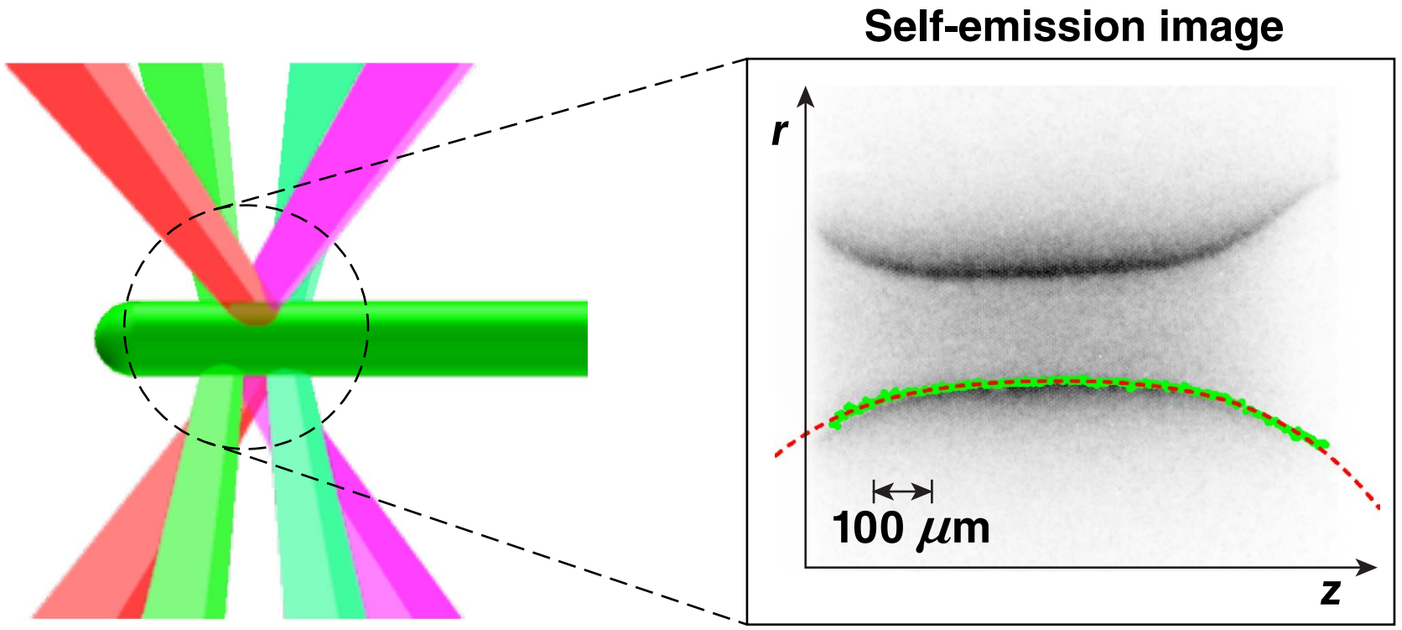
First Results from Laser-Driven MagLIF Experiments on OMEGA: Optimization of Illumination Uniformity



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Summary

Uniform compression was obtained by overlapping oblique beams at the center and driving the ends with normal beams

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- Scaled-down laser-driven magnetized liner inertial fusion (mini-MagLIF) experiments were conducted without a magnetic field and laser preheat
- A uniform compression was achieved by optimizing the illumination of normal (9°) and oblique (31°) beams using self-emission images
- Future experiments will explore enhanced optimization by increasing the separation between normal and oblique beams using higher energy

