T9 Beamline Test

Preliminary Results

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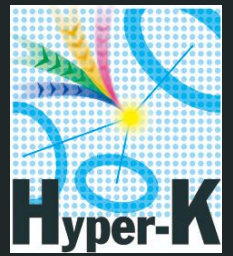
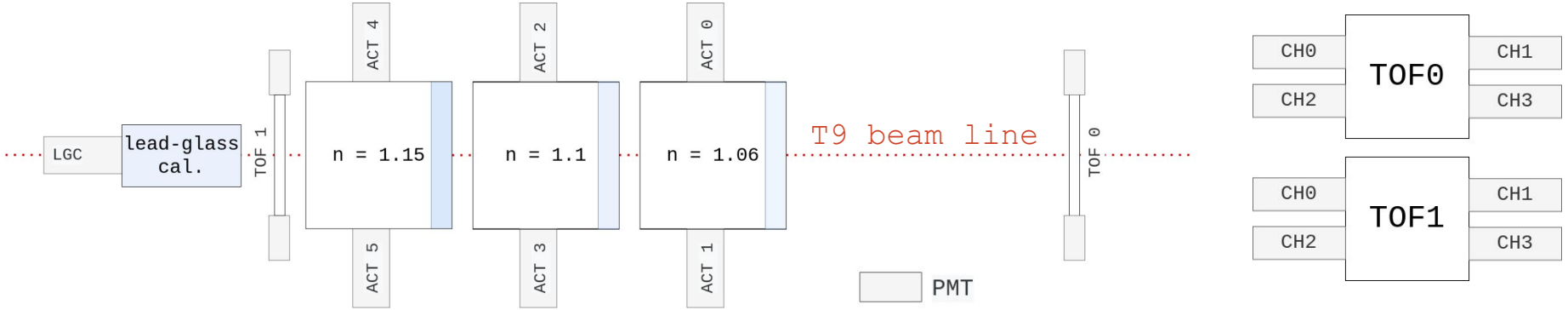
on behalf of the TB crew (Mark Hartz, Akira Konaka, Antonin Lindner, Sahar Taghayor)

July 21st, 2022



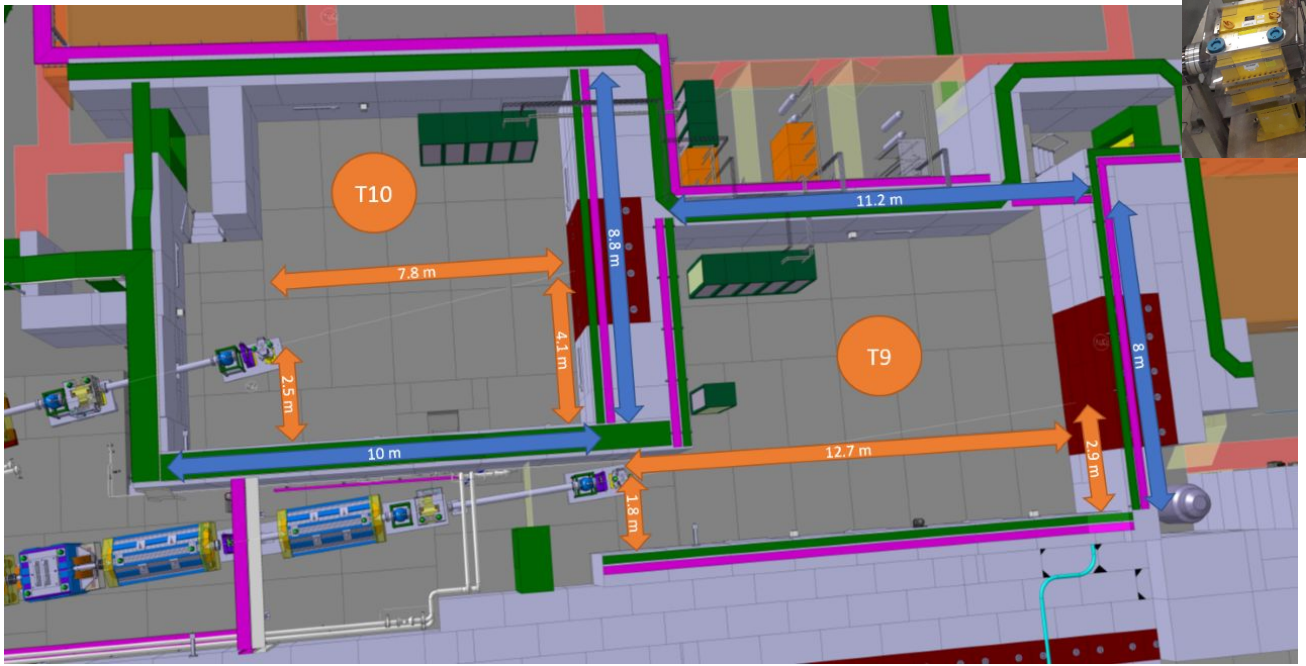
Motivation

- Using the T9 secondary beam for WCTE without a tertiary beamline will significantly reduce the cost and simplify the mechanical design
- Main goals
  - Measure particle rates at very low momenta (200 MeV/c - 500 MeV/c)
  - Identify challenges for WCTE

