ITER Ion Cyclotron Heating and Fueling Systems

D.A. Rasmussen[1], L.R. Baylor[1], S.K. Combs[1],
E. Fredd[2], R.H. Goulding[1], J. Hosea[2], D.W. Swain[1]

[1]*Oak Ridge National Laboratory, Oak Ridge, TN, Rasmussenda@ornl.gov*
[2]*Princeton Plasma Physics Laboratory, Princeton, NJ*

The ITER ion cyclotron system offers significant technology challenges. The antenna must operate in a nuclear environment and withstand heat loads and disruption forces beyond present-day designs. It must operate for long pulse lengths and be highly reliable, delivering power to a plasma load with properties that will change throughout the discharge. A development and testing program will be required to validate the proposed ITER antenna design, and to modify it if needed.

The ITER ion cyclotron system consists of one eight-strap antenna mounted in a horizontal midplane port; eight rf sources covering the 35-65 MHz frequency range that can deliver a total of 20 MW of IC power to the plasma, and associated high-voltage DC power supplies; and a set of transmission lines connecting the antenna to the sources, with matching and decoupling components.

There are several R&D tasks that must be completed successfully before the final procurements and fabrication can be started. A low-power electrical mockup of the antenna must be fabricated and tested in order to validate the functioning of the antenna and to optimize the design. A prototype of the tuning mechanism must be designed and tested. A high-power prototype antenna must be built and tested under vacuum at voltages similar to those expected for ITER operation. This prototype will be one current strap (i.e., 1/8 of the full antenna) with the tuning mechanisms, vacuum transmission line and vacuum window. A test of the proposed dual-output transmitter tube configuration with a variable load that simulates load changes during plasma operation will be required.

The ITER fueling system consists of a gas injection system and multiple pellet injectors for edge fueling and deep core fueling. Pellet injection will be the primary ITER fuel delivery system. The fueling requirements will require significant improvements in pellet injector performance. The pellet injectors must safely operate with tritium and be able to reliably supply hydrogenic species throughputs well beyond present-day designs. It must operate for long pulse lengths (~3000 s) and be highly reliable, delivering nearly 400 torr-L/s of tritium rich pellets. The proposed design is based on a centrifuge accelerator fed by a continuous screw extruder. Inner wall pellet injection with the use of curved guide tubes will be utilized for deep fueling.

A development and testing program will be required to validate the proposed ITER pellet injector design, and to modify it if needed. A high throughput extruder prototype would be tested in the laboratory. A centrifuge prototype (capable of producing 3mm pellets at 50 Hz at a speed of ≥300 m/s) would be tested in the laboratory and field tested on an existing fusion device.