Xenon purification and Radon measurements for EXO

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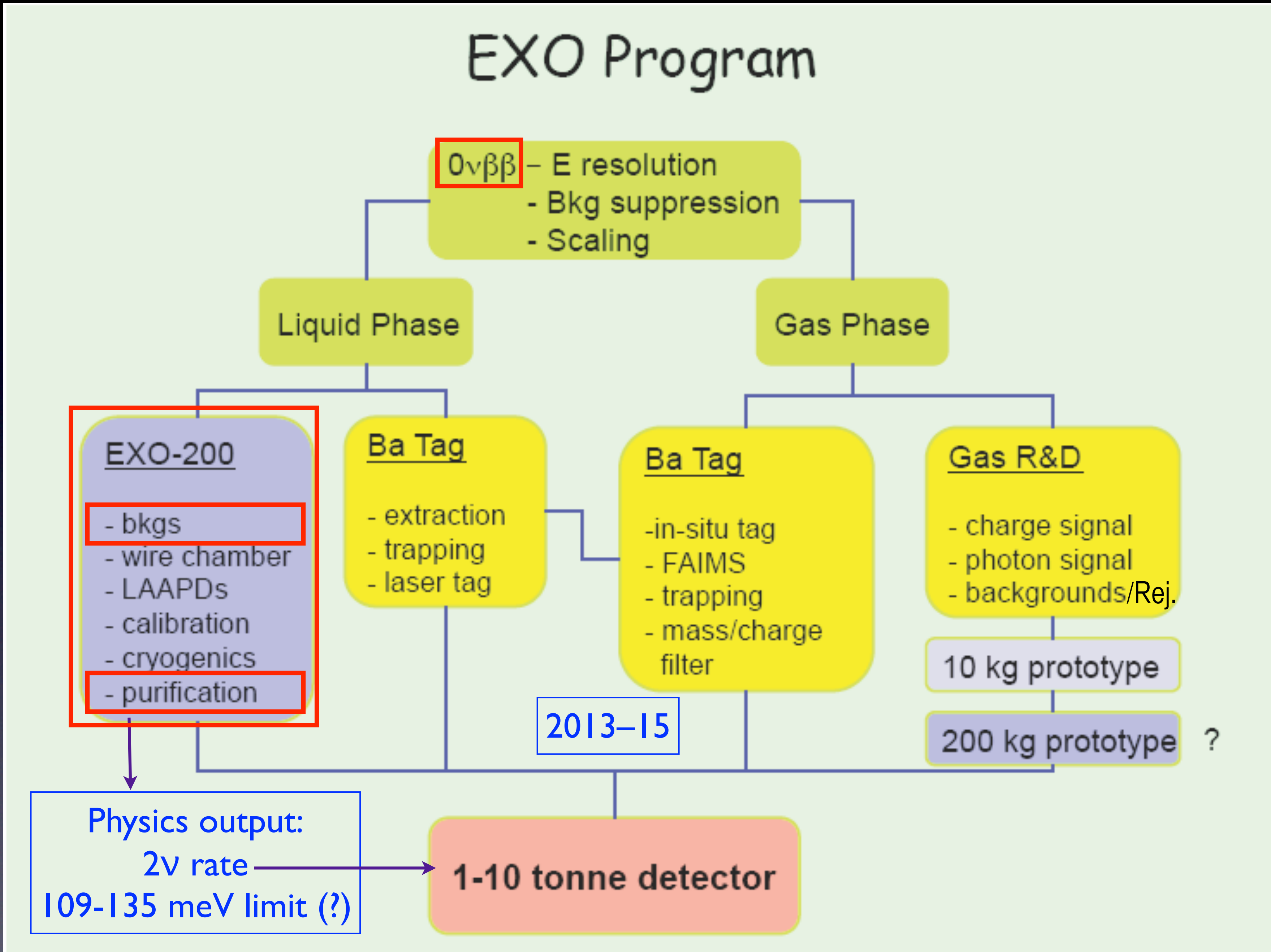
LRT'10 – SNOLAB – 100829

Plan

- EXO-200
- Electrostatic Counters (ESCs)
- Radon, thoron, actinon emanation
- Xenon purification for EXO-200


EXO Program
0νββ – E resolution
- Bkg suppression
- Scaling
Liquid Phase
Gas Phase
EXO-200
- bkgs
- wire chamber
- LAAPDs
- calibration
- cryogenics
- purification
Ba Tag
- extraction
- trapping
- laser tag
Ba Tag
-in-situ tag
- FAIMS
- trapping
- mass/charge filter
Gas R&D
- charge signal
- photon signal
- backgrounds/Rej.
10 kg prototype
200 kg prototype
?
2013–15
Physics output:
2ν rate
109-135 meV limit (?)
1-10 tonne detector

EXO-200: Sensitivity

2 year sensitivities for the EXO-200 $0\nu\beta\beta$ search.

Mass (tonne)	Efficiency (%)	Run time (yr)	$\sigma(E)/E$ @ 2.5 MeV (%)	Radioactive background (events)	$T_{1/2}^{0\nu}$, 90% C.L. (yr)	Majorana mass (meV)	
						RQRPA[1]	NSM[2]
0.2	70	2	1.6	40	6.4×10^{25}	109	135

1. Simkovic et al., *Phys. Rev.* C**79**, 055501(2009) [g_A= 1.25]; 2. Menendez et al., *Nucl. Phys.* A**818**, 139(2009) [UCOM results]

EXO-200 will also search for $2\nu\beta\beta$ of ^{136}Xe, which has not been observed.

	$T_{1/2}^{2\nu}$ (yr)	Events/year (no efficiency applied)
Experimental limit		
Luescher et al, 1998	**$> 3.6 \times 10^{20}$**	**< 1.3 M**
Bernabei et al, 2002	**$> 1.0 \times 10^{22}$**	**< 48 k**
Gavriljuk et al, 2005	**$> 8.5 \times 10^{21}$**	**< 56 k**
Theoretical prediction [$T_{1/2}^{max}$]		
QRPA (Staudt et al)	**$= 2.1\cdot10^{22}$**	**= 23 k**
QRPA (Vogel et al)	**$= 8.4\cdot10^{20}$**	**= 0.58 M**
NSM (Caurier et al)	**$(= 2.1\cdot10^{21})$**	**(= 0.23 M)**

EXO

EXO is a multi-phase program to search for the neutrinoless double beta decay of ^{136}Xe. The ultimate goal is a ton-scale experiment with ~10 meV sensitivity to the Majorana mass as well as positive identification of the barium daughter ion.

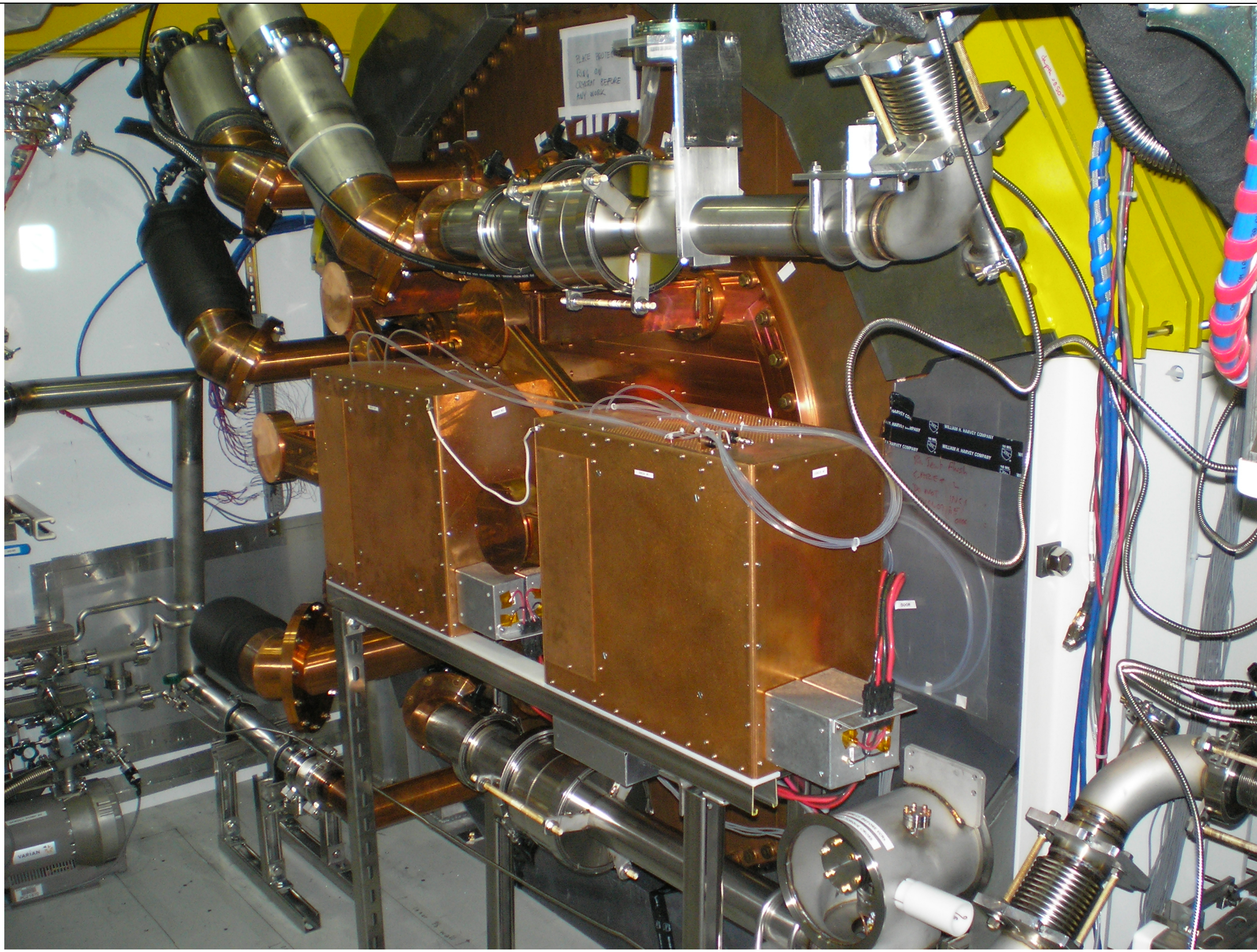
Case	Mass (tonne)	Efficiency (%)	Run time (yr)	*σ(E)/E* @ 2.5 MeV (%)	$2\nu\beta\beta$ background (events)	$T_{1/2}^{0\nu}$, 90% C.L. (yr)	Majorana mass (meV)	
							RQRPA[1]	NSM[2]
Conservative	1	70	5	1.6	0.5 (use 1)	2×10^{27}	19	24
Aggressive	10	70	10	1	0.7 (use 1)	4.1×10^{28}	4.3	5.3

1. Simkovic et al., *Phys. Rev.* C**79**, 055501(2009) [$g_A = 1.25$]; 2. Menendez et al., *Nucl. Phys.* A**818**, 139(2009) [UCOM results]

Assumptions:

- 80% enrichment in ^{136}Xe
- Intrinsic low background and Ba tagging to eliminate all radioactive background
- Energy resolution only used to separate the 0ν from 2ν modes: Select 0ν events in a $\pm 2\sigma$ interval centered around the 2458 keV endpoint
- Use for $2\nu\beta\beta$ $T_{1/2} > 1 \times 10^{22}$ yr (Bernabei et al.)

