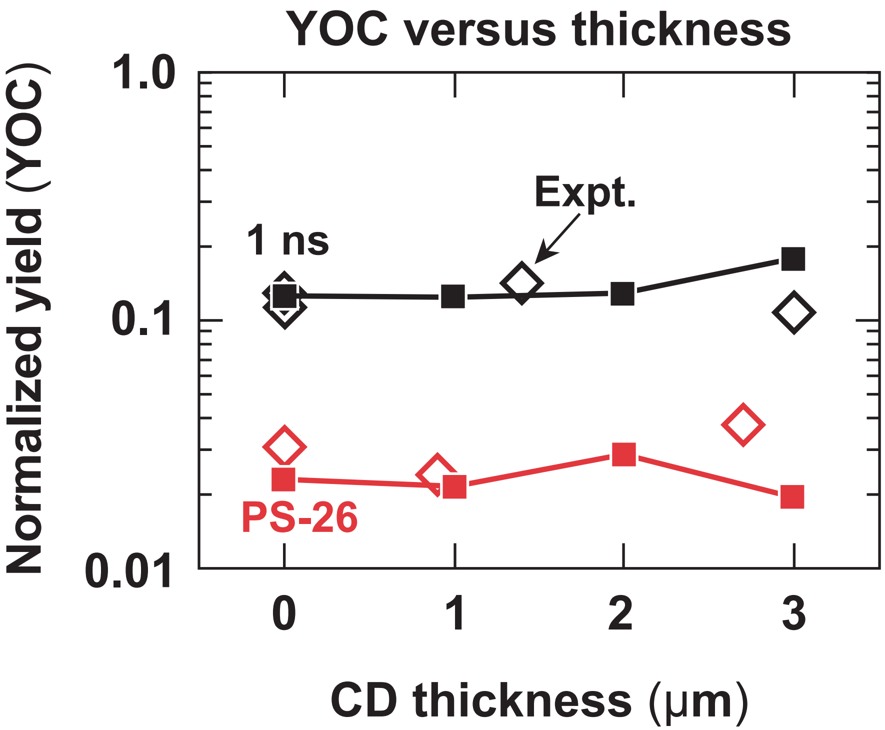
One-Dimensional Simulation of the Effects of Unstable Mix on Neutron and Charged-Particle Spectra from Laser-Driven Implosion Experiments



