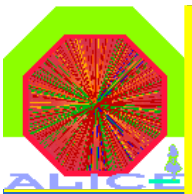
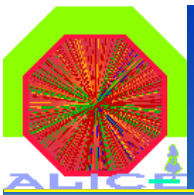


Position Resolution, Electron Identification and Transition Radiation Spectra with Prototypes of the ALICE TRD

Christian Lippmann

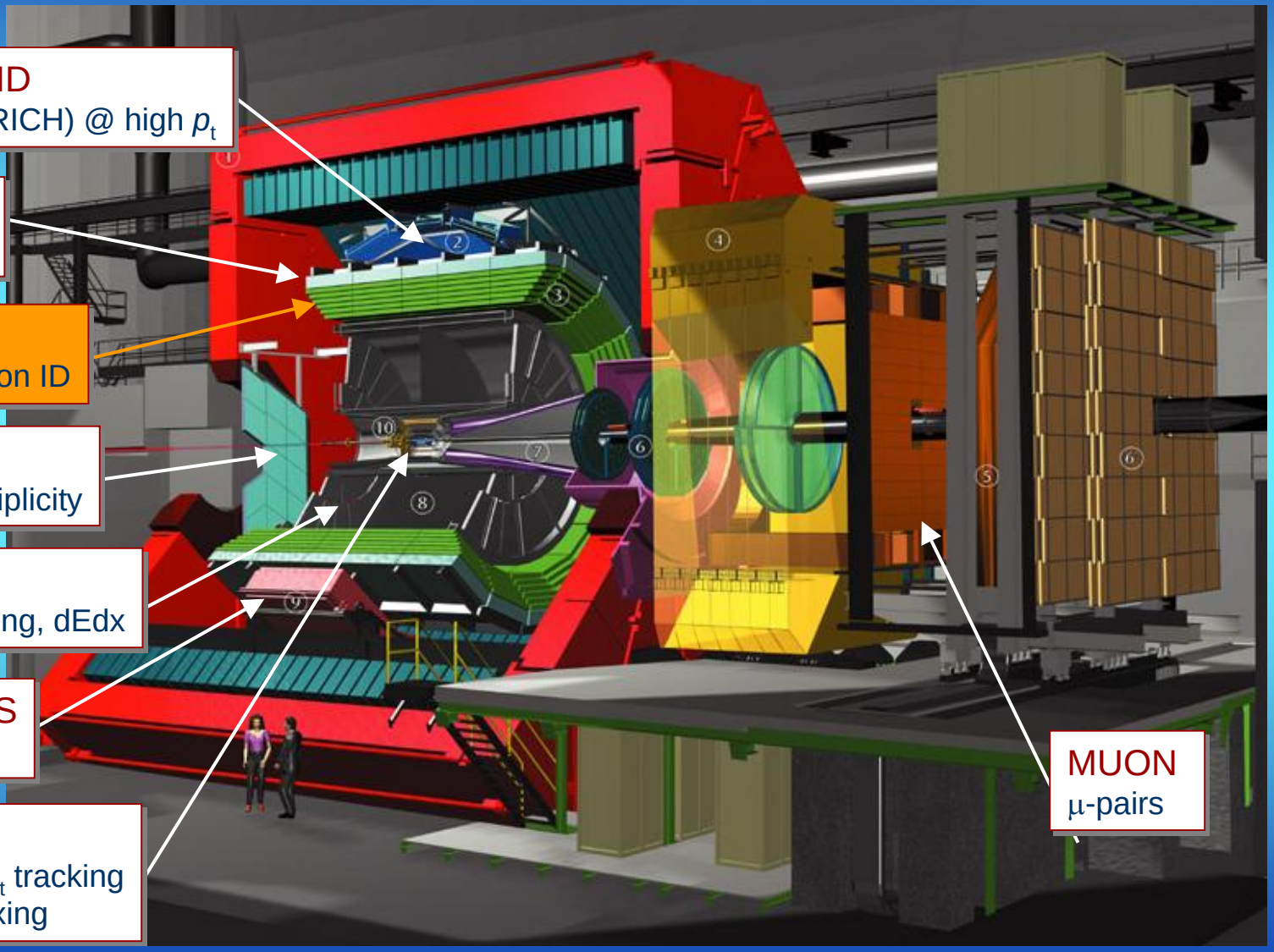
for the ALICE TRD Collaboration



Outline

- **The ALICE TRD**
- **Requirements**
- **Working Principle**
- **Test Beam Setup**
- **Results**
- **Summary and Outlook**

