Research on rapid imaging with cosmic ray muon tomography

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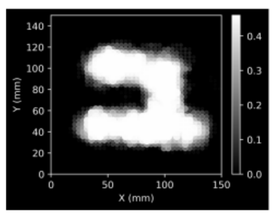
Cosmic ray muons tomography is a non-destructive imaging technique that uses the natural radiation of cosmic ray muons to create tomographic images of objects. Here presents a novel imaging algorithm that effectively utilizes experimental measurement data to achieve rapid and clear imaging of cosmic ray muons. A clear image can be obtained with only 20 min of measurement time and approximately 200 effective muons. However, the current detection flux is only about 0.044 cm^{-2} min^{-1}, which is significantly lower than the natural cosmic ray flux of about 1 cm^{-2} min^{-1}.

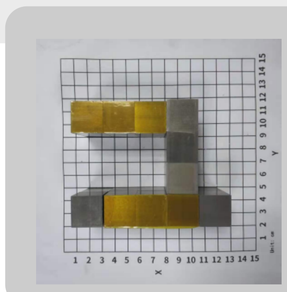
We have also made some meaningful explorations in muon transmission imaging, and here we will present a preliminary research result, in the hope of contributing new perspectives and inspiration to the research in this field.

Tomography Results

60 minutes

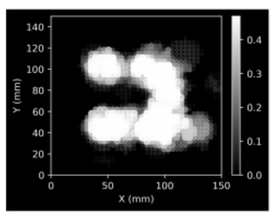
(~ 600 events)

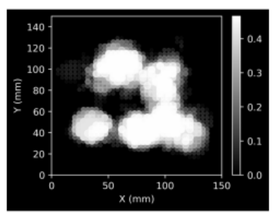




30 minutes

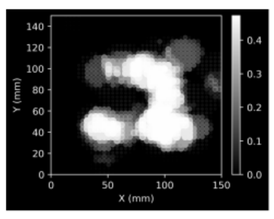
(~ 300 events)

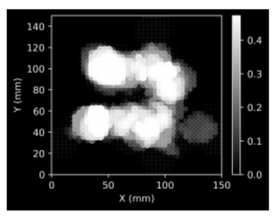


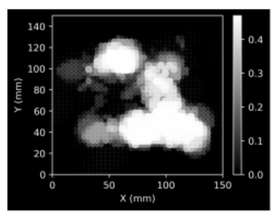


20 minutes

(~ 200 events)







The Ratio Algorithm Without Voxel Imaging

To maximize the utilization of experimental data, a ratio algorithm without voxel imaging has been proposed here.

A letter "μ" was made of small tungsten cube as a test object, and the size of each cube was 2 cm × 2 cm × 2 cm. In the vertical direction, the thickness of the sample was 4 cm. During online measurements, the system records measurement results in a file every 10 minutes. Each file typically contains around 100 effective muons that are utilized for the imaging algorithm.

The imaging results obtained using the ratio algorithm without voxel imaging. From top to bottom, the images correspond to the imaging results after 60 minutes, 30 minutes, and 20 minutes of measurements, respectively. The figure demonstrates that a relatively clear image of the letter μ can be obtained with just 20 minutes of measurement time and around 200 effective muons.

The current detection system has a detection flux of about 0.044 cm^{-2} min^{-1}, which is significantly lower than the natural cosmic ray muon flux of about 1 cm^{-2} min^{-1}. However, there is a significant potential for enhancing the detection flux of the system in the future. By increasing the detection flux, muon imaging can be achieved in shorter time periods.

The relevant content has been published in Sci. Rep. 13, 19718 (2023)

Supplementary Information: The online version contains supplementary material available at https://doi.org/10.1038/s41598-023-47023-w.

Preliminary Results of Muon Transmission Imaging

In the field of cosmic ray muon transmission imaging, we have also embarked on a fruitful exploration journey and successfully developed an innovative imaging algorithm.

The algorithm was then applied to experimental measurement data of a building, and the preliminary imaging results clearly showed significant density differences between the right and left areas of the building, which was consistent with the actual internal building structure of the building, thus strongly validating the effectiveness and practicality of the transmission imaging algorithm.

Thank you for your brief stay.

May our efforts bring you a little surprise and delight.