Performance studies of the LC-TPC GEM module using a UV laser system

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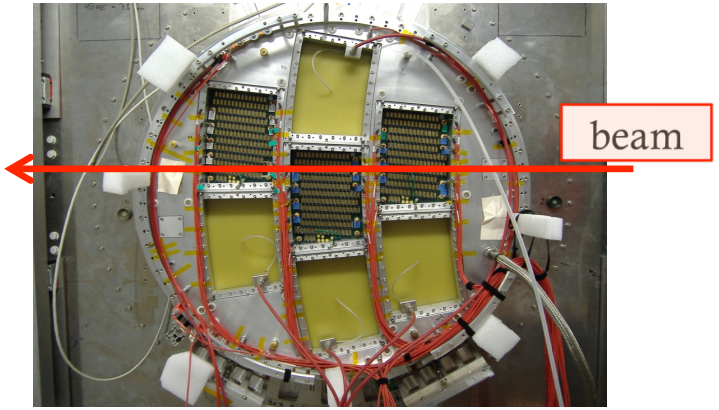
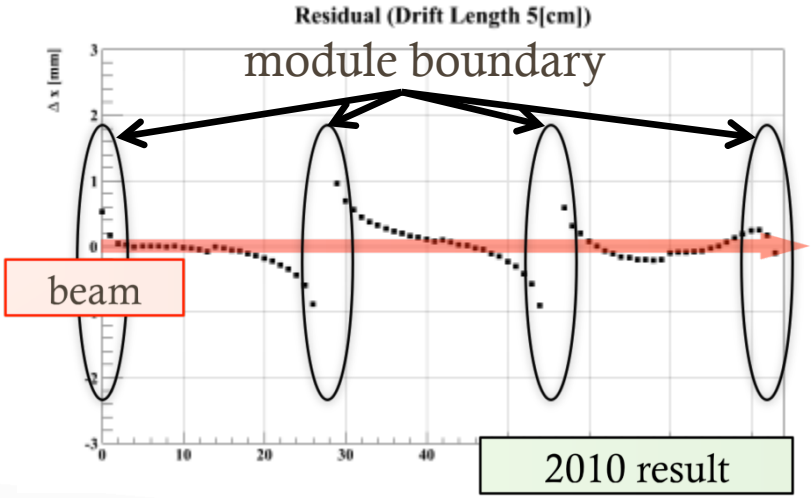
LP1(Large Prototype1)TPC





We had the beam test
in 2009.2010 at DESY.

We found the big Distortion.

Reason of this Distortion;
The electric field of the
GEM module was bent.

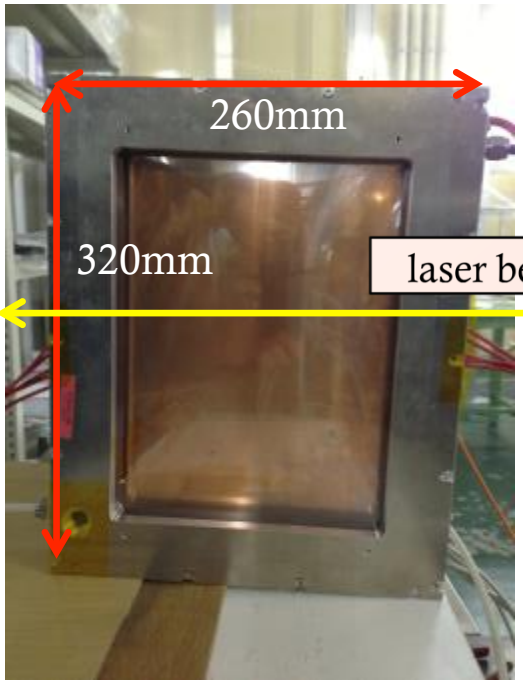
Purpose

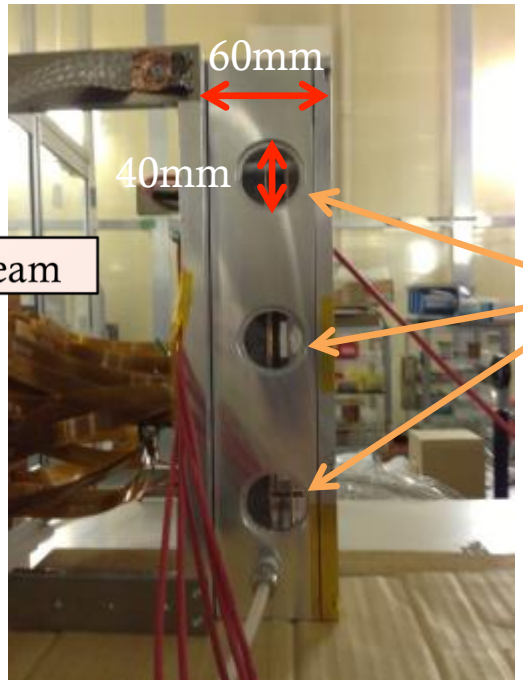
We should check the electric field before beam test.

But, we do not have any system to evaluate the Distortion.

The performance of GEM-TPC is investigated
by using ultraviolet laser.

