Tracker for CEPC reference detector TDR

WANG Meng 王萌

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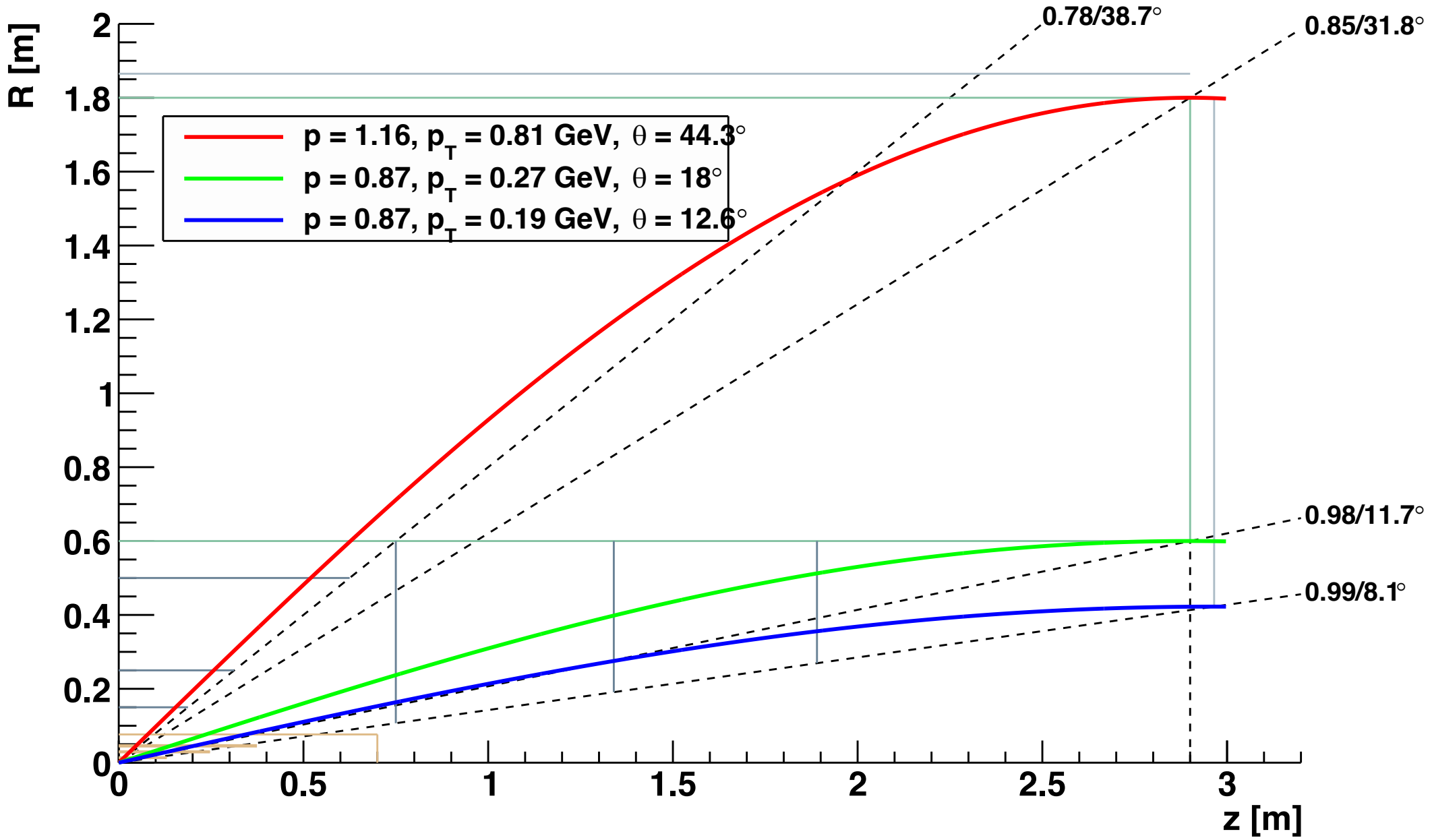