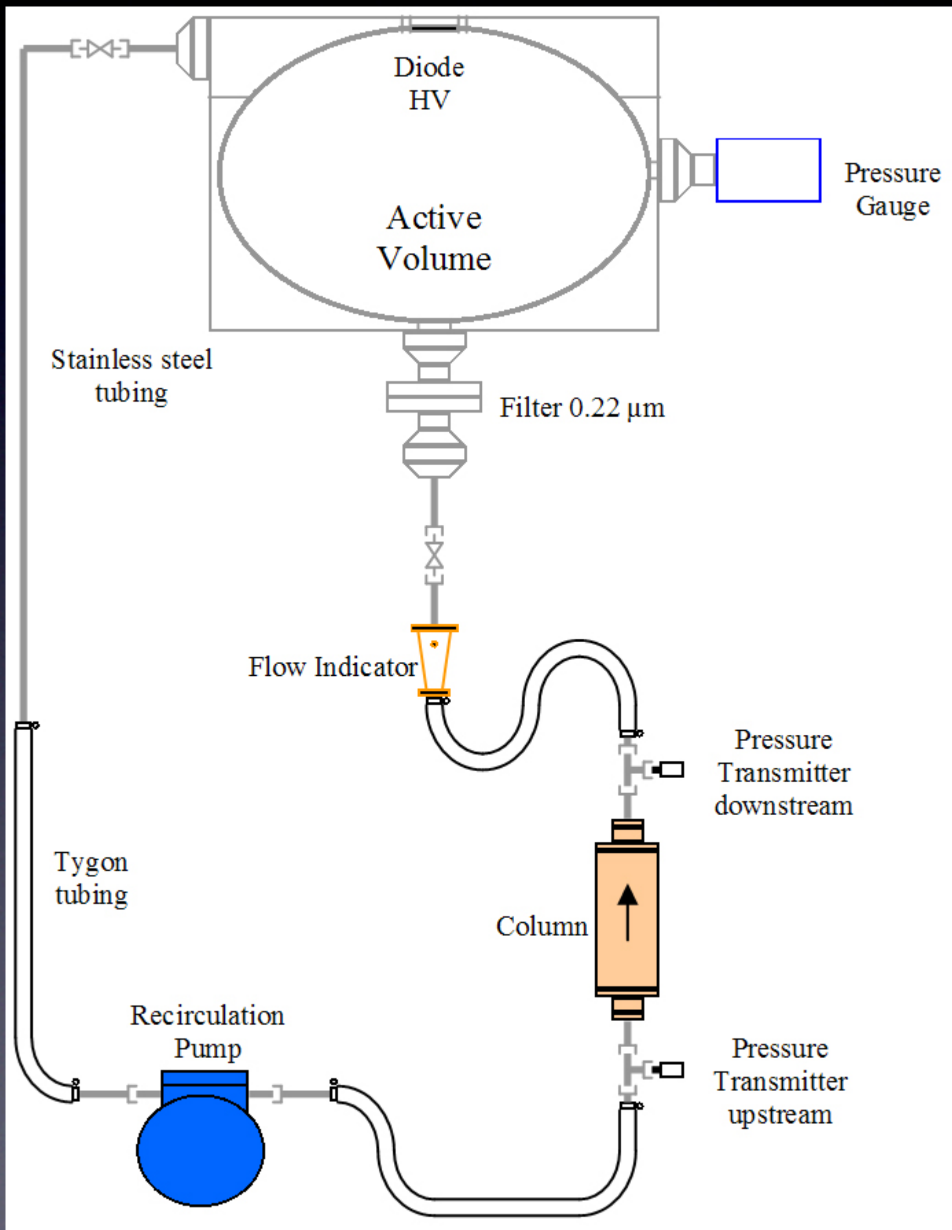
EXO-200 Start of DAQ very near future



Dolinski

Electrostatic Counters

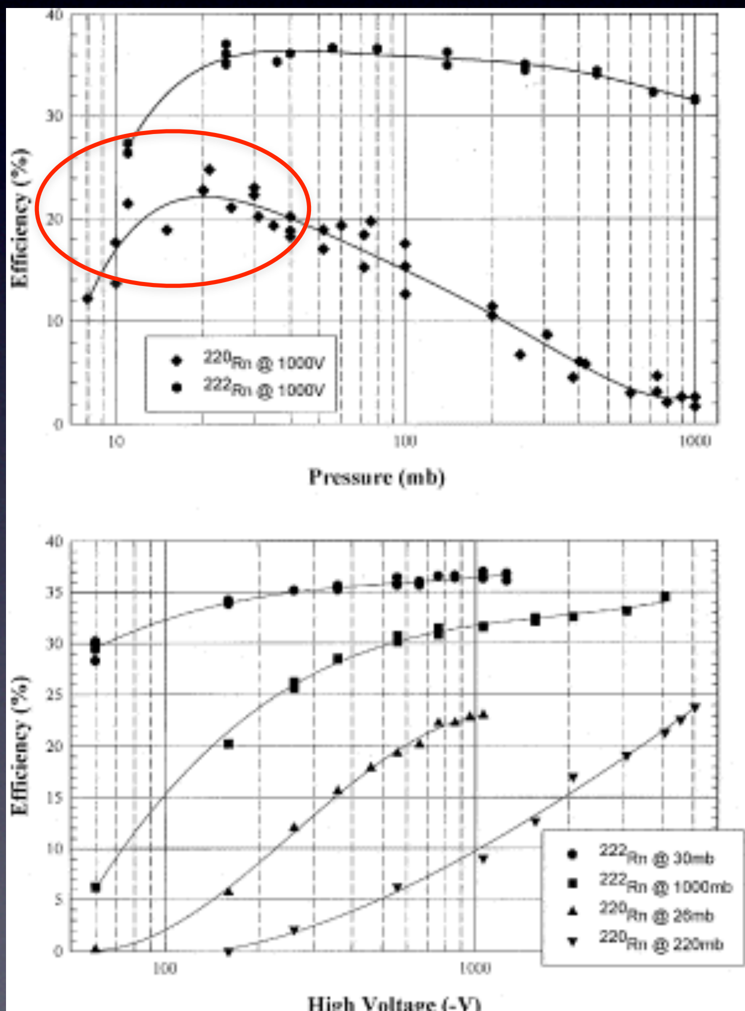
Developed to Measure ^{224}Ra, ^{226}Ra in SNO

