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SPACE-BASED SOLAR NEUTRON OBSERVATIONS FOR CUBESAT PROJECT

Abstract

We have been worked on space-based solar neutron observation mission by small satellites, starting from graduate students' proposal in 2014. This paper describes the scientific importance of our proposed mission and details of the novel radiation detector with a novel photo-semiconductor device which has not been utilized in the space environment yet. The requirement and concept design of the cubesat including challenging part in the bus system are also summarized. It is known that cosmic-rays are accelerated and propagated to the Earth in association with solar flares, however, particle acceleration mechanism is still unknown. Only neutrons can be direct probe to clarify the ion acceleration mechanism in the Sun because they are not affected by the magnetic field, and thus directly travel to the Earth with original acceleration information. But there is only a few 10s solar neutron detection since its discovery in 1980 because previous ground-based neutron detectors have insufficient sensitivity. Only one space-based detector dedicated for solar neutron observation is SEDA-AP FIBer detector onboard the International Space Station (ISS). It has detected more than 20 solar neutrons so far, but is suffered from secondary neutron background from the ISS itself with a huge mass ($\sim$ 400 ton). Small satellites with a tiny mass are expected to perform highly sensitive observation with much smaller neutron background. To satisfy the mission requirement, we are developing very compact and high sensitive solar neutron spectrometer and designing the whole satellite system. The detector utilizes novel photon-detector MPPC (Multi-Pixel Photon Counter) which has a small sensitive area of 33 mm and 6x6 mm and a quantum efficiency of 35% at 450 nm. It can realize a high gain of 10^6 with a low bias voltage of 50-60 V, while a usual photo-multiplier tube realizes the same gain with a high bias voltage ($\sim$ 1000 V). This device has not been used in the space environment and its on-orbit verification is another purpose of this mission. For the satellite system design, this mission requires relatively large power budget because continuous observation during sunshine should be realized as much as possible. In addition, the detector should be kept at low temperature to reduce the thermal noise of the MPPC. To realize the requirements, this cubesat is planned to equip the custom-made radiator made from the novel composite material which has high thermal conductivity, and novel power management system with the model based battery status estimator.