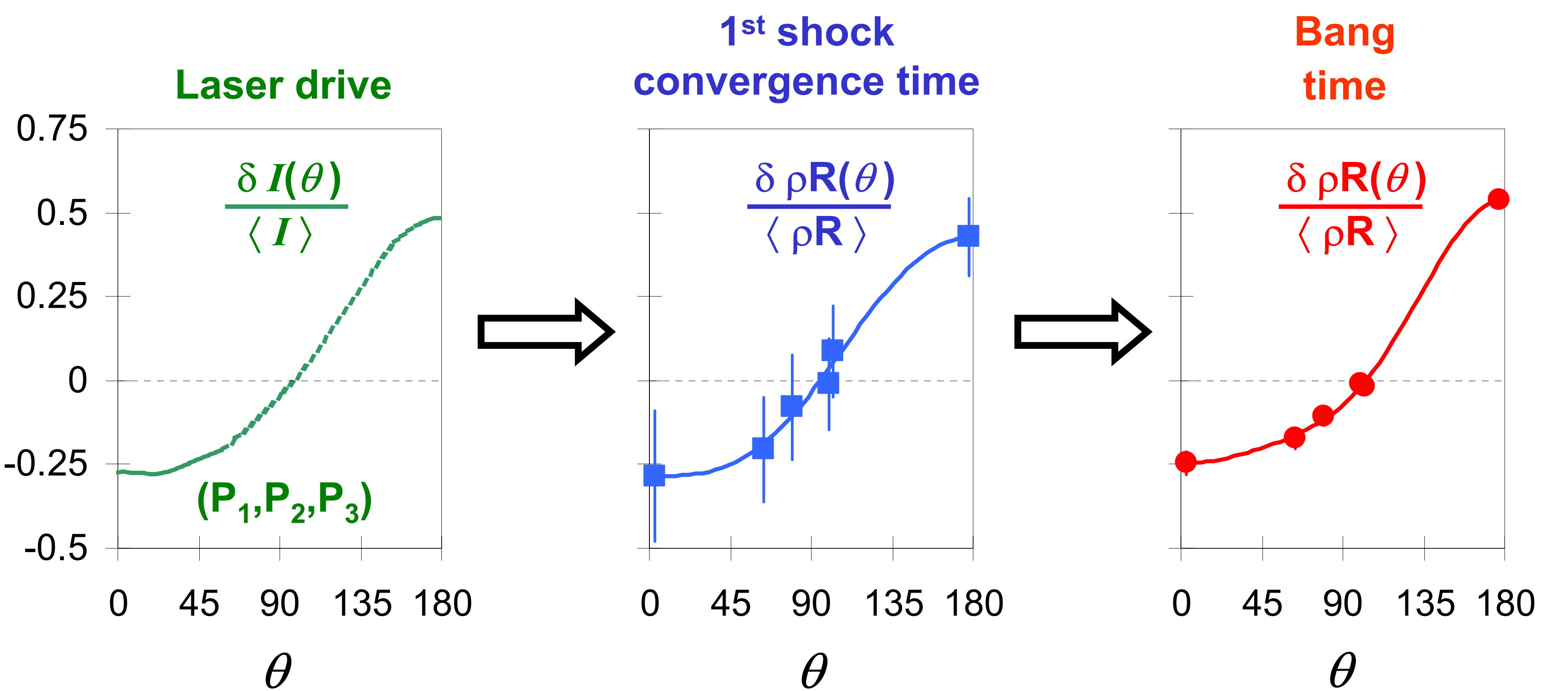
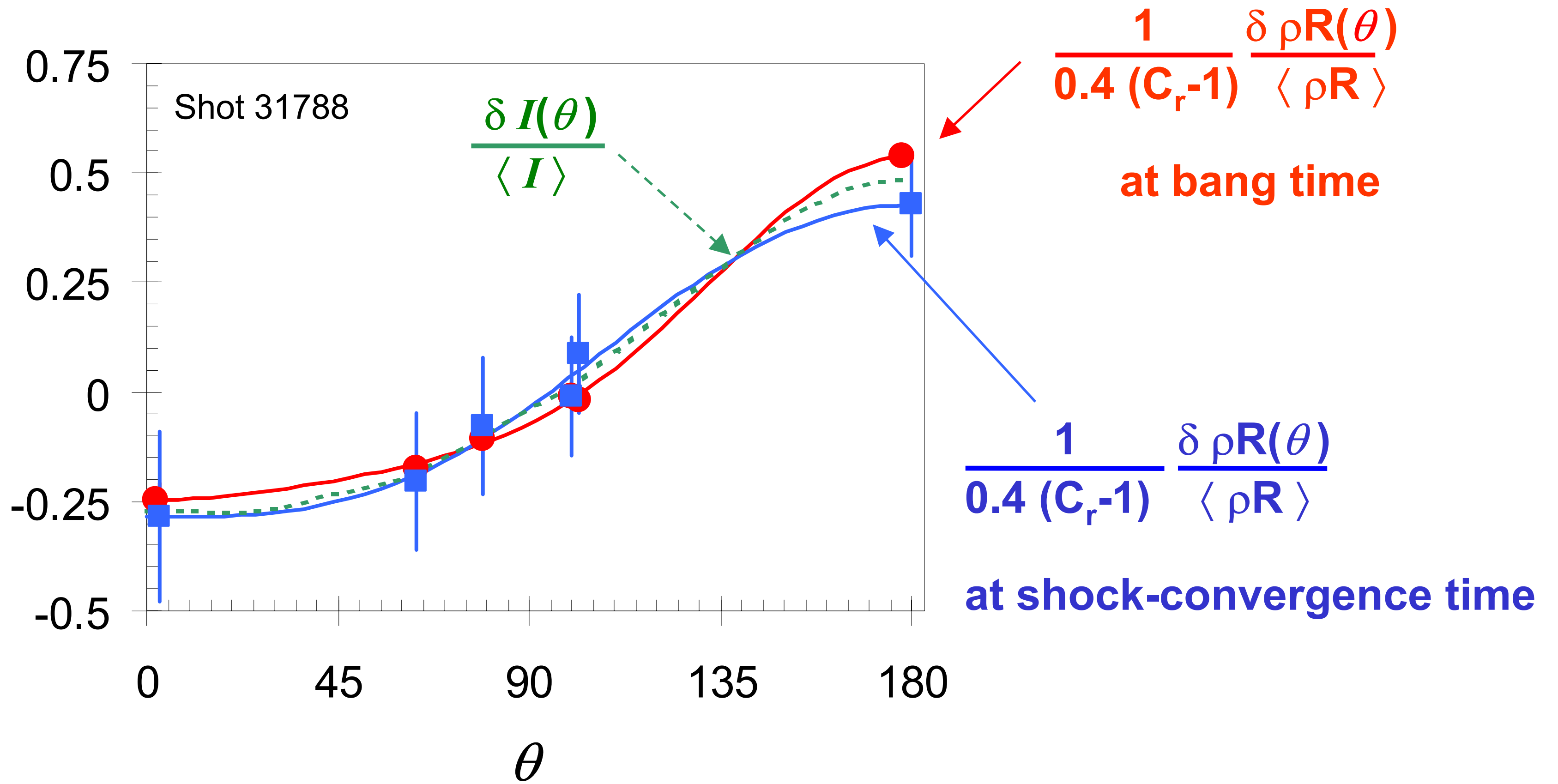
ρR-asymmetry time evolution following low-mode drive asymmetry at OMEGA



