Status report TPC task

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DESY

EUDET Annual Meeting 2007

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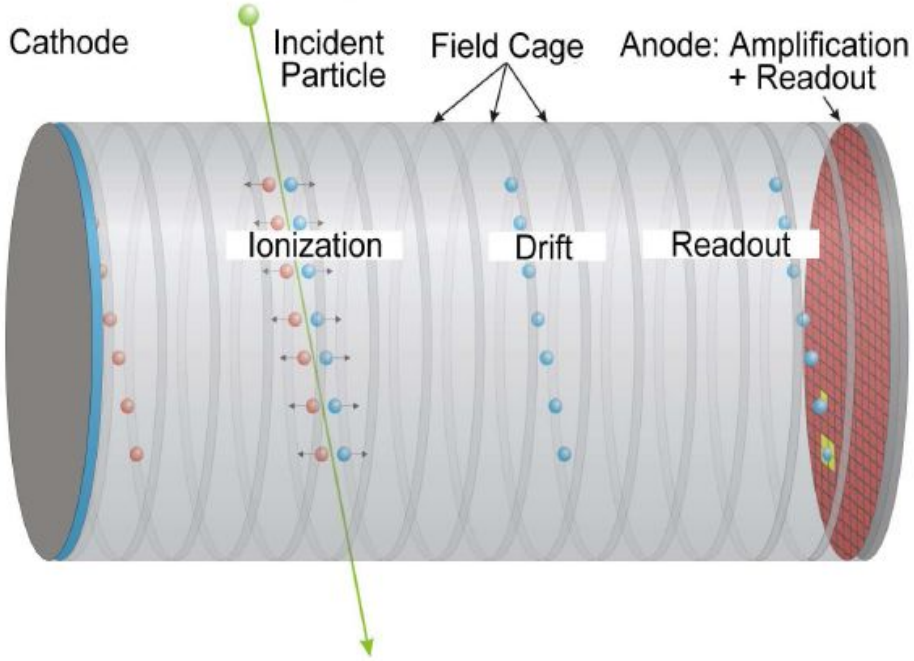
The ILC-TPC

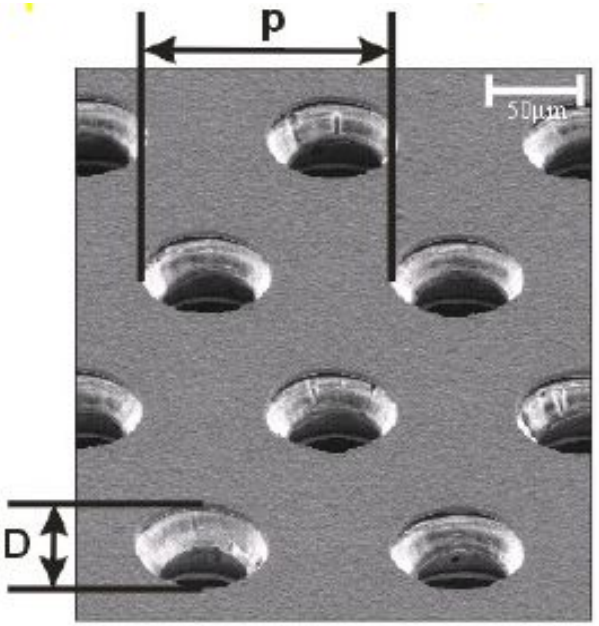
- Performance goals and design parameters for a TPC with standard electronics at the ILC detector

Size (LDC–GLD average)	$\phi = 3.6$m, L = 4.3m outside dimensions
Momentum resolution (B=4T)	$\delta(1/p_t) \sim 10 \times 10^{-5}$/GeV/c TPC only; $\times$ 0.4 incl. IP
Momentum resolution (B=4T)	$\delta(1/p_t) \sim 3 \times 10^{-5}$/GeV/c (TPC+IT+VTX+IP).
Solid angle coverage	Up to at least $\cos\theta \sim 0.98$
TPC material budget	$< 0.03X_0$ to outer fieldcage in r
	$< 0.30X_0$ for readout endcaps in z
Number of pads	$> 1{\times}10^6$ per endcap
Pad size/no.padrows	$\sim$ 1mm$\times$4–6mm/$\sim$200 (standard readout)
$\sigma_{\text{singlepoint}}$ in $r\phi$	$\sim 100\mu$m (for radial tracks, averaged over driftlength)
$\sigma_{\text{singlepoint}}$ in rz	$\sim$ 0.5 mm
2-hit resolution in $r\phi$	$<$ 2 mm
2-hit resolution in rz	$<$ 5 mm
dE/dx resolution	$<$ 5 %
Performance robustness	$>$ 95% tracking efficiency for all tracks–TPC only)
(for comparison)	($>$ 95% tracking efficiency for all tracks–VTX only)
	$>$ 99% all tracking[13]
Background robustness	Full precision/efficiency in backgrounds of 1% occupancy
	(simulations estimate $<$ 0.5% for nominal backgrounds)
Background safety factor	Chamber will be prepared for 10 $\times$ worse backgrounds
	at the ILC start-up.

with MPGD

The ILC-TPC

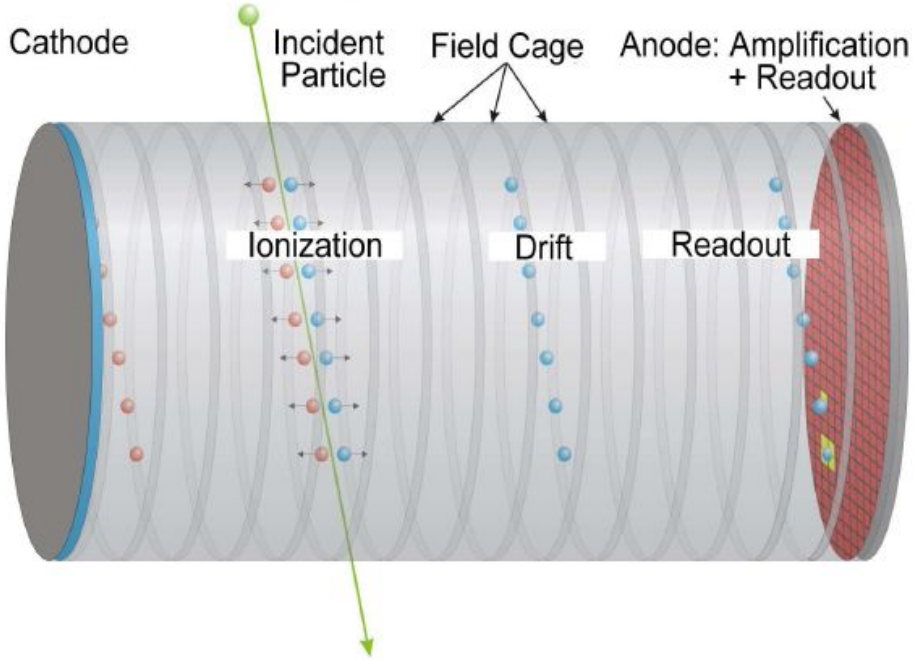


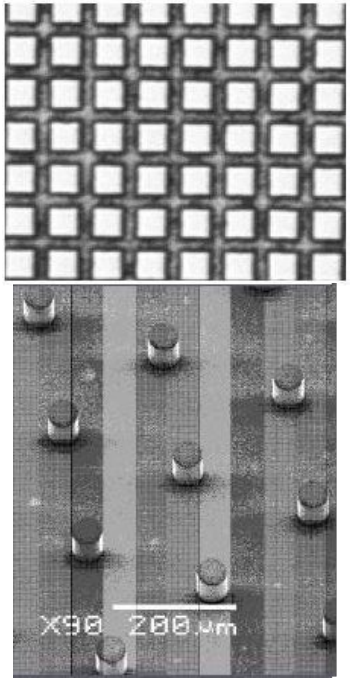


p=140µm
D=70µm

Gas Electron Multiplier (GEM):
50µm Kapton foil, each side covered with 5µm Cu clad;
multiple stage