The ALICE Experiment



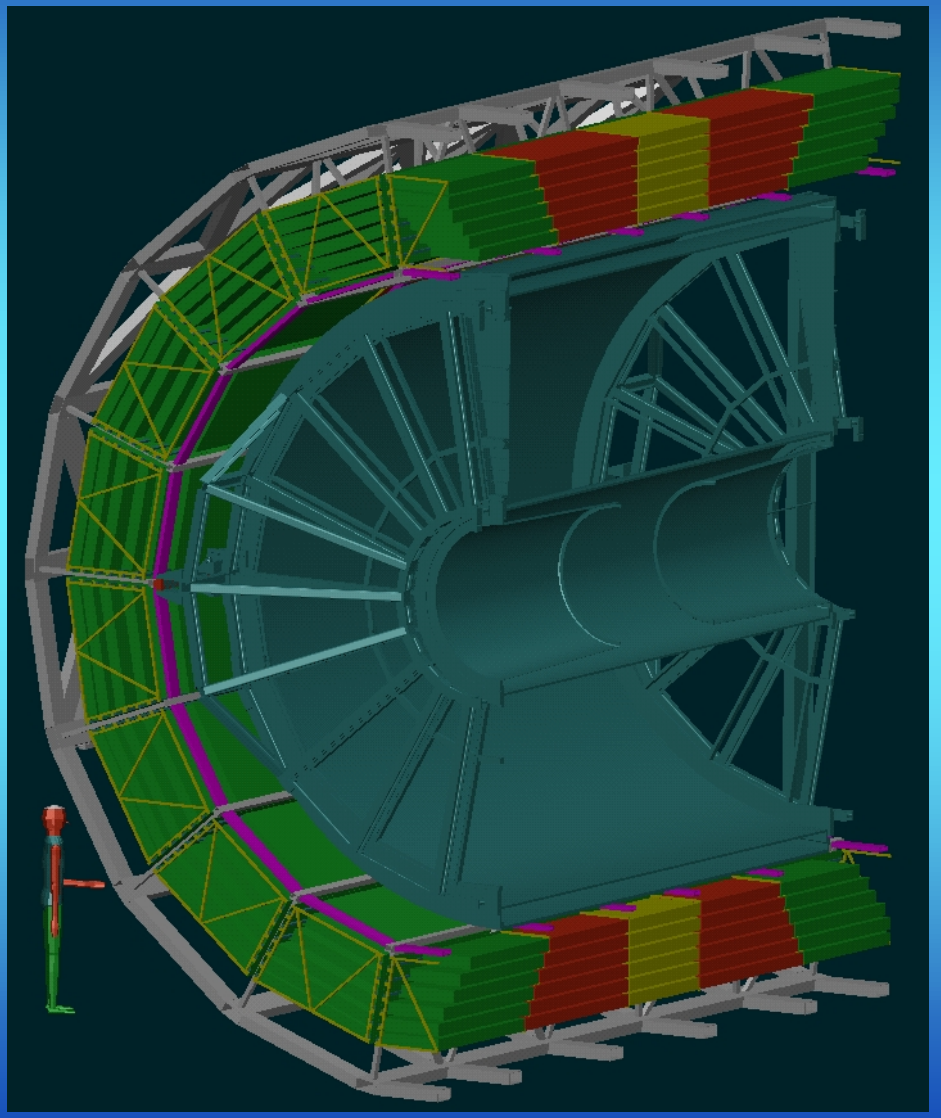
The TRD (Transition Radiation Detector)

- 18 supermodules
- 6 radial layers
- 5 longitudinal stacks

$\Rightarrow$ 540 chambers
$\Rightarrow$ 750m^2 active area
$\Rightarrow$ 28m^3 of gas

Each chamber:
$\approx$ 1.45 x 1.20m^2
$\approx$ 12cm thick (incl. Radiators and electronics)

in total 1.18 million read out channels



Requirements

The TRD should:

- **Provide electron identification.**

  Pion rejection factor ≈ 100 required

- **Increase the tracking capability of the experiment.**

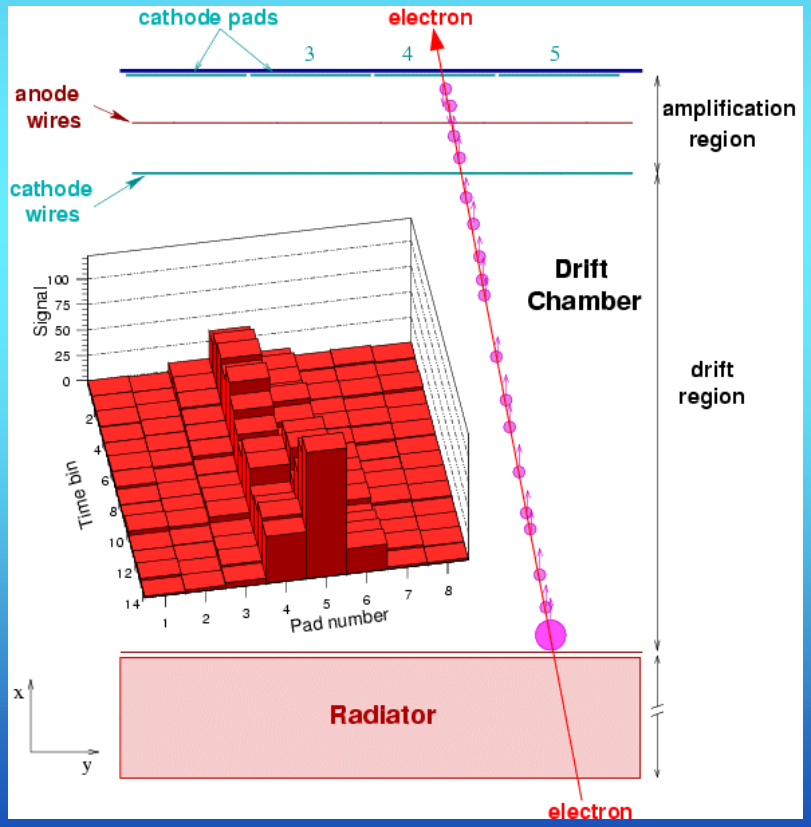
  Angular resolution $\sigma_\alpha < 1°$ required

