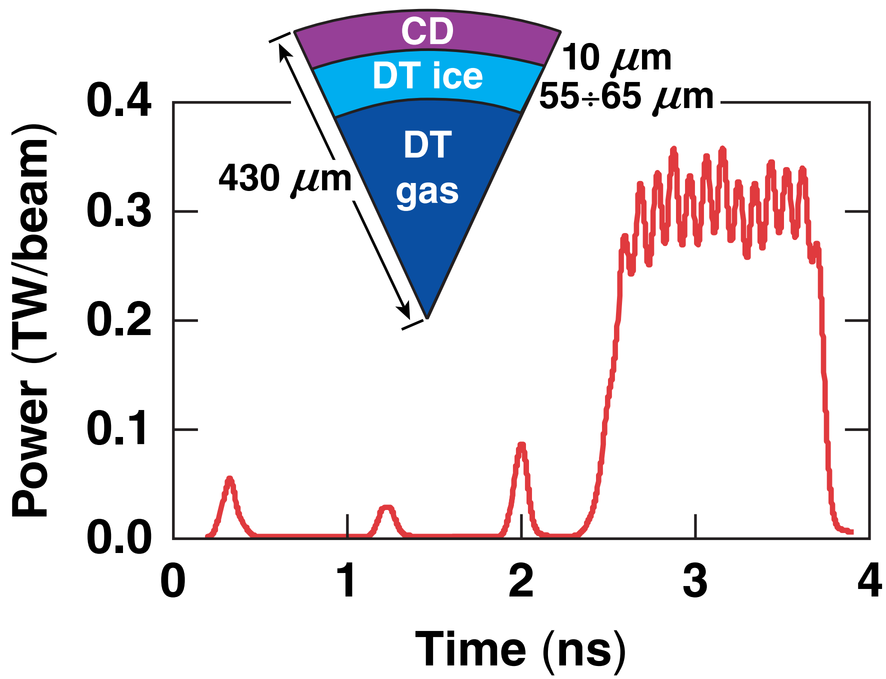
# Multiple-Picket Cryogenic Target Designs and Performance for OMEGA and the NIF




V. N. Goncharov
University of Rochester
Laboratory for Laser Energetics

51st Annual Meeting of the
American Physical Society
Division of Plasma Physics
Atlanta, GA
2–6 November 2009

Summary

# Cryogenic low-adiabat, multiple-picket designs on OMEGA achieve areal densities above 85% of predicted values

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- Multiple-picket designs are used to facilitate shock tuning
- Picket energies and step intensity in the main drive are adjusted to match the predictions
- High areal densities up to ~300 mg/cm$^2$ in cryogenic-DT-fuel compression have been achieved in designs with an implosion velocity ~$3 \times 10^7$ cm/s driven at peak intensity ~$8 \times 10^{14}$ W/cm$^2$

# Collaborators


**T. C. Sangster, T. R. Boehly, S. Hu, R. L. McCrory, P. W. McKenty, D. D. Meyerhofer, P. B. Radha, W. Seka, S. Skupsky, and C. Stoeckl**

