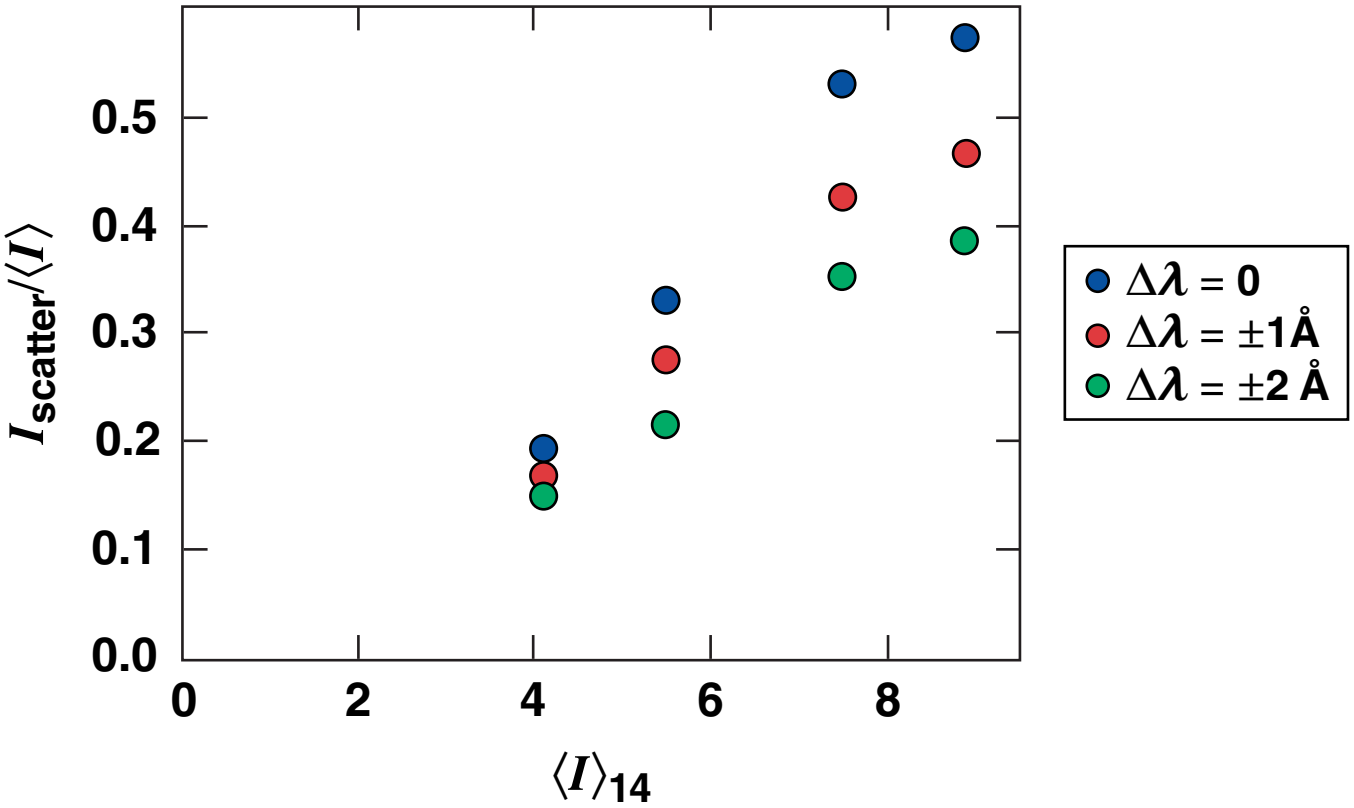
Cross-Beam Energy Transfer Driven by Incoherent Laser Beams with Colors



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Summary

In direct-drive inertial confinement fusion (ICF) plasmas, the use of wavelength detuning in incoherent laser beams can influence cross-beam energy transfer (CBET)

