vSANS Sample Environment

1) Collimation Options → New Sample Sizes
2) Sample Holder Options for Complex Fluids
    a. Commercial (Hellma-type) Quartz Cells
    b. New sizes of Ti-Cells (Circular and Rectangular)
3) New Sample area layout
    a. Rad. Safety Interlocked Sample Staging area
    b. No sample chamber → Condensation issue
    c. Larger available area → Larger sample blocks
4) Heat Transfer Calculations / Meas. w Current 10CB
5) Possible New Cooling Block Design Features
    a. Insulate (foam and/or vacuum)
    b. Double Block/Bath using “Leap-Frog” T-settings
    c. Reduce Block Volume for Quicker Equil. Response
6) Shutdown Fabrication “to do” List

Sample Aperture Sizes

{ beam current ~ area }

- For circular aperture: **30 mm dia.**
- For Narrow slit

  1.5 mm or 3 mm x 75 mm
- For Converging Beams:

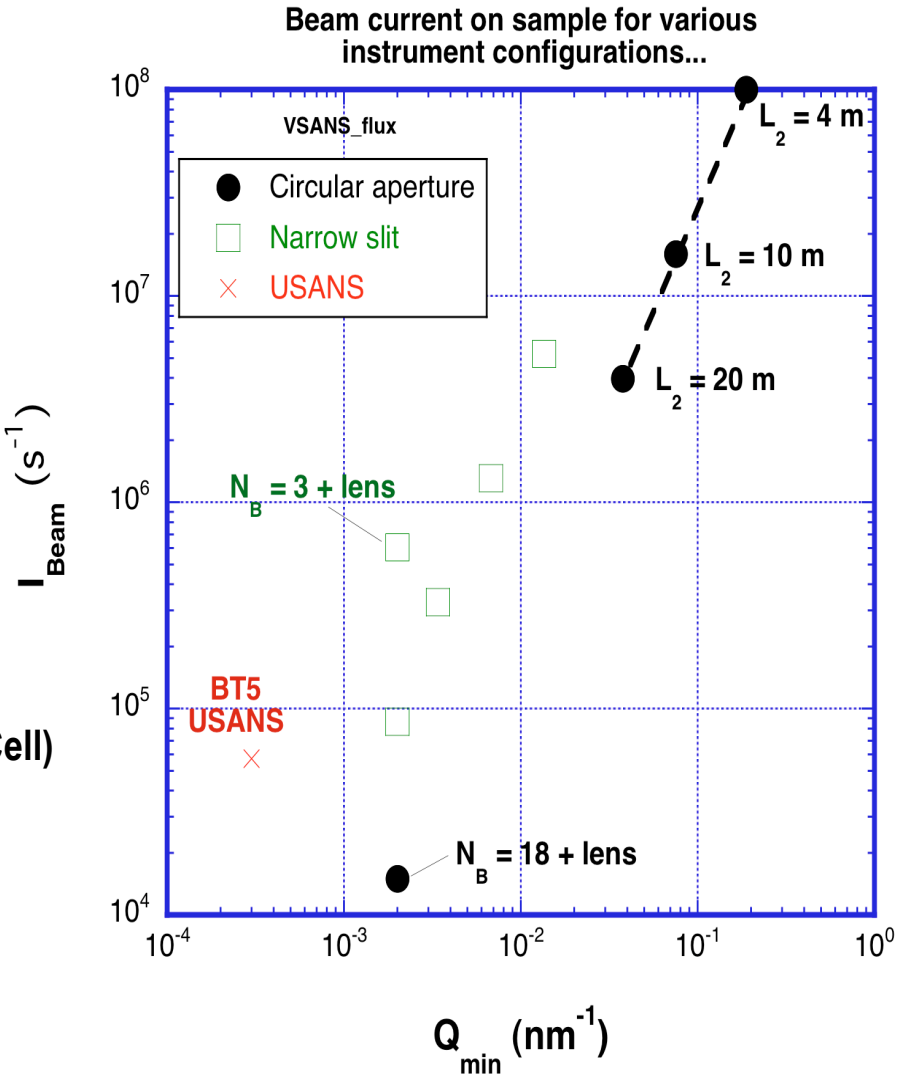
  38 mm x 75 mm

USANS Beam Current:

16 mm (5/8") dia. →28,000 s-1 (current Ti-Cell)

22 mm (7/8") dia. → 48,600 s-1 (gain 1.7)

29 mm (9/8") dia. → 67,900 s-1 (gain 2.4)



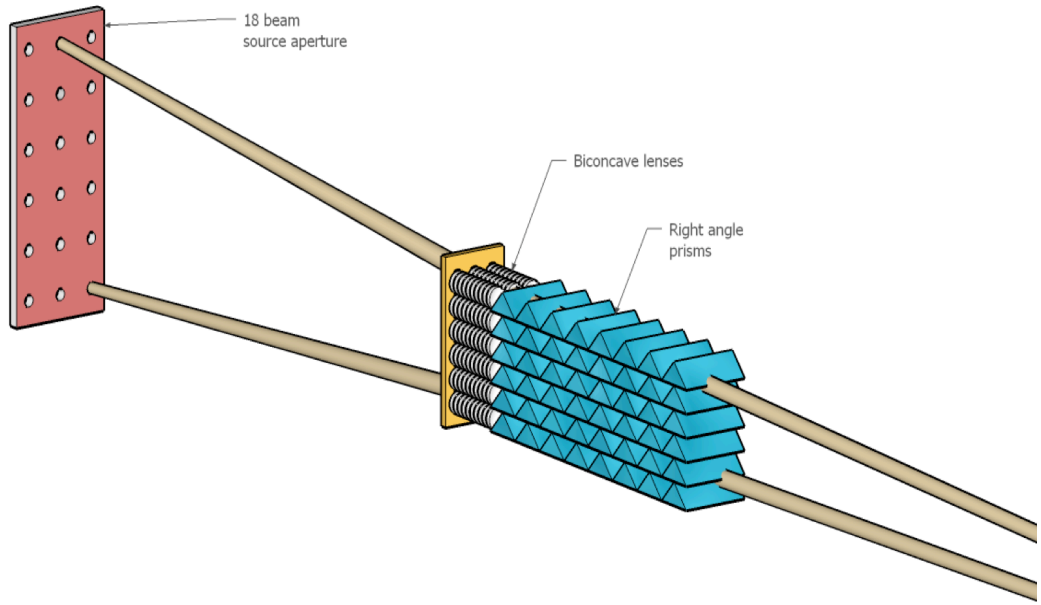
18 Converging Beams:

3 x 6 beams using 12.5 mm dia.

Lenses:

Width = 3 x 12.5 mm = **38 mm**

Height = 6 x 12.5 mm = **75 mm**



Largest Commercial Quartz Cell Options (Hellma)

Order Number	**120-000-1-40**
Type	**120-QS**
Material Color Code:	QS
Light Path:	1 mm
Volume:	280 µl
Outer Dimensions:	
Height:	
Width:	
Depth:	3,5 mm
Inner Dimensions:	
Width:	**19 mm dia.**
Base Thickness:	
Number of windows:	2

Print

Order Number	**404-1-46**
Type	**404.000-QX**
Material Color Code:	QX
Light Path:	1 mm
Volume:	700 µl
Outer Dimensions:	
Height:	47,5 mm
Width:	23,6 mm
Depth:	3,5 mm
Inner Dimensions:	
Width:	18,5 mm
Base Thickness:	2,5 mm
Number of windows:	2

Print

Height: 38 mm
Width: 18.5 mm

Disadvantages:

- sometimes hard to clean properly
- Lost of cells through breakage
- Significant cost **> $300** each

Possible choice for Narrow Slits… → 1.5 mm wide x 75 mm tall:
Also quartz capillaries or custom cells

Order Number	**110-1-40**
Type	**110-QS**
Material Color Code:	QS
Light Path:	1 mm
Volume:	350 µl
Outer Dimensions:	
Height:	52 mm
Width:	12,5 mm
Depth:	3,5 mm
Inner Dimensions:	
Width:	9,5 mm
Base Thickness:	1,5 mm
Number of windows:	2

Print

Height: 37 mm
Width: 9.5 mm

Order Number	**100-1-40**
Type	**100-QS**
Material Color Code:	QS
Light Path:	1 mm
Volume:	350 µl
Outer Dimensions:	
Height:	45 mm
Width:	12,5 mm
Depth:	3,5 mm
Inner Dimensions:	
Width:	9,5 mm
Base Thickness:	1,5 mm
Number of windows:	2

Print

Height: 37 mm
Width: 9.5 mm

Existing Ti-Cell Design:

19 mm dia. Fill volume

25 mm dia. x 1.6 mm a-Quartz windows

Enlarged Ti-Cell Design → Circular Apertures

32 mm dia. Fill volume

38 mm dia. x 1.6 mm a-Quartz windows

Other Design Changes:

- Thin body by 2.5 mm
- Retaining plates from **Aluminum**
- Increase max. scat. angle from 25˚ to **30˚**
- Bolts from #8 Low-heads to **#10 Buttonhead**
- Fill Port from #10 to **¼"-20**

{ Drawing Markups Complete }

New Rectangular Style “Large” Ti-Cell

44 mm wide x 95 mm tall fill volume

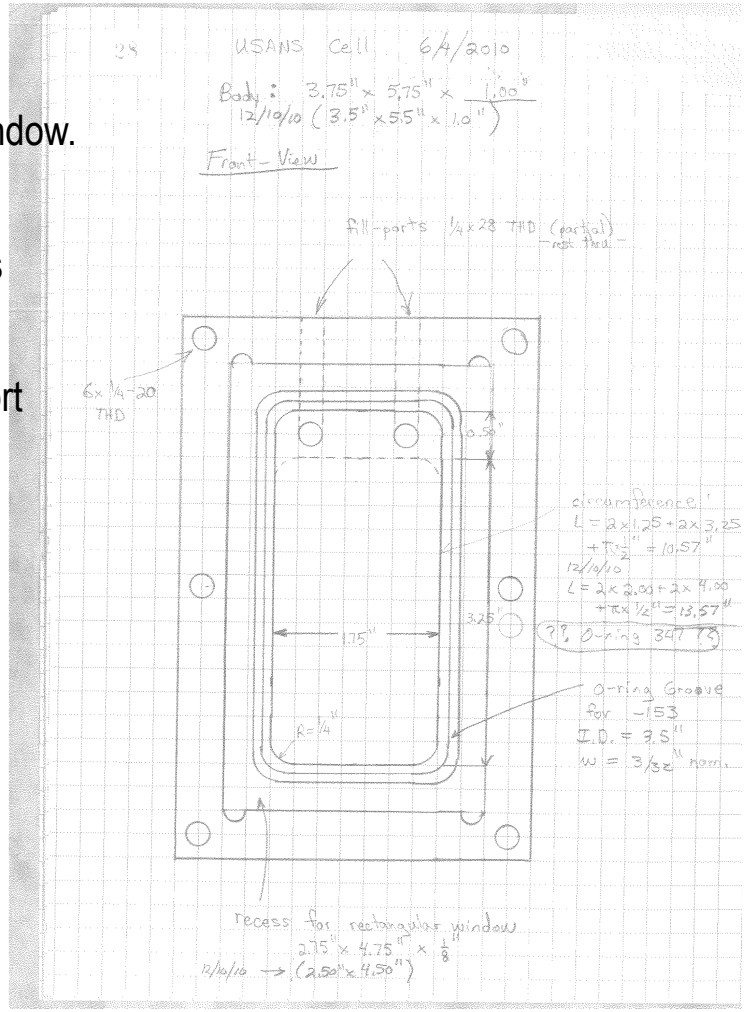
Window: a-Quartz 70 mm x 120 mm x 3.2 mm

