

GEM-TPC Data Rate Estimates and Readout Architecture

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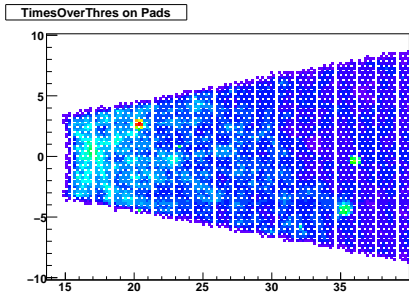
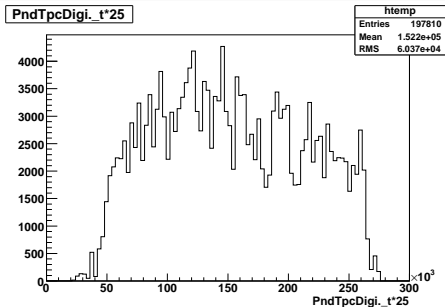
supported by: Maier-Leibnitz-Labor der TU und LMU München, BMBF, EU



TPC Simulation / Digitization

Input for data rate estimates

- Full GEANT simulation + digitization
- DPM event generator
 $p_{beam} = 2\text{GeV}$
- Event rate: 10^7 events/s
- 2000 events overlayed
- Long CT option (150cm)
- ~ 4 drift times
($4 \cdot 55\mu\text{s} = 220\mu\text{s}$)
- 24° sector \rightarrow scale ~ 14
- 78102 hexagonal pads 1.5mm outer radius

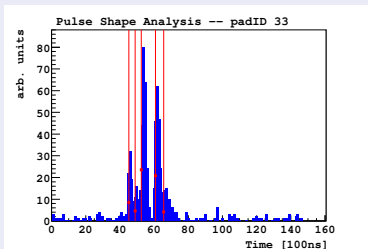


Pulse Extraction

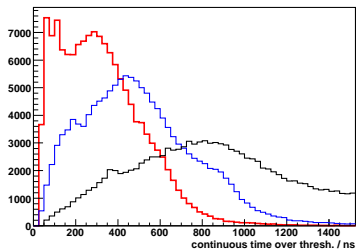
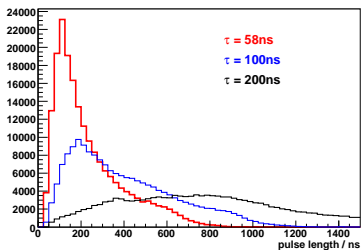
Simu parameters

- CRRC-shaper
 - ▶ $\tau \in \{58, 100, 200\}$ ns
- 12 bit ADC 40MHz
- Threshold: $\sim 2100e^-$
- $\rightarrow 78102 \cdot 55\mu s \cdot 40MHz = 172M$ Voxels

Pulse splitting



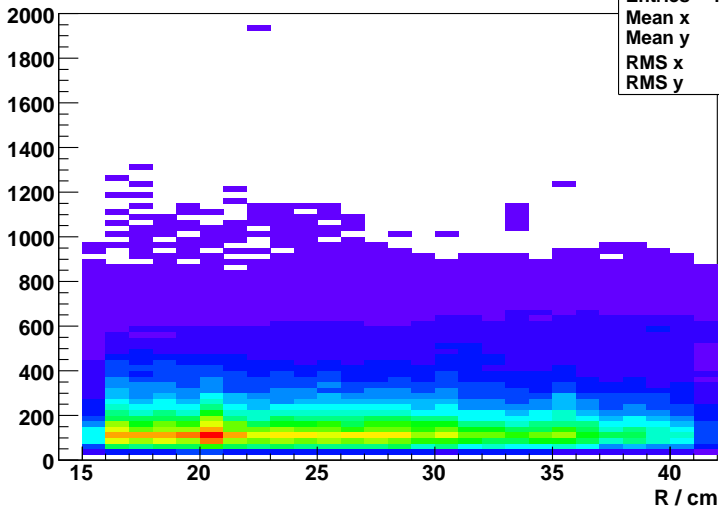
Data from test chamber



Pulse Lengths vs Radius

Shaping time $\tau = 58ns$

DigiLength vs R



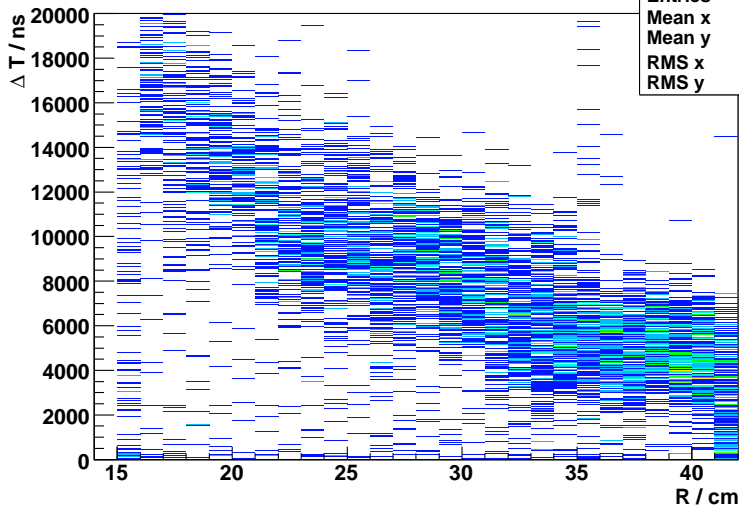
DigiLengthR

Entries	197810
Mean x	27.33
Mean y	236.1
RMS x	7.281
RMS y	163.7

Occupancy: Total Time over Threshold (per $220\mu\text{s}$)

