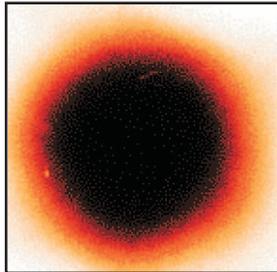


# Optimized Direct-Drive Uniformity

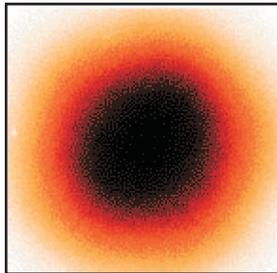


## Beam shape

New DPP (n = 4.2)



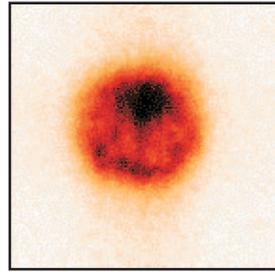
500  $\mu\text{m}$



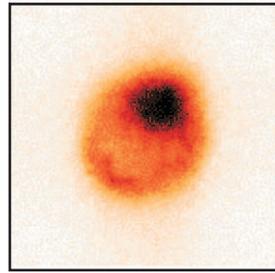
Current DPP (n = 2.3)

## Beam balance

Enhanced balance

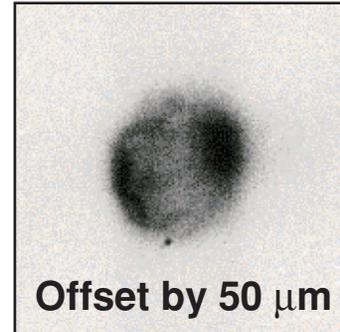


100  $\mu\text{m}$

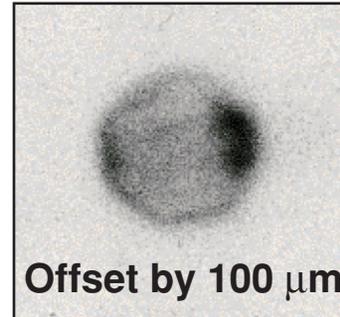


Standard balance

## Beam pointing, target positioning



Offset by 50  $\mu\text{m}$



Offset by 100  $\mu\text{m}$

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

44th Annual Meeting of the  
American Physical Society  
Division of Plasma Physics  
Orlando, FL  
11–15 November 2002

# Collaborators

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**P. W. McKenty**

**T. Kessler**

**R. Forties**

**J. A. Kelly**

**L. Waxer**

## Summary

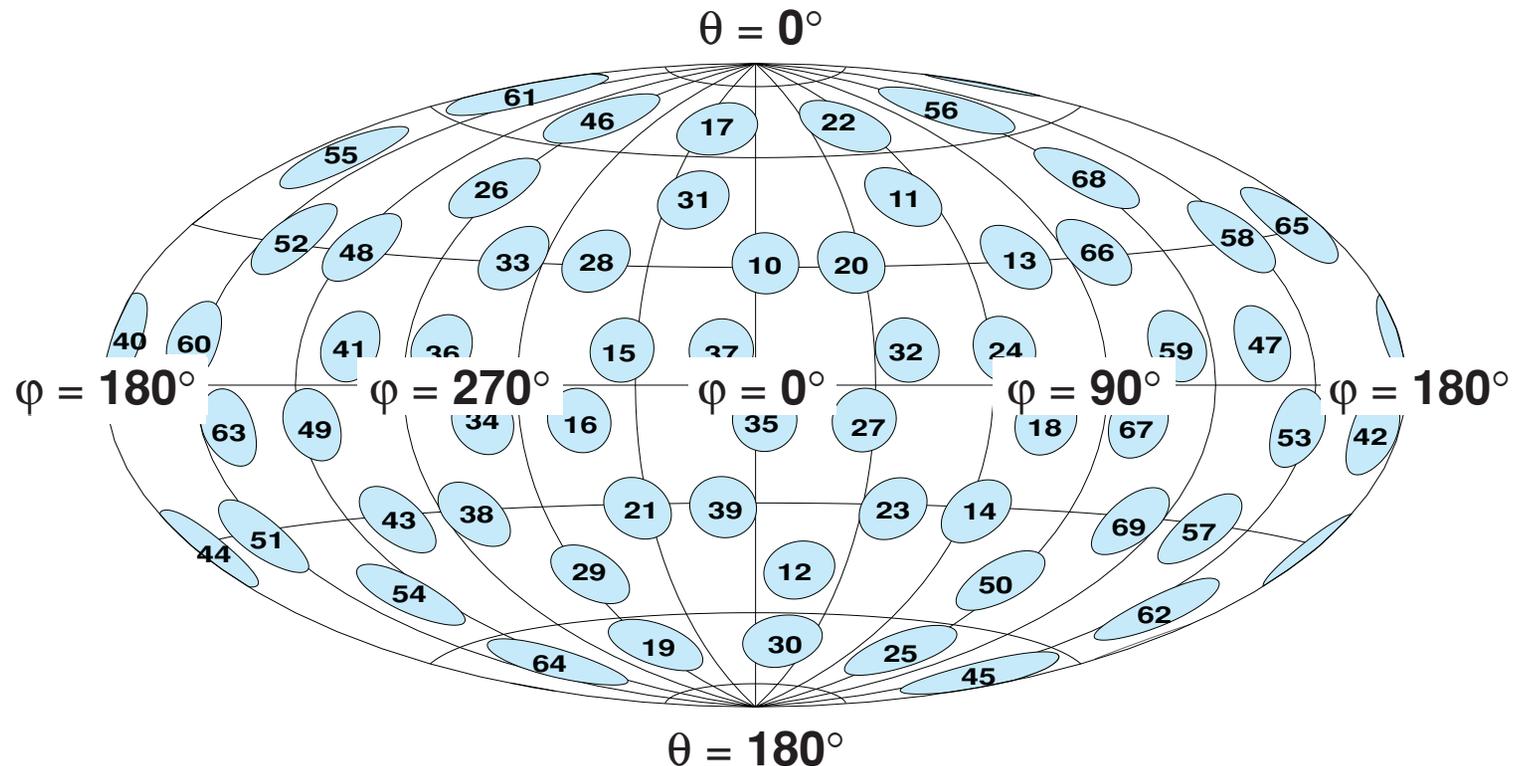
# Direct-drive illumination uniformity on OMEGA can be further optimized with a new beam shape

