Studies of the electric field strength in a TPC

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- ILC, FLC and TPC

- Planar TPC-model

- Fieldmaps of the TPC-model

- Drift-plots of the TPC-model

- 3D-model

- Summary

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Introduction

The International Linear Collider (ILC)

– will collide electrons with positrons

– collision energy of 500 to 1000GeV

– precision measurements of particles

Elektronen   **Positronen**

5 GeV LINAC   DR   Undulator   5 GeV LINAC   DR

Haupt-LINAC   Haupt-LINAC
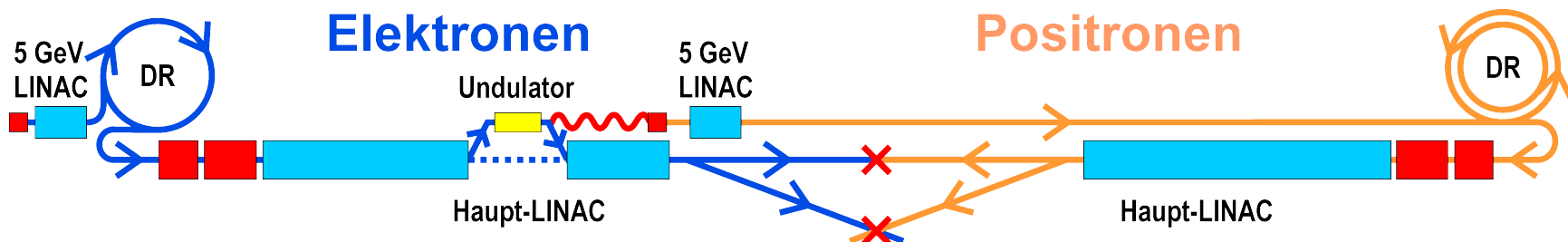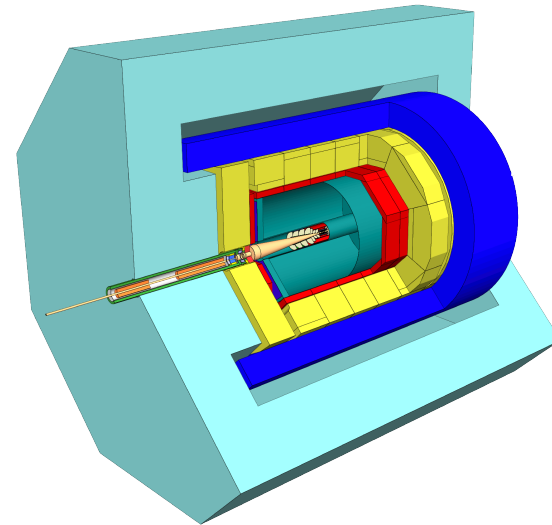
- FLC = **F**orschung an **L**epton **C**ollidern = research on lepton colliders

- TPC = subgroup of the FLC group

    – Do research on and design of Time Projection Chambers

# Time Projection Chamber

- Time Projection Chamber (TPC)
    - Gas filled volume
    - Particles ionise gas (track)
    - Particles drift to anode because of homogeneous electric field
    - x- and y-component can be measured
    - z-component is reconstructed by arrival time
    - Magnetic field to detect charge

