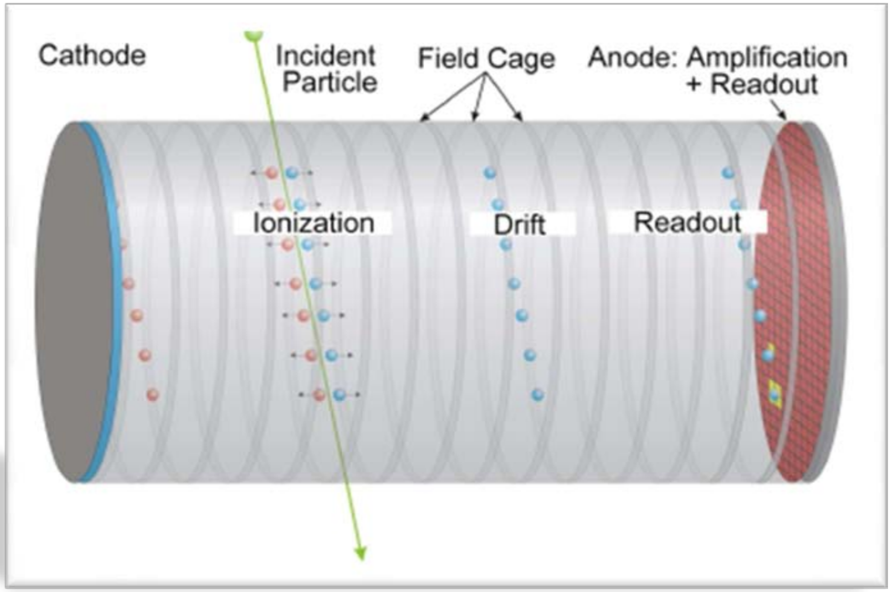
A New GEM Module for the LPTPC

By

Stefano Caiazza

Basics – The TPC



Gas Tight Container where ionization occurs

Well known Electric and Magnetic Fields

- To control the drifting inside the chamber
- The most simple configuration is with homogenous fields perprendicular to the readout system

Amplification and Readout system

- Reconstruct the 3D position of the ionization clusters

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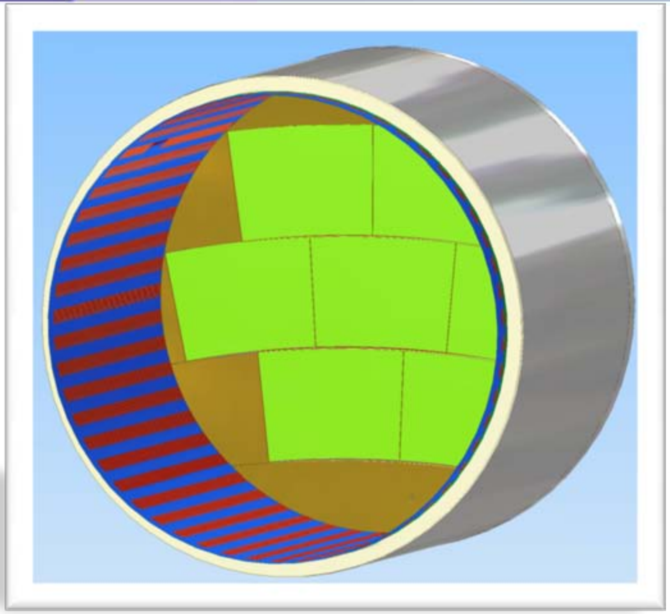
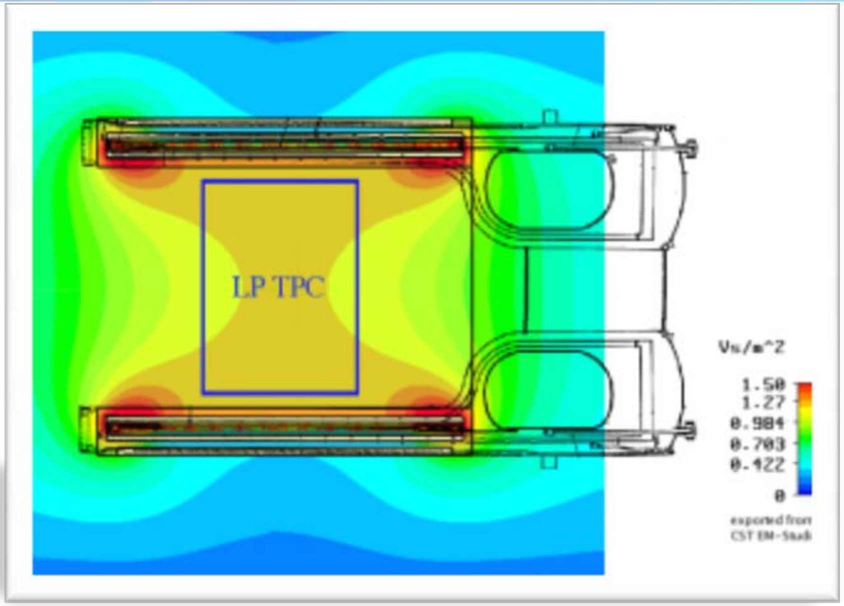
Basics – Our TPC, the LPTPC





