Innovations in target fabrication techniques at the University of Michigan

S.R. Klein[1],

C.C. Kuranz[1], P. Susalla[2], R.S. Gillespie[1], C.M. Huntington[1],

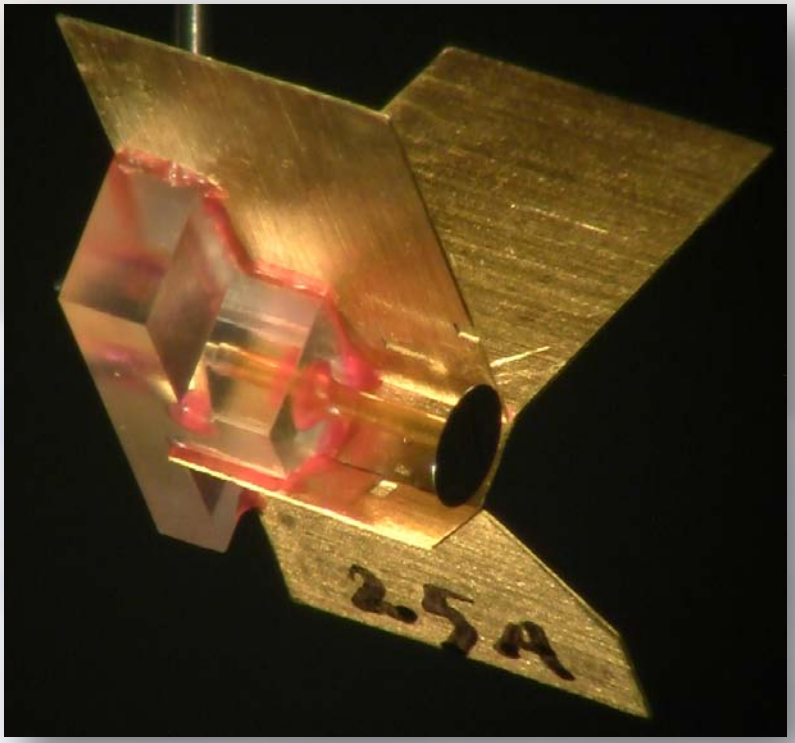
E.J. Gamboa[1], S. Chadwick[3], B. Lairson[3], D. E. Hoover[4], F. Elsner[4],

R P. Drake[1]

[1]University of Michigan, Ann Arbor MI 48109,
[2]University of Wisconsin, Madison, WI 53706, [3]Luxel Corp., Friday Harbor, WA 98250,
[4]General Atomics, San Diego, CA 92121

We have been making our own targets since 2003

- Majority of shots on OMEGA
  - 7 shots in 2012
- Nike
- Trident
- NIF this summer*
- Titan



2012 Radiative Shock Target

Undergrads are an integral part of our target building process

Dave Kaczala

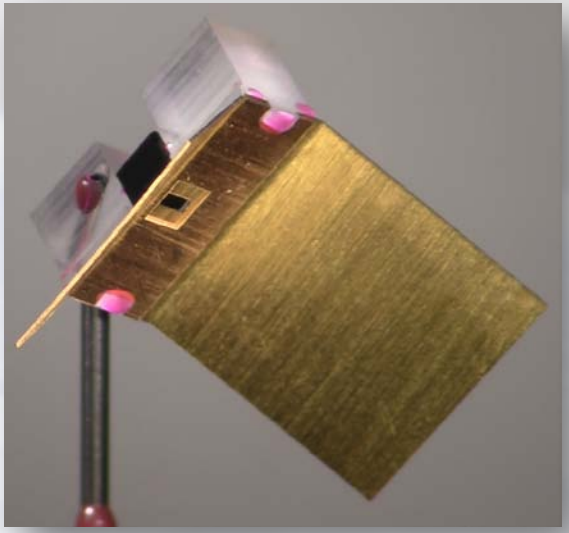
Poster Session: P-05

Grant & Nate

Topics I will be highlighting today are:

- Custom shaped polyimide tubing
- Bent foils
- Acrylic structures

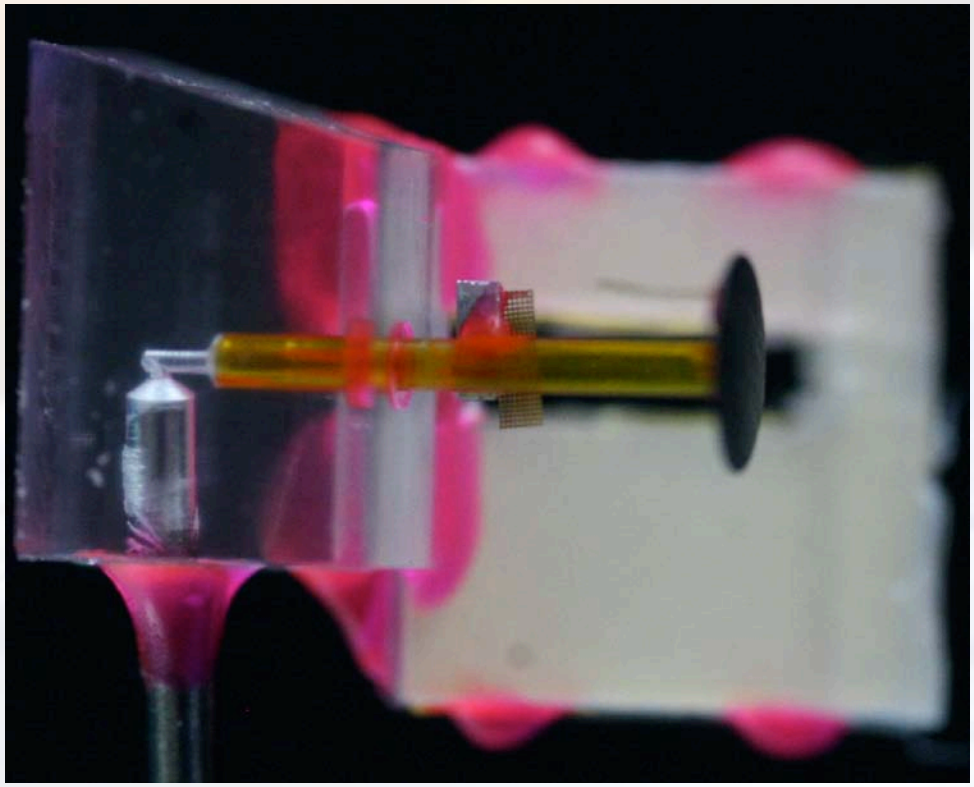
2012 Radiative Shock Nozzle



2012 Low density, carbon blast-wave target

Our radiative shock experiments nominally use round polyimide tubes

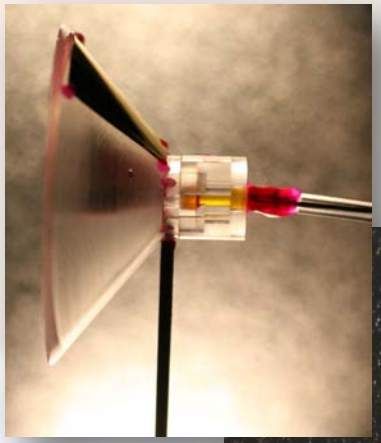
2011 Radiative Shock Target



- 625 µm OD round, polyimide tube, wall thickness 25 µm
- Xenon filled
- Beryllium drive disk, 20 µm thick
- This year's variation is an elliptical cross section

