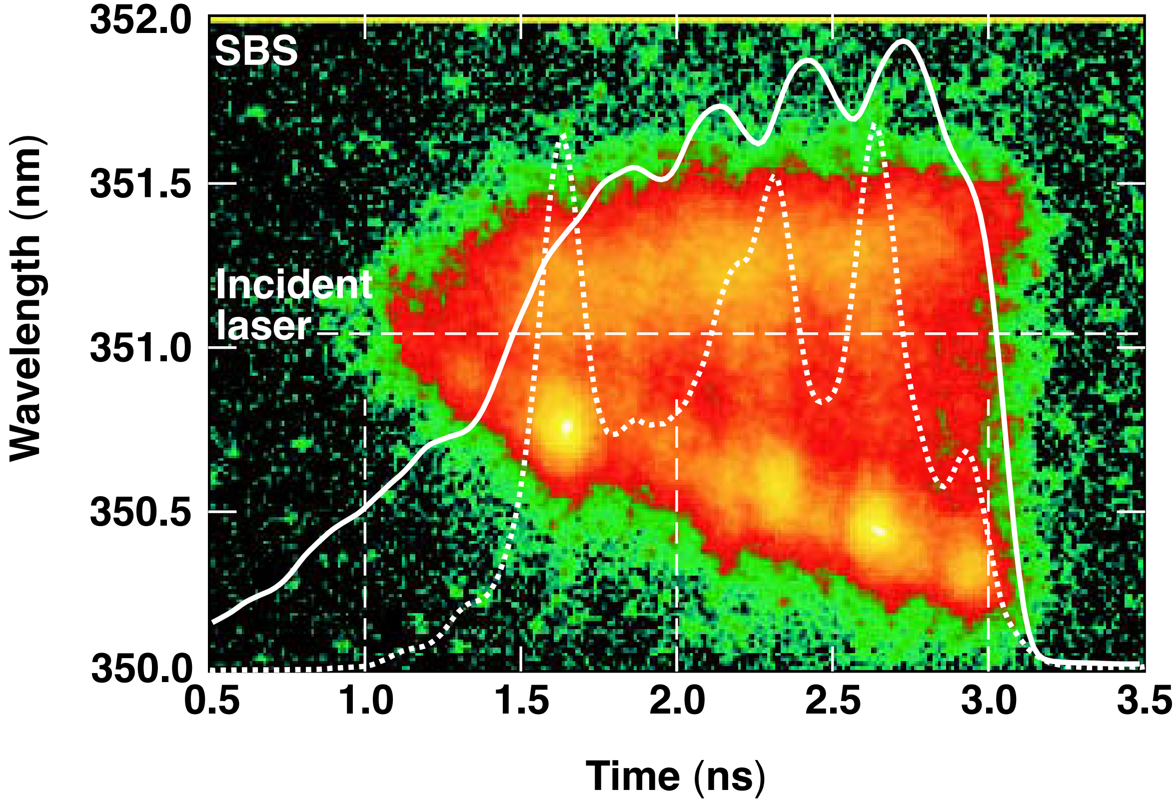
Theoretical Interpretation of SBS Observations in OMEGA Long-Scale-Length Plasma Experiments



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Summary

SBS arises primarily in "hot spots" and seems to be seeded by light reflected from critical

UR LLE

- Polarization smoothing (PS) reduces the level of SBS to that seen at half the incident intensity without PS, implying that SBS levels are determined by hot-spot intensities.
- Ion waves are strongly damped.
- The red-shifted portion of the spectrum appears to derive from light reflected from critical, but it is difficult to account for levels and shifts.