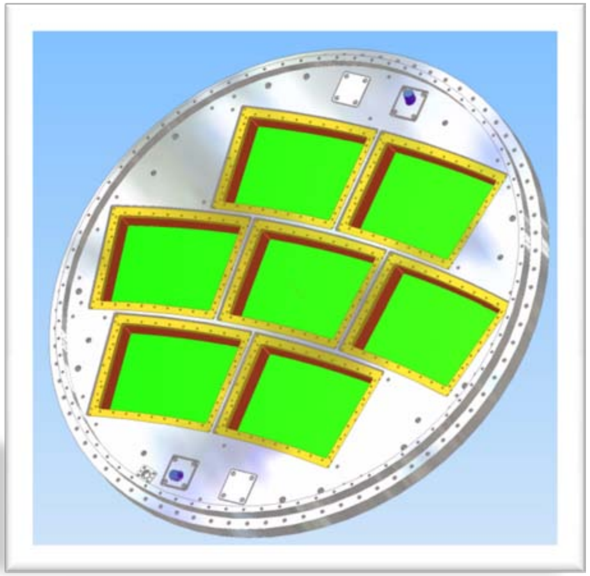
Field Cage designed by Peter Schade

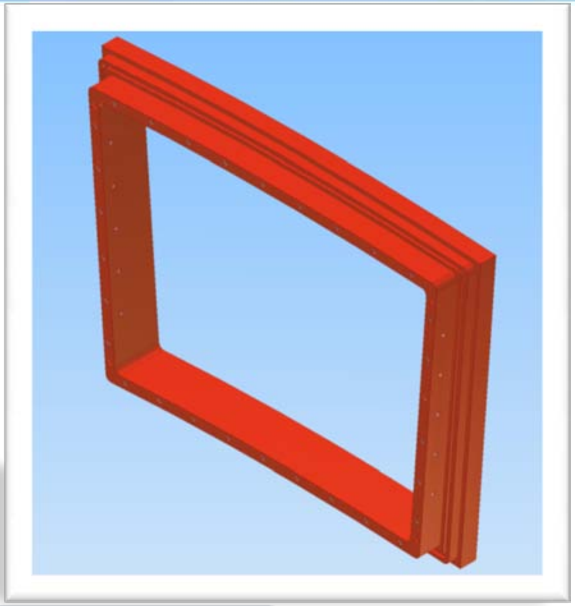
- 60 cm drift length
- 72 cm inner diameter
- Designed to fit inside PCMAG

PCMAG

- Superconductive Magnet with standalone Lhe Cooling and low mass coil
- 1 Tesla Magnetic Field
- Supplied by KEK

Basics – LPTPC Endplate





Endplate

- Designed by Dan Peterson at Cornell
- Aluminum Alloy
- Accomodates seven identically shaped modules

