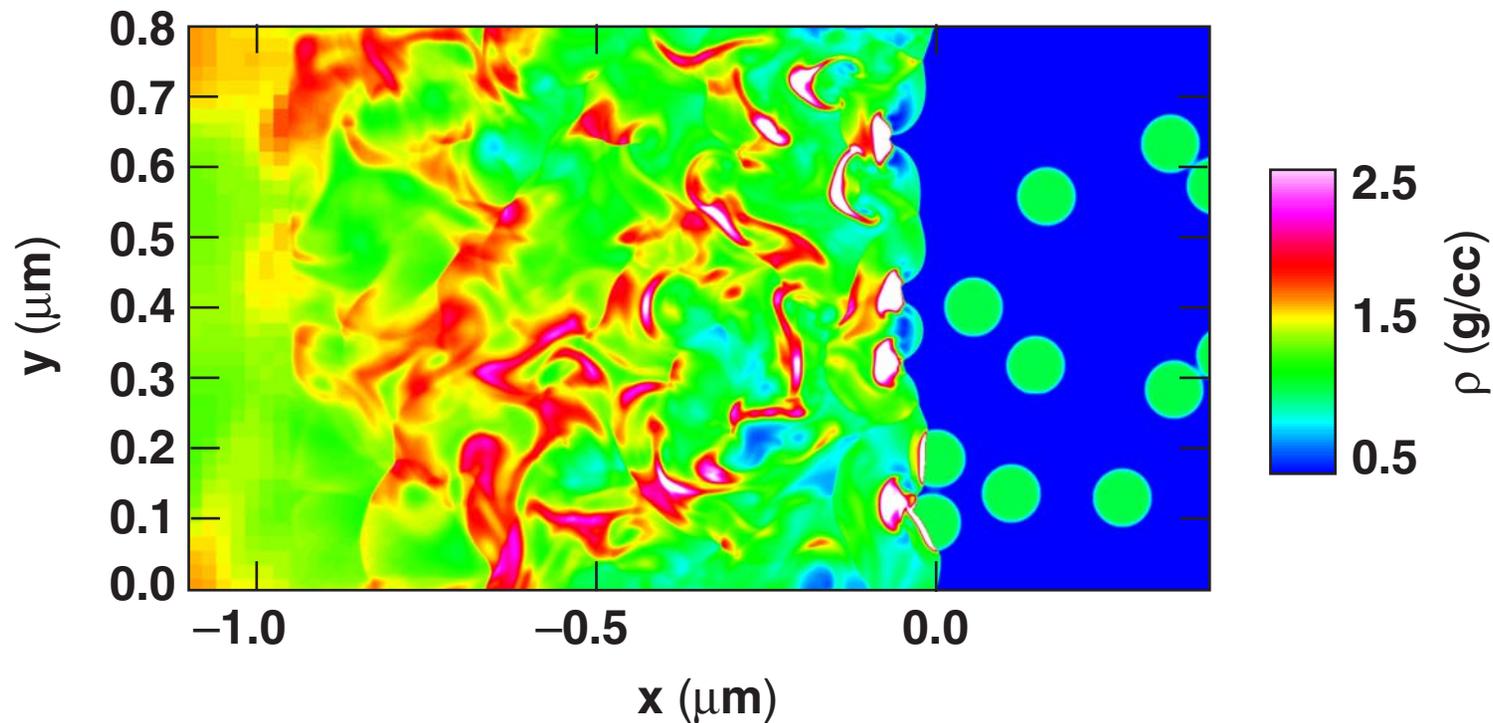


Shock Propagation in Wetted Foam



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Strong shocks in wetted foam obey the Rankine–Hugoniot jump conditions

- Plastic foam layers saturated with DT in NIF ignition target designs have higher laser absorption and higher gains than “all-DT” designs.
- Shock interaction with the foam microstructure generates a mix region for the CH fibers and the DT fuel.
- The post-shock conditions quickly approach to within a few percent of the Rankine–Hugoniot values, validating the homogeneous approximation.

