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P3.003 Conceptual design of low aspect ratio superconducting tokamak with high magnetic field (T15-SC)

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The next stage of the upgrade of T-15MD machine (R=1.5m, a=0.67m, B≤2T, Ipl=2MA) to the superconducting one (excluding the limits of pulse duration) with basically the same geometry is suggested. The estimations show the possibility to make a toroidal magnet with aspect ratio A=2.2, magnetic field on the axis Bo=5T, maximum magnetic field Bm= 12.5T. Such increase in Bo provides the possibility to get plasma current up to 5 MA.

The main design problem for such device is the limited space for current flow in the Toroidal Field coils and for the supporting structure of the coils. The toroidal magnet design suggests the SC-winding takes the main part of mechanical loads due to thick wall conduit that works together with coil casings. Each of 16 toroidal coil will consist of three layer: HTSC inner one, Nb3Sn middle one and NbTi outer one. Each layer will be connected with that of neighboring coils, providing three-layer toroidal winding. Each layer will be charged independently, having the same discharge time to avoid the energy exchange during charging and protection discharge.

The cooling will be done by two-phase He pushed from bottom to the top of coil by ejector pumps through the coil volume with many channels between the turns or by pushing it across the coil in horizontal direction.

This new project with its favorable combination of low aspect ratio A and really high magnetic field B is beneficial for the plasma performance and the long-pulse discharge via high fraction of bootstrap current.

The main research topics foreseen are the confinement features at high B and low A, steady-state operation and plasma wall interaction. This project will also serve as a test-stand, which is absolutely necessary for the Fusion Neutron Source SC magnet design, mastering and tests.

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