Target Fabrication at Lawrence Livermore National Laboratory

23rd Target Fabrication Specialist Meeting
Annapolis, Maryland
April 23rd, 2019

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for LLNL Target Fabrication Group

LLNL-PRES-956011

Lawrence Livermore National Laboratory

Reliable *target production* with the associated *science and technology* development is a critical part of the stockpile stewardship mission

NIF

Omega

Z

As well as smaller facilities (JLF, etc.)

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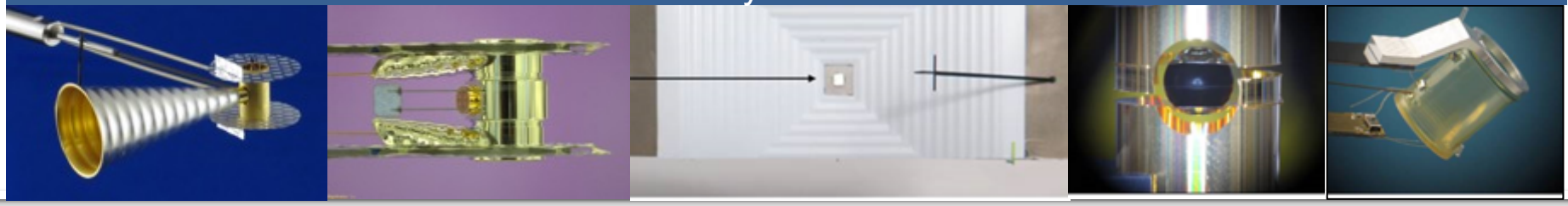
HED Physics and ICF



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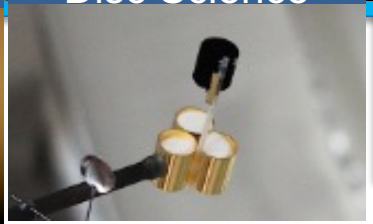
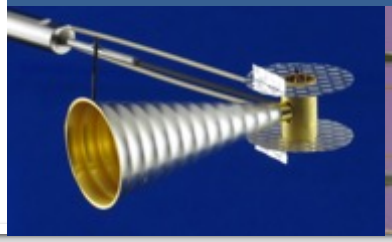
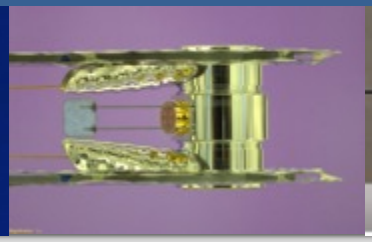
Nat. Sec. Apps

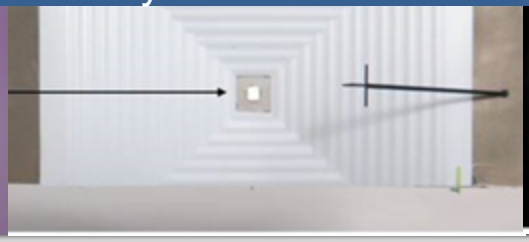
Disc Science

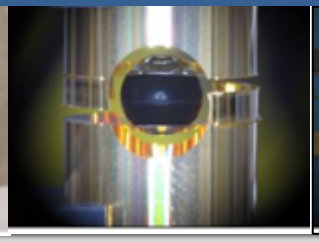


HED Physics and ICF









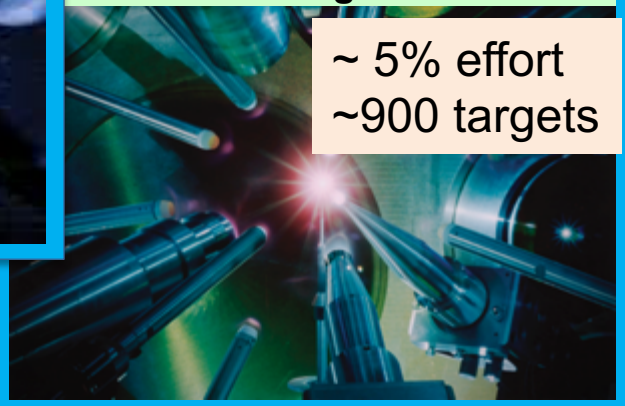
Reliable *target production* with the associated *science and technology* development is a critical part of the stockpile stewardship mission

NIF

~ 90% effort
~ 500 targets

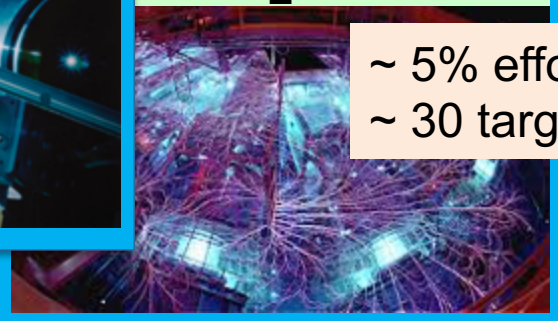
As well as smaller facilities (JLF, etc.)

Omega



~ 5% effort
~900 targets

Z



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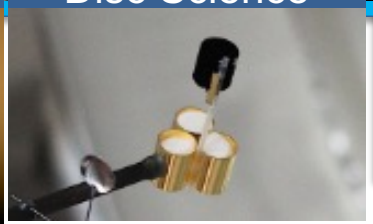
Nat. Sec. Apps