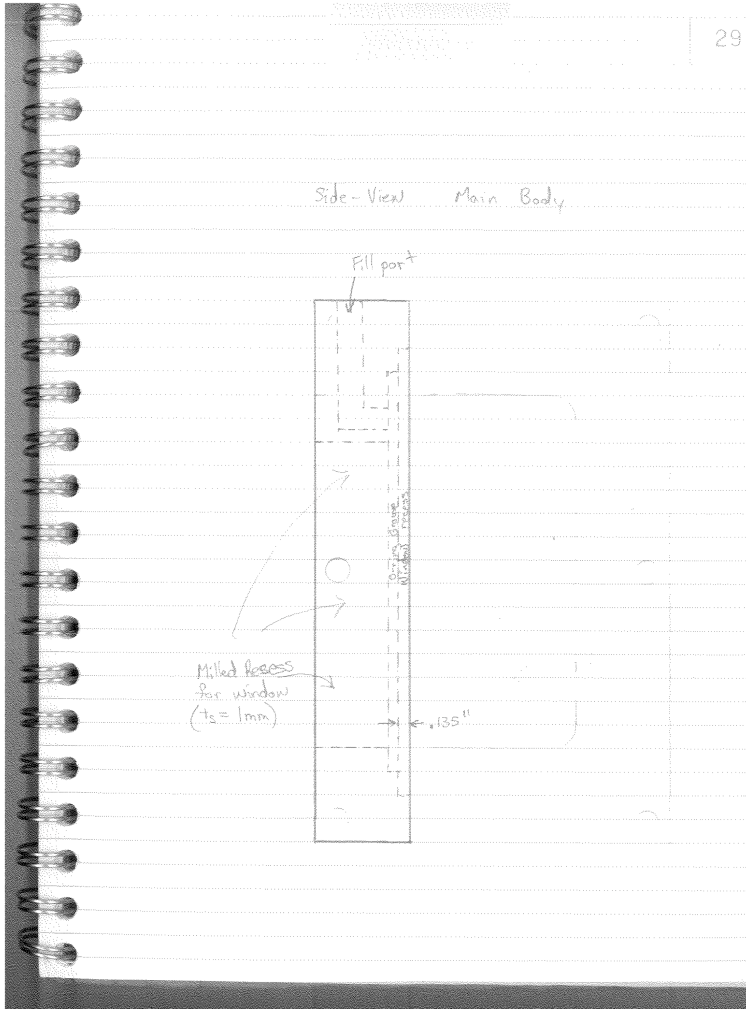
Notes:

- Grade 5 Ti for low Bgd Window.
- One rectangular window.
- One O-ring sealed to glass

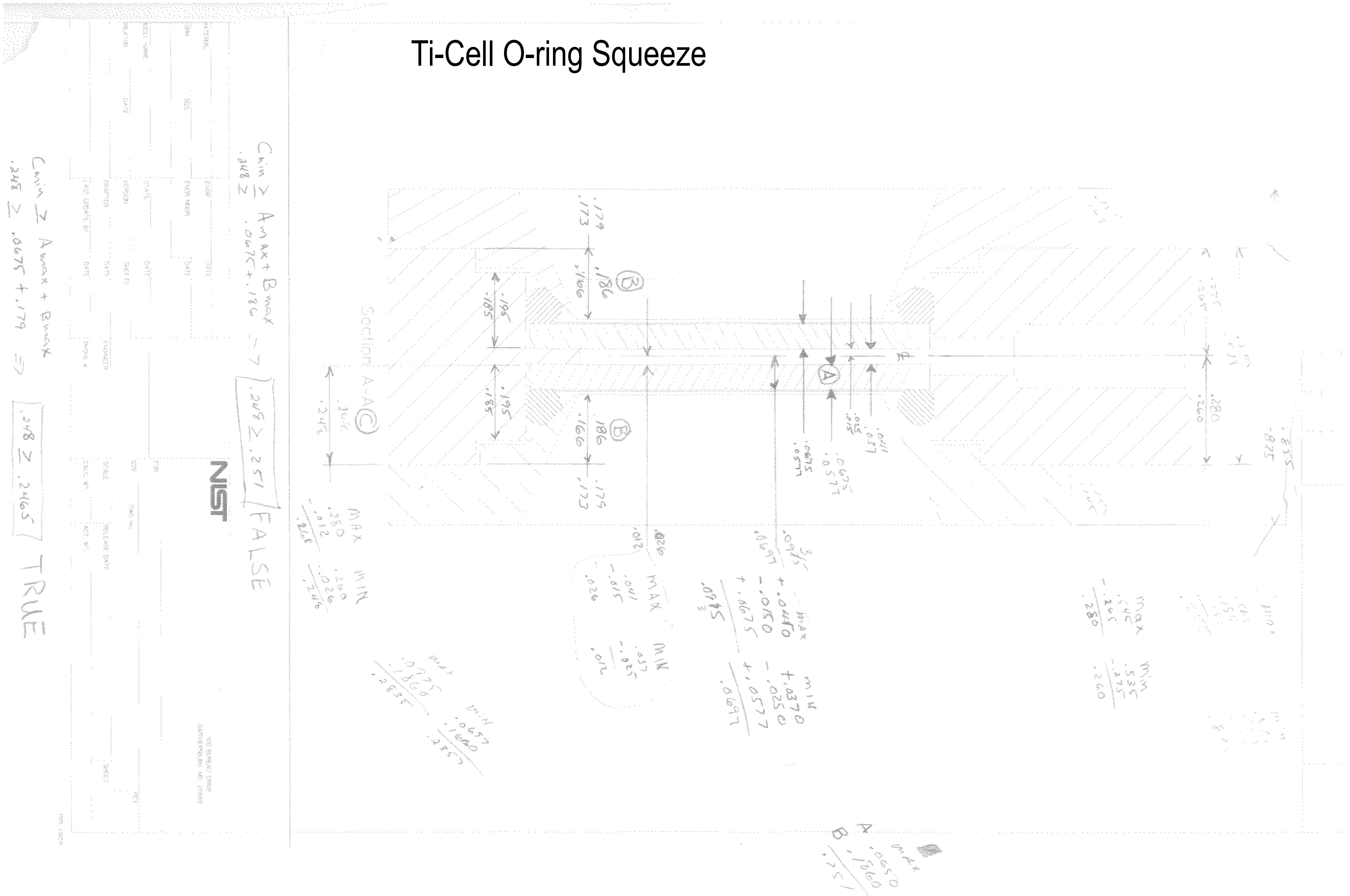
{ Eliminates excess fill gap }

- Offsetted Fill + Exhaust Port





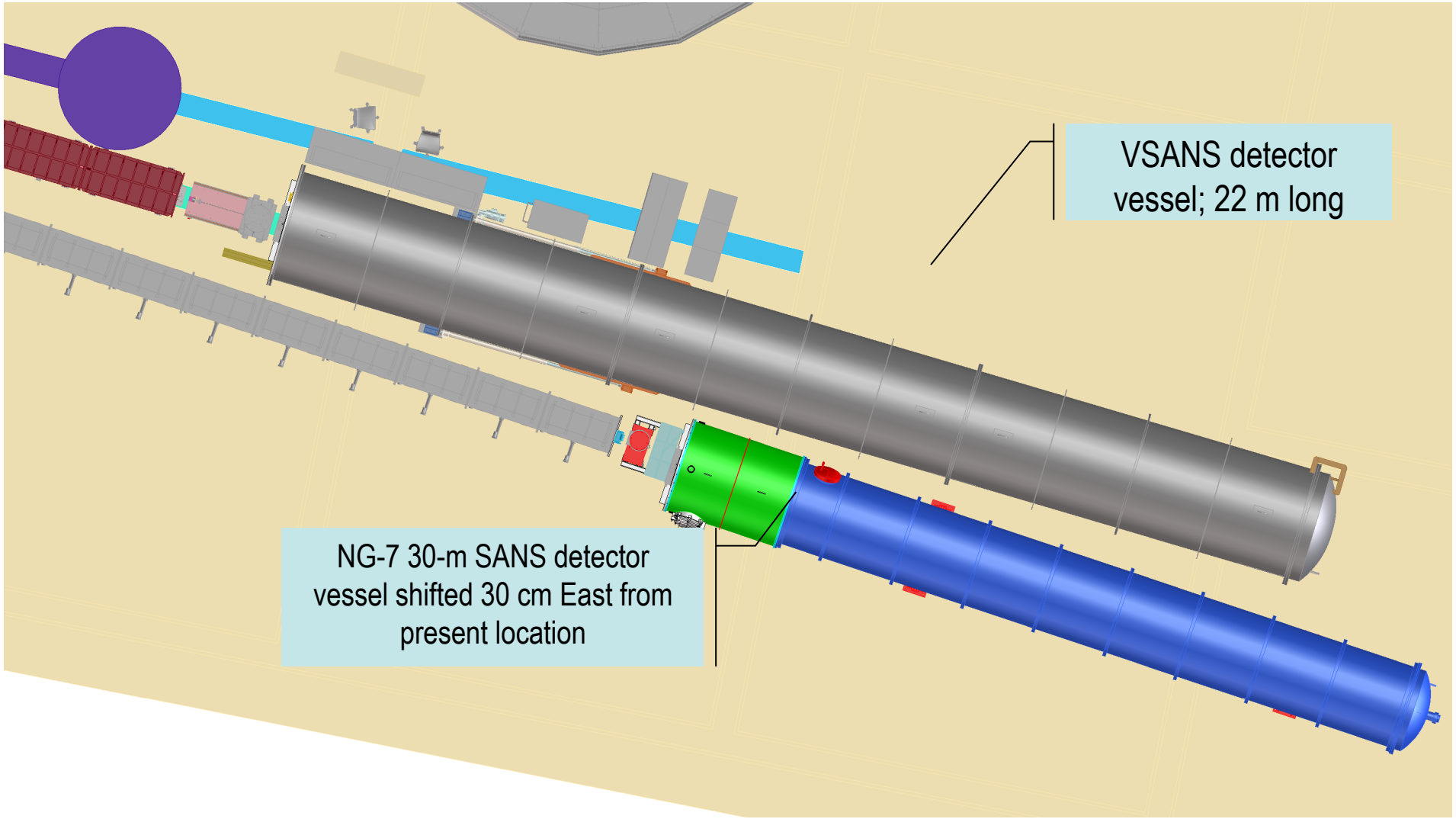
Ti-Cell O-ring Squeeze



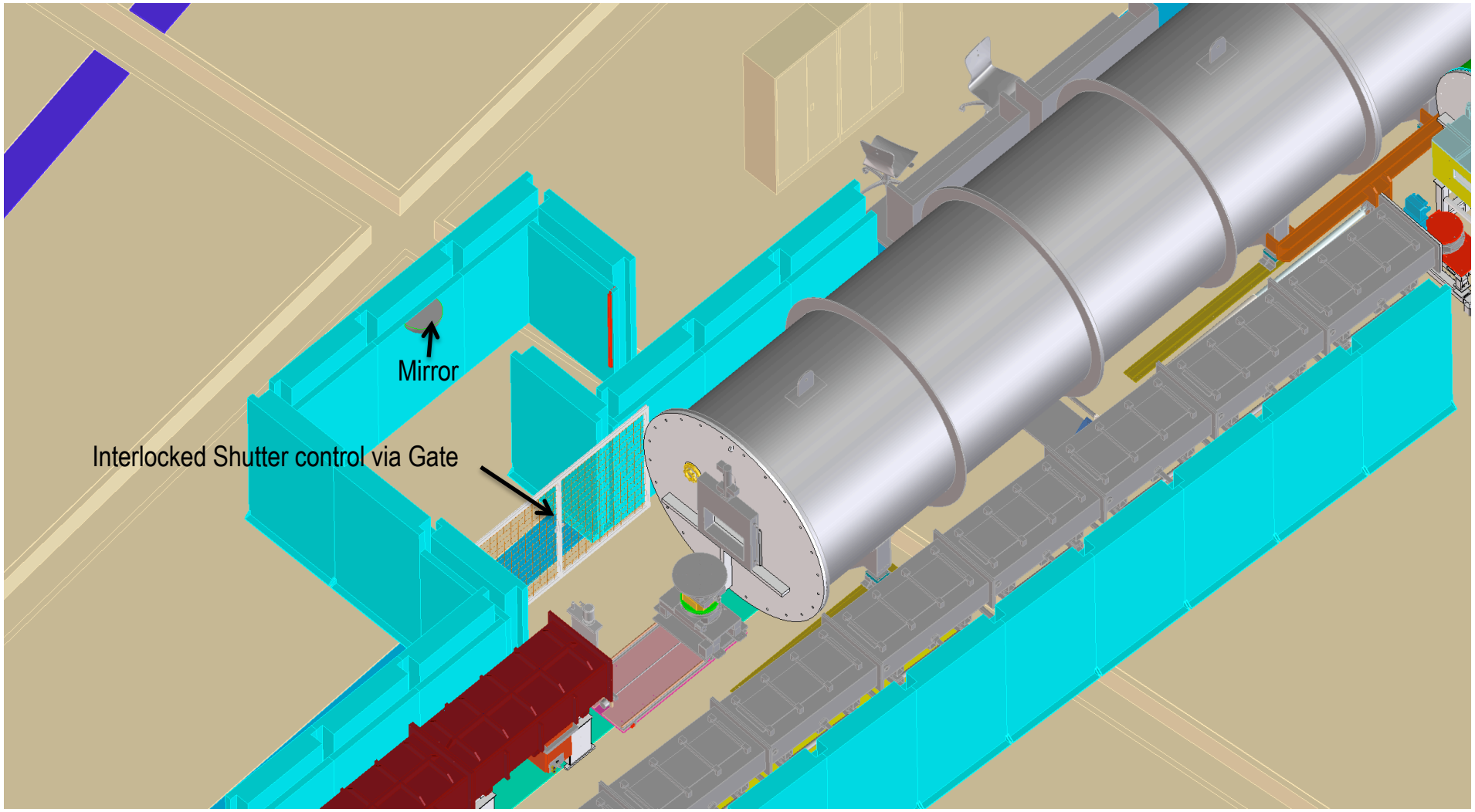
Sample Area space: Center of Beam to Obstruction:

vSANS: 55” NG7-SANS: 32”

