Detector development projects in Budapest

RMKI - **E**LTE **Ga**seous Detector

Research and **D**evelopment Group

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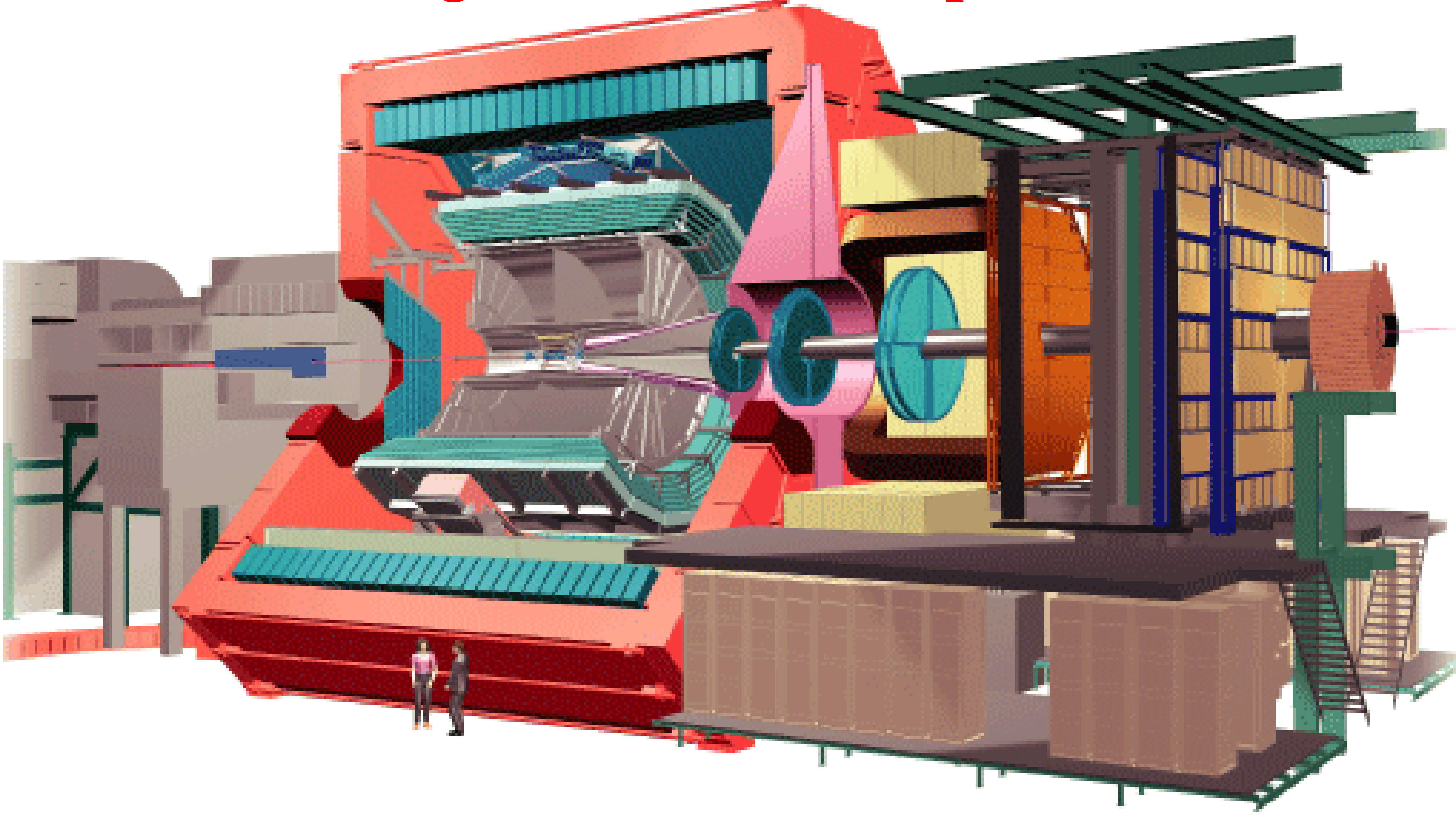
RD51 Collaboration Meeting, 23-15.11.2009., CERN

Outline

- **High P_T Trigger Detector for ALICE VHMPID**
  - **ALICE and its PID**
  - **VHMPID**
  - **Need for a trigger for VHMPID**
  - **Trigger detector requirements, possiblities**
  - **Technological choises, studies so far**
- **NA61 Centrality Detector**
  - **NA61**
  - **Ideas for detecting grey protons**
  - **Technological choises, studies so far**

ALICE

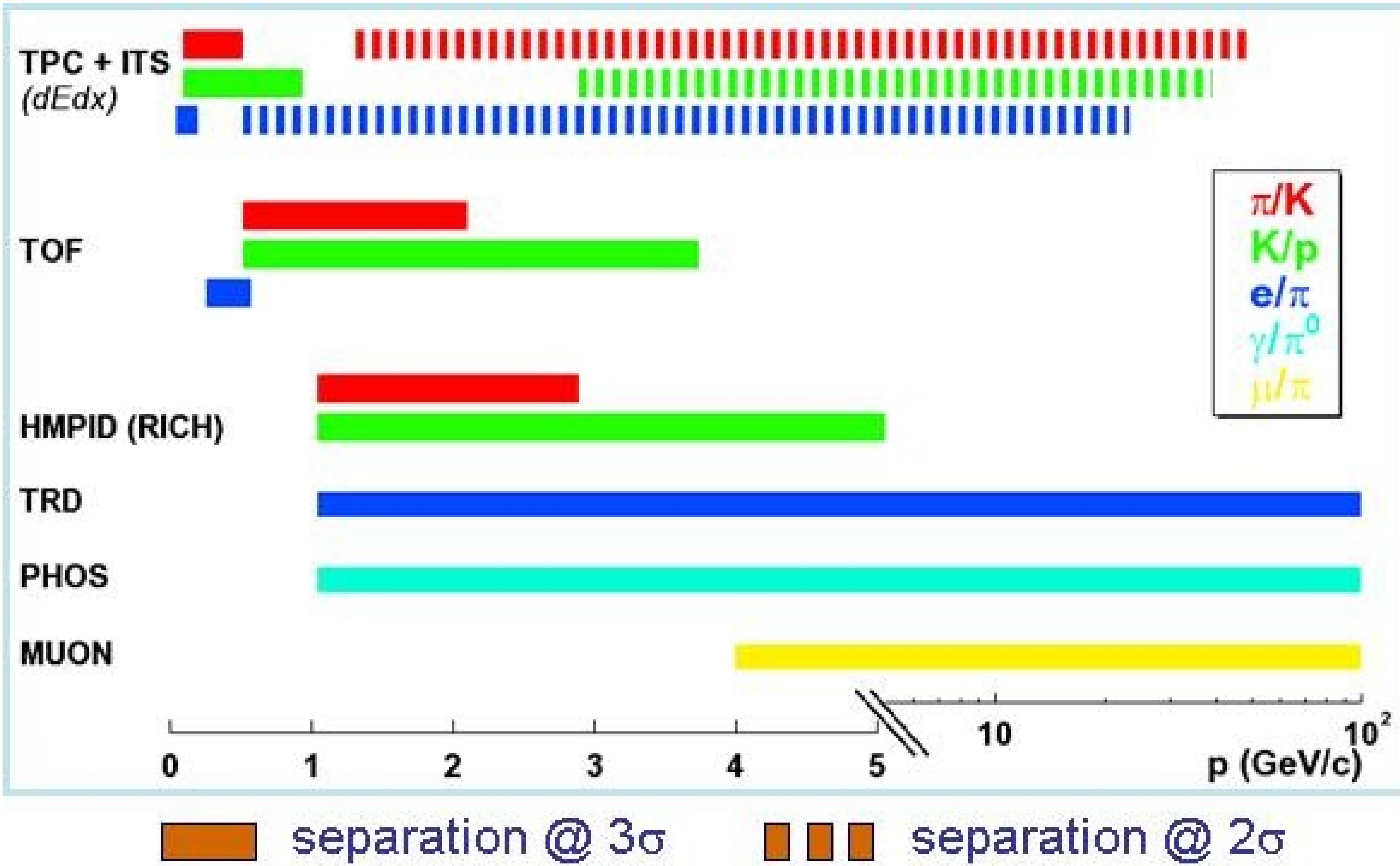
(A Large Ion Collider Experiment)



