# Hypernuclear Target System

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Hall C Hypernuclear Experimental Readiness Review

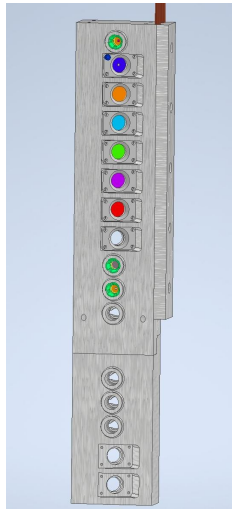
June 4, 2026

# Overview

- Conceptual design
  - Overall view
  - Design concept
  - Ladder design
  - Thermal analysis of key targets
- Target Project
  - Costs
  - Resources required

# Major Design Elements

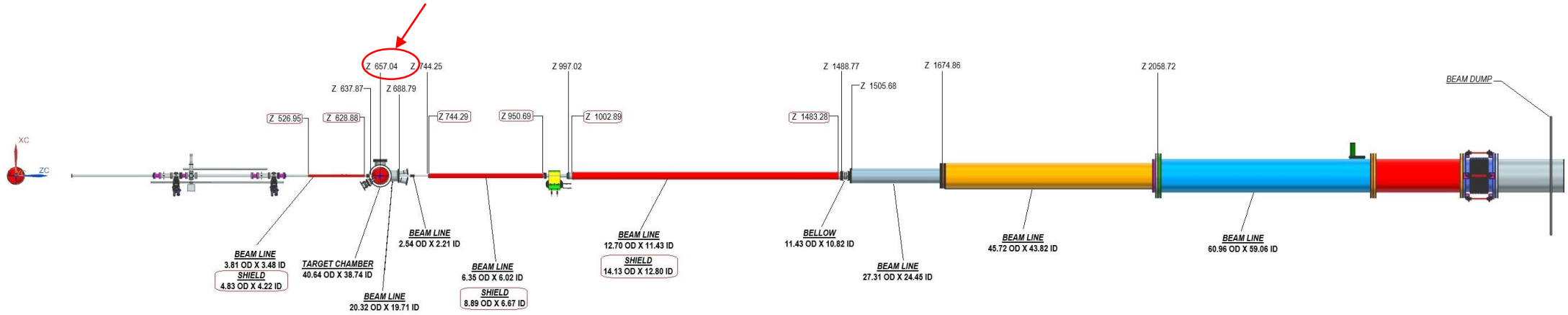
- Vacuum System
  - Chamber
  - Load lock
  - Stand
  - Pumping systems
- Cold Ladder
  - Cryo interface
  - Ladder
  - Motion system
  - Solid targets



- Cryo system
  - Transfer can
  - Small flex T-lines
  - Large supply and return T-lines with control valves
- Instrumentation and controls
  - Interlocks/FSD
  - Software
  - Instrumentation
  - Breakout boxes etc.

# Target Position in Hall C

Target is 6.57 m downstream from nominal pivot.



