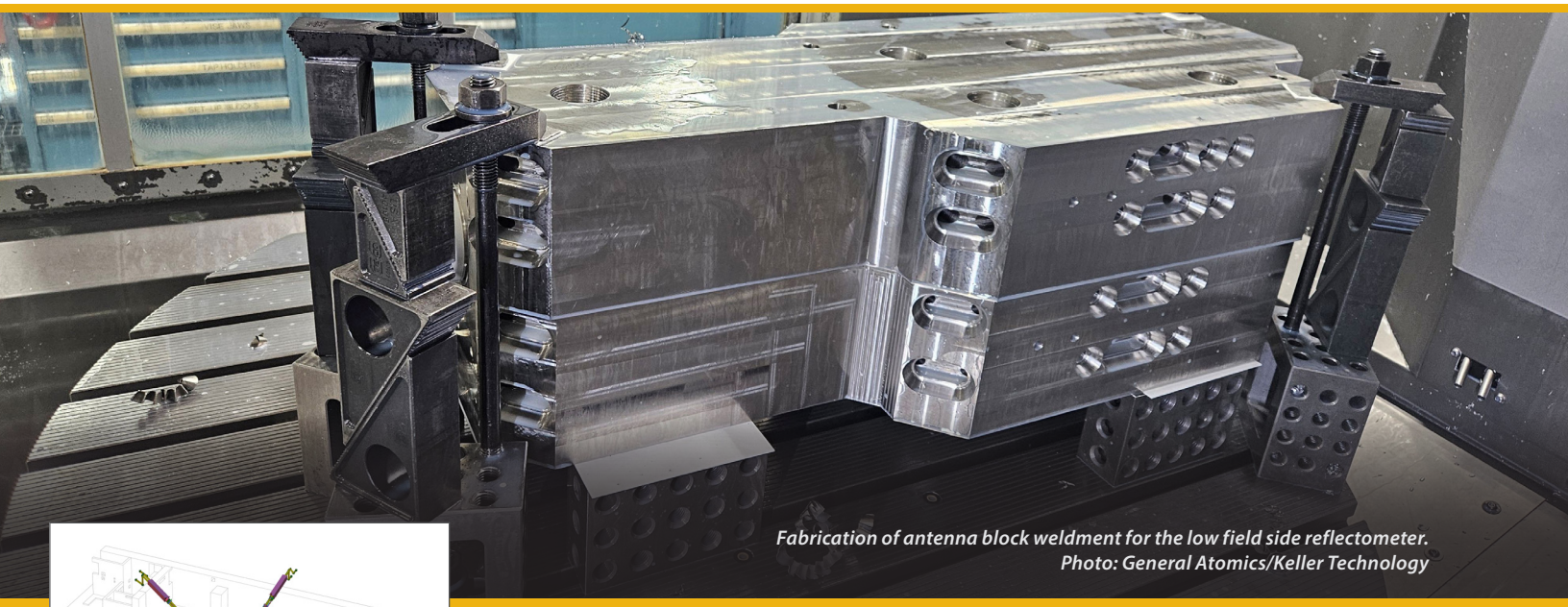
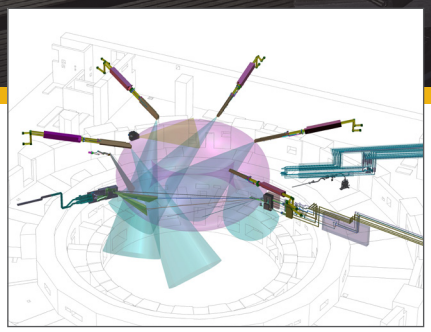
usiter.ornl.gov

Diagnostics



Fabrication of antenna block weldment for the low field side reflectometer. Photo: General Atomics/Keller Technology



U.S. diagnostic systems. Image: US ITER

U.S. Contribution

US ITER is responsible for the research and development, design, and fabrication for 14% of ITER's port-based diagnostic systems, including integration of four diagnostic port plugs, plus seven instrumentation systems out of a total of approximately 45 individual diagnostic systems. The European Union, Japan, the Russian Federation, China, Korea, India, and the technical teams at ITER headquarters are also contributing diagnostics to ITER.

