



**Report of the  
MQXFA12  
Coils Acceptance Review**

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 1 of 7



**US HL-LHC Accelerator Upgrade Project**

**Report of the MQXFA09 Coils Acceptance Review**

*July 12<sup>th</sup> 2022*

- Steve Gourlay (chairperson), LBNL
- Arup Ghosh, BNL retired
- Attilio Milanese, CERN



# Report of the MQXFA12 Coils Acceptance Review

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 2 of 7

## TABLE OF CONTENTS

1. GOAL AND SCOPE .....	3
2. TECHNICAL DETAILS .....	3
3. COMMENTS .....	4
4. RECOMMENDATION .....	4



# Report of the MQXFA12 Coils Acceptance Review

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 3 of 7

## 1. Goal and scope

The HL-LHC AUP project is planning to start assembly of MQXFA12. This is the 5th series low-beta quadrupole magnet (MQXFA) for the Inner Triplet of the High Luminosity LHC. If MQXFA12 meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC. For MQXFA12 assembly AUP is planning to use QXFA coils: 136, 137, 224 and 225. Coil 218 is planned for future use in MQXFA07b and is the spare coil for MQXFA12. Coil 218 was reviewed during the *Coils Acceptance Review for MQXFA07b and MQXFA11* [2] and is assumed acceptable for use in MQXFA12, if needed. In addition, we would like to discuss with the committee the possible use of coil 220 as spare coil for MQXFA12, if voltages will be within specs. Coil 220 was reviewed during the *MQXFA10 Coils Acceptance Review* [3].

Conductor and series coil specifications are presented in [4-8]. Discrepancy or Non-conformity Reports are generated whenever a component does not meet specifications.

The reviewers are requested to review discrepancies and non-conformities in strands, cables and coils, for the following coils: 136 (cable P43OL1155), 137 (cable P43OL1162), 224 (cable P43OL1148), and 225 (cable P43OL1149).

## Technical details

### Committee

Steve Gourlay (chairperson), LBNL  
Arup Ghosh, BNL retired  
Attilio Milanese, CERN

### Date and Time

July 12, 2022. Start time is 7/9/10/16 (LBNL/FNAL/BNL-FSU/CERN)

### Location/Connection

Video-link by Zoom, info by email.

### Link to agenda with talks and other documents

<https://indico.fnal.gov/event/55343/>



# Report of the MQXFA12 Coils Acceptance Review

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 4 of 7

## 2. Review Charges responses

The committee is requested to answer the following questions:

1. Have Discrepancies and Non-conformities been adequately documented and processed? YES
2. If there are critical Discrepancies/Non-conformities, have they been adequately documented and processed? YES
3. Did the L3s properly identified critical Discrepancies/Non-conformities? YES
4. Is there any coil that you recommend not to use in MQXFA12?

No, based on the material that was presented.

5. Are you OK with the possible use of coil 220 as spare coil for MQXFA12 and for future magnets?

YES: The popped strands issue now appears to be less critical based on the autopsy results of MQXFA07; however, it would be interesting to check whether the delicate operation performed on the reacted-not-yet-impregnated coil (removal of two outer layer poles and insulation repair) has also been performed on other coils which have since been cold tested.

6. Do you have any other comment or recommendation regarding these coils and their conductor for allowing MQXFA12 to meet MQXFA requirements [1]?

See Comments below.



# Report of the MQXFA12 Coils Acceptance Review

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 5 of 7

## 3. Comments

The presentations were well prepared with additional information in the Appendices.

The same comment regarding coil 220 can be made for 224 with respect to the removal of the two outer layer poles after reaction prior to impregnation and is a cause for concern. This was catalogued in the Review Report of MQXFA10 when Coil 220 was considered. Coil 220 underwent a "pole-short" repair similar to coil 224. A similar "pole-short" repair for Coil 216 was performed before impregnation. Coil 216 was presumably used in Magnet MQXFA09 that was not tested but was sent back to LBNL for reassembly. Magnet 10 is being tested at BNL and is behaving well. The committee was not aware if Coil 216 was used in the re-assembly of Magnet 10.

Delamination on coil 136 could be further inspected when the coil is re-measured, and a local repair could be considered.

It now seems generally okay to use a coil which has been observed to have popped strands during coil winding. A "popped-strand" DR has been documented for other coils that the committee has reviewed.

The committee was not aware whether a coil in which popped strands were seen has been successfully tested in a magnet.

Coil 214 that limited MQXFA07 performance had a "popped strand" DR, but as shown it was not the cause for the limited performance.

Coil 136: This coil has several dimensions (as measured at LBNL) that are out of tolerance and not well understood. As discussed at the meeting, we strongly recommend that this coil be re-measured at LBNL and cross-checked again with the FNAL measurements. More generally, the committee suggests that such a cross-checks between measurements in the different labs could become systematic, or at least performed before a coil acceptance review in case dimensional acceptance criteria are not met.



# Report of the MQXFA12 Coils Acceptance Review

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 6 of 7

All Cables are dimensionally within specifications and fairly uniform. Extracted strand  $I_c$  and RRR are well above specifications.

Regarding Coil Ordering, there are many options available for coil assembly for a voltage criterion of  $<353$  V.

## 4. Recommendations

Re-measure coil 136 at LBNL and cross-check again with the FNAL measurements. The committee further suggests to make measurement cross-checks a standard procedure.

## 5. References

- 1) *MQXFA Functional Requirements Specification*, US-HiLumi-doc-36
- 2) *Coils Acceptance Review for MQXFA07b and MQXFA11*, US-HiLumi-doc-4224.
- 3) *MQXFA10 Coils Acceptance Review*, US-HiLumi-doc-4186
- 4) *Specification for Quadrupole Magnet Conductor*, US-HiLumi-doc-40
- 5) *Cable Specification*, US-HiLumi-doc-74
- 6) *Quadrupole Magnet Cable Insulation*, US-HiLumi-doc-75
- 7) *QXFA Series Coil Production Specification*, US-HiLumi-doc-2986
- 8) *QXFA Series Coil Fabrication Electrical QC plan*, US-HiLumi-doc-521



# Report of the MQXFA12 Coils Acceptance Review

US-HiLumi-doc- 4321  
Other:  
Date: 07-12-2022  
Page 7 of 7