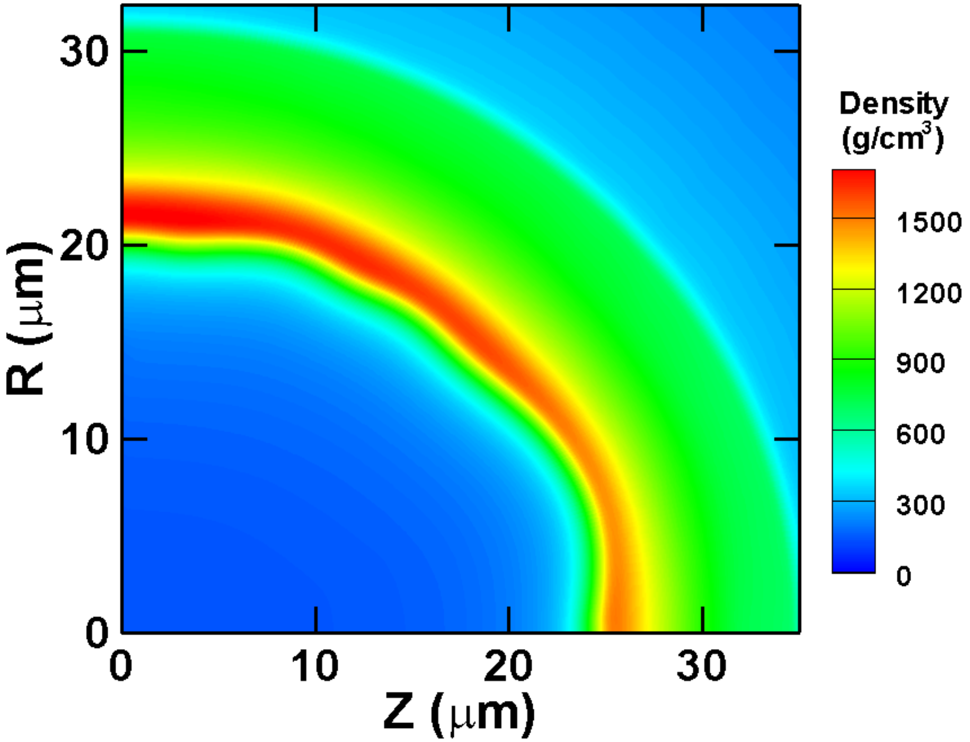
A Plastic-Ablator Shock-Ignition Design for NIF



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Summary

Plastic-ablator targets are predicted to have a higher Two-Plasmon-Decay intensity threshold than all-DT

- Plastic-ablator targets have higher Two-Plasmon-Decay (TPD) thresholds than DT ablators, and therefore may avoid preheat from TPD hot electrons.
- Plastic ablator targets are being studied in 1-D for robustness
  - Minimum Yield-over-clean (YOC) required for ignition
  - Spike pulse timing
  - Hot electron energy deposition in the shell
- DRACO simulations are studying 2-D effects

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TPD Threshold parameter[1]: $F_{\mathrm{TPD}} = \dfrac{I_{14} L_n(\mu\mathrm{m})}{230 \cdot T_e(\mathrm{keV})}$

		$\langle I_{14} \rangle$*	L_n(µm)	T_e (keV)	**F_{TPD}**
DT	main	7.5	375	2.5	**4.9**
	spike	69	425	5.0	**25.5**
CH	main	7.5	350	3.5	**3.3**
	spike	69	400	7.0	**17.1**

