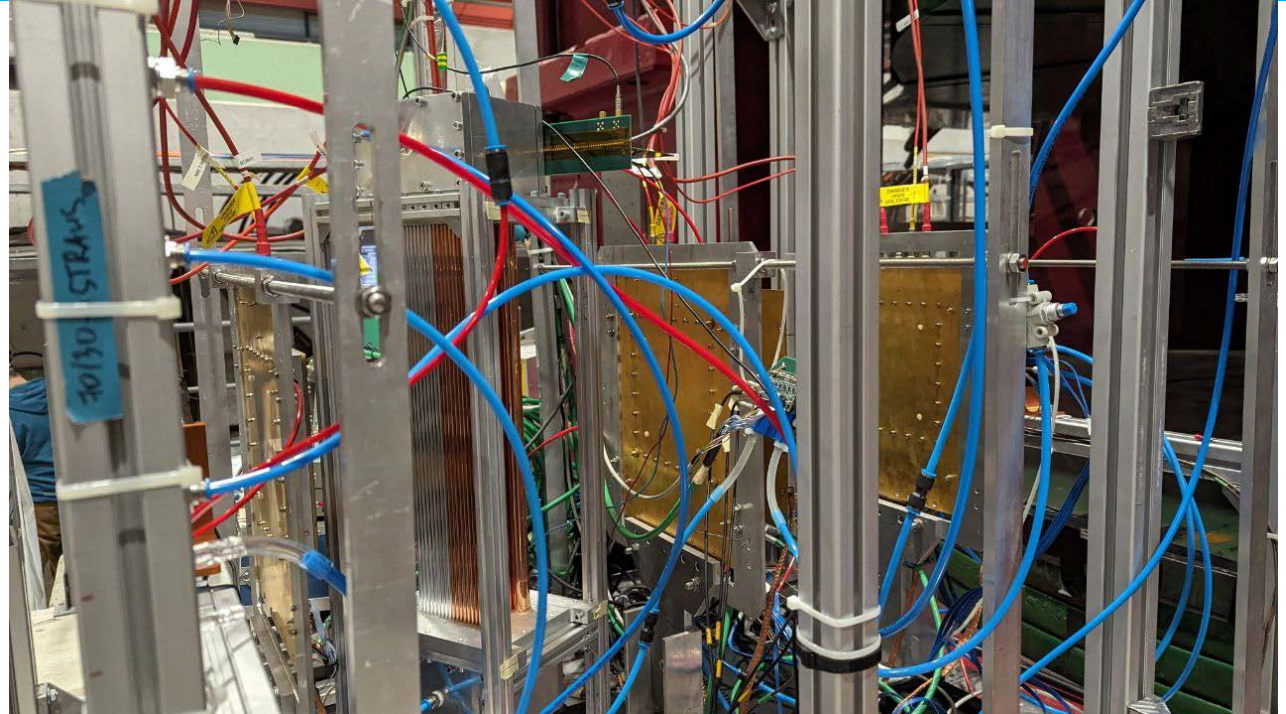


DRD1 program of the StrawTrackerRD setup



Yerzhan Mukhamejanov
on behalf of the StrawTrackerRD team

Motivation

- Tracking and PID performance of straw trackers operated with different readout options
- Measurements with existing ASICs (VMM3, Tiger)
- Validation of Garfield++/LTSpice simulation
- Input for future ASIC developments
- Timing (SPS H4 and H8 dump) and charge (PS) measurements
- The program is well adjusted with WP3-F

Readout under the test

VMM3

- ▶ widely used as readout of micro-pattern gas detectors
- ▶ was a base for the production VMM3a version for the ATLAS New Small Wheel readout
- ▶ flexible settings of analogue input circuitry
- ▶ time measurements (nominally 8-bit TDC)
 - ▶ time-at-threshold (T@T)
 - ▶ time-at-peak (T@P)

TIGER

- ▶ is used in BES-III GEM readout
- ▶ optimised architecture with two different shapers and thresholds for time and energy measurements
- ▶ precise 10-bit fine timing resolution
- ▶ charge measurement:
 - ▶ integration
 - ▶ time-over-threshold mode

