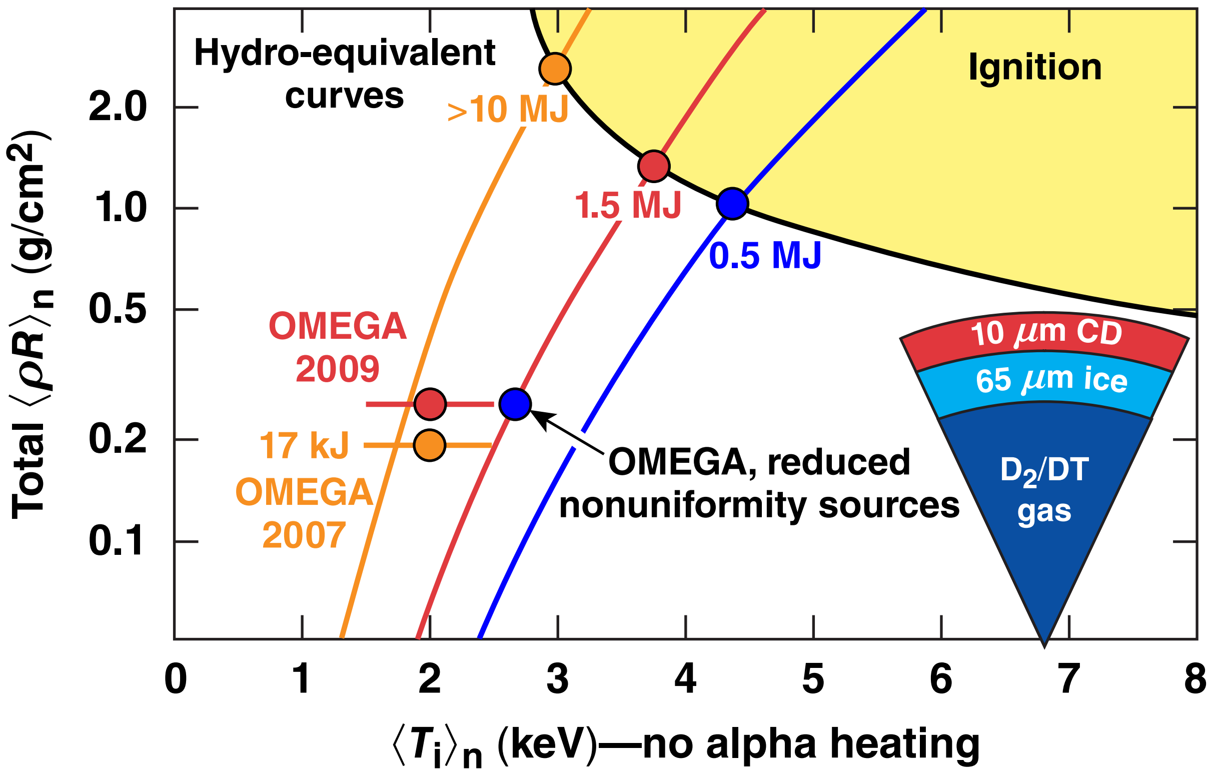
Improving Uniformity in Cryogenic-DT Implosions on OMEGA



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Summary

A number of efforts are underway at LLE to improve the target and drive uniformity for cryogenic-DT implosions

- Gas-filled CH-shell implosions confirm the shell stability of the cryogenic-DT design[1]
- Multidimensional simulations and modeling confirm current performance and set the requirements for higher-yield performance with cryogenic DT[2]
- To meet the requirements for higher yield performance, LLE is
  – testing a new moving cryostat to improve alignment stability and TCC offset minimization at t_0
  – implementing enhanced layering to improve the quality of the stalk-mounted DT target layer
  – eliminating capsule surface debris
  – phase locking SSD to the laser driver to ensure reproducible picket pulse shapes
  – converting to 0.3-THz, three-color-cycle, 2-D SSD to minimize beam mispointing

[1]P. B. Radha (TO5.00003).
[2]V. N. Goncharov (QI3.00001).

