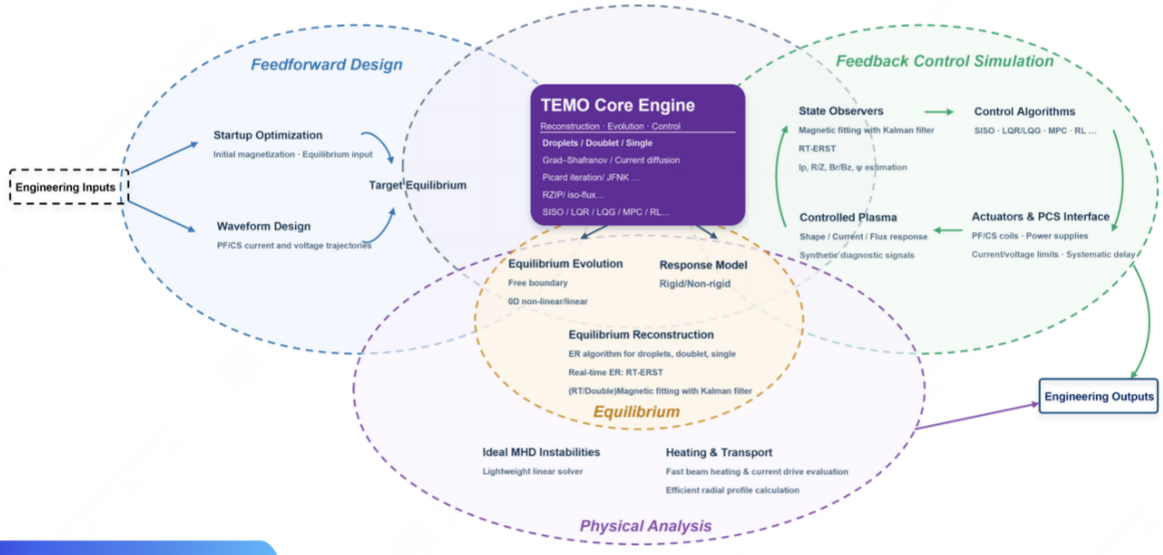
TEMO

Intruduction

TEMO (Tokamak Equilibrium Modeling toolbox for Operation) is an operation-oriented tokamak equilibrium toolbox that covers the entire experimental workflow, from discharge design to analysis. It supports full closed-loop simulation of the evolution, observation, and control of both singlet/doublet configurations, providing strong support for discharge design, controller design, diagnostic data processing and physics experiment analysis during experimental operations.



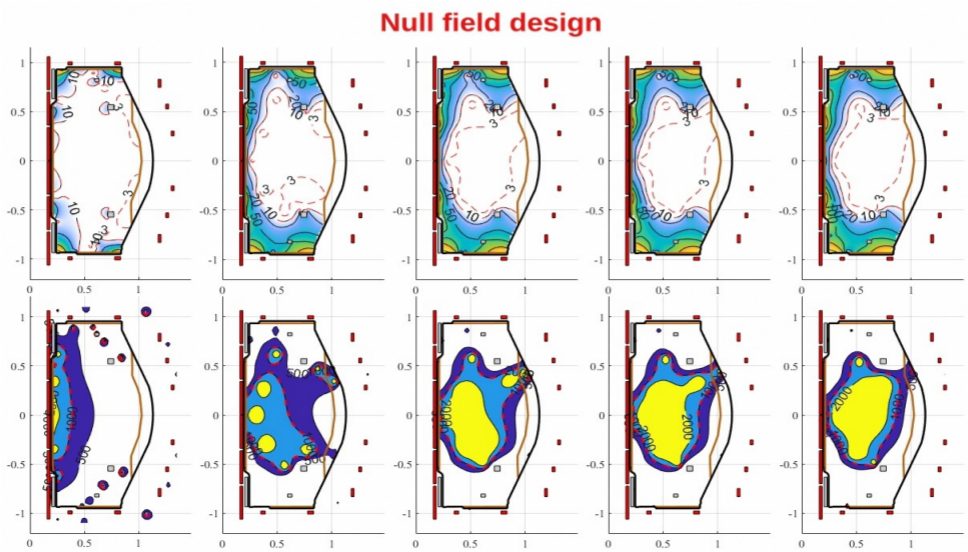
Features

1. Supports three self-consistent and high-fidelity equilibrium computation methods, including equilibrium reconstruction, forward free-boundary calculations, and coil-current reconstruction.
2. Supports feedforward design and various feedback-control simulation functions. Based on the feedforward design, it produces a feasible discharge scenario. Feedback-control simulations are carried out based on plasma response model to investigate plasma-control strategies, providing a basic plan for control experiments.

