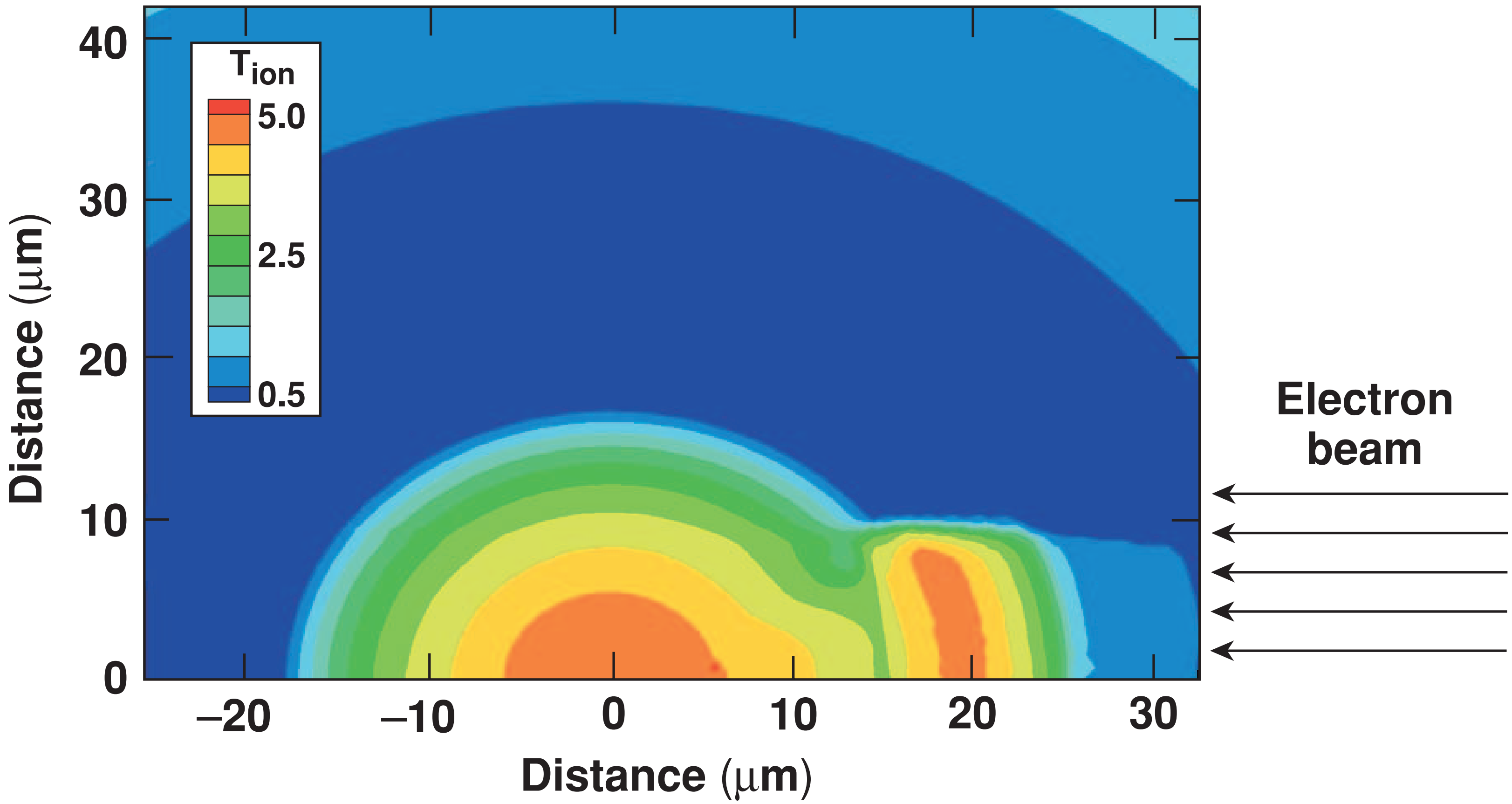
Transport of Relativistic Electrons for Modeling Fast Ignition in the 2-D Hyrocode *DRACO*



