



Report of the MQXFA08b structure and shim review

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US HL-LHC Accelerator Upgrade Project

Report of the MQXFA08b structure and shim review

June 14, 2022

- Peter Wanderer, BNL, chairperson
- Susana Izquierdo Bermudez, CERN
- Rodger Bossert, FNAL



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1. Goal and scope

The HL-LHC AUP project is starting the assembly of MQXFA08b magnet. This is the first re-assembly of an MQXFA magnet that did not meet requirements during vertical test. If MQXFA08b meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC.

During vertical test MQXFA08 reached and hold acceptance current (16.53 kA) but showed detraining to ~15.7 kA afterwards. All detraining and limiting quenches were in coil 213 [2]. The other three coils of MQXFA08 did not show any issue and will be re-used in MQXFA08b. Coil 219 has been selected to replace coil 213.

MQXFA08 coils were reviewed during the MQXFA08 Coils Acceptance Review [3]. Coil 219 was reviewed during the Coils Acceptance Review for MQXFA07b and MQXFA11 [4]. MQXFA08b coil ordering and voltages were reviewed during a Working Group meeting [5]. MQXFA08 structure was reviewed during the MQXFA08 Structure & Shims Review [6].

MQXFA Series magnet specifications are presented in [7]. Discrepancy or Non-Conformity Reports are generated whenever a component does not meet specifications [8].

The goal of this review is to evaluate MQXFA08b structure assembly and shim plans. Reviewers should also assess that discrepancies and non-conformities from MQXFA08 disassembly and inspection have been adequately processed, and that the shims will allow MQXFA08b to meet MQXFA requirements [1].

Technical details

Committee

- Peter Wanderer, BNL, chairperson
- Susana Izquierdo Bermudez, CERN
- Rodger Bossert, FNAL

Date and Time

June 14, 2022. Start time is 7/9/10/16 (LBNL/FNAL/BNL/CERN)

Location/Connection

Video-link by Zoom, info by email.

Link to agenda with talks and other documents

<https://indico.fnal.gov/event/54942/>



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2. Review Charges response

The committee is requested to answer the following questions:

1. Have discrepancies and non-conformities been adequately documented and processed?

Finding: No.

- There are two issues that need to be resolved before the assembly begins: load pad arc marks (item C in K. Rays talk, slide 8) and master keys dress out following bronze key damage (D)
- One issue needs to be resolved prior to electrical testing of the assembled magnet: cracked cliq lead insulation (#353).

Comment: Work on these issues is underway.

- Regarding the cracked cliq lead insulation (#353); this is a problem with the design of the cliq cable insulation that was provided by CERN. The solution of replacing the cables with a new, acceptable design has been provided by them. However, depending on the state of assembly, it may be difficult to replace the cables in some of the magnets without a significant amount of rework and risk.
- “(D) bronze key stuck to master keys, both top & one right master key pair – cracks persist after key removed” needs to be carefully addressed. Keeping in mind that the iron is brittle at cold, an analysis is needed to show that there is not a potential risk for crack initiation in the region where the master has cracks

Recommendations:

- Compile a list of the magnets, if any, for which a complete replacement of the earlier style cliq leads cannot be completed, which includes the solution for each one. The list does not need to include magnets that have already been shipped to Fermilab.
- Carry out the analysis re: crack initiation listed above.
- Report the resolution of load pad arc marks to the L2 manager prior to commencing work that incorporates them.

2. If there are critical non-conformities, have they been adequately documented and processed?

Finding: No. .

3. Are the proposed shims adequate for allowing MQXFA08b to meet MQXFA requirements [1]?

Finding: Yes.

Comment: The shims were calculated using same stress targets as the pre-series and series magnets. This magnet will incorporate changes to the pole key gap relative to previous magnets (ref. DocDB 4009). Nevertheless, this is the first time AUP is assembling in the same magnet virgin coils and already tested coils. The choice of AUP is to use the coil geometry before cold power testing for the already tested coils, consistent with LARP experience.

Recommendation: none.

4. Have all recommendations from previous reviews [9] been adequately addressed?

Finding: Results of two recommendations from the review of Magnet MQXFA11 (evaluation of CERN method for applying preload via bladders in the cooling holes in conjunction with standard bladders elsewhere in the yoke; incorporation of Belleville washers) are not available for this magnet.

Comment: Work on the recommendations is underway.

Comment: In the review of magnet MQXFA11, one of the comments was: The cause of the recent decrease in the size of coils from both laboratories needs to be found. An update on the status of the investigation was not provided.

Recommendation: Carry these two recommendations and the coil size decrease study to the next magnet review.

5. Do you have any other comment or recommendation to assure MQXFA08b is going to meet requirement?

Finding: Yes.

Comment: Editing the work instructions for the horizontal yoke-shell subassembly to include the check on the straightness of the yoke shell is underway.

Recommendation: Complete update of this WI for use in MQXFA08b.

3. Summary of Recommendations:

Recommendations that need to be resolved for use in the assembly of MQXFA08b:

- load pad arc marks (item C in K. Ray's talk, slide 8)
- master keys dress out following bronze key damage (item D) including analysis of possible crack initiation,
- revise WI for yoke-shell assembly to include check of straightness

Recommendations that needs to be resolved prior to electrical testing of the assembled magnet:

- replacement for cracked cliq lead insulation (#353)

Recommendations to be carried forward to the next magnet review:

- evaluation of CERN method for applying preload via bladders in the cooling holes in conjunction with standard bladders elsewhere in the yoke;



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- incorporation of Belleville washers;
- list of magnets requiring custom cliq cables,
- study of decrease in coil size

4. References

- 1) *MQXFA Functional Requirements Specification*, US-HiLumi-doc-36.
- 2) *MQXFA08 Test Results*, <https://indico.fnal.gov/event/53196/>
- 3) *MQXFA08 Coils Acceptance Review*, US-HiLumi-doc-4057.
- 4) *Coils Acceptance Review for MQXFA07b and MQXFA11*, US-HiLumi-doc-4224.
- 5) Coil WG meeting on May 26, 2022, <https://indico.fnal.gov/event/54756/>
- 6) *MQXFA08 Structure & Shims Review*, US-HiLumi-doc-4058.
- 7) *MQXFA Series Magnet Production Specification*, US-HiLumi-doc-4009.
- 8) *Handling of Discrepancies and Nonconformances*, US-HiLumi-doc-2484.
- 9) *MQXFA11 Structure & Shims Review*, US-HiLumi-doc-4309.