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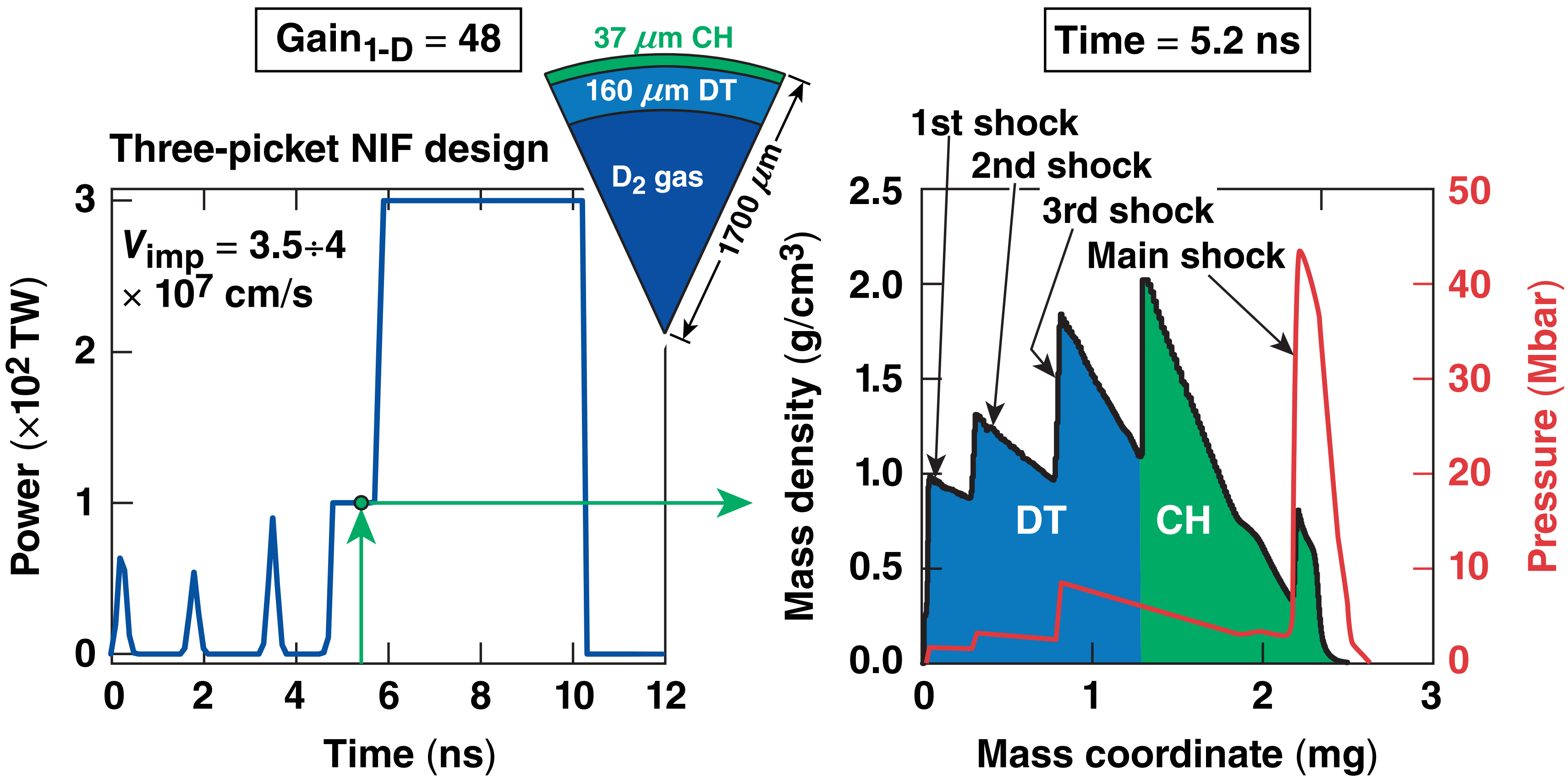
Plasma Science and Fusion Center
Massachusetts Institute of Technology

# A new NIF ignition design uses three pickets to optimize shock tuning

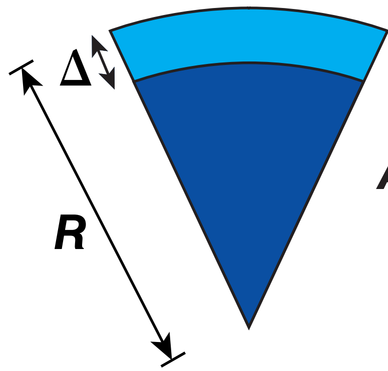



TC8286c

# A step in the main drive is essential for low-adiabat, high-implosion-velocity designs

**Drive pressure must exceed 100 Mbar**

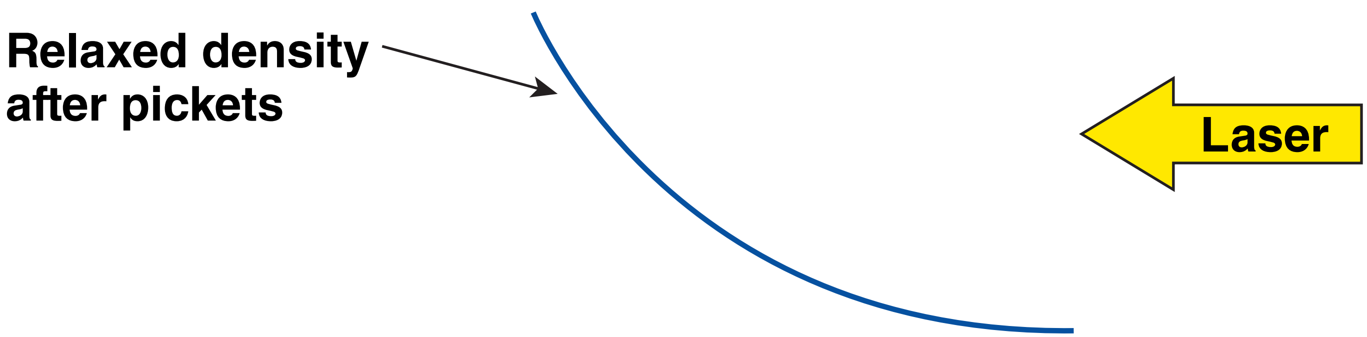
- **Shell stability:**




$$A_{in} = \frac{R}{\Delta} \approx 60 \left( \frac{V_{imp}}{3 \times 10^7} \right)^2 \left( \frac{p_{Mbar}}{100} \right)^{-2/5} \alpha^{-3/5}$$

