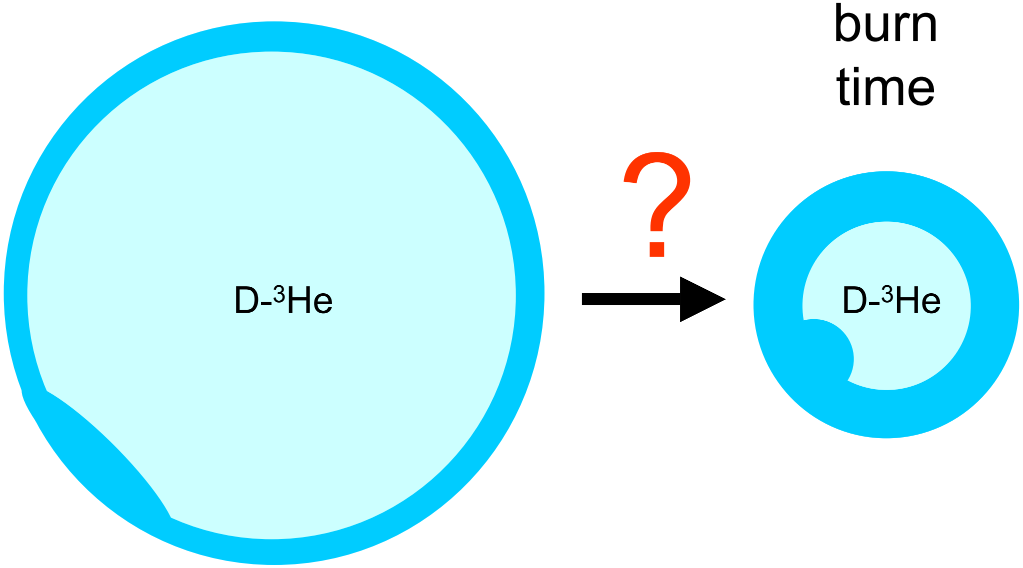
Measurement of ρR-asymmetry time evolution in implosions at OMEGA

An earlier time

Compression burn time



We routinely see low-mode ρR asymmetries at compression burn time.

Can we observe precursors at an earlier time and measure growth rates?

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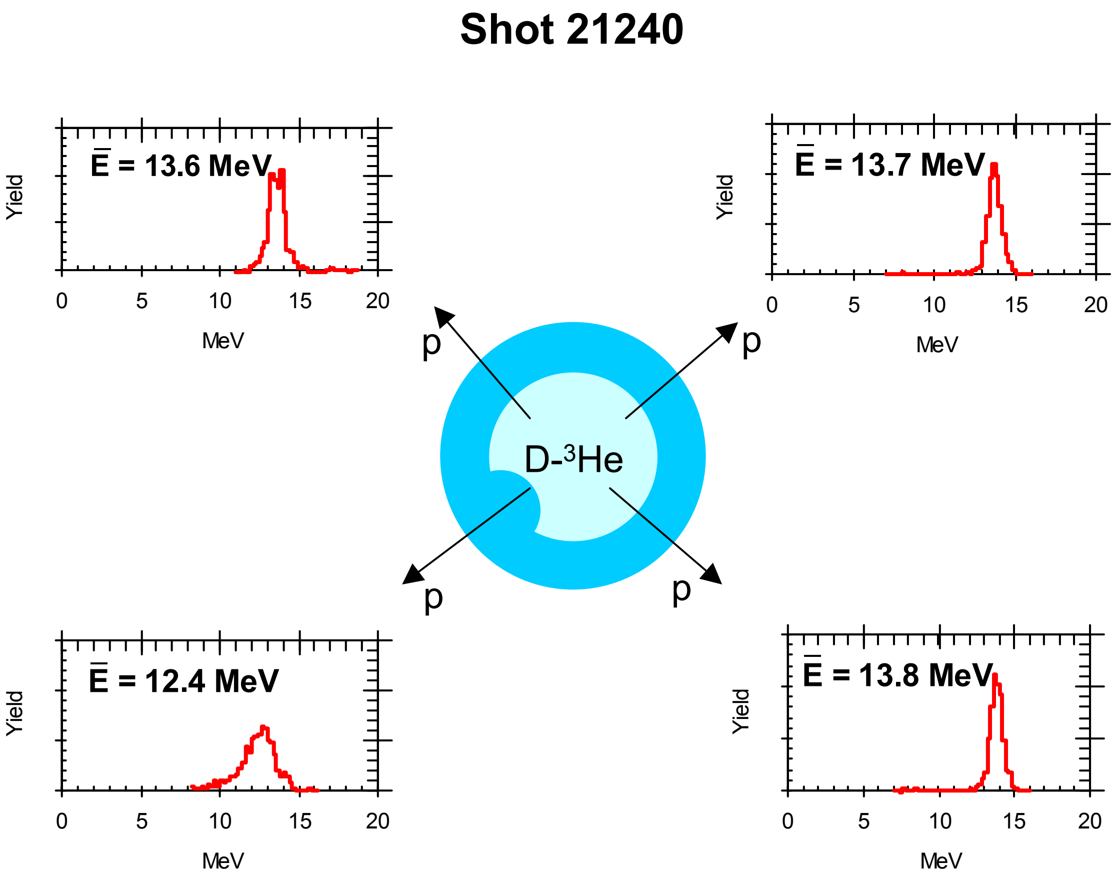
Outline

- How we measure ρR asymmetries
- How information about capsule structure at two distinct times is contained in spectra of 14.7-MeV D^3He protons
- Preliminary results indicating that low-mode-number ρR asymmetries at compression time have observable precursors ~400 ps earlier, and have been amplified by ~x10

Low-mode ρR asymmetries are observed by measuring D^3He proton energies at different angles



We measure:

$\bar{E}\,(\theta,\phi)$

$\Delta E\,(\theta,\phi) \equiv E_{birth} - \bar{E}\,(\theta,\phi)$

We infer:

$\rho R(\theta,\phi)$ $[\propto \Delta E\,(\theta,\phi)]$

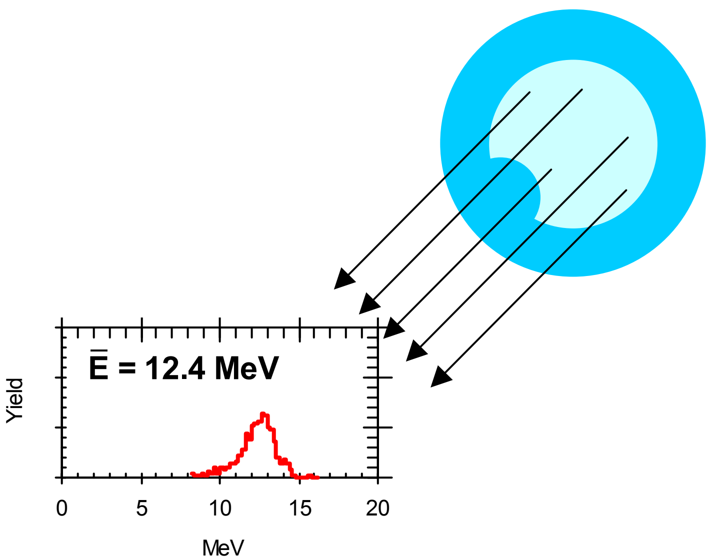
$< \rho R >$

$\delta\,\rho R\,(\theta,\phi) \equiv \rho R(\theta,\phi) - < \rho R >$

$< \delta\,\rho R >_{rms}$

Low-mode ρR asymmetries are observed by measuring D^3He proton energies at different angles

"Low-mode" ($\ell \lesssim 4$), because each $\bar{E}(\theta,\phi)$ averages over a significant part of the shell.



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$< \delta \rho R >_{rms}$

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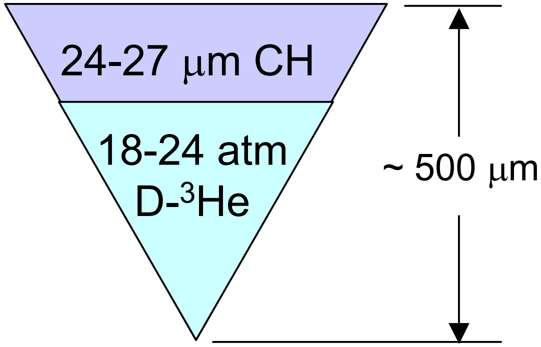
We'll be studying D^3He-filled capsules with thick CH shells

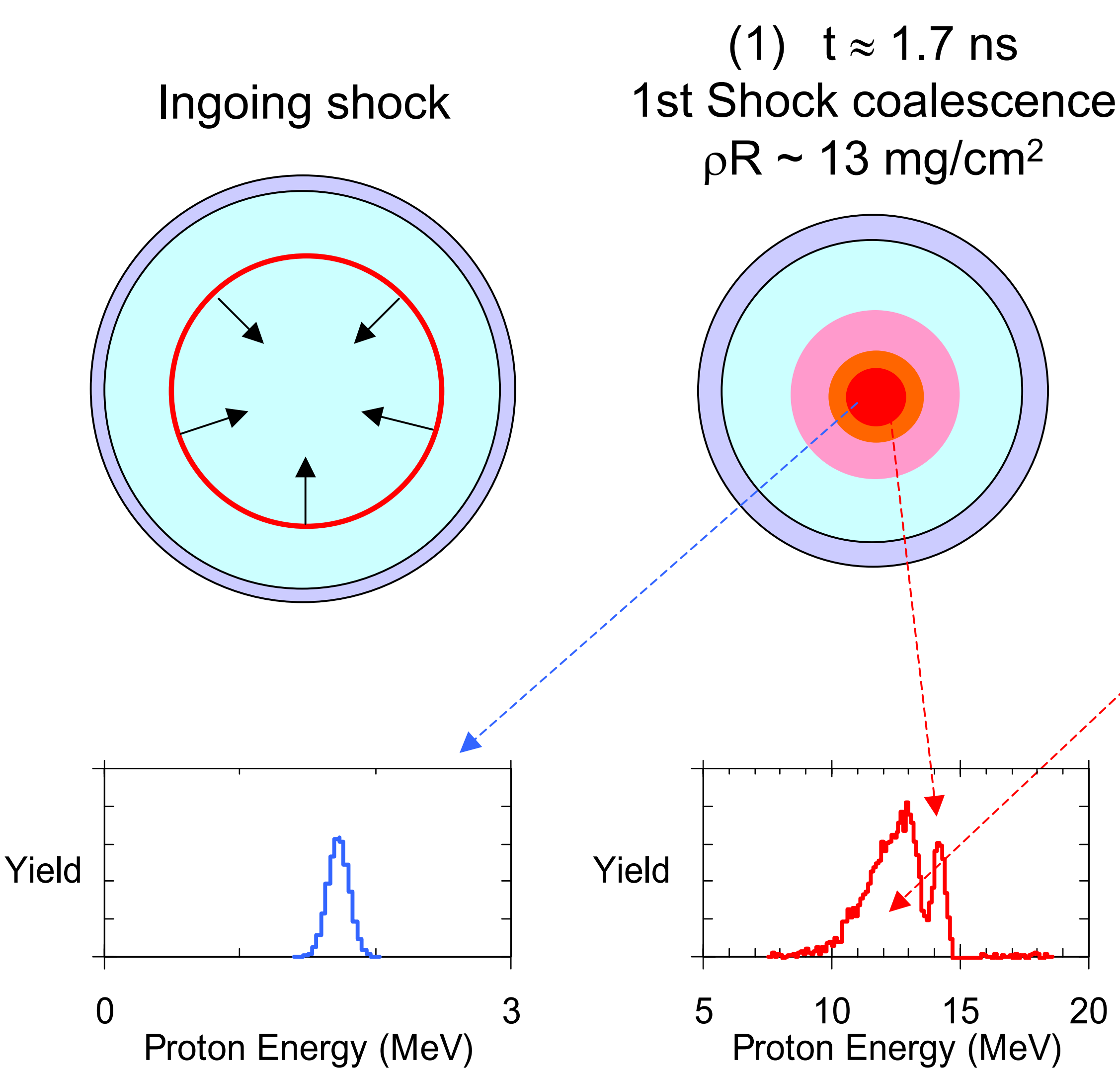
Room temperature capsules:



60-Beam OMEGA laser:

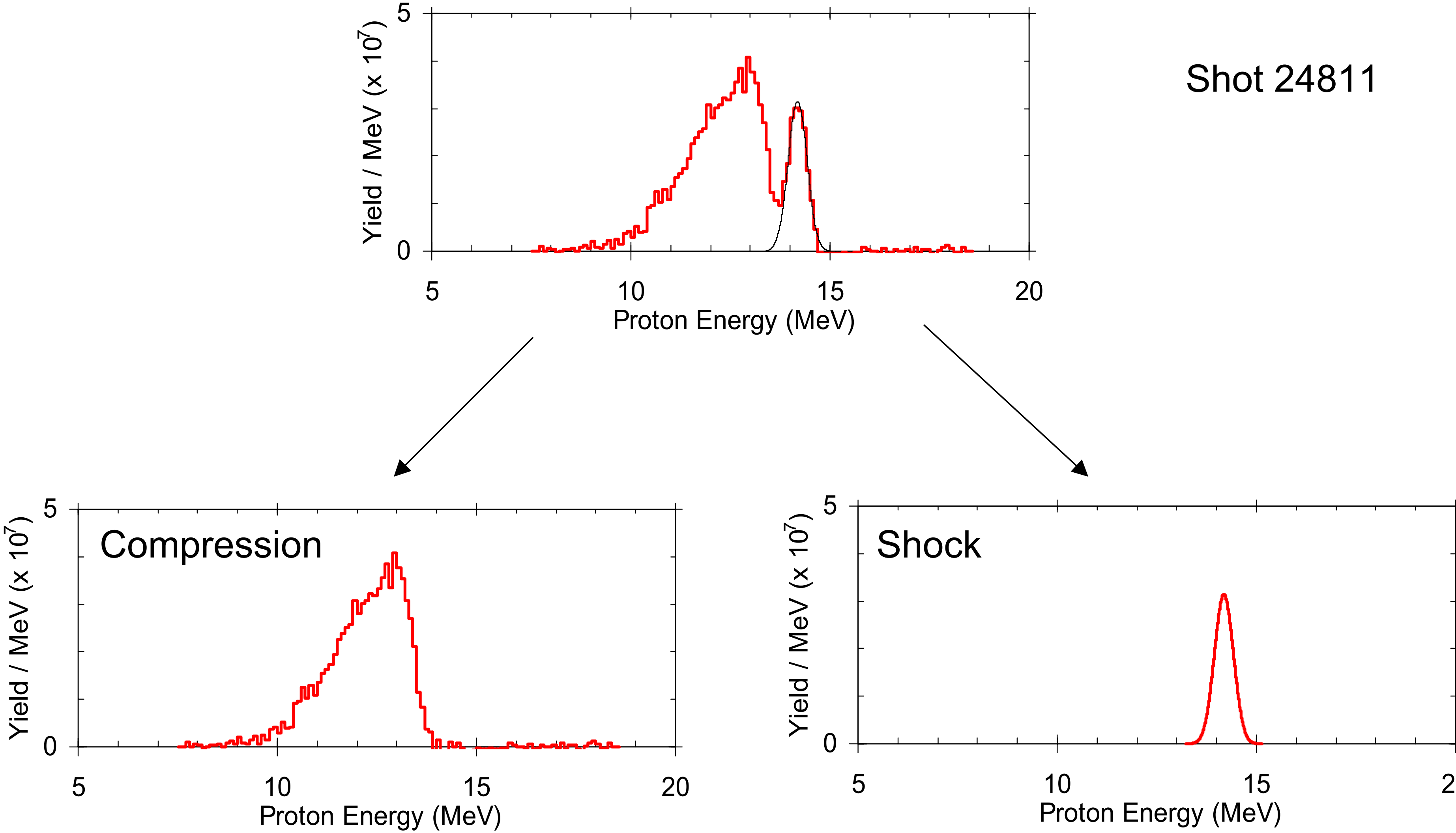
Pulse shape:	1-ns square
Beam smoothing:	2D-SSD + PS
On-target energy:	~22 kJ

There are two distinct time intervals during implosion when charged particles are generated*

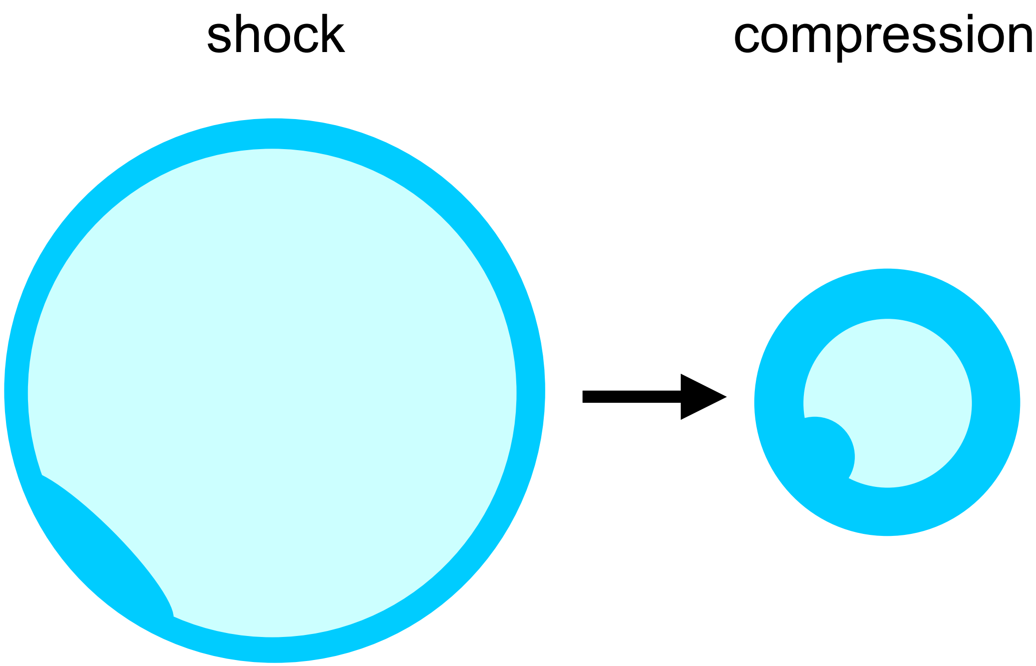


*R.D. Petrasso *et al.*, Phys. Rev. Lett. (to be published)

