High Magnetic Field Performance of a GEM-TPC

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On behalf of the U. Hamburg/DESY TPC group:

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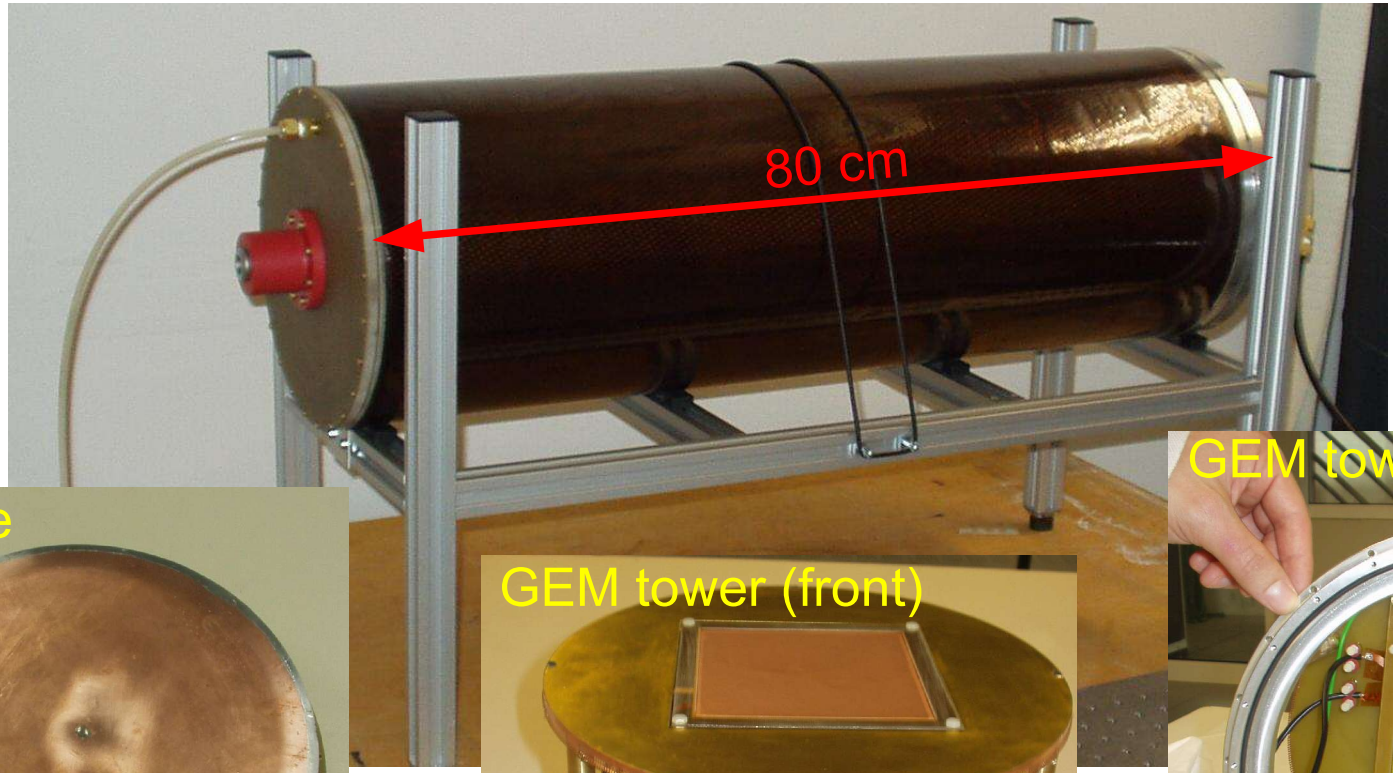
Group Activities

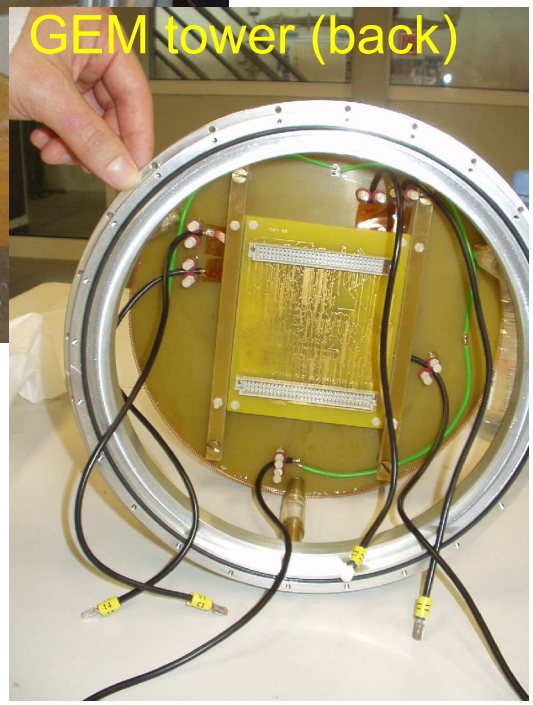
Determine the following properties for a TPC with a GEM based gas amplification system:

- Measurement of the point resolution in magnetic fields up to 5 T (with cosmic muons)
- Determination of the double track resolution in magnetic fields up to 5 T (with UV laser beams)
- Study point and double track resolution for different pad geometries/arrangements

TPC Setup

Finished a new GEM-TPC prototype for resolution measurements in high magnetic fields last fall:

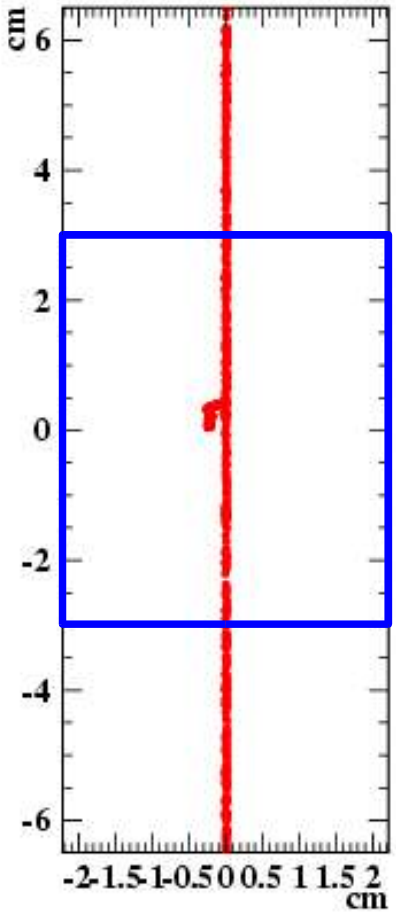




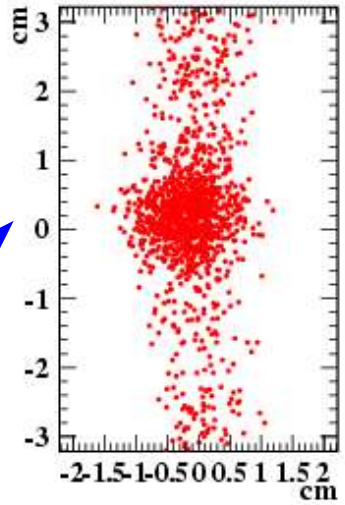
Impact of Magnetic Fields

Why are resolution measurements in B fields important?

Primary ionization cloud:

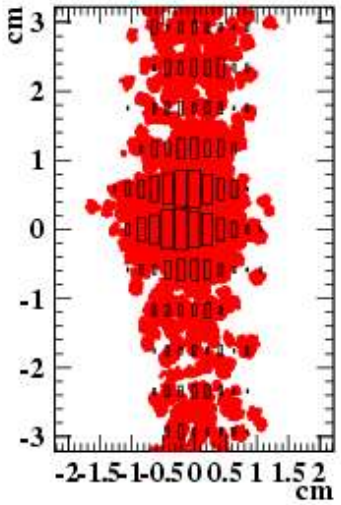


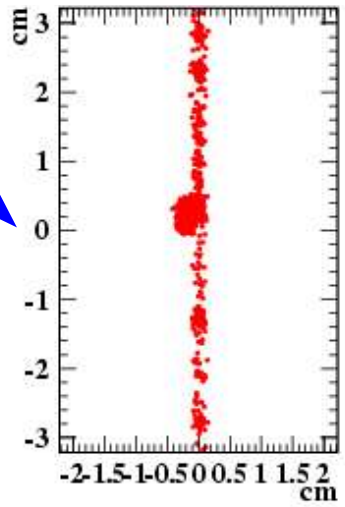
Charge cloud after 1 m drift:



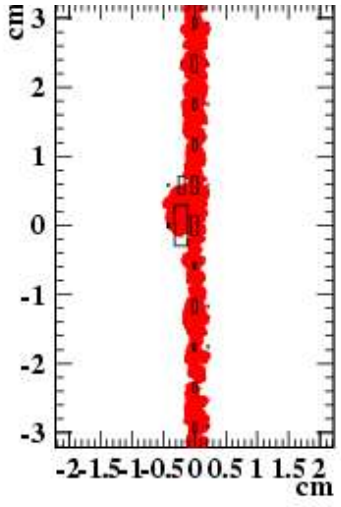
B = 0 T

Charge cloud on pads:





B = 4 T



Measurements in 5 T Magnet

The Magnet:

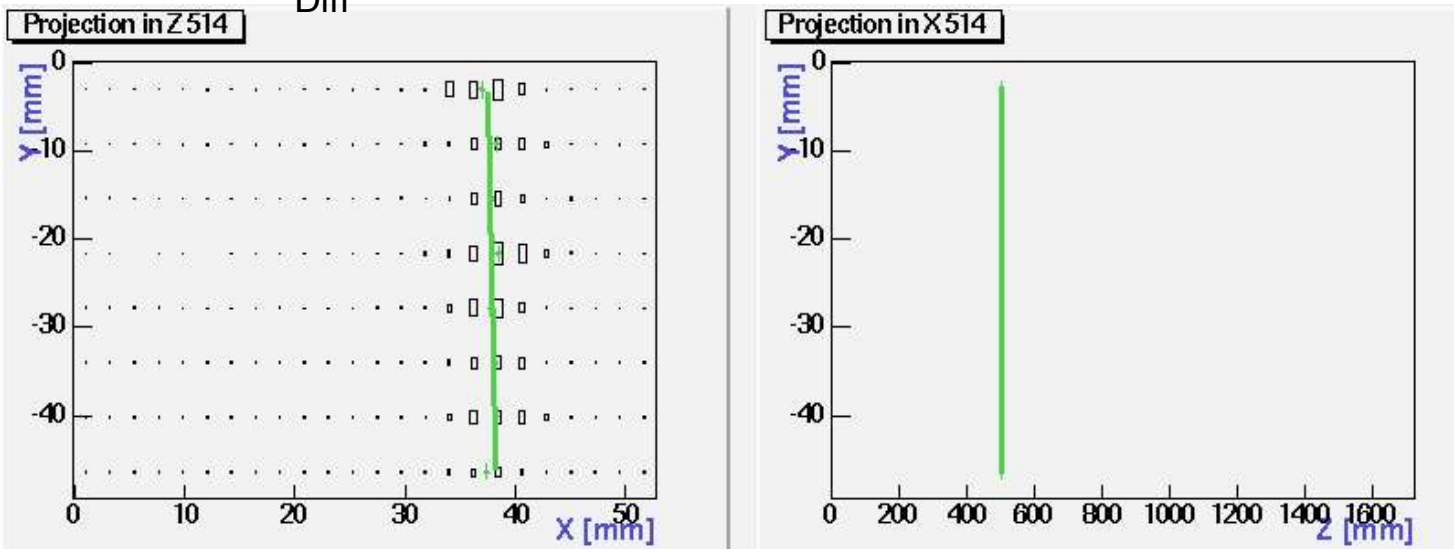
- Superconducting magnet
- 5.3 T maximal field
- 28 cm aperture
- 187 cm cryostat length

The Chamber:

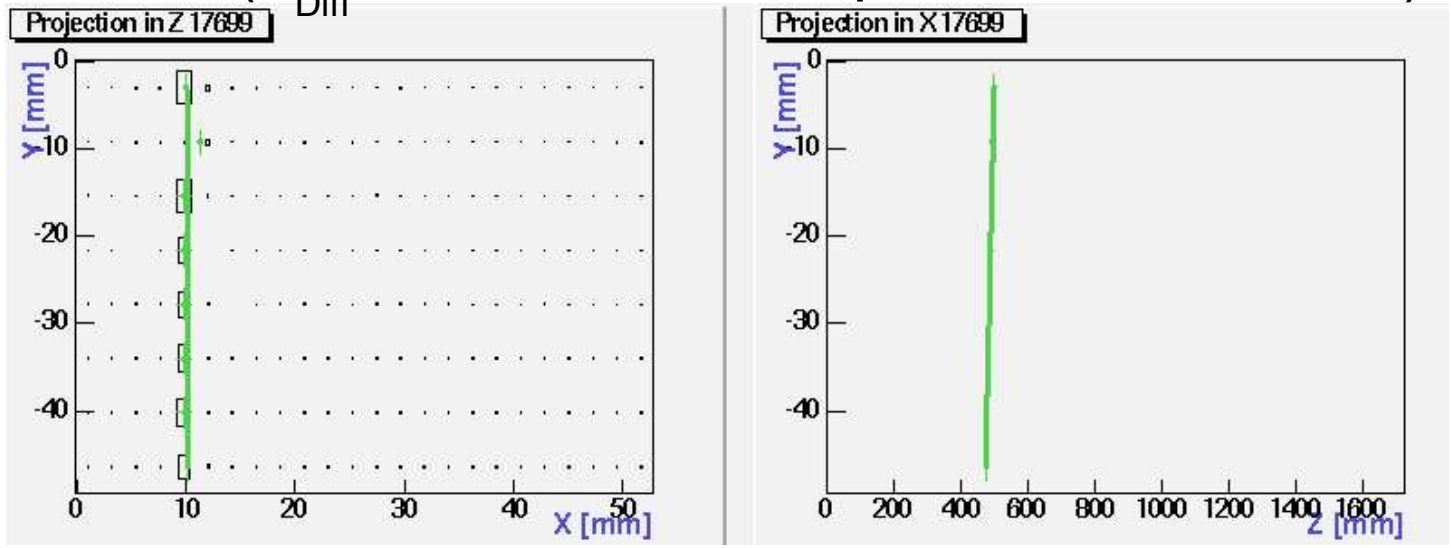
- 192 readout channels
- 6 x 2 mm readout pads
- Active area 5.28 x 4.96 cm^2
- Gas Ar-CH_4-CO_2 (93-5-2)
- Tracks by cosmic muons
- ALEPH based readout electronics

