Hypernuclear Target Conceptual Design Elements and Cost

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Hall C Hypernuclear Experimental Readiness Review

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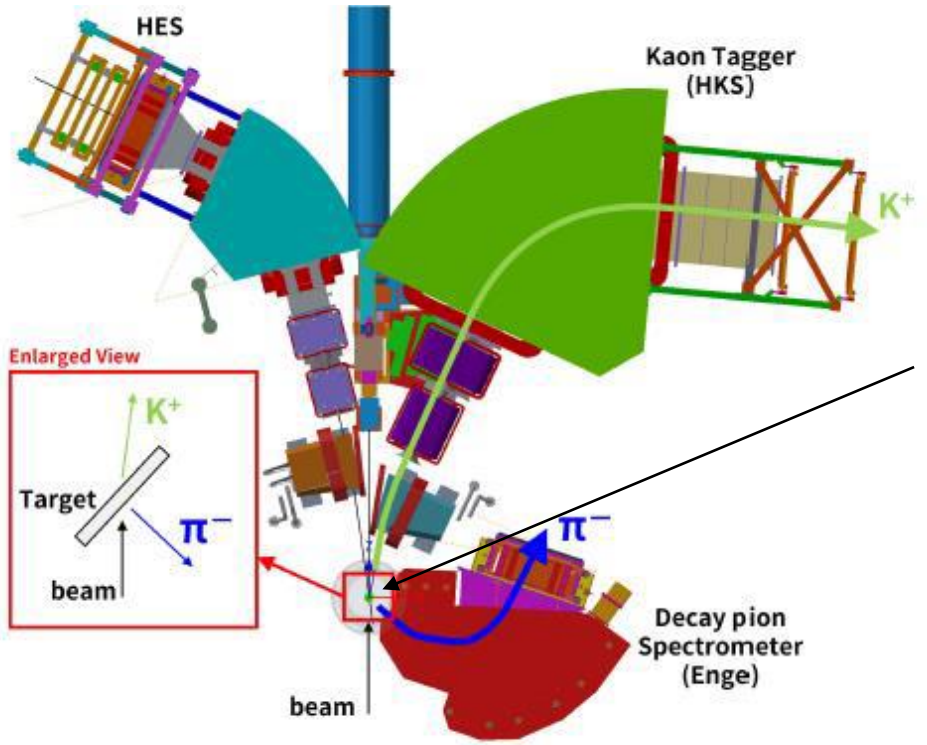
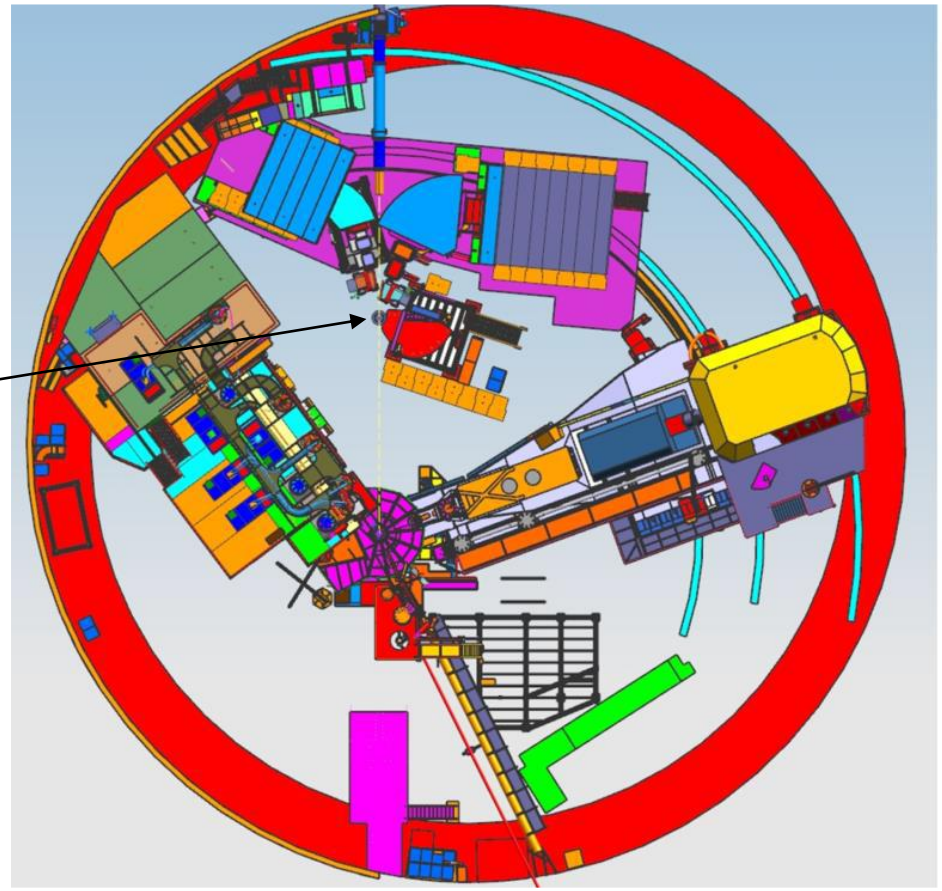
Design Status