The Modules

- Cornerstone shape
- 22 cm wide (average value) – Max width 24 cm
- 17 cm high

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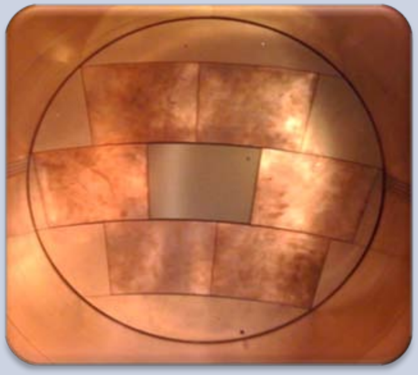
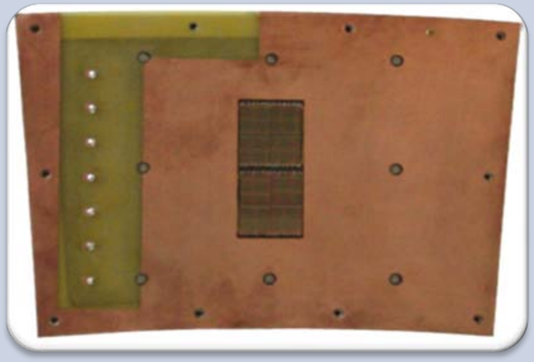
Basics – The Modules we have





Micromegas

- Built at Saclay
- Pad Readout
- Multiple versions with naked or coated pads
- Readout with T2K Electronics

Asian GEM

- Built in Japan and China
- Japanese produced GEM
- Pad Readout with Altro Electronics
- GRP Frame on the upper and lower side

Bonn GEM

- 10X10 cm Standard CERN GEM
- Pad Readout with Altro Electronis
- Pixel readout with integrated electronics

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Desy Module – Our Goals

Maximum Sensitive Area

- We will need to use a custom designed GEM

Gain Uniformity between 5/10%

- We need to ensure a good flatness of the GEM
- The uniformity may be improved with calibration
- Good dE/dx resolution

Spatial resolution under 100 µm

- Small pad size

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Desy Module – Design Steps

Four Components

- The Backframe
- The GEMs
- Framing and Support Structure
- Anode Readout Plane

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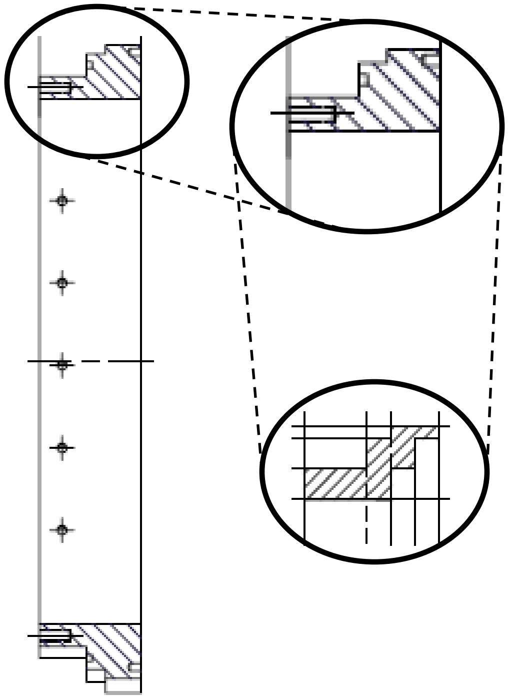
The new backframe: Design



Goal

- To increase the available space on the connector side of the readout plane

Solution

- Remove part of the backframe structure
- The element which has been thinned is only supporting the pad plane
- We don’t expect negative effects from this upgrade

Production

- The production of the backframe will be performed at the University of Hamburg workshop

Materials

- The material chosen is an aluminum alloy called AlMg4,5MN (Dogal 5080)

