Target Fabrication Developments at the University of Michigan

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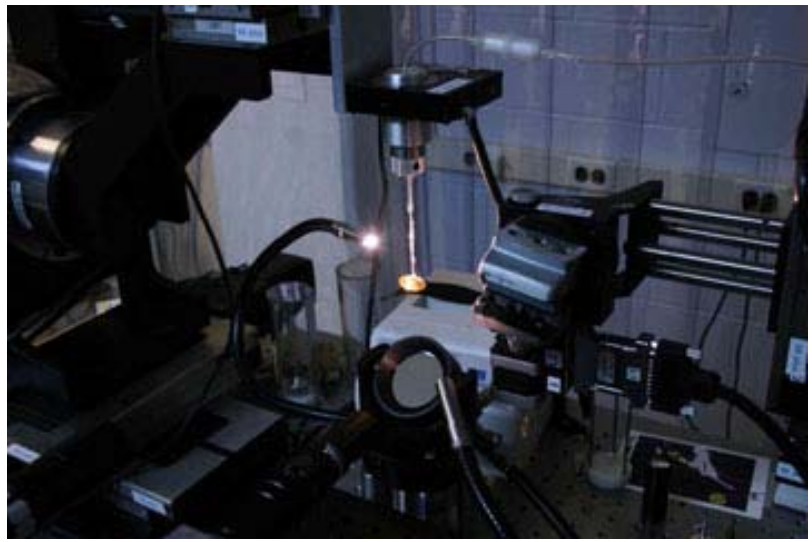
Overview

- Fabrication methods using motorized stages ensure precision-build targets
- Target designer works closely with the target fabrication team, and provides several quality assessment checks throughout the build process
- Shot campaigns began in 2003 and have continued through the present
- Significant improvements have been made in experimental design and build

Fabrication System

- 2 independent sets of motorized stages used to precisely orient the target for assembly and extensive characterization of the finished target
- 12 total mechanical stages which allow for a nearly full range of orientations
- Optics allow for resolution of movement on the order of tens of microns



Fabrication system with target attached

Typical Build Schedule

- Design
  - Fabrication team works closely with PIs to develop experimental targets and suggest ways to improve designs given fabrication capabilities
- Material Preparation and Ordering
- Assembly
  - PIs have consistent access to fabrication team throughout the build, which allows for improvements of target design in mid-build
  - Quality assessment checks throughout build allow for targets outside spec to be discarded and rebuilt as needed
- Metrology

Experimental Campaigns

- SuperNova Rayleigh-Taylor (SNRT)
  - CC Kuranz and RP Drake
  - May 2008
- Radiative Shock Dynamics
  - FW Doss and RP Drake
  - July 2008, October 2008
- Thomson Scattering Off Radiative Shock
  - A Visco, CM Huntington, and RP Drake
- Kelvin-Helmholz Experiments
  - EC Harding and RP Drake
  - December 2007

