



中國科學院高能物理研究所
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Status of CEPC ref-TDR Chapter06

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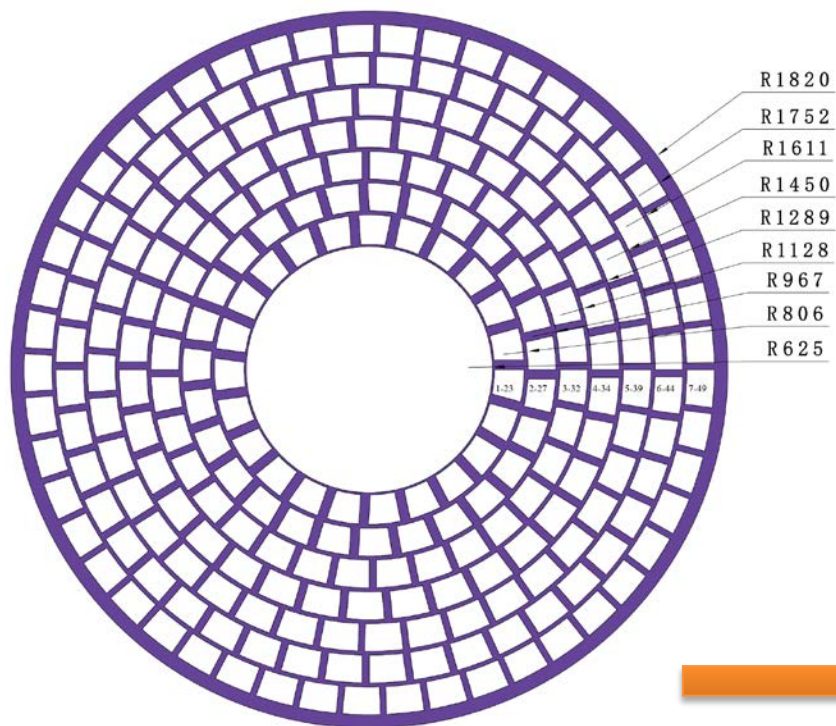
On behalf of the gaseous tracker group

07 January, 2025

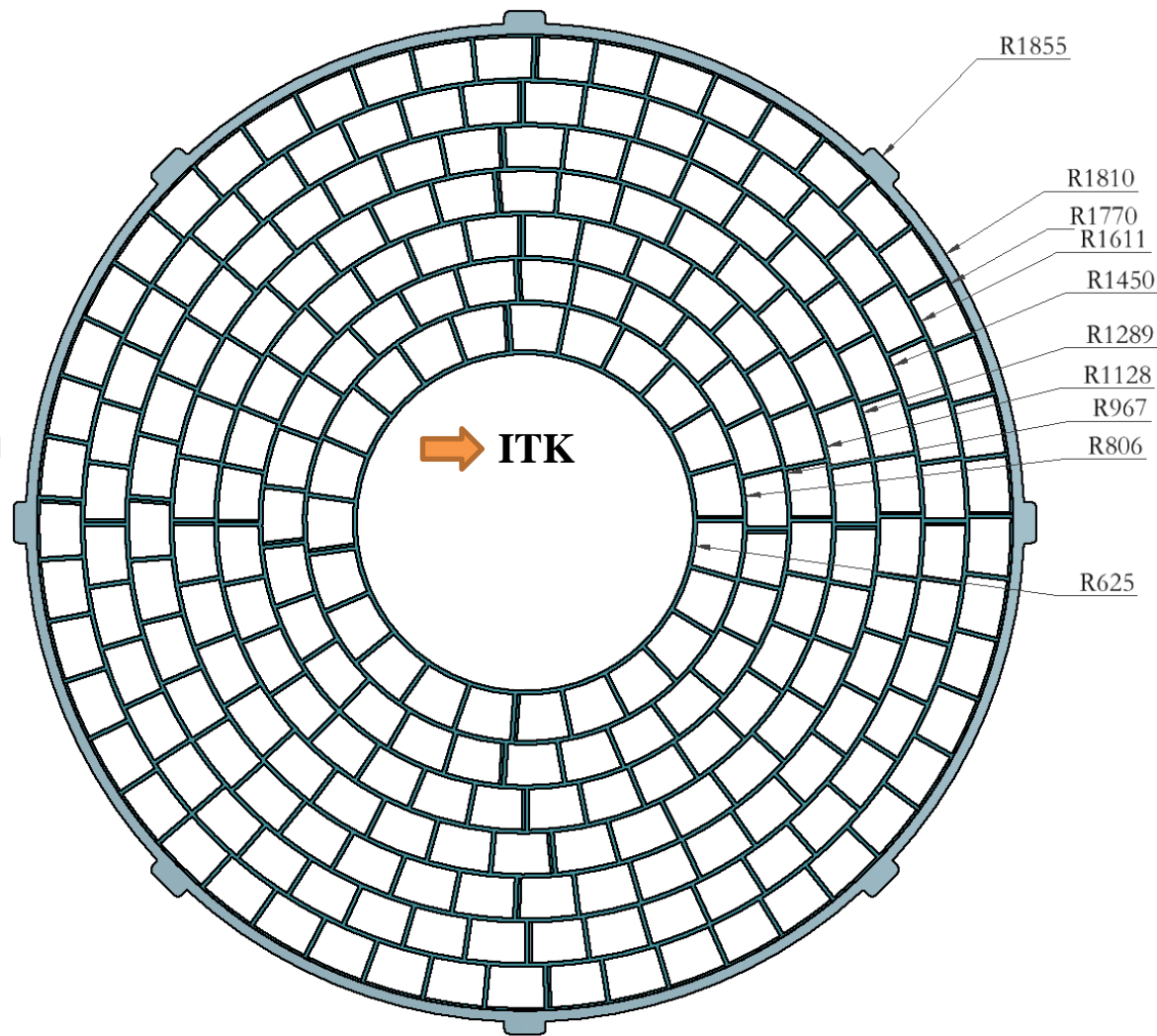
- **Update design of TPC**
- **BG source and estimation**
- **Status of Chapter6**

