Jupiter Icy Moon Explorer, Submillimeter wave Instrument: Delivery status of the 1200 GHz high spectral resolution receiver front end

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***Abstract*—The Jupiter Icy Moons Explorer (JUICE) is a mission chosen in the framework of the Cosmic Vision 2015-2025 program of the Science and Robotic Exploration Directorate of the European Space Agency. The Submillimeter Wave Instrument (SWI) is a spectrometer/radiometer instrument operating in two submillimeter channels between 530 – 625 GHz and 1080 – 1275 GHz to study the dynamics of Jupiter's stratosphere, vertical profiles of wind speed, temperature, composition and structure of exospheres of Ganymede, Europa and Callisto. LERMA is responsible for the delivery of critical sub-systems of the two channel front- ends, including its 1200GHz mixer and last frequency stage local oscillator. In this paper we will describe the SWI radiometer front-end system and address the different procurement steps of the flight hardware. We will present some of the test structures used, the tests conditions as well as some of the failure criterias and allowable drifts during screening of the flight models and include discussion on endurance testing of its qualification models.**

Keywords—Schottky diode, GaAs, heterodyne detection, submillimeter wave, THz, space qualification, SWI, JUICE, Jupiter.

I. Introduction

Interplanetary space missions such as JUpiter ICy moons Explorer (JUICE) implies particularly severe constraints on devices reliability over a time range that includes approximately 8 years cruising to Jupiter and operations in varied environments. In addition to the requirement for high scientific return, high technological demands are required on the instruments [1][2]. A critical aspect of the system relates to failure of one device within the local oscillator chain or the mixer that represents a single point failure causing non-operationality of the full instrument. The goal of this study is define a safe operating range for the SWI based on III-V Terahertz Schottky junction in particular and to demonstrate operation equivalent to the mission duration.

II. Results

The tuning conditions of the system have to fulfill safe and long term operation as define for each models. In particular, each of the multiplier and mixer diodes require to sustain a certain amount of incoming and dissipated power expressed per junction area (in mW/μm^2) related to DC current density during operation and over time and taking into account the increase of efficiency of frequency multipliers at cryogenic operation discussed in this presentation and more extensively in [3].

References

[1] "Exhaustive Qualification and endurance testing of the 300 GHz Frequency Doubler of the Sub-Millimeter Instrument of the Jupiter Icy Moon Explorer Mission", L.Gatilova, J. Valentin, J.Treuttel, A. Feret, G.Gay, S. Caroopen, T.Vacelet, S. Mignoni, Y. Jin J-L. Roux , In Proceeding of SPIE, Astronomical Telescopes and Instrumentation, Motreal, July 2022.

[2] "Space qualification of MMIC Schottky diodes chips for SWI instrument of JUICE mission", This conference, J.Valentin et al.

[3] "Jupiter Icy Moon Explorer, Submilimeter wave Instrument: 1200 GHz high spectral resolution receiver front end Part I : RF Performance optimization and definition of acceptance levels <by J.Treuttel, L.Gatilova, J.Valentin et al.> and , Part II: Qualification and endurance testing <by J.Valentin, L.Gatilova et al.> - Two papers in preparation

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