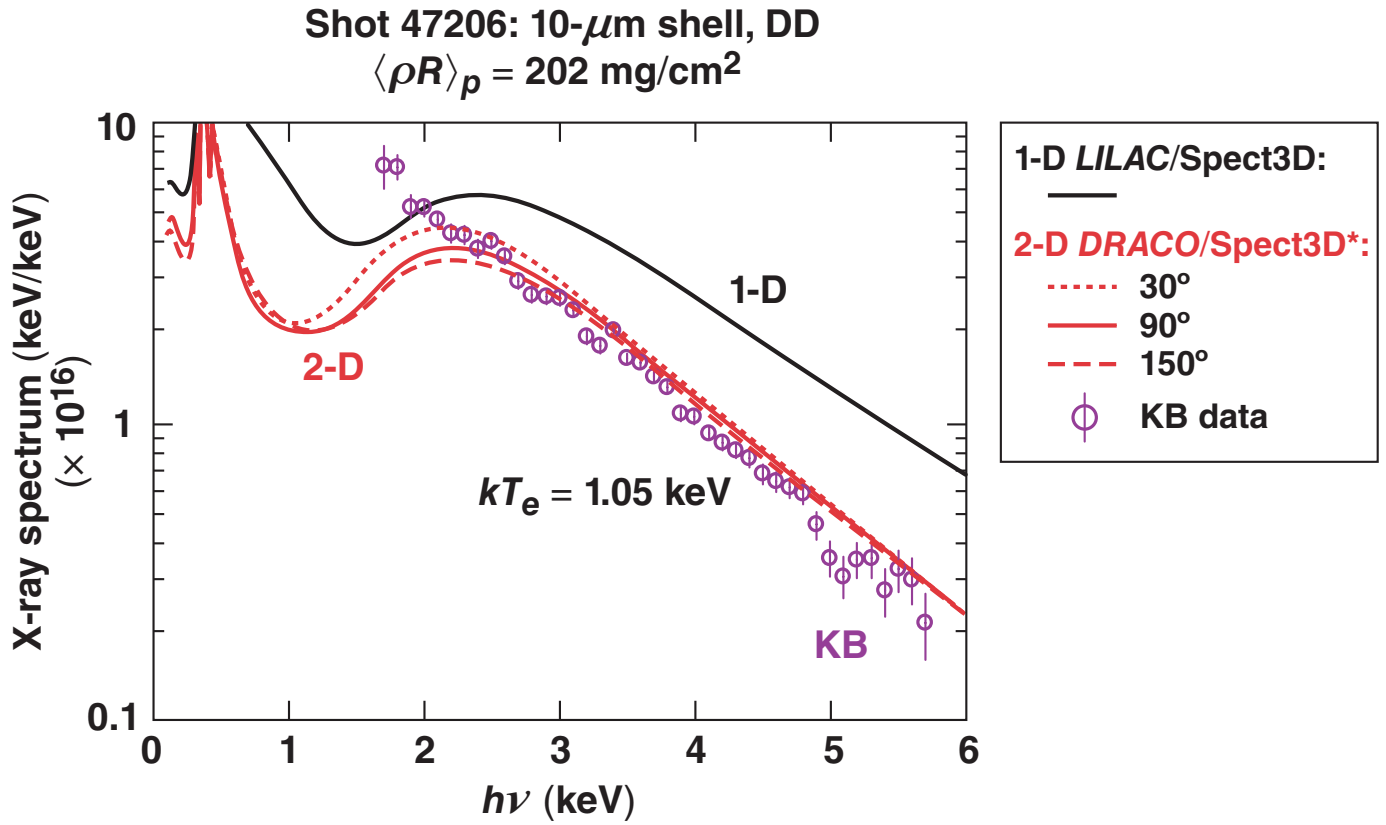
Radiative Transport Modeling Relevant to Cryogenic Implosion Simulation and Diagnosis



R. Epstein *et al*.
University of Rochester
Laboratory for Laser Energetics

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Summary

The continuum x-ray spectra of cryogenic target implosions should provide T_e and ρR diagnostic information

UR LLE

- Spectra simulated with low-order-implosion nonuniformity display the observed continuum temperatures and intensities.
- Low-order-implosion nonuniformity reduces the shell absorption at the soft end of continuum spectra, but not enough to fully account for the low measured absorption.
- Possible explanations for the low measured absorption includes opacity reduction due to strongly coupled plasma effects.

