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## **Thu-Mo-Or16-04: Mechanical performance of the first two prototype 4.5 m long Nb<sub>3</sub>Sn low- $\beta$ quadrupole magnets for the Hi-Lumi LHC Upgrade**

*Thursday 26 September 2019 11:45 (15 minutes)*

The U.S. High-Luminosity LHC Accelerator Upgrade Project (HL-LHC AUP) team is collaborating with CERN in the design and fabrication of the first 4.5 m long MQXFA magnets, a 150 mm aperture high-field Nb<sub>3</sub>Sn quadrupole magnet that uses the aluminum shell-based bladder-and-key technology. The first two prototype magnets, MQXFAP1 and MQXFAP2, were assembled and tested while the first pre-series structure (MQXFA03) was in fabrication. This paper summarizes the mechanical performance of these prototype structures based on the comparison of measured strain gauge data with finite element model analyses from all load steps to powering. The MQXFAP1a magnet almost reached ultimate current before a short to ground was detected and the test was stopped. The MQXFAP2 magnet experienced a low training performance due to a fractured aluminum shell. The mitigations and analyses for the pre-series magnets are discussed in the context of the transition to pre-series production. Lastly, we also report on the first magnetic and fiducialization measurements.

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