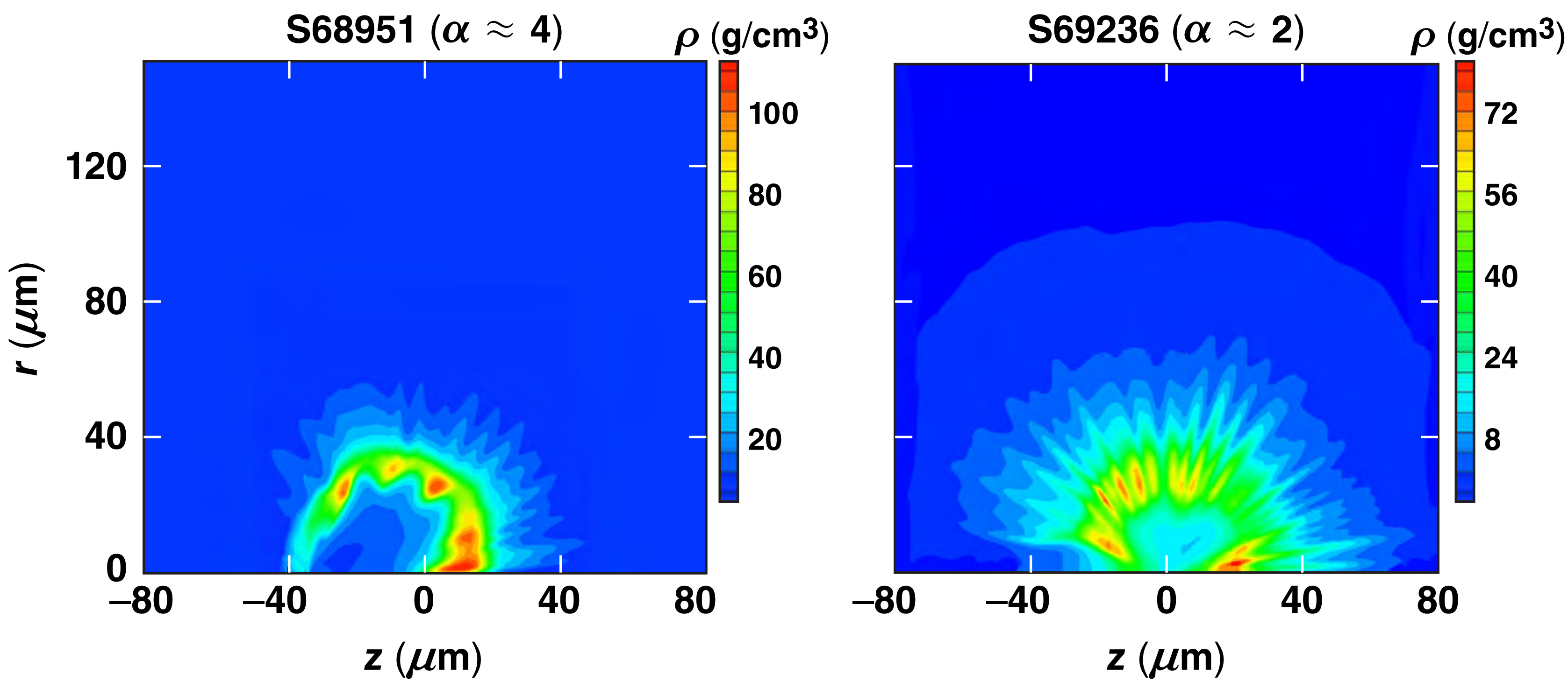
Integrated Two-Dimensional *DRACO* Simulations of Cryogenic DT Target Performance on OMEGA



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55th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
11–15 November 2013

Summary

Integrated *DRACO* simulations examined the perturbations in cryogenic DT implosions on OMEGA

- Laser imprint and target perturbations were examined for a variety of cryogenic DT target implosions at ignition-relevant implosion velocities ($V \sim 3.8 \times 10^7$ cm/s) on OMEGA using *DRACO*
- Integrated *DRACO* simulations have reproduced most of the experimental observations for the mid-adiabat ($\alpha \approx 4$) implosions
- For low-adiabat ($\alpha \approx 2$) implosions, the nonuniformity sources included cannot fully explain the reduction in target performance

