Observations of x- and gamma-rays associated with winter thunderclouds on the Sea of Japan (2)

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High-energy radiations from thunderclouds and/or lightning have been observed by various
past experiments. The maximum energy of the radiations sometimes extend over 1 MeV. However, it has been still unknown how such high-energy radiations are produced in a thundercloud and/or lightning, since the past experiments have poor timing and energy resolutions and does not cover energies greater than 3 MeV. Therefore, we start observations at Kashiwazaki-Kariwa nuclear power plant located at the Sea of Japan, with optical, sound and electric field monitors as well as instruments to detect x- and gamma rays, aiming to elucidate the mechanism to emit high-energy
radiations from thunderclouds and that of the underlying particle acceleration.

We have two reasons to select Kashiwazaki-Kariwa nuclear power plant. One is that high energy radiations, ranging from 50 keV to 3 MeV, has been already observed by monitoring posts arranged in the power plant. Another is a feature of winter lightning at the Sea of Japan. It seems that winter lightning has more 100 times total radiation power than summer one. Thus it is quite suitable to search for high-energy emissions at the power plant on the Sea of Japan.

Installed at the Kashiwazaki-Kariwa nuclear power plant on 2006 December, our measurement system has been successfully operated. The system is divided into two major parts. One part has a wide energy range from from 50 keV to 80 MeV, consisting of spherical NaI/CsI scintillators with a diameter of 3 inch, plastic ones and an electric filed meter. Having no shield to actively reject secondary cosmic rays and environmental gamma rays, the equipped scintillators measure omnidirectional
radiations. Another part are composed of NaI/BGO scintillators, plastic ones and environment monitors to measure optical flushes and acoustic sound produced by lightning. The cylindrical NaI scintillator, with a dimension of 3 inch X 3 inch, is capable of observing the radiations from 50 keV to 3 MeV with a high energy resolution of around 0.7 keV and a timing resolution of 10 usec. In addition, it is surrounded by the well-type BGO scintillator and the plastic scintillator plate to reject radiations which are not derived from thunderclouds and lightning. Thus the NaI scintillator can effectively detect only photons related with thunderclouds and/or lightning.

Using the newly installed system at Kashiwazaki-Kariwa nuclear power plant, we succeeded in detecting high energy gamma rays extending up to 10 MeV from a winter thundercloud on early morning of 2007 Jan 7. In this presentation, the event are mainly shown and discussed, together with other event
probably associated with thunderclouds and/or
lightning.