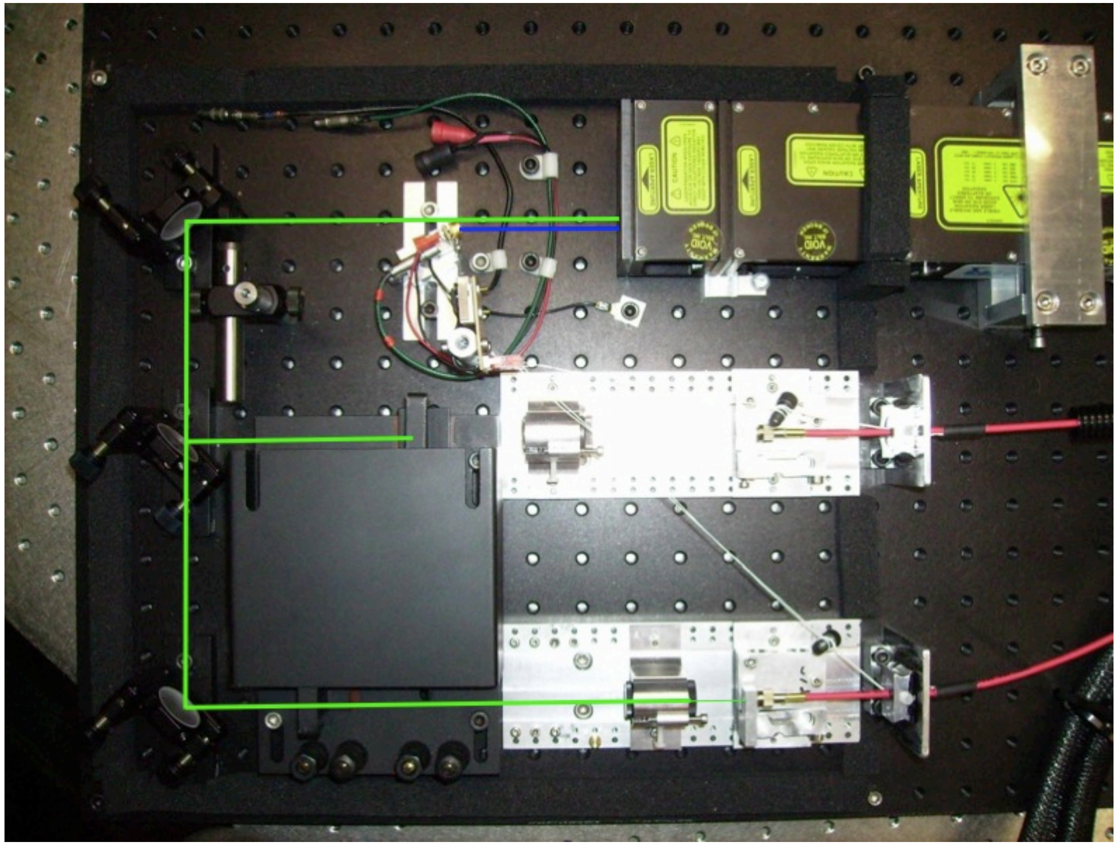
Distortion measurements from the patterned TPC cathode