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- The OMEGA 60-beam geometry provides the basis to achieve highly uniform levels of direct-drive illumination.
- Calculations show that a new distributed phase plate (DPP) design can further minimize nonuniformities due to target position, beam balance, and beam pointing.
- With the new DPP design, the illumination nonuniformities averaged over time can be reduced to  $\lesssim 1\%$  rms.

# Intensity overlap calculations are performed on an Aitoff equal-area projection of the sphere



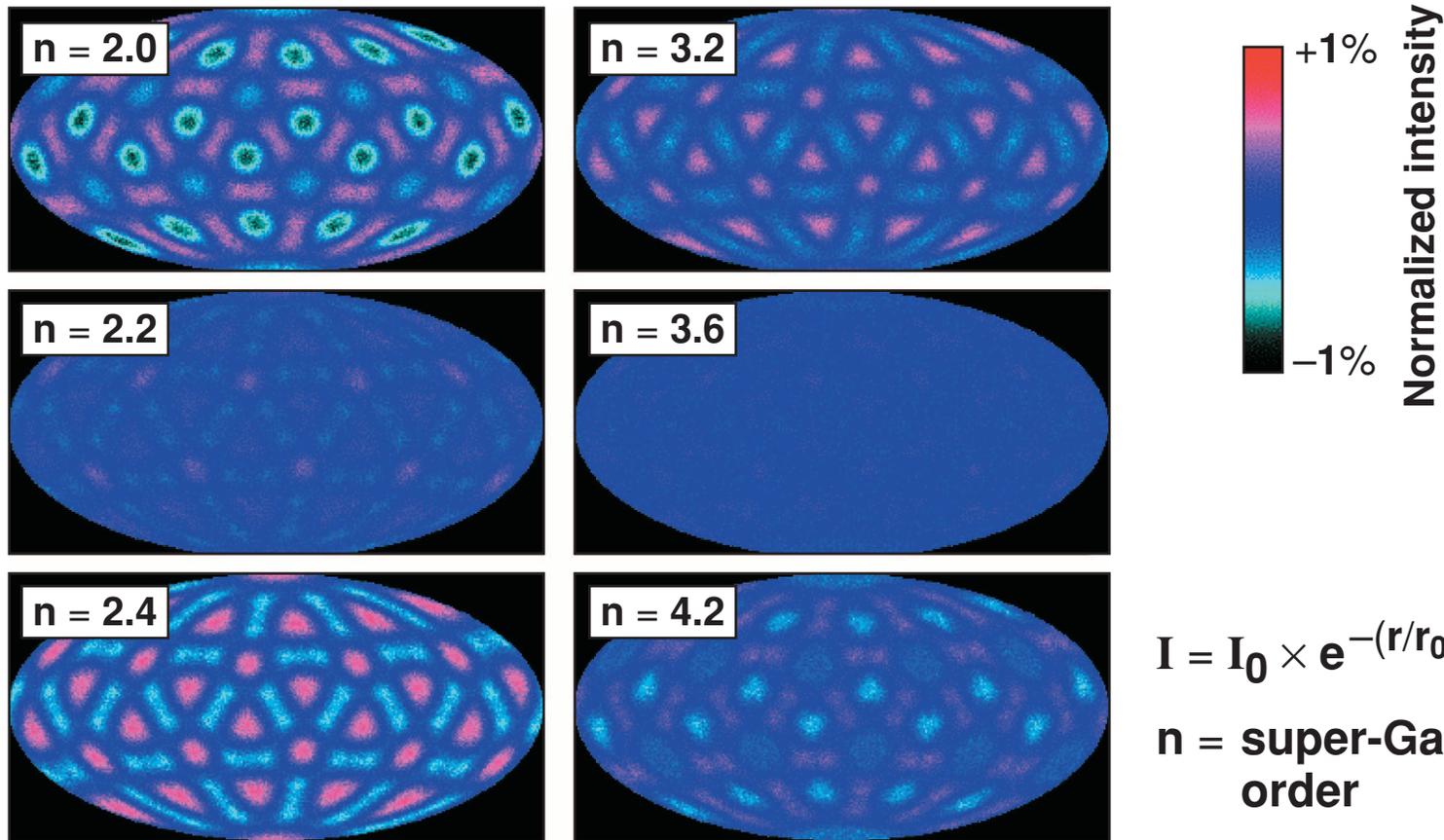
$$I(\theta, \varphi) = \sum_{i=1}^n I_i(\theta - \theta_i, \varphi - \varphi_i) \times f_{\text{abs}}(\theta - \theta_i, \varphi - \varphi_i),$$

