Beam Test with the DESY GridGEM TPC Prototype Module

with support from Lund and Japanese LCTPC groups

LCWS11

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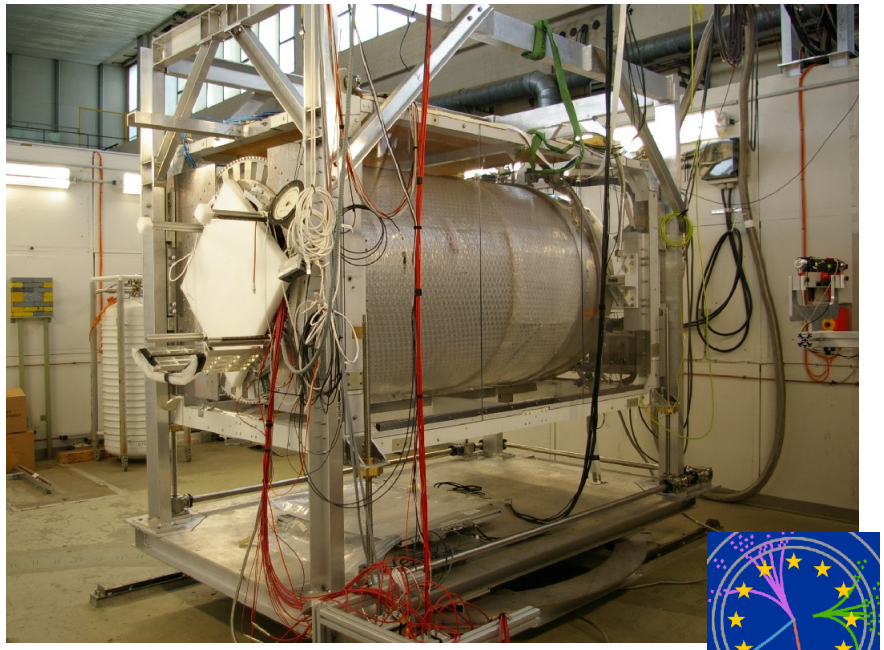
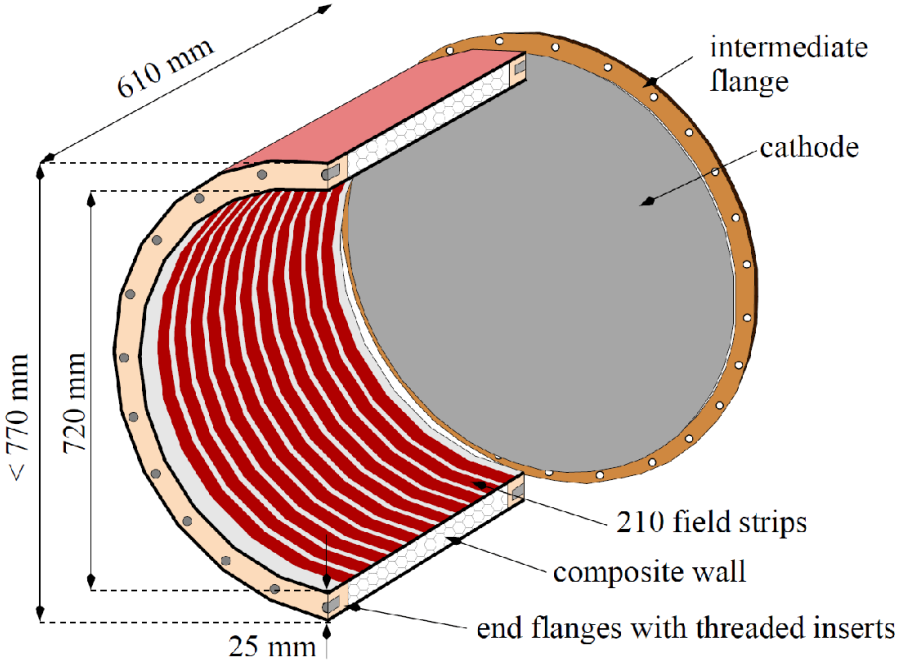
Testbeam Setup at DESY

- Set up in DESY II test beam, area T24/1 (e+/e- from 1 to 6 GeV/c)
- Comprises:
  - PCMAG magnet, 1T magnetic field possible
  - Mounted on movable lifting stage (3 axis)
  - HV and gas system including slow control system
  - Cosmic and beam trigger
  - Photo electron laser calibration system
- Outer silicon detector for reference
  - Work in progress based on ZEUS vertex detector