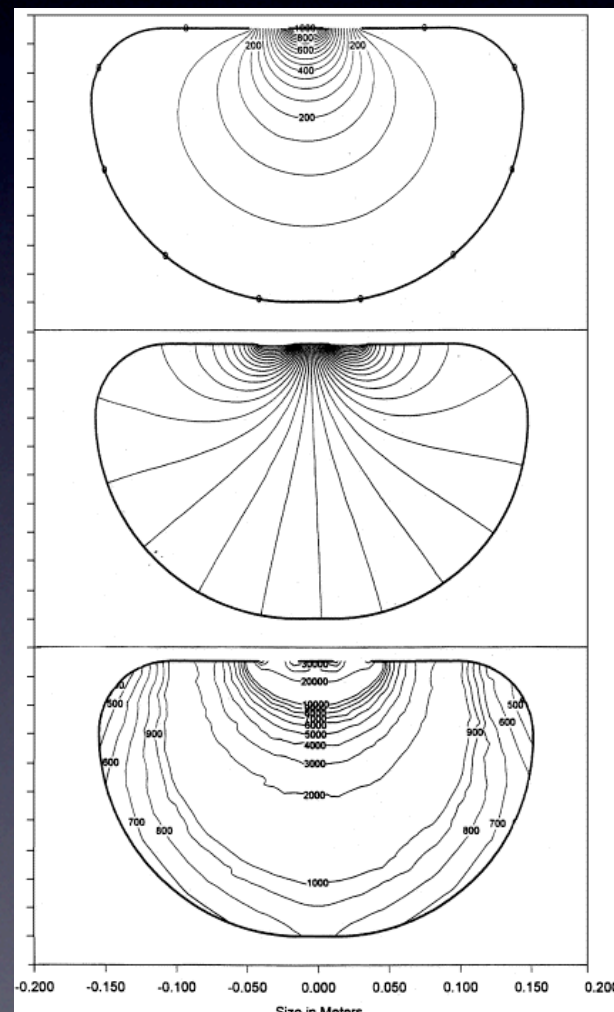


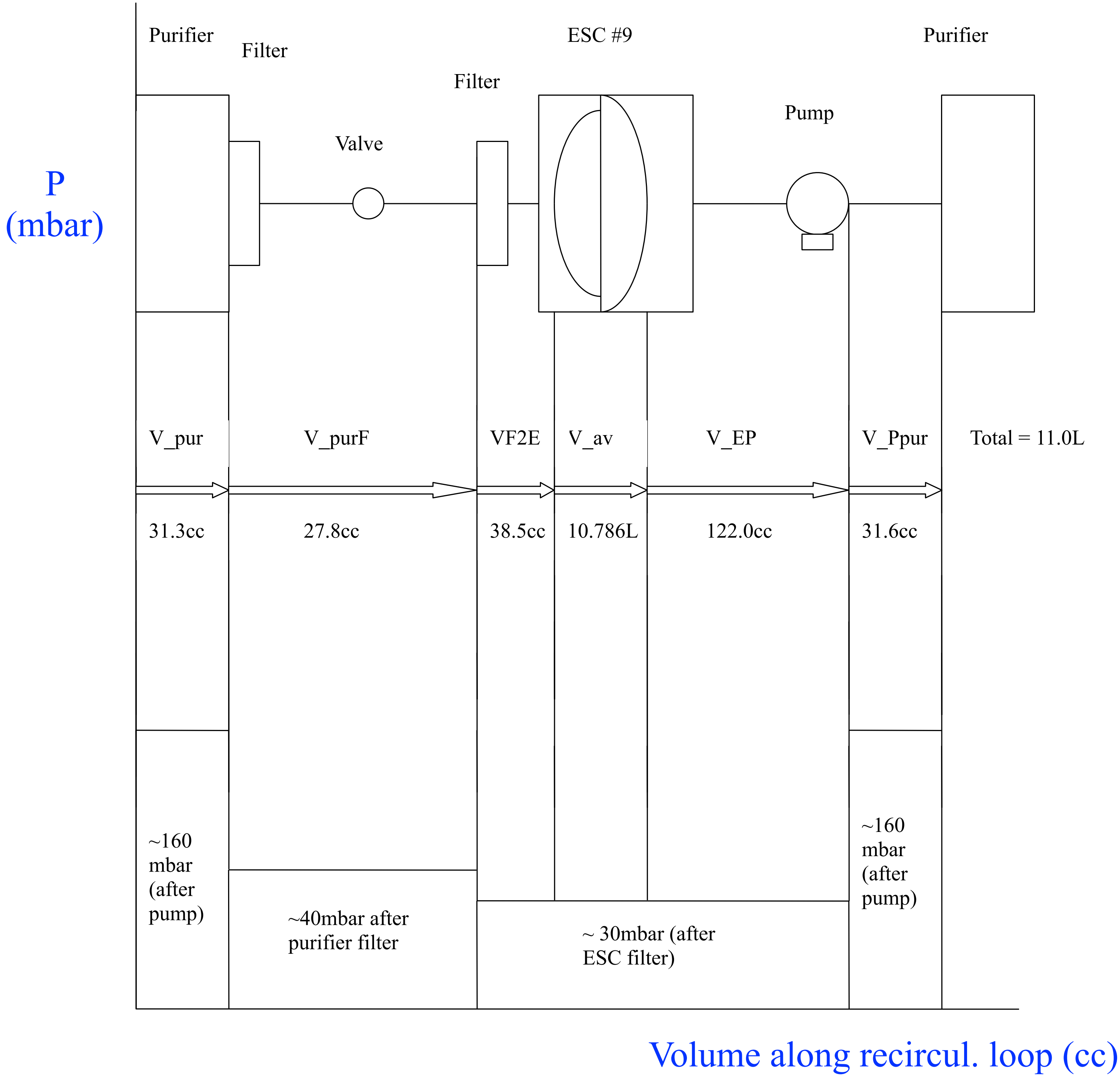
- A recirculation pump forces a carrier gas gas through the sample and into the ESC for analysis.
- 10L Decay Chamber, filled with Electrostatic field
- 70% of Rn daughters +charged
- Rn daughters precipitate onto Si PIN diode
- Alpha spectroscopy
- Time series analysis returns ^{220}Rn, ^{226}Ra, ^{228}Th and ^{224}Ra at time zero

Designed specifically for high ^{220}Rn detection efficiency: 22.5% @ 25mbar N_2

J.X. Wang et.al., NIM A 421 (1999) 601
T.C. Andersen et.al., NIM A 501 (2003) 399–417







