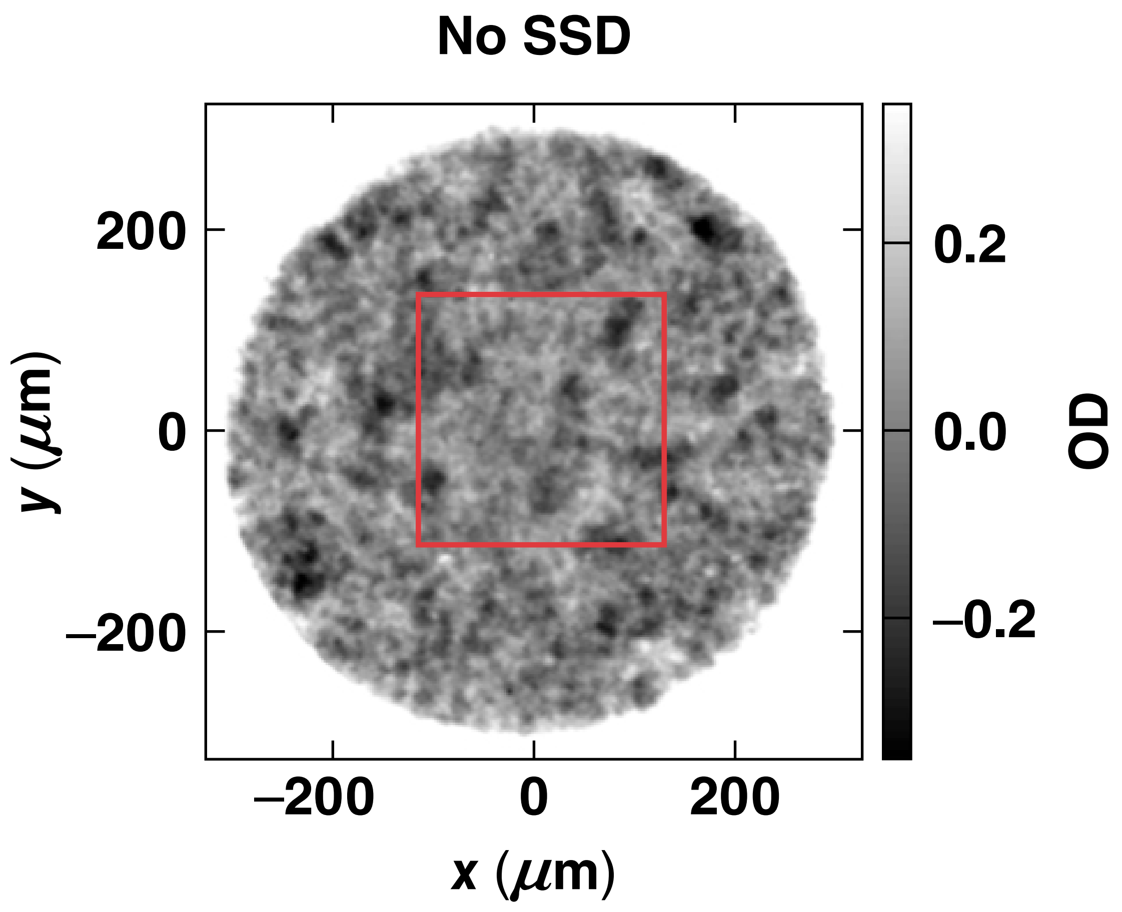
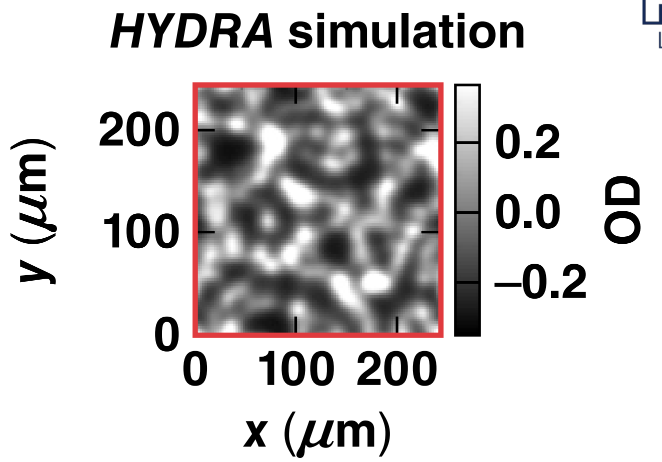
# Three-Dimensional Simulations of Flat-Foil Laser-Imprint Experiments at the National Ignition Facility

