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Flight verification and performance of a discrete MCP anode with ASIC

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Recently, time resolution of the low energy charged particle measurement is becoming higher and higher. There exist several development items to realize high time resolution measurements including development of a charged particle detector. Most of the recent satellite-borne instrumentation for low energy charged particle (eV/q - 10s keV/q) measurement adopts top-hat type electrostatic analyzers [Carlson et al., 1983, Young et al., 1988]. Since the top-hat type electrostatic analyzers have wide field of view of 360deg. with uniform transmission characteristics, they are suitable for low energy charged particle measurement by spin-stabilized spacecraft. Using top ?hat type electrostatic analyzers, one dimensional circular position sensing is necessary in order to determine the incident particle direction. For this purpose, a detector with MCP (Micro Channel Plate) and anode that collects the multiplied charged particles has been widely used. There are several types of one-dimensional circular position sensing anode. For the high time resolution measurements, the anode has to measure high enough count rates in order to keep good statistics for short sampling time. The most appropriate anode for the high time resolution measurements is discrete anode where different anodes are used for different positions and each anode has its own amplifiers. Although discrete anode has been widely used, the problem is that the required power and the size of the electronics circuit become unacceptably large for the satellite borne instruments when the higher position sensing resolution is necessary. In order to solve this problem, an MCP anode with ASIC has been developed [Saito M. et al., AIP Conf. Proc. 1144, 48 (2009), DOI:10.1063/1.3169303]. In order to use the anode for sounding rockets and satellites, it should be lightweight and low power consumption. The anode should survive the vibration / shock during the launch, wide temperature variation and radiation. We have decided to adopt the anode configuration that discrete anode is formed on 1mm ceramic substrate, and the bare ASIC chip is installed on the backside of the ceramic. It has been turned out that the S/N performance is very good since the amplifier is very near to the anode. Whole ceramic substrate except discrete anode pattern that collect electrons is parylene coated in order to protect the ASIC and the bonding wires from humidity and (metal) dusts. So far, we have performed radiation test including total dose and single event latch up, thermal cycle test between -40deg. and 85deg. It is found that the anode can detect count rate of 25MHz/channel. The anode has been successfully flight verified by two Norwegian sounding rocket experiments ICI-2 and ICI-3 (Launched from Ny Alesund, Svalbard, Norway in Dec. 2008 and 2011). In the near future, this anode will be used for detecting low energy ions with Mercury Ion Analyzer (MIA) on BepiColombo/MMO. The ASIC chip and its implementation will be widely used for the future missions that require lightweight low power consumption, high time resolution charged particle measurements.

Keywords: charged particle, detector, ASIC, MCP anode