Status of Large TPC Prototype Field Cage

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DESY Hamburg

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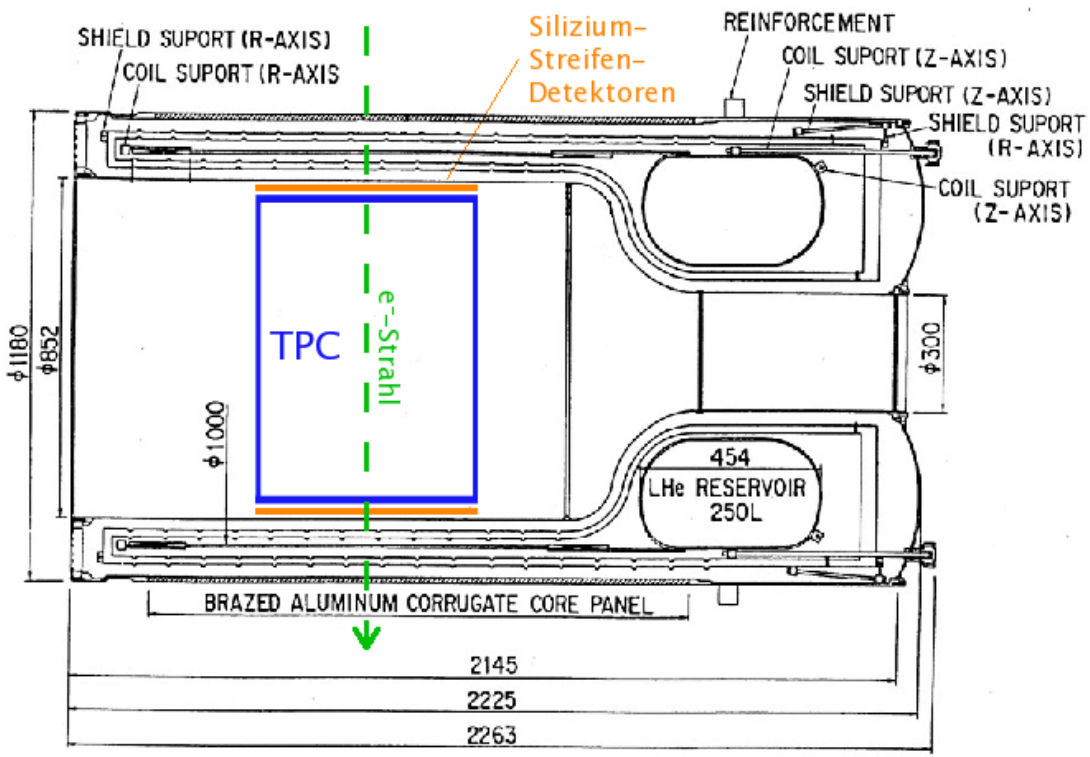
task for desy tpc group

development and construction of field cage for a large TPC prototype within EUDET

