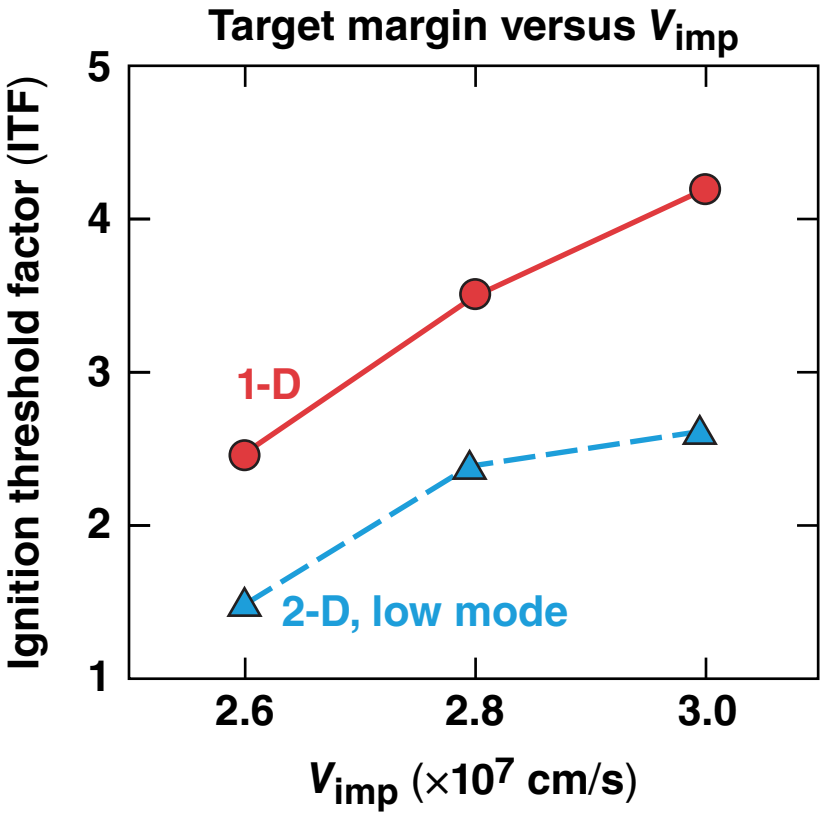
An Implosion-Velocity Survey for Shock Ignition at the National Ignition Facility



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Summary

Simulations of shock ignition (SI) at the National Ignition Facility (NIF) indicate best performance and stability at velocities below 3×10^7 cm/s

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- A parameter study varied the implosion velocity and quantified the target robustness in 1-D and 2-D for plastic-ablator cryogenic capsules
- This study used polar-drive beam geometry to evaluate long-wavelength perturbations and laser imprint to study short wavelengths
- The target margin in 2-D with polar drive increases with implosion velocity
- Low-velocity capsules showed less sensitivity to laser imprint

Collaborators

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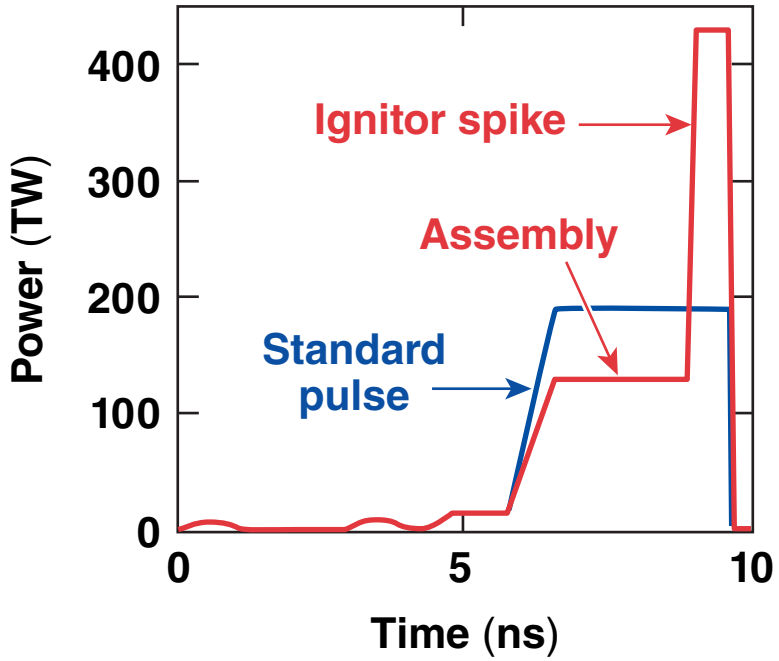
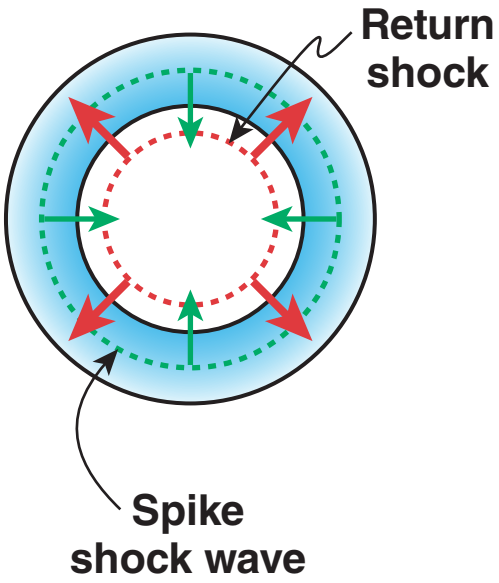
Shock ignition separates the fuel-assembly phase from the ignition phase using a single laser system

