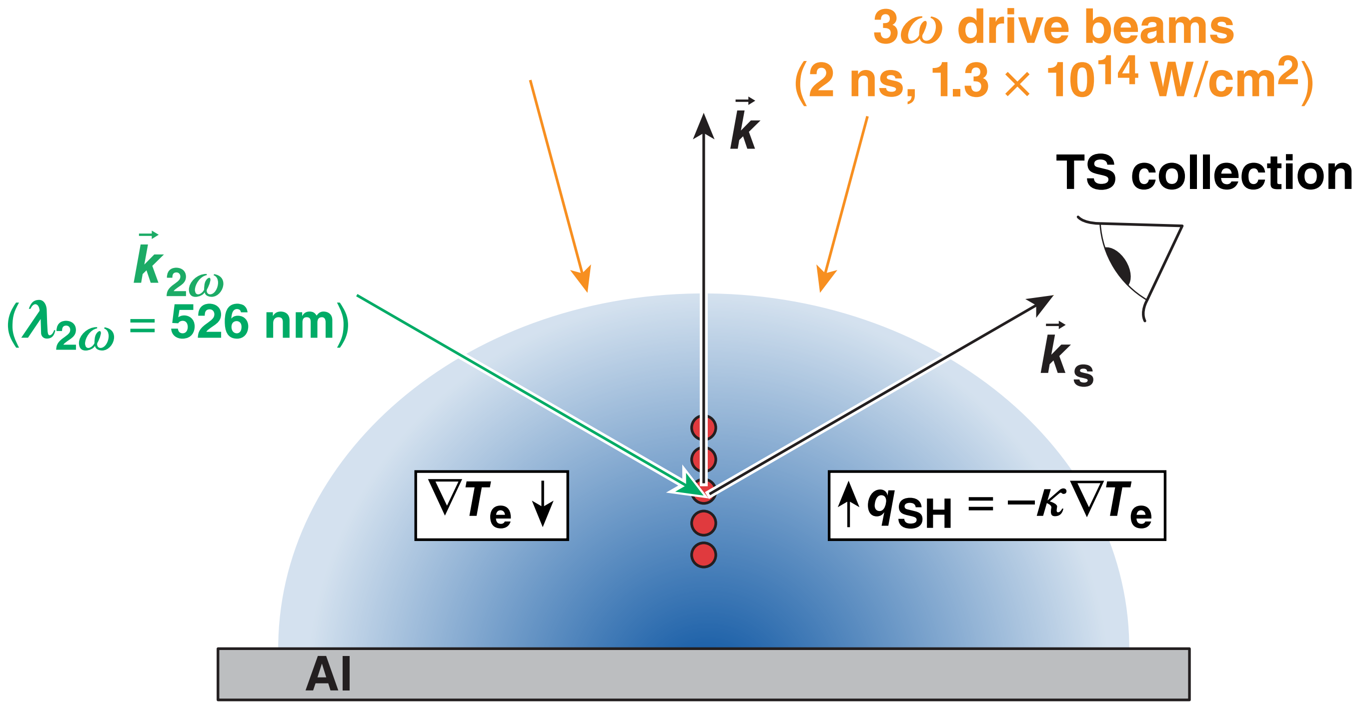
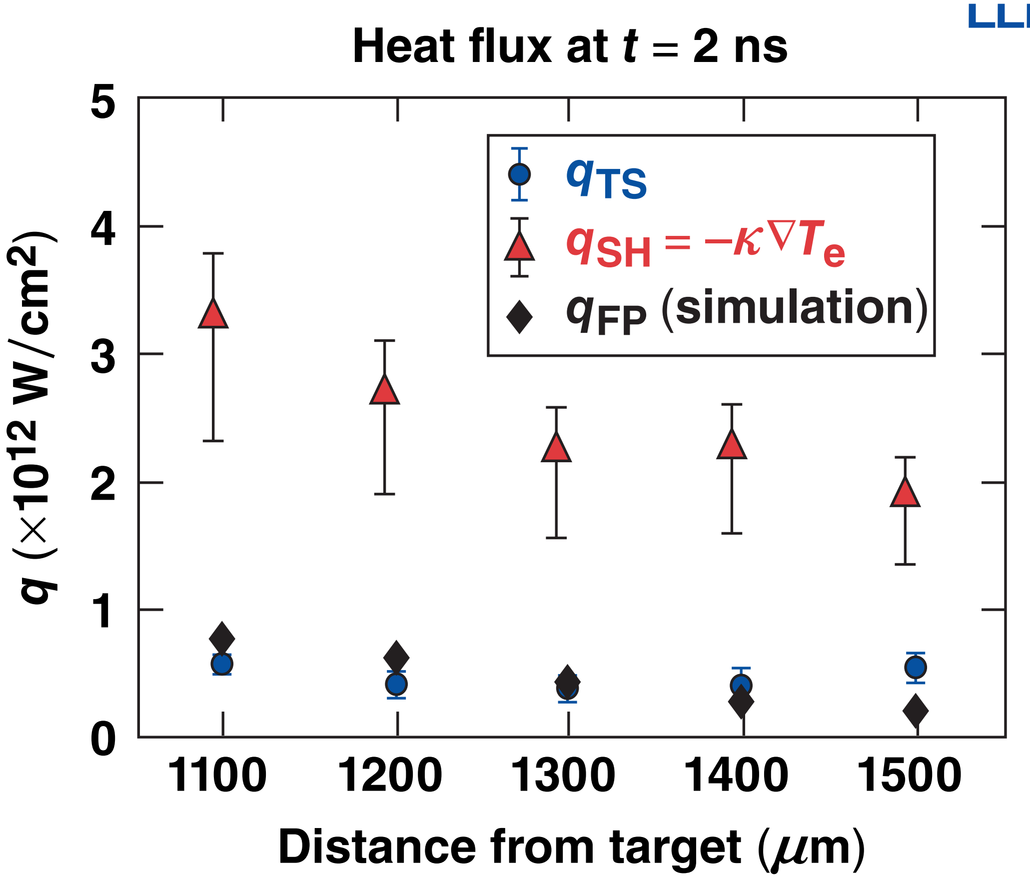
Heat-Flux Measurements in Laser-Produced Plasmas Using Thomson Scattering from Electron Plasma Waves





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Thomson scattering from ion-acoustic waves (IAW’s) and electron plasma waves (EPW’s) were used to measure the heat flux in coronal plasmas

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- Local plasma conditions obtained from Thomson scattering provide an independent measurement of the heat flux using the Spitzer–Härm (SH) thermal-transport model
- Heat-flux measurements indicate the SH model is not valid and nonlocal effects are present
- Fokker–Planck simulations recover values obtained from measuring changes in Thomson-scattering spectra from EPW’s resulting from heat flux

