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TOF and Shower Trigger Algorithm and Online Matching with MDC Tracks

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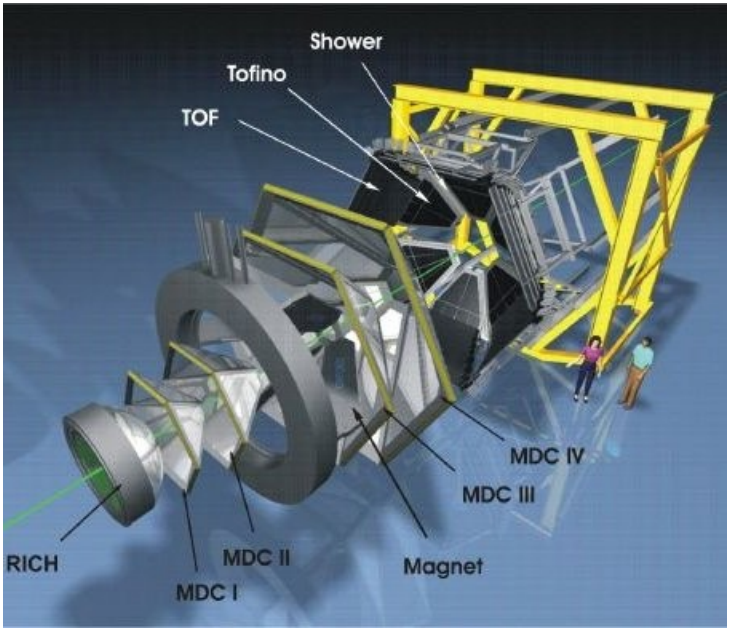
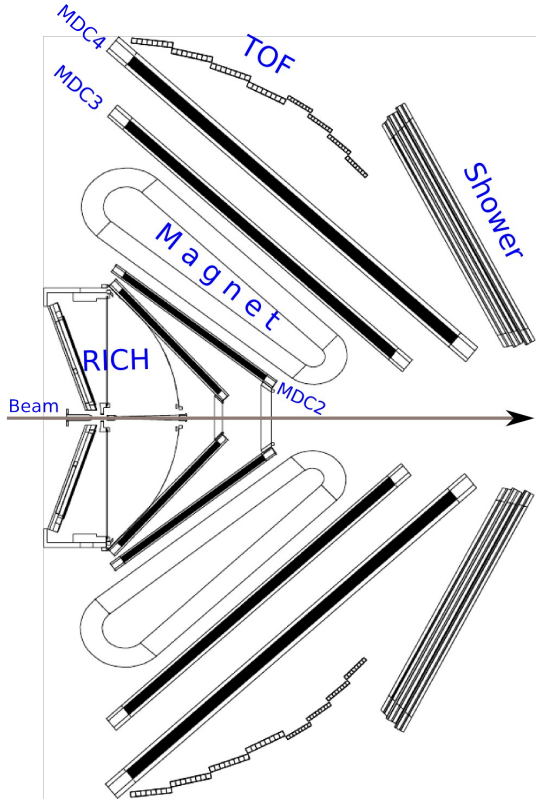
Motivation

- Trigger update for the HADES detector
  - high detector occupancy (heavy ion collision)
  - more selective trigger by using more trigger parameters
  - existing: electron signature recognition in RICH, Shower and TOF, correlation of RICH – Shower/TOF
  - new: correlation with MDC, using computing power of FPGAs on Compute Node
- Testcase for PANDA
  - get experience with the Compute Node
  - reuse parts of trigger algorithms
- Goal: implement TOF/Shower – MDC correlation algorithm in FPGA

