INTENSE MidTerm Review.

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Intense
H2020 MSCA ITN
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Biographic information and previous studies.

- I was born in Malaga (South of Spain) in 1997.
- I moved to study a Degree in Physics at the University of Granada 2015-2019.
- Master in Particle and Astroparticle Physics at the University of Granada 2019-2020.
- Master Thesis in: “Measurements of the physical properties of neutrinos through oscillation experiments”.
    - In depth study of the quantum-mechanical effect of neutrino oscillation and how they are influenced by matter effects in order to study the most appropriate experimental strategy to measure a possible violation of CP symmetry in the lepton sector.
- Working as a research assistant at the University of Granada in the Short-Baseline Near Detector (SBND) experiment at Fermilab 2021.
    - Focused on light simulation / photon propagation.
- Became a PhD student on the Mu2e experiment in July 2021 at The University of Manchester.

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Courses attended.

- Training events.

- Fermilab 2021 Summer School at LNF 2-4 August 2021.
- C++/STL Fermilab course, August-September 2021.
- Intense Training Program: Cosmic Ray Muography November 2021, Ghent, Belgium.

- Contributions.

- HEP Forum 23rd, 24th November 2021, Oxford.
- Submitted First Year Report 15th March 2022 and passed the “viva” exam.
- Test beam in Dresden (Germany) at HZDR (gELBE) from 20th to 25th April 2022+ result presentation at Mu2e STM General meeting.

- Future courses.

- Advanced Graduate Lectures on practical Tools, Applications and Techniques in HEP, 13th-17th June.

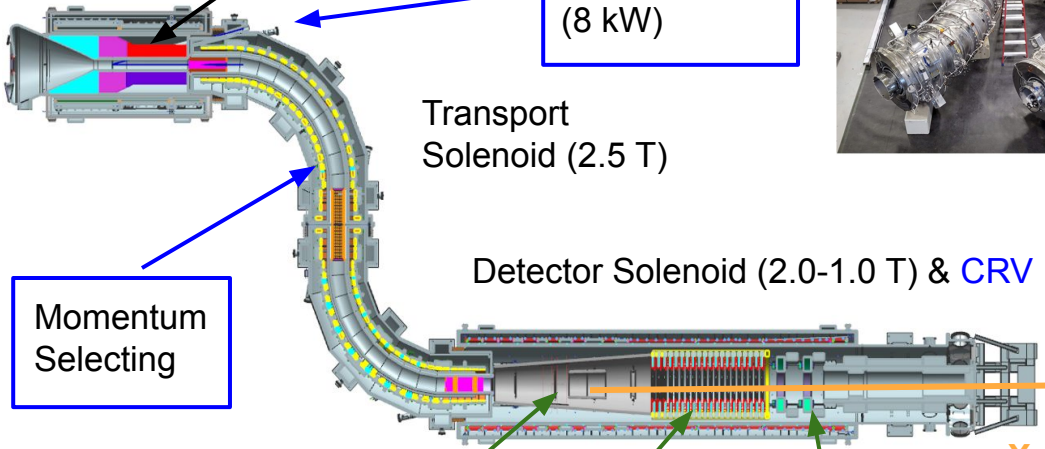
- HEP Summer School, 4th - 16th September 2022.

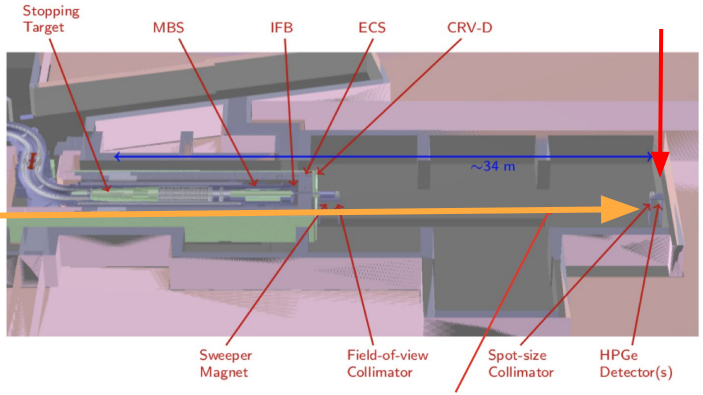
Mu2e.

Production (4.5 – 2.5T) Solenoid

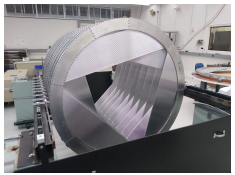
8 GeV protons (8 kW)

STM Detector: HPGe and LaBr





Polyethylene Absorber



35 m

Sensitivity of 8×10^{-17} requires 10^{10} muons/s to interact with the aluminium (stopping) target.

$$\mathrm{BR} = \frac{\Gamma\left(\mu^- + \mathrm{N} \rightarrow e^- + \mathrm{N}\right)}{\Gamma\left(\text{nuclear } \mu^- \text{ captures}\right)}$$

Muons (< 75 MeV/c) are captured by the aluminium and in that process characteristic X-rays are emitted.