Update design of TPC endplate

TPC detector	Key Parameters
Modules per endcap	248 modules /endplate
Module size	206mm × 224mm × 161mm
Geometry of layout	Inner: 1.2m Outer: 3.6m Length: 5.9m
Potential at cathode	- 62,000 V
Gas mixture	T2K: Ar/CF ₄ /iC ₄ H ₁₀ =95/3/2
Maximum drift time	34μs @ 2.75m
Detector modules	Pixelated Micromegas



OTK ←

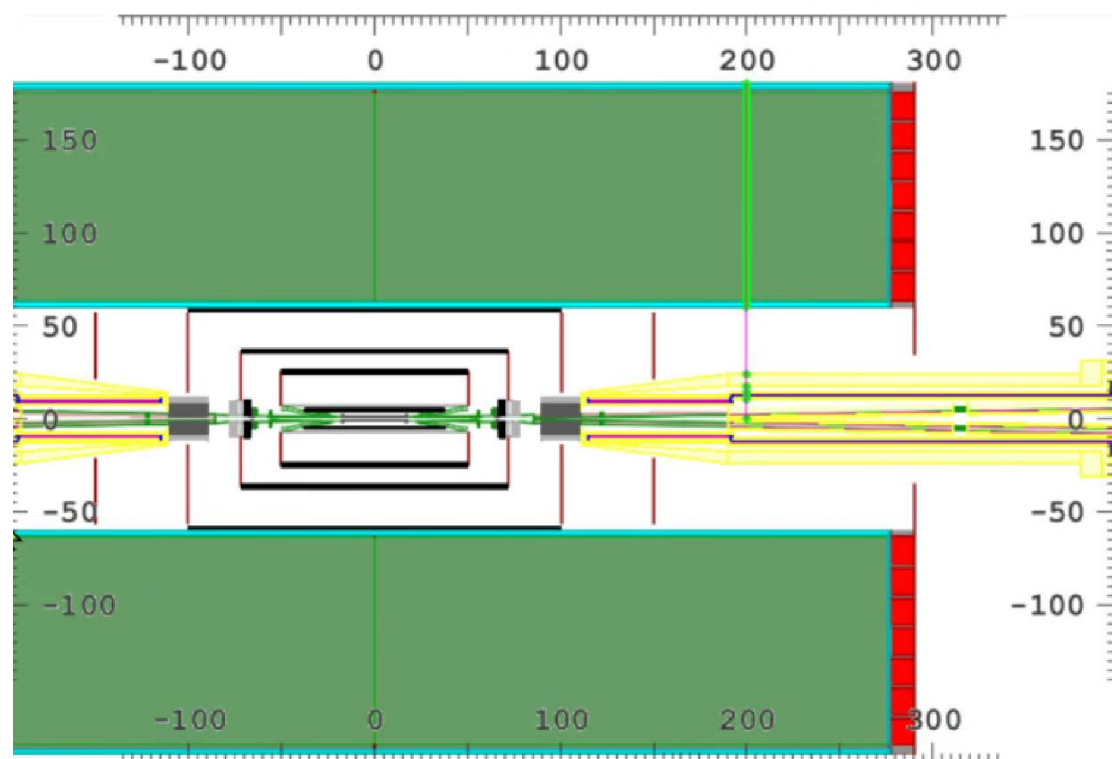


Detector Module Water Cooling Design

Background Sources at Higgs/ Low luminosity Z @3T

- Higgs/Z background sources
 - I. Pair production (Luminosity related)
 - II. Single Beam (BGB, BGH, Touschek Scatter...)
