Proton Temporal Diagnostic for ICF Experiments on OMEGA

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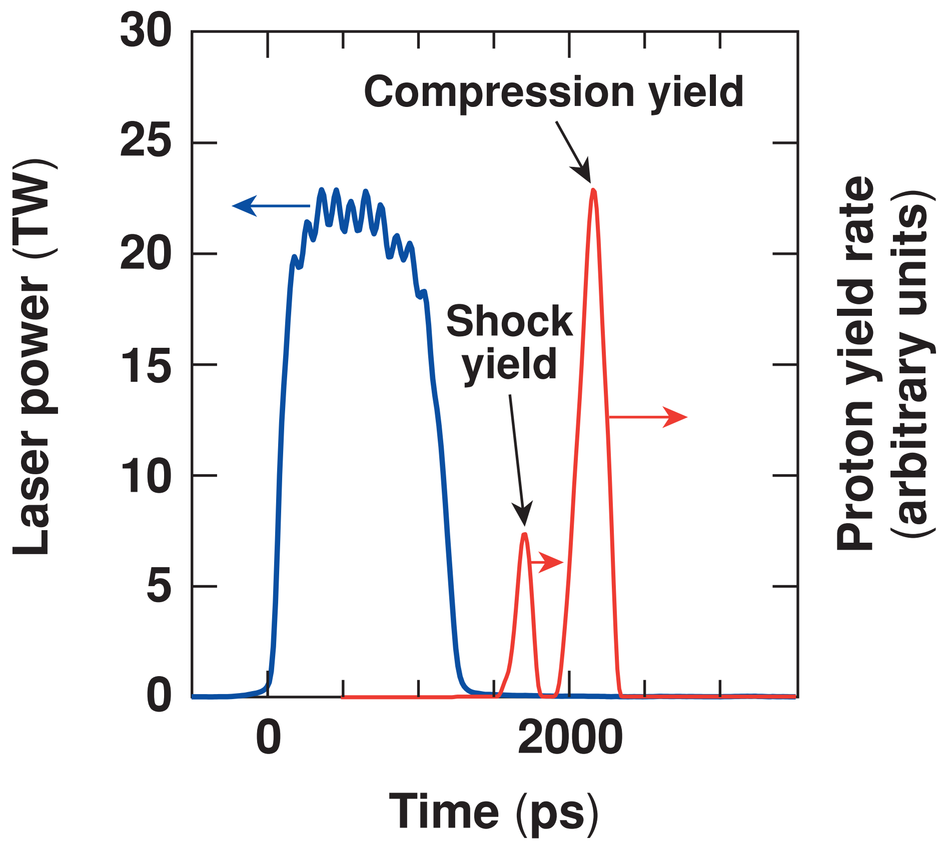

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Summary

We developed a proton temporal diagnostic (PTD) to record a fusion reaction history of protons in a D^3He implosion