Patrick Conley — University of Victoria

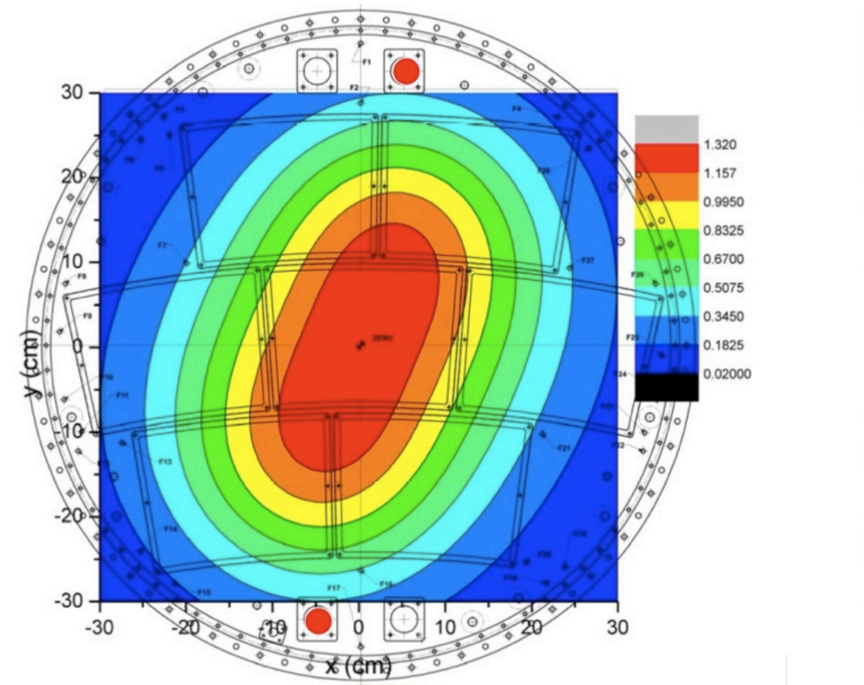
Laser system: overview

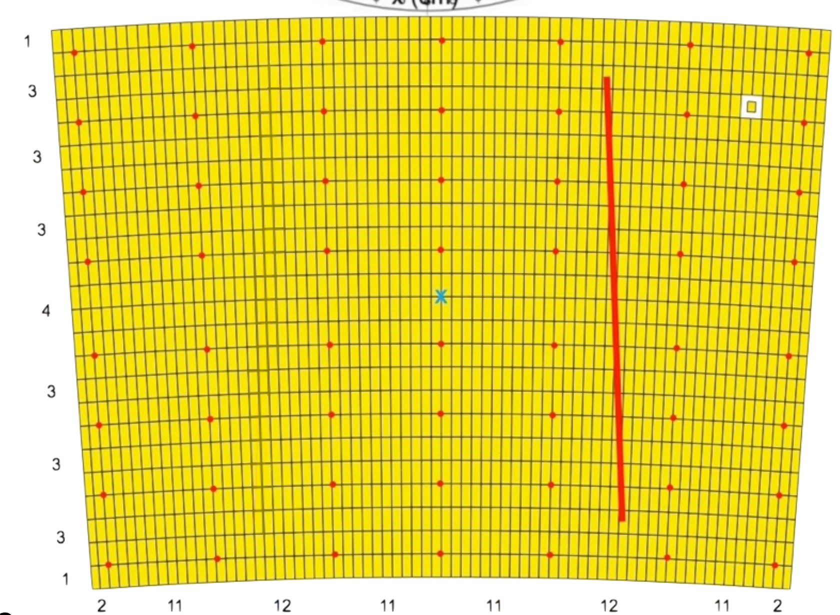
- Pulses of UV light are created from an Nd:YAG laser
- Light is split by a beamsplitter into two equal beams, which are focussed into a pair of fibre-optic cables
- Electronics trigger is provided by a photodiode (silver plate, upper-left) using stray light



Laser system: overview

- Fibres terminate at the endplate and defocus light into the TPC (red dots at top and bottom of endplate)
- Intensity on cathode is strong and constant over the central module: it was used for tests
- Cathode contains an Aluminum pattern which releases electrons by PE effect under UV light
- Positions of hits reconstructed to calculate distortions and other TPC properties (diffusion, drift velocity...)





Laser system tests

- Reconstruction is most precise when a cathode dot lies at the corner of four pads
  - Only the Saclay Micromegas modules use an appropriate geometry
  - Most tests performed with Micromegas
- An error during construction of the cathode resulted in a mirrored pattern. Not all dots were at the intersection of four pads
  - This will be fixed in a future cathode

Laser system tests May: Micromegas

- First test of the system
- Used a Micromegas with resistive foil to increase diffusion
- Used 3m fibre optic cables:
  - Discovered the laser power supply provides less power in a strong B field - tests with GEM + ALTRO and Aug. Micromegas tests used longer fibre-optic cables
  - In B=1 tests here the laser did not provide enough power to consistently give four pads of data per cathode dot
- Measurements performed:
  - Several laser intensities (to find ideal intensity)
  - Several positions of the TPC (z=4.3cm, 15cm, 30cm, 50cm beam-readout distance)
  - With HV to one dummy module unplugged
  - With a gradually-changing B field

