

Hypernuclear Target Design, Schedule and Cost

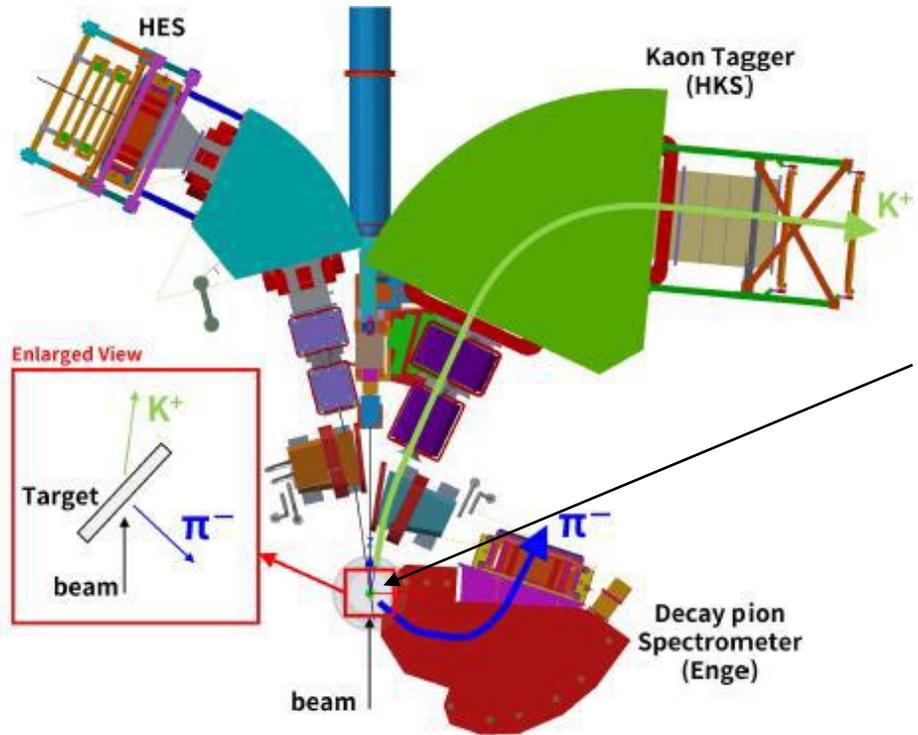
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12 February 2026

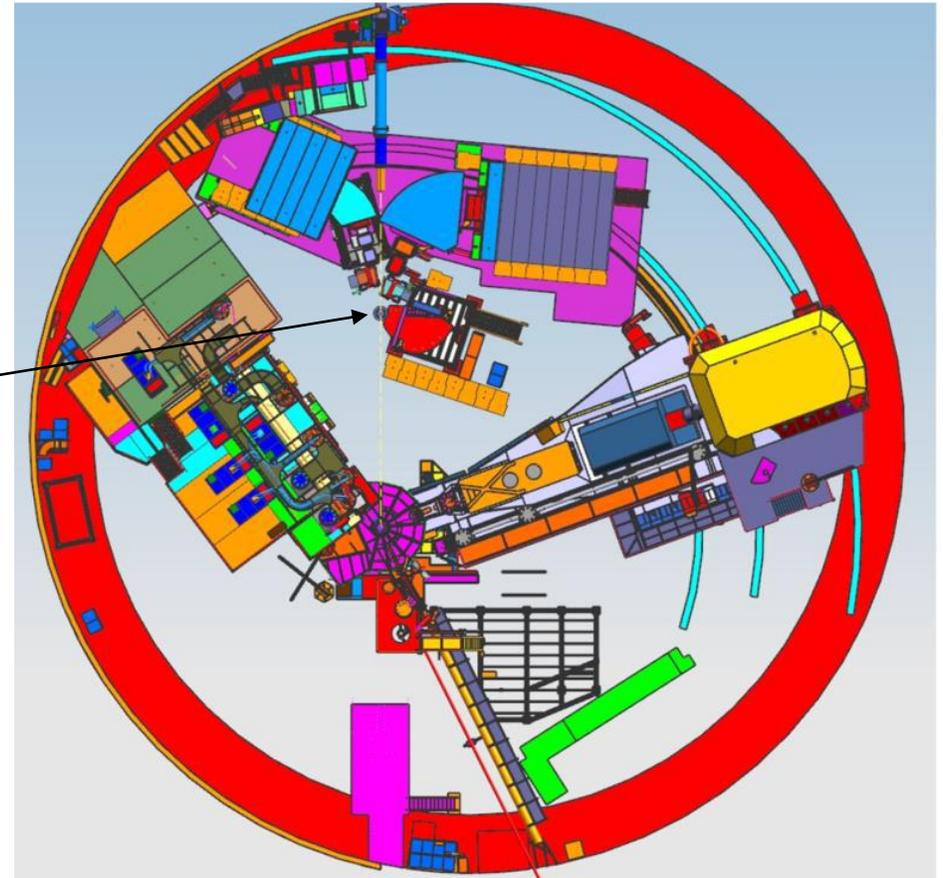
Design Status

- Currently in very early stages of the design
 - Coarsely adapting the PREX/CREX target system to HKS needs
 - This includes the cryogenic fluid transfer subsystem
- Only solid targets no gas cells
- Enge location is challenging to chamber design and adds spacial constraints.
- Preliminary thermal analyses show concept at least workable for 3 spectrometer operation for all solid targets at the proposed beam currents. We still need to fine tune this analysis
 - Students, JLAB staff.
- Alignment of the target will be challenging.
- Considering load/lock system to accommodate need for α source