Collaborators

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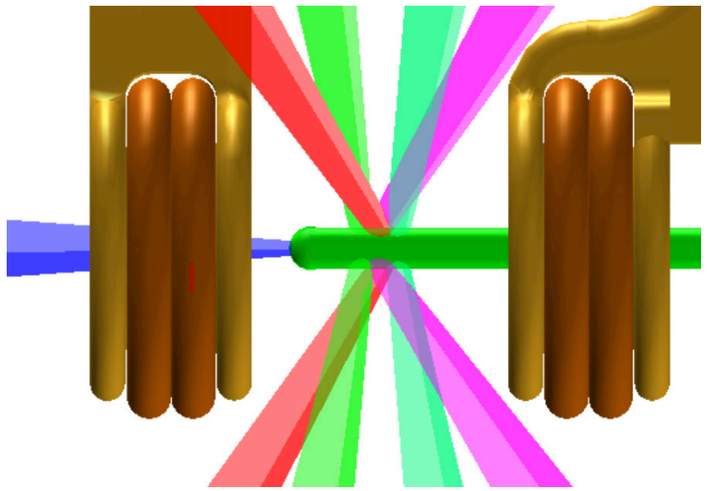
A target 1000× smaller in volume than the Z MagLIF* target is imploded by the OMEGA laser

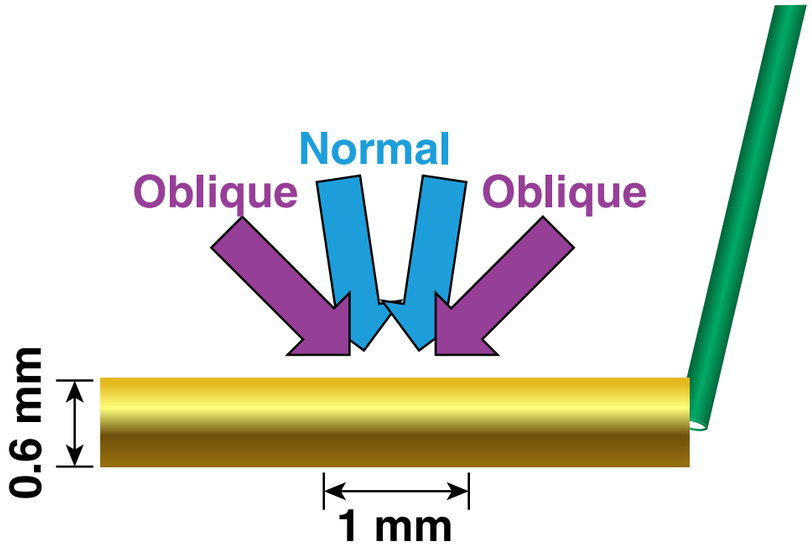


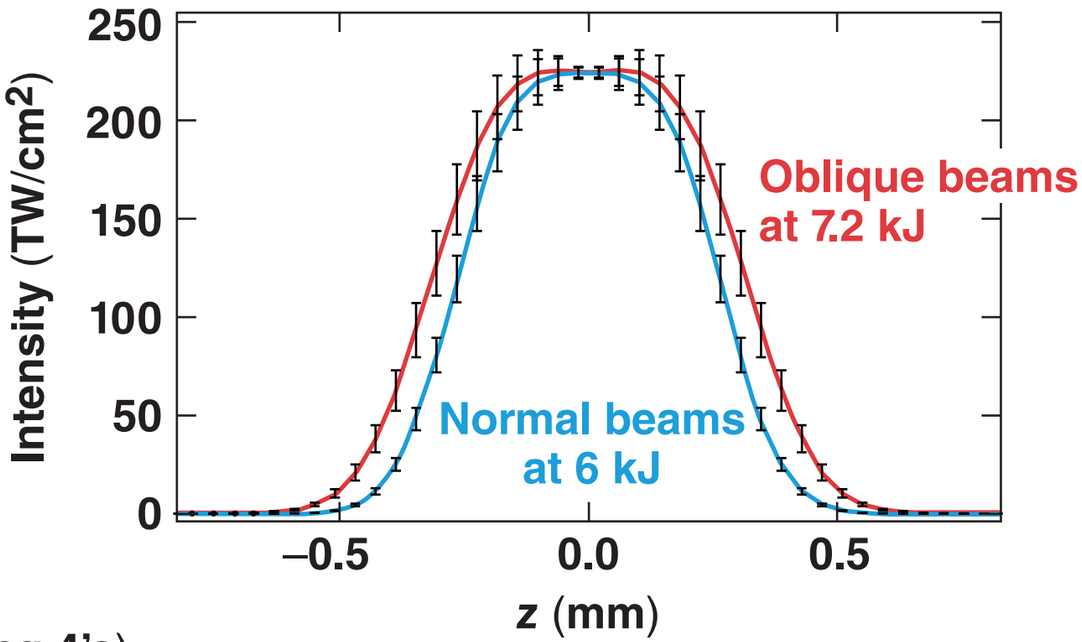
	Mini MagLIF	Z MagLIF**
Outer diameter (μm)	600	5580
Δ (μm)	30, CH	465, Be
L (μm)	700	7500
Gas	1.6 mg/cm^3 D_2	0.7 to 1.5 mg/cm^3 D_2
B_0 (T)	10	10
E_{target}	10 kJ (~0.01 MJ/cm)	1 MJ/cm