C. D. Zhou and R. Betti, Phys. Plasmas 14, 072703 (2007).

- **Pressure of main shock increases as it propagates through the shell**




TC8702

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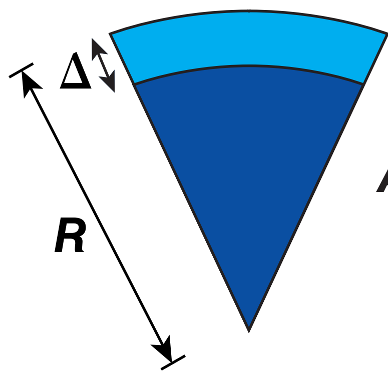


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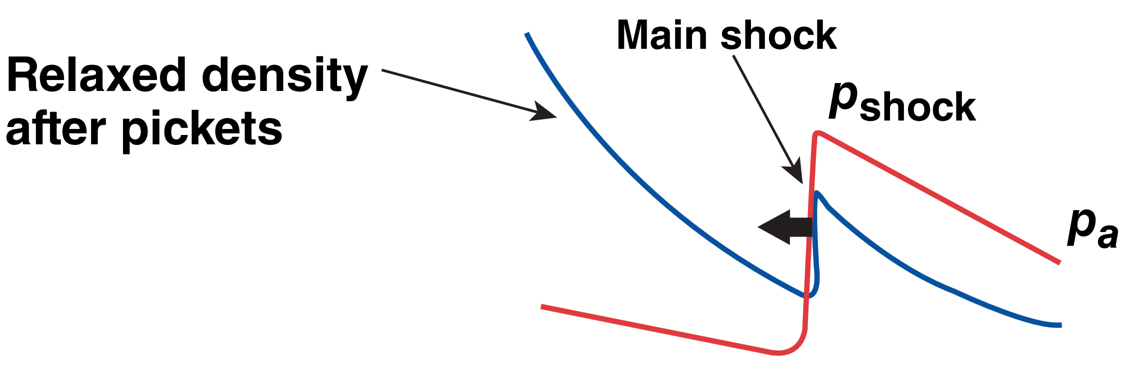


TC8702

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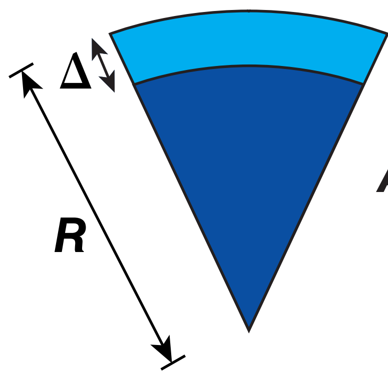


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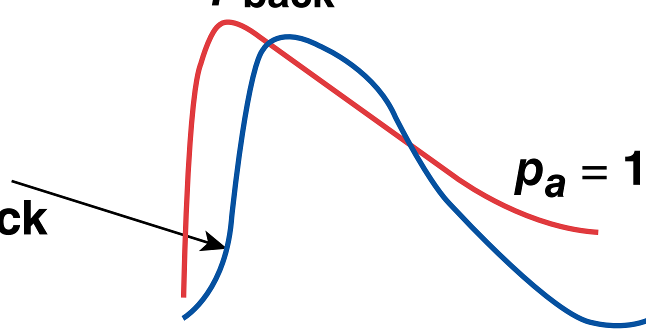
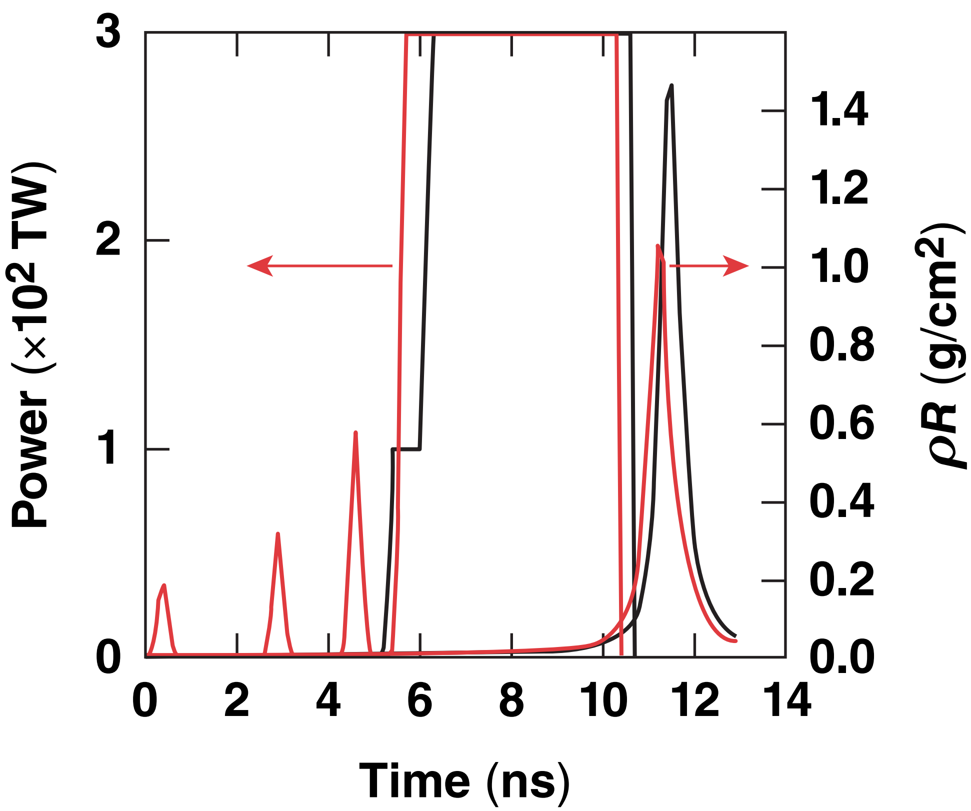



