

Report of the EuCARD-HFM Short Model Coil Review

Hold by video-meeting on December 12, 2011

Review Committee:

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Question to the reviewers:

- Is SMC the correct way for preparing the Fresca2 magnet project ?
- What is eventually missing in the SMC program ?

Taking into account that SMC is not the core of the EuCARD project, and that we are already late: we have announced to the EC that, at the official end of EuCARD (April 2013), only one FRESCA2 coil will be tested, and that the full dipole will be tested only at the end of 2013 (main deliverable of task 3)

- Are there improvements to be done for SMC3b and further (the next ones to be built) ?

The ESAC Committee would like to congratulate Gijs de Rijk, Juan-Carlos Perez and the SMC team for the inclusive and well-prepared presentations. We really appreciate the effort performed in bringing the SMC program to the present level of achievement.

This review is the first one of a series of small reviews addressing specific parts of the FRESCA2 project. The Committee believes that these reviews will be very useful for the management of the project, and suggests changing the format to internal reviews, possibly involving external reviewers, for greater flexibility. The reports of the internal reviews will be useful for the next ESAC review of the FRESCA 2 project.

This report is arranged in the form of responses to the questions presented in the charge.

Is SMC the correct way for preparing the Fresca2 magnet project ?

The SMC program is designed to be a test bed for developing the various aspects of Nb₃Sn coil and magnet technology and as such has been very successful, culminating in the test of SMC3, showing that there is a good understanding of the magnet performance coupled with careful analysis. The team is to be congratulated for this successful magnet. On-going detail analysis of the strain gauge data from the Run 3 test would help in further understanding the relationship of preload, strain gauge data and quench performance. However, this program is limited in what can be developed for the final dipole magnet, in particular because of the absence of the flared ends and of an open bore, and because of the different type of the layer jump.

Some SMC work (for instance the SMC 11T) is supporting other programs and is therefore out of the scope of this review. The SMC3b (the coils of which are being fabricated using cable similar to SMC3) is testing out an insulation scheme of the end-parts that may prove beneficial to the program as this was one area of insulation failure seen in SMC3. This resolution is significant as the effect of axial loading can be studied and is necessary in the final FRESCA2 magnet. For the FRESCA2 magnet the type of S2-glass sleeve cable insulation used for SMC3 is adequate, as the unit length of the coils is ~ 200-250 m and such type of sleeve can be used, although it is labor intensive. For now this choice is acceptable. Other insulation schemes are being pursued under separate programs.

What is eventually missing in the SMC program ?

Taking into account that SMC is not the core of the EuCARD project, and that we are already late: we have announced to the EC that, at the official end of EuCARD (April 2013), only one FRESCA2 coil will be tested, and that the full dipole will be tested only at the end of 2013 (main deliverable of task 3)

The SMC coils allow a short turnaround time and use a limited amount of conductor; on the other hand they lack several features of the FRESCA2 coils, most significantly: the flared ends and the open bore. The layer jump in FRESCA2 is also very different from the one used in SMC coils.

Realizing the limitations of the SMC program, the FRESCA2 team outlined a second pathway (RMC) of testing out elements of the final magnet technology. Using a longer straight section and a bigger structure, the team plans to test a pair of coils using the FRESCA 20 mm wide cable. The first goal is to check out the performance of the wide cable and examine if the layer jump (similar to the one envisioned for FRESCA coils), which is in high field, may limit the magnet performance. Their plans do not include the implementation of the flared ends. This will be tested in the first coils made using the FRESCA2 coil tooling that is under procurement.

This RMC program is quite a leap forward in the complexity and size of magnet compared with SMC, and according to some Committee members, it is a necessary step for building the final magnet. However, there is not much time interval in the completion of the first test of an RMC magnet and the need to start coil fabrication for FRESCA2 in FY12-Q4.

Secondly, one of the difficult challenges of using racetrack coils with a reasonable bore size is not addressed in the RMC plans: the flared ends. Many members believe that this may be the trickiest design challenge. However, this challenging design feature is not addressed at all before final coil fabrication begins.

Several members are concerned that the RMC development may cause further delays to FRESCA2. Since no updated schedule was presented at this review, the Committee cannot further address this point. In order to reduce the risk of significant delays, the Committee recommends moving ahead with the fabrication of FRESCA2 dummy coils as quickly as possible. Depending on schedule and resources the fabrication of FRESCA2 dummy coils may be done in parallel with the RMC R&D or, according to some committee members, it should replace the RMC R&D if they cannot be done in parallel.

Since a FRESCA2 coil uses about 4 km of wire there is the hesitancy of “wasting” wire to learn more about coil fabrication. Similar programs have shown that strand availability may stifle technology development. It appears that there is not enough superconductor strand planned within the program for rapid technology development.

Are there improvements to be done for SMC3b and further (the next ones to be built) ?

The SMC3b plan is well devised and the Committee supports it. It is very important for the FRESCA2 team to confirm the excellent performance of SMC3, while avoiding the electrical issues. The effect of axial preload should also be addressed with SMC3b. Other programs have shown that small racetrack coils can operate well with minimal or no axial preload, whereas larger coils need adequate axial preload and support. The SMC3 has a 1.25 mm strand for “historic” reasons. Although not optimal this is not a good reason for not going ahead with the SMC3b.

If the FRESCA2 team decides to go ahead with the RMC it may be beneficial to redirect the resources planned for SMC4 and SMC5 toward the RMC.

Additional comments and recommendations

The Committee recommends the development and maintenance of a resource loaded schedule (i.e. a schedule with human resource allocation) showing the links among major tasks. Such a schedule will help the project management in finding the optimal balance between R&D-oriented tasks (SMC, RMC, FRESCA2 dummy coils) and the need to avoid/reduce additional delays. It will also be very useful for the ESAC Committee if, in addition to purely technical matters, it reviews the status and plans of the overall project.

The Committee suggests starting the next ESAC review with the responses to the recommendations in the report by the Committee of the review held at Saclay in January 2011.

In preparation for the next ESAC review the Committee suggests a thorough analysis of test results and issues encountered by similar projects (for instance the HD R&D at LBNL) in order to assure the highest probability of success by addressing the main potential issues as earlier as possible. The Committee expects this analysis to be a highly valuable contribution to the next review.