Collaborators

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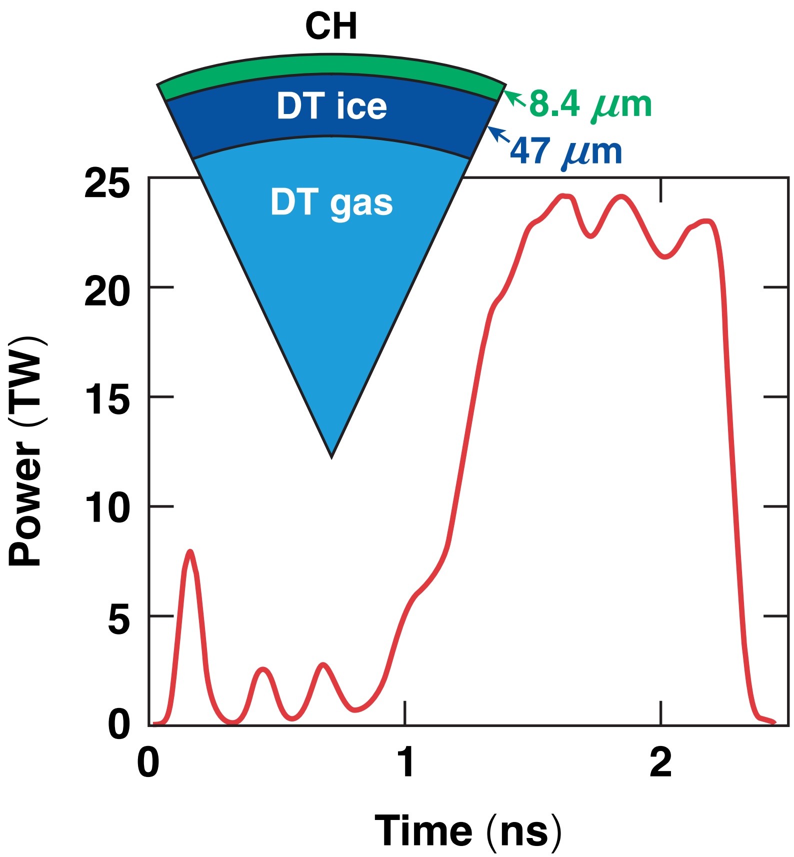
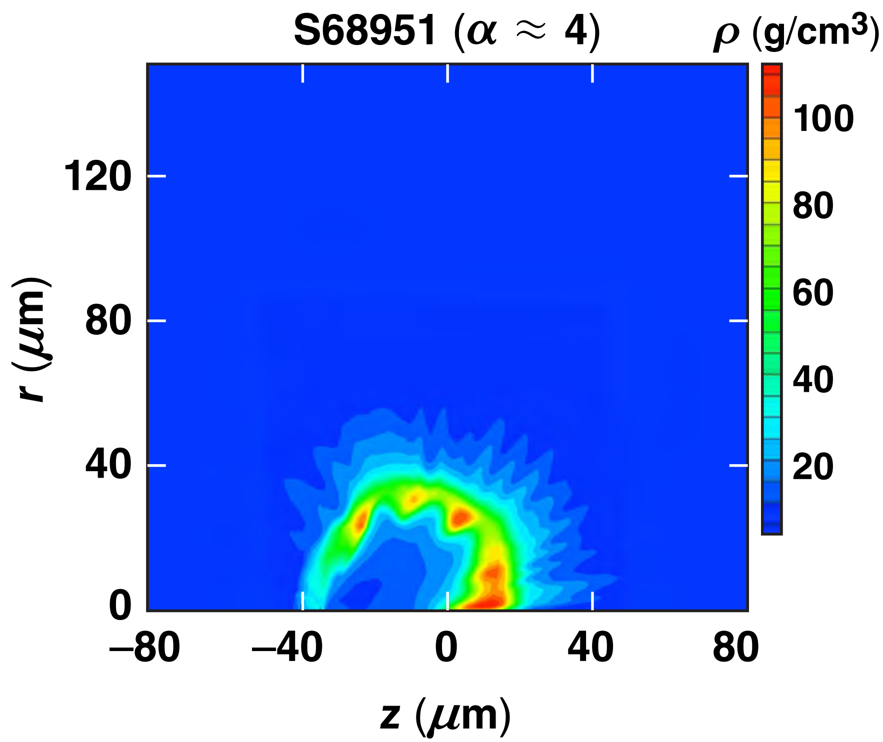
Perturbation effects on cryo DT target performance can be examined by multidimensional simulations

- **The 2-D radiation hydrocode *DRACO* is used to perform the integrated simulations**
- **The nonuniformity sources include laser imprint (up to $\ell = 150$), laser mistiming and mispointing, power imbalance, target offset, and ice-layer roughness**
- **The nonlocal* and cross-beam energy transfer (CBET)** effects are mimicked by a time-dependent flux limiter in 2-D simulations through matching the 1-D trajectory**
- **The 2-D simulation results are further post-processed with *Spect3D*† and *IRIS*‡ to extract the x-ray emission and ρR information for comparison with experiments**

* J. A. Delettrez *et al.*, U04.00007, this conference.
** J. A. Marozas *et al.*, C07.00004, this conference.
† Prism Computational Sciences, Inc. Madison, WI 53711.
‡ P. B. Radha *et al.*, Bull. Am. Phys. Soc. 44, 194 (1999).