Collaborators

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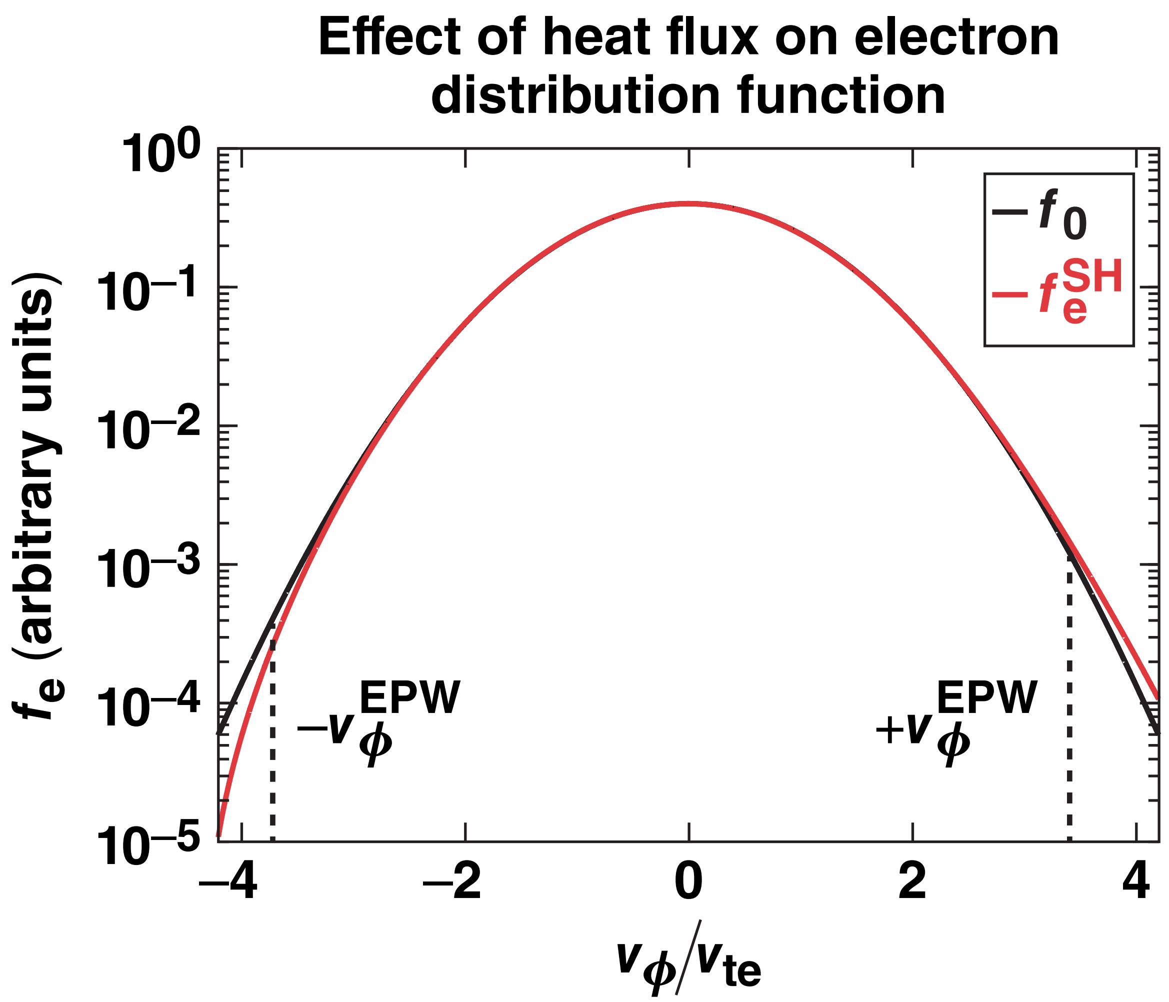
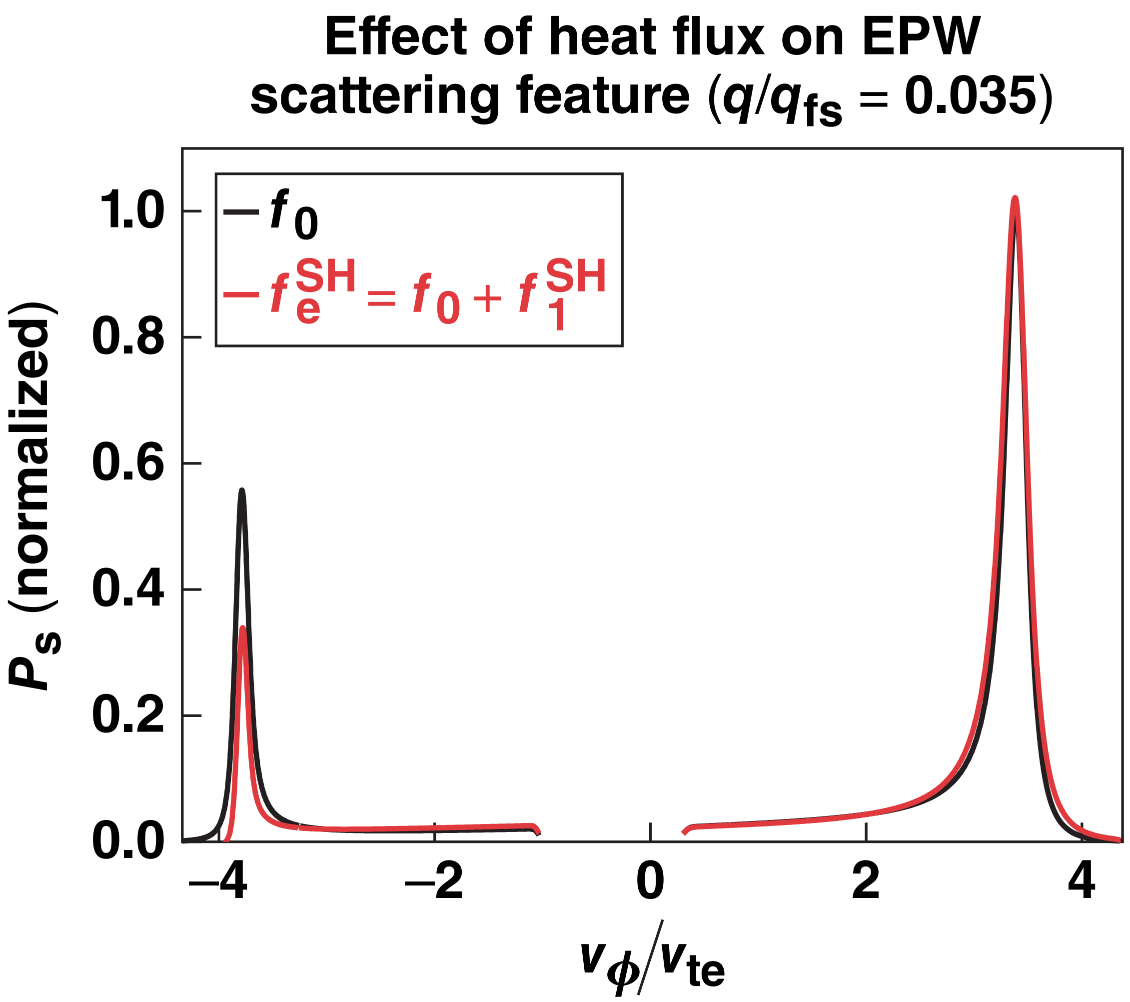
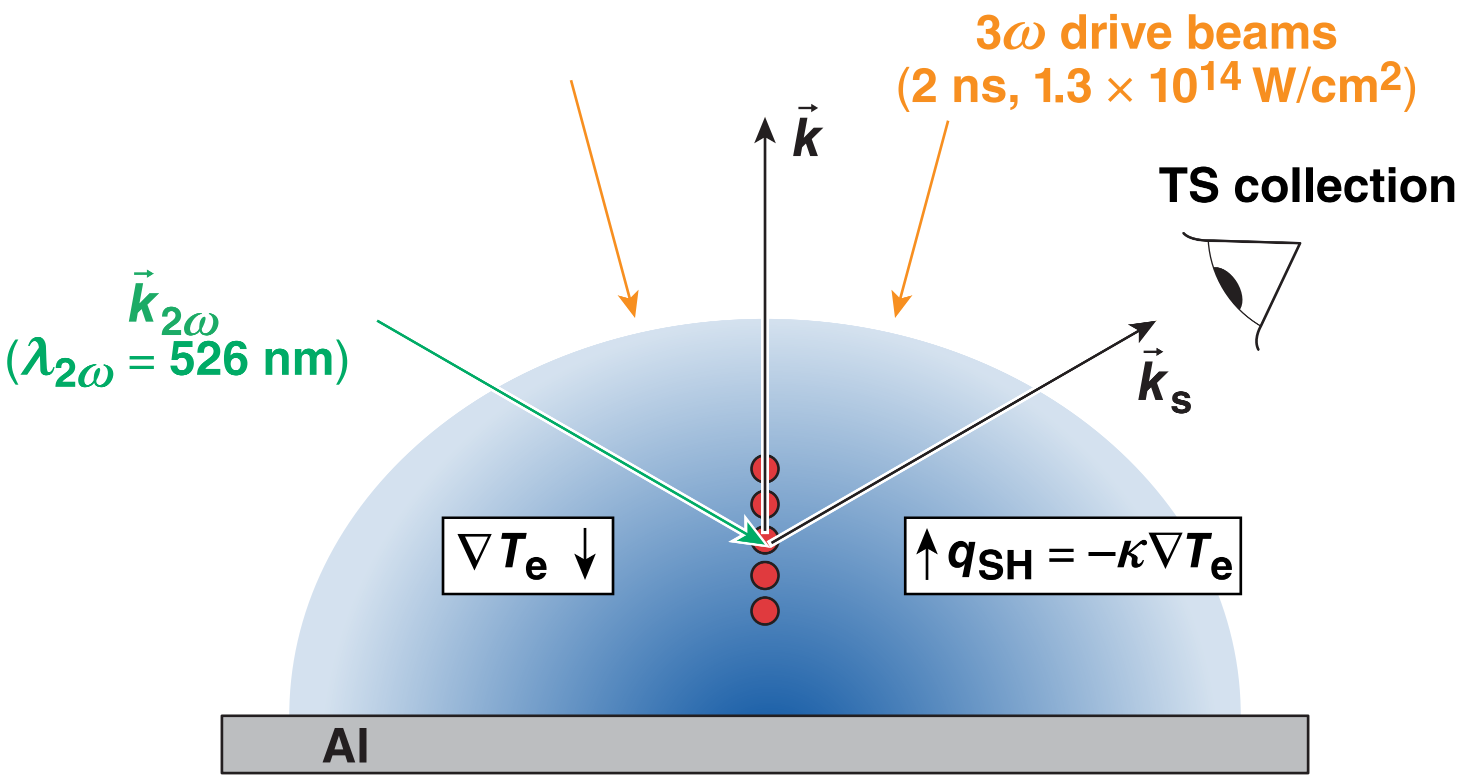
Changes in the electron distribution function caused by heat flux affect the Thomson-scattering spectrum from EPW's





