Early-time evolution of radiative shocks on the Omega Laser

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Shock waves become radiative when…

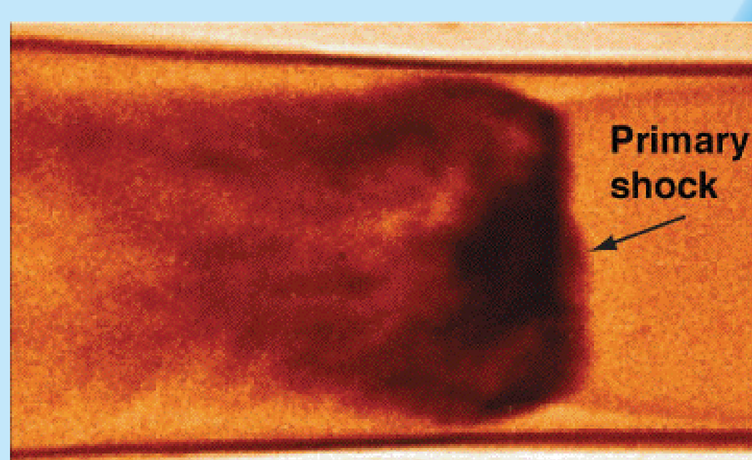
Radiative energy flux would exceed incoming material energy flux

Where post-shock temperature is proportional to u_s^2

The ratio of these energy fluxes is proportional to u_s^5/ρ_o

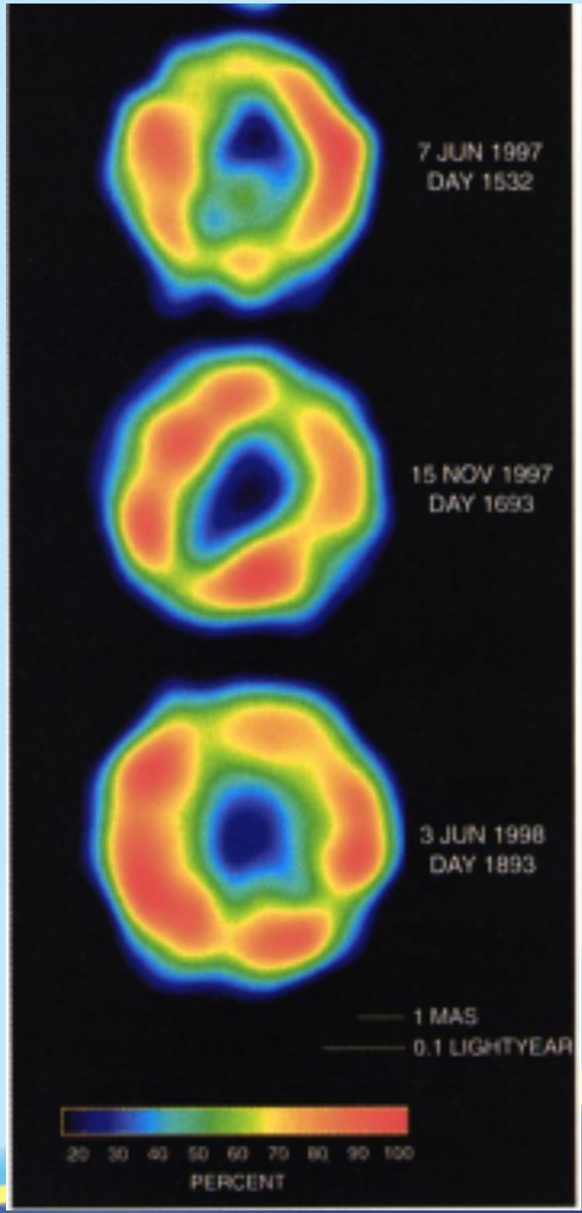
Implying threshold velocities ….