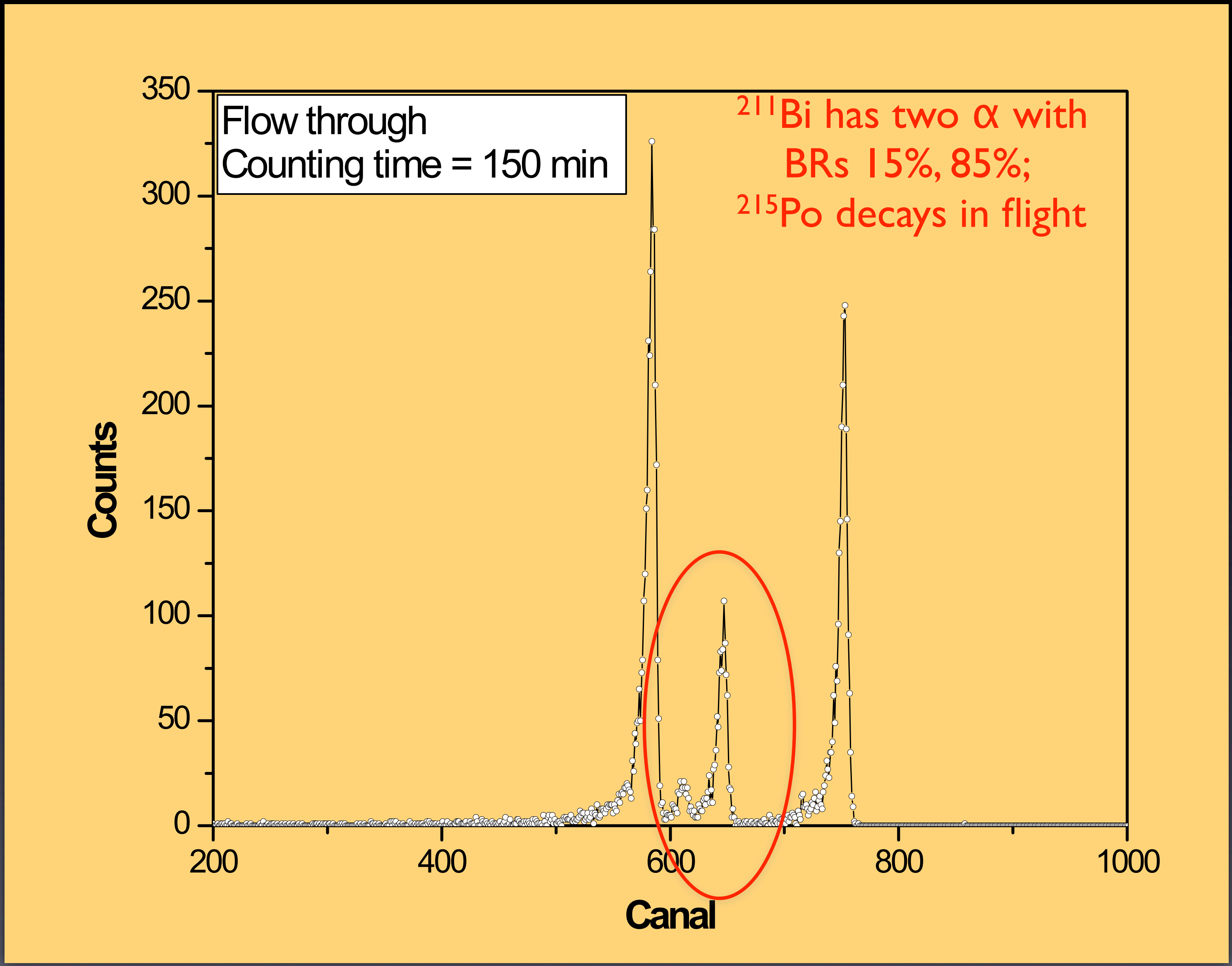
Efficiencies

^{222}Rn: Volume

^{220}Rn: Volume +Transport

measure $p_i V_i$; know mass flow; obtain transfer time

Sensitivity to ^{219}Rn through ^{211}Bi

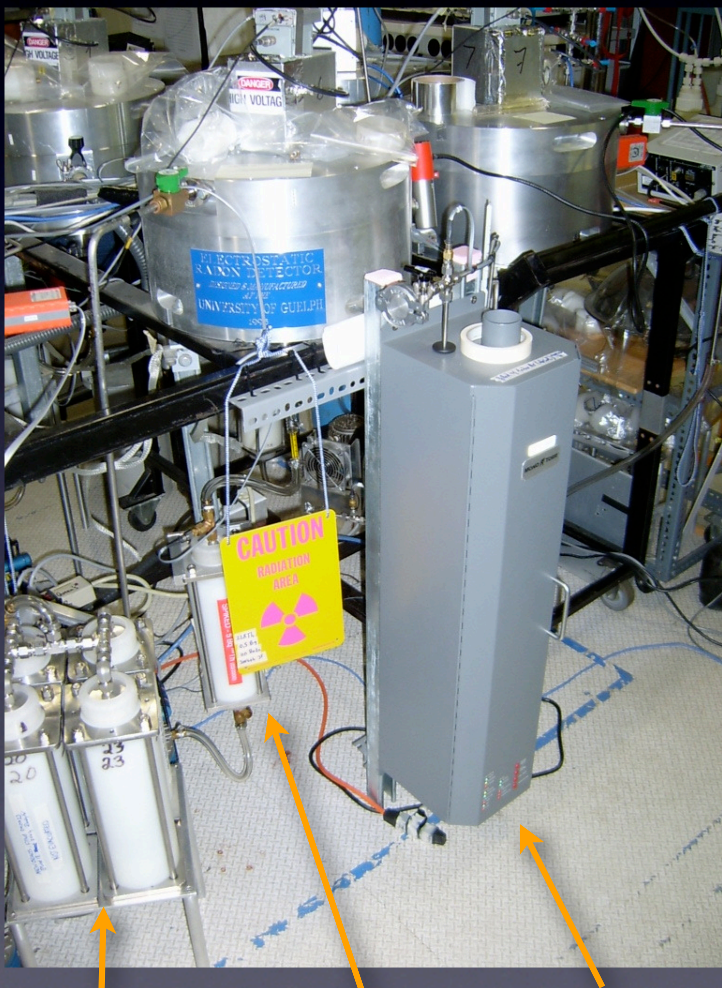


ESC Farm at SNOLAB

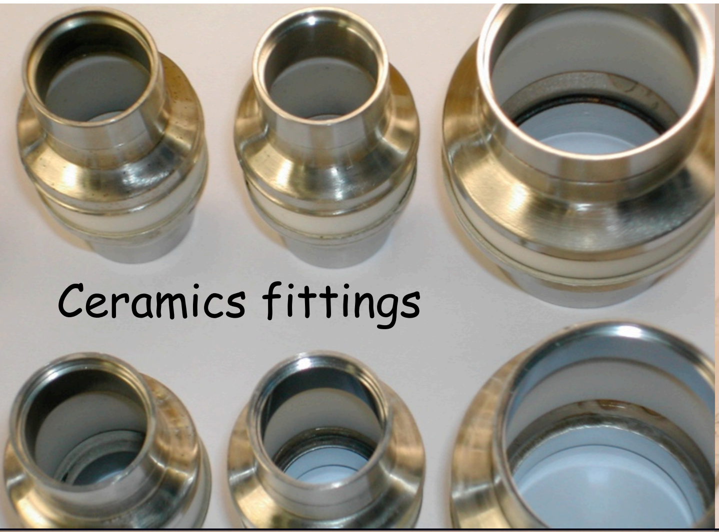
- Measure radon from U / Th / Act chains, in N_2, Ar, Xe
- From 9 counters down to 6 for general emanation studies (still 8 in use for EXO)
  - ESC#5 moved to WIPP (and well used)
  - ESC#7 lent to Alberta (SNO+ Rn–free air)
  - ESC#3 dedicated to Rn trap work (upcoming slides)
- Worked hard to reduce backgrounds further / maintain:
  - sensitivity: 5 resp. <~10 atoms/day in ^{220}Rn resp. ^{222}Rn
  - sensitivity ~50 atoms/day in ^{219}Rn

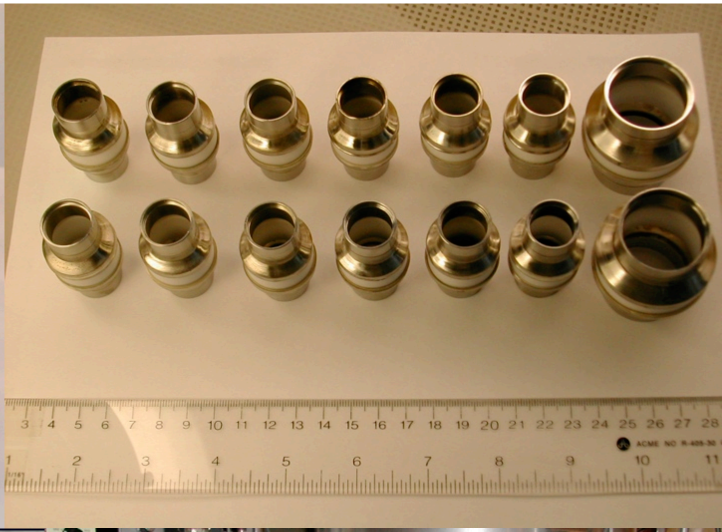
Radon Emanation

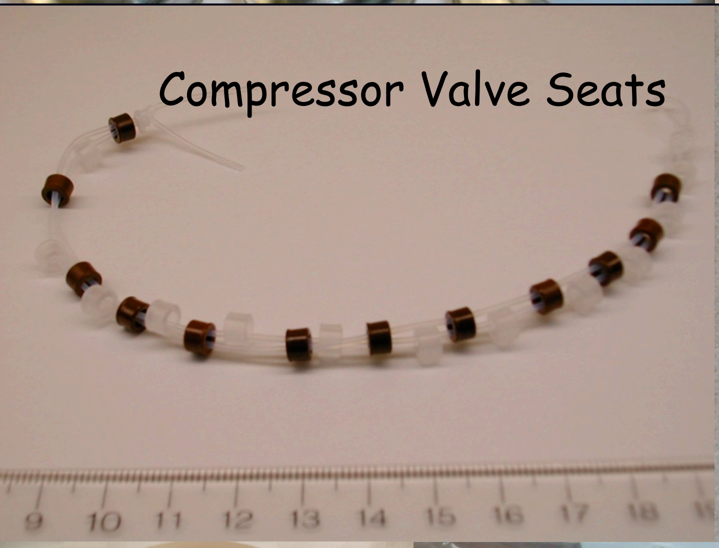
Array of 9 Electrostatic Counters (ESCs) at SNO > SNOLAB

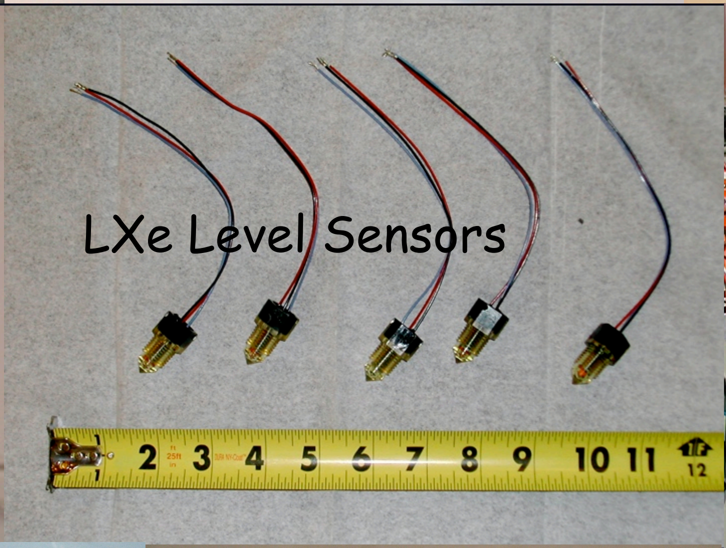


- Electrostatic counters operated by LU at SNO - well understood in N_2
- Must use Ar with purifier, this changes:
  - lower drift voltage 1000 > 600V
  - transport efficiency / active volume
  - Po charge fraction (maybe)
- Used 0.5Bq ^{228}Th source (after SAES runs) to recalibrate ESC:
  - ε_{det} = 26% ^{222}Rn - in Ar, 600V
- Subtract Blank = Purifier bypassed
- > 30 samples counted for EXO
- One ESC relocated to EXO Clean Room for in-situ measurements ON-GOING NEEDS









SAES Purifier II - SLAC Spare

DuPont Teflon TE-6472 Lot# 0503830033 APT drum #041 - DuPont Teflon TE-6472 Lot# 0506830001 Sealed drum, DuPont - Espanex sheet for flat cable (from A. Piepke) - Ceramics electrical breaks 9998-06-W(12) + 17199-01-W(2) - LXe Level Sensors (from P. Rowson) - Valve seats for GXe systems (from C. Hall) - Teflon coated o-rings (compressors) (from C. Hall) - Phosphor Bronze Spiders for APDs (from A. Pocar) MD152.B.1 - Copper plates (from A. Pocar) MD152.A.1 - Copper plates (from A. Pocar) MD152.A.1 - Macor rods (from V. Stekanov) MD197 - Epoxy for cables F/T (from L. Yang) MD196, MD99 - SAES Purifier I (Carleton) MT-PS4 - SAES Purifier II (MT-PS4 SLAC #2/2 Spare) - SAES Purifier III (PF4C3R1 - Cartrige only) - SAES Purifier IV (MT-PS4 SLAC #1/2 Original) - NuPure Eliminator CG (from Al Odian) - Mott Filter 1 of 3 (MD198) - Mott Filters 2+3 of 3 (MD198)

EXO Radon Emanation Measurements Summary

http://thoron.phys.laurentian.ca/~jfarine/exo/RnEmanResults.html

local day week SNO LU EXO Pcso Spl+Catlg Physics Phys Confs Ref hot G4 ROOT root LSB pp sp adm Crier Swge

EXO Radon Emanation Measurements Summary

Last update 23 July 2008
J. Farine, Laurentian University

Radon yields when given in atoms/day are always total, as measured.

All dates are in the 6-digit format YYMMDD.

Object	References (author date)	Sample characteristics				Emanation rates				^{224}Ra conc. (10^{-12} gTh_{eq}/g)	^{226}Ra conc. (10^{-12} gU_{eq}/g)
		MD#	Mass (g)	Area (m^2)	# of items	Total		Per unit area			
						^{220}Rn/d	^{222}Rn/d	^{220}Rn/m^2d	^{222}Rn/m^2d		
SAMPLES											
DuPont Teflon TE-6472 Lot# 0503830033 Taken from APT drum #041 by APT on 3 August 2005	BA051020 BA060104 BA.JF051110	TBD	602.1	(3.8)		< 5	36 ± 7	< 1	9.5 ± 1.8	< 25 ‡	56 ± 10 ‡
DuPont Teflon TE-6472 Lot# 0506830001 Sealed drum from DuPont. Samples collected in UA clean room	BA051020 BA060104 BA.JF051110	MD11	718.2	(4.5)		< 5	< 12	< 1	< 3	< 20 ‡	< 16 ‡
Espanex sheet for flat cable (from A. Piepke)	JF060707	MD1, MD52		1.60		< 10	< 10	< 6.3	< 6.3		
Ceramics electrical breaks (from V. Strickland). Part#(qty): 9998-06-W(12) +	JF060330			7.9E-2 (29%	12+2	< 9.5	< 8.2	< 121	< 105		

Upcoming update to EXO radioactivity measurements will include all Rn results

Radon Trap

Required Rn levels in EXO–200

- Monte-Carlo
- 200 kg Xe 80% enrichment in ^{136}Xe
- σ_E = 1% at $Q_{\beta\beta}$= 2479 keV
- No fiducial or tracking cut
- No ^{214}Bi-Po delayed coincidence cut
- Energy acceptance $\pm 2\sigma$ around $Q_{\beta\beta}$ (2430 - 2530 keV)
- Chose $\langle m\nu \rangle$=0.39 eV as a reference scale (central value, neglect large 95%CL uncertainties), NME by Staudt et al.

