Pulses in `meep`

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Gaussian sources in `meep` are defined according to the discrete-time derivative of a Gaussian[1]

$$f(t) = -\frac{1}{\mathrm{i}\omega}\frac{\partial}{\partial t}\exp\left(-\mathrm{i}\omega t - \frac{(t-t_0)^2}{2\delta t^2}\right) \tag{1}$$

Or, explicitly

$$f(t) = \exp\left(-\mathrm{i}\omega t - \frac{(t-t_0)^2}{2\delta t^2}\right)\left(1 + \frac{(t-t_0)}{\mathrm{i}\omega\delta t^2}\right) \tag{2}$$

Note that the time derivative is a sum of two exponentials, the second being proportional to $1/\delta t^2$. The temporal width parameter δt is proportional to the inverse of the width in frequency space. This suggests that the actual difference between Equation 1 and a "true" Gaussian of the form

$$f(t) = \exp\left(-\mathrm{i}\omega t - \frac{(t-t_0)^2}{2\delta t^2}\right) \tag{3}$$

is negligible. I will assume the form of Equation 3 for all practical purposes.

The output from `display-fluxes` shows that for a `gaussian-src`, given a center frequency f and `fwidth` parameter δf, the resulting Gaussian is centered on f and has *bounds* $f \pm \delta f/2$. This means the actual FWHM (or most likely 1/e) width of the pulse is only controllable indirectly through manipulating the bounds.

Figure 1 shows several pulses at different frequencies with the same `fwidth` parameter of 0.3. Note that the center frequency is slightly offset from what would be expected. For computing transmission and reflection spectra, this difference should not pose any problems, as these coefficients are all relative to the incident radiation.

[1] `http://ab-initio.mit.edu/wiki/index.php/Meep_Reference`

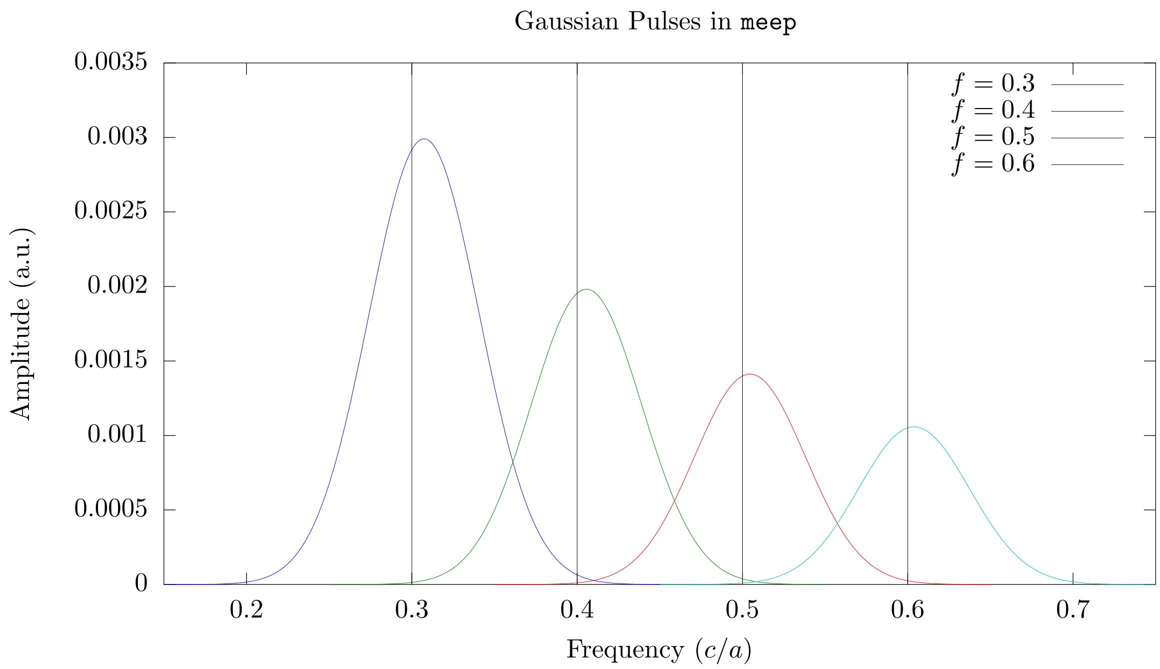

Figure 1: Gaussian pulses as produced by `meep` for different frequencies. All pulses had a relative width δt of 0.3. Note that the Gaussian centers are slightly offset, an artifact of the time derivative implementation.