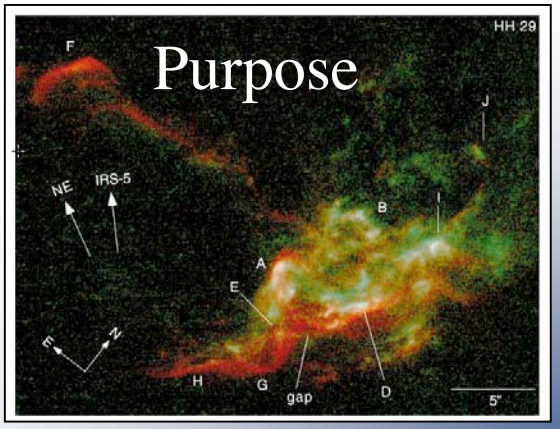
Target Basics

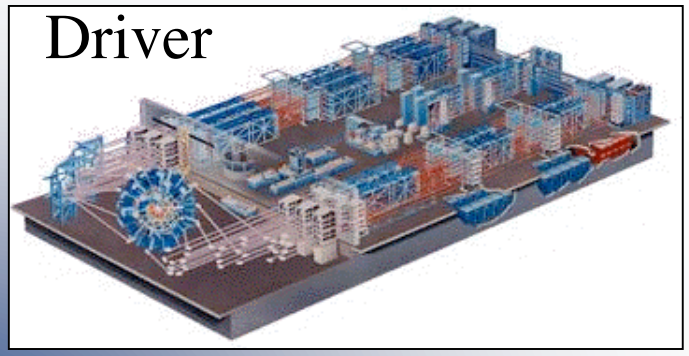
Brent Blue
General Atomics

Omega Laser Facility Users Group Workshop
April 28th, 2010

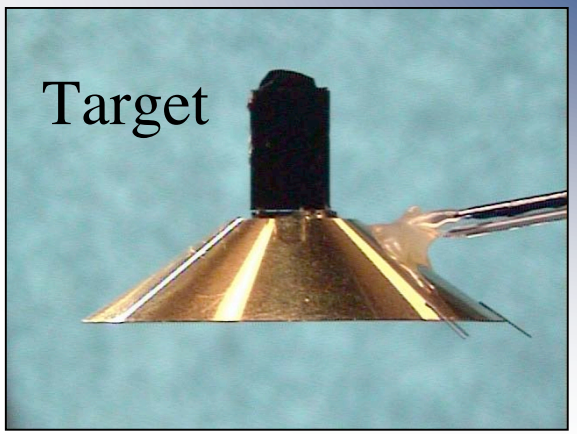
GENERAL ATOMICS

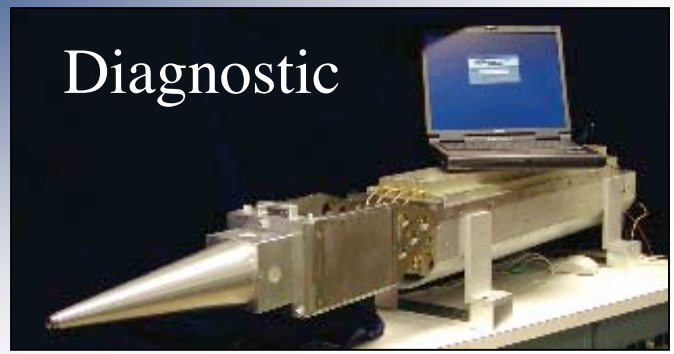
What makes a successful experiment?