The ILC-TPC



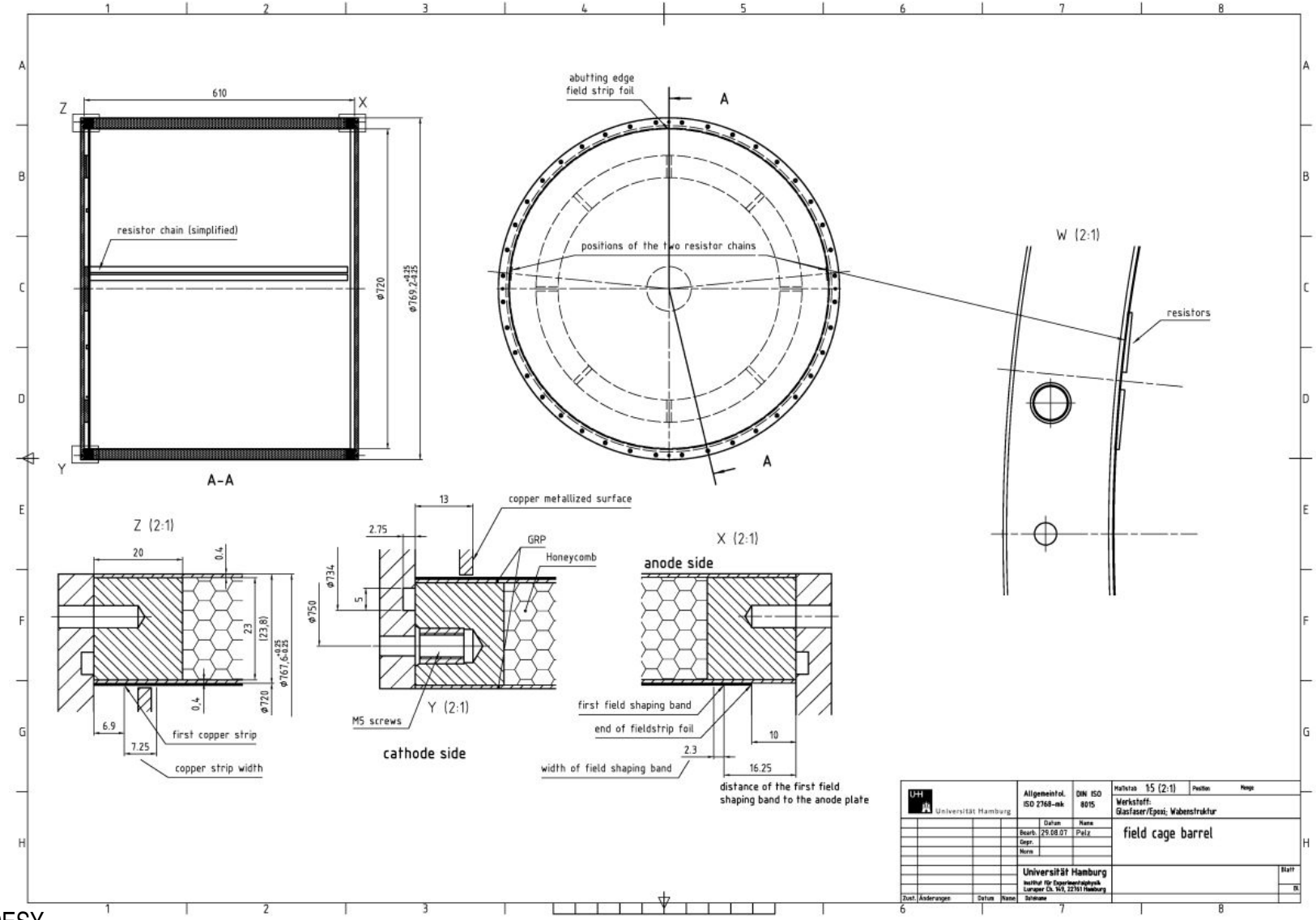


Micro Mesh Gaseous Structure (Micromegas):
micromesh sustained by 50 µm pillars,
multiplication between anode and mesh;
one stage

The Large Prototype LP-TPC

- Large TPC prototype JRA2:
  - $O(\varnothing) \approx 1$ m
  - low mass field cage
  - modular endplate system for large surface GEM and MicroMegas system
  - development of prototype electronics for GEM and MicroMegas
- Large bore magnet PCMAG JRA2:
  - B $\approx$ 1 Tesla, $\varnothing \approx$ 0.85 m, standalone He cooling, provided by KEK
  - infrastructure (control, fieldmapping etc.) through EUDET
- Si-envelope

LP-TPC FC


610
Z
X
Y
resistor chain (simplified)
ø720
ø769.2 +0.25 -0.25
A-A
abutting edge
field strip foil
A
positions of the two resistor chains
W (2:1)
resistors
Z (2:1)
20
0.4
23
(23.8)
ø767.6 +0.25 -0.25
ø720
6.9
7.25
first copper strip
copper strip width
13
copper metallized surface
2.75
GRP
Honeycomb
ø734
ø750
5
M5 screws
Y (2:1)
cathode side
X (2:1)
anode side
first field shaping band
end of fieldstrip foil
width of field shaping band
2.3
10
16.25
distance of the first field
shaping band to the anode plate
Universität Hamburg
Allgemeintol. ISO 2768-mk
DIN ISO 8015
Maßstab 1:5 (2:1)
Werkstoff:
Glasfaser/Epoxi; Wabenstruktur
Bearb. 29.08.07 Pelz
field cage barrel
Universität Hamburg
Institut für Experimentalphysik
Luruper Ch. 149, 22761 Hamburg
Blatt

LP-TPC FC

- Field cage FC:
  - $\varnothing_{inner}$ = 0.720 m
  - $\varnothing_{outer}$ = 0.769 m
  - length l = 0.610 m w/o endplates

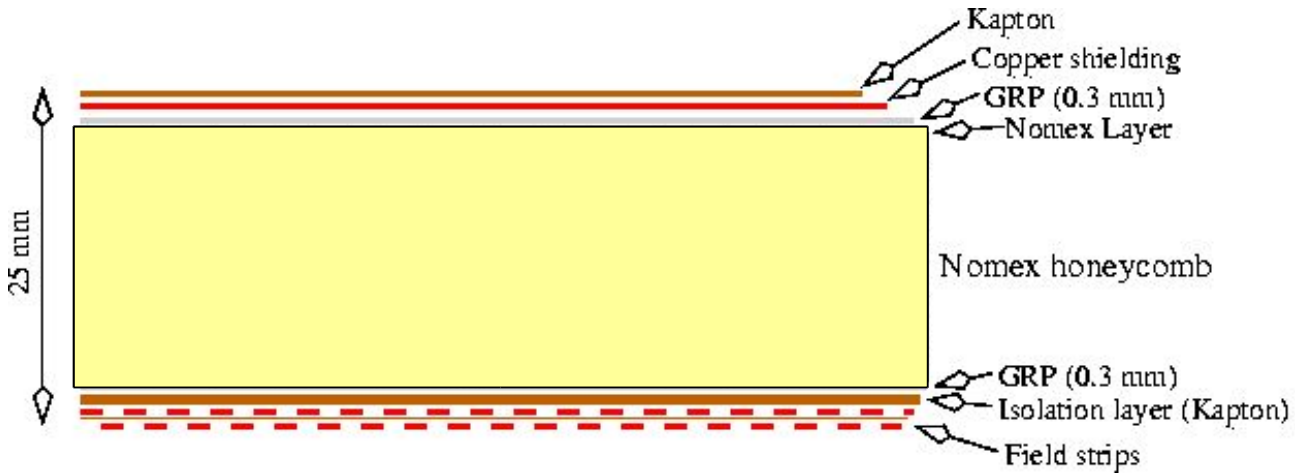
- Design:

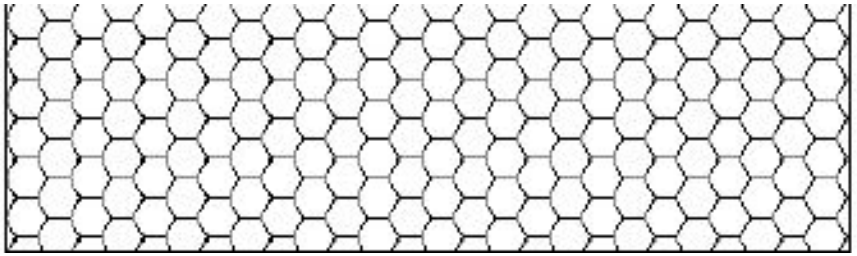
  final details to be discussed (inserts, screws, o-ring groove dimension)

