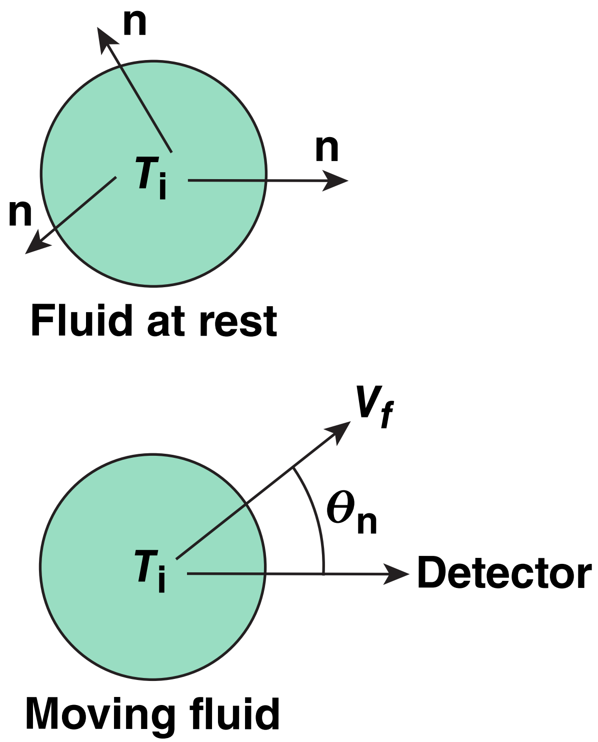
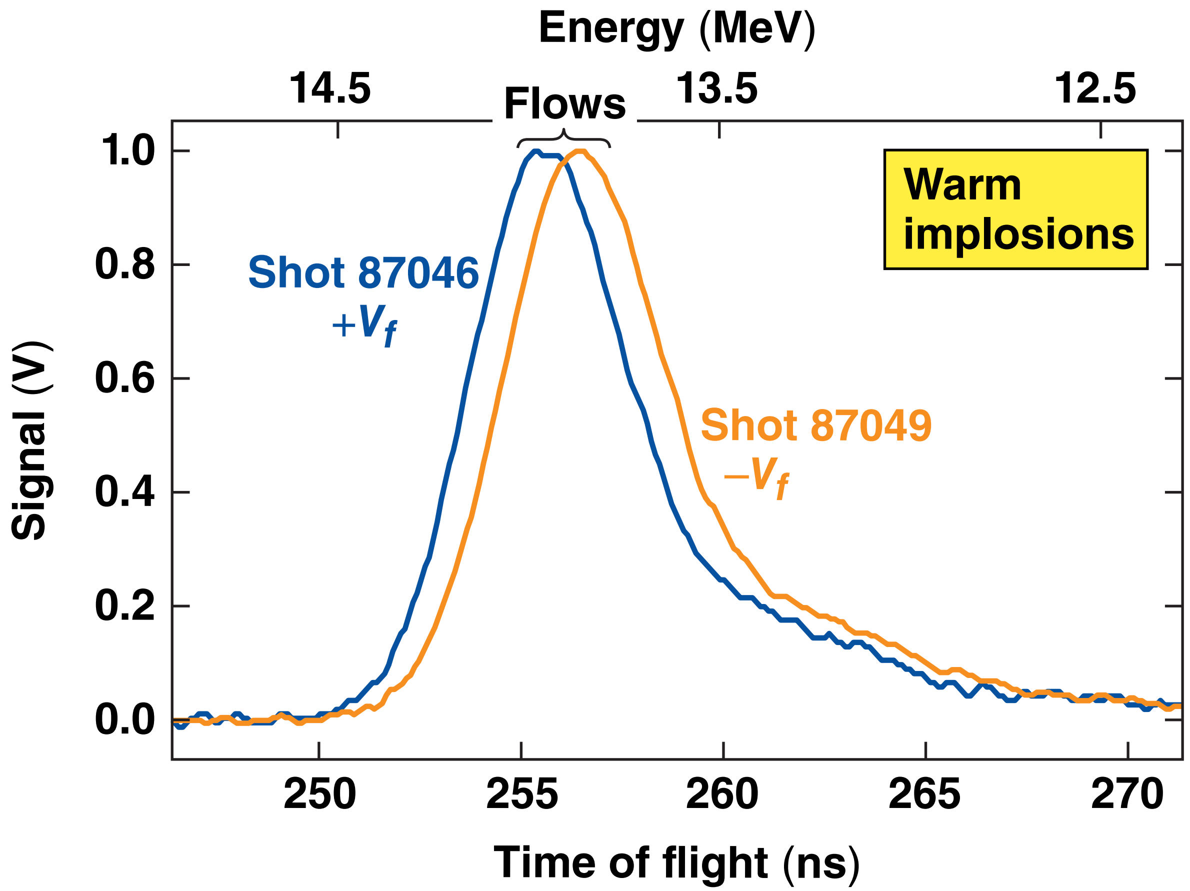
Indications of Bulk Fluid Motion in Direct-Drive Implosions