Two Events

0 Tesla (σ_{Diff} = 3.9 mm ≈ 2 pads for 50 cm drift):



4 Tesla (σ_{Diff} = 0.5 mm = 0.25 pads for 50 cm drift):



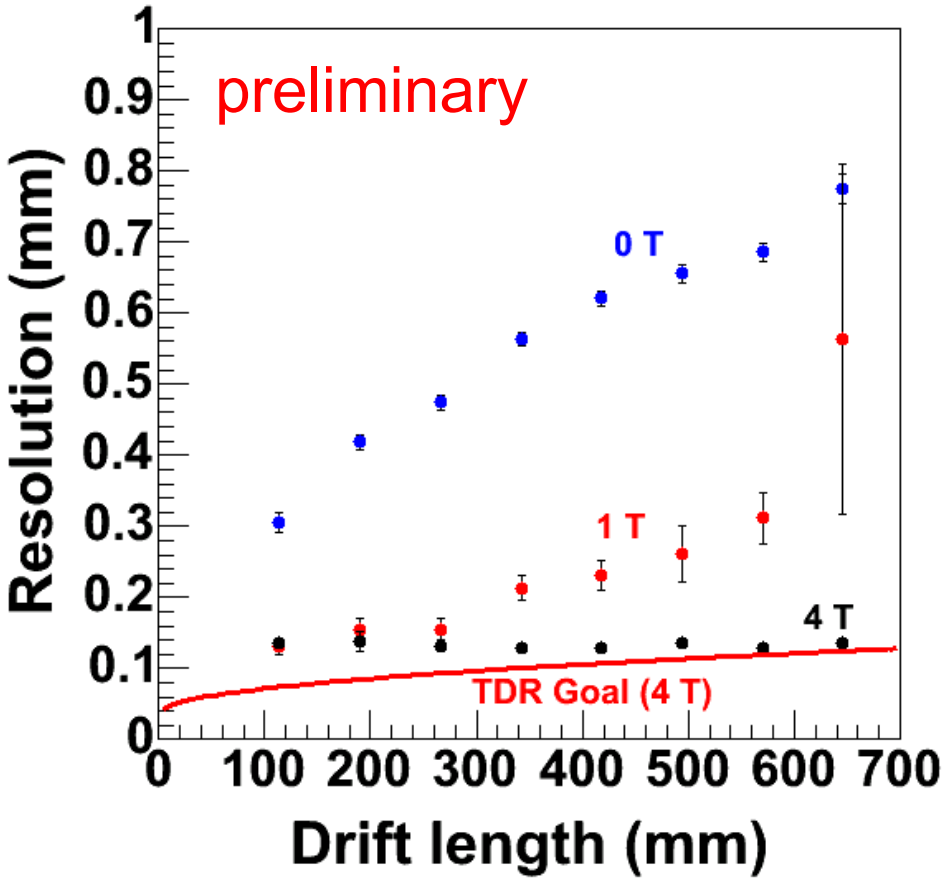
Point Resolution

Large drift volume of prototype allows resolution measurements up to 70 cm drift distance

- Resolution rises with drift length due to diffusion for 0 T and 1 T.
- At 4 T, even at 70 cm drift distance no rise in the resolution seen

Resolution achieved with first preliminary analysis:

≈ 130 μm at 4 T



More investigations needed to determine limiting systematic effects

Gain Homogeneity

How homogeneous is the gain of a GEM based gas amplification system?