ITS, TPC, TRD, TOF, Muon Arm, ZDC, V0, T0,

HMPID, EMCal, PHOS, VHMPID?

PID at ALICE

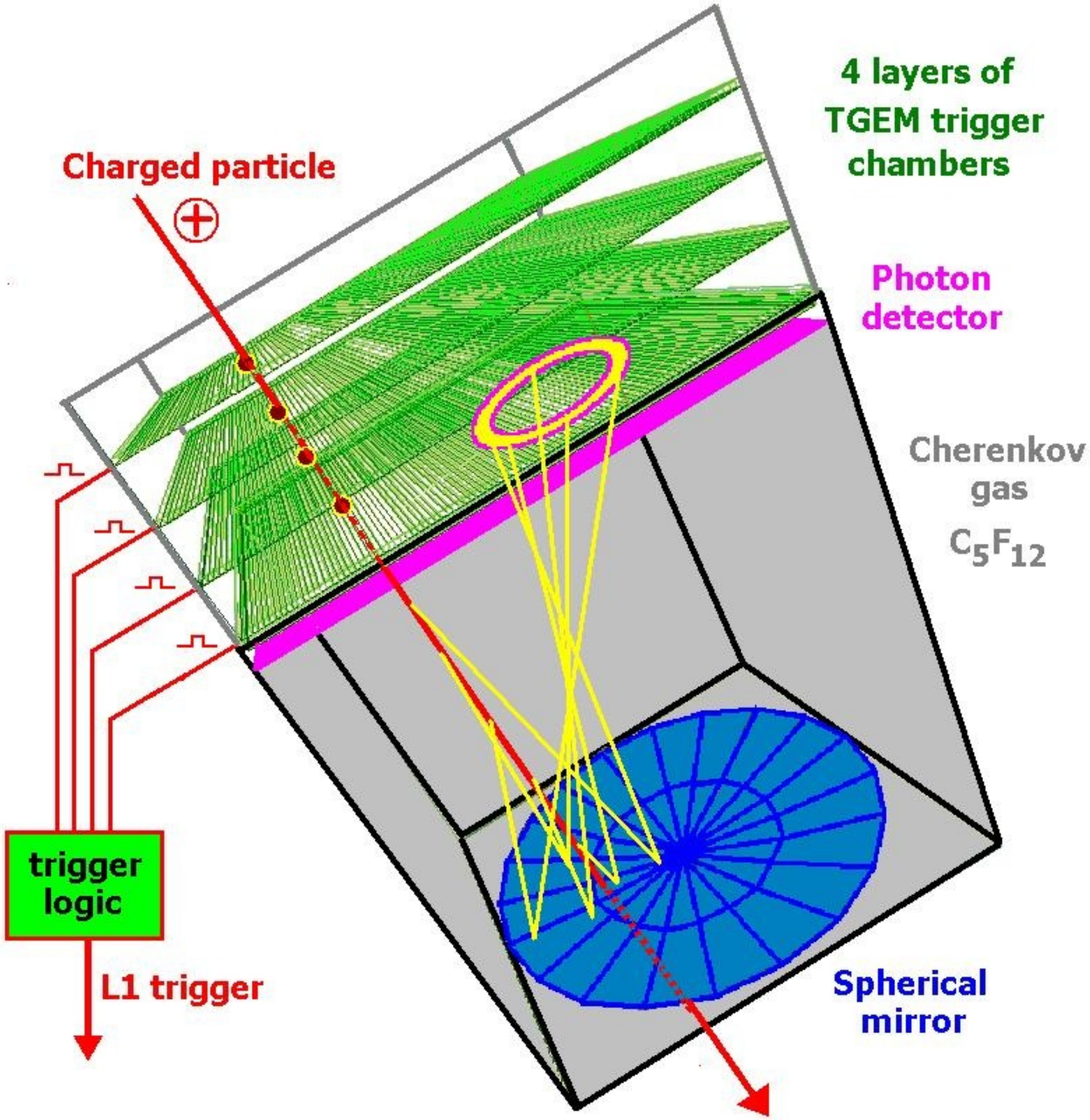


VHMPID: π,K,p separation at 5 GeV < p_T < 15 GeV

Physics motivations

- **π, K, p yields at 5 GeV < p_T < 20 GeV**
  - **P**roton/pion anomaly (~ RHIC)
  - Prticle production mechanisms (thermal,coalescence,pQCD)
  - Fragmentation function at the QGP
  - Jet energy loss, flavour dependence
  - High p_T D- and B-meson and Λ_c, Λ_b-baryon reconstruction
- **Near-side hadron-hadron correlations**
  - B-M (π-p) and B-aB (p-p) correlation (~ RHIC)
  - Di- and Multihadron FF (D_{BM} ?=? D_B*D_M ; D_B*D_{aB} ...)
- **Cooperation with other specail detectors at ALICE**
  - Near-side photon-hadron correlations : PHOS
  - Away-side jet-photon correalations : EMCAL

