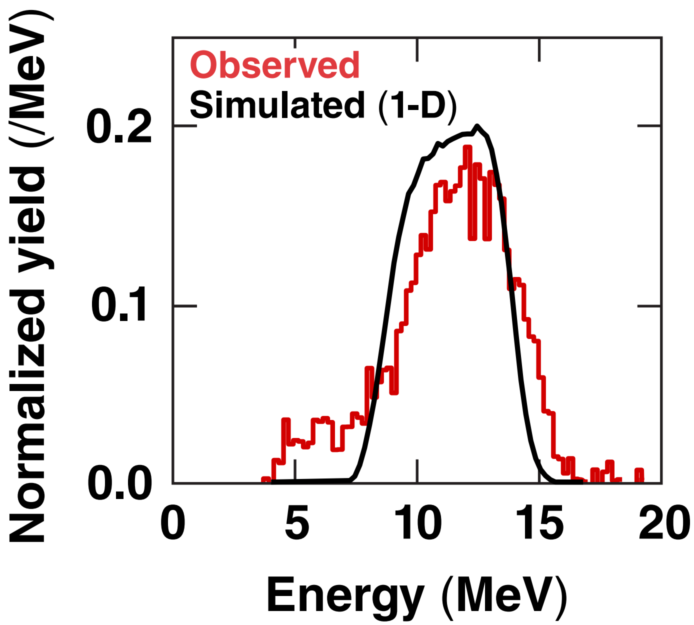
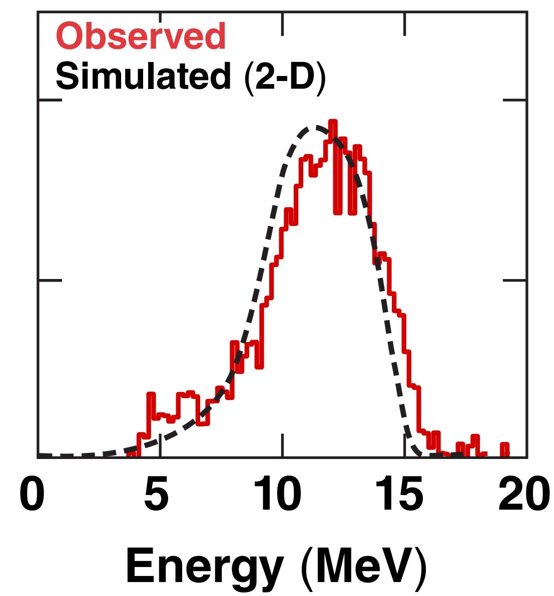
Modeling Observables to Diagnose Areal Density in OMEGA Implosions

Secondary proton spectrum
OMEGA cryogenic implosion; $\alpha \sim 2.5$



1. Burn truncation
2. Timing
3. Multidimensional ρR variations



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Summary

Good agreement between measured and simulated areal densities are obtained when non-ideal implosion effects are included

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- Areal density depends crucially on shock timing, preheat, and equation of state.
- Nonuniformities result in burn truncation.
  - preferentially sampling early-time areal density making observed values lower than 1-D simulation by 10 to 20%
- With increasing intensities, sampling effects alone cannot explain the observed degradation in areal densities in OMEGA implosions.
- Shock-timing experiments* indicate that shock mistiming may account for degraded areal densities in cryogenic implosions.

*T. R. Boehly (QI1.00003)
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TC8361

Collaborators

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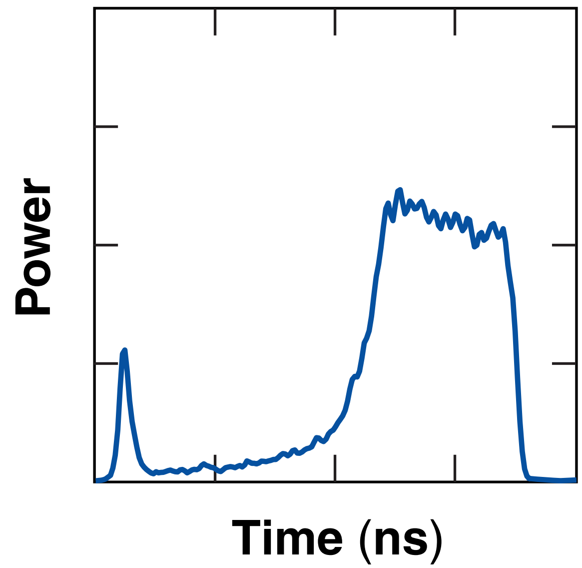
Areal density is the only implosion observable that provides information on the shell adiabat

$$\rho R_{max} = \frac{2.6\,(E_L)^{0.33}\,V_{imp}^{0.04}}{\alpha^{0.55}} \qquad (1)$$

