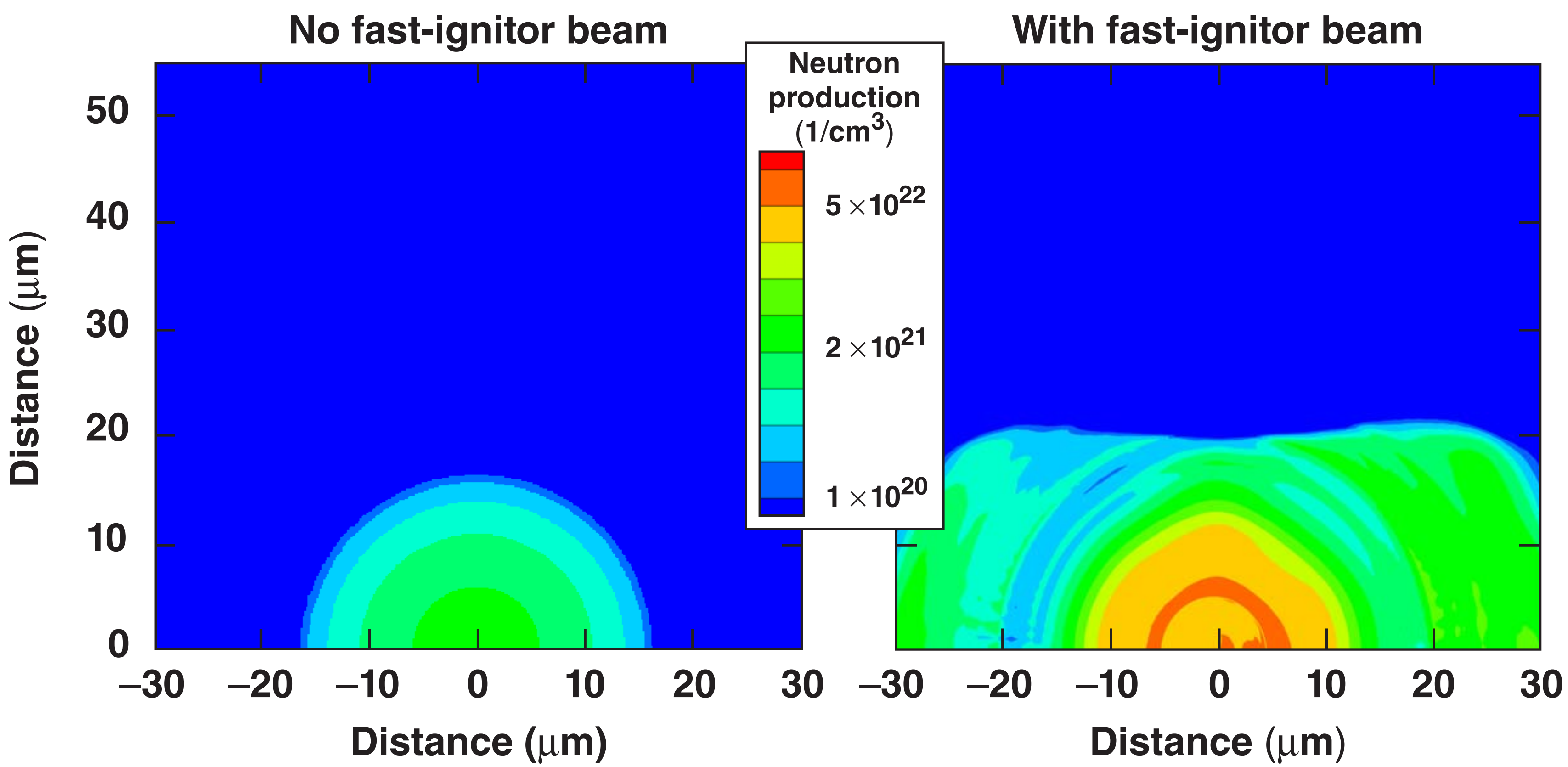
Simulation of Enhanced Neutron Production for OMEGA EP Cryogenic Implosions