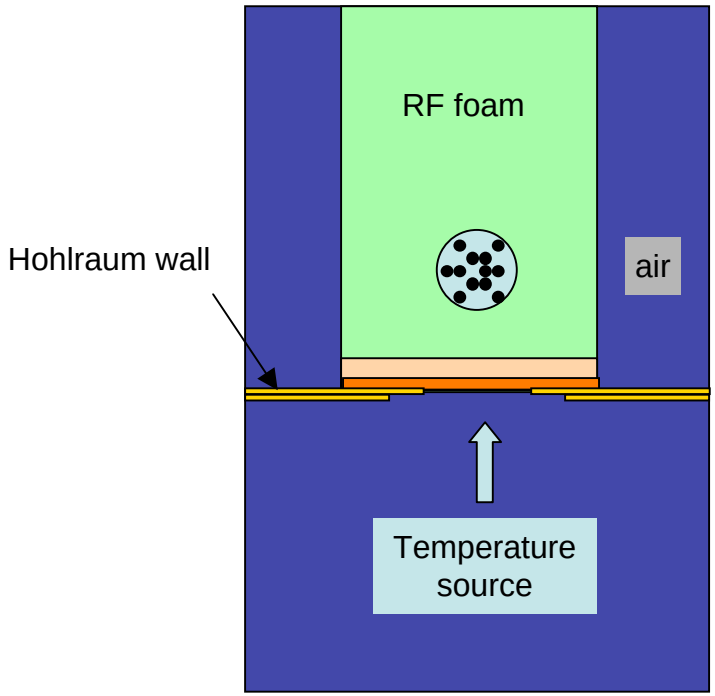
Results



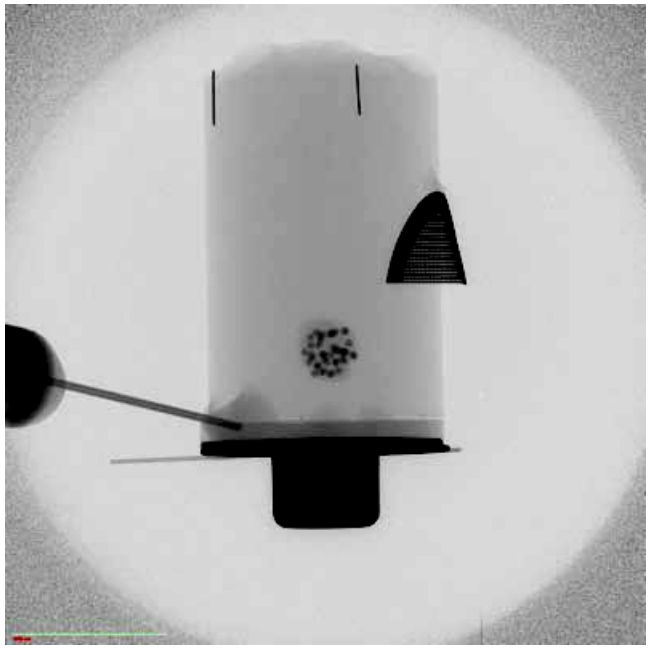


Knowledge of a real target is critical to experimental success

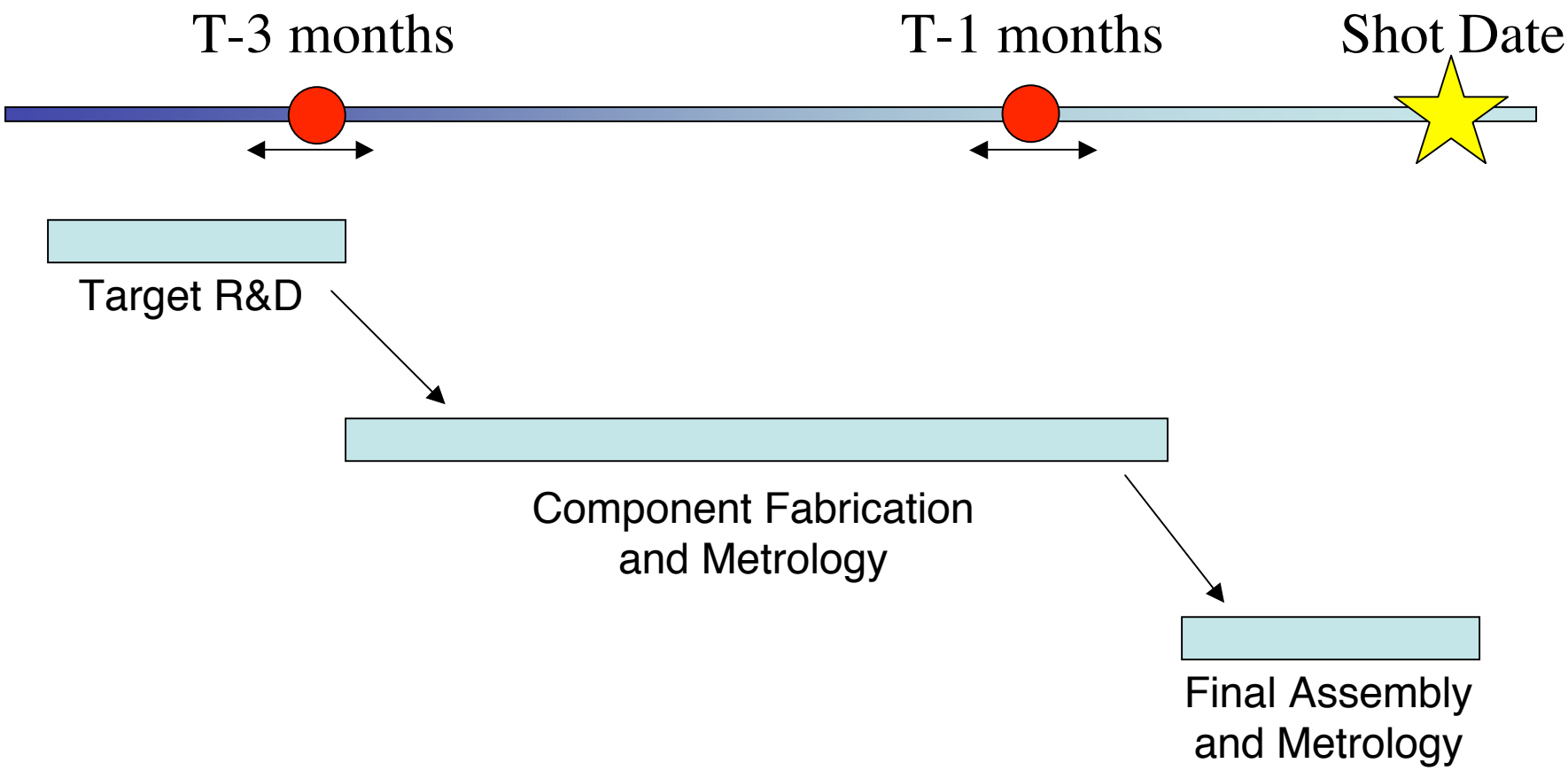
Simulation



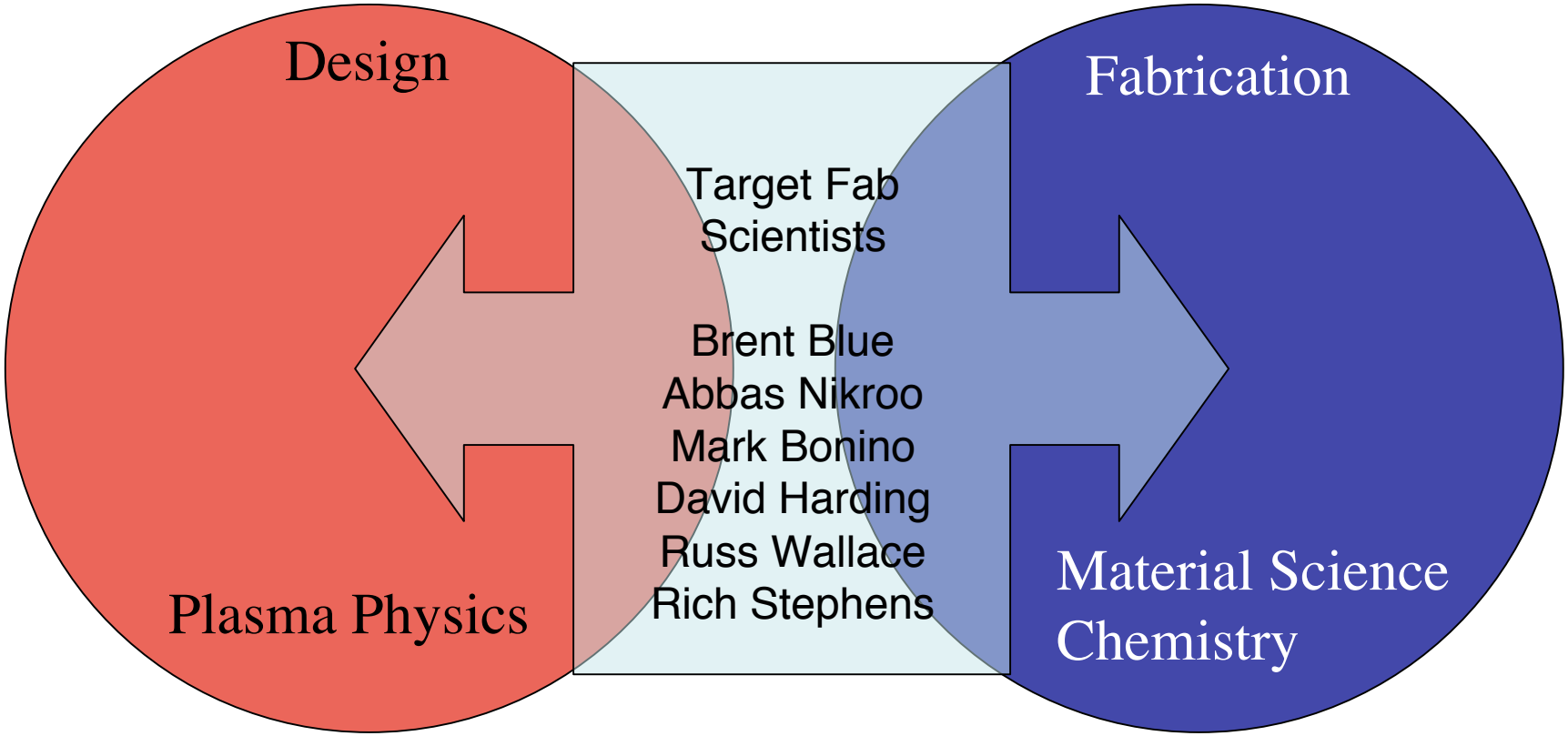
Experiment



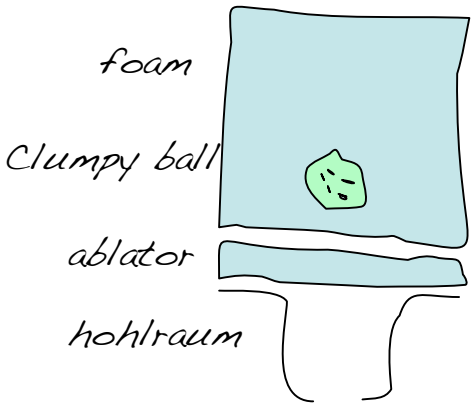
R&D is the first step in the target production timeline

