Optimization of a Short-Pulse–Driven Si He$\alpha$ Soft X-Ray Backlighter

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The higher backlighter brightness makes it possible to radiograph the cryogenic implosion closer to peak compression or at higher implosion velocity.

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A shaped crystal imager (SCI) setup is used for backlighting cryogenic implosions

- The backlighter target is not in the focus of the SCI imager, which makes it insensitive to the laser focal-spot distribution
- With a direct line-of-sight (LOS) block and a collimator, the SCI system is well shielded against the self-emission of the target
The signals from flat targets were compared with foam targets, flat targets with a laser prepulse, and targets with a thin (10-μm) CH shield.
The time-integrated spectra show little gain for the foam targets.
The time-integrated spectra show a significant increase in signal for targets with a UV prepulse and targets with a shield.
The time-resolved measurements showed a large increase in x-ray pulse duration for the prepulses.

- Three different filters were placed in front of an ultrafast x-ray streak camera:
  - Aluminum (top)
  - Chlorine-doped CH (middle)
  - CH (bottom)
A knife-edge target was used to check the spatial resolution of the image.

Time-gated measurements with an SCI setup and a 40-ps exposure time showed the expected \(~5\times\) increase in signal.
The different configurations used the following laser parameters

1. 10-ps pulse, 200-m$^2$ focus
2. 10-ps pulse, 300-m$^2$ focus
3. 20-ps pulse, 200-m$^2$ focus
4. 20-ps pulse, 300-m$^2$ focus

The laser pulse duration and focal spot size were varied to find the optimum illumination setup.
Summary/Conclusions

The brightness of a short-pulse–driven Si He$_\alpha$ backlighter was increased by $\sim 5 \times$.*

- High backlighter brightness is important to maximize signal-to-noise and signal-to-background in radiography experiments like backlighting cryogenic implosions.*
- Low-density SiO$_2$ foam targets, the effects of a laser prepulse, and Si targets with a CH “shield” were compared to solid-density flat Si targets irradiated by a 1 kJ, $\sim$10 to 20 ps IR laser.
- The CH shield targets showed the best performance with an $\sim 5 \times$ improvement in time-integrated emission and an x-ray pulse duration of $\sim 25$ ps.
  - The conversion efficiency from laser light into Si He photons is of the order of $\sim 10^{-5}$.

The higher backlighter brightness makes it possible to radiograph the cryogenic implosion closer to peak compression or at higher implosion velocity.