*For 95TW (main drive) focused at R_{focus}=1000µm; and

350TW (spike), half focused at R_{focus}=1000µm, half at R_{focus}=500µm

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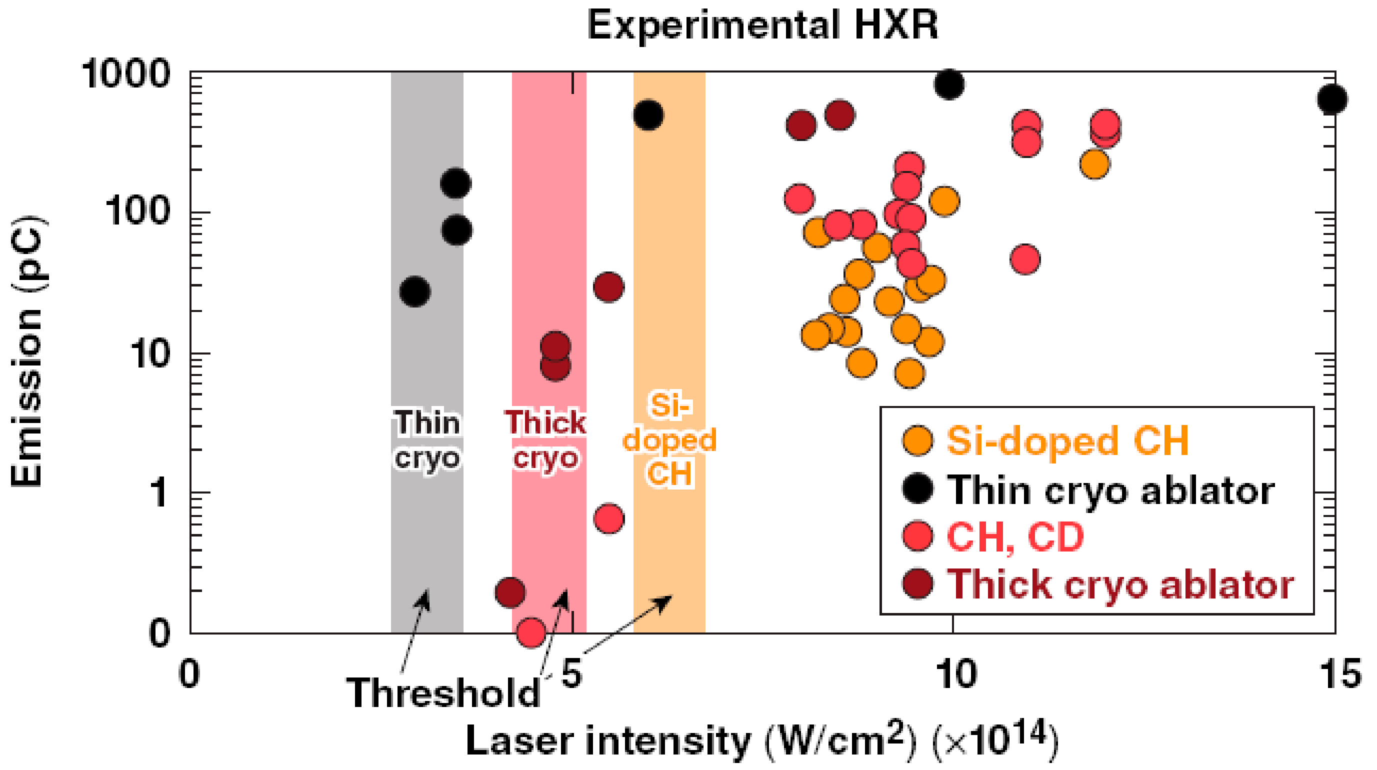
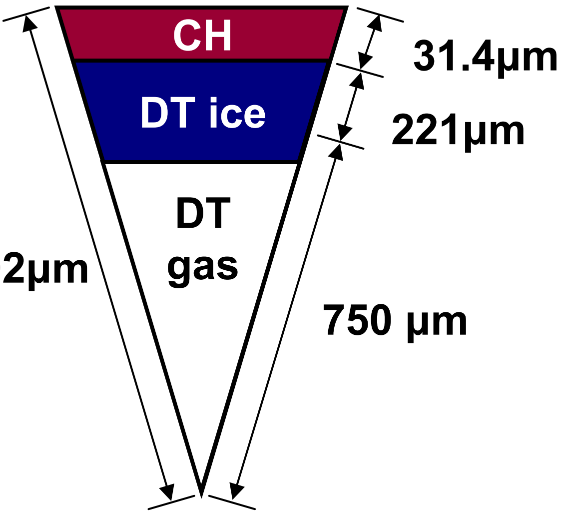
[1] A. Simon *et al.*, Phys. Fluids 26 (10), 3107 (1983).

OMEGA implosions with thick plastic ablators produce fewer hard x rays.