  → **$T_{1/2}$=1.5 10^{25} y,** $\beta\beta 0\nu$-mode: 34 events per year
- Background from Radon <10% of the expected event rate

in the TPC : 11 Rn atoms

Rn trap design goals

- A constant 11 Rn in the TPC means max ingress is ~2 Rn/day
- This is for all sources
- TPC internals likely to contribute too (will be measured!)
- To be on safe side, want "zero" Rn ingress from loop
- How much is zero ?
  - here, << 2 Rn/day - say 0.1 Rn/day (factor of 20)
- Problem: monitoring
  - current levels are 100 atoms (20 pushing)
- Choose design criterium:
  - trap efficiency such, that < 0.1 Rn/day ingress
- Thus, need to know load to the trap (trap removes a fraction)

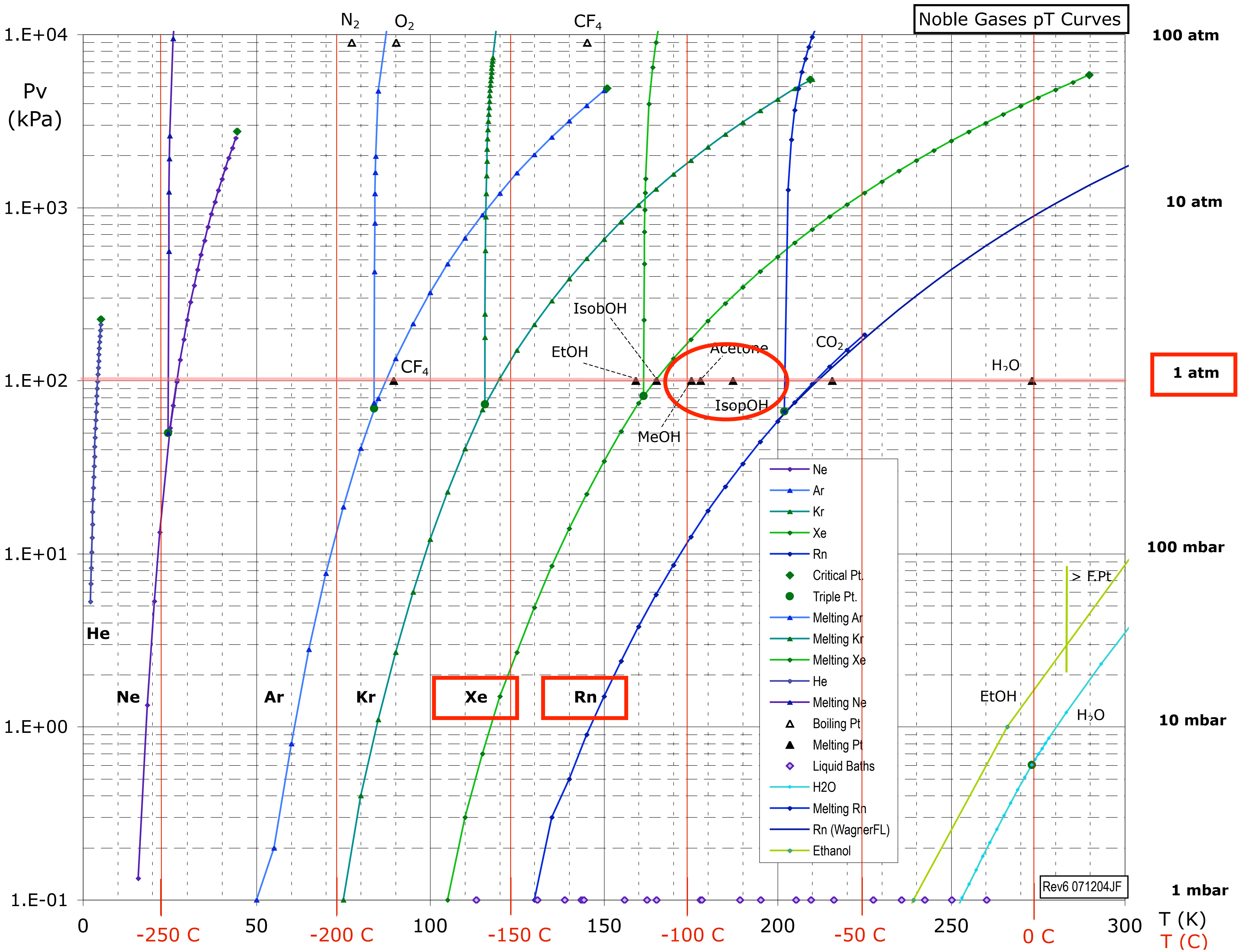
Radon Balance

Component	Total (Rn/d)
SAES Getter	<110
Valve seats	< 20
GXe systems	25±10
GXe compr. lines	*(66±20)*
Mott filters	50
Total source q	< ~ 200

At equil. $q = \lambda N$; $N \sim 1100$ atoms – Safer: 1000 Rn/day

Rn Trap Design Goal and Plan

- Reduction required is from 1000 to 0.1 Rn/day
- This is 1 part in 10E4 → target effciency = 99.99%
- But! this must be met at 20 LPM, max dP 1 psi, 166K
- 1) Preliminary tests w/ different traps
  - Mark I ~1g brass wool, 160 mbar N_2 (WIPP) → 60% (next 3 sl.)
  - Mark II ~2g brass wool, 1 atm Xe (SNOLAB) → 90%
- 2) Found that OFHC Cu has very good ΔH_{ads} for Rn
- Dedicated xenon system w/ cooling and X-over HXs
- In parallel, developed two models for radon removal to define trap parameters while acquiring data



Noble Gases pT Curves
Pv (kPa)
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
1.E-01
100 atm
10 atm
1 atm
100 mbar
10 mbar
1 mbar
N_2
O_2
CF_4
CF_4
IsobOH
EtOH
Acetone
IsopOH
MeOH
CO_2
H_2O
He
Ne
Ar
Kr
Xe
Rn
EtOH
H_2O
> F.Pt
Ne
Ar
Kr
Xe
Rn
Critical Pt.
Triple Pt.
Melting Ar
Melting Kr
Melting Xe
He
Melting Ne
Boiling Pt
Melting Pt
Liquid Baths
H2O
Melting Rn
Rn (WagnerFL)
Ethanol
Rev6 071204JF
0
50
100
150
200
250
300
T (K)
-250 C
-200 C
-150 C
-100 C
-50 C
0 C
T (C)

