Performance Evaluation of the Detectors for the DeeMe Experiment

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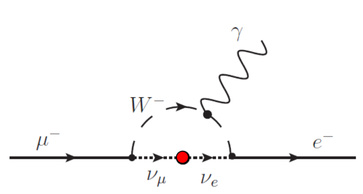
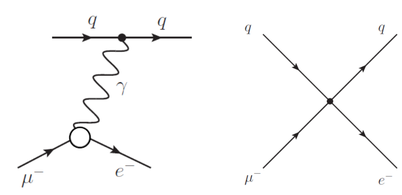
1 Charged Lepton Flavor Violation

- Prohibited in the Standard Model (SM)
- The branching ratio for $\mu \rightarrow e\gamma$ suppressed to $\leq 10^{-54}$ even including the neutrino mixing
- Some theoretical models beyond the SM predict sizable branching ratios
- Observation with a high rate clearly means the existence of new physics

Diagram for $\mu \rightarrow e\gamma$



Photonic and non-photonic diagrams for $\mu q \rightarrow eq$

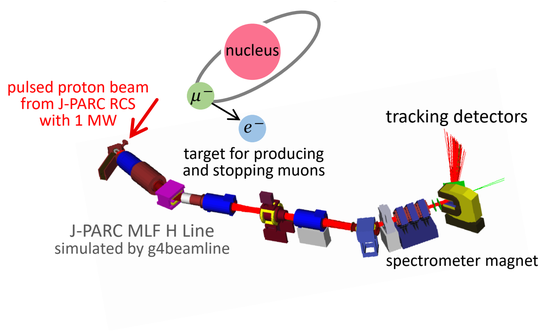


- SUSY-GUT
- SUSY-seesaw
- extended Higgs sector etc.

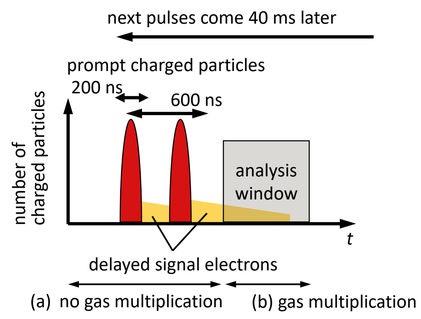
2 DeeMe Experiment

- An experimental search for muon to electron conversion in the nuclear field
- Our goal: a single event sensitivity of $< 1 \times 10^{-13}$ for a C target or $< 2 \times 10^{-14}$ for a SiC target for 2×10^7 seconds / year
  - Current upper limits: 7×10^{-13} for a Au target (SINDRUM-II), 4.6×10^{-12} for a Ti target (TRIUMF)
- Preparation in progress at J-PARC MLF
- The spectrometer consists of a magnet and four multi-wire proportional chambers (MWPCs)