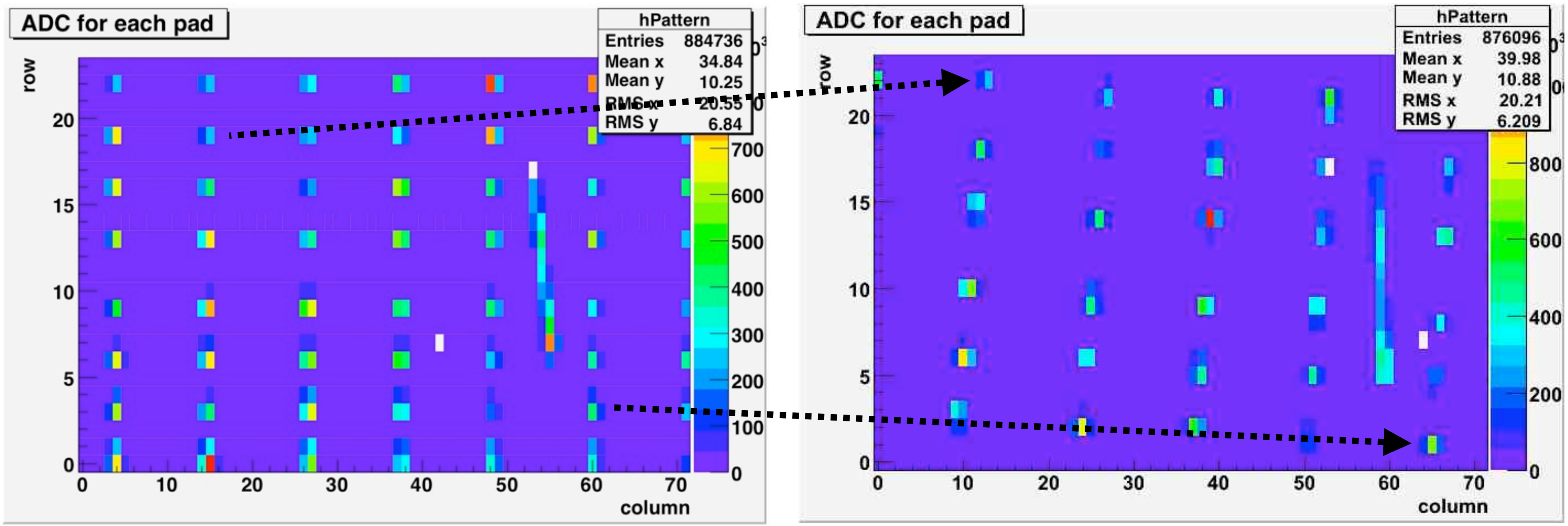
Laser system tests
May: Micromegas - Results

- Measurements performed:
  - Several laser intensities (to find ideal intensity)
  - Several positions of the TPC (z=4.3cm, 15cm, 30cm, 50cm beam-readout distance)
  - With HV to one dummy module unplugged
  - With a gradually-changing B field (to observe change in electron counts as B field increased)

Laser system tests
May: Micromegas - Results

Measurements in homogeneous and inhomogeneous fields

- Comparison of z=15cm and z=50cm positions shows strong distortions - most importantly rotation of the module
  - Easy to see with the laser system
  - Precise analysis has not been performed



