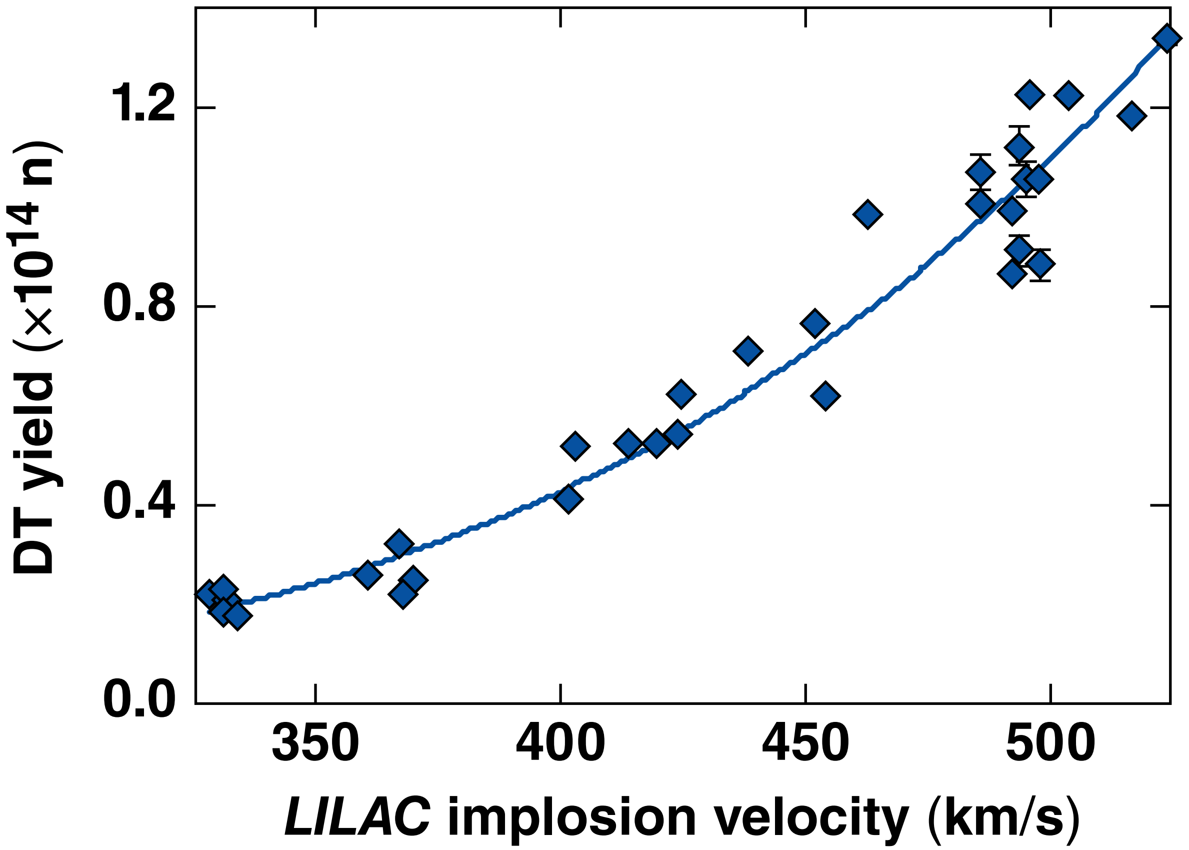
Experimental Results from the High-Adiabat Cryogenic Implosion Campaign on OMEGA



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Summary

High-adiabat implosions have proven to be a valuable technique to extend the performance of cryogenic target experiments

- Implosion velocities >500 km/s are achieved by lowering target mass and improving coupling
  - 330 km/s < implosions velocity < 520 km/s
- High-adiabat implosions show 1-D–like trends
  - ion temperature shows the expected 1-D scaling with implosion velocity
- The highest neutron yield achieved was 1.34×10^{14}

E26752

Collaborators

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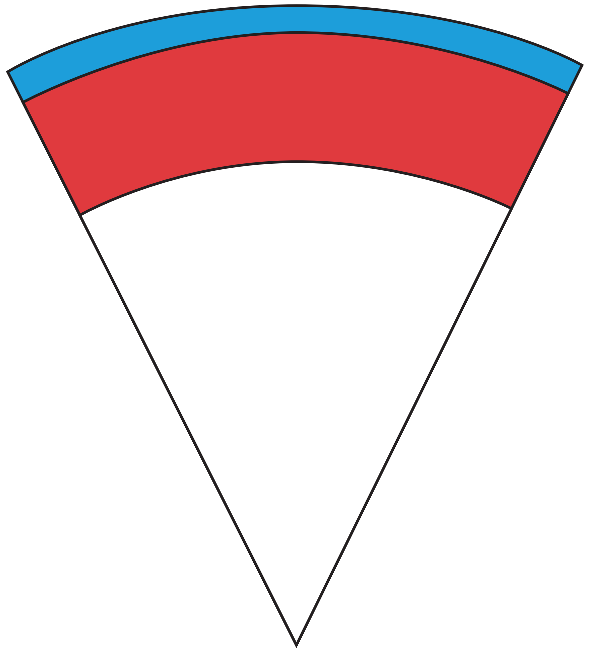
*R. Betti, TI2.00001, this conference (invited).
**V. Gopalaswamy *et al.*, CO8.00010, this conference.