Disc Science



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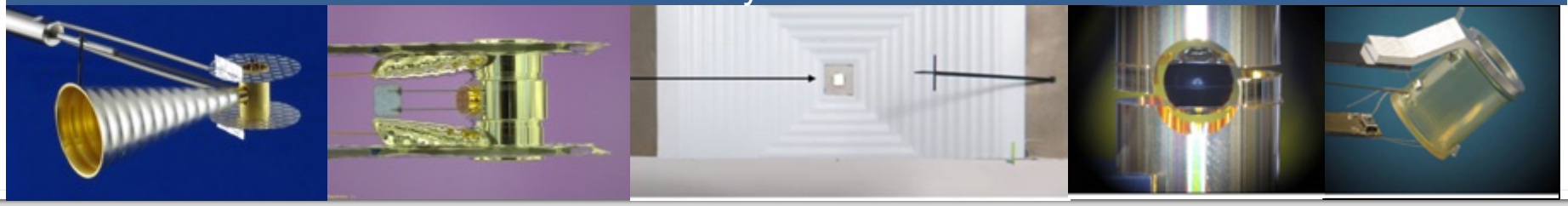
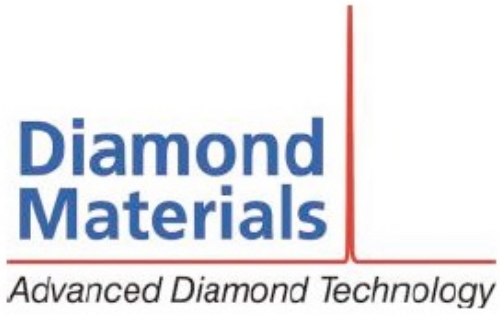
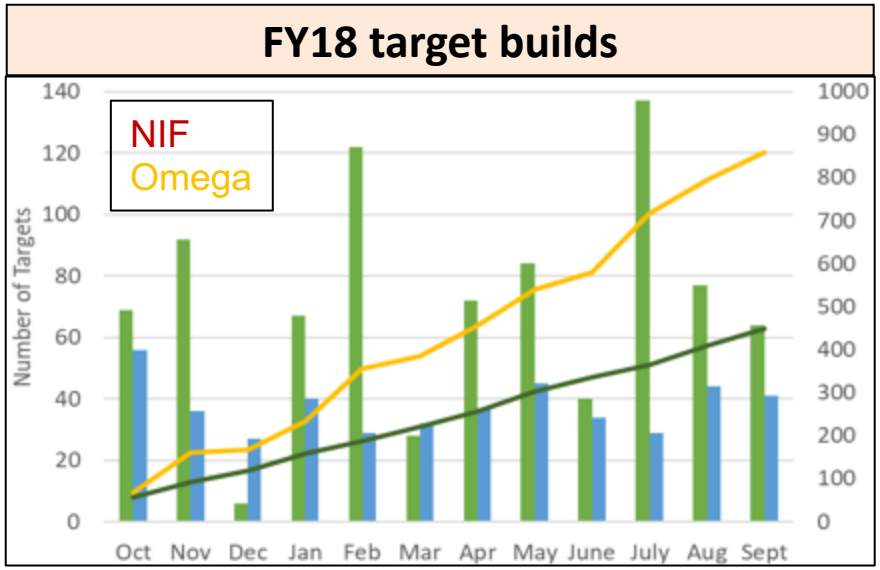


LLNL Target Fabrication leverages close collaborations with other labs and institutions



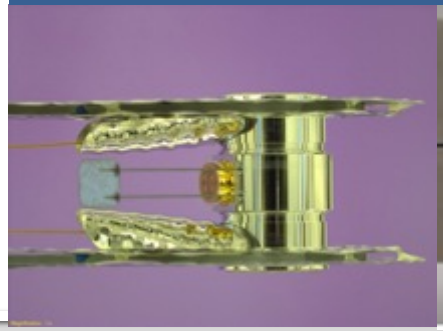
LLNL Target Fab builds nearly 500 NIF targets per year with an evolving mix of platforms



Many stakeholders determine the mix of targets built:

- HED and ICF councils determine Physics needs
- NIF provides optic damage (shot energy) and scheduling limitations
- Target Fab provides capacity and feasibility limits
- There are about 20% spares, mainly for the cryogenic targets

Cryo target (B381)



Warm complex target (B381W)

Warm simple target (B298)

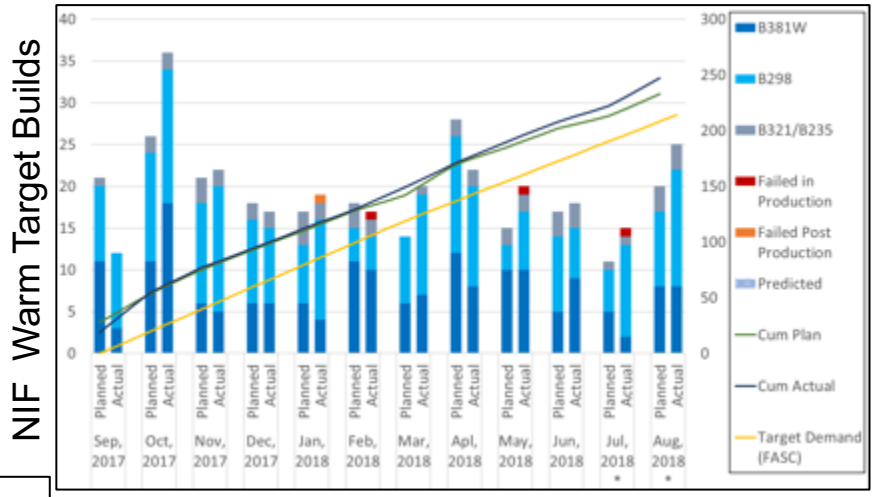
We track metrics for continual improvement of target production by making needed adjustments

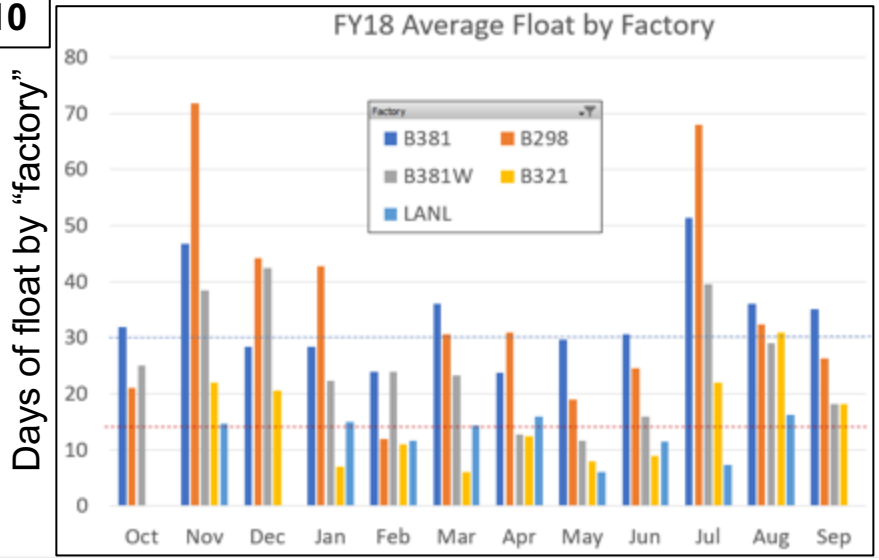
- **We collect a variety of production metrics that help us plan, evaluate our progress, and calculate our build capacity**
  - Number of Targets assembled each month
  - Target float (shot date – target build completion date)
  - Assembly effort hours

Butlin, Tue 11:10

- **We collect metrics that help us understand issues and help us prioritize our resources**
  - Production problems
  - Cross training
  - Cleanliness data