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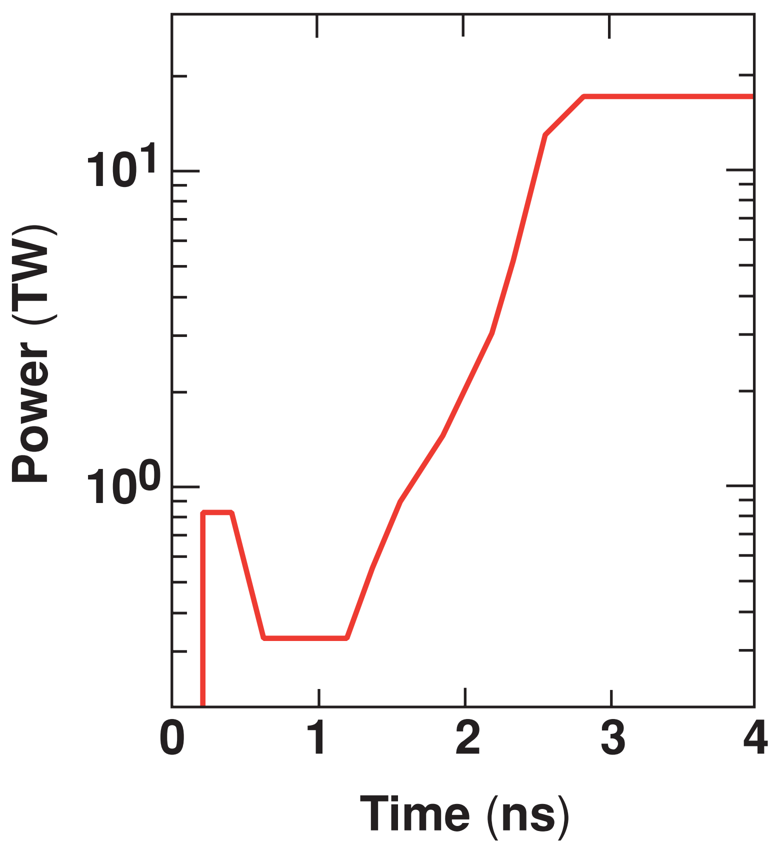
Summary

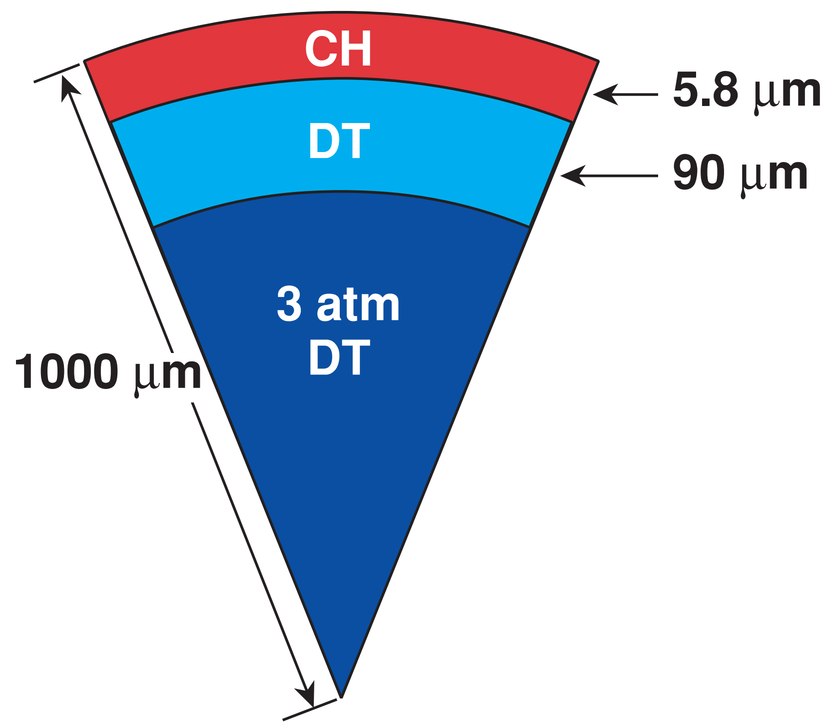
We present integrated simulations of the interaction of the EP fast-ignitor beam with OMEGA cryogenic capsules