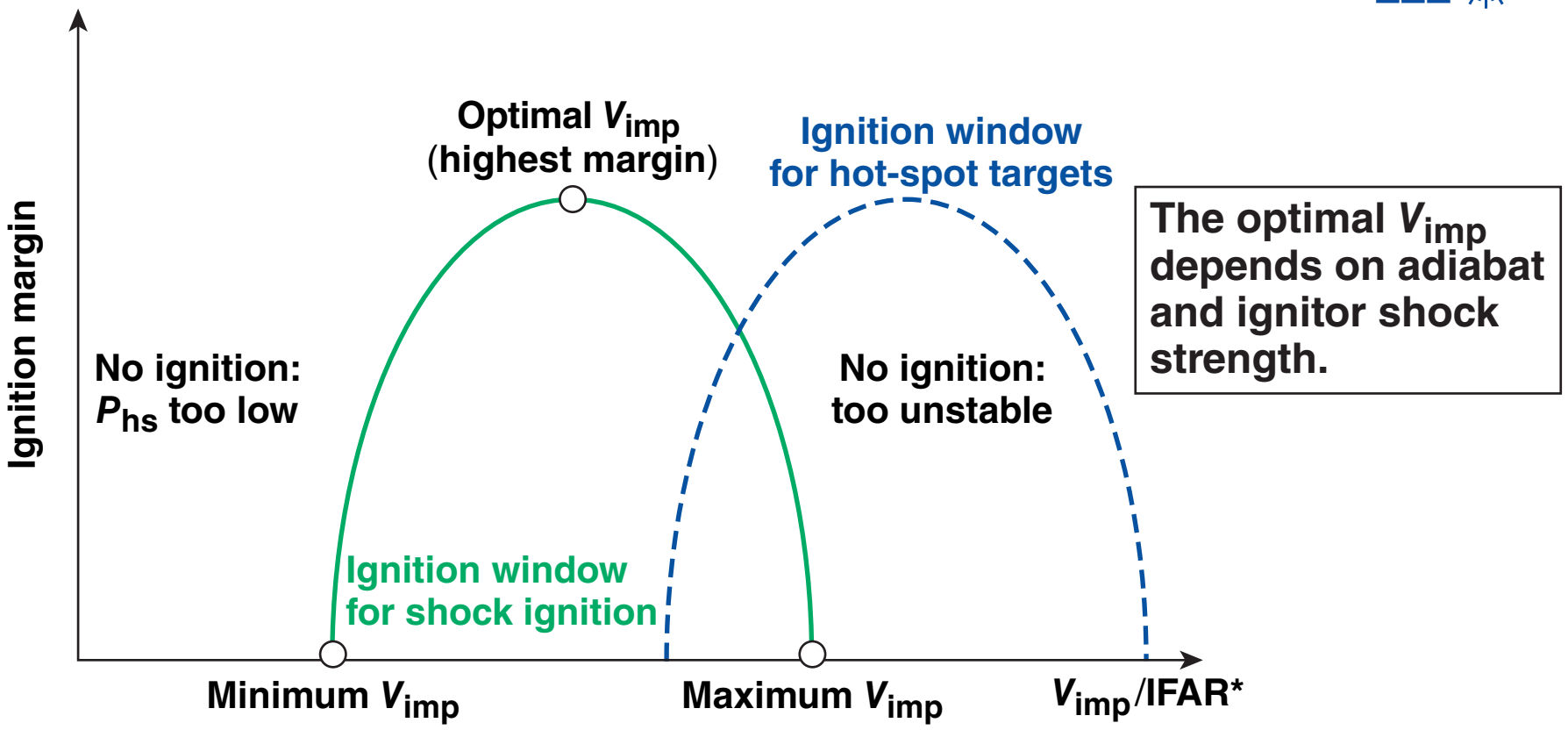




The late-time shock amplifies the hot-spot pressure.

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

The optimal implosion velocity for shock ignition is constrained by both 1-D dynamics and multidimensional stability characteristics



The optimal V_{imp} depends on adiabat and ignitor shock strength.

The ignition window for shock ignition is lower than for the hot spot.

