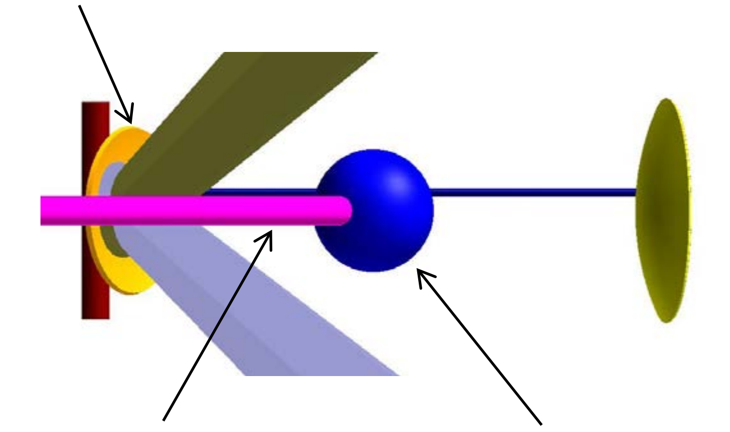
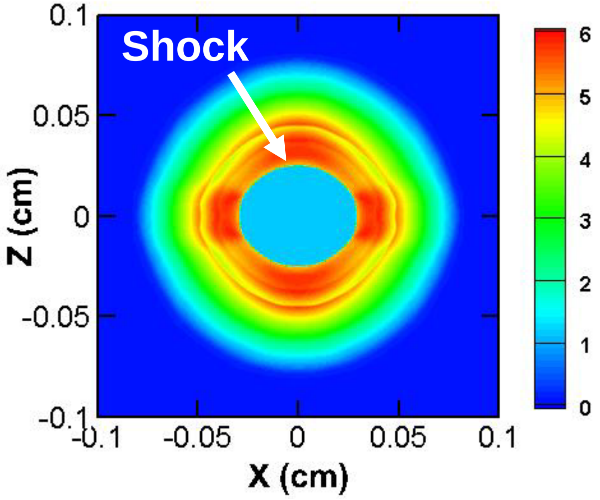
Cross-Beam Energy Transfer in Simulations of NIF-Scale Strong Spherical Shock Experiments





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Summary

DRACO simulations with a pump-depletion CBET model* match the shock trajectories and captures the shape of the shock front

- Solid-sphere laser-coupling experiments were conducted in polar direct drive at the National Ignition Facility (NIF) investigating laser energy coupling with high laser intensity spikes**
- Simulations indicate that CBET reduced the laser absorption during the spike pulse by ~15% at 1×10^{15} W/cm^2 and 2.5×10^{15} W/cm^2
- CBET changes the shape of the shock front from round to oblate
- The shock trajectories in 1-D simulations are not strongly influenced by hot electrons at the levels observed in experiment

*J. A. Marozas *et al*., Phys. Rev. Lett. 120, 085001 (2018).
**S. P. Regan, *et al*., BO09.00014, this conference

Collaborators

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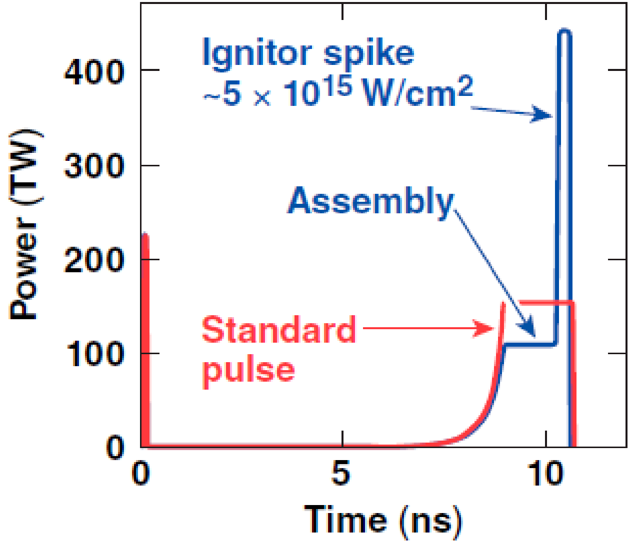
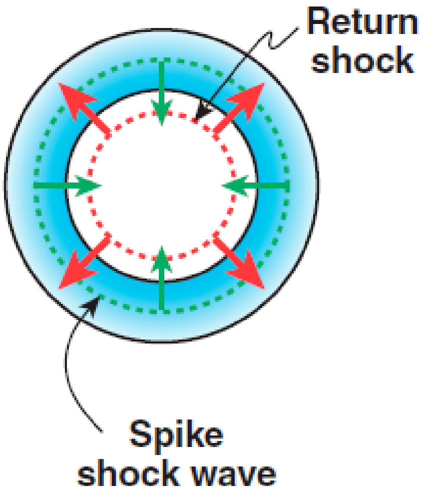
R. H. H. Scott and K. Glize

