Performance of High granularity readout TPC for CEPC TDR

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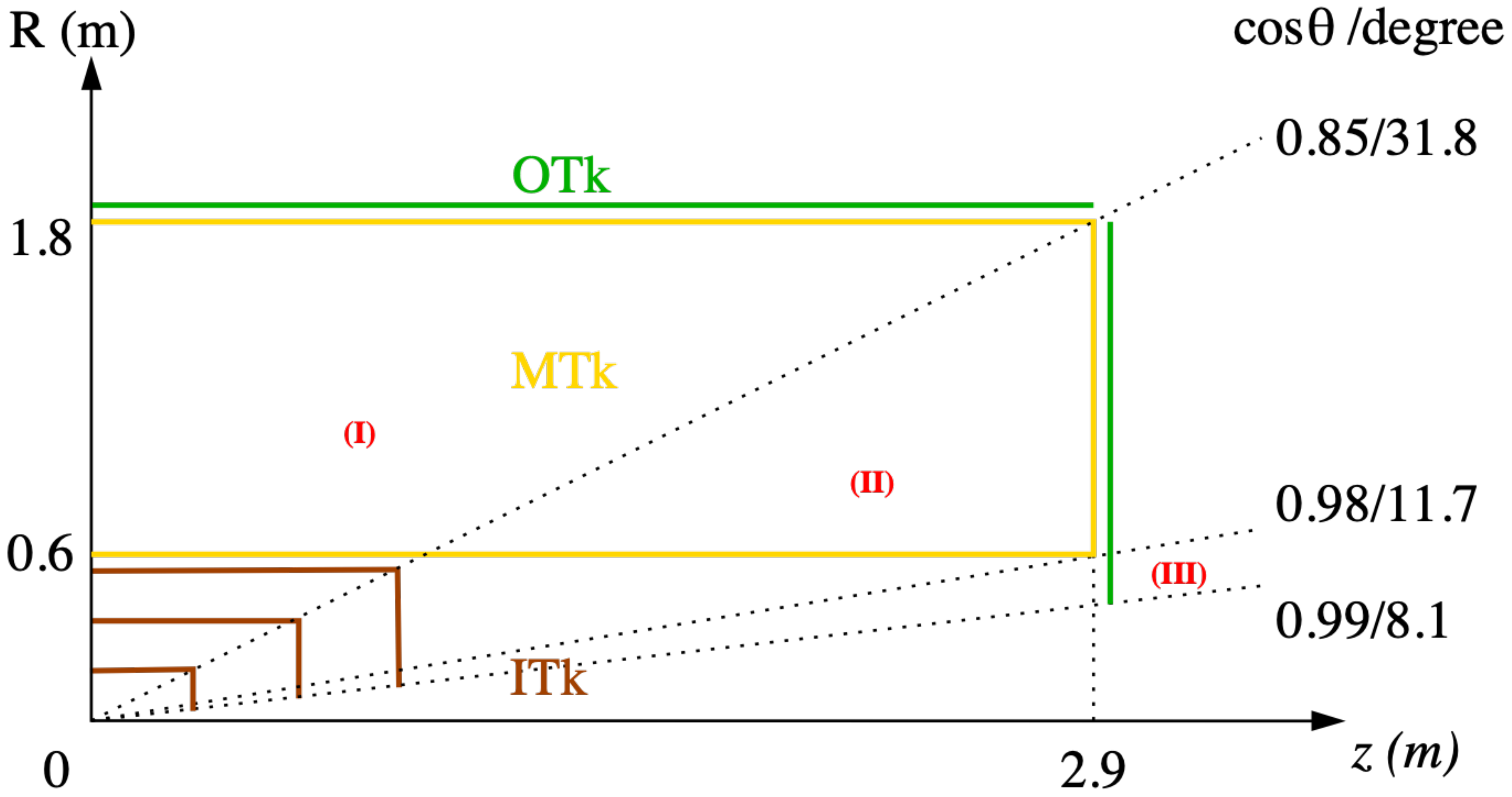
- **High granularity readout TPC as the main track**

Track detector system in CEPC Phy.&Det. TDR

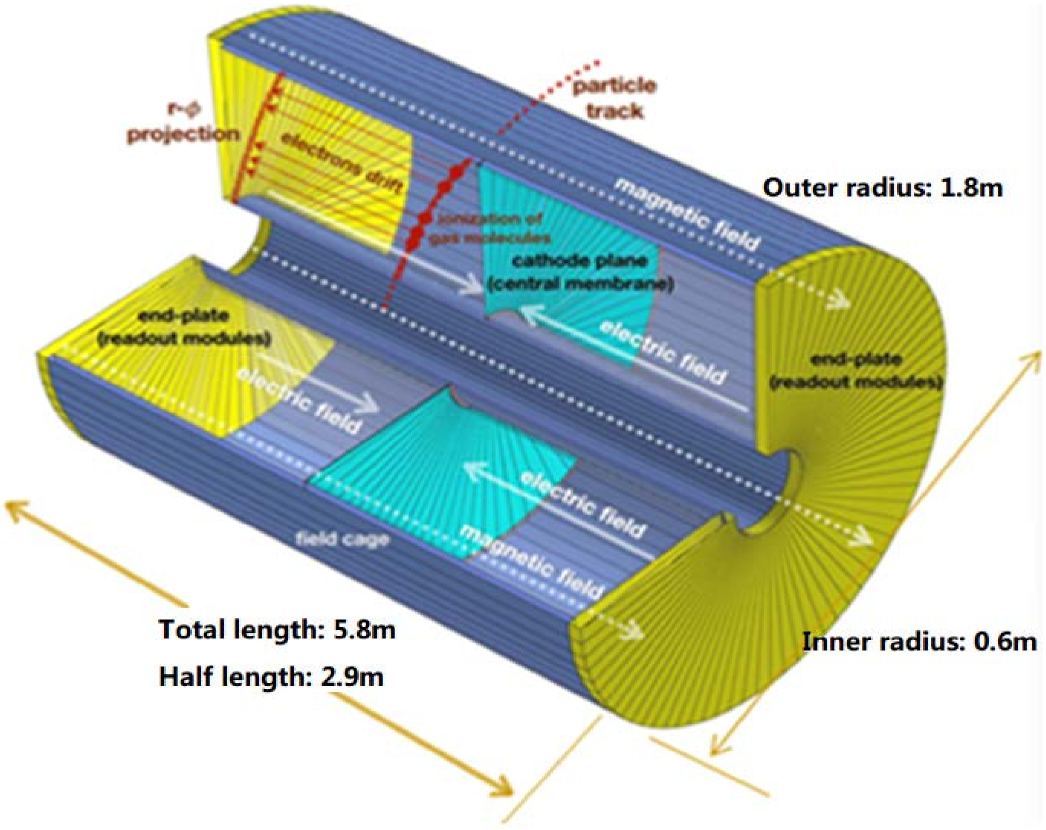
- The track detector system's geometry was finalized.
    - Converging geometries as quickly as possible in preparation for physics simulation
    - Geometry diagram from the slides on Tuesday in this week