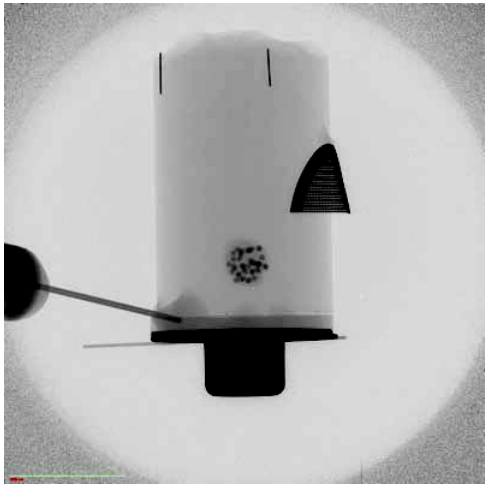


Engage target fabrication early



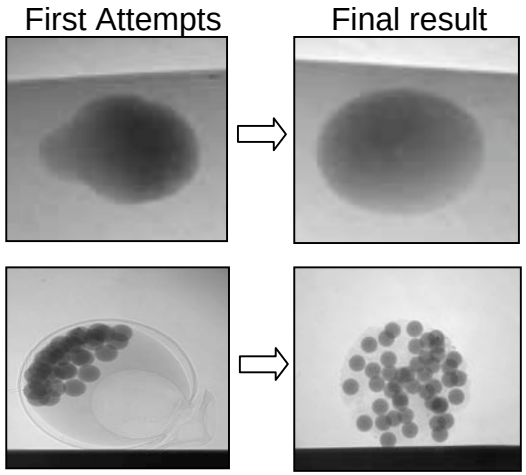
NLUF AstroShock targets required significant R&D to determine if we could even make the targets

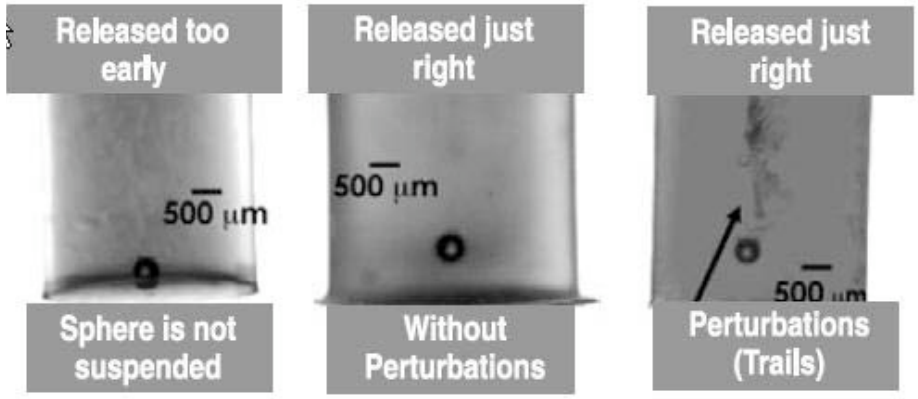




Dispersed
- uniformity
- shape

Clumpy
- random distribution

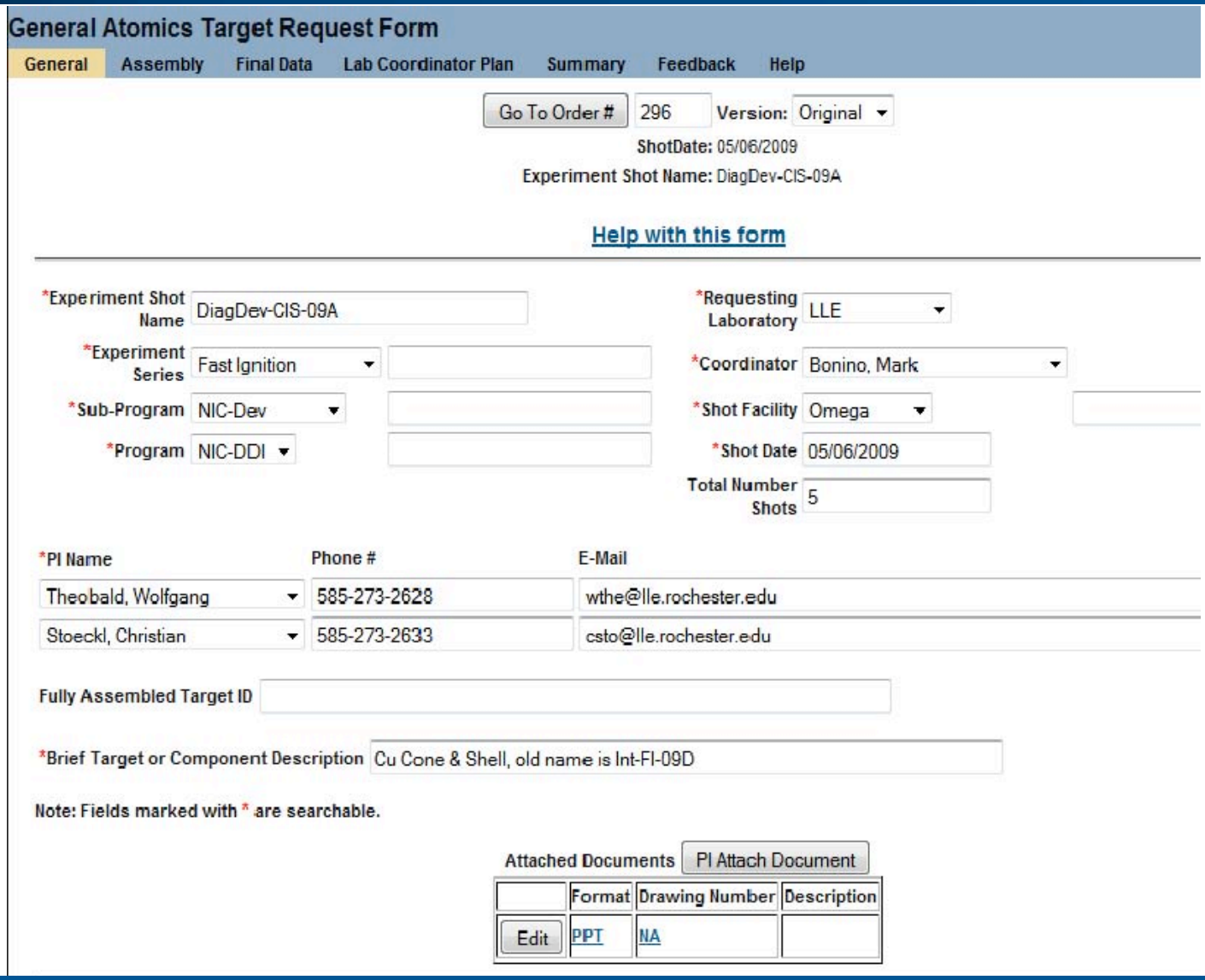




It's now time to specify the target

- Design Finalized!
- We know that we can make it
  - All R&D completed
- Enough time to make, nominally 3 months
  - Can be longer for complex parts
- All parameters specified
  - Dimensions
  - Materials
  - Tolerances
  - Metrology

OMEGA target request process starts with the target request form: TRF



General Atomics Target Request Form

General | Assembly | Final Data | Lab Coordinator Plan | Summary | Feedback | Help

Go To Order # 296 Version: Original

ShotDate: 05/06/2009

Experiment Shot Name: DiagDev-CIS-09A

Help with this form

*Experiment Shot Name: DiagDev-CIS-09A

*Requesting Laboratory: LLE

*Experiment Series: Fast Ignition

*Coordinator: Bonino, Mark

*Sub-Program: NIC-Dev

*Shot Facility: Omega

*Program: NIC-DDI

*Shot Date: 05/06/2009

Total Number Shots: 5

*PI Name	Phone #	E-Mail
Theobald, Wolfgang	585-273-2628	wthe@lle.rochester.edu
Stoeckl, Christian	585-273-2633	csto@lle.rochester.edu

Fully Assembled Target ID

*Brief Target or Component Description: Cu Cone & Shell, old name is Int-FI-09D

Note: Fields marked with * are searchable.