Mid-adiabat ($\alpha \approx 4$) cryo DT implosions are found to be less affected by perturbations



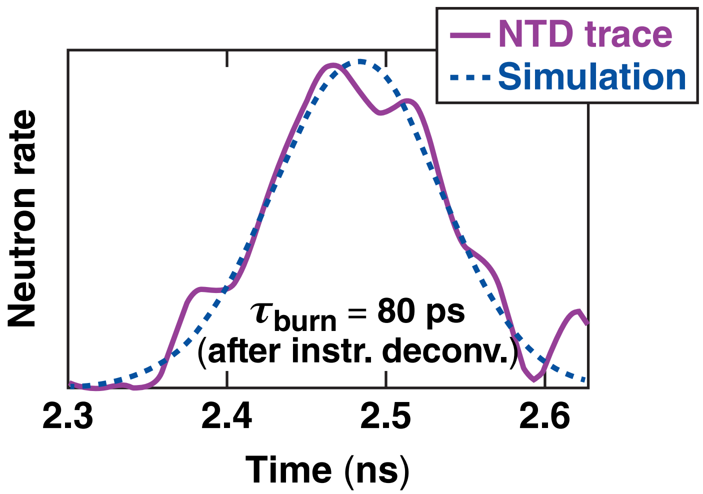


Target offset: 6 μm
Ice roughness: σ_{rms} ~ 1.4 μm
Laser imprint: ℓ_{max} = 150

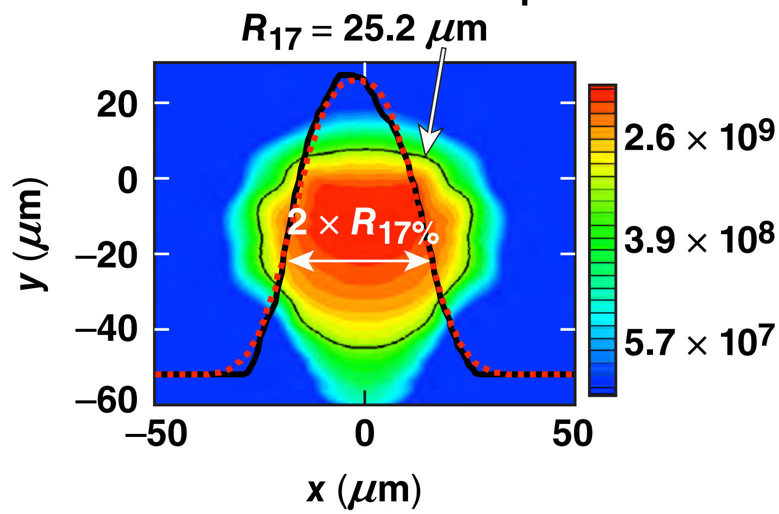
TC10820

DRACO simulations reproduced the experimental observations in neutron yield, ρR, and ion temperature

Neutron temporal diagnostic (NTD)



