Los Alamos
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Mo100 to Mo99 Production Target: Design Status and Test Results

2015 Mo99 Topical Meeting

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UNCLASSIFIED

Concept and Brief History

Concept: Irradiate Mo100 with an electron beam to produce Mo99.

Initial proposal was 6 mm beam on 6 mm dia. cylinder at around 15 MeV.

Evolved quickly to 6 mm beam on 12 mm target, with cylinder segmented into disks for increased surface area to volume ratio.

Design now stands at 12 mm diameter beam at 42 MeV and 2.71 mA on each end of a 29 mm diameter disk stack, 4.2 cm total target solid thickness. Total heat load about 150 kW.

First experiment was water cooled. Unacceptable corrosion.

Helium adopted as coolant. Adequate heat transfer requires high mass flow: Pressurized gas for increased density and high velocity necessary.

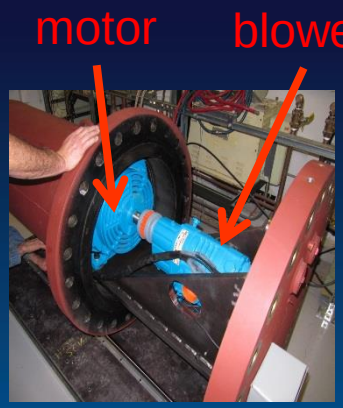
Pressurized Helium System

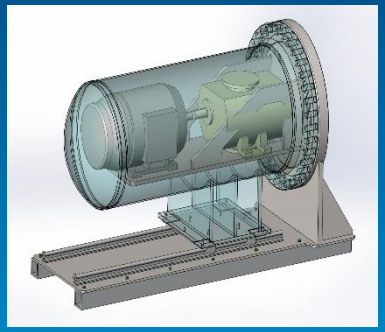
Stand alone gas circulators for high pressure are expensive. Now being reconsidered for multiple target cooling.

Meanwhile, concept borrowed from Princeton is a roots blower inside a pressure vessel, as now in operation at ANL and LANL.

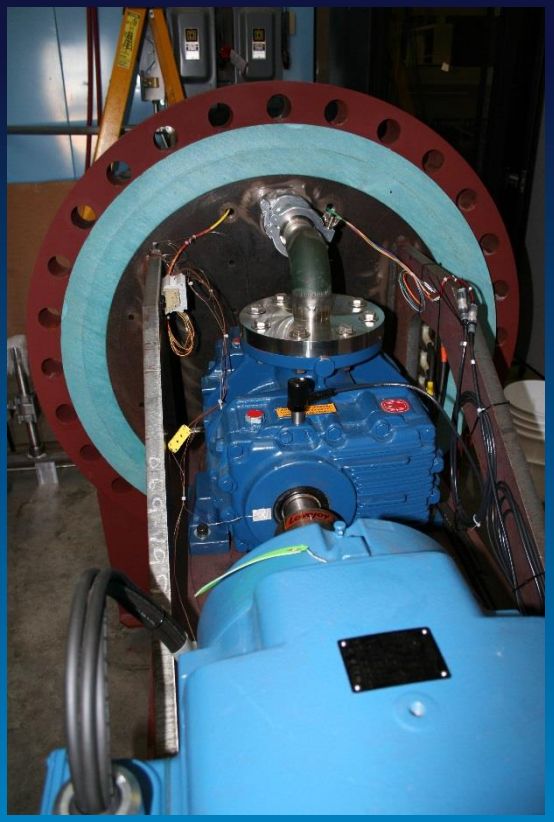
The current target requirements demand more mass flow (400 g/s). Same concept for now but bigger blower. Ready for operation now at LANL.