Test Chamber





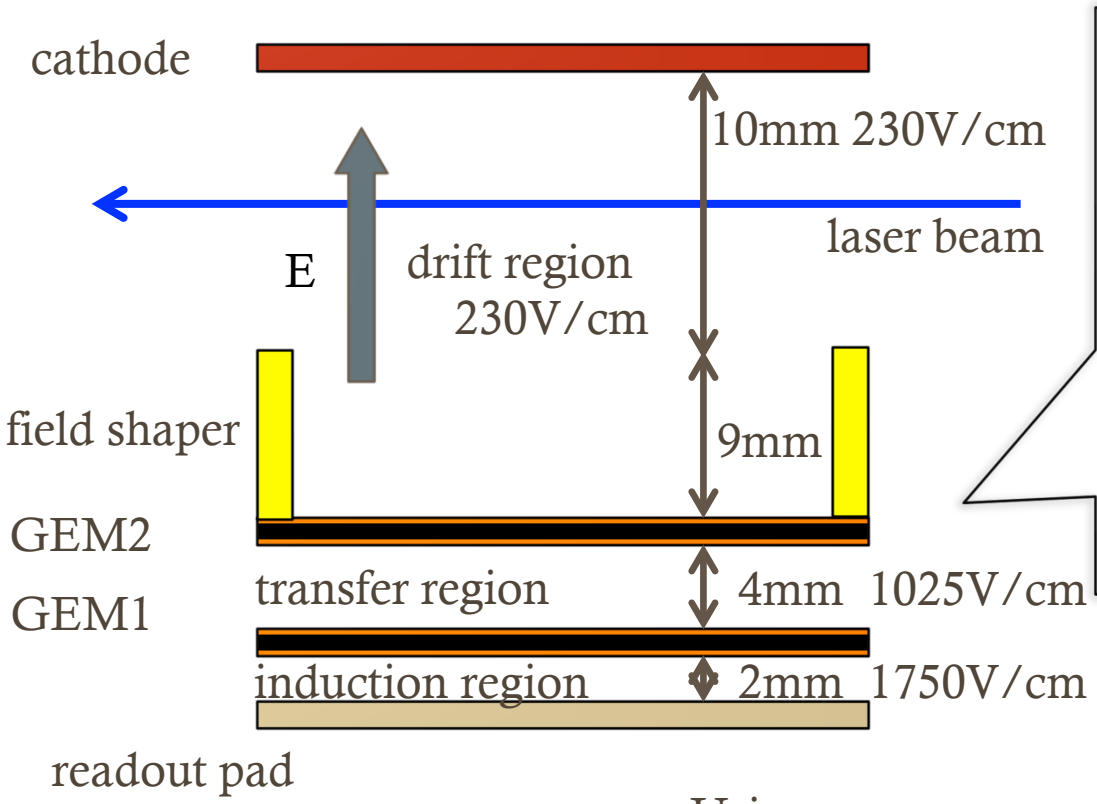
Chamber size

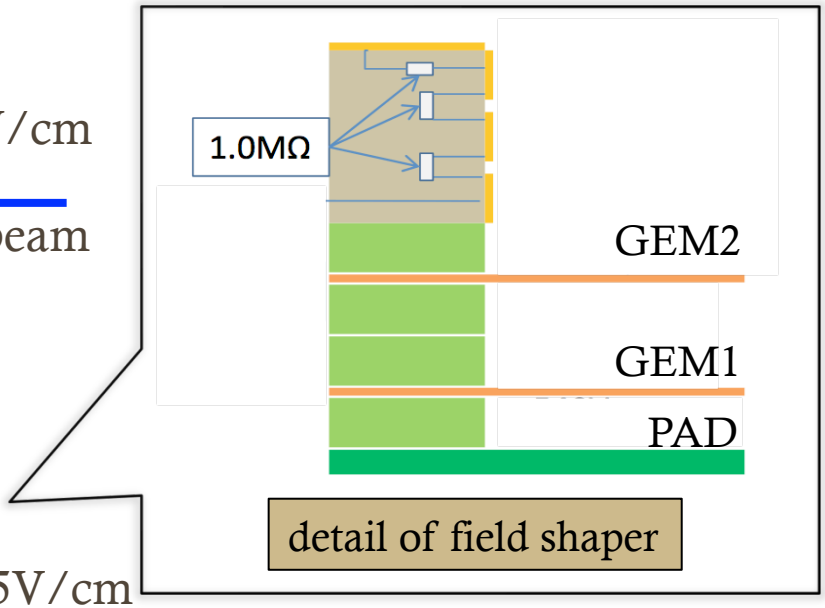
260mm×320mm×60mm

Laser

Nd-YAG laser wavelength: 266nm
rate: 1~20Hz (Using 10Hz)

Layout sketch



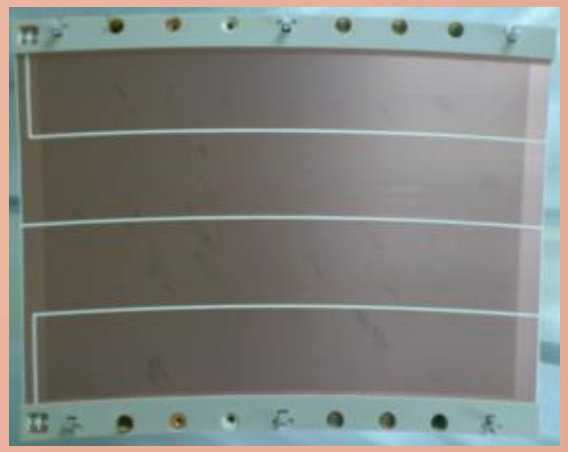


Using gas

T2K (**Ar : CF_4 : $isoC_4H_{10}$=95 : 3 : 2**)

GEM

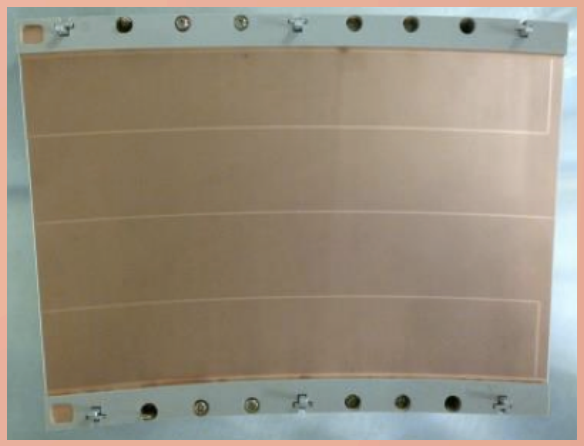
Old GEM



used in 2012 beam test

It has 1mm electrode boundary
on both sides.

