Cryotarget for KLF

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Target Group

K-long requirements

Target Requirements for K-long physics

- Target materials: LH_2 & LD_2
- Target dimensions: 40 cm x 6 cm dia.
- Fluid density precision: ± a few percent (some boiling ok)
- Beam heating: negligible
- *z* location: same as GlueX

Is this correct? If not, please let me know now.

The GlueX Cryotarget

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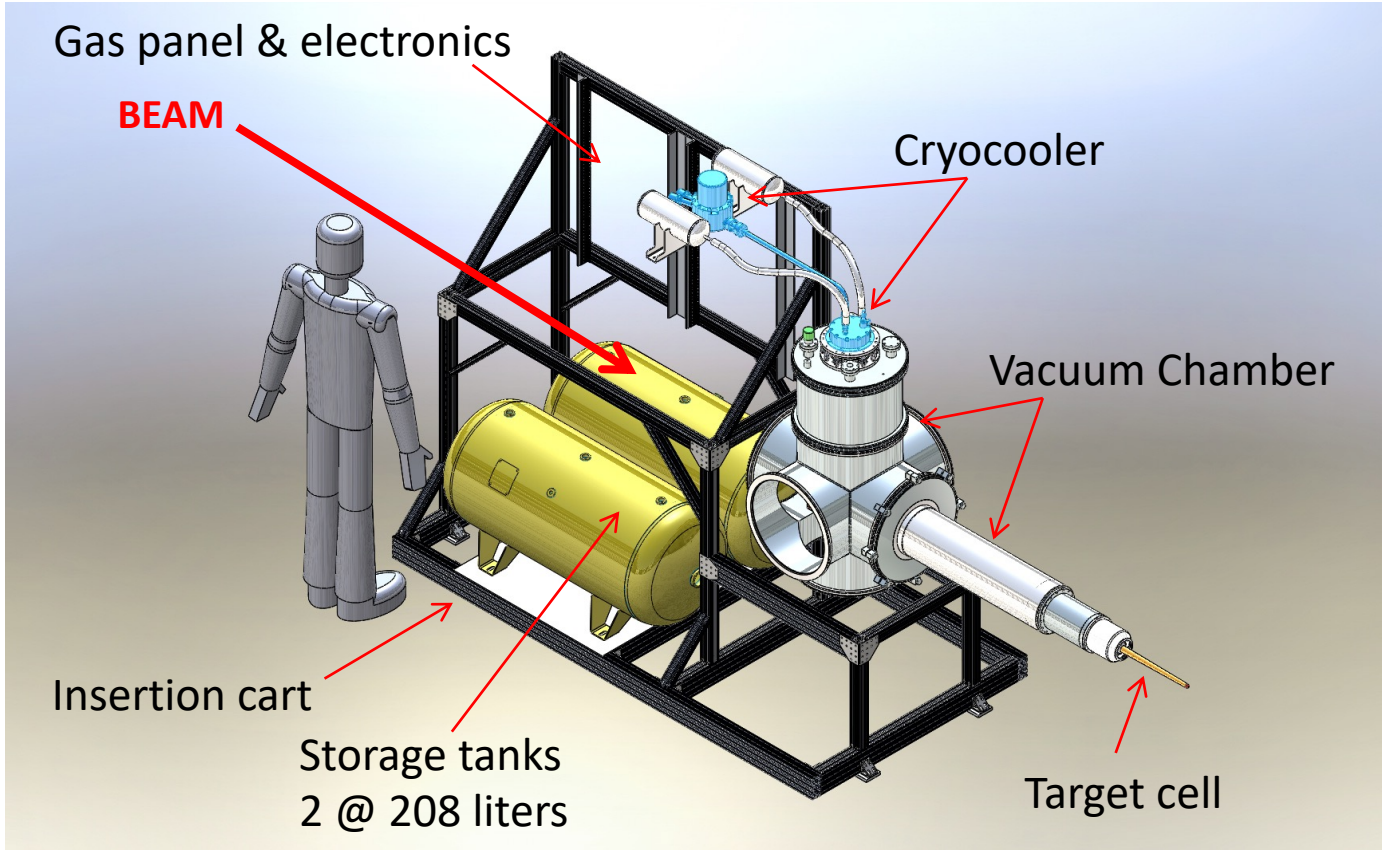


Our total gas inventory is ~ 73 g or 811 liters STP stored at 1.9 atm (29 psia)

