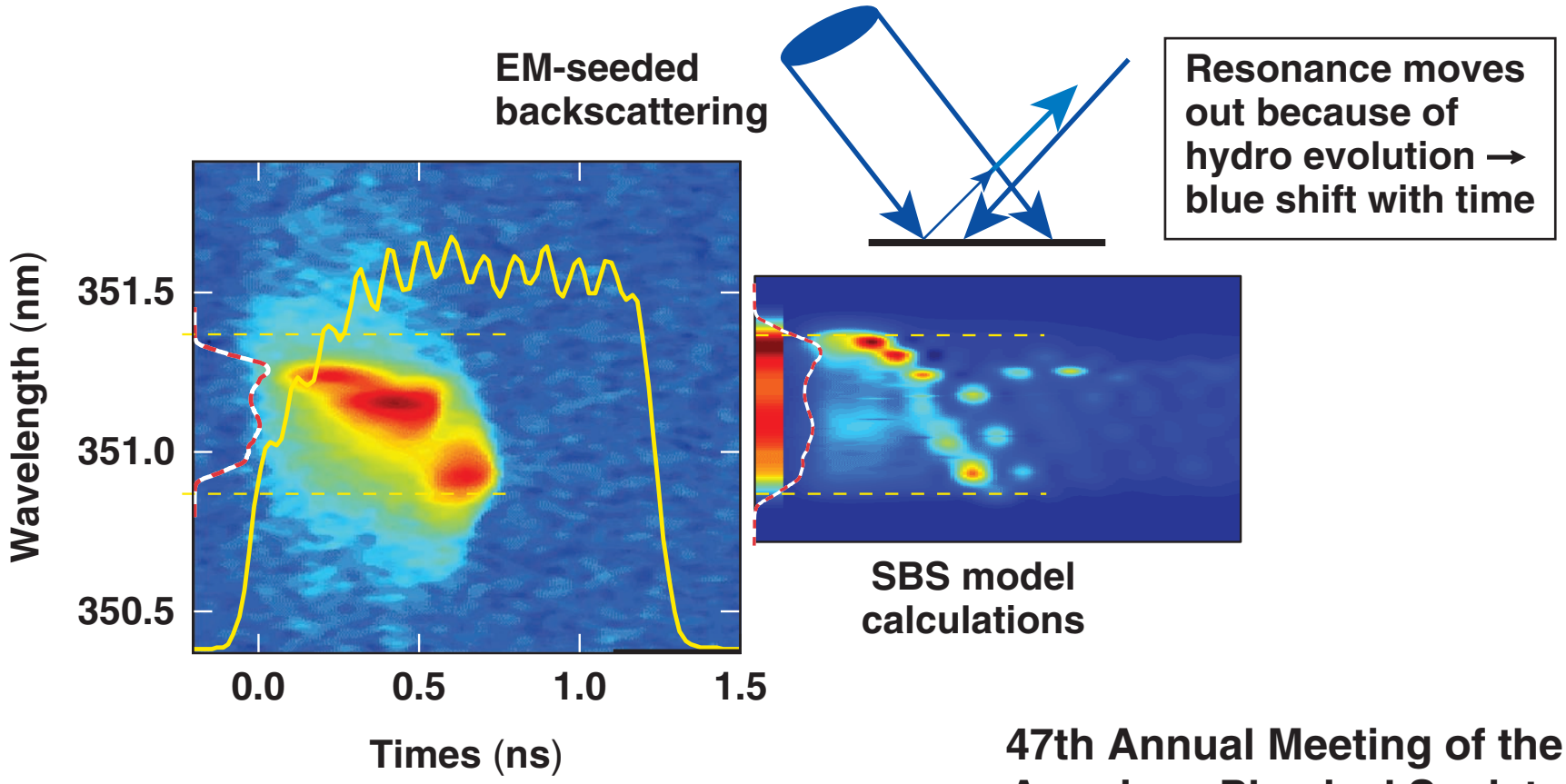
Stimlated Brillouin Scattering in Plasmas Relevant to Direct-Drive Laser Fusion

UR LLE



W. Seka *et al*.
University of Rochester
Laboratory for Laser Energetics

47th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
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Summary

Present OMEGA long-scale-length experiments establish the importance of electromagnetic seeding of SBS below the conventional threshold

UR LLE

- Flat velocity profiles (long gradient lengths) are predicted for direct-drive NIF ignition experiments and are reproduced in current OMEGA experiments.
- SBS strongly favors these regions. Simple model calculations agree well with current SBS spectra and their temporal behavior.
- Electromagnetic (EM) seeding in these experiments has been clearly established.
- The importance of EM-seeded SBS near n_c in NIF direct-drive experiments still has to be evaluated.

Collaborators

**J. Myatt, A. V. Maximov, R. S. Craxton,
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H. Baldis

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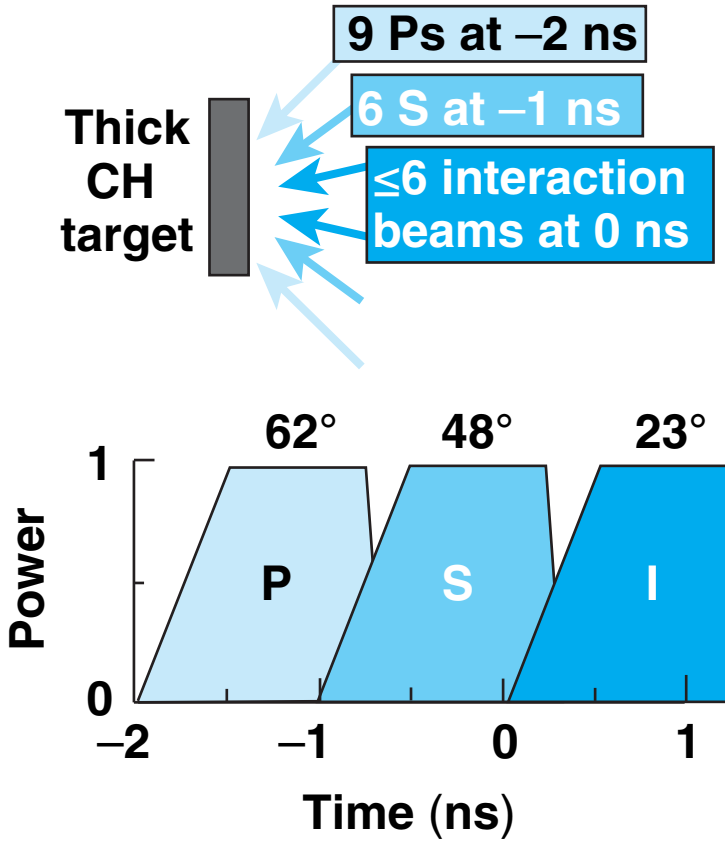
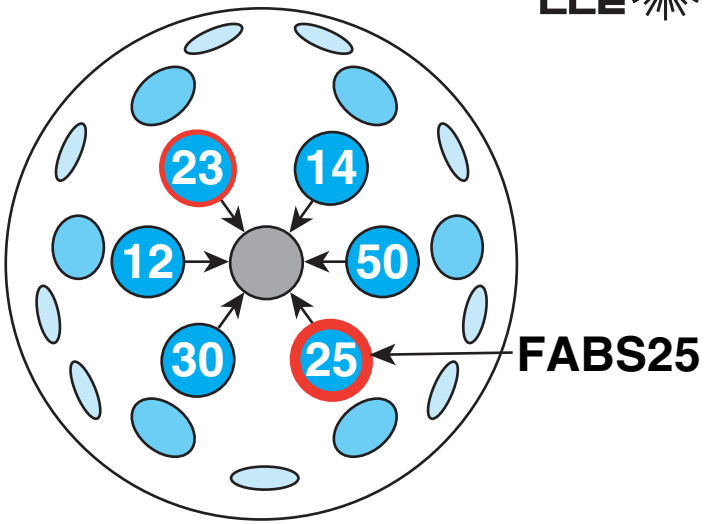
Lawrence Livermore National Laboratory**

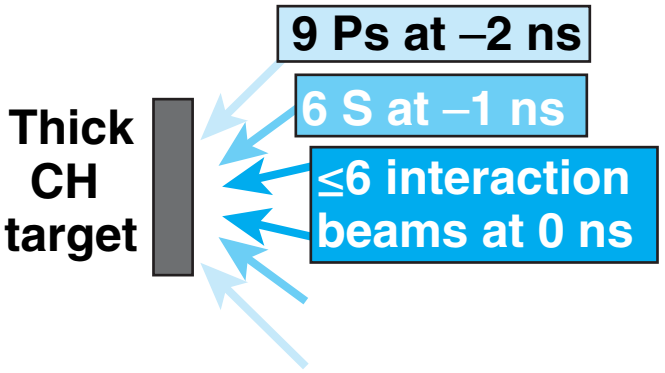
OMEGA long scale lengths experiments use multiple interaction beams at oblique incidence to identify EM-seeded SBS

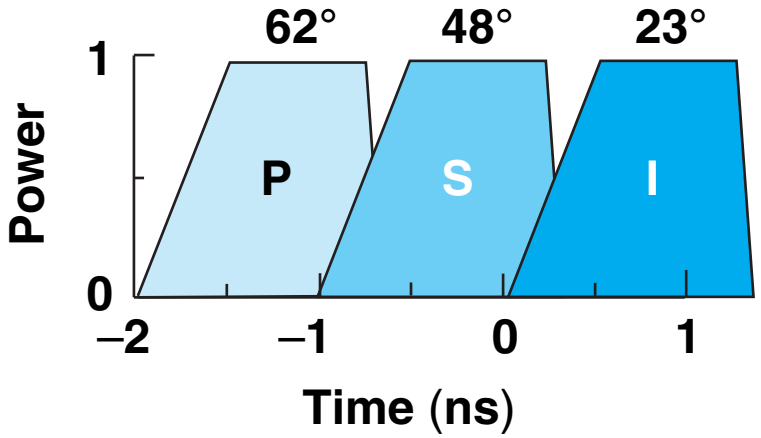


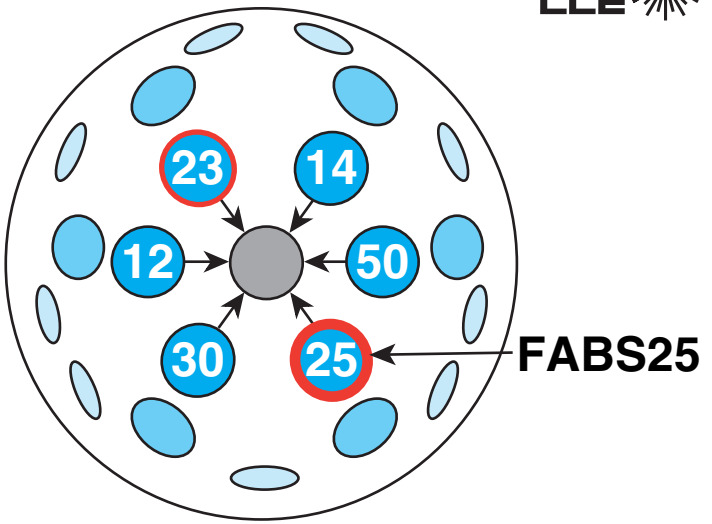


E10977c

OMEGA long-scale-length experiments use multiple interaction beams at oblique incidence to identify EM-seeded SBS