- EUDET → user LCTPC collaboration

LP-TPC FC

FC wall



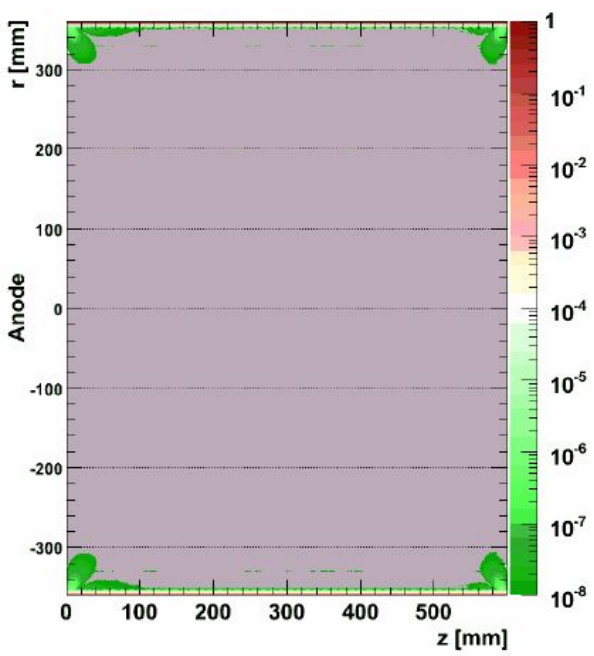


Nomex hc structure
top view

LP-TPC FC

Set of field calculations has been performed

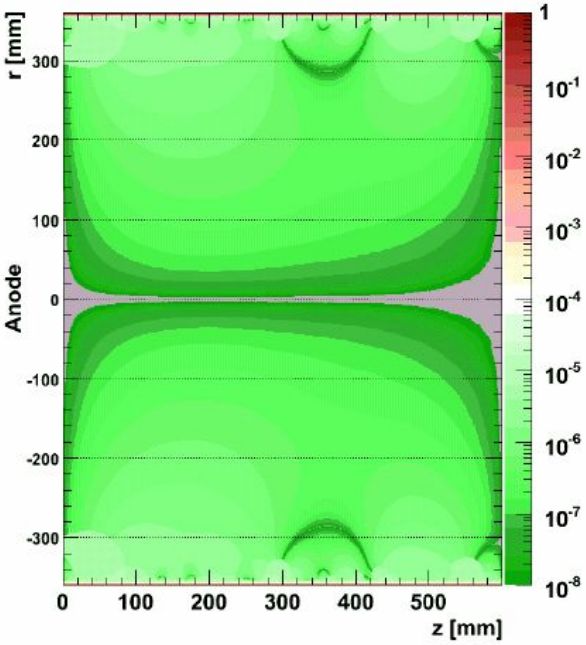
mirror strips



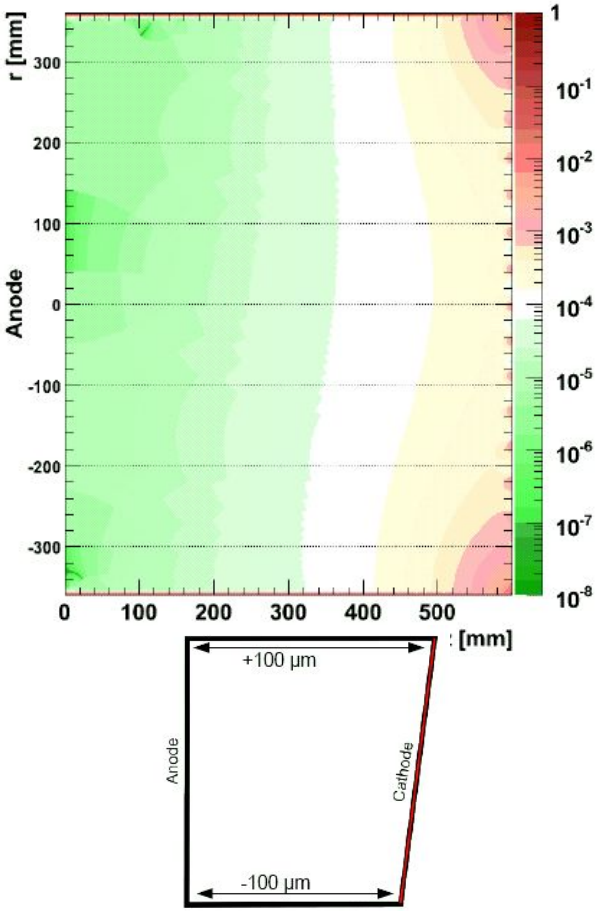
Shown: $E / E_{nominal}$

Goal: Deviations below 10^{-4}

non perfect R



non perfect R + tilted cathode

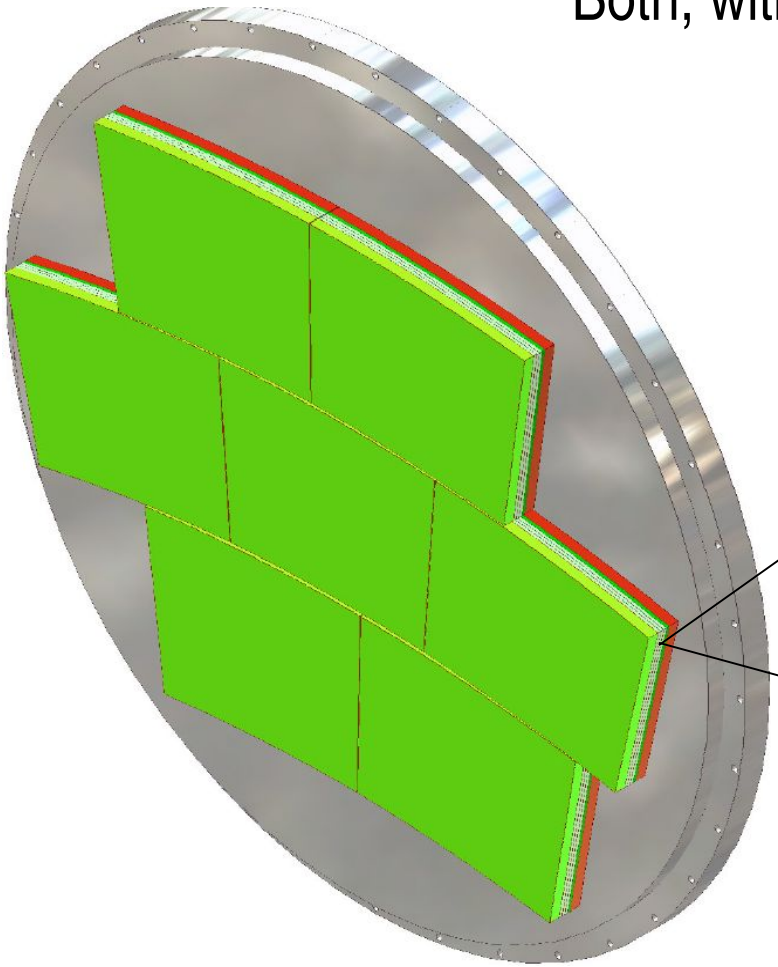


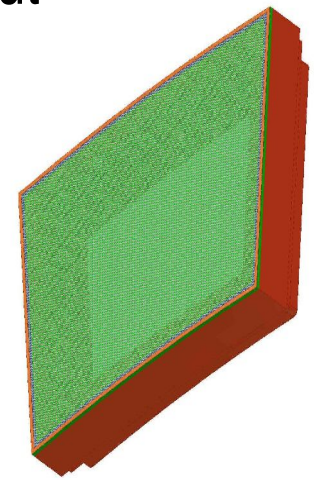
= Value below Accuracy Limit

R. Diener, DESY

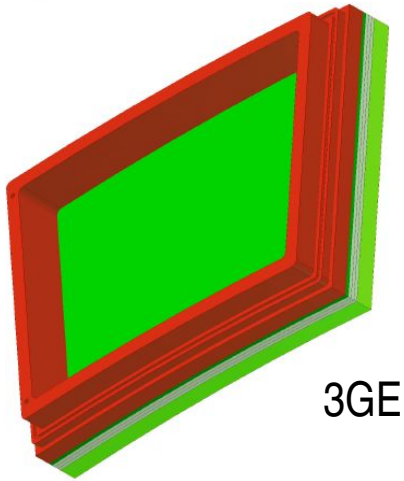
LP-TPC Endplates

Both, with pad and Si readout





MicroMegas



3GEM+Gate

D. Peterson, Cornell

The LP TPC

Integration schedule:

Field Cage

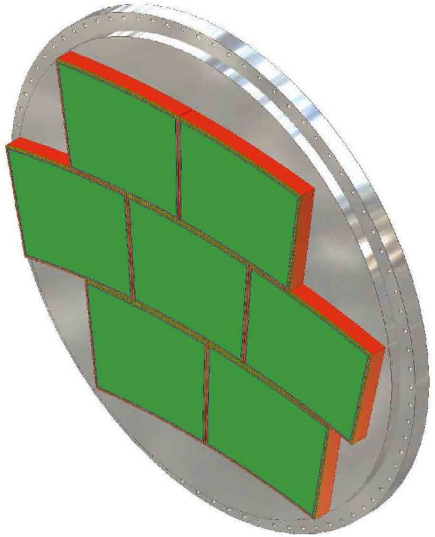
- FC approaching:
  - 2007, mid October: Fieldstrip foil
  - 2007, till end of October: soldering of resistors on foil
  - 2007, till mid November: production of field cage
  - 2007, beginning of December: field cage at DESY