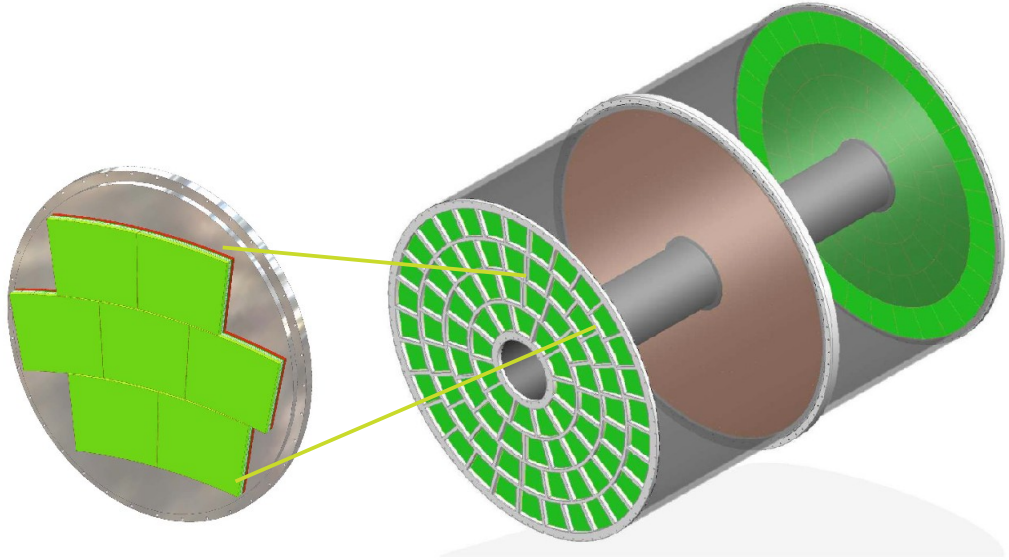


Large Prototype TPC

- Large Prototype TPC:
  - Based on experience with small prototypes
  - Ø 72cm, L=61cm

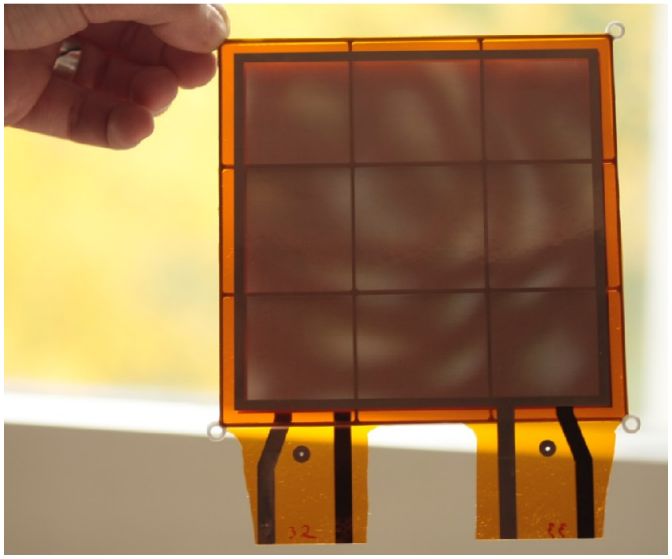


- Endplate designed to house up to seven readout modules
- Modules:
  - Designed to be similar to modules to be used in ILD TPC
  - Dimensions: ~ 23x17cm^2



