

A simulation of track distortion in GEM module

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June 19, 2014

Outline

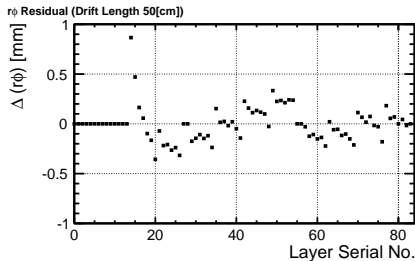
- 1 Introduction
- 2 Simulation tools
- 3 Electric field
- 4 Distortion of GEM

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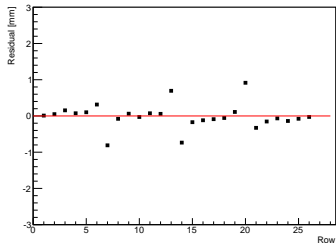
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Introduction

- Track distortion near the GEM gap was observed in both beam test and laser test.
- We try to explain the distortion by simulation.



(a) Beam test



(b) Laser test

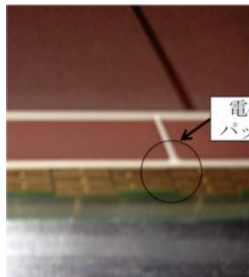
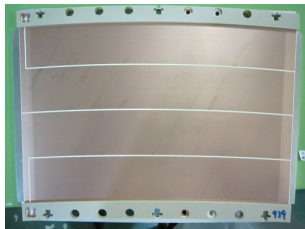


図 5.2.3 中心の GEM の電極境界とパッドの関係図

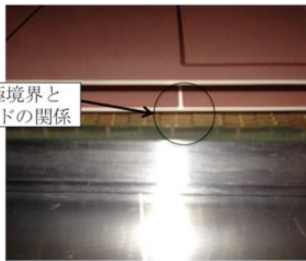


図 5.2.4 左右の GEM の電極境界とパッドの関係図

Table 1 : The relative position of pad centers and gap centers

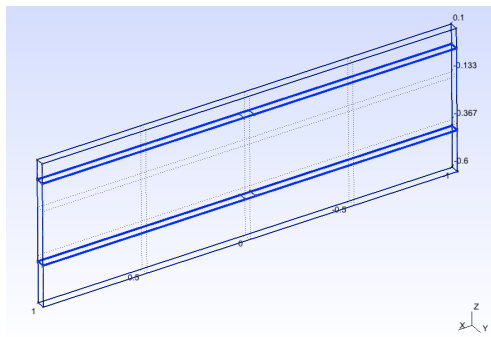
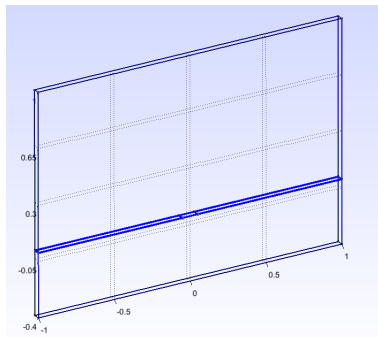
Row	Distance
6	-0.435
7	0.1
13	-0.265
14	0.265
20	-0.1
21	0.435

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Simulation tools

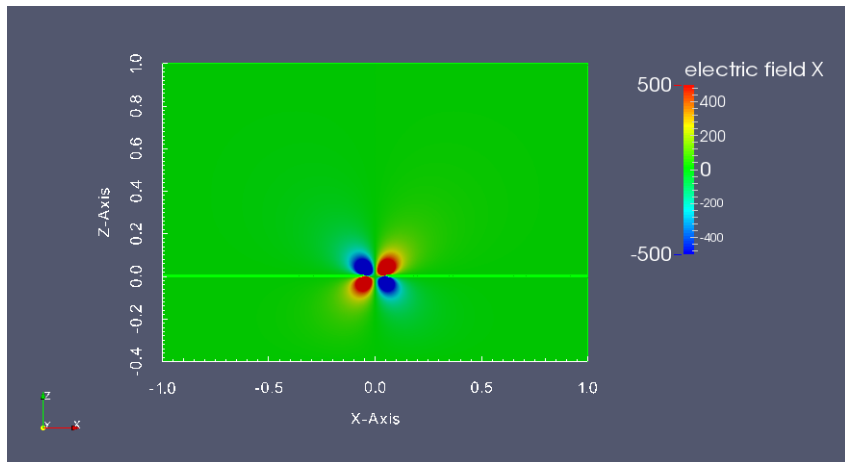
- Gmsh: create detector geometry and mesh.
- Elmer: electric field calculation with FEM.
- Garfield++: MC simulation software for gaseous detector.