TC8702

# Reducing the main shock strength leads to higher areal densities




TC8703

# The current experimental campaign addresses both shock timing and effect of reduction in the main shock strength

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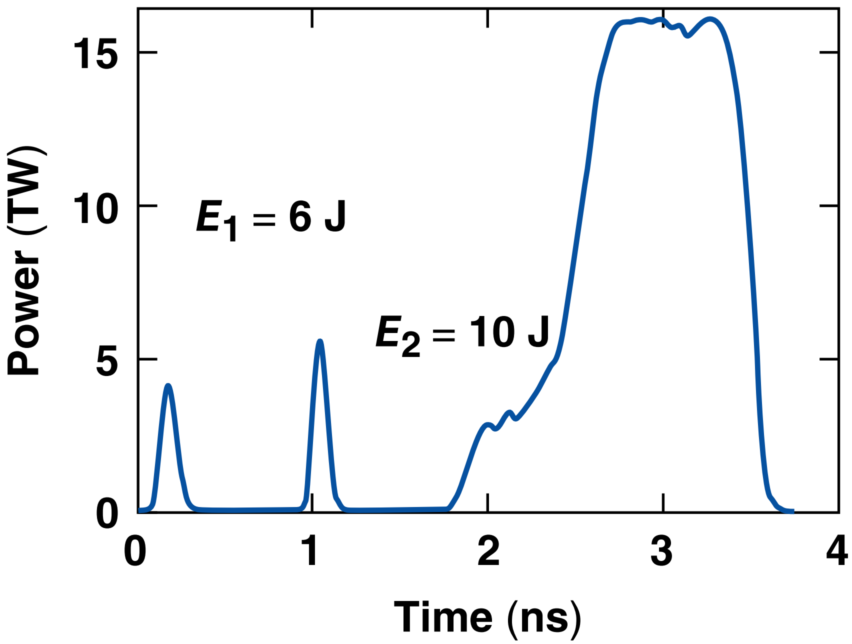
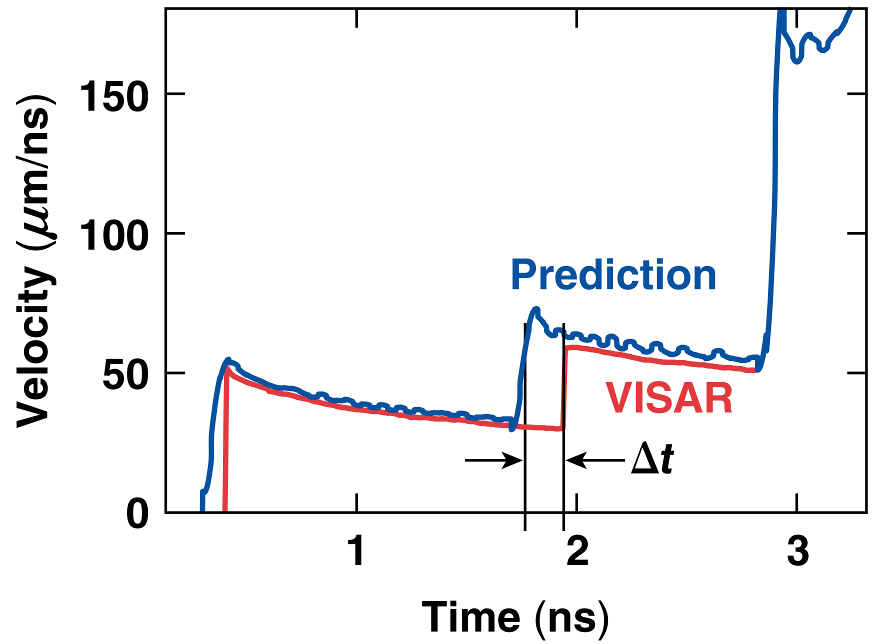