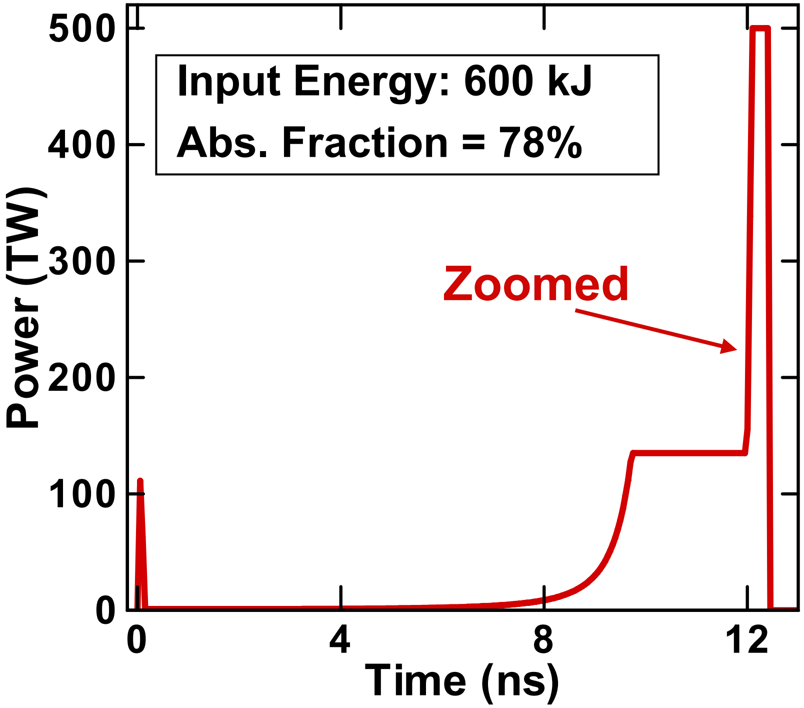


A. Maximov, APS-DPP (2007).

A thick plastic-ablator shock-ignition target was designed for 600kJ



Gain (1-D)	78
ρR (g/cm^2)	2.17
v_{imp} (cm/s)	$2.98 \cdot 10^7$
IFAR_{peak}	41*



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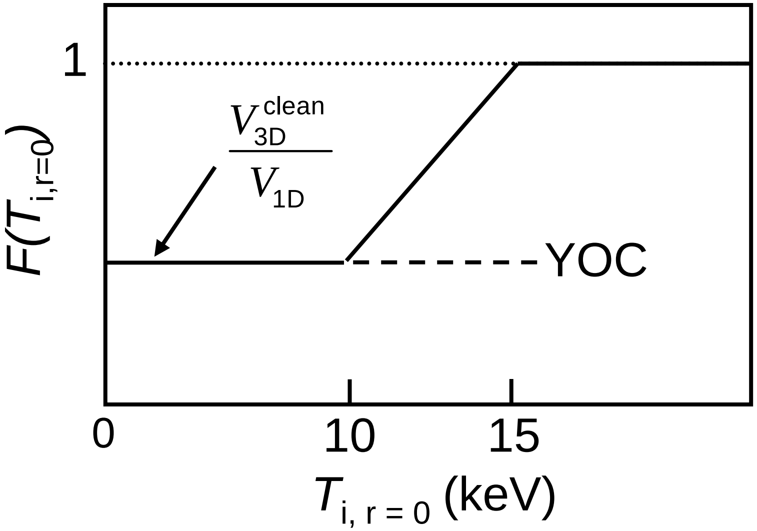
*IFAR of NIF all-DT point designs ~40-50

The YOC is used as an input parameter for the 1-D clean-volume model; the 1-D Ignition Threshold Factor (ITF) is calculated from the Minimum Yield-over-clean require for ignition

- **The fusion rate is modified at sub-ignition temperatures by the ratio of clean volume to the 1-D hotspot volume**