Collaborators



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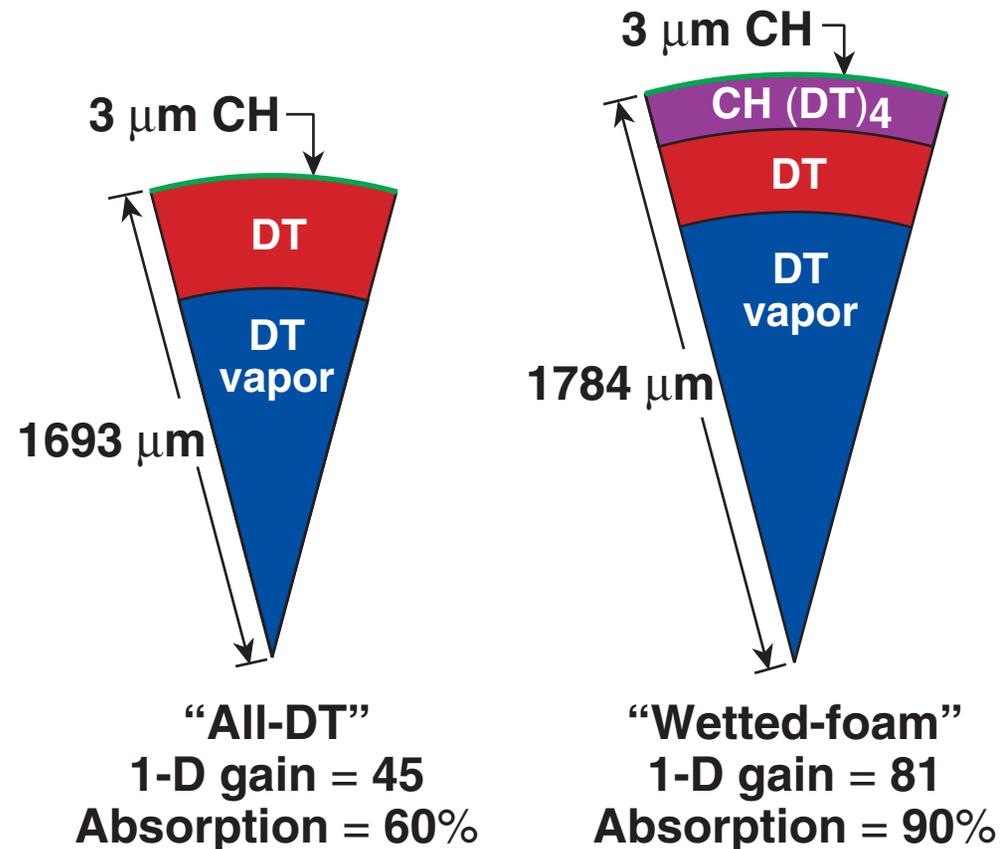
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Wetted foams have higher absorption, allowing higher gain for stability comparable to all-DT designs

- A typical foam fiber spacing is $0.2 \mu\text{m}$.
- Wetted foam designs are generally simulated using an average mixture of the CH and DT.
- Fiber-resolved simulations are used to gauge effects of microstructure on shock propagation¹.

