Stabilized HEB receiver at 2.5 THz

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***Abstract*— We report on a method to stabilize a hot electron bolometer (HEB) mixer. HEB mixers are currently the most sensitive heterodyne receivers above 1.5 THz, with applications that include astronomical observations, atmospheric remote sensing and imaging. However, when compared with other mixers such as Schottky diode and superconductor-insulator-superconductor (SIS) receivers, HEBs suffer from inferior stability. This ultimately places undesirable constraints on observation strategies. Astronomical sources, in particular, are often weak with the signal deeply embedded in the noise, requiring long integration periods.**

In this paper we report a new stabilization technique that utilizes the sensitive direct detection properties of an HEB to implement feedback control of the local oscillator (LO) laser power by means of novel swing-arm actuator placed in the optical beam path. Rapid control of the LO power is used to maintain a constant operating bias point of the HEB and thus stabilize the mixer conversion gain and output noise, leading to longer Allan times. We demonstrate that this technique yields a factor of 50 improvement in the spectroscopic Allan variance time which is shown to be over 30 sec in a 12 MHz noise fluctuation bandwidth. Furthermore, this method can in principle compensate for the signal direct detection effect often observed in small area HEB's. We also show that this technique can be applied when measuring receiver noise temperature with consistent results for three different methods. The swing-arm actuator is thus shown to be an effective substitute for a rotating polarizer.

This method can easily be applied to practically any LO source and at any frequency since the modulation of LO power is achieved using a dedicated optic element. LO stabilization is demonstrated here for a CO2 pumped gas laser at 2.5 THz. The enhanced stability afforded by the proposed technique will make astronomical observing routines such as 'on the fly mapping (OTF)' significantly more efficient as fewer off source reference scans will be needed.