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Moving on Up, to the Top

New approach doubles the current that can be driven by microwave heating at the DIII-D National Fusion Facility

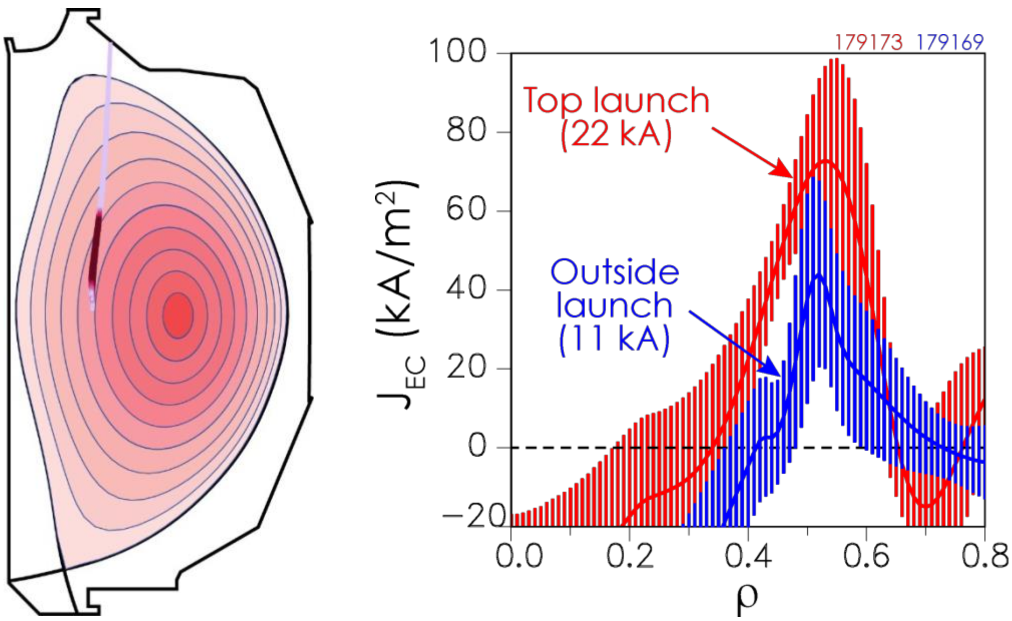

Figure 1: The red line shows that the trajectory of the microwaves from a top-launch position aligns well with the plasma to drive current over a long path (dark shading). Measurements shown right confirm much more current is driven with top launch (red) than conventional outside launch (blue). Image courtesy of Xi Chen, DIII-D National Fusion Facility

The Science

Researchers at the DIII-D National Fusion Facility in San Diego have demonstrated a new approach for injecting microwaves into a fusion plasma, doubling the efficiency of a critical technique that could have major implications for future fusion reactors. The results show that launching the microwaves into the plasma from the top delivers substantial improvements in driving plasma current due to improved coupling to high-energy electrons and a longer interaction path in the resonance zone.

The Impact

Building economical fusion reactors in the future will require driving electric current efficiently in specific regions of the plasma—a technique known as current drive. If researchers can improve the efficiency of current drive, it will help pave the way to practical and economical fusion energy.

Summary

Researchers at DIII-D looked into one of the techniques to drive current, known as Electron-Cyclotron Current Drive (ECCD), which uses extremely powerful microwaves to heat electrons in the plasma.

The ECCD microwaves were traditionally injected from the outside of the tokamak (right-hand side in the image) toward the heart of the plasma. Recent computer modeling at DIII-D, however, predicted that efficiency could be substantially improved by moving the injection point toward the top of the tokamak and carefully directing it to precise points away from the center. Based on that modeling, Dr. Xi Chen led a team that designed and installed a new system to achieve this new approach. The top-launch configuration aligns the microwave trajectory with both the magnetic field and energy distribution of electrons in the plasma so that the microwaves selectively interact with only the most energetic electrons. Over an extended distance, this can double the current drive efficiency.

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Publications

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Example citation with DOE Pages link:

Xi Chen, *et al.* "Top Launch for Higher Off-axis Electron Cyclotron Current Drive Efficiency" *EPJ Web of Conferences* **203**, 01004 (2019). [DOI: https://doi.org/10.1051/epjconf/201920301004]

Related Links

[include optional related links, one per line]

Xi Chen, *et al.* "Higher Off-Axis Electron Cyclotron Current Drive Via Top Launch Approach" 2019 APS-DPP, Post-deadline Invited [DPP19-2019-002180] http://absimage.aps.org/image/DPP19/MWS_DPP19-2019-002180.pdf