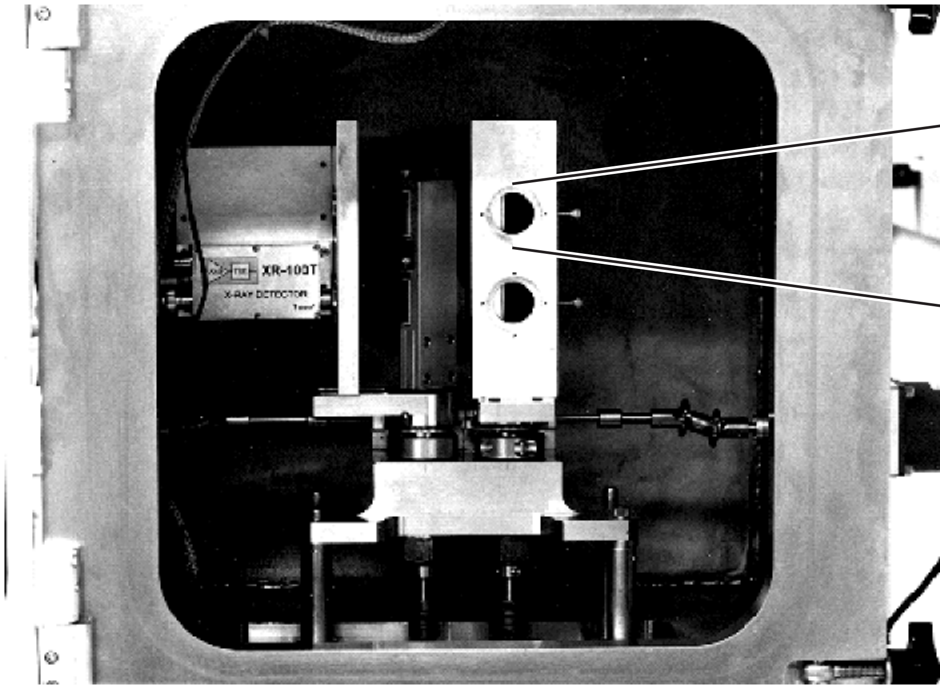
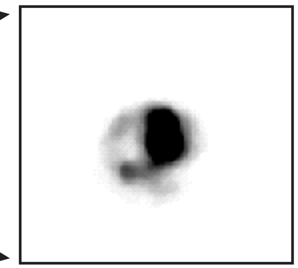
Monochromatic Imaging of Direct-Drive Implosions on OMEGA





5.27-keV image
of Ti-doped,
compressed CH shell

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Monochromatic imaging of directly driven target implosions on the OMEGA UV laser system has been accomplished with LLE/LANL's jointly developed gated monochromatic x-ray imager (GMXI). The instrument can obtain time-integrated or time-resolved (framed), narrow-band (~20-eV) images of target x-ray emission. Images of targets containing Ar-doped fuel, Ti-doped shells, as well as undoped targets (D_2-filled CH shells) reveal the shape and size of the implosion core. These are being used to characterize the quality of the direct-drive implosions as a function of target parameters (fill pressure and shell thickness) and laser conditions (pulse shape, beam balance, and beam smoothing). This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460.

Summary

Monochromatic imaging is used to quantify improvements of implosion symmetry on OMEGA

- We find that both shell and fuel emission can be isolated and diagnosed using doped shells (Ti) or fuel (Ar).
- Monochromatic imaging shows that improved SSD [1 THz and polarization smoothing (PS)] has a beneficial effect on target compression.
- Comparisons of stalk- and web-mounted target show that target mounts are adding negligible perturbations to the core.
- Structure in the cores of current OMEGA direct-drive implosions is likely due to power imbalance [low ℓ-modes (1 to 5)].

