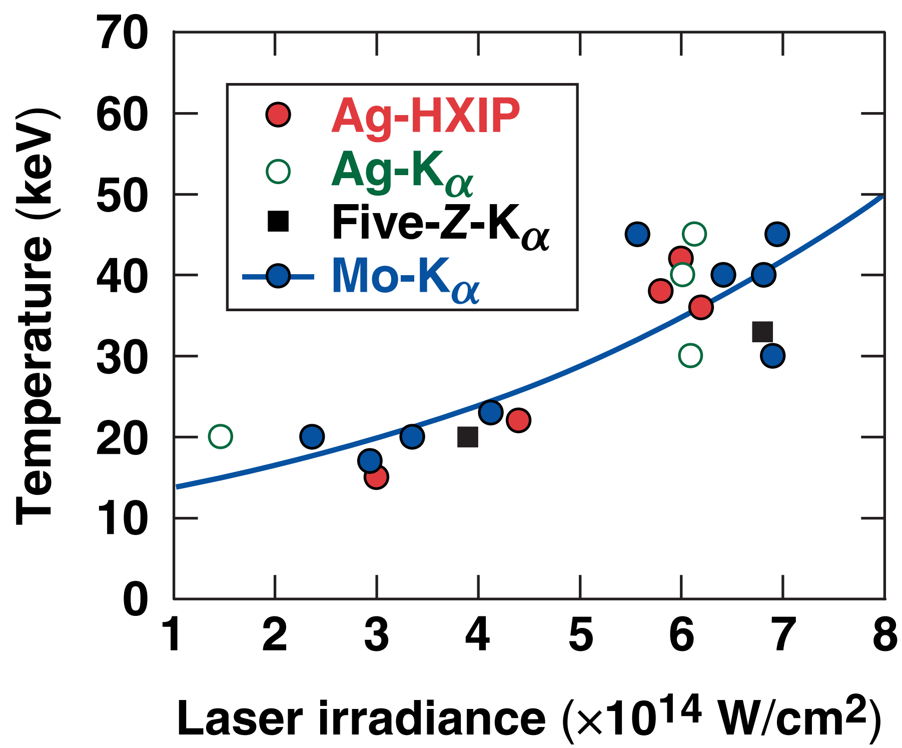
Fast-Electron Temperature Measurements in Laser-Irradiation at 10^{14} to 10^{15} W/cm^2



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Summary

The temperature of fast electrons in planar-target irradiation using UV pulses at 10^{14} to 10^{15} W/cm^2 was measured

- The bremsstrahlung radiation was measured by a nine-channel filter spectrometer and detected by an image plate
- Two types of experiments used the K_α radiation from high-Z signature layers embedded in plastic
- The fast-electron temperature rose from ~15 keV to ~50 keV in the intensity range of 1 to 7×10^{14} W/cm^2
- Approximately 1% laser energy to fast-electron conversion efficiency was inferred

Collaborators

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Long-scale-length planar CH plasmas are produced on OMEGA EP to study the generation of fast electrons by two-plasmon decay (TPD)

