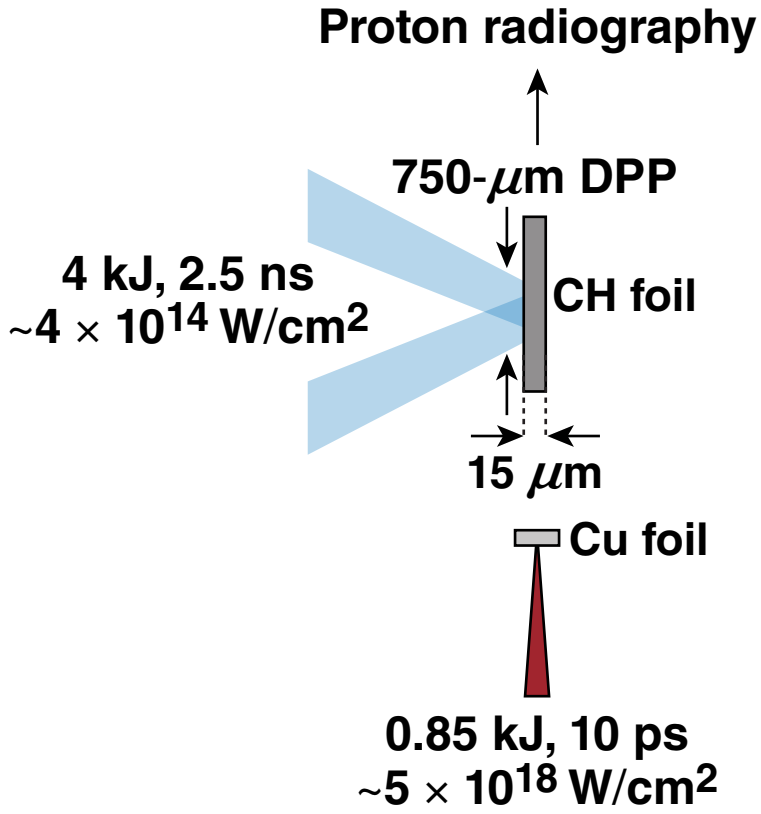
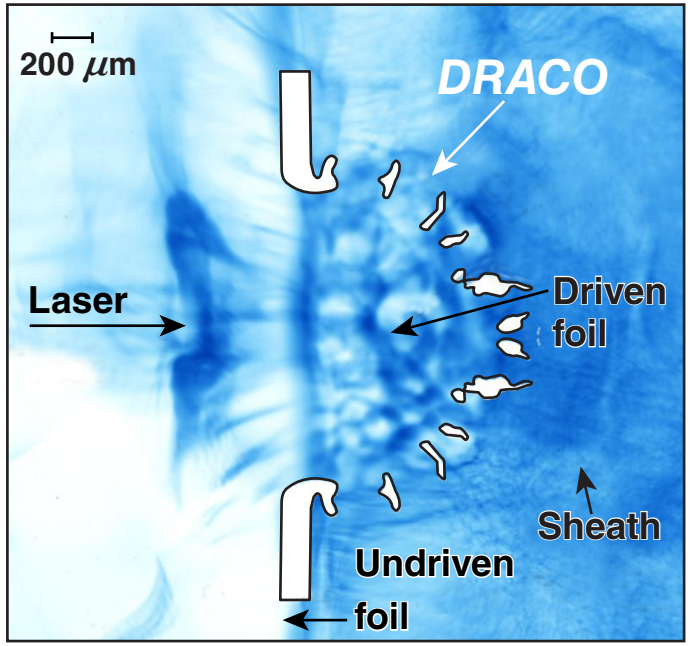
Magnetic-Field Generation in Planar Plastic Targets on OMEGA EP





$t = t_0 + 2.5$ ns

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Summary

MG-level magnetic fields generated by Rayleigh–Taylor instability are observed in the laser-driven foils

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- Self-generated magnetic fields can affect electron transport
- Magnetic-field generation is diagnosed using laser-driven proton radiography of 15-μm-thick planar CH targets irradiated at $I \sim 4 \times 10^{14}$ W/cm^2 on OMEGA EP
- The Rayleigh–Taylor instability is predicted to produce MG-scale magnetic fields in a broken foil during the acceleration phase
- A proton ray-tracing code will be used to reproduce characteristics of the radiography images

Collaborators

P. M. Nilson, I. V. Igumenshchev, S. X. Hu, C. Stoeckl, D. H. Froula, and D. D. Meyerhofer

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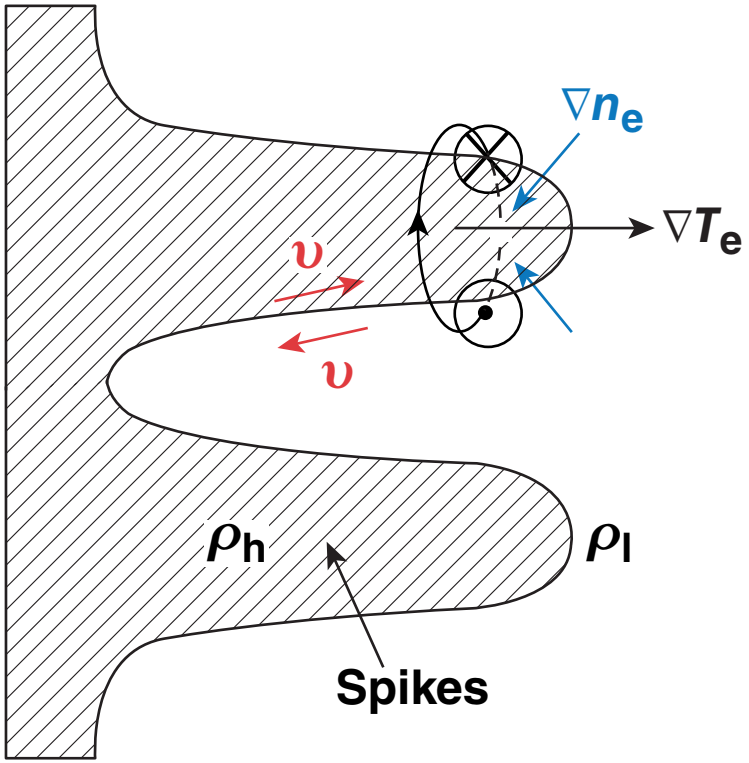
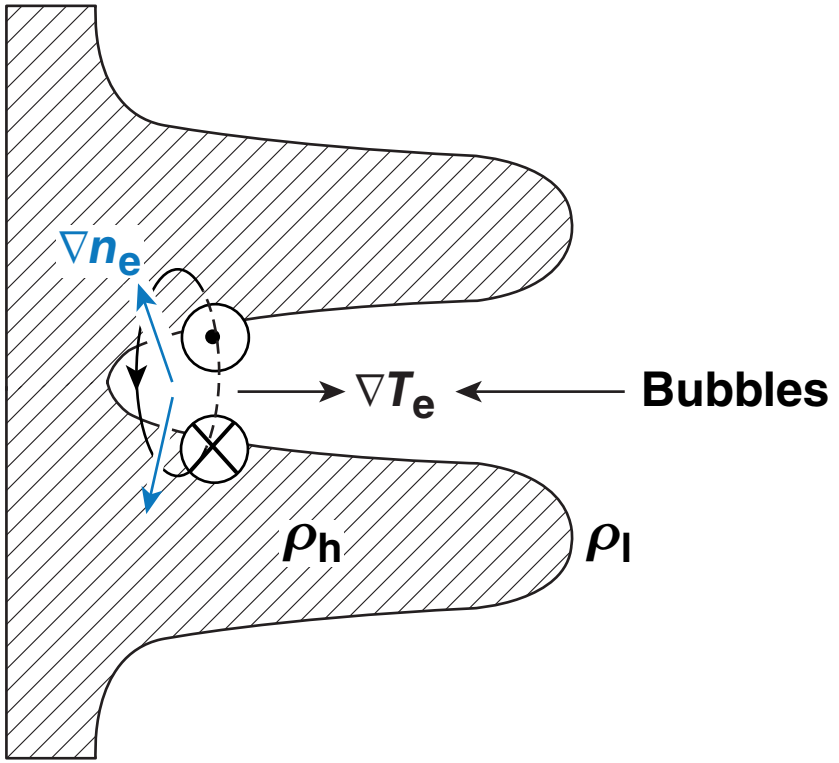
The Rayleigh–Taylor instability in laser-driven targets generates large amounts of fluid vorticity*

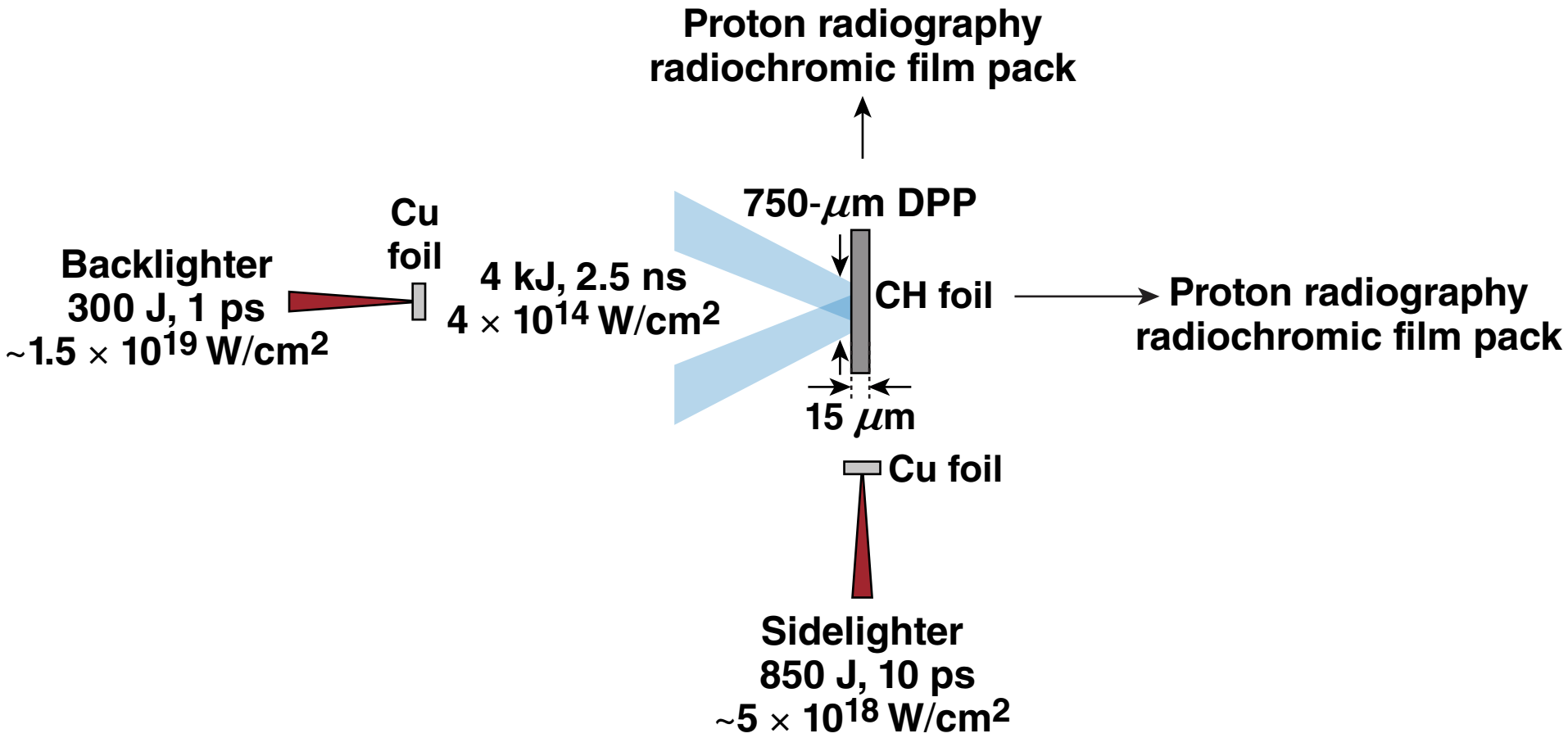




Azimuthal magnetic fields are generated by $\nabla n_e \times \nabla T_e$.

*K. Mima, T. Tajima, and J. N. Leboeuf Phys. Rev. Lett. 41, 1715 (1978).
R. G. Evans Plasmas Phys. Control. Fusion. 28, 1021 (1986).
R. Betti and J. Sanz Phys. Rev. Lett. 97, 205002 (2006).

Magnetic-field generation was studied using the acceleration of planar, 15-μm-thick plastic targets on OMEGA EP



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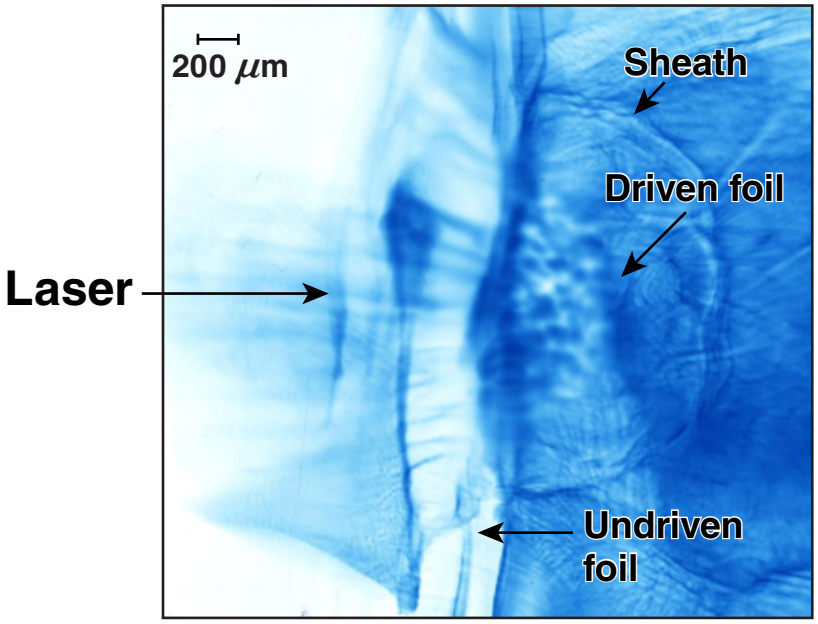
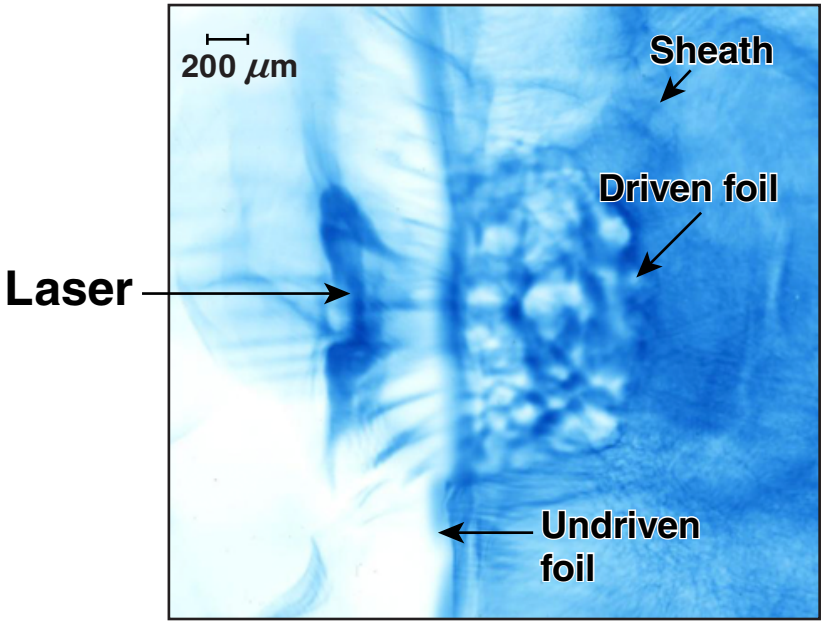
Proton radiography reveals magnetic-field generation and its evolution



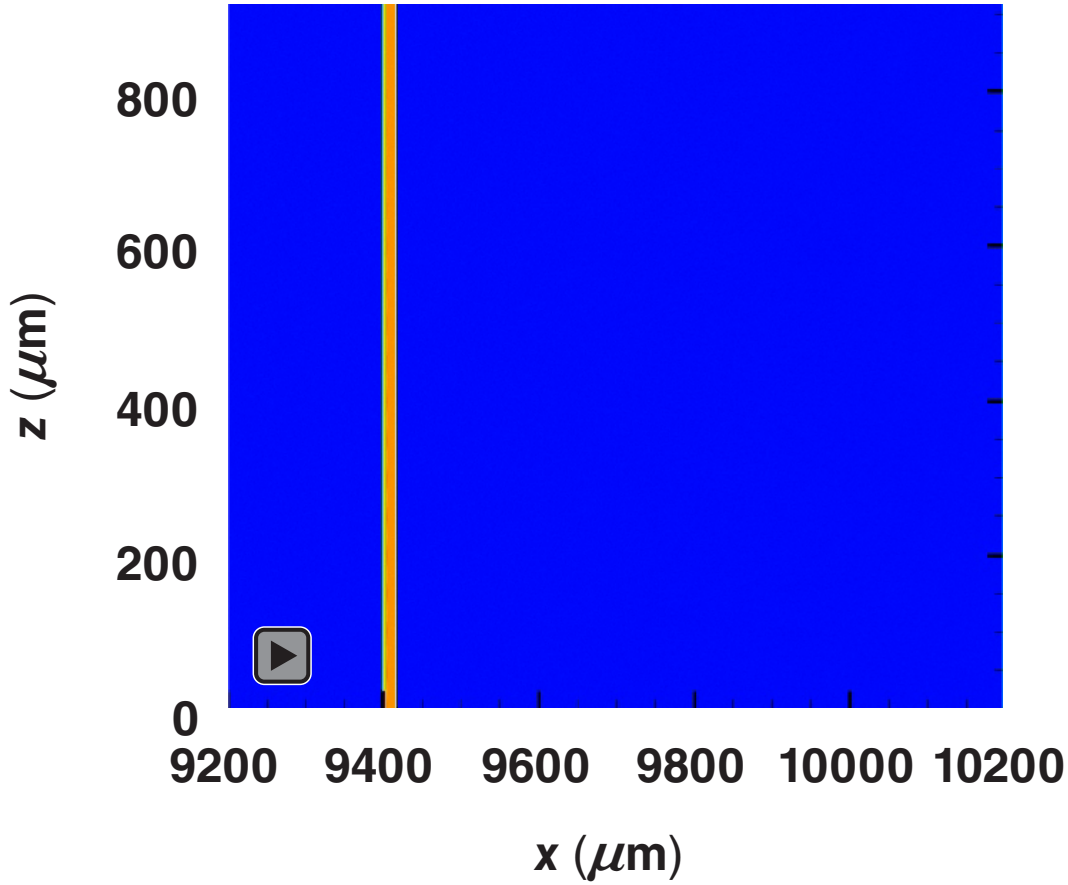
$t = t_0 + 2.0$ ns
$E = 13$ MeV



$t = t_0 + 2.5$ ns
$E = 13$ MeV

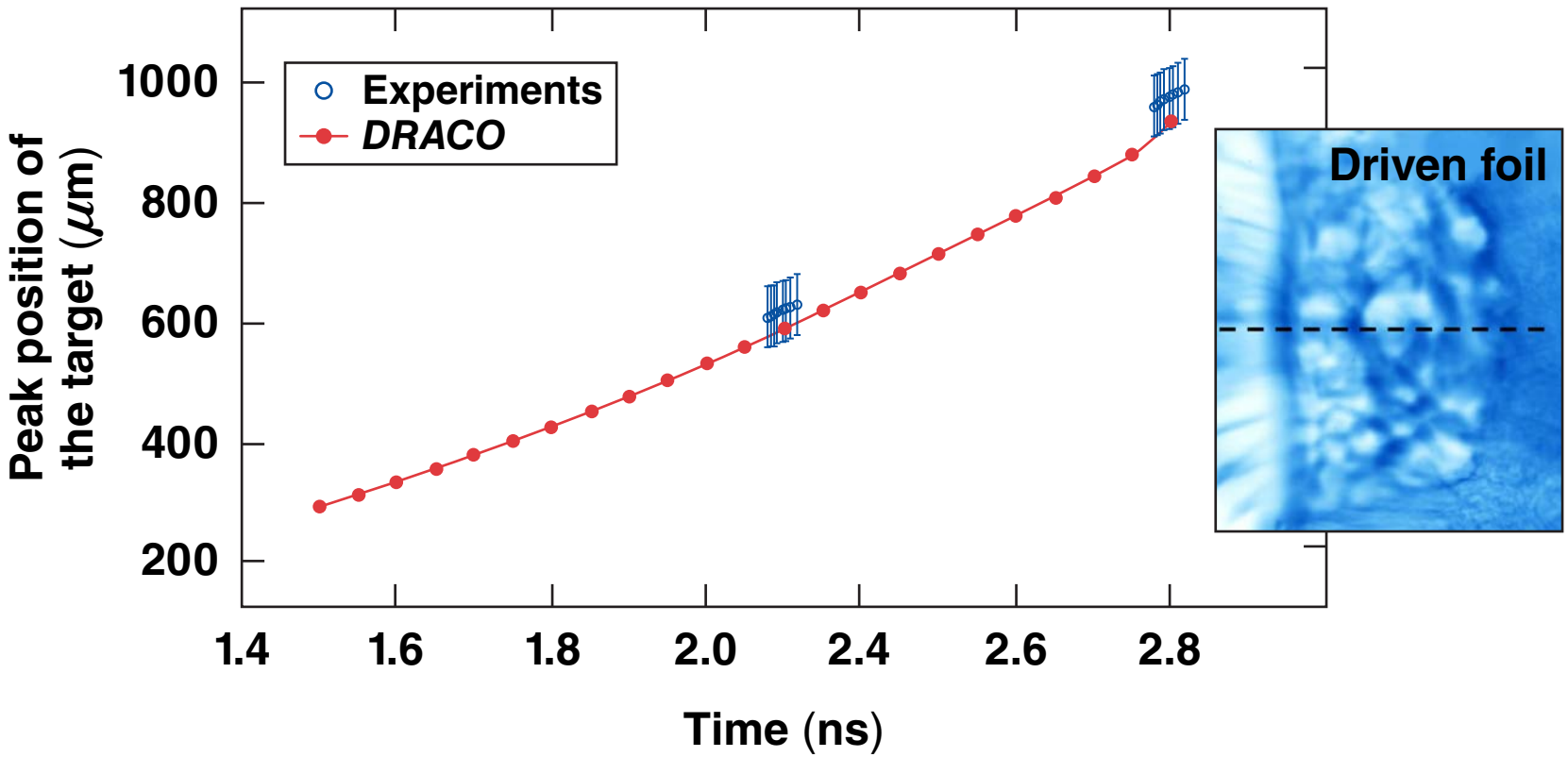
Bubble size scale doubles in 500 ps.

A 2-D magnetohydrodynamic simulation with *DRACO** predicts a broken foil caused by Rayleigh–Taylor instability during the acceleration phase



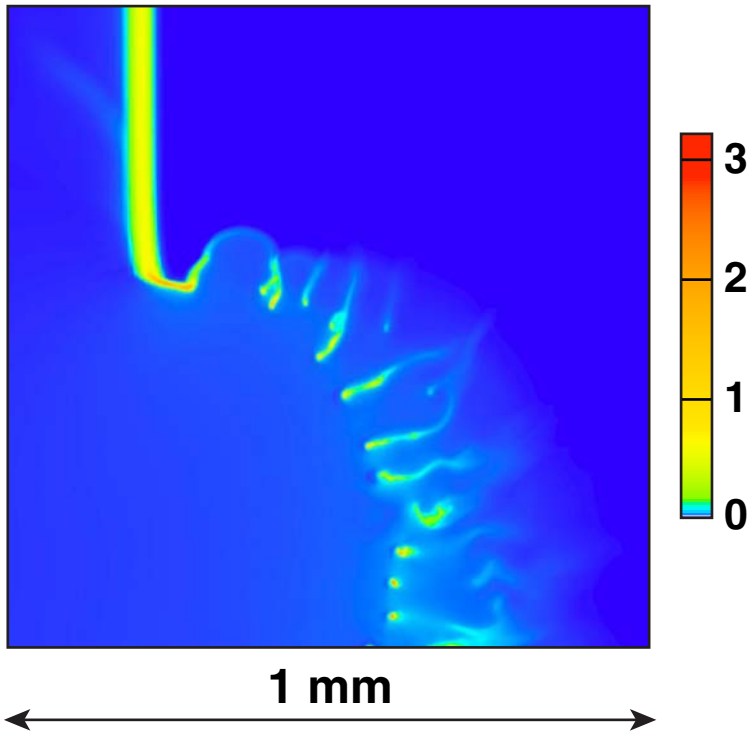
*D. Keller *et al.*, Bull. Am. Phys. Soc. 44, 37 (1999).
P. B. Radha *et al.*, Phys. Plasmas 12, 032702 (2005).

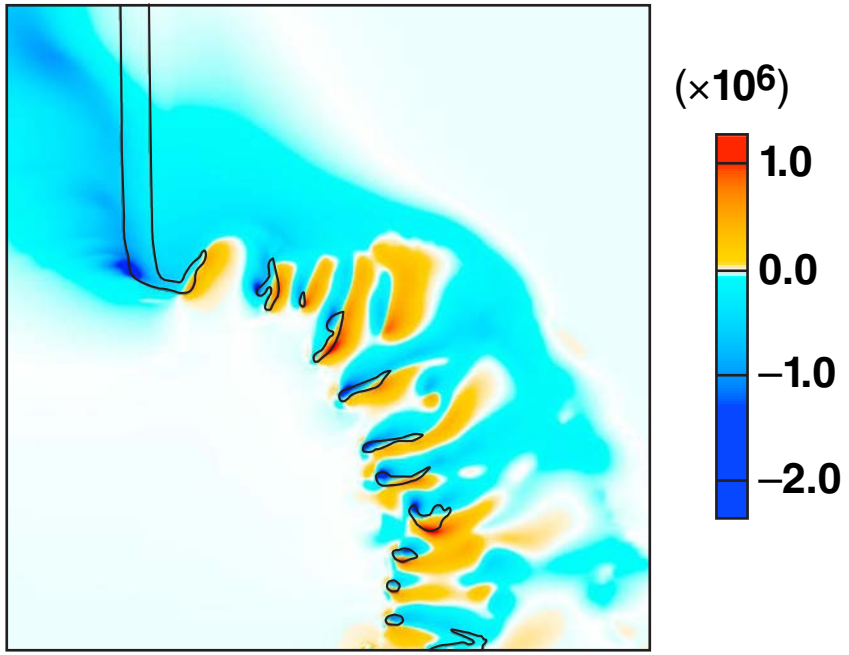
*DRACO** reproduces the measured foil trajectory



*D. Keller *et al.*, Bull. Am. Phys. Soc. 44, 37 (1999).
P. B. Radha *et al.*, Phys. Plasmas 12, 032702 (2005).

MG-level magnetic fields are predicted in the broken foil

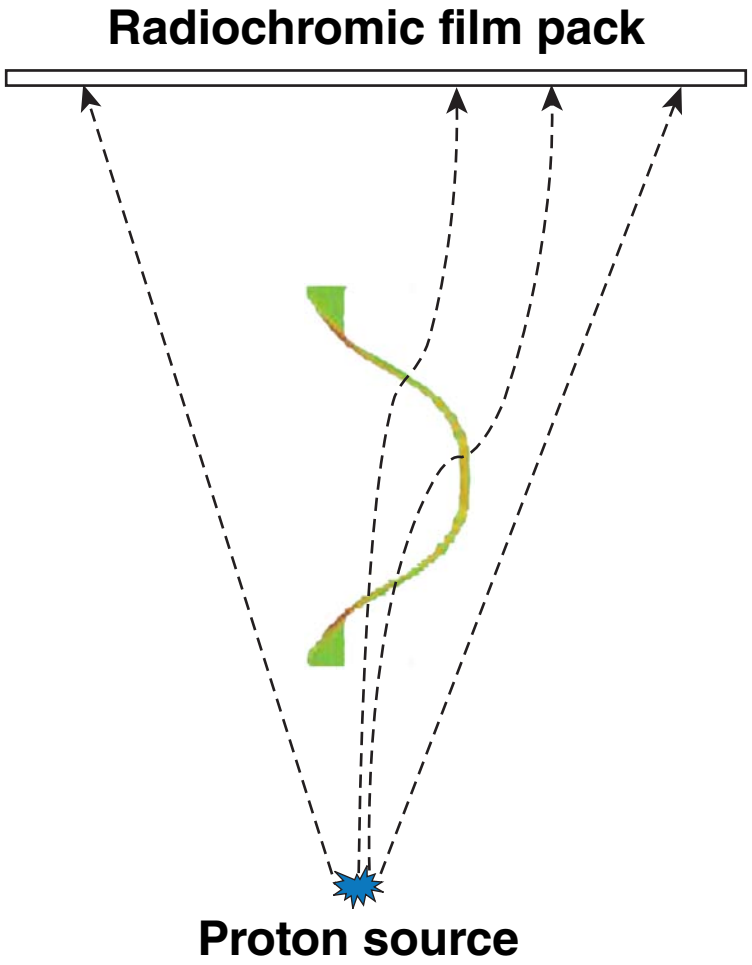




Black line: density contour at 0.05 g/cm^3

$t = t_0 + 2.1$ ns

A proton ray-tracing code will be used to reproduce characteristics of the radiography images



$$\frac{d\vec{x}}{dt} = \frac{\vec{P}}{\gamma m}$$

$$\frac{d\vec{P}}{dt} = q\left(\vec{E} + \frac{\vec{P} \times \vec{B}}{\gamma m}\right)$$

$\vec{E}, \vec{B}$ taken from *DRACO*

Summary/Conclusions

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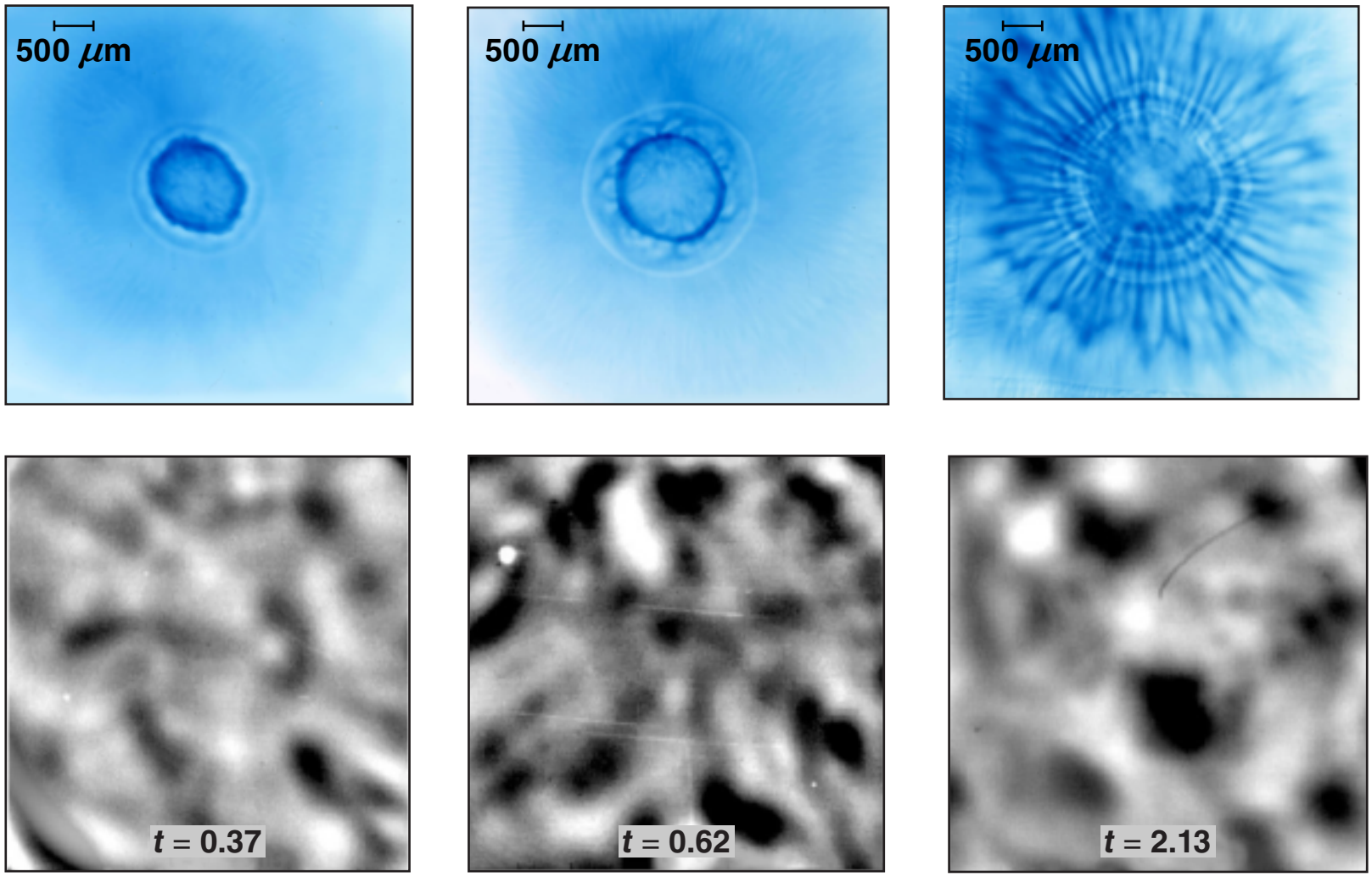

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