Fredrick H. Séguin *et al.*
Massachusetts Institute of Technology
Plasma Science and Fusion Center

45th APS DPP Meeting, 2003

ρR-asymmetry time evolution following low-mode drive asymmetry at OMEGA



Fredrick H. Séguin *et al.*
Massachusetts Institute of Technology
Plasma Science and Fusion Center

Summary

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

- o $\delta\, I(\theta)$ produces $\delta\, \rho R(\theta)$ with the same shape;

- o $\delta\rho R(\theta)$ maintains that shape throughout the implosion
  - – different modes grow at the same rate; no phase inversions

- o Amplitudes depend primarily on the radial convergence ratio C_r:

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

Collaborators

M.I.T.
Plasma Science
and Fusion Center

J.R. Rygg
J.A. Frenje
C.K. Li
R.D. Petrasso*

University of Rochester
Laboratory for
Laser Energetics

J.A. Delettrez
V.Yu. Glebov
V. Goncharov
R.L. Keck
J. Knauer
F.J. Marshall
P.W. McKenty
D.D. Meyerhofer
T.C. Sangster
V. Smalyuk
J.M. Soures

Lawrence Livermore
National Laboratory

S. Hatchett

*Visiting Senior Scientist, LLE

Previous work with proton spectra indicated correlations between low-mode $I(\theta,\phi)$ and $\rho R(\theta,\phi)$ at OMEGA

- $\delta\ \rho R(\theta,\phi)$ growth due to spherical convergence effects should lead at bang time to*

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

and that data for both room-temperature and cryo D_2 capsules are roughly consistent with this growth if

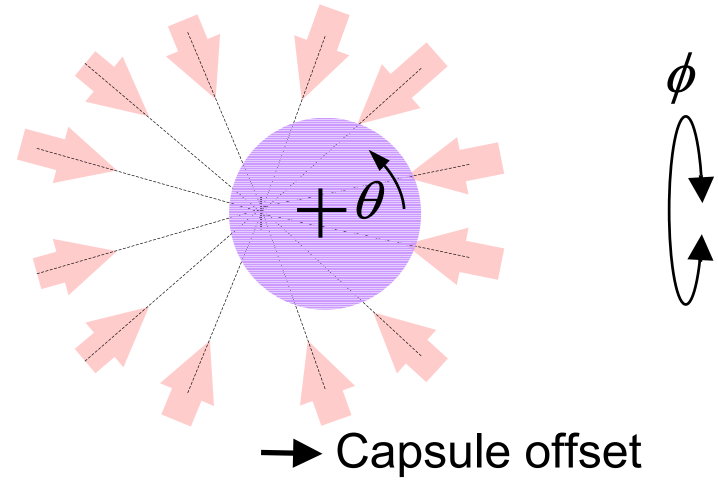
$$K \sim \frac{1}{2}$$

*C.K. Li *et al*., submitted to PRL

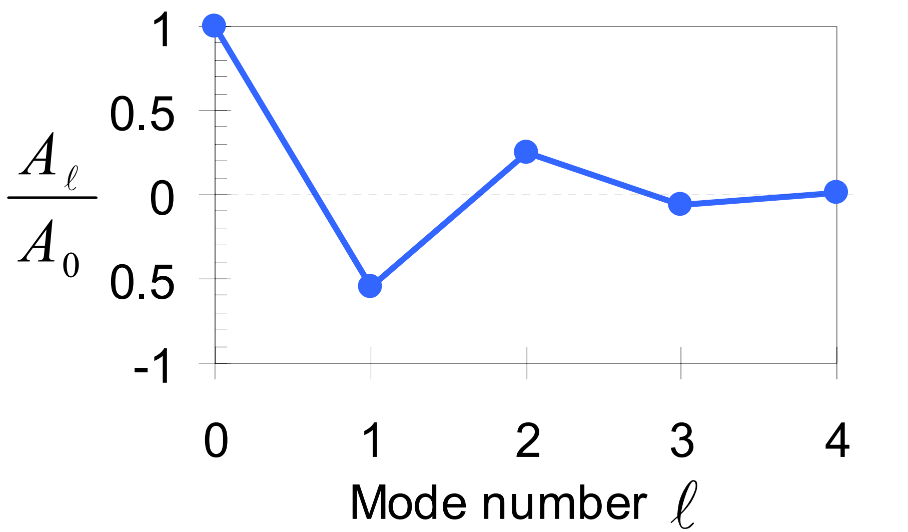
New experiments have been performed with controlled drive asymmetries

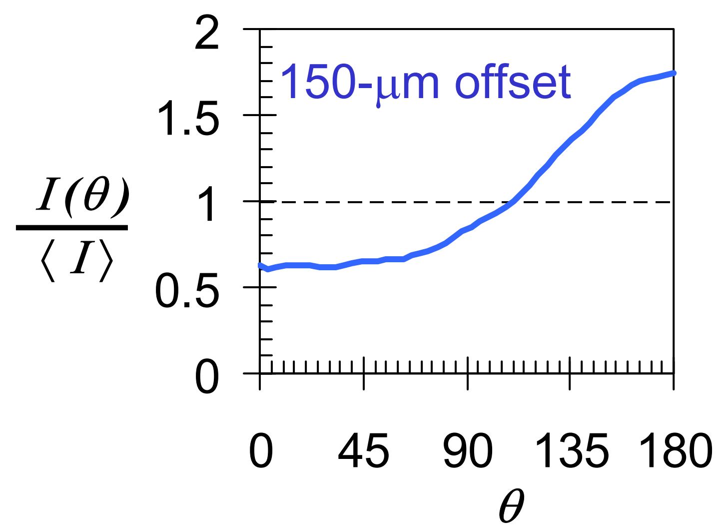
<u>60-Beam OMEGA laser</u>:

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

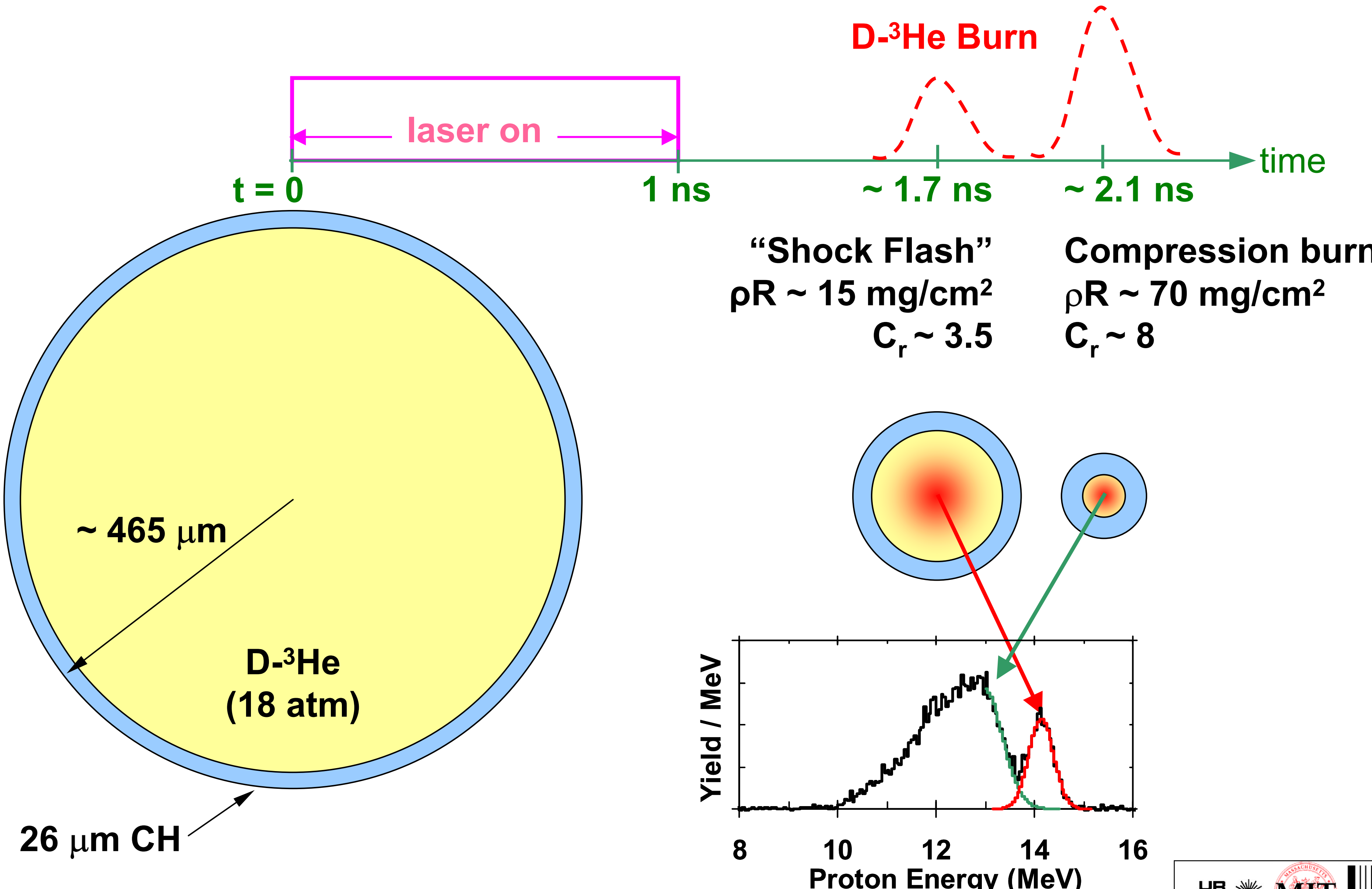


Asymmetry is dominated by P_1, P_2, P_3



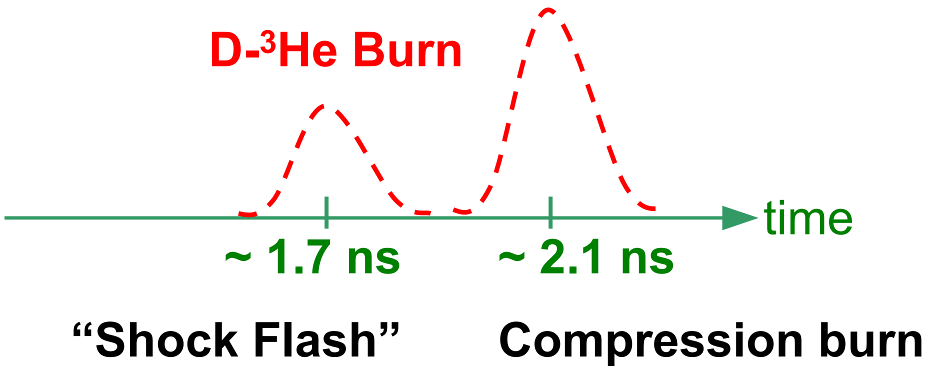


ρR was studied at two different times

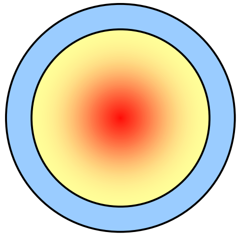


J.A. Frenje – FI2.004
PTD and ρR evolution

V.Yu. Glebov – UP1-007
PTD

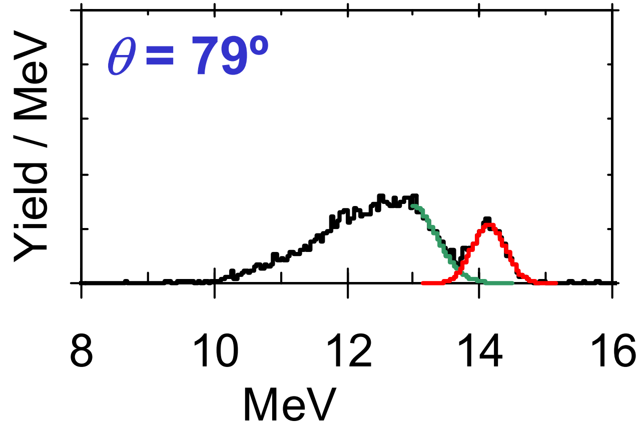


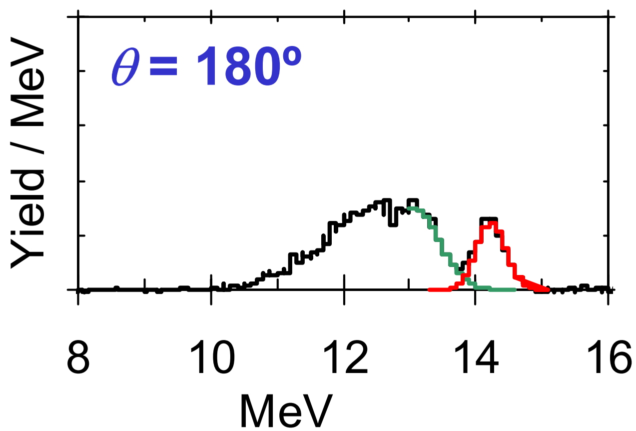
R.D. Petrasso – CO2.013
Dynamics of the shock convergence