Walters, Wed 11:00; Braun, Fri 9:30

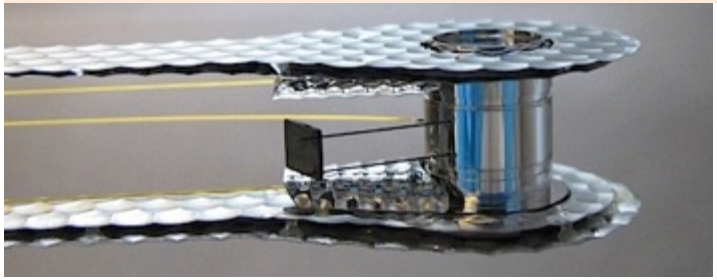




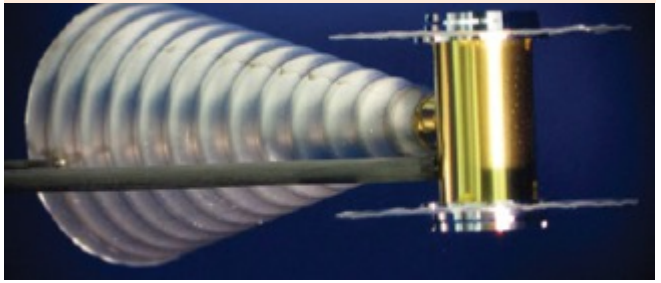
Mechanical design is integral to target fabrication and facilitates assembly and target acceptance for fielding

"Standard" Platforms (small deltas)

Capsule and/or hohlraum size change

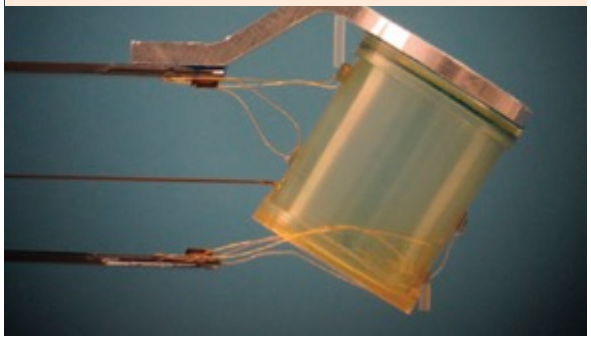


Physics package change (EOS)

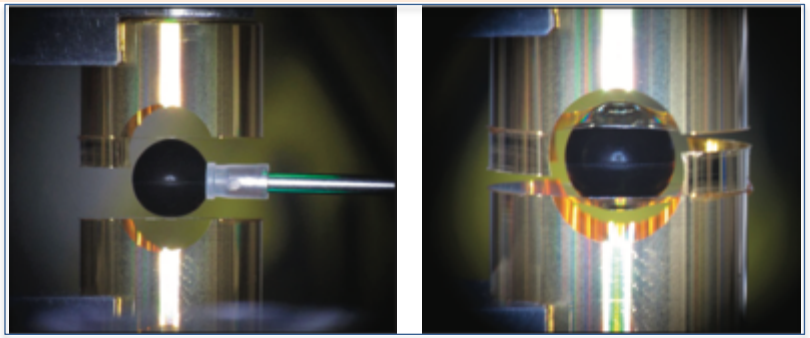


Platforms with "major changes" affect facility safety as well as assembly

MagLIF Cryogenic gas pipe

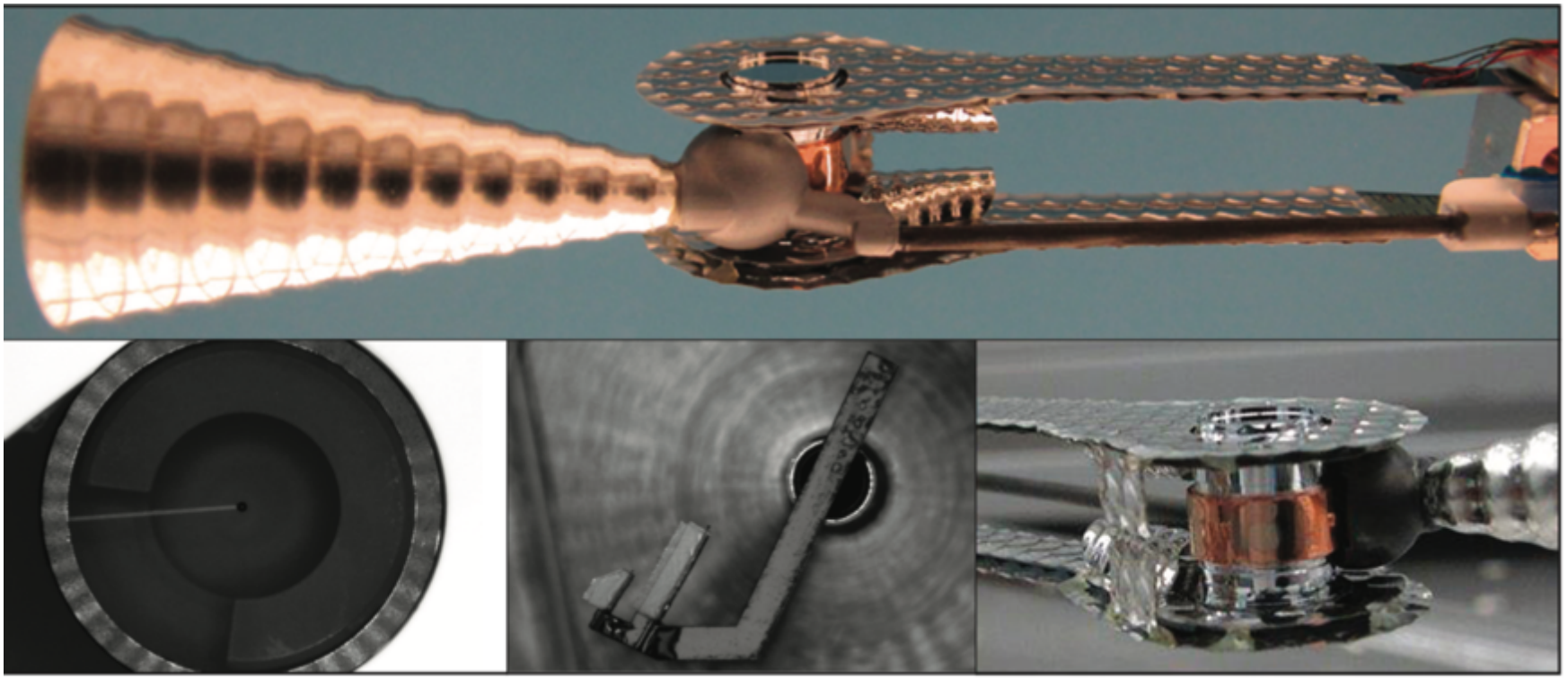


El Nino ARC Radiography



Hash, Fri 9:10

Compton Radiography target embodies crucial interaction between target fab, physics and facility