Hall C HKS Layout



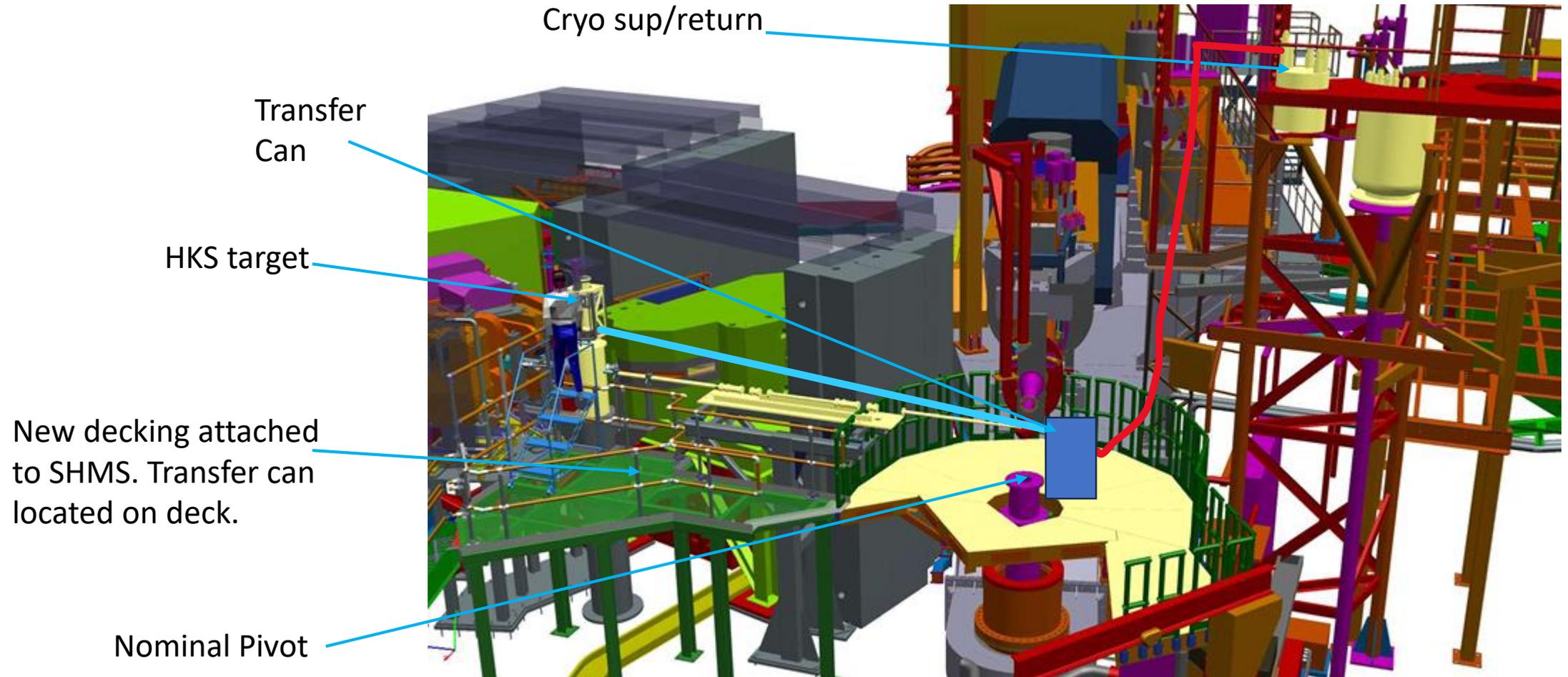
Target



Cryogenic Distribution System

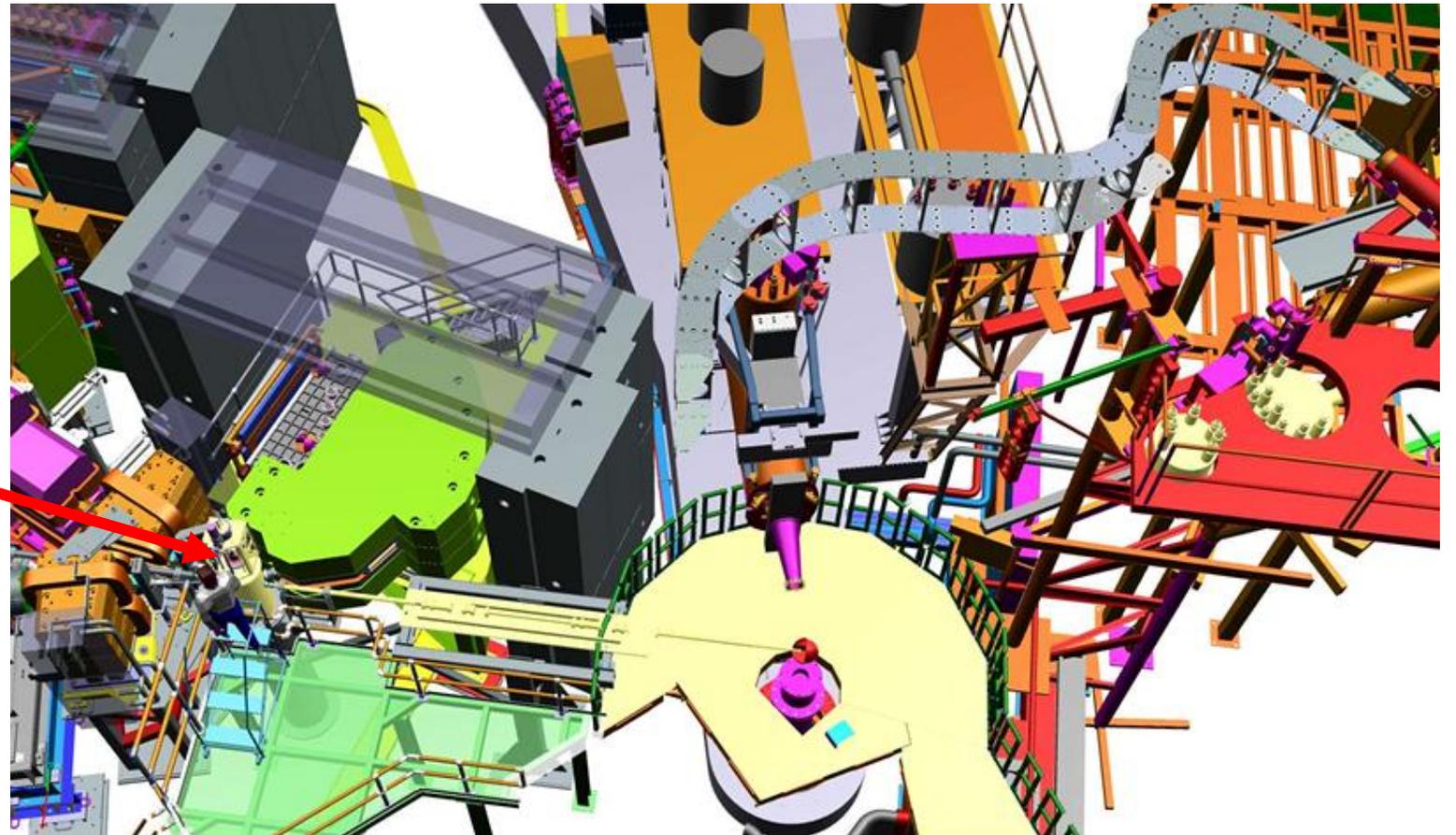
- Use standard 1.5” transfer lines with integrated control valves.
 - We have two such lines however they are too short and will have to be lengthened.
- The 1.5” lines will feed a transfer can to adapt to 0.5” transfer lines.
 - PREX T-Lines cannot be reused and new ones will need to be fabricated
 - The transfer can
- Currently we are optimizing location for the transfer can.
 - We can then design (length only) and start fabrication of them.
- Low power requirements
 - Compatible with MOLLER but we will still need to keep T-lines cold ~200W at 20K.