$$f_{\text{abs}}(\theta - \theta_i, \varphi - \varphi_i) \approx \hat{\mathbf{r}} \cdot \hat{\mathbf{r}}_i = \cos \alpha, \quad \alpha \leq \frac{\pi}{2}$$

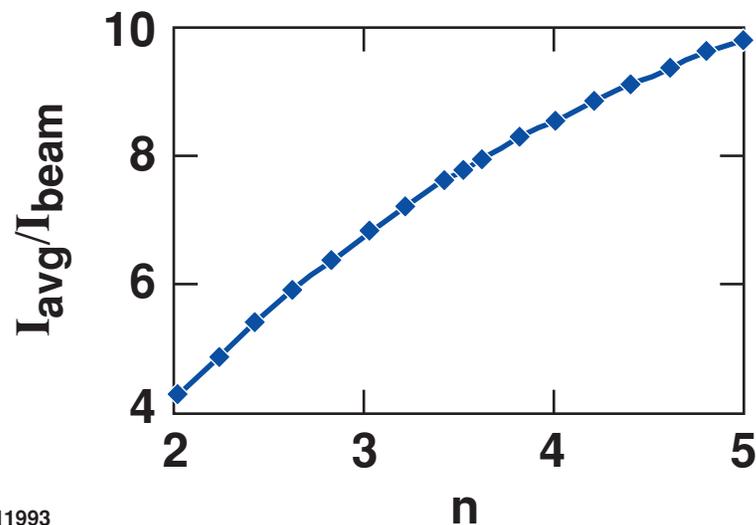
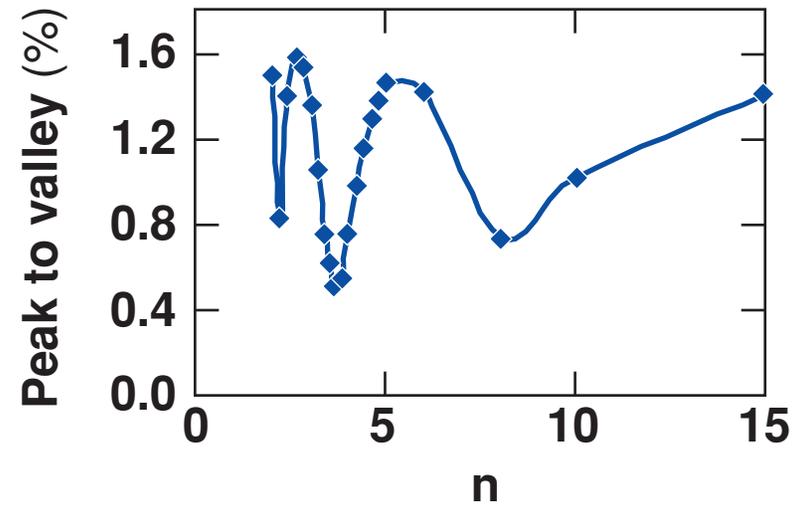
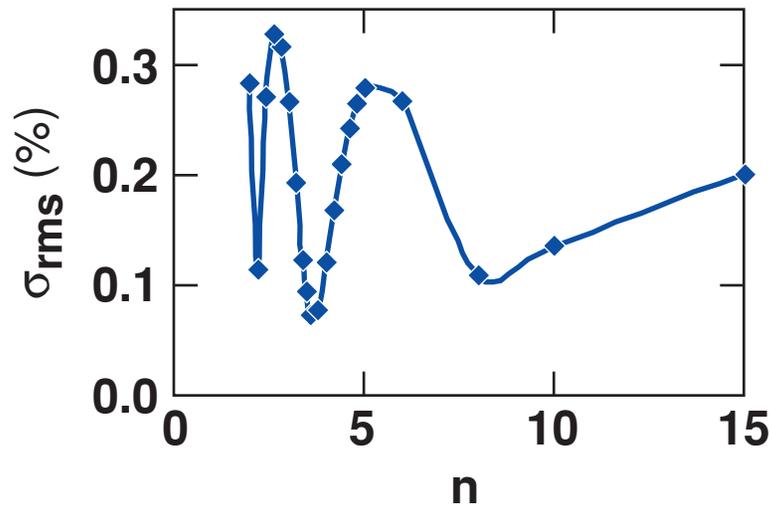
**Absorption is assumed to follow a simple cosine dependence.**