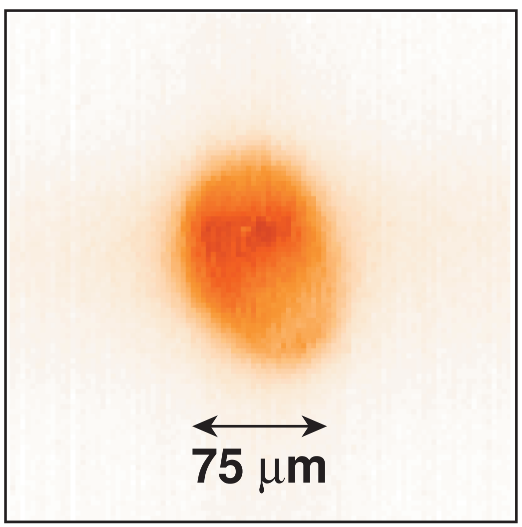
The gated monochromatic imager was jointly developed by LLE and LANL

- The Gated Monochromatic X-Ray Imager (GMXI) is used to image emission from highly compressed cores.
- Resolution of 5 μm in narrow bands (<15 eV) is obtained with state-of-the-art multilayer diffractors (WB_4C).
- The pass band can be continuously tuned in the range from ~2 to 7 keV.
- Images can be recorded on x-ray film, x-ray cameras (CID’s), or framing cameras (~80-ps frame times).

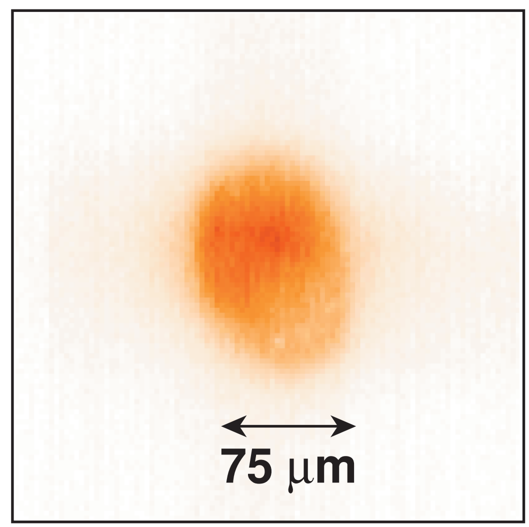
The GMXI has been used to obtain CID-recorded monochromatic x-ray images of imploded cores

OMEGA shot 19645
15-atm-D_2-filled, 20-μm-thick CH shell
0.35-THz SSD, no PS

Ar Heβ (3.683±0.011 keV)



Ar Hβ (3.935± 0.012 keV)



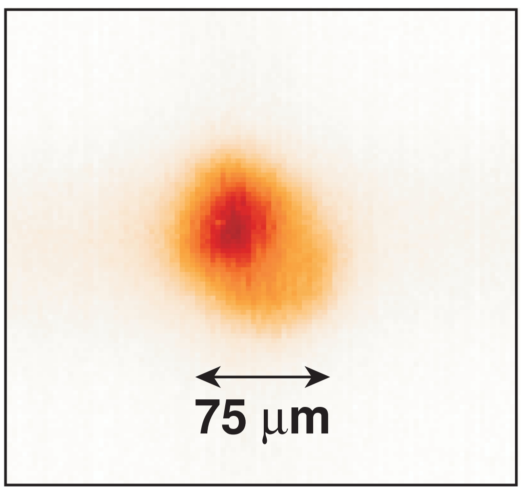
Time-integrated images were obtained with CID cameras.

E10730

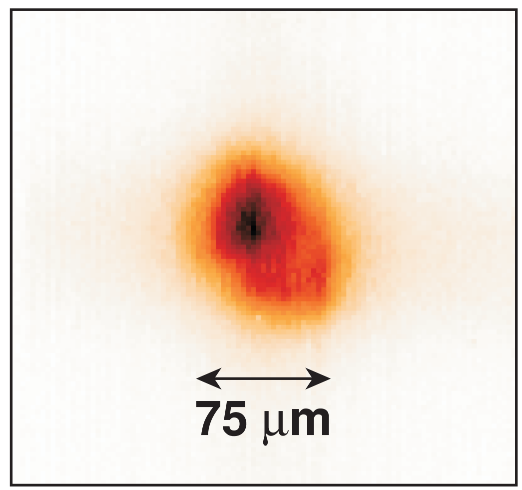
The GMXI has been used to obtain CID-recorded monochromatic x-ray images of imploded cores

OMEGA shot 19642
15-atm-D_2-filled, with 35% AR,
20-μm-thick CH shell
0.35-THz SSD, no PS

Ar Heβ (3.683±0.011 keV)



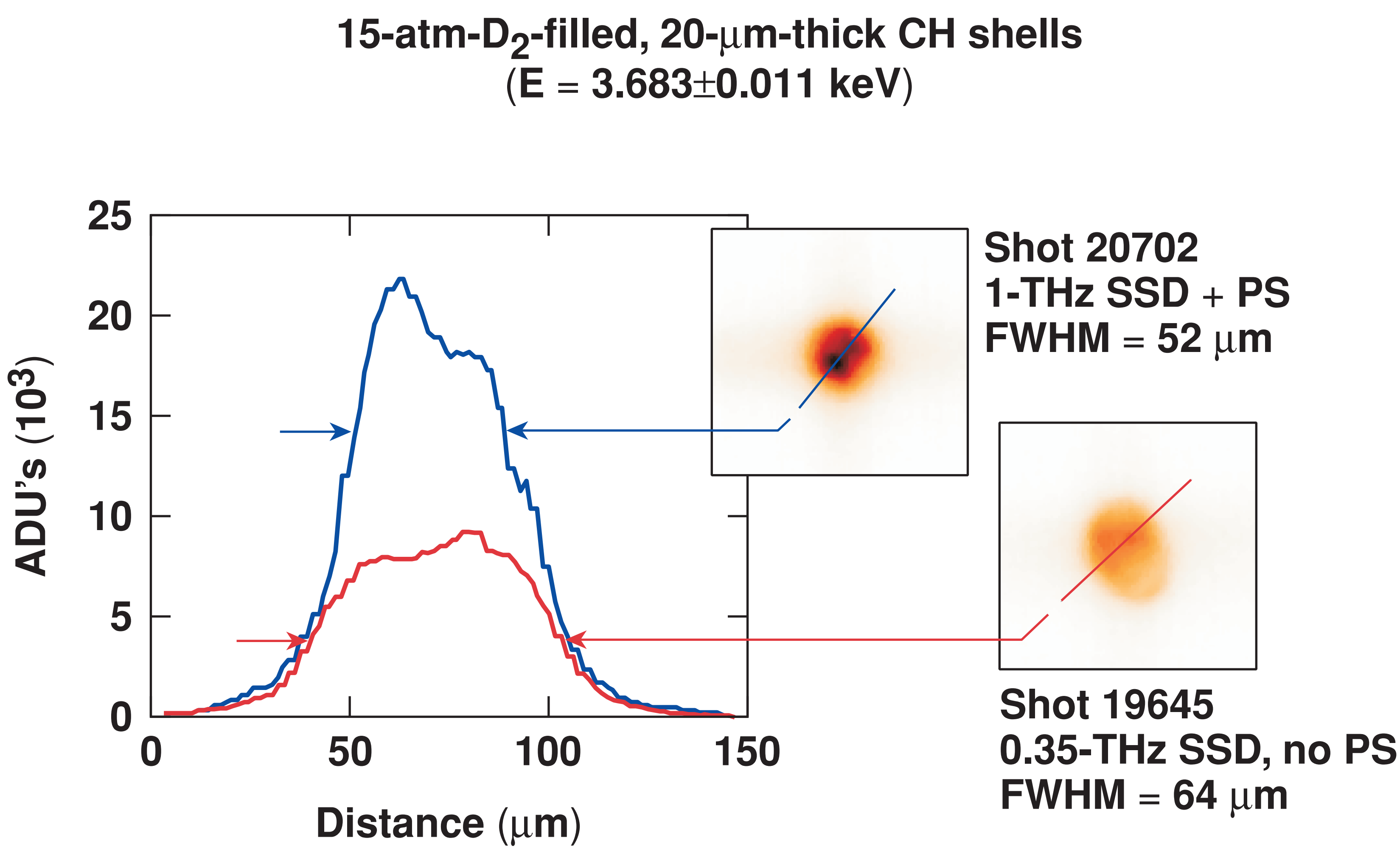
Ar Hβ (3.935± 0.012 keV)



Time-integrated images were obtained with CID cameras.