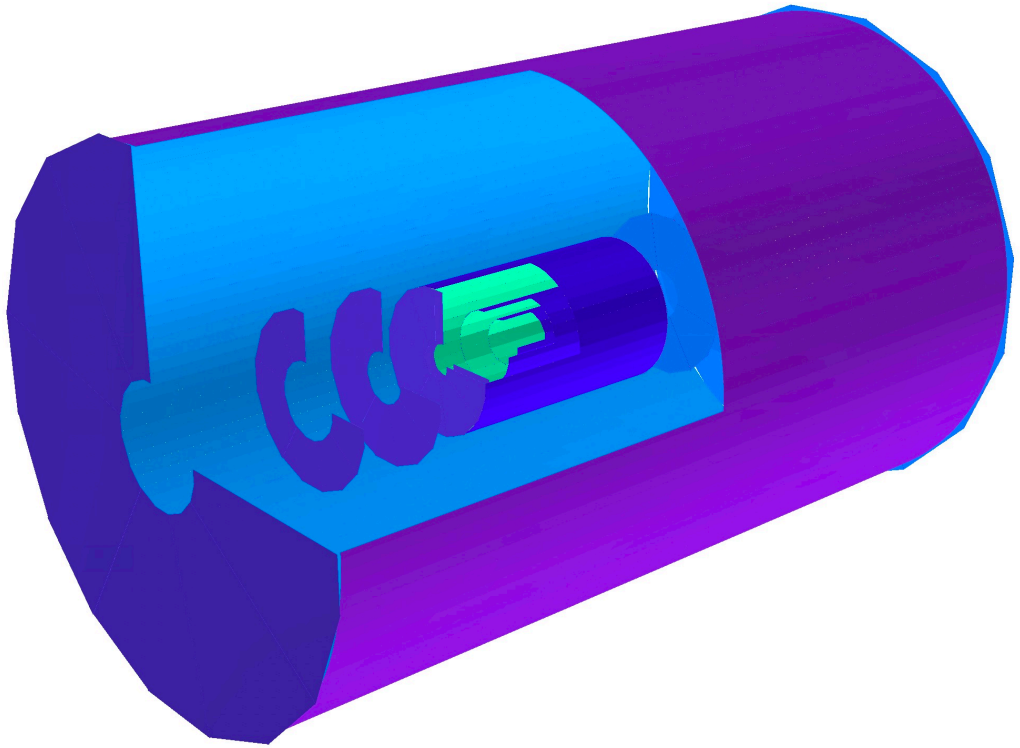
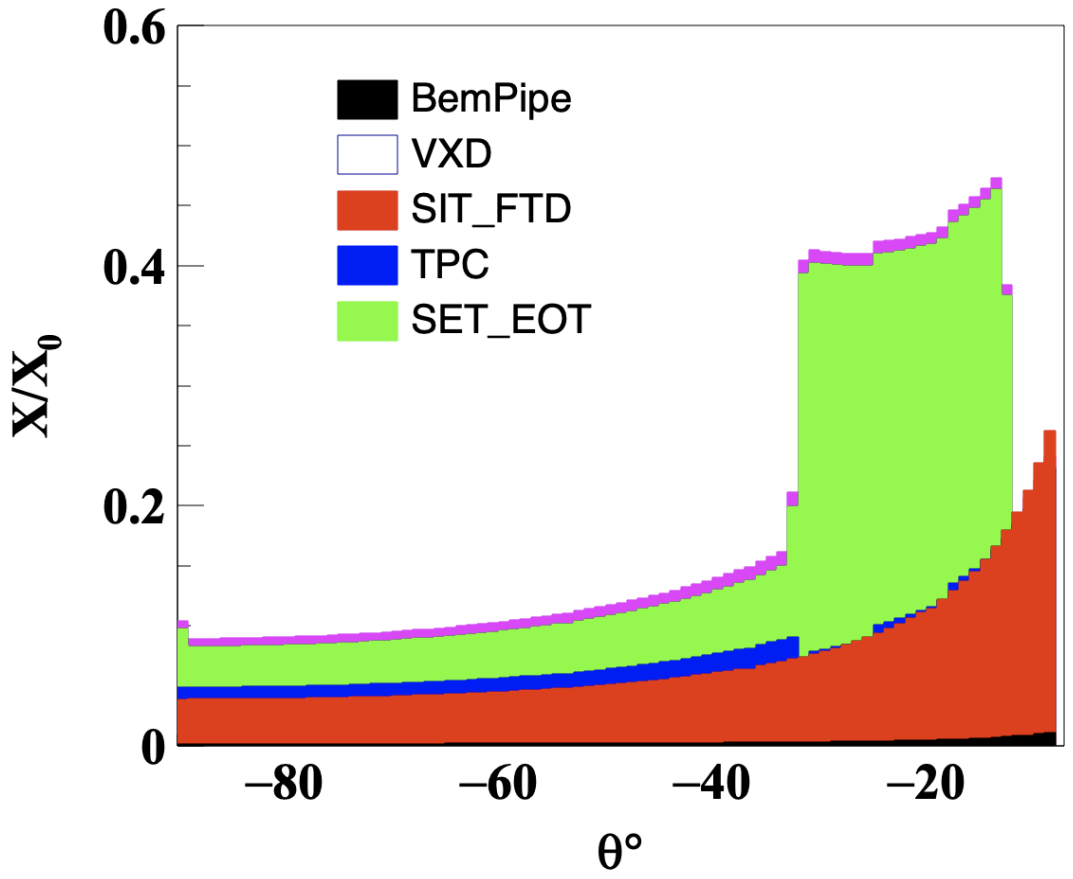
optimisation strategy and procedure