**Both ideal and actual beam profiles are used.**

The  $n = 3.6$  super-Gaussian profile has a deeper, broader  $\sigma_{rms}$  minimum (uniformity maximum)



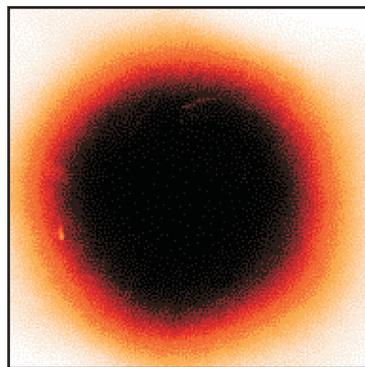
# In the OMEGA 60-beam illumination geometry, there are beam shapes that optimize the uniformity



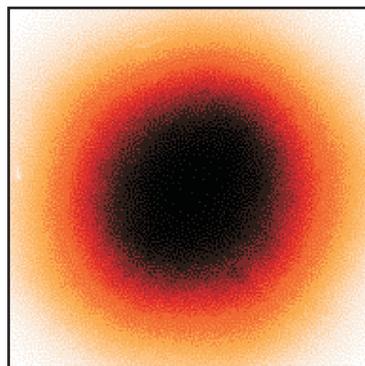
- $n = 2.2$  and  $3.6$  are preferred super-Gaussian orders.
- The  $n = 3.6$  order is less sensitive to beam mispointing and beam-to-beam imbalance.

# The new DPP design is a higher-order super-Gaussian and is more optimum for direct-drive illumination on OMEGA

New DPP ( $n = 4.2$ )