The GlueX Cryotarget

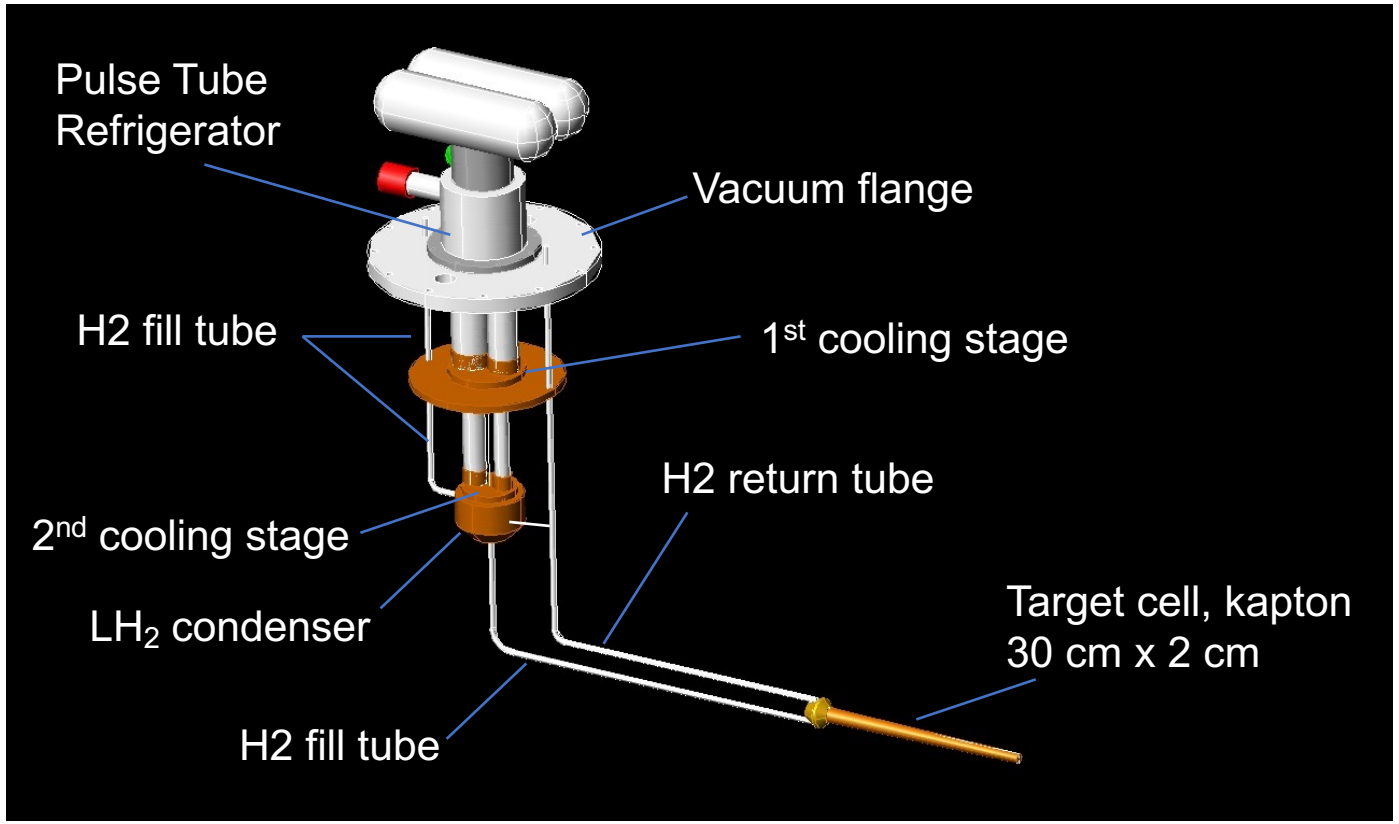
Hydrogen gas is cooled and condensed by a two-stage cryocooler

Base temperature: ~3 K
Cooling power: ~15 W @ 20 K

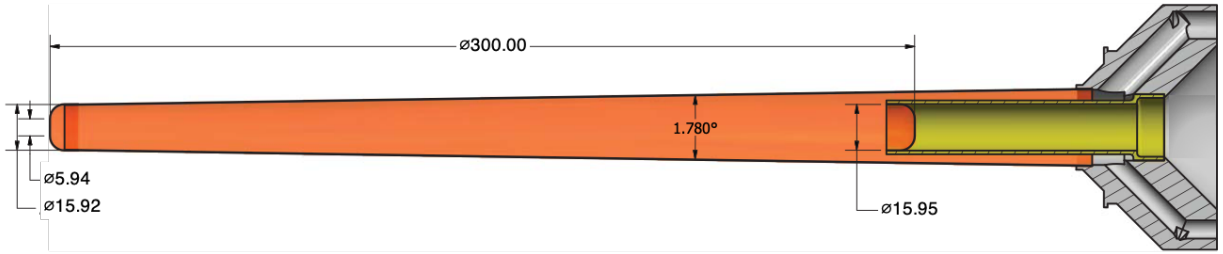
Convective flow between condenser and cell for faster cooling

Hydrogen is subcooled ~1 K below the vapor pressure curve to suppress boiling.