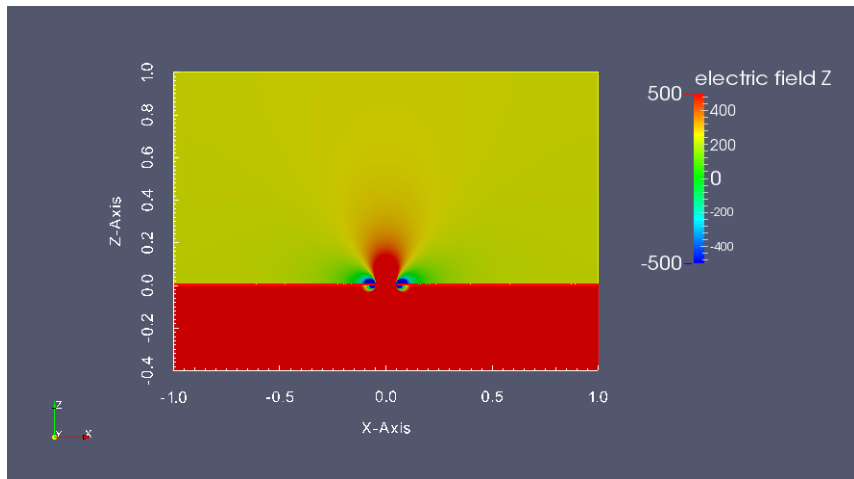
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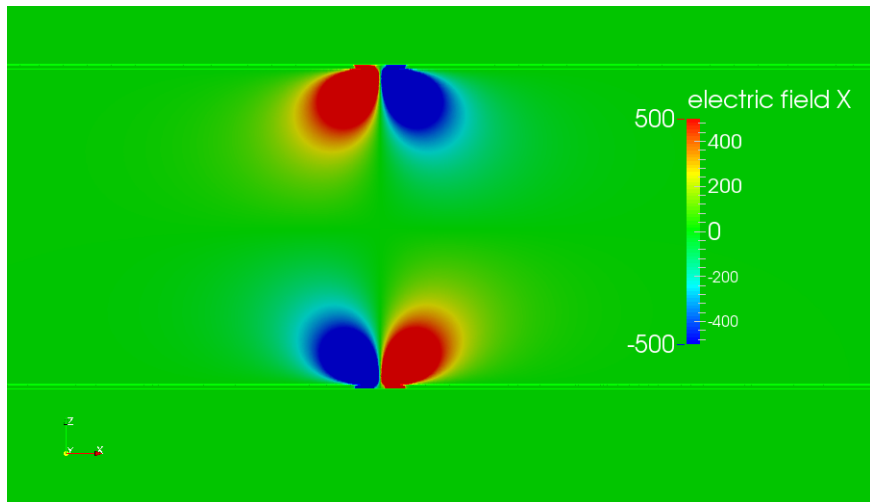
Electric field of old GEM (E_x)



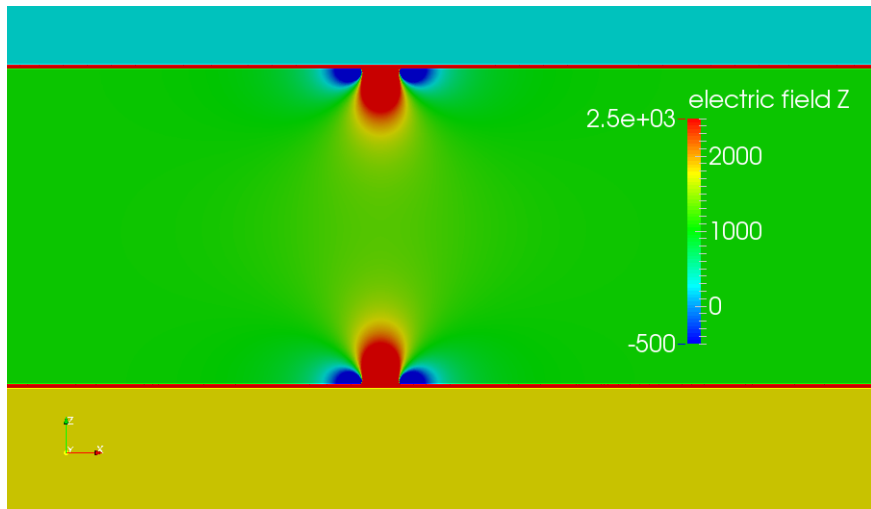
Electric field of old GEM (E_z)