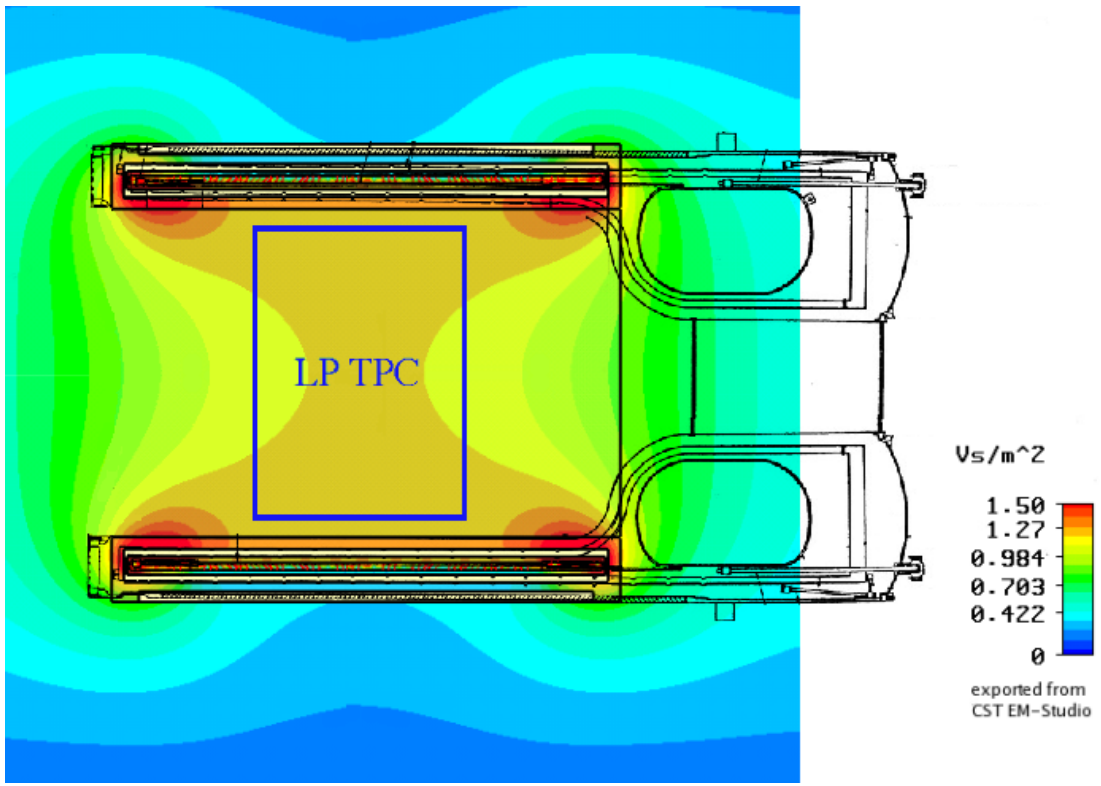
- electron test beam area at DESY available
- field cage is part of infrastructure
  $\longrightarrow$ will be used by many groups
- superconducting magnet PCMAG defines dimensions of field cage
- prototype shall be a first step to the LC TPC
  $\longrightarrow$ the barrel should be leightweight but stable
  $\longrightarrow$ little material budget for walls