E10753

Lineouts through monochromatic x-ray images of imploded cores show the effect of broadband SSD



E10670

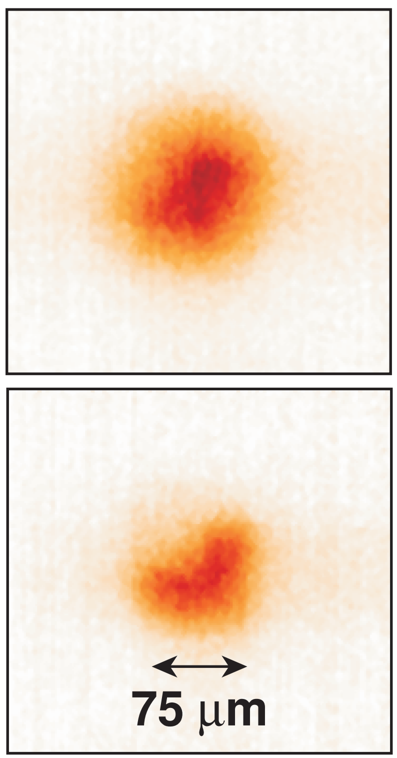
GMXI images of Ar emission suggest that SSD has a beneficial effect on compression

15-atm-D_2-filled, 20-μm-thick CH shell with Ar-doped fuel and Si-doped burnthrough layer

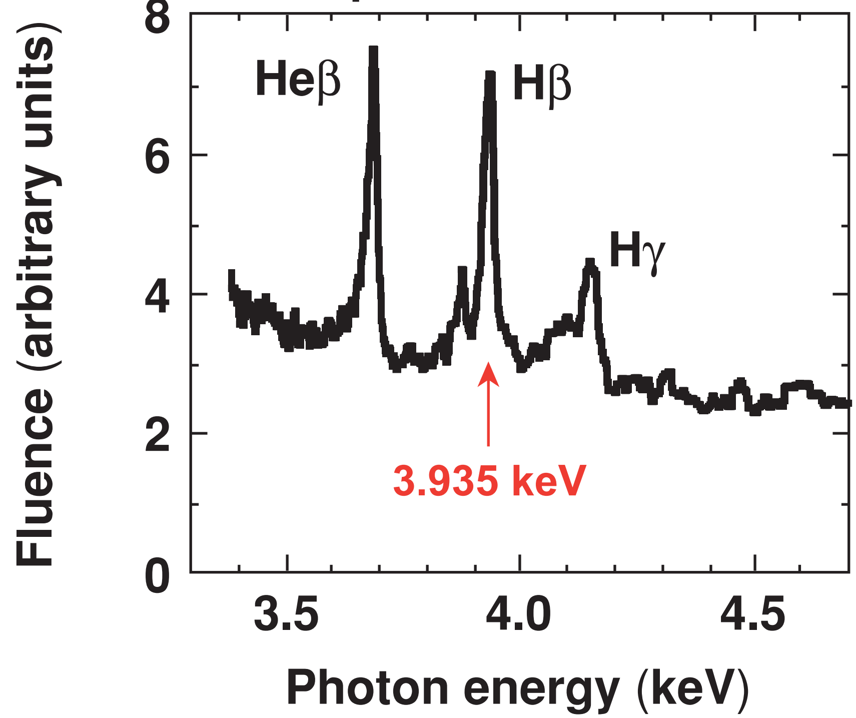
Ar Hβ (3.935±0.012 keV)

Shot 21140 SSD off

Shot 21133 SSD on (1 THz)