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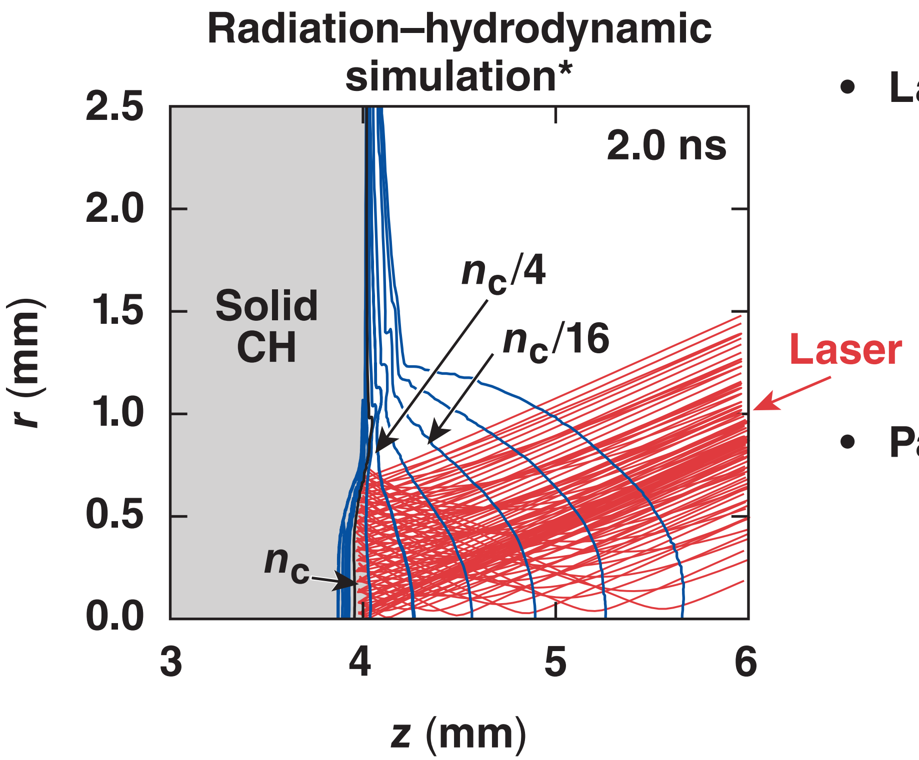
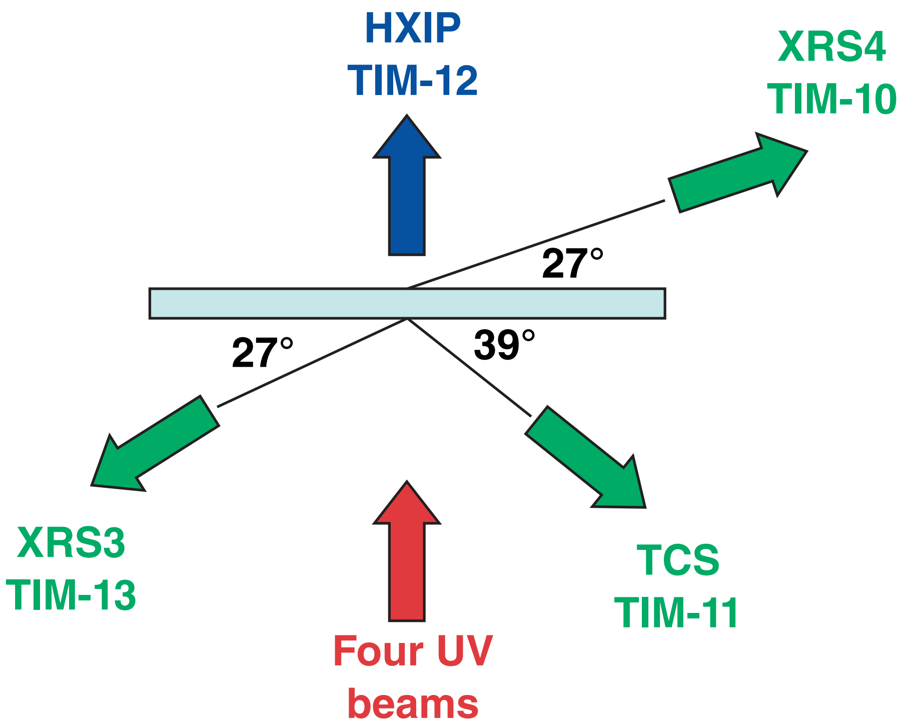


- Laser pulse
  - temporal profile: square, τ = 2 ns
  - beam spot size: $D \approx$ 1 mm
  - energy: up to 8 kJ in four beams
  - incident intensity: I = 1 to 7 $\times 10^{14}$ W/cm^2
- Parameters at N_{qc}
  - intensity: I_{qc} = 0.5 to 4.5 $\times 10^{14}$ W/cm^2
  - density scale length: $L_n \leq 400\ \mu$m
  - plasma temperature: $T_e \leq$ 2.5 keV
  - common wave gain:** $G \sim I_{qc} \times L_n/T_e \leq 7$

*B. Yaakobi *et al*., Phys. Plasmas 19, 012704 (2012); S. X. Hu *et al*., Phys. Plasmas 20, 032704 (2013).
**D. T. Michel *et al*., Phys. Plasmas 20, 055703 (2013).