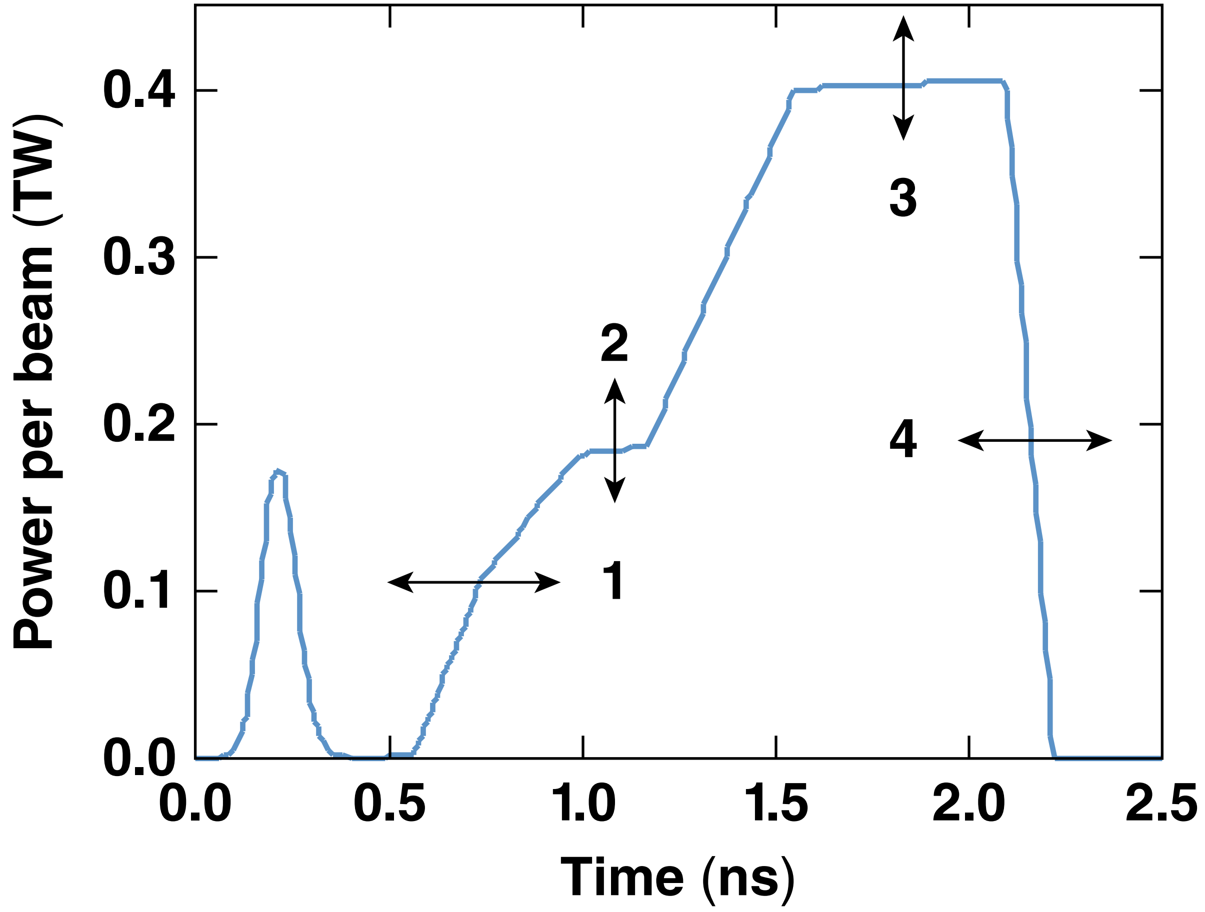
The target outer diameter and mass were varied to change the implosion velocity



- Target outer diameters (laser coupling*)
  - 860-μm minimum to 980-μm maximum
- Shells
  - CH: 8 μm thick
  - CD: 7.5 μm thick
- Cryogenic layer thickness
  - 53-μm maximum to 40.2-μm minimum
- 330 km/s < implosion velocity < 520 km/s

*S. P. Regan *et al.* Phys. Rev. Lett. 117, 025001 (2016); 117, 059903(E) (2016).

Single-picket laser pulse shapes were adjusted to match target parameters and study preheat



Picket height and width

Fixed pulse-shape adjustments

1. Timing of the drive relative to picket
   - set adiabat through shock timing
2. Height of the drive step
   - fine-tuned shock structure
3. Drive intensity
   - study preheat caused by "hot" electrons
4. Drive duration
   - tuned total energy of the drive
5. SSD* on/off
   - changed initial imprint seed

