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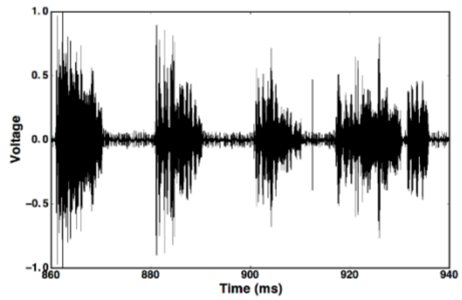
# Slow Your Roll

## Scientists at DIII-D Gain Insight into Controlling Fusion Products



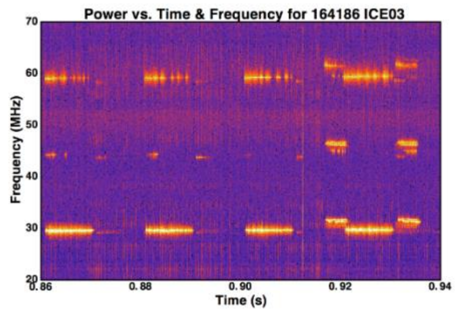




Image courtesy of DIII-D

*The top image shows magnetic measurements of fluctuations on DIII-D driven by energetic ions. An analysis of this signal reveals oscillations occur at particular frequencies, and demonstrate thresholds in the intensity of the energetic ions that switch these oscillations on or off,, as seen in the orange bars in the bottom image.*

### The Science

To create a practical fusion energy reactor, researchers need to control the energetic products of fusion reactors. These speedy ions, which are electrically charged helium nuclei ("alpha particles"), provide the self-heating ability of the reactor as they give their energy to the fusion fuel. But they can also drive eddies in the magnetic field that lead to localized losses of the alpha particles, with potential to damage the walls of the fusion device.

### The Impact

A team at the DIII-D National Fusion Facility recently took a different approach to studying these difficult-to-measure particles by analyzing high-frequency magnetic oscillations. The research showed promising results that have not only yielded insights into the physics of the particles themselves, but may also lead to new and reliable ways to monitor and manage how well fast ions are contained in future reactors.

## Summary

Part of the research challenge in measuring the fast ions lies in the harsh environment at the heart of a tokamak. Delicate sensors used in today's research tokamaks would be destroyed in future fusion reactors, which will have much higher power. The DIII-D team used a rugged magnetic sensor and high-performance computing to capture and interpret a small wiggle created in the device's magnetic field by these fast particles. This magnetic field fluctuation (Figure 1) provides information on the properties and behavior of the speedy ions and how they interact with plasma waves. This not only enables measurement of their behavior, but also crucial tests of underlying theories about how they behave, in order to predict behavior in future devices.

The next step for the fusion community will be to use the data generated to expand the capabilities of computer models that interpret the behavior of fast ions based on these oscillations. Once models are made more effective, they could be coupled with the rugged magnetic sensors in future high-power reactors to provide real-time control of the conditions that affect fast ions. If that feedback loop can be established, the fast ions could not only be kept from damaging the tokamak walls, they could be used to heat the plasma more efficiently.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## Publications

[At least one publication is required. For each publication, please ensure that a link to the DOE PAGES record (article details page) is either embedded in the title of the article's citation or pasted separately within the Publications(s) section of the highlight.

*Example citation with DOE Pages link:*


Thome et al., 2019, Nucl. Fusion. Central Ion Cyclotron Emission in the DIII-D Tokamak, https://iopscience.iop.org/article/10.1088/1741-4326/ab20e7/meta

Thome et al., 2018, Rev. Sci Instrum. Radio frequency measurements of energetic-particle driven emission using the ion cyclotron emission diagnostic on the DIII-D tokamak https://aip.scitation.org/doi/full/10.1063/1.5035561