Two categories of elliptical tubes were made

Nozzle



Plain Elliptical

Nozzle tubes have a wide, circular cross section that tapers into an ellipse or circle

1.2 mm OD, round tapered down into either an:

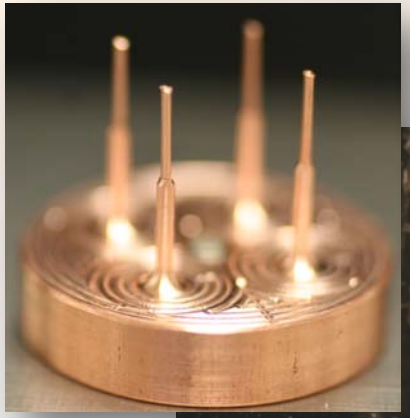
- Elliptical shaft with a major axis of 1.2 mm and a minor axis of 625 μm
- Circular shaft of 625 μm OD

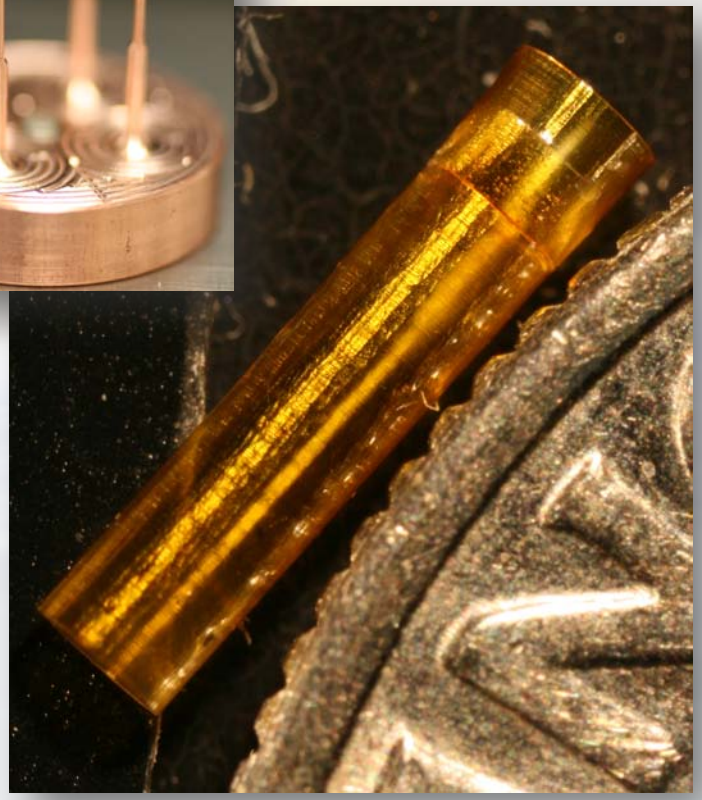
Nozzle tubes were made by coating copper mandrels with liquid polyimide

~ diameter of a quarter

- Machined by the University of Michigan
- Dipped in liquid PI solution at a controlled draw speed, 5 μm layers
- Rotated during soft-baked
- Imidized at above 300° C
- Copper was chemically etched out

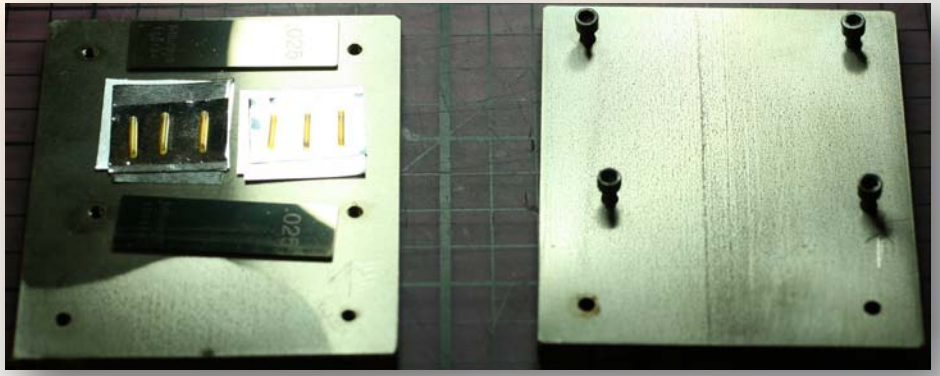
Creating elliptical tubes with axial uniform wall thickness proved challenging

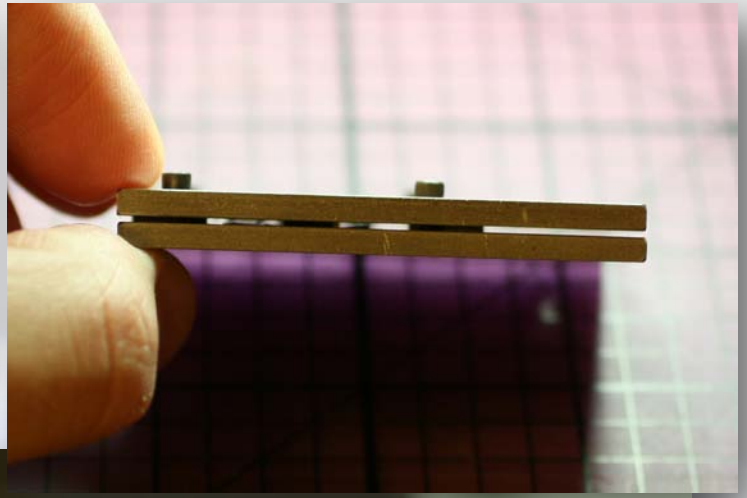


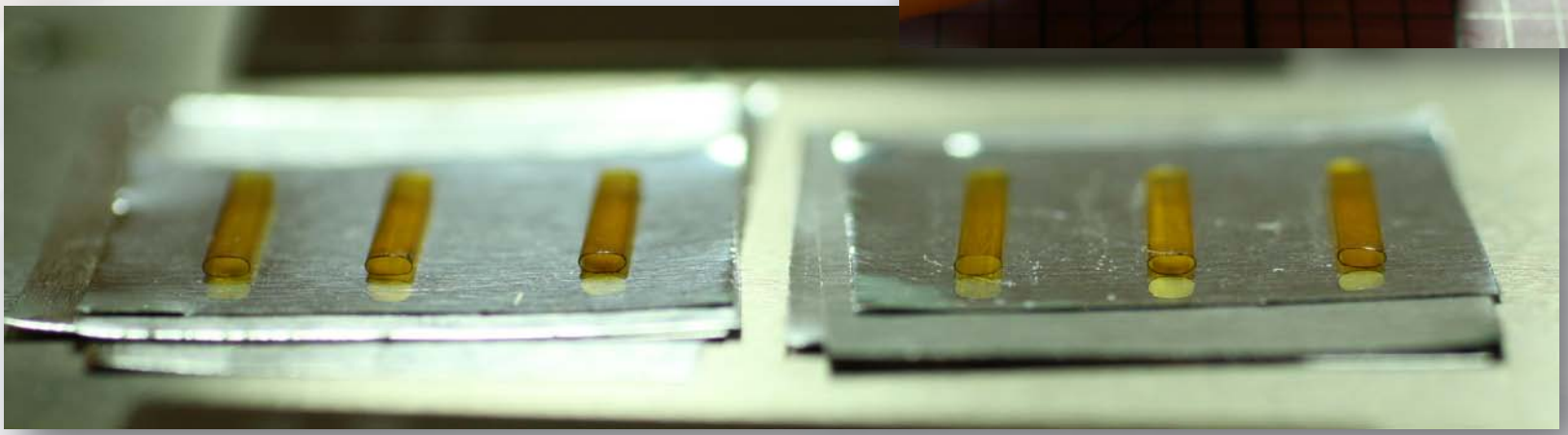


- Leading and trailing "runway" improves uniformity down the length of the tube
- Elliptical tubes axially ***non***-uniform
- Narrow edges were too thin to be gas tight, conversely the broad sides were too thick

