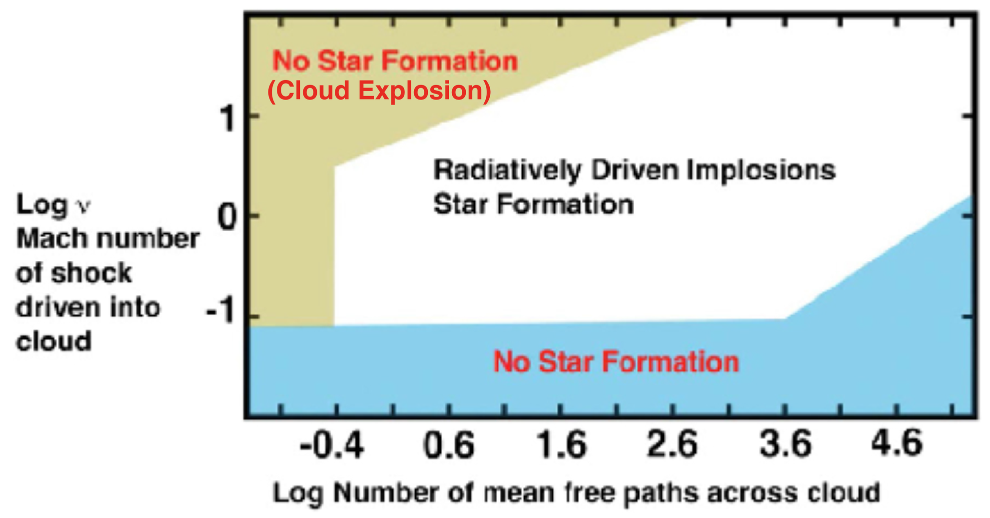
Experiments relevant to understanding the interaction of stellar radiation with molecular clouds

R. VanDervort[1], J. Davis[1], M. Trantham[1], S. Klein[1], P. A. Keiter[1], R. P. Drake[1]

[1] University of Michigan, USA

Stellar radiation compresses or explodes local gas clouds

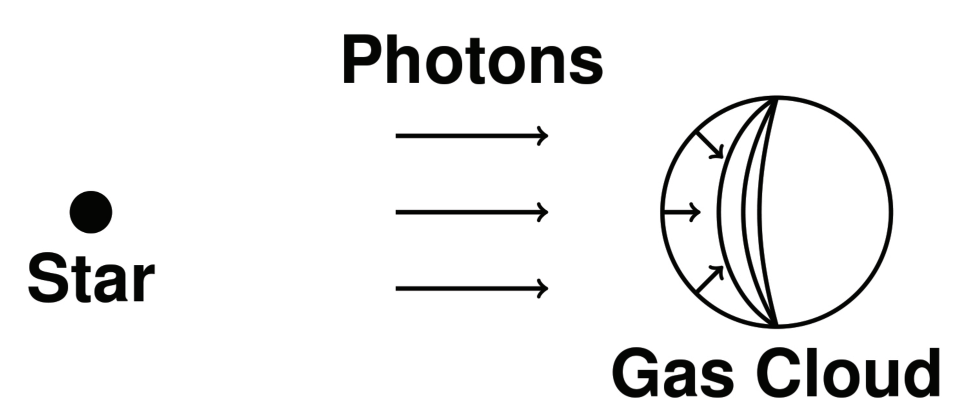


[1] P. A. Keiter et al.: "Design of laboratory experiments to study radiation-driven implosions," High Energy Density Physics, Volume 22, p. 37-40 (2017)

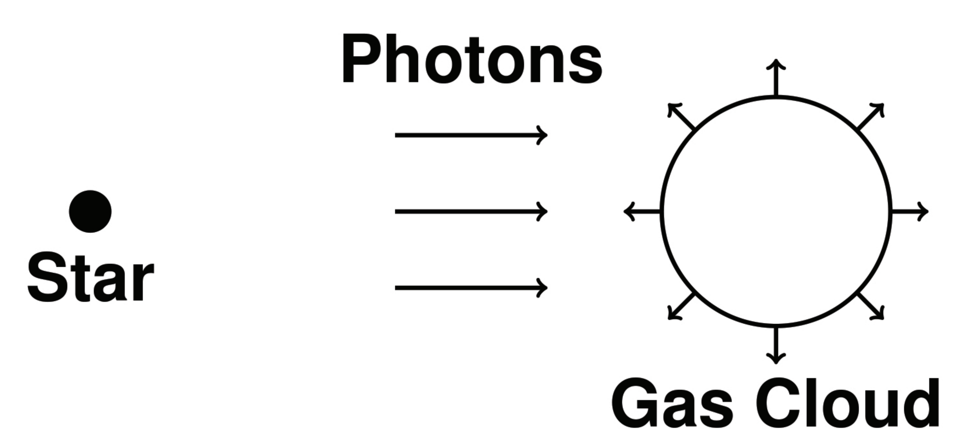
[2] F. Bertoldi: "The Photoevaporation of Interstellar Clouds. I. Radiation-Driven Implosion," Astrophysical Journal, vol. 346, p. 735-755 (1989)

