Gas Analysis: Development of a Drift Velocity Monitor Chamber (VdC) for the CMS Barrel Muon DT Chambers

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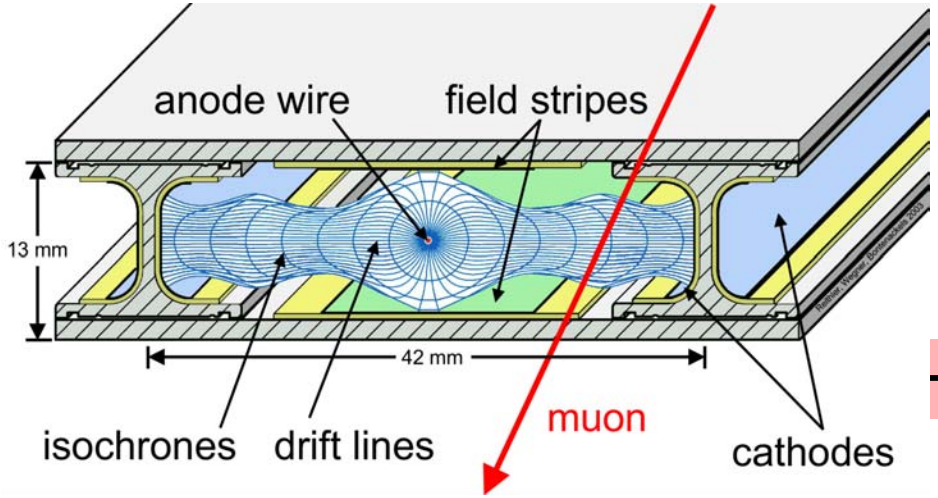
CMS-Week

Overview

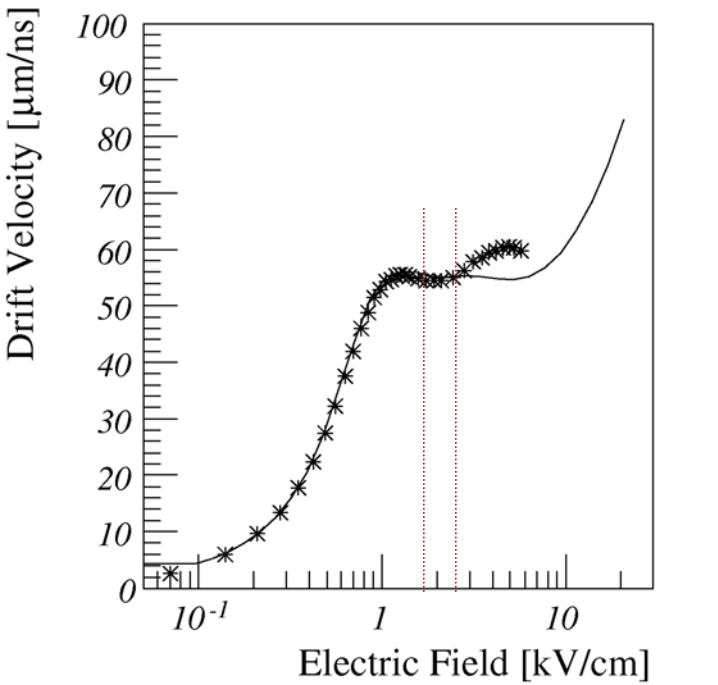
- The CMS Barrel Muon DT Gas System
- The Drift Velocity Monitor (V_d-Chamber)
  - Aim and Concept
  - Electric Field
  - Technical Realisation
- Summary + Outlook

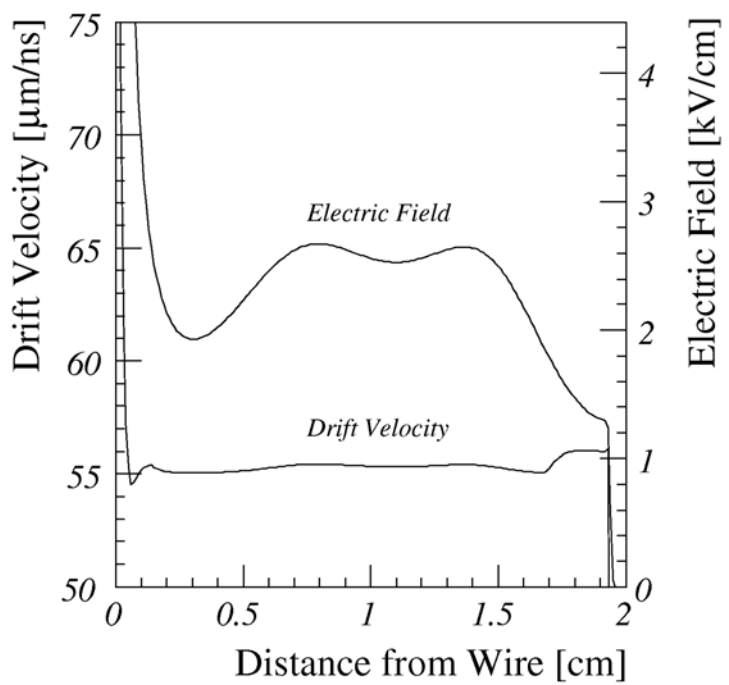
The Drift Cells



Gas: Ar/CO_2 85%/15%
Drift velocity (v_d) ~ 55µm/ns
t_{max} ~ 380ns
Cell Resolution: 3-5ns (~1% of t_{max})

