Measurements of Imprinting with Laser Beams at Various Angles of Incidence in Planar CH Foils

Imprint efficiency ($\mu$m) vs. Angle of incidence (°)

University of Rochester
Laboratory for Laser Energetics

46th Annual Meeting of the American Physical Society
Division of Plasma Physics
Savannah, GA
15–19 November 2004
Summary

Imprinting decreases as the beam angle of incidence increases

- Experiments used 20-μm-thick CH targets driven by six overlapped beams at \( \sim 10^{14} \text{ W/cm}^2 \).

- Beam mistiming significantly increases the imprinting; when the imprint beam was advanced by \( \sim 50 \text{ ps} \) it increased imprinting by up to eight times.

- Imprinting was reduced by \( \sim 3 \) times when the imprint beam angle of incidence was increased from 20° to 60°.
Imprint efficiency is determined from the ratios of imprinted to preimposed optical-depth modulations.

Imprint efficiency: $\text{IE} = \frac{a_{\text{impr}}(t)}{a_{\text{preim}}(t)} \times a_0$

- Targets are 20-$\mu$m thick CH foils.

Predictions of the imprinting model* are used to compare with experimental data.

\[ d_t^2 \eta + 4k V_a d_t \eta + k^2 V_{bl} V_a \eta = \frac{2}{5} k \frac{\delta I}{I} C_s^2 e^{-kD_{ac}(t)} + d_t \left[ C_s \frac{\delta I}{\sqrt{5} I} e^{-kD_{ac}(t)} \right] \]

Fire polishing

\[ \text{Accelerational modulation} \]

\[ \text{Dynamic overpressure} \]

\[ \text{Post-shock velocity modulation} \]

Parameters simulated by the 1-D code LILAC.

- \( C_s \) = sound speed
- \( V_a \) = ablation velocity
- \( V_{bl} \) = blow-off velocity, \( V_{bl} = V_a / 2kL_o \)
- \( L_o \) = density scale length
- \( D_{ac} \) = distance between ablation and critical surfaces

A special DPP with a 2-D 60-µm wavelength perturbation is used in imprint efficiency measurements.

CH foil with vertical 60-µm-wavelength perturbation

Five drive beams with regular DPP’s

Imprint beam with special DPP

Imprint beam 49 advanced by 10 ps

Fourier-plane image

2-D preimposed modulations

2-D imprinted modulations
Imprint efficiency is determined from the ratios of measured imprinted and preimposed optical-depth modulations.

\[
IE = \frac{a_{impr}}{a_{preim}} \times 0.125 \mu m
\]

\[
\frac{\delta I}{I} = 0.093
\]
Imprinting is very sensitive to beam mistiming.

**Imprint at 60-μm wavelength**

- **Imprint efficiency (μm)**
- **Imprint beam delay (ps)**

- Imprint efficiency ranges from 0.1 to 10.0 μm.
- Imprint beam delay ranges from -200 to 300 ps.
The imprint efficiency of broadband modulations is measured with all drive beams having SG8 DPPs.

- CH foil with horizontal 60-\(\mu\)m-wavelength perturbation
- Imprint beam with regular DPP
- Five drive beams with regular DPP’s

Fourier-plane image:
- Shot 35124
- 3-D broadband imprinted modulations
- 2-D imprinted modulations
The imprint efficiency of 3-D broadband modulations is determined using the ratios of azimuthally-averaged imprinted modulations to 2-D preimposed modulations

\[ IE = \frac{\bar{a}_{\text{impr}}}{a_{\text{preim}}} \times 0.125 \mu m \]

3-D broadband imprinted modulations

2-D preimposed modulations

\[ \frac{\delta I}{I} = 0.0051 \]
The imprinting of broadband modulations increase with beam mistiming

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Imprint efficiency ($\mu$m) vs. Imprint beam delay (ps)
Imprinting is reduced in beams with higher angles of incidence.

![Graph showing the relationship between Imprint efficiency (µm) and Angle of incidence (°). The graph includes data points for different advancements (100 ps and 50 ps) and a modeling result with an advance of 50 ps.]
Summary/Conclusions

Imprinting decreases as the beam angle of incidence increases

• Experiments used 20-μm-thick CH targets driven by six overlapped beams at \(~10^{14}\) W/cm\(^2\).

• Beam mistiming significantly increases the imprinting; when the imprint beam was advanced by \(~50\) ps it increased imprinting by up to eight times.

• Imprinting was reduced by \(~3\) times when the imprint beam angle of incidence was increased from 20° to 60°.