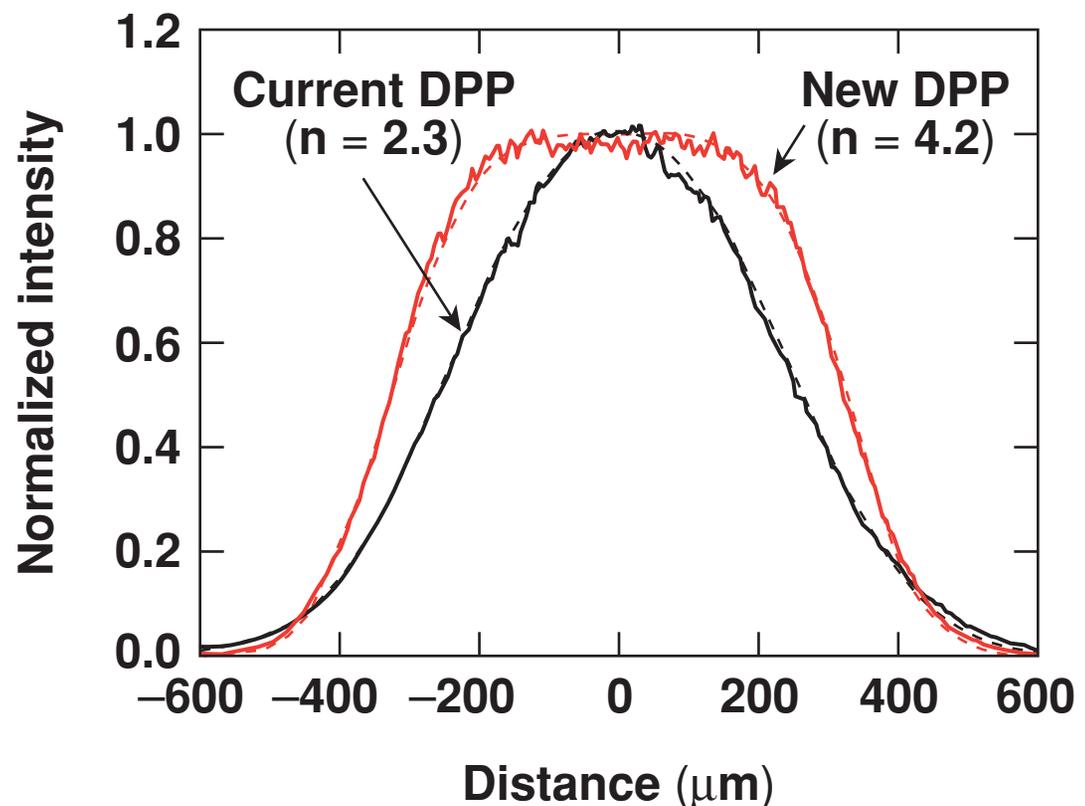


500  $\mu\text{m}$

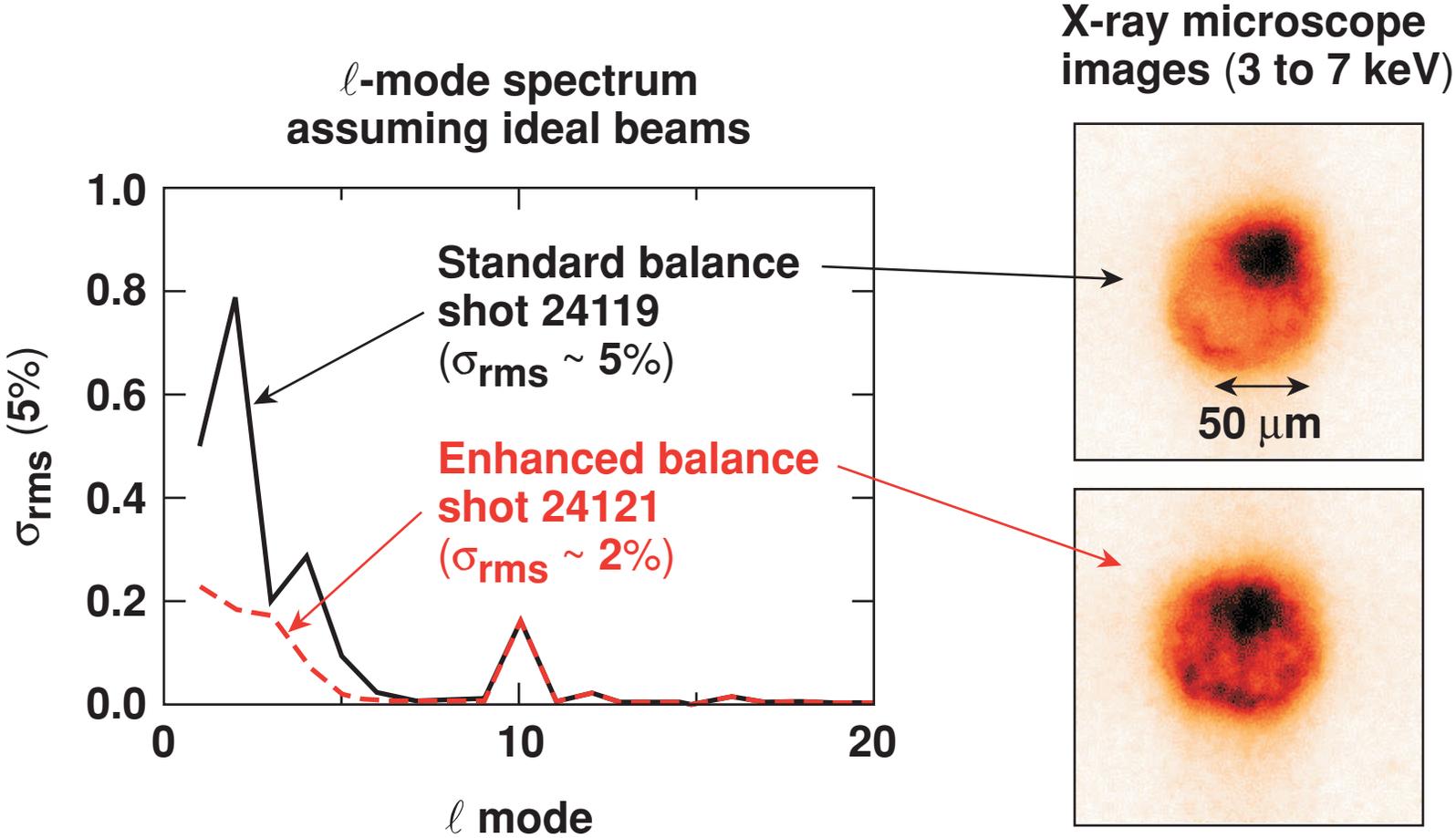


Current DPP ( $n = 2.3$ )

Horizontal lineouts through ETP's  
(best fits are dashed lines)



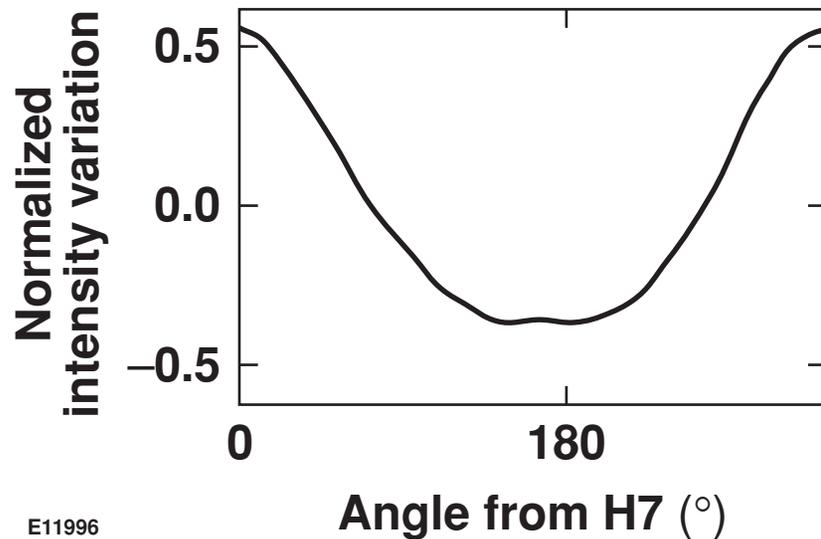
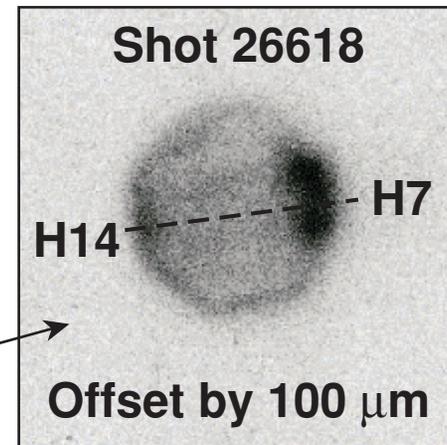
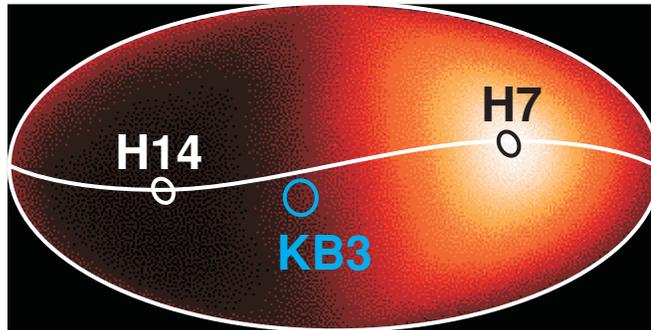
# Beam balance affects the low- $l$ -mode ( $l \leq 6$ ) contributors to the illumination nonuniformity



# Target positioning has a dramatic effect on implosion symmetry

OMEGA offset implosion of 15-atm-D<sub>2</sub>-filled, ~920- $\mu$ m-diam, 20- $\mu$ m-thick CH shells