TC9311

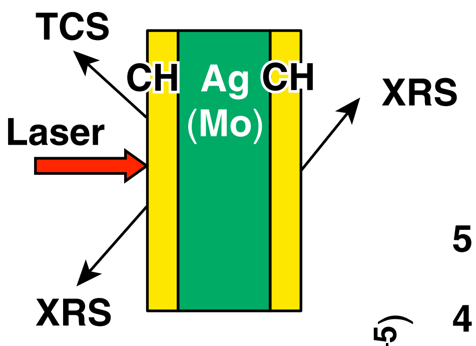
Experiments were performed using plastic targets with embedded high-Z signature layers



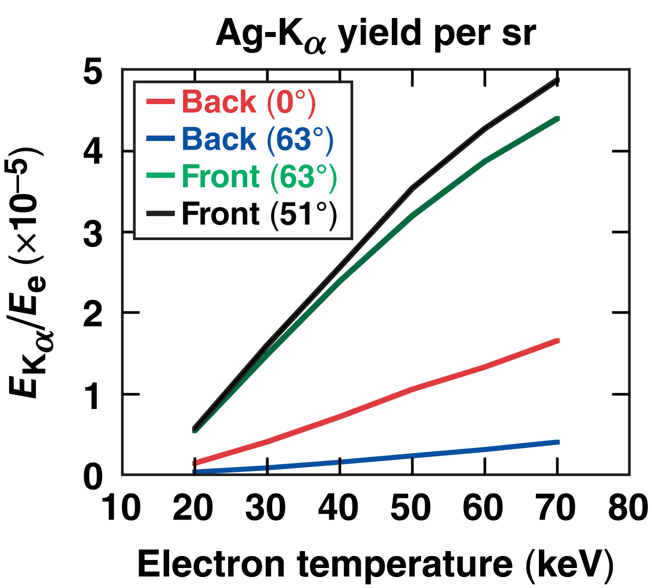
- Targets
  - 5-, 35-, 50-, 100-, 127-μm-thick Ag foils coated with 30 μm CH
  - 30-, 100-μm-thick Mo foils coated with 30 μm CH
  - five consecutive-Z layers (Nb, Mo, Rh, Pd, Ag, 5-μm each) coated with 25 μm CH

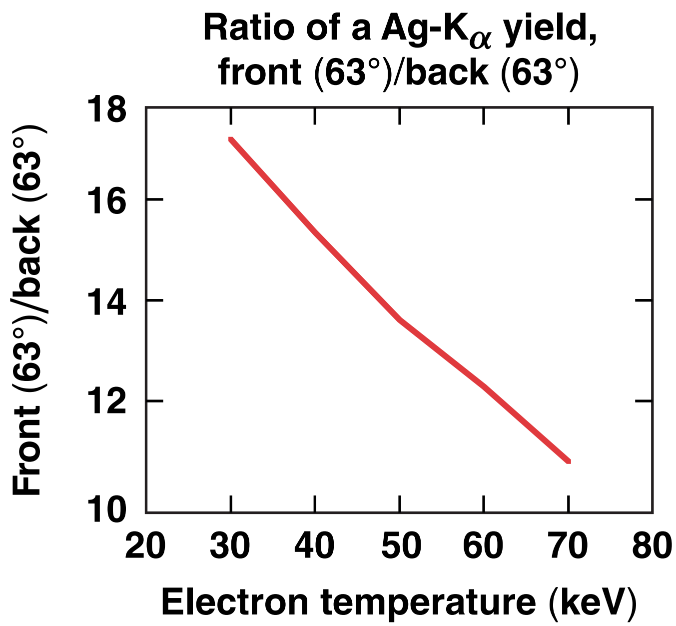
- Diagnostics
  - nine-channel filter spectrometer with image plate [hard x-ray image plate (HXIP)]
  - Cauchois-type quartz spectrometer [transmission crystal spectrometer (TCS)]
  - two identical LiF crystal spectrometers [x-ray spectrometer (XRS)]

