Low system noise temperature:
    - < 280K Single Sideband at 230 GHz
    - < 650K Single Sideband at 640 GHz
  - Wide spectral coverage:
    - 180-270 GHz (for tropospheric measurements)
    - 620-660 GHz (stratospheric measurements)
  - Sideband separation: > 15 dB
  - Amplifier front-end operating temperature: 20K





The dual-polarized, sideband separated receivers at 180-270 GHz (left) and 620-660 GHz (right) developed using HEMT-based amplifiers and multipliers. They require 20K cooling, as compared to superconductor-insulator-superconductor (SIS) receivers which need to be cooled to 4K.

Accomplishments

- Designed and fabricated the HEMT-based low noise amplifiers, fundamental balanced and subharmonic mixers, and frequency multipliers for sideband separating receivers operating in the 180-270 GHz and 620-660 GHz frequency bands.
- Developed and demonstrated an ultra-wideband orthomode transducer (OMT) operating in the 180-270 GHz bandwidth with low insertion loss (< 0.5 dB), good return loss (> 18 dB), and excellent isolation between orthogonal polarizations (better than 30-35 dB over the entire band).
- Developed, and tested waveguide 90° quadrature hybrids in the 180-270 GHz and 620-660 GHz frequency bands with excellent return loss (> 25 dB), amplitude imbalance (better than ± 1 dB), and phase imbalance (90 ± 5°).
- Assembled the above components into sideband-separated receivers, and demonstrated that the noise temperature goals were met (measured results were ≤ 150K in the 180-270 GHz band and ≤ 650K in most of the 620-660 GHz band).
- Demonstrated sideband ratios of better than 10 dB across the RF and IF frequencies in both frequency bands.

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