Concept of the experiment

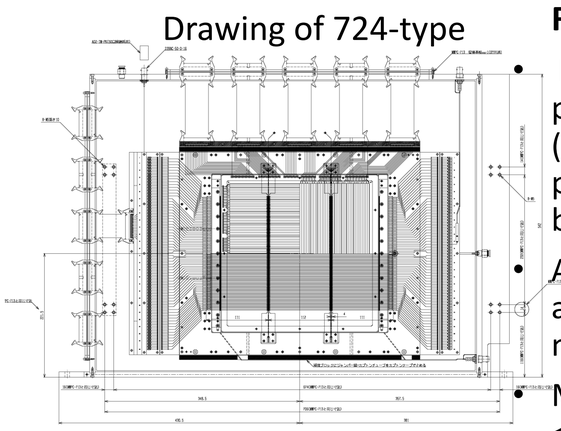


Expected charged particles hitting the MWPCs



3 The MWPC

Drawing of 724-type

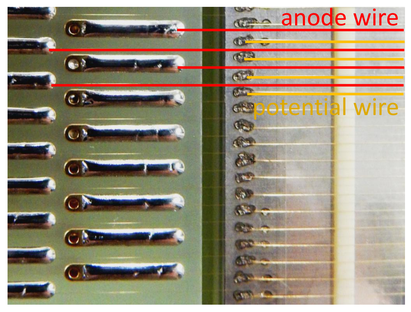


Requirements

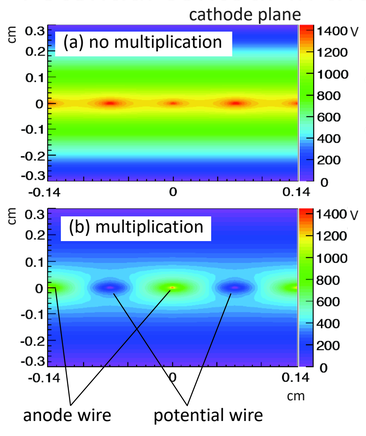
- High-rate tolerance to prompt charged particles ($\simeq 10^6$ particles / readout) produced by pulsed proton beam from J-PARC RCS
- After that, needs to detect a signal electron with a momentum of 105 MeV/c
- Momentum resolution < 0.4% (RMS)

The cathode strips seen from the window

Wires in the chamber

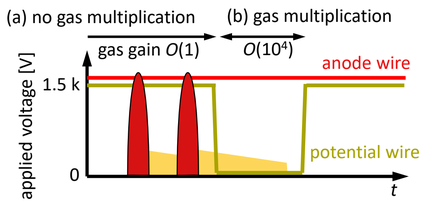


Potential contour in the chamber

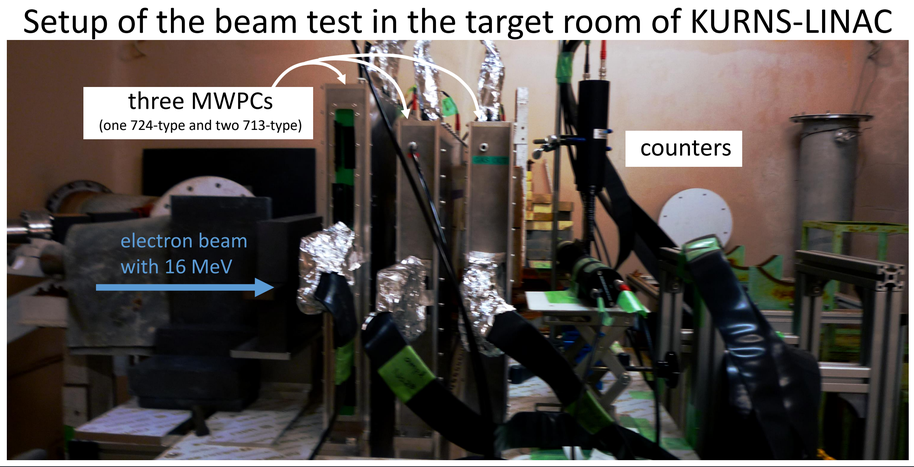


Structure

- Cathode strip readout
- Two types of wires (anode and potential)
  - Makes it possible to control the gas gain dynamically

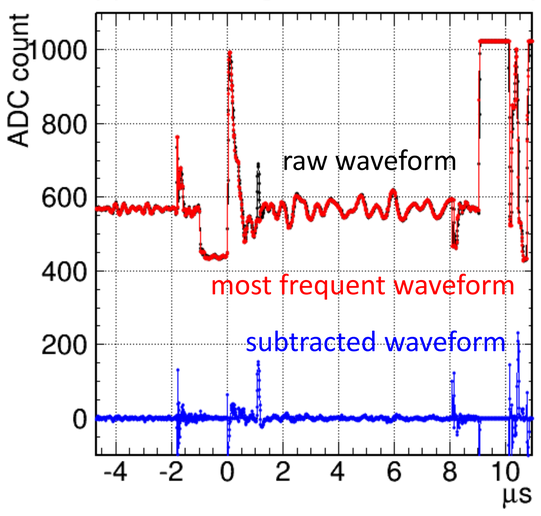


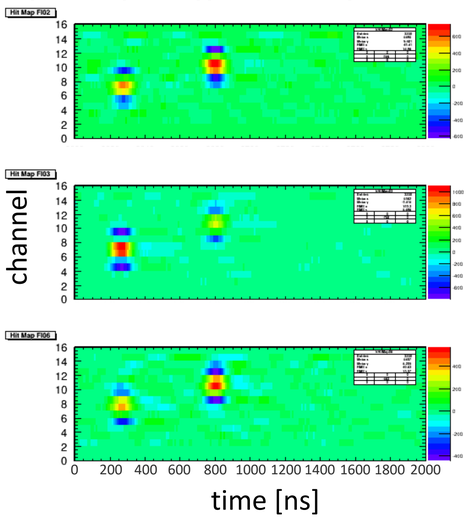
Setup of the beam test in the target room of KURNS-LINAC



