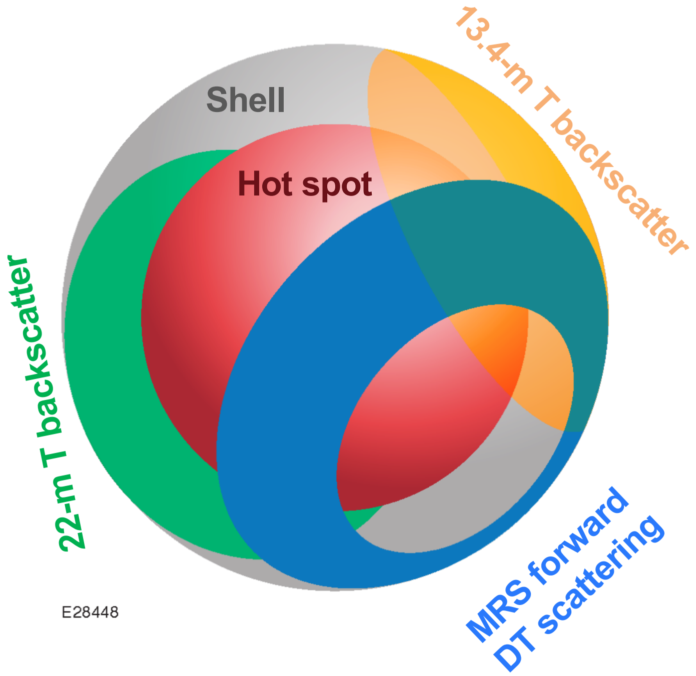
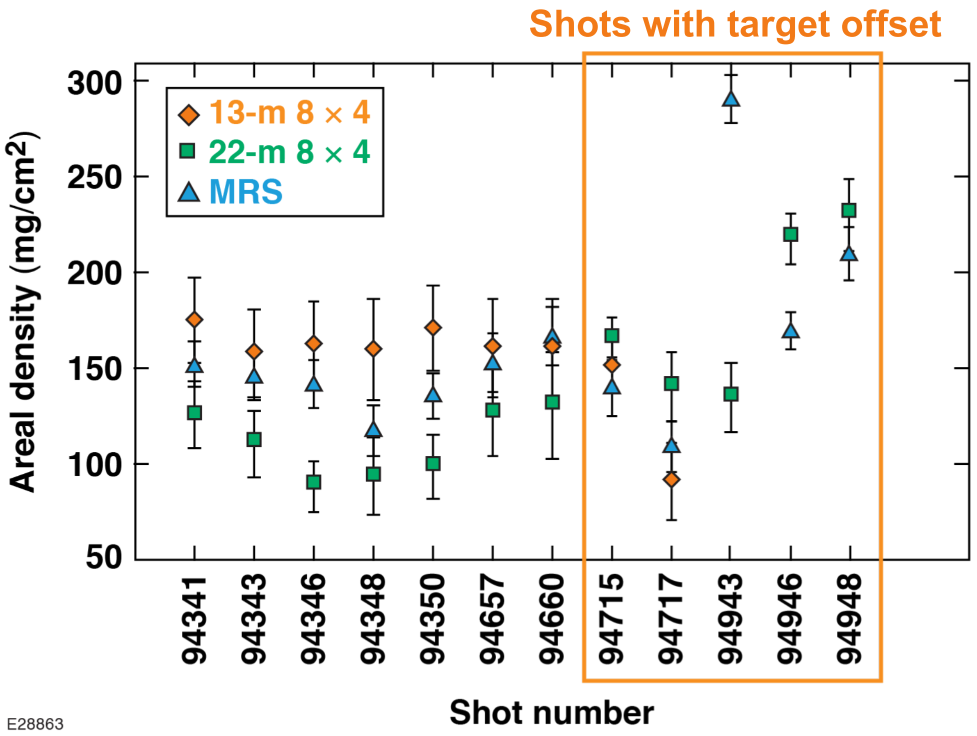
Observed Variations in Areal Densities as Measured by Detectors Along Multiple Lines of Sight





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ρR measurements from the first* and second shielded and collimated nTOF LOS and the MRS** provide a more complete view of implosion symmetry

- The spatial coverage of the compressed ρR was increased from 24% to 34% of 4π on OMEGA with the addition of the new nTOF LOS
- A low-mode asymmetry has been observed in the compressed fuel layer of DT cryogenic implosions
- An offset was strategically imposed based on flow data
  - this resulted in a change in the spatial distribution of ρR

nTOF: neutron time of flight
LOS: line of sight
MRS: magnetic recoil spectrometer

* C. J. Forrest *et al.*, Rev. Sci. Instrum. 87, 11D814 (2016).
** J. A. Frenje *et al.*, Rev. Sci. Instrum. 79, 10E502 (2008).