O. M. Mannion
University of Rochester
Laboratory for Laser Energetics

59th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Milwaukee, WI
23–27 October 2017

Summary

The neutron time-of-flight (nTOF) spectrum is now used to measure bulk flows on OMEGA implosions

- Inertial confinement fusion (ICF) implosions with low-mode asymmetries induce bulk flows in the capsule, leading to residual kinetic energy not transferred into heat energy
- Bulk flows manifest themselves in the nTOF spectrum as shifts in the neutron kinetic energy from their nominal peak values
- Measurements of the neutron spectrum on OMEGA indicate bulk flows as large as 60±20 km/s

Future work will extend this analysis to multiple lines of sight.

Collaborators

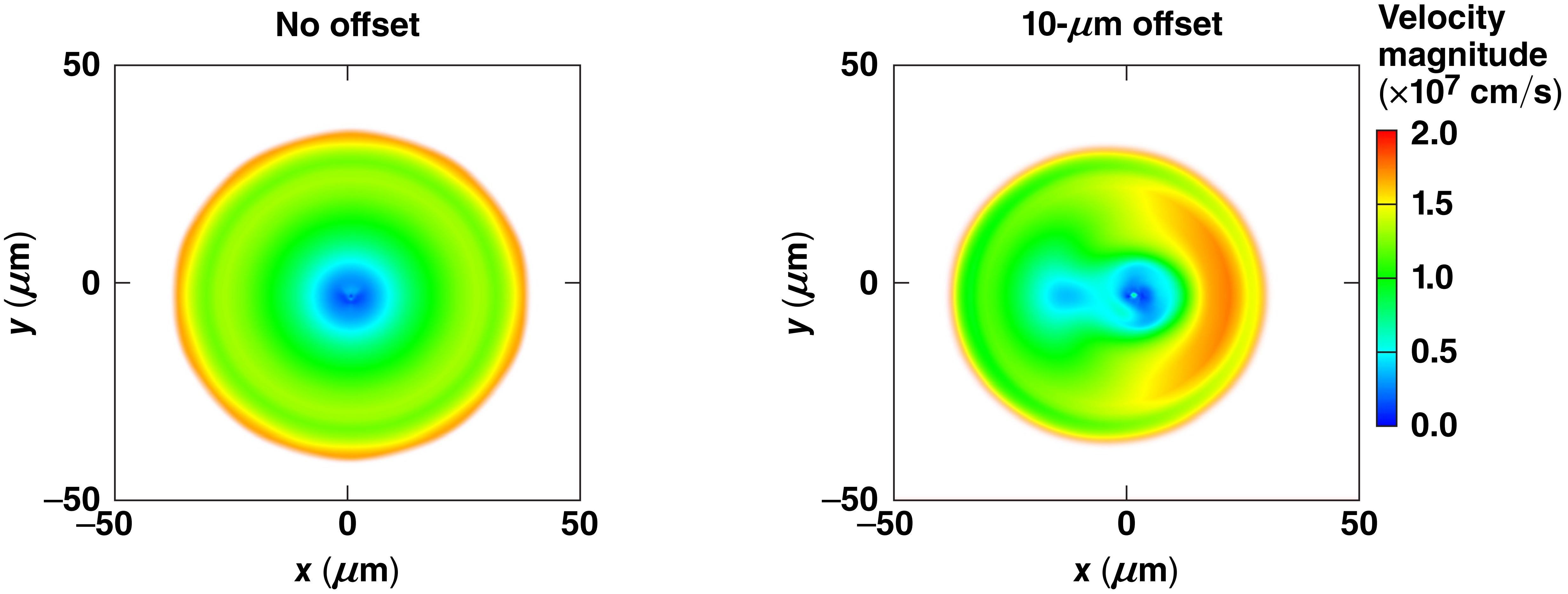
K. S. Anderson, C. J. Forrest, V. Yu. Glebov, C. Stoeckl, V. N. Goncharov, J. P. Knauer, P. B. Radha, S. P. Regan, and T. C. Sangster