$\rightarrow$ Important for good dE/dx resolution (TDR goal: 5 %)

Measurement of gain homogeneity requires good calibration of each readout channel

Calibration method:

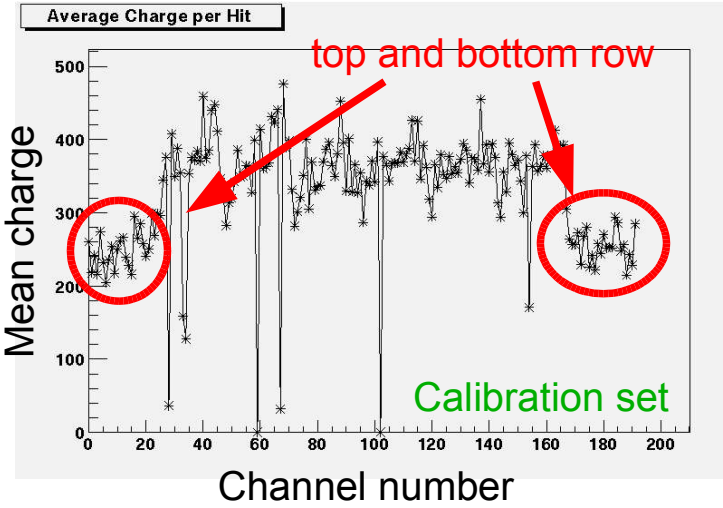
Split data sample into two sets:

- Calibration set
- Analysis set

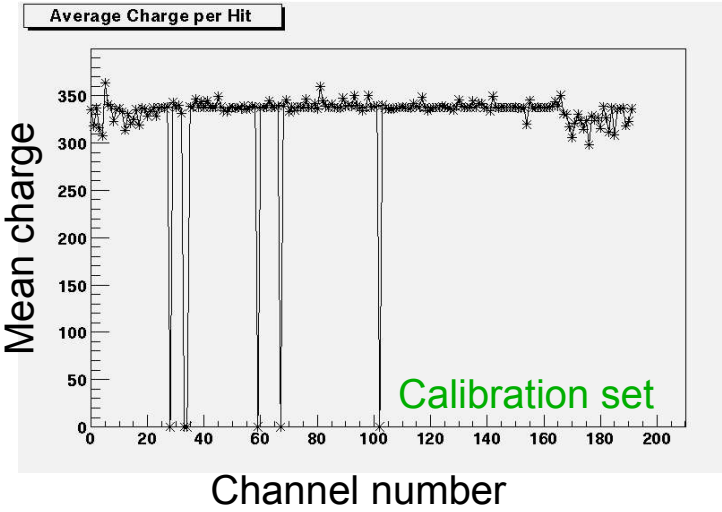
Take calibration set and re-weight mean charge in each channel to be equal to the channel averaged charge

Gain Homogeneity (2)

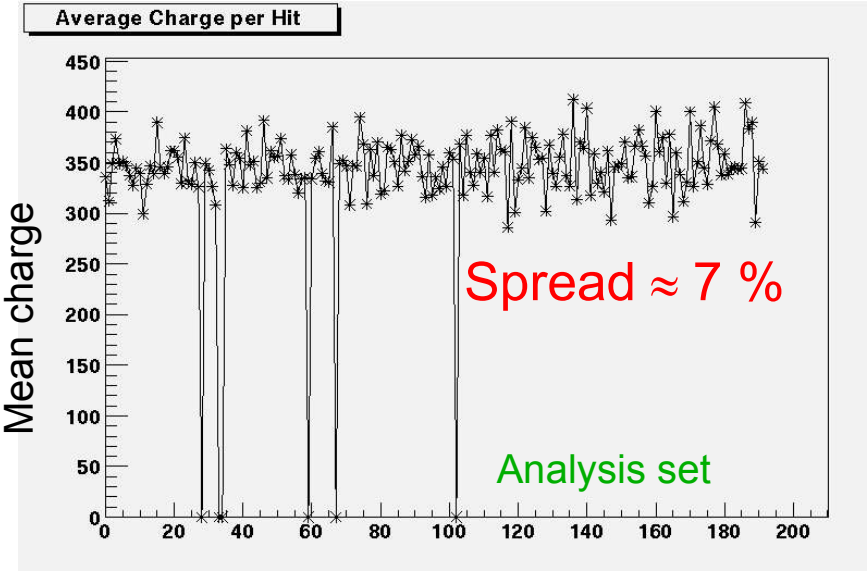
Before calibration:



After calibration:



Analysis set:



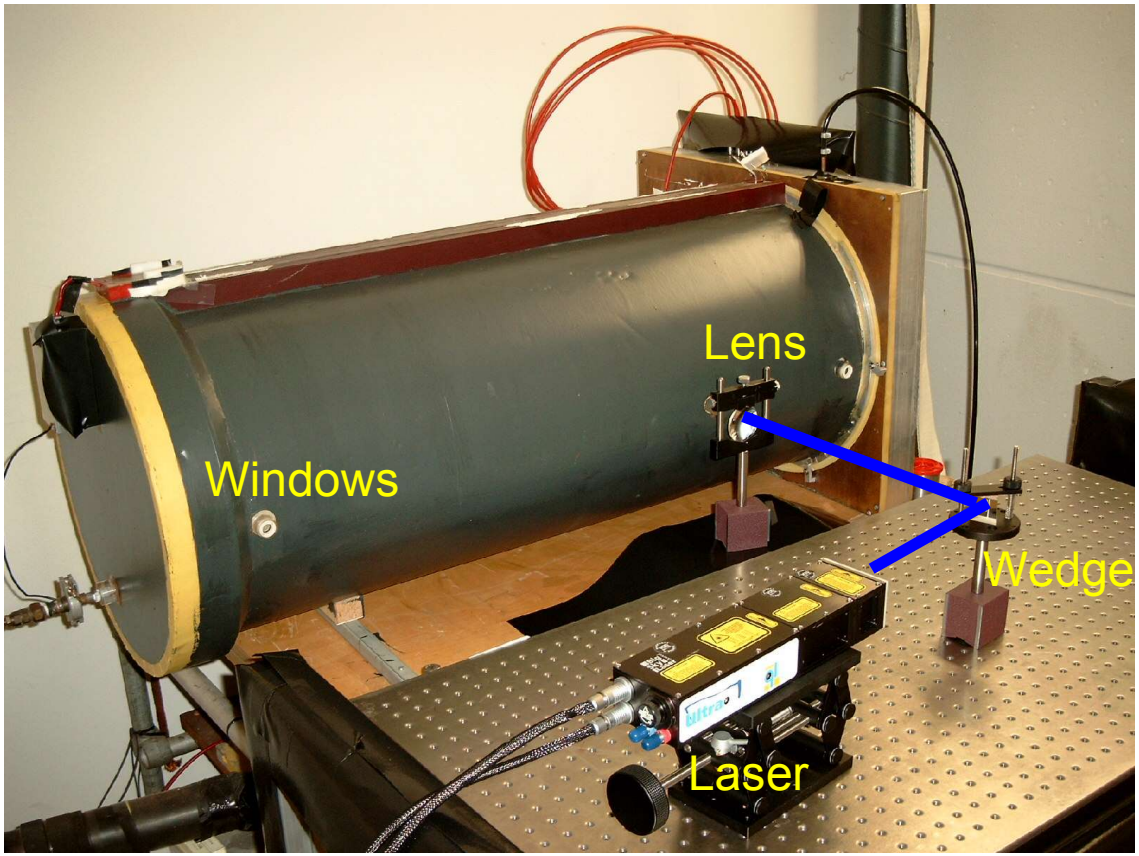
7% spread still contains statistical, thermal, ..., fluctuations

→ more work (data?) needed

UV Laser System

Preparations ongoing to measure the double track resolution in high magnetic fields with a laser system

