Ultra-broadband integrated room-temperature Schottky diode based local oscillators for line surveys in the 400-2070 GHz range

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***Abstract*—We report here on a novel approach to produce room-temperature Schottky diode base local oscillator sources with RF bandwidth potentially up to 40% without compromising conversion efficiency with regards to state-of-the-art traditional designs. The approach consists of using the non-linear capabilities of the device to diplex two or more multiplying cells in a single channel, without requiring external waveguide diplexers. Initial results show coverage from 1350-1550 GHz and 1860-2070 GHz with 20-150 µW output power.**

Keywords—terahertz, local oscillators, Schottky diodes, frequency multipliers.

I. Introduction

Stars form in cores, which condense from interstellar clouds, and thereby incorporate material from their placental core. The process is regulated by stellar feedback, e.g. winds from massive stars and supernova explosions that reshape these clouds. Without this feedback, all the available gas and dust in galaxies like our own would have coalesced into stars long ago. The dynamics of the different gas components of the ISM have to be measured with exquisite precision. Wind-resolved observations require high-spectral resolution receivers tunable to each of the key tracers the govern these processes. For instance: (i) emission and absorption lines of water and its isotopologues from 557 GHz to 1670 GHz; (ii) the [CII] line at 1901 GHz, valuable tracer of the rate of star formation and of the evolution of interstellar atomic diffuse to dense molecular clouds in which new stars form; (iii) the fine structure lines of [NII] at 1461 and 2459 GHz, required to probe ionized regions.

Herschel/HIFI has been an enormously successful space instrument, contributing to our understanding of the ISM and star formation. The GREAT instrument on SOFIA and the GUSTO and ASTHROS balloons are continuing this legacy with modest array receivers. However, future missions will require focal plane arrays covering the entire submillimeter-wave spectrum, which are impossible with state-of-the-art heterodyne receivers. A typical high-spectral resolution heterodyne receiver consists of an antenna, a frequency mixer (SIS or HEB, based on frequency), a Schottky diode-based frequency multiplied LO source, and the IF processor Since the HEB mixers are inherently broadband, as long as the proper antenna structure is used, the bottleneck is the RF bandwidth of the LO (~15% only). Because of this limitation, the HIFI approach required fourteen terahertz local oscillator (LO) sources to cover its RF range of 480-1908 GHz.

II. Approach and Preliminary Results

Using the non-linear characteristics of Schottky multipliers, and with a thorough joint design of the multiplier diodes and matching circuitry, two or more different multiplier "cells" can be diplexed to work together as one, multiplying the bandwidth by the same factor, and potentially achieving full waveguide band coverage. The approach does not require waveguide diplexers and does not compromise the performance (output power and conversion efficiency) with respects to traditional narrow-band multipliers. In the conference, we will present the progress towards a single tunable multiplier chain aiming to cover the 400-2060 GHz with a single channel. Initial results with two multiplier cells combined can be seen in Fig. 1. The chain is driven by a single W-band power amplifier producing ~150 mW and delivers 20-150 µW with coverage between 1350-1550 GHz and 1860-2070 GHz'.

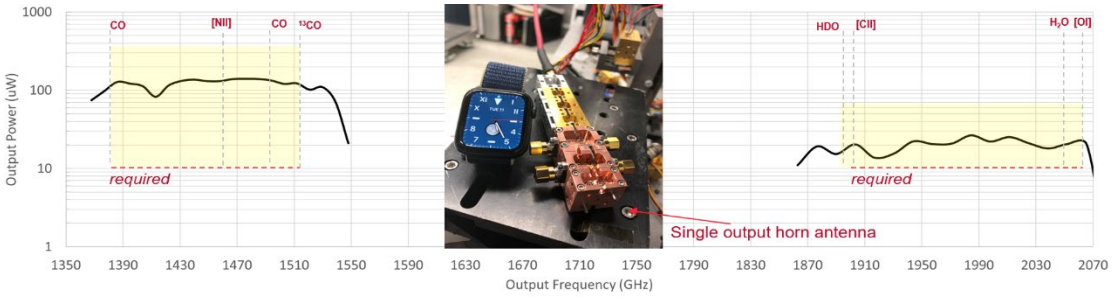

Fig. 1. ASTHROS payload under I&T, showing the 2.5-m primary mirror and the ~4.5-m long sunshade

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