Collaborators

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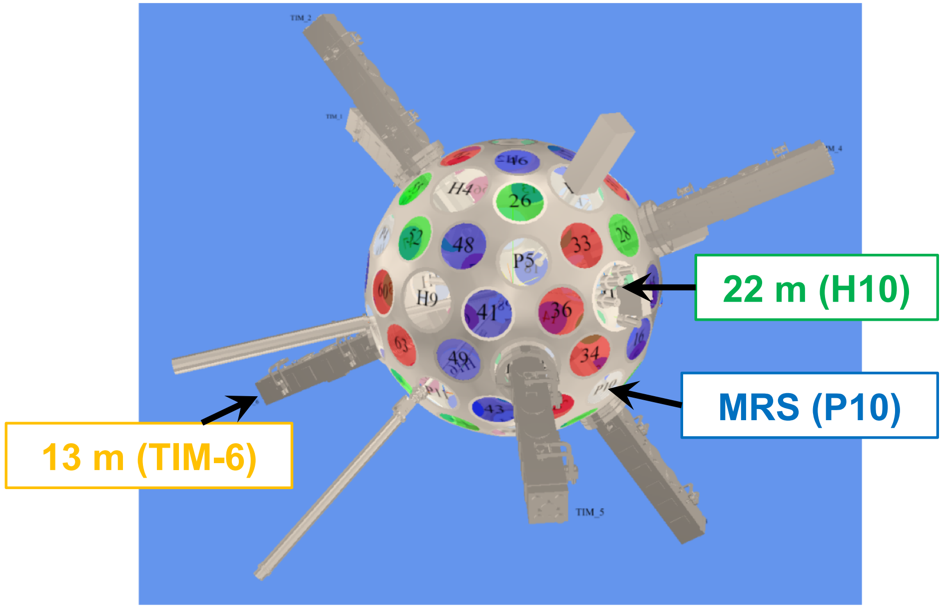
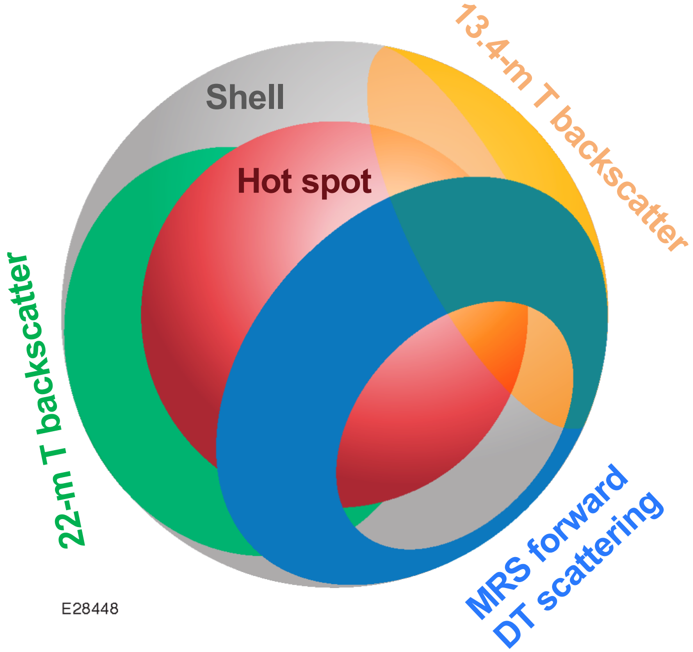
The new 22-m LOS is now operational on the OMEGA Laser System

- Detectors in this LOS include an 8 $\times$ 4 (xylene) nTOF detector for areal-density measurement and a Petal detector for flow measurement
  - these are analogous to existing detectors in the 13.4-m LOS
- The nTOF in this LOS allows for more uniform coverage of the target's areal density