*S. A. Slutz *et al.*, Phys. Plasmas 17, 056303 (2010).
**M. R. Gomez *et al.*, Phys. Rev. Lett. 113, 155003 (2014).

TC12528

Energy-coupling efficiency was tested by imploding a hollow target using only normal or oblique beams





- Normal beams: 9° (Ring 4's)
- Oblique beams: 31° (Ring 3's)
- 2.5-ns square pulse was used
- The energy in normal beams was lowered to keep the same incident intensity on the target's outer surface

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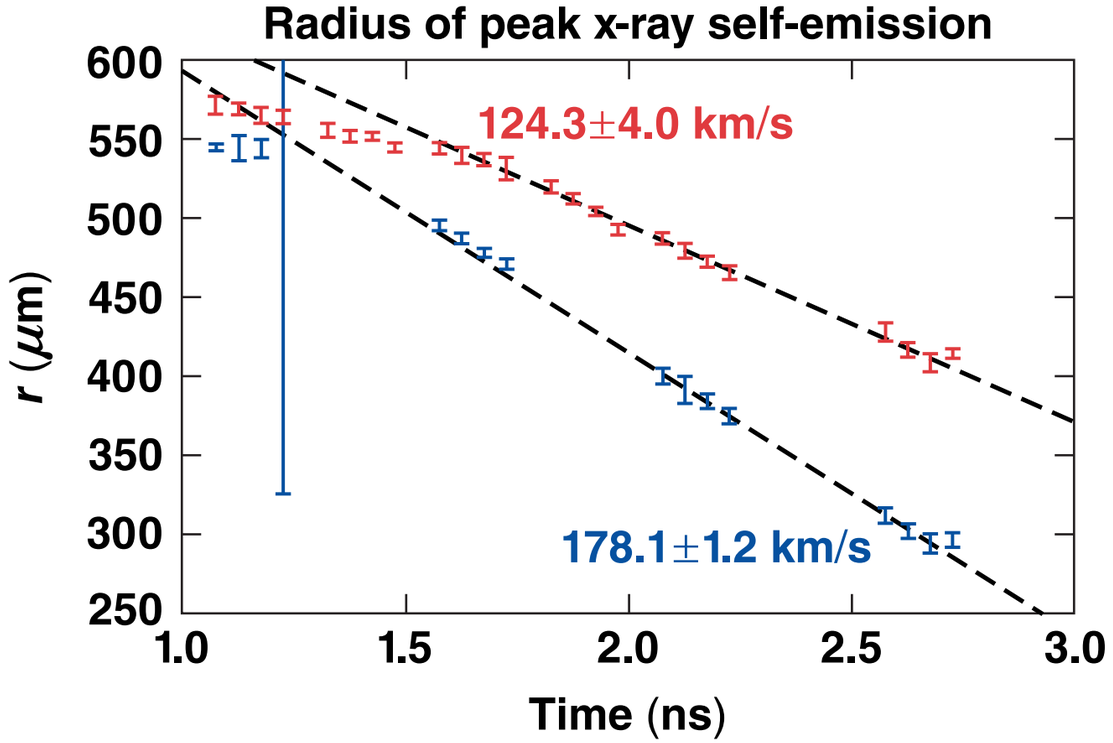
A 40% higher implosion velocity was inferred from normal-beam illumination relative to the oblique beams



