

Mission and Overview of a Fusion Development Facility

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A Fusion Development Facility (FDF) is proposed to make possible a fusion demonstration power plant (DEMO) as the next step after ITER. To make possible a DEMO of the ARIES-AT type, the mission of the FDF should be to carry forward Advanced Tokamak physics and enable development of fusion's energy applications.

FDF should demonstrate advanced physics operation of a tokamak in steady-state with burn, producing 100-250 MW fusion power with modest energy gain ($Q < 5$) in a modest sized device. Modest size (we envision a device between DIII-D and JET in size) is needed to minimize the cost consistent with the mission. FDF is envisioned as an aspect ratio 3.5 tokamak, whose technical and physics basis is sufficiently in hand to allow proceeding to design and then construction in a few years time. It will be a direct follow-on of DIII-D and Alcator C-Mod, with the construction features of those machines and similar auxiliary heating and current drive systems. Full noninductive, high bootstrap operation will enable continuous operation for periods up to two weeks. FDF must further develop all elements of AT physics for an advanced performance DEMO.

With neutron flux at the outboard midplane of $1\text{--}2\text{ MW/m}^2$ and a goal of a duty factor of 0.3, FDF can produce fluences of $3\text{--}6\text{ MW-yr/m}^2$ in ten years of operation. FDF will have a goal of demonstrating closing the fusion fuel cycle, producing its own tritium and building up a supply to start up DEMO. The development of blankets suitable for tritium, electricity, and hydrogen production will be done in port modules. The most promising candidates will be deployed as full blankets in FDF. The full blankets will allow testing of various plasma facing materials at high temperatures and the incorporation of coil systems for controlling ELMs and Resistive Wall Modes. Two to three full blankets and about a dozen port blanket types could be tested.

FDF, ITER, IFMIF, and other AT devices will provide the basis for a fusion DEMO power plant of the ARIES-AT type.

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