Collaborators

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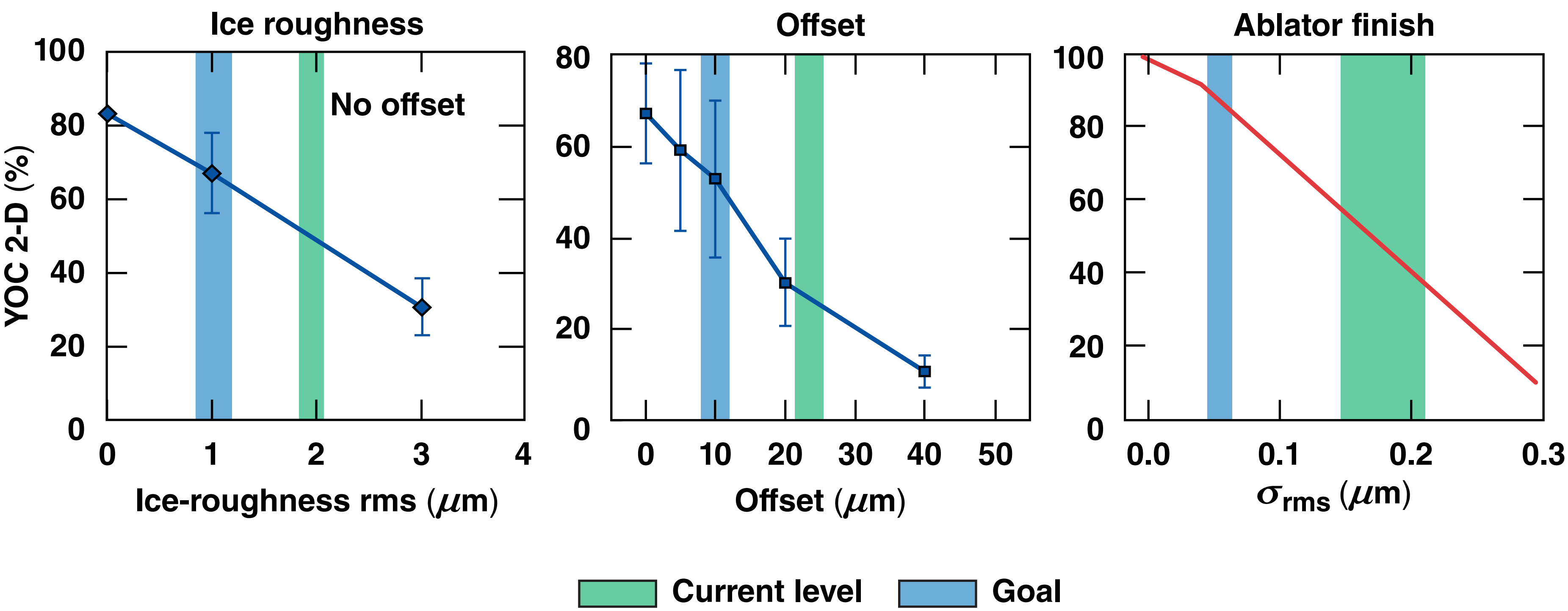
2-D *DRACO* simulations[1] show yield reduction for various perturbation sources



Current levels of nonuniformity account for much of the performance degradation in cryogenic-DT implosions.

V. N. Goncharov (QI3.00001).

[1]S. X. Hu *et al.*, Phys. Plasmas 17, 102706 (2010).

