CEPC Detector R&D Project

2.3 Drift Chamber Activities

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Change history

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| **Revision** | **When** | **What changed and why** |
| 1 | 13/12/2019 | First draft |
| 2 | 28/04/2020 | Update on funding availability |
| 3 | 05/01/2021 | Update on scheduling and funding |
|  |  | < 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 . 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).

2.3 Drift Chamber Activities: Project Objectives

The proposed Cluster Counting/Timing technique, which consists in measuring the arrival times on the sense wires of each individual ionization cluster generated in a drift cell, offers the possibility of greatly improving both the momentum resolution and the particle identification capabilities of this kind of gas sampling detectors (separation powers of better than a factor two with respect to the traditional method of dE/dx have been demonstrated experimentally). The drift chamber proposed for the IDEA detector exploits the peculiarities of such a tracking system.

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

2.3 Drift Chamber Activities: Sub-projects Description

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| **Project ID** | **Title** | **Description** |
| 2.3.1 | Development of new wire materials. | Find suitable proposals for new wire materials together with the corresponding technologies for anchoring the wires to the endplates. |
| 2.3.2 | Development of a DAQ board specific to Cluster Counting/Timing for data reduction and pre-processing of drift chamber signals sampled at high rates. | Implement, within a single FPGA board, peak finding algorithms on a large number of analog to digital conversion channels (128 being the ultimate goal), for parallel pre-processing, to reduce costs and system complexity, and to gain on flexibility in determining proximity correlations among hit cells for track segment finding and triggering purposes. |
| 2.3.3 | Construction of a full length drift chamber prototype. | Full mechanical test of the proposed innovative technologies on the new types of wires and of the new concepts for the design of the drift chamber wire structure placed inside a light gas-tight envelope. |
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2.3 Drift Chamber Activities: CEPC Relationship

All three activities are strictly (almost exclusively) related to the design of the central tracking chamber of the IDEA detector, for both the CEPC and the FCC-ee.

2.3 Drift Chamber Activities: Project Schedule

Project 2.3.1 has received funds from INFN CSN1. Activity was expected to start in 2020 and to be completed by the end of 2022. In the meantime, we are currently engaged in tests of light polymeric fibers and Carbon monofilaments and in different technologies for anchoring such wires to the endplates. Because of the unexpected situation due to the COVID-19, this project will suffer a delay, currently estimated in approximately 9 months.

Project 2.3.2 has received funding from INFN/CSN1 for the design of a FPGA board with two RO channels, which should be completed by the end of 2020. Here again, we expect a six months delay due to the COVID-19. Moreover, in the framework of the AIDAinnova project, we have been funded for the extension of this FPGA board from 2 to 4 channels, to be completed by the middle of 2024.

Project 2.3.3 is staged in three different steps.

The first one includes the construction of small drift tube prototypes to test the new wire types and the RO scheme with FPGA board prototype of project 2.3.2. For this step, we have received funds from INFN CSN1. We expect to complete these prototypes by the middle of 2022.

The second step, which is supposed to start during spring 2020, with funds secured by the already financed CREMLINplus program, foresees the construction of a drift chamber for the CMD-3 experiment at the Budker Institute for Nuclear Physics at Novosibirsk, Russia. This chamber will exploit the same technology, including the new concept for the wire support structure, as the CEPC/FCCee prototype and, therefore, will act as a full system test of the IDEA drift chamber, except for the reduced dimensions. Commissioning of this chamber will occur at during 2024. Once more, due to the unexpected COVID-19 situation, this step will suffer a delay of approximately 9 months.

The third, more ambitious step concerns the construction of a full-scale prototype, 4 m long, to fully demonstrate the mechanical and electrostatic stability of the proposed solutions, together with the capability of data reduction and pre-processing of the multichannel RO board. Funds for this step will need to be secured.

2.3 Drift Chamber Activities: Funding Availability

During 2019, we have been funded from INFN-CSN1 with 4.5 keuro for the first phase of project 2.3.2 and, for the years 2021-2024, 70 keuro for its continuation from the AIDAinnova project.

During 2020, we have been funded from INFN-CSN1 with 16.5 keuro for studies on new wire materials and for small drift tubes prototypes.

We have secured funding for the second step of project 2.3.3, in the amount of 364 keuro.

We can count on adequate support for travel to China according to the MISE-FEST agreement.

We are, however, missing the funds needed for the construction of the full-scale prototype of the drift chamber described in the third step of project 2.3.3.

2.3 Drift Chamber Activities: Leadership Arrangement

Leading institute for the three projects will be INFN-Lecce (coordinated by F. Grancagnolo). Given the geographic proximity, INFN-Bari (coordinated by N. De Filippis) will actively participate in all phases of the R&D, although common tasks will be clearly differentiated and each unit will autonomously contribute to the whole project.

Significant support will be given by the BINP group at Novosibirsk (coordinated by I. Logashenko) and by the industrial companies EnginSoft (coordinated by M. Perillo), for what concerns simulations and finite element analysis of the mechanical structures, and by CAEN (coordinated by A. Iovene) for what concerns industrialization of the different versions of RO boards.

2.3 Drift Chamber Activities: Manpower Resources

For each of the 4 years of the R&D program

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| **Type** | **Average FTE Expected** |
| 10 Faculty | 2.5 |
| 3 Postdoc | 2.4 |
| 3 PhD Students | 1.8 |
| 4 Engineers | 0.8 |