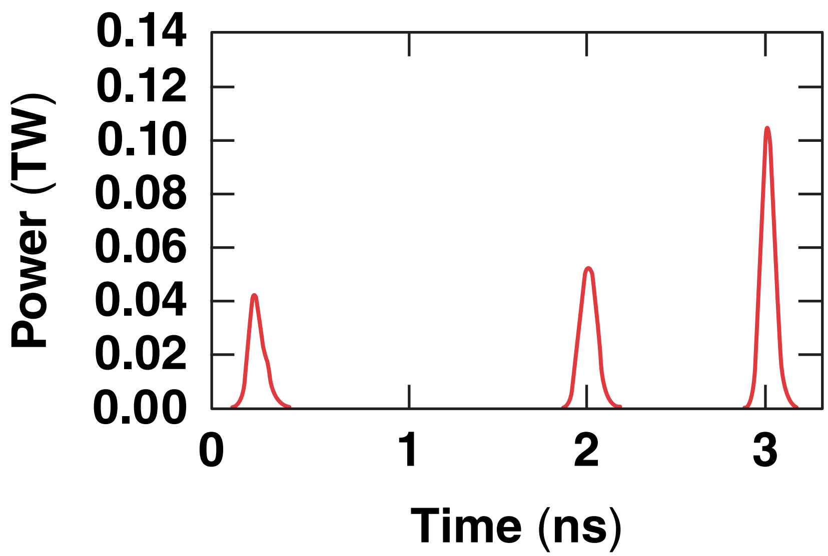



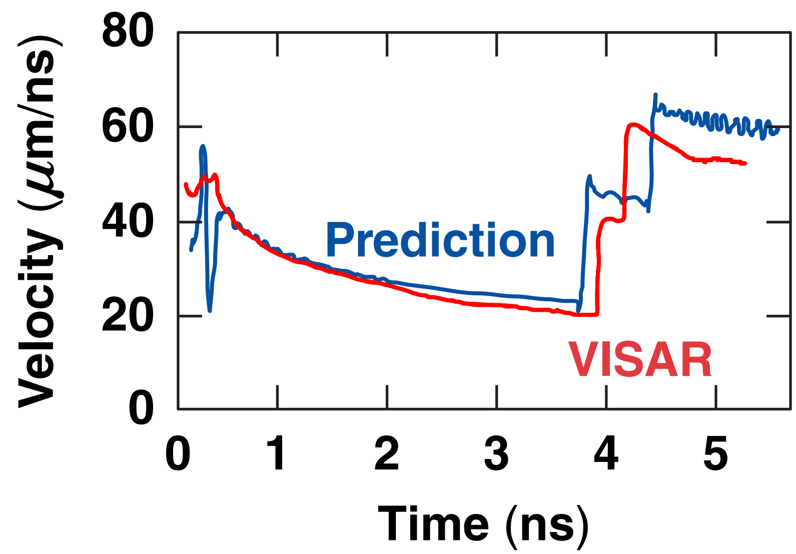

**Timing of shocks launched by first two tickets is complete.**

TC8431a

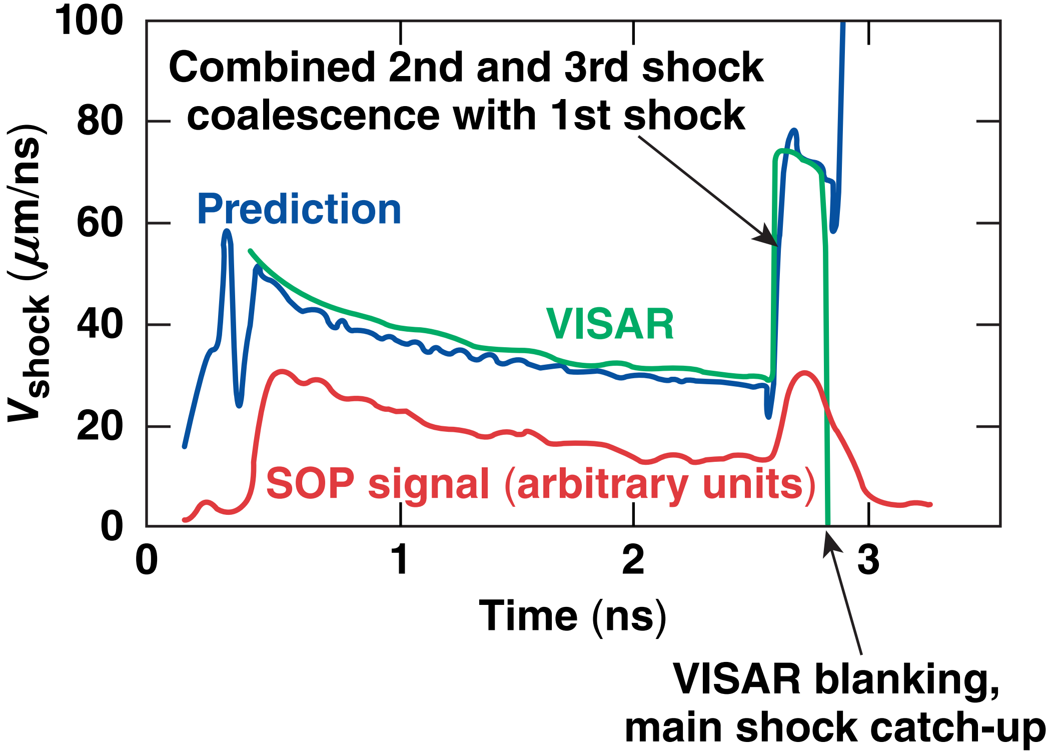
T. R. Boehly (UO5.00001).