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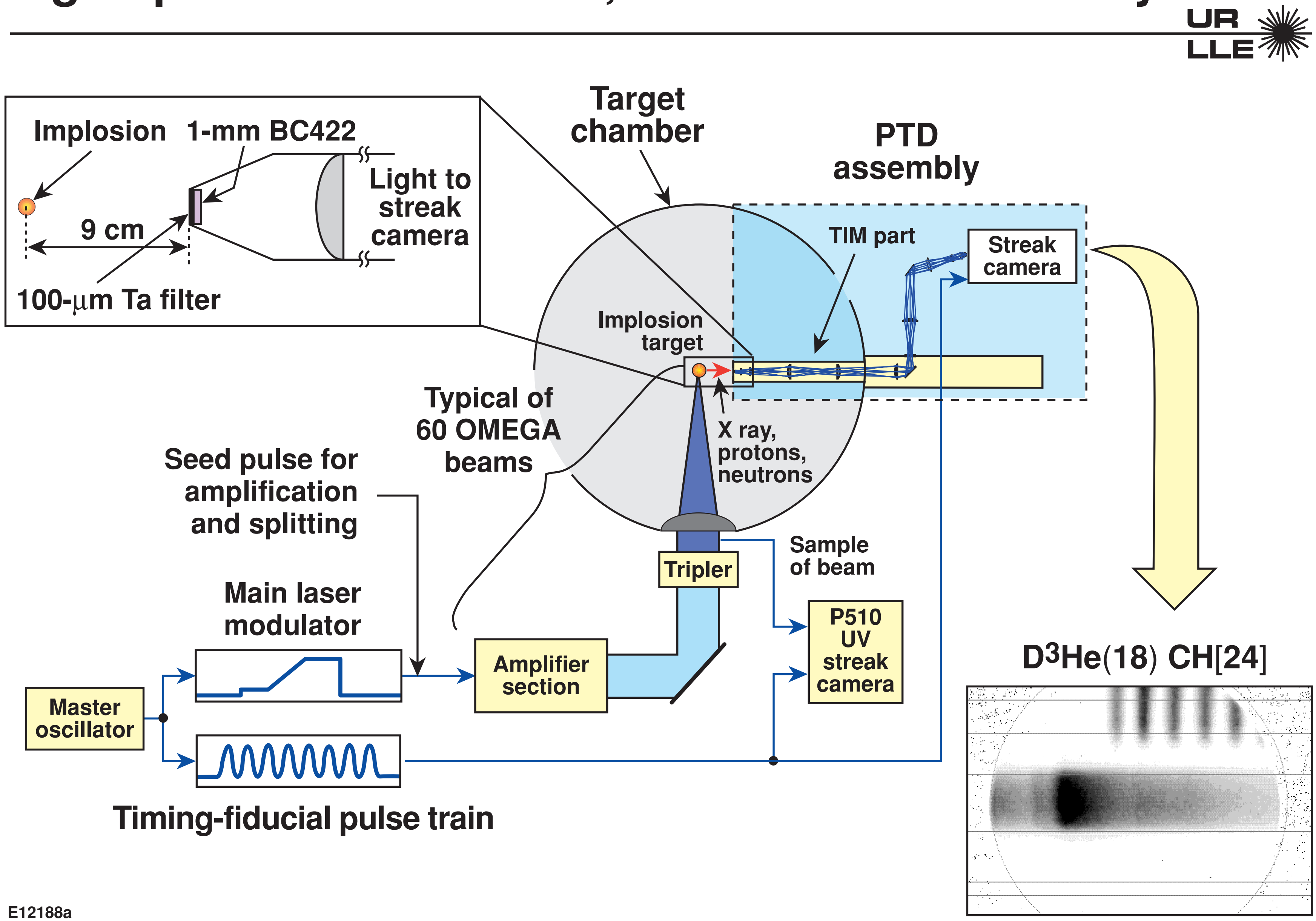
- PTD is a TIM diagnostic based on a fast scintillator, optical system, and optical streak camera with an instrumental resolution of 25 ps.
- The main purpose of PTD is to measure shock time and ρR evolution in D^3He implosions.
- The neutron bang time and total ρR can be inferred from PTD data in D_2 implosions.
- Additionally, PTD can operate as a fast hard-x-ray detector with an x-ray cutoff energy between 10 keV and 100 keV.

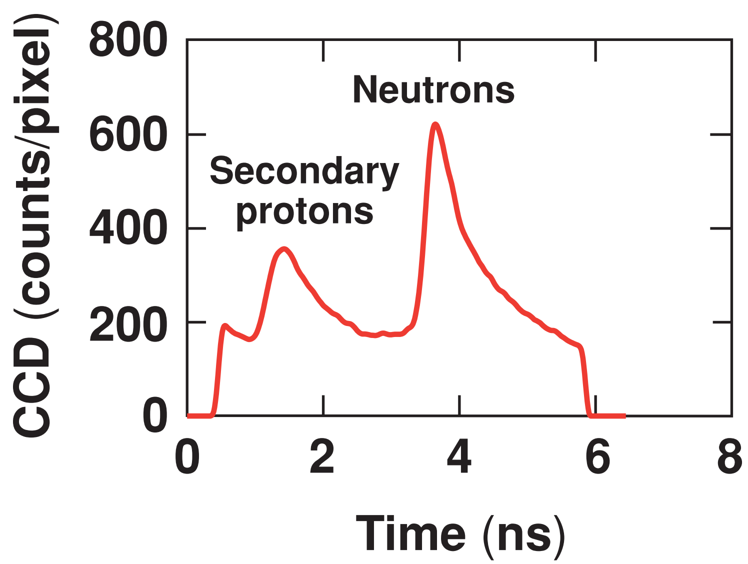
PTD is based on a fast scintillator, optical system, high-speed streak camera, and OMEGA fiducial system