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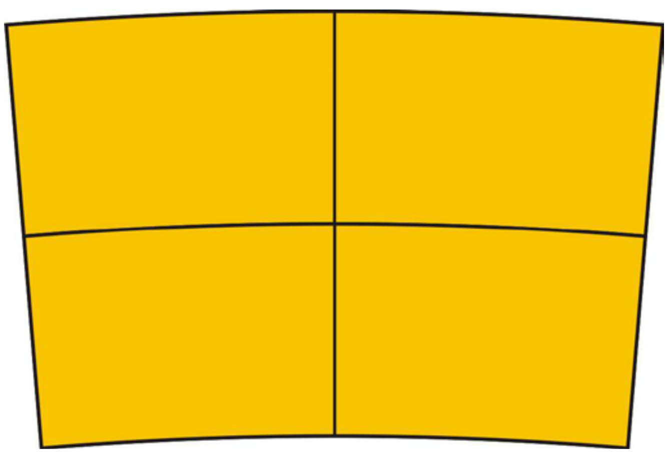
The GEMs: Design



Custom GEM

- Specifically designed to get the maximum sensitive area

Produced by CERN

- 50 μm kapton foil
- Chemical etching

Standard hole size and pitch

- 70 μm hole size
- 140 μm hole pitch

4-fold electrode segmentation

- The surface of the GEM must be segmented to reduce the damage caused by electrical discharges

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Frame and Support System: Issues

Standard GEM frames made of GRP (Glass Reinforced Plastic)

- The width of the frame is about 1 cm
- No supported areas inside the frame

Decrease the size of the unsupported areas

- Gain uniformity limited by the GEM sagging
- To reduce the sagging we must limit the unsupported areas of the GEM

Increase the sensitive area

- Sensitive area limited by the presence of supporting materials
- To increase the sensitive area we need to reduce the width of the framing and supporting structure

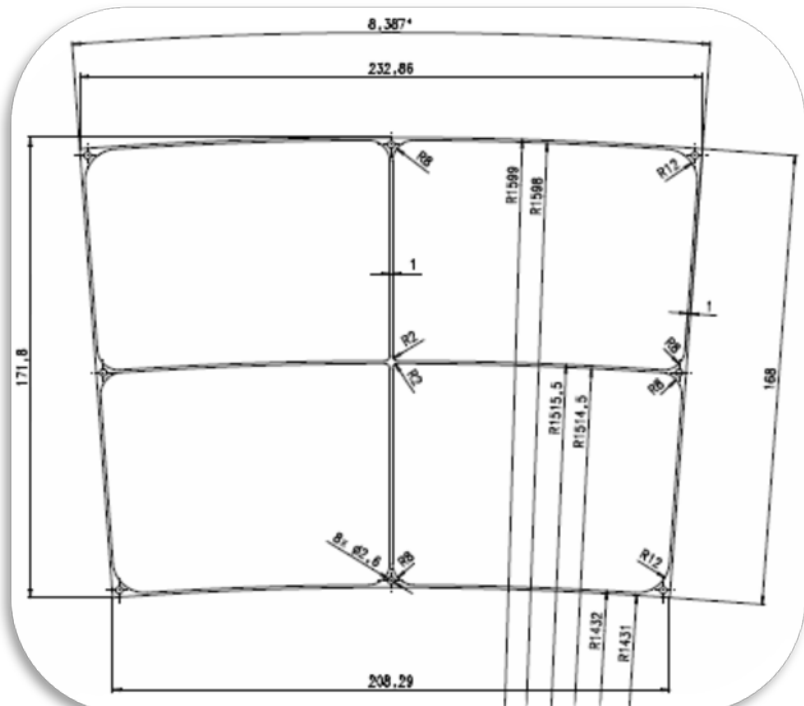
Frame and Support System: Our Solution

What we need:

- Insulating material stif
  GRP
- The material should be machinable at thicknesses smaller than 1 cm

What we choose:

- Alumina Ceramics
- Almost 4 times stiffer than GRP
- May be machined with widths up to 0.3 mm



