AOGS 2006

Development of a New Low Energy Charged Particle Detector for In-Situ Plasma Measurement in the Earth's Magnetosphere

MIHO SAITO[1], YOSHIFUMI SAITO[2], TOSHIFUMI MUKAI[2], KAZUSHI ASAMURA[2]

[1] *Tokyo univ.*

[2] *ISAS/JAXA*

The future magnetospheric exploration missions (ex. SCOPE: cross Scale COupling in the Plasma universE) aim to obtain electron 3D distribution function with very fast time resolution below 10 ms to investigate the electron dynamics that is regarded as pivotal in understanding the space plasma phenomena such as magnetic reconnection. This can be achieved by developing a new plasma detector system which is fast in signal processing with small size, light weight and low power consumption. The new detector system consists of stacked micro channel plates and a position sensitive multi-anode detector with on-anode analogue ASIC (Application Specific Integrated Circuits). The analogue ASIC includes multi-channel charge amplifiers, discriminators and counters. The combination of the multi-anode and the ASIC techniques is expected to make the fastest position signal processing with small size, light weight and low power consumption, compared to other position detection techniques that have ever been used. The key technology is to accommodate the ASIC on the rear side of the anode (ceramic) plate of which a multiple discrete anode pattern is printed on the front side. Instead of using discrete capacitors, which are usually required to insulate a high voltage applied to the anode, capacitive coupling between the anode pattern on the front side and the signal pickup pattern on the rear side is used as decoupling capacitors. The anode plate is made of alumina with thickness of 1 mm, and the capacitance for each anode is about 3pF, which is smaller by two orders of magnitude than those of discrete capacitors conventionally used. However, our experimental result shows that the attenuation of signals due to the low capacitance is about 50 % at most, and hence our new concept is useful. Multi-anode system usually suffers from false signals caused by mainly two effects. One is the effect of electrostatic coupling between the discrete anodes since our new detector consists of many adjacent anodes with small gaps to increase the detection areas. Our experimental results show that there exists coupling effect of about 10% from the adjacent anodes. Although the effect of 10% coupling can be effectively avoided by a suitable discrimination level of the signal processing circuit, it is highly preferable to increase the capacitance of the anode plate in the future development. Non negligible charge cloud size on the anode also causes false counts. The initial electron cloud at the MCP output has angular divergence. Furthermore, space charge effects may broaden the size of the charge cloud. We have obtained the charge cloud size both experimentally and theoretically. On the whole, we conclude that our new multi-anode detector system is applicable (though further studies are still necessary) to future missions that require high-time resolution measurements of hot plasmas in the magnetosphere.