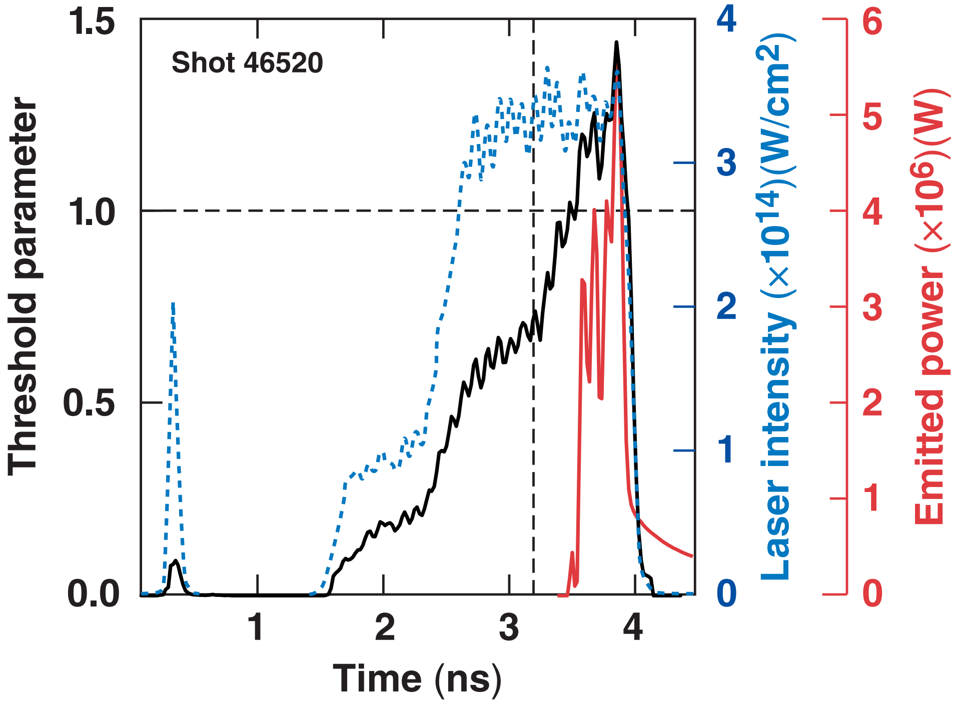
Simulations on the Effect of Energetic Electrons Produced from Two-Plasmon Decay in the 1-D Hydrodynamic Code *LILAC*

Threshold parameter and HXR emission



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Preheat from the $2\omega_p$ instability contributes to the observed ρR reduction in cryogenic implosions

- Fast-electron transport in the 1-D code *LILAC* models the source and transport of electrons produced by the $2\omega_p$ instability.
- The production of the fast electrons depends strongly on conditions at the quarter-critical surface.
- Qualitative agreement with experiment was obtained for the emitted hard x-ray energy.
- The laser energy into fast electrons decreases as the $\langle Z \rangle$ of the target increases, mostly due to an increase in the thermal electron temperature and a decrease in the laser intensity at $N_c/4$.

Collaborators

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The fast electrons are transported with a multi-group diffusion model in the 1-D hydrocode *LILAC*

- Includes slowing down of electrons through Coulomb collisions and fast-ion losses through momentum conservation.
- Electrons are created when the threshold parameter for the $2\omega_p$ instability* exceeds unity

$$\eta = I_{14} L_{\mu\mathrm{m}}/233\, T_c\,(\mathrm{keV})$$

- The energy source scales as

$$\frac{E_{\mathrm{fast}}}{E_{1/4\,N_c}} = 0.30\,\frac{\log(\eta)}{\log(3.0)}$$

- The source temperature is obtained from a fit to the experimental measurement as

$$T_s = 130\left[\frac{T_c\,(\mathrm{keV})}{2.2}\right]^{0.4}\left[\frac{I_{14}}{8}\right]^{0.63}(\mathrm{keV})$$

