The Double Turn Method for the MEG II Spectrometer Characterisation

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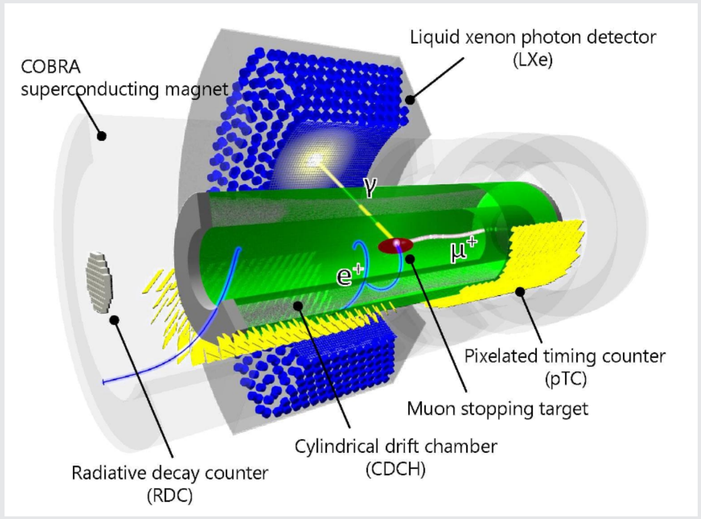
The MEG II Experiment



Looking for the charged lepton flavour violating decay

$$\mu \to e\gamma$$

with an expected sensitivity to a branching ratio of

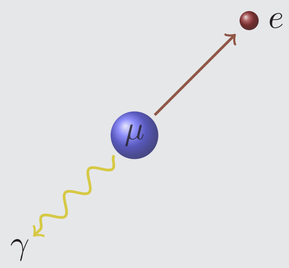
$$BR(\mu \to e\gamma) < 4 \times 10^{-14} \quad [1]$$

Current best result by MEG

$$BR(\mu \to e\gamma) < 4.2 \times 10^{-13} \quad [2]$$

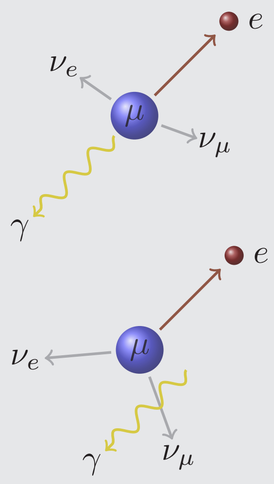
The Expected Signal

The Signal



The signal is characterised by a 52.8 MeV γ and a 52.8 MeV e^+ in back to back geometry.

The Backgrounds

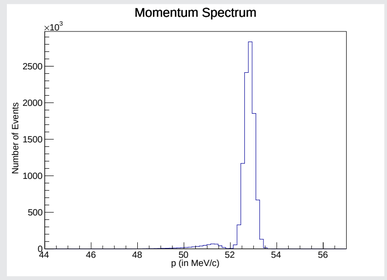


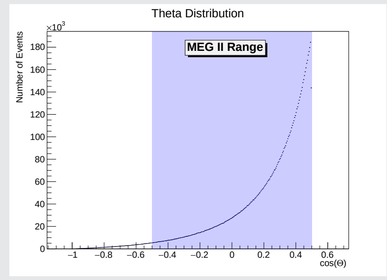
RMD events may look like a signal event if the neutrinos are emitted at low energy.

A 52.8 MeV positron from Michel decay coincides back to back with a 52.8 MeV γ from elsewhere (RMD, annihilation in flight).

The Mott Calibration

By Mott scattering a positron beam on the muon stopping target, positrons with the signal energy are obtained in the MEG II spectrometer [3].





As seen from the two figures, a spread in momentum remains. Further, a continuous angular distribution is observed.

Comparing Monte Carlo truth values to their reconstructed values, one obtains the following resolutions (gaussian σ):

Energy	Polar Angle	Azimuth Angle
82.4(7) keV	4.71(4) mrad	4.05(4) mrad

These values are only accessible through simulation and not during the experiment.

The Working Principle of the Double Turn Method

- Choose e^+ tracks with two turns in the CDCH
- Analyse each turn individually, extract

