Sherlock *et al.* Reply: Kemp and Sentoku [1] have observed heating in solid targets due to the presence of plasma waves induced by fast electrons, in agreement with our own work [2] and the subsequent 2D simulations of Héron and Adam [3], who find anomalous heating associated with plasma waves much deeper inside the target.

The Comment claims to have used identical simulation parameters (10^4 particles per cell) in calculating the temperature, but we used 400 particles per cell, as stated in the Letter. Therefore, a genuine, detailed comparison of simulation results may be difficult.

(1) The Comment points out that increasing the fast electron current in the Spitzer formula leads to agreement between the Spitzer and particle-in-cell models for a 90 fs pulse and $x \gtrsim 9\ \mu$m. We have experimented with many reasonable energy cutoffs used to define j_f, including $5v_{\mathrm{th}}$ ($\approx$4 keV). While they do exhibit differences, we find that heating associated with plasma waves eventually becomes important in each case, at significant depths. For example, the use of $5v_{\mathrm{th}}$ fails at early times, then enters a period of agreement with Spitzer ($t \approx 90$ fs), then later fails again. Kemp and Sentoku's result is shown only during the period of agreement and therefore does not provide a verification of Spitzer. We have found similar problems with all cutoffs used. The ambiguity in defining j_f when the background and fast distributions are not distinct can be remedied by artificially preventing electrons in the energy range 5–300 keV from entering the bulk of the target, so that the background and fast distributions are clearly separated. In such simulations, plasma-wave associated heating is still present throughout the target, demonstrating that the observed departure from Spitzer is not simply an artifact of an incorrect choice of cutoff. The energy range 4–30 keV is difficult to analyze, as plasma waves strongly distort the distribution function in this range. Considering the fact that 30 keV electrons do not travel fast enough to reach $x = 9\ \mu$m in 90 fs, their inclusion in a strict comparison to Spitzer is questionable since their presence is linked to the excitation of plasma waves. Most of the electrons below $\sim$10 keV are excited from the background, and that is the reason we also used a 10 keV cutoff, as mentioned in the Letter. Furthermore, we observe non-Spitzer transport even at times when the heating rate appears to match the Spitzer rate, indicating that it may not be correct to use any cutoff—no matter how well it behaves—as a means of verifying Spitzer heating.

(2) The modest drop in the electric field shown in Fig. 4 of Ref. [2] was not mentioned in the text because it is apparent in the figure. The drop (across this spatial range) becomes a rise if one chooses to plot the field at slightly different times. We have no doubt that plasma-wave associated heating drops with distance into the target, in common with all other known heating mechanisms (due to spatial dispersion). Héron and Adam [3] have shown in large scale 2D simulations with more realistic pulse lengths that the strength of plasma waves deep in the target increases with time, and that there is a significant level of plasma-wave excitation wherever there are energetic particles. Schmitz *et al.* [4] have also observed bunches throughout the target in 2D simulations.

Kemp and Sentoku appear to regard the mechanism as a resonance process and infer that the bunch width needs to be shorter than the plasma wavelength. However, in common with many other Langmuir wave excitation mechanisms, the process of excitation by relativistic electrons need not be resonant, and therefore waves can be excited by bunches longer than the skin depth.

Regarding the Comment's main objection, that plasma-wave associated heating is a surface effect: the term "surface" is traditionally associated with the critical surface, a thin region of thickness on the order of the skin depth ($\approx$0.05 μm), where $\mathbf{j} \times \mathbf{B}$ heating occurs. Heating to a depth of "a few microns" must be considered volumetric if the target itself is only a few microns thick. The size of the heated region depends on the laser pulse length, intensity, spot size, and target parameters. We do not agree with general conclusions about the size of the heated region based on the examination of (very low energy) 90 fs pulses in infinite targets.

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