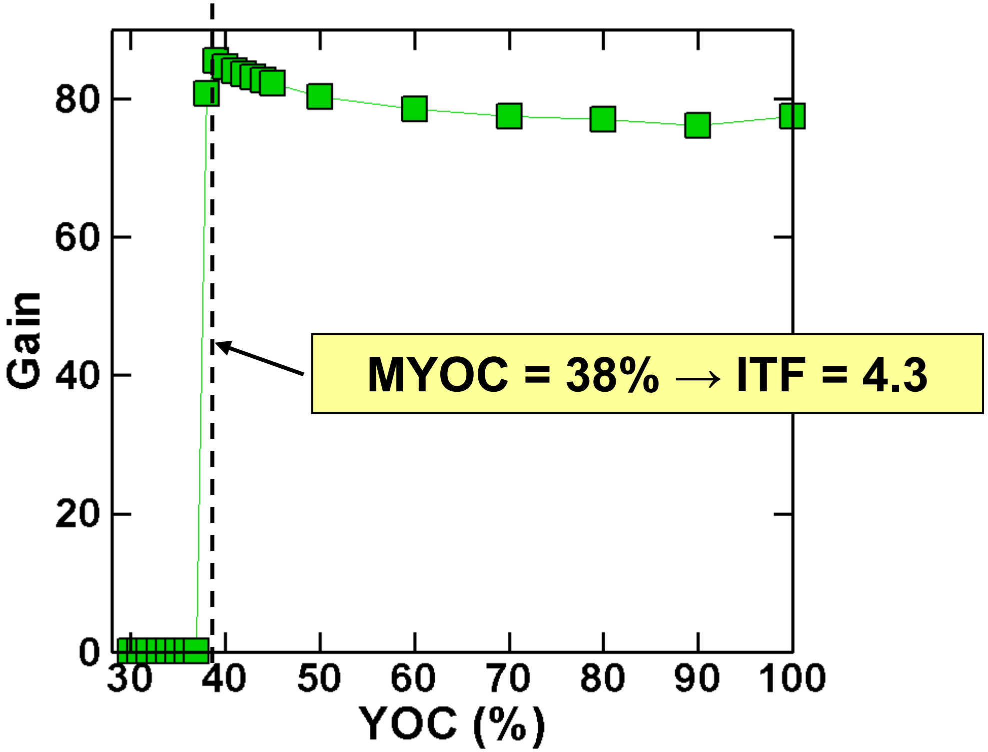
$$\langle \sigma v \rangle_{\text{mod}} = F(T_{i,r=0})\langle \sigma v \rangle$$

$$\boxed{ITF(1D) = \frac{1}{MYOC^{1.5}}}$$



c.f. K. Anderson, APS/DPP 2009
P. Chang, APS/DPP 2009

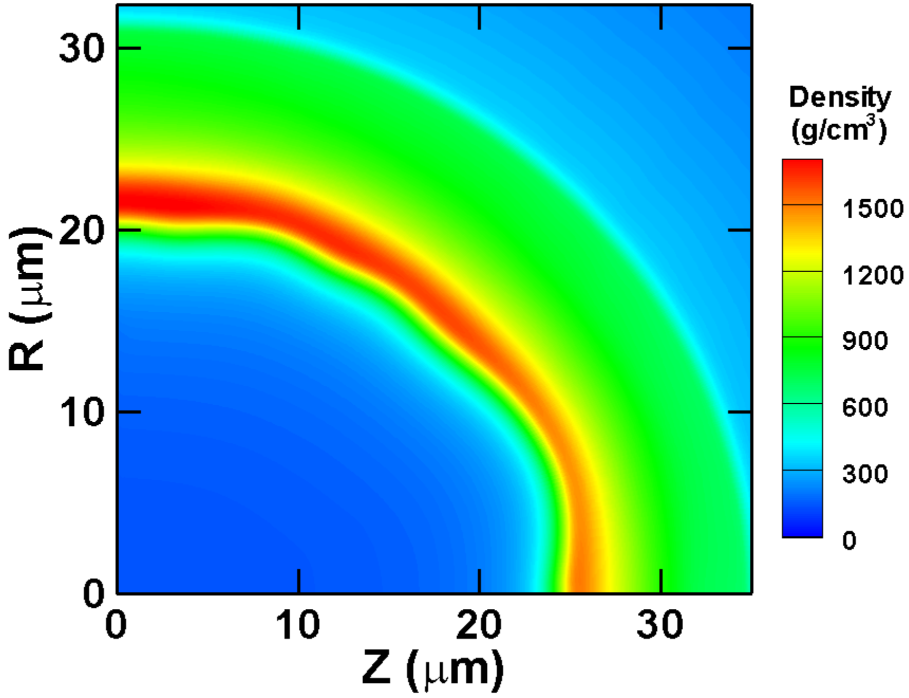
The minimum yield-over-clean (MYOC) required for ignition for the CH 600kJ design is 38%, corresponding to an ITF of 4.3



MYOC = 38% → ITF = 4.3

Two-dimensional DRACO runs with low-mode inner ice roughness give similar results for the MYOC