$\alpha = P/P_F$; E_L = laser energy

V_{imp} = implosion velocity



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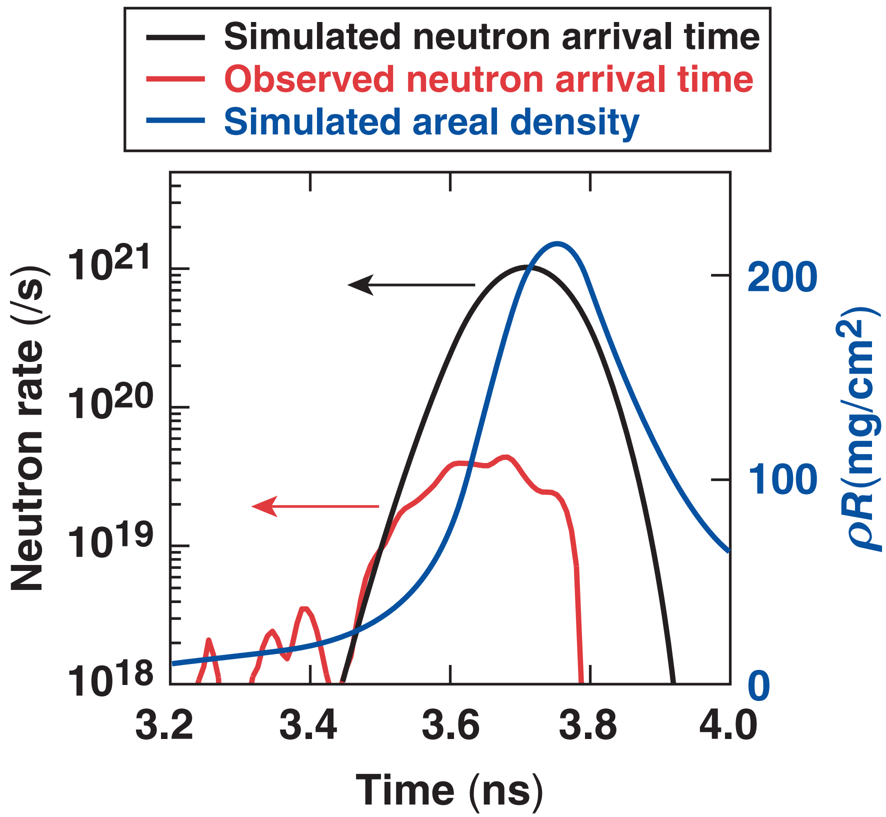
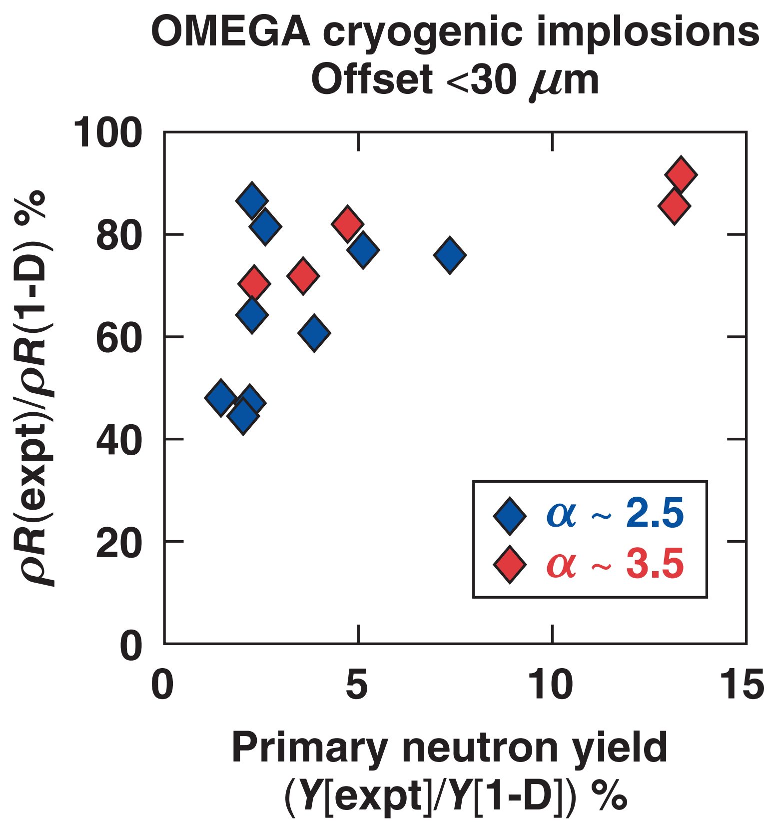
[1]R. Betti and C. Zhou, Phys. Plasmas 12, 110702 (2005).