We detect these X-rays 35m away from the target to “count the muons”.

Stopping Target Monitor (STM).

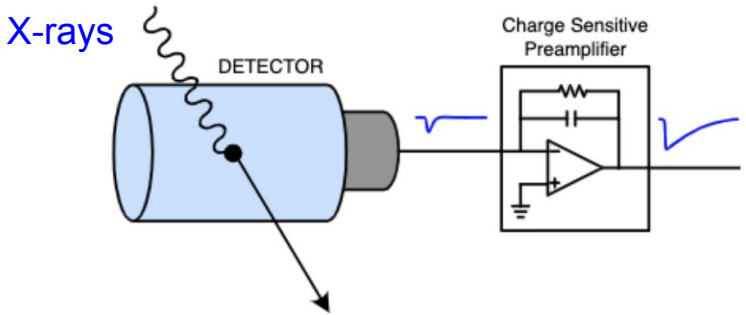
Signal of conversion electron at 104.5 MeV

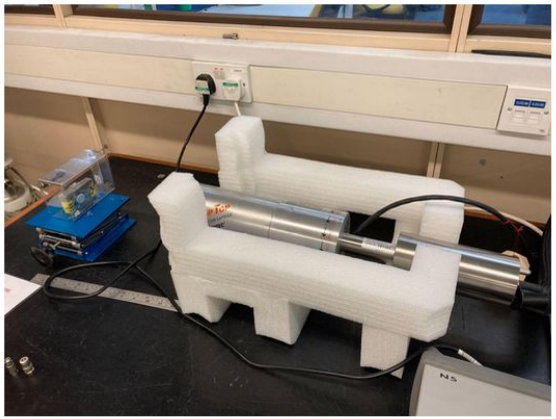
$$\mathrm{BR}^{\mathrm{Al}} = \frac{\Gamma\left(\mu^- + \mathrm{Al} \rightarrow e^- + \mathrm{Al}\right)}{\Gamma\left(\mu^- + \mathrm{Al} \rightarrow \nu_\mu + \mathrm{Mg}\right)} < 8 \times 10^{-17}\ (90\%\ \mathrm{C.L}).$$

Ordinary muon capture on the nucleus

STM: Two detectors (HPGe and $LaBr_3$).

Detector: HPGe+preamplifier.

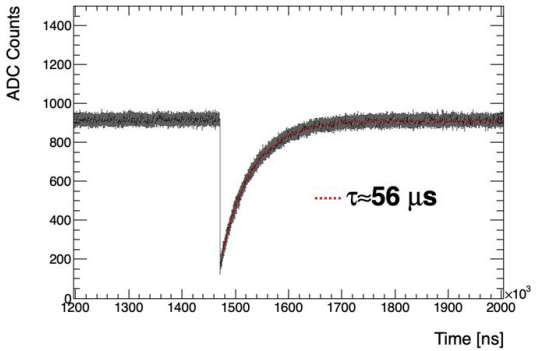




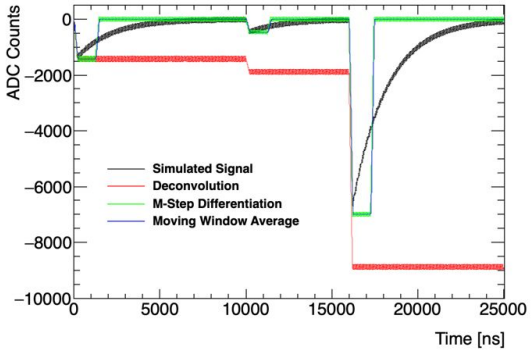
Phd Thesis at the Mu2e experiment.

Software development: MWD and Pulse Finding algorithm + Source Data analysis (^{137}Cs and ^{152}Eu).

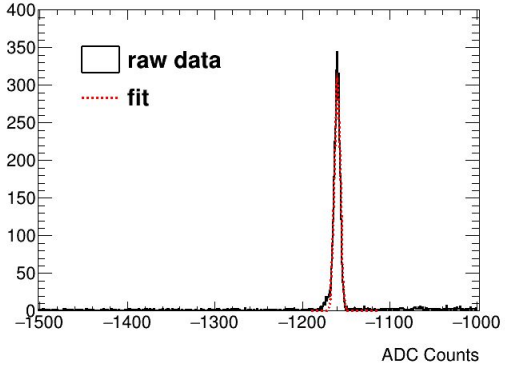
- X-rays reach the detector, the electrons ionise the material creating e-h pairs that drift in the detector creating the pulses.
- The signal is sent to the readout board and an ADC samples these values in 16-bit words.



