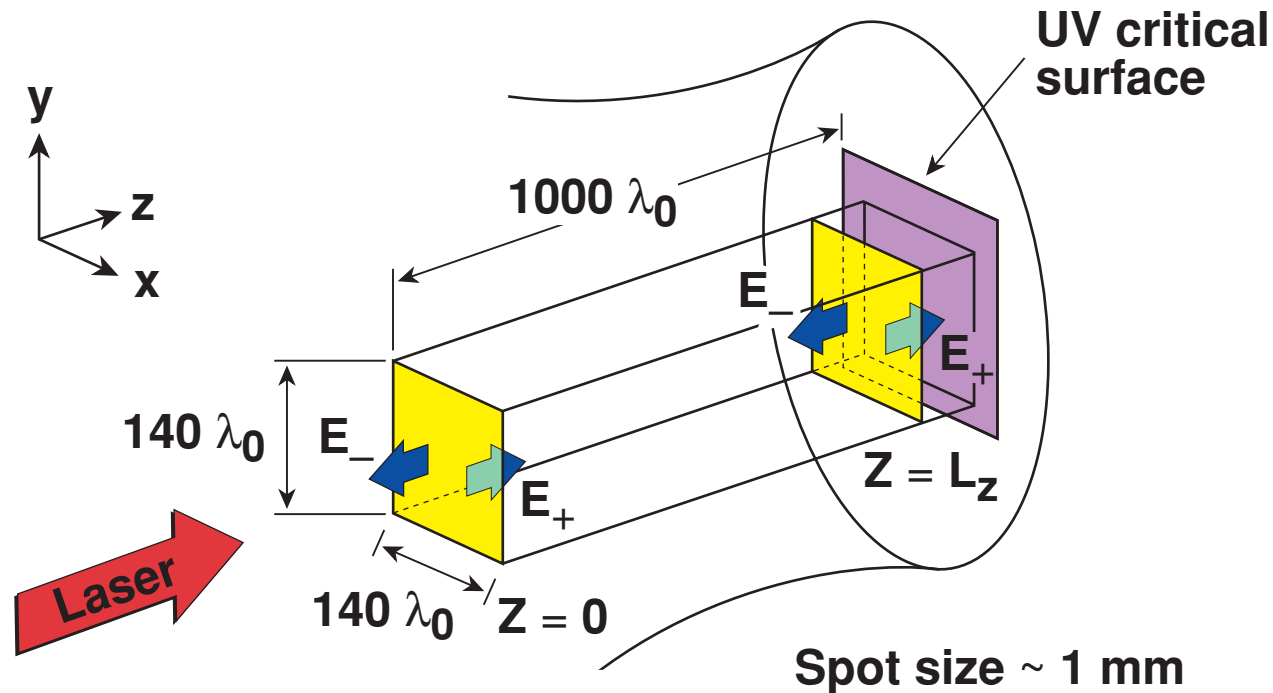


# Modeling Laser–Plasma Interaction Physics Under Direct-Drive Inertial Confinement Fusion Conditions



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## Conclusions

# OMEGA direct-drive LPI experiments have been successfully modeled using pF3D



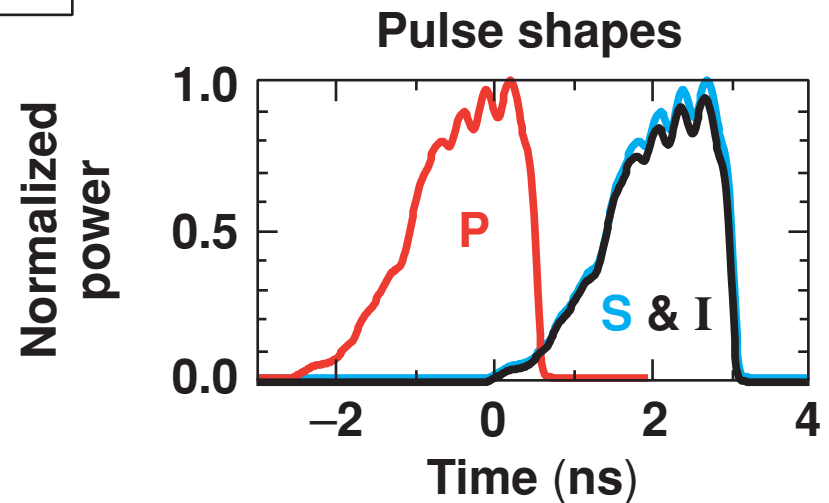
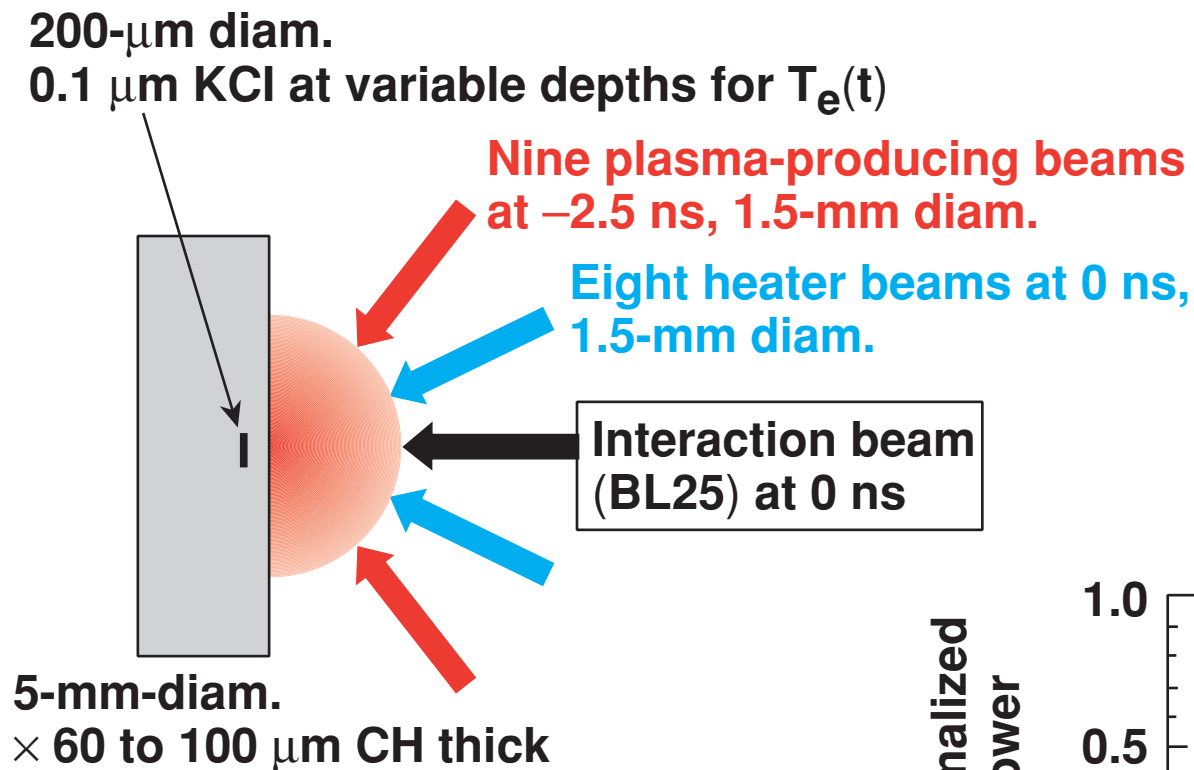
- **First large-scale simulations relevant to direct-drive OMEGA LPI experiments**
  - **DPP beams with intensities in the range (4–16)  $10^{14}$  W/cm<sup>2</sup>**
  - **Favorable comparison of simulated backscatter with OMEGA experiments**
  - **SBS <1% in main part of pulse for intensities in the range (4–16)  $10^{14}$  W/cm<sup>2</sup>**
  - **Hydrodynamic evolution of “shelf” in plasma profile is critical.**
  - **Reflectivity is sensitive to details of the “shelf”.**
- **Enhanced ion-wave fluctuations near quarter-critical surface are observed as a result of laser self-smoothing and low SBS reflectivities.**
  - **Plasma-induced smoothing threshold intensity near  $10^{15}$  W/cm<sup>2</sup>**
  - **Experimental evidence of TDP saturation near  $10^{15}$  W/cm<sup>2</sup>**