Outline

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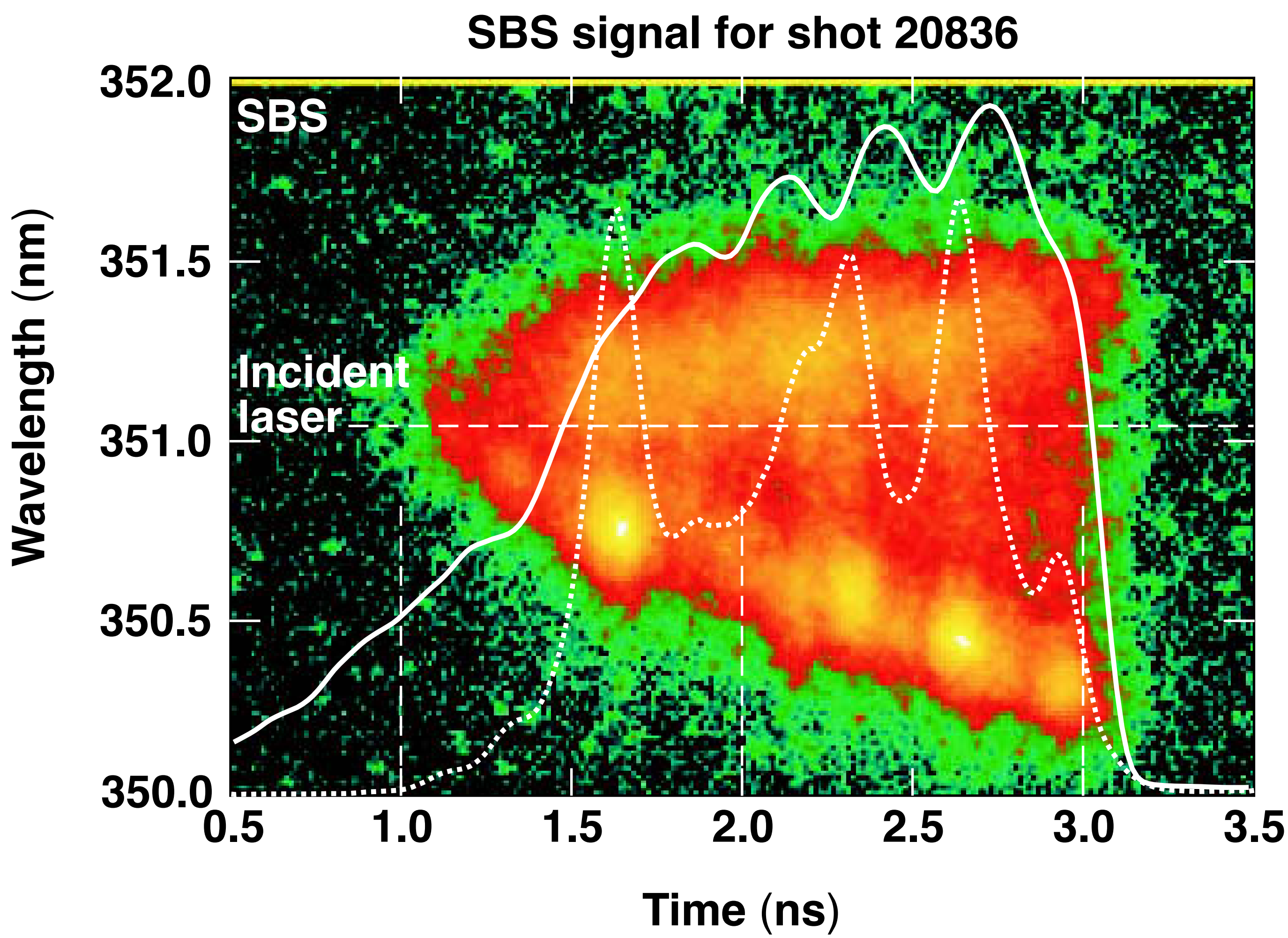
- Aspects of SBS spectra
- Ion-acoustic modes in multicomponent plasmas
- Strong-damping SBS model and calculation of growth factors in simulated profiles
- Summary and conclusions