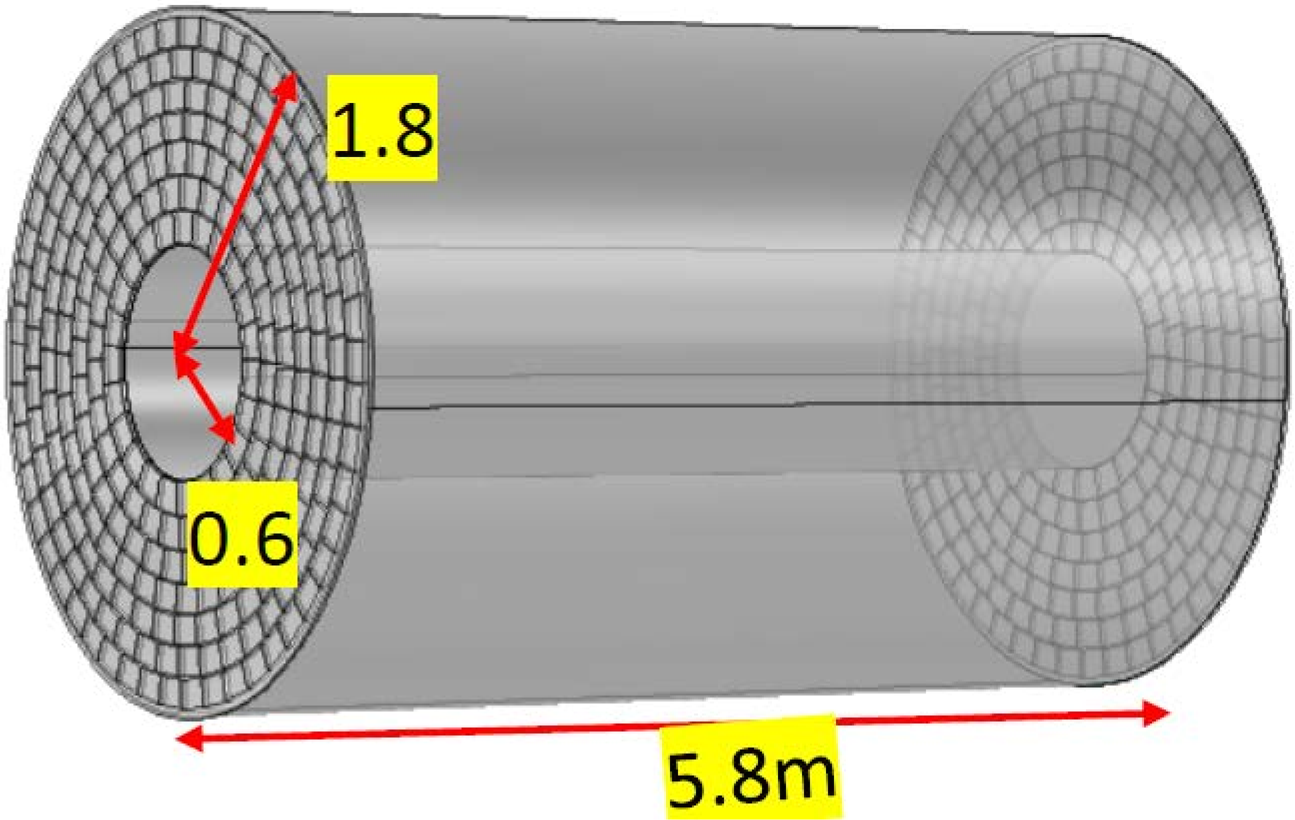


Almost finalized Geometry of the track detector system

TPC detector in CEPC Phy.&Det. TDR

- General geometry of TPC and the optimization modules in endcap
- 3D optimization design on going