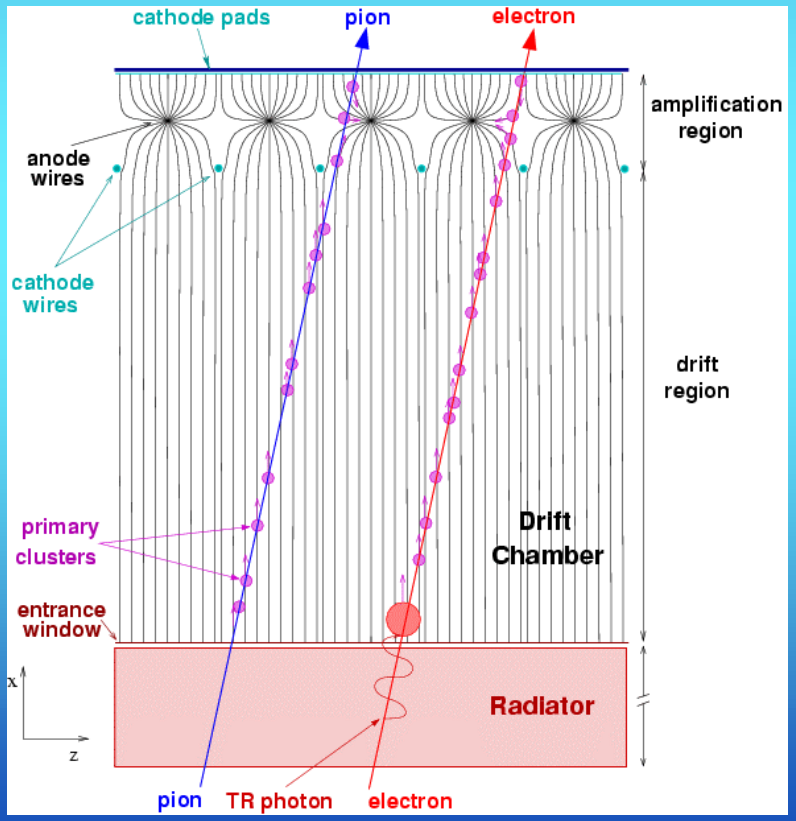
  Position Resolution $\sigma_x < 400\mu m$ required

- **Provide trigger on high-p_t electrons.**
  - **Same Requirements**

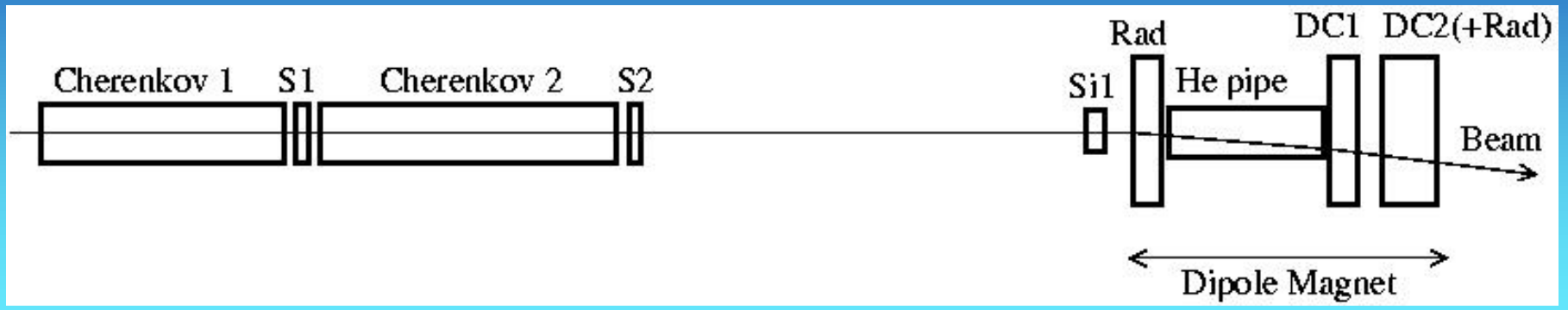
Working Principle of the TRD

- **Drift chambers with FADC readout at 10MHz combined with a fiber/ foam sandwich radiator in front.**
- **Transition Radiation (TR) photons (< 30keV, only for electrons) are absorbed by high-Z gas mixture (Xe,Co_2) ⇒ large clusters**



