

# The TriForce Project: Progress and Plans

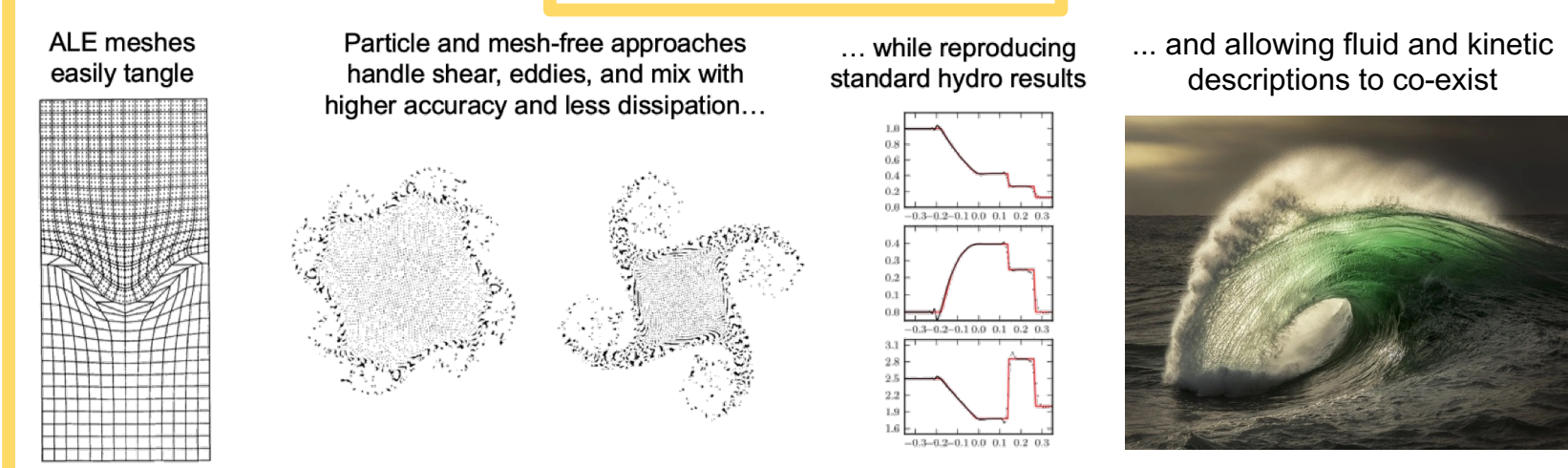
A. B. Sefkow, J. G. Shaw, A. Kish, M. Lavell, R. Masti, A. Sexton, S. Borge, A. Bowman, M. Burns, S. A. Cohen, J. R. Davies, S. Dwarkadas, R. Follett, C. Galea, K. Hemsley, K. Jarvis, Y. Lawrence, S. Pai, M. Paluszek, A. Poudel, W. Scullin, S. Sikorski, R. B. Spielman, A. Srinivasan, S. Thomas, and S. Zhai

The TriForce Center for Multiphysics Modeling, a collaboration between the Departments of Mechanical Engineering, Physics, Computer Science, and the Laboratory for Laser Energetics at the University of Rochester

