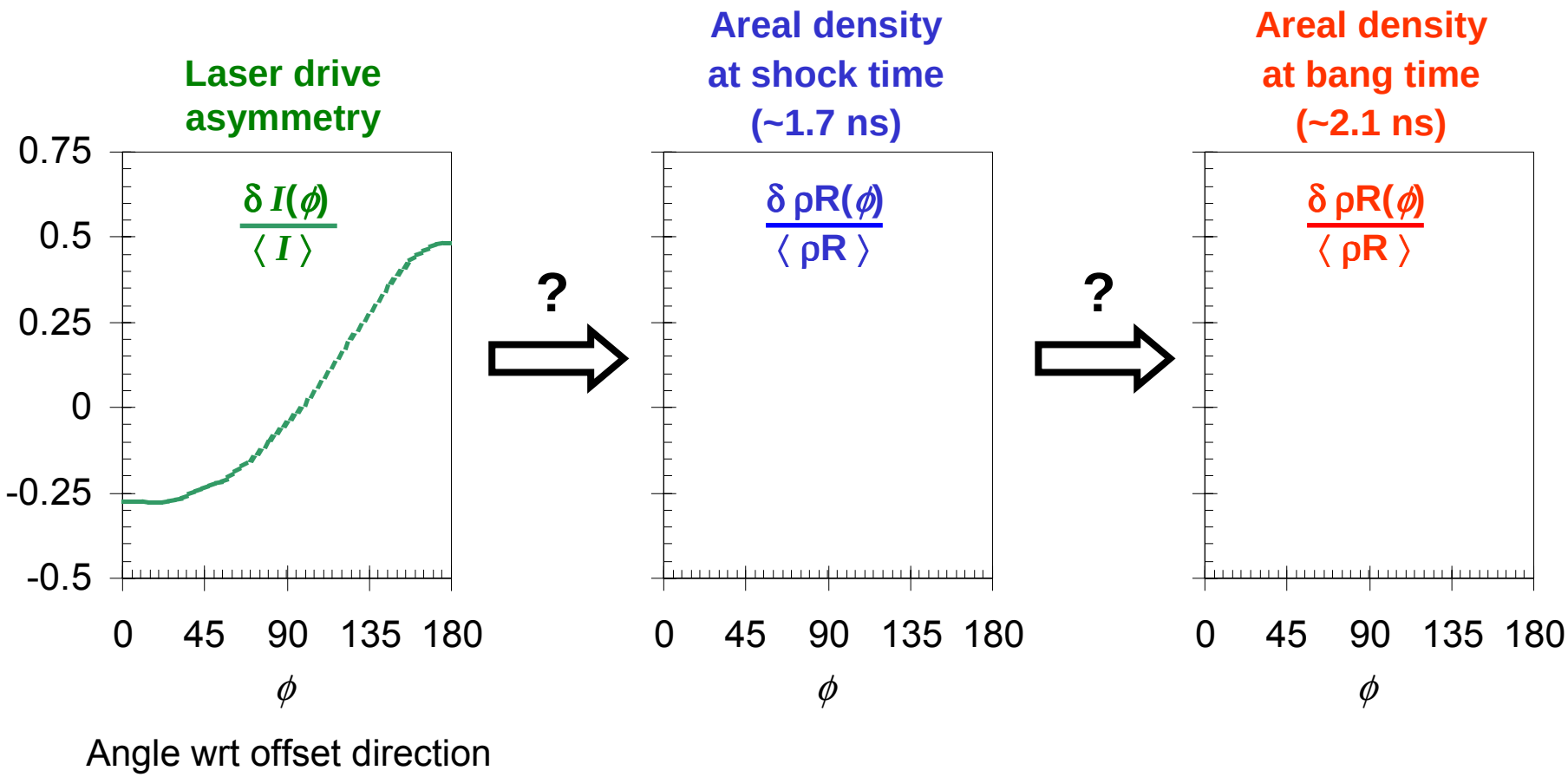
Time evolution of ρR asymmetries in OMEGA direct-drive implosions



Fredrick H. Séguin *et al.*
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Annual Anomalous
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22-27 June 2003

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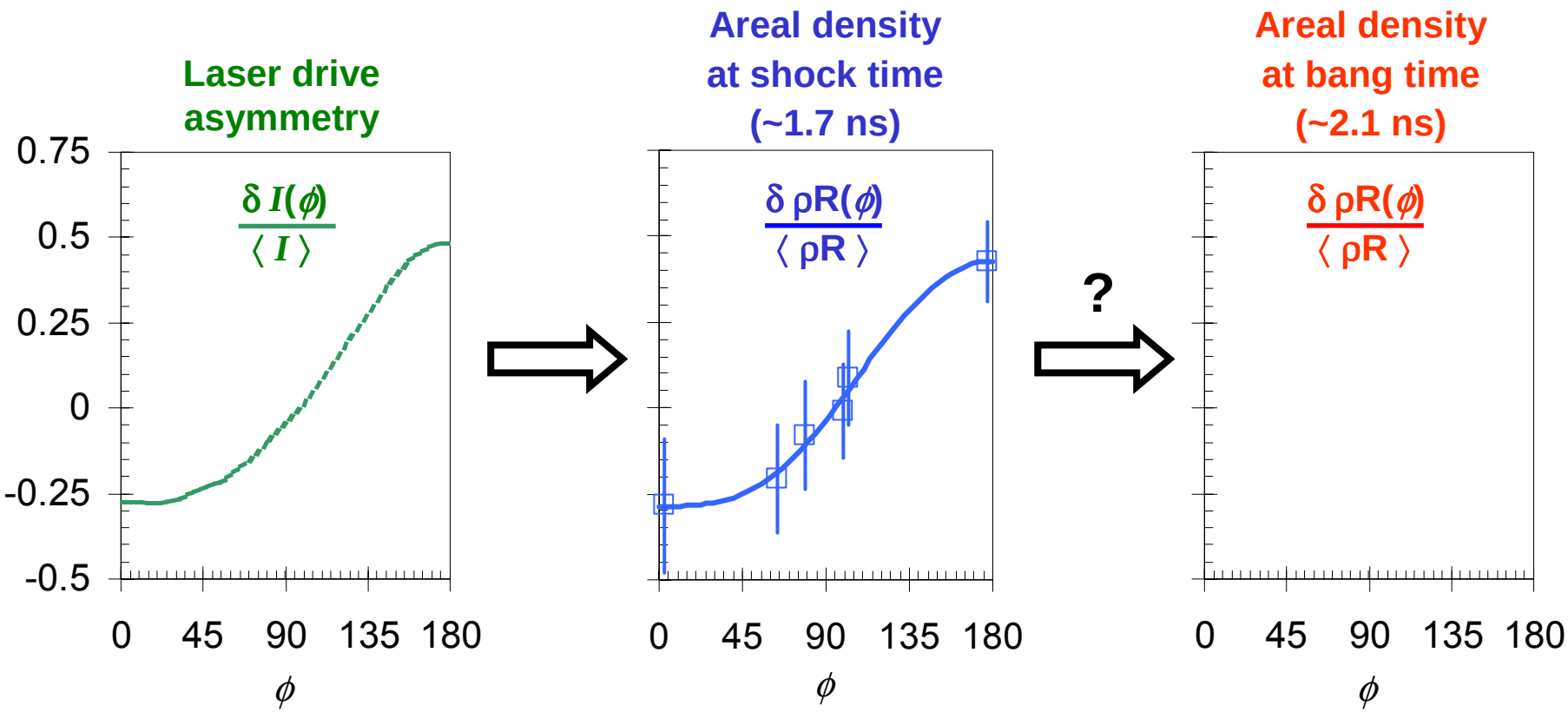

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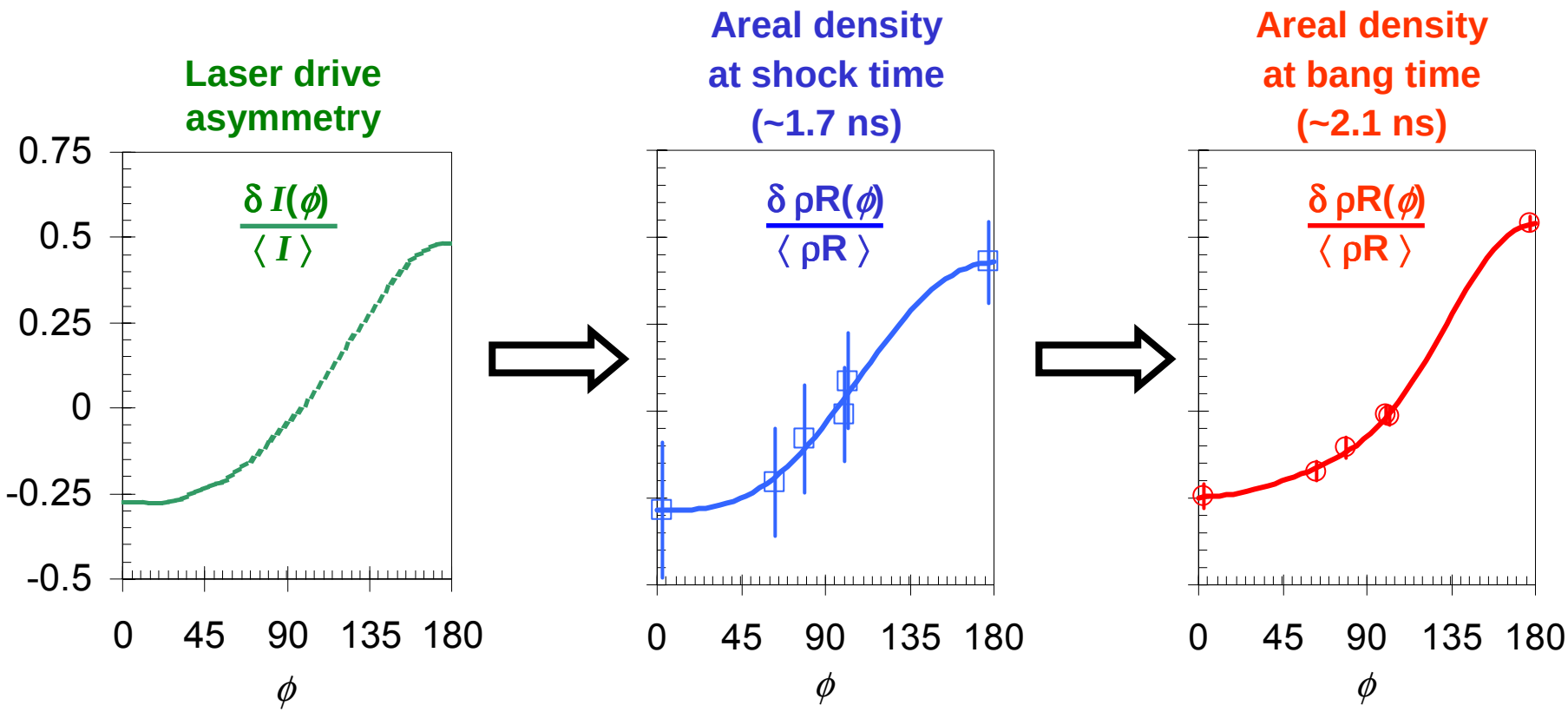

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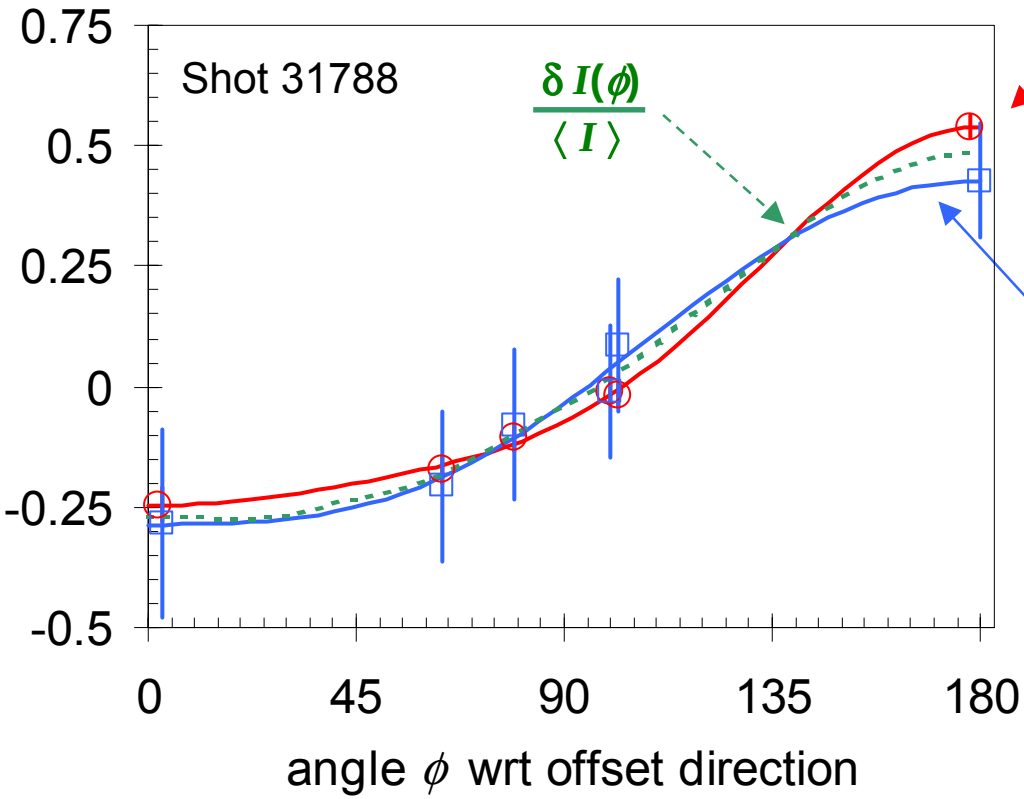

$$\frac{1}{0.4\,(C_r\text{-}1)}\,\frac{\delta\rho R(\phi)}{\langle \rho R \rangle}$$

at bang time

$$\frac{1}{0.4\,(C_r\text{-}1)}\,\frac{\delta\rho R(\phi)}{\langle \rho R \rangle}$$

at shock-coalescence time

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Summary

For asymmetric OMEGA laser drive $I(\phi)$ dominated by mode numbers $\lesssim 3$, applied to room-temperature capsules with thick CH shells,

- $\delta I(\phi) = I(\phi) - \langle I \rangle$ produces $\delta \rho R(\phi) = \rho R(\phi) - \langle \rho R \rangle$ with the same shape;
- $\delta \rho R(\phi)$ maintains that shape throughout the implosion …
- with amplitude depending primarily on the radial convergence ratio C_r:

$$\frac{\delta \rho R(\phi)}{\langle \rho R \rangle} \approx 0.4 \left(C_r - 1\right) \frac{\delta I(\phi)}{\langle I \rangle}$$

- Modes 1 and 2 grow at the same rate, with no phase inversions.

Collaborators

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S. Hatchett

*Visiting Scientist, LLE

This work is a logical extension of previous work that showed correlations between drive asymmetry and ρR asymmetry

- Small changes in $I(\phi)$ result in changes in ρR(ϕ)*
- δ ρR growth due to Bell-Plesset-like convergence effects should lead at bang time to**

$$\frac{\langle \delta \rho R \rangle_{rms}}{\langle \rho R \rangle} = K\left(C_r - 1\right)\frac{\langle \delta I \rangle_{rms}}{\langle I \rangle}$$

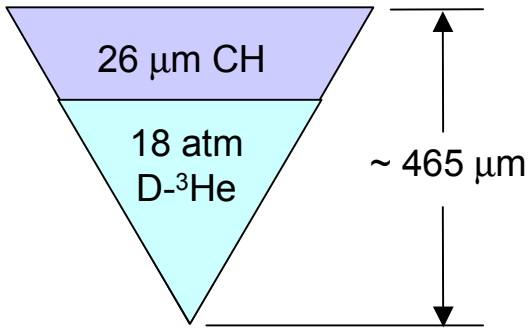
- Data for low modes involving room-temperature and cryo D_2 capsules at OMEGA were roughly consistent with this growth** if

$$K \sim \frac{1}{2}$$

*F.H. Séguin *et al*., Phys. Plasmas 9, 3558 (2002).
**C.K. Li *et al*., submitted to Phys. Rev. Lett.

New experiments have been performed for controlled drive asymmetries and accurate study of ρR(ϕ) at different times

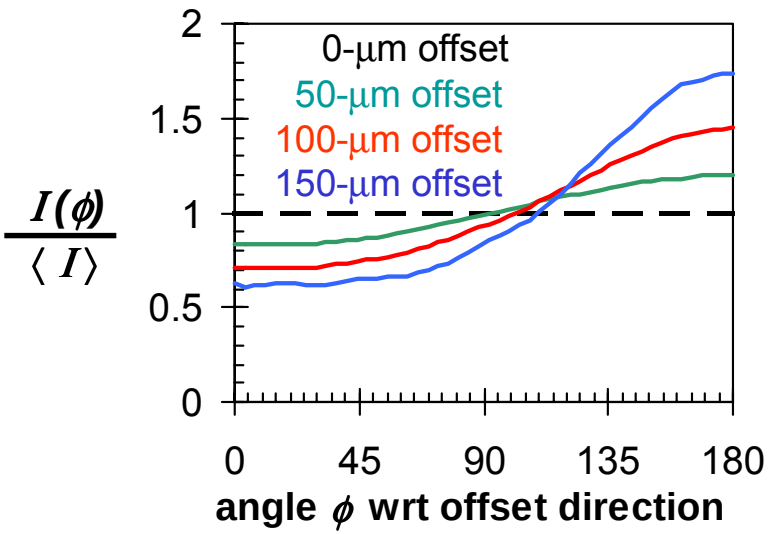
Room temperature capsules:



60-Beam OMEGA laser:

Pulse shape:	1-ns square
Beam smoothing:	2D-SSD + PS
On-target energy:	~23 kJ

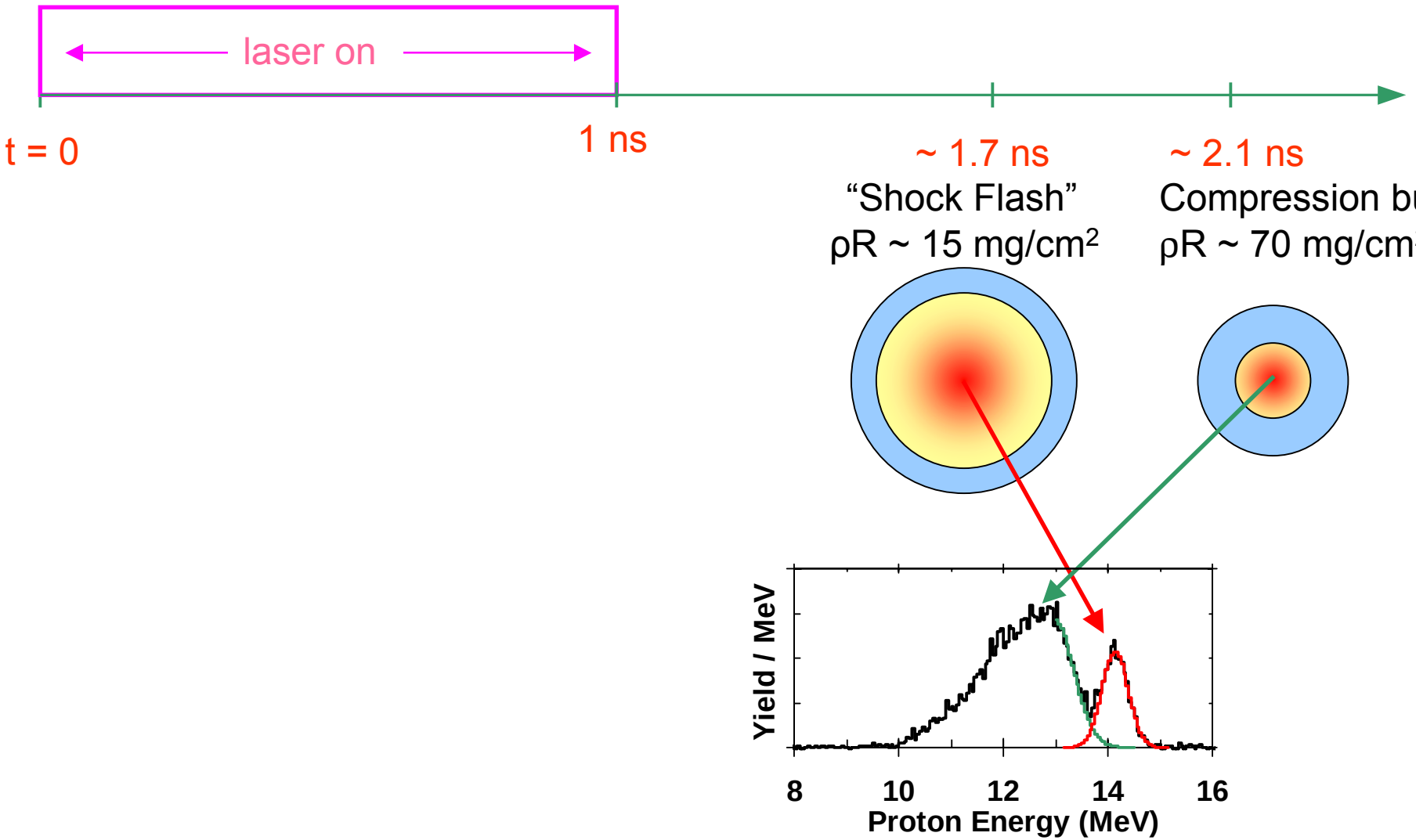
Different $I(\phi)$ were generated by offsetting capsules from Target Chamber Center:



ρR(ϕ) was inferred from the energy lost by D^3He protons leaving at different ϕ:

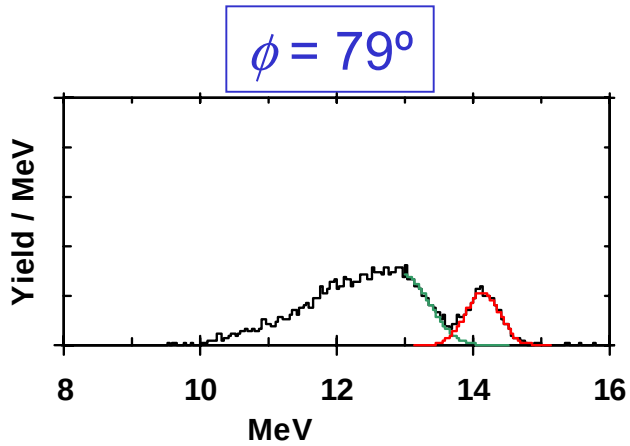
Proton spectra were measured by 6 WRF proton spectrometers

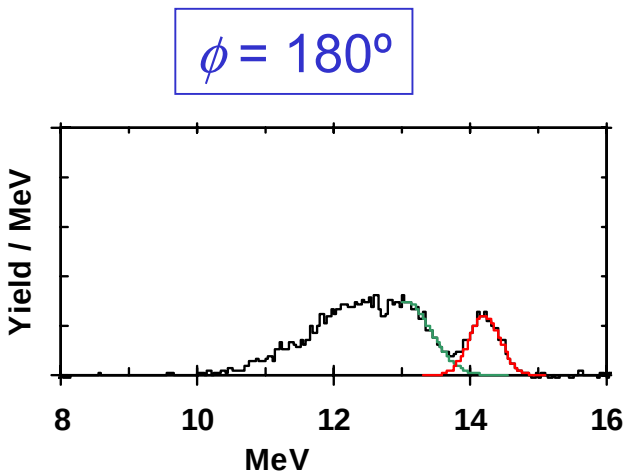
There are two distinct time intervals during a D^3He-capsule implosion when D^3He protons are generated*

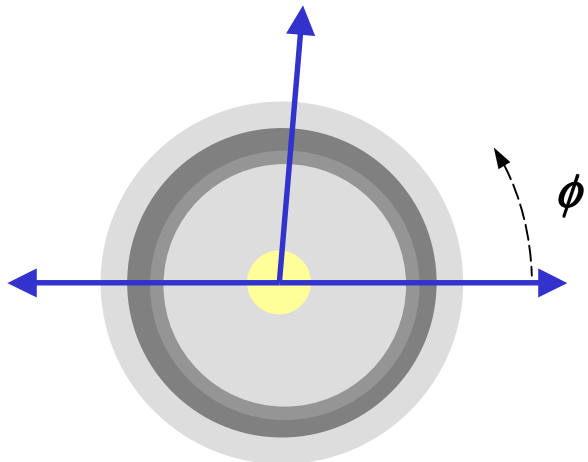


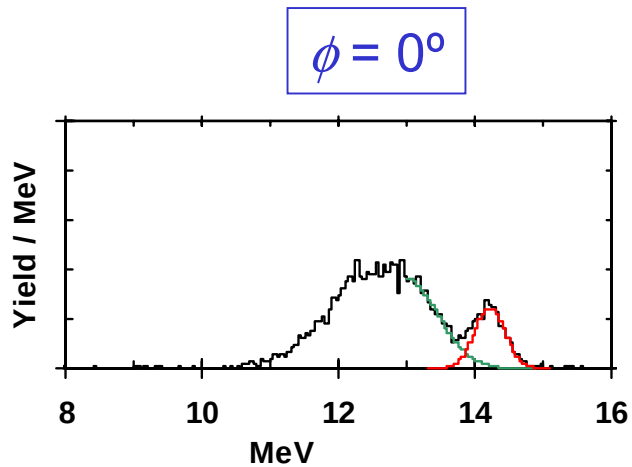
*Petrasso *et al.*, Phys. Rev. Lett. **90**, 095002-1 (2003).

With no offset, all spectra are similar and ρR is nearly independent of angle

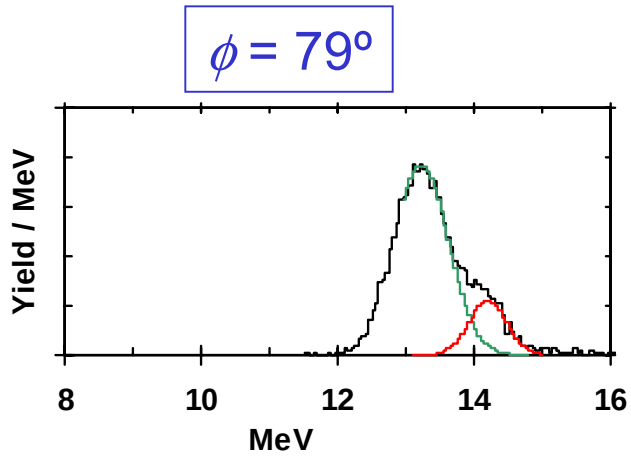


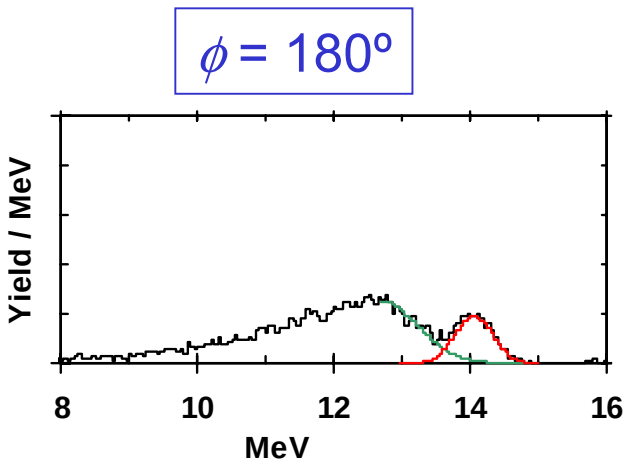


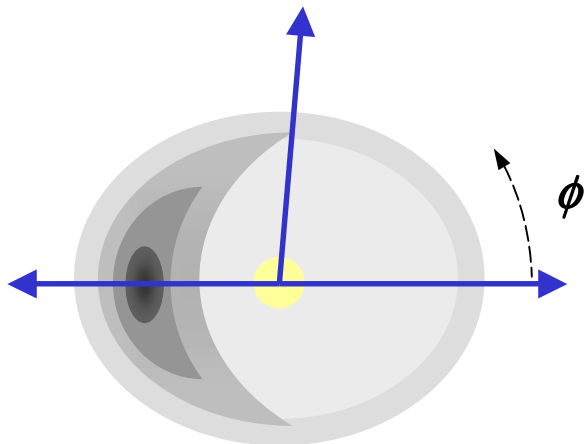


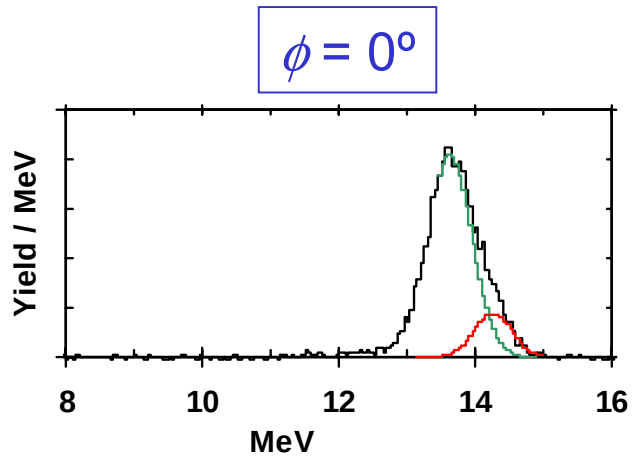


With a 50-μm offset, spectra (and ρR) are different at different angles



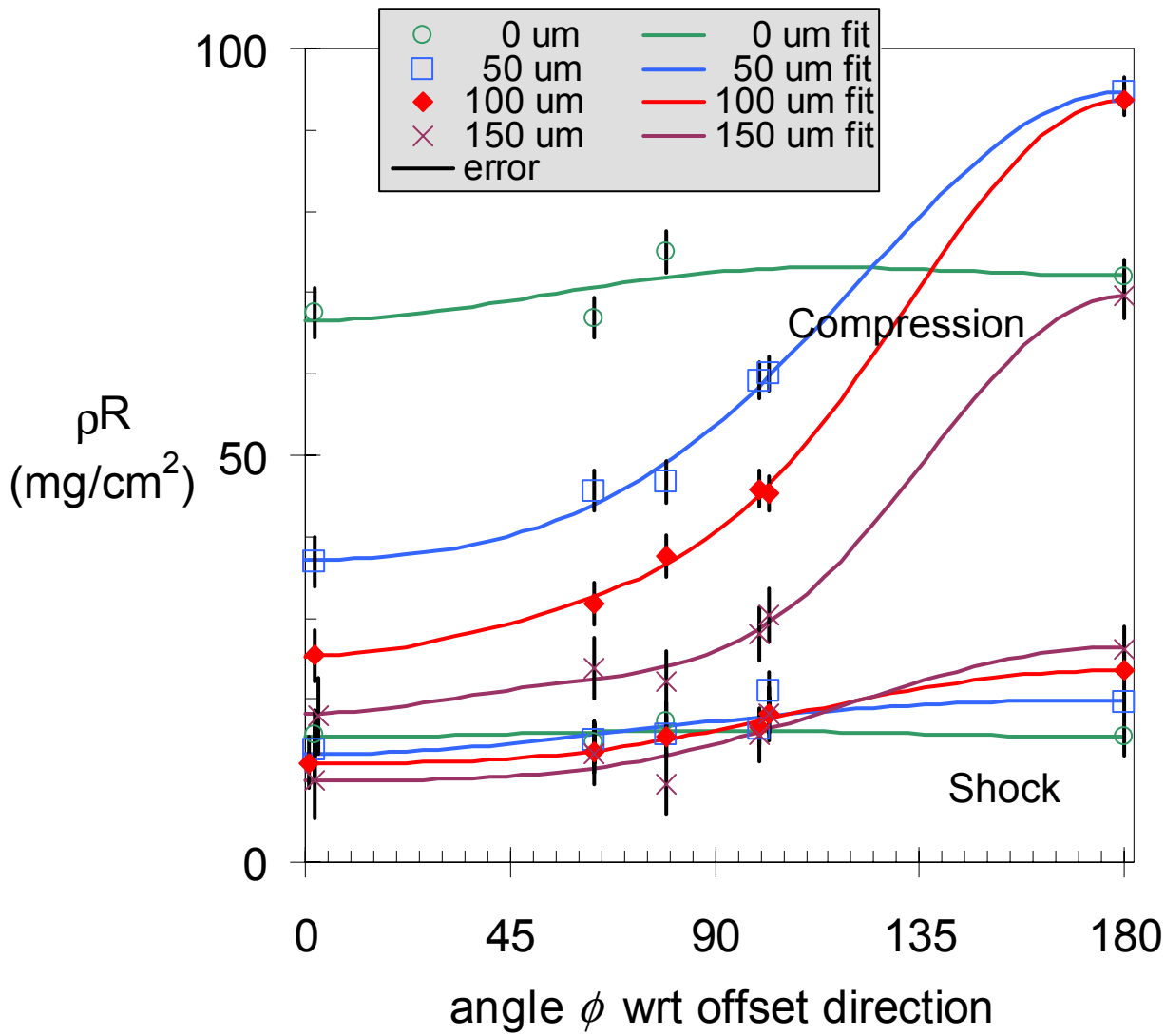




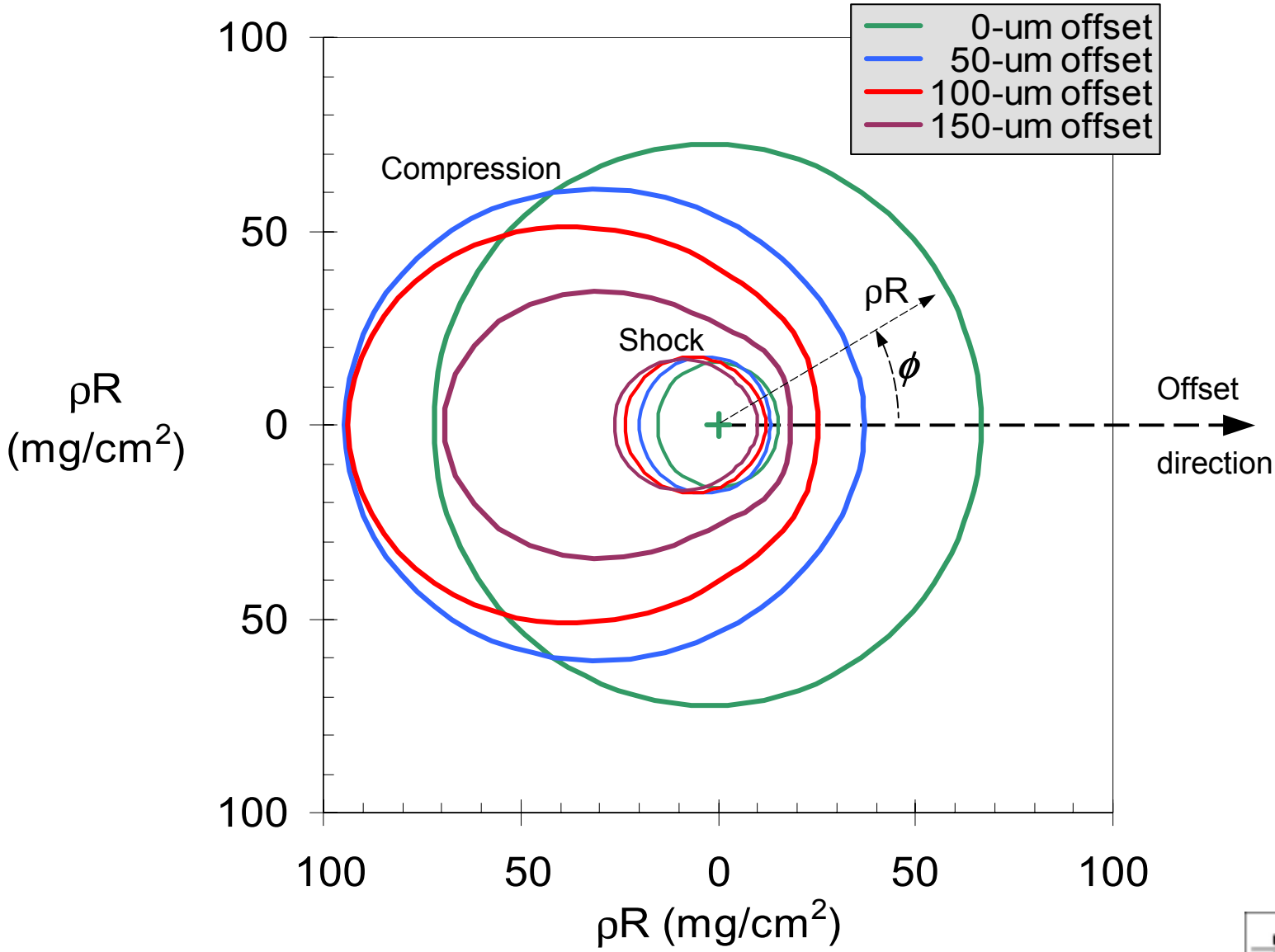


Direction of offset

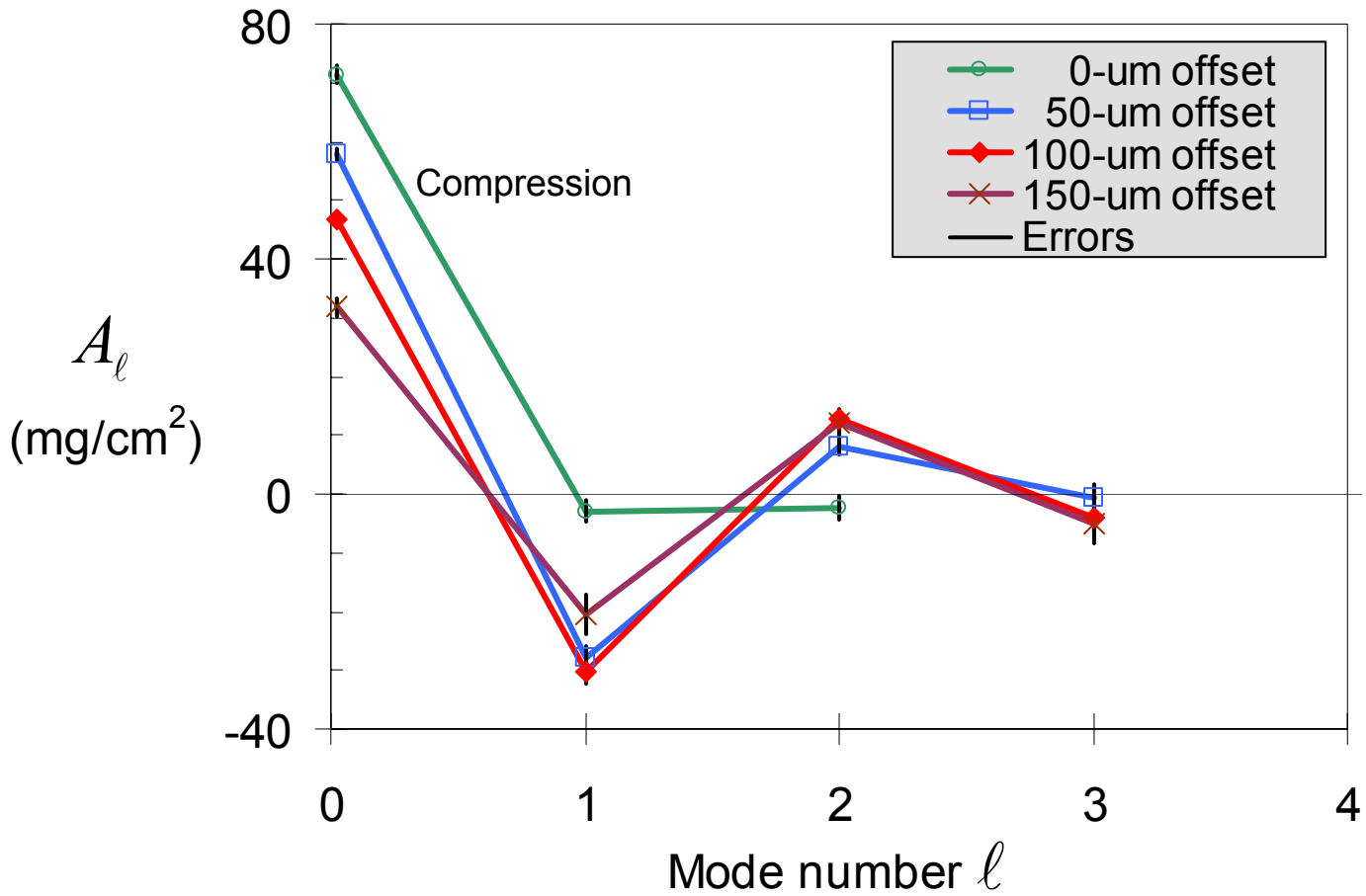
ρR measurements can be plotted and fit with $\rho R(\phi) = \sum_{\ell} A_{\ell} P_{\ell}(\cos(\phi))$



Another way to show the deduced ρR *vs* ϕ



Mode amplitudes for the fits $\rho R(\phi) = \sum_{\ell} A_{\ell} P_{\ell}(\cos(\phi))$



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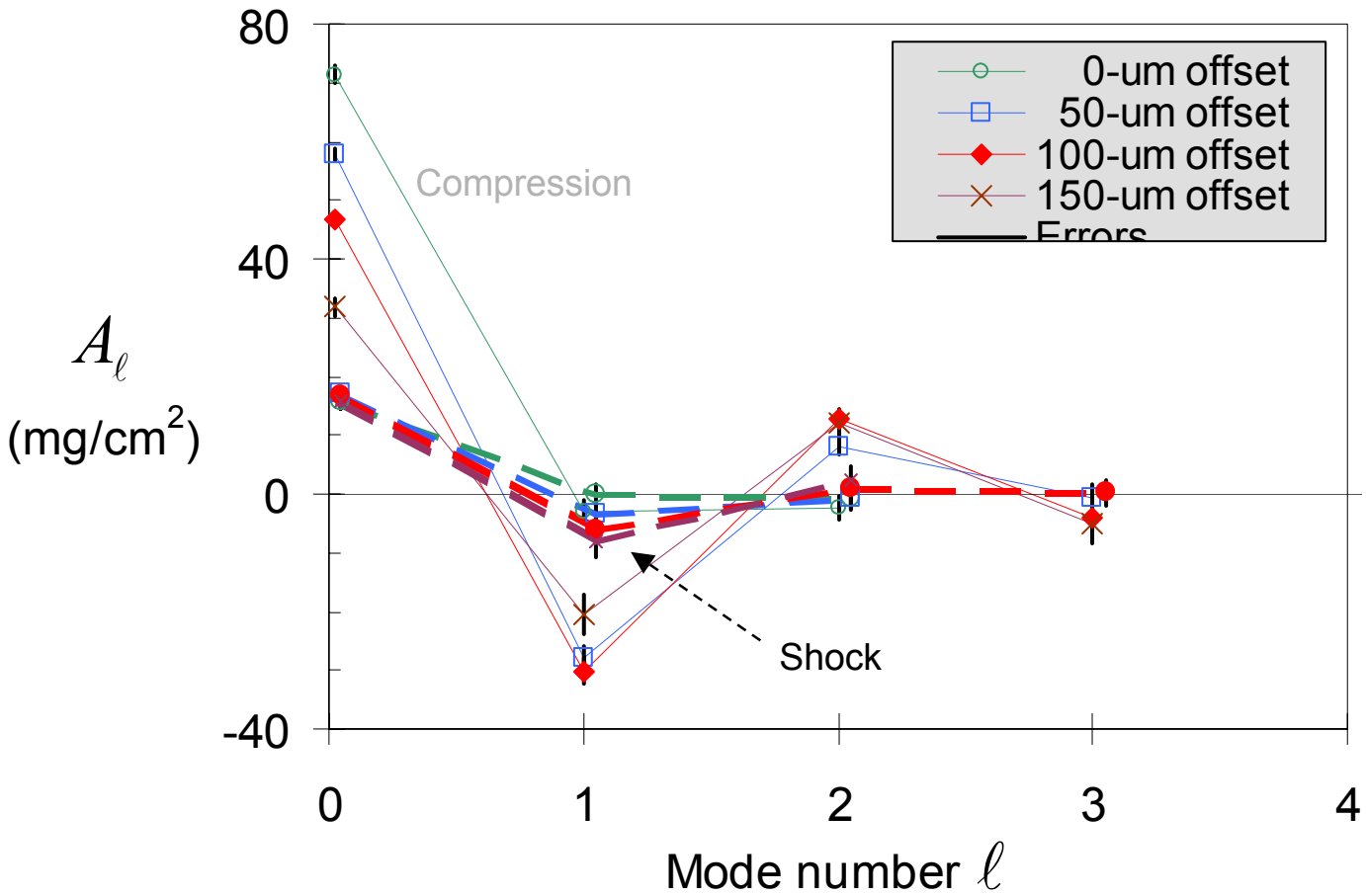
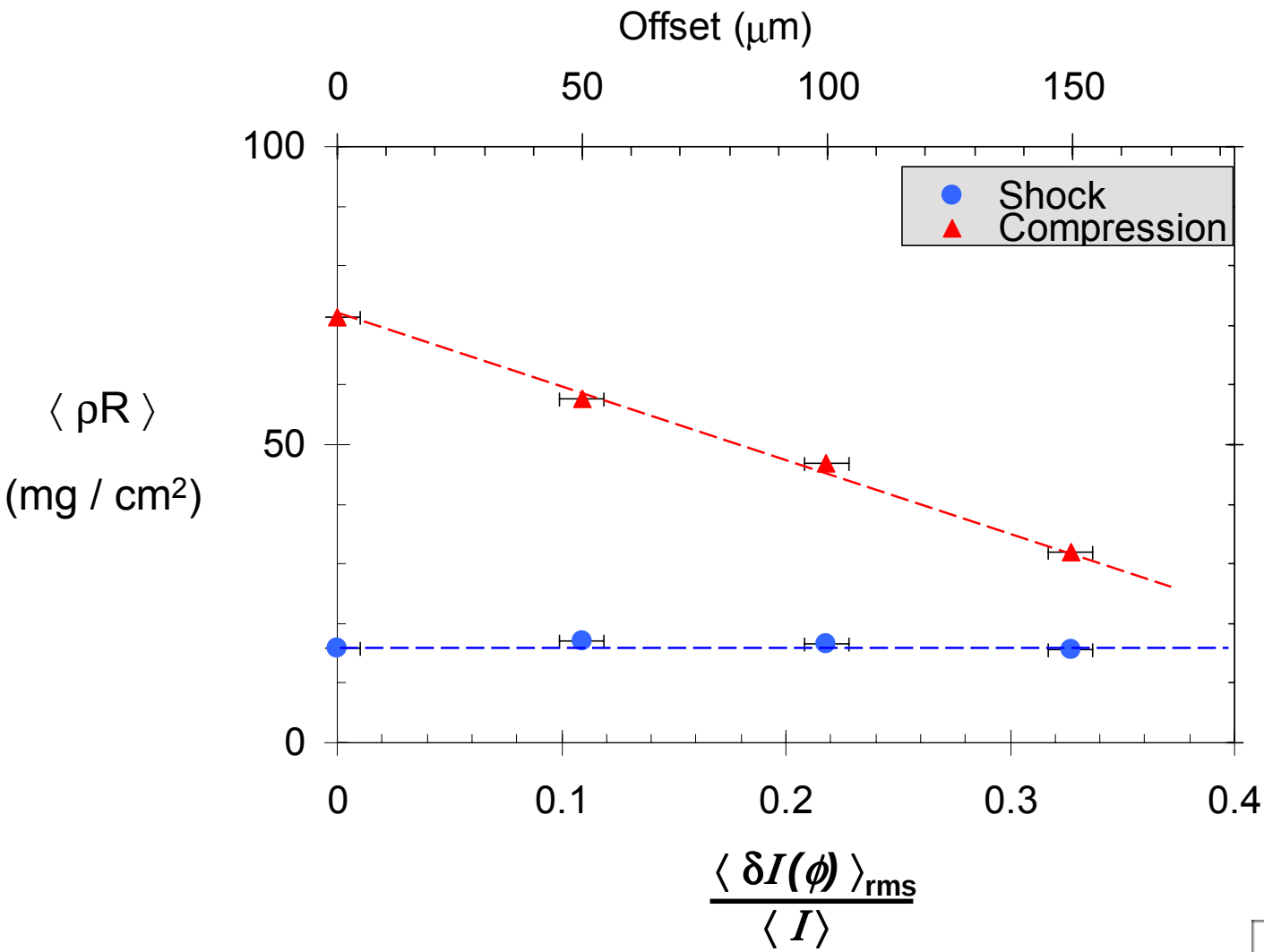


⟨ ρR ⟩ at shock time is independent of offset, while ⟨ ρR ⟩ at bang time decreases with offset

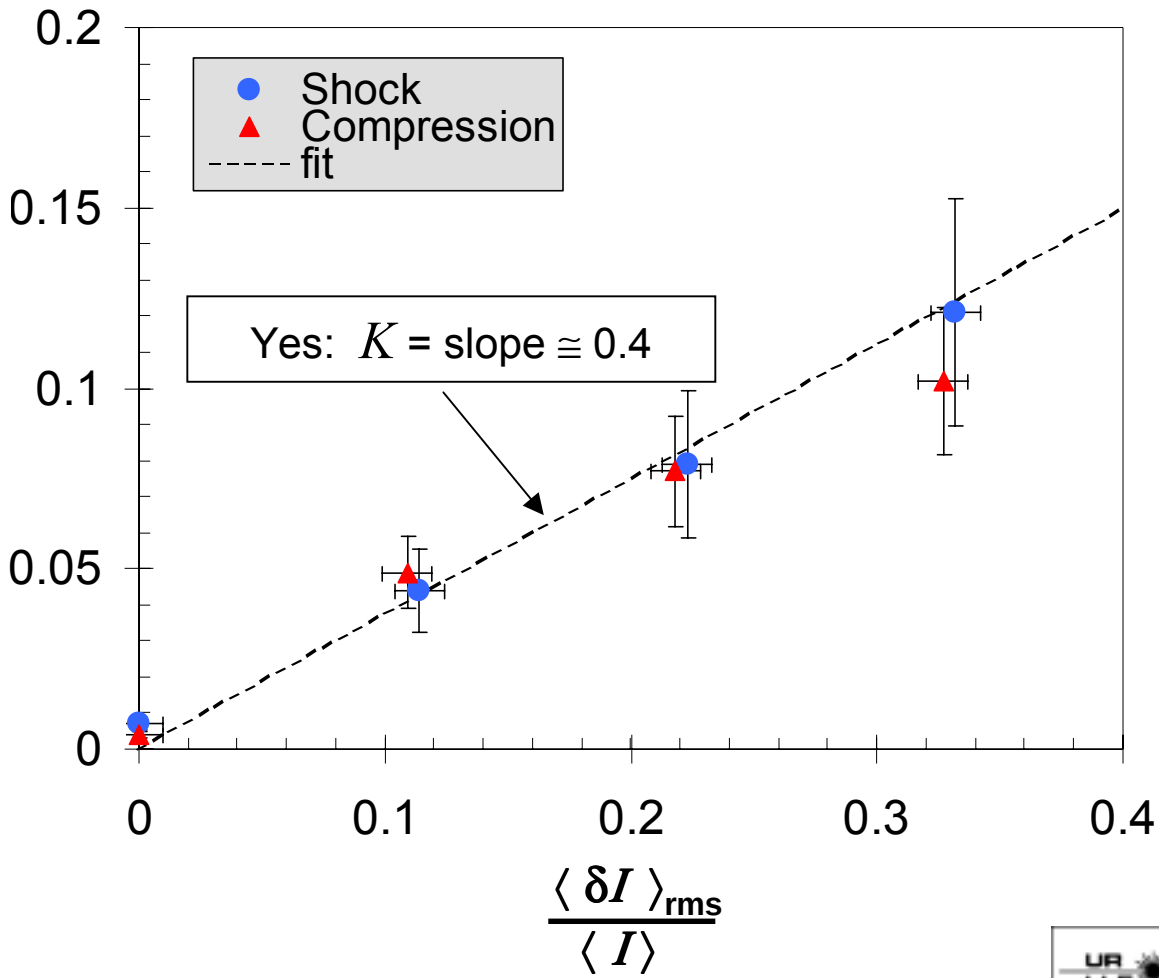


If we average $\delta\rho R(\phi)$ and $\delta I(\phi)$ over 4π, are they compatible with the previously-proposed scaling

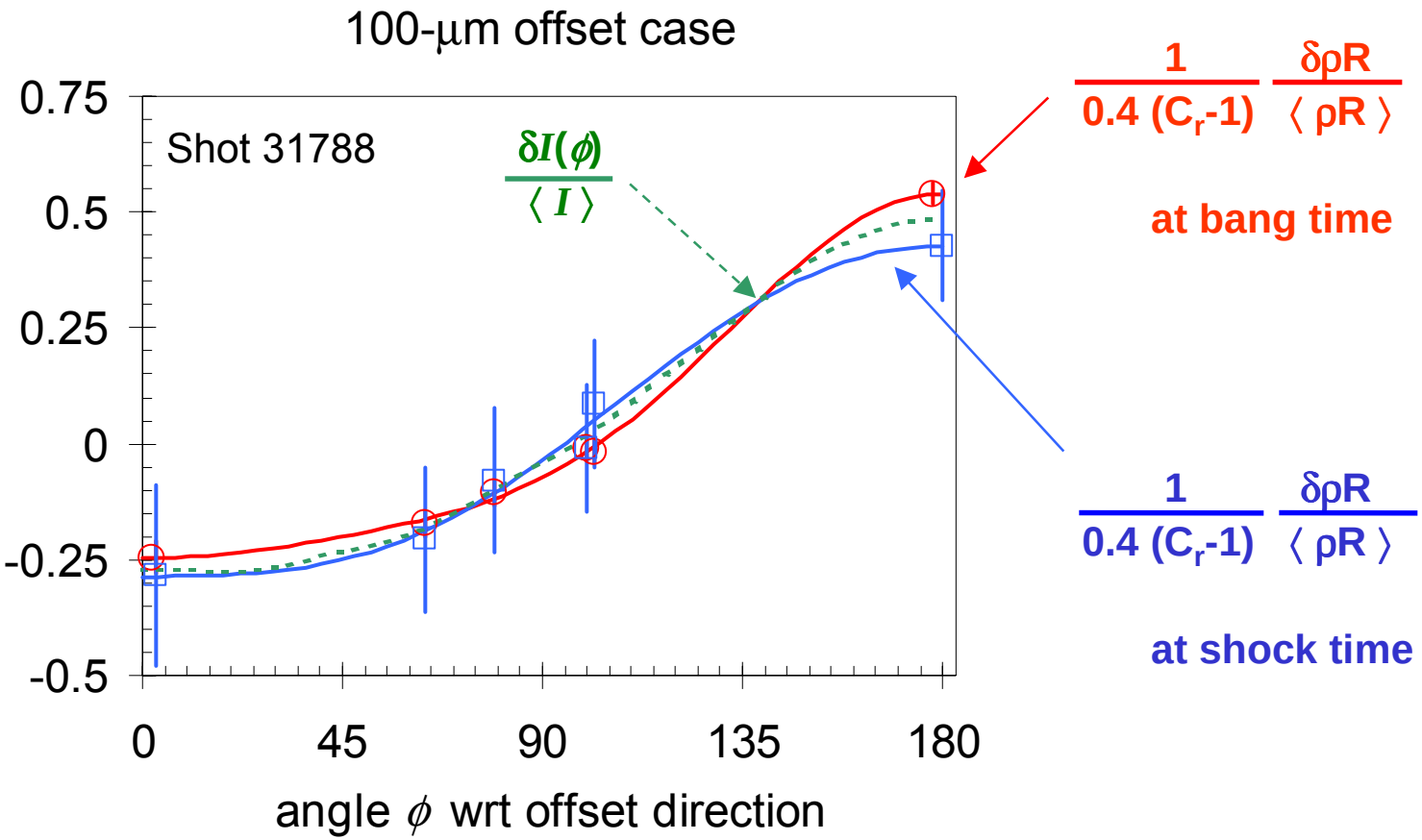
$$\frac{\langle \delta\, \rho R\rangle_{rms}}{\langle\, \rho R\rangle} = K\left(C_r - 1\right)\frac{\langle \delta\, I\rangle_{rms}}{\langle I\rangle}$$

?

$$\frac{1}{(C_r\text{-}1)}\ \frac{\langle\, \delta\rho R\,\rangle_{rms}}{\langle\, \rho R\,\rangle}$$



The angular dependence of the laser drive, $I(\phi)$, is carried through to $\rho R(\phi)$ at shock time and at bang time



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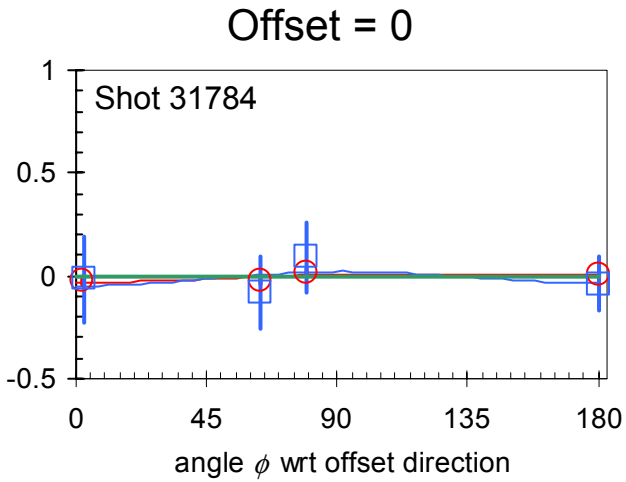

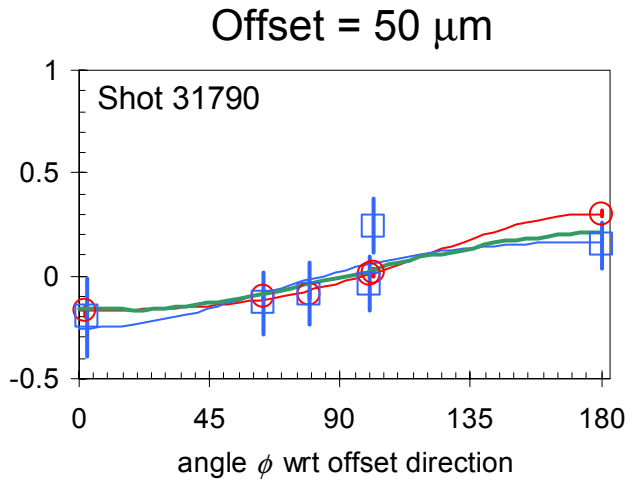

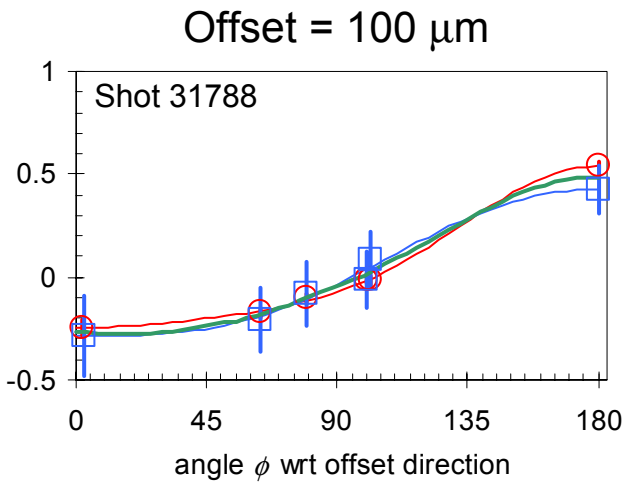

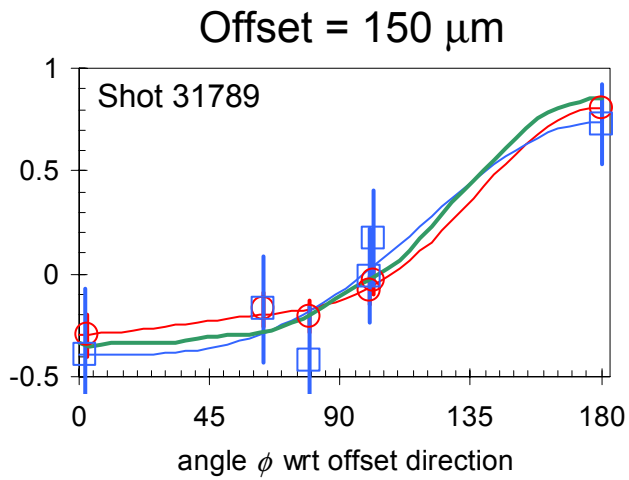

$$\frac{\delta I(\phi)}{\langle I \rangle}$$

$$\frac{1}{0.4\,(C_r\text{-}1)}\,\frac{\delta \rho R(\phi)}{\langle \rho R \rangle}$$

at shock time

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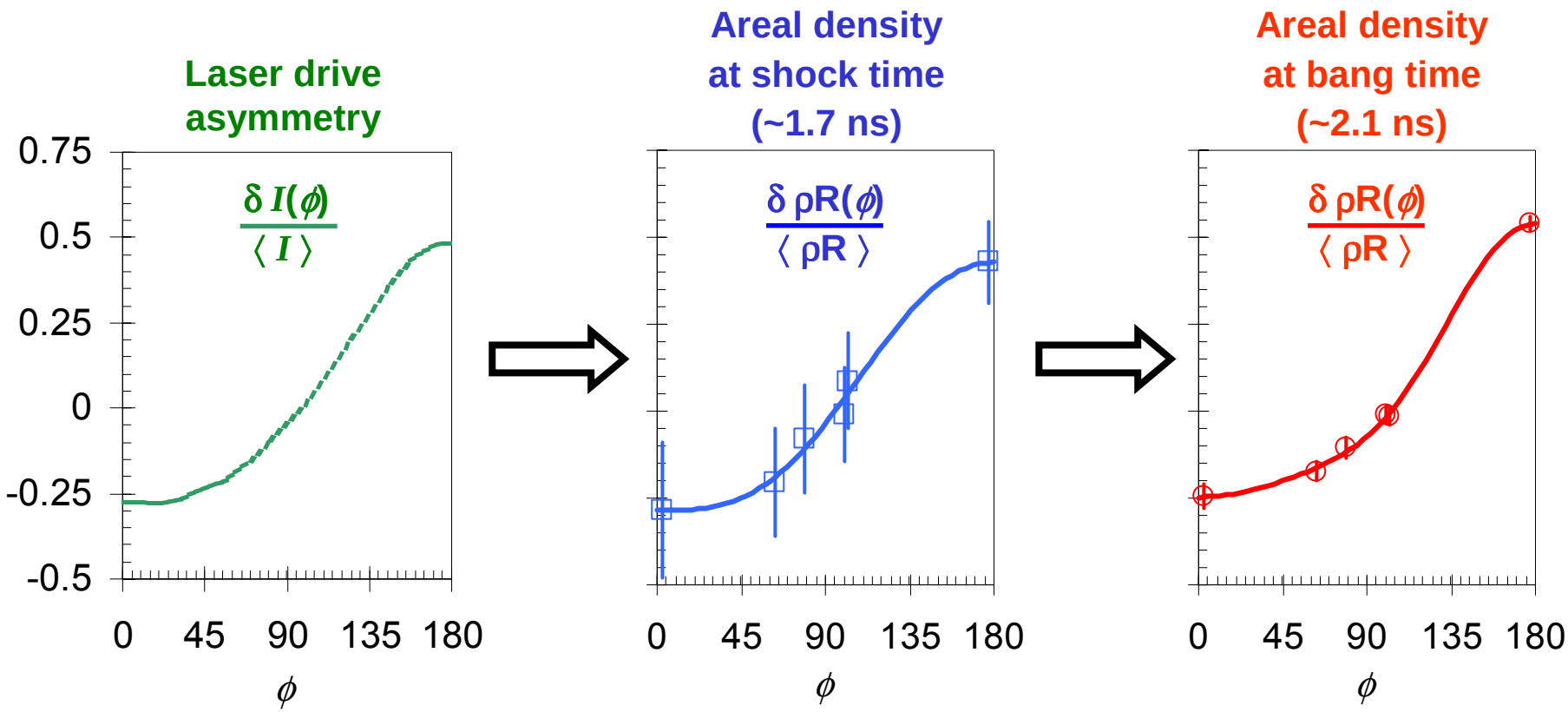

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