Interaction dependent on incident photon energy, cloud thickness, and cloud density

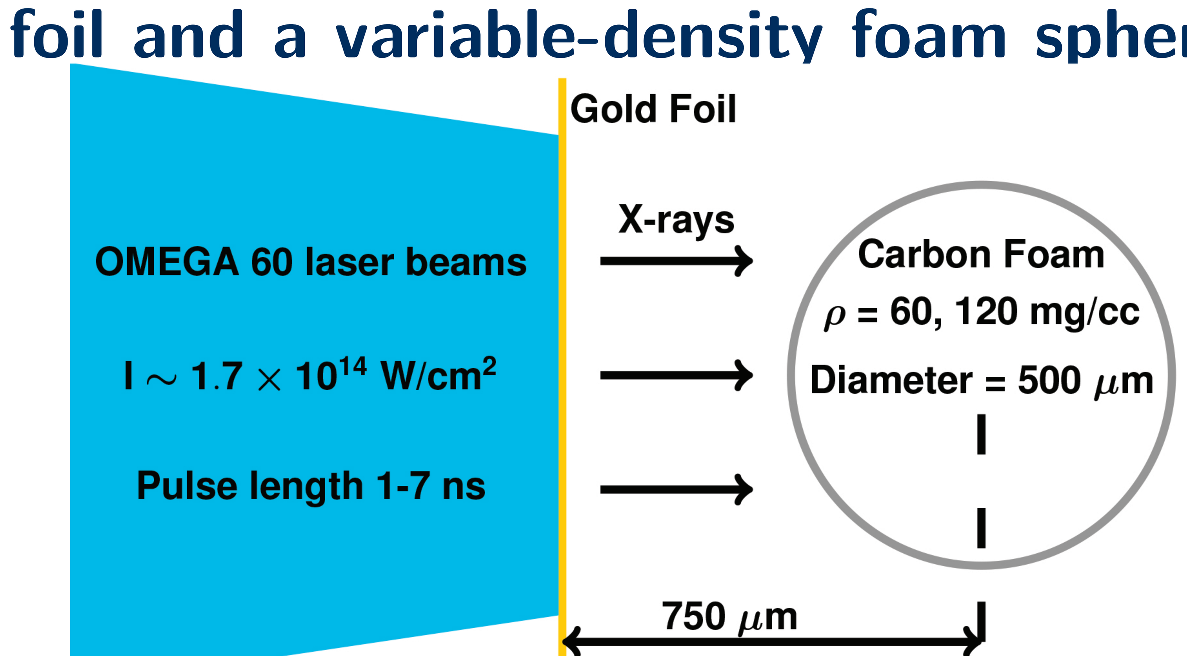
- Optically thick: Photons absorbed at one cloud edge
  - Drives asymmetric shock into cloud



- Optically thin: Photons permeate and heat cloud
  - Cloud explodes



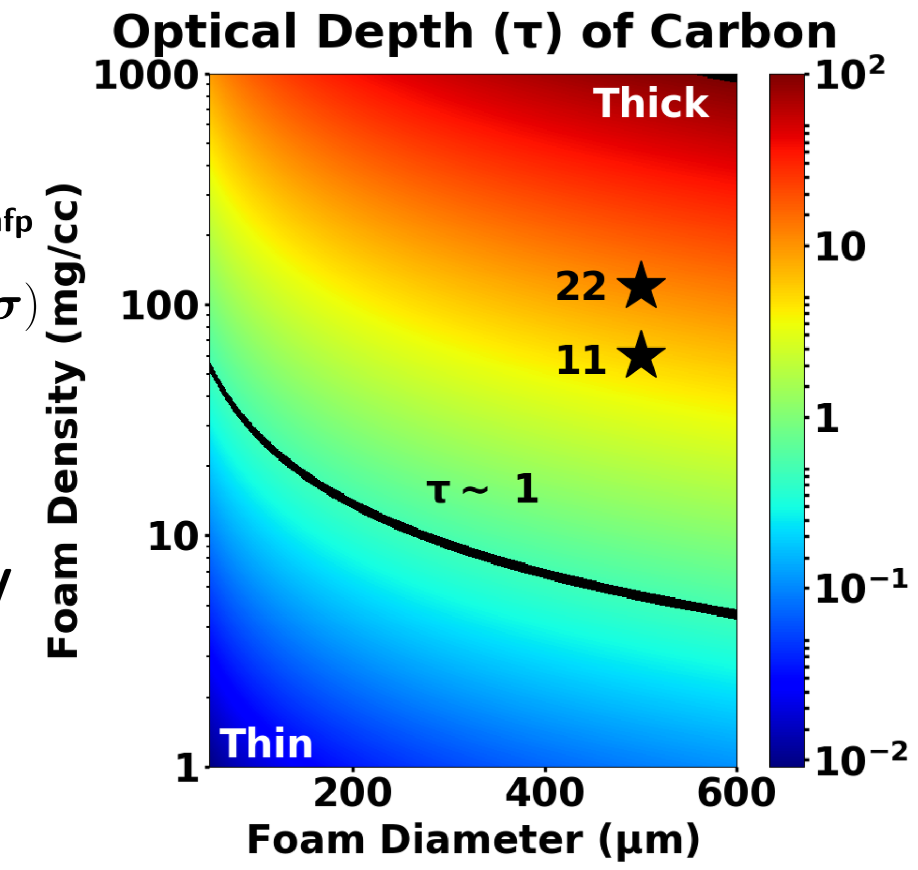
The platform is driven by laser-irradiated thin-gold foil and a variable-density foam sphere



[3] J. Davis et al.: "Soft X-ray emission from laser-irradiated gold foils," Physics of Plasmas 25, 073304 (2018)

Foil temperature, foam diameter, and foam density determine the optical depth (τ)

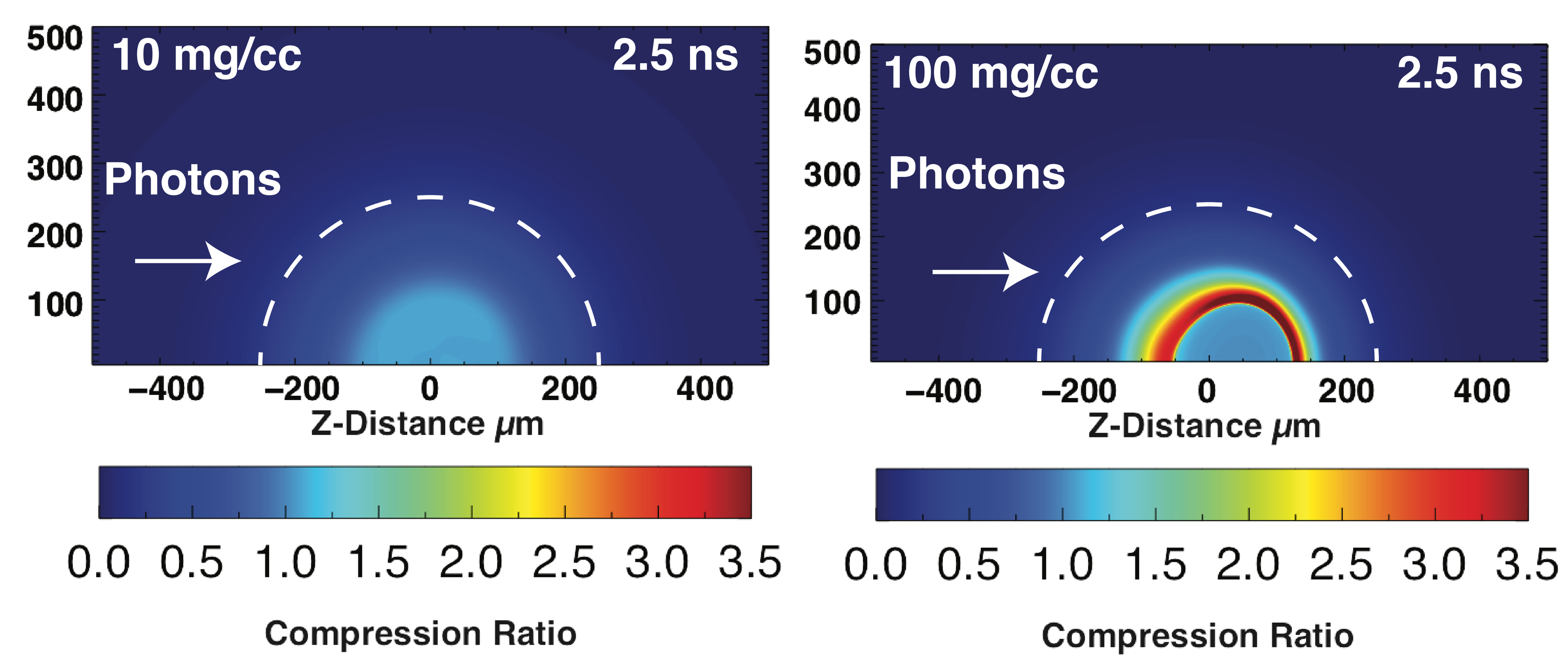
- $\tau \sim$ Diameter$/\lambda_{\mathrm{mfp}} = \mathrm{D}/\lambda_{\mathrm{mfp}}$
- Mean free path: $\lambda_{\mathrm{mfp}} = 1/(\rho\sigma)$
- $\tau \sim \mathrm{D}\rho\sigma$
- Carbon foam
- Peak photon energy $\sim$ 230 eV
- $\sigma \sim 3600\ \mathrm{cm}^2/\mathrm{g}$ [4]