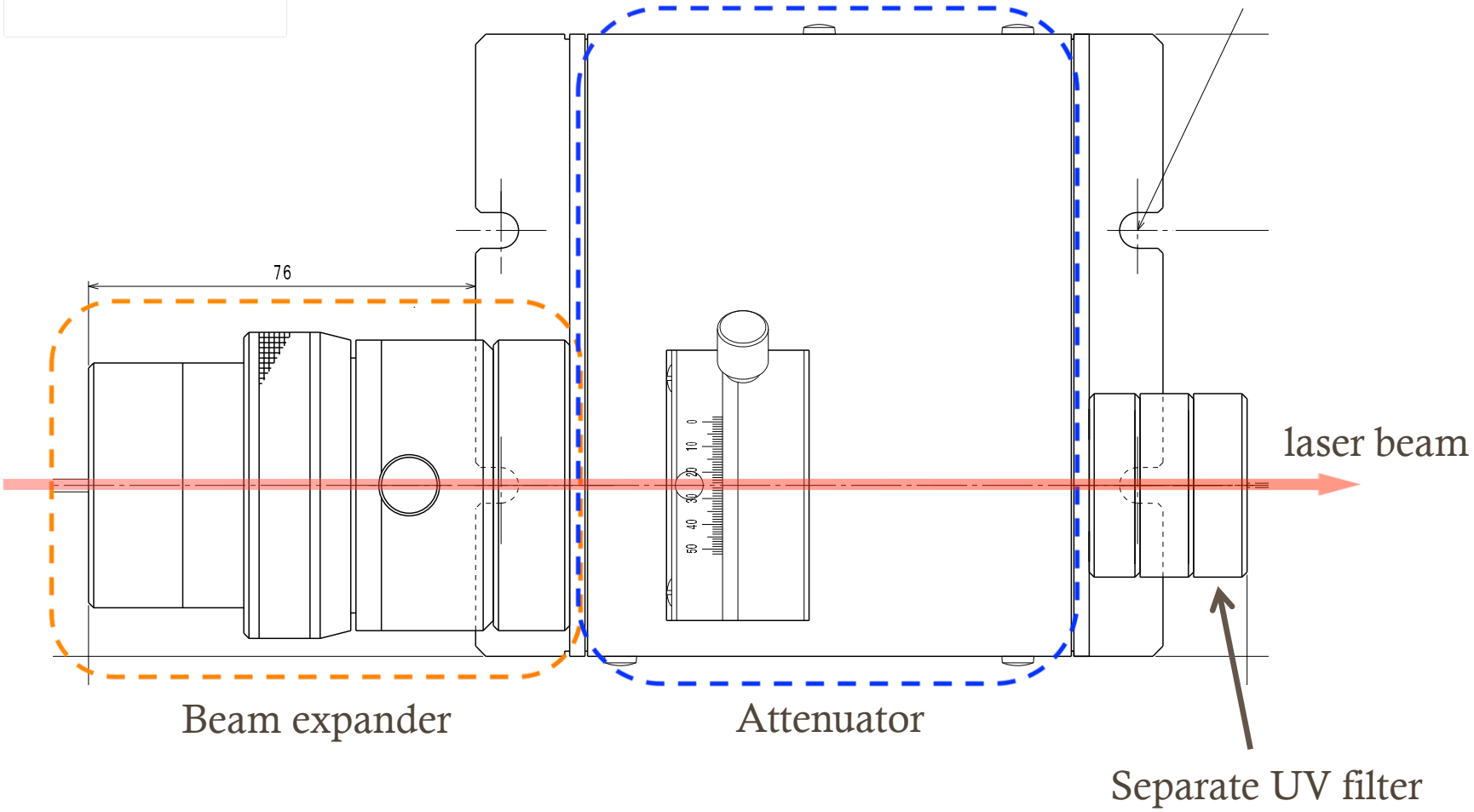
New GEM



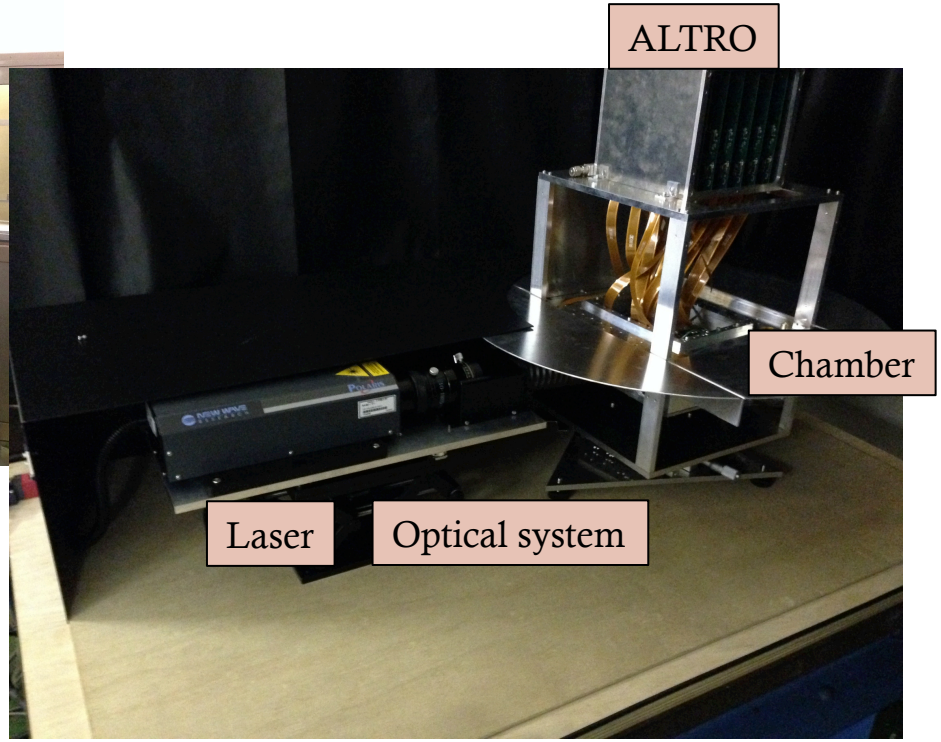
Front side :
No electrode boundary

Back side :
0.5mm electrode boundary

Optical set up

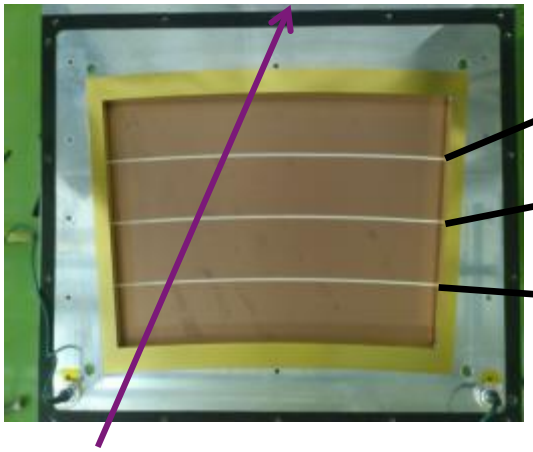


Laser system