Each spectrum can be divided into two components with different information content



We want to compare structure at the two times

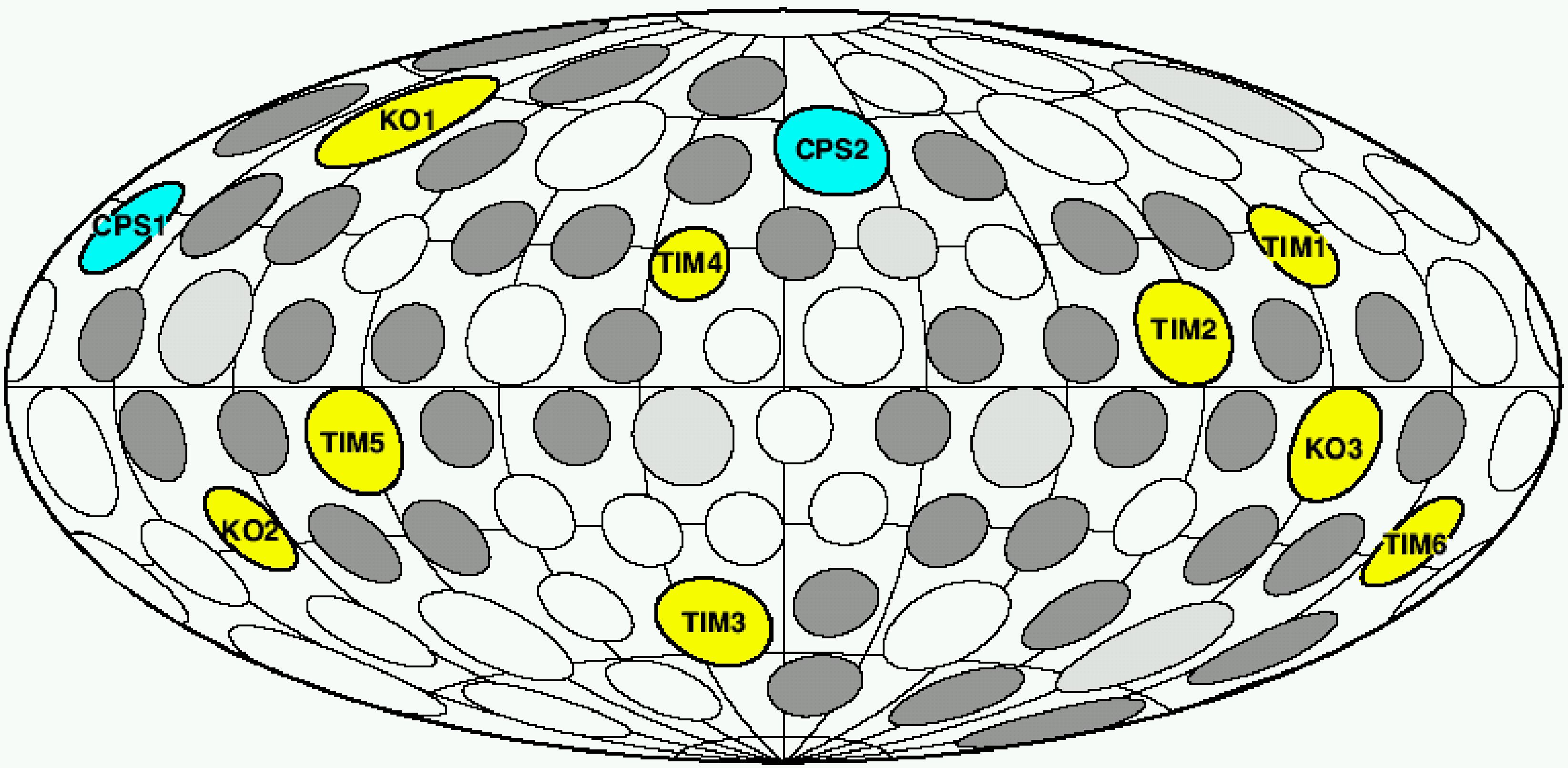


$< \rho R_S >$ = a $< \rho R_C >$ (growth in $< \rho R >$)

$< \delta\, \rho R_S >_{rms}$ = b $< \delta\, \rho R_C >_{rms}$ (growth in asymmetry amplitude)

$\delta\, \rho R_S\, (\theta,\phi)$ $\overset{?}{=}$ c $\delta\, \rho R_C\, (\theta,\phi)$ (are angular structures correlated?)