Endplates

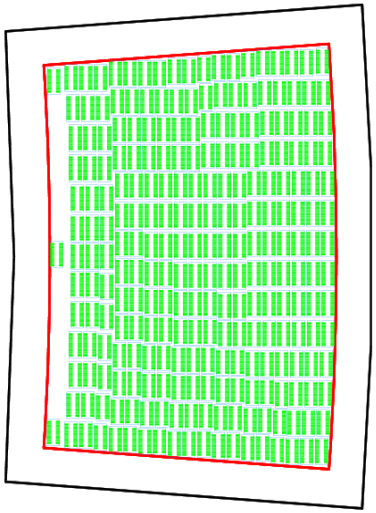
- Convergence between FC and EP

LP-TPC Readout

Endplate with panels



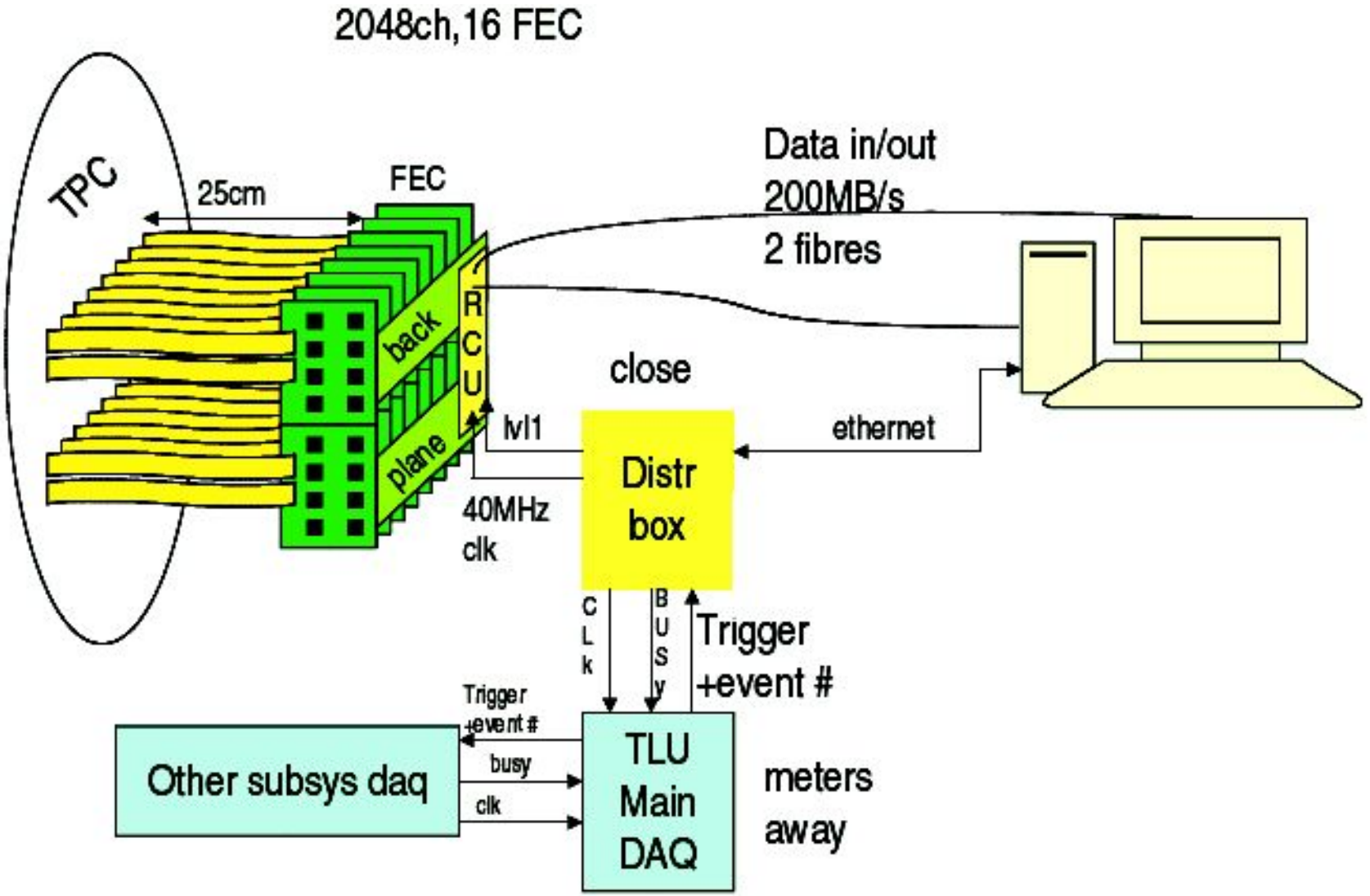
Panel with connectors



Two strategies pursued in EUDET

- FADC-based (Lund, CERN)
- new TDC (Rostock)

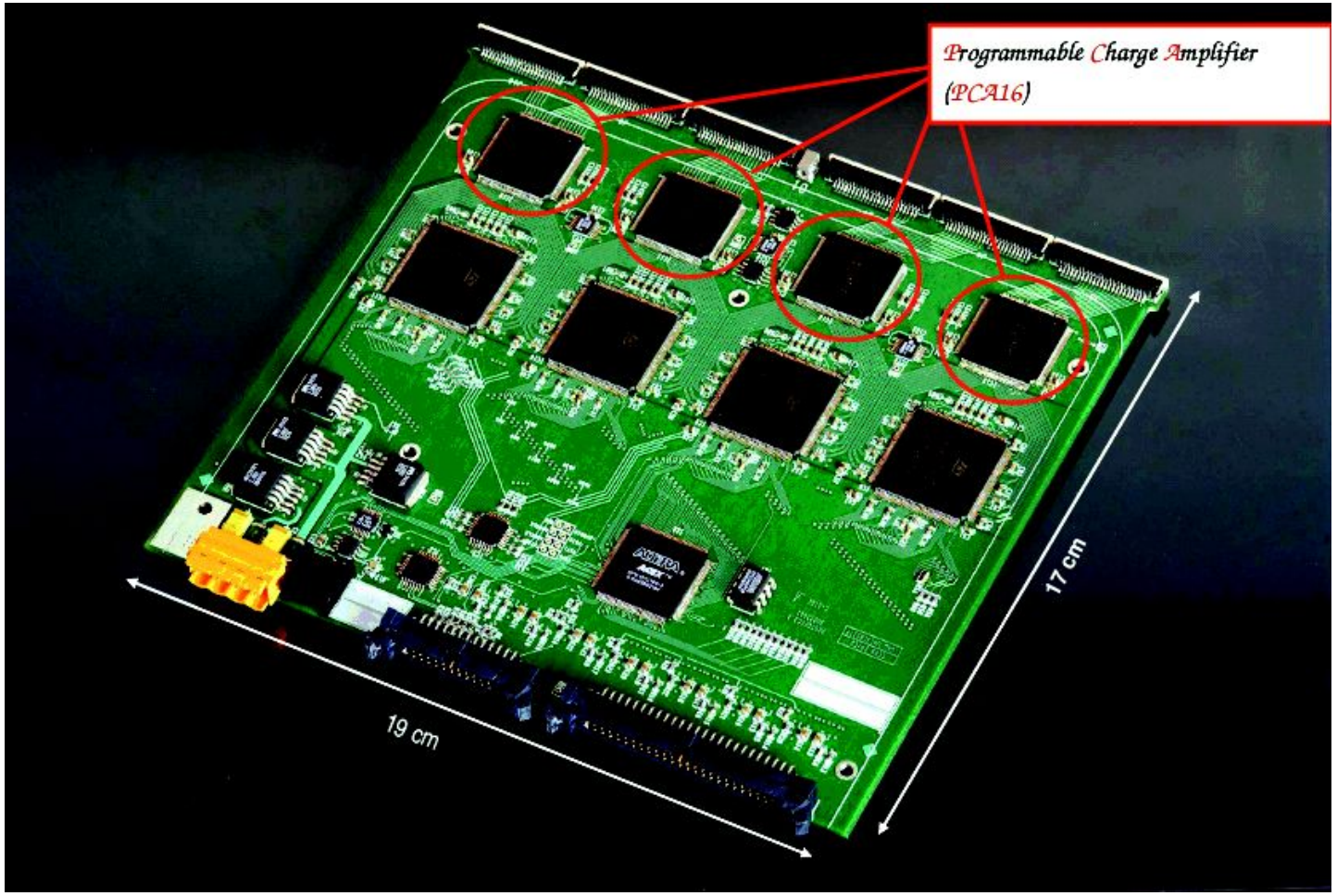
LP-TPC FADC Electronics



L. Jönsson LUND

LP-TPC FADC Electronics

Alice TPC FEC, modified amplifiers, based on ALTRO Chip



L. Jönsson LUND

LP-TPC FADC Electronics

Programmable Charge Amplifier PCA16

1.5 V supply; power consumption <8 mW/channel

16 channel charge amplifier + anti-aliasing filter

Single ended preamplifier

Fully differential output amplifier

Both signal polarities

Power down mode (wake-up time = 1 ms)

Programmable peaking time (30 – 120 ns)

Programmable gain in 4 steps (12 – 27 mV/fC)

Preamp_out mode

Tunable time constant of the preamplifier

LP-TPC FADC Electronics

Number of available 40 MHz ALTRO chips from ALICE (~2000 ch) 125

New production of 25 MHz ALTRO chips for other experiments:

Number of chips produced	16489
Number of chips accepted by the test	14273 (86%)
Number of chips not accepted by the test	2216 (14 %)
Number of chips ordered by other exp.	13400
Remaining accepted chips available for ILC-TPC	873

Out of the chips that failed the test it is expected that 33% may be recuperated 730

Total number available chips for ILC-TPC ~1600

This number corresponds to 25600 channels

LP-TPC FADC Electronics

Electronics FADC

- Programmable Charge Amplifier (prototype)

  12 channel non-programmable charge amplifier produced and tested

  16 channel programmable charge amplifier (PCA16) produced; 200 chips (Sept. 2007)

  Tests of PCA16 (Nov. – Dec. 2007)

LP-TPC FADC Electronics

Integration schedule:

Electronics FADC

- 10-bit multi-rate ADC (prototype), 4-channel 10-bit 40-MHz ADC (December 2007, schematic design)