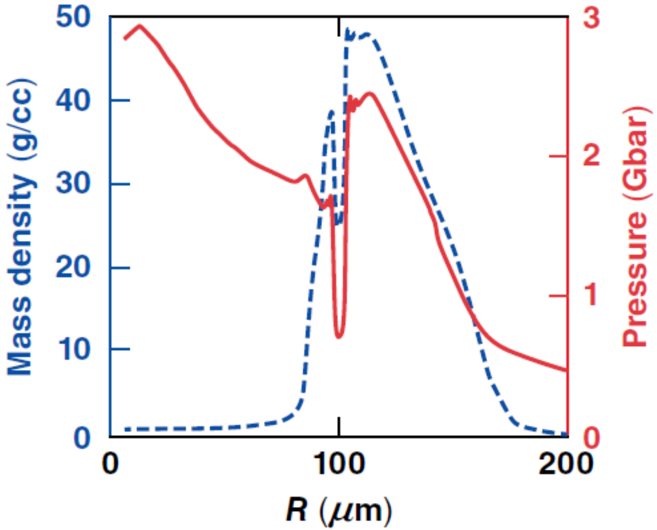
STFC Rutherford Appleton Lab

Shock ignition* (SI) adds a high-intensity spike at the end of the laser pulse to launch a strong shock wave, igniting the precompressed fuel





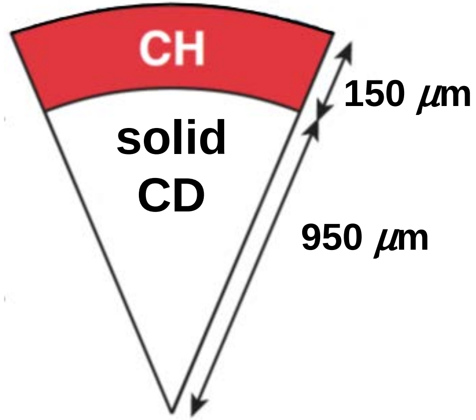
Convergent shock launched at 300 Mbar reaches 2.5 Gbar at shock collision