Collaborators

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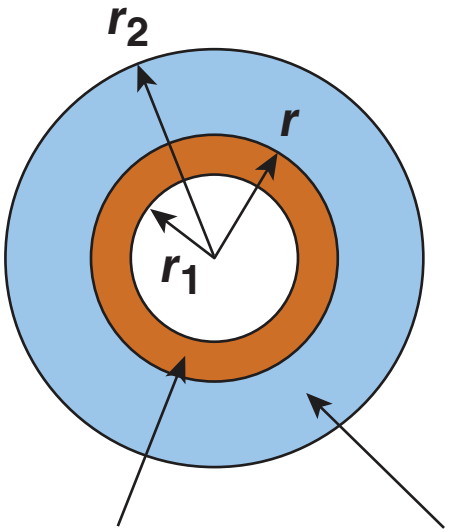
Related talk: F. J. Marshall (JO3.00004)

The continuum-spectrum peak shifts with shell areal density in a simple two-layer shell model

Cryo shell at peak compression with a variable source/absorber split (parameter f).

$\rho = 140$ g/cm^3

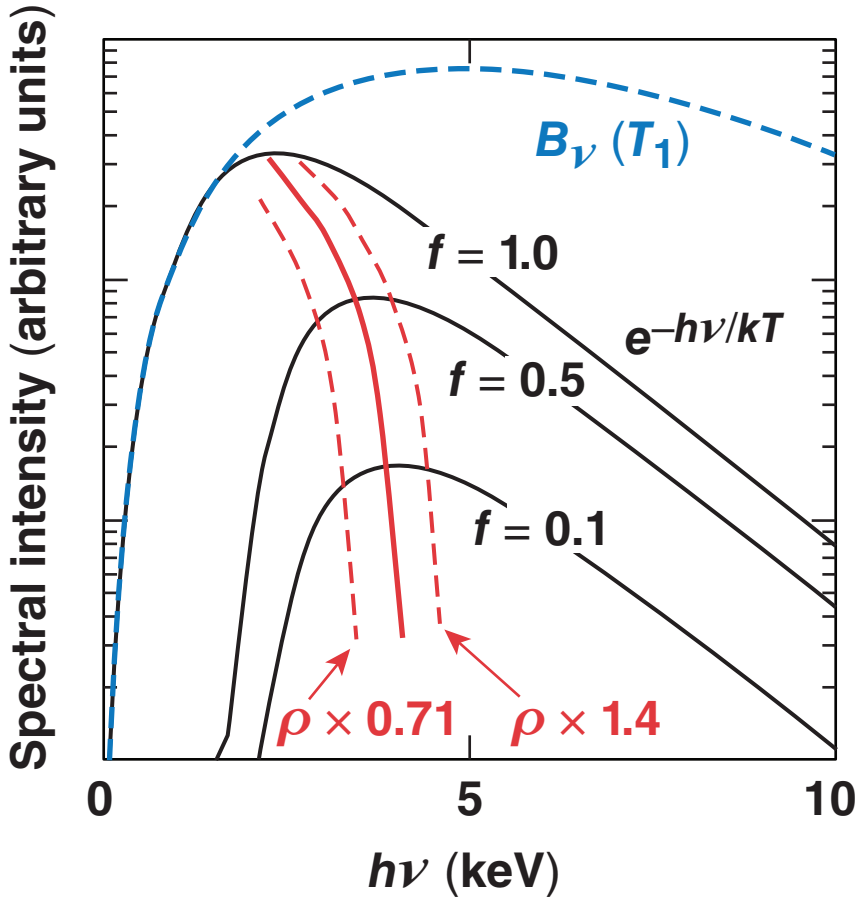


$r_1 = 15\ \mu$m
$r_2 = 30\ \mu$m

$r = r_1 + f(r_2 - r_1)$

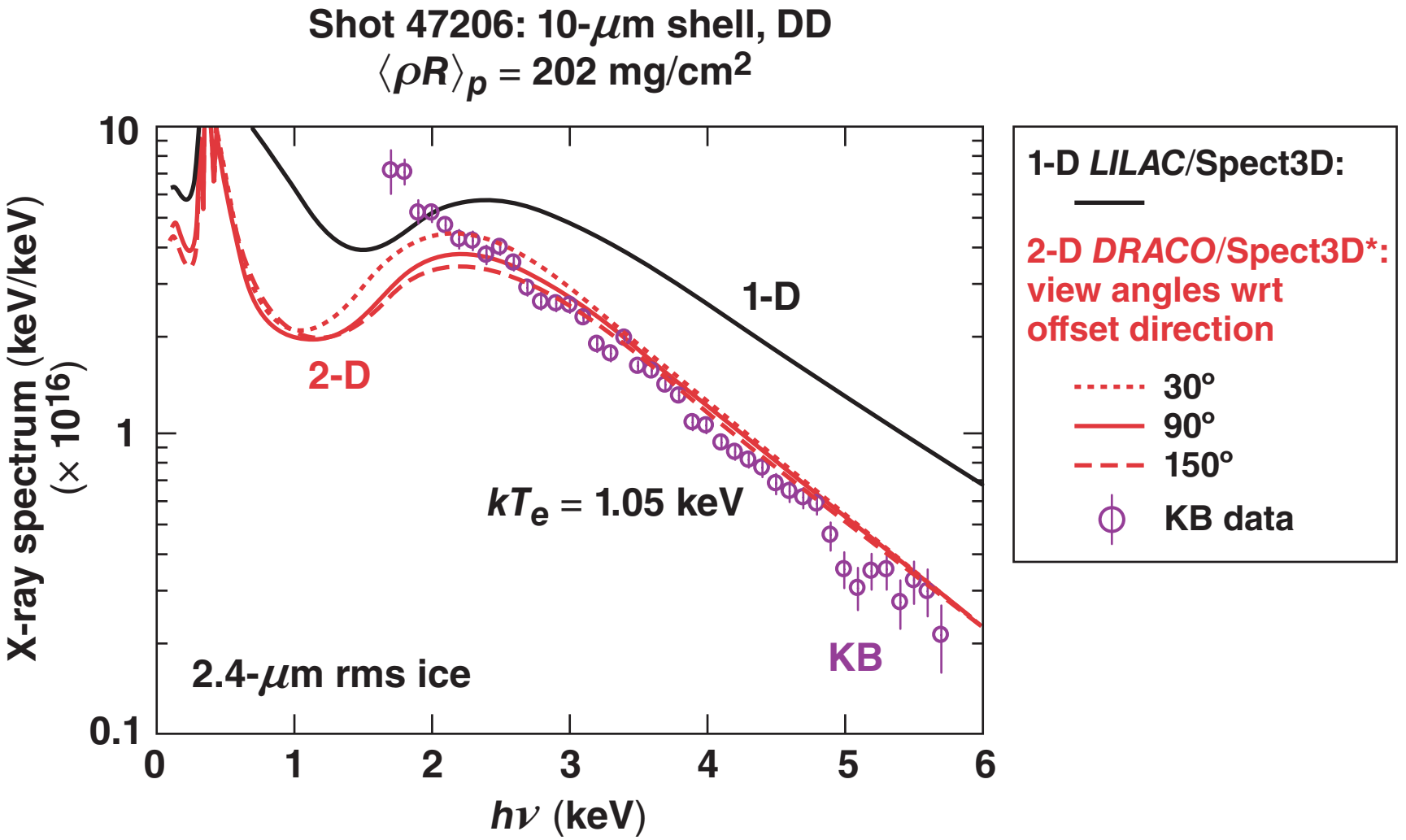
Hot source
$T_1 = 1.75$ keV

Cold shell
$\alpha_2 = 1.8$
$T_2 = 0.1$ keV



TC7948

The spectral temperature and hard-x-ray intensity of the core of shot 47206 are simulated accurately