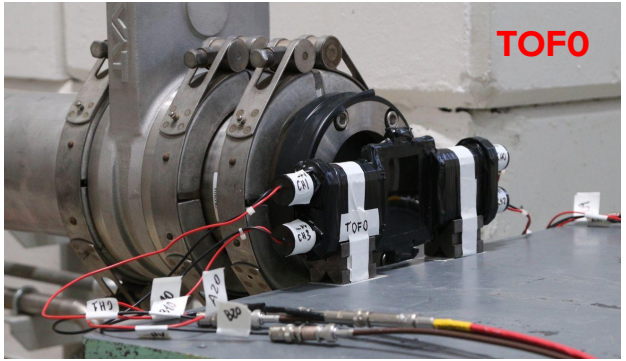


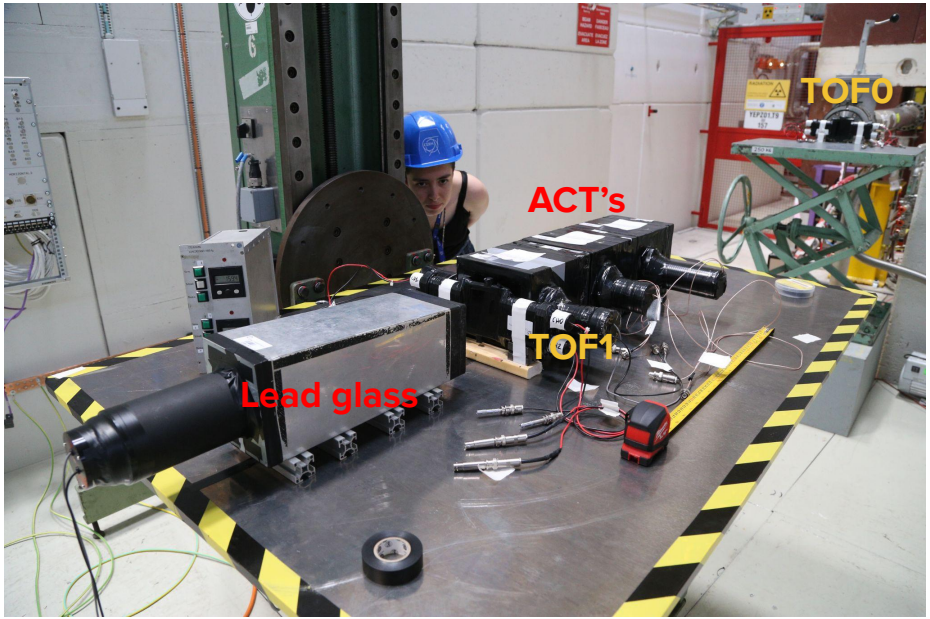
- TOF: scintillator time of flight. ACT: Aerogel-Cherenkov Threshold box.