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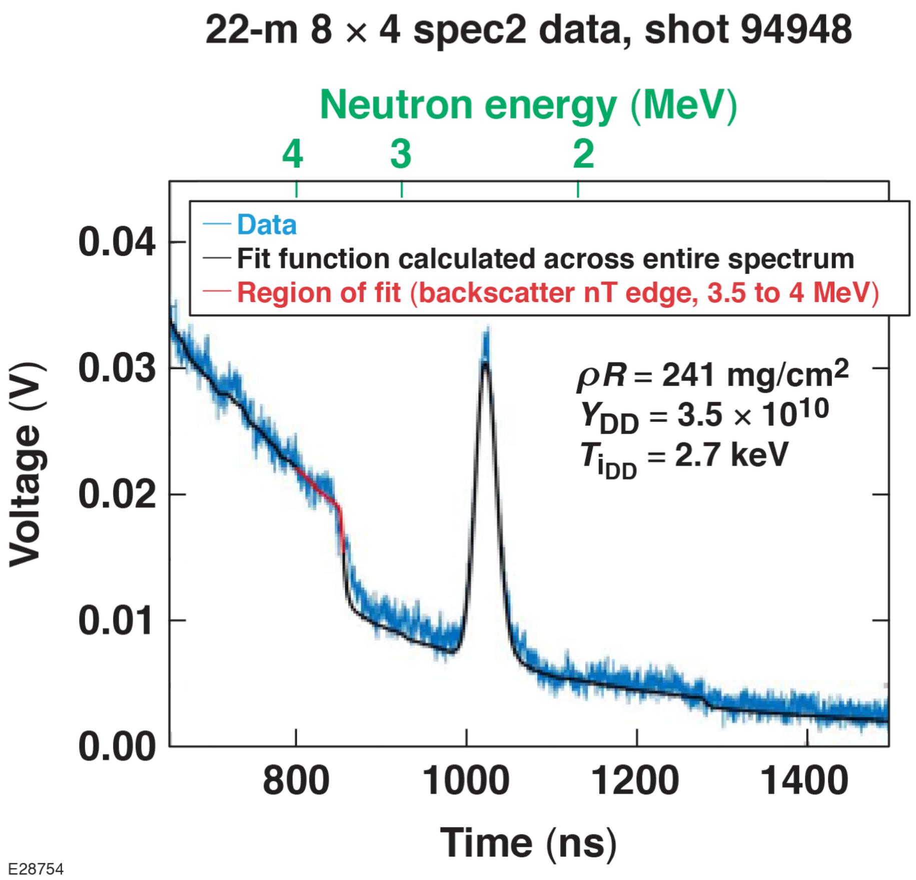
Analysis of the xylene nTOF data infers an areal density using a fit to the neutron spectrum from 2 to 4 MeV