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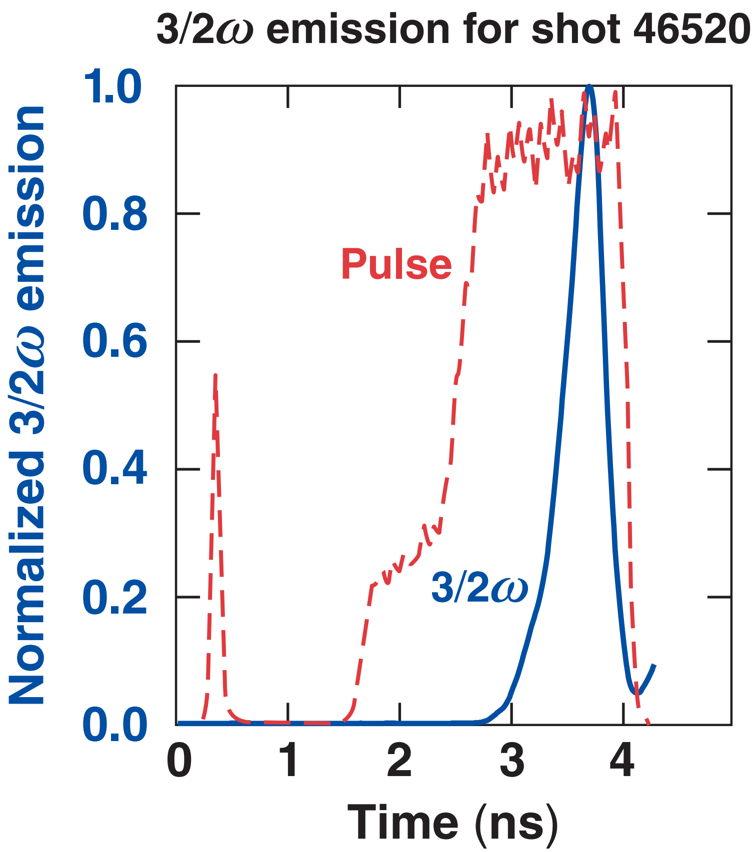
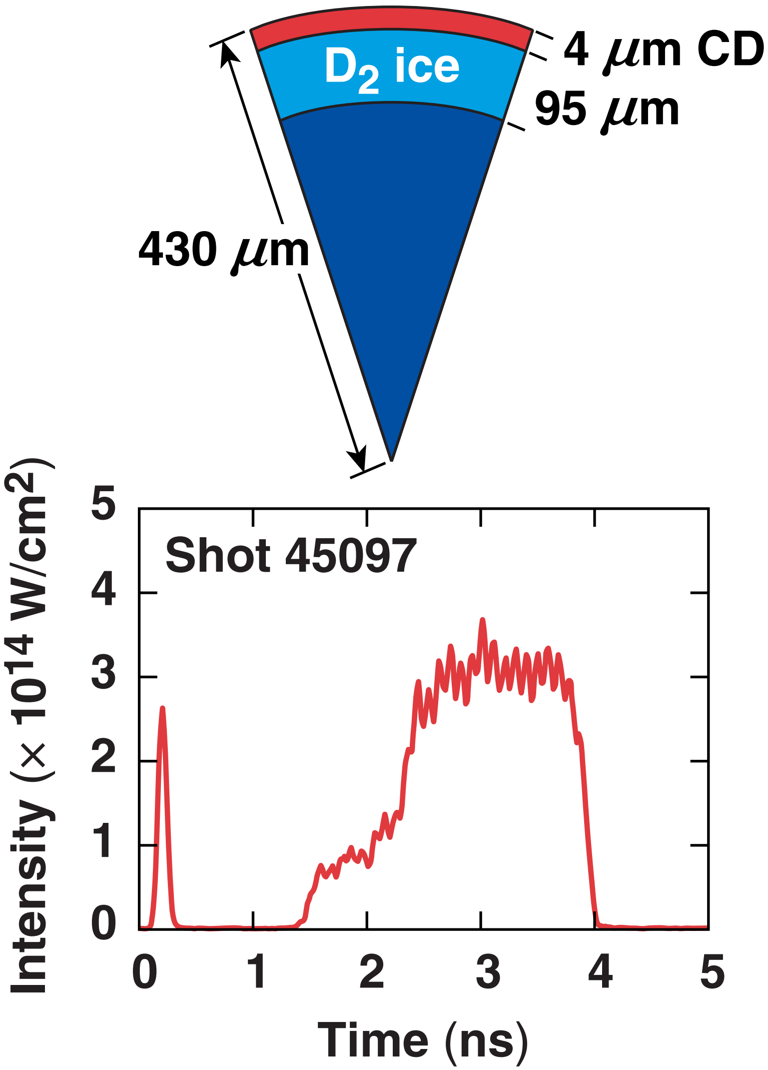
*A. Simon *et al.*, Phys. Fluids 26, 3107 (1983).

