TB 2022 first preliminary results

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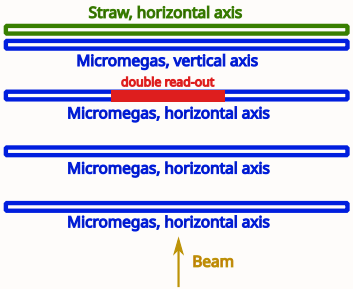
Reminder: setup

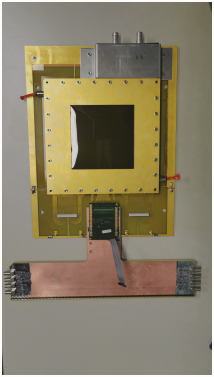


Setup

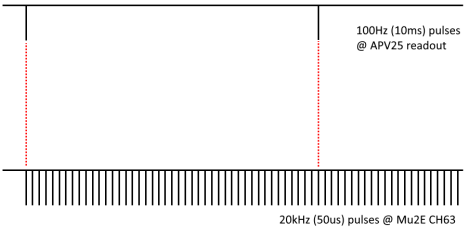
- Readout 1:
  - Straw with VMM3-based Mu2E
  - DAQ: VERSO
- Readout 2:
  - MicroMegas with APV
  - DAQ: MMDAQ3
- Cross-board: MM Layer 2 passed to both, Mu2E and APV readout.

Problem

The main problem: no built-in method for synchronization between readouts



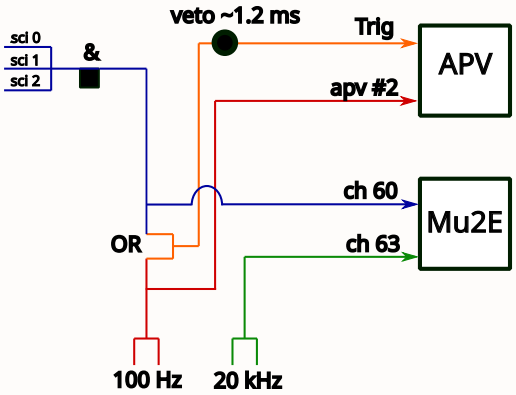
Reminder: synchronization method



Synchronization method

- Using two-channel pulser generator
- Sending two signals with different frequences and constant ratio between them.
- For Mu2E:
  - Fine timing based on 12-bit BCID count (each BCID – 25 ns, full cycle – 102 μs)
  - Pulser frequence selected to have two pulser signal in one cycle – 20 kHz
  - Estimated pulser period in 25ns counter: 2000 counts
- For APV:
  - We have trigger veto $\sim$ 1.2 ms
  - Pulser frequence selected to be 200 times lower then for Mu2e – 100 Hz
  - Estimated pulser period in 25ns counter: 400000 counts

Reminder: signal scheme



Signal scheme description

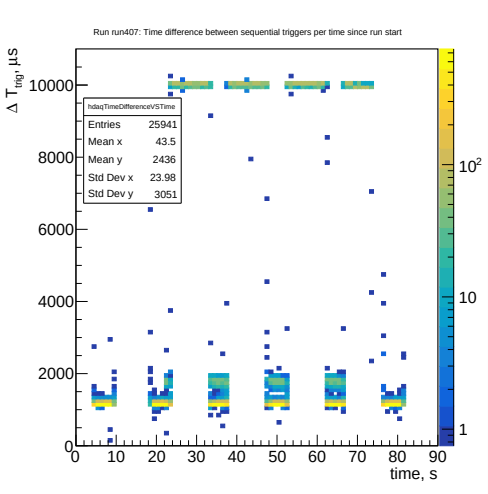
- Mu2E:
  - Triple scintillator coinsidence passed to channel 60
  - 20 *kHz* pulser signal passed to channel 63
- APV:
  - *OR* of the:
    - Triple scintillator coinsidence
    - 100 *Hz* pulser signal

    passed as a APV trigger with veto $\sim$ 1.2 *ms*
  - 100 *Hz* pulser signal passed to the APV #2 (used only for pulser signal)

Reminder: APV: distribution of ΔT_{trig} in a run

Run scheme

- The SyperCycle length: 28.8 s, two spills per SC.
- We have good pulser signals during time between spill, but have no signals inside spill due to veto
- But we can use the "srsTimeStamp" variable, which increases per $\sim$ 25 ns, in 0.4 s time window.
- That should be enough for synchronization inside spill



