TEMO: A COMPREHENSIVE AND VERSATILE EQUILIBRIUM MODELLING TOOLBOX FOR TOKAMAK OPERATIONS

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ABSTRACT

- A novel Tokamak Equilibrium Modelling toolbox for Operations (TEMO) is developed in the MATLAB environment.
- TEMO is developed using object-oriented programming, making it highly extensible.
- With the axisymmetric equilibrium and magnetic field null calculations as the core functionality, it has extended many applications, such as linear and nonlinear plasma response model analysis, feedforward discharge waveform design and feedback controller design, etc.

ORGANIZATION OF THE CODE MODULES
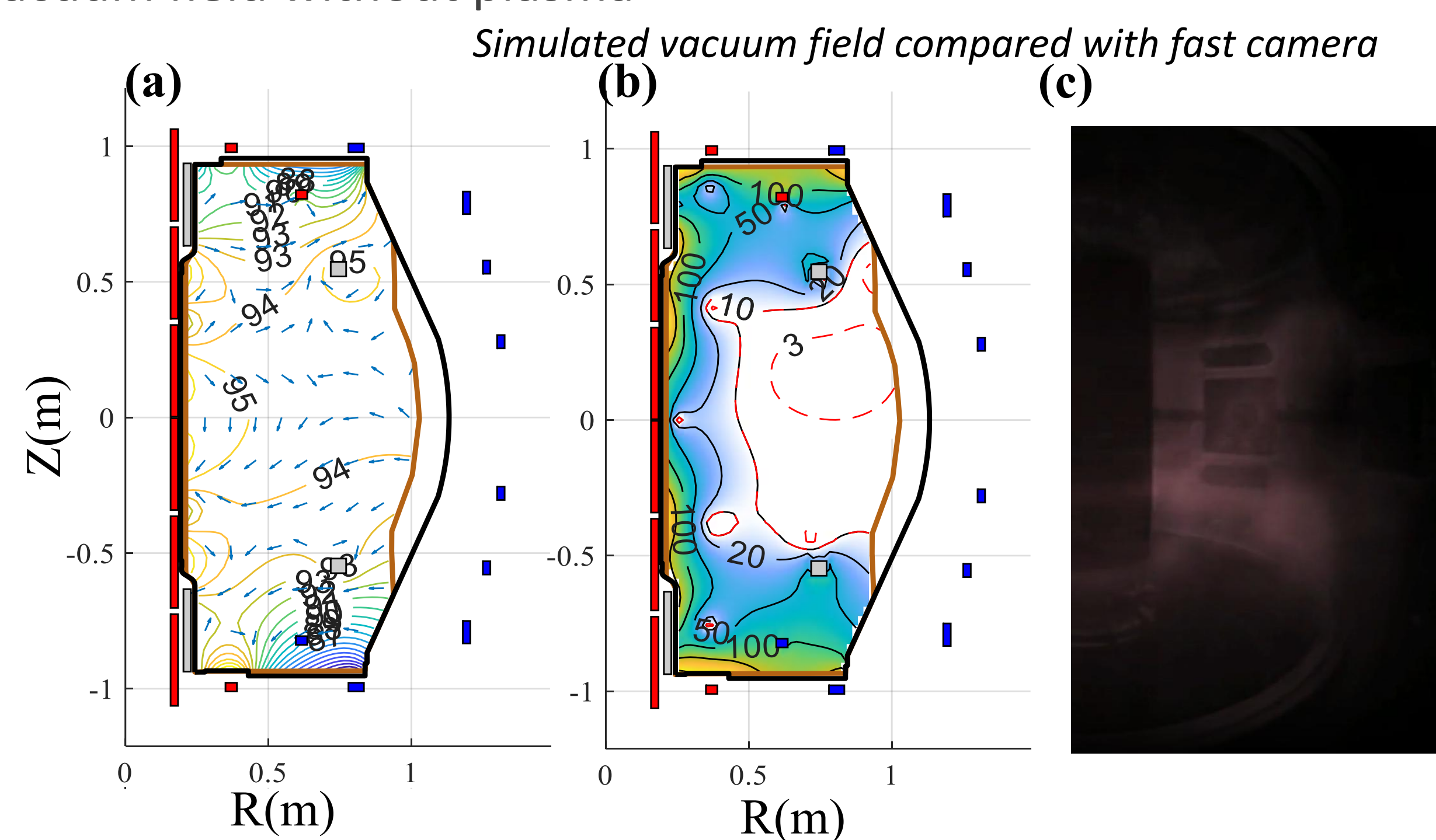

The overall structure of TEMO
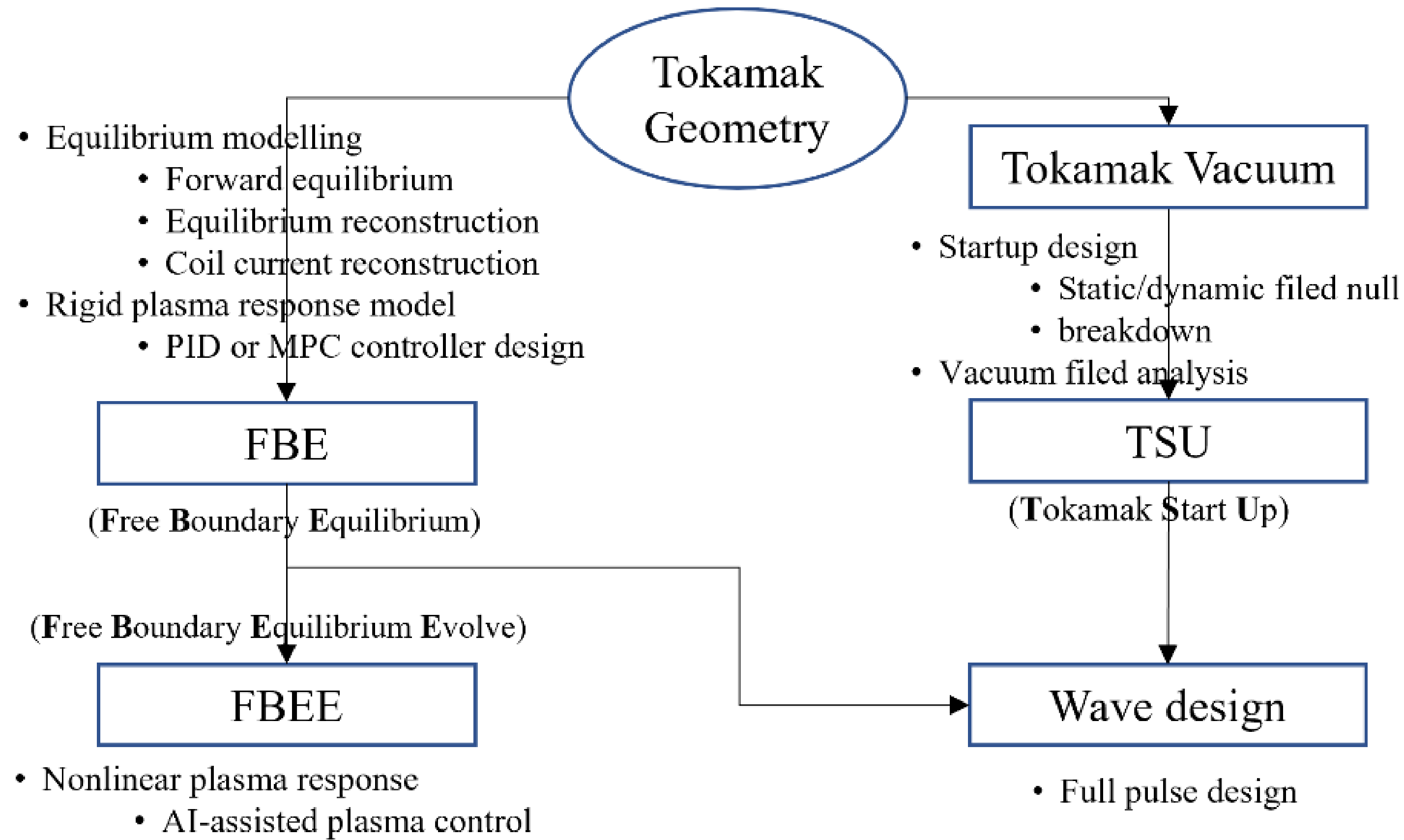
- the Geometry class is the most fundamental one
- In the left is the plasma less modules
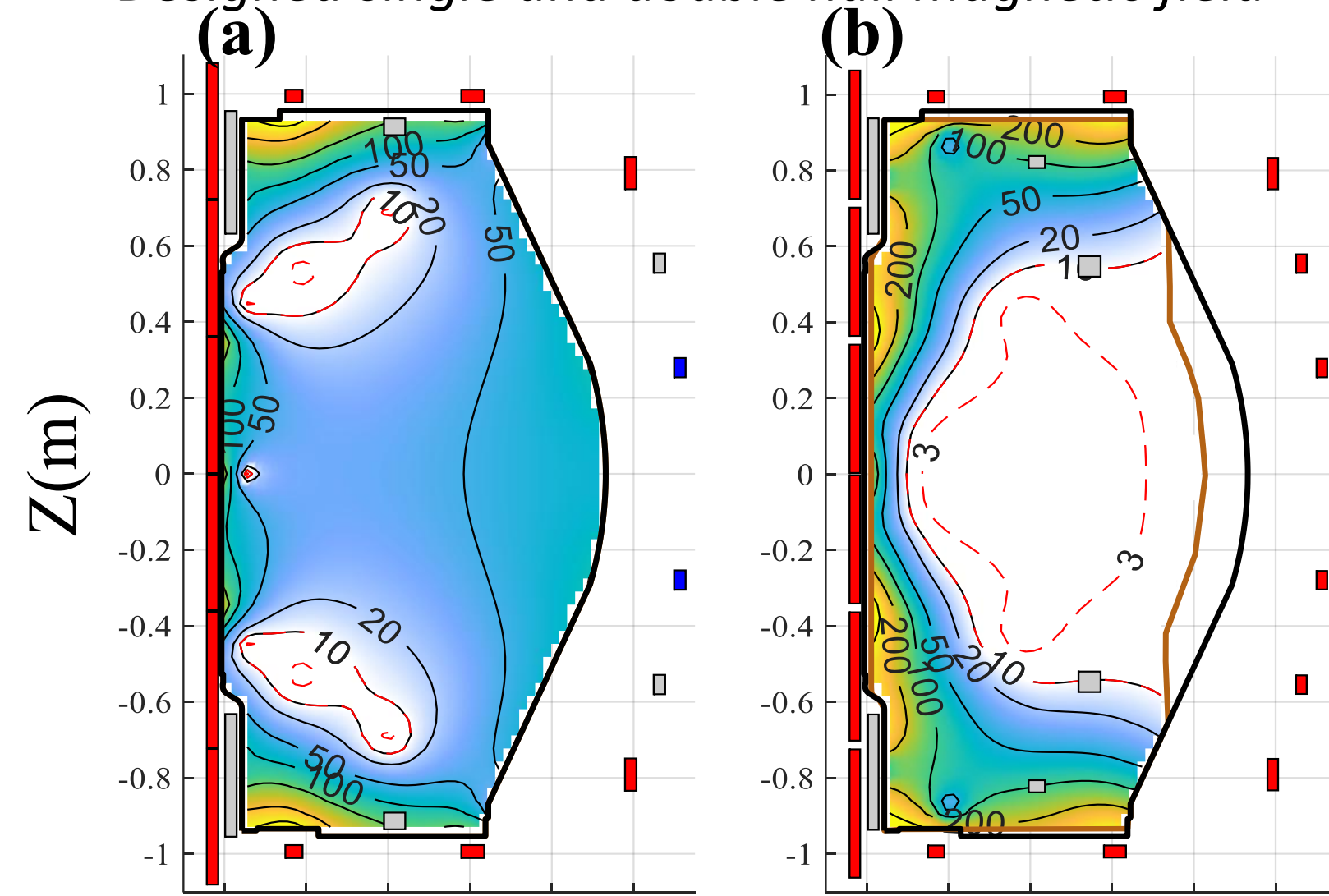- In the right is the modules with plasma

