



Report of the MQXFA06 structure and shim review

US-HiLumi-doc-3719

Other:

Date: 11/2/2020

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US HL-LHC Accelerator Upgrade Project

Report of the MQXFA06 structure and shim review

October 20, 2020

- 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 MQXFA06 magnet. MQXFA06 is the fourth pre-series of the MQXFA low beta quadrupoles to be used in Q1 and Q3 for the High Luminosity LHC. If MQXFA06 meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC.

MQXFA06 coils were reviewed on September 25, 2020 [2]. MQXFA pre-load targets and pre-loading sequence for MQXFA03 and following magnets were approved by AUP Technical Board on July 5, 2019 [3].

The goal of this review is to evaluate the MQXFA06 structure and shim plan. The reviewers are requested to assess that the MQXFA06 structure meets the MQXFA Structural Design Criteria [4], that non-conformities have been adequately processed, and that structure and shims will allow MQXFA06 to meet MQXFA requirements [1]

2. Technical details

Committee

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

Date and Time

October 20, 2020. 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/45847/>



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3. Review Charges response

The Committee appreciated the detailed technical discussions with the LBNL staff.

The committee was requested to answer the following questions:

1. Does the MQXFA06 structure meet the MQXFA Structural Design Criteria [4]? **Yes.**

Finding: The MQXFA06 structure has the same design as the MQXFA03, MQXFA04, and MQXFA05 structures, which were found to meet the Structural Design Criteria.

2. Are there major non-conformities? If answer is yes, have they been adequately documented and processed? **No.**

3. Are the proposed shims adequate for allowing MQXFA06 to meet MQXFA requirements [1]? **Yes.**

Finding: Preload targets are the same as those for magnets MQXFA03 - MQXFA05.

Finding: Average preloads achieved in these magnets were within the target range.

4. Is there anything that could prevent MQXFA06 to meet the MQXFA Interface Specification [5]? **No.**

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

6. Do you have any other comment or recommendation to assure MQXFA06 is going to meet requirements. **Yes.**

4. Comments

Question #1: Structure

- Coil Selection. Consider adding field quality to the parameters that are reviewed as part of the coil selection process.
- Yoke and Pad. It would be useful to monitor and control the weights of yokes and pads to ensure that magnetic iron is uniformly distributed within the magnet.
- Keyway. It may be useful to add plots of keyway asymmetry for conforming coils also, to better understand the impact of nonconforming pole keyways as assembled.

Question #6: Other.

- Review coil manufacturing procedures for Fermi – BNL differences that do not arise from the obvious differences in coil winding and curing.



5. Recommendations

Question #1 Structure.

- End Plate Shifts. Revise analysis to include inspection data taken when magnet arrives at BNL.
- Pole Offsets. Evaluate effect on field quality of 0.6 mm offsets in the pole of one coil, such as coil 117.
- Pions. Evaluate procedure for installation of pions, to obtain better accuracy of initial installation without the need to remove insulation.

Question #3 – Shims

- Bolt Tightening: Reevaluate bolt tightening sequence and procedure, in light of the AUP-CERN differences in approach. Emphasize squareness of assembly / equal collar gaps.
- Coil sizes: If appropriate, create “corrected” coil azimuthal size plots versus axial location to show corrected sizes after shimming.
- Preload: Estimate preload along the full length of the magnet, particularly at the minimum coil size locations, as compared to the coil preload for the measured coil size at the strain gauge location.
- Coil Selection: Consider using coil 123 instead of coil 117 to eliminate the need for midplane shimming proposed to coils 117 and 119, and to eliminate the need to correct the condition of 350 μ m beyond acceptable limit of pole key asymmetry.

6. References

- 1) MQXFA Functional Requirements Specification, US-HiLumi-doc-36.
- 2) MQXFA06 Coils Acceptance Review, US-HiLumi-doc-3675.
- 3) MQXFA03 pre-load targets and pre-loading sequence, US-HiLumi-doc-2496.
- 4) MQXFA Structural Design Criteria, US-HiLumi-doc-909.
- 5) MQXFA Magnet Interface Specification, US-HiLumi-doc-1674.
- 6) Report of the Review of the MQXFAP2 Al-Shell Issue and Lessons Learned, US-HiLumi-doc-2192; MQXFA05 Structure & Shims Review, US-HiLumi-doc-2904.

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