VHMPID in ALICE

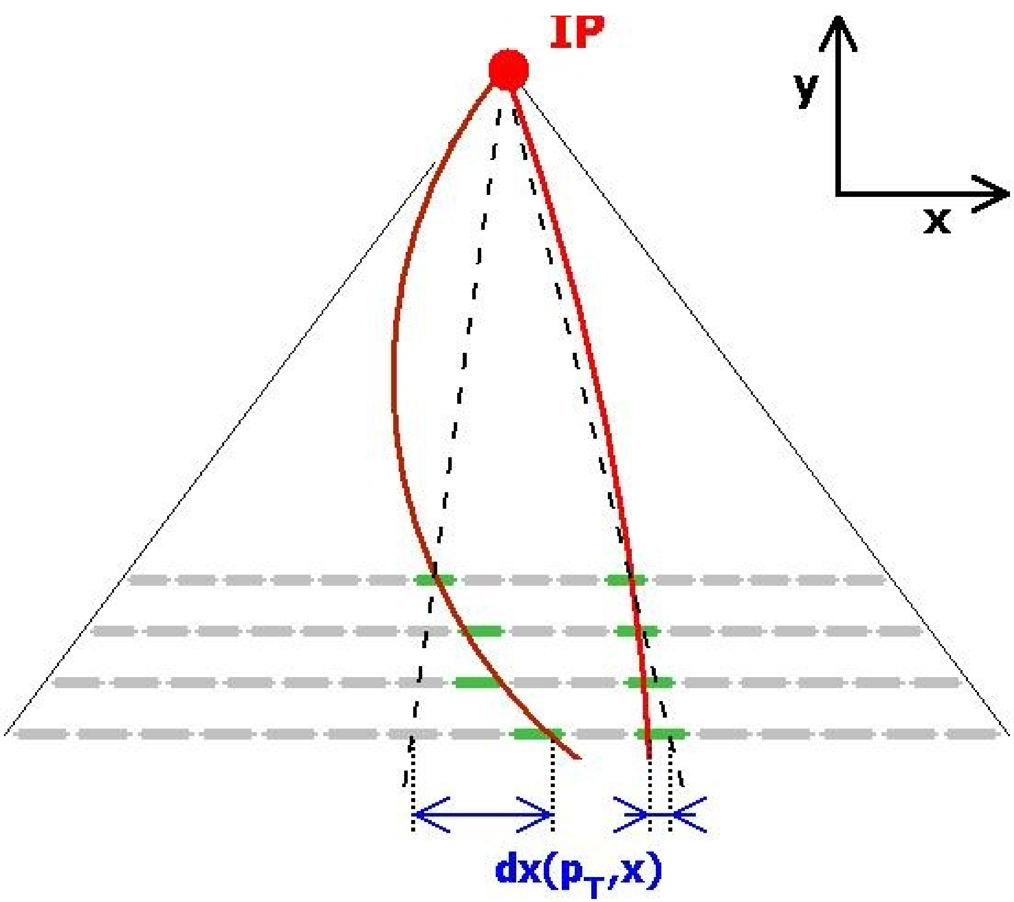


- Event by event analyses
- PID in the region: 5 GeV/c < pT
- Cherenkov radiation: only gas can be used
- Mirror generated circles
- Need for an **L1** trigger: within 5 μs

