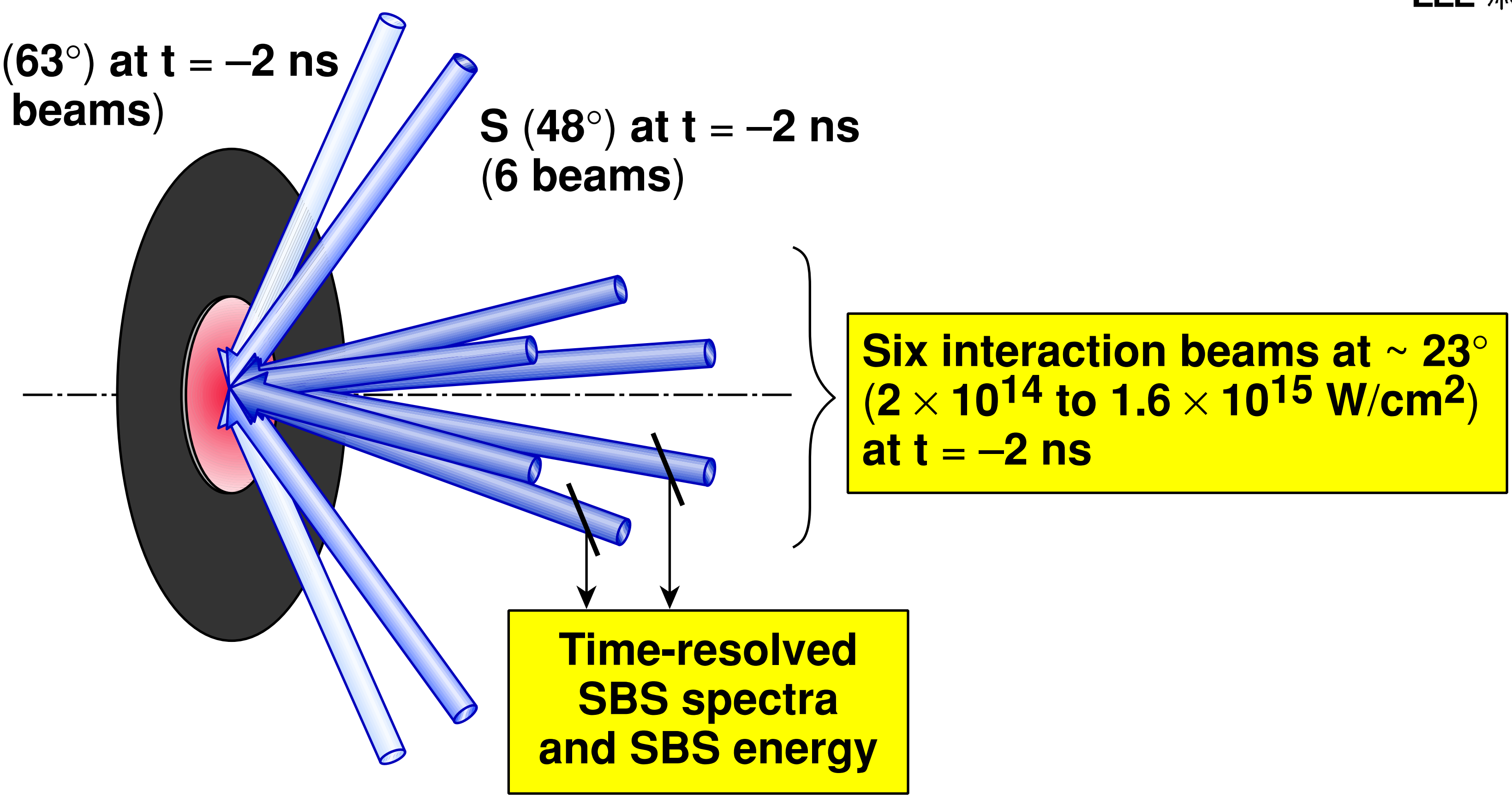
Stimulated Brillouin Sidescatter and Backscatter in NIF-Scale Direct-Drive Plasmas



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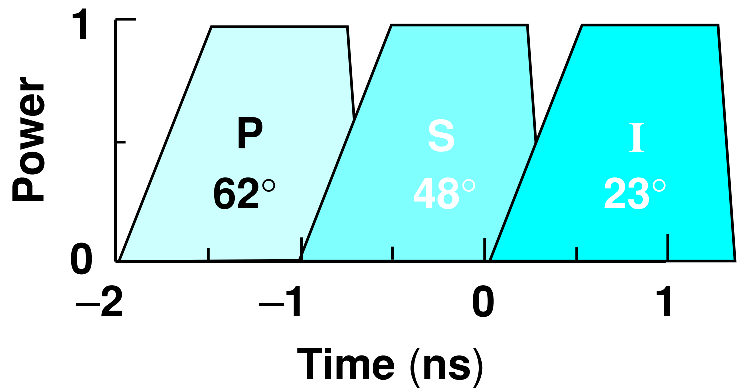
Summary

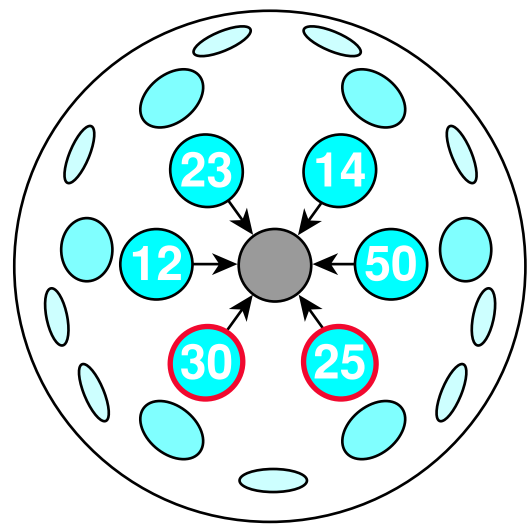
Multiple-beam SBS NIF-scale plasmas show EM-seeded SBS and early quenching

