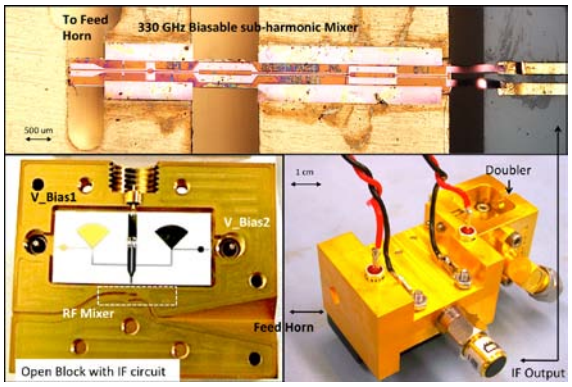
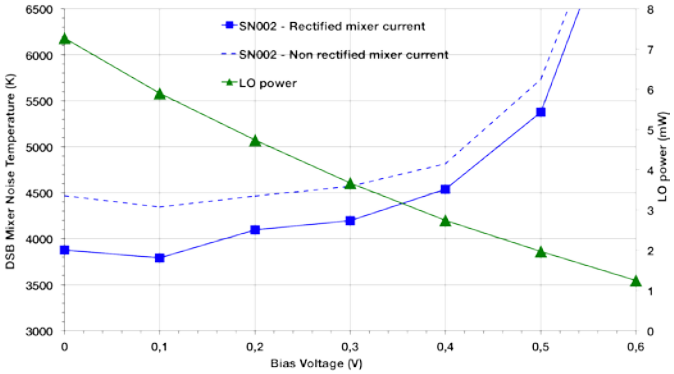
A Novel 330 GHz Sub-Harmonic Mixer with Independently Biased Schottky Diodes

J.Treuttel[1*], B.Thomas[2], A.Maestrini[1&3], J.V-Siles[4], C.Lee[4] and I.Medhi[4]
1 *Observatoire de Paris, LERMA, Paris, 75014, France,*
2 *Radiometer Physics GmbH, Meckenheim, Germany*
3 *Université Pierre et Marie Curie, Paris, 75005, France,*
4 *NASA-Jet Propulsion Laboratory, Pasadena, CA, USA,*
* Contact: Jeanne.treuttel@obspm.fr, phone +33-1-40-51-20-79

Abstract **— The balanced properties and local oscillator (LO) frequency put to half the RF frequency of the sub-harmonically pumped mixers give a great advantage over single ended mixers. Moreover, biasing independently the two diodes offer the advantages of 1) reducing the LO power requirement, 2) allowing a larger range of LO power to pump the mixer and therefore improve the relative bandwidth with no other tuning than the LO frequency, and 3) compensating the asymmetries found for DC parameters characterization through I-V curve measurement. Nevertheless the implementation of DC-bias circuitry at high frequency is particularly delicate and mounting uncertainties can result in a breaking of the symmetry involved in the balance of the device and produce cross-mode coupling. Fairly large capacitors near the diode cell have been used in [1] with diodes in a balanced configuration, but this solution reduces the mode confinement near the diode and relies on the circuit mounting. Very compact on-chip capacitors have proven to be a solution but require a special effort in the fabrication of sub-micron circuits [2]. Another option consists in applying the bias through the IF port. This option offers the advantages of both biasing the diode independently with different voltage level and bypass the need of circuitry near the diodes. Multilayer transmission line designs to obtain independent DC-paths for the diodes of an anti-parallel pair mixer have been proposed in [3]. This solutions leads to a high fabrication effort and rely on the quality of the insulators and a pinhole density level. In order to bypass the drawbacks induced by these technological issues, we propose a novel sub-harmonic mixer at 330 GHz with a monolayer solution to compensate the diode imbalance of sub-terahertz devices. The circuit features a balanced pair of Schottky diodes in which the RF, LO and IF signals are transmitted on the even quasi-TEM mode of a split transmission line and the DC-bias voltage of each of the diodes comes from the IF port through a two-DC port bias tee. The implementation of the dual-DC port bias-tee with radial stub offers a simple way to use monolayer process in the 2-4 and 6-8 GHz IF frequency band. The measurements confirm that the signal propagates along the structure as predicted over the 320 - 360 GHz frequency band with an imbalance compensation under independent bias conditions for each of the diodes resulting in a improvement of the noise temperature up to 14 % at 335 GHz. This type of structure has potential applications at terahertz frequencies where high power source are scarce, and for foundries that want to avoid the use of capacitor on chip near the balanced diode cell.**





330 GHz biasable balanced sub-harmonic mixer: assembly and test at the Jet Propulsion Laboratory.

[1] E. Schlecht, J. Gill, R. Dengler, R. Lin, R. Tsang, and I. Mehdi, "A unique 520-590 GHz biased subharmonically-pumped schottky mixer," IEEE Microwave and Wireless Components Letters, vol. 17, no. 12, pp. 879–881, Dec. 2007. 1
[2] B. Thomas, A.Maestrini, B. Thomas, A. Maestrini, J. Gill, R. L. C. Lee, I. Mehdi, and P. de Maagt, "A broadband 835–900-GHz fundamental balanced mixer based on monolithic gaas membrane schottky diodes," IEEE Transactions on Microwaves Theory and Techniques, vol. No. 7, pp. 1917–1924, July 2010. 1
[3] T. Lee, C. Chi, J. Esat, G. Rebeiz, and G. Haddad, "A novel biased- anti-parallel schottky diode structure for subharmonic mixing," IEEE Microwave and Guided Wave Letters, vol. 4, no. 10, pp. 341–343, October 1994. 1, 3