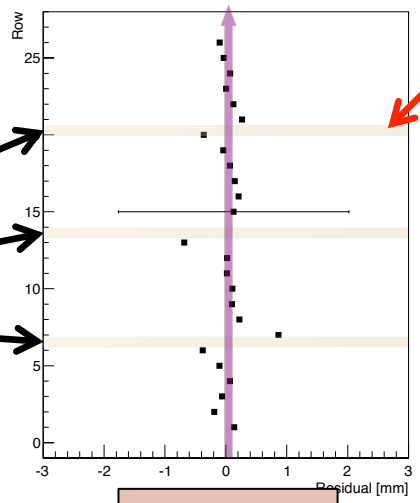


Results of old GEM (2012)

laser



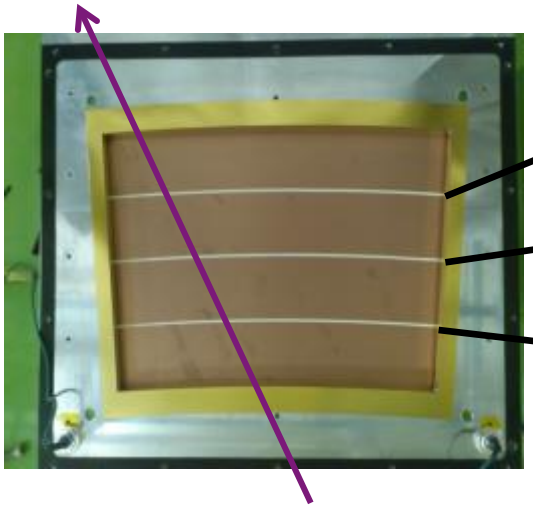
laser

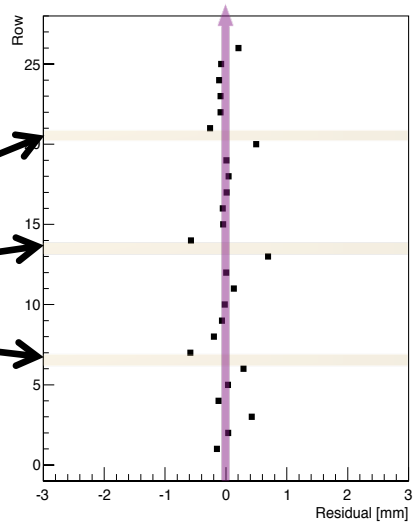


GEM boundary (1mm)

Distortion found at the near of the electrode boundary.