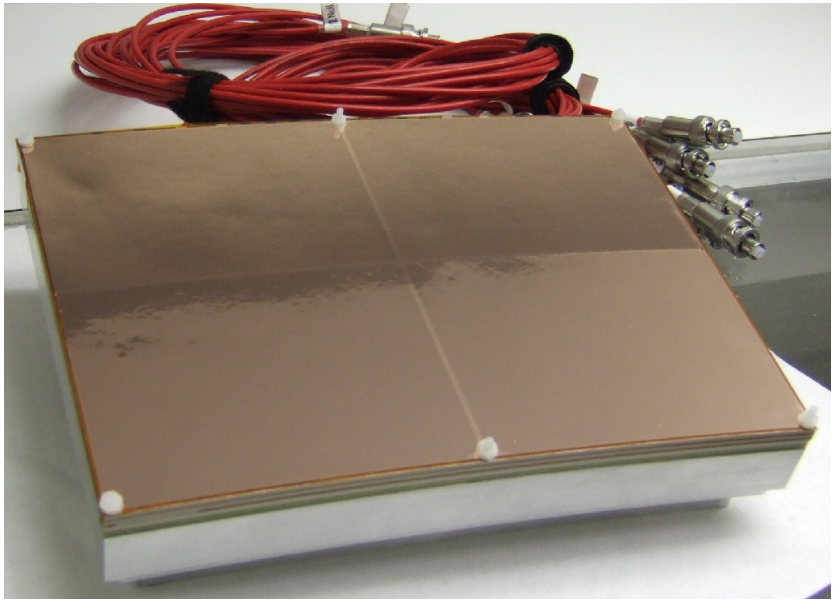
GridGEM Mounting

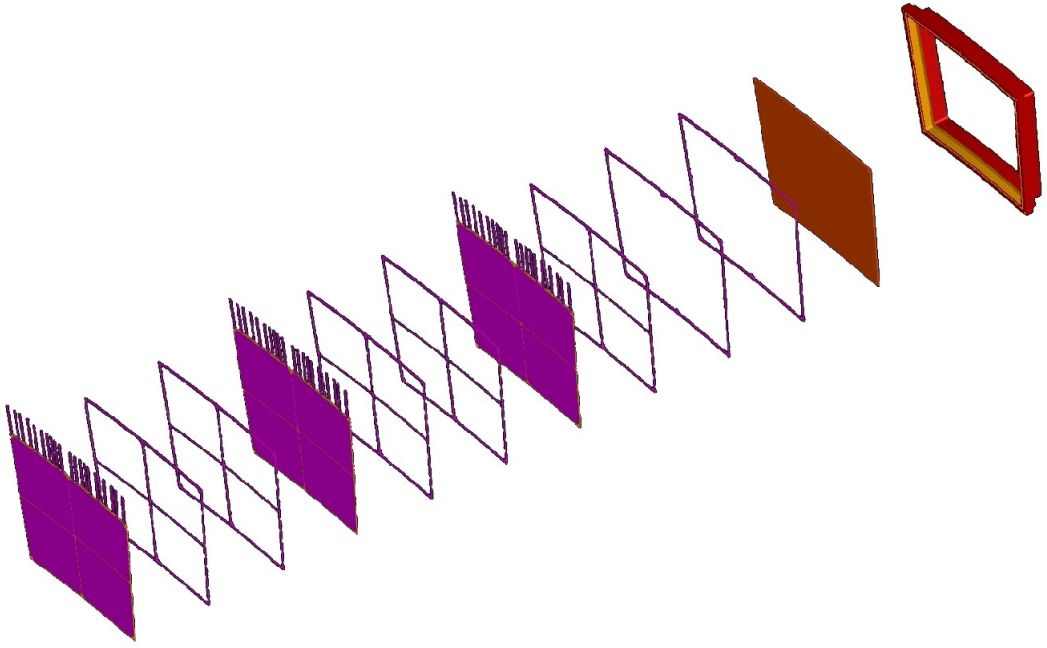
- Idea: replace frames to mount GEMs by a thin grid:
  - Grid made of Aluminum Oxide
  - Based on studies in small prototype (Ø ~ 30cm)
- Advantages:
  - Lightweight, integrated structure
  - Improved flatness of GEM foil:
    - less gain variations
    - better electric field homogeneity in the TPC
  - Simpler construction and possibility to cover large areas with minimal dead space
- No significant impact on overall resolution
- Very small dead area
- Material budget lower than with framed GEMs

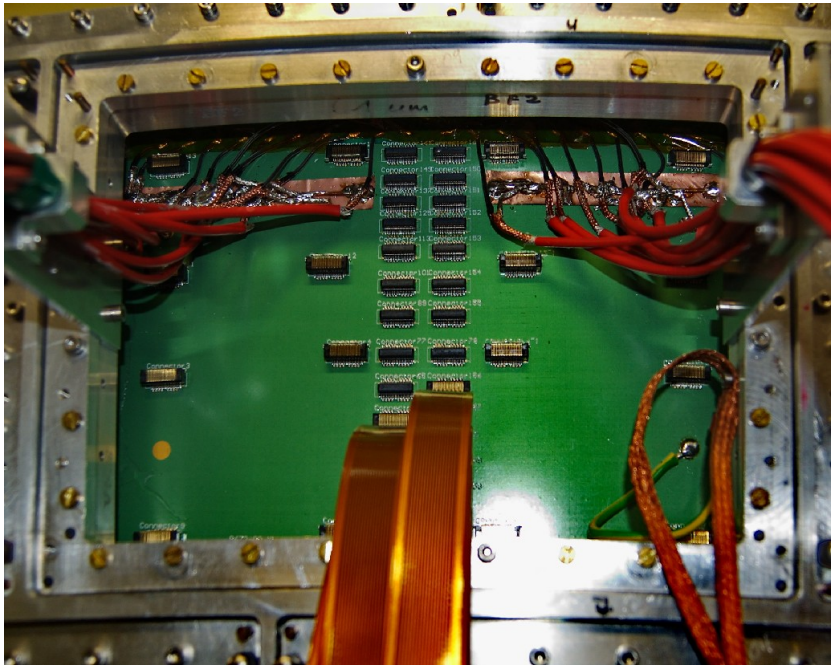


GridGEM Module

- Dimensions: ~ 23x17cm^2
- Triple GEM amplification
- Grid divides area in four sectors
- GEM design adapted:
  - One side divided in 4 sectors (limits stored energy per sector)
  - Other side: one sector covering whole area