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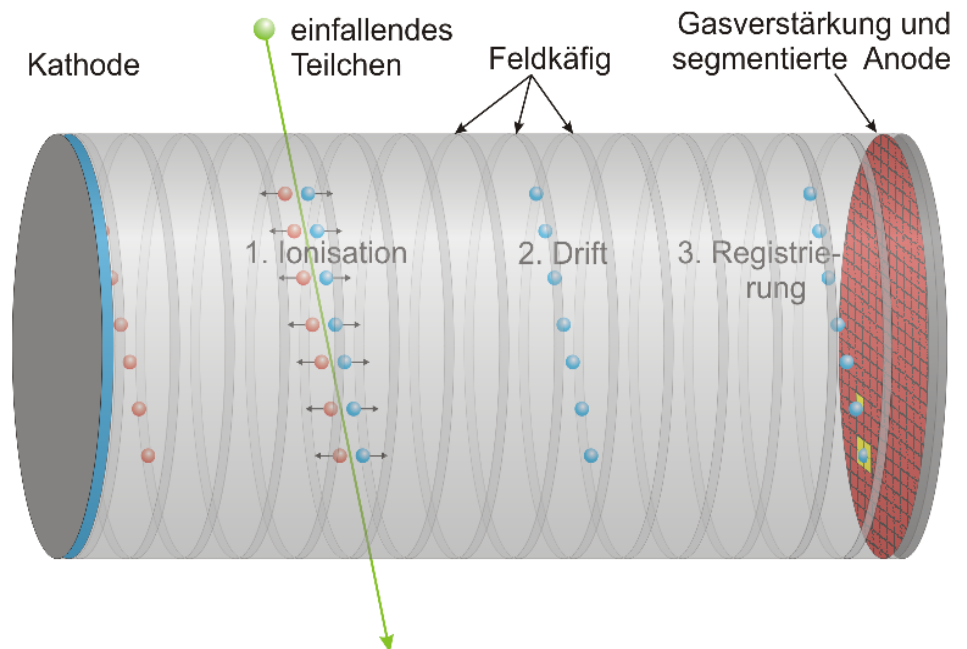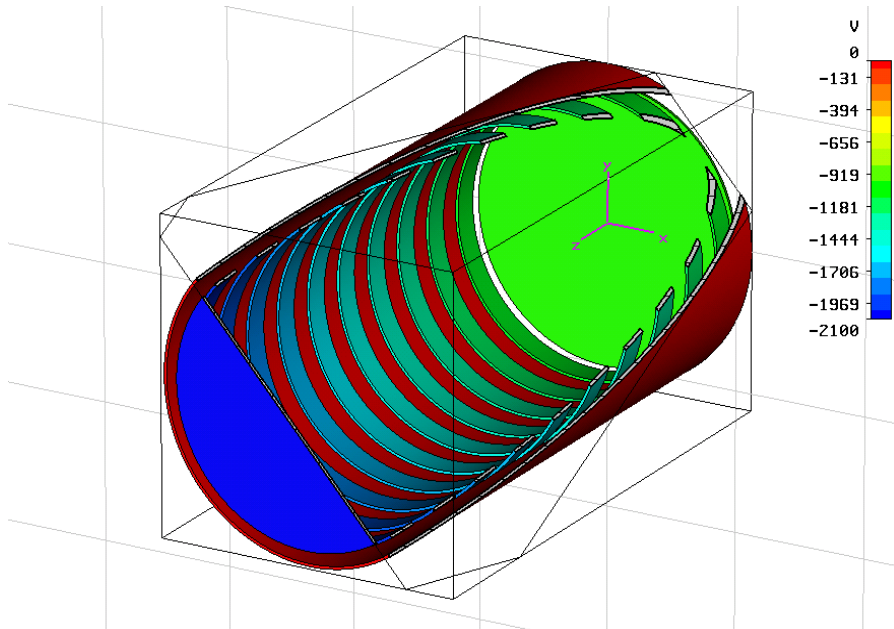
CST calculation

- Aim: calculating different field strip geometries to get a homogeneous electric field in the drift volume

  - Variation of field strip width

  - Variation of gap

  - Insertion of additional field strips

- Field calculations done with CST EM-Studio

- CST allows to calculate 3dim. models

- Changeable Parameters:

  - Radius
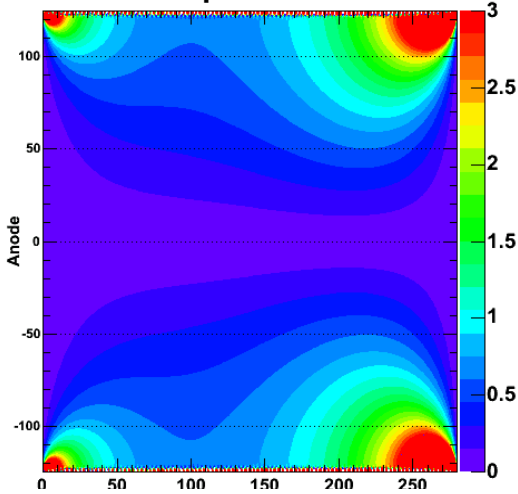
  - Number of field strips

  - Width of field strips
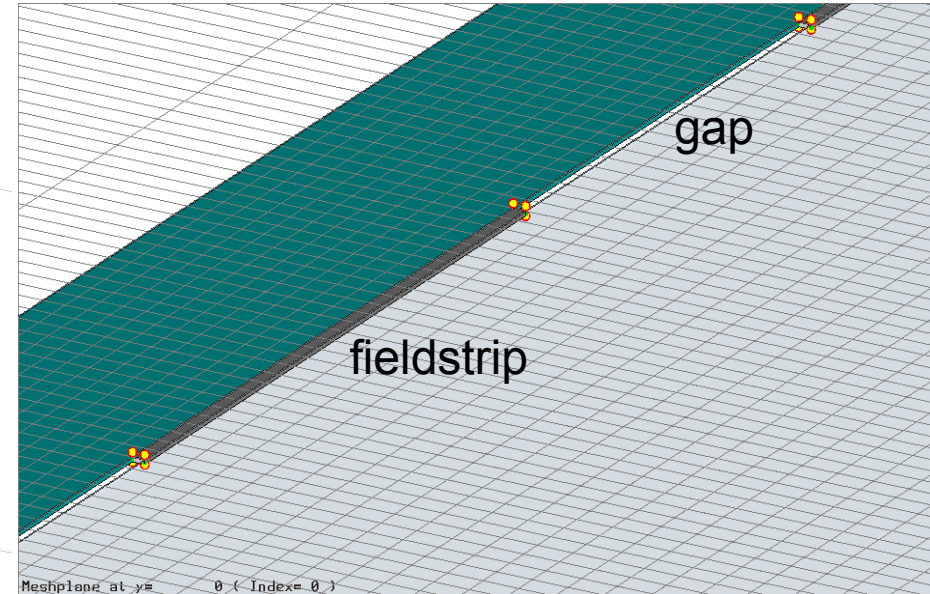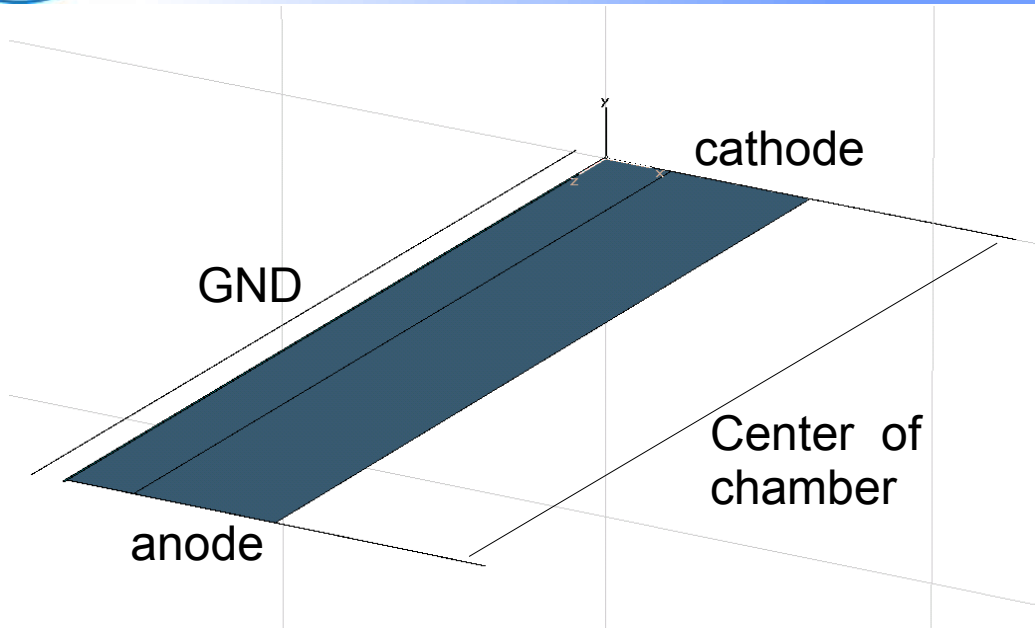
Planar TPC-Model

- Cylindric TPC is simplified to a planar model (rotational symmetry, boundary conditions)

  - The field maps illustrate the electric field strength inside the TPC

    - Normalized to nominal value

  - TPC-model with different field strip widths: 1.6mm, 2.0mm and 2.4mm with constant pitch of 2.8mm
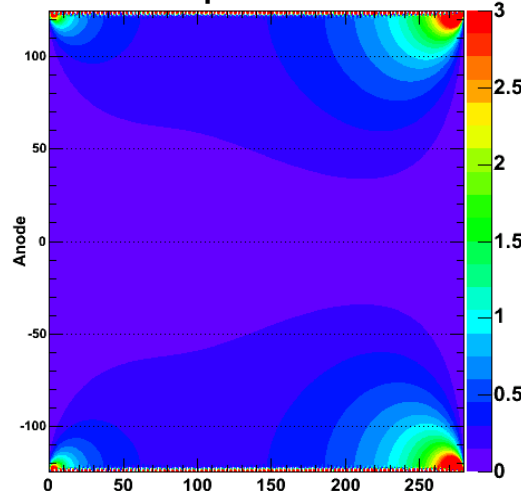
Meshing:

- Field strip:
  - 1.6mm
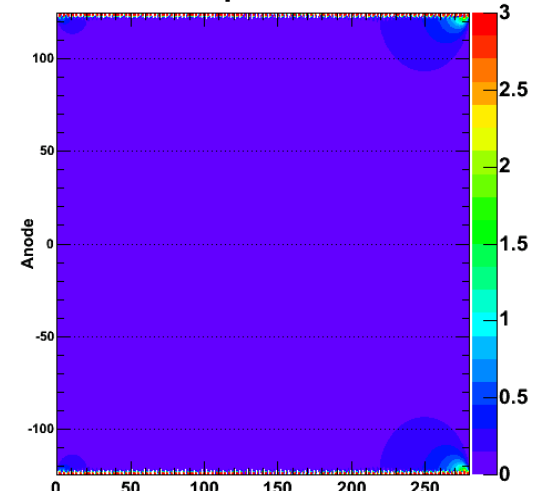 - 29 mesh cells

