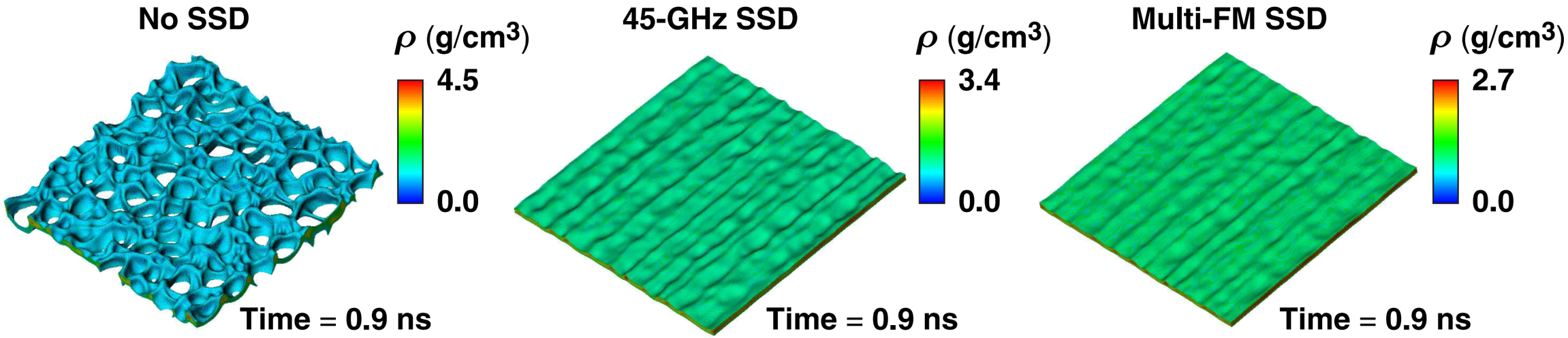
Three-Dimensional Evaluation of Laser Imprint in National Ignition Facility Multi-FM Smoothing by Spectral Dispersion Experiments

UR LLE

***HYDRA* simulations**



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Summary

Multi-FM smoothing by spectral dispersion (SSD) was validated at the National Ignition Facility (NIF)

- One-quad multi-FM planar-imprint experiments confirmed expected ~1.6× higher effectiveness of multi-FM compared to the NIF's 45-GHz SSD (with LLE's diffraction grating) in imprint reduction
- Three-dimensional *HYDRA* simulations resolve all single-beam imprint modes and are in reasonable agreement with the experimental data
- X-ray imaging-system resolution of ~10 μm is required to image imprint-seeded areal-density modulations in the NIF flat-foil imprint experiments

Collaborators

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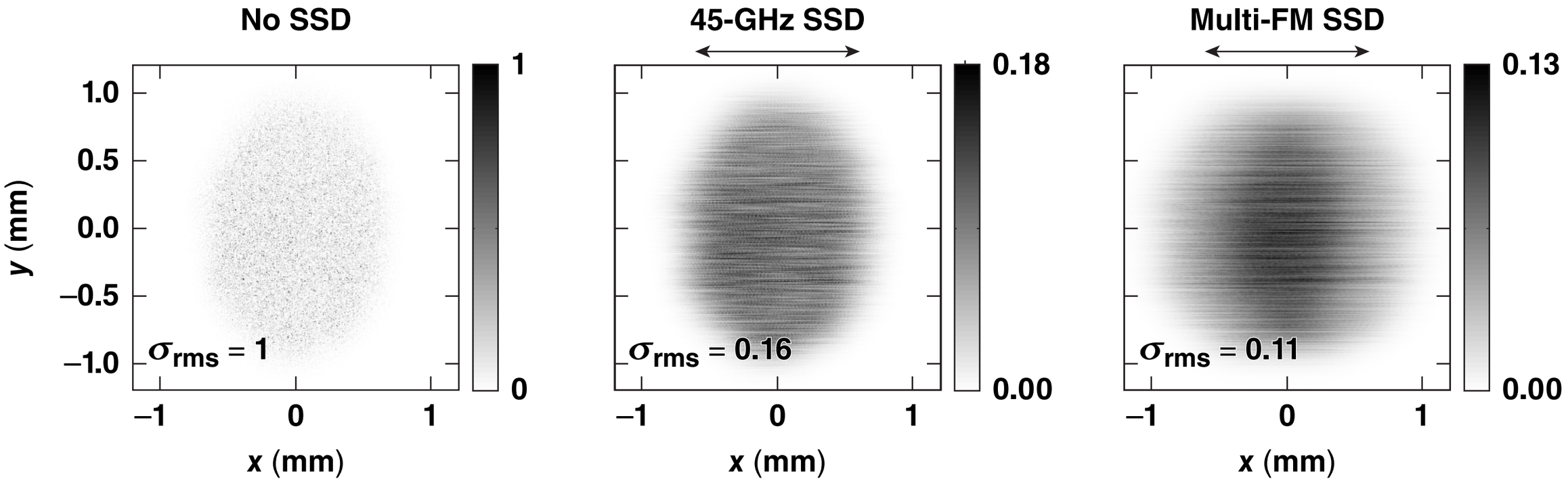
Lawrence Livermore National Laboratory