- Simulations using *LILAC* and *Spect3D* give: $E_L \propto V_{imp}^{1.7}$
- A reduction of ~50% in normal-beam illumination is required to match the implosion velocity from oblique-beam illumination

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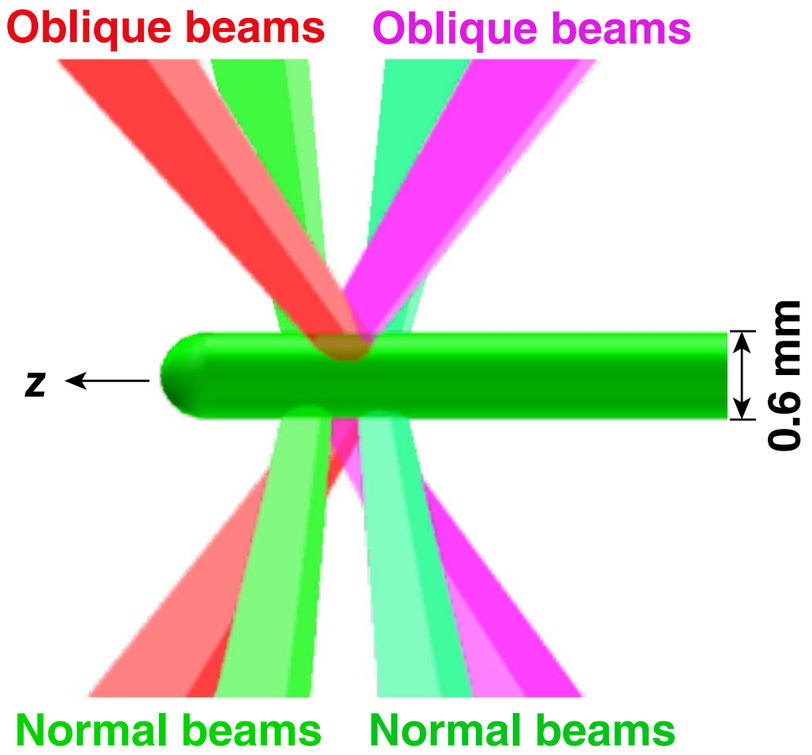
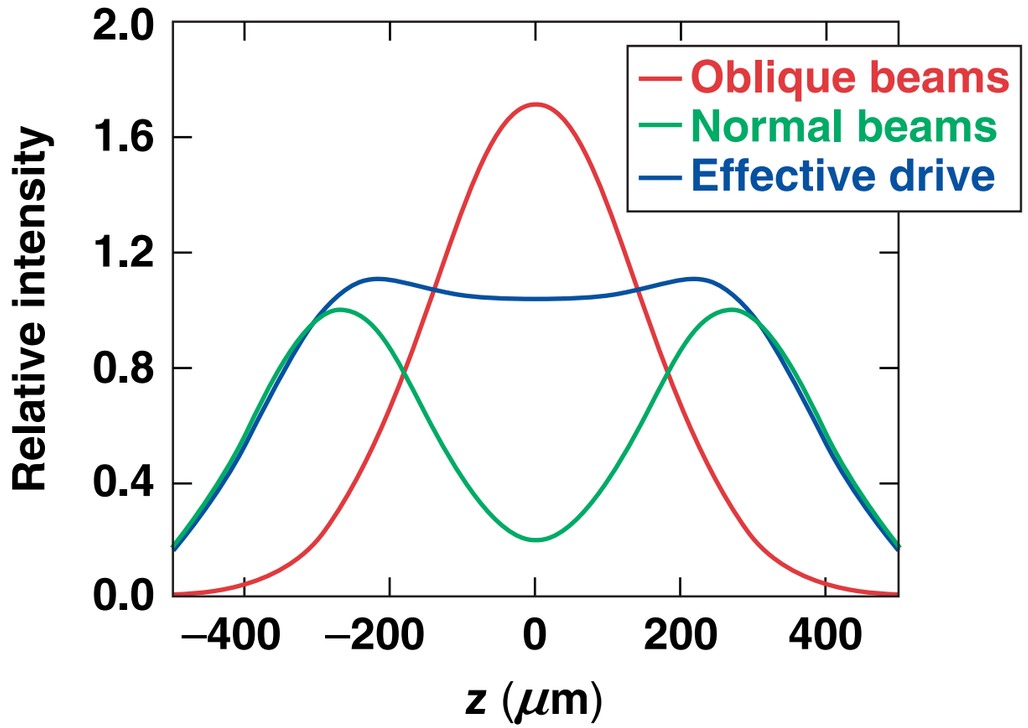
Effective drive energy comes from a weighted combination of the normal- and oblique-beam energy