$3/2\omega$ light emissions at energies above 60 keV indicate the presence of the two-plasmon-decay instability

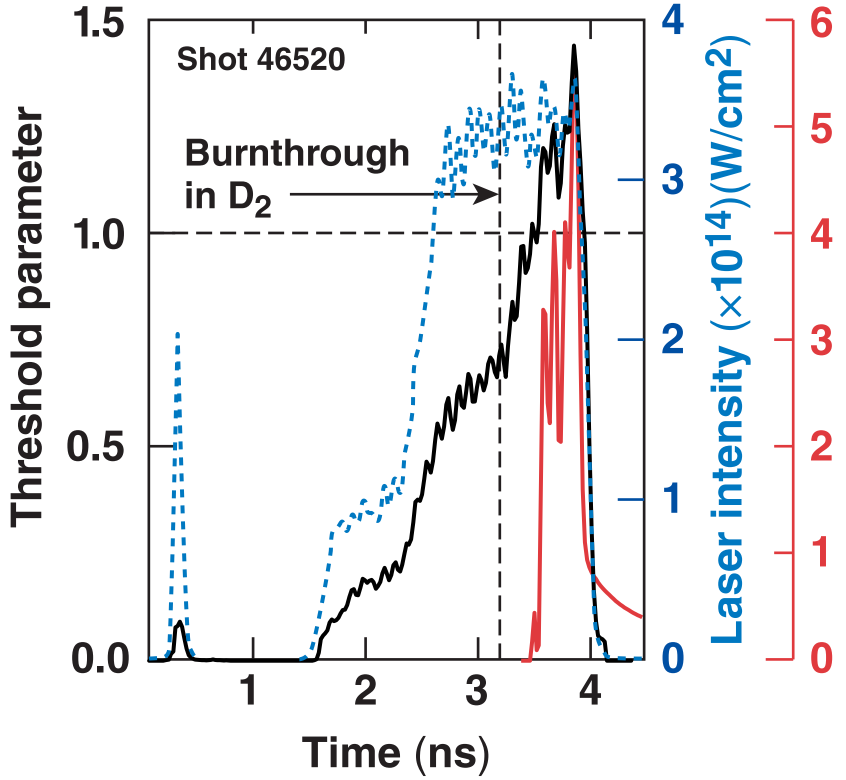




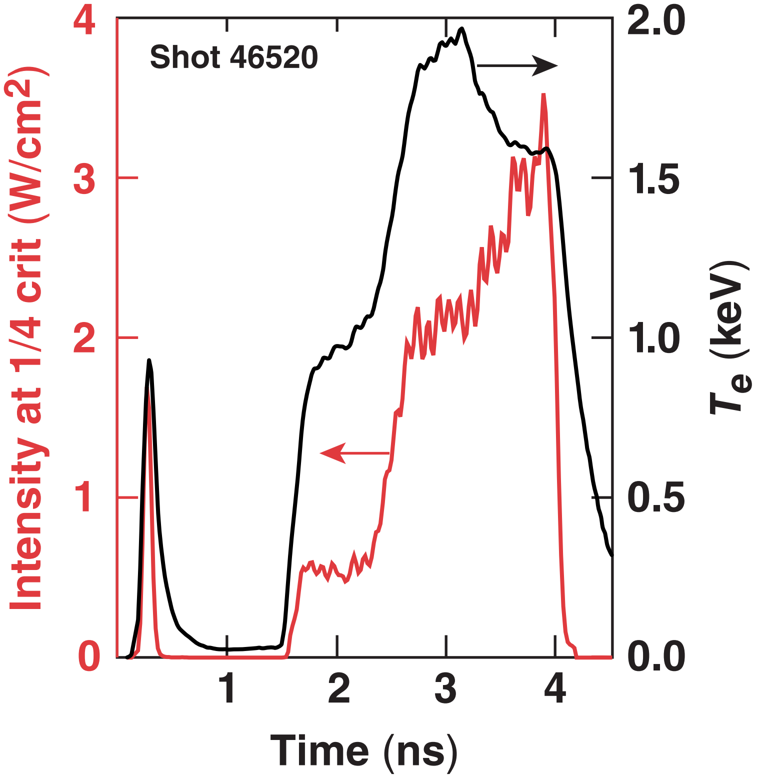
For cryogenic targets with a thin CD shell, the threshold parameter increases after burnthrough into D_2