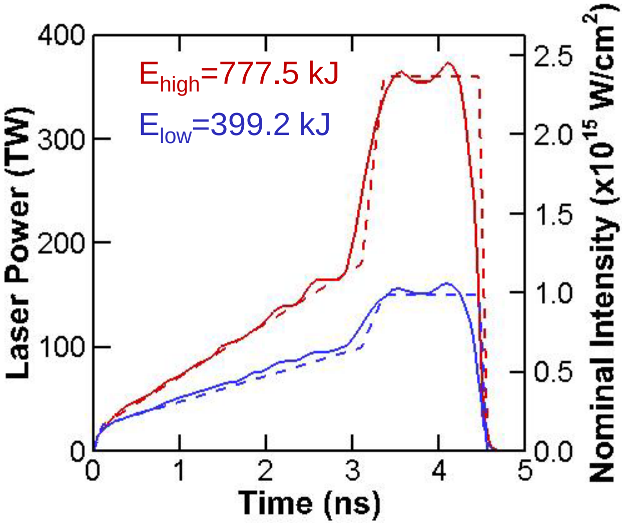


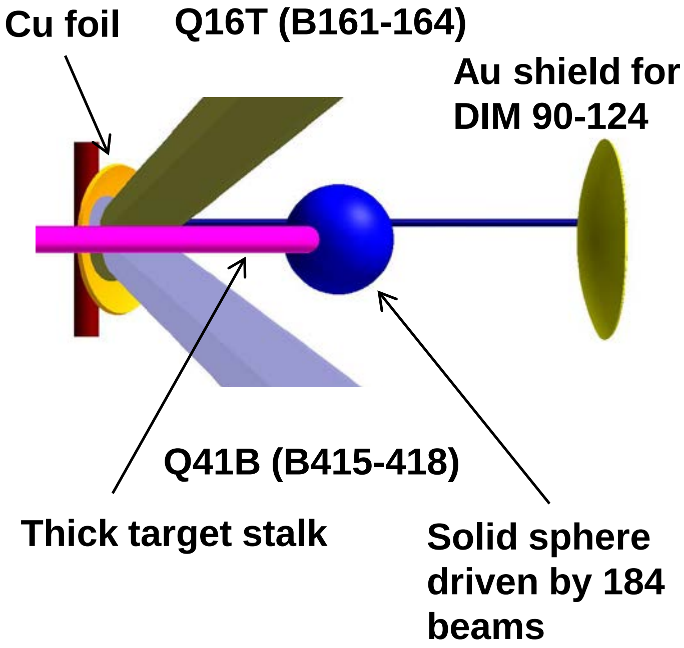
Laser energy coupling at these high laser intensities is not well characterized

*R. Betti, *et al.*, Phys. Rev. Lett. 98, 155001 (2007).

Two experiments were performed with polar drive on the NIF to assess laser energy coupling at two different laser intensities







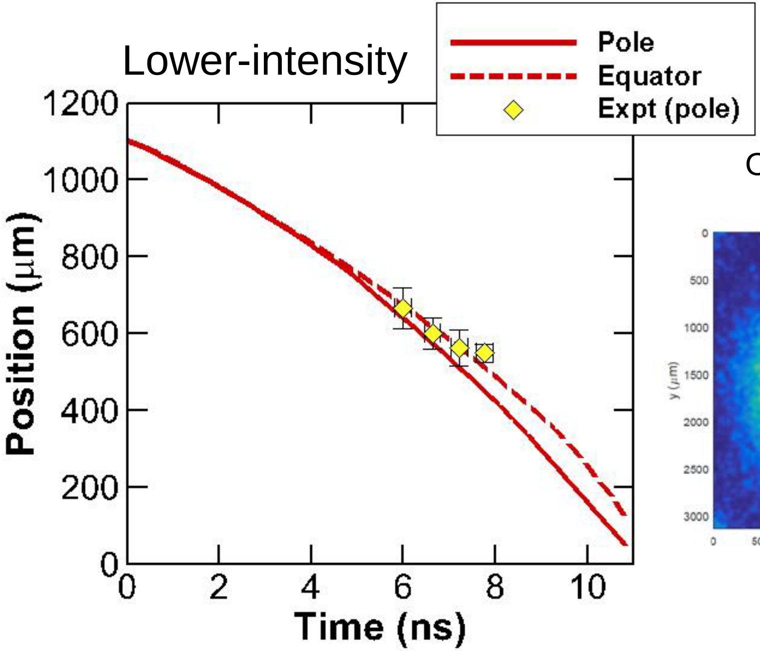
Peak intensities: 1×10^{15} W/cm^2 and 2.5×10^{15} W/cm^2

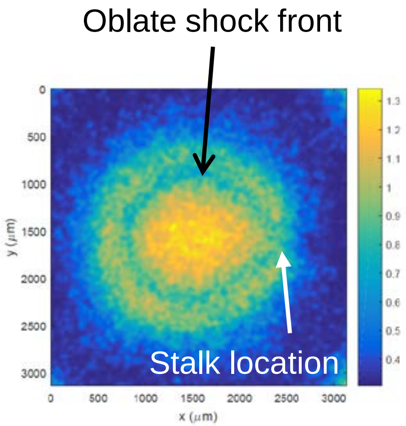
The plasma conditions of these shots are similar to ignition designs for the NIF