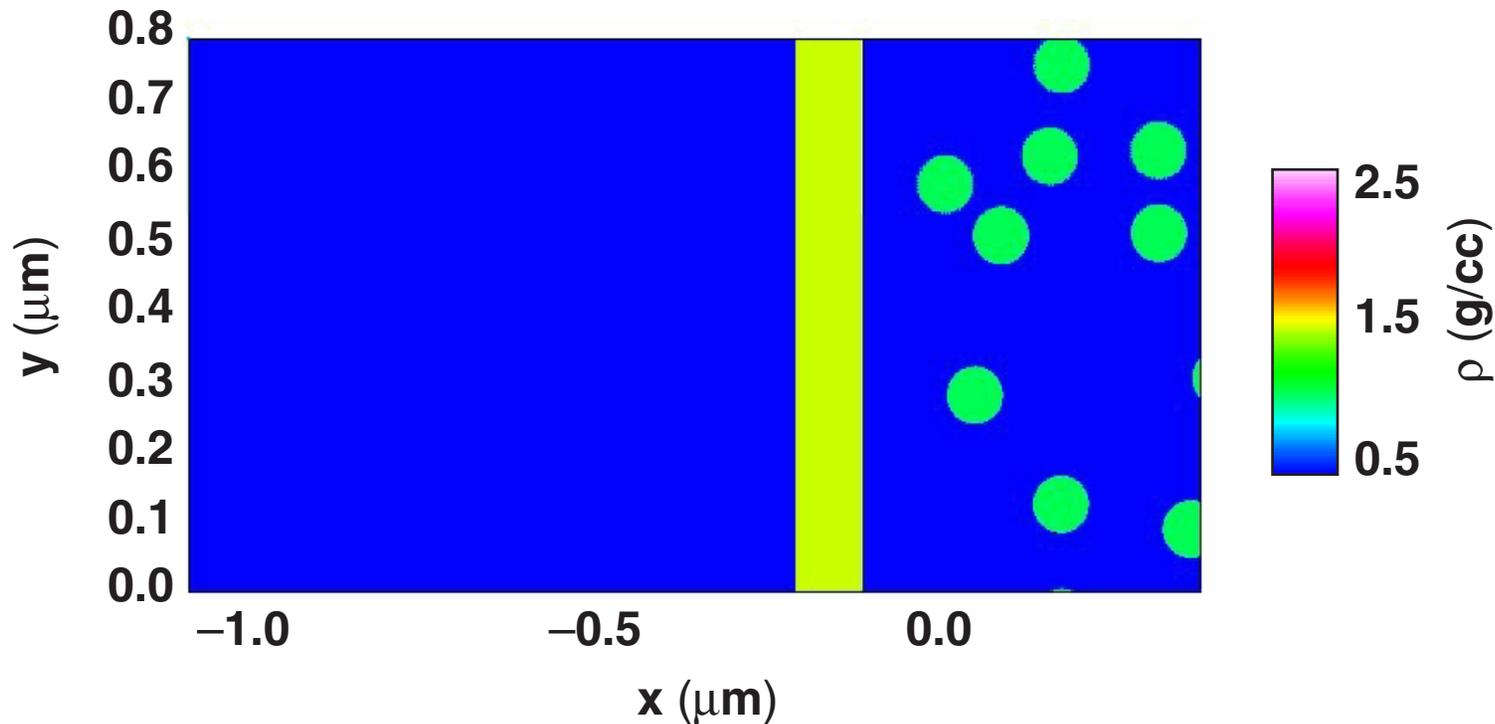


¹G. Hazak *et al.*, *Phys. Plasmas* **5**, 4357 (1998),
A. D. Kotelnikov and D. C. Montgomery, *Phys. Fluids* **10**, 2037 (1998),
F. Philippe *et al.*, *Laser Part Beams* **22**, 171 (2004).

The adaptive-mesh refinement code *AstroBEAR* was used to model the fluid flow in wetted-foam layers



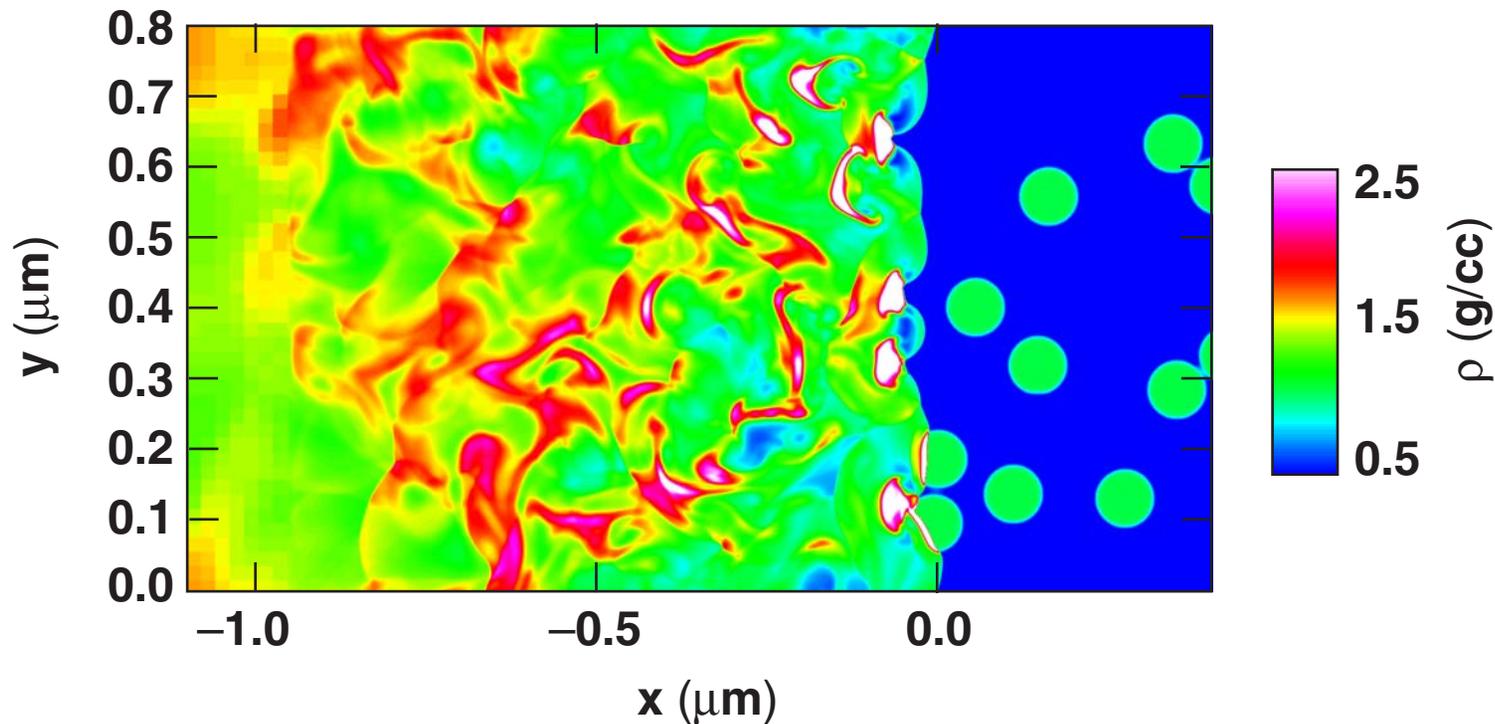
- *AstroBEAR* uses ideal-gas EOS, and has no radiation or heat transfer.
- *AstroBEAR* solves the (inviscid) Euler equations with material tracking.
- The inflow boundary condition models steady-state ablation.