$$\eta = I_{14} L_{\mu m} / 233\, T_c\ (\text{keV})$$

Threshold parameter and HXR emission



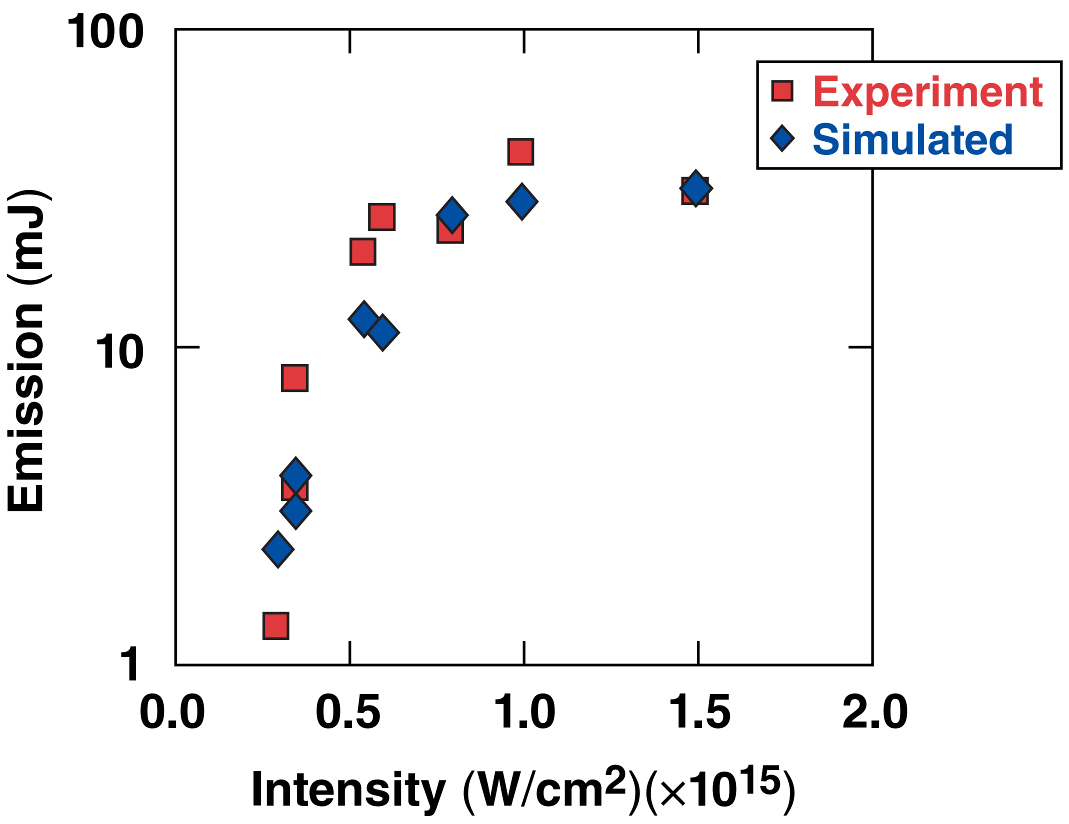
Threshold parameter variables



The scale lengths do not change significantly during the high intensity part of the pulse.

