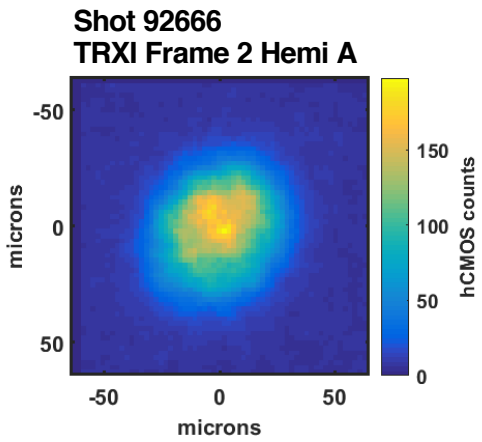
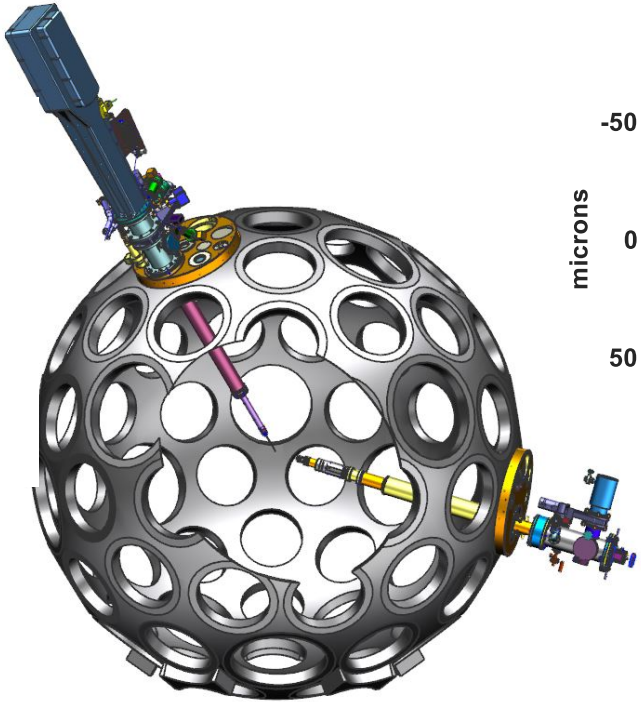
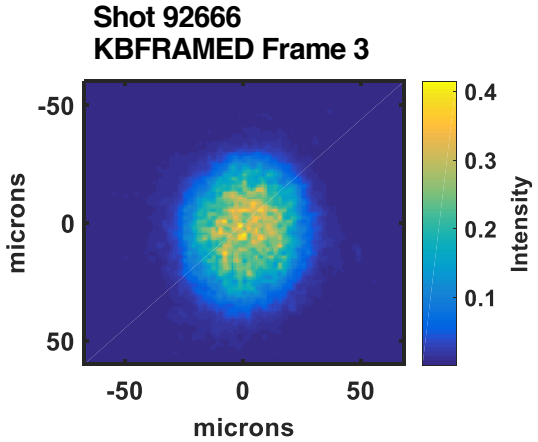
Three-dimensional Gated Hot-Spot X-ray Imaging on OMEGA







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Laboratory for Laser Energetics

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American Physical Society
Division of Plasma Physics
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Orthogonal lines-of-sight are used on OMEGA to diagnose multidimensional effects on laser direct drive (LDD) implosions

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- The core width inferred from the common axis of the two independently calibrated imagers agrees within experimental uncertainty
- Dynamic experiments were performed that demonstrate low-mode hot spot distortions in cryogenic LDD implosions can be modified through systematic offsetting of the initial target location to achieve better symmetry at stagnation and improved yield

"Three-dimensional" diagnostics provide critical information for understanding LDD implosions

Related Talks:
S. Regan YO5.00002 (Tomorrow)
C. Stoeckl PO7.00010

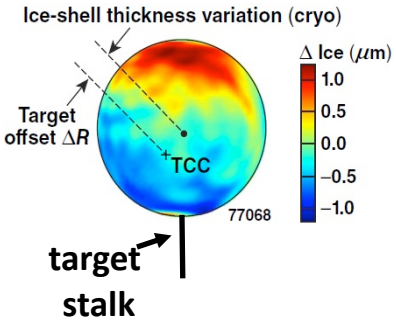
Collaborators

F. J. Marshall, W. Theobald, C. Sorce, O. Mannion, D. Cao, I . Igumenchev, S. P. Regan, R. C. Shah, J.P. Knauer, V. N. Goncharov, R. Betti, T. C. Sangster