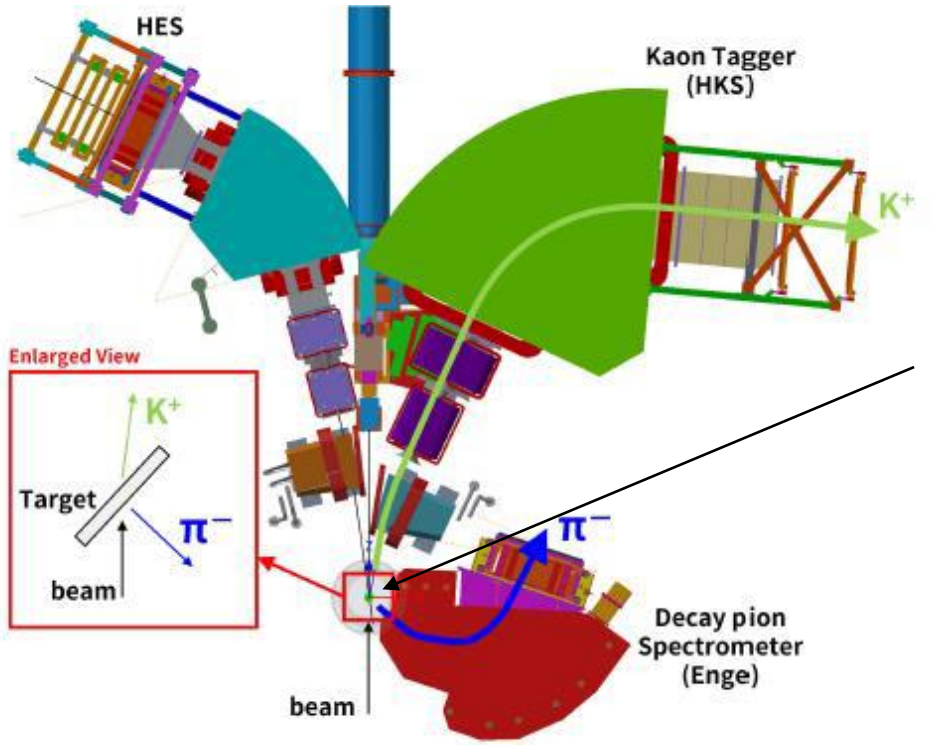

HYPER NUCLEAR BEAM LINE SIZE INFORMATION

04/14/2026

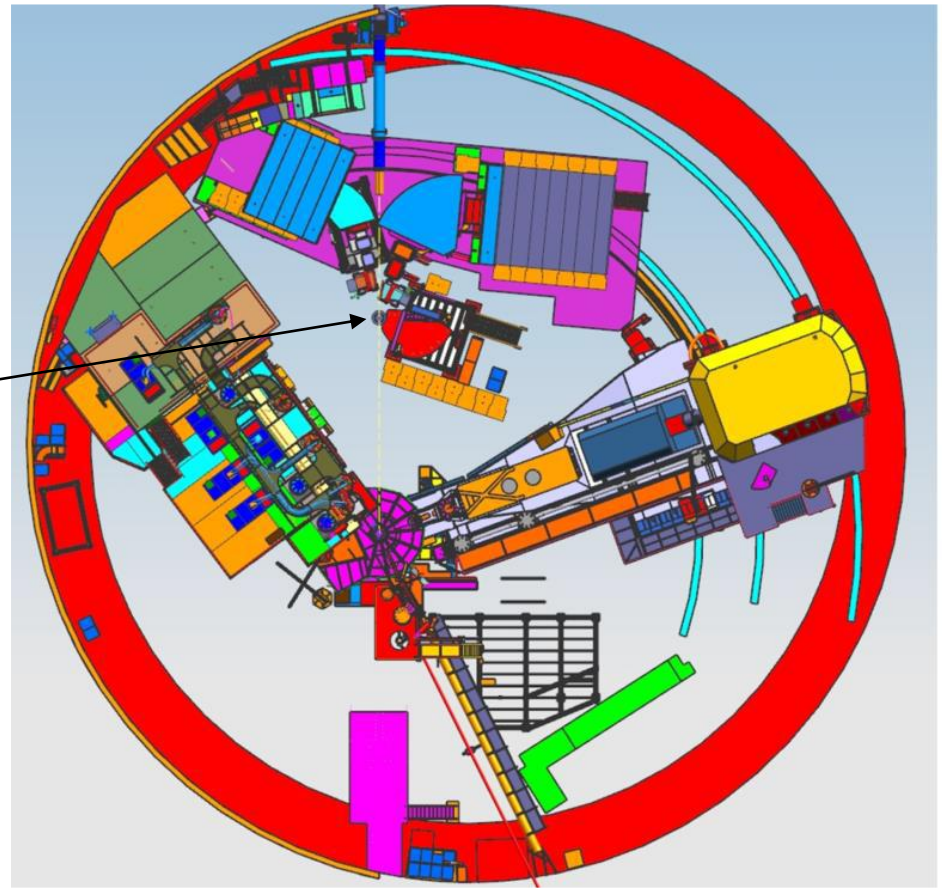
J. Shiflett

Units are (cm)