  Momentum $p_{1,2}$

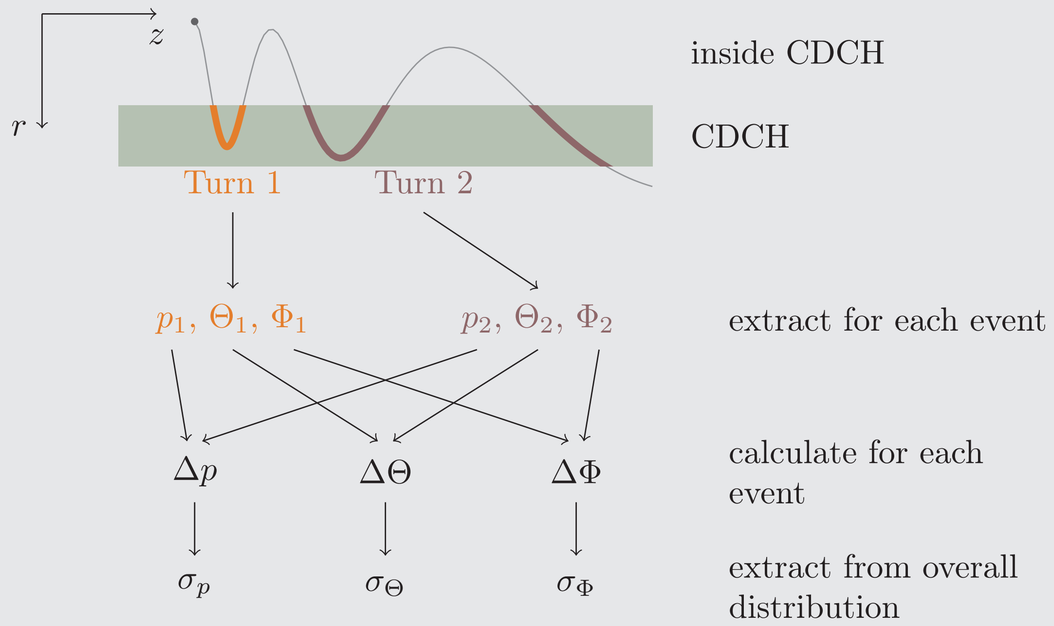
  Polar Angle $\Theta_{1,2}$

  Azimuth Angle $\Phi_{1,2}$
- Both values are from the same positron with one momentum and one direction. The resolutions can be estimated from the differences

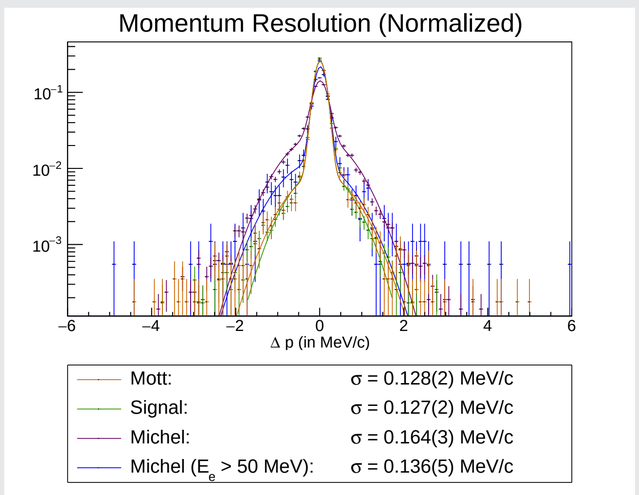
$$\Delta p = p_2 - p_1$$

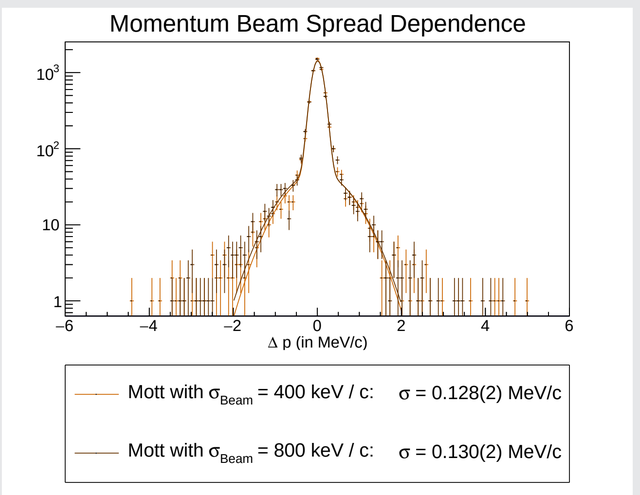
$$\Delta\Theta = \Theta_2 - \Theta_1$$

$$\Delta\Phi = \Phi_2 - \Phi_1$$



Results





In terms of the double turn method, simulated Mott events (orange) behave just as signal events (green) are expected to behave.

Very similar results are obtained for the angular variables.

The obtained spectra by the double turn method are independent of the beam properties.

Conclusions

Double Turn Algorithm

- applicable to any track with two or more turns in CDCH
- Mott events are most promising

Double Turn vs MC Truth

- Deviations in resolution are observed (Factor ≈ 1.5)
- Deviations are expected as DT based on differences of two reconstructed single turns. MC truth is mostly based on tracks with one or one and a half turns.

References

[1] A. M. Baldini et al. (MEG II Collaboration): *The design of the MEG II experiment*, arXiv:1801.04688v1 [physics.ins-det] (2018)

[2] A. M. Baldini et al. (MEG Collaboration): *Search for the lepton flavour violating decay $\mu^+ \to e^+\gamma$ with the full dataset of the MEG experiment*, Eur. Phys. J. C 76, 434 (2016)

[3] For more informations about the CDCH see Marco Chiappini's poster *"The new drift chamber of the MEG II experiment"*, PM2018