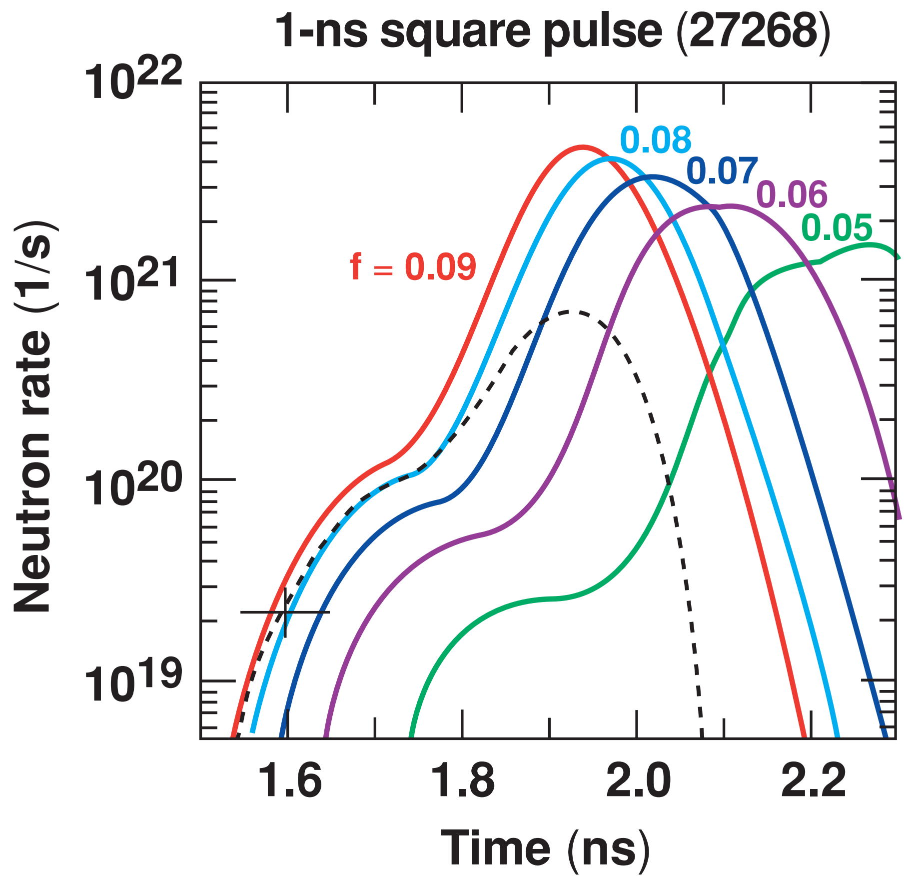
Numerical Investigation of Recent Laser Absorption and Drive Experiments of CH Spherical Shells on the OMEGA Laser



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Contributors

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Summary

Dedicated experiments on the OMEGA laser have measured absorption fraction and implosion timing

- Neutron temporal diagnostics (NTD), shell trajectory, and temporal x-ray emission measured the drive efficiency.
- Laser absorption was measured with improved diagnostics.
- The timing and the level of both the shock yield and the onset of the compression yield are sensitive to the flux limiter.
- Absorption measurements require a flux limiter value below 0.06 (harmonic).
- A flux limiter between 0.07 and 0.08 gives general agreement with implosion timing.
- Work is ongoing to reconcile the two results.

The flux limiter affects independently the drive and the laser absorption fraction

- The flux limiter controls the flow of the absorbed energy into the target and affects
  - the drive though the mass ablation rate and
  - the absorption fraction through the electron temperature in the corona.
- It is active at and inside the critical surface.
- Two methods are used to compute the thermal flux:
  - the sharp cutoff: $Q = \max(Q_{SH}, Q_{FS})$
  - the harmonic mean: $Q = (Q_{SH}Q_{FS})/(Q_{SH} + Q_{FS})$