University of Rochester
Laboratory for Laser Energetics

M. Gatu Johnson

Plasma Science and Fusion Center
Massachusetts Institute of Technology

Bulk motion of the capsule reduces performance by leaving residual kinetic energy (KE) in the shell and hot spot



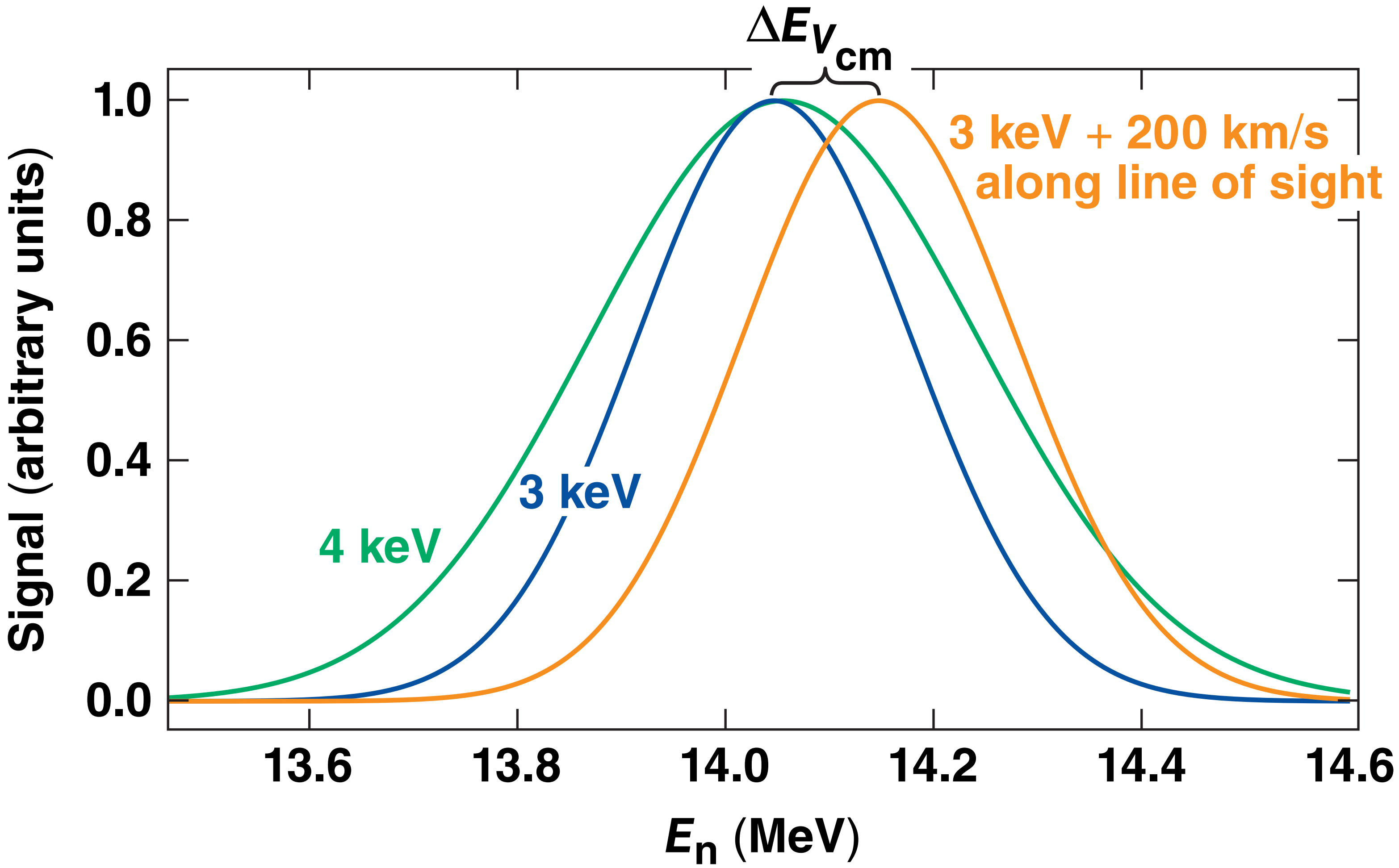
Residual fuel KE = 68 J
Residual KE fraction ≅ 3%