Preferential sampling of the areal density due to burn truncation can produce apparent degradation of observed areal densities



Simulated ρR	182 mg/cm^2
Inferred ρR	138 mg/cm^2



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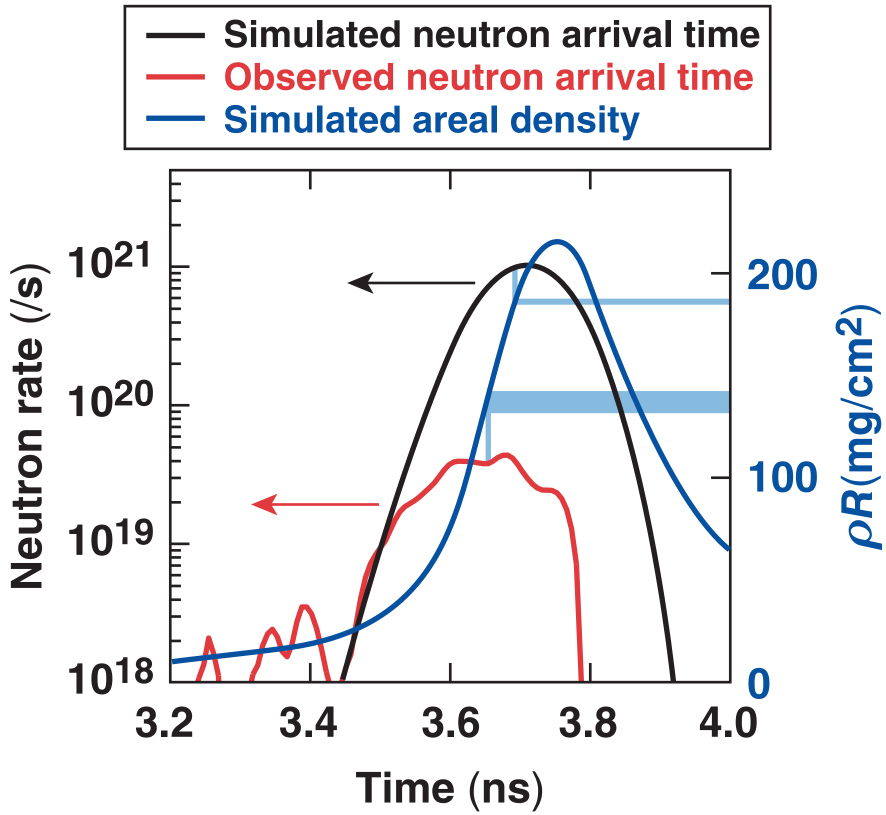
Preferential sampling of the areal density due to burn truncation can produce apparent degradation of observed areal densities