Chamber Location Side View



Chamber Location Top View

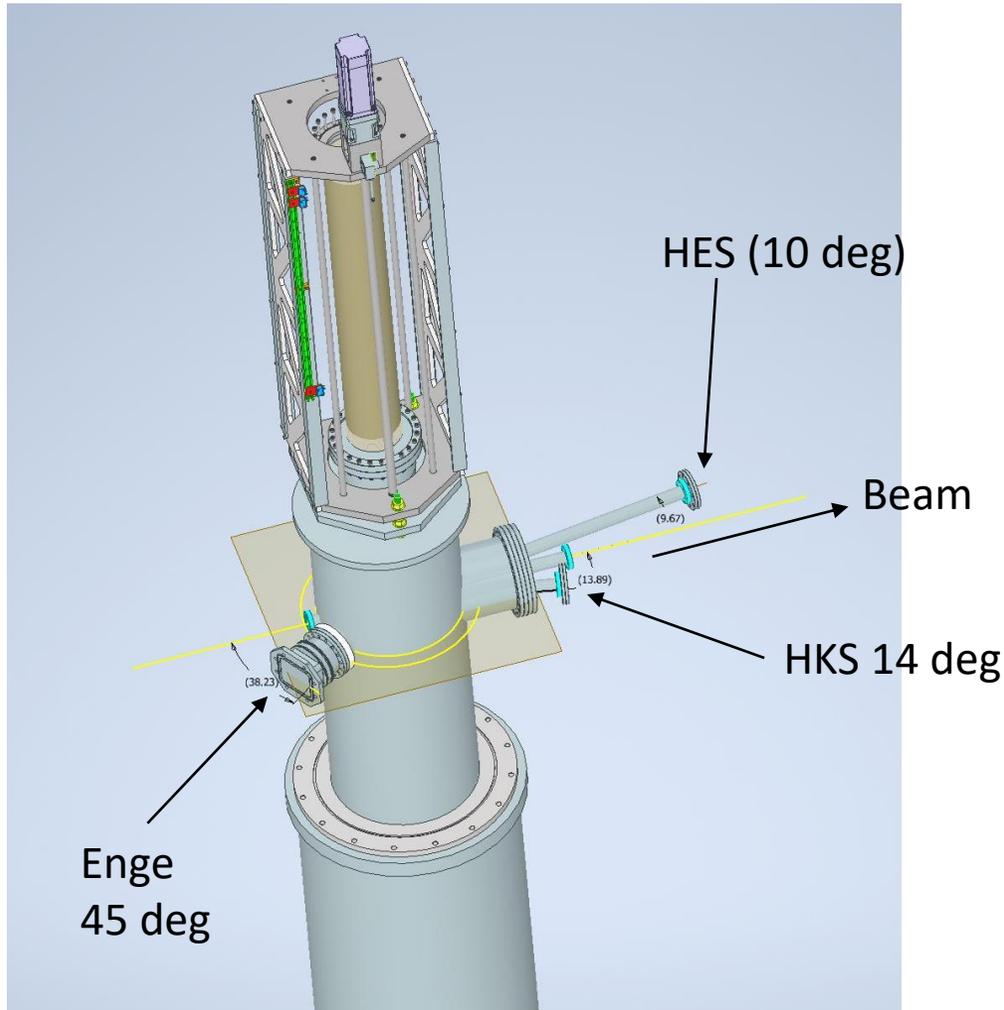
HKS Target
~260 in downstream
from pivot



Scattering Chamber Requirements

- Vacuum connections to three spectrometers
 - There will need to be some flexibility in the system for alignment purposes at least.
- Target will hang vertically into the beam line
- Alpha source swapping will require the chamber to be opened during the run
 - Ca, LiH, and Li targets will need to be protected from exposure to oxygen.
 - One possible solution is to develop a load/lock
- Load/lock system presents some design challenges
 - Added length to motion system
 - Access ports well above beam line
 - Less rigid system so alignment might be sloppy

