Dual Band 1.3mm/3mm Receivers for the NOEMA Observatory

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***Abstract*—The NOEMA observatory was completed in 2022 with its last 12th antenna delivered and commissioned successfully together with the track length extensions. Next step for the observatory upgrades is the implementation of a dual-frequency observation mode where the 1.3 mm and 3 mm bands (based on SIS mixers) can be observed simultaneously using a dichroic mirror, all in dual polarization, full 4-12 GHz IF bands. We will present the current status of this development which is due to be completed by end of 2024.**

***Keywords*—heterodyne, SIS mixers, dichroic, mm bands**

I. INTRODUCTION

THE NOEMA observatory (Northern Extended Millimeter Array) is the successor of the Plateau de Bure Interferometer (PdBi), which consisted of 6x15m antennas located at the Plateau de Bure, in the French Alps at an altitude of ~2500 m. The interferometer had two tracks: a North-South of ~370m length and an East-West track of about 760m. The NOEMA project goals were to provide 6 additional 15 m antennas and extend substantially the East-West track from 760m to 1700m, while operating a state-of-the-art heterodyne receiver, observing in 4 bands (3mm, 2mm, 1.3mm and 0.85 mm), using sideband separation SIS-based receivers, in a dual polarization mode, with 4-12 GHz IF bandwidth. The NOEMA observatory was successfully complete in 2022.

The next step in the observatory upgrade is to provide a dual-band capability, as we are now limited to observing one band at the time. The goal therefore is to be able to observe the 1.3 mm and 3 mm bands simultaneously, co-aligned on sky while maintaining the state-of-the-art performance of the system.

II. DUAL BAND RECEIVER SPECIFICATIONS AND DESIGN

The Plateau de Bure Interferometer already had dual-band capabilities, but that was done selecting the bands via polarization. Therefore, the system sensitivity was decreased during dual-band operations. Now, the choice for combining the bands relies on dichroic filters, where the selection is done by frequency, with minimum losses, while keeping the dual-polarization capability for each band. IRAM is developing this dichroics using several layers of metallization on quartz substrates.

As of March 2024, 7 antennas out of the 12 have being equipped with the new mechanical and optical required components. In summer and fall 2024, the remaining antennas will be equipped, together with the installation of the new warm IF components, and second correlator unit that will allow operating in dual band.

Element	3mm Band	1.3mm Band
Frequency range (RF)	70-119 GHz	196-276 GHz
Mixer topology	2SB – SIS mixers	2SB – SIS mixers
IF bandwidth	4-12 GHz	4-12 GHz
Configuration	2SB mode - dual polarization	2SB mode – dual polarization
Dichroic losses	Max 5% losses	Max 5% losses

The full design of the system will be presented, together with the required hardware changes and the first preliminary performance assessment.

This upgrade using warm frequency separation dichroic will possibly be followed in the future with a receiver implementing the dichroic at cold (inside the cryostat), to minimize the loss contributions to the system temperature.

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