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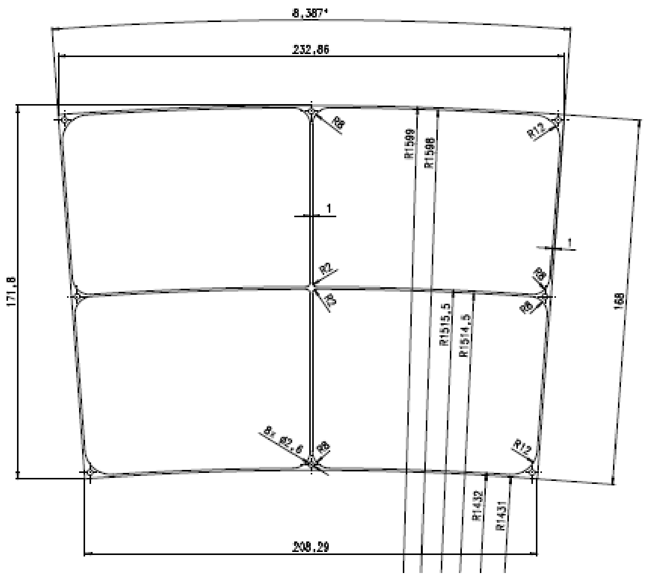
Frame and Support System: Main Features



Modular structure

- Every GEM can be separately framed
- The framed GEM can be piled up to form the stack using “ungemmed” frames as spacers
- There are 8 strong points for the mounting and aligning of the support structure

1.0 mm width

- The external frame and the internal grid structure are 1.0 mm wide
- Smaller widths were considered and discarded because of insufficient resistence

Grid patterns

- Many grid patterns have been considered
- The one shown has been selected for the first tests

Production

- We are in contact with two firms and evaluating their proposals

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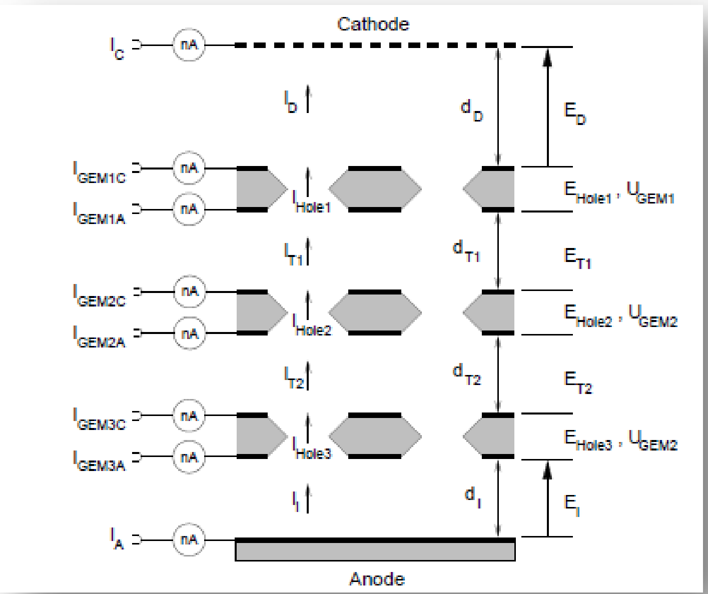
The GEM Stack: Features



Three GEM + possible gate

- Three GEM stack
- Optional fourth module (gating)
- The gate may be both GEM or wire based

Time resolution

- Small induction gap → better time resolution
- Time resolution depends also on the longitudinal diffusion during drift

Defocussing

- Gap's size and fields influence the defocussing of the electron clouds
- The defocussing and the pad size influence the point resolution

Ion backdrift

- Influenced by the fields and of the potential across the GEMs

Gap size and field intensities not yet finalized

- Simulation and calculation will be performed in the near future to find the best compromise