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Summary

# NIF* experiments were performed to measure imprint-seeded nonuniformities in planar foils driven with and without 45-GHz SSD applied to the laser pulse

- Excellent high-resolution x-ray radiography data with a clearly visible imprint signature were obtained
- Three-dimensional *HYDRA* simulations were used to capture 3-D physics of 1-D smoothing by spectral dispersion (SSD) and resolve all single-beam imprint modes
- Simulations predict a higher level of imprint, faster Rayleigh–Taylor (RT) growth rate, and early saturation time relative to experiments
- X-ray preheat from the backlighter is hypothesized to cause target preheat and reduce imprint

TC13896

*NIF: National Ignition Facility

# Collaborators

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M. Karasik

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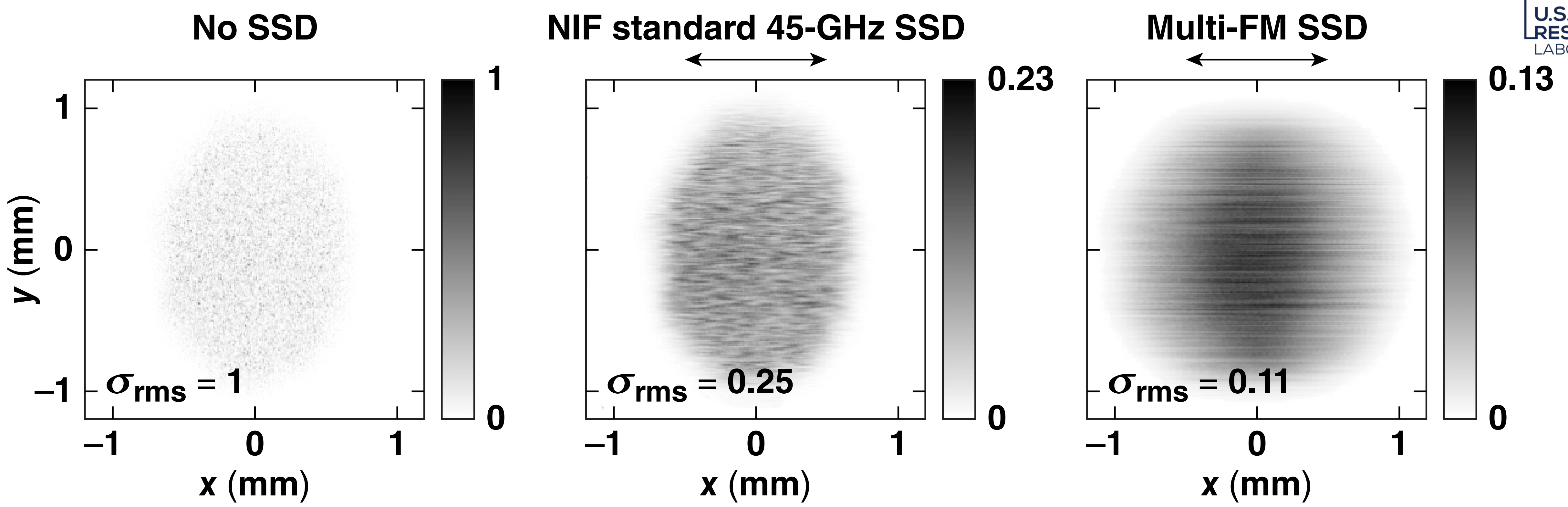
# Single-beam smoothing is required for high-performance direct-drive implosions on the NIF

Calculated time-integrated inner-cone (23.5°) beam intensity




**One-dimensional multi-FM SSD* (multifrequency modulation smoothing by spectral dispersion) has been validated** on a single quad (Q24B) of the NIF**

*J. A. Marozas, J. D. Zuegel, and T. J. B. Collins, Bull. Am. Phys. Soc. 55, 294 (2010).
**A. Shvydky *et al.*, Bull. Am. Phys. Soc. 61, BAPS.2016.DPP.JO5.3 (2016).