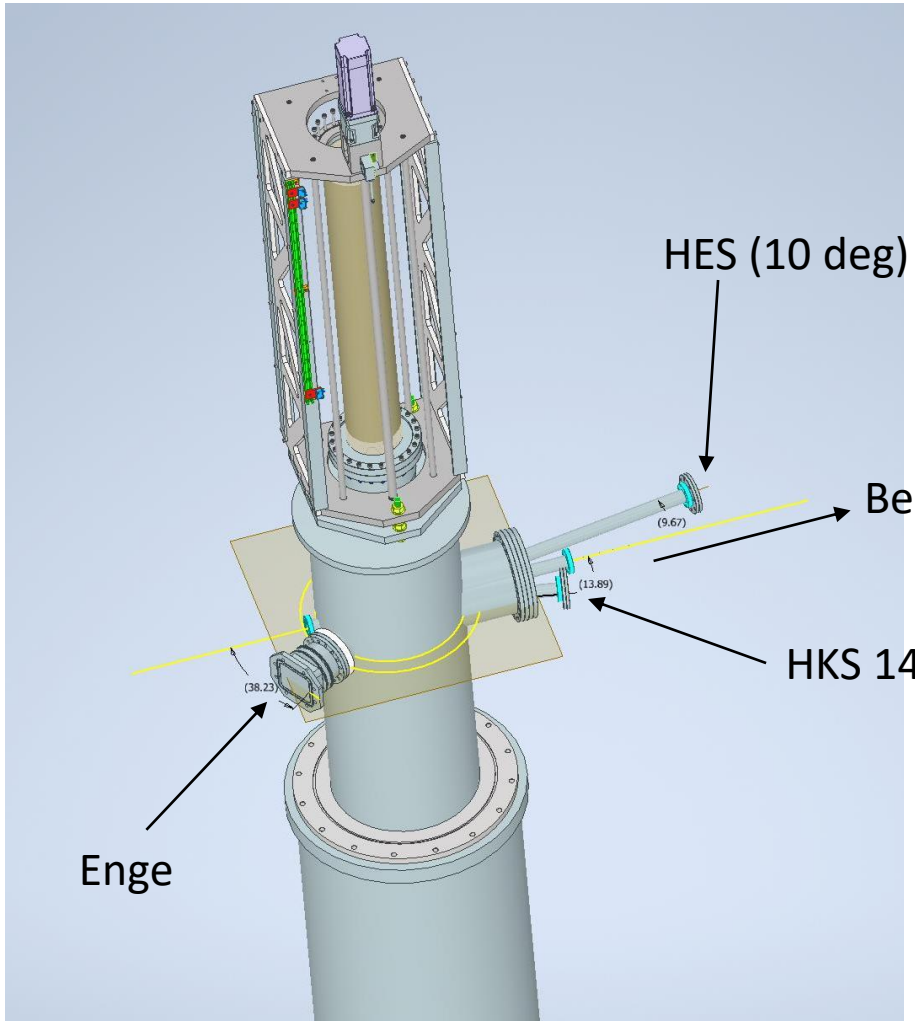
# Hall C HKS Layout




Target



# HKS Target Concept

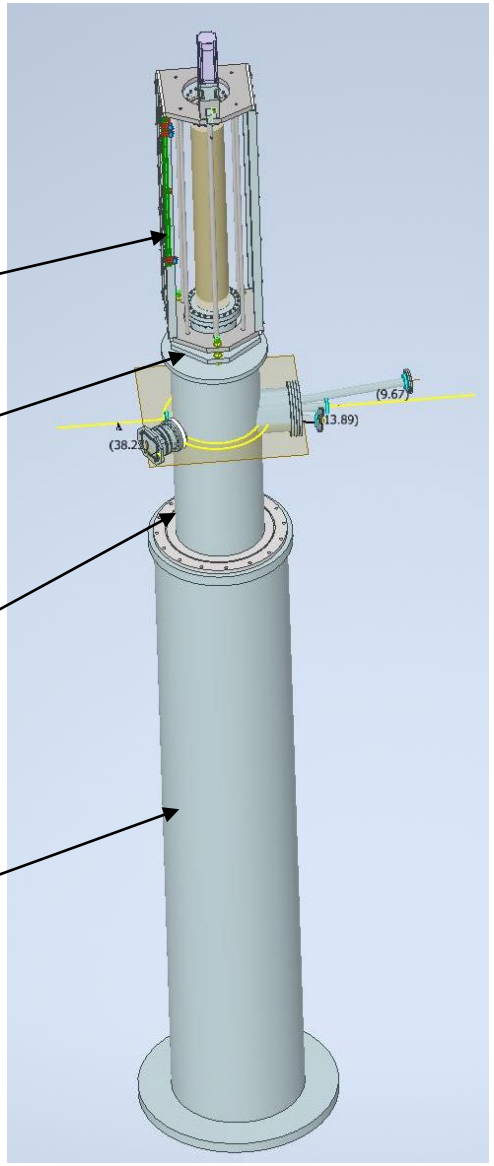



Motion system

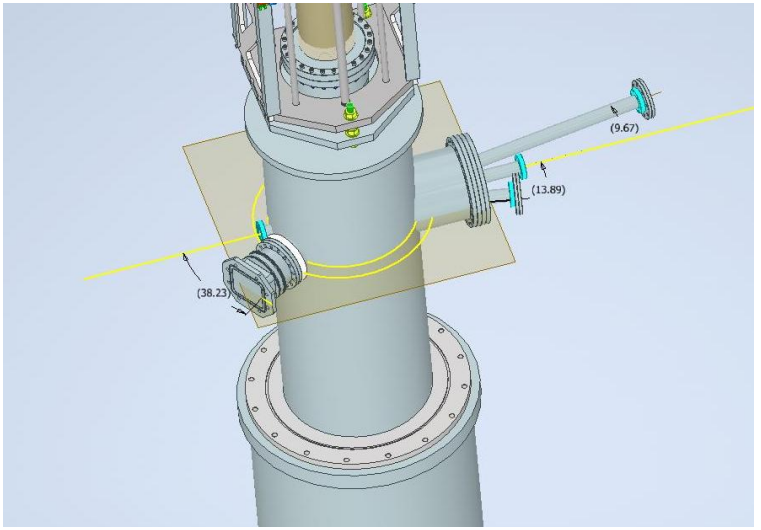
Proposed load lock

Scattering Chamber (norm beam height)