UR LLE

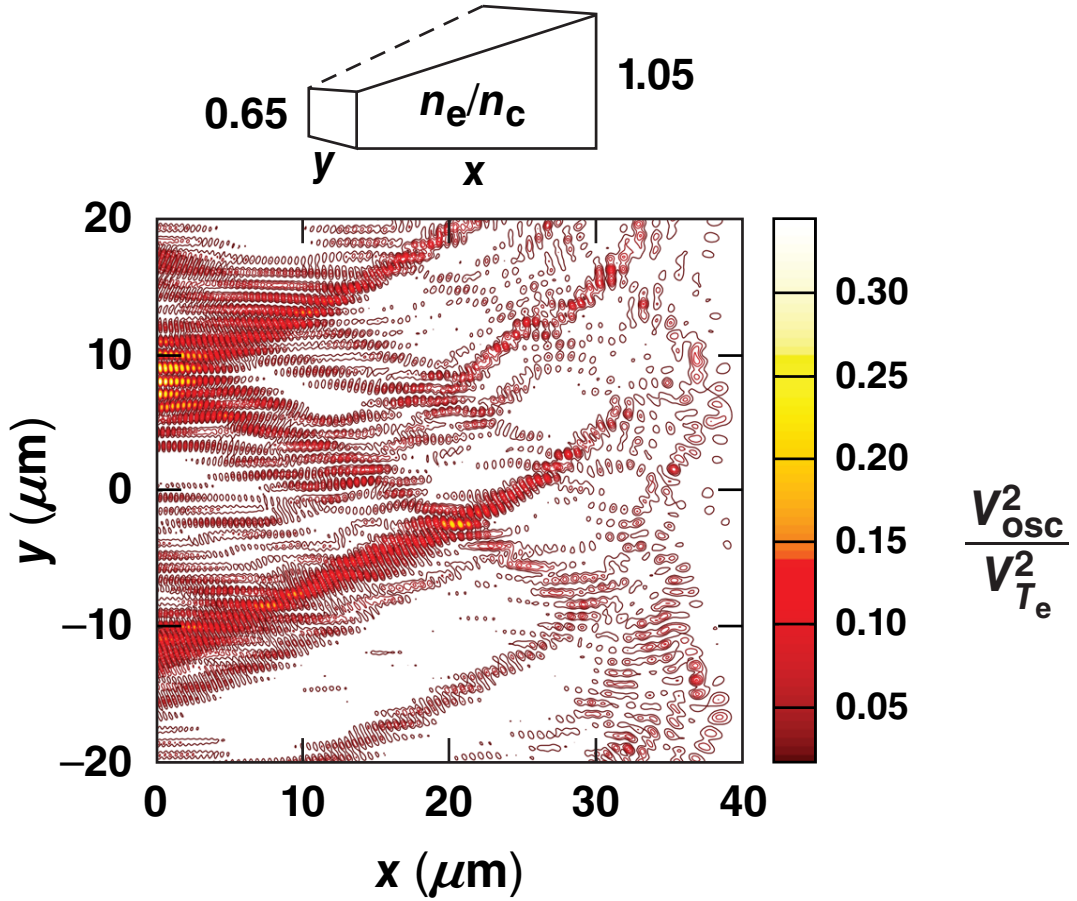
- In dense plasmas (including beam turning points) the use of wavelength detuning (colors) leads to
  - the increased frequency broadening of reflected light
  - the reduction of the scattered-light intensity [can be comparable to the effect of time incoherence from smoothing by spectral dispersion (SSD)]
- The increase of weaker beam intensity caused by CBET can be mitigated by the use of beam wavelength detuning

Nonlinear propagation of laser beams with wavelength detuning has been modeled in dense plasmas

- Beams with wavelength detuning are used to limit beam-to-beam coupling
  - reduced paraxial model can be used far from turning points
  - Two-dimensional non-paraxial model near turning points