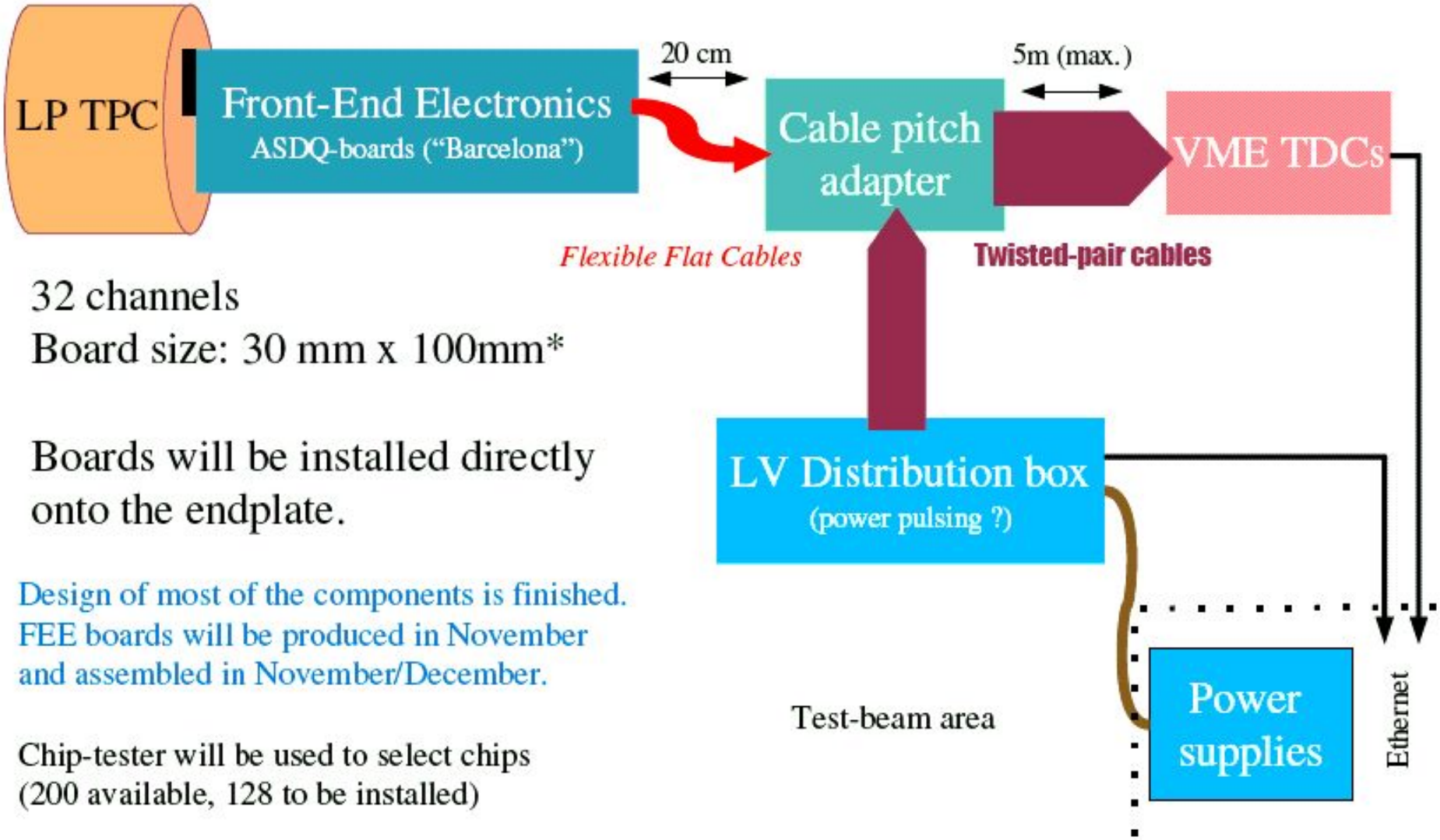
  Available: ~125 ALTRO chips 40 MHz

  ~1600 ALTRO chips 25 MHz

  Modified circuit board (design) (Oct. 2007)

- Operating DAQ-system (Test system operating Sept. 2007)
- Production and bench-top tests of modified FEC. (Dec. 2007; provided minimum 8 PCA16 available in Lund)

LP-TPC TDC Electronics



32 channels
Board size: 30 mm x 100mm*

Boards will be installed directly onto the endplate.

Design of most of the components is finished.
FEE boards will be produced in November and assembled in November/December.

Chip-tester will be used to select chips
(200 available, 128 to be installed)

A. Kaukher, Rostock

LP-TPC TDC Electronics

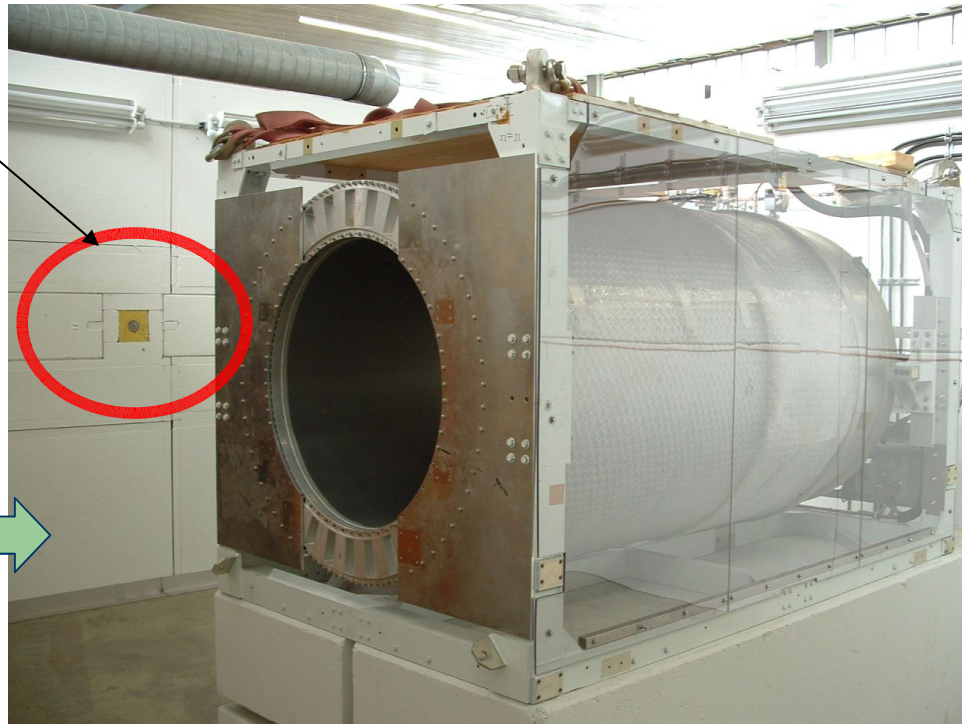
Integration schedule:
Electronics TDC

- FEE boards – Nov. 2007, assembly Dec. 2007
- Most of hardware to be ready by end of 2007 (except LV distr. box)

JRA1-PCMAG

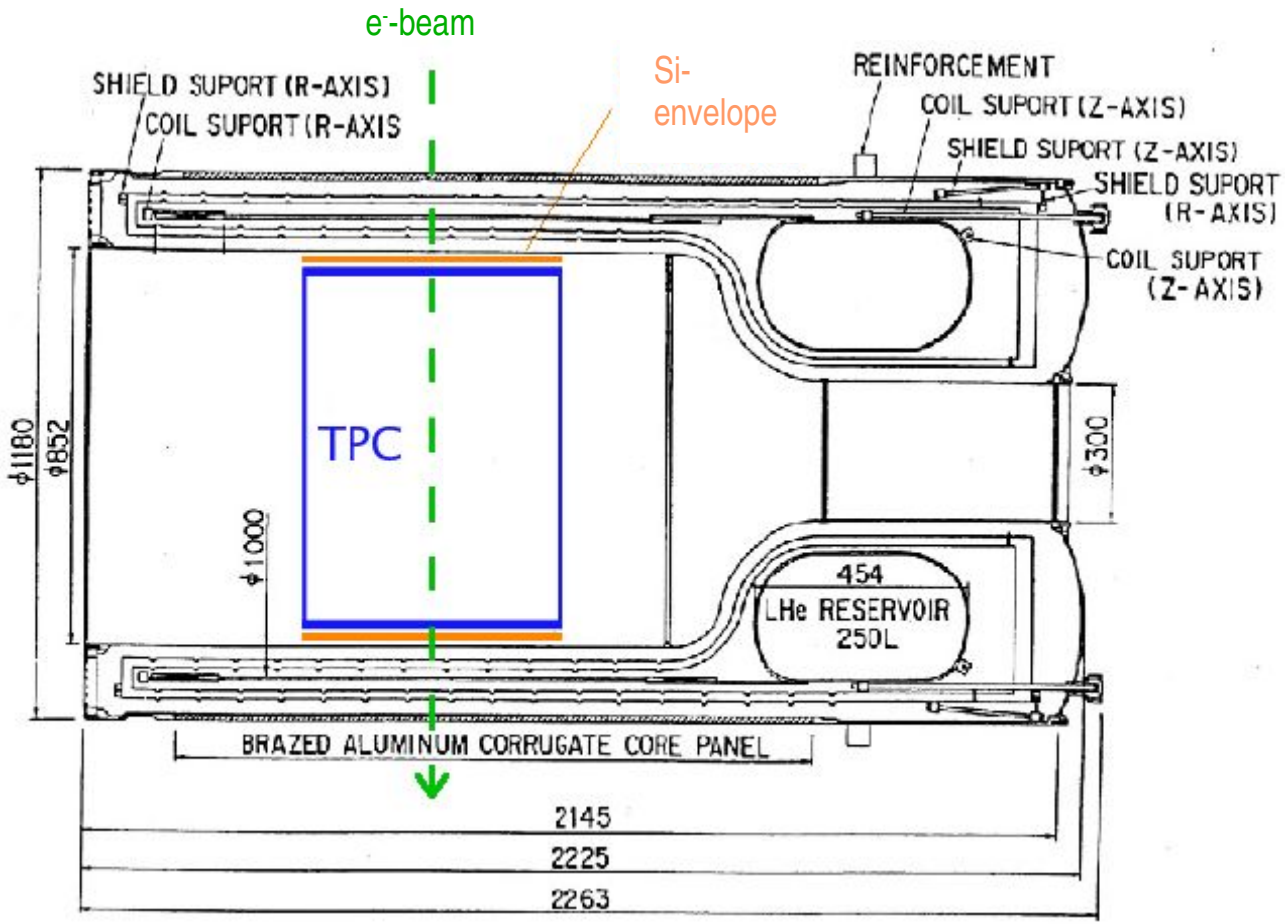
TPC will be adjusted
- horizontally
- vertically
- rotationally