PLAMA LESS MODELUES

Vacuum class

- validate system parameters
- comparison between measured and simulated signals
- Vacuum field without plasma

Simulated vacuum field compared with fast camera

TSU class

- startup research
- global optimization algorithm
- Static or dynamic
- Single or double magnetic field null

*Designed single and double null magnetic field*

MODELUES WITH PLASMA

FBE class

- Static equilibrium calculations
- Forward and inverse, equilibrium reconstruction, coil current reconstruction, and forward free boundary equilibrium
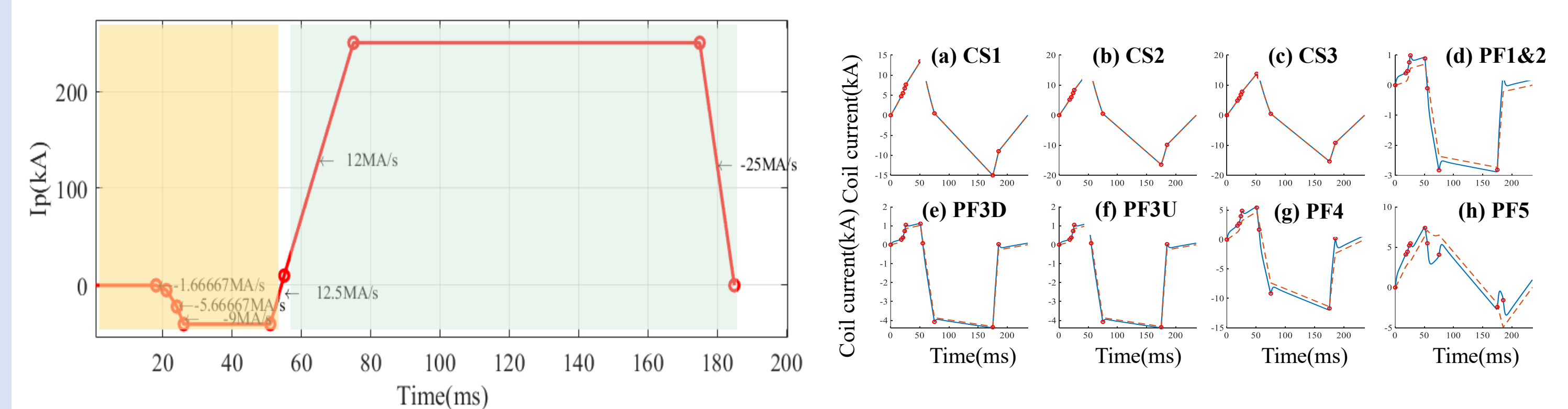

Different configurations calculated by FBE class
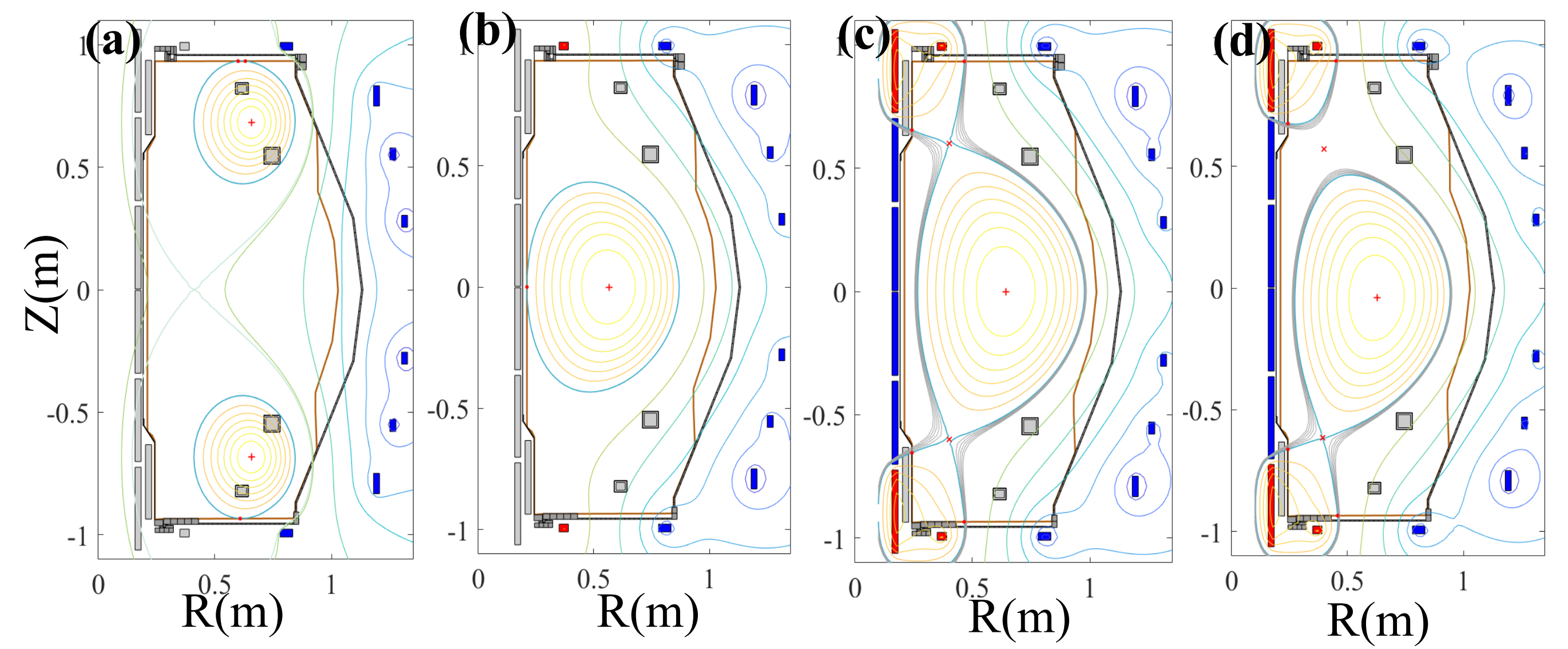
FBEE class