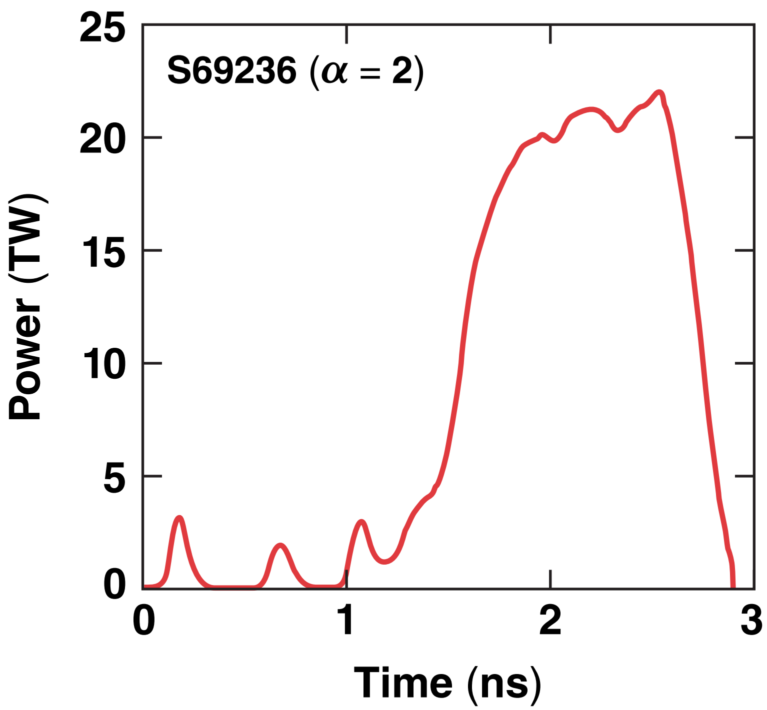
Measured self-emission profile

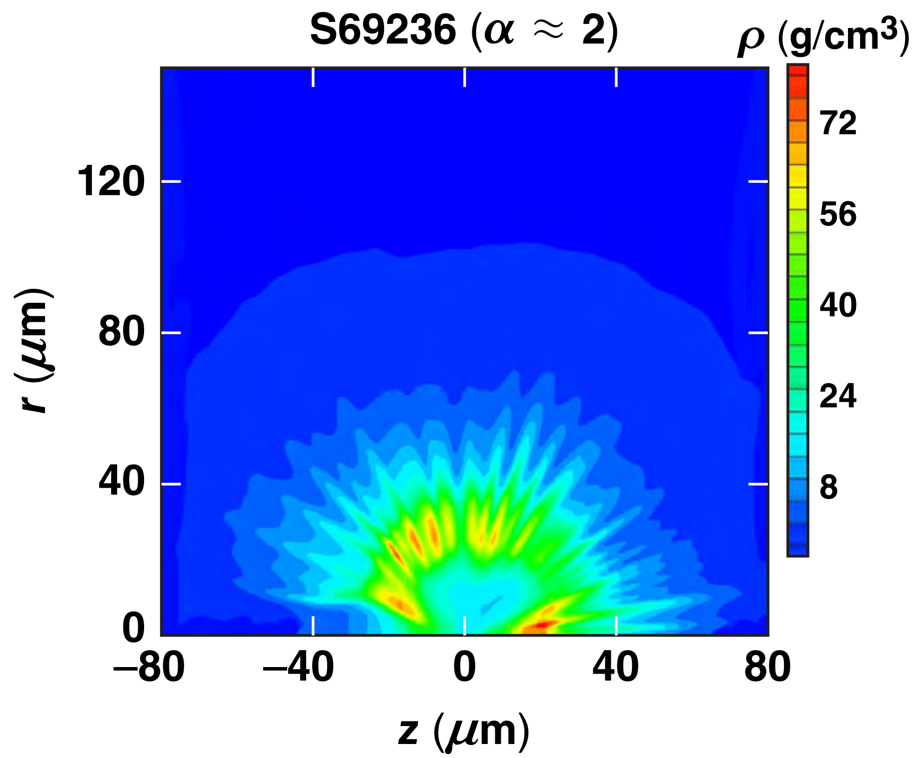


	Simulation	Experiment
Yield	3.9×10^{13}	3.0×10^{13}
T_i	3.7 keV	3.6 keV
ρR	180 mg/cm^2	170 mg/cm^2
τ	80 ps	80 ps
R_{17}	24.4 μm	25.2 μm

E22296c

Low-adiabat ($\alpha \approx 2$) cryo DT implosions are more susceptible to laser and target perturbations