- strategy
  - 桶部 (Barrel-ITK, BITK) 和端盖 (Endcap-ITK, EITK) 先分别独立优化，再合并优化。
  - 针对动量测量精度和径迹重建效率优化，当测量精度的差别在可接受范围内（比如 < 1‰）时，选择效率最佳的。
  - 先优化几何排布 (layout)，再优化探测器的性能参数，即单点测量的空间分辨率 (σ_φ, σ_z for barrel, σ_R for endcap) 和物质量
  - 先分别针对Higgs和Z-pole取数优化，当差异较大时，再考虑折衷方案（比如Higgs优先？）
- procedure (Higgs and Z-pole respectively)
  1. 初始几何和性能参数：固定顶点探测器 (VTX) 和外径迹室 (BOTK, EOTK)，BITK和EITK以某个极角分界，考虑VTX的几何边界
  2. 分别优化桶部和端盖的层数与位置，层数从1层开始，4或5层为止
  3. 获得两者的优化排布后，扫描 (pT, θ)，检查结果，并做全模拟 (full simulation) 验证
  4. 优化分界线的极角
  5. 优化空间分辨率参数
  6. *重复以上步骤直到收敛*
  7. 用全模拟做一个端盖倾角的对比

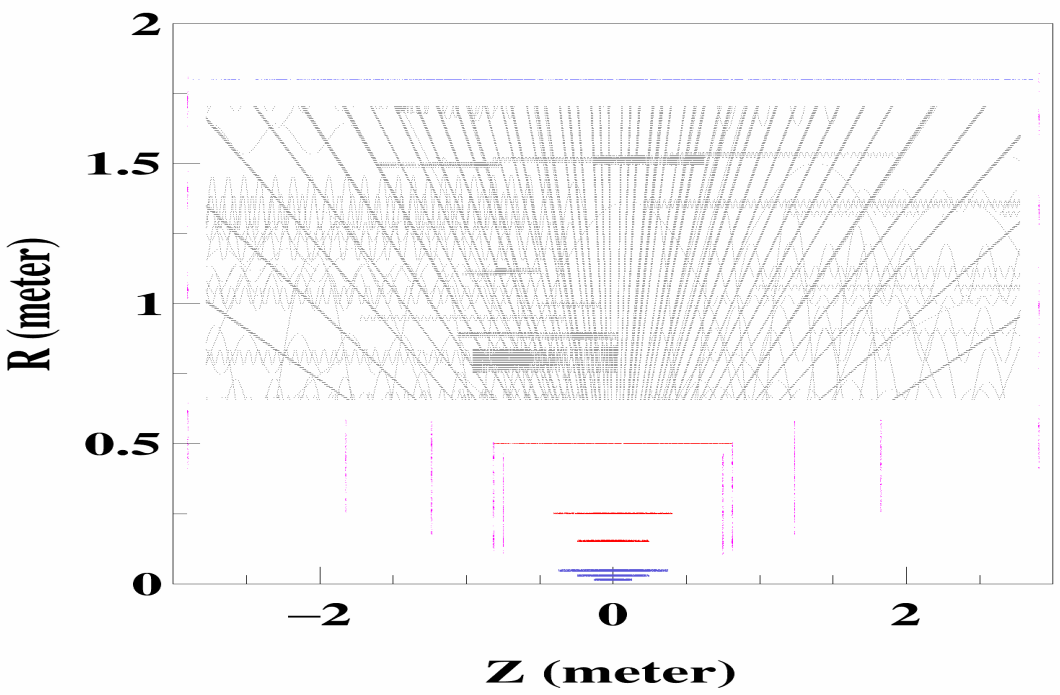

R [m]
z [m]
p = 1.16, p_T = 0.81 GeV, θ = 44.3°
p = 0.87, p_T = 0.27 GeV, θ = 18°
p = 0.87, p_T = 0.19 GeV, θ = 12.6°
0.78/38.7°
0.85/31.8°
0.98/11.7°
0.99/8.1°
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0.5
1.5
2.5
3

