(A project to measure differential cross section dσ/dt of the elastic process $\mu\ e \to \mu\ e$ *)*

A short report on the testrun activity in 2024 and plans for 2025

by

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on behalf of the MUonE collaboration

MUonE requested 2 weeks of beam time on M2 as main user for these technical tests :

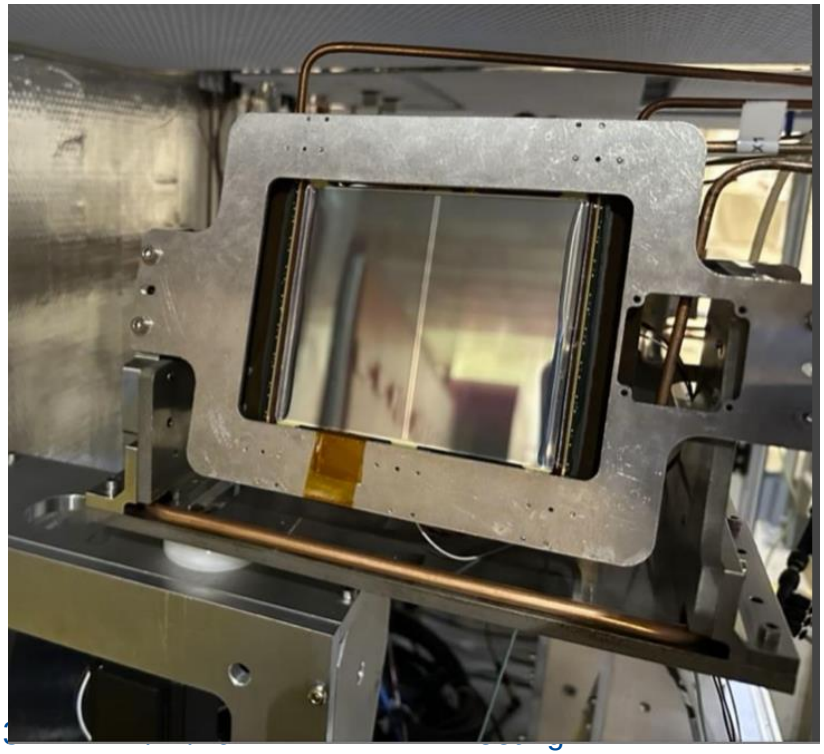
- Establish calibration routine to achieve uniform efficiency across and within modules (Requires beam)
- Install fast timing reference as independent reference for efficiency
  - -- For in-depth studies of dynamic or asynchronous effects
- Improve on efficiency for data taking in DAQ under high intensity conditions
  - -- Use event filtering to reduce network and computing loads

MUonE run on M2 beamline in 2024 from 13 Sept. to 4 Oct.

Achievements of the testrun 2024

The setup consisted in 12 tracker modules (2S from the CMS upgrade-II project, housed in ‘stations’ see figure) and a calorimeter (25 crystals PbWO4).

Used 160 GeV muons high and medium intensity and 40 GeV electrons.



Achievements of the testrun 2024

For the test beam 2024, the primary goal was the preparation for 2025.

We now have a DAQ system that can handle multiple tracking stations, ECAL and TDC detectors, combining their data into a single output packet

- the demonstration of a **multi-FPGA** design is invaluable for future large-scale runs

- firmware now capable of applying **online selection**, can be expanded to implement multiple types of trigger and multiple data streams e.g. for commissioning vs physics vs DataQualityMonitor

The synchronisation between the **TDC and Tracker** shows the feasibility of the FC7-based readout of new detectors into the mainline DAQ

The experience gained from this year places us in a good position for future runs where the stability of the DAQ will be critical to physics results. *(but we should not assume success unless dedicating time in advance to run with detectors)*

Plans for 2025

- The MUonE collaboration plans to perform in 2025 a test run with a complete scaled down setup of the final detector with a possible sensitivity to the hadronic corrections to the α running .

- The **M2 beam at 160 GeV/c**, with its present performance and parameters is adequate for this first measurement in 2025.

- The apparatus will consist of **3 tracking stations** (the final experiment will have 40), the calorimeter of 25 PbWO4 crystals in use now, a **muon ID** downstream the calorimeter, consisting essentially of a tracking station equipped with 2S modules.
  MUonE plans to interleave 8 (12) 2S modules between the magnets of the final part of the beam line in order to upgrade the performance of the present BMS.
  The BMS, which measures the incoming muon energy, is considered an important component of the MUonE apparatus: this information will be of crucial help in the analysis.

- Discussions are ongoing within the collaboration to investigate the possibility and the **opportunity to run in 2026**. We are also investigating the possibility to use different beam energies (i.e. between 60 and 200 GeV) to improve the control of the systematic errors.