- Currently in very early stages of the design
  - Adapting the PREX/CREX target system to HKS needs
- Working 2 options
  - Only present the solid target system without fluid targets
  - Ideally we would fabricate one system for both fluid and solid targets
- Original design concept was to adapt the $x_b > 1$ target ladder to HKS
  - This will not meet our needs for three spectrometer operations (ENGE) which presents challenges to the mounting scheme
- Thermal analyses confirm our concept is acceptable for 3 spectrometer operation for all solid targets at the proposed beam currents.
- Will need to work on design to allow alignment

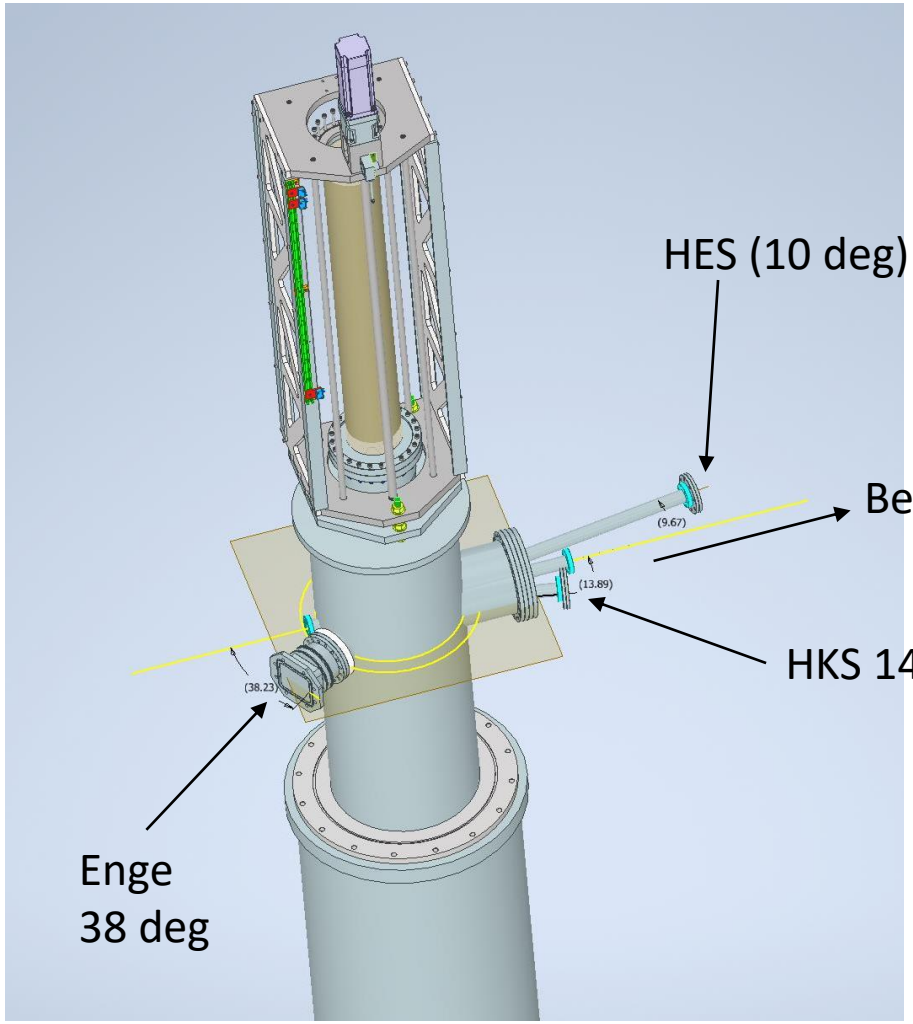
Hall C HKS Layout



Target



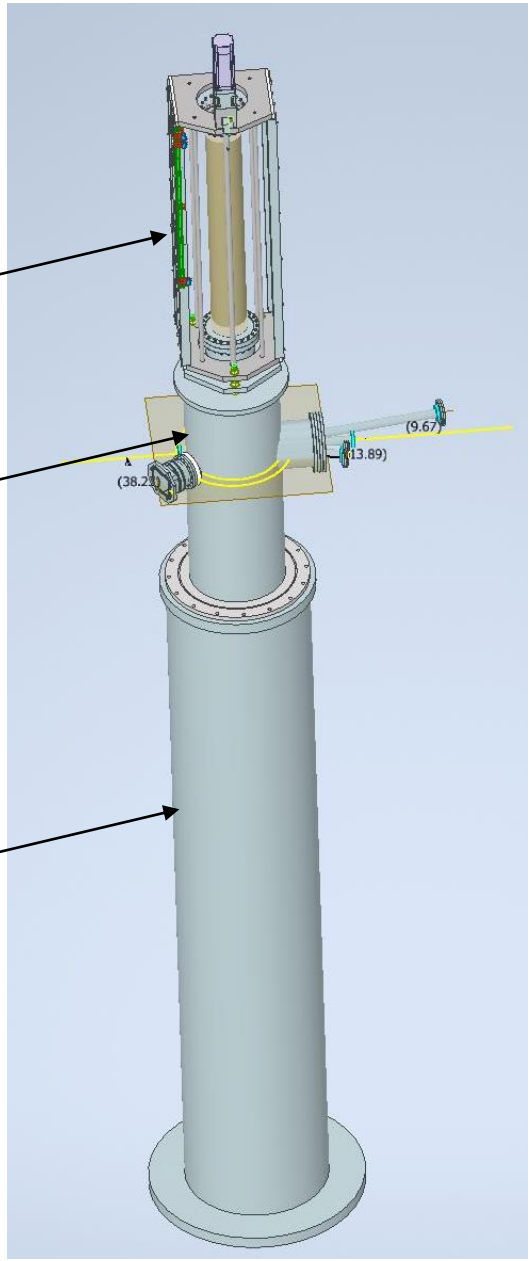
HKS Target Concept



Motion system

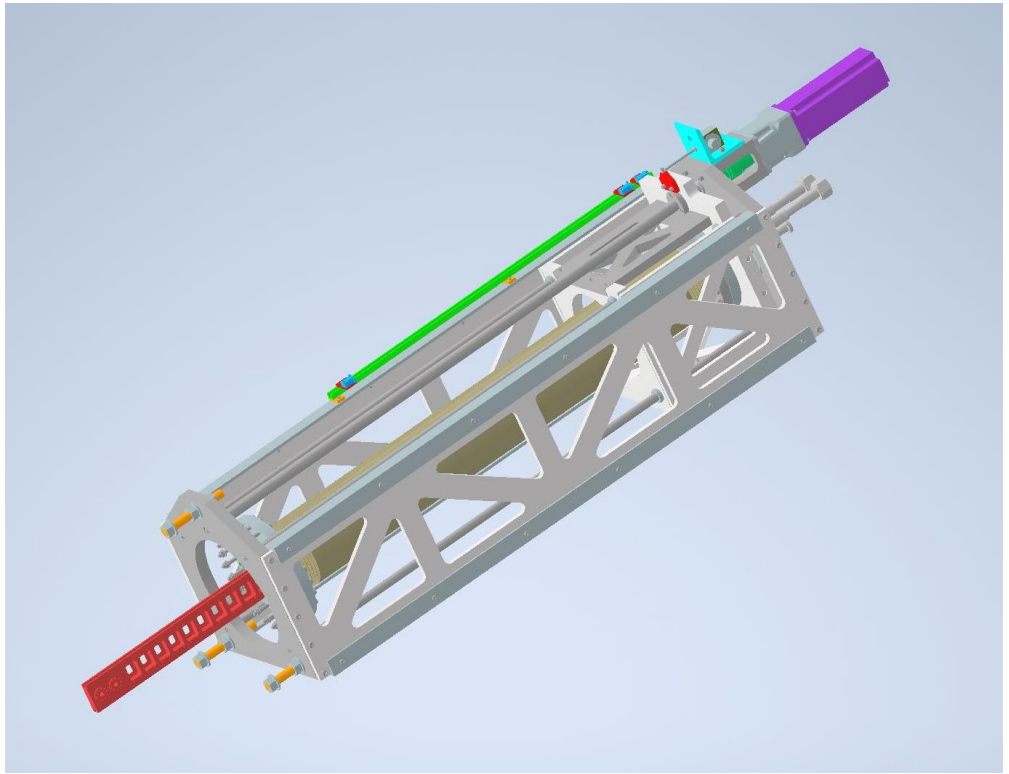
Scattering Chamber
(norm beam height)