Rn Trap Design Goal and Plan

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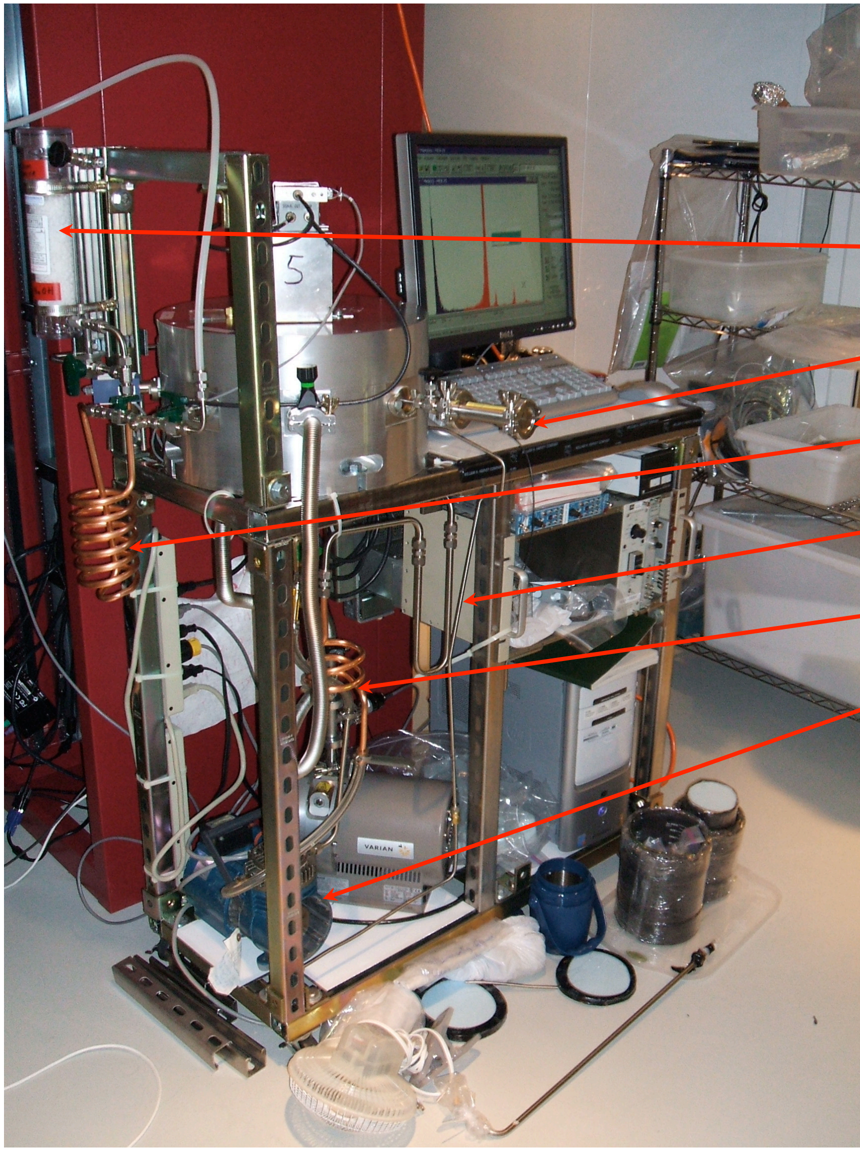
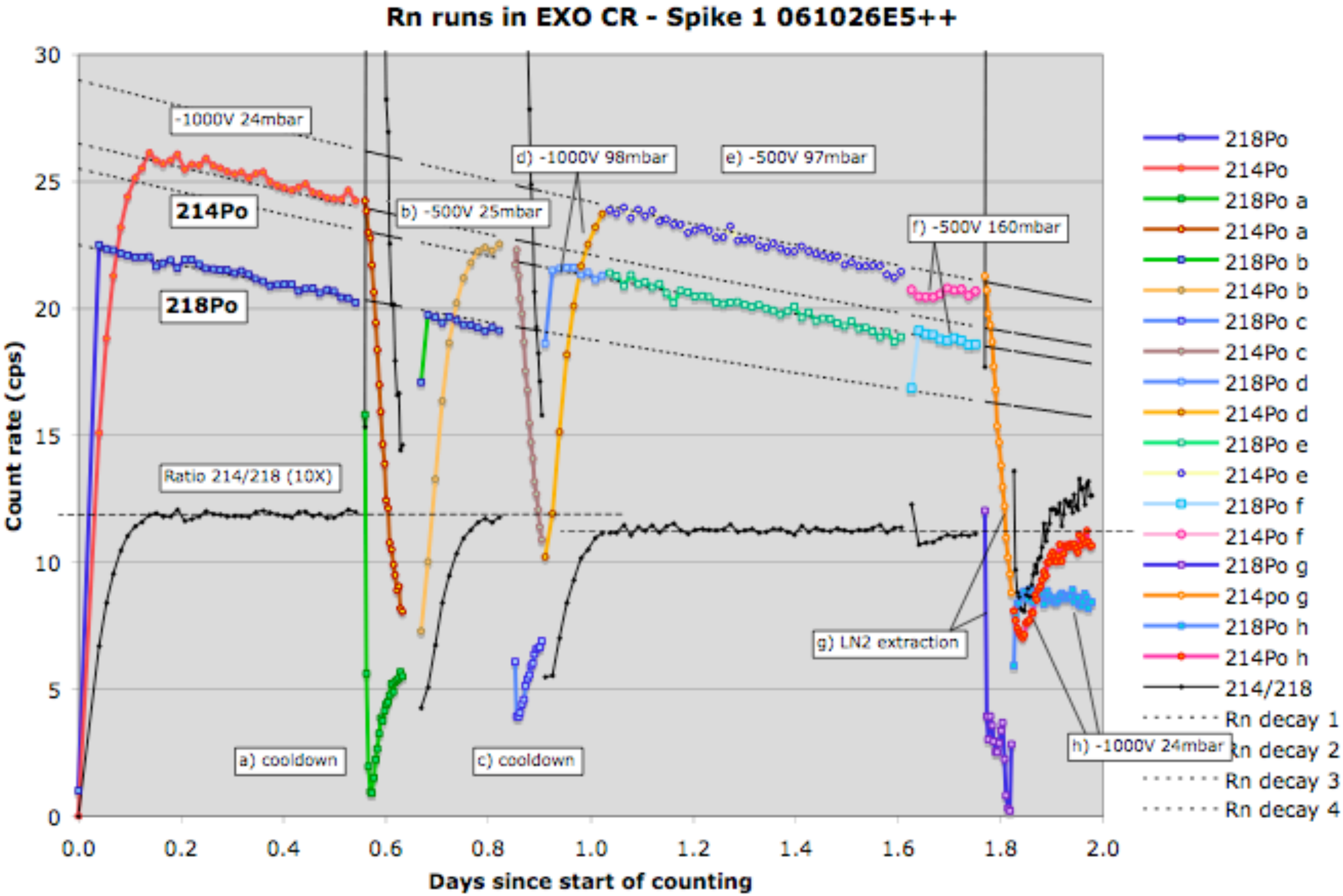
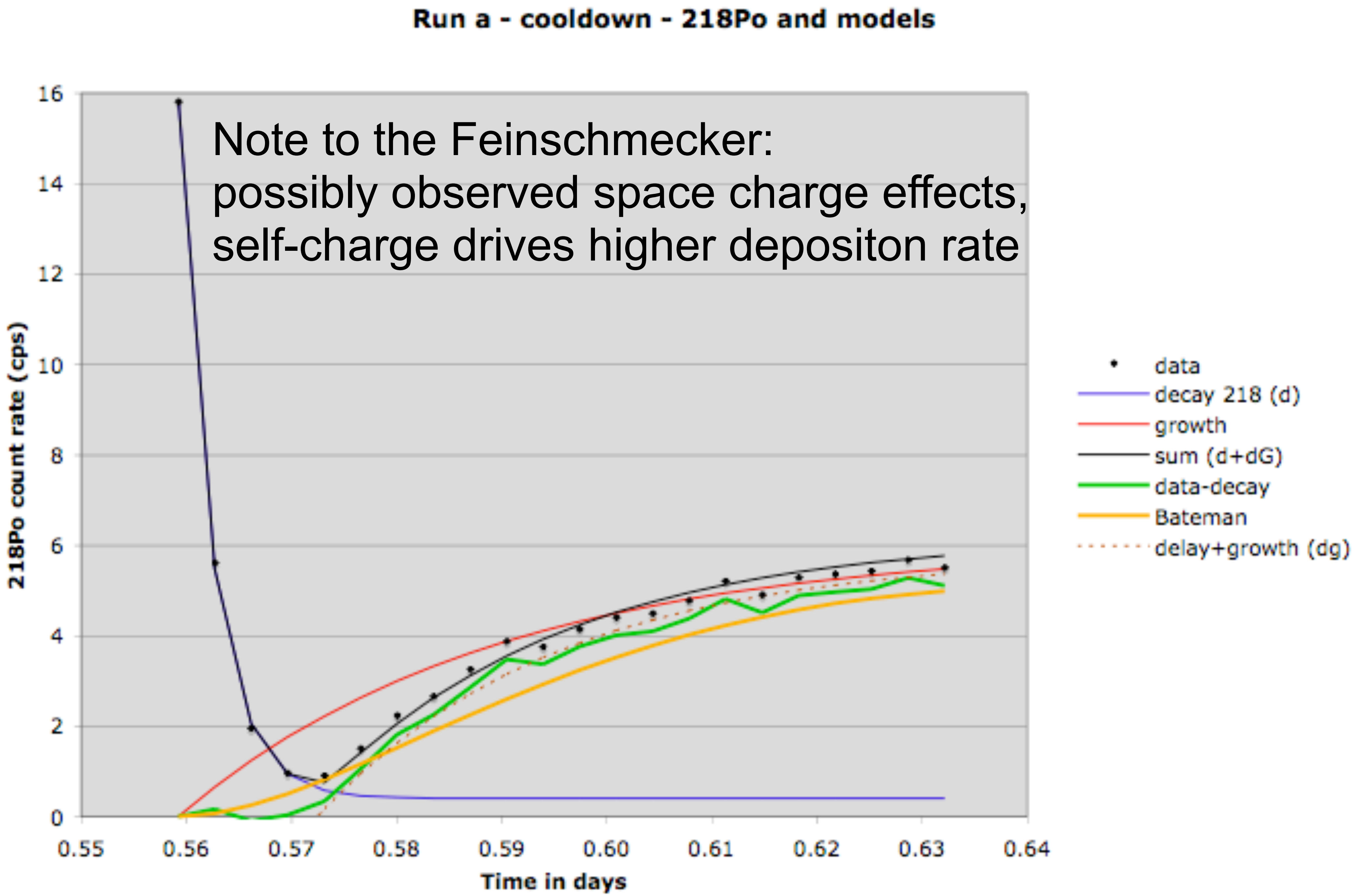
Radon Trap Development



- 1a) ESC dedicated to EXO-200
- Augmented with:
  - CO_2 trap
  - Rn source
  - Water vapour trap
  - Radon trap Mark I (LN_2)
  - Heat exchanger
  - Recirculation pump
- Study Rn removal efficiency
- Local needs in Rn emanation
- Will monitor Rn in EXO-200 Radon Tent (target ~50 mBq)


Rn runs in EXO CR - Spike 1 061026E5++
Count rate (cps)
Days since start of counting
-1000V 24mbar
214Po
218Po
b) -500V 25mbar
d) -1000V 98mbar
e) -500V 97mbar
f) -500V 160mbar
Ratio 214/218 (10X)
a) cooldown
c) cooldown
g) LN2 extraction
h) -1000V 24mbar
218Po
214Po
218Po a
214Po a
218Po b
214Po b
218Po c
214Po c
218Po d
214Po d
218Po e
214Po e
218Po f
214Po f
218Po g
214po g
218Po h
214Po h
214/218
Rn decay 1
Rn decay 2
Rn decay 3
Rn decay 4



Run a - cooldown - 218Po and models
Note to the Feinschmecker:
possibly observed space charge effects,
self-charge drives higher depositon rate
218Po count rate (cps)
Time in days
16
14
12
10
8
6
4
2
0
0.55
0.56
0.57
0.58
0.59
0.60
0.61
0.62
0.63
0.64
data
decay 218 (d)
growth
sum (d+dG)
data-decay
Bateman
delay+growth (dg)