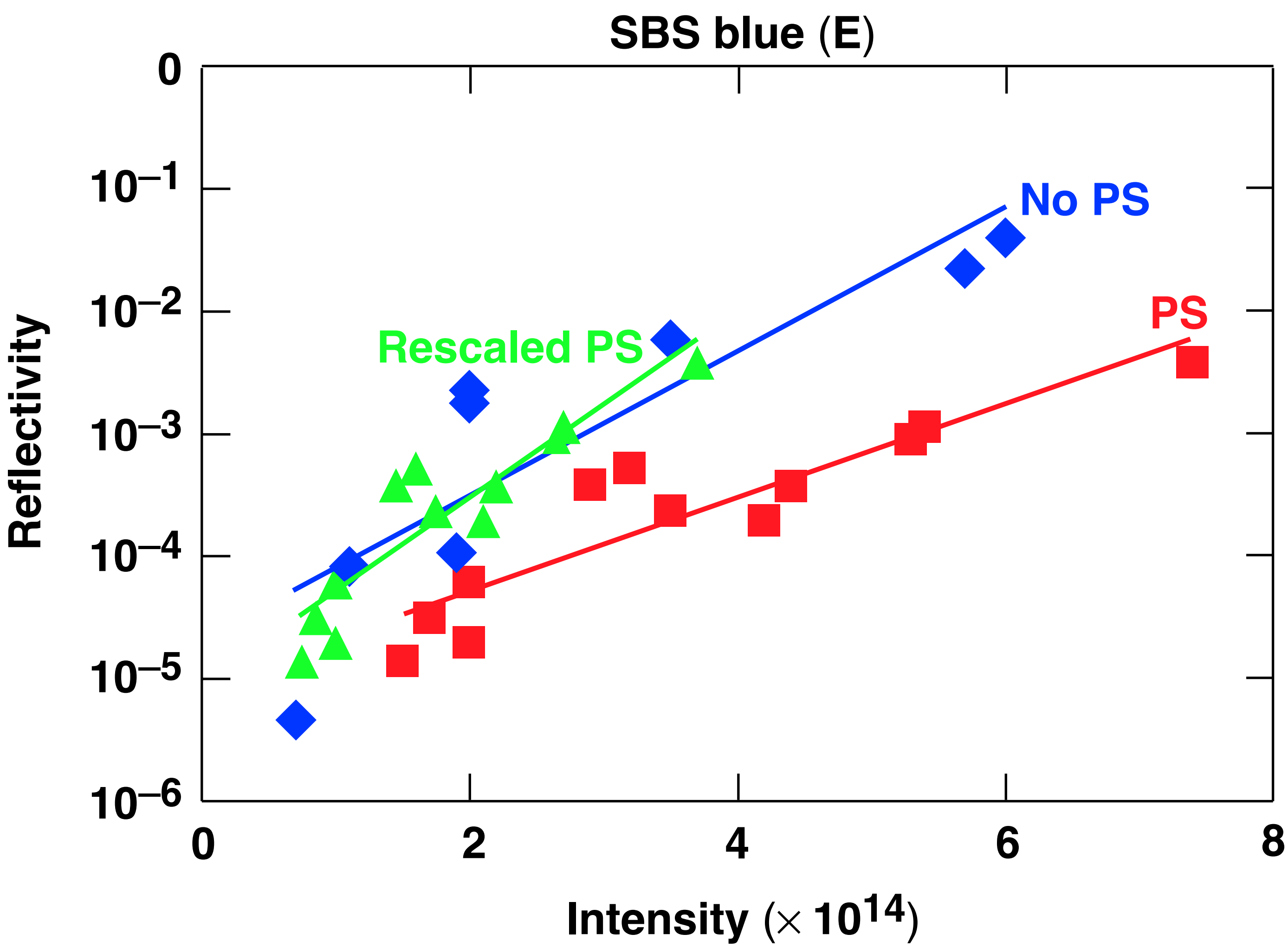
SBS spectrum consists of distinct "red" and "blue" features



