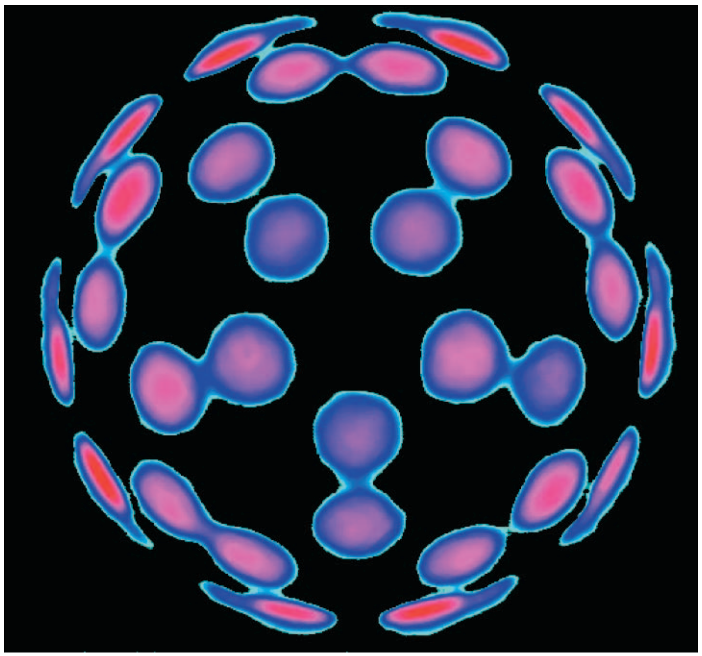
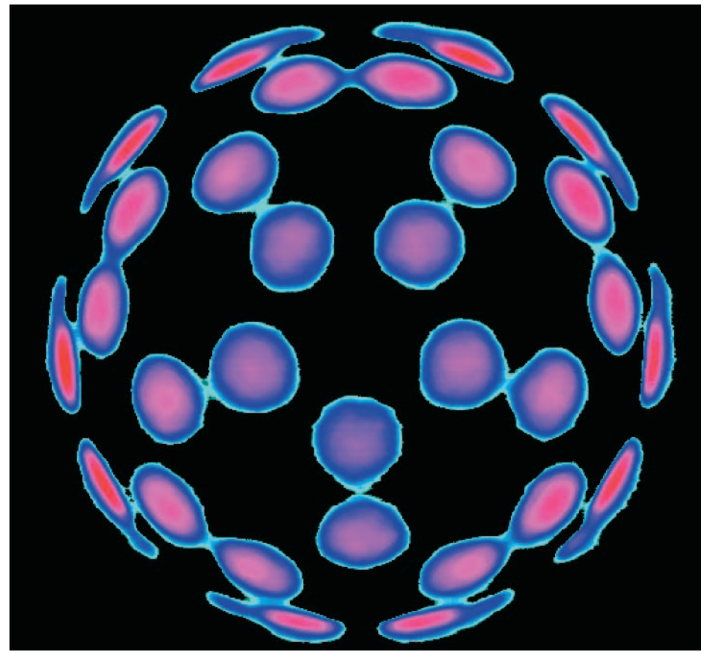
Direct-Drive Implosions on OMEGA with Optimized Illumination Uniformity





F. J. Marshall
University of Rochester
Laboratory for Laser Energetics

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Collaborators

**J. A. Delettrez, R. Epstein, R. Forties, V. Yu. Glebov,
J. A. Kelly, T. J. Kessler, J. P. Knauer, P. W. McKenty,
S. P. Regan, V. A. Smalyuk, and C. Stoeckl**

**University of Rochester
Laboratory for Laser Energetics**

J. A. Frenje, C. K. Li, R. D. Petrasso, and F. H. Séguin

**Massachusetts Institute of Technology
Plasma Science and Fusion Center**

Summary

Direct-drive illumination uniformity on OMEGA has been improved by using a new beam shape

- Several low ℓ-mode sources of direct-drive illumination nonuniformity have been minimized:
  - beam pointing
  - beam-size variation
  - beam balance
  - target position
- A new distributed phase plate (DPP) design, yielding a different beam shape and size, has facilitated minimizing these contributors.
- With the new DPP design, the low ℓ-mode illumination nonuniformities, averaged over time, have been reduced to ~1% rms.

The low ℓ-mode contributors to illumination nonuniformities on OMEGA have been significantly reduced with new DPP's

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	σ_i	ℓ mode	Previous DPP's n = 2.3	New DPP's n = 3.7
Perfect beam	σ_n	10	0.1	0.1
Beam imperfections	σ_{beam}	1–5, 10, 20	1.1	0.6
Size variations	σ_{size}	1–6	1.5	0.6
Pointing	σ_{pntg}	1–6	2.2	0.7
Target position	σ_{pos}	1, 2	$<$ 1.0	$<$ 0.4
Beam balance	σ_{bal}	1, 2, 3	1.3	0.6
		σ_{total}	3.3%	1.3%

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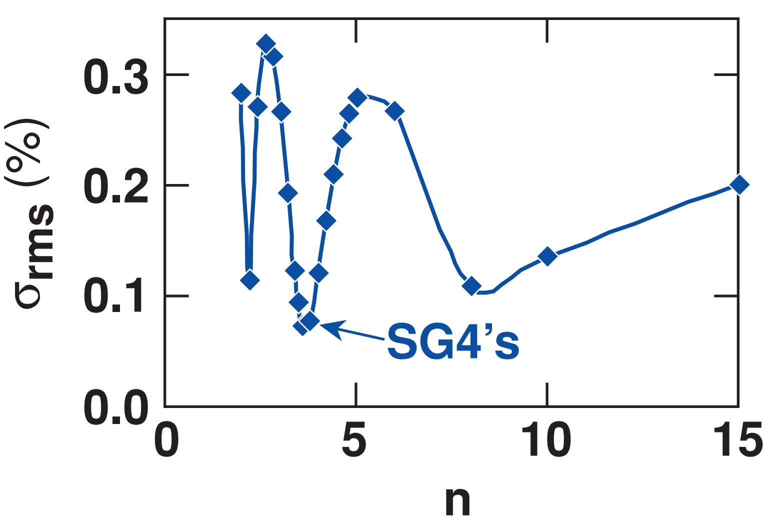
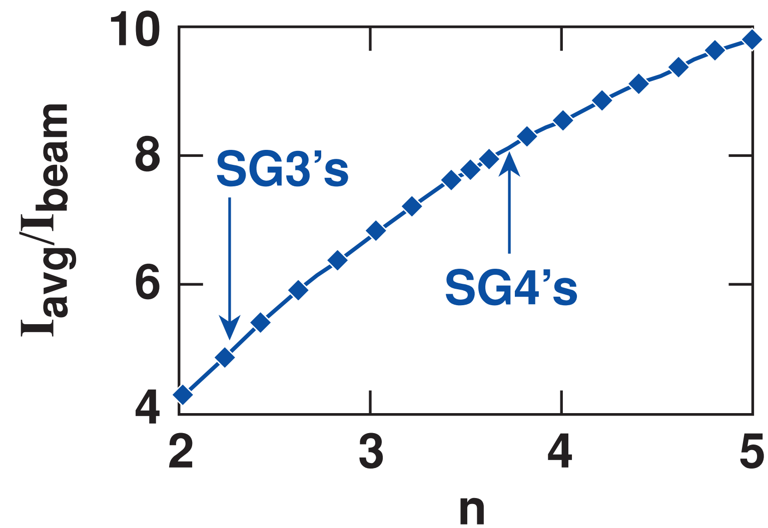
In the OMEGA 60-beam illumination geometry, there are beam shapes that optimize the uniformity





- n = 2.2 and 3.6 are preferred super-Gaussian orders.
- The n = 3.6 order is less sensitive to beam mispointing and beam-to-beam imbalance.

SG3's:
n = 2.3, R_0 = 308 μm
$D_{95\%}$ = 930 μm

SG4's:
n = 3.7, R_0 = 380 μm
$D_{95\%}$ = 865 μm

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The new DPP design with a flatter profile is more optimum for direct-drive illumination on OMEGA

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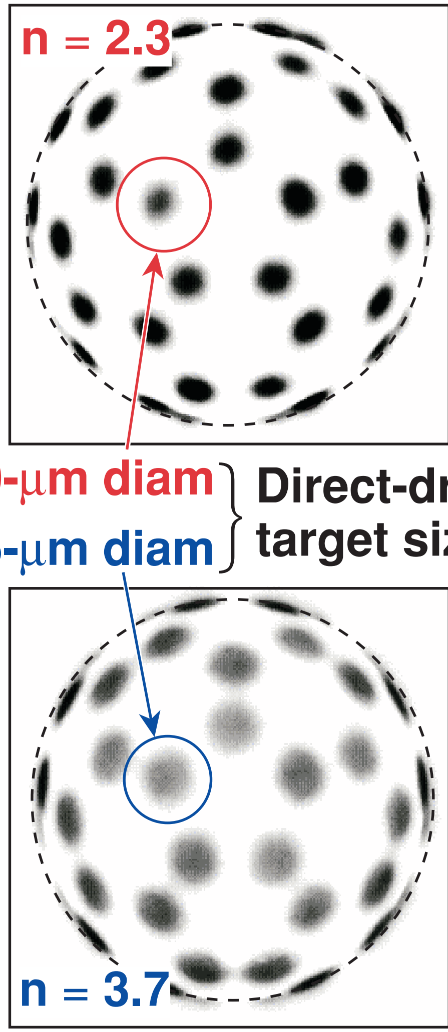
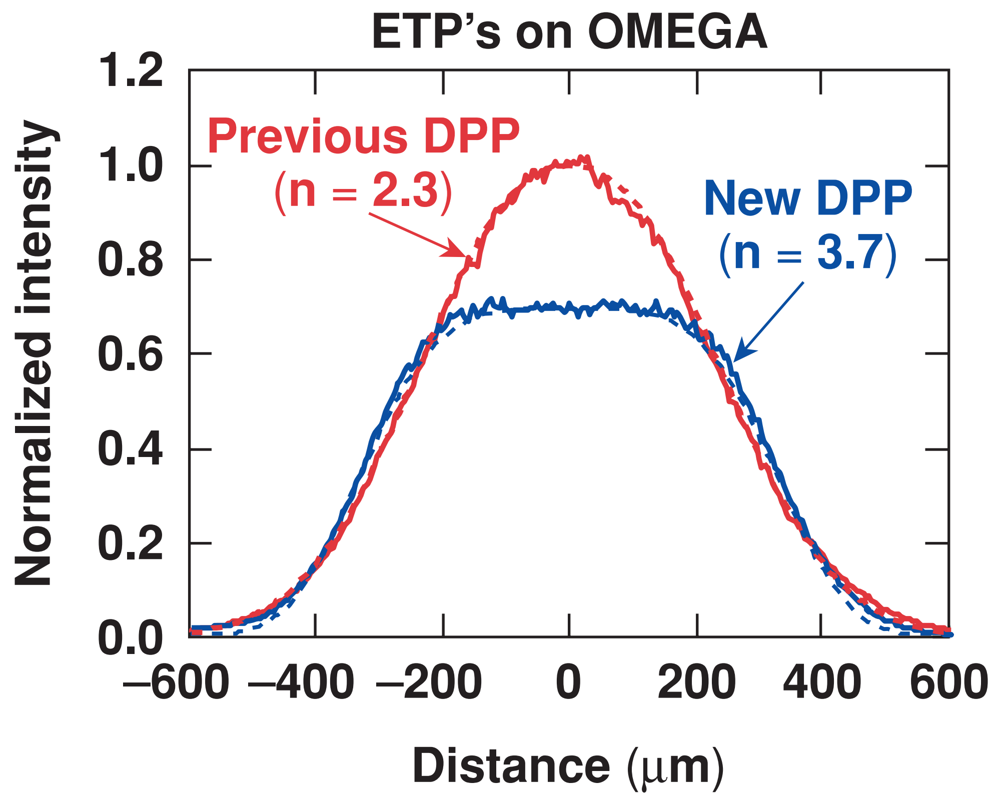
Pointing surrogate images





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Beam mispointing has been reduced to as low as 11-µm rms by active repointing

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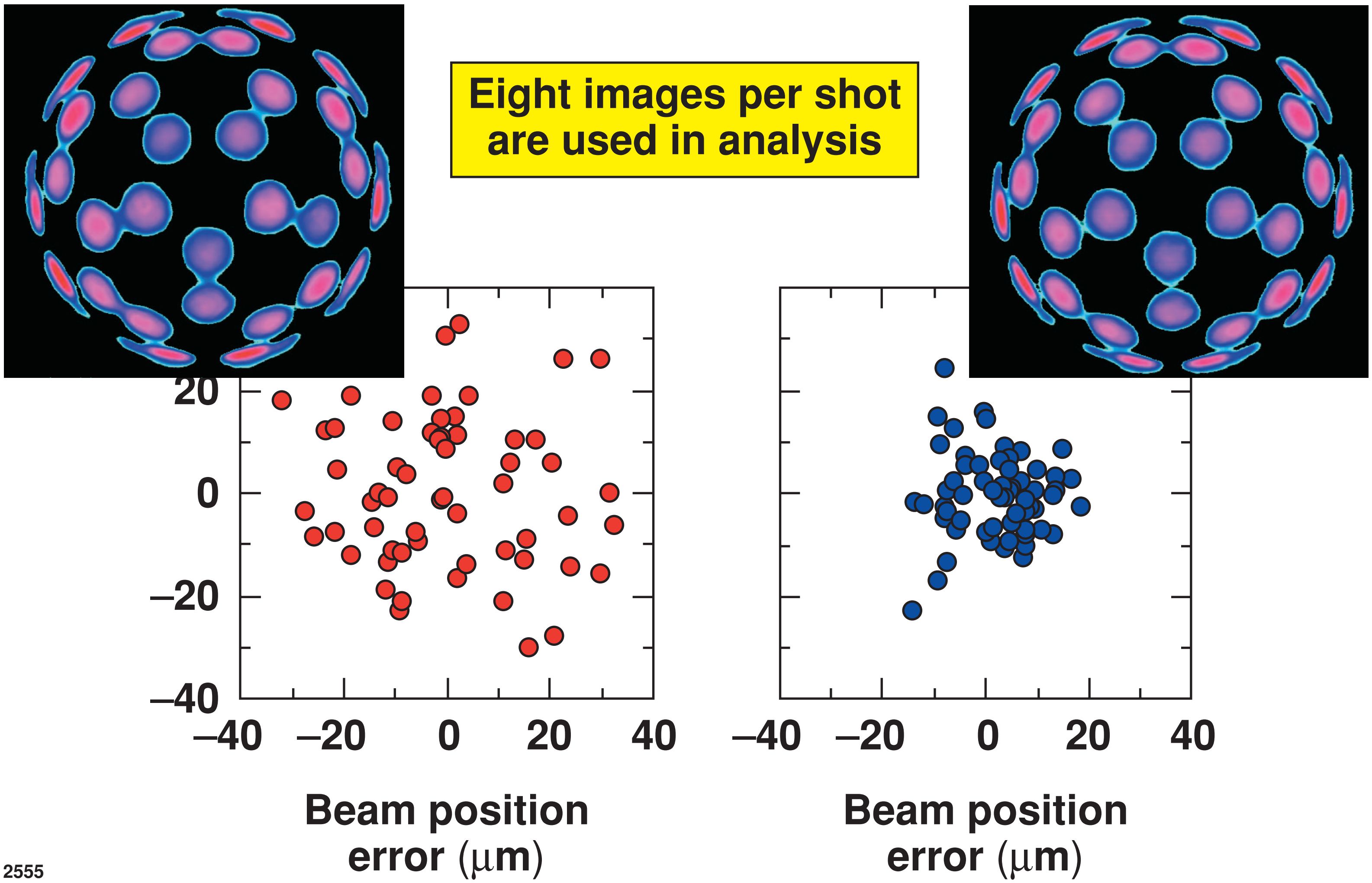
Before repointing 23-µm rms

4-µm Au Pointing Target Images

After repointing 11-µm rms



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Nonuniformities resulting from beam mispointing have been significantly reduced

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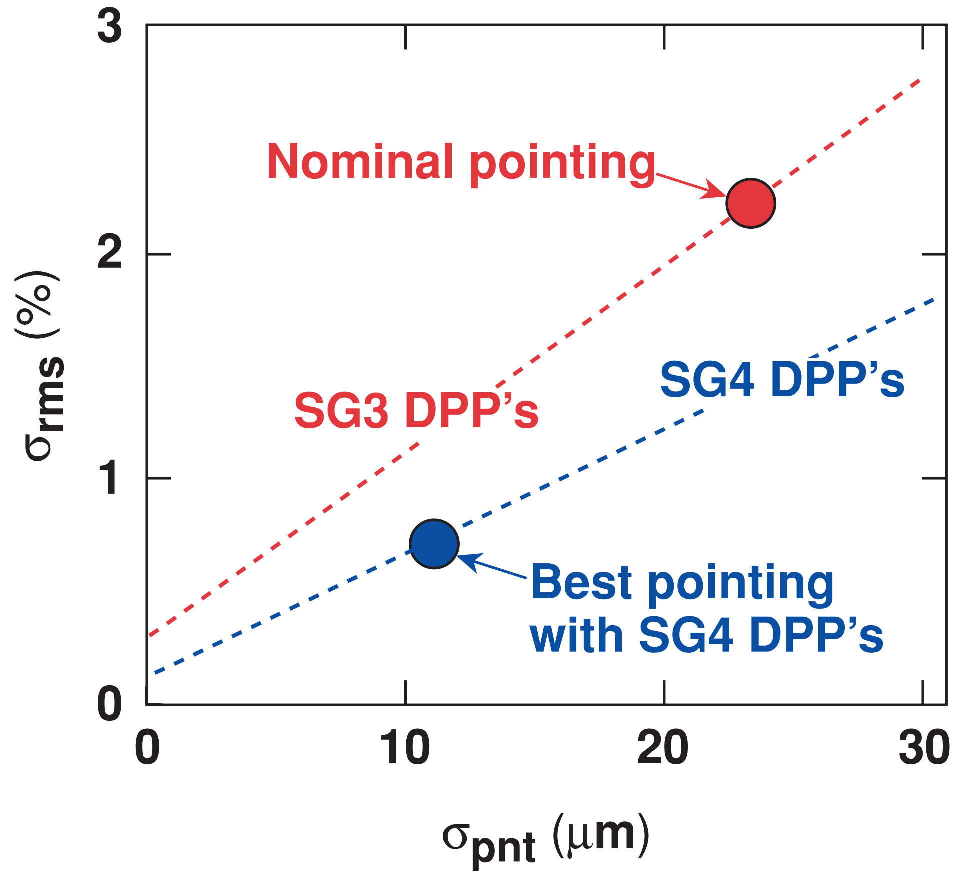
Simulations of Gaussian mispointing distribution on OMEGA



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The beams of OMEGA have a larger area and a smaller beam-to-beam variation with SG4 DPP's

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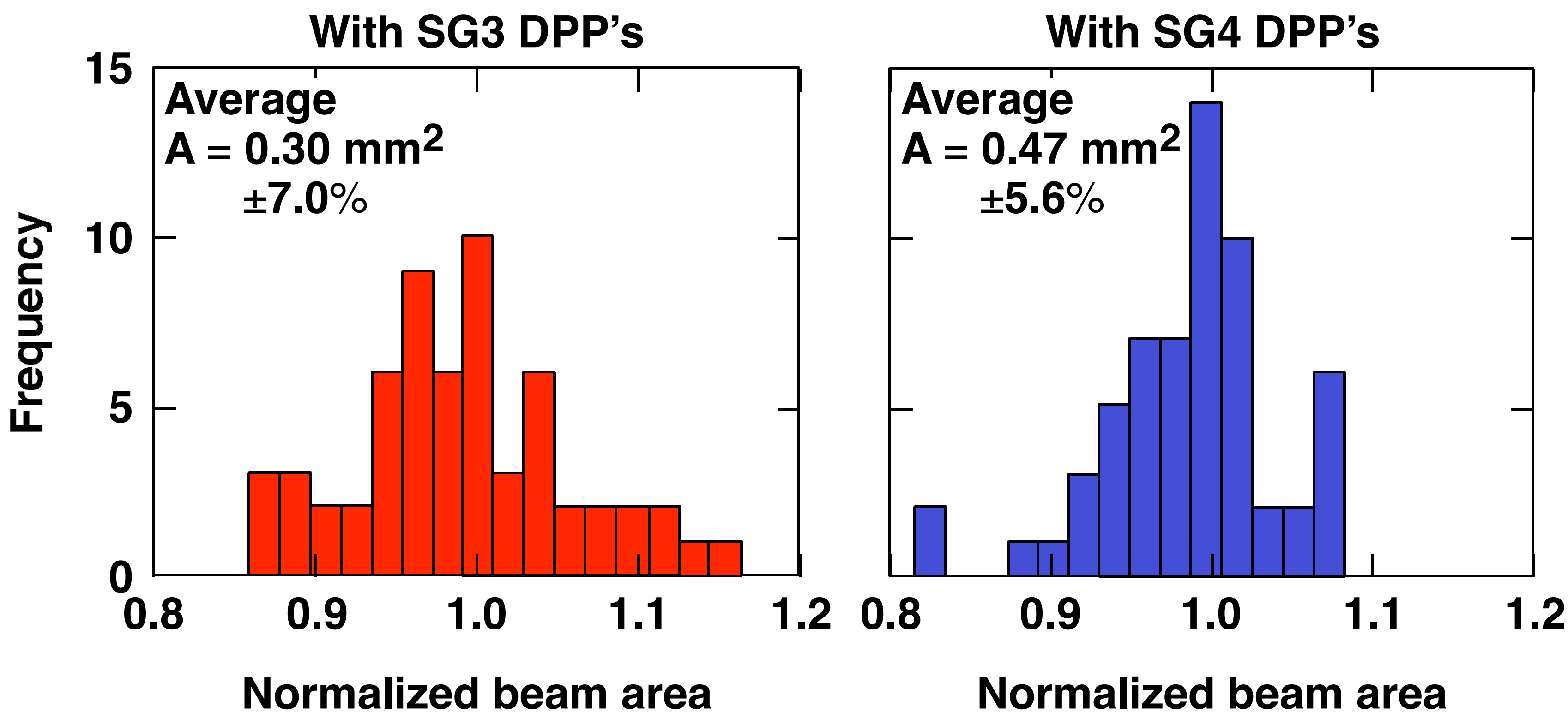
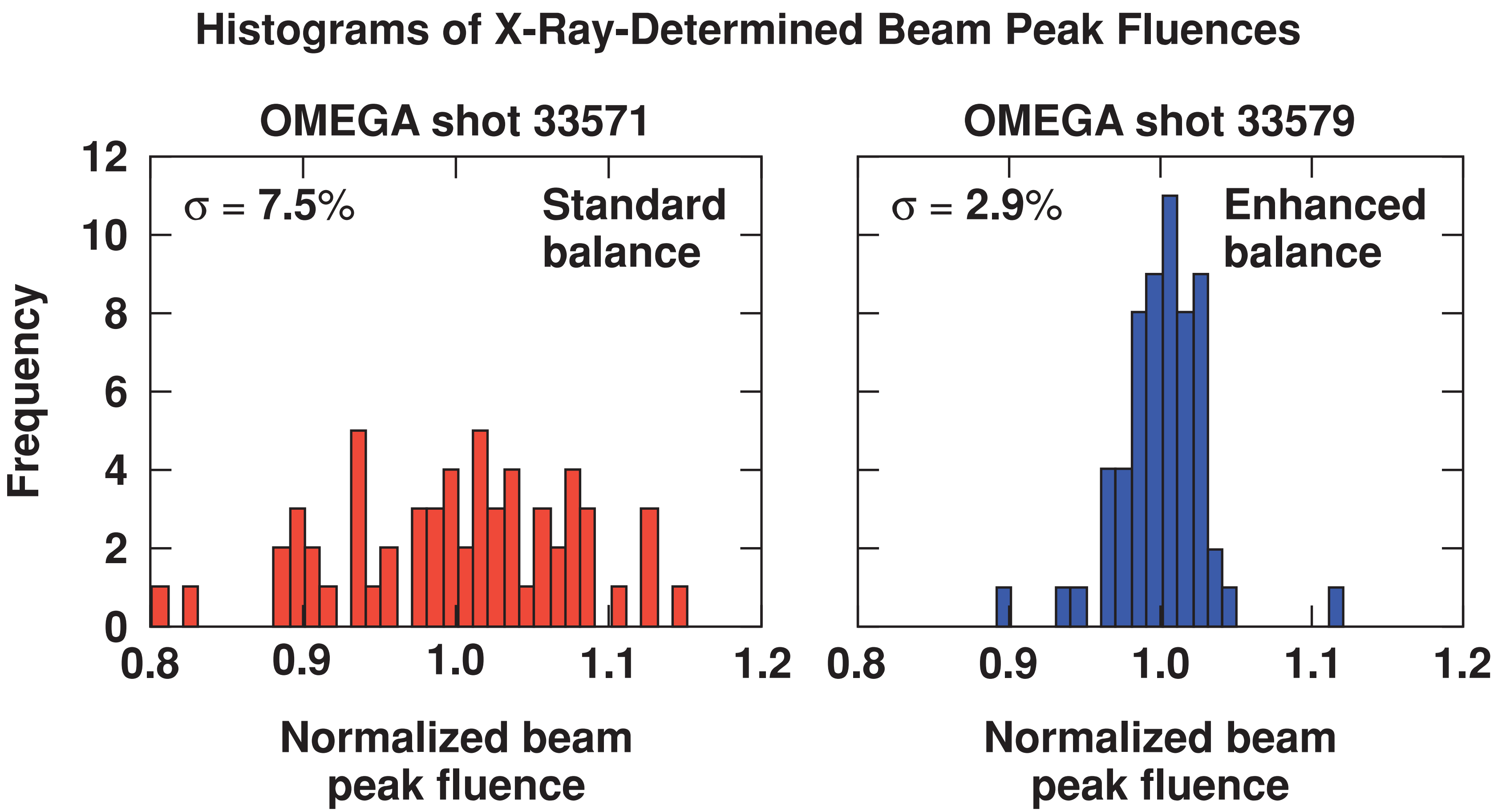
OMEGA beam area distributions with 1-THz SSD and PS



We have used the enhanced balance technique* to minimize on-target beam-to-beam differences



*F. J. Marshall *et al.*, accepted for publication, Phys. Plasmas (2003).

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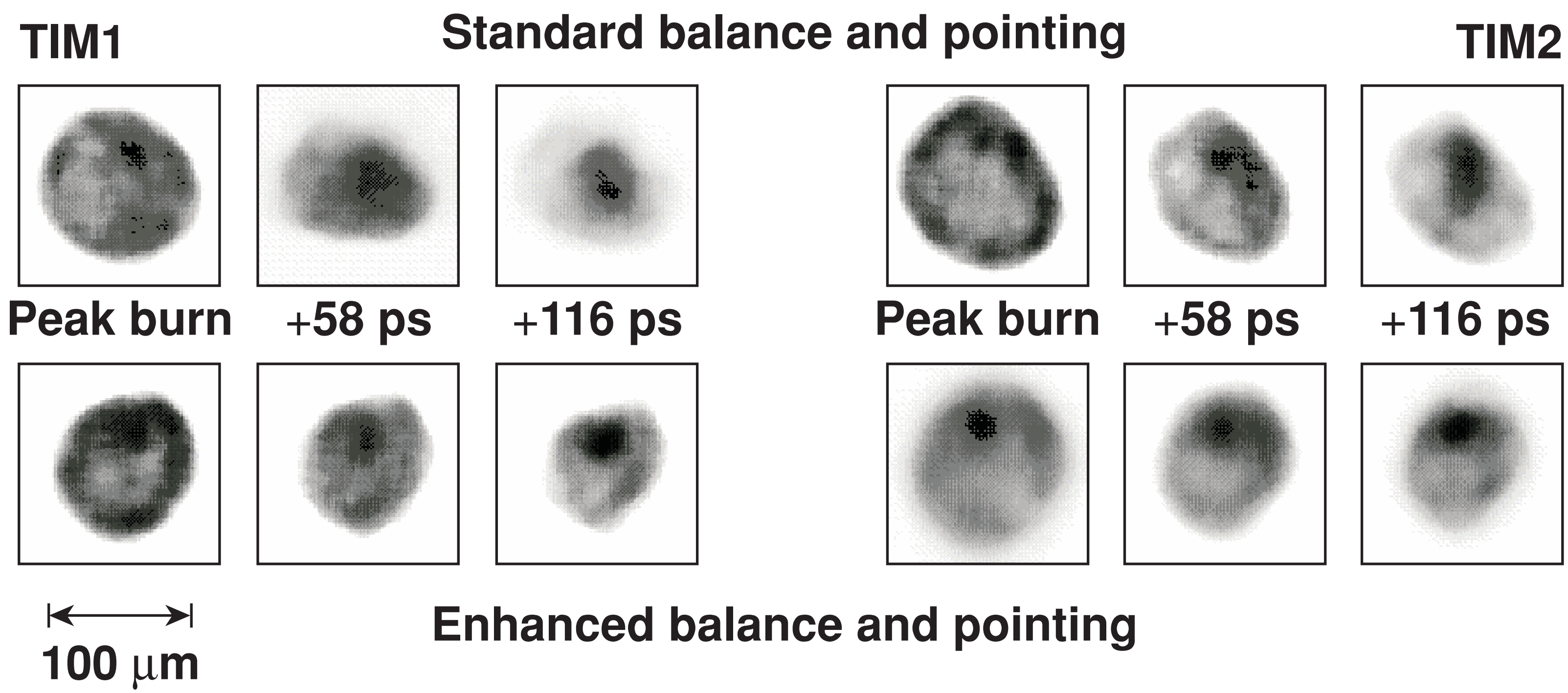
Minimizing the lowest ℓ-mode nonuniformities with new DPP's, enhanced beam balance, and beam repointing has resulted in more-symmetric implosions

Framed x-ray images
15-atm-D_2-filled, 20-μm-thick CH-shell implosions



E12557

Summary/Conclusions

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