

# TPC Large Prototype Facility

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DESY

LCTPC collaboration meeting  
21-September-2009

A horizontal dotted line at the bottom of the slide.

Main objective: Large Prototype (LP) of a TPC.

## Consisting of

- **Field cage**
- **Readout electronics**
- **DAQ and Monitoring**
- **Gas-/HV-system**
- **Common Software**
- **SiLC envelope**
- **End plate**
- **MPGD detector modules**
- **Cosmic/beam trigger**

Magnet (PCMAG) + infrastructure  
T24 Test beam

Key:



present







partially missing



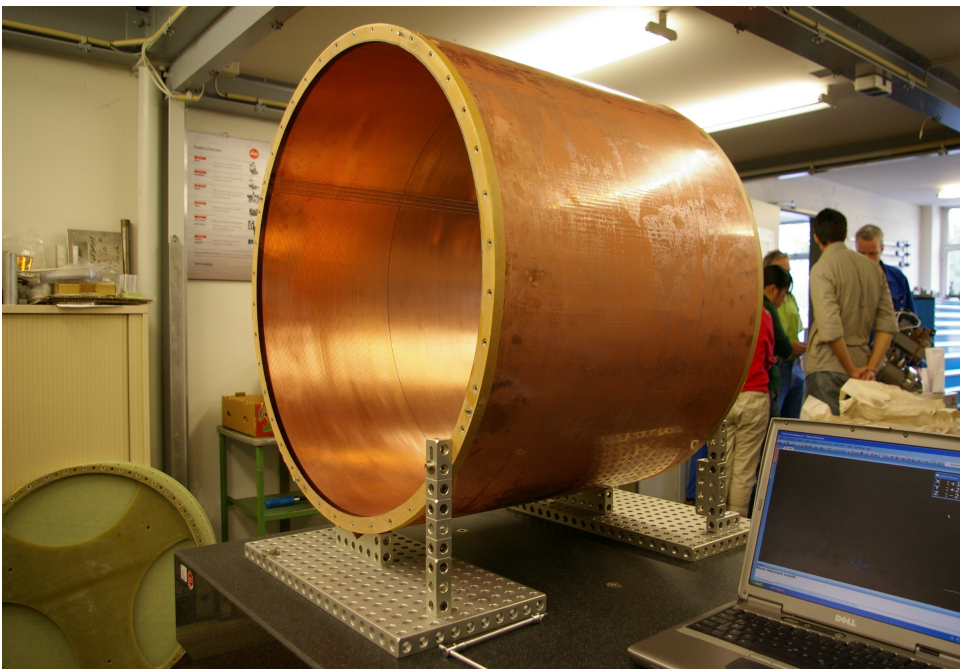
missing

## LP Subsystem meeting in Feb-2008

### Requirements

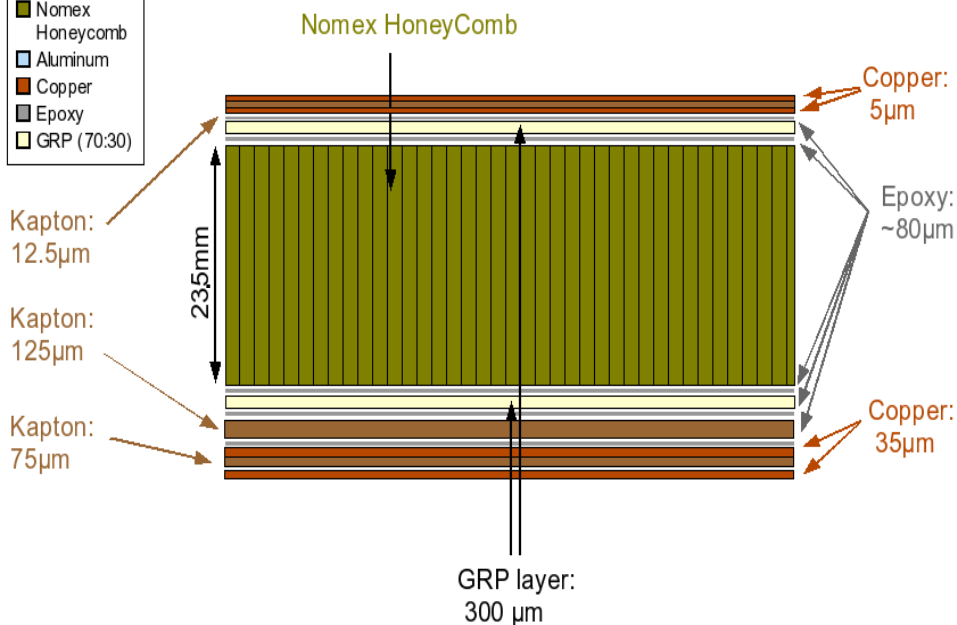
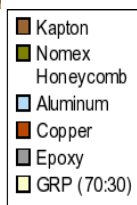
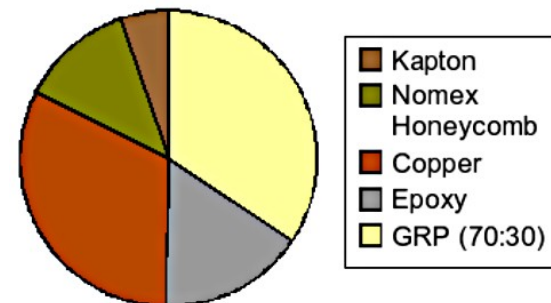
- LP needs
  - **The detector itself**
    - FC 
    - Cathode 
    - Endplate 
    - Amplification panels 

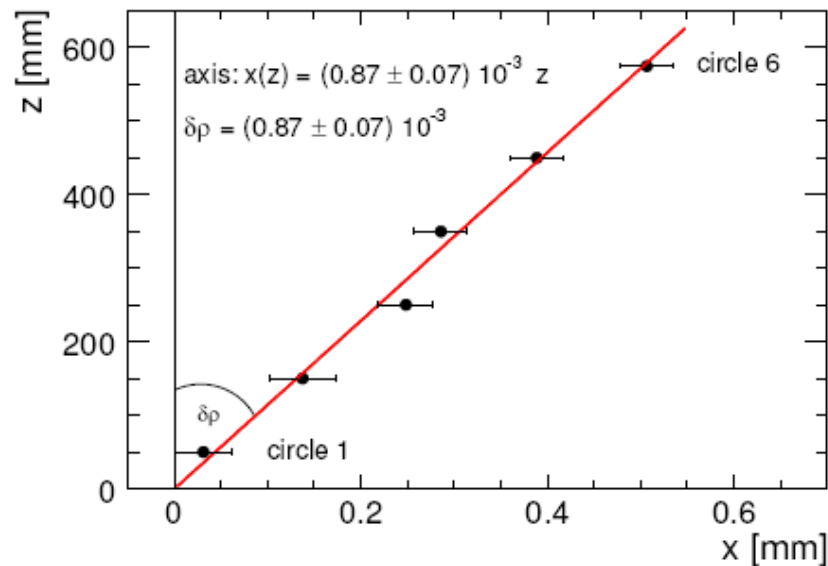
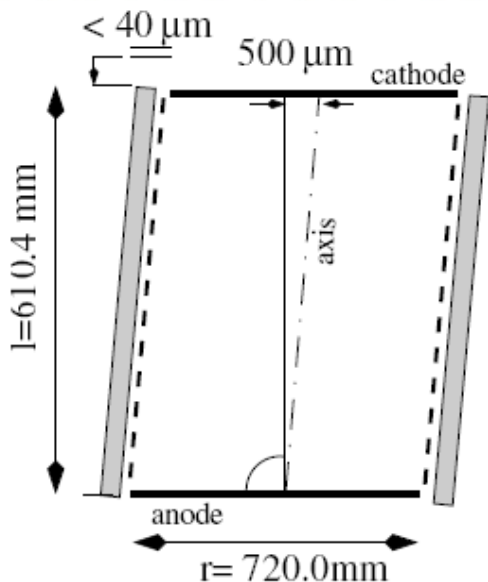
Hardware: build together and have a TPC 