E24230c

Thomson scattering was used to measure the heat flux, electron temperature, and electron density in coronal plasmas

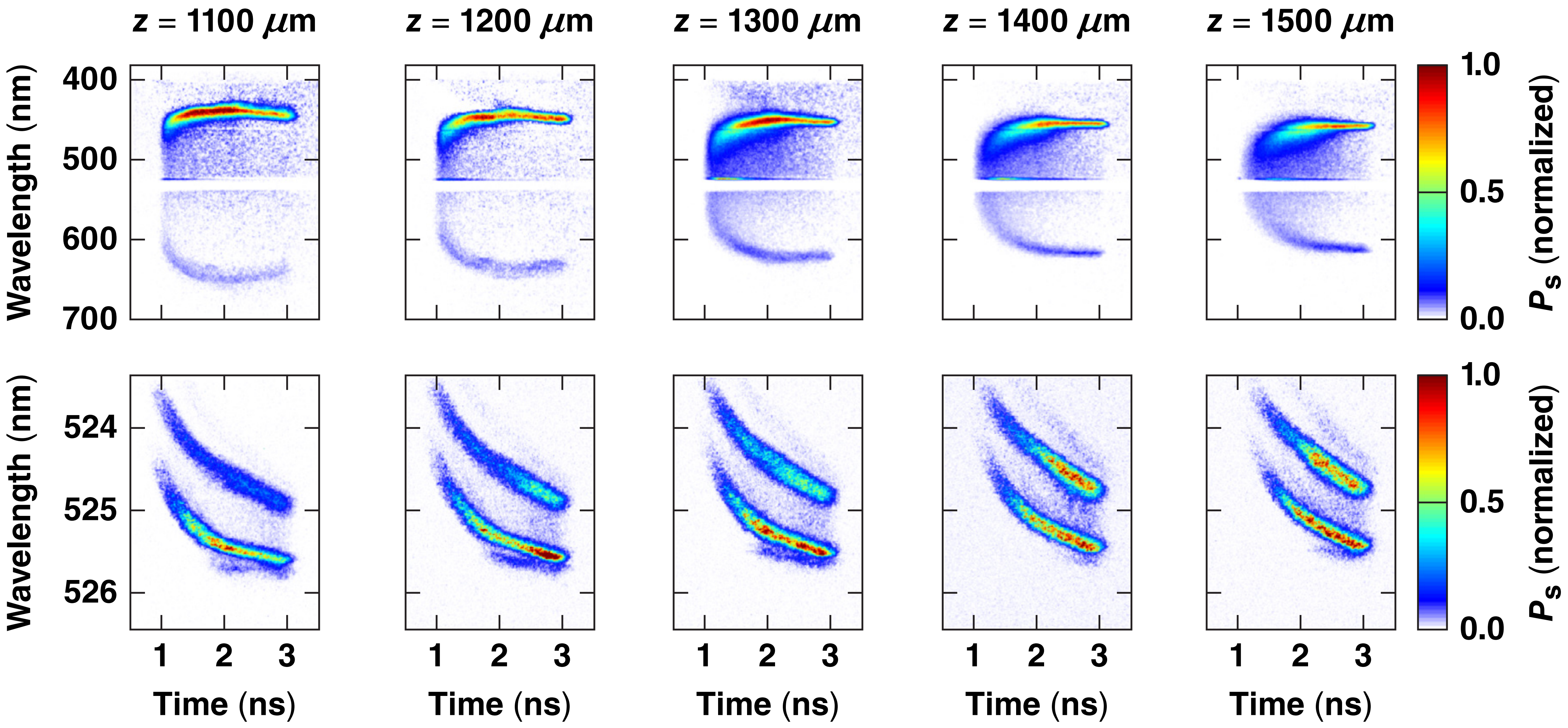


- Thomson scattering (TS) provides local measurements of T_e, n_e, and q in a 50 × 50 × 50-μm^3 volume
- Probing five different locations provides values for ∇T_e
- q_{SH} was determined by measuring T_e, n_e, and ∇T_e

Thomson scattering provides two separate measurements of heat flux by probing plasma waves along the direction of the temperature gradient.