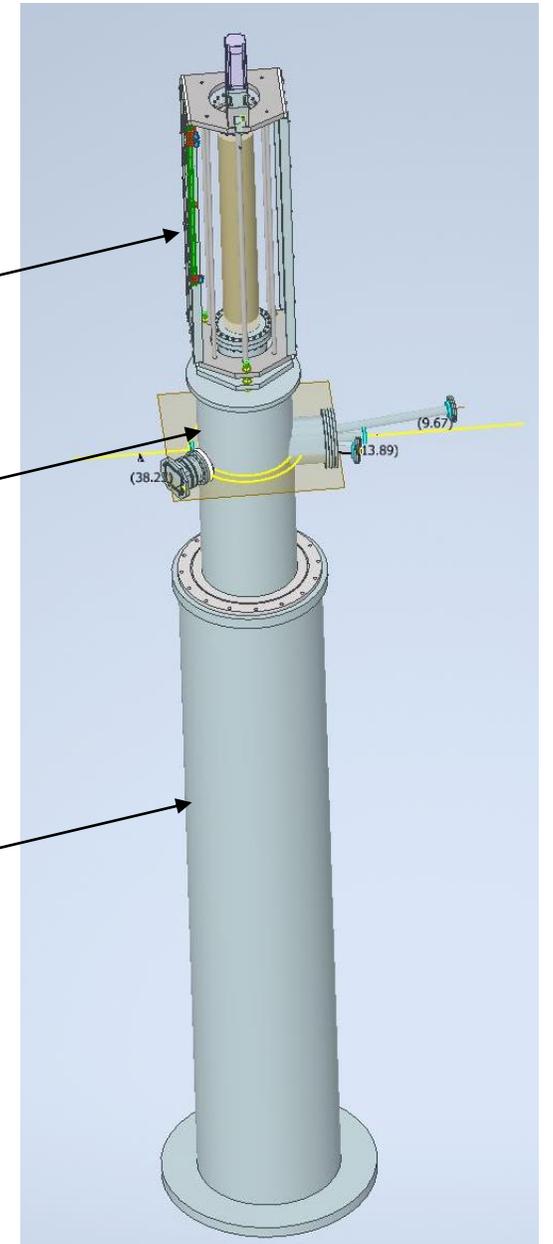
HKS Target Concept



Motion system
With possible
load/lock

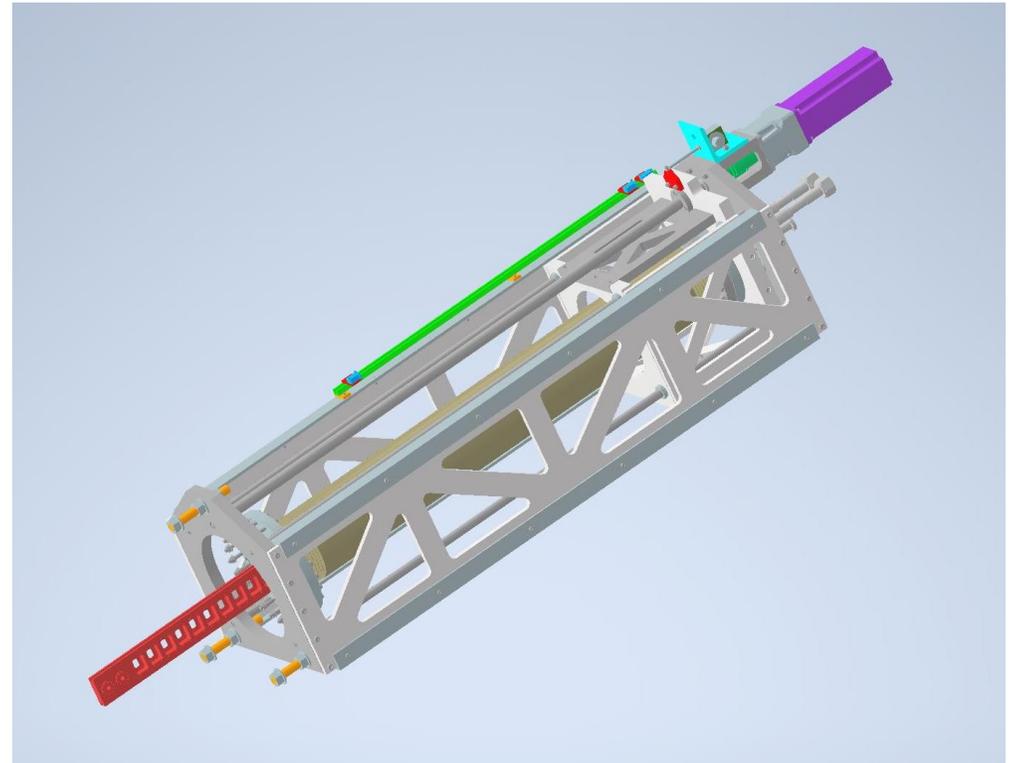
Scattering Chamber
(norm beam height)

Scattering
Chamber post



Motion System

- Adapt principles of the PREX target to HKS.
- Cryogenic system
 - Component design similar to PREX
- Length of travel must be determined
 - This can accommodate all solid tgts
 - Extra length for load lock
- Adding “x”, “z”, “ θ ” motion
 - “y” motion is normal vertical target motion
 - This will add to cost and add complexity to design
- We can use much of the existing target control system
 - Epics based
- New controls would be needed.
 - Software -> EPICS
 - Control cables would be needed. Might be possible to extend current cryotarget control cables



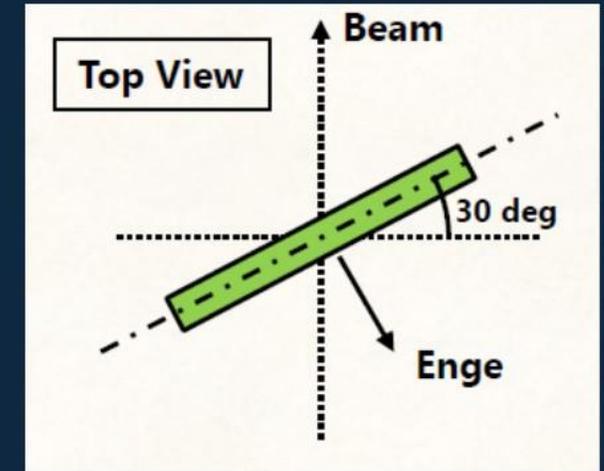
Solid Target Ladder

- 11+ solid target positions
 - Ca, Li and LiH should not be exposed to air for periods longer than few minutes.
 - Possible need for H₂ target
- H₂O target cannot run when target is cold
- Need details of alpha source to complete the ladder design.
- There is effort from target group to develop LiH as target material
 - Needed for polarized target run as well.
- LiH can release H atoms if temperature is too high. This “release” temp is below melting point.
 - LiH must handle raster off operation
 - LiH production may be inconsistent

For ENGE

- 30-deg tilt
- 100 mg/cm²
- Calibration target (α source)
 - Same diameter as $^{40,48}\text{Ca}$
 - α target is unmounted during beamtime
 - α target is next to carbon hole target (to be surer beam pos.)
- Other requirements
 - ENGE vacuum is kept even when the scattering chamber is open