UR LLE

- The OMEGA EP laser will produce short-pulse (~20-ps), high-intensity beams ($> 10^{19}$ W/cm^2) to study the physics of fast ignition.
- A relativistic electron transport model is being added to the multidimensional hydrocode *DRACO*.
- In this presentation, a simple penetration model is used to slow electrons from a monoenergetic constant beam source.
- Stagnation is modified by shocks driven by the electron-heated high-density shell, depending on the timing of the beam:
  - an extra "spherical" kick at time of low shell ρR (< 0.3 g/cm^2)
  - one-sided displacement at peak shell ρR (> 0.4 g/cm^2)
- The order of magnitude increase in the neutron production rate is easily diagnosable.

A direct-drive target was designed at OMEGA energy (25 kJ) to give > 300-g/cm^3 densities





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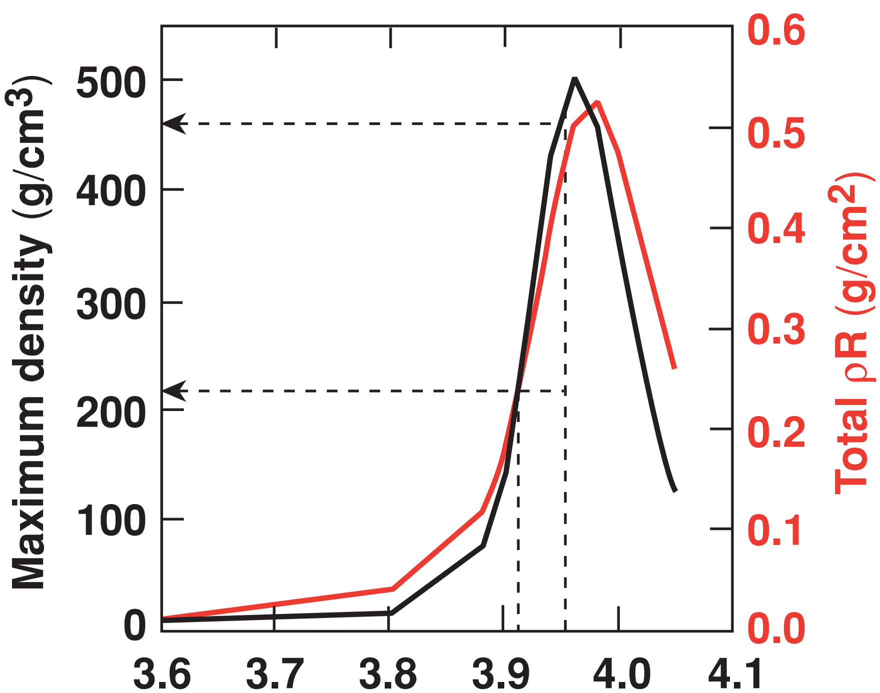
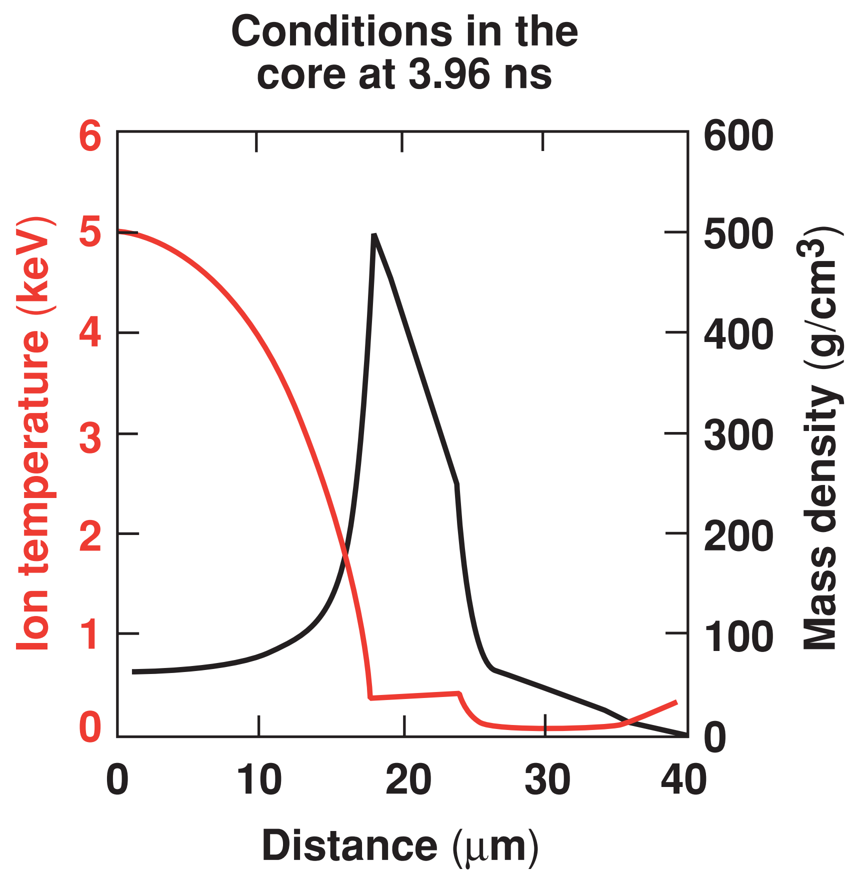
Fast-ignitor mass densities are reached

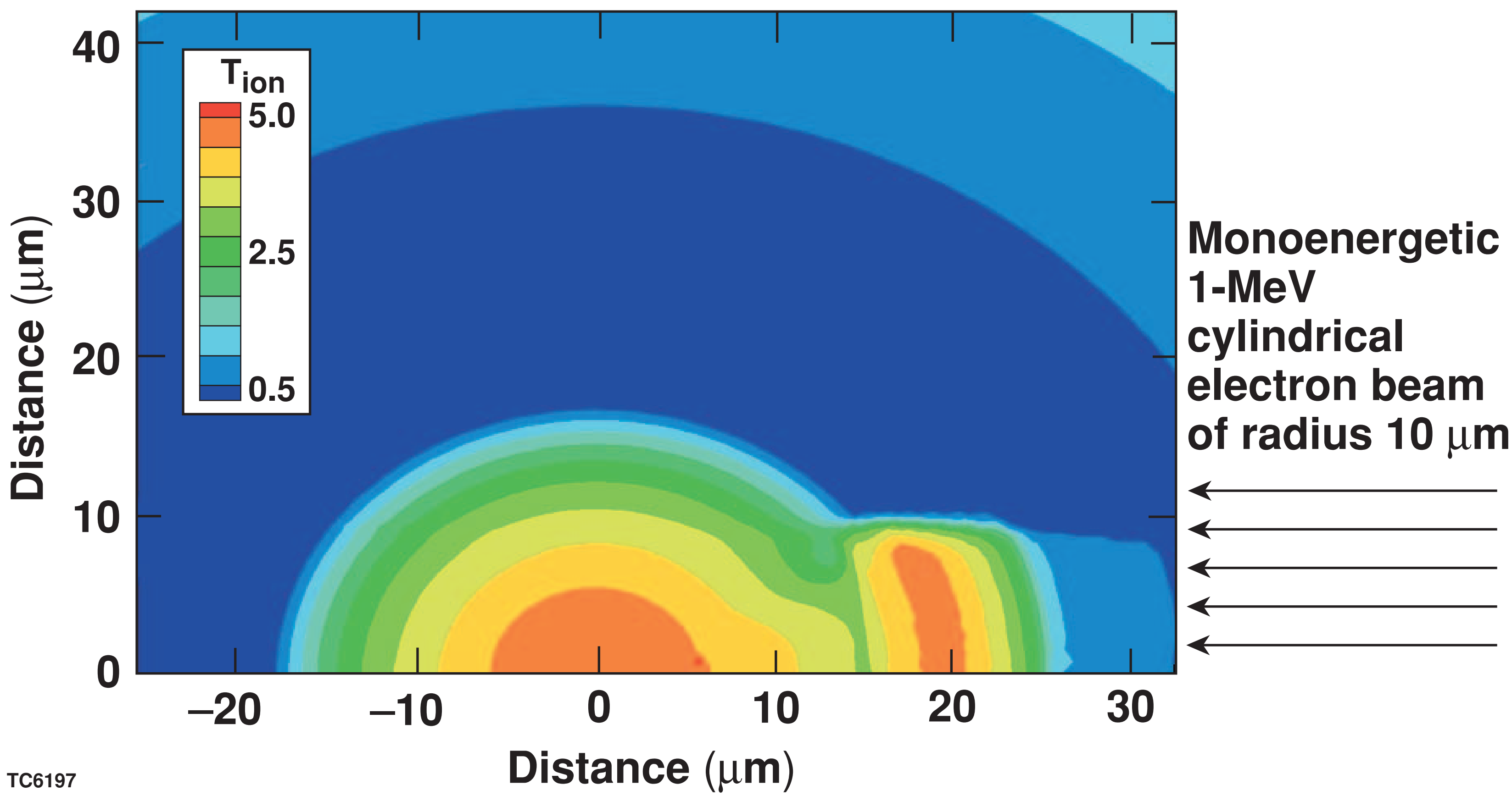




A 1-MeV electron has a range of about 0.4 g/cm^2.

Simulations were carried out with a 20-ps, 1-MeV electron beam with total energies of 400 J and 1 kJ

- Electrons are instantaneously transported through the target.
- They give their energy to the background electrons using a penetration depth formulation applied in each zone.