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Summary

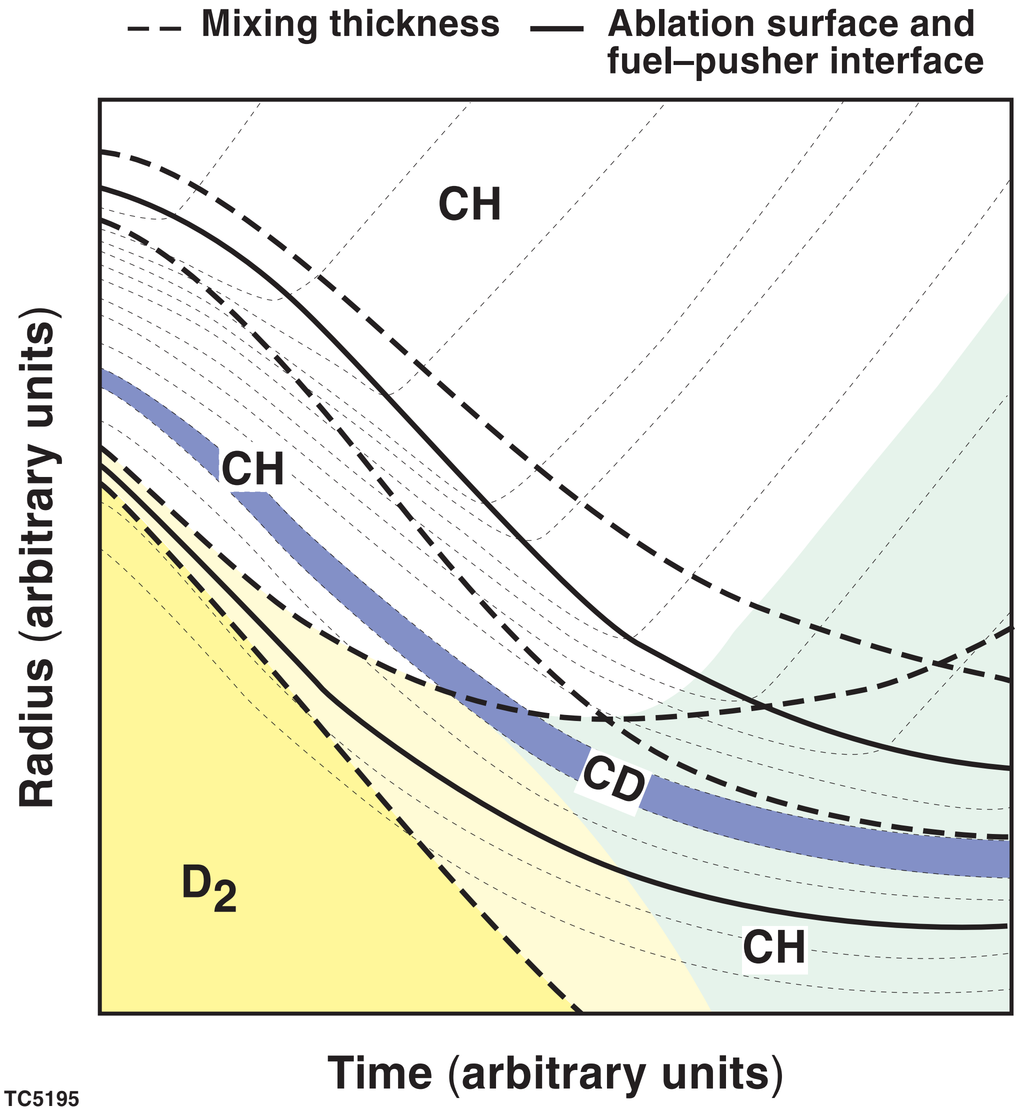
Modeling of mix in the 1-D hydrocode *LILAC* reproduces experimentally observed behavior of primary and secondary neutron production

- The mix model includes the transport of target constituents, thermal energy, and turbulent energy due to both the acceleration and deceleration instabilities.
- Primary neutron yields are reduced by mixing fuel with cold shell material.
- Neutron-averaged source temperatures are higher when mix quenches the cooler outer core.
- Secondary neutron yield, energy spectra, and their dependence on target composition are significantly modified by mix.

Outline

- Modeling of mix in 1-D
- Primary and secondary DD neutrons
- Modification of neutron production by mix
- Illustrative examples
- Conclusions

"Bubble and spike" mixing thickness is obtained from a multimode Rayleigh–Taylor perturbation model*



- $\frac{d^2}{dt^2} A_\ell = \gamma^2(t) A_\ell$ including Bell-Plesset effects
- Takabe form for $\gamma^2(t)$
- Haan saturation procedure for