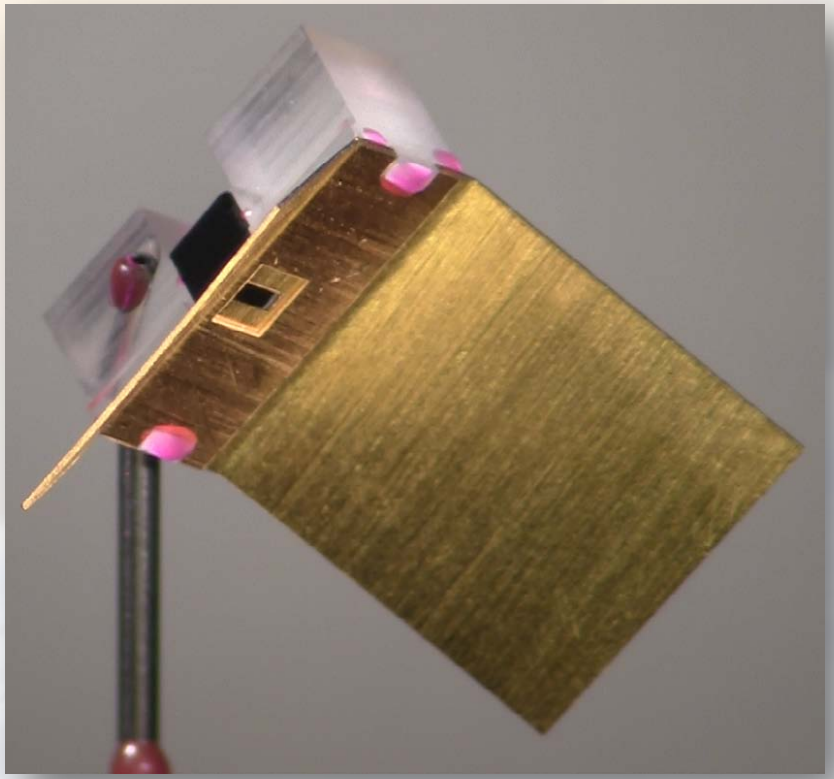
Round tubes were heated between two plates to create an ellipse