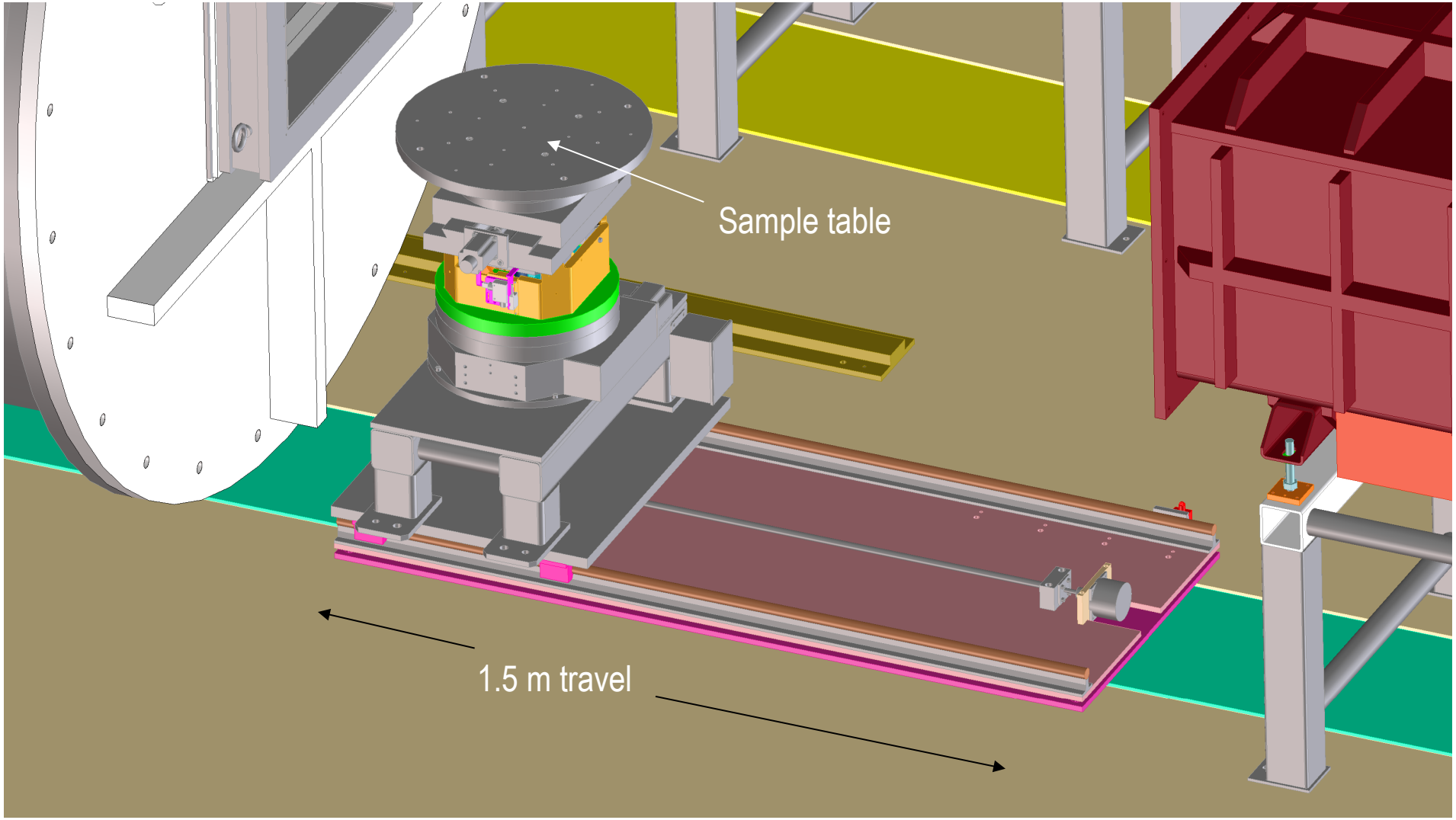
vSANS **Velmex slide: 60” dovetail, 48” travel (2.5x current 30m instr. range)**



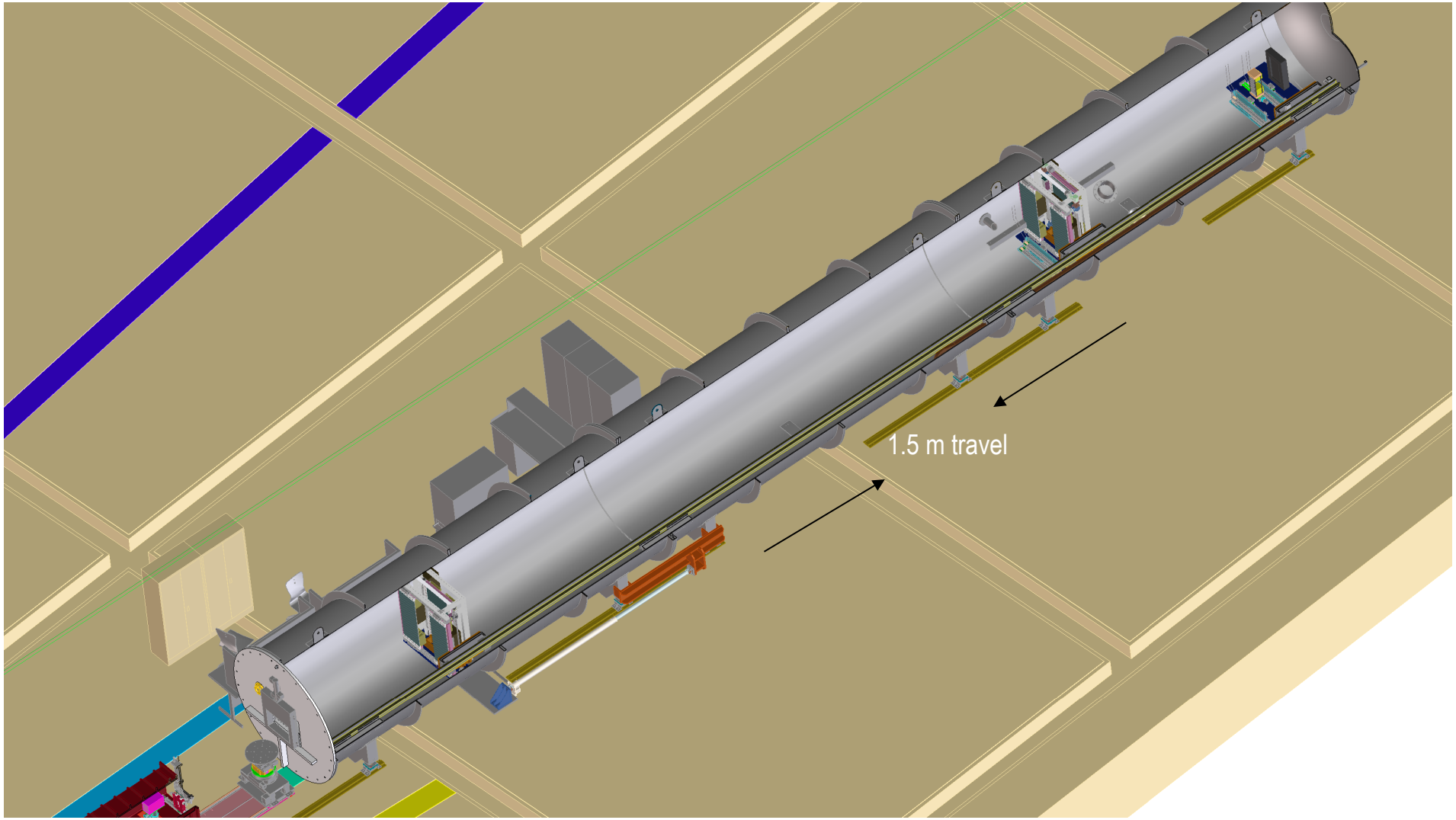
Possibility of higher beam current (40 to 500x) and ability to walk thru beam requires:
1) Wall shields to maintain Low radiation areas + ALARA 2) Interlock shutter



New vSANS sample Area→ No Sample Chamber



Cutaway view of detector vessel showing three movable detector carriages



Possible design changes for new **Heating/Cooling Blocks**:
(Choice of materials, plumbing, insulation, size …)

SANS Thermostat Sample Holder

Ancillary code: SC-1

Used on:

Quokka (SANS)

Quokka (ANSTO) Cooling Block Designs
(similar to NCNR's blocks… massive)

10 sample positions

Based on a design at the NIST neutron scattering facility in the USA this 10 position sample changer operates between 20C and 300C.

Sample Changer - SANS (twenty position)

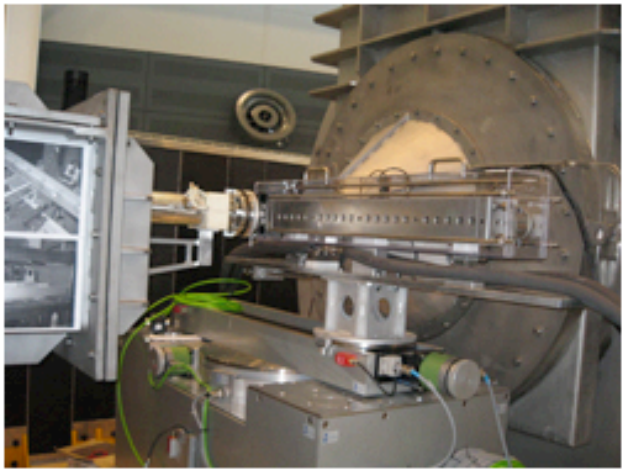
Ancillary code: SC-2

Used on:

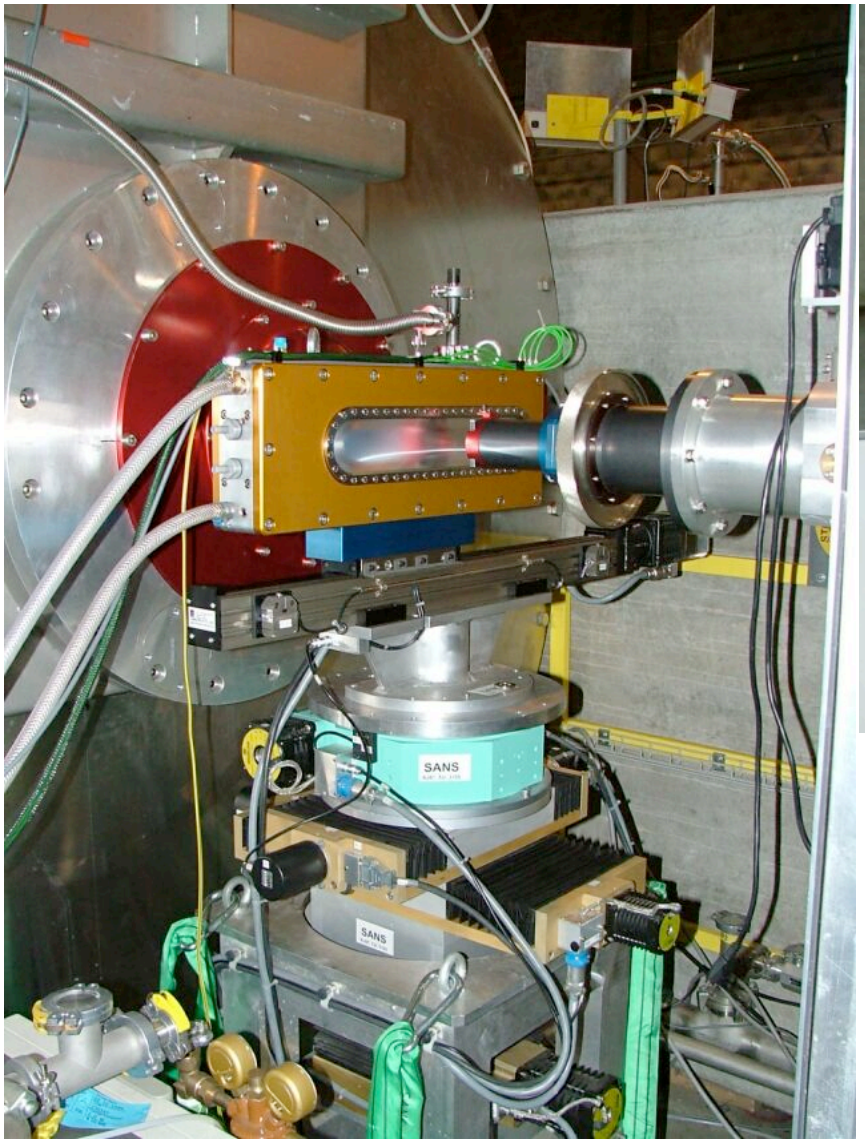
Quokka (SANS)

20 sample positions

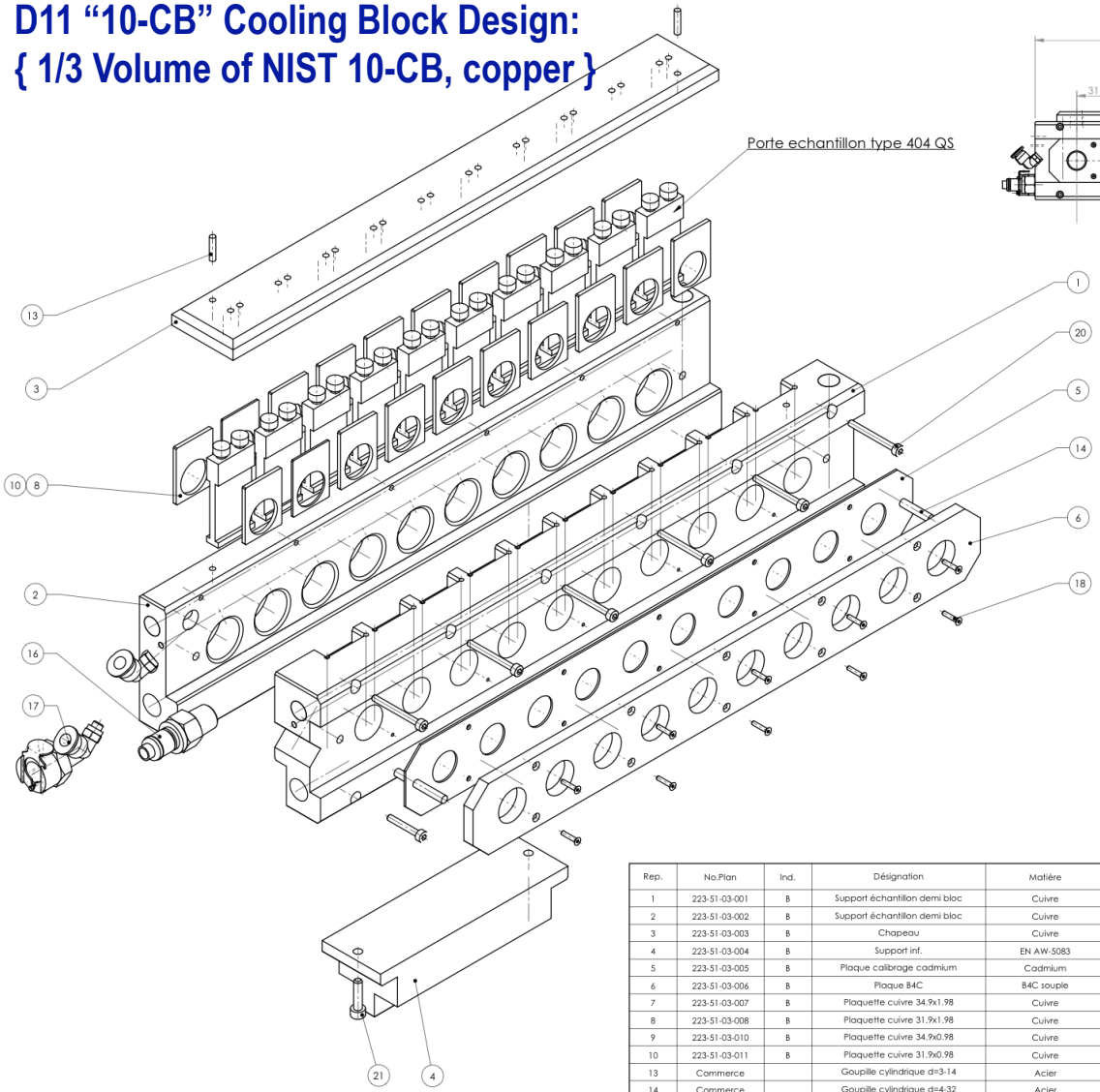
Based on a design at the NIST neutron scattering facility in the USA this 20 position sample changer operates between -10C and 80C.

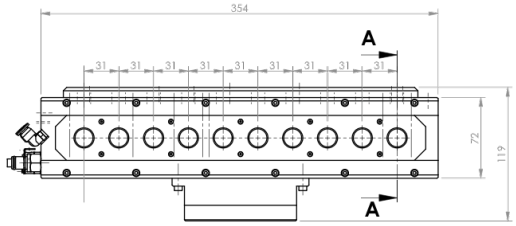


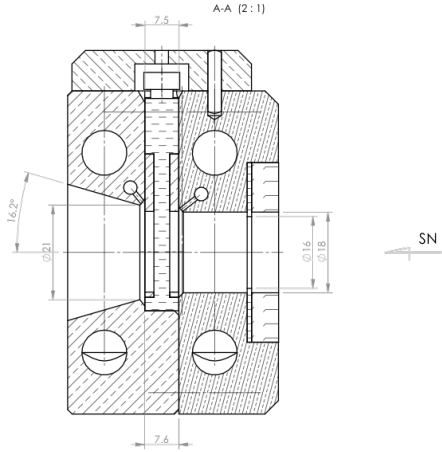
PSI 10-CB: Vacuum (**Thermos**) Insulation, samples **bolted** to copper sink, small **thermal mass**.



D11 “10-CB” Cooling Block Design:
{ 1/3 Volume of NIST 10-CB, copper }







Rep.	No.Plan	Ind.	Désignation	Matière	Qté	Fournisseur	Observations
1	223-51-03-001	B	Support échantillon demi bloc	Cuivre	1		
2	223-51-03-002	B	Support échantillon demi bloc	Cuivre	1		
3	223-51-03-003	B	Chapeau	Cuivre	1		
4	223-51-03-004	B	Support inf.	EN AW-5083	1		
5	223-51-03-005	B	Plaque calibrage cadmium	Cadmium	1		
6	223-51-03-006	B	Plaque B4C	B4C souple	1		
7	223-51-03-007	B	Plaquette cuivre 34.9x1.98	Cuivre	20		
8	223-51-03-008	B	Plaquette cuivre 31.9x1.98	Cuivre	20		
9	223-51-03-010	B	Plaquette cuivre 34.9x0.98	Cuivre	20		
10	223-51-03-011	B	Plaquette cuivre 31.9x0.98	Cuivre	20		
13	Commerce		Goupille cylindrique d=3-14	Acier	2		
14	Commerce		Goupille cylindrique d=4-32	Acier	2		
15	Commerce		Raccord coudé M5 QSML M5-6	Matériau <non spécifié>	2		FESTO
16	Commerce		Connecteur mâle	Matériau <non spécifié>	1	CPC	Ref.PLCD 24004
17	Commerce		Connecteur femelle	Matériau <non spécifié>	1	CPC	Ref. PLCD 10004
18	Visserie		Vis Fhc M2-10	Inox	10		
19	Visserie		Vis Chc M3-20	Inox	6		
20	Visserie		Vis Chc M3-30	Inox	6		
21	Visserie		Vis Chc M4-16	Inox	2		

Ind.	Date	Dessinateur	Vérificateur	Resp.technique	Modifications
B	01/09/06	CA/SEI		P LINDNER	PLAN REFAIT
A	09/2003	MIGUET			Edition du plan

Tolérances générales: Linéaires: x Angulaires: x
Rugosité:
Matière:
Traitement:
Masse: 7.51 Kg
Observations:

Echelle: 1:1

CANAL H15 - D11
NOUVEAU CHANGEUR ECHANTILLON
SUPPORT ECHANTILLON
Ensemble support échantillon type 404 QS

INSTITUT LAUE LANGEVIN
6, rue Jules Horowitz - BP156
Grenoble Cedex 9 - France

Format: A1
N° de plan: 223-51-03-000
Page: 1/1
Indice: B

W:\Dossiers_Manips\H15-D11\d11-223\223-51-Nouveau changeur échantillon\223-51-03-Support échantillon\223-51-03-000-Ensemble support echantillon type 404 QS

Material Choices for Block, cells and windows

Material	Density	Heat Capacity	Thermal Conduc.	Thermal Diffus.	Corrosion Resist.	Activation Resist.	Scattering Bgd
Copper	8.94 g/ cm3	3.4 J/ cm3/K	3.94 J/ cm/s/K	**1.16** cm^2/s	Poor	Medium	Medium
Aluminum (pure)	**2.70**	2.43	2.22	**0.91**	Fair	**Excel.**	**Low**
Aluminum (6061)	**2.70**	2.43	1.67	**0.69**	Fair	**Excel.**	High
Titanium Grade 2	4.51	2.35	0.16	0.068	**Excel.**	**Excel.**	Medium
Titanium Grade 5	4.44	2.35	.067	0.029	**Excel.**	**Excel.**	**Low**
Stainless Steel 304	8.00	4.0	0.16	0.04	**Excel.**	Medium	High
Silicon	2.33	1.65	1.49	**0.90**	**Excel.**	**Excel.**	**v. Low**
a.Quartz	2.20	1.65	0.014	0.0085	**Excel.**	**Excel.**	**~Low**

