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3D density imaging with muons flux measurements from underground galleries

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Atmospheric muons flux measurements provide information on sub-surface density distribution, giving insights on the medium structure. We measured the muons flux from the underground galleries of the Tournemire experimental platform to image the medium between the galleries and the surface. The experiment aimed at evaluating the capacity of the method to detect the presence of discontinuities produced either by secondary strike-slip faults that present small vertical displacements or by a karstic network may be present at the level of an upper aquifer. Measurements were performed from three different sites so the trajectories of detected muons paths intersect in the medium. Such a configuration provided complementary information on the density distribution, offering the possibility to seek density variations at different depths. A specific calibration method was applied in order to interpolate the data acquired at different times with the same muons sensor. Muons flux measurements variations were then processed through a non-linear inversion, producing a 3D image of the density together with an evaluation of the different distinguished targets reliability. The density distribution showed the presence of a very low density region at the level of the upper aquifer, suggesting the presence of a karstic network hosting locally cavities. The trace of secondary strike-slip faults did not appear clearly on the image as the density contrast they produce might be too low compared to the signal to noise ratio present in the muons flux data. We propose different strategies to improve the density image accuracy.