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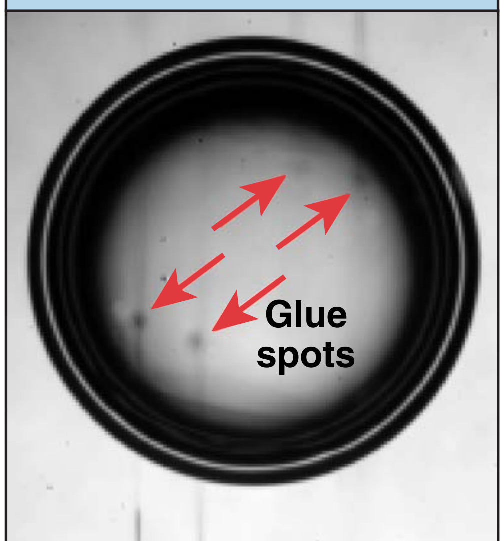
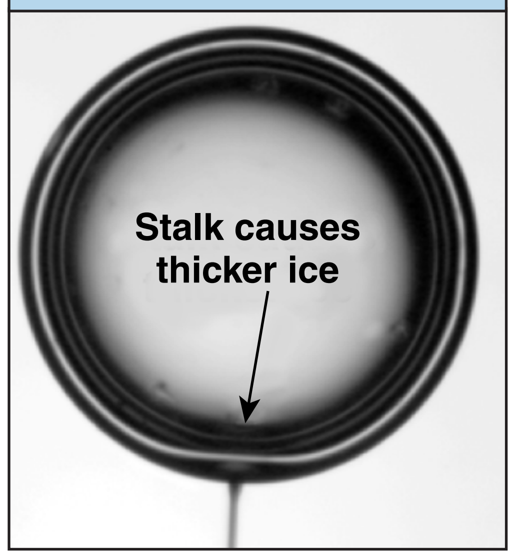
LLE developed a stalk-mounted target to improve alignment stability and reduce surface perturbations

- The fundamental vibration frequency (700 Hz) of a stalk-mounted target is higher than that of a silk-mounted target (200 Hz)
- The single glue spot for a 12-μm stalk is comparable in mass/scale to a single glue spot (4× total) for web-mounted targets
- Eliminates silk shadowing imprint on capsule surface
- However, the ice is significantly thicker above the stalk-thermal short

0.8-μm rms	2- to 3-μm rms





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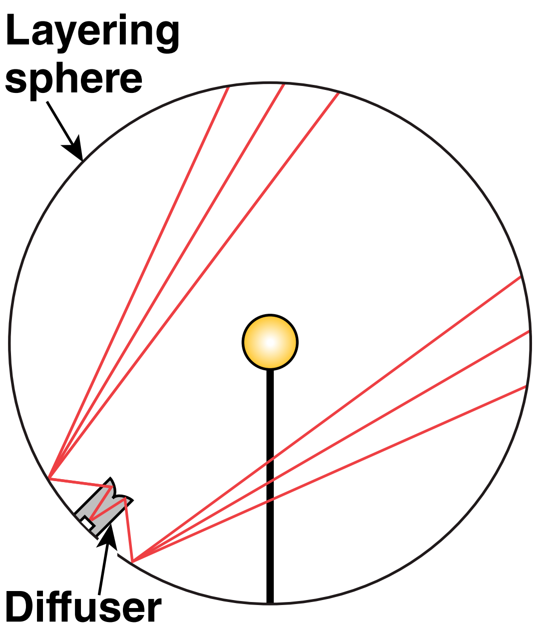
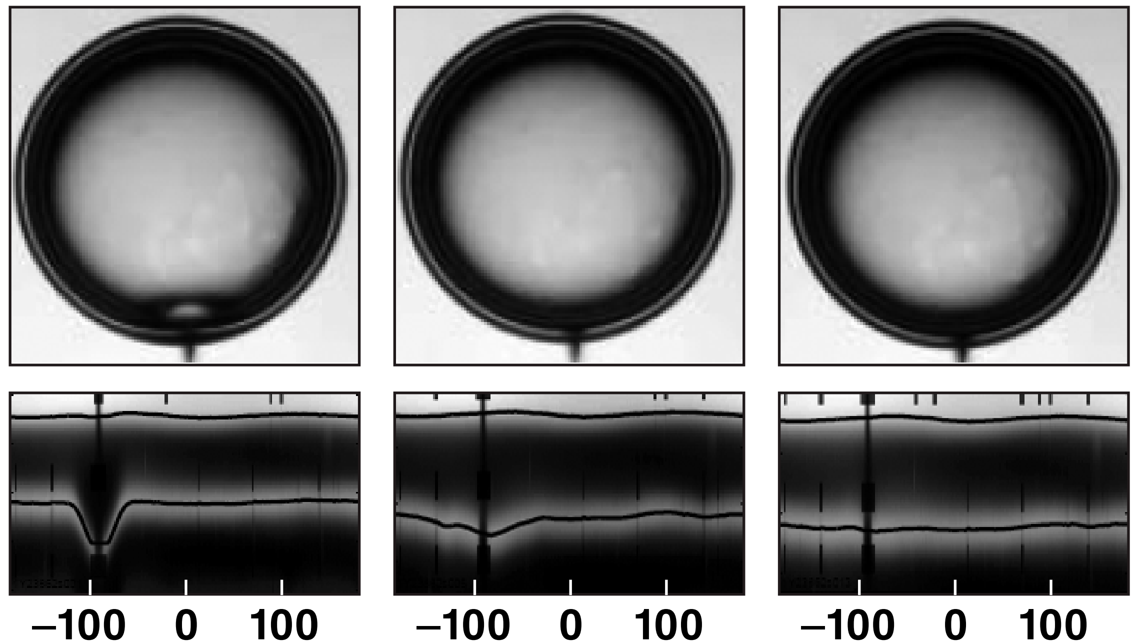
Auxillary heating of the stalk (either direct joule heating or external IR illumination) restores the DT-layer quality