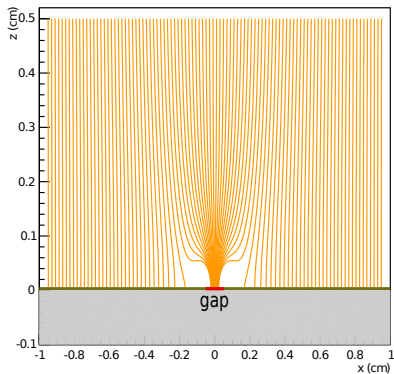
Electric field of new GEM (E_x)



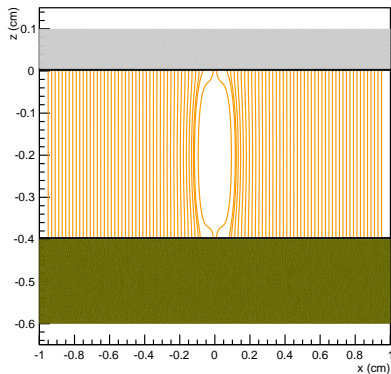
Electric field of new GEM (E_z)



Drift lines



(a) Old GEM



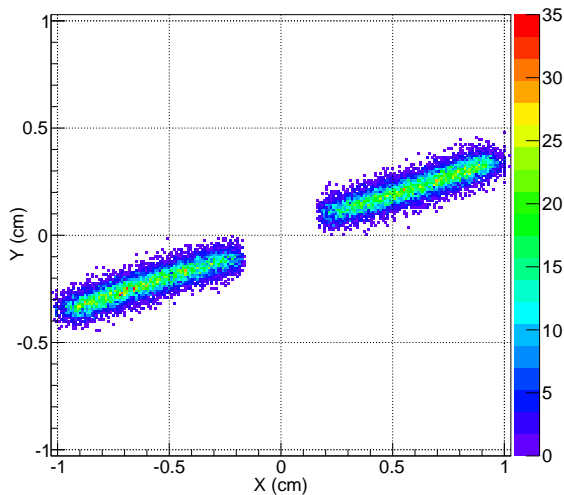
(b) New GEM

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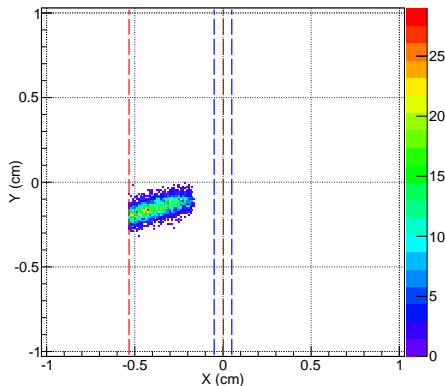
Electron endpoints (B=0 T)

