

New Fusion Research Into Slowly Rotating Plasmas Gives Favorable Results for ITER Performance

Experiments on the DIII-D tokamak show that the beneficial characteristics of a long duration, high performance operating scenario are maintained for ITER-similar values of the Mach number and plasma shape.

Experiments on several tokamaks around the world, including the DIII-D tokamak (in La Jolla, California), have developed a long duration, high performance plasma discharge that is an attractive operating scenario for ITER. This “hybrid” scenario combines the beneficial characteristics of high plasma pressure (relative to the magnetic field pressure), high energy confinement, and benign plasma instabilities, resulting in a stationary operating mode having a fusion performance that greatly exceeds the standard “high confinement mode” scenario. However, extrapolating this hybrid scenario to ITER was not straightforward because the large amount of angular momentum injected from the neutral beam heating system resulted in a rotation Mach number several times greater than predicted for ITER. Since rapid rotation is known to improve the plasma confinement and stability properties, it remained to ascertain the characteristics of the hybrid scenario in plasmas with more ITER-similar values of the rotation Mach number.

Recently the DIII-D tokamak has studied the properties of the hybrid scenario using a new configuration for the neutral beam heating system that can inject significantly less angular momentum. In addition, a new plasma shape for the hybrid scenario was developed on DIII-D that was more similar to the ITER shape. These experiments showed that the beneficial characteristics of the hybrid scenario, *i.e.*, high plasma pressure, high energy confinement, and benign plasma instabilities, were maintained in plasmas that rotated up to ten times more slowly than the original cases. While a modest reduction (~20%) in the energy confinement time was measured as the rotation Mach number was decreased, as expected theoretically, the product of the energy confinement time and plasma pressure (proportional to fusion gain) remained well above the “high confinement mode” value. Thus, recent DIII-D experiments with ITER-similar values of the rotation Mach number and plasma shape have shown that the hybrid scenario continues to meet and exceed the fusion performance requirements of the ITER project.

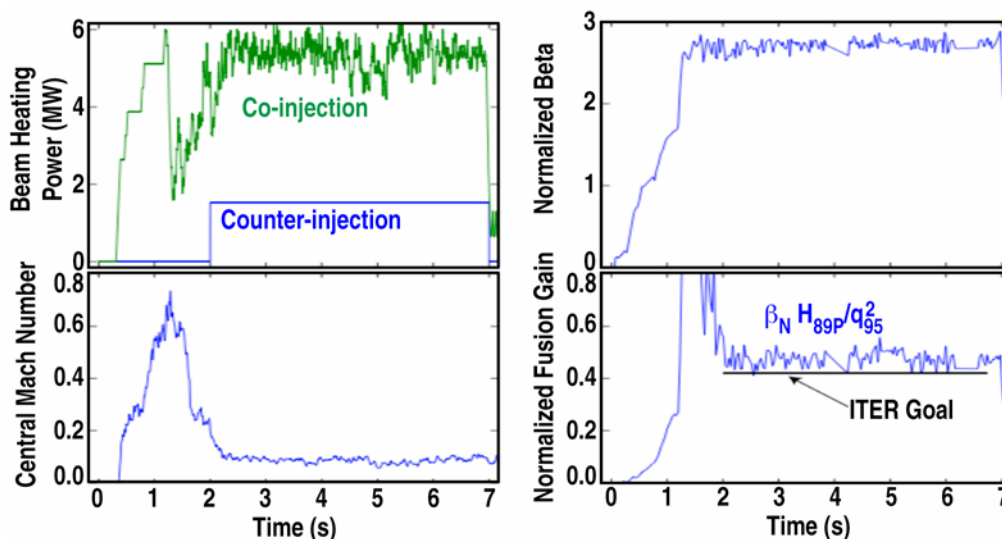


Fig. 1. Normalized fusion performance remains above ITER’s required value even for slowly rotating plasmas.

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