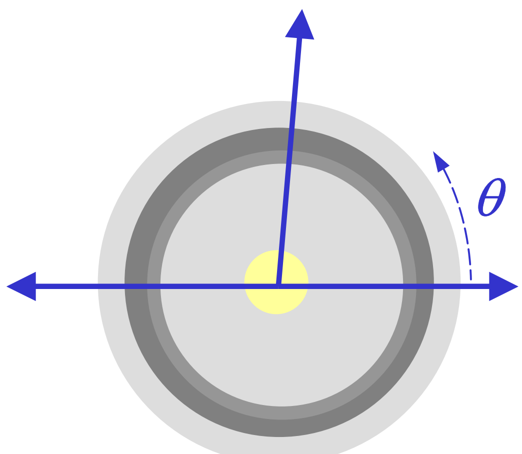


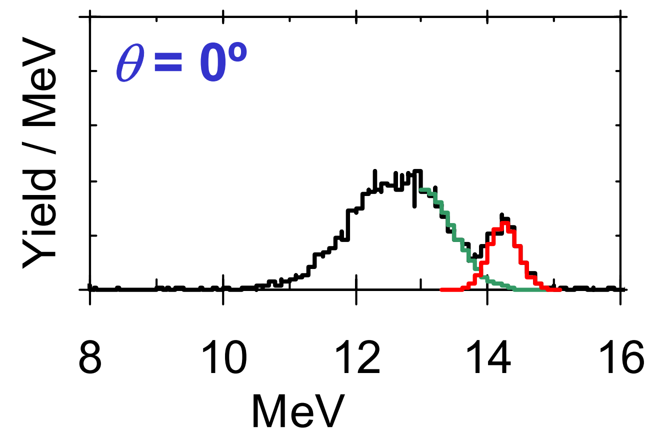
ρR was studied at different angles (typically 6)

Shot 31784:
offset = 0 μm



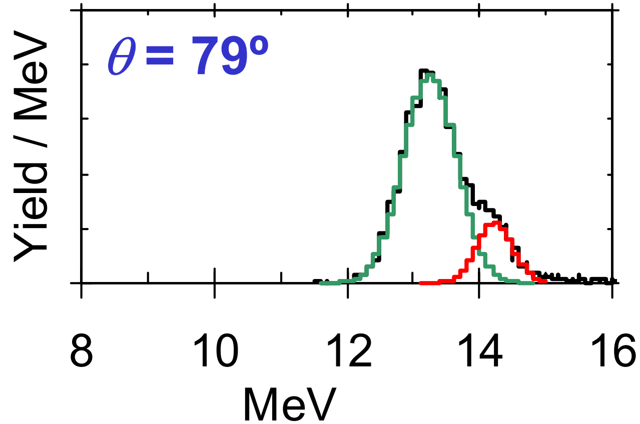


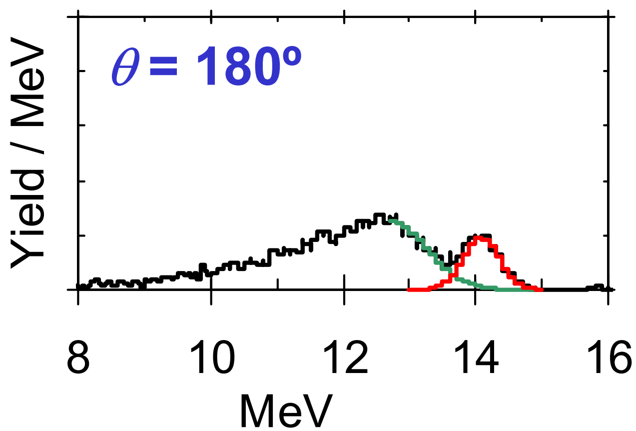


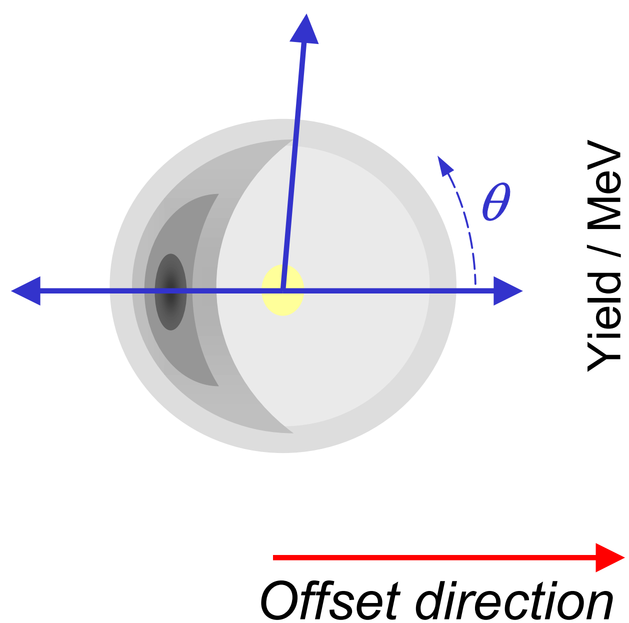


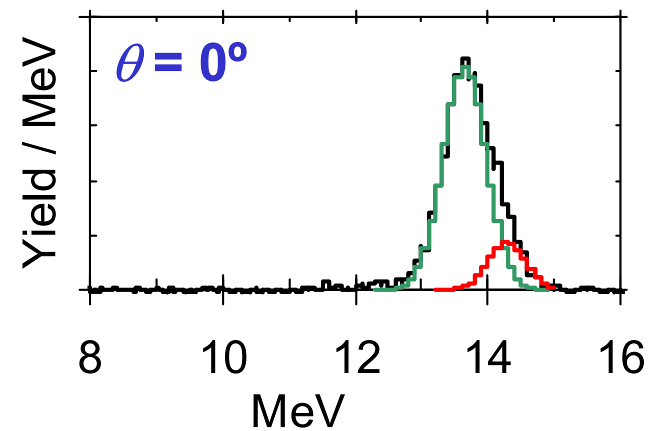
When the capsule was offset, spectra (and ρR) were different at different θ