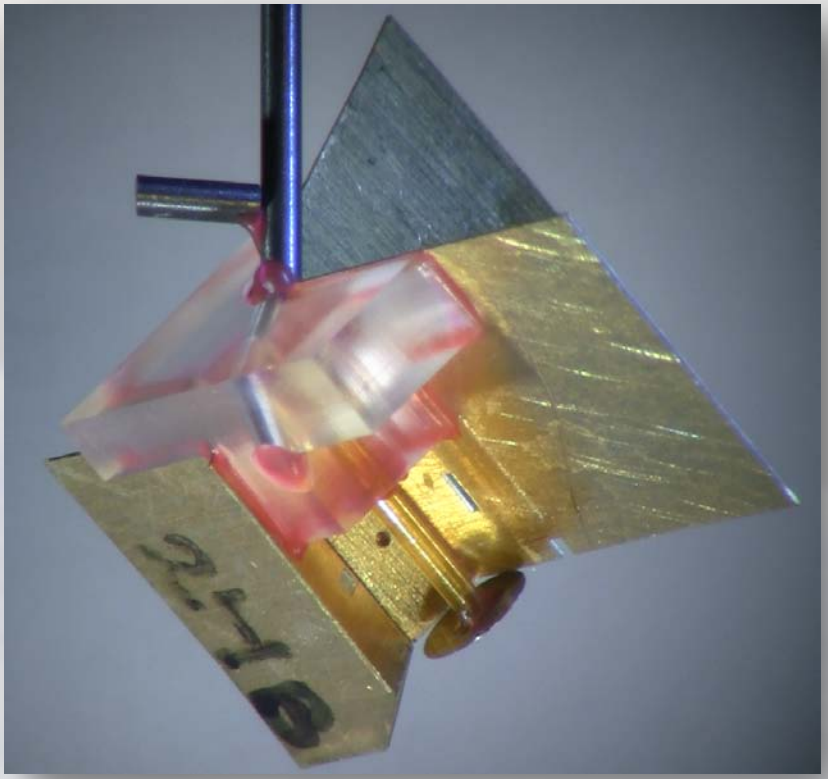




Bent foils were used in two Thomson scattering targets to shield diagnostics



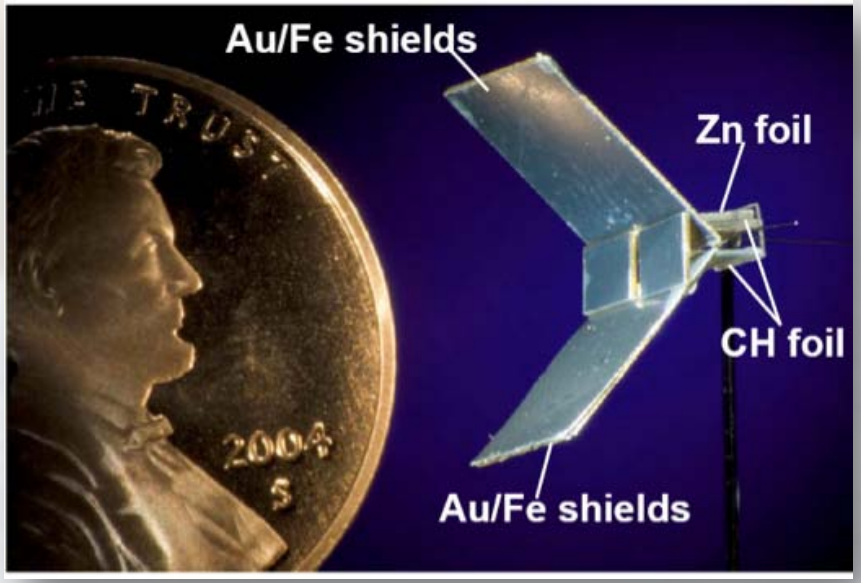
Low density, carbon blast-wave target



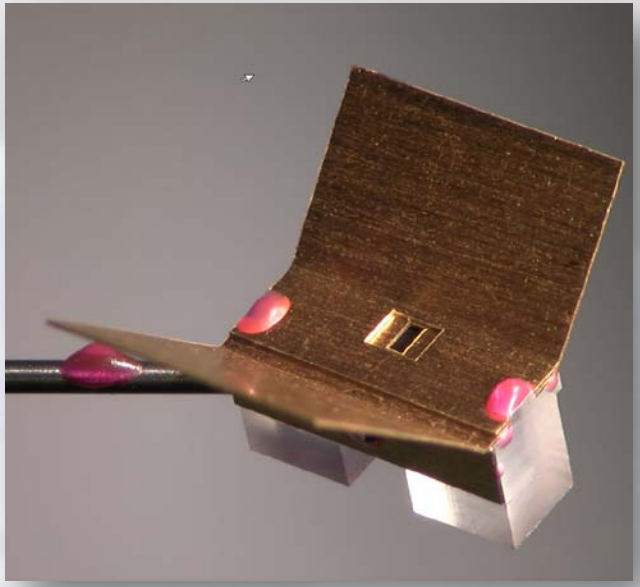
Xenon radiative shocked target

Bending foils necessitates fewer overall target components

- Target with 4 foils glued together to create shielding
- U of M target with 2 bent foils for same shielding

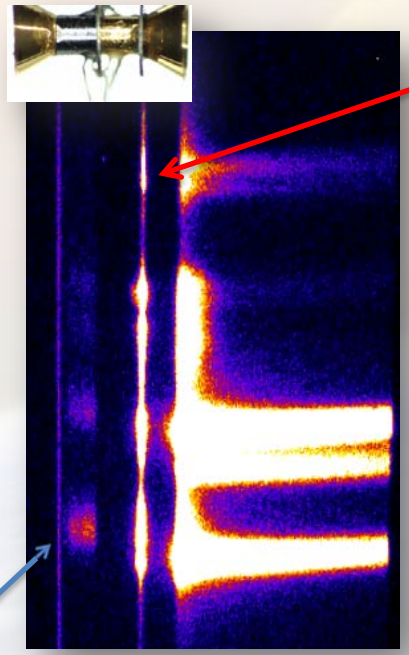


Sawada et al, Phys. Plasmas, 2007



Low density, carbon blast-wave target, 2012

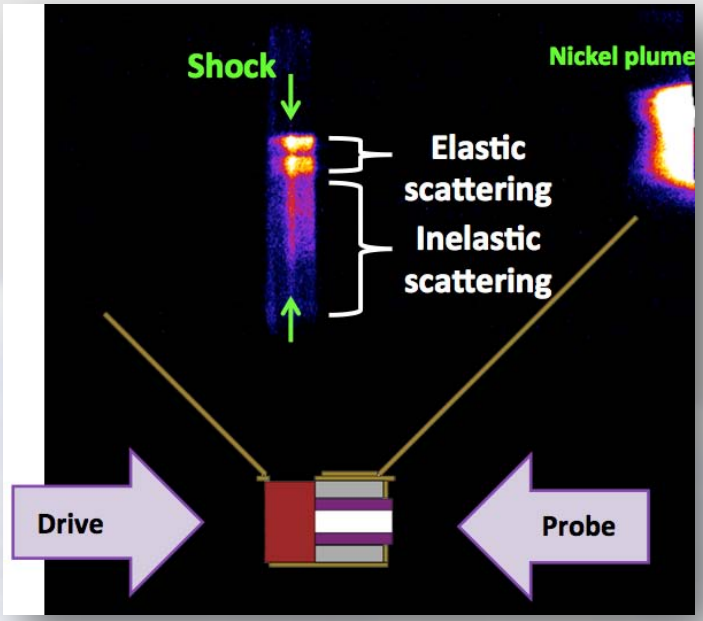
Seams between foils allows source x-rays to interfere with scattered spectra



