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Perspectives for the High Field Approach in Fusion Research and Advances within the Ignitor Program

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The Ignitor Program maintains the objective of approaching D-T ignition conditions by incorporating systematically advances in high magnetic field technology and in experiments on high density well confined plasmas. Another objective is to chart the development of the high field line of experiments. Considering that a detailed machine design has been carried out [1], a subset of the areas to be covered is: 1) Numerical Simulations and Relevant Transport Theory. The machine parameters have been optimized so to allow a programed combination of Ohmic heating, alpha-particle heating and ICRH to approach ignition. A transport model [1] is formulated by which the effects of the (anomalous) current diffusion can be directly investigated and in which the threshold power to access H-mode confinement can be significantly reduced when Z-eff is low. 2) Plasma Disruptions and Sensors. In depth analyses have been carried out on the onset and development of disruptions and the adopted control system with favorable conclusions. A diagnostic system with innovative elements, such as a multipurpose Second-Harmonic-Interferometer and a sensoring function for the onset of disruption, has been devised. 3) Nonlinear feedback control simulations with 3D structures. A new tool (CarMa0NL [2]), describes the evolution of axisymmetric plasmas with three-dimensional conducting structures. An upgrade of CarMa0NL, including the position-shape-current integrated feedback controller has been used. 4) Superconducting components. The cables adopted for the largest poloidal field coils involve about 300 MgB_2 multi-filamentary strands (each) of 1 mm in diameter and a copper tube for the He-gas flow in the center with advanced design and electrical properties of these strands. 5) High Field Superconducting Experiments. An important incentive for the analysis of high field superconducting experiments is the realization that "hybrid"high fields magnets can be fabricated using two components: MgB_2 for the "low" field outer part and a high temperature superconductor for the high field inner part. The parameters of a superconducting compact machine capable of producing currents about 15 MA have been identified.

[1] B. Coppi, A. Airoldi, R. Albanese, et al., Nucl. Fus. 53, 104013 (2013).
[2] F. Villone et al., Pl. Phys. Cont. Fus. 55, 095008 (2013).

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