



**Report of
MQXFA13b
Coils Acceptance Review**

US-HiLumi-doc- 4956
Other:
Date: 11/08/2023
Page 1 of 6



US HL-LHC Accelerator Upgrade Project

**Report of
MQXFA13b Coils Acceptance Review**

November 08, 2023

- Arup Ghosh (Chairperson), BNL retired
- Susana Izquierdo Bermudez, CERN
- GianLuca Sabbi, LBNL



Report of MQXFA13b Coils Acceptance Review

US-HiLumi-doc- 4956
Other:
Date: 11/08/2023
Page 2 of 6

TABLE OF CONTENTS

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



Report of MQXFA13b Coils Acceptance Review

US-HiLumi-doc- 4956
Other:
Date: 11/08/2023
Page 3 of 6

1. Goal and scope

The HL-LHC AUP project is planning to start assembly of MQXFA13b. MQXFA13 showed a long training with some detraining after quench 10. It was able to reach acceptance current after 24 quenches. Subsequently, it quenched at every up-ramp after a down-ramp at 100 A/s. All detraining and ramp-dependent quenches were in coil 227 [1]. The other three coils of MQXFA13 did not show any issue and will be re-used if they pass QC tests (electrical and CMM) after disassembly.

If MQXFA13b meets MQXFA requirements [2] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC.

In MQXFA13b AUP is planning to use one of these new QXFA coils: 150, 234, 241 and 242.

Conductor and series coil specifications are presented in [3-7]. Discrepancy or Non-conformity Reports are generated whenever a component does not meet specifications.

Three coils (150, 234, and 242) have been presented at the MQXFA16 or MQXFA17 Coil Acceptance Review [8, 9]. At that time, it was recommended not using these coils because of small arc length in the ends. Updated analysis of this issue will be presented during this review.

The reviewers are requested to review discrepancies and non-conformities in strands, cable, and coil 241 (cable P43OL1188). In addition, they are requested to comment about the analysis of CMM measurements for all coils.

2. Review Charges responses

The committee is requested to answer the following questions:

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

YES. As recommended, MQXFA17 used coils 151, 152, 237 and 239. Also, as requested, CMM measurements were made at both the lead and return ends and the data were presented for the coils being considered. These data are quite useful in the understanding of stress-strain at the coil ends.



Report of MQXFA13b Coils Acceptance Review

US-HiLumi-doc- 4956

Other:

Date: 11/08/2023

Page 4 of 6

2. Have Discrepancies and Non-conformities been adequately documented and processed (all DR/NCR for coil 241, and new DR/NCR for the other coils)?

Coil 241 has only minor DR recorded at the coil manufacture stage. Strand and cable used for this coil also has only minor acceptable discrepancies.

It is noted that all the other coils being considered were reviewed earlier and were accepted for use in magnets. They were being held in reserve as the minimum arc length-excess which occurs at the coil-ends were similar to coil 227 that limited magnet 13 performance.

3. If there are critical Discrepancies/Non-conformities, have they been adequately documented and processed?

Yes.

4. Is there any coil that you recommend not to use in MQXFA13b?

At this stage, we recommend that coils 234 and 242 not be used as a replacement for coil 227 in this magnet.

5. Do you have any other comment or recommendation regarding these coils and their conductor for allowing MQXFA13b to meet MQXFA requirements [1]?

See sections below for comments and recommendations

3. Comments

FEM calculations presented show that the micro-strain at the coil-ends increases rapidly at low pre-stress levels for coils that have a larger difference in arc-length excess between the straight section and the end region of the coils. At a nominal pre-load of 67 MPa, calculations show that the micro-strain at the ends of the end of coil 227 probably reached ~5000 micro-strain. This is judged to be above an acceptable limit of 4500 micro-strain as was reached in MQXFA05 which was pre-loaded at RT to 72 MPa. Magnet MQXFA13 was pre-loaded to 67 MPa.

Based on present understanding, it is the intention of using a higher pre-load of 80 MPa if the difference in the arc-length between the straight-section and the end region at the spacer-wedge region is slightly above 210 μm . This threshold is deemed acceptable, since magnet MQXFA05 tested well at 4.2 K.



Report of MQXFA13b Coils Acceptance Review

US-HiLumi-doc- 4956
Other:
Date: 11/08/2023
Page 5 of 6

4. Recommendations

Based on detailed CMM end-measurements, the difference between arc-length excess in the straight section and that at the end region for coils 234 and 242 is $> 250 \mu\text{m}$. Using the $210 \mu\text{m}$ threshold guidance, we would recommend that these two coils not be considered at this stage in assembling magnet 13b. Preparations for using end shims on the loading keys should be completed soon so that coils with larger arc-length excess can be considered for future assemblies.

We encourage AUP to pursue destructive inspection of coil 227 to confirm the present understanding of the failure mechanism for magnet MQXFA13, as it was done with MQXFA07 and MQXFA08.

In terms of documentation, the situation is improving, but there are still documents missing for the coils/cables assembled in CM2 and CM3 (MQXFA04/05/10/11). Considering that the project is approaching the end of coil production, we encourage to allocate sufficient resources to assure all fabrication data (up to the completion of the coils at least) is uploaded in MTF.

Technical Information

Committee

Arup Ghosh (chairperson), BNL retired
Susana Izquierdo Bermudez, CERN
GianLuca Sabbi, LBNL

Date and Time

November 8, 2023. Start time is 7/9/10/16 (LBNL/FNAL/BNL-FSU/CEA-CERN)

Location/Connection

Video-link by Zoom, info by email.

Link to agenda with talks and other documents

[MQXFA13b Coils Acceptance Review \(8-November 10, 2023\) - INDICO-FNAL \(Indico\)](#)



Report of MQXFA13b Coils Acceptance Review

US-HiLumi-doc- 4956
Other:
Date: 11/08/2023
Page 6 of 6

5. References

- 1) [MQXFA13b Coils Acceptance Review \(8-November 10, 2023\) · INDICO-FNAL \(Indico\)](#)
- 2) *MQXFA Functional Requirements Specification*, US-HiLumi-doc-36
- 3) *Specification for Quadrupole Magnet Conductor*, US-HiLumi-doc-40
- 4) *Cable Specification*, US-HiLumi-doc-74
- 5) *Quadrupole Magnet Cable Insulation*, US-HiLumi-doc-75
- 6) *QXFA Series Coil Production Specification*, US-HiLumi-doc-2986
- 7) *QXFA Series Coil Fabrication Electrical QC plan*, US-HiLumi-doc-521
- 8) *MQXFA16 Coils Acceptance Review*, US-HiLumi-doc-4900
- 9) *MQXFA17 Coils Acceptance Review*, US-HiLumi-doc-4937