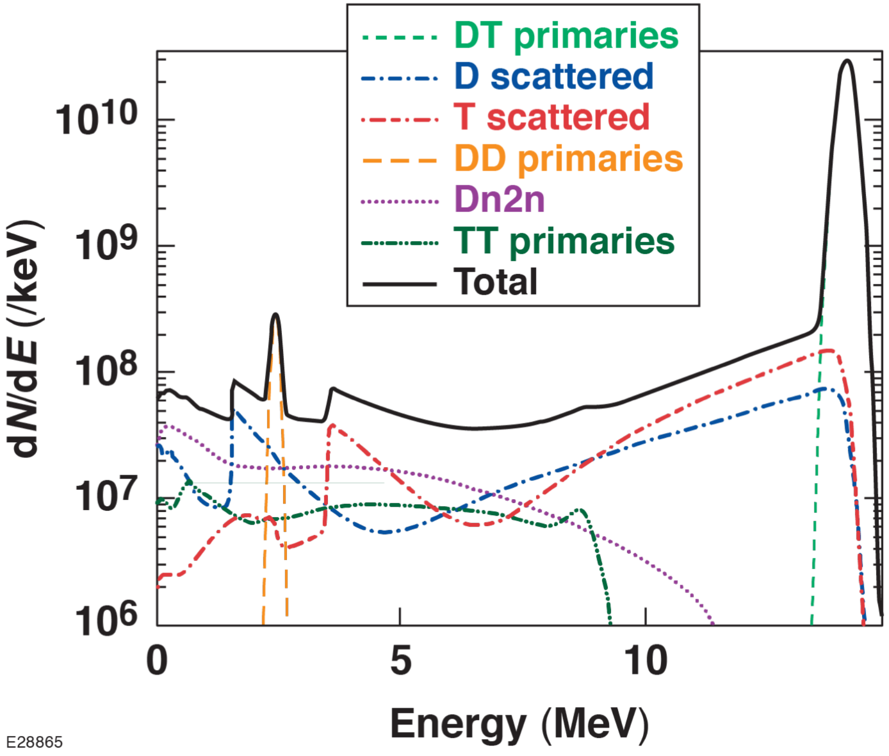
- The fit function for this detector is

$$V(t) = \left\{\left[50\ \Omega * \frac{k_2}{k_1} * \mathrm{NLO}(E) * \frac{\mathrm{d}N}{\mathrm{d}E}\frac{\mathrm{d}E}{\mathrm{d}t}\right] \otimes \mathrm{IRF}\right\} + \mathrm{background}$$

- $\frac{k_2}{k_1}$ = calibration constants
- NLO(E) = nonlinear light output with beamline attenuation, as modeled by MCNP
- IRF = matrix representation of instrument response function
- dE/dt = Jacobian
- The background is an exponential decay, inferred from a shot with low areal density

MCNP: Monte Carlo n-particle (MCNP) transport code

Analysis of the xylene nTOF data infers an areal density using a fit to the neutron spectrum from 2 to 4 MeV