Residual fuel KE = 120 J
Residual KE fraction ≅ 6%

K. S. Anderson, UO4.00013, presented at the 57th Annual Meeting of the APS Division of Plasma Physics, Savannah, GA, 16–20 November 2015;
M. M. Marinak *et al.*, Phys. Plasmas 8, 2275 (2001).

TC12525a

The moments of the neutron spectrum encode essential diagnostic information about the reactants



$$\langle E \rangle = E_0 + E_{th} + \Delta E_{V_{cm}}$$

$$\left\langle \left(E - \langle E \rangle\right)^2 \right\rangle \propto T$$

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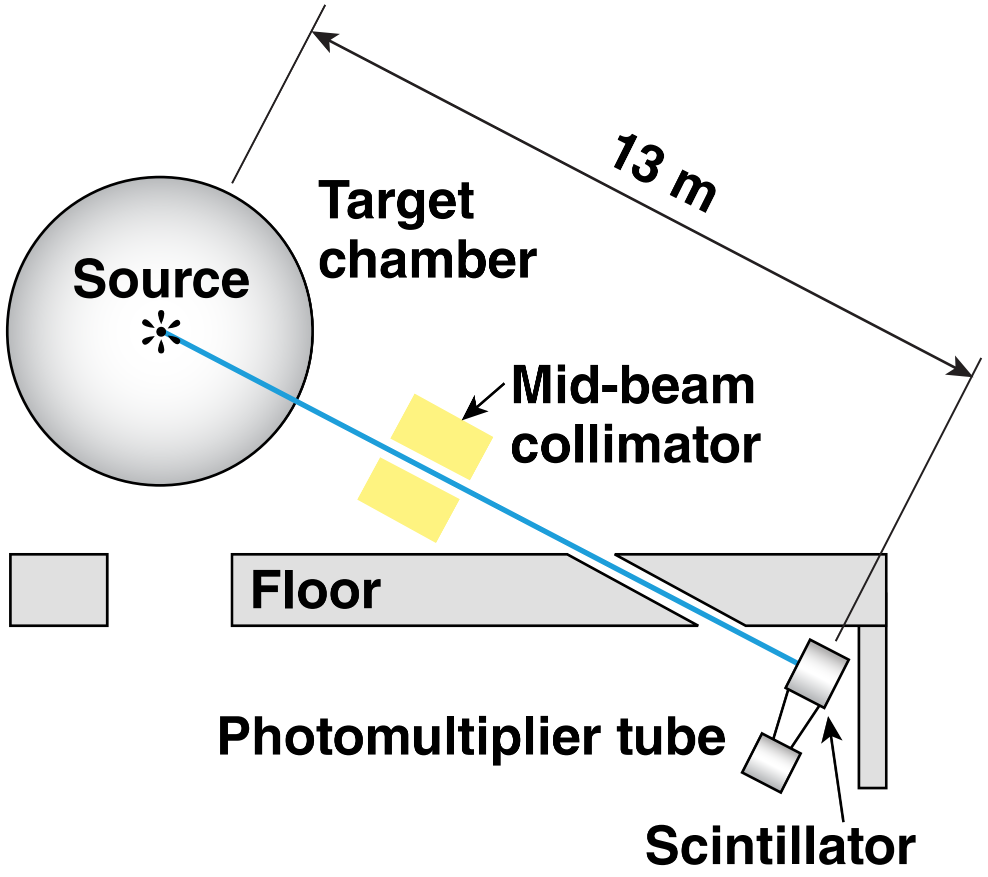
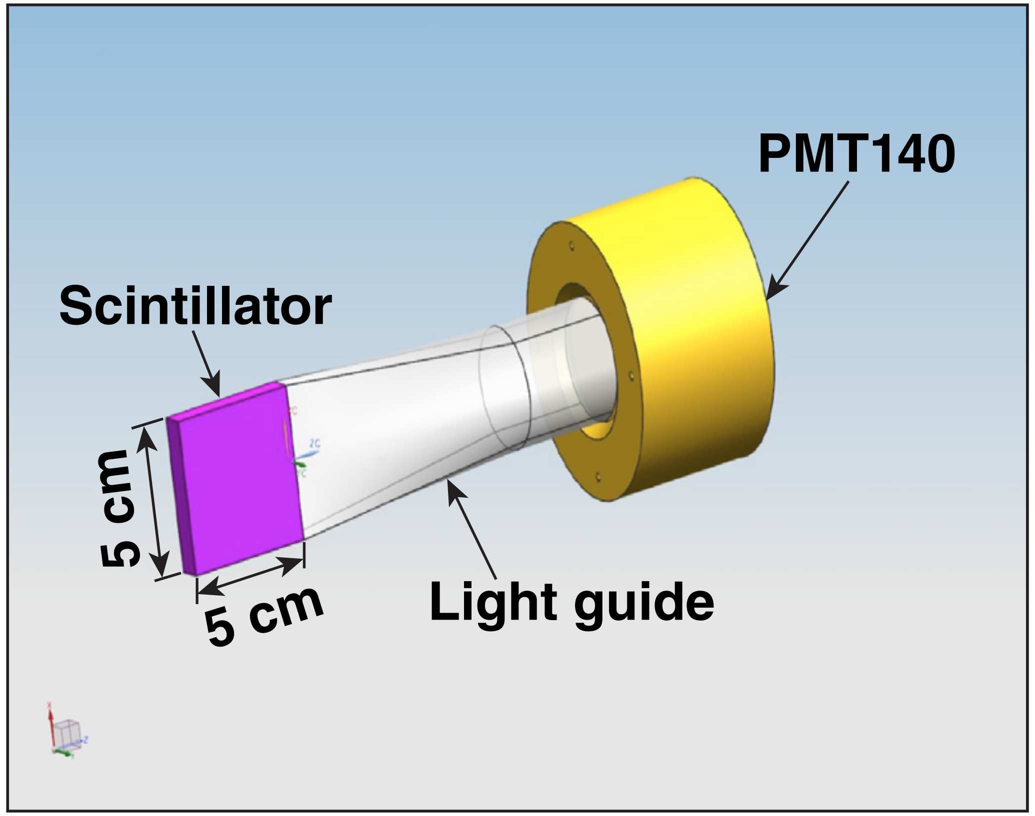
The petal detector* is used to measure the neutron spectrum





The small scintillator volume results in a very narrow instrument response function.