Very High Momentum Particle Identification Detector

HPTD in ALICE

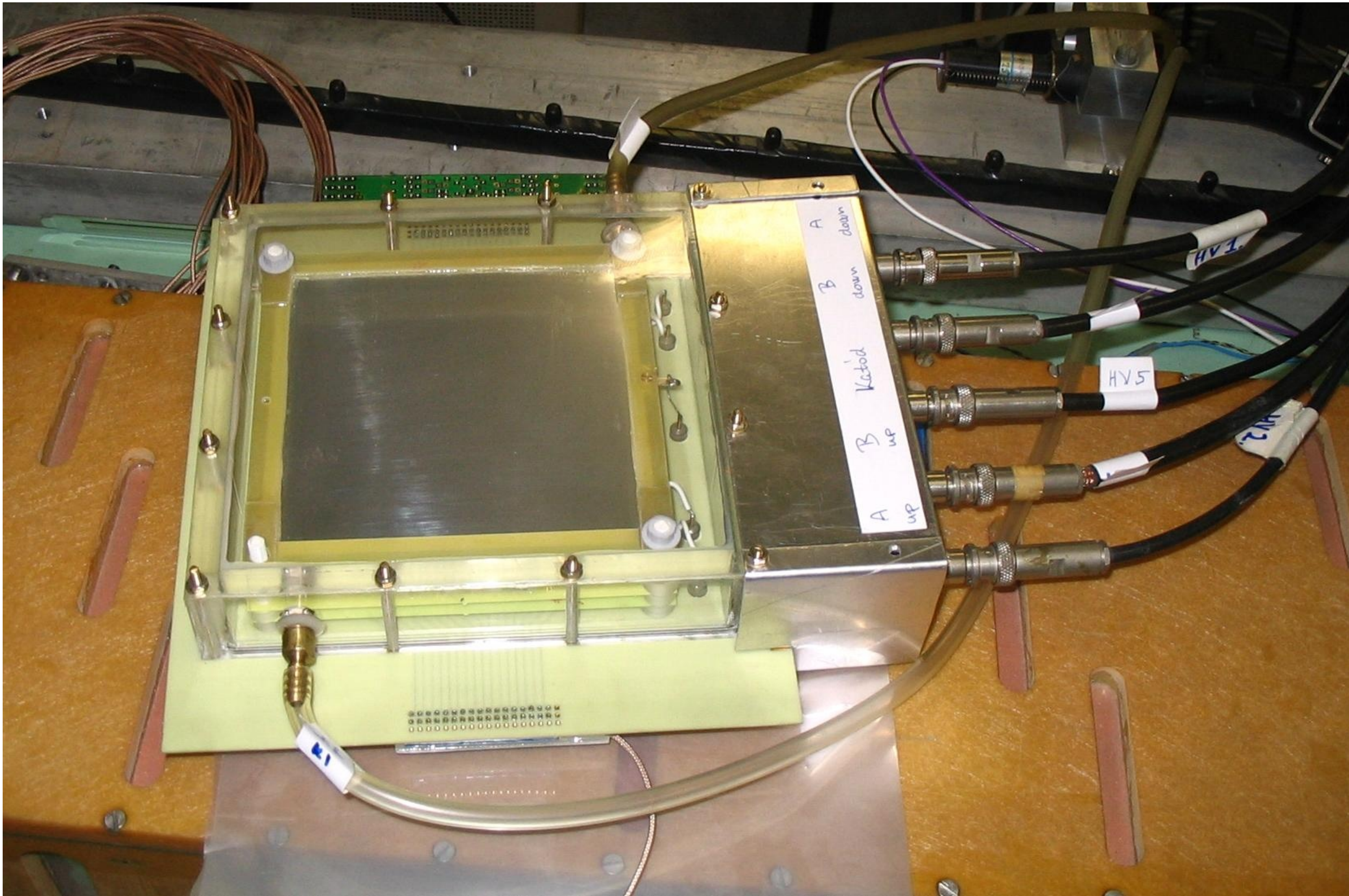
High P_T Trigger Detector



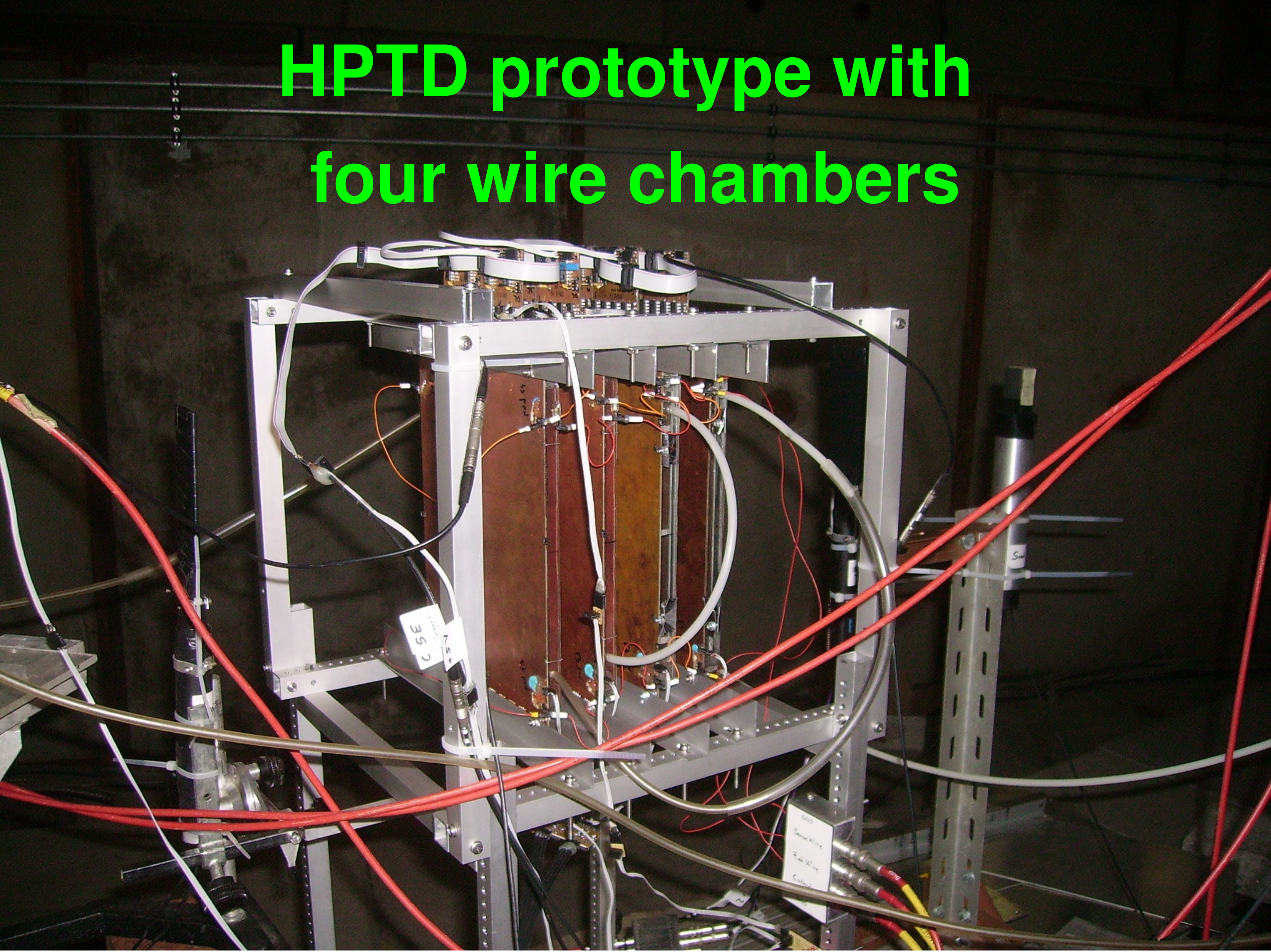
- Measure particle inclination
- Good resolution along the direction of bending
- Pad size optimization through simulations (2-5 mm wide)
- Detector requirement
  - high granularity (pads<2cm^2)
  - high multitrack resolution
  - no amplitude meas. needed
  - narrow response function (1 pad/hit)