Diameter: Inner 720 mm,  
 Outer 770 mm  
 Wall thickness 25 mm  
 Length 610 mm  
 HV to be applied: up to 20 kV

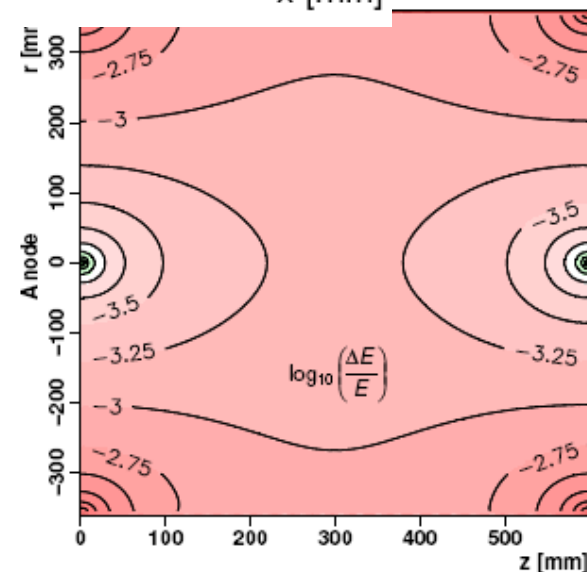
Radiation Length: 1.31% of  $X_0$



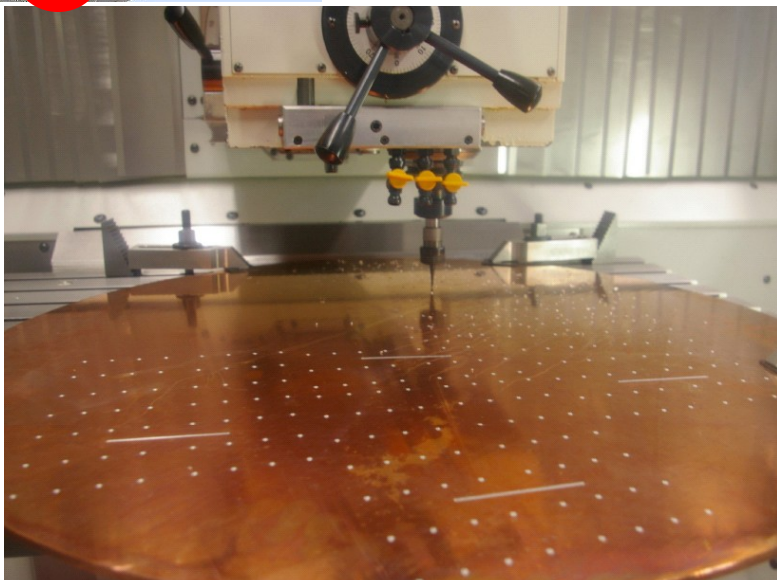
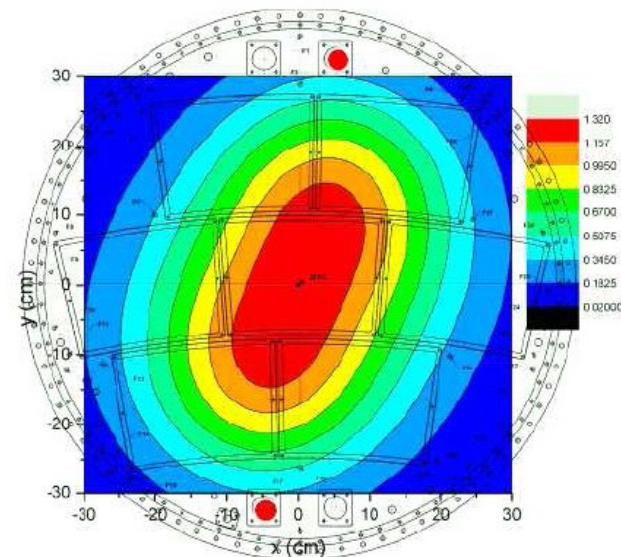
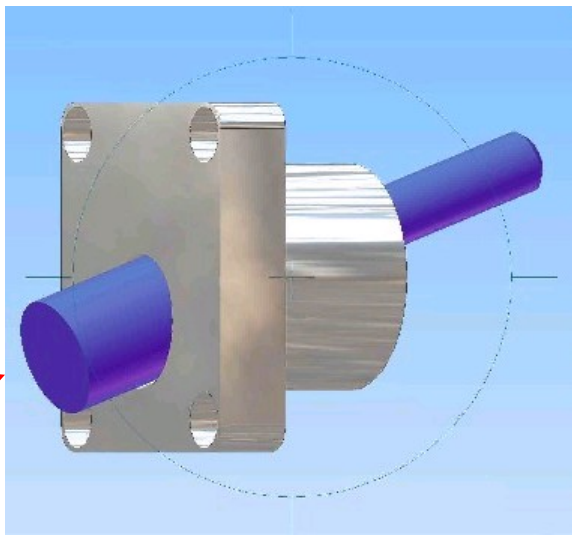
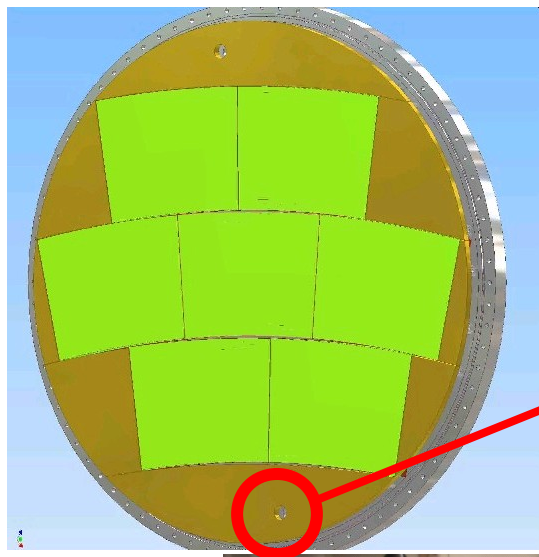