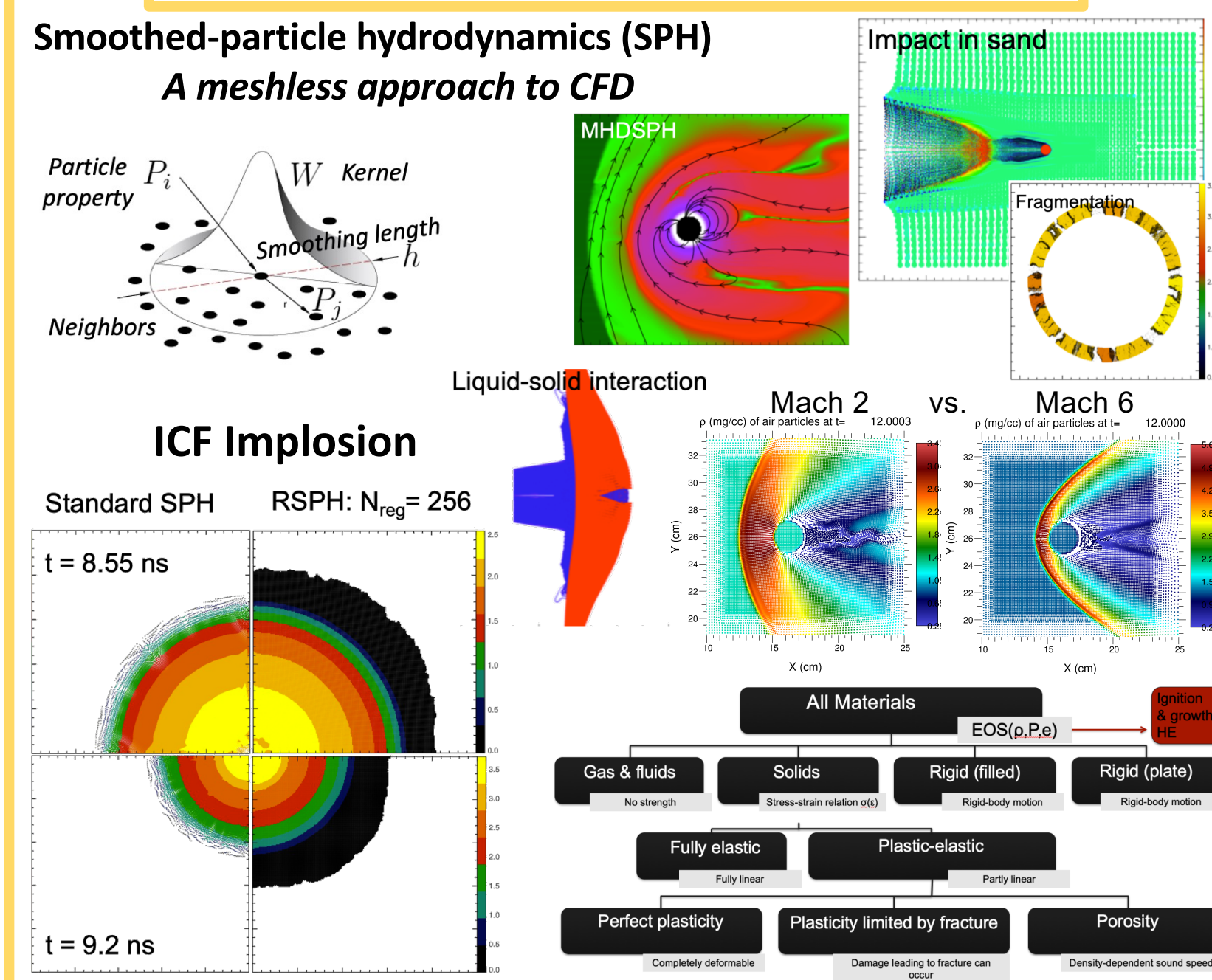
## Summary

- **TriForce** is a modular C++ framework for parallel GPU-accelerated **particle-based hybrid fluid-kinetic** 3D simulations
- The goal is to provide **better predictive capability** and **access to advanced models** for the benefit of the academic community.
- **Student involvement: high school, undergraduate, and graduate**

## Why particles?



## Particle-based meshless fluid algorithms



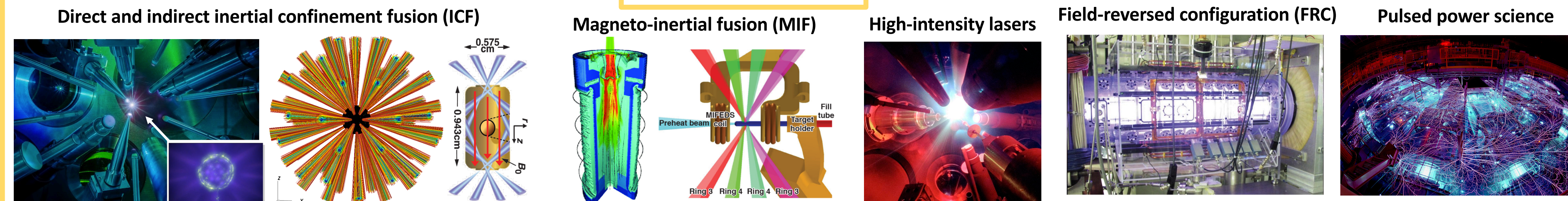
## Material models (fluids)