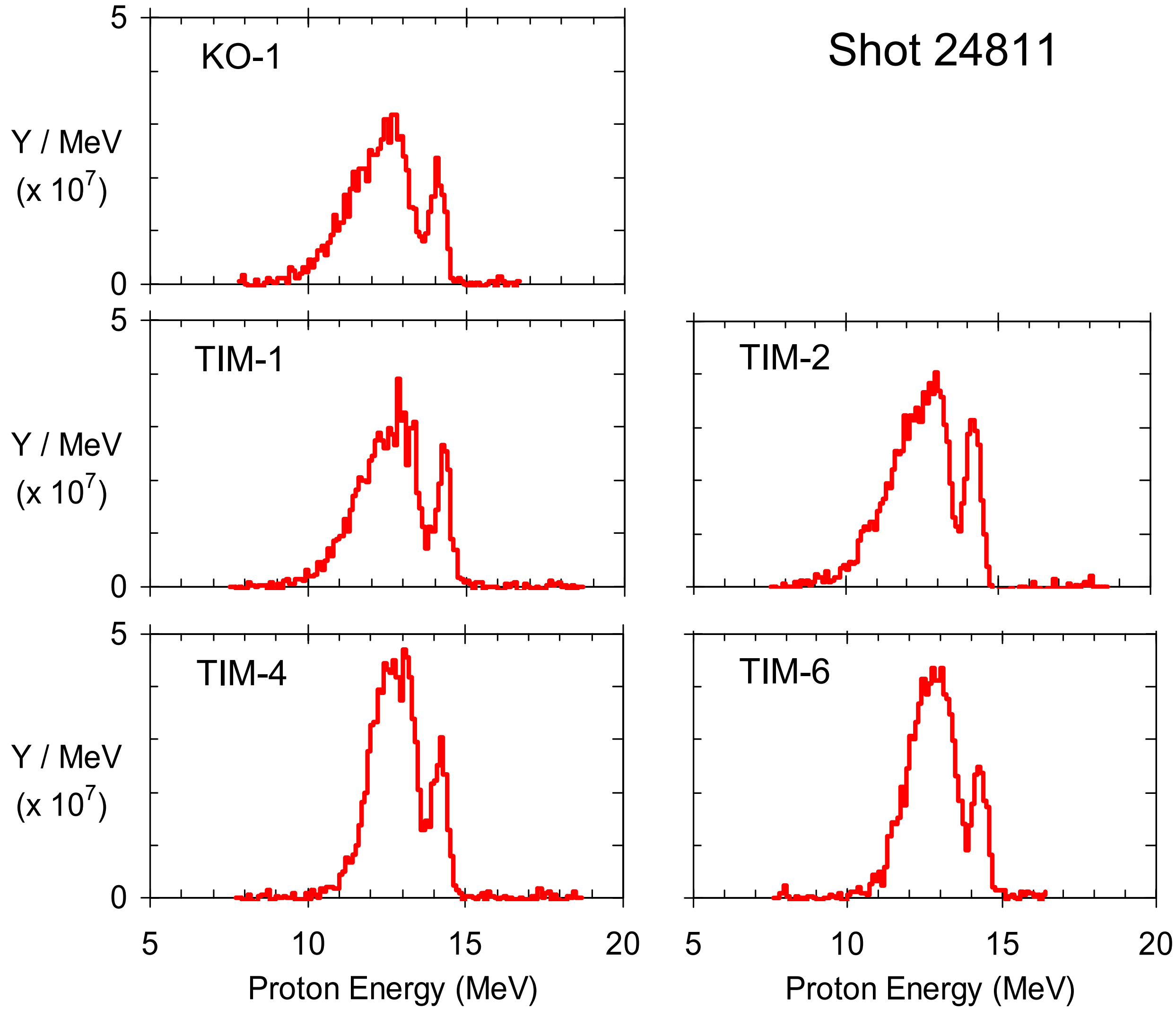
Up to 11 ports on the OMEGA target chamber can be used for charged-particle spectrometers



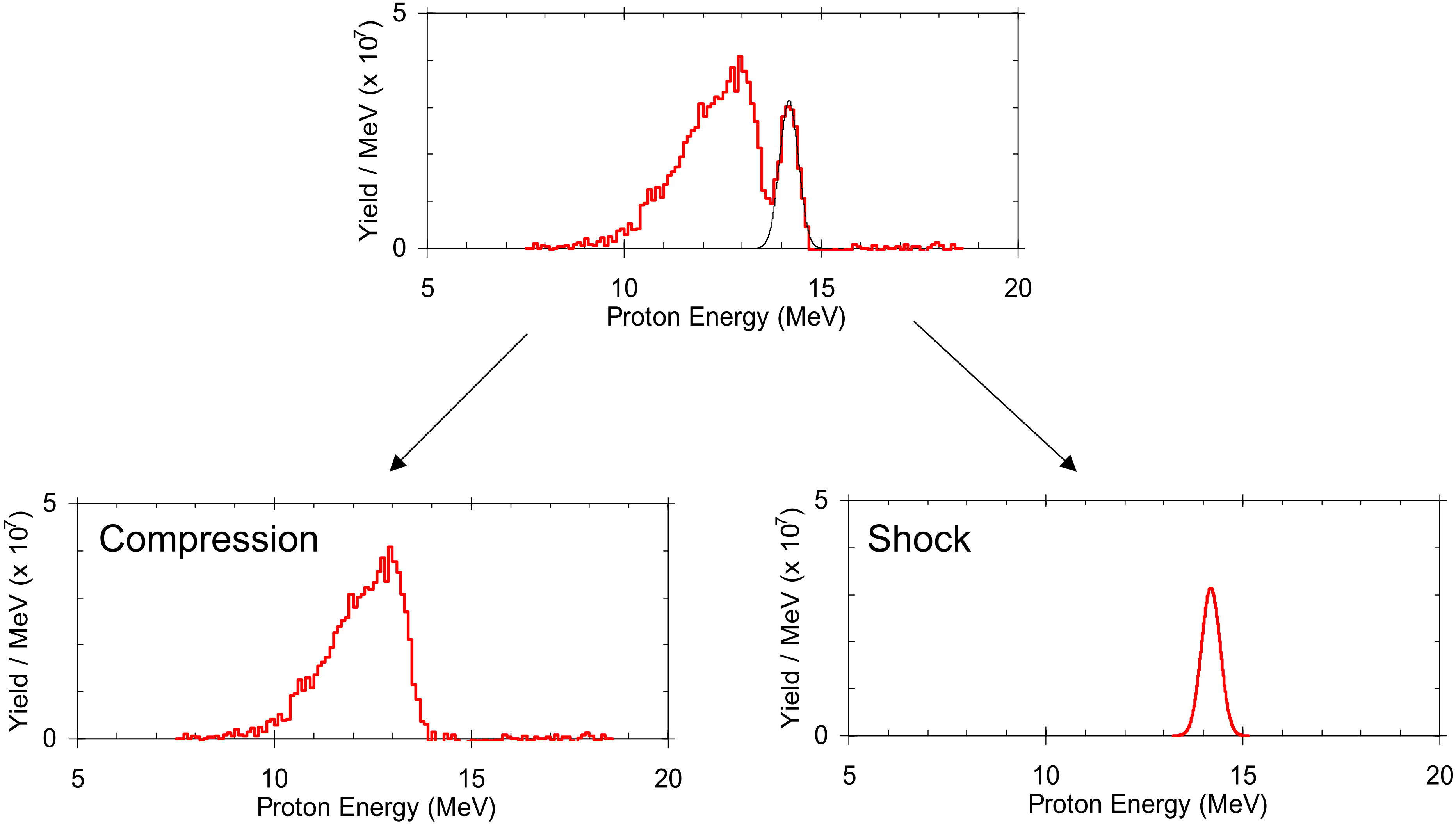
= Wedge-Range-Filter proton spectrometers (WRFs)

