

Thundercloud gamma-ray observations at Kashiwazaki aiming at source altitude and beaming measurements and a new trial at Tokyo Skytree in FY2018

*Kazuhiro Nakazawa¹, Takahiro Matsumoto², Yuuki Wada², Alexia Fabiani¹, Teruaki Enoto³, Kazufumi Okuda², Yoshihiro Furuta⁴, Yuki Aizawa², Takayuki Yuasa⁵, Harufumi Tsuchiya⁴, Mitsuteru Sato⁶, Kazuo Makishima⁷

1. Nagoya University, 2. University of Tokyo, 3. Kyoto University, 4. JAEA, 5. RIKEN, 6. Hokkaido University, 7. Kalvi IPMU, University of Tokyo

MeV gamma rays from lightning and thundercloud reaching the ground are sometimes observed from the winter thunderstorm activities along the coastline of Japan Sea. We, the Gamma-Ray Observation of Winter Thunderclouds (GROWTH) collaboration, are observing such phenomena from 2006 at Kashiwazaki, Niigata prefecture (e.g. Tsuchiya et al. 2007), and recently increasing the number of observation sites, including Ishikawa prefecture (e.g. Wada et al. at M-IS27 session). Since FY2016, we have been operating new detectors at Kashiwazaki dedicated to measure the altitude and beaming of gamma-ray source in thundercloud. Three collimated detectors aiming at different sky regions are deployed. A minute-long gamma-ray emission (or "long-burst") was observed on Jan 26th, 2019 with the system, and we are analyzing the peaking time difference among the three detectors to perform triangulation using the wind speed. Preliminary results suggest the altitude to be lower than ~300 m, but because the emission was relatively weak and photon statistics are not enough, we are estimating the upper-limit of the source altitude and its beaming. Independently, we also started an observation campaign at the 450 m altitude of Tokyo Skytree, aiming at gamma-ray detection from lightning (so called downward TGF) of summer thunderstorm. The tower is one of the locations most frequently hit by lightning. We had three hits on May-Sep. 2018, but no TGF was observed to date, confirming the fact that not all the lightnings are observationally associated with gamma rays. Because our team is observing several downward TGFs from winter thunderstorms (e.g. Enoto et al. 2017), increasing data will enable us to compare the difference among the lightning with and without TGF. The study will be also boosted with the launch of TARANIS satellite in early 2020, dedicated for simultaneous observation of TGF, electrons, optical and radio emission from lightning.

Keywords: Thundercloud, lightning, MeV gamma rays, TGF