- Dynamic equilibrium calculations
- root-finding problem
- JFNK method

Control simulation based on FBEE
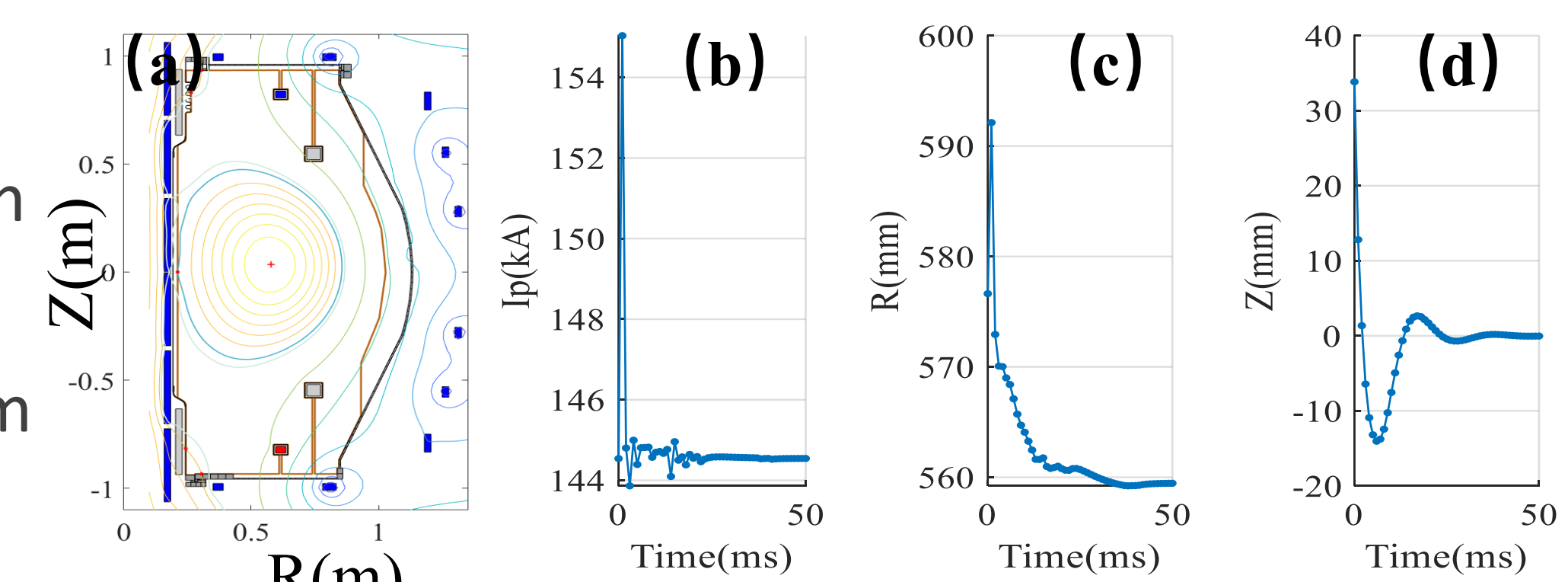
Wave design class

