Simulation of MPD trigger system for MPDRoot software

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MPD detectors

“Fast” detectors

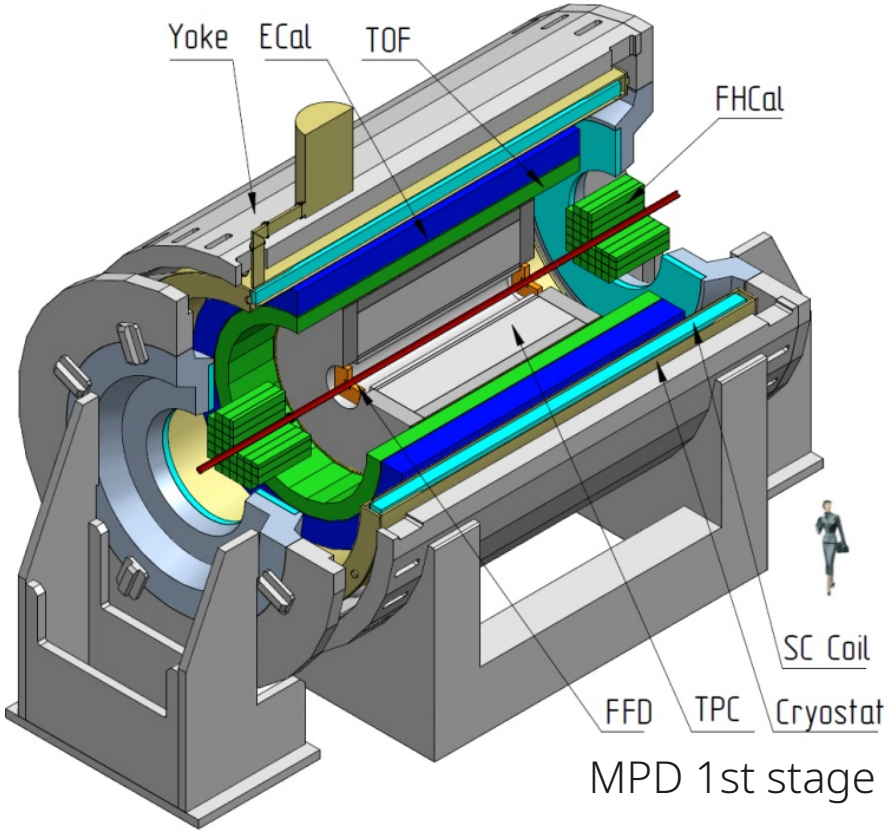
used as triggers and for data gathering

- FFD – fast forward detector
- TOF – time of flight system
- FHCal – forward hadron calorimeter

