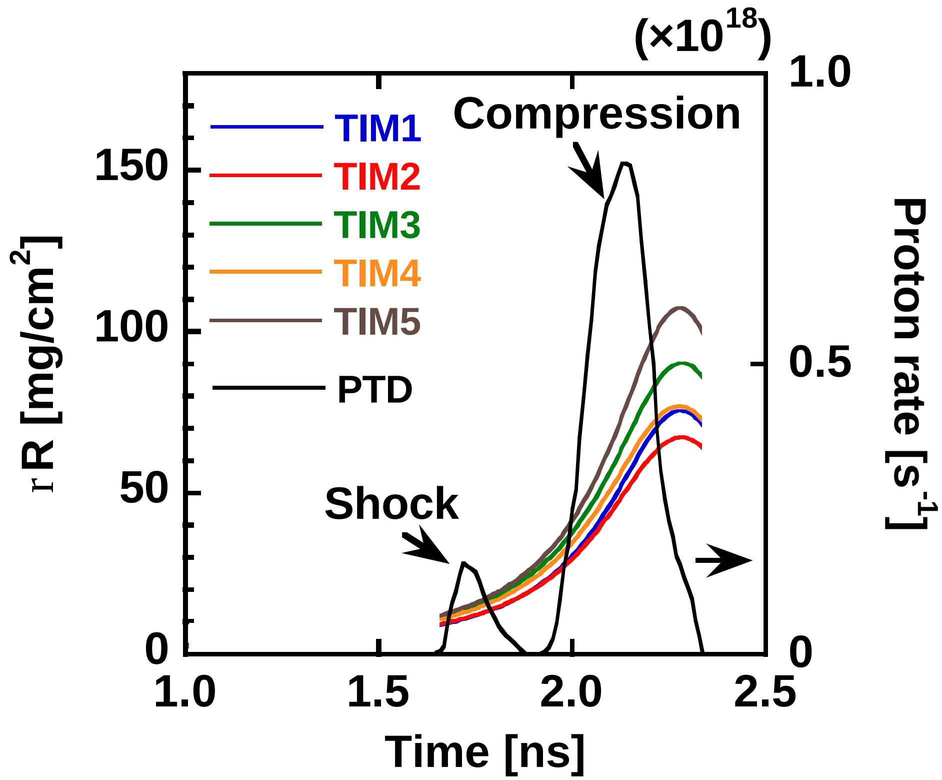
Measurement of shock-coalescence timing and ρR evolution of D^3He implosions at OMEGA



Johan Frenje
MIT - Plasma Science and Fusion Center

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Collaborators

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Summary

Shock-coalescence timing and ρR evolution of D^3He implosions have been measured at OMEGA

- A series of 18-atm D^3He filled CH capsules with thickness varying from 20 to 27 μm were imploded using 1-ns square laser pulses delivering 23 kJ.
- D^3He-reaction rate and ρR evolution were determined using a proton temporal diagnostic (PTD) in combination with several D^3He-proton spectrometers.
- First results show that D^3He proton production history is similar to DD neutron production history.
- Unique results from the PTD such as shock-coalescence time and shock-burn duration have been obtained and compared with 1-D calculations.
- Preliminary analysis suggests that low-mode ρR asymmetries at shock time are mirrored at bang time.

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Related work

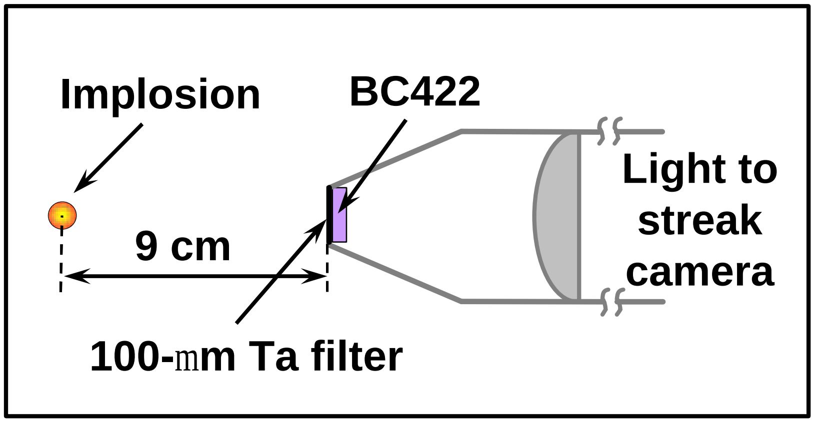
Recent related papers:

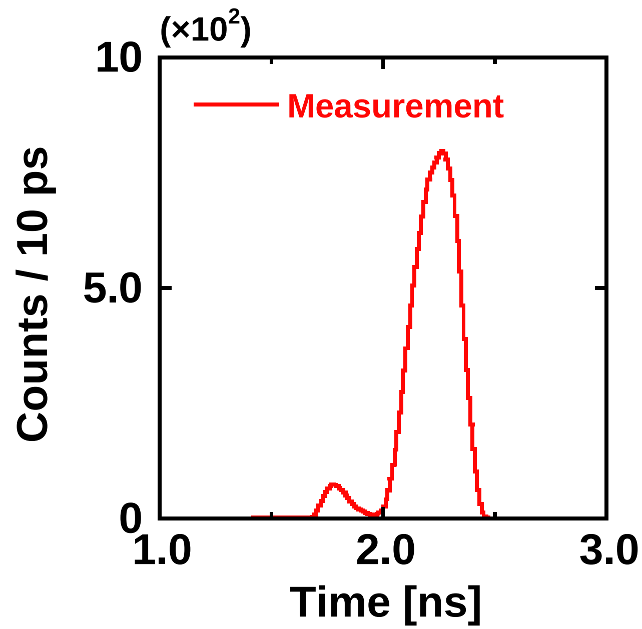
R. D. Petrasso et al., Phys. Rev. Letters 90 (2003) 095002.
V. A. Smalyuk et al., Phys. Rev. Letters 90 (2003) 135002.

Related talks and posters at this conference:

J. DeCiantis et al, MP4
V. Yu. Glebov et al., THO3
J. R. Rygg et al, THO6
F. H. Séguin et al., THO5

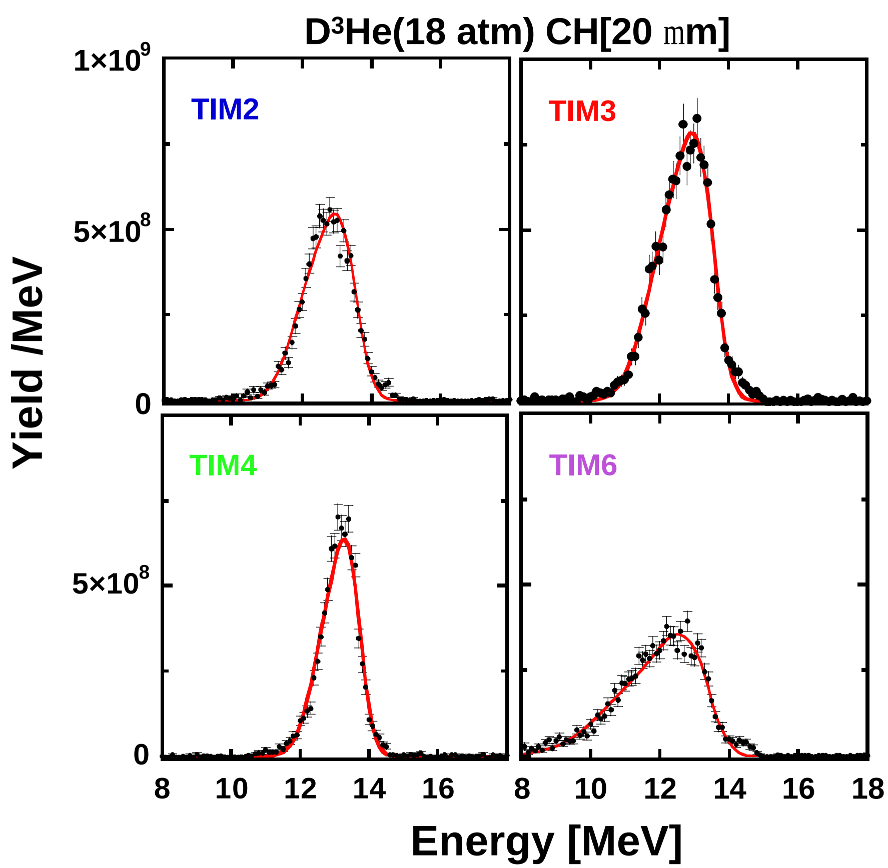
PTD data must be corrected for time dispersion caused by source and shell geometry, ρR evolution, Doppler broadening and PTD response