Achieved mechanical accuracy:

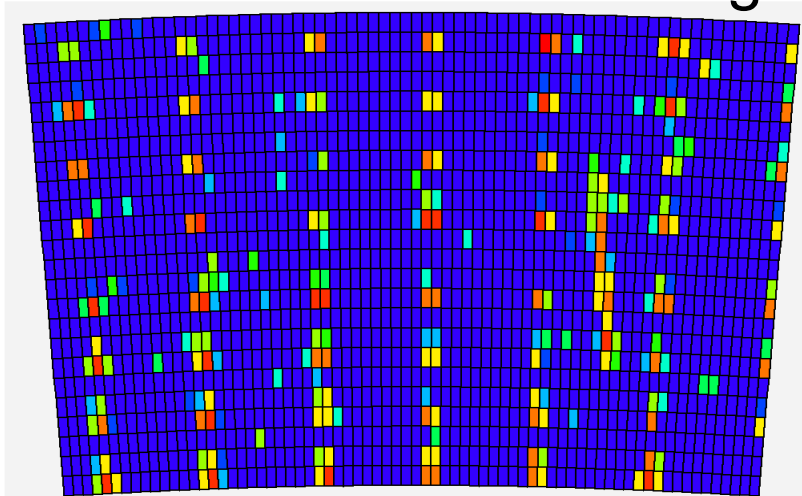
- Alignment of the end faces:  $\delta l < 40 \mu\text{m}$
- Alignment of field cage axis:  $\delta A \sim 500 \mu\text{m}$
- Field quality  $10^{-4} \lesssim \Delta E/E \lesssim 10^{-3}$

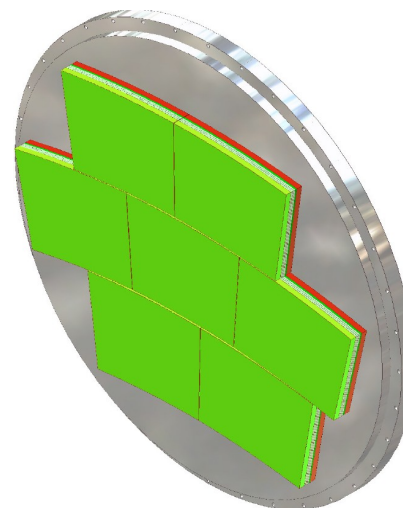
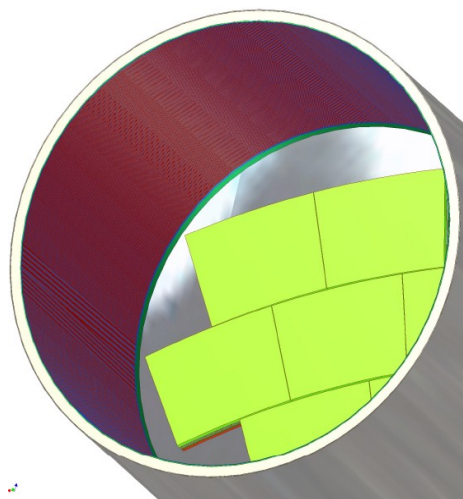
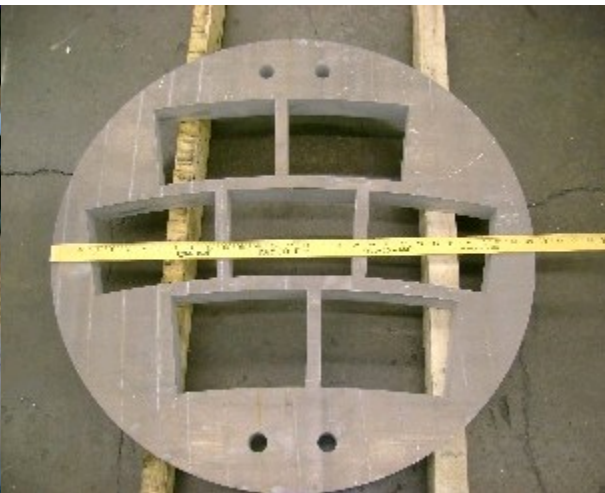
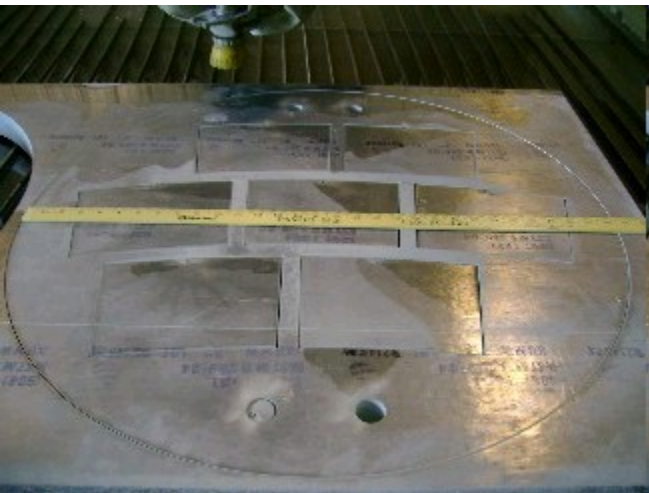