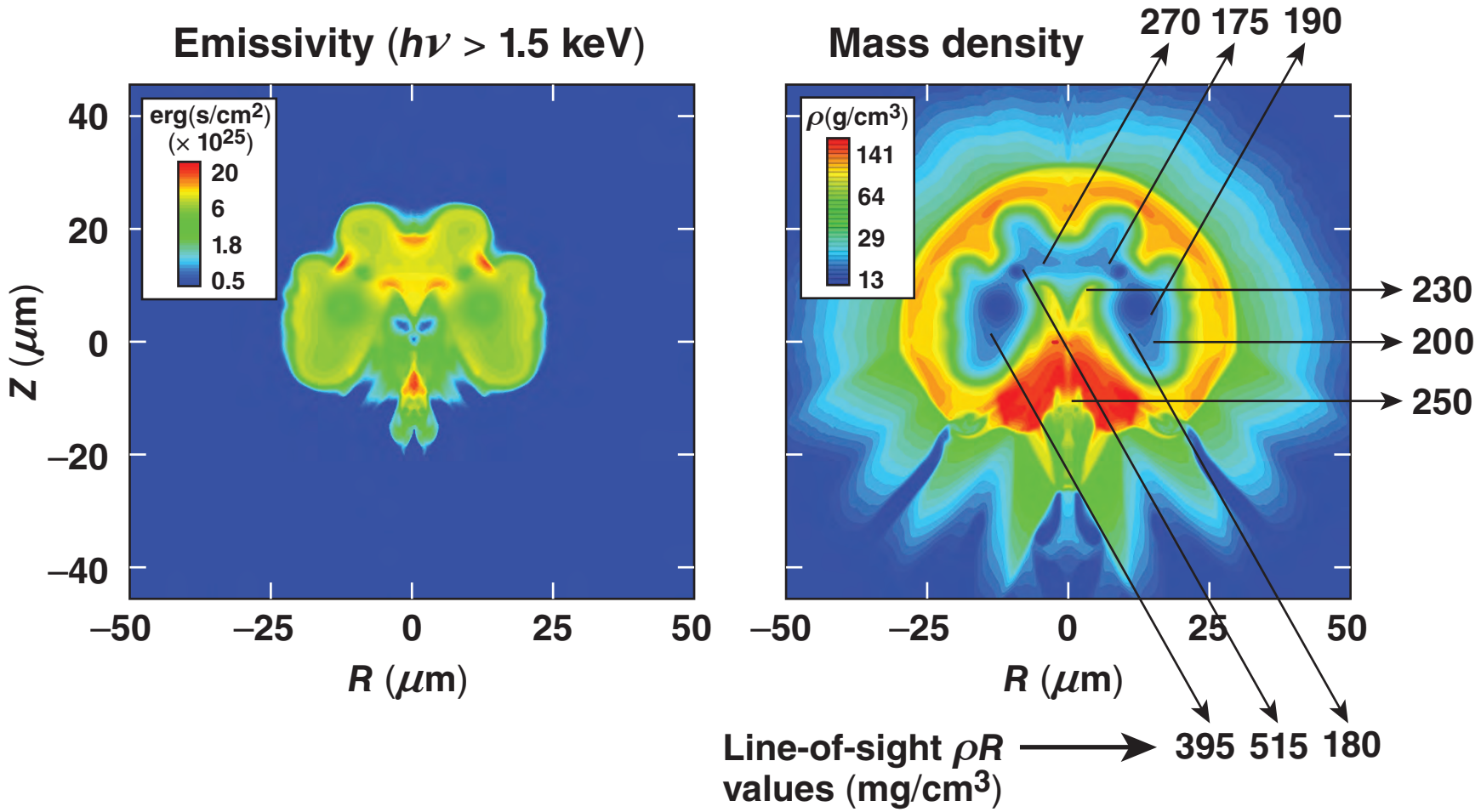
TC7949

*Spect3D: PRISM Computational Sciences, Inc., Madison, WI.

The simulated spectrum of the cryogenic high-ρR