- VFAT applicability?
- Simple pattern recognition with FPGAs

HPTD prototype with TGEMs



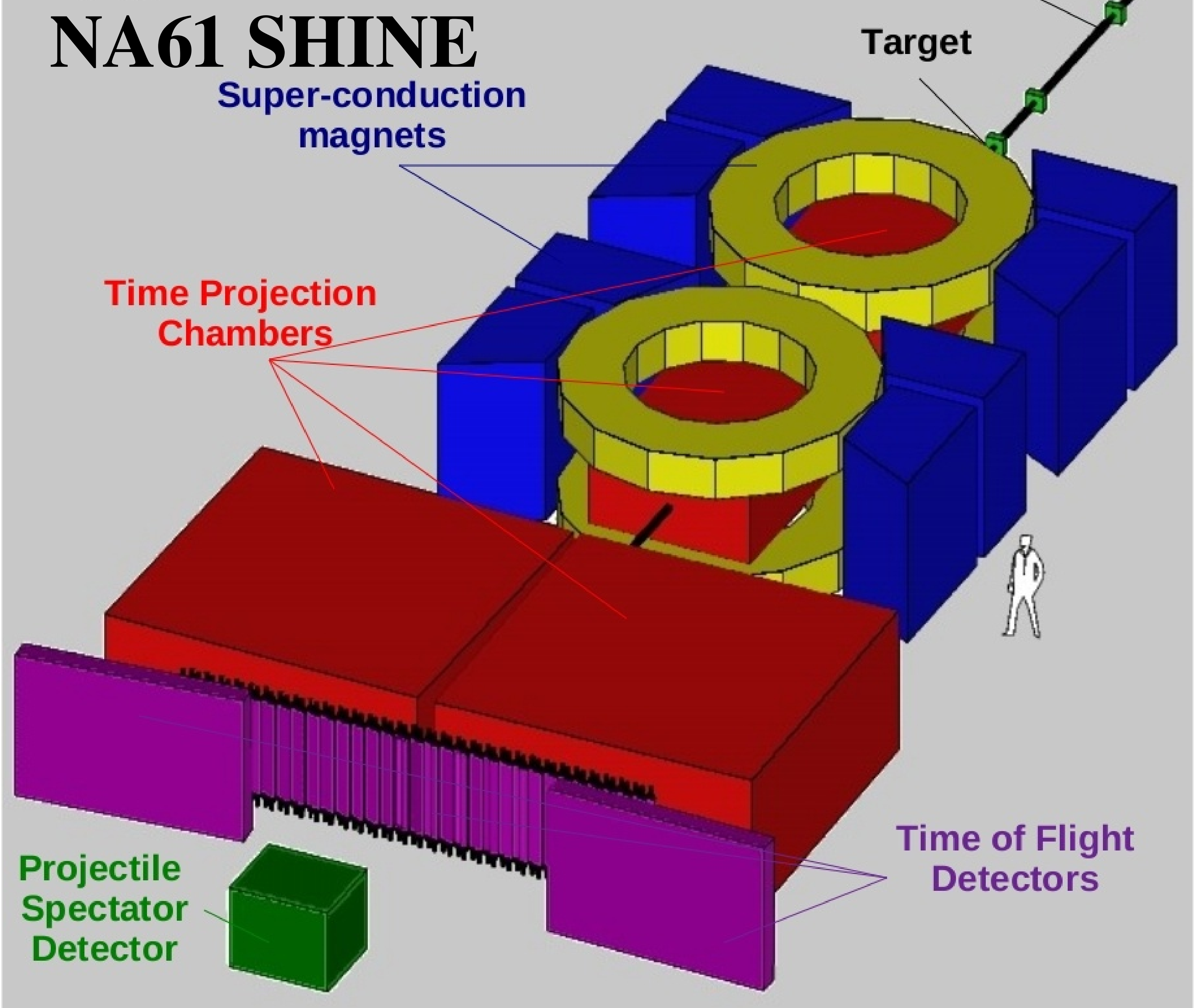
HPTD prototype with four wire chambers



Technologial choises, studies

- **TGEM**
  - Test chambers, test beam at PS last year, results presented at the Collaboration Meeting in Paris
  - Problems with sparking
- **Classical MWPC**
  - wide response function
- **Modified MWPC (CCC)**
  - narrow response function wire chamber
  - test beam at PS, last month
- **Micromegas** (Forseen first prototype and beam test in 2010)
- **GEM** (Forseen first prototype and beam test in 2010)

NA61 SHINE



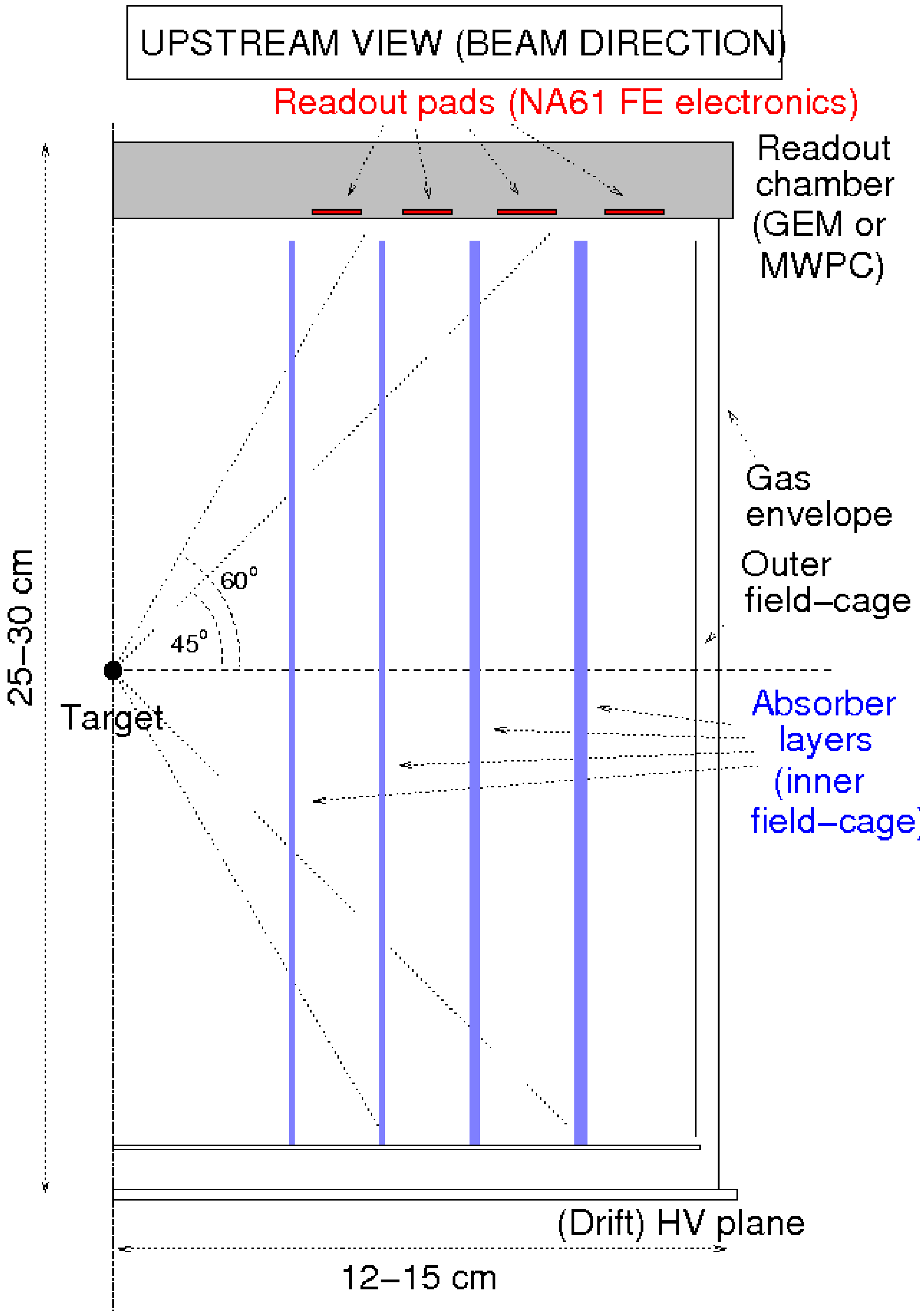
Target
Super-conduction magnets
Time Projection Chambers
Projectile Spectator Detector
Time of Flight Detectors

NA61 Centrality Detector via Low Momentum Multiplicity and Identification detector

- h+A interactions: low momentum (gray) particle measurement: energy and identification.
- Centrality measurement, transition from “black” evaporation component to “gray” knock-on protons

- A+A interactions: backward multiplicity

(centrality or forward-backward correlation)

