HKS Target Design and Status

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Design Status

- Design is in concept stage
  - Solid target concept complete
  - Gas targets will need input from collaboration
- Exploring 2 options
  - System with solid targets only
  - System with both fluid and solid targets
- Both systems require cryogenic cooling
  - Pb and Li both benefit from this
  - He and Hydrogen gas cells will need it to reach proposed densities
- A simplistic method for optimization of the cells/solid targets has been developed
- Fluid systems are designed to appropriate Codes and Standards
  - Somewhat limiting

“Original” Proposal (circa 2022)

- Solid targets
  - Some basic solid targets
    - C, Al, B4C etc.
  - More Challenging
    - Lead, Ca40,48, Li6 etc.
- Gas Cells
  - H2, He3 and He4
  - Tuna can with vertical axis perpendicular to the beam
  - Diameter is 20 cm
  - Total Al thickness 162 mg/cm^2
  - Gas pressures low

Optimization of the Cells

- Assumptions for improvement
  - Thinner cells walls
  - Higher fluid densities
  - Smaller diameter
- Plan to use actively filled cells
  - This is contrast to the tritium target were the cells were filled with a static pressure
  - Two gas isotopes can be used concurrently
  - One gas species at a time (e.g., H2 and D2)
- Requires gas handling system
  - PREX target did not requrie

Status of Optimization

- Cell geometry
  - 7.5 cm tuna can
  - Wall thickness depends on fluid pressure
  - Height of thin section is 2 cm
  - Mechanical knife edge sealing system
  - No welding on cell or cell block
- Fluids: 2 options
  - Option 1: Fluid pressure 60 psia – wall thickness 0.13 mm
  - Option 2: Fluid pressure: 130 psia – wall thickness 0.25 mm
  - Operate He targets at 5.6K
  - Operate Hydrogen targets at 35K
- This improves the ratio of fluid to target cell wall as well as overall thickness
- Smaller cell form factor will be easier to design around

Comparison

Three concepts are compared

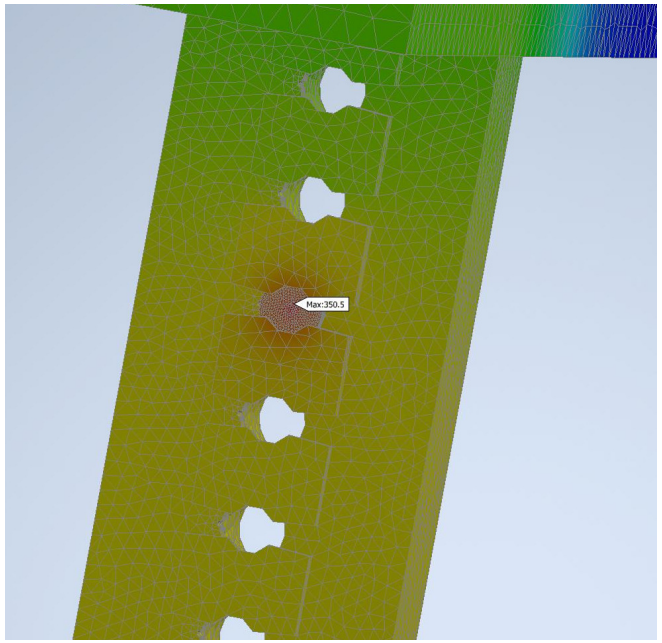
Fluid	**2022 Cell 2022**		**Option 1) P=60 psia**		**Option 2) P=130 psia**		**Fluid only**	**Fluid only**
	ρt fluid	Fluid to wall	ρt fluid	Fluid to wall	ρt fluid	Fluid to wall	#1 to 2022	#2 to 2022
	g/cm^2		g/cm^2		g/cm^2			
H2	54	0.33	24	0.35	61	0.45	1.13	1.13
D2	-	-	50	0.73	133	0.99	-	-
He3	165	1.02	322	4.7	566	4.2	1.95	3.4
He4	228	1.41	803	11.8	998	7.4	2.75	7.4

Thermal Loads

Target Matl Material	Wall thick (mm)	Rho of wall (g/cm^3)	Length (cm)	Imax (microA)	Nom Thick (gm/cm^2)	Density (g/cm^3)	Actual Thick (mm)	Q in wall (W)	Q in tgt (W)
H2	0.25	67.5	7.5	20	0.061	0.008	75	4.9	5.5
D2	0.25	67.5	7.5	20	0.133	0.018	75	4.9	6
He3	0.25	67.5	7.5	20	0.566	0.0755	75	4.9	32
He4	0.25	67.5	7.5	20	0.998	0.133	75	4.9	41
CH2				2	0.5	0.88	5.6		1.3
Li6				50	0.1	0.53	2		10
B4C(11)				50	0.1	2.52	0.5		8.5
C				50	0.1	1.8	0.5		8.5
Al				50	0.1	2.7	0.38		9
Ca40				50	0.075	1.5	0.5		7.5
Ca48				50	0.09	1.8	0.5		7.5
PB208				25	0.114	11.38	0.1		5

