SciFi beam detector:
Introduction/reminder of this detector for the beam time 2024

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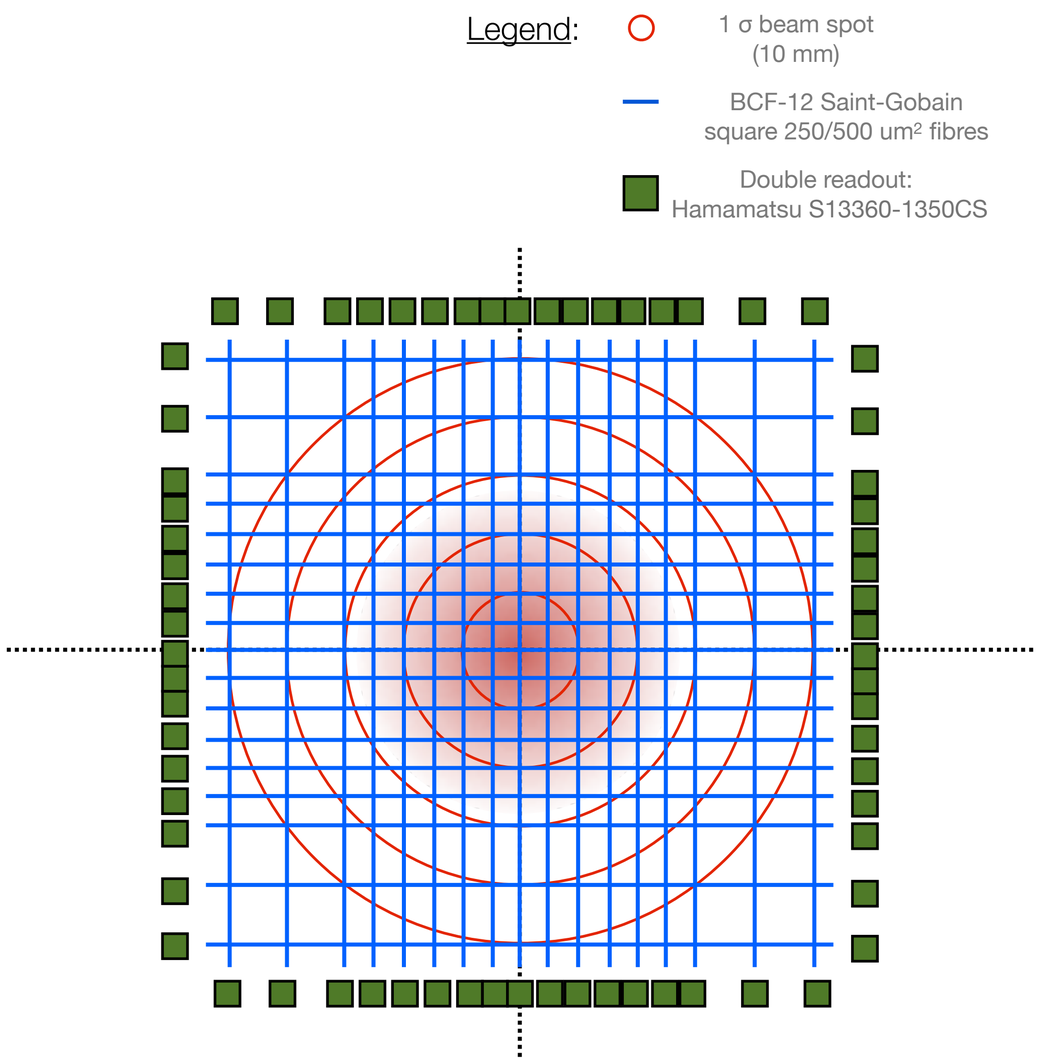
April 4-5 2024
muEDM collaboration meeting

The SciFi detector

- Characteristics:
  - quasi-non-invasive
  - high rate sustainable
  - able to work in magnetic field
  - in vacuum
  - if possible: permanently mounted along the beam line (movable to prevent radiation damage)
  - to measure: beam profile and rate even over the physics run

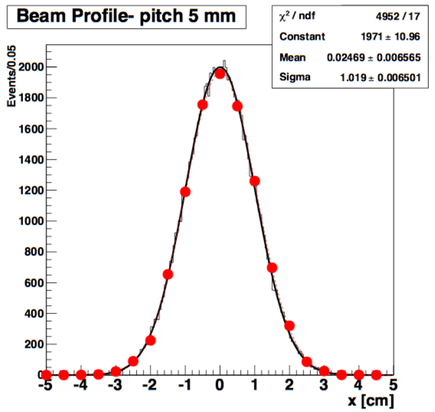


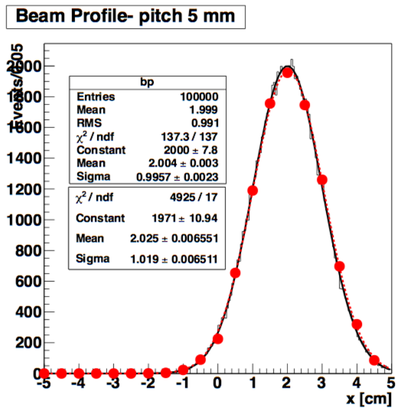
SciFi detector - MC and TOY MC for the optimal design