No OPO light	50 mW OPO	50 mW OPO
$t_0 = 0$;	$t_0 + 20$ min;	$t_0 + 60$ min;
2.2 μm	1.3 μm	0.5 μm

Auxilliary heating (direct heating of the stalk) is being incorporated into the DT target insertion cryostats.

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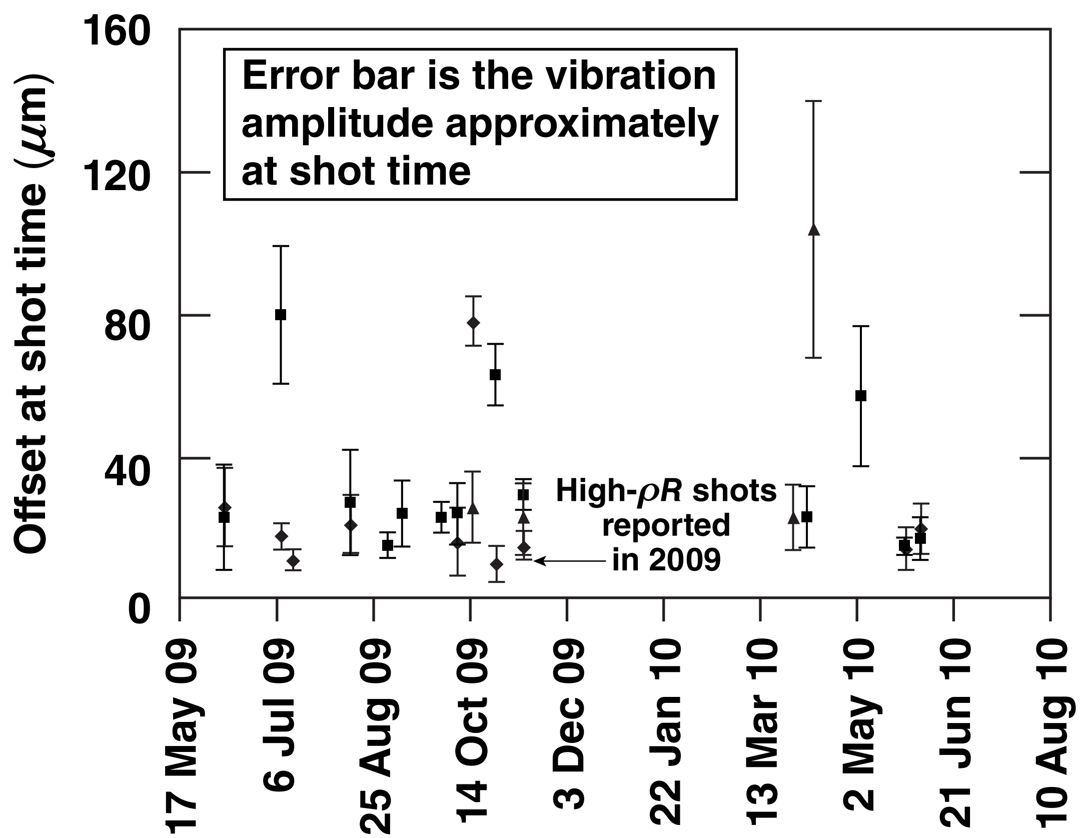
High-speed video shows that targets do not vibrate away from TCC either misaligned or shift when the shroud is removed



A new moving cryostat and transfer cart have been developed with mechanical stability requirements for routine target alignment to within ~10 μm; expect qualification before January 1.