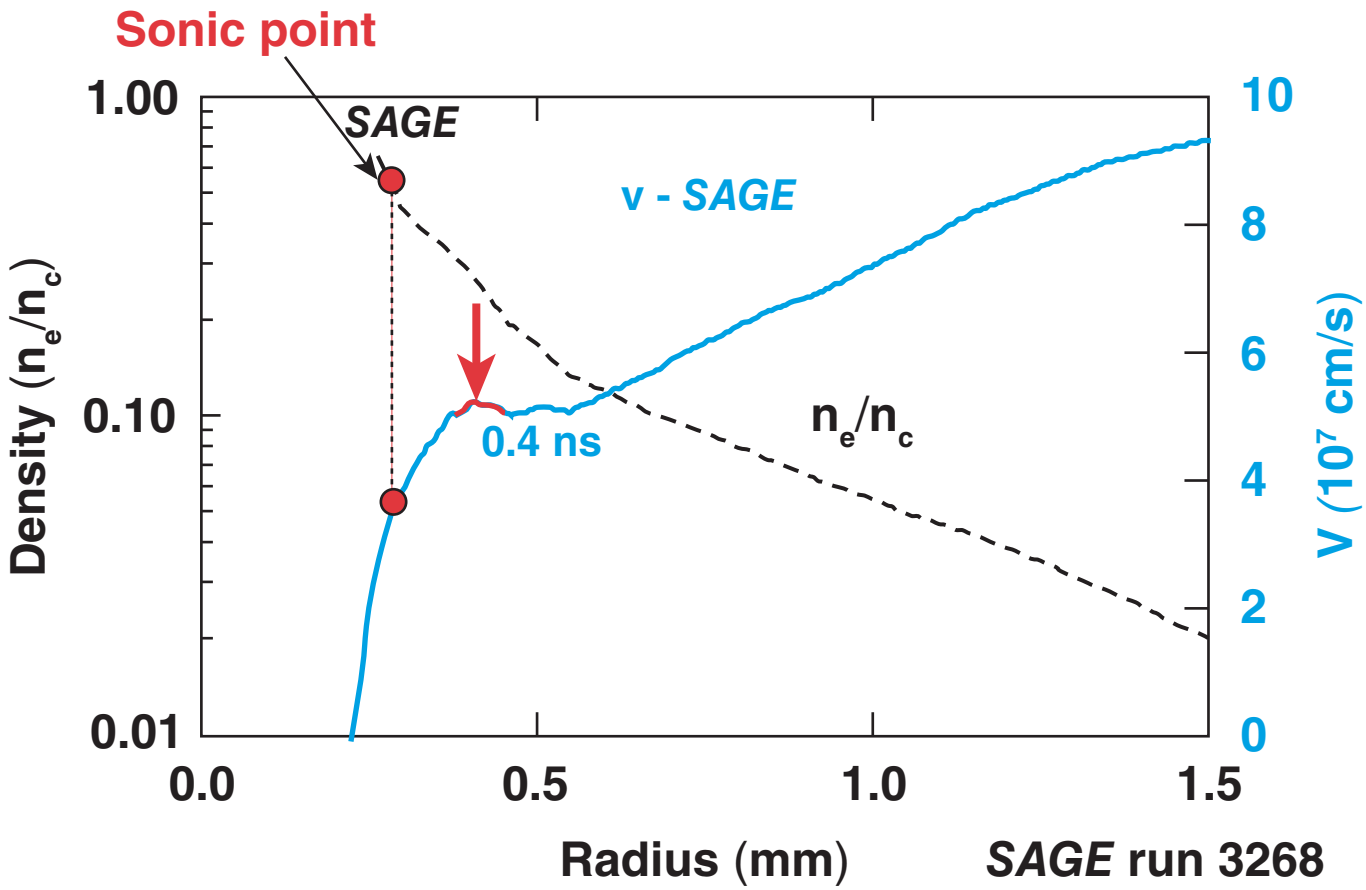


- FABS25 observes
  - SBS backscatter (25)
  - Specular reflection and seeded SBS sidescatter (23)
  - Enhanced sidescatter if (23) and (25) are present

- This permits separation of pure SBS and EM-seeded SBS

E10977d

NIF plasma conditions are reasonably well approximated by *SAGE* predictions for OMEGA experiments for $n_e < n_c/4$



E13885a

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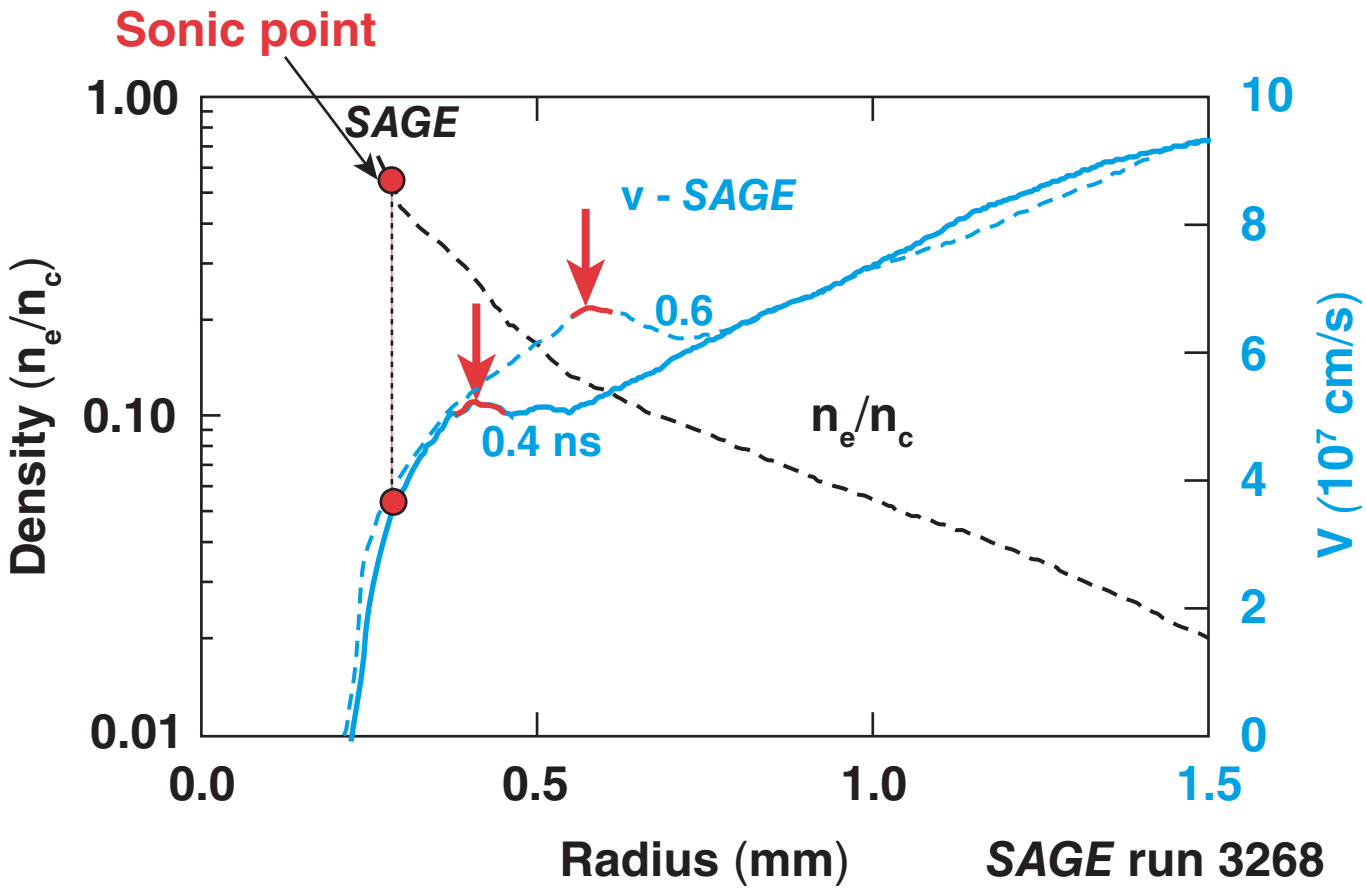

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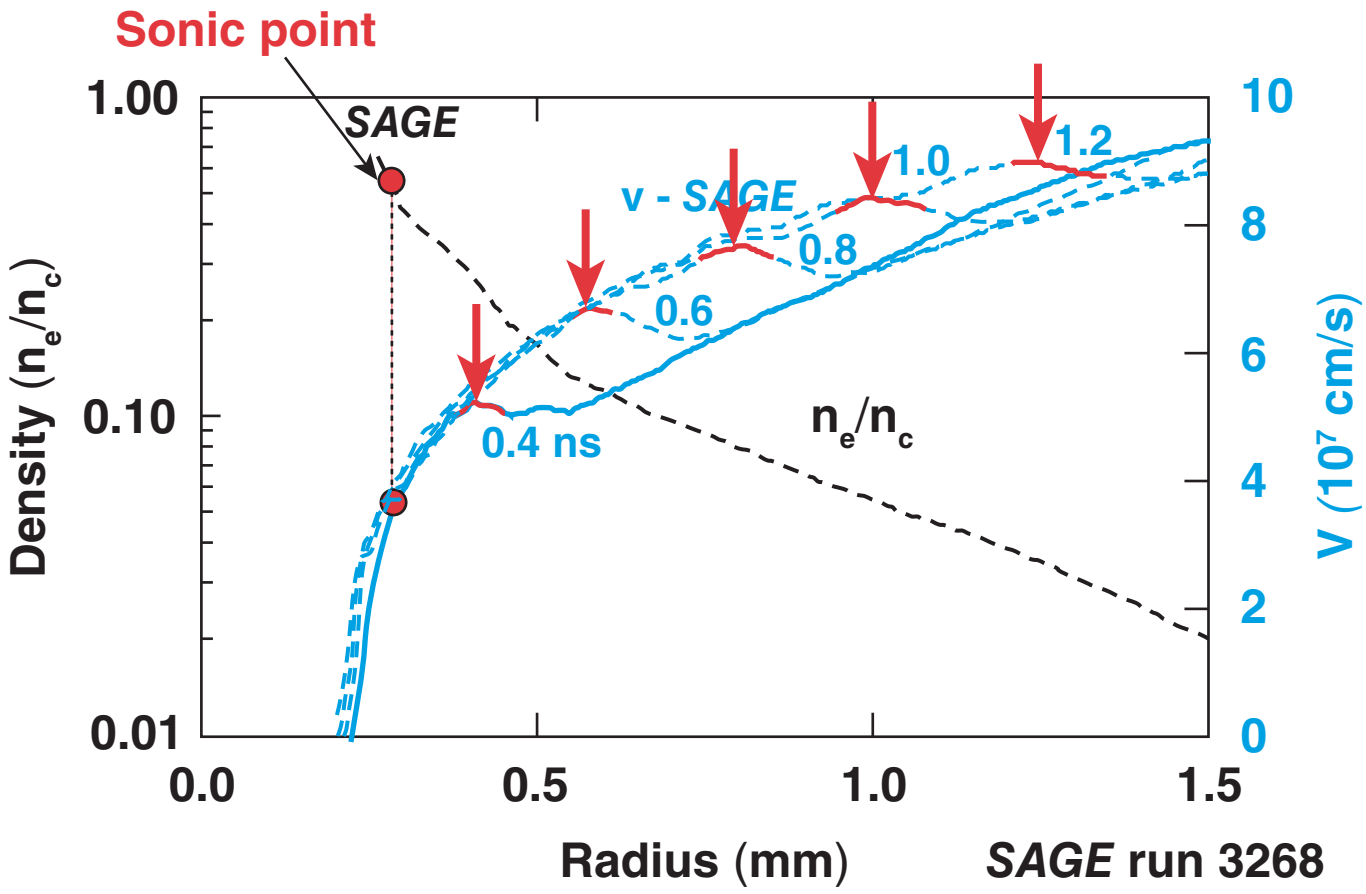