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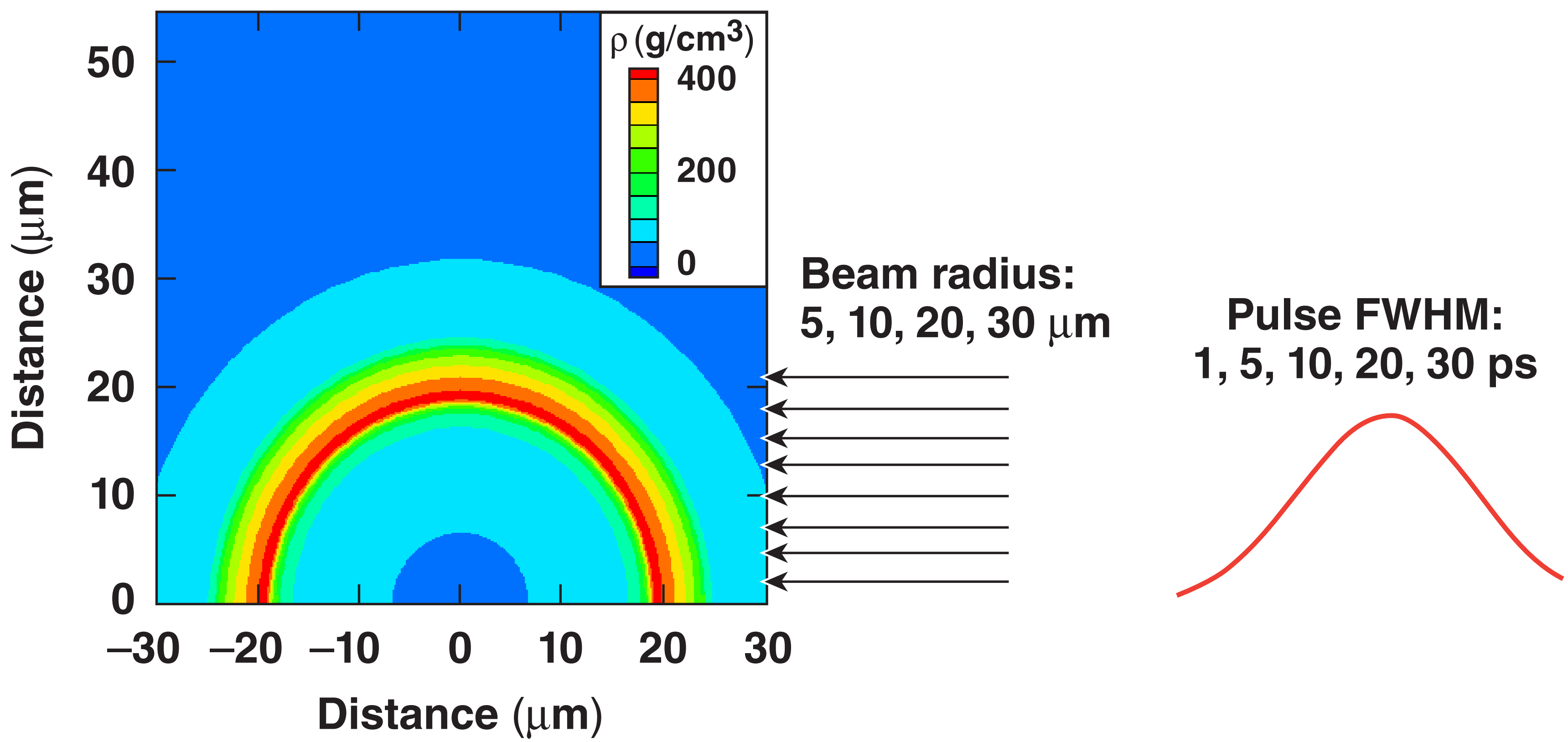
46th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Savannah, GA
15–19 November 2004

Summary

Interaction of the OMEGA EP beam with an imploding cryogenic capsule significantly enhances neutron yield

- The OMEGA EP Laser will add a short-pulse (2.5 kJ in 20 ps), high-intensity beam (>10^{19} W/cm^2) to OMEGA to study the physics of fast ignition.
- The simulations were carried out with a range of realistic electron sources.
- Near stagnation, the relativistic electrons heat the cold fuel, which explodes and creates a dense and hot core that produces over 10^{15} neutrons.
- Including alpha transport increases the yield by 50%.

Simulations were carried out for a 2.5-kJ, 1-μm-wavelength laser with a varying beam radius and FWHM

