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Mechanical Design of the Nb3Sn Cos-theta Short Model Dipole for the Future Circular Collider

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The future of the particle accelerators points to a new CERN's circular collider with an order of magnitude increase in the center-of-mass energy compared to the Large Hadron Collider (LHC). To achieve this increase from 14 TeV to 100 TeV a 100 km tunnel will be required to host the collider. This particle accelerators requires a new generation of double aperture superconducting magnets, capable of generating a high quality, stable 16 T magnetic field in a 50 mm bore. To manage this challenging task a roadmap, including several intermediate steps, was planned in the development of accelerator-grade Nb3Sn magnets under a specific four-year CERN-INFN agreement. The first of these steps will be the construction of a short, single aperture cosθ dipole, with a target magnetic field of 12 T and an ultimate field of 14 T. In this contribution, the design of this short model, called Falcon Dipole (Future Accelerator post-LHC Cosθ Optimised Nb3Sn Dipole) will be presented. To generate the required field, this magnet will feature a two-layer design, with state-of-art Nb3Sn conductor. This work is focused on the mechanical analysis of this short model. To cope with the intense magnetic forces that are generated in the magnet during operation and to ensure the integrity of the conductor, a novel mechanical structure has been identified, the so-called "bladder and key", a technique that has never been used in cosθ dipoles and needs to be validated. In conclusion, this paper presents 2D and 3D finite element analyses able to describe all the constructive steps that meet the requirements imposed by the project to ensure the correct operation of this magnet.

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