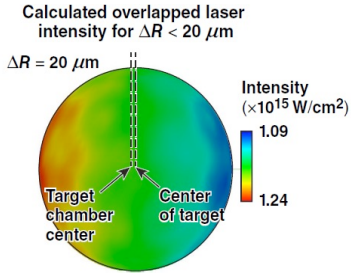
Laboratory for Laser Energetics

Multidimensional effects are seeded by many sources of nonuniformity in laser direct drive

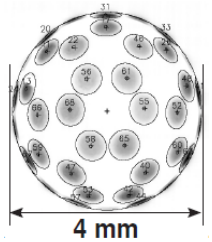
Target layer uniformity, engineering features



Target positioning

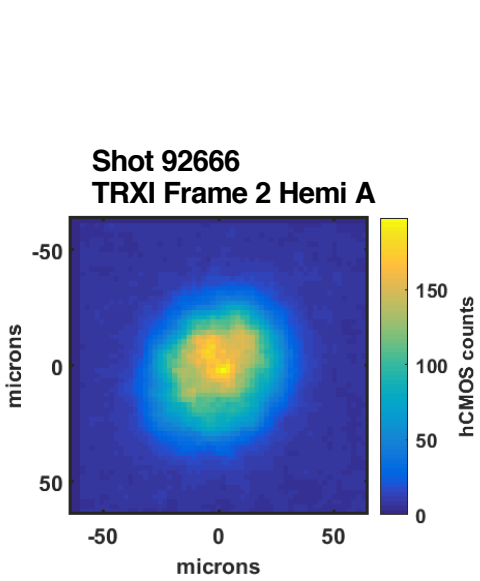


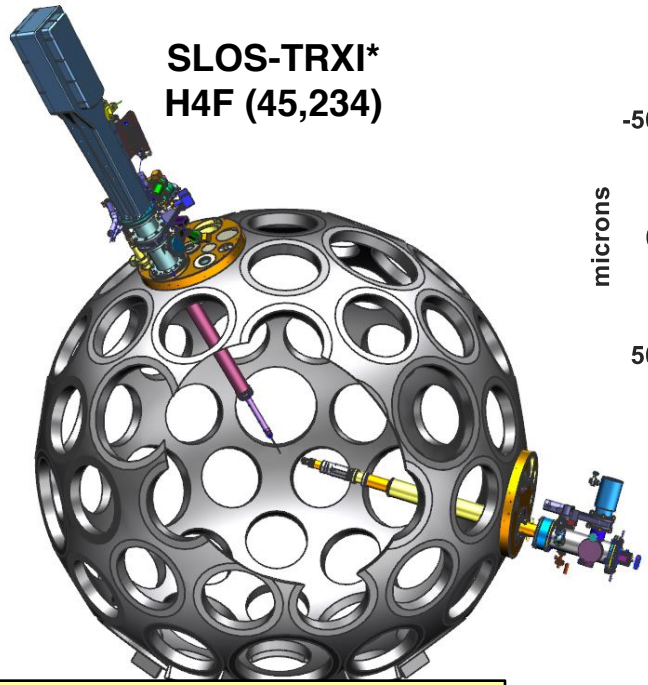
Beam pointing, timing, laser power

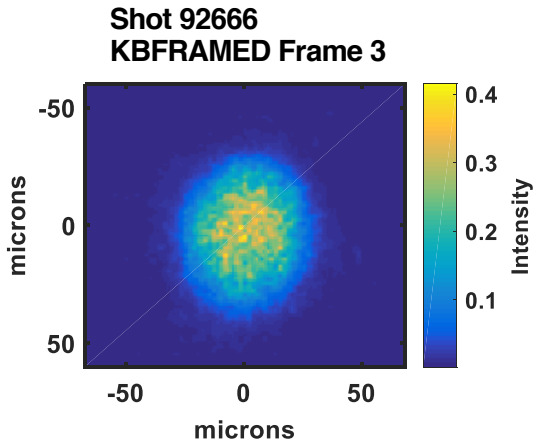


The on-target, laser energy balance and target positioning can be adjusted to compensate some sources of systematic nonuniformity.

Implosions on the OMEGA Laser System are observed along two semi-orthogonal lines of sight with gated x-ray imagers capable of 30-ps temporal resolution and 10-μm spatial resolution







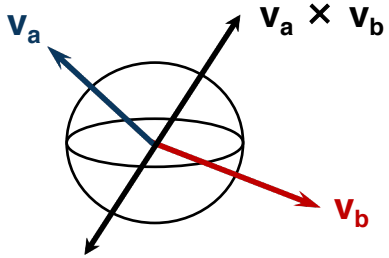
A third orthogonal time-resolved line-of-sight is planned.