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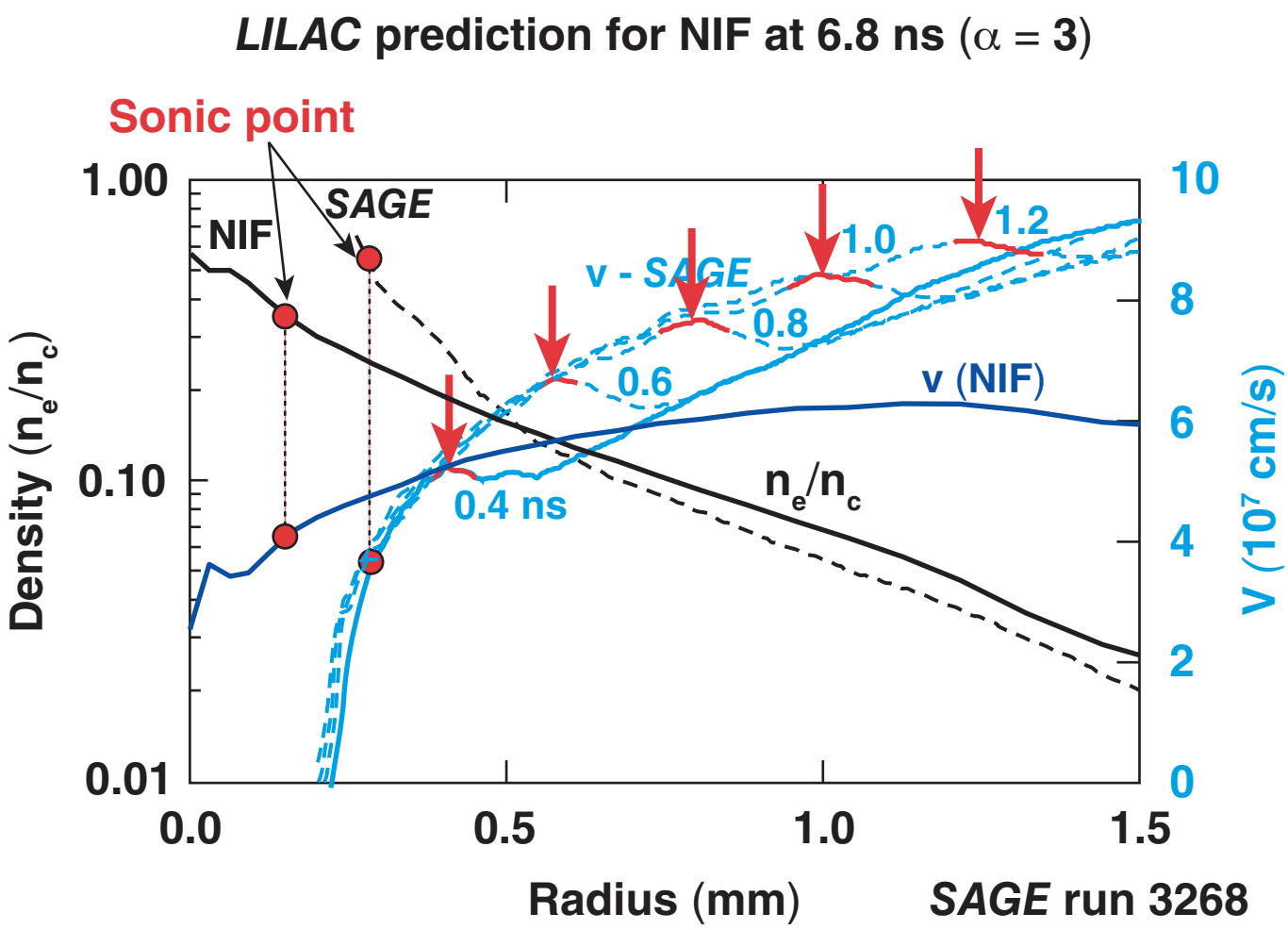
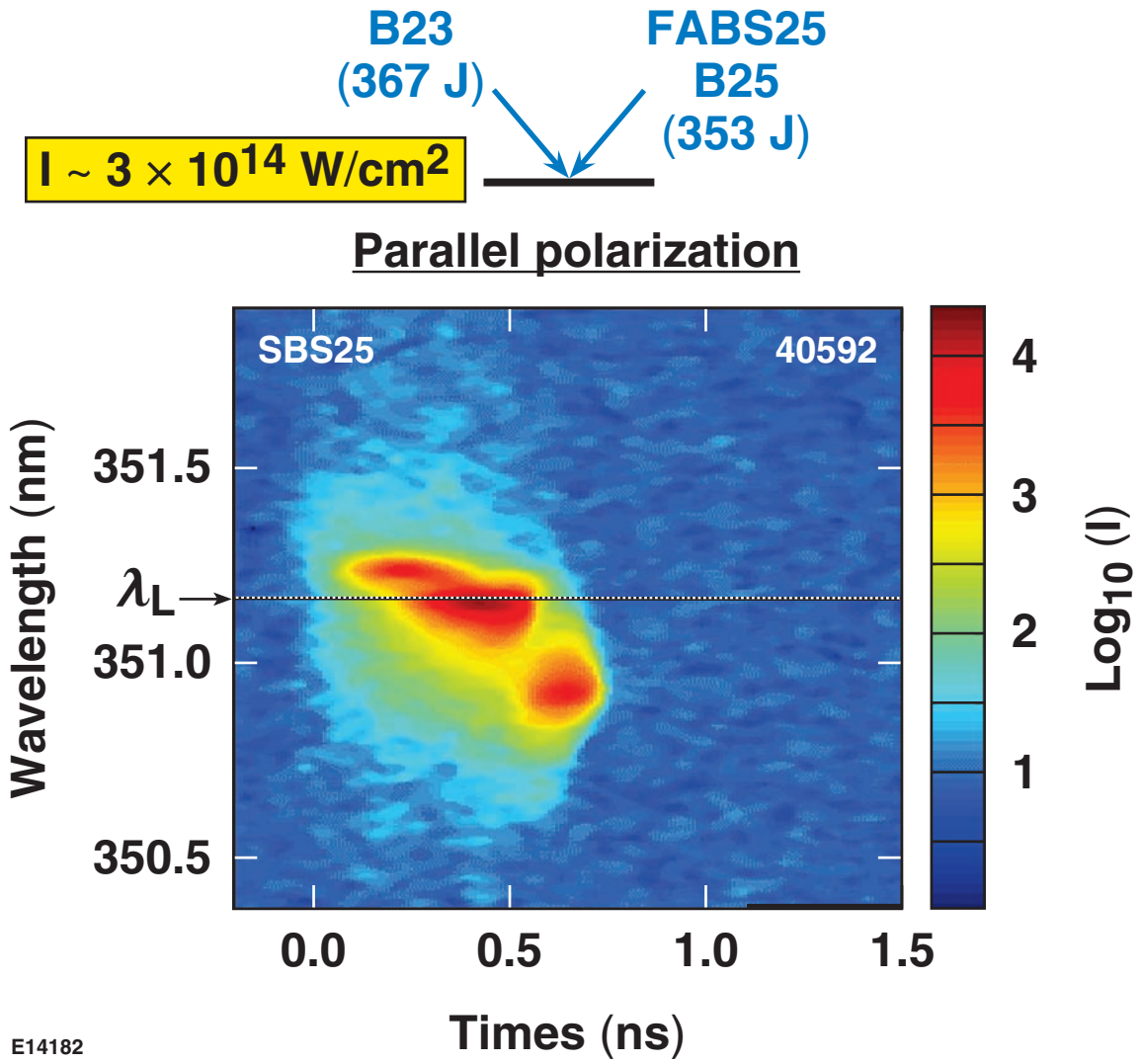


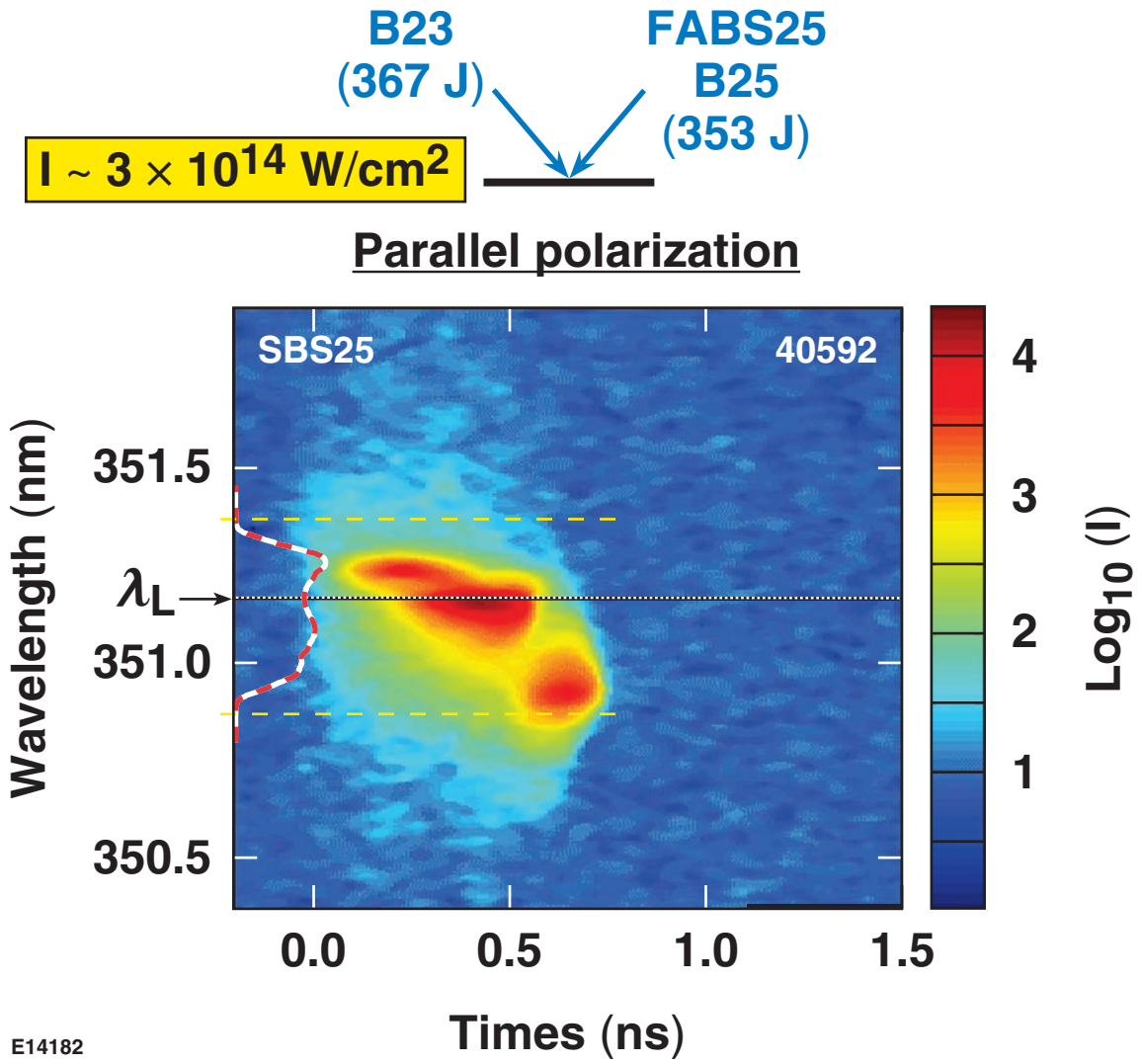
E13885a

Electromagnetic seeding of SBS from specular reflection is apparent in the amplitude and spectrum of scattered light



E14182

Electromagnetic seeding of SBS from specular reflection is apparent in the amplitude and spectrum of scattered light



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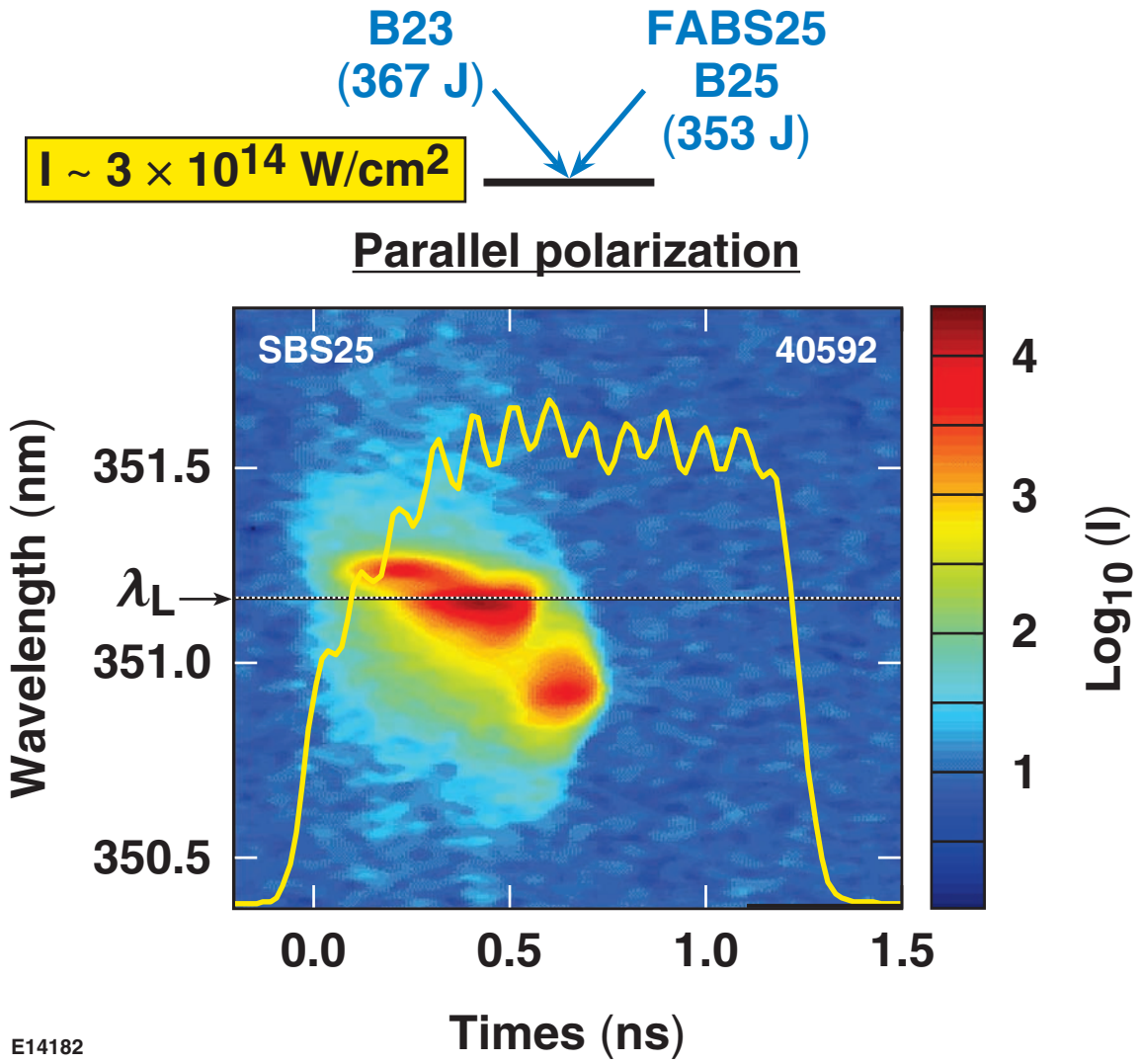