 - III. Synchrotron Radiation
 - IV. Injection background

Bkg type	Space charge density(steady)	Remark	Optimization strategy
Pair + Single Beam	$\rho_{sc0} \sim 0.04 \text{ nC/m}^3$ (R=60cm) 8um, 2.75m Drift Length @ inner radius	Without low P_T e^-/e^+ (<10MeV) in TPC caused by ~MeV γ	Acceptable
Pair + Single Beam	$\rho_{sc1} \sim 60 \times \rho_{sc0}$	With low P_T e^-/e^+ (<10MeV) in TPC caused by ~MeV γ	Analysis initial position distribution of ~MeV γ (Main contributions) and Add shielding

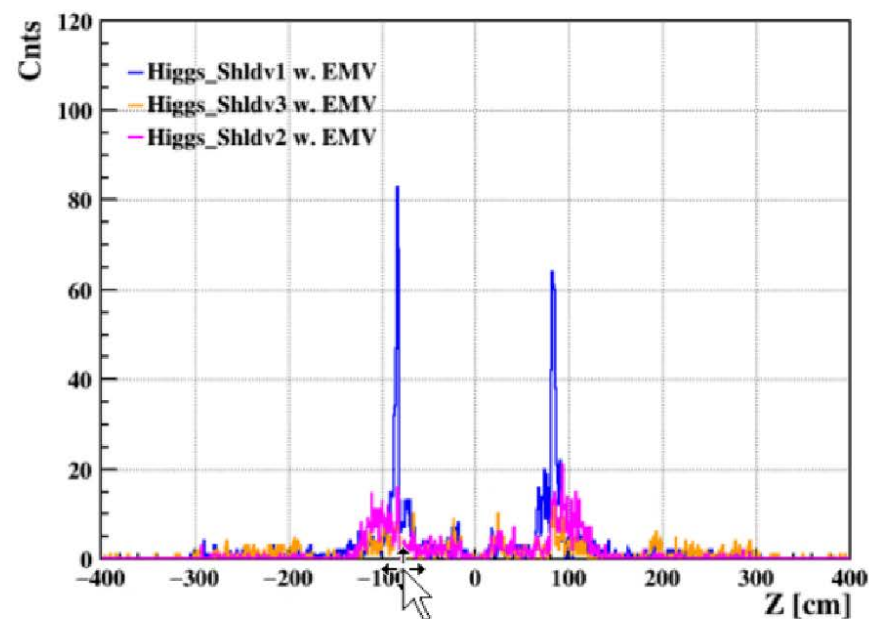
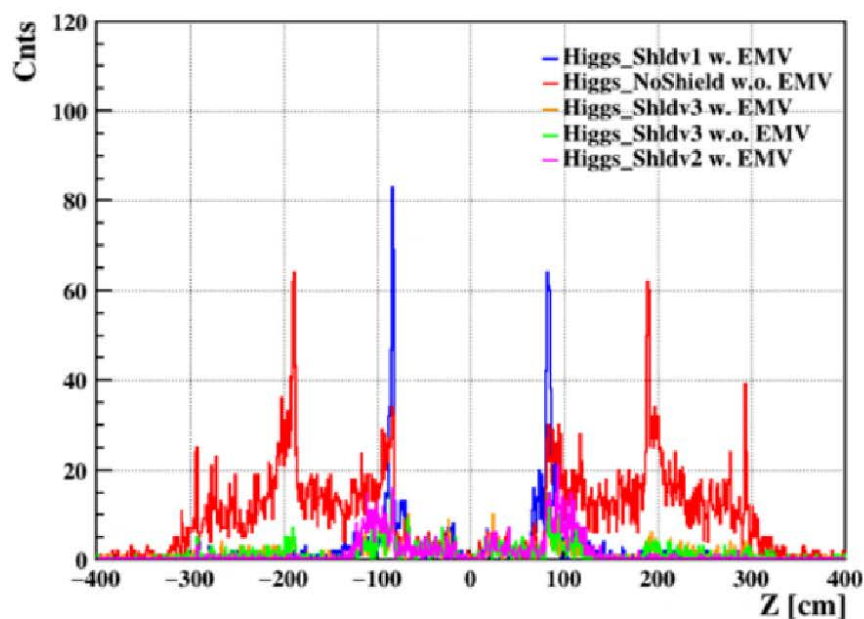