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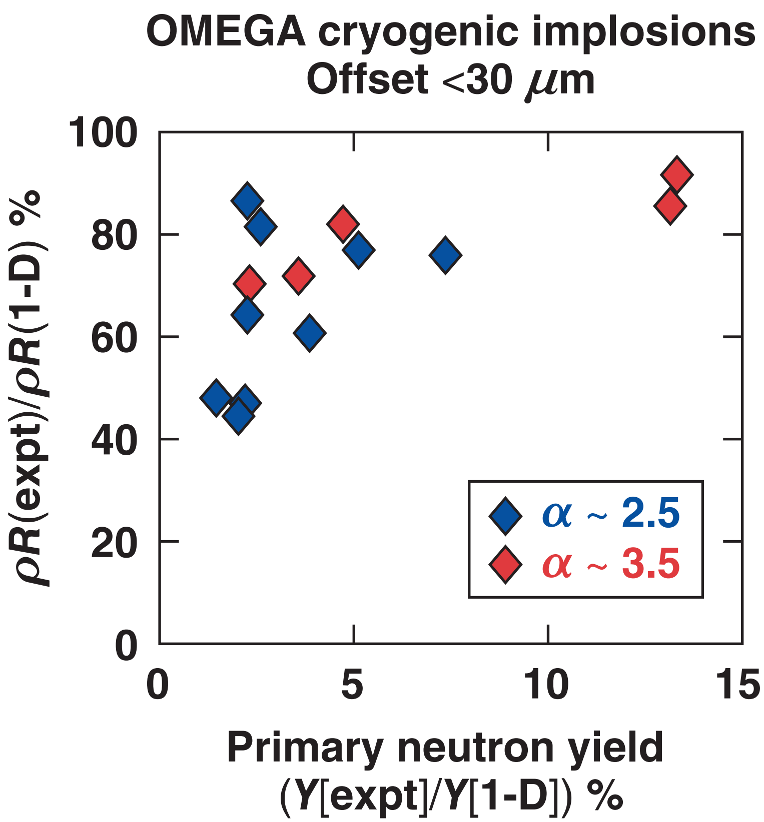

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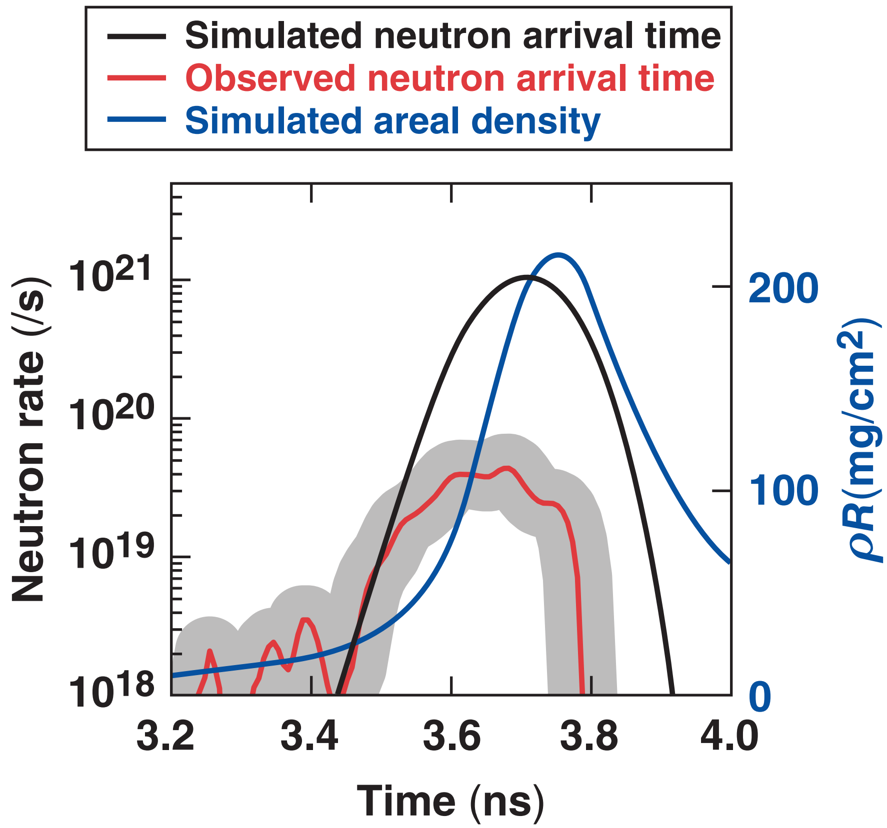
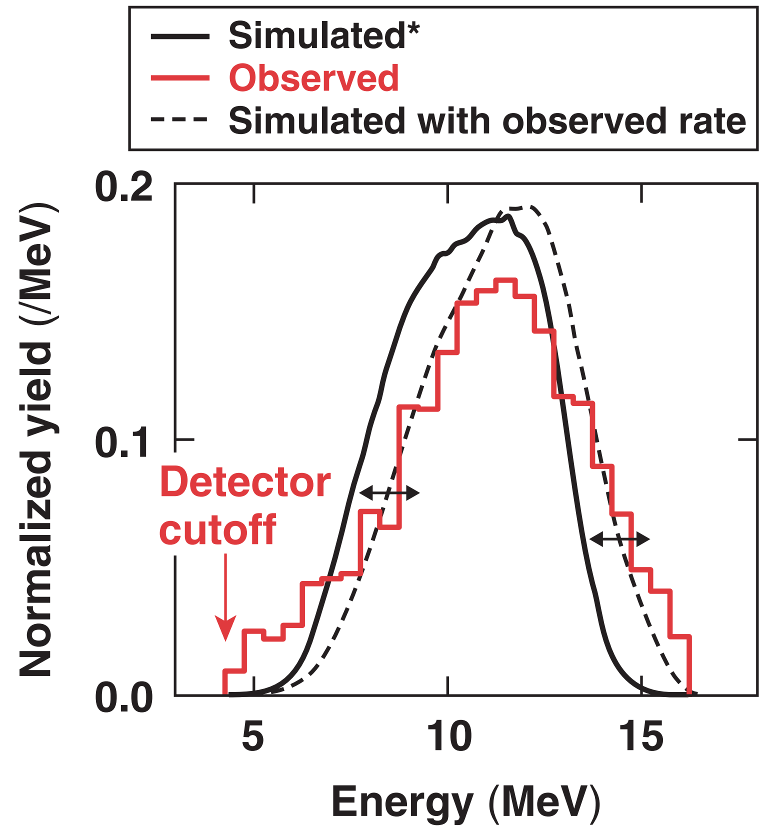
Better agreement between simulation and observation is obtained when burn truncated is included