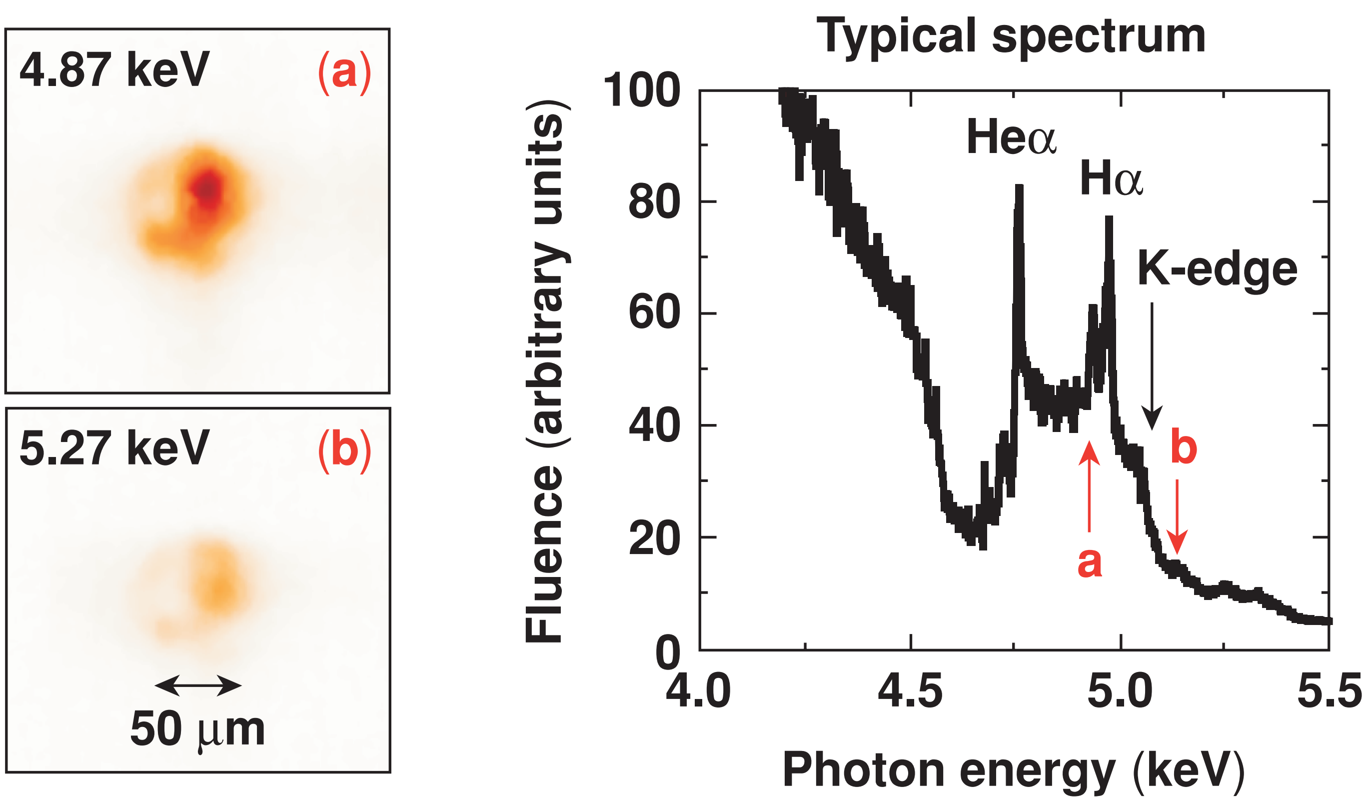
AR spectrum, shot 21144



E10731

Monochromatic images taken with the GMXI show the shape of the imploded Ti-doped shell region