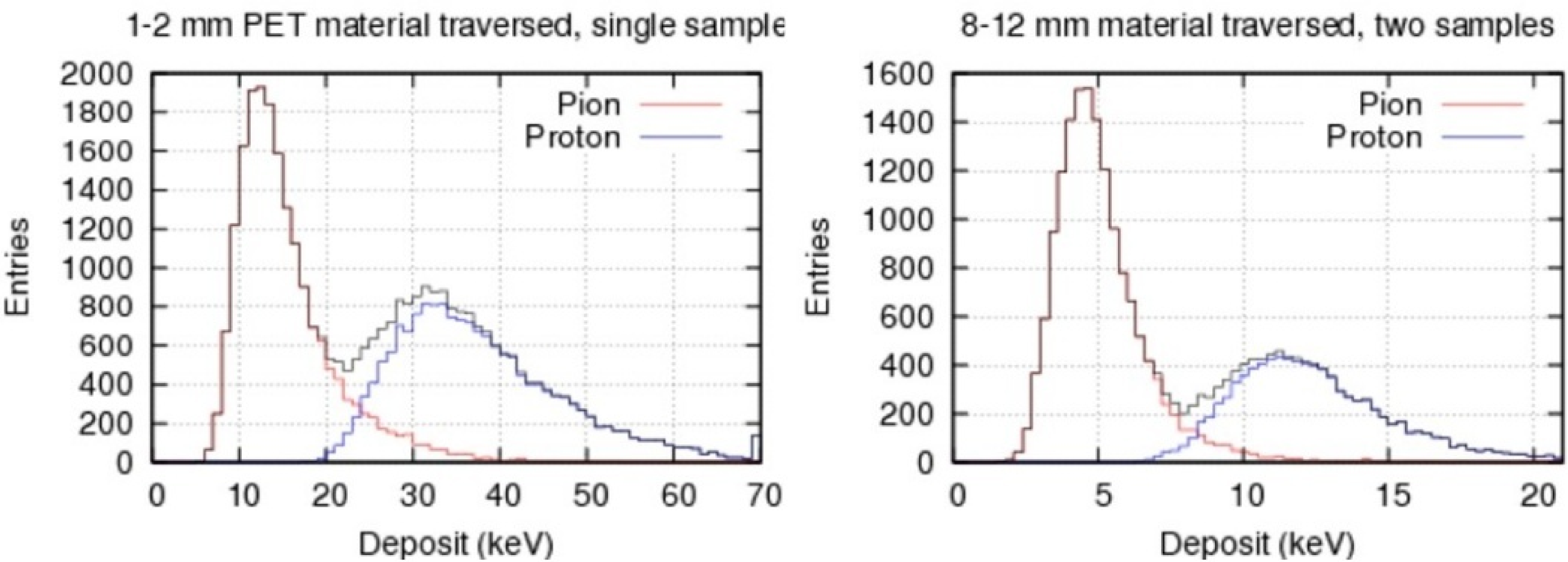


Principle of operation

- Simultaneous measurement of **dE/dx** and **range**: energy and identification
- Intervals in particle range defined by absorber layers (constant thickness to be traversed)
- dE/dx measured over order of 1 cm in a small TPC (field cage printed on absorber)
- Electronics: same as for NA61!

Operation principle: Simulation

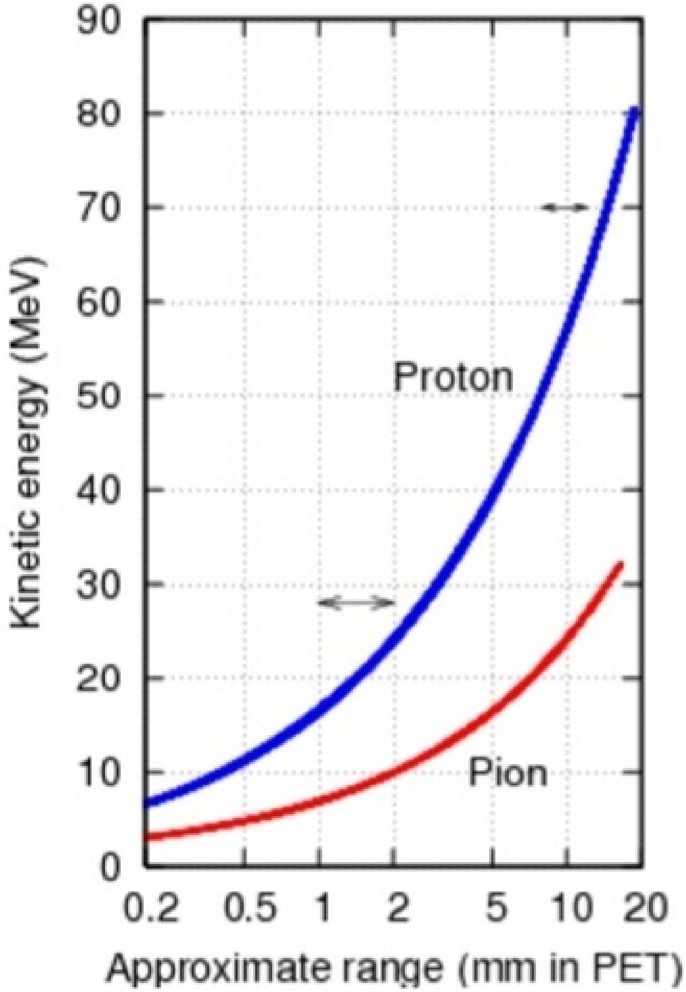
- Preliminary! PAI (Fermi-) model of ionization
- Below: deposit distribution in range intervals

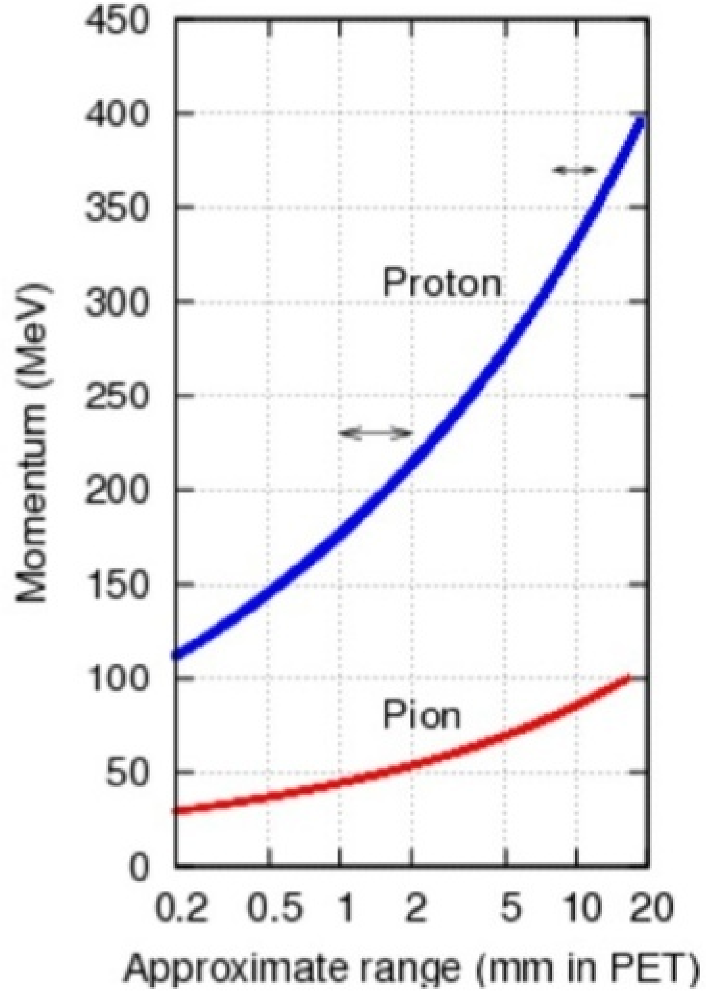


- Clearly identified proton and pion peak!