Parameters

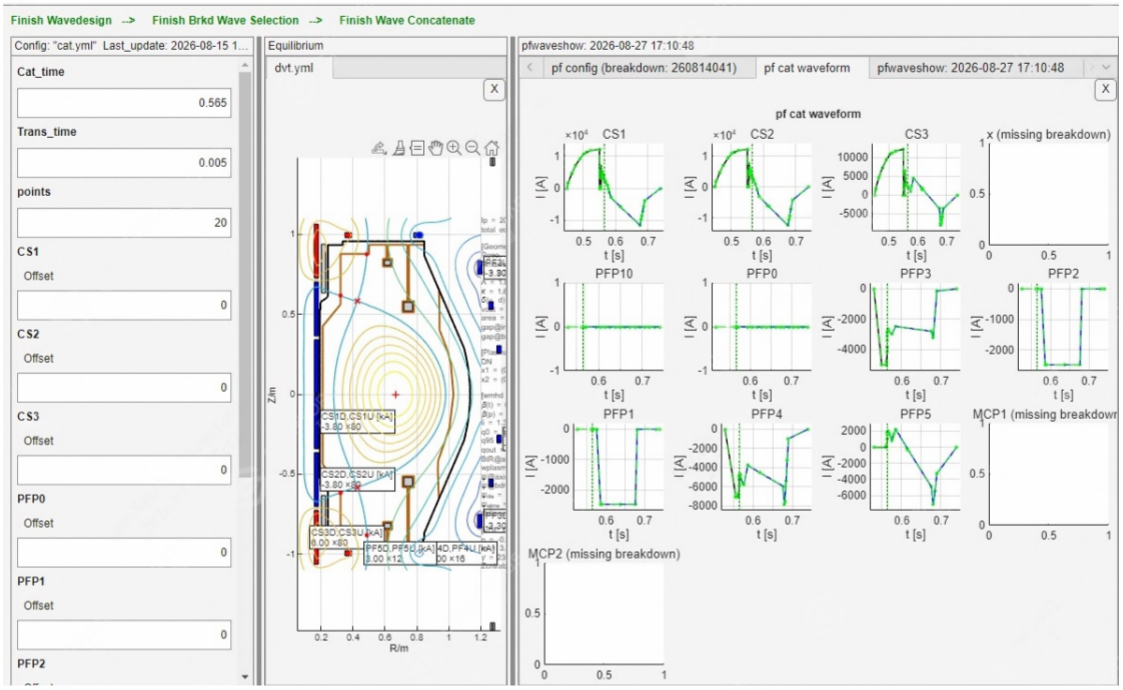
TEMO Specifications	
Static Equilibrium	Supports equilibrium reconstruction, forward free-boundary calculations, and coil-current reconstruction.
Discharge Scenario Design	Supports null field design and optimization. Based on static equilibrium design, TEMO support discharge -scenario design.
Free-Boundary Equilibrium Evolution	Supports 0D linear and nonlinear free-boundary equilibrium evolution. 1D-related capabilities are under development.
Control Simulation	Supports closed-loop control simulations for singlet RZIP and isoflux configurations. Supports closed-loop control simulations for doublet RZIP configurations. Control algorithms include SISO, LQR/LQG, MPC, RL, etc.
Other Physics Analysis	Supports ideal magnetohydrodynamic (MHD) instability analysis. Supports basic analysis of NBI heating and heat transport.
Device Design	Based on the overall TEMO framework, supports 0D tokamak device design.