Time calculation

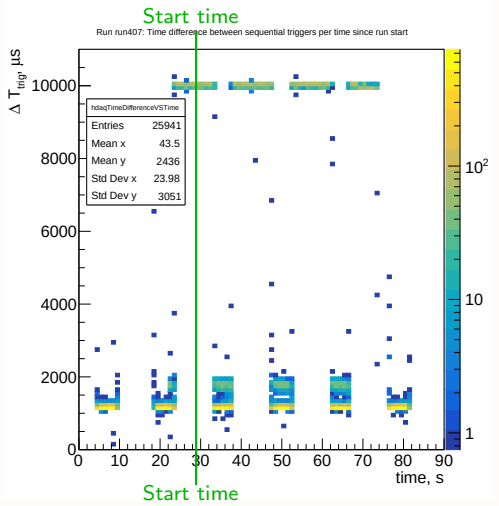
Time difference calculation

- Types of time variables in Mu2E:
  - DAQ time (μs)
  - BCID (GrayDecoded) – per 25ns
  - tdo – addition to BCID
- Types of time variables in APV:
  - DAQ time (μs)
  - srsTimeStamp – per $\sim$ 25ns
- Time difference between pulser signals can be calculated as:
  - DAQ time difference
  - Number of pulser periods · pulser frequency

Calculated run time from start up to the last pulser signal

- DAQ time difference in Mu2E: 44531.3 *ms*
- DAQ time difference in APV: 44522.6 *ms*
- Time difference from pulser counts in Mu2E: 44527.7 *ms*
- Time difference from pulser counts in APV: 44520.0 *ms*

Difference within APV pulser cycle



Comparison between DAQ time and pulser time

Comparison between DAQ time and pulser counts

Compared two time differences:

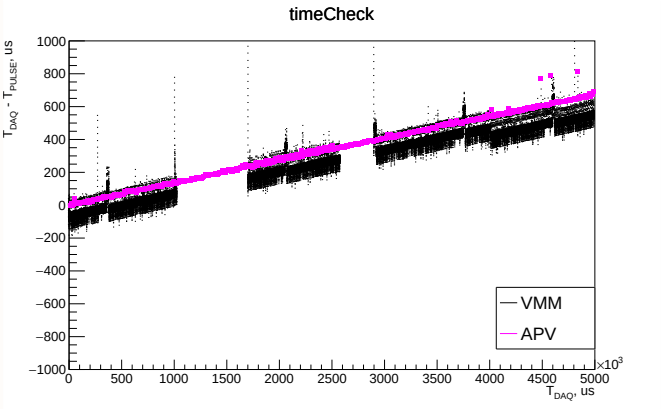
1. DAQ time difference since the first pulser
2. Number of pulser periods multiplied to the pulser frequency

On Y-axis the difference between (1) and (2).

Possible reasons

1. DAQ time inaccuracy
2. Pulser frequency inaccuracy

Comparison between DAQ time and pulser time between spills



DAQ us time	(difference to previous)	srsTimeStamp	(difference to previous)
682039	(10264)	3891380	(400037)
692040	(10001)	4291418	(400038)
702044	(10004)	4691456	(400038)
712045	(10001)	5091494	(400038)
722045	(10000)	5491531	(400037)
732048	(10003)	5891569	(400038)

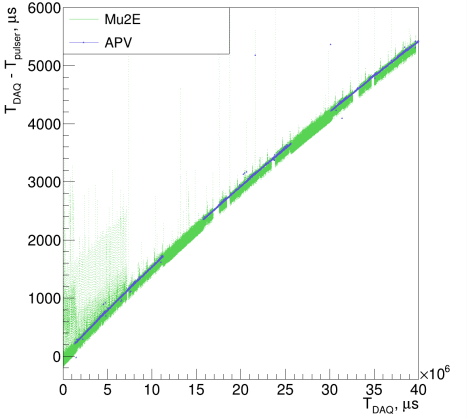
srsTimeStamp period

Standard srsTimeStamp between pulsers: 400038

Time calculation method

1. Time between pulsers calculation in Mu2E
   - Pulser period is 2000 ± 2 bcid counts
   - Pulser signal with period non equal $2000 \cdot N$ counts removed
   - Time between pulsers is $50\mu s$
   - Time periods less then a pulser calculated from bcid and tdo
2. Time between pulsers calculation in APV
   - Pulser period is 400038 srsTimeStamp counts
   - Pulser count during spill estimated from srsTimeStamp difference for pulser after/before spill
   - Time between pulsers is $10ms$
   - Time periods less then a pulser calculated from srsTimeStamp

Comparison between DAQ time and pulser time during run 0814(Mu2E) & 407(APV)



Summary

Summary and current work

- We are sure with the time method calculation
- Currently working on merging events within pulser periods. Possible methods:
  - Signals from the double read-out of MicroMegas **(current work)**
  - Stefano's proposal: use the APV and Mu2E separately and merge by the precise track in APV and the straw signal in Mu2E

Thank you for attention!

Backup slides

srsTimeStamp

DAQ us time	(difference to previous)	srsTimeStamp	(difference to previous)
682039	(10264)	3891380	(400037)
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