

Second Review of the EuroCirCol WP5 Working Group



Review Committee:

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General Comments

- A diverse and well-coordinated group.
- Lots of hard work evidenced by considerable progress since the review last May!
- Excellent responses to the recommendations.

CHARGE

1. Are the baseline parameters considered in the study credible for a FCC CDR?
2. In the CDR we will describe a baseline design, with also a brief description of alternatives. The proposed baseline design is the cosine-theta: do you support this choice or would you suggest a different one?
3. Do you have any suggestions for improvements to the design options presented during the review?
4. Is there any specific additional study that you suggest to perform in view of the preparation of the FCC CDR?
5. Do you have any comments on the EuroCirCol WP5 Road-Map?

1. Are the baseline parameters considered in the study credible for a FCC CDR?

Yes

- Conductor performance expectation is likely to be realized within the required timeframe. Nevertheless, continuous investment and effort should continue to achieve this goal.
- All designs are very close to the stress limit. There could still be uncertainty in the coil pack modulus. We encourage continued Measurements of representative winding pack compositions, Geometries and boundary conditions to reduce uncertainties.
- The assumed conductor cost reduction is highly uncertain at this time and should be reflected in the CDR. Perhaps by using a range?

Recommendation:

Establish a common materials database and document the design criteria.

We recommend to establish a strain criteria for the conductor and make sure it is met.

2. In the CDR we will describe a baseline design, with also a brief description of alternatives. The proposed baseline design is the cosine-theta: Do you support this choice or would you suggest a different one?

Yes

- We support the choice of cosine-theta as a baseline for the CDR but the other options should remain under consideration as resources allow.
- The operating margin seems feasible at this time but will need to be reassessed by making short models.
- We encourage continued work on 3D design and analysis.

Recommendation:

Obtain more realistic data on manufacturability and operating performance through an R&D program. Build magnets!

3. Do you have any suggestions for improvements to the design options presented during the review?

- The cut-out in the pole for the cos-theta needs further analysis and optimization of the shape.
- Further, the cut-out requires winding and curing two layers together. The Implication of curing two layers together should be studied more carefully.
- For the block and other designs it is important to get feedback from WP2 Regarding compensating end field harmonics with the body.
- Since the design assumes sliding between pancakes features should be added to assure smooth sliding and avoiding stick-slip.
- In the longer term, investigate alternative impregnation systems with a goal to improve magnet performance.

4. Is there any specific additional study that you suggest to perform in view of the preparation of the FCC CDR?

- We suggest a technological risk analysis for each design.
- If you can prove that the CLIQ can be made reliable with some redundancy we suggest making it the baseline.
- The quench protection analyses for both heaters and CLIQ indicate that the 350 K hotspot temperature limit could be met. Nevertheless, that is a high number.
- Some fatigue analysis has been done, but this should be carried out for all design options.

Recommendations:

Generate a risk register with mitigation strategies for each of the designs.

Undertake some thermal mechanical stress analyses to determine if stress or strain criteria in the magnet are not exceeded at the 350 K hot spot temperature.

Perform a sensitivity analysis on the assumed properties of structural and coil pack materials and contact interface assumptions.

5. Do you have any comments on the EuroCirCol WP5 Road-Map?

- The cost model is based on the LHC which is based on a different technology. Optimize production cost taking into account the different technological steps required for Nb₃Sn magnets.
- Time for writing is getting short so the focus should be on documenting the baseline design for the CDR.