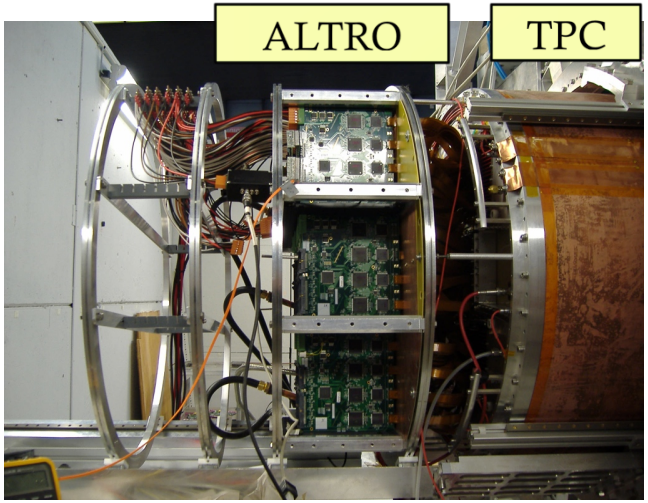
Residual

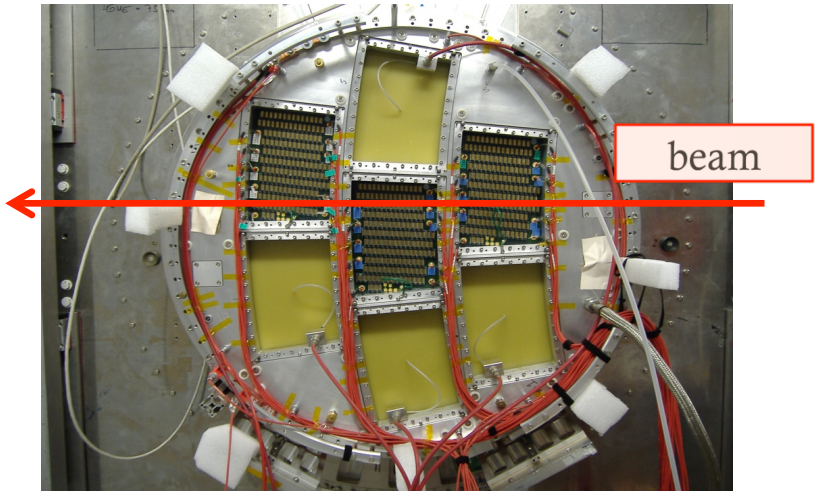


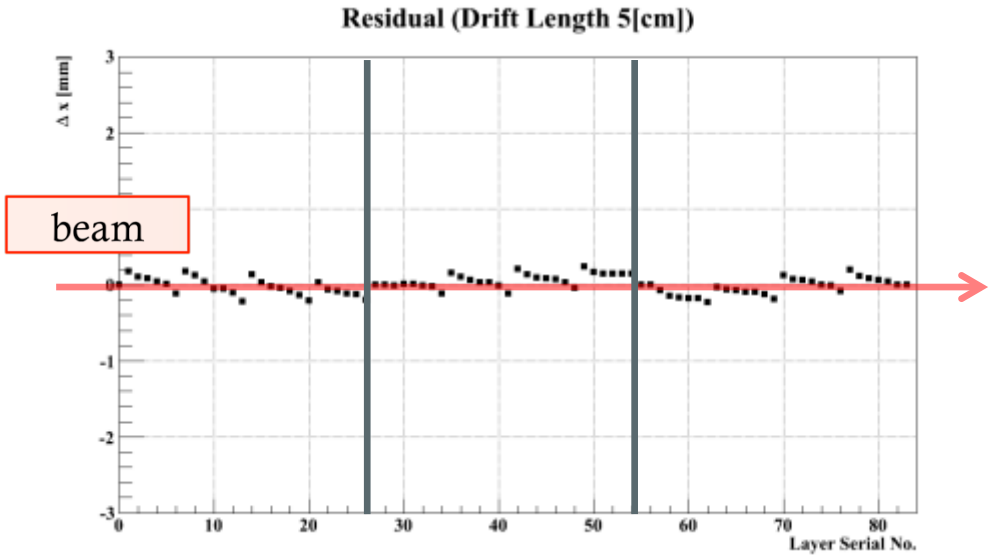


Opposite Distortion

2012 Beam Test







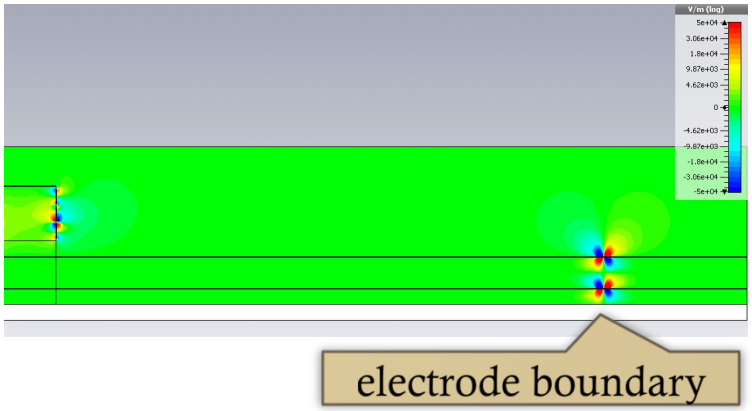
The result of beam test is also identical with laser test.

Simulation with old GEM

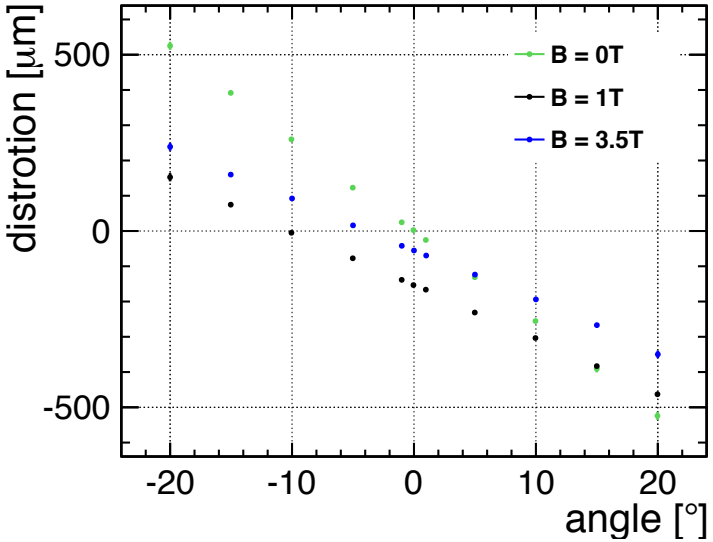
Simulation of electric field

Distortion from GEM electrodes

- Field transverse to the drift direction
- Scale (logarithmic): $[-500\,\mathrm{V/cm}, 500\,\mathrm{V/cm}]$