100 g/s at 300 psi





400 g/s at 400 psi

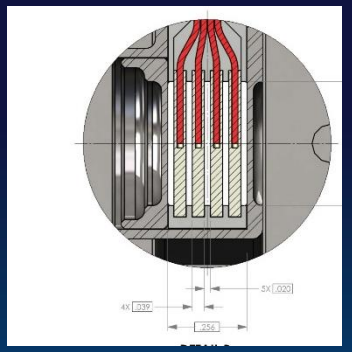


Targets: Testing

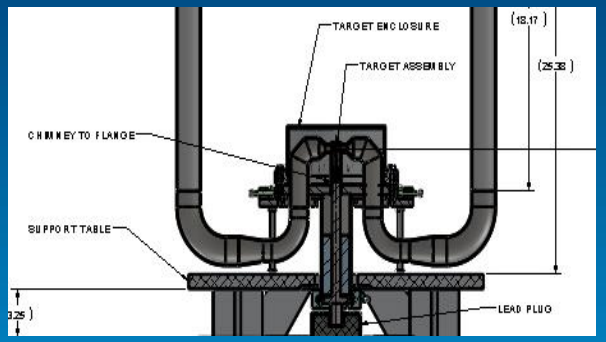
Concept: Disks separated by coolant gaps in a housing with Inconel window.

Most tesing to date are with a 6 mm beam on 12 mm target, with cylinder segmented into 1 mm thick disks for increased surface area to volume ratio and spaced 0.5 mm apart.

First tests on 4-disk target

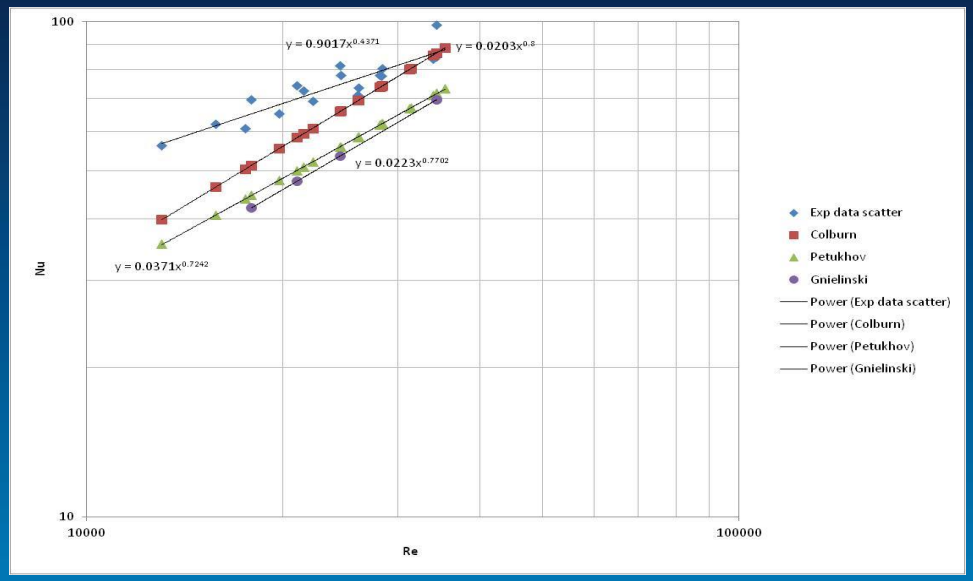


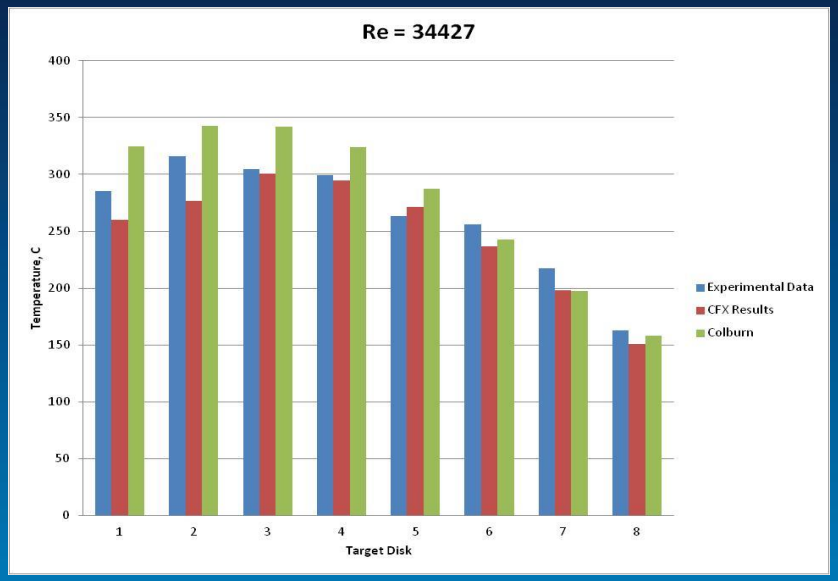
Now using 25-disk target, top-hat configuration