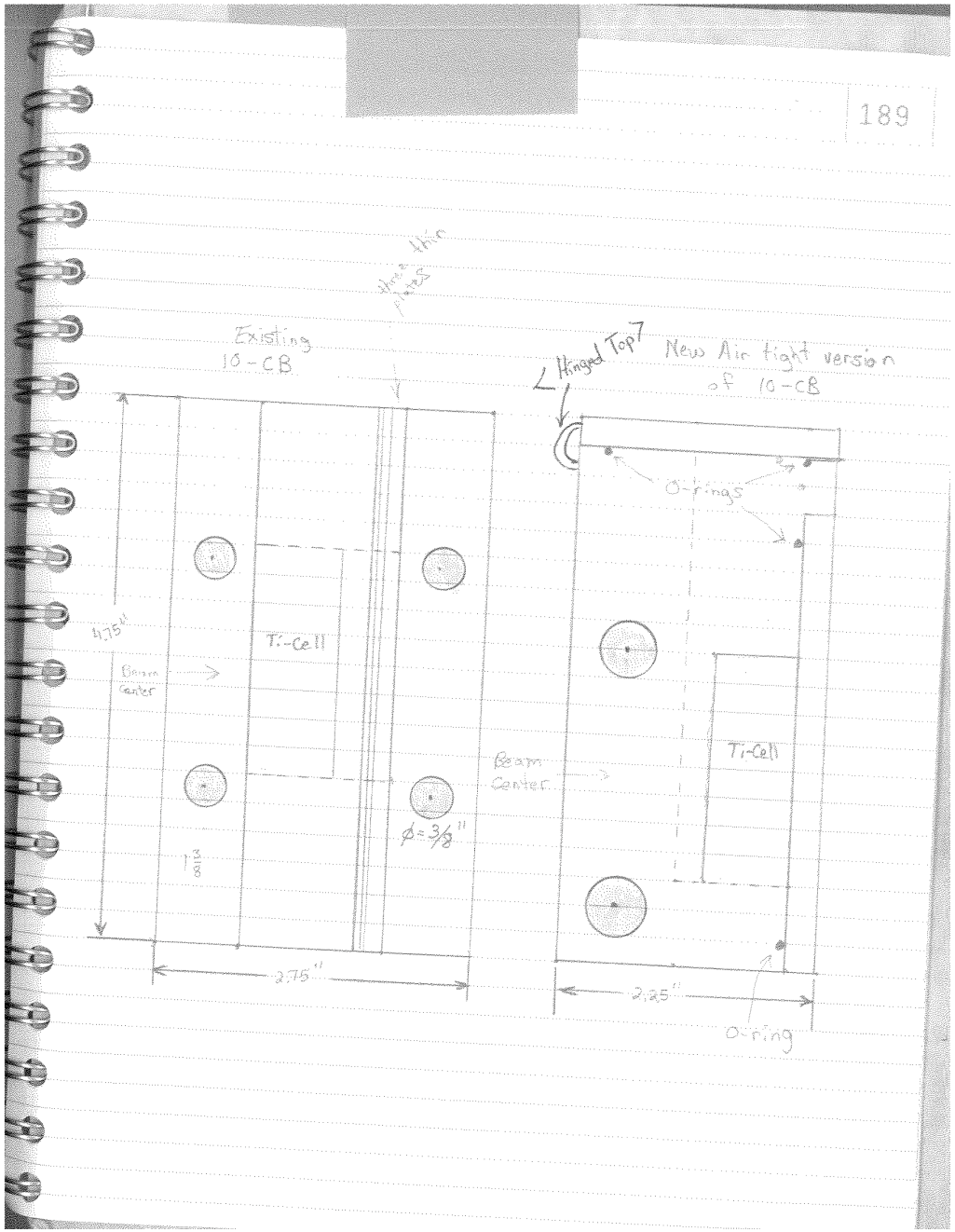
Block: → Aluminum 6061 (low weight, easily machined, low activation)

Sample Cell Bodies → Titanium Grade 2 (Corrosion resistance, easily machined)

Windows → a-Quartz, Silicon, Titanium Grade 5 (low Bgd, low cost)

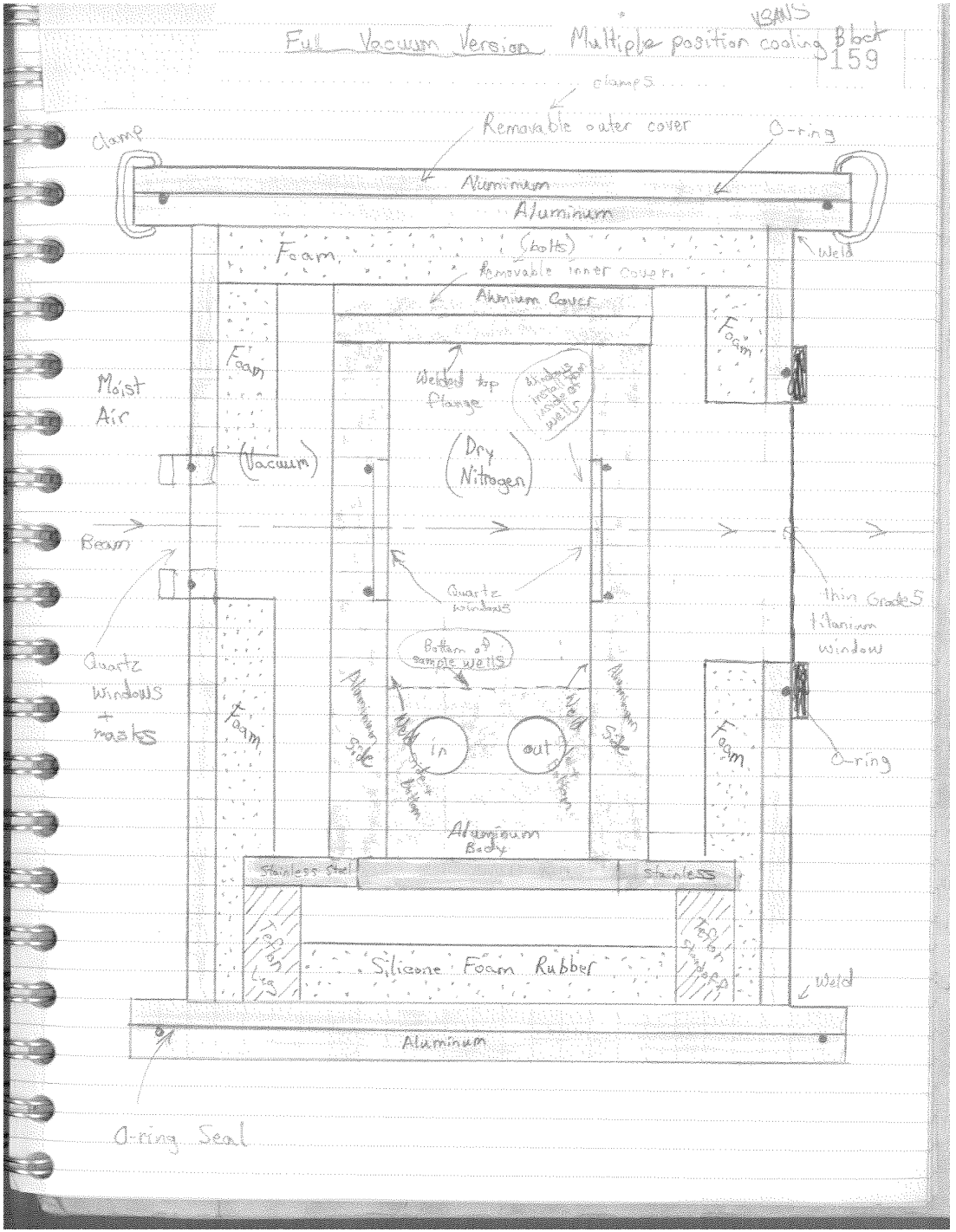
Suggested changes over current 10-CB

- Two vs. Four flow channels
- Reduce block volume (thermal mass..)
- Increase scat. Angle from 30˚ to 45˚.
- Vacuum tight design (thermos).



Comments:

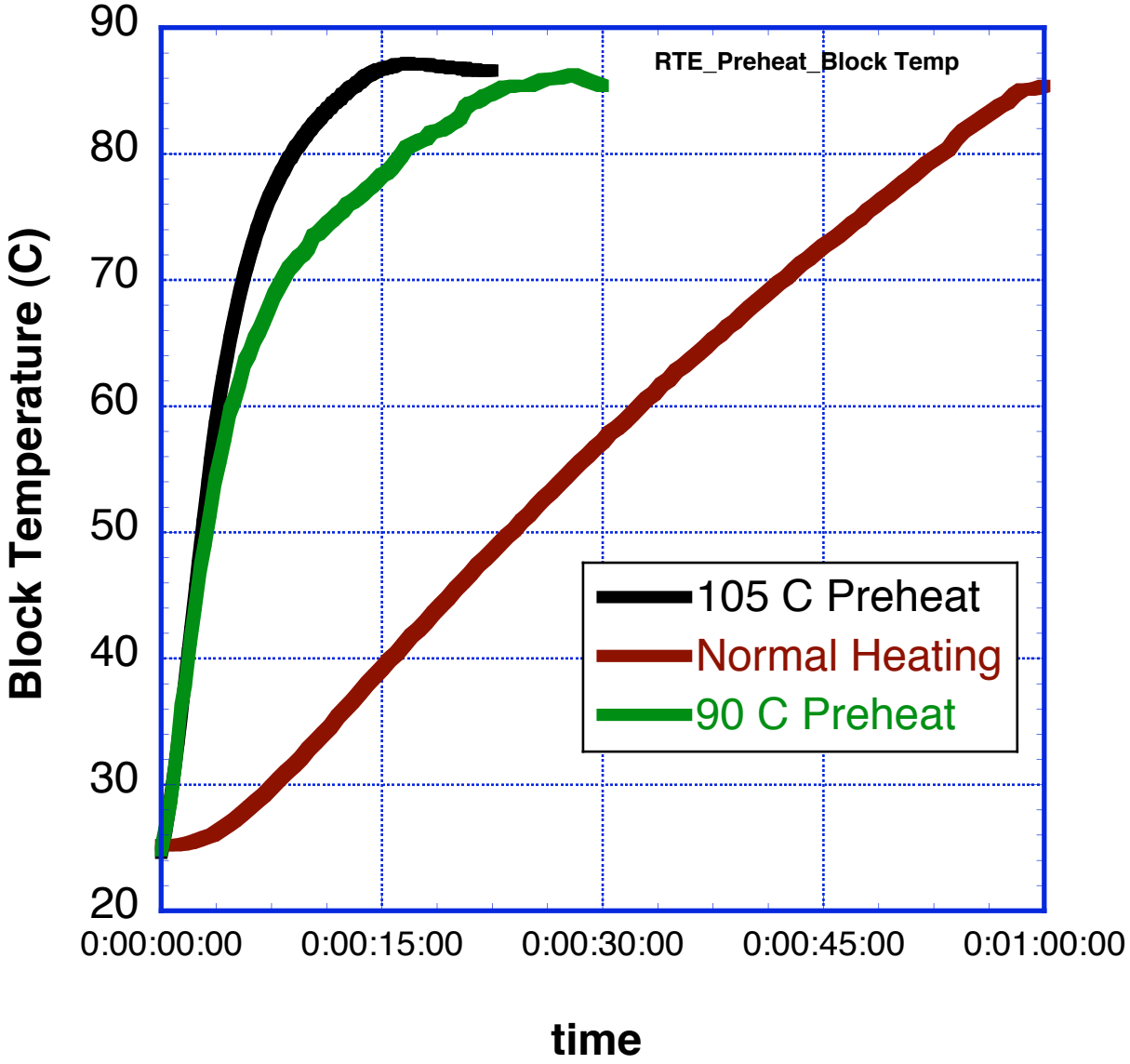
- Sample (inner block) in **dry Nitrogen**
- Outer under Vacuum (**Thermos**)
- Quartz and Ti (grade 5) Windows.
- Only Two-cooling bath channels in base.



Comments:

- Slow bath heat rate
- Large T undershoot **(-3.5 C˚)**
- Julabo Bath is much faster!

