部分軌跡を用いたMEG II実験陽電子
スペクトロメータ検出器の性能評価の試み

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Outline

• Introduction
  • $\mu \rightarrow e\gamma$ Decay
  • MEG II Experiment
  • Positron Spectrometer
• Detector Commissioning 2018-2019
• Commissioning Data Analysis
• Summary
$\mu \rightarrow e\gamma$ Decay

- $\mu \rightarrow e\gamma$: charged Lepton Flavor Violation (cLFV)
  - Prohibited in the standard model / Predicted in the beyond standard model within experimental reach
  - To discover $\mu \rightarrow e\gamma$ means to discover the new physics!!

- Signal kinematics of $e$ and $\gamma$: 2 body decay
  - Timing, position, and momentum is the key parameters

180° (back to back) at the same timing from the same position
MEG II Experiment

• The most sensitive $\mu \rightarrow e\gamma$ search with the most intense muon beam ($7 \times 10^7 \mu^+/s$) in Paul Scherrer Institut

• Precise background separation is the key to success – Innovative positron detectors were developed
pixelated Timing Counter (pTC)

\[ \sigma \text{(Timing)} \sim 80 \text{ ps with each counter} \]

\( \times \ 512 \)

\[ \sim 8 \text{ hits/positron on average} \]

- MEG II pTC measure the positron crossing timing with the precision of \( O(30 \text{ ps}) \)
- 512 "pixelated" design enables the multi-hit information (\(~8 \text{ hits / positron on average}\)
Cylindrical Drift Chamber (CDCH)

- Ultra-low mass (90% helium based mixture and 10% isobutene) cylindrical stereo wire chamber to reconstruct the positron track with 2 times better efficiency (~70%) from MEG
- 192 drift cell (7-9mm square shape) x 9 layers
Outline

• Introduction

• Detector Commissioning 2018-2019
  • Configuration
  • First Look

• Commissioning Data Analysis

• Summary
Situation & Configuration

• Readout electronics was strictly limited in both years: only \(~6\% (96/1728 \text{ cells})\) of CDCH and \(25\% (128/512)\) of pTC were available
  • In 2020?
• There are still many problems we are facing… anyway, we now have the data and have to start the analysis to understand the detector
In 2018, pTC + CDCH were operated for the first time. Current oscillation, inner layers could not reach the nominal vol. Wire tension (+3.8 mm) was not enough -> overstretching to +5.6mm, achieved the nominal high voltage in 2019. Electronics synchronization problem – correction from software.
In 2019, we succeeded to apply nominal vol on inner / outer conf, but…
Sync problem again – situation seems worse than 2018
we found that L1, L3, L5 has less hits – no stereo information this year
Anomalous current (10—480 μA) observed – we could not continue DAQ in Nov

Available this year (304 - 431)
-> For SPX Independent Tracking, hit should be in 320 – 415
• The pulse height is roughly ~ 1/10
  • ~1/5 from wrong electronics gain of CDCH
  • ~1/2 from many factors (unbalanced gains in 2018, the missing effects in MC, z-dependence of drift-cell size etc …
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  • Z reconstruction in CDCH
  • Partial Track Reconstruction
  • Z evaluation
• Summary
Z Reconstruction in CDCH

• Z calculation by 2 methods:
  • Time difference (σ ~ 5 cm)
    • \[ z = \frac{T_{up} - T_{down}}{2} v \]
    • Time calibration is needed
  • Charge division (σ ~ < 1 cm ?)
    • \[ z = A L_{eff} \]
      where \( A = \frac{Q_{up} - Q_{down}}{Q_{up} + Q_{down}} \) (charge asymmetry) and \( L_{eff} = \frac{2R + \rho L}{2\rho} \) (effective wire length)
    • Gain/ Effective wire length calibration is needed

• For MC tracking study, assuming 10 cm uncertainty for Z
  • Z measurement information helps pattern recognition

• For hit finding from SPX, z position cut is effective

• Understanding the z resolution with commissioning data is necessary!
Partial Track Reconstruction

• SPX self-track + CDCH 3-layer hits
  • Starting from pTC track, search the CDCH hits and add them to the track
  • Fitting with Deterministic Annealing Filter (DAF) from GENVIT
  • Stereo information is used for the clustering -> 2019 data not available
    • Today I will focus on 2018 data

1.34e7 michel data
Z evaluation

2018 data (low-intensity, 1.34e7)

- **Charge**
  - Mean: 25.9
  - Std Dev: 44.94

- **Time dif**
  - Mean: -39.83
  - Std Dev: 41.51

MC (Signal Only)

- **Charge**
  - Mean: -3.291
  - Std Dev: 11.37

- **Time dif**
  - Mean: -4.026
  - Std Dev: 18.54

- \((Z_{CDCH \ measured} - Z_{SPX})\)
  - Measured \(z\) in CDCH and pTC \(z\) does not match well in data
  - 2 peak can be seen: around \(z=0\) (center, high rate) and \(z \approx 100\) (near SPX)
Summary

- Detector commissioning for positron detectors in 2019 has been completed
  - We succeeded on accumulating the positron spectrometer data, analysis ongoing – Today I showed the preliminary results
  - We also found some serious problems for detector operation / software analysis point of view - Must overcome
  - Partial track reconstruction algorithm was developed – We succeeded on positron track reconstruction from data for the first time