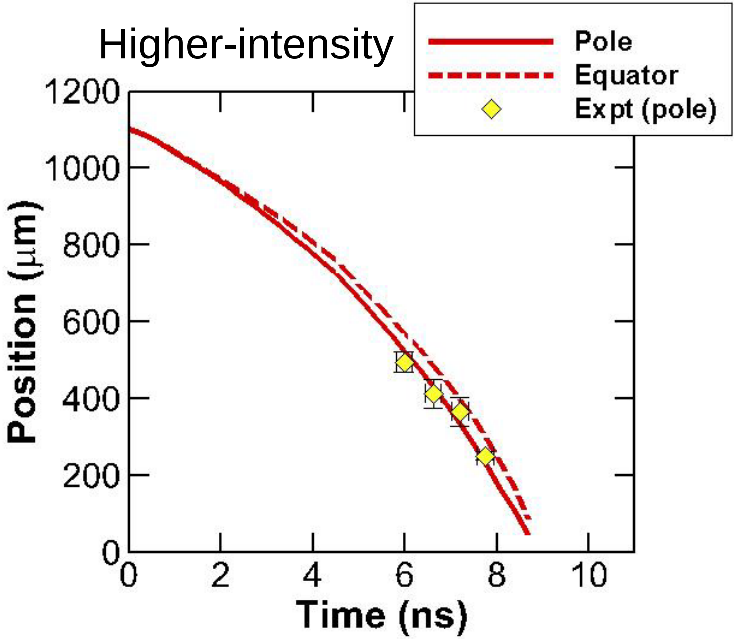
	Lower-intensity N190204-003	Higher-intensity N190204-002	SI Point Design (NIF)* (flux-limited thermal, no-CBET)
Average Intensity (10^{15} W/cm^2)	**1.0**	**2.5**	**3.4†**
Scale length‡ (µm) (pole/equator)	**330/400**	**400/420**	**450 (avg)**
T_e (keV)‡	**3.2**	**4.5**	**8.5**

*K. S. Anderson, *et al*., Phys. Plasmas 20, 056312 (2013).
†Maximum value of 8.0x10^{15} W/cm^2 in the center of “zoomed” spike beams
‡Simulated (*DRACO*) values at quarter critical, middle of spike pulse.

DRACO simulations with pump-depletion CBET match the experimental shock trajectories well