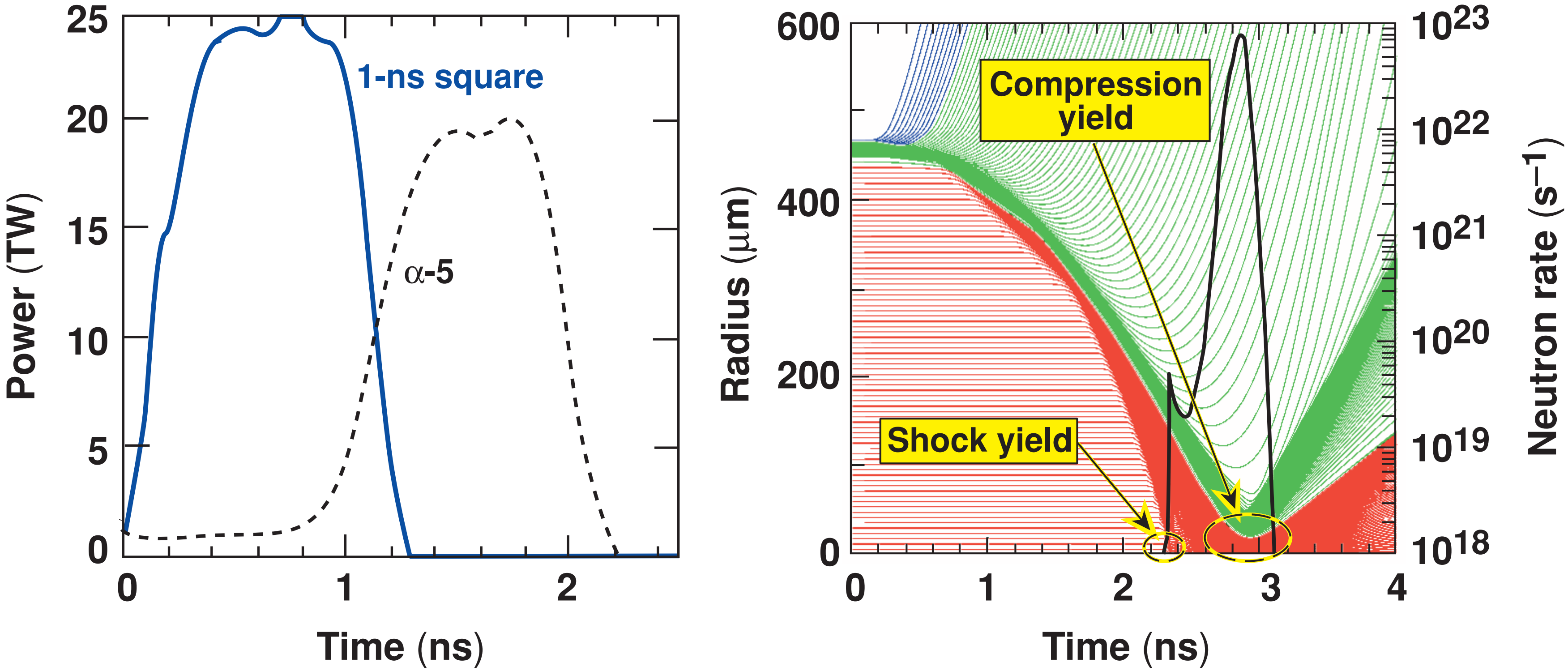
The absorbed energy was measured with two independent diagnostics

- **Two differential plasma calorimeters measure the plasma and scattered light reaching the tank wall (time integrated).**
- **Two full-aperture backscatter stations (FABS, *f*/6) measure the scattered and refracted light through two focusing lenses (time integrated and time resolved).**
- **Two subsidiary scattered light diagnostics measure the scattered/refracted light between the lenses (time integrated and time resolved).**
- **The signals from all six calorimeters are very consistent with overall errors estimated at 2% (absolute) from shot to shot.**

The drive timing was obtained from x-ray and neutron diagnostics

- The shell trajectory was measured with an imaging streak camera and a framing camera.
- The onset of stagnation was via the shock yield measured with the neutron temporal diagnostic (NTD).
- The temporal x-ray emission was obtained from a diamond detector.