*In-flight aspect ratio

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Robustness to long-wavelength modes was evaluated using polar-drive nonuniformities and to short-wavelength modes using laser imprint

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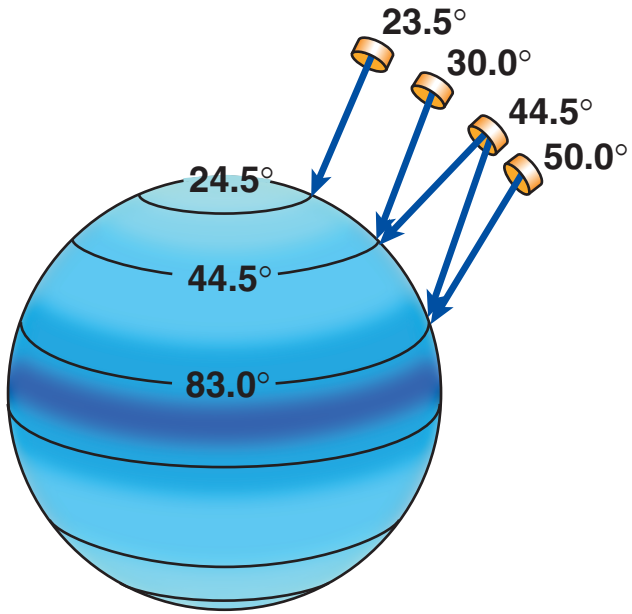
Polar drive

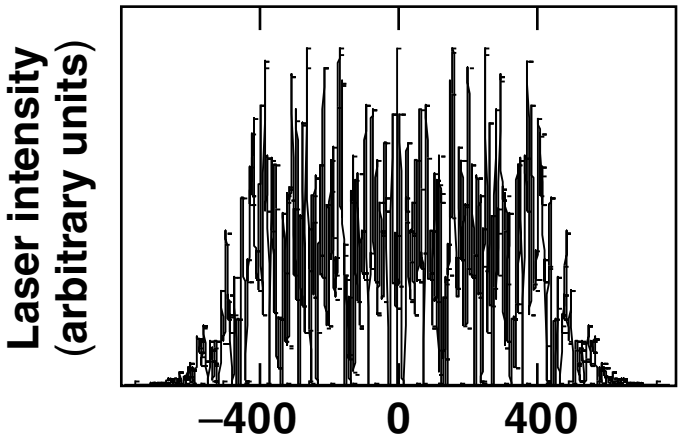
Beams are repointed toward the equator to ensure adequate symmetry