“Slow” detectors

used only for data gathering

- TPC – time projection chamber
- ECal – electromagnetic calorimeter



MPD 1st stage

Particles reach time per detector

Expected conditions

collision point smeared

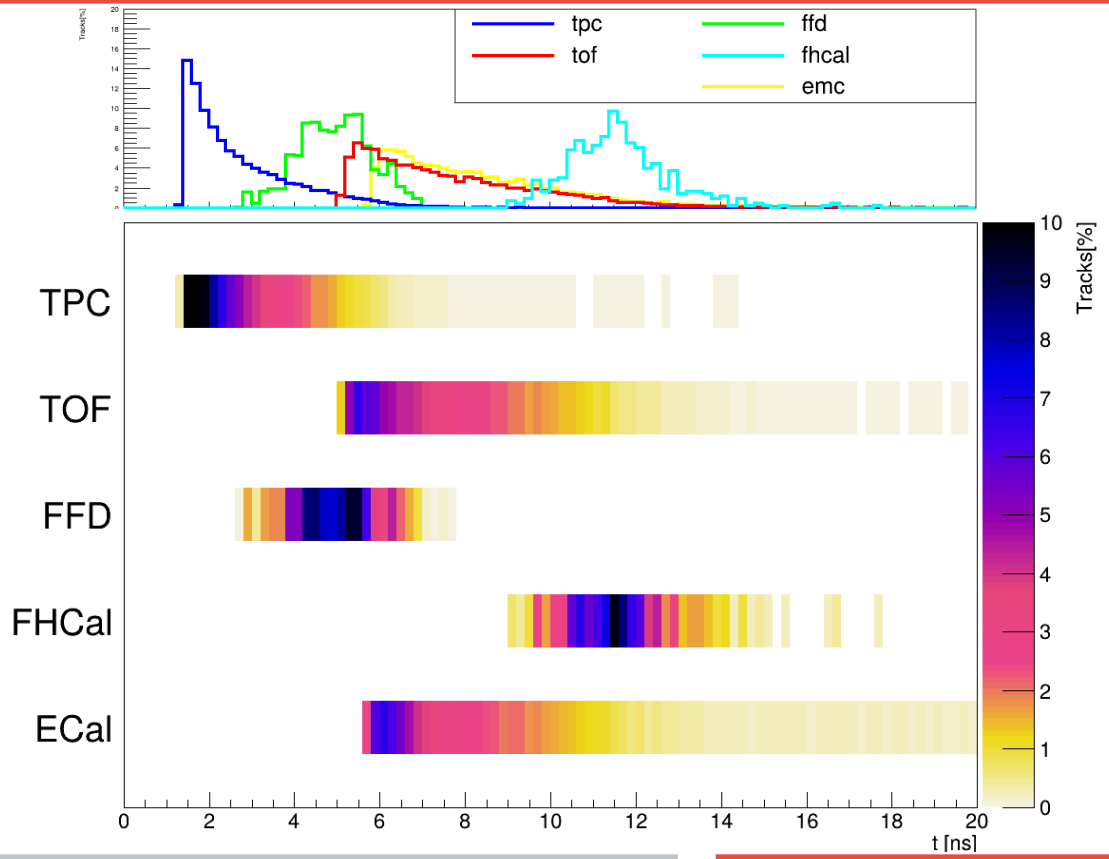
σ = 24 cm

100 events of PHSD generator

Reach time gathered from

Primary particles

π^0 gammas



MPD Time projection chamber (TPC)