E12188a

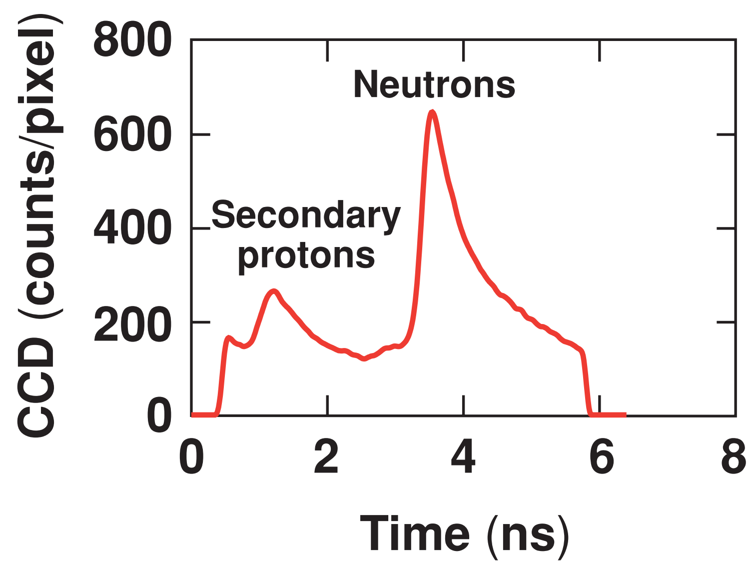
A 100-μm Ta filter is close to optimum for PTD

PTD signal
100 μm Ta



Shot #29807
D_2(3)CH[19.3]
1-ns square pulse
$Y_n = 3.1 \times 10^{10}$

PTD signal
200 μm Ta

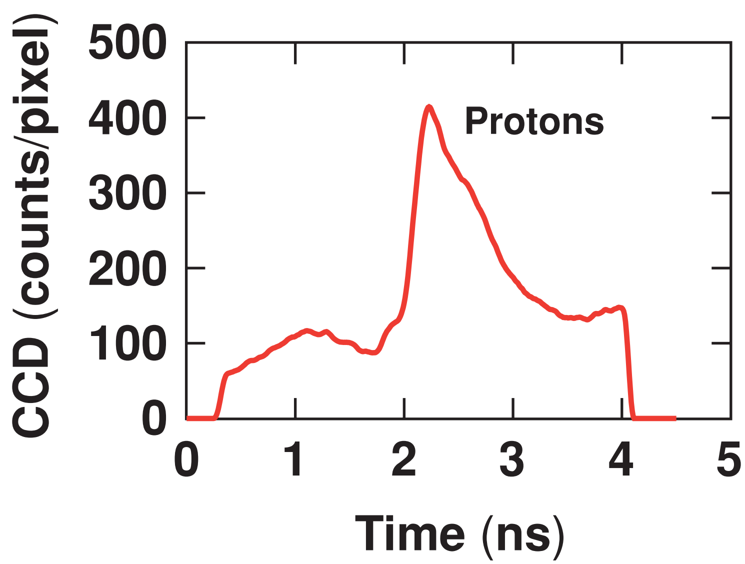


Shot #29808
D_2(3)CH[19.3]
1-ns square pulse
$Y_n = 3.3 \times 10^{10}$

E12291

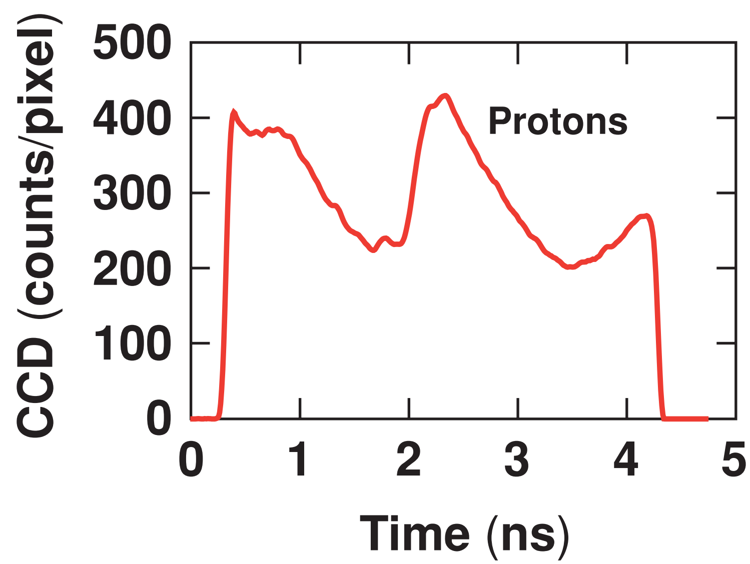
A 100-μm Ta filter is close to optimum for PTD

PTD signal
100 μm Ta



Shot #28935
$^3He(12)D_2(6)CH[19.8]$
Shaped pulse with $\alpha = 5$
$Y_n = 3.7 \times 10^9$