Applications



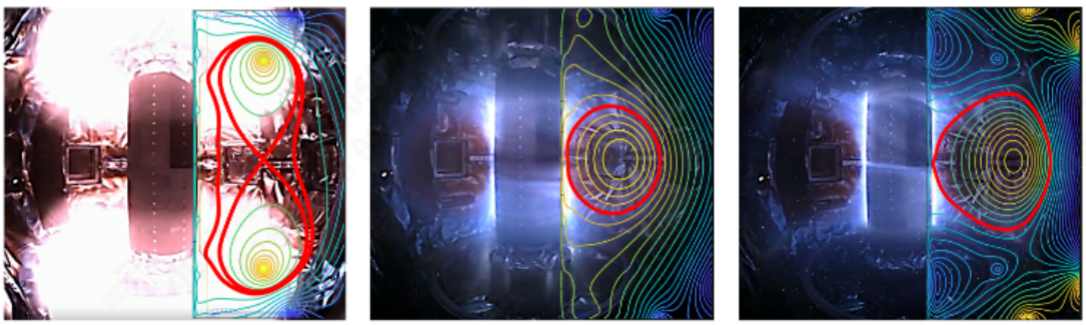
Null Field Design: Supports dynamic null field design, self-consistent eddy-current compensation, and generation of coil current waveforms required for plasma breakdown.