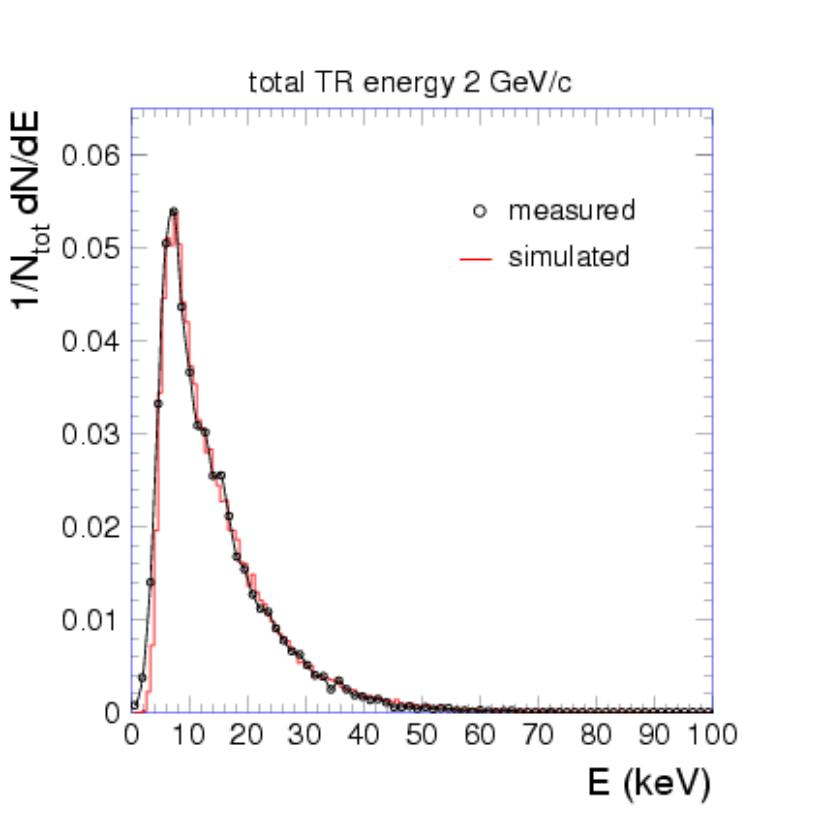


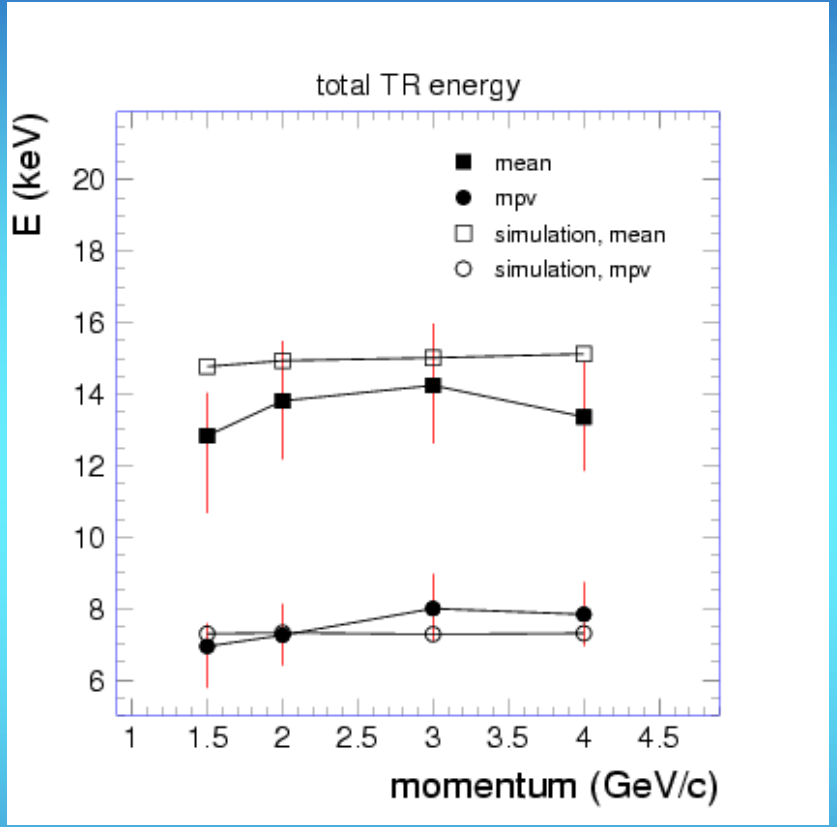
Testbeam Setup 1:



- **Testbeam at CERN PS in October 2002**
- **Momenta up to 4GeV/c**
- **S1, S2: Scintillators as trigger**
- **Cherenkov: Electron tagging**
- **Si1: Track position**
- **Dipole Magnet: Separate TR**
- **He pipe: Minimize TR absorption**