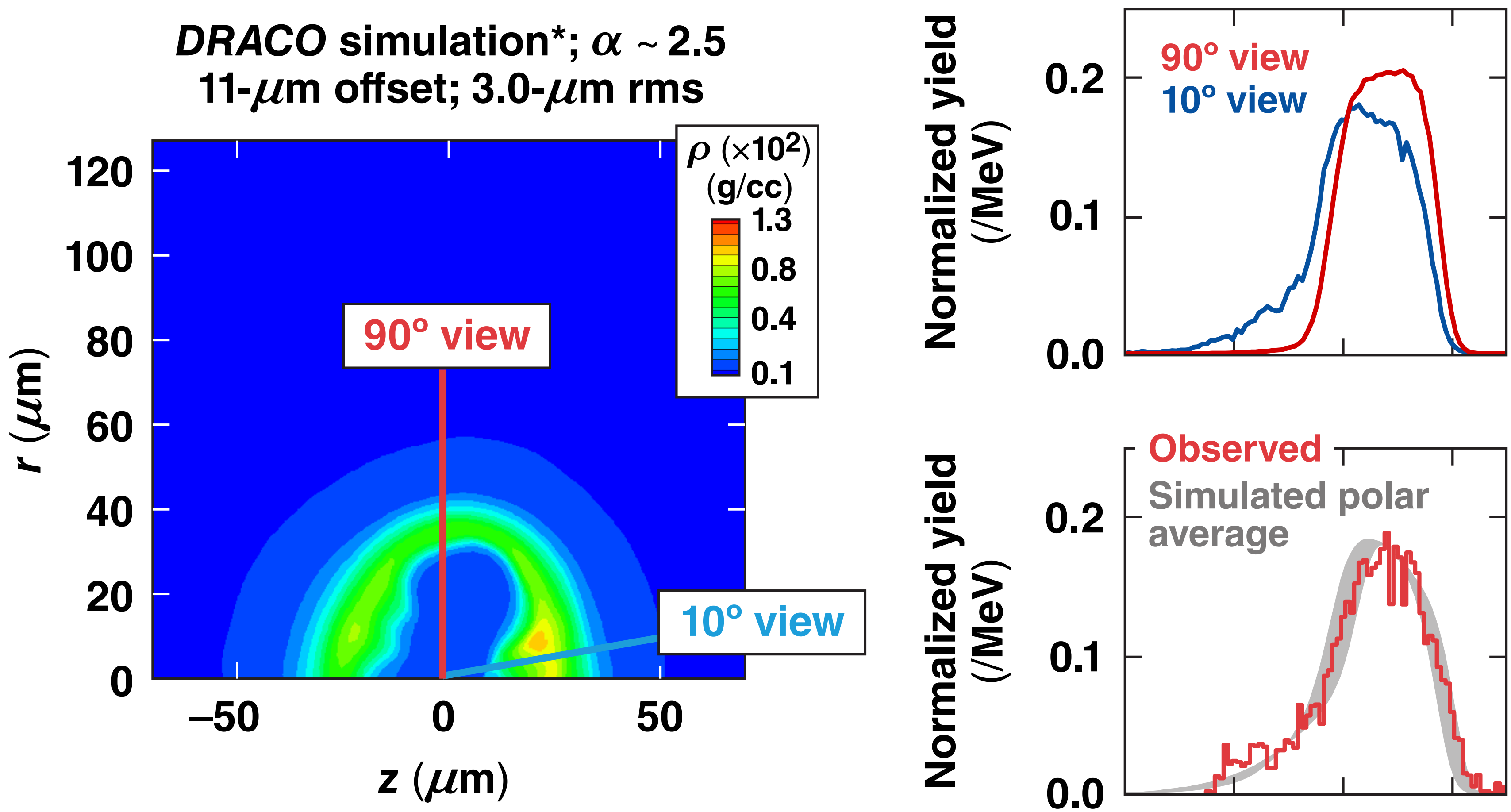


	ρR (mg/cm^2)
Simulated	182
Observed	144±9
Inferred using observed rate	140±20

TC8364

*P. B. Radha *et al.*, Bull. Am. Phys. Soc. 44, 194 (1999).

The low-energy tail in the secondary proton spectrum