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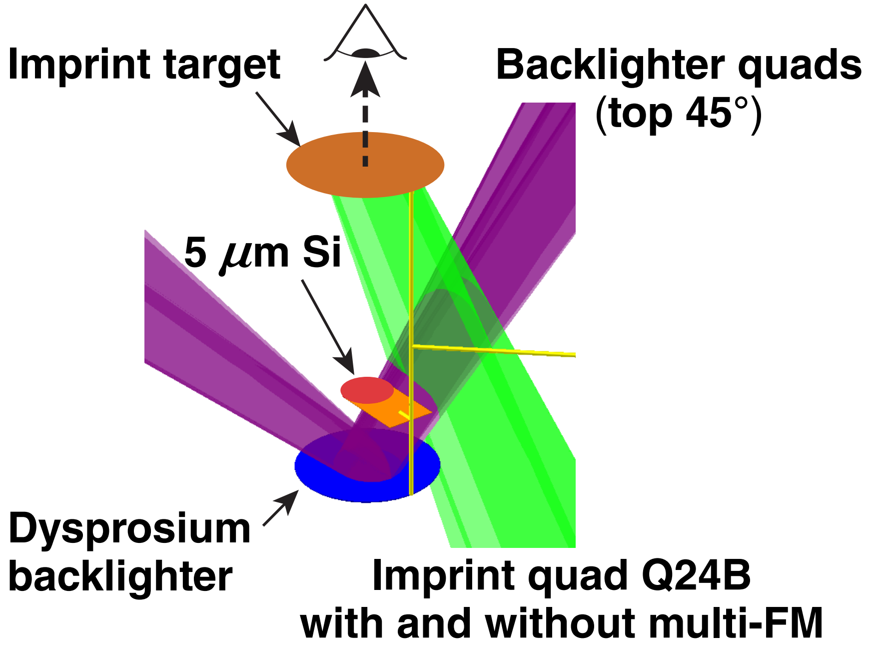
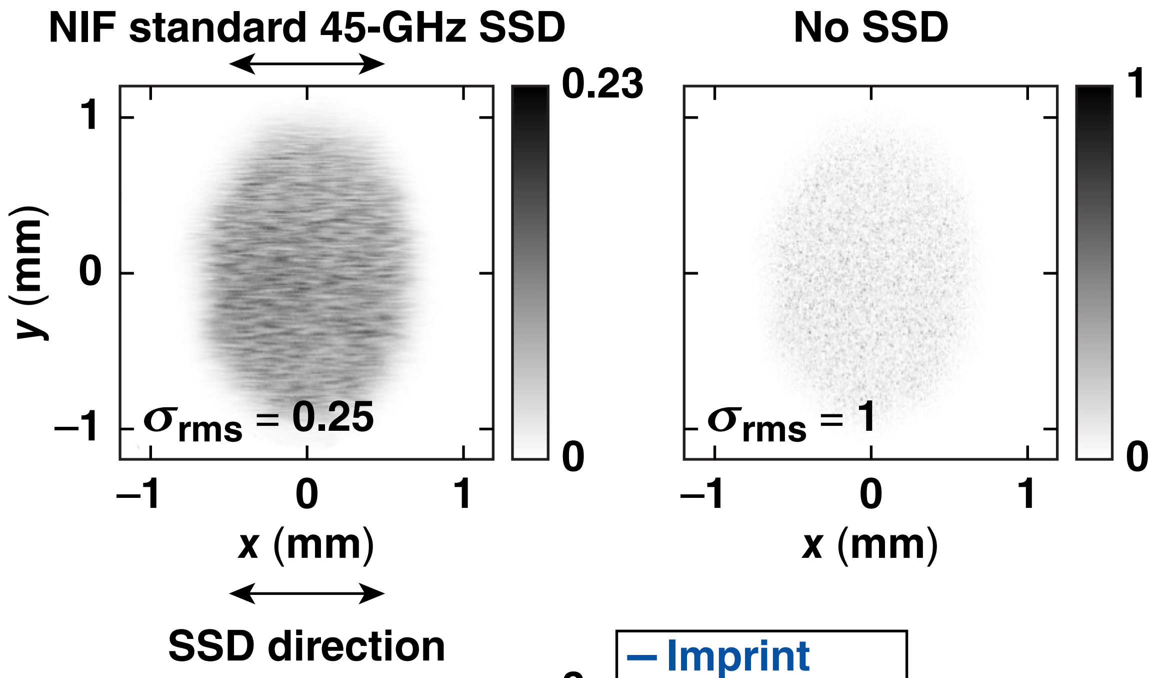
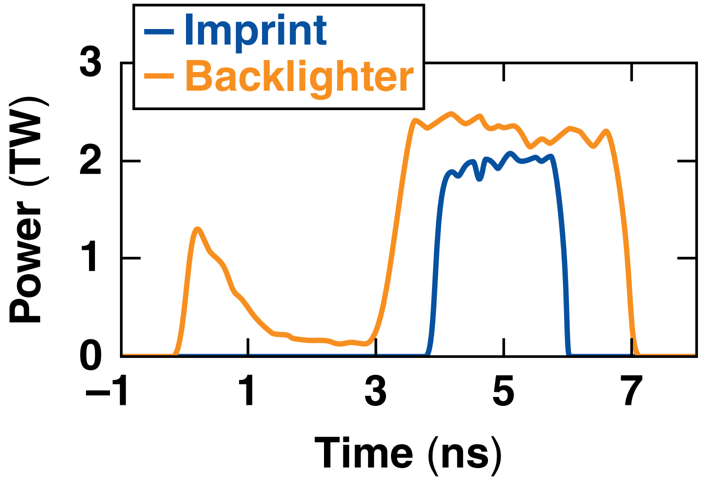
# NIF planar experiments used single-beam drive with no SSD and the NIF standard 45-GHz SSD