Simulations show qualitative agreement for the HRX emission with the experimental results

Thin CD-shell cryogenic target



HRX$_{tot}$ (mJ) = HXR (pC) × 0.050 (mJ/pC) obtained from a Mo calibration using T_{hot} = 65 keV

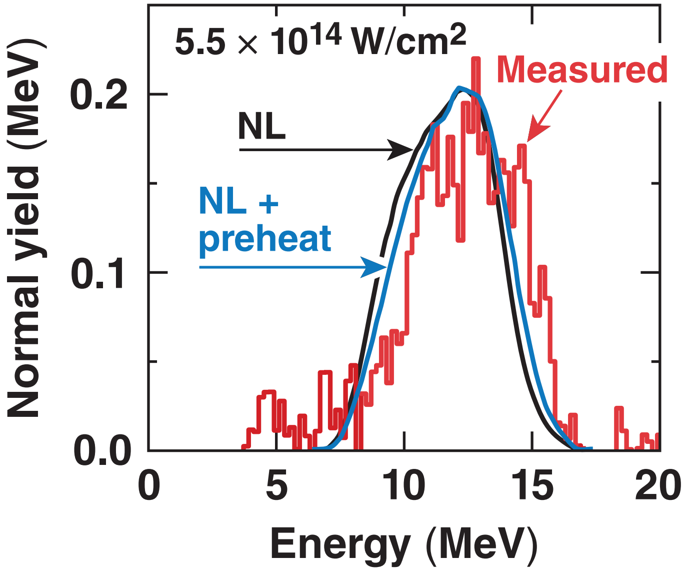
Proton sampling and 0.1% preheat by $2\omega_p$ electrons yield computed ρR's close to experimental values

- The preheat energy from the HRX measurement* is estimated around 8 to 12 J with an error of about a factor of 2, yielding a maximum preheat energy of 0.1% of the laser energy.
- The computed ρR is also reduced by about 6% to 25% when sampling the time-dependent ρR with the truncated neutron production.**

Preheat ρR's with 0.1%

Intensity ($\mathrm{W/cm^2}$)	ρR (NL) ($\mathrm{g/cm^2}$)	ρR (PH) ($\mathrm{g/cm^2}$)	ρR (sample)	ρR (exp.)
3.5×10^{14}	148	147	139	137
5.5×10^{14}	174	146	119	113
1.0×10^{15}	125	100	94	92

Includes sampling



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* B. Yaakobi *et al*., Phys. Plasmas 7, 3714 (2000).
**P. B. Radha *et al*., Bull. Am. Phys. Soc. 51, 104 (2006).

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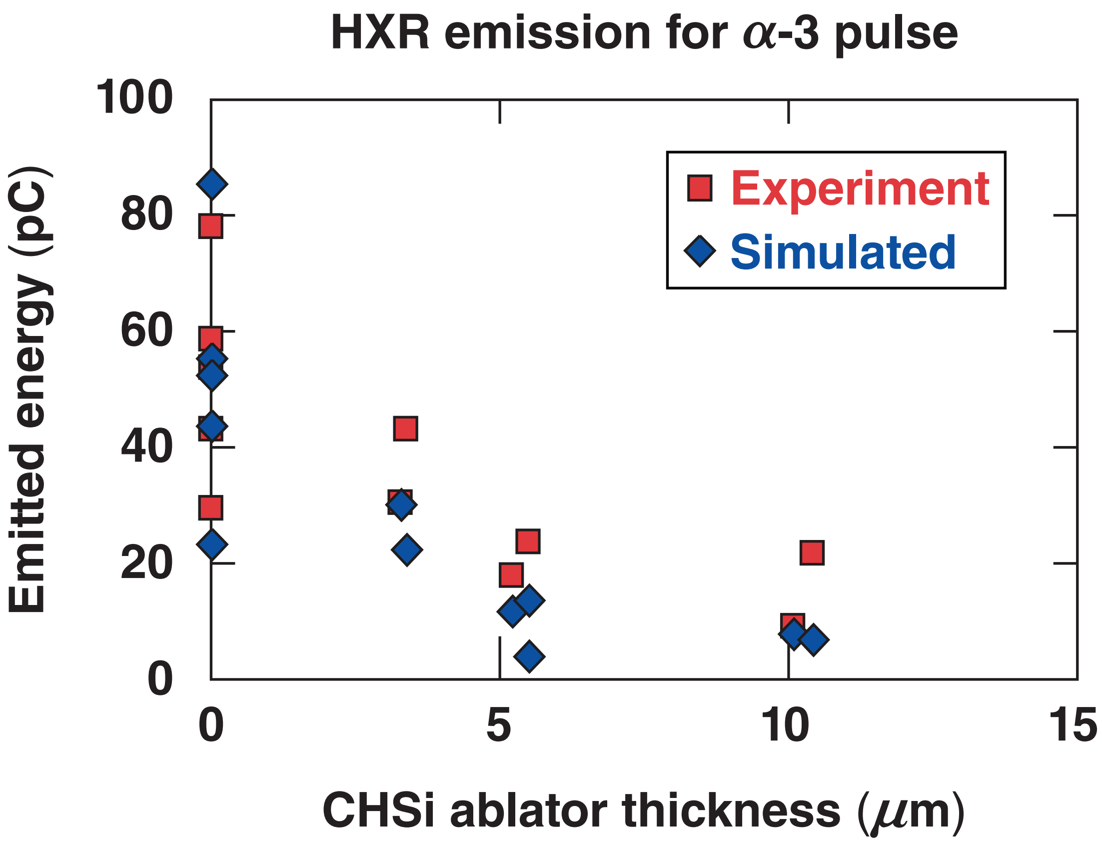
Warm targets with a thick CHSi outer ablator produce a lower HRX emission than CH ablators



