# Feed-out of Rear-Surface Perturbations to the Ablation Interface and Subsequent Growth

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The transference of perturbations from the inside of a DT-ice layer to the ablation surface (called "feed-out") is a potential problem for high-gain, direct-drive inertial confinement fusion targets. This problem has been addressed theoretically[1] with a model that is valid for wave number times the compressed-target thickness $kd_c < 1$. The work described is a series of planar experiments designed to study the feed-out of rear-surface perturbations to the ablation interface. We irradiate 20-μm-thick CH targets with 351-nm radiation from the OMEGA laser. The incident laser pulse shape is a 1-ns rise to a 2-ns constant intensity of $1 \times 10^{14}$ W/cm$^2$. The single-mode, rear-surface perturbations have wavelengths of 60, 30, and 20 μm with an initial amplitude of 1 μm. The range for $kd_c$ for these experiments is from 0.5 to 1.5. The theoretical model is compared to both the 2-D hydrodynamic simulation and the experimental data. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460, the University of Rochester, and the New York State Energy Research and Development Authority.

1. R. Betti *et al.*, Phys. Rev. Lett. **81**, 5560 (1998).

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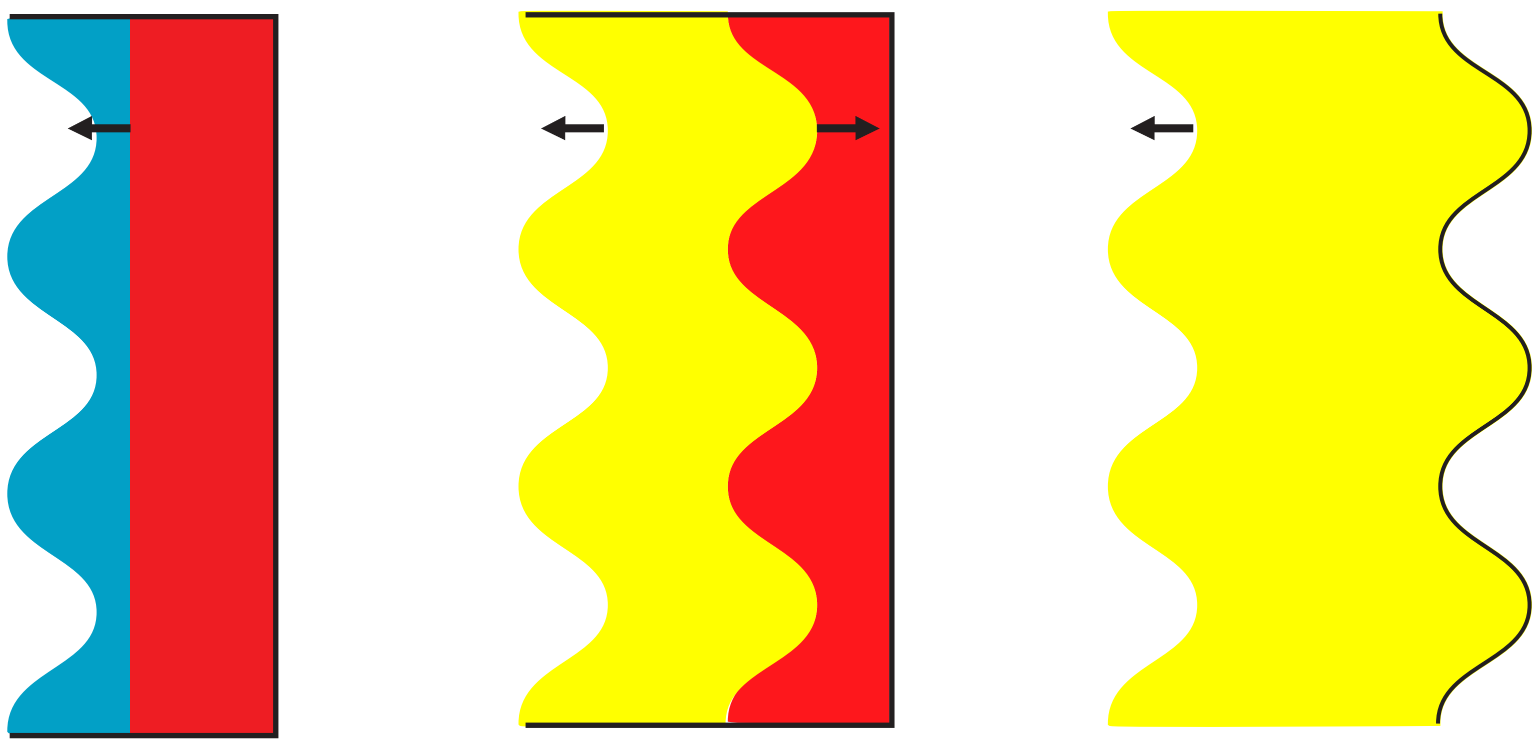