→drift velocity should be known to better than 1%





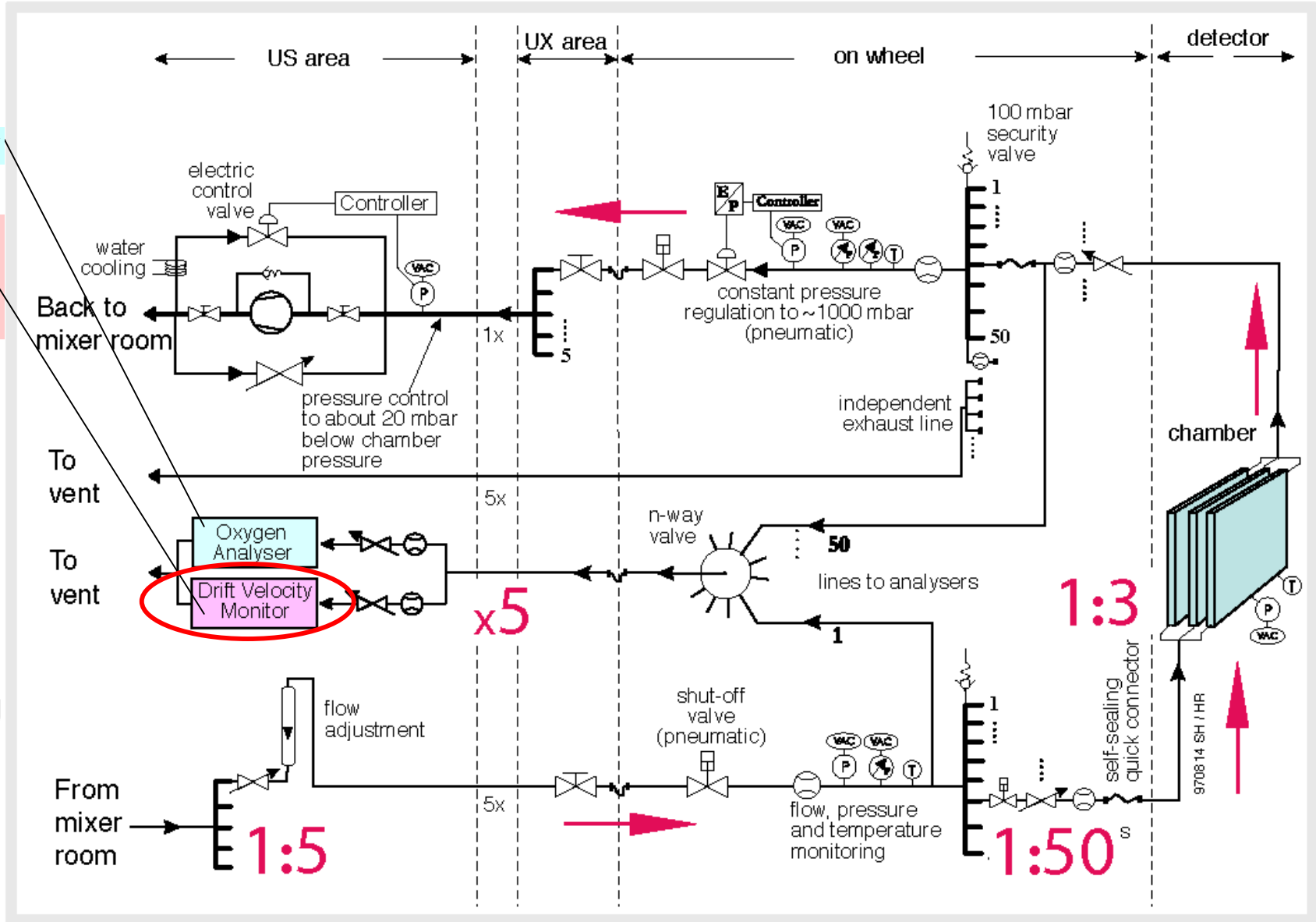
- **E-Field in Drift Cells not homo-geneous (1.5-2.7 kV/cm)**

→ For monitoring, measure at constant and known electric field, e.g. use a drift cell with homogeneous field.

Electric field and drift velocity inside the drift cells (CMS – Technical Design Report „The Muon Project“, p=1bar, gas: Ar/CO_2 85/15

The Gas System

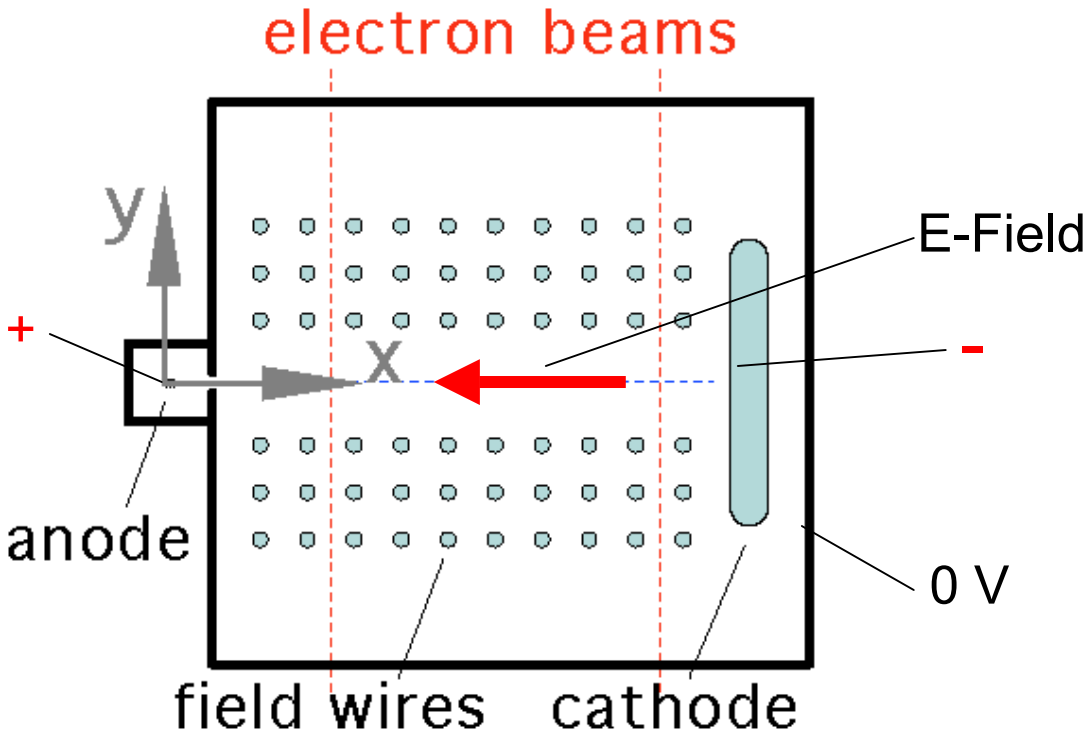
- Monitoring of gas parameters with O_2-analyser (commercial) and drift velocity monitor (VdC = V_d-Chamber)
- Gas at outlet of every chamber tested in 1-2 days cycle
- VdC: small (~20cm) drift chamber for direct monitoring of the drift velocity

