Development of Muon Spin Imaging Spectroscopy

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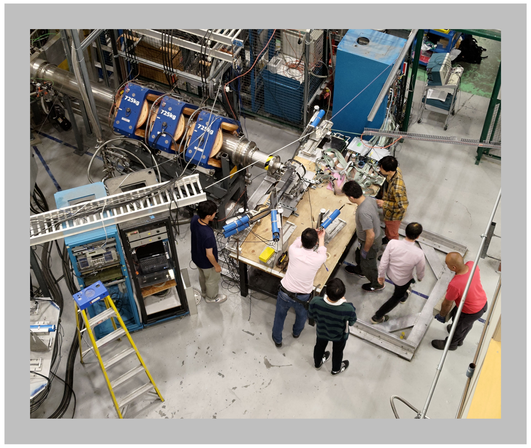
Abstract

The muon spin relaxation/rotation/resonance (μSR) technique is one of the strongest methods to examine material characters. However, the detector set does not have spatial resolutions at all. Therefore, our group is trying to develop a new imaging technique to extend μSR. We made a new detector set made of plastic scintillation fibers so that we can track back trajectories of each positron, identify where they come from in the sample, and analyze μSR data at each position in it to make an image of it.



We did the experiment at M20D in Meson Hall in July.

What is μSR?

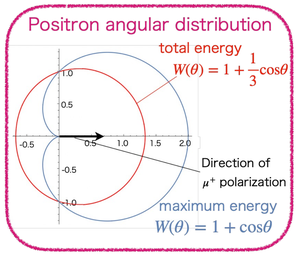
μSR is the method utilizing spin polarized muon beams.

We measure the relaxation/rotation/resonance of positrons emitted from muon decays by detecting the asymmetry of them.

Muon decay

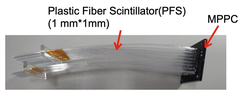
$$\mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu$$

Positron angular distribution

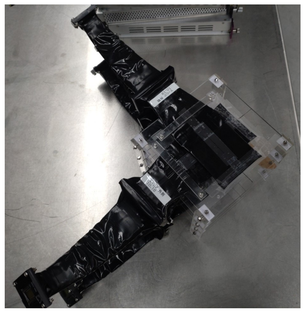


How our detector set works

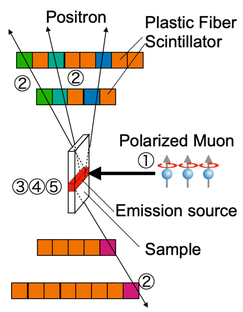
1. Irradiate muon beams into the sample
2. Detect positron
3. Trackback positrons
4. Identify position's emission source
5. Analyze each position of the sample



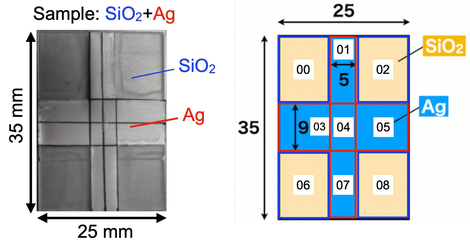
Position sensitive detector



What our detector set (after shading) looks like



Analysis/Results



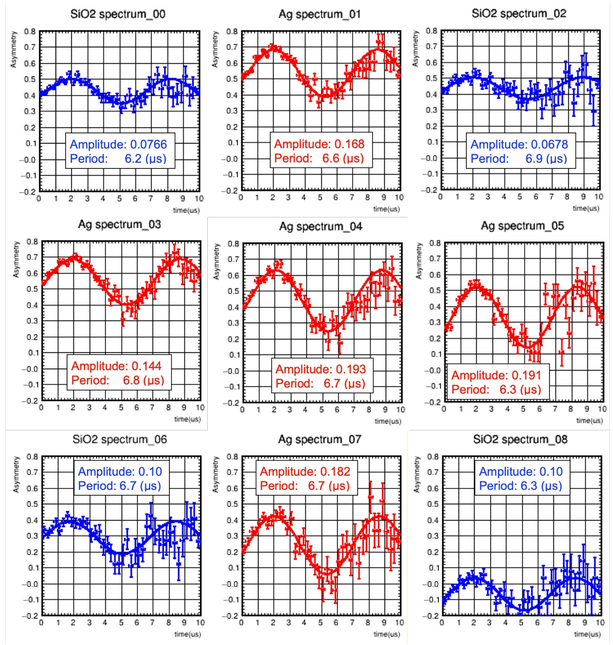
Measured the sample made of Ag and SiO_2

According to the analysis…

✓ We can see the difference between the material in the amplitude of the spectra

→ Consistent with the data taken by DAQ at TRIUMF!!!

The results of Ag and SiO_2 show the characteristic of μ^+ muonium respectively



Conclusion/Future works

- We have got some results of imaging, which shows us the potential of this research.
- We measured a sample that has multiple holes of different diameters and would like to evaluate the spatial resolution by analyzing it.
- We hope we can apply this method to other fields such as biology, life science, medicine, etc…

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Discovery, accelerated