α-3 pulse
9×10^{14} W/cm^2
6% Si-doped CH

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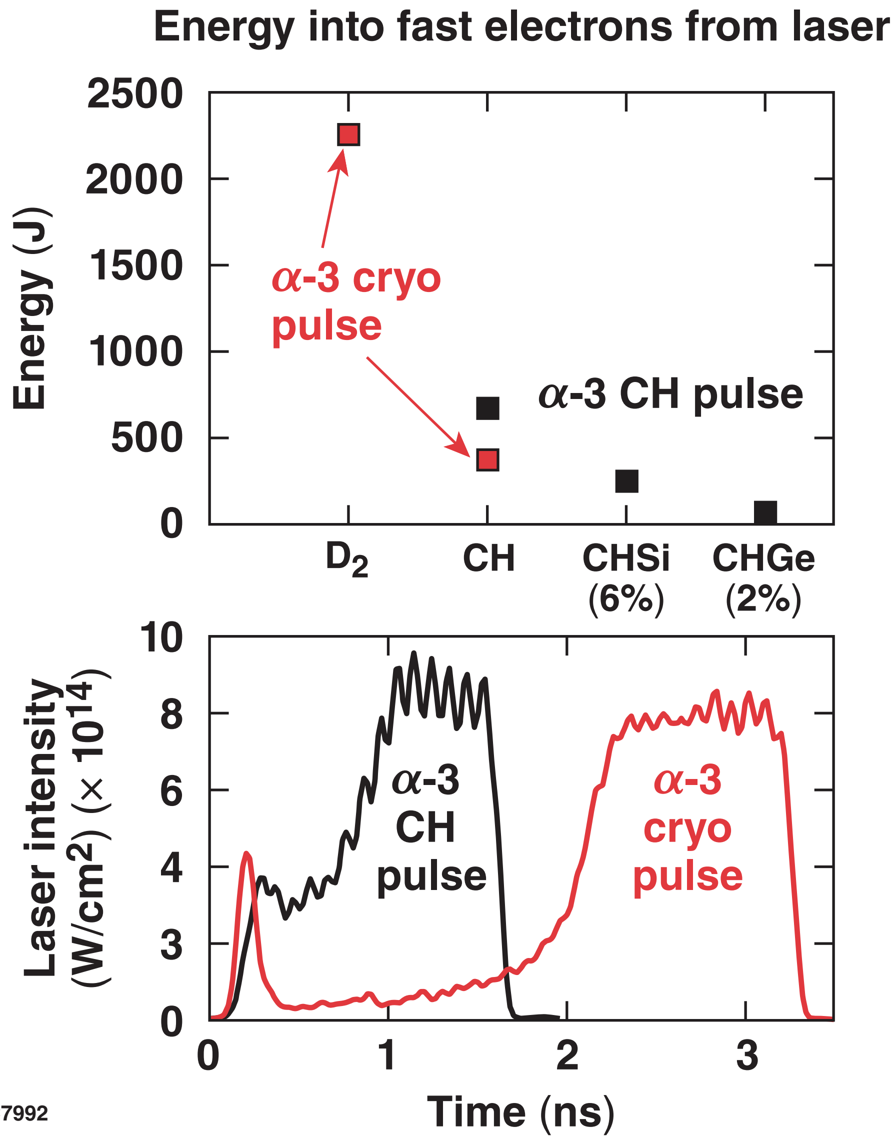
The energy deposited into the fast electrons decreases with increasing ⟨*Z*⟩ of material ablated


Energy into fast electrons from laser

- The differences in the energy deposited between cryogenic and warm targets are due to decrease in $I_{1/4}$ and increase in T_e.
- The difference due to CH dopants is mainly due to increase in T_e.
- The scale length is the same in all cases.