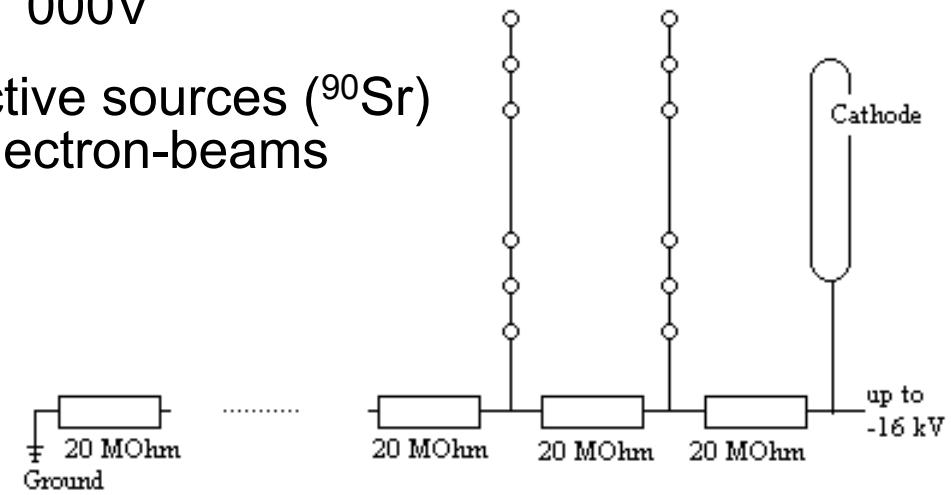


Sketch of the CMS Muon Barrel Gas System (CMS Technical Design Report „The Muon Project“)

V_d-Chamber: Homogeneous Field

- Principle of chamber as used for L3 (relative measurement of v_d)
- Redesign necessary for higher voltage (up to 2.5 kV/cm)
- Very homogeneous field in middle region („sensitive region“) achieved with field shaping electrodes.
- U_{anode}= 1 800 V
- $U_{cathode}$≤ -16 000V
- Two radioactive sources (^{90}Sr) →ionising electron-beams



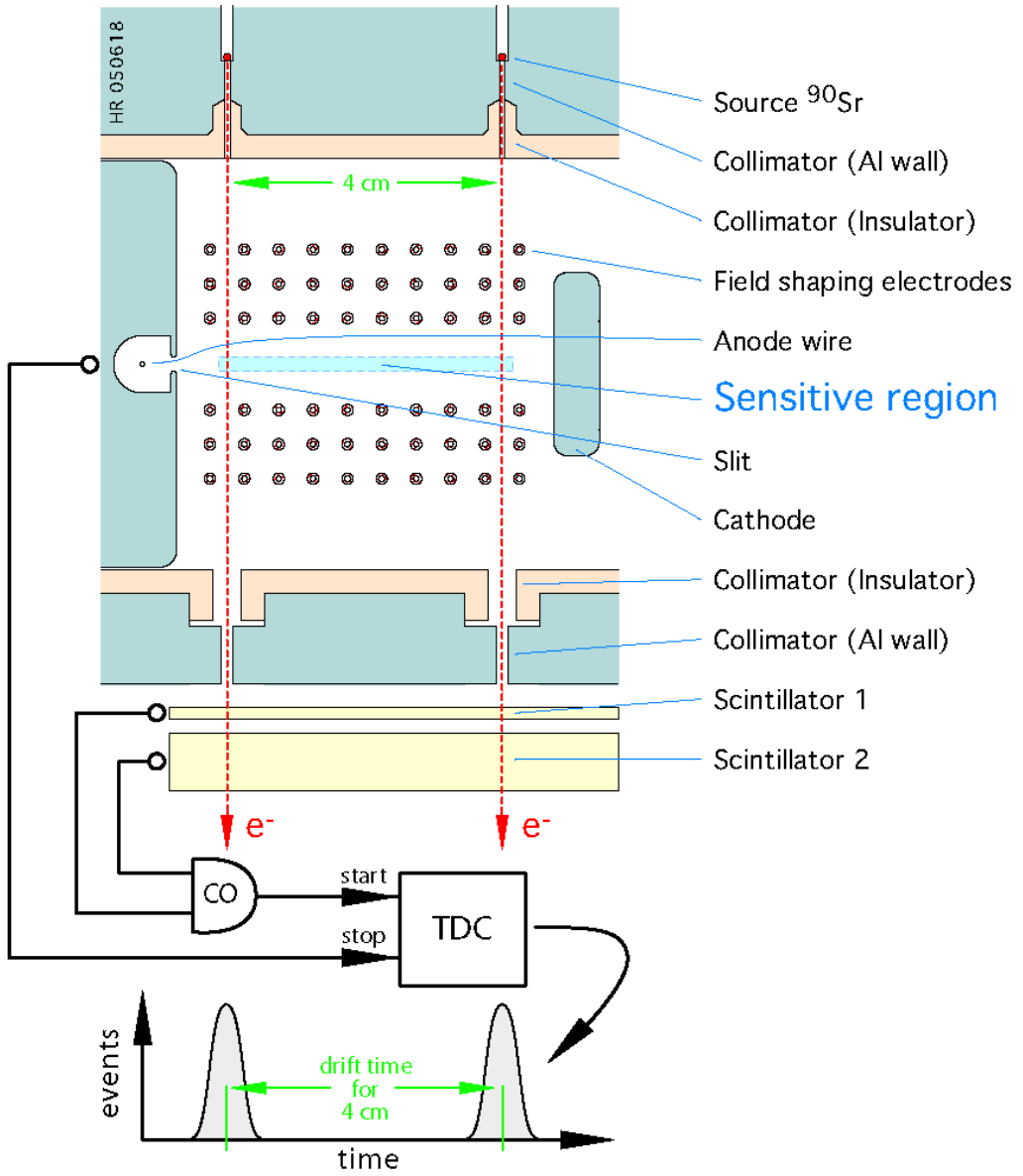


- Only one high voltage supply needed → when varying, field structure stays the same
- $U_{cathode}$= -16kV → I=73 µA

V_d-Chamber: Readout

- Two beams of ionising β^- from radioactive source (^{90}Sr), detected by scintillators (trigger)
- Drift times from each beam are measured
- Difference of average drift time between the two beams measures drift velocity in the sensitive Region