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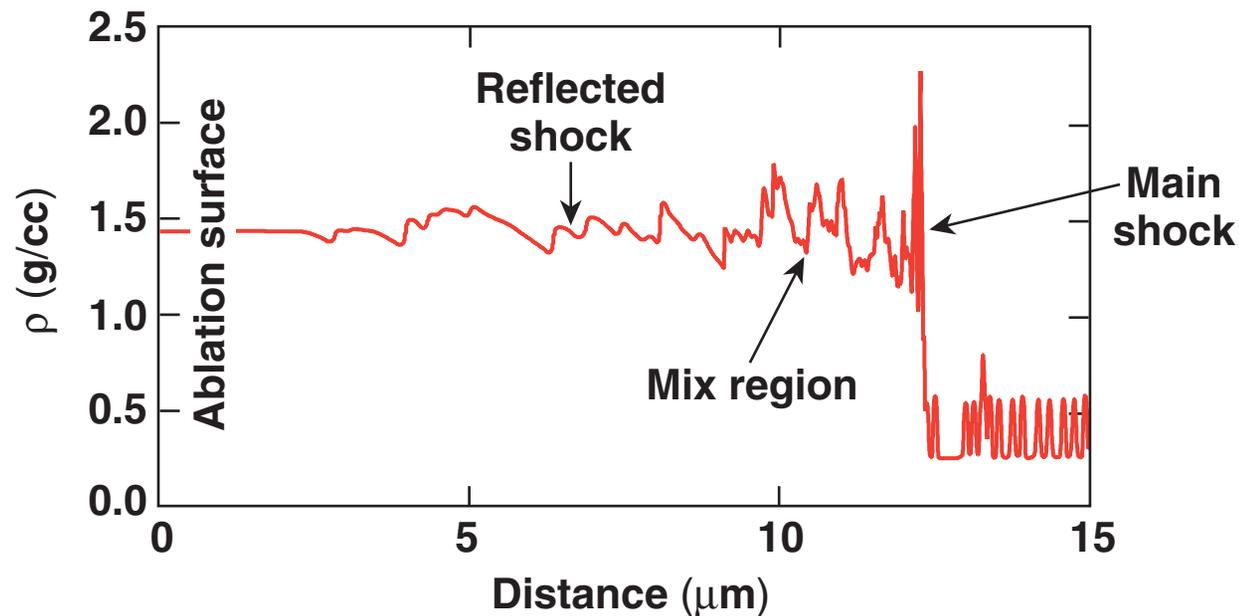


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The inflow conditions used model the ablative boundary condition in wetted-foam targets