Material	D [cm]	X0 [cm]	D/X0 [%]
Air	10.5000	30392.1242	0.0345
stainless_steel	0.5000	1.7658	28.3158
lHe	1.0000	754.5867	0.1325
CrZrCu1@150	1.0000	1.4974	66.7840
lHe	1.0000	754.5867	0.1325
stainless_steel	0.5000	1.7658	28.3158
Air	3.0000	30392.1242	0.0099
stainless_steel	6.5000	1.7658	368.1055
Air	36.0000	30392.1242	0.1185
G4_Cu	0.0010	1.4356	0.0697
CarbonFiber	0.0100	28.6083	0.0350
G4_Cu	0.0030	1.4356	0.2090
Polyimide	0.0050	29.4030	0.0170
G4_Cu	0.0030	1.4356	0.2090
CarbonFiber	0.0100	28.6083	0.0350
T2KGas1	117.4680	11764.8276	0.9985
CarbonFiber	0.0100	28.6083	0.0350
G4_Cu	0.0030	1.4356	0.2090
Polyimide	0.0050	29.4030	0.0170
G4_Cu	0.0030	1.4356	0.2090
CarbonFiber	0.0100	28.6083	0.0350
G4_Cu	0.0010	1.4356	0.0697
T2KGas1	2.4680	11764.8276	0.0210
Summary	totalDistance = 180.0000 [cm]		total material budget = 494.1175[%]

Comparison of the optimization geometry

• Different Geo Models:

- NoShield 几何(分段Lumi, 低温恒温器外部仅有0.3cmTi), 低能 γ 产生位置, 沿束流管分叉往后 $100\text{cm} < |Z| < 300\text{cm}$ 区域, $|Z|=200\text{cm}$ 处???
- Shldv1 几何(分段Lumi, 低温恒温器外部包括7cm不锈钢), 低能 γ 产生位置主要在两段LumiCal之间
- Shldv2 几何(紧凑Lumi, 低温恒温器外部包括7cm不锈钢和1cm钨), 低能 γ 产生位置主要在束流管分叉处, Lumi可以阻挡部分 γ , $|Z| > 150\text{cm}$ 后基本产生的低能 γ 基本不进入TPC
- Shldv3 几何(紧凑Lumi, 低温恒温器外部为0.3cmTi和1cm钨), 低能 γ 产生位置主要在束流管分叉处, Lumi可以阻挡部分 γ , $|Z| > 150\text{cm}$ 后有少量低能 γ 进入TPC

