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

J. A. Delettrez
University of Rochester
Laboratory for Laser Energetics

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Summary

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

- Neutron temporal diagnostics (NTD) 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 separately the drive and the laser absorption fraction

- The flux limiter controls the flow of the absorbed energy into the target and affects
  - the drive through 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: \( Q = \min(Q_{SH}, Q_{FS}) \)
  - the harmonic mean: \( Q = \frac{Q_{SH}Q_{FS}}{Q_{SH} + Q_{FS}} \)
The laser absorption is modeled in *LILAC* with 2-D ray tracing and classical inverse bremsstrahlung.

- 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.
Targets with two different radii were irradiated by two different pulses.

- **Time (ns)**: 0, 1, 2
- **Power (TW)**: 0, 25, 5, 930 or 1100
- **1-ns square**
- **CH (15 μm)**
- **15 atm D₂**: 930 or 1100 μm
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 measured and simulated absorption fractions show the same trend over a wide range of experimental conditions.

Scattered light absorption

Green fill: CHSi shells
Experimental error bars are size of symbols
For CH shells *LILAC* needs a low value of flux limiter to match the experimental measurements.
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,\textsuperscript{1} and
  - Fokker-Plank calculations of the thermal flux.\textsuperscript{2, 3}

- Absorption measurements agree with a flux limiter below 0.06.

- Time-dependent flux limiter\textsuperscript{3} goes the wrong way.

- Many considered scenarios failed because of the coupling between absorbed energy and drive efficiency through the flux limiter.

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