The fast-electron temperature was inferred using K_α measurements from the front and back of thick Ag (Mo) targets



Monte Carlo *EGSnrc** simulations for a 127-μm Ag target



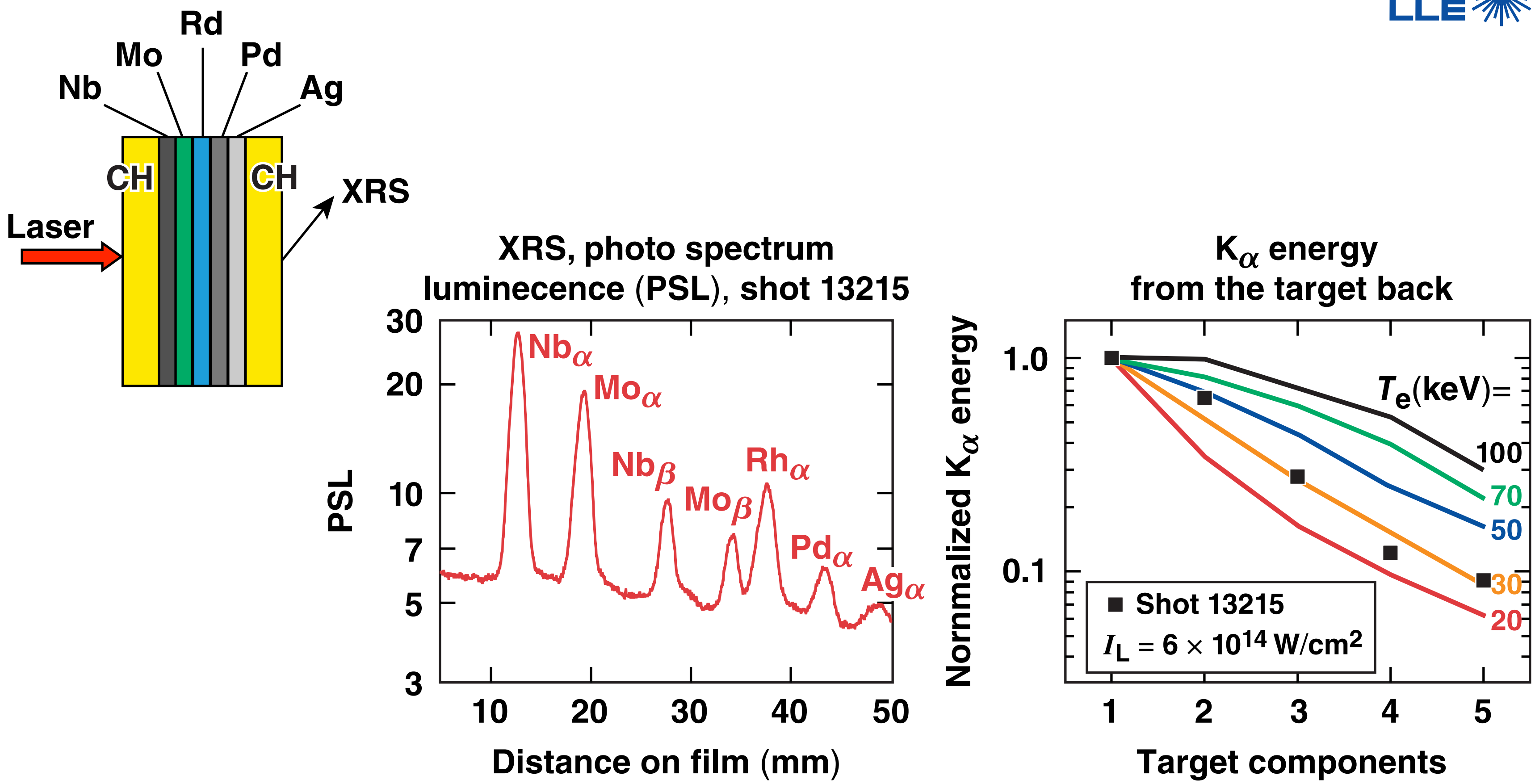


- The ratio of K_α emitted toward the front and the back decreases with increasing *T*: K_α is emitted deeper into the foil and therefore absorbed less on the way to the back of the target

TC11647

*I. Kawrakow *et al*., NRC, Ottawa, Canada, NRCC Report PIRS-701 (May 2011).