*V. Yu. Glebov *et al.*, CO8.00001, this conference.

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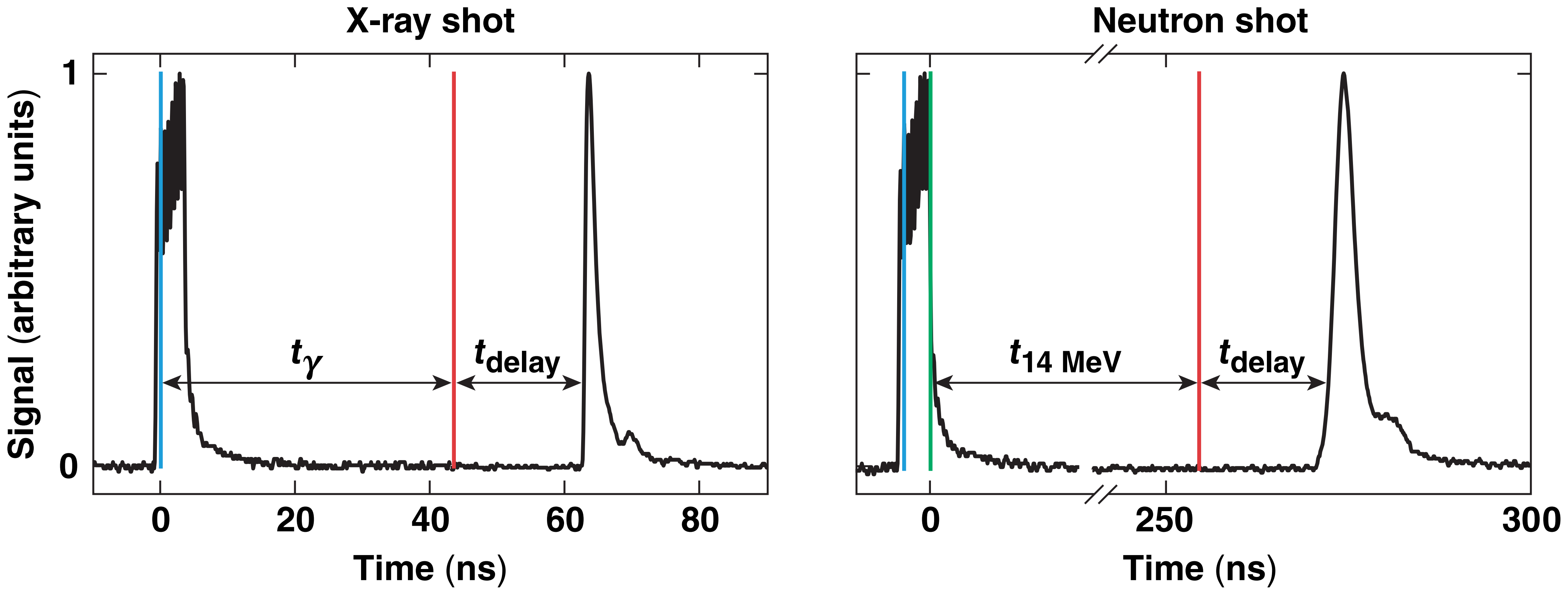
Absolute timing calibration is achieved with an optical fiducial along with x-ray timing shots

- The optical fiducial* enables accurate placement of the laser pulse and bang time on the time axis



The x-ray calibration shot allows us to quantify the inherent delay and determine an absolute timing axis.