- 20-$\mu$m CH planar foil target
- 2-TW power single beam and $10^{14}$ W/cm$^2$ on-target intensity
- 15-$\mu$m-diam pinholes versus 30 and 40 $\mu$m in previous experiments

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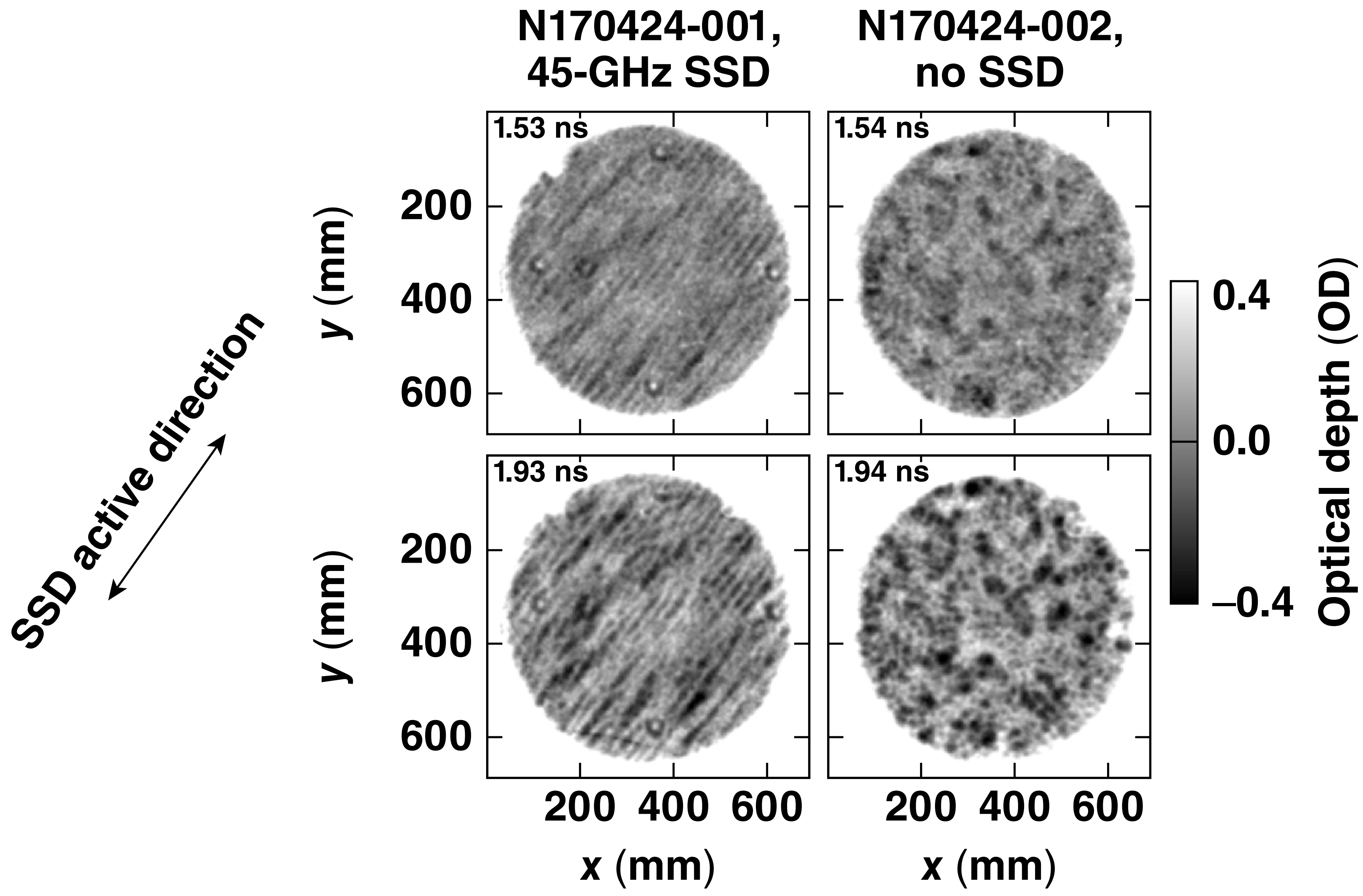
# Excellent data were obtained with a clearly visible imprint signature




