

Performance of a 4.7 THz waveguide HEB mixer for SOFIA's upGREAT

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We present the heterodyne performance characterisation of a waveguide-technology HEB mixer at 4.7 THz. The HEB mixer was developed for the upGREAT focal plane array extension of the German Receiver for Astronomy at Terahertz frequencies (GREAT), which currently is in operation on SOFIA. The High Frequency Array (HFA) at 4.7 THz will consist of 7 pixels and will be combined with the 14 pixel Low Frequency Array (LFA) at 1.9-2.5 THz, using similar waveguide mixers [1].

The HEB mixer is designed and fabricated at KOSMA, with the device utilizing normal metal planar circuitry including a waveguide antenna, transmission lines and beamlead structures for DC and RF contact [2]. New for our HEB device is the combination of in-house deposited NbN for the superconducting microbridge and a 2 µm thin silicon substrate, which is shaped from SOI wafers using MEMS front- and backside processes. The broadband RF coupling measured with an FTS shows an excellent match with the circuit design. With a QCL local oscillator operating at 4.745 THz, near the frequency of the [O I] line of astronomical interest, we measure an uncorrected noise temperature T_{rec} (Rayleigh-Jeans) of 1200 K at 250 MHz IF using a HDPE dewar window with 73% transmission and a 88 % signal transmission 13 µm thick Mylar beamsplitter in horizontal polarization and an evacuated signal path to the calibration blackbodies. The 3 dB IF noise roll-off is 3.3 GHz, which is a significant increase in comparison to our previous NbTiN HEBs on silicon nitride membranes.

The waveguides are fabricated from a CuTe alloy by stamping techniques in the KOSMA in-house workshop. The achieved accuracy, e.g. of the 48 µm by 24 µm waveguides, is 1 µm. The waveguide mixer uses a smooth-wall spline profile feedhorn, optimized and manufactured at Radiometer Physics GmbH. Our measurements confirm the excellent quality of the beam pattern of the mixer, which is important for a focal plane array [3].

The heterodyne characterisation of the KOSMA mixer was performed in the (up)GREAT consortium test bed at the MPIfR using a QCL based local oscillator developed by the DLR-PF for the GREAT H-Channel [4].

References

1. see presentation C. Risacher
2. P. Pütz, C. E. Honingh, K. Jacobs, M. Justen, M. Schultz and J. Stutzki, Terahertz hot electron bolometer waveguide mixers for GREAT, A&A 542 L2 (2012) doi: 10.1051/0004-6361/201218916
3. see presentation T. Bertrand
4. see presentation H. Richter