is due to nonuniformities in the compressed shell



- Burn truncation is included in the secondary spectrum calculations.

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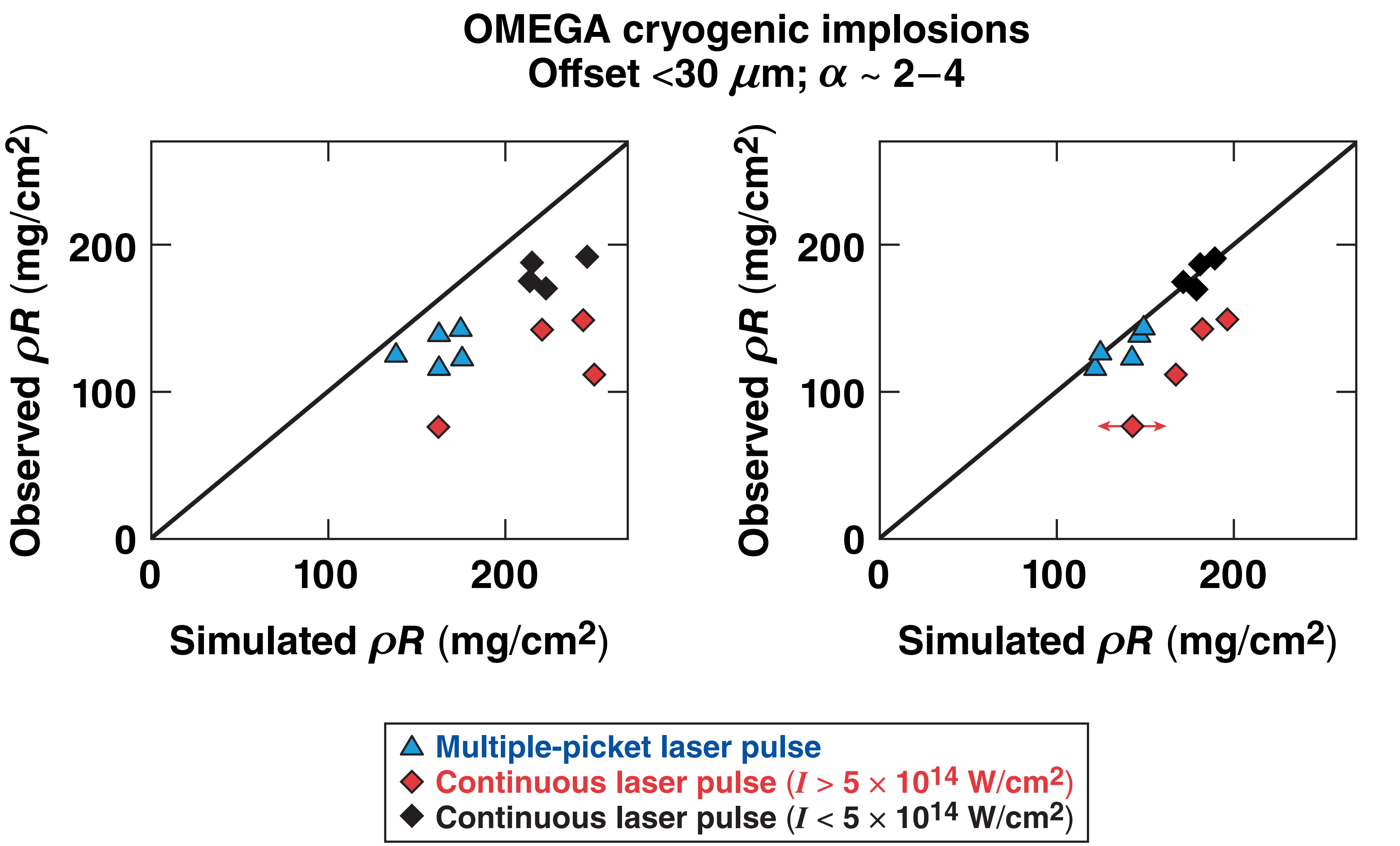
*S. Hu (NO5.00005).