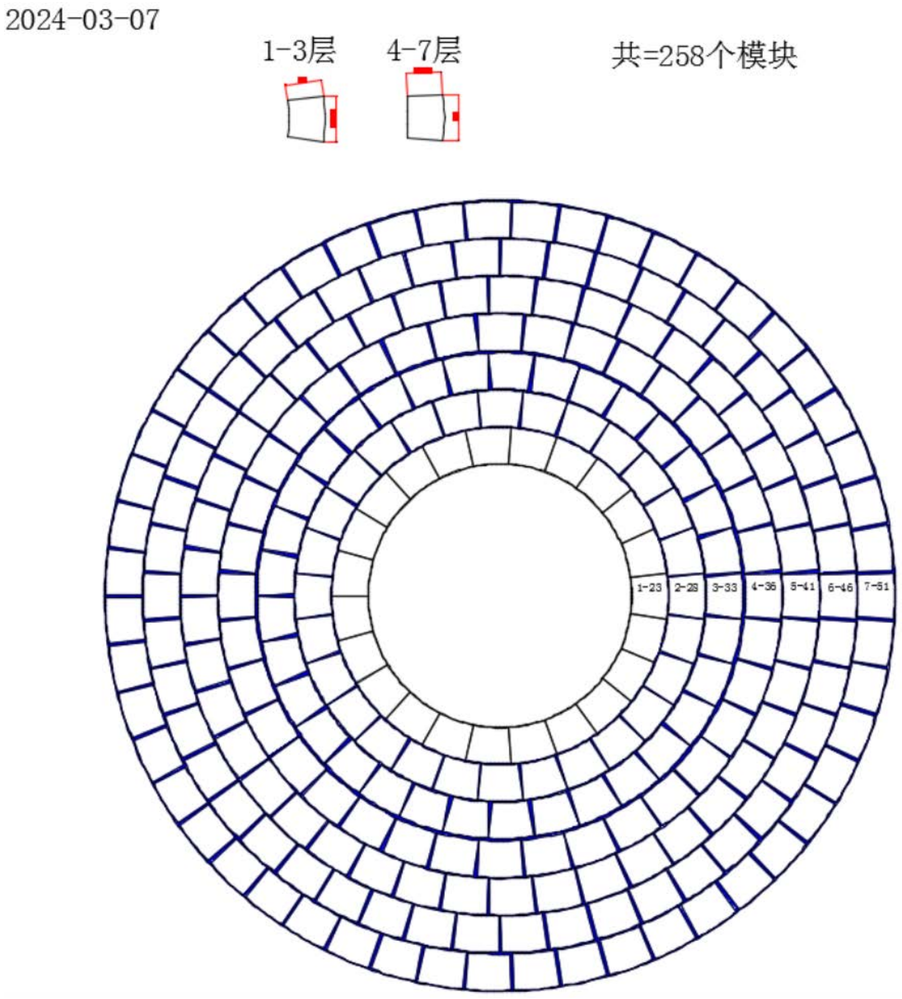


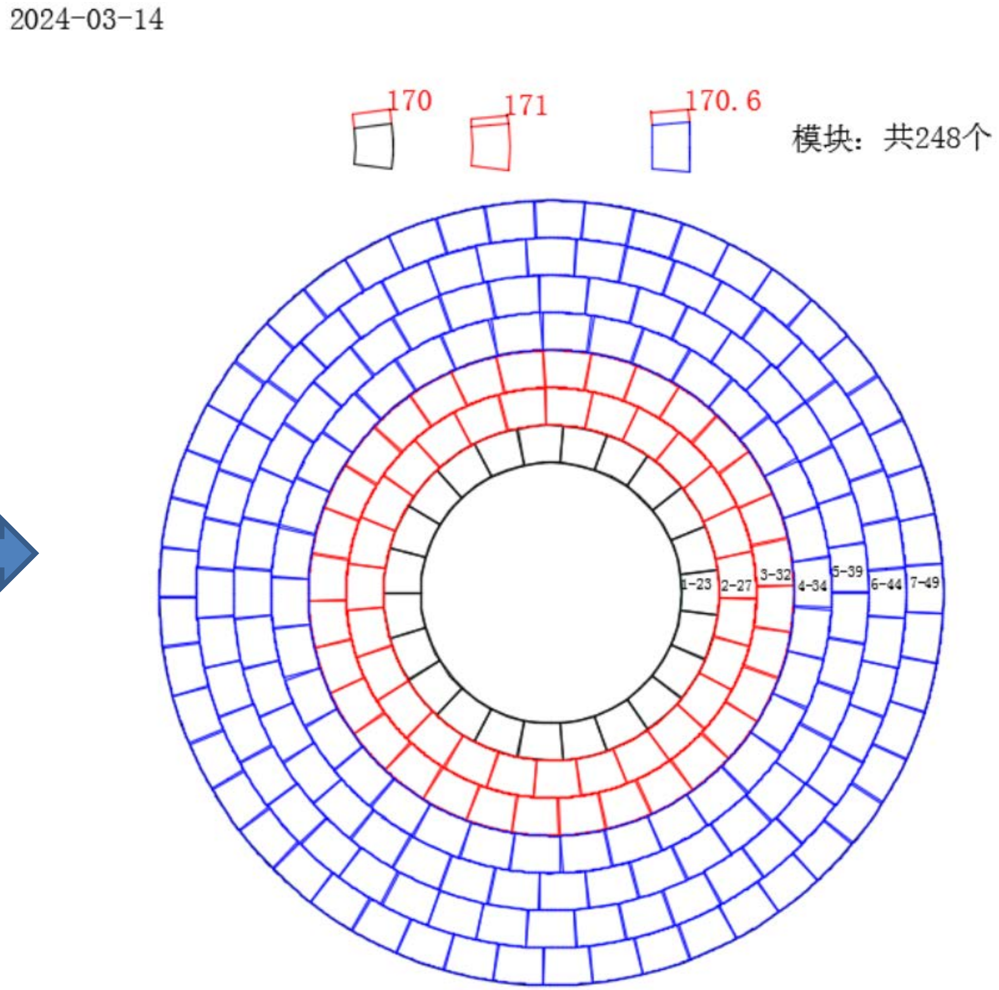


Almost finalized Geometry of TPC detector and the Endplate

TPC detector in CEPC Phy.&Det. TDR

- Optimization modules in the endcap
  - Coverage of the sensitivity readout area from **92% to 96%**





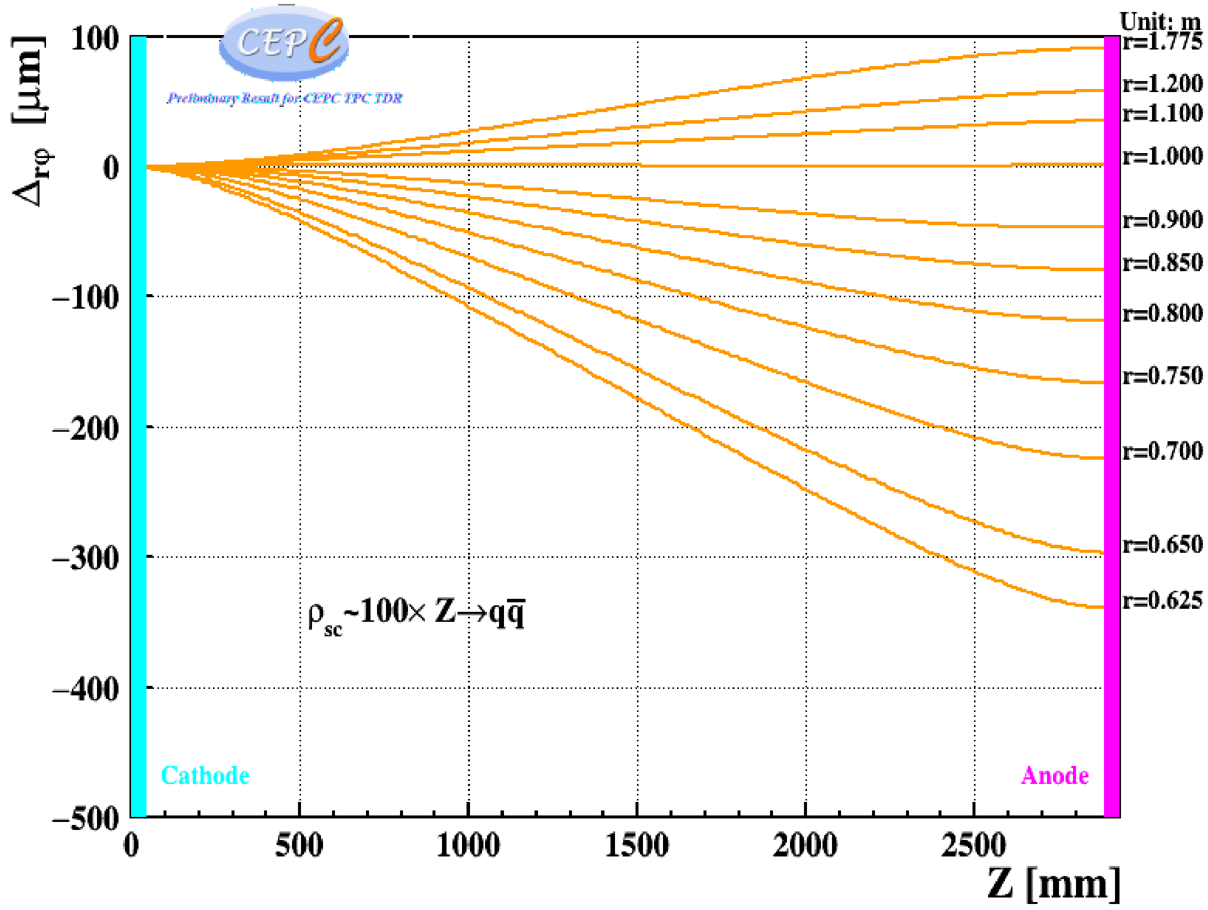
Optimization of Geometry of TPC detector and the Endplate