$$E_{\text{drive}} = 0.5\,E_{\text{oblique}} + E_{\text{normal}}$$

TC12531

X-ray self-emission is used to infer implosion uniformity

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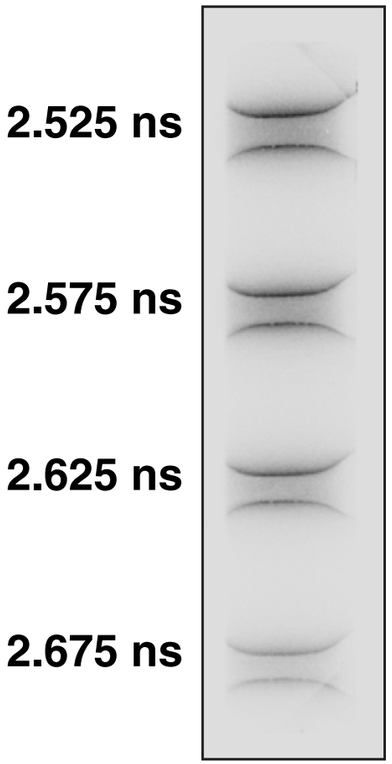
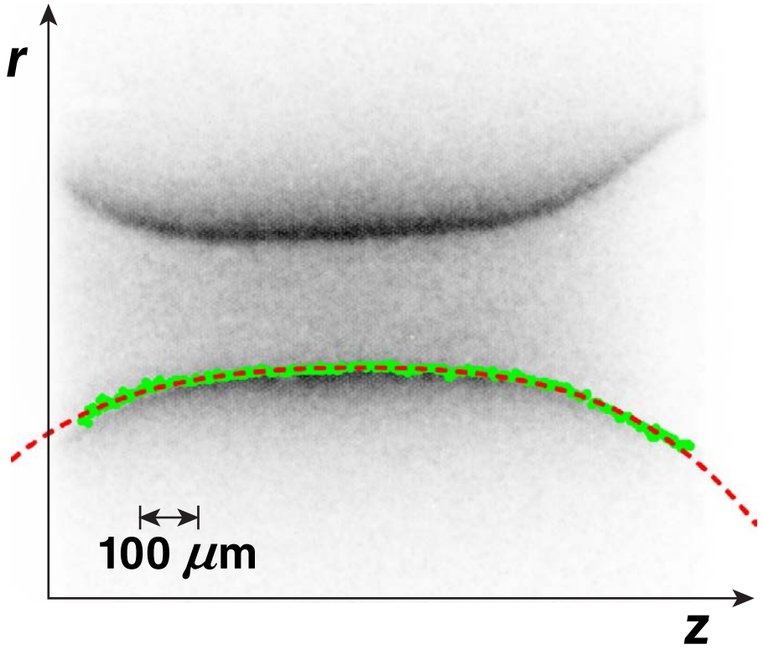
X-ray framing camera (XRFC) images from self-emission