$I_{peak} = 7.4 \times 10^{14}$ W/cm^2

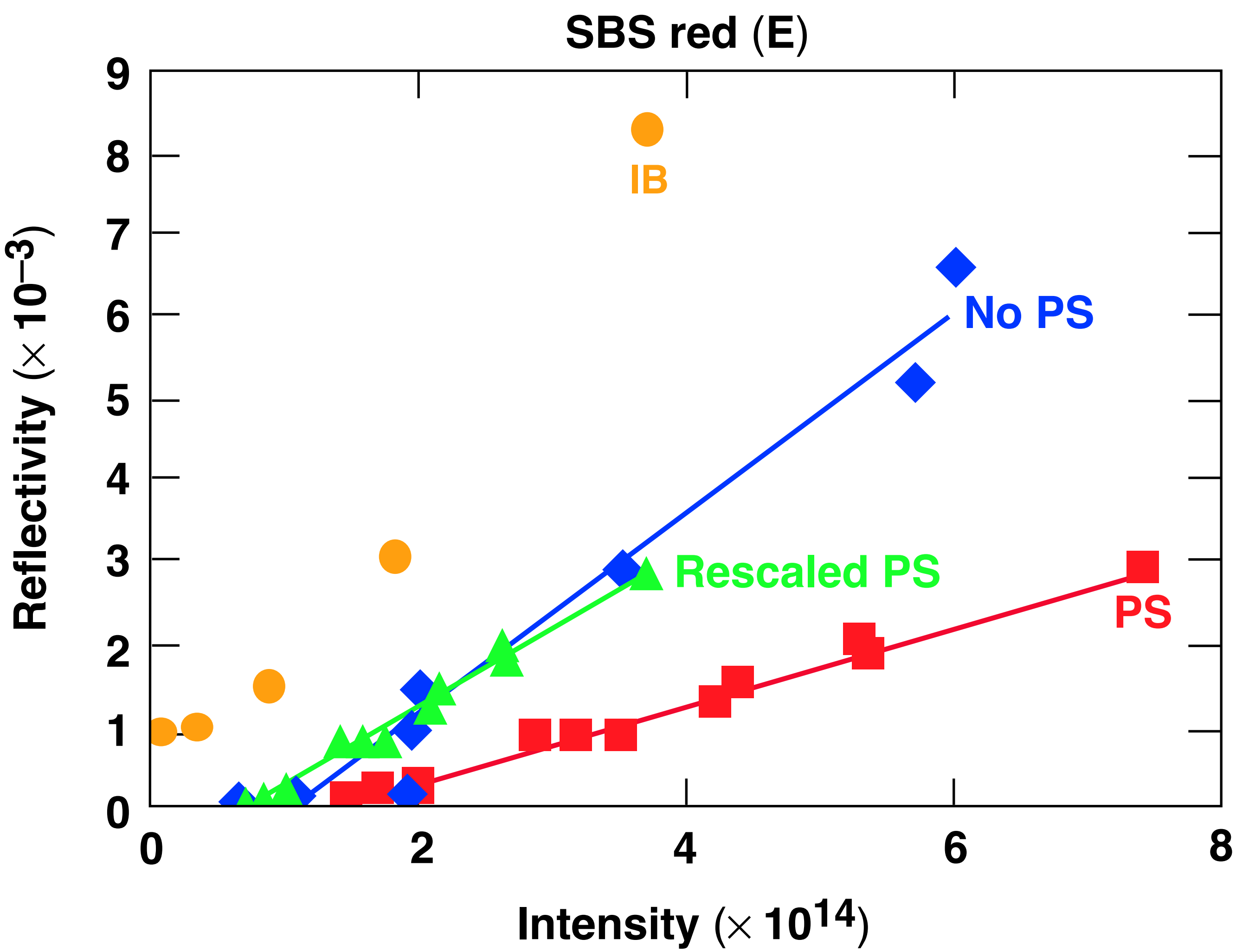
P2134

“Blue” feature depends exponentially on hot-spot intensity



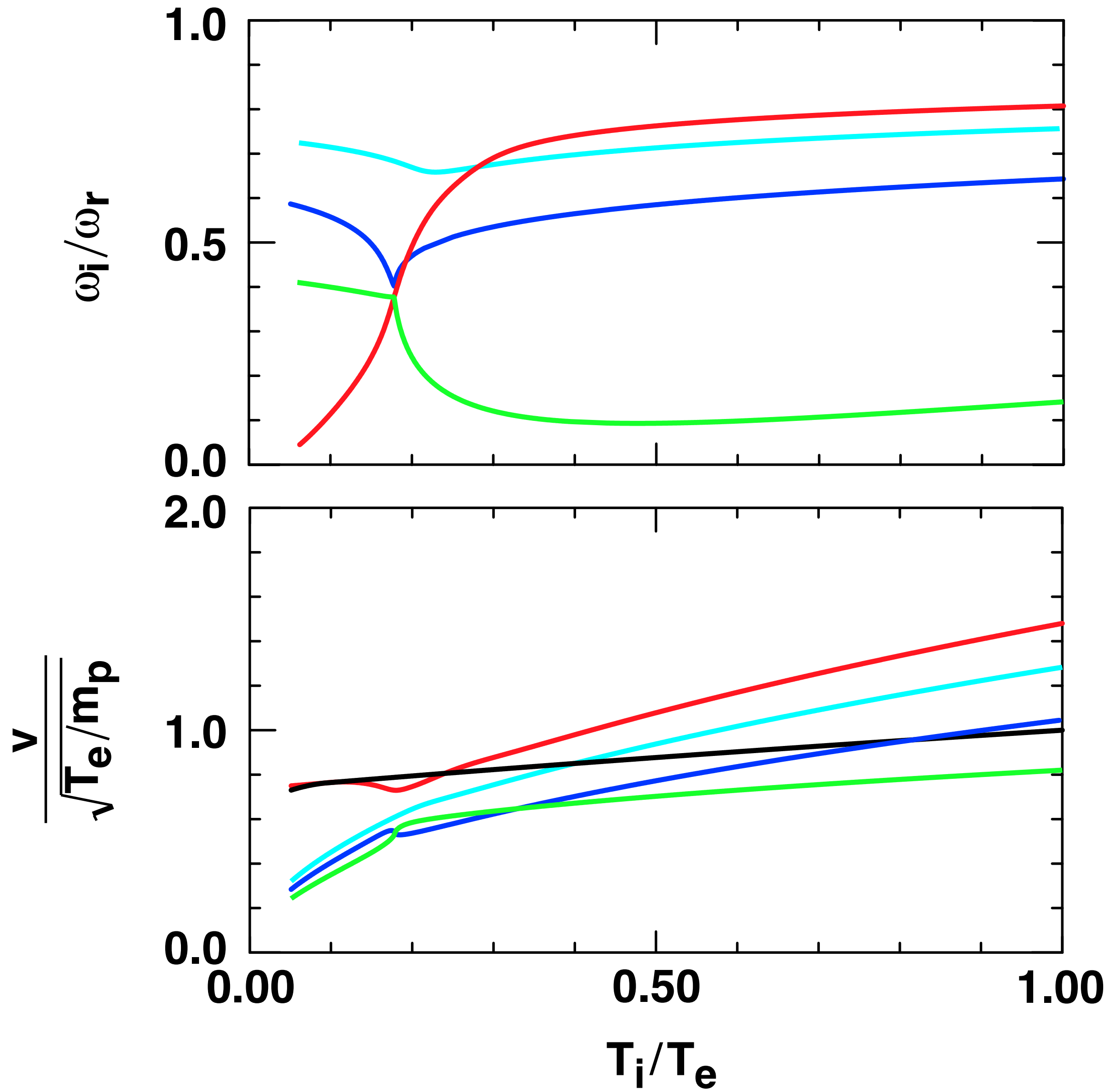
P2135

“Red” feature depends linearly on hot-spot intensity



P2136

All ion-acoustic modes are strongly damped



P2137

In strongly damped plasmas the SBS gain may be computed by integrating a local gain factor

