



Report of the MQXFA11 structure and shim review

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US HL-LHC Accelerator Upgrade Project

Report of the MQXFA11 structure and shim review

March 17, 2022

- Peter Wanderer, BNL chairperson
- Mike Anerella, BNL
- 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 MQXFA11 magnet. This is the fourth series magnet of the MQXFA low beta quadrupoles to be used in Q1 and Q3 for the High Luminosity LHC. If MQXFA11 meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC.

MQXFA11 coils were reviewed on November 12, 2021 [2].

The dis-assembly of MQXFA07 showed a large asymmetry in pole-key gaps. MQXFA Series magnet specifications [3] were changed in order to prevent excessive asymmetry in future magnets.

AUP decided to dis-assemble MQXFA09 because a critical non-conformity was found during final inspection. Therefore, MQXFA11 is going to use the structure that we used to assemble and pre-load MQXFA09. MQXFA09 structure was reviewed on July 22, 2021 [4].

The goal of this review is to evaluate MQXFA11 structure assembly and shim plans. Reviewers are requested to assess that MQXFA11 assembly is going to meet the revised MQXFA Series magnet specifications [3] and that it will prevent the critical NCR that caused MQXFA09 disassembly.

Reviewers should also assess that discrepancies and non-conformities of the magnet structure have been adequately processed, and that the shims will allow MQXFA11 to meet MQXFA requirements [1]. Technical details

Committee

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

Date and Time

March 17, 2022. Start time is 7/9/10/15 (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/53560/>



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2. Review Charges response

The committee is requested to answer the following questions:

1. Have Work Instructions (travelers) been revised to meet the revised MQXFA Series magnet specifications [3]?

FINDING: yes

COMMENT: A draft copy of the revised Coil Pack WI contains the current value for the pole key gap. The procedure for achieving these pole key gaps was successfully used for building the coil packs for magnet MQXFA10.

RECOMMENDATION: Review existing pole gap data at 50 ft-lb and 75 ft-lb to verify whether an adjustment is needed in the target pole gap specification as a result of the new collar clamping method (since prior gap specification was based on 75 ft-lb and the new method likely results in a lower average torque)."

RECOMMENDATION: If the interception of force through the pole key is considered as a possible contributor to the performance degradation in MQXFA07 and MQXFA08, it shall be addressed in MQXFA11.

RECOMMENDATION: In case the decision is to increase the pole gap, a closer follow up of the first coil packs and magnets magnetic measurements is needed to assess that it does not have a significant impact on the field quality or field angle. A detailed comparison of the magnetic measurements of MQXFA10-first build up (non-uniform gaps) and MQXFA10-second build up (uniform gaps) is advised, to assess the importance of the squareness of the coil pack and the uncertainty of the coil position within the magnet.

2. Have Work Instructions (travelers) been revised to prevent the critical NCR that caused MQXFA09 disassembly?

FINDING: yes

COMMENT: A draft copy of the revised Coil Pack WI contains the inspection procedure needed to prevent the folding of the midplane Kapton. The draft WI also includes the new procedure for squaring the coil pack.

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

FINDING: Yes.

COMMENT: The Assembly and Loading WI has been revised to prevent removal of the bladders when the load keys are not present. NCR #320 (problem with loosing bolts secured with thread locking compound) documented this problem for MQXFA11. To avoid future problems at this stage of magnet



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production, use of this compound will be deferred to assembly of the cryostatted unit at Fermilab.

RECOMMENDATION: none.

4. If there are major non-conformities [6], have they been adequately documented and processed?

FINDING: No major non-conformities have been found in MQXFA11.

RECOMMENDATION: none.

5. Are the proposed shims adequate for allowing MQXFA11 to meet MQXFA requirements [1]?

FINDING: Yes, with the exception of one location in two coils.

COMMENT: The procedure for calculating the shims was that used for previous magnets.

COMMENT: It was determined that the low coil arc lengths measured at $z=1465$ mm in coils 222 and 223 were the result of anomalies in the data around the pole key. When the anomalies were removed, the arc lengths were within specification. The cause of the anomalies is not yet known.

RECOMMENDATION: none

6. Have all recommendations from previous reviews [5] been adequately addressed?

FINDING: Yes.

7. Do you have any other comment or recommendation to assure MQXFA11 is going to meet requirements?

COMMENT: The cause of the recent decrease in the size of coils from both laboratories needs to be found.

RECOMMENDATION: Determine whether it is possible for AUP to adopt the CERN method for applying preload via bladders in the cooling holes in conjunction with standard bladders elsewhere in the yoke. This has been demonstrated to permit greater margin in coil stress and should be able to be implemented with exact configurations of CERN bladders and spacers in these regions of the magnet.

FINDING: Screws are locked into threaded holes with ORAPI Freinage Moyaen 303 (the CERN approved locking compound) on both the splice box and the housings which enclose the quench protection heater jumpers. It has been found that the screws cannot be removed without breaking the housings or the covers from the splice boxes.

COMMENT: When preparing for testing at BNL, or when preparing a magnet for cold mass at Fermilab, covers for these components occasionally need to be removed. If the threads are locked in this way at LBNL, these operations may not be able to be completed without breaking the splice box or housing covers, causing delays as well as risk. Consideration was given to having this operation

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done during the cold mass assembly at Fermilab, but this solution has schedule impact that is considered undesirable.

RECOMMENDATION: Change method of securing screws. Belleville washers which are available in 316 Stainless are an option. Other methods of securing screws can be considered.

3. Comments

4. Recommendations

5. References

- 1) *MQXFA Functional Requirements Specification*, US-HiLumi-doc-36.
- 2) *MQXFA11 Coils Acceptance Review*, US-HiLumi-doc-4224.
- 3) *MQXFA Series Magnet Production Specification*, US-HiLumi-doc-4009.
- 4) *MQXFA09 Structure & Shims Review*, US-HiLumi-doc-4183.
- 5) *MQXFA10 Structure & Shims Review*, US-HiLumi-doc-4202.
- 6) *Handling of Discrepancies and Nonconformances*, US-HiLumi-doc-2484.