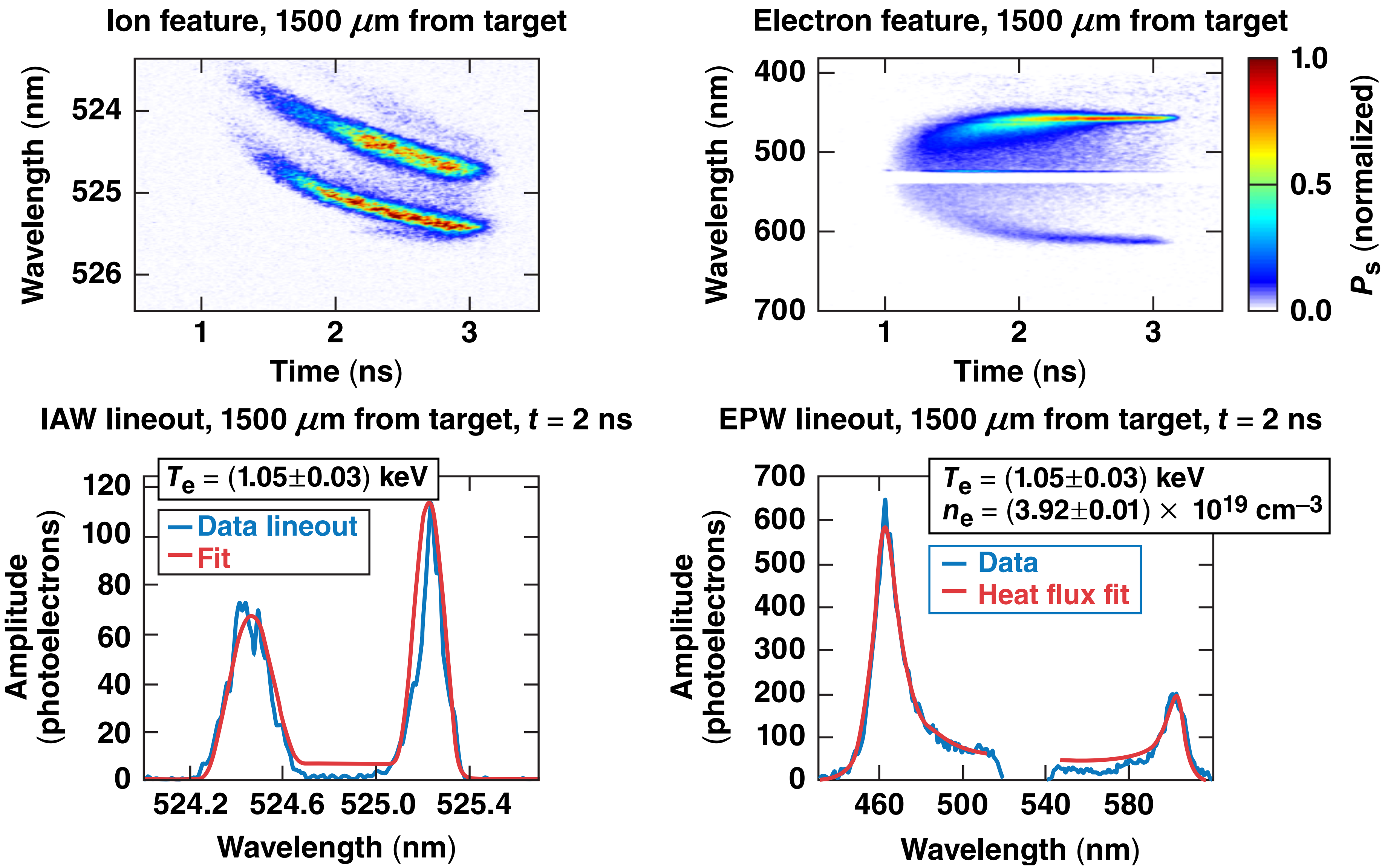
E24097c

Thomson-scattering spectra obtained at five locations in the corona were used to measure the heat flux



E24098b

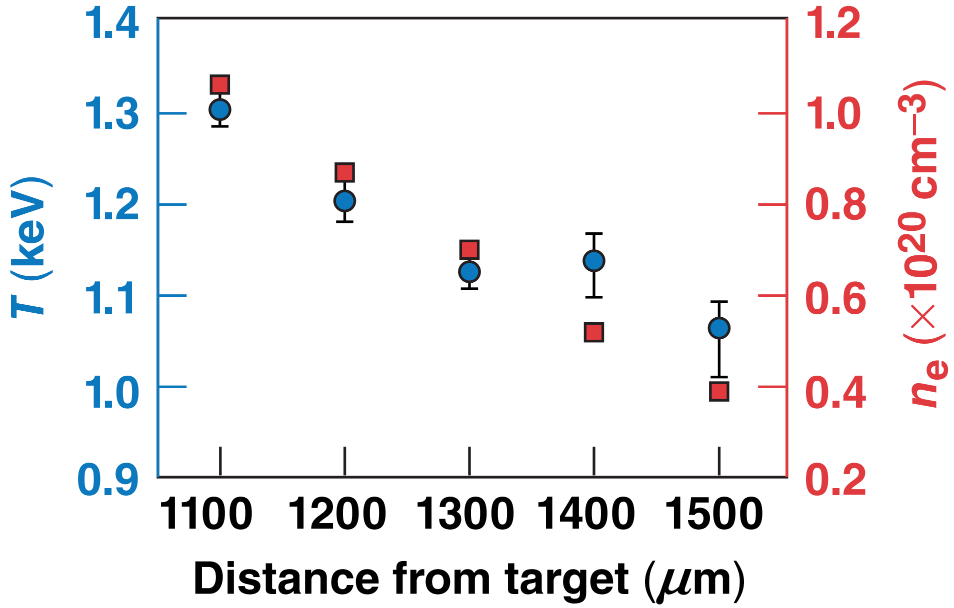
The scattering spectra are fit to determine the electron temperature and density



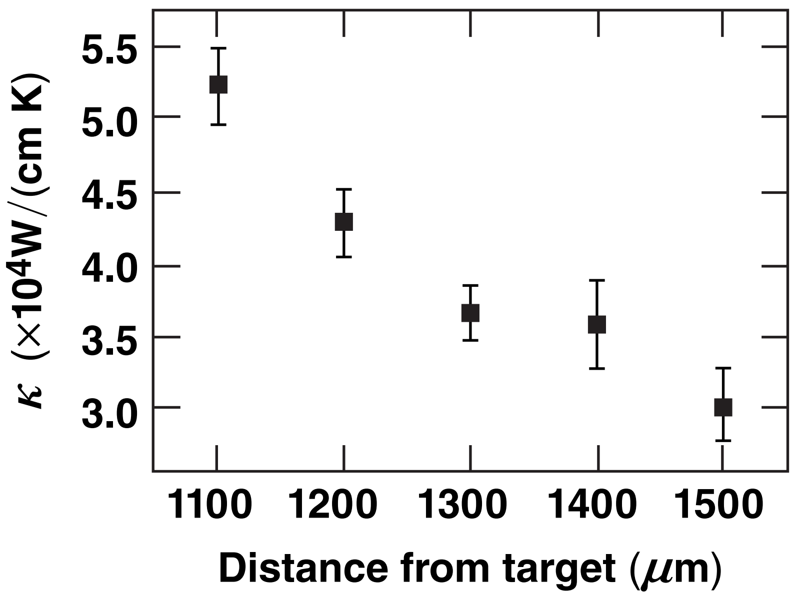
E26700

The electron temperature and density measurements are used to infer the heat flux

