Contribution ID: **13** Type: **Plenary talk**

Magnetic-field imaging by cosmic-ray muon (Magic-μ)

Thursday 25 November 2021 16:15 (20 minutes)

Cosmic-ray muon radiography, also called muography, can exploit the internal structure of an object that muons traversed. In the conventional absorption method, transmission or absorption ratio to background terrestrial muon flux can determine the density length. After the scattering method was invented, muography can inspect nuclear materials' existence in targets. The identification is possible because the nuclear materials have a large electron density to scatter muon at large angles. This study proposes new targets, "magnetic field imaging" and "magnetic flux density measurement." We call the project, Magic-μ, which is short for MAGnetic field Imaging by Cosmic-ray MUons. When a muon traverses in a magnetic field, they are deflected and change their trajectories with its velocity and charge. In other words, the magnetic field must distort the muography image from its original (non-magnetic field condition) image only around the magnetic field. The distortion is detectable with the same process as anomaly detection in the absorption muography. This technique is promising to detect the degradation of a superconductive coil of a fusion reactor because it can find a weak magnetic field region. Next, let us move toward magnetic flux density measurement. In standard muography, muon charge identification is not necessary, but it is mandatory for the magnetic flux density measurement. We will install a muon charge identifier to a standard absorption muography detector. Also, a novel data analysis technique is required to determine the absolute value of the magnetic flux density from the distorted image. We will start with the so-called template matching method, which can find displacement from a template image, a muography image without a magnetic field. We will estimate the magnetic flux density from the displacement. It is useful to understand the magnetic field applied by multipole electromagnets using for Fixed-Field Alternating Gradient accelerator. Additionally to these overviews, simulation results for the feasibility study will be shown in the workshop.

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Session Classification: New Ideas

Track Classification: New ideas