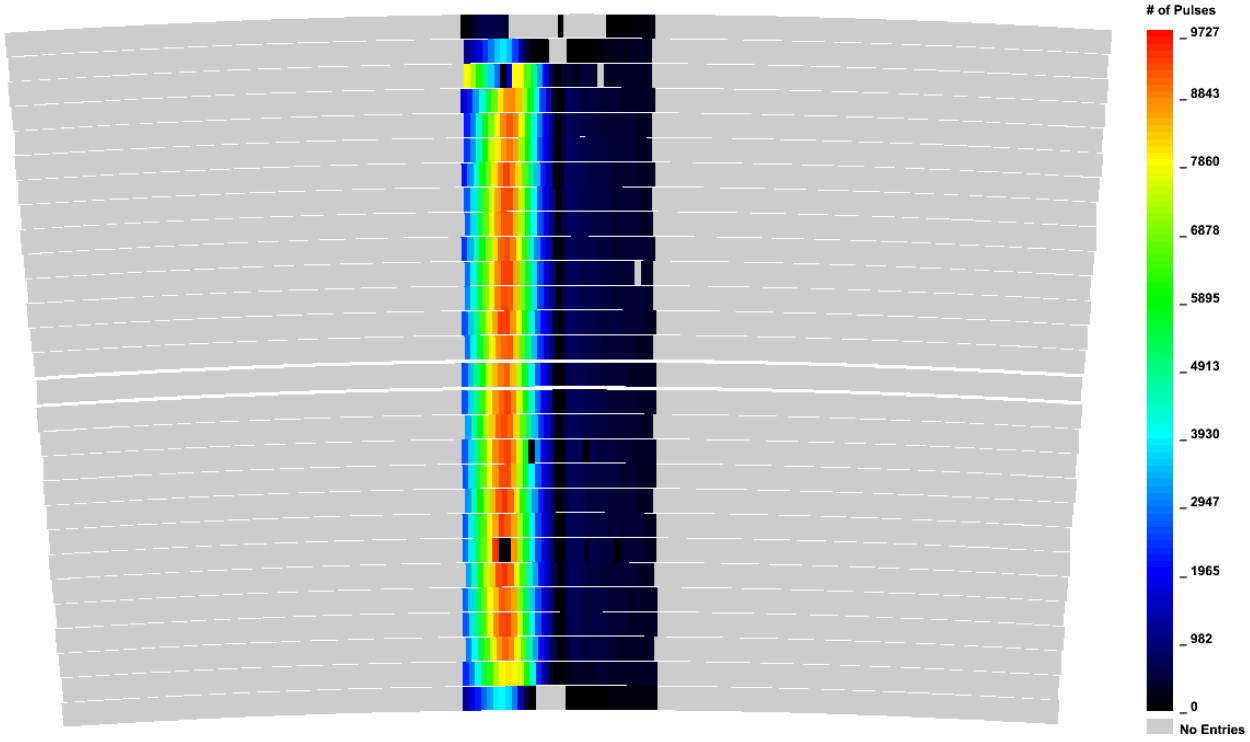


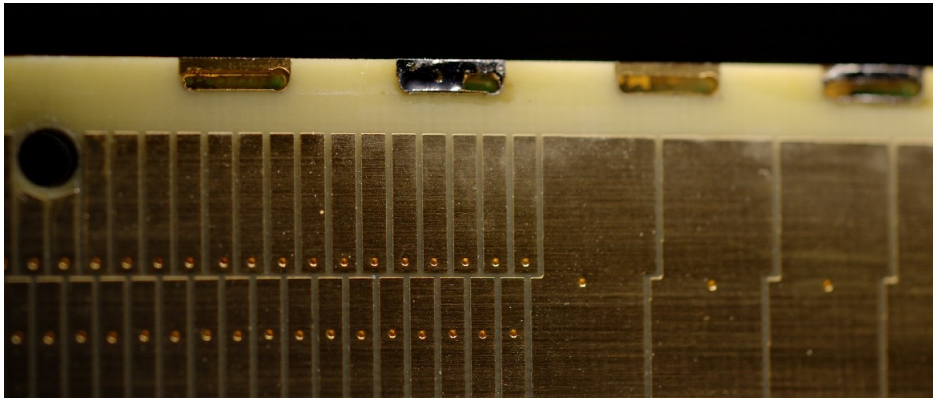




GridGEM Module

- In this iteration: simple pad plane
- Only area in the middle covered by small pads (pitch: ~ 1.26x5.85mm^2) and instrumented
- Around: Larger pads (connected to ground)
- Read out using modified ALTRO electronics with PCA16 preamplifier @ 20MHz





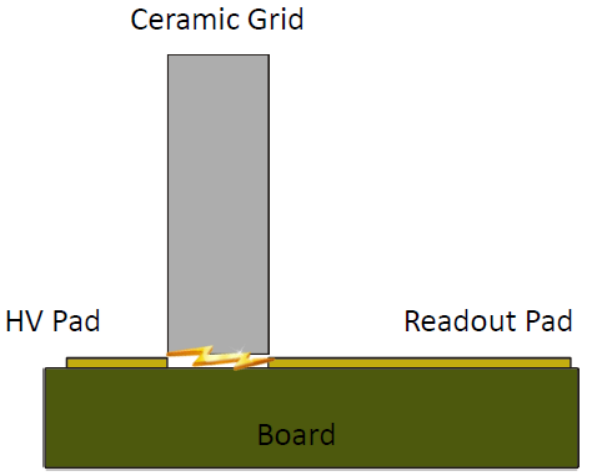
Measurement Campaign

- Testbeam effort in June/July 2011
- Most runs taken without magnetic field

- HV problems:
  - Insulation between pads and HV connection insufficient
    - Solved by adding additional glue

  - Trips several times destroyed GEM sectors:
    - Protection resistor too far from GEM
    - Additional charge from coaxial cable increased released energy at trip