z=15cm

z=50cm

Laser system tests May: Micromegas - Results

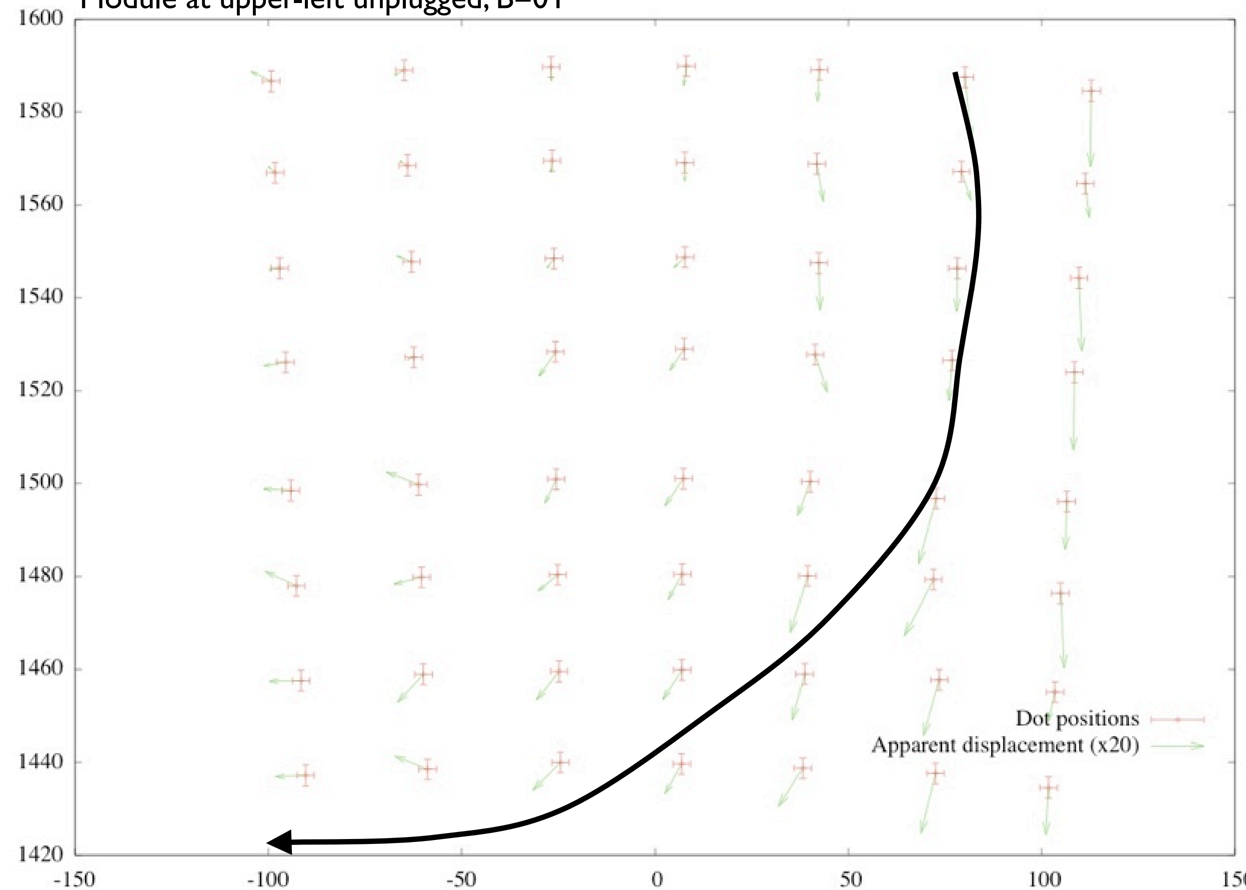
Measurements with E distortions

- Distortion in dot positions is easily measurable: direction shown with black arrow for visibility

- Unplugged module was not grounded: E distortion changed over time
  - Average distortion decreased from ~1mm to ~0mm over 400s

- Measured only in B=0T field

Module at upper-left unplugged; B=0T



Laser system tests
GEM + TimePix

- Brief measurement taken during TimePix tests
  - Readout is only large enough to display one (and another half) cathode dot
  - Enough to demonstrate the laser and TimePix work together
  - No analysis attempted

Laser system tests JGEM + ALTRO

- First use of longer fibre-optic cables
  - Intensity scan showed that higher electron counts were possible in B=1T; hits covered 2-3 rows
- Measured:
  - Different drift lengths (different B homogeneities)
  - Two drift fields (E=140,230V/cm), at two B fields (B=0,1T)
- Analysis has not been performed