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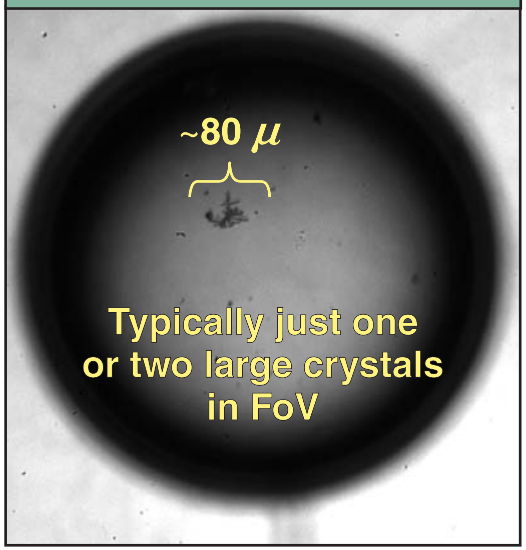
Reducing surface particulate and condensibles has been a challenge

- Morphology of the surface features is consistent with particulates and crystalline condensables on the outer and inner surfaces, respectively, of the CD shell
- Analysis of 31 DT targets from 10 independent fill cycles suggests the defect density varies significantly, but has generally increased with time since 2009
- The defect distribution and type can vary from capsule to capsule within a fill
- Scale of the defects ranges up to 80 μm; the thickness of the features is a 1 μm or more (opaque at mid-IR wavelengths)

The surface defects can be clearly seen if the characterization station optics are center focused

Crystalline structures suggest frozen gas



Small opaque features suggest particulates

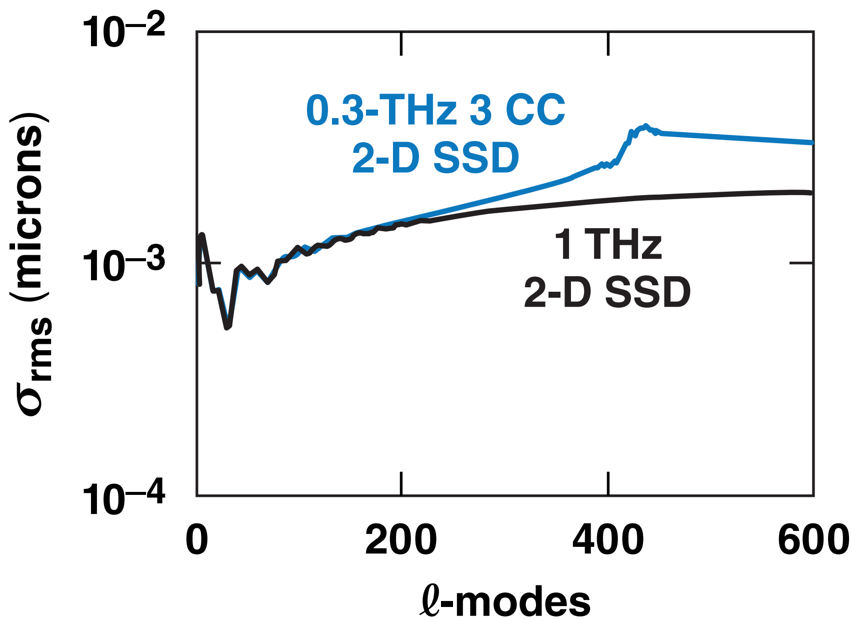
Some of the particulate defects can be seen on the limb of the target, suggesting the thickness can be many microns.