Angle: 20°



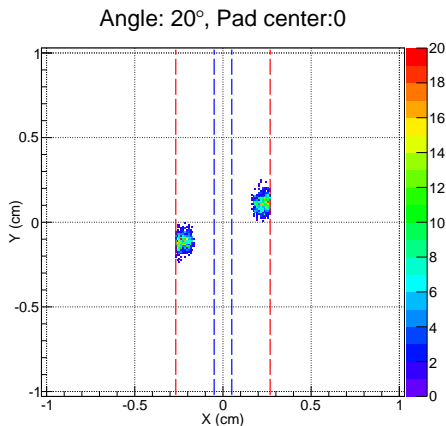
Distortion calculation

Angle: 20° , Pad center: -0.265



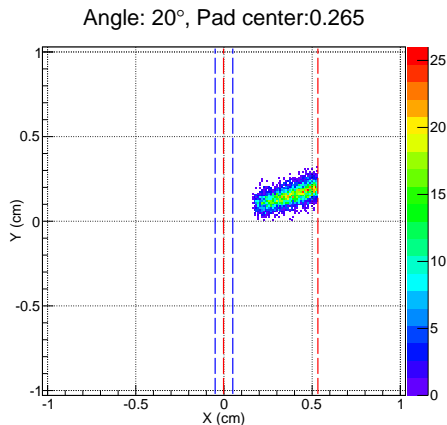
$$\bar{y} = -0.153 \text{ cm}, y_{\text{exp}} = -0.265 \times \tan(20^\circ) = -0.096 \text{ cm}$$
$$\text{distortion} = \bar{y} - y_{\text{exp}} = -0.056 \text{ cm} = 560 \mu\text{m}$$

Distortion calculation



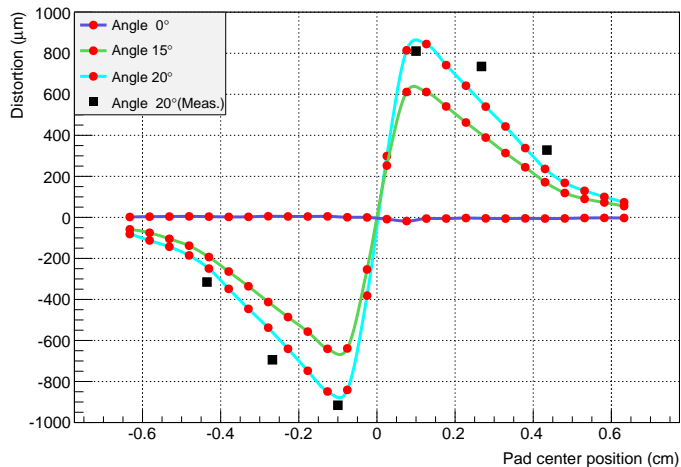
$$\bar{y} = -0.0041 \text{ cm}, y_{\text{exp}} = 0. \times \tan(20^\circ) = 0. \text{ cm}$$
$$\text{distortion} = \bar{y} - y_{\text{exp}} = -0.0041 \text{ cm} = 41 \mu\text{m}$$

Distortion calculation

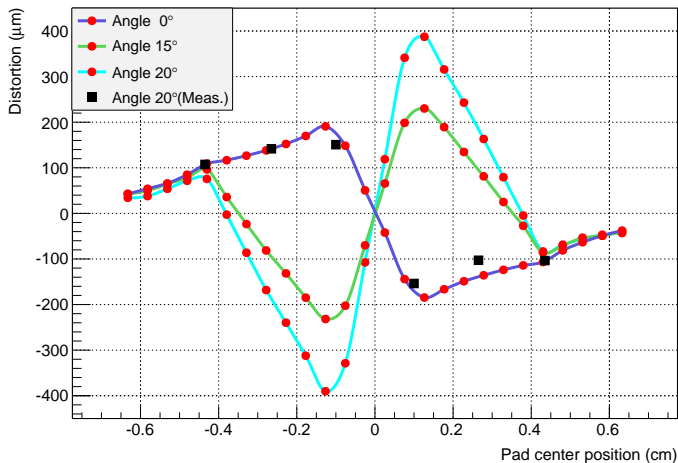


$$\bar{y} = 0.153 \text{ cm}, y_{\text{exp}} = 0.265 \times \tan(20^\circ) = 0.096 \text{ cm}$$
$$\text{distortion} = \bar{y} - y_{\text{exp}} = 0.057 \text{ cm} = 570 \mu\text{m}$$

Track distortion at B=0T (laser test)



Track distortion at B=1T (beamtest, 2012)



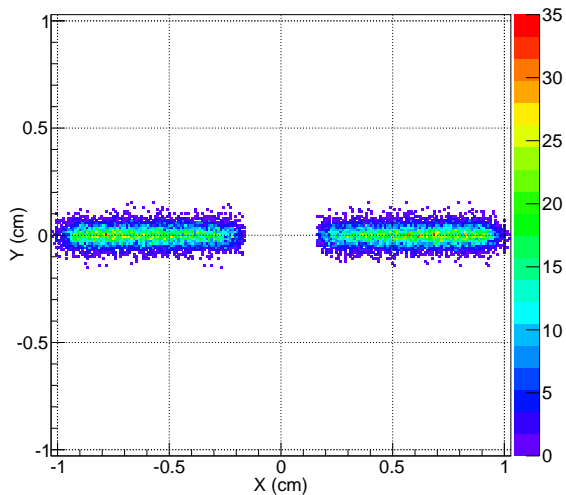
Summary

- Using Garfield++ to simulation electron drift in a electric field calculated by Elmer.
- The simulation result is consistent with the measured distortion for both beam test and laser test.
- Further work: take the effect of C.O.G into account.