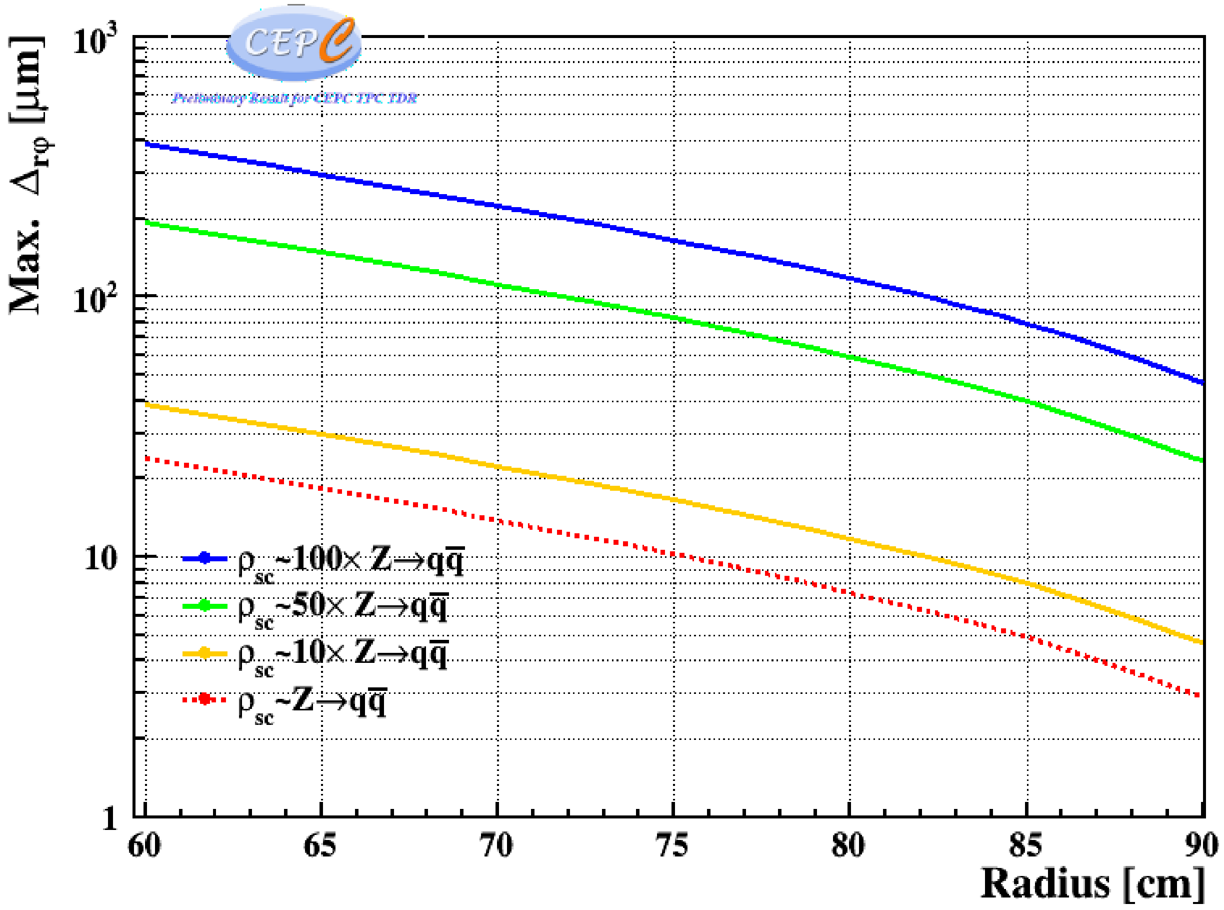
高粒度时间投影室 High granularity readout TPC @cosθ≃0.98

Parameters	Higgs run	Z pole run
B-field	3.0T	2.0T
Pad size (mm)/All channels	0.5mm×0.5mm /2×3×10^7	0.5mm×0.5mm /2×3×10^7
Material budget barrel	0.012 X_0	0.012 X_0
Material budget endcap	0.17 X_0	0.17 X_0
Points per track in rφ	2200	2200
σ_{point} in rφ	100μm (full drift)	400μm (full drift)
σ_{point} in rz	≃ 0.1 – 0.5 mm (for zero – full drift)	≃ 0.2 – 0.8 mm (for zero – full drift)
2-hit separation in rφ	0.5mm	0.5mm
K/π separation power @20GeV	3.1σ	3σ
dE/dx	3.2%	3.2%
Momentum resolution normalised: $\sigma_{1/pT} = \sqrt{a^2 + (b/pT)^2}$	a = 1.21 e -5	a = 2.69 e -5
	b = 0.60 e -3	b = 0.90 e -3

