REGARD

RMKI - ELTE GAseous detector Research and Development

MWPC option for HPTD: the Close Cathode Chamber

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RMKI - ELTE GAseous detector Research and Development

- an RMKI – ELTE collaboration

  RMKI: KFKI Research Institute for Particle and Nuclear Physics of the Hungarian Academy of Sciences
  ELTE: Eötvös Loránd University, Budapest

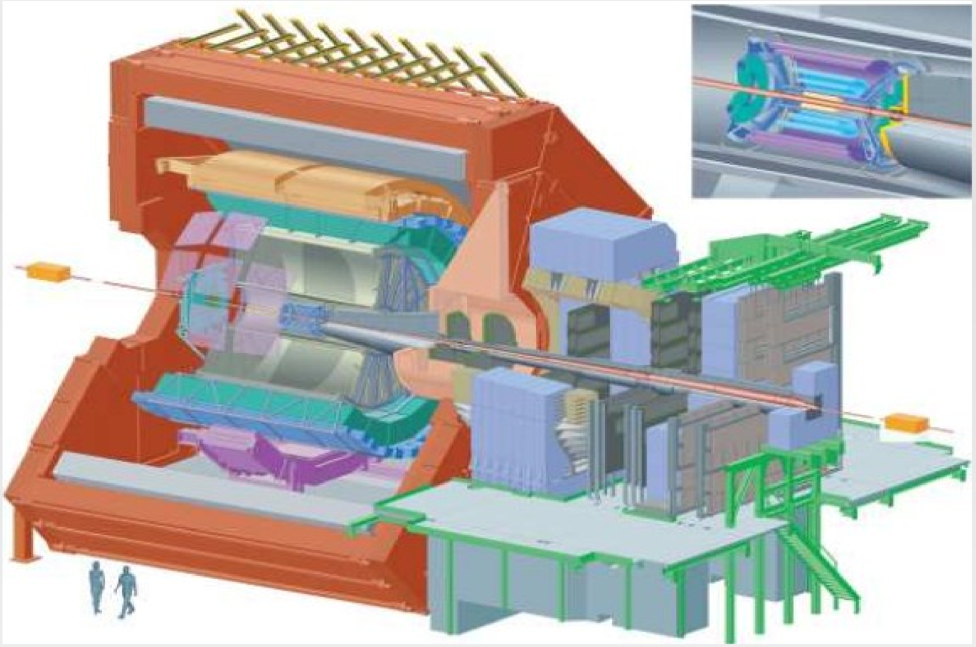
- since 2009

- Recently ongoing projects:
  - High p_T trigger detector (HPTD) developement for VHMPID
  - Muon tomography
  - Centrality detector for the NA61 experiment

- Members: D. Varga, Gy. Bencze, G. Hamar, K. Márton, L. Oláh, G. Kiss, Gy. Bencédi, P. Horváth, Cs. Lipusz, A. László, L. Kovács

The ALICE experiment at LHC

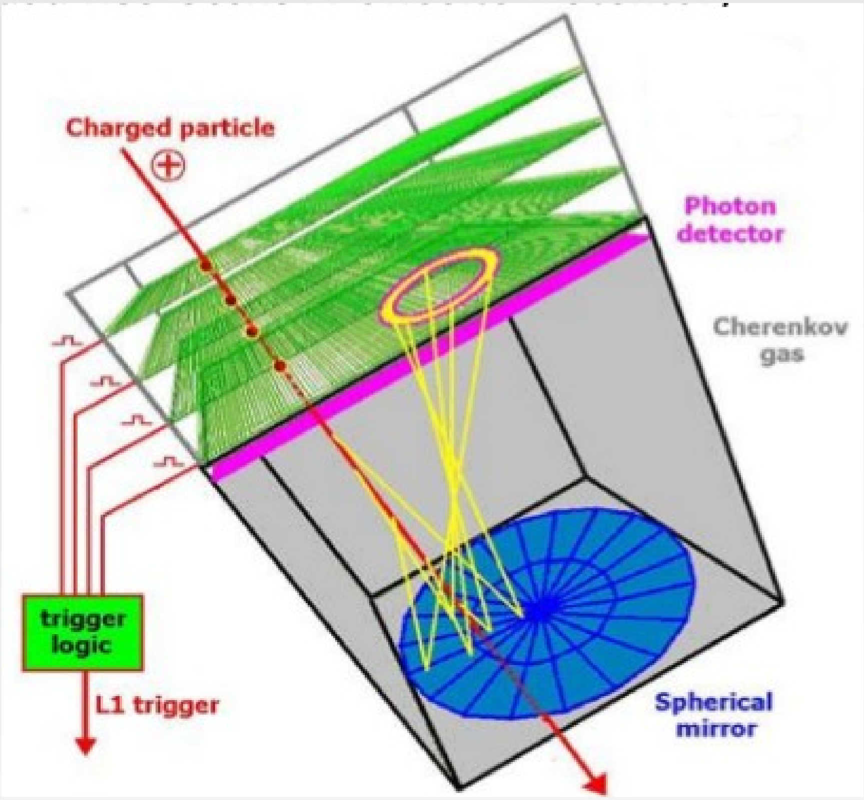
- A Large Ion Collider Experiment
- Onion-like layered structure
- Designed to study heavy-ion collisions, collect information about QGP