*SSD: smoothing by spectral dispersion

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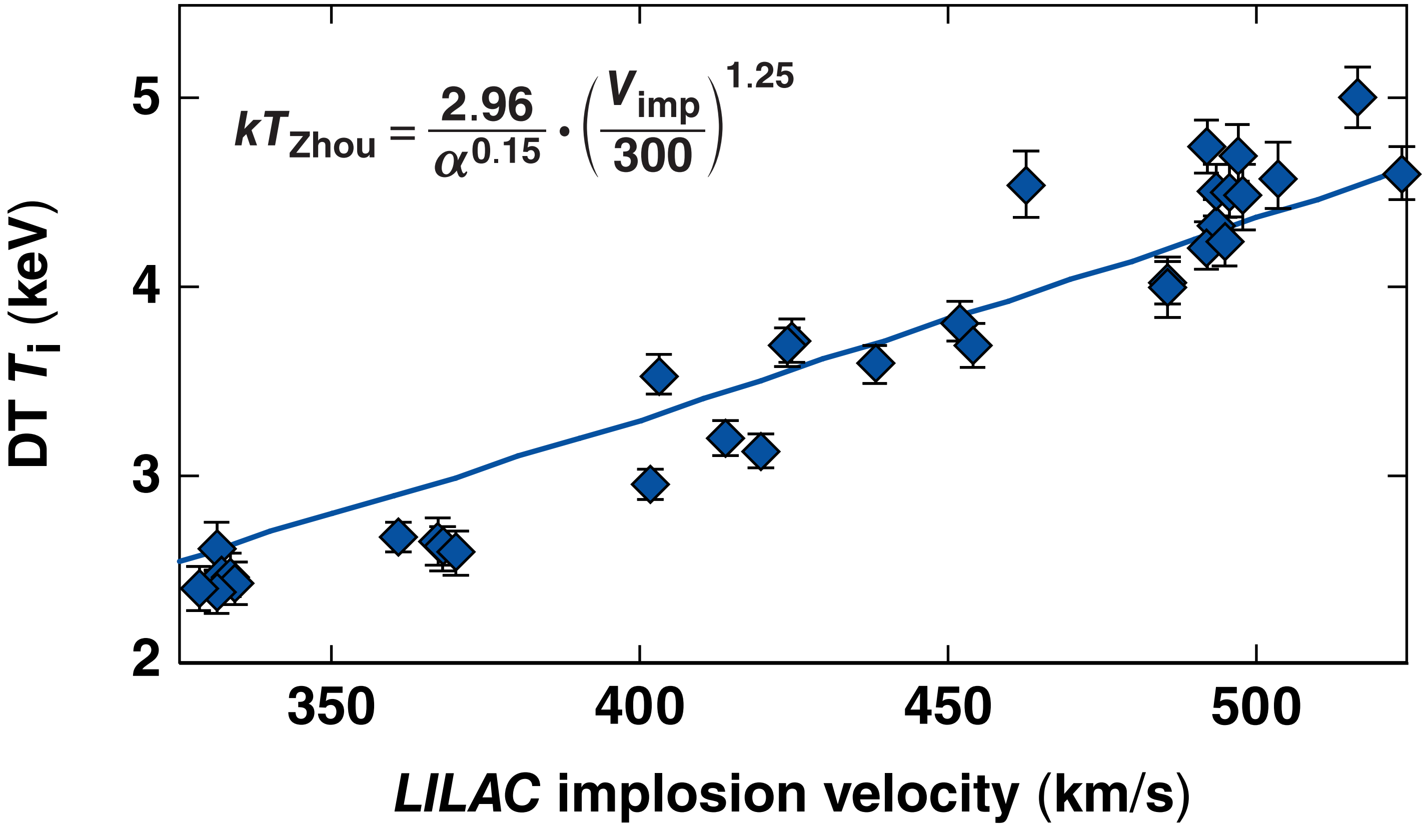
Ion temperature versus implosion velocity is explained by a 1-D scaling formula*



Best fit of Zhou–Betti formula to date

$\alpha = 5.3 \pm 1.0$

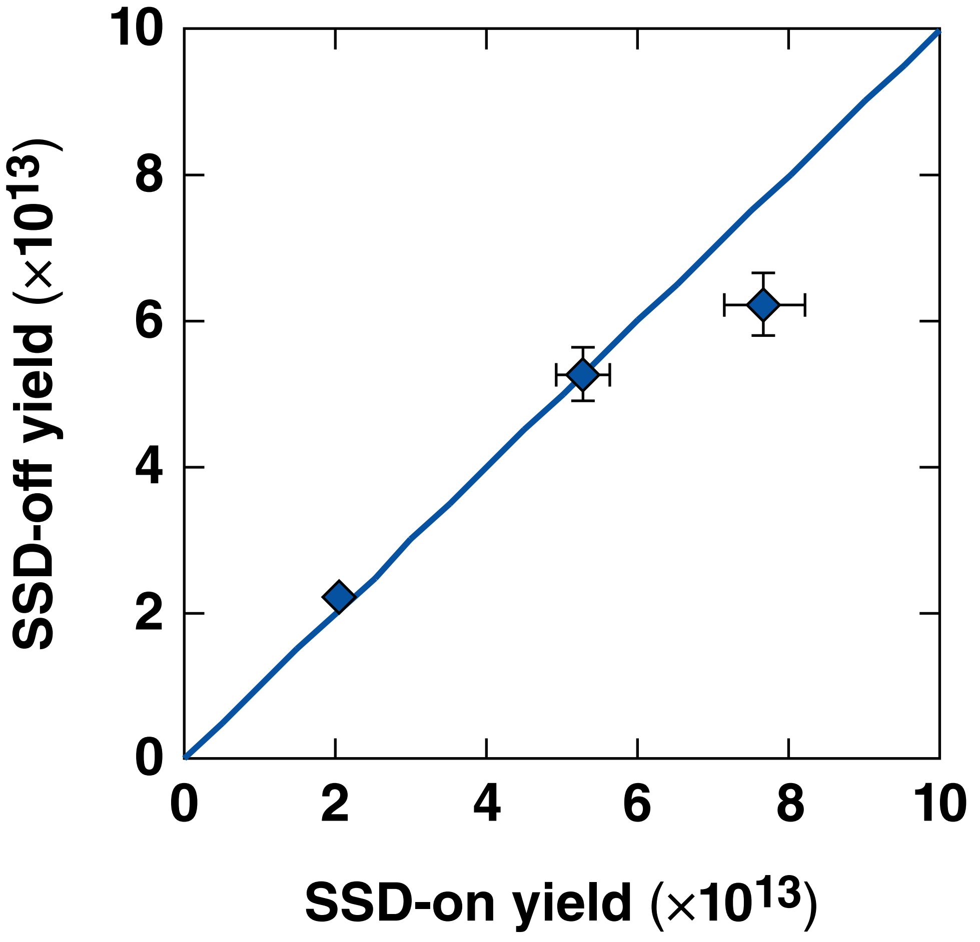
Average from *LILAC* 1-D hydrodynamic simulation

