# QCHFM – Fusion Plasma Example

This example demonstrates how QCHFM (Quantum-Coherent Hybrid Flow Modeling) can be used to simulate the behavior of plasma inside a magnetic fusion reactor, such as a tokamak. These environments are highly dynamic, with edge instabilities, heat transport, and nonlinear interactions.

## Objective

To model plasma flow within a magnetic confinement system, capturing instabilities, magnetic effects, and regions of high uncertainty. This supports the design of safer, more efficient fusion reactors.

## Simulation Setup

- Domain: Toroidal (donut-shaped) 2D slice of a tokamak chamber

- Magnetic field: Applied with circular field lines

- Heat flux: Introduced from the core outward

- Edge instabilities: Triggered by perturbations near the boundary

## QCHFM Layers Applied

- Theoretic Core: Modified fluid dynamics equations with magnetic and thermal effects

- Practice Layer: Edge-localized mesh refinement and plasma viscosity models

- Quantum Overlay: Introduces stochastic drift at plasma edge and hot spots

## Output

- Velocity, temperature, and density fields

- Edge-localized turbulence maps

- Confidence overlay indicating trust in predictions under magnetic pressure

## Insights

QCHFM identified edge turbulence zones where uncertainty was highest—matching observed regions in experimental reactors where confinement breaks down. This can help inform fusion scientists where safety margins are lowest and where improvements in control are most needed.

This use case shows QCHFM's value in environments that blend physics, heat, and instability—ideal for nuclear fusion modeling.