

Cryo-Target/³He Thermal Analysis Update

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Hall A - SBS meeting

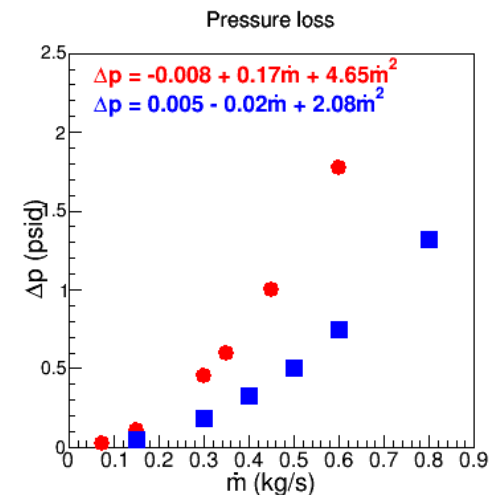
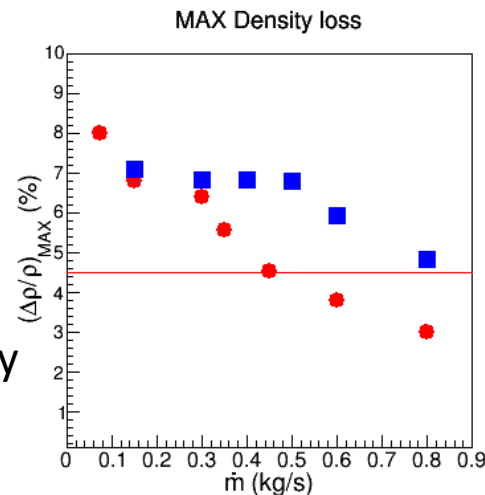
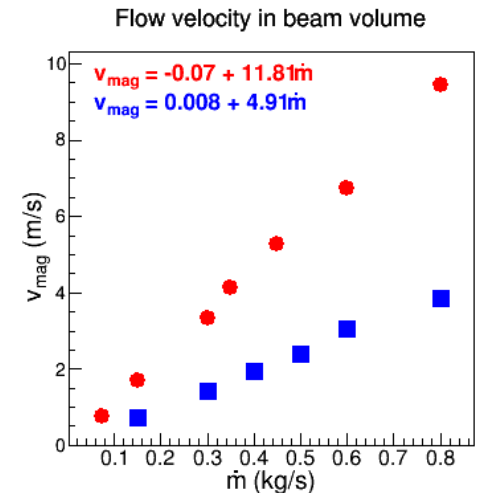
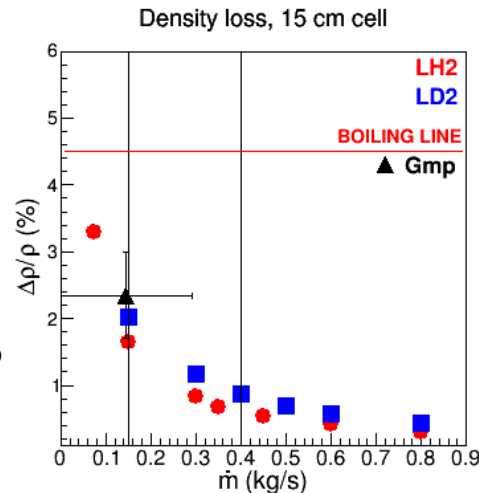
14 Jul 2017

Cryogenic Targets for SBS

- GMn: - 10 and 15 cm target cells are standard in the standard target chamber
 - had the ERR on June 15, 2017
- GEp(5): - 40 cm long target cell required, non-standard @jlab
 - no work has been done since the last collaboration meeting (July 2016) on this target
- GEN: - CFDFAC thermal analysis on 60 cm long ^3He target cell with Cu endcaps in beam up to 60 μA beam current, with the in-beam cell cooled to LN2

