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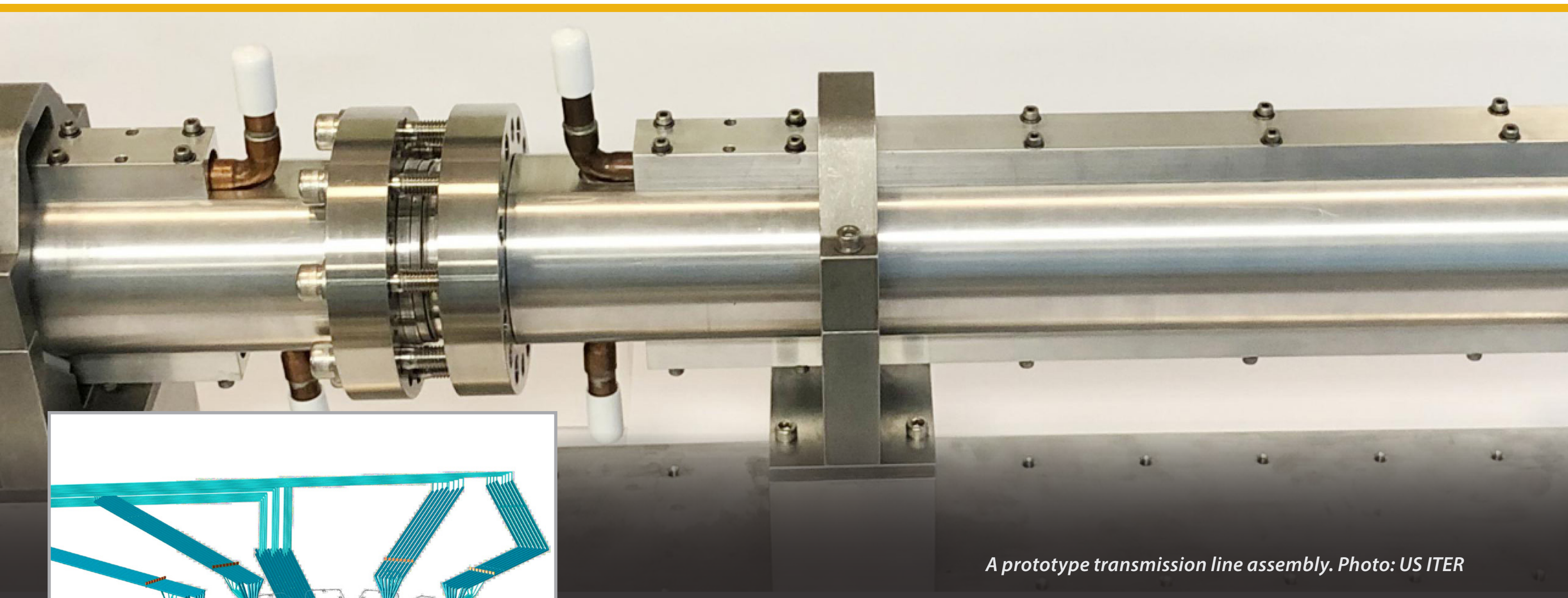
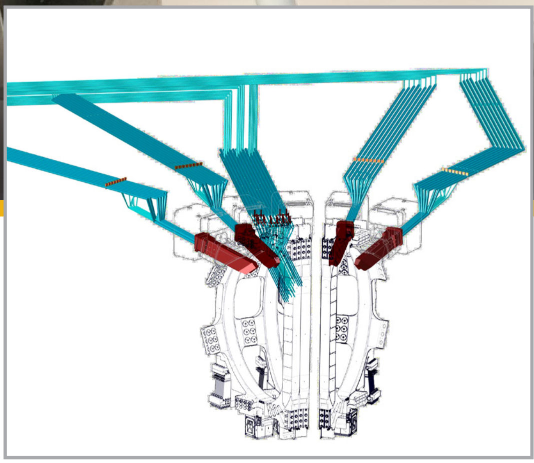
Electron Cyclotron Transmission Lines



A prototype transmission line assembly. Photo: US ITER



Electron cyclotron transmission lines design. Image: US ITER

US Contribution

US ITER is responsible for the electron cyclotron transmission lines, including research and development, design, and fabrication.

