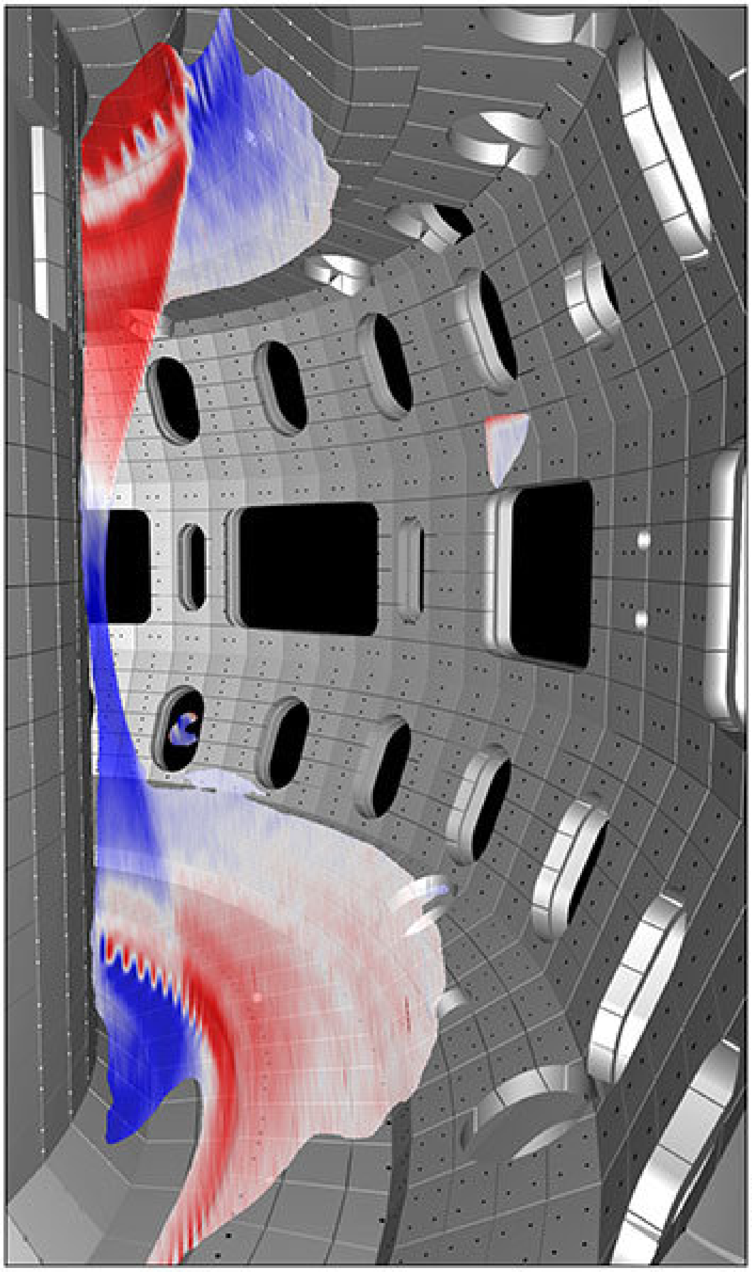
Seeing all the colors of the plasma wind

June 4 2018



Credit: US Department of Energy

When it comes to plasma winds in a tokamak, researchers are always looking for the Goldilocks solution—one that is just right. Winds that are too high or too low can reduce plasma efficiency. Researchers at the DIII-D National Fusion Center are using a new type of imaging to help get the wind moving at just the right speed. Plasma winds are more commonly referred to as flows. Researchers are using coherence imaging to better understand the velocities of ions in the flow. The results will help design effective exhaust solutions. These solutions will improve fusion plasma performance and raise efficiency.

Flows with speeds over 40 kilometers/second can transport heat and particles long distances in the boundary plasma of a fusion tokamak. When these flows are traveling too fast, or if they become stagnant, they can hurt plasma performance by allowing the buildup of impurities. Characterizing both impurity and main-ion flows with coherence imaging offers greater spatial detail than previous methods. It enables the detailed model/experiment comparison needed to improve models. In addition to greater spatial detail, the imaging datasets offer insights on extremely hot as well as high-performance plasmas. Scientists can use the datasets to investigate complex 3-D flows.

Coherence imaging measures red- and blue-shifted emission from ions radiating in the visible spectrum by combining an interferometer with a fast camera. The resulting images are used to calculate the velocity throughout the camera's field of view. The resulting datasets benchmark sophisticated fluid modeling of the tokamak's plasma divertor.

In this study, researchers compared 2-D helium ion velocities in the scrape-off-layer and divertor regions of the DIII-D tokamak to state-of-the-art fluid modeling simulations using a sophisticated code. The velocity of singly charged helium ions traveling along magnetic field lines was predicted well by the model in the region close to the divertor plate where He+ is the dominant ion, and electron-physics dominates the momentum balance. Further upstream, where doubly charged helium (He2+) is the main ion species and ion physics becomes more important, fluid modeling underestimates the velocity by a factor of 2 to 3. These results indicate that better understanding is required to predict the ion population's behavior in these challenging conditions and that there is still much to be learned about the role of ions in the tokamak divertor.

More information: C. M. Samuell et al. 2D imaging of helium ion velocity in the DIII-D divertor, *Physics of Plasmas* (2018). DOI: 10.1063/1.5017999

Provided by US Department of Energy