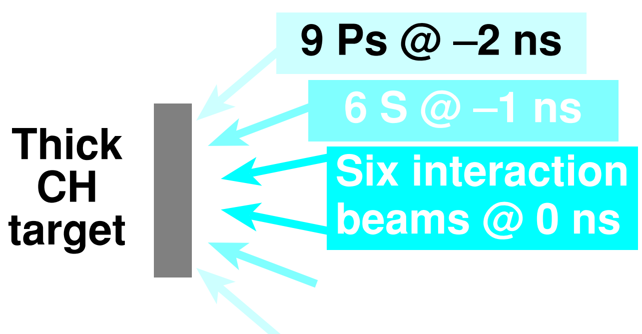
- Experiments on OMEGA at 351 nm with full beam smoothing were carried out in plasmas relevant to NIF direct-drive implosions.
- Multiple-beam effects are dominated by EM-seeded SBS.
- SBS is quenched before the peak of the pulse (indicative of filamentation?).
- SBS power reflectivities appear to saturate around a few percent.
- Existence of common (central) ion waves is consistent with data.

Multiple-beam SBS interaction experiments used three sets of delayed beams, six of them interaction beams



BL	25	30	12	23	14	50	
I_{14}	4	16	4	8	16	8	(W/cm^2)



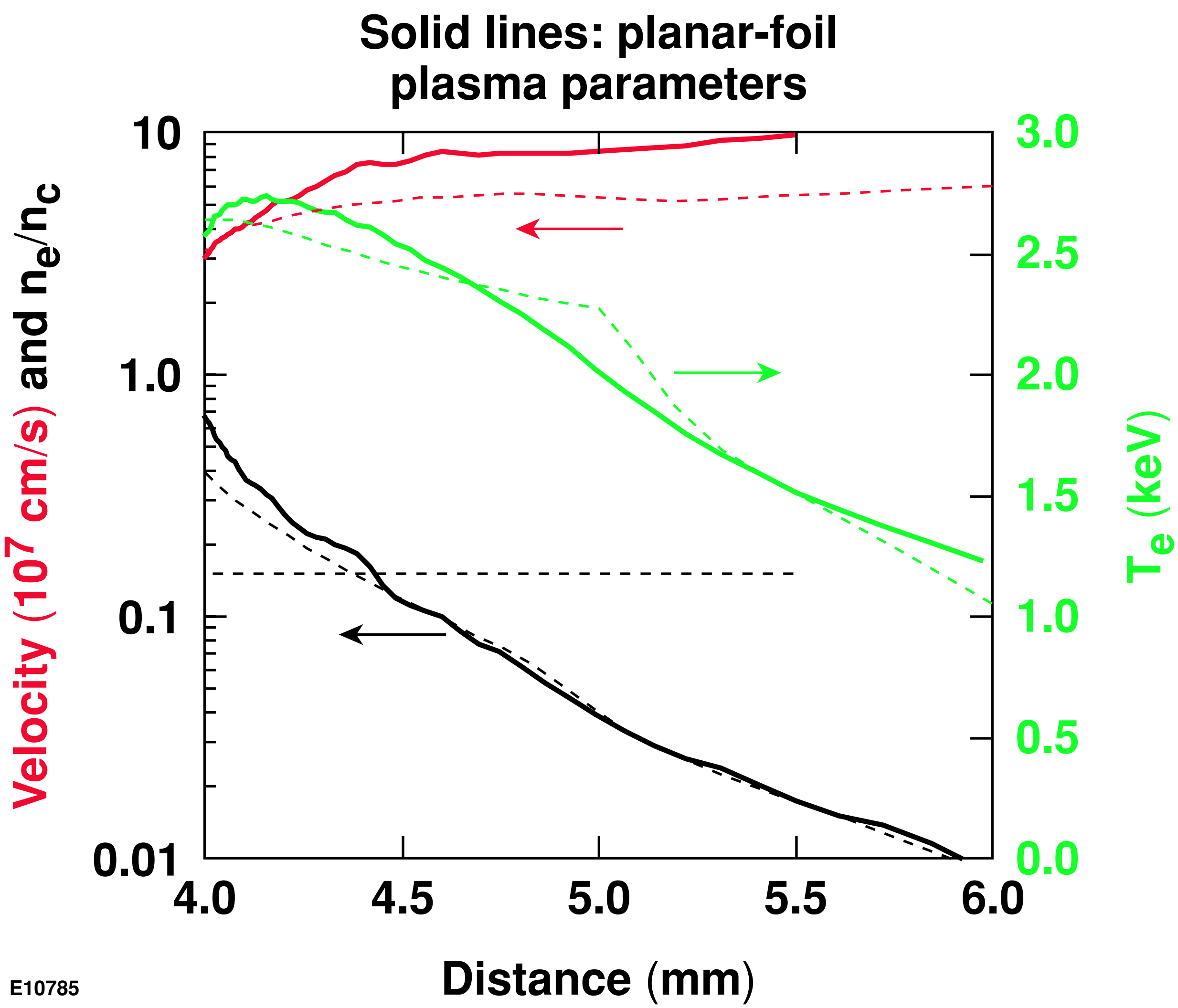


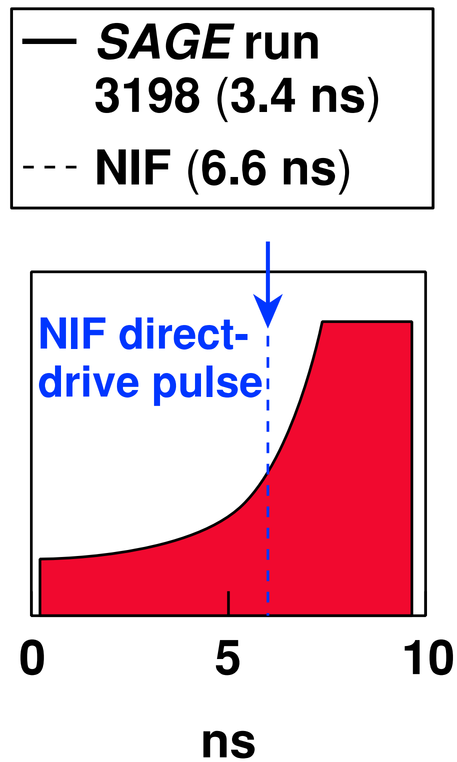
Intensities are varied with phase plates; energies are kept constant.

- Plasma density scale lengths and T_e roughly correspond to NIF direct-drive conditions.