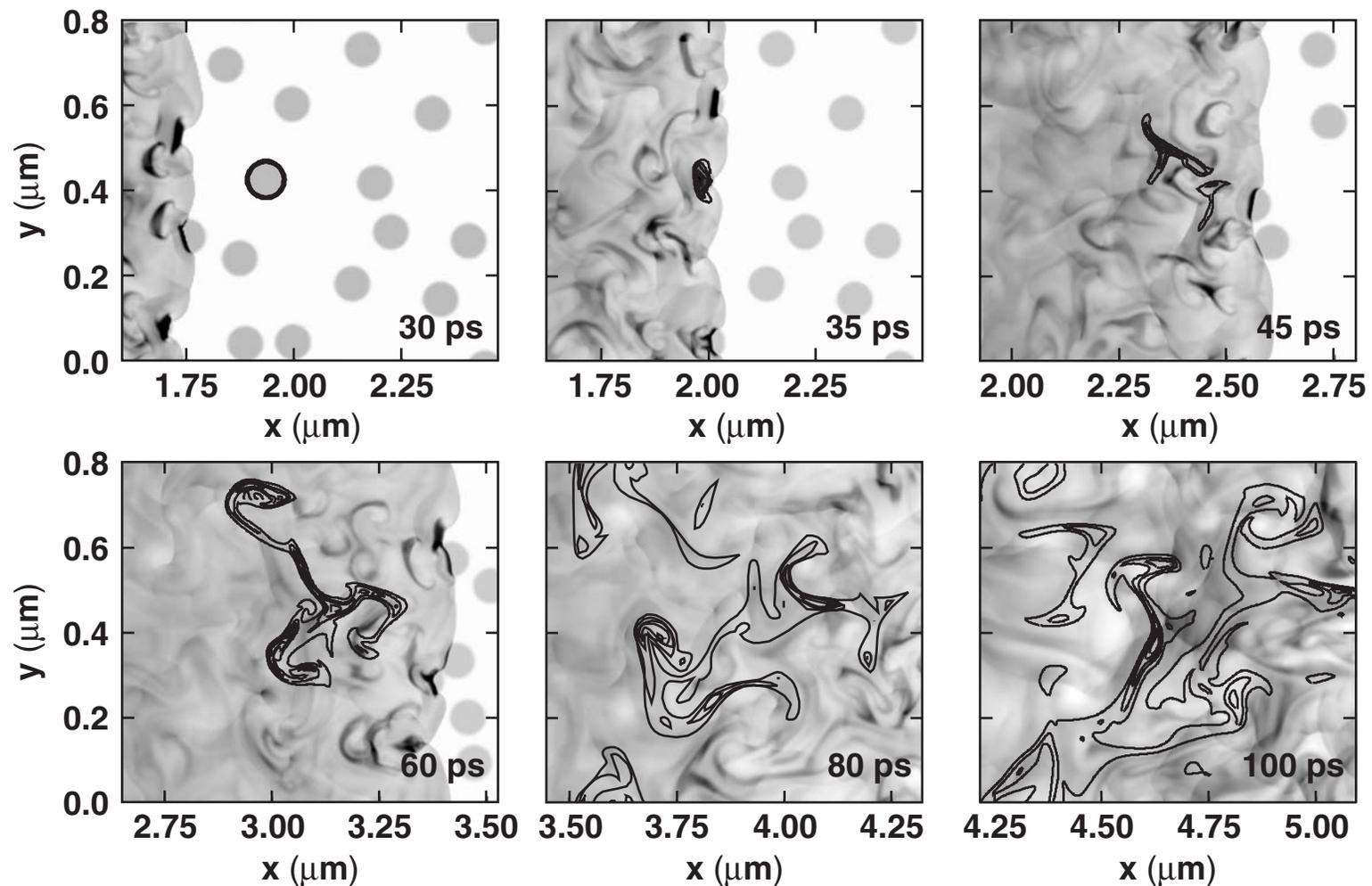
- In an ICF wetted-foam target, the main shock reflects off the fibers, sending shocks toward the ablation surface.



- These raise the post-shock pressure above the ablation pressure.
- When they reach the critical surface, a rarefaction wave is sent into the target correcting this overpressure.
- The corrected pressure is simulated in the AMR simulations using inflow conditions equal to the steady-state post-shock conditions in the wetted foam.

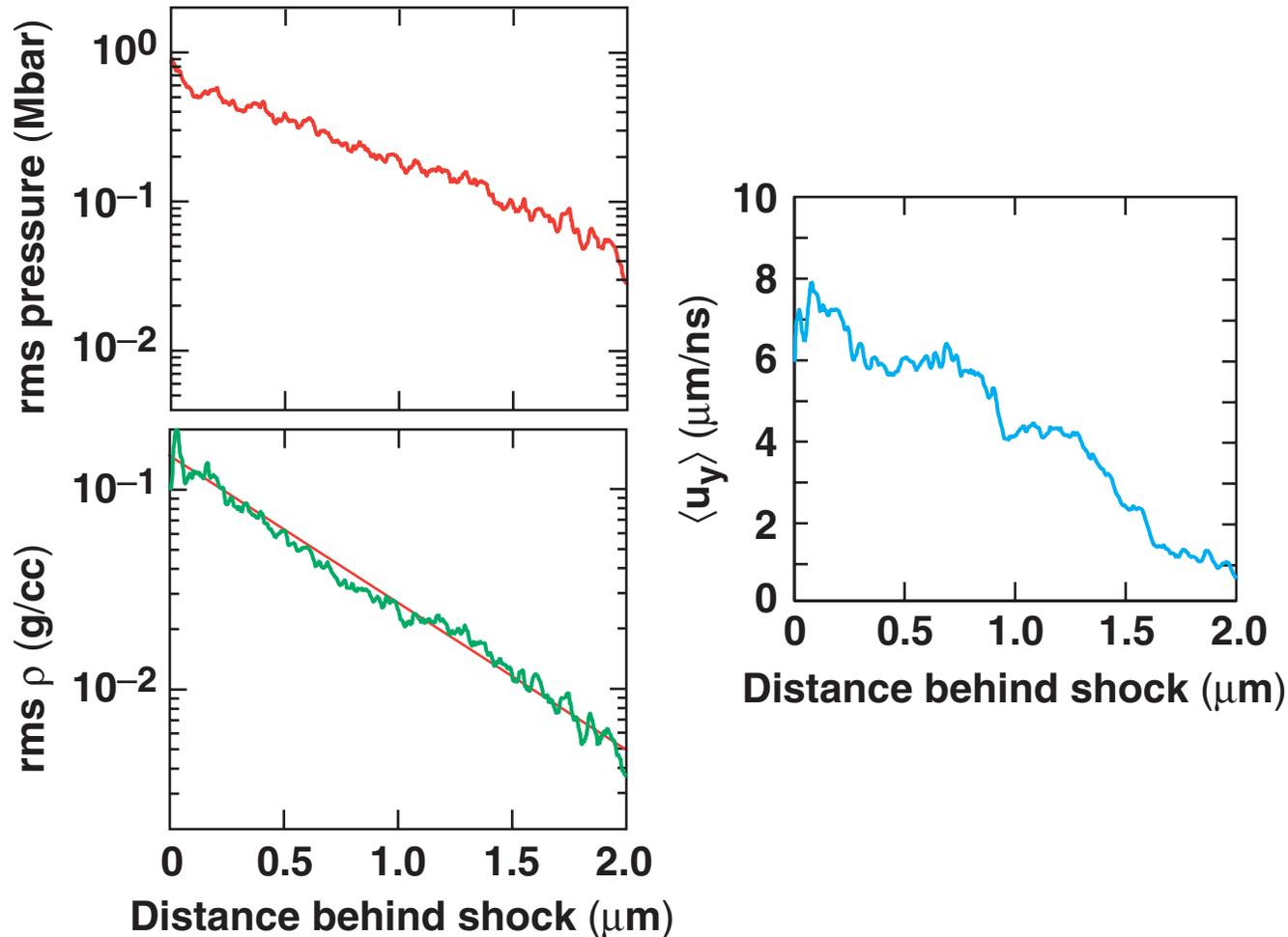
The DT and fiber materials are efficiently mixed by the first shock