Results 1: TR Spectra

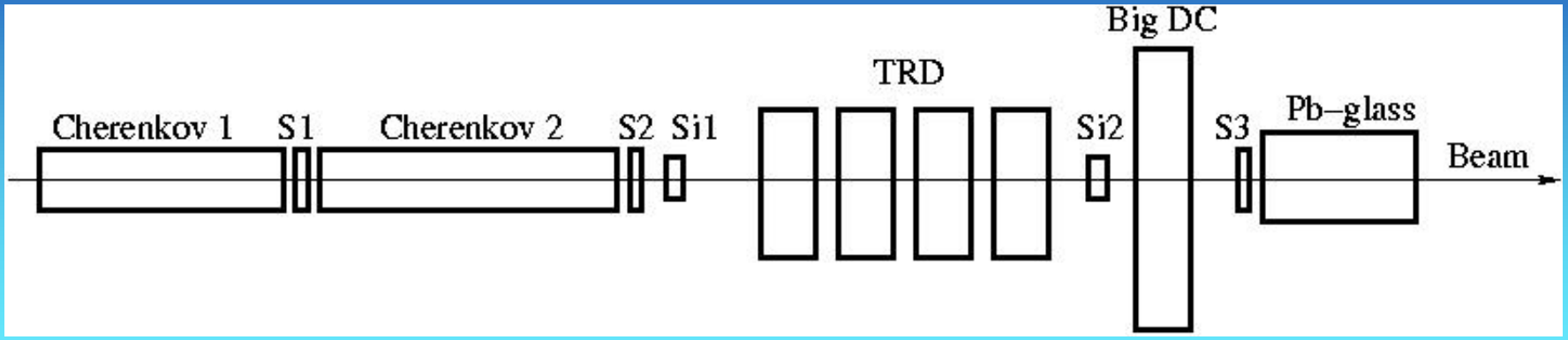




- **We have a quantitative understanding of TR production and absorption.**

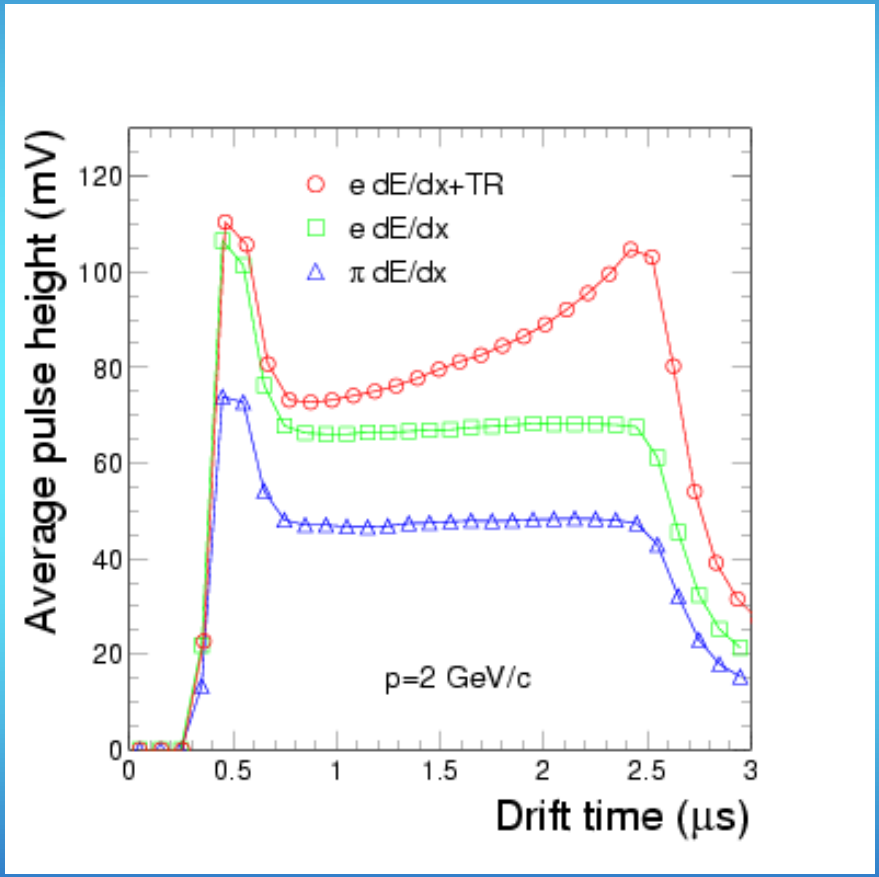
[O.Busch, TRDs for the 3rd Millenium, Bari'03]

Testbeam Setup 2:



- **Testbeam at CERN PS in October 2002**
- **Momenta up to 6GeV/c**
- **Added a calorimeter for better electron tagging**
- **Stack of 4 small TRD prototypes**
- **Si1, Si2 for position reference**

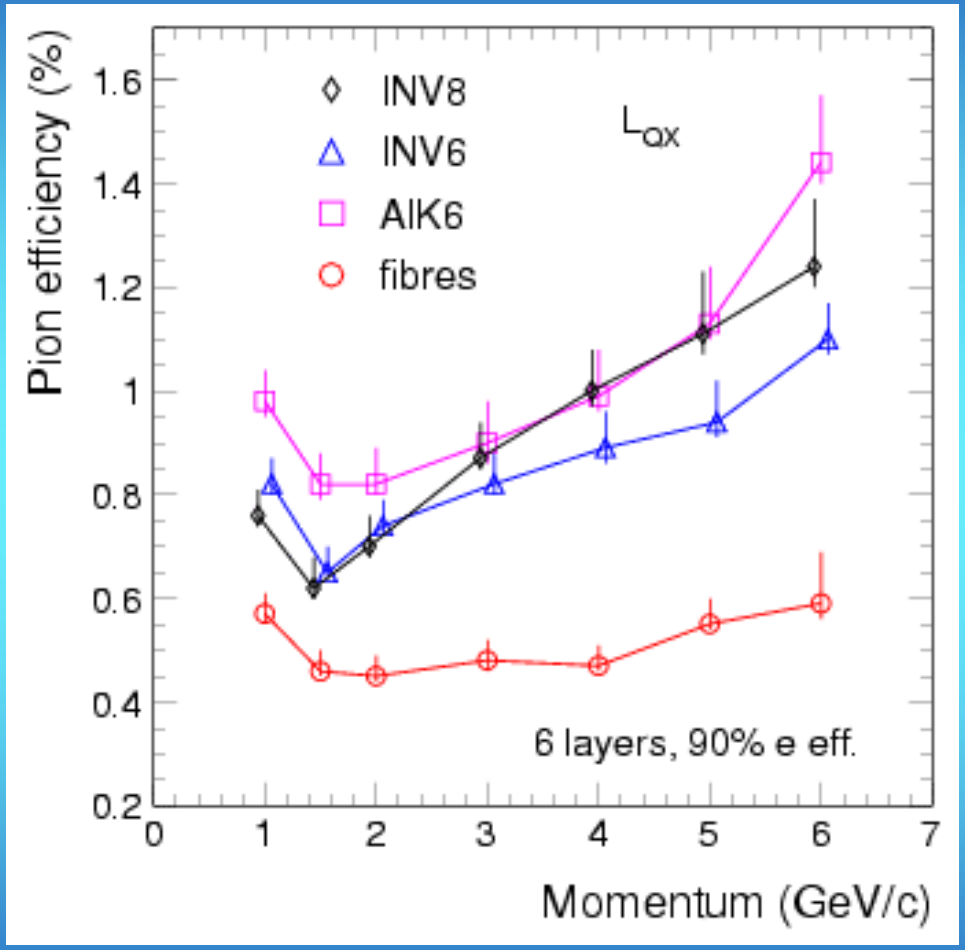
Results 2: Average Signals



- Pulse height vs. time bin for
  - pions,
  - electrons only dE/dx,
  - electrons dE/dx+TR.
- We find for electrons:
  - larger dE/dx.
  - characteristic TR energy deposit on top.
- Use differing energy deposit and TR signature to identify electrons!