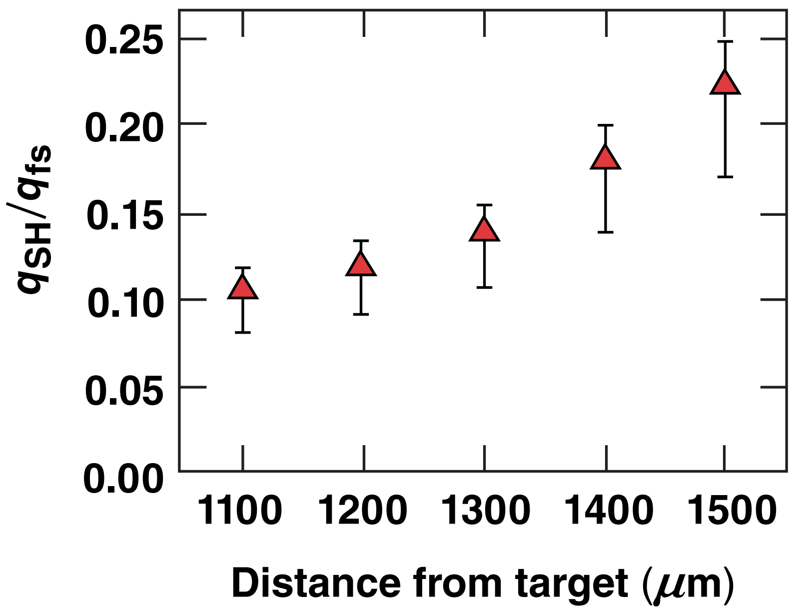
Electron temperature and density profiles at t = 2 ns