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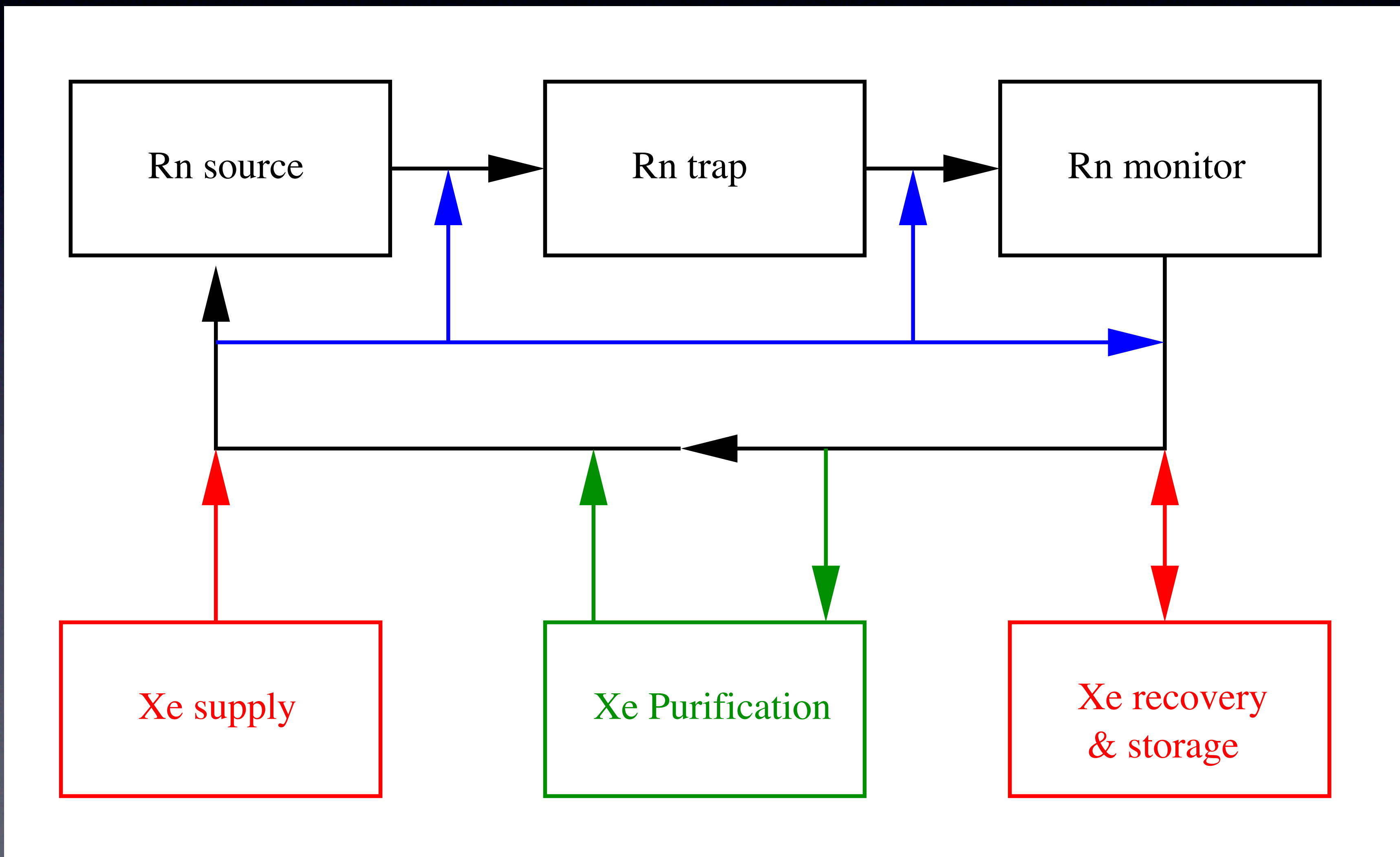
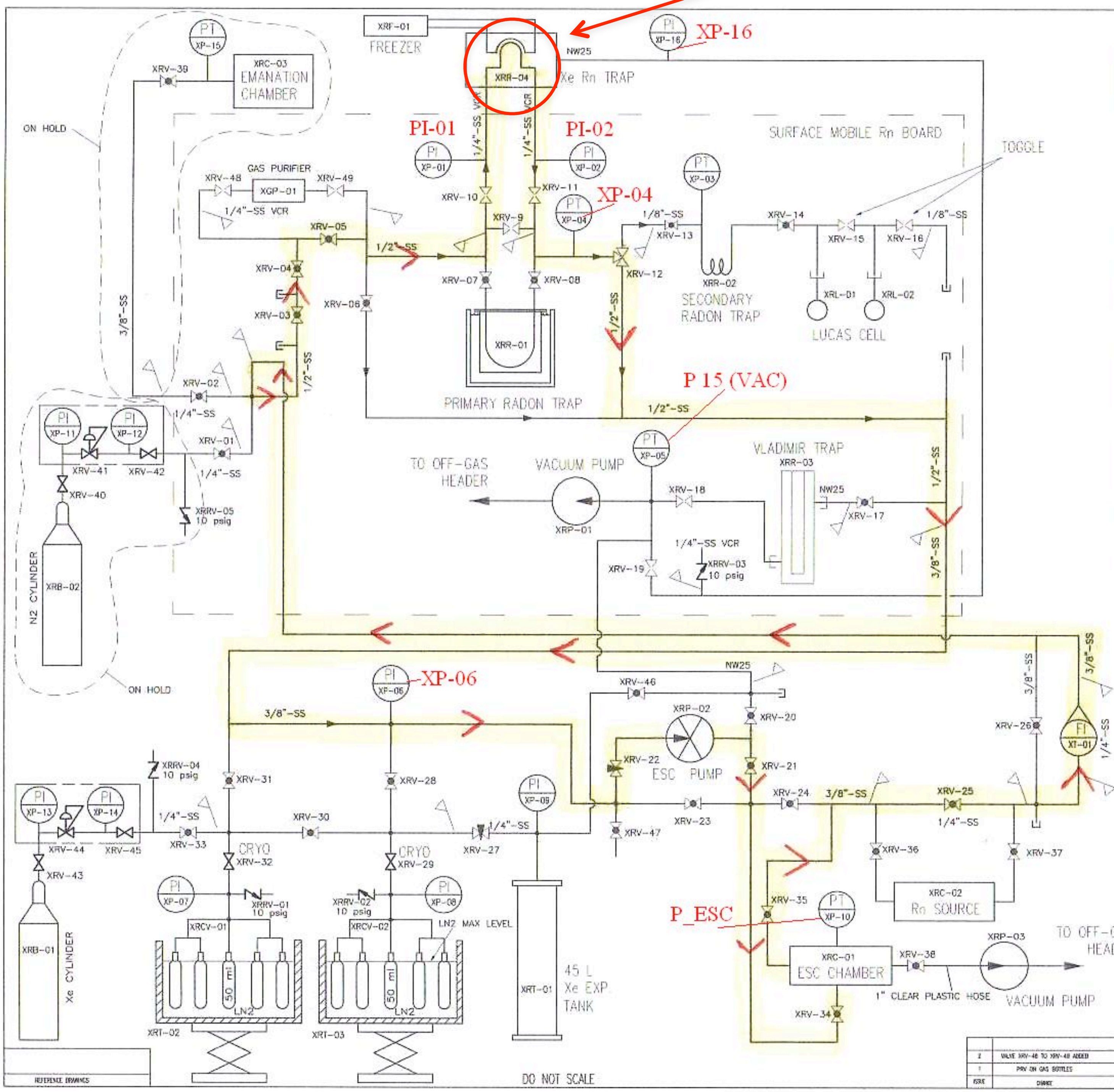
Dedicated xenon system at SNOLAB Concept



XeRn System - current trap has few gm brass wool



VALVE LIST

VALVE No.	P/N	DESCRIPTION
XRV-01	SWAGELOK p/n SS-1RS4	BALL, 1/4" SWG
XRV-02	SWAGELOK p/n SS-31RS4	BALL, 1/4" SWG
XRV-03 XRV-04 XRV-05 XRV-06 XRV-07 XRV-08	SWAGELOK p/n SS-45S8	BALL, 1/2" SWG
XRV-09 XRV-10 XRV-11	SWAGELOK p/n SS-4BK-V51	BELLOWS, 1/4" FVCR
XRV-12	SWAGELOK p/n SS-45XS8	BALL, 1/2" SWG
XRV-13 XRV-14	SWAGELOK p/n SS-41S2	BALL, 1/8" SWG
XRV-15 XRV-16	SWAGELOK p/n SS-OGS2	TOGGLE, 1/8" SWG
XRV-17	SWAGELOK p/n SS-63-TS8	BALL, 1/2" SWG
XRV-18 XRV-19	LESKER p/n SA0100MVQF	BELLOWS, FLUOROCARBON, QF25
XRV-20 XRV-21	SWAGELOK p/n SS-43GS6-1466	BALL, 3/8" SWG
XRV-22	SWAGELOK p/n SS-1RS4-AG-HL	NEEDLE, 1/4" SWG
XRV-23 XRV-24	SWAGELOK p/n SS-43GS6-1466	BALL, 3/8" SWG
XRV-25	SWAGELOK p/n SS-42S4	BALL, 1/4" SWG
XRV-26	SWAGELOK p/n SS-43GS6-1466	BALL, 3/8" SWG
XRV-27	SWAGELOK p/n SS-1RS4-AG-HL	NEEDLE, 1/4" SWG
XRV-28	SWAGELOK p/n SS-43GS6-1466	BALL, 3/8" SWG
XRV-29	SWAGELOK p/n SS-6UW	CRYO, 3/8" SWG
XRV-30	SWAGELOK p/n SS-44S6	BALL, 3/8" SWG
XRV-31	SWAGELOK p/n SS-43GS6-1466	BALL, 3/8" SWG
XRV-32	SWAGELOK p/n SS-6UW	CRYO, 3/8" SWG
XRV-33	SWAGELOK p/n SS-1RS4RG-NL	BALL, 1/4" SWG
XRV-34 XRV-35	SWAGELOK p/n B-6P6T	BALL, 3/8" SWG
XRV-36 XRV-37	SWAGELOK p/n SS-4P4T	BALL, 1/4" SWG
XRV-38		
XRV-39	SWAGELOK p/n B-44S6	BALL, 3/8" SWG
XRV-40		COMES WITH BOTTLE
XRV-41 XRV-42		REGULATOR CGA 580 TO 1/4" SWG
XRV-43		COMES WITH BOTTLE
XRV-44 XRV-45		REGULATOR CGA 580 TO 1/4" SWG
XRV-46	SWAGELOK p/n SS-45S8	BALL, 1/2" SWG
XRV-47		BALL, 3/8" SWG
XRV-48 XRV-49	SWAGELOK p/n SS-4BK-V51	BELLOWS, 1/4" FVCR

PUMP LIST

PUMP No.	P/N	DESCRIPTION
XRP-01	ALCATEL, MODEL: 2010	NW25 PORTS
XRP-02	KNF, MODEL: UN035 TTR	DIAPHRAGM, 3/8" SWG PORTS
XRP-03	ALCATEL, MODEL: 2010	NW25 PORTS

EQUIPMENT IDETIFICATION SYSTEM

First two letters XR stands for Xenon-Radon and
XRV-valve
XRR-Trap
XRP-Pump
XRL-Lucas cell
XRC-Chamber
XRB-Bottle
XRT-Tank
XRF-Freezer
XRCV-Receiver tank
XRRV-Relief valve
XGP-Gas Purifier
XP-pressure gauge or transmitter
XT-Flow meter

NOTE:

1. OPERATING PRESSURE RANGE – 10^{-6} Torr – 15 psig
2. OPERATING TEMPERATURE RANGE – 10°C TO 40°C, EXCEPT LN2 TANKS
3. THIS GAS SYSTEM IS NOT WITHIN THE SCOPE OF TSSA, AND IS NOT F
4. PRESSURE REGULATOR NOT TO BE SET ABOVE 10 PSIG. THIS NOTE MUST ALSO BE ON REQULATOR TOO.