[4] Estimated from http://henke.lbl.gov/optical_constants/filter2.html

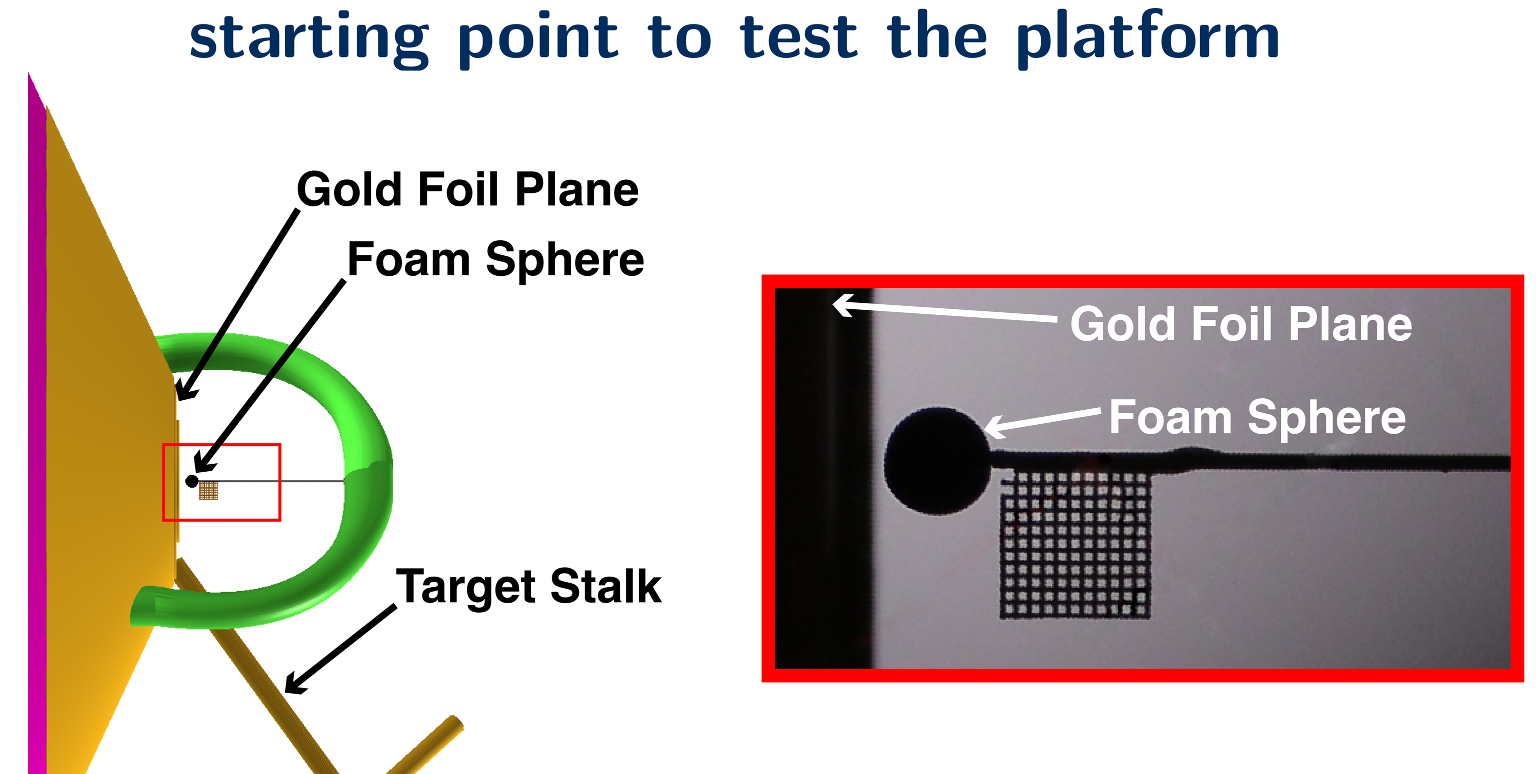
2D CRASH radiation hydrodynamic simulations show both compression and explosion limits

