Development of ASIC for energetic electron detector for future planetary explorations

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The origins of electrons in our solar system are the solar wind and the ionized atmosphere of planets and satellites, and their energy is typically less than 1 eV, at most 1 keV. Nevertheless, energetic electrons of more than tens of keV have been observed in all planetary magnetospheres. Some fraction of these electrons precipitate into the atmosphere and deposit their energy. However, it is difficult to quantitatively evaluate the effects of energetic electrons on the atmospheric dynamics and chemistry of outer planets and their satellites, due to the lack of detailed measurements. For such future observations, it is important to cover the large solid angle, since the energetic electron flux is not necessarily isotropic. Keeping this in mind, we develop an energetic (10 - 100 keV) electron detector which has hemispherical field of view without the spacecraft spin. For planetary explorations, which place stringent limitation on payload mass, we aim to miniaturize the sensor by applying the ASIC (Application Specific Integrated Circuit) technology to analog signal processing circuits. It is composed of preamplifiers, shaping amplifiers, peak holders, comparators, and Analog-to-digital converters. We designed an ASIC so that its dynamic range and the wave form peaking time to be 10^6 e^- and ~1 us, respectively, in consideration of the gain and the high capacitance of the assumed detector (Avalanche Photodiode, APD). The performance was confirmed in the simulation. Furthermore, we designed the layout of the ASIC circuit optimized for APD and estimated that it could be mounted on a 5 mm square chip. This size is about 100 times smaller than the size of the analog circuit board (70 mm x 30 mm) before applying ASIC technology and it is estimated to reduce the weight of the energetic electron detector by half (about 1.5 kg).

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