Results 3: Pion Efficiency

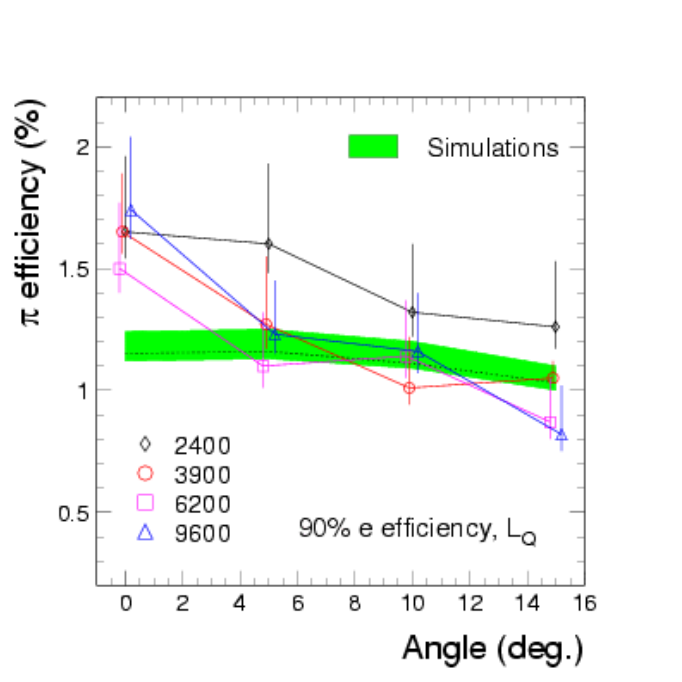
- The *pion rejection* has to be large to minimise number of pions misidentified as electrons.
- The *pion efficiency* is the inverse of this value and has to be minimized.
- Different radiator types were tested.
- L_{QX} = bidimensional likelihood. Uses:
  - deposited charge (dE/dx+TR)
  - position of largest cluster
- We reach a rejection factor 100



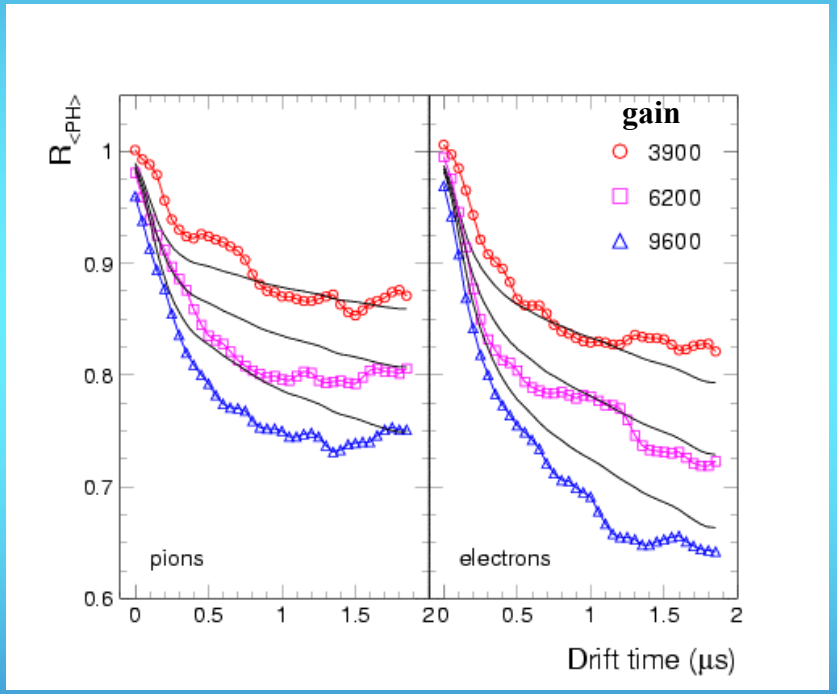
- Can be increased by Neural Network (Poster HK12.42)

Results 4: Space Charge Effect (SCE)

- **We expect a space charge effect for perpendicular tracks from pileup of ions around same wire spot for given track.**
- **Can influence pion rejection!**



Simulation without SCE:
Pion rejection performance as function of angle should be constant