3D detector

XY – pad position on end-cap of TPC

Z – signal-in-time measurements

drift time of electrons via drift velocity

MPD TPC

2 halves

Gas composition: Ar 90% + CH4 10%

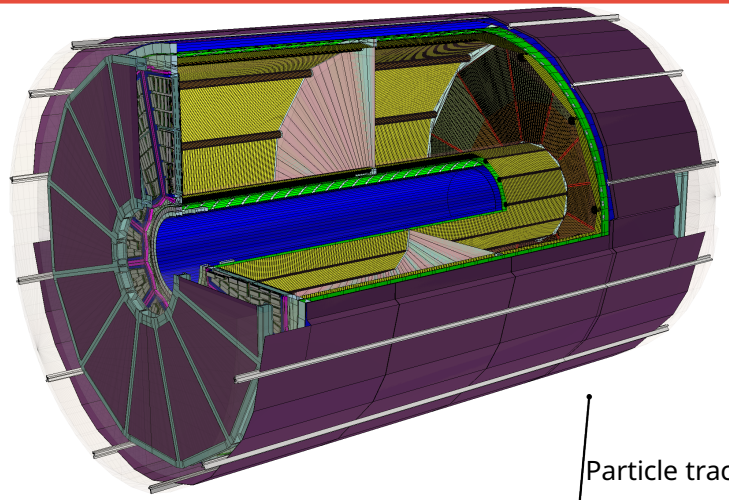
Magnetic field: B = 0.5 Tesla

Electric field: E = 140 V/cm

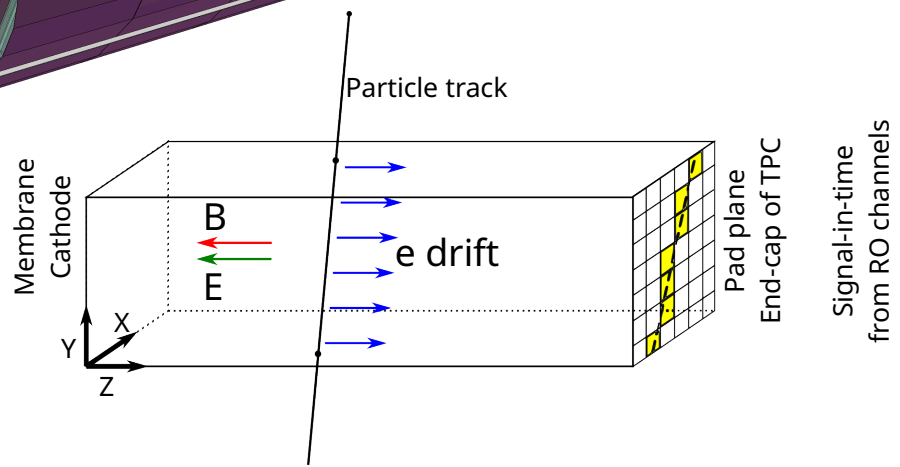
Drift length: 163 cm

~95000 Read-Out channels (pads) on both end-caps

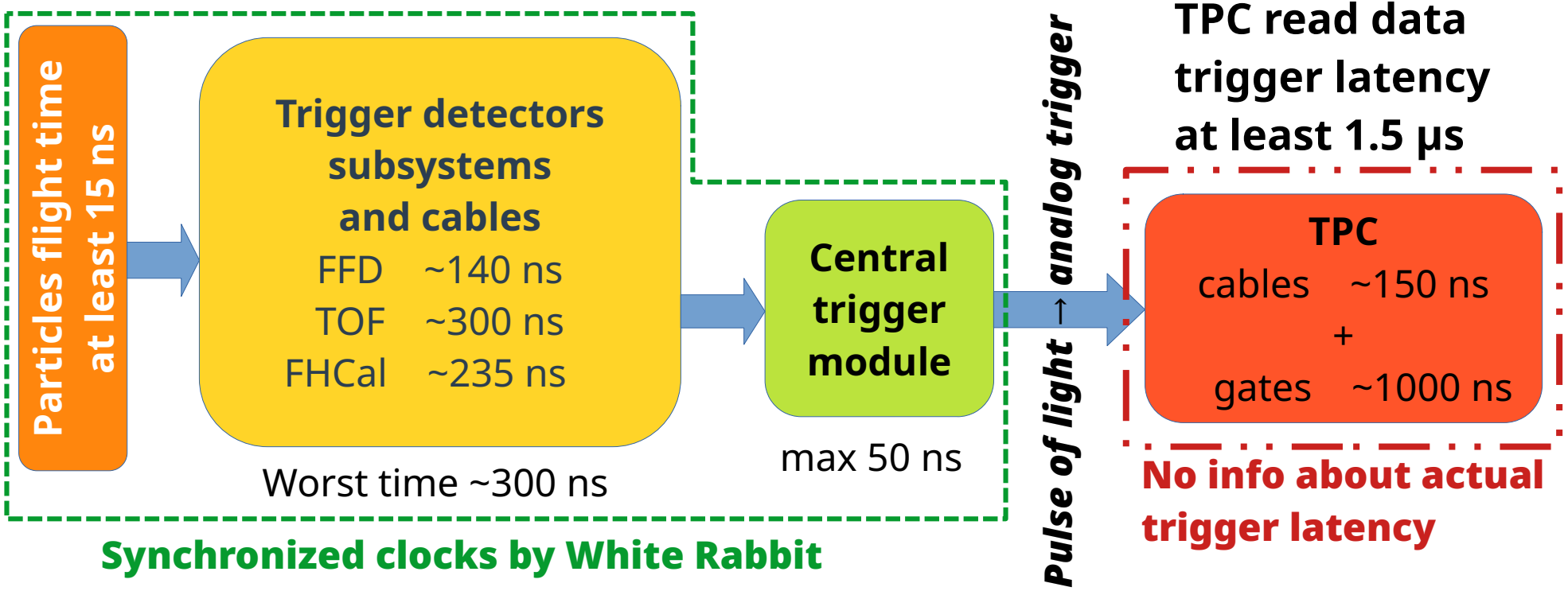
310 time buckets (100 ns per bucket)