Momentum (energy) – range relation

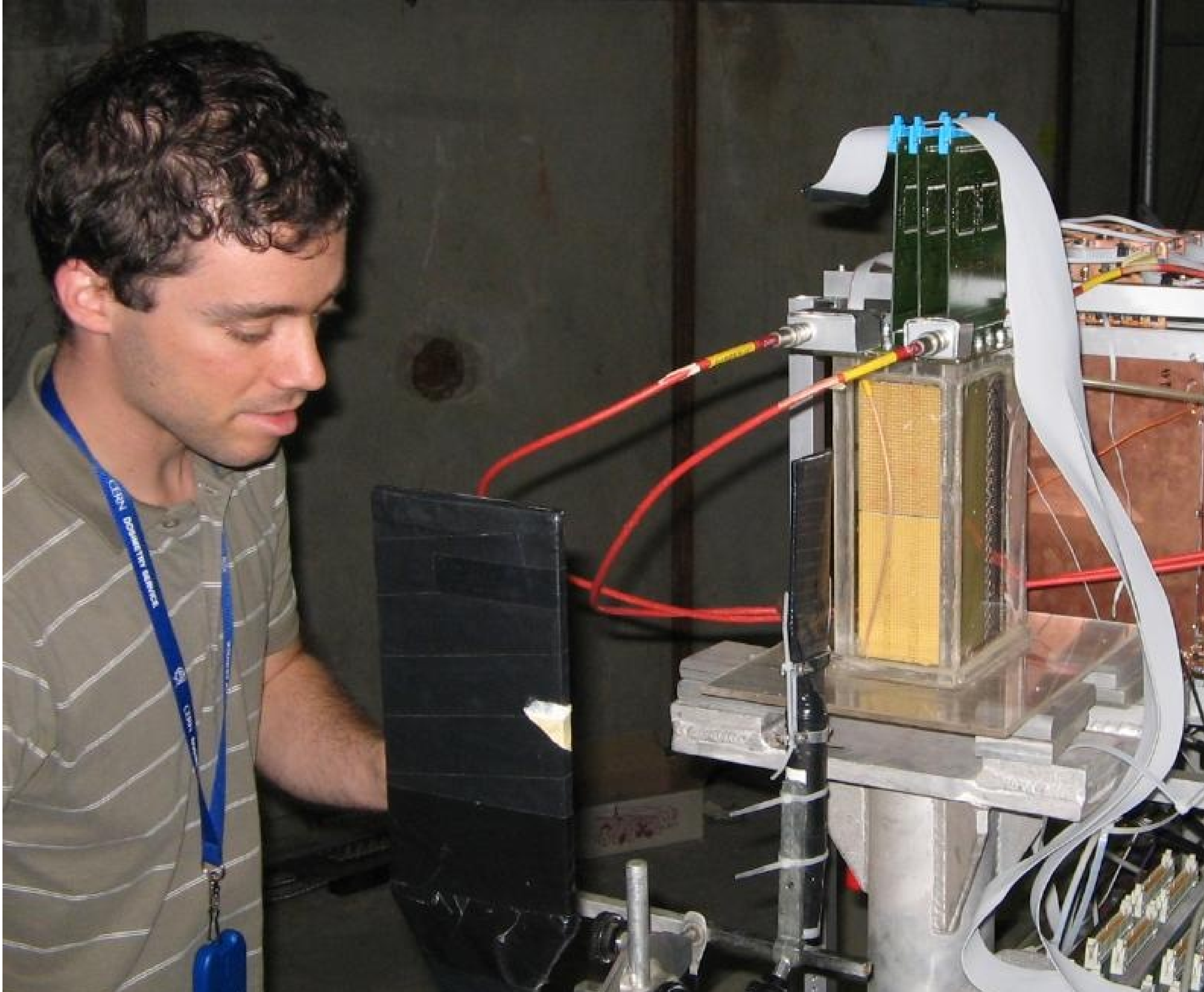
- Useful range: 0.5 – 20 mm in PET (shorter in heavier material, e.g. Cu); minimal target thickness needed.