PTD signal
50 μm Ta

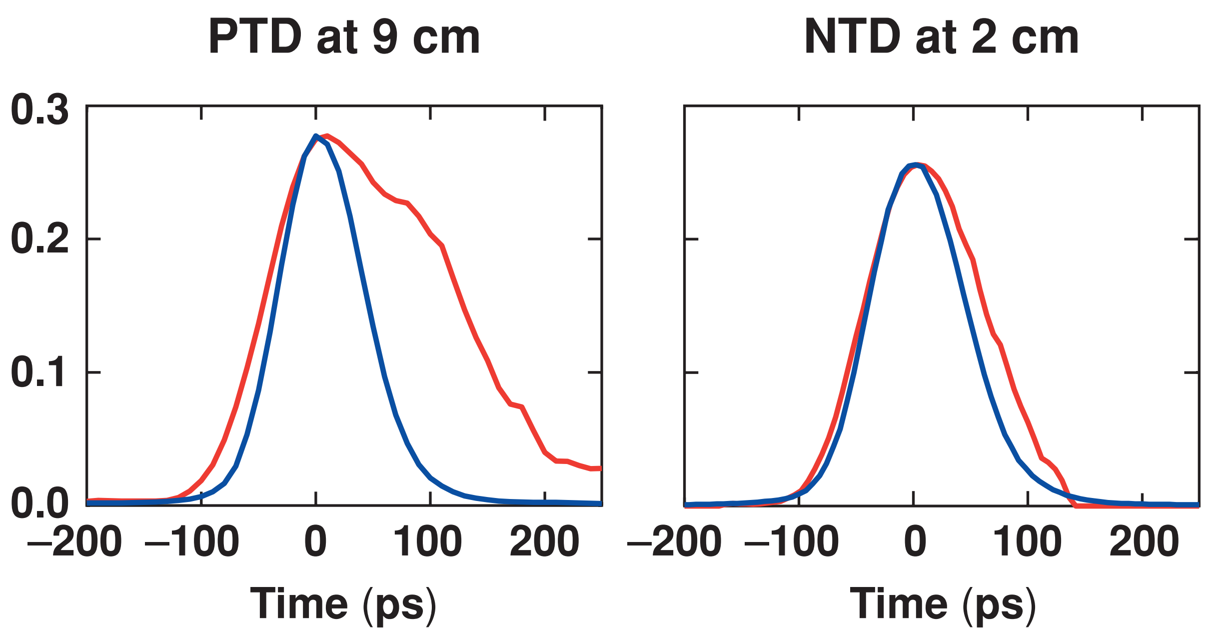


Shot #28936
$^3He(12)D_2(6)CH[19.9]$
Shaped pulse with $\alpha = 5$
$Y_n = 4.0 \times 10^9$

E12292

PTD timing calibration was performed with 100-μm Al filter and 100-ps laser pulse on a gold ball target

Shot	Δ Time
31651	5 ps
31656	–3 ps
31658	–1 ps



Comparison of PTD and NTD signals suggests the presence of hot electrons with energies of 100 to 300 keV.

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The main purpose of PTD is to measure shock time and ρR evolution in D^3He implosions