PCMAG from KEK

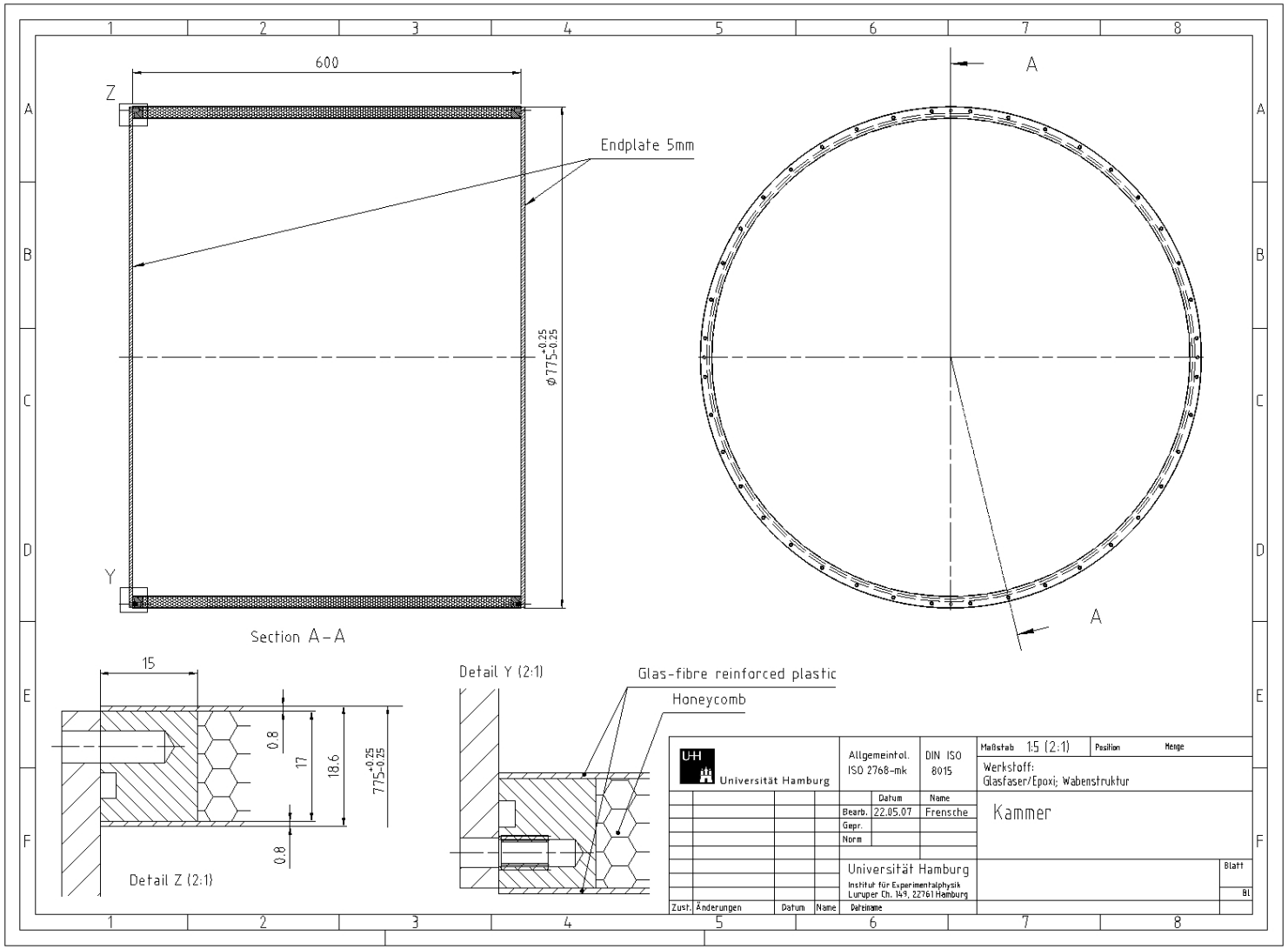


setup in magnet

PCMAG from KEK



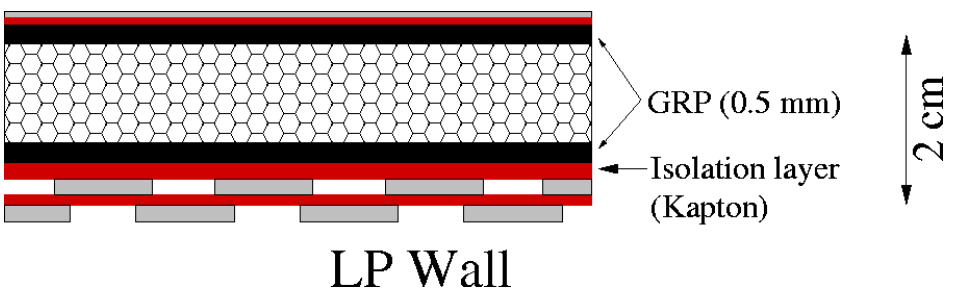
design of field cage

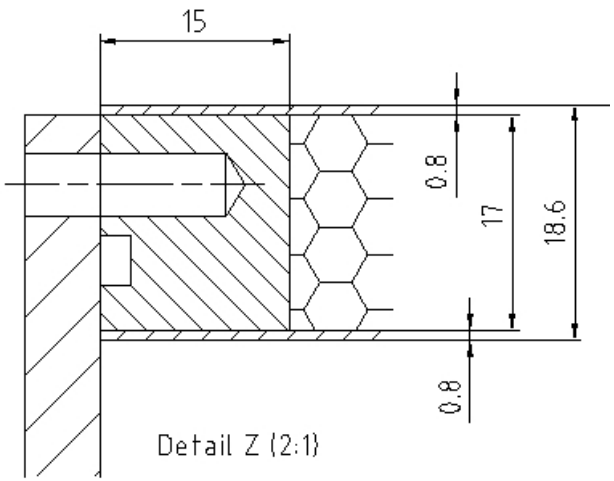


inner diameter: 730 mm, length: 60 cm, wall thickness: 2 cm

wall structure

- composite material
- two thin layers of glass-fibre reinforced plastic, honeycomb Nomex as spacer
- flanges made of G10 with helicoils and o-rings