The neutron burn history shows details of the shock arrival and the stagnation phase of the implosion



Targets are 15 μm CH or CHSi shells filled with 15 atm D_2, D_2/Ar, or D_2 ^{3}He, and diameters 930 μm and 1100 μm.

The laser absorption is modeled in *LILAC* with 2-D ray tracing and classical inverse bremsstrahlung

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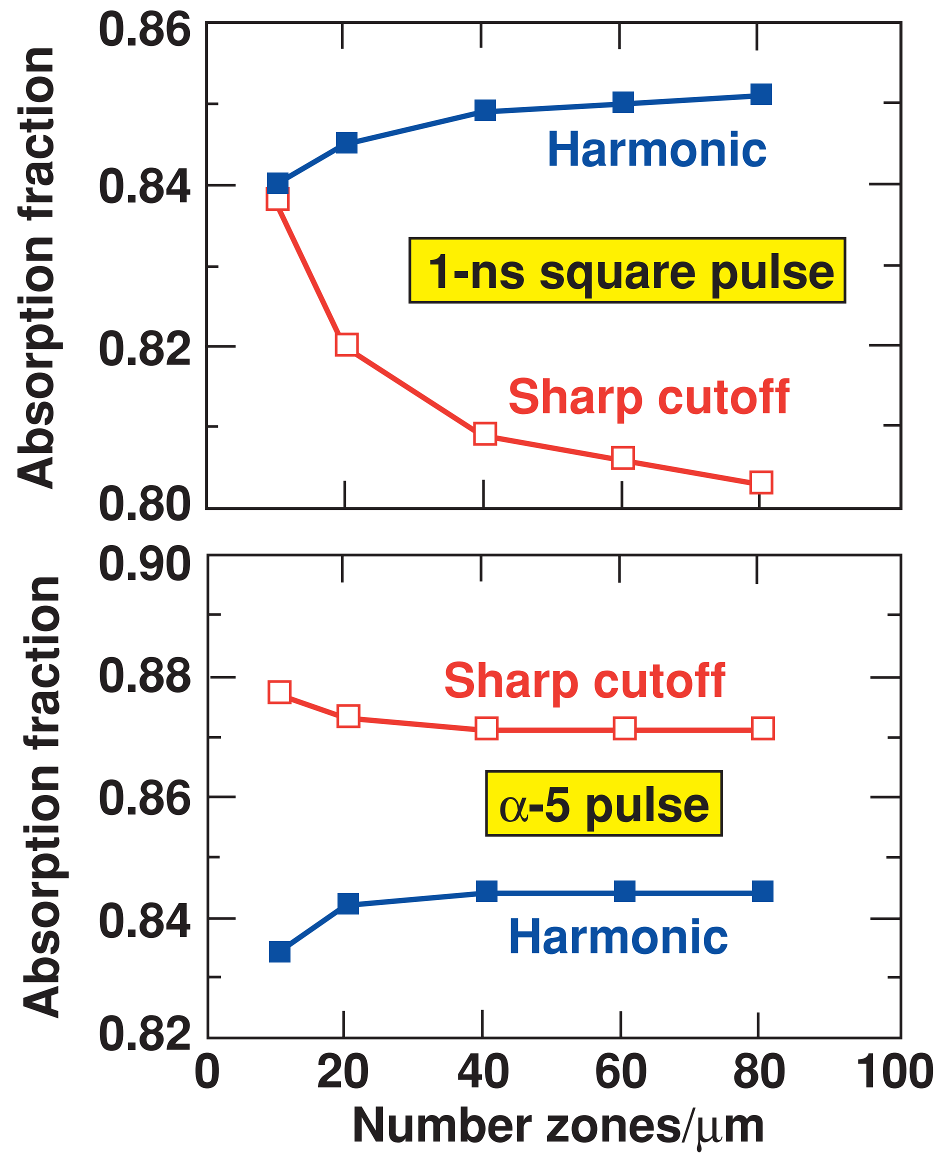
- The ray trace uses the measured DPP spatial distribution, including the effect of SSD and PS.
- The absorption model includes the Langdon effect.
- The density profile at and below the critical surface is zoning dependent.
- The harmonic mean method is less sensitive to zoning than the sharp-cutoff method.