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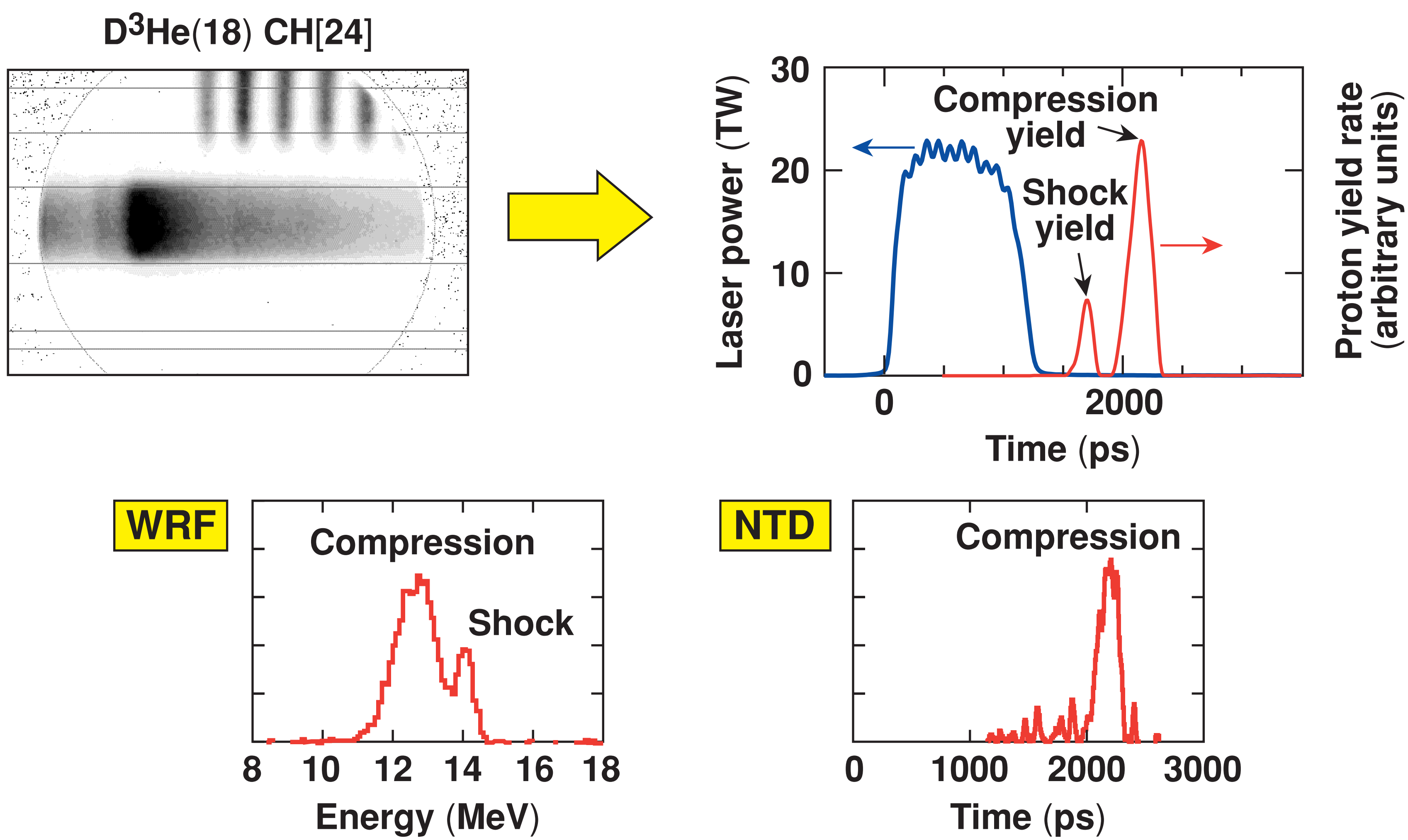
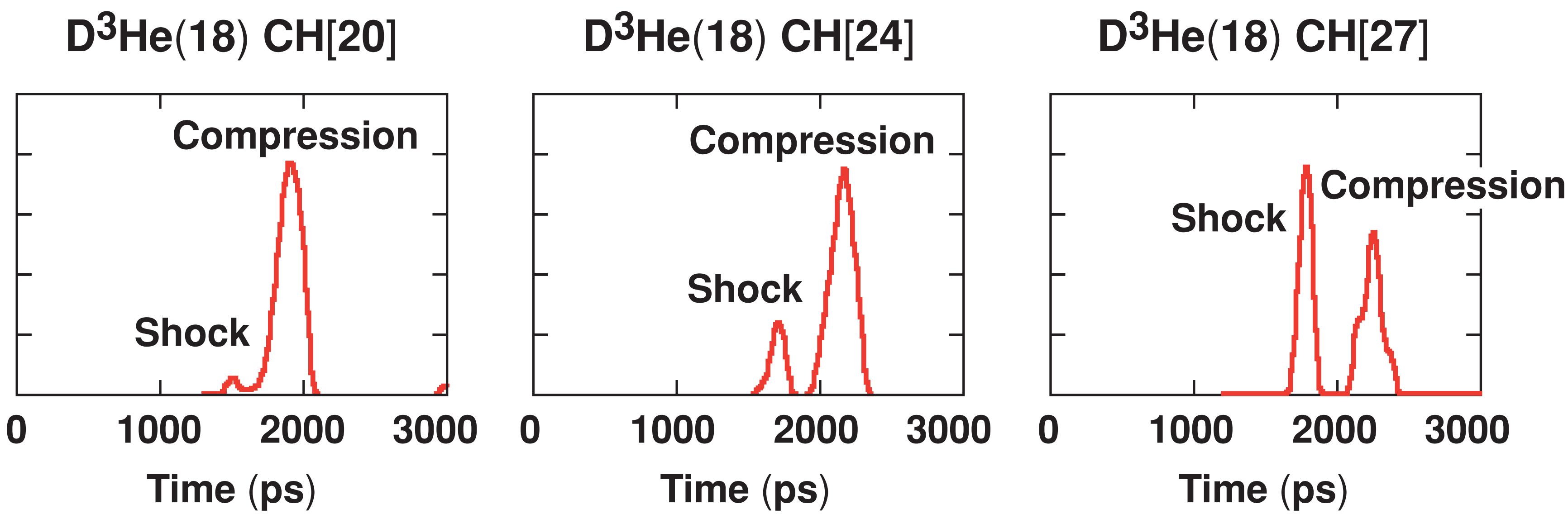


Shock peak is much more evident in PTD data than in NTD and WRF data.