Shaping time $\tau = 58\text{ns}$

TimesOverThres vs R



TimesR	
Entries	5732
Mean x	30.55
Mean y	7529
RMS x	7.407
RMS y	3927

Rates before cluster finding

$$\frac{200000 \text{ digis}}{\text{sector} \cdot 200 \mu\text{s}} \cdot 14 \text{ sectors} = 1.4 \cdot 10^4 \text{ digis}/\mu\text{s}$$
$$= 1.4 \cdot 10^{10} \text{ digis}/\text{s}$$

Average hit rate: **180kHz / channel**

$$1 \text{ digi} = 32 \text{ bit}$$

$$R = 450 \text{ Gb/s} \approx 56 \text{ GB/s}$$

Data link requirements

- Assuming 1Gb links
- 78102 pads
- 610 links with 128 channels / link

Goal: Eventbuilding / Filtering

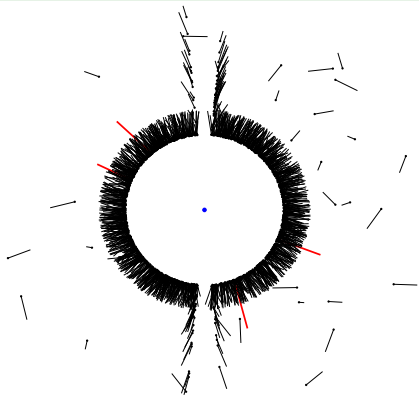
- 1 Clustering
- 2 Tracklet recognition
- 3 V0 recognition
- 4 t0 assignment (event deconvolution)
 - ▶ TPC only: topological constraints (target pointing ...)
 - ▶ Connection to other detectors

Questions

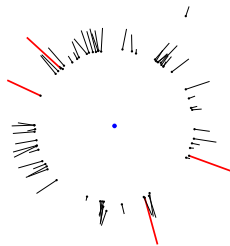
- 1 Which task is performed where?
- 2 How to organize data - how can we parallelize?
- 3 How to combine TPC with rest of spectrometer?

Event Deconvolution

Event + bkg

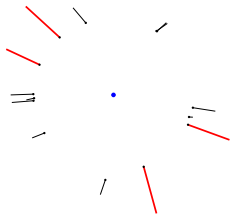


Target pointing $2\mu\text{s}$ cut

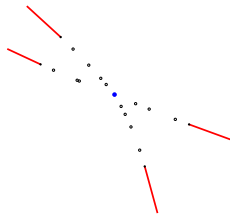


Event Deconvolution

Target pointing 200ns cut

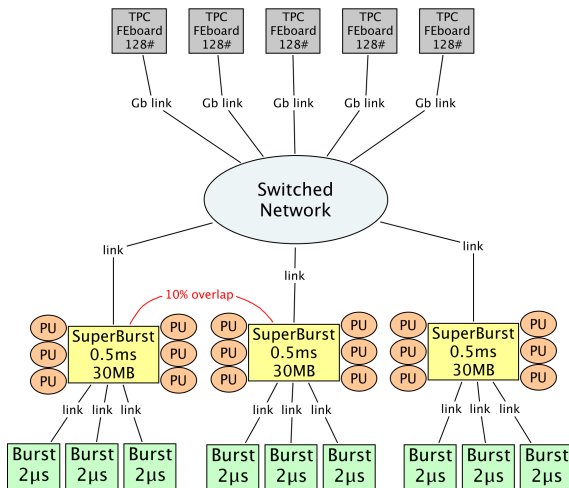


Correlation with MVD



Bursts and Superbursts

- HESR burst structure: $2\mu\text{s}$ bursts + 400ns Silence \leftrightarrow TPC drift time: $55\mu\text{s}$



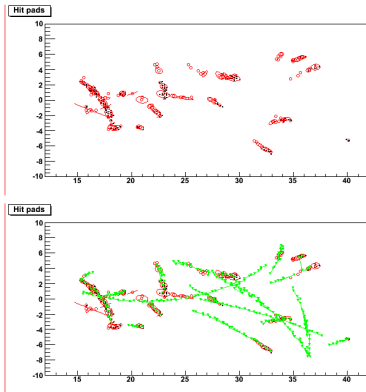
Geographical Parallelization

Preserve locality as long as possible!

- SuperBurst \approx 15000 tracks
- Need to parallelize reconstruction

Options:

- Geographical partitioning of data
Regions of interest
- Fast parallel access memory



Rate Estimates:

- Fast shaper $\tau = 58ns$, 40MHz ADC, long chamber
- Pulse splitting mandatory
- Average hit rate: 180 kHz / channel
- Total average data rate: 60 GB / s

General Architecture:

- ~ 600 Gb links from FE
- 0.5ms SuperBurst structure (30MB)
- Tracklet reco and event deconvolution on SuperBurst level
- Geographical parallelization for pattern reco