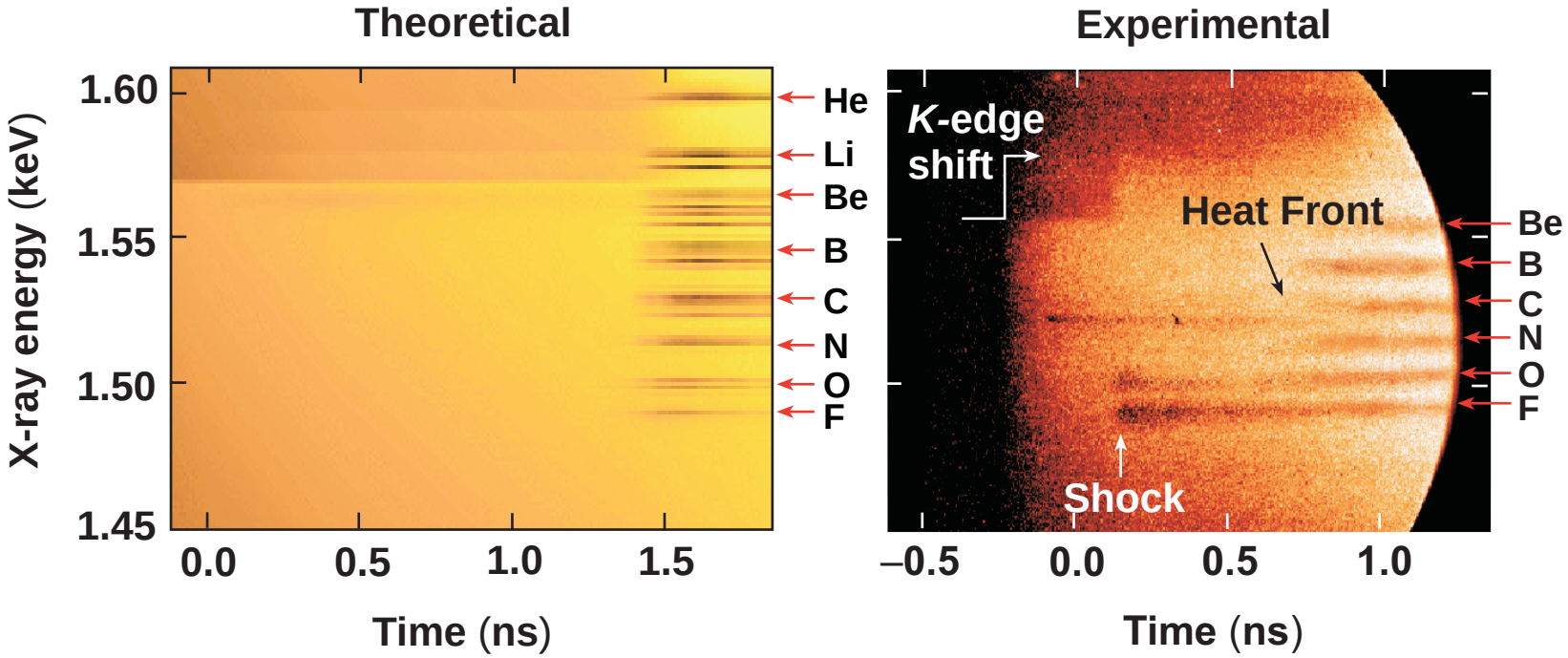
Two-Dimensional Simulations of X-Ray Absorption Spectra from Nonuniformly Driven Planar Targets



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Two-Dimensional Simulations of X-Ray Absorption Spectra from Nonuniformly Driven Planar Targets

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The effects of the ablative Rayleigh–Taylor instability on simulated absorption spectra in planar targets are examined. Spectra from embedded layers have been used as diagnostics of thermal transport, shock preheat, and other effects. Obtaining consistent temperature values from conventional analysis requires that the signature material remain within bounds that do not exceed a narrow range of conditions. We consider modifications of the spectrum due to, for example, dilution and bias by higher transmission through thin spots in the absorbing layer. We also examine the applicability of one-dimensional turbulent mix modeling to short-scale, multidimensional structure. In this work, the spectral analysis post-processor SPECT3D[1] is used in conjunction with the one-dimensional hydrocode *LILAC* and the multidimensional hydrocode *DRACO*. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460.