Generates long-wavelength perturbations, $\ell \leq 20$

Single-beam speckle from phase plate

Radial lineout of laser intensity



Generates short-wavelength perturbations, $\ell > 20$

Laser imprint modeled using multi-FM SSD*

*Multi-frequency-modulation smoothing by spectral dispersion

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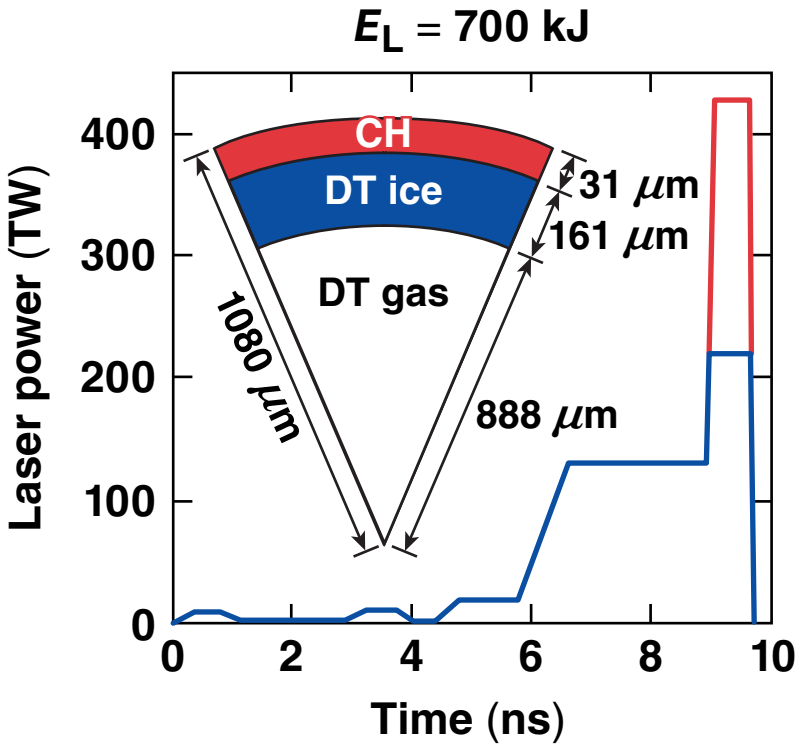
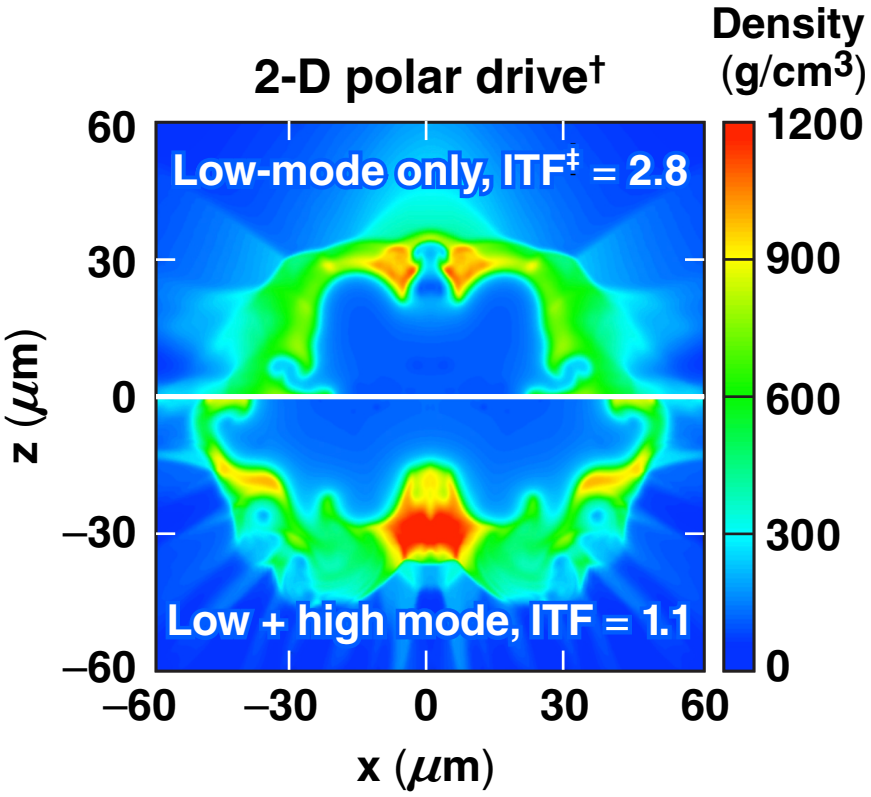
The previous shock-ignition* design for the NIF showed the highest sensitivity to polar-drive (PD) beam geometry and laser imprint





$V_{imp} = 3.1 \times 10^7$ cm/s
ITF (1-D) = 4.1 IFAR = 22

*K. S. Anderson *et al.*, Phys. Plasmas 20, 056312 (2013).
†Used a five-ring PD scheme
‡Ignition threshold factor