Laser system tests
August: Micromegas

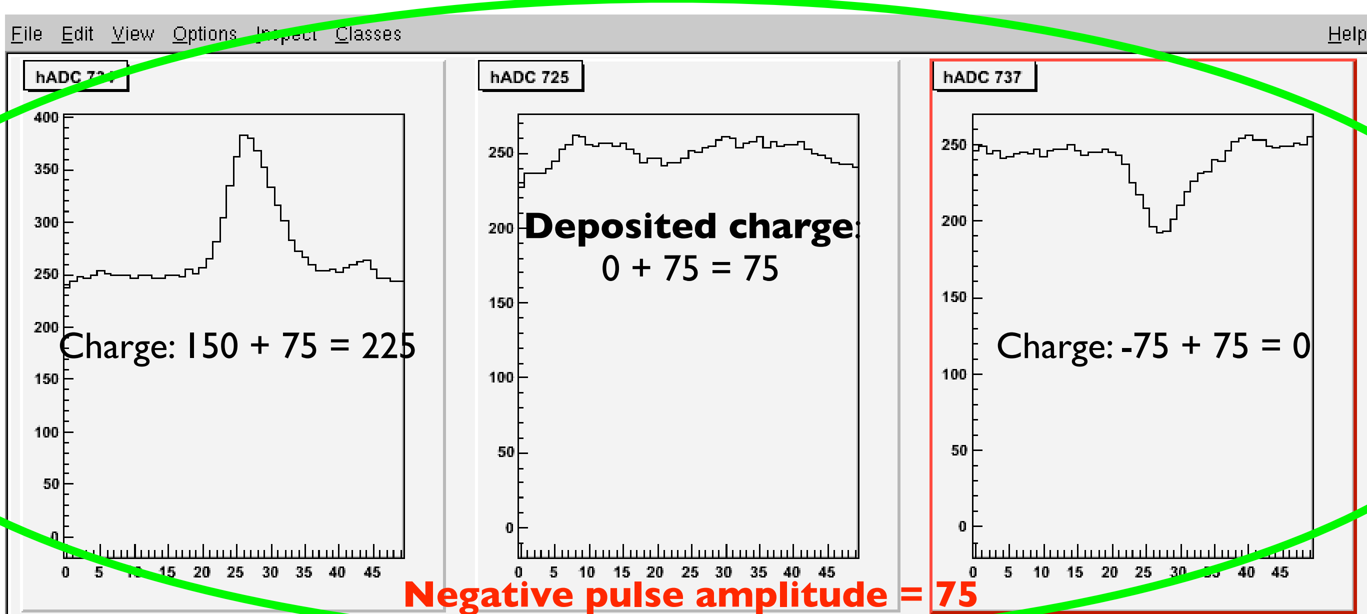
- Used a Micromegas without resistive foil: known diffusion allows precise reconstruction
- Use of long fibres does allow higher electron counts, hits on multiple rows
  - Multi-row hits allow much more precise reconstruction
  - One fibre was discovered to be damaged - cost was uneven light intensity on cathode
- August data has not yet been analysed in detail

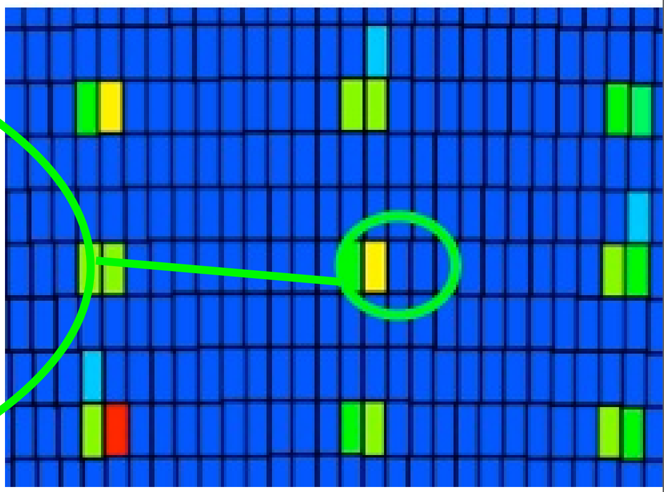
- Measurements performed:
  - Several drift fields
  - Several positions of the TPC (z=4.3cm, 15cm, 30cm, 50cm beam-readout distance)
  - With HV to one dummy module grounded (B=1T)
  - Distortions in B=1T, B=0.5T
  - Without zero-suppressed data
  - With fibres shining individually into top and bottom of endplate