Scattering Chamber support



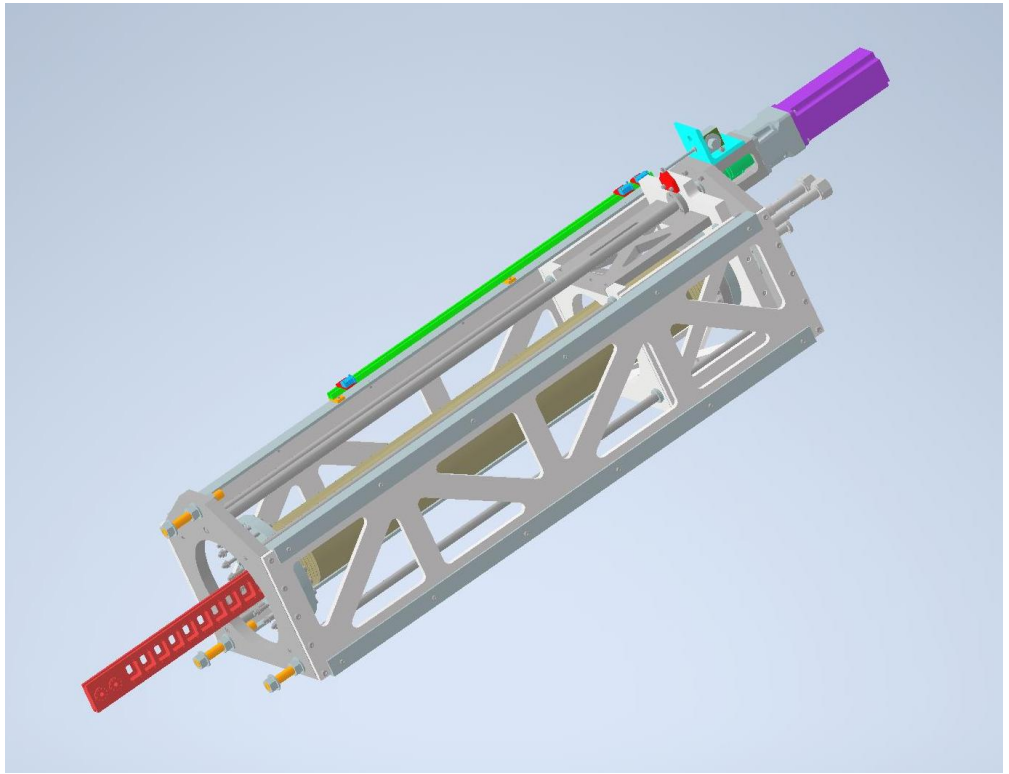
# Scattering Chamber Requirements



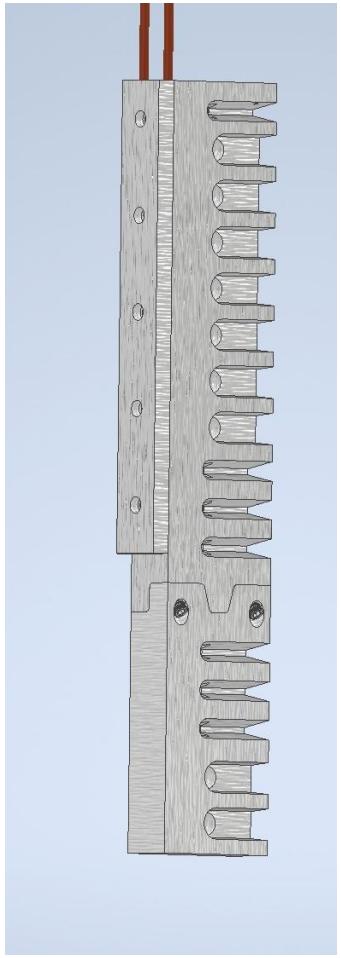

- 5 Connections to various vacuum spaces
  - Up/Down stream beamline
  - Each Spectrometer
  - All but one of these must be flexible connections
    - ENGE shall be fixed
- Load lock feature is needed
  - Allow full vacuum isolation from beamline and spectrometers
  - Provide easy access to the chamber for loading sensitive targets - Ca,Li, and LiH
  - Small volume for rapid pump down - Limit exposure time to sensitive targets
- Additional alignment fixture will need to be included
  - Chamber is fixed to ENGE.
  - Target alignment requirements driving the need for this subsystem

# Motion System and Ladder

- Develop new motion system with travel through load lock feature to handle O2 sensitive targets.
  - Travel requirement is extended to more than 30 inches with load lock/alignment components
  - This is additional expense and design/fab challenge
- Simple linear motion design for moving the target along the beam-y axis only
- Feedthru for cryogenic lines and thermometry
- Base model will be developed from PREX system

