Gibbon and Bell Reply: In their Comment,[1] Esarey and Ting present an interesting real-space picture of the phenomenon of laser beam focusing in the presence of a beat wave. Their results appear to be in agreement with the essential points of our analytical and numerical analysis of "cascade focusing" given in the Letter.[2]

A further physical interpretation of this phenomenon can be found in Ref. 3, which we outline briefly here. The electromagnetic waves can be represented by two laser pumps $(\omega_0,\mathbf{k}_0)$ and $(\omega_1,\mathbf{k}_1)$ and their sidebands generated by interaction with a plasma wave $(\omega_p,\mathbf{k}_p)$. The finite beamwidth manifests itself as an angular spread in wave number about the direction of beam propagation. If the rms angular spread of each of the pumps is θ_0, then by averaging over all cascade interactions, it can be shown that the rms spreads θ_{-1} and θ_2 of the modes at $\omega_{-1}=\omega_0-\omega_p$ and $\omega_2=\omega_1+\omega_p$ are given by $\theta_{-1}^2=\theta_0^2+2(\omega_p/\omega_0)\Delta$, and $\theta_2^2=\theta_0^2-2(\omega_p/\omega_1)\Delta$, respectively, where Δ is the total frequency shift (including relativistic and linear detuning) of the plasma wave relative to the pumps. If the upper cascade mode defocuses, the lower mode focuses, and vice versa. However, the total mean angular spread of both modes is

$$\theta_{-1}^2+\theta_2^2\simeq 2\theta_0^2+2(\omega_{p0}/\omega_0)^2\Delta,$$

which implies a net focusing or defocusing depending on the frequency mismatch.

The contrasting behavior of upper and lower sidebands appears to be consistent with the "beamlets" picture in the Comment. In summary, there seems to be a number of different ways of looking at cascade focusing: (a) the moment analysis given in Ref. 2, (b) the real-space picture given by Esarey and Ting, and (c) the Fourier-space description in Ref. 3.

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[2]P. Gibbon and A. R. Bell, Phys. Rev. Lett. **61**, 1599 (1988).
[3]P. Gibbon, Phys. Fluids B (to be published).