Picket shape and laser spot-size variations caused by asynchronous SSD operation may also contribute to yield under performance

UR LLE

- OMEGA was recently converted to 0.3-THz, three-color-cycle, 2-D SSD smoothing
- The picket pointing error is predicted to drop from ±30 μm to ±5 μm in one of the SSD dimensions
- Phase locking the SSD modulators to the laser front end guarantees identical picket shapes for all shots
- The reduced bandwidth of 0.3-THz, three-color-cycle, 2-D SSD leads to more-efficient frequency conversion and more energy available on target

The bandwidth-color-cycle product produces equivalent 1-THz 2-D SSD smoothing for ℓ-modes <200



Simulations show that ℓ modes > 200 decouple quickly so the benefit of the 1-THz 2-D SSD should be minimal

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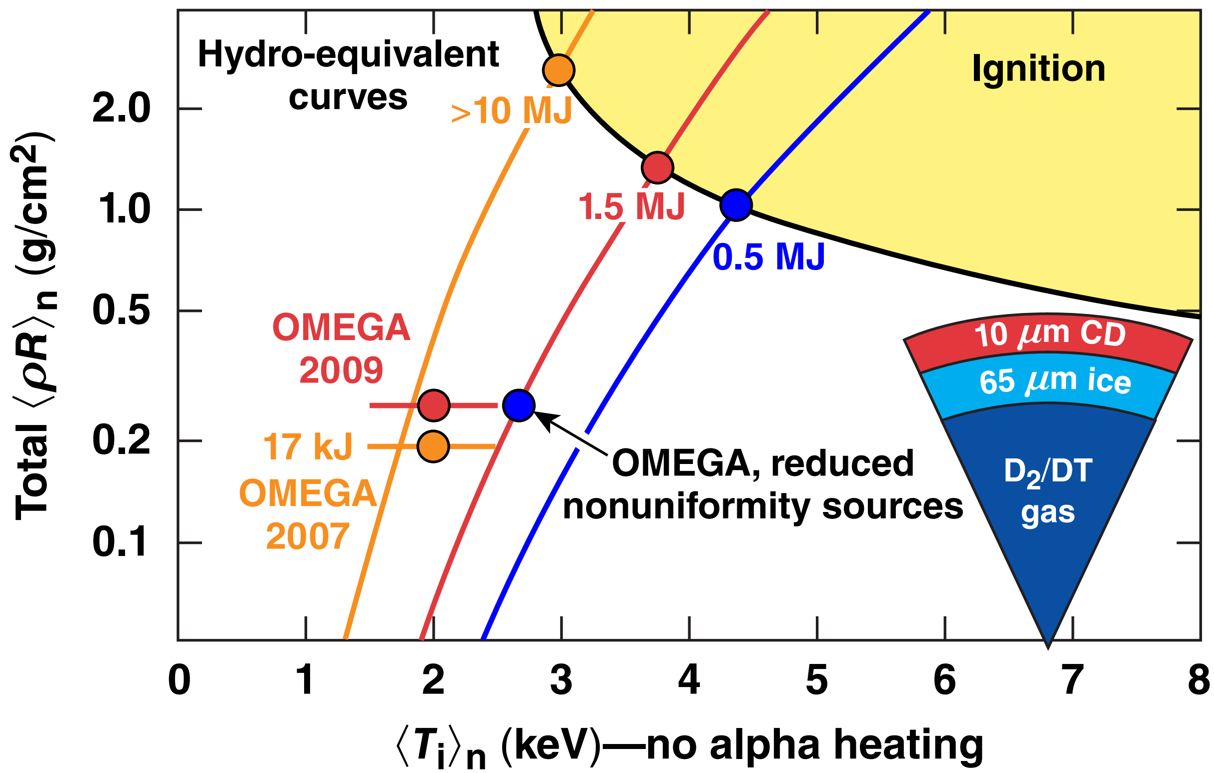
The goal is to increase the size of the hot spot (reduce mix) and make it hotter



On Wednesday, V. N. Goncharov (QI3.00001) will show the current OMEGA theoretical hydrodynamic scaling for ρR, $\langle T_i \rangle_n$, and Y_n (used to calculate the ignition threshold factor).

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Summary/Conclusions

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