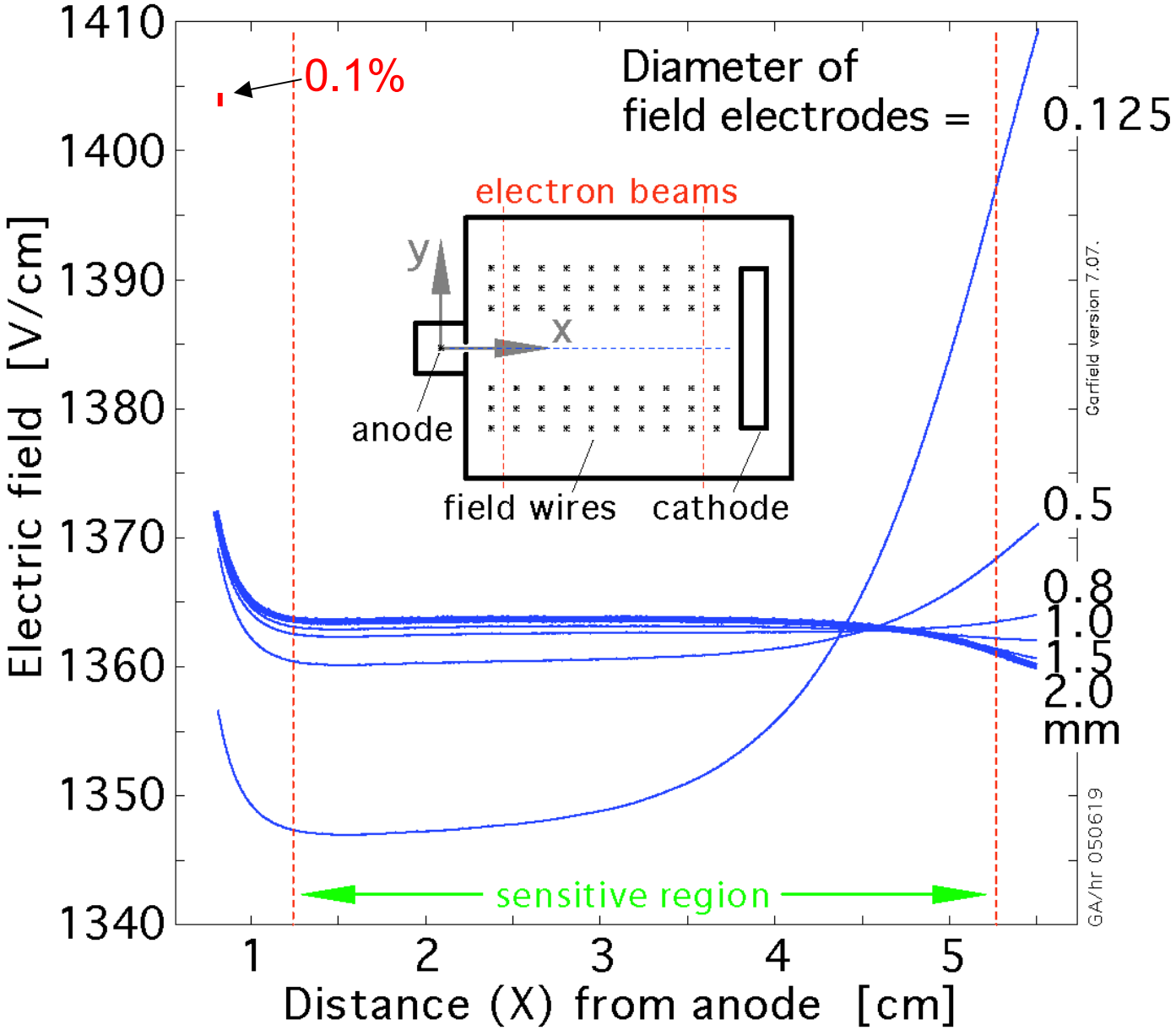
→ E-Field has to be homogeneous in sensitive Region only!!!