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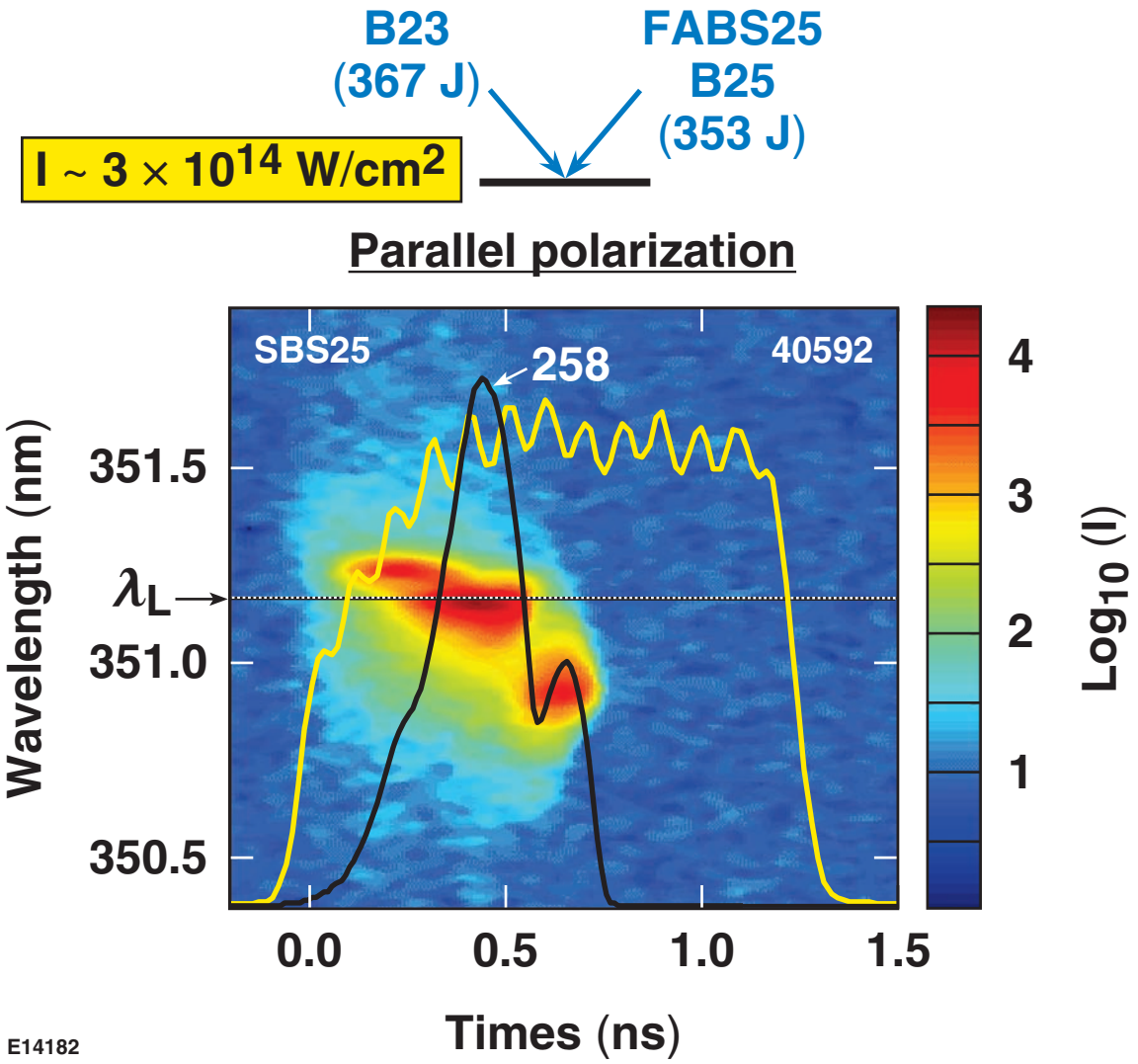

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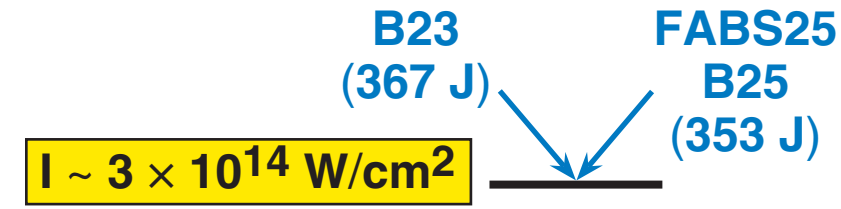
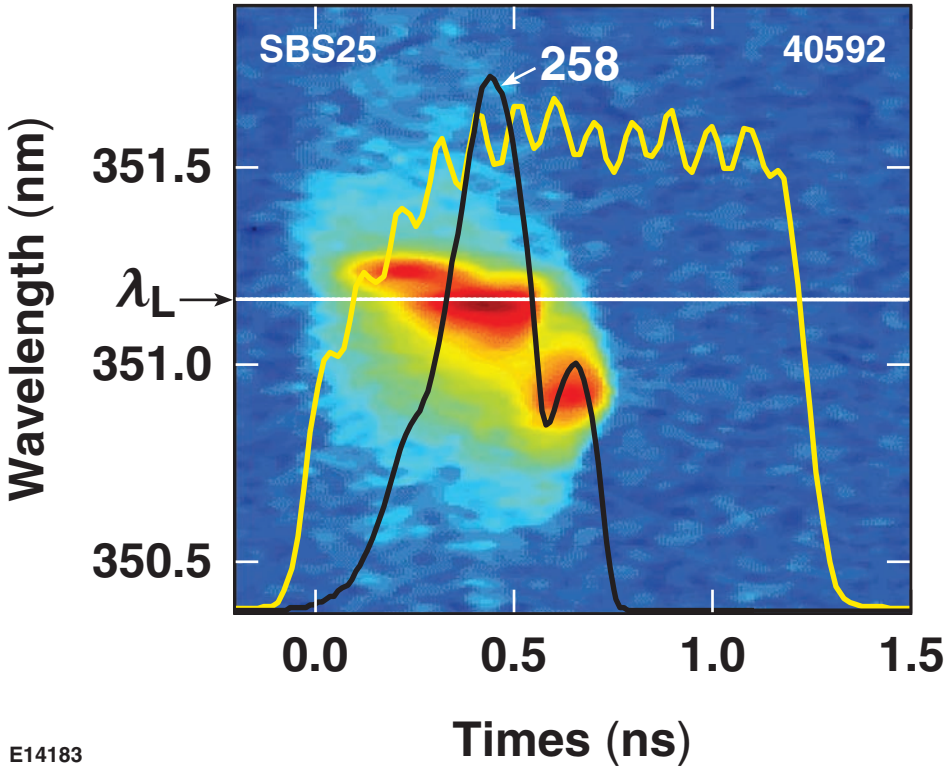
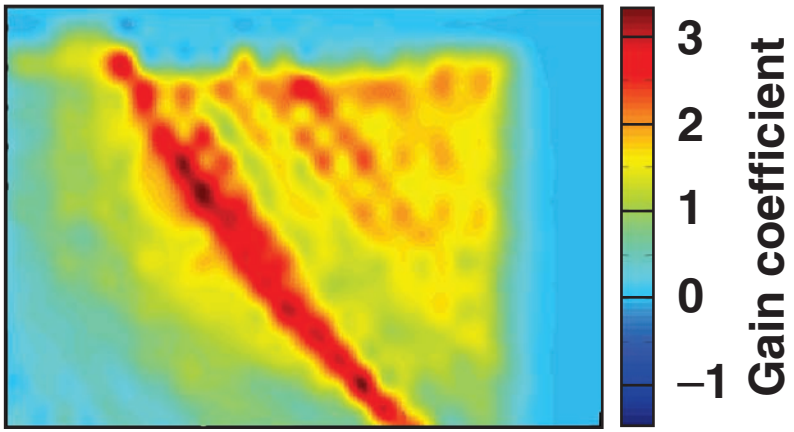


Parallel polarization



- SBS gain coefficient calculated for 3×10^{14} W/cm^2 and plasma conditions given by 2-D *SAGE* predictions



E14183

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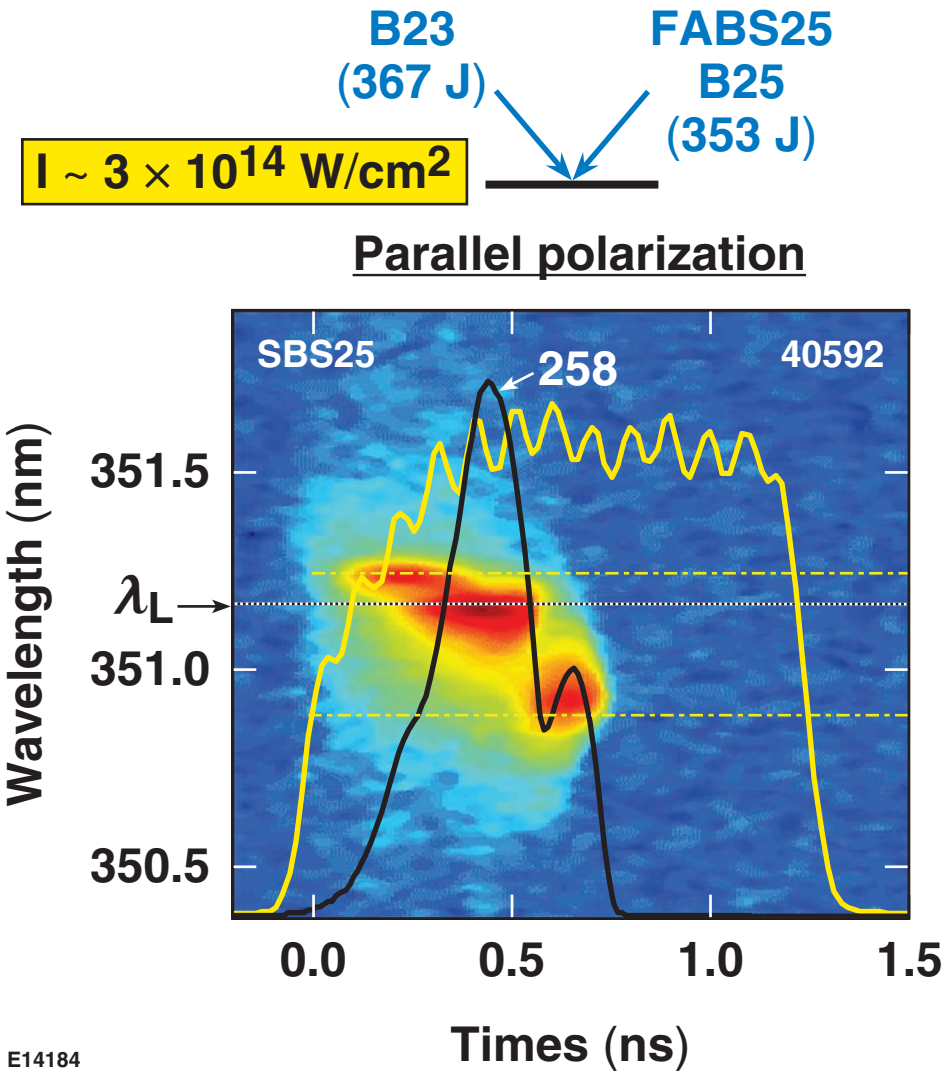