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The measured and simulated absorption fractions show the same trend over a wide range of experimental conditions

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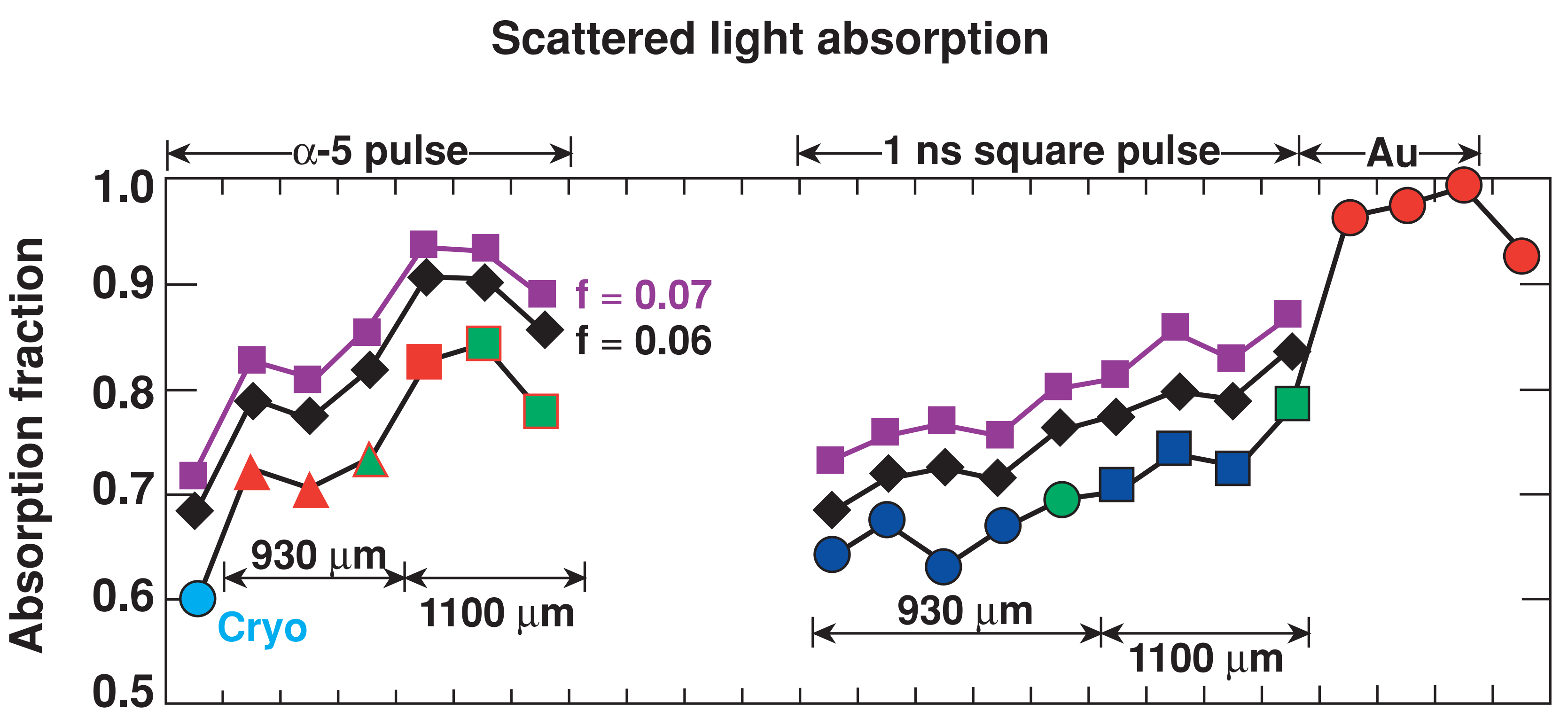