Gap in shields, allows Ti He-α and continuum through

Source Plume

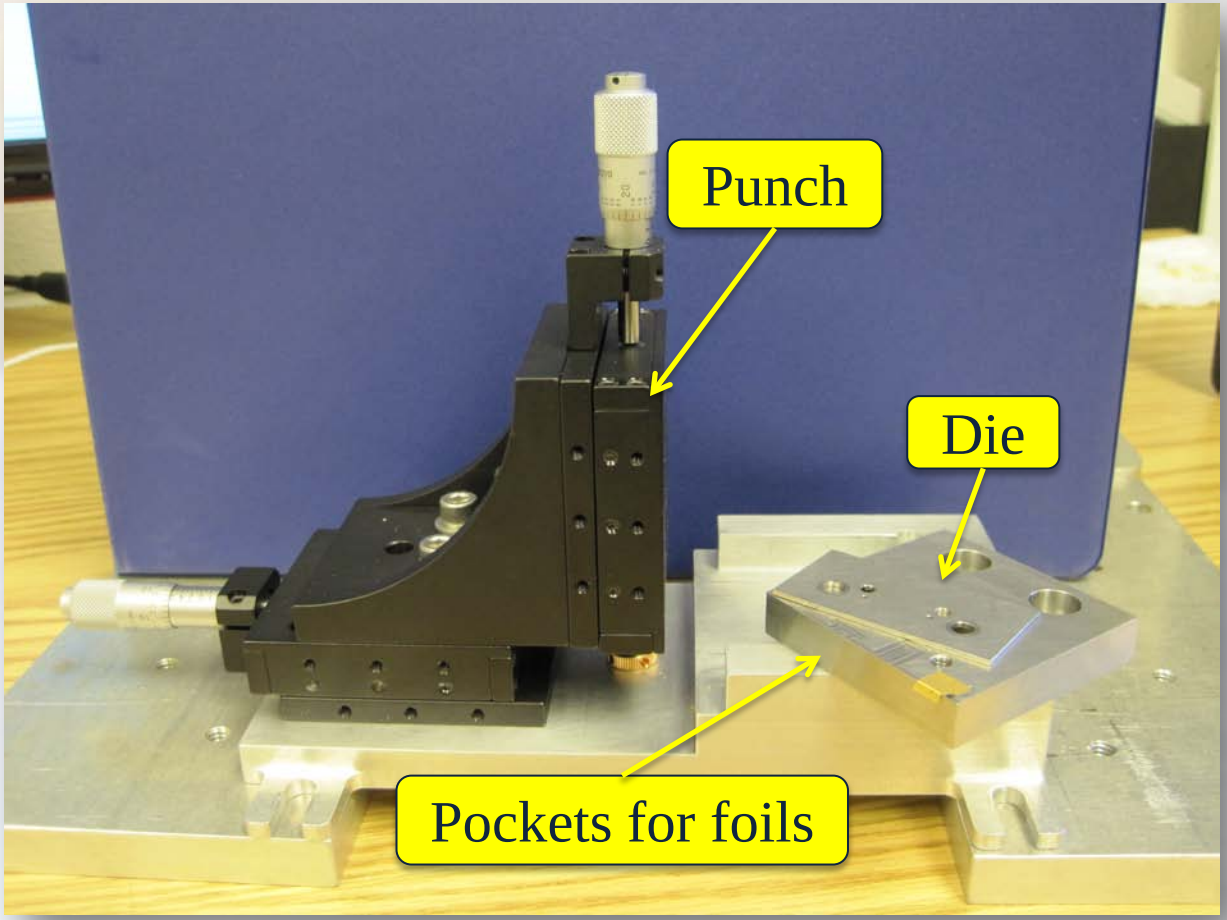
Scattering



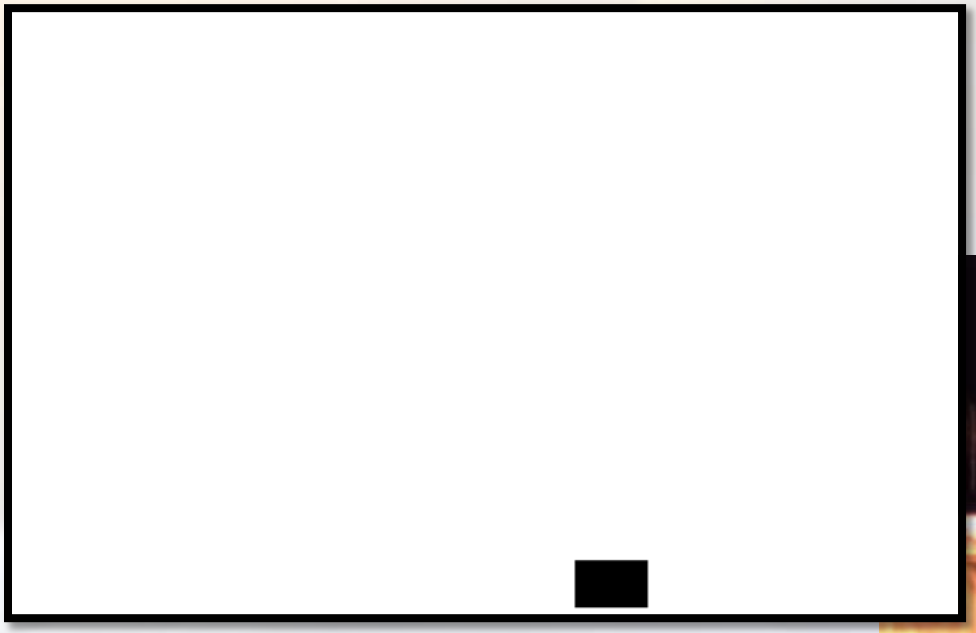
- Gap in shielding appears as a vertical line
- No evidence of leakage!

Bending jig used to bend gold foil shielding for Thomson scattering target

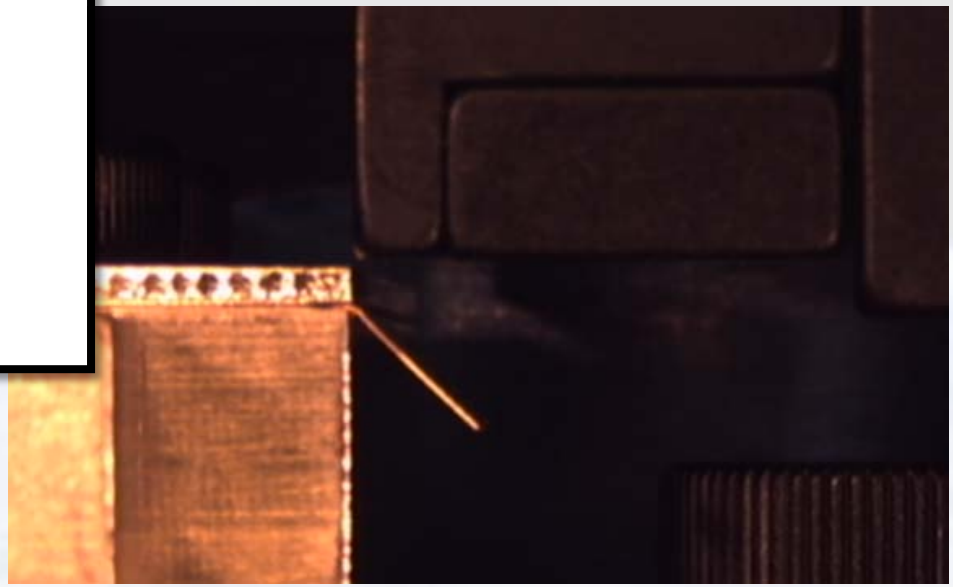
- Two linear stages mounted perpendicular to one another
- Vertical stage is used as punch, that which presses down to bend the foil
- A slot for the die



The punch is slowly brought down a small fixed distance from the die



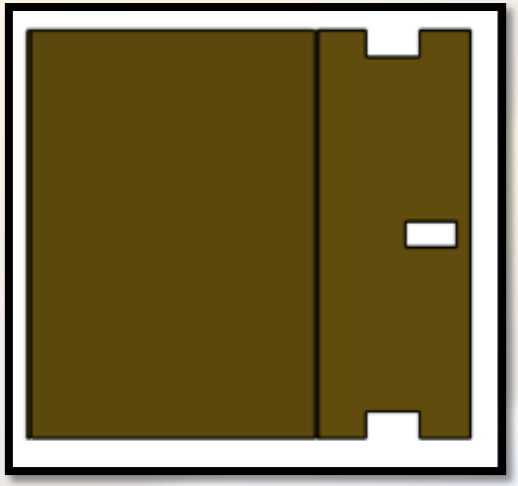
- The punch is slowly brought down until foil is at the correct angle