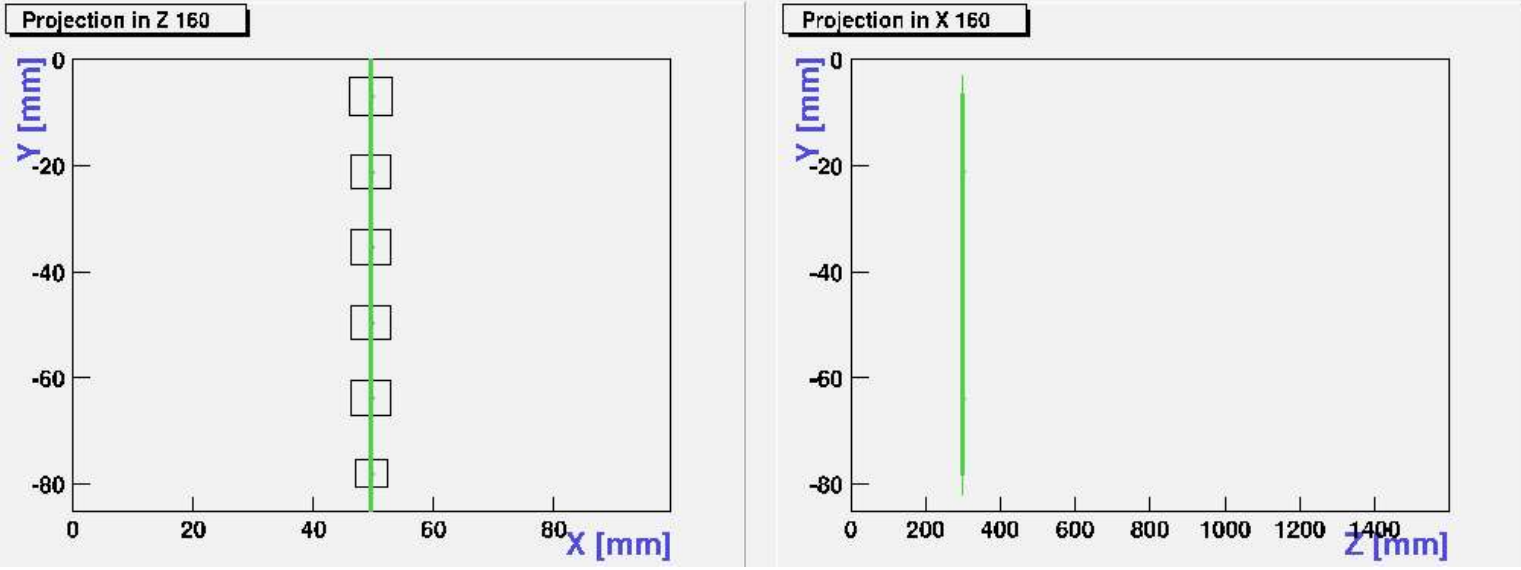
To avoid interference with measurements in magnet, the laser tests are carried out with our old chamber



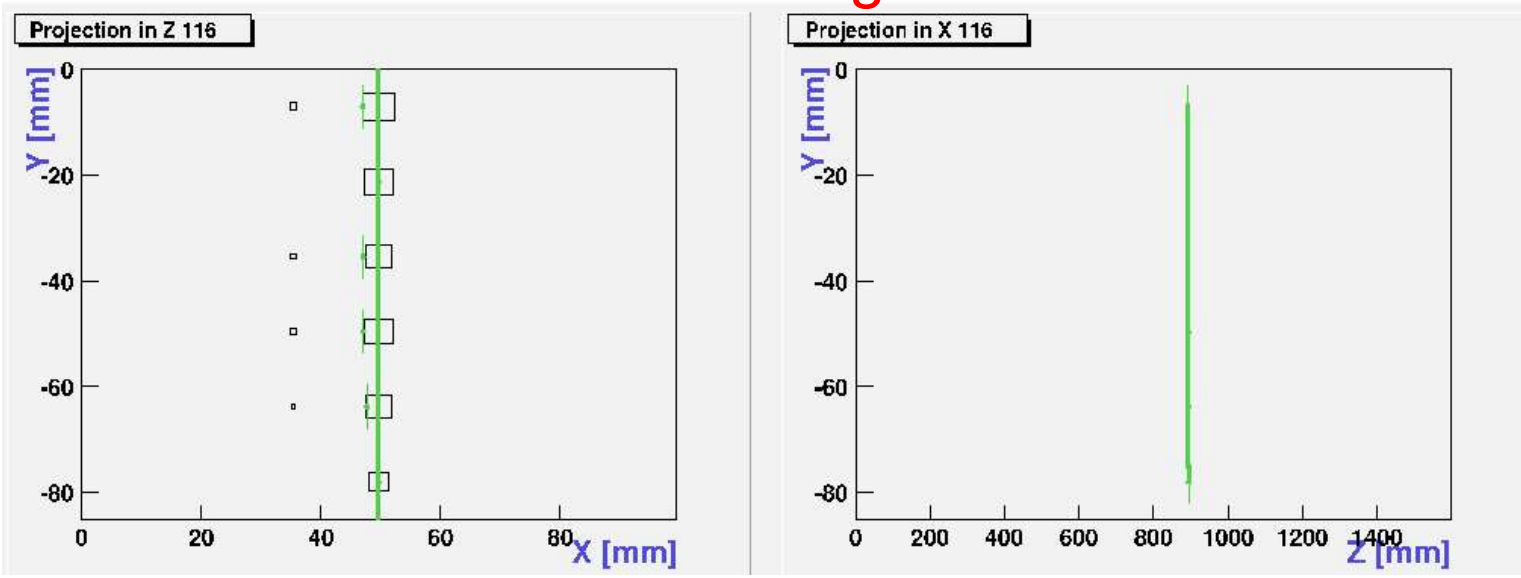
Setup used to produce first laser tracks in the TPC