Backup slides

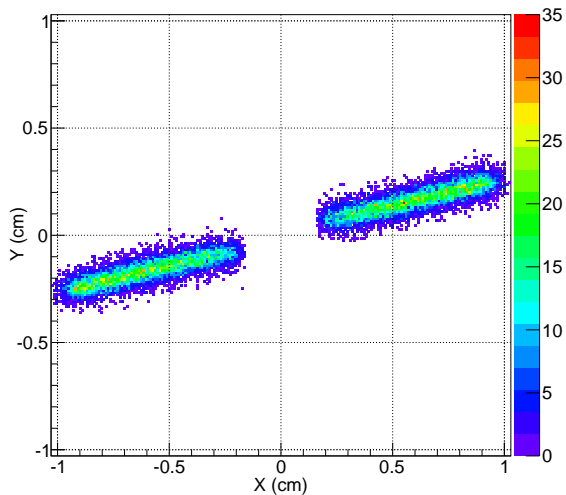
Electron endpoints (B=0 T)

Angle: 0°



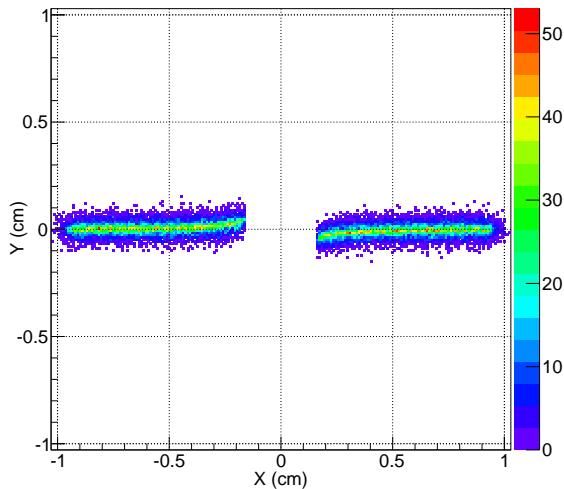
Electron endpoints (B=0 T)

Angle: 15°



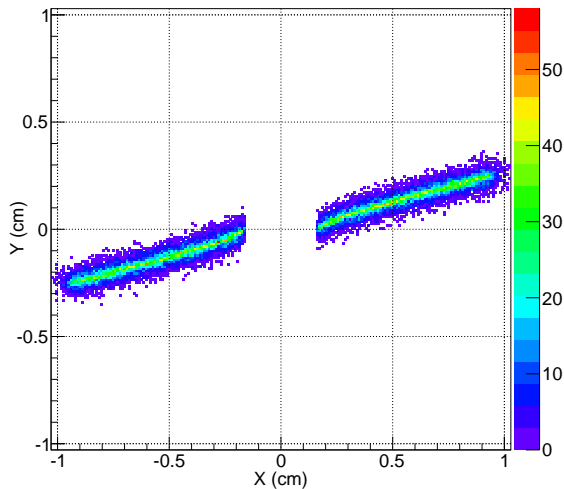
Electron endpoints (B=1 T)

Angle: 0°



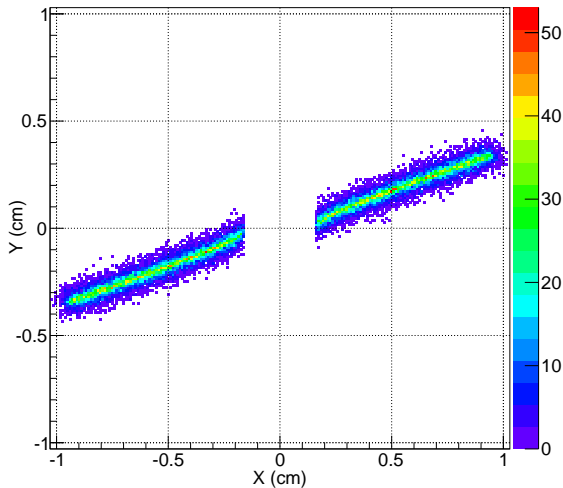
Electron endpoints (B=1 T)