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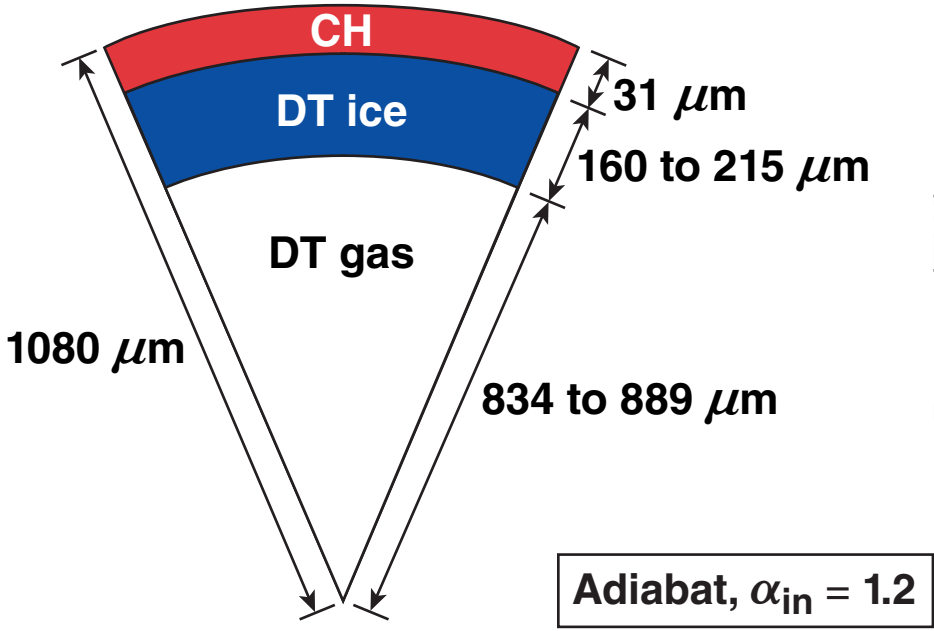
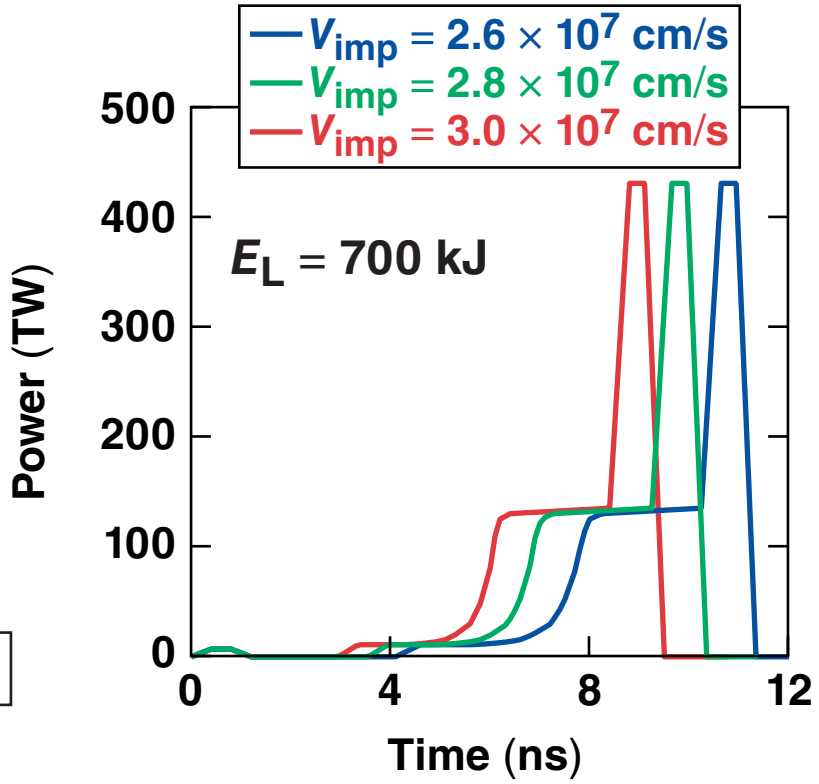
Three new designs were analyzed; the velocities were varied by changing the target thickness



