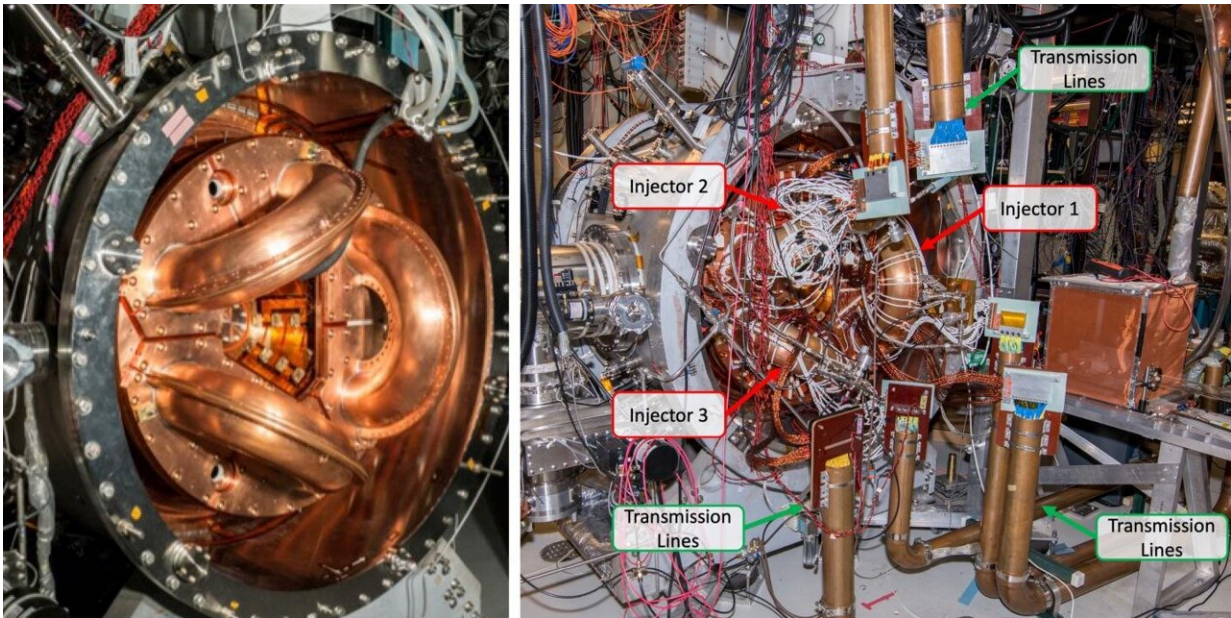


Gaming graphics card allows faster, more precise control of fusion energy experiments

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Two photos of the team's prototype reactor, showing the three injectors with (right) and without (left) the electrical circuits (labeled in green on the right) used to form magnetized plasmas in each injector. The GPU precisely controls each of these circuits, allowing the researchers to fine-tune plasma formation in each injector. The individual plasmas then combine and naturally organize into a doughnut-shaped object, similar to a smoke ring. Credit: University of Washington

Nuclear fusion offers the potential for a safe, clean and abundant energy source.

This process, which also occurs in the sun, involves plasmas, fluids composed of charged particles, being heated to extremely high temperatures so that the atoms fuse together, releasing abundant energy.

One challenge to performing this reaction on Earth is the dynamic nature of plasmas, which must be controlled to reach the required temperatures that allow fusion to happen. Now researchers at the University of Washington have developed a method that harnesses advances in the computer gaming industry: It uses a gaming graphics card, or GPU, to run the control system for their prototype fusion reactor.

The team published these results May 11 in *Review of Scientific Instruments*.

"You need this level of speed and precision with plasmas because they have such complex dynamics that evolve at very high speeds. If you cannot keep up with them, or if you mispredict how plasmas will react, they have a nasty habit of going in the totally wrong direction very quickly," said co-author Chris Hansen, a UW senior research scientist in the aeronautics and astronautics department.

"Most applications try to operate in an area where the system is pretty static. At most all you have to do is 'nudge' things back in place," Hansen said. "In our lab, we are working to develop methods to actively keep the plasma where we want it in more dynamic systems."

The UW team's experimental reactor self-generates magnetic fields entirely within the plasma, making it potentially smaller and cheaper than other reactors that use external magnetic fields.

"By adding magnetic fields to plasmas, you can move and control them without having to 'touch' the plasma," Hansen said. "For example, the [northern lights](#) occur when plasma traveling from the sun runs into the

Earth's [magnetic field](#), which captures it and causes it to stream down toward the poles. As it hits the atmosphere, the charged particles emit light."

The UW team's prototype reactor heats plasma to about 1 million degrees Celsius (1.8 million degrees Fahrenheit). This is far short of the 150 million degrees Celsius necessary for fusion, but hot enough to study the concept.

Here, the plasma forms in three injectors on the device and then these combine and naturally organize into a doughnut-shaped object, like a smoke ring. These plasmas last only a few thousandths of a second, which is why the team needed to have a high-speed method for controlling what's happening.

Previously, researchers have used slower or less user-friendly technology to program their [control systems](#). So the team turned to an NVIDIA Tesla GPU, which is designed for machine learning applications.

"The GPU gives us access to a huge amount of computing power," said lead author Kyle Morgan, a UW research scientist in the aeronautics and astronautics department. "This level of performance was driven by the computer gaming industry and, more recently, machine learning, but this graphics card provides a really great platform for controlling plasmas as well."

Using the graphics card, the team could fine-tune how plasmas entered the reactor, giving the researchers a more precise view of what's happening as the plasmas form — and eventually potentially allowing the team to create longer-living plasmas that operate closer to the conditions required for controlled fusion power.

"The biggest difference is for the future," Hansen said. "This new system

lets us try newer, more advanced algorithms that could enable significantly better control, which can open a world of new applications for [plasma](#) and [fusion](#) technology."

More information: K. D. Morgan et al, High-speed feedback control of an oscillating magnetic helicity injector using a graphics processing unit, *Review of Scientific Instruments* (2021). [DOI: 10.1063/5.0044805](https://doi.org/10.1063/5.0044805)

Provided by University of Washington

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