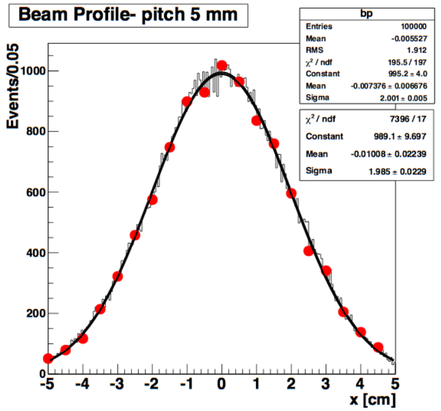
- Beam reconstruction and misalignment (MC and TOY MC)

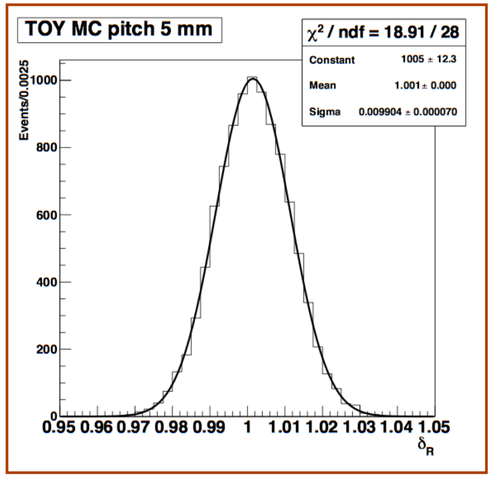
Example of TOY: $\delta_R = R_{rec}/R_{sim}$

- Studied configurations: Fibre Pitch = [2, 10] mm, Beam shifts: [1, 20] mm, Beam spot (σ) = [5, 20] mm
- Beam rate and profile: **~ 1% or better**



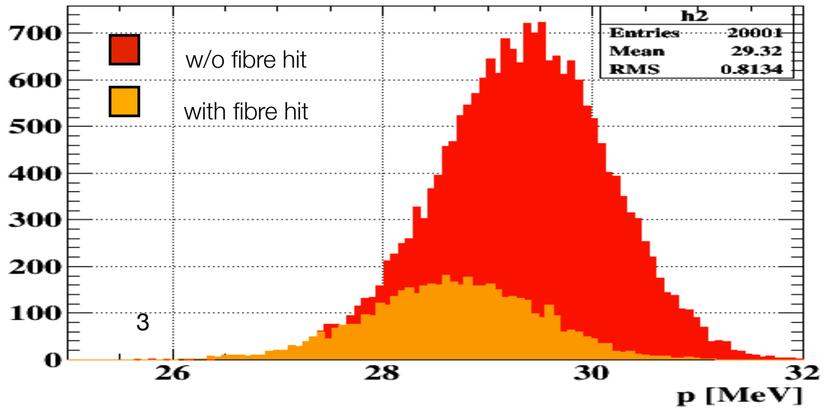






- Beam transparency and transmission

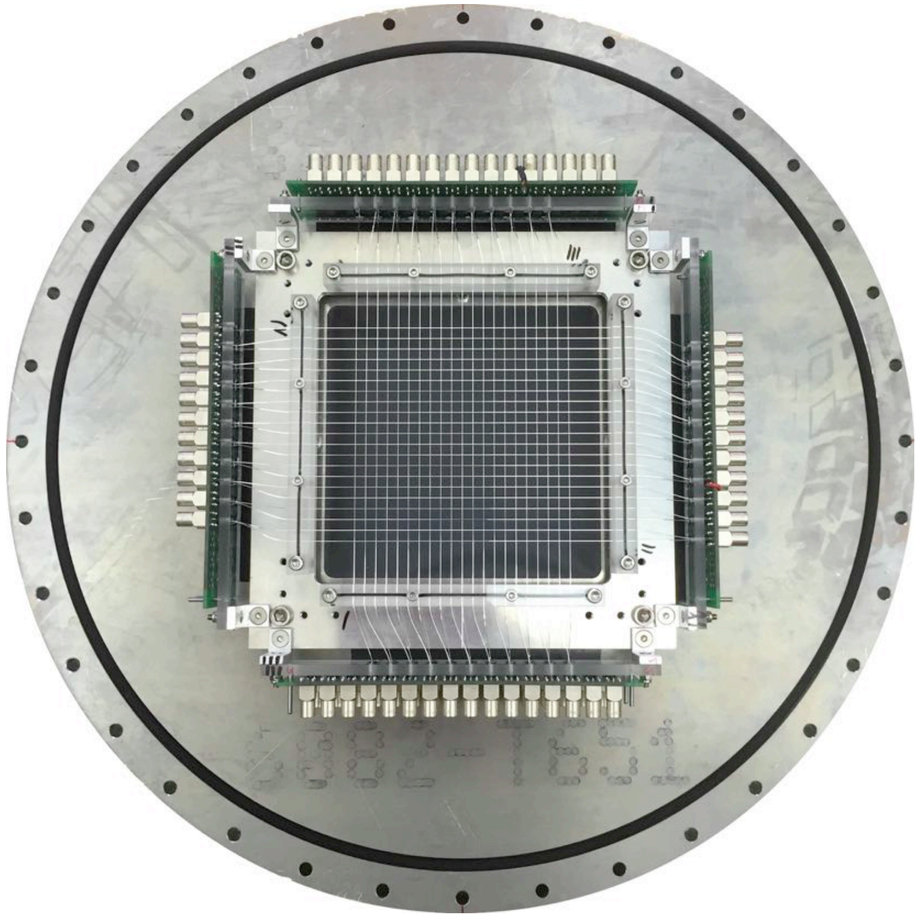
Momentum distribution ($p_{initial}$ = 29.3 MeV/c)