E14184

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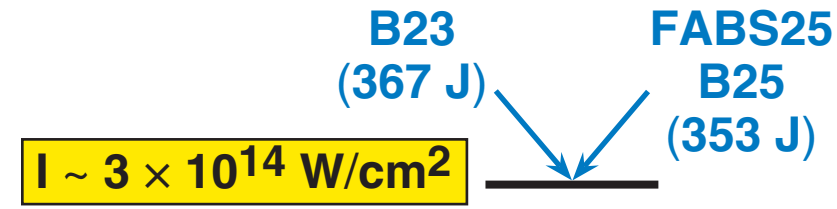
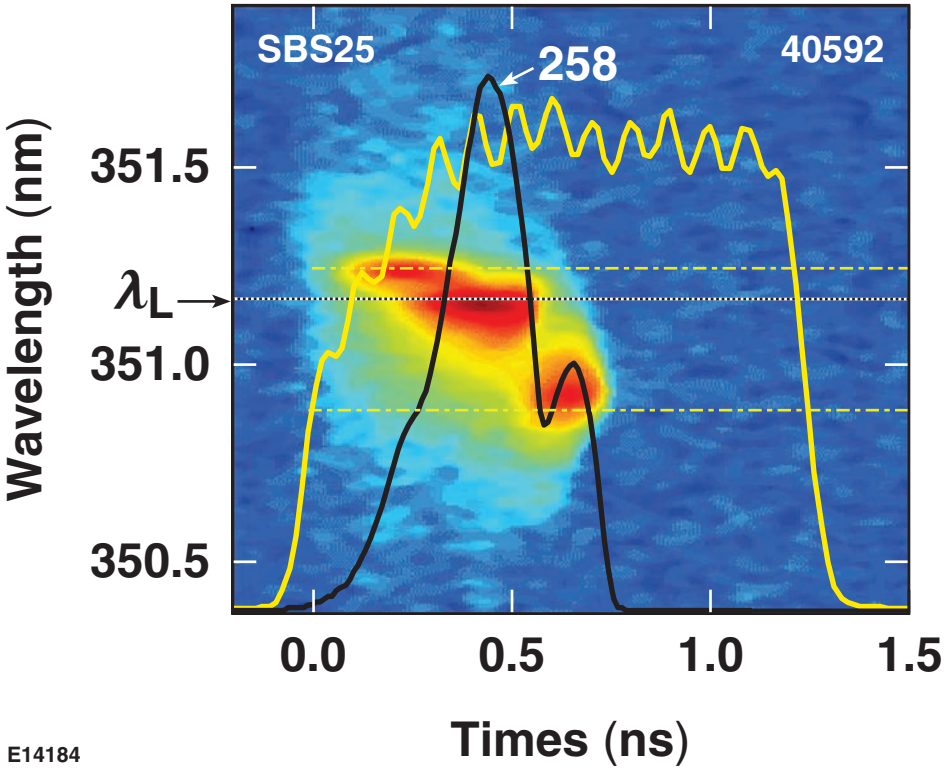
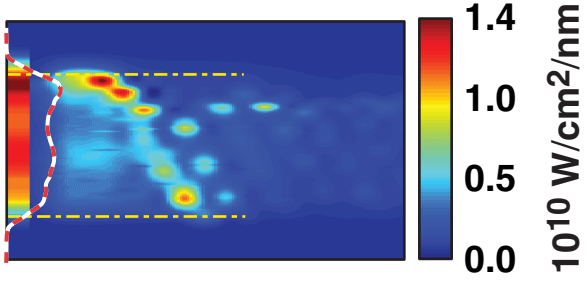
UR LLE



Parallel polarization



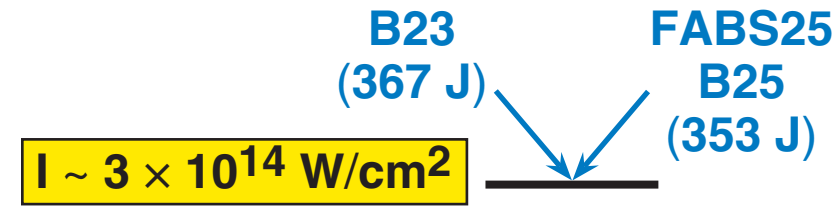


SBS model calculations for reflected spectral power (gain factor ~10×)

E14184

Electromagnetic seeding of SBS from specular reflection is apparent in the amplitude and spectrum of scattered light

UR LLE



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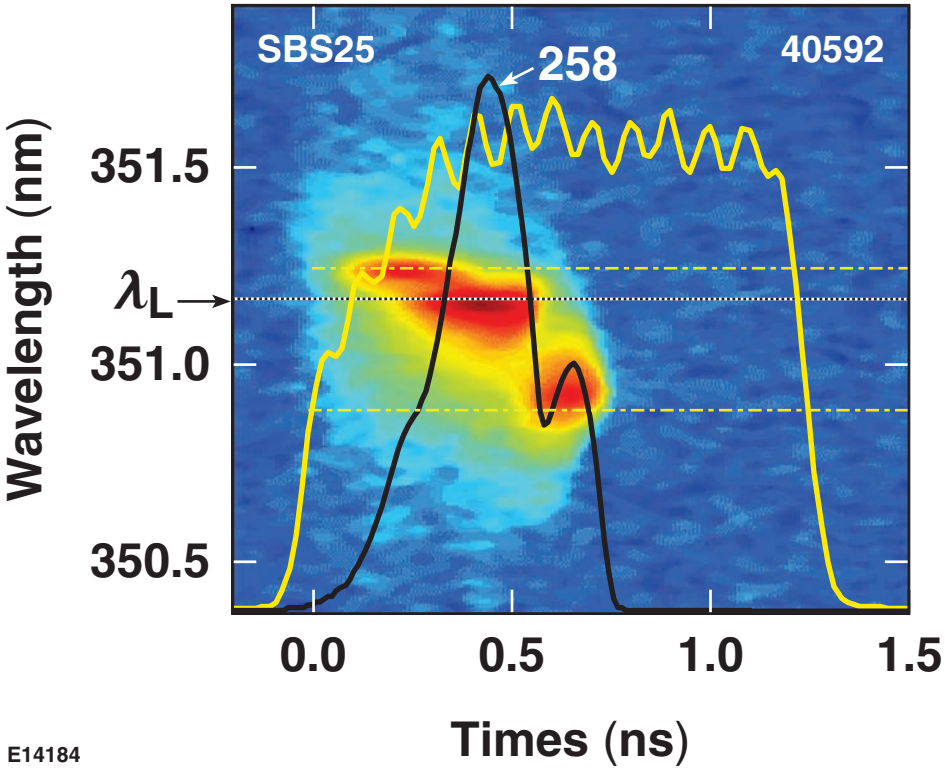

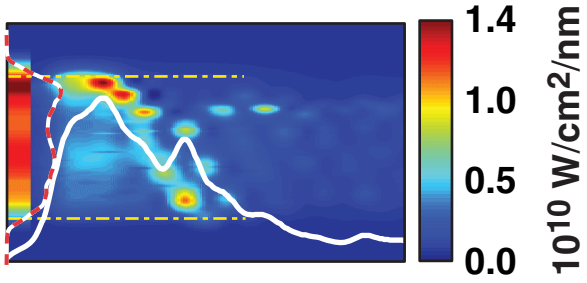

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E14184

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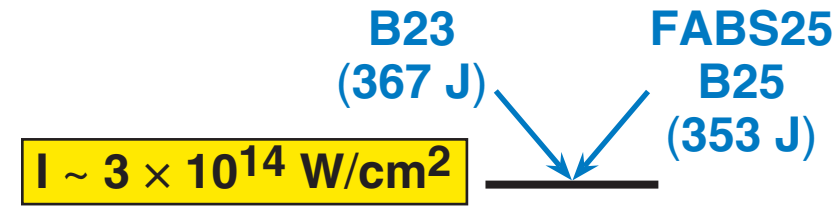

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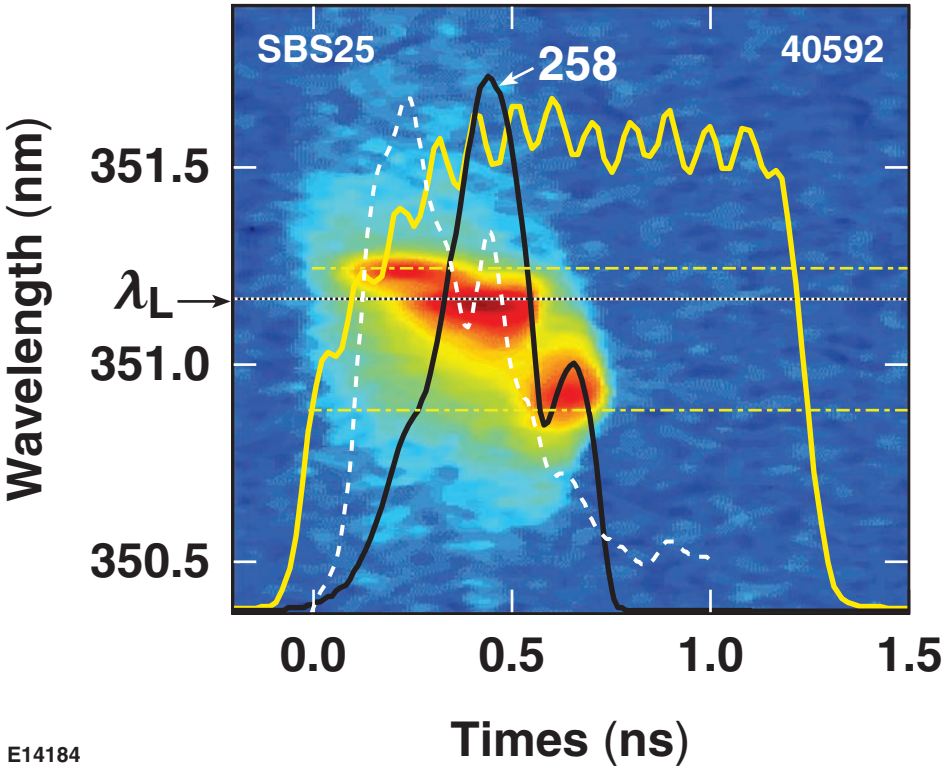

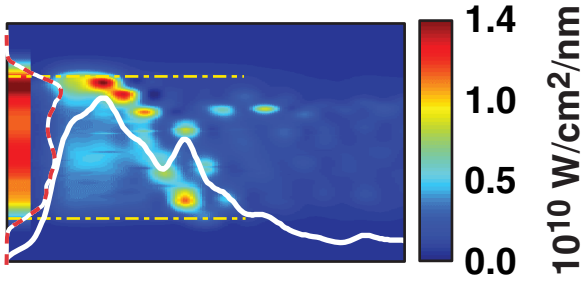

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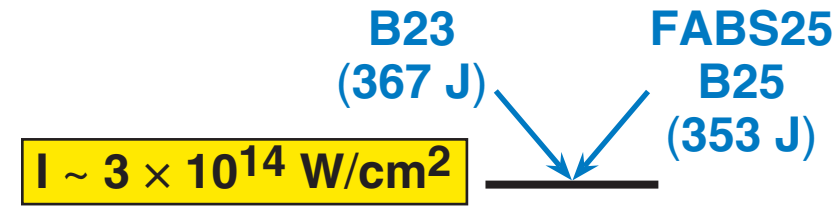