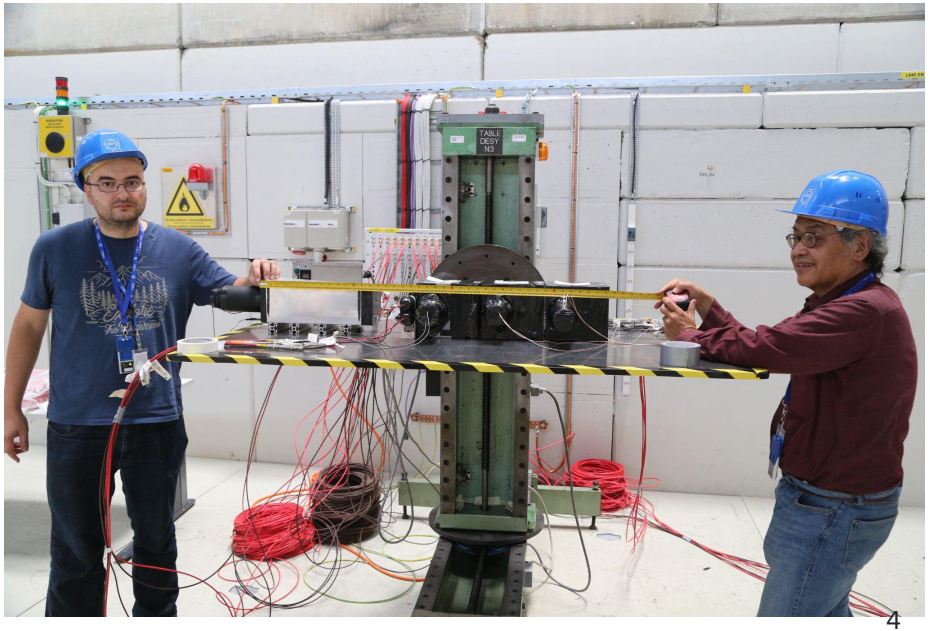
T9 Beam Line



Experimental Setup

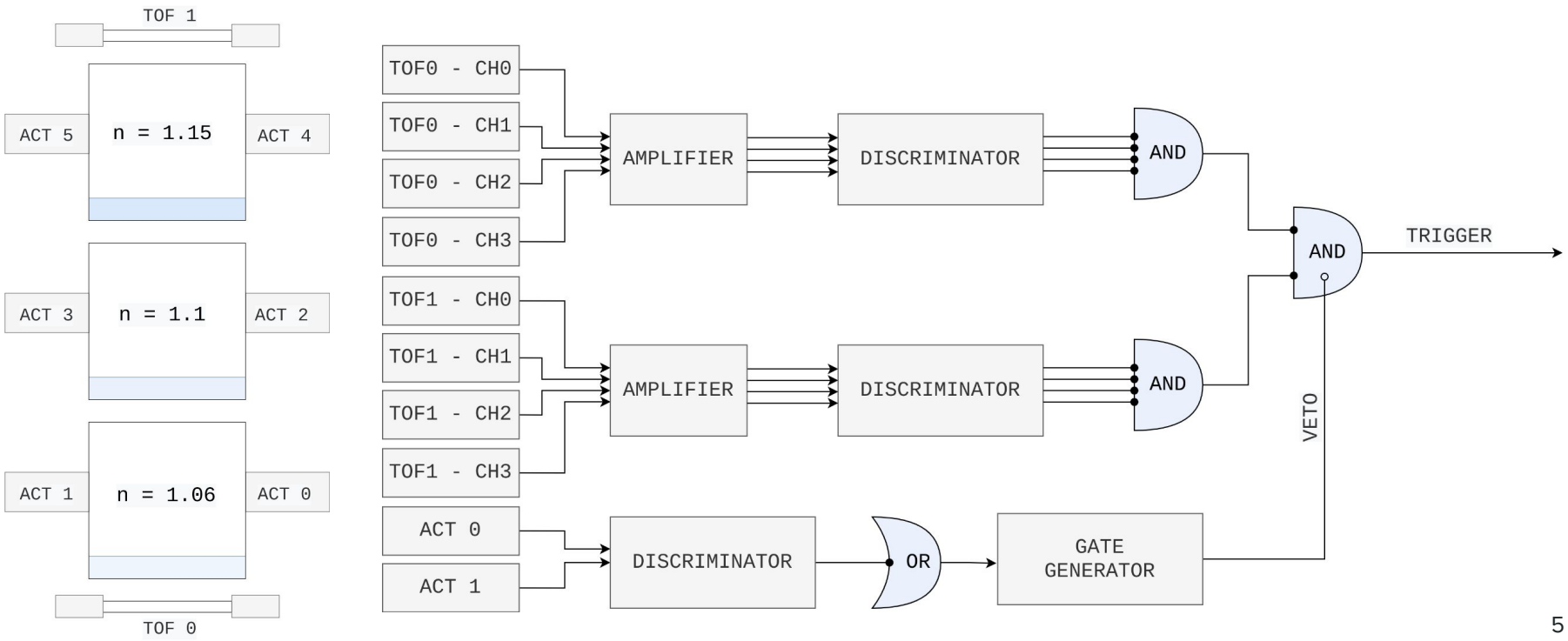






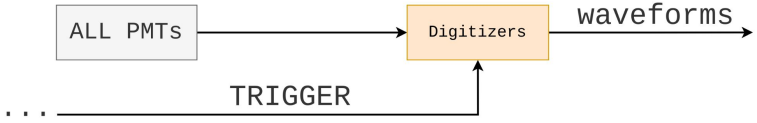
Trigger

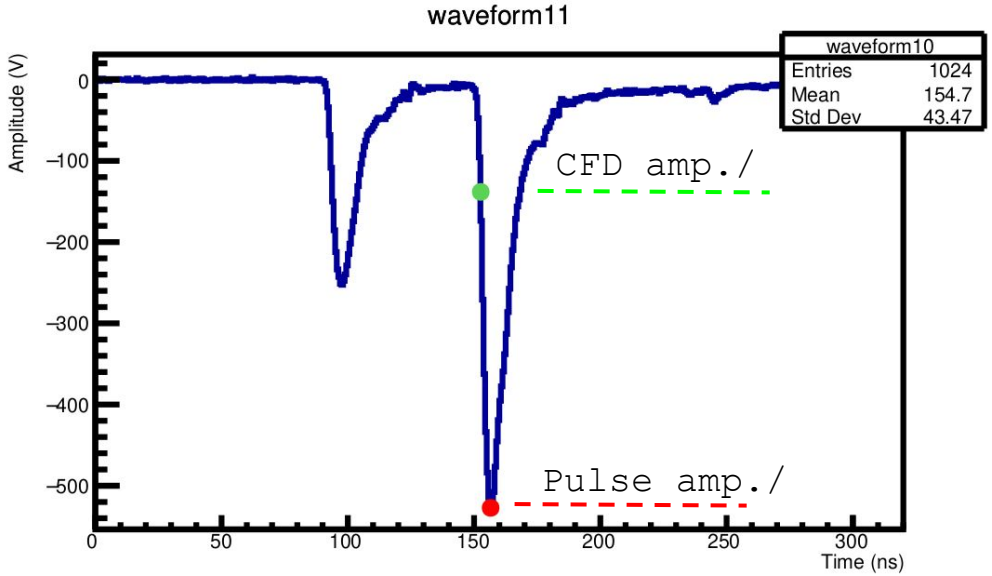
- Trigger starts as a coincidence between TOF0 and TOF1.
- An electron veto (ACT 0+1) is used to stop saturation of digitizer buffer.