Targets: Test Results

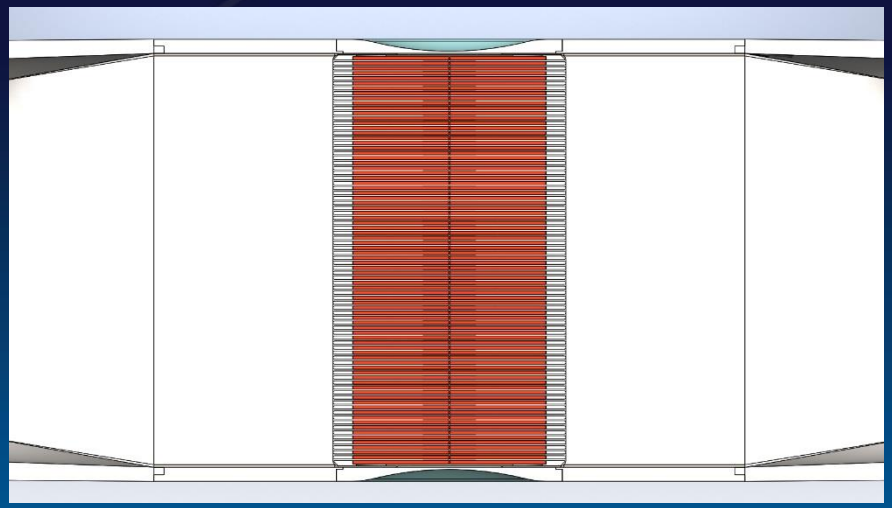
Test conducted spring 2015 indicate sufficiently accurate performance prediction by both semi-empirical correlation and by finite element analysis.

