Plans for the CEPC CDR

-TPC tracker

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On behalf of the tracker detector subgroup

2017/04/17

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

Baseline design and Mechanics

TPC 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

pre-CDR → **CDR**

Current R&D

- Simulation and estimation
  - Z-pole run for CEPC R&D (prepared one NOTE)
  - Tracker alignment and calibration (~100um resolution)
  - Hybrid detector module concept

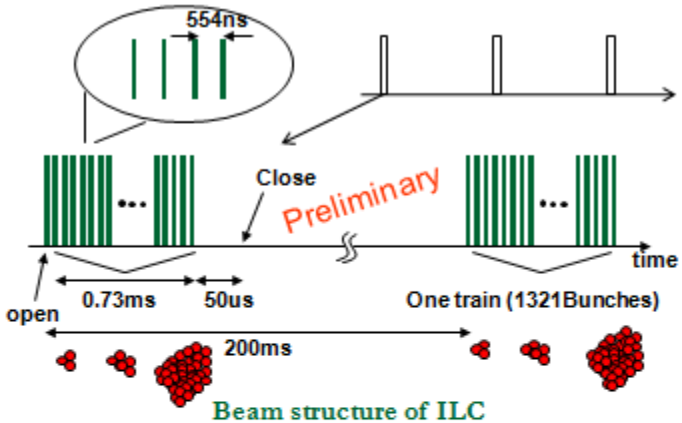
- Experiment and module R&D
  - Continuous Ion Back Flow detector module (GEM+MM)
    - IBF could reach to ~0.1%
    - Stable long time operation
    - Maintaining the electron transmittance
    - Plan to design and study in 1.0T magnetic (In LCTPC collaboration) /1~2years

    MOST funding/IHEP+THU
  - Prototype with laser system
    - Laser system with 266nm
    - Drift velocity
    - Electric field in fieldcage
    - Waveform sampling electronics
    - Plan to assemble and test/~1 year

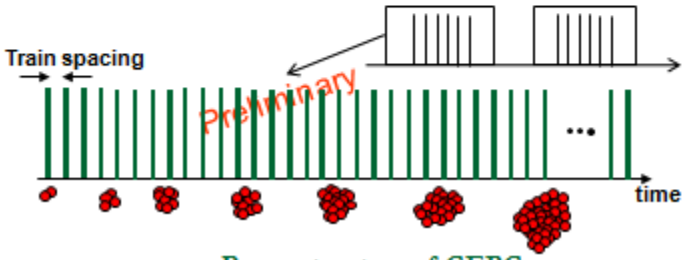
    Key NSFC funding/IHEP+THU

Electrons produced by UV

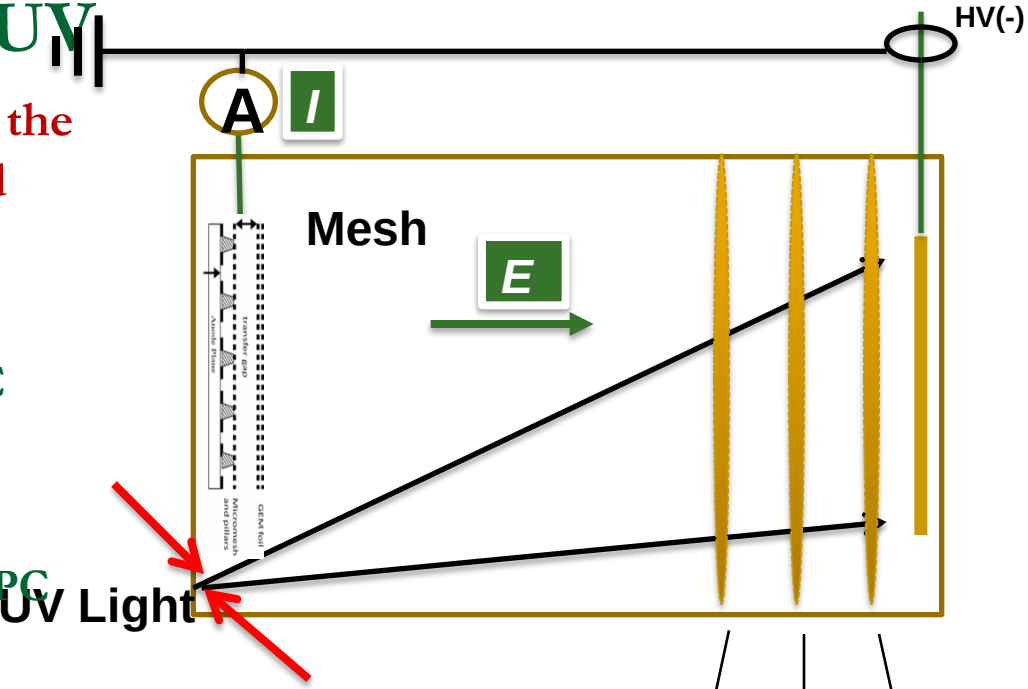
- To mimic the bunch structure & the ions distortion with UV light and laser split beam
- In the case of ILD-TPC
  - Bunch-train structure of the ILC
  - Power pulsing mode
- In the case of CEPC-TPC
  - Bunch-train structure of the CEPC