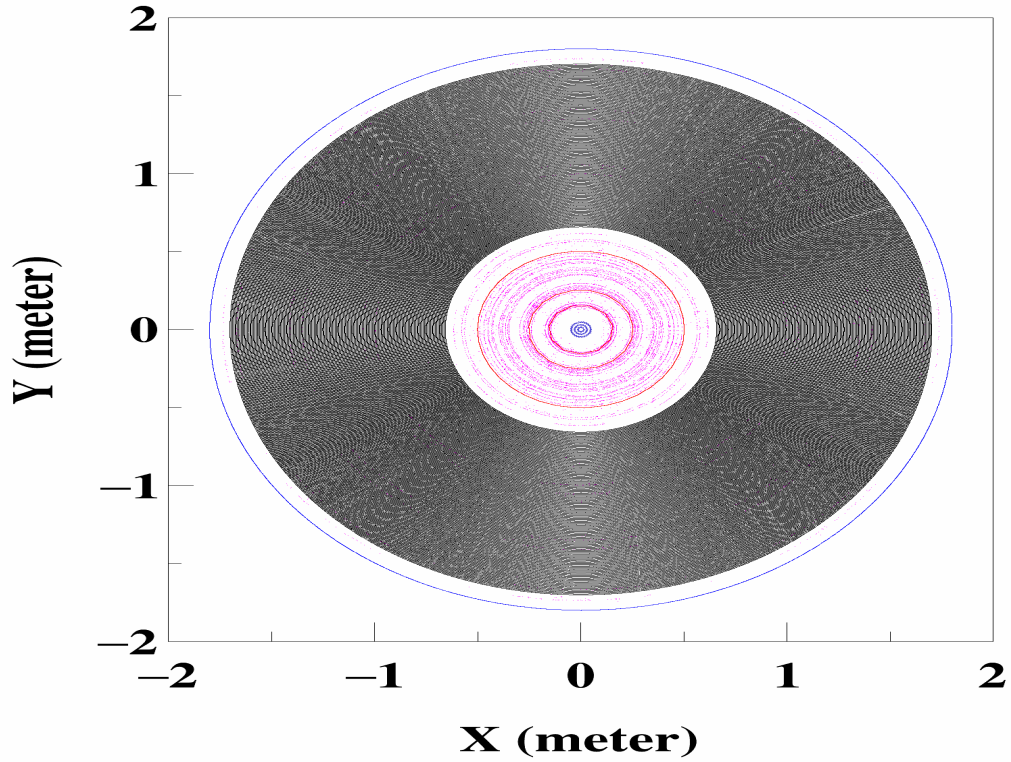
Full simulation tools ready: TDT_o1_v01



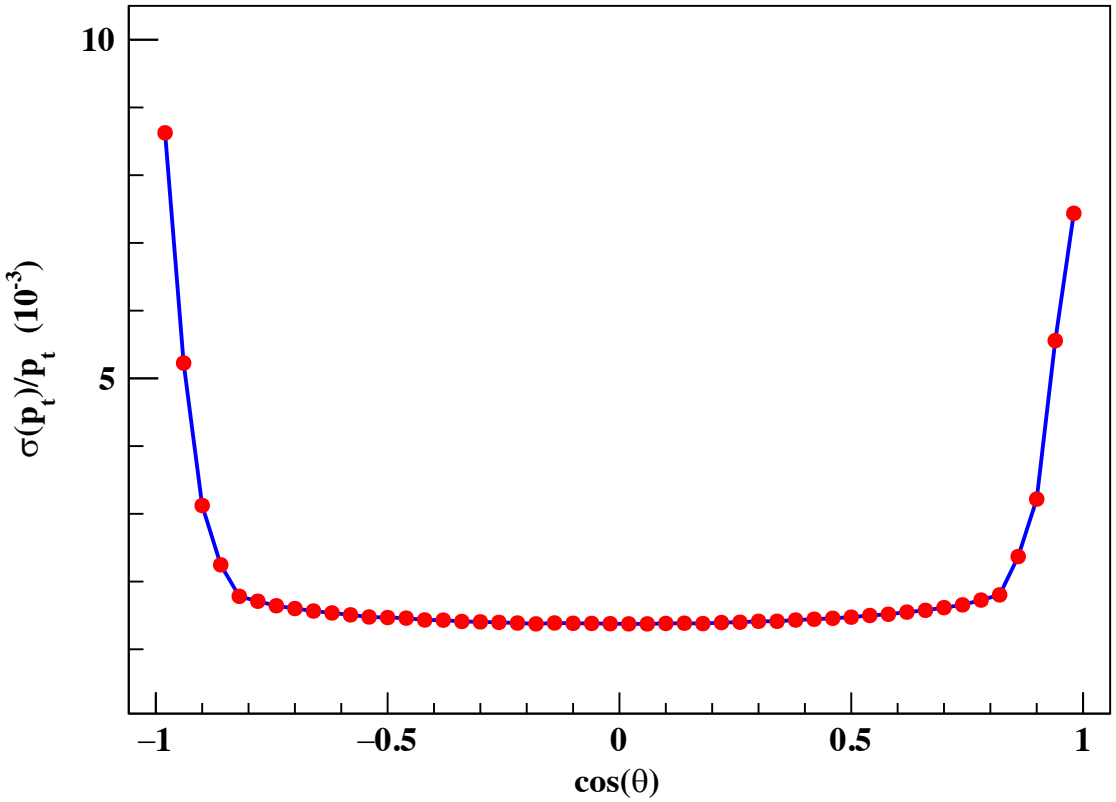


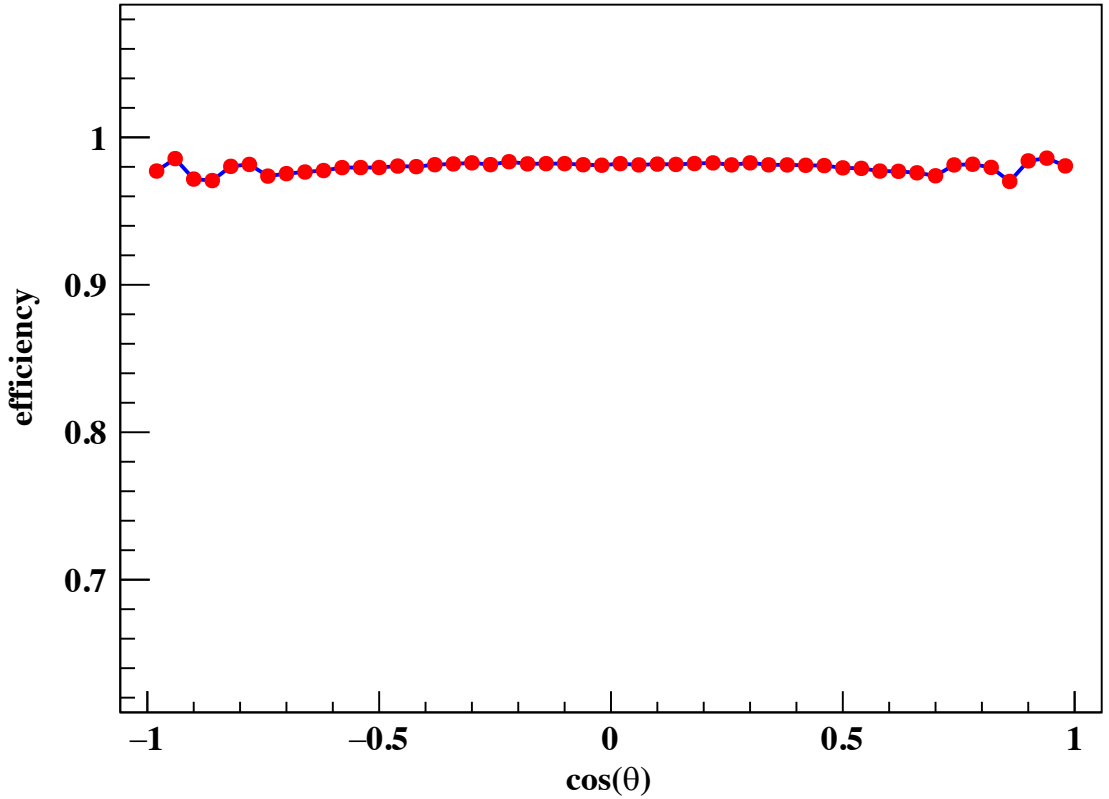
Hit maps: longitudinal and transverse





tracking precision and efficiency



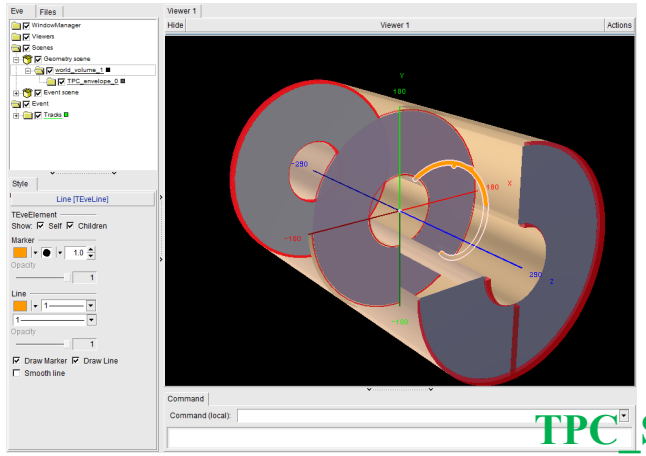


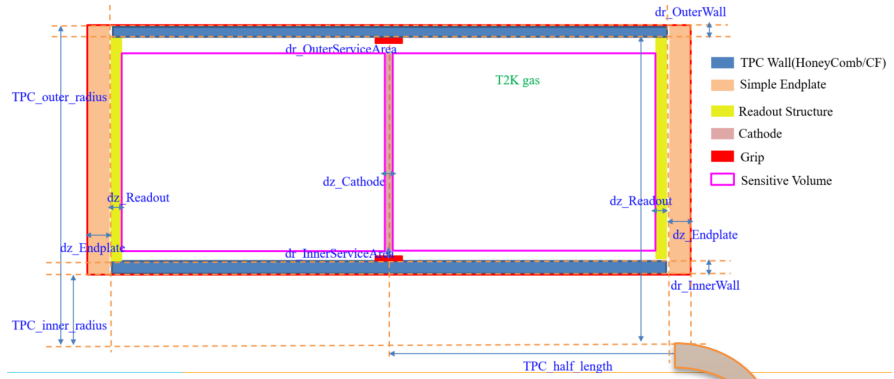
pt = 5 GeV muons

Update TPC parameters to CEPCSW software package

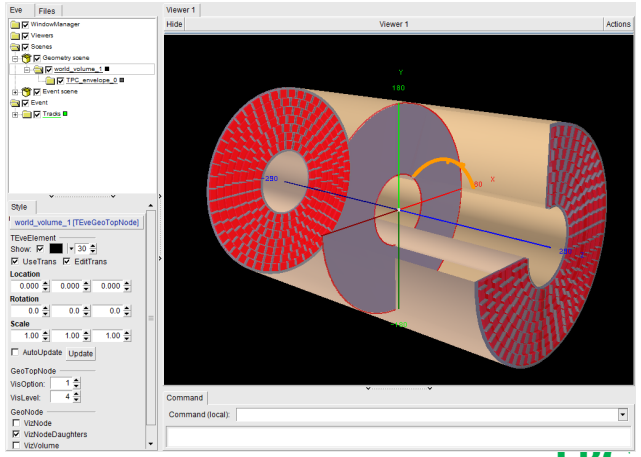
Xin She

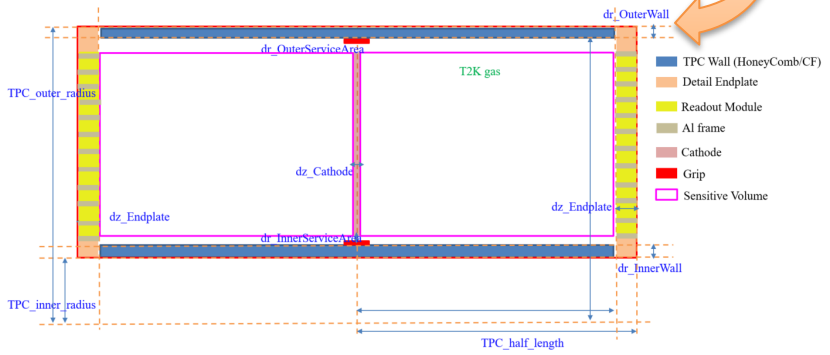