Shot 21163
15-atm-D_2-filled, 20-μm-thick CH shell
with Ti-doped inner layer

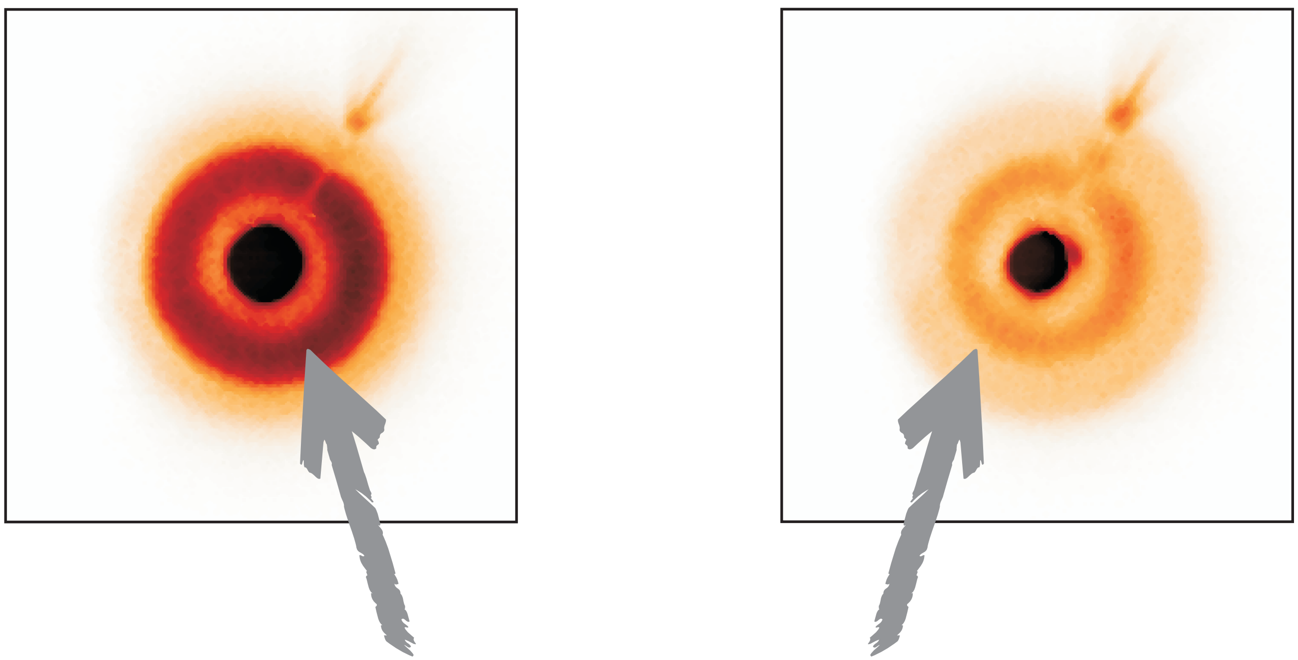


E10732

By reducing acceleration-region nonuniformities SSD increases the importance of stalk perturbations

Time-integrated pinhole camera x-ray images
(2 to 5 keV)

Shot 21140 SSD off	Shot 21149 SSD on (1 THz, with PS)



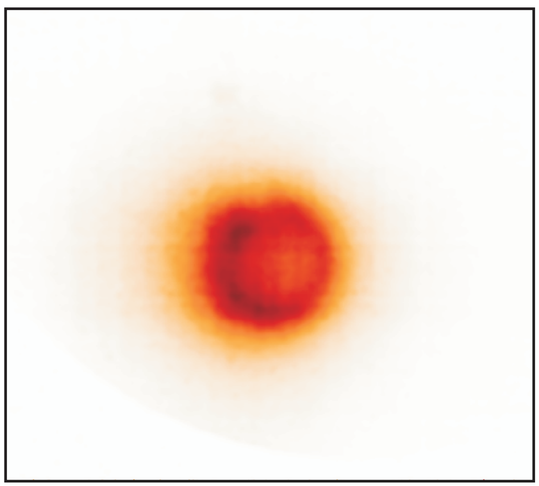
11-μm imbedded Si-doped layers

E10733

Clear evidence of stalk perturbations can be seen in images of low-convergence-ratio implosions

20-atm-DT-filled glass shells

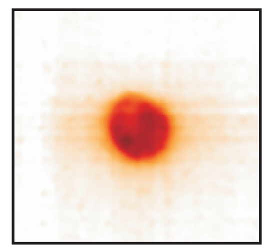
2.6-μm-thick shells (4 to 7 keV)



200 μm

SSD on (1 THz)

4.1-μm-thick shell E = (3.683±0.011 keV)