- Equation of state  
*Analytic, tabular (FPEOS, LEOS, SESAME)*
- Opacity and  $\langle Z \rangle$   
*Analytic, tabular (Astrophys., FPEOS, etc)*
- Electrical resistivity  
*Spitzer, tabular (QLMD)*
- Viscosity  
*Real and artificial*
- Surface tension
- Stress-strain and material strength  
*Elastic-plastic, Steinberg-Guinan-Lund*

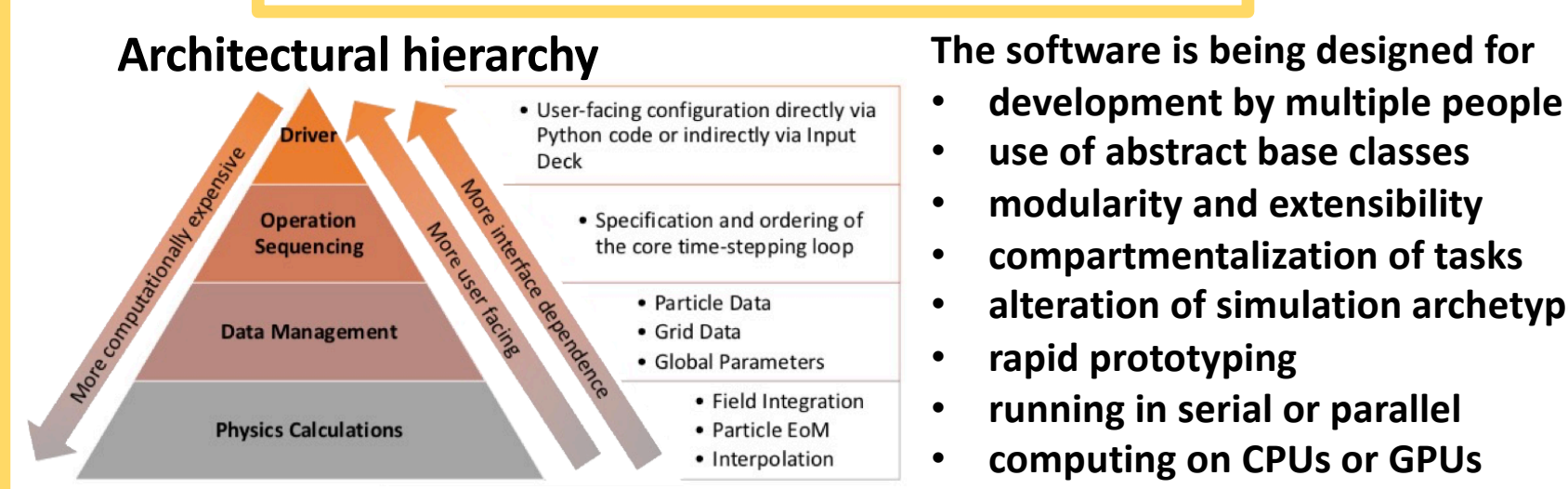
## Other models and advanced structures

- Explicit or implicit particles & fields
- Adaptive particles and meshes
- Charged particle beams
- Ionization and excitation
- Magnetohydrodynamics
- Circuit model
- Nonlocal thermal conduction
- Nuclear fusion and  $\alpha$  transport
- Neutron transport
- Photon transport
- Gravity
- Nonplanar geodesic polyhedral mesh
- Unstructured mesh (triangulated)
- Chaining cells
- KD-Trees
- RT and Tensor core GPU algorithms