Temperature was inferred from K_α measurements using a five consecutive-Z layer target



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A nine-channel filter x-ray spectrometer with image plate (HXIP) has been developed

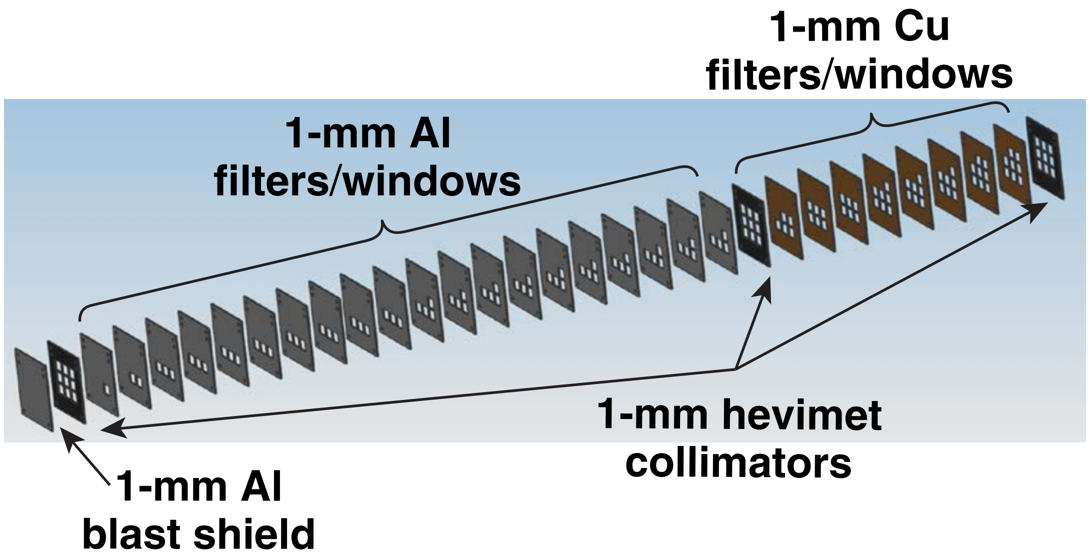
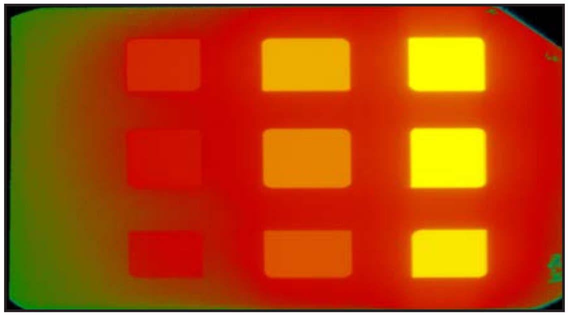
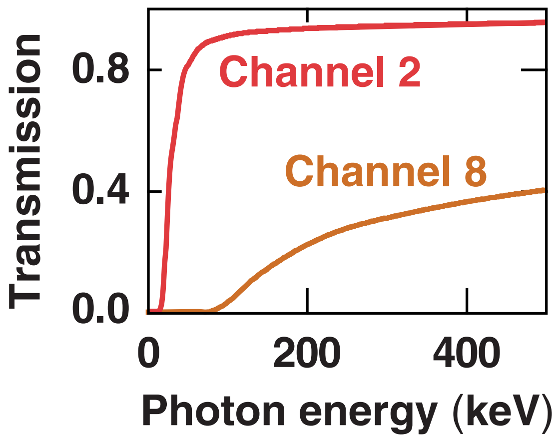