- Gap:
  - 1.2mm
  - 21 mesh cells

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Fiedmaps

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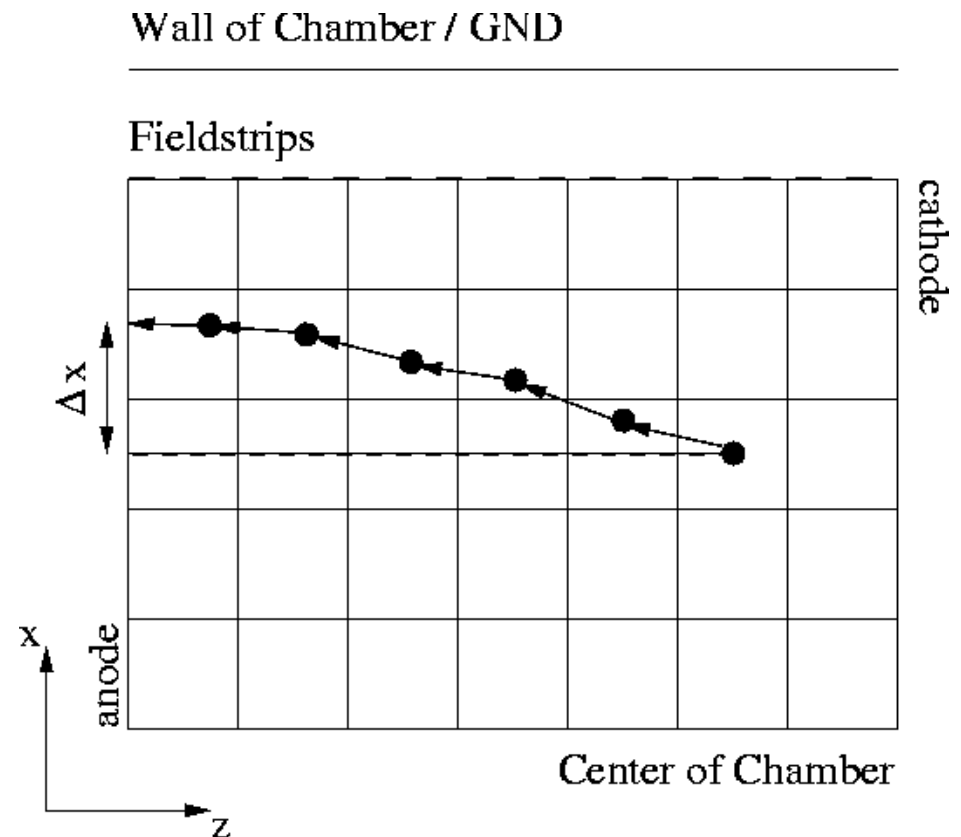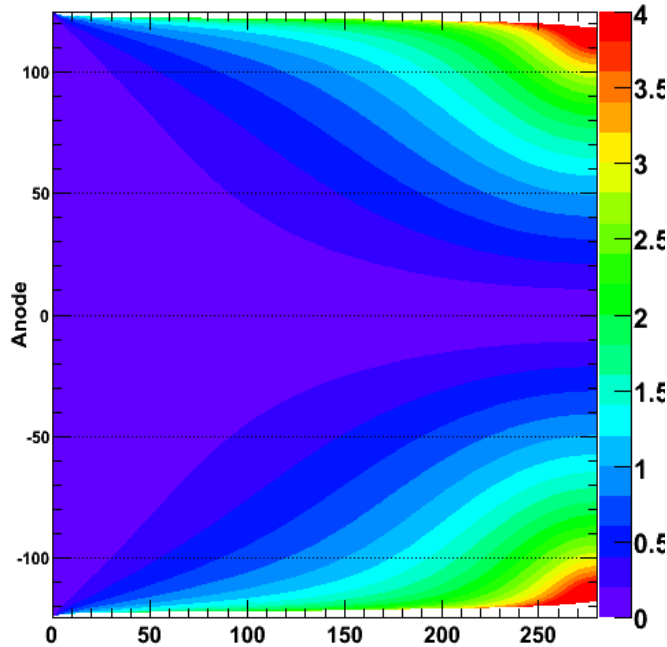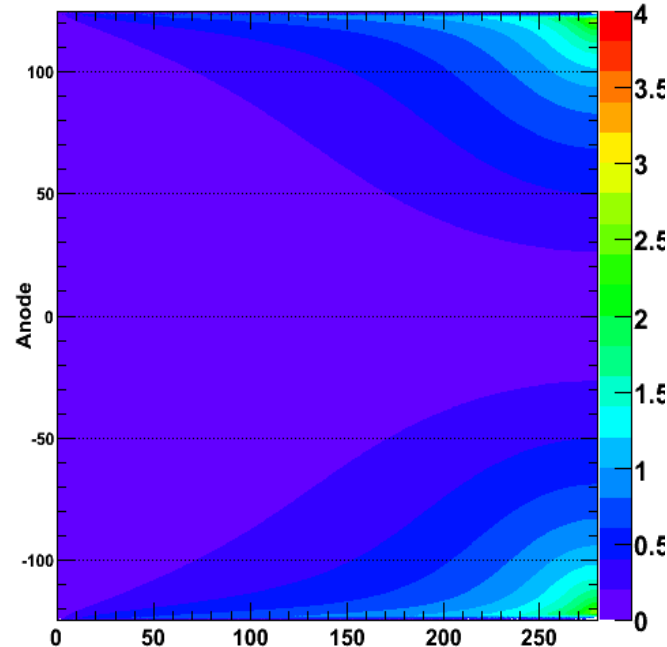# Drift-plot
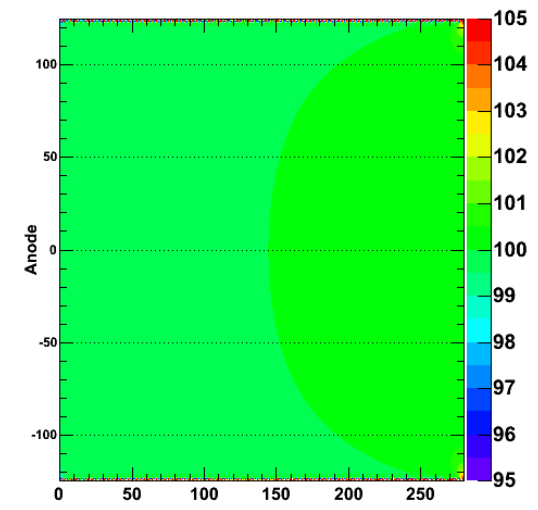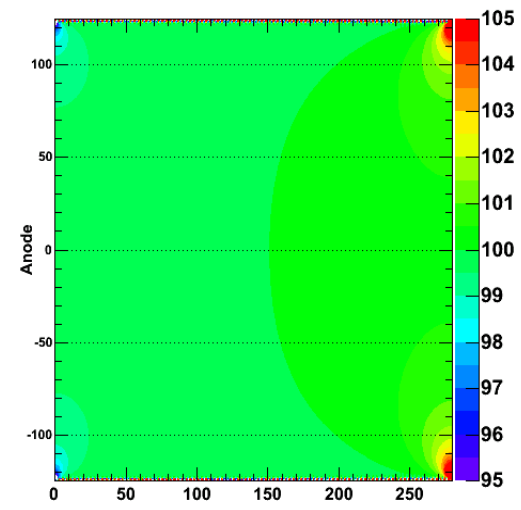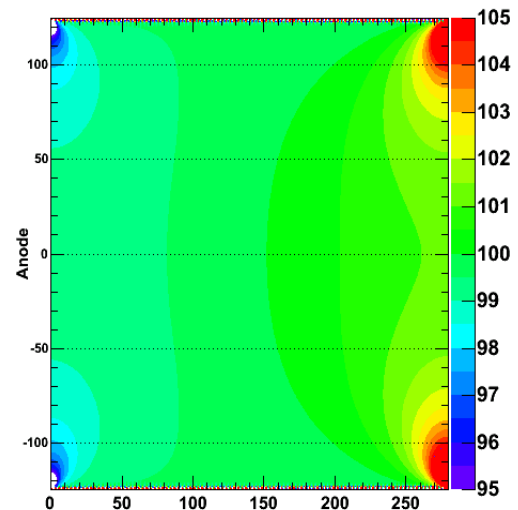
- To evaluate the field quality the drift is simulated