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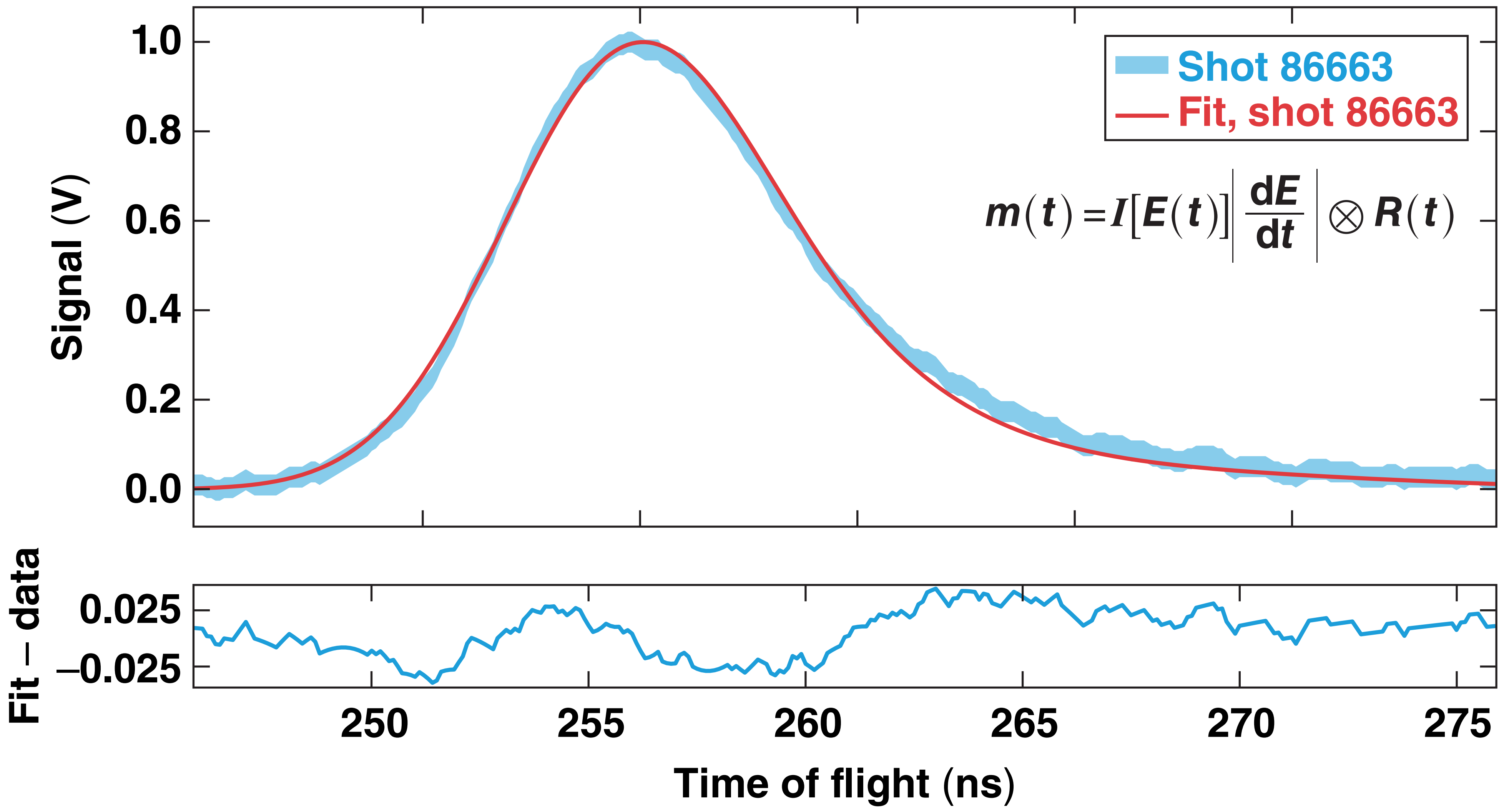
*LLE Review Quarterly Report 88, 171 (2001).