Shot 31787:
offset = 50 μm



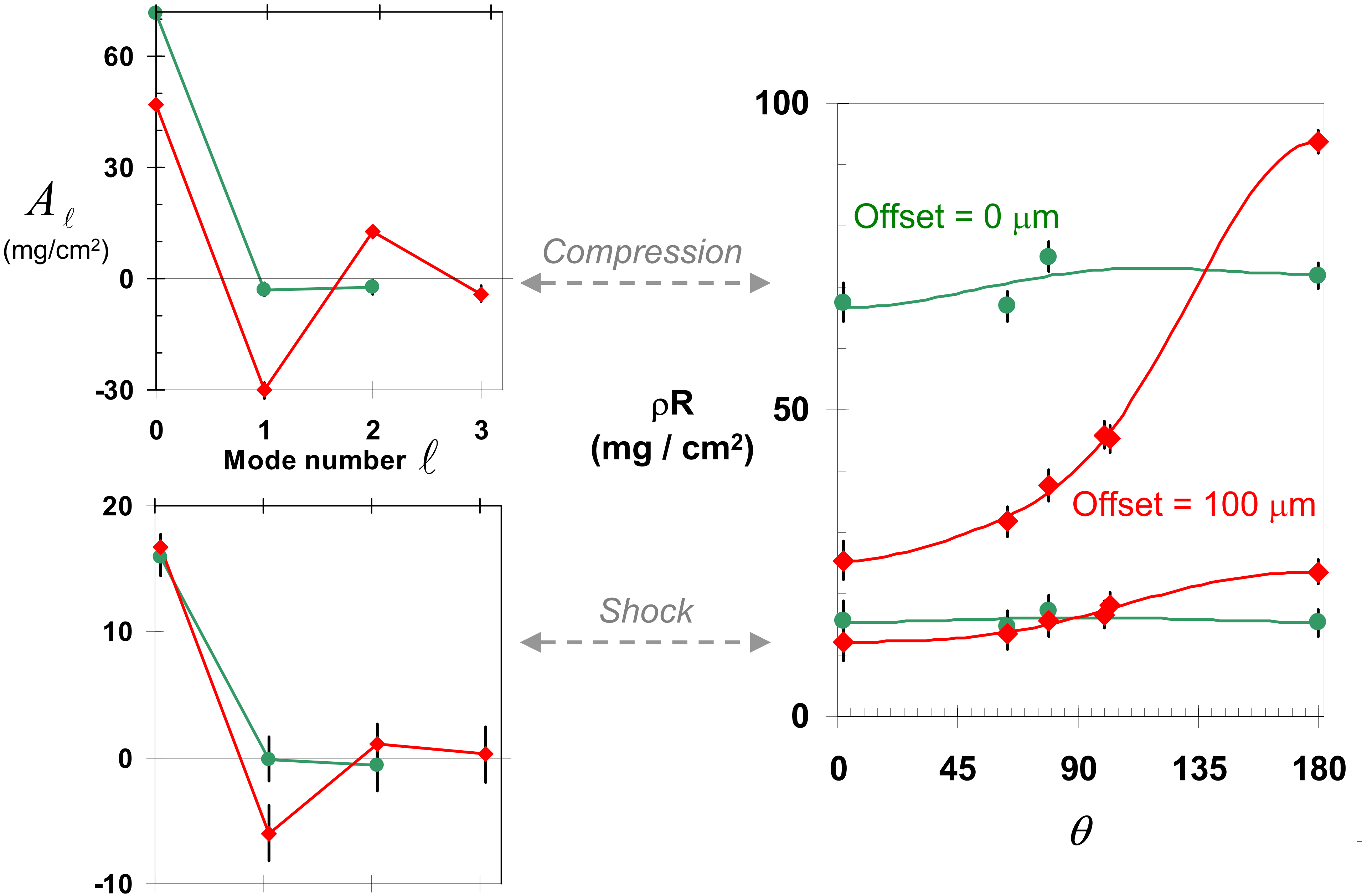




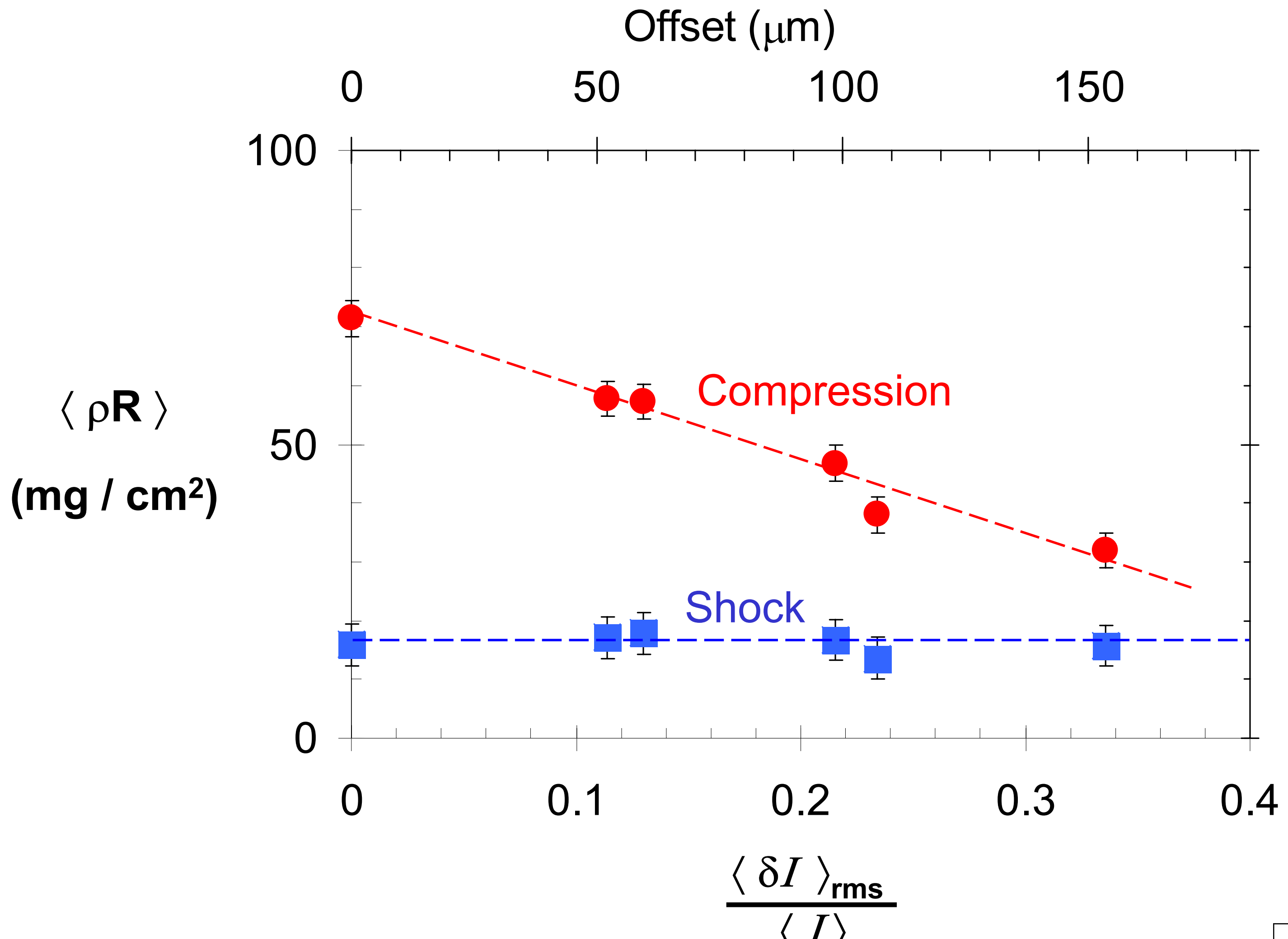


UR LLE MIT

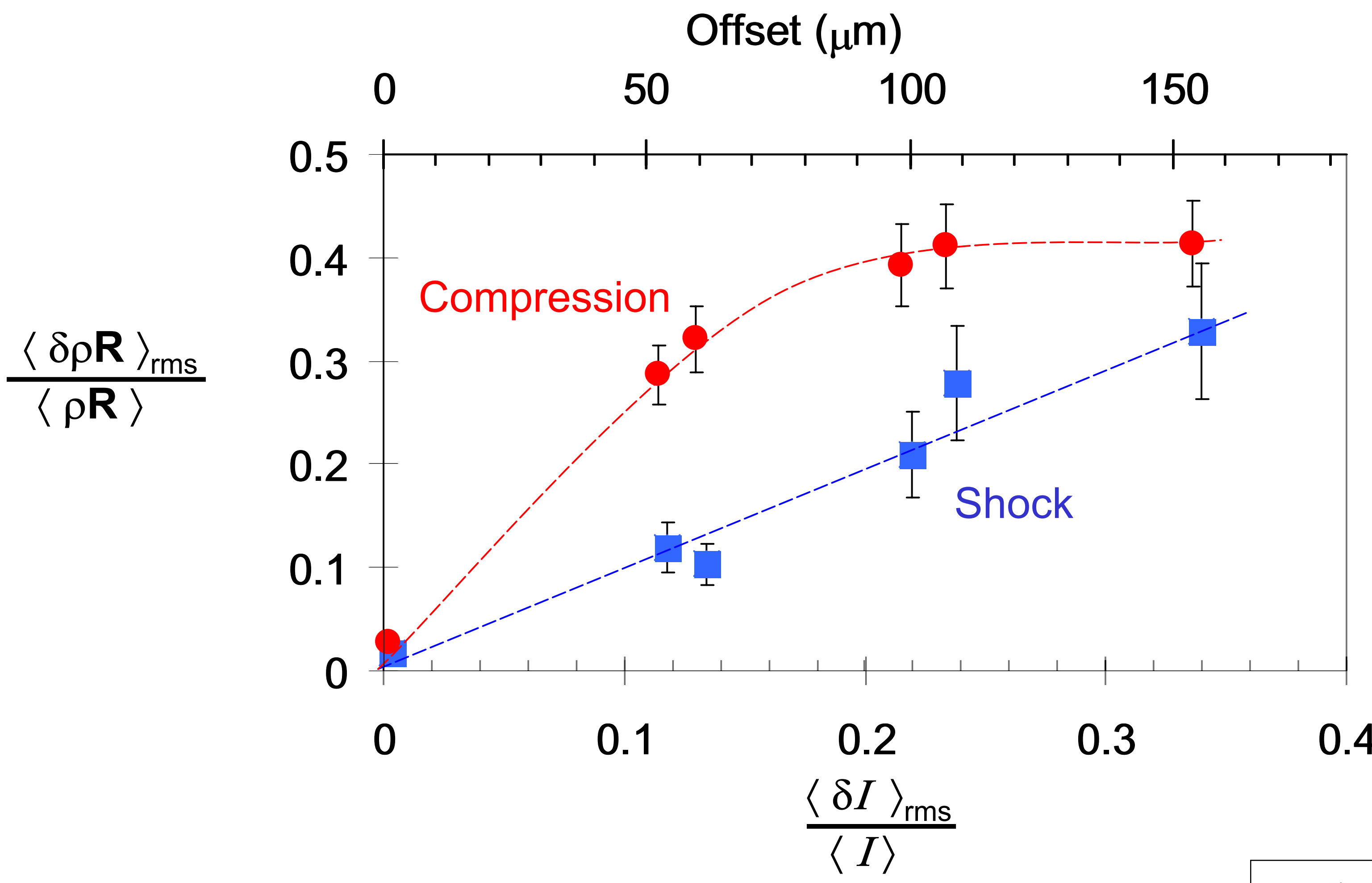
Fitting with $\rho R(\theta) = \sum_{\ell} A_\ell P_\ell(\cos\theta)$ gives us mode amplitudes