- All parameters of pixel TPC detector **completed** to input CEPCSW software package.
  - Based on the update geometry of TPC as the track detector in CEPC TDR
  - Updated parameters have been integrated in CEPCSW





TPC_Simple_TDR_o1-v01





TPC_ModularEndcap_TDR_o1-v01

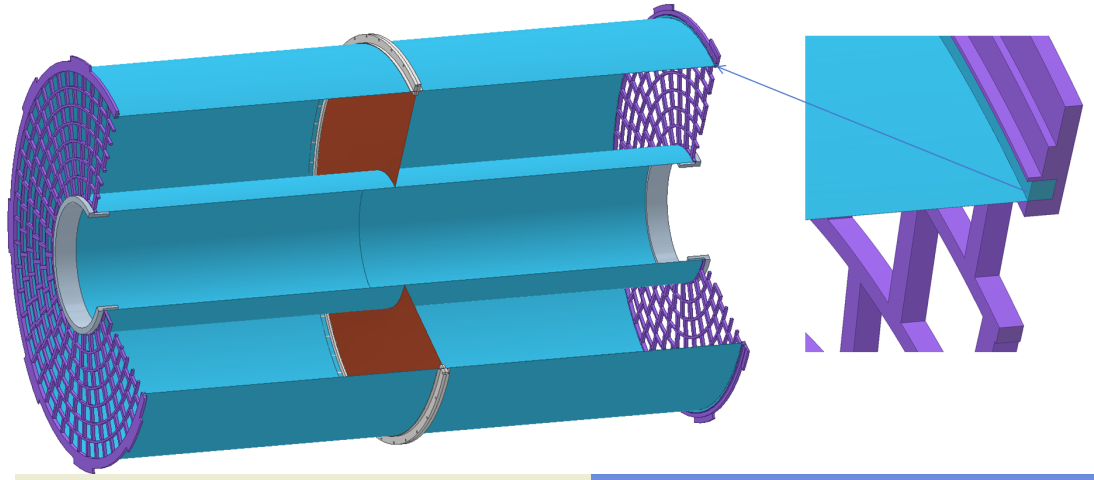
TPC parameters updated to CEPCSW

- Gas Volume: T2K mixture gases
- MPGD Readout: Micromegas detector
- Barrel: Honey comb and CF options
