



# Report of the MQXFA09 Structure and Shim Review -Final

US-HiLumi-doc-4183

Other:

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## US HL-LHC Accelerator Upgrade Project

### Report of the MQXFA09 Structure and Shim Review

*July 22, 2021*

- Rodger Bossert, FNAL chairperson
- Mike Anerella, BNL
- Helen Felice, CERN



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## 1. Goal and scope

The HL-LHC AUP project is starting the assembly of MQXFA09 magnet. This is the second series magnet of the MQXFA low beta quadrupoles to be used in Q1 and Q3 for the High Luminosity LHC. If MQXFA09 meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC.

MQXFA08 coils were reviewed on June 16, 2021 [2]. MQXFA Series magnet specifications are presented in [3]. Discrepancy or Non-Conformity Reports are generated whenever a component does not meet specifications.

The goal of this review is to evaluate the MQXFA09 structure and shim plan. The reviewers are requested to assess that discrepancies and non-conformities of the magnet structure have been adequately processed, and that the shims will allow MQXFA09 to meet MQXFA requirements [1].

## 2. Technical details

### Committee

- Rodger Bossert, FNAL chairperson
- Mike Anerella, BNL
- Helen Felice, CERN

### Date and Time

July 22, 2021. 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/50067/>

### 3. Review Charges response

The committee was requested to answer the following questions:

1. Have discrepancies and non-conformities been adequately documented and processed? Yes
2. If there are major non-conformities, have they been adequately documented and processed? Yes.
3. Are the proposed shims adequate for allowing MQXFA09 to meet MQXFA requirements [1]? Yes.
4. Have all recommendations from previous reviews [4] been adequately addressed? Yes.
5. Do you have any other comment or recommendation to assure MQXFA09 is going to meet requirements? See comments below.

### 4. Findings

1. Heng Pan has departed, and a replacement has been added (Laura Garcia Fajardo), but it will take some time to become acquainted with the data. Consequently, strain gauge analysis will be more difficult to complete efficiently in the short run. Strain gauge data analyses for magnets MQXFA05 and MQXFA06 are not yet finished.
2. Two stations are now being used to build two magnets simultaneously. The plan is to continue a schedule which requires two simultaneous builds. The previous PRR recommendation, to develop a resource loaded schedule to determine resources required to support this plan, has not yet been completed and is projected to be complete in the next two weeks. Related to this effort, a senior supervisor technician is retiring in the near future.
3. The epoxy impregnated fiber glass on some coils from Fermilab is chipping away at the pole as a result of trimming and needs to be dressed. In some areas it has chipped away enough to expose jagged edges and bare metal.
4. One coil from BNL was reported as having an exposed uninsulated wire. LBNL indicated this had not yet been independently reported to BNL.
5. Heat Exchanger and Integration Table Interference problems have been understood and preventative actions have been taken (end plate and splice box revisions, alignment tooling modifications) for the future including this magnet.

## 5. Comments

1. Since Heng Pan has departed, strain gauge data analysis will be more difficult to complete on time. As a result, more attention needs to be paid to finish analyzing strain gauge data. In particular, relative preload data during cooldown specific to shell stress for magnet MQXFA06 is not available.
2. On slide 4 of “MQXFA09 Preload Proposal”, the 80 MPa azimuthal preload is stated as 80 MPa at R.T after 24 hours, and also that this assumes 5-10 MPa decrease in 24 hours. For the axial preload the total rod strain is stated as 950  $\mu\epsilon$  at R.T., but not whether this value is before or after relaxation or how much and how long the relaxation is expected to be. It would be good to make these statements consistent for both the azimuthal and axial preload.
3. It would be a significant advantage to the Project to report all nonconformances, even informally, on a more timely basis.

## 6. Recommendations

1. Response to recommendation #1 from the Production Readiness Review - “Complete a comprehensive daily workflow study using two magnet assembly lines in parallel. Confirm minimum required technical resources to support both assembly lines. Ensure sufficient resources are available for this minimum requirement plus contingency for illnesses, vacation, and other unexpected loss of resources” is still a work-in-progress. Please put sufficient effort to completing the schedule with resource loading for the two teams simultaneously during the two weeks stated. Related to the previous statement, Slide 6 of “MQXFA09 Response to Recommendations” includes four technicians for magnet construction, which technically is enough for two stations. However, one (Ahmet Pekedis) is about to retire, and there is no accommodation for other loss of resources. Effort should be put into hiring technicians for the production crew, and to ensuring that there is enough overlay between Ahmet and his replacement. In addition, it is not clear if the mechanical instrumentation installation is covered by another set of technicians or if the pool of 4 technicians is covering assembly and instrumentation. This point should be clarified.
2. On slide 13 of “Magnet Fabrication Travelers, Non-Conformities and Resolution”, a picture of the epoxy impregnated fiber glass peeling off the upper surface of coils 129 and 130 is shown, leaving rough irregular edges which might subsequently cut the ground plane insulation. In some cases, the metal surface of the key is exposed. This non-conformity could also leave an excessive void which might compromise the support of the coils. This was described as a recurring problem. Although a repair is planned at LBNL, the committee feels that –



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- a. A standard repair procedure with an L2 approved off-normal form (US-HiLumi-doc-2481) should be required before proceeding with MQXFA09 assembly.
  - b. This procedure should also be discussed with Fermilab engineers and/or technicians to find a solution to this issue so this non-conformance is not repeated.
3. Proceed with the MQXF09 Assembly after recommendation 2. is completed.

### 7. References

- 1) MQXFA Functional Requirements Specification, US-HiLumi-doc-36.
- 2) MQXFA09 Coils Acceptance Review, US-HiLumi-doc-4091.
- 3) MQXFA Series Magnet Production Specification, US-HiLumi-doc-4009.
- 4) MQXFA08 Structure & Shims Review, US-HiLumi-doc-4058.