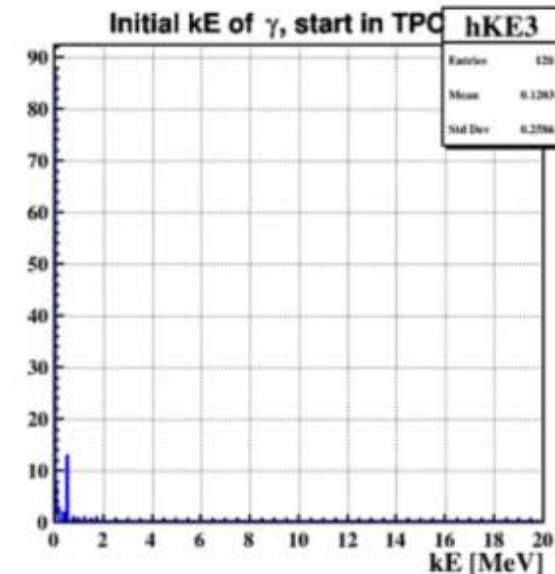
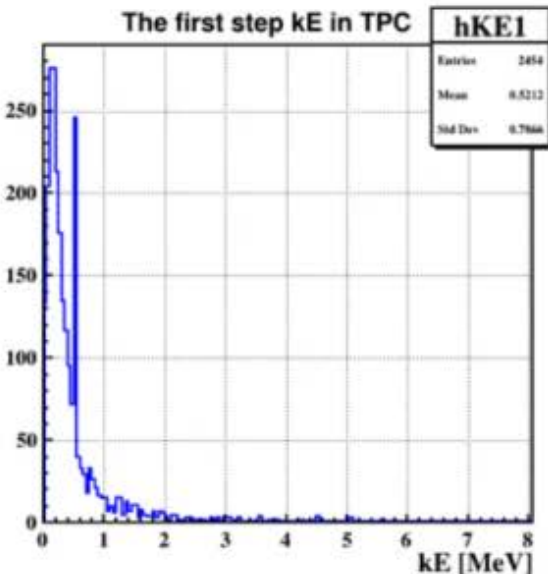
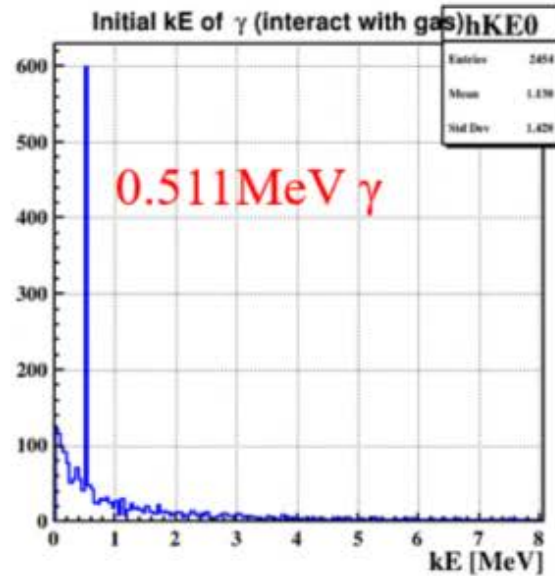
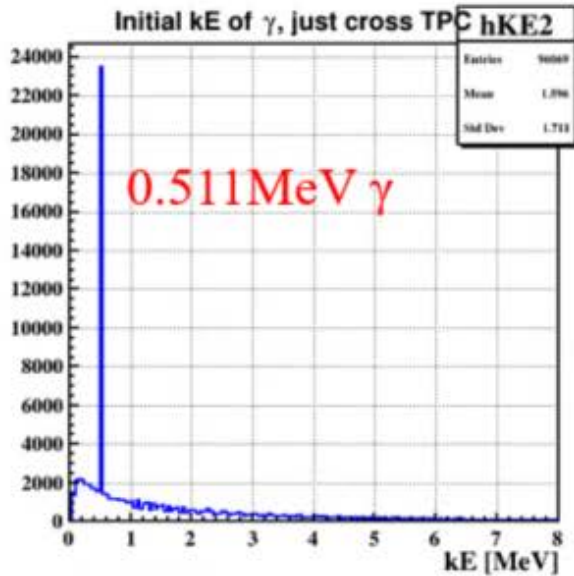


γ initial position distribution



Optimization with the shield

Gamma (<10MeV) events at low luminosity Z @3T



γ energy distribution (10BX WholeLZ241204 log)

- 1.2×10^7 tracks (γ, e^-, e^+, \dots) in total
- 8.4×10^6 γ tracks (~70.0%)
- 9.9×10^4 γ will cross TPC and ~ 2454 γ will interact with T2K gas through “compt, phot, conv” process, 96096 γ just cross TPC without energy deposit
- ~1.3% γ energy > 10 MeV
- Large number of 0.511 MeV γ (through e^+ annihilation)
- Average energy deposit: 27.12 MeV/BX by sum all secondary e^- dE, small less than the result from .root file (32.3 MeV/BX)
- So, low energy γ is the main contributions of beam background for TPC, similar to Higgs mode.