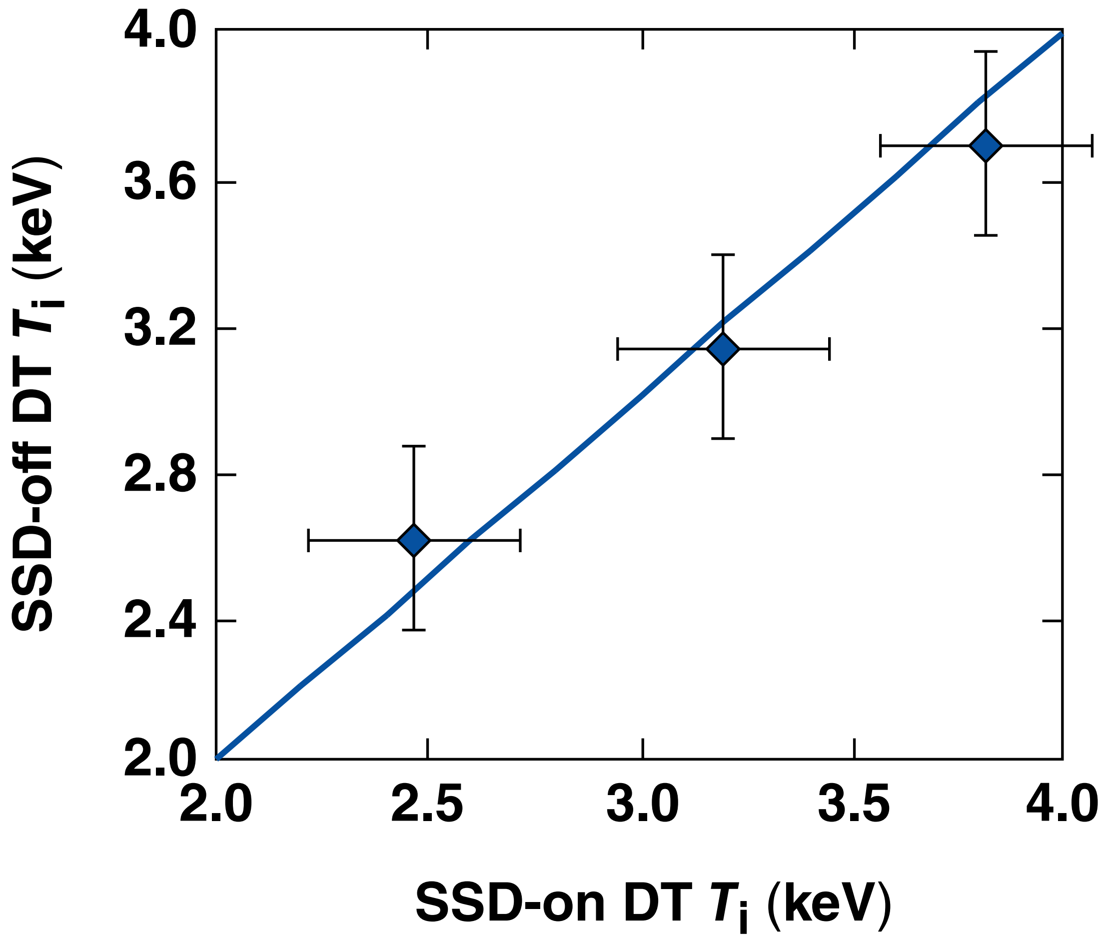
$\alpha = 5.5 \pm 0.9$

Ion temperatures show the expected scaling.