- **The equation for SBS intensity is**[1] $\frac{\partial I_{SBS}}{\partial x} + \frac{I_{SBS}}{L_{abs}} = \frac{I_{pump} I_{SBS}}{L_{gain}}$.

Here, L_{abs} is the absorption length and L_{gain} is the local gain length:

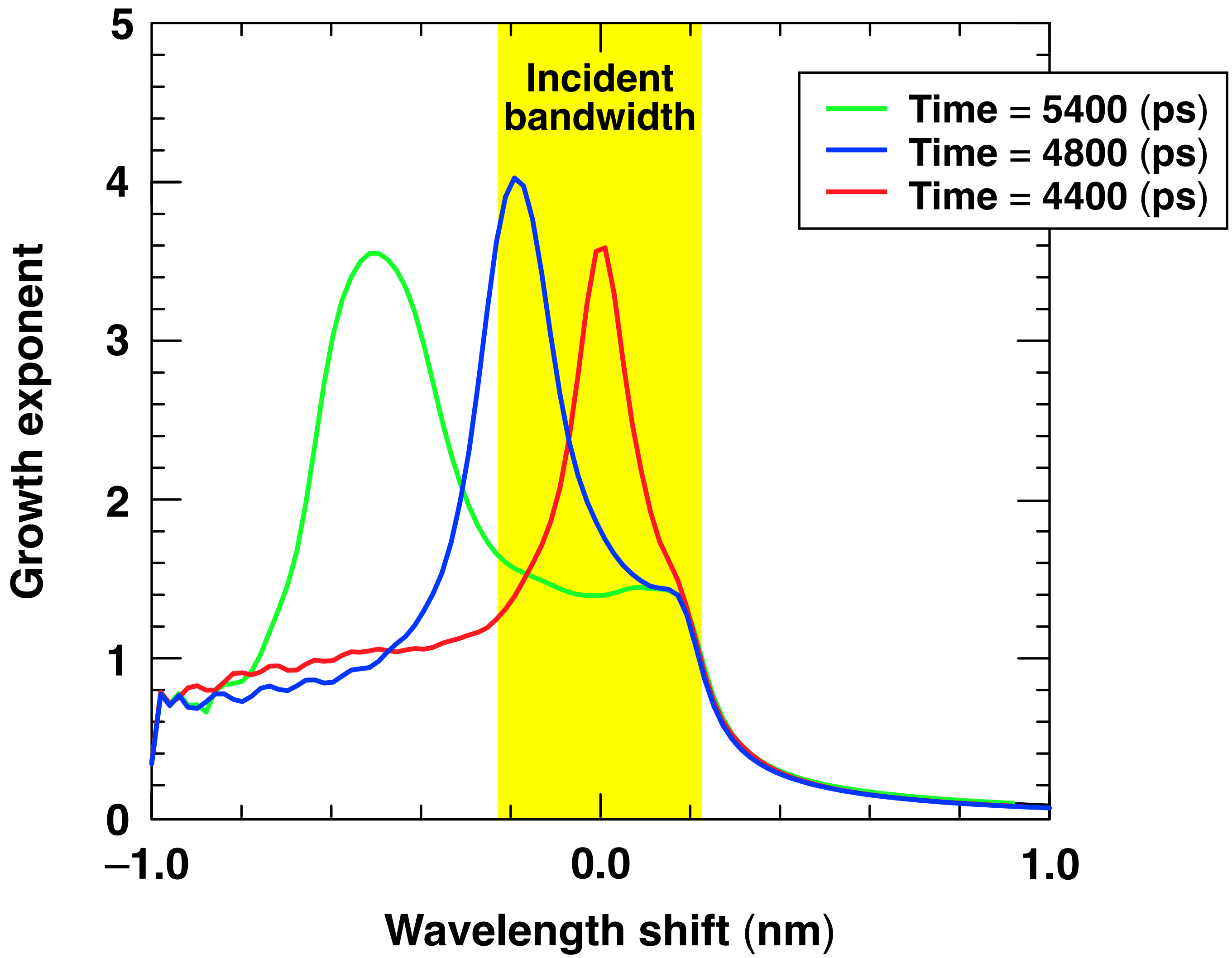
$$L_{gain}^{-1} = \frac{k_0}{4} \frac{n_e / n_c}{\sqrt{\cos^2\theta - n_e / n_c}} \frac{m_e v_{osc}^2}{T_e} \left[\left(1 + \frac{3T_i}{ZT_e} \right) \left(\frac{v_i}{\omega_s} \right) \right]^{-1} p(\eta),$$