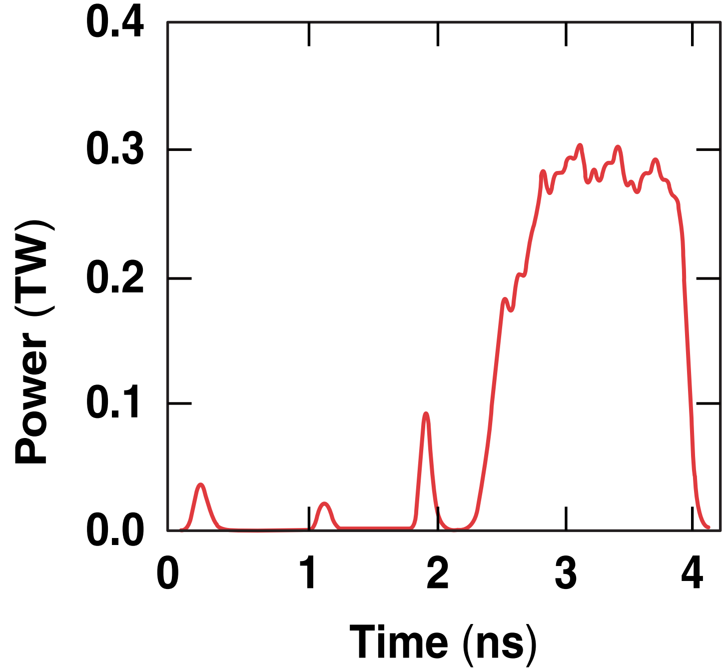
# Tuning of the third picket is carried out with stand-alone triple-picket pulses



# Main shock tuning is achieved by timing the catch-up signature in SOP and VISAR




TC8705

# Areal densities ~200 mg/cm$^2$ (>85% of 1-D) are achieved in triple-picket square designs

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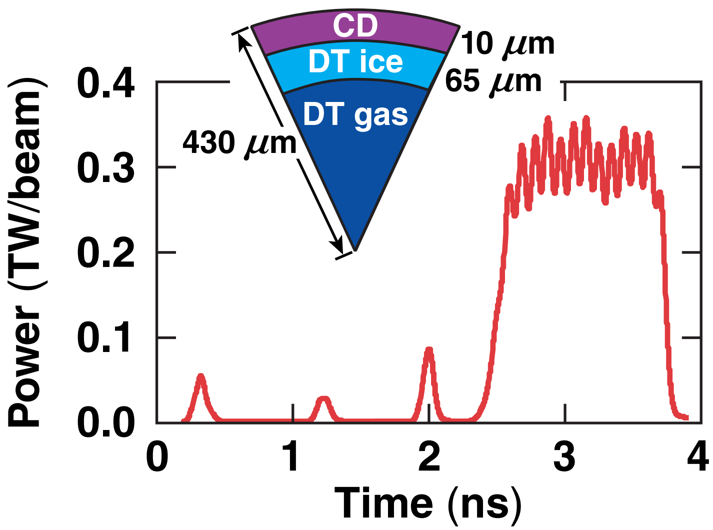
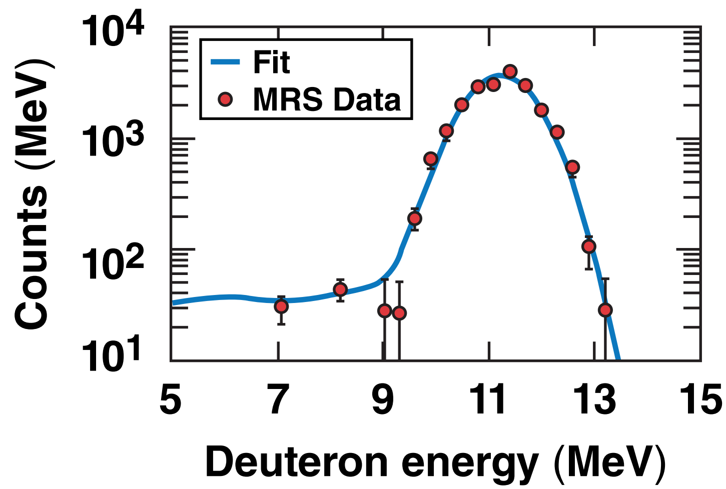
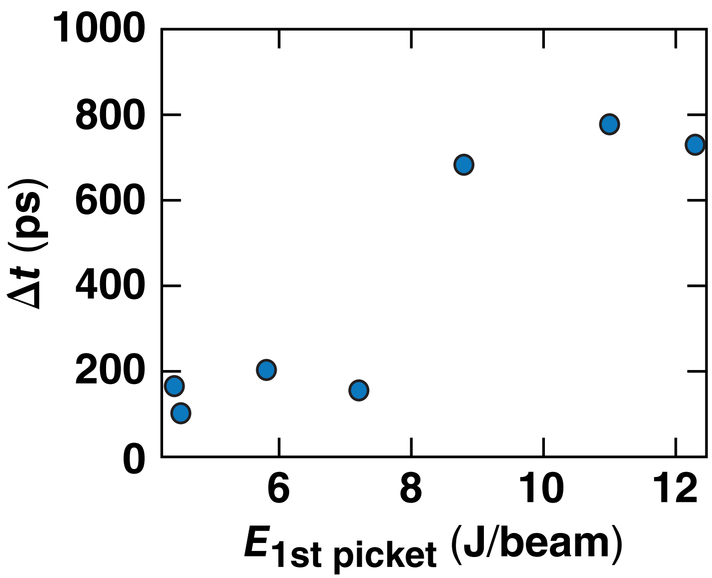
MIT