Beam structure of ILC

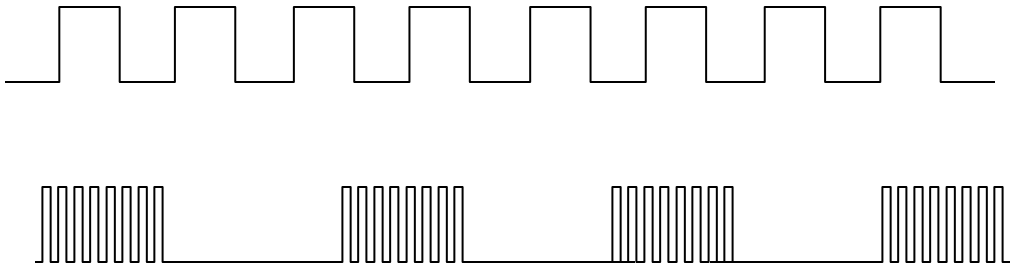


Beam structure of CEPC



Control shutter

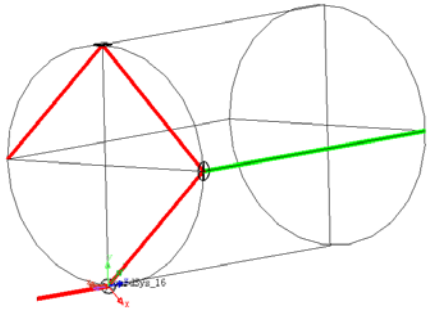
Electrons disc

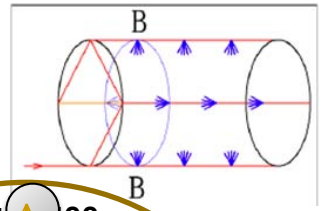


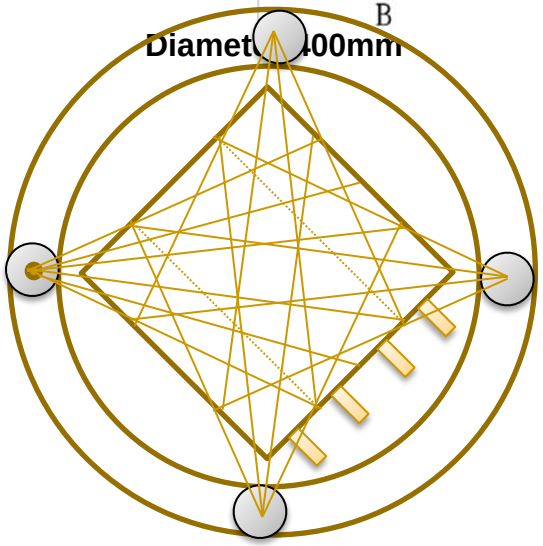
Shutter time similar to ILC and CEPC beam structure

