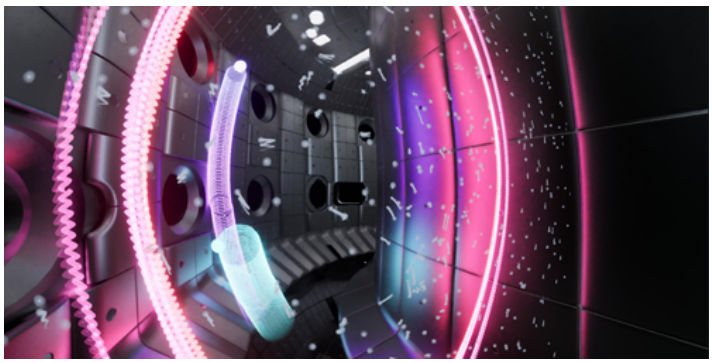
Preventing a Tokamak from Overheating

Fusion reactor experiments in Switzerland have demonstrated a new way to remove unwanted heat from a magnetically confined plasma.

By **Charles Day**

Among the most enduring designs for a fusion reactor is the tokamak, which uses a doughnut-shaped magnetic field to trap burning plasma. But some of the plasma still interacts with the reactor wall, which can cause severe damage. Now, on one of the key European tokamak experiments, Kenneth Lee of the Swiss Federal Institute of Technology in Lausanne (EPFL) and his collaborators have demonstrated a new and potentially efficient way to shed excess heat [**1**].

The experiment was conducted at the Variable Configuration Tokamak (TCV) on the EPFL campus. Like other modern tokamaks, TCV hosts a so-called *X*-point: The cross-section of the doughnut's outer magnetic field features a point at the bottom where the field lines cross, creating an opening for reaction by-products to drain away through a narrow magnetic funnel called a divertor. In 2015, researchers at a tokamak in Germany discovered that plasma at the *X*-point radiates strongly, thereby removing potentially troublesome thermal energy.



Credit: EPFL/Swiss Plasma Center (SPC) and Laboratory for Experimental Museology (eM+)

The EPFL team realized they could boost the useful, heat-removing radiation by reconfiguring the confinement field to include a second *X*-point along the divertor funnel. Experiments at the TCV vindicated this concept, which they call the *X*-point target radiator (XPTR). What's more, conditions for filling the XPTR with plasma turned out to be easy to achieve and control. Lee points out that the XPTR concept could be implemented at SPARC, a next-generation tokamak reactor being developed by Commonwealth Fusion Systems, Massachusetts, in collaboration with MIT.

Charles Day is a Senior Editor for ***Physics Magazine***.

REFERENCES

1. K. Lee *et al.* (TCV Team and EUROfusion Tokamak Exploitation Team), "*X*-point target radiator regime in tokamak divertor plasmas," **Phys. Rev. Lett. 134, 185102 (2025).**