Half-Integer Harmonic Images from Spherical Implosions Point Toward Localized, Multi-Beam Two-Plasmon Decay

Angle-of-incidence–limited irradiation nonuniformity in HEX and PENT locations are evident in $3\omega/2$ and $\omega/2$ images

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Summary

Images of the $3\omega/2$ and $\omega/2$ emission from implosion experiments identify details of the two-plasmon-decay (TPD) processes

- $3\omega/2$ and $\omega/2$ images are consistent with driving common waves in HEX and PENT ports on OMEGA

- Comparison of on-target laser-light nonuniformity and $3\omega/2$ and $\omega/2$ images allows for inferences on TPD driven in localized areas

- $3\omega/2$ emission can potentially be used to explain observed discrepancies between scattered-light measurements and LILAC predictions
Collaborators


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At overlapped intensities of $<4 \times 10^{14}$ W/cm$^2$ the LILAC predictions for scattered light are within 2% of the time-integrated measurements.

No measureable TPD ($3\omega/2$)  
No HXRD signals
Time-resolved scattered-light spectra for high-intensity implosions are consistent with significant energy loss to TPD plasmons.
Multibeam TPD interaction imposes symmetry restrictions and favors HEX and PENT locations on OMEGA

Shot 62737, LILAC at $t = 2.2$ ns

OMEGA sphere at $n_c/5$ with beam locations

DDP = SG4
Assuming multibeam TPD, ray tracing with realistic plasma conditions is used to find TPD locations.
Theory limits multibeam TPD growth to a beam angle of ≤40°

OMEGA sphere at \( n_c/5 \) with beam locations

Maximum angle of incidence for multibeam TPD

Shot 62737, LILAC at \( t = 2.2 \) ns

DDP = SG4
HEX and PENT locations on OMEGA are naturally favored for multibeam TPD interaction

Shot 62737, LILAC at $t = 2.2$ ns

Maximum angle of incidence for multibeam TPD

OMEGA sphere at $n_c/5$

with beam locations

$DDP = SG4$
Limiting local beam angles to <35° reveals the irradiation nonuniformity for otherwise optimum illumination uniformity.

Overall drive (illumination) nonuniformity ~0.3%

Shot 62737, LILAC at t = 2.2 ns

OMEGA sphere at \( n_c/5 \)

with beam locations

DDP = SG4
Changing the target illumination can significantly change the location of likely TPD

Overall drive (illumination) nonuniformity degraded to 10%

Shot 62737, LILAC at $t = 2.2$ ns

OMEGA sphere at $n_c/5$
with beam locations

Laser

impact parameter

$10^{14} \text{ W/cm}^2$

5.5

5.0

4.5

4.0

3.5

DDP = SG4
The structure observed in $3\omega/2$ images is consistent with TPD operating in well-localized regions.
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$\omega/2$ images are dominated by refraction and can be understood using ray tracing.

$LILAC$ simulation for shot 62737, 150 J/beam
Different illumination conditions lead to distinct changes in $\omega/2$ images.

Shot 62737, 150 J/beam
- Tangential focus

Shot 62845, 175 J/beam
- Narrow focus

Landau cutoff on target

E20434
Different illumination conditions lead to distinct changes in $\omega/2$ images.
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