Attached Documents | PI Attach Document

	Format	Drawing Number	Description
Edit	PPT	NA	

OMEGA target request process starts with the target request form: TRF

Component Type | Fab. Center | Best Effort

Order: GA / Non-GA | None

General Descriptor | WONO

Primary Descriptor | GA Order

Usage: External / Internal | Customer #

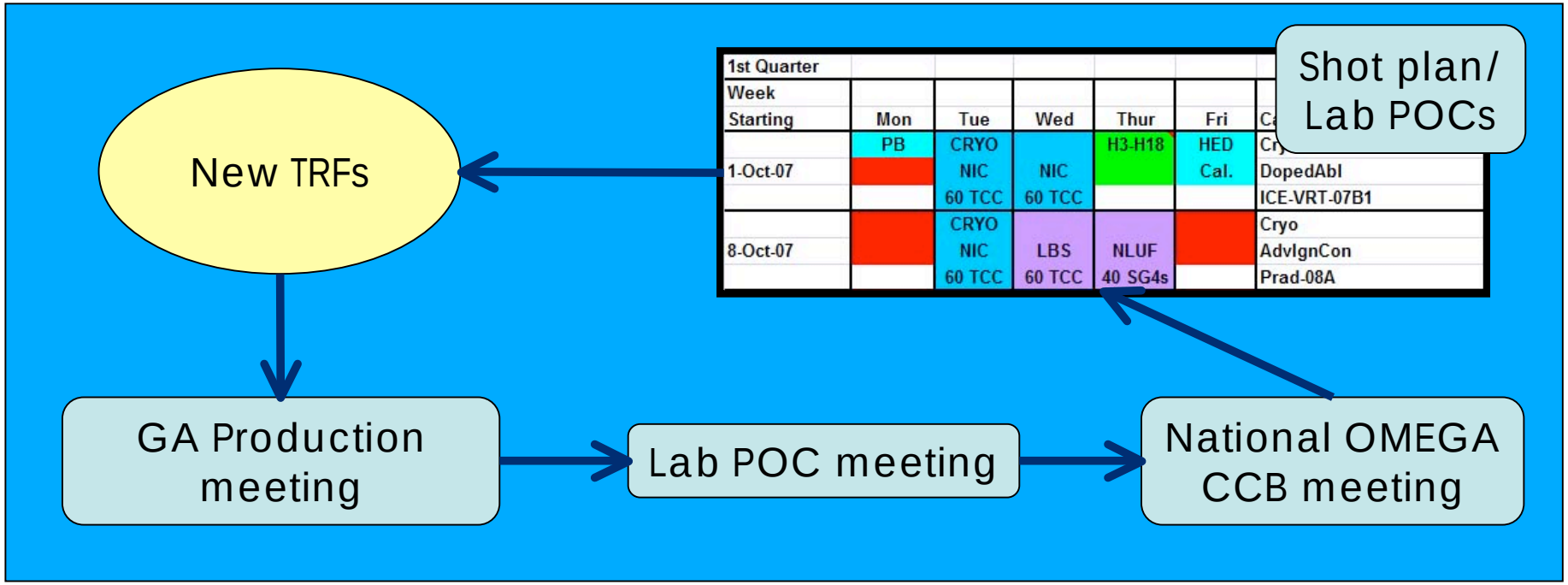
Edit/Add | Remove | Clear Edit Area

Check here if any component requires assembly

	GA	Fab Center	Component Type	General Descriptor	Primary Descriptor	Group	Secondary Descriptor	Due date	Qty.	Usage	Best Effort	WONO	GA Order	Cust. #		
Edit	GA	IDC	Capsule	CH	CHsingle	A	40 micron SCD to CPM, 2 racks of 12	03/06/2009	24	Internal	None	C30272-9570	IDC-LLE-296-Int-FI-09D Rev 0		Order Specs	Status
Edit	GA	IDC	Capsule	CH	CHsingle	A	40 micron SCD for TCC and neutronics reference	04/06/2009	7	External	None	C30272-9570	IDC-LLE-296-Int-FI-09D Rev 0		Order Specs	Status
Edit	GA	CPM	Micromachining	Cone/Shield	Cone	A B C	20 mic thick Cu Cone 25 mic thick Cu Cone 30 mic thick Cu Cone	04/13/2009 04/13/2009 04/13/2009	5 5 5	External	None	C30272.9490	COM-Int-FI-09D Cone & Shell	Int-FI-09D	Order Specs	Status
Edit	GA	DDC	Capsule	Cryo	SCD	A	CD shells	04/16/2009	6	External	None	C30272 3020	DDC 296 DiagDev-CIS-09A		Order Specs	Status