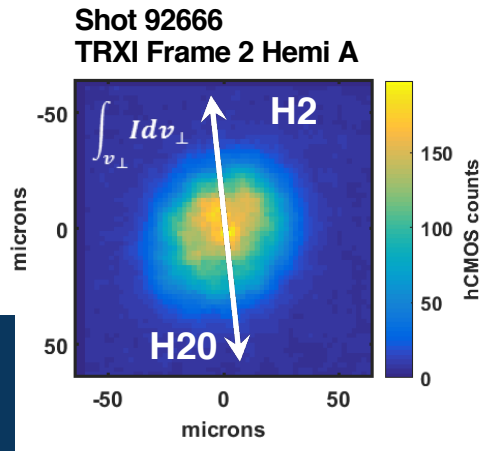
*W. Theobald *et al.*, Rev. Sci. Instrum. 89 10G117 (2018).
**F. J. Marshall Rev. Sci. Instrum. 88 093702 (2017).

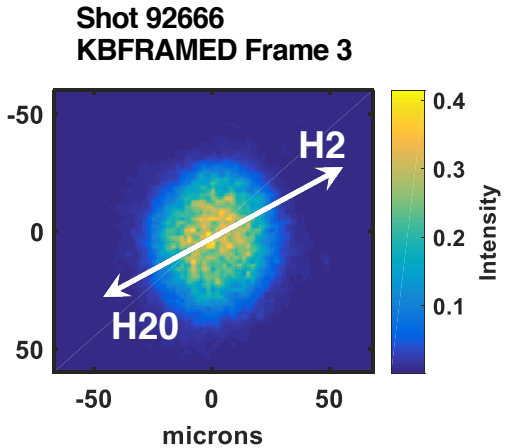
Analyzing the flux along the common-viewing axis* allows two lines-of-sight to measure the same quantity

- For two viewing vectors a and b, the common orthogonal view is a × b
  - In the case of TRXI and KBFRAMED, that vector lies along H2-H20
  - Find the projection of the common-view vector in each imagers' view
- Integrate the image perpendicular to the projected vector
- The analysis is conducted on two time-aligned images

The integrated emissivity in the plane perpendicular to the common-view axis is identical in both imagers for an optically thin shell.



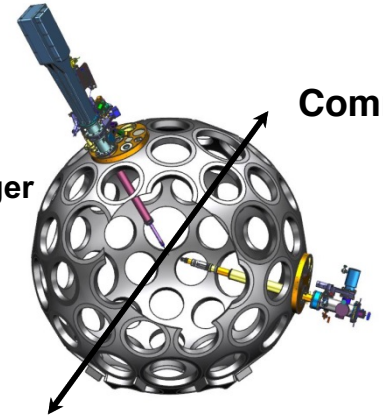




*L. R. Benedetti *et al*, Rev. Sci. Instrum. 10G105 (2018).

The inferred size along the common axis between SLOS-TRXI and KBFRAMED agrees within experimental uncertainty

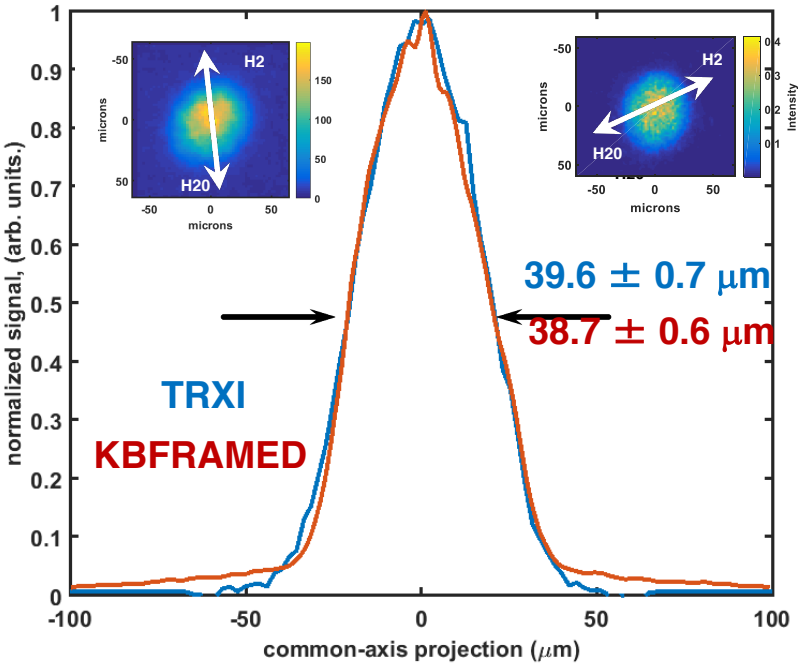
SLOS-TRXI
Multi-pinhole imager
hCMOS* detector