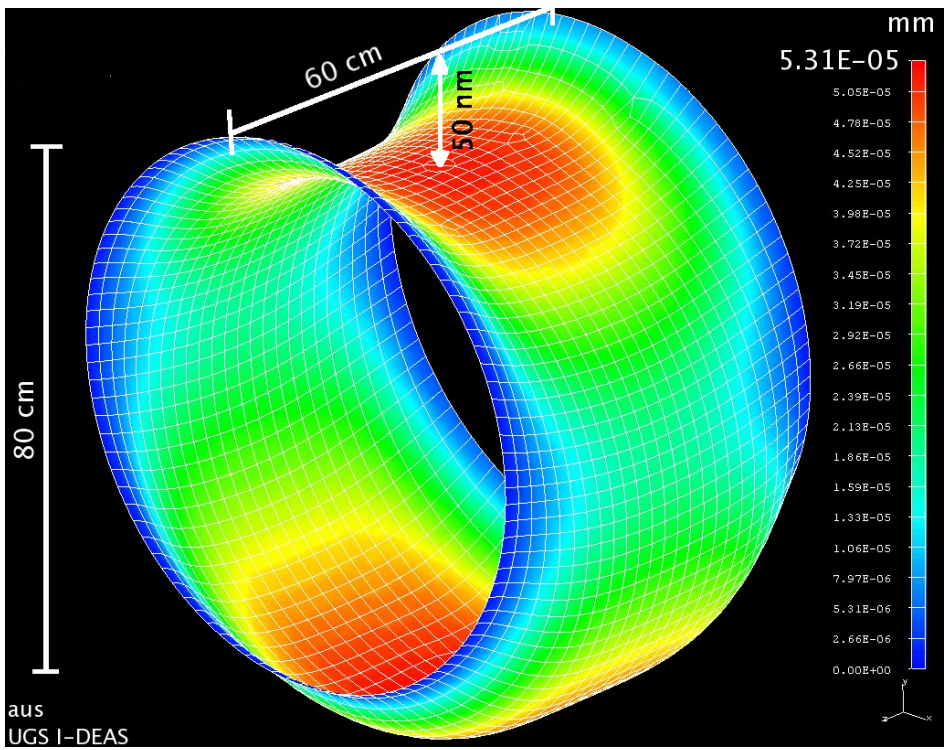


mechanical calculations

intention: thinnest possible structure
finite element program

$$=> 0.5\,\mathrm{mm} - 19\,\mathrm{mm} - 0.5\,\mathrm{mm} \quad \text{(GRP-Nomex-GRP)}$$

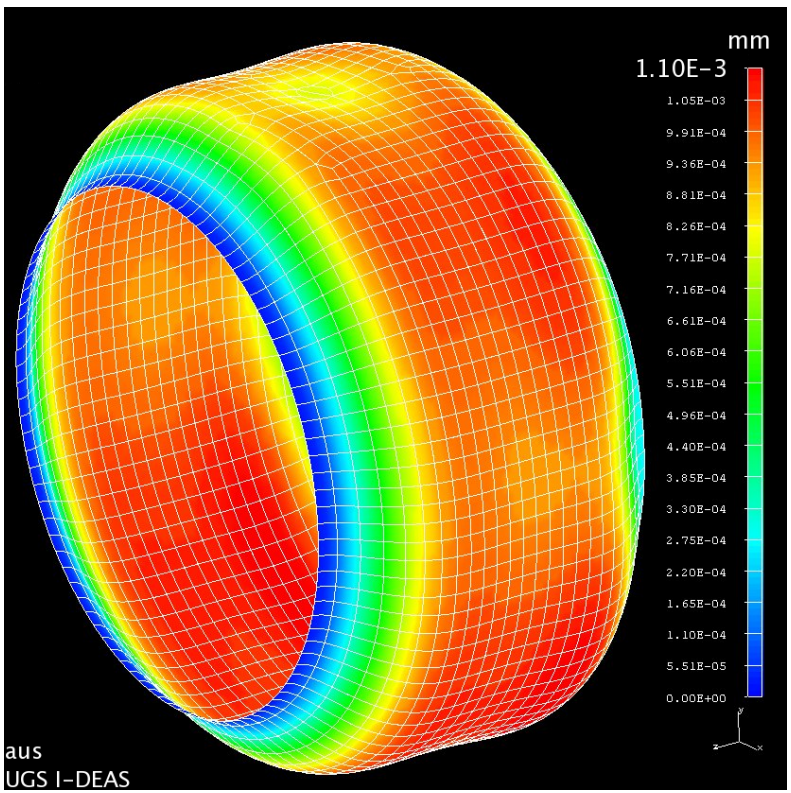
sag of field cage, supported only on endplates