Principle and geometry of the Vd chamber

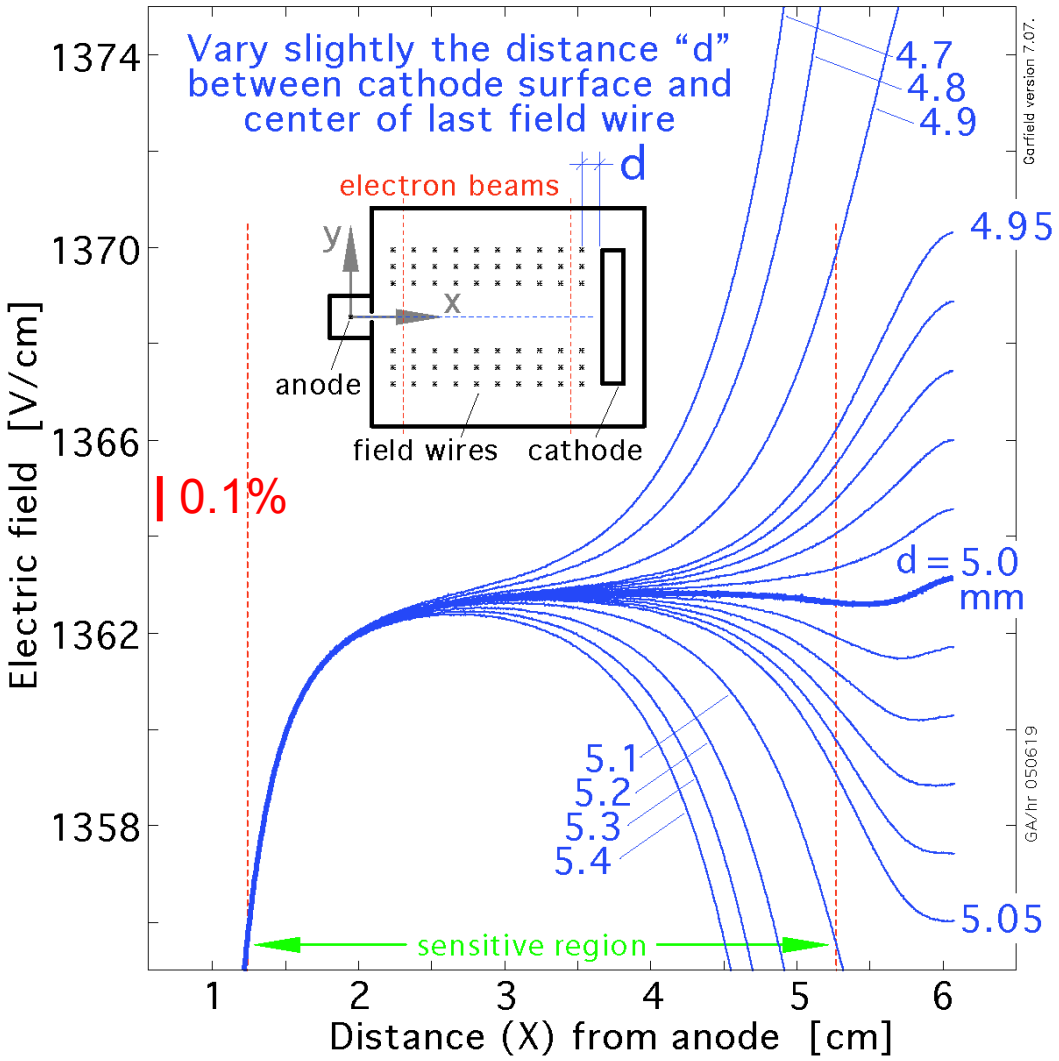
Optimising the Field – Part I

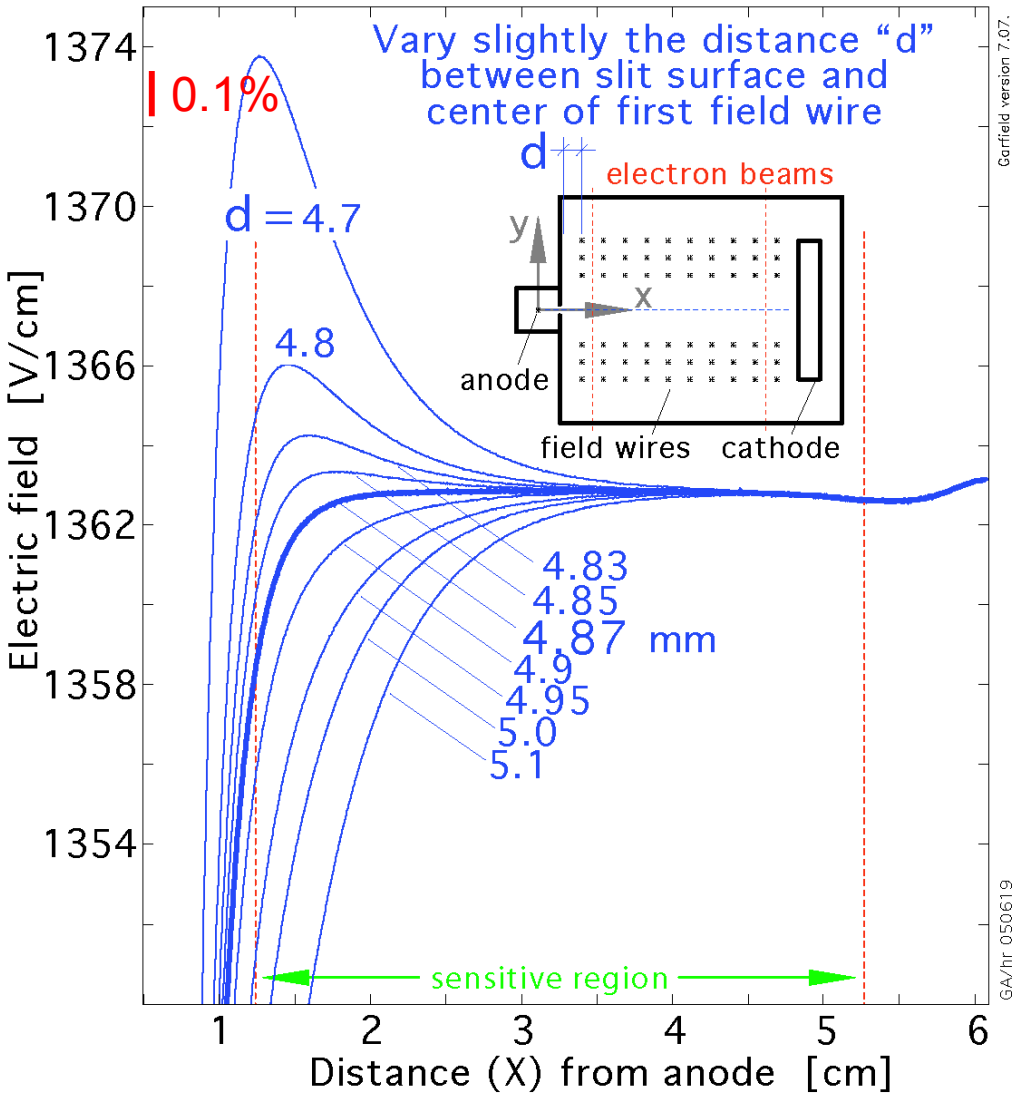
- Many parameters varied for optimisation (Simulations with GARFIELD):
  - Diameter of field electrodes
  - Field electrodes position & spacing
  - Number of field electrodes
  - Cathode layout + position
  - Slit size and design
  - Chamber layout
  - Resistors