Fitting function

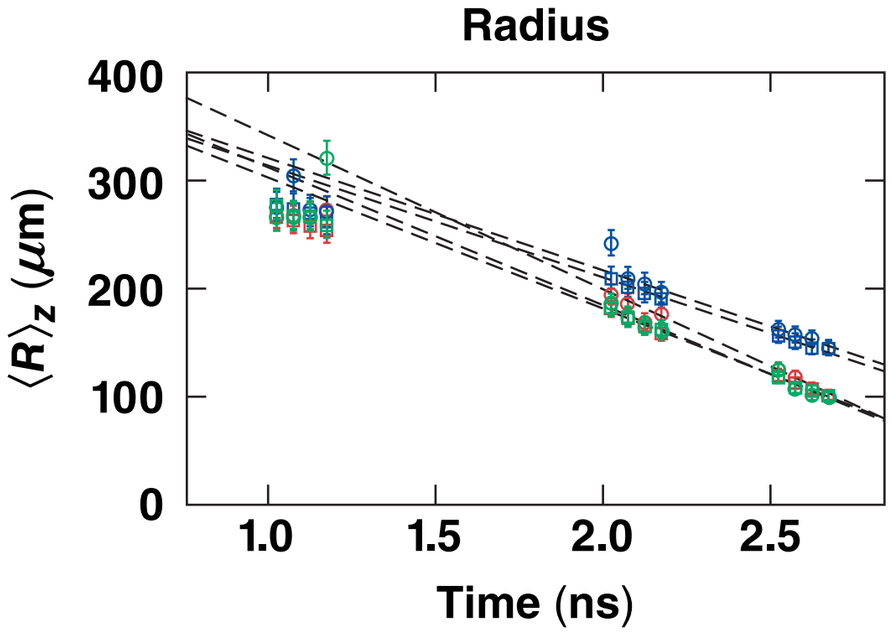
$$R(z) = a + b\,(z - z_0)^2 + c(z - z_0)^4$$

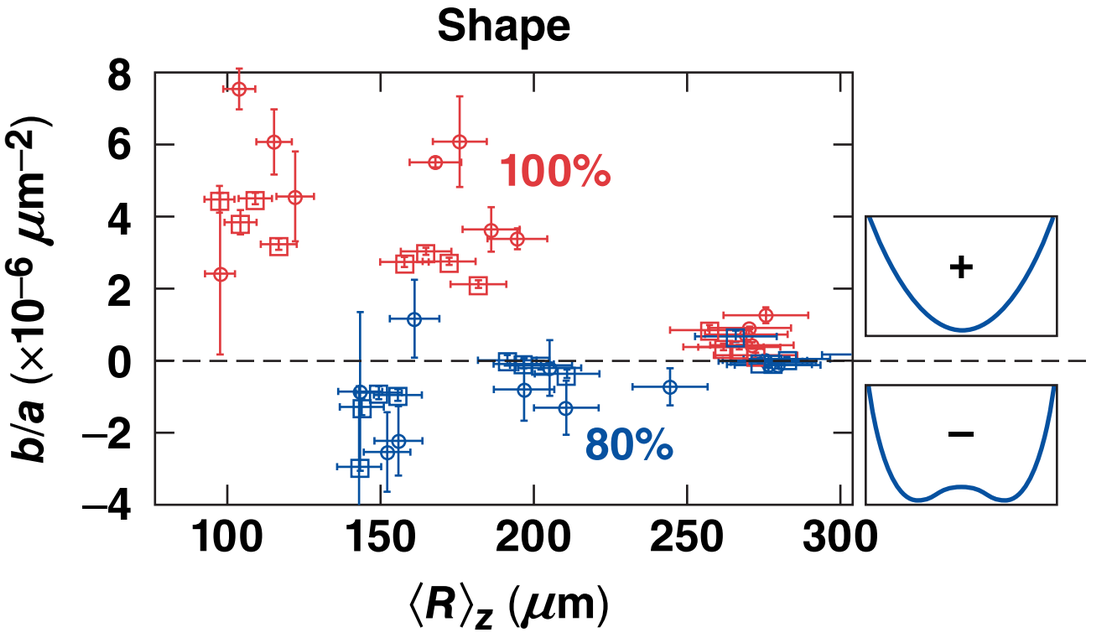
$$\langle R \rangle_z = \frac{1}{\text{length}} \int R(z)\,dz$$

- **The length is defined as the region where the root-mean-square variation in the radius is less than 5%**

