

French contribution on the SWI hardware and flight models acceptance levels

Observatoire de Paris – PSL and C2N – CNRS: J. Treuttel¹, L. Gatilova¹, S. Mignoni^{1*}, S. Caroopen^{1*}, A. Feret¹, T. Vacelet¹, J. Valentin¹, G. Gay¹, A. Cavanna², Y. Jin², A. Maestrini^{1*}, J-M. Krieg¹

With the participation and support of: V. Lavignolles, J-L. Espagnol³, D. Moirin⁴, J. Spatazza⁵, C. Berthod⁵, T. Gaultier⁴, O. Mbeumou⁴, M. Gregoire⁶, C. Doucet⁶, M. Heim⁷, G. Cibiel⁷, J-L. Roux⁷, C. Goldstein⁷, F. Courtade⁷, C. Larigauderie⁷

Industrial partners: C. Batut⁸, B. Bonnafé⁸, T. Delazzari⁸, T. Dehaene⁹, S. Mener⁹, F. Sepot⁹, J. Cerisier⁹, A. Duvivier⁹, B. Napolitano¹⁰

Abstract—The Submillimeter Wave Instrument of the European Space Agency L1 mission JUICE (cosmic-vision program 2015-2025) is a technically ambitious instrument designed for studying numerous aspects of Jupiter's atmosphere and Galilean moons. The instrument consists of two 1200 GHz and 600 GHz receivers, featuring high frequency Schottky diode based MMIC chips used in mixers and frequency doublers. These components are the core devices of the receivers where the frequency conversion occurs. High scientific goals have generated high constraints on the receivers and their single point failure MMIC chips and their accompanying subsystems (micro-mechanical blocks, filtering and DC bias circuits, regulator box). The presentation will give an overview of the technical challenges regarding the full procurement contribution from the Observatoire de Paris - PSL to the flight model front end receivers, from specification to delivery. The discussion includes other critical parts developed with the French industry, such as the dual-Ka band synthesizer and USO reference clock.

Keywords—Schottky diode, GaAs, heterodyne detection, submillimeter wave, THz, space hardware, SWI, JUICE, Jupiter, verification matrix, Team work, Partnership.

I. INTRODUCTION

Interplanetary space missions such as JUPITER ICy moons Explorer (JUICE) implies particularly severe constraints on devices reliability. In addition to the requirement for high scientific return, high technological demands are required on the SWI instruments [1]. SWI will operate at state-of-the-art noise temperature level performances below 3000 K [2] within a passively cooled 120-150 K temperature range in the highly radiative Jovian environment up to 300 krad TID over 11 years (approximately 8 years cruising to Jupiter and 3 years of operations).

We report on the French contribution in the hardware delivery that includes the 1200 GHz Schottky mixer, 300 GHz [3] and 600 GHz LO source last stage multipliers and their accompanying subsystems (micro-machined gold coated aluminum blocks manufactured by SAP⁸, filtering and DC/IF bias alumina and silica circuits, regulator box manufactured with SERMA¹⁰, 300 GHz thermal break interface to the warm electronic stage). This includes other critical part of the delivery developed with the industry, such as the dual-Ka band synthesizer (Syrlinks) and USO reference clock (Rakon).

II. RESULTS

The Observatoire de Paris - PSL LERMA has been in charge of the final delivery of the Engineering Models (EM), Structural and Thermal Models (STM), Flight Models (FM) and Flight Spare (FS) models hardware for both 600 GHz and 1200 GHz SWI front end channels (excluding the 600 GHz mixer). All models were submitted to a specification of compliance and traceability list amongst which are: performances, workmanship test levels for flight hardware, sinusoidal and random vibration tests, radiation test, size, volume, mass, qualification [4], coating, bounding ... All deliveries were completed between November 2018 and September 2021 [5].

We will present the specification, compliance list and technical challenges in relation to the characterization results on delivered models.

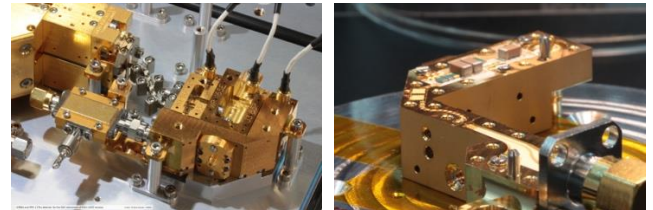


Figure: Left: SWI FM 1200 GHz front end in its delivery box. Right: Half block of the 1200 GHz SHM including DC and IF circuit boards.

III. REFERENCES

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¹ Observatoire de Paris - PSL, CNRS, LERMA, Paris, 75014, France;

^{1*} Was at Observatoire de Paris - PSL, CNRS, LERMA; ² Université Paris-Saclay, CNRS, Centre for Nanoscience and Nanotechnology (C2N), Palaiseau, 91120, France; ³ Bureau Veritas, Exploitation Agence Aéronautique & Espace, Toulouse, France; ⁴ Hensoldt Space consulting, Toulouse, 31100, France; ⁵ Division Technique de l'INSU, CNRS,

Meudon, 92195, France; ⁶ Logiquel pour DTN/QE/BA – CNES, Blagnac, 31700, France; ⁷ Centre National d'Etudes Spatiales (CNES), Toulouse, 31400, France; ⁸ Société Audioise de Précision, France; ⁹ Syrlinks, France; ¹⁰ SERMA HCM-Systrel, France.