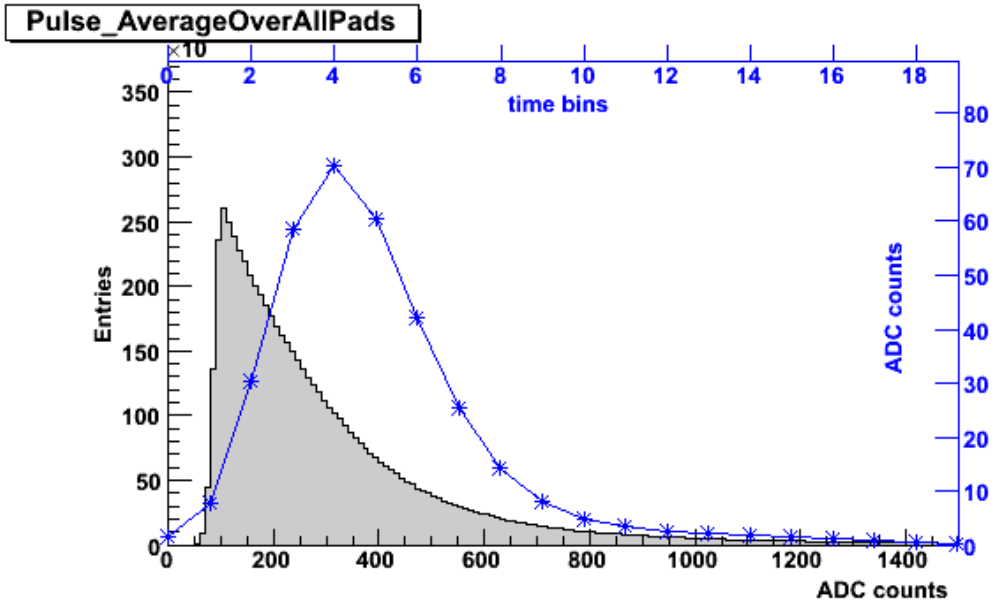
- Data presented here:
  - Taken without magnetic field
  - Scan in Z over length of chamber at 11 positions