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Summary

Spectral simulation using 2-D hydro supports simple interpretations of absorption spectra

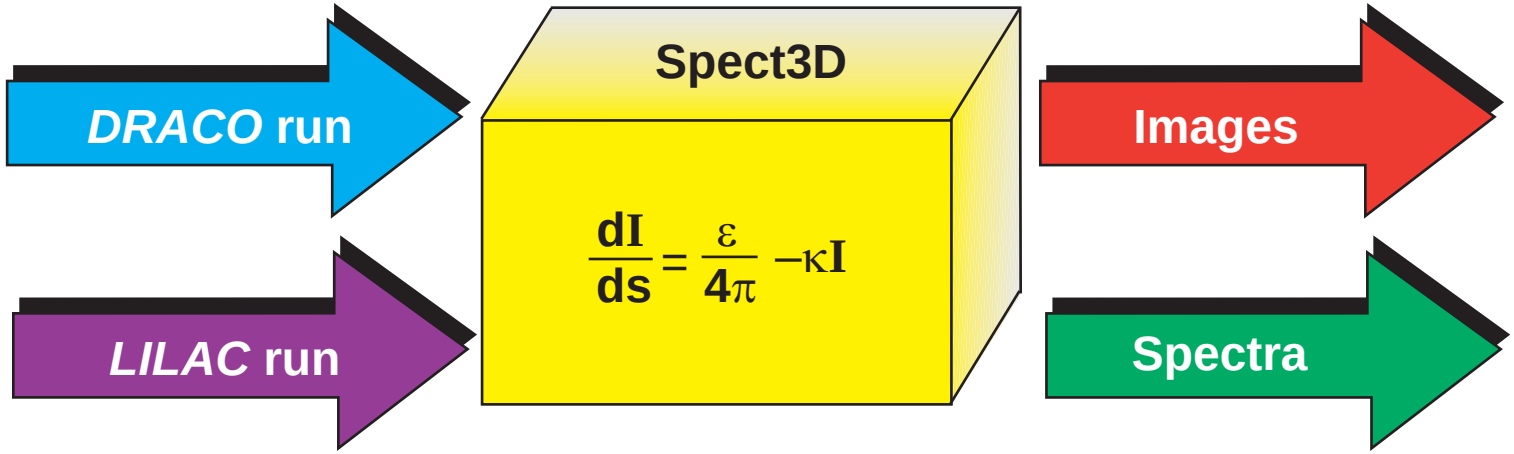
UR LLE

- Each absorption line indicates a particular temperature, and simultaneous lines indicate a temperature range.
- 2-D simulation and radiation postprocessing support this interpretation, even for highly distorted signature layers.
- The distorted dopant and temperature distributions are both highly nonuniform, but they can be somewhat correlated.
- Simulated spectra with nonuniform illumination share important qualitative features with observed spectra.

Outline

- The Spect3D postprocessor
- Absorption lines and edges
- Temperature determination from absorption spectra
- Spectral simulation with 2-D hydro
- Comparison with an observed spectrum

The Spect3D* radiation-transport postprocessor solves the radiative transfer equation



- *DRACO* and *LILAC* produce hydrodynamic simulations of OMEGA experiments.
- Spect3D produces images and spectra at specific time steps using the equation of transfer and a DCA atomic model.

CP1.053, JP1.034

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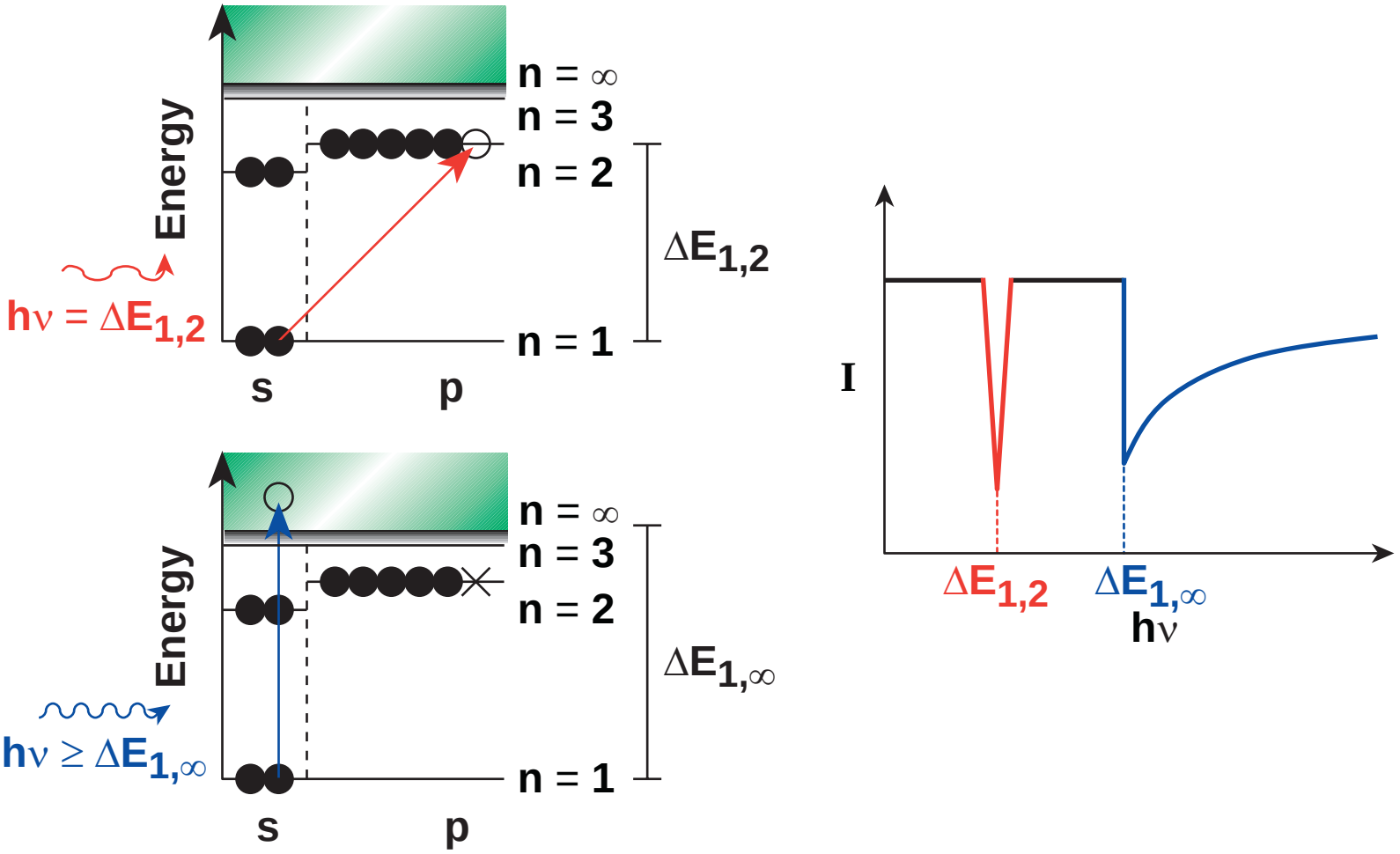
Absorption lines and edges are caused by bound–bound and bound–free transitions