Status of Chapter6

- 6.1 Physics requirements
- 6.2 Gaseous tracker system overview
 - 6.2.1 Technology comparison
 - 6.2.2 Baseline gaseous tracker
 - 6.2.3 R&D efforts and results
- 6.3 Pixelated readout Time Projection Chamber
 - 6.3.1 Time Projection Chamber detector
 - 6.3.2 Pixelated readout electronics
 - 6.3.3 Design of mechanical and cooling
 - 6.3.4 Commissioning and validation of prototype
 - 6.3.5 Challenges and critical R&D
 - 6.3.6 Costs
- 6.4 Performance
 - 6.4.1 Overview of the simulation framework
 - 6.4.2 Physical process in the framework
 - 6.4.3 Tracking performance
 - 6.4.4 Particle identification
 - 6.4.5 Improvement using the machine learning algorithm
 - 6.4.6 Beam background source and estimation
 - 6.4.7 Alternative the drift chamber
- 6.5 Prospects and outlook

- **整体文档基本完成**
- **已整合入IHEP Overleaf文本内**
- **下周计划 (Draft version 0)**
- **Shared with 11 members of ILD and LCTPC collaboration**



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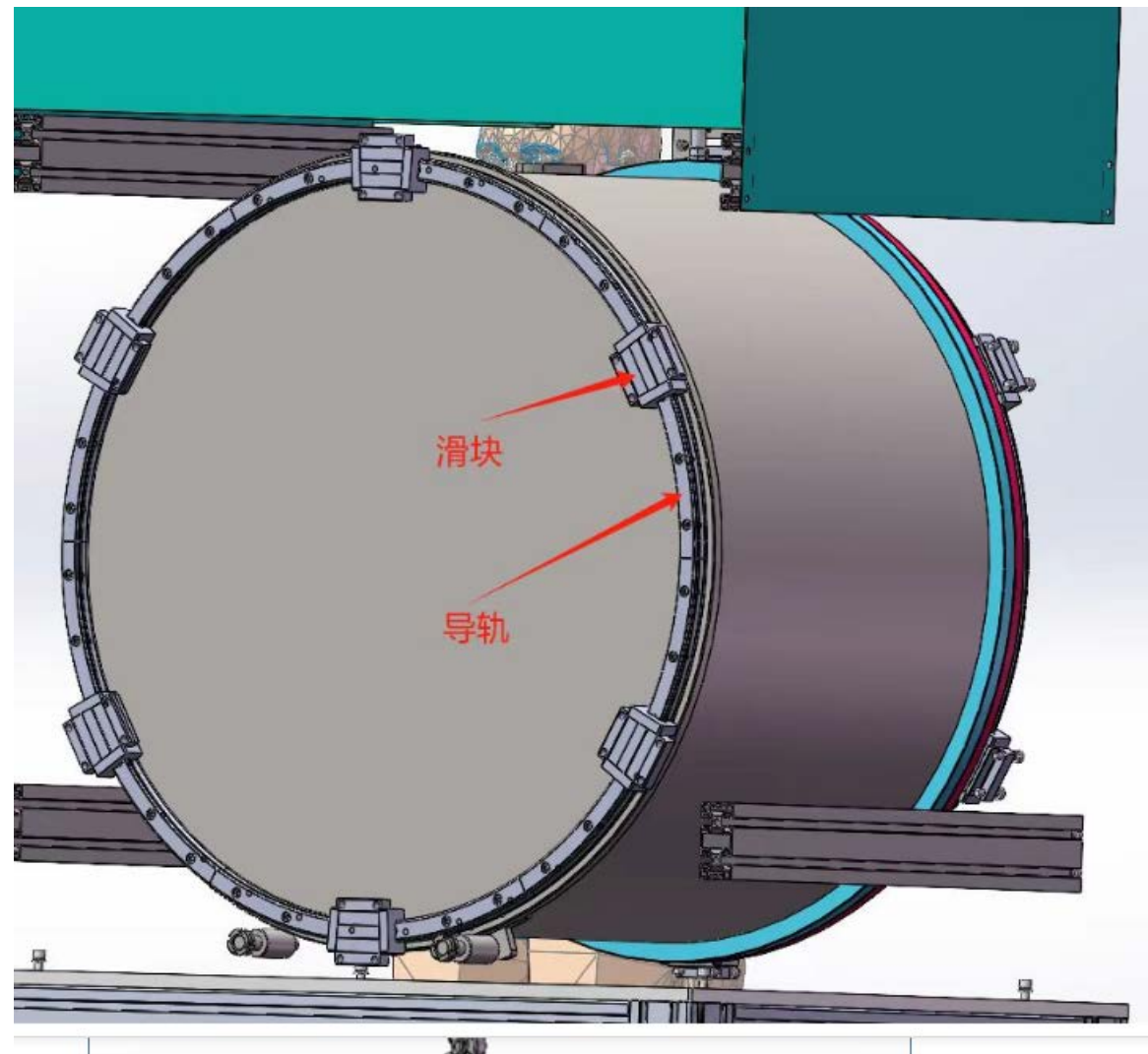
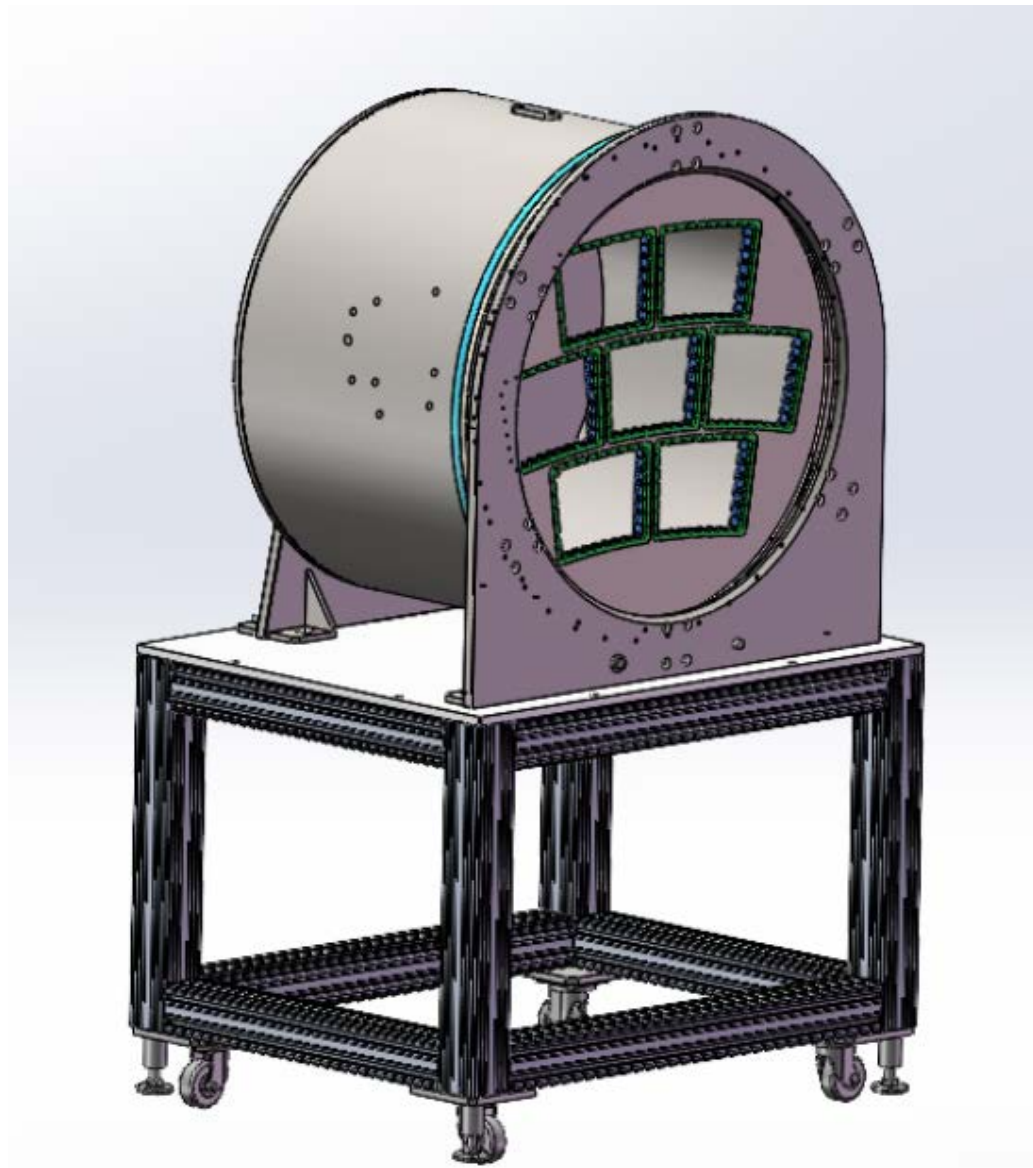
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Prototype of TPC



Many thanks!