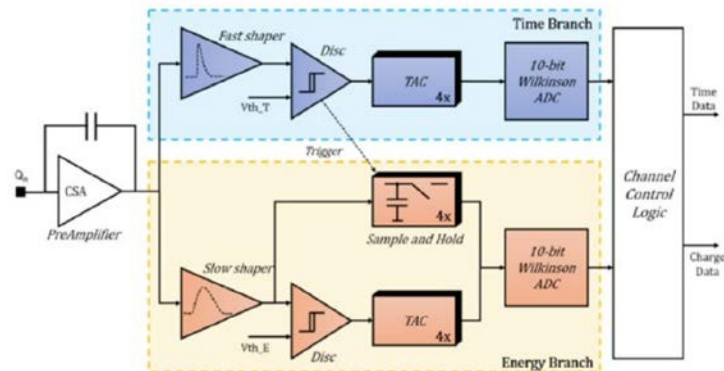
	VMM3	TIGER
Number of channels	64	64
Clock frequency	10...80 MHz	160...200 MHz
Input capacitance	<300 pF	<100 pF
Dynamic range	Linearity within $\pm 2\%$ up to 2 pC	50 fC
Gain	0.5, 1, 3, 6, 9, 12, 16 mV/fC	12 mV/fC
ENC (energy branch)	<3000	<1500
TDC binning	~ 1 ns	50 ps
Maximum event rate	140 kHz/ch	60 kHz/ch
Consumption	15 mW/ch	12 mW/ch

Peaking time

25...200ns

60/170ns

TIGER Architecture



Straws under the test

Straw arrays

First straw setup at PS
(with a custom readout)

Next steps
Tracker prototypes

Straw Prototype

Straw and wire diameters:

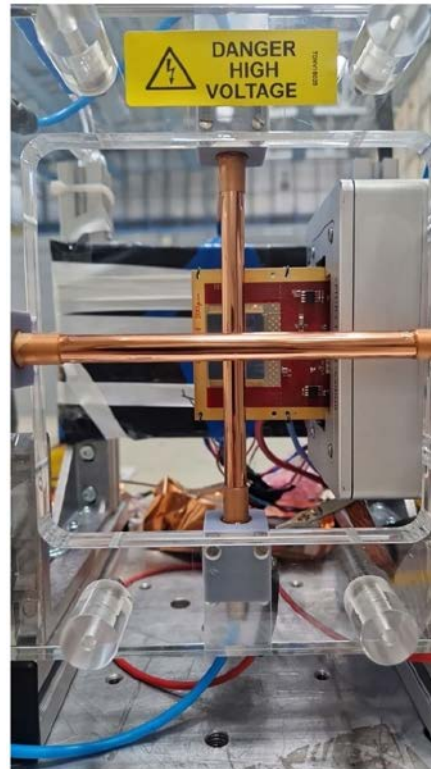
20mm/30 μ m: *SHiP* type

10mm/30 μ m: *NA62/SPD* type

5mm/20 μ m:

NA62 upgrade (Cu/Au coating)

DUNE (Al metallization)



First DUNE prototype

H4 Setup

Measurements at H4:

- tracking performance
- charge with muons
- combined prototype + straw array from July TB

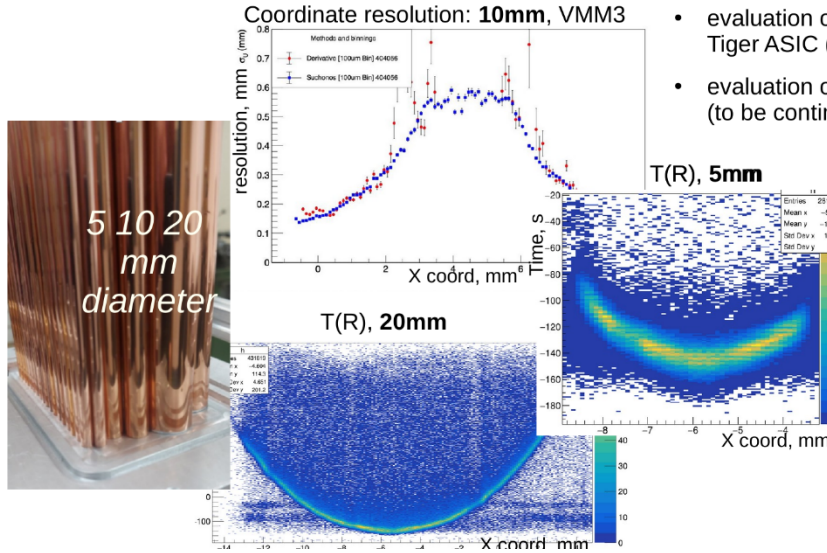
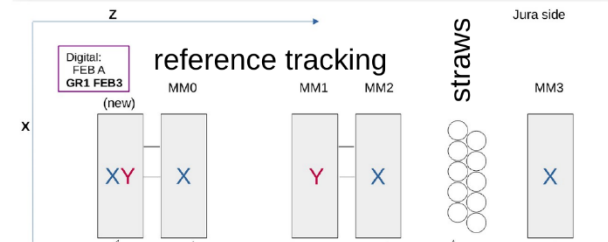
Goals for July TB:

- improve reference tracking (together with Torino)
- measurements with improved prototype and/or array of straws
- measurements with optimized noise level
- overpressure test?