- Endplate: optimization to the details design
- Mechanics: update geometry

Optimization of TPC barrel : Carbon Fiber

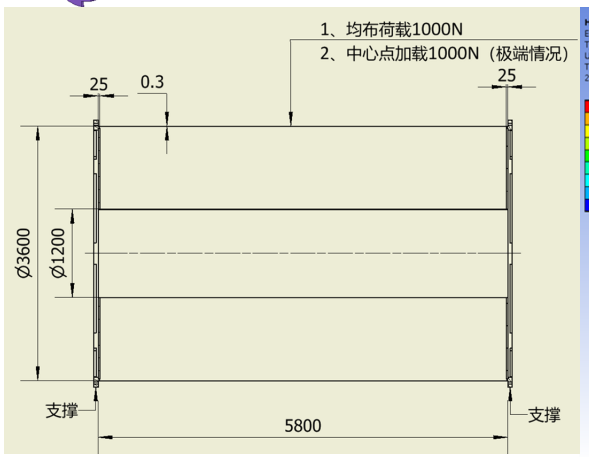
- Consideration of new Carbon Fiber barrel instead of the honeycomb barrel
- **Ultra-light material** of the TPC barrel : **0.63% X_0 in total, including**
  - FEA preliminary calculation: 0.2mm carbon fibber barrel can tolerant of LGAD OTK (**100Kg**)
- Optimization of the connection back frame of the endcap (on going)