- Detectors: ITS, TPC, TOF, HMPID, PHOS
- Objective: particle tracking and identification (PID)
- Measuring the momentum, the energy loss and the velocity

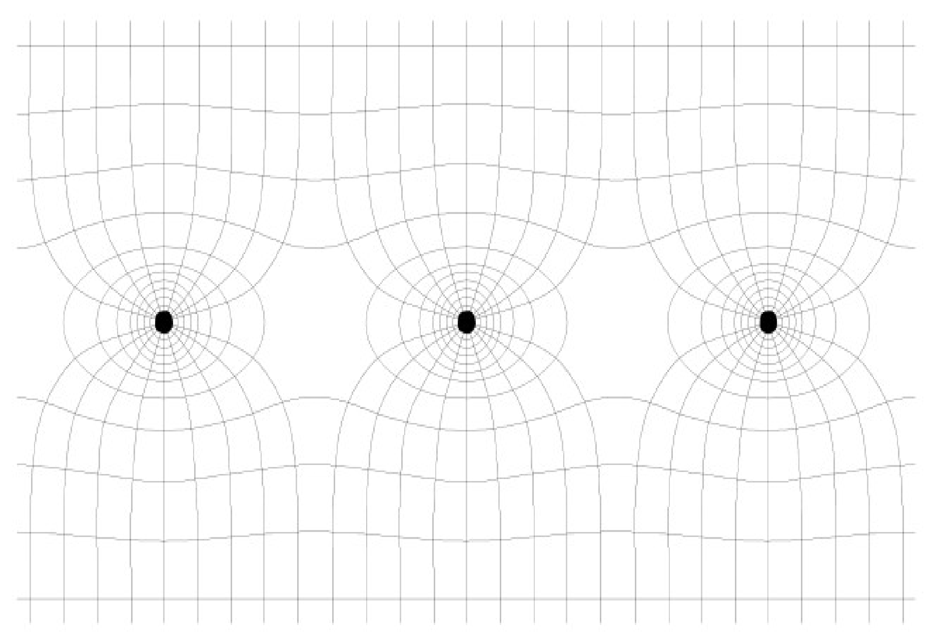
VHMPID

- PID in the current configuration: under 5 GeV/c
- Planned extension for ALICE: Very High Momentum Particle Identification Detector (VHMPID), international collaboration
  - Cherenkov radiation in C_4F_{10} gas (n = 1.004)
  - Focusing photons to a ring with spherical mirrors
  - Velocity measurement according to the radius and location of the rings
  - Up to 25 GeV/c

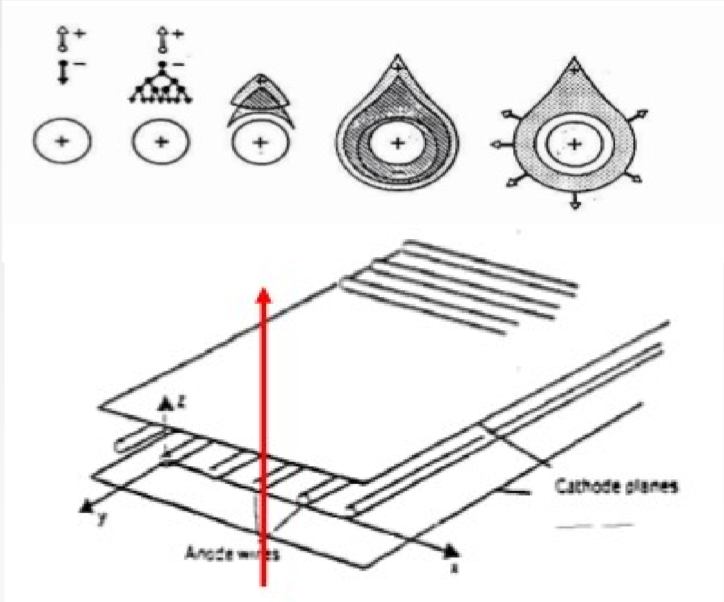


- Limited data storage speed but only few particles with high energy → event selection needed: HPTD