Temperature measured in two spots inside target cell (top & bottom)



The GlueX Cryotarget



GlueX Target Cell

Based on Hall B design

Ø1.6 x 30 cm^3

Volume: 0.12 L

Cylinder is 130 um aluminized kapton

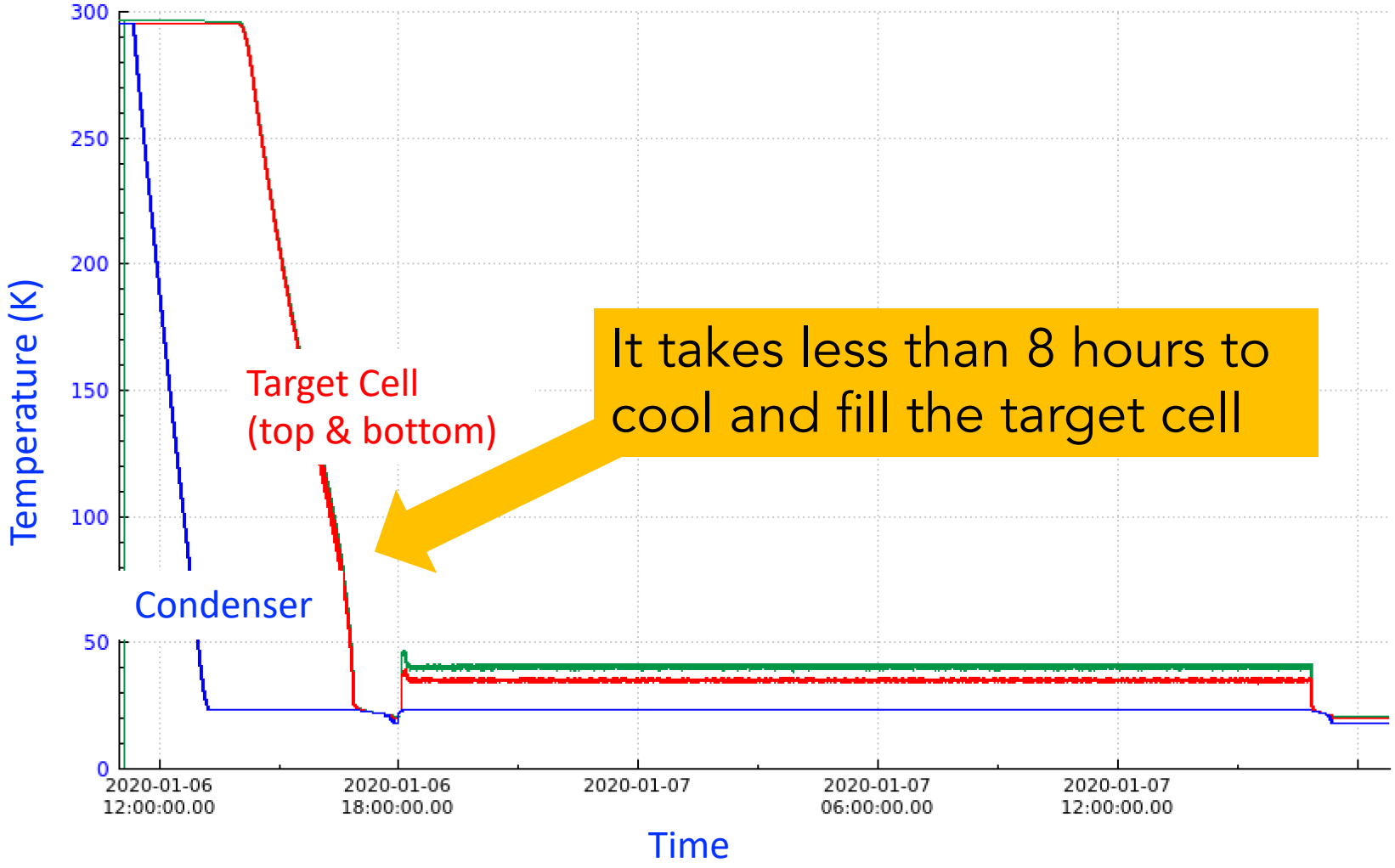
Entrance & exit windows are 75 um kapton

Base is aluminum, with stainless steel fill/return tubes

Maximum allowed pressure is 42 psid

➔ System is designed to release H_2 pressure at <42 psi during catastrophic loss of insulating vacuum