For autumn TB:

- test with Goliath

The setup:



Reference tracking:

- MM detectors (250 um, 400 um) + Tiger readout (Torino University)

Under test: a combined straw tracker prototype + two types of readout: Tiger and VMM3

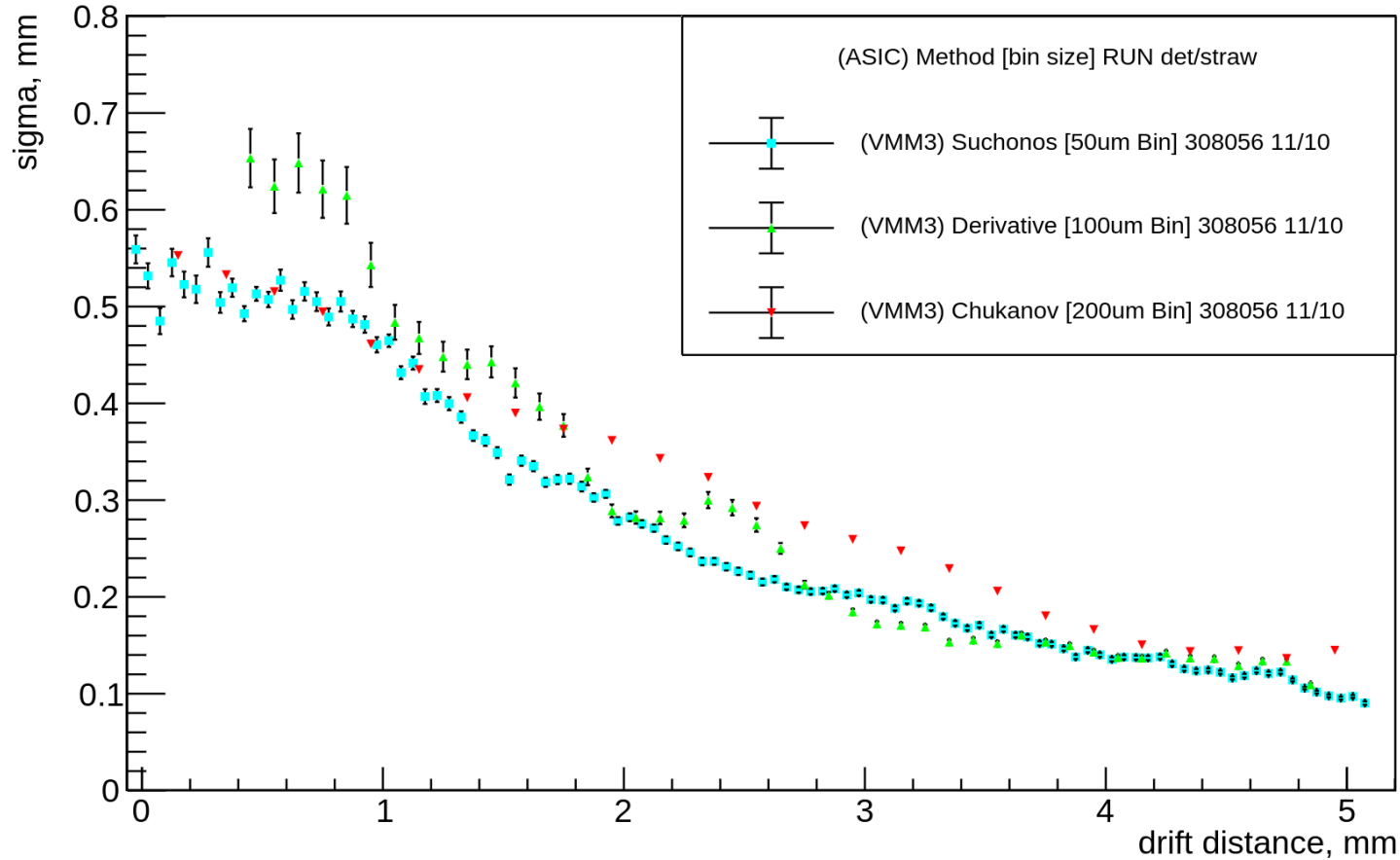
Goals:

- evaluation of the realistic noise prediction and thresholds settings for the developing ASICs (Dune, DRD1-WP3)
- evaluation requirements for SHiP STT readout
- evaluation of TimeOverThreshold mode capability for straw readout with Tiger ASIC (to be continued at H8)
- evaluation of the charge measurement requirements for future PID options (to be continued at PS T9)

- ✓ Improved reference tracking resolution
- ✓ TIGER readout for high charge/high rate under study
- ✓ Upgraded TIGER FEB and cooling design
- ✓ Efficient data taking at H4, studies to be continued at H8
- ✓ Offline analysis started

2023 Test Beam Results

Spatial Resolution: Methods comparison



- data analysis is improving
- ongoing:
 - accounting for the finite reference tracker resolution
 - comparison to Garfield++/LTSpice simulation

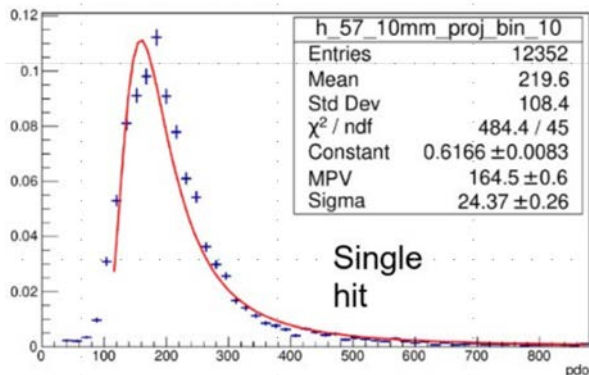
PS Program

The resolution of the ionizing energy loss (charge) measurements is important for PID. Only very limited studies can be done with SPS muon beam.

Straw SPS setup – charge measurements for muons:

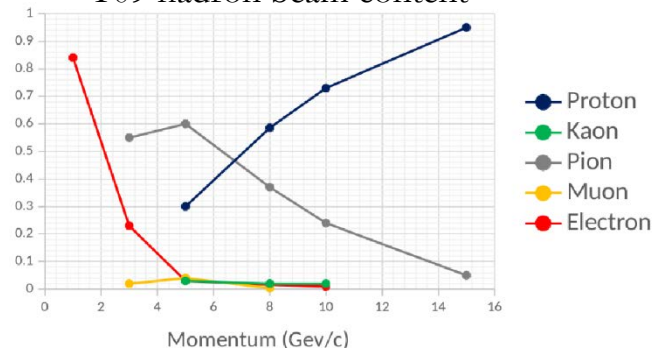
MIP with VMM3 (not calibrated response)

TB-2023-August-H4-57: 10mm straw #9 energy, 1.0mm from wire

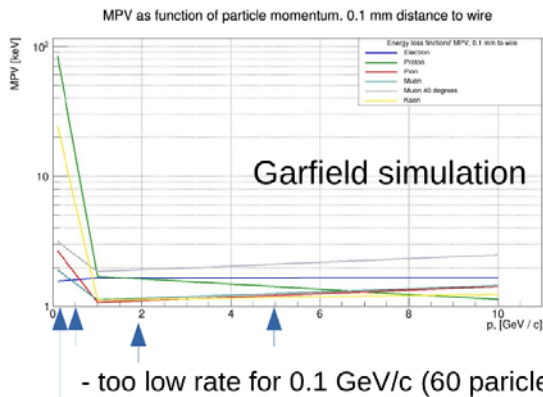


For dedicated charge measurements 2 TB slots at PS T09 have been booked. One week in May was used for preliminary measurements to prepare for final measurements in October.

T09 hadron beam content



Goal: to understand PS T09 beam conditions for October measurements



@ T09:
pi+mu+e
(<5 GeV)