Scattering
Chamber post



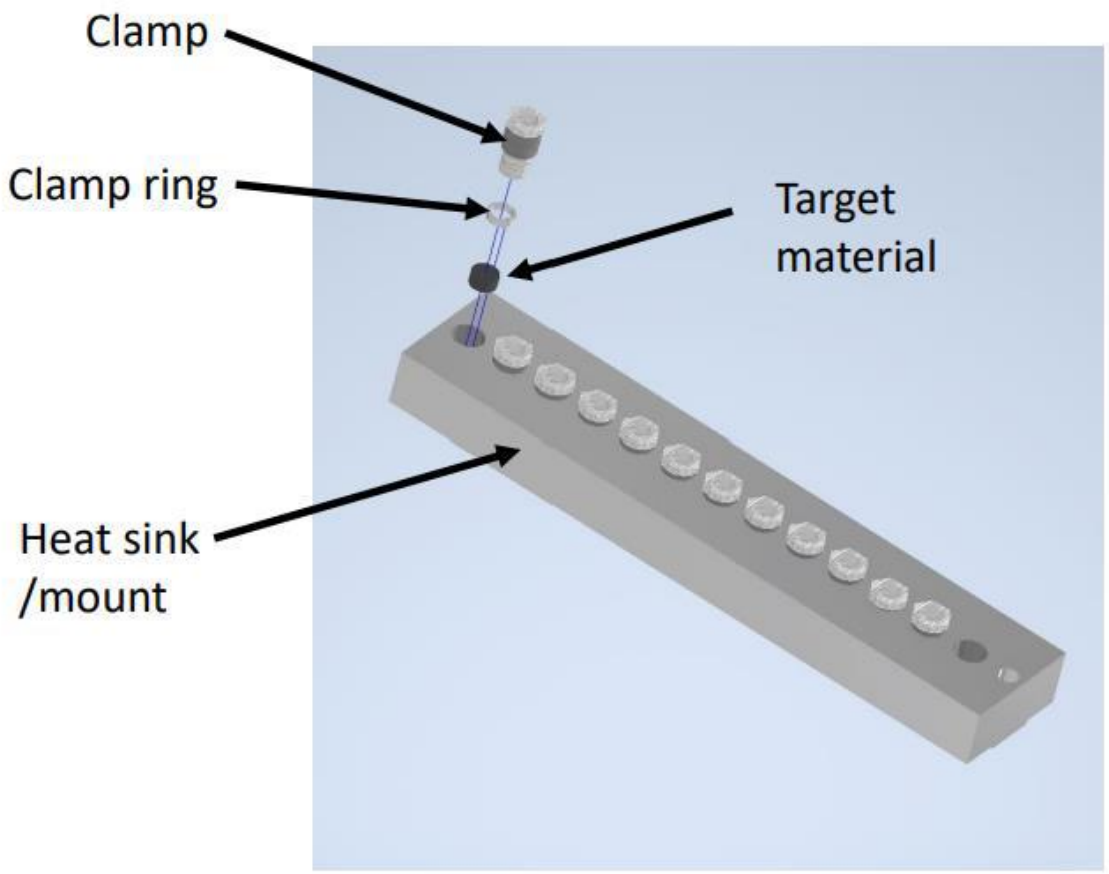
Motion System and Ladder

- Adapt PREX target to HKS.
  - Horz to vertical (Beam y)
- Cryogenic system
  - Component design used for PREX
- Greater than 24 inches of linear travel
  - This can accommodate all solid and fluid targets
  - Difficult to align we do not have 6 deg of freedom
- We can use existing gas handling system for fluid targets