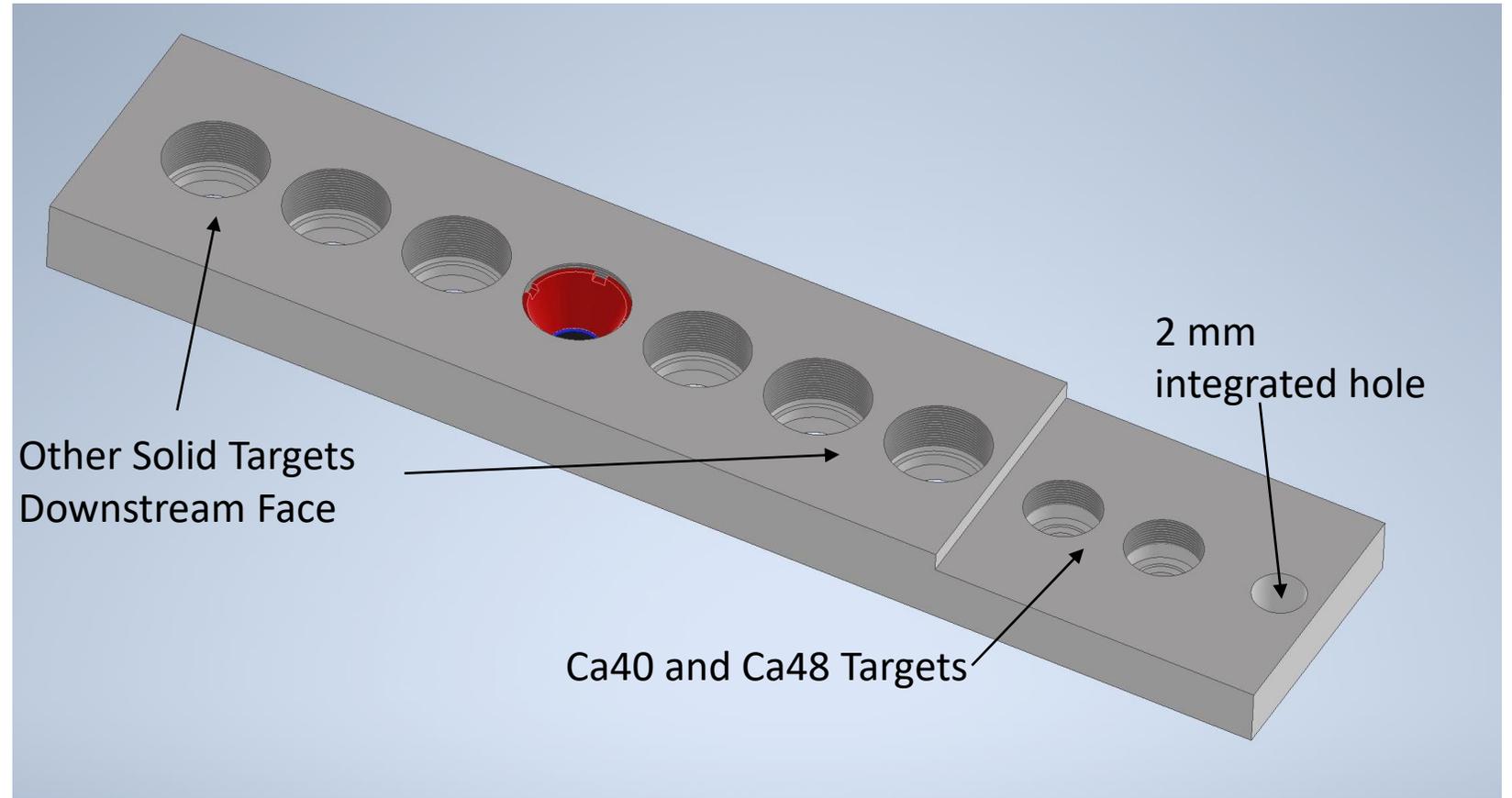
Figure from Sho



Concept Solid Target Ladder

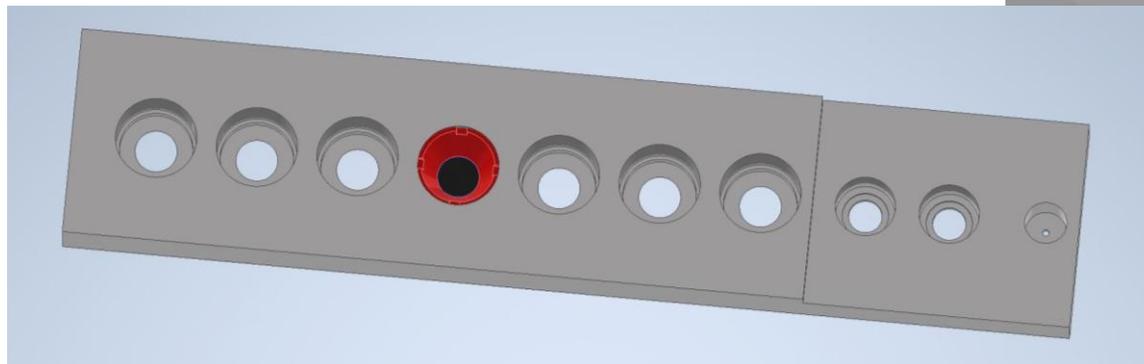