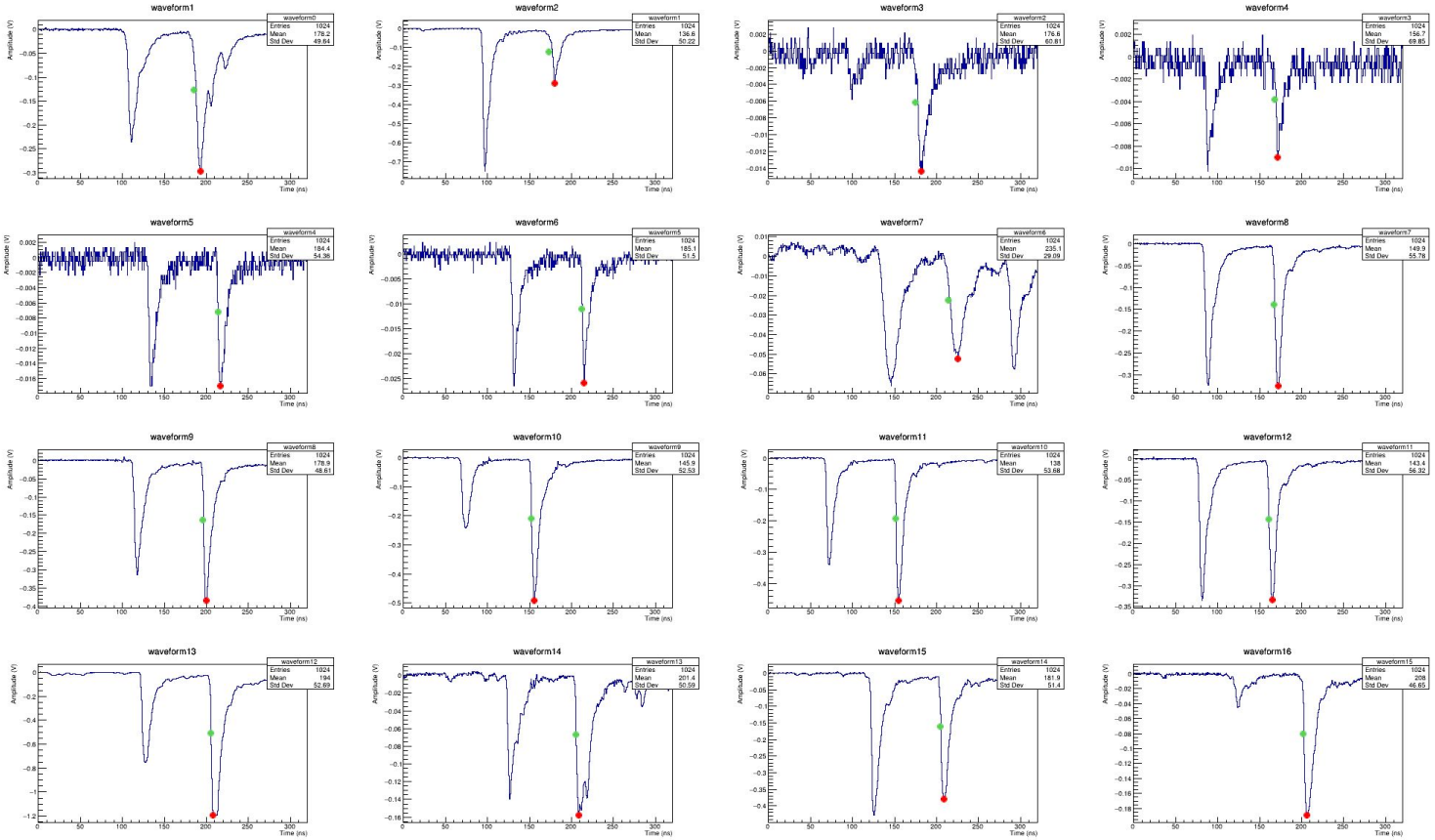
Pulse information

- Pulse information is acquired both online and offline.
- Amplitude, charge and pulse timing for pulses within a given time window.
- Constant-fraction discriminator (CFD) to determine time.
  - Timing at a percentage of rise time (10% to 90% of amplitude).

