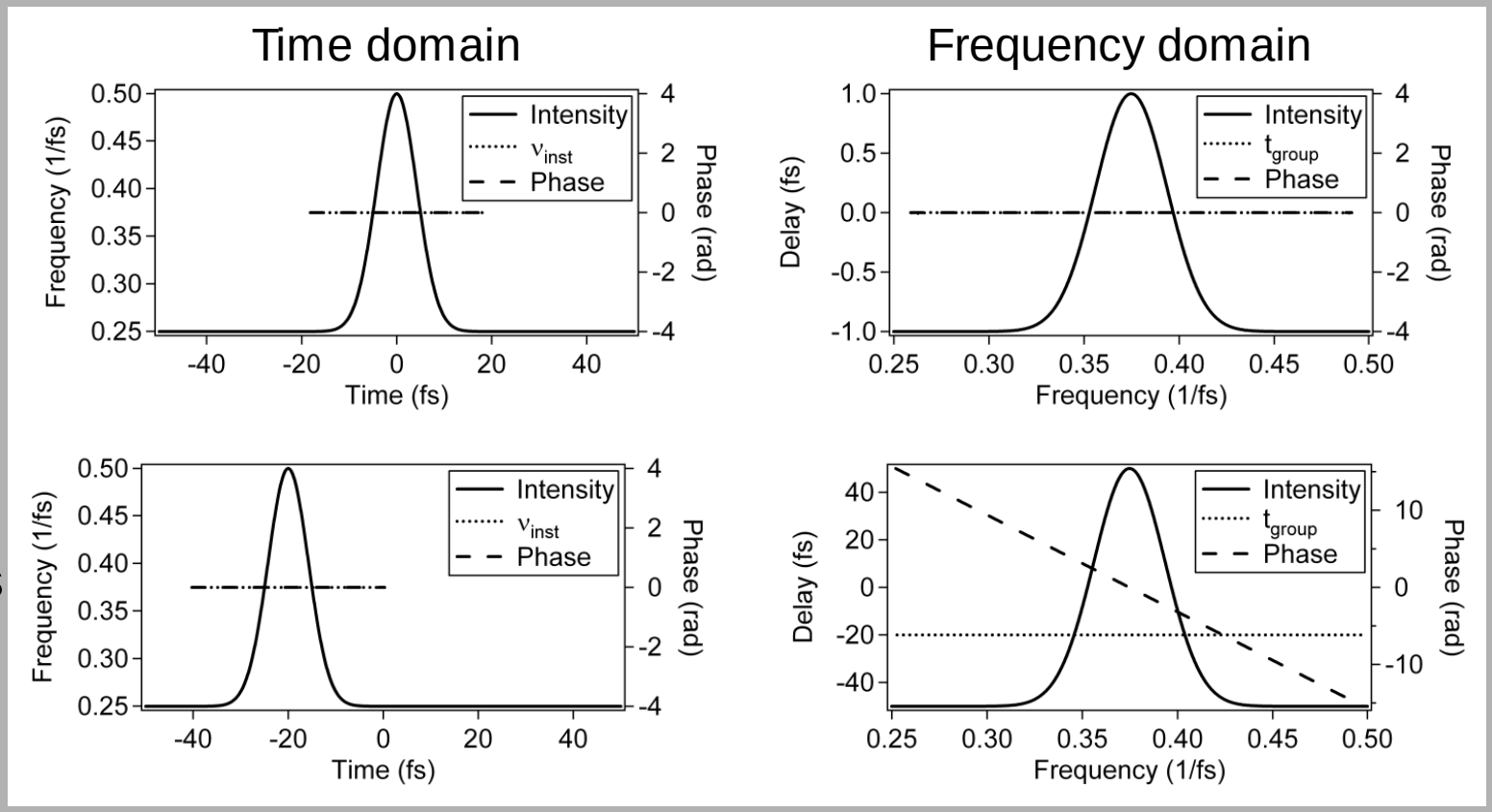
First-order phase in frequency: a shift in time

By the Fourier-transform Shift Theorem, $f(t-\varphi_1) \supset F(\omega)\exp(-i\omega\varphi_1)$

$\varphi_1 = 0$

$\varphi_1 = -20$ fs



Note that φ_1 does not affect the instantaneous frequency (except to delay or advance it), but the group delay = φ_1.

