



Contribution ID: 67

Type: **Poster Presentation**

Development of Muon Spin Imaging

μ SR is a spectroscopy using a spin-polarized muon beam. It is a method to observe the muon spin rotation, relaxation and resonance by using the detection of positrons emitted asymmetrically to the muon spin axis, and is widely used as one of the physical property methods to search for magnetic fields inside materials. However, the conventional μ SR can only measure physical properties of the entire sample because it uses detectors without position sensitivity.

Therefore, we have developed a new method called muon spin imaging using position-sensitive detectors. This method can determine the muon stop position in the sample by tracking both muon and positron trajectories, and enables μ SR measurements in a small area of the sample. Then, by analyzing the μ SR spectra for each sample position, 3D imaging of the sample with various μ SR parameters becomes possible.

In this study, 2D images of a sample of a known material combination were produced using a surface muon beam with uniform energy, and the position resolution of the images was evaluated. The experiment was performed at TRIUMF in September 2024, using a drift chamber and a fiber tracker for muon and positron tracking respectively. The material boundary for a combined Al and Al₂O₃ sample, was successfully imaged with a resolution of less than 1.0 mm.

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Funding Agency

Multidisciplinary PhD Program for Pioneering Quantum Beam Application (PQBA) at Osaka University, Scholarship of Graduate School of Science of Osaka University for Overseas Research Activities, Fundamental Electronics Research Institute (FERI), Osaka Electro-Communication University (OECU), JSPS Kakenhi Grant Number JP22H00110, KEK-TRIUMF Exchange Program for Early Career Researchers (EPECR)

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Session Classification: Poster session 2

Track Classification: Beamlines and instruments