Clear | Query | Update | Save as New

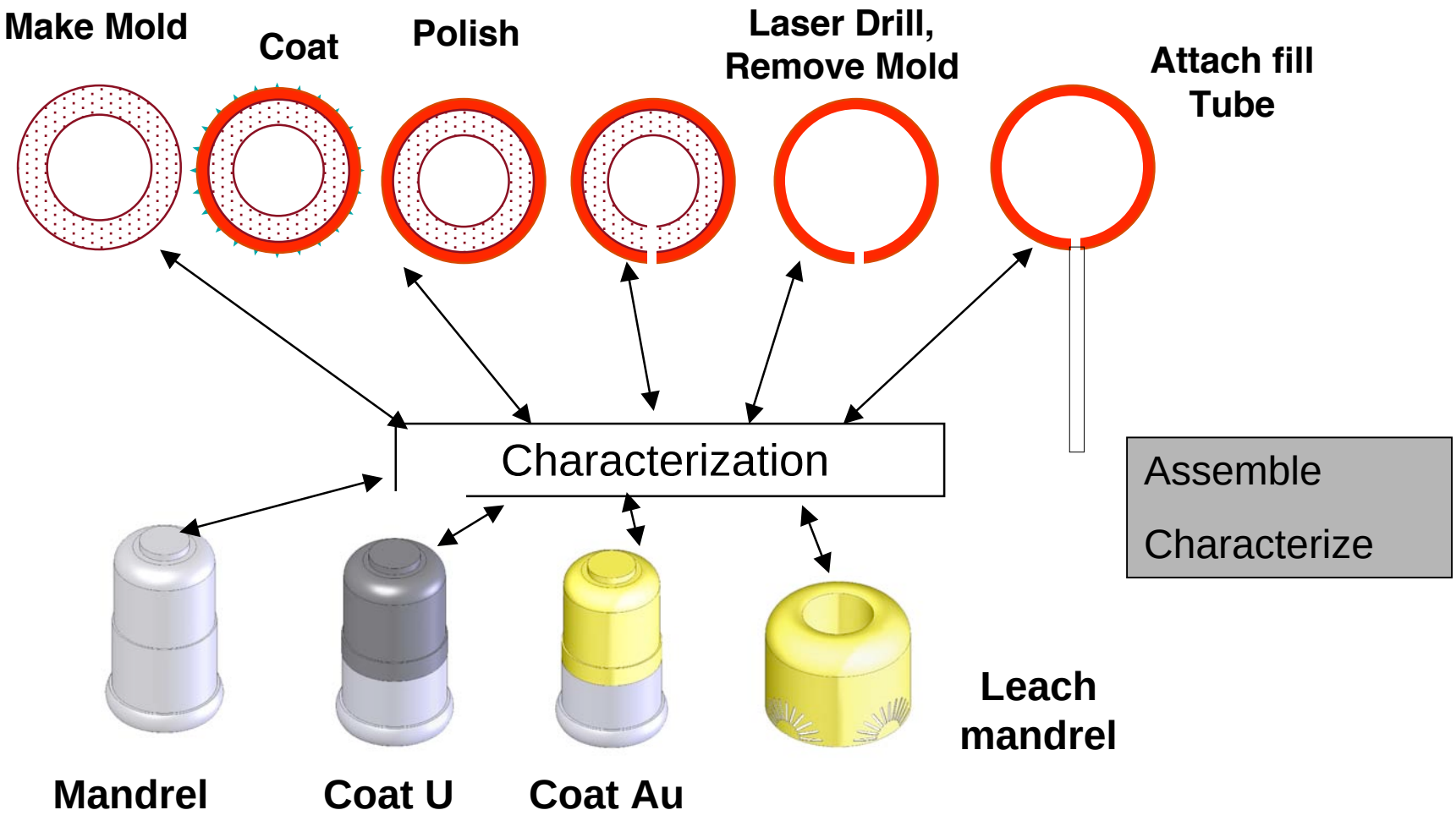
High level scheduling completed in close partnership with laboratory POCs, TFEs, and PIs



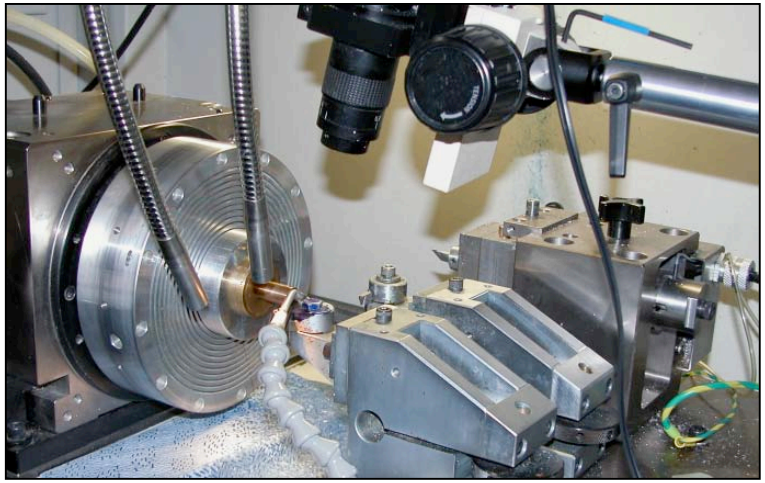
OMEGA change control board process

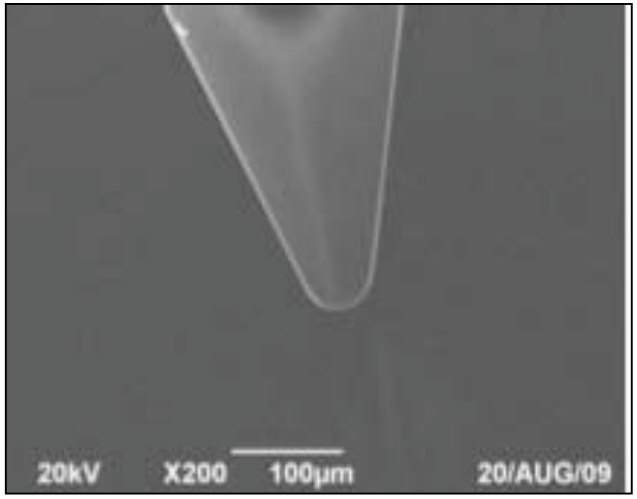
- **Discuss all OMEGA targets:**
  - **Track status**
  - **Flag and resolve issues**
  - **Planning**

Hohlraum and capsule production require precision mold manufacture, diverse coating and multi characterization capabilities



