A Single-Sideband 530-600GHz Integrated Receiver Utilizing Tunable Waveguide Filters

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Sideband separating receivers radically simplify analysis of spectral regions where many species exist, such as the 530-600 GHz band when studying planetary atmospheres. Sideband-separating mixers use quadrature combining of two mixers to down-convert both sidebands but require careful balancing of the two mixer paths. A simpler approach is possible if a fixed LO frequency can be used. This allows filtering of the image-band before a double-sideband mixer. In addition to reducing circuit complexity, this approach provides higher sideband rejection than typically achieved with sideband separating mixers.

Fig 1 (top) shows the system diagram. The integrated receiver combines a 281GHz LO chain with a multiplication factor of 27 with two sub-harmonic mixers. IF filters follow each mixer. Both sidebands are down-converted by splitting the incoming signal and then filtering each path. The LO is located at 562GHz and down-converts 531-557GHz and 568-600GHz, providing an 11GHz band where the filters can cross-over. Secondary down-conversion is used to place the species of interest into the spectrometer's bandwidth. To set the noise temperature of the system, 520-600GHz LNAs will precede the splitter.

This approach requires very precise location of the passband edges. Machining tolerances makes realization of the desired filters' passbands unlikely, so a tunable waveguide filter approach is utilized. It has been found that waveguide filters can be effectively tuned by adjusting the gap in the E-plane split waveguide block [1]. By controlling the gap in the filter block with 5um thick shims, the filters can be aligned to within +/- 3 GHz, without significant change in the passband width or insertion loss.

Fig. 1 (middle) shows the discrete version of this system, where the tunable filter and splitter have been separated from the integrated receiver to verify this tunable filter approach. The graph shows the conversion gain of each mixer path, which includes the loss of the splitter, filter and mixer, and the gain of an IF amplifier.

To further reduce losses, a fully integrated version of the system that combines the receiver with the filter and splitter has been developed and results of this device will be presented at the conference.

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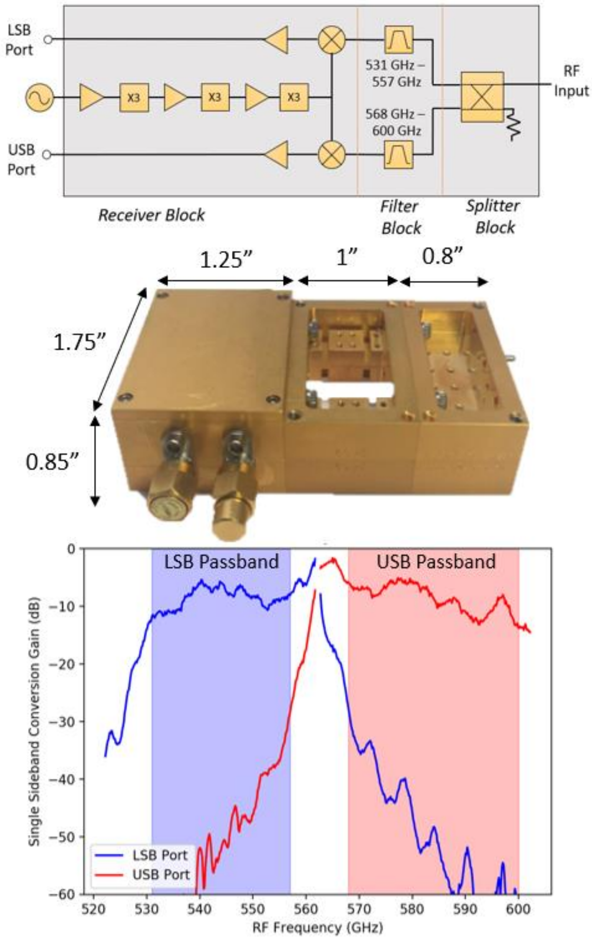

Fig. 1. (Top) The block diagram of the 530-600GHz receiver. (Middle) The discrete 530-600 GHz receiver system in three blocks. From left to right: Integrated receiver, Tunable Filter, Splitter. (Bottom) is the conversion loss of the full system showing less than -10 dB conversion loss and over 30 dB of sideband rejection across both upper and lower passbands.

References

[1] D. Koller, E. W. Bryerton and J. L. Hesler, "WM380 (675–700 GHz) Bandpass Filters in Milled, Split-Block Construction," in IEEE Transactions on Terahertz Science and Technology, vol. 8, no. 6, pp. 630-637, Nov. 2018.

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