Target offset: 8 μm
Ice roughness: σ_{rms} ~ 1.3 μm
Laser imprint: ℓ_{max} = 150

TC18021

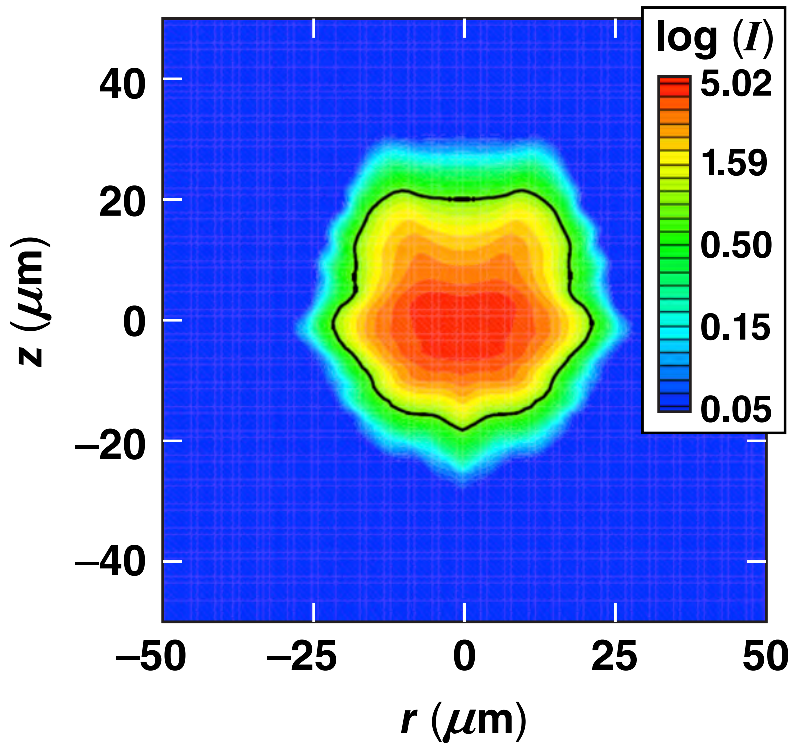
The experimental observables for $\alpha \approx 2$ implosions cannot be fully explained by the nonuniformity sources currently included in the simulations

UR LLE

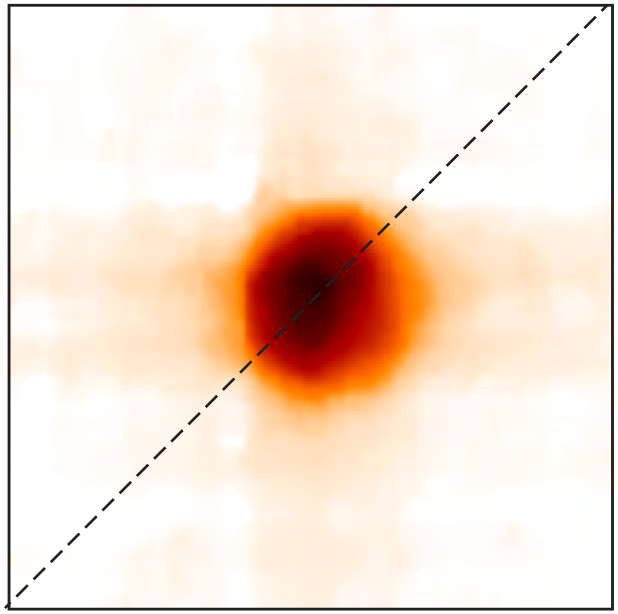
	Simulation	Experiment
Yield	1.7×10^{13}	1.1×10^{13}
$\langle T_i \rangle_n$ (keV)	2.9	3.0
$\langle \rho R \rangle_n$ (mg/cm^2)	190	110
Burn width (ps)	79	150

The x-ray image from the *DRACO–Spect3D* simulation is smaller than experiments for the $\alpha \approx 2$ implosion

DRACO + *SPECT3D*



GMXI* (experiment)
OMEGA shot 69236: GMXI c



Lineout indicated by dotted line

DRACO: $R_{17\%}$ = 20.1 μm
Experiment: $R_{17\%}$ = 33.3±0.4 μm

*Gated monochromatic x-ray imager

Hot-spot pressure and burnwidth comparisons also indicate the degraded low-adiabat implosions*

Pressure	Simulation	Experiment
S68951 ($\alpha \approx 4$)	35.0 Gbar	31.5 Gbar
S69236 ($\alpha \approx 2$)	41.0 Gbar	18.0 Gbar

Burnwidth	Simulation	Experiment
S68951 ($\alpha \approx 4$)	80 ps	80 ps
S69236 ($\alpha \approx 2$)	79 ps	150 ps

*V. N. Goncharov, GI3.00001, this conference (invited).

Possible sources for the performance reduction of low-adiabat implosions are being investigated

- The accuracy of laser-imprint simulations in *DRACO* is being examined with OMEGA high-resolution VISAR (OHRV) measurements
- Preliminary analysis suggested that the simulation underestimates the laser-imprint effect
- The thermal conductivity and opacity models have also been re-examining with first-principle quantum molecular dynamics (QMD) calculations
- The QMD calculations showed 3 to 5× higher thermal conduction in the boundary between hot-core and cold-fuel shells, which may change the hot-spot formation dynamics
- Surface defects,* radiation preheat…

*I. V. Igumenshchev *et al.*, Phys Plasmas 20, 082703 (2013).

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