Plans for the CEPC CDR

-TPC tracker

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On behalf of the tracker detector subgroup

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Plan for the CDR

- Based on the pre-CDR contents and ILD like version
- List of resources in tracker R&D
  - IBF for distortion
  - Alignment and calibration of tracker
- Man power

- ~100 μm position resolution in rφ
- Systematics precision (<20 μm internal)

6 The CEPC Detector

6.1 Detector Overview

6.4 Main Tracking Detector – TPC

6.4.1 Design ~~and Challenges~~

6.4.2 ~~Alignment and Calibration~~

6.4.3 ~~Critical R&D~~

Simulation and Estimation
- Requirements of Higgs and Z pole run
- Occupancy in high rate
- Distortion of IBF

Mechanics

detector module R&D

Alignment and calibration
- Alignment by laser system
- Gas/HV/Readout
- Software/correction methods

Wire chamber option

Further R&D

Cost estimation

Discussion in Wuhan conference.

pre-CDR → **CDR**

Draft of contents

Draft of the TPC tracker for CEPC CDR

H.R Qi, ...

May 3, 2017

Contents

TPC requirements for CEPC

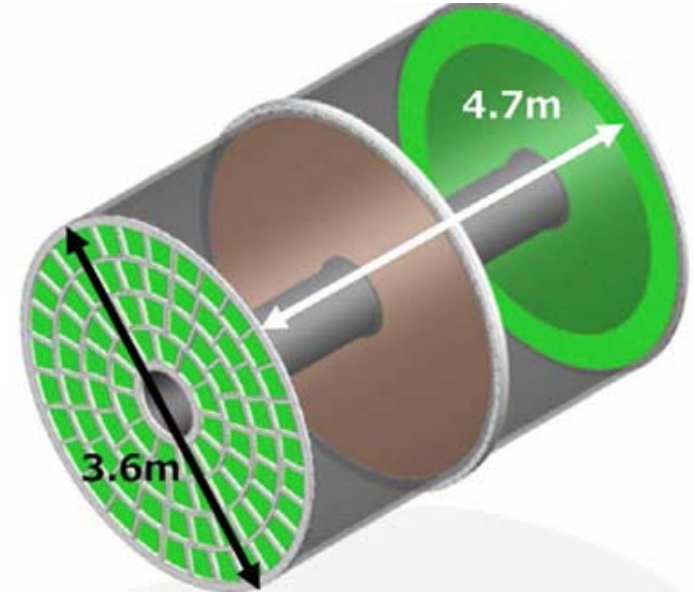
TPC could be as one tracker detector option for CEPC, 1M ZH events in 10yrs E_{cm} ≈250 GeV, luminosity ~2×10^{34} $cm^{-2}s^{-1}$, can also run at the Z-pole

The voxel occupancy takes its maximal value between 2×10^{-5} to 2×10^{-7}, which is safety for the Z pole operation. Of course, it is well for Higgs run too.

https://doi.org/10.1088/1748-0221/12/07/P07005

TPC detector concept:

- **Motivated by the H tagging and Z**
- **Main tracker detector with TPC**
- **~3 Tesla magnetic field**
- **~100 μm position resolution in rφ**
- **Systematics precision (<20 μm internal)**
- **Large number of 3D points(~220)**
- **Distortion by IBF issues**
- **dE/dx resolution: <5%**
- **Tracker efficiency: >97% for pT>1GeV**

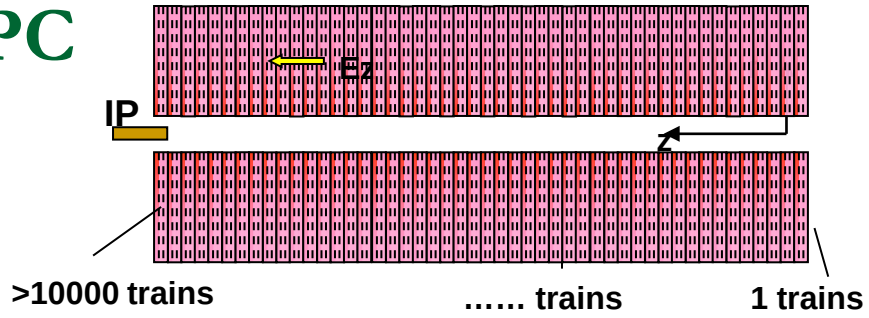


TPC detector concept

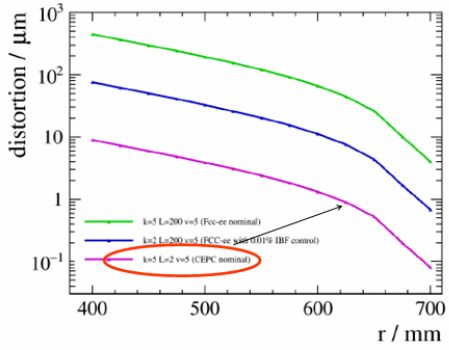
Technical challenges for TPC

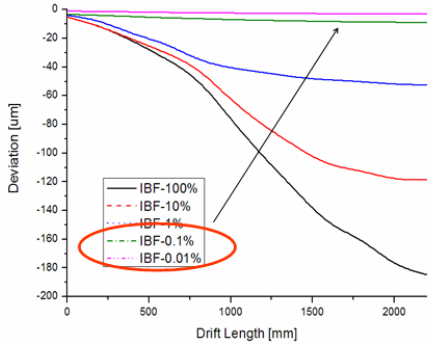
Ion Back Flow and Distortion :