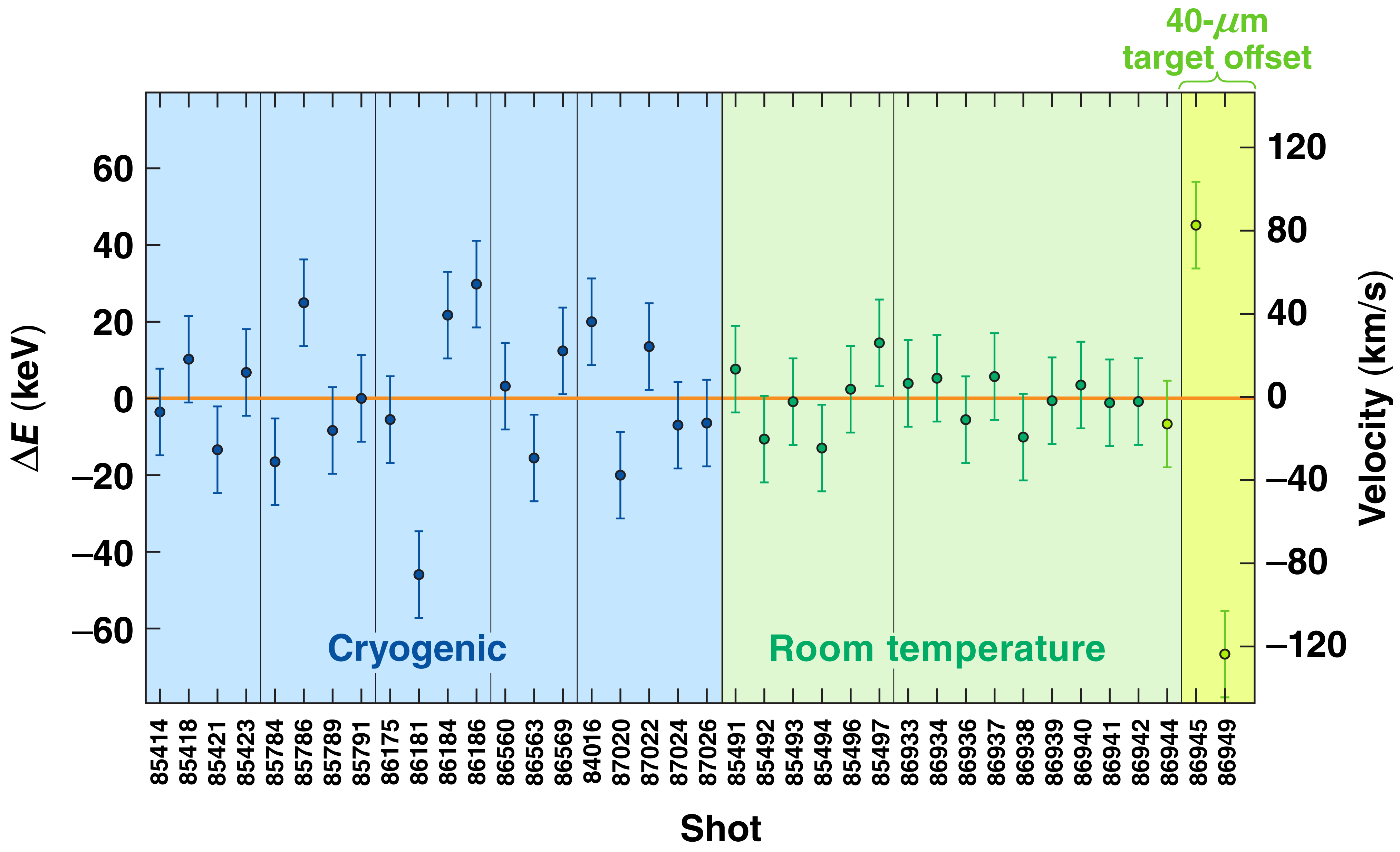
The forward-fitting procedure* is used to infer the first and second moments of the neutron spectrum



*R. Hatarik *et al.* J. Appl. Phys. 118, 184502 (2015).

E26735

Observed variation in the neutron kinetic energy peak in DT cryogenic implosions imply bulk fluid velocities as large as 60±20 km/s



E26736

Summary/Conclusions

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