TC5492

A temperature mosaic can be used as a diagnostic tool to determine temperature ranges

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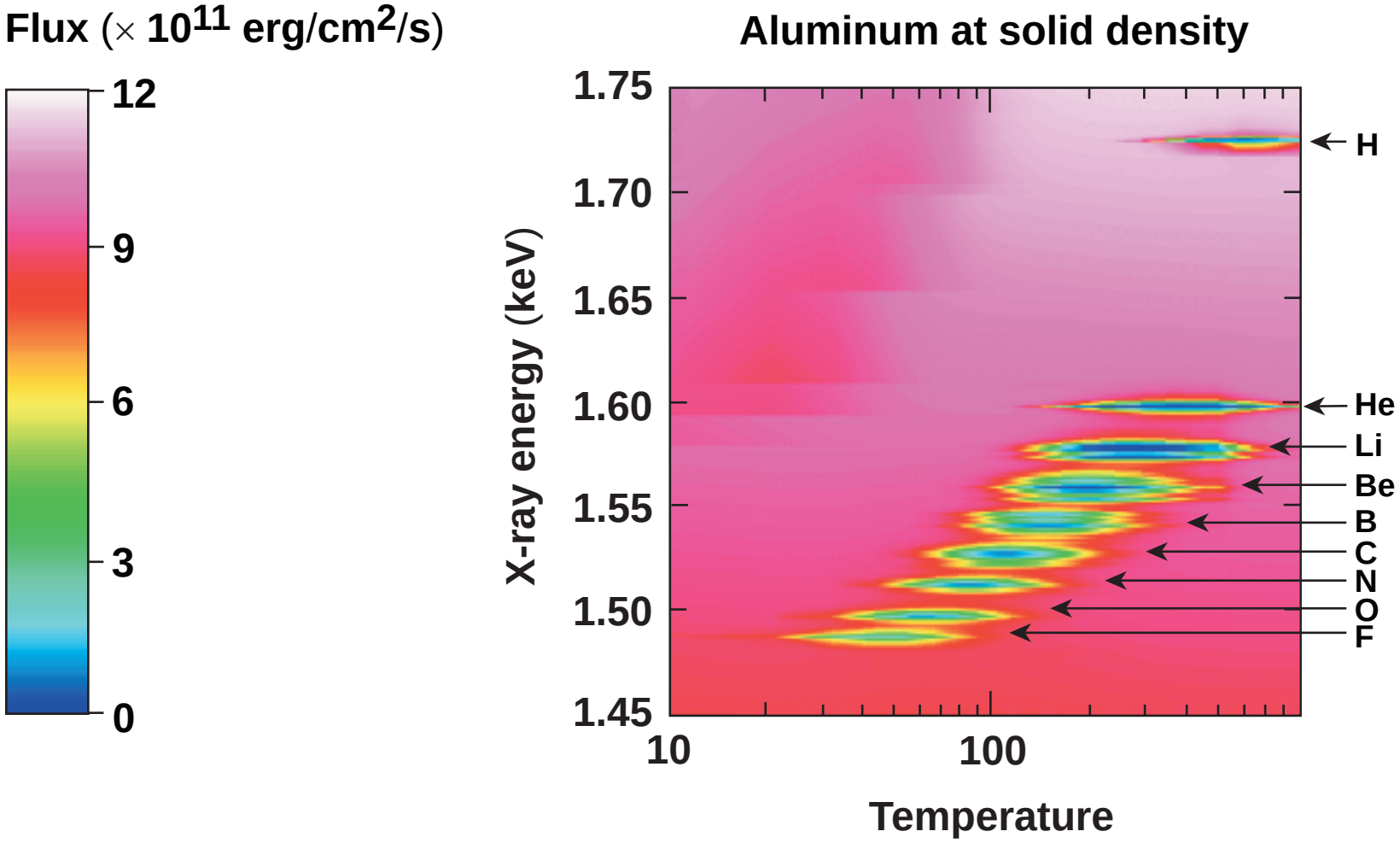
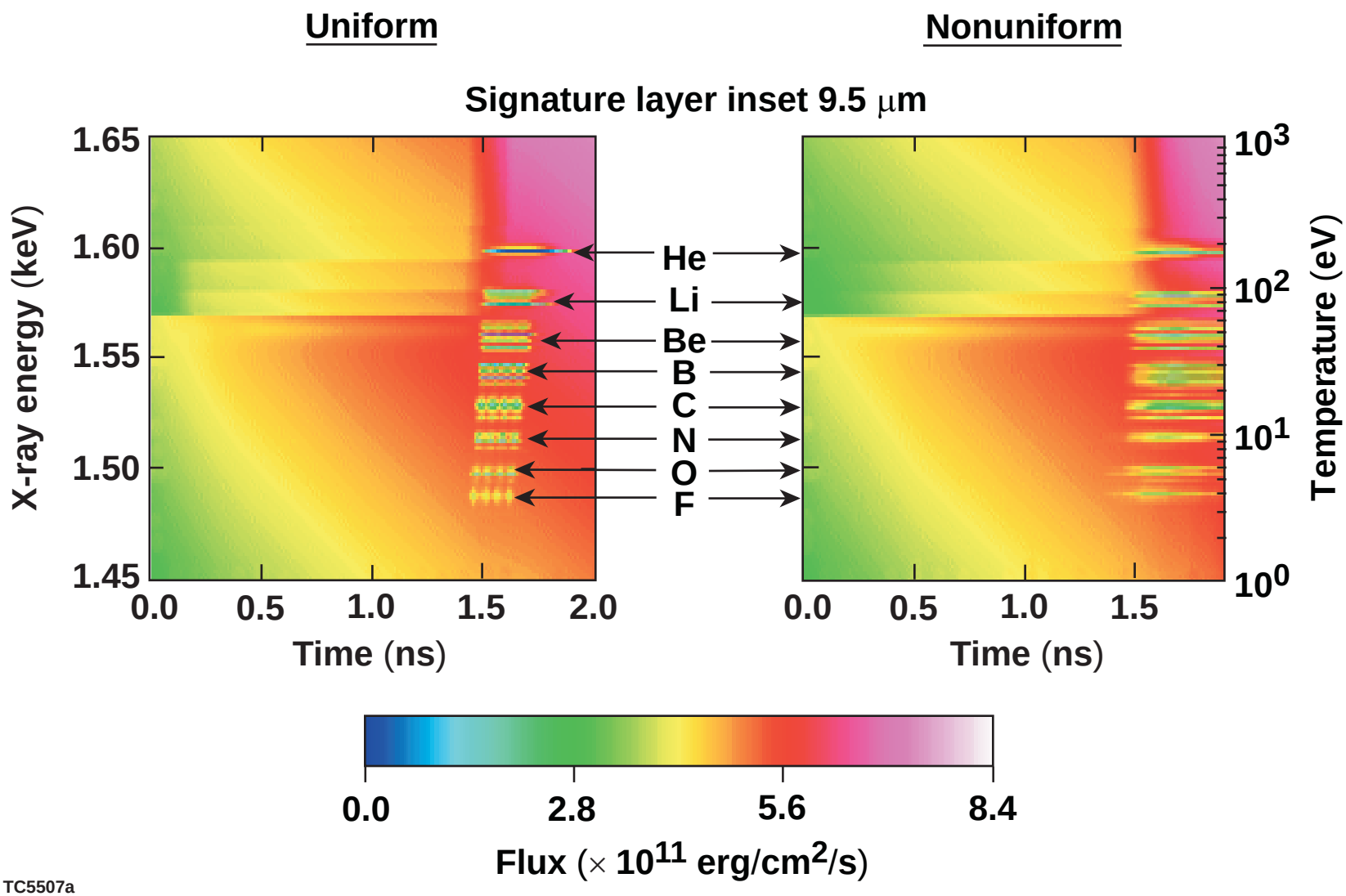


