The DIII-D Upgrade to Prepare the Scientific Basis for Burning Plasma Operation in ITER and Steady State Fusion in Future Reactors*

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An upgrade to DIII-D is proposed in order to confront the scientific challenges required to prepare the next generation of fusion devices. An increase to low torque dominant electron heating (Fig. 1) with high power electron cyclotron heating and rotatable neutral beams for full power balanced injection will heat electrons as fusion alphas do, to develop the scientific basis for burning plasma relevant regime optimization over a wide range in β_N.

To prepare the foundation for quasi-continuous operation for a future reactor, off-axis current drive and total heating power are being raised, with a second neutral beam depositing off-axis and increased neutral beam energy. Integrated modeling projections indicate this will access fusion relevant performance and self-driven current (Fig. 2) to resolve the physics and optimization of self-consistent self-sustaining plasma regimes. Ultra fast wave "helicon" heating will also be tested as a potentially efficient current drive source for reactors.

A new configurable divertor (Fig. 3) is envisioned that, coupled with an extensive diagnostic set, will enable an improved understanding of SOL and divertor physics through detailed model-experimental comparisons. Particular emphasis will be placed on understanding the impact of diverter geometry on the minimum upstream density needed for detachment and the stability of the detachment front. Based on this, an optimized configuration will be implemented to integrate a high performance core and acceptable boundary for a combined steady state fusion solution.

In addition, DIII-D will continue to develop the physics basis for robust control of fusion plasmas, with improved 3-D field capabilities to optimize ELM control and stability, and enhanced disruption mitigators to safely quench the plasma.

These developments, combined with ongoing diagnostic improvements, will provide critical information to prepare for burning plasma operation in ITER, and establish the physics basis for design decisions on future quasi-steady state fusion reactors over the next ten years.

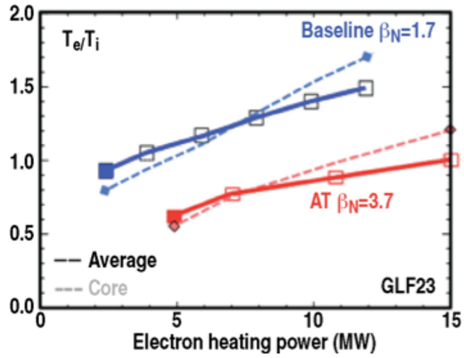

Fig. 1. Increased electron heating will access burning plasma relevant transport mechanisms.

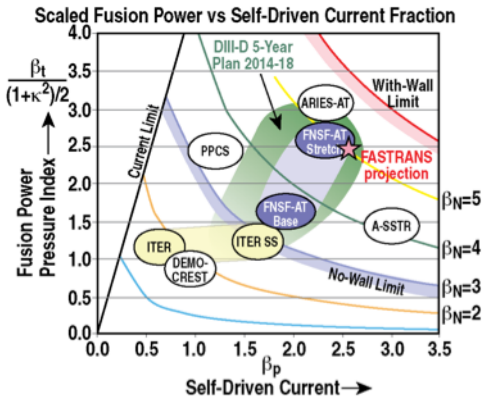

Fig. 2. Additional off-axis and total neutral beam power will enable optimization of the power plant core.

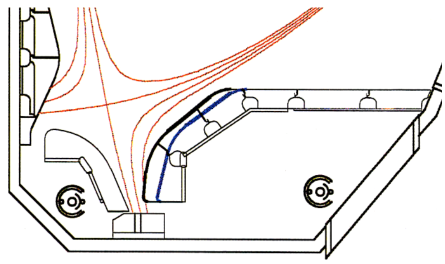

Fig. 3. The physics basis for a potential improved reactor boundary solution will be developed with a configurable slot divertor.

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