  – Electron started out of every cell

  – Drifted in steps of equal length (0.2mm) towards the anode

  – Assumption $v = v(E)$ for each step

- Results:

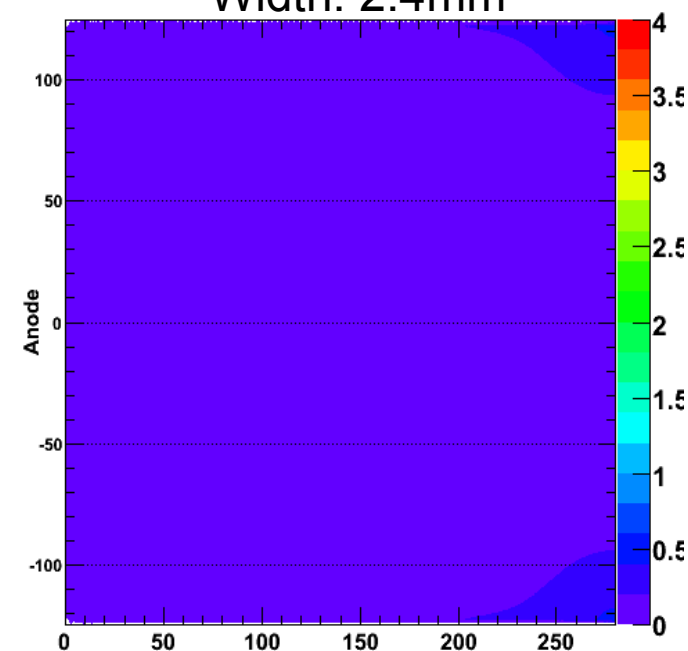 – Displacement in x

  – Time of arrival (not yet)