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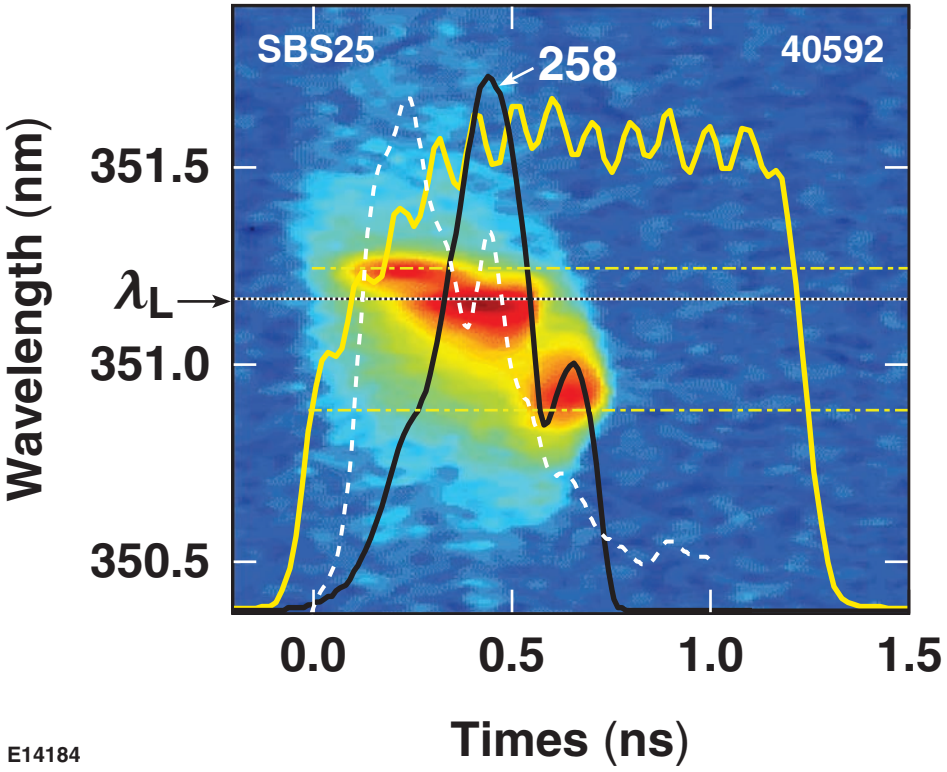
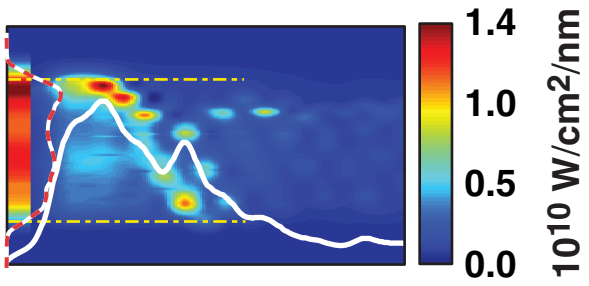


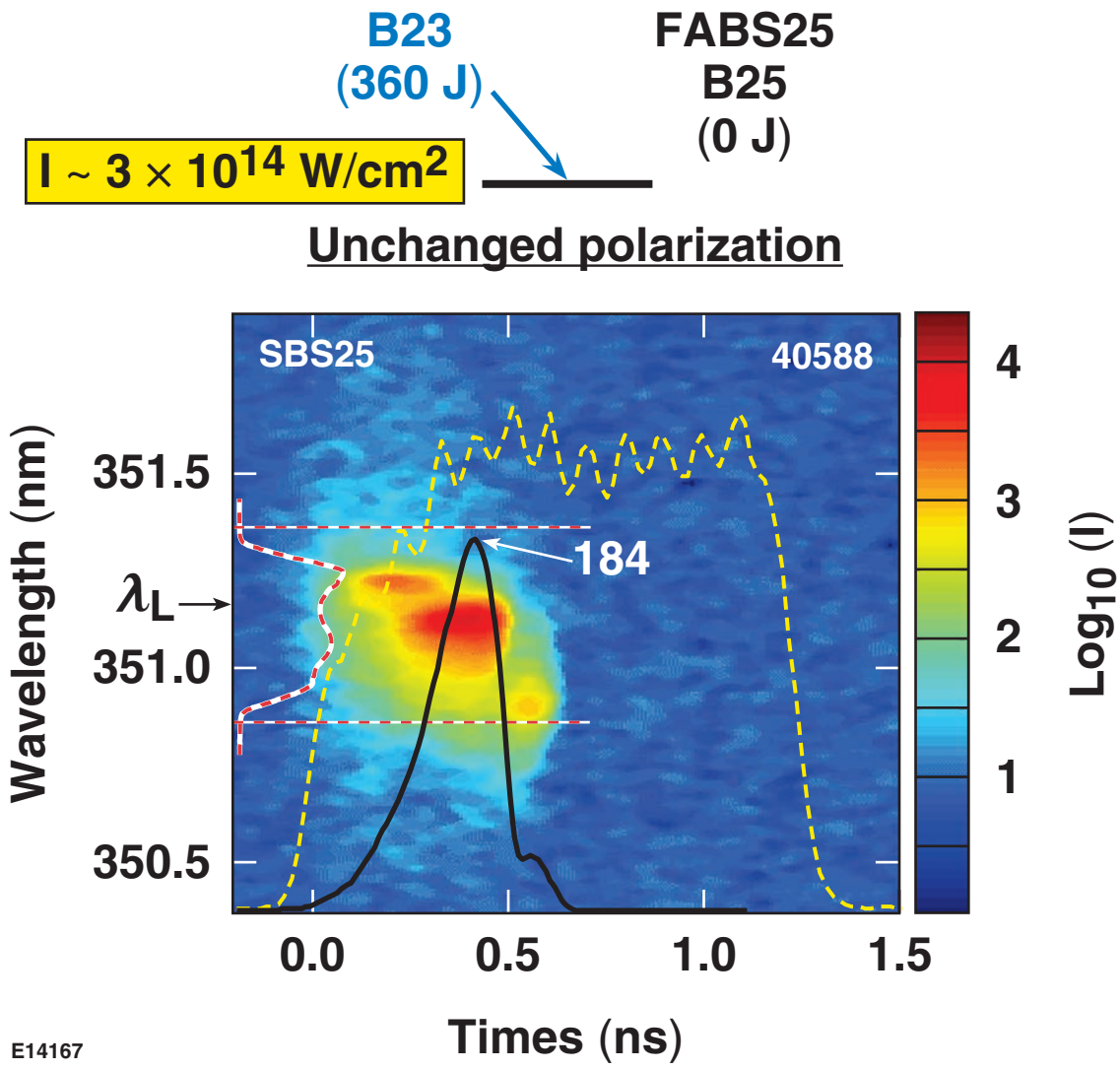
Note: these intensities are far below the SBS threshold for amplification from thermal noise and use only average intensities.



SBS model calculations for reflected spectral power (gain factor ~10×)

E14184

Electromagnetic seeding of SBS from specular reflection is apparent in the amplitude and spectrum of scattered light



E14167

Electromagnetic seeding of SBS from specular reflection is apparent in the amplitude and spectrum of scattered light

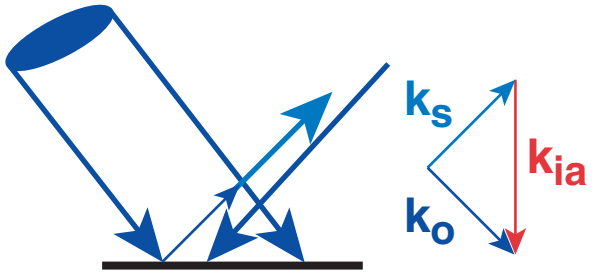
UR LLE

B23
(360 J)

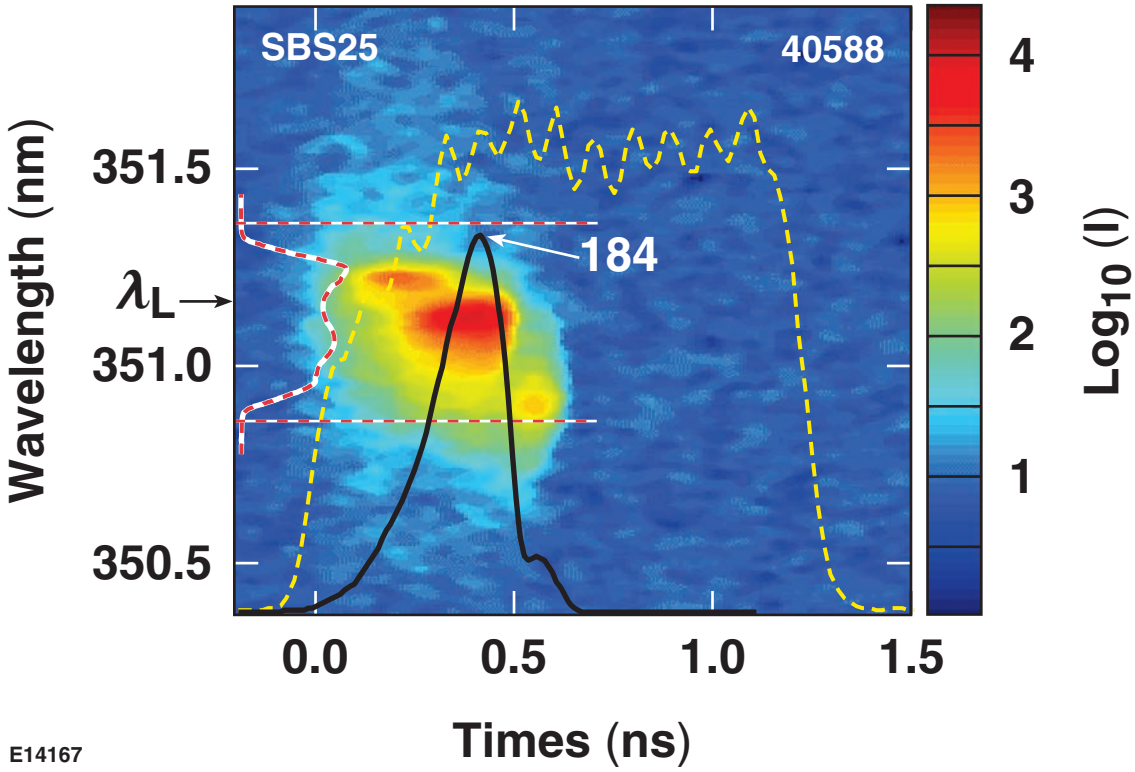
FABS25
B25
(0 J)

$I \sim 3 \times 10^{14}$ W/cm^2

EM-seeded sidescattering
EM-seeded backscattering



Unchanged polarization



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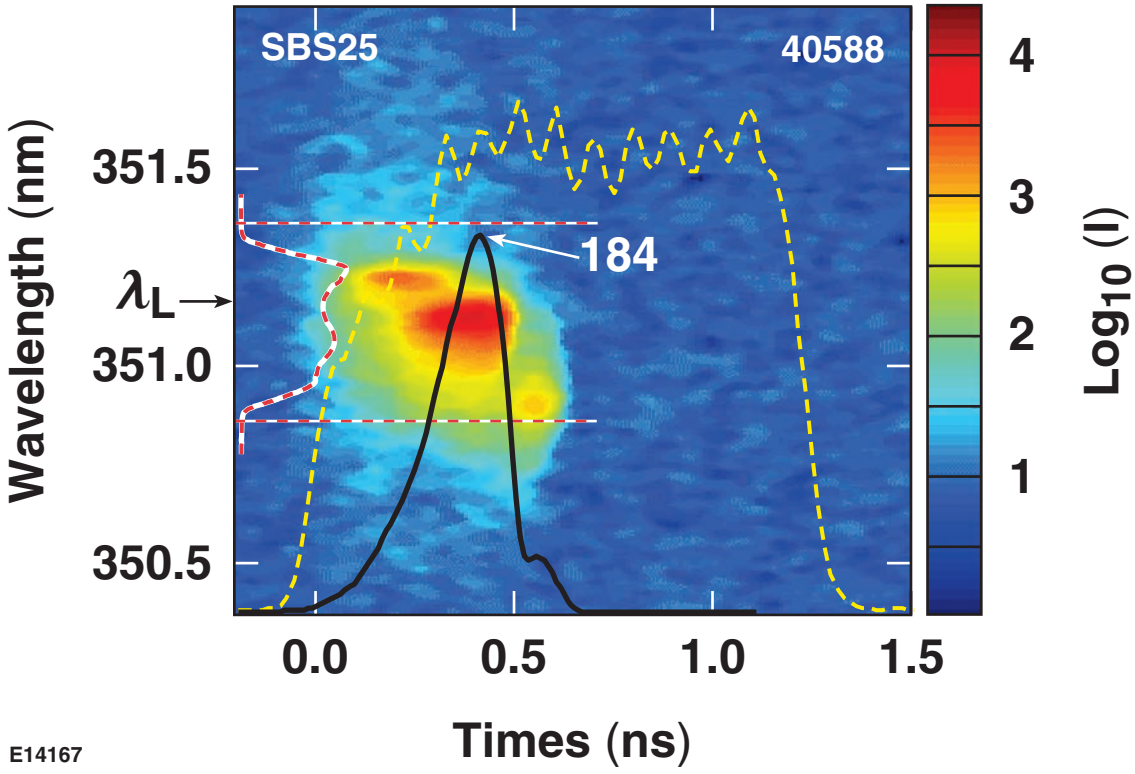