where $p(\eta) = \frac{\left(\frac{\nu_i}{\omega_s} \right)^2 \eta}{\left(\eta^2 - 1 \right)^2 + \left(\frac{\nu_i}{\omega_s} \right)^2 \eta^2}$ **and** $\eta = \frac{v_0}{c_s} \cos\theta + \frac{\omega_i}{\omega_s}$.

- **The simulation code SAGE is used to provide the profiles of the plasma parameters over which the above equations are integrated.**

[1]C. J. Randall, J. A. Albritton, and J. J. Thomson, Phys. Fluids 24, 1474 (1981).

The peak computed gain as a function of wavelength agrees well with "blue" feature



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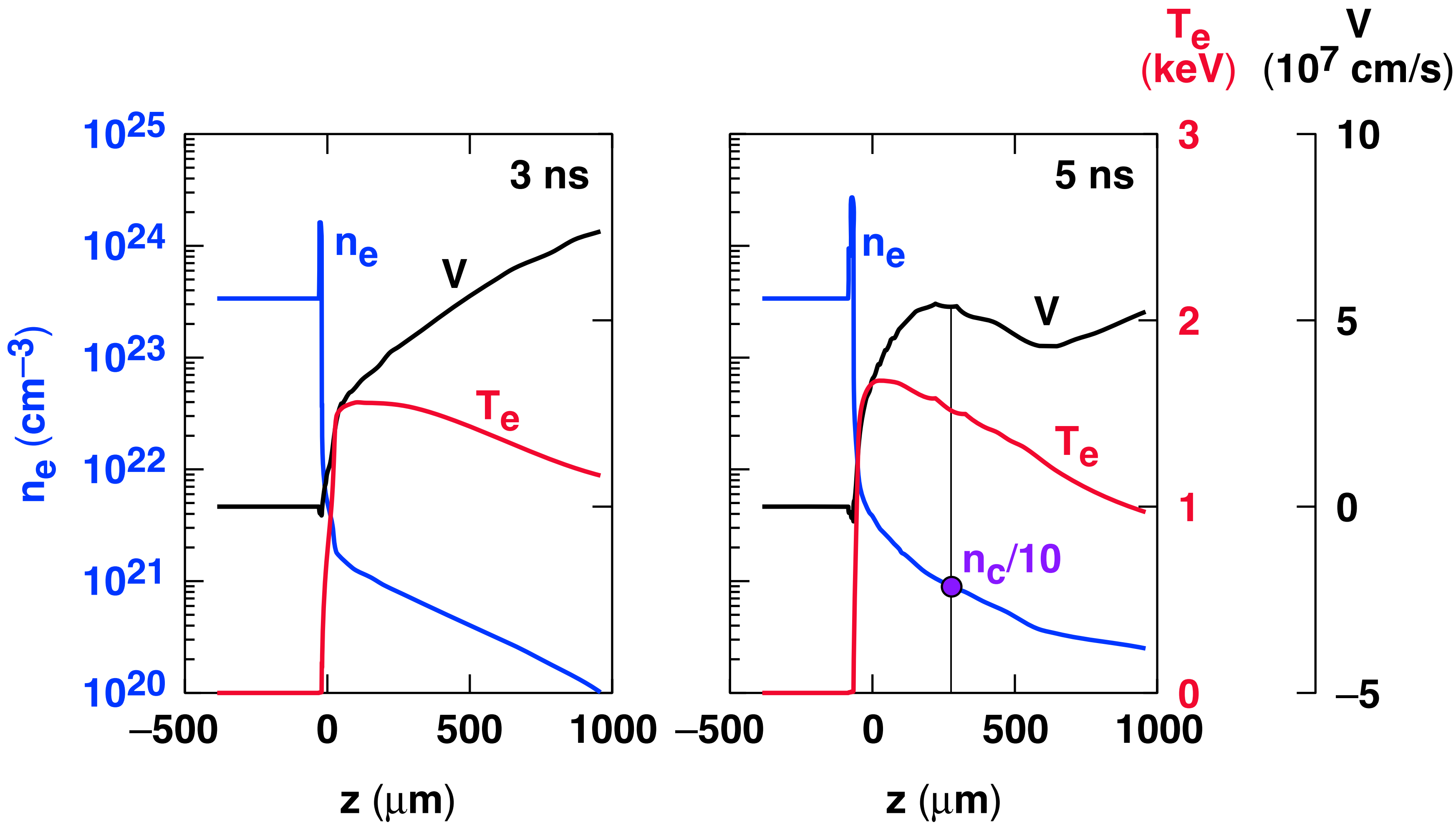
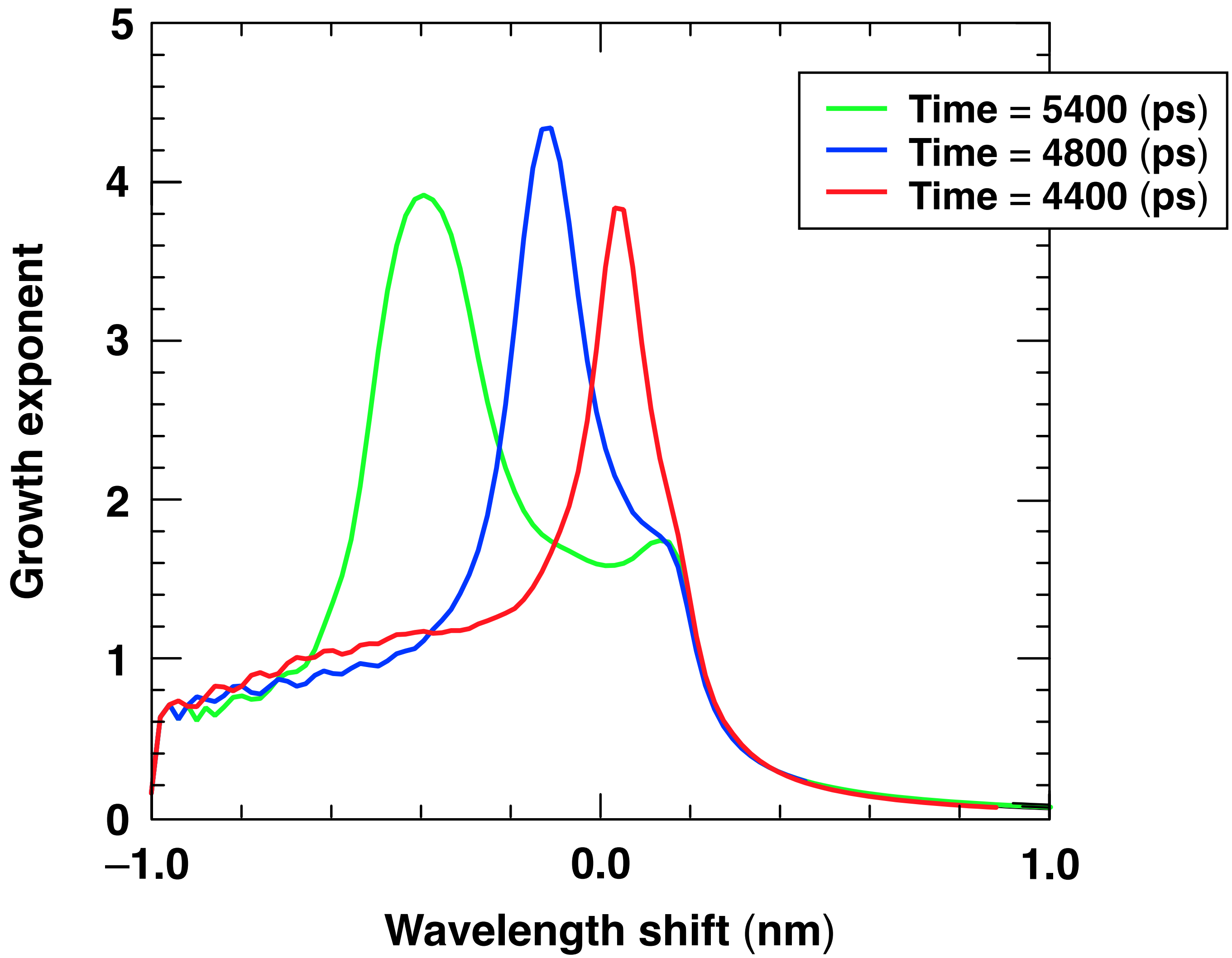
At 5 ns, the velocity profile is flat around $n_c/10$