The GlueX Cryotarget



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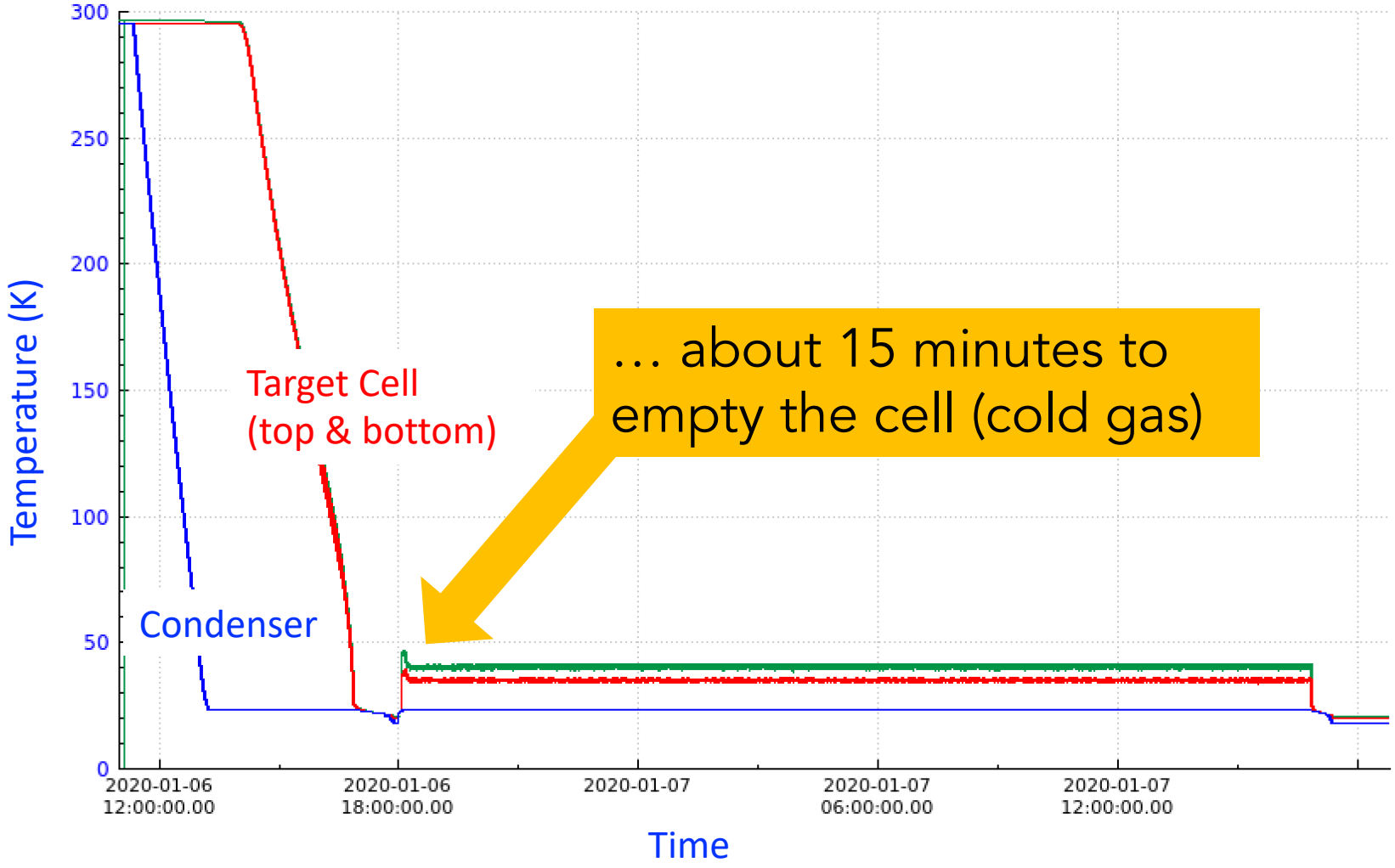
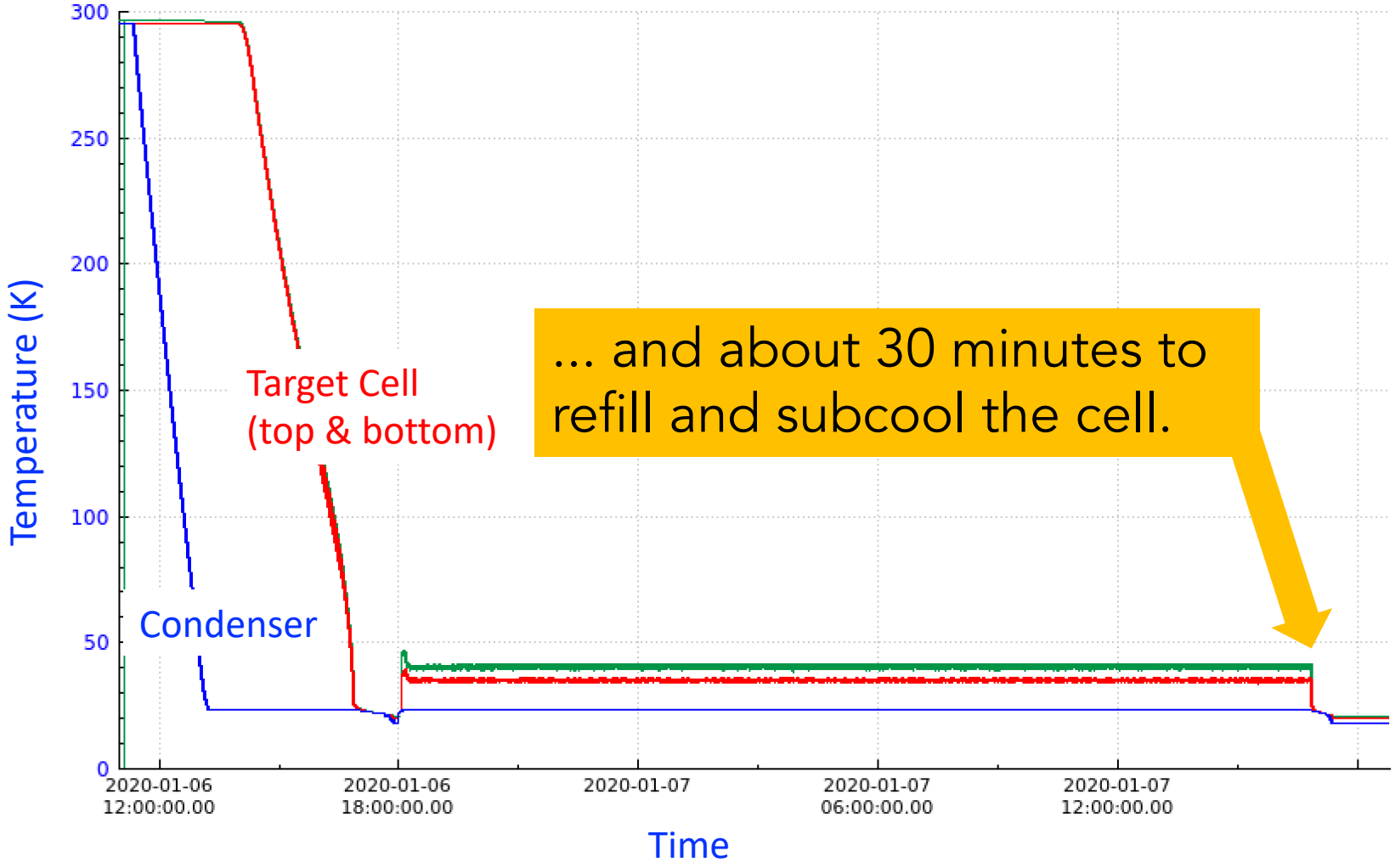