Pattern seen with Micromegas





D. Peterson,  
Cornell

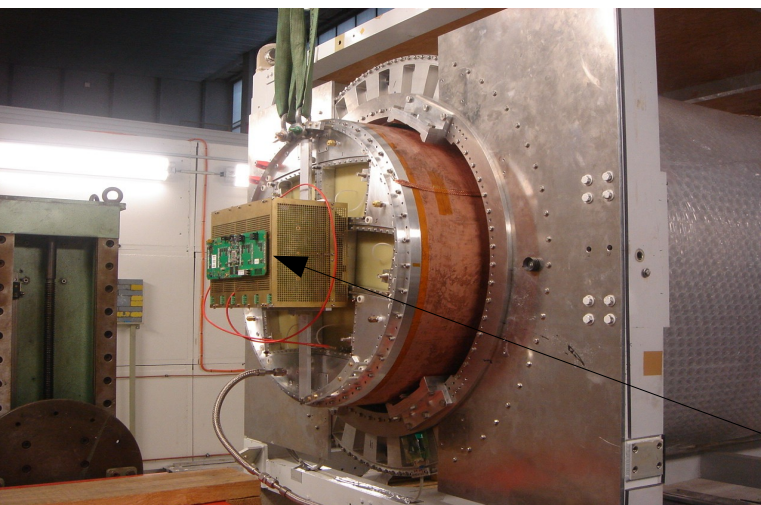
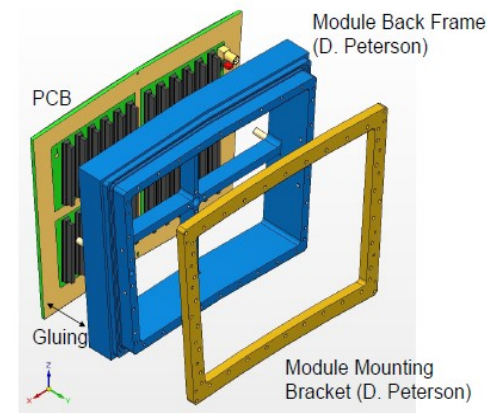
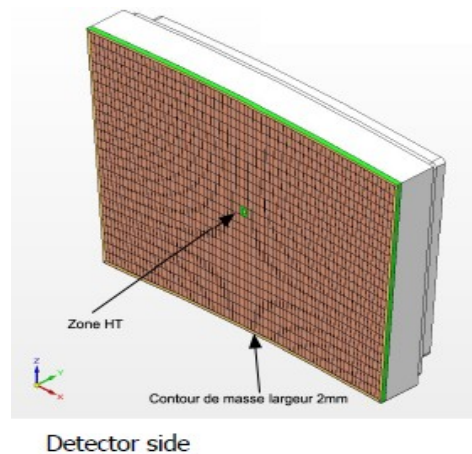
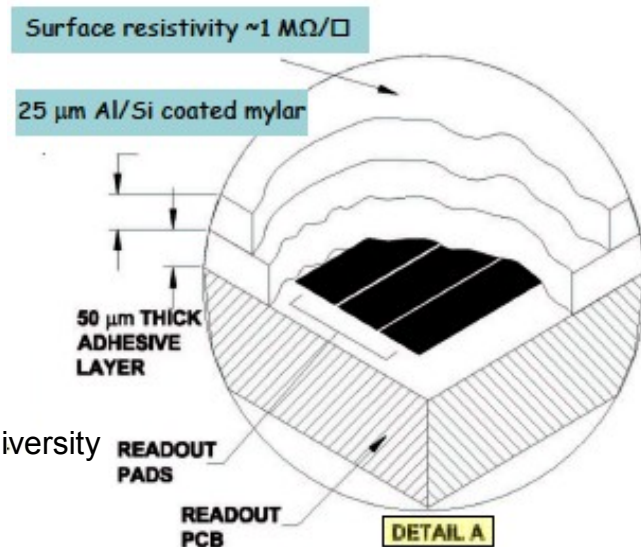




‘Bulk Micromegas’ panels, without resistive foil and with resistive carbon-loaded kapton, have been produced at CERN (Rui de Oliveira)

**MicroMeGaS for LP:**  
**24 rows x 72 pads**  
**Av. Pad size: 3.2 x 7mm<sup>2</sup>**

P. Colas, CEA Saclay  
 M.S.Dixit, Carleton University

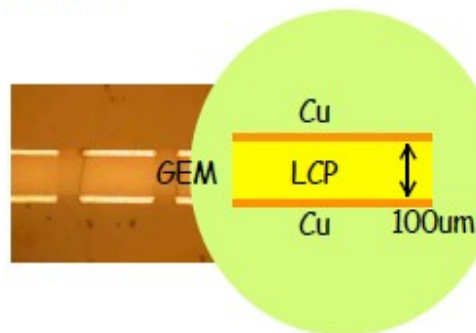


Readout electronics: AFTER (T2K TPC)

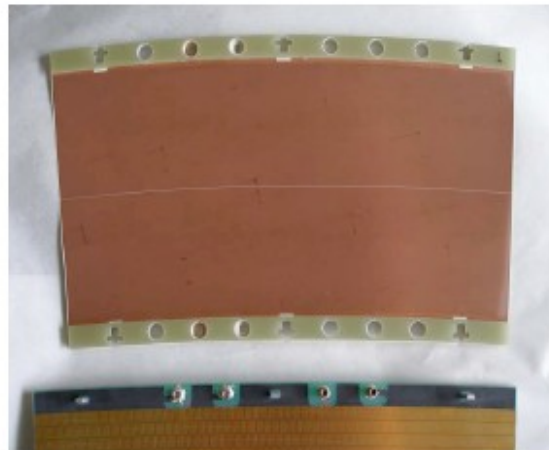
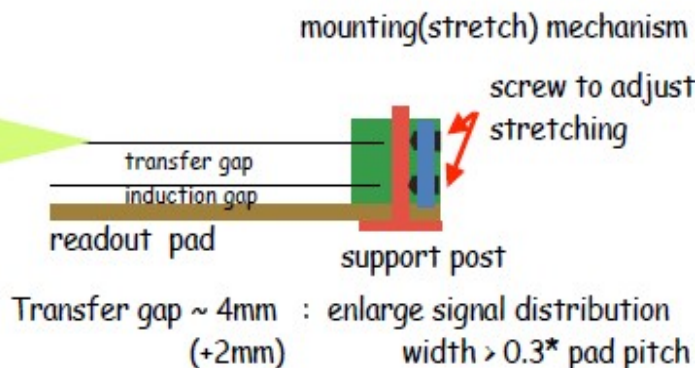
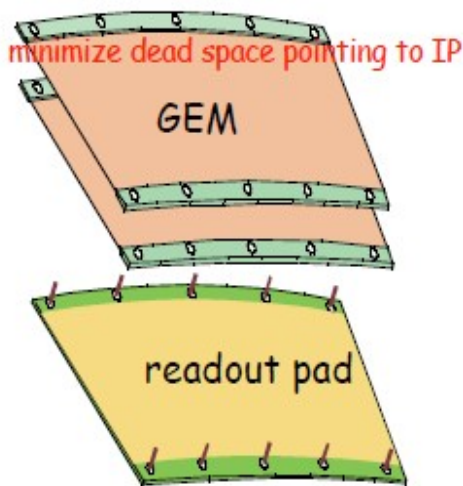




## GEMs



frame : top & bottom frame.  
no side frame

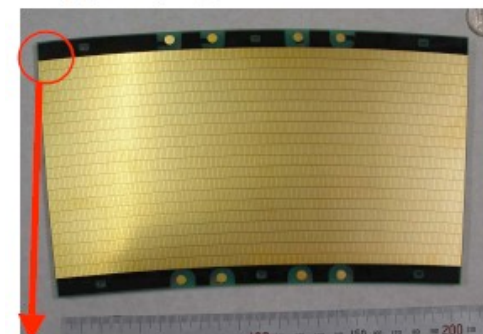


Optional: gating GEM

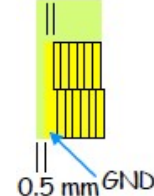
A. Sugiyama, Saga Univ.

