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The possibilities of Cherenkov telescopes to perform cosmic-ray muon imaging of volcanoes

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Volcanic activity is regulated by the interaction of gas–liquid flow with conduit geometry. Hence, the quantitative understanding of the inner shallow structure of a volcano is mandatory to forecast the occurrence of dangerous stages of activity and mitigate volcanic hazards.
Among the techniques used to investigate the underground structure of a volcano, muon imaging offers some advantages, as it provides a fine spatial resolution, and does not require neither spatially dense measurements in active zones, nor the implementation of cost demanding energizing systems, as when electric or active seismic sources are utilized.
The principle of muon radiography is essentially the same as X-ray radiography: muons are more attenuated by higher density parts inside the target and thus information about its inner structure are obtained from the differential muon absorption.
Up-to-date, muon imaging of volcanic structures has been mainly accomplished with detectors that employ planes of scintillator strips. These telescopes are exposed to different types of background noise (accidental coincidence of vertical shower particles, horizontal high-energy electrons, flux of upward going particles), whose amplitude is high relative to the tiny flux of interest.
An alternative technique is based on the detection of the Cherenkov light produced by muons. The latter can be imaged as an annular pattern that contains the information needed to reconstruct both direction and energy of the particle. Cherenkov telescopes have never been utilized to perform muon imaging of volcanoes. Nonetheless, thanks to intrinsic features, they offer the possibility to detect the through-target muon flux with negligible levels of background noise. Under some circumstances, they would also provide a better spatial resolution and acceptance than scintillator-based telescopes. Furthermore, contrarily to the latter systems, Cherenkov detectors allow in-situ measurements of the open-sky energy spectrum of atmospheric muons, that is needed to asses a reference model of the through-target integrated flux.
Here we describe our plans for the production of a Cherenkov telescope with suitable characteristics for installation in the summit zone of Etna volcano.