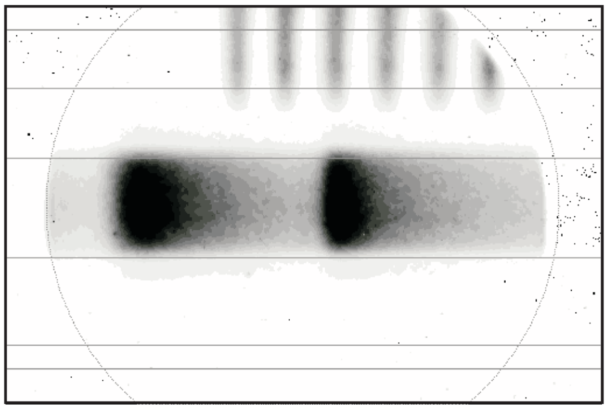
E12294

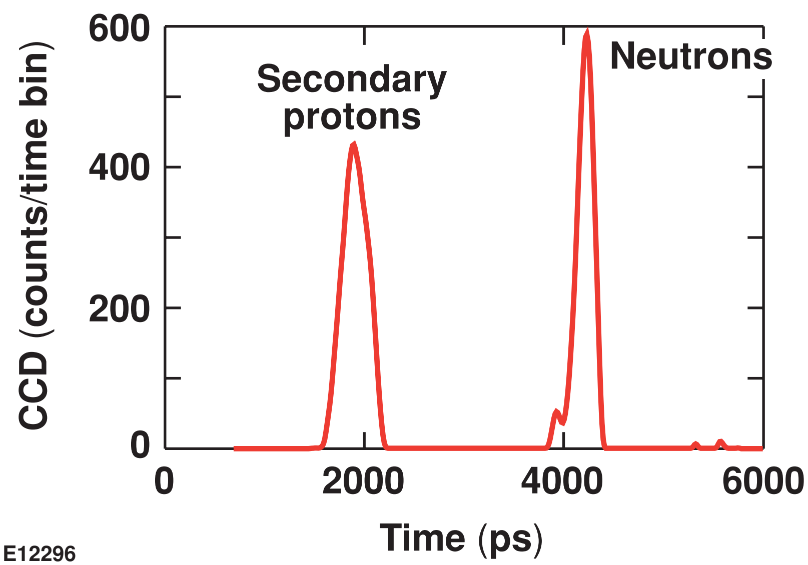
The ratio of proton shock yield to compression yield in a D^3He implosion is a function of shell thickness

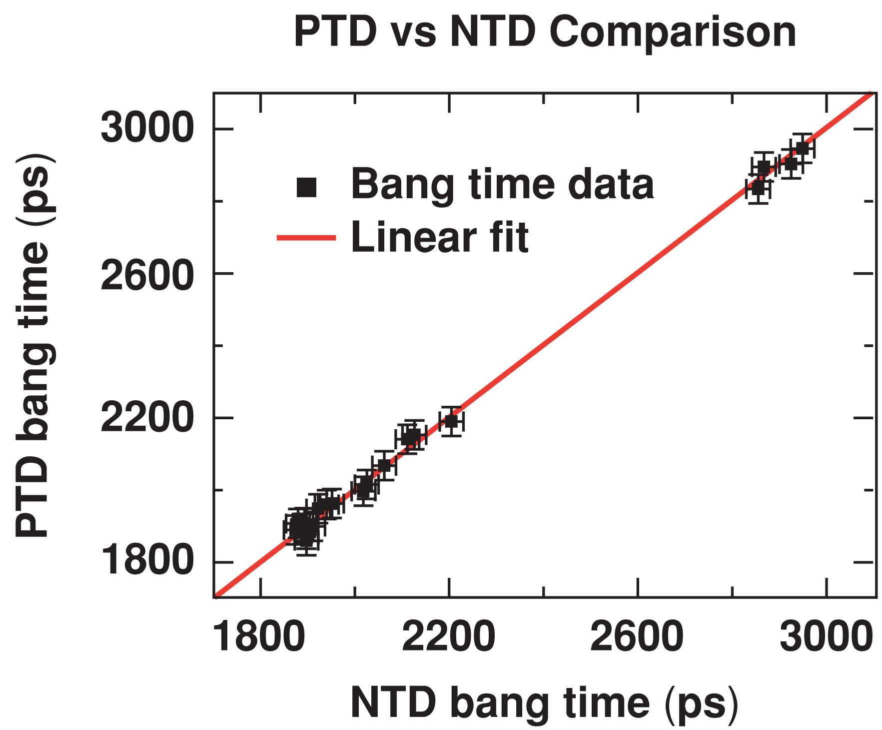


E12295

In D_2 implosions PTD can measure neutron bang and burn width almost as well as NTD