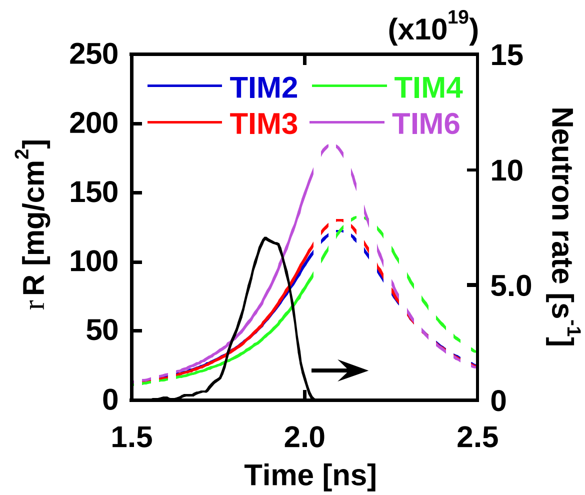




- **Source and shell geometry:** From Proton Core Imaging data and X-ray imaging data (J. DeCiantis et al, MP4).
- **Doppler broadening from $T_i(t)$:** From calculations.
- **PTD response:** From Monte-Carlo simulations.
- **ρR evolution:** Needs to be determined.

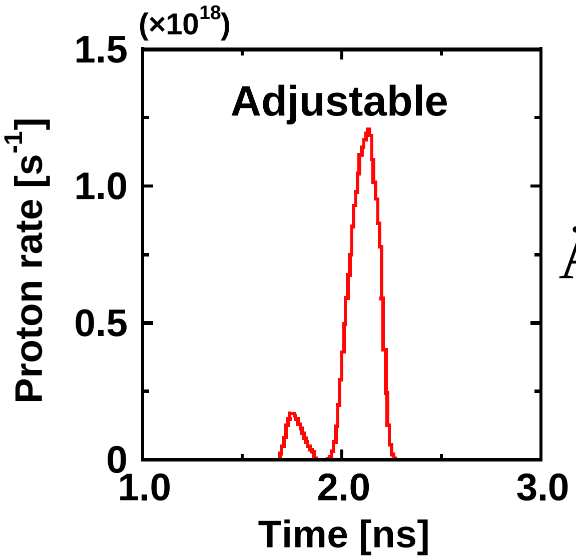
Using neutron burn rate as initial input rR(t) was inferred from a fit to measured D^3He-proton spectrum





$$rR(t) = \frac{c_1}{(t - c_2)^2 + c_3}$$

A convolution of D^3He production history and components causing time dispersion are used to fit measured PTD data