First Generation Target Images

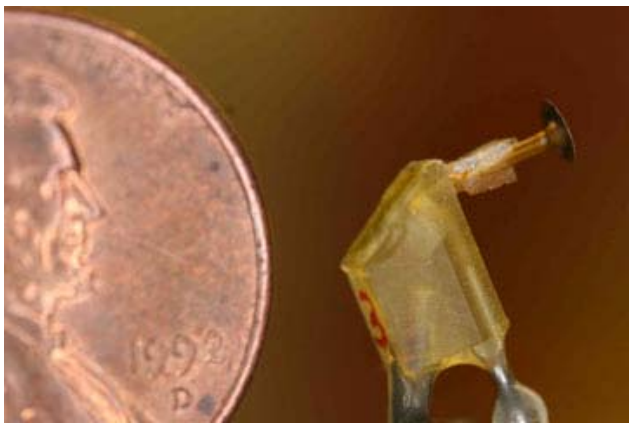
August 2004 SNRT target

August 2005 Thomson scattering target

Second Generation Targets

May 2006 SNRT Target

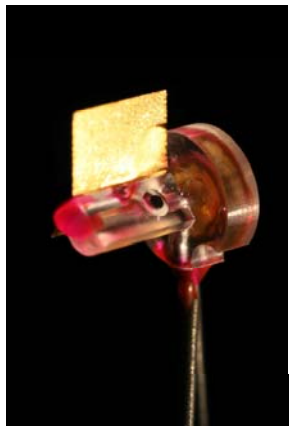
December 2006 SNRT Target



August 2006 SNRT Target

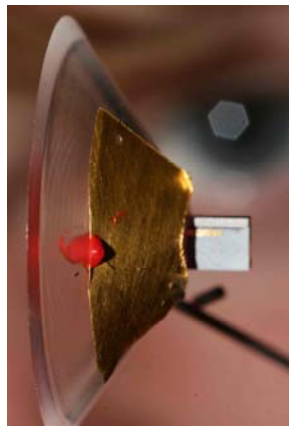
March 2007 SNRT Target

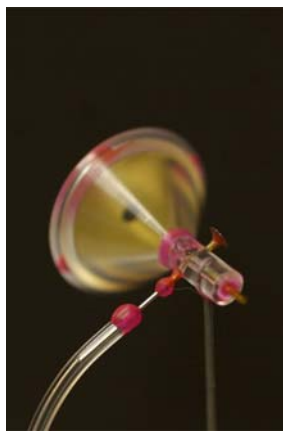
Recent Target Images



January 2008 Thomson Scattering Target

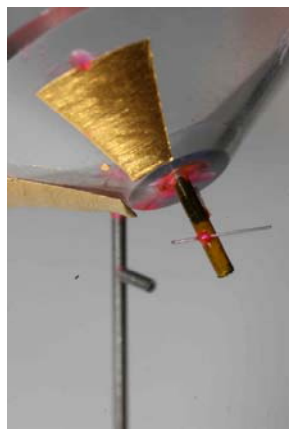
May 2008 K-H Target





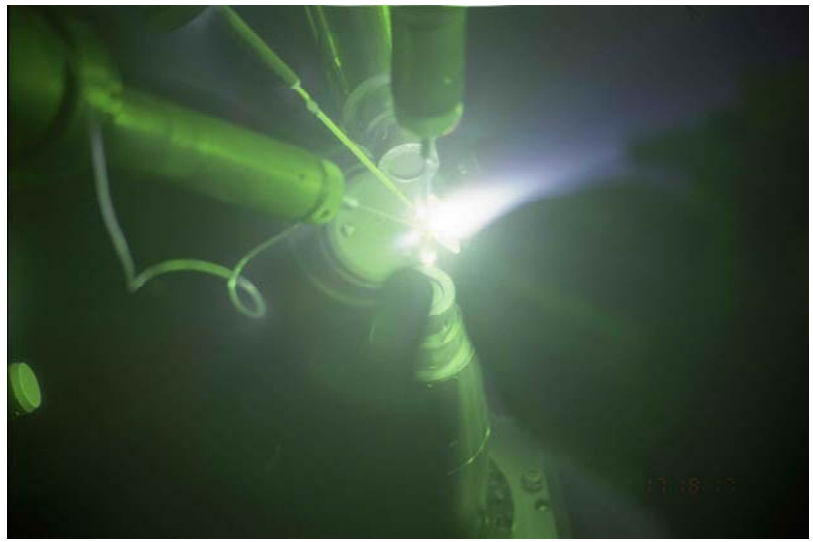
March 2009 Thomson Scattering Target

May 2008 SNRT Target



Experimental Success

- Successfully built targets over a wide range of designs for more than 15 experimental days on Omega
- Obtained some of the best radiographic data of blast-wave-driven Rayleigh-Taylor instability growth and radiative shocks in laser experiments
- Developed accurate fabrication techniques that ensure consistently built targets



Visible light image of radiative shock experiment on Omega

Acrylic Shields

- Changed from using gold shields to using machined acrylic
  - Allowed for added precision in assembly
    - Features could be added to improve consistency
    - Countersinks allow for greater positional accuracy and relative angular precision
  - Improves alignment methods
    - Translucence gives more options and better views of targets
    - Precision machining of features onto the shield can be given reticules and will have high degrees of consistency
  - Gold wedges attached to outsides of the shield block the diagnostics from emission near drive surface

Stalks As Gas Fill Line

- Used stalks for filling targets with gas instead of attaching fill tube to the target body
  - Used hollow tubes as stalks to connect shield to the Nova mount
  - Nova mounts then adapted to allow for gas feed line to attach and be gas tight
  - Countersink in shield for inserting the stalk also has 50 μm hole to drive tube
  - Gas travels into the Nova mount, up the stalk and into the drive tube
- Removes stress on the target from having the long tube attached to it.
- Disadvantage is that it requires a small hole in the side of the drive tube - some concern about its effect

Frames for Dual Radiography

- Single acrylic frame for attachment of tantalum pinholes for radiography
- Improves overall alignment accuracy in the same manner as the shields for the targets
- Greatly decreases alignment time for dual radiography by decreasing the number of targets to align
- Loses ability to individually align backlighters
  - Impacted the quality of some images on October 2008 dual radiography campaign

Various Other Improvements

- Colored UV-cure epoxy
  - Glue visibility allows us to ensure relevant areas are clear of glue
  - Pink epoxy helps when building gas-tight targets to ensure all necessary connections are well-sealed
- X-ray calibration feature
  - Adding a component with accurately known opacity in view of our diagnostics allows us to calibrate the density in radiography images
- Tungsten carbide stalks
  - More consistent than glass pipettes, tungsten carbide rods can also serve the dual purpose of a gas-fill hose

Metrology

- Fabrication system allows for extensive characterization of the targets before experiment
- Quantifies all important measurable initial conditions of the experiment
- Targets found to be out of spec can be repaired or rebuilt in a timely fashion in order to meet strict timelines
- New advancements in target design and material development has noticeably improved alignment precision and general build accuracy
  - While this has been noted, it has not yet been fully quantified at this time
  - Existing metrology data from previous experiments can be used to further review this

Review

- We have made several advancements in target design
- Our fabrication techniques allow us to adapt to new designs while maintaining accuracy and repeatability
- Target designs are evolving to incorporate new diagnostics
- Further improvements are being developed for advancing current target designs