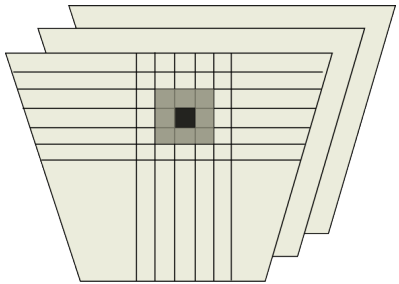
HADES Detector



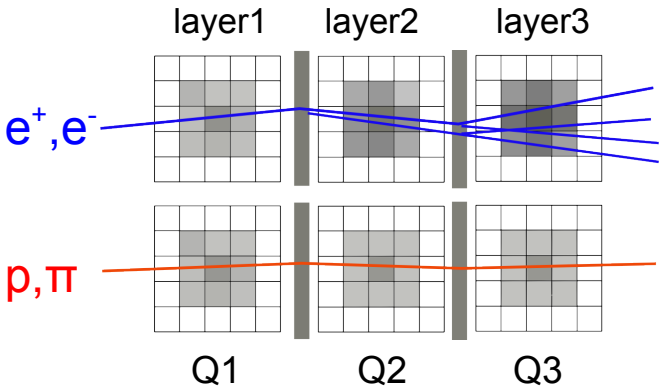


Shower Detector

one sector



- 3 layers of drift chambers with lead converters in between
- 942 pads per layer:
  32 rows , 20 - 32 colums



Electron signature recognition:

1) search local maximum in first layer
2) calculate charge of 9 pads in each layer
3) apply cut:
   Max(Q3-Q2, Q3-Q1) > Q_thresh

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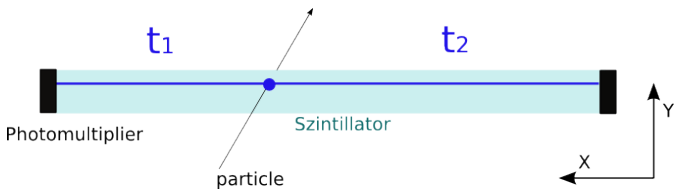
TOF Detector

- 64 scintillator strips in y direction:
  - 8 strips grouped together in one plane (module)
  - 8 modules / sector
- two photomultipliers / strip for tof and x position determination

module:

- y position: strip number
- x position
  in module coordinate system:
  $x=(t_1*k_1 - t_2*k_2)*V_g - x_{offset}$

strip:



Electron signature recognition:

1) calculate time:
   $time=(t_1*k_1 + t_2*k_2)*0.5 - t_{offset}$
2) apply cut: time < T_{start} + T_thresh

time resolution: ≈150ps
position resolution in x: ≈2cm

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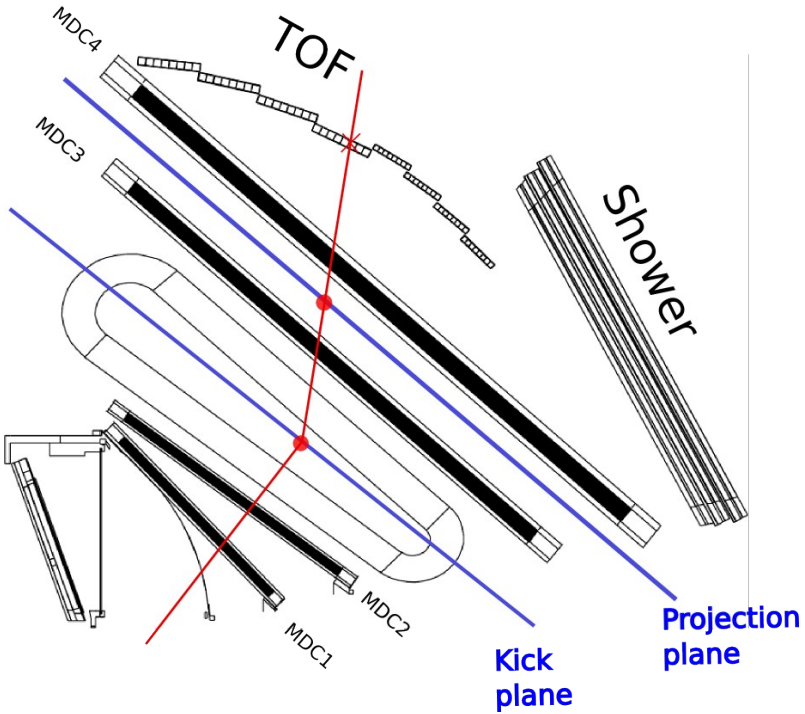
Correlation of Outer MDC and TOF/Shower



- Using points on kick plane and projection plane
- Calculate intersection point of the track with the TOF/Shower detector
- Search for a TOF/Shower hit in a certain window