- Full-beam smoothing (1-THz 2-D SSD and polarization smoothing)
- SBS and SRS with and without time resolution in two beams

E10977

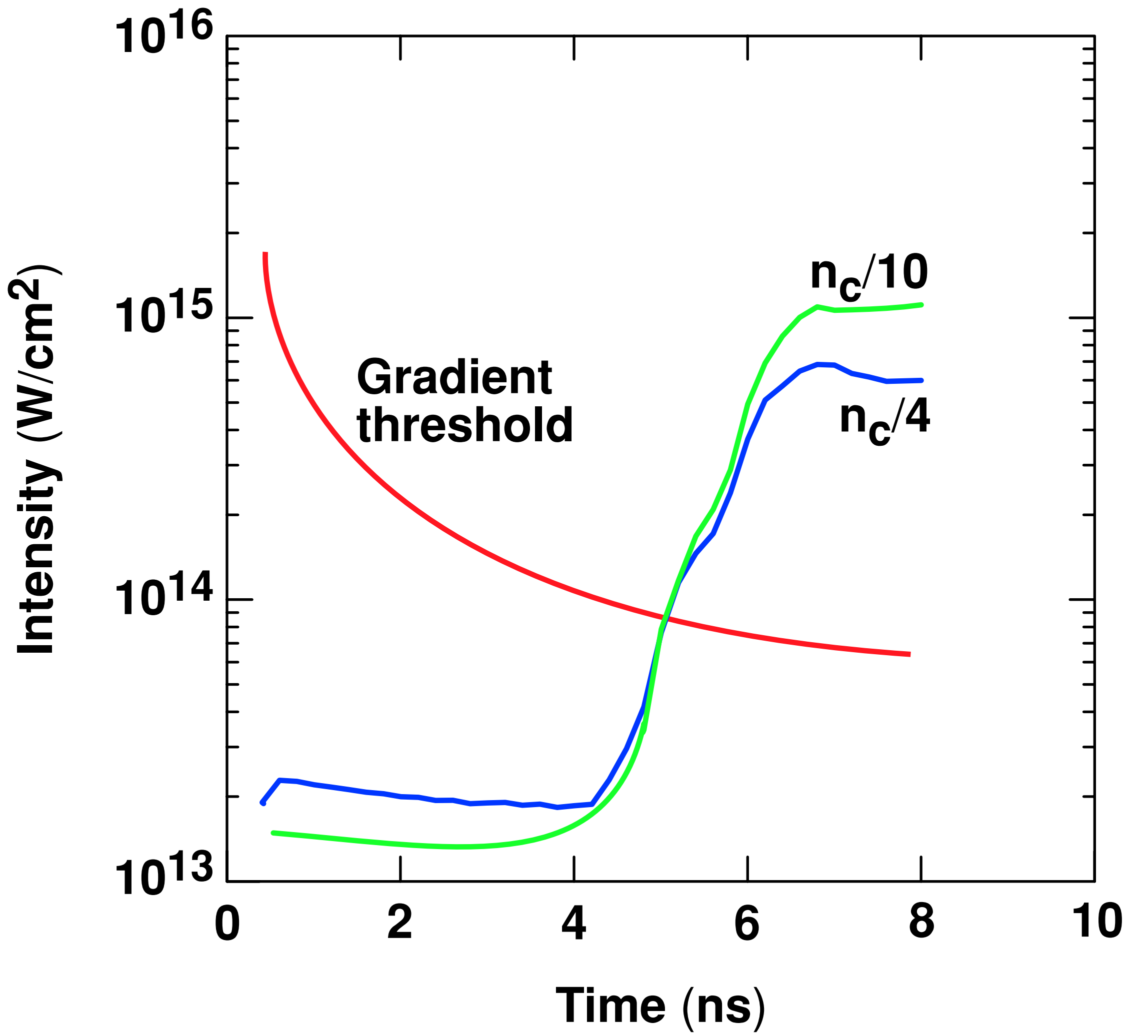
A 2-D simulation of OMEGA planar-foil plasma resembles direct-drive NIF conditions at ~ 6 ns into the laser pulse





E10785

In NIF-scale plasmas the SBS threshold is determined primarily by the velocity gradient



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

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

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

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

where $p(\eta) = \dfrac{\left(\dfrac{\nu_i}{\omega_s} \right)^2 \eta}{\left(\eta^2 - 1 \right)^2 + \left(\dfrac{\nu_i}{\omega_s} \right)^2 \eta^2}$ and $\eta = \dfrac{V_0}{c_s} + \dfrac{\omega_i}{\omega_s}$.