TC12532

Implosion uniformity is optimized by reducing energy in the oblique beams



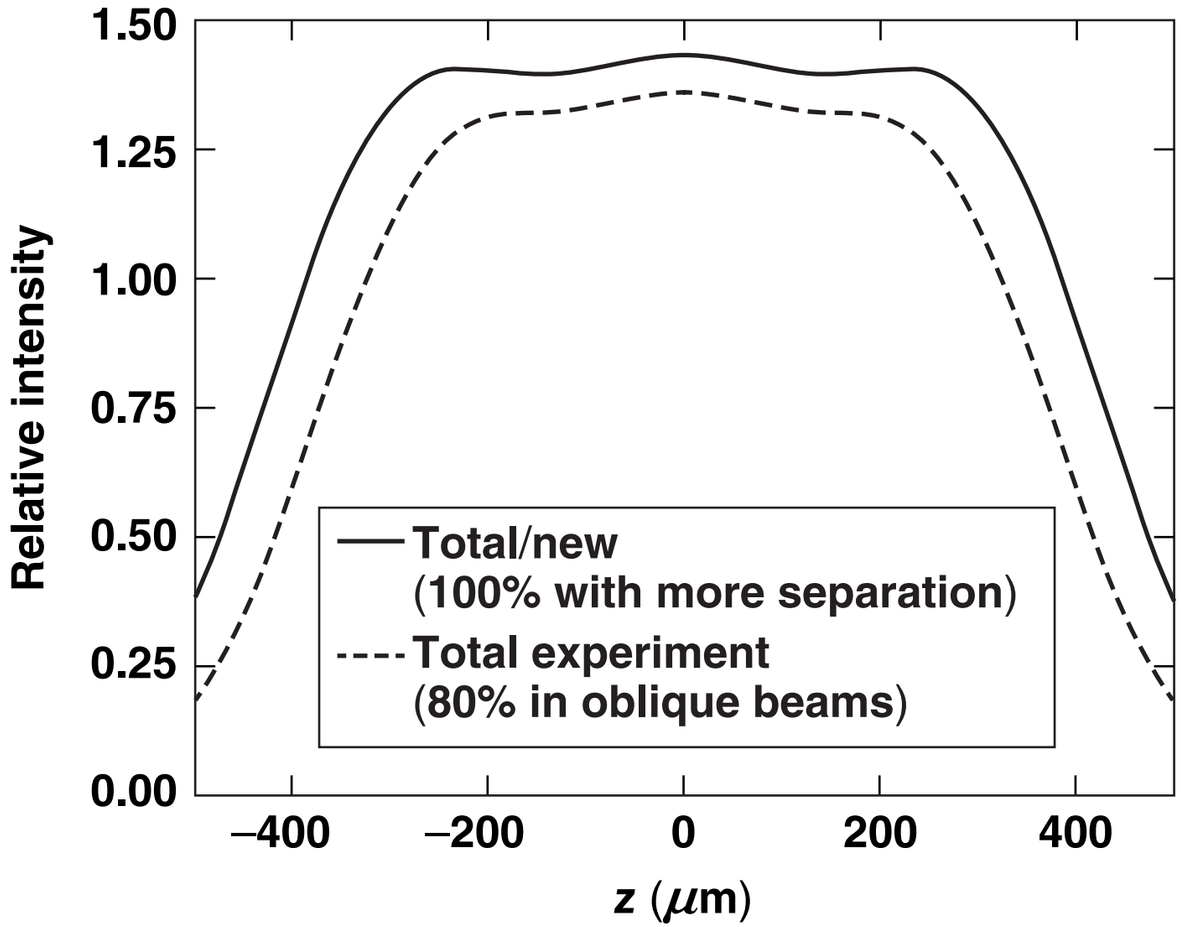


Oblique (%)	*V* (km/s)
100	136.9±3.8
90	132.4±7.6
80	107.7±3.2

- **Fitting function**
  $R(z) = a + b(z - z_0)^2 + c(z - z_0)^4$
- ***b*** **> 0: greater compression at the center**
- ***b*** **< 0: greater compression at the ends**

TC12533

Better use of the oblique-beam energy is achieved by illuminating a larger region of the target



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Summary/Conclusions

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