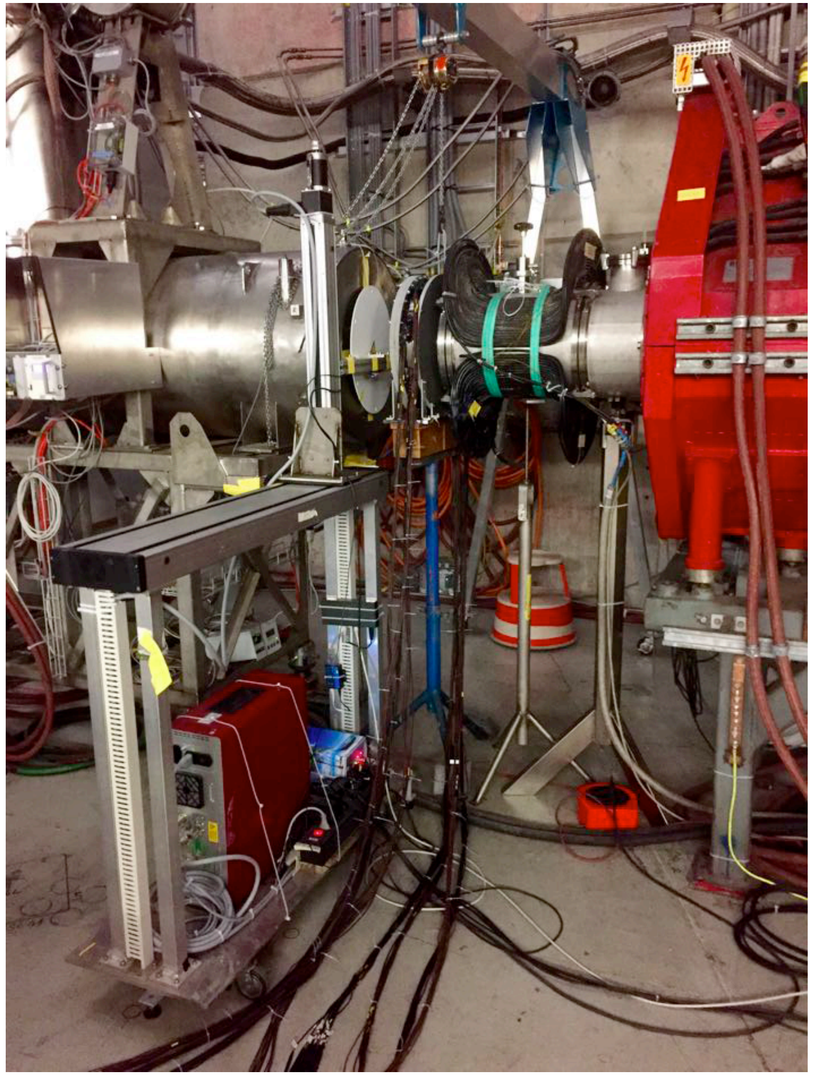
- MC inputs: pitch = 5 mm, beam spot (σ) = 15 mm, coverage: 5 σ
- Transparency: (NOT hitting fibre events)/(total events) **≥ 92 %**
- Transmission: (stopped events in the target)/(total events) **~ 100 %** [also confirmed by the measurements with the dummy US RDC]