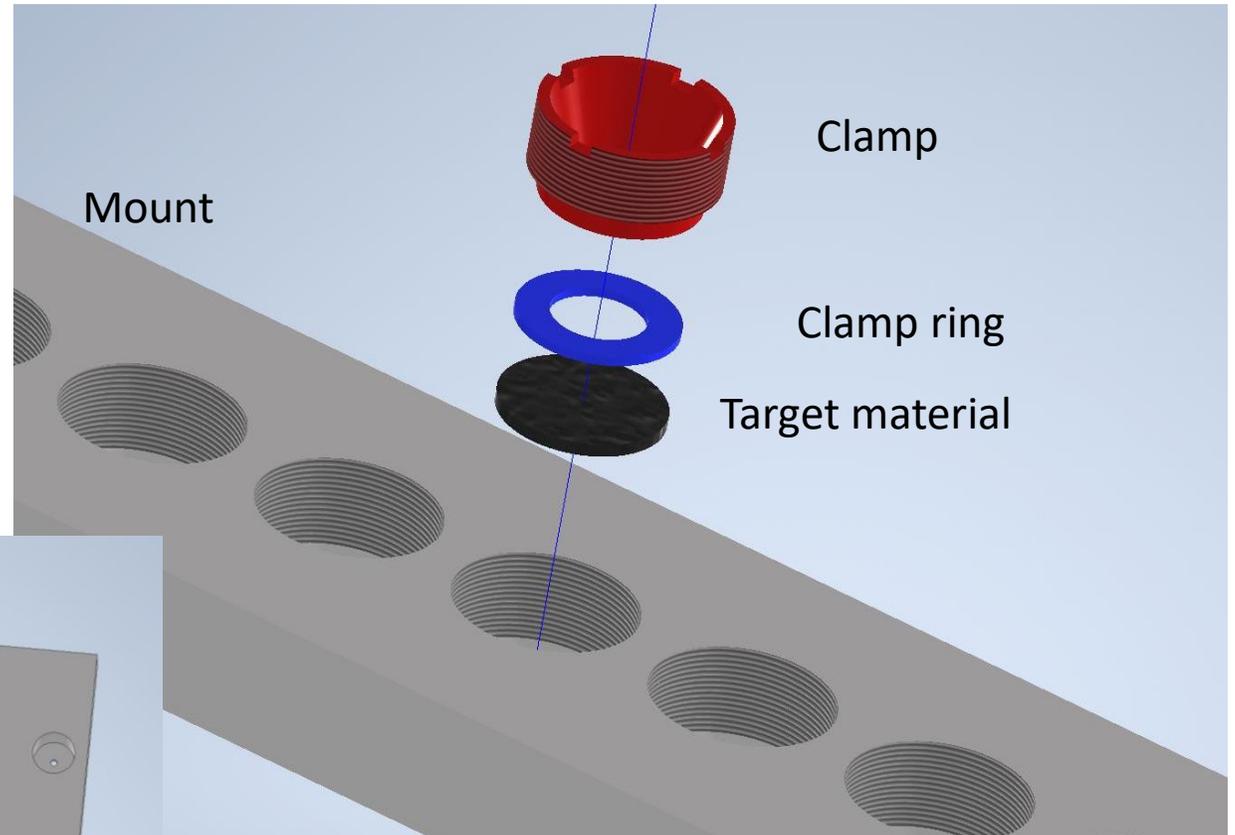
Calcium target mount is recessed for cost saving.