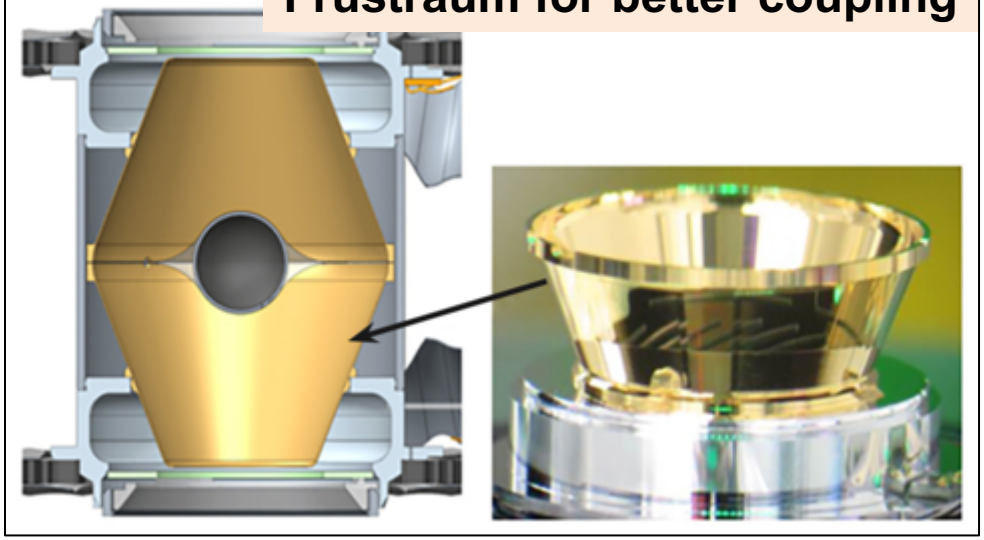


0.2mm Tungsten Carbide sphere *Vee Flag Backlighter Assembly* *Additional Shielding*

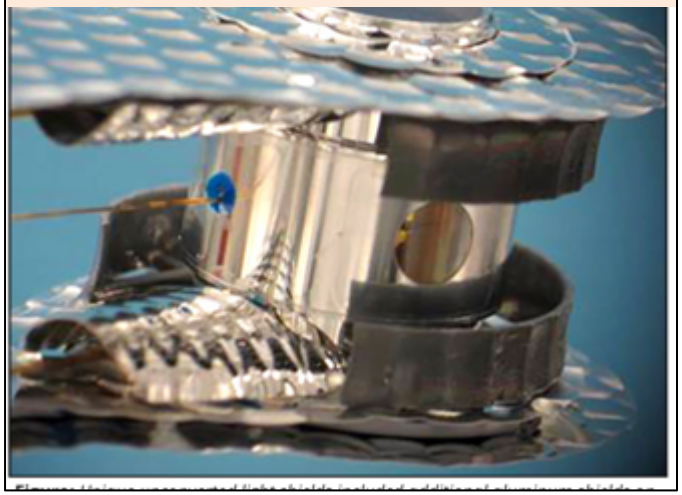
Kroll, Thu 2:30

A number of other new platforms have been developed for future ICF and HED use

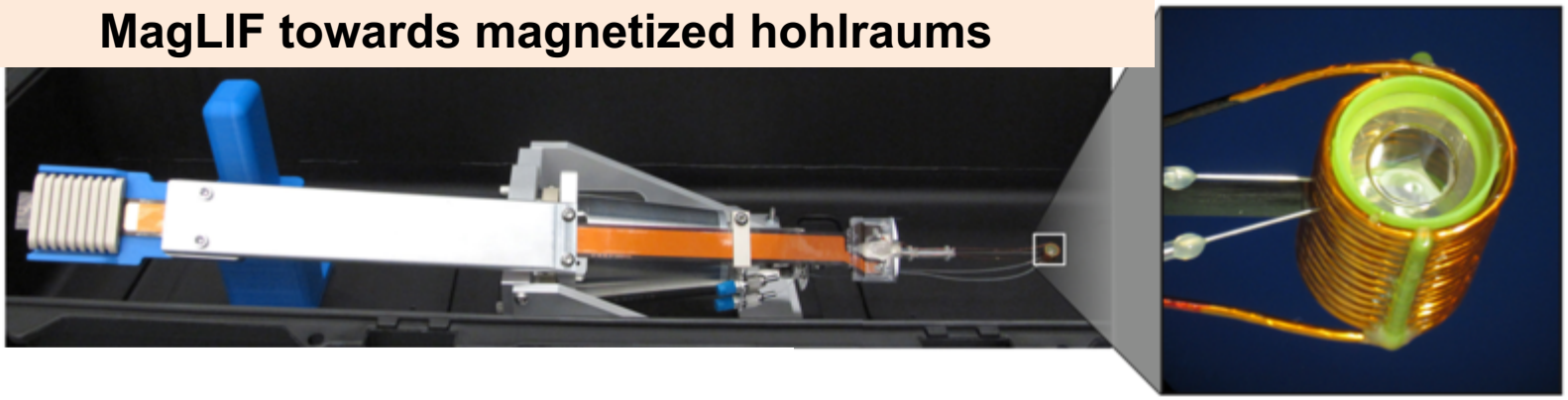
Frustraum for better coupling



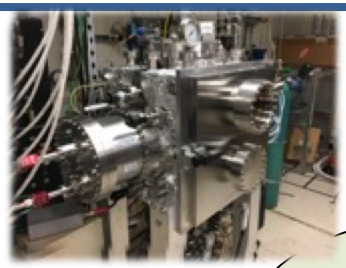
”Huge” TMP for scale up



MagLIF towards magnetized hohlraums

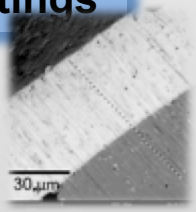


LLNL Target Fab S&T retains a dedicated pool of experts and leverages capabilities in other directorates