Material	**Xe (Omega)**
Density	**0.01 g/cc**
Threshold velocity	**60 μm/ns (km/s)**
Drive Pressure	**40 Mbar (10^6 atm)**



Radiative shocks are abundant in our universe

- Supernova shocks
  - During propagation through the star and as it emerges
- Supernova ejecta can develop into a radiative shock
- Supernova remnants can enter a radiative phase
- Some accretion phenomena



SN1993J, (Bartel, Science, 2000)

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Many radiative shock experiments have been performed at HEDP facilities (an abbreviated list)

- Driven radiative shock waves
  - Bouquet, PRL 2004, Koenig, PoP 2006, Reighard, PoP 2006, Doss PoP 2009 and others
- Radiative blast waves
  - Grun, PRL 1991, Edwards PRL 2001, Peterson, 2006, Hansen, PoP 2006, Moore PRL 2008 and others
- Reverse radiative shock waves (relevant to accretion phenomena)
  - Talks by Suzuki-Vidal, Loupias, Krauland and Felize
- Facilities include LULI, Omega, Pharos, Janus, Vulcan, Z machine, Z-beamlet, MAGPIE, NIF (soon) and others

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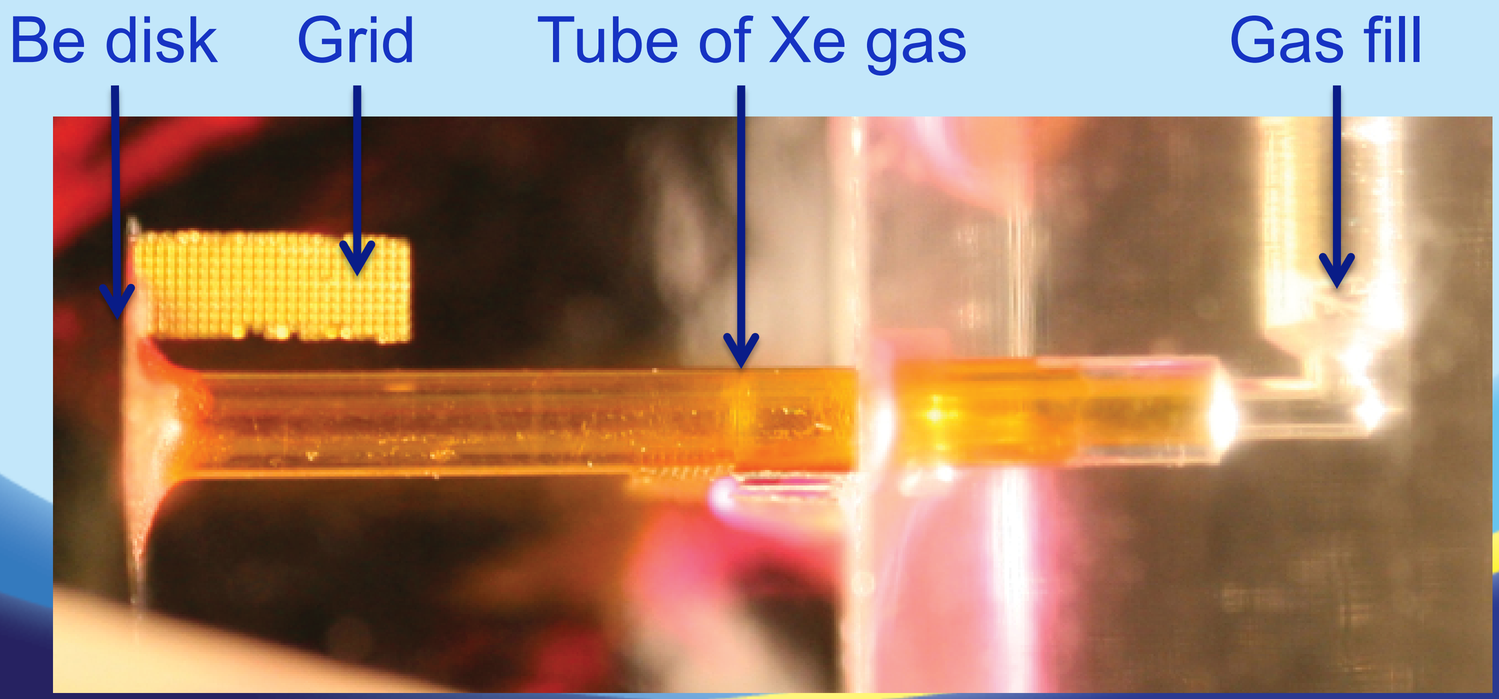
We seek to understand the early-time evolution of a driven radiative shock waves