Maxim distortion calculation using new geometry

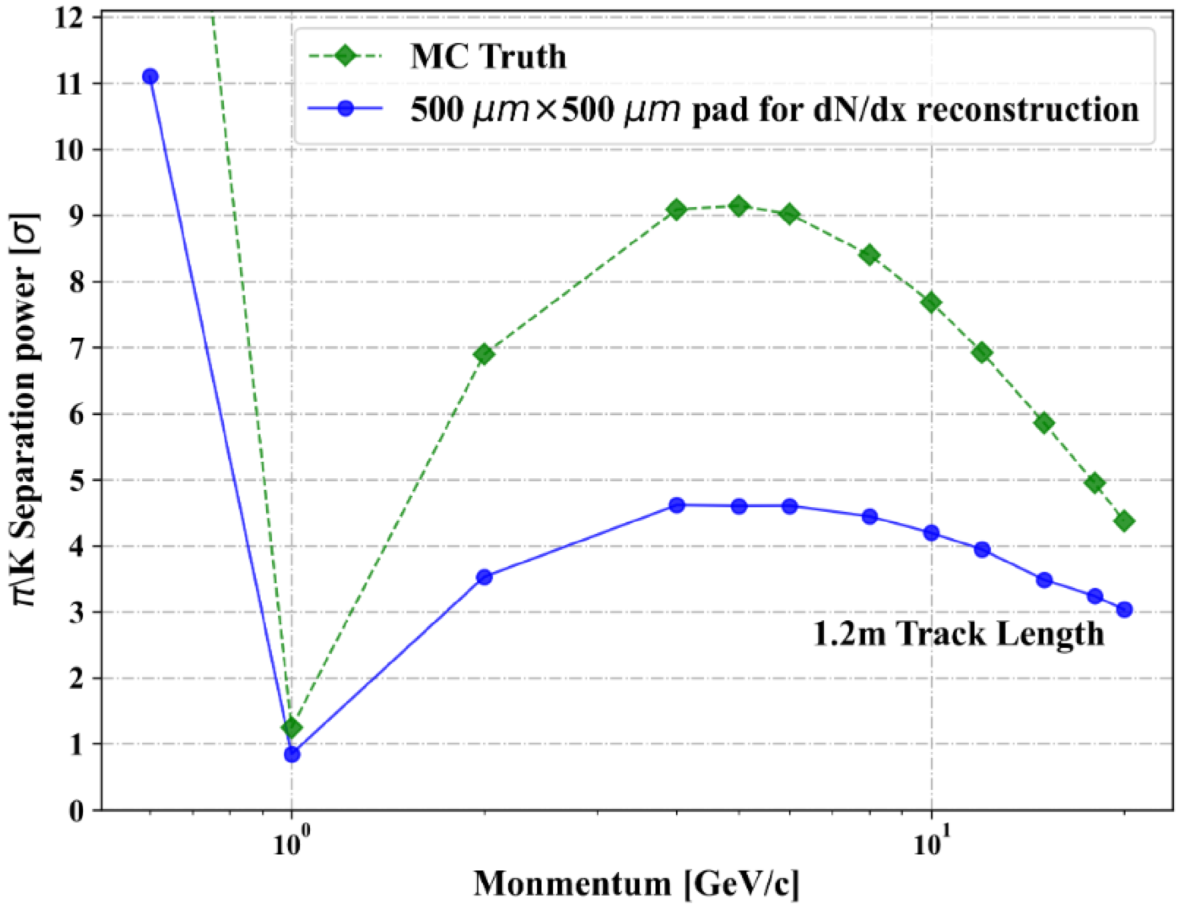
- **Maxim distortion with e+e- to qq at Z pole (物理事例的畸变影响)**
- **Maxim distortion under the different Beamstruggle background (物理事例×10、 ×50、 ×100倍本底的影响)**

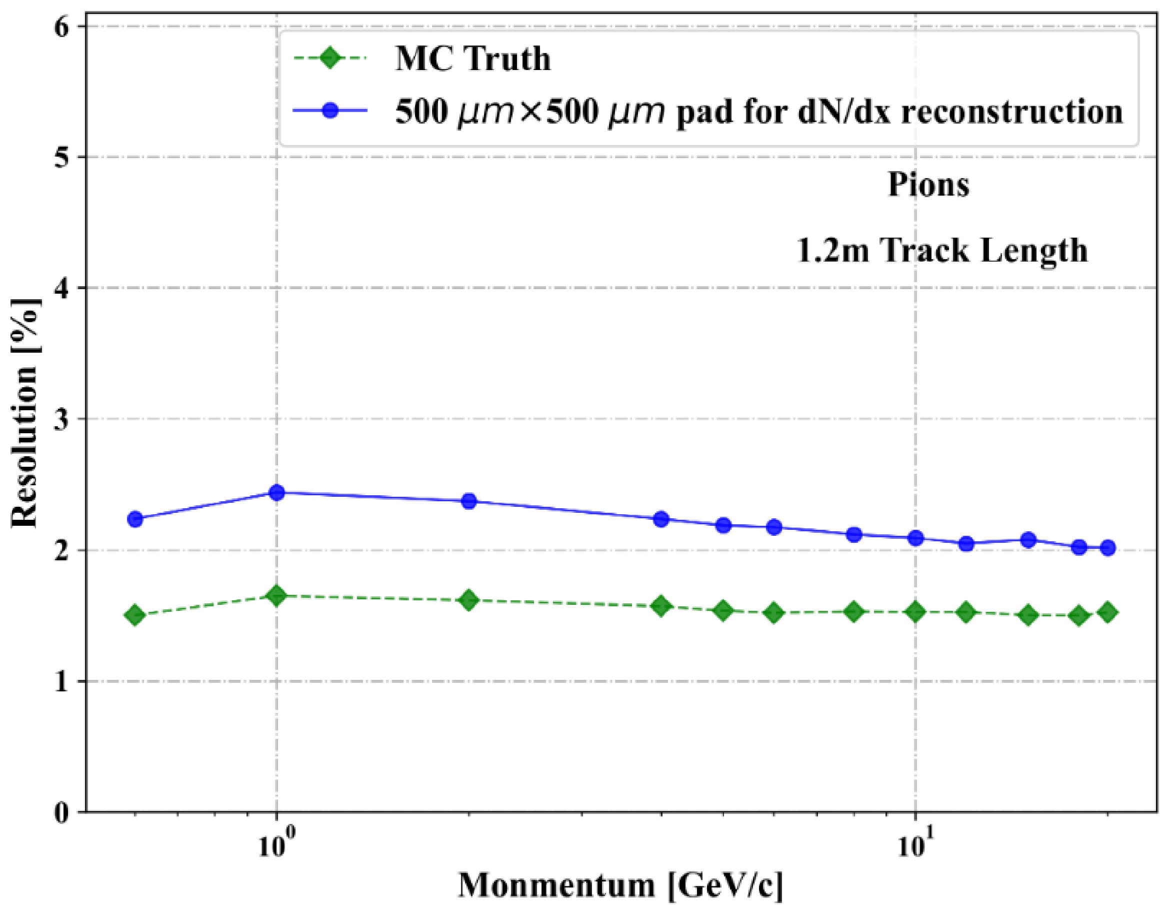




PID Performance using dN/dx

- **Separation power分辨结果**
  - **利用重建的簇团来研究π/K鉴别能力，在20GeV和50cm漂移距离下π/K 分辨能力为3σ**
  - **高粒度读出单元具有提高π/K separation power分辨率的潜力**