- The level of mixing can be gauged by tracking a single fiber.



Fluctuations decay quickly behind the shock

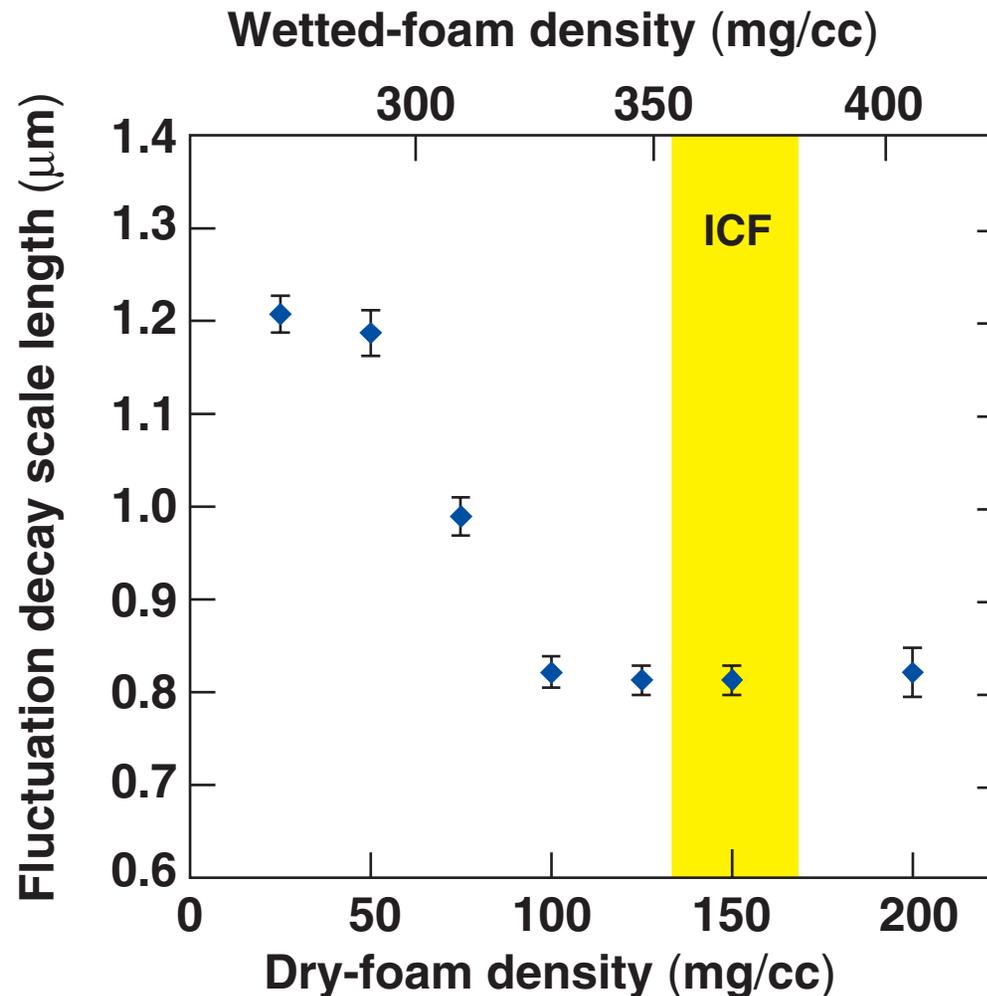
- The decay rate is approximately the same for each mode.
- The decay rate does not change when the resolution is increased.