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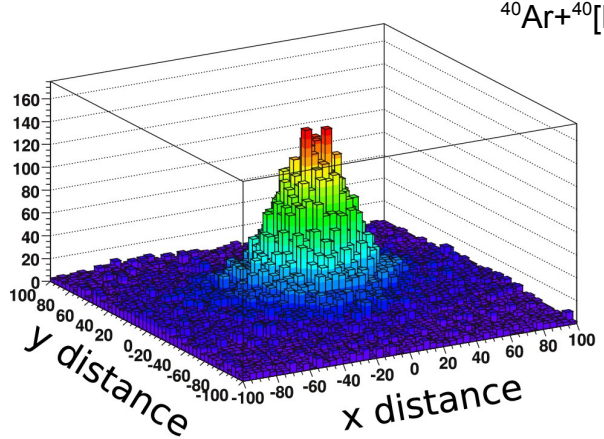
Correlation of Outer MDC and TOF/Shower

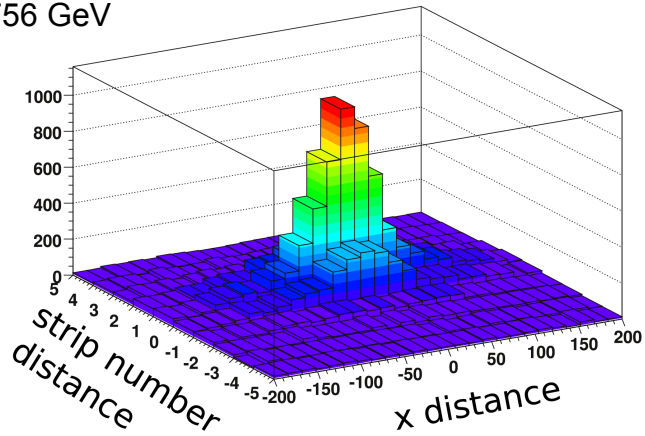
1) Calculate intersection point of MDC track with each of the 9 planes (8 tof modules , 1 shower module)
2) Determine which module was hit
3) Shower: search for a hit in a (x, y) window on padplane
   TOF: search a TOF hit in a (x, strip number) window

Shower-MDC correlation

^{40}Ar+^{40}[KCl] @1.756 GeV



TOF-MDC correlation



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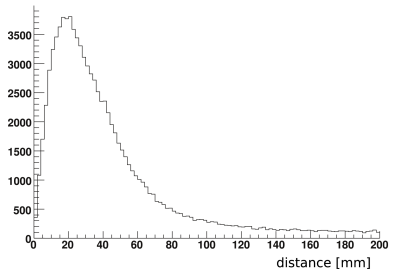
Trigger Software Emulation

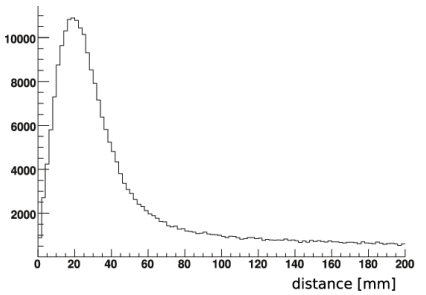
real data: ^{40}Ar+^{40}[KCl] @1.756 GeV

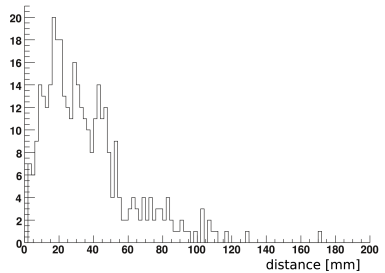
Distance of TOF hit to nearest MDC intersection point with a strip (sector coordinates)

Distance of Shower hit to nearest MDC intersection point with padplane (module coordinates)

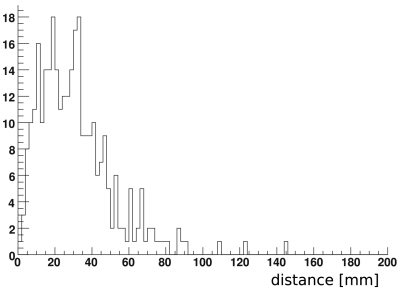


all hits





Lepton hits



Preliminary Emulation Results

efficiency: triggered events with a lepton / all events with a lepton
reduction: all events / triggered events
enhancement: efficiency * reduction

TOF/Shower (time of flight, shower pattern) + outer MDC correlation:
efficiency: 0.9 , reduction: 2 , enhancement: 1.8 (for sector0)

Outlook

The algorithm can improve the trigger

Next step: implement on FPGA on the Compute Node

Thank you for your attention