Each frame is an overlap of four camera frames

**Imprint modulation features are persistent in time.**

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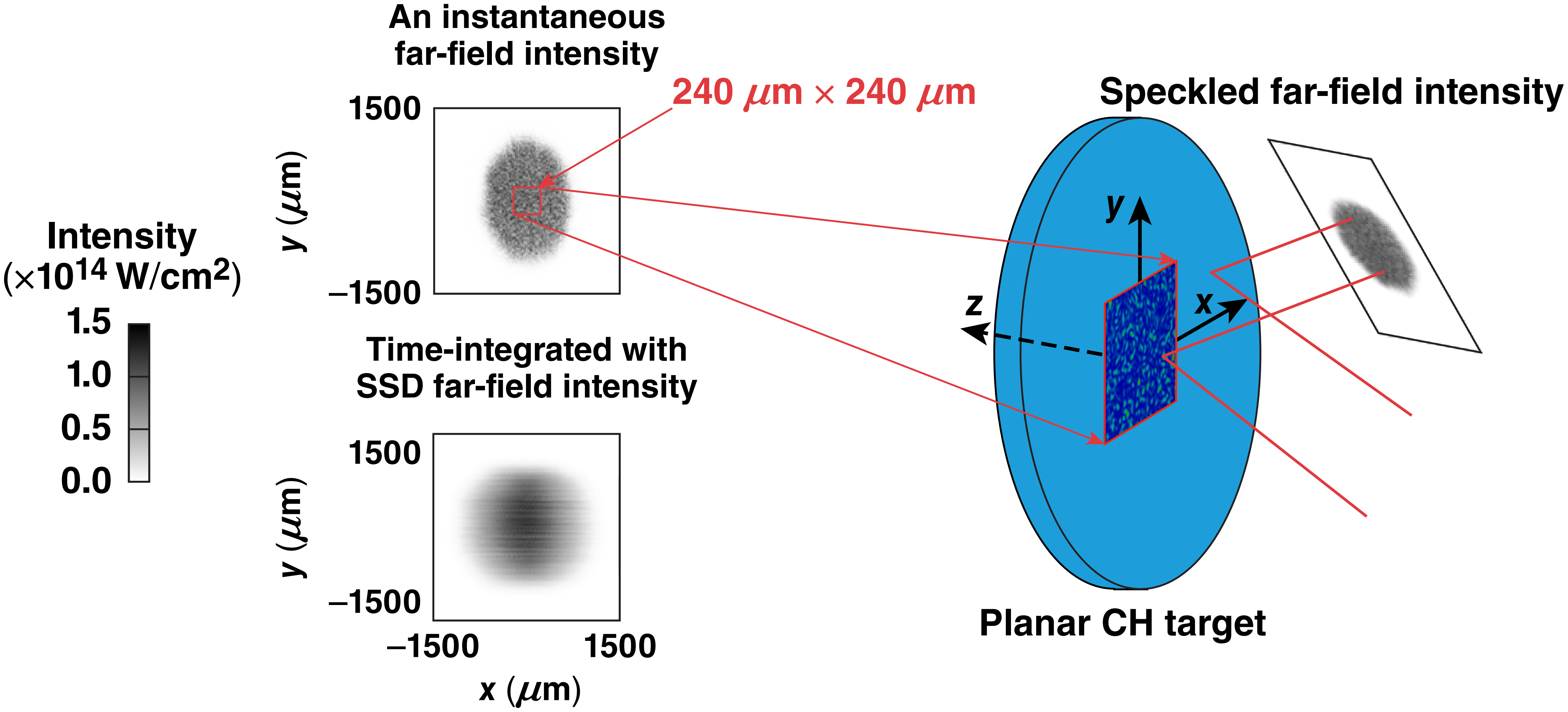
# The 3-D code *HYDRA** is used to simulate the impact of SSD