Model according to TPC TDR v7

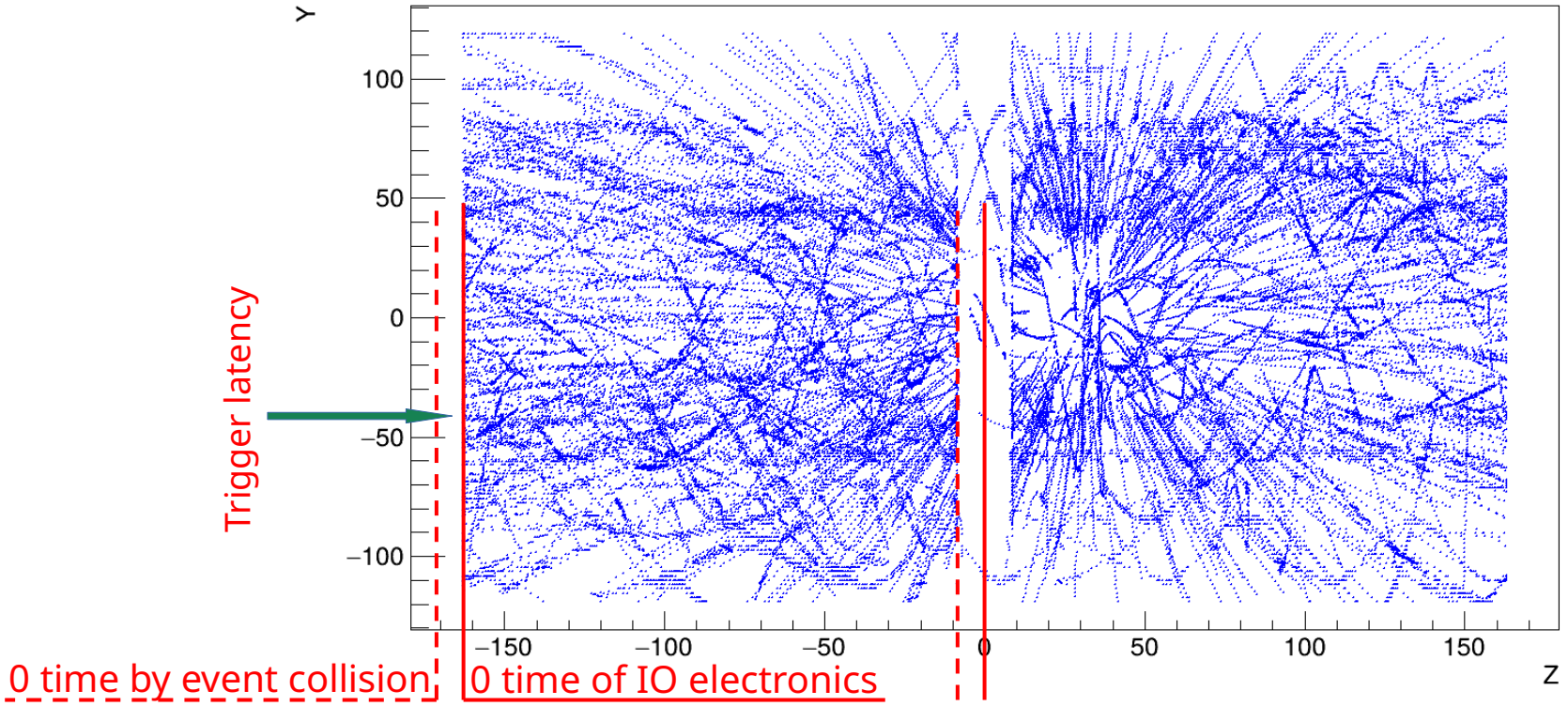


Trigger flow



Simulations of event in TPC with trigger latency

Collision point at (0, 0, 24 cm), PHSD event generator

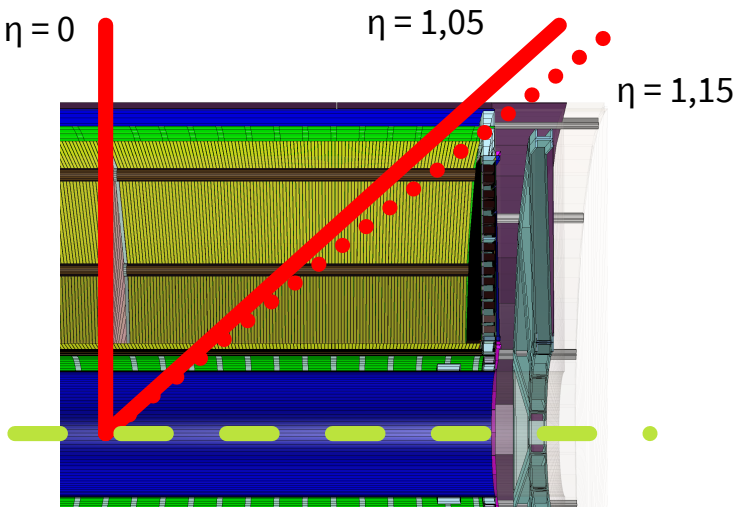


TPC trigger problems

TPC — slow detector with «memory»

Electrons drifts while read-out electronics waits for trigger and gates are opened

- Lose data near end-caps of TPC
  - Pseudorapidity reducing $\Delta\eta$ = ~0.1
- Offset of all data if there is no measurement or calculation of trigger latency
  - Offset ~8.3 cm with expected electrons drift velocity 5.5 cm/μs



TPC read-out electronics has no time sync with White Rabbit