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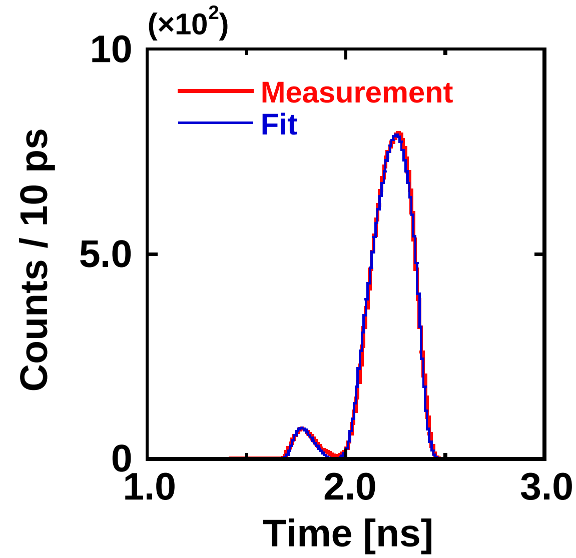
Time dispersion caused by:

rR(t)
geometry
$T_i(t)$
+
PTD response



Number of free parameters used in fitting are equal to number of time bins with data.

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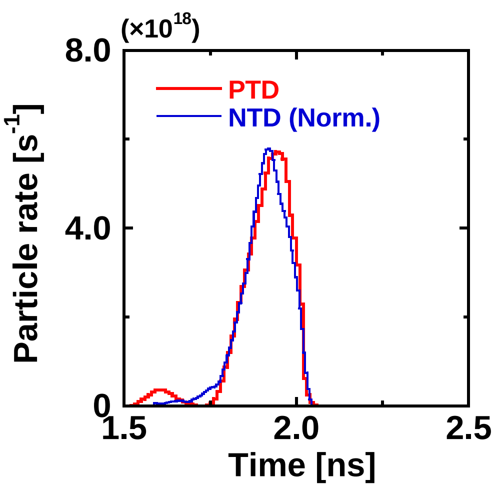
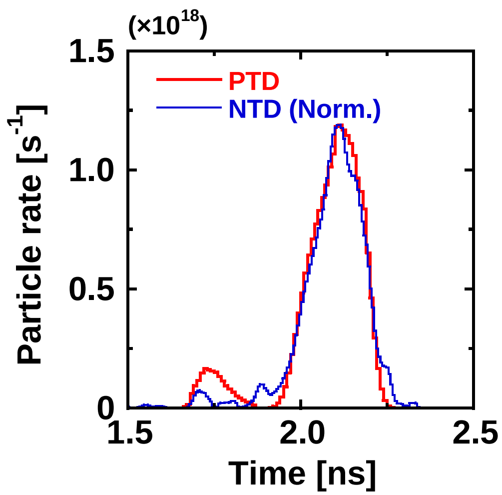
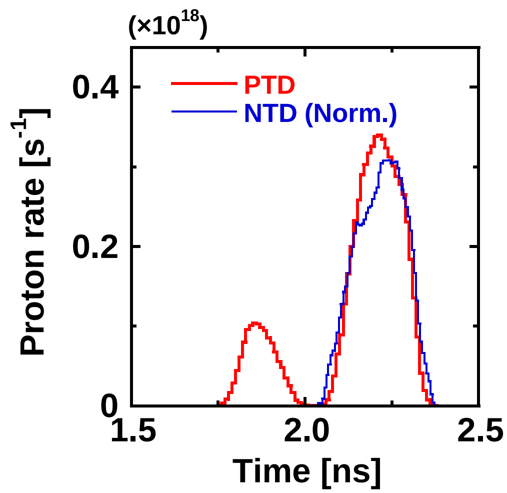
First results show that D^3He proton production history is similar to DD neutron production history

D^3He(18atm)CH[20mm] D^3He(18atm)CH[24mm] D^3He(18atm)CH[27mm]