28 pad rows (176/192 pads/row)  
~1.2(w) x 5.4(h) mm<sup>2</sup>  
staggered every each layer

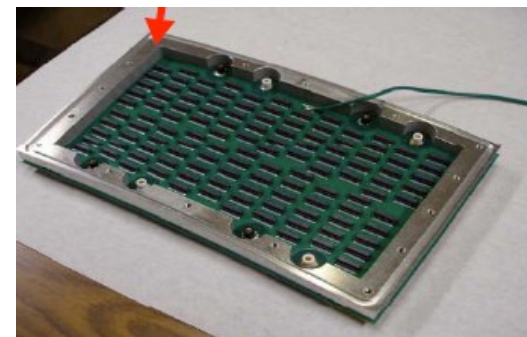
Total 5,152 ch/module

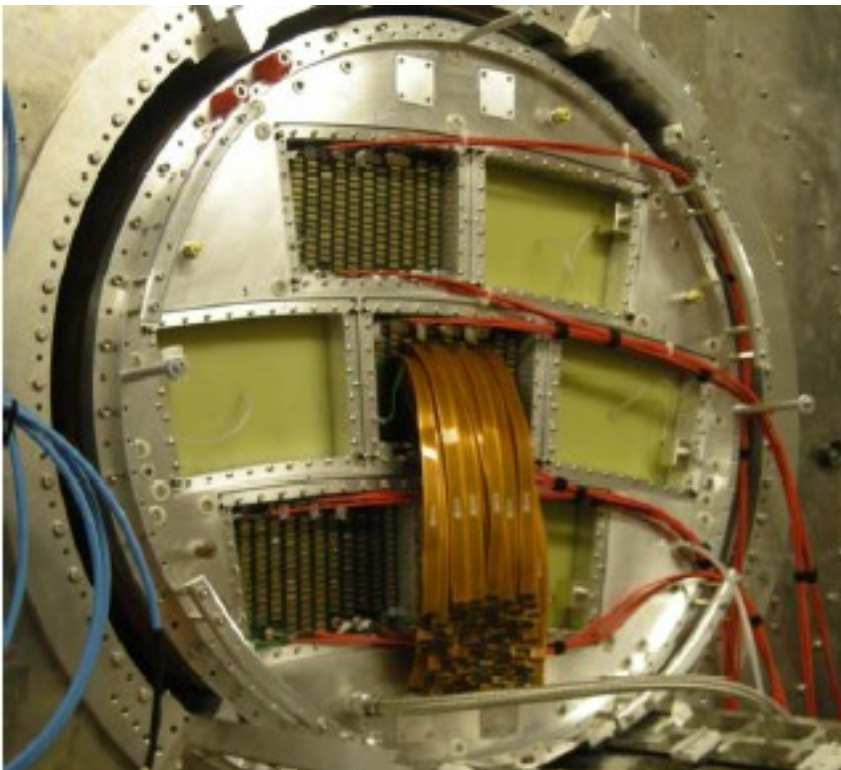


0.5 mm



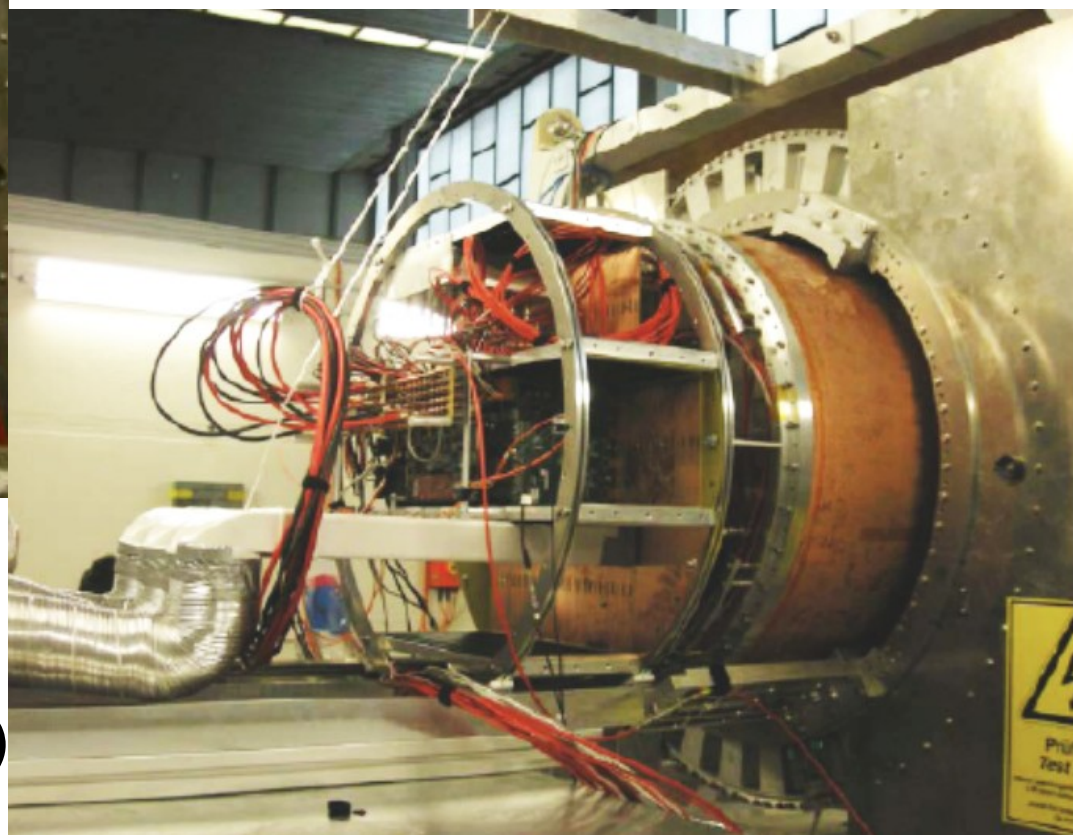
6 layers PCB  
one GND layer



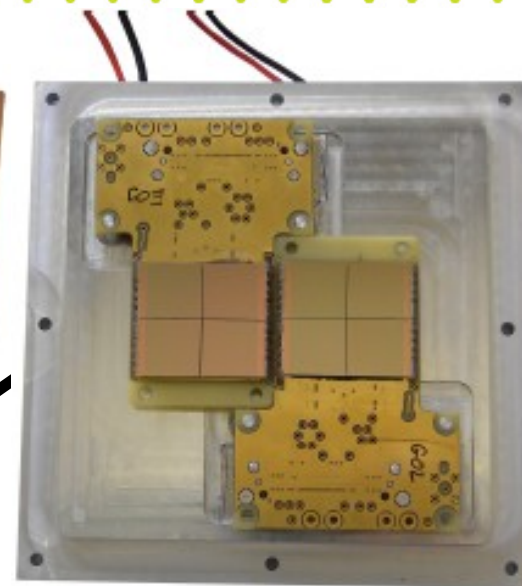


About 3200 channels  
readout electronics

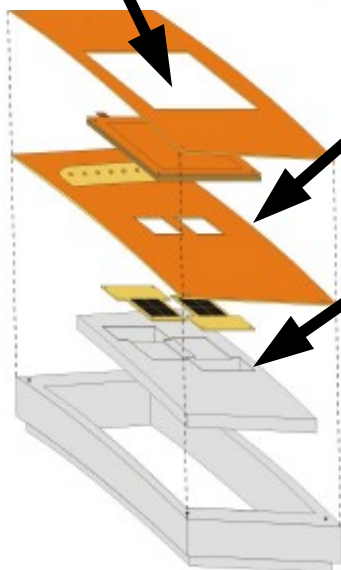
Readout electronics:  
Based on ALTRO (ALICE TPC)  
L. Joensson, LUND University