Green fill: CHSi shells
Experimental error bars are size of symbols

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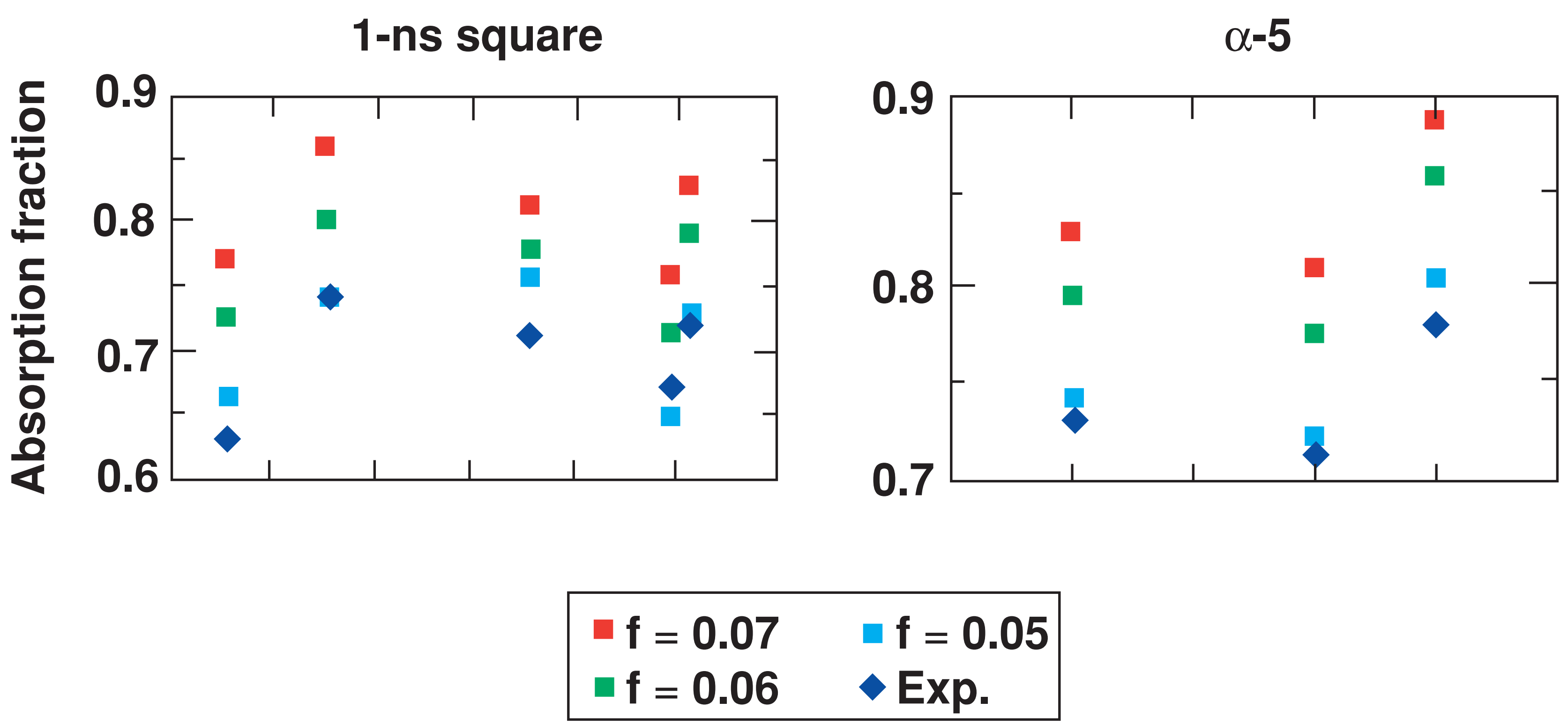
For CH shells and generic conditions *LILAC* needs a low value of flux limiter to match the experimental measurements