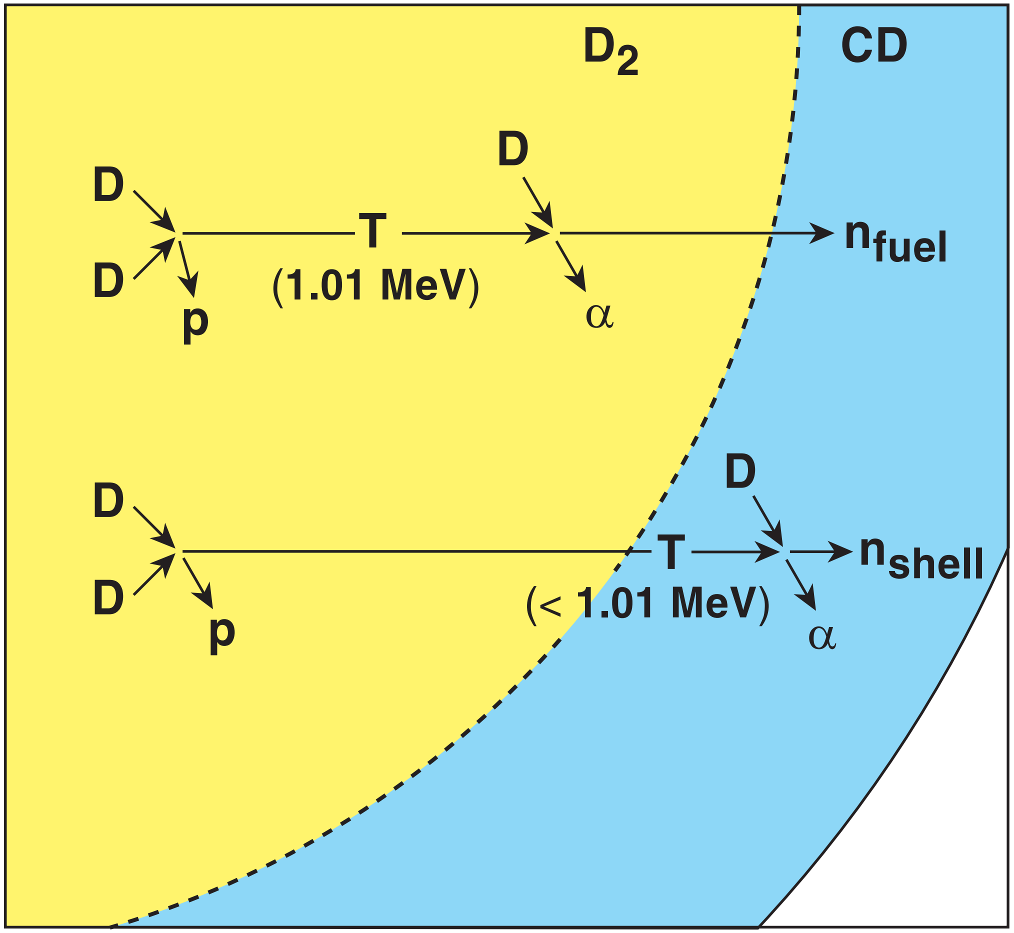
$$A_\ell(t) > \frac{2R(t)}{\ell^2}^{*}$$

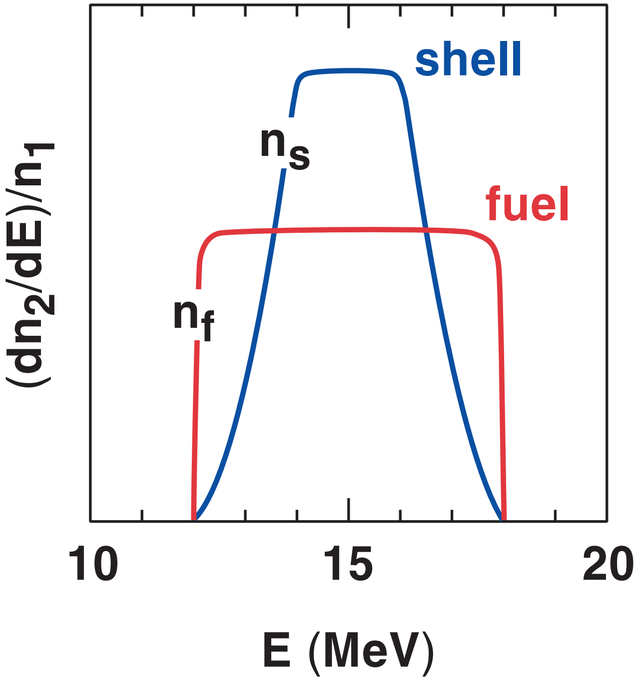
- Initial perturbation spectrum $A_\ell(t = t_0)$ specified at ablation surface and fed through to fuel–pusher interface over time.
- Mix is modeled as a diffusive transport process.

TC5195

*S. W. Haan, Phys. Rev. A 39, 5812 (1989).