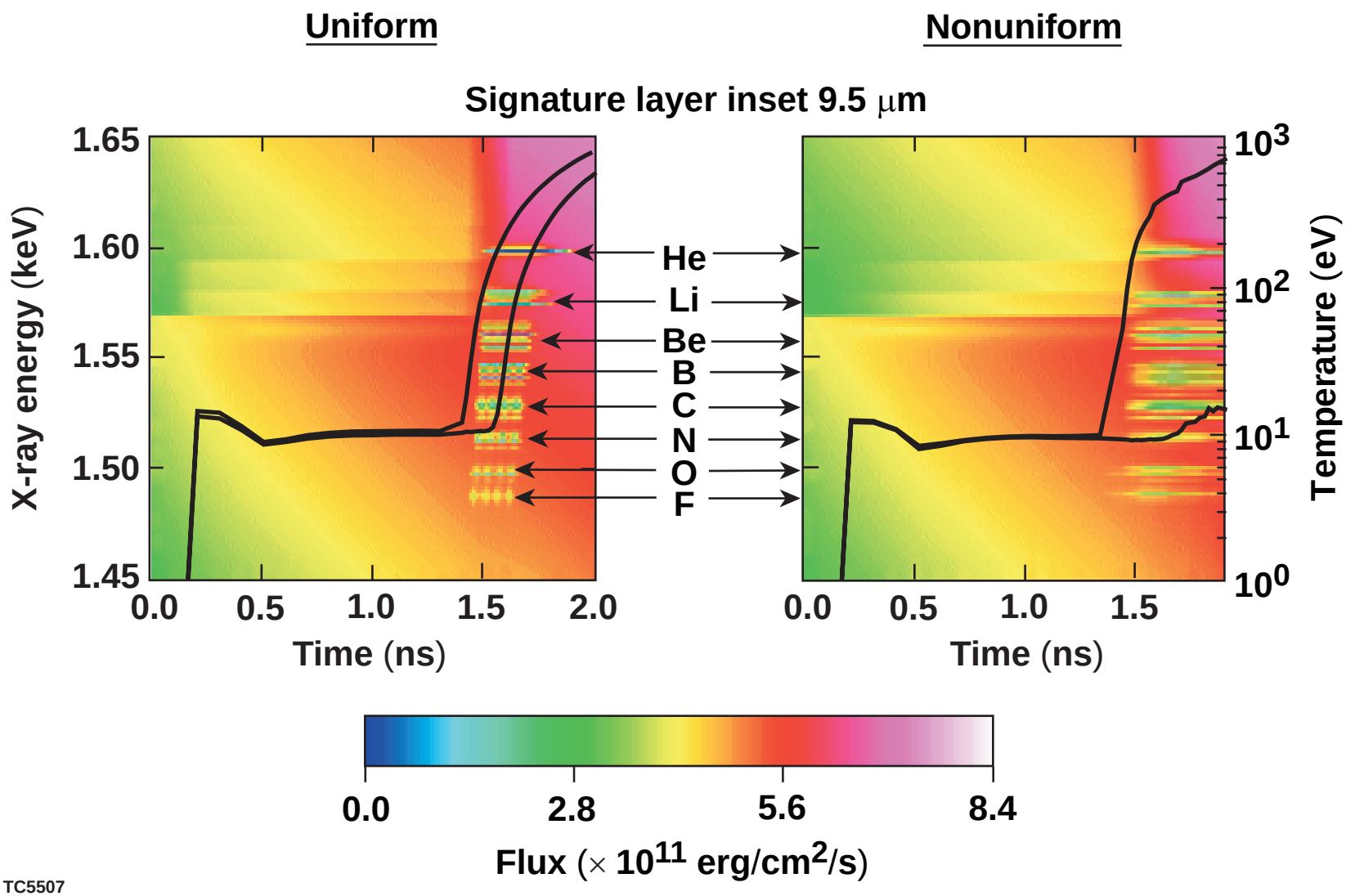
TC5506

Simulated spectra of an Al signature layer show differences between uniform and nonuniform illumination



TC5507a

Simulated spectra of an Al signature layer show differences between uniform and nonuniform illumination



TC5507

The perturbed temperature and material distributions of the signature layer are nonuniform