T_e = 2 keV
$\Delta\lambda$ = 0, ±1, ±2 Å

θ = ±20°
f/6



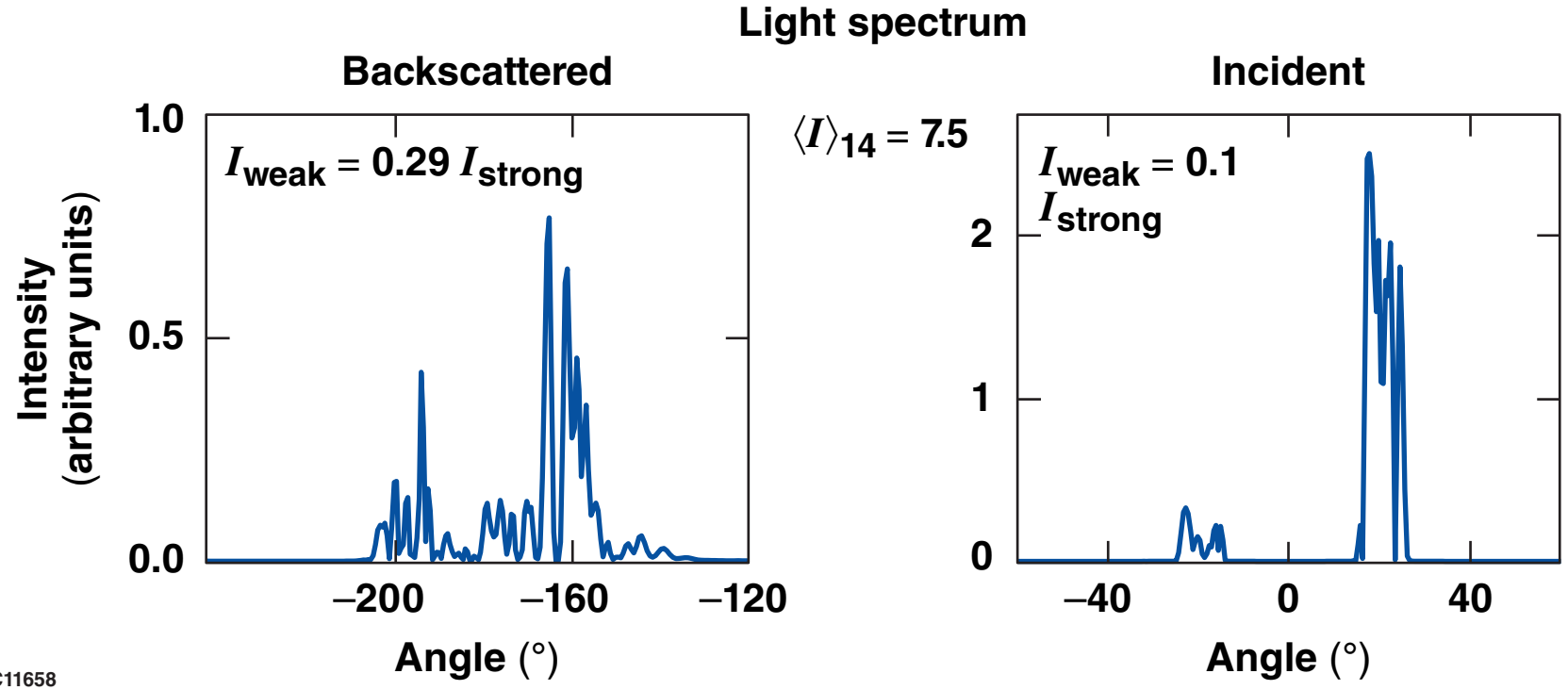
TC11657

Our model includes backward and forward stimulated Brillouin scattering (SBS), beam self-focusing, field swelling and absorption