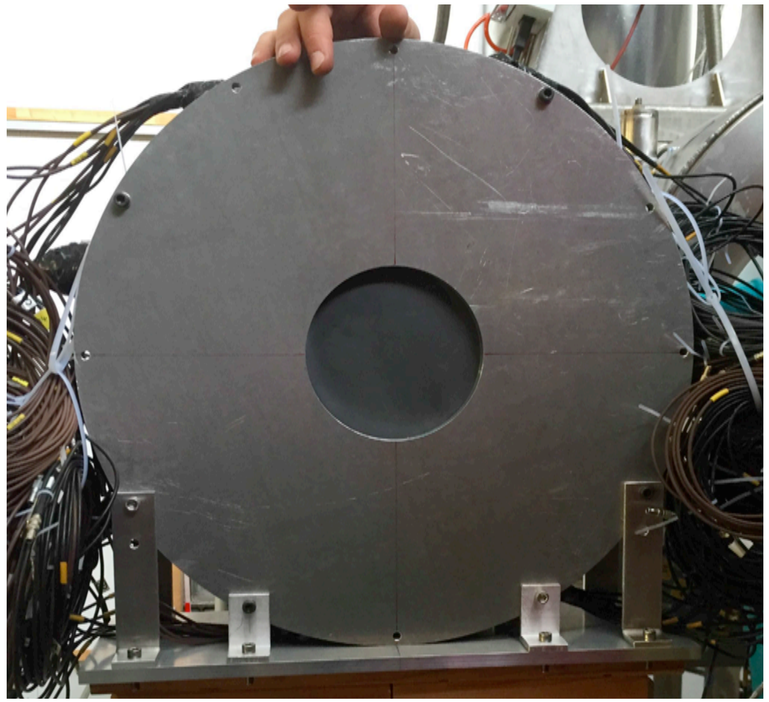
SciFi in air: The first detector

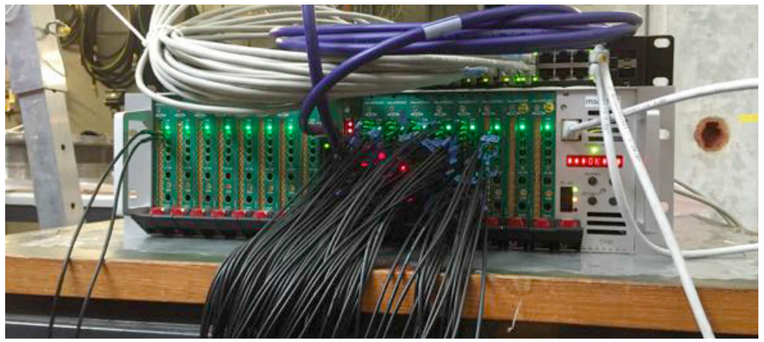
- Main features:
  - Beam profile and rate in few seconds of exposure - online monitoring. Particle ID. Not invasive. Insensitive to magnetic field.
- A fibre grid: 2 layers (X,Y)
- Fibre/layer: 21
- Fibre length (free from the frame)~ 200 mm
- Fibre pitch (from center to center, to be cross-checked): 5 mm
- Total number of channels (double readout): 84
- Fibres: Saint Gobain Double cladding square 500 um
- Photosensors: Hamamatsu MPPC S13360-1350CS
- Power: ~ 55.0 V
- Pre-amplifiers: (PSI/Wavedream) gain = 1-100
- DAQ + TRG: WaveDAQ + “OR” of all “AND” from SiPM on the same fibre
- Version: Detector in vacuum (the first detector, the so called “Prototype” was in “air”)
- Final version: in vacuum and movable



SciFi in air: The first detector at work







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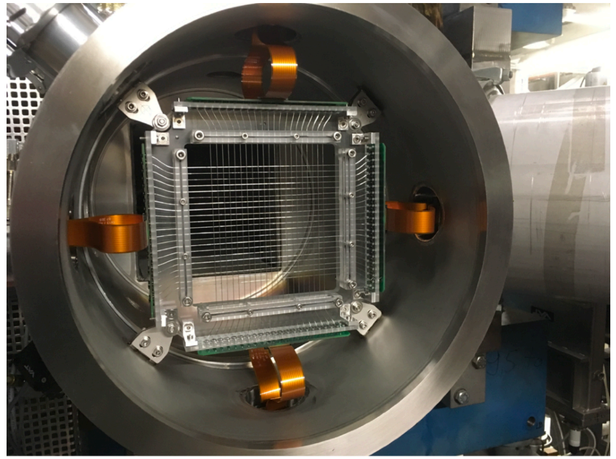