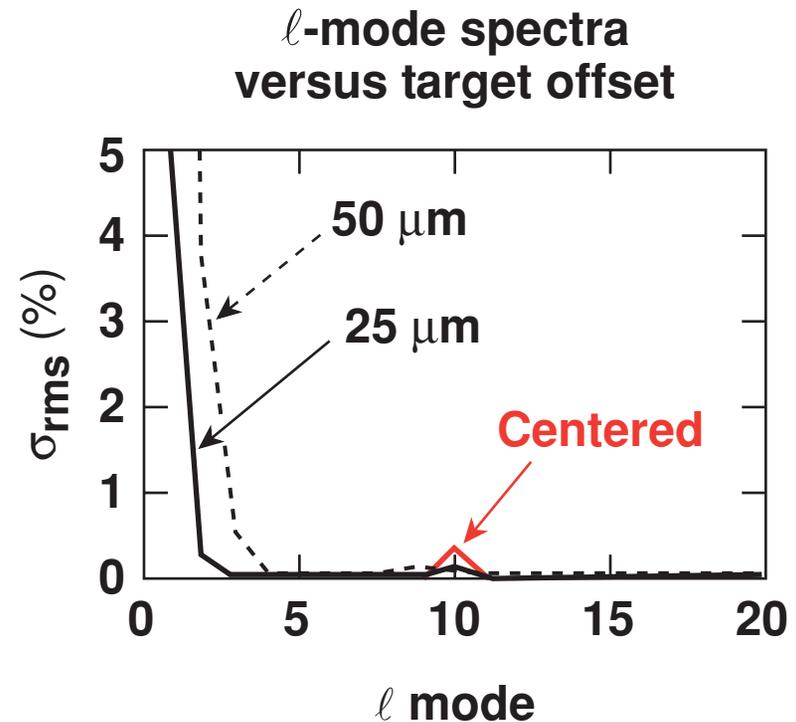
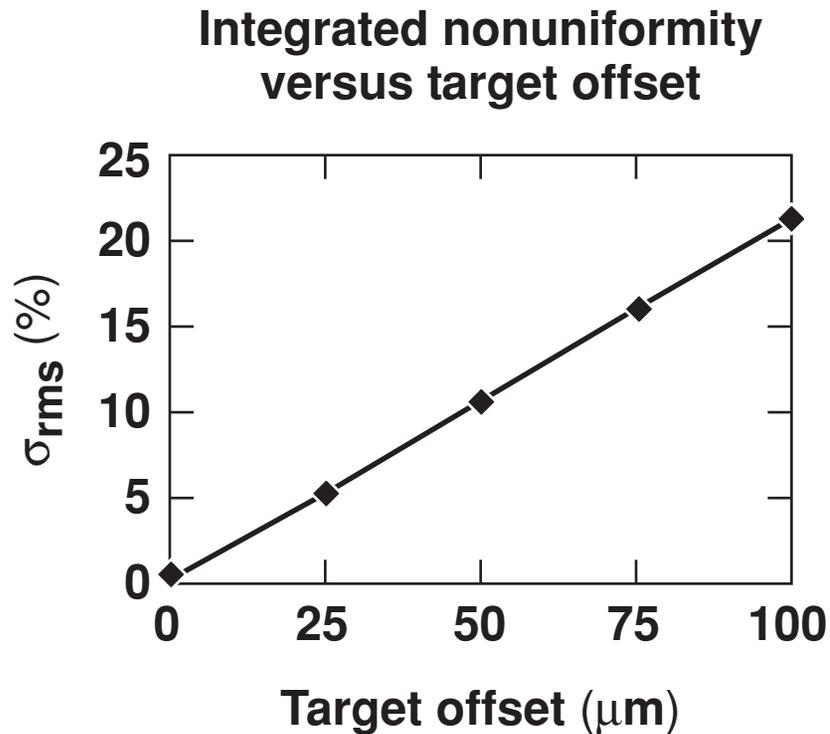
KB3 x-ray images