implosion is formed by a nonuniform source

UR LLE

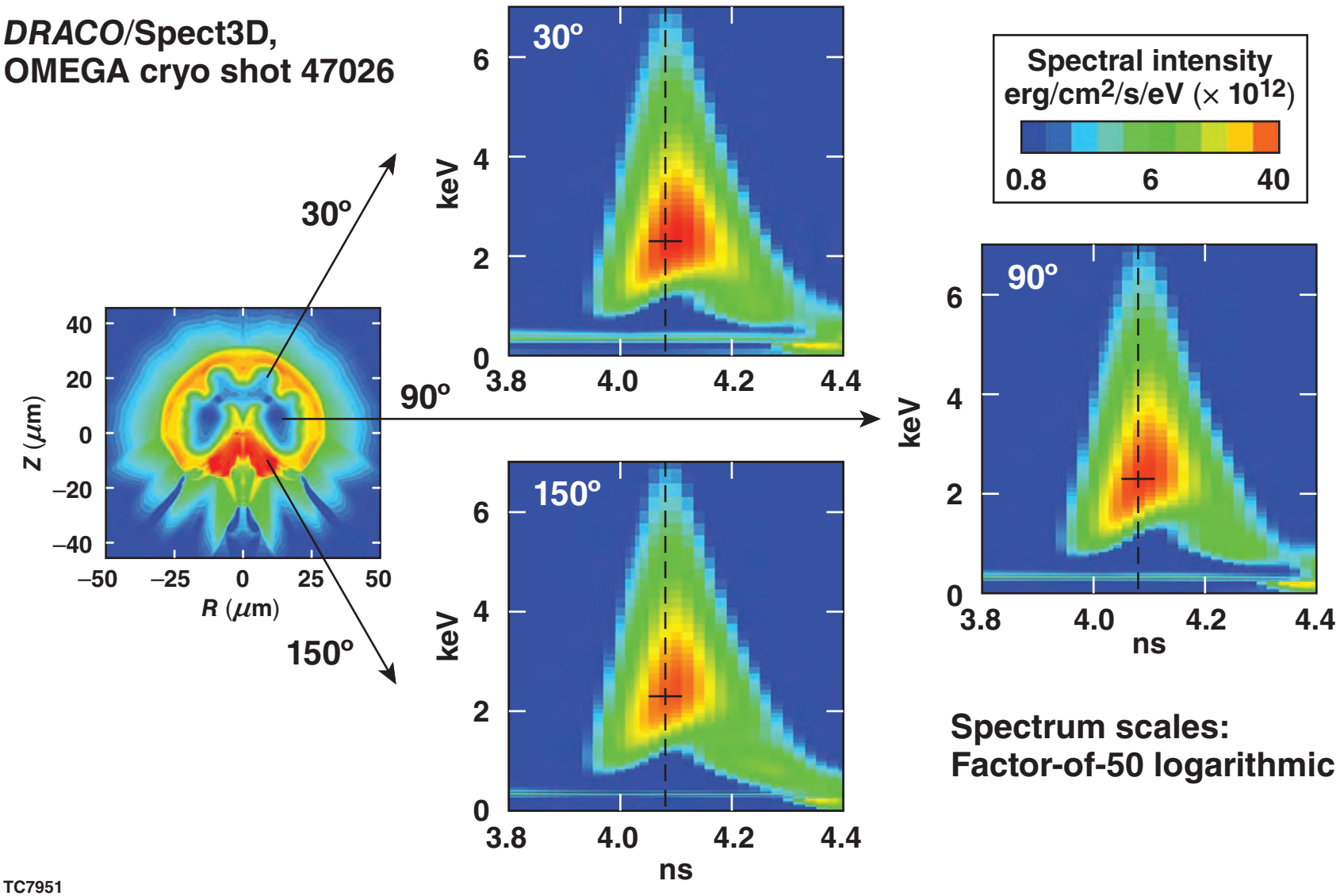
Cryo shot 47206 profiles at peak neutron emission, t = 4.08 ns