Heat conductivity at t = 2 ns

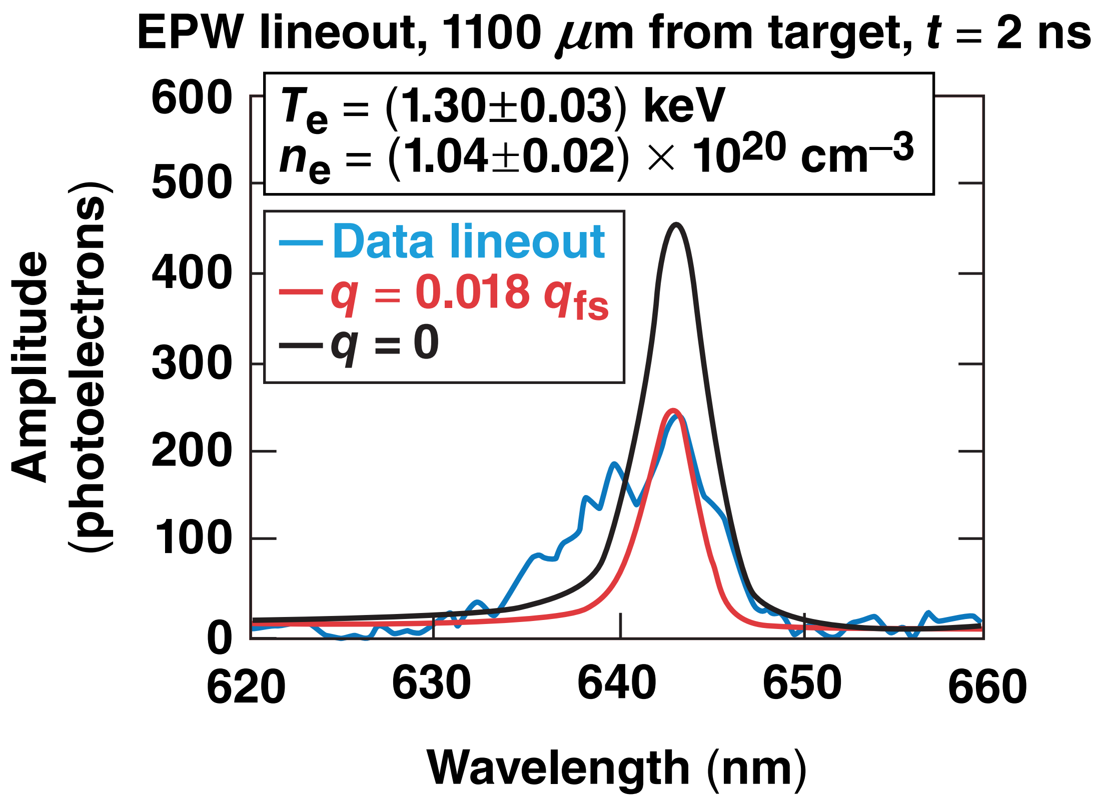


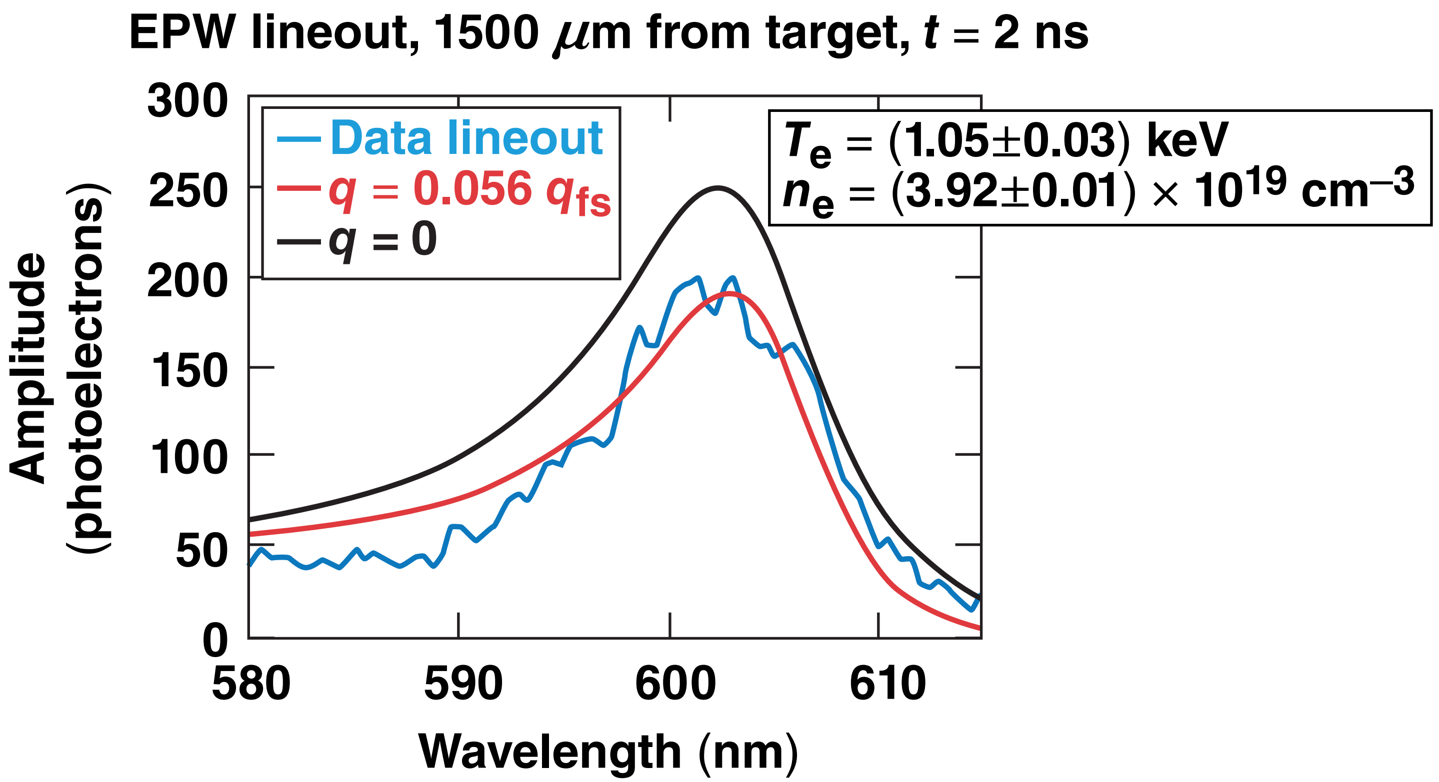
Heat flux at t = 2 ns



E26701

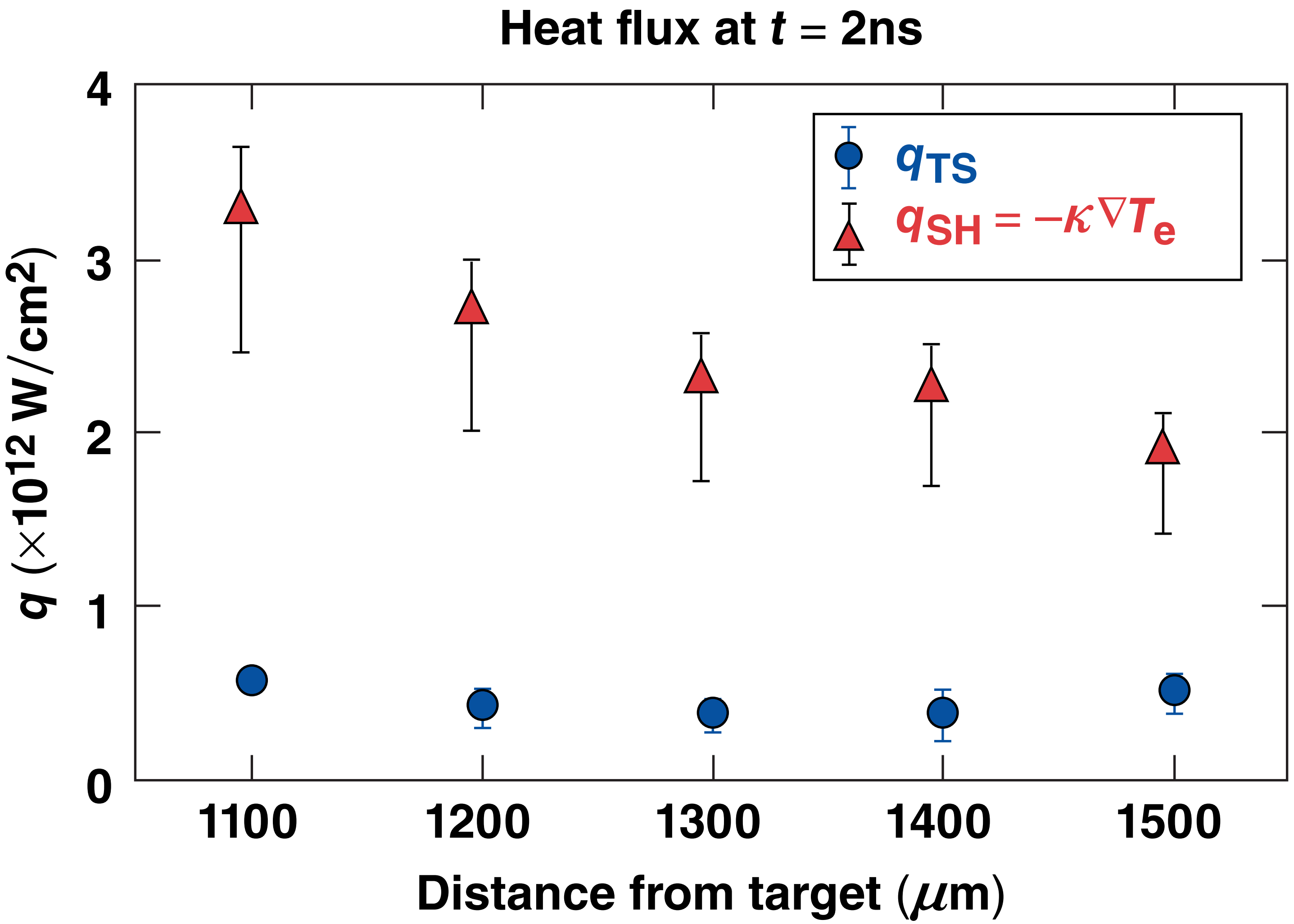
The relative amplitudes of the EPW scattering features were used to measure heat flux