- Sphere diameter initially 500-μm
- Foil edge to sphere center distance initially 1-mm

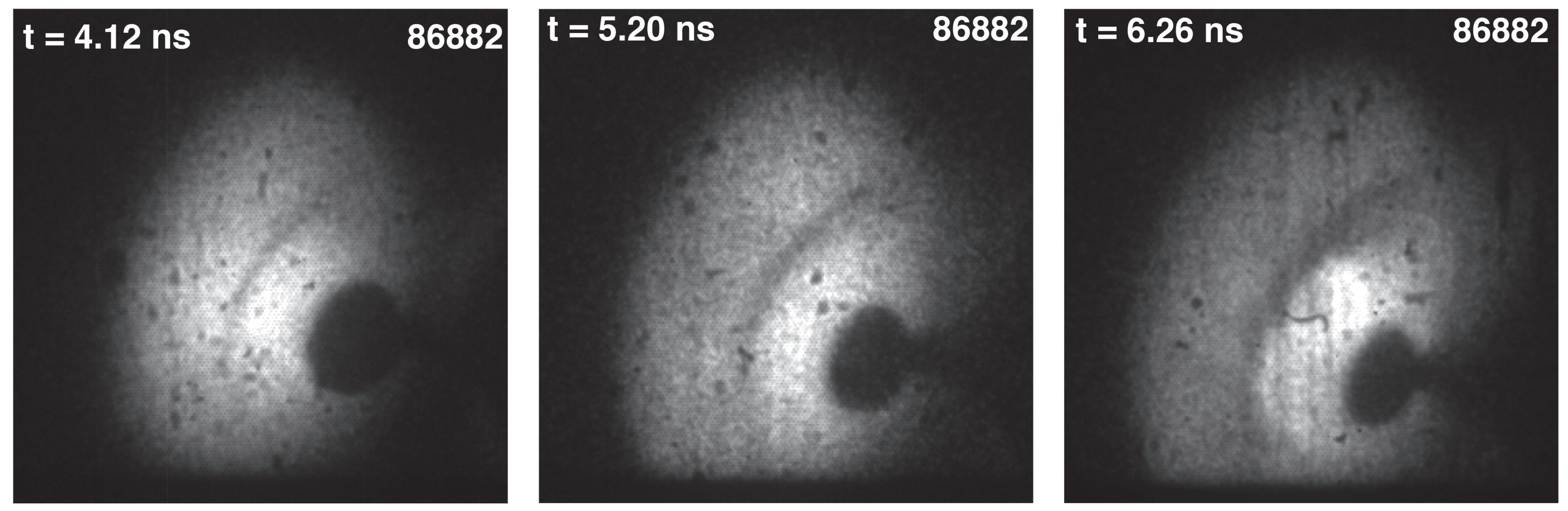


[5] B. van der Holst et al; "CRASH: A Block-adaptive-mesh Code for Radiative Shock Hydrodynamics-Implementation and Verification"