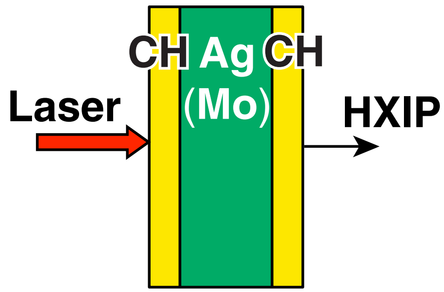
Image plate





TC11649

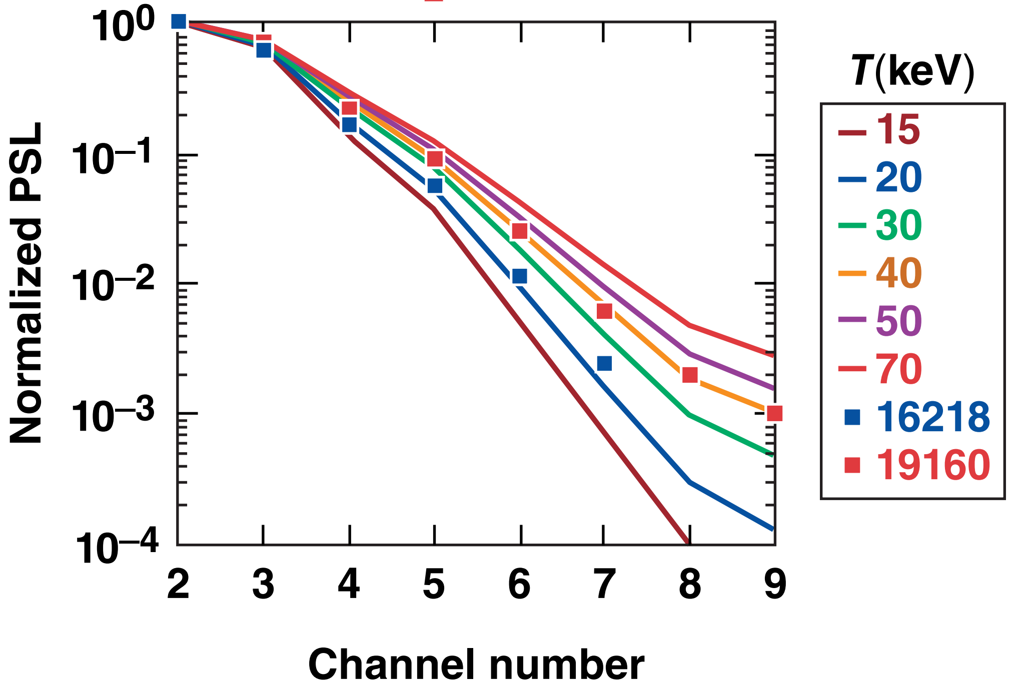
HXIP measurements (channels 2 to 9) indicate a single-temperature fast-electron distribution



PSL in two shots (squares) and simulated PSL assuming single-temperature, fast-electron distributions (solid lines)

