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Development of Transient μSR at J-PARC

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To obtain one time-differential μSR spectrum using a conventional technique, we must wait around 10^2 minutes. In the majority of μSR experiments, the μSR spectrum is recorded as a function of temperature. Thus, such a long recording time (t_{record}) has not been a serious problem, because the lead time (t_{read}) for stabilizing temperature requires typically 10-20 min, which is shorter than the recording time ($t_{lead} < t_{record}$). However, due to the developments of the high-intensity pulsed muon beam with a repetition of 25 Hz in J-PARC MUSE and the multi-detector counting system, the recent data recording time is very short compared with the time to stabilize the measurement condition ($t_{record} < t_{lead}$), which makes t_{lead} a significant bottleneck for the advanced μSR measurements. In order to solve this problem, we are developing a novel data record and analysis technique to use a high-intensity muon beam more efficiently. In the novel technique named transient μSR, the sample environment, such as temperature and magnetic field, is continuously changing during the μSR measurements. Positron events in each muon pulse are recorded as multidimensional data, i.e., along with the number of pulses and the changing parameter. The whole data is then resorted as a function of the parameter. This transient μSR technique also enables us to study a transient phenomenon that is now unavailable with the standard μSR technique. It should be emphasized that the feasibility of this technique crucially depends on the intensity of the pulsed muon beam. We have also developed a new software based on ROOT to analyze the huge number of the μSR spectrum within a reasonable amount of time. We will introduce the analysis software how to analyze the transient μSR data and report the results obtained under dynamic sample environments.

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