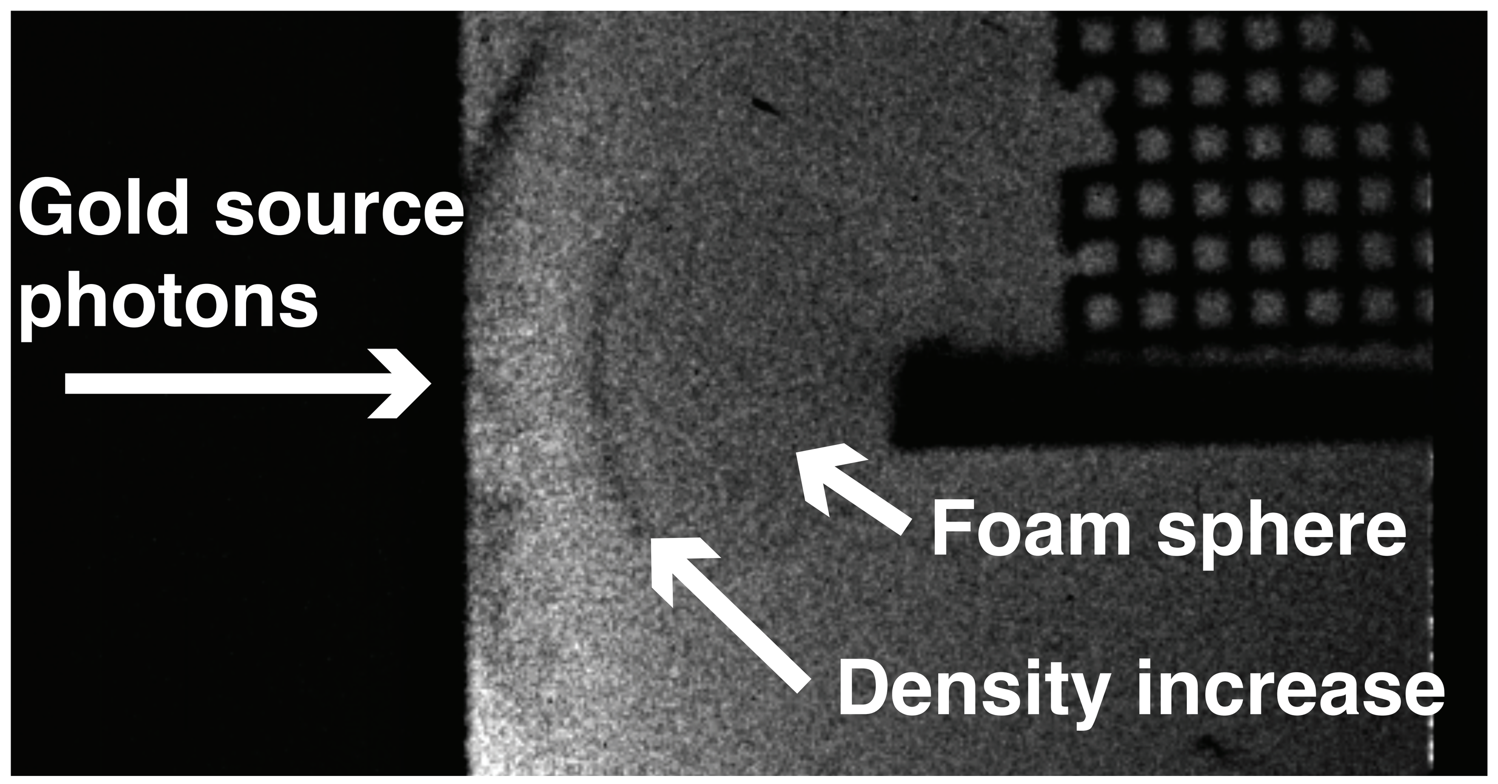
Optically thick limit provides a well-understood starting point to test the platform



Soft x-ray radiography from the first experiment indicates compression



Backlit-pinhole radiography from the second experiment shows asymmetric compression



We are developing an experimental platform to explore the range of conditions found when stars irradiate gas clouds

- Local hot, massive stars cause gas clumps to explode or compress
  - Gas cloud fate dependent on initial optical depth
- Simulations show the platform can reach optically thin and thick limits by changing foam density
- Initial experiments started in the optically thick regime for physics and diagnostic simplicity
  - First optical depths $\sim$ 11 and 22
  - Asymmetric compression of spheres radiographed
- Data sets are under analysis

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