ITER Hybrid Scenarios in DIII–D: Favorable Performance Projections for ITER

Recent experiments on the DIII–D tokamak at General Atomics in San Diego have demonstrated stationary plasma performance that projects to longer pulse length and/or higher gain operation of ITER than the present ITER baseline scenario. These stationary plasmas have confinement and stability properties that substantially exceed the corresponding ITER baseline parameters. Projections from the case shown in the figure below which corresponds to about 2/3 of ITER's nominal plasma current imply the full fusion power could be obtained in ITER but in pulses extended to about one hour in duration (up from the 400 seconds baseline case). Alternatively the higher performance case shown in the figure below which corresponds to nearly the full plasma current in ITER implies higher fusion gain in shorter pulses. These hybrid operating modes, which still use a small amount of OH transformer flux to support the plasma current, may enable ITER to meet its fusion power goals at reduced plasma current and/or to achieve much longer pulse lengths.

In either case, the key element for achieving these stationary, high performance discharges appears to be reaching high pressure and triggering a small level MHD mode before the onset of larger reconnection events (known as sawteeth) in the plasma center. The large-scale nature of the sawteeth lead to localized magnetic perturbations, which can lead to the onset of other large MHD modes. These larger MHD modes generally lead to degraded plasma performance, unless other mitigating measures are taken. Analysis indicates that the small level MHD modes significantly reduce the penetration of current into the plasma core and thus make it less susceptible to large sawteeth and undesirable large MHD modes.

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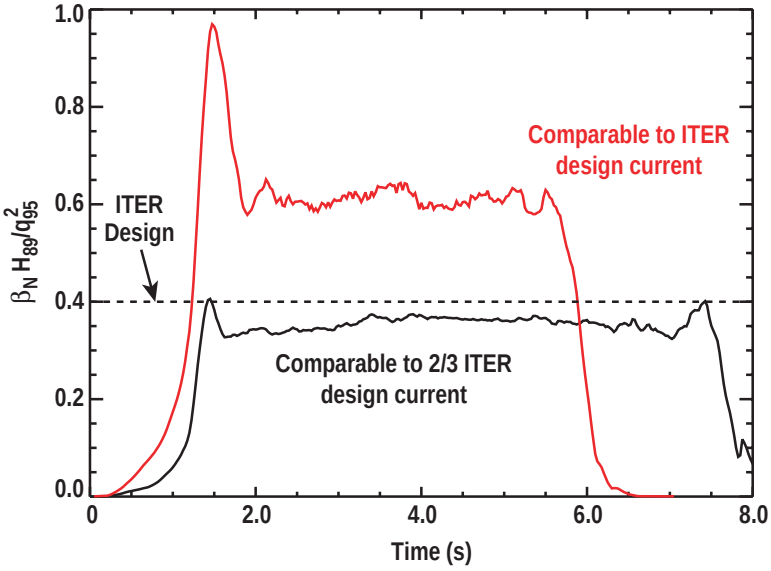

Time histories of the normalized fusion performance ($\beta_N H_{89} / q_{95}^2$) for two stationary discharges in the DIII–D tokamak. The normalized fusion performance indicates how well the tokamak contains the plasma pressure and energy and is related to energy gain in a burning plasma. The discharge shown in red operates with a magnetic configuration similar to the ITER design. The discharge in black has a magnetic configuration similar to an ITER discharge with 2/3 of the design current.

T.C. Luce, "High Performance Stationary Discharges in the DIII–D Tokamak," to be published in Bull. Am. Phys. Soc., 2003.

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