Laser system tests
August: Micromegas - Results

Negative-polarity pulses

- Charge deposited during the 7ns laser pulse drains the mesh - apparent charge on all pads drops by a significant amount: Correct charge deposited on a pad is (amplitude of signal) + (amplitude of negative pulse)
  - Amplitude of negative pulse can be measured from pads far from any dots
- Most measurements were taken without zero-suppression: we can reconstruct the negative charge and positive charge on apparently un-hit pads (eg. hADC 725 below)





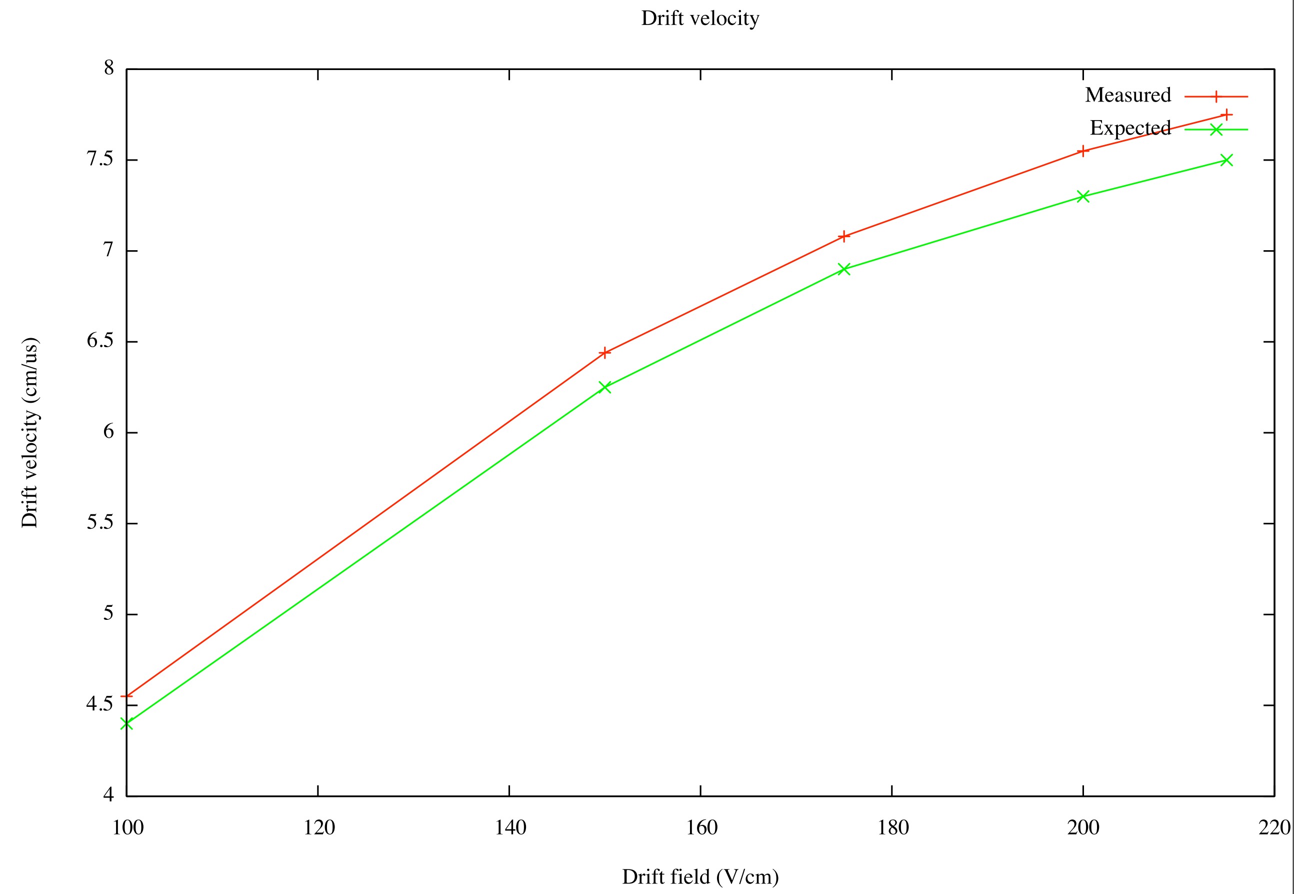
Laser system tests August: Micromegas - Results