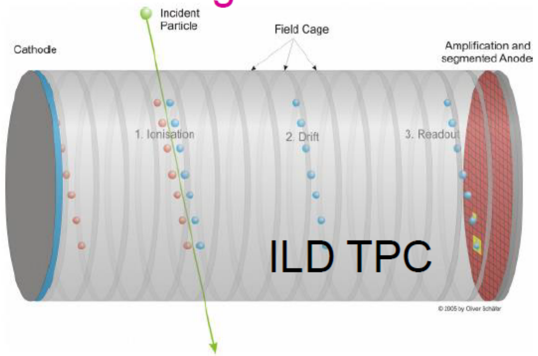




dE/dx + cluster counting

dE/dx is a well-established PID method that comes 'for free' (I exaggerate) in gaseous tracking detector. However, usually limited to < 10 GeV/*c*. One limiting factor is the presence of Landau tails which necessitates using a truncated mean.

This approach being actively pursued by Linear Collider TPC collaboration, who are searching for ways to improve performance, e.g. improving readout granularity



$$\sigma_{dE/dx} \sim L^{-0.47} \times G^{-0.13}$$

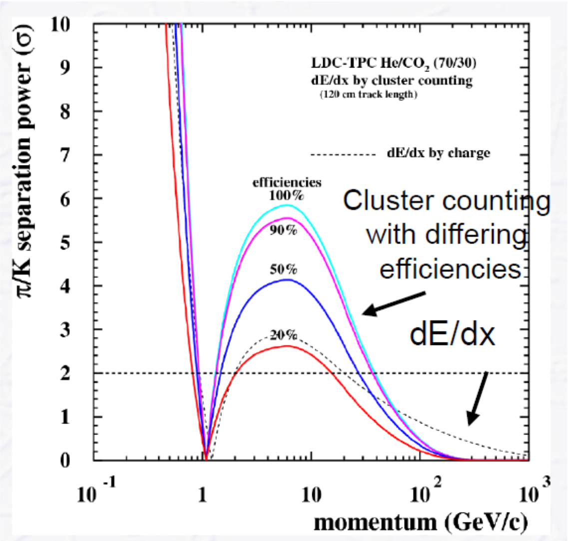
track length — granularity

$$\sigma_E = 0.41\, N_R^{-0.43} (xP)^{-0.32}\,.$$

Various readout solutions pursued:

- GEMs or micromegas with pad-based readout
- Micromegas with pixel-based readout

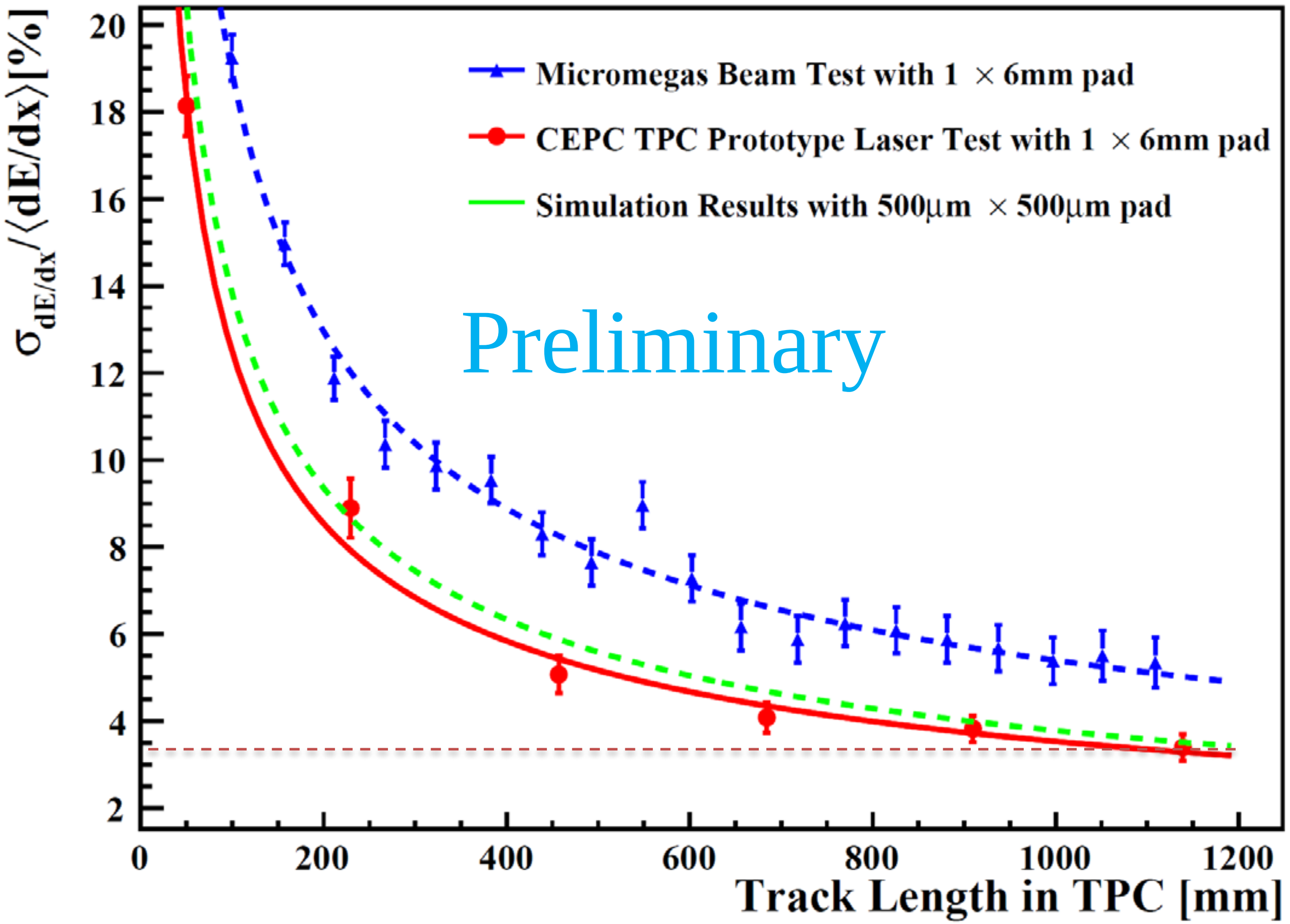
Alternatively count *clusters*, rather than energy, which is less sensitive to Landau tails (here high granularity readout also very helpful).