# Outline

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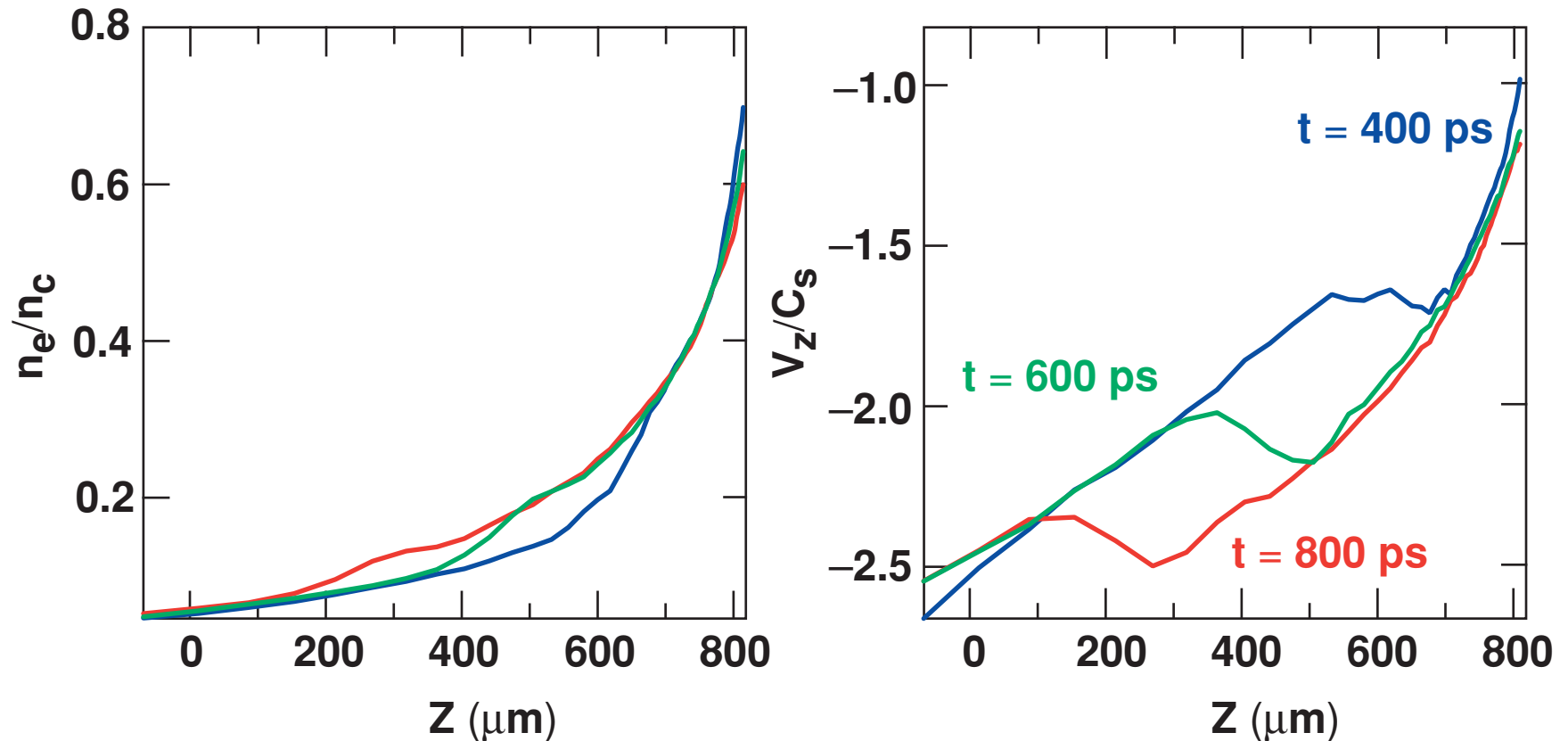
- **Collaboration with LLNL for pF3D**
  - Direct-drive simulation geometry
  - Treatment of the critical surface
  - Plasma inhomogeneity modeled using *SAGE* data as an initial condition
- **Simulations including backward SBS**
  - Single DPP beam with averaged intensities in the range (4–16)  $10^{14}$  W/cm<sup>2</sup>
  - OMEGA experiments show two spectral features in backscatter, red and blue
  - Comparison of backscattered light with blue feature
  - Evidence for the importance of the “shelf” in expansion velocity
  - Extrapolation to NIF targets
- **Enhanced ion-wave fluctuations near quarter-critical surface**