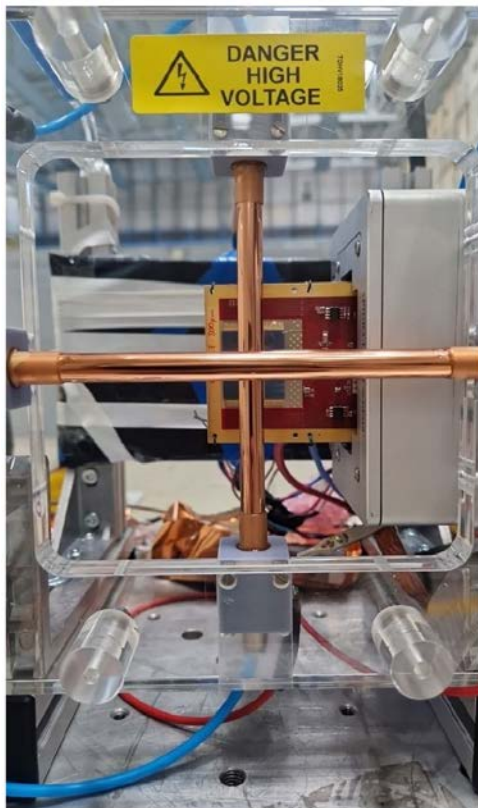
Electrons are tagged
with the Cherenkov detector
15 mV threshold

- too low rate for 0.1 GeV/c (60 particles/spill),
- ok with 0.3 and 0.5 GeV/c – but seems not the best region for us
- 1-2 GeV seems promising for charge resolution measurements
- for lower momenta – offline analysis of the collected data started

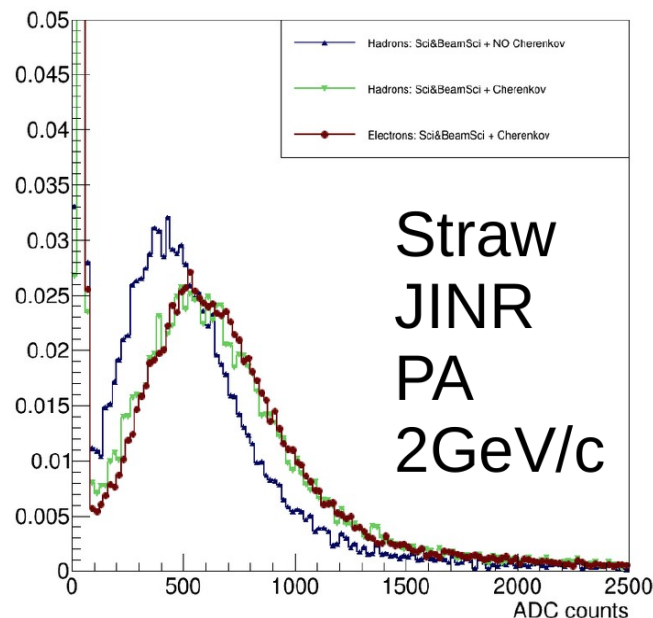
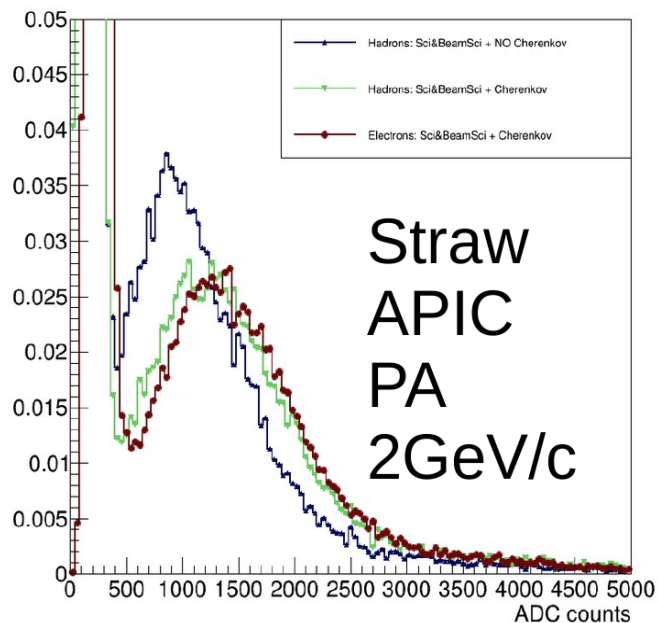
PS Program

Straw PS setup 1

Straw arrays
(with a custom readout)



- Two straws read out with two custom PA
 - APIC (RD51) $\sim 400\text{ns}$ peaking time
 - JINR $\sim 1\mu\text{s}$ peaking time
- Timepix detector
- Scintillator



Straw: careful analysis + comparison with simulation is needed

Conclusions:

Work ongoing on:

- Spatial resolution - measurements at H4 within DRD1;
 - Improvement of the reference tracking (together with Torino team);
 - Understanding and improving noise level;
 - Improved prototype/straw array;
- Charge measurements - standalone datataking at PS T09;
- Preparation for TB datataking/development/calibration (together with Torino team) – H8 beam dump;