First Laser Tracks

30 cm drift length:

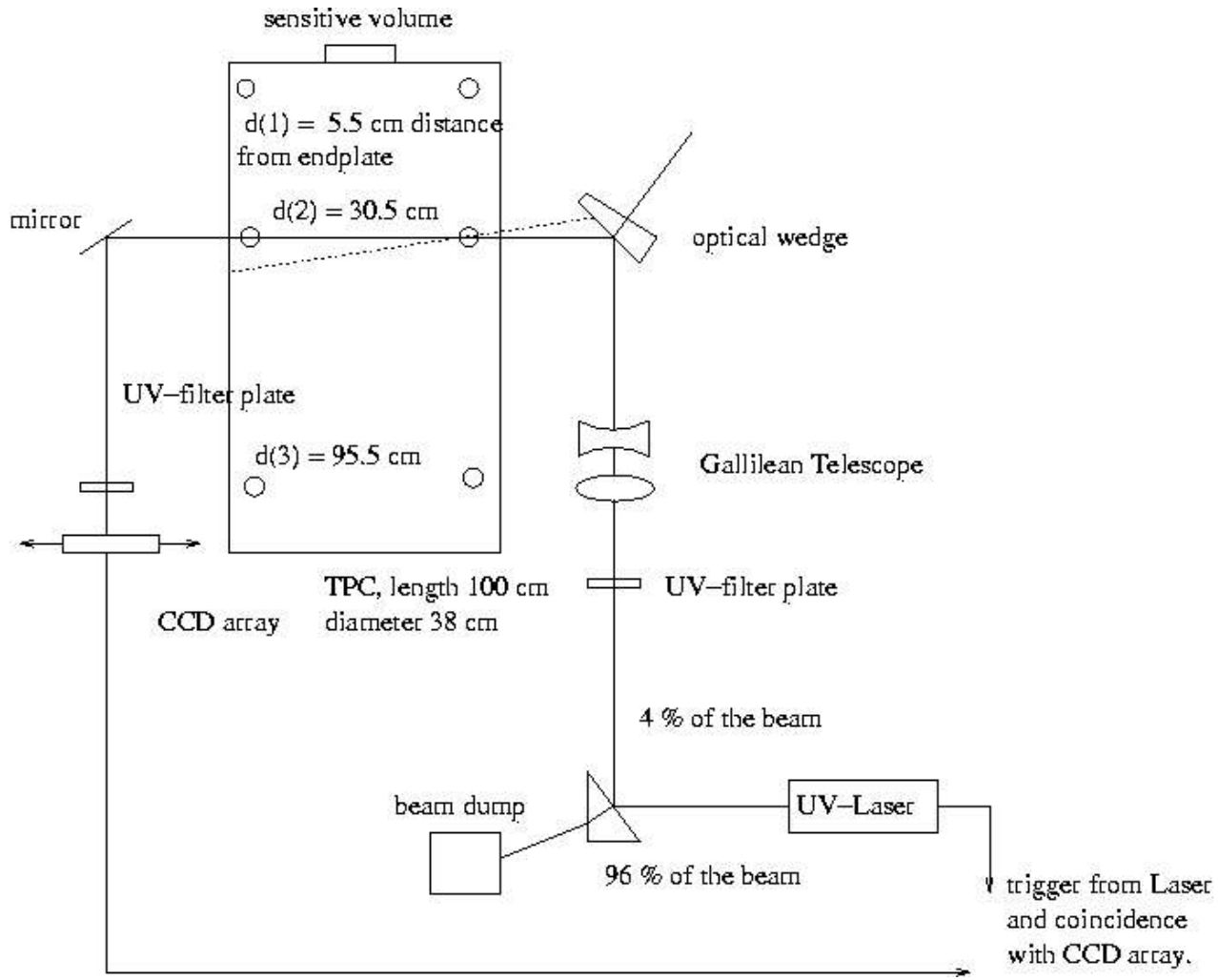


90 cm drift length:



Laser Setup for Double Tracks

Sketch of the laser setup to produce double tracks:



Setup is under construction, first double track events expected soon

Summary and Outlook

- Successful data taking in magnetic fields up to 4 T.
- Preliminary Analysis: Resolution at 4 T seems to be limited by systematic effects at the $\approx$ 130 μm level.
- Further magnet runs start this week. Runs with different pad arrangements are planned.
- First laser tracks seen in TPC. Setup to produce double tracks under construction.