Run 3261
TC5645

At oblique incidence, gains are somewhat larger and shifts smaller



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Even at lower intensities the time history of the red feature suggests SBS rather than simple reflection

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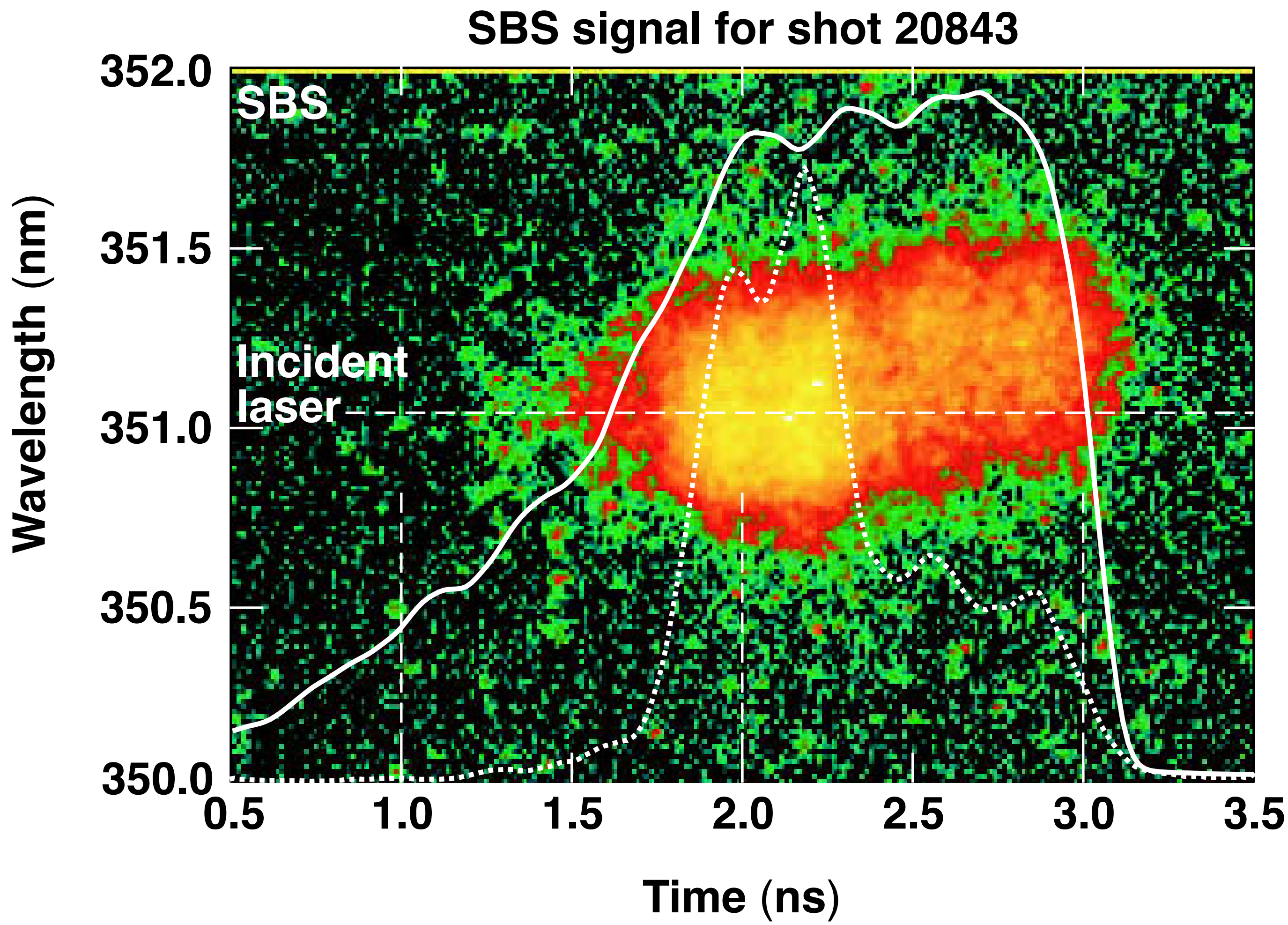

$I_{peak} = 1.7 \times 10^{14}$ W/cm^2

P2141

The present model does not account for some observed features of the SBS emission

- Levels of the "red" feature lie below those expected from simple inverse bremsstrahlung absorption.
- The increasing red shift at later times is not accounted for by the SBS gain factor or the bulk hydro motion.
- These phenomena may result from hot-spot behavior near critical, e.g., enhanced localized absorption and Doppler shift.

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