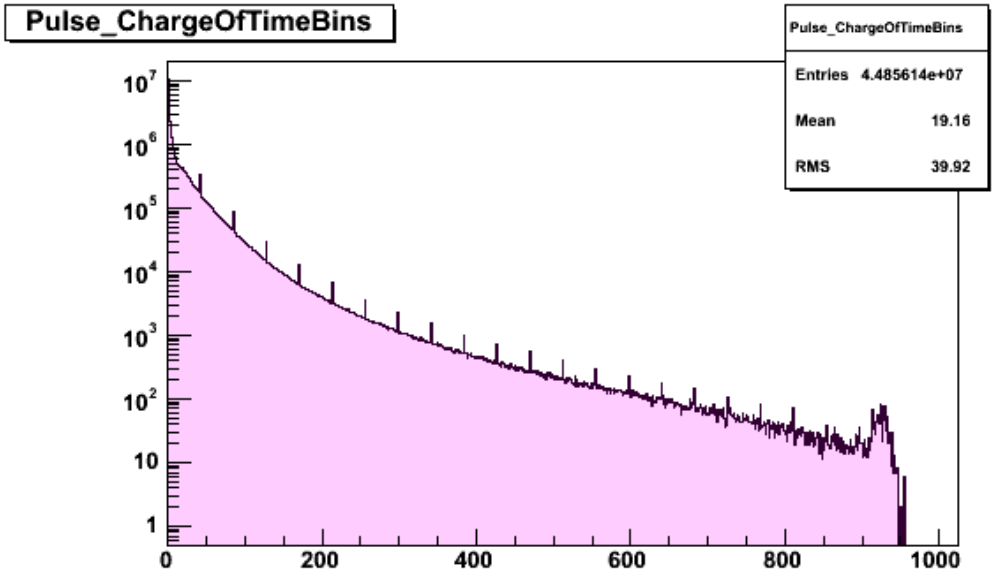


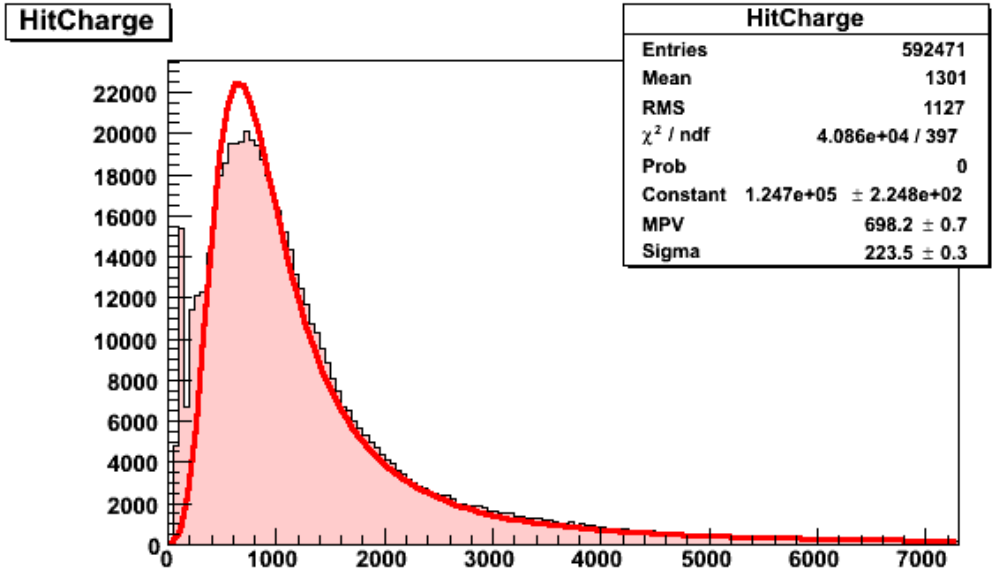
First look at the data

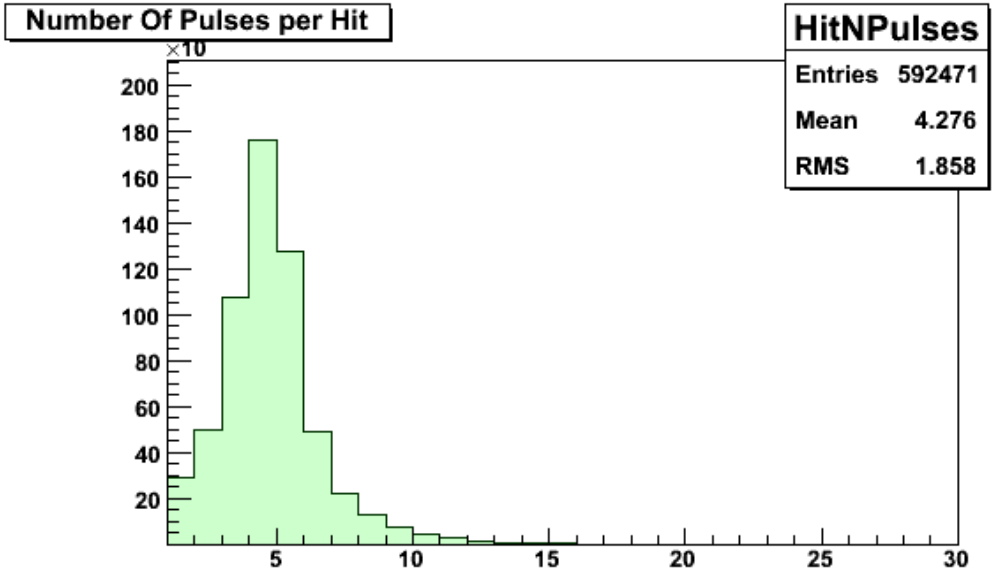
Example of Pulse / Charge Data

Run 17697, ~ 185mm from readout