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Summary

# Feed-out of the rear-surface perturbation has been measured for $0.6 < kd_{compressed} < 1.8$

- The experiment was configured to measure the feed-out of large-amplitude, rear-surface perturbations.
- Hydrodynamic simulations agree with the feed-out of a rear-surface perturbation and Rayleigh–Taylor growth on CH targets.
- Target $\Delta\rho r$'s calculated from the theoretical model of R. Betti[1] *et al*. agree with the experimentally measured optical depth.

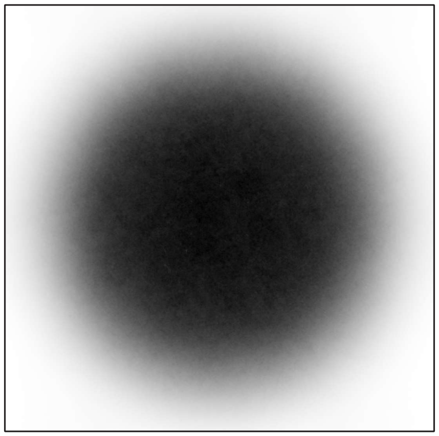
[1]R. Betti, V. Lobatchev, and R. L. McCrory, Phys. Rev. Lett. 81, 5560 (1998).

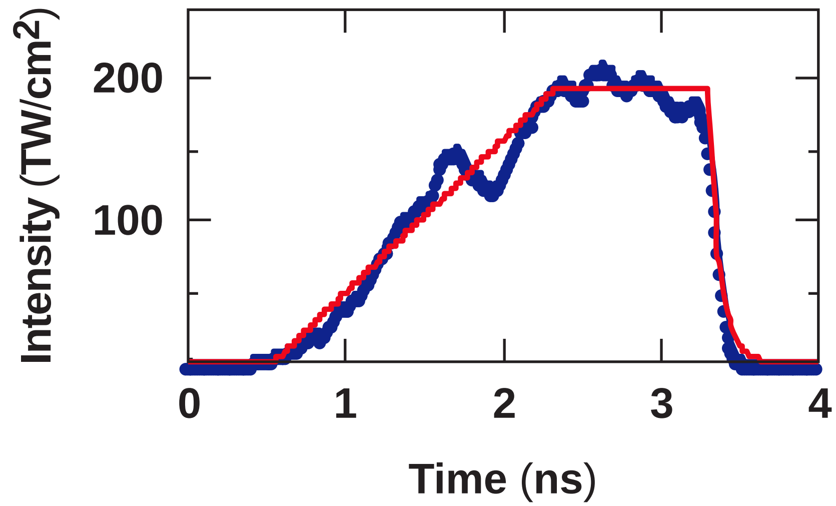
Outline

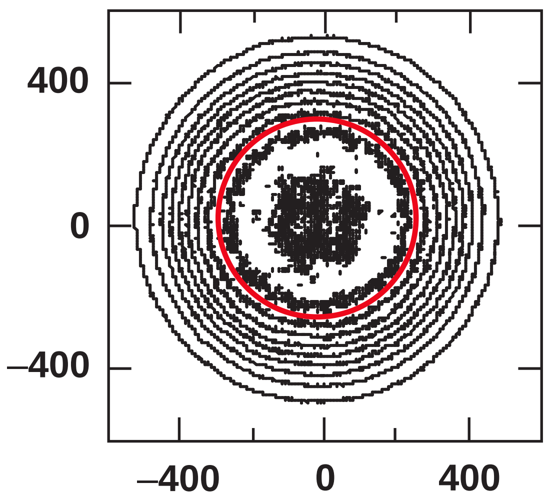
# Feed-out of rear-surface perturbations to the ablation interface and subsequent growth

- Experimental configuration
- Hydrodynamic simulations and experimental data
- Theoretical model and experimental data