w.r.t. beam line



Problem: magnetizable components

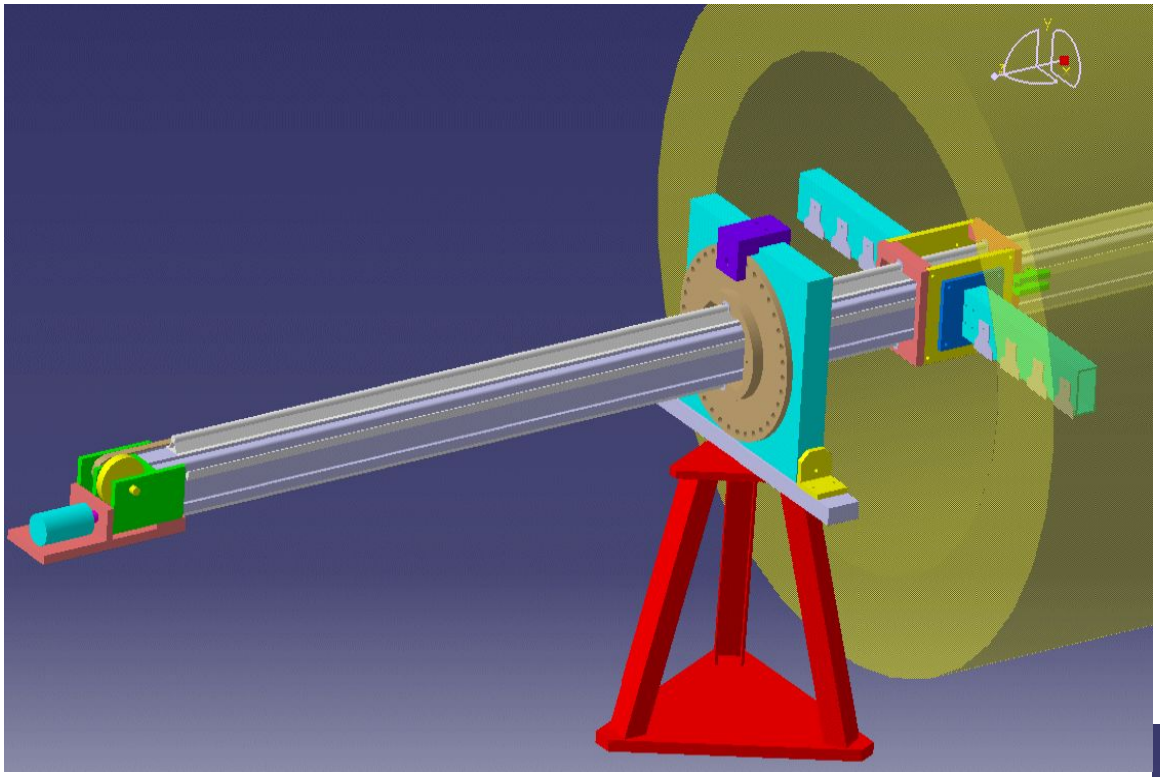
TPC-Test beam-PCMAG



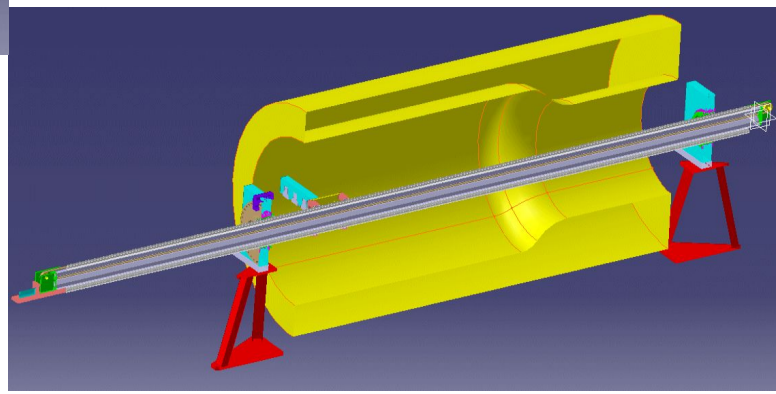
$B_{max} \cong 1.25$ T

L. Hallermann, DESY

Field Mapping



Field measurements performed in July 2007



P. A. Giudici / C. Bault

TPC-Test beam-PCMAG

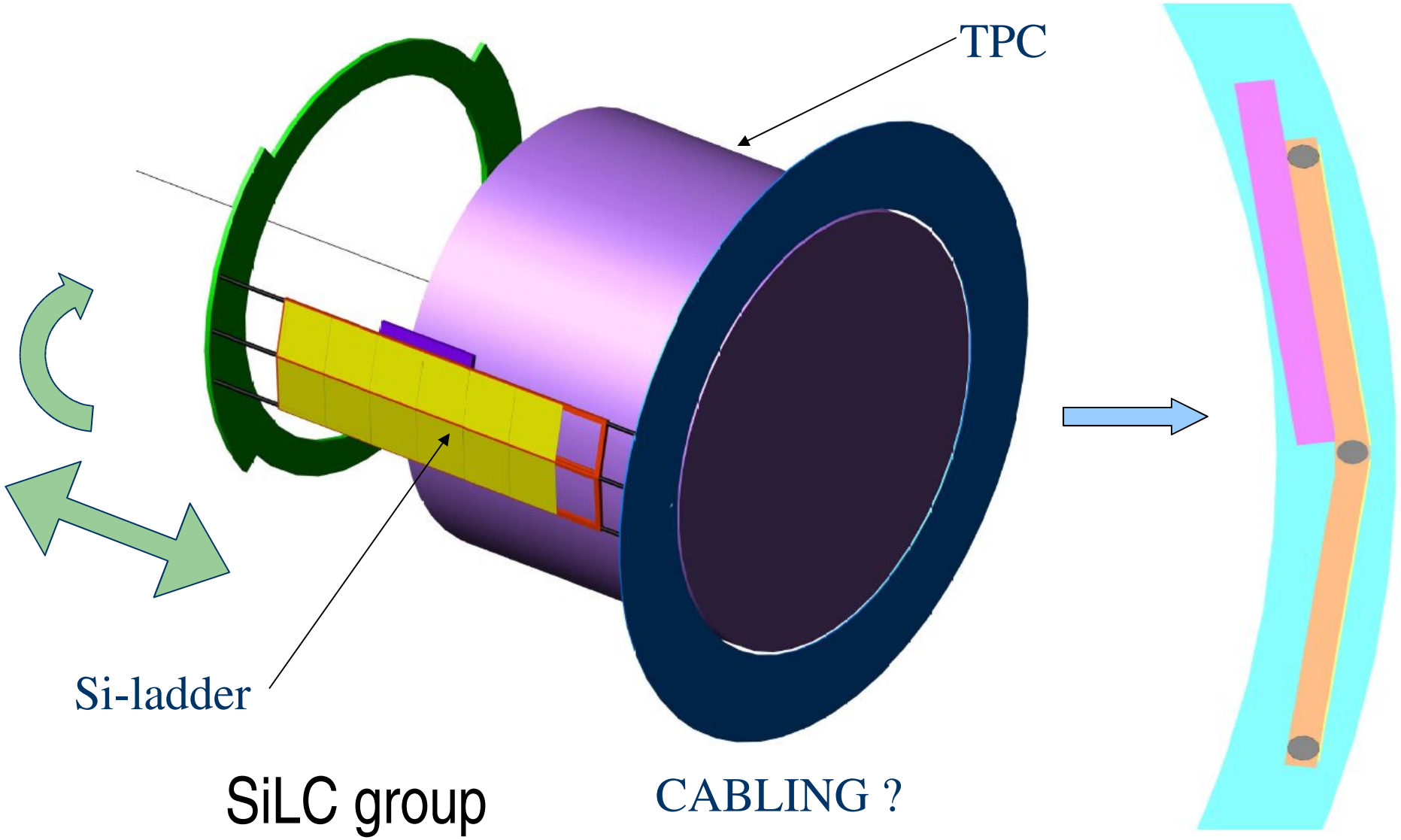
JRA1 PCMAG

- Successfully operated
- Field map will be finished by Dec. 2007
- Modifications w.r.t. safety