Secondary DT neutrons from the fuel and from CD layers have distinct energy spectra





H. Azechi, M. D. Cable, and R. O. Stapf,
Laser & Particle Beams 9, 119–134 (1991).

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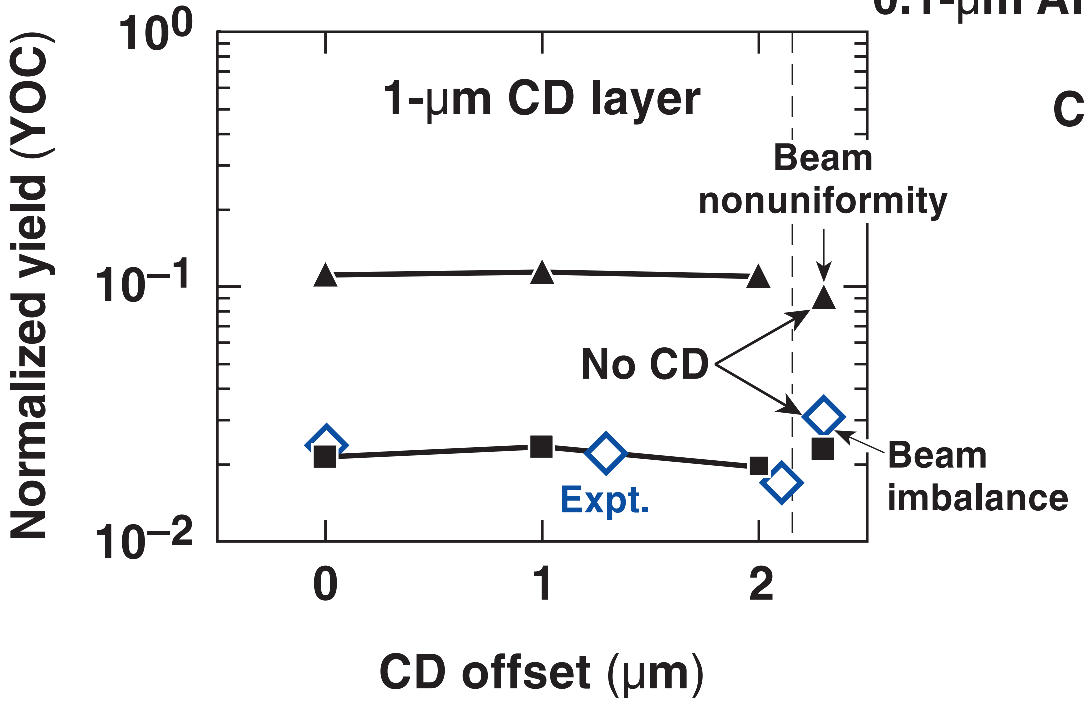
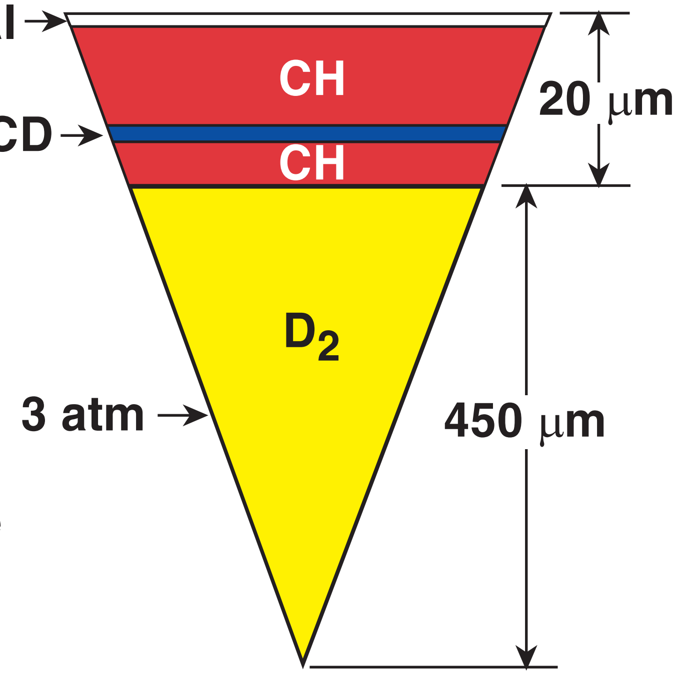
Cooling by fuel–pusher mix lowers DD neutron yield to observed levels