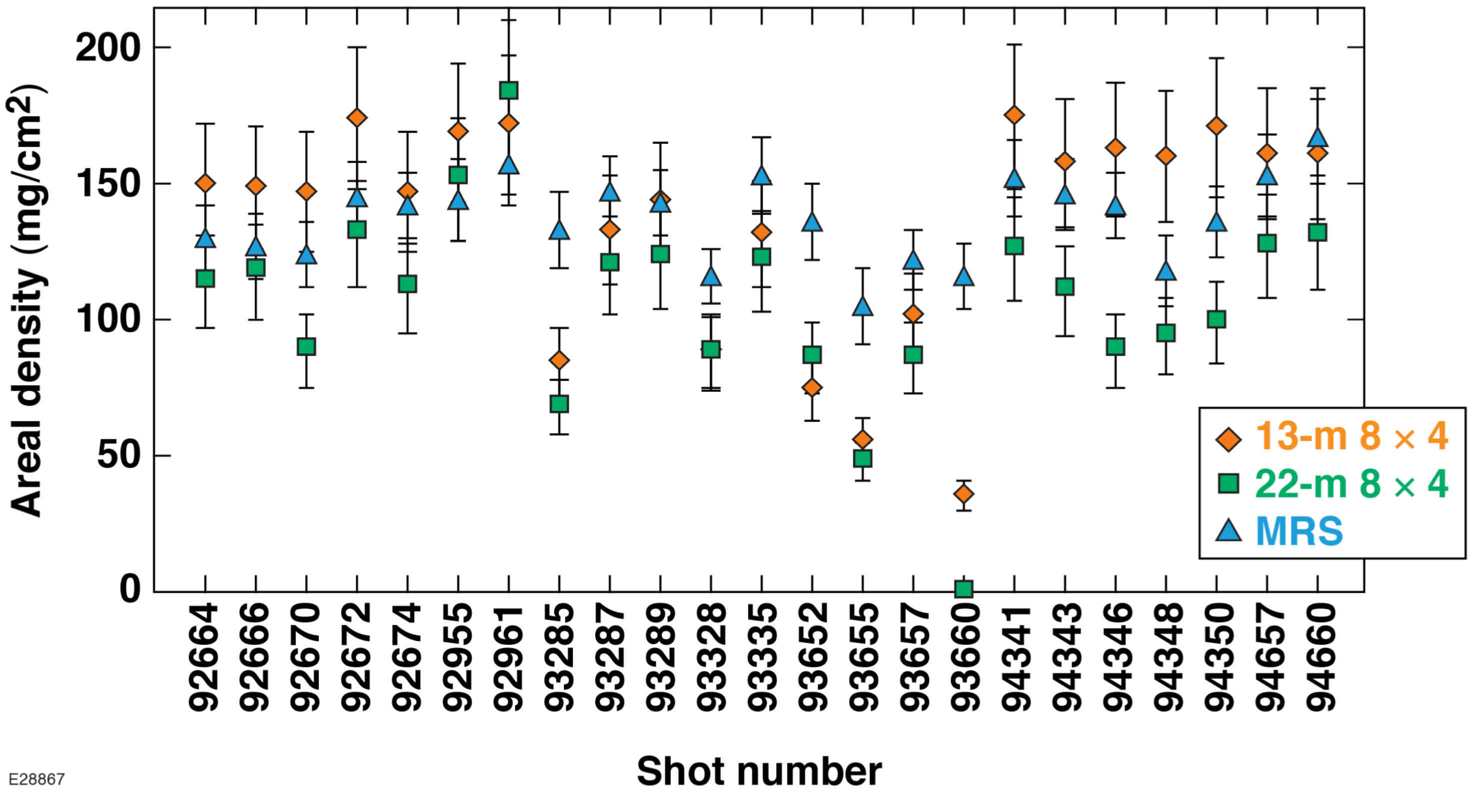


- $\frac{\mathrm{d}N}{\mathrm{d}E}$ is a model of the neutron energy spectrum that includes single scatters on D and T, DD primaries, TT primaries, and deuterium breakup [D(n,2n)p]
  - Areal density is inferred from single scatters of DT neutrons on D and T from 3.5 to 4 MeV

LLE Review Quarterly Report 150, 104 (2017).

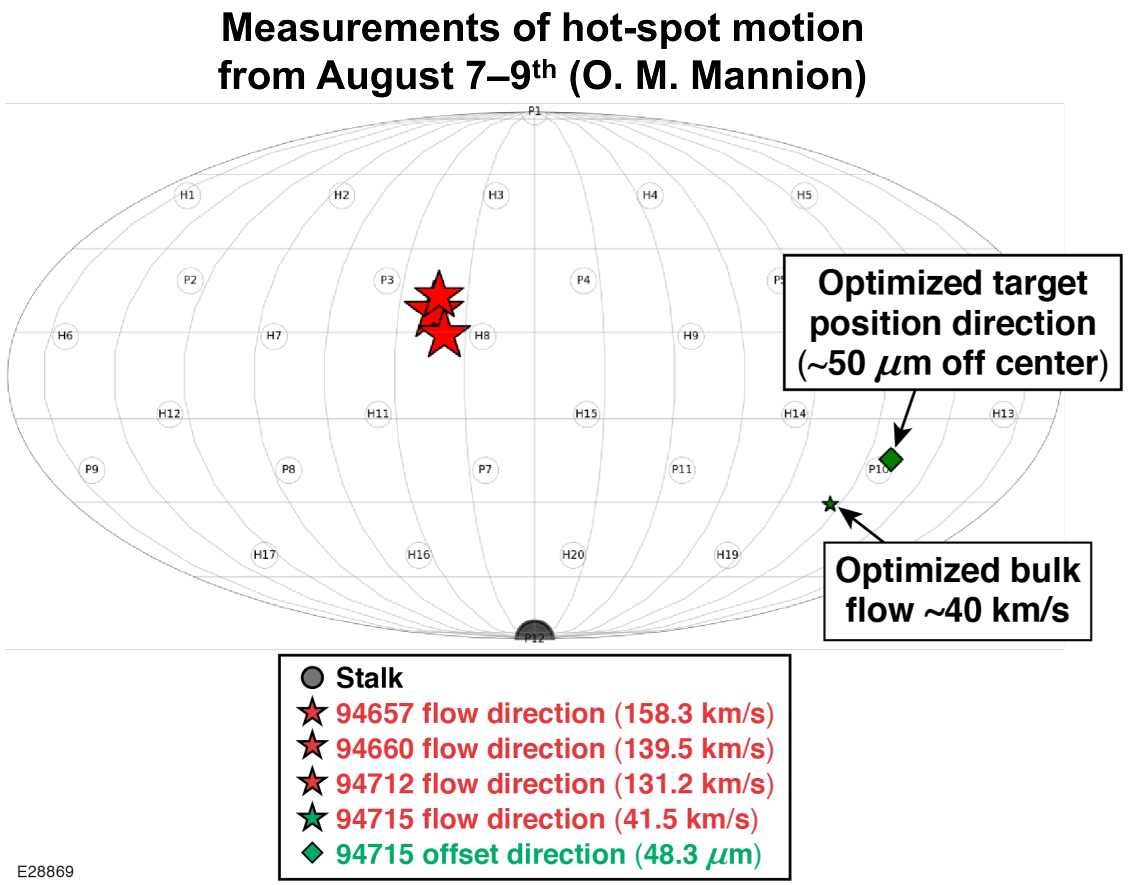
Recent data suggest systematic cold-fuel asymmetries in many cryogenic experiments