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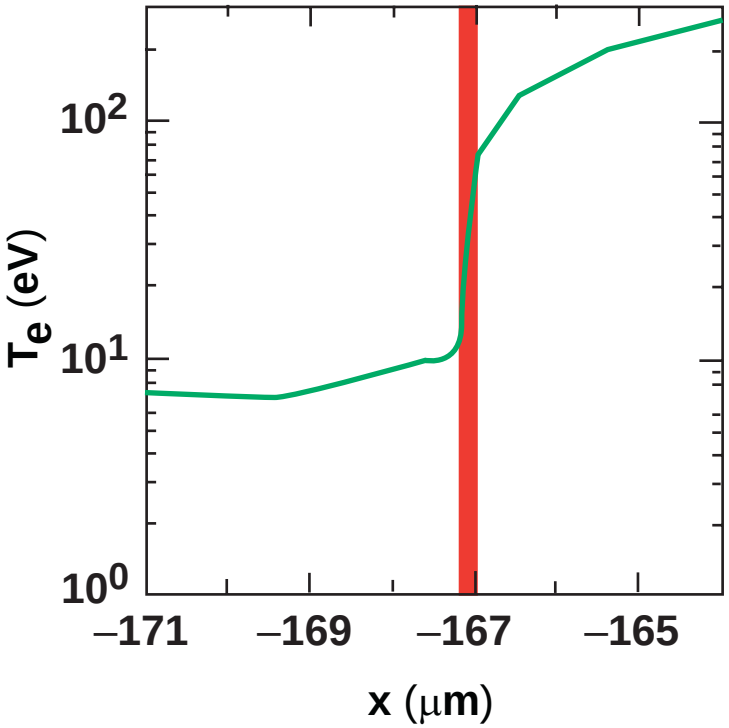
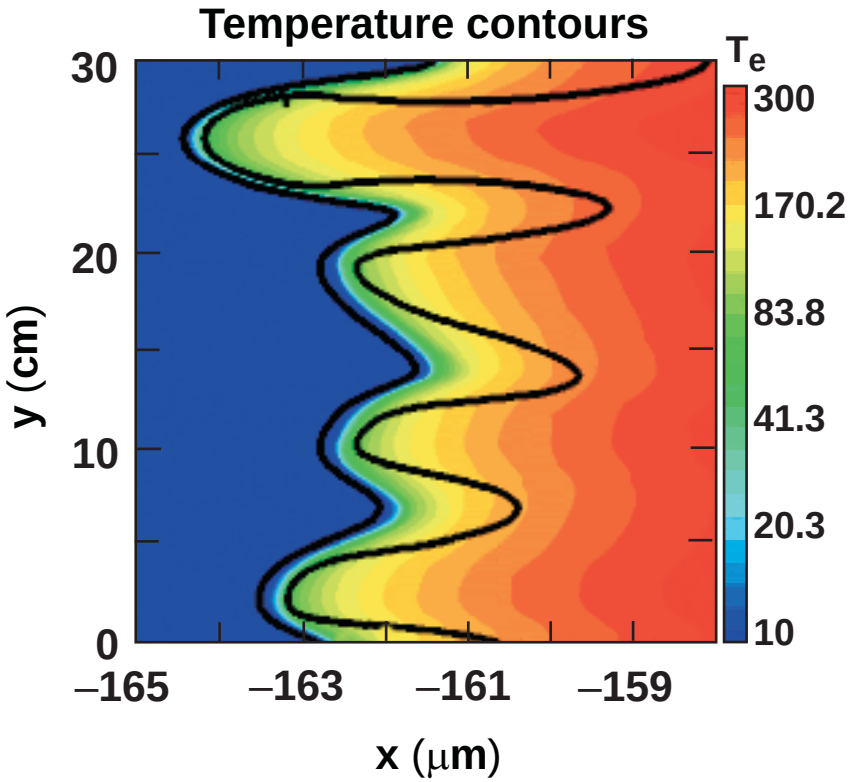
Uniform Illumination