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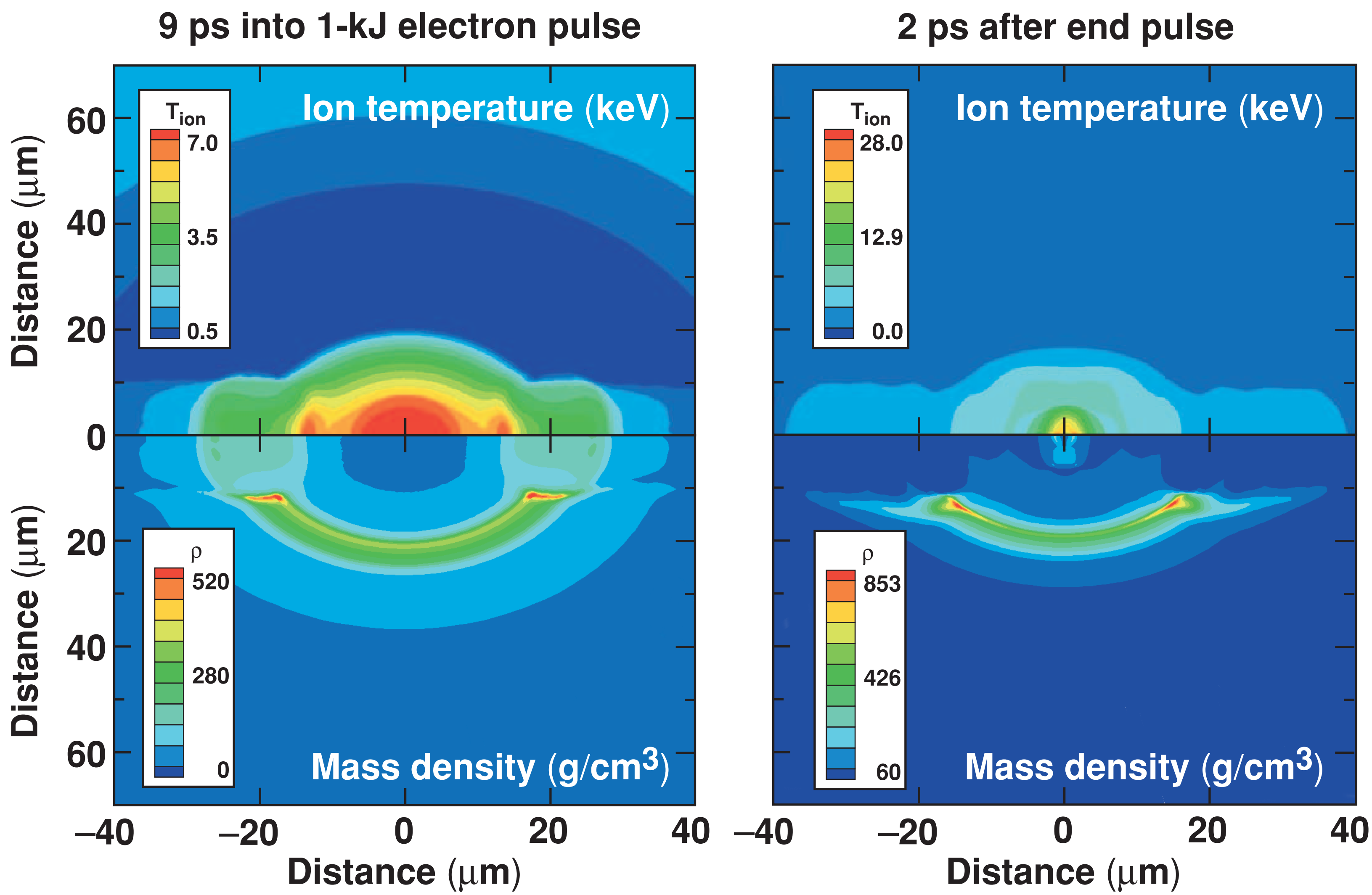
For low density (250 g/cm^3) the beam heats the two sides of the target and creates colliding shocks at the center