- We can also use much of the existing control system
  - Epics based



Repurpose $x_b > 1$ Ladder

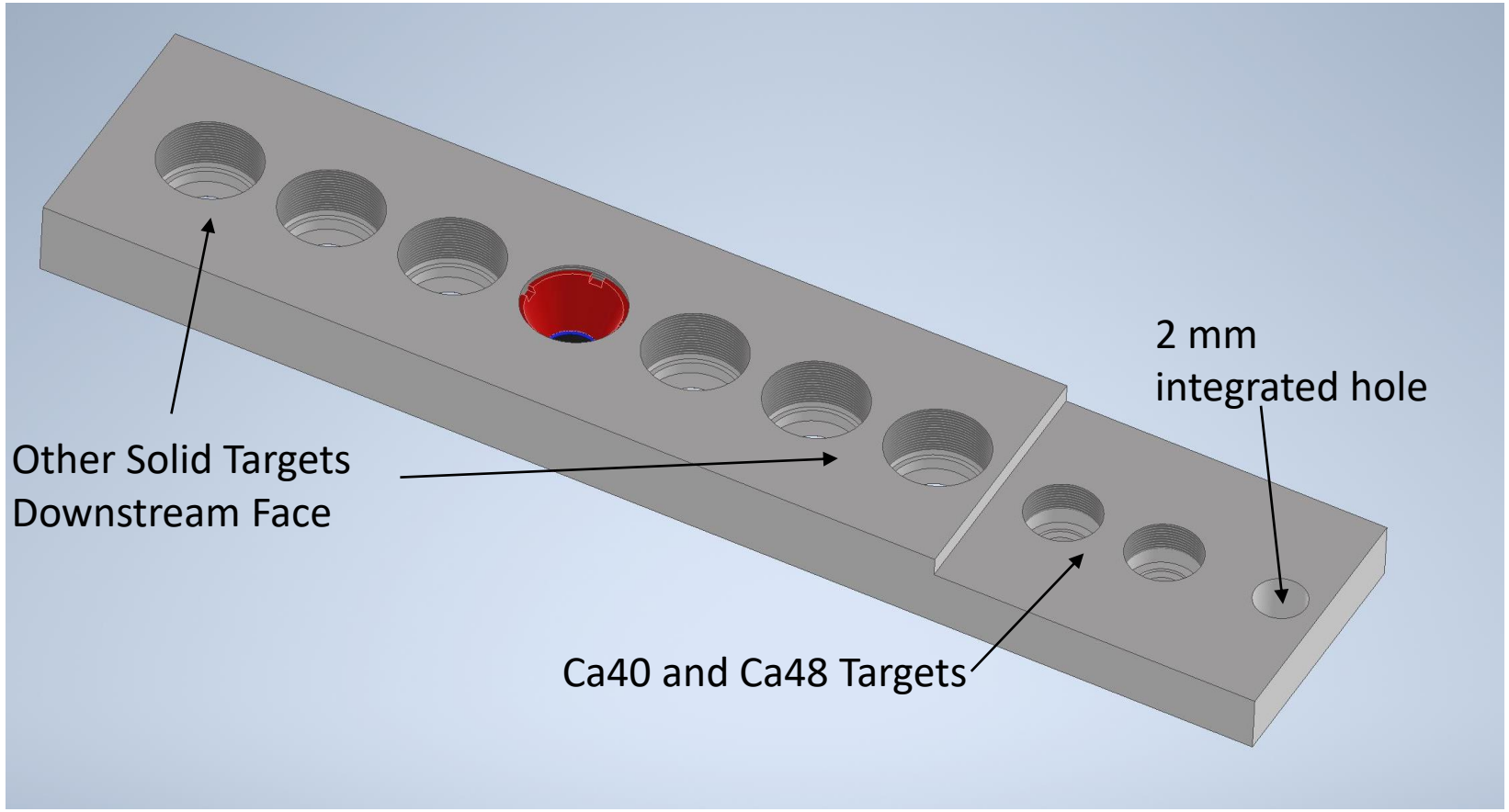
- Upstream face view shown to right
- The acceptance of Enge will be shadowed by the mount system
- Design features excellent thermal contact for the target material and for the clamp
- Design is partially in response to beam missteering event in Hall A/CREX where Ca48 target was damaged.