4 Analysis of the Beam Test in February 2019

- Put three MWPCs at the electron-beam exit
- Gas flow: Ar 37.0 mL/min. & iso-C_4H_{10} 10.0 mL/min. & R-134a 3.0 mL/min.
- Applied voltage: 1540 V to 724-type (wire spacing 0.75 mm) & 1510 V to 713-type (0.7 mm)





i. Use raw waveforms and make a template waveform (the most frequent waveform)

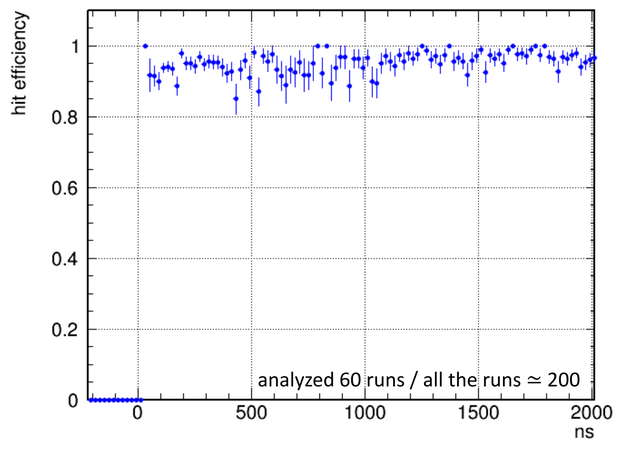
ii. Subtract each point

iii. Sum it up in the direction of time and channels

iv. Find hits

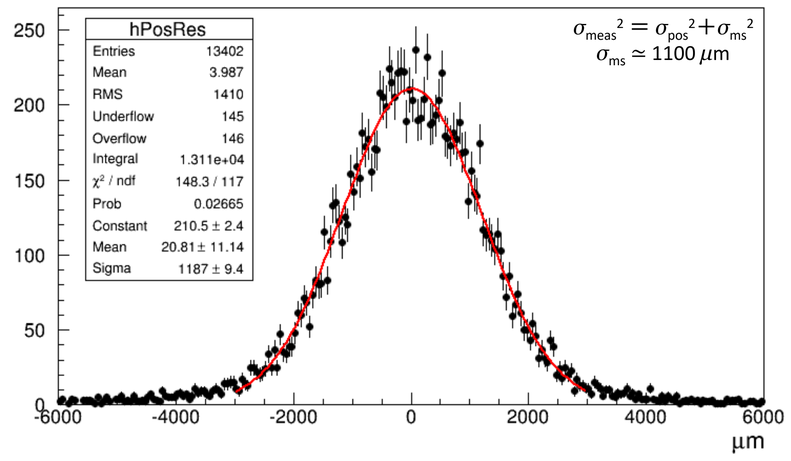
Hit efficiency vs. time

ratio of the number of hits on the middle MWPC to the coincidence hits



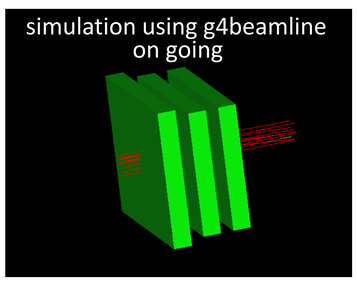
Position resolution

position difference between the hit position on the middle MWPC and the linear-fitted position obtained from the other two MWPCs



5 Summary and Future Prospects

- All four of the MWPCs have been manufactured. They work well in actual operation
- Hit efficiency > 95% and position resolution is (1186.9±9.4) μm including the effect of multiple scattering. To obtain the intrinsic resolution, the simulation calculation is on going
- We will have the next beam time in July 2019. Plan to study further gas optimization and to increase the beam energy to 40 MeV



CLFV2019 on June 17th, 2019 at Fukuoka International Congress Center, Fukuoka, Japan