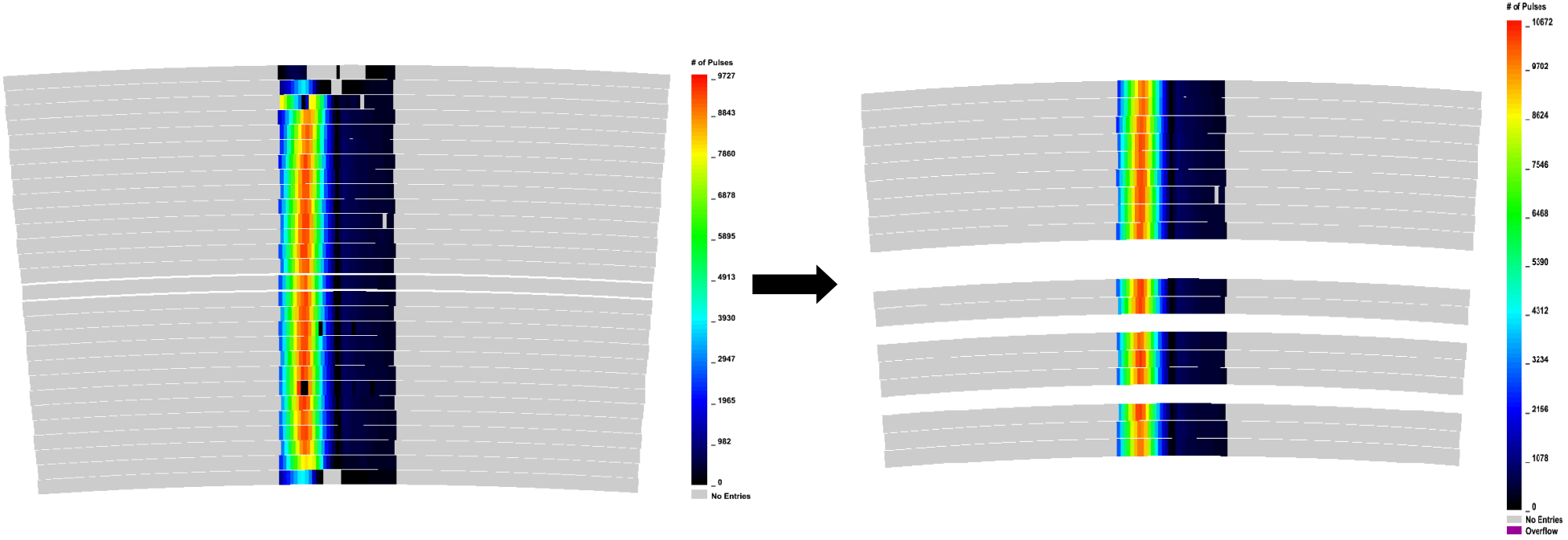






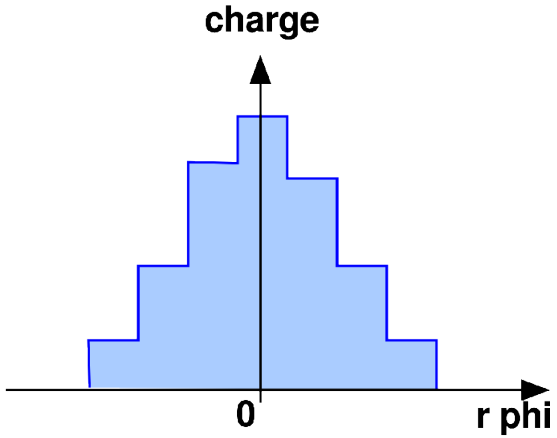
Cuts

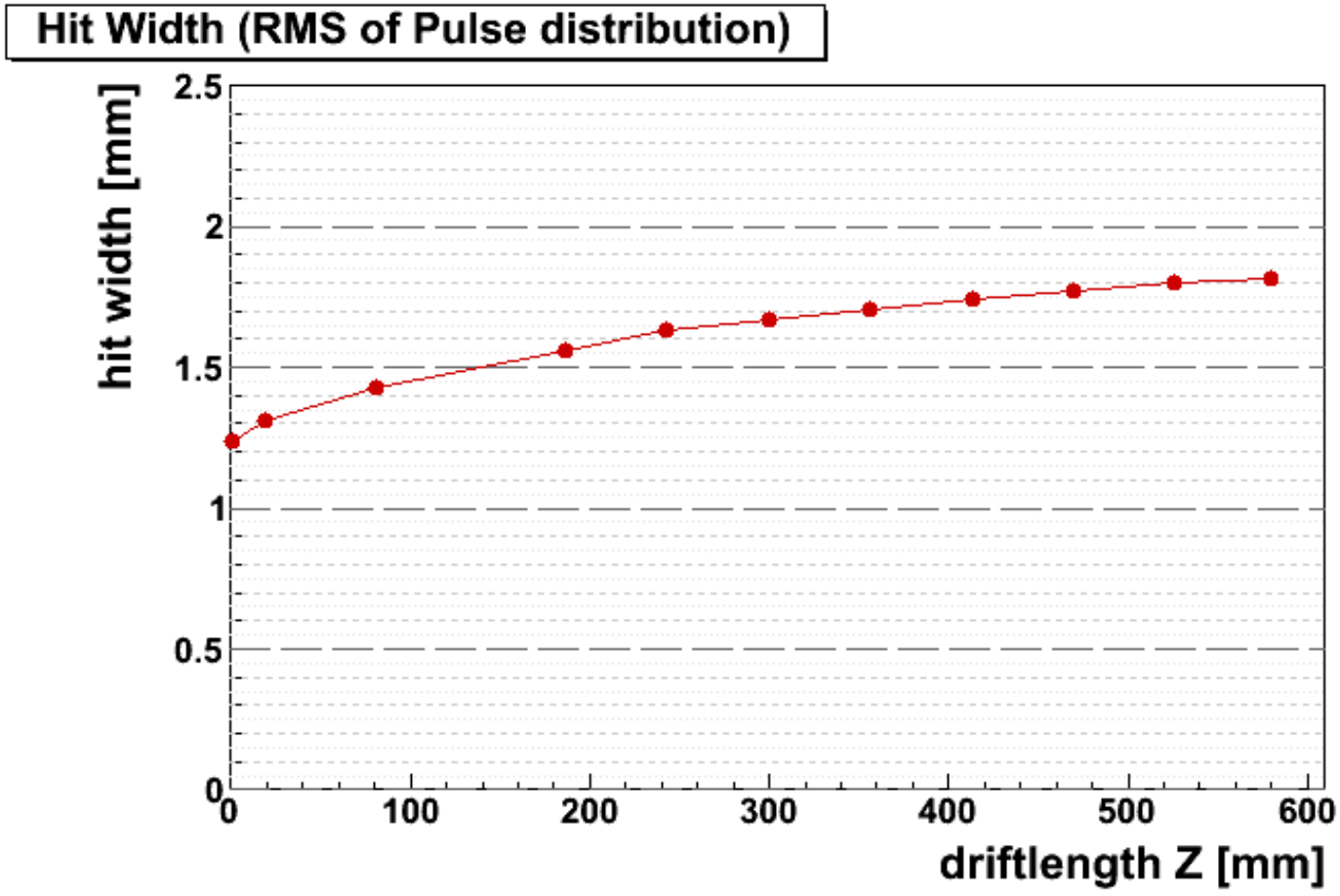
- Rejected hits consisting of only one pulse
- Cut out rows 1-2, 24-28 (edge effects) 6,10 (dead channels),13-14 (grid)



