

## **A Burning Plasma Diagnostic Technology Initiative for the US Magnetic Fusion Energy Science Program**

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The US magnetic fusion energy science program requires an initiative for development of the necessary diagnostics to support burning plasma experiments beyond ITER, such as a future FNSF, CTF and eventually DEMO facilities. Extensive diagnostic measurements of burning plasma behavior will be essential to optimize the US investment in ITER going forward. Because the steady-state thermonuclear environment of burning plasmas will severely constrain the measurement capabilities of many present-day diagnostic systems, new methodologies need to be developed and integrated into plasma control and operation/safety systems.

Many existing diagnostic systems, that support current facilities and are being adapted for ITER, will simply not work on high-duty-cycle burning plasma experiments beyond ITER. Providing diagnostic solutions for burning plasmas is critical as there are currently both measurement gaps (e.g., alpha particles, tile erosion, dust) and measurement extensions to long-pulse, high-flux and high-fluence future burning plasma facilities that do not have viable solutions.

At present, the US magnetic fusion energy science program does not support the development of innovative diagnostics for burning plasma experiments in general. The US ITER Project Office provides support for the construction of ~7 US-credited ITER diagnostics. However, some critical measurements required for the success of ITER's mission are still unmet. Currently, the Office of Fusion Energy Sciences provides support for diagnostic development for existing domestic experimental facilities; however, burning plasma diagnostics for future burning plasma experimental facilities are excluded due to insufficient funds. This represents a serious gap in the US program which will negatively impact the US leadership in future burning plasma experiments.

Development of and research in plasma diagnostics is also a key area for training the next generation of fusion plasma researchers. This will be critically important for the scientific exploitation of burning plasma experiments beyond ITER. A US burning plasma diagnostic initiative, as part of a strong and comprehensive diagnostic development program, would also strengthen the vital link among university, national laboratory, and industry groups in the US as they work together for the development of fusion energy.

The components of a US initiative for the development of innovative diagnostics for burning plasma experiments as part of a comprehensive national diagnostic development program are listed below. Such an initiative would build on the traditional US strength in diagnostic innovation and would enhance the contributions of the U.S. magnetic fusion program.

The main elements of this proposed new initiative are as follows:

1. Expansion of the present OFES diagnostic development program so as to provide support for short- and long-term development and implementation of new diagnostics and extensions of existing diagnostics (where feasible) needed for burning plasma research.
2. Integration of the capabilities of burning plasma diagnostics into existing analysis and simulation codes and, ultimately, into plasma control systems.