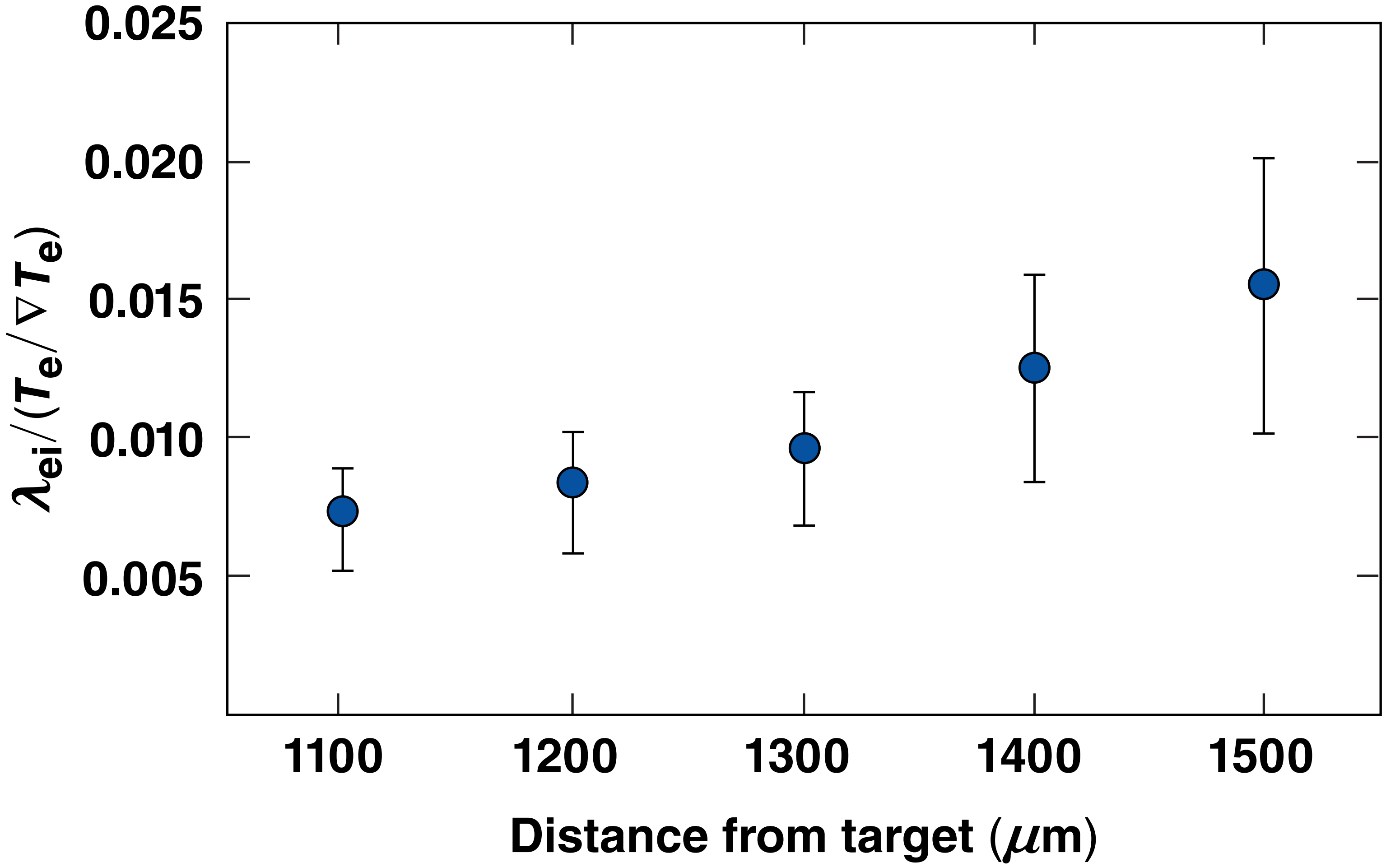
E26702

The two methods of measuring heat flux are not consistent



Measurements of the mean free path and temperature scale suggest that classic thermal transport (SH) is not valid

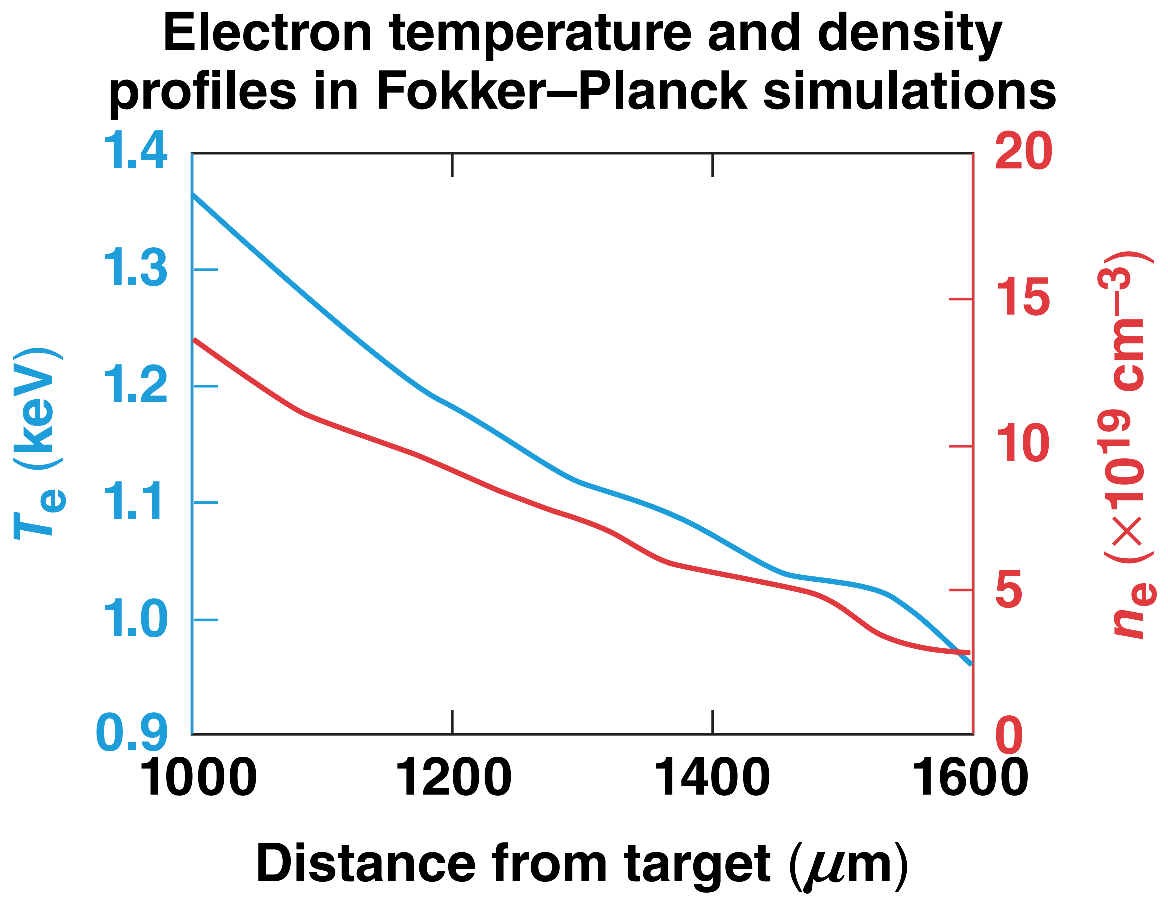
Ratio of mean free path to temperature scale length at t = 2 ns