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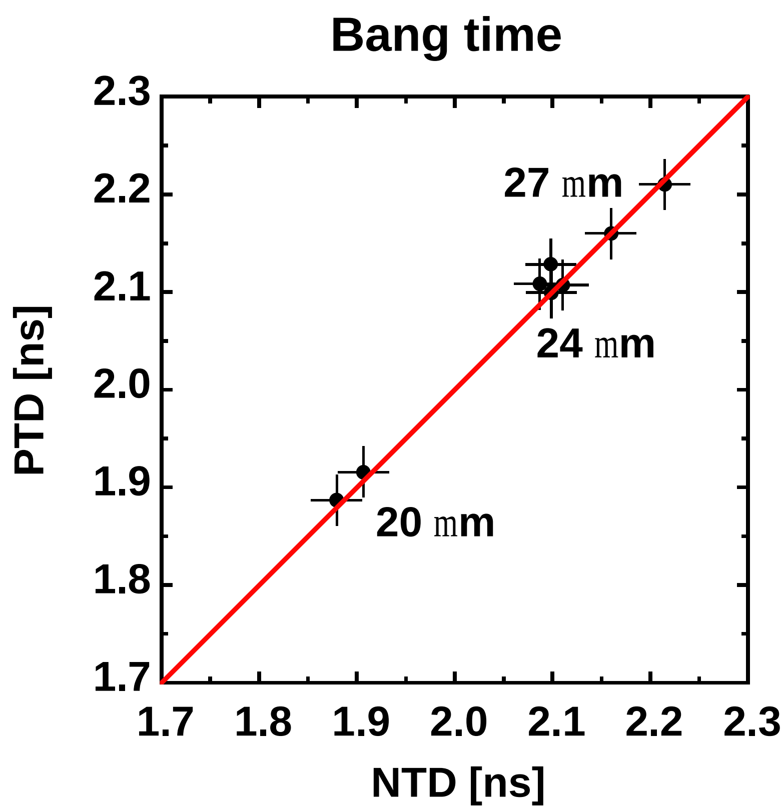
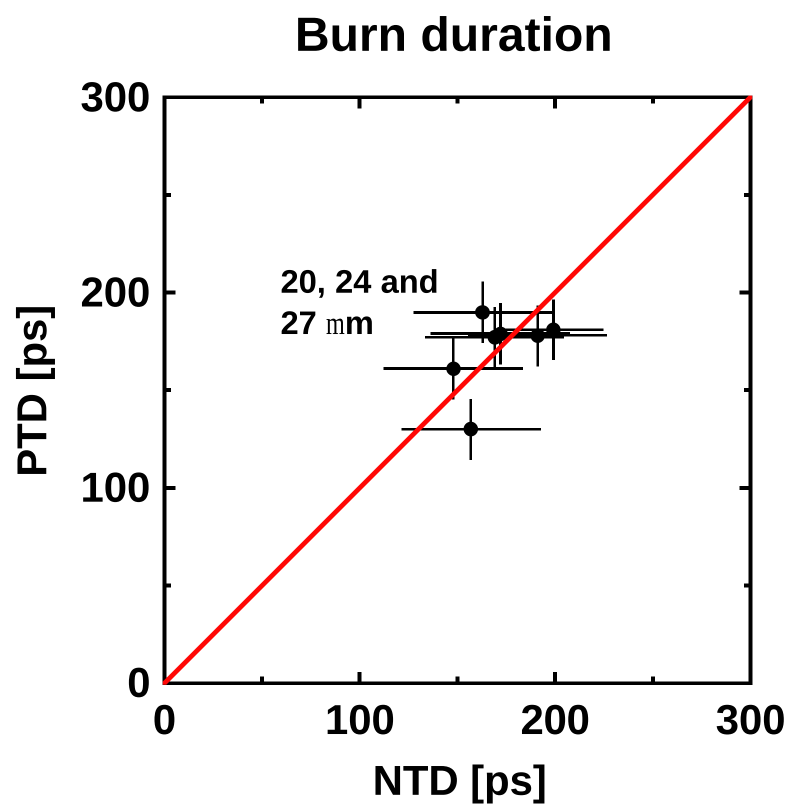
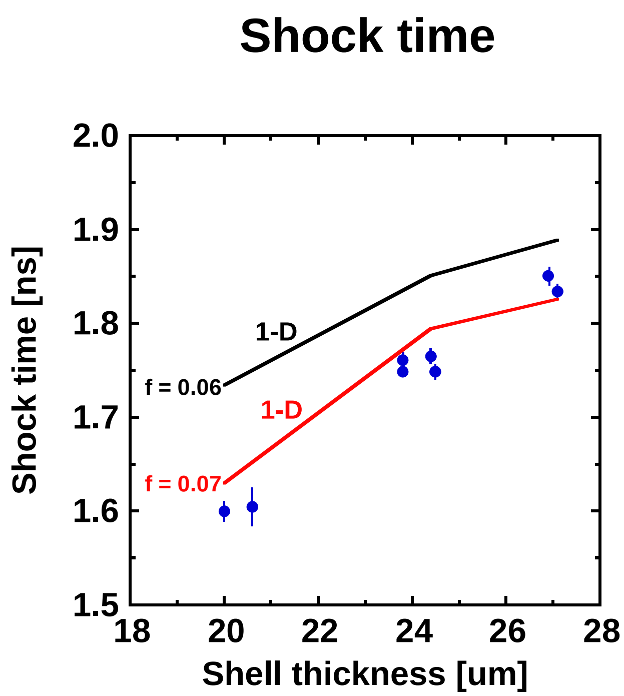