- Irradiance of ~ 10^{15} W/cm^2
- Shock launched in Be and moves into Xe gas at 1.1 atm
- Shock velocities of over 100 km/s



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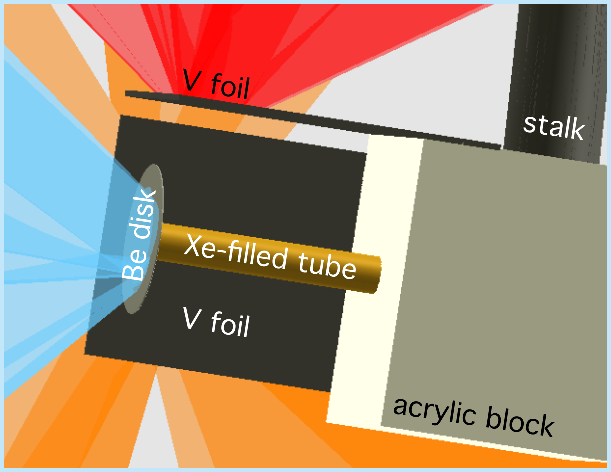
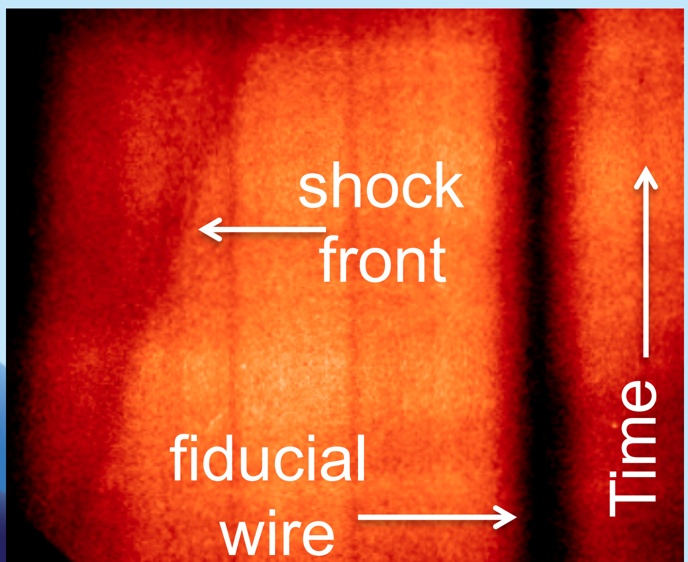
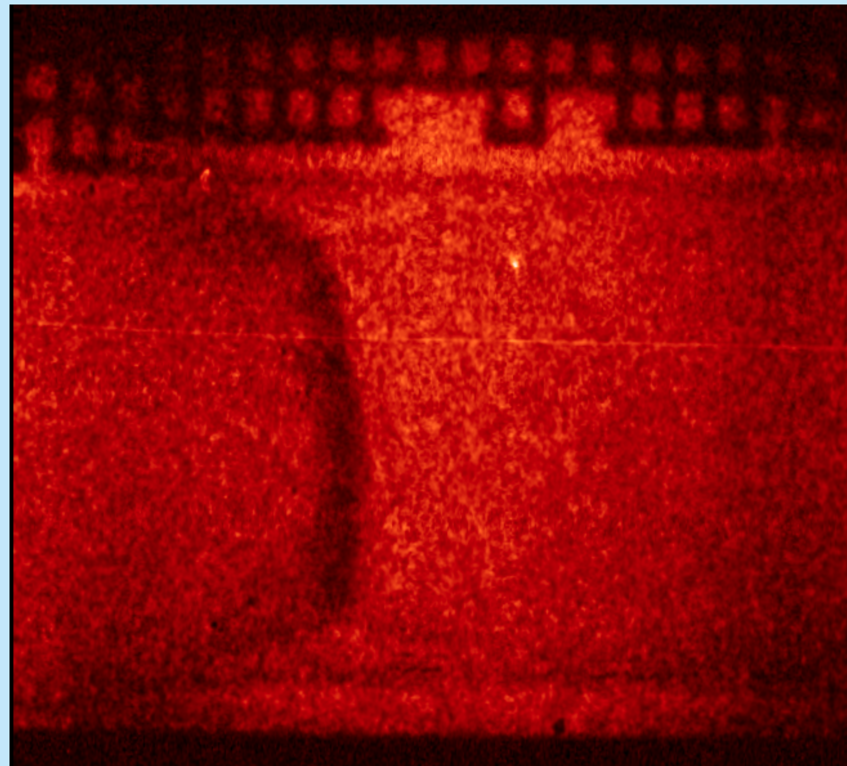
We observe these shocks with x-ray radiography from 2 views