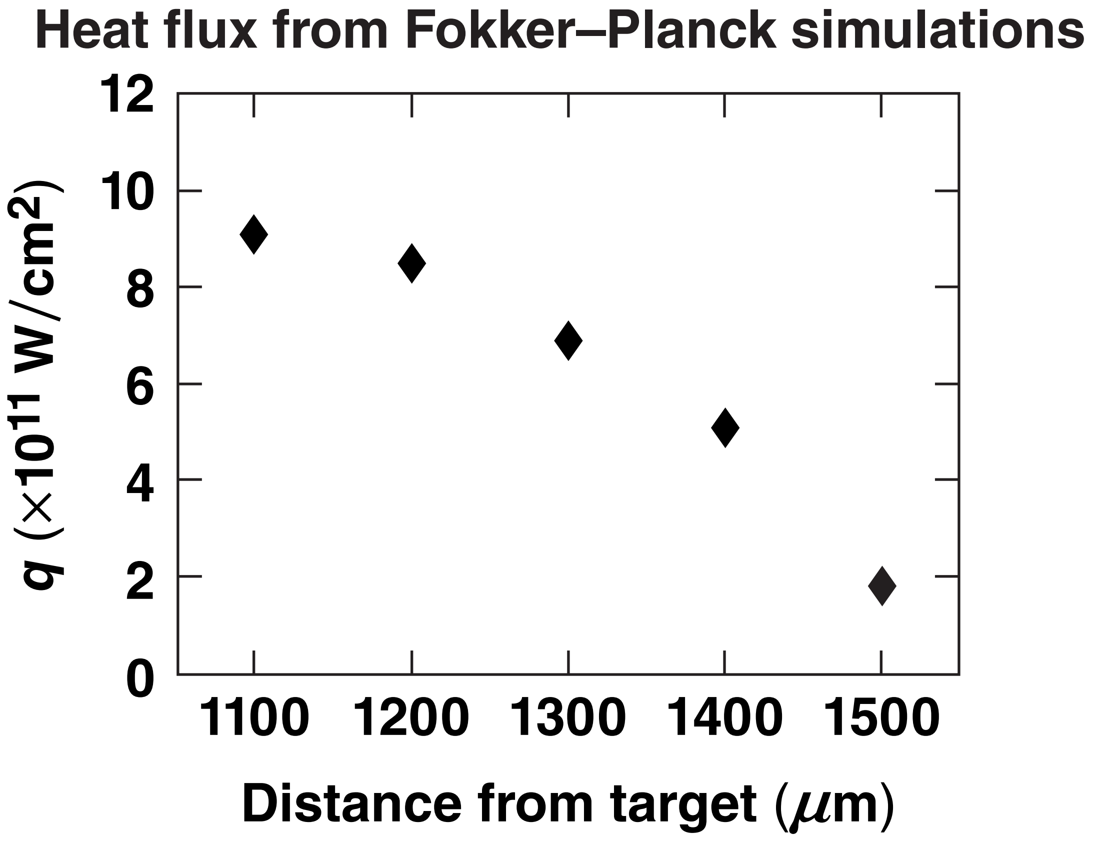


The SH model breaks down at $v_\phi = 4v_{T_e}$ when $\lambda_{ei}/L_T = 0.004$.

E26704

Heat-flux values from Fokker–Planck simulations* are obtained using measured plasma profiles



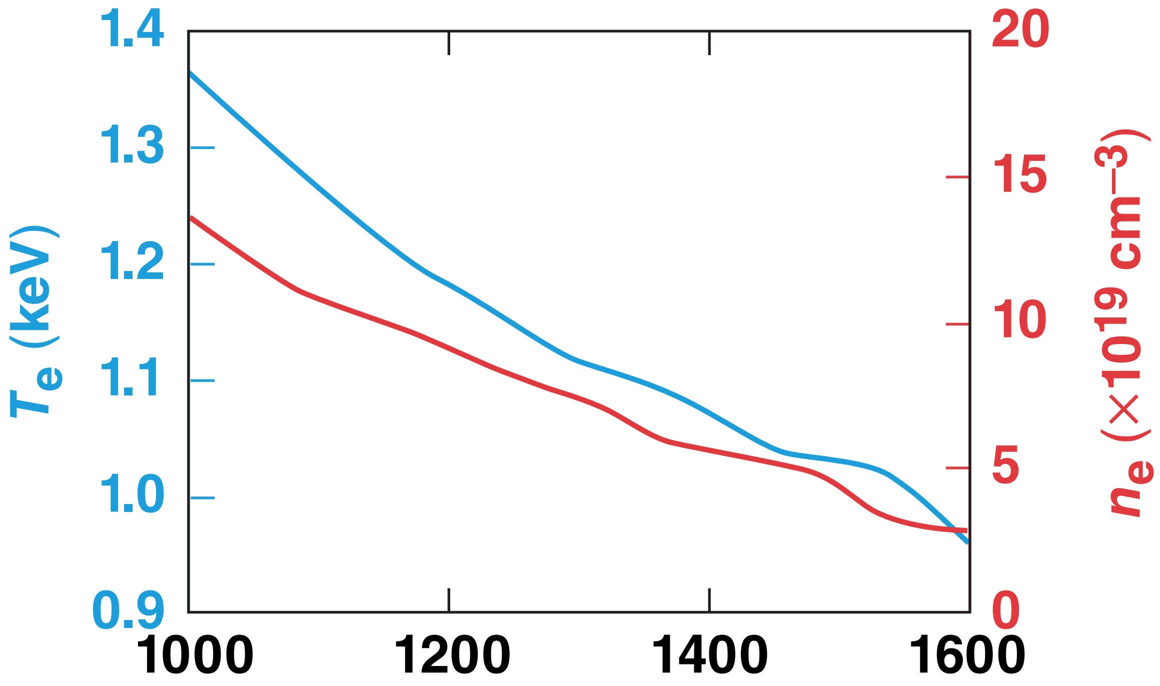


*M. Sherlock, J. P. Brodrick, and C. P. Ridgers, Phys. Plasmas 24, 082706 (2017).

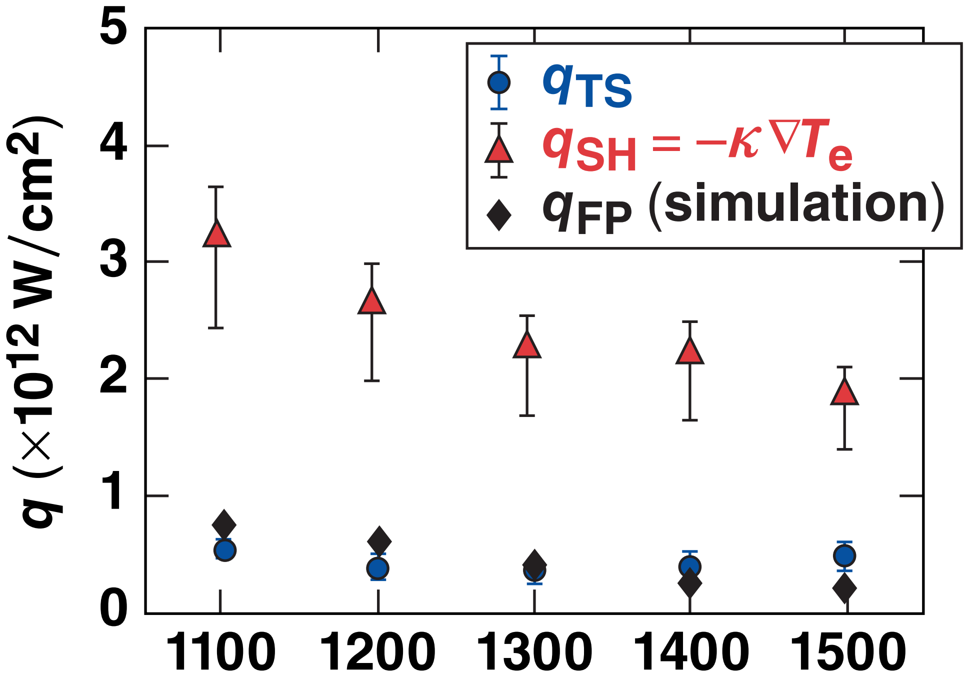
E26705

Heat-flux values from Fokker–Planck simulations* are obtained using measured plasma profiles (continued)

Electron temperature and density profiles in Fokker–Planck simulations



Heat flux at t = 2 ns



Heat-flux values from Fokker–Planck simulations agree with measured values from non-Maxwellian electron distribution functions

*M. Sherlock, J. P. Brodrick, and C. P. Ridgers, Phys. Plasmas 24, 082706 (2017).

E26823

Thomson scattering from ion-acoustic waves (IAW's) and electron plasma waves (EPW's) were used to measure the heat flux in coronal plasmas

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