The Entrance and Time of Flight detector prototypes of the muEDM experiment

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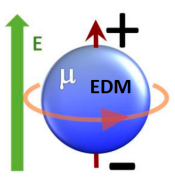
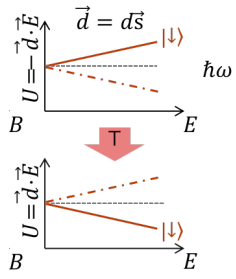
Introduction

- **Electric Dipole Moments** (**EDMs**) are very sensitive tools to search for New Physics (behind Standard Model)
- In particular **EDMs** of fundamental particles are intimately connected to the violation of time invariance T and the combined symmetry of charge and parity CP
- The muon plays a special role being the only bare particle whose EDM can be directly probed

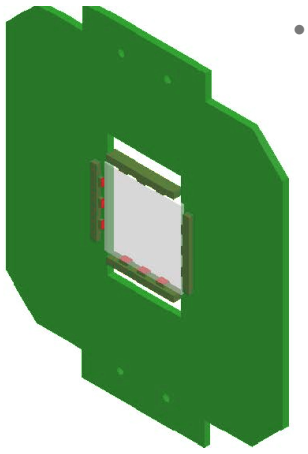




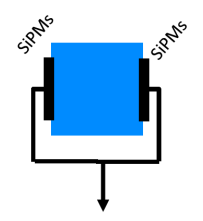
EDM, $\mathbf{d} = \eta qh/4mc\,\boldsymbol{\sigma}$

The Entrance and TOF detectors

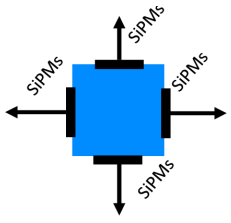
- A **very thin** (<100 um), to minimise the multiple scattering, and **full** efficient (>95%) to store all muons, plastic (BC400) detector coupled to Silicon-Photomultipliers (SiPMs)
  - to provide a **fast** trigger pulse for the magnetic kicker
  - to keep under control systematic effects for the clockwise and counter clockwise muon injection via a time of flight (TOF) measurement
- Challenges
  - Full detection efficiency and good timing resolution (<500 ps) collecting a small amount of scintillation light



- Multi-channel independent readout
  - To face with small signal and high thermal noise contamination for a full detection efficiency, the signal being correlated pulses the second uncorrected ones



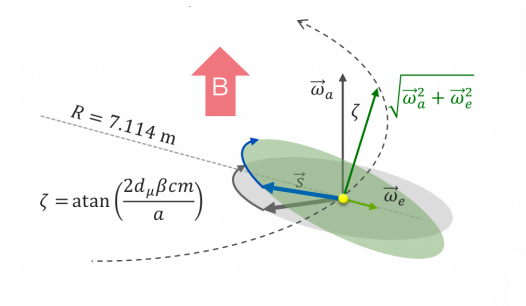
Single channel readout

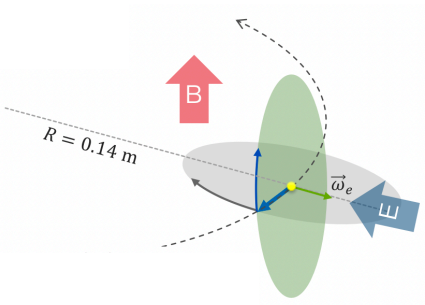


Multi channel readout

The muEDM experiment

- *Muons from pion-decay for a high polarisation (> 90%)*
- *Continuous and not invasive beam diagnostic tools*
- *TOF for muon momentum measurement*
- *Injection through a superconducting channel*
- *Fast scintillator for trigger pulse*
- *Magnetic pulse to stop the muon longitudinal motion*
- *Weakly focusing field for muon storage*
- *Thin electrodes for the electric field for the frozen spin technique*
- *Positron tracker for the momentum measurement and the EDM signal*
- *Auxiliary detectors for setting up the optimal conditions*
- *TDAQ*
- *MC/Analysis*