Shot 16218, $I_L = 4 \times 10^{14}$ W/cm^2

Shot 19160, $I_L = 6 \times 10^{14}$ W/cm^2



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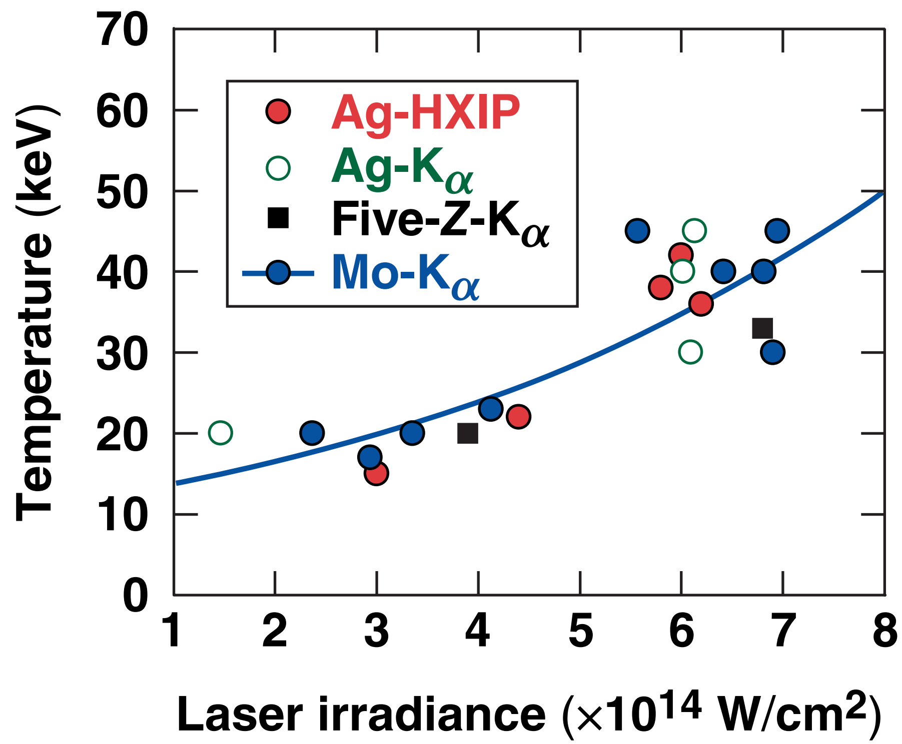
Temperatures inferred from HXIP and K_α measurements agree in experiments using different targets



The fast-electron temperature rises from ~15 keV to ~50 keV in the intensity range of 1 to 7 × 10^{14} W/cm^2.

TC11652

Fast-electron temperature and x-ray yield measurements have been used to estimate the preheat energy

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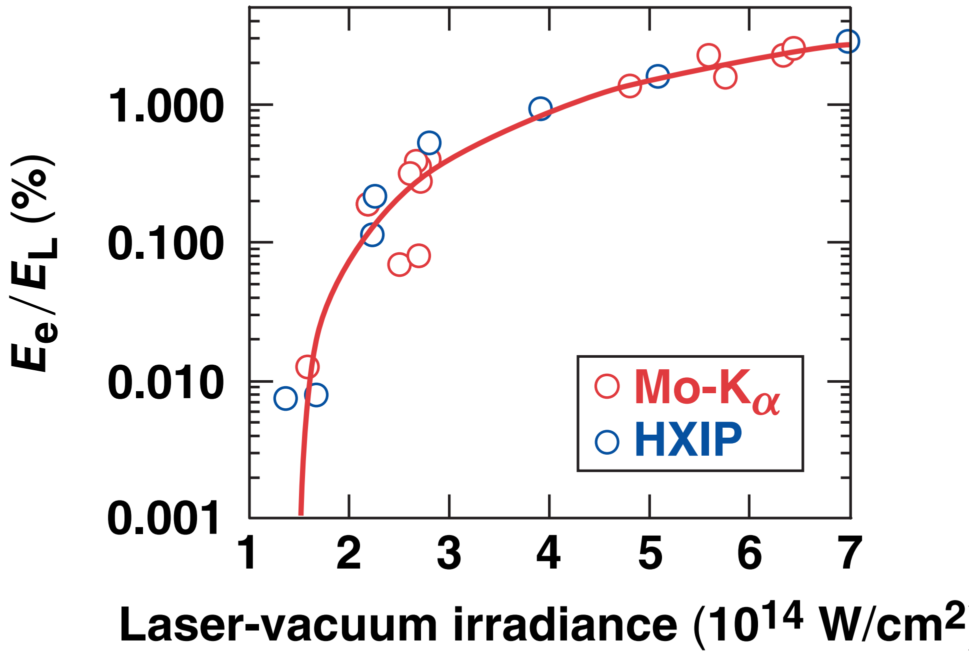
Comparison of preheat inferred using Mo-K_α and HXIP measurements



- ~1% of the laser energy is converted to fast electrons, confirmed using different diagnostics
- Only ~1/4 of the fast electrons will be intercepted by the compressed fuel because of a wide angular divergence*

TC11653

*B. Yaakobi *et al*., Phys. Plasmas 20, 092706 (2013).

