Possible application of stroboscopic muography to monitoring periodic eruptions

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Most of the muon radiography measurements have been applied to stationary objects, but only a few dynamic studies have so far been performed (e.g. imaging before and after the 2009 Asama eruption; Tanaka et al., 2009). One of the reasons which makes it difficult for us to perform real time or rapid time sequence radiography is the relatively low intensity of the cosmic ray muon flux that leads to long integration times to reach an adequate contrast in muon transmission images. However, such low cosmic ray muon flux can be compensated for by averaging a large number of short acquisition frames, as in the case of periodic processes. If we assume a vent, with a radius of 10 m to detect it through 400-mwe-thick rock, the horizontal penetrating muon flux will be $5x10^{-5}$ sr^{-1} $cm^{-2}s^{-1}$ and $7x10^{-5}$ sr^{-1} $cm^{-2}s^{-1}$ and the required angular resolution of 100 mrad, located at a distance of 200 m from the vent, can therefore collect 0.02 and 0.03 s^{-1} for each condition, and 2500 eruption events can distinguish these conditions at a 3 sigma confidence level. 2500 eruption events are not unrealistic if we consider that 110 eruptions were observed in Stromboli between 14 and 17 October 2007 (Goto et al., 2008). In this work, we evaluated this idea by utilizing a comprehensive model system that consists of a muon detector with an active area of 0.16 m^2 and an electric furnace with a diameter of 15 m as a periodic test target. The variations in the density contrast were clearly observed with a period of 12 hours by averaging 17 frames. The result infers a possible application of stroboscopic muography to monitoring periodic eruptions.