MWPC



- Principles of operation:
  - Passage of a charged particle: energy loss in the detector by ionisation
  - Electrons drifting to the wires
  - Multiplication in the nearby of a wire
    10^5 gain → measurable signal

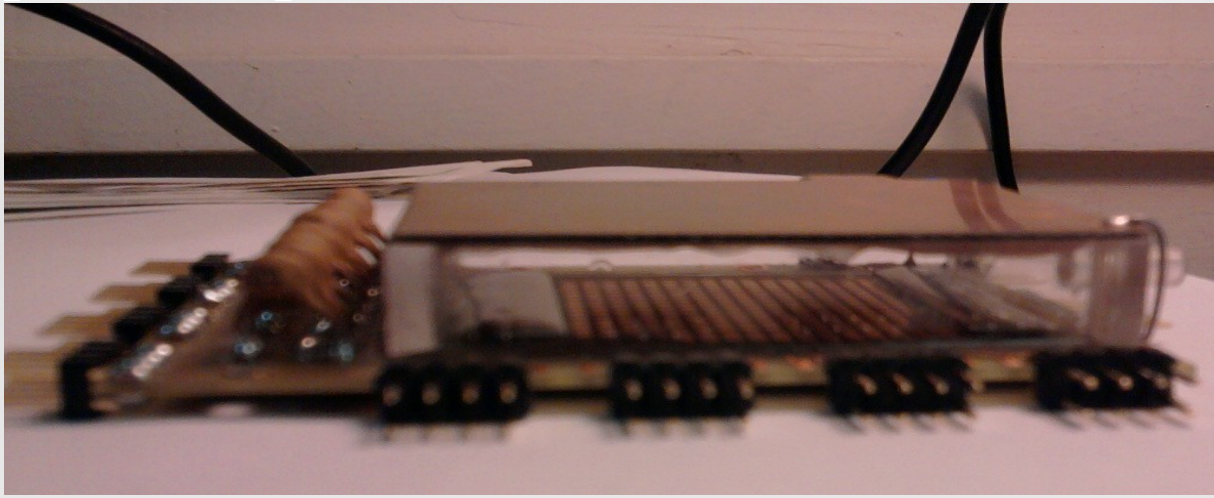


- Anode wires (”sense wires”) in the middle between the cathode plates
- Detectors filled with inert gas + UV quenching gas mixture
  typical: Ar-CO_2, 9:1

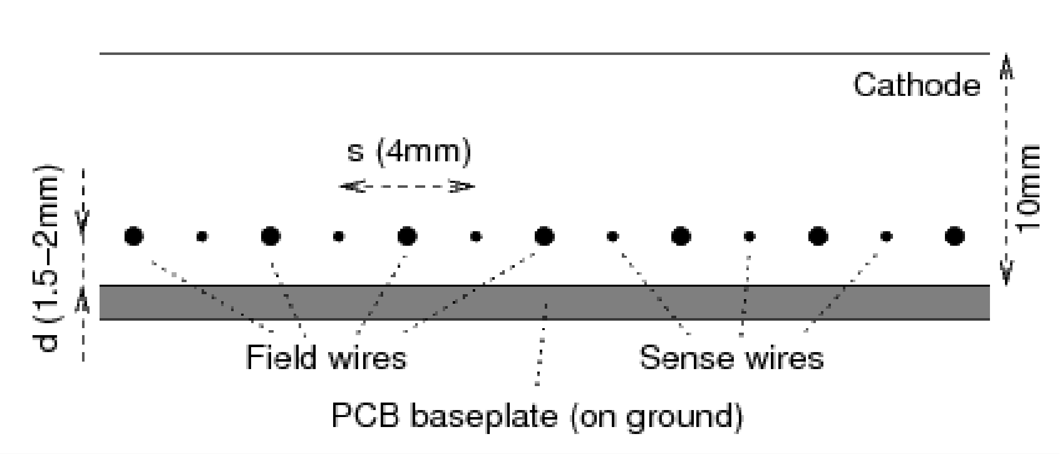
HPTD

- High p_T Trigger Detector for ALICE VHMPID
- Position measurement on a few m distance from the vertex point
- Known magnetic field → impulse measurement according to the angle of incidence
- Possibility to store 40 times more ”interesting” events
- Requirements:
  - Space resolution: few mm-s
  - Large size
  - Fast signal (< 5 μs)
  - Low material budget
- Realization: multiwire proportional chambers with close cathode chamber (CCC) structure, in few layers