TC7950

DRACO/Spect3D time-resolved spectra of high-ρR implosions are very similar from all viewing angles

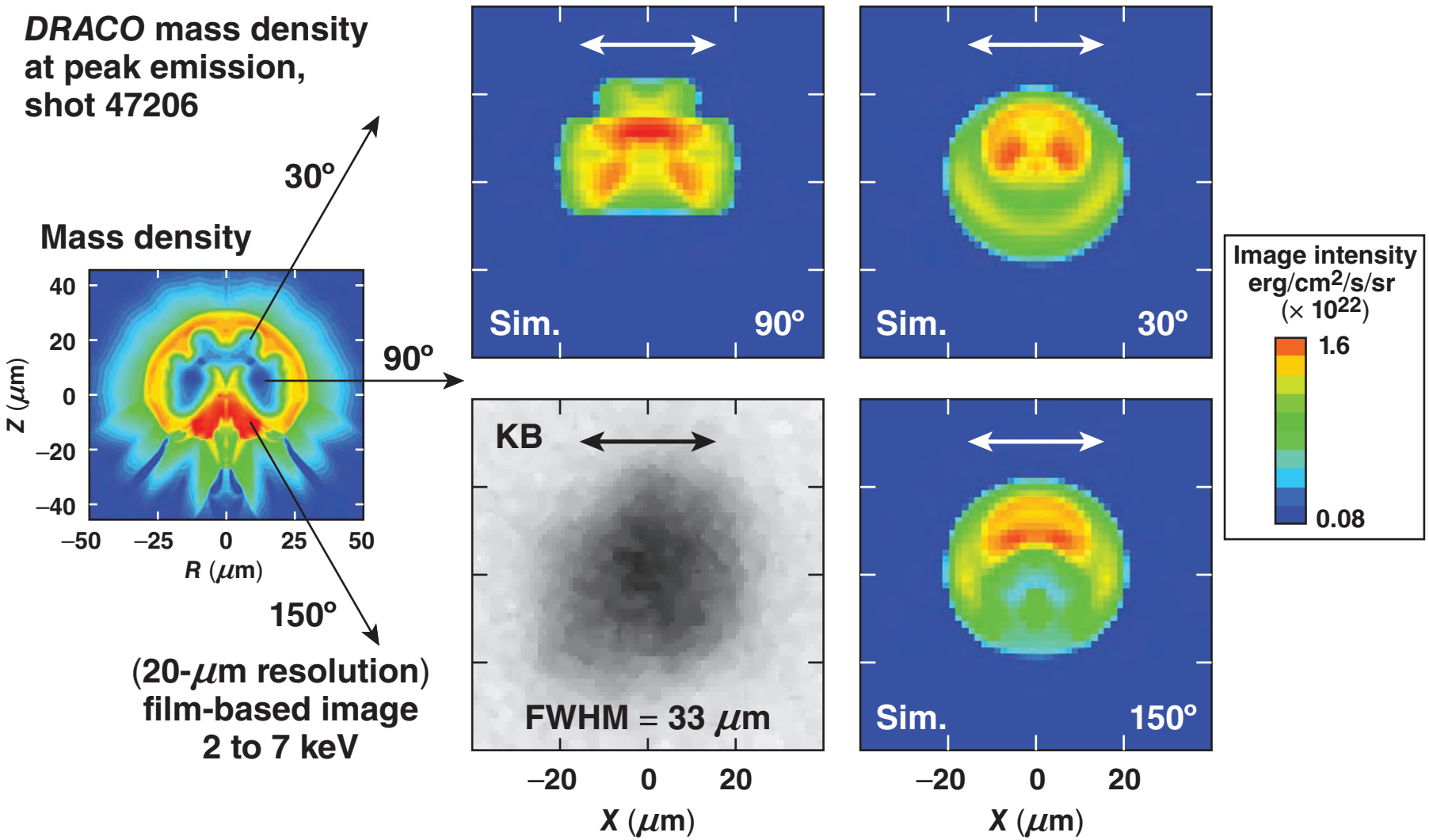
DRACO/Spect3D,
OMEGA cryo shot 47026



Spectrum scales:
Factor-of-50 logarithmic

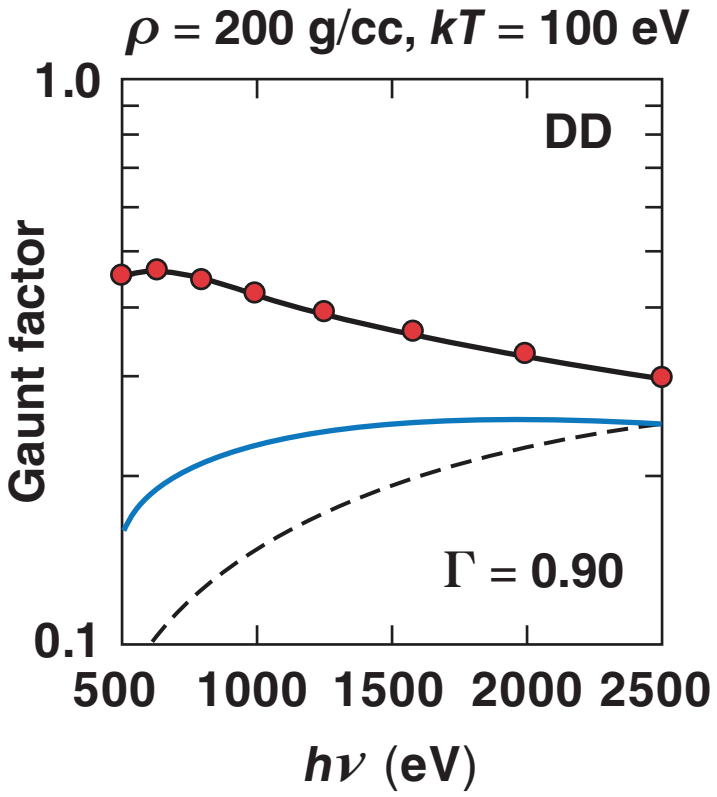
TC7951

DRACO/Spect3D x-ray images of high-ρR cores match the measured size of the of the spectral source



TC7952

The compressed-shell opacity model must include all relevant high-density strong-coupling effects



Opacity models

- Astrophysical Opacity Tables, LANL