- 1-µm CD in 900-µm-diam, 27-µm shell, shaped 21-kJ PS-26 pulse





◇ Expt. data —▲— Single-beam nonuniformity —■— Beam imbalance

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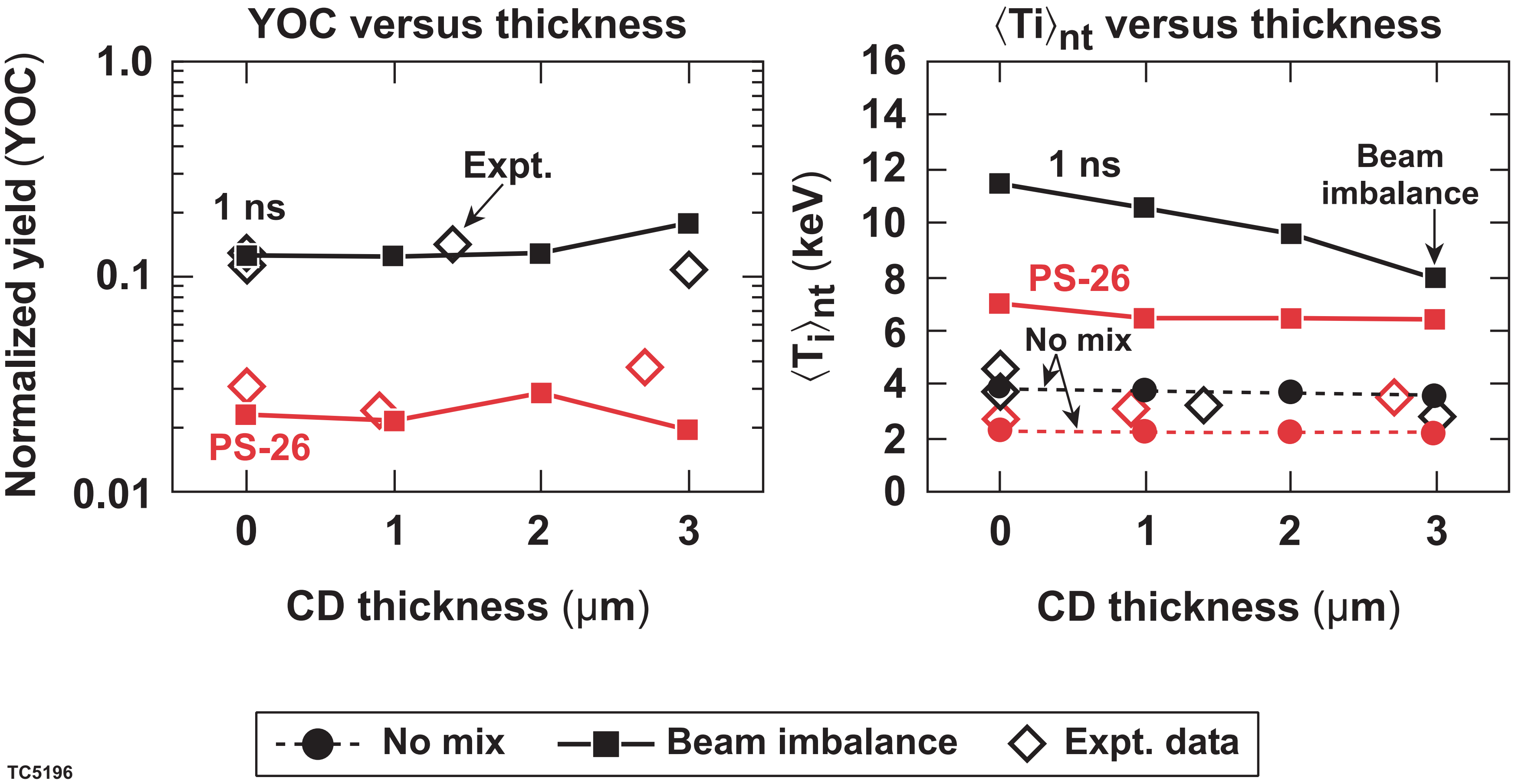
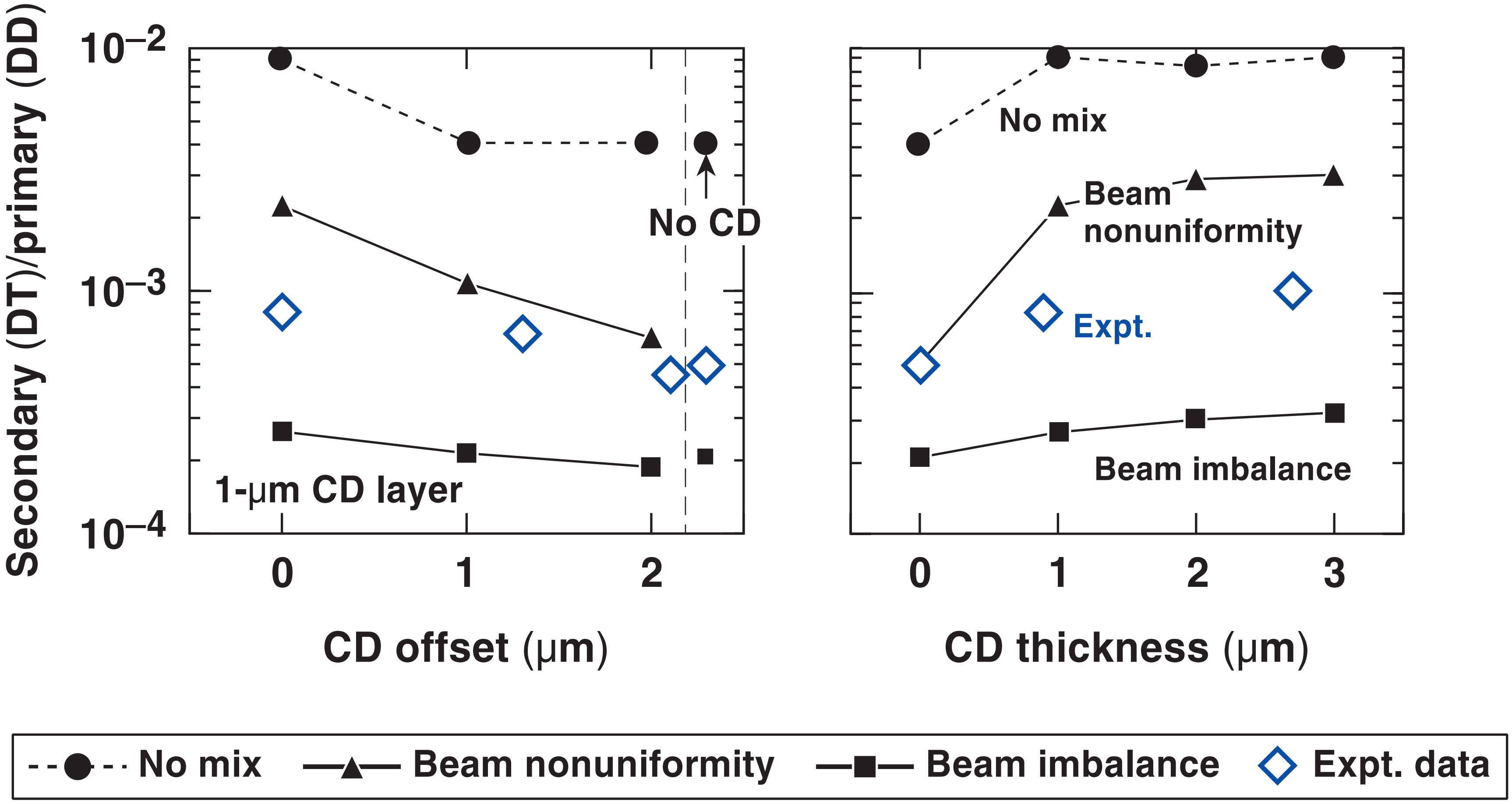
Cooling due to mix reduces the neutron yield, but raises the neutron-averaged ion temperature

