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Fabrication and assembly performance of the first 4.2 m MQXFA magnet and mechanical model for the Hi-Lumi LHC Upgrade

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The LHC Accelerator Research Program (LARP), in collaboration with CERN and under the scope of the high luminosity upgrade of the Large Hadron Collider, is in the prototyping stage of the development of a 150 mm aperture high-field Nb₃Sn quadrupole magnet called MQXF. This magnet is mechanically supported using a shell-based support structure, which has been extensively demonstrated on several R&D models within LARP, as well as in the more recent short MQXF model (1.2 m magnetic length) program. The MQXFA magnets are each 4.2 m magnetic length, and the first mechanical long model, MQXFA1M (using surrogate aluminum coils), and MQXFA1 prototype magnet (the first prototype with Nb₃Sn coils) have been assembled at LBNL. In this paper, we summarize the tooling and the assembly processes, and discuss the mechanical performance of these first two structures, comparing strain gauge data with finite element model analysis. Additionally, magnetic measurements will be discussed along with alignment and fiducialization data of these structures, and their implications on the long MQXF magnet program.

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