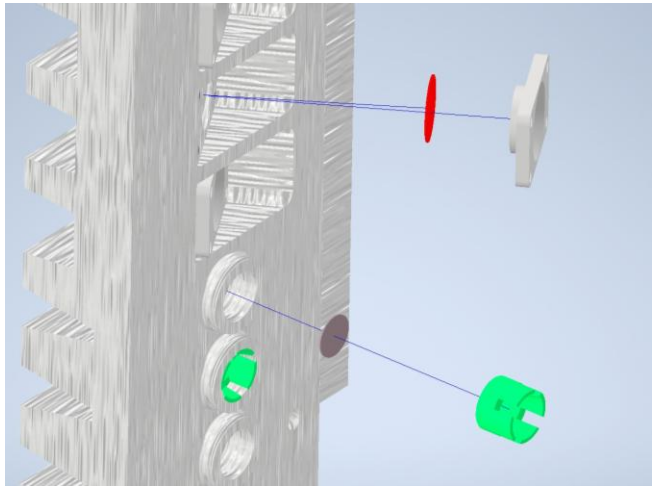


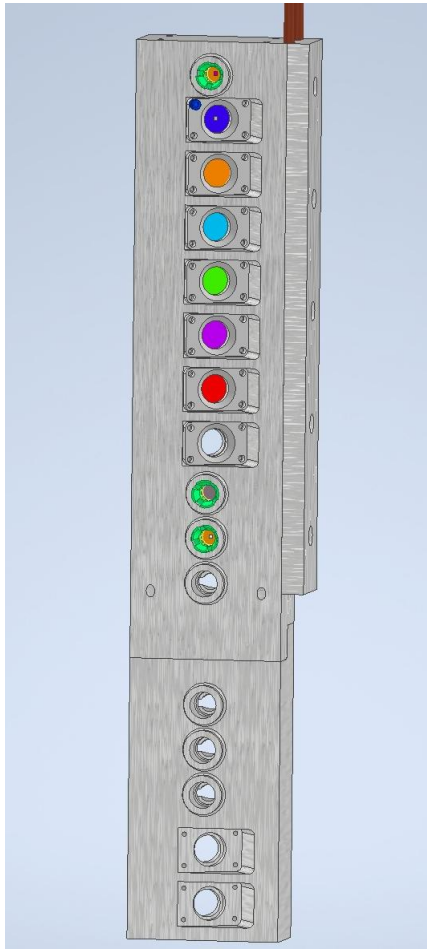
# Cold Ladder Concept



Upstream face

- Cryogenic ladder to carry full list of solid targets
- Accommodates both 0 deg and 30 deg targets
- Provides protection for sensitive/high value targets
- Cartridge feature should allow for quick loading of oxygen sensitive targets
- Fabricated from aluminum with copper cooling lines