- Beam-to-beam coupling can be described by backward SBS gains

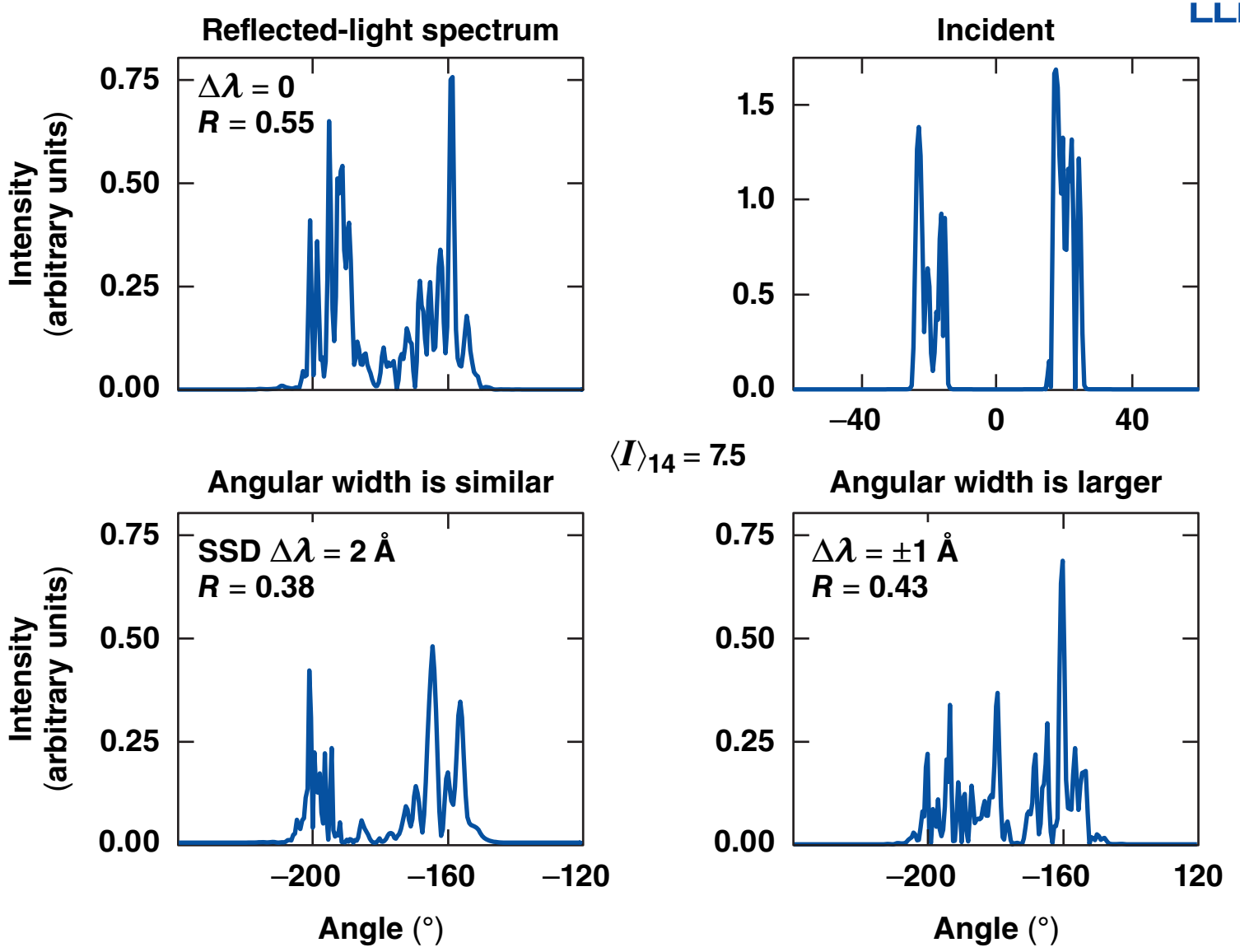
$$\frac{dG_{SBS}}{d\ell} = \frac{\omega_0^2}{2c^2 n_c}\,\mathrm{Re}\left\{\frac{n_e k_s^2 c_s^2 \times I_0}{2\nu_i \omega_s + i\left[(\omega_s + k_s v_0)^2 - k_s^2 c_s^2\right]} \times \frac{1}{2k_{0x}}\right\},$$