Waveform design

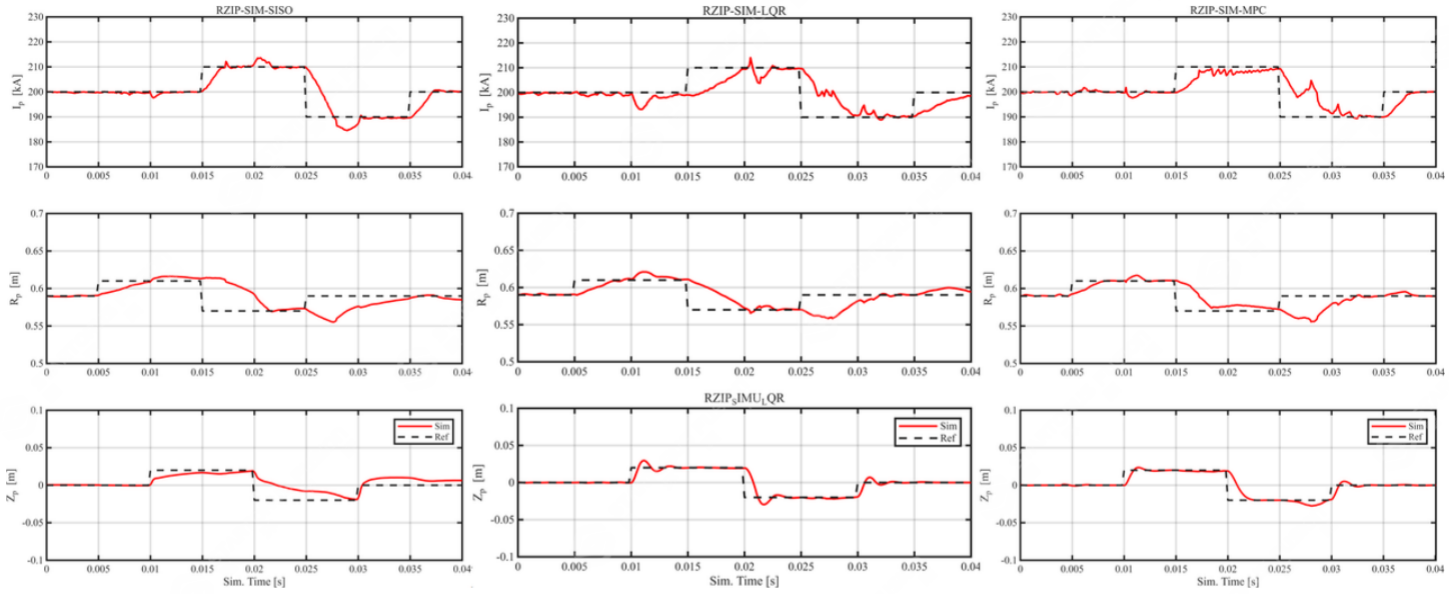


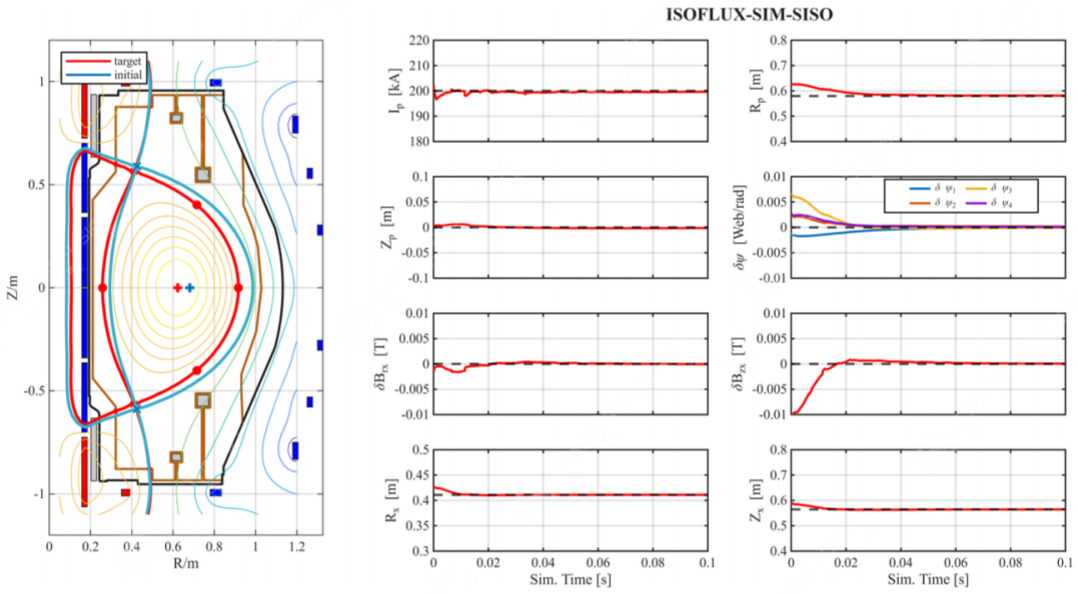
Discharge Waveform Design: Designs feedforward waveforms for the ramp-up and flat-top phases based on singlet/doublet equilibrium configurations, and concatenates them with the breakdown waveform to produce a complete discharge waveform.

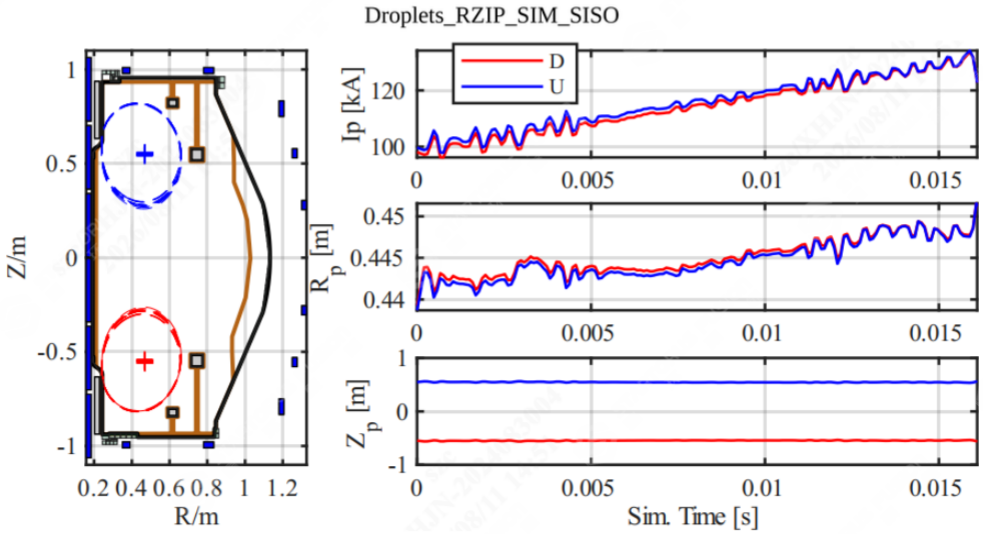
Equilibrium Reconstruction of Droplets/Doublet/Singlet



Equilibrium Reconstruction: Provides stable equilibrium reconstruction of complex singlet/doublet configurations, supplying equilibrium data for experimental analysis.







Control Simulation: Supports offline simulations of singlet SISO, LQR, LQG, and MPC control, as well as RL-controller training, together with RZIP_SISO control simulations for doublet configurations, providing solutions for plasma feedback control.