



# Review of the MQXFAP2 AI-Shell Issue and Lessons Learned

US-HiLumi-doc-  
Other:  
Date: 2/11/2019  
Page 1 of 4



## US HL-LHC Accelerator Upgrade Project

### Review of the MQXFAP2 AI-Shell Issue and Lessons Learned



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US-HiLumi-doc-  
Other:  
Date: 2/11/2019  
Page 2 of 4

## TABLE OF CONTENTS

1. GOAL & SCOPE.....	3
2. CHARGES .....	3
3. TECHNICAL DETAILS .....	4



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US-HiLumi-doc-  
Other:  
Date: 2/11/2019  
Page 3 of 4

## 1. Goal & scope

The HL-LHC AUP project is planning to start assembly of MQXFA Pre-series magnets in April 2019. In fall 2018 the second MQXFA prototype (MQXFAP2) demonstrated limited performance caused by the fracture of an aluminum shell.

It is mandatory for the AUP project to assure that all causes of the MQXFAP2 shell failure are understood, and that the proposed design has enough margin to prevent similar failures in future MQXFA magnets.

Samples of shell material (Al-7075) have been tested at cold temperature in order to assess material properties and their dependence from different tempers: T6 samples (proposed for production), T652 samples extracted from the fractured shell, and T652 samples from other shells. Computation of peak stresses and stress intensity factors vs. fault size have been performed. AUP has developed Structural Design Criteria (SDC), and the SDC for the aluminum shells were reviewed on October 5, 2018.

The reviewers are requested to assess the understanding of the MQXFAP2 issue, and the margin of the proposed design based on measured properties and implementation of the Structural Design Criteria.

## 2. Charges

The committee is requested to answer the following questions:

1. Is the mechanism of the MQXFAP2 issue well understood? Is the explanation satisfactory?
2. Is the FEM analysis adequate to understand failure mechanism and identify critical parameters?
3. Are the cold measurements on shells samples sufficient to assess critical material properties, their variability and dependence from Al-7075 temper?
4. Do the proposed design (choice of material, temper and fillet radii) and QC plan meet the AUP Structural Design Criteria (SDC)?
5. Have all recommendations of the aluminum shell SDC review been addressed?
6. Have all Lessons Learned been appropriately addressed, and have all improvements been implemented, from Design Analysis to Non-Conformity Reporting?
7. Do the proposed design and QC plan provide enough margin to avoid similar issues in MQXFA production magnets?
8. Do you have any other comment or recommendation to assure MQXFA magnets will not experience the MQXFAP2 issue?



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US-HiLumi-doc-  
Other:  
Date: 2/11/2019  
Page 4 of 4

### 3. Technical information

#### Committee

Helene Felice – CEA, chairperson

Paolo Ferracin – CERN

Manuchehr Shirmohamadi (Shir) – San Francisco State University

Raymond Yee – San Jose State University

#### Date and Time

March 22, 2019. Start time is 7:00 am (Pacific time)

#### Location/Connection

LBNL, room B47

Video-link by Zoom, info by email.

#### Link to agenda with talks and other documents

<https://indico.fnal.gov/event/19886/>