Target Performance for GMn

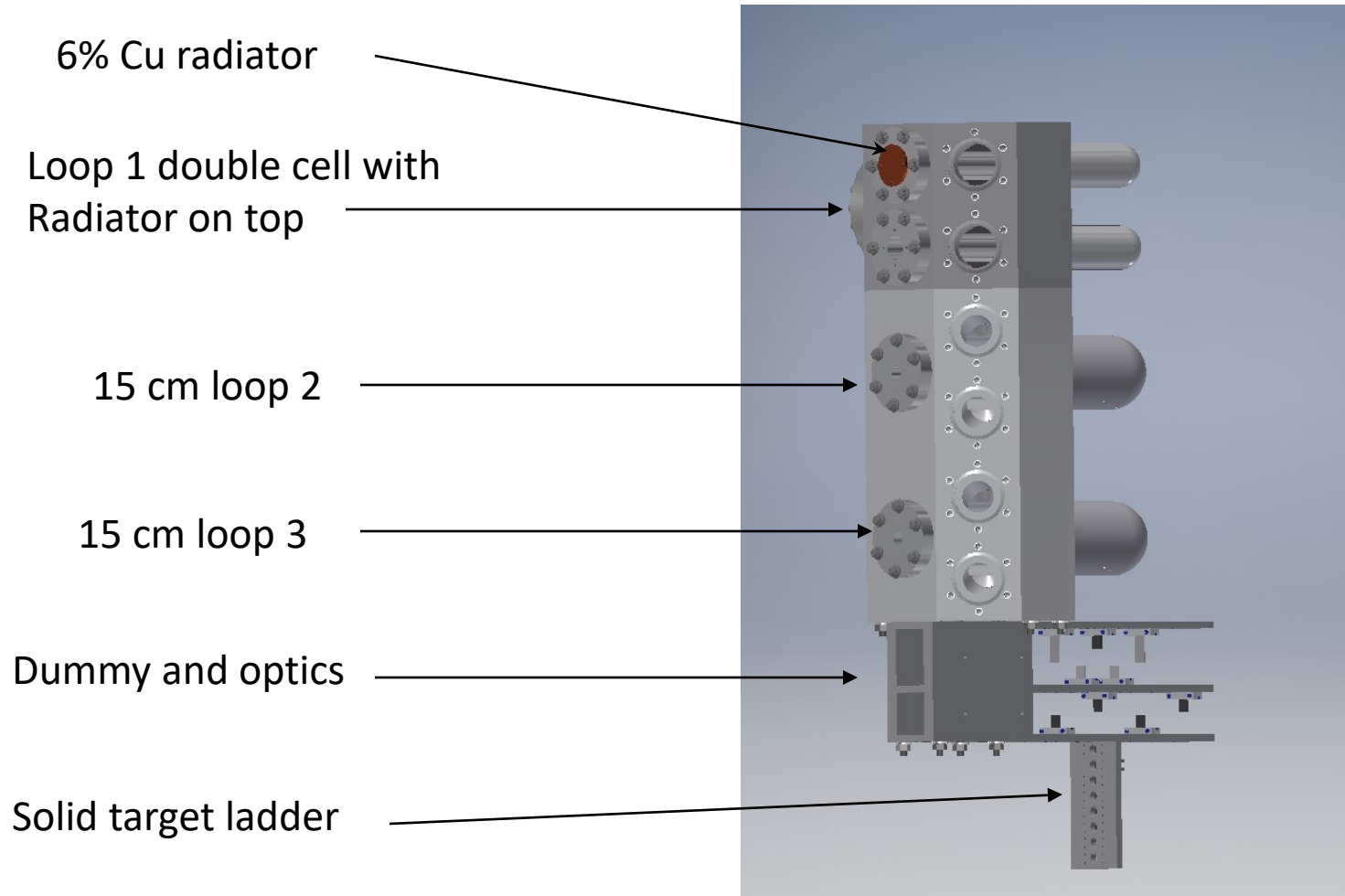
- CFDFAC(ility)@jlab designed high performance target cells for LH2/LD2 up to 30 cm long to be used in the standard target setup
- GMp LH2 target studies 2016-2017 validated the CFDFAC cell design at 15 cm long, with the current LH2 pump
 - measured LH2 density loss $(2.3 \pm 0.9)\%/100 \mu\text{A}$
 - CFDFAC predicted LH2 density loss $(1.9 \pm 0.4)\%/100 \mu\text{A}$
- With the current cryogenic pump, predicted performance of a 15 cm long LD2 target cell at $30 \mu\text{A}$ is a density loss of 0.6%