The GlueX Cryotarget

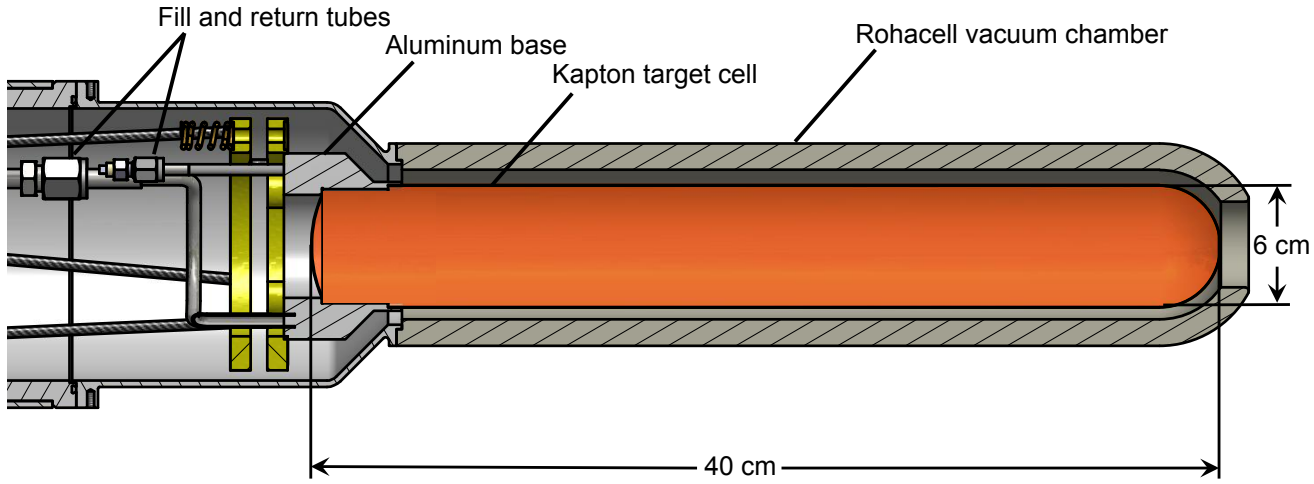


Modifications for KLF

Cell Volume

The proposed target cell for KLF has a volume of 1.1 L.

