Far-field beam pattern technique for high pointing accuracy characterization of GUSTO HEB mixer arrays

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Until now HEB mixer arrays employed in supra-THz heterodyne detection consist of multiple individual mixers (e.g. UpGreat) that could be aligned with the respective individual optics. In GUSTO [1], a NASA ultra-long duration balloon borne Terahertz observatory, that will employ three HEB mixer arrays to simultaneously measure the THz relevant molecular lines of [NII], [CII] and [OI] lines at 1.4, 1.9 and 4.7 THz, it requires the use of compact monolithic arrays consisting of 8 pixels, in a 4x2 configuration, that may not be independently moved or aligned. This new geometry imposes the need for a requirement on the pointing accuracy of each individual pixel. In the case of GUSTO all pointing vectors should be aligned within 0.1 degrees in relationship to the array mixer block normal. The pointing requirement implies two different challenges. The first is to set proper component tolerances (e.g. lens fabrication) and its assembly. The second is the characterization of the final assembly. The latter is the focus of this work.

In order to properly characterize the pointing of any individual pixels, an obvious approach is to characterize its beam pattern at the desired frequency. A near field phase and amplitude or a far-field amplitude measurement can simultaneously characterize not only the pointing but the beam pattern of the individual mixer, a very important information for the validation of the arrays. Due to the complexity and not yet developed phase and amplitude measurements for higher frequencies, e.g. 4.7 THz, we have been focusing on the amplitude only measurement.

In the past a widely used technique was the rotation of the mixer at the beam waist position whilst facing a THz beam, which is typically from the LO. In our opinion there are a few drawbacks of this technique to characterize with sufficient resolution the GUSTO mixer such as: a) the need for a highly reliable system to align the HEB mixer to the rotation axis of the stage, affecting the side lobe level and balance; b) the mechanical (in)stability of the rotation stage moving such a big mass, which could be solved by longer waiting times but would lead to unrealistic long scans. c) the impossibility for such technique to co-register the pointing of all the pixels in the array assembly; Therefore, we explore another technique that makes use of the scanning of an Hot/Cold load in the far field of the mixer, which is operated in heterodyne mode similarly as reported in [2].

We report on a beam pattern technique setup with sub 0.1 degrees resolution for single pixel characterization. For this the HEB is operated in the heterodyne mode, the LO provided by a FIR Gas Laser or QCL, and the measurable signal from a chopped Hot Source aperture that is scanned 1 meter away from the HEB. The hot source setup used is similar to the one used in [3]. For improved pointing resolution multiple planes are measured. The same technique is employed while using the HEB as a direct detector to simultaneously characterize the pointing of the entire array vs the normal reference. The characterization measurement is in progress and we will update the outcome at the conference.

References

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