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Strain measurements of a combined superconducting magnet on sextupole coils and solenoids during its assembly and excitation

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A combined superconducting magnet on six sextupole coils and four solenoids are currently developed by the Institute of modern physics of Chinese Academy of Sciences (IMPCAS). As a prototype for the fourth-generation ECR ion source operating at frequency of 45 GHz, each coil is made of a single and brittle Nb3Sn wire. To effectively prevent the wires motion from performance degradations and a quench, a pre-stress is essential for the combined superconducting magnet during its assembly using bladder-key technology. Thus, their strains behaviors were also focused during its assembly and excitation, indicating that operation of the combined superconducting magnet. In this paper, the mechanical behaviors of the combined superconducting magnet during assembly and operation were evaluated by detecting its external support structure. Several low-temperature resistance strain gauges and their compensations were affixed directly on its external support structure. Many groups of wireless strain acquisition system were used for the strain measurements of the combined superconducting magnet. It is shown that the strains measured in the superconducting magnet give much valuable information characterizing the deformation and the stress state during the assembly, cooling down and excitation. Finally, the combined superconducting magnet with the combined support structure were tested successfully for excitation. The strain measurements of external support structure were almost unchanged. It was proved that the support structure with the aluminum shell can hold well the combined coil.

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