

Development of High Energy particle Instrument using low noise Si-strip detectors with VA32TA under the high radiation environment

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We are developing a high-energy particle detector in the high-count rate environment (for example, Mercury explore, Jupiter Orbiter explore and interplanetary spacecraft) in order to solve the acceleration mechanism and the process of high-energy particle on the collision less plasma shock region in the space. The key observation is to measure the maximum energy of accelerated particles correctly. For that goal, the first, it is important to reduce the pile up events in order to measure the correct maximum energy and the second, it must have the measurement of wide energy range.

The new developed low-noise high-energy particle detector for high-count rate environment consist of Silicon Strip Detector (SSD) and the readout analog-LSI chips VA32TA developed by IDEA Co., SLAC and ISAS. The low noise system consists of SSD (Strip pith 400 mm; Strip gap 100 mm; Strip length 25.6 mm), RC chip and VA32TA fronted LSI that is newly developed for this system. The RC chip provides bias voltage via poly-silicon bias resistor and AC-coupling between strip and preamplifier channels. For that chip had been developed, the SSD system becomes compact and light. But since the RC chip is small device, the yield of the AC-coupling capacitor is not a concern. The VA32TA fronted LSI is a 32-channel low noise MOS amplifier. The VA32TA have been developed based on the VA32C and TA32C LSIs. The VA32TA is fabricated in AMS 0.35 mm technology that is measured to be radiation hard to a few Mrad or more. It is useful for missions in the high radiation environment, for example inner-magnetosphere explore, radiation belt, Mercury and Jupiter orbiter. The VA32TA consists of 32 channels of signal-readout circuits and each channel includes charge sensitive preamplifier, slow CR-RC shaper, sample/hold, analog multiplexer chain (VA section) and fast shaper, discriminator chain (TA section). The SSDs and RC chips are manufactured by Hamamatsu Photonics, Japan and IDEAS ASA, Norway, manufactures VA32TA. The number of read out channel in the new SSD is 64 channels per side. The VA32TA LSI can read out all 64 channels independently. It is the key point that every channel signal can be processed respectively using small and light read out system for the high-count rate environment.

This SSD system performance was tested by 241Am (X-Ray) and its result was quiet well; the energy resolution (FWHM) is less than 2keV at 20 degrees. The performance of the new SSD system for charged particles was tested using proton beams with energy of 6 MeV from the medium energy accelerator in HIMAC of the National Institute for Radiological Science. It is result that the new SSD system works well and has high performance to detect not only x-rays but also charged particles. It is certain that this new SSD system can measure correct energy of incident particles in high-count rate environment using the accelerator.

We will report the results of the new SSD system for high-energy particles detector for the planetary and interplanetary future missions.