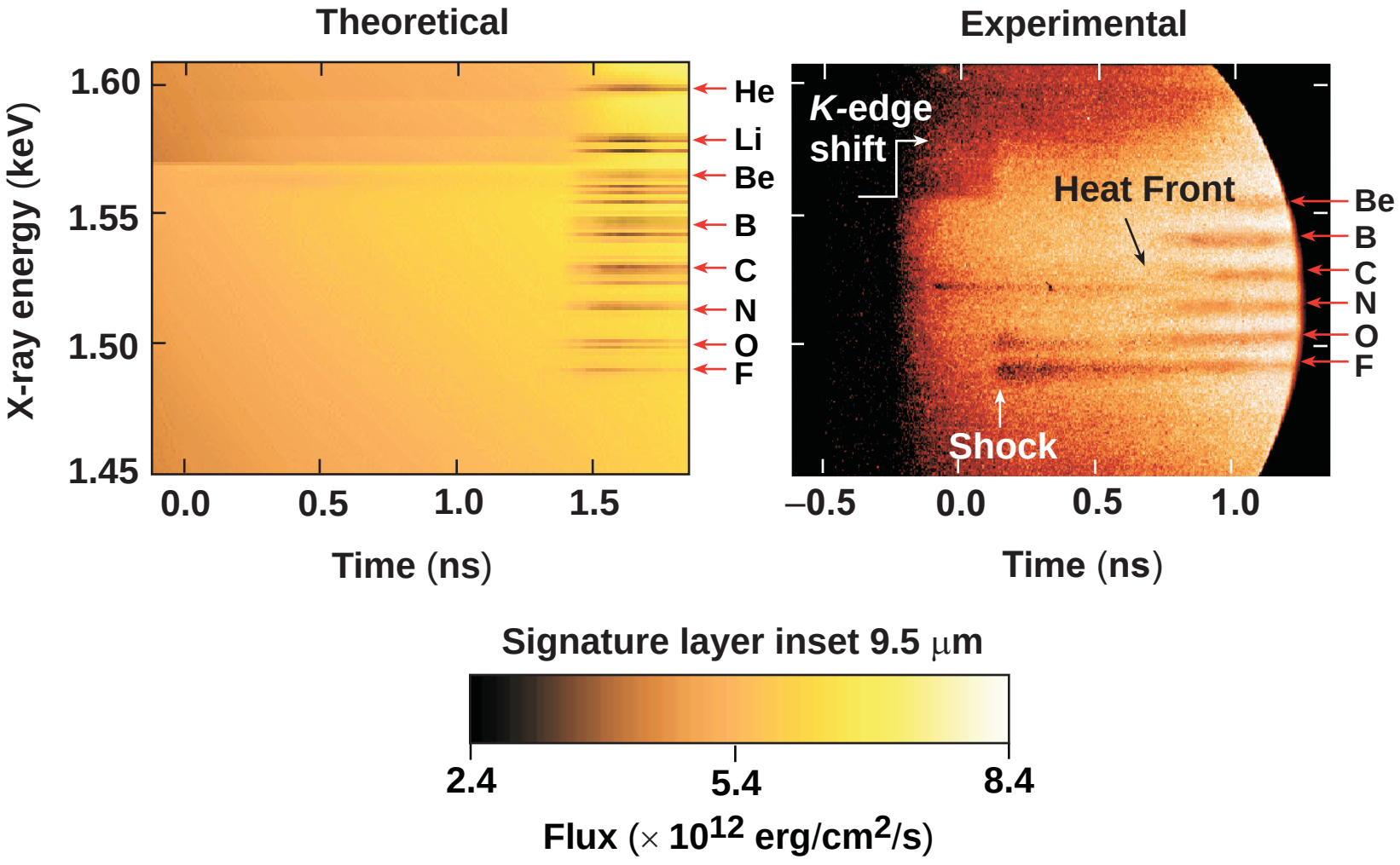
Nonuniform Illumination



Signature layer inset 9.5 μm; time = 1.48 ns

TC5494

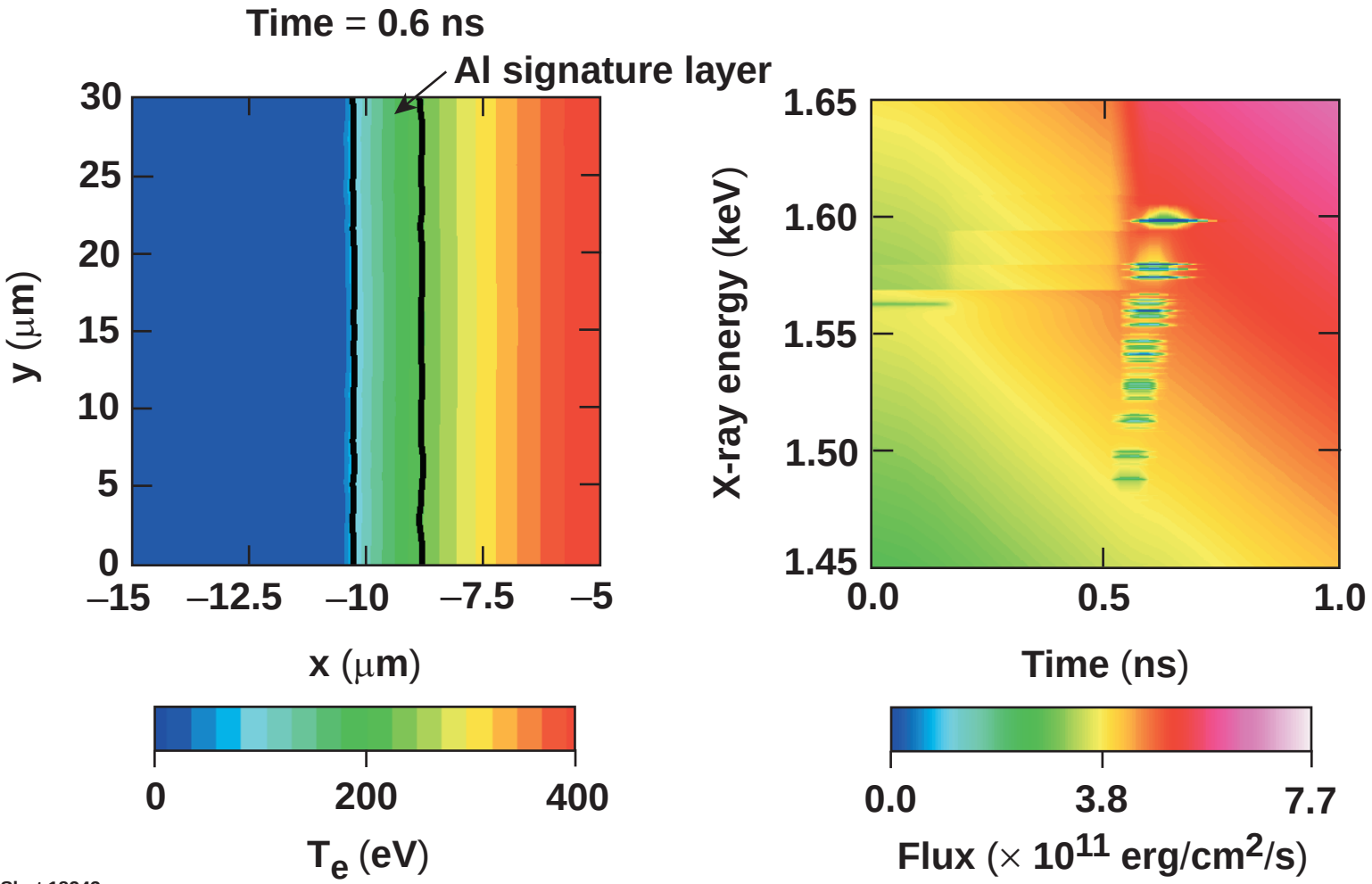
The simulated spectrum based on nonuniform illumination shares important qualitative features with the experimental result