Drift velocity

- Cohesive laser pulse gives us precise information about drift velocity after few events

- Measurements of drift velocity in several E fields show good agreement with expectations

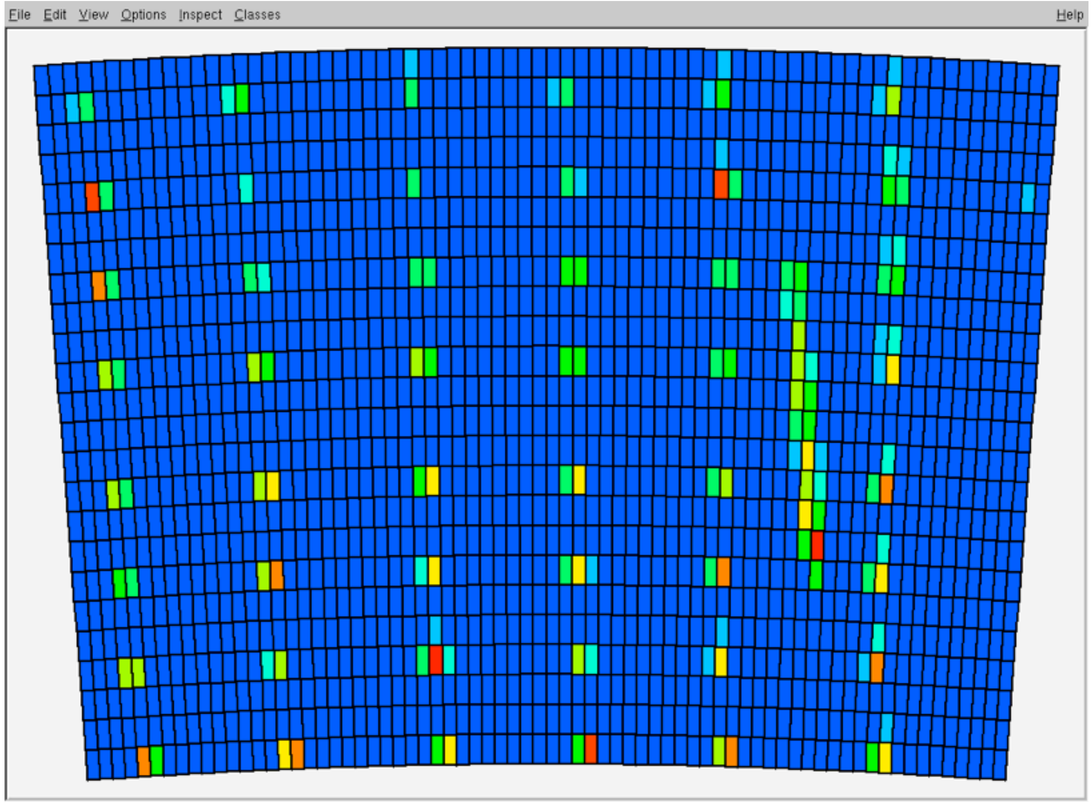
- Velocity measured at these drift fields at different magnetic fields and in inhomogeneous magnetic and electric fields



Laser system tests August: Micromegas - Results

Inhomogeneous E field

- Measurements have been taken with one dummy module removed from HV and grounded, and with all dummy modules grounded.
- Similar measurements were taken in May without magnetic field, and without grounding. In all but one case distortions were undetectable.
- All dummy modules have been grounded (B=1T)
- The top has been shifted slightly left relative to the bottom



Summary

- Laser system measures distortions in the TPC using photoelectrons created by sources at known positions on the cathode
- System was tested with Micromegas + T2K electronics, GEM + ALTRO, and GEM + TimePix. Cathode pattern is properly measured by all systems
- Analysis of Micromegas data shows consistent measurement of drift velocity and distortions
- Much of the analysis still needs to be performed