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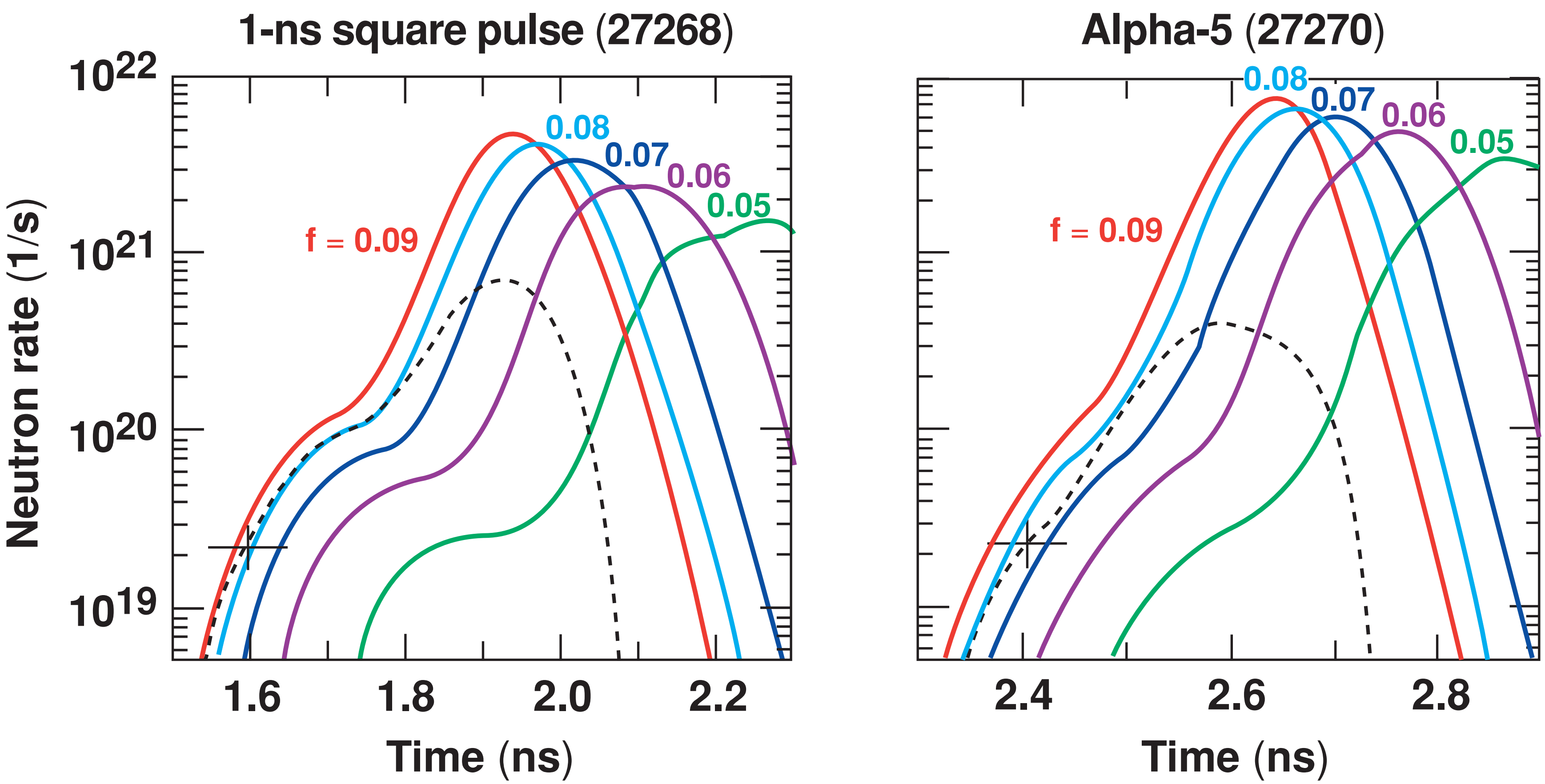
The NTD timing is best matched by a flux limiter between 0.07 and 0.08 harmonic