Adiabat, $\alpha_{in} = 1.2$



Velocity (cm/s)	2.6×10^7	2.8×10^7	3.0×10^7
Gain (1-D)	69	62	58
ITF (1-D)	2.5	3.5	4.2
$IFAR_{2/3}$	14	17	20

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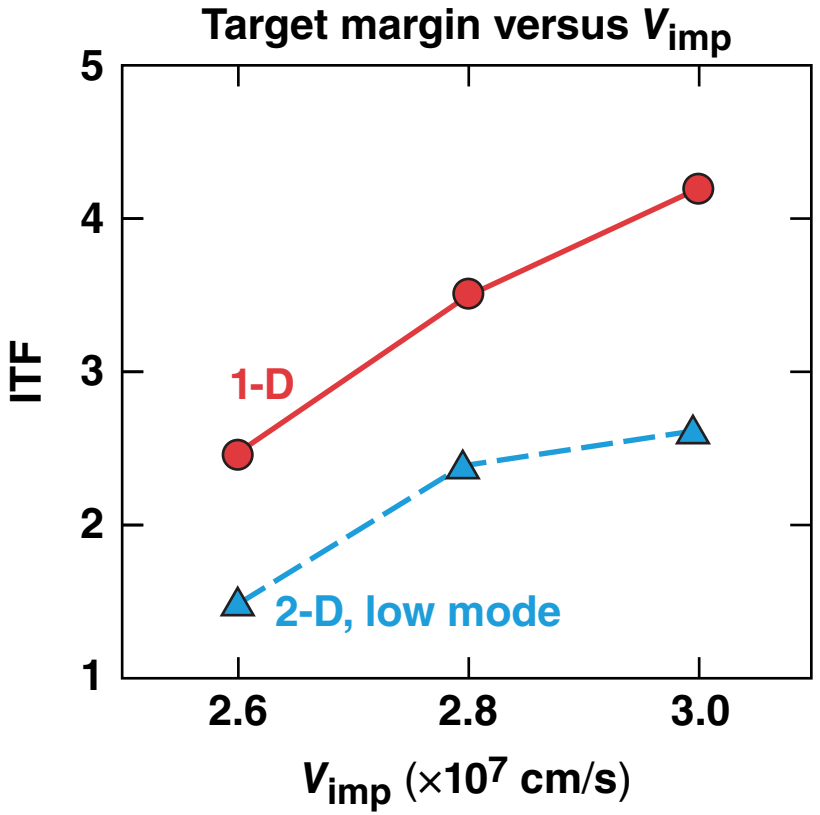
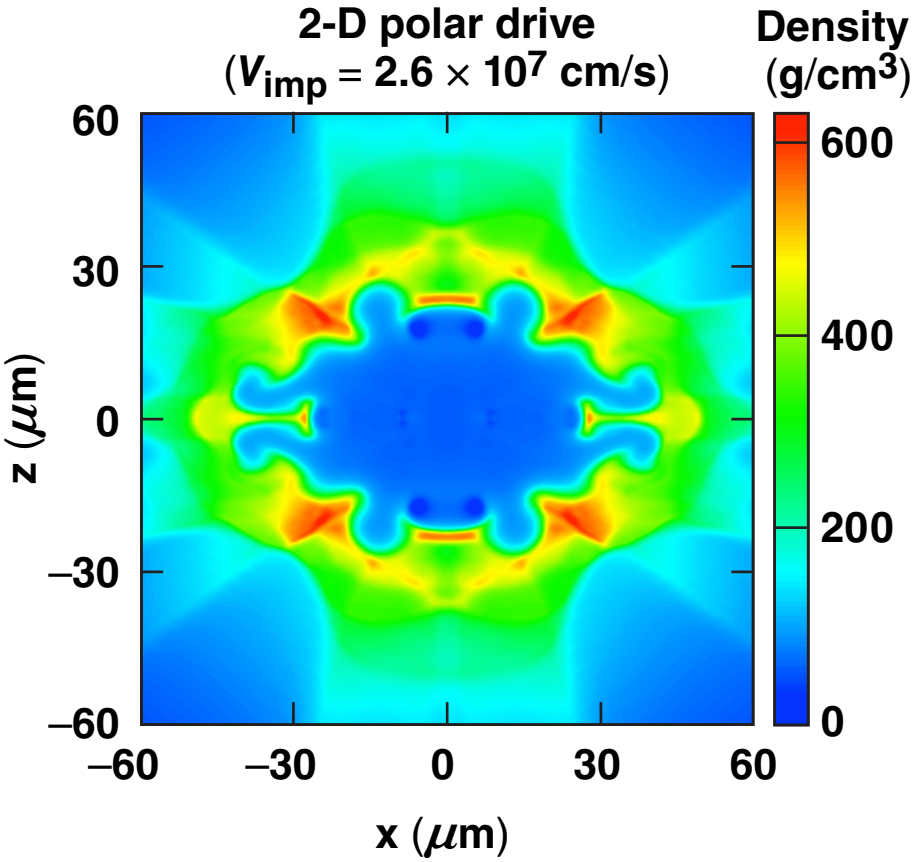
The margin in 2-D polar-drive simulations increases at higher implosion velocities