= Magnet-based charged-particle spectrometers (CPSs)

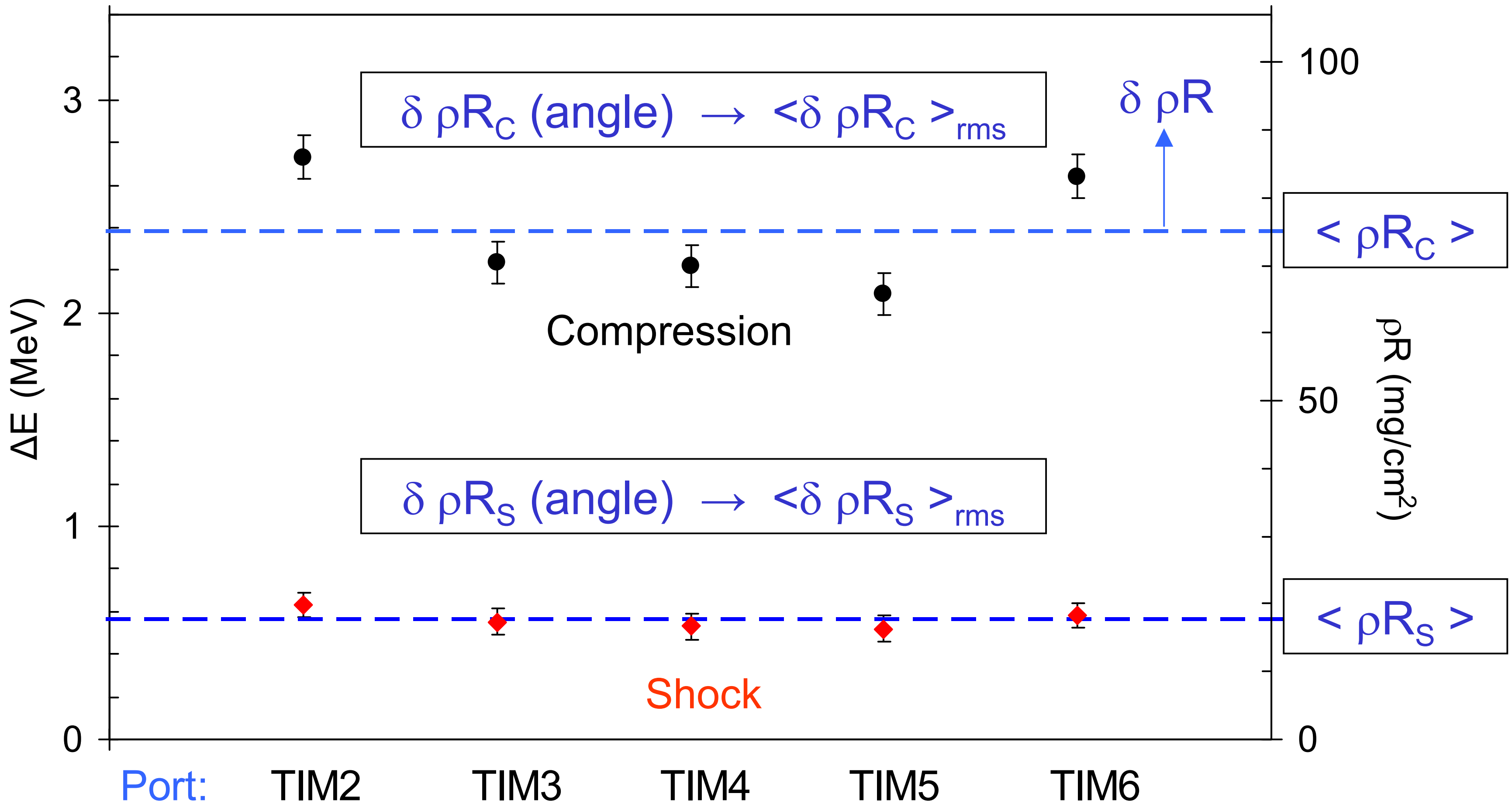
Multiple spectra can be measured during each shot