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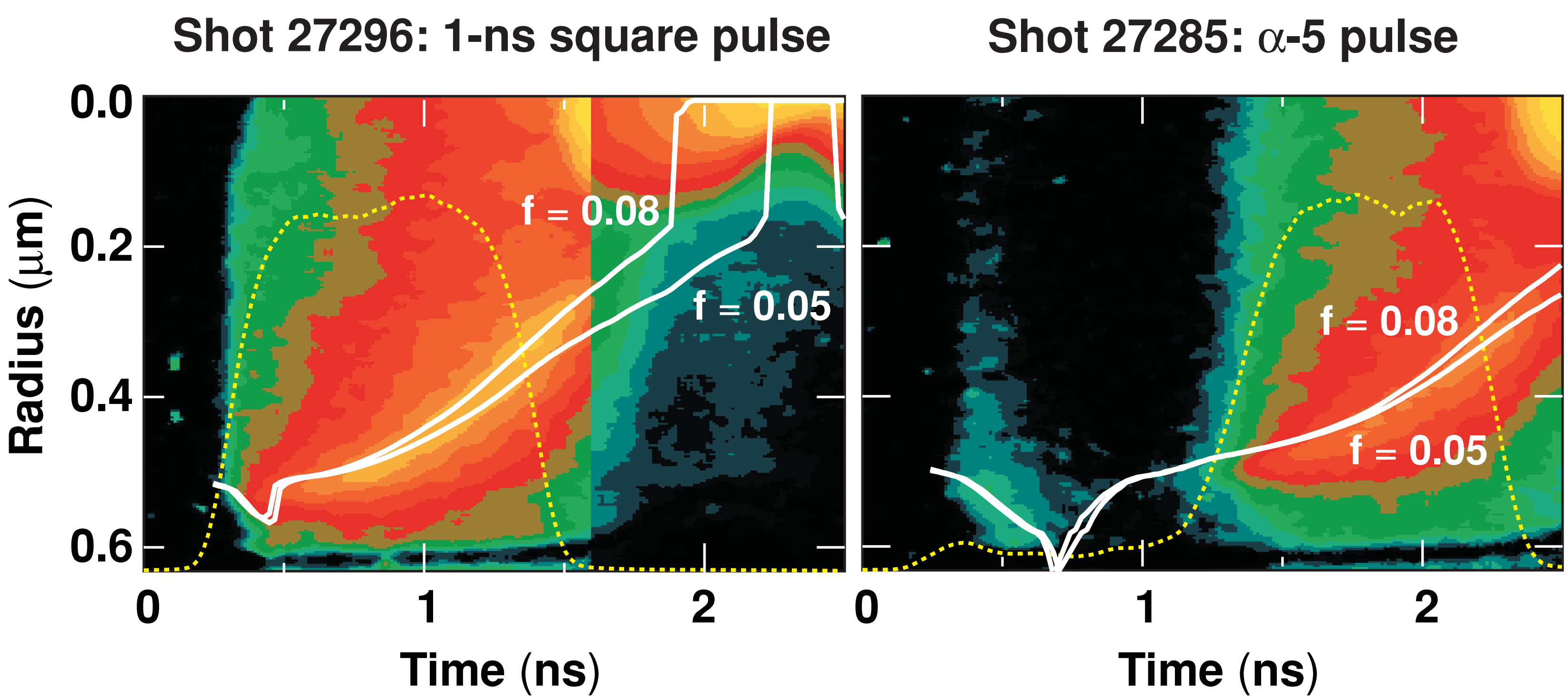
The shell trajectories confirm the results of NTD



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Reconciliation between the results of the absorption and implosion timing is difficult

- Flux-limiter values between 0.07 and 0.08 are supported by
  - NTD and x-ray timing in the experiments reported here,
  - Ar emission timing in doped-core mix experiments,[1] and
  - Fokker-Plank calculations of the thermal flux.[2, 3]
- Absorption measurements agree with a flux limiter below 0.06.
- Time-dependent flux limiter[3] goes the wrong way.
- Many considered scenarios failed because of the coupling between absorbed energy and drive efficiency through the flux limiter.

[1]S. P. Regan *et al.*, Phys. Plasma 9, 1357 (2002).
[2]J. P. Matte *et al.*, Phys. Rev. Lett. 53, 1461 (1980).
[3]A. Sunahara, Bull. Am. Phys. Soc, 46, 181 (2001).

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Summary/Conclusions

Dedicated experiments on the OMEGA laser have measured absorption fraction and implosion timing

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