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

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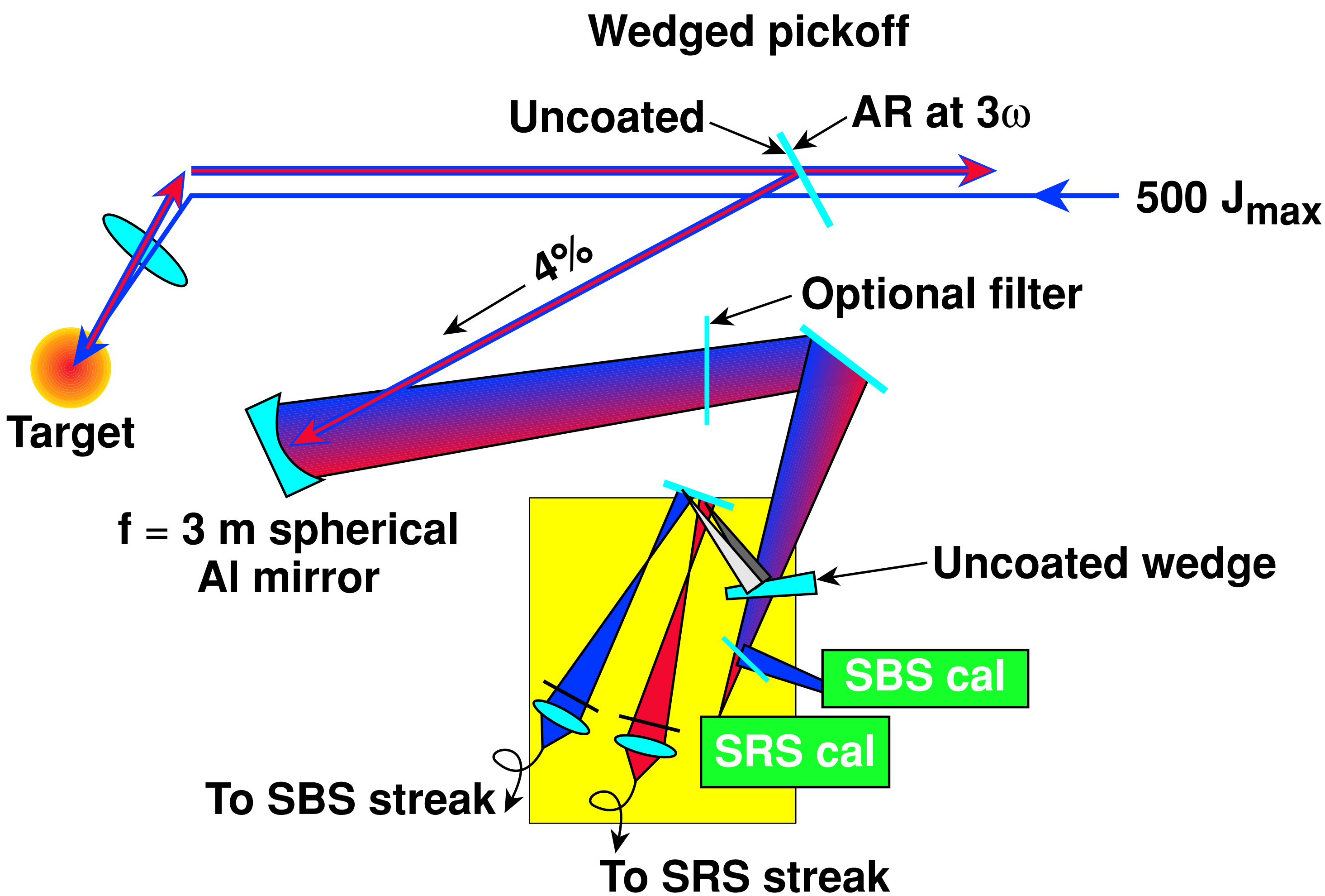
[1]C. J. Randall, J. A. Albritton, and J. J. Thomson, Phys. Fluids 24, 1474 (1981).

P2138

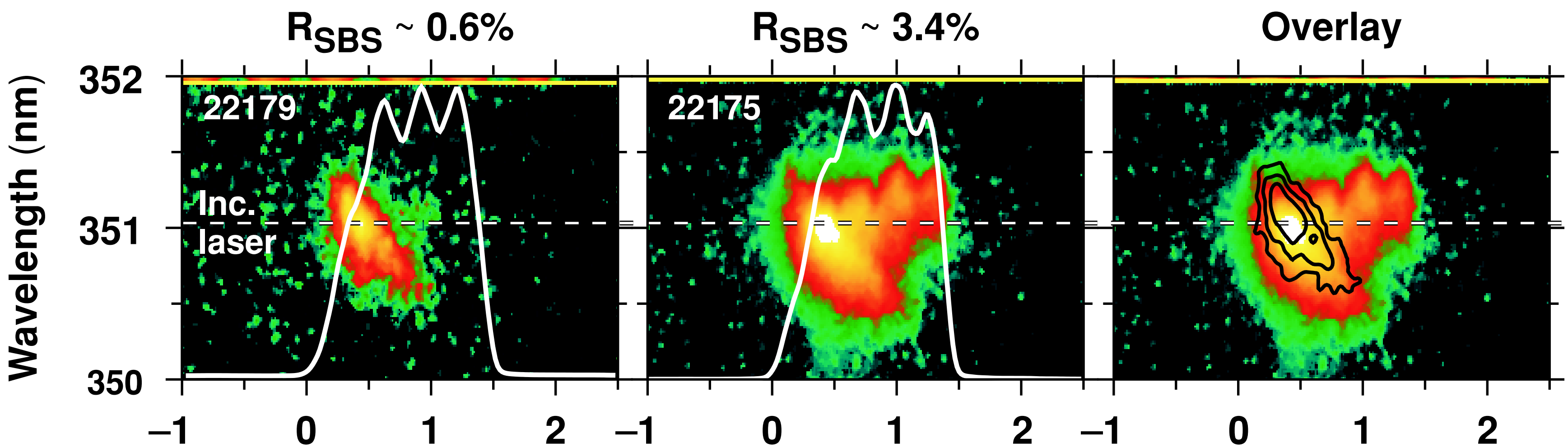
Two full-aperture backscatter stations (FABS) measure time-integrated and time-resolved SBS and SRS backscatter energy and spectra on OMEGA



