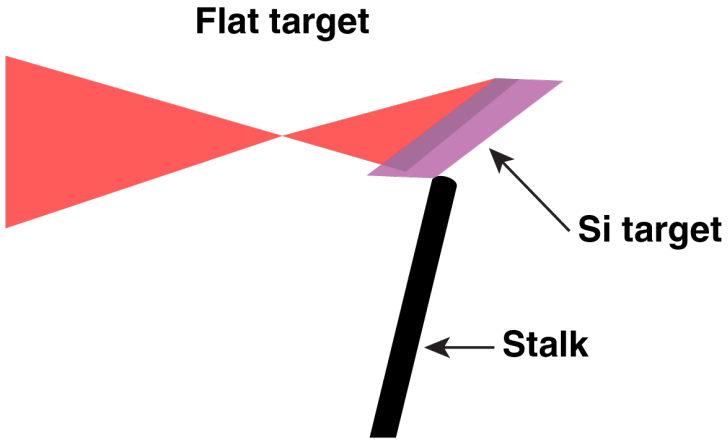
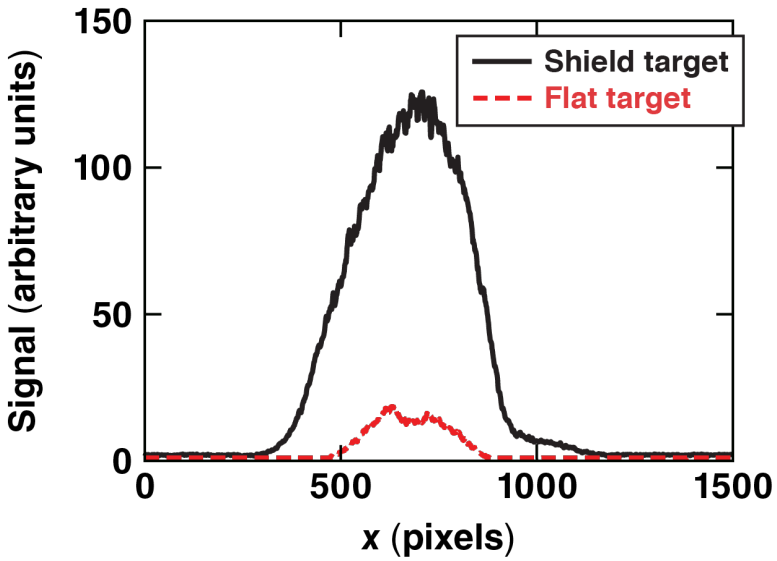
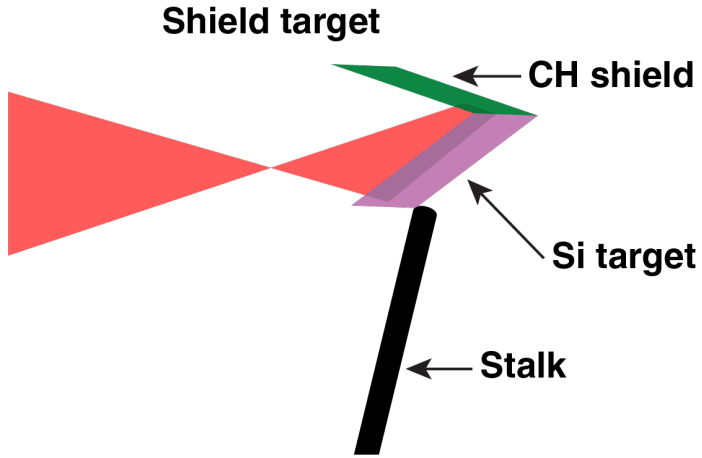
Optimization of a Short-Pulse–Driven Si He_α Soft X-Ray Backlighter







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Summary

The brightness of a short-pulse–driven Si He_α backlighter was increased by ~5×

- 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, ~10 to 20 ps IR laser
- The CH shield targets showed the best performance with an ~5× improvement in time-integrated emission and an x-ray pulse duration of ~25 ps
  - the conversion efficiency from laser light into Si He photons is of the order of ~10^{-5}

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

*C. Stoeckl, Physics of Plasmas 24, 056304 (2017).

Collaborators

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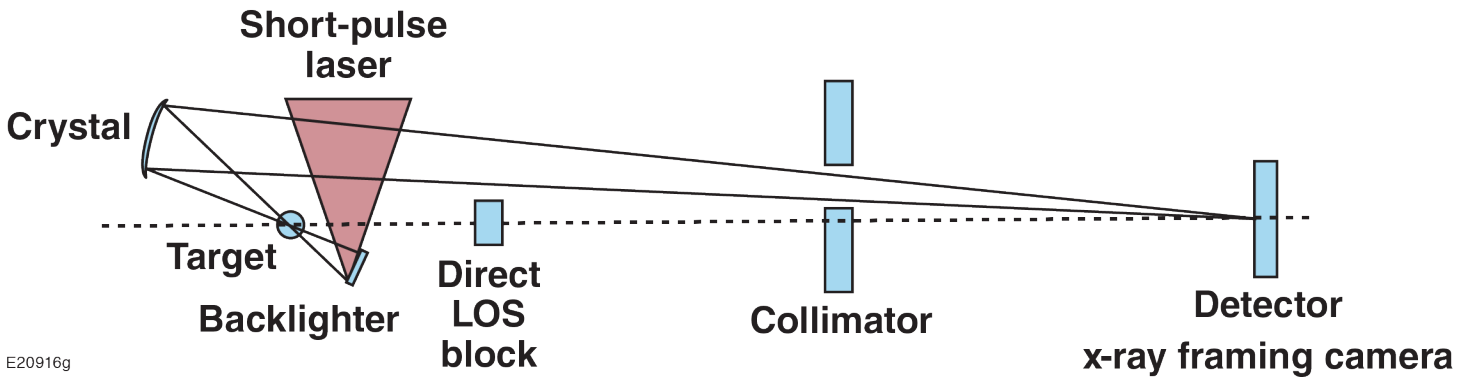
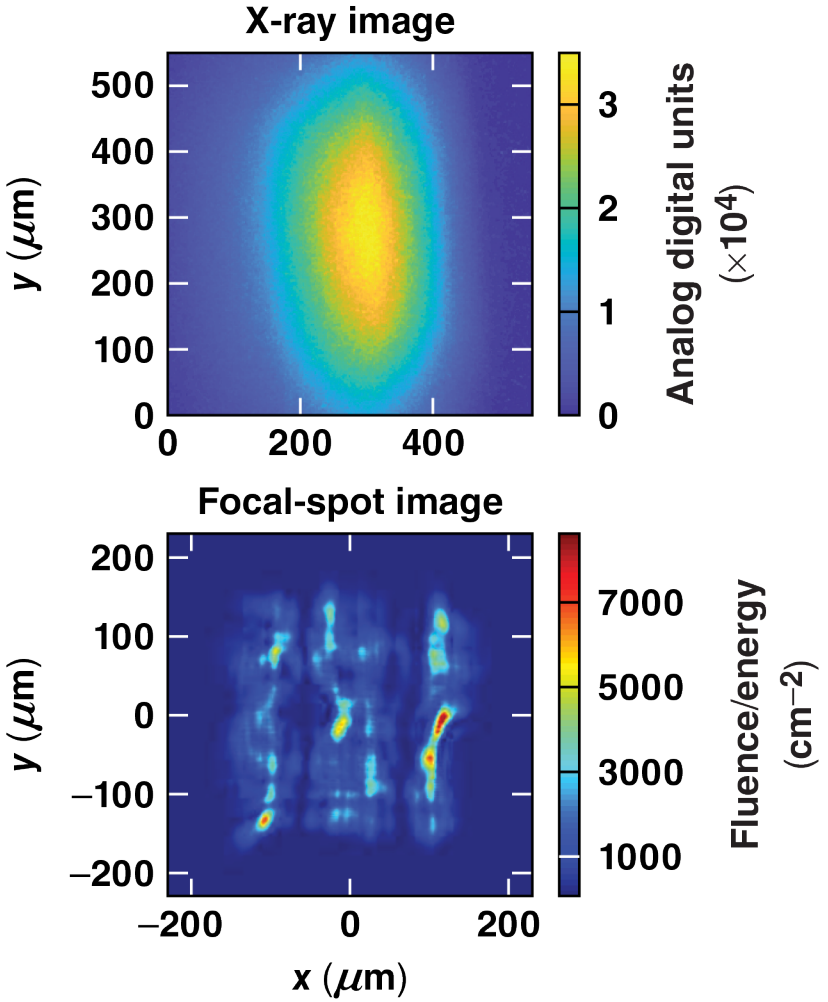
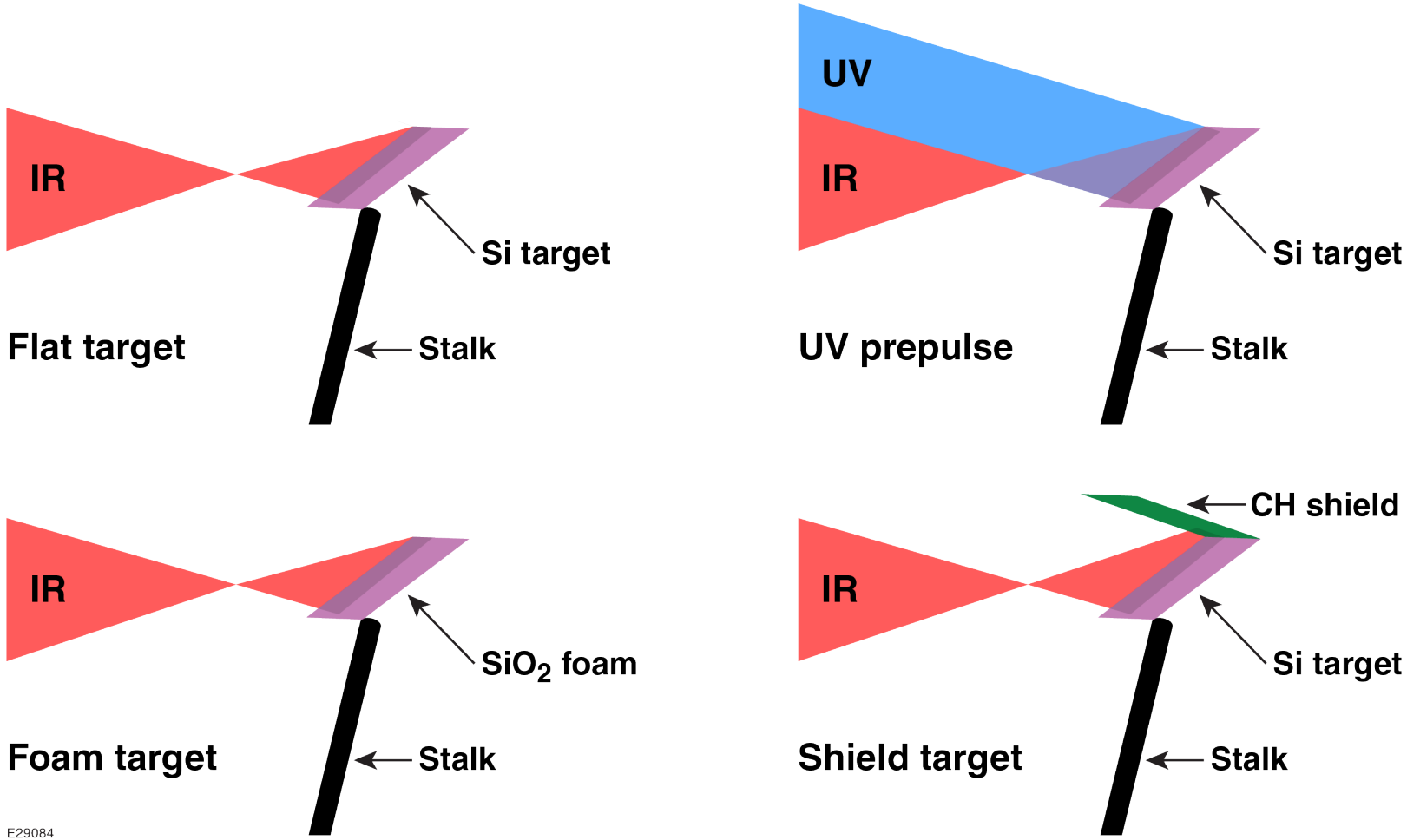
A shaped crystal imager (SCI) setup is used for backlighting cryogenic implosions



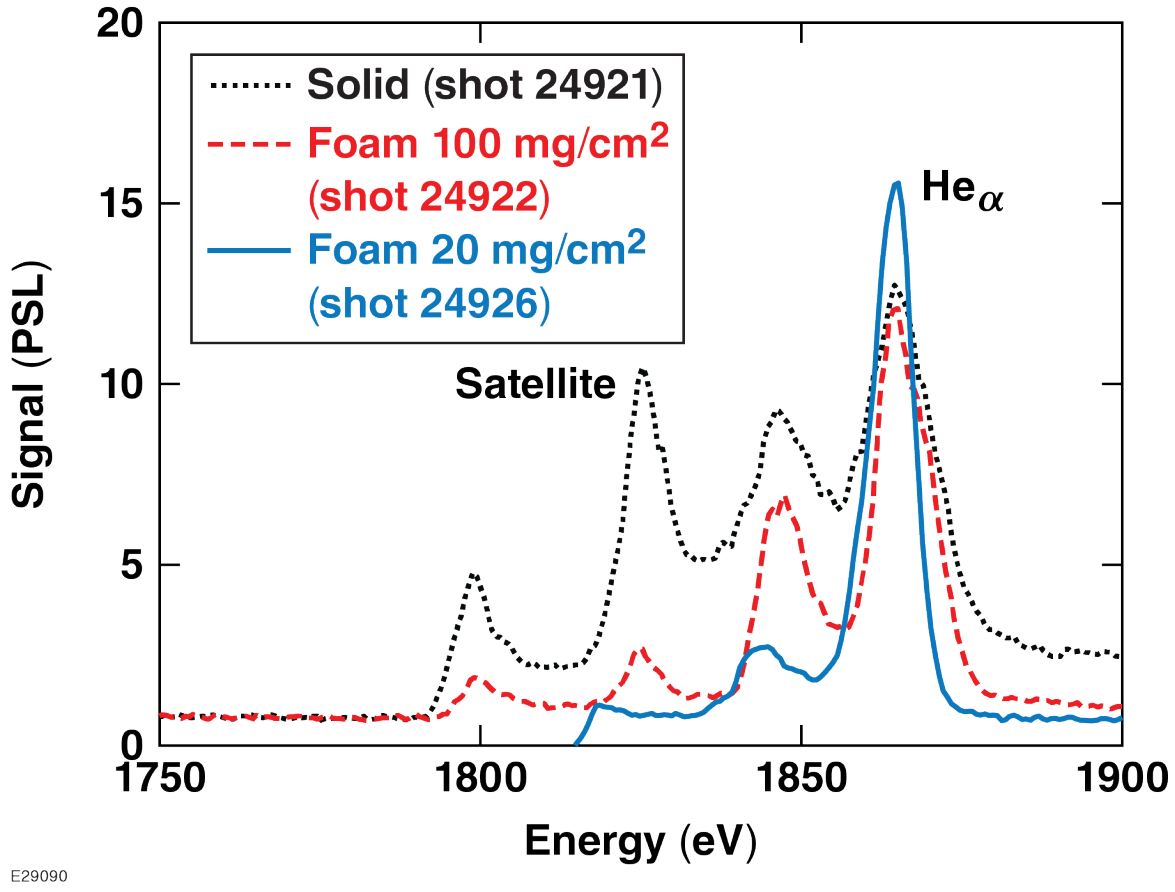


- The backlighter target is not in the focus of the SCI imager, which makes it insensitive to the laser focal-spot distribution
- With a direct line-of-sight (LOS) block and a collimator, the SCI system is well shielded against the self-emission of the target

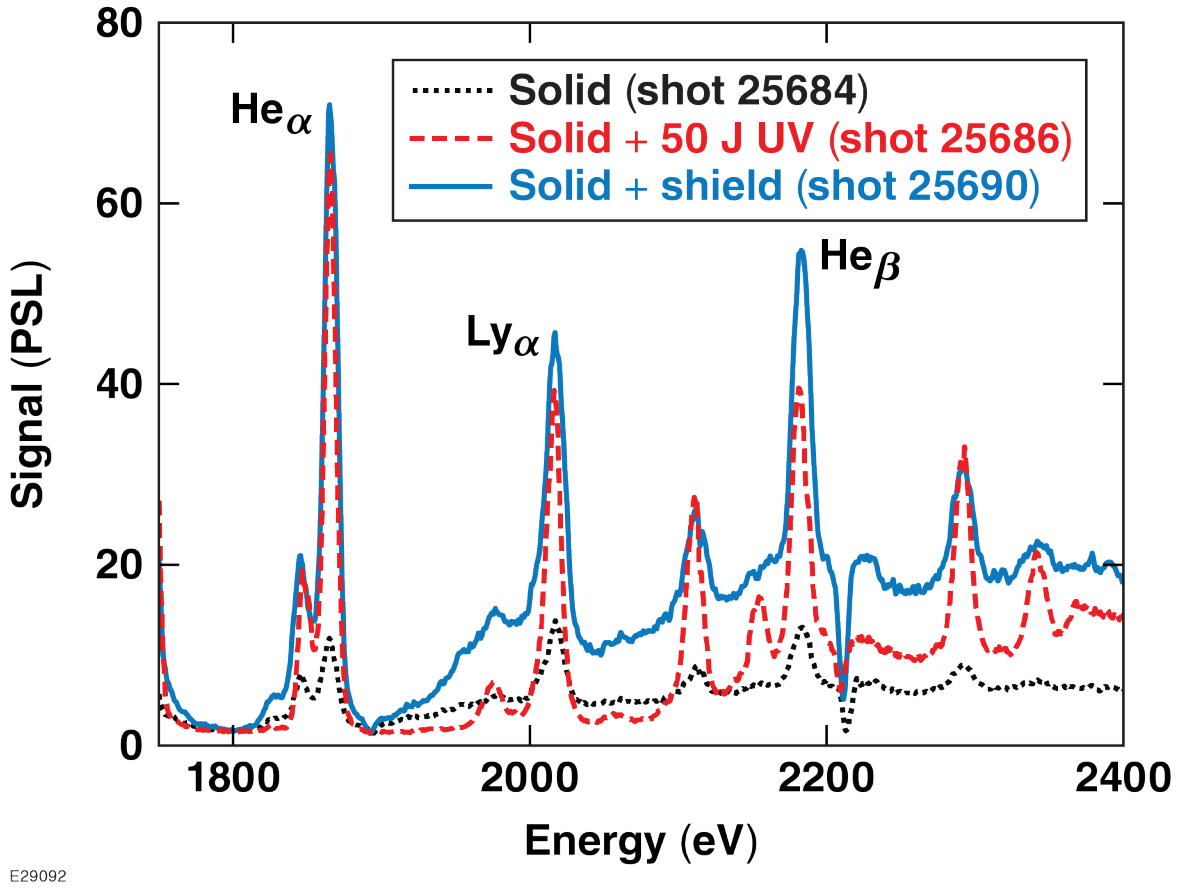
The signals from flat targets were compared with foam targets, flat targets with a laser prepulse, and targets with a thin (10-μm) CH shield



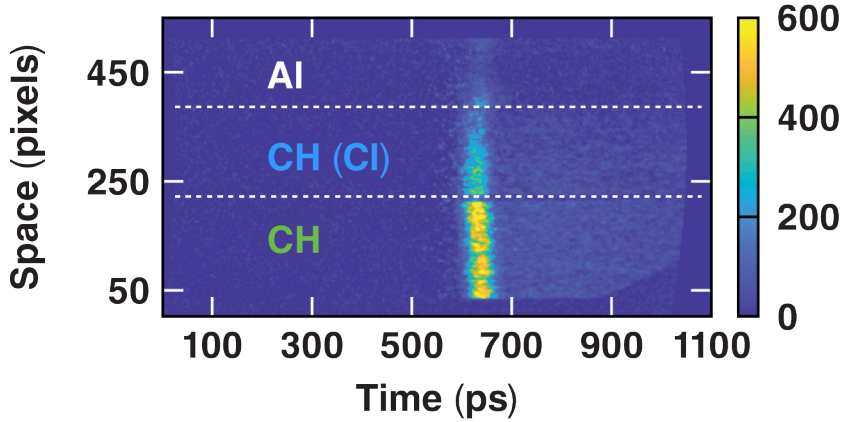
The time-integrated spectra show little gain for the foam targets



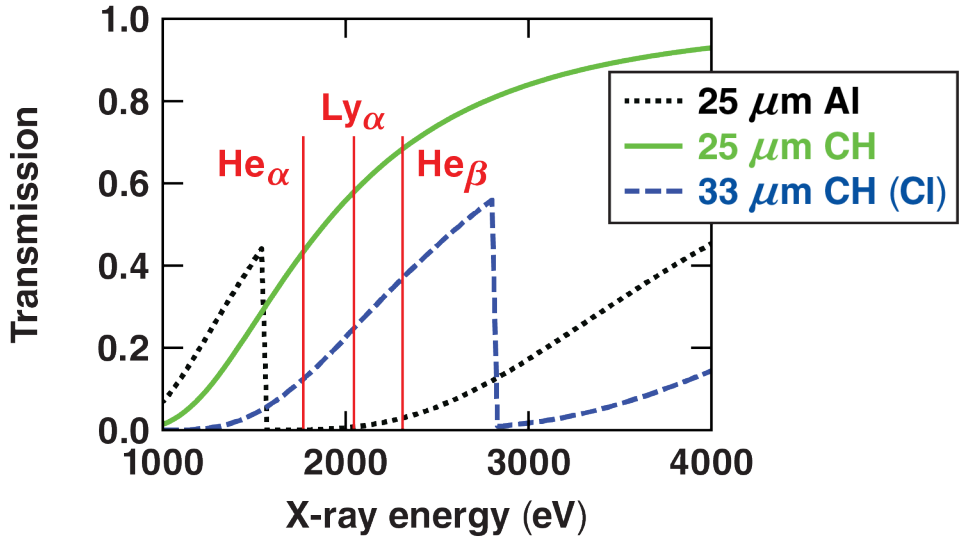
The time-integrated spectra show a significant increase in signal for targets with a UV prepulse and targets with a shield



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)



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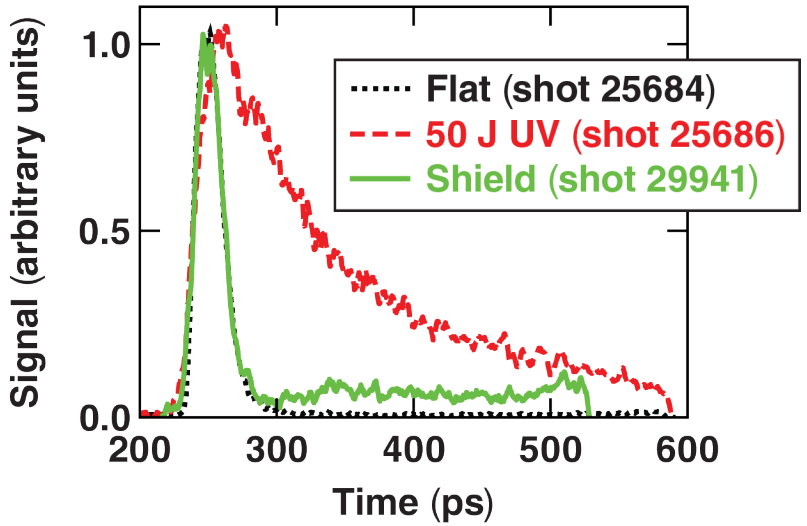

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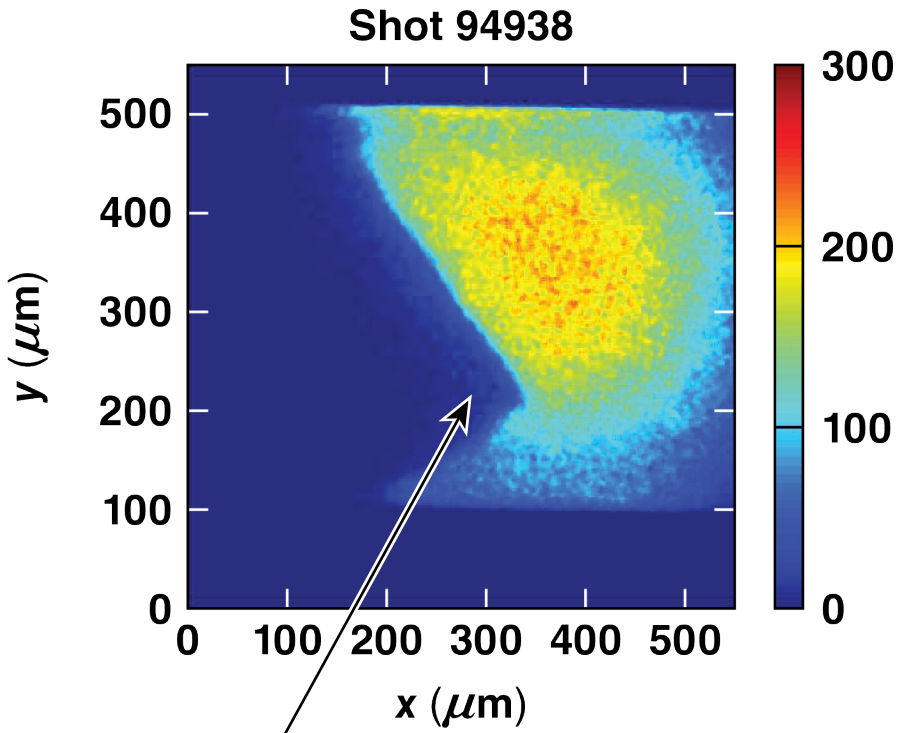
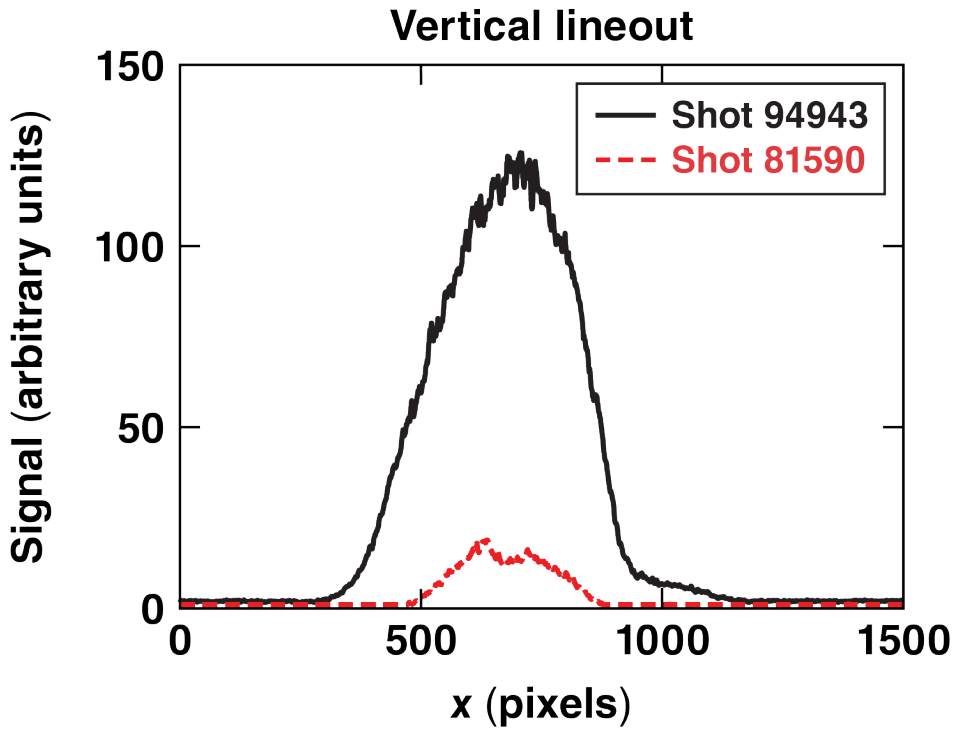
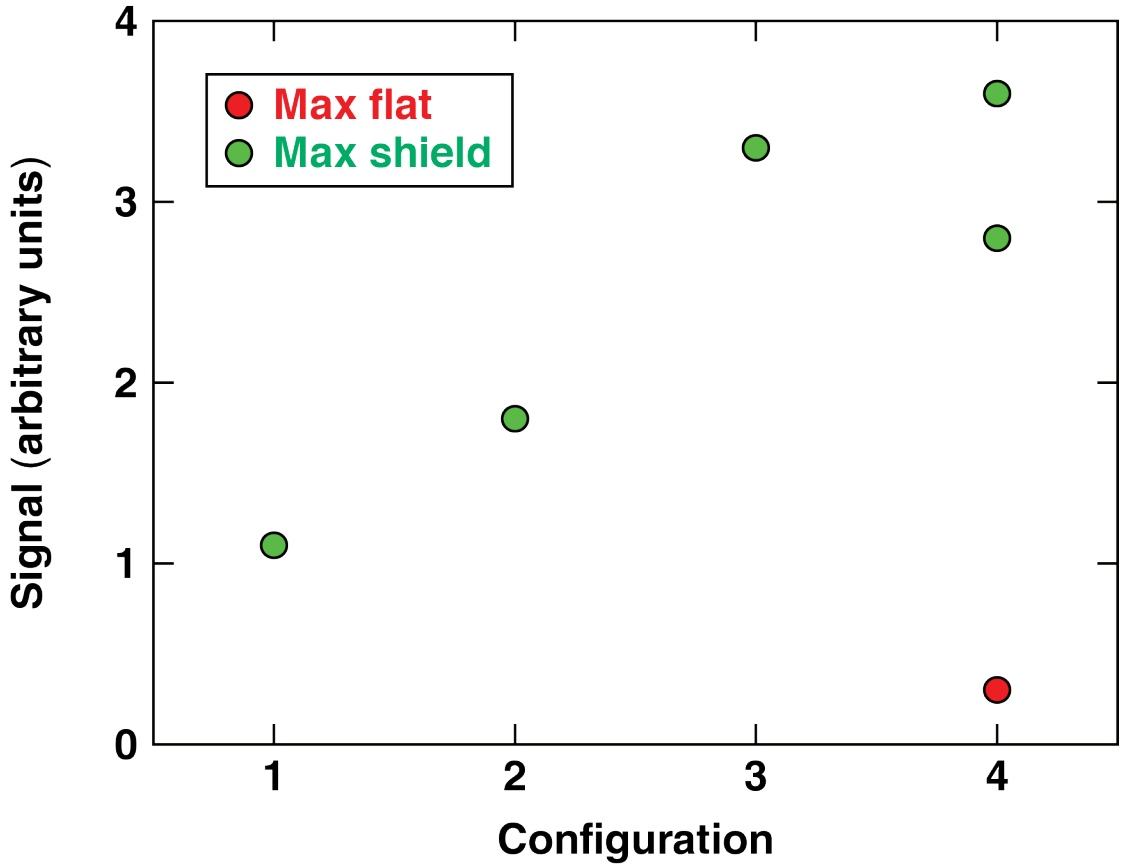
Time-gated measurements with an SCI setup and a 40-ps exposure time showed the expected ~5× increase in signal





A knife-edge target was used to check the spatial resolution of the image

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



- 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

Summary/Conclusions

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