ERR for GMn

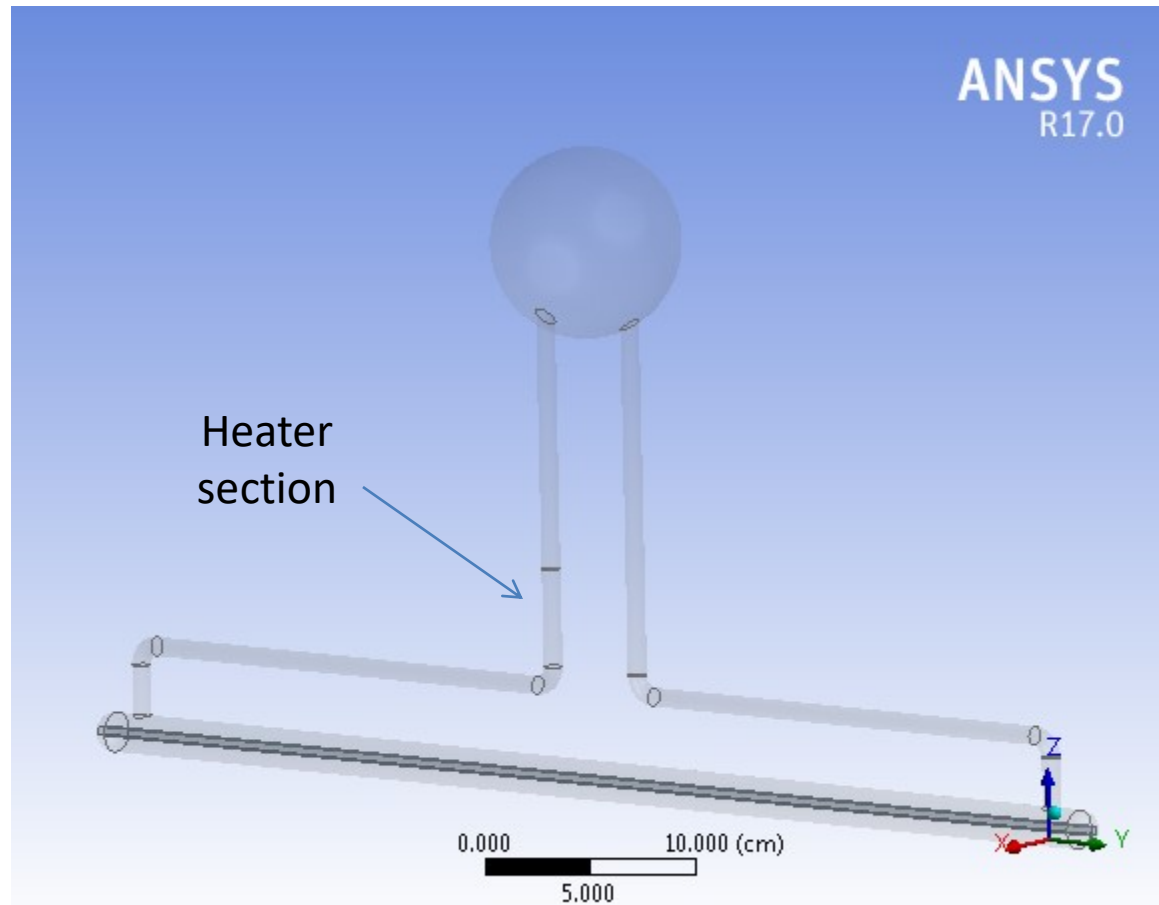
- Held on June 15, 2017 @jlab, target presentation by Dave Meekins from the jlab target group
- Target covered by charge item 4: *Provide the target and scattering chamber configuration and requirements*
- ERR report 1. Findings:
 - The standard Hall A cryotarget system will be used, with one loop fitted with an additional copper radiator
 - The standard scattering chamber with modified chamber windows will be used.
- 2. Comments: none; Recommendations: none.
- Passed the ERR, but there are some minor alterations to be done to the target chamber to reduce the area of thin windows, which are the responsibility of the Hall A engineering (Robin W.), estimated at 2 weeks design and 4 weeks machining

