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Radio and Plasma Wave Investigation around Jupiter
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Future Jovian mission is now planned for 2020s.
One of its major objectives is the investigation of electromagnetic system connected and driven by Jupiter. Under the international collaborations, we have started the development for the small-sized radio sensor for this mission from 2011, by the aid of the Grant-in-aid of JAXA Payload Development etc.
We succeeded to establish the base technical elements for (1) light-weight rigid antenna with simple and reliable extension capability and (2) small-sized radiation-hard preamp with the highest sensitivity.

In any missions related to plasmas, electric field from DC to several 10s MHz has contributed to the remote-sensing and in-situ studies of dynamics and energetic interactions in the electromagnetic system, associated with remote optical measurements and in-situ particle and magnetic field sensors.
For the Jovian project, an Europe-USA-Japan joint team is formed for the plasma and radio wave studies. Especially in Jupiter, its radio wave is important as a remote sensing tool for the direct measurement of Jovian radio source regions distributing around the Jovian system, i.e., polar region, radiation belts, Io torus system, and Galilean satellites with thin atmospheres. We are involved for this team based on the high reputation of Plasma Wave Investigation (PWI) aboard the BepiColombo/MMO, and have developed the small-sized radio sensor package with antenna and preamp within the tightest resource limitations.

We investigated base technologies for (1) a 3-axial antenna with 2m length, extracting at the Earth orbit and can be kept during the long travel till the end of the mission on the orbit around Galilean satellite, and (2) a 3-axial preamp covering 10kHz-100 MHz with the highest sensitivity, enough radiation tolerance in Jovian environment, the hardest in the solar system, within the mass limit less than 200g. For the former, we established a simple extension mechanism based on the self-extracting thin BeCu and CFRP element, which is based on the combination of the key technologies in the SCOPE Z-axis antenna (STEM-type extension mechanism but with a complex motor system) and the sounding rocket antenna (self-extraction but with limited length, only 1 m). For the latter, under the collaboration with the IRF-Uppsala (Sweden) team, we established the key parts of the radiation-hard analogue custom IC technologies, in which the most difficult part was a relay in the package with high-impedance, small-sized, and high-reliability. In parallel, we also tested the high-sensitivity preamp BBM under the radiation hard condition, and proved that even in 200 krad the degradation of the noise level is only the twice, without critical linearity and sensitivity damages. In 2012, we are proceeding to the next phase, including the design of a backend receiver with direct sampling scheme with fast (100-125MHz) rad-hard A/D.

Since the small but reliable extension mechanism and electronics are not so much expensive, we can also consider the implementation to sounding rocket experiments. After the full establishment of this technology, we will be able to adopt it to any space radio and planetary missions in which the resource is very tight.

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