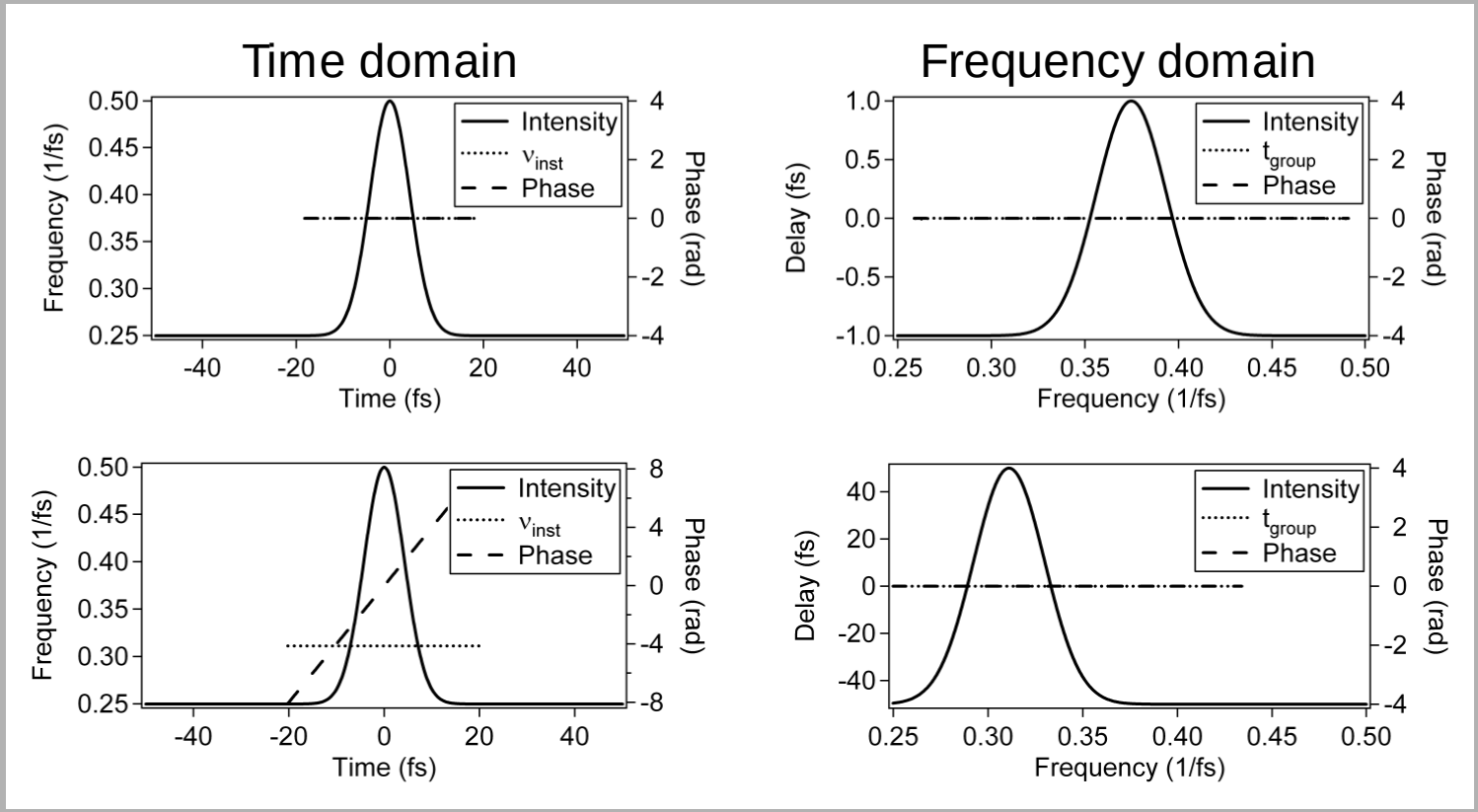
First-order phase in time: a frequency shift

By the Inverse-Fourier-transform Shift Theorem:

$$F(\omega+\phi_1) \subset f(t)\exp(-i\phi_1 t)$$

$\phi_1 = 0/\text{fs}$

$\phi_1 = -.07/\text{fs}$



Note that ϕ_1 does not affect the group delay (except to shift it in frequency), but it does affect the instantaneous frequency = $-\phi_1$.