Arrows indicate the ranges on figures before

Hadronic effects to be considered in refined analysis!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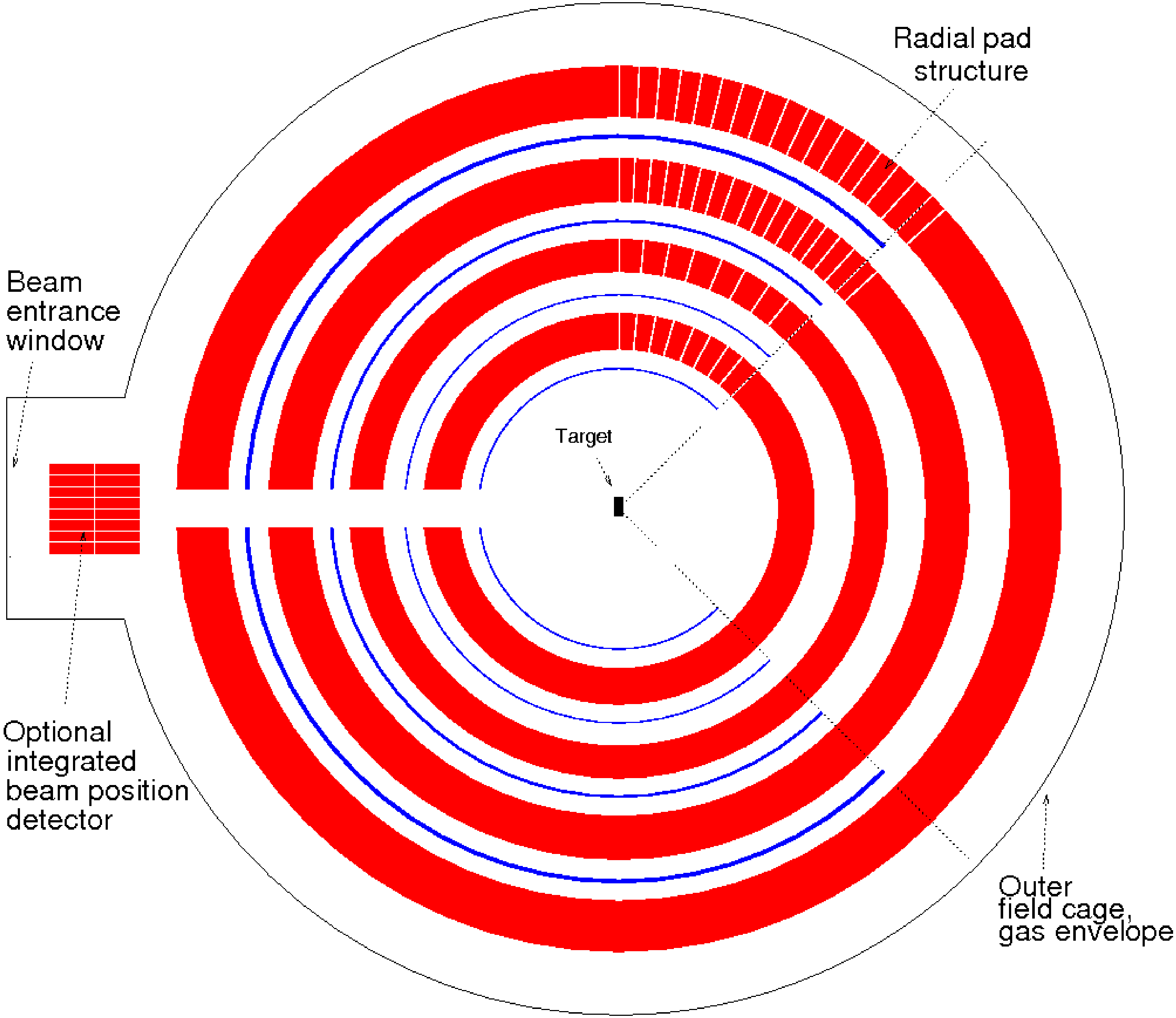
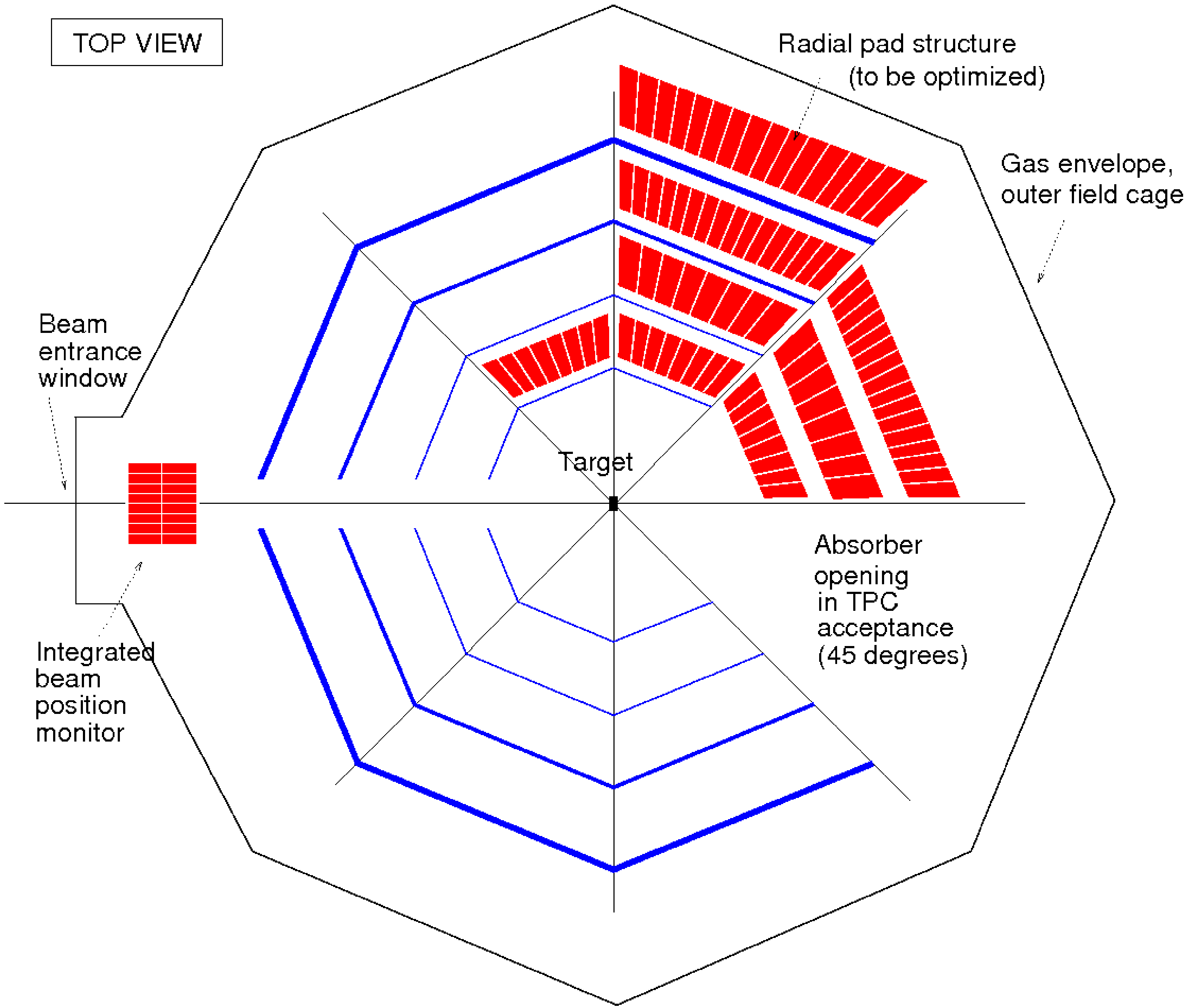
Technologival choises, studies

- Readout technology:
  GEM (possibility of complete cylindrical structure)
  or **MWPC** (as in NA49 TPC-s)
- Radial pad structure
  - Pad sizes to be optimized (resolution, ionization)
    (total pad number: 1 CT board)
  - Cylindrical structure: more complicated absorber construction (thickness varies with height!)
  - Polygonal structure: simpler, with dead zones
- Studies so far: test beam with first prototype

Cylindrical structure



Polygonal structure



Summary

- **High P_T Trigger Detector for VHMPID**
  - **VHMPID: new R&D for ALICE**
  - **Need for a trigger : HPTD**
  - **Fast, high granularity, narrow response, 1bit digitalization, pattern recognition.**
- **NA61 Centality Detector**
  - **Detecting grey protons via range and dE/dx**
  - **Field cage on absorbers**
  - **Slow protons, wide dE/dx range, geometry embraces the target, NA61 electronics**