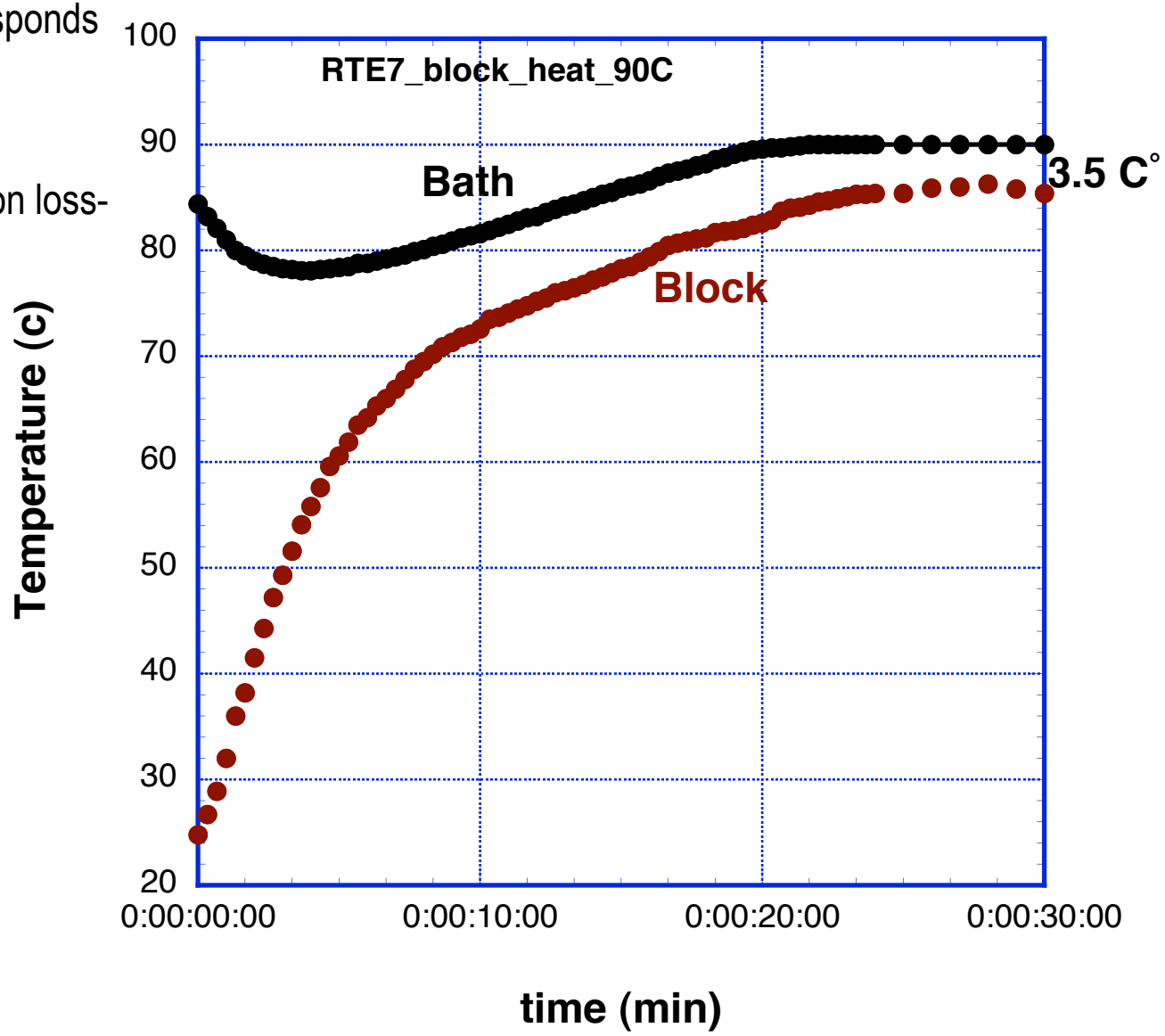
Heating of 10-CB from 25 C˚ to 90 C˚ with Neslab RTE-7
{ Normal ramp, bath preheated to 90 C˚ and 105 C˚ }



Temperature Offset Corresponds to **2.5 Ltr/min** pump rate.

Cooling rate with pump off

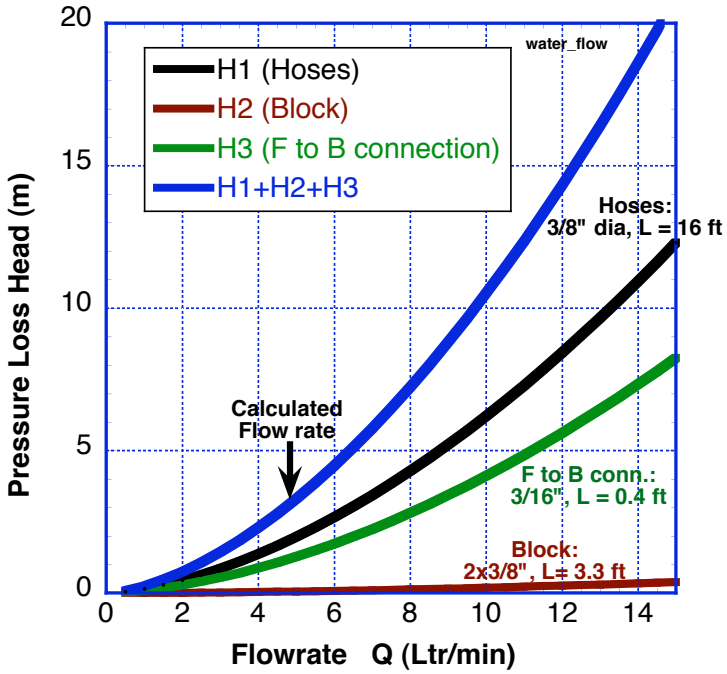
Yields -**100 Watt** convection loss-rate

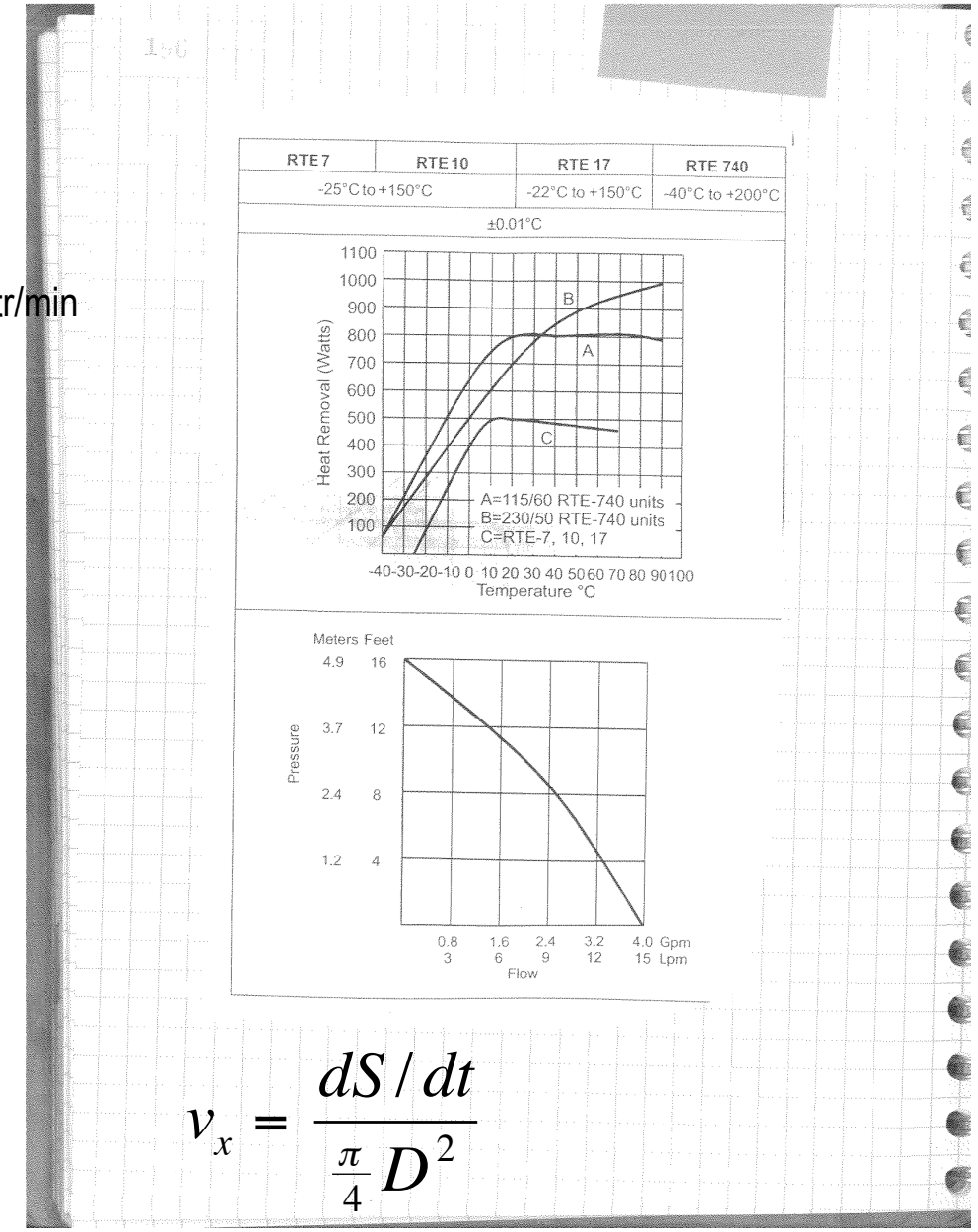


RTE-7 Bath Flowrate:

Calculated: **5** Ltr/min

Measured from Temperature Curves: **2.5** Ltr/min

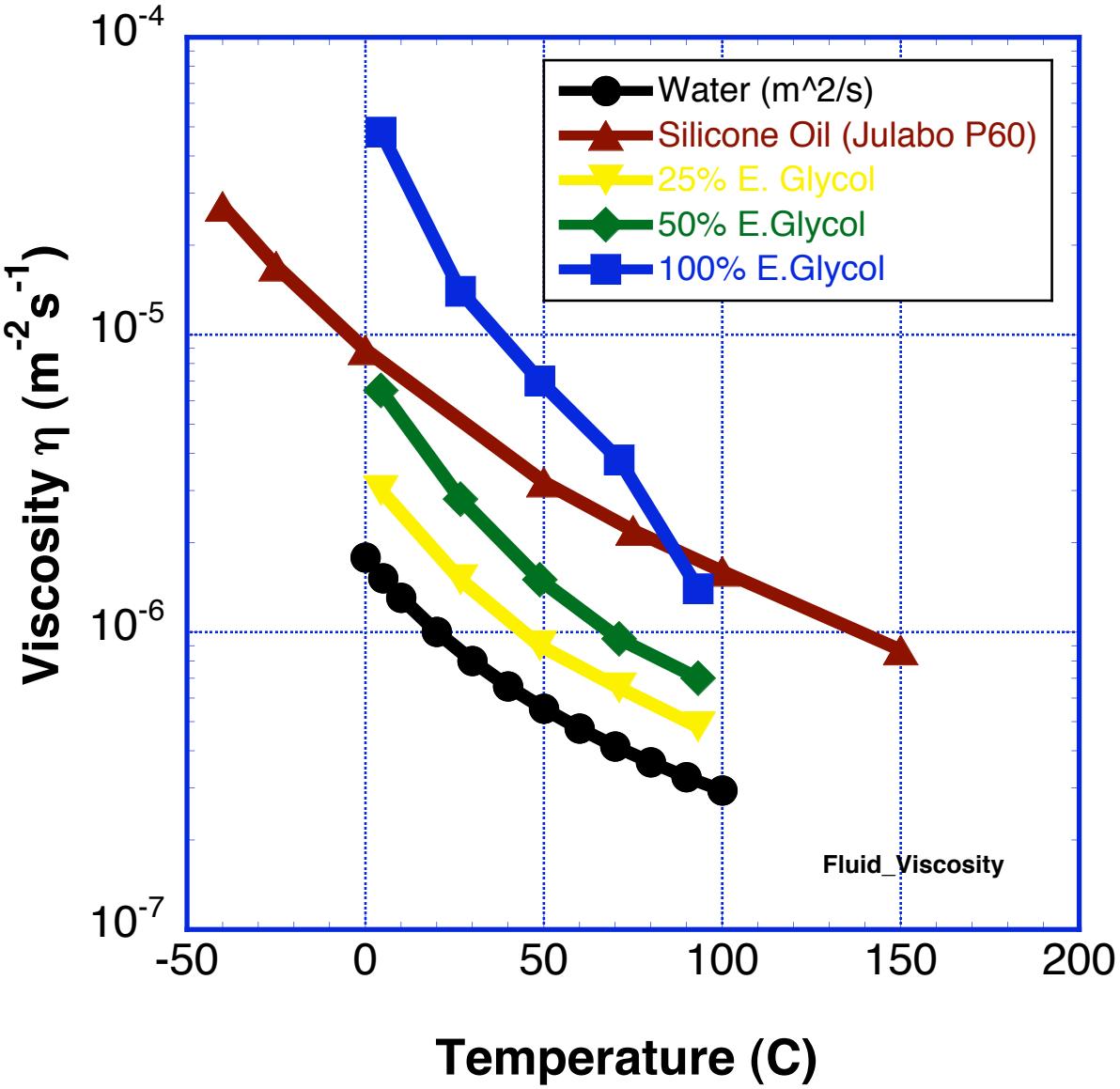




$$h_L = 2C_f \frac{L}{D} \frac{V_x^2}{g}$$

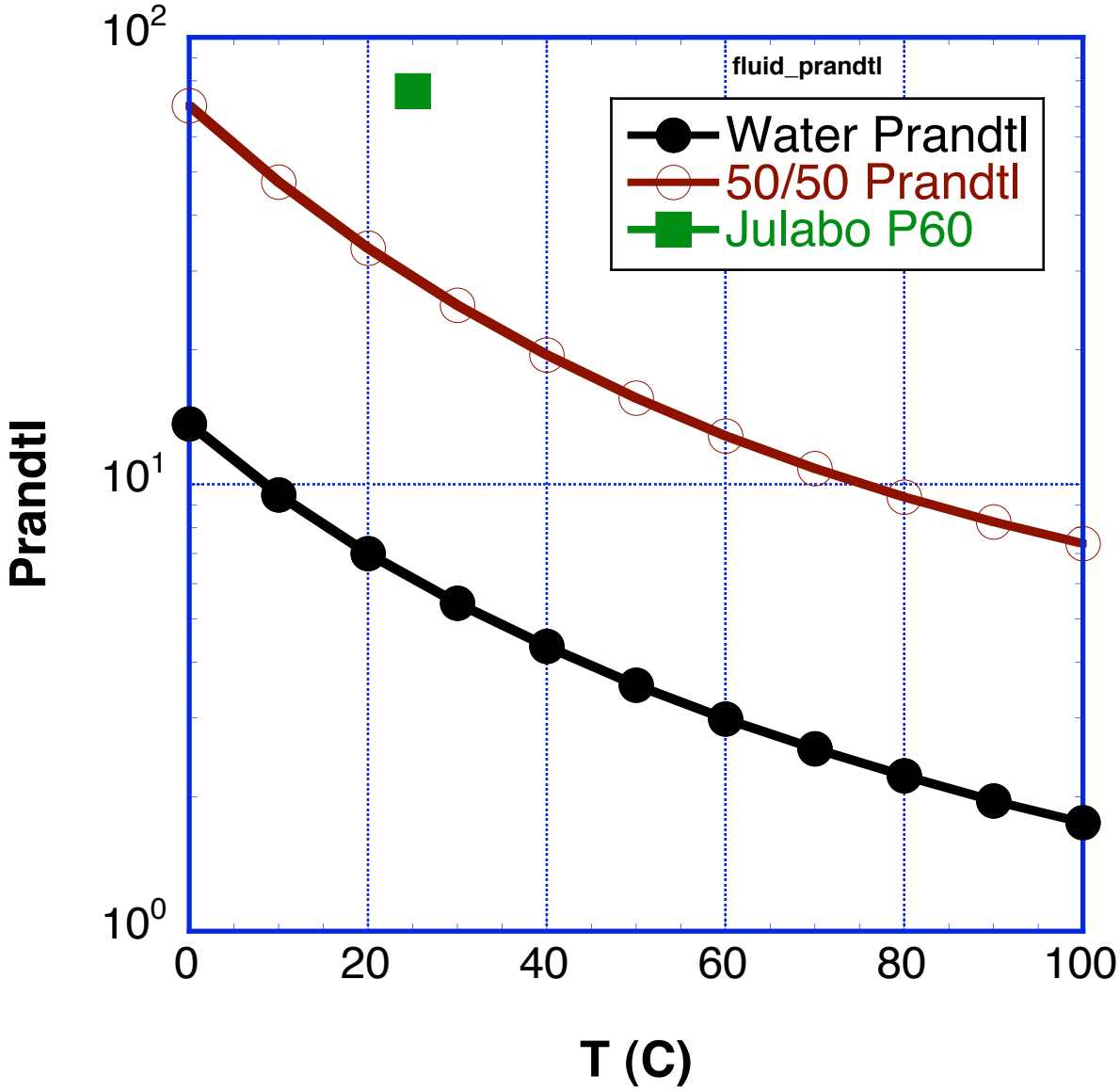
$$v_x = \frac{dS/dt}{\frac{\pi}{4} D^2}$$

FLUID	HEAT CAPACITY
Water	4.2 J/ cm^3/K
50% Water 50% E. Glycol	3.2
100% E. Glycol	2.2
Silicone Oil	1.6



Prandtl Number for various Heat Transfer (bath) fluids

$$P_r \equiv \frac{\nu C_P}{k}$$



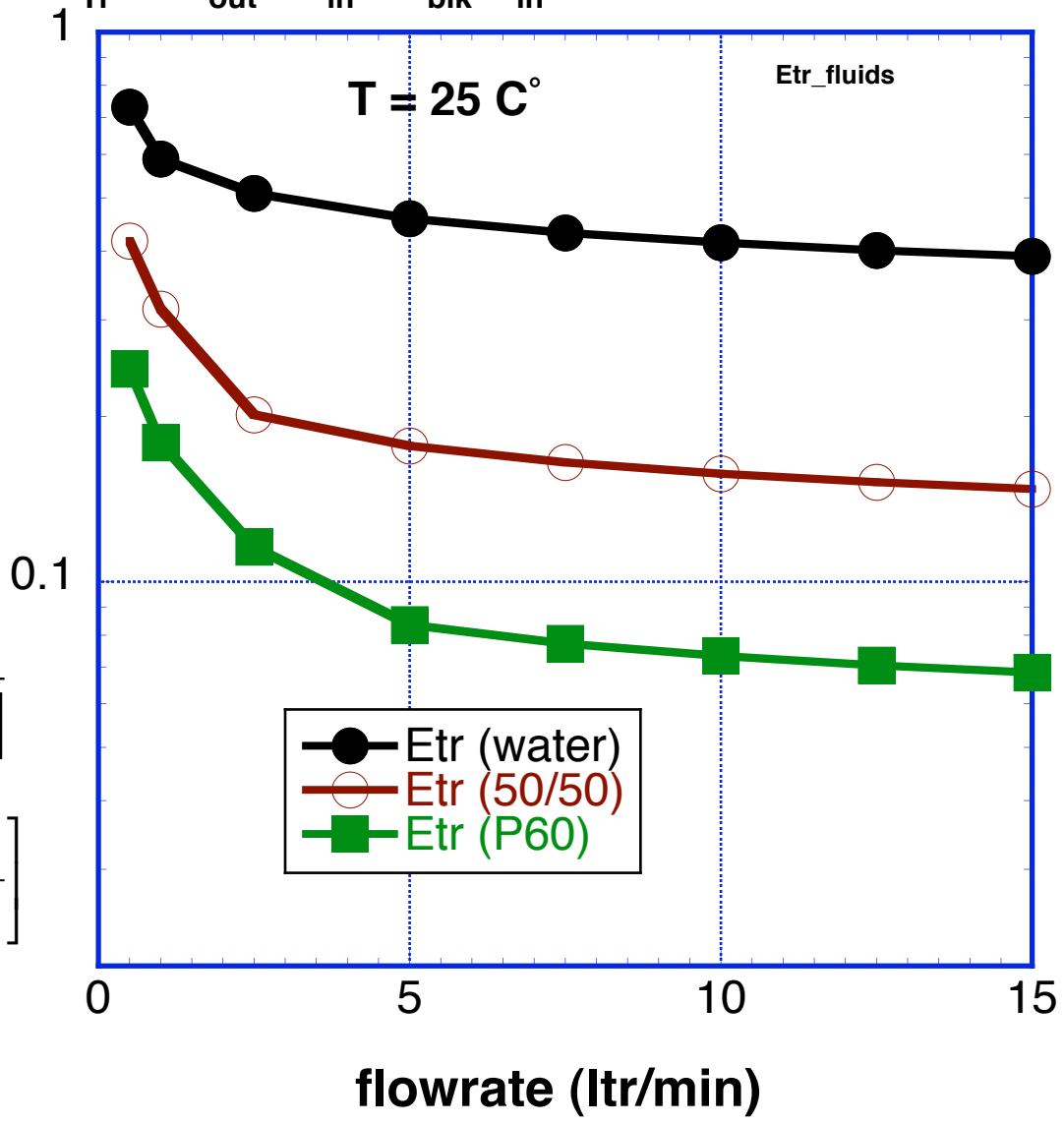
$$R_e = \frac{v_x D}{\nu}$$

$$C_F \cong \frac{0.331}{\left[\ln\left(\frac{5.74}{R_e^{0.9}}\right)\right]^2}$$

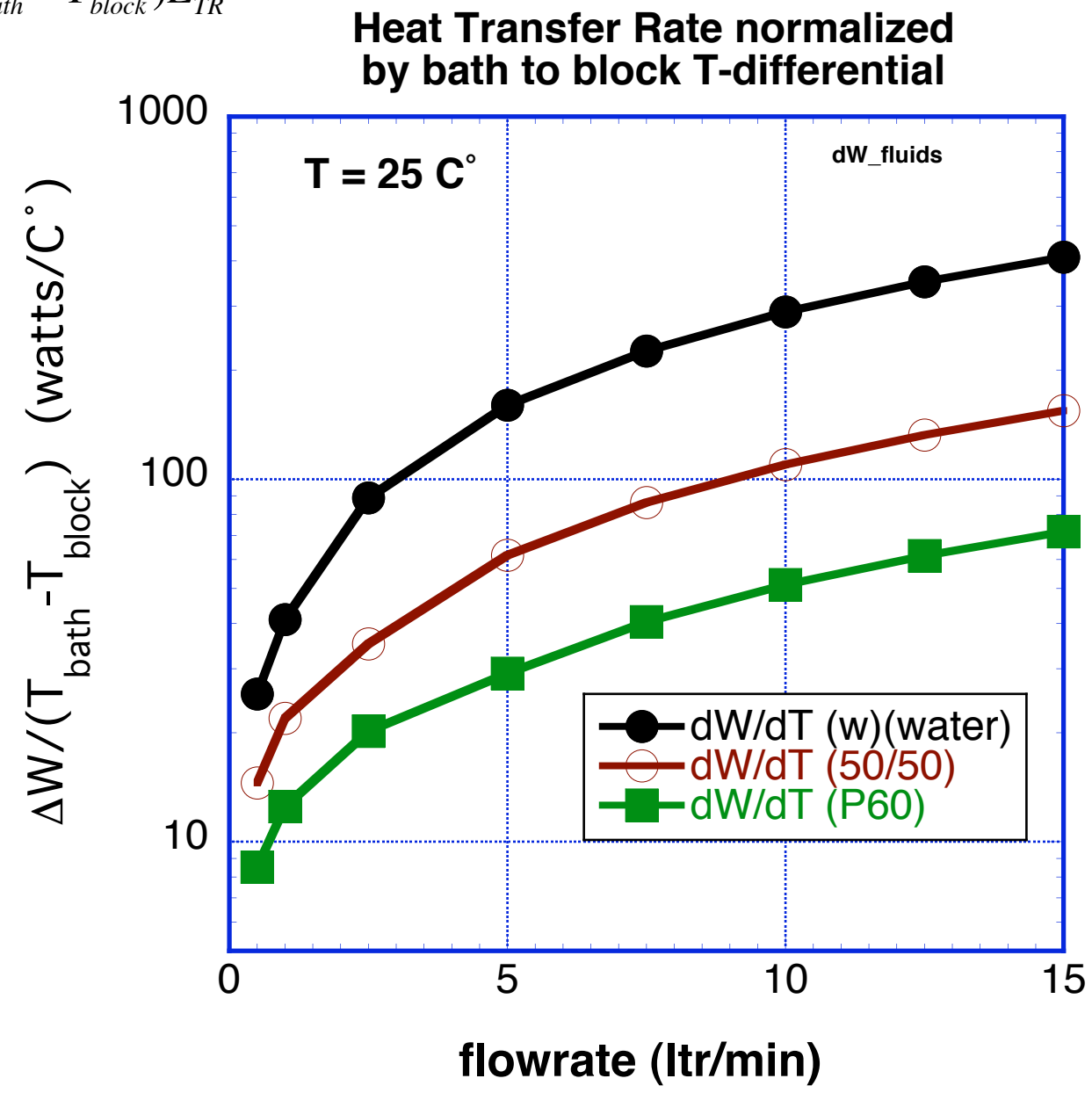
$$S_T = \frac{C_F/2}{1+5\sqrt{C_F/2}\left[P_r - 1\right]}$$

$$E_{TR} \equiv \frac{T_L - T_S}{T_O - T_S} = \exp\left[-S_T \frac{4L_B}{D_B}\right]$$

Efficiency of Heat Transfer from Bath to block:
$E_{Tr} = (T_{out} - T_{in})/(T_{blk} - T_{in})$ using Prandtl Analogy...