TC5508

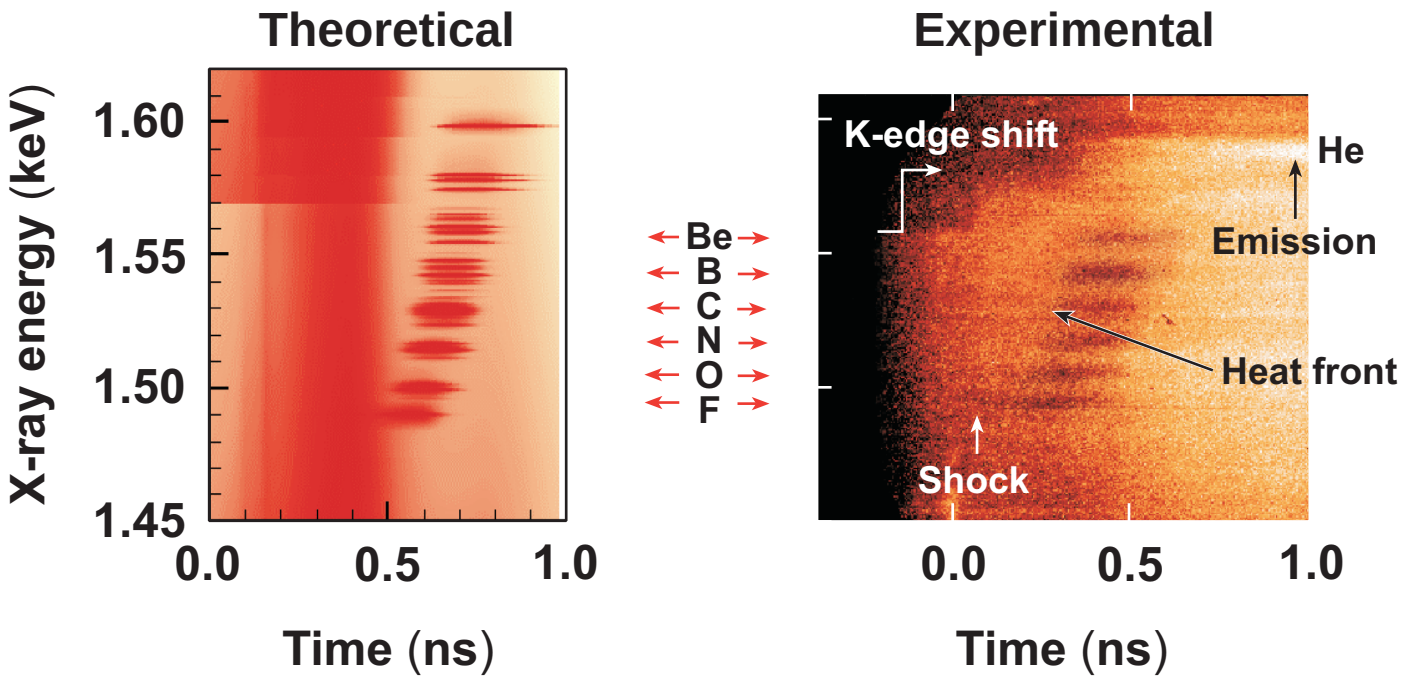
An Al signature layer buried 5 μm deep shows a staircase progression in the absorption lines

- The signature layer moves uniformly into the ablation region.



Shot 18243
TC5581

Simulated spectra share important qualitative features with experimental results



- Al signature layer inset 5.0 μm

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