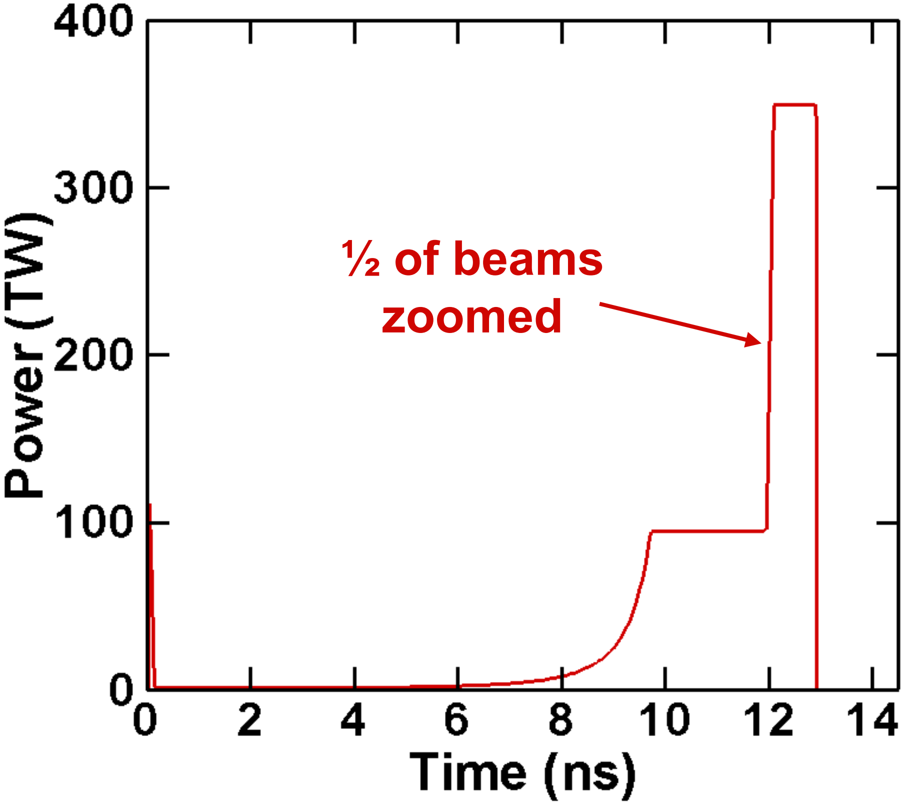
Target ignites with 1.2 µm
RMS ice roughness



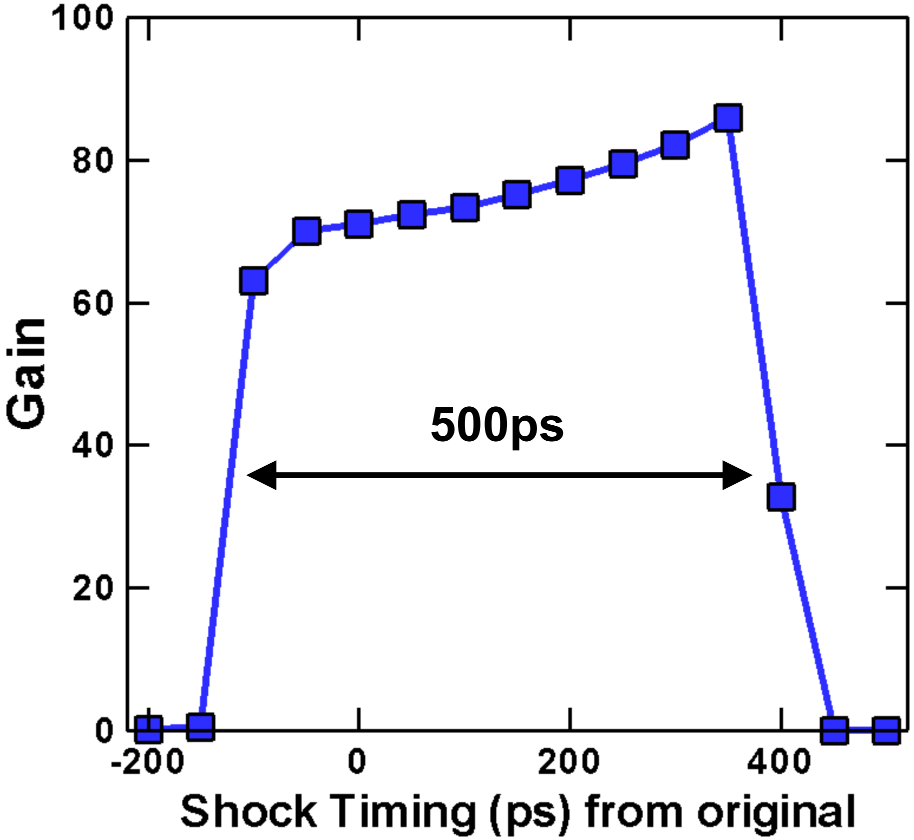
The original laser pulse was modified to conform to NIF capabilities

