Introducing LORENTZ: A Novel Low-temperature Near-field Terahertz Chamber for Instrument Characterisation.

P. Moseley*[1], L. Rolo[1], A. Baryshev[2,3], T. Vos[4], A. Belitskaya[3], D. A. Ronso da Costa Lima[2],P. de Maagt[1] and P. Hartogh[5]

***Abstract*— The Low-temperature Near-field Terahertz Chamber (LORENTZ) is a novel facility recently installed and commissioned at ESTEC, ESA. This facility has the unique ability to characterize the antenna performance off full sub-millimeter instruments in operational environments down to 80k. We provide an overview on the various design and commissioning steps that were required to ensure all parts of the test facility would operate reliability in such challenging conditions. We also present how the facility performed during the first full measurement run of flight hardware and a roadmap for future developments.**

Keywords—Antenna, RF Testing, Cryogenic, THz, SWI

I. Introduction

The Low-temperature Near-field Terahertz Chamber (LORENTZ) is a novel facility recently installed and commissioned at ESTEC, ESA. It offers the unique ability to measure the RF antenna performance of full instruments in their representative environmental conditions they will experience during mission operation.

Currently antenna patterns of sub-millimeter instruments are performed at room temperature and rely on thermal modeling to predict if any deformation in the optical elements will occur. Such predications increase in complexity and uncertainty as the operational frequency rises. Due to complexity and cost of future instruments, relying on such simulations can be high risk. Therefore, LORENTZ was conceived to mitigate this.

II. Test Facility Architecture

The unique capability of the facility is that it can accommodate a full instrument up to 1900mm cubed with a weight up to 500kg and cool it down to 80k inside a RF anechoic chamber. Within the same chamber, a 1x1m planar scanner offers micron positioning accuracy. This combination allows testing to be performed between 50GHz and 1500GHz. The RF signal is sampled at various positions with the planar scanner, which is transformed to retrieve key performance indicators of the instrument such as gain and pointing accuracy.

The most challenging aspect in designing this test facility was creating a way to thermally isolate the scanner from the anechoic chamber. Due to the large scan plane and accuracy requirements, any large temperature gradients placed on the scanner would heavily degrade its performance. Therefore, a moveable RF and thermal shield was designed. This allows the RF probe an unobstructed view to inside the anechoic chamber, while blocking all thermal radiation. A schematic of this setup is shown in Fig.1.

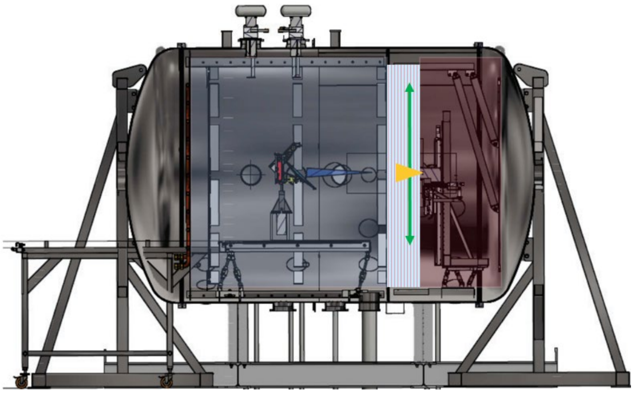

Fig. 1. Cross-section of the test facility. Left side shows the cryogenic anechoic chamber, the right side shows the scanner held under vacuum but at 280K. Between them is a movable shield that contains the RF probe.

The facility was successful in performing its first full measurement run of flight hardware, by verifying the RF performance of the SWI instrument for JUICE[1], Fig. 2. A more detailed view will be given on the various design and commissioning steps that were required to ensure all parts of the test facility would operate reliability in such challenging conditions.

III. Future capabilities and opportunities

This successfully test is just the beginning for the facility. In the initial design stages of the facility, it was already foreseen that it should be upgradable to allowing cooling down to 4k, to increase the suitability for future THz instruments, including full end-to-end testing of cryogenic receivers.

The facility is open to all industry and institutions that could benefit from its unique capability. It is hoped that this conference will be the right platform to make the wider community aware.

References

[1] https://www.mps.mpg.de/planetary-science/juice-swi

Fig. 2 Testing of SWI inside the LORENTZ chamber

[1]ESA ESTEC, Netherlands; [2] Kapteyn Astronomical Institute, University of Groningen, Netherlands; [3]Dutch Terahertz Inspection Services B.V. Netherlands; [4]SRON, Leiden, Netherlands; [5]MPS (Max Planck Institute for Solar System Research), Germany

NOTES: