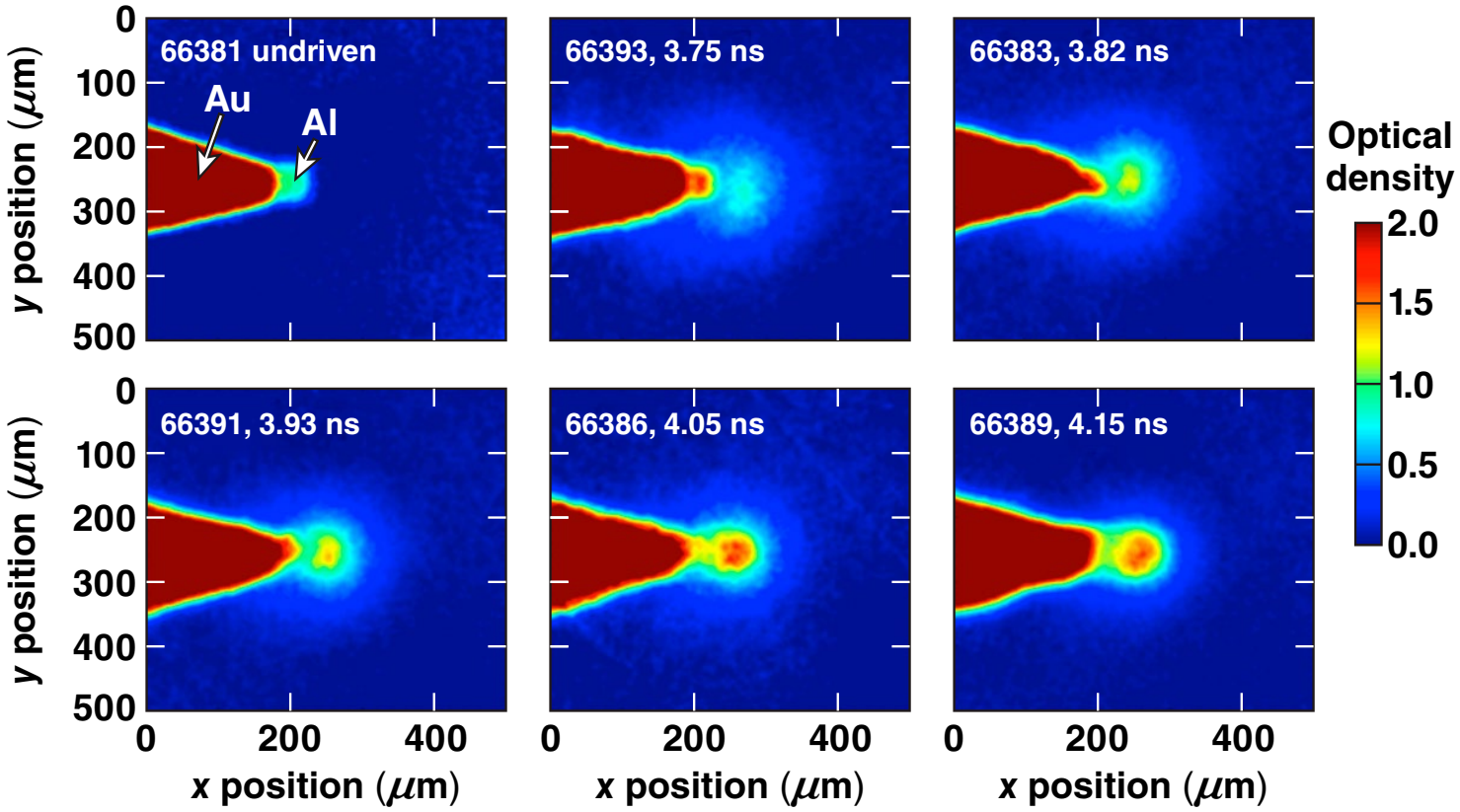
Monochromatic 8.05-keV Flash Radiography of Imploded Cone-in-Shell Targets



W. Theobald
University of Rochester
Laboratory for Laser Energetics

54th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Providence, RI
29 October–2 November 2012

Summary

High-quality radiographic images of imploding cone-in-shell targets were taken close to peak compression

UR LLE

- Cu K_α backlighting with OMEGA EP and monochromatic imaging provides high spatial resolution (~10 μm) and high time resolution (~12 ps)
- The time of the peak areal density was measured and is in good agreement with 2-D *DRACO* simulations
- The optical density of the compressed CH was measured at 8.05 keV for various times during the implosion
- A peak areal density of >300 mg/cm^2 is inferred from the measurement

Collaborators

A. A. Solodov, C. Stoeckl, R. Epstein, V. Yu. Glebov, G. Fiksel, S. Ivancic, F. J. Marshall, G. McKiernan, C. Mileham, P. M. Nilson, and T. C. Sangster

University of Rochester
Laboratory for Laser Energetics and Fusion Science Center

L. C. Jarrott and F. N. Beg

University of California, San Diego

E. Giraldez, R. B. Stephens, and M. S. Wei

General Atomics

H. McLean

Lawrence Livermore National Laboratory

H. Sawada

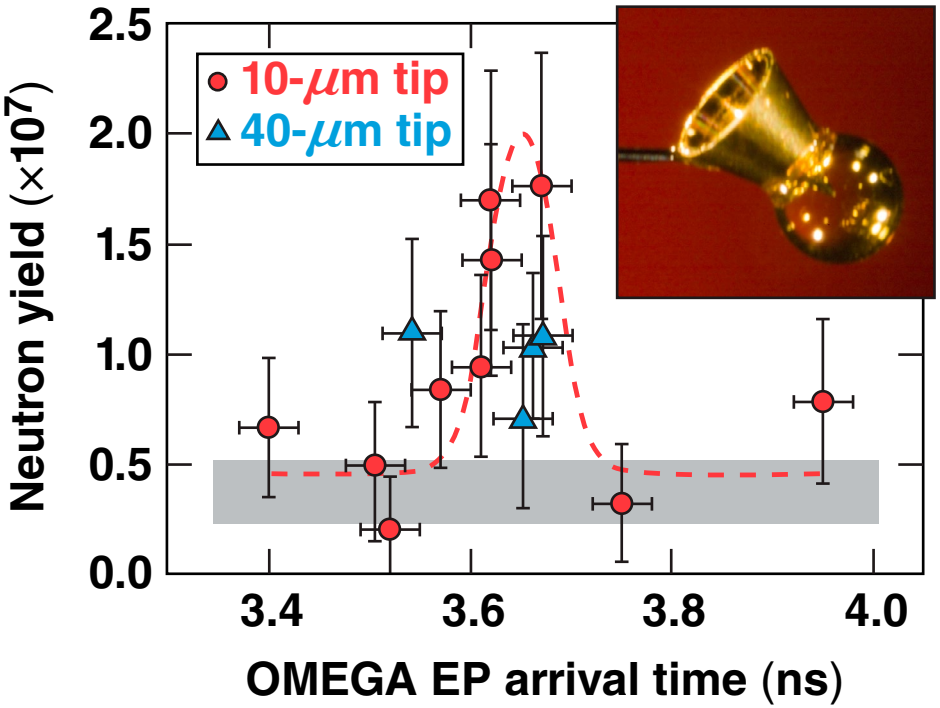
University of Nevada, Reno

J. Santos

Centre Lasers Intenses et Applications
University of Bordeaux, France

Motivation

OMEGA fast-ignition experiments with Au cone-in-shell targets measured 3.5% coupling efficiency[1]



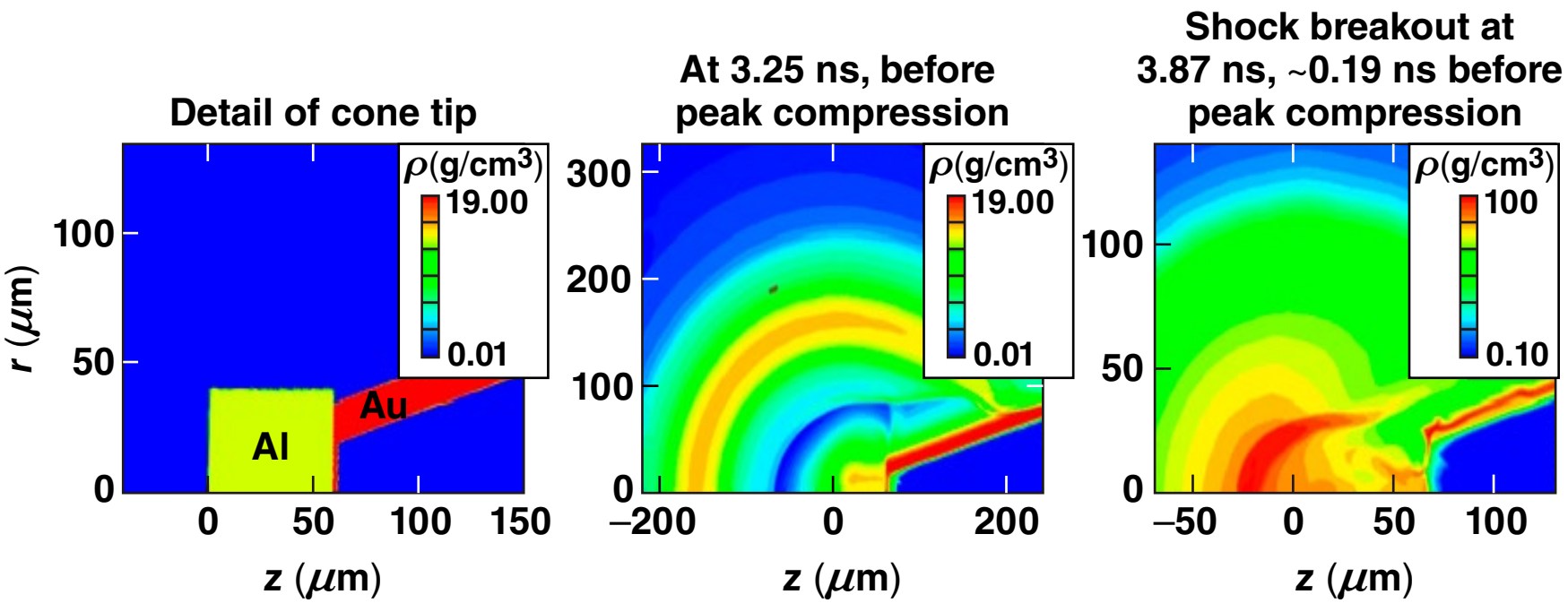
10-ps, 1-kJ short pulses

- Integrated *DRACO*[2]–*LSP*[3] simulations show that most of the fast electrons are lost in the gold cone
- A lower-*Z* material promises better fast-electron transport and enhanced coupling

[1] W. Theobald *et al.*, Phys. Plasmas 18, 056305 (2011).
[2] P. B. Radha *et al.*, Phys. Plasmas 12, 056307 (2005).
[3] D. R. Welch *et al.*, Phys. Plasmas 13, 063105 (2006).

E21606

Hydrodynamic simulations of an aluminum tip cone-in-shell target were performed with *DRACO**

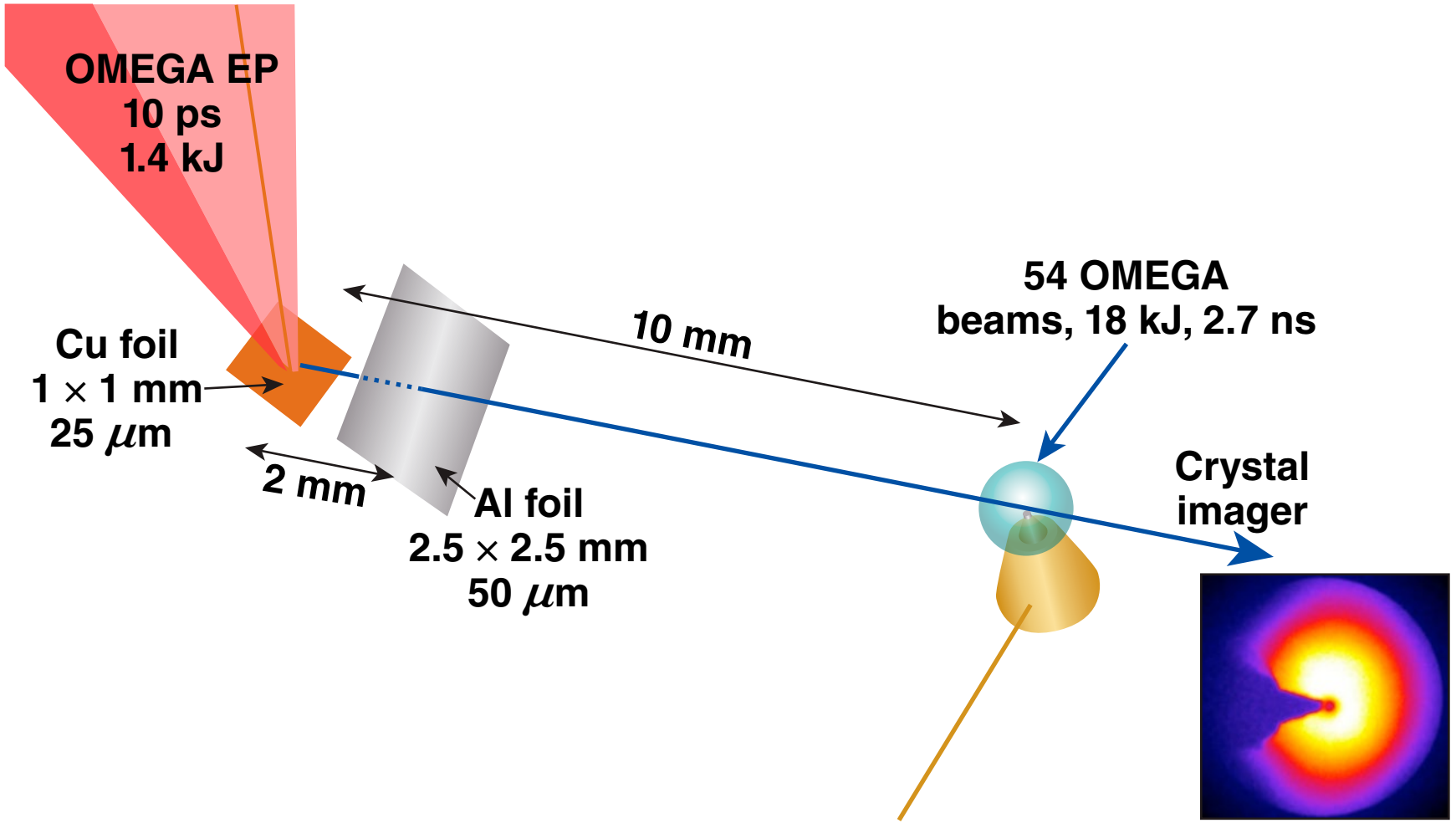


- The target design promises a better shock resilience (~80-ps later breakout) than the previous Au tip target

E21608

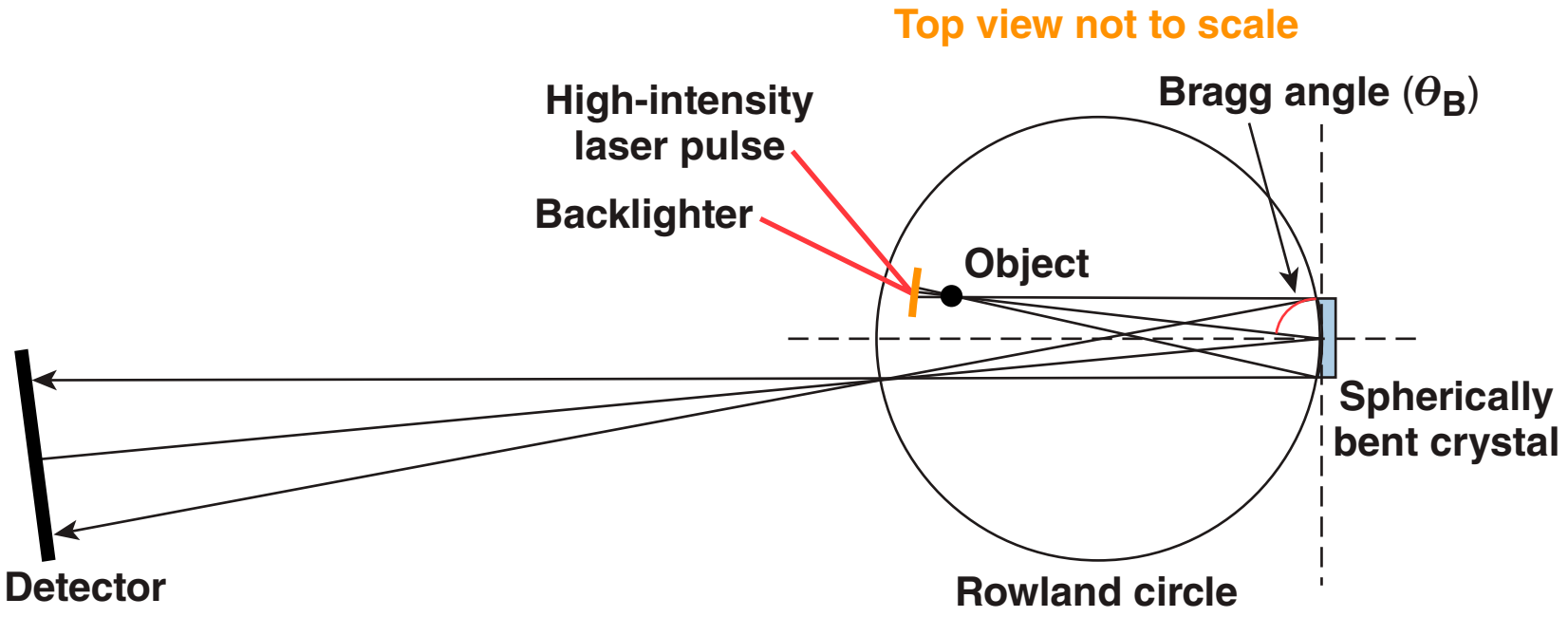
* P. B. Radha *et al.*, Phys. Plasmas 12, 056307 (2005); A. A. Solodov, BO4.00015, this conference.

Flash radiography combined with monochromatic imaging was used to image the fuel assembly



E21609

A high-quality spherical crystal x-ray imager for OMEGA* provides high resolution images for various experiments

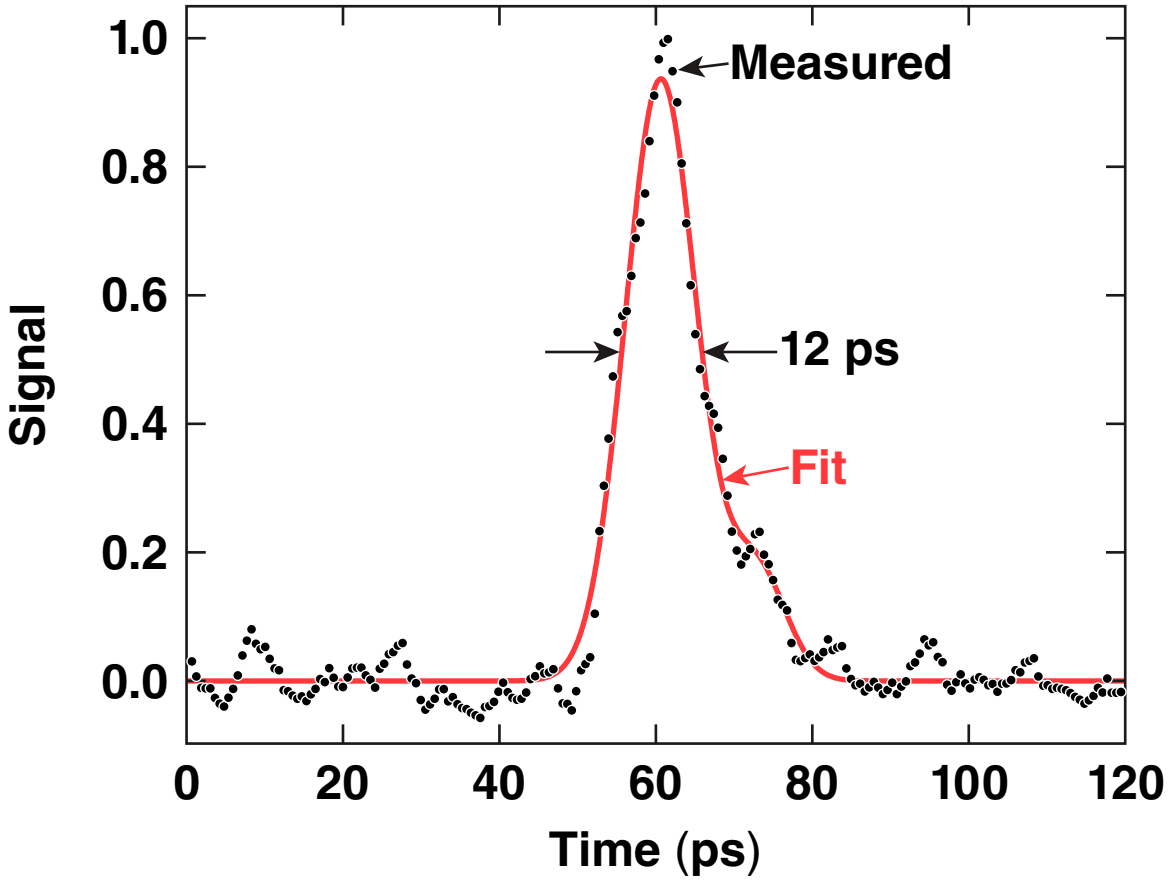


- Cu $K_{\alpha 1}$ line emission: 8.048 keV (1.541 Å)
- Monochromatic imaging (ΔE ~ 6 eV, at 8.05 keV)
- High spatial resolution: ~10 μm
- Large light-collection area ~f/10

E18857c

*C. Stoeckl *et al.*, Rev. Sci. Instrum. 83, 10E501 (2012).

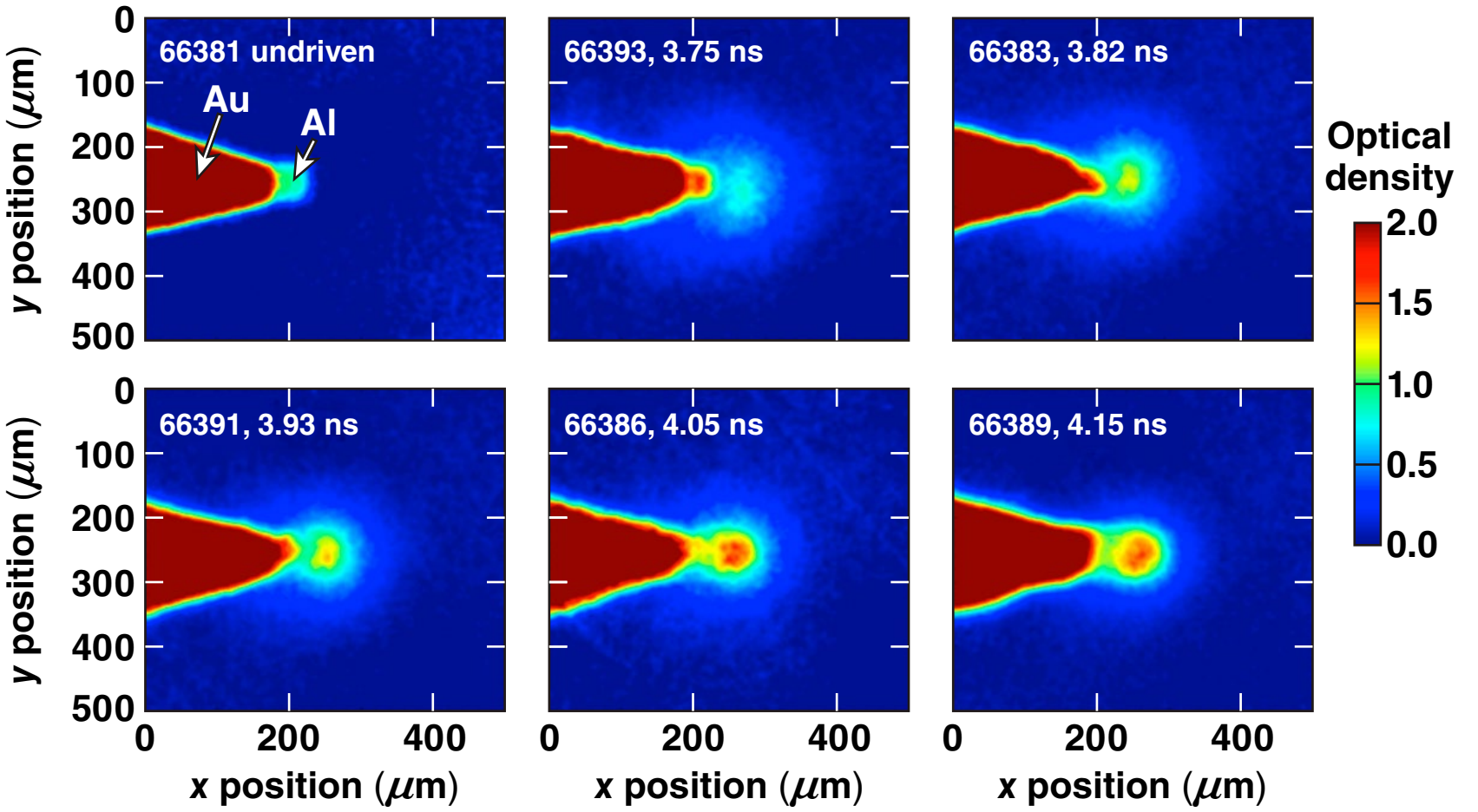
The K_α flash lasts for 12 ps



Time-resolved K_α x-ray emission from a Cu foil target irradiated with a ~1 kJ, 10-ps pulse.*

*P. M. Nilson *et al.*, Phys. Rev. Lett. 108, 085002 (2012).
P. M. Nilson, JO5.00001, this conference.

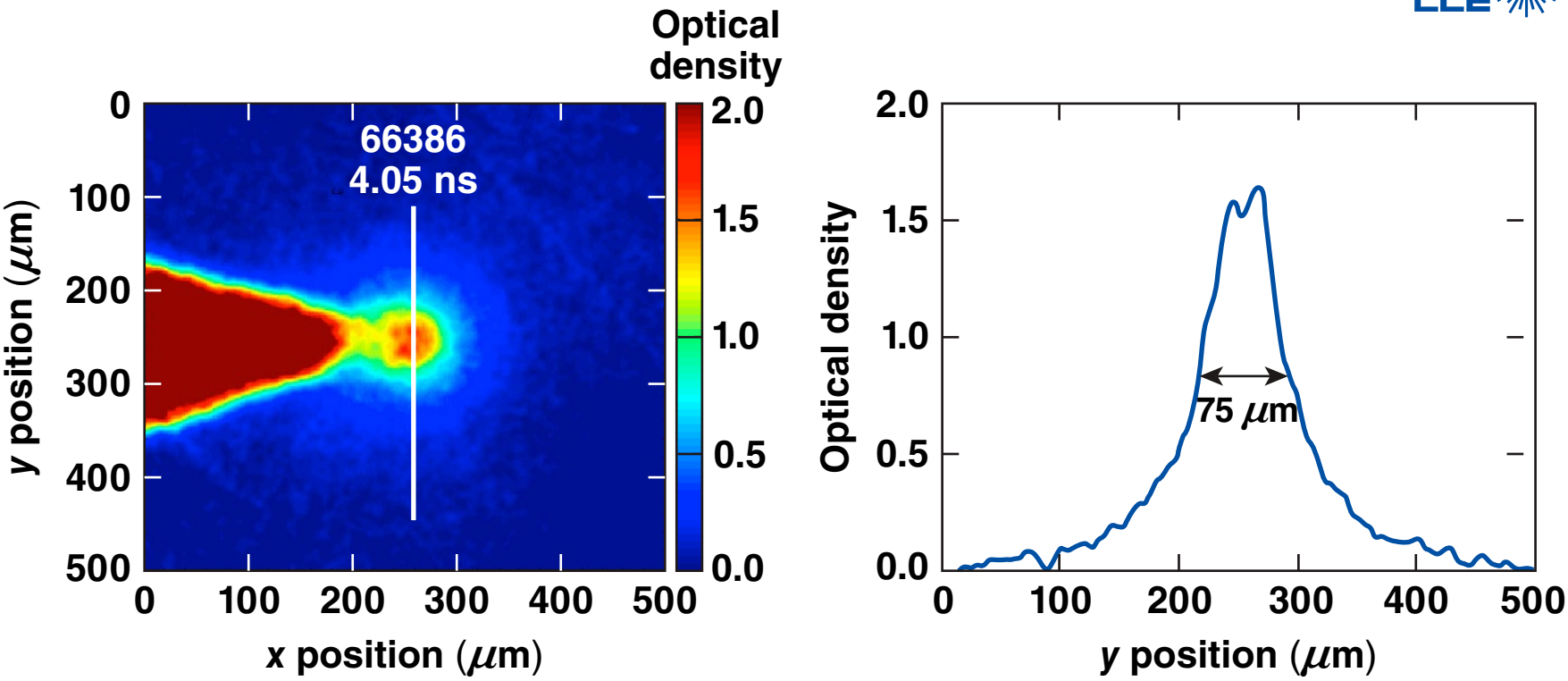
Radiographic images of imploding cone-in-shell targets were taken at various times around peak compression



- The predicted time of peak compression from 2-D *DRACO* simulations is at 4.1 ns

E21611

The areal density of the compressed core can be extracted from the measured optical densities



Average mass absorption coefficient (μ) of CD plasma from PrismSPECT*

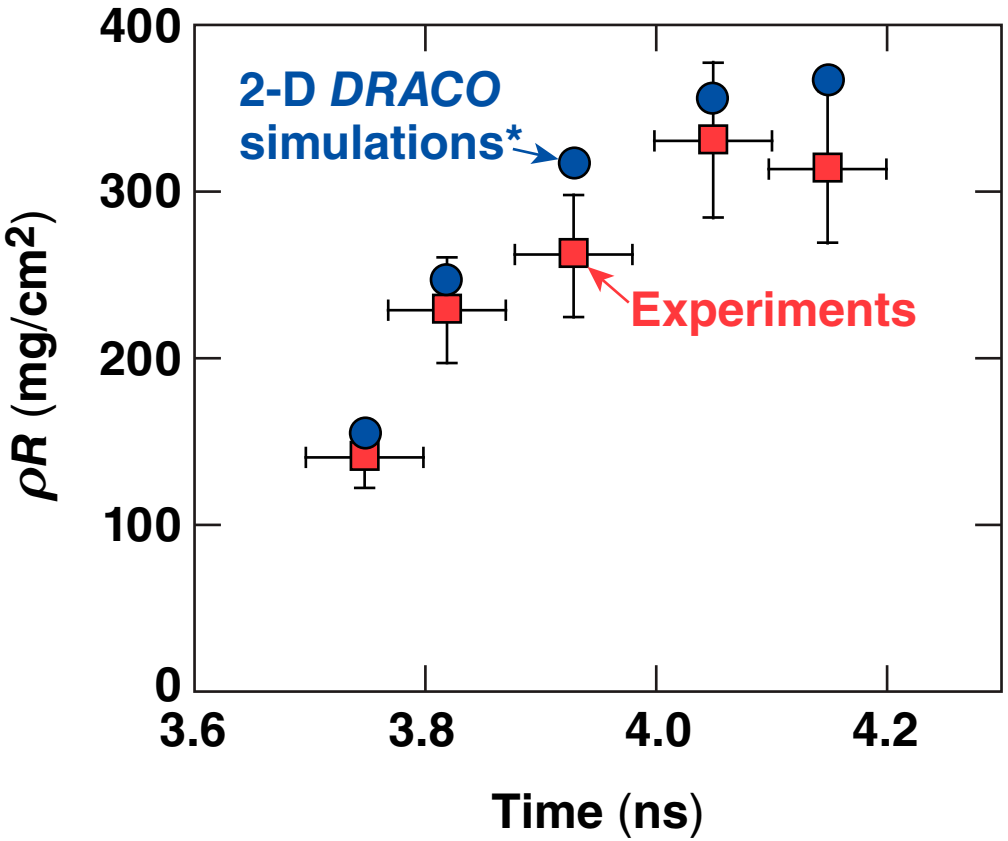
$$\langle \mu \rangle = \frac{\int \mu(r)\rho(r)\mathrm{d}r}{\int \rho(r)\mathrm{d}r}$$

$$\rho R \approx \ln(I_0/I)/(2\langle \mu \rangle)$$

E21612

*J. J. MacFarlane, Prism Computational Sciences, Inc., Madison, WI 53711.

The measured peak areal density exceeds 300 mg/cm^2



E21613

* A. A. Solodov, BO4.00015, this conference.

Summary/Conclusions

High-quality radiographic images of imploding cone-in-shell targets were taken close to peak compression

UR LLE

- Cu K_α backlighting with OMEGA EP and monochromatic imaging provides high spatial resolution (~10 μm) and high time resolution (~12 ps)
- The time of the peak areal density was measured and is in good agreement with 2-D *DRACO* simulations
- The optical density of the compressed CH was measured at 8.05 keV for various times during the implosion
- A peak areal density of >300 mg/cm^2 is inferred from the measurement