Diamond turning machining, capable of sub-micron accuracy





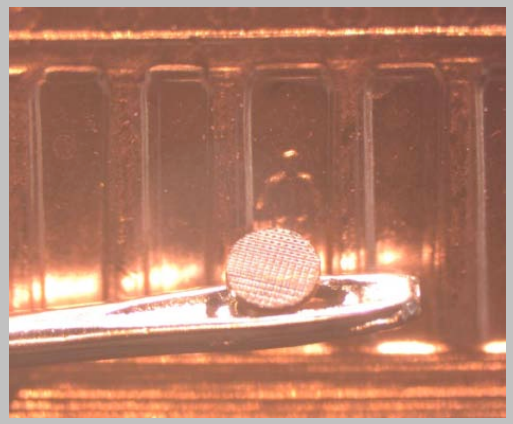
GA has 9 diamond turning lathes

7 General purpose

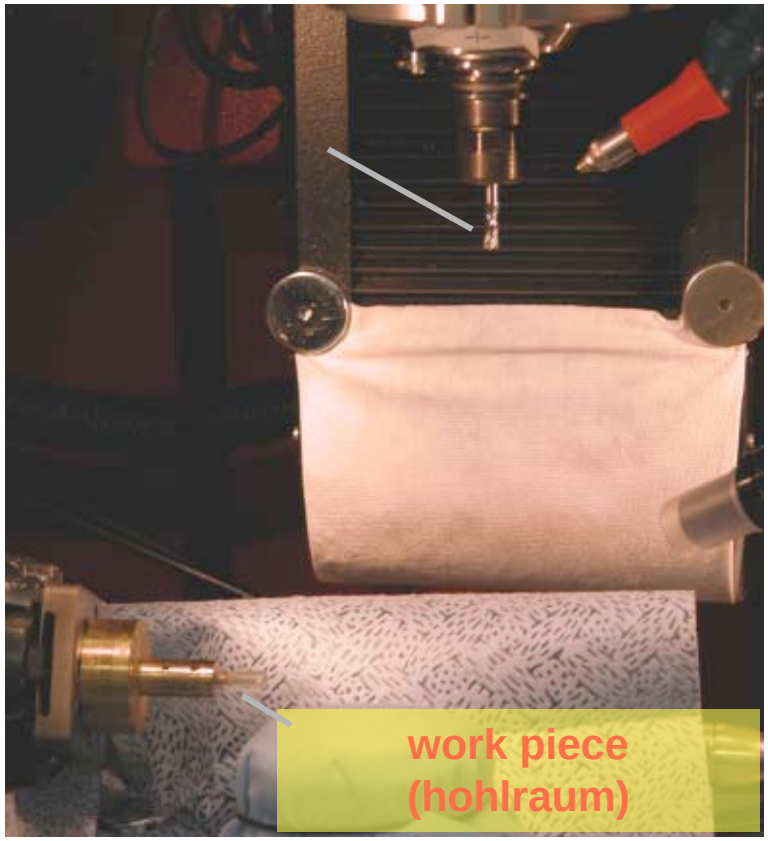
1 Beryllium

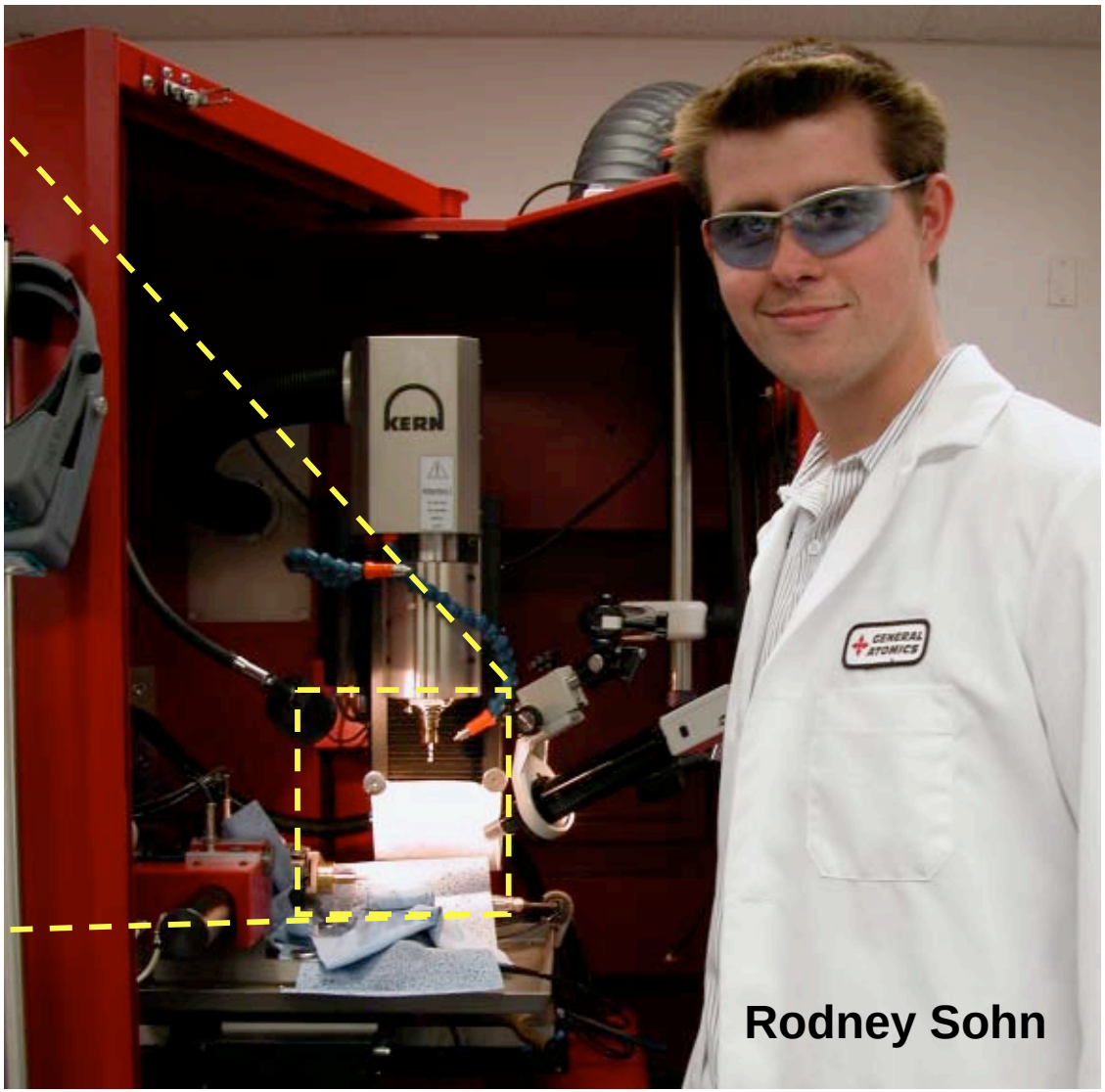
1 Uranium

SNRT target on the back of a penny



Precision milling allows us to make 3D shapes with micron accuracy





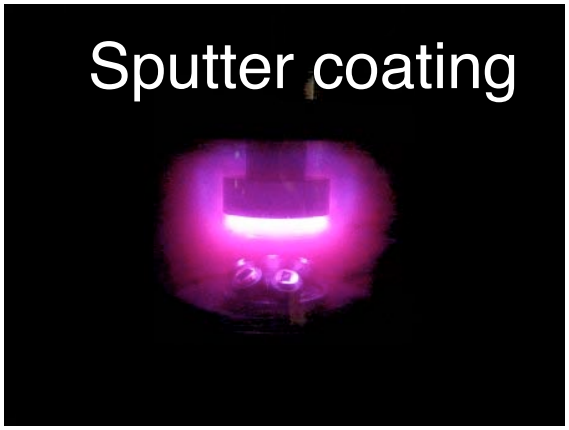
Sample of component variety shipped Q1-FY09

http://fusion.gat.com/ift/ICF_Catalog/index.html

Many elements and compounds can be coated onto targets

Aluminum
Boron
Boron Carbide
Boron Nitride
Carbon
Chromium
Copper
Dysprosium
Gadolinium
Gold Boron
Iridium
Iron
Manganese
Molybdenum
Neodymium
Nickel
Scandium
Silicon
Silver
Silicon Dioxide
Tantalum
Tellurium
Tin
Titanium
Titanium Dioxide
Tungsten
Vanadium
Zinc

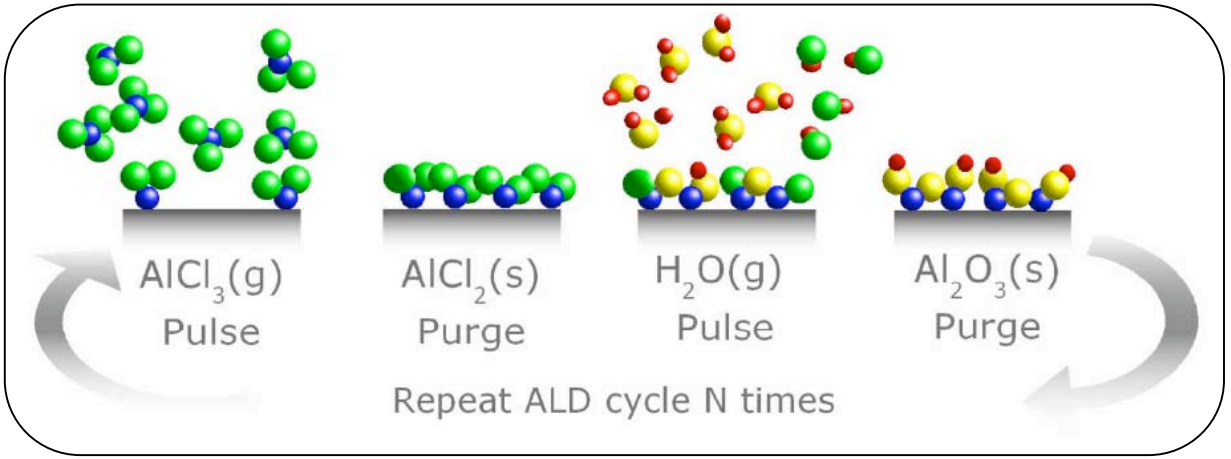
Sputter coating



Electroplating

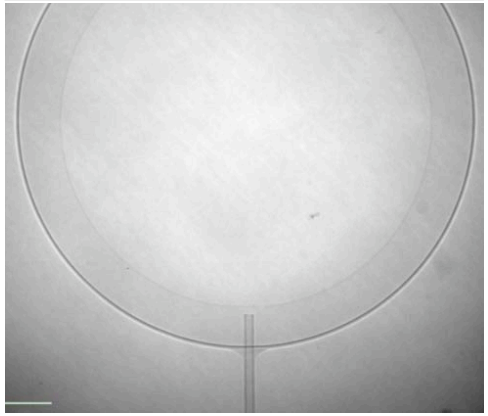
Gold
Copper

Atomic Layer Deposition (ALD)