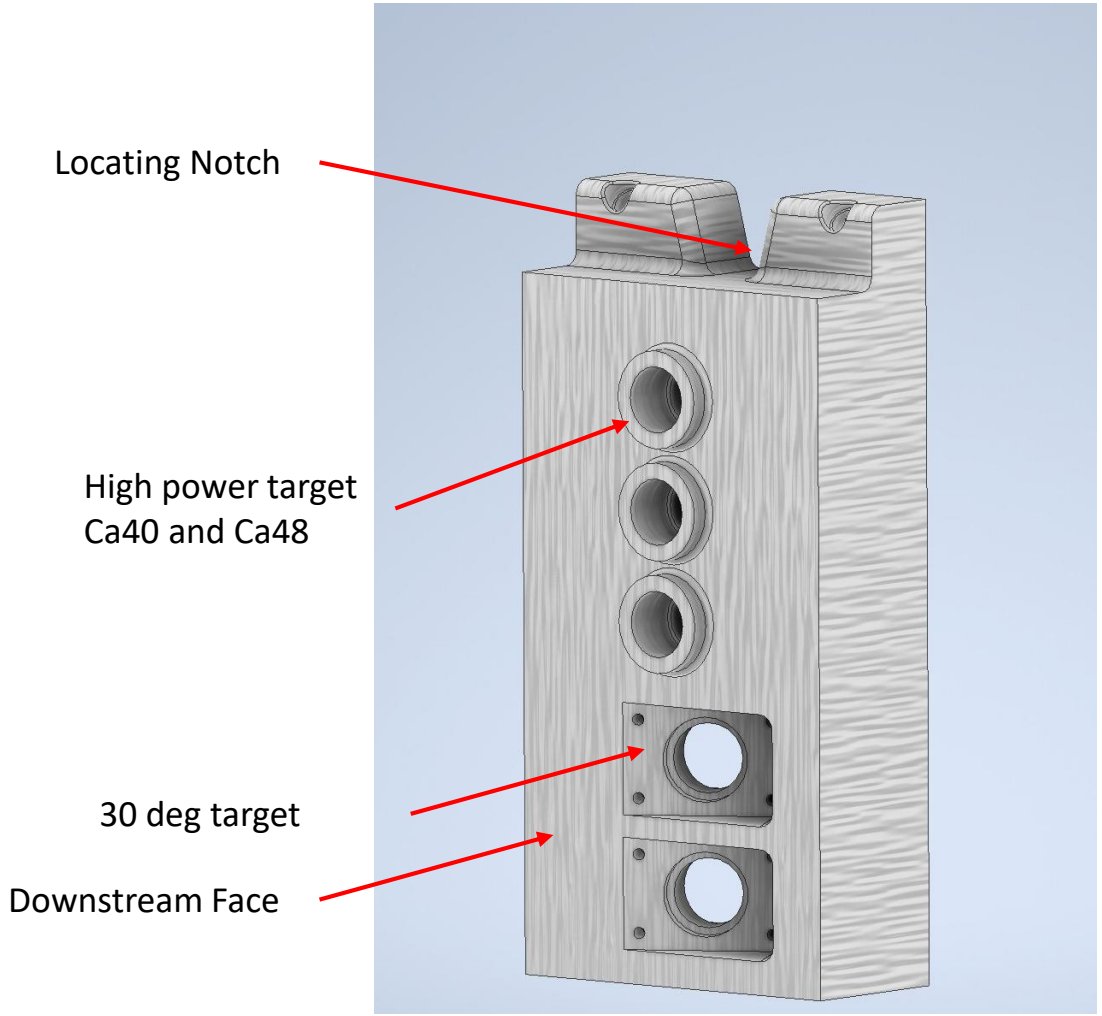




Downstream face

# Loadable Cartridge

- Concept design shown to right
- Loadable cartridge
  - Can be installed in load lock location
- Ca, Li, and LiH targets will be preloaded on Cartidge
- Hole target will be located on cartridge as well.
- Custom cartridge with hole will be developed for the $\alpha$ source
- Can quickly be installed
- Still offers decent thermal contact with main ladder
- Design optimization is still in progress



# Solid Targets

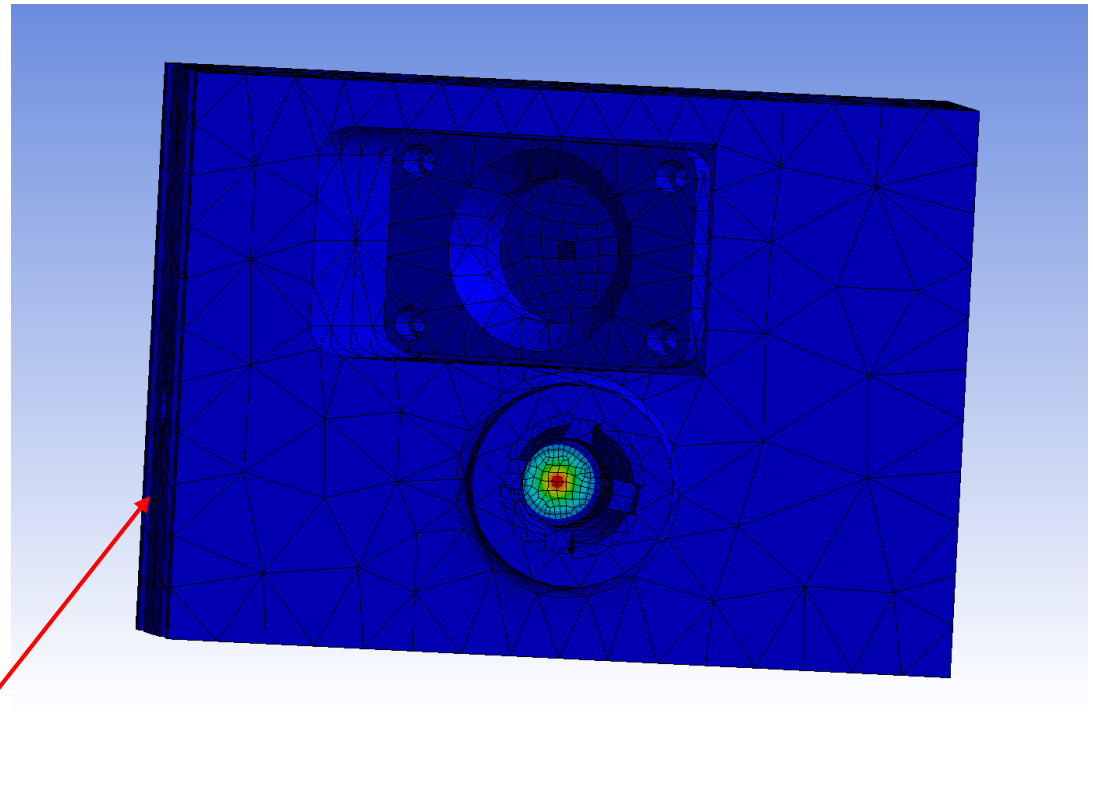
| Target # | Target | Thick $(mg/cm^2)$ | Beam Thickness $(mg/cm^2)$ | Min Raster $(mm\ x\ mm)$ | Imax $(\mu A)$ | Comment |
|---|---|---|---|---|---|---|
| 1 | $^{6}LiH$ | 87 | 100 | 2x2 | 50 | Energy Cal |
| 2 | $^{6}LiH$ | 87 | 100 | 2x2 | 50 | 1 $mm\ \Delta z$ |
| 3 | $^{208}Pb$ | 150 | 150 | 2x2 | 25 | |
| 4 | $^{208}Pb$ | 150 | 150 | 2x2 | 25 | Spare |
| 5 | $^{6}Li$ | 87 | 100 | 2x2 | 50 | |
| 6 | $^{27}Al$ | 130 | 150 | 2x2 | 50 | |
| 7 | $CH_2$ | 450 | 450 | 2x2 | 2 | Short life |
| 8 | $^{11}B_4C$ | 110 | 127 | - | 50 | |
| 9 | $C$ | 87 | 100 | - | 50 | |
| 10 | $C$ | 65 | 75 | - | 50 | |
| 11 | $C$ | 87 | 87 | - | 50 | |
| 12 | $^{9}Be$ | 87 | 100 | - | 50 | |
| 13 | $^{40}Ca$ | 150 | 150 | 2x2 | 50 | |
| 14 | $^{48}Ca$ | 150 | 150 | 2x2 | 50 | |
| 15 | $Hole$ | - | - | - | 50 | Integrated |
| | H2O* | 500 | 500 | 2x2 | 5 | Windows do not conduct heat well |
| | $\alpha$ source | - | - | - | 0 | ENGE Cal. Removed before beam |