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

Inner-cone (23.5°) beam intensity with different levels of smoothing



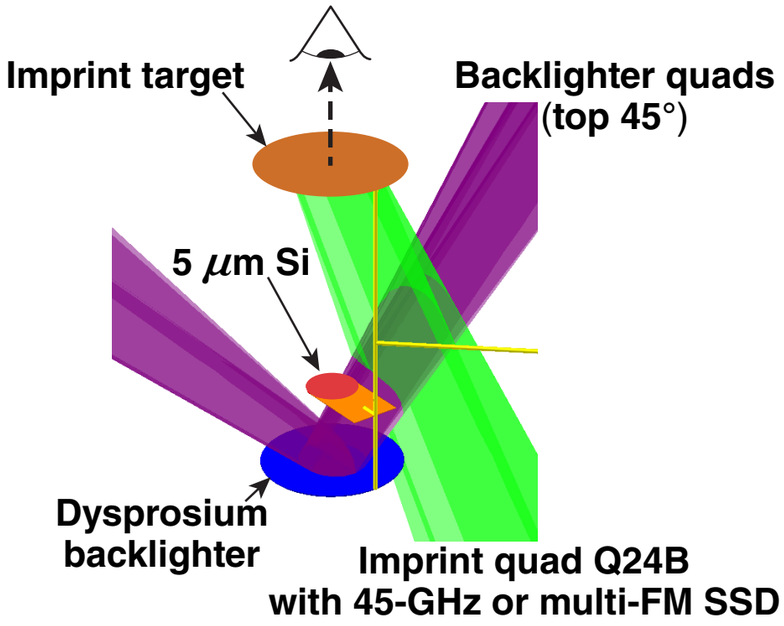
1-D Multi-FM SSD* has been implemented in a single quad (Q24B) on the NIF.

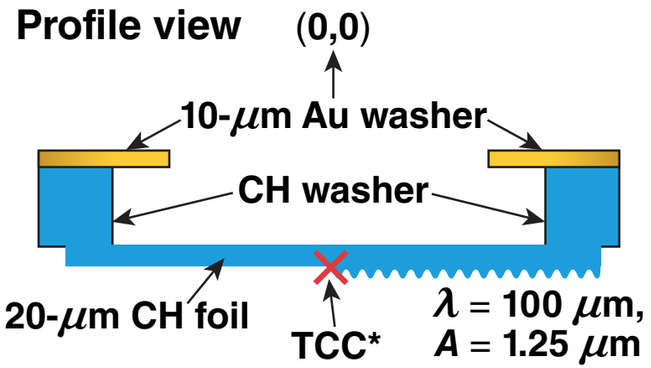
rms: root mean square

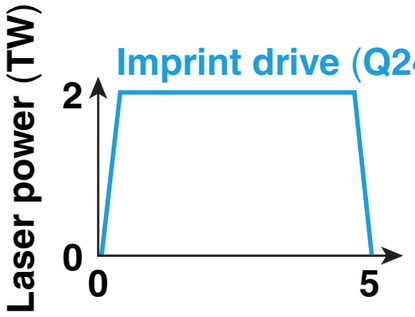
*J. A. Marozas, J. D. Zuegel, and T. J. B. Collins, Bull. Am. Phys. Soc. 55, 294 (2010).