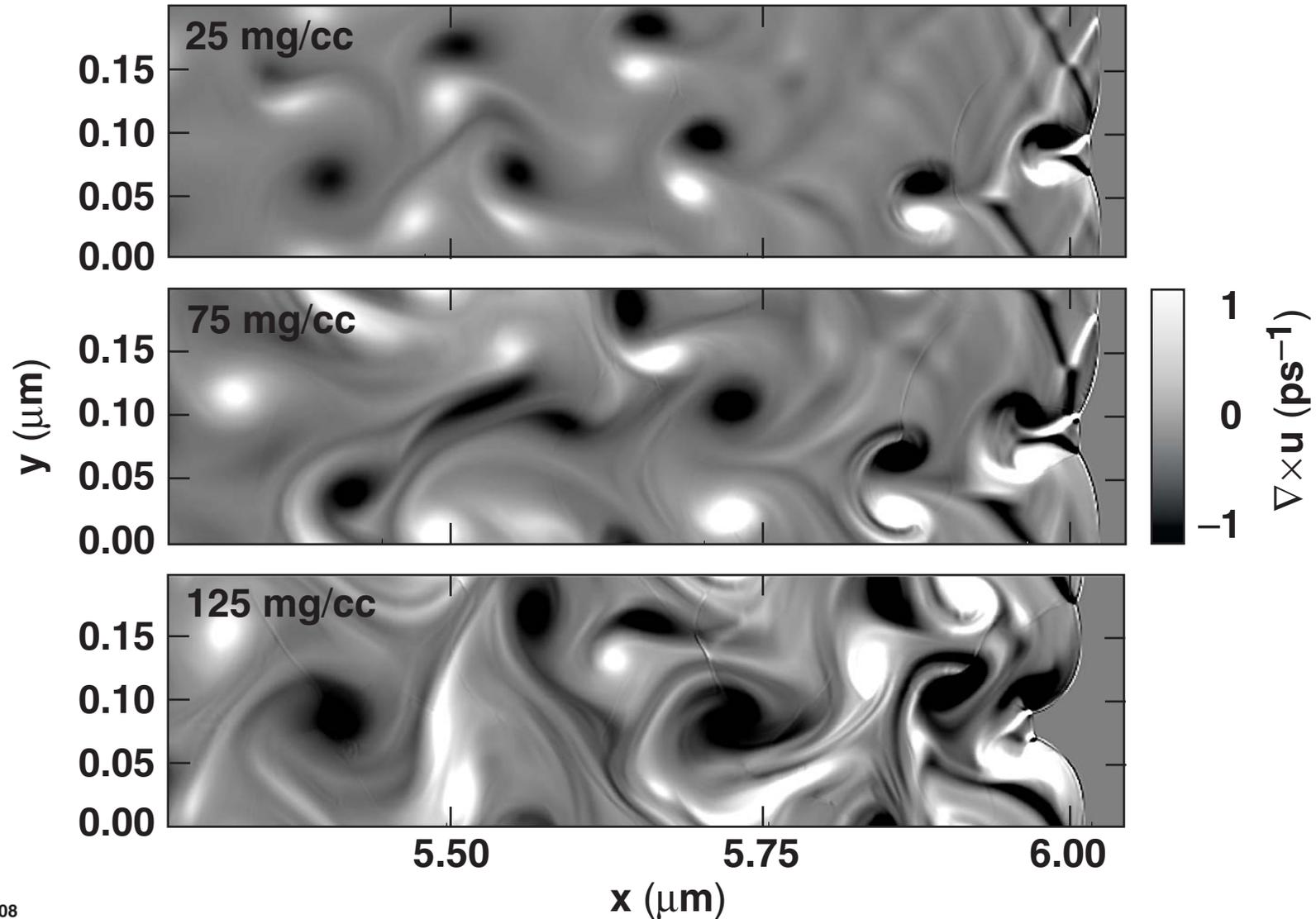
- Simulation size $8 \mu\text{m} \times 0.8 \mu\text{m}$.