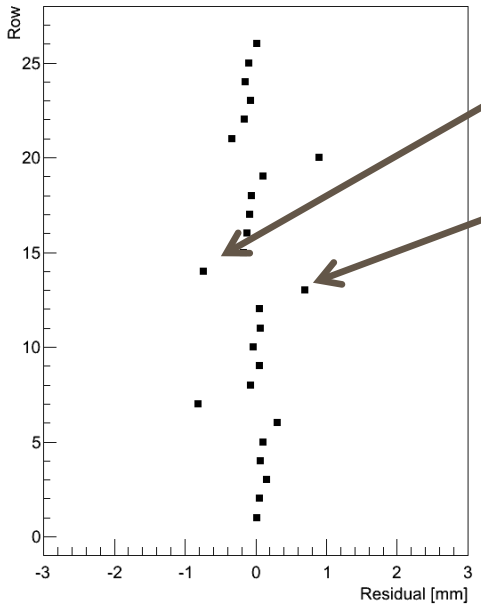


Angle dependency of distortions



by K.Zenker

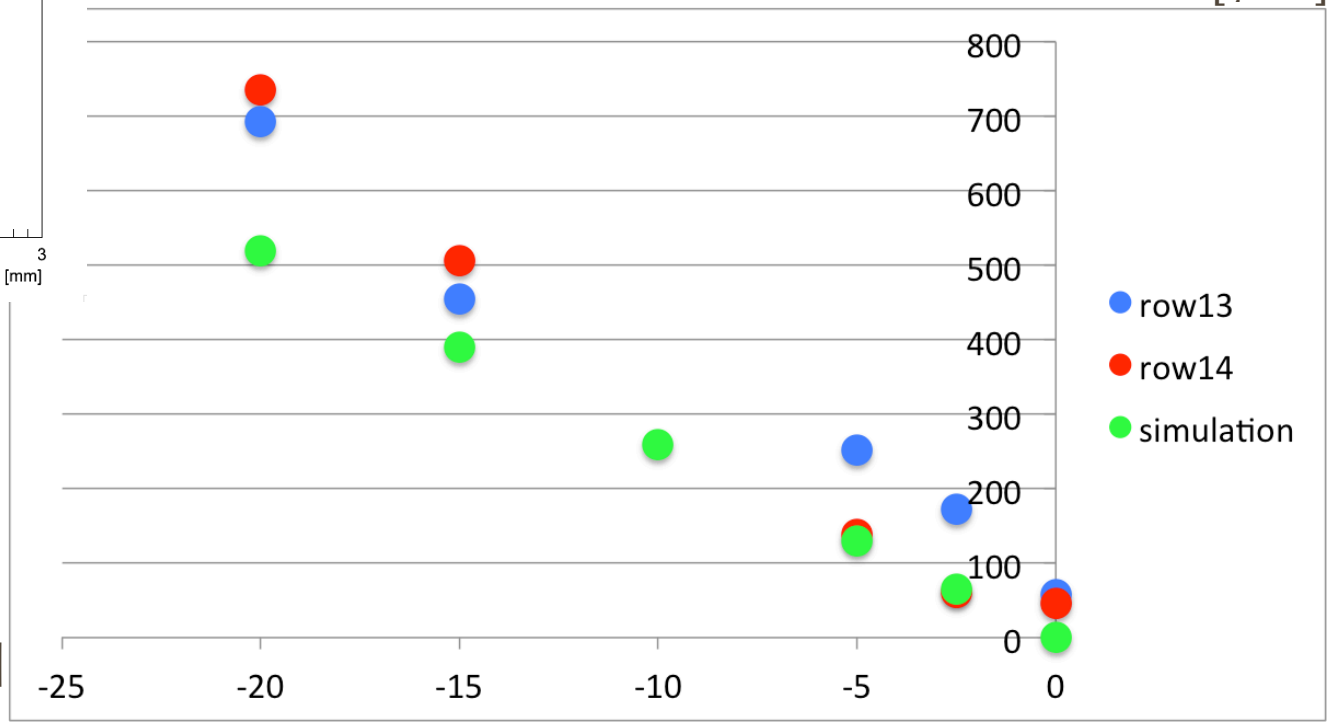
Comparison with simulation



row14

row13

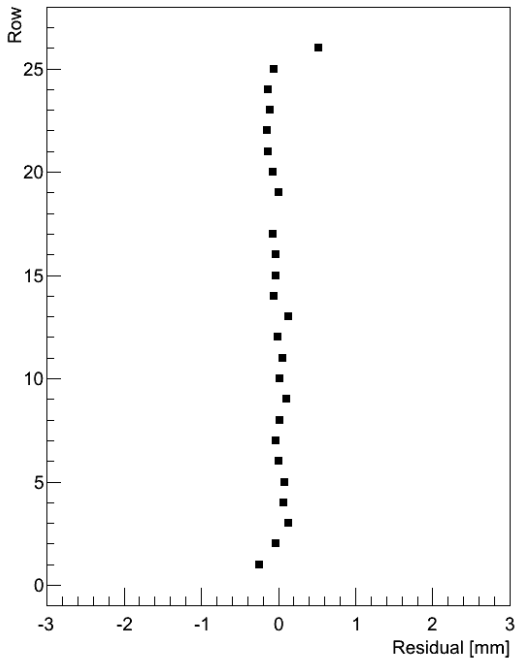
distortion[μ m]



angle[°]