- ~100 μm position resolution in rφ
- Distortions by the primary ions at CEPC are negligible
- More than 10000 discs co-exist and distorted the path of the seed electrons
- The ions have to be cleared during the ~us period continuously
- Continuous device for the ions
- Long working time



Amplification ions @CEPC

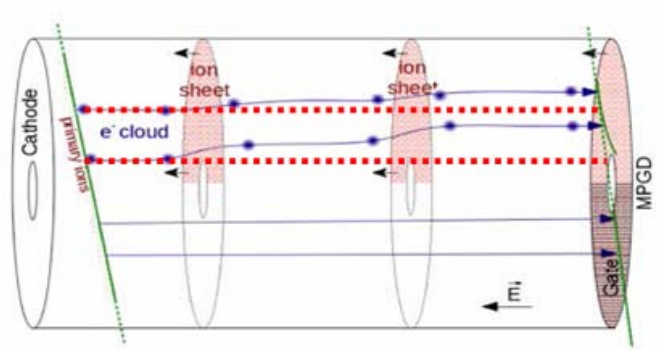




Evaluation of track distortions

Calibration and alignment:

- Systematics precision (<20 μm internal)
- Geometry and mechanic of chamber
- Modules and readout pads
- Track distortions due to space charge effects of positive ions

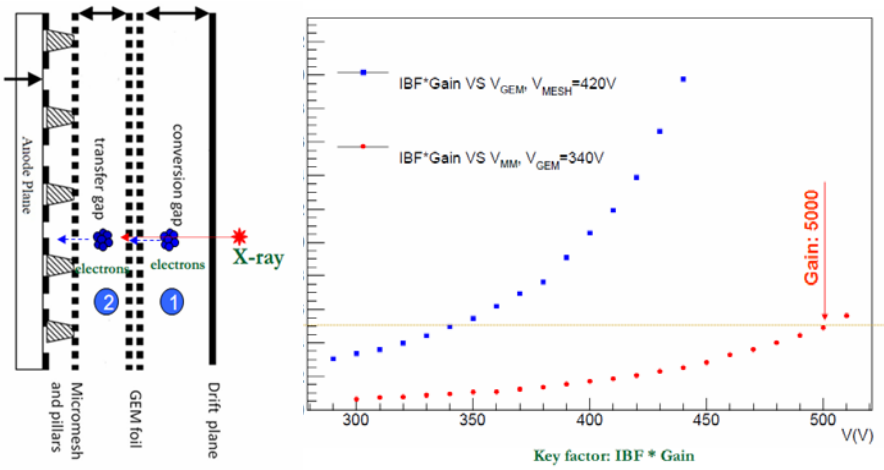


Ions backflow in drift volume for distortion

Possible technical solution

Continuous IBF module:

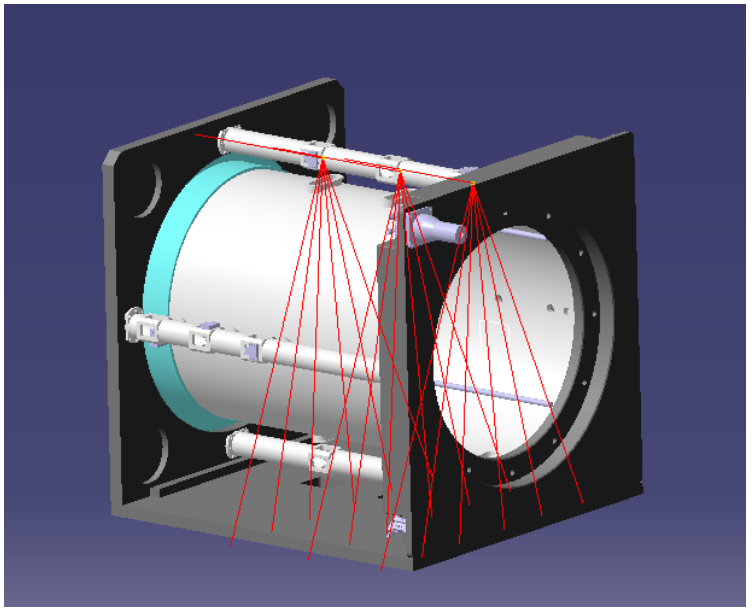
- Gating device may be used for Higgs run
- Open and close time of gating device for ions: ~ μs-ms
- No Gating device option for Z-pole run
- Continuous Ion Back Flow due to the continuous beam structure
- Low discharge and spark possibility



Continuous IBF prototype and IBF × Gain

Laser calibration system:

- Laser calibration system for Z-pole run
- The ionization in the gas volume along the laser path occurs via two photon absorption by organic impurities
- Calibrated drift velocity, gain uniformity, ions back in chamber
- Calibration of the distortion
- Nd:YAG laser device@266nm



TPC prototype integrated with laser system

Manpower and activities

- TPC detector R&D @IHEP (2016~2020)
  - Huirong Qi,
  - Yulian Zhang (PhD,IHEP), Haiyun Wang(PhD,IHEP), Zhiwen Wen(PhD,IHEP)
  - Prof. Jin Li
  - Funding from MOST and NSFC(~3.5 Million RMB)
- Electronics R&D &Tsinghua (2016~2020)
  - Zhi Deng
  - Yiming Cai(PhD,THU), Zhao Mingrui (Master, THU) and three PhDs in electronics lab
  - Prof. Yuanning Gao, Prof. Yulan Li
  - Funding from NSFC (~2.0 Million RMB)
- Inhabitation of IBF using graphene @Shandong Univ.
- Operation gas simulation@Lanzhou Univ.
- IBF simulation@...