The shock is at ~600 μm at 4.5 ns

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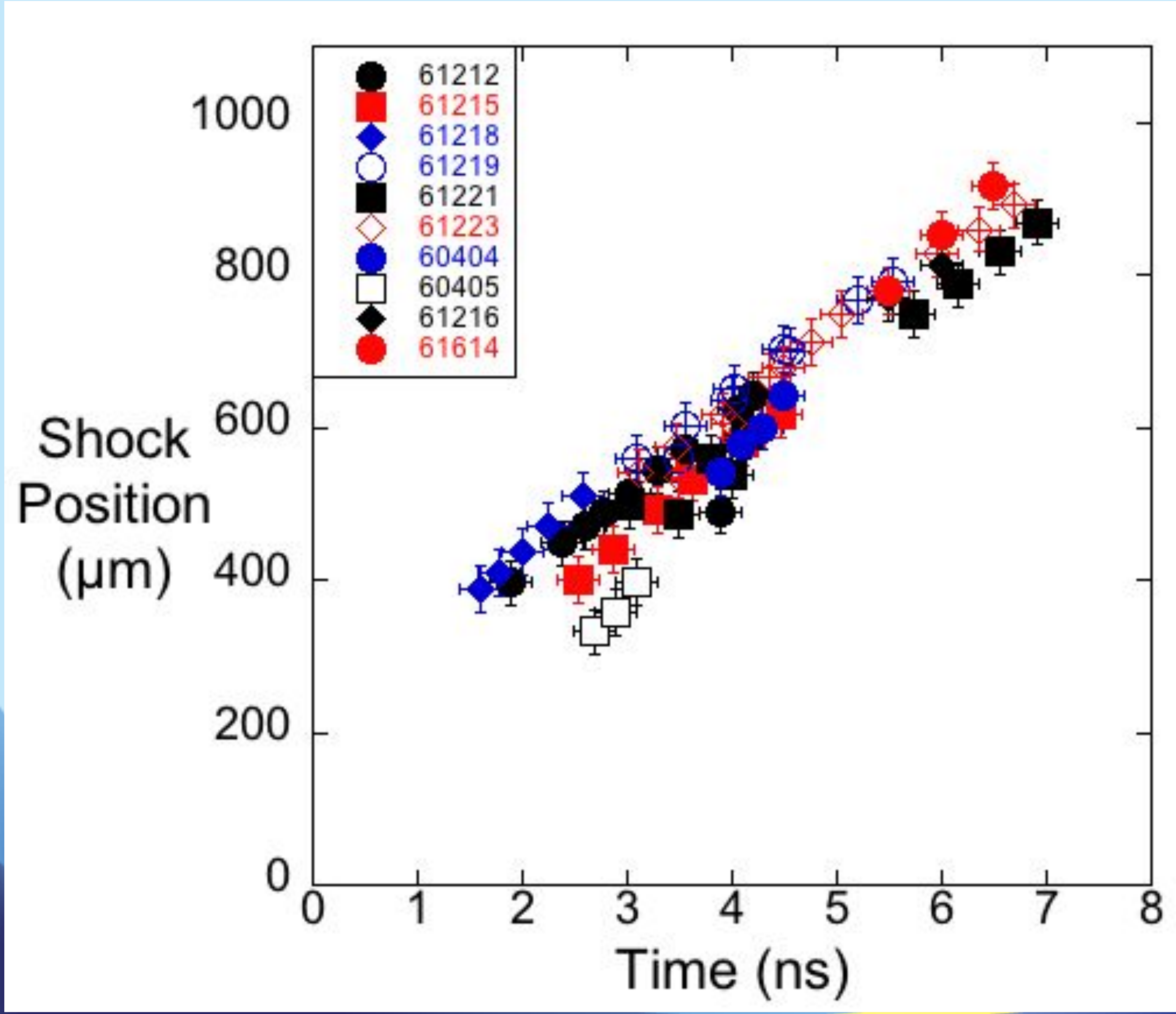
Results from data analysis of streaked and area radiography