$V_{imp}$ ~ 3 × 10$^7$ cm/s
$R_{h.s.}$ ~ 20 $\mu$m
YOC ~ 10%
$I$ ~ 7.5 to 8 × 10$^{14}$ W/cm$^2$



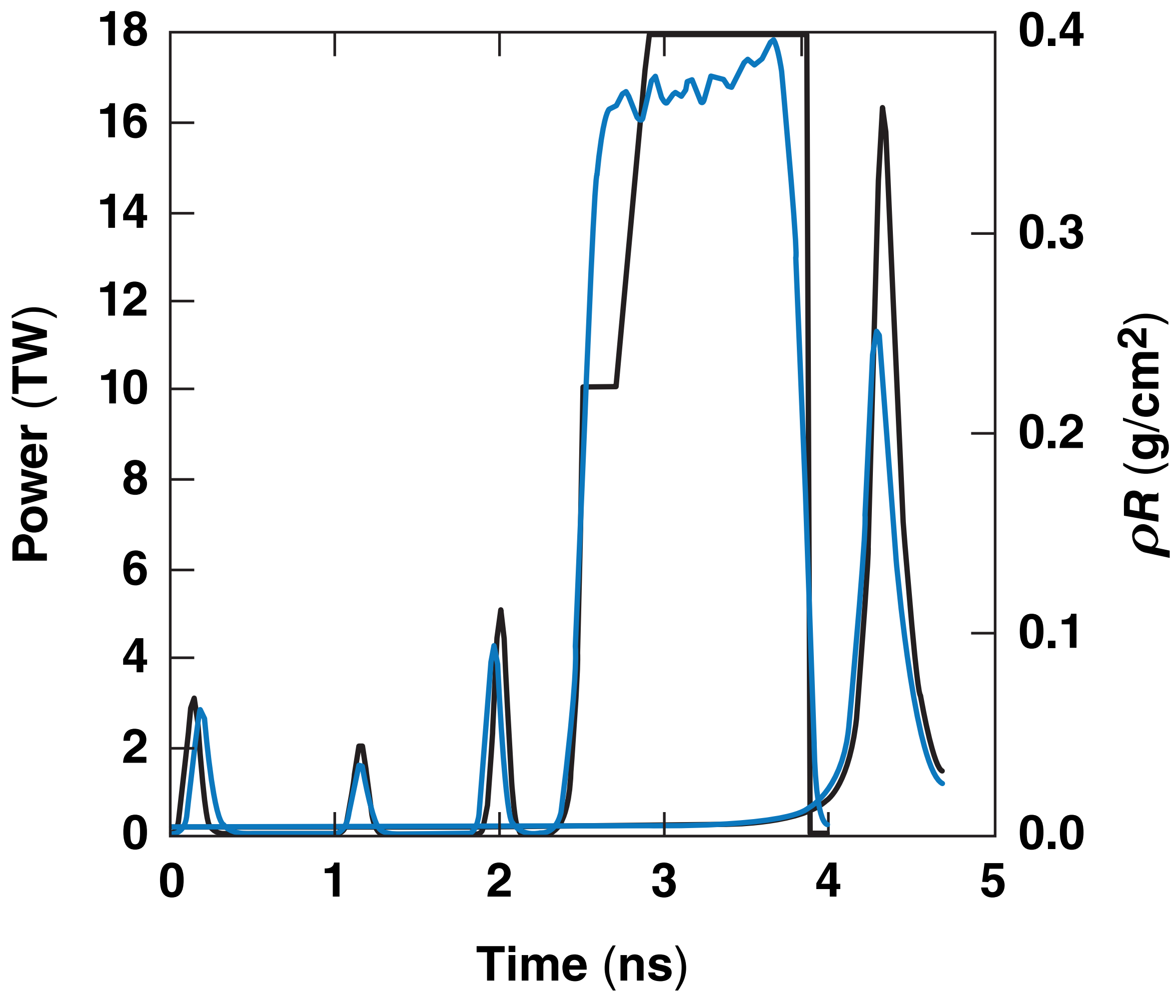

$\rho R$ = 185±27 mg/cm$^2$
$\rho R_{1\text{-}D}$ = 214 mg/cm$^2$




TC8514a

T. C. Sangster (N12.00002).

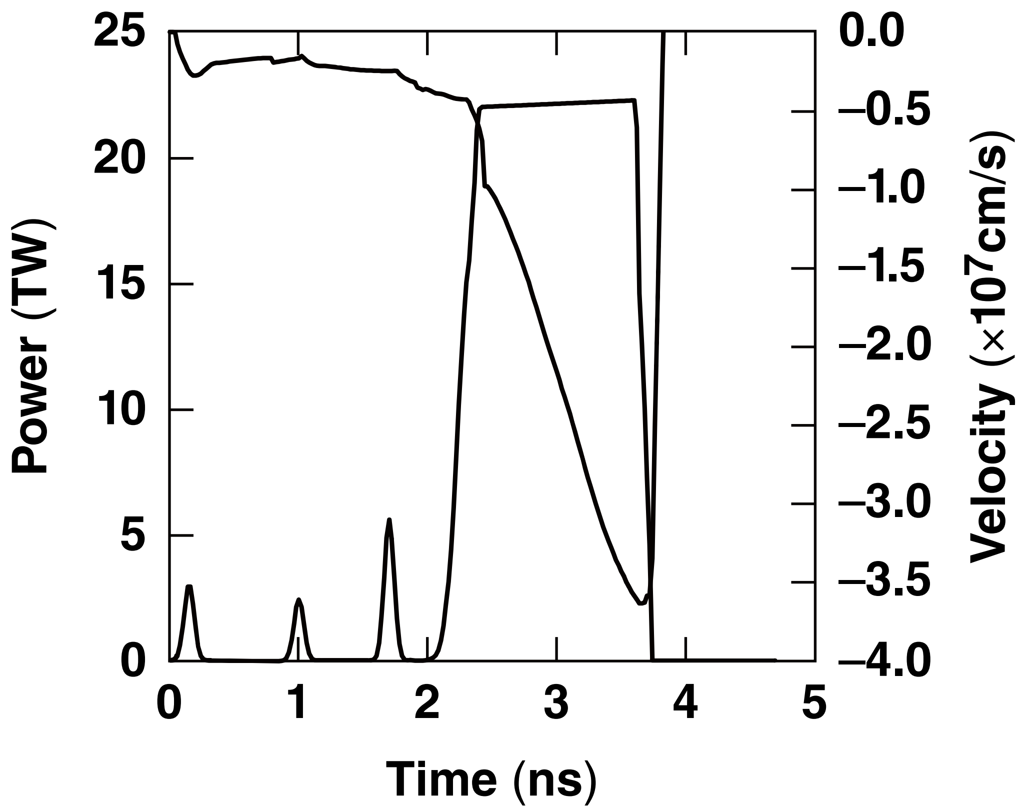
# Triple-picket designs with a step lead to higher measured areal densities




$V_{imp} \sim 3 \times 10^7$ cm/s
$R_{h.s.} \sim 15\ \mu$m
YOC ~ 5%
$I \sim 7.5$ to $8 \times 10^{14}$ W/cm$^2$
$\langle\rho R\rangle_{1\text{-D}} = 310$ mg/cm$^2$
$\langle\rho R\rangle_{exp} = 295\pm65$ mg/cm$^2$

TC8608

# Ignition-relevant implosion velocity $V_{imp}$ ~ 3.5 × $10^7$ cm/s will be achieved on OMEGA using 55-$\mu$m-thick DT ice and $I_{peak}$ ~9 × $10^{14}$ W/cm$^2$




$V_{imp}$ ~ 3.5 × $10^7$ cm/s
$R_{h.s.}$ ~ 20 $\mu$m
YOC ~ 10%
$I$ = 9 × $10^{14}$ W/cm$^2$
$\langle \rho R \rangle_{1\text{-D}}$ = 220 mg/cm$^2$

**A higher-adiabat square main pulse is used to enhance shell stability.**

TC8706

Summary/Conclusions

# Cryogenic low-adiabat, multiple-picket designs on OMEGA achieve areal densities above 85% of predicted values

- Multiple-picket designs are used to facilitate shock tuning
- Picket energies and step intensity in the main drive are adjusted to match the predictions
- High areal densities up to ~300 mg/cm$^2$ in cryogenic-DT-fuel compression have been achieved in designs with an implosion velocity ~3 $\times$ 10$^7$ cm/s driven at peak intensity ~8 $\times$ 10$^{14}$ W/cm$^2$