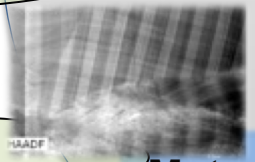
Precision machining

Coatings



Vapor Processing Lab

Tomography



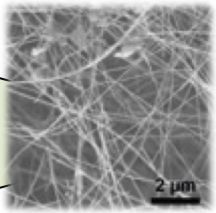
TEM/FIB

Metrology & Spectroscopy

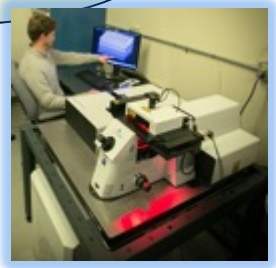
Advanced materials

Foams

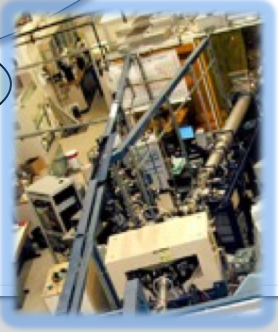
Soft Matter/ Nanomaterials



Additive Manufacturing



Beamline measurements

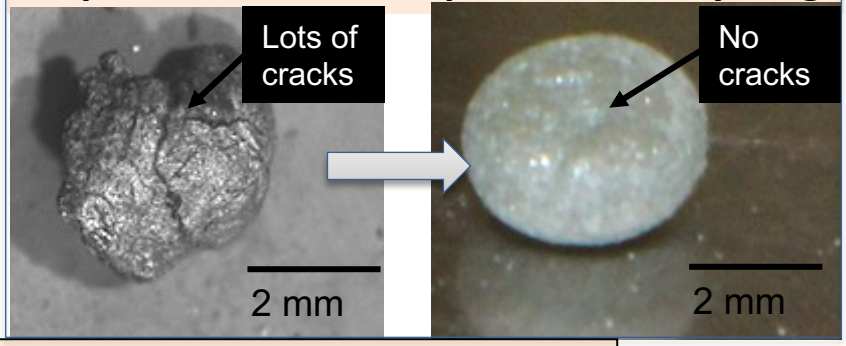


Shin, Thu 11:40

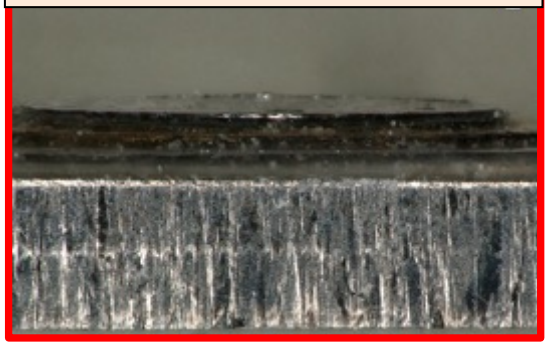
Bhandarkar, Tue 1:30

We have improved plutonium material quality and are increasing capabilities while solving delamination issues

Improvements of Pu process & recycling

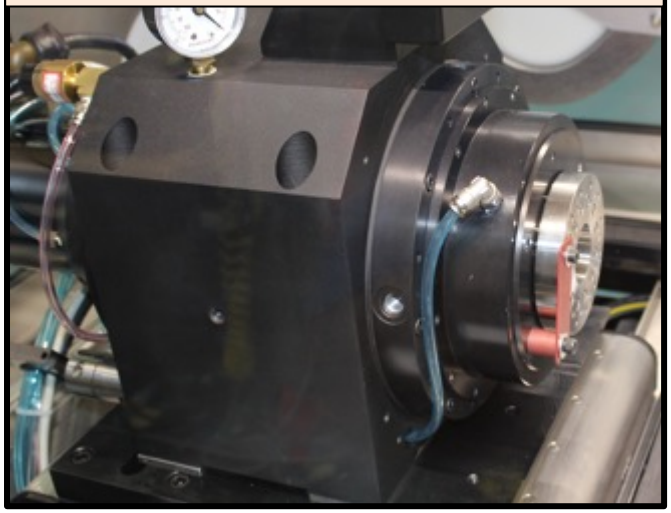


Delamination?



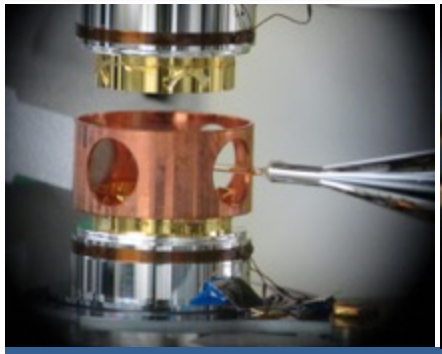
New Pu facility will be operational by end of FY19

Diamond turning machine



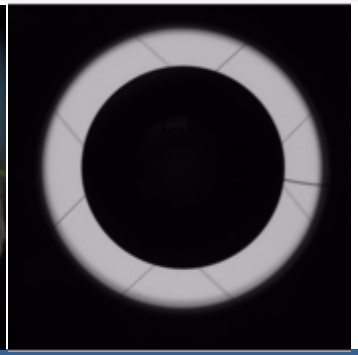
Wilson, Wed 1:50

Alternate capsule support development is focused on tetracage design with nano-yarn development

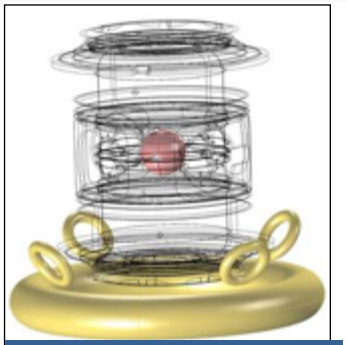


4-part hohlraum

Fishing pole



Tetracage



Mag levitation

10^{16} neutron yield!

