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Mechanical validation of the Combined Support Structure for FECR Nb3Sn Superconducting Magnet Prototype

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The Fourth-generation ECR (FECR) ion source Nb3Sn Superconducting Magnet is being developed by Institute of modern physics, Chinese Academy of Sciences. In order to reduce the risk of development, a representative prototype is designed. The FECR prototype consists of two Nb3Sn solenoid coils and six Nb3Sn sextupole coils, This paper reports on the assembly process and cool-down to cryogenic temperature of the combined support structure of the FECR prototype. The structure of the FECR prototype magnet is designed to provide the adequate pre-stress, through the use of load keys, water-pressurized bladders, and an Al alloy shrinking cylinder. To validation the assembly and loading procedures, the structure was assembled with Al blocks (dummy sextupole coils) and extend stainless-steel formers (dummy solenoid coils) that replaced the brittle Nb3Sn coils, and then cooled-down to 77 K with liquid nitrogen. The evolution of the mechanical behavior was monitored via strain gauges located on different components of the structure (shell, rods, and dummy coils). We focus on the expected stresses within the structure after assembly, loading and cool-down. The expected stresses were determined from the 3-D finite element model of the structure. A comparison of the 3-D model stress predictions with the strain gauge data measurements is made. The coherence between the predicted contact pressure with high pressure Fuji Paper and strain/stresses with the experimental gauge measurements will validate the FEM model of the structure.

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