The Close Cathode Chamber (CCC)



- Main differences:
  - Asymmetric layout
  - Field wires, on negative potential
  - Different potentials on the cathode plates (the lower one on ground)
- Cathode segmentation → the pad plane
- 21 μm 125 μm thick wires
- Signal readout: from the wires or the pads – same resolution (because the pads are close enough to the wires)
- fast digital readout from the pads



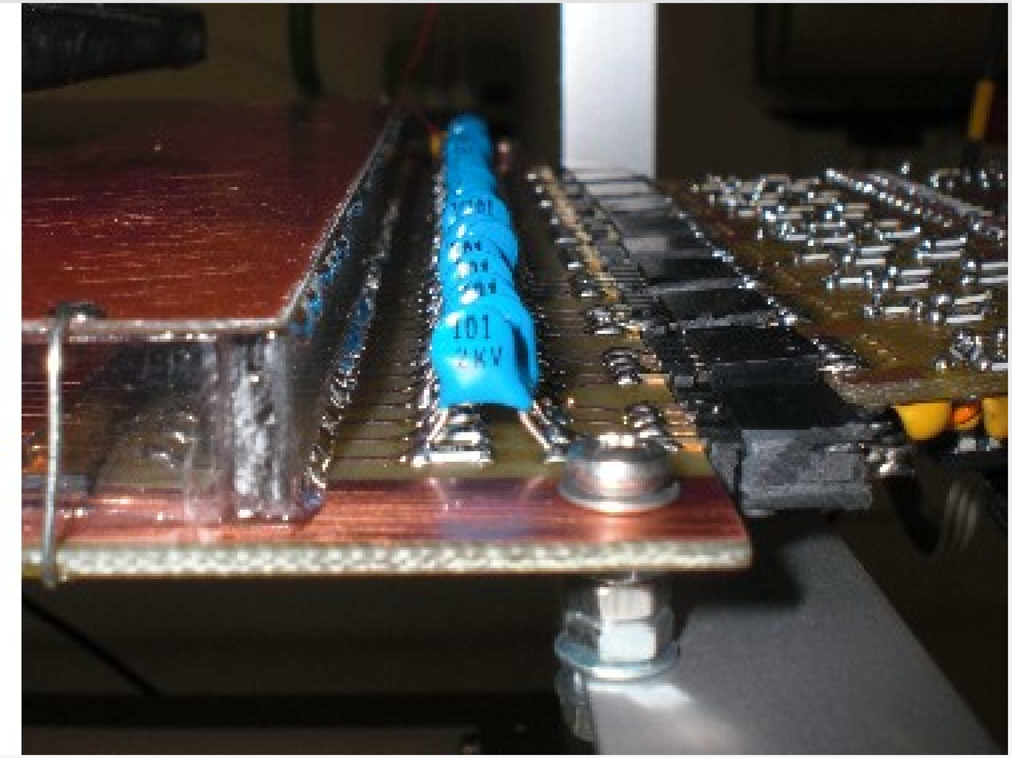
CCC – conception of the used model

- The gain is a local phenomena in the nearby of the wire
  → it is a function of the charge (Q_s) on it

- Known parameters:
  - the geometry of the chamber
  - potentials on the wires/cathodes