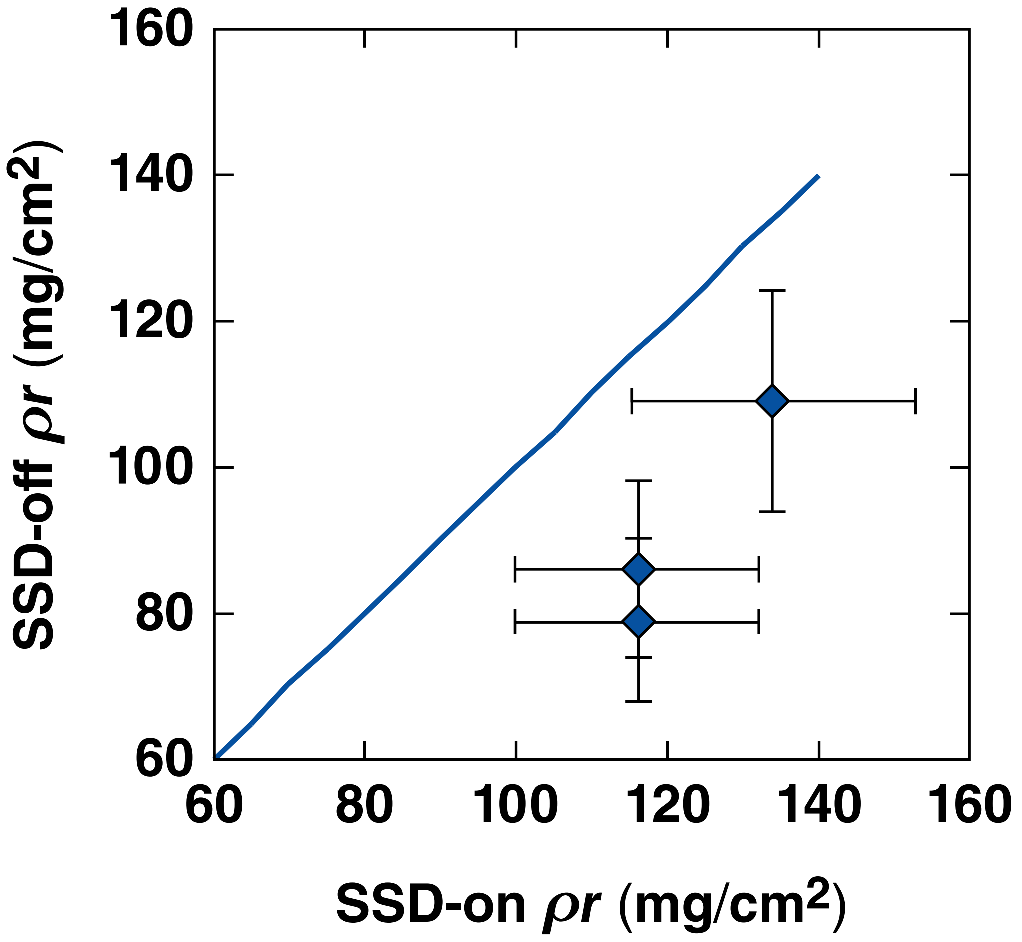
*C. D. Zhou and R. Betti, Phys. Plasmas 14, 072703 (2007).

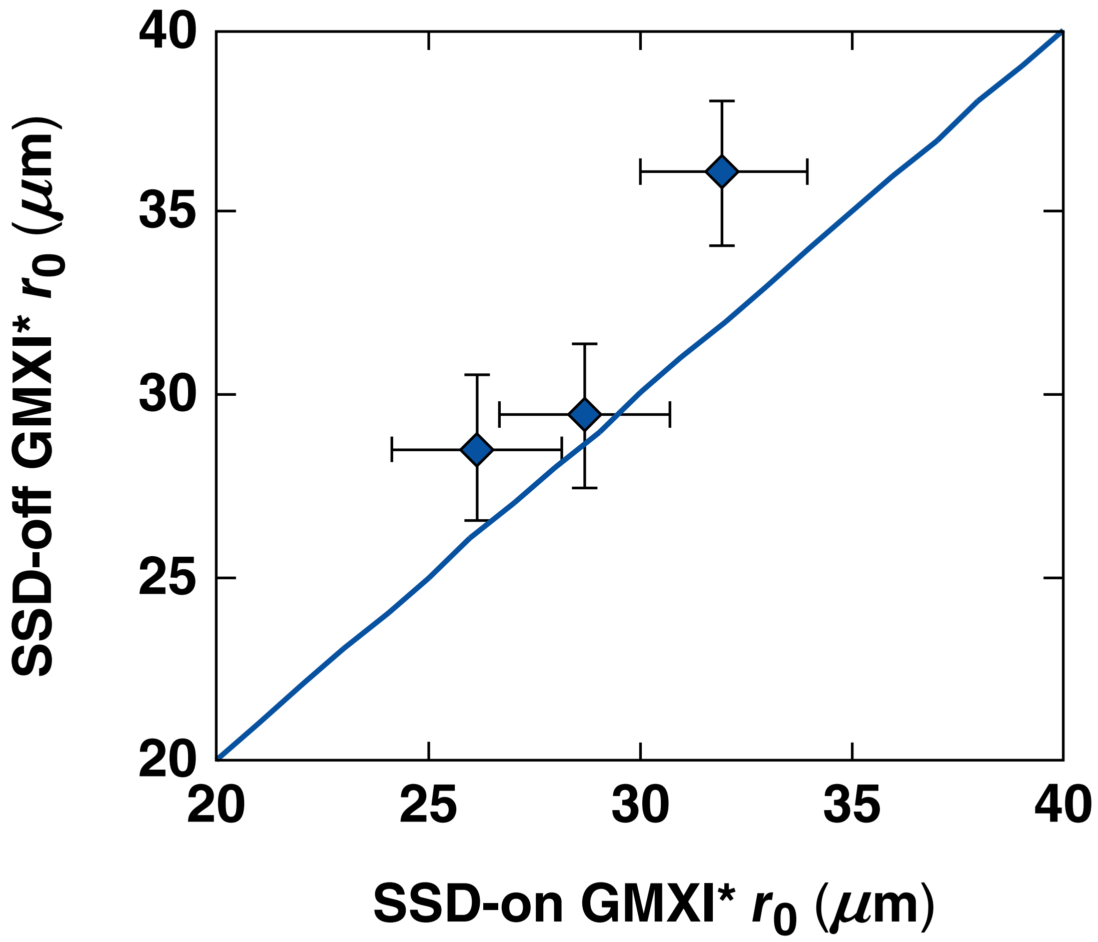
Neither yield nor ion temperature are affected by SSD