Hit Widths

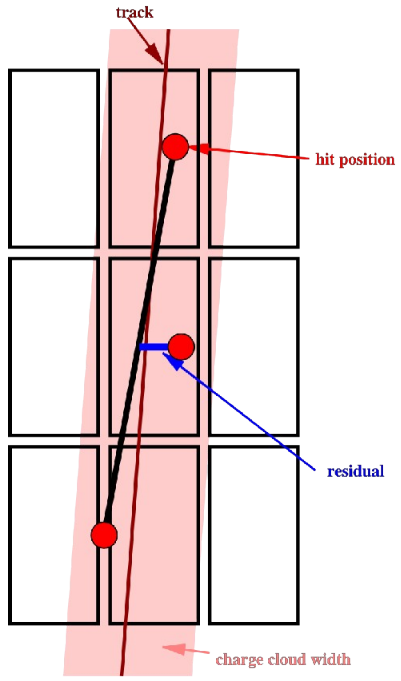
- Method:
  - For each hit fill pulse charges and rφ position in histogram centered at 0
  - Determine RMS of histogram
  - Mean of RMS distribution taken as hit width

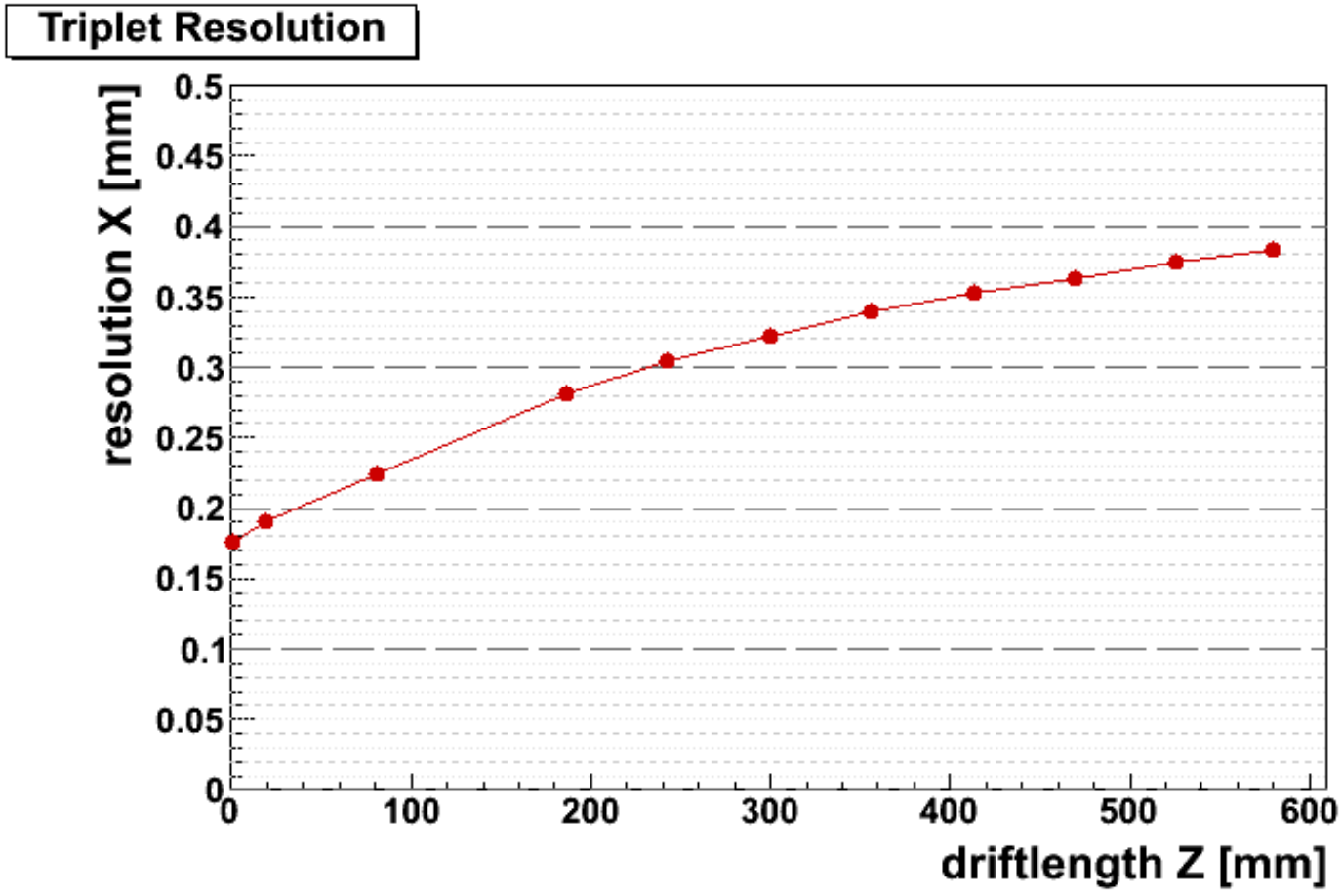




Triplet Resolution

- Straight line though hit above and below defines “track”
- Residual: distance of middle hit from this line
- Point resolution: $\sigma_{res} = \sqrt{\frac{2}{3}}\,\sigma_{gaus}$





Last Slide

- A triple GridGEM module was constructed and tested in the Large Prototype at the DESY test beam stand
- Several problems of the module design were identified and based on this experience a new iteration will be developed
- First look at the data shows reasonable results
- Further analysis ongoing

- Test beam phase and following reconstruction lead to improvements in the software:
  - Extended CED event and reconstruction display
  - Reconstruction chain tested with real data and many bugs fixed
  - New analysis code developed
  - Further improvements ongoing

- Thanks to the Lund and Japanese colleagues which were a big support in many areas