Electric Field along the midle line (y=0), calculated with GARFIELD

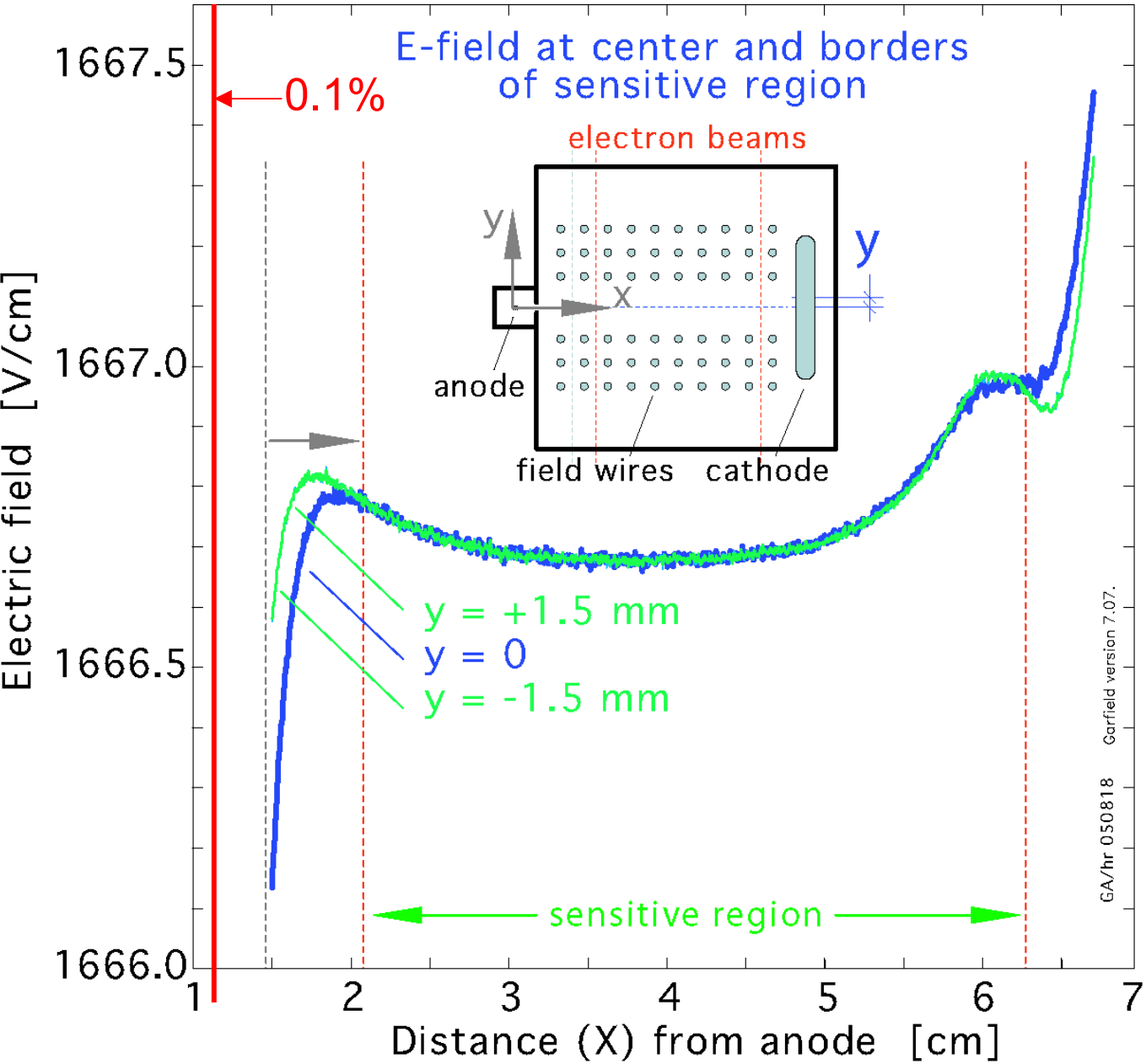
Optimising the Field – Part II





Impact on electric field along the middle line, when varying the distances between field electrodes and cathode/wall. calculated with GARFIELD

Final Layout and E-Field

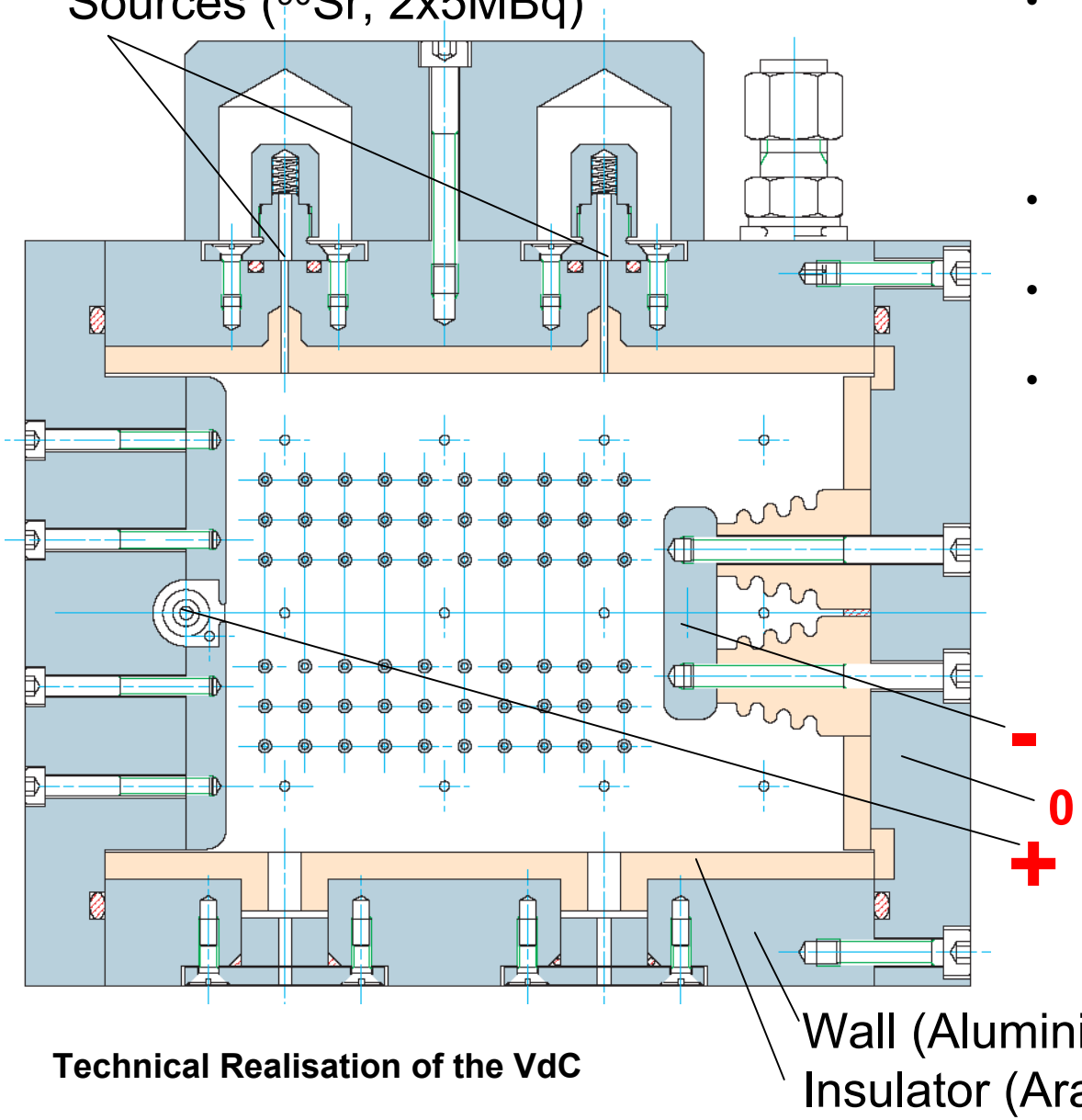


Electron beams at 2.1cm (6.3cm) distance from anode wire.
→t_{drift}~ 3.8µs (11.5µs)