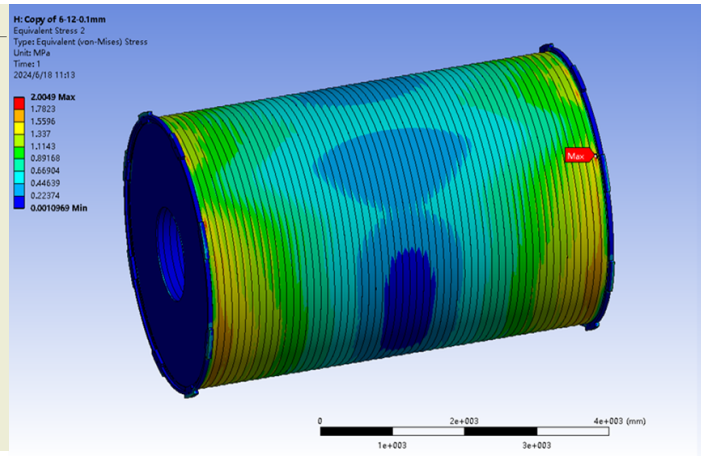
Junsong Zhang

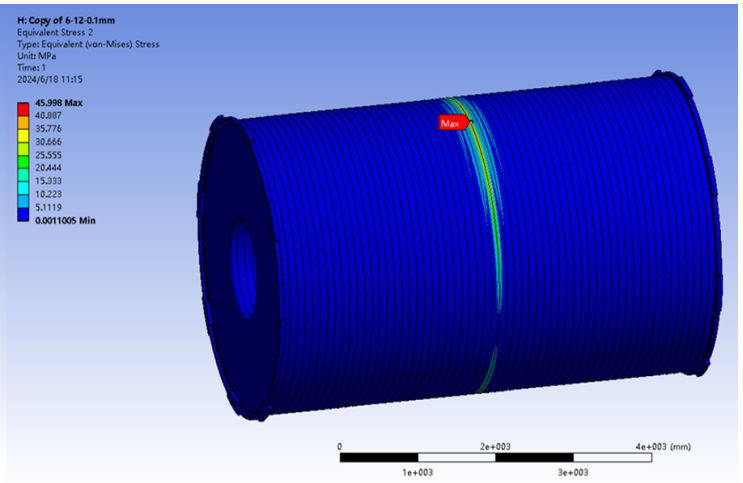


Material budget of TPC barrel

Layer of the barrels	D[cm]	X_0[cm]	d/X_0[%]
Copper shielding	0.001	1.45	0.07
CF outer barrel	0.020	25.28	0.08
Mirror strips	0.003	1.35	0.19
Polyimide substrate	0.005	32.65	0.02
Field strips	0.003	1.35	0.19
CF inner barrel	0.020	25.28	0.08
Sum of the material budget			**0.63**