Including the effects of burn truncation gives better agreement with experiment



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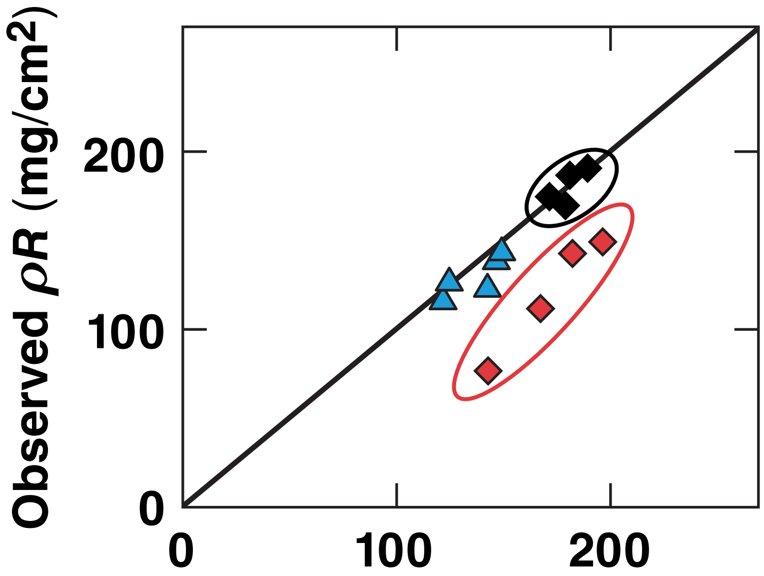
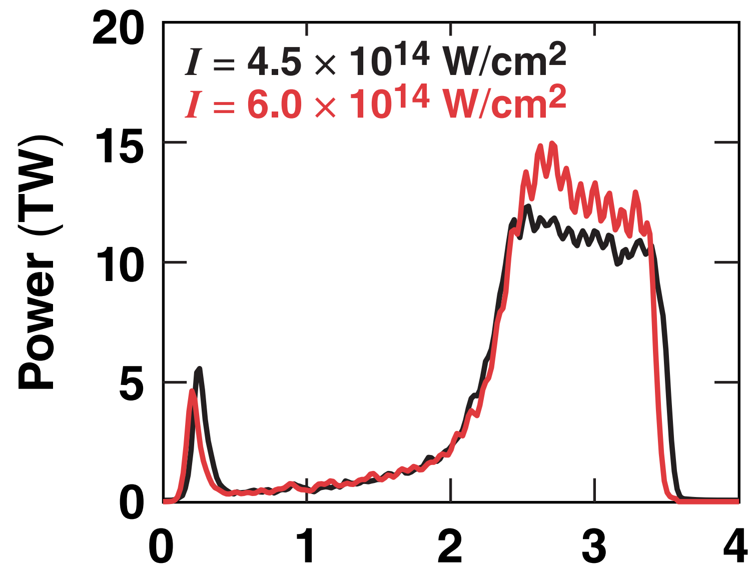
Including the effects of burn truncation gives better agreement with experiment