$$I_0 = |E|^2 / 4\pi n_c T_e$$



TC11658

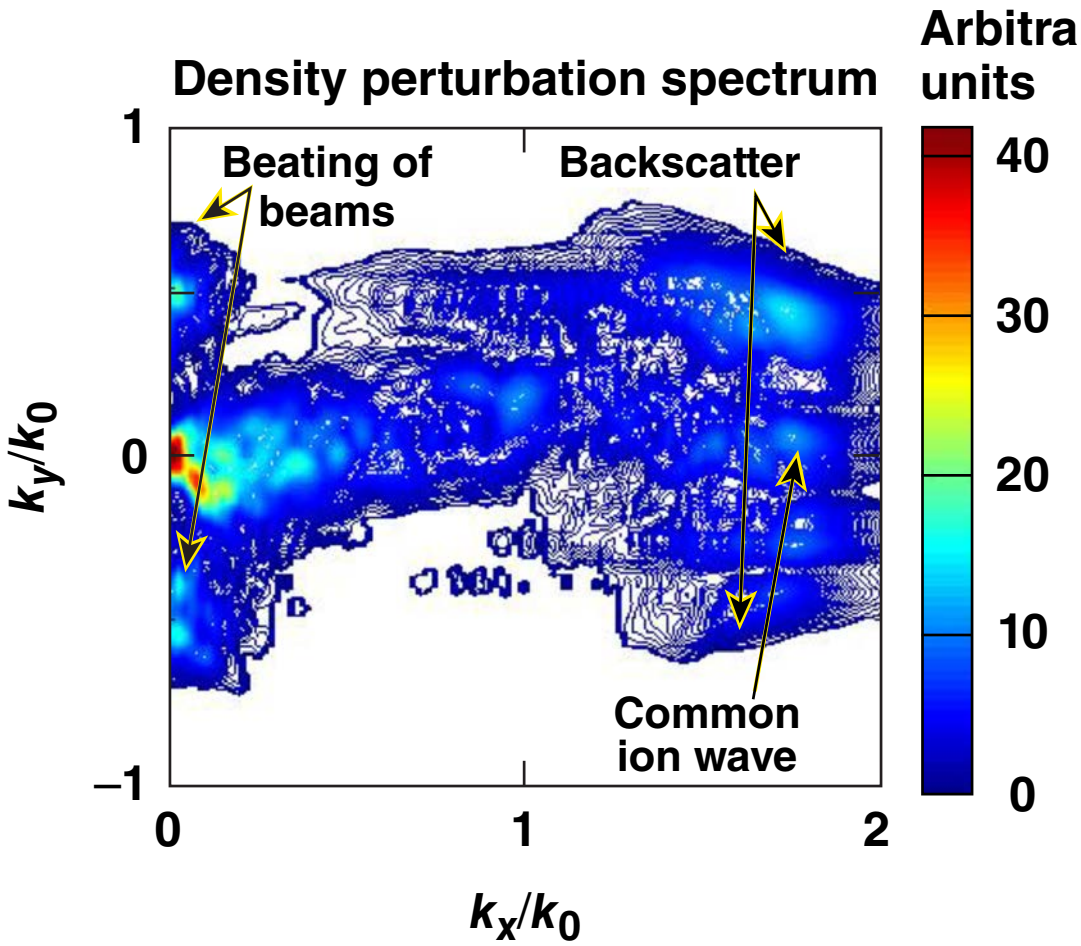
The use of wavelength detuning in driving laser beams can limit the reflectivity of beams from the dense plasma region



