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Design, Construction, and Testing of 0.5-m-long, 18-mm Period Nb₃Sn Superconducting Undulator Magnets

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Design and fabrication of a new Nb₃Sn-based superconducting undulator (SCU) are underway at the Advanced Photon Source (APS) of Argonne National Laboratory in collaboration with Fermilab and Lawrence Berkeley National Laboratory. This device will be installed on APS's storage ring and will deliver a wide range of hard x-rays to APS users. To develop a robust and reliable fabrication process, the magnet development consists of several steps. First, magnetic and mechanical simulations were performed to optimize the magnet design; then the design matured further by fabricating and testing a series of very short prototypes, ~8 cm long with a period length of 18 mm. These short prototype studies were previously reported [1, 2]. Second, the design was scaled to an intermediate length of 0.5 m. These two steps led to the final design of 1.1-m-long magnets, which are currently being fabricated. The quench behavior of each 0.5-m-long undulator magnet, as well as undulator assemblies from these magnets, was studied. The first SCU assembly did not meet the design specifications due to breakdown of the insulation. The second SCU assembly, with an improved design and fabrication process based on lessons learned, achieved the design undulator field of 1.2 T. The design was further optimized, and a third set of magnets was fabricated and successfully tested. Design features of the magnets, fabrication steps, and test results will be discussed in more detail.

[1] I. Kesgin et al., IEEE Trans. on Appl. Supercond., vol. 30, no. 4, pp. 1-5, 2020.

[2] I. Kesgin et al., IEEE Trans. on Appl. Supercond., vol. 29, no. 5, pp. 1-4, 2019.

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