# The OMEGA laser system illuminated the target at $2.0 \times 10^{14}$ W/cm$^2$ with a beam nonuniformity of 2.4%






| | |
|---|---|
| Spot size at 90% $I_0$ | 700 μm |
| Number of beams | 6 |
| Phase plates | super-Gaussian |
| Phase-plate order | $4.5[e^{-(r/r_0)^{4.5}}]$ |
| Polarization | DPRs in 6 beams |
| Smoothing | 2-D SSD |
| SSD bandwidth | 0.2 THz |
| Drive nonuniformity | 6.4% – 0.1 ns; 2.4% –1 ns |

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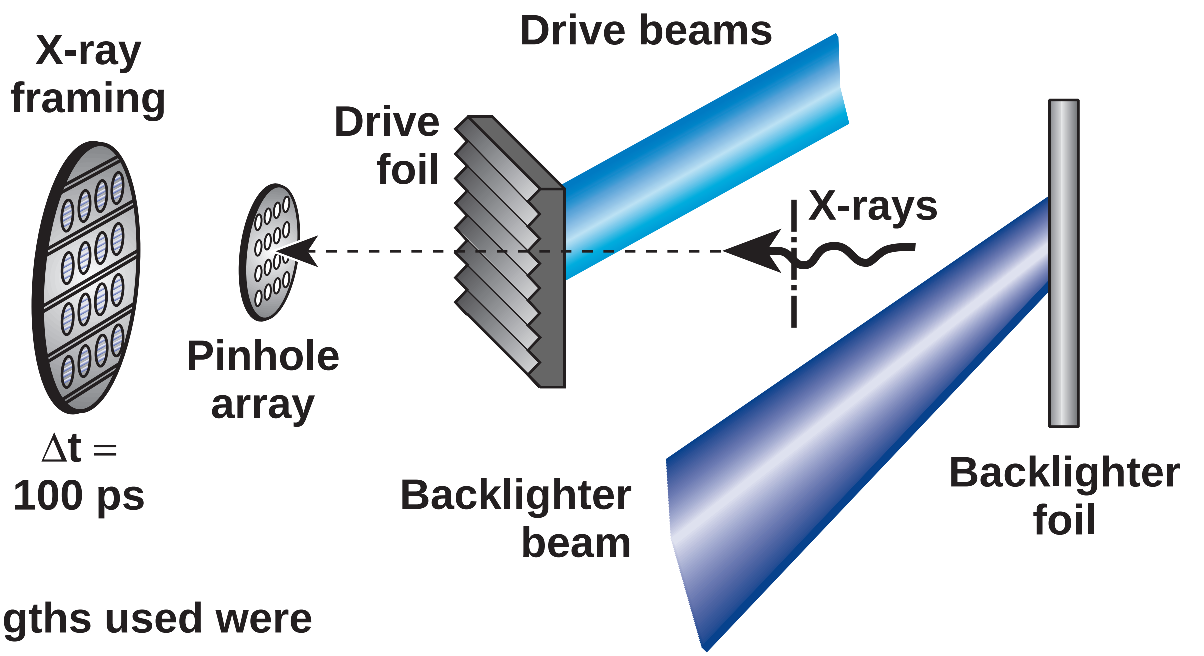
# Feed-out of the rear-surface perturbation was measured for three wavelengths




- Perturbation wavelengths used were
  - 60 µm with a 0.5 µm amplitude
  - 30 µm with a 0.5 µm amplitude
  - 20 µm with a 0.5 µm amplitude
- Target foils were constructed from 20-µm-thick CH.
- Targets with 60-µm wavelength perturbations had a front-surface amplitude = 10% of rear-surface amplitude (0.05 µm).