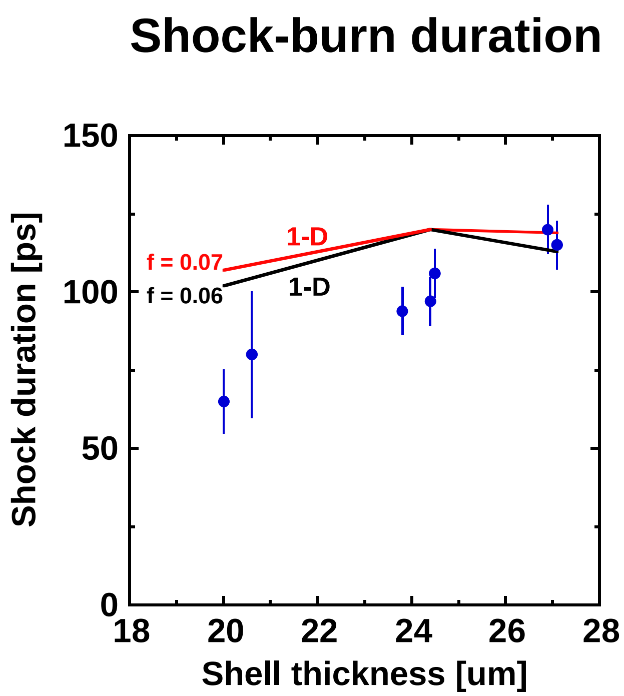
Similar bang time and burn duration are inferred from D^3He proton and DD neutron production histories