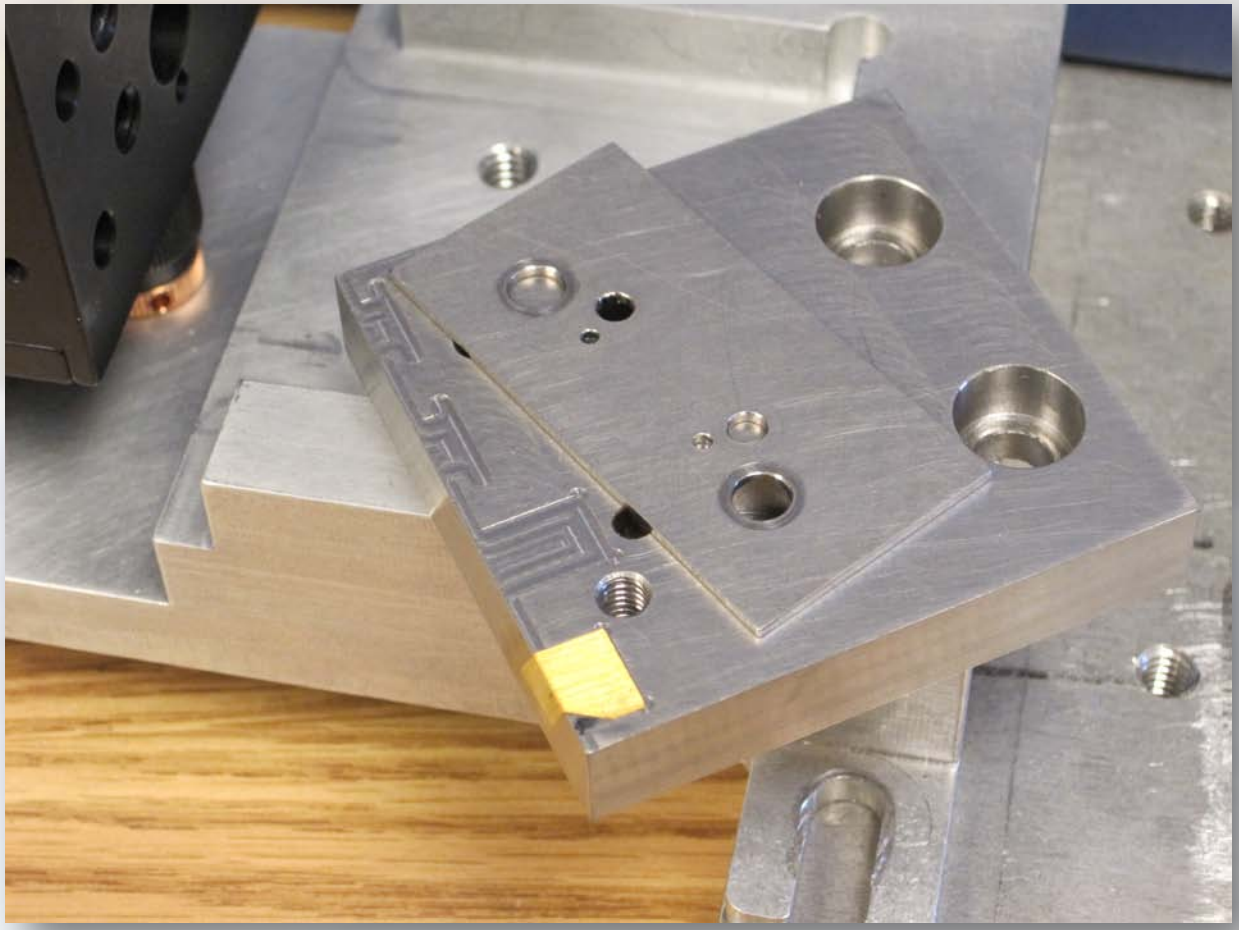


- The foil is *over bent* to allow for a metal's natural spring back

Diehl et al, Prod. Eng., 2010

The die has pockets machined into it that fit the foils precisely

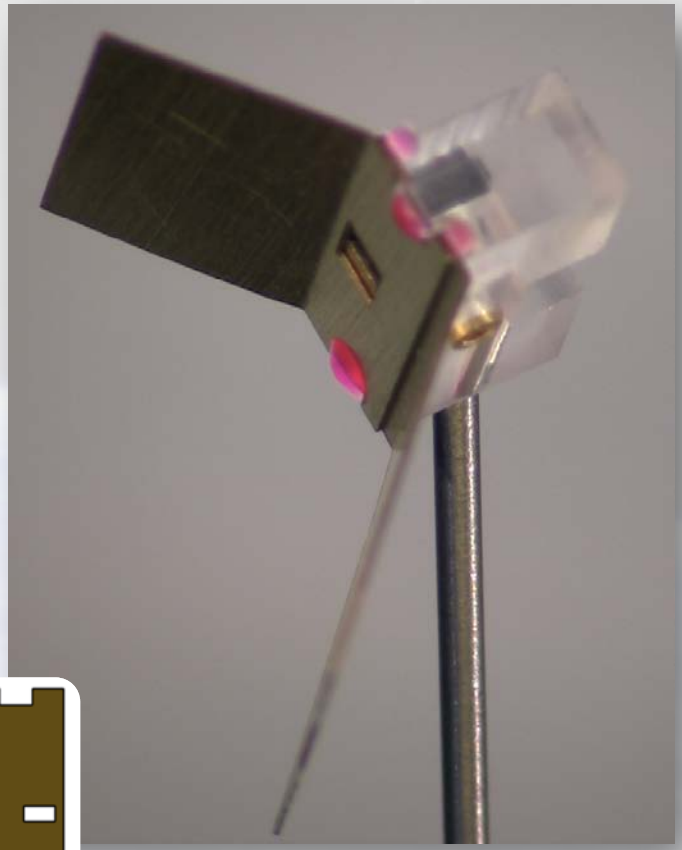




- Keying constrains the foils' from moving as the punch is brought down

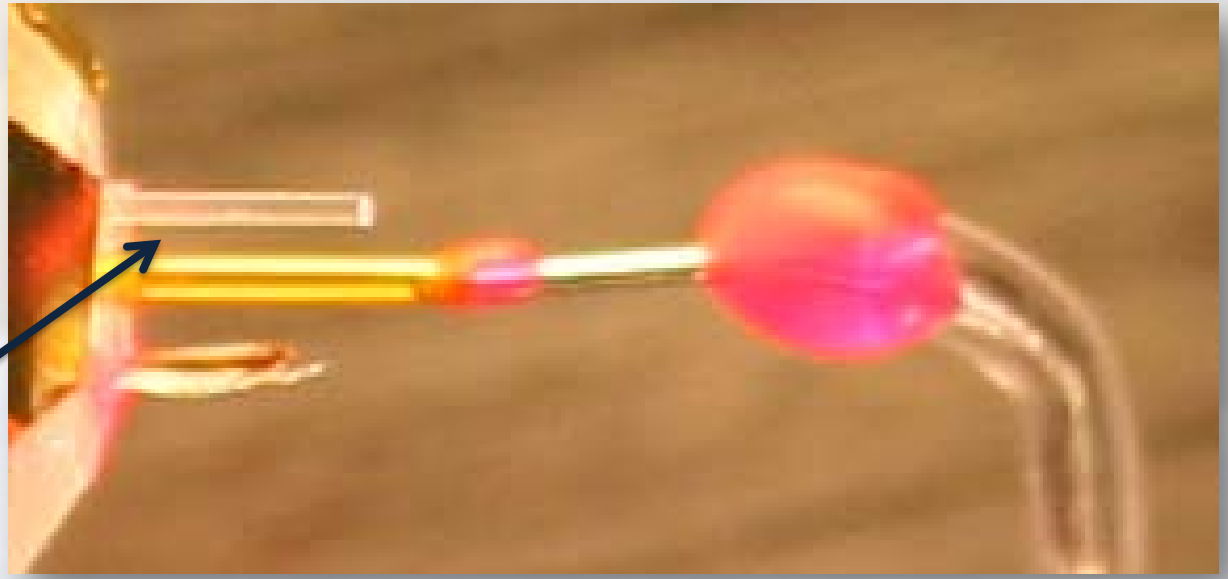
Machined acrylic bases increase our repeatability and ease overall target build

- Keying laser cut into foils while male was machined into the acrylic
- This constrained the foils, thus constraining the slits
- These keys served the dual purpose of constraining the foils during bending and during the build
- Very repeatable target