The measured areal density decreases when SSD is off

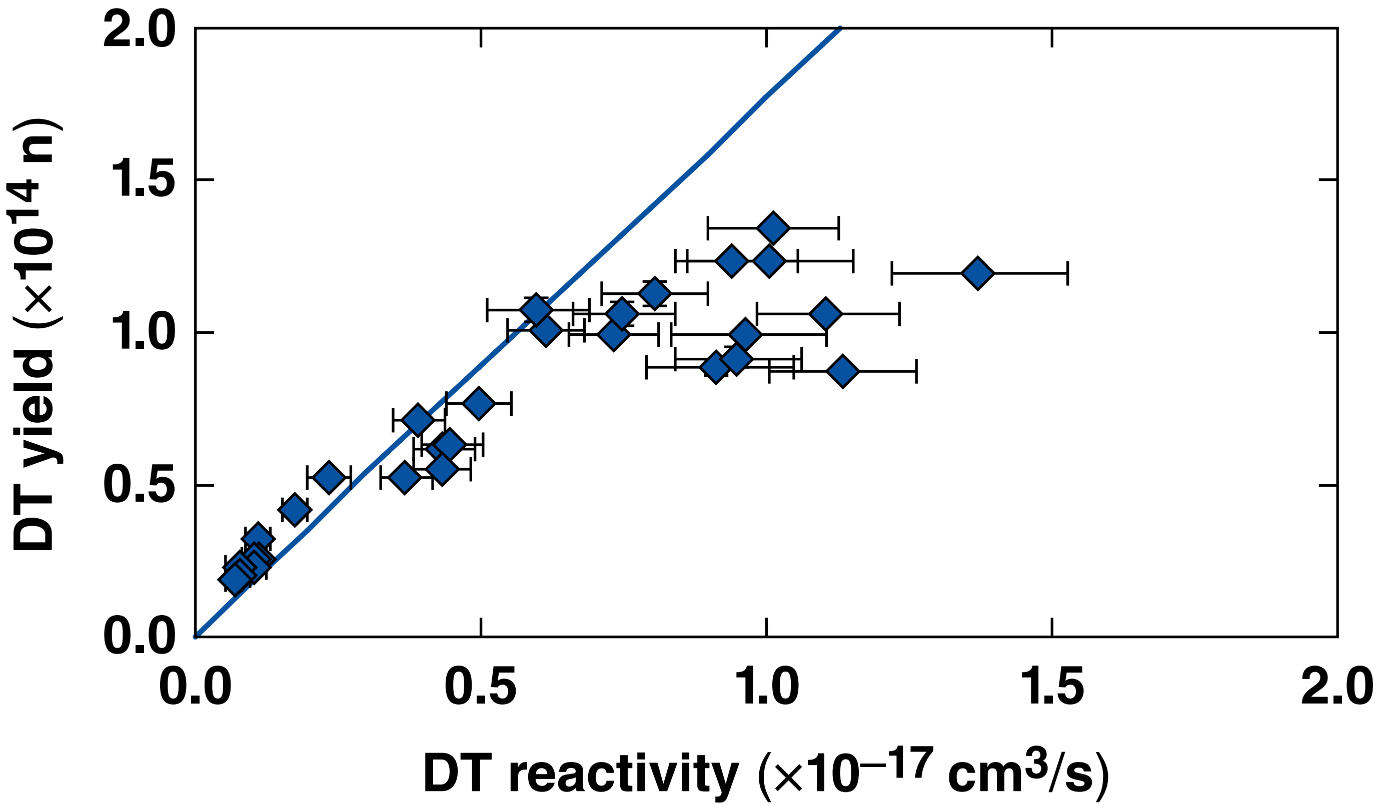




Imprint may compromise the cold fuel layer but not the "hot spot."