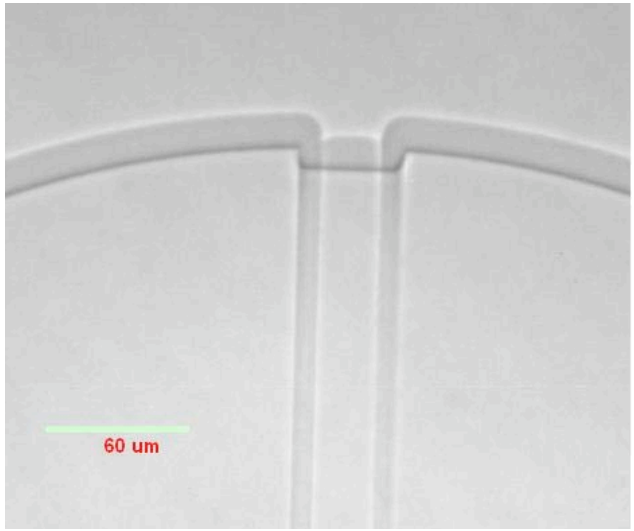
GA produces many plastic, glass, foam, and Beryllium capsules

Foam capsules with fill tube for FoamImp



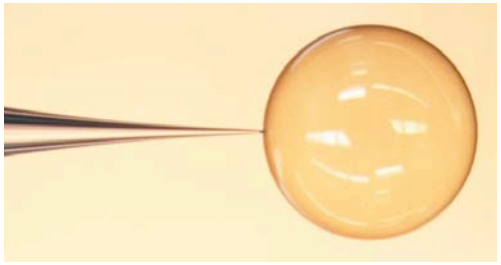
Capsule and cone for Fast Ignition

Inner trenched capsule for DImE



Double Shell for DynHohl

NIF Direct Drive Fill Tube Target

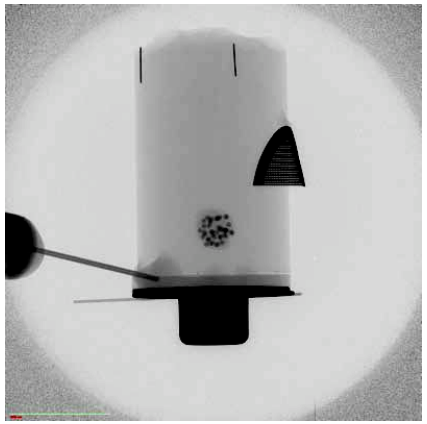


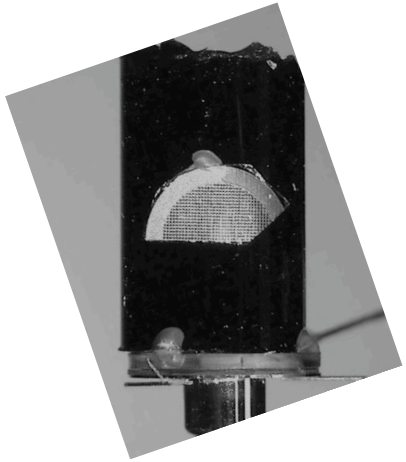
Cryo shell for NIC

Metrology: the final critical fabrication step

Group B — Clumpy Aluminum Oxide Ball Target

No.	Specification	Value	Specification Tolerance ±	B1	B2	B3	B4	B5	B6	Meas. Error ±	Note
1	Foam Density (mg/cc)	300	30	296	296	296	296	294	294	4	Batch average: Measured on 2 witness pieces of foam for each batch
2	Z Distance from center of ball to drive face (um)	900	200	980	1117	1159	1113	976.3	885.32	10	Measured by radiography
3	Distance of ball center from axis of foam (um)	0	500	346	269	178	82	384.45	254.75	20	Measured by radiography
5	Diameter of Foam Cylinder (mm)	3.9	0.2	3.92	3.84	3.91	3.88	3.69	3.69	0.02	
6	Minimum Length of Foam Cylinder (mm)	5	1	6.0	6.1	5.7	5.8	5.9	5.4	0.1	Length must be >4000um, foam may have rough edge on the end of the foam (but drive face will be smooth)
7	Maximum deviation from Flatness (um)	<30									Best effort; Measured on drive side face on a sampling of targets at Alberquerque
8	Ball clump/distribution diameter (um)	1000	NA	1172	1035	1063	1062	911	903	200	
10	Number of balls in clump (#)	46	5	37	46	21	34	30	43		
11	Ball diameter (um)	130	NA	130	130	130	130	130	130		
	ball material	Ruby (Al_2O_3 + <0.05% Cr)									
	Batch ID Number			RF090616-A	RF090616-B	RF090616-C	RF090616-D	RF090430-B	RF090430-D		



