Cross-Beam Energy Transfer Platform on OMEGA

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Cross-beam energy transfer (CBET) has been measured using the Tunable OMEGA Port 9 (TOP9) system.

- A new laser–plasma interaction (LPI) platform with a gas-jet target and transmitted-beam diagnostics has been activated on OMEGA.
- Laser transfer was measured as a function of the wavelength shift between pump and probe beams.
- Thomson scattering provided spatial and temporal measurements of plasma parameters.
Collaborators


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Current CBET models are insufficient to predict laser coupling in direct drive and implosion symmetry in indirect drive.
The TOP9 CBET platform will investigate beam configurations relevant to both direct- and indirect-drive inertial confinement fusion schemes.

\[ \Delta \lambda \approx \lambda_0 \frac{c_s}{c} [1 + \cos(\theta)] \]
The OMEGA LPI platform’s diagnostic suite meticulously characterizes beam and plasma conditions
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Gas jet

\[ \Delta \lambda = 3 \text{ nm} \]

Tunable OMEGA Port 9
The OMEGA LPI platform’s diagnostic suite meticulously characterizes beam and plasma conditions

Gas jet

Δλ = 3 nm

Tunable OMEGA Port 9

Wavelength (nm)

Time (ns)

Transmitted beam diagnostic
The OMEGA LPI platform’s diagnostic suite meticulously characterizes beam and plasma conditions

Gas jet

$\Delta \lambda = 3 \text{ nm}$

Tunable OMEGA Port 9

Transmitted beam diagnostic

Thomson-scattering system
The gas-jet system and ten UV heater beams form the plasma before the pump and probe arrive.
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- **Heaters**: 4 TW
- **Pump**: 0.4 TW
- **Probe**: 0.08 TW

- **Time (ns)**: 0.5, 1.0, 1.5
- **Power**
  - Heaters: 4 TW
  - Pump: 0.4 TW
  - Probe: 0.08 TW

- **Heater beams**
- **Gas-jet nozzle**
  - $0.0 < t < 0.5$ ns: Plasma formation
  - $0.5 < t < 1.0$ ns: Pump–probe interaction

- **TOP9**
The gas-jet system and ten UV heater beams form the plasma before the pump and probe arrive.
The amount of energy transferred between the pump and probe depends on the TOP9 wavelength shift.

- **Shot 90450**: $\Delta \lambda = -5 \, \text{Å}, 10.2 \, \text{J incident}$
- **Shot 90443**: $\Delta \lambda = 0 \, \text{Å}, 14.8 \, \text{J incident}$
- **Shot 90444**: $\Delta \lambda = 5 \, \text{Å}, 13.1 \, \text{J incident}$

CCD: charge-coupled device
2ω imaged Thomson scattering measures plasma parameters with spatial resolution

$0.0 < t < 0.5 \text{ ns: Plasma formation}$
$2\omega$ imaged Thomson scattering measures plasma parameters with spatial resolution
$2\omega$ imaged Thomson scattering was used to measure the spatial density and temperature profile of the target plasma.
$3\omega$ streaked Thomson scattering measures on-shot plasma parameters with temporal resolution from the center of the plasma.

$0.0 < t < 0.5 \text{ ns}$

Plasma formation
$3\omega$ streaked Thomson scattering measures on-shot plasma parameters with temporal resolution from the center of the plasma
3$\omega$ streaked Thomson scattering measures on-shot plasma parameters with temporal resolution from the center of the plasma.
3ω Thomson-scattered light is measured on TOP9 shots to measure temporally resolved plasma parameters.

![IAW feature diagram](image1)

![EPW feature diagram](image2)

![Normalized IAW](image3)

![Normalized EPW (blue)](image4)
Plasma parameters vary slowly through the CBET interaction and are measured throughout the TOP9 pulse.
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