Overview

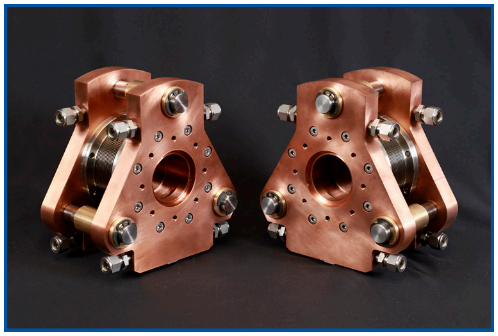
The electron cyclotron heating transmission lines enable a mission-critical burning plasma in ITER by advancing the technology for a unique range of power, pulse length, and microwave frequency. This heating and current drive system heats the electrons in the plasma with a high-intensity beam of microwave radiation. Electron cyclotron heating will be used to deposit heat in very specific places in the plasma. Power will be provided by high-frequency gyrotrons. The US transmission line design will provide efficient power (20 MW) transfer from 170 GHz gyrotron sources to launchers in the tokamak port plugs. The transmission lines feature multiple lines of evacuated aluminum waveguides with internal corrugations that can transmit 1.2 MW per line, while minimizing power transfer losses to ≤ 10%. Approximately 4 km of transmission line will be part of this system, connecting 24 sources to 56 feeds.

Status

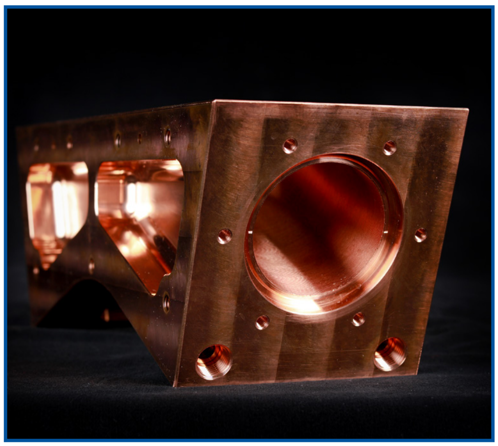
The team has completed a major portion of the final design of the system of 24 transmission lines, including all microwave components and structural supports. The remaining design will be completed in mid-2024.

Fabrication of prototype components required for first plasma are nearing completion, and our industry partners have begun shipping the prototypes. Testing will begin at the Swiss Plasma Center in Switzerland in March 2023.

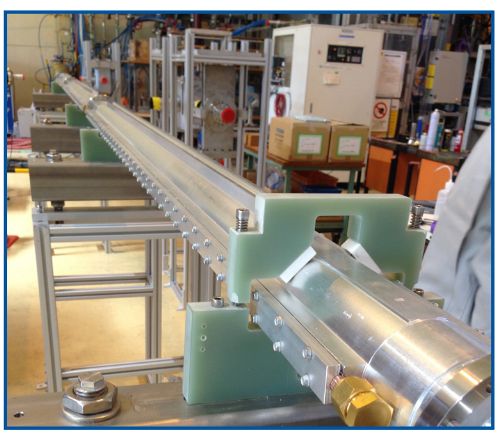
Waveguide switch prototype. Photo: US ITER/ORNL



Transmission line expansion unit prototypes. Photo: US ITER/ORNL



Body of a 140-degree miter bend prototype. Photo: US ITER/ORNL



US-produced waveguide in a test stand at The National Institutes for Quantum and Radiological Science and Technology in Japan. Photo: US ITER

Technical Description

Power transfer from 170 GHz gyrotron sources to launchers

Provide efficient power transfer from 24 170-GHz gyrotron sources to five separate launchers

Transmit 1.2 MW per line for up to 1 hour

On average, power loss < 10%

On average, HE_{11} mode content > 90%

Contributors include

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