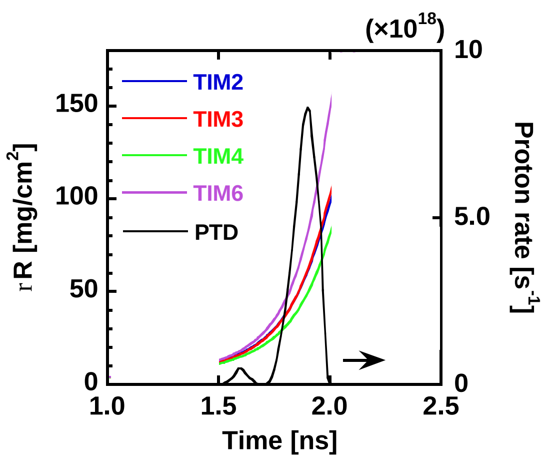
Unique results from the PTD such as shock time and shock-burn duration have been obtained and compared with 1-D calculations



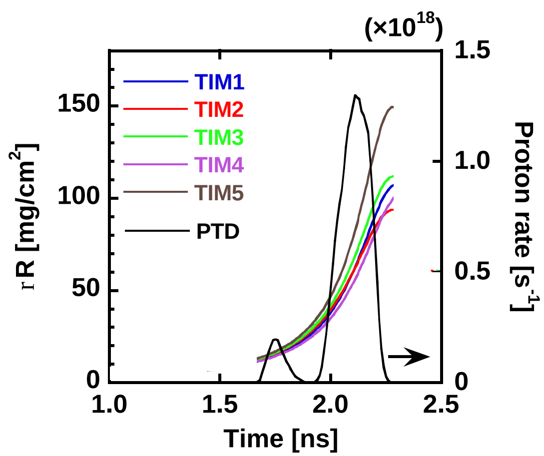


Using an iterative process ρR(t) was determined from D^3He proton production history and energy spectra

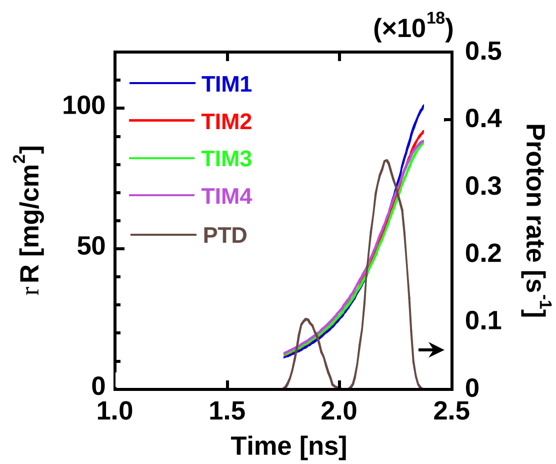
D^3He(18atm)CH[20μm]



D^3He(18atm)CH[24μm]



D^3He(18atm)CH[27μm]



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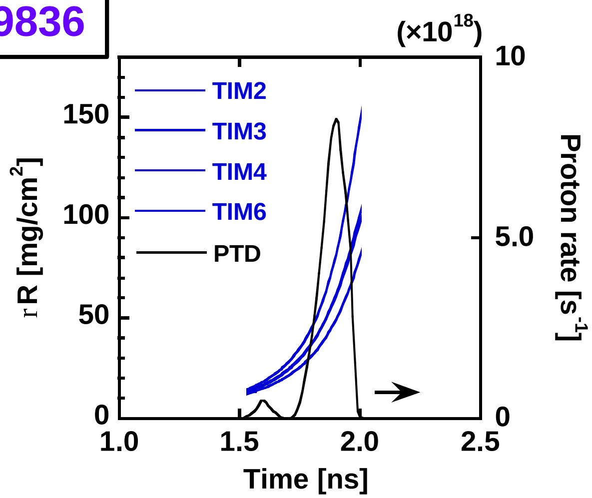
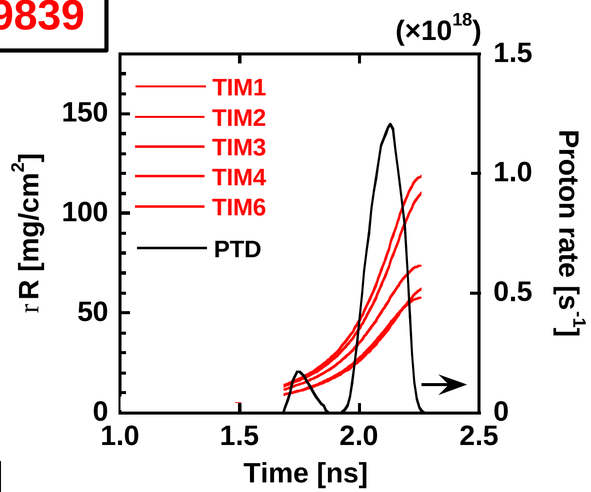
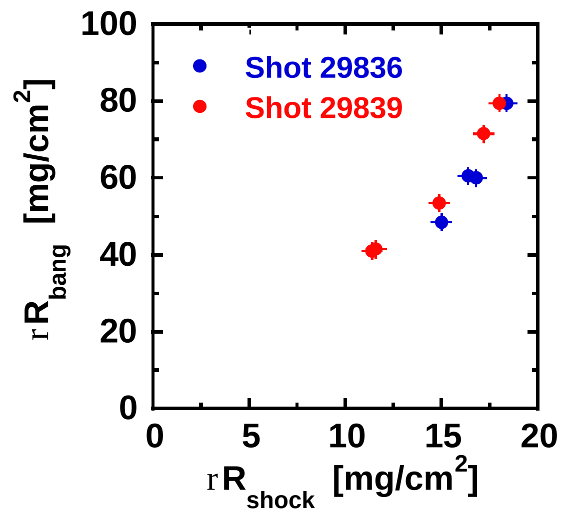
Preliminary analysis suggests that low-mode ρR asymmetries at shock time are mirrored at bang time