Each spectrum can be divided into two components with different $\bar{E}$

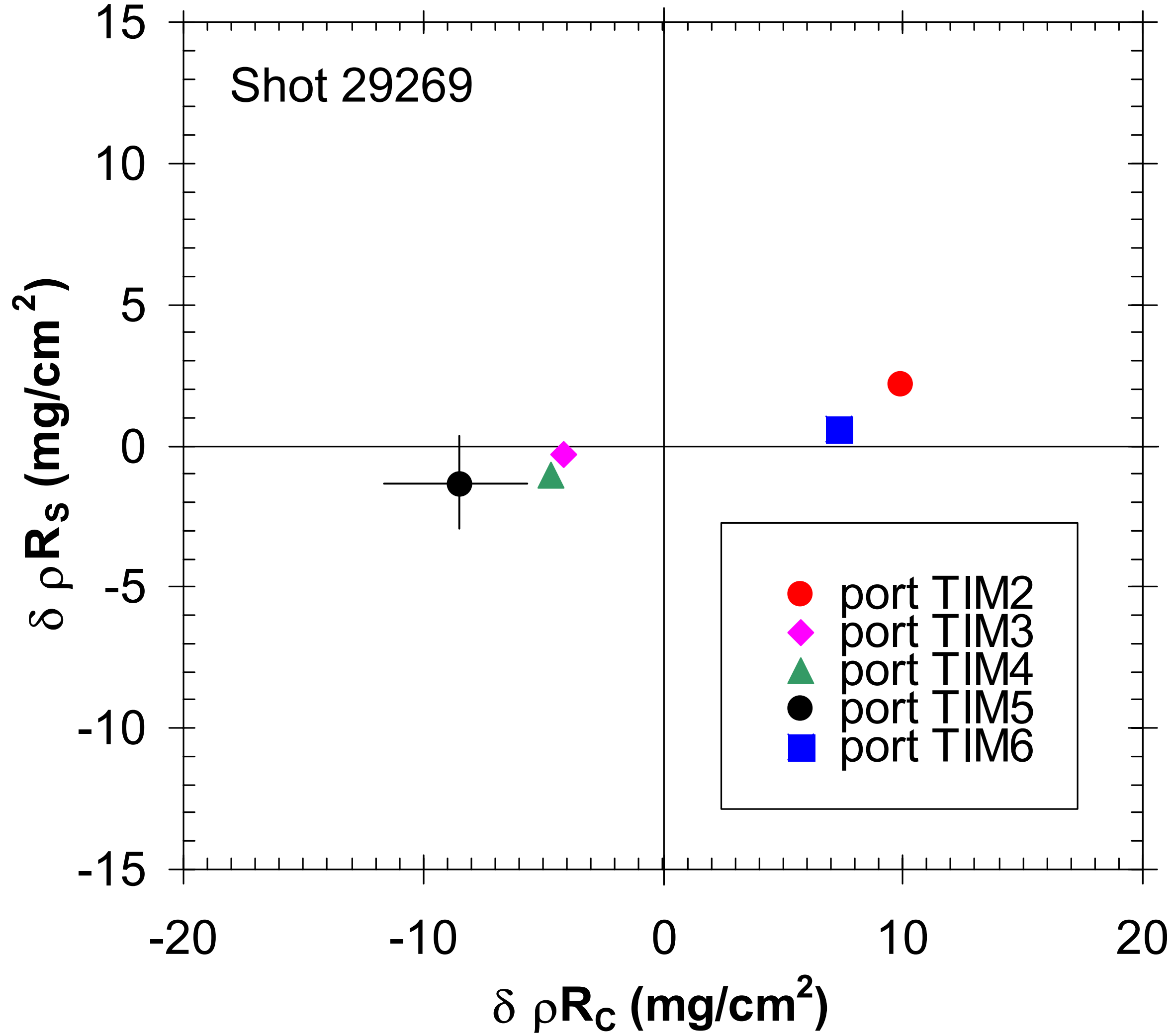


For each component, there is a < ρR > and a distribution of deviations δ ρR from < ρR >

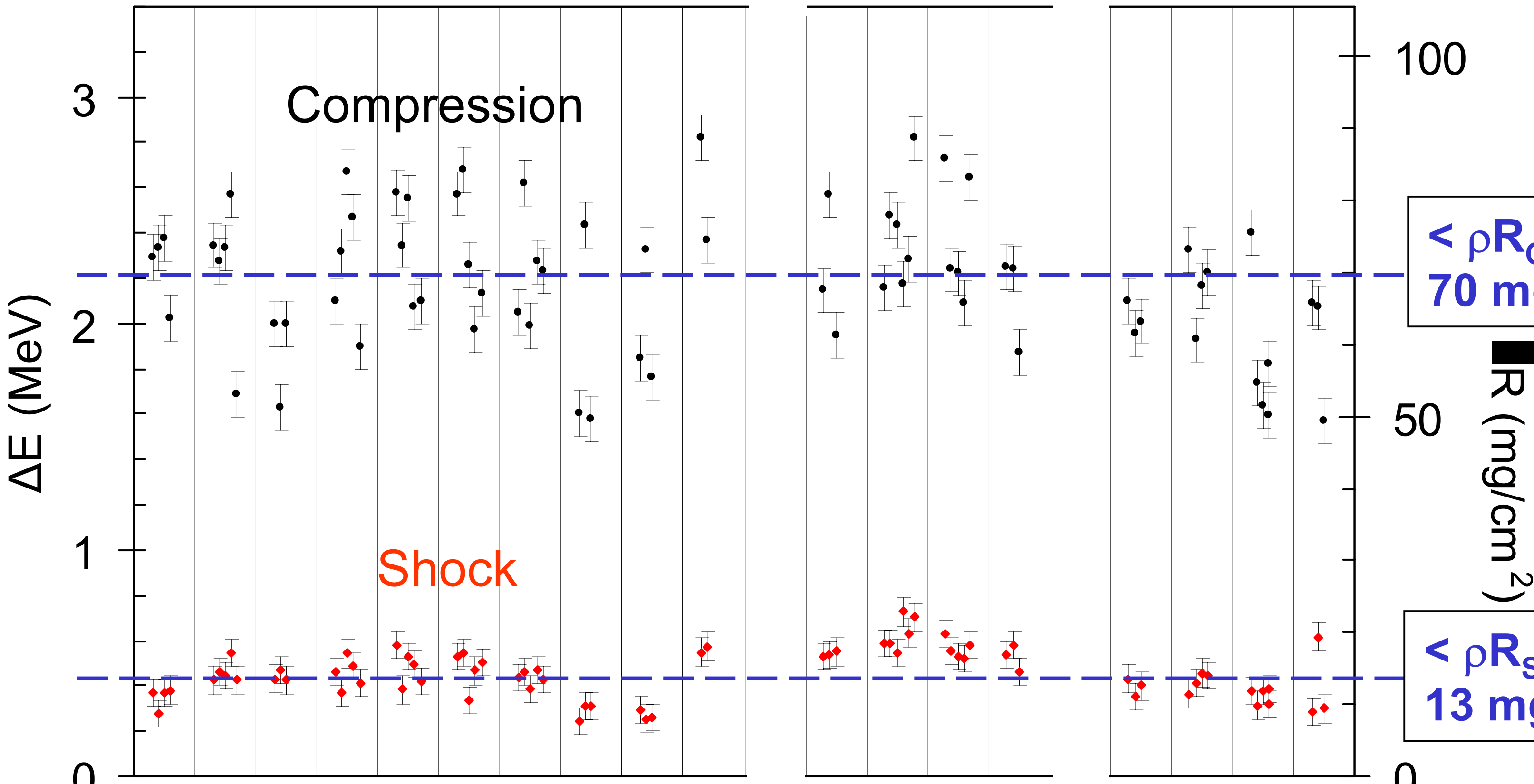


Shot 29269 27 μm 18 atm

We can look for a correlation between asymmetries at the two times by plotting $\delta\rho R_S$ *vs.* $\delta\rho R_C$