The fluctuation decay scale length is $\leq 1.2 \mu\text{m}$

- The ICF-relevant foam densities are large enough to provide increased absorption, but small enough to minimize radiative preheat of the fuel.

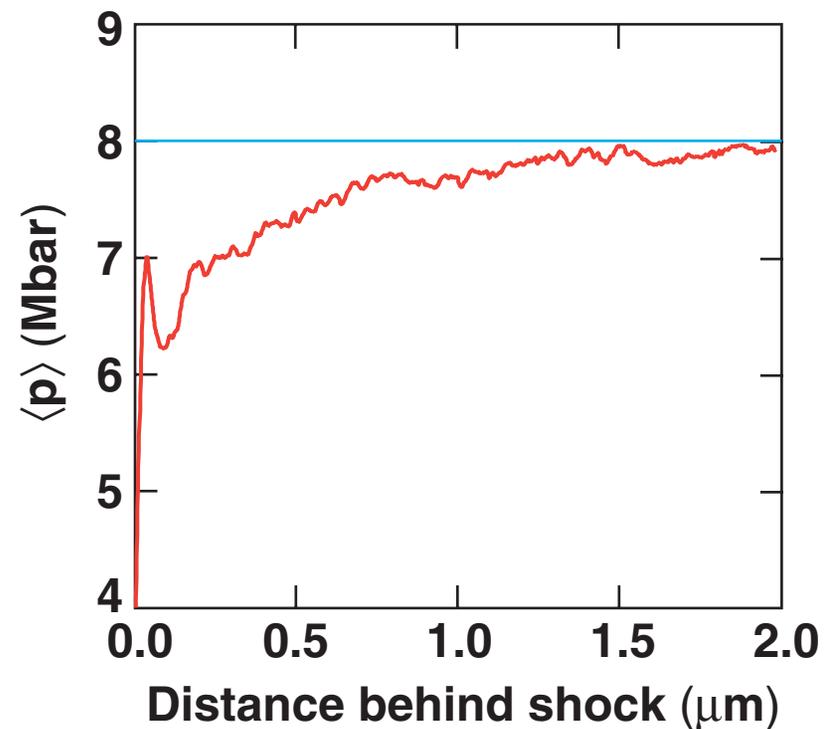
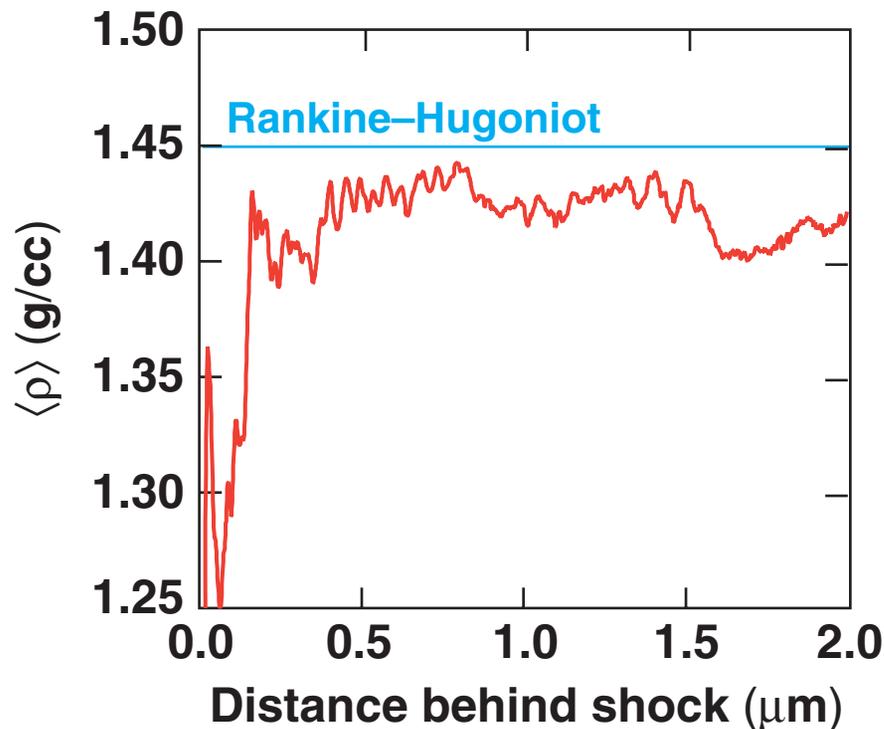


The fiber vortex pair interaction time scale is determined by the foam density



The flow variables asymptote to a few percent of the Rankine–Hugoniot values

- From an $0.8 \mu\text{m} \times 8 \mu\text{m}$ simulation:



- The ratio of the kinetic energy to total energy is 52% in the mix region.
- The shock speed is $\sim 0.3\%$ slower than the homogeneous shock speed.

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