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Drift-plots

- Scale: x-displacement in mm
- White area illustrates the "dead" volume
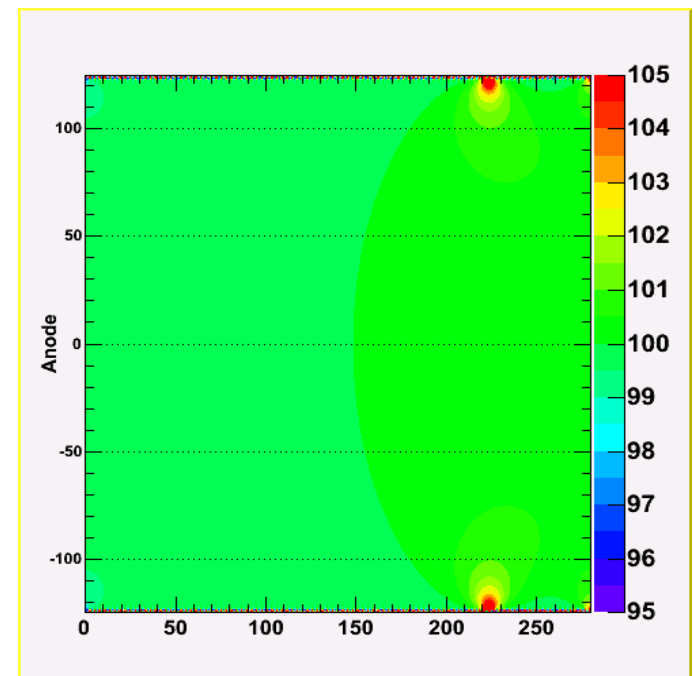
Failing resistor

- In the MediTPC 4 parallel resistors connect two neighbouring field strips

- If one fails (e.g. bad soldering) the resistivity rises by a factor of 4/3

    - Influence on the field quality?

    - Influence on drift of electrons?

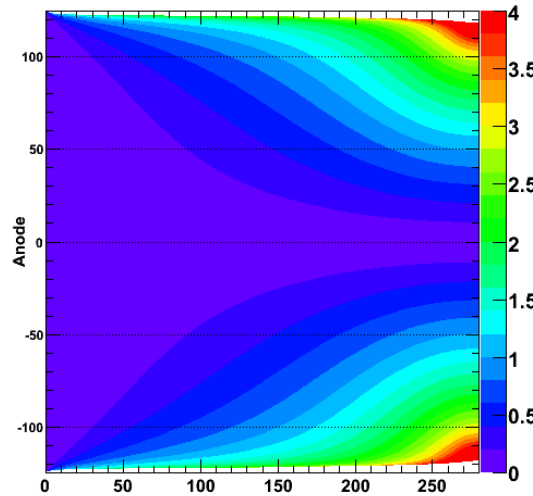   - Sensitive volume lost?

Width: 1.6mm

Width: 2.4mm

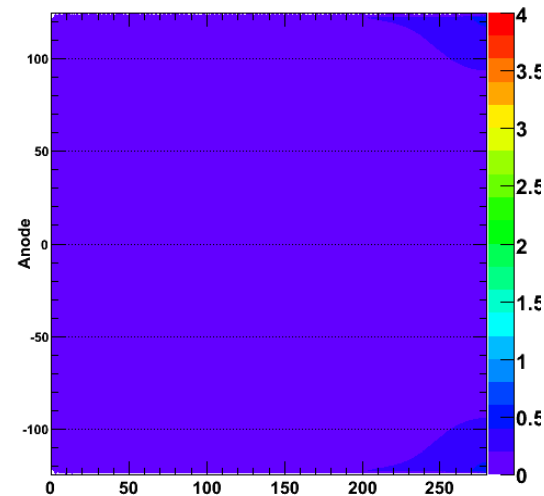Isabell Steinseifer:
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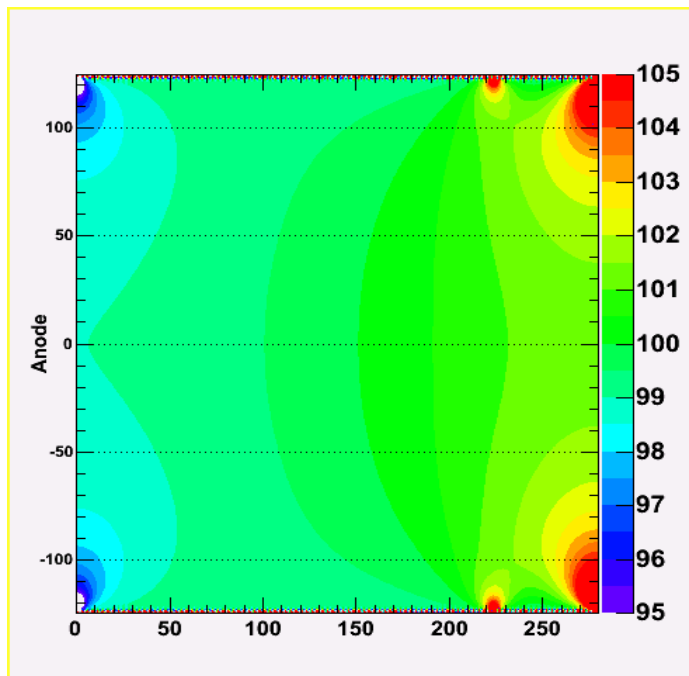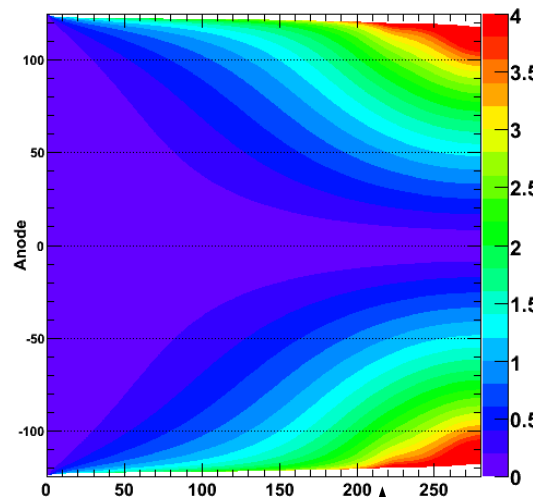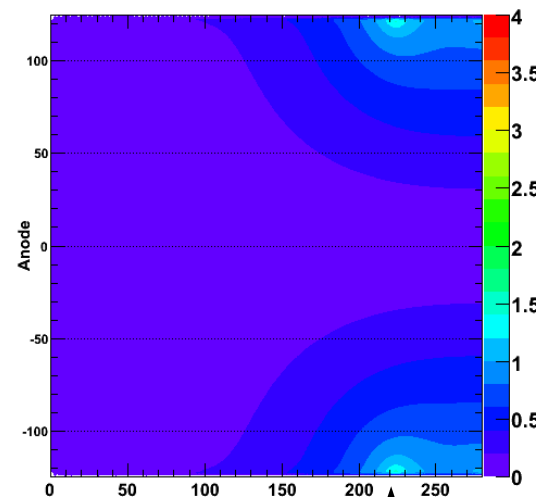
Comparison: Width: 1.6mm