- Main drive reduced from 135 TW to 95 TW
- Spike power reduced from 500TW to 350TW

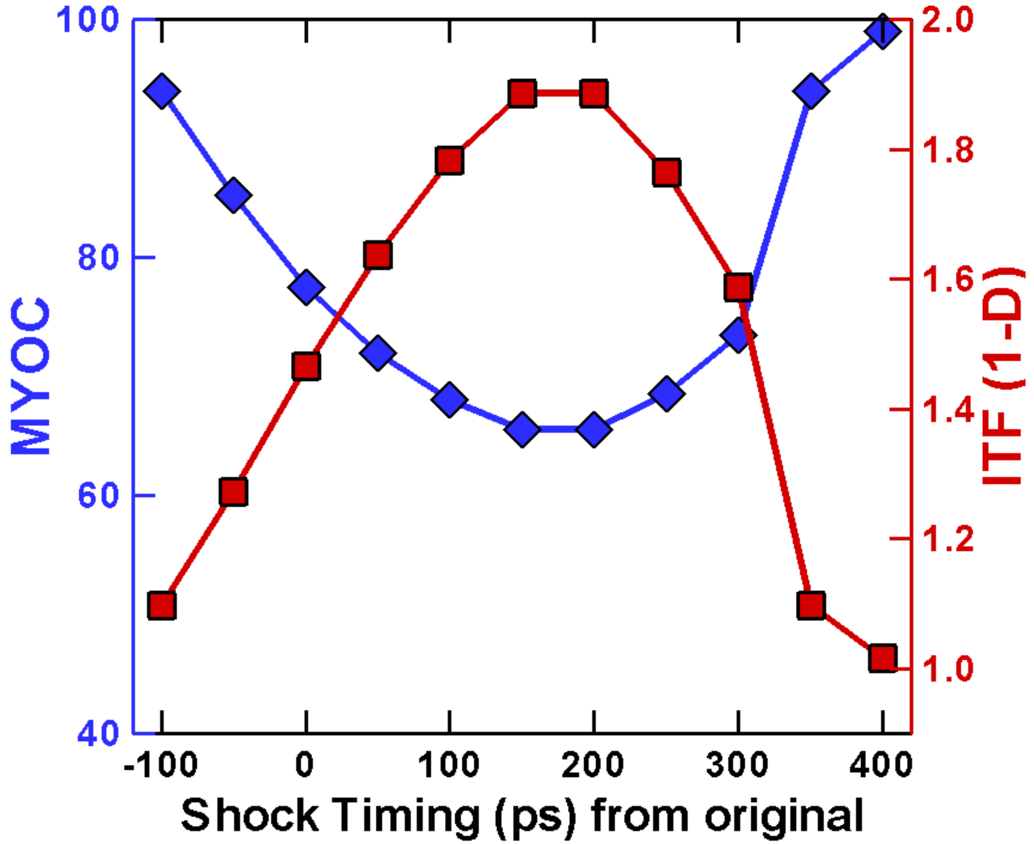
Gain (1-D)	**70**
ρR (g/cm^2)	**2.07**
v_{imp} (cm/s)	**$2.98 \cdot 10^7$**
$IFAR_{peak}$	**36**