We need to use data from many implosions



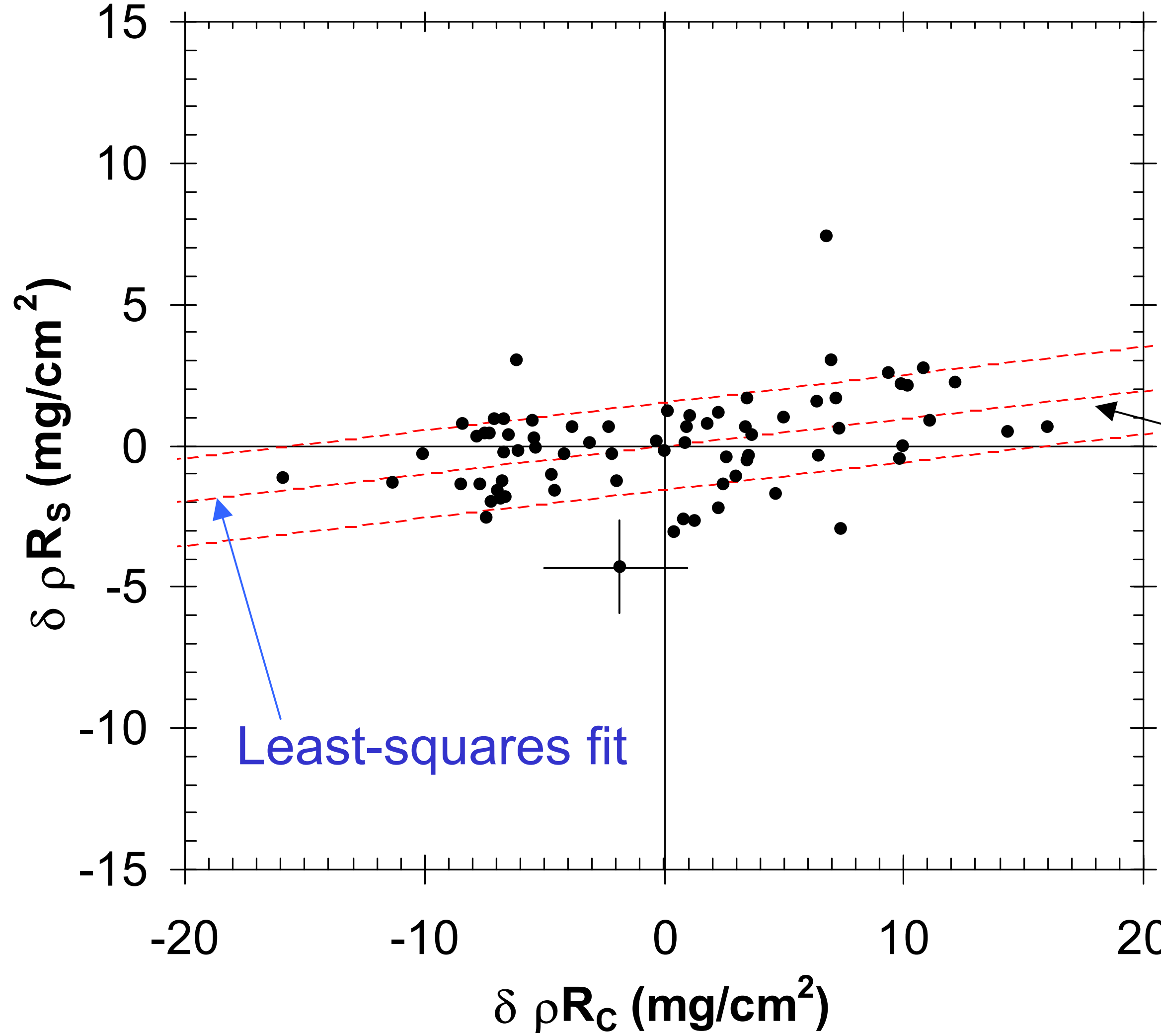
$< \rho R_C > \approx$ **70 mg/cm²**

$< \rho R_S > \approx$ **13 mg/cm²**

$<\delta \rho R_C>_{rms} \approx$ **8 mg/cm²**

$<\delta \rho R_S>_{rms} \approx$ **0.9 ± 0.5 mg/cm²**

On average, there is a correlation between ρR asymmetries at the two times



Compensating for known correlations between uncertainties in $\delta\ \rho R_C$ and $\delta\ \rho R_S$,

$$\frac{\delta\ \rho R_S}{\delta\ \rho R_C} \approx 0.04 \pm 0.04$$

The part of $< \delta\ \rho R_S >_{rms}$ correlated with $\delta\ \rho R_C$ is

$(0.04 \pm 0.04) < \delta\ \rho R_C >_{rms}$

$\approx 0.3 \pm 0.3$ mg/cm^2

Preliminary conclusions

~ 400 - 500 ps →

	shock time	comp. time	Interpretation
$< \rho R >$ (mg/cm^2)	13	70	$<\rho R>$ grows by ~ x5
$< \delta \rho R >_{rms}$	0.9 ± 0.5	8	The rms amplitude of low-mode (ℓ~1-4) structure grows by ~ x10
Part of $< \delta \rho R >_{rms}$ correlated with compression value	0.3 ± 0.3	8	Some of the structure retains phase coherence, some doesn't

- Future work has to increase the accuracy of these measurements with:
  - More spectrometers per shot
  - More shots
  - Smaller measurement errors

Some related talks

Overview of charged-particle asymmetry measurements → C. K. Li *et al.*

		Asymmetry	Shock
V.N. Goncharov	RI1.004	X	
I.V. Igumenshchev *et al.*	FO2.005	X	
C. K. Li *et al.*	RI1.005	X	X
F. J. Marshall *et al.*	GO2.007	X	
P. W. McKenty *et al.*	GO2.008	X	
R. D. Petrasso *et al.*	GO2.015		X
P. B. Radha *et al.*	FO2.003	X	
R. Rygg *et al.*	GO2.014	X	X
B. Schwartz *et al.*	KP1.147		X
V. A. Smalyuk *et al.*	QI1.005	X	
J. M. Soures *et al.*	GO2.005	X	