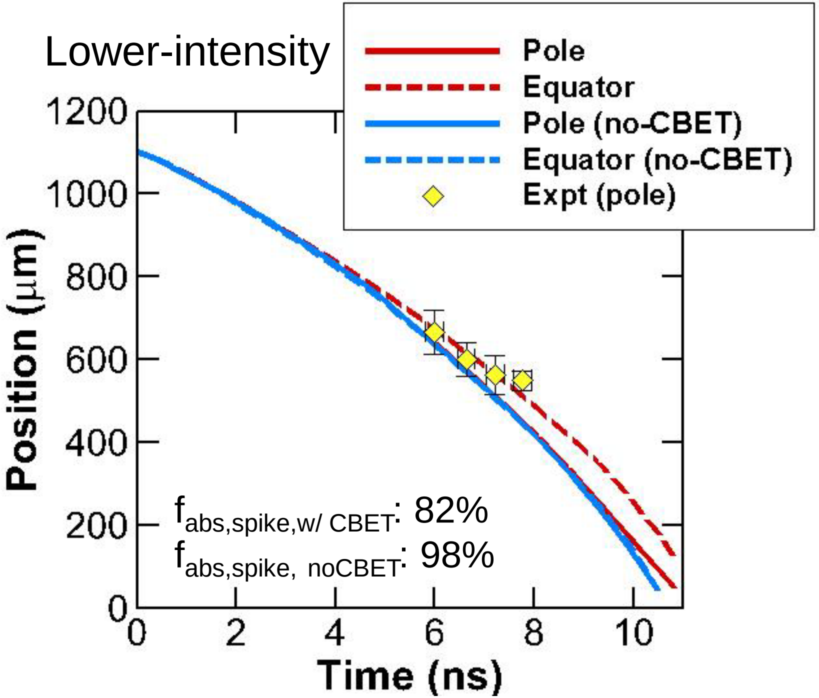


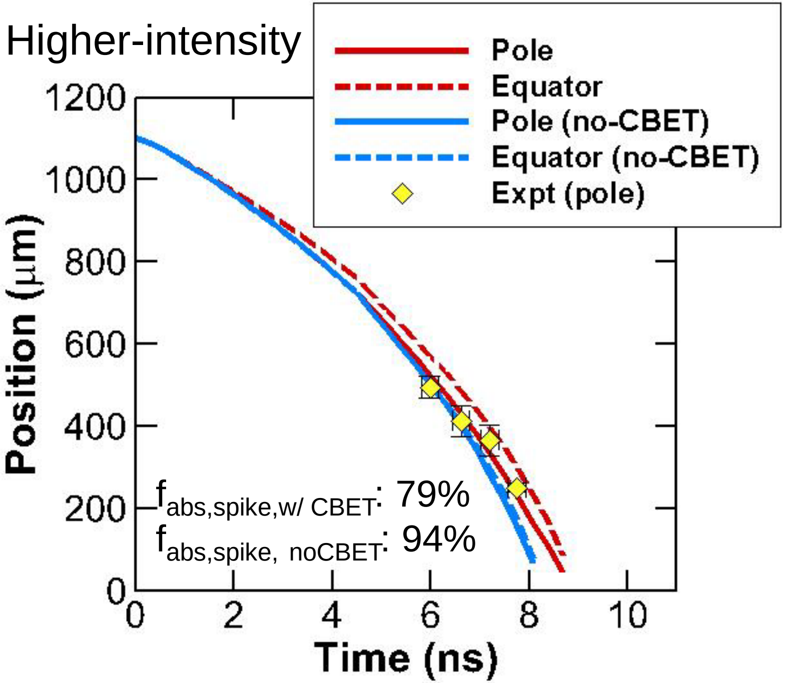




Analysis of the Equatorial shock position was adversely affected by the stalk

Most of the CBET effect on the shock is at the equator and on the second, high-intensity shock