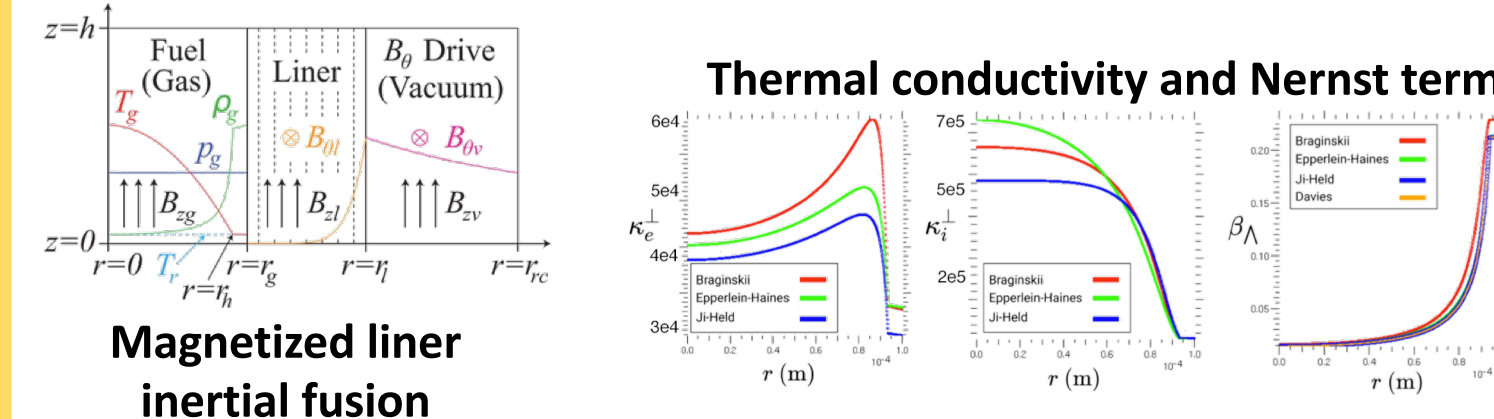
## Scientific motivation



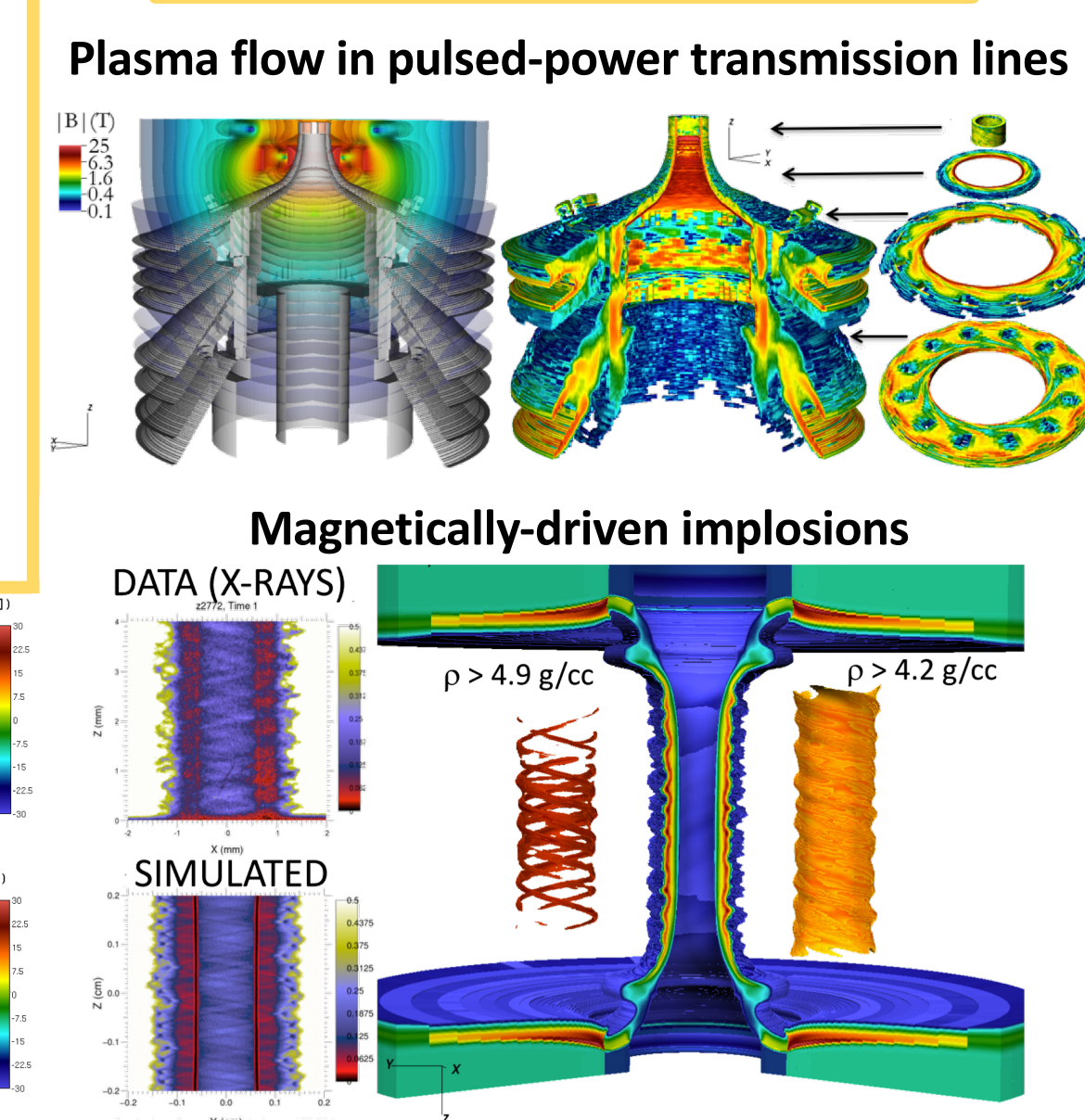