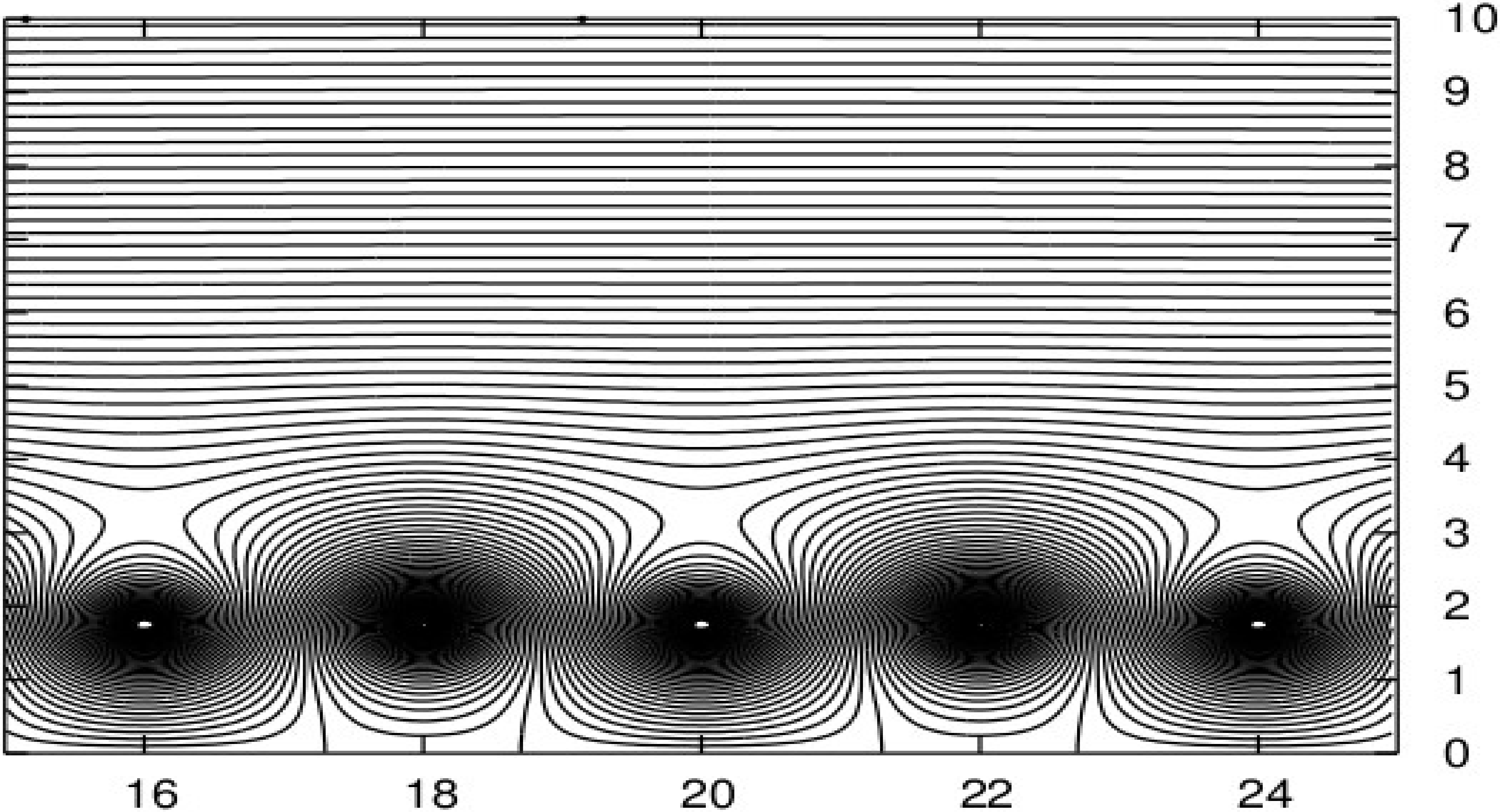
→ Q_s can be calculated
→ as well as the Gain
(by comparing the measurements with the calculations)