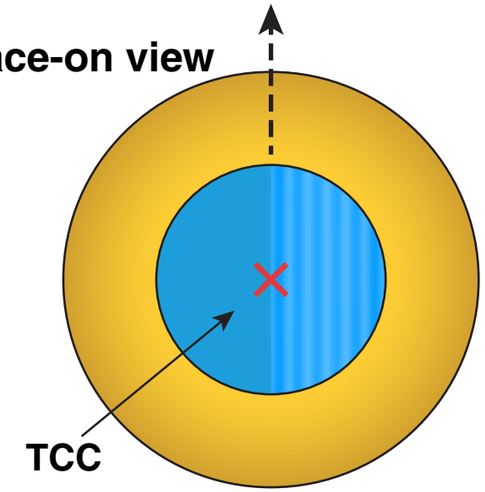
TC13010

One-quad multi-FM planar-imprint experiments were performed to validate Multi-FM SSD on the NIF







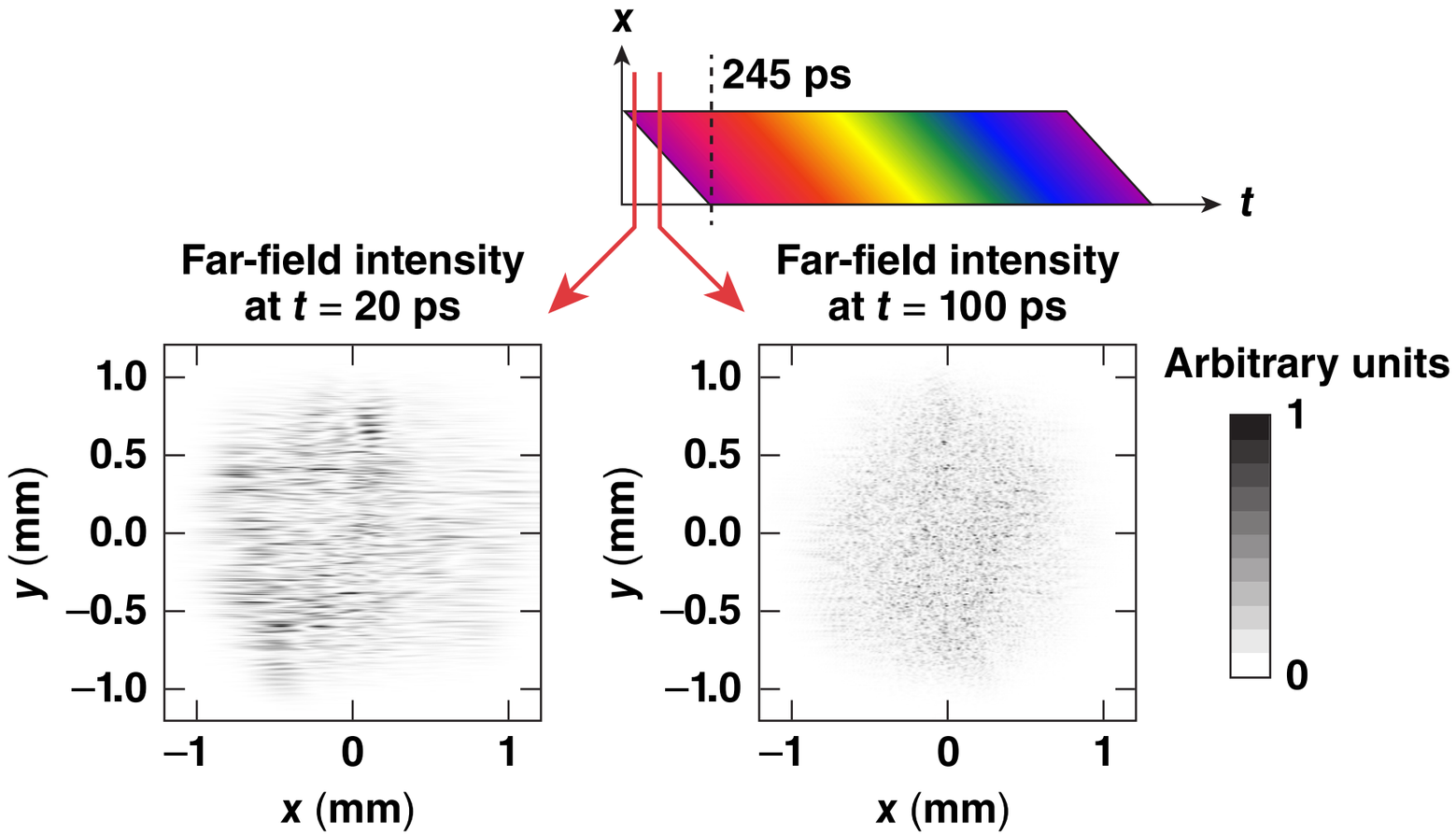


- Shot N160204 used multi-FM SSD (3-GHz + multi-FM modulators; 130-GHz total bandwidth)
- Shot N160205 used 45-GHz SSD (3-GHz + 17-GHz modulators; 75-GHz total bandwidth)
- Both shots used the Laboratory for Laser Energetics (LLE's) 1700-l/mm diffraction grating (compared to the NIF's standard 1050 l/mm)

TC12564a

$\overline{\text{TCC}}$ = target chamber center

Calculated* instantaneous far-field spots are used to model the effects of speckle and SSD