# NIF plasma conditions are produced on OMEGA with staggered multiple-beam irradiation of solid CH targets



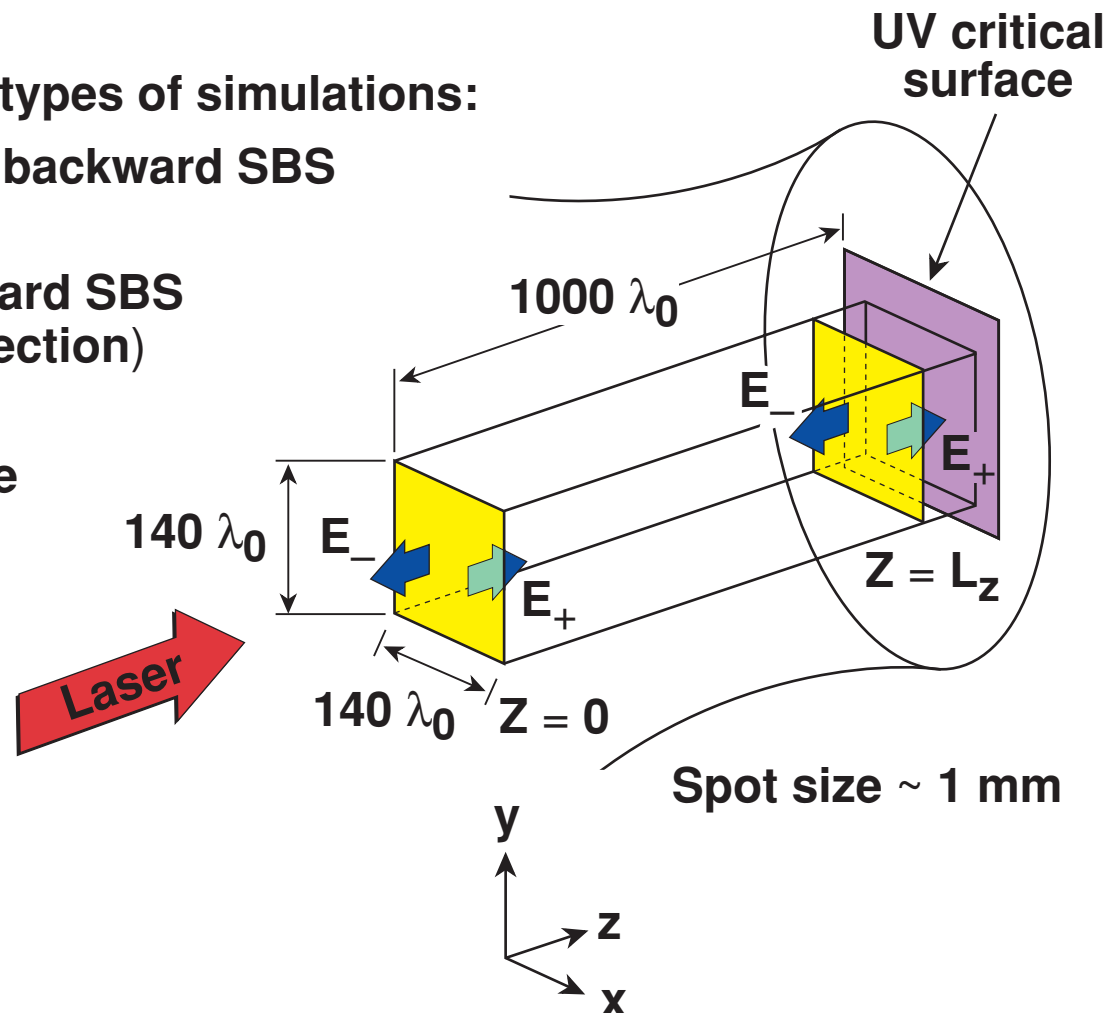
# A “shelf” in the plasma expansion velocity is a common feature of all direct-drive experiments

- Ablation due to the rising pulse of the interaction beam creates a shelf that propagates down the gradient with time.



# Large-scale pF3D simulations of OMEGA direct-drive LPI experiments have been carried out with the correct inhomogeneous plasma profiles

- We have carried out two types of simulations:
  - 3-D “pencil” with no backward SBS (shown to right)
  - 2-D slice with backward SBS (no variation in y direction)
- Currently the underdense and transcritical regions are treated separately.



# The level and temporal dependence of the simulated SBS reflectivity are consistent with experiment

- The reflectivity has its maximum early in the laser pulse.
- During the later part of the pulse the reflectivity is less than a few percent for all simulated intensities.
- The reflectivity is not far from linear gain estimates.