- Exact coulomb
- Ion-sphere potential
- Stewart & Pyatt ion-sphere/ Debye–Hückel

- The AOT Gaunt factor is the exact degenerate coulomb Fermi–Dirac result of Nakagawa *et al*.*
- The ion-sphere potential replaces the coulomb potential in strongly coupled plasmas ($\Gamma > 1$).

Strongly coupled ion-sphere opacity reduction is potentially very significant.

TC7953

*M. Nakagawa, Y. Kohyama, and N. Itoh, Ap. J. Suppl. 63, 661 (1987).

Summary/Conclusions

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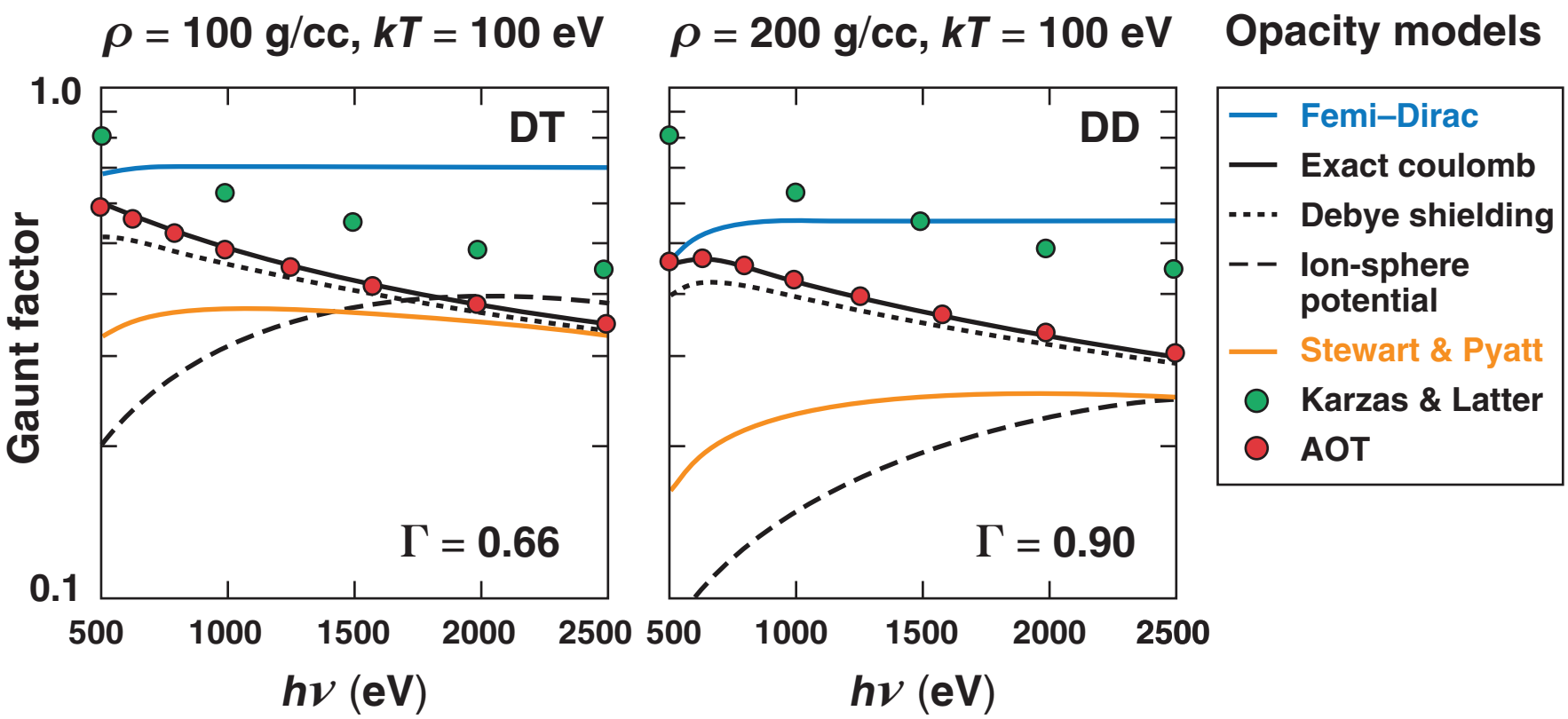