Average shock velocity over 130 km/s!

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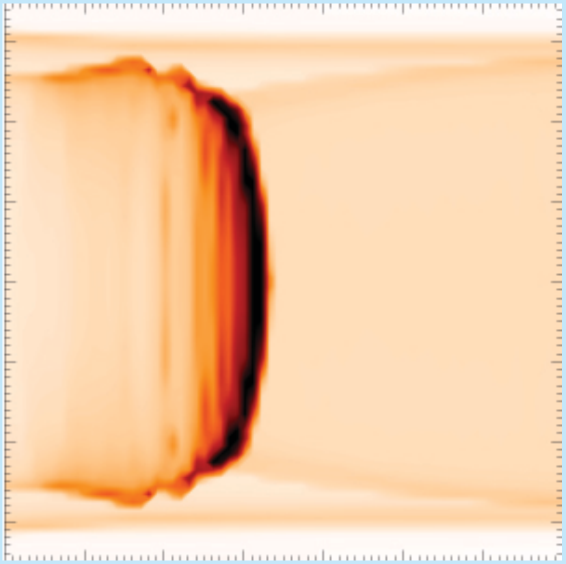
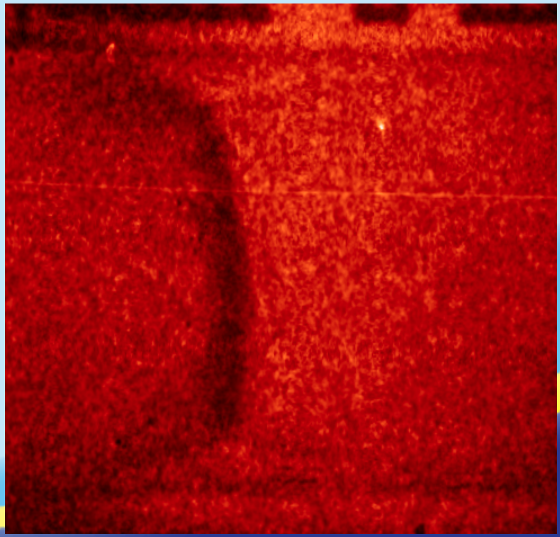
Simulations of the experiment are performed with the CRASH code

- The CRASH code includes
  - 3D Radiation Hydrodynamics
  - Flux-limited multigroup diffusion
  - Models laser energy deposition
- See posters/talks by Fryxell, Malamud, Moran-Lopez, Myra, Rutter, Sweeny, Trantham, Van der Holst



t = 4.5 ns



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Conclusions and future directions

- We create driven radiative shocks in the laboratory with velocities of over 130 km/s!
- We have applied a variety of diagnostic techniques including x-ray radiography, optical pyrometery, and x-ray Thomson scattering
- We are using the CRASH code to model the experiment
- We have a radiative shock experiment on NIF on June 15th!

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Talk Outline

- Description of radiative shocks
- Motivation and astrophysical connection
- Target and diagnostic description
- X-radiography results
- Comparison to simulations with the CRASH code
- Conclusions and future directions