* H2O cell backup for LiH

Rotated $30^o$

Thermal Model for Lead-208 Assy.

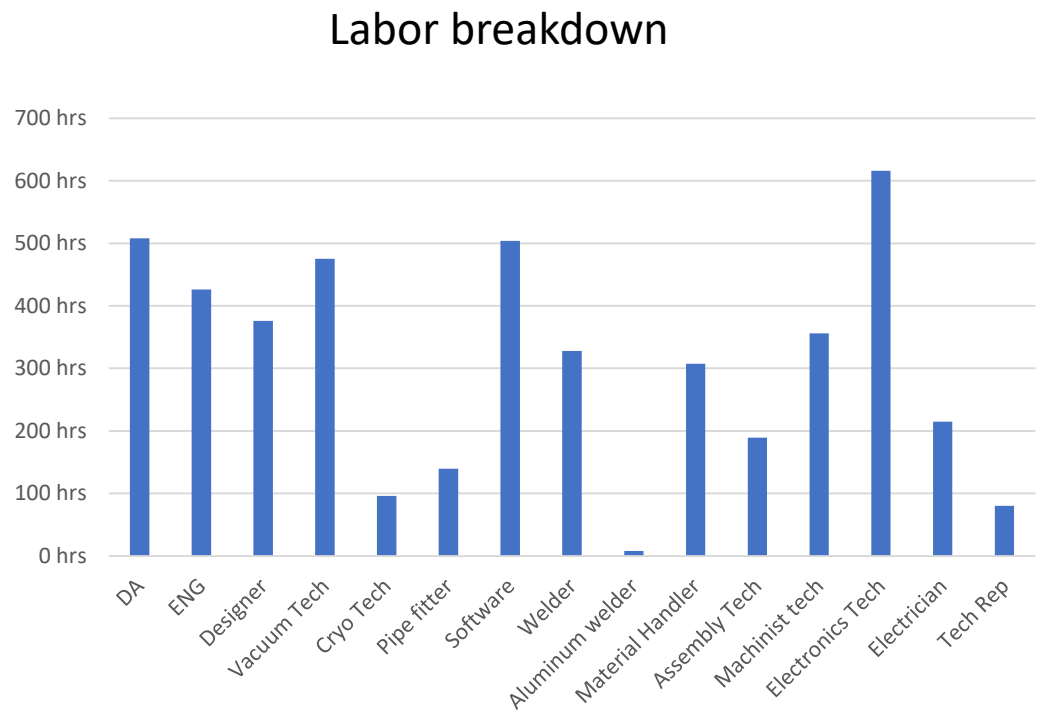
- $\rho t = 150\, mg/cm^3$
- Beam current 25 microA
- $t = 0.13\, mm$
- 6W of beam heat
- Power density is $12\, W/mm^3$
- Cooling channel held at 40K
- Material models
  - MPDB for lead
  - MPDB and Weisend for Aluminum 7075
- Max temp 470K
  - Lead melts at ~600K
  - FCC below 600K