SciFi detector - at work

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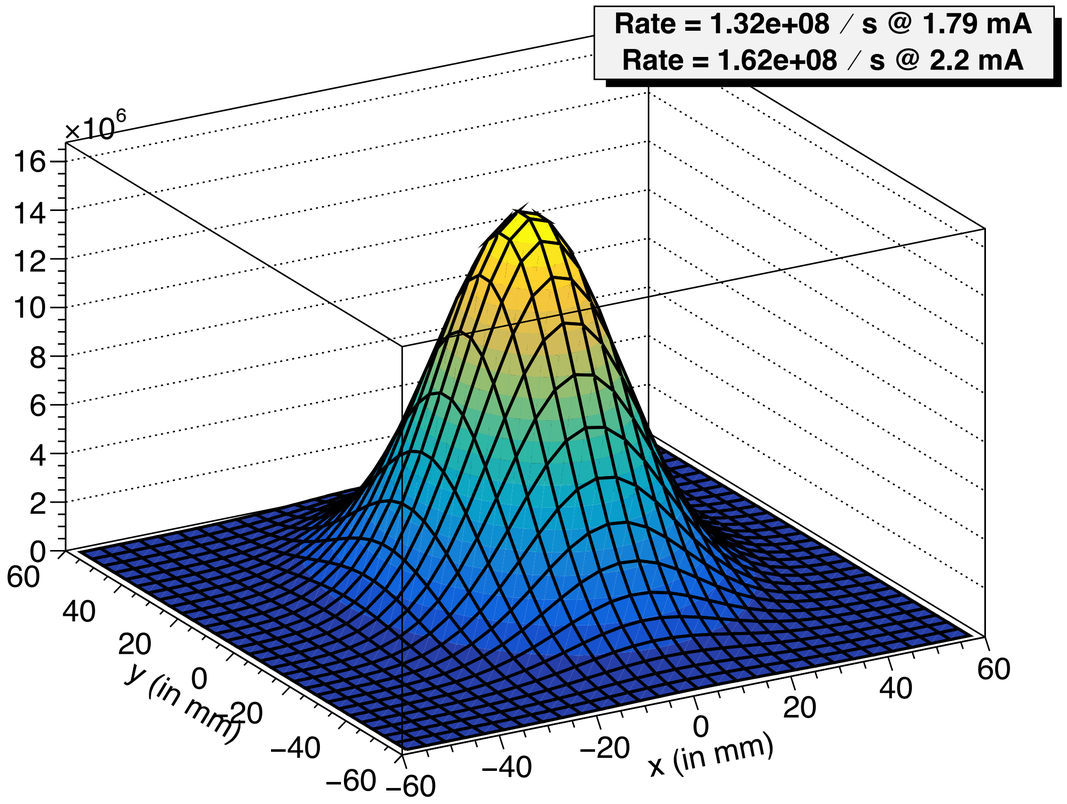
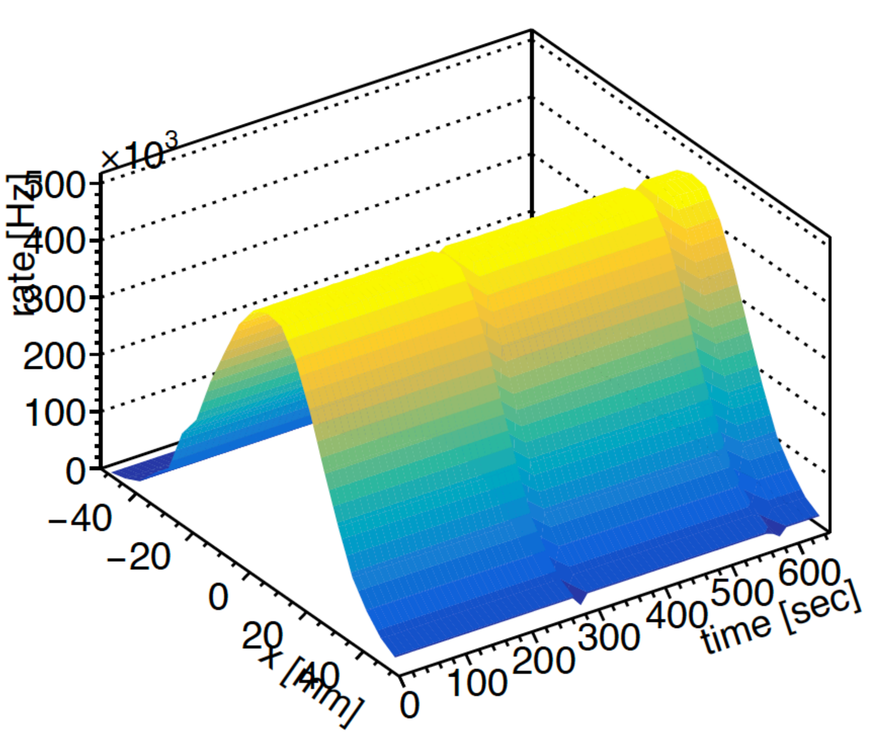
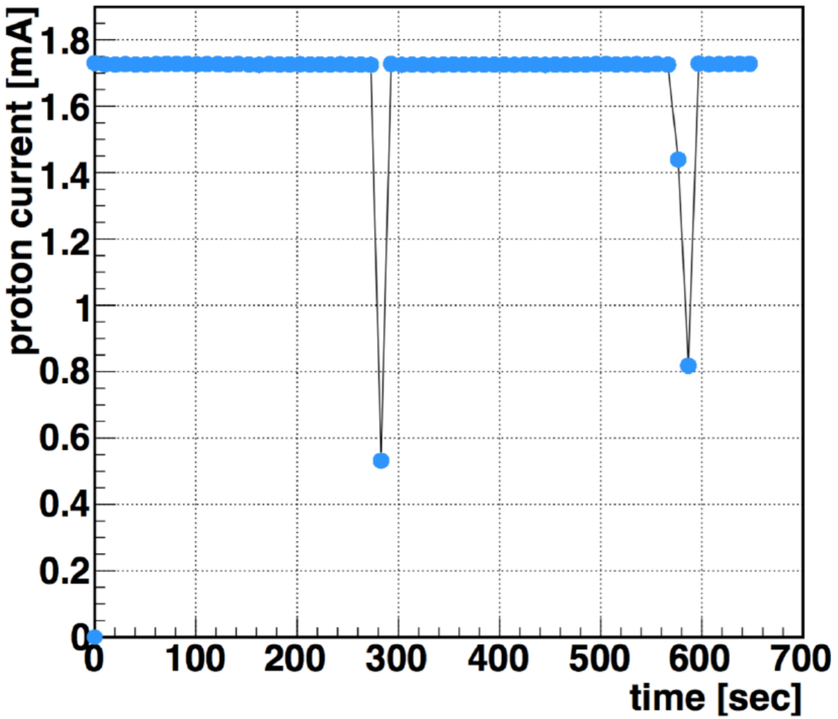