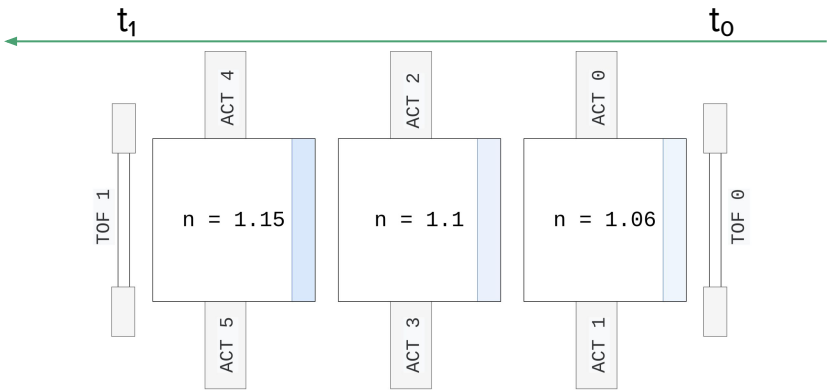




Pulse information



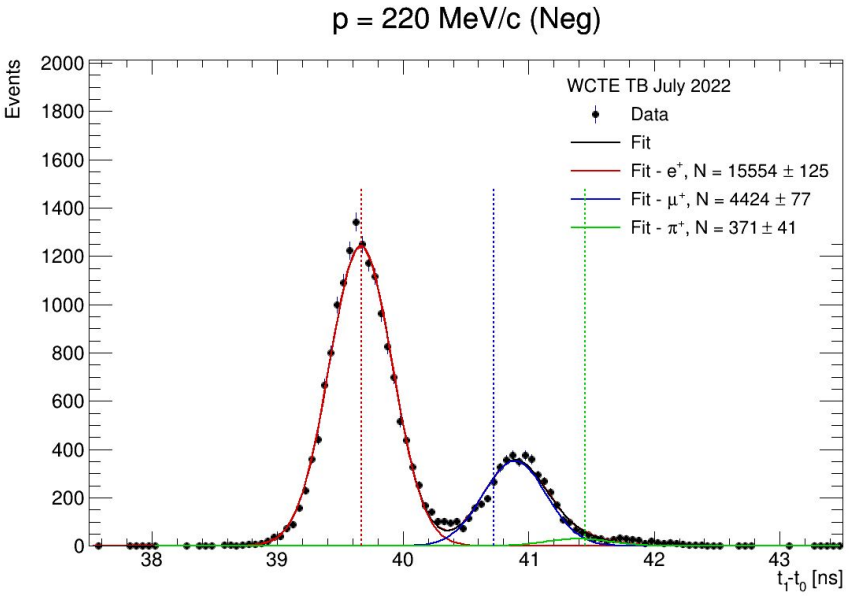
Event selection

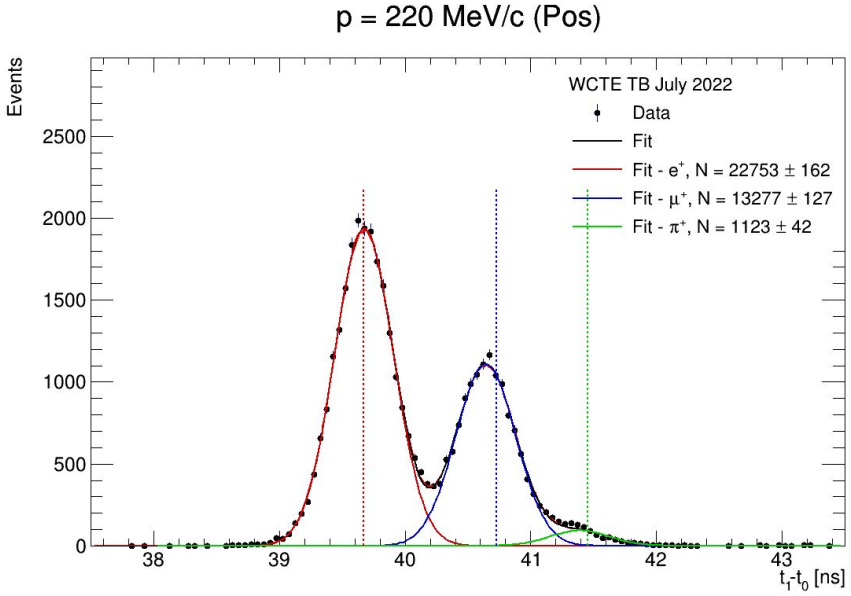


- Events are matching between the 2 digitizers.
- Require TOF amplitudes not to saturate the digitizers, then TOF = t_1 - t_0.:
  - t_0 is average time of 4 `TOF0` PMTs; t_1 is average time of 4 `TOF1` PMTs
- Cut on the sum of amplitudes of the ACT pairs:
  - `ACT0+ACT1` < 10 mV;
  - `ACT2+ACT3` < 12 mV;
  - `ACT4+ACT5` < 20 mV.

Results – Example TOF distributions

- Theoretical vertical lines for the μ and π TOF shifts after the fitted e peak.
- TOF peak positions: a possible beam bias between Pos and Neg momenta?

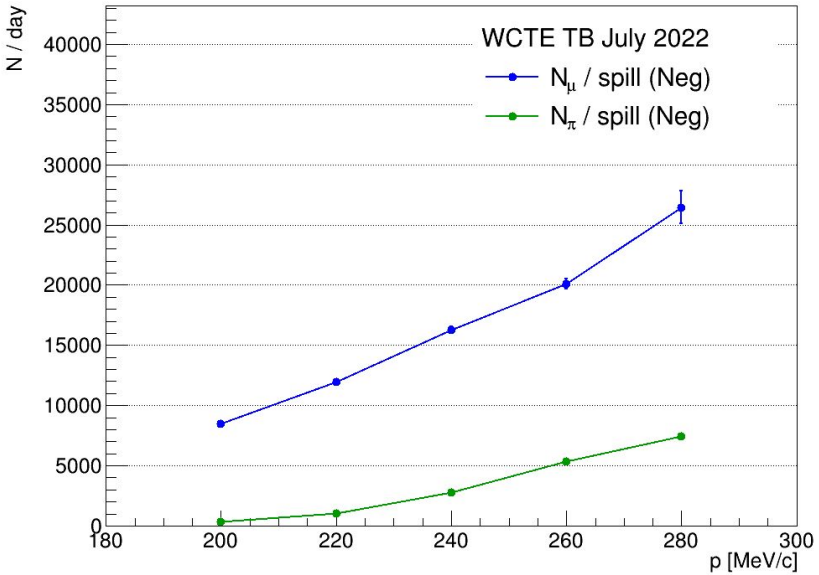




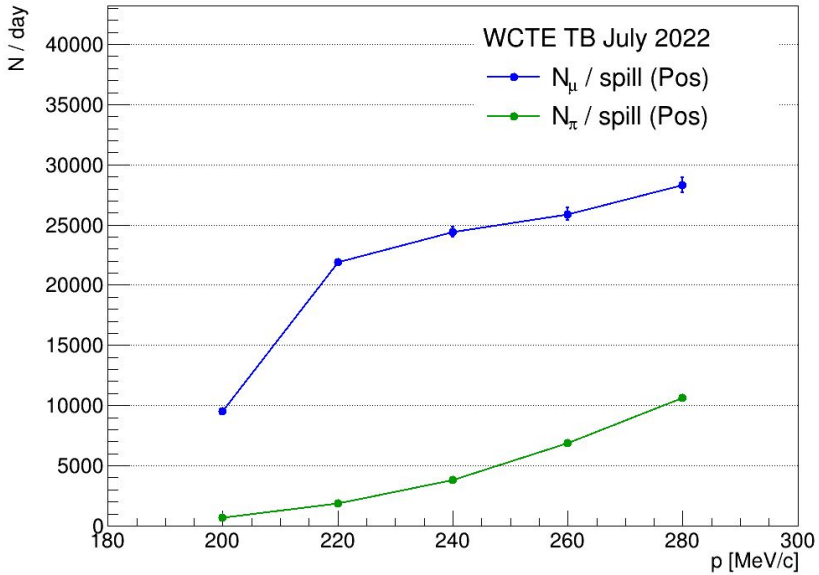
Results – observed **μ** and **π** yields per day.