Machined acrylic bases also serve as fiducials

2010 Radiative Shock Target

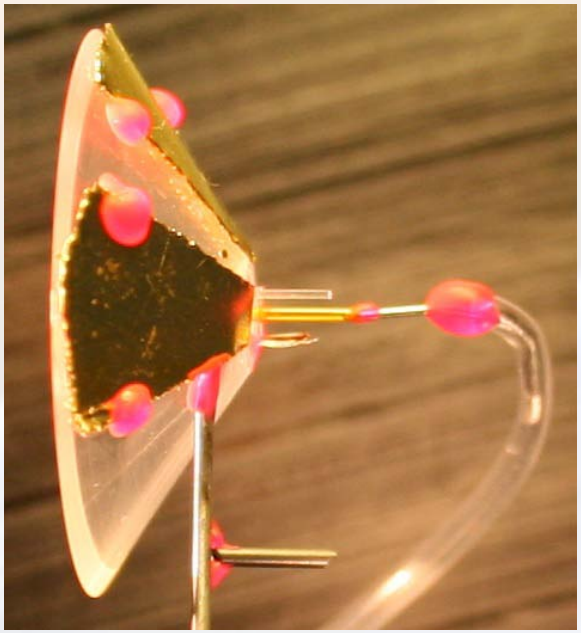


Fiducial

- Fiducial machined out of the same acrylic block as the rest of the target, therefore doesn't have to be added separately
- Repeatable in placement and length

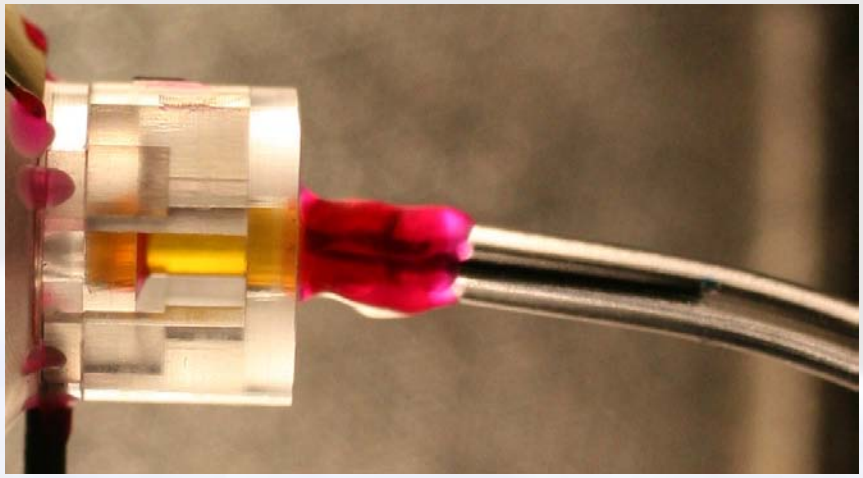
Machined acrylic can provide much needed support to delicate components

2010 Radiative Shock Target



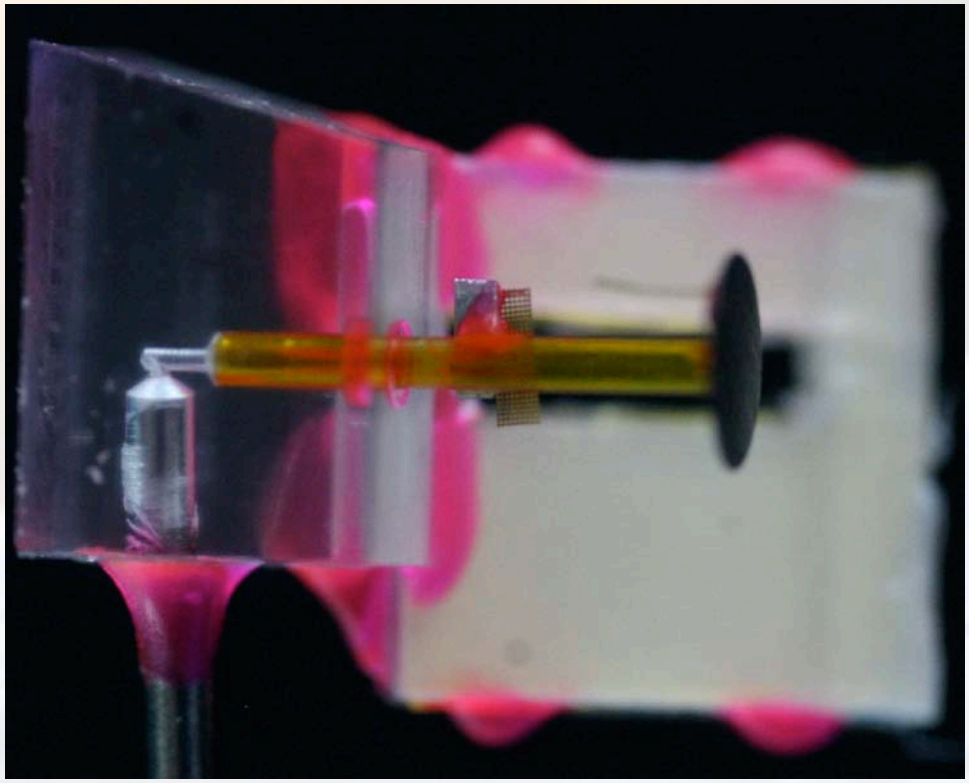
- Tube is unsupported and exposed

2011 Radiative Shock Target



- Keeps tube horizontally straight
- Tube is well protected
- Orients elliptical tube

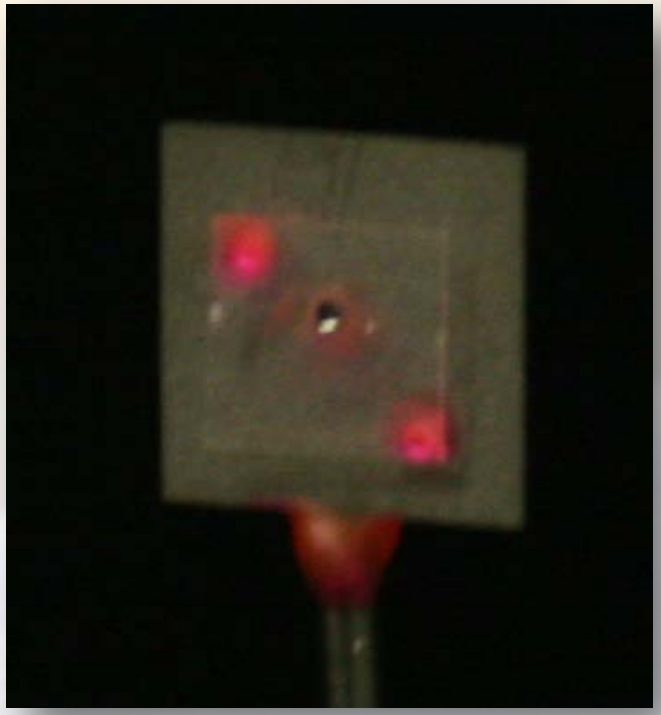
Machined acrylic also acts as a gas tight tube to allow gas fill through the stalk