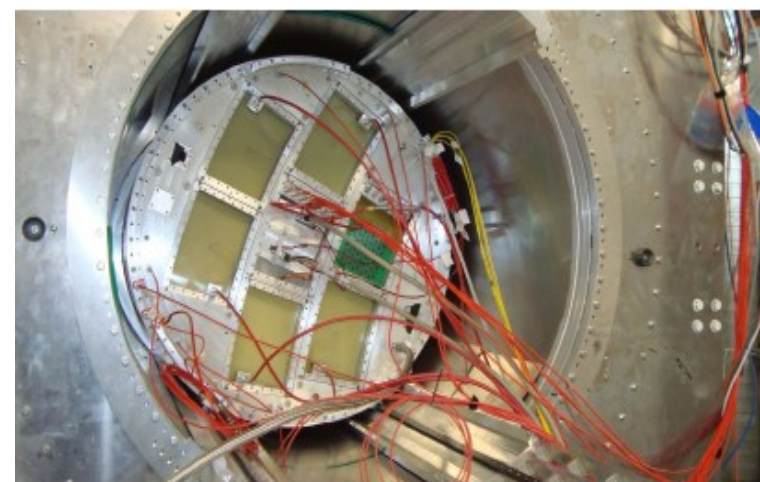


anode plane  
GEMs  
readout plane  
quad-boards  
reinforcement of  
anode plane  
redframe



Readout:  
2 quadboards  
(4 TimePix  
Chips each)

J. Kaminski, Univ. of Bonn



## LP Subsystem meeting in Feb-2008

### Requirements

- LP needs
  - **Operating the detector**
    - Chamber gas 
    - HV 
    - Monitoring 

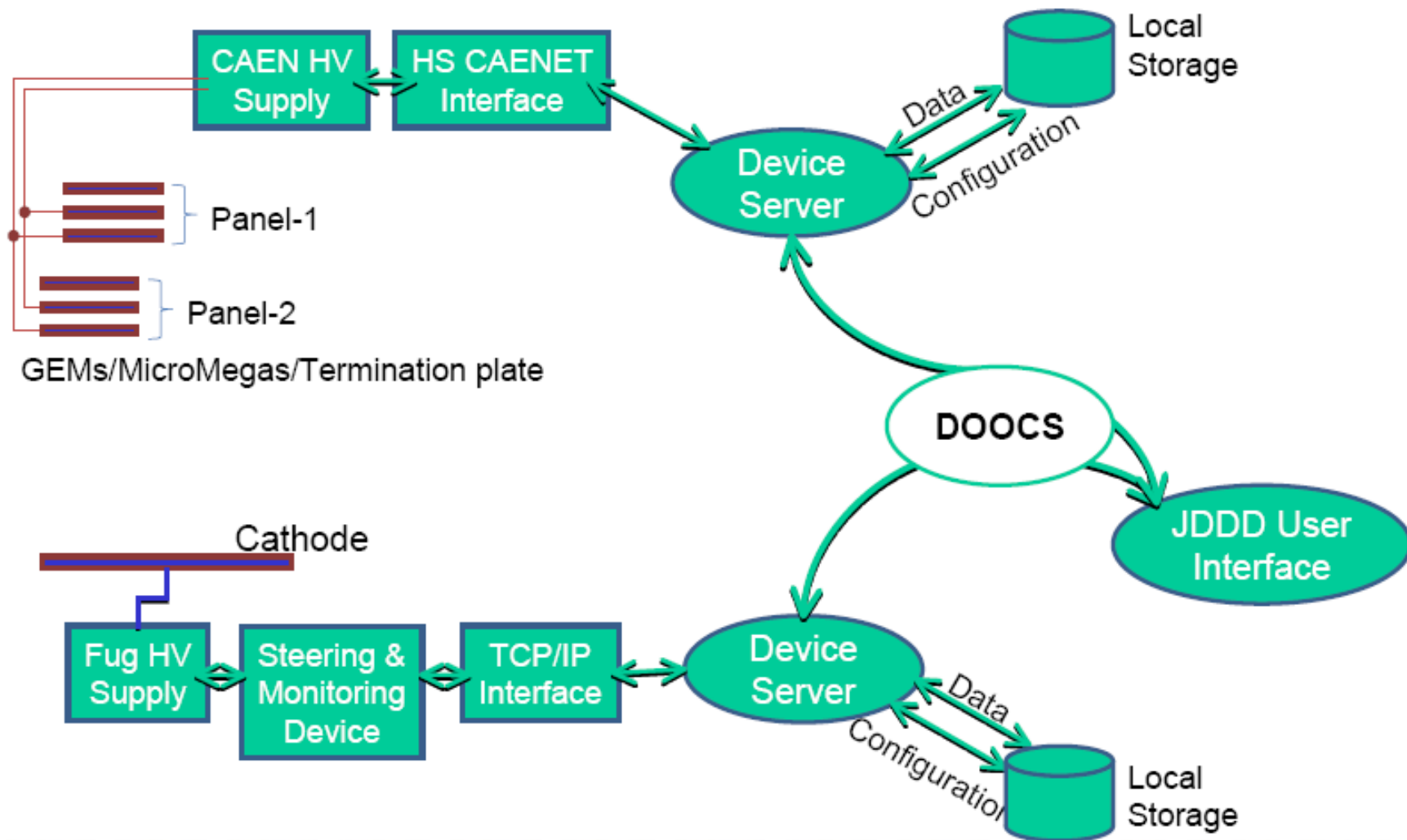
Hardware: build a supply and monitoring system for the TPC

Software: enable monitoring data to be stored and synchronized with TPC data



Basic gas system installed:

- Mass Flow Controller → gas pressure regulation
- Stainless steel flexible tubing
- Monitoring of pressure, temperature and  $\text{H}_2\text{O}/\text{O}_2$
- Safety valve



B. Gaur, Univ. Siegen

## Monitoring via DOOCS:

Distributed Object Oriented Control System; output as LCCD stream in LCIO format




hardware is connected to control system with Beckhoff devices

### Monitored parameters (so far)

- Temperature
- Gas pressure
- Gas flow
- Impurities
- HV control

## LP Subsystem meeting in Feb-2008

### Requirements

- LP needs
  - **Reading the data**
    - Electronics  
    - DAQ 

Hardware: built a readout system for the TPC

Software: enable data to be read out



## *Three-fold readout electronics:*






- ALICE based:  
new PCA16 amplifier chip + ALTRO chip (EUDET & LCTPC) → adopted to ILC environment; designed within EUDET DAQ scheme
- T2K based:  
AFTER electronics for T2K TPC (CEA Saclay)
- TDC based:  
ASDQ chip + TDC (EUDET & Uni Rostock)