- No info about latency between firing trigger and actual start of gathering data

Algorithms to calculate TPC trigger latency (fast)

Calculates based on RAW data

Detecting end time of summarized data from whole half

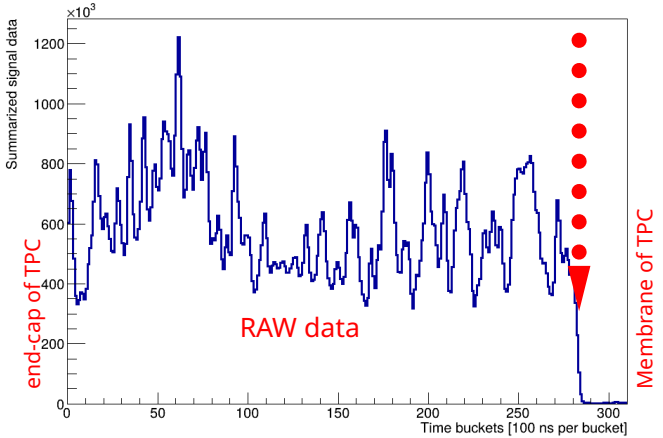
Very rough, unmeasurable offset (“slope” of data end is not steep enough)

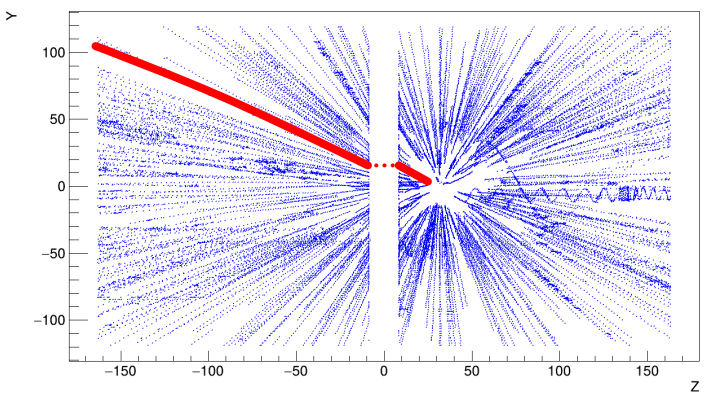
Calculates based on reconstructed hits

Only events with vertex that has significant offset along beam axis from membrane position

Combine gap by ends of cut tracks that crosses membrane (no track reconstruction)

Rough too, unmeasurable offset (cut ends hits have unmeasurable offset from membrane)





Algorithms to calculate TPC trigger latency (slow)

