Measurements of the Two-Plasmon-Decay Instability on OMEGA

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Two-plasmon-decay instability is the primary source of hot electrons in both planar and spherical experiments

- The $3\omega/2$ signature of the two-plasmon-decay instability correlates very well with the hard x-ray emission in both planar and spherical geometries.
- Smoothing by spectral dispersion (SSD) enhances the hard x-ray emission in spherical and long-scale-length planar experiments.
- Polarization smoothing (PS) using birefringent wedges lowers the hard x-ray emission.
- Experiments using targets of different diameters indicate that the overlapped intensity dominates the scaling of the hard x-ray emission and the $3\omega/2$ signature of the two-plasmon-decay instability.
Hot electrons can significantly reduce the target gain

- The effect of an 80-keV hot-electron tail was simulated using the fast-electron package in *LILAC*.
- About 4% of the energy absorbed into fast electrons couples into the DT-ice fuel layer.
The $3\omega/2$ signature of the two-plasmon-decay instability is produced by Thomson scattering.

Two-plasmon decay (primary decay process)

Self-Thomson scattering (secondary scattering process)
Four hard x-ray detectors using single-edge-type filters are used to measure the hot-electron temperature.
Planar-foil experiments use three sets of delayed beams, six of which are interaction beams...

Thick CH target

Angle to target normal

62° 48° 23°

Power

Time (ns)

0 1

3ω/2

Pick-up telescope

Spectrometer

Streak
The blue shifted peak is missing in the $3\omega/2$ spectrum in planar experiments.
The hard x-ray signals from the planar experiments show a trend of increased signal with SSD.
In spherical geometry, the overlapped intensity on target depends on the target diameter.

![Diagram of beam-intensity envelope and target](image)

- **Beam-intensity envelope**
- **Target**

**Graphs:**
- **Single-beam envelope**
  - Intensity vs. Radius (mm)
  - Intensity: 0.0 to 1.0
  - Radius: -1.0 to 1.0

- **Intensity on target**
  - Intensity (10^{14} W/cm^2) vs. Diameter (mm)
  - Intensity range: 0 to 10
  - Diameter range: 0.9 to 1.1

**Data:**
- Peak single-beam intensity
- Overlapped intensity (60 beams)
The $3\omega/2$ signal from spherical experiments shows the typical two-peak structure

- CH shell, 950-µm diam., $8 \times 10^{14}$ W/cm$^2$ overlapped, 1-ns square
$3\omega/2$ light correlates with hard x rays for square pulse

- CH shell, 950-μm diam., $8 \times 10^{14}$ W/cm² overlapped, 1-ns square
Improvements in the single-beam nonuniformity by SSD or PS affect the hard x-ray emission for spherical targets

- CH shell, 950-\(\mu\)m diam., 1-ns square, varying single-beam intensity

\[
\text{Signal} = 0.013 \times \exp \left( \frac{I_{14}}{1.19} \right)
\]
The hard x-ray signal, temperature, and $3\omega/2$ signal correlate very well with the target radius for spherical targets.

- CH shell, $1.8 \times 10^{14} \text{ W/cm}^2$ single beam, 1-ns square
Changing the target diameter is equivalent to changing the laser power for spherical targets

- CH shell, $1.8 \times 10^{14} \text{ W/cm}^2$ single beam, 1-ns square

![Graph showing the relationship between signal and overlapped intensity. The equation is $\text{Signal} = 0.013 \times \exp (I_{14}/1.19)$, where $I_{14}$ is the overlapped intensity in $10^{14} \text{ W/cm}^2$. The graph includes data points labeled HXRD2.]
Two-plasmon-decay instability is the primary source of hot electrons in both planar and spherical experiments

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