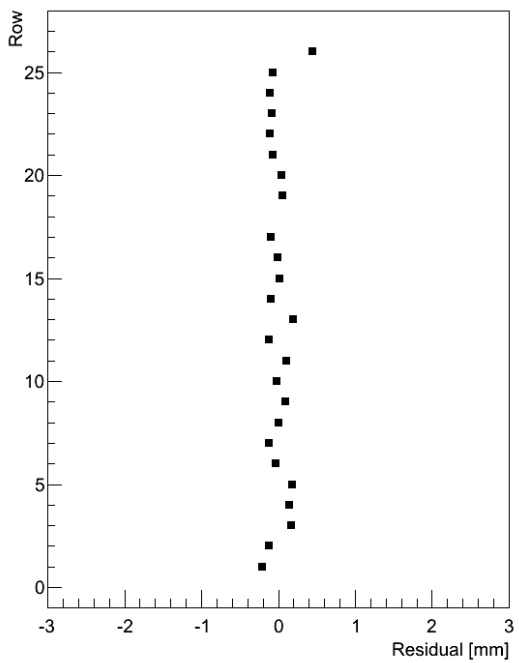
Results of New GEM

15°



Distortion : ~100 μ m

20°



Distortion : ~150 μ m

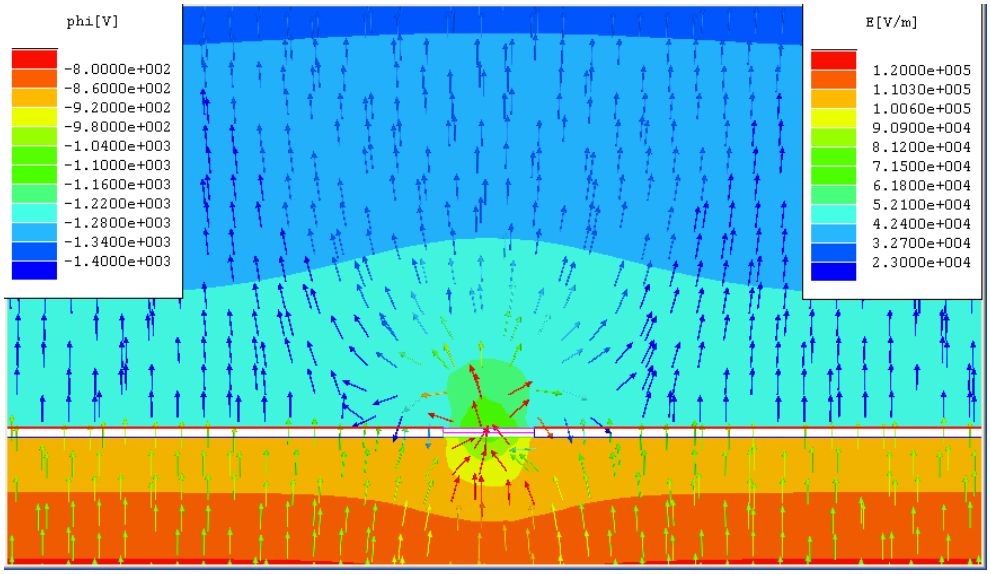
Distortion is much lower !!

Summary

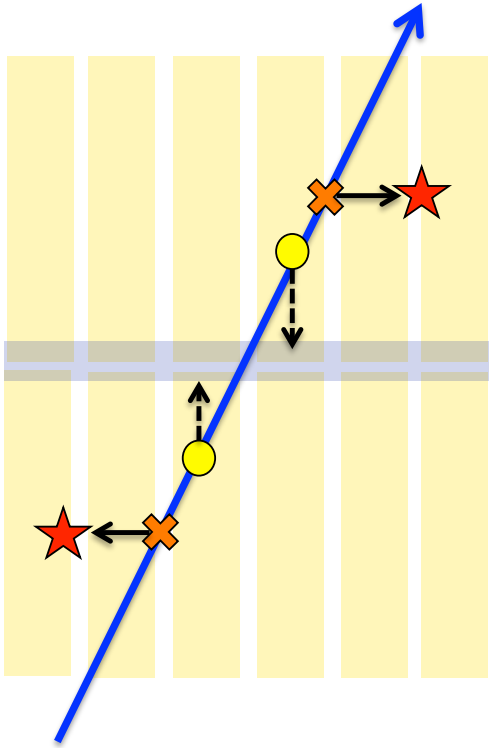
- We created a system to check the electric field using a UV laser.
- We checked distortion of the electric field around GEM boundary, and we found that 1mm boundary is too wide.
- From comparison with the 2012 beam test and simulation, we can say this system is useful as a way to evaluate the distortion.
- And, we have confirmed that the new GEM distortion is much smaller than old GEM.
- Next: check the distortion of wire gate with new GEM

Consideration

Electron goes to the GEM boundary, because the transfer region's electric field is much higher than drift region.
Because electron charged up the boundary, and the C.O.G of electron is biased which led the distortion.