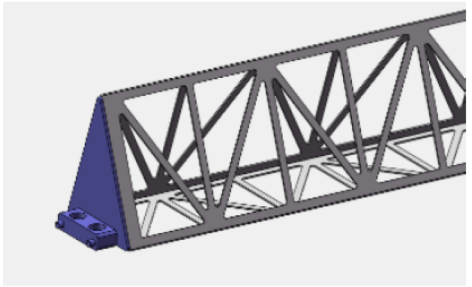


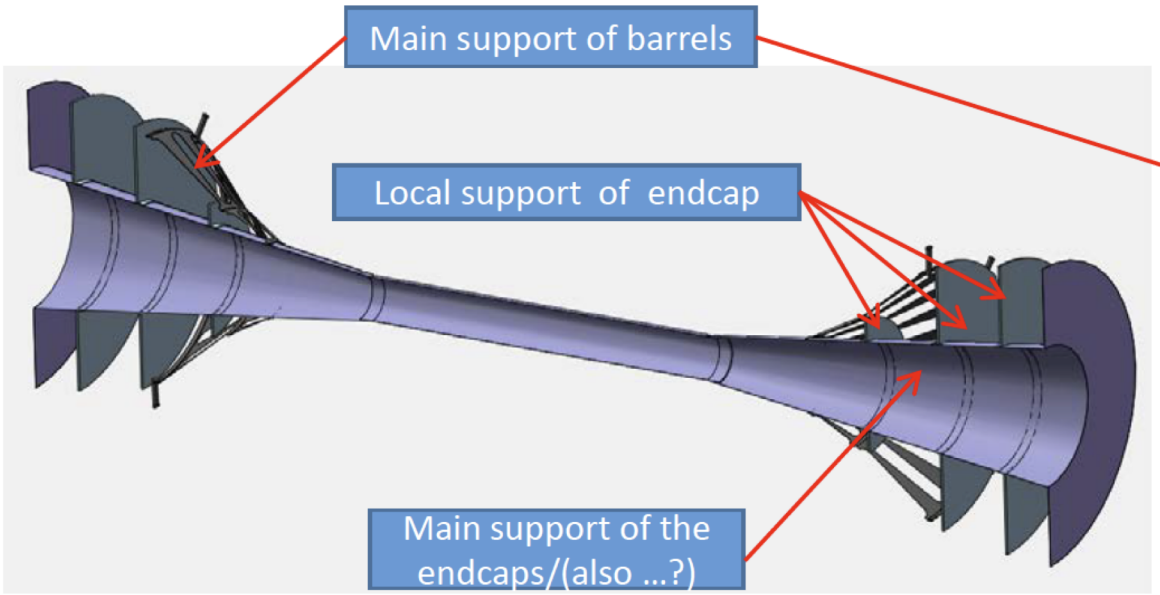


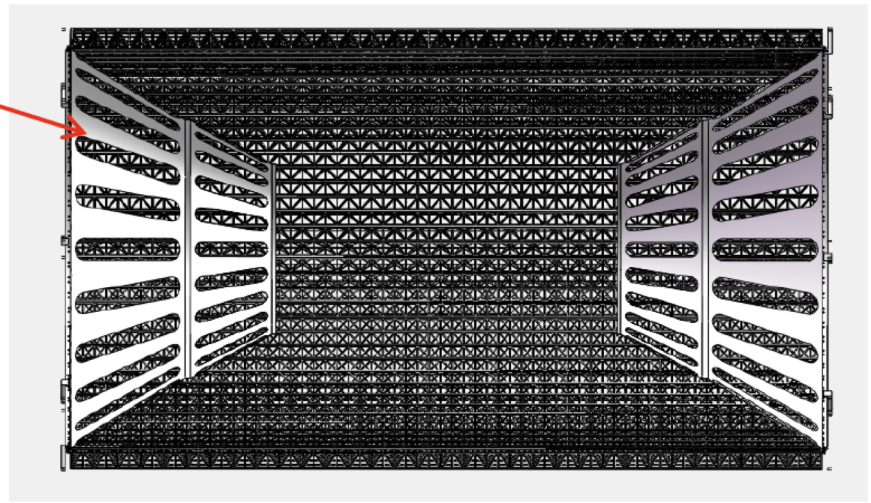


ITk: preliminary support scheme

Local support:
Barrels stave - truss structure
Endcaps - flat ring







Requirements on the z resolution in barrel trackers

Is 20 cm SET strip acceptable?

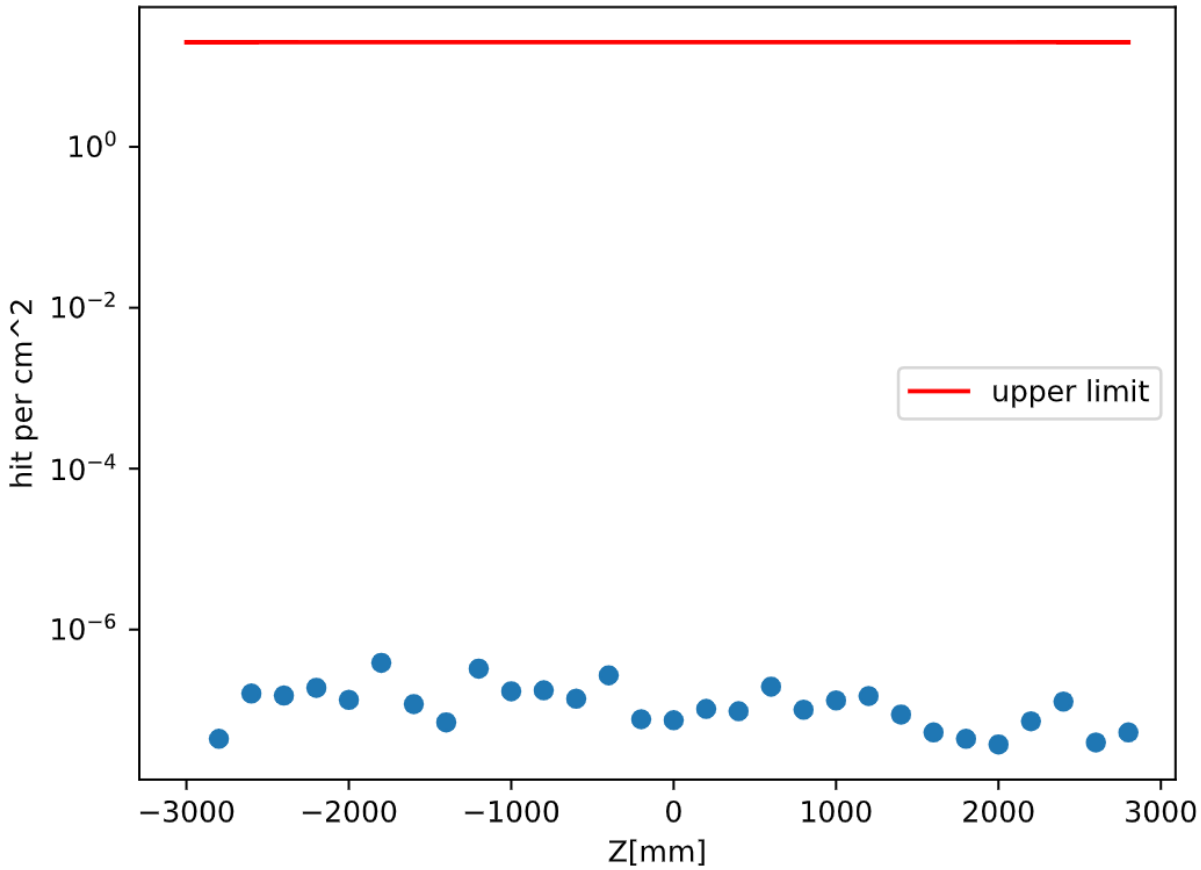
- z resolution slightly influence performance
- only limited by the occupancy of the strip

Configuration

- OTk z_{length} = 20 cm (10cm * 20cm sensor)
- Rφ_{pitch} = 25 μm
- Signal Events: Z->bb
- Only tracker (with TPC), no Ecal

Conclusion:

20cm strip length is acceptable for signal events.
Signal hit rate on Barrel: 11 hit s^{-1} cm^{-2}



hit rate within 50ns

Thank you for attention!