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Development of small-sized radio sensor for future Jovian mission

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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 drived by Jupiter. Under the international collaborations, we have started the development for the small-sized radio sensor for this mission from 2011. 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, Euro-USA-Japan joint team is formed for the plasma and radio wave studies. Especially in Jupiter, it 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 several satellites with thin atmospheres like Io, Europa, Ganymede, and Calisto. We are involved for this topic, based on the Plasma Wave Investigation (PWI) aboard the BepiColombo/MMO, and started the small-sized radio sensor package with antenna and preamp within the tightest resource limitations.

In 2011, we investigated base technologies for (1) a 3-axial antenna with 2m length, extracting at the Earth orbit and can be kept along the long travel to the orbit around Galilean satellites, and (2) a 3-axial preamp covering 10 kHz - 50 MHz with highest sensitivity, enough radiation tolerance in Jovian environment (the hardest in the solar system), within the mass limit less than 200g, and

For the former, we established the simple extension mechanism based on the self-extracting thin metal element, which is based on the combination of the SCOPE Z-axis antenna (STEM-type extension mechanism but with a complex motor system) and the sounding rocket antenna (self-extraction antenna but limited within 1m extension length). 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 enough. 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 will proceed to the next phase.

These small but reliable extension mechanism and electronics are not so much expensive. Therefore, we consider to apply them to sounding rocket experiments. It can be also adopted to any space and planetary missions in which the resource is very tight.

Keywords: electric field, plasma wave, radio wave, antenna, sensor, Jupiter