- 20-µm, 900-µm diameter shell, 1-ns pulse
- 27-µm, 900-µm diameter shell, shaped PS-26 pulse



Mix reduces the dependence of secondary DT neutron yield on the offset and thickness of the CD layer

- 27-μm, 900-μm CH shell, 21-KJ, PS-26 pulse



Mix reduces the dependence of secondary DT neutron yield on the offset and thickness of the CD layer

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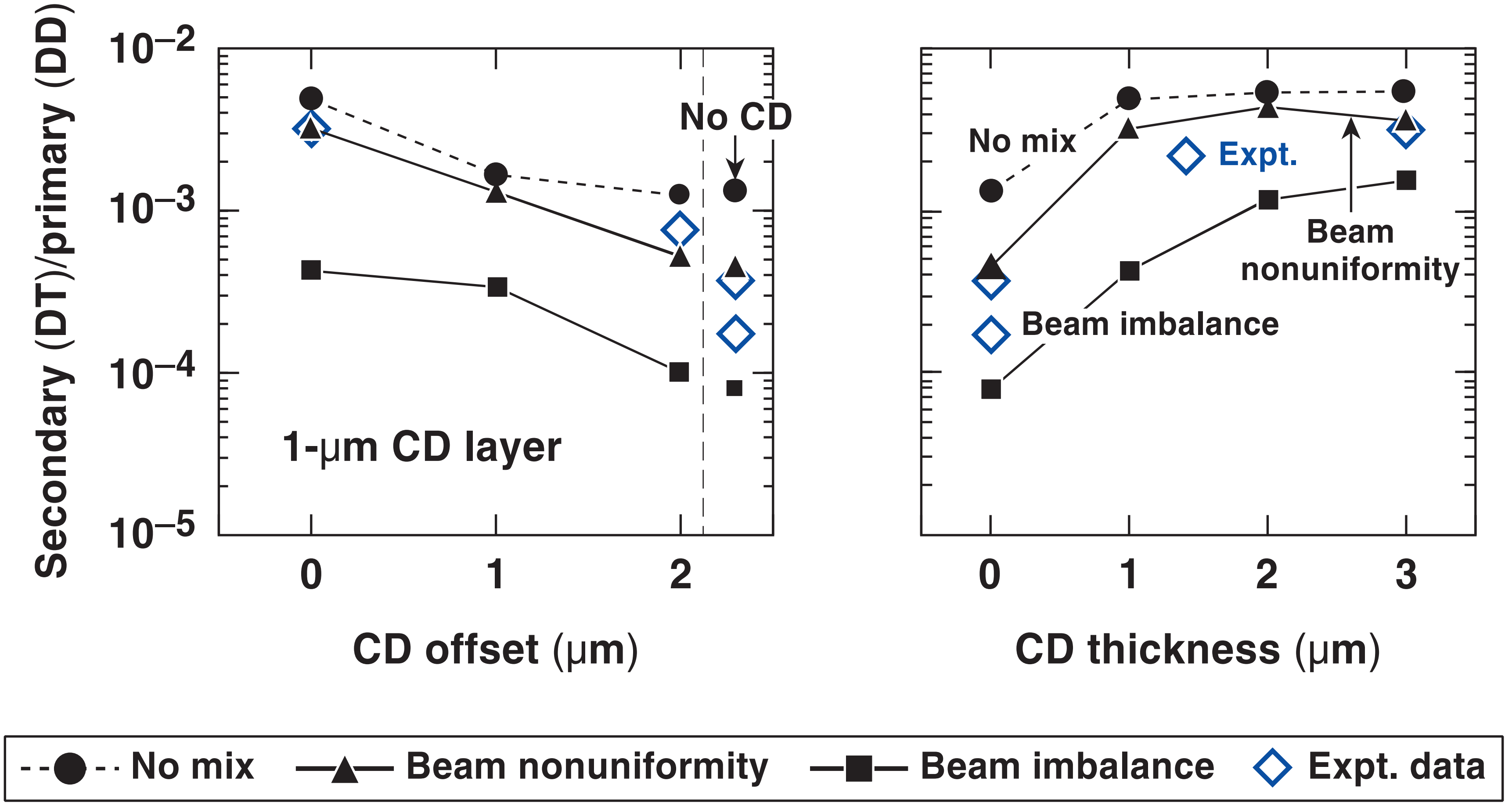
- 20-μm, 900-μm CH shell, 1-ns pulse