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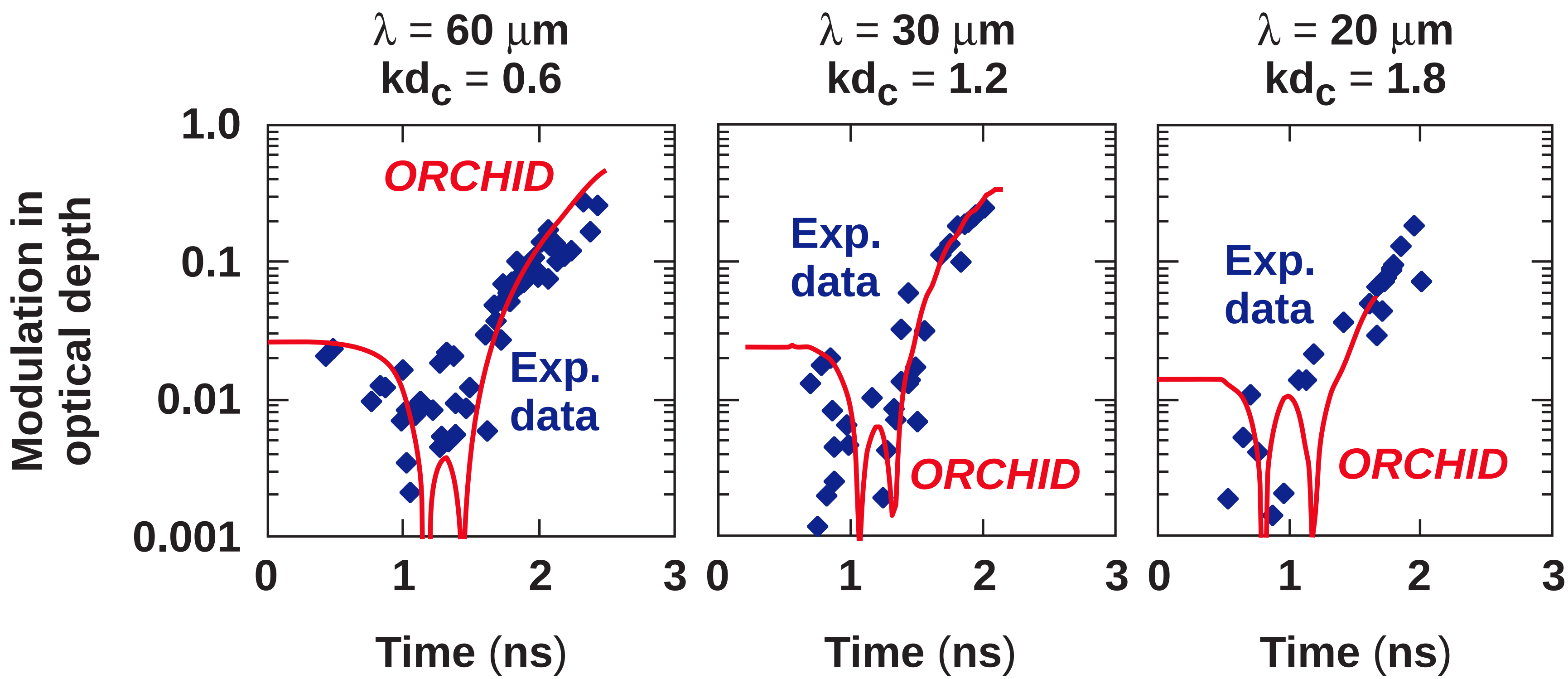
# Hydrodynamic simulations of feed-out agree with the experimental data