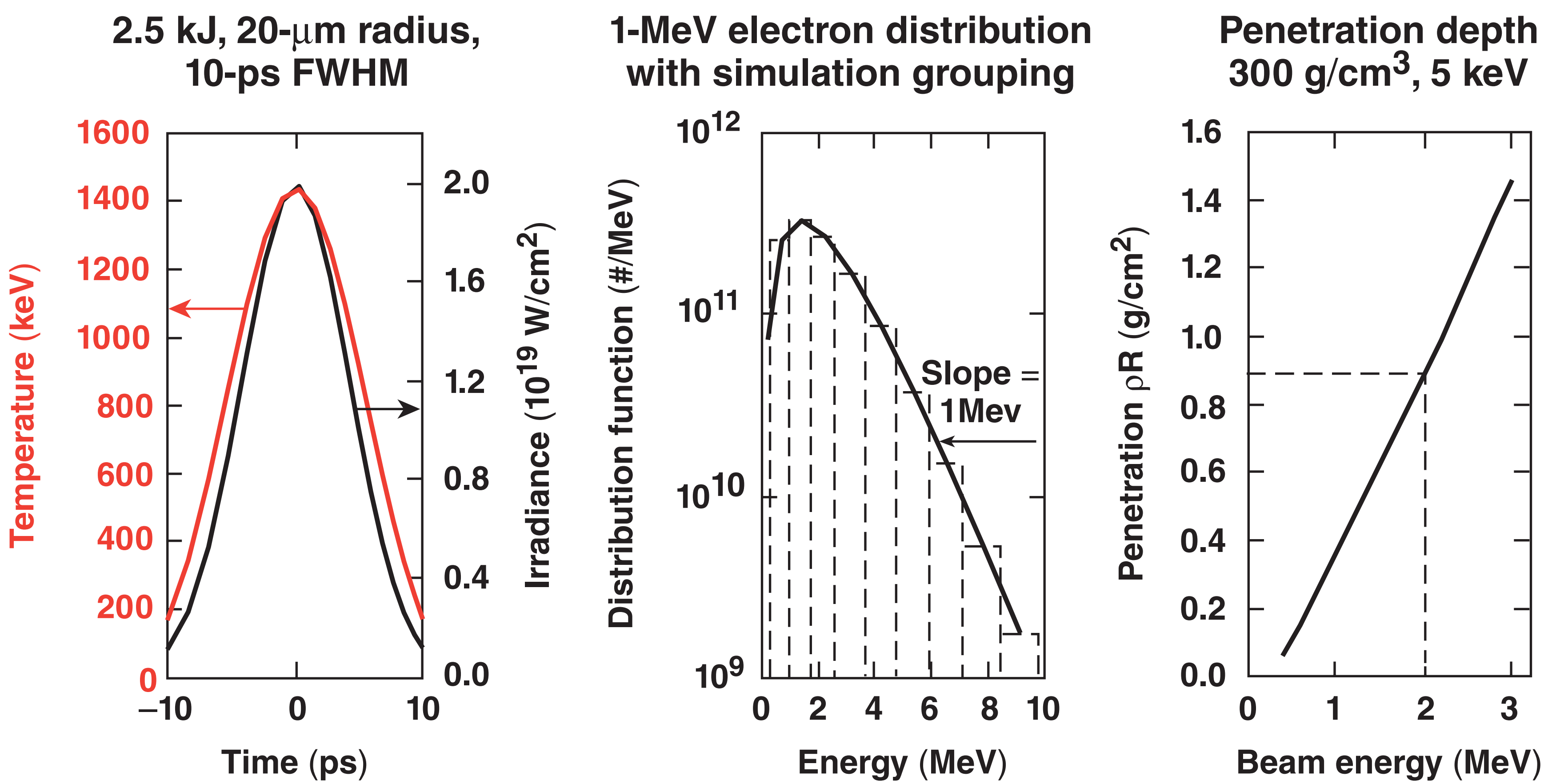


- The electrons are transported parallel to the pole in a single time step and lose energy according to a model by C. K. Li and R. D. Petrasso.*

* To be published in Phys. Rev. E

TC6499a

The electron source is a one-dimensional Maxwellian distribution computed from the laser intensity and a conversion efficiency

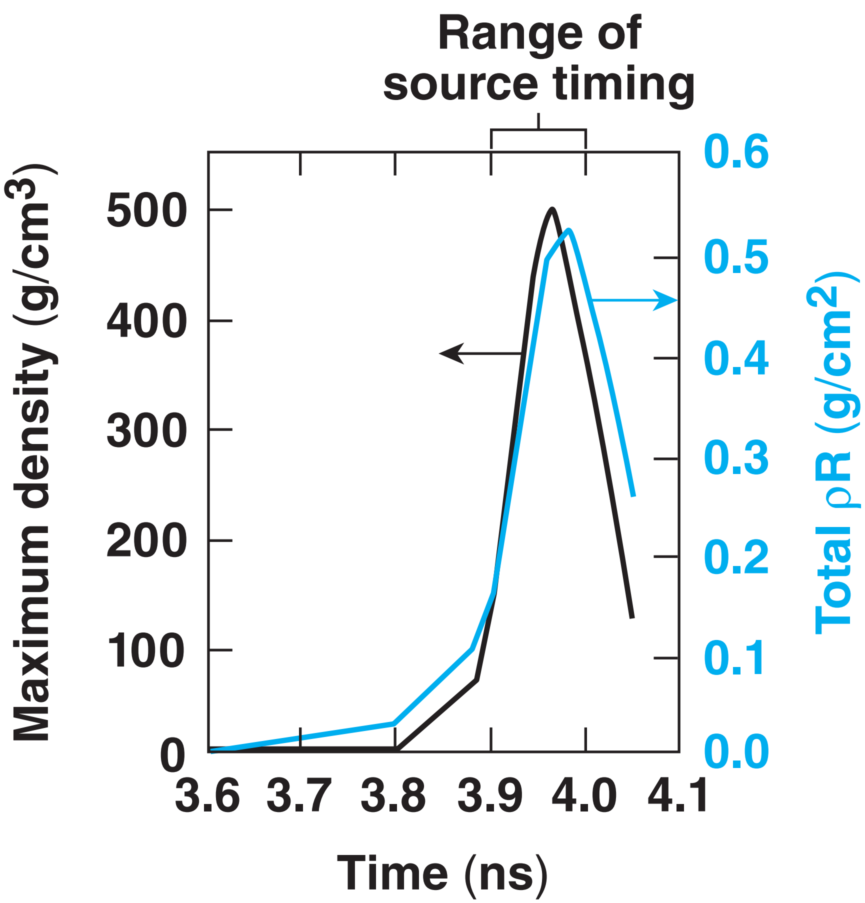


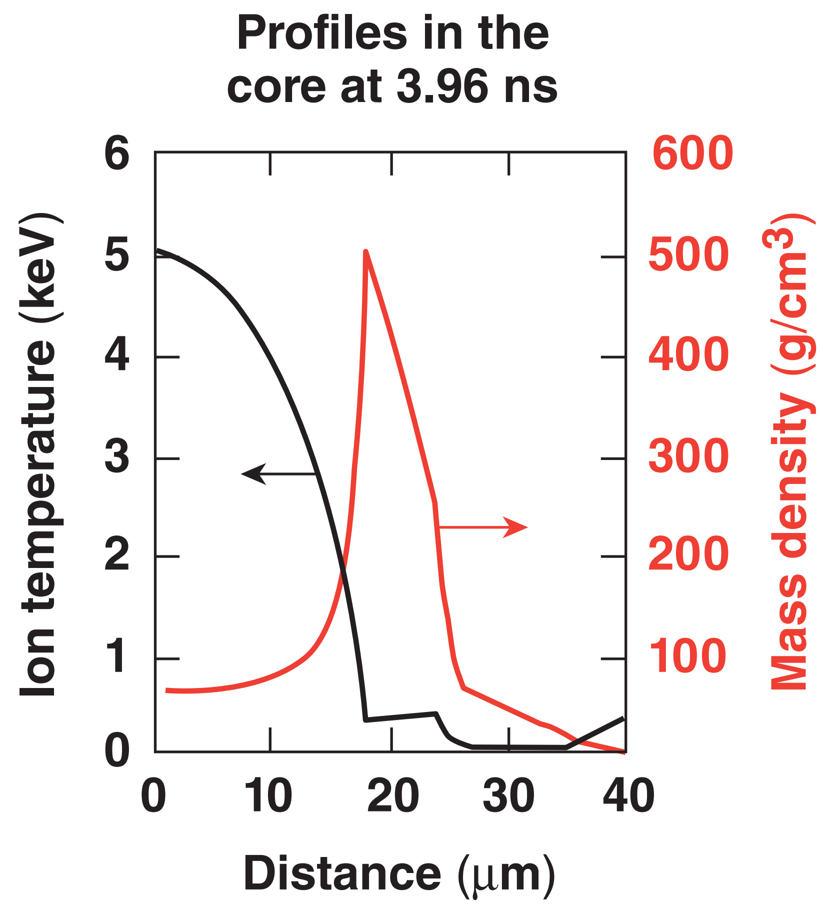
$T = 511 * [(1 + I/1.47 \times 10^{18})^{0.5} - 1]$ (keV) $\rightarrow$ slope of Maxwellian (from Wilks*)

* S. C. Wilks *et al*, Phys. Rev. Lett. 9, 1383 (1992).

TC6500c

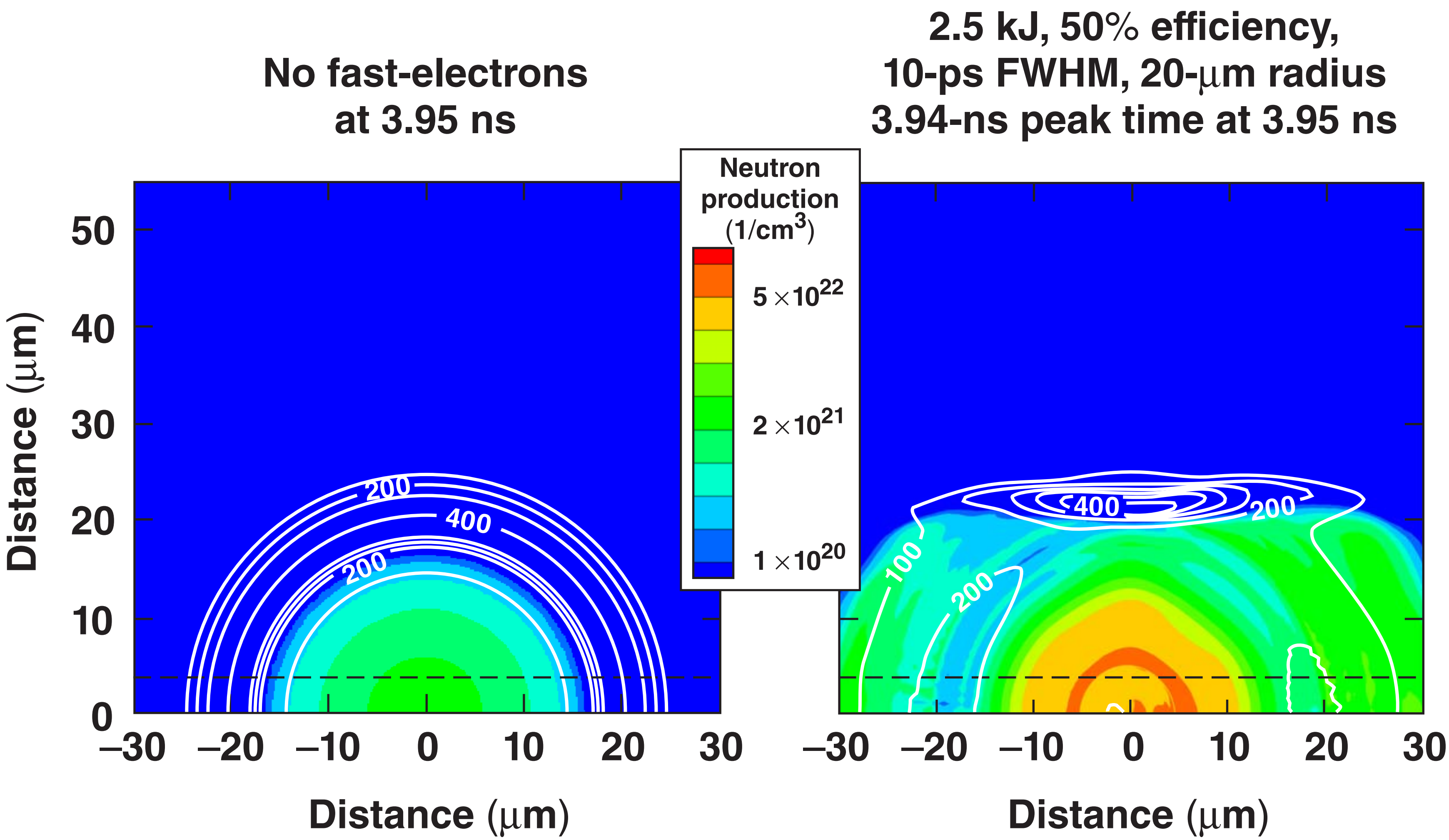
A target and pulse were designed to reach the ρR needed to stop most electrons