Dimensions are Ø6cm x 40cm



The cooling & warming times will increase:

- about 9 hours for initial cooling
- 45 minutes to empty the cell (filled w/ cold gas)
- 90 minutes to refill it

This is probably not a problem…

Modifications for KLF

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The proposed target cell for KLF has a volume of 1.1 L.

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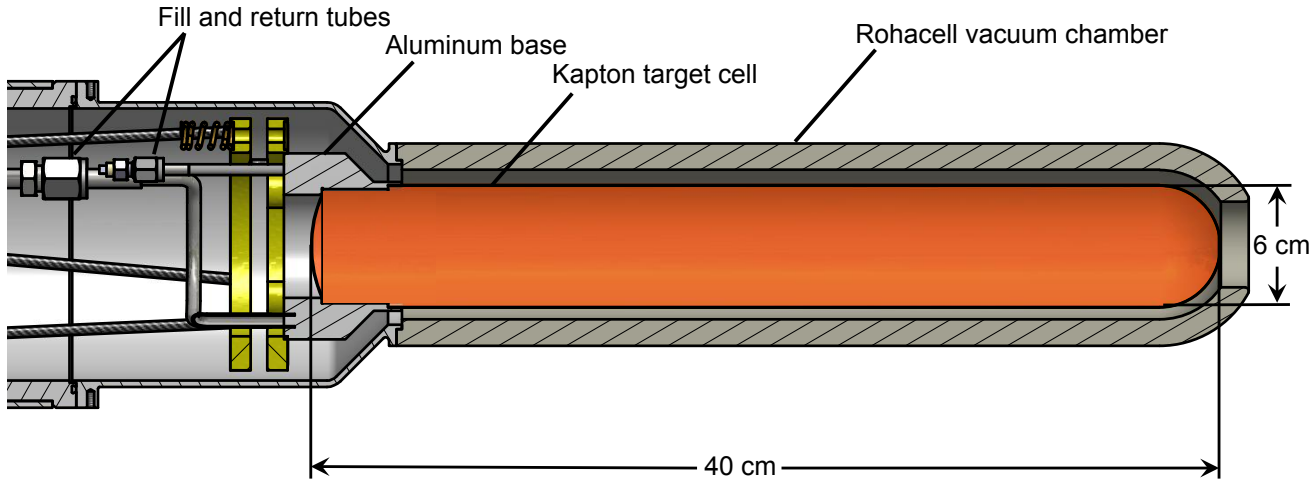


We must store more gas now: 1300 liters stp

Use existing 2x208 liter tanks: 3.1 atm (~45 psia)

We must change the pressure relief valves. And make the target cell stronger.

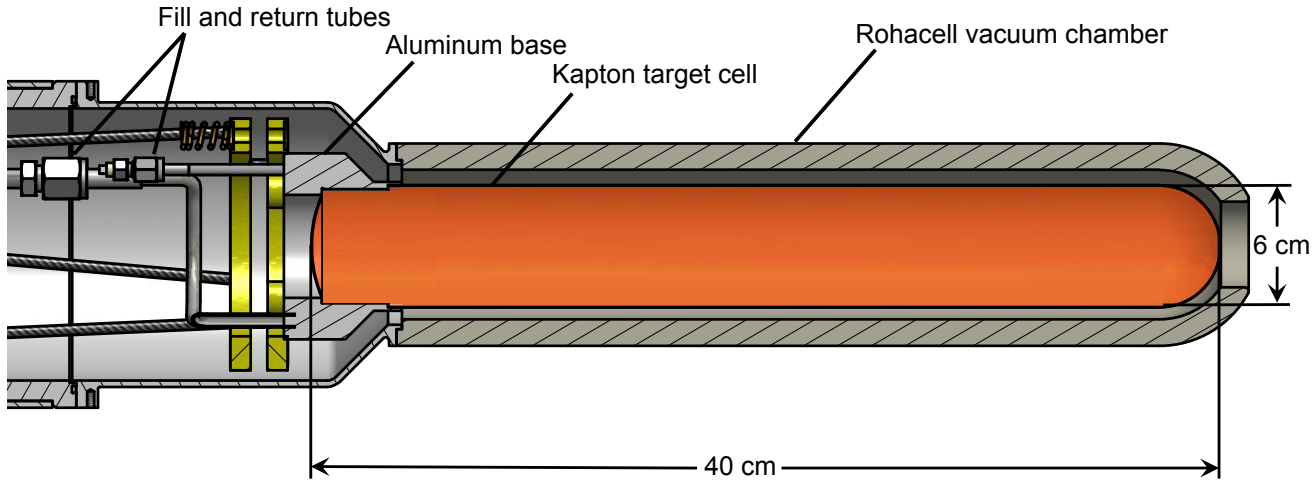
Modifications for KLF

Rupture Strength

The GlueX cell has a diameter of 2 cm, and a thickness of 0.1 mm. It has maximum allowed pressure of 42 psi.