100  $\mu$ m  

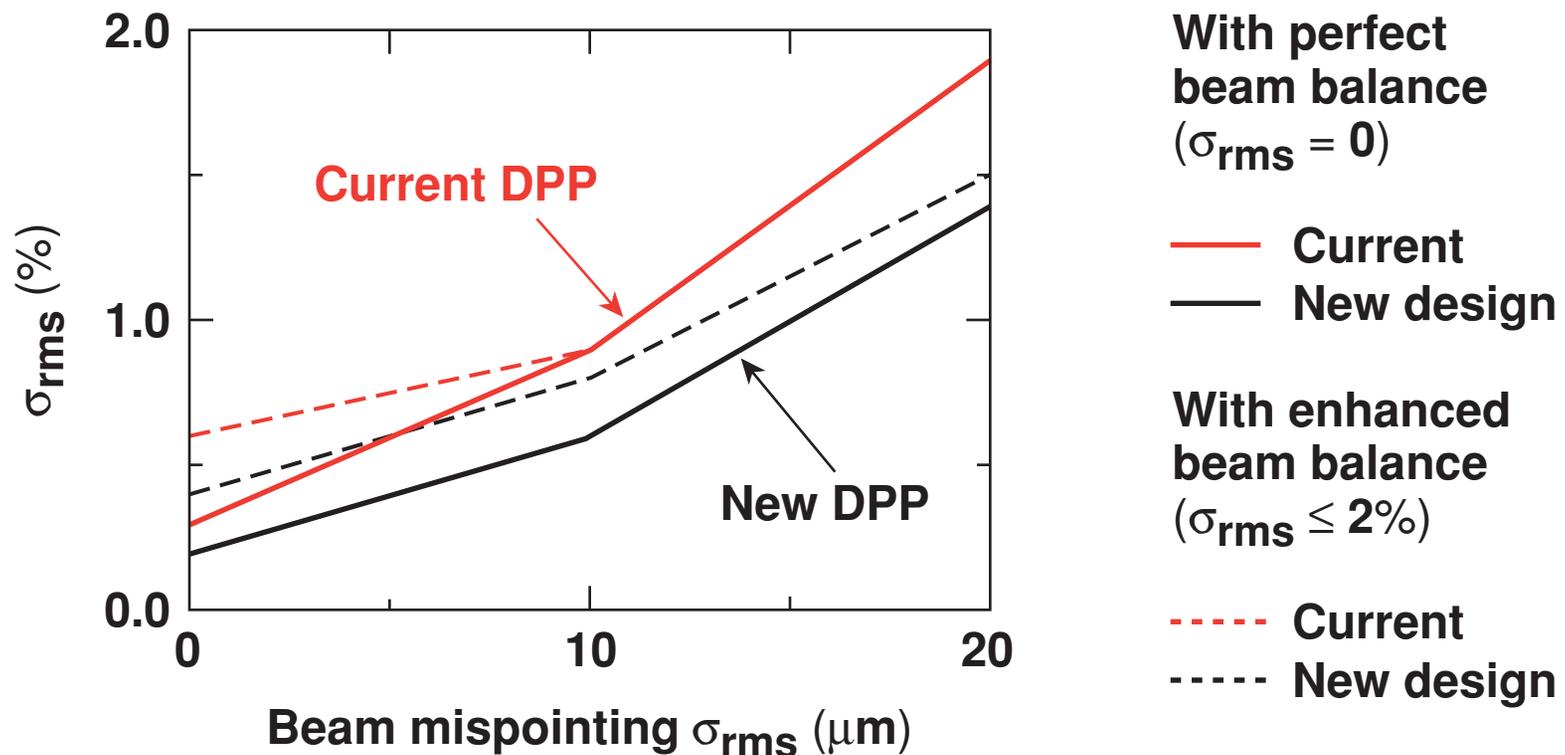

Related presentation:  
Soures *et al.* – GO2.005

# The target must be accurately positioned to minimize low- $\ell$ -mode ( $\ell \leq 6$ ) contributions to the illumination nonuniformity



The target must be positioned to better than  $\sim 5 \mu\text{m}$  to obtain  $\sigma_{\text{rms}} < 1\%$ .

# Both beam imbalance and beam mispointing contribute to low- $\ell$ -mode ( $\ell \leq 6$ ) illumination nonuniformities



**The new DPP design is less sensitive to beam imbalance and beam mispointing.**

# The low $\ell$ -mode ( $\ell \leq 6$ ) contributors to illumination nonuniformities on OMEGA can be significantly reduced by using an optimized beam shape

## $\sigma_{\text{rms}}$ contributors

	Beam shape	Beam pointing	Beam balance	TOTAL
Current DPP's (n = 2.3)	1.1%	1.9%	1.3%	2.6%
New DPP's (n = 4.2)	0.6%	0.6%*	0.4%†	0.9%

\* Requires precision beam pointing ( $\leq 10 \mu\text{m rms}$ )

† Requires precision beam balance ( $\leq 2\% \text{ rms}$ )

All values are time averaged assuming 1-THz SSD conditions.

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