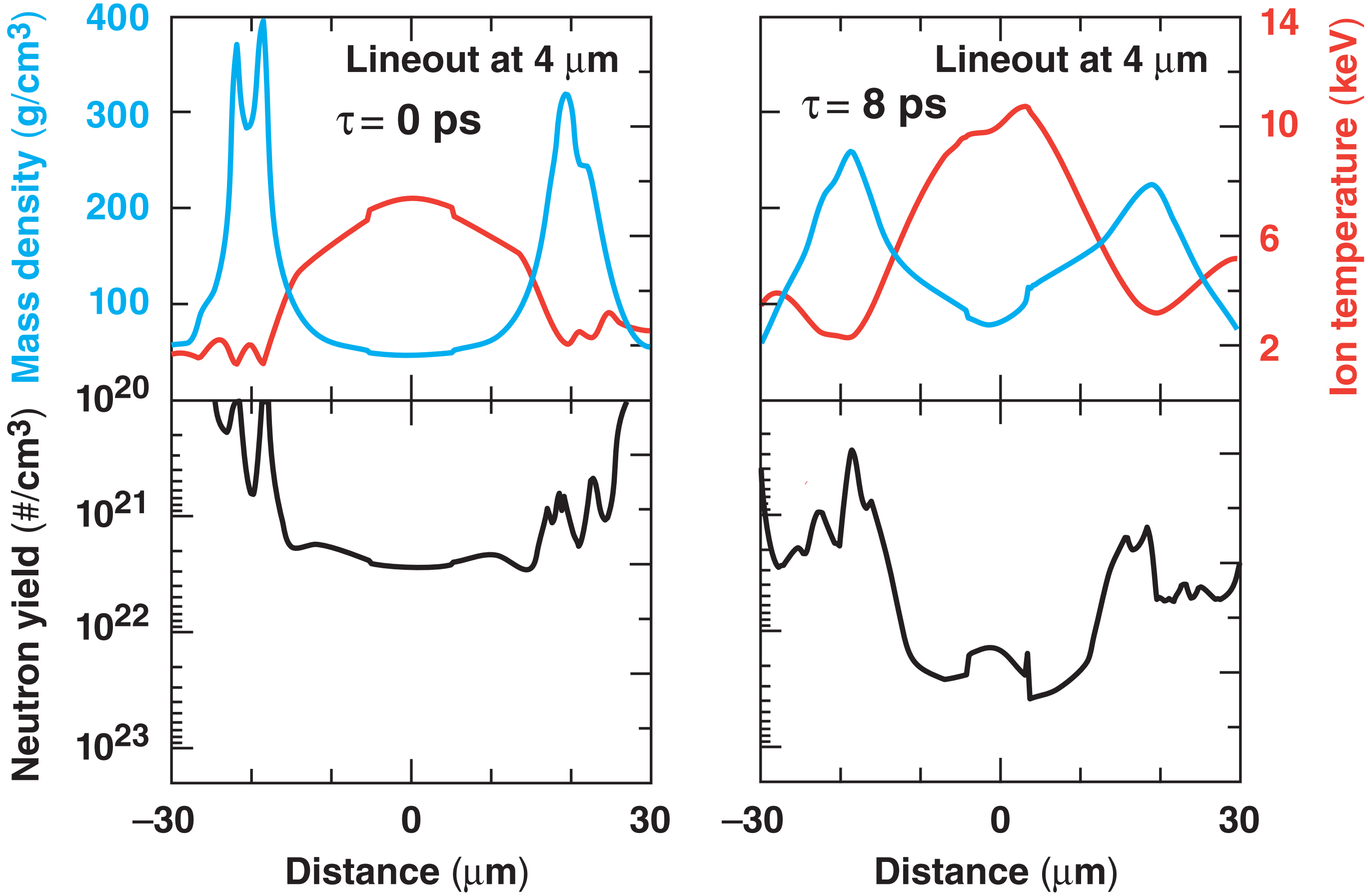
TC6196c

The electron pulse significantly increases the neutron production in the hot core and the high density shell