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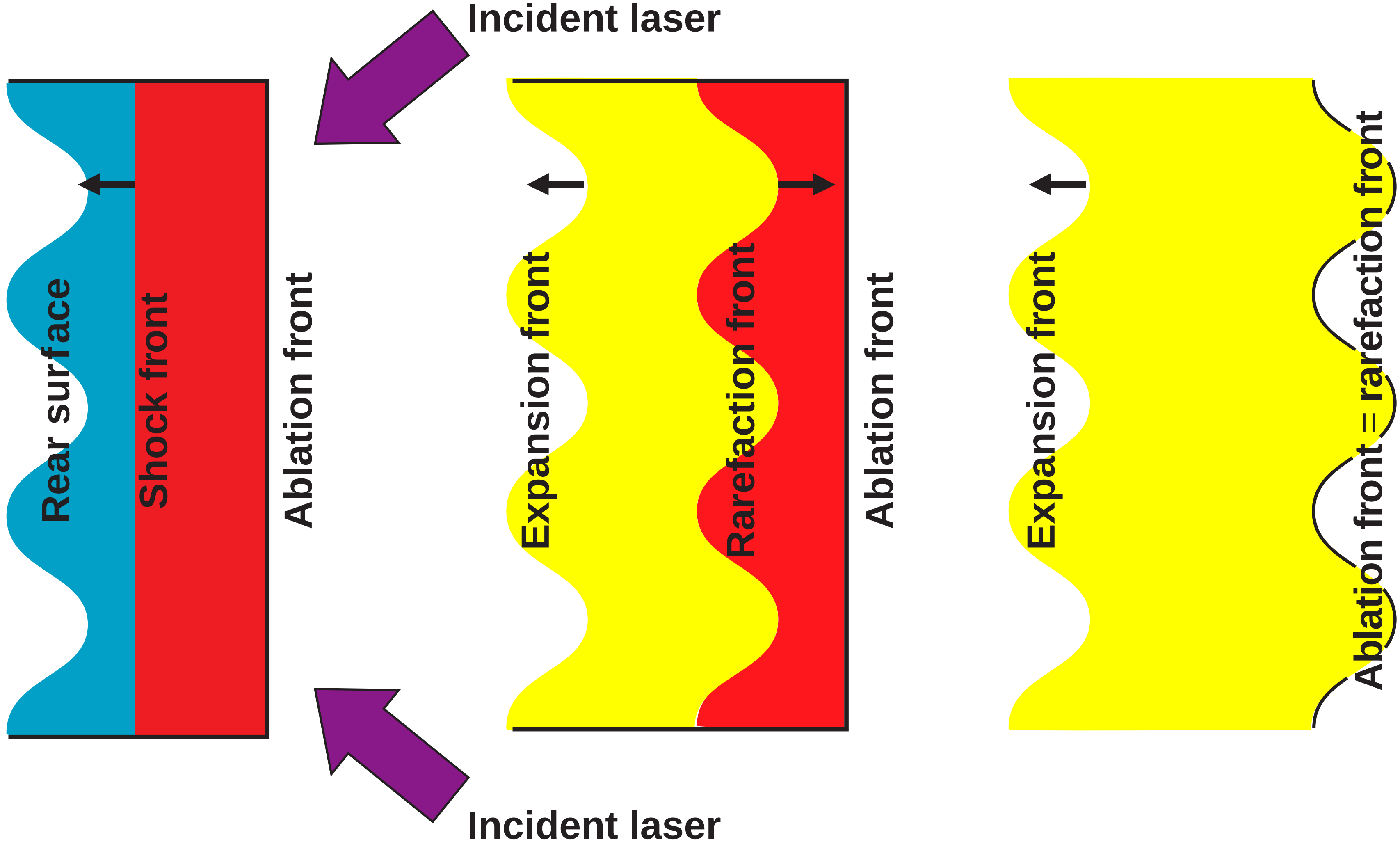
# If the rear surface is rippled, the rippled rarefaction wave will imprint a perturbation on the ablation front (feed-out)

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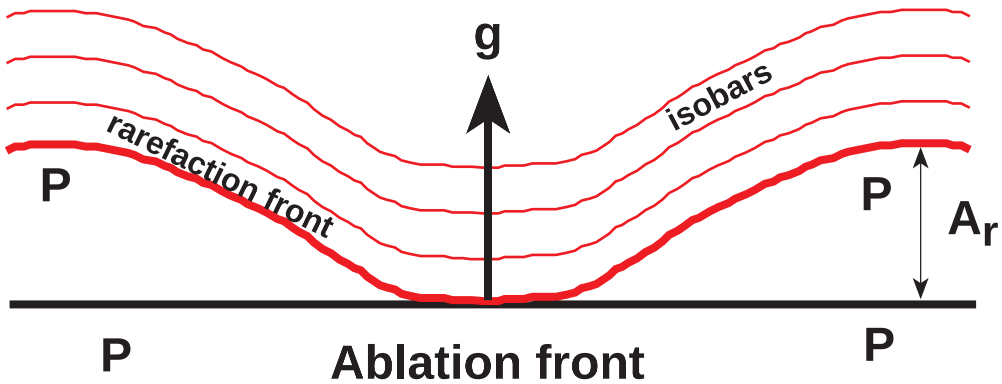
# When the rippled rarefaction wave reaches the ablation front, it imprints a velocity perturbation and the ablation front develops a ripple that starts growing linearly in time