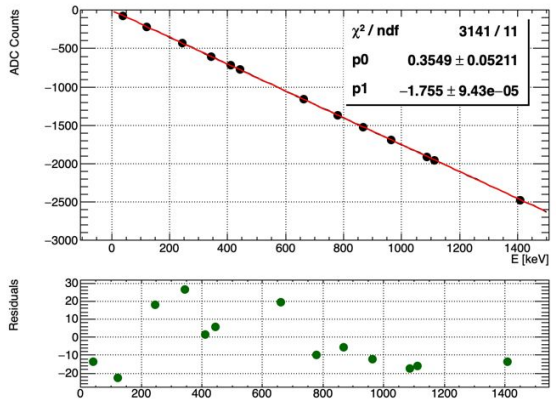
MWD + Pulse Finding



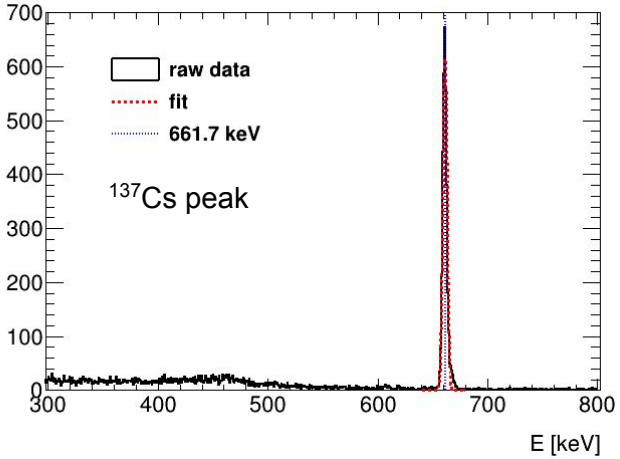
- The MWD algorithm allows to convert the signal in trapezoidal pulses based on the deconvolution.
- The algorithm depends on M and L parameters.
- Applying the Pulse Finding algorithm we are able to recover the height of the pulses in ADC Counts.
- Calibration: the ADC peaks have to be identified with the well-known energy peaks of the Cs and Eu.