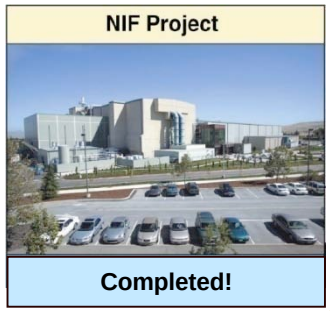


Know what you are shooting before the shot

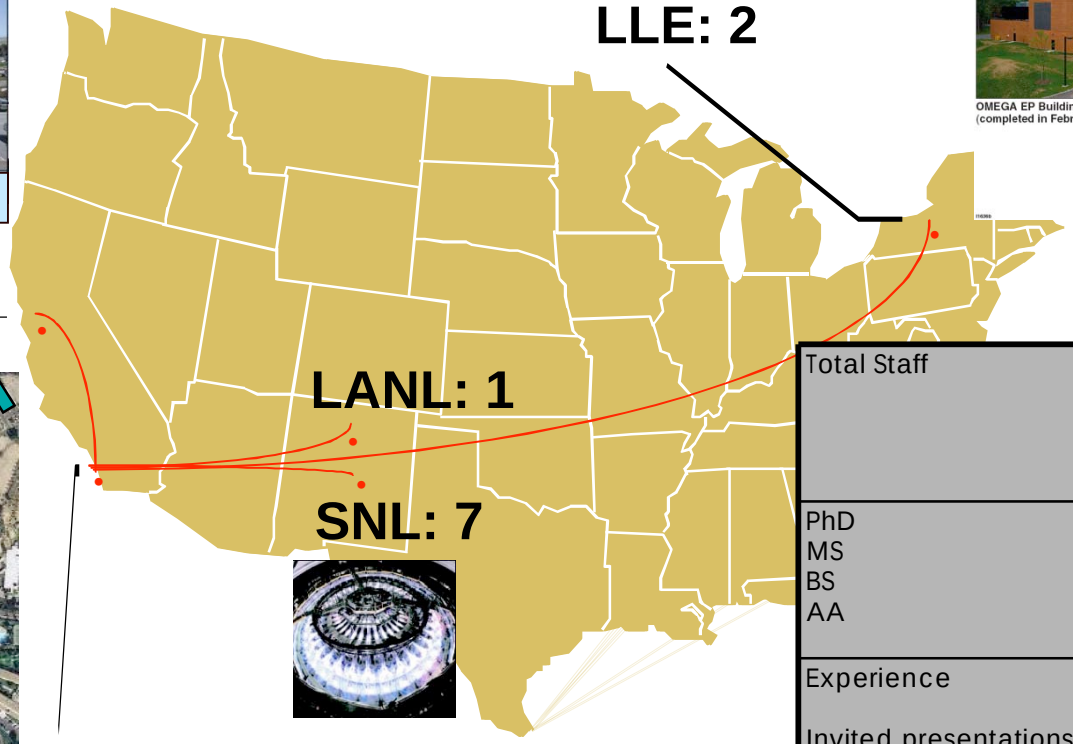
Target destroyed

Can't go back

General Atomics IFT has an experienced ICF target fabrication team



LLNL: 10

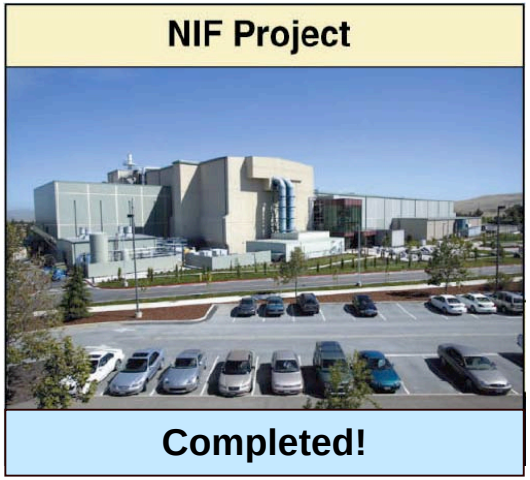


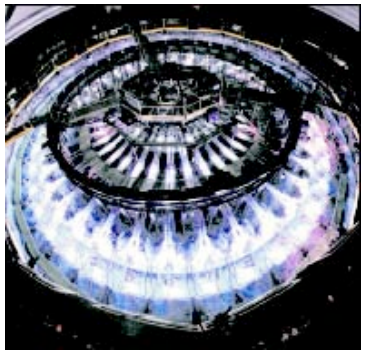
Total Staff	100 GA and subs 22 Students/Interns 3 Consultants 10 collaborators
PhD MS BS AA	22 10 27 27
Experience Invited presentations Peer-reviewed publications	~ 900 person-years 7 (2007-08) 231 since 2000

GA staff are both in San Diego and onsite at various facilities

GA produces targets for all the major NNSA ICF facilities

- Three major new ICF facilities





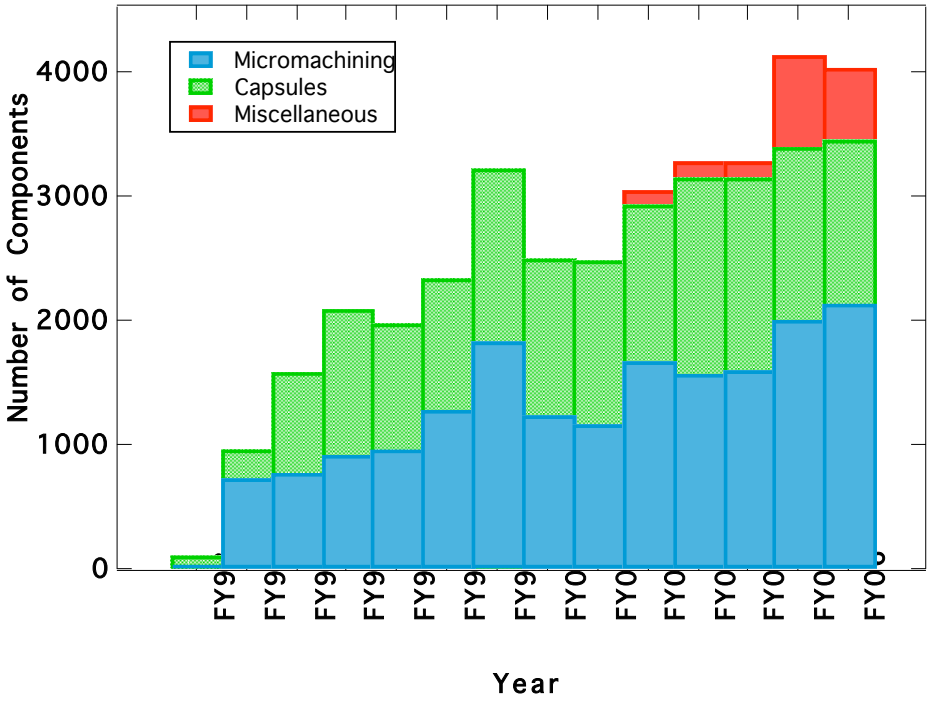
Z-R

- The facilities use thousands of high precision targets/year
  - OMEGA ~ 4000 targets/year
  - ZR ~ 200 targets/year
  - NIF ~ many hundreds targets/year

GA has over 19 years of ICF target fabrication experience

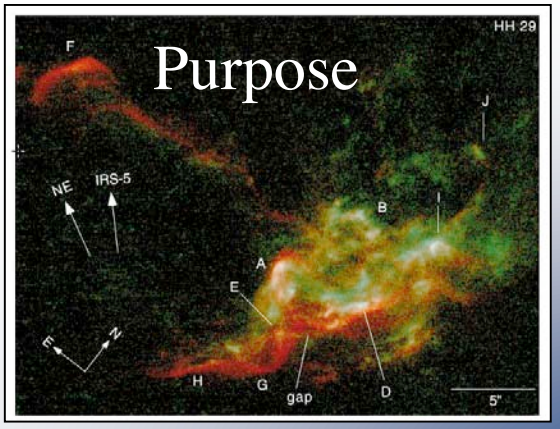
GA annually produces thousands of components for OMEGA under a stringent Quality Management System

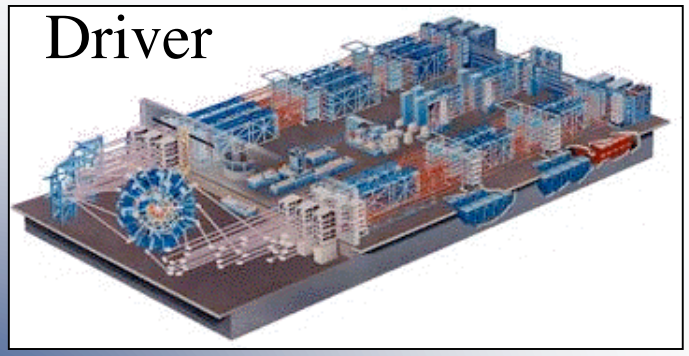
- Reliable fabrication of 4,000 components/year for ~70 categories
- ISO 9001:2000 sets a management structure
  - Customer interactions
  - Change controls
  - Documented work procedures
  - Regular internal/external audits
  - Quality Control
  - Staff training and publications
  - Quality Assurance
  - Management Review



Continual Improvement is a Key Objective

Quality targets for quality experiments





Results