**AFTER electronics for MicroMeGAS (resistive anode readout)  
ALTRO and TDC based electronics will be hooked to the GEM detector modules  
(connector compatibility)**

## LP Subsystem meeting in Feb-2008

### Requirements

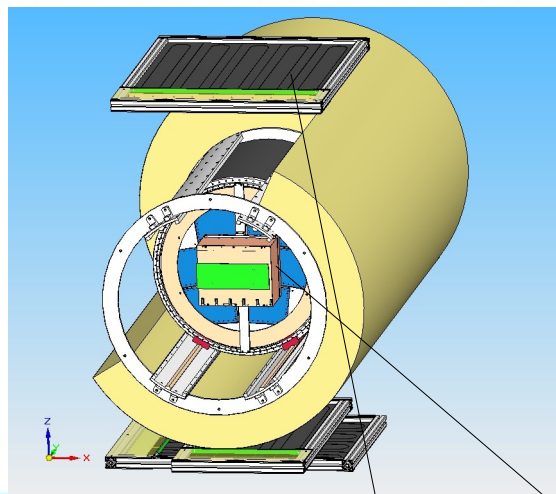
- LP needs
  - **Particles to measure**

- Calibration 
- Testbeam 
- Magnet 
- Trigger 
- Analyze 

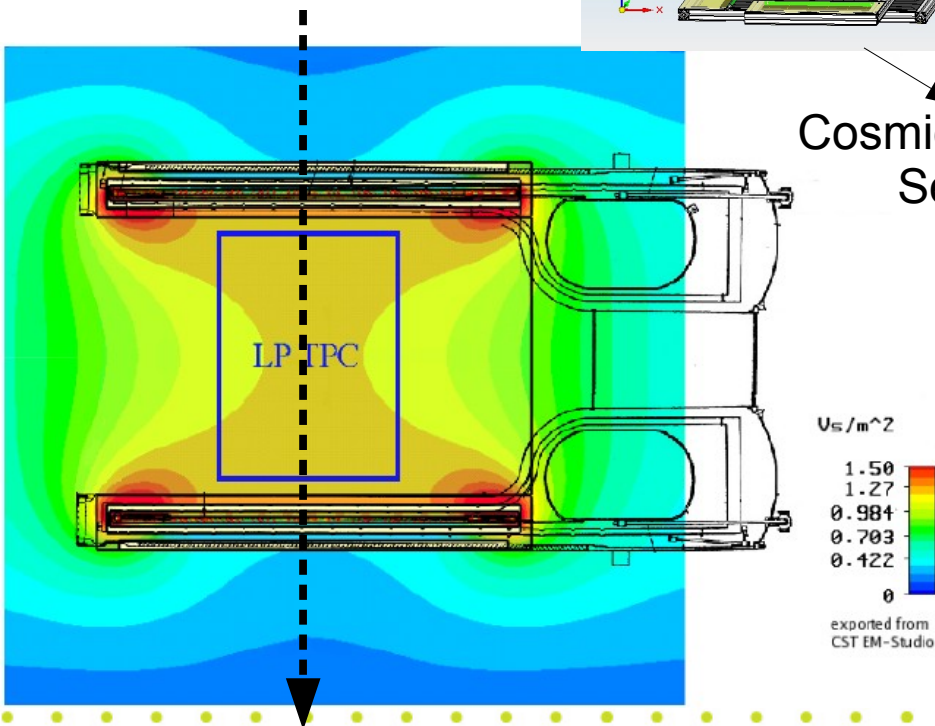
Hardware: place the TPC in a magnet and expose it to calibration/testbeam particles

Software: analyze the taken data and compare with simulated

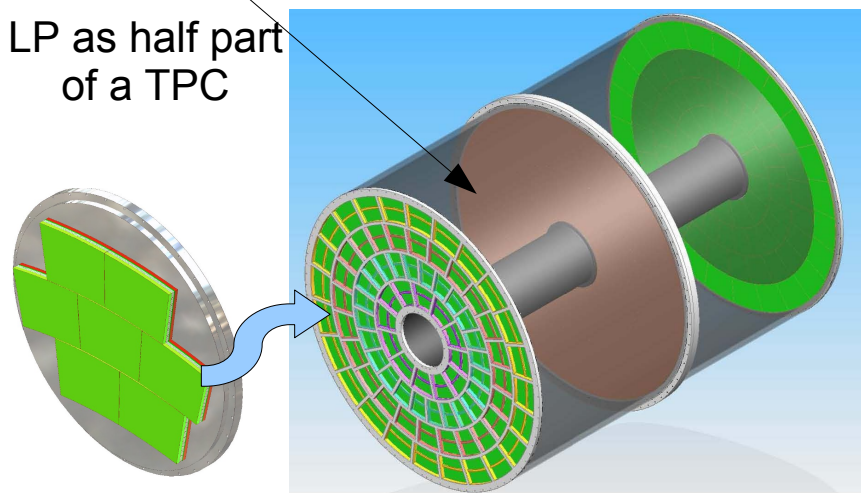
- *PCMAG*:  
superconducting  
magnet, up to 1.25 T
- $e^-$  test beam  
@DESY  
( $1\text{ GeV}/c < p < 6\text{ GeV}/c$ )

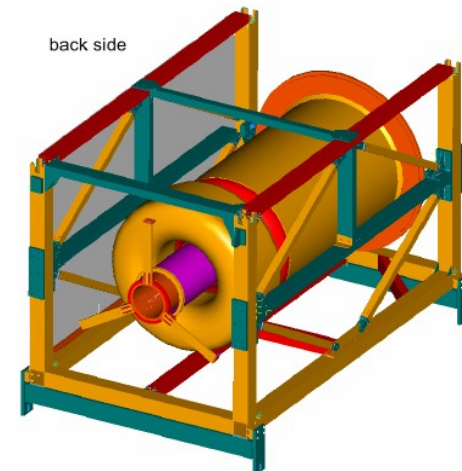
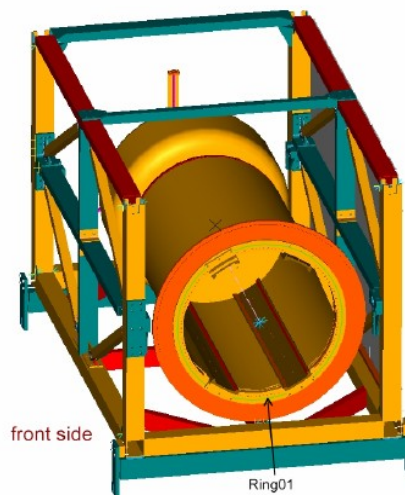
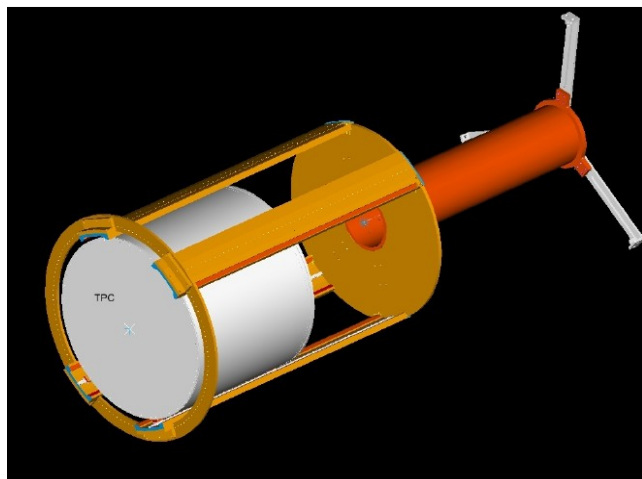