OMEGA cryogenic implosions
Offset <30 μm; α ~ 2–4





- △ Multiple-picket laser pulse
- ◆ Continuous laser pulse ($I > 5 \times 10^{14}$ W/cm^2)
- ◆ Continuous laser pulse ($I < 5 \times 10^{14}$ W/cm^2)

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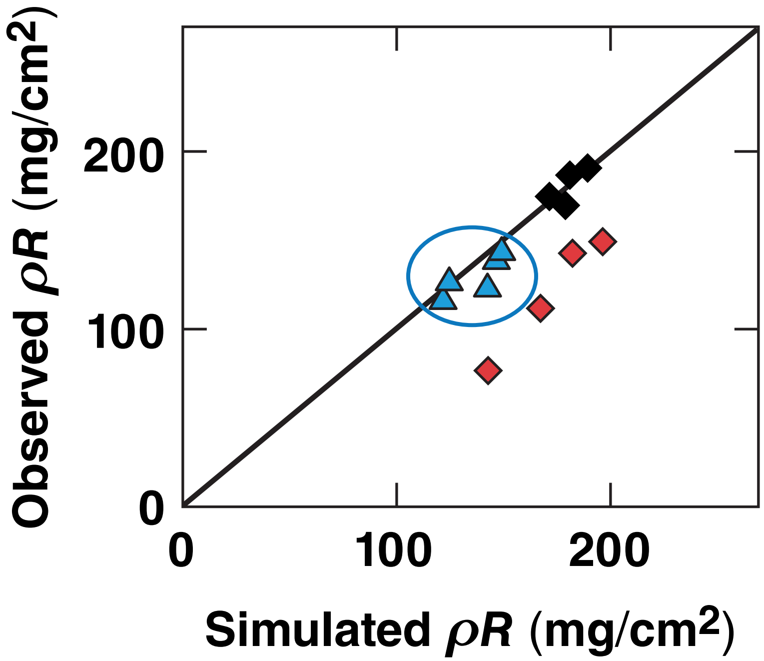

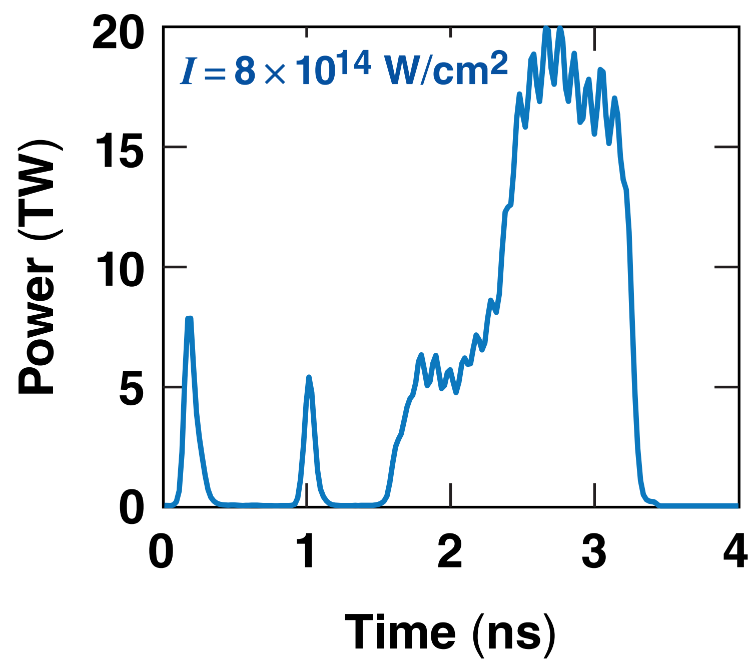

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Summary/Conclusions

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