A Simulation Resource Team for Innovative Fusion Concepts

BETHE Kickoff Virtual Workshop
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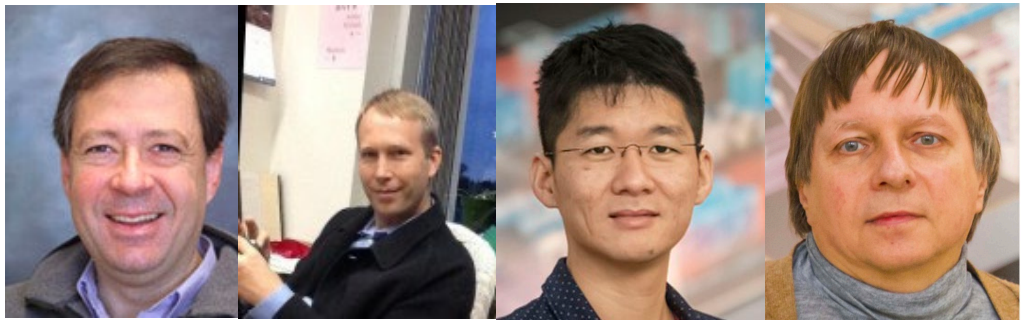
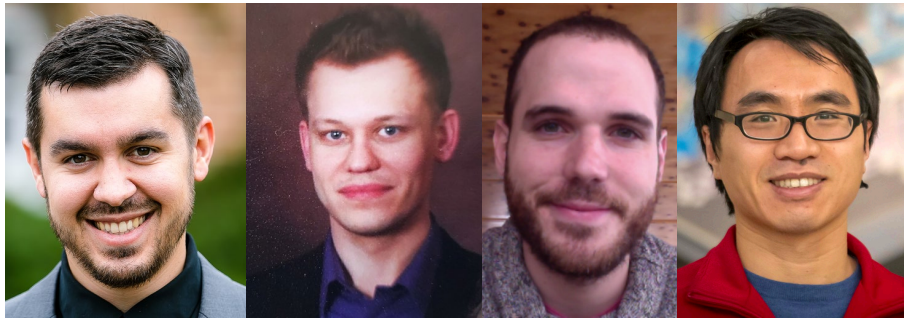
Meet the Team at the University of Rochester!

- **Petros Tzeferacos** - PI, project lead, FLASH lead
- **Adam Sefkow** - co-PI, TriForce lead
- **Chuang Ren** - co-PI, OSIRIS lead
- **Riccardo Betti** - co-PI, theory & simulations support
- **Jonathan Davies** - co-PI, theory & liaison
- **Han Wen** - co-PI, OSHUN & OSIRIS simulations
- **John Shaw** - Scientist, TriForce simulations
- **Eddie Hansen** - Postdoc, FLASH simulations
- **David Michta** - Postdoc, FLASH simulations
- **Fernando García-Rubio** - Postdoc, theory
- **Ka Ming (Jack) Woo** - Postdoc, theory & simulations
- **Graduate student** - open position, HPC support

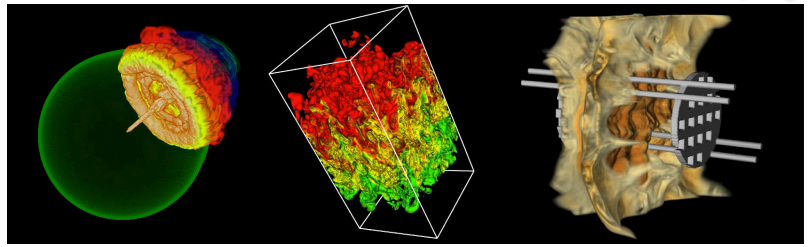




UR Theory & Modeling Capability Team to provide simulation support for Concept Teams and assess leading Concepts

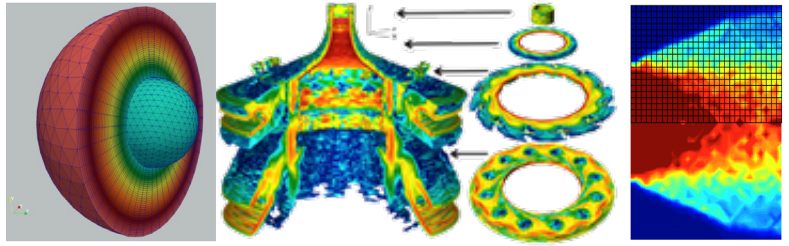
- Four components:
  - (1) Carry out simulations for Concept Teams;
  - (2) Independent simulations of key fusion Concepts;
  - (3) Assist Teams in the use of simulation codes;
  - (4) Modest development to enhance fidelity.
- A suite of simulation codes – fluid, hybrid, and kinetic: Principal codes are **FLASH**, **TriForce**, and **OSIRIS**. **OSHUN** to develop models of magnetized transport.
- Engage with Concept Teams that focus on Plasma-Jet-Driven Magneto-Inertial Fusion **(PJMIF)**, Field-Reversal Configurations **(FRC)**, and the staged Z-pinch **(SZP)**.

FLASH code



Multi-physics AMR MHD code for HEDP and plasma astrophysics

TriForce



Meshless fluid/kinetic hybrid simulation tool

OSIRIS

Fully relativistic, massively parallel PIC code

Major Milestones, Risks, and Outcomes

Major Milestones

- FLASH and OSIRIS integrated simulations of **PJMIF** Concept. Evaluate perturbation effects on energy-gain, fluid/kinetic effects
- Provide independent integrated assessment of the **SZP** Concept based on theory and FLASH and TriForce simulations
- Assessment of energy-gain potential of **PFRC** Concept at 10x density, 4x volume, and 100x timescale with TriForce simulations
- State-of-the-art FLASH and TriForce **transport coefficients** from OSHUN

Technical Risks

- Delayed engagement with the Concept Teams due to needed model development effort / access to experimental data for validation
- Need for high-performance computing (HPC) resources

Major Outcomes

- **Sustainable simulation support** for OPEN, ALPHA, and BETHE projects
- **Assist multiple Concept Teams** and provide **independent assessments**

Key techno-economic metrics of the project

- Numerical simulations are critically important for the design and interpretation of Innovative innovative fusion schemes. However, **establishing adequate simulation capabilities** for new fusion concepts can easily be **more expensive** and **time-consuming** than building the first experiment.

- The Simulation Resource Team overcomes this “entry-barrier” in a **cost-effective manner** by developing a flexible, multi-purpose, multi-physics simulation capability suitable for many innovative fusion concepts.

- The **broad availability** of the simulation codes involved and the **training** the Simulation Resource Team will provide will ensure a **sustainable simulation resource** for the ARPA-E BETHE Program to enable **novel disruptive technologies**.

- Future support of academic teams from the **INFUSE Program** can make our Simulation Resource Team **a sustainable resource for the fusion community beyond BETHE**.