CEPC Detector R&D Project

2.1 TPC Module and Prototype

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| Document Responsible: | Qihurong |
| Last saved by on | 12/18/2019 2:04:00 PM |
| Revision number: | 1 |
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Change history

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| --- | --- | --- |
| **Revision** | **When** | **What changed and why** |
| 1 | 12/12/2019 | First draft |
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|  |  | < Add further lines to table as required > |

Readme first

1. Please do not delete or modify this section or its structure.
2. Only change text enclosed by (and including) angled brackets “< … >”.
3. Don’t change field directly, instead modify the document options, under File🡪 Properties (or similar)
	* Enter name of person that wrote the document in Document:Summary: Author
	* The project ID number, should follow the rules provided to you earlier. The number should be changed in Document:Custom: PBS.
	* The project name should be changed in Document:Summary: Subject.
4. In Section [*Project Objectives*](#ProjectObjectives) provide a brief description of the project goals, i.e. why and what is being produced, for PBS item **1.1** **Vertex Prototype**. If this project includes identifiable sub-projects you can indicate them in the [*Sub-projects Description*](#SubprojectsDescription) Section, otherwise submit a separate document for each of them. The sub-project IDs are free for you to define.
5. Finally, remember to update the [*Change History*](#ChangeHistory).

2.1 : Project Objectives

Time Projection Chambers (TPCs) have been extensively studied and used in many fields, especially in particle physics experiments, including STAR and ALICE. Their low material budget and excellent pattern recognition capability make them ideal for three dimensional tracking and identification of charged particles. The TPC detector will operate in continuous mode on the circular machine. To fulfill the physics goals of the future circular collider and meet Higgs/Z run, a TPC with excellent performance is required. MPGDs with outstanding single-point accuracy and excellent multi-track resolution are needed. We have proposed and investigated the ions controlling performance of a novel configuration detector module. The aim of this study is to suppress ion backflow (IBF) continually.

2.1 TPC Module Prototype: Sub-projects Description

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| **Project ID** | **Title** | **Description** |
| 2.1.1 | IBF TPC module | The continuous IBF suppression TPC module for the circular collider’s beam structure |
| 2.1.2 | Low material budget TPC | Low material budget to satisfy CEPC requirements  |
| 2.1.3 | TPC prototype | High space resolution with MPGD, IBF detector module and calibration using UV system |
| 2.1.4 | Chamber | Field cage and connector and Barrel, Low-mass mechanical structure for TPC detector |
| 2.1.5 | FEE electronics | Low power consumption R&D for FEE electronics and ASIC chips |
| 2.1.6 | Calibration system | UV laser beam to calibration |
| 2.1.7 | Mechanical structure | Stability and strong supporting |
| 2.1.8 | Cooling | CO2 cooling for the readout |
| 2.1.9 | HV and low power | Low power Crate, connector, cable and HV system |

2.1 TPC Module Prototype: CEPC Relationship

The preliminary baseline design of CEPC detector is a PFA concept, with a superconducting solenoid of 2.0-3.0 Tesla surrounding the inner silicon detector, TPC tracker detector and the calorimetry system. In order to accommodate the CEPC collision environment, some necessary changes have been made to the Machine Detector Interface (MDI) and sub-detector design. The CEPC design, for instance, has a significantly shorter focal length L\* of 1.5-2.0m than that of the ILC design (3.5m), which indicates that the final focusing magnet QD0 will be placed inside the CEPC detector. In addition, unlike the ILC detector, the CEPC detector will operate in continuous mode, which imposes special considerations on power consumption and subsequent cooling of the sub-detectors.

Aiming for the CDR and TDR of the CEPC project, two-phase funding scheme is proposed by the funding agency, the Ministry of Science and Technology (MOST) of China. To launch the project, the MOST funded the CEPC accelerator and detector R&D project for phase-I period of 2016-2021. Among sub-detectors, the feasibility study of the TPC tracker detector was initiated for the purpose to identify feasible technology options and to gain expertise to build the detector units which meet the basic requirements of the CEPC detector design. The specific research goals of this MOST project are described as following.

2.1 TPC Module Prototype: Project Schedule

2020.1 -2020.12

Estimation of TPC technology at Tera/Mega Z

Simulation

TPC module R&D

Experiment

Resolution and IBF/Electron Transmission

TPC Prototype R&D

Study in 1.0T magnetic field

Pixel TPC R&D

LCTPC Collaboration

2.1 TPC Module Prototype: Funding Availability

MOST

CEPC R&D – TPC /2017.6-2022.6

TPC prototype R&D/IHEP/1.2M RMB

TPC ASIC chip R&D/Tsinghua/1.1M RMB

NSFC

Key Program

2017.1-2020.12 TPC calibration R&D /IHEP/1.2M RMB

2017.1-2020.12 TPC calibration R&D /Tsinghua/1.9M RMB

General Program

2018.1-2021.12 TPC module R&D/IHEP/0.6M RMB

2020.1-2023.12 TPC R&D/IHEP/0.6M RMB

2.1 TPC Module Prototype: Leadership Arrangement

IHEP: Qi Huirong

Tsinghua: Deng Zhi

2.1 : Manpower Resources

FTE staff from IHEP

 TPC R&D：Qi Huirong

Engineer： Zhang Jian

PhD: Yuan Zhiyang, Chang Yue

FTE staff from Tsinghua

 TPC ASIC R&D：Deng Zhi

PhD: Cai Yiming

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| **Type** | **Average FTE Expected** |
| Faculty | 3 |
| Postdoc |  |
| Students | **3** |
| Engineers | 1 |