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Physics Design and Analysis Code SPECTRE for Tokamak Based Fusion Reactors

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SPECTRE is a 0-D physics code developed for Indian DEMO reactors. The code gives a set of operating points based on the ignition criteria and the radial build up is estimated by solving iteratively for the plasma temperaturefor a given fusion power and fusion gain (Q). The ratio of plasma density to Greenwald density is chosen so that the reactor operateswithin density limit while the beta limit is checked after obtaining the consistent plasma parameters. The code takes pre-defined plasma shape parameters,aspect ratio, profile factors of temperature and density, edge safety factor. Engineering constraints like maximum allowable field at the TF inner leg, blanket and shield thickness are also given depending upon the technological requirements.
The energy confinement for this study is based on IPB98(y,2) scaling law.The helium fraction is estimated by balancing the net power coupled to plasma with transport losses by assuming the ratio of helium particle confinement time to global energy confinement time. The ratio of the ion temperature to electron temperature is estimated and given as an input to the code. The power balance includes losses like synchrotron,Bremsstrahlung and impurity line radiation.The possible impurities depending upon the choice of plasma facing components are considered for estimating the line radiation.Line radiation from Tungsten and Beryllium are considered in the code from the impurity fractions. The plasma temperature is estimated by solving the power balance equation iteratively. Derived plasma parameters like L- H power threshold, bootstrap fraction, neutron wall load, loop voltage and Divertor heat load are estimated.

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Author: Mr MENON, Vinay (Institute for plasma research)

Co-authors: Mr SHARMA, Aashoo (Institute for Plasma Research); Prof. DAS, Amita (Institute for plasma research); Mr DANANI, Chandan (Institute for Plasma Research); Prof. BORA, Dhiraj (Institute for plasma research); Prof. KAW, P K (Institute for plasma research); Mr KUMAR, Rajendra (Institute for Plasma Research); Mr PRAGASH, Ravi (Institute for Plasma Research); Dr KHIRWADKAR, Samir (Institute for Plasma Research); Dr DESHPANDE, Shishir (Institute for Plasma Research); Dr RADHAKRISHNAN, Srinivasan (Institute for plasma research); Dr PRADHAN, Subrata (Institute for Plasma Research); Mr PRASAD, Upendra (Institute for Plasma Research)

Presenter: Mr MENON, Vinay (Institute for plasma research)

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