KBFRAMED
16 image KB microscope
High speed framing camera

The agreement between these independently calibrated detectors demonstrates the confidence and consistency of these measurements

Integrated emissivity along common-axis

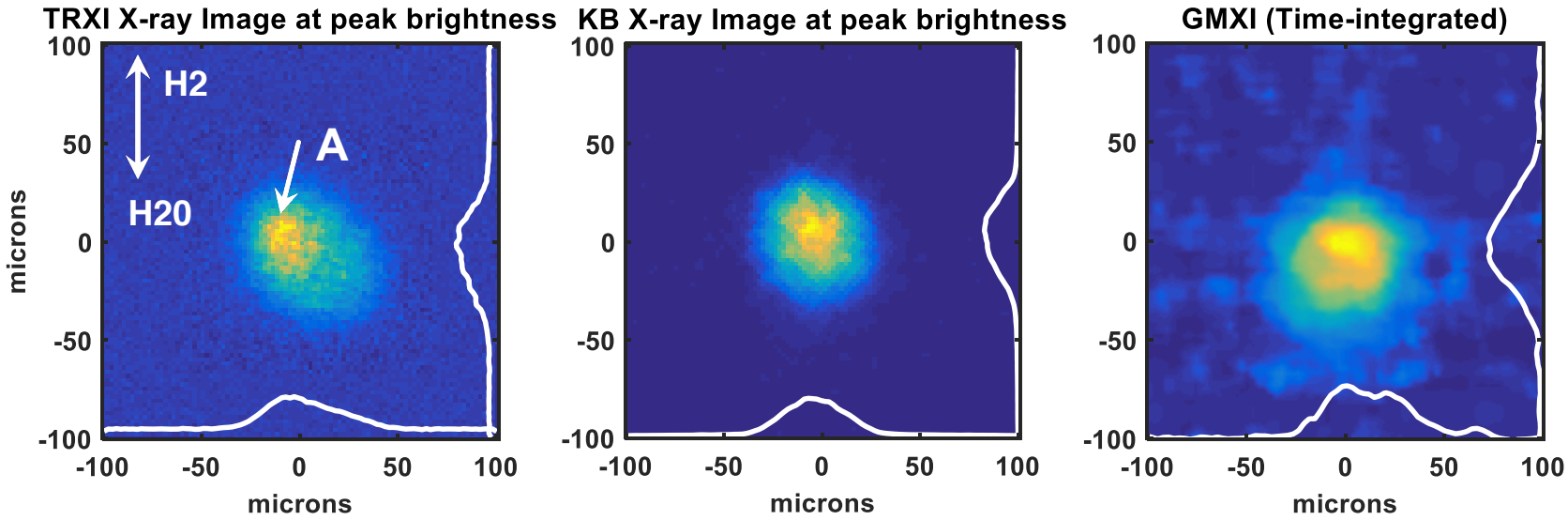


*L. Claus *et al.*, Proc. SPIE 9591, 95910P (2015).

Viewing the hot-spot from several directions gives a sense of uncompensated asymmetry at stagnation for nominal laser pointing, balance, and target positioning