GMn Target Stack Assembly

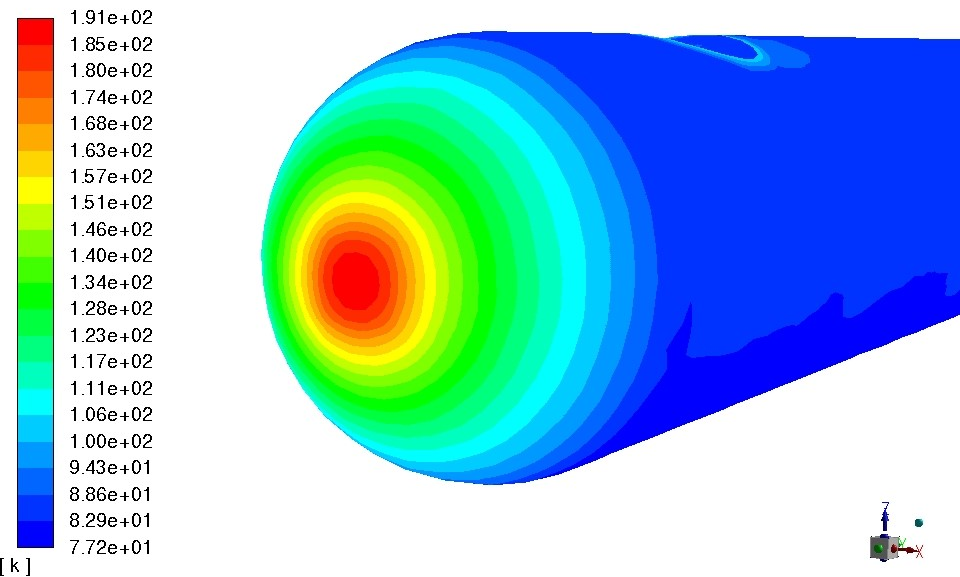


^3He Target Cell, CFDFAC Flow/Thermal Analysis

- 60 cm long glass cell with metal (Cu) end-caps, 2 cm diameter with 3 liter polarizing cell
- 40 atm ^3He with the in-beam cell kept at 77 K, the polarizing cell at 240 °C and the heater at 90 °C
- 4x4 mm² beam raster for beam currents 30-60 μA
- Glass walls taken to be 1.327 mm thick, Cu beam nipples 0.254 mm thick



contour-2
Static Temperature



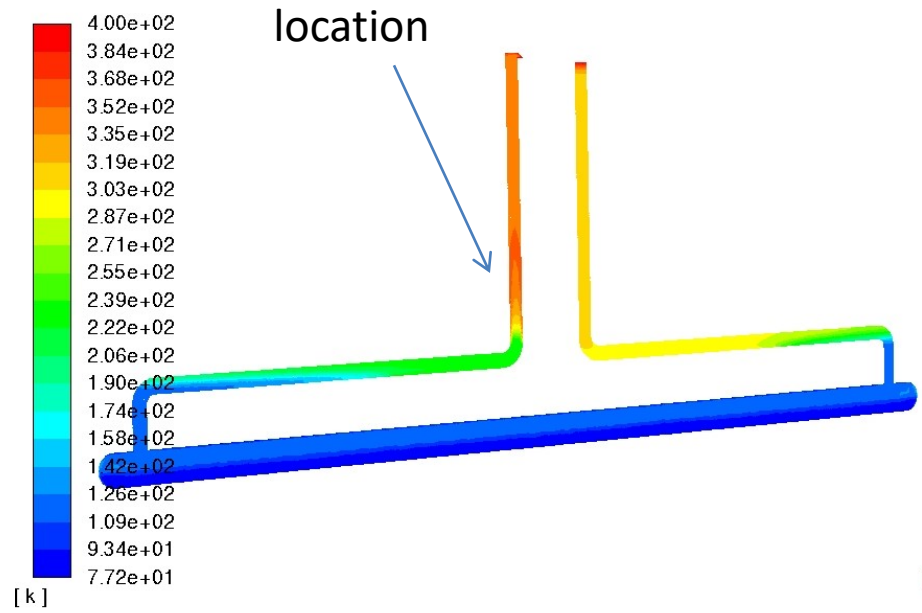
Temperature profile through
the cell with an upper cut at
400 K, average temperature in
beam volume 115 K

