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Mechanical Analysis of a 14 T Whole-Body MRI Magnet

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A 14 T whole-body MRI superconducting magnet is currently being designed at the Institute of Plasma Physics Chinese Academy of Sciences. The main coils will be wound with the Nb₃Sn Rutherford cable-in-channel conductors, actively shielded, and operate at 1634 A to produce a central field of 14 T in an 840 mm warm bore. The magnetic field homogeneity is 5 ppm in a 45cm DSV. The inductance is 441 H and the stored energy is 615 MJ. To generate such a high-field in a large warm bore, the Nb₃Sn conductors will experience significant magnetic stress and strain, which may lead to irreversible degradation of critical current. Therefore, mechanical analyses are conducted to assess the mechanical behaviour of the 14 T MRI magnet, at the following load conditions: room-temperature preloading, cool-down from RT to 4.5 K, and operating conditions. Several approaches are being considered to reduce the hoop strain of the Nb₃Sn conductors, which will be compared with the experimental result of the tensile strain irreversibility limit.

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