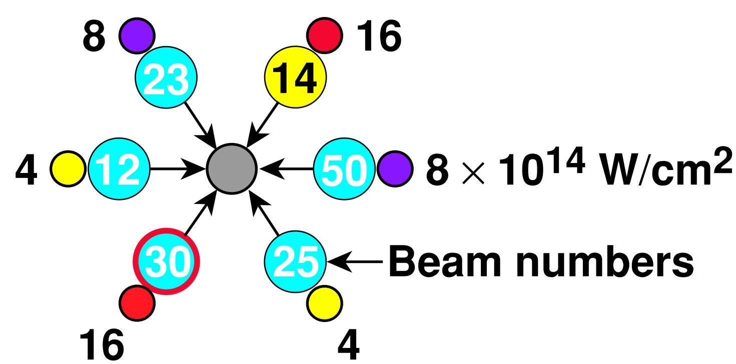
E11076

Multiple-beam experiments are dominated by EM-seeded SBS backscattering

$I_{30} = 1.6 \times 10^{15}$ W/cm^2, SSD at 1-THz and PS

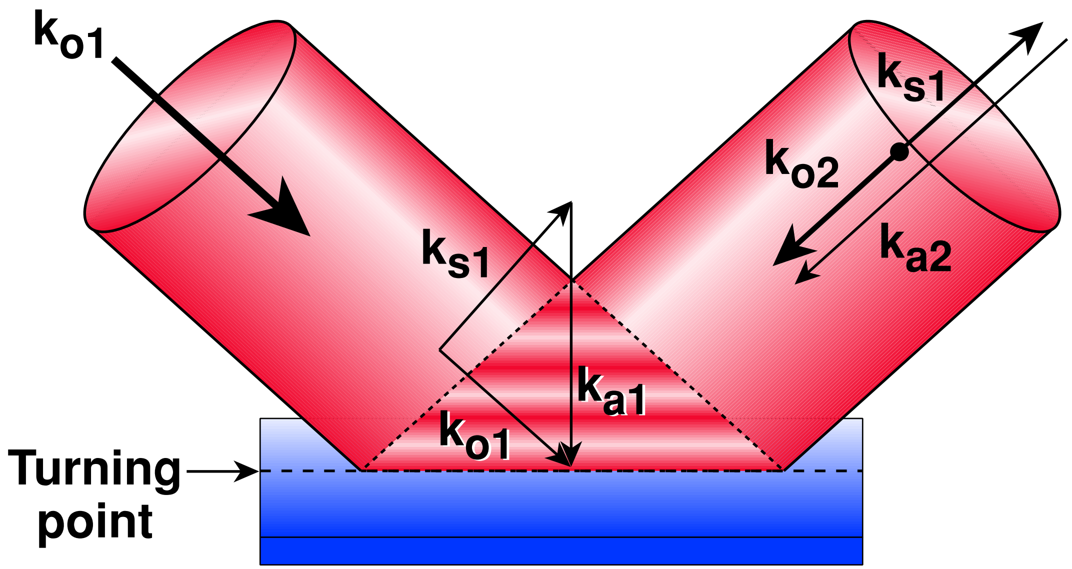


Beam 14 off



E10779a

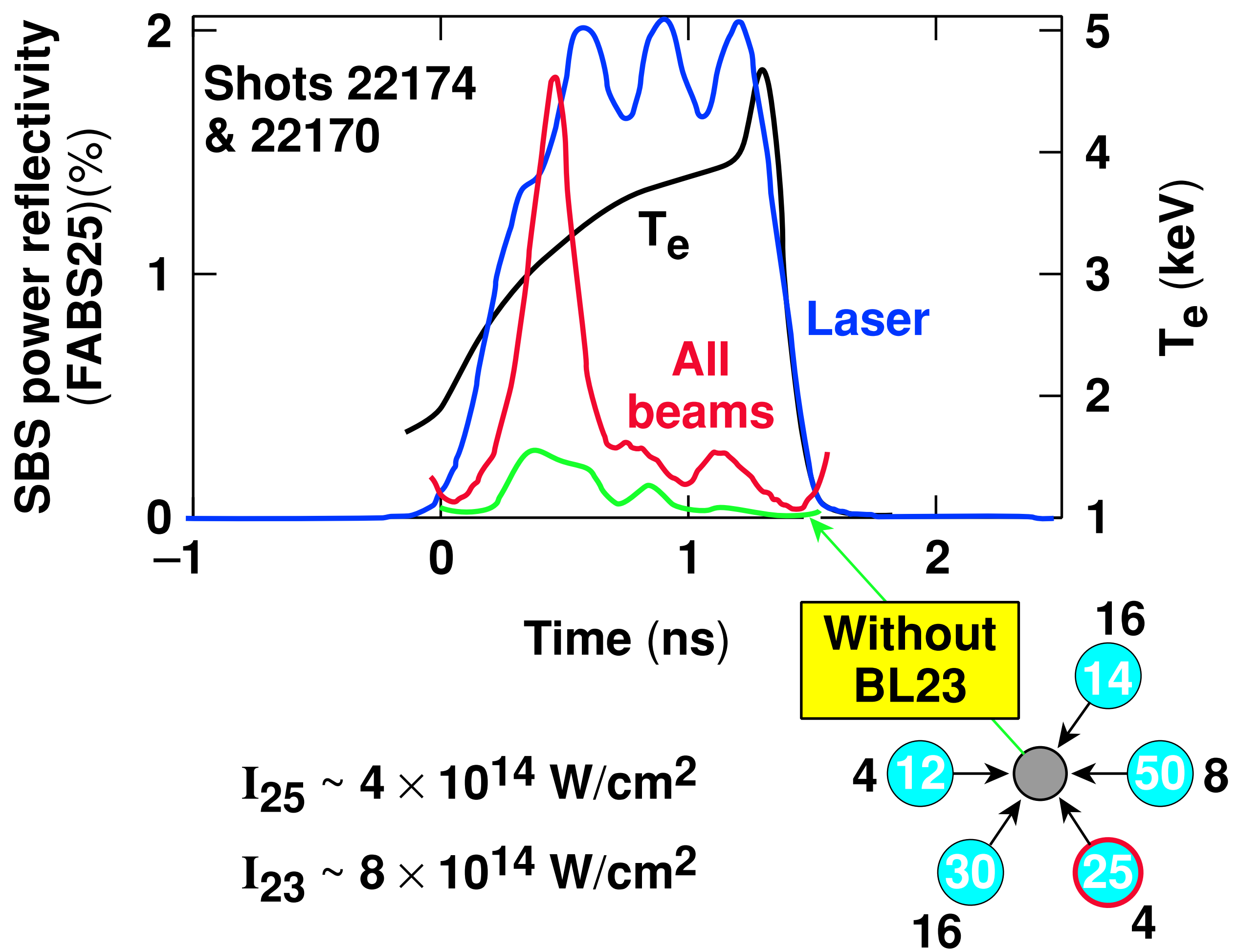
SBS sidescattering can be EM- or ion-wave-seeded; SBS backscattering is EM-seeded by SBS sidescattering



- SBS seeding is most effective near the sonic point ($\lambda_{SBS} \sim 0$).
- The experiments show that most of the SBS signal comes from very close to the sonic point.
- Sidescatter ion waves are the same for all opposing pairs of interaction beams—*but they are not necessarily in the same location in space.*

E11275

The multibeam SBS signals are dominated by amplification of specularly reflected light



$I_{25} \sim 4 \times 10^{14}$ W/cm^2

$I_{23} \sim 8 \times 10^{14}$ W/cm^2

Note: The specularly reflected light is expected to increase with time due to heating of the plasma

E10949

At low intensities common SBS ion waves contribute to SBS sidescattering of BL23 (ion-wave seeding)