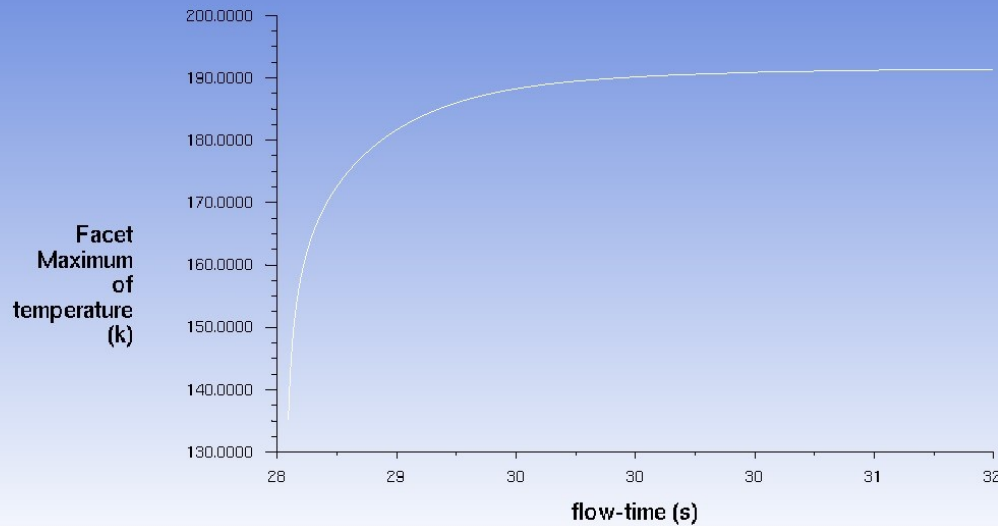


Temperature profile in the beam
nipples 4x4 mm² and the copper
windows, assumed to be 0.254 mm
thick

$$\Delta T_{\max} = 114 \text{ K}$$
$$T_{\max} = 192 \text{ K}$$

contour-2
Static Temperature





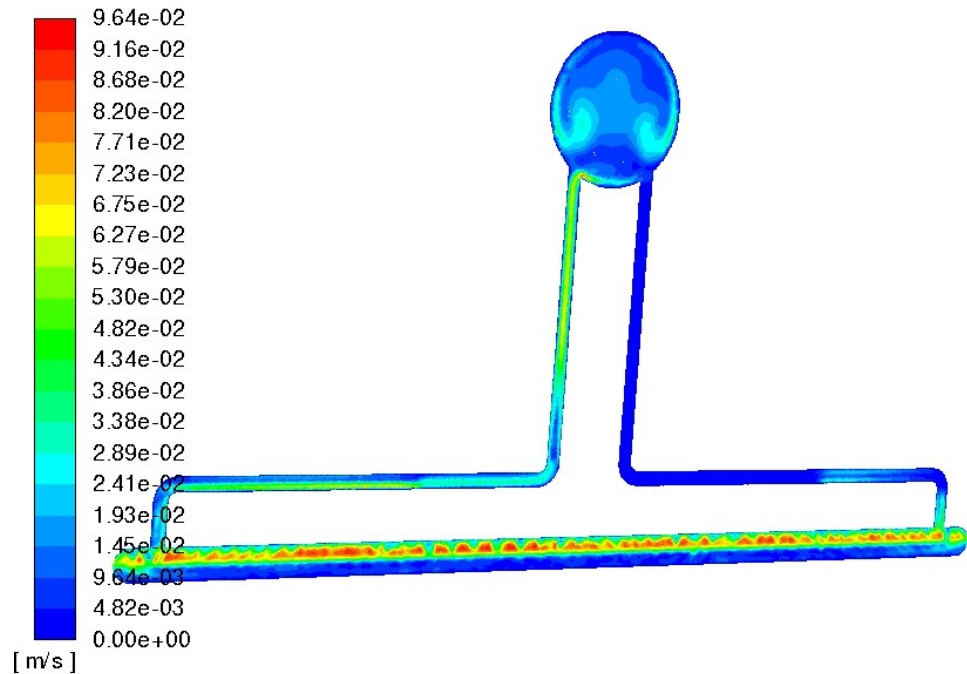
3He flow velocity magnitude profiles in cross section through the whole cell