TC11768

The spectra of density perturbations show different ion-acoustic waves driven in dense plasmas

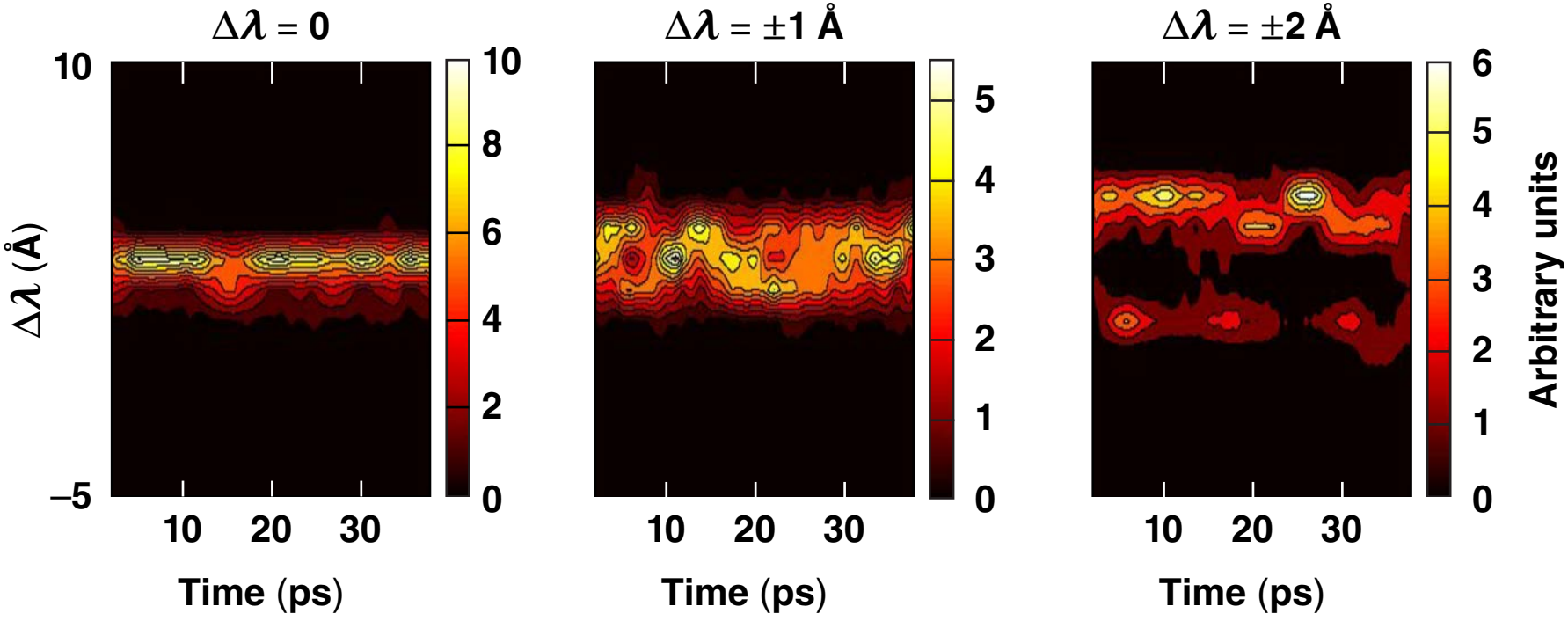
$\theta = \pm 20°$
$\langle I \rangle_{14} = 7.5$
$\Delta\lambda = \pm 1$ Å