Very homogeneous E-field in sensitive region: ca. 0.02%

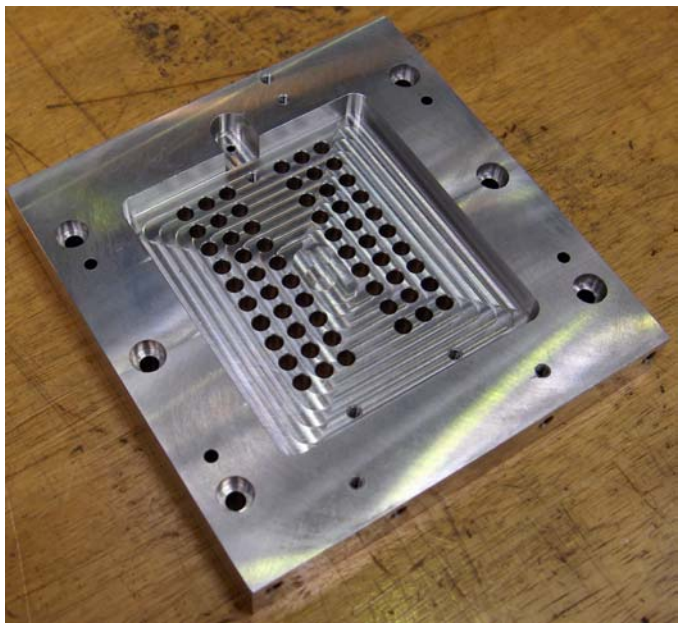
Electric Field along the middle line (y=0) and along y= ± 1.5 mm, $U_{cathode}$=-11kV. The electron beams are shown as dashed red lines, the dashed grey lline is the former position of one electron beam. Calculated with GARFIELD

Chamber Construction



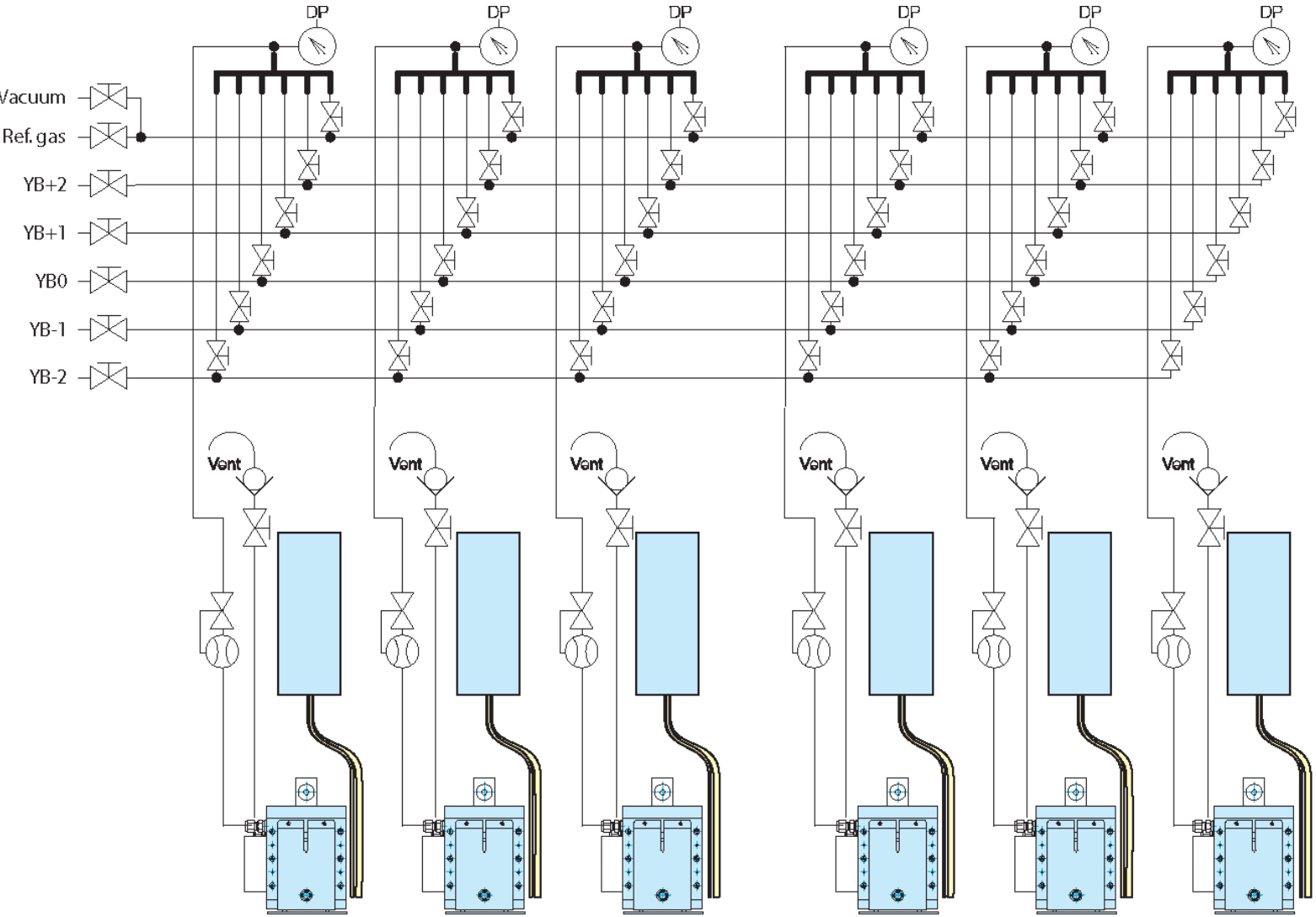
Technical Realisation of the VdC

- Collaboration with Debrecen (Gyula Zilisi helped by others), who will focus on the DAQ-System
- Chamber design is completed
- Construction of prototype in progress
- Mass production (1 VdC per wheel, plus spare) planned for next year



One Aluminium-Wall of the V_d-Chamber

Gas Distribution



N.B.: The status ON/OFF of every valve must be electronically readable, to permit unattended operation.

Study of gas system for Vd chambers
H. Reithler 050816
File: 050816vd-circuit.eps

- One gas line from each wheel and one for reference gas
- One Vd-Chamber for each wheel
- For test purpose can route the gas to any Vd-Chamber

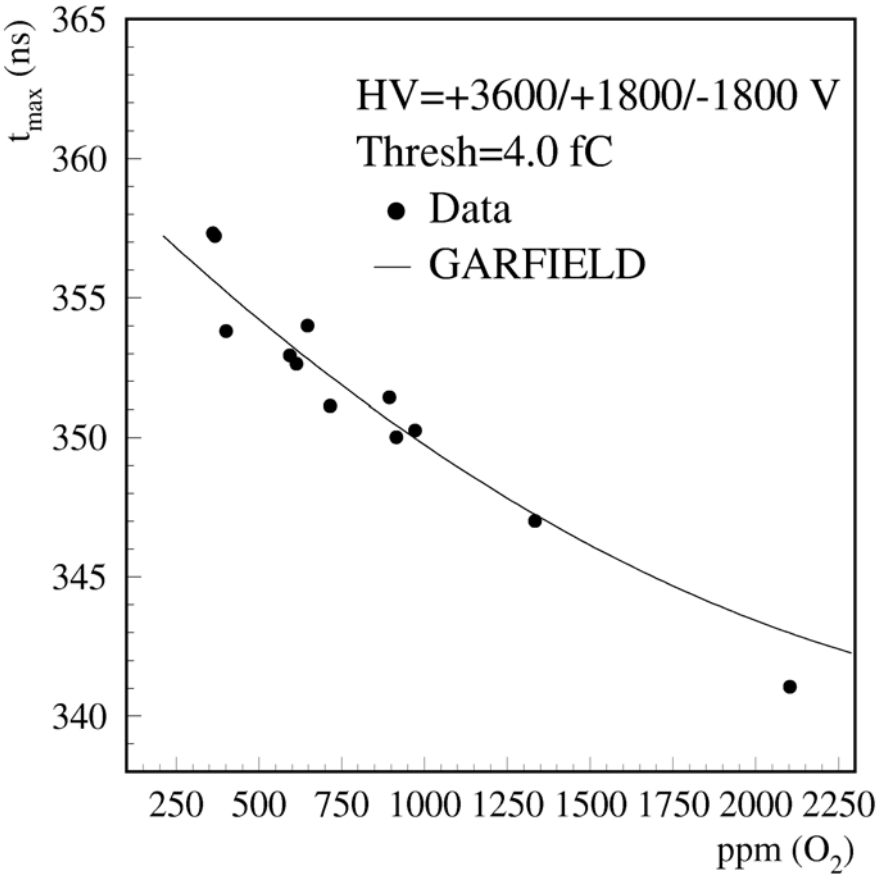
→ Chambers can be cross-checked

Summary and Outlook

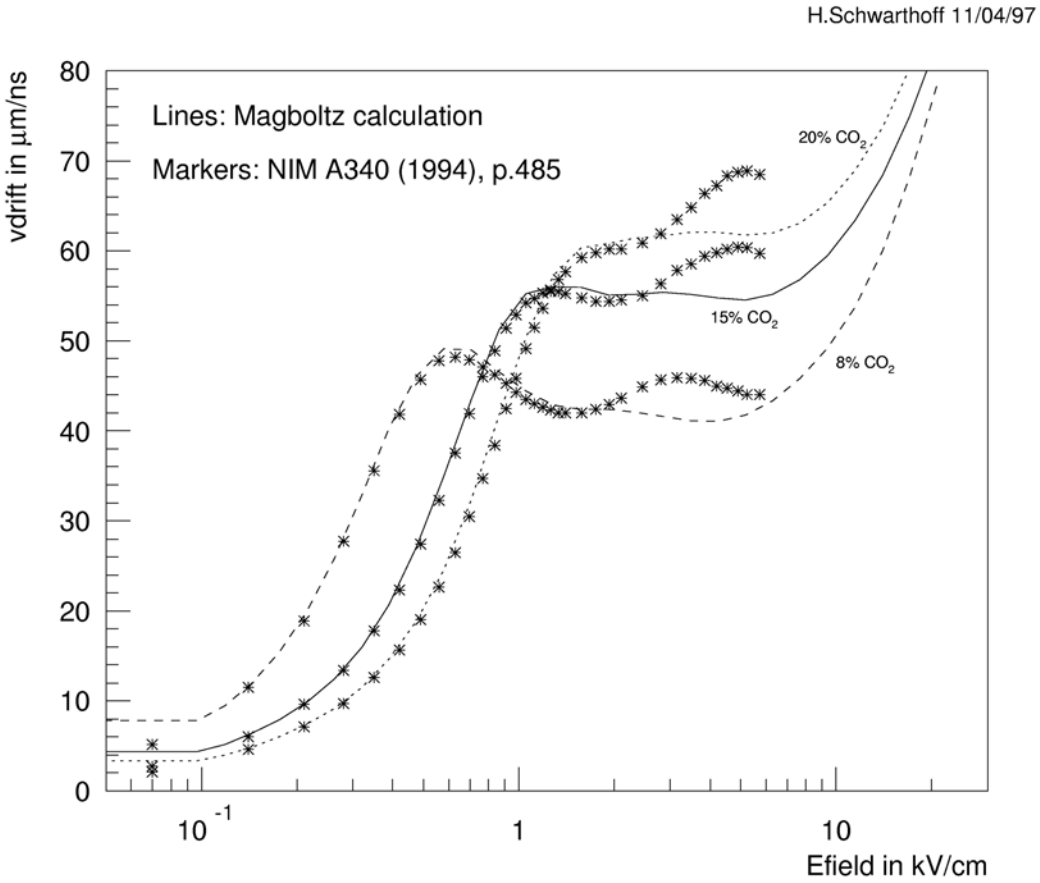
- Gas analysis for DT chambers: measure Oxygen content with commercial analyser and monitor drift velocity by direct measurement with dedicated small drift chamber, called V_d-Chamber (VdC).
- Developing V_d-Chamber (VdC) similar to chamber used in L3. New design is able to work with higher electric fields.
- Systematic studies improved homogeneity of the electric field: expect $\Delta E/E<0.02\%$ in sensitive region.
- V_d-Chamber prototype presently under construction.
- Testing of VdC-prototype in early 2006.

Backup-Slides

Gas Impurities



Source: CMS – Technical Design Report "The Muon Project"



Source: PhD-Thesis Hubert Schwarthoff, III.Phys.Inst.A , RWTH Aachen