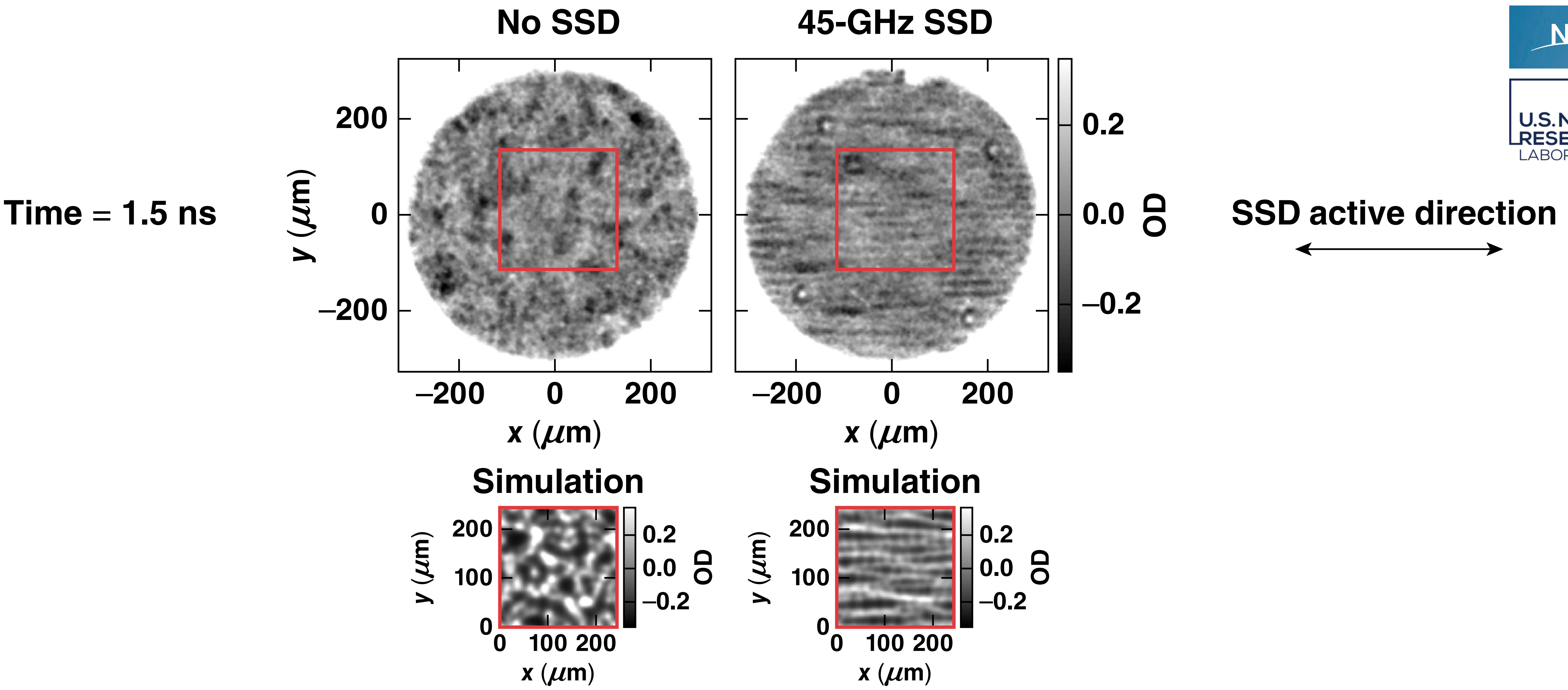



- Simulations use *HYDRA*'s spherical laser-deposition model and resolve speckle size (~6 μm)

*M. M. Marinak *et al.*, Phys. Plasmas 8, 2275 (2001).