$$k_0 = \frac{\omega_0}{c}\sqrt{1 - \frac{n_{e,b}}{n_c}}$$

TC11660

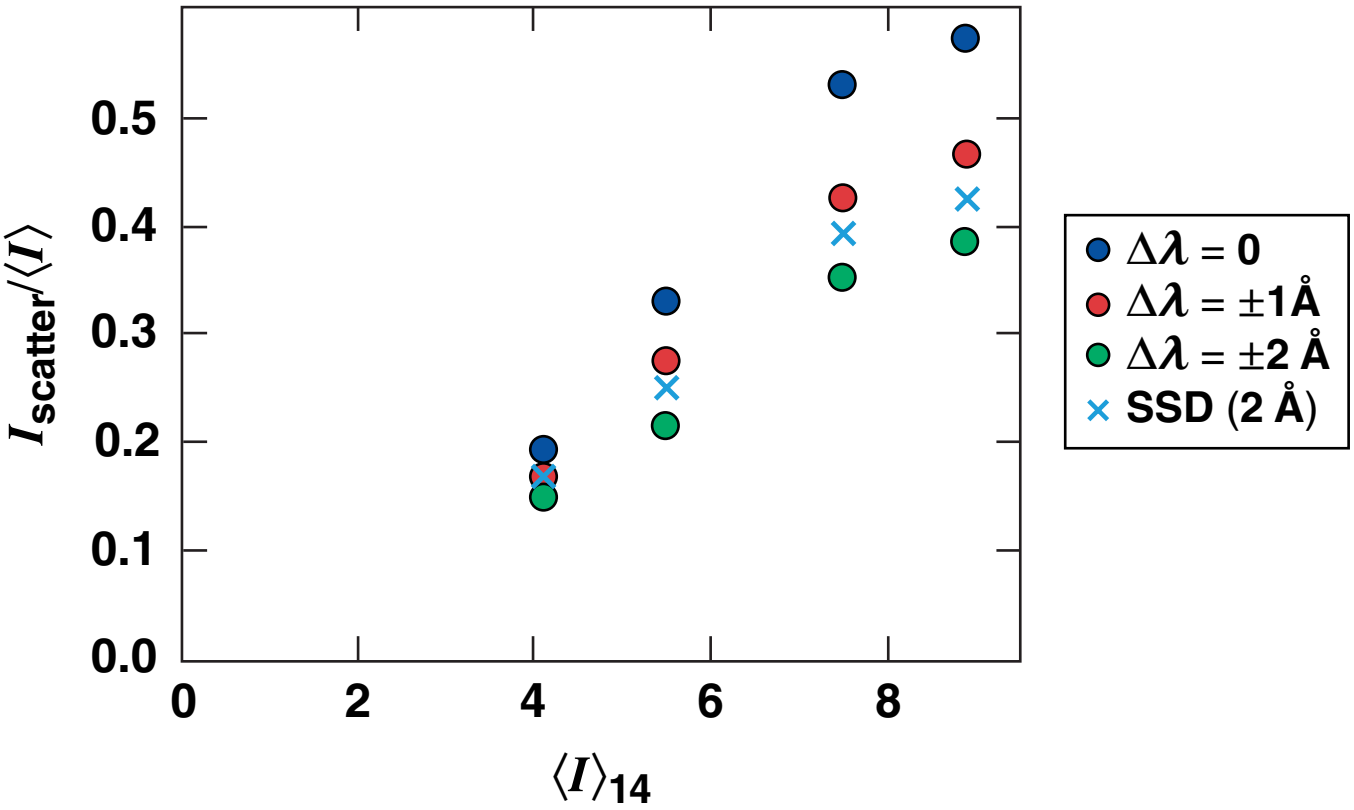
The frequency spectra of reflected light show spectral broadening when the driving beams have wavelength detuning



- The intensity of reflected light decreases with the increase of $\Delta\lambda$ from 1 Å to 2 Å