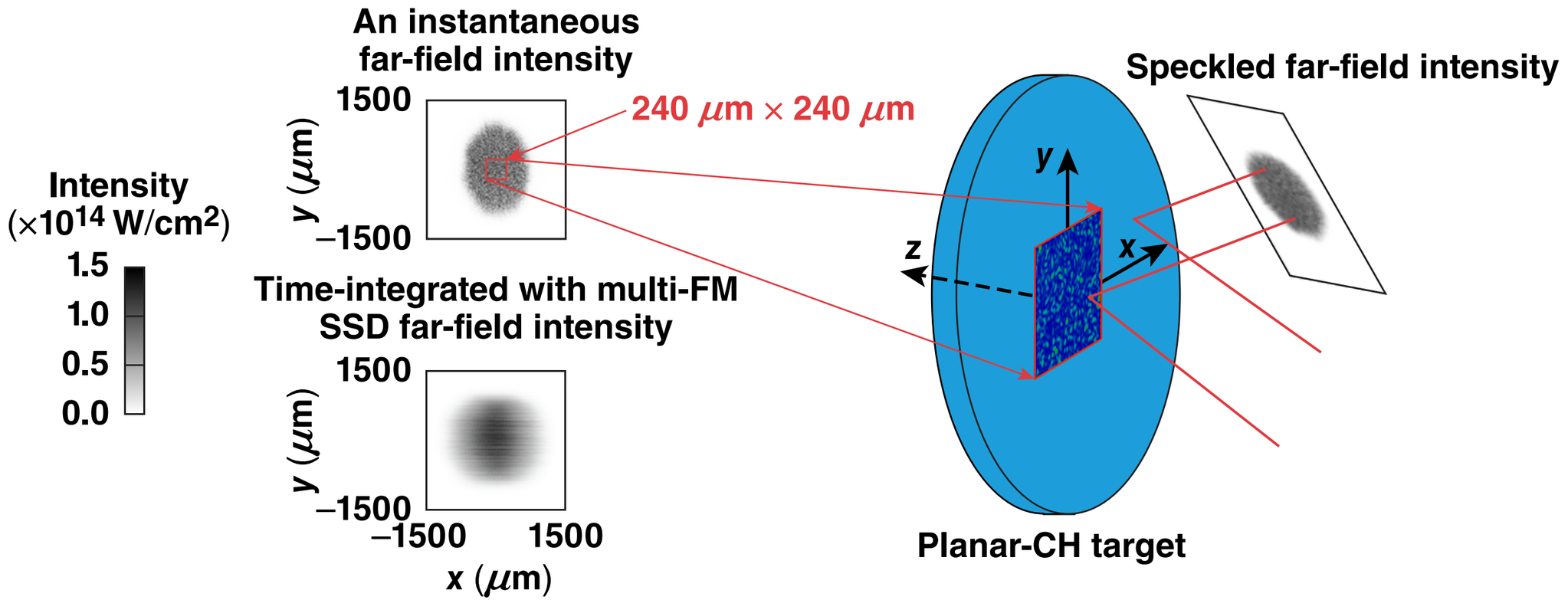


- Speckle pattern changes in time

*J. A. Marozas *et al.*, J. Opt. Soc. Am. B 19, 7 (2002).