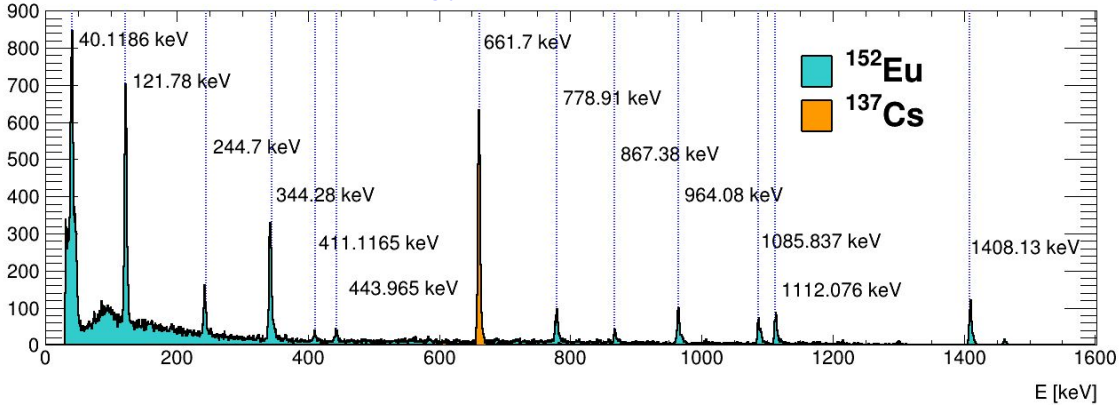
^{137}Cs + ^{152}Eu Calibration

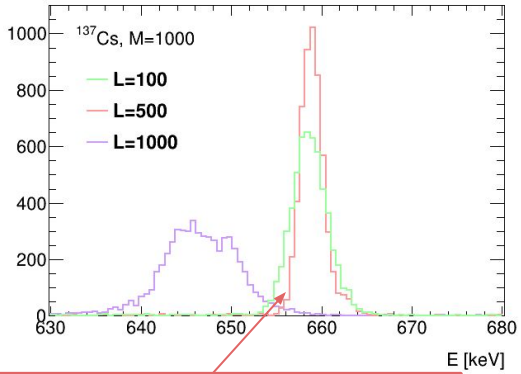


We are able to reproduce the energy spectrum



^{137}Cs + ^{152}Eu Energy Spectrum

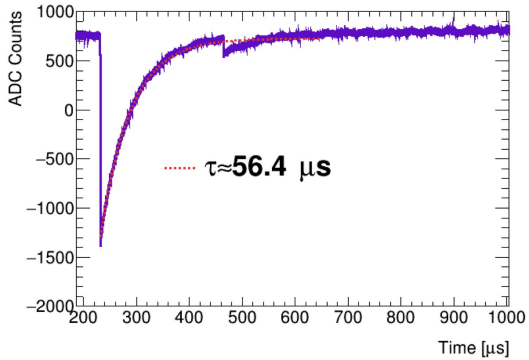


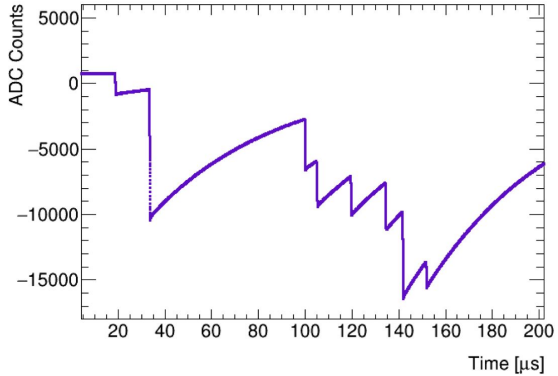


$$\sigma_{\mathrm{TOT}}(661.7\ \mathrm{keV}) = 1.238 \pm 0.014\ \mathrm{keV}$$

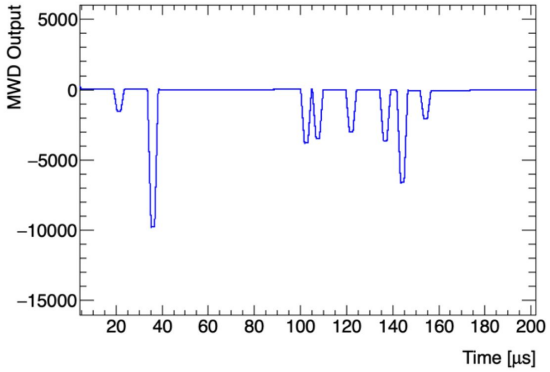
Test Beam at gELBE - Data analysis.

Signal

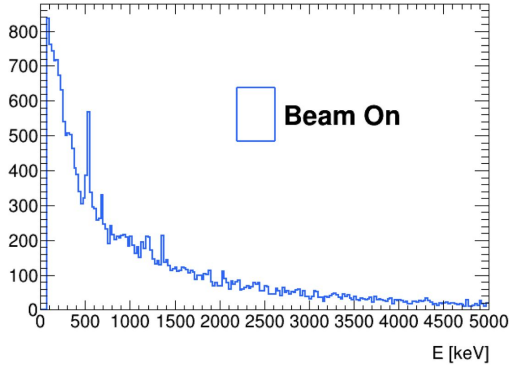


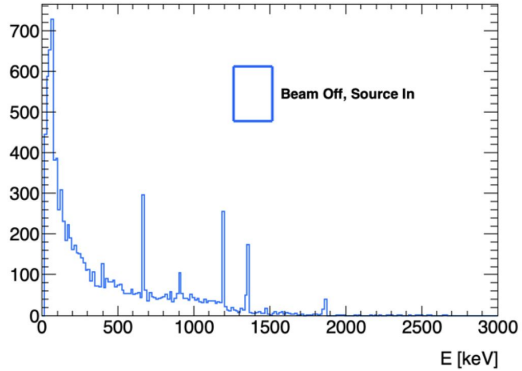


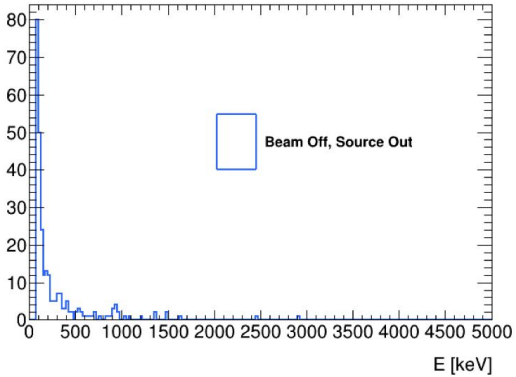
MWD Algorithm



Reconstructed energy spectrum







Future work.

In the short-term:

- With simulated pulses evaluate the MWD algorithm’s efficiency and its contribution to the overall energy resolution.
- Optimise a single zero-suppression algorithm such that it can be implemented initially with the online DAQ framework and then subsequently on the readout FPGA in HLS.
- Define the offline ART-record structure for the STM data.

In the medium-term:

- Commission the STM detector at FNAL: interface the current online code with the experiment’s OTSDAQ system and EPICS slow-control system.
- Improve the simulation of the STM in the Mu2e (ART/GEANT4) framework.