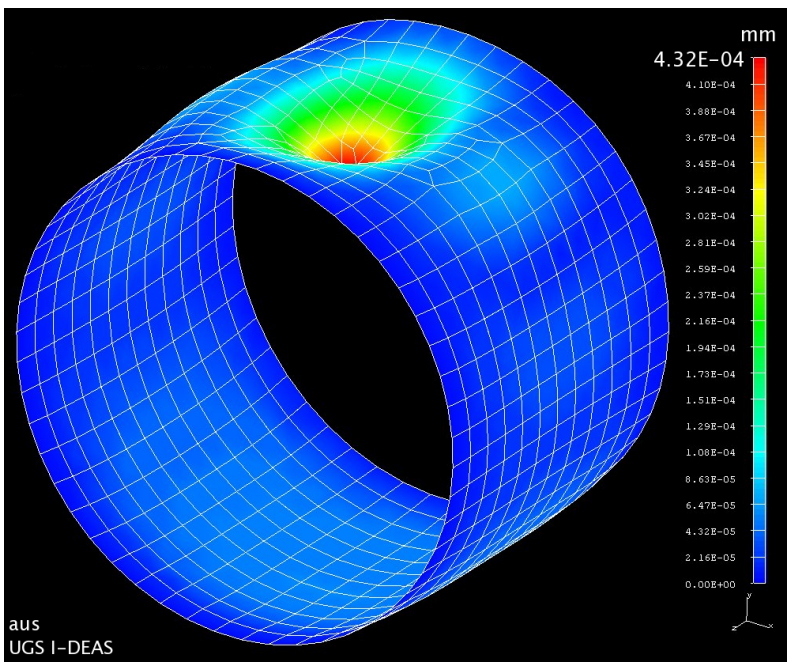
mechanical calculations II

$0.5\,\mathrm{mm} - 19\,\mathrm{mm} - 0.5\,\mathrm{mm}$ (GRP-Nomex-GRP)

internal pressure of 0.1 bar



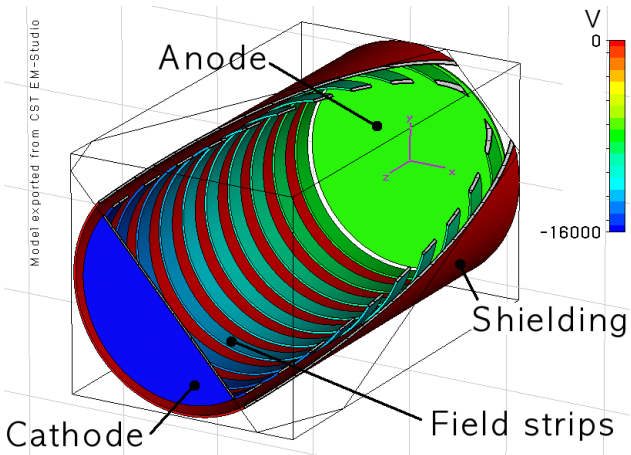
additional load of 5 kg

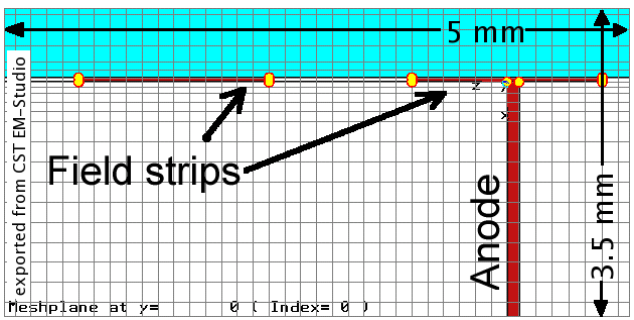


model for simulation with finite element method

- drift field calculated for different layouts of field strips
- 2 dim model with $5 \cdot 10^6$ mesh cells leads to very accurate results
- field deviations:

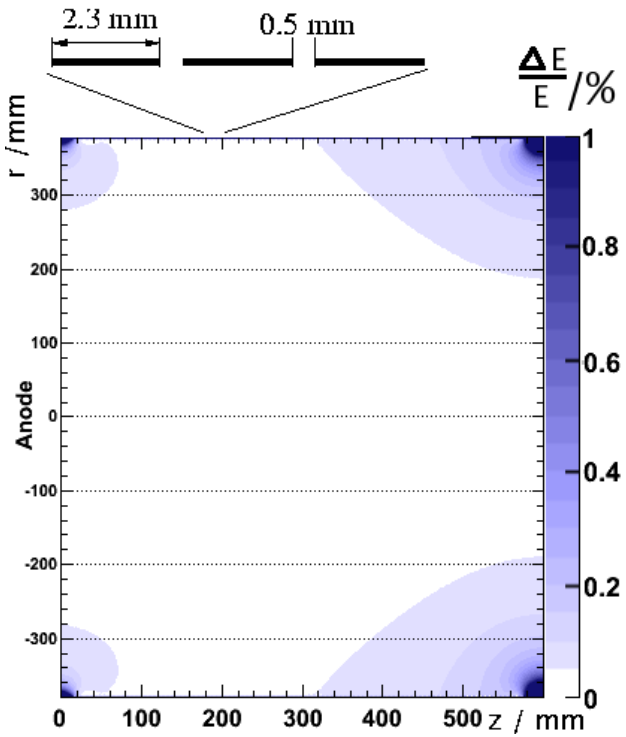
$$\frac{\Delta E}{E} = \frac{|\vec{E}_{nom} - \vec{E}_{calc}|}{E_{nom}}$$