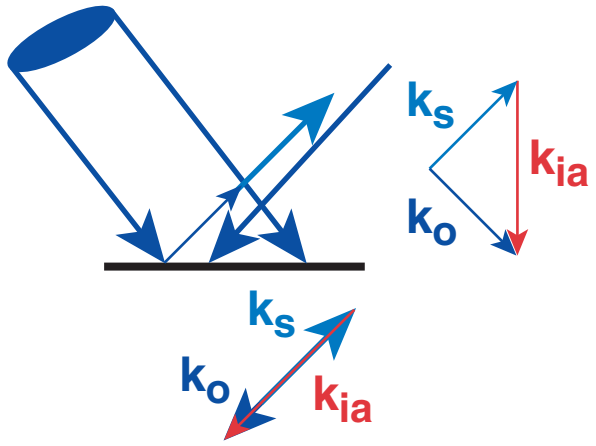

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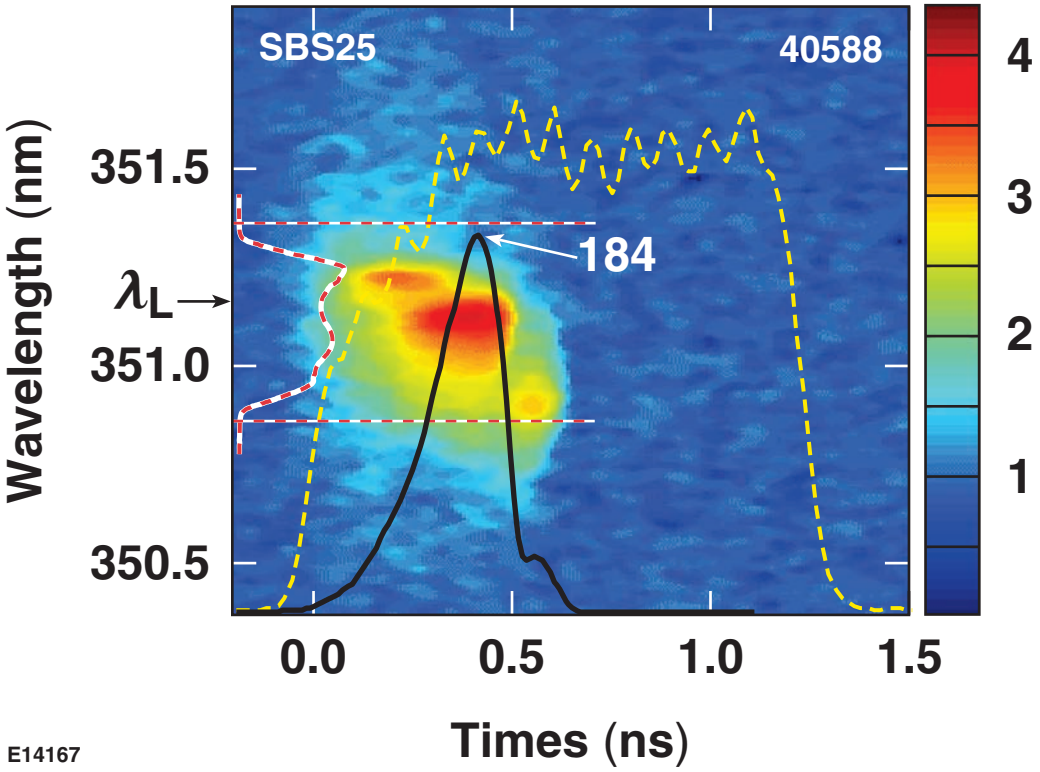

EM-seeded sidescattering
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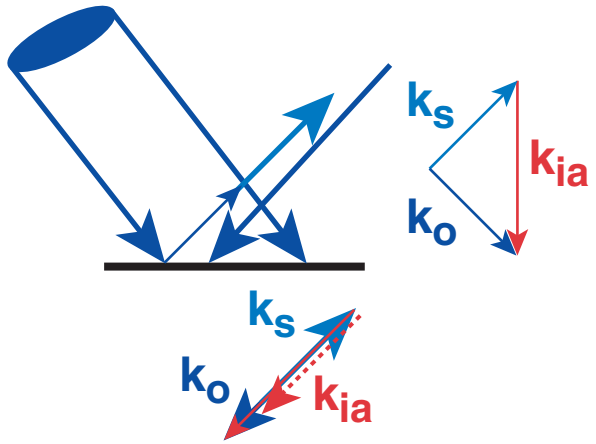
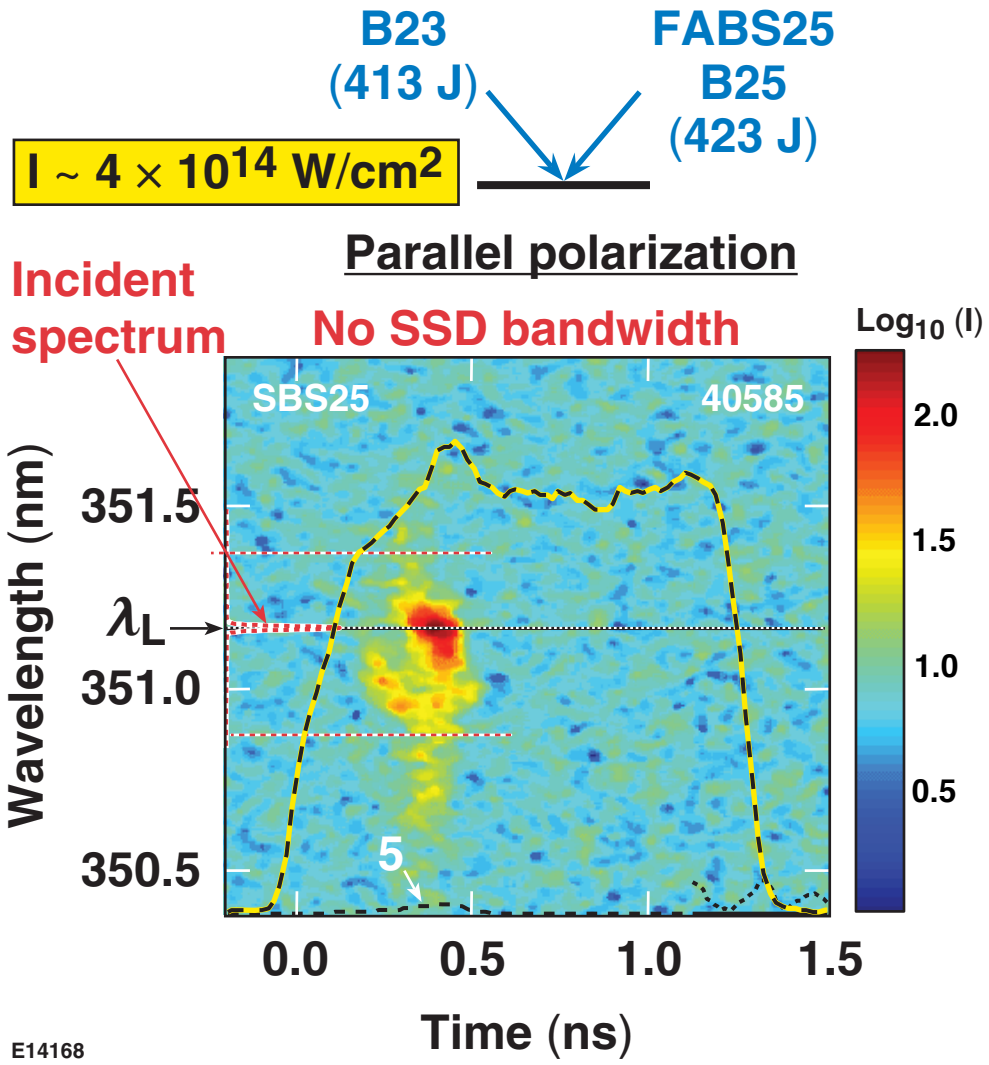


Since the SBS gain is $\propto k_{ia}$, the sidescatter SBS gain at 23° incidence is almost the same as for the backscatter.

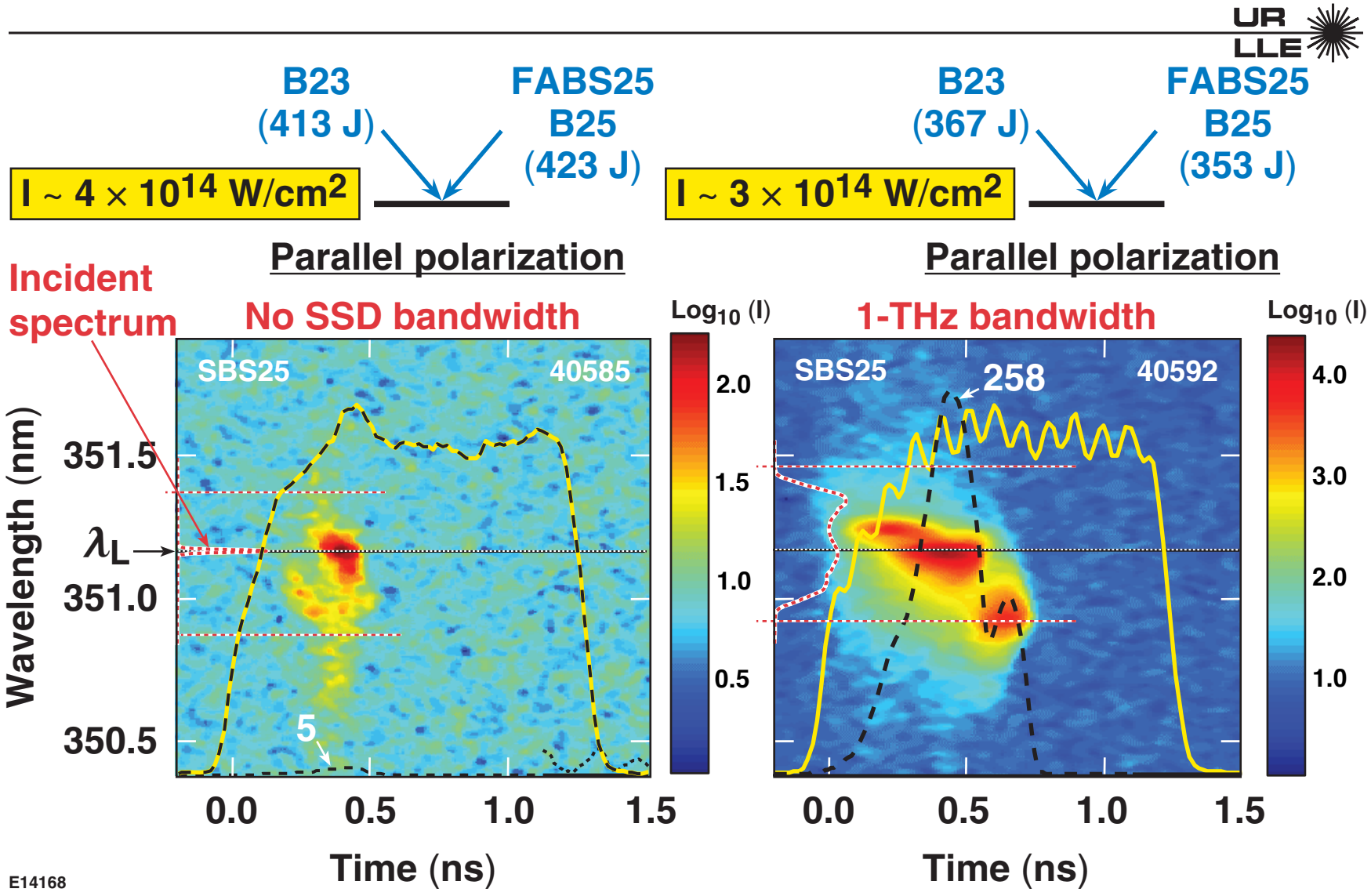
E14167

Without SSD, EM-seeded SBS occurs in a narrow-wavelength band, resulting in a short duration and low backscatter