- Scenario development

Designed plasma current and poloidal field coils waveform

Designed breakdown scenario
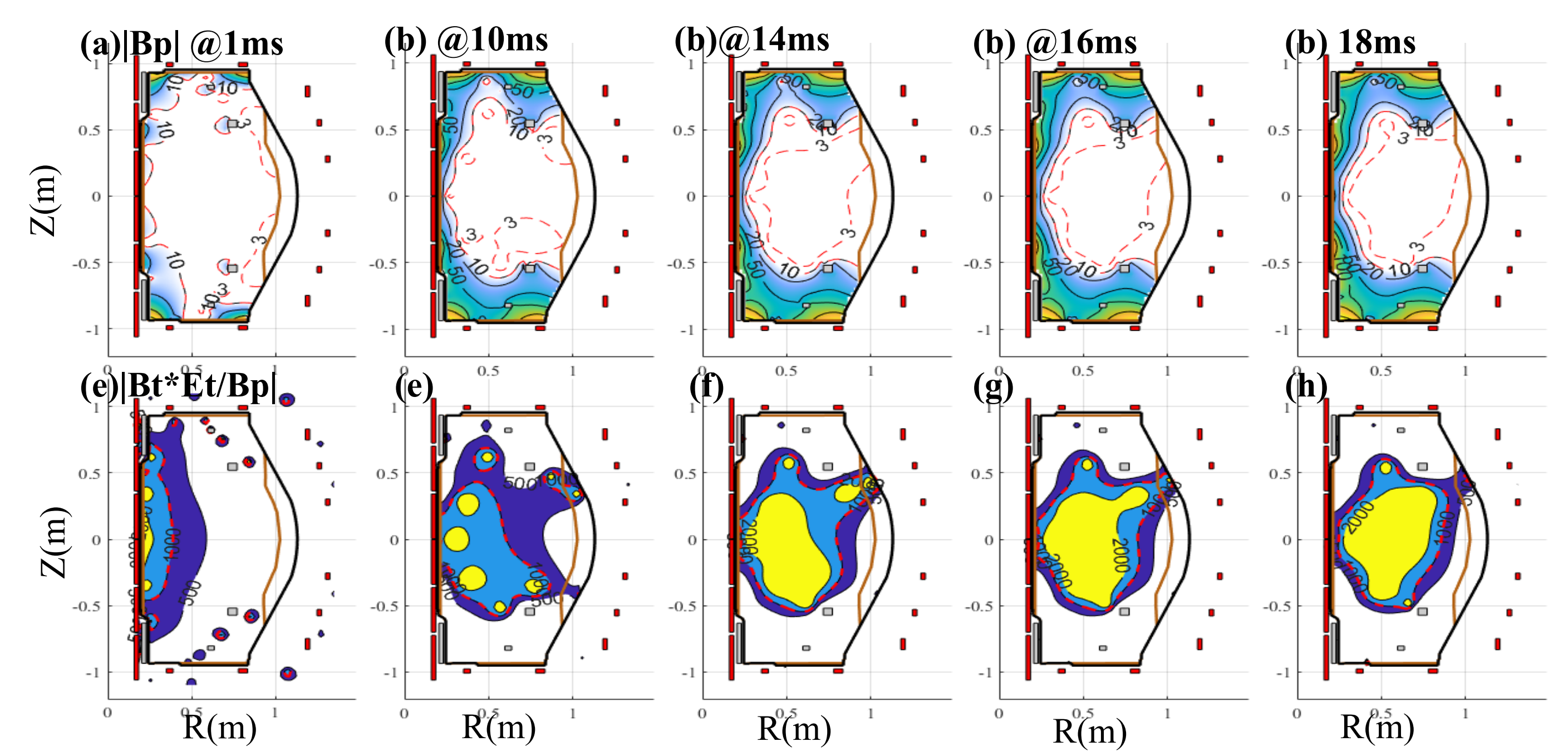
CONCLUSION

- TEMO is a powerful and versatile equilibrium modelling toolbox that integrates design optimization, real-time control, and equilibrium analysis, making it well suited for tokamak operations.
- Future plans include FBEE with double ring plasma and with energy transport; a new control class dedicated to plasma control; a new class dedicated to discharge analysis.

ACKNOWLEDGEMENTS / REFERENCES