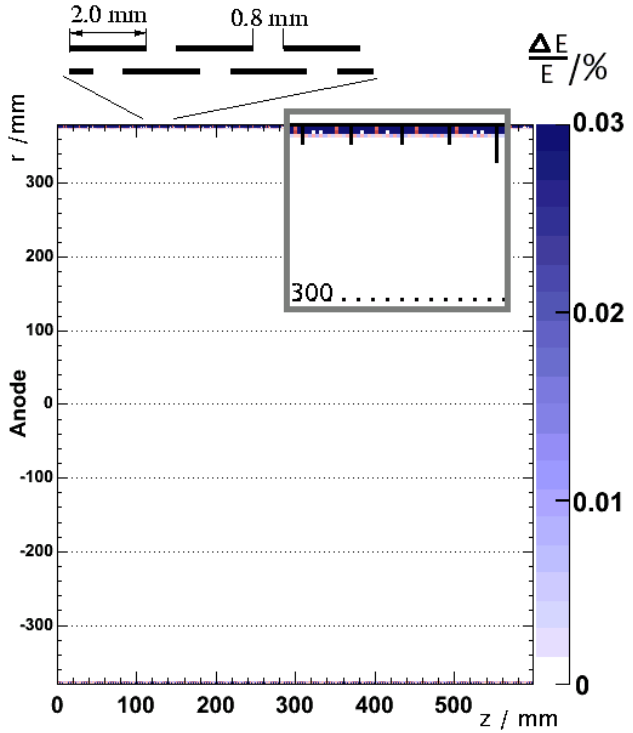
electrostatics II

single layer of field strips



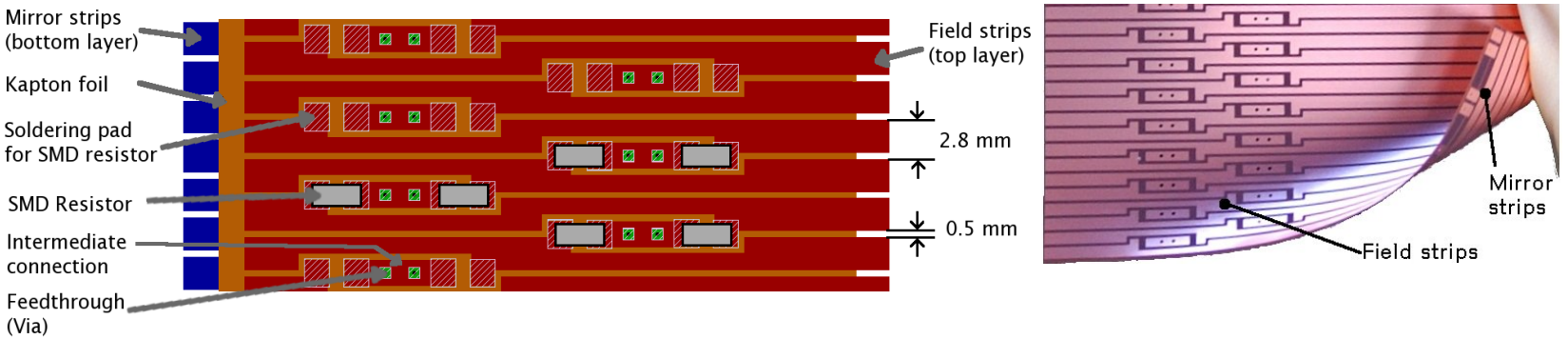
⇒ deviations in corners of the chamber

mirror strips on intermediate potential



⇒ no deviations anymore in the drift volume

field strip foil



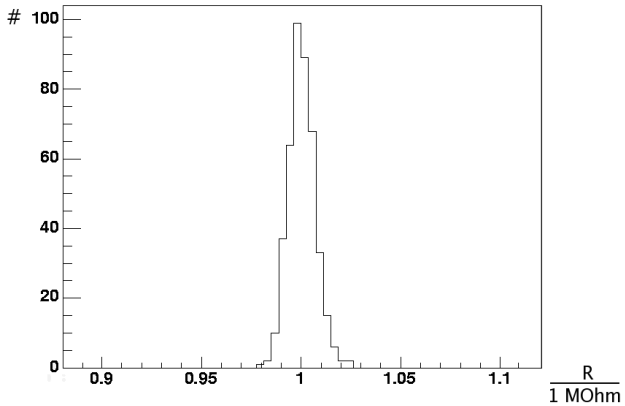
- innermost layer of field cage
- size: 60 cm x 230 cm (length x inner circumference)
- Kapton coated with copper strips
- SMD resistors splitting the potential
- electric tests with sample piece succesful
