Progress in mechanical design of CEPC detector TDR

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1. Ref-TDR Report

CEPC Detector Mechanical Integration : (Ref-TDR)

1. Overall mechanical layout
   Based on design requirements of sub-detectors and their electronics
2. Connection structure between sub-detectors and the installation of sub-detectors
   Provide design guidance for the interface of each sub-detector
3. Configuration of the underground experimental Hall
   Space for the detector and installation
   Vertical shaft hoist, lifting equipment, and other essential infrastructure
4. Others
   Underground auxiliary hall, Ground Halls

2. SUMMARY OF FIRST IDRC MEETING REPORT (第一次IDRC会议报告总结)

Findings, comments, and Recommendations on the mechanical aspects

有关机械方面的结果、评论和建议

MDI

Mechanical interface between the detector structure with a large magnet system and the final beam focusing magnet should be critically important to be carefully studied in communication with the accelerator group in both viewpoints of magnetic field interaction and mechanical vibration. Measurements of vibrations at the proposed CEPC site and evaluation of their impact on offset between the beams at the IP, taking into account expected vibration modes in the mechanical transfer functions of the most sensitive magnetic elements within the cryostat, are needed. The Committee notes that the cantilevered cryostat for the final focusing magnet system will also involve an auxiliary support 3.3 m from the IP, on the ECAL, which may be beneficial for stabilization. It is nevertheless important to pursue a detailed evaluation, in particular for the twisted mode, which is the most dangerous mode for the vertical offset between the beams.

1. 与加速器接口设计
2. 振动传递和干扰问题……

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TRACKING

Alignment between ITK and OTK: The relative alignment of the ITK and OTK has a significant impact on the global tracking precision. The simulation must in corporate realistic alignment tolerances and errors, reflecting expected mechanical installation uncertainties

ITK和OTK之间的准直问题……

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TRACKING --- ITK and OTK

The envisaged power consumption is 300 mW/cm^2 (ASIC) and requires active CO_2 cooling. The full coverage will require ~3500 wafers with 2 different sensor designs in the barrel and 21different detectors in endcaps (wedge-shaped). The purpose of the detector is to provide a TOF point for the tracks originating at the same vertex (PID)

OTK的冷却问题……

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TRACKING --- TPC

The mechanical alignment of the modules has to be excellent (a few tens of microns) to avoid systematics on the sagitta measurement.
The electric and magnetic fields have to be precisely parallel to avoid ExB distortions. This calls for a very uniform magnetic field (see magnet section).

TPC的电场和磁场的平行问题……

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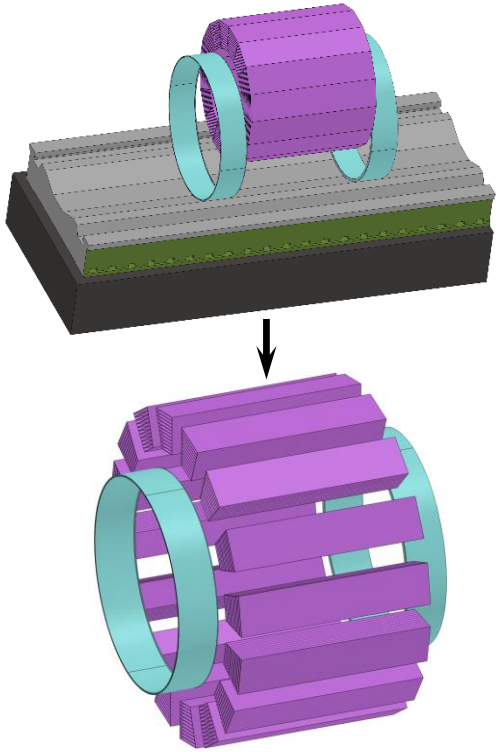
MECHANICAL INTEGRATION

Findings

The study team presented the first ideas about the mechanical integration for the reference detector. In particular, they developed a concept for the installation sequence of the various detector elements and possible mitigation measures to compensate for the sagging of HCAL modules due to their self-weight (18.8mm), which is larger than the gap between HCAL and ECAL (10mm).

HCAL的组装变形控制问题……



Deformation : 18.8 mm

Deformation : 3.3 mm

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MECHANICAL INTEGRATION

Comments

Not much work has been done so far in terms of the integration of detector services. Beyond sufficient space to be foreseen in the detector for cables, fibers, cooling pipes and hoses, but the services also have an impact on the detector's performance through their material budget.

1. 预留管线空间问题
2. 结构件材料选择问题

Moreover, an estimate of the total power budget including power conversion efficiency and losses along the cables is necessary to correctly define the size of the power plants and of the services, and the impact of the services on the detector design

冷却系统及辅助设施涉及的功耗问题
(功率转换和电缆损耗)

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MECHANICAL INTEGRATION

Recommendations

1. Correctly size the service channels accounting for contingency. Space and material for services should also be duly considered in the simulations of the detector performance.
2. It would be important to define the considered cooling agents (air, water, CO_2 etc.) for all sub-detectors, which doesn't seem to be the case yet.

1. 电缆空间问题
2. 冷却设计问题

Further investigations going beyond the reference TDR will be needed at a later stage, including air cooling studies for the vertex detector to demonstrate the required cooling performance within the specifications in terms of vibrations.

1. 风冷对振动的影响

3. Work Plan

2.1 How to answer the questions of the IDRC ?

The best answer : Complete the design

最好的回答：完成设计(虽然有难度，但必须做……)

2. Work Plan

2.2 Work arrangement for November 4 regular meetings (11月4日例会工作安排)

Completion status of overall detector design
探测器总体设计完成情况

1. 总图 General Drawing
2. 安装 Installation design
3. 连接 Connection design

Completion status of connection design
连接设计完成情况

1. Unfinished parts:

Connection between ECAL and HCAL
Connection between ECAL and TPC

2. All other connection designs have been completed

下周一(11月12日)讨论的问题:
1. 设计要求 Design Requirements
2. 连接结构 Connection structure

Sub-Detectors

Mechanical Design of Ref-TDR Report : (Includes……)
1. Mechanical main structure (calculation and analysis)
2. Cooling Structure (calculation and analysis)
3. Pipeline layout 管线排布设计
4. Connection structure 连接结构 --- 这是承上启下的关键内容