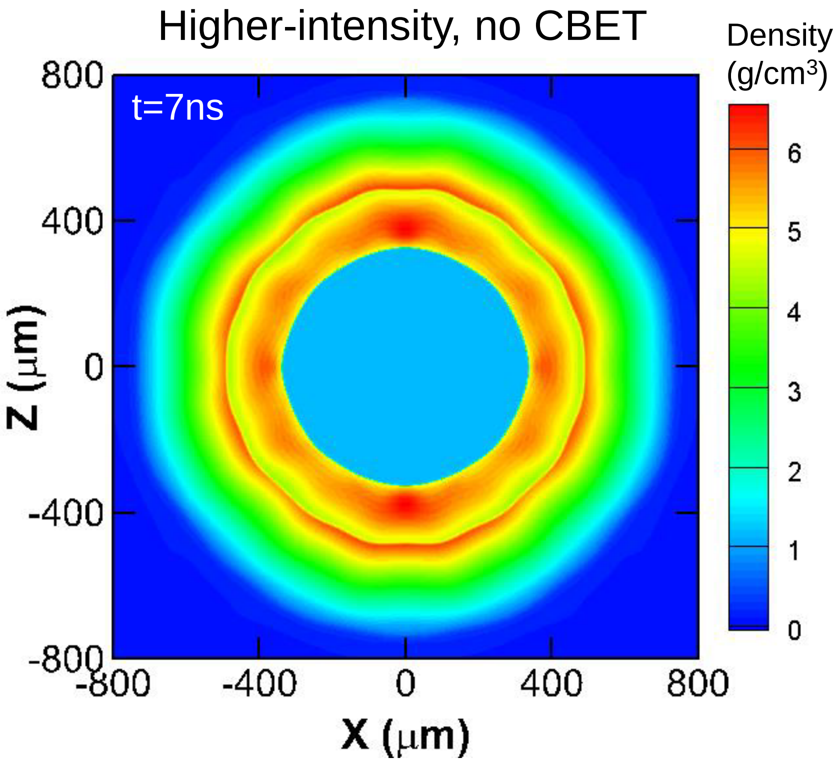


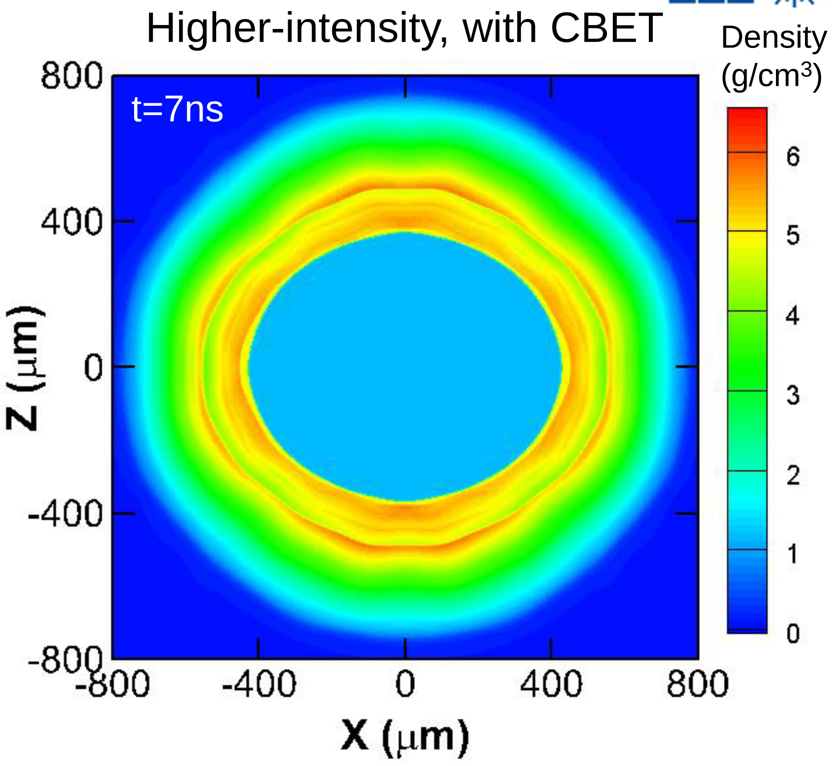
Laser focal spots were elliptical and smaller than the target

UNIVERSITY of ROCHESTER

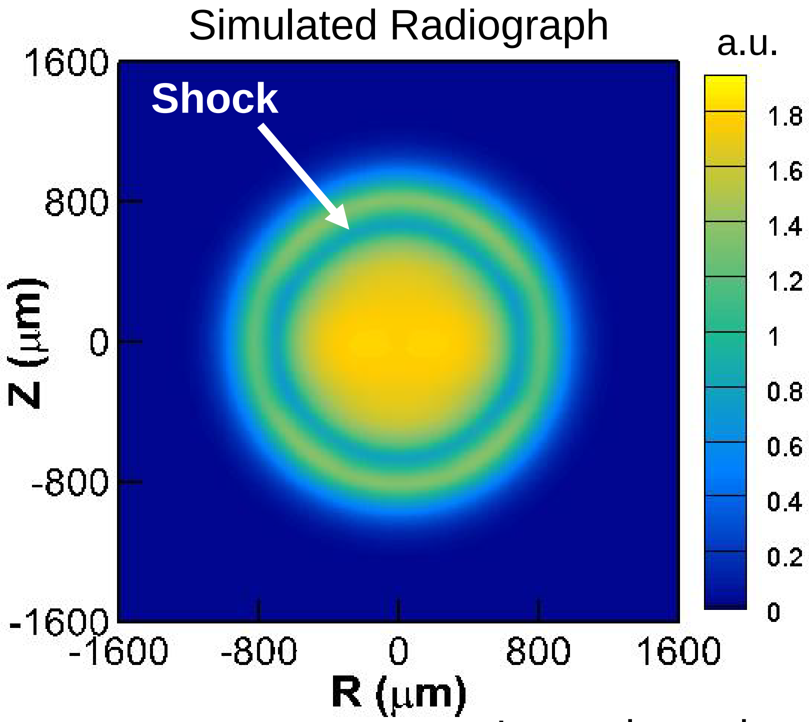
*Both CBET and No-CBET runs performed with non-local thermal transport