TC13109

Three-dimensional *HYDRA** is used to simulate the 3-D impact of SSD

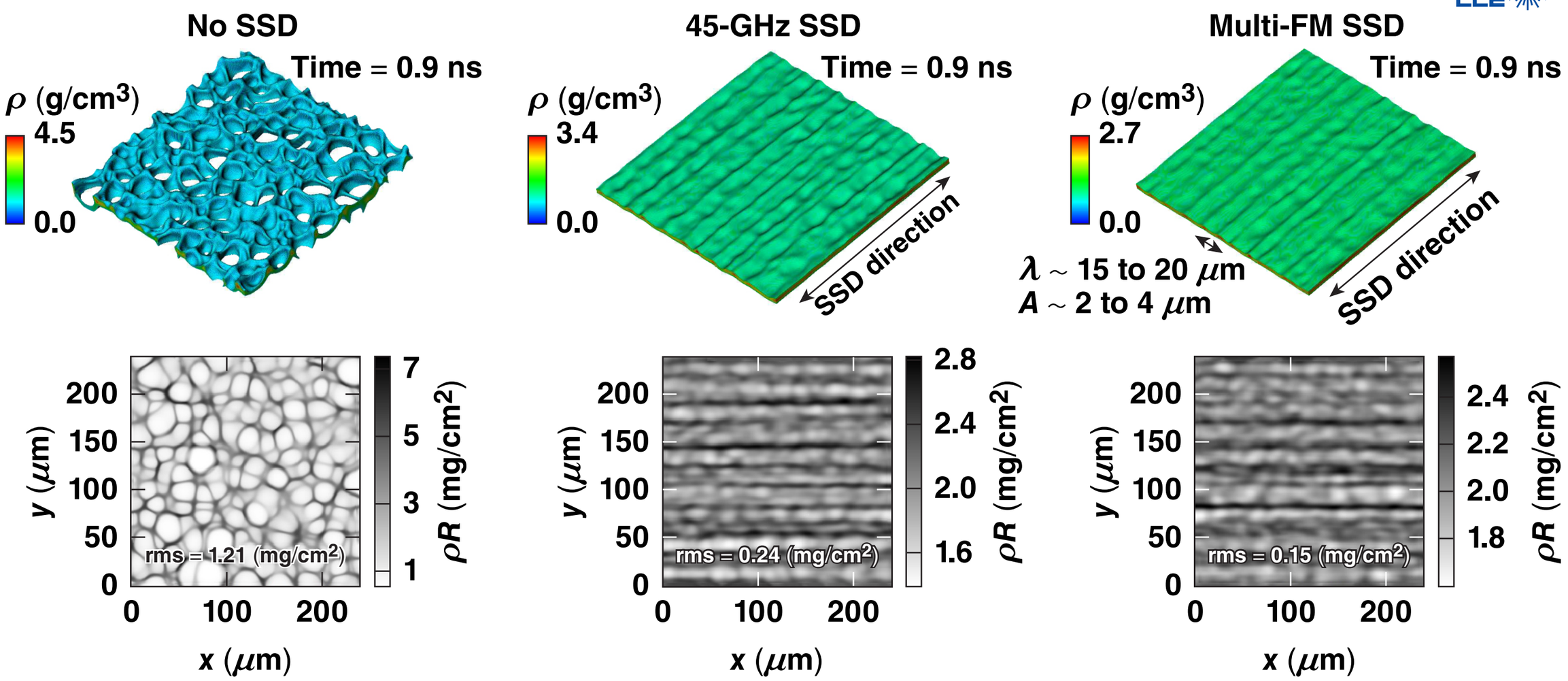


- Simulations use *HYDRA*'s spherical laser deposition model (no refractive smoothing)
- Simulations resolve the speckle size (~6 μm)
- Surface corrugation was not simulated

