Multi-point Observations of Thundercloud Gamma-rays: Development of Portable Detectors and Results of Fiscal 2016 Winter Observation

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On-ground detections of bremsstrahlung gamma-rays with energy extending up to 10 MeV from winter thunderstorms indicate electron accelerations inside thunderclouds (e.g. Trii et al., 2002, Tsuchiya et al., 2007). In order to resolve time variation and structure of the electron accelerators, we started to construct a multi-point system to detect thundercloud gamma-rays (Enoto et al., JpGU 2016 M-IS14, Enoto et al. 2017 M-IS05). In fiscal 2016, we have developed a small electronics board consisting of a FPGA/ADC board and a front-end board. The FPGA/ADC board, with 9.5 cm ×9.5 cm area, has a 4ch Analog-to-Digital Convertor which is controlled by Raspberry Pi. The front-end board has preamplifiers and shapers to be coupled with BGO scintillators and PMTs, a GPS receiver, and high voltage suppliers. We set up portable detectors including the electronics board and a BGO scintillator. Five detectors were installed in Kanazawa and Komatsu on October 2016, one in Suzu and two in Kashiwazaki on December 2016. In December 8th to 9th, four detectors in Kanazawa and Komatsu detected thundercloud gamma-rays for several minutes. The gamma-ray enhancements exhibited continuum spectra extending up to 10 MeV. In addition, we succeeded in a multi-point detection of gamma-rays from an identical thunderstorm by two detectors in Komatsu because a difference of the detection time is consistent to a passing time of the thunderstorm. We will report current status of the electronic board development and a result of the fiscal 2016 winter observation.

Keywords: winder thunderstorm, gamma-ray, electric field, electron acceleration