Polar-drive designs optimized using *TELIOS** simplex optimizer

*T. J. B. Collins, *et al.* Phys. Plasmas 19, 056308 (2012).

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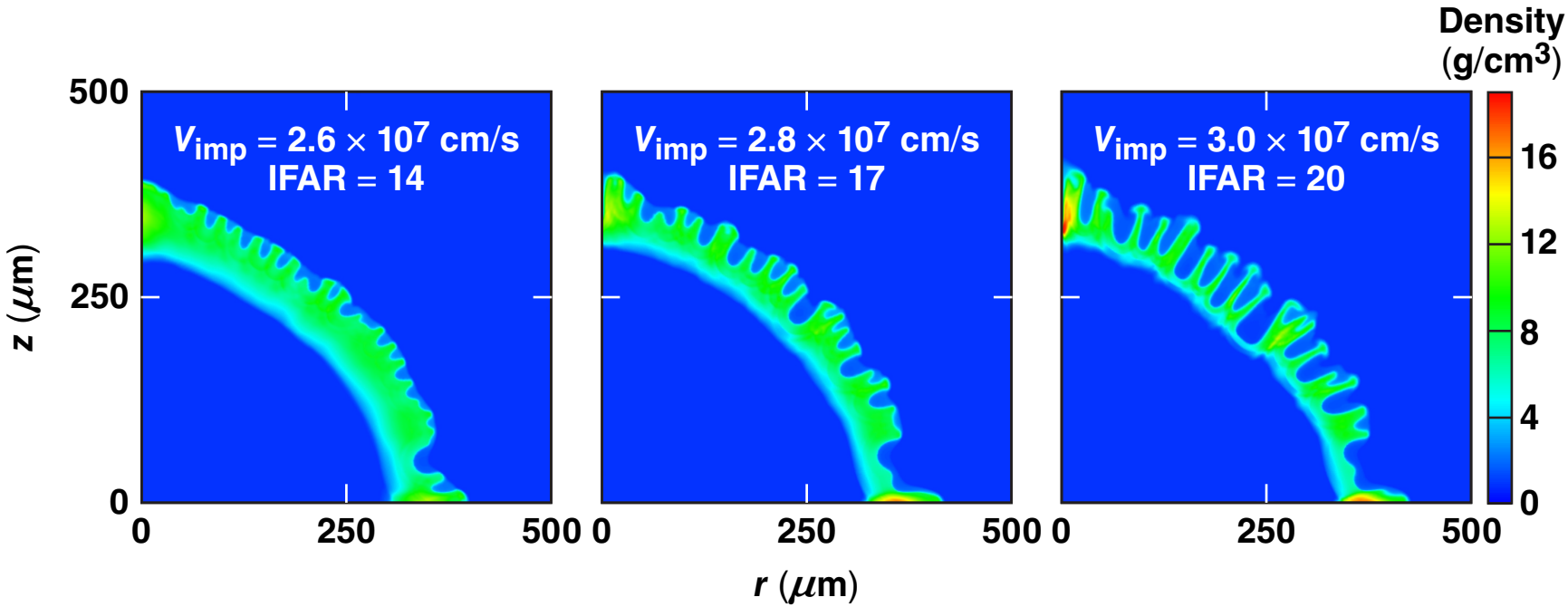
Low-velocity, low-IFAR targets show less susceptibility to imprint



ITF analysis with laser imprint is in progress.

TC11533

Summary/Conclusions

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