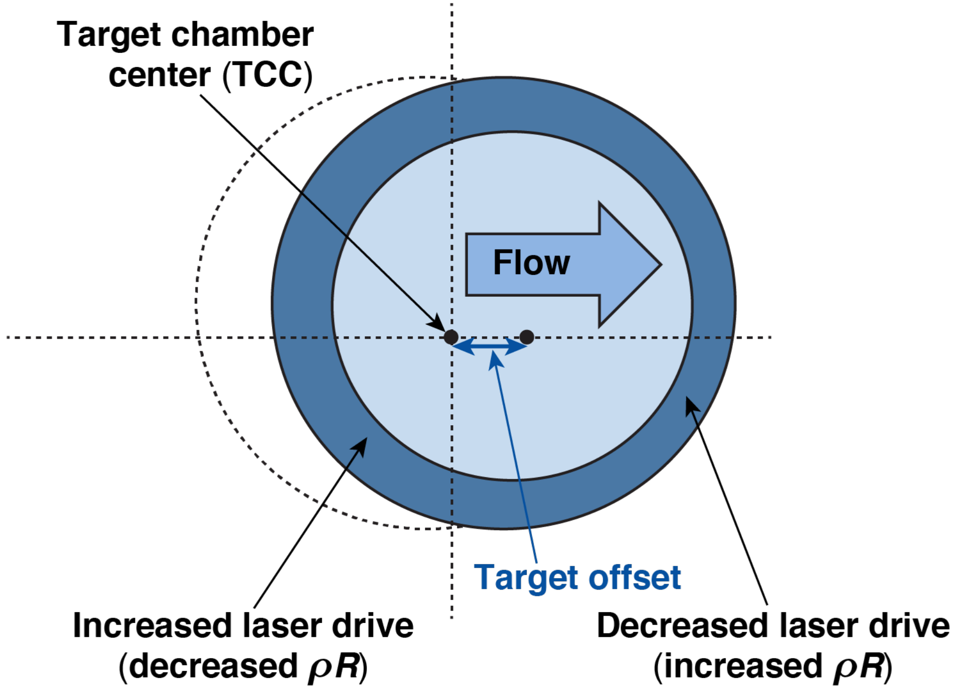
- Data from 25 cryogenic shots show that 13-m 8 × 4 sees an average of 30 mg/cm^2 more than 22-m 8 × 4



An offset was applied to correct these asymmetries

- Offset direction and distance were based on flow measurements and an assumption of ℓ = 1 asymmetry