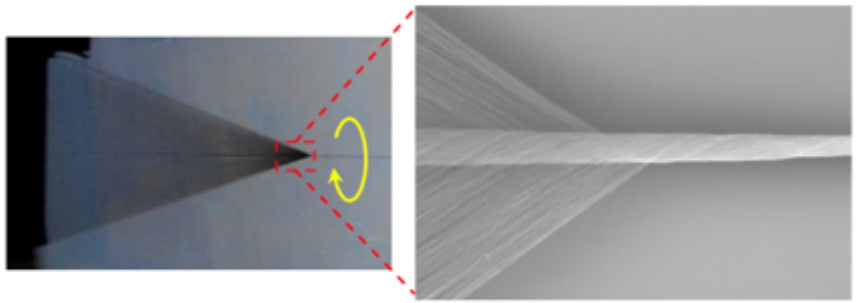
Not robust

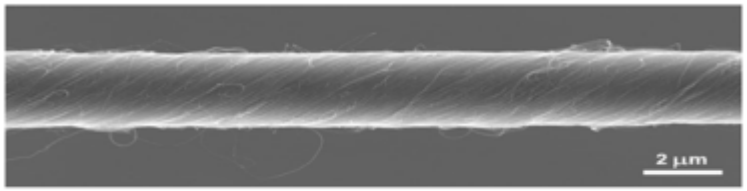
Schiaffino, Wed 2:50

Kucheyev, Wed 2:30

Nano yarns are based on carbon nano-tubes

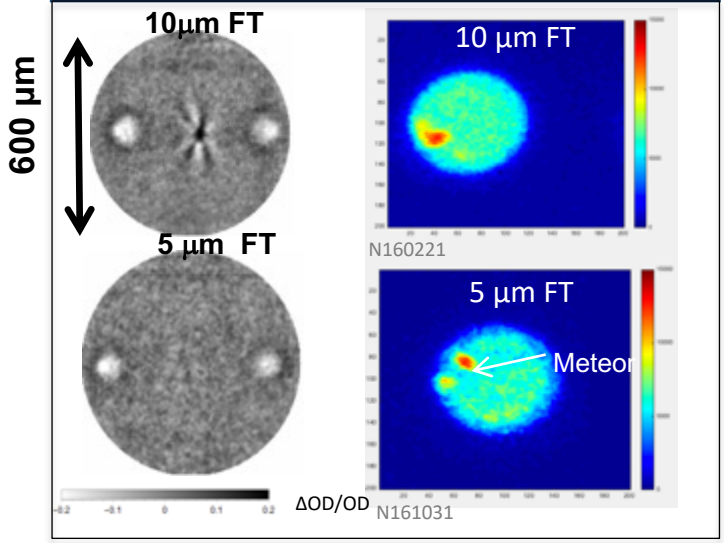
Lepro, Wed 2:10



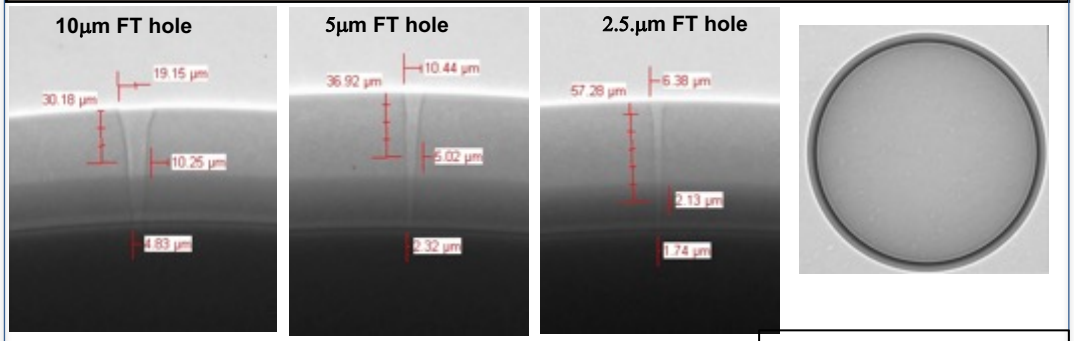


There have been significant advances in reduction of fill tube to ~ 2 µm and fabrication of nano-grain HDC

Shot data on FT effects on implosion



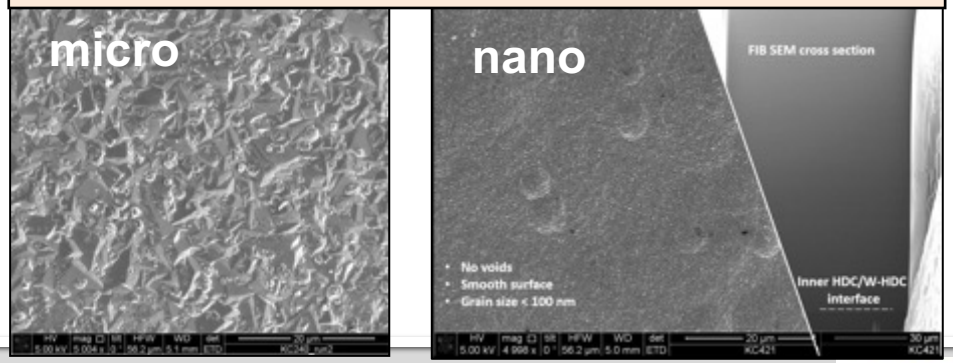
Solid mandrel removal time for HDC has been reduced from ~ 6 months to several days for even 2 µm fill tubes!



Kong, Thu 9:50

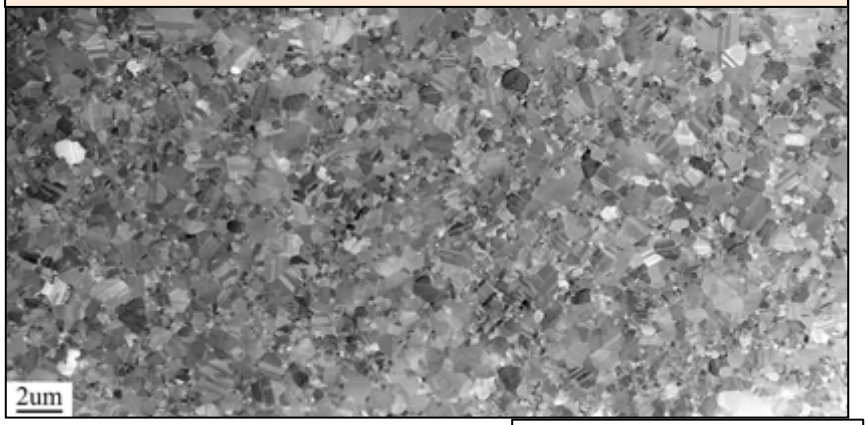
Omega 2D VISAR experiments have shown reduced perturbation with nano grain diamond

Nano grain reduces shock velocity perturbations



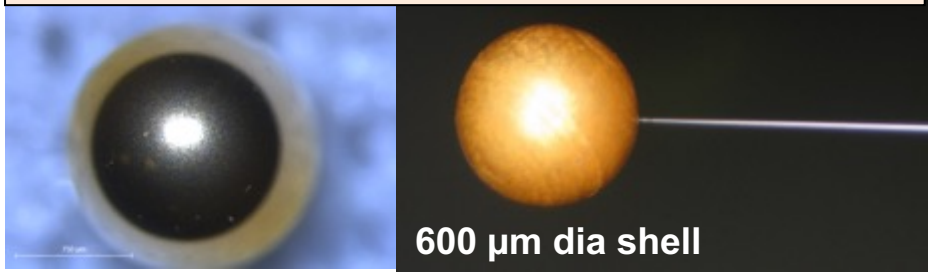
R&D efforts using electrodeposition and HiPIMS are being pursued for metal shell fabrication