Measured beam profile and rate consistent with the default pill detector within < 5%.
Beam line: pie5; particles: 28 MeV/c positive muons

Beam profile and rate

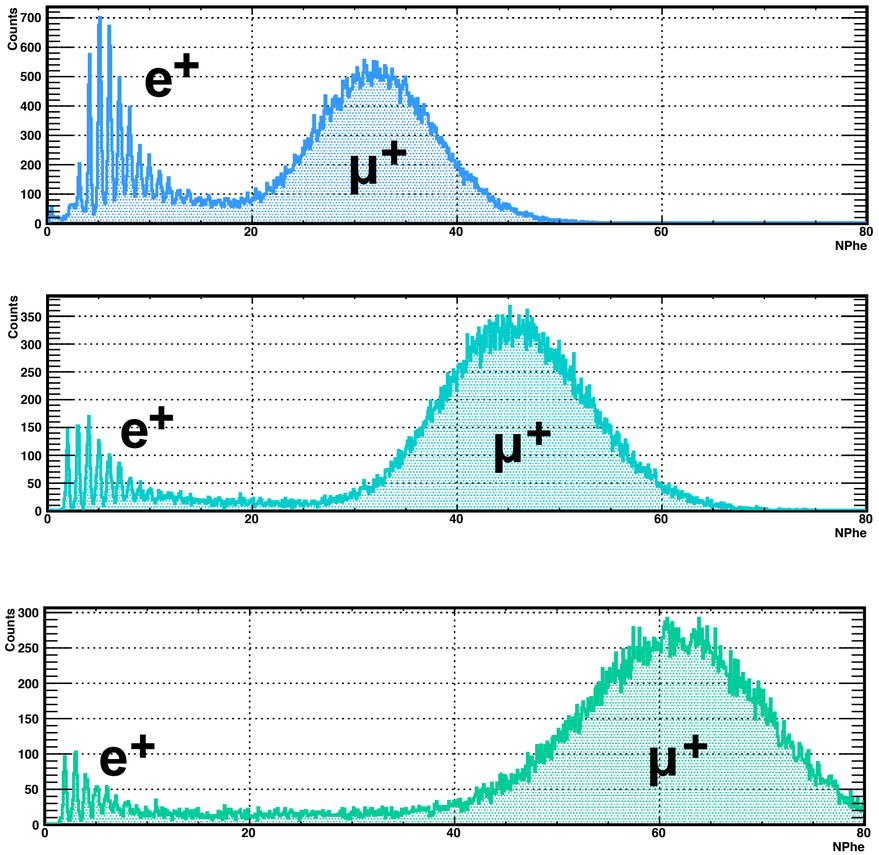
- Example of beam intensity drop as detected by the Sampling SciFi





Particle ID

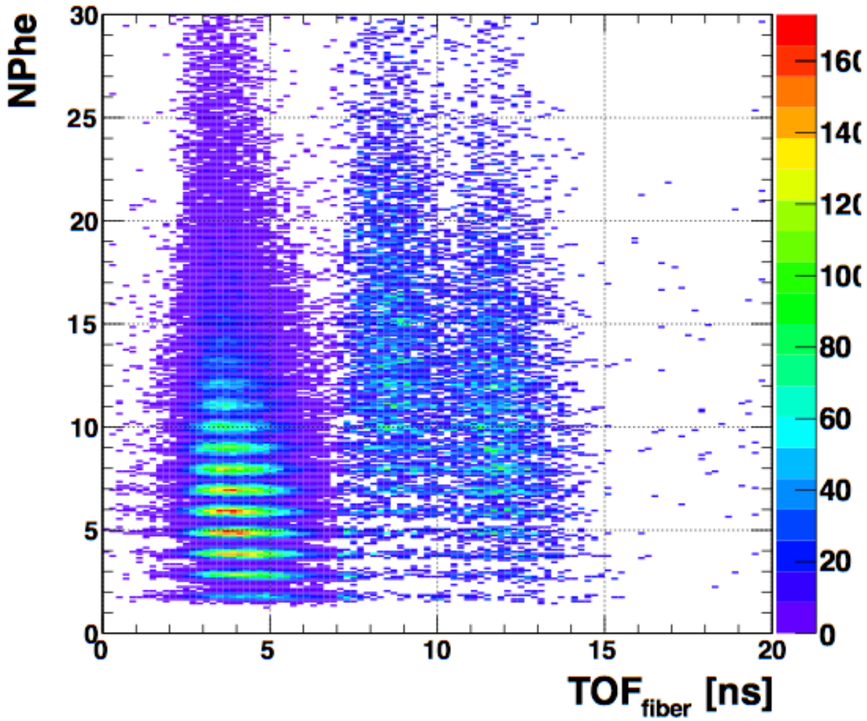
- Clear separation between minimum ionizing positrons and ``low energy” muons based only on the measured charge