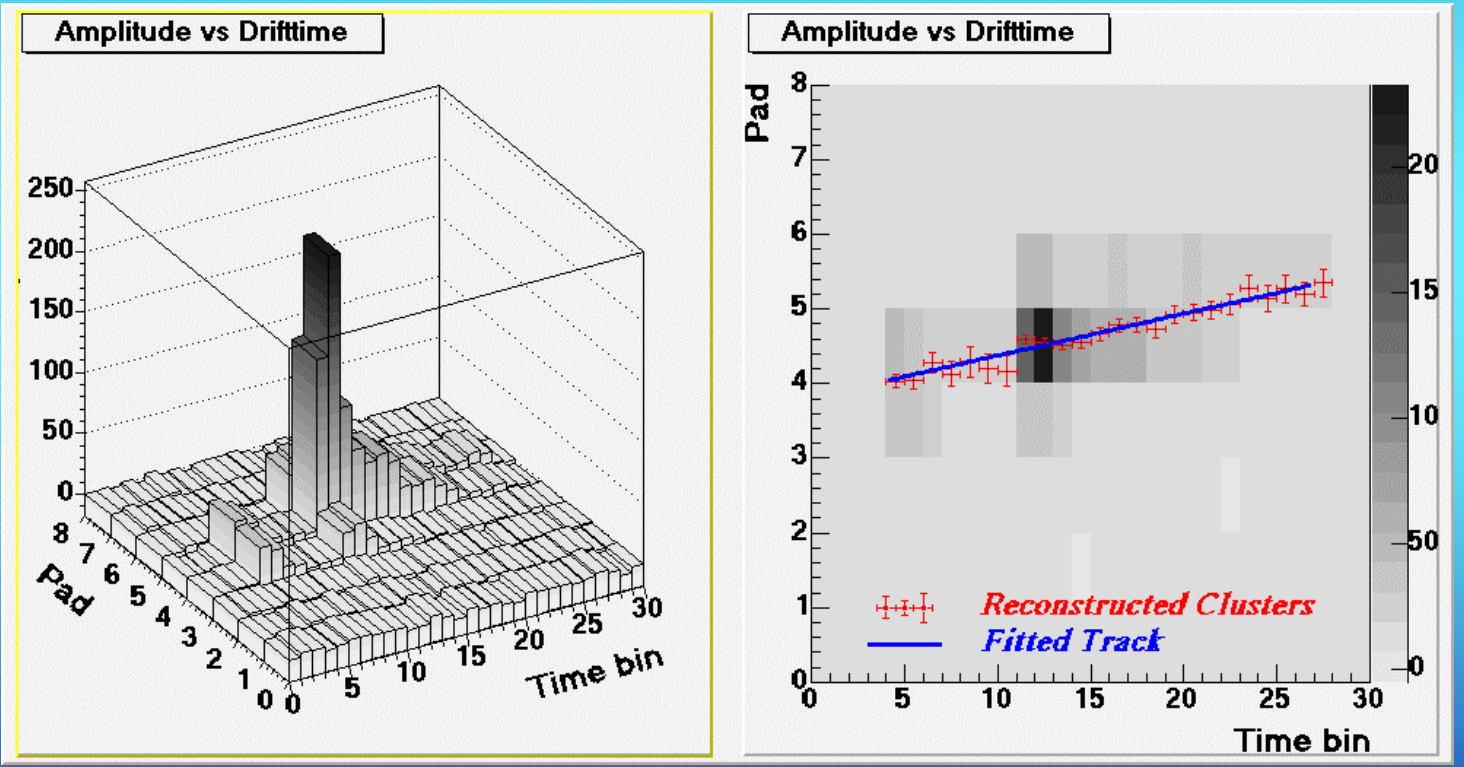


Simulation with SCE:
Ratio of Pulse Heights at 0° and 15° and comparison to simulations.

[A.Andronic et al., NIM A in press]

Tracking: Example Event

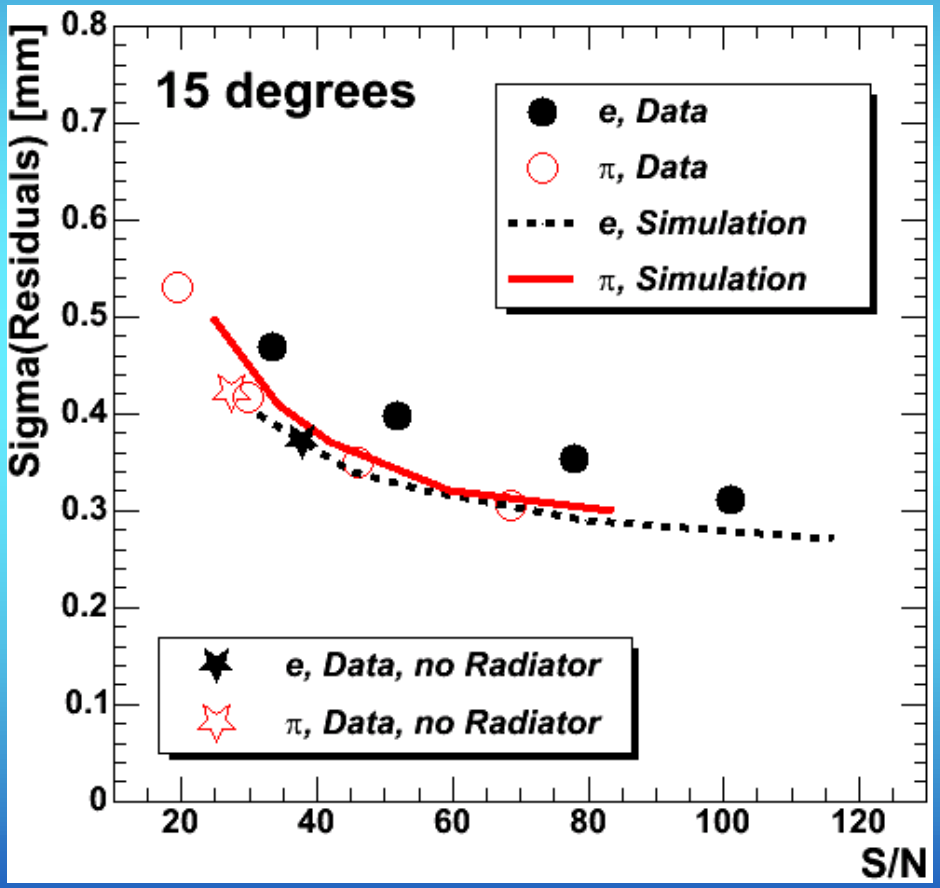
- The pulse height is sampled at 10MHz on eight pads.
- For each time bin the position along the pad rows is reconstructed.
- A straight line fit leads to the incident particles track.