- Assuming 40s between spills (conservative assumption, typically the rate is 2x).
- @200MeV Neg: 400 π^- / day :: @220MeV Neg: 1000 π^- / day.
- @200MeV Pos: 700 π^+ / day :: @220MeV Pos: 1800 π^+ / day.

Negatively charged particles

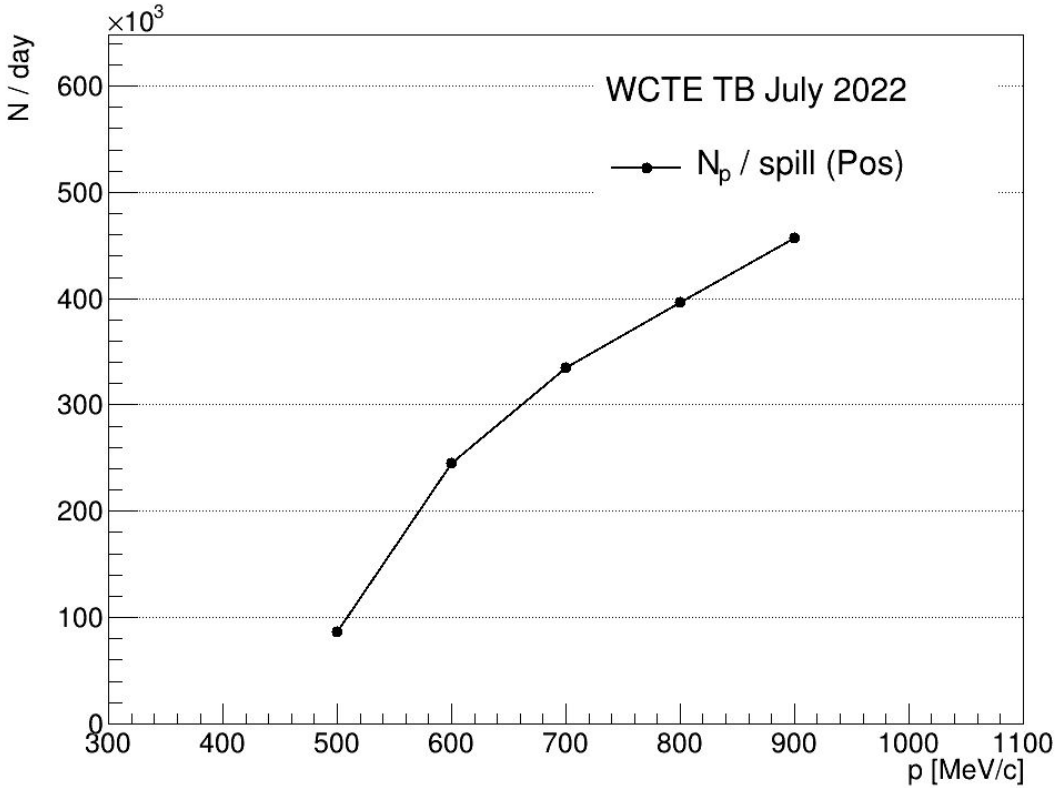


Positively charged particles



Results – observed **proton** yields per day.

- Assuming 40s between spills (conservative assumption, typically the rate is 2x).

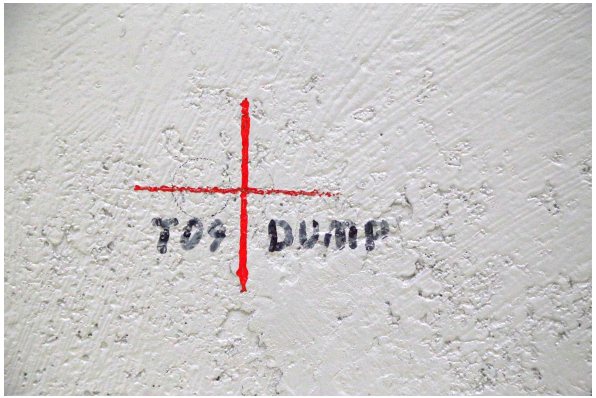


Challenges to be addressed

- Electron veto efficiency
  - We need very high efficiency (99.9%) and low material budget ➔ electron TOF distribution overlaps with muon distribution ➔ muon purity is a concern
- TOF resolution
  - We need ~100 ps resolution and low material budget
  - New TOF prototype with SiPMs and fast scintillator is underway.
- Beam protons
  - Even in low momentum configuration, we don’t see any protons below 500 Mev/c
- Momentum bias
  - We noticed momentum bias in TOF distributions for positive and negative beam
  - Understanding the beamline will be of crucial importance for WCTE

Conclusions

- Preliminary: able to separate muons for pions for the range of 220-280 MeV/c.
- Toward feasibility of identifying muons and pions for low-energy beam using scintillator-based TOF and aerogel-cherenkov boxes.
- Challenges identified and to be addressed by WCTE.