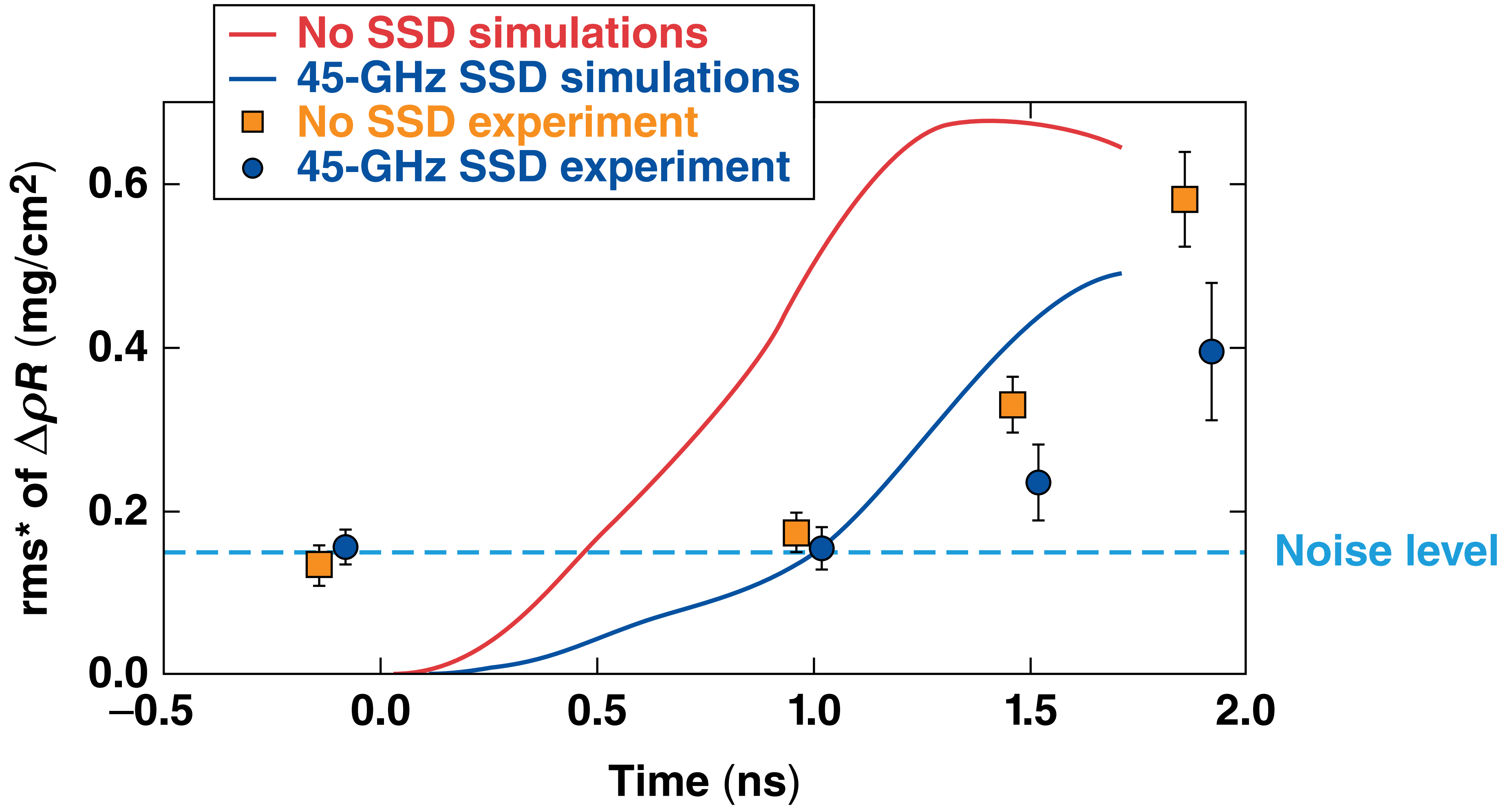
TC12566b

# Simulations reproduce similar features as seen in the experimental radiographs but with much higher optical depth




15-μm pinhole and framing-camera blurring were applied to simulated images

# Simulations predict a higher lever of imprint, faster Rayleigh–Taylor growth rate, and early saturation time compared to experiments