Cosmic Trigger  
Setup



LP as half part  
of a TPC





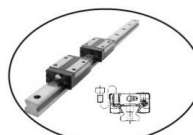
Design Study of the Magnetmovementtable

Support structures:

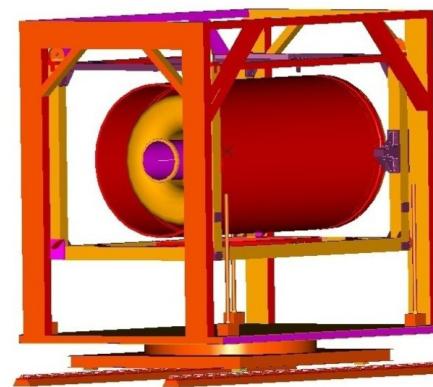
- TPC
- PCMAG



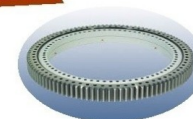
Power Jack



Linear guiding



Bearing

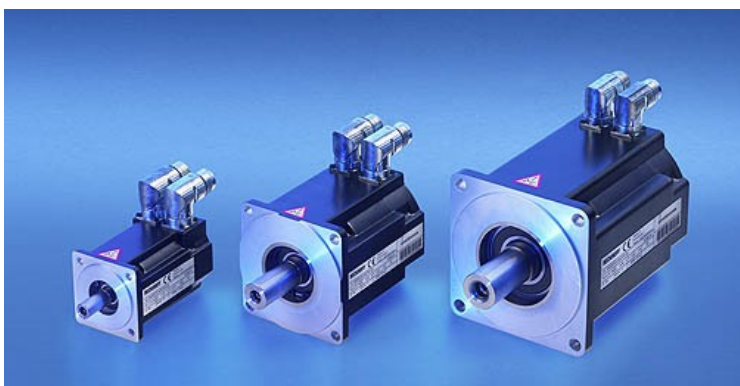


F. Hegner, V. Prah, R. Volkenborn, DESY





## Actuation and Control

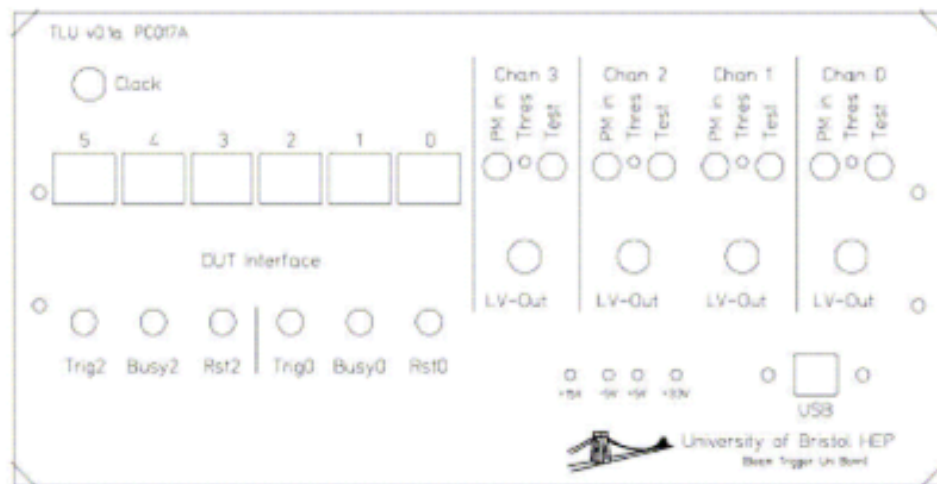


Trigger Logic Unit (TLU) provided by University of Brussels:

- 4 comparators
- Beam trigger with scintillators

TLU outputs:

- Trigger signal (LVDS)
- Event number (LVDS) pulled out by a data clock (LVDS)



Distributor box:

- Get event# from TLU and tag event with time
- Send event # + time to DAQ computer, assert BUSY for a fixed time: waiting for DAQ PC end of r/o
- Provide common clock

Goal:

- Common data taking
- Common data stream
- Common data format
- Unified reconstruction and analysis

**M**odular **A**nalysis & **R**econstruction for the **L I N**ear Collider

Modular MarlinTPC:  
Marlin based simulation, digitization,  
reconstruction and analysis code for the TPC

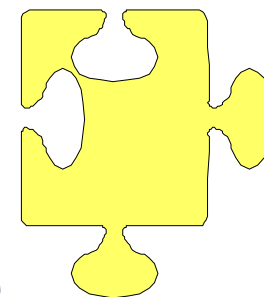
## LP Subsystem meeting in Feb-2008

### Requirements

LP tests need

- **a full running and cooperative subsystem's environment**
- ♦ **coordinated assembly**
- ♦ **coordinated alignment and calibration**
- ♦ **an operating testbeam environment**
- ♦ **coordinated data simulation and analysis**

⇒ **interplay between the subsystems**





- Field cage, cathode end plate / alignment wheel, cathodes delivered, one cathode patterned
- 3200 channels of ALTRO electronics in use  
1800 channels of AFTER electronics in use  
640 channels TDC electronics available → noise problems
- TLU trigger system available → synchronization problems

- Gas-/HV-system in use
- Common software under construction
- Infrastructure for SiLC envelope installed
- LP assembled, commissioned and being tested
- LP with three different MPGD operated
- 12 weeks of test beam with LP operation so far → more to come

- A Large Prototype of a TPC has been built and is being assembled/tested/commissioned by the LCTPC collaboration
- Two MPGD technologies (with three electronics techniques) are being tested:
  - ★ Micromegas
  - ★ GEM
- Infrastructure for Large Prototype has been constructed
- $e^-$  test beam (DESY) in conjunction with PCMAG ( $1T$  magnet)
- Preliminary results are looking very promising
- Further test beam campaigns in the next year:
  - + Backplane integrated 10,000 channel readout system, based on ALTRO electronics
  - + Seven Micromegas modules with AFTER electronics attached to the modules