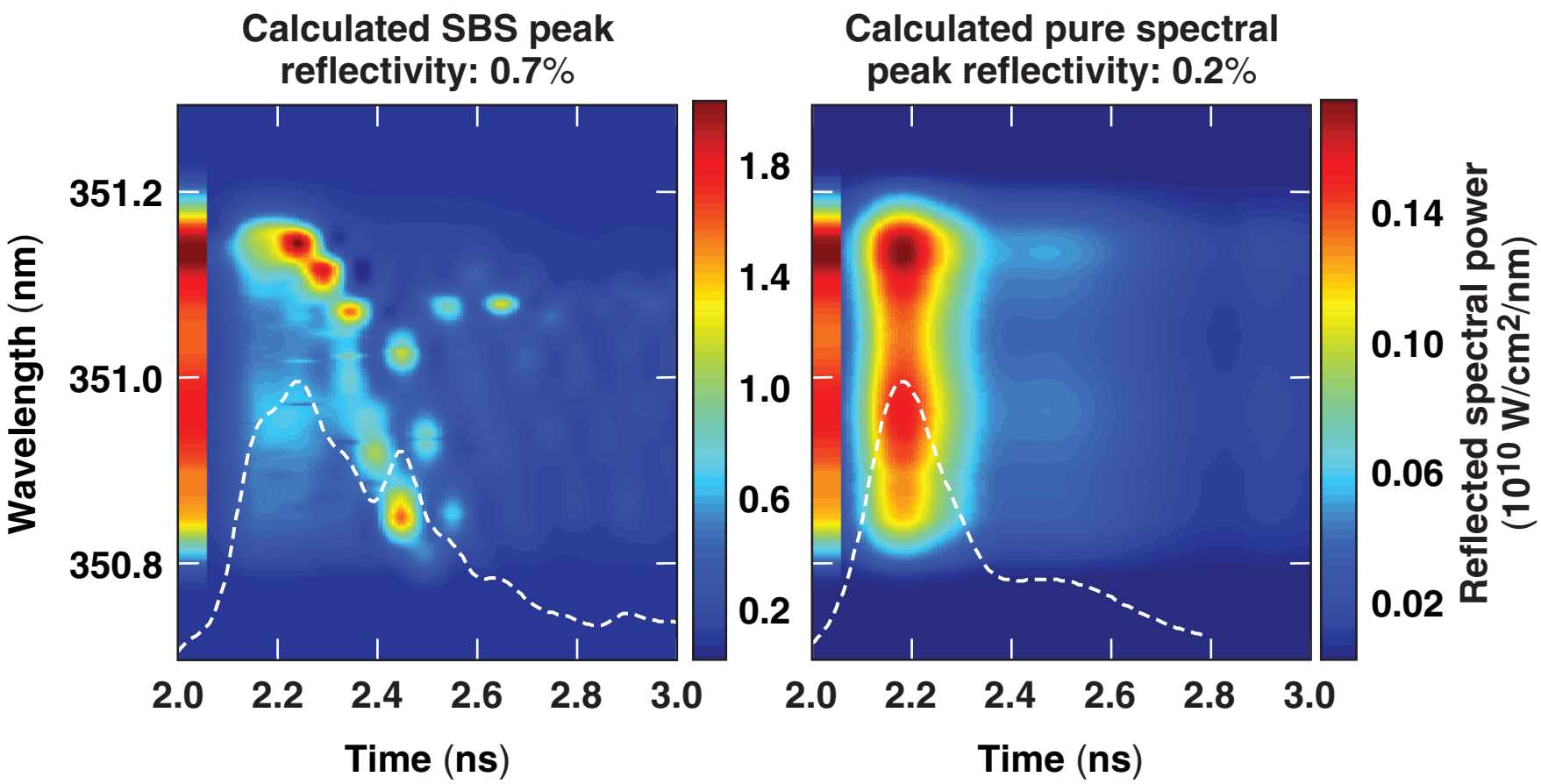
E14168

Without SSD, EM-seeded SBS occurs in a narrow-wavelength band, resulting in a short duration and low backscatter



E14168

Pure specular reflection and EM-seeded SBS are easily distinguished in the calculated spectra and the reflectivities

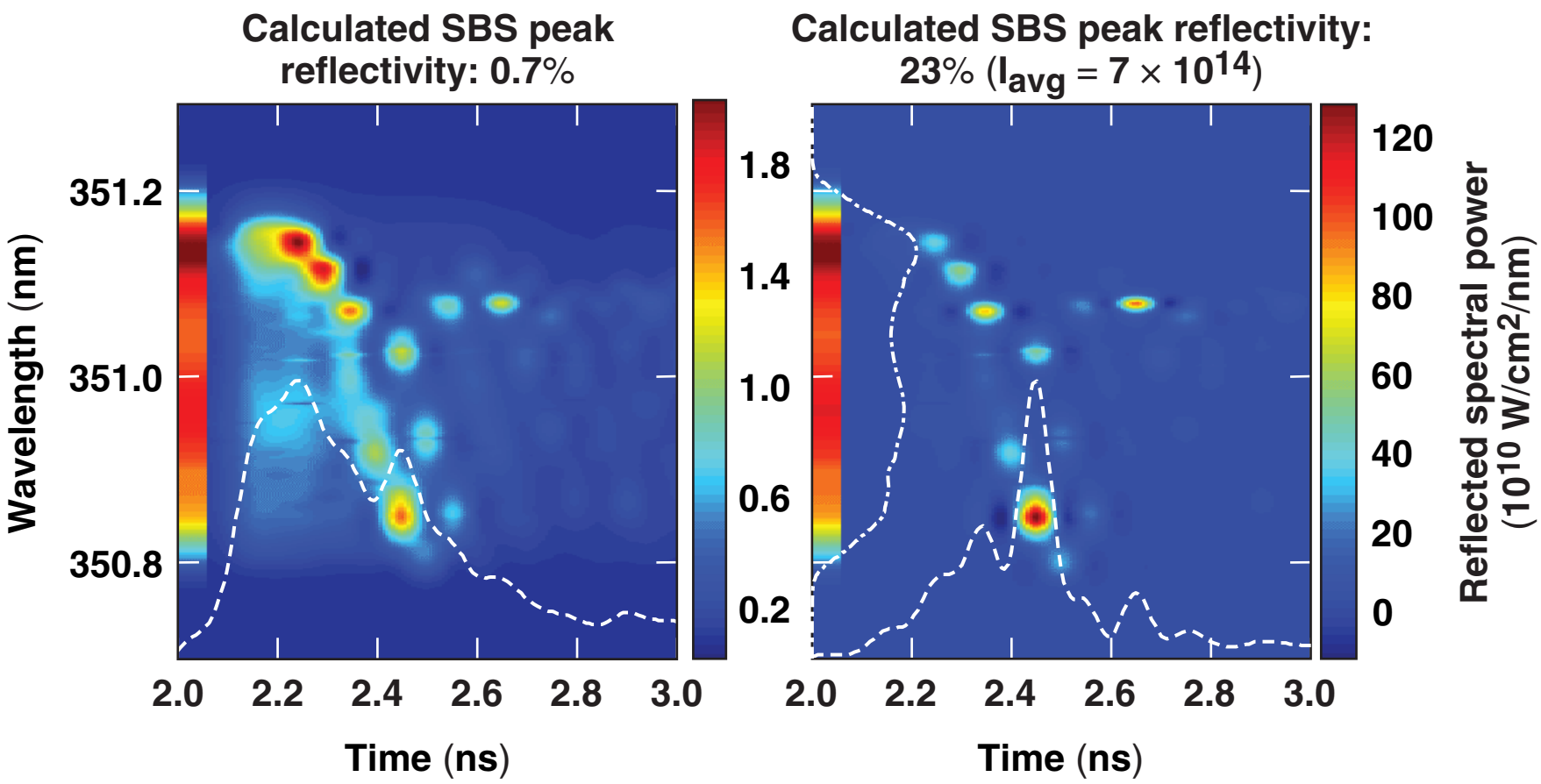


This model uses average intensities, ignoring the high-intensity speckle. Including the speckles would significantly raise the SBS scattered power.

E14169

Pure specular reflection and EM-seeded SBS are easily distinguished in the calculated spectra and the reflectivities

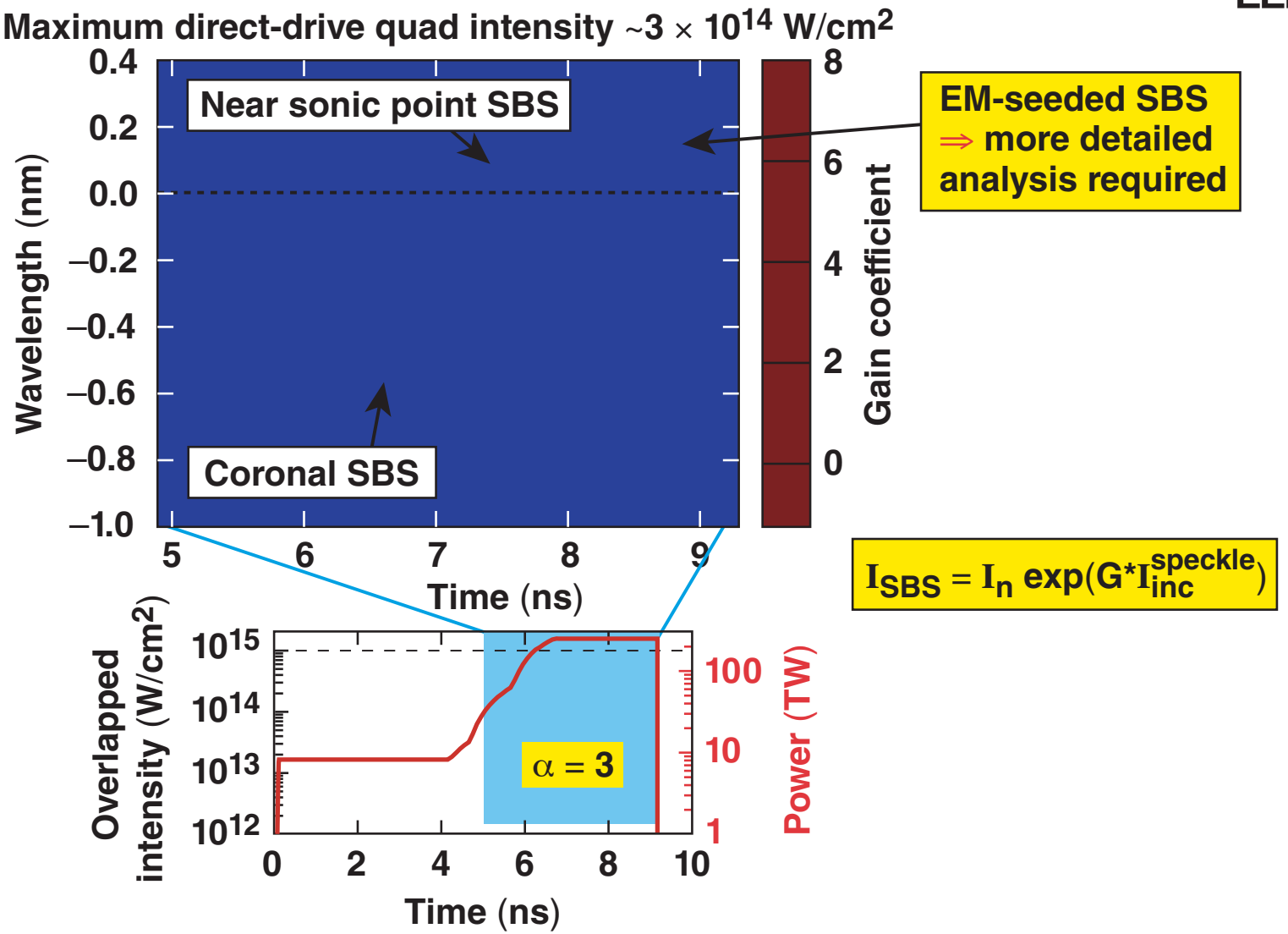
UR LLE



Assuming that ~5% of the intensity distribution has intensities $>I_{avg} = 7 \times 10^{14}$ W/cm^2 for $I_{avg} = 1.5 \times 10^{14}$ W/cm^2 → SBS reflection of ~2 to 3%.

E14191

SBS gain predictions for the NIF quad are similar to OMEGA in low-density corona; high-density SBS may be higher on the NIF



E13888

Summary/Conclusions

Present OMEGA long-scale-length experiments establish the importance of electromagnetic seeding of SBS below the conventional threshold

UR LLE

- Flat velocity profiles (long gradient lengths) are predicted for direct-drive NIF ignition experiments and are reproduced in current OMEGA experiments.
- SBS strongly favors these regions. Simple model calculations agree well with current SBS spectra and their temporal behavior.
- Electromagnetic (EM) seeding in these experiments has been clearly established.
- The importance of EM-seeded SBS near n_c in NIF direct-drive experiments still has to be evaluated.