This will drop to about 14 psi if the cell diameter increases to 6 cm.

This can only be mitigated by using thicker (and stronger) cell walls.



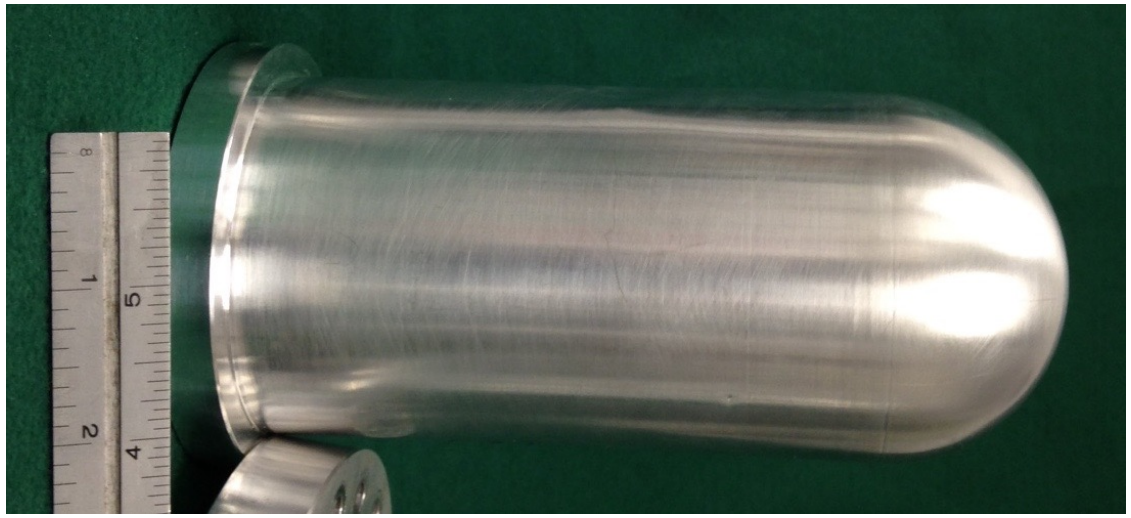
Modifications for KLF

Rupture Strength

For example, the liquid hydrogen target cells in Halls A & C are machined from Al-7075 with <0.2-3 mm walls.

These are rated for 100 psi.

We will utilize the same aluminum for the KLF target.



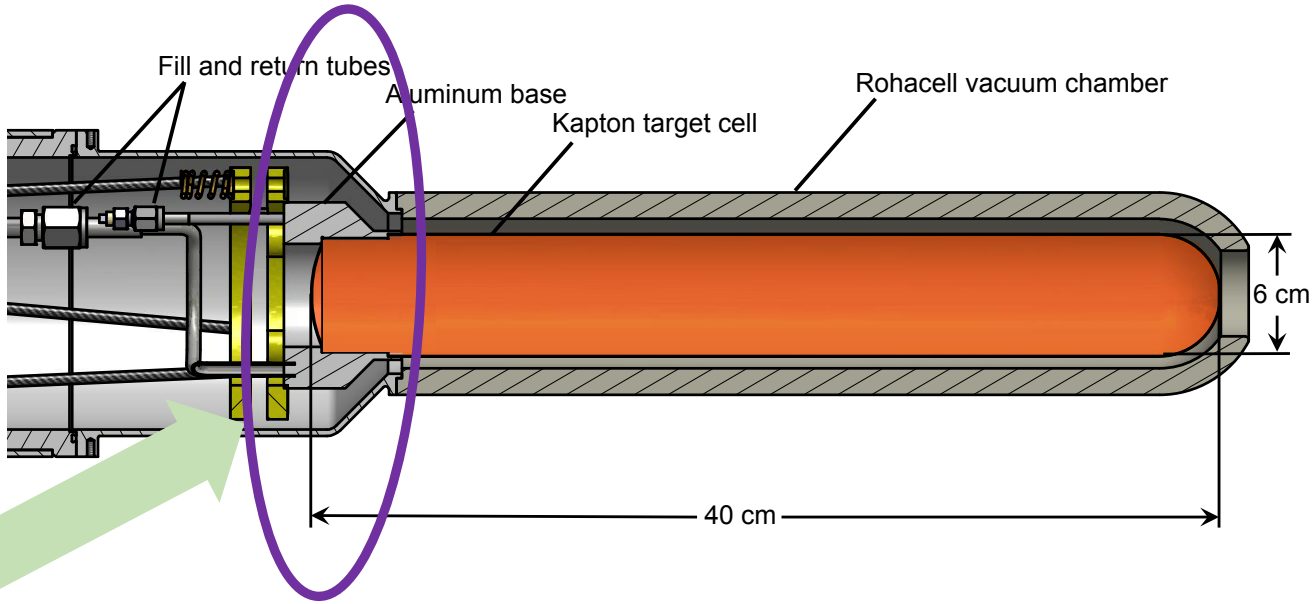
The wall thickness (g/cm^2) will increase but radiation length remains the same, 0.28.