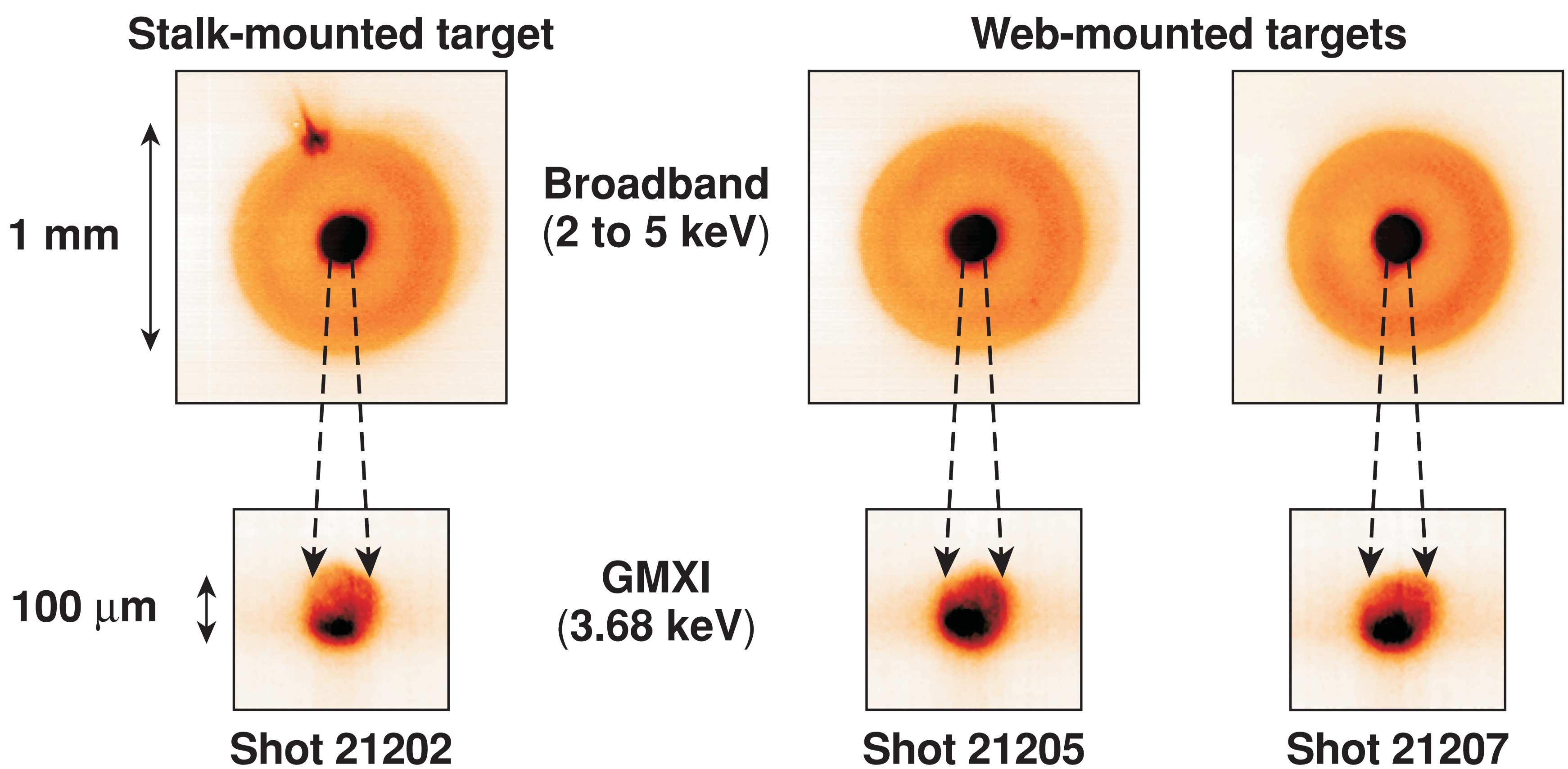


SSD off

E10734

Experiments show that the effect of the stalk on higher convergence ratio implosions is small

15-atm-D_2-filled, 20-μm-thick CH shells



E10735

Summary/Conclusions

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