*GMXI: gated monochromatic x-ray imager

Yields <10^{14} are correlated with reactivity calculated at the nTOF* ion temperatures



$$Y = f_T \, f_D \, n_{DT}^2 \, \sigma\nu_{DT} \, V_{HS} \, t_b$$

for yield >10^{14}
DT kT_i may not be the thermal temperature

or

$n_{DT}^2 \, V_{HS} \, t_b$ is not constant

*nTOF: neutron time of flight

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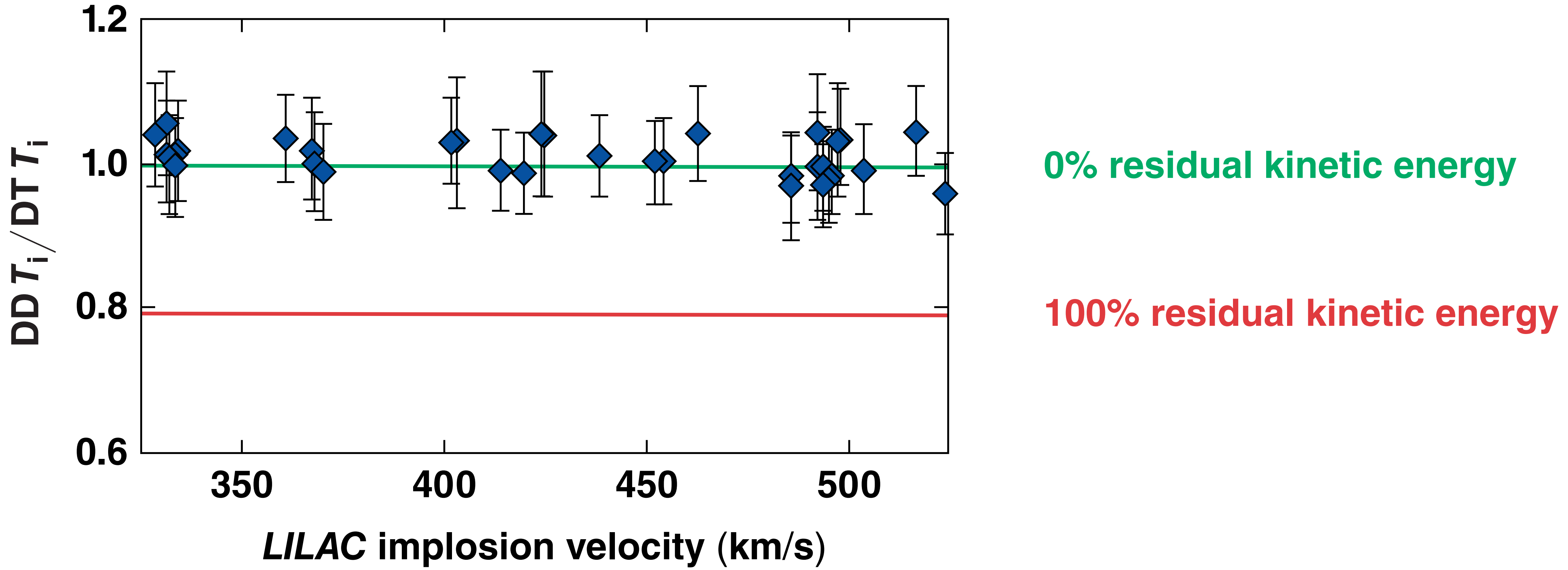
High-adiabat implosions show little residual kinetic energy*



The T_i ratio indicates that the temperature measurement reflects the thermal temperature.

*T. J. Murphy, Phys. Plasmas 21, 072701 (2014).

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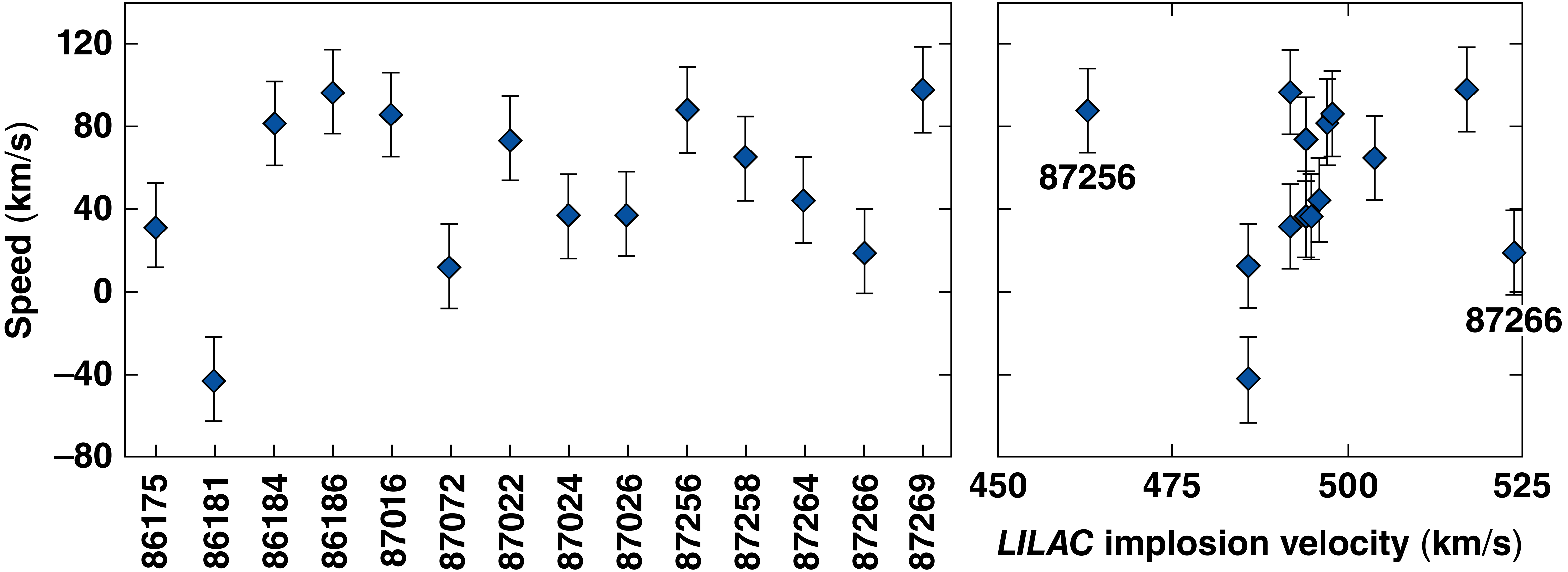
The maximum center-of-mass speed projected along the 13.4-m nTOF line of sight* is 98±21 km/s