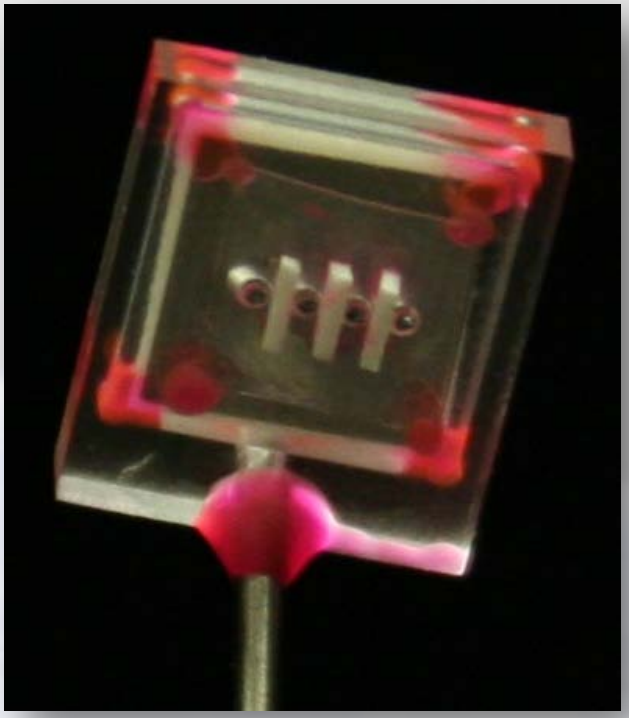
2012 Radiative Shock Target

- Filling through the stalk eliminates extra components
- It is easy to see obstructions
- Hard stops in acrylic constrain lengths of components

Acrylic frames fix stalk angles

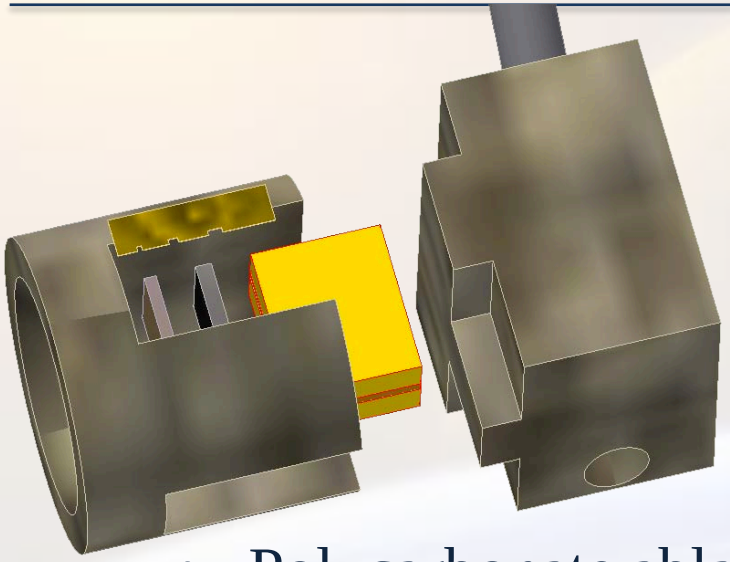


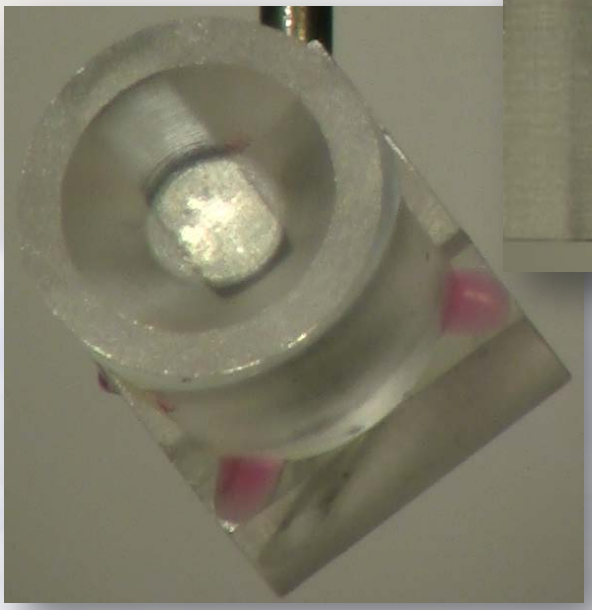
- This backlighter needs to be assembled on our system

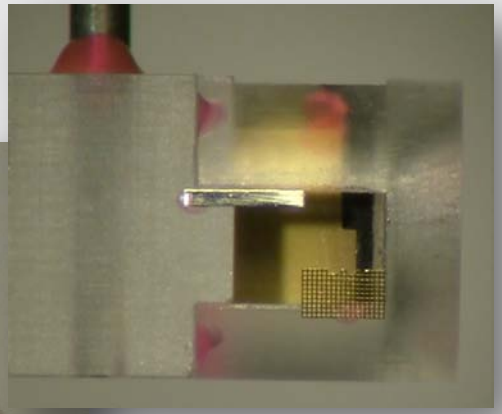


- Stalking can be done by hand

Machined structure can be part of the experimental package





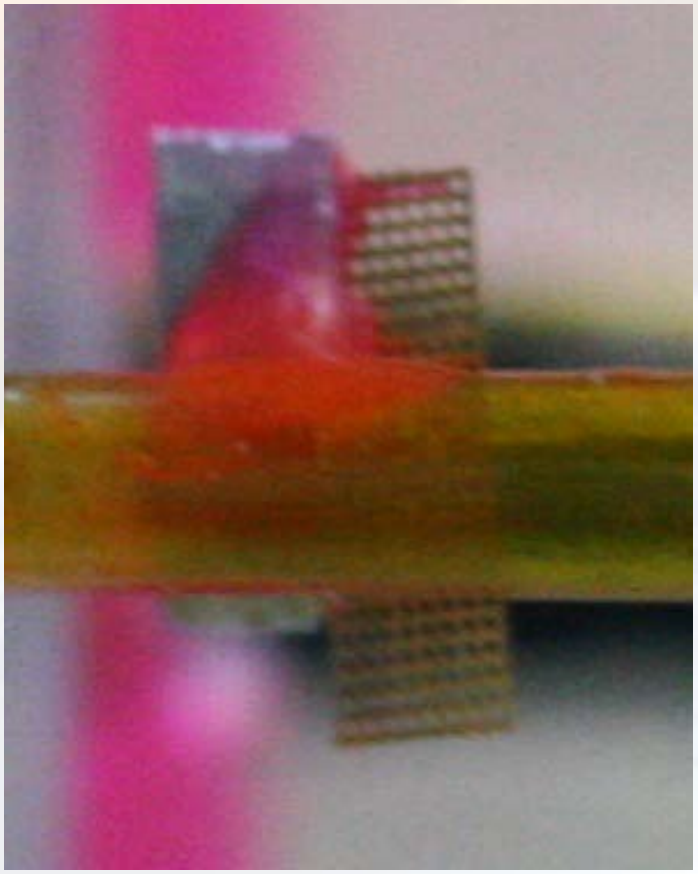


2012 Richtmyer - Meshkov Target

- Polycarbonate ablator
- Bromiated CH layer
- CRF layer
- Polyamide-imide block that has a CHI tracer strip with a multi-mode sinusoidal machined pattern provided by GA

The pink color of our glue enables us to know where it is!

2010 Radiative Shock Target



- Because the glue is opaque to x-rays and can harmfully interact with the physics, care must be taken in it's placement.
- The bright pink color ensures us that it is not blocking data or fiducials.

Conclusion

- Custom elliptical polyimide tubing allowed us to explore asymmetric shocks on xenon gas.
- Bent foils are far more efficient at shielding diagnostics from expanding plasmas and their targets are easier to build than targets with separate pieces glued together.
- We use acrylic structures that support all our target components and increase our repeatability.
- The bright pink glue used on our targets helps prevent data and fiducials from being obscured.

Niagara Falls
March 2012

Los Alamos
May 2012