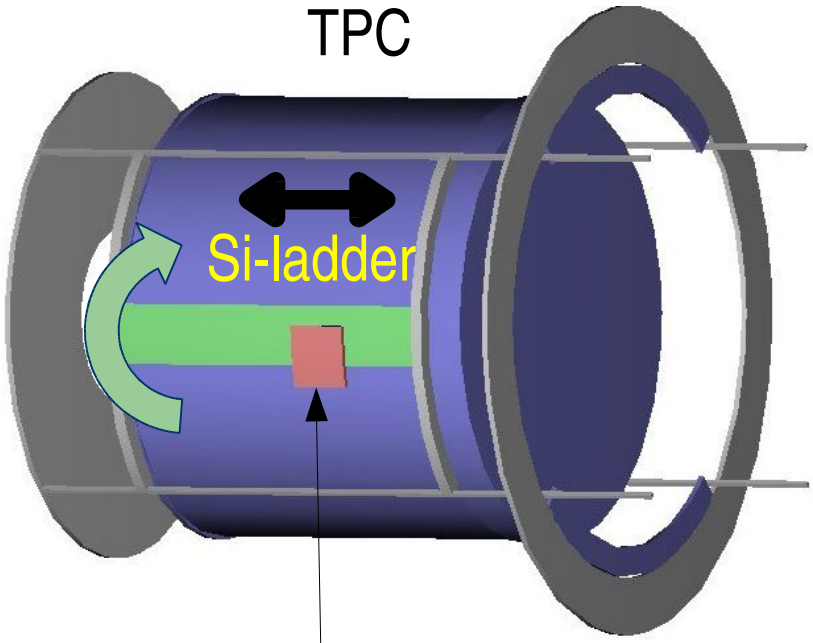
Support structure

- Stability calculations
- Influence of magnetizable components (e.g. lift table)
- Implementation in Jan. 2008

Si-Envelope



Si-Envelope

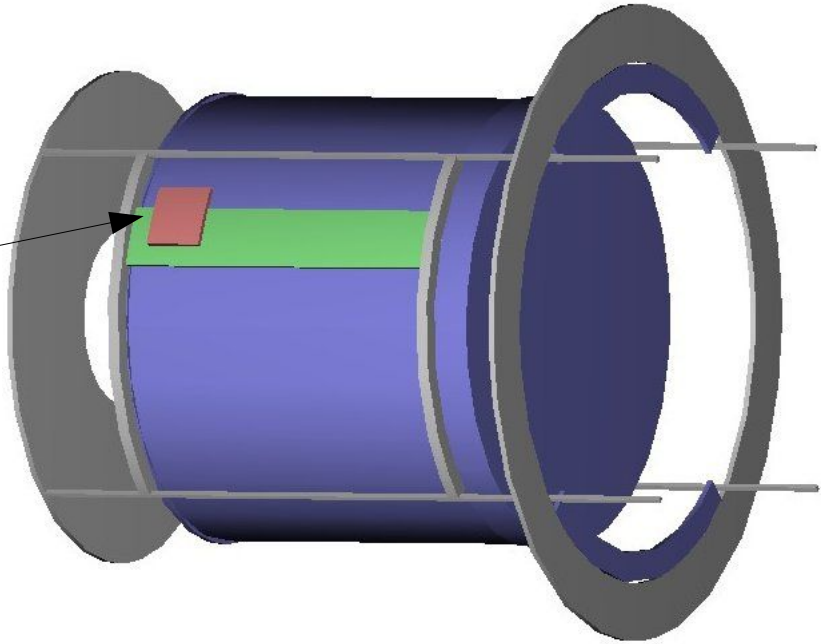


Si detectors as precise reference entry and exit point for tracks traversing the TPC:

resolution

10-12 μm in rϕ

20 μm in z



Si device: **limited** in size/area

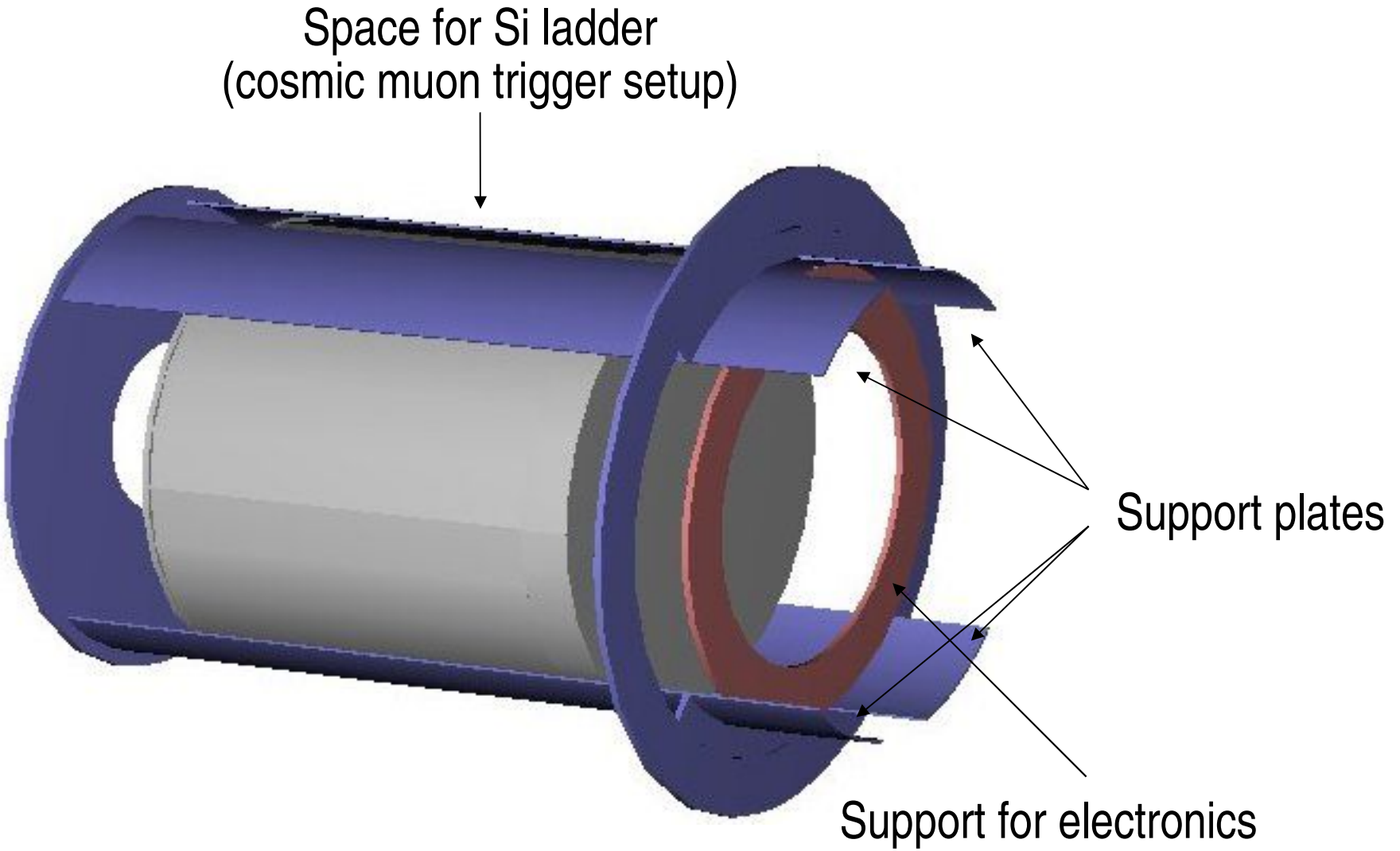
Si-Envelope

Integration schedule:

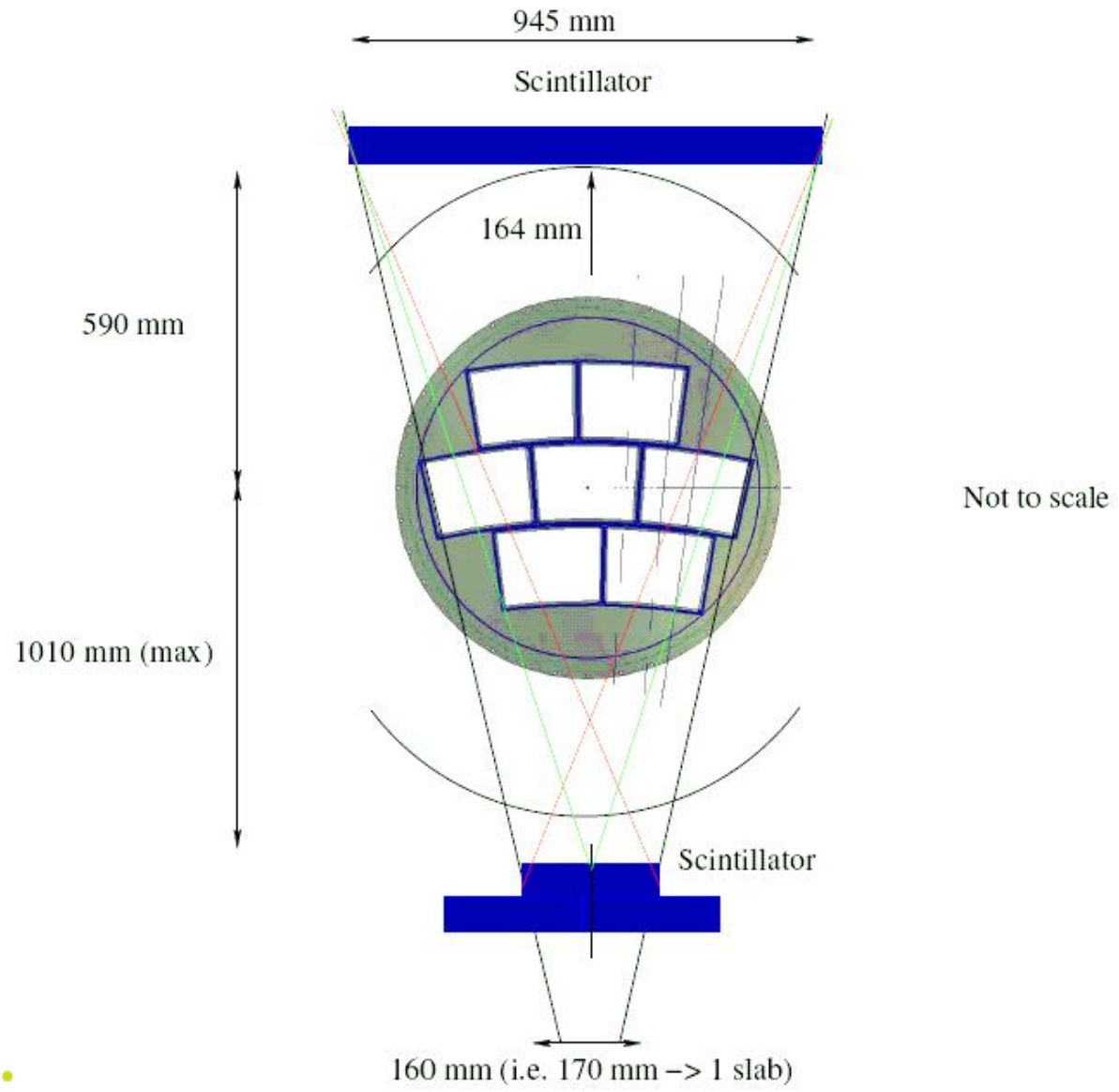
Si envelope

- **Time constraints only allow CMS front-end and readout electronics**
- Limited readout area: 38,4 cm^2
- 18 muon coincidences in the Si modules expected per day
- Too much effort for this? No, because first system test of TPC+Si readout systems

LP-TPC Support

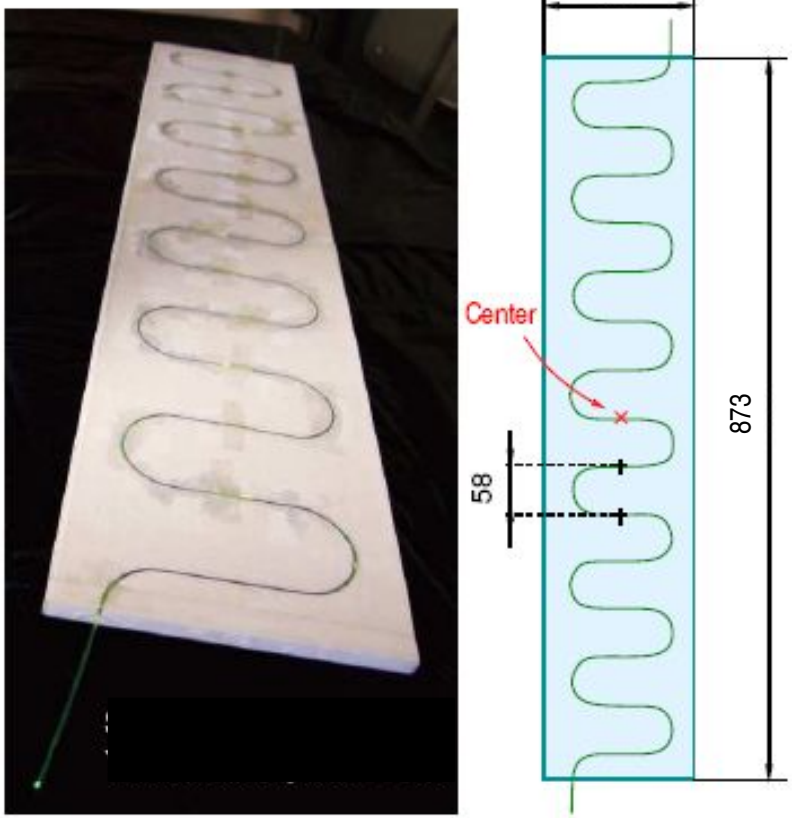


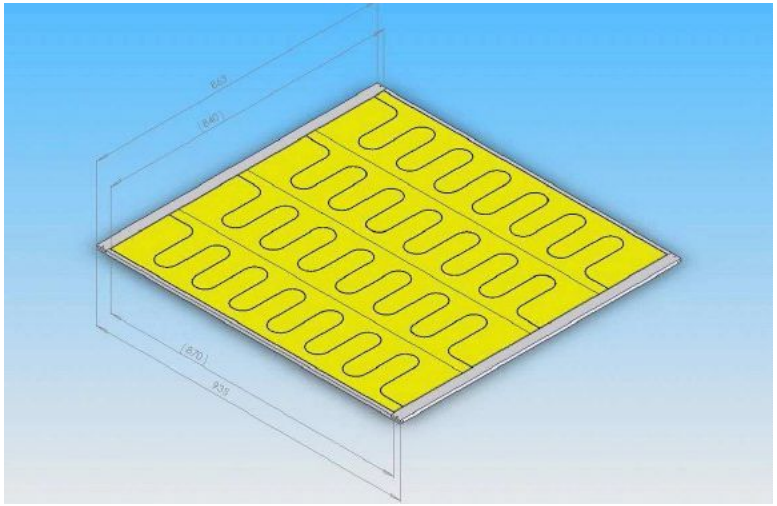
Cosmic Trigger Setup



Cosmic Trigger Setup

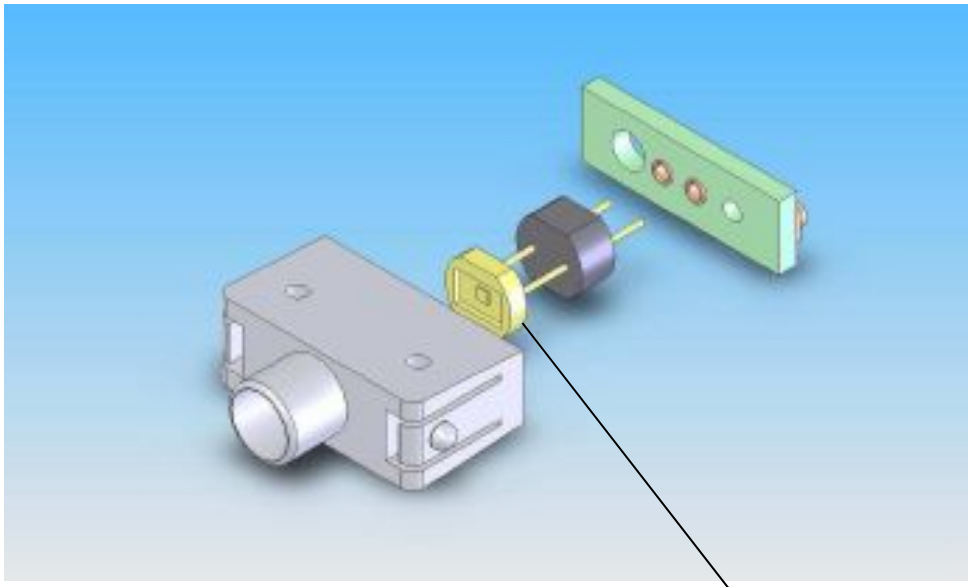
Scintillator produced by Uniplast in Vladimir (Russia)





Plastic scintillator with white chemical reflector;
4 mm deep S-shape groove for WLS (ϕ = 1 mm);
WLS: Kurary Y11, double clad

Cosmic Trigger Setup



Exploded view of optical connector

MultiPhoton PixelCounter (MPPC):
Active area 1 x 1 mm, pitch 100 µm,
ceramic package

Cosmic Trigger Setup

Cosmic trigger hodoscope:

a Russian-Japanese-French collaborated effort

- Scintillator slabs and MPPC ordered
- Mounting and light tight box to be produced
- To be mounted to PCMAG's supporting frame

Summary & Outlook

- EUDET Field Cage will become available by Dec. 2007
- ALTRO chips (40 Mhz) for 2000 channels available
- Production and bench-top tests of modified FEC In Dec. 2007
- Support structure available in Jan. 2008
- Cosmic muon trigger hodoscope available by Jan. 2008

Cosmic muon data taking in the first quarter of 2008