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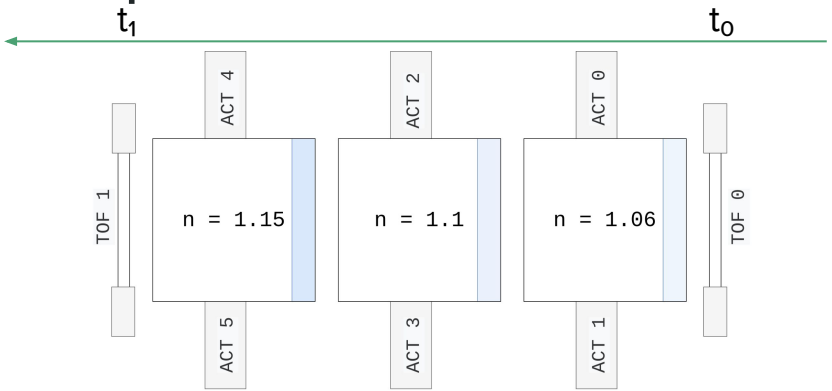

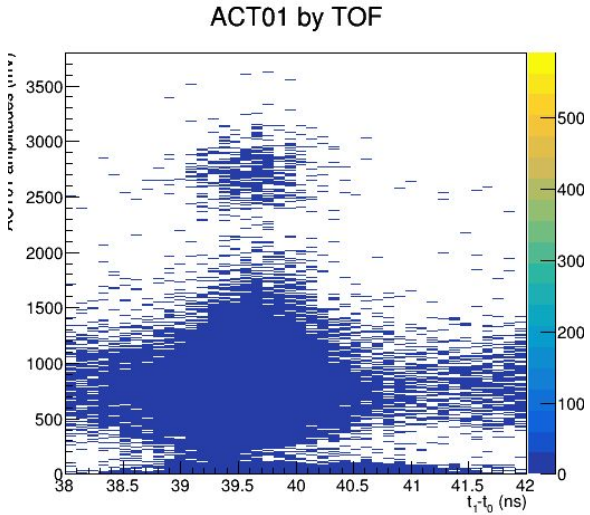

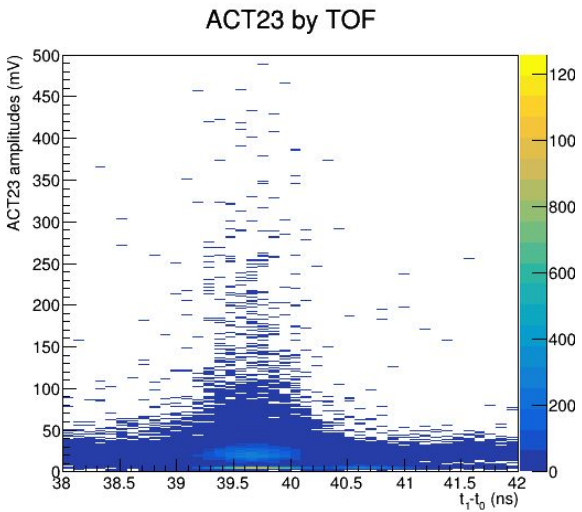

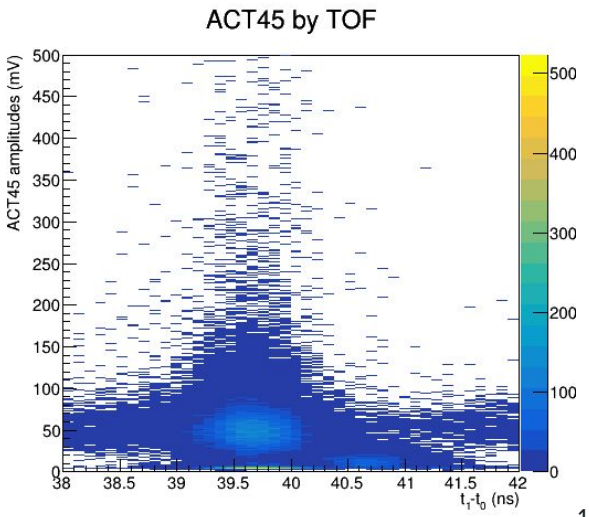

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