High transverse field μSR with $\frac{\pi}{2}$-RF pulse spin control technique

R. Kadono[1,2], K. H. Satoh[2], A. Koda[1,2], K. Nishiyama[1] and M. Mihara[3]

[1] *Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK), Tsukuba, Ibaraki 305-0801, Japan*
[2] *Department of Materials Structure Science, The Graduate University for Advanced Studies (Sokendai), Tsukuba, Ibaraki 305-0801, Japan*
[3] *Department of Physics, Osaka University, Toyonaka, Osaka 560-0043, Japan*

Pulsed muon beam has an inherent problem that the time resolution for the conventional μSR measurements is limited by the beam pulse width ($= \delta$), which would be particularly serious for experiments at the J-PARC Muon Experiment Facility (MUSE) where δ would be 100-130 ns. It is much desired to establish routine technique to overcome the limit of pulse width for wider range of applications. For this purpose, a radio frequency (RF) technique has been known to be useful; The basic idea is to rotate the initial muon polarization (P_μ) from $P_\mu \parallel H$ to $P_\mu \perp H$ direction by applying a short RF pulse that satisfies the condition $\gamma_\mu H_1 \Delta t = \pi/2$, where H_1 ($\perp H$) is the RF field, Δt is the RF duration, and H is the holding field. Then, because the time relative to the RF pulse is well-defined irrespective of the muon arrival time, P_μ exhibits coherent Larmor precession around H. Thus, the $\frac{\pi}{2}$-RF pulse allows us to observe TF-μSR without limitation from δ.

Here, we report our result for the $\frac{\pi}{2}$-RF pulse experiment at 200 MHz (corresponding to 1.475 T), the highest precession frequency ever observed, using a pulsed muon beam at KEK ($\delta \simeq 50$ ns).
A single-turn coil resonator fitting to a He gas-flow cryostat was fabricated, and the sample space ($\simeq 3 \times 3 \times 1$ cm^3) in the resonator was filled with MgB_2 powder (a type II superconductor with $T_c \simeq 39$ K). As shown in Fig. 1, we were successful to observe a muon precession signal in time domain. The reduction of asymmetry upon the onset of superconductivity below T_c was also confirmed, demonstrating that the signal was actually coming from muons stopped in the MgB_2 sample. Details on the experiment and a preliminary result will be presented in this contribution.

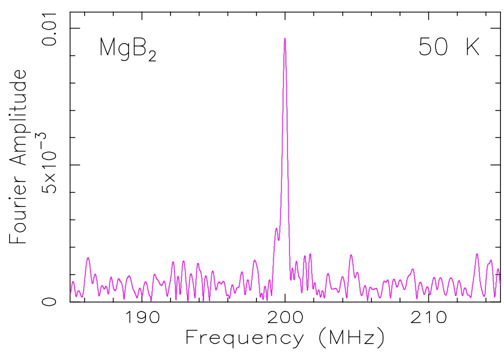

Fig. 1: Fast Fourier Transform of μSR spectrum over a time region from 1.5 μs to 6 μs (where the RF noise is negligible) obtained from a time spectrum.