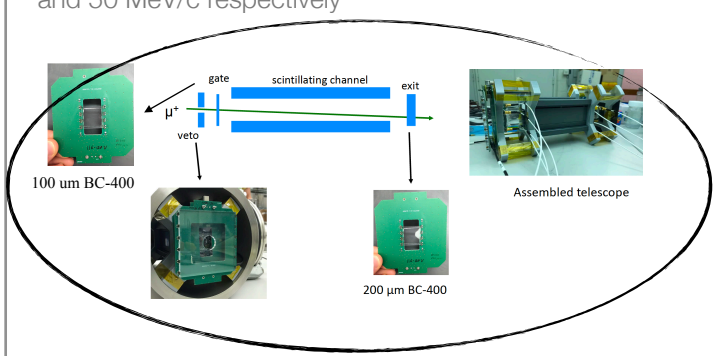


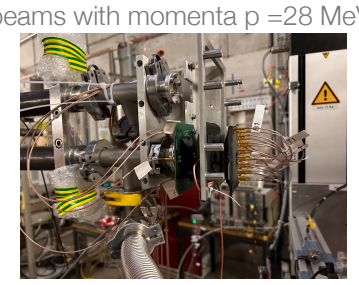


From the "frequency" approach…to the **frozen-spin** technique

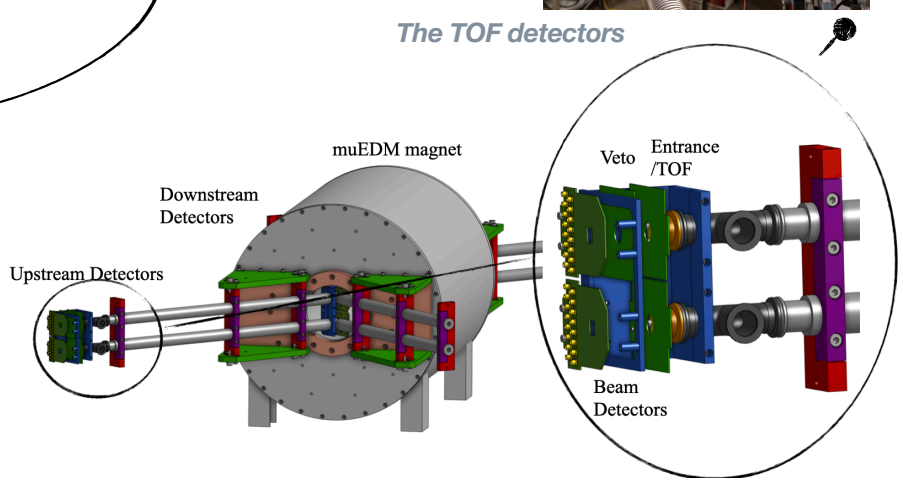
Beam Times

- Measurements have been performed during beam times at PSI using muon and positron beams with momenta p =28 MeV/c and 50 MeV/c respectively

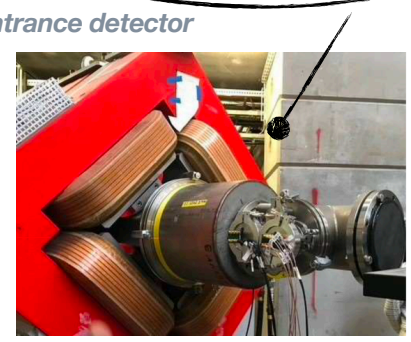




The TOF detectors



The Entrance detector

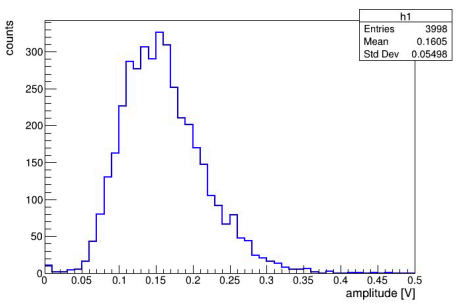


Results

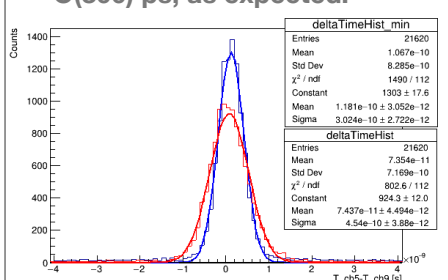
- The detector performances match the muEDM requirements

Amplitude spectrum from 28 MeV/c muons passing through a 100 um thick detector .

Measured detection efficiency > 95%



Measured "intrinsic" time resolution:
O(300) ps, as expected!



Timing algorithm: Constant fraction

- Two fixed channels (red)
- First arrival (blue)