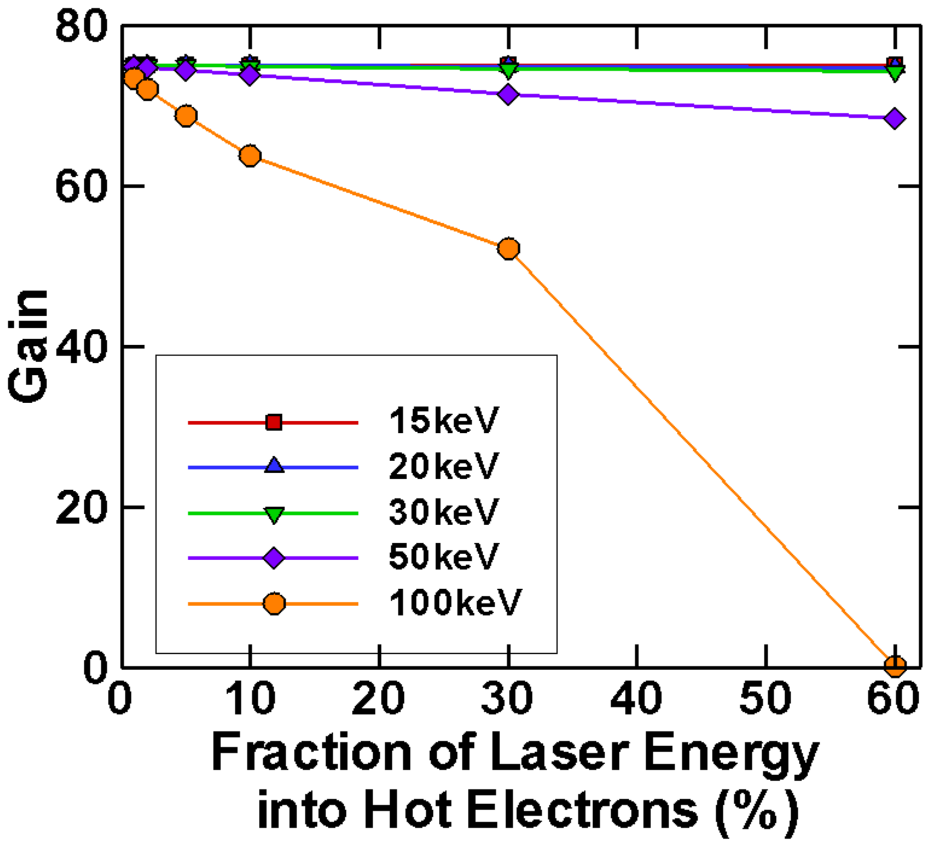
The shock timing window is reduced to ~500ps with lower main drive power and spike pulse.



The Minimum Yield-over-clean (MYOC) required for ignition is a function of shock timing.



The plastic-ablator SI design is robust to hot electrons up to 50keV at 60% of laser energy during the spike pulse