Electric field around GEM boundary



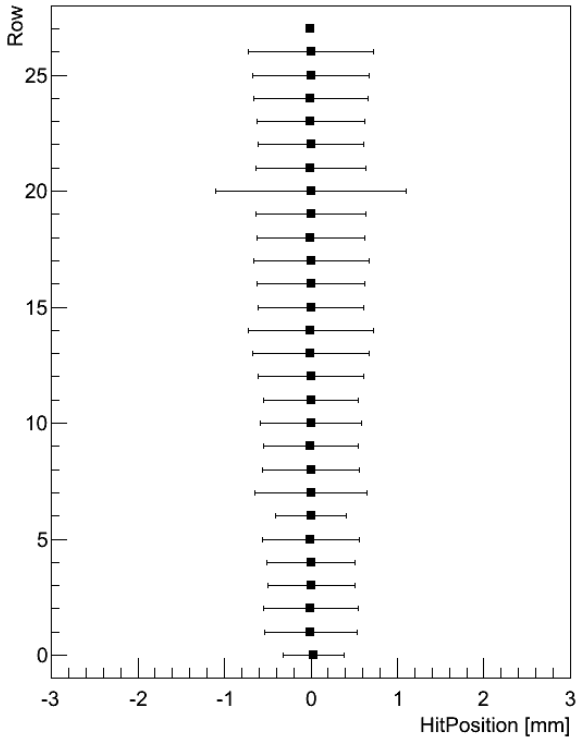
The schematic near the boundary

:electron

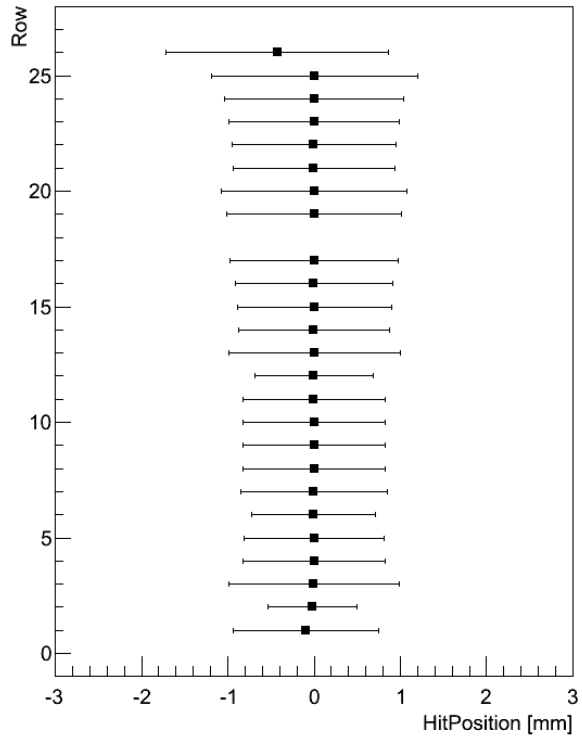
:correct hit

:real hit

Laser beam profile



Old GEM : 20°



New GEM : 20°

Noise study

Last year

- Use all
  RMS: about 2~3

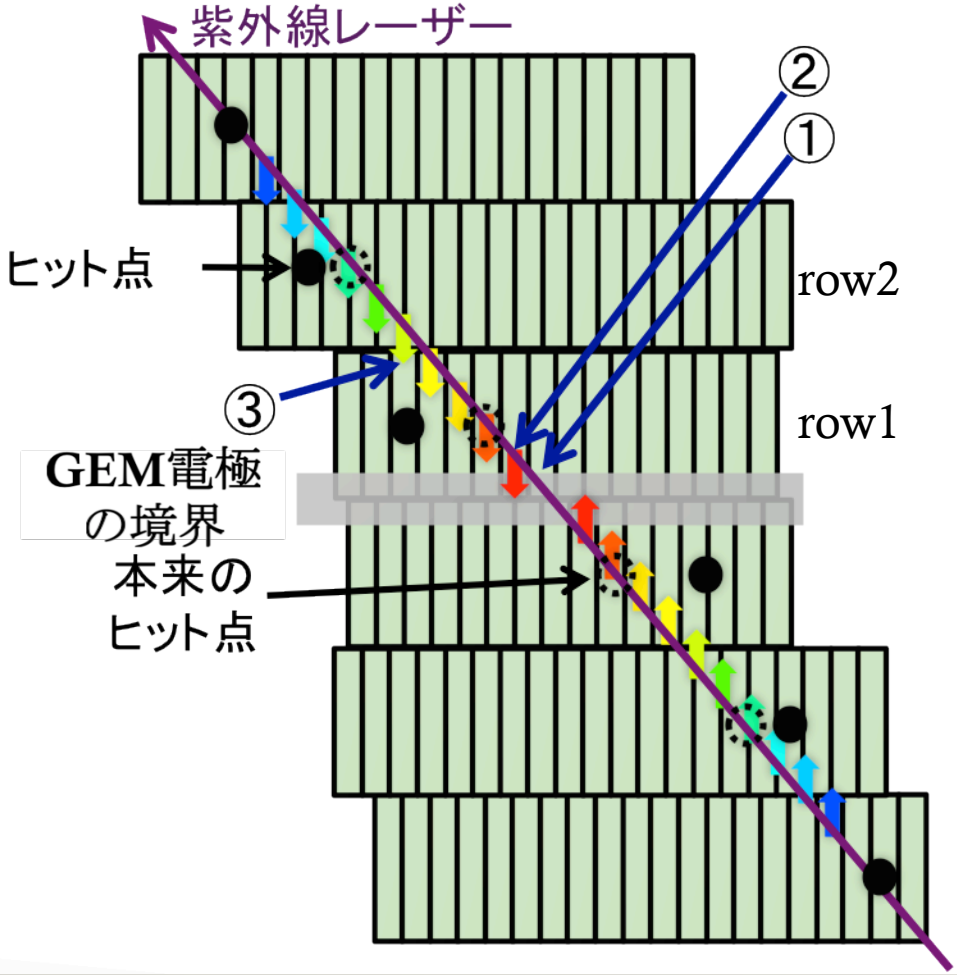
Change
- make new frame
  united ALTRO and chamber
- new HV cable
  attached ground line

Now

- No high voltage and laser
  RMS: about 1
- No laser
  RMS: about 1
- Use all
  RMS: about ~1.1

very good!!

考察



row1の①のパッドに到達するはずの電子はGEMの境界に阻まれ到達できない

row1の②のパッドに到達するはずの電子は境界へ向かう電場の歪みにより到達できない

③の本来row2に到達する電子は境界へ向かう電場の歪みによりrow1のパッドに到達してしまう

これらによりDistortionが発生