The 12th International Particle Accelerator Conference Development of bunch width monitor with high time resolution for low emittance muon beam in the J-PARC muon g-2 / EDM experiment

Mai Yotsuzuka^A,

T.Iijima^{A,B,C}, K.Inami^A, M.Otani^C, Y.Kondo^{D,E}, N.Saito^F, Y.Sue^A, K.Sumi^A, Y.Takeuchi^G, Y.Nakazawa^E, T.Mibe^C and H.Yasuda^H

^ANagoya univ.,

^BKMI Nagoya univ., ^CKEK, ^DJAEA, ^EIbaraki univ., ^FJ-PARC center, ^GKyushu univ., and ^HUniversity of Tokyo

J-PARC muon g-2/EDM experiment

- The discrepancy of the muon anomalous magnetic moment (g-2) between the experimental and theoretical values is updated to 4.2σ [1].
- The J-PARC muon g-2/EDM experiment aims to measure with high precision by the novel method using <u>a low emittance muon beam</u>.



Problem of a muon linear accelerator

Since corresponds to the rapid energy changes associated with acceleration, developing a muon linac* consisting of four different RF accelerating cavities.

The beam mismatch occurs serious emittance growth.



Since adapts APF-method to realize high acceleration efficiency,



Suppression of emittance growth

Beam matching based on actual measurements between different acceleration cavities is important.

• Based on the evaluation in the simulation, design a beam transport line consisting of diagnostic systems and optical systems.



 In order to suppress longitudinal emittance growth below 40%, need to have <u>a high time resolution of 40 ps.</u>

(=It corresponds to an accuracy of approximately 1% of the acceleration phase.)

 In order to also use demonstration tests, require to <u>detect low-intensity muon beams.</u>

For achieving high time resolution

Using Micro-channel plate (MCP), we develop a new bunch width monitor capable of measuring low emittance muon beams with high time resolution.

- MCP detect muon directly using secondary electron amplification, and have a high responsiveness.
- The CFD circuit* used in the readout system suppresses the degradation of time resolution that depends on the signal wave height.



* Developed as the prototype readout system of the Time- of-propagation counter which install in the Belle II detector.

Evaluation of time resolution

Since the performance of the MCP is not understood, <u>a test bench is developed</u> <u>with picosecond pulse laser</u> to evaluate.



We showed that bunch width monitor achieved the required time resolution.

Considerations for time resolution limitations ^{7/8}

The wave height dependence was evaluated, and <u>it suggests that there is a</u> <u>limitation due to the readout system and laser</u>, which is match the prediction from the classification (p6).

Prospect: We are selecting and evaluating a waveform readout digitizer with DRS4 to further improvement of a bunch width monitor.



Summary

- Precise measurement of muon g-2 and EDM using low emittance muon beam are planned at J-PARC. In order to suppress emittance growth which is important during re-acceleration, <u>we have developed a bunch width monitor</u> <u>with high time resolution using MCP.</u>
- We have guaranteed that the time resolution of bunch width monitor is <u>σ~40 ps from the evaluation by the test bench.</u> In addition, we revealed it enable achieving higher time resolution that improvement of the readout system and laser.
- The first ultra slow muon acceleration and emittance measurement plan to perform at 2022. We will optimize the bunch width monitor such as introducing an insertion mechanism, to use in real beam line.