Summary/Conclusions

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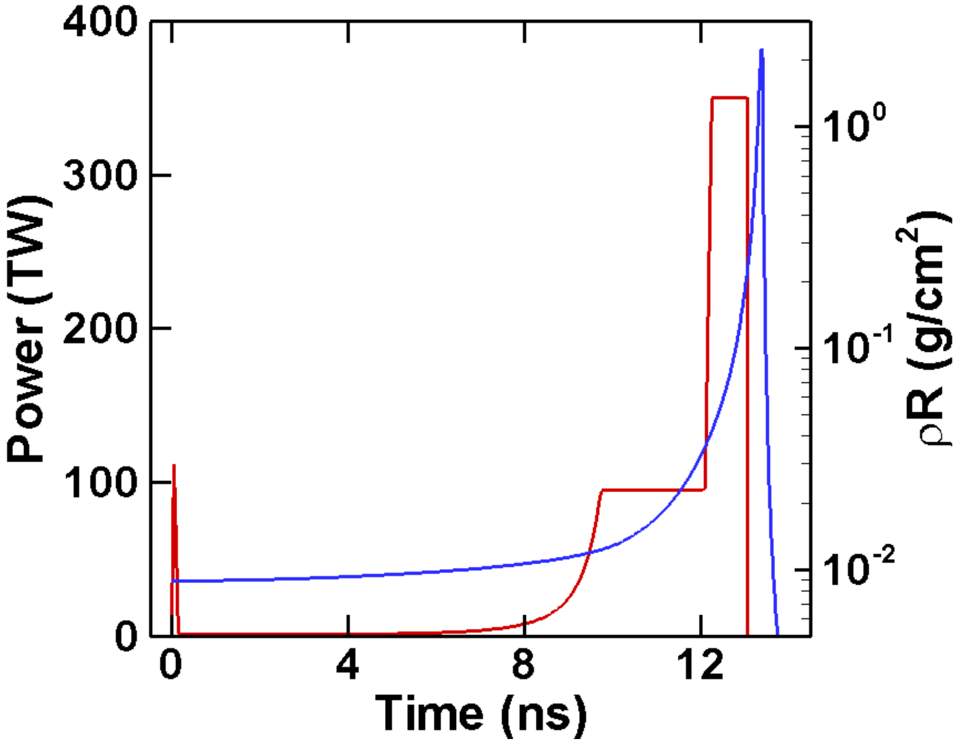
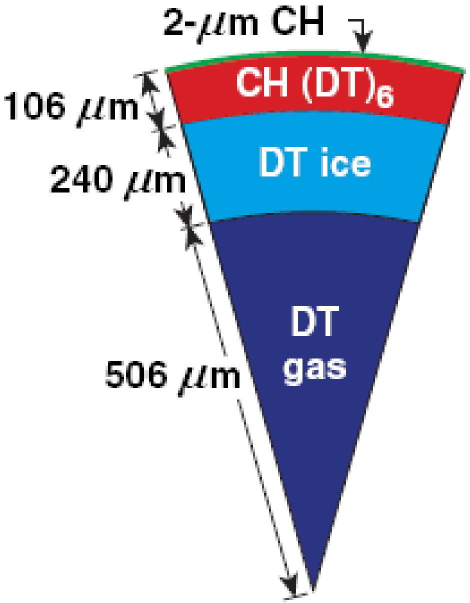
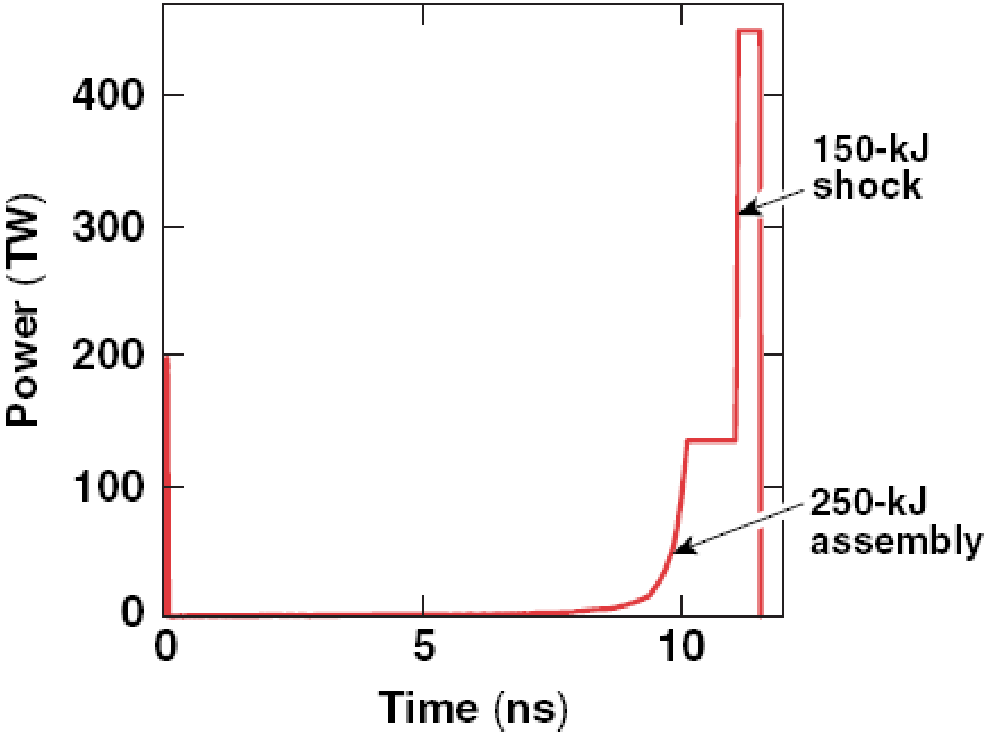
Target gain is unaffected by hot electrons up to 30keV at up to 5% of the main-drive laser power.



Stopping range for 30-keV hot-electrons in CH is < 1.2 mg/cm^2

A sub-NIF target was designed for two-dimensional simulation studies





E_L = 400 to 500 kJ, $V_i = 2.4 \times 10^7$ cm/s, α = 0.7 to 1.0, IFAR = 18

Two-dimensional simulations indicate perturbations in the shell and ignitor shock