Modifications for KLF

Cell Length

The proposed target cell for KLF has a volume of 1.1 L.

Dimensions are Ø6cm x 40cm



Problem: This is too long for the existing scattering chamber.

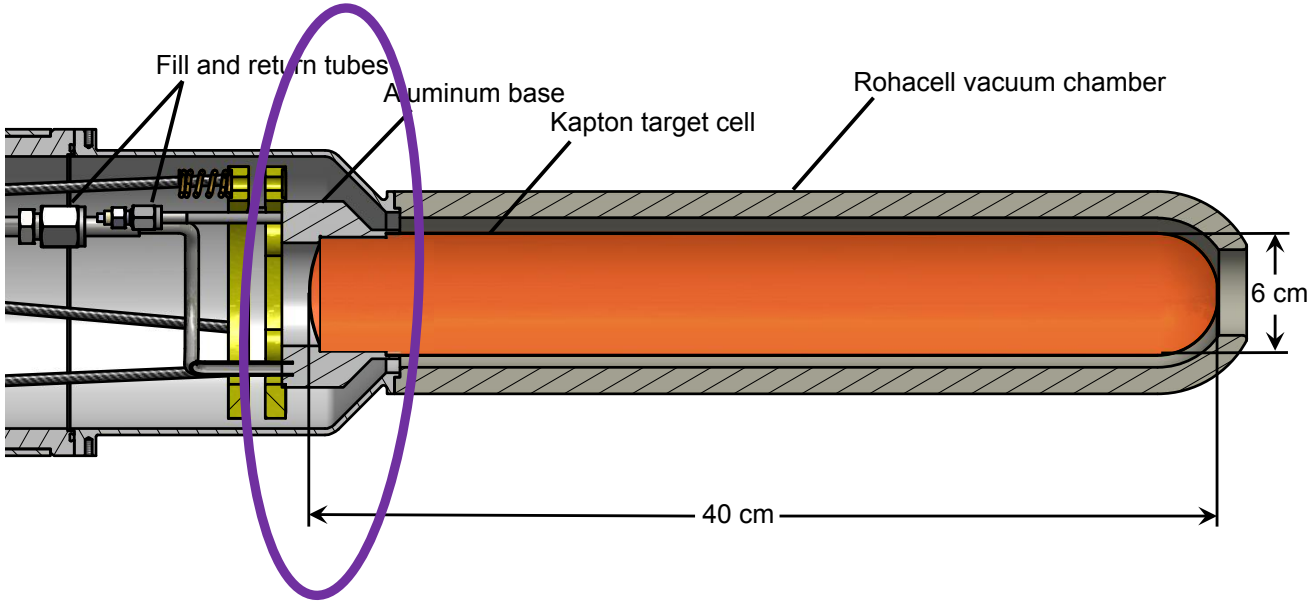
If we make the chamber longer, will the start counter still fit?
What about a new start counter?

Modifications for KLF

Cell Length

The scattering chamber utilizes 10 mm thick Rohacell 110XT foam (0.11 g/cc).

To provide more space we will replace it with 1 mm thick carbon fiber (1.7 g/cc)



We have fabricated and used these for both polarized and cryogenic targets in Hall B (RGC, RGD, RGE)

Modifications for KLF

Deuterium vs Hydrogen

Deuterium condenses at a higher temperature than hydrogen, so this will not be a problem.

Deuterium has a slightly higher liquid-to-gas expansion ratio, so this must be taken into consideration when analyzing the pressure safety requirements.

Without significant modifications, we will not be able to store both deuterium and hydrogen gases simultaneously.

- ➢ Rapid/frequent switching between LD2 & LH2 will not be possible.

Schedule

KLF is tentatively schedule to start at beginning of FY27

- 3 month design
- 6 month fabrication
- 3 month installation and testing

Other Target Group Activities

Hall A: MOLLER cryotarget installation
Hall B: Cryotarget ops, polarized target installation
Hall C: Cryotarget ops, hypernuclear installation

Summary

The GlueX cryotarget has proven (so far) to be a very reliable and low-maintenance apparatus

An initial design study shows that a larger target cell can be accommodated within the existing vacuum chamber

Modifications to the existing GlueX target will be required to stay in compliance with the lab's pressure vessel safety standards.

Liquid deuterium is also an (easy) option, although rapid switching between LH2 & LD2 might increase the design modifications substantially