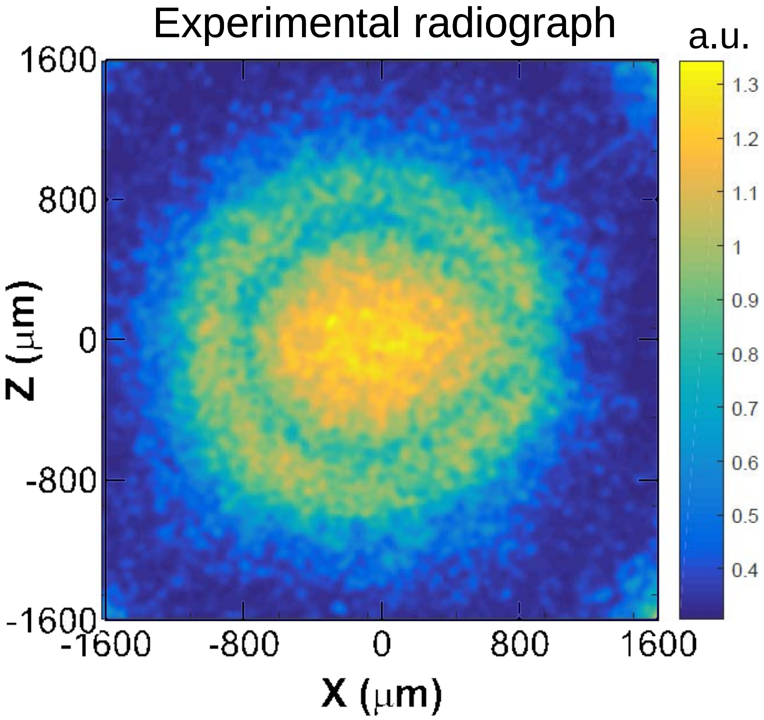
CBET alters the shape of the imploding shock to more oblate