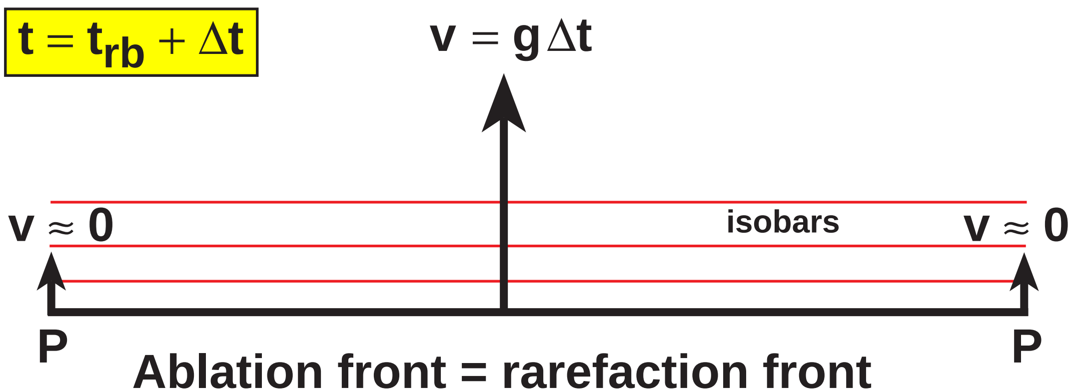
**$t = t_{rb}$ = rarefaction-wave break-out time**