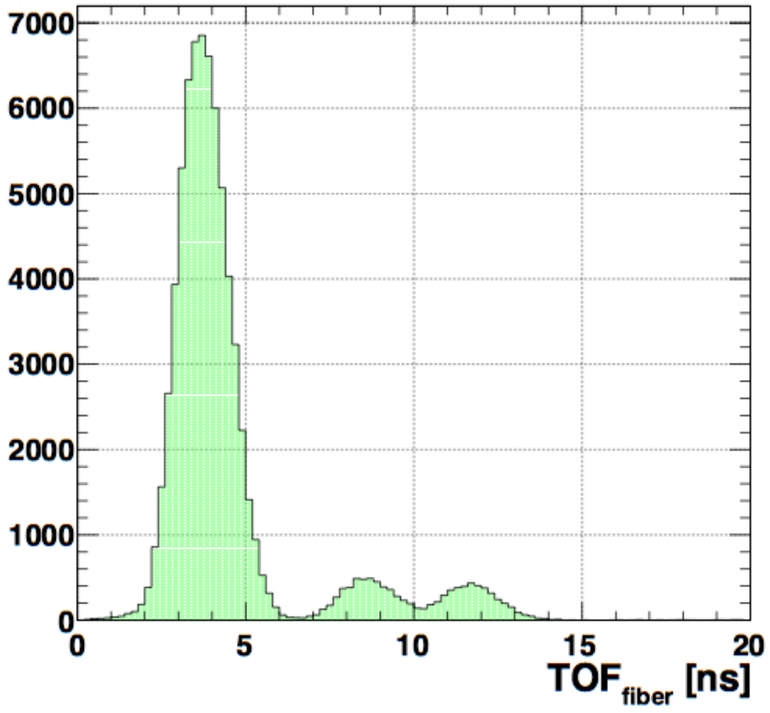


Particle ID for mip

- Minimum ionizing particle separation adding the time-of-flight measurement (w.r.t. the accelerator radio-frequency)
- p = 115 MeV/c (piM1)