TC7992

Summary/Conclusions

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- The production of the fast electrons depends strongly on conditions at the quarter-critical surface.

- Qualitative agreement with experiment was obtained for the emitted hard x-ray energy.

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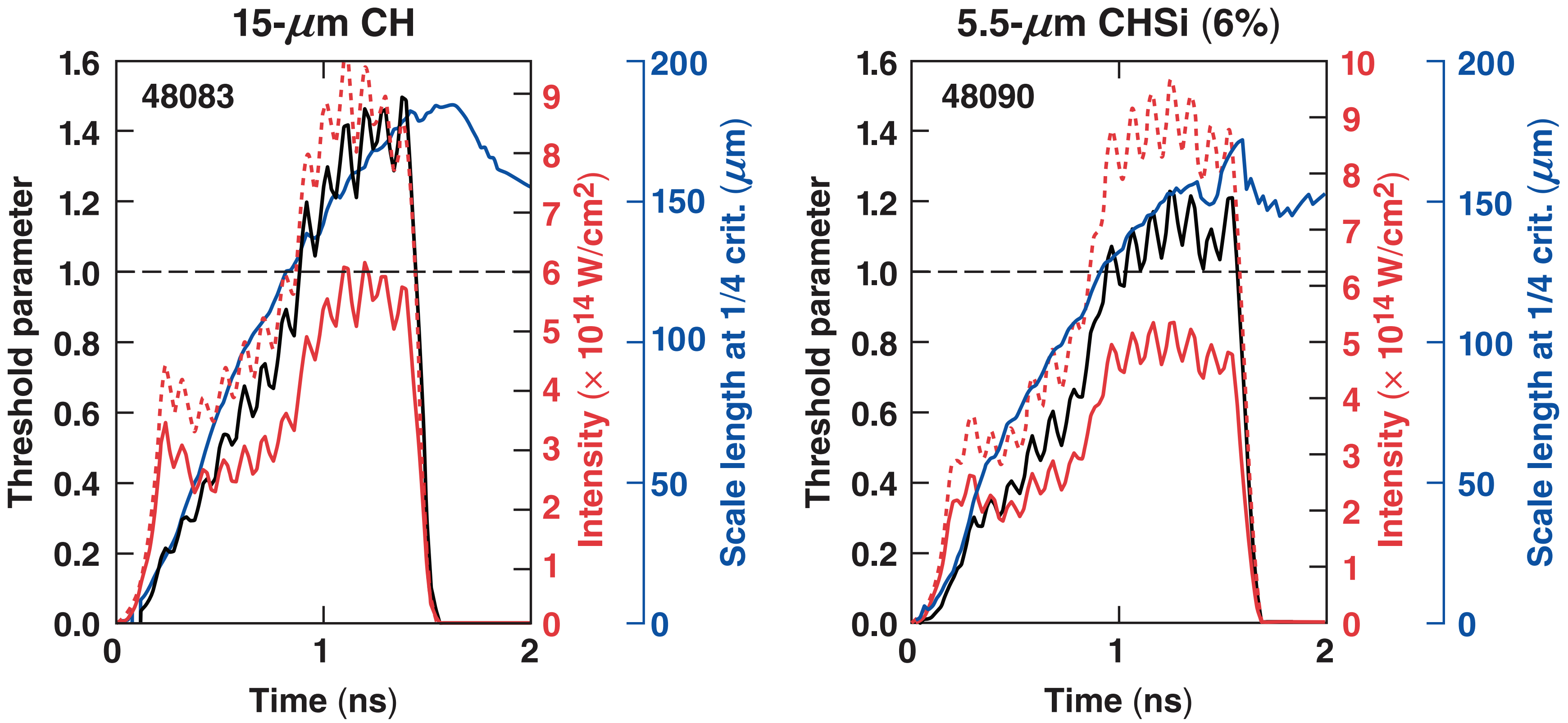