Max temperature evolution in the Cu beam nipple at a beam current of 60 μA

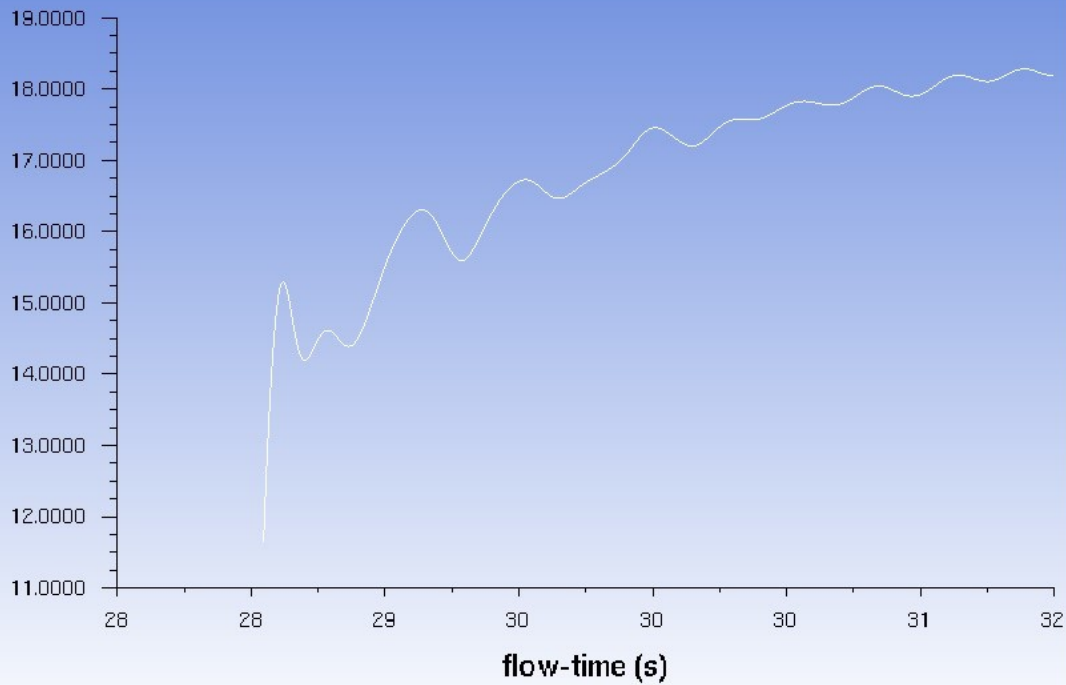


contour-1
Velocity Magnitude



drho_bv

Volume-Average
of
drho



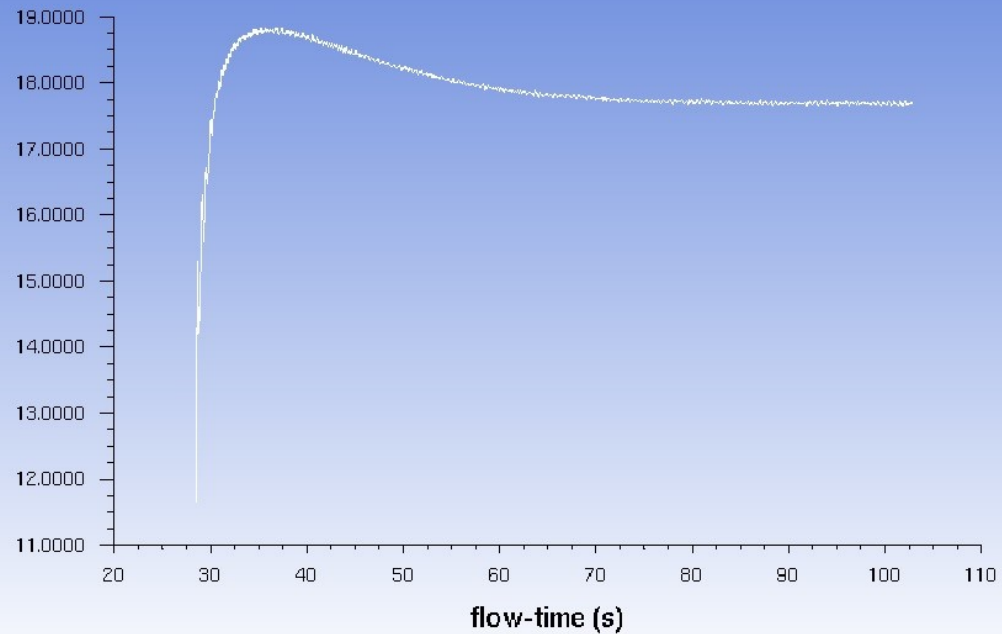
3He density loss in the
first 3 sec of 60 μ A
beam current

Long term average of
3He density loss at 60
 μ A beam current

Estimated total density
loss 17.7%

drho_bv

Volume-Average
of
drho



flow-time (s)

Summary

- GMn passed the ERR in June 2017, will use 15 cm long LD2 cells (copies of the GMp cells), CFDFAC predicted LD2 density loss at 30 μ A is 0.6%
- The target chamber needs minor alterations to accommodate GMp, Hall A engineering responsible
- No work done over the past year on Gep(5) 40 cm long target
- Thermal analysis of 3He 60 cm long cell up to 60 μ A beam current done in transient mode with the in-beam cell cooled to LN2