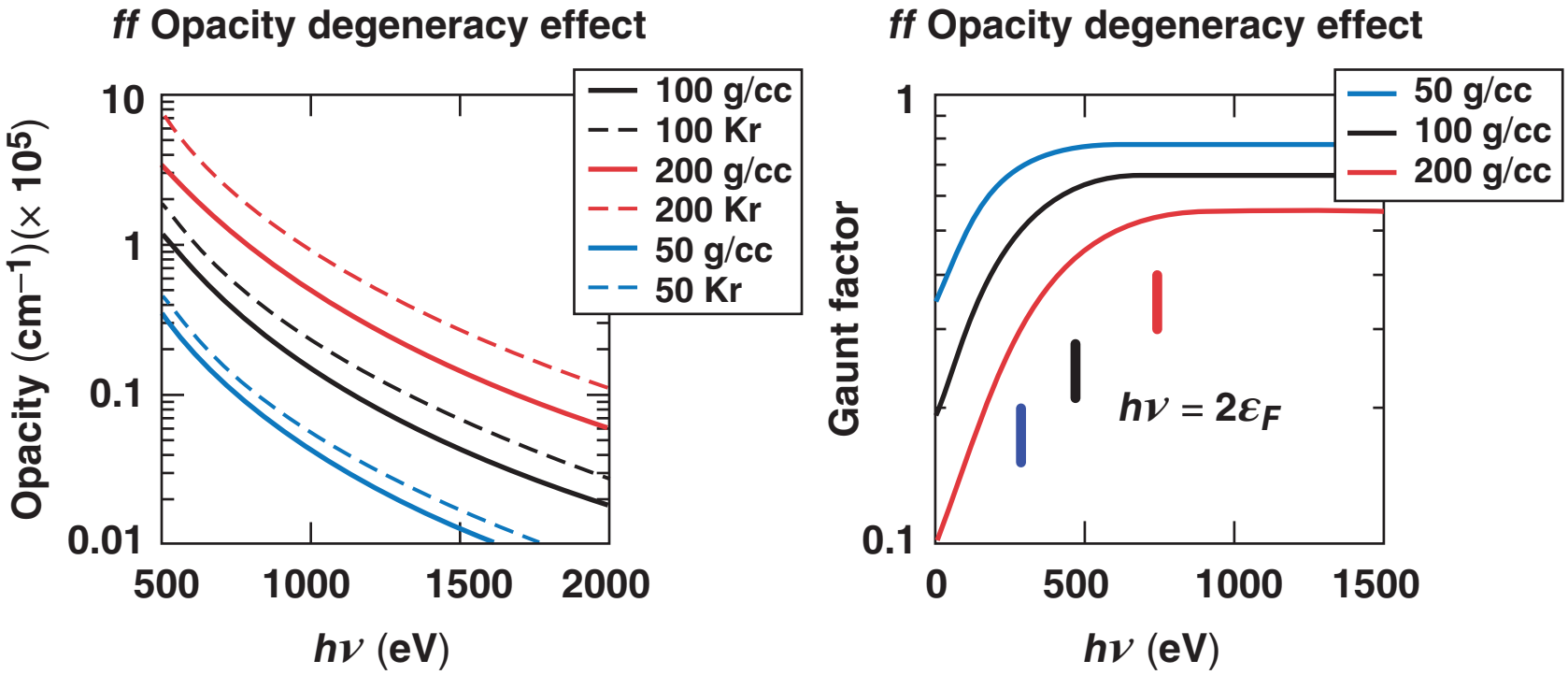
- The AOT Gaunt factor is the degenerate exact coulomb potential, Fermi–Dirac result of Nakagawa *et al*.