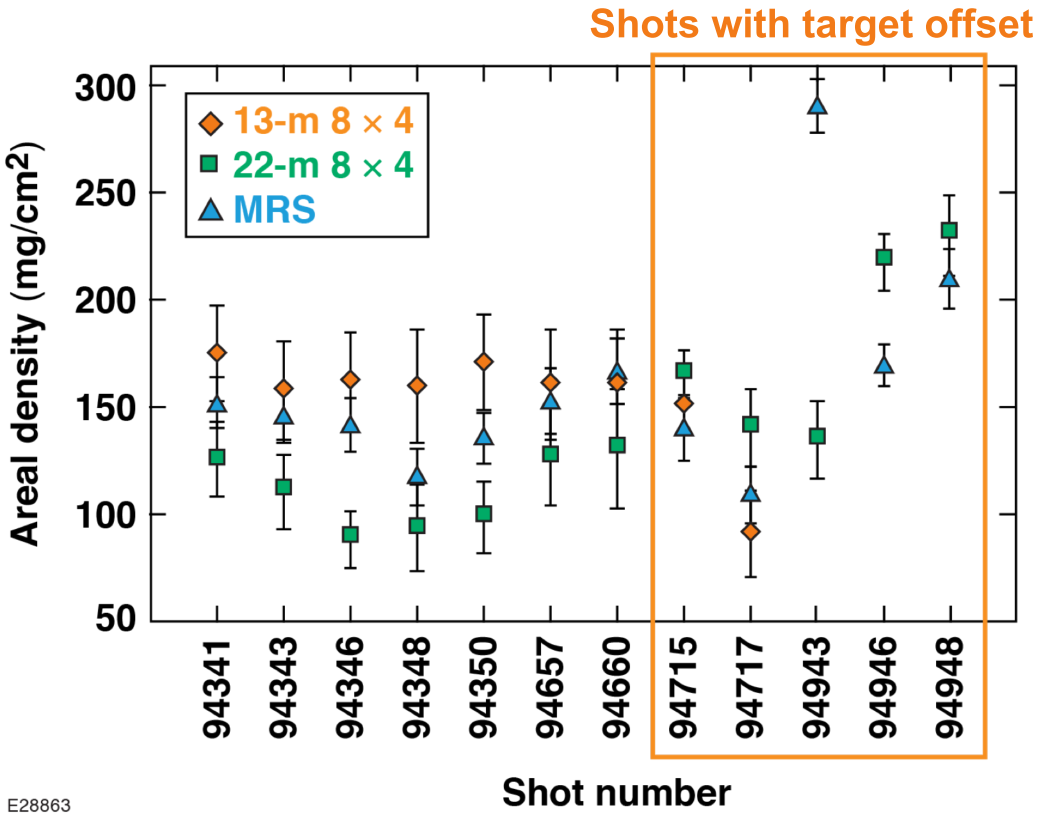


E28869

S. Regan *et al.*, YO5.00002, this conference.

Recent data suggest systematic cold-fuel asymmetries in many cryogenic experiments

- Data from 25 cryogenic shots show that 13-m 8 × 4 sees an average of 30 mg/cm^2 more than 22-m 8 × 4
- Shots with offset targets have reversed this trend—we have seen up to 48 mg/cm^2 more areal density on 22-m 8 × 4



E28863

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  - this resulted in a change in the spatial distribution of ρR

Future work will focus on quantifying the 3-D shape of the compressed shell and incorporating additional measurements of areal density.

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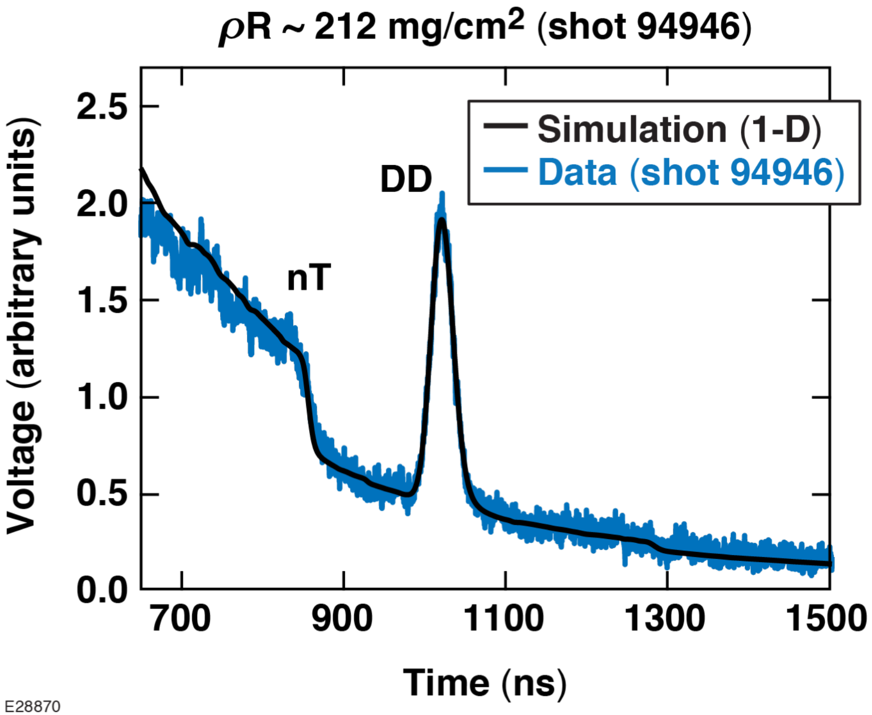
Backup

nTOF analysis can be extended to higher energies

- This would give additional information about the areal density past the backscatter region
- One complication is that the background and areal density cross section have degenerate parameters towards the forward scattering regions
  - confidence in background is key to this measurement



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Areal density distribution reflects changes in implosion symmetry with changes in target position

- Fits below are from 800 to 1100 ns (~2 to 4 MeV) on 22-m 8 $\times$ 4
  - black line extrapolates fit across entire range of data
  - red line represents backscatter region (3.5 to 4 MeV) from which areal density is inferred