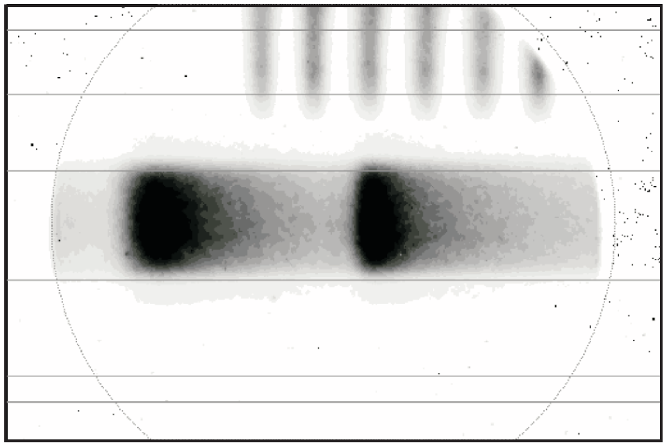


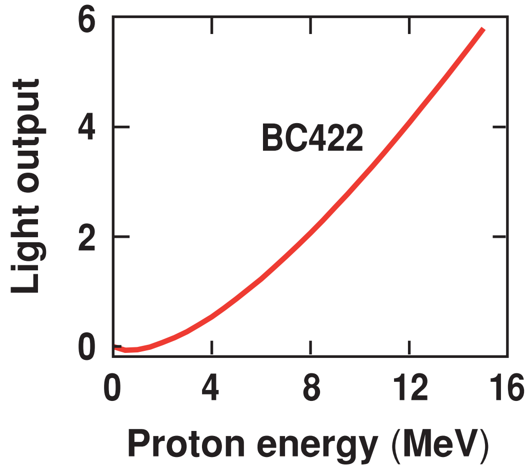


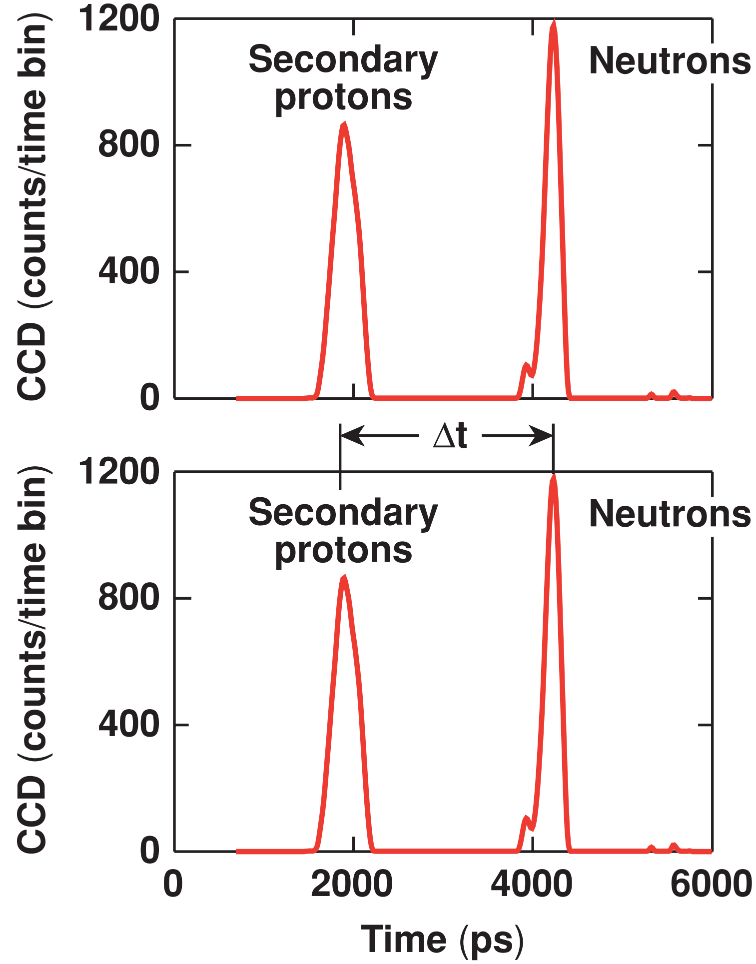


E12296

The total ρR can be inferred from secondary protons energy downshift measured by PTD in D_2 implosions