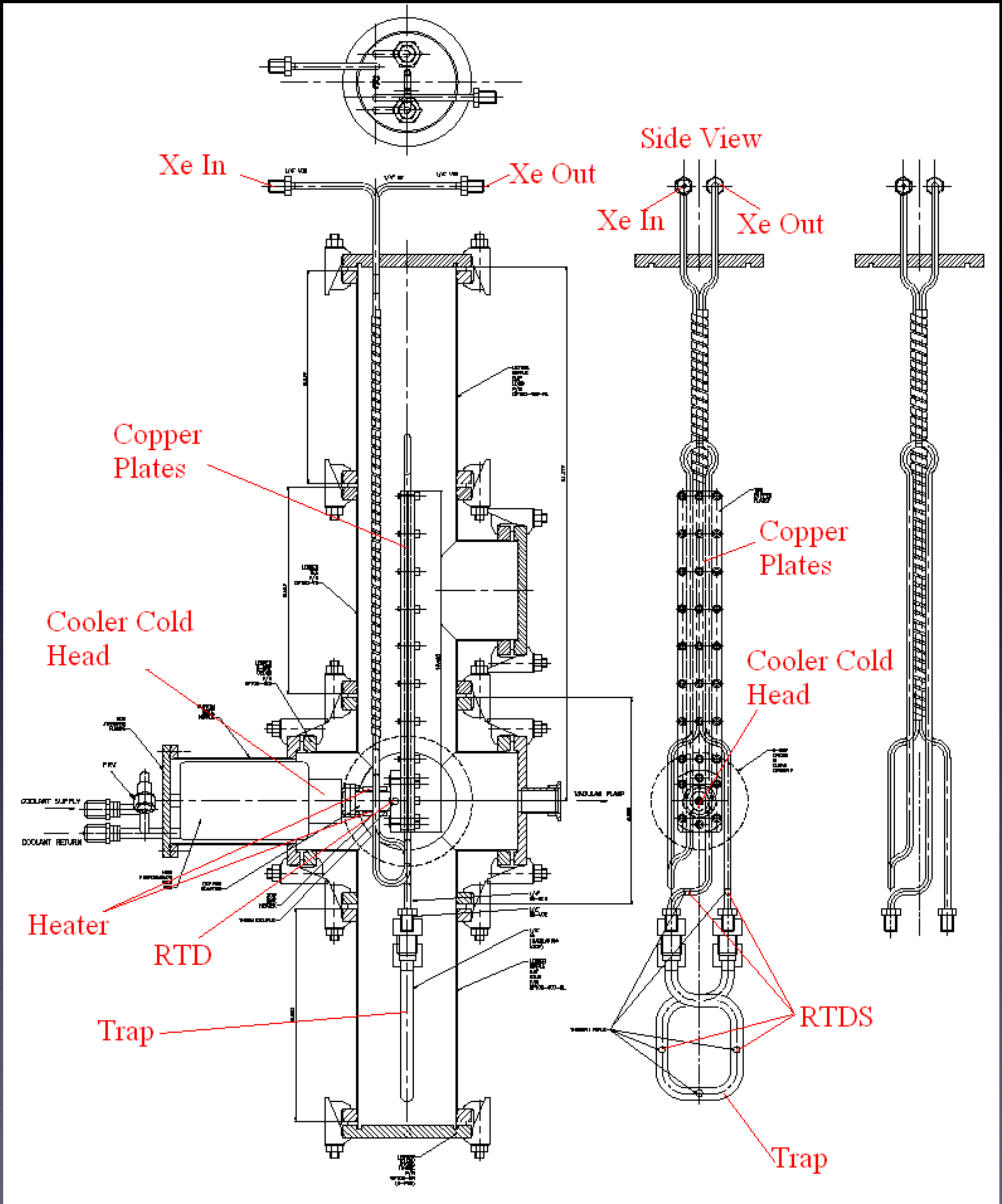
2	VALVE XRV-48 TO XRV-49 ADDED	SEPT. 12/08	
1	PRV ON GAS BOTTLES	APR. 14/08	
ISSUE	CHANGE	DATE	

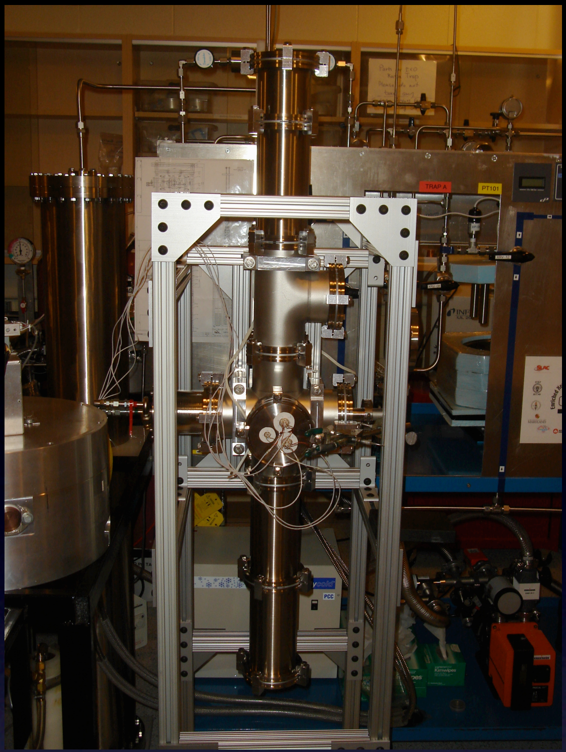
SNOLAB — SNOLAB-CARLETON, OTTAWA, ONTARIO

TITLE: Xe TRAP ASSEMBLY FLOWSHEET

DRAWING NUMBER: SLDO-EXO-FL-7127-C

Radon Trap Cold Enclosure



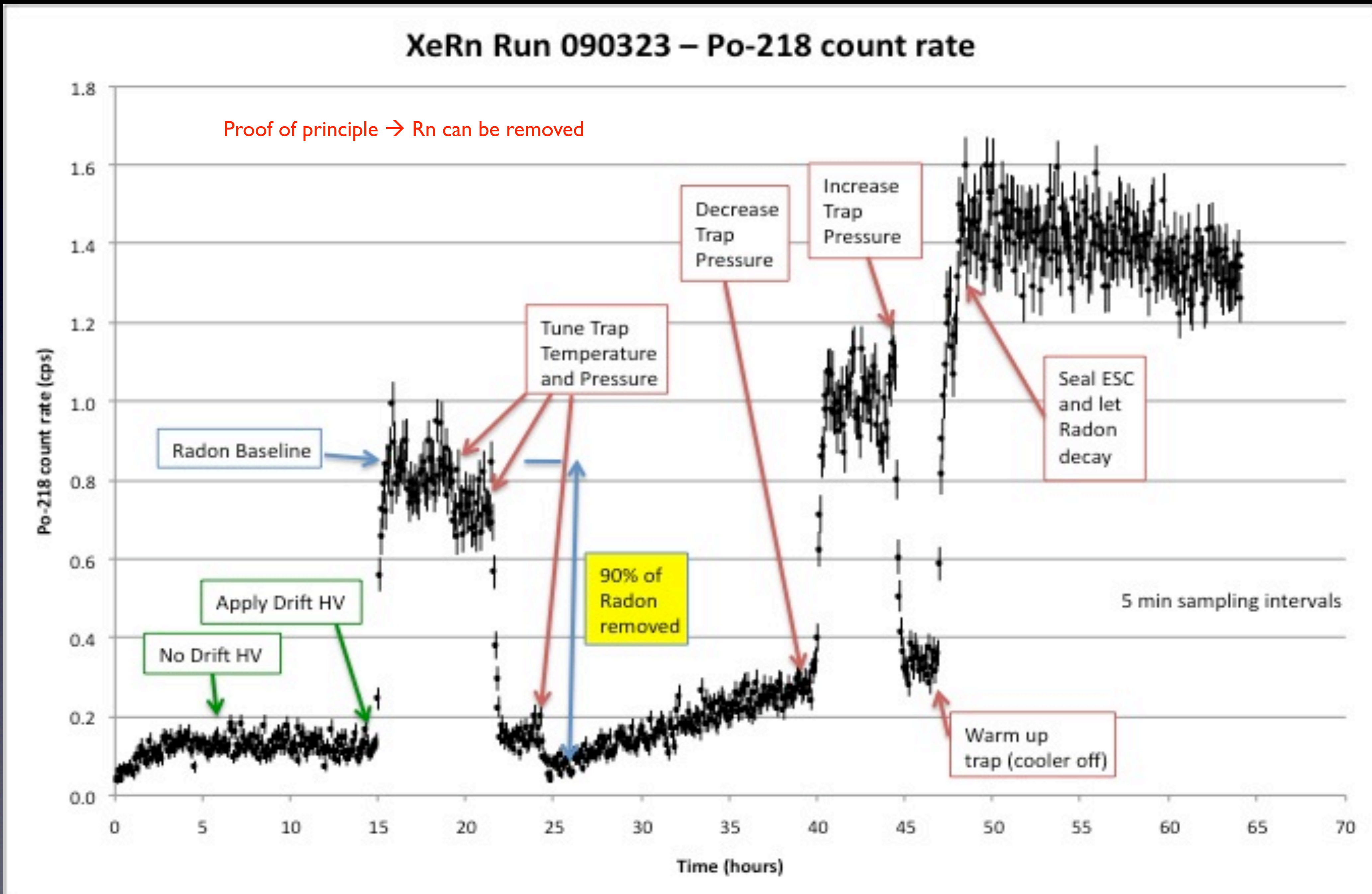


Custom designed heat exchanger (Ken McFarlane, Oleg Li, SNOLAB)

Commercial cooler Polycold CryoTiger 30W @ -100C

Allows for easy exchange of trap of different designs