Angle: 15°

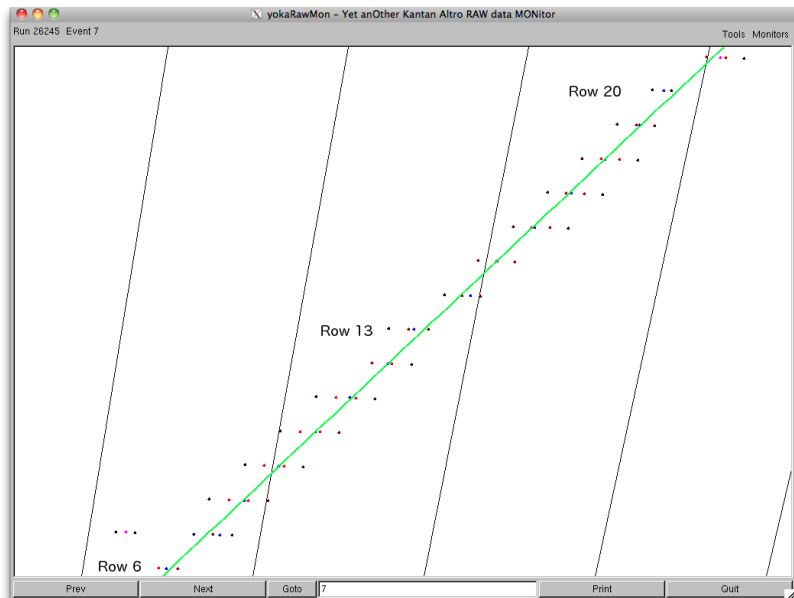


Electron endpoints (B=1 T)

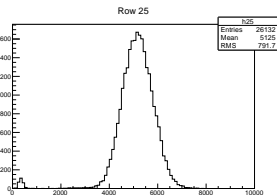
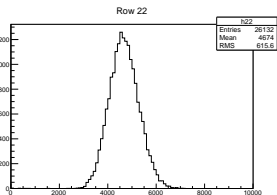
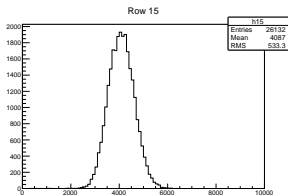
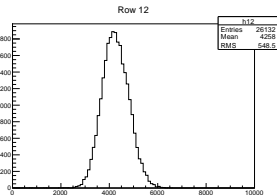
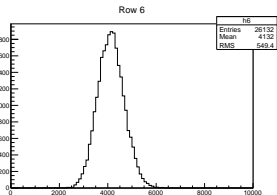
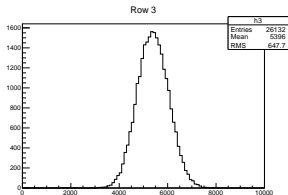
Angle: 20°



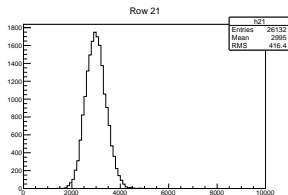
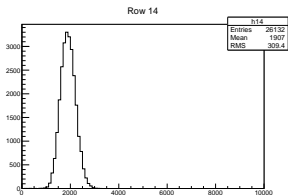
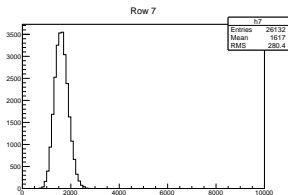
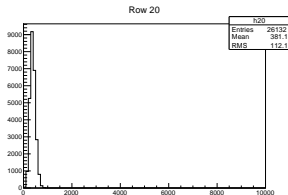
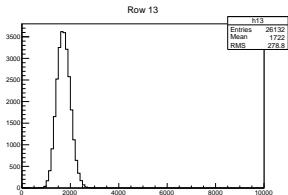
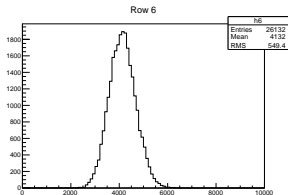
Event display for laser test



Measured charge of hits away from gaps in laser test



Measured charge of hits near gaps in laser test



Distortion of new GEM