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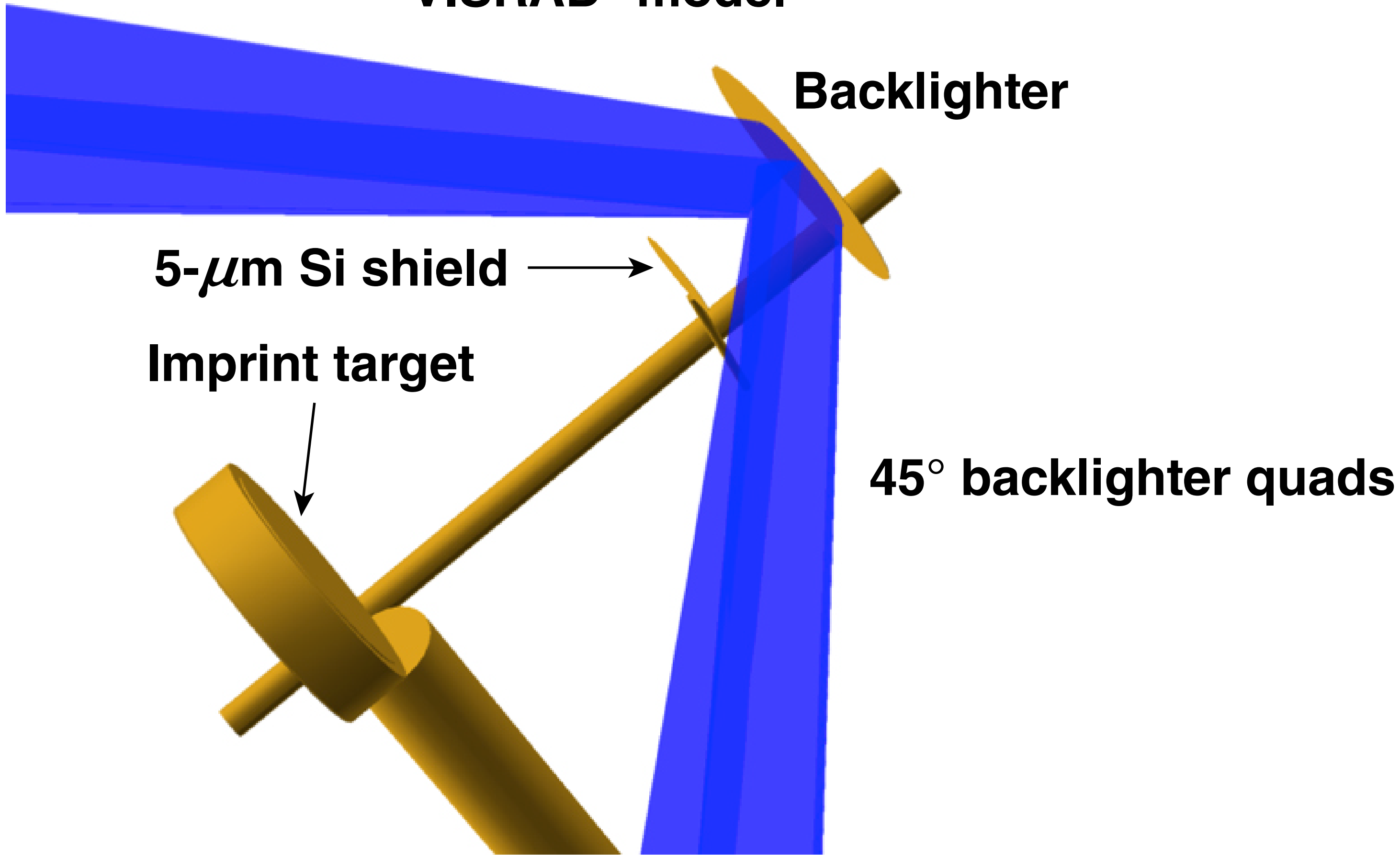
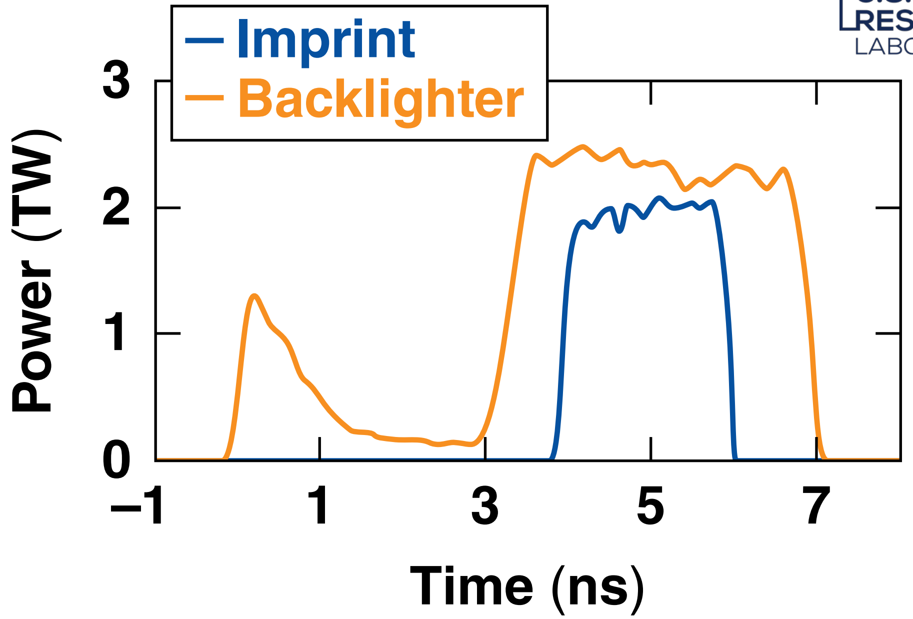
*rms: root mean square

# X-ray preheat is hypothesized to be the cause of the lower than predicted level of imprint observed in experiments

VISRAD* model




The experiments are being considered to be repeated using a delayed backlighter pulse.

*J. J. MacFarlane, J. Quant. Spectrosc. Radiat. Transf. 81, 287 (2003).

TC13902

# NIF* experiments were performed to measure imprint-seeded nonuniformities in planar foils driven with and without 45-GHz SSD applied to the laser pulse

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NIF

U.S. NAVAL RESEARCH LABORATORY

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