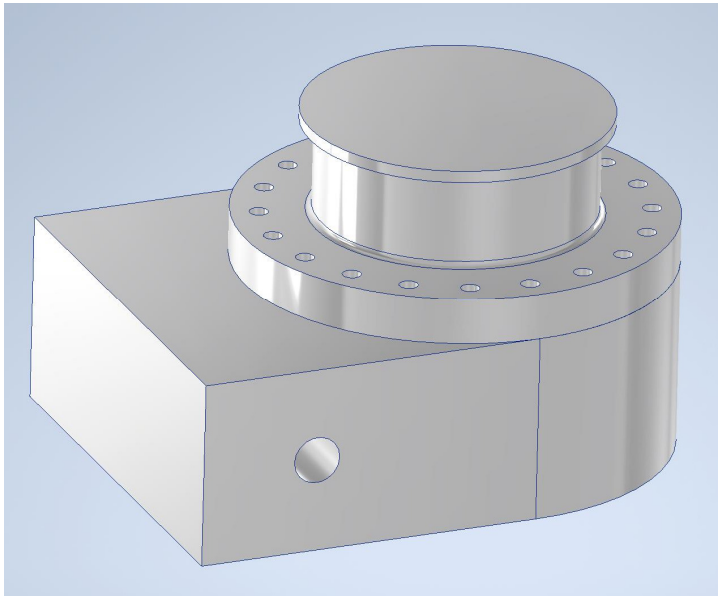
Analysis of Hall C Ca Solid Target

- 80 microA
- Heat sink 30K
- 2x2 mm raster
- Max temp 350K
  - Similar for Li
- This will not be any problem for HKS
- Still need to study lead



Concept Cell/Block Design

- Cell and block fabricated from ASTM B209 7075 aluminum
- All metallic seals no welding
- Cell is machined and measured to high accuracy.
  - 20% deviation on thin wall cell
  - 10% deviation on thicker wall cell
- Expect ~10% density reduction at full current
- Out of plane acceptance is larger than +/- 4 deg
- Fairly easy to fabricate
  - We have similar models with smaller radius

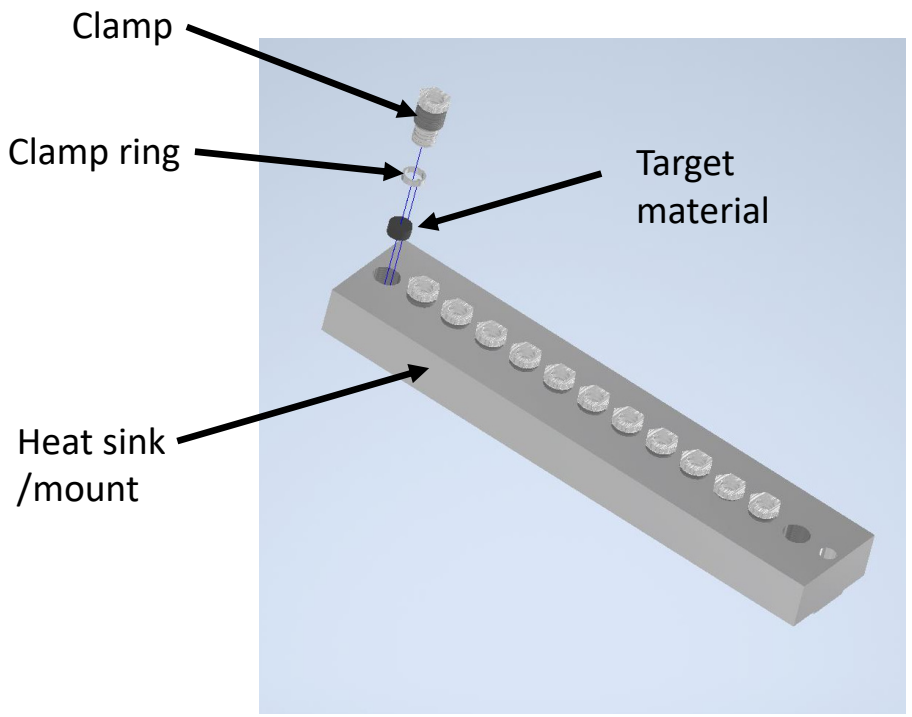


Solid Targets

- Lead and calcium will present challenges
  - Lead will need to be cryogenically cooled with good thermal conductivity
    - Realistic thickness will need to be at least 0.1 mm
  - Ca targets will need special handling
    - Ca48 stock at Jefferson Lab is highly compromised
    - Recommend purchasing new Ca48 foil ($50K to $60K)
- Other solid targets are relatively simple to work with
  - Proposed thickness are OK
  - Multi-foil: reduce to +/- 5 cm to closer match cell length
- Design path:
  - Combine latest Hall C solid target ladder with PREX/CREX motion system and T2 target style heat sink.

Solid Target Ladder

- Solid target design concept
- All components are aluminum 7075
- Target material is clamped into the frame with sufficient force to ensure good Kc
- Threaded clamp screws into heat sink
- Nuclear grade anti-seize is used to enhance Kc and prevent galling
- Clamp ring prevents spinning of the target foil
- Proven to work will all targets except lead
  - Has not been tested with lead
  - Thermal simulations are in process



Motion System

- Single axis motion system
- Feedthru via bellows
  - Cryo and target fluids are fed thru top flange
  - Thermometry located on ladder
- Position repeatable to better than 20 microns.
- Drive control system is already installed in Hall C

Scattering Chamber

- Will need to work with collaboration and Hall C engineering to develop this design
- Earlier we can start on this the better