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

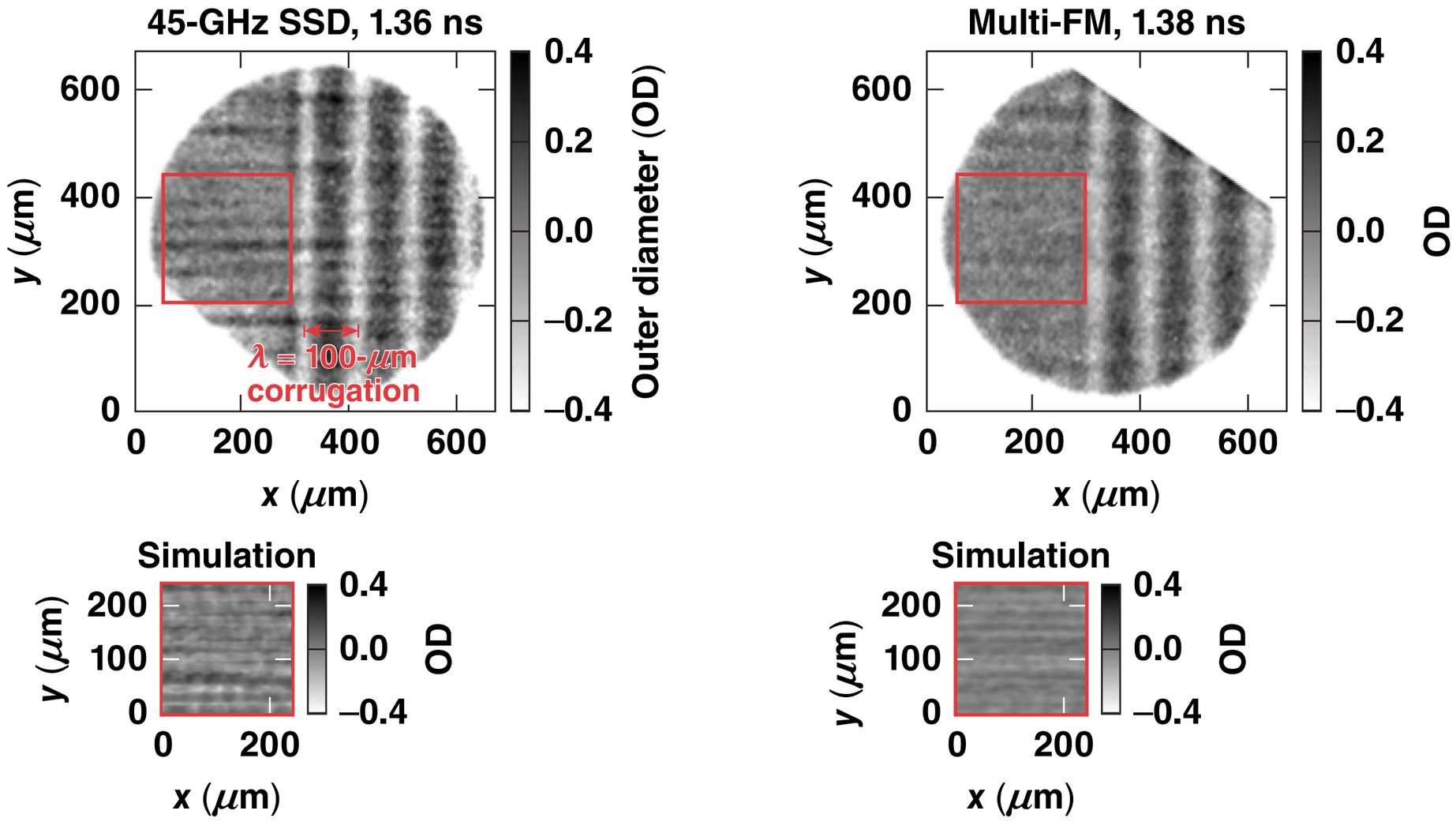
TC12566a

HYDRA simulations predict high-amplitude surface nonuniformities at the time of the earliest radiograph