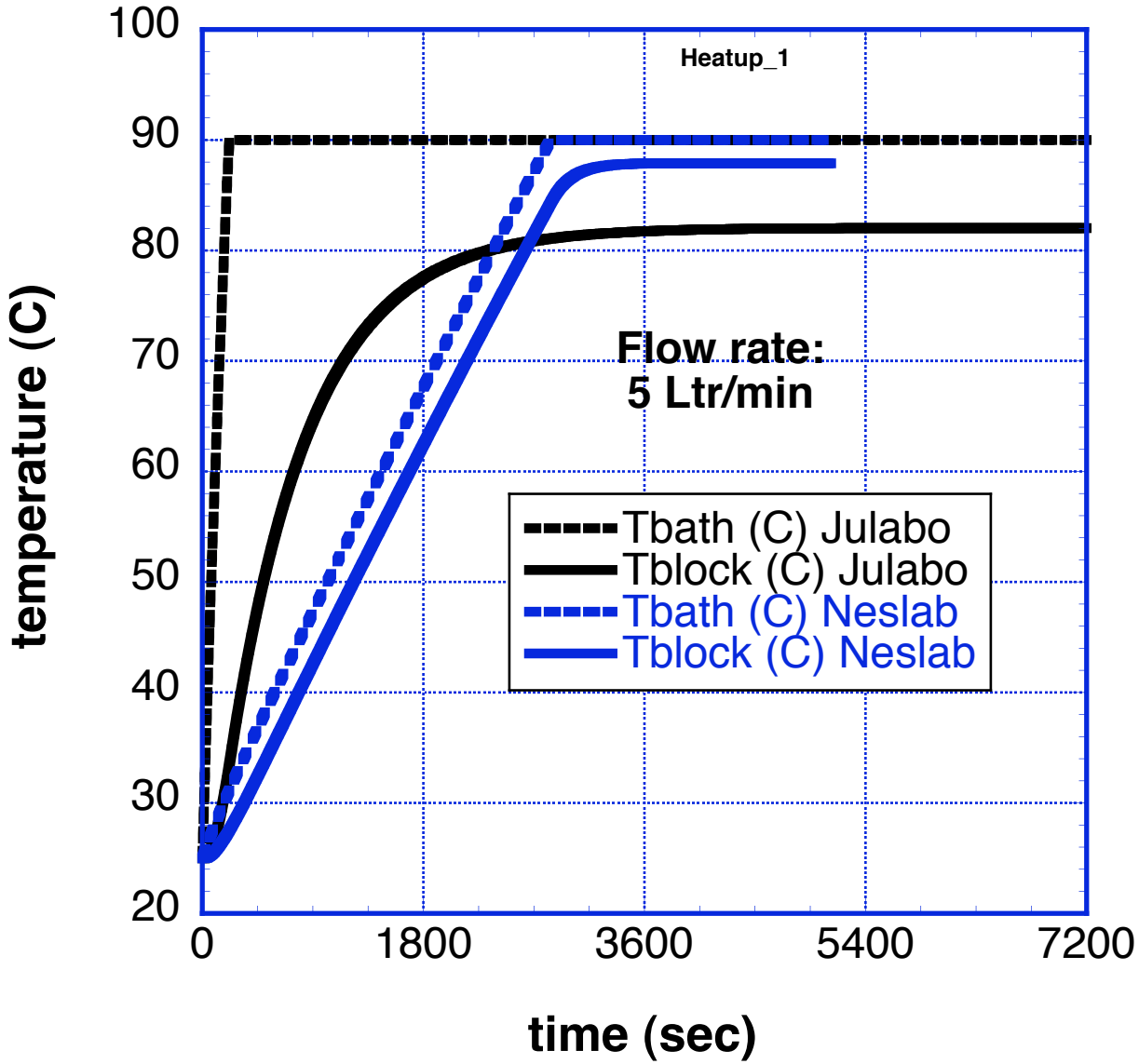
$$\Delta w = \frac{dS}{dt} C_{P,fluid} (T_{bath} - T_{block}) E_{TR}$$

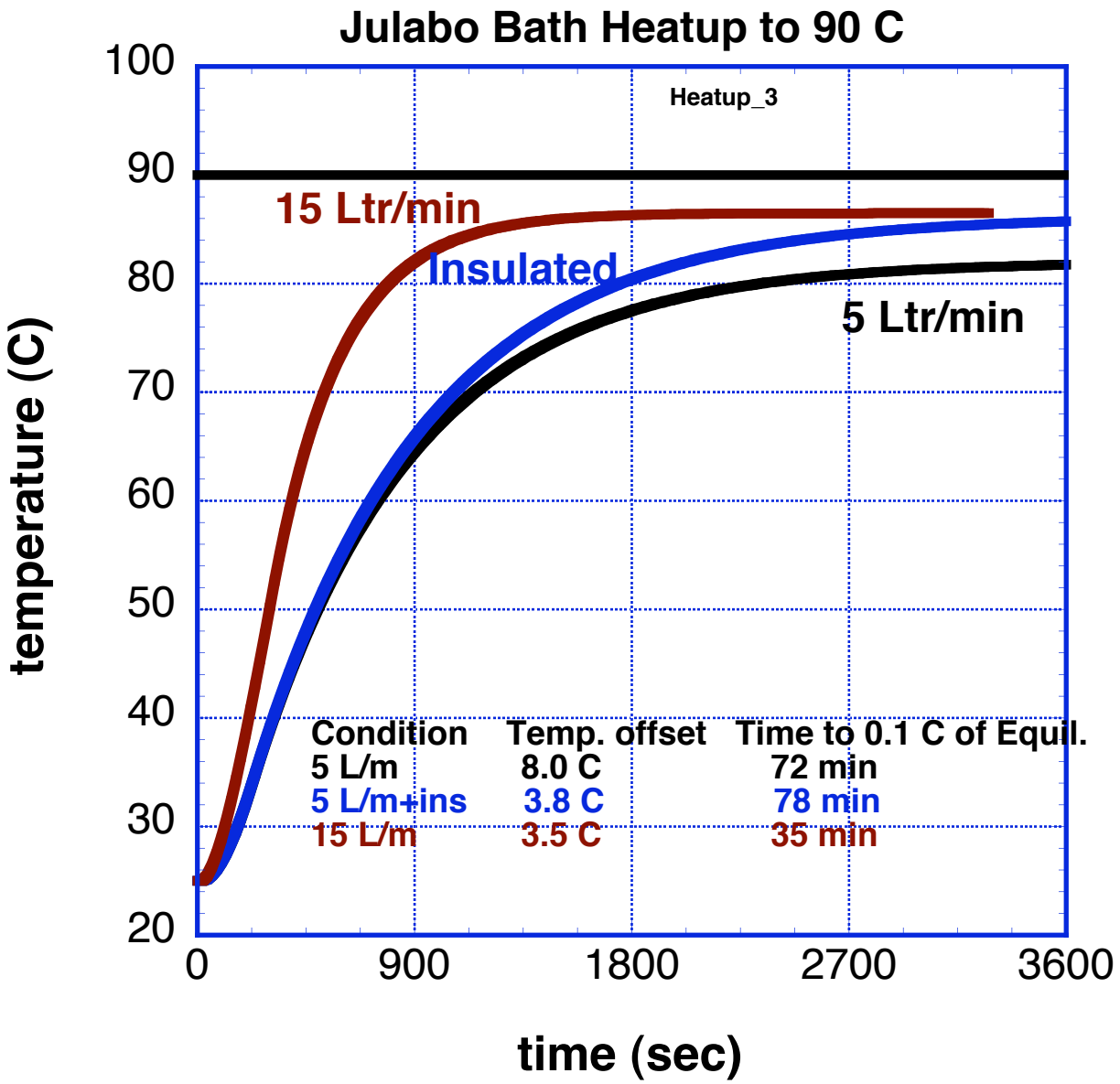


Bath Specs Comparison

Spec.	Neslab RTE-7	Julabo LH45	Huber "Tango"
Bath Volume	7.2 Ltr	2.5 Ltr	2 Ltr
Pump (max) pressure	0.5 Bar	1.6 Bar	0.9 Bar
Max. Pump rate	**15 Ltr/min**	**24-33 Ltr/min**	**33 Ltr/min**
Fluid	Water+ E. Glycol	Silicone Oil	Silicone Oil
Heat Capacity (T=25 C)	3.24 J/cm3/K	1.63 J/cm3/K	1.63 J/cm3/K
Heater	800 Watts	1800 Watts	1500 Watts
Cooler (max)	500 Watts	1200 Watts	450 Watts
Heating rate (pump+10 CB)	**1.4 C˚/min**	**8.0 C˚/min**	**6.9 C˚/min**
Cooling rate (pump+10 CB)	-0.9 C˚/min	-5.3 C˚/min	-2.1 C˚/min
Temp Range	-25 C˚ to 150 C˚	**-40 to 250 C**	**-40 to 200 C**

Item	Julabo	Neslab
Undershoot (C˚)	8.0 C	2.1 C
Time to 0.1 C eq.	72 min	57 min




Julabo Bath Heatup to 90 C
Heatup_3
15 Ltr/min
Insulated
5 Ltr/min
temperature (C)
time (sec)
100
90
80
70
60
50
40
30
20
0
900
1800
2700
3600
Condition
Temp. offset
Time to 0.1 C of Equil.
5 L/m
8.0 C
72 min
5 L/m+ins
3.8 C
78 min
15 L/m
3.5 C
35 min

New Cooling Block Design Choices:

1) Two blocks+baths in one allows one block to be at Temperature while other equilibrates **("Leap Frog")**. Will require ICE to command two separate baths.

2) Insulate with **Silicone foam** insulation + outer shell. Reduces temperature gradients and temperature undershoot by **factor of two**, and eliminates condensation.

3) Insulate with **vacuum**. Removes condensation and reduces gradients and undershooting by **factor > 20x**. Inner sample block must be air/vacuum tight.

4) Reduce volume (**thermal mass**) of block. Reduces equilibration time and undershoot. (Similar to PSI or D11 design). May involve fewer sample positions.

5) Increase efficiency of heat transfer $\mathbf{E_{TR}}$ by using serial vs split-parallel flow…

6) Increase pump rate dS/dt by using larger ID tubing and fittings.

Priority List and Budget for new Ti-Cell Sizes

	Description	Cost
2011	1) Velmex Slide: 48" travel	$3,189
	2) 32 mm diameter fill cells (Qty: 50 x 1mm, 50 x 2 mm, 30 x 4 mm)	$13,000
	3) **5**-position room temperature holder for BT-5 USANS	$2,000
	4) **20**-position room temperature holder for VSANS and 30m SANS	$6,000
	5) Two **9**-position cooling blocks (-25 C ≤ T ≤ 130 C) for vSANS + 30m to be used in tandem.	$10,000
	6) **4**-position cooling block (-25 C ≤ T ≤ 130 C) for BT-5 USANS	$4,000
2012	7) 44 mm x 95 mm Ti Cells for 18 conv. Beams on vSANS (Qty: 30x 1mm, 30 x 2 mm, 20 x 4 mm)	$16,000
	8) **12**-position room temperature holder for 18 beams on vSANS	$6,000
	9) Two **5**-position cooling block for 18 beams on vSANS	$10,000
	Total	**$70,189**