Without recess, \$120K more in Ca48



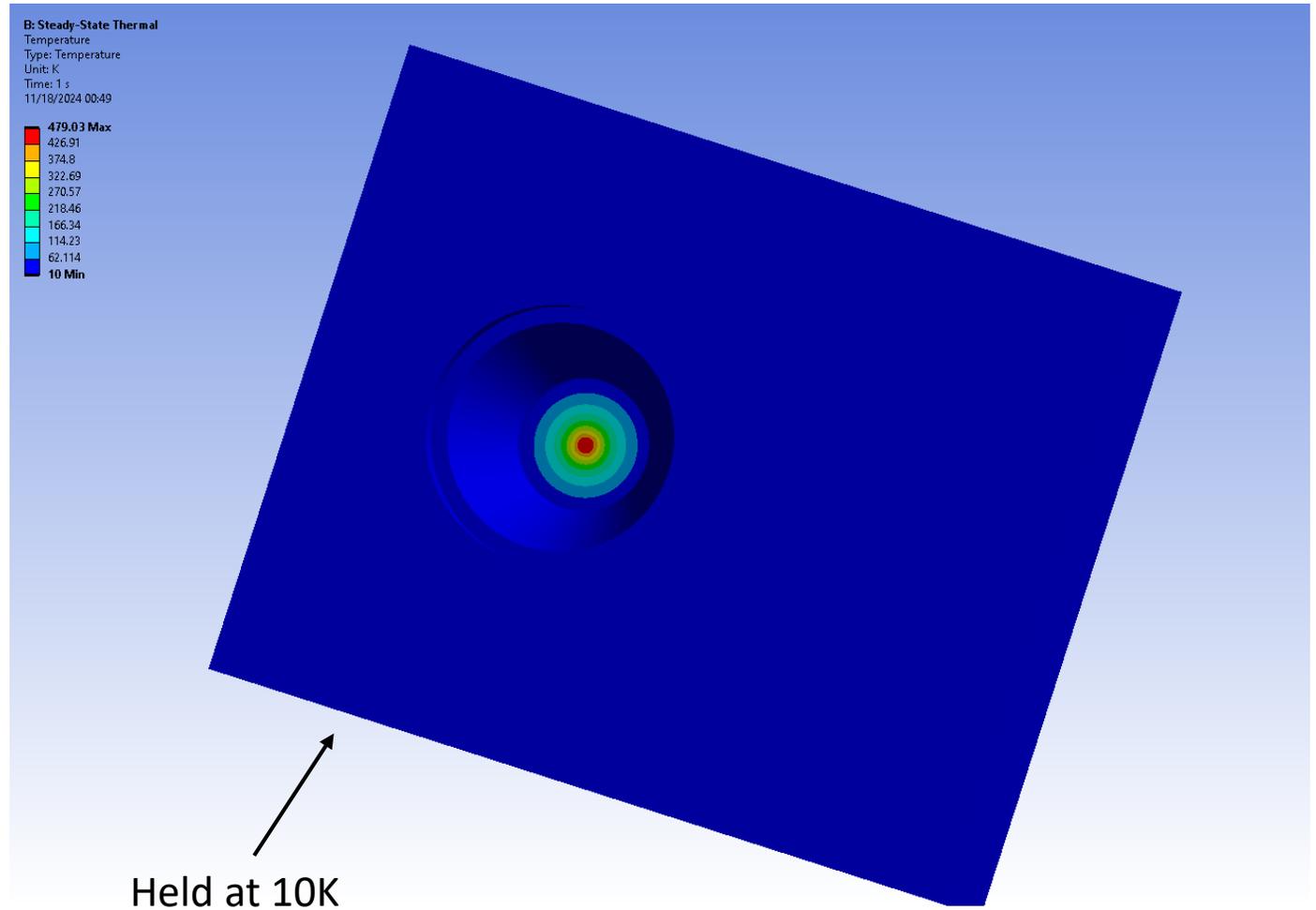
Concept Solid Target Ladder

- All components (ex targets) are aluminum 7075
- Nuclear grade antiseize used for better thermal cond and to prevent seizing
- All 9 targets can be accommodated with full acceptance for all three spectrometers



Thermal Model for Lead-208 Assy.

- $\rho t = 150 \text{ mg/cm}^3$
- Beam current 25 microA
- Raster $2 \times 2 \text{ mm}^2$
- $t = 0.13 \text{ mm}$
- 6W of beam heat
- Power density is 11.6 W/mm^3
- Walls held at 10K
- Material models
 - MPDB for lead
 - MPDB and Weisend for Aluminum 7075
- Max temp 479K
 - Lead melts at $\sim 600\text{K}$
 - FCC below 600K



Ladder Summary

- Design of ladder is critical to moving the design process forward for the entire target.
- Rotation of the solid targets 30 deg from beam normal will present some challenges
 - Targets will need to be “wider”
 - Increase the cost for Ca48
- Somehow, we will have to optimize the rotation with cost and function.

Cost Estimate Non-labor

- Non-labor costs:
 - Target materials (detailed on next slide)
 - \$200K
 - Motion system \$50K
 - Frame \$20K
 - Bellows \$10K
 - Flanges/Fittings \$10K
 - Drive/Misc \$10K
 - Load lock \$25K
 - T-lines \$20K + \$15K
 - Transfer Can
 - Reuse PREX can for solid targets only
 - Chamber/Stand \$50K
 - Total: ~\$400K to \$450
 - Ca48 Cost will rise with larger targets. Have not priced in 2026

Solid target costs

Target	Z	A	Thick (mg/cm ²)	Density (g/cc)	Req Thickness (cm)	Required Mass (g)	Cost	I _{max} (microA)
LiH			0.45	0.93	0.484	1.647	\$???	2
Lithium-6	3	6	0.1	0.458	0.218	0.366	\$ 5,000.00	50
Beryllium	4	9	0.1	1.848	0.054	0.366	\$ 5,000.00	50
Calcium-40	20	40	0.15	1.55	0.097	0.230	\$ 10,000.00	50
Calcium-48	20	48	0.15	1.86	0.081	0.230	\$ 100,000	50
Carbon-12	6	12	0.15	1.8	0.083	0.549	\$ 500.00	50
B-11 (B4C)	5	11	0.15	2.52	0.060	0.549	\$ 7,000.00	50
Aluminum	13	27	0.15	2.699	0.056	0.549	\$ 500.00	50
Lead-208	82	208	0.15	11.4	0.013	0.549	\$ 25,000.00	25
Spare Lead								
Spare LiH								
CH2?								

Without adjustments to Ca targets, cost would go up at least \$120K.

Labor Resources/Time Required to Fabricate

- Design solid targets only
 - Design Authority 480 hours
 - Load lock and alignment + 80
 - Designer 320 hours
 - Load lock and alignment + 100
- Fabrication
 - 6 months of calendar time at least for target group
 - Need welder, fitter, electrical, DA ...
 - Machine shop work (build to print components)
 - Ca48 can take up to 12 months to procure if approved by DOE. This process has started recently.