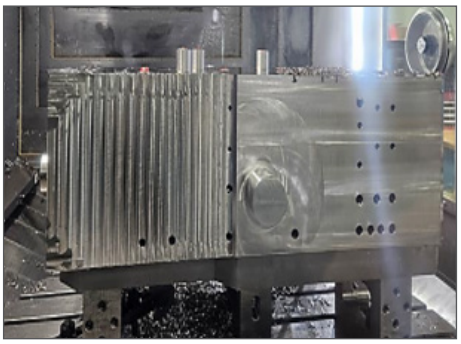
Overview

ITER diagnostic systems provide measurements to aid understanding of plasma behavior and optimize fusion performance. Because of the harsh environment inside the tokamak vacuum vessel, these systems must cope with a range of conditions not previously encountered by diagnostic technology, all while performing with high reliability. Diagnostics provided by US ITER will include microwave, laser, x-ray, and optical systems. US ITER is responsible for the following instrumentation systems: core X-ray crystal spectrometer, electron cyclotron emission radiometer, low field side reflectometer, motional Stark effect diagnostic, residual gas analyzer, toroidal interferometer/polarimeter, and upper infrared/visible cameras. US ITER also will design, fabricate, assemble, and test U.S.-provided port plugs, specifically the upper ports (U11, U14), and equatorial ports (E3, E9). In addition, US ITER will support the integration of multiple diagnostics into these plugs, including some from other domestic agencies.

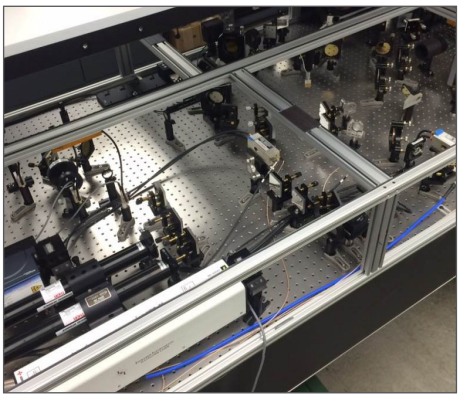
Precision long-bore drilling in a component of the low side field side reflectometer. Photo: General Atomics/Grand Valley Manufacturing

Status

Most of the diagnostic systems are in final design. Fabrication of in-vessel components for the low field side reflectometer is well underway. Captive overhead supports for both the low field side reflectometer and toroidal interferometer/polarimeter were installed at ITER.



Gun-drilled block at start of pre-weld machining of antenna block for the low field side reflectometer. Photo: US ITER/Keller Technology



Toroidal interferometer/polarimeter prototype optical table. Photo: General Atomics

Technical Description

Core X-ray crystal spectrometer. Measures the temperature of the ions from the hot plasma core to the cooler plasma edge.

Diagnostic residual gas analyzer. Measures the composition of exhaust gases leaving the tokamak in the edge and divertor regions, including hydrogen and helium isotopes and other constituents.

Electron cyclotron emission radiometer. Measures the temperature of the electrons from the core to the edge.

Low field side reflectometer. Measures the electron density in the outer layers of the plasma by probing the plasma with microwave beams and detecting the reflected wave.

Motional Stark effect diagnostic. Measure the plasma current density, providing data that are important for understanding conditions for plasma stability.

Port integration. Integrates 18 tenant diagnostics into four U.S.-supplied port plugs (two upper ports and two equatorial ports) including interspace and port cell support structures.

Toroidal interferometer/polarimeter. Measures the electron density profile by probing the plasma with laser beams, providing data that will be used to control the density in real time.

Upper infrared/visible cameras. Image the high heat flux surfaces in the vacuum vessel using sophisticated camera systems to check for hot spots and particle emissions.

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