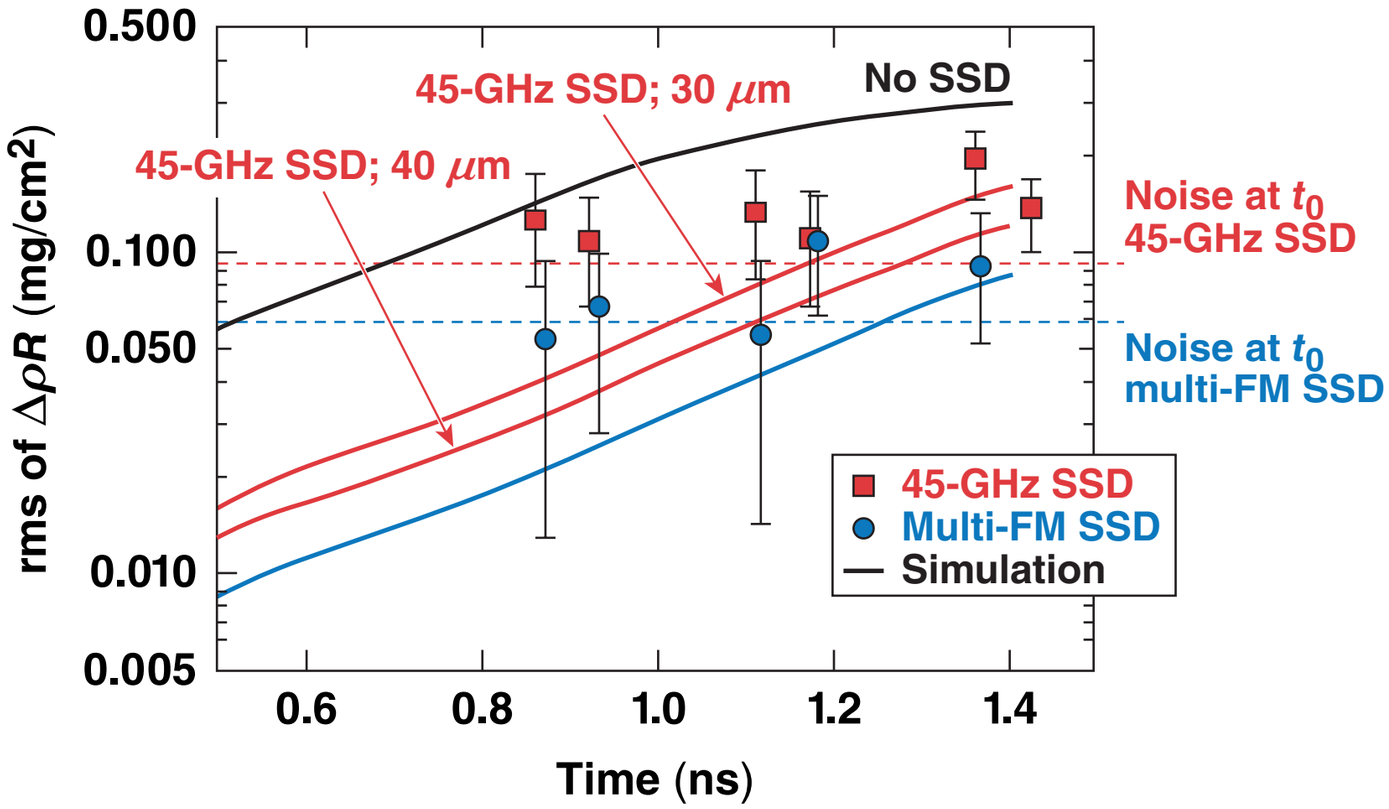
TC13011

Simulations reproduce imprint features seen in the experimental radiographs



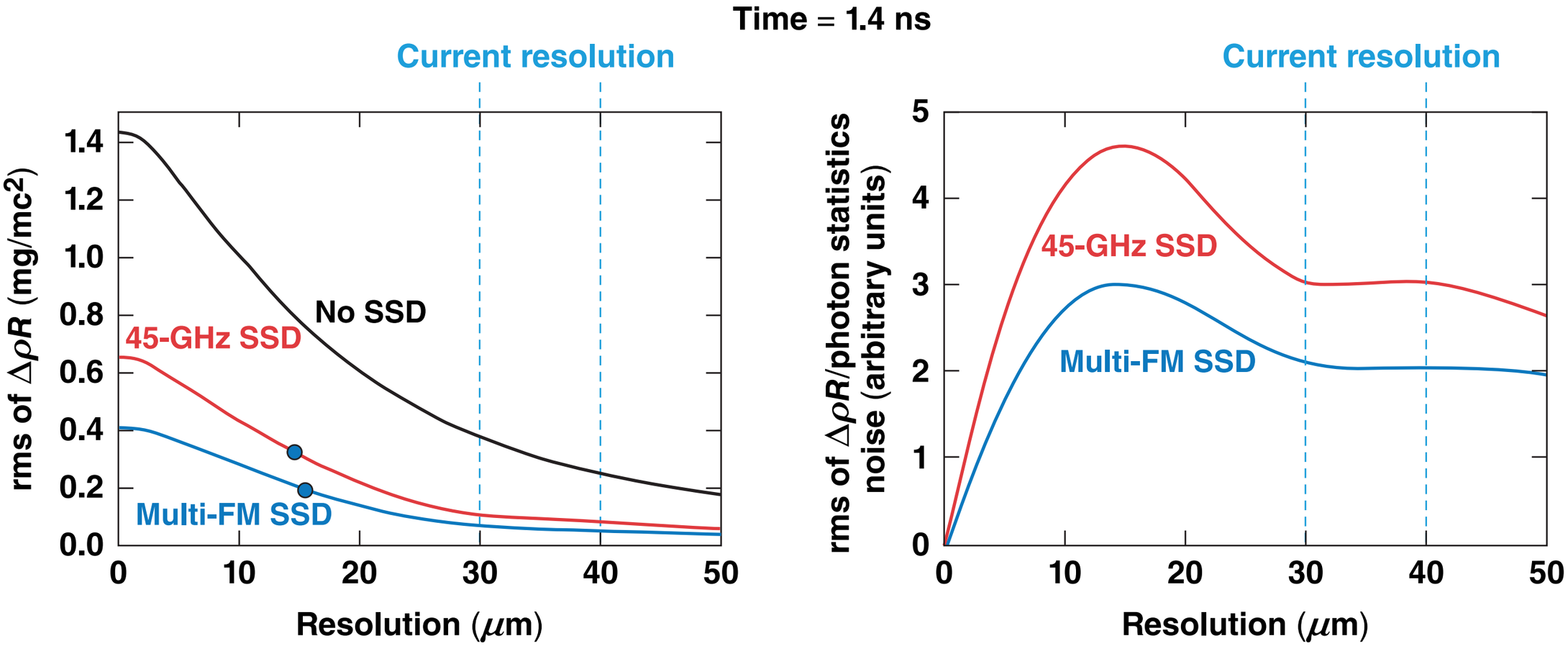
TC13012

Simulated imprint-seeded broadband modulations of the areal density are within error bars of the experimental data above the noise level



TC13013

X-ray imaging-system resolution of ~10 μm is required for imaging the imprint-seeded areal-density modulations



TC13110

Summary/Conclusions

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