Higher implosion velocities show higher speeds except for two outlying shots.

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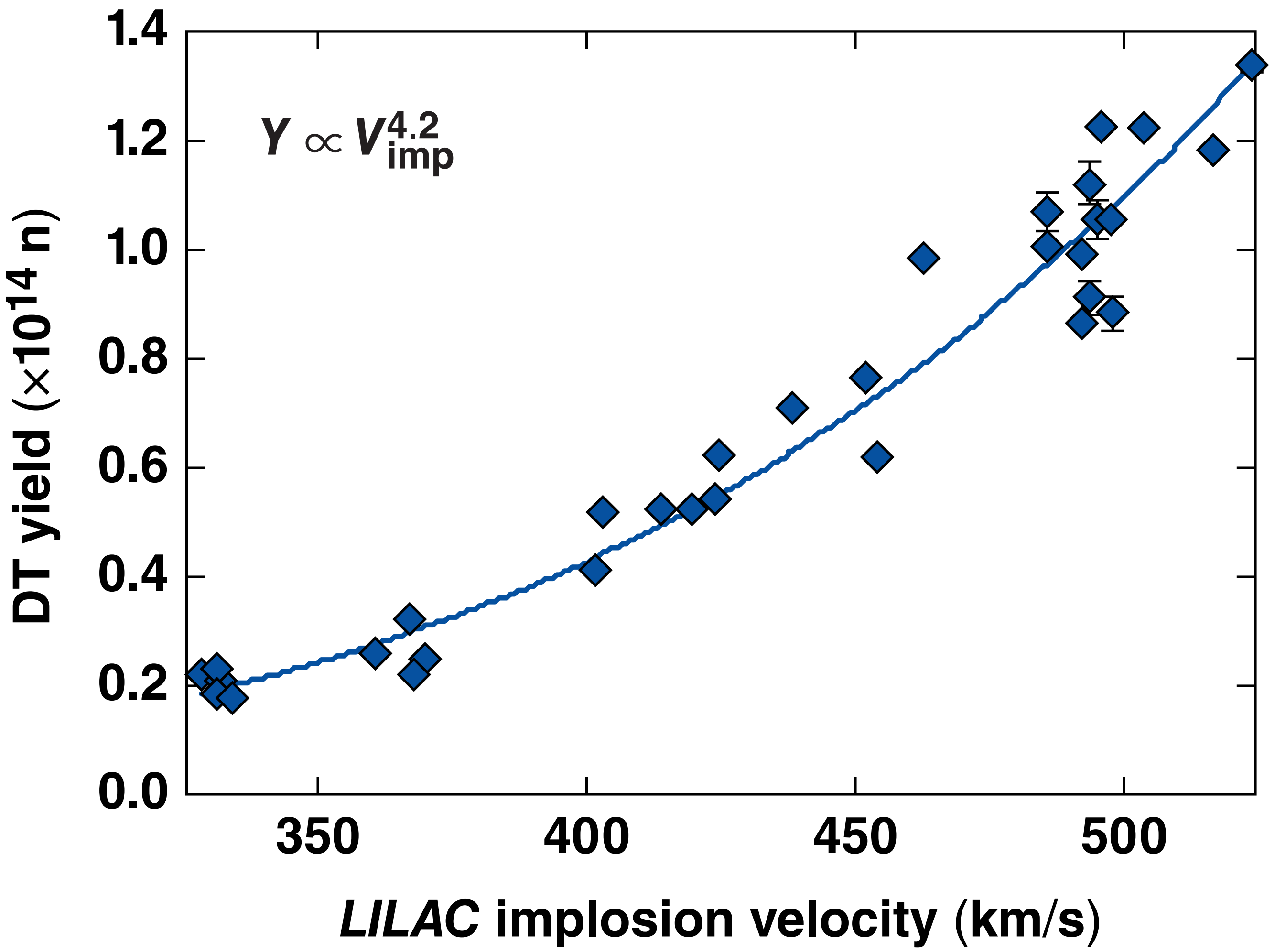
*O. M. Mannion *et al.*, CO8.00003, this conference.

The measured yield scales as the fourth power of the implosion velocity up to 500 km/s



The maximum yield was $1.34 \times 10^{14} \pm 1 \times 10^{12}$ neutrons.

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High-adiabat implosions have proven to be a valuable technique to extend the performance of cryogenic target experiments

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Future experiments will use 1-D model to improve target ρr keeping yield high.