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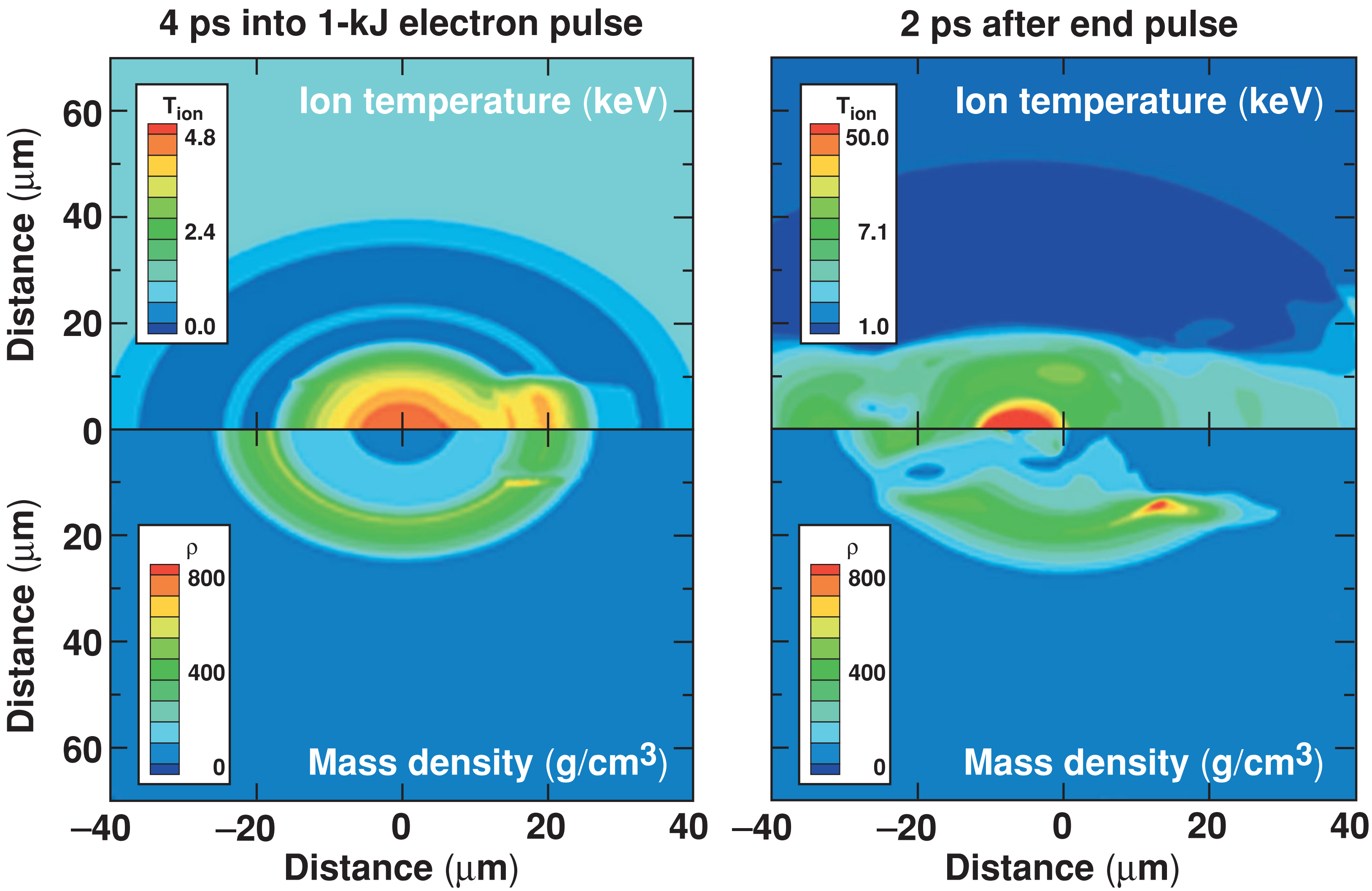
For high density (500 g/cm^3) the beam heats only one side of the target sending a shock through the center