UR LLE

OMEGA Shot 94712 Exp. Yield = 0.77×10^{14}

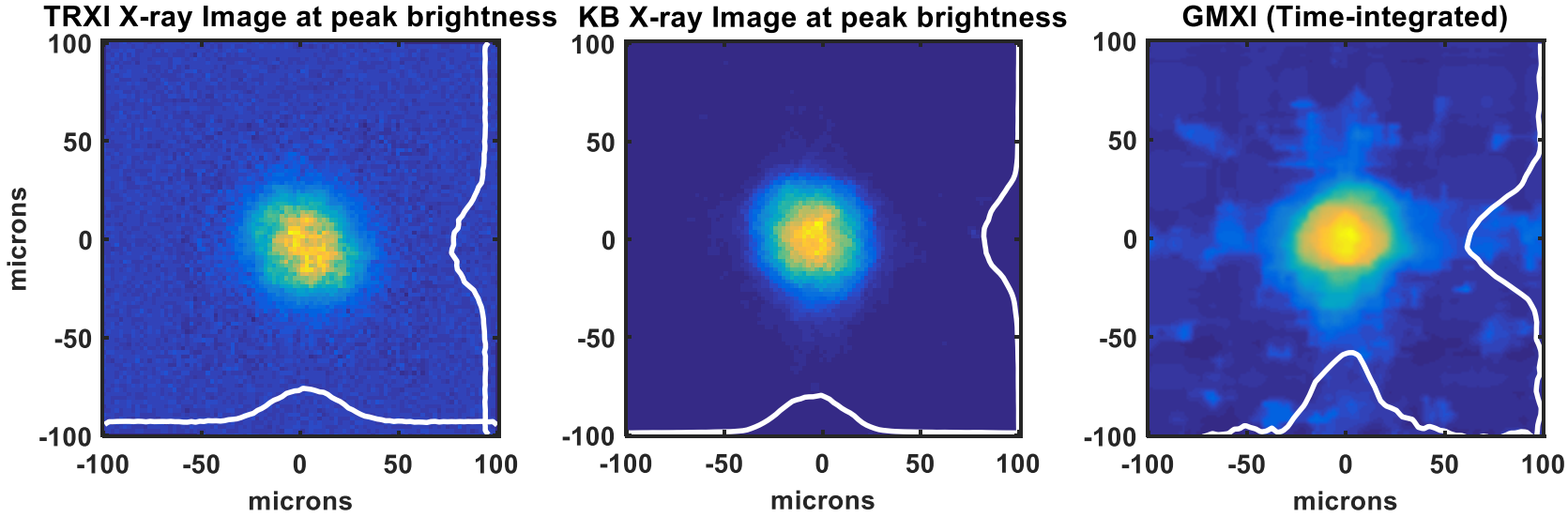


The images are rotated so that the common-axis is upright

The hot-spot is considerably more round and centrally peaked as viewed by both imagers when a calculated offset is applied to the target

UR LLE

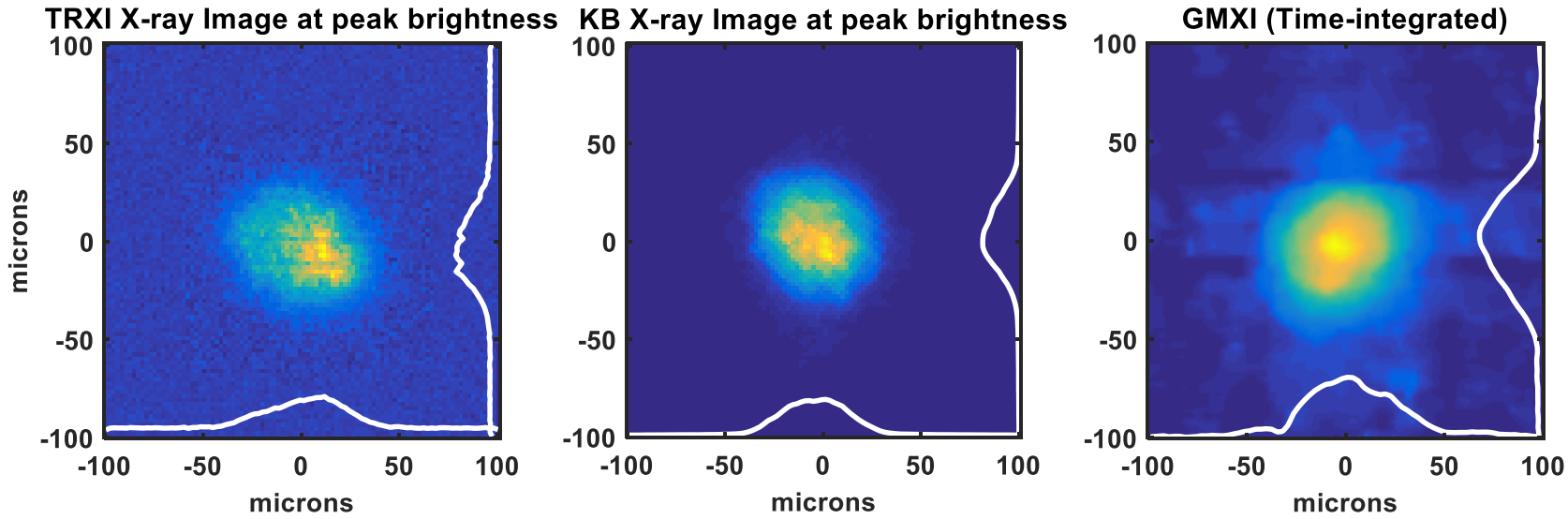
OMEGA Shot 94715 Exp. Yield = 1.33×10^{14}



In this case the target was offset by 48 μm

Increasing the offset more led to degraded performance

OMEGA Shot 94717 Exp. Yield = 0.45×10^{14}



Control over low-mode hot-spot distortion is demonstrated through systematic offsetting based on inputs from multi-dimensional diagnostics

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