dE/dx and particle ID performance with cluster counting, M. Hauschild, Valencia, Nov 2006

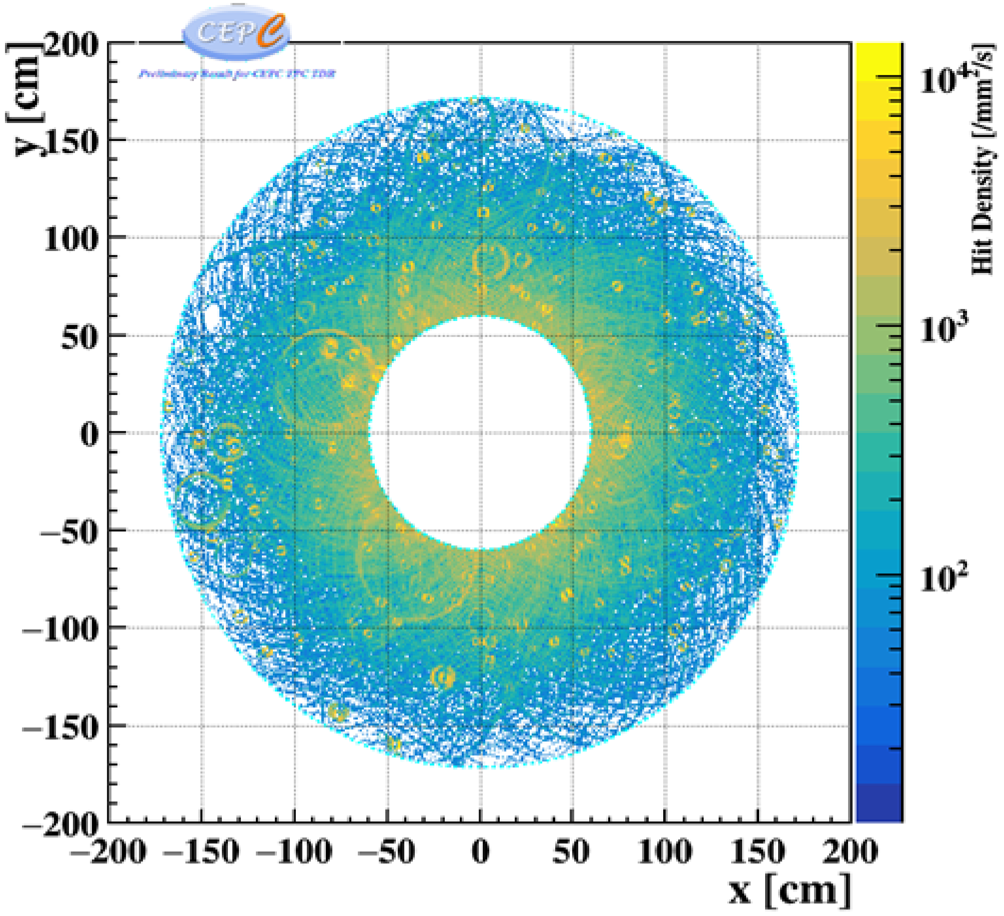
PID Performance using dE/dx

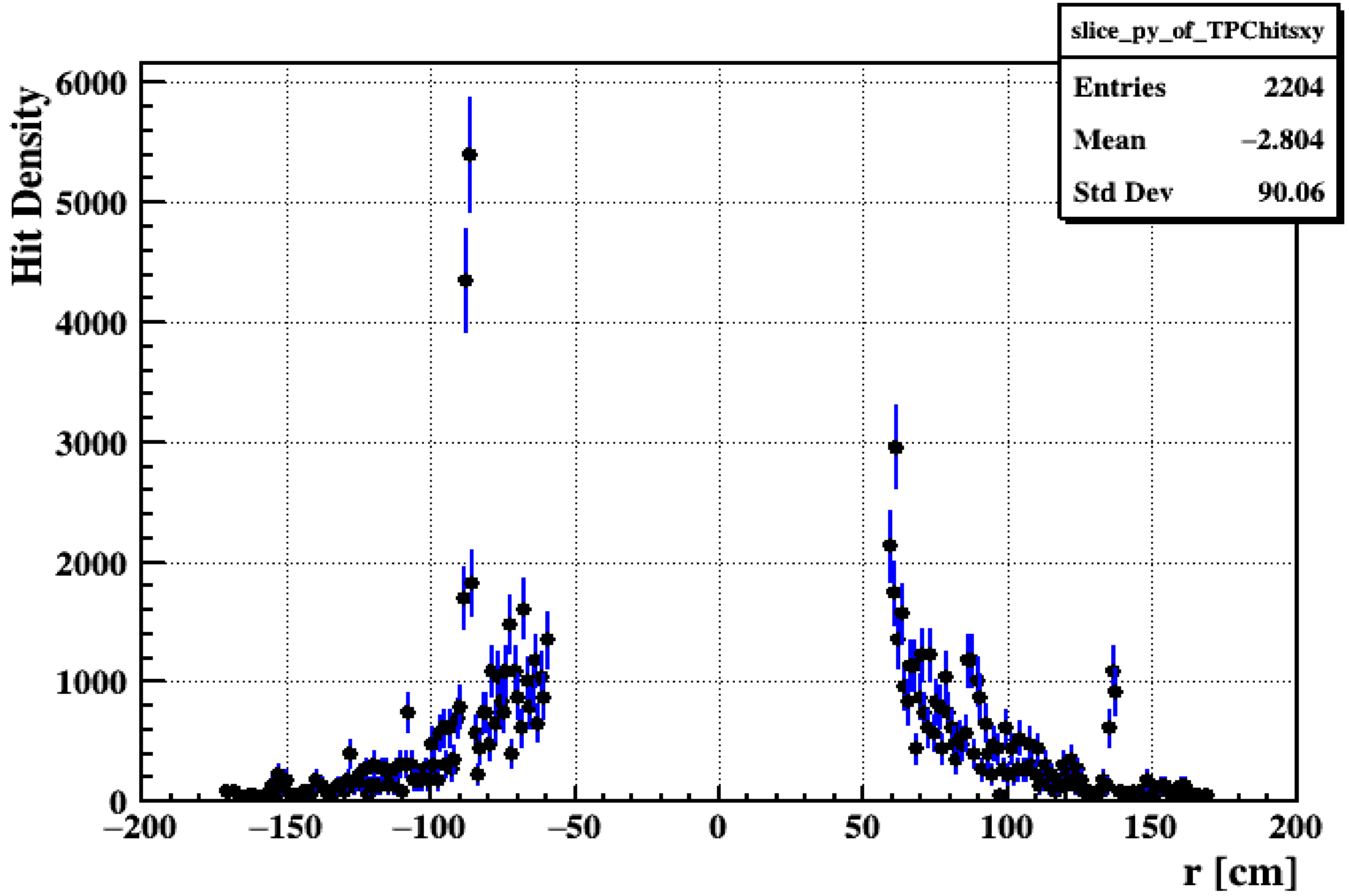
- **dE/dx的粒子鉴别能力结果**
  - **蓝色数据线为Micromegas探测器的束流实验结果**
  - **红色数据线为266nm UV laser测试的接近于本征分辨的实验结果**
  - **绿色数据线为500μm×500μm读出单元模拟结果**