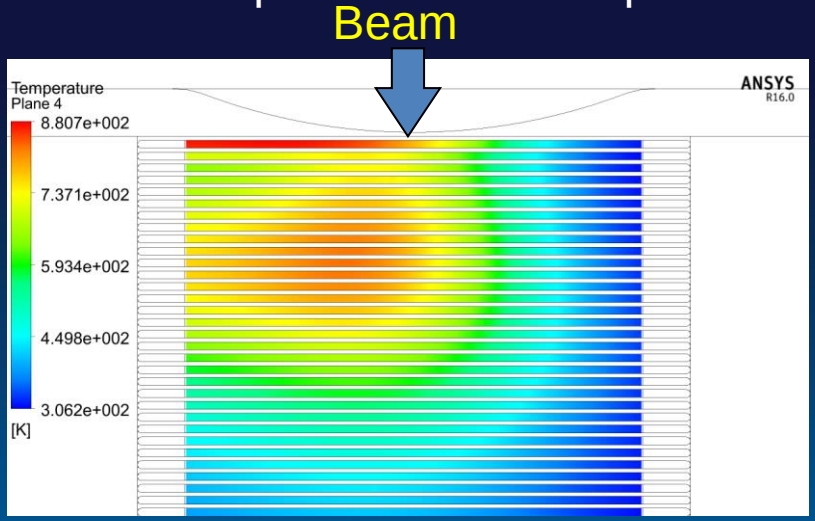


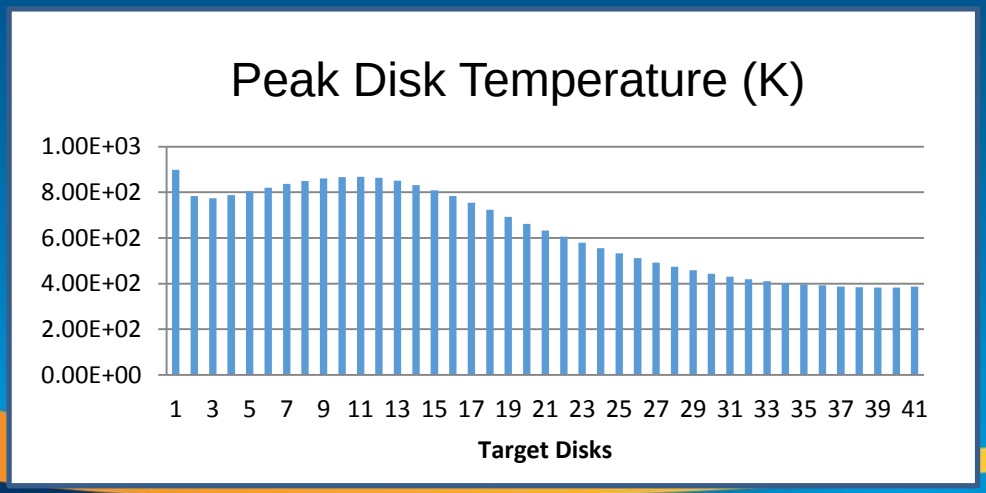


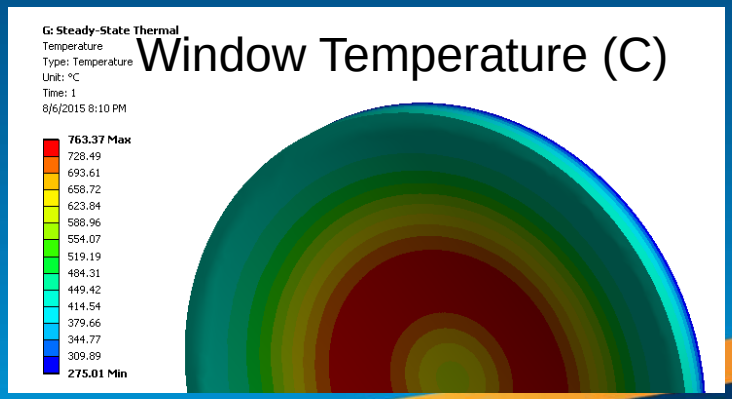
Targets: Plant Design

The production goal now has the target at 29 mm diameter, with a 12 mm FWHM beam. Currently, 82 disks are 0.5 mm thick and spaced 0.25 mm apart.









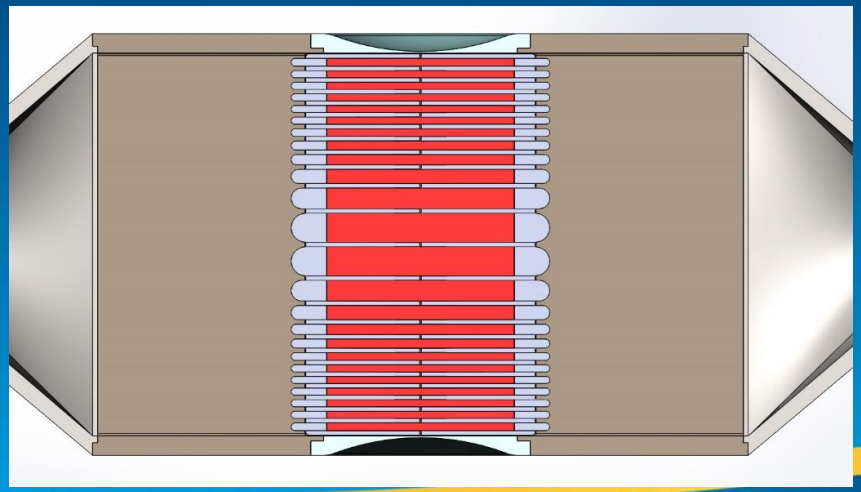
Targets: Plant Design

Baseline design on previous slide is fully satisfactory for Mo99 production.

