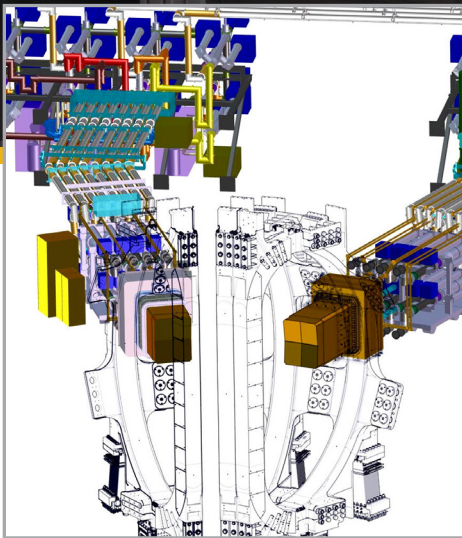


*Ion cyclotron transmission line prototype in a test stand for seismic analysis.  
Photo: US ITER*



*Ion cyclotron transmission lines design.  
Image: US ITER*

## US Contribution

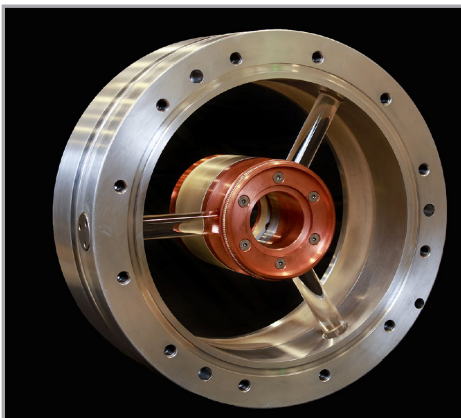
US ITER is responsible for the ion cyclotron transmission lines and impedance matching system, including research and development, design, and fabrication.

## Overview

The ion cyclotron transmission lines enable a mission-critical burning plasma in ITER through advancements in radio frequency transmission and matching technology. The ion cyclotron heating and current drive system heats the ions and electrons in the plasma with a high-intensity beam of electromagnetic fields. Generators produce high-power radio frequency waves that are carried along multiple transmission lines to antennas located in the vacuum vessel, which launch the heating fields into the plasma. The ion cyclotron transmission lines will provide efficient power (20 MW) transfer from 40–55 MHz between the radio frequency sources and the plasma heating antennas. The system will include coaxial transmission lines and a matching/tuning system to minimize power transfer losses. The pressurized lines can transmit up to 6 MW per line. In total, approximately 1.5 km of line connects eight sources to 16 antenna feeds.

## Status

Industry partners are currently fabricating major 50-ohm transmission line component prototypes, including transmission line straight, gas barrier, 90-degree elbow, and assembly bellows. Successful completion of high-power radio frequency testing of the prototypes will support final design validation for segments of the 50-ohm transmission line. Testing is scheduled for late 2024.



*Inner conductor support prototype with quartz rods. Photo: US ITER/ORNL*



*The resonant ring test stand at ORNL is used to test prototype components. Photo: US ITER*

## Technical Description

**Transmission line operational frequency range:** 40-55 MHz

Transmission line connects 8 RF sources to 16 antenna feeds

1.5 km combined length, 30 cm diameter transmission lines through three buildings

Transmission lines guide up to 12 MW peak between the matching system and the antenna

**Power coupled to plasma per antenna:** 10 MW (upgrade, 20 MW)

**Maximum pulse length:** 3,600 s, 25% duty cycle (1 hour on, 3 hours off)

Provide fast arc detection, real-time processing of a multivariable state-space impedance control system to enable maximum radio frequency power transmission to the plasma

## Contributors include

Cincinnati Fan (Mason, OH)

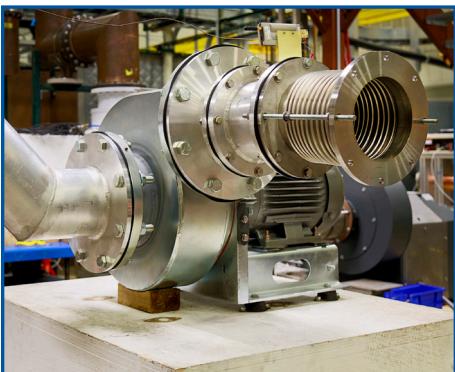
Comet (San Jose, CA)

Dielectric Communications (Raymond, ME)

Mega Industries, LLC (Gorham, ME)



*Rotary joint four-port switch prototype. Photo: US ITER/ORNL*



*A blower component for the high-powered resonant test line at ORNL. Photo: US ITER/ORNL*

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