Laser calibration for TPC prototype

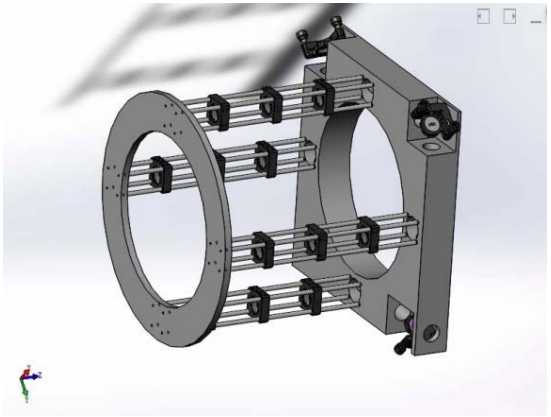
- Goals of laser for TPC detector
  - The ionization in the gas volume along the laser path occurs via two photon absorption by organic impurities
  - Drift velocity, gain uniformity
- To reduce the distortion effect
  - E×B effect study
  - Drift Velocity measurement
  - Good resolution in space and tin
    - No production of σ-rays
    - No multiple scattering
- Baseline design **(DONE)**
  - Nd:YAG laser device
  - λ = 266 nm or E = hν = 4.66 eV
  - Energy: ~100 uJ/pulse
  - Duration of pulse: 5 ns
  - Active area:200mm×200mm
  - Drift length: 500mm
  - Outer diameter:~400mm
  - GEM readout

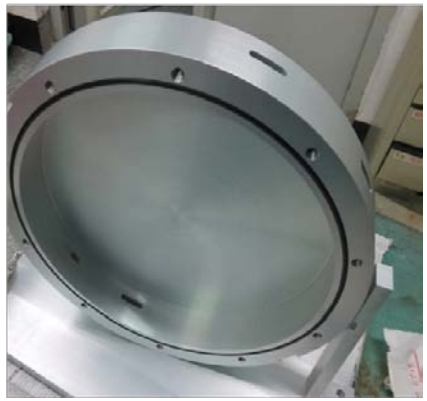






Laser calibration baseline design

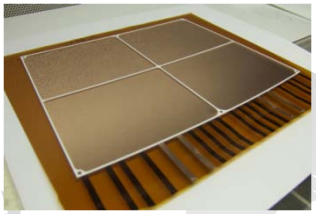
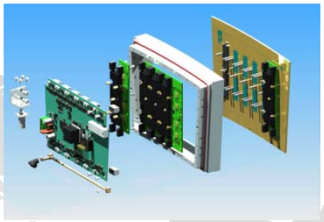
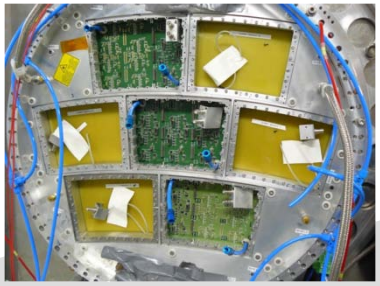




The assembled module test with 266nm laser

Tsinghua and IHEP Cooperation

Timelines

Concept study | **Smaller prototype** | **Large prototype** | **Common module**

2006~2010 | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019**

2006~2010
Tsinghua starting for prototype
PCB readout design
Dr. Li bo
Prof. Yulan Li

2012
TUTPC prototype
GEM-TPC prototype
Micromega-TPC

2013
MPGDs suffer less from ExB effects than MWPCs
They require less heavy mechanics

2014
IHEP starting for prototype
Hybrid concept for IBF
Dr. Huirong Qi
Prof. Yuanning Gao

2015
GEM prototype
Micromemgas protype
Ingrid prototype
Hybrid prototype

2016
We are in here
Hybrid prototype starting
Calibration using laser

2017
Common module
Laser calibration
Cooling
Electronics