

CEPC Detector R&D Project

5.2 HTS solenoid magnet

Document Responsible:	Zhu Zian
Last saved by on	12/18/2019 3:28:00 PM
Revision number:	1

Change history

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

Readme first

- i. Please do not delete or modify this section or its structure.
- ii. Only change text enclosed by (and including) angled brackets "< ... >".
- iii. 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.
- iv. In Section [Project Objectives](#) 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](#) Section, otherwise submit a separate document for each of them. The sub-project IDs are free for you to define.
- v. Finally, remember to update the [Change History](#).

5.2 HTS solenoid magnet: Project Objectives

A large HTS solenoid concept is proposed by IHEP team for the CEPC detector, with the calorimeter located outside of the solenoid, which requires a very thin solenoid.

The HTS solenoid is supposed to use YBCO stacked-tape cable as the conductor. The radiation length of single YBCO tape coated with 10 μm copper is about 0.004 X_0 , we can get a thinner solenoid by using HTS compare to LTS. Therefore, the YBCO stacked-tape cable and the cryogenics are brought into R&D. Up to 20% additional reduction in the overall thickness may be achieved with more R&D and engineering.

The objectives of the detector magnet R&D projects are relative to the four different tasks listed as follows.

5.2 HTS solenoid magnet: Sub-projects Description

Sub-project ID	Title	Description
5.2.1	Development of HTS conductor	Develop aluminum stabilized ReBCO stacked tape cable, the tapes are embedded in a pure aluminum, cable length > 200 m, current > 6 kA at 20 K. We also consider other HTS cables if they are suitable for large detector magnet.
5.2.2	Development of 20 K cooling for HTS coil	Explore the cooling mechanism and heat conductivity structure at 20 K, study the stability and quench behavior at this temperature.
5.2.3	Development of low material cryostat	Study the cryostat structure with less mass material to make particles more easily penetrate to reach the calorimeter.
5.2.4	Construction of 1:20 superconducting coil prototype	Develop the prototype of large HTS magnet, study the winding process, cable joint, quench protection and so on, with an inner diameter 2m, 4.2K liquid helium cooling, stack cable 4mm width 20 layers.
		< Add further lines to table as required >

5.2 HTS solenoid magnet: CEPC Relationship

All four activities are strictly (almost exclusively) related to the design of the solenoid magnet of the CEPC detector.

5.2 HTS solenoid magnet: Project Schedule

Project 5.2.1 and 5.2.4 got funding from the Chinese Academy of Sciences Foundation for original innovation project from 0 to 1, research focus on the key technology of high temperature superconducting magnet for large detector in the future. It was expected to complete the project by the end of 2024.

Project 5.2.2 and 5.2.3 have to get new funding support, activity is expected to start in 2023, we expect to master all aspects of the technology of large-scale HTS detector magnet and complete the project by the end of 2026.

5.2 HTS solenoid magnet: Funding Availability

We have obtained 3M CNY from the Chinese Academy of Sciences Foundation for original innovation project from 0 to 1, for the key technology of high temperature superconducting magnet for large detector in the future, mainly focus on the research described in the first and second step of project 5.2.1 and 5.2.2.

We are missing the funds needed for the low material cryostat study described in the third and fourth step of project 5.2.3 and 5.2.4.

5.2 HTS solenoid magnet: Leadership Arrangement

Leading institute for the HTS solenoid magnet project will be Institute of High Energy Physics, CAS (coordinated by Ning Feipeng).

Significant support will be given by the industrial companies, Toly Electric Works Co. LTD at Wuxi (coordinated by Liao He'an) and Shanghai Superconductor Technology Co. Ltd at Shanghai (coordinated by Zhu Jiamin) for what concerns high temperature superconducting cable development. Cooperation partners for simulations and finite element analysis of the cable and coil are under investigation.

5.2 HTS solenoid magnet: Manpower Resources

Type	Average FTE Expected
5 Faculty	2
1 Postdoc	0.5
4 Students	2
1 Engineer	0.5