Cu coating using HiPIMS process



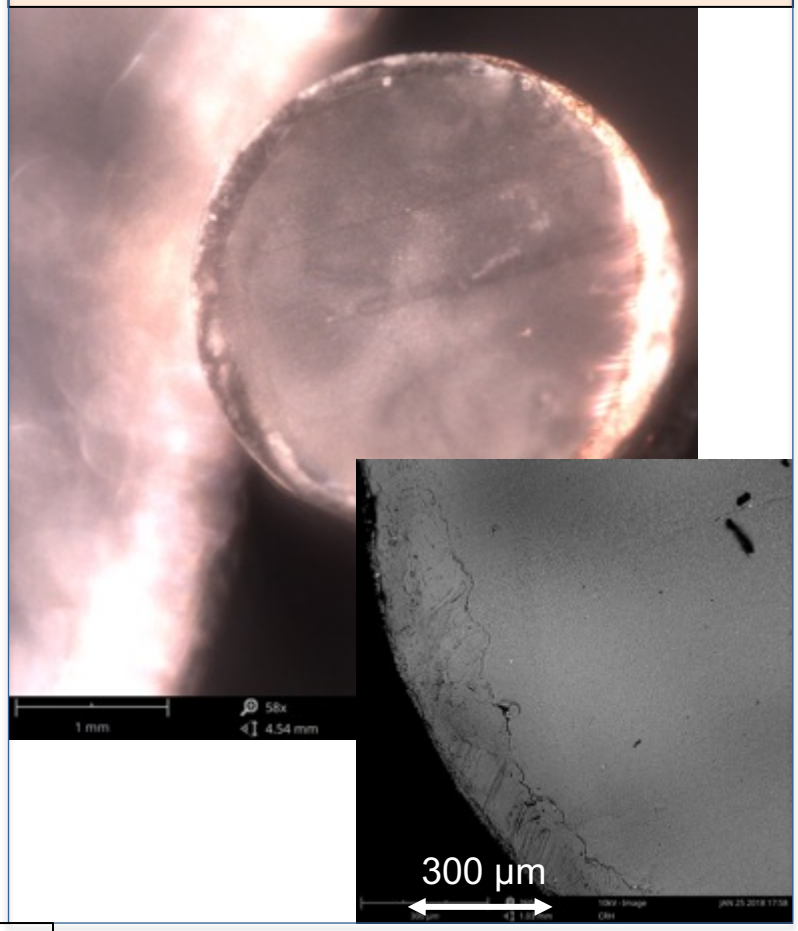
Engwall, Tue 1:50

Graded metal shells by e-deposition



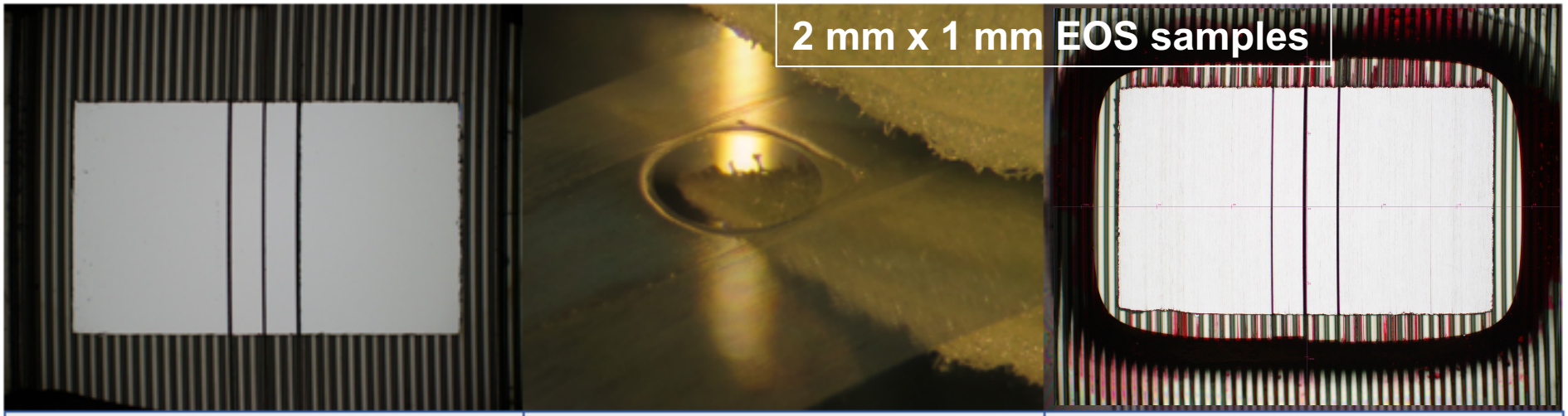
Peters, Thu 9:10

Aluminum plating from ionic liquids



Horwood, Thu 9:30

Advances in diamond turning have enabled new classes of precision targets and materials



Iridium EOS specimen: < 50nm parallelism overall < 15nm parallelism in ROI <12 nm Ra (surface roughness)	Iron (shown above): <16 nm Ra (surface roughness) Tantalum: <12 nm Ra (surface roughness)	Tantalum EOS specimen; < 12nm parallelism overall < 7nm parallelism in ROI <12 nm Ra (surface roughness)

This feeds into Pu machining work in Superblock as the processes will be similar using same trained personnel

Castro, Wed 9:50

Very low density shaped foams have been developed using templating and nano-wires