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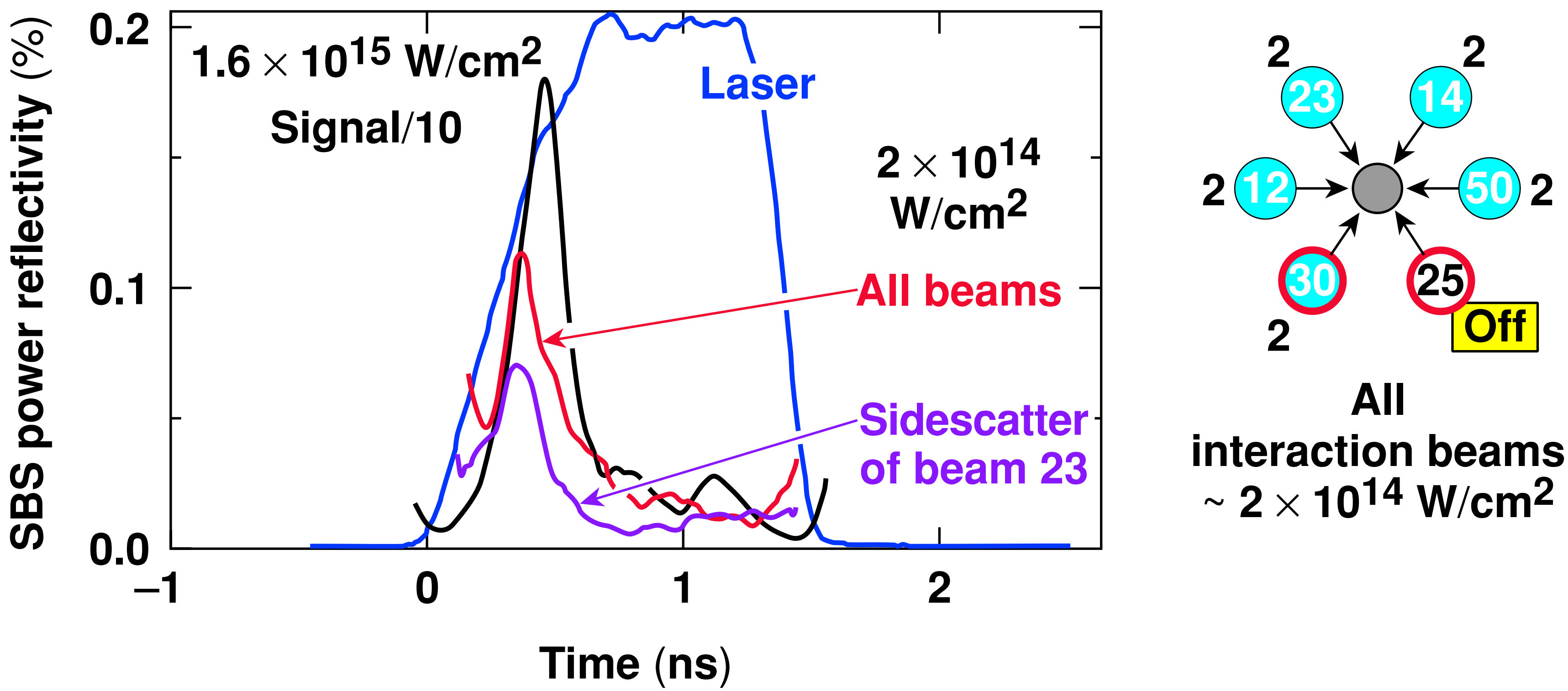
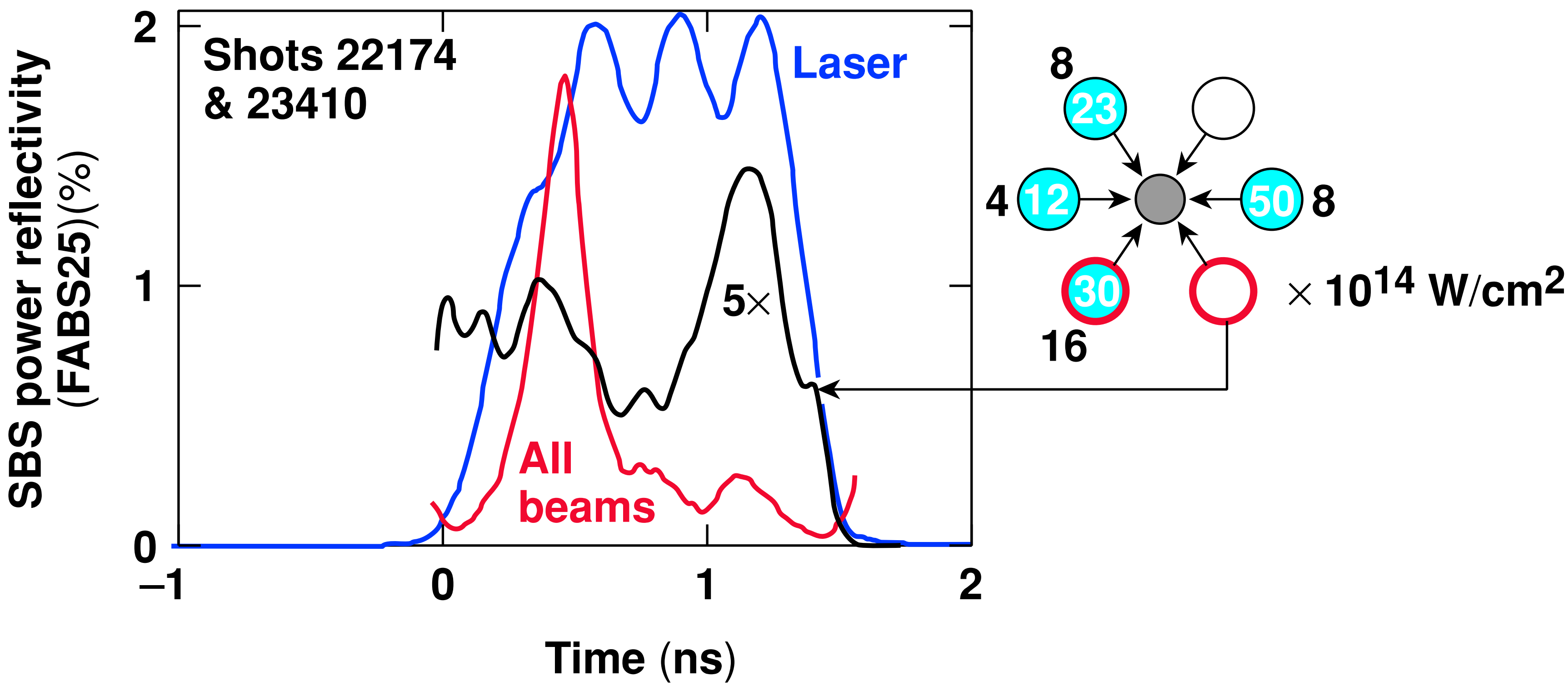


