Close-Out of MQXF Cable Review

5-6 November 2014

Introduction

- Critical and important project; unique opportunity to make higher performance, space effective accelerator magnets using Nb_3Sn
- Enthusiastic transatlantic team, bringing a new generation
- Good communication between Hi-Lumi and LARP
- Great recent progress
- It has to move from an R&D effort to a construction project!

Overall/schedule - 1

- Design goals shall be conservative because Nb_3Sn accelerator magnet technology is still not sufficiently matured and impregnated Nb_3Sn coils operated at 1.9 K are prone to self-field instabilities

- Therefore: optimize margin by all means, such as: increasing length, revisiting Cu-to-non-Cu ratio, and so on.

- Make use of model/prototype phase for finalizing specifications essential for success, including of acceptance criteria

Overall/schedule - 2

- Keep 2 strand suppliers; if one supplier has less maturity, it will require more resources
- Schedule is challenging; there should be some clearly defined articulations and decision points between the phases
- Address plan B

Technical specs

- Not complete at this time
  - Relationship of superconductor properties to magnet performance has not been clearly defined
- Add requirement on strand cleanliness and surface conditions (especially for bare copper strands)
- Clarify billet/unit length approval
- Benefit from model/prototype program to confirm that the following specs are correct:
  - strand I_c: 361 A at 4.2 K and 15 T
  -RRR: 150 on virgin strand/100 on extracted strand
- Address R_a and R_c on cable

RRP

- Go ahead with 132/169 lower Sn content; final decision in one year concerning series production contract (back up being 108/127)

- Consider proposal to reduce keystone angle

PIT

- Promote a substantive development program with BEAS to optimize strand properties and establish performance baseline for series production
- In the meantime, CERN should go ahead with RRP for model magnet production and should optimize phasing of strand/cable deliveries between RRP and PIT.
- Reduced keystone angle is a must.

QA/QC

- Must be finalized during model/prototype phase
- Level of verification measurements can be based upon ITER experience
- Promote development of in-line video quality control of cable (in particular, at the thin edge)
- Better identify qualification plans including specific cryogenic tests such as: “local” measurements, full-size conductor tests and magnet tests
- For series productions: all acceptance tests should have criteria; requirements should be identical for LARP and Hi-Lumi

Conclusion

1. Are the Functional or Technical Specification for conductor strand and cable adequate to the scope of the MQXF ?

Incomplete

Are they sufficiently developed and reasonably finalized ?

incomplete

2. Does the design of strand and cable meet the specifications in terms of minimum Ic, maximum allowed degradation, minimum RRR, maximum Deff, stability request, cable size, and unit length ?

I_C and minimum RRR have to be revisited

D_{eff} is not critical around 50 μm

3. Assess the likelihood of meeting – with adequate margin – the chosen specifications and requirements based on the decade long experience acquired by LARP in cables and magnet construction and the most recent experience in Europe.
Very optimistic, needs more optimization

4. Is the plan for two types of strand architecture (RRP and PIT) correctly managed inside the program?
PIT needs more support

5. Is the procurement schedule, with associated QA and test plan, credible and adequate for the prototyping phase (where applicable) and for the construction phase?
Not yet, need to better articulate the different project phases and the decision points