Concept Solid Target Ladder

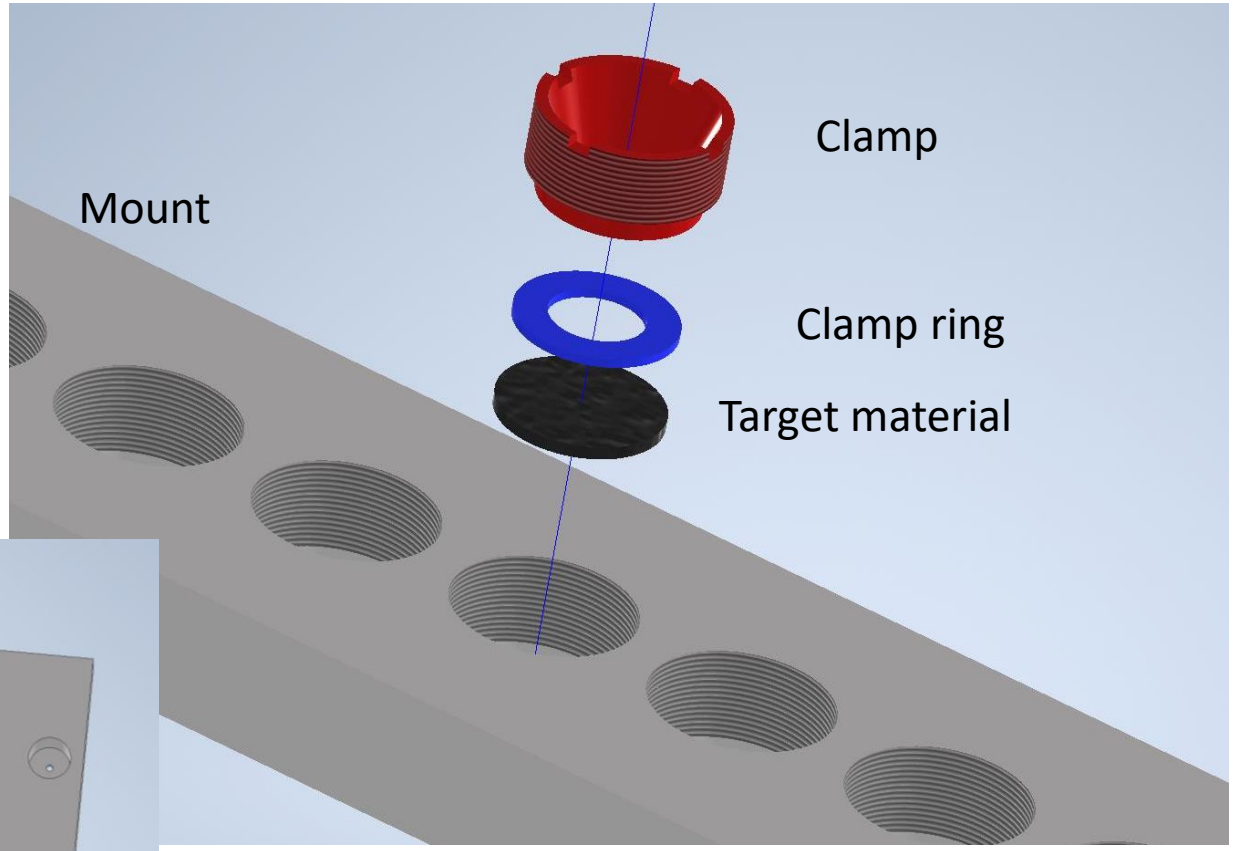
Calcium target mount is recessed for cost saving.

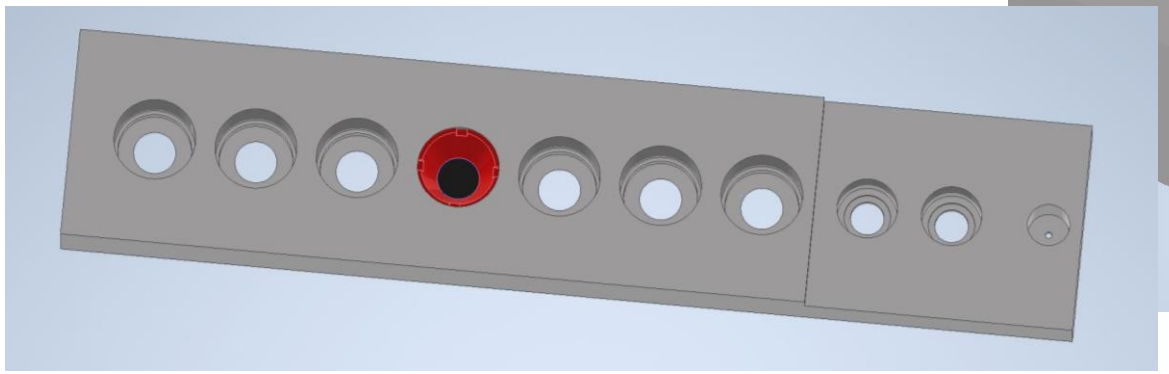
Without recess, $120K more in Ca48



Concept Solid Target Ladder

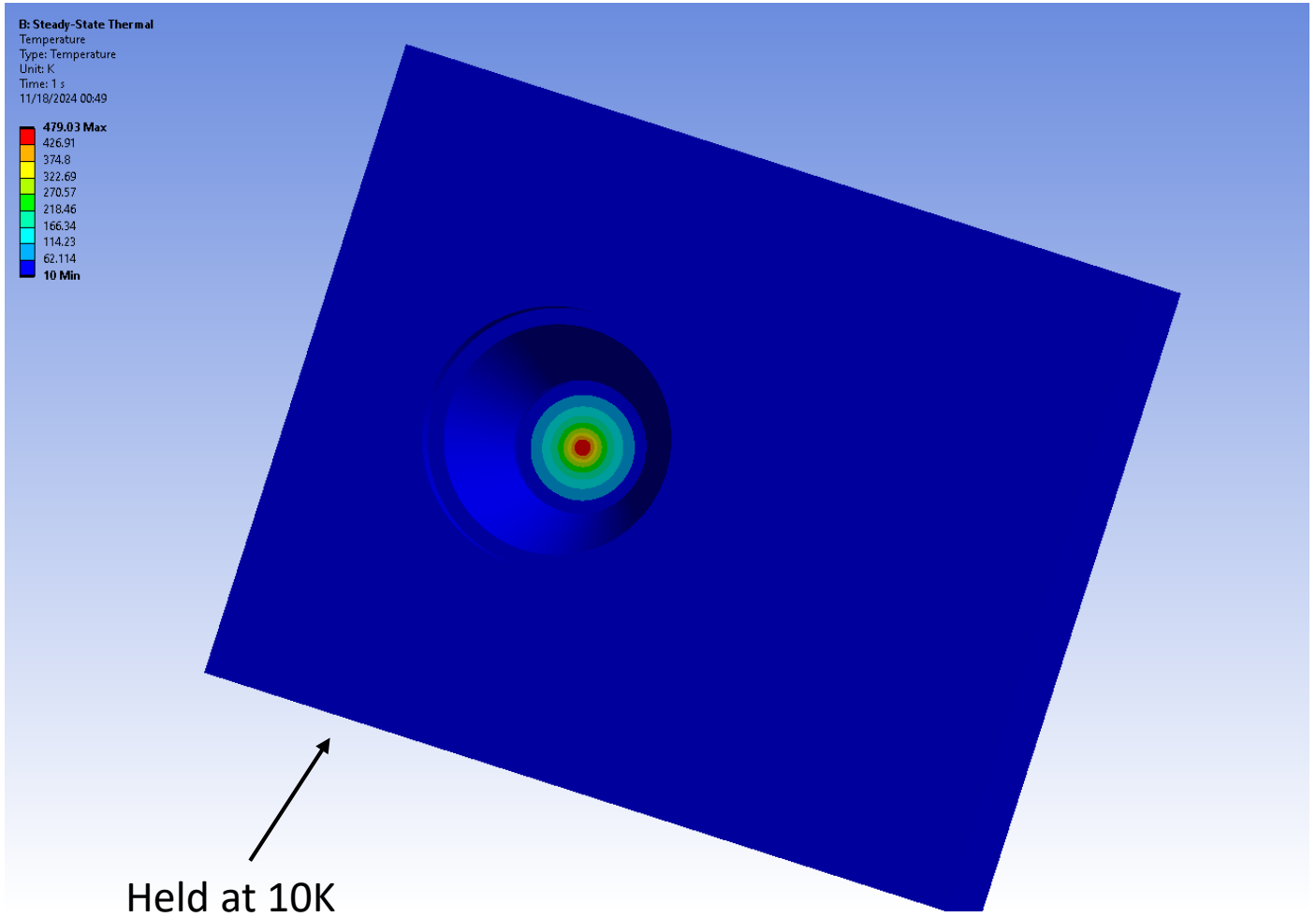
- All components (ex targets) are aluminum 7075
- Nuclear grade antiseize used for better thermal cond and to prevent seizing
- All 9 targets can be accommodated with full acceptance for all three spectrometers





Thermal Model for Lead-208 Assy.

- $\rho t = 150\, mg/cm^3$
- Beam current 25 microA
- $t = 0.13\, mm$
- 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 ~600K
  - FCC below 600K
- Independent analysis by S. Covrig-Dusa, F. Garibaldi, G.Urciuoli
  - Max temp ~400K
  - Slightly different geometry



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
  - Fluid target piping $20K
  - T-lines $20K
  - Transfer Can
    - Option 1: Reuse PREX can for solid targets only
    - Option 2: Possibly redesign/build for fluid targets ($50K)
  - Chamber/Stand $50K
  - Total: ~$400K

Solid target costs

Target	Z	A	Thick (mg/cm^2)	Density (g/cc)	Req Thickness (cm)	Required Mass (g)	Cost	Imax (microA)
Helium-3	2	3		0.0325	200.000		$ 30,000.00	50
Helium-4	2	4		0.0335	200.000		$ 30,000.00	50
Deterium	1	2		0.024	200.000			50
Hydrogen				0.01	200.000			50
CH2 (C2H4)n			0.45	0.93	0.484	1.647	$ 500.00	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	$ 80,000.00	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

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

Labor Resources Required to Fabricate

- Design solid targets only
  - Design Authority 480 hours
  - Designer 320 hours
- Fabrication
  - 6 months of calendar time at least for target group
    - Need welder, fitter, DA …
    - Machine shop work (build to print components)
    - Ca48 can take up to 12 months to procure if approved by DOE.
- These estimates could carry significant measurement error
  - Procurement estimates are currently difficult to make.
  - Work processes have be significantly impacted by recent changes to procedures and requirements.