## Modular multiphysics simulations



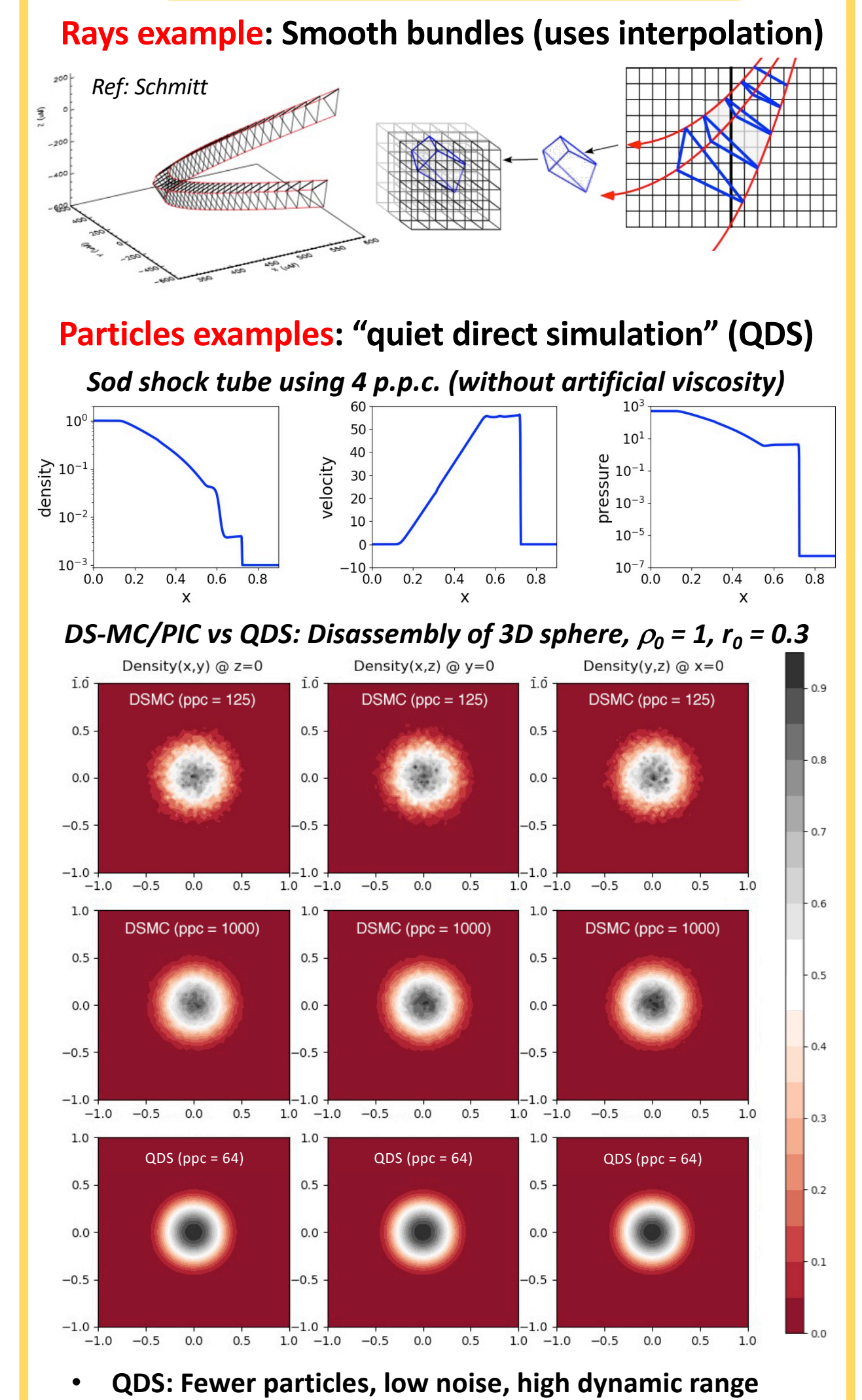
## MHD transport coefficient sensitivity studies