Hit density at the inner radius at Z pole 2T

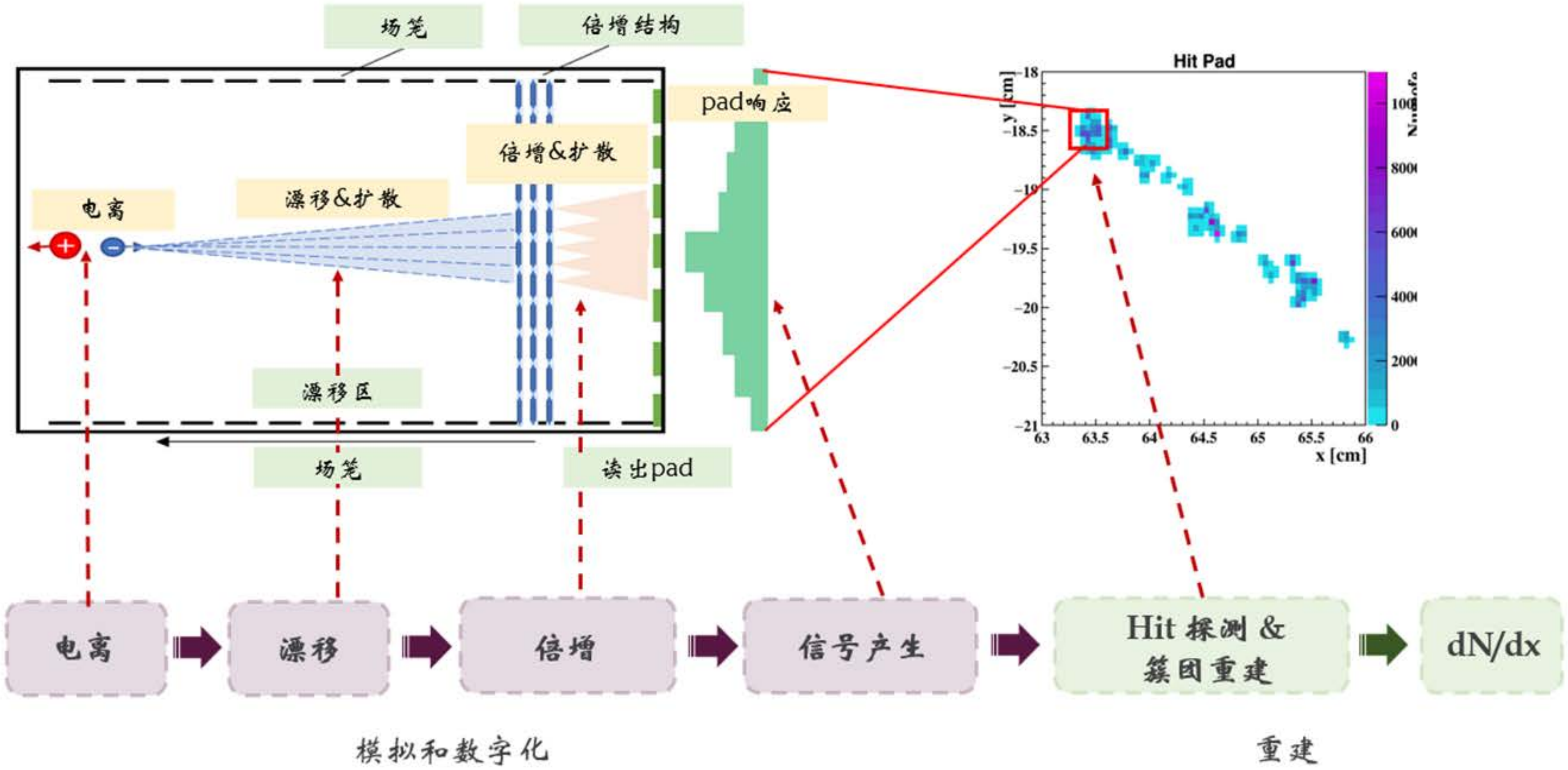
- **Inner radius (0.6m)**
  - **全模拟下的Hit density结果，由于3T → 2T的磁场变化，有出现打圈的低动量径迹可能性**

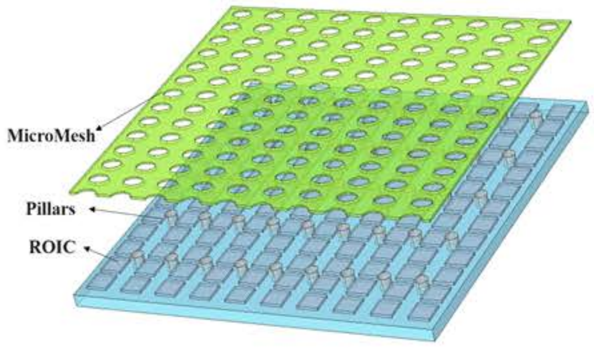




像素型TPC模拟优化软件框架

- 自主搭建了像素型TPC全模拟软件框架
- 成功实现径迹上簇团信息、Hit信息的获取以及径迹的在线显示
- 完成了径迹重建及分析





像素型读出结构