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The development of infra-free and portable muon counting system for muon radiography

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We will report the development of portable and infra-free muon counting system with silicon photon-counting device, which will achieve more frequent observations for muon radiography. We are hoping for discussing what kind of geological information can be retrieved with the new muon detector.

Muon radiography is a non-destructive inspection based on high penetration power of cosmic ray muon. It has been applied to several volcanoes. For example, the observation at Mt.Showa-Shinzan (Tanaka.et.al,2007) found the density excess which implies the intrusive magma. In Satsuma-Iojima Island, the density deficit below the crater was detected which indicates the existence of high porosity region. In addition, three-dimensional tomography with dual observations was conducted in Mt.Asama(Tanaka.et.al,2010).

However, all of these observations were conducted where the infrastructure (e.g. electricity and road) was well-organized. If we can improve the flexibility in measurement location, more comprehensive search for various volcanoes becomes possible. For instance, we could place a detector near an active volcano and could detect the movement of magma in a vent. Three-dimensional tomography will be more easily achieved.

The present muon detector comprised of plastic scintillators and photomultiplier tubes (PMTs) requires commercial electricity or huge solar panels (at least 1 meter square). Therefore, the measurement locations have been limited. A more power-effective and light detector has to be developed. For these purposes, silicon photon-counter MPPC(Multi-Pixel Photon Counter) is a feasible device because it is small ($<$ 1cm cube) and does not need high voltage compared with PMT (70V for MPPC and $>$ 1kV for PMT). If we can build a detector with MPPC, the power consumption of front-end electronics becomes almost negligible. MPPC is also good at cost compared with PMT (50 USD for MPPC and 1000 USD for PMT per channel).

In this report, the inspection of MPPC's performance and the whole design of MPPC muon counting system will be explained. The authors are hoping for discussing the possible applications to volcanology.

Keywords: muon, radiography, density structure, MPPC