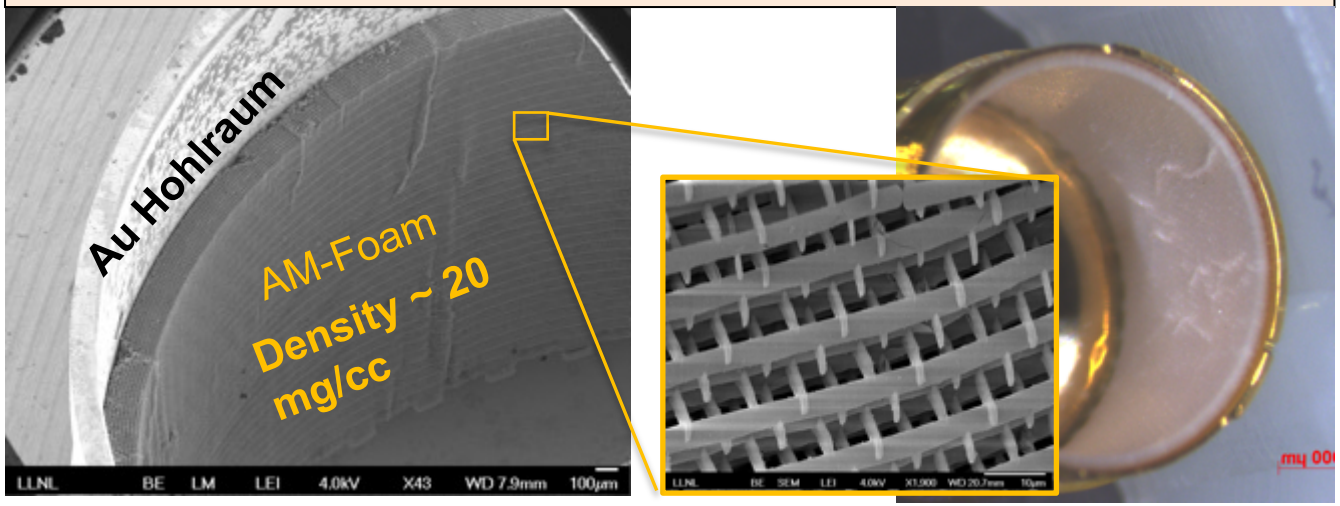
- Atomic Layer deposition on templates to make metal oxide hohlraum liners

Oakdale, Wed 1:30

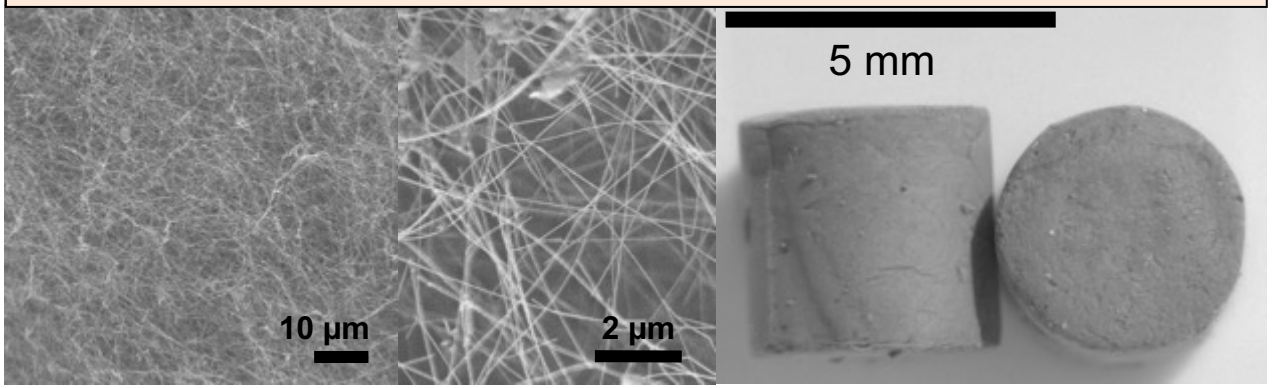
- Nano-wire ultra-low density metal foams

Fears, Thu 3:10

10 nm Ta2O5 coated foam liner (post polymer-removal)



2.6 mg/cm3 Ag - Nano Wire foams



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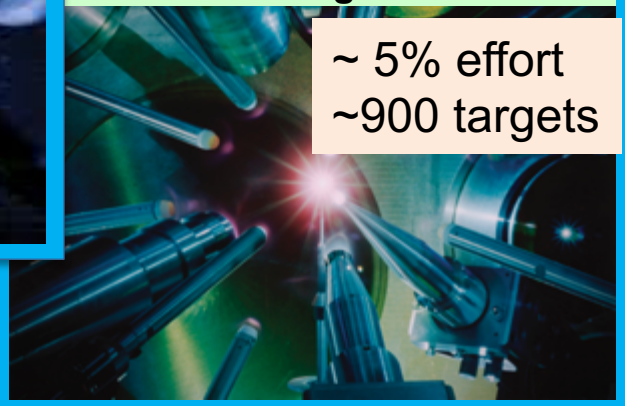

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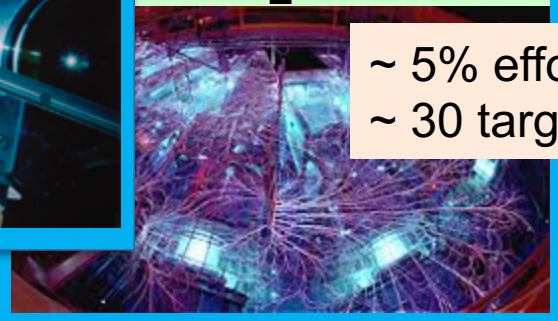

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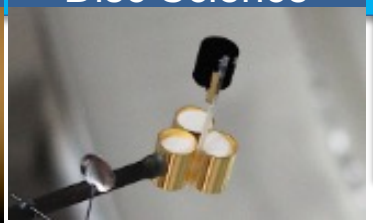
Nat. Sec. Apps

Disc Science



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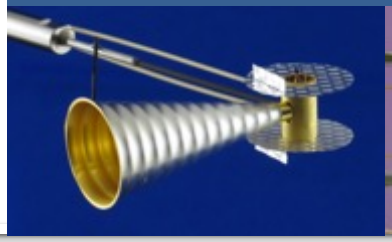

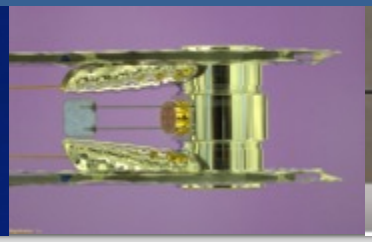

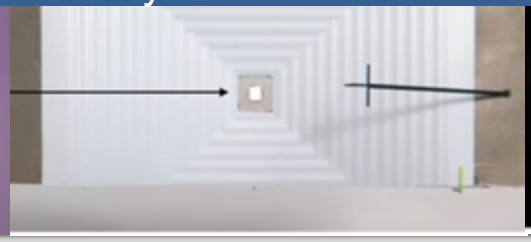

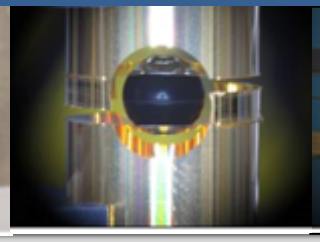


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