Strongly coupled ion-sphere opacity reduction is potentially very significant.

TC7954

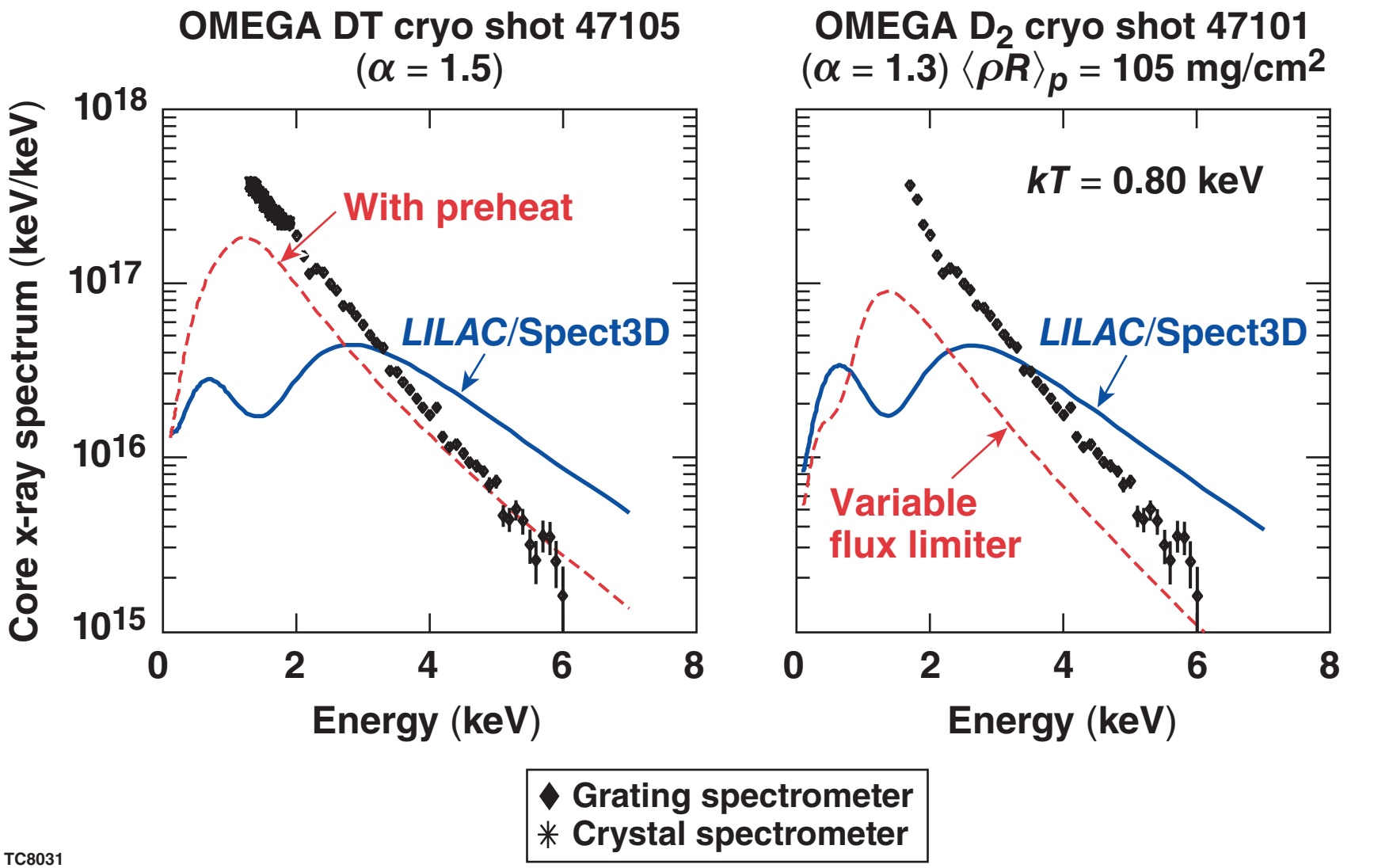
The degeneracy of compressed-shell electrons substantially reduces the free-free opacity

DD kT = 100 eV



- Above $h\nu = 2\varepsilon_F$, only the initial electron states are degenerate.

Simulated spectra similar to the measured spectra are obtained with modified thermal-transport models



TC8031