- Residuals define Position Resolution

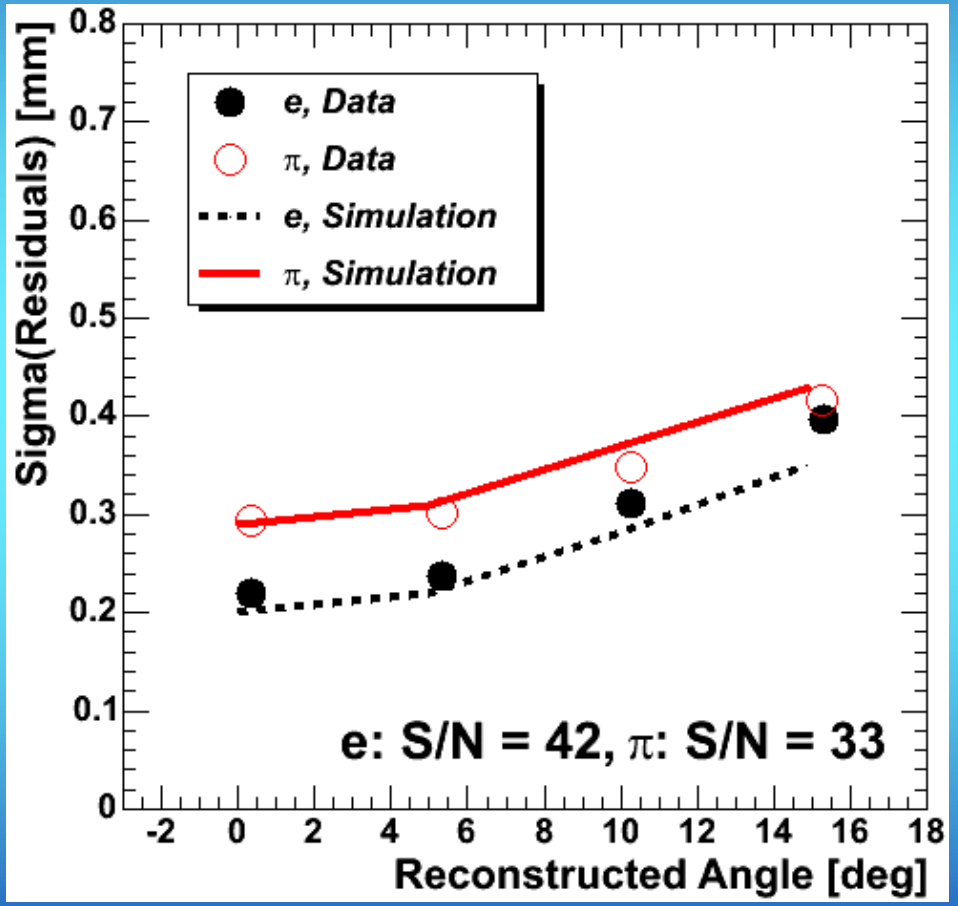
Results 5: Position Resolution

- Position Resolution = Sigma of Gauss-fit to Residuals Histogram
- Here vs. signal-to-noise
- Example at 15°
- Larger Signals ⇒ better resolution
- σ_x = 300 - 400µm
- When a radiator is used, the resolution is worse for electrons ⇒ Bremsstrahlung
- Nice agreement with simulation!

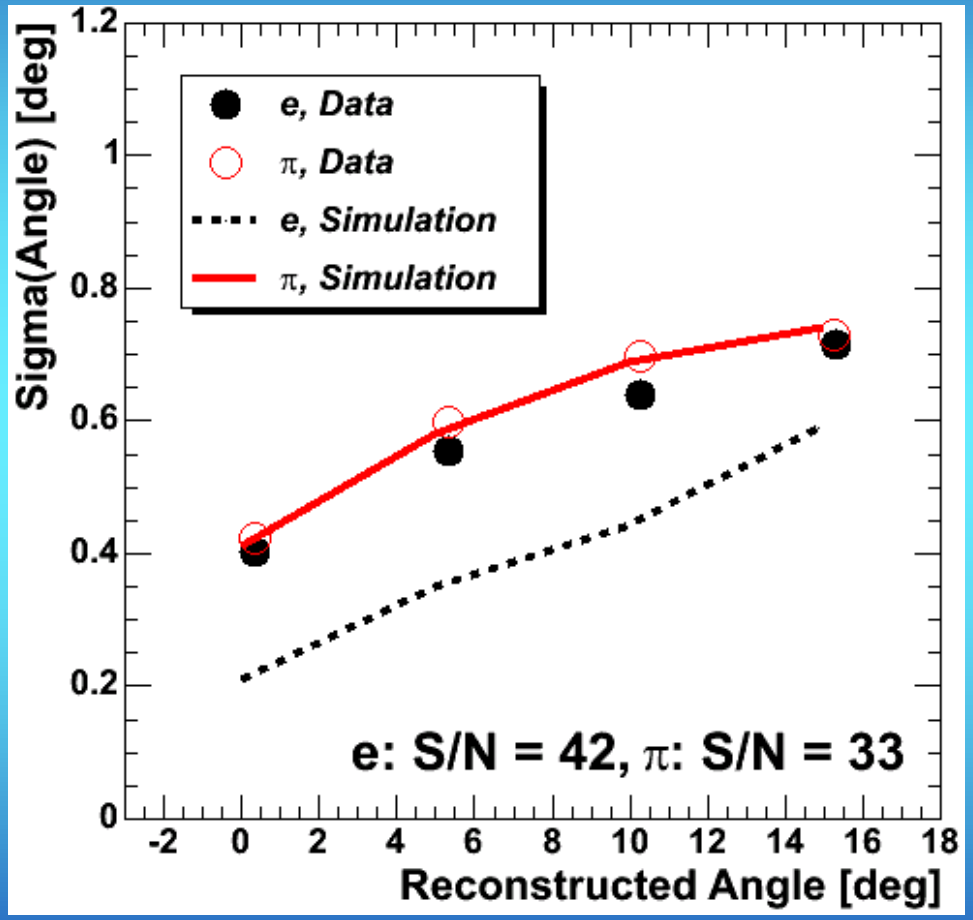


Results 6: Position Resolution vs. Angle

- Nominal gain (4000)
- Requirement met: $\sigma_x \leq 400\mu m$
- Resolution for electrons better due to larger S/N
- Nice agreement with simulation



Results 7: Angular Resolution vs. Angle



- **Requirement met:** $\sigma_\alpha < 1°$
- **For electrons the agreement is not so good**

  $\Rightarrow$

  more investigations

Summary and Outlook

- We have tested prototypes of ALICE TRD chambers.
- The requirements are met. We reach:
  - a position resolution of σ_x=200 - 400μm,
  - an angular resolution of σ_α=0.4 - 0.7° and
  - a pion rejection factor of 100.
- Different systematic effects (Space charge effect, …) are well understood.
- We have measured pure TR spectra for our specific Radiators.
- Outlook:
  - Mass production starts (see talk HK45.9).
  - Testbeam with stack of 6 final fullsize TRD chambers in october at CERN.