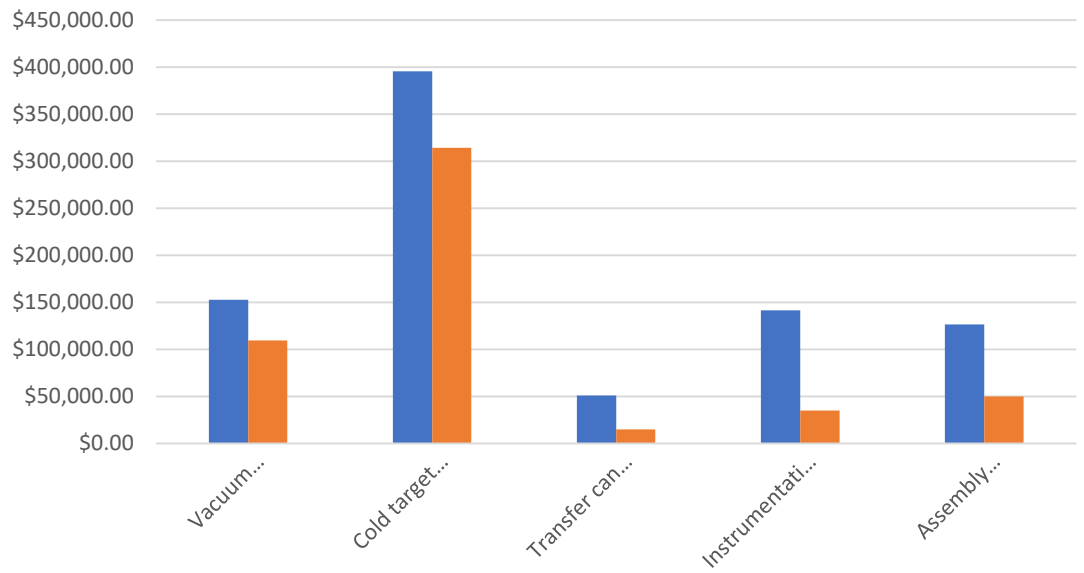
Held at 40K in cooling channel

# Labor Resources Required to Fabricate

| Name | Remaining Work |
|---|---|
| DA | 507.81 hrs |
| ENG | 426 hrs |
| Designer | 376 hrs |
| Vacuum Tech | 475.33 hrs |
| Cryo Tech | 96 hrs |
| Pipe fitter | 139.33 hrs |
| Software | 504 hrs |
| Welder | 328 hrs |
| Aluminum welder | 8 hrs |
| Material Handler | 307.33 hrs |
| Assembly Tech | 189.33 hrs |
| Machinist tech | 356 hrs |
| Electronics Tech | 616.19 hrs |
| Electrician | 214.67 hrs |
| Tech Rep | 80 hrs |



# Cost Estimate




## Cost Breakdown

| Name | Remaining Cost | Cost2 |
|---|---|---|
| HKS Target System | $866,266.13 | $523,500.00 |
| Vacuum System | $152,440.00 | $109,500.00 |
| Cold target ladder | $395,360.00 | $314,000.00 |
| Transfer can and T-lines | $50,760.00 | $15,000.00 |
| Instrumentation/Controls | $141,369.47 | $35,000.00 |
| Assembly Installation | $126,336.67 | $50,000.00 |
| | | |
| H2O cell/ladder | ++ $106,000.00 | ++ $50,000.00 |

Solid target materials $250K

# Target Group Skill Matrix

| | Group Member | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Skill** | D. Akers | J. Brock | C. Carlin | C. Flanagan | D. Griffith | M. Hoegerl | P. Hood | T. Kagawa | C. Keith | H. Lu | S. Madlock | J. Maxwell | D. Meekins | J. Thorton | D. Williams |
| Assembly Tech | | √ | | √ | √ | √ | √ | | √ | √ | √ | | √ | √ | √ |
| Cryo Tech | | √ | | | | | √ | | √ | | √ | | √ | | |
| DA | √ | | | | | | | | | | | | √ | | |
| Designer | √ | √ | | √ | | | | | | √ | | | √ | | |
| Electrician | | | | | √ | | | | | | | | | | |
| Electronics Tech | | √ | √ | | √ | | | | √ | | | | √ | √ | |
| ENG | √ | √ | | | | | | | √ | | | | √ | | |
| Machinist tech | | √ | | | | √ | √ | | | | √ | | √ | | √ |
| Material Handler | | √ | | | | √ | √ | | | | √ | | √ | | √ |
| Pipe fitter | | √ | | | | √ | √ | | √ | | √ | | √ | | |
| Tech Rep | | √ | | | | | | √ | √ | √ | | √ | √ | | |
| Vacuum Tech | | √ | | | | | √ | | √ | | √ | | √ | | |
| Welder | | | | | | √ | | | | | √ | | | | |
| Software | | | √ | | | | | | √ | √ | | √ | √ | | |

# Summary

- HKS Target list has been finalized
- Conceptual design has matured to meet requirements for 3 spectrometer operations
- Total estimated cost $870K
  - Non-labor $500K ($250K for solid targets)
  - Roughly 4800 hours of labor to complete
- Target group has resources to complete this work however, there is competition for these resources.