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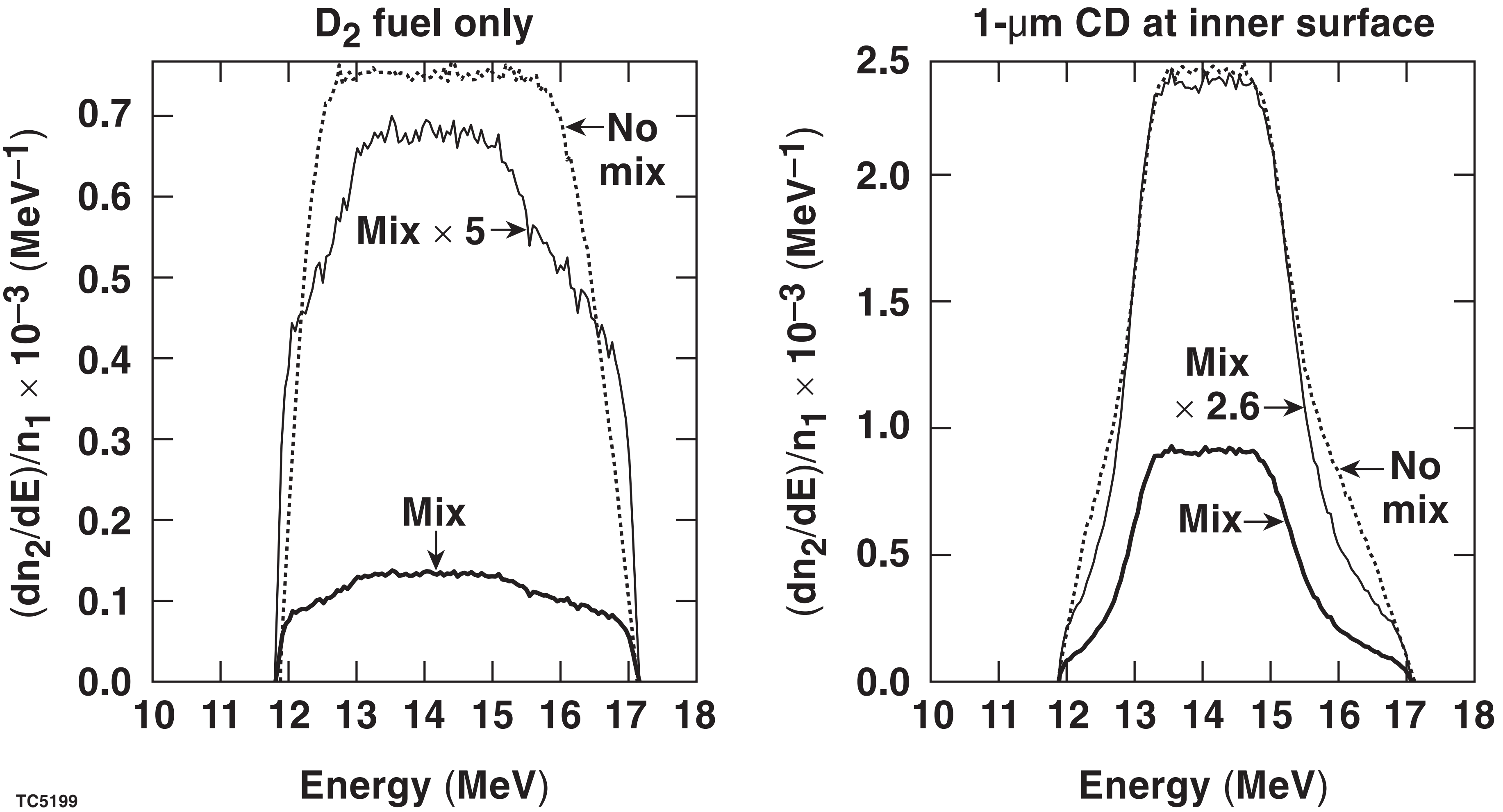
Mix modifies the distinct energy spectra of secondary neutrons originating from the fuel and shell

- 27-µm, 900-µm diameter shell, shaped PS-26 pulse
- *IRIS* Monte-Carlo post-processor



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