TC6503a

The heated shell explodes, producing a shock wave that heats the core



Time with respect to the peak of the 10-ps pulse timed at 3.94 ns

TC6505d

The neutron yield remains within a factor of two in about a 100-ps range for the pulse timing

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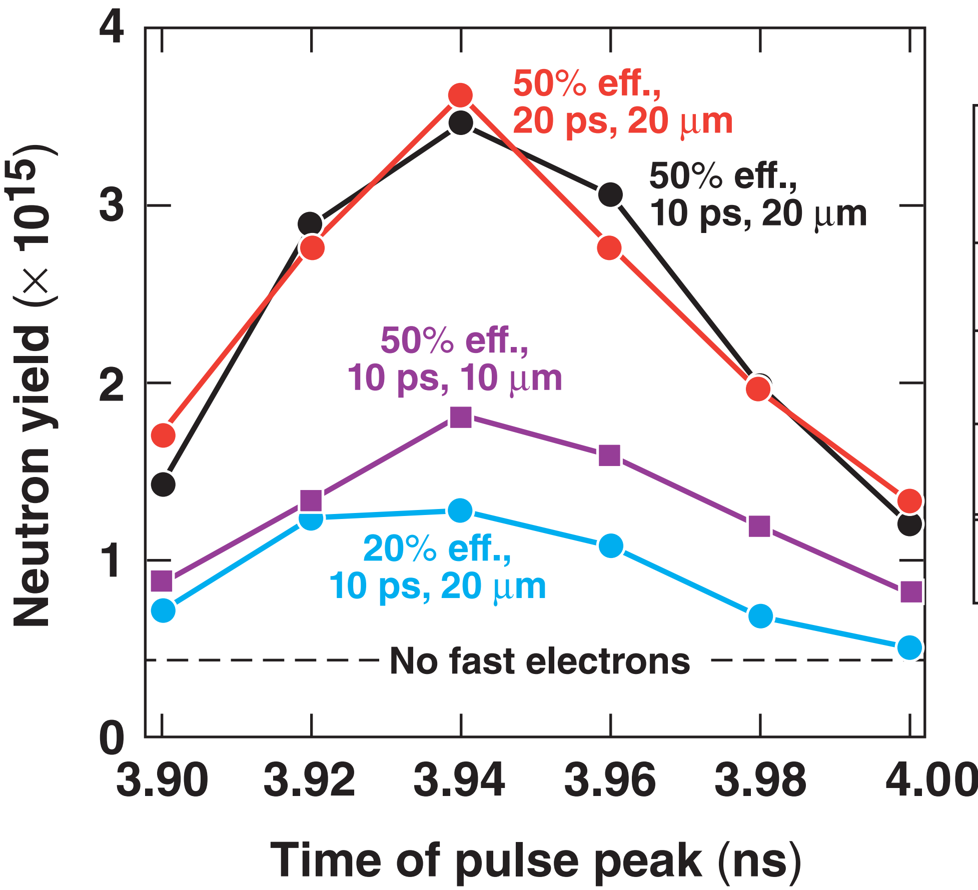
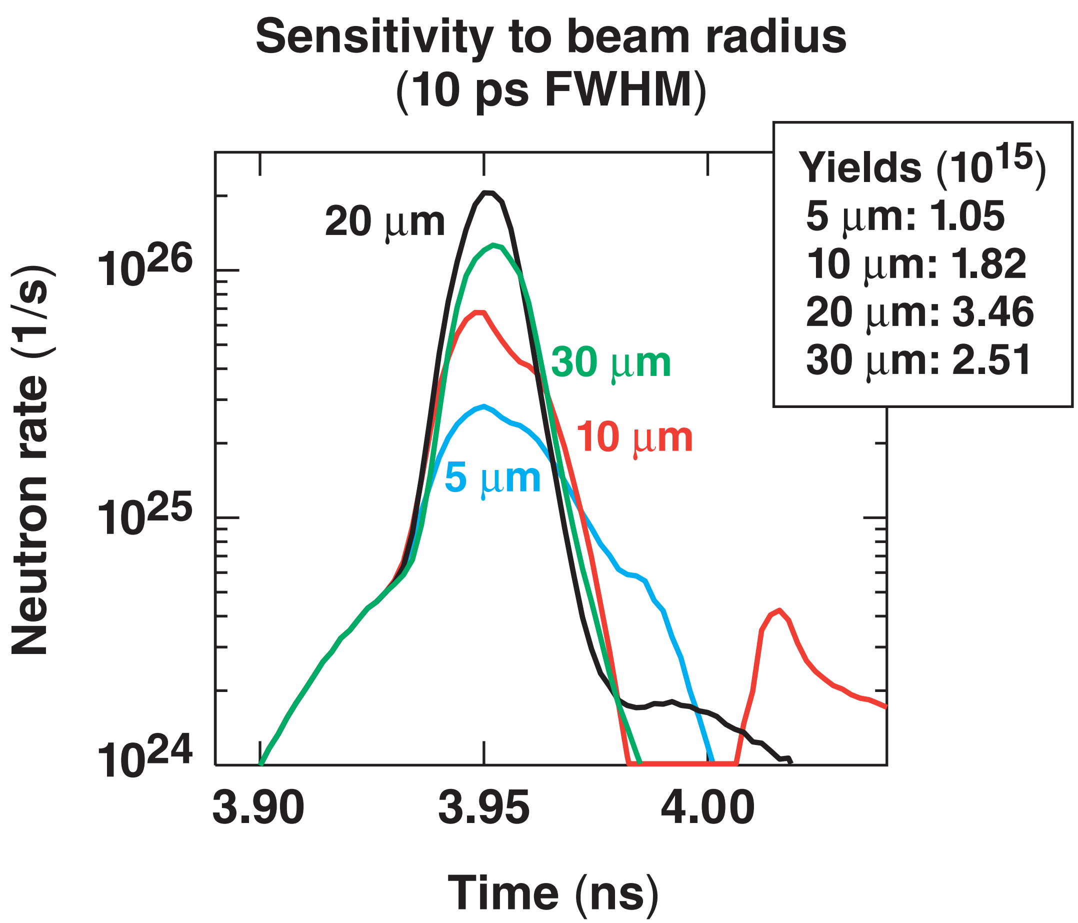


Peak intensity (W/cm^2)	Energy deposited* (kJ)
1×10^{19}	1.00 (40%)
2×10^{19}	0.79 (32%)
8×10^{19}	0.30 (12%)
2×10^{19}	0.32 (13%)

*3.94-ns case

TC6502

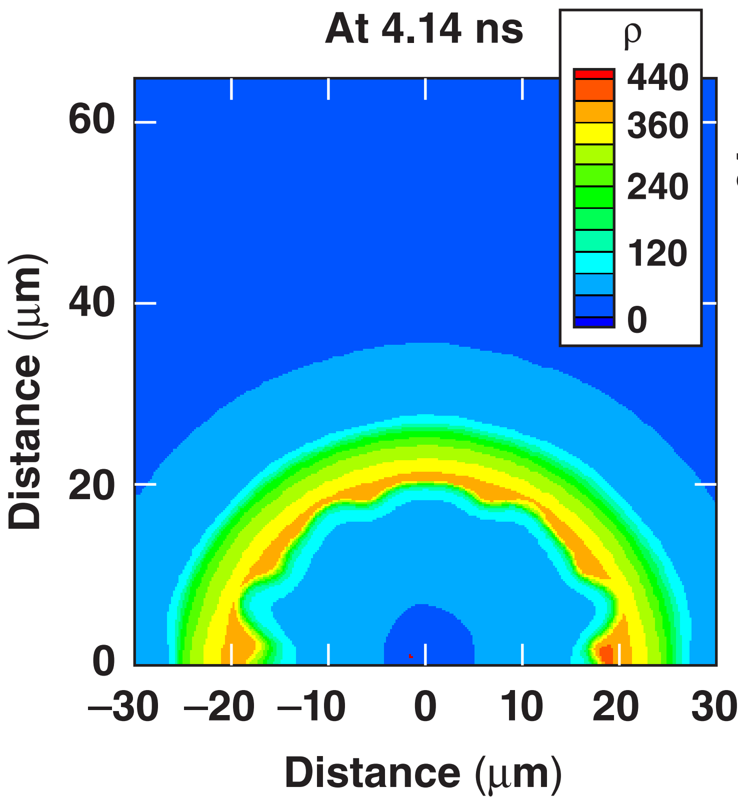
The neutron yield is sensitive to the beam radius but not to the pulse duration between 5 ps and 30 ps

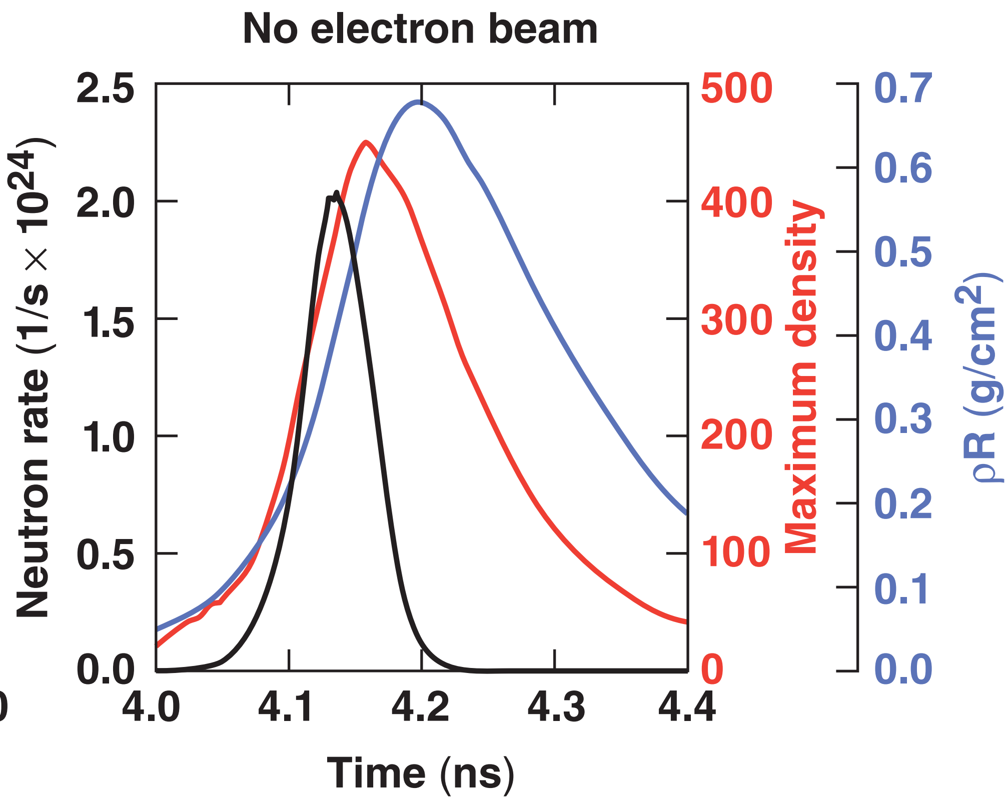


2.5 kJ, 50% efficiency, 3.94 ns pulse timing

TC6506a

Simulations were carried out with illumination nonuniformity due to power balance





Simulation without electron beam; ρR taken along the pole axis

TC6842

Including alpha transport in the simulation increases the yield by over 50%

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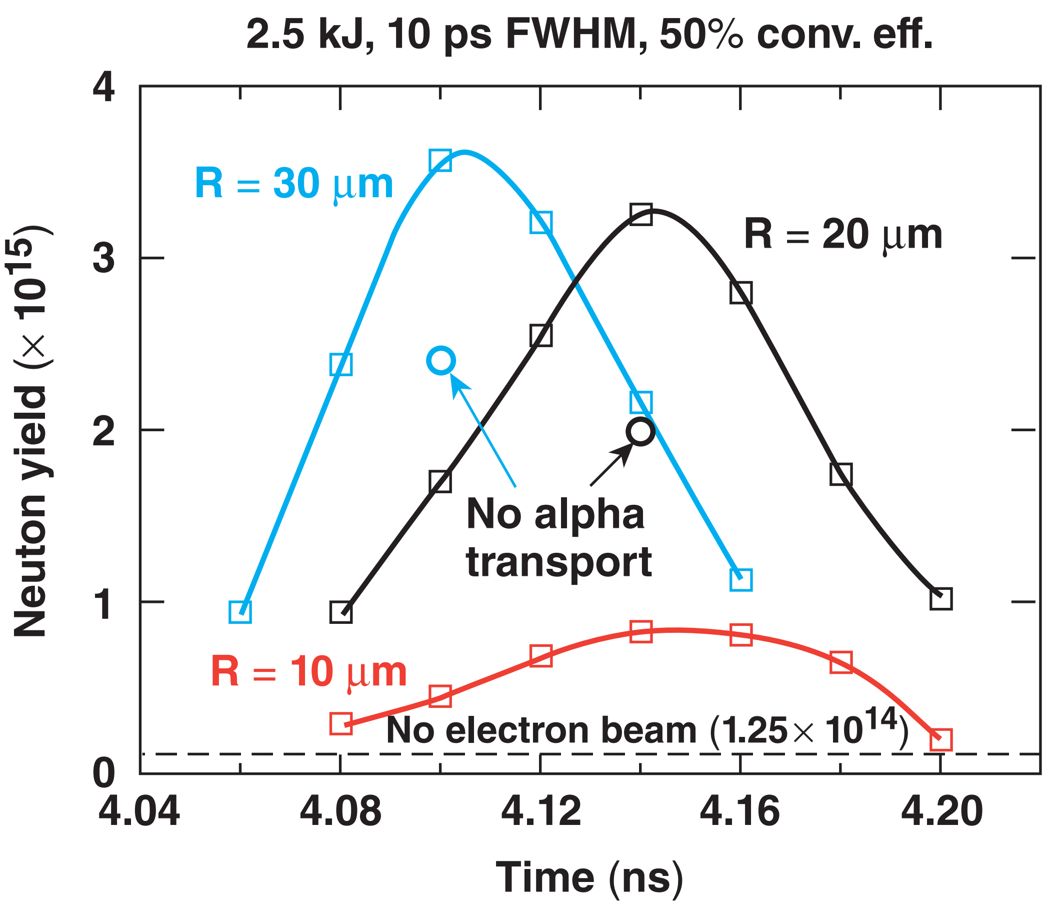

Simulations with power balance and alpha transport give the same yields as the uniform case without alpha transport.

TC6843

Summary/Conclusions

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