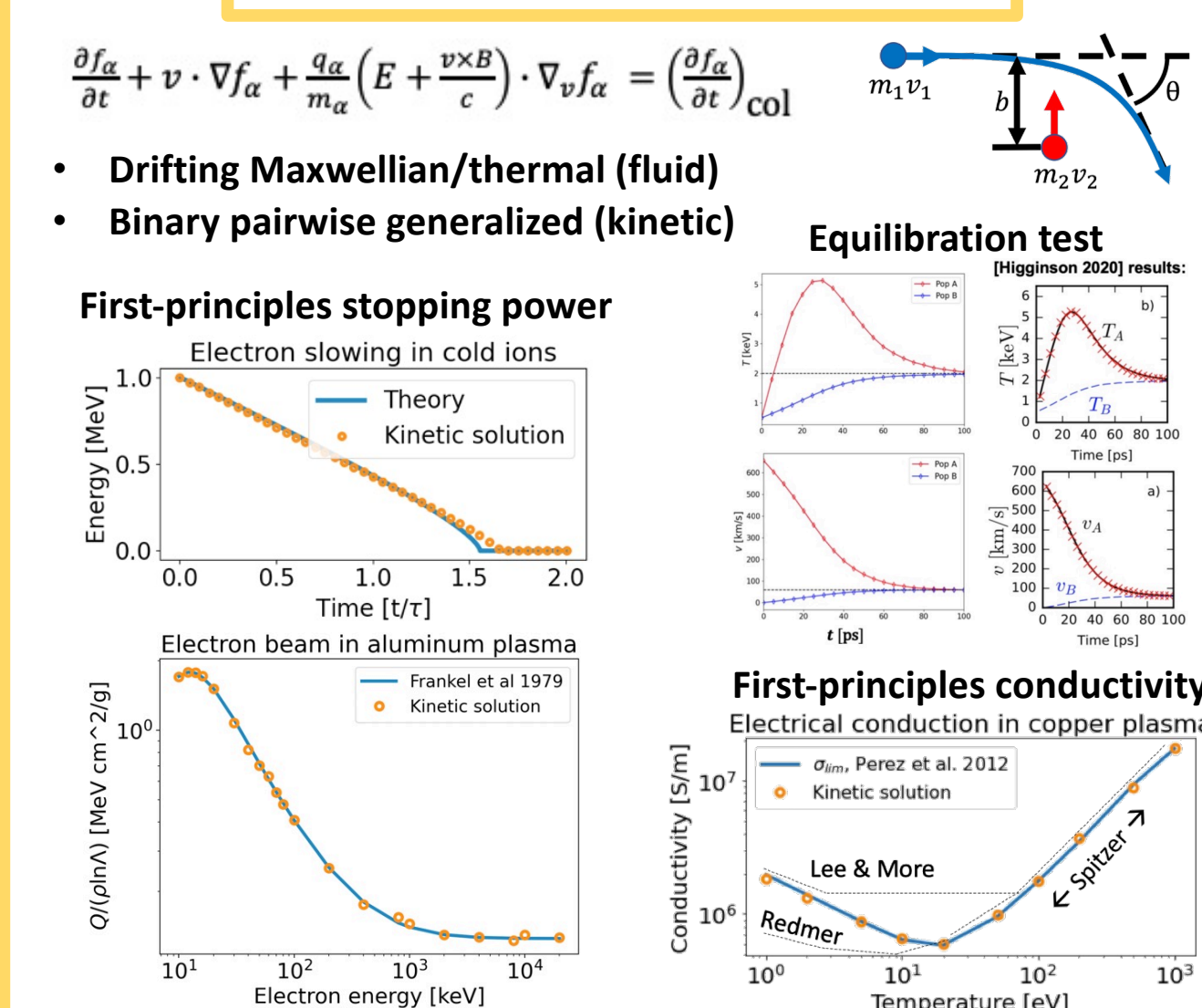
## Magnetized plasma physics



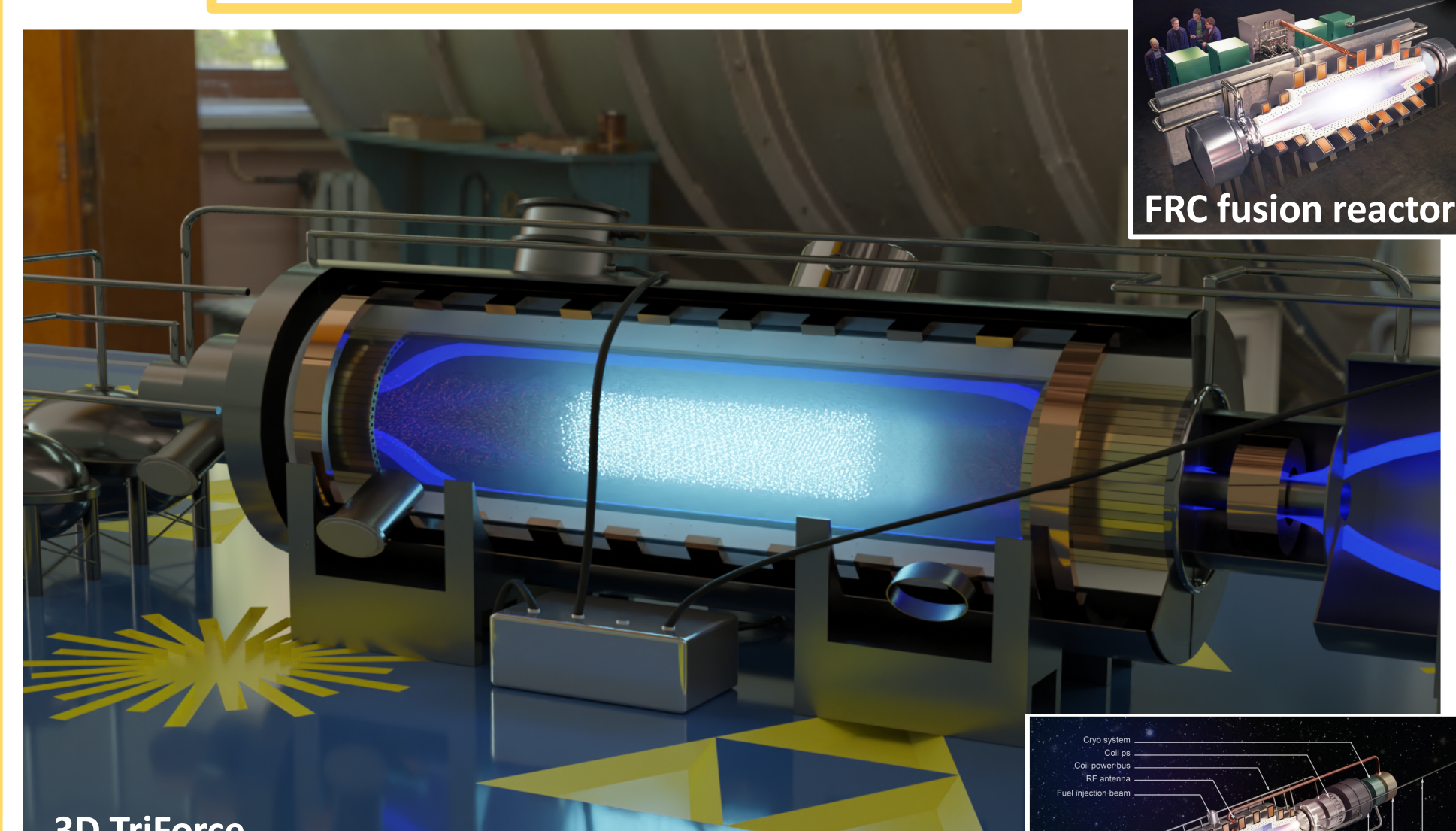
## Low-noise "quiet" methods



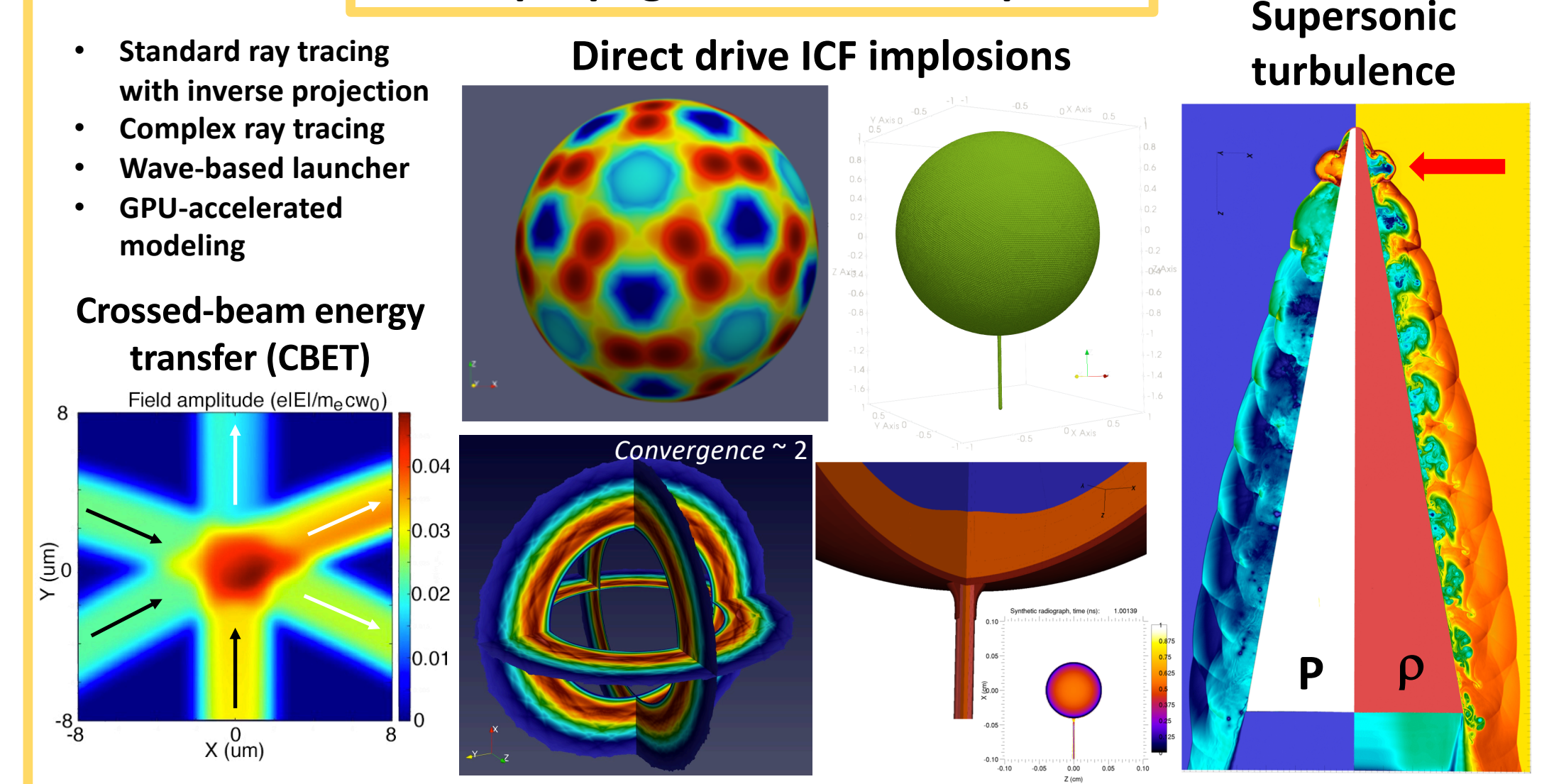
## Coulomb collision models



## Field-reversed configuration (FRC)



## Laser propagation and absorption



## References

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## Acknowledgments

This material is based upon work supported by the Department of Energy (DOE) Office of Fusion Energy Sciences (OFES) under Award Number DE-SC0017951, the DOE Advanced Research Projects Agency - Energy (ARPA-E) under Award No. AR-0001272, the National Science Foundation under Award No. CNS-1900803, and the DOE National Nuclear Security Administration (NNSA) under Award No. DE-NA0003856. We also thank Brookhaven, Oak Ridge, and NVIDIA for support.