$$\Delta t = \frac{A_r}{C_s}$$

$$v = g\Delta t$$

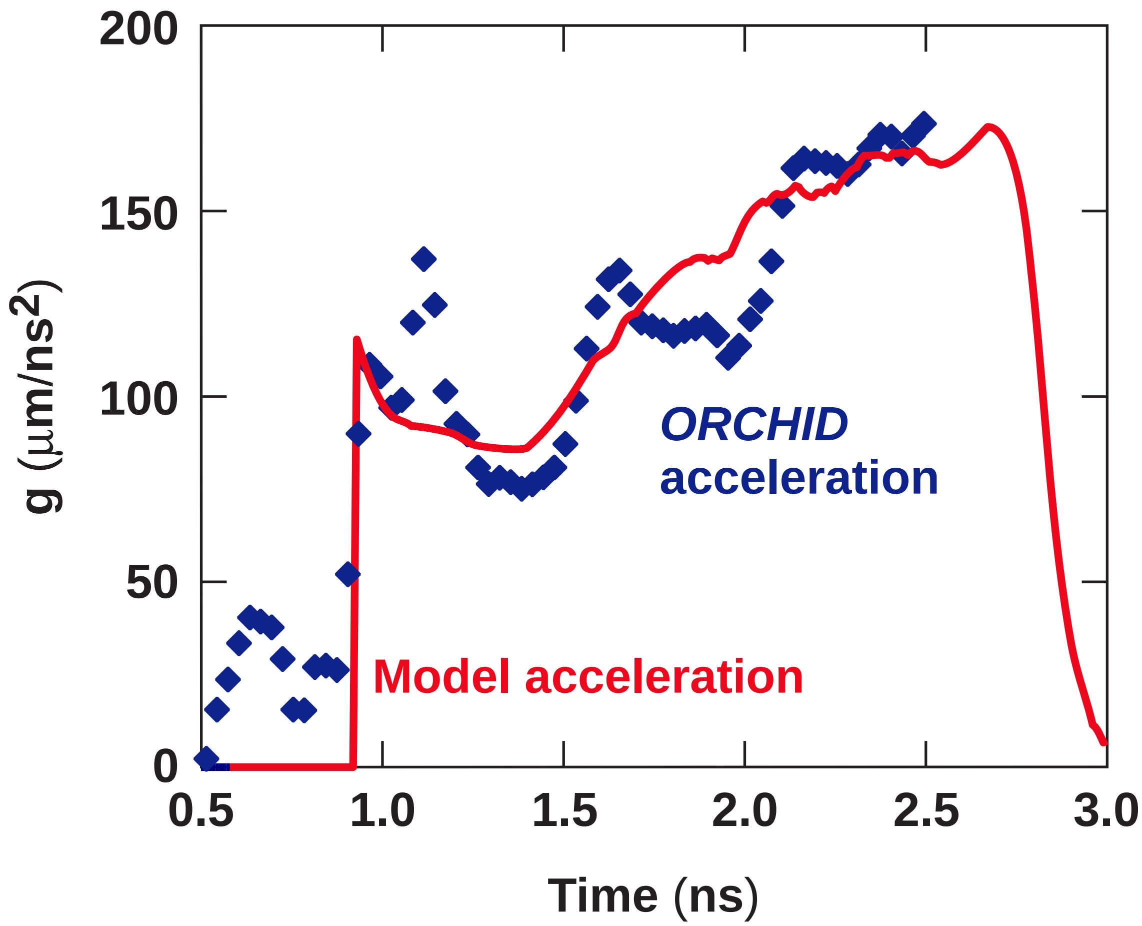
**$t = t_{rb} + \Delta t$**



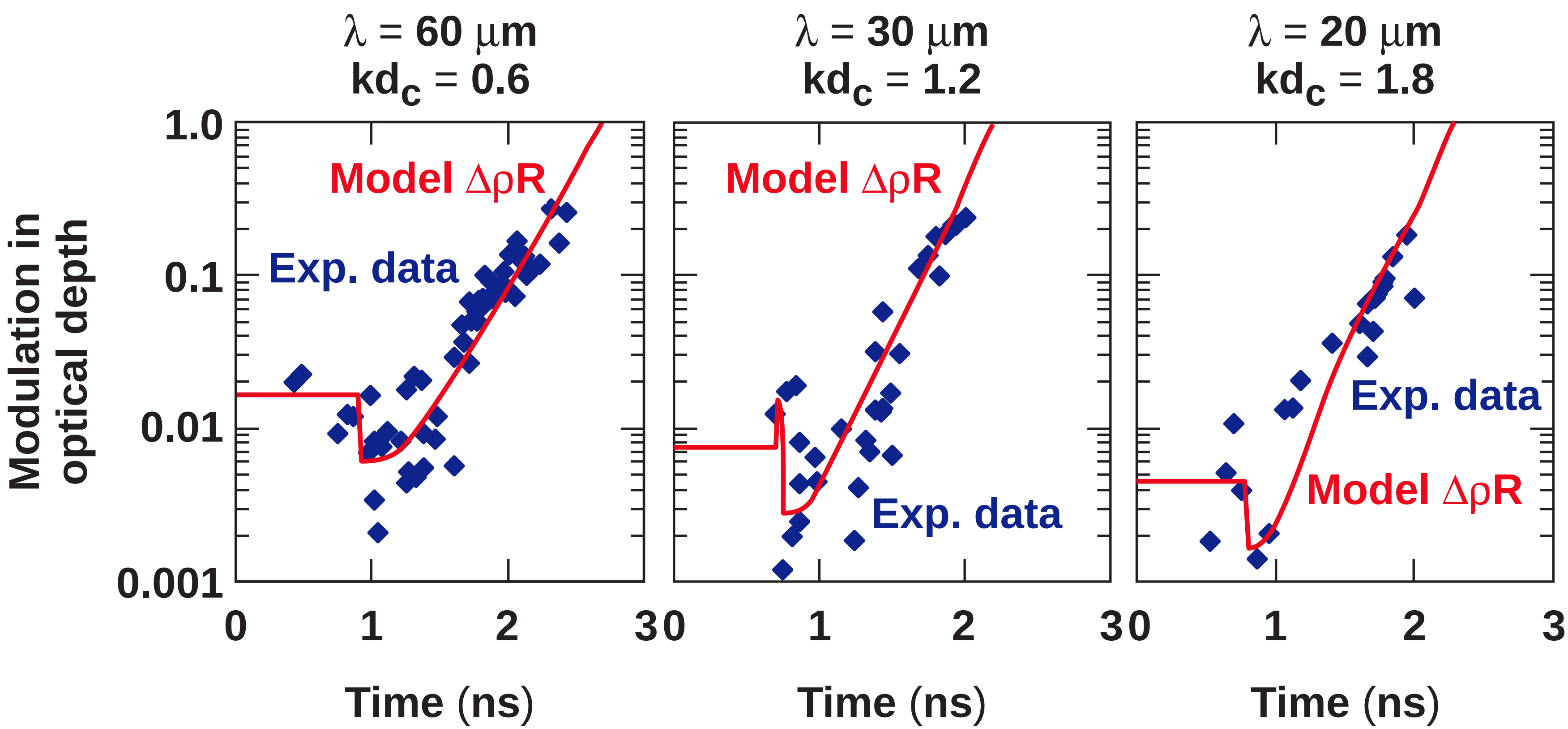

$$g(t_{rb}) = \frac{5}{2}\frac{P}{\rho d}$$

→ This theory is only valid for $k\,d_c < 1$.

# The acceleration as calculated by a planar-foil model agrees with the results from *ORCHID* simulations



# Calculated ρR from Betti's long-wavelength model agrees with experimentally measured optical depth




- ρR is scaled by x-ray mfp and framing camera MTF.

Summary/Conclusions

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