

## X-ray/Gamma-ray observations along the coast of Japan Sea associated with the winter thunder clouds (1)

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Recently, the X-ray and/or gamma-ray detections has been reported from natural lightnings and lightning conduction experiments. These results may show the possibilities that electrons are accelerated to the relativistic velocity in the electric fields of thunder clouds and/or lightning discharges with radiating bremsstrahlung X-rays. These kinds of phenomena have been observed by the monitoring posts in nuclear power plants along the coast of Japan. Ionization chambers and NaI scintillators of these posts recorded the short (less than 30 sec) intense bursts, and dose increases for a minute or two, associated with winter thunder clouds. However, little is known about the types of radiations, detailed time variations, and energy spectra of these phenomena.

In order to investigate these phenomea in more detail, we designed and manufactured two types of radiation detectors. The One has a directional visibility to the zenith direction, and in a complementary style, the other has an all-around sensitivity. For the former detector, we employed the same design concepts of the Hard X-ray detector on board X-ray astronomy satellite Suzaku. The main NaI scintillator of this detector is surrounded by well-type BGO active shileds. The anti-coincidence of these BGOs can eliminate the environmental radiations from the ground, and can achieve the low background level. This detector records an each radiaton event with 40 keV– 3 MeV energy range, and with 10 usec time resolution. Besides, a plastic scintillator above the NaI/BGO can discriminate electrons from photons. On the other hand, the latter detector with all-around sensitivity has spherical NaI, CsI, plastic scintillator with high energy spectral sensitivity (especially more than 1 MeV). In addition to these two radiation detectors, some environmental sensors such as photo sensors, sound sensors, electrical field sensors can monitor the surrounding environment.

We set up these detectors in the Kashiwasaki-kariwa nuclear power plant in last December, and started the observation. During the early one month observation, we can find out

the dose increase for a minute or two associated with the the thunder cloud activity. Using the anti-coincidence of BGO/plastic scintillators, it was shown that gamma-rays with 3 MeV or more come from above. The spectra extends at least to 10 MeV. In this talk, we will introduce the brief overview of the experiments and its results.