Window is the vulnerable structure. Some improvements to lower temperature will be made but Inconel strength still quite good at 760 C.

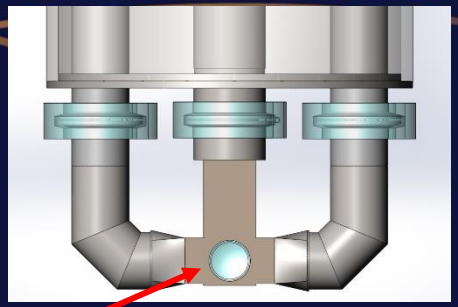
Design can be improved with thicker disks, graded thickness with depth into target, and wider coolant gaps.

Beam spot size optimization will impact target design, and beamspot error bar needs to be considered.

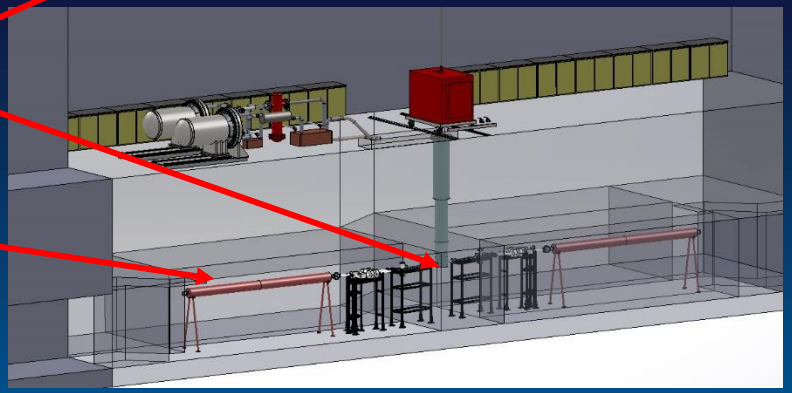


Plant Layout

Plant will have 8 target stations, 7 in continuous operation, another cycled in during maintenance.

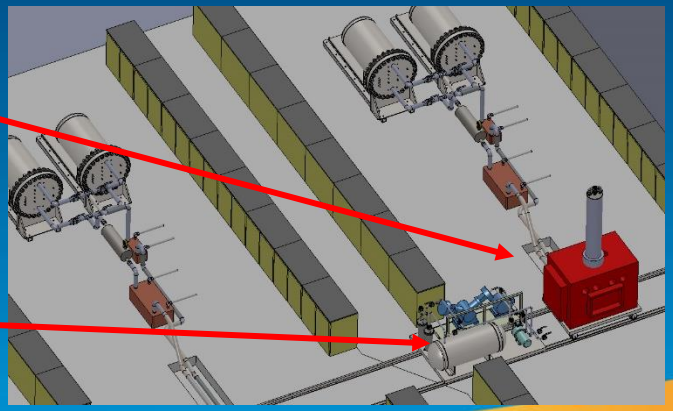


Targets mounted at the end of a long shaft through shielding.



Accelerators on ground level, targets raised through 10 ft thick concrete floor for handing and reload.

Targets rise directly into a hot cell on rails for removal and load into transport cask.



Gas handling and clean-up system on same rail.

Summary and Path Forward

Tests to date indicate performance is acceptable and predictable.

Current baseline design for the plant is acceptable by design but requires testing. Ample room for design improvements indicated by analysis. Need to expand analysis to include non-optimal beam size or shape.

Optimal window design still a work in progress. Target optimization studies likely to reduce diameter.

Out-of-beam tests using resistive heating is proposed for FY16.

Need in-beam tests on plant-typical target.