TC11661

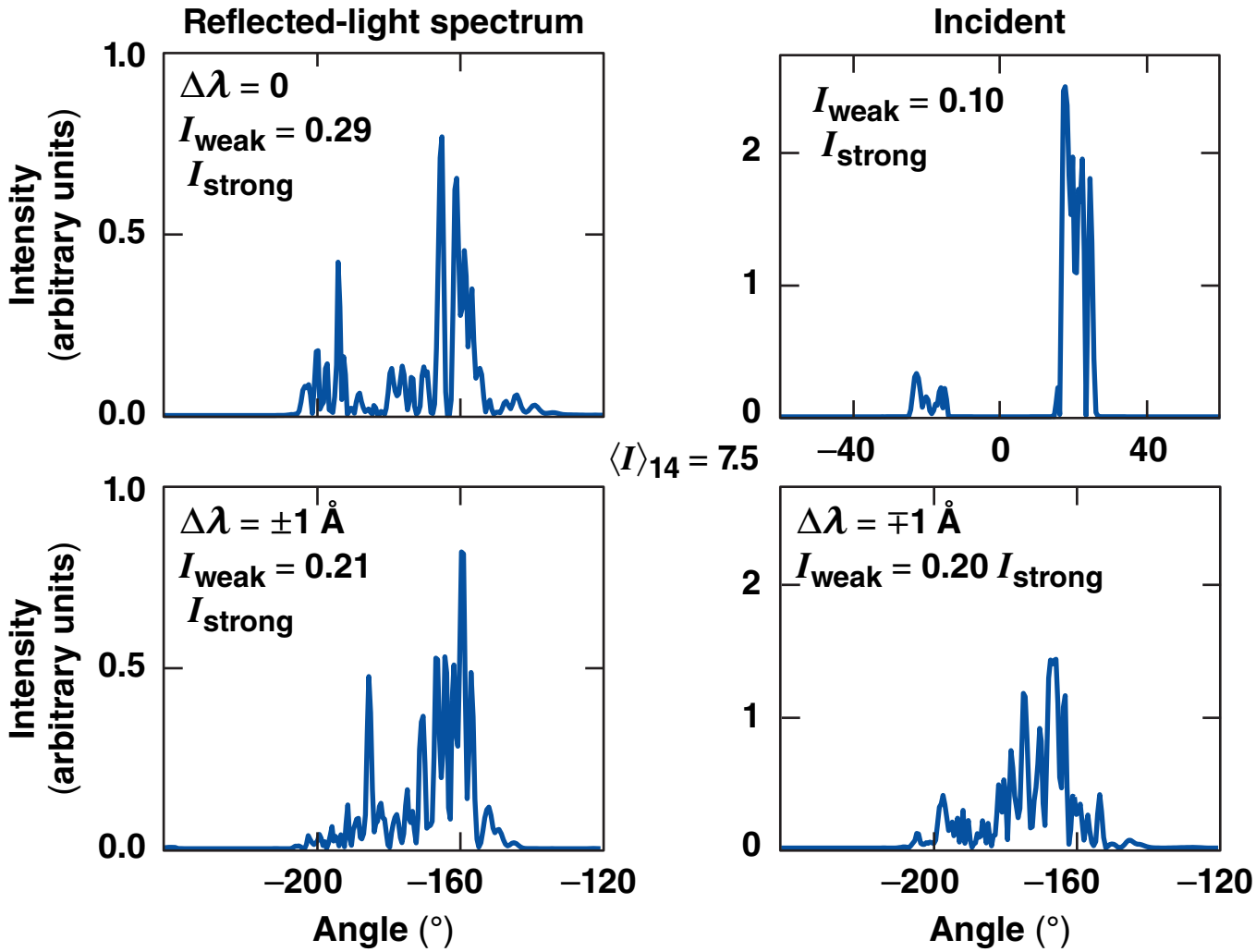
The effect of wavelength detuning on the scattered-light intensity has been studied for different intensities



- The effect of beam wavelength detuning on the scattered-light intensity can be comparable to the effect of SSD

TC11662

For driving laser beams of unequal intensity, the use of wavelength detuning can mitigate the increase of the weaker beam intensity



TC11769

Summary/Conclusions

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