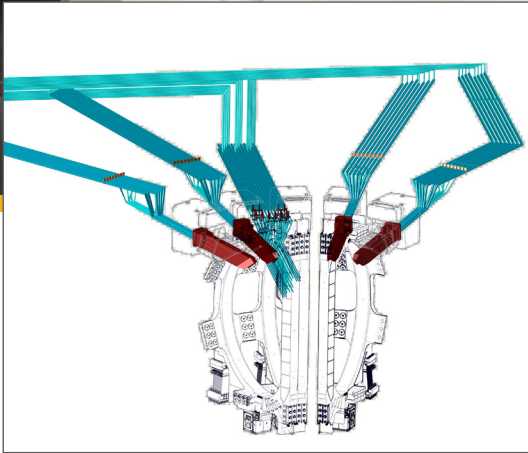


A prototype transmission line assembly. Photo: US ITER



Design of electron cyclotron transmission lines. Photo: US ITER

U.S. 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 U.S. 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 $\leq 10\%$. Approximately 4 kilometers of transmission line will be part of this system, connecting 24 sources to 56 feeds.

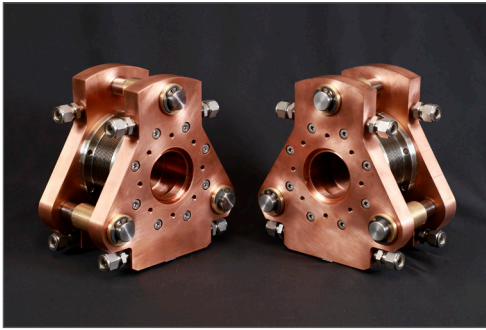
Status

The team has nearly completed the final design of the system of 24 transmission lines, including all microwave components and structural supports. The second and final design review was conducted in 2024.

Fabrication and high power microwave testing have been completed on nine out of 10 prototype components. The last remaining prototype, the polarizer miter bend, is in fabrication. Contracts have been awarded to industry vendors for the transmission line waveguide, switches, miter bends, expansion units, the direct-current (DC) break, and pump outs.



Sections of a waveguide. Photo: Teledyne Brown Engineering



Transmission line expansion units.
Photo: US ITER/ORNL

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, HE11 mode content > 90%

Contributors include

ARMEC Corporation (Knoxville, TN)

Curti Costruzione Meccaniche S.p.A (Castel Bolognese, Italy)

Dymenso LLC (San Francisco, CA)

EPFL Swiss Plasma Center (Lausanne, Switzerland)

General Atomics (San Diego, CA)

Keller Technology Corporation (Tonawanda, NY)

Liseqa, Inc. (Kodak, TN)

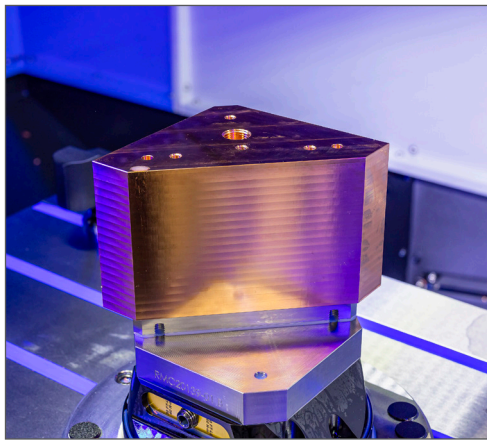
Precision Fabricating & Cleaning, Inc. (Cocoa, FL)

Rhinstahl AMG (Mason, OH)

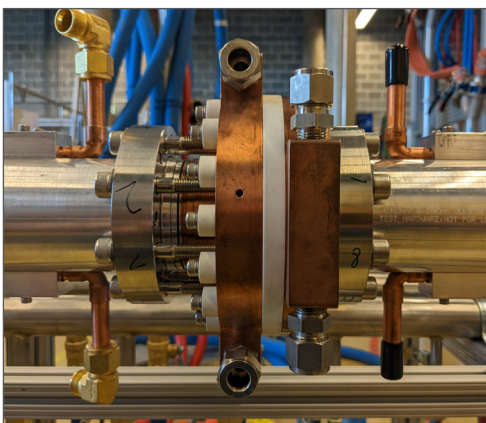
Technetics Group (Columbia, SC)

Teledyne Brown Engineering Inc. (Huntsville, AL)

Vacuum Technology, Inc. (Oak Ridge, TN)



A 90-degree miter bend body made of a copper alloy.
Photo: US ITER/ORNL



A direct-current (DC) break for electron cyclotron transmission lines. Photo: US ITER

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