  $\longrightarrow$ 90 V between two neighbouring strips possible

  $\Rightarrow$ foil allows a maximal drift field of $E_{drift}^{max} = 320\,V/cm$

drift field quality

influence of resistors on drift field

- SMD resistors with $1\,\mathrm{M}\Omega \pm 0.1\%$
  $\Rightarrow$ modified potential on strips
  $\Rightarrow$ calculated field
  deviations up to 0.1%



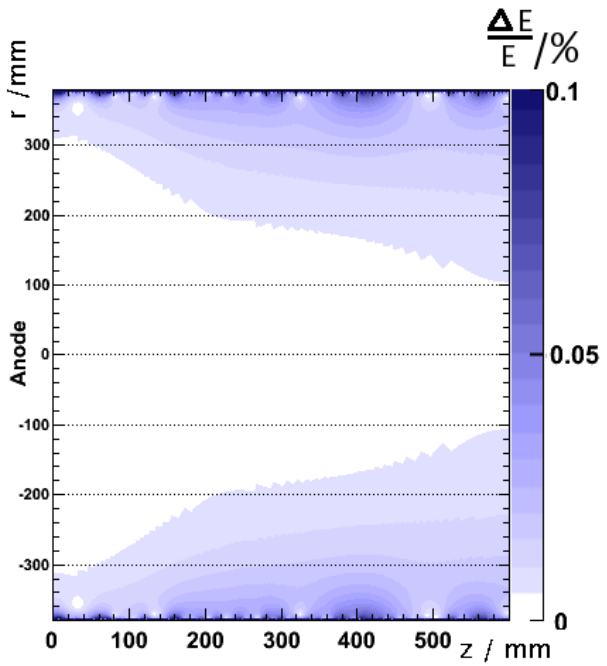
generated resistors

impact of assembly on quality of field

- variations if cathode and anode not exactly parallel ($1\,\mathrm{mm} \Rightarrow 0.3\%$)