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UR LLE

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XRS confirms an increased signal in HXIP channel 1 resulting from *T* ~ 2-keV x rays generated in the plasma corona

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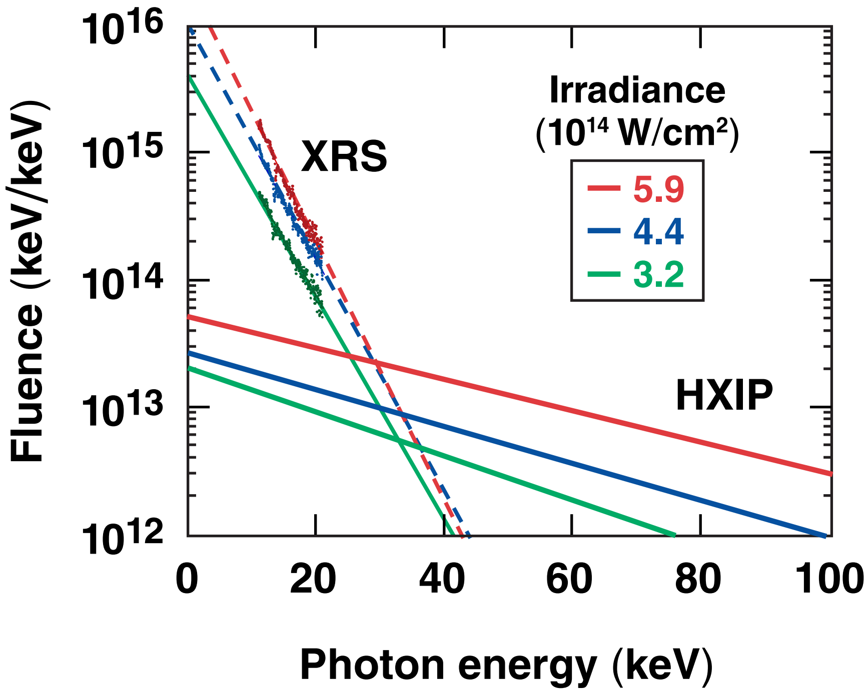
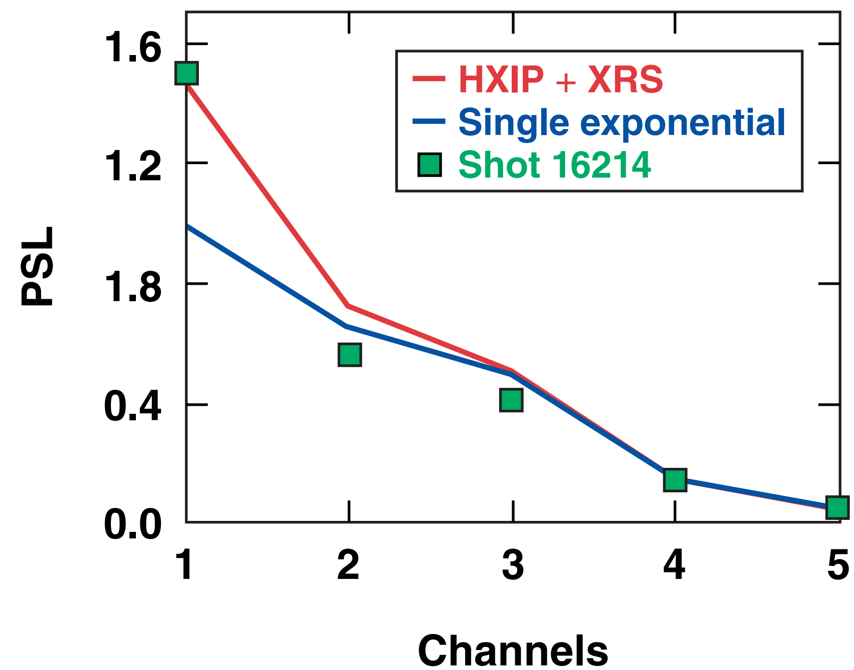
Combining XRS and HXIP absolutely calibrated spectra



Composite HXIP + XRS spectrum better reproduces the measurement



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