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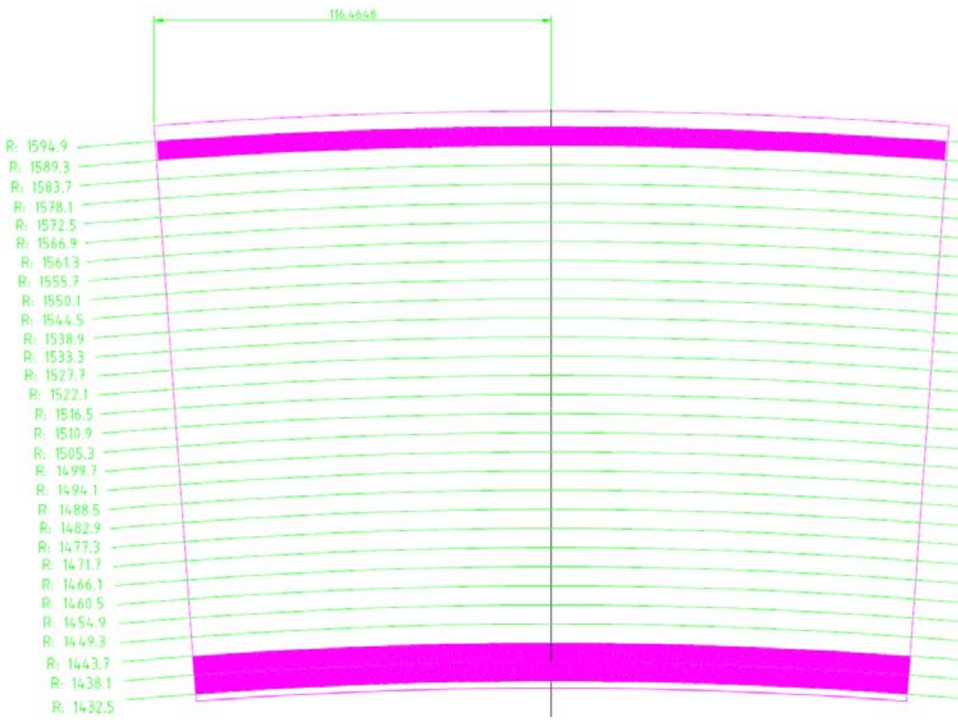
Anode Readout Plane: Features



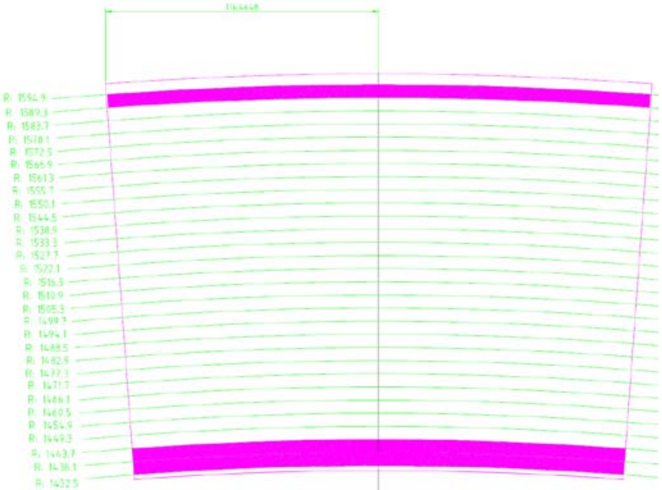
Structural Features

- Ensure gas tightness
- Support the GEM stack
- Provide power to the GEM stack

Readout Features

- Pad readout
- Maximum possible sensitive area
- Readout by ALTRO electronics

Anode Readout Plane: Design



In collaboration with Bonn University

- The design is still in his infancy
- Using the data acquired testing the Bonn GEM module

Pad size

- (1.1 ÷ 1.25) x (5.6 ÷ 5.8) mm
- 28 rows
- Row gaps aligned with the GEM segmentation gap

GEM Power supply

- Supplied from power pads on the PCB itself
- Using the ceramic structure to separate the power from the readout pads

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Something more: new measurement

Gain Calibration

- Beam calibration
- Laser calibration
- Radioactive source calibration

Gate efficiency

- Confront the efficiency of GEM and wire gates

Ion Backdrift Measurement

- We need the equipment to perform this measurements on the LP

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Conclusions

Module Backframe

- First design ready
- Production of the first prototype began

Ceramic Framing

- First design ready
- Evaluating producer's offers

GEMs

- First design ready
- Getting feedback from CERN to update this design

Anode Readout Plane

- Design just beginning

Other ideas

- Compare gating modules
- Test the gain homogeneity of the modules
- Measure the ion backdrift in the TPC

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