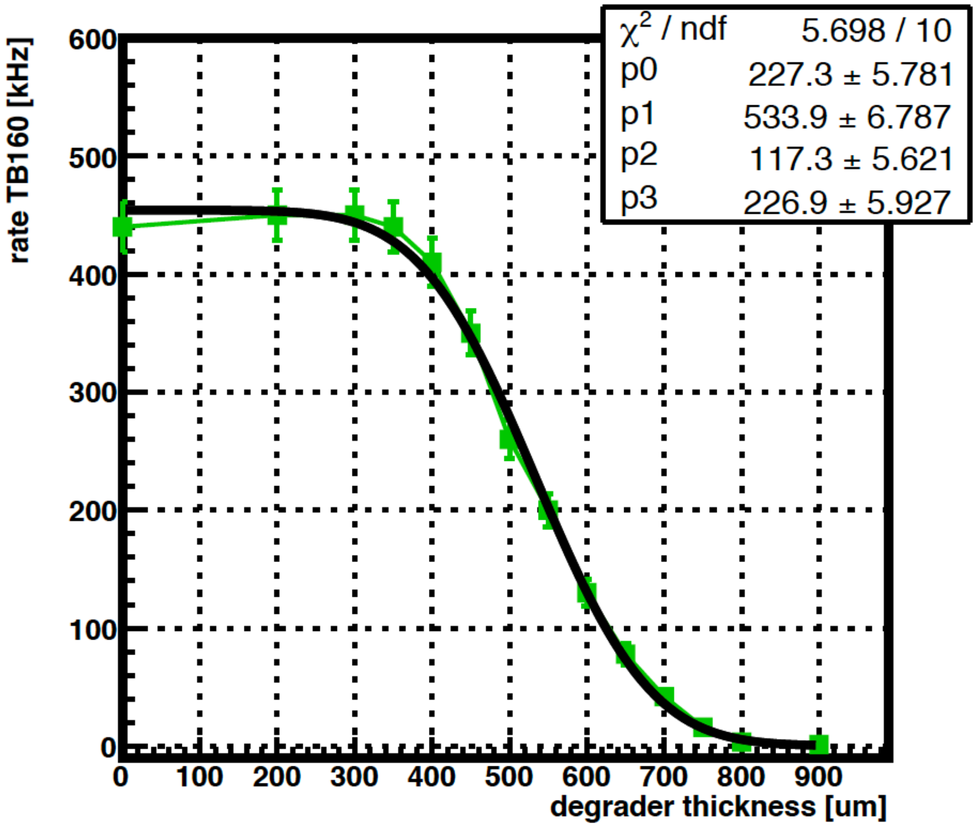
e^+ π^+ μ^+





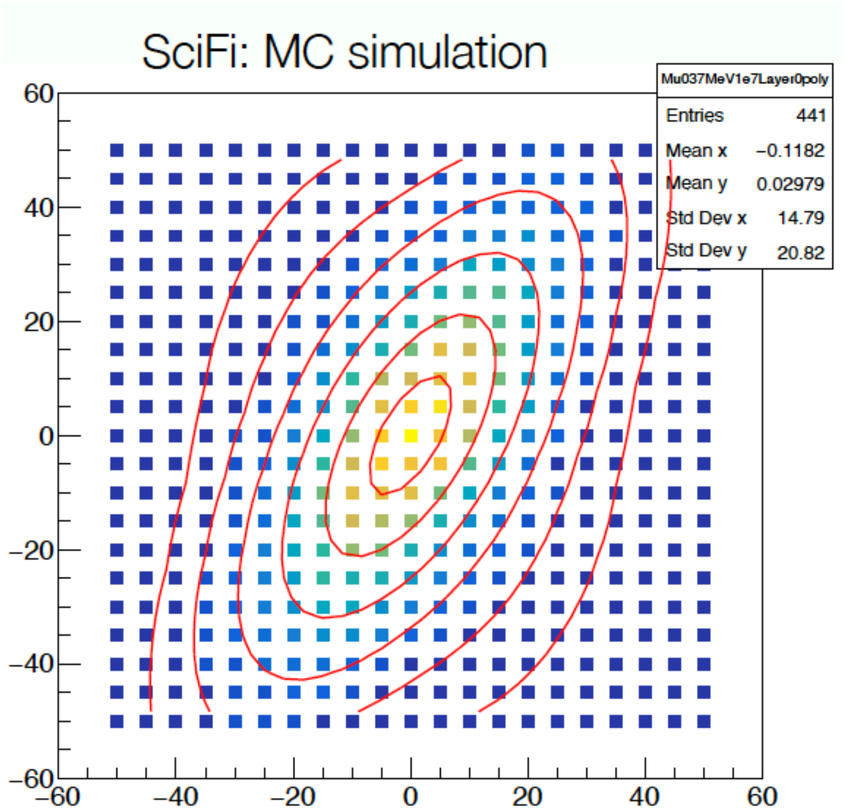
Muon range curve

- Steps: 50 um thick mylar foils, charge threshold: 1.3 Nphe
- Result: (mylar equiv.) 534 ± 7 (stat) ± 3 um (sys) [fully consistent with pill counter measurements and MC simulations]



A bit more…

- New feature: correlation parameter measurement.
  - A first test using the T(DAQ) scalers has been done and looked promising



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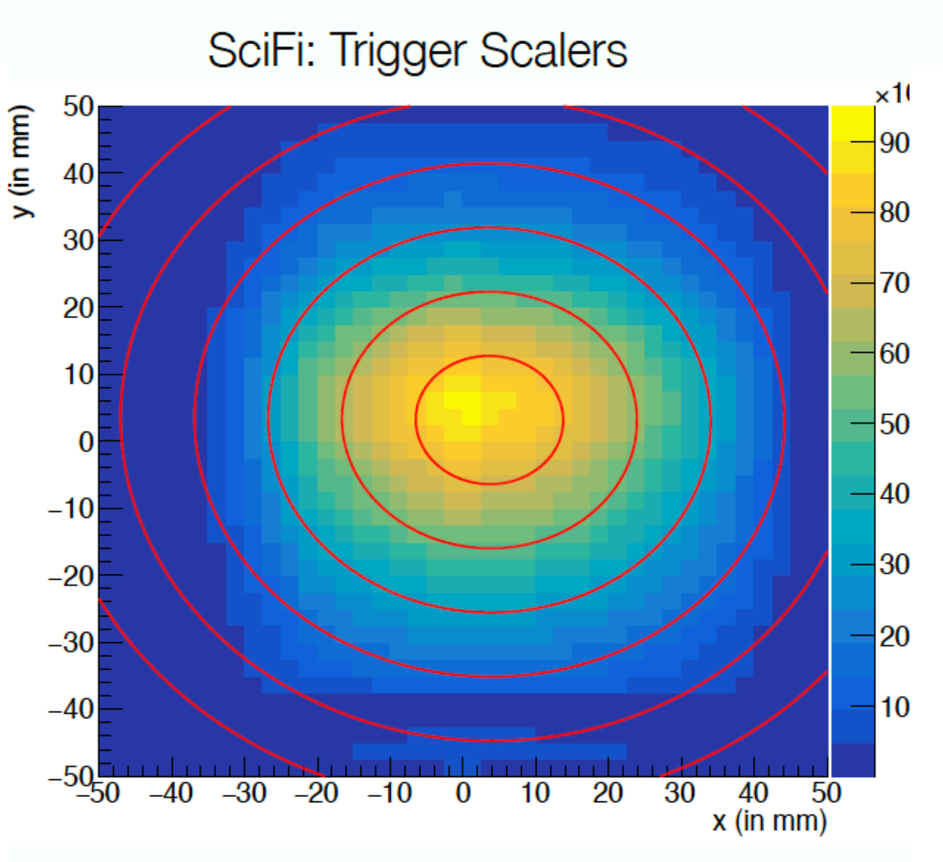

Outlook

- The detector is available for the beam time
- More (young) people will be involved to operated it