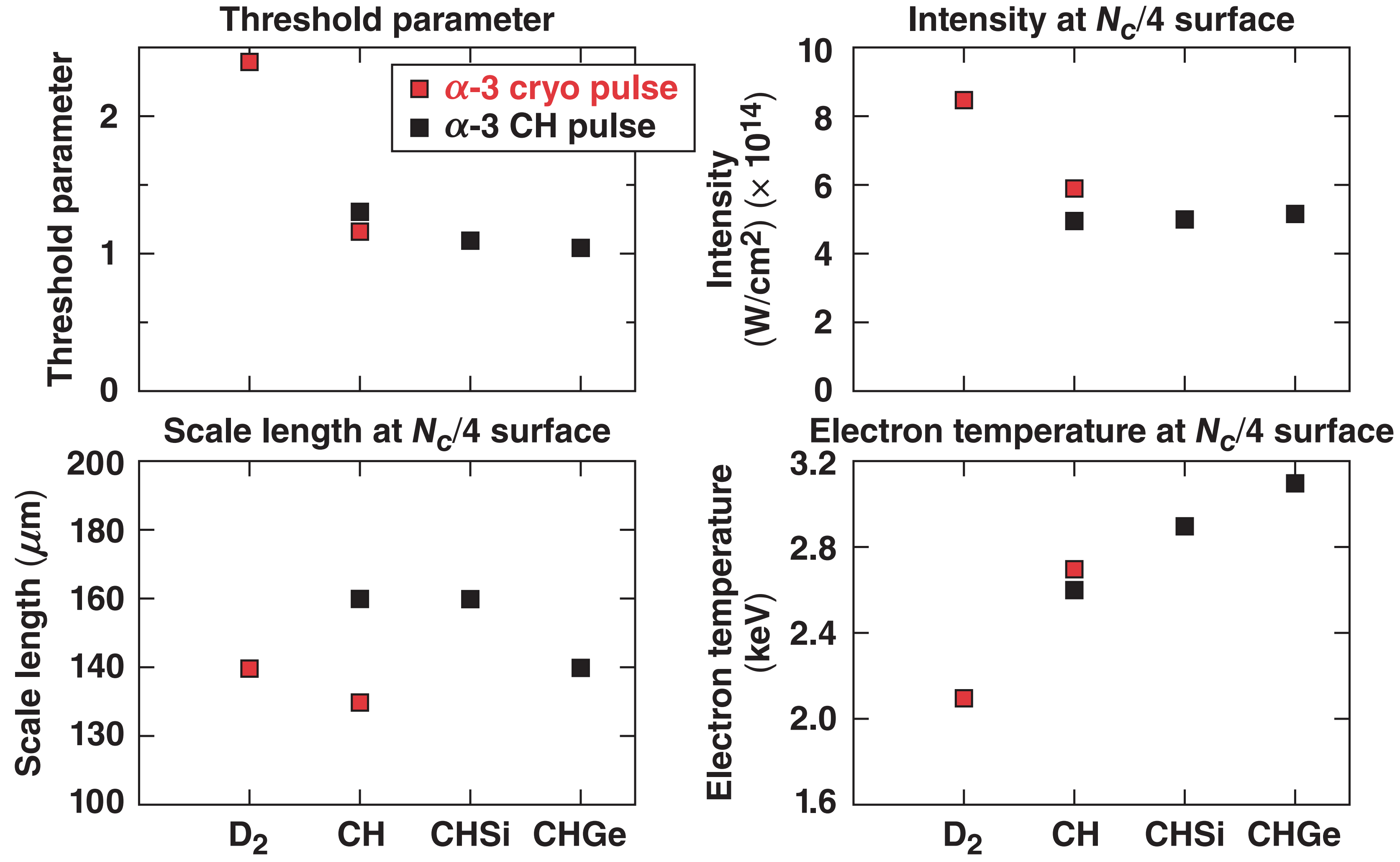
In the case of CHSi-coated CH targets the reduction in threshold parameter is due to the lower intensity and the higher T_e at $N_c/4$



The threshold parameter is mostly affected by the electron temperature at $N_c/4$, except for the D_2 case



$$\eta = I_{14} L_{\mu m}/233\, T_c\,(\text{keV})$$

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