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Preliminary Design of a High Current R&W TF Coil Conductor for the EU DEMO

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Paschen failures in ITER and W7-X superconducting coils at the acceptance tests have shown that it is highly desirable to lower the coil discharge voltage of the DEMO TF coils. Another benefit of lowering the discharge voltage might be the reduction of the number of coil feeders, i.e. connect in series the TF coils inside the cryostat, which is attractive for machine integration. For a given Ampere Turn (AT), one way to reduce the discharge voltage is decreasing the coil inductance. Since the inductance of a coil is proportional to N^2, where N is the number of turns, for a given total TF current $\mathrm{N_{turn}} \cdot \mathrm{I_{op}}$, decreasing the number of turns corresponds to a higher current flowing through each turn, which results in the inductance being proportional to I_{turn}^{-2}. This means that increasing the current will have a quadratic impact on the inductance and thus a linear impact on the discharge voltage making the design of a high-current ($\approx$ 105 kA) CICC attractive for the EUROfusion DEMO project. In the case of DEMO, increasing the operating current from 66 kA to 105 kA leads to a reduction of the TF discharge voltage of a factor 3. Designing a high current TF coil conductor layout include performing mechanical and thermo-hydraulic studies to investigate the conductor stability during operation. This contribution will thus present the first design for a react-and-wind TF conductor made of $\mathrm{Nb_3Sn}$ and Cu as stabilizer designed for an operating current of 105 kA alongside the results of dedicated mechanical and thermo-hydraulic analyses.

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