Calculates based on primary vertex reconstruction

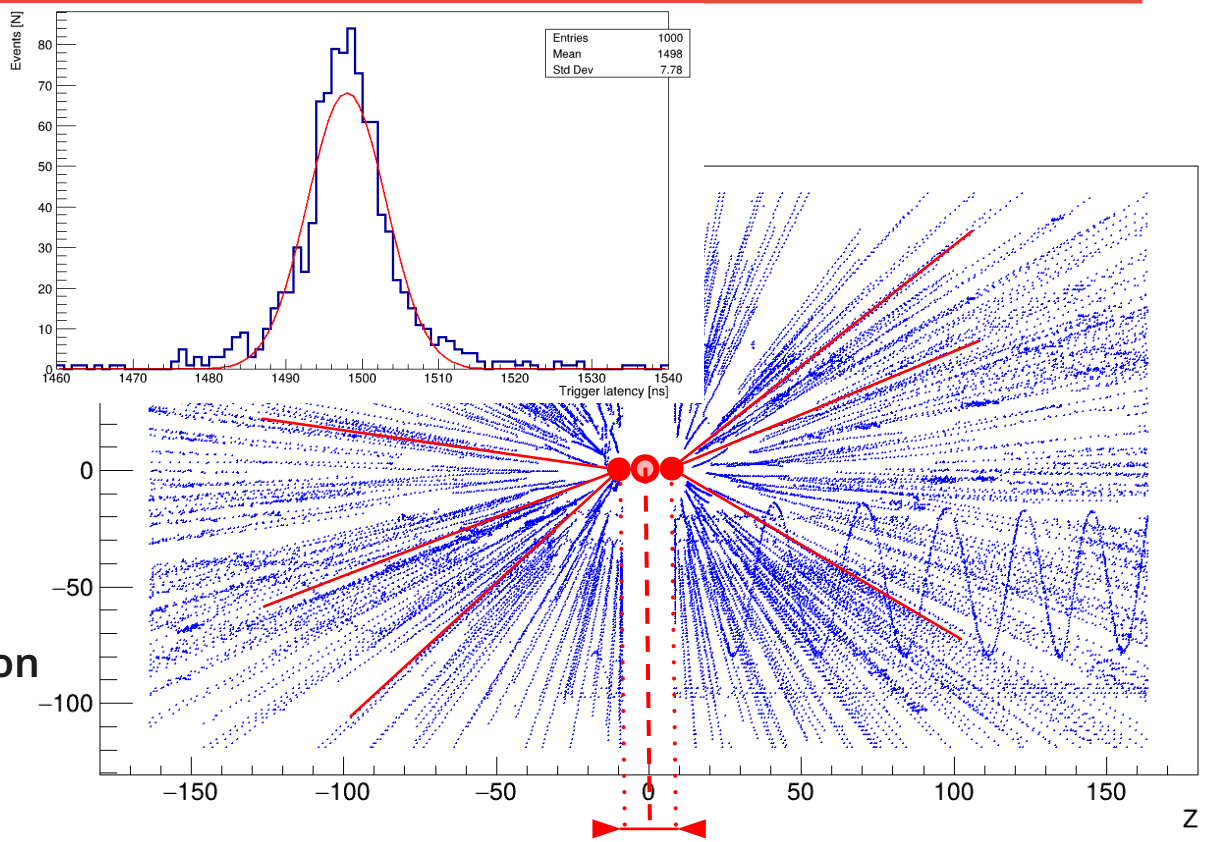
- 2 different vertex positions per each half of TPC
- Assuming that the vertexes are the single one in real → merging them in a single one provides trigger latency

Not enough precision per event

Not suitable if vertexes > 1

Almost doubles time for event reconstruction

- Tracks reconstruction 1st iteration → trigger latency
- Tracks reconstruction 2nd iteration → event



Results of simulations

Reach times of particles for each MPD facility detectors was simulated

Trigger latency has significant impact on TPC data gathering

- trigger latency leads to loosing data in TPC
- trigger latency should be considered during event reconstruction
- trigger latency may be calculated from data with great limitations

Trigger latency will be measured «in place» by additional systems on assembled MPD facility for each event

That`s it

Thank you

for attention!

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