INNOVATIVE FOCAL PLANES IN SUBMILLIMETER WAVE RADIOMETERS FOR ATMOSPHERIC CHEMISTRY STUDY AND ICE CLOUDS OBSERVATION

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1. INTRODUCTION

Remote sensing in sub-millimeter waves would provide important data for atmospheric chemistry (Earth, planets), cosmology and astro-chemistry: molecular clouds, star forming, galaxies and comets study. In Europe, many sub millimeter wave studies and projects, led most of the time by research laboratories, are applied to radio astronomy (e.g. programs Planck and Herschel). However Earth observation with sub millimeter wave radiometers is still undeveloped. Only one satellite embarking a sub millimeter radiometer named ODIN has been launched until today. Moreover, climatologists have required a sub-millimeter sounder for years to observe ice clouds.

Space missions for Earth observation in sub-millimeter wave field promoted access to higher sub millimeter wave frequencies with technology becoming more and more reliable and integrated. This technological effort for focal plane integration has to be continued to simplify the accommodation of sub-millimeter wave space instruments and thereby reduce their costs. Thanks to CNES founding, EADS ASTRIUM analyzed the capability to improve performance of sub millimeter wave instruments for two specific applications: atmospheric chemistry study and ice clouds and precipitations observations. The areas for improvement are focused on global instrument architecture and on some specific focal plane components such as dichroïc filters and mixers.

2. SELECTION OF TWO ARCHITECTURES OF SUB-MILLIMETER WAVE RADIOMETERS: "ATMOSPHERIC CHEMISTRY" AND "ICE CLOUDS AND PRECIPITATIONS"

The instrument requirements for the study of the atmosphere chemistry are based on those of MWLS, the European Limb sounder from PREMIER mission, which is preset among future Explorer ESA missions. A set of architectures fulfilling theses specifications has been studied. The selected baseline architecture is presented in this paper. It is proposed to broaden the bandwidths of the 340 GHz and 500 GHz channels of the selected architecture, compared to MWLS.

As regards the second application "Ice clouds and precipitations observation", the instrument requirements are derived from CIWSIR mission. This mission was proposed to ESA to explore the earth but was not selected until today. Several proposals for microwave imagers have emerged since this ESA tender phase in 2001. In our study, the architecture trade-off leads to a conical scanning radiometer in 5 bands (183, 243, 325, 448 and 664 GHz). This architecture is described in this paper.

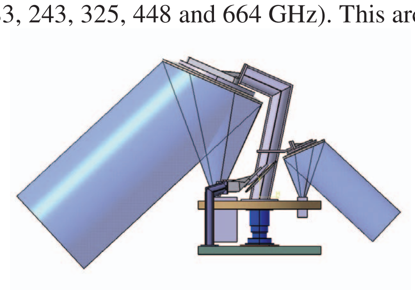

Fig. 1. Conical scanning radiometer for ice clouds and precipitations observations.

3. PRELIMINARY DESIGN OF TWO INNOVATIVE EQUIPMENTS OF THE RADIOMETER FOCAL PLANE

In both architectures, critical technologies are identified and two innovative equipments are preliminary designed. After analyzing the state of the art of the sub millimeter wave FSS (Frequency Selective Surface) to evaluate its feasibility, the quasi-optical network demultiplexing 183, 243 and 325 GHz channels is proposed. Moreover a 500 GHz mixer exhibiting 8 GHz FI bandwidth is designed thanks to microwave electromagnetic simulation software. This design for the application "Atmospheric chemistry" is very close to the double side band mixer at 448 GHz required for the application "Ice clouds and precipitations", which also should have about 8 GHz FI bandwidth. The different designs are presented and discussed in this paper.

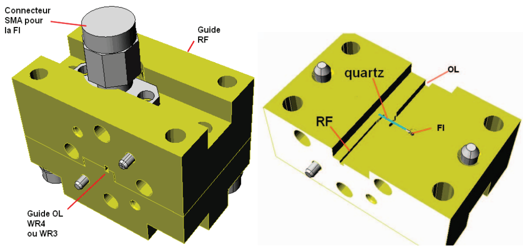

Fig. 2. Artist's view of 500 GHz mixer

4. CONCLUSION

In conclusion, to meet the scientific and operational requirements, focal planes of sub-millimeter wave radiometers must have excellent performance, particularly in term of loss and noise factor. Noise performances of the Schottky diode mixers and quasi-optics network performances are suitable with the need for the application "Ice clouds and precipitation". This kind of mission with the proposed architecture based on a conical scanning radiometer with 5 frequency bands from 183 to 664GHz can thus be envisaged in the next years. The application "Atmospheric chemistry" is more challenging with regards to the preliminary assessment of focal plane performance because of more stringent specifications.

5. BIBLIOGRAPHY

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