- **All beams: back- and sidescatter interact synergistically.**

E11274

Without beams 25 and 14, mostly specular reflection from beam 23 is observed

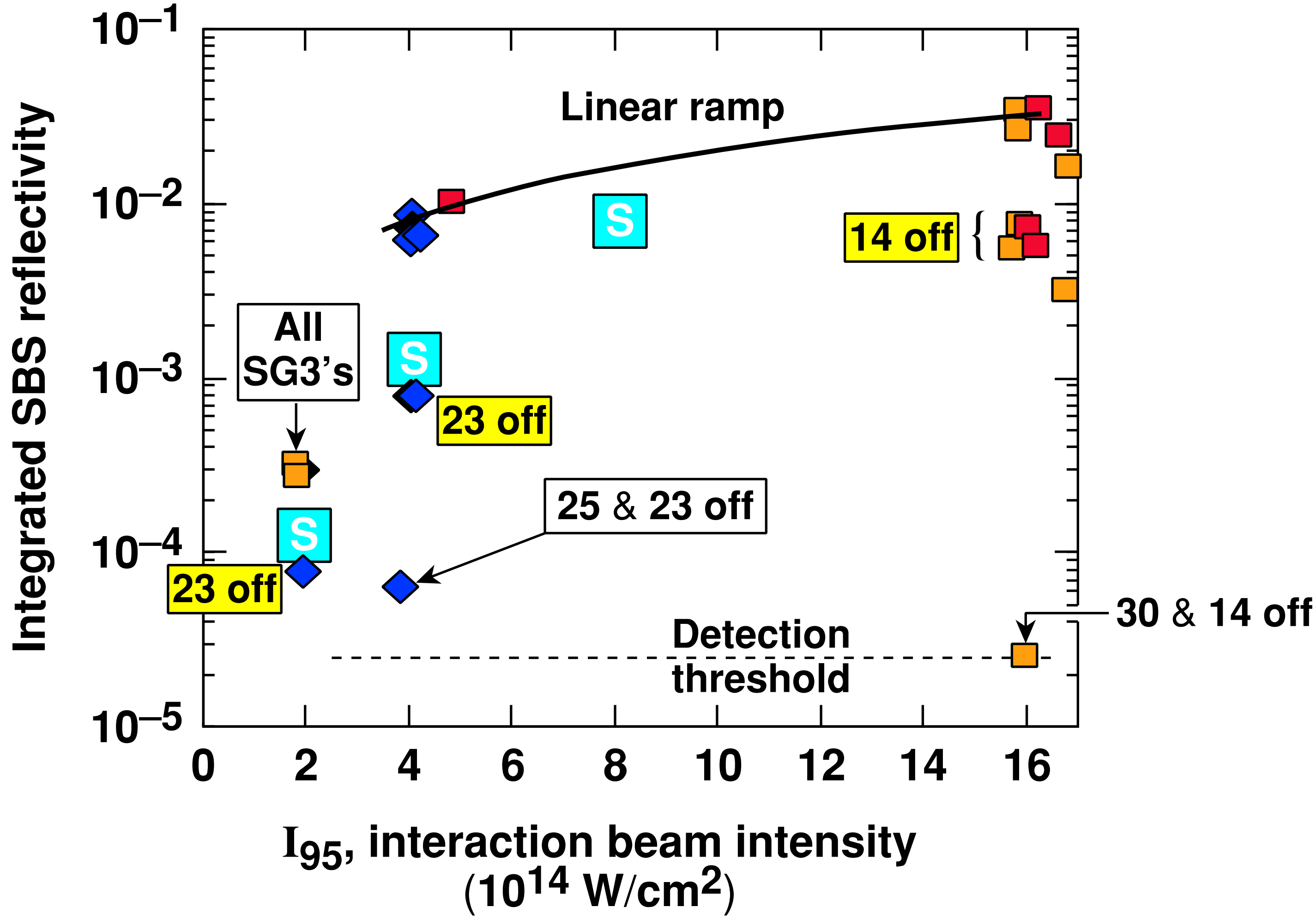


Note: The specularly reflected light increases with time due to heating of the plasma.

- **This supports the notion that common ion waves contribute to SBS sidescattering.**

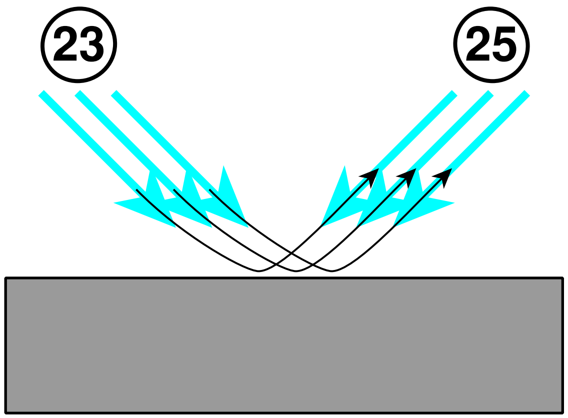
E10978

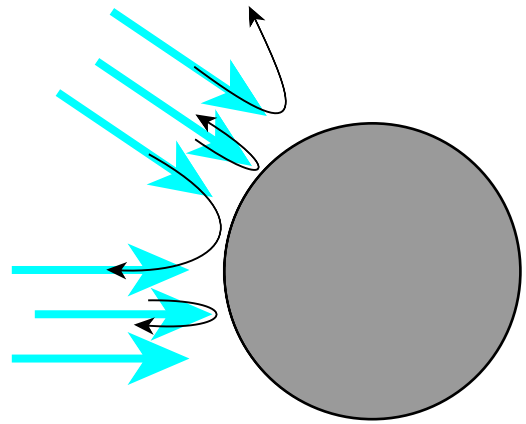
Present single-beam SBS data are consistent with older data



E10981

Multiple-beam experiments in planar geometry are only a rough approximation for spherical experiments





- Overlapping beams in planar targets are not exactly equivalent to overlapping beams in spherical geometry.
  - ♦ Energetically, seeding in planar geometry is much more efficient.
- The present experiments have approximately the right density scale lengths but the velocity scale lengths are too short.
- Single-beam interaction experiments at perpendicular incidence have reduced SBS seeds due to increased absorption near the critical density

Summary/Conclusions

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