drift field quality

- expected sum of distortions smaller than 0.5%

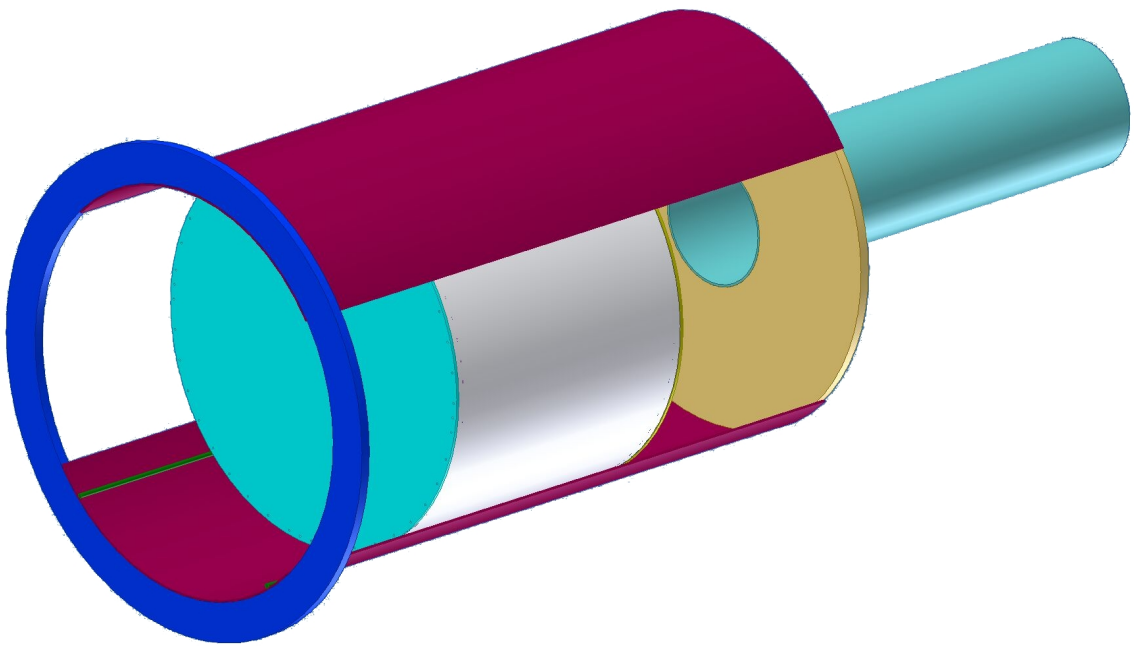


production of field cage

- field cage will be built by external company, specialised in composite materials
- field strip foil ordered from another company
- soldering of resistors to the foil will be done by DESY workshop
- simple G10 caps are part of field cage
  $\longrightarrow$ one will be the cathode
- first anode with readout structure built by LC TPC collaboration

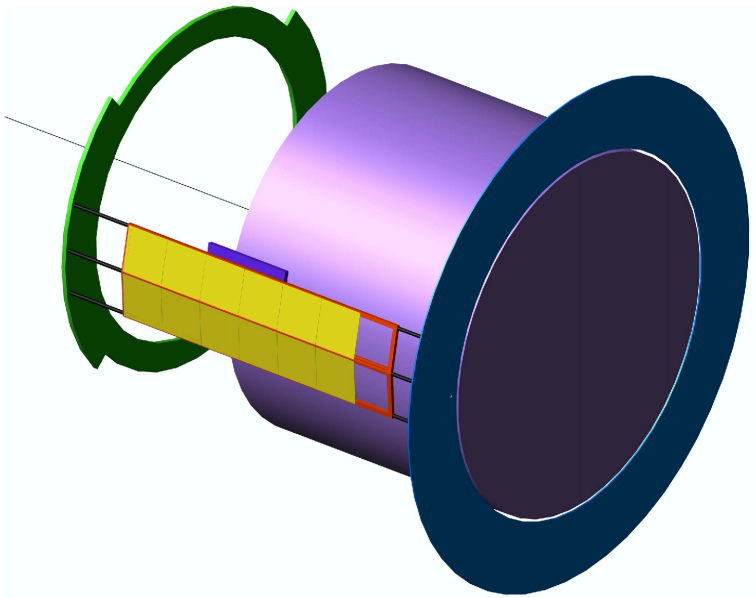
mounting structure

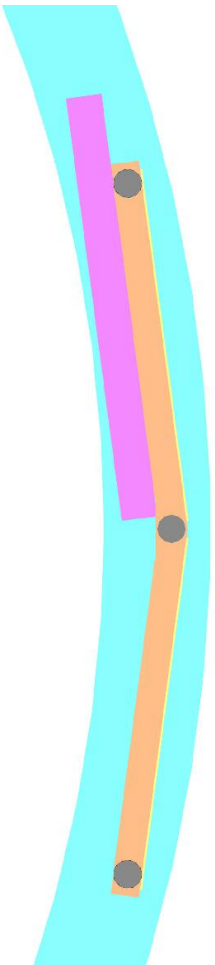
- whole magnet located on a movable lifting table in test beam area
  $\longrightarrow$ precision of about 1 mm
- TPC supported by structure of bended aluminum plates



silicon strips

two perpendicular layers of silicon on each side of field cage
$\Rightarrow$ two independent reference points for particle tracks





- modules from SiLC collaboration,
  each 10 x 10 cm^2
- expected resolution in $r\varphi \approx 10\mu\mathrm{m} - 12\mu\mathrm{m}$
- expected resolution in $z \approx 20\,\mu\mathrm{m}$

current status and outlook

- wall material has to be chosen
  - honeycomb Nomex
  - Rohacell foam
  $\longrightarrow$ constructional and HV tests

- field strip foil arrival expected within the next few weeks
  $\longrightarrow$ assembly of resistors

- expected delivery of field cage to DESY: end of August 2007