Width: 1.6mm

Width: 2.4mm

Working resistor

Failing resistor

Failing resistor

Failing resistor

Mirror and laser-hole
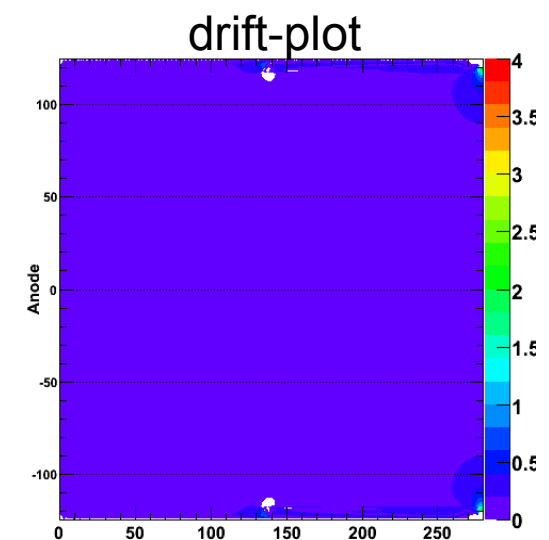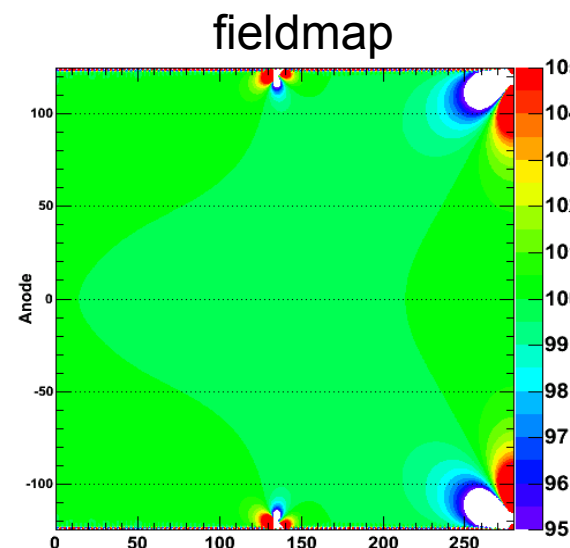
- Because of testing the TPC with a laser, it is necessary to insert a mirror in the TPC and to cut a hole in the cathode

- Calculation is incorrect, because the problem is not rotational symmetric

- For this problem a cylindric 3D-TPC-model is needed

Example:

Width: *2.4mm*
Gap: *0.4mm*
mirror: *10mm*
laser-hole: *7mm*

fieldmap

drift-plot

- huge 3D-model

- The mesh cannot be chosen as precise as in case of the planar model

- Problem: a lot of data, but the calculation is not very accurate
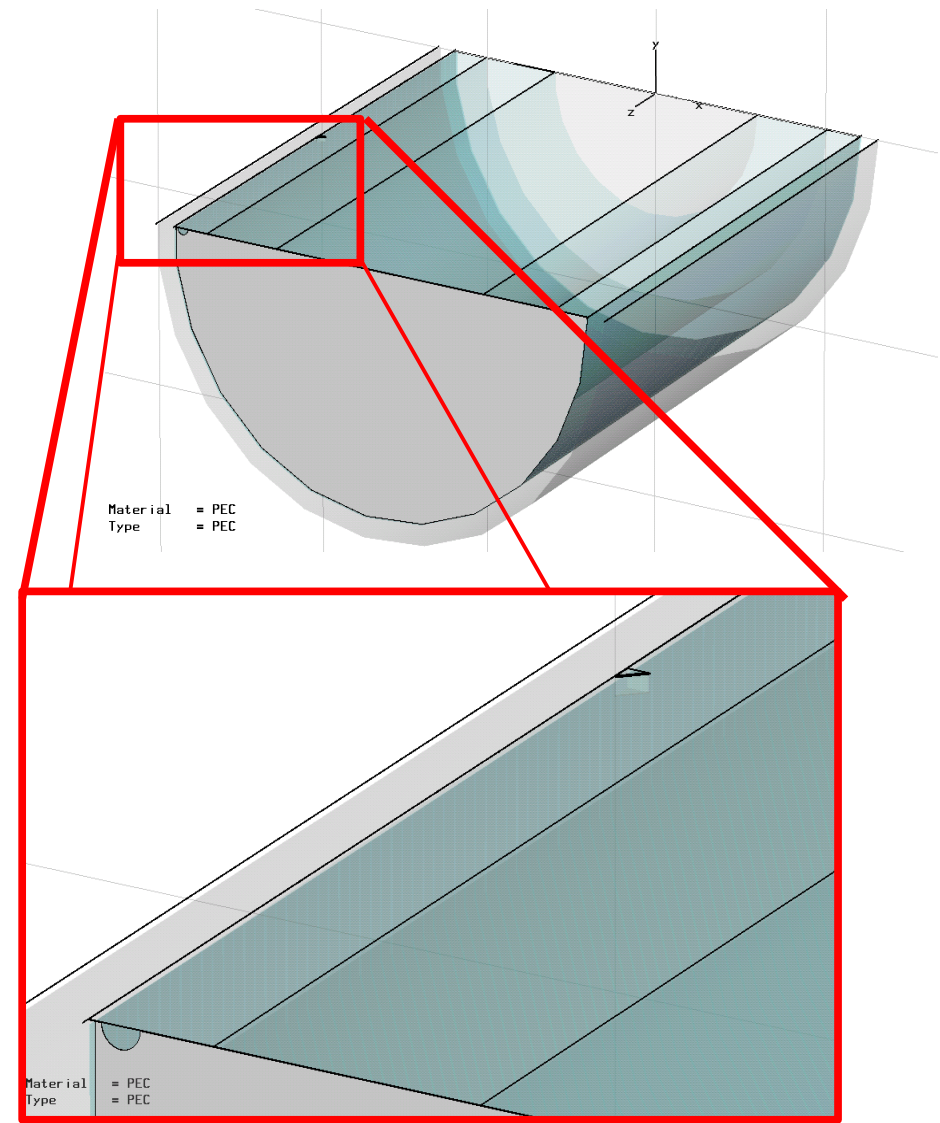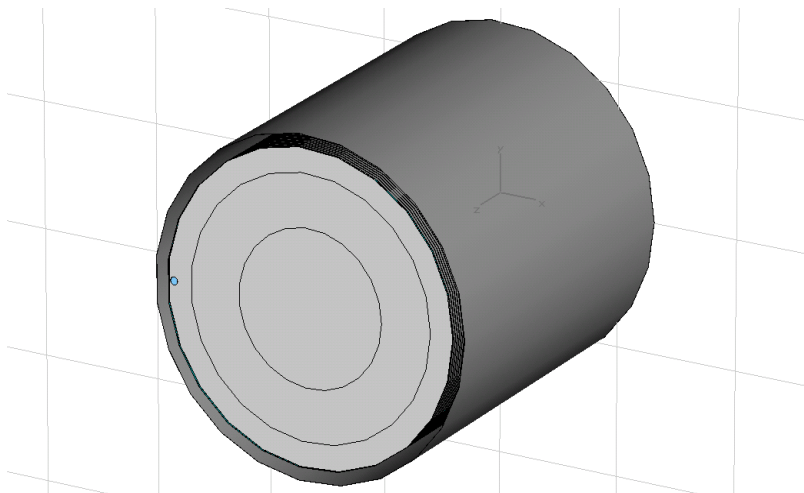
Summary

- Field calculations with CST allow to investigate different field strip geometries

- Fieldmaps illustrate the electric field strength

- Drift-plot to evaluate different strip geometries

  - Radial displacement

  - Time of arrival

- Influence of different problems on the electric field strength

- 3D-TPC-model still in progress

  - No results yet