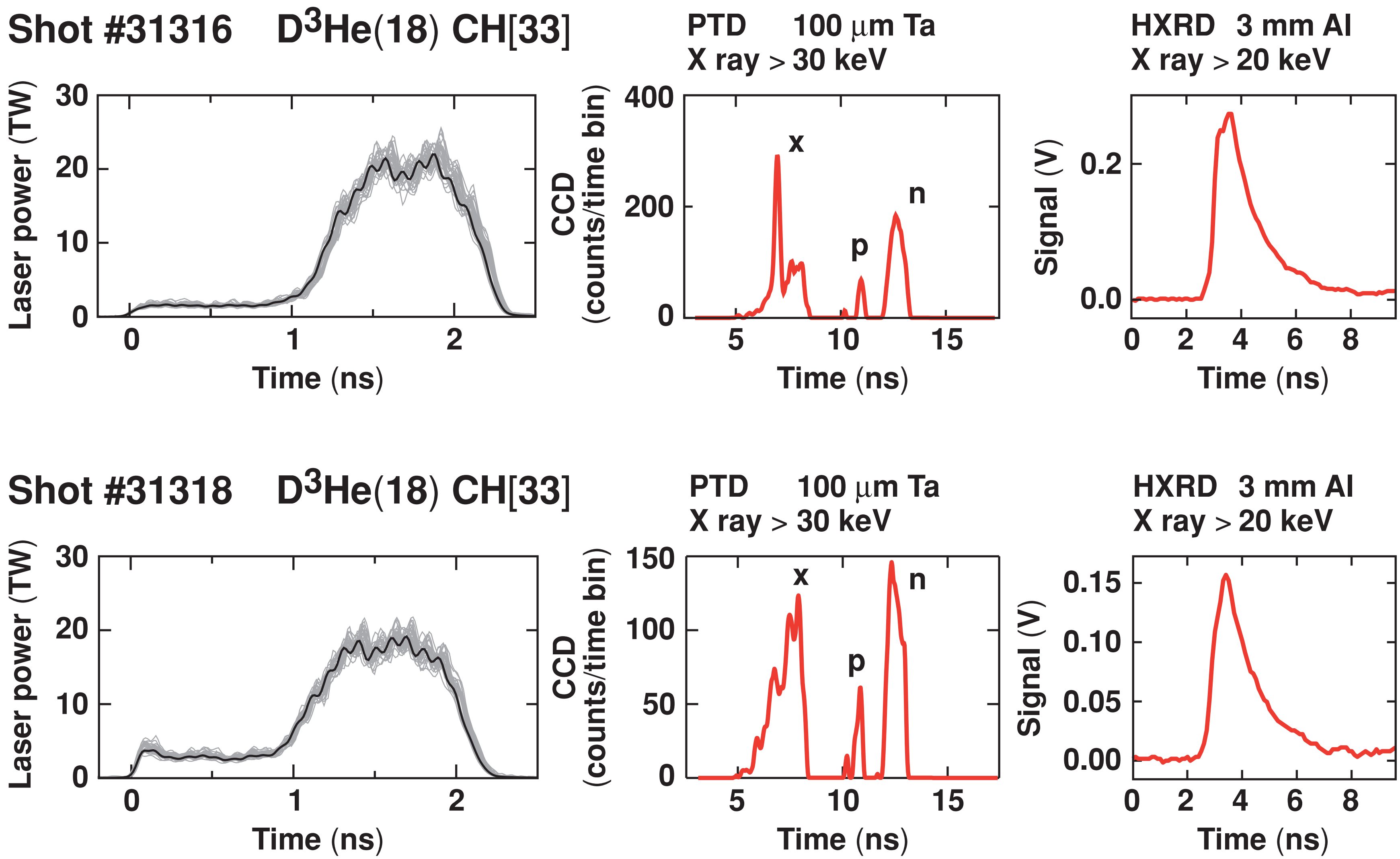




Energy downshift is measured from the time-of-flight difference between secondary protons and primary neutrons.

E12297

Additionally, PTD can operate as a fast hard-x-ray detector with a x-ray cutoff energy between 10 and 100 keV



E12298

Summary/Conclusions

We developed a proton temporal diagnostic (PTD) to record a fusion reaction history of protons in a D^3He implosion

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E12299