Shot 29836



Shot 29839





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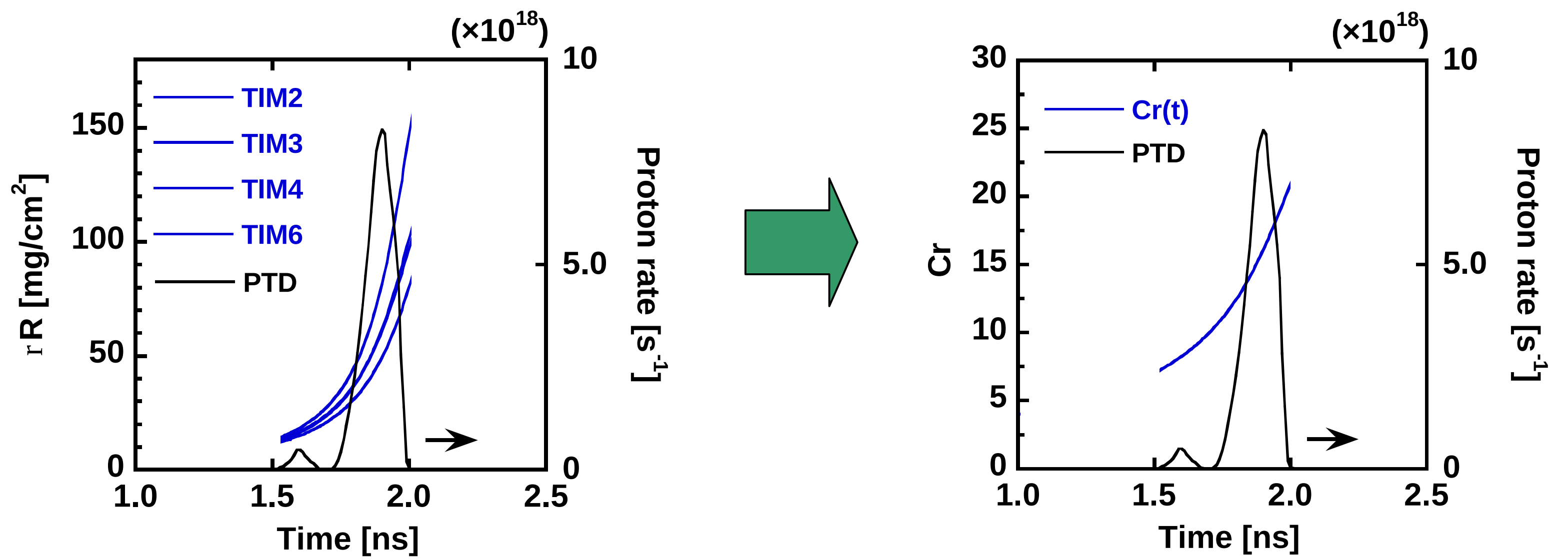
Evolution of convergence ratio has been inferred from D^3He proton production history and energy spectra



$$Cr(t) = \sqrt{\frac{\langle \rho R(t) \rangle}{f \times \rho R_{initial}}}$$

f = fraction of initial shell not ablated away

F. H. Séguin et al., THO5

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