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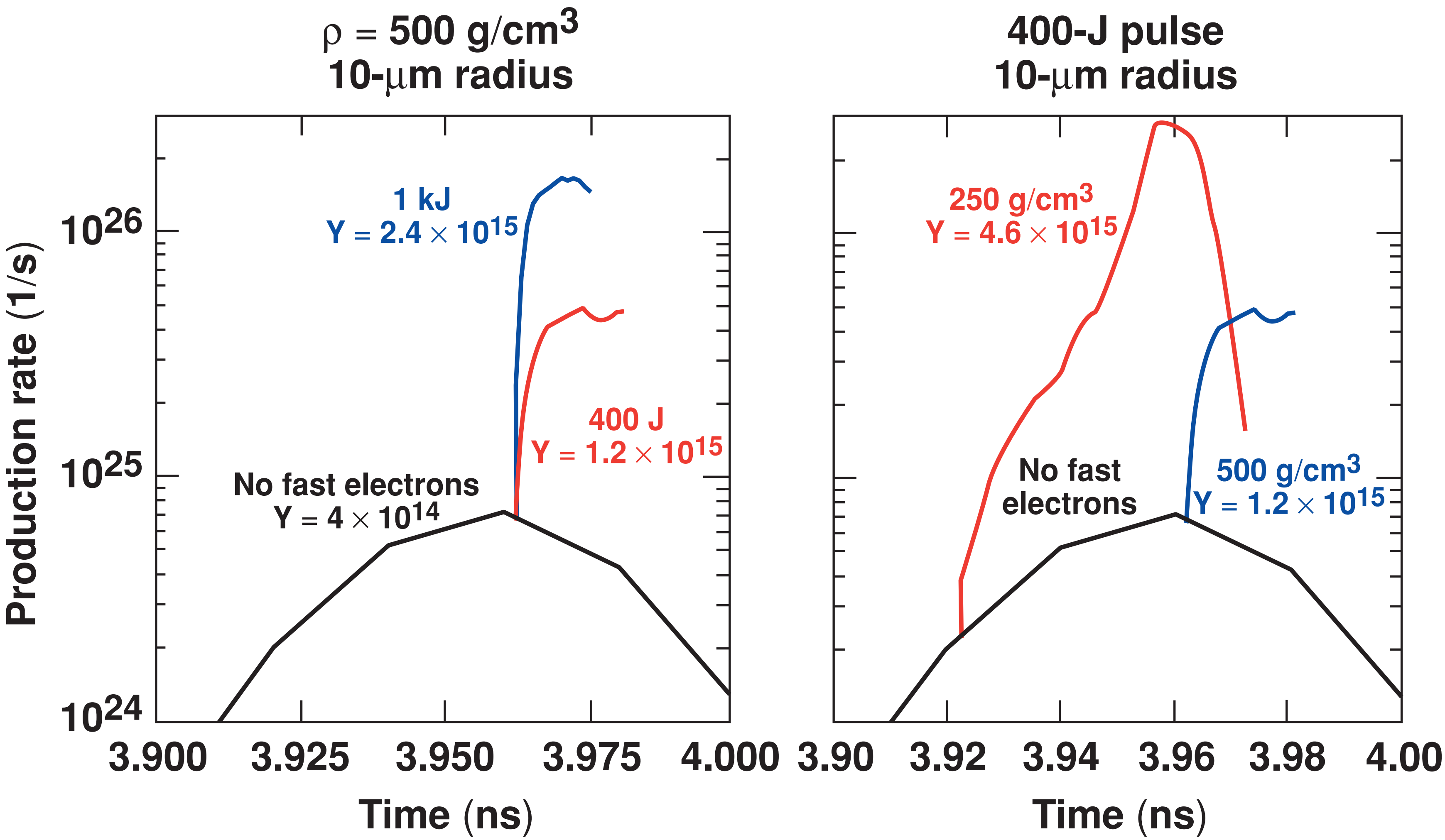
The fast-ignitor beam creates a burst of neutrons that can be easily diagnosed



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Future work includes improvements in the electron beam source and the transport

- Add a spectrum at a temperature given as a function of the fast-ignitor laser beam.
- Use a slowing-down formula for the electron energy loss instead of a penetration depth model.
- Include beam spread.
- Add more realistic physics (return current, electric fields, magnetic fields) to the transport, either explicitly or semi-empirically based on the results of 3-D PIC code simulations.
- Simulation of implosions with expected illumination and inner ice nonuniformites.

Summary/Conclusions

Irradiation by the EP fast-ignitor beam of OMEGA-imploded cryogenic capsules provides sensitive observables

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- **The OMEGA EP laser will produce short-pulse (~20-ps), high-intensity beams (>10^{19} W/cm^2) to study the physics of fast ignition.**
- **A relativistic electron model is being added to the multidimensional hydrocode *DRACO*.**
- **In its first iteration, a simple penetration model is used to slow electrons from a monoenergetic beam source.**
- **The fast-ignitor beam lead to an increase in the neutron production rate of about an order of magnitude.**
- **A secondary implosion driven by the heated high-density shell can be either “spherical” or one-sided depending on the electron source beam energy.**
- **Many improvements in the model are planned to make it more realistic.**