- Simplification:
infinite long wires/cathodes
→ 2D model

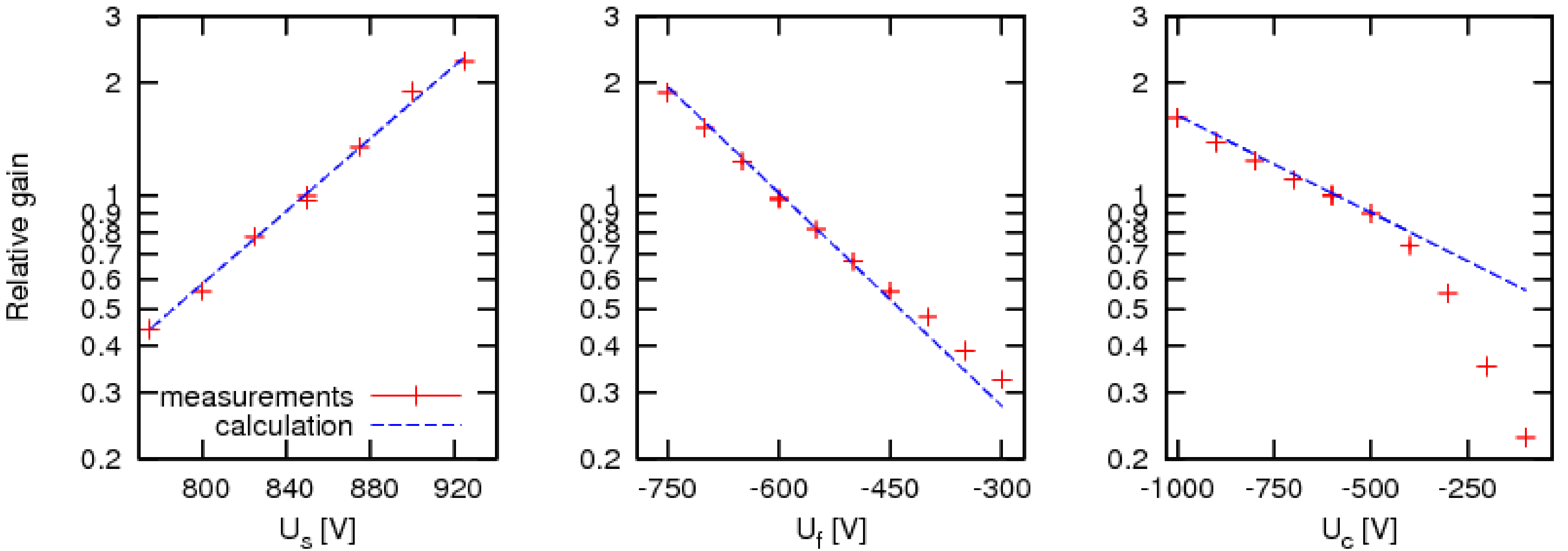


A CCC at work

Equipotential lines in the CCC chamber

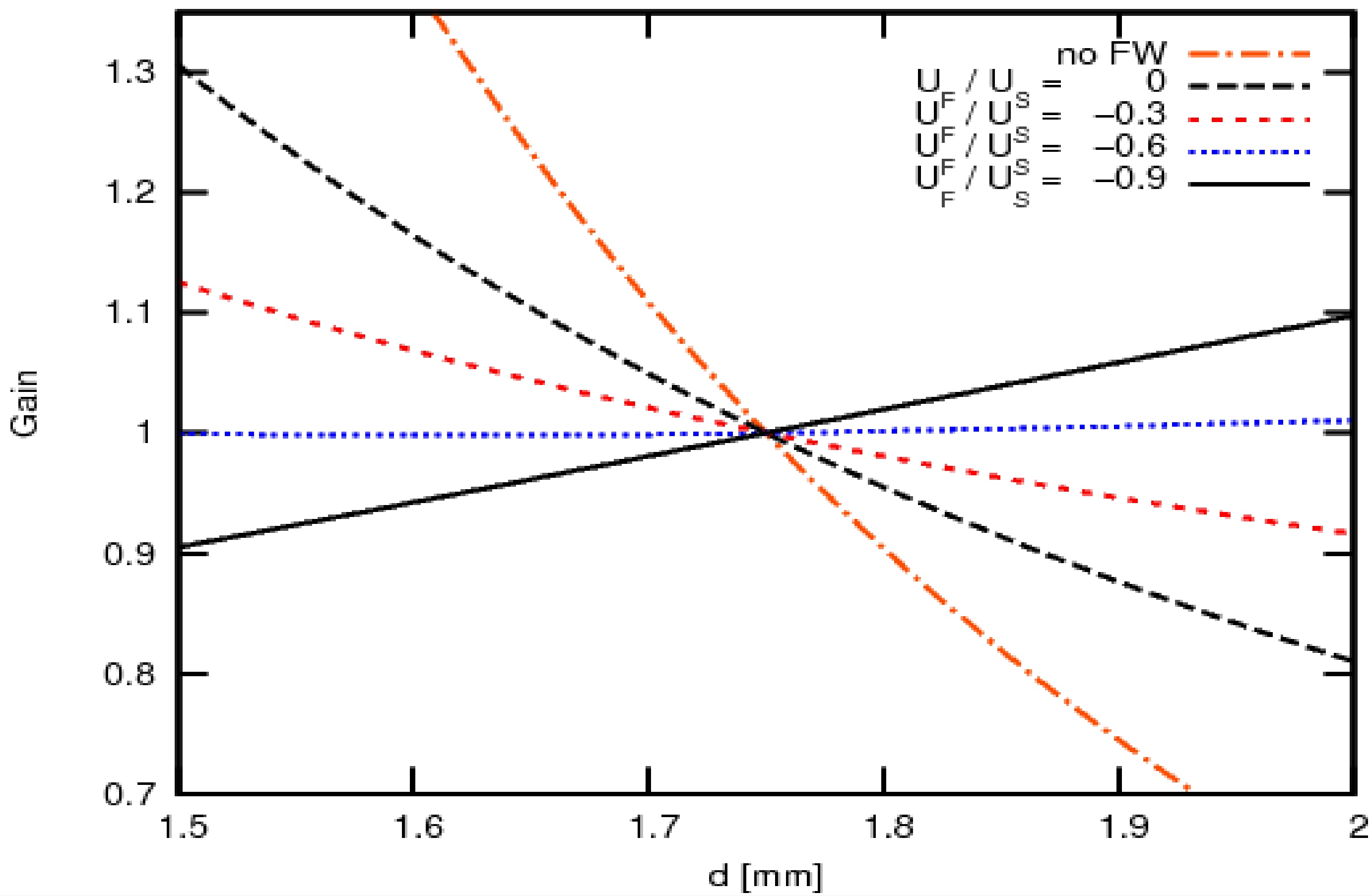


CCC – measurements I.