The shape of the shock front is captured well in simulations with CBET





Lower-intensity shot, N190204-003

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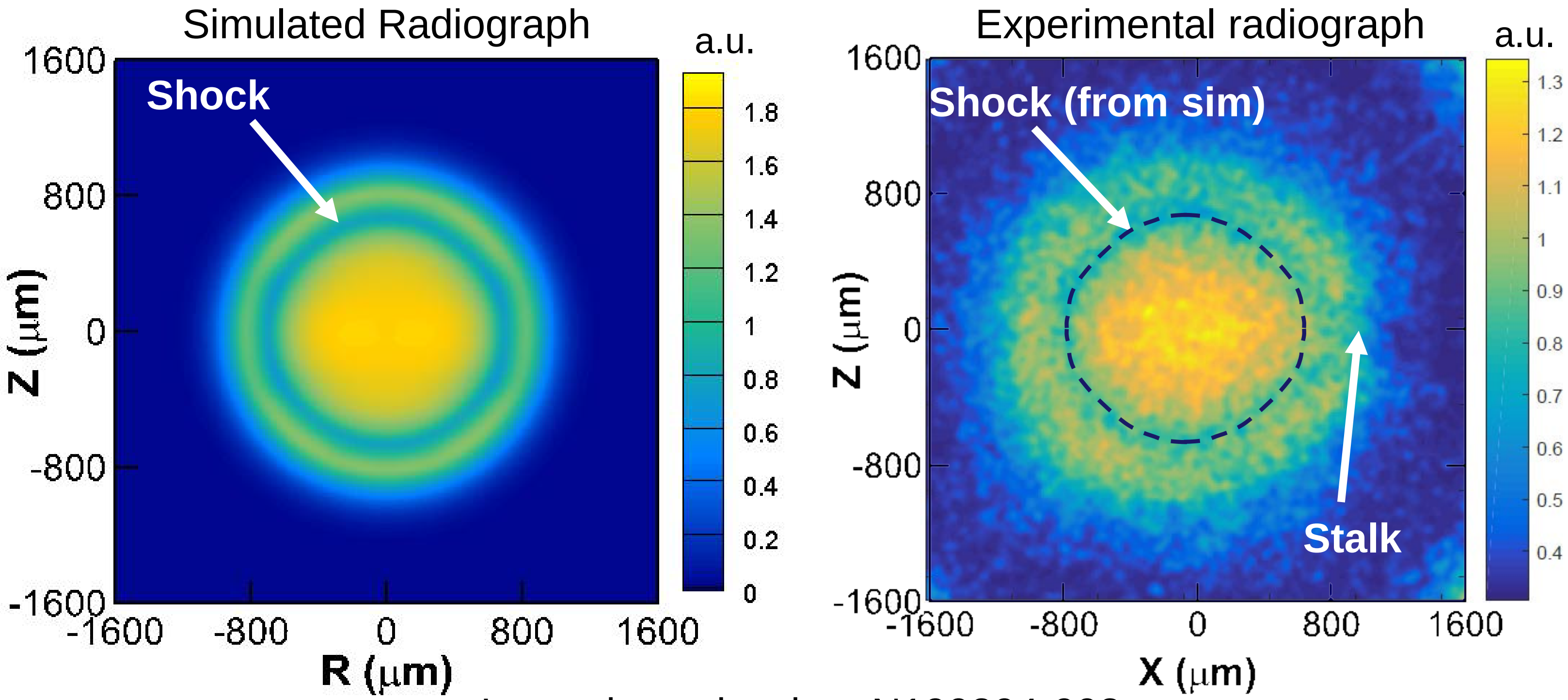
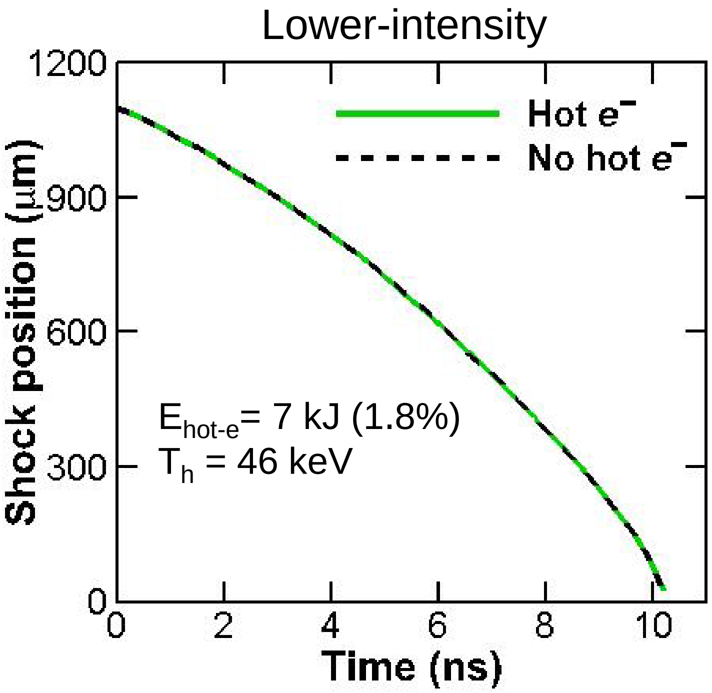
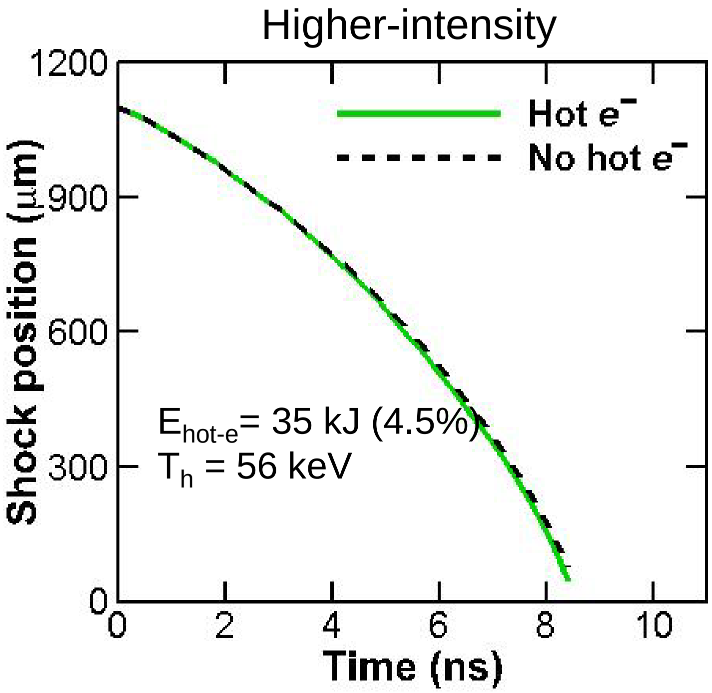


Lower-intensity shot, N190204-003

Hot electrons do not seem to make a significant difference in the shock trajectory

1-D LILAC simulations





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