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Preliminary strain measurement in high field superconducting magnets with fiber Bragg gating (FBG)

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High field superconducting magnets sustain large Lorenz force during operation. The superconductors for high field applications like Nb3Sn is strain sensitive, therefore it is essential to measure the strain level in superconducting coils during operation. Compared with traditional approach with resistance stain gauges, Fiber Bragg Grating Sensors (FBG) has significant advantages in high field applications. FBGs are anti-electromagnetic interferential, possible to measure the local strain inside the superconducting coils, and only sensitive to strain at a low temperature range from 4.2K to 20K[1]. In this study, resistance strain gauges and FBG were impregnated in the racetrack Nb3Sn and iron-based superconducting coils in a high field dipole magnet, and also attached to the outer surfaces of longitudinal rods and Aluminum shell of the magnet. The measurement was performed from room temperature assembly to the excitation at 4.2K. The experimental results show that the strain measurement with FBGs is accurate, stable and repeatable in the entire process of the experiment. Compared with resistance strain gauges, FBGs have a lower noise and a better performance at high magnetic field, high stress level and high excitation speed, and could reflect the process of internal strain variation of the superconducting coils during the whole process, indicating the advantages of FBGs applied for strain measurement in high field magnets.

[1] S. James et al., "Strain response of fibre Bragg grating sensors at cryogenic temperatures,"Meas. Sci. Technol., vol. 13, no. 10, pp. 1535–1539, 2002

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