- Fitting on the U_s dependence → direct connection between the calculated Q_s ”charge” and the measured gain
- The difference at low cathode voltages are due to the reduced efficiency of charge collection

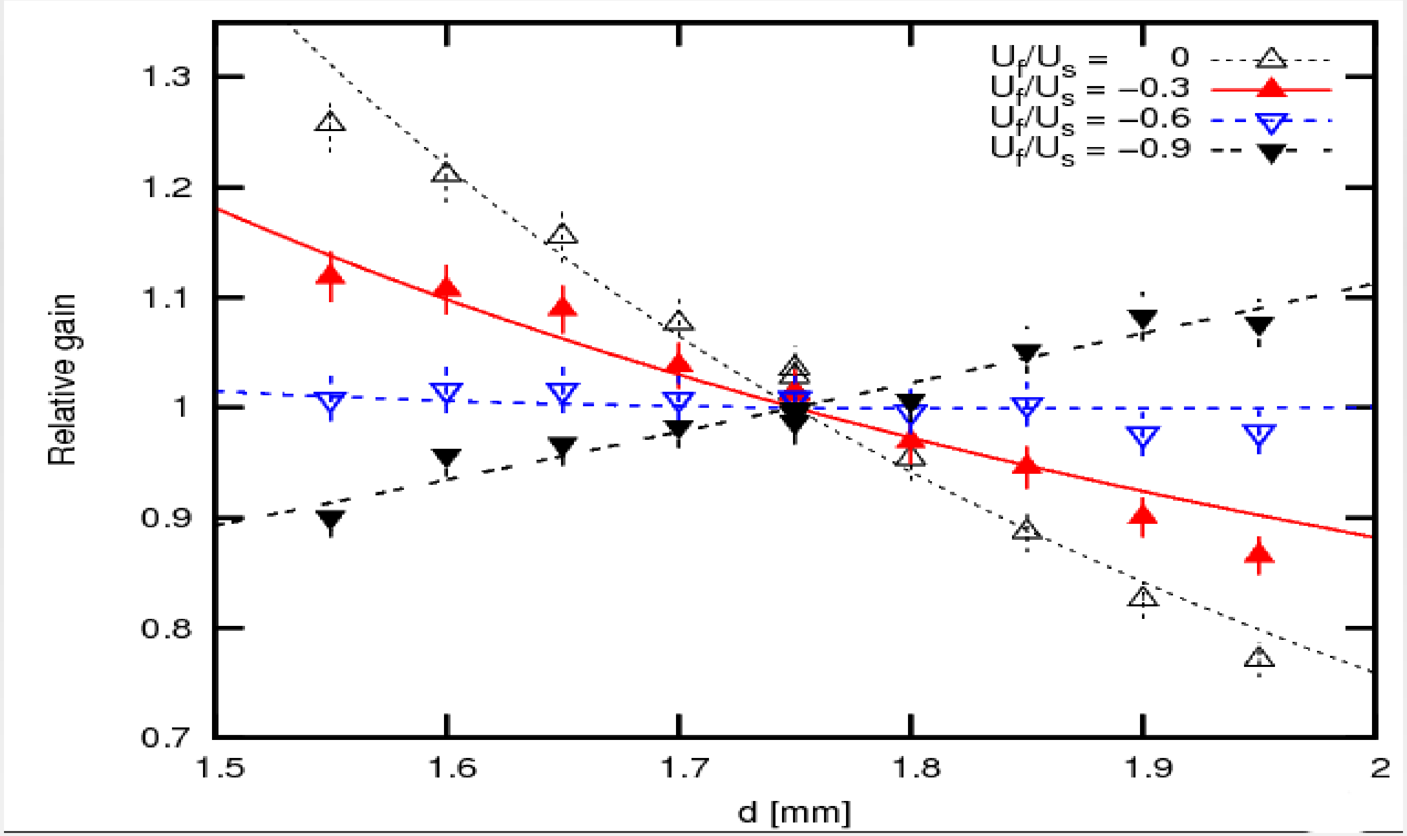
CCC – calculations I.



- The relative gain as a function of lower cathode and wire plane distance (d)

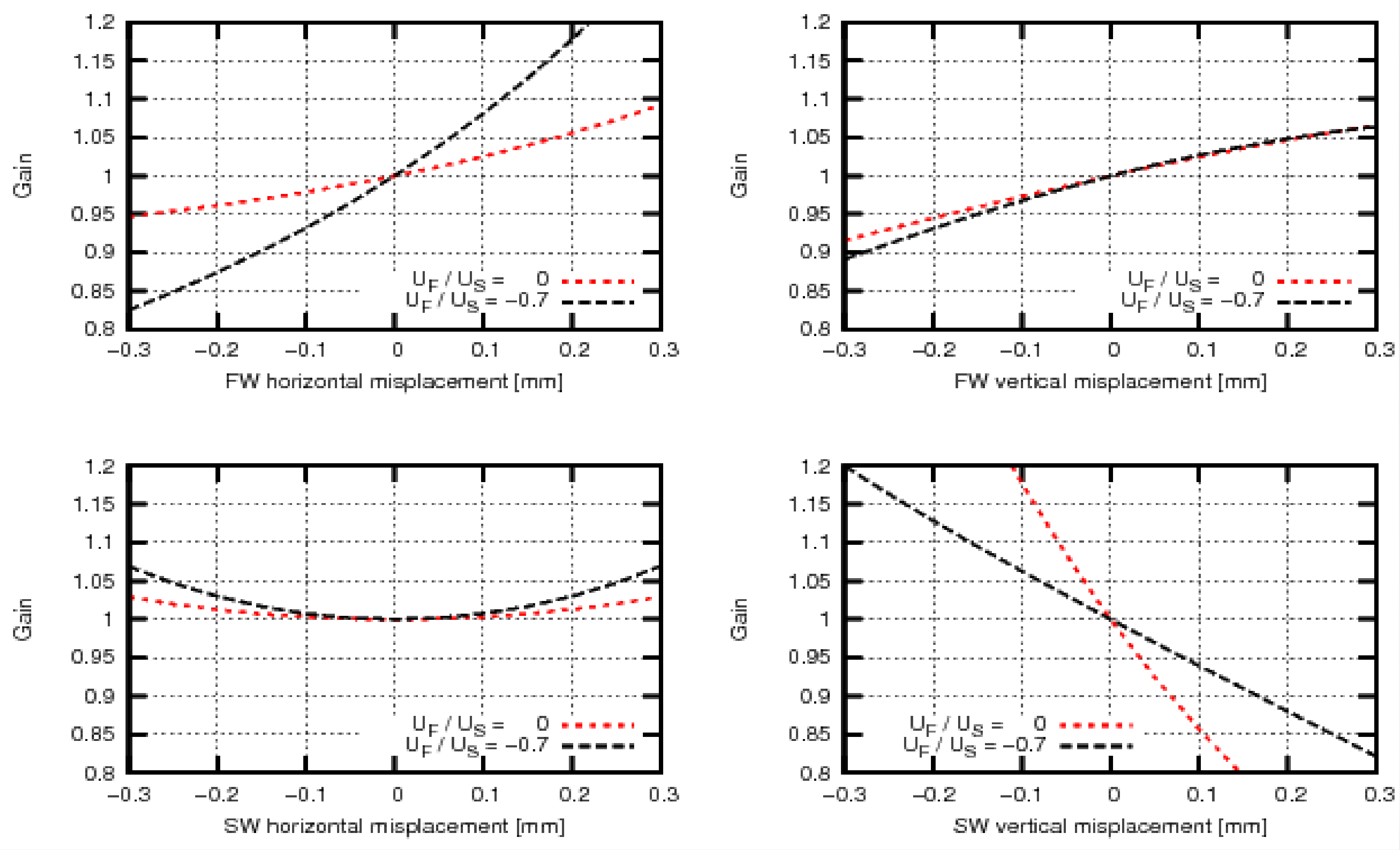
- The dependence on d can be eliminated on a wide range (few hundred μm) → the mechanical tolerance is one order of magnitude bigger than in conventional MWPCs!

CCC - measurements II.



- The relative gain as a function of lower cathode and wire plane distance (d). The calculations are consistent with the measurements.
- Measurements with a chamber where the wires were fixed at different heights on the two side

Further calculations



CCC - Summary

- Weaker restriction on mechanical tolerance:
  - The cathode plane flatness is less critical
  - Can be used lighter support structures, with less material budget
  - The wire plane can be placed close to the cathode plane
- The dependence on the horizontal misplacement of wires is more strong, but handling this parameter is much easier, than the cathode flatness
- Small prototypes (18 cm x 25 cm) are working properly, as well as the one with size 45 cm x 48 cm
- Proved to be a reasonable candidate as the technology choice for HPTD
- The CCC chambers are suitable for triggering the ALICE VHMPID detector.