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



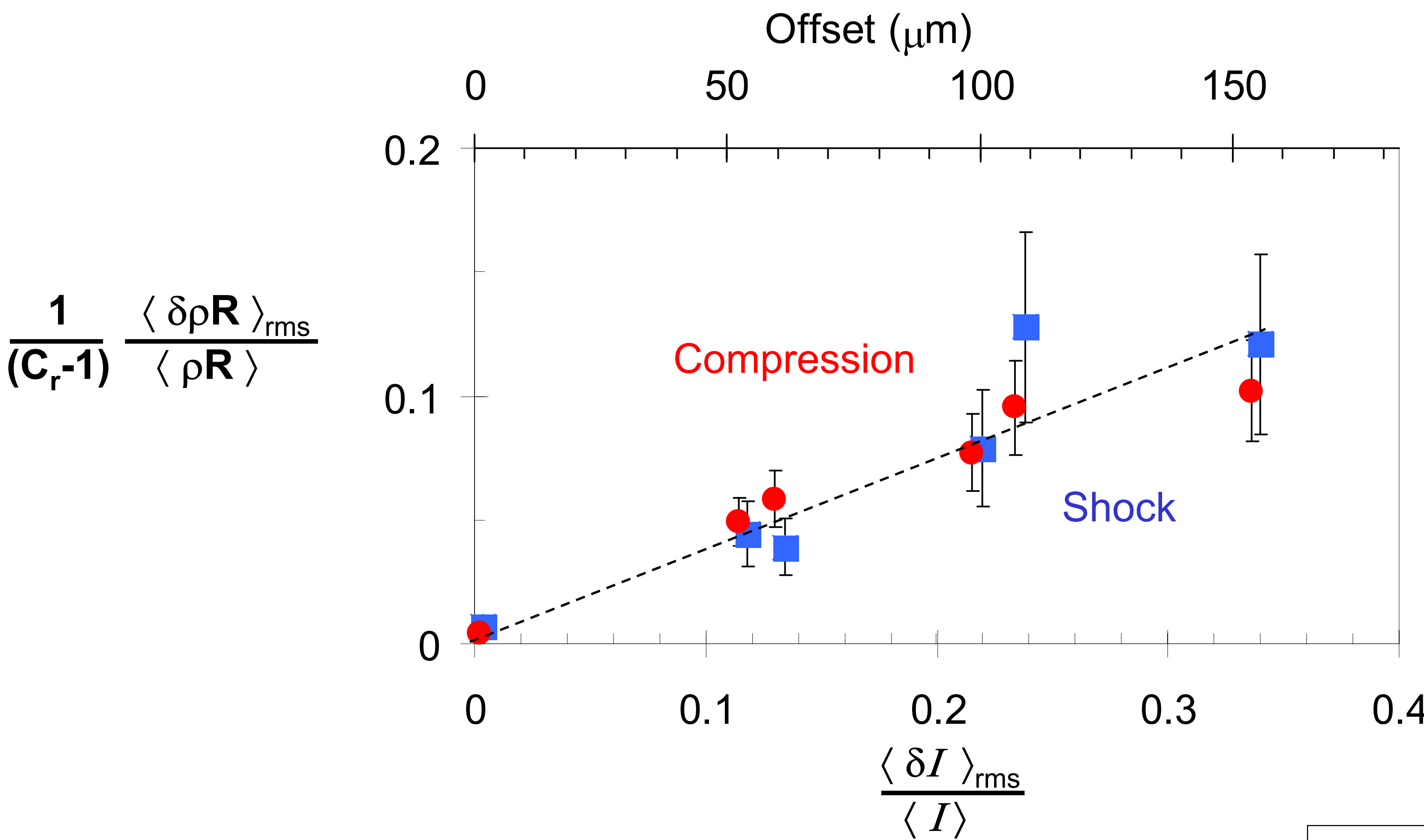
$$\frac{\langle \delta\rho\mathbf{R} \rangle}{\langle \rho\mathbf{R} \rangle} \neq K \frac{\langle \delta I \rangle}{\langle I \rangle}$$



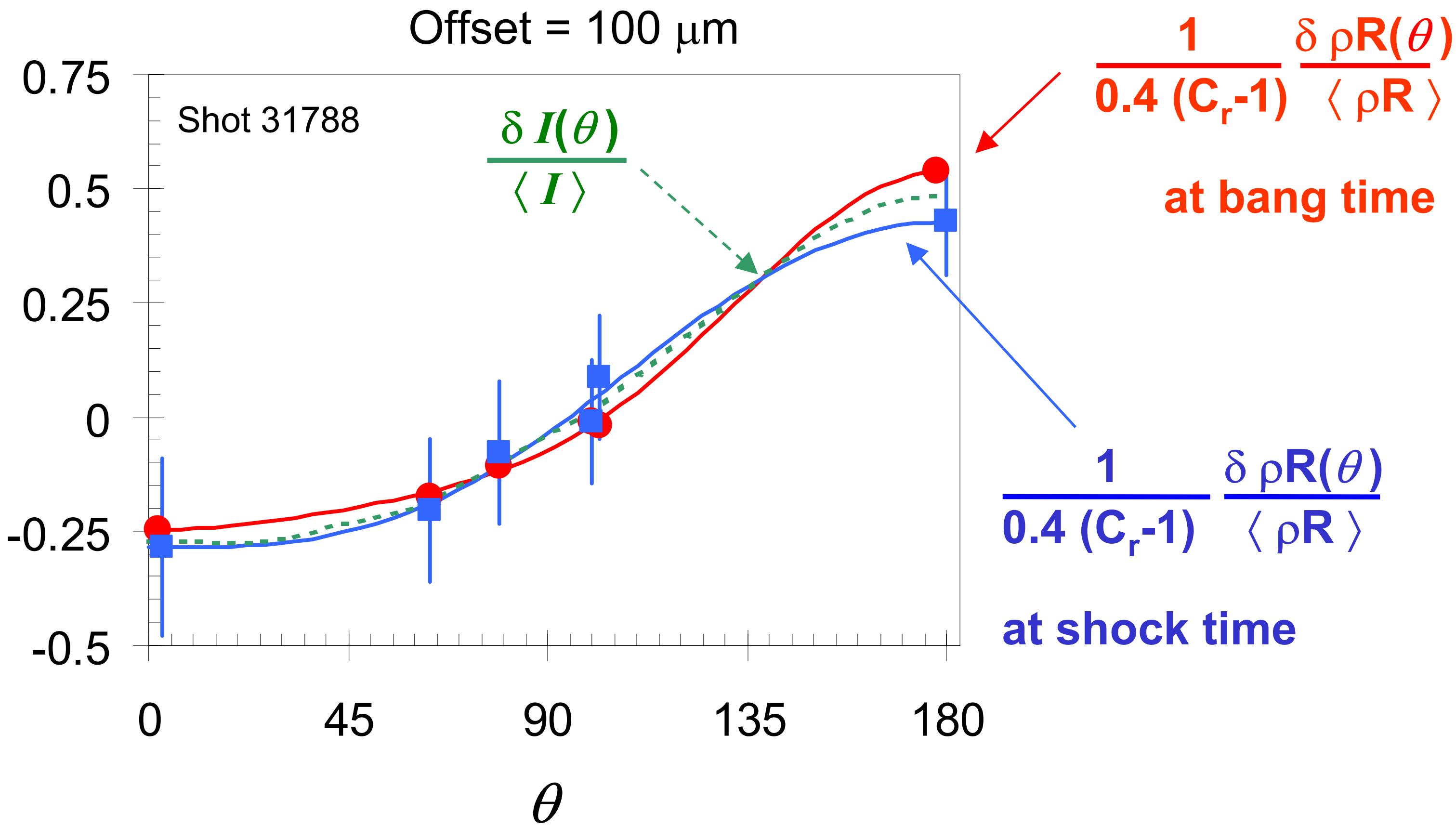
The previously-proposed scaling

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

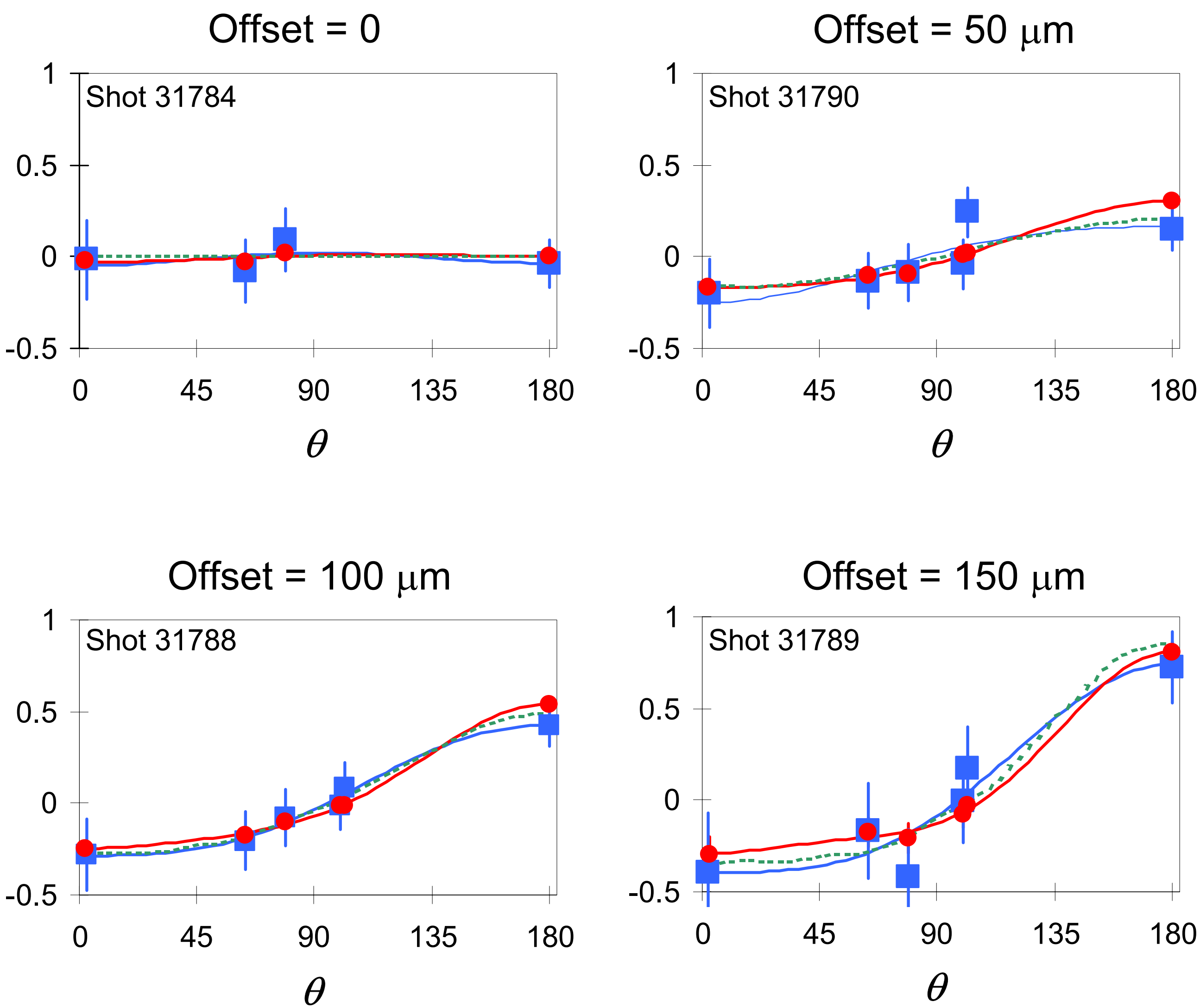
works at different times with $K \approx 0.4$



The angular dependence of $I(\theta)$ is carried through to ρR at shock time and at bang time



The angular dependence of $I(\theta)$ is carried through to ρR at shock time and at bang time



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

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

at bang time

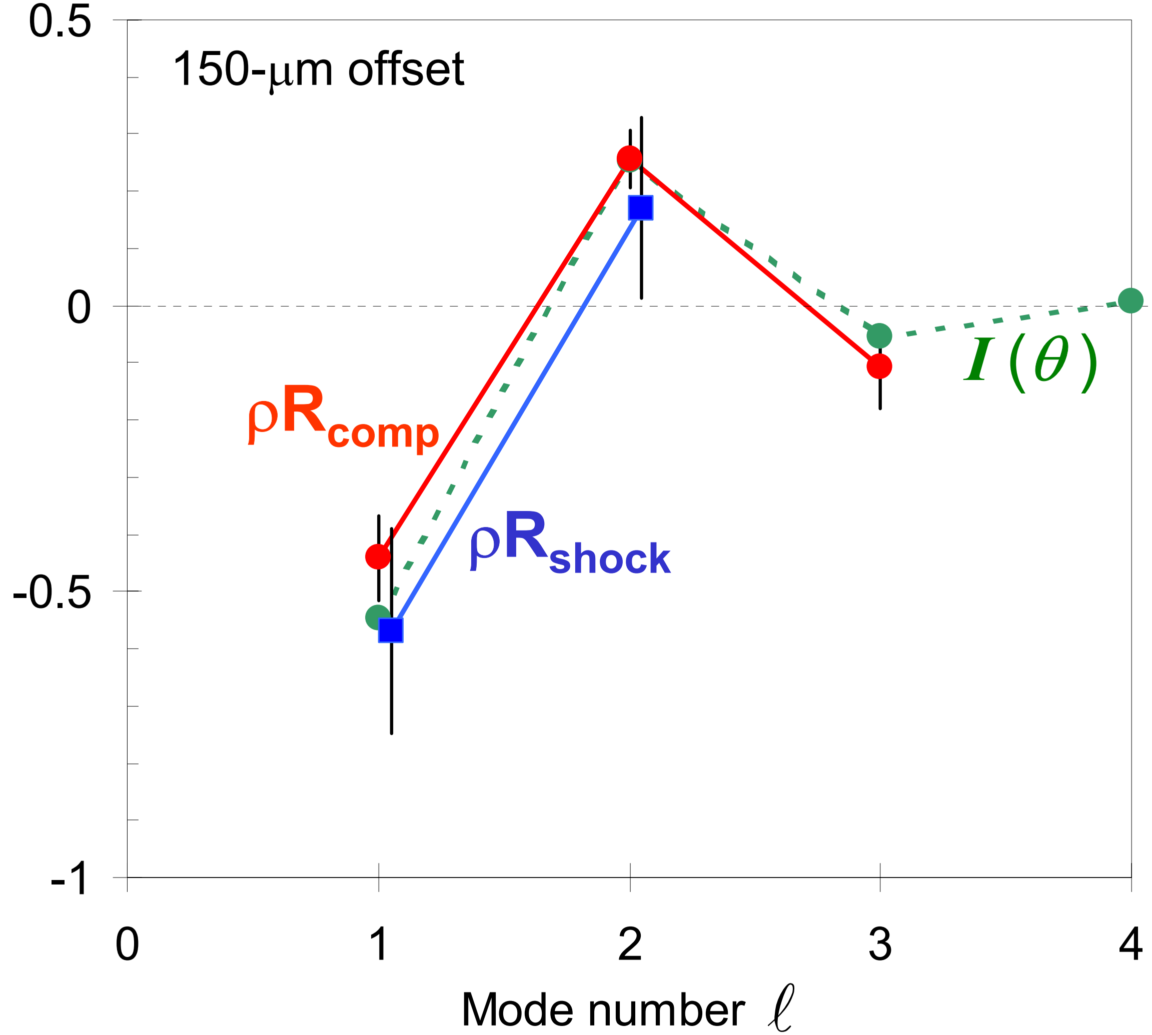
$$\frac{1}{0.4\,(C_r-1)}\;\frac{\delta\,\rho R(\theta)}{\langle \rho R \rangle}$$

at shock time

Individual mode amplitudes scale as predicted

$$\frac{A_\ell}{A_0} \quad \text{for} \quad I(\theta)$$

$$\frac{1}{0.4\,(C_r-1)}\,\frac{A_\ell}{A_0} \quad \text{for} \quad \rho R(\theta)$$



Summary

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

- $\delta I(\theta)$ produces $\delta\, \rho R(\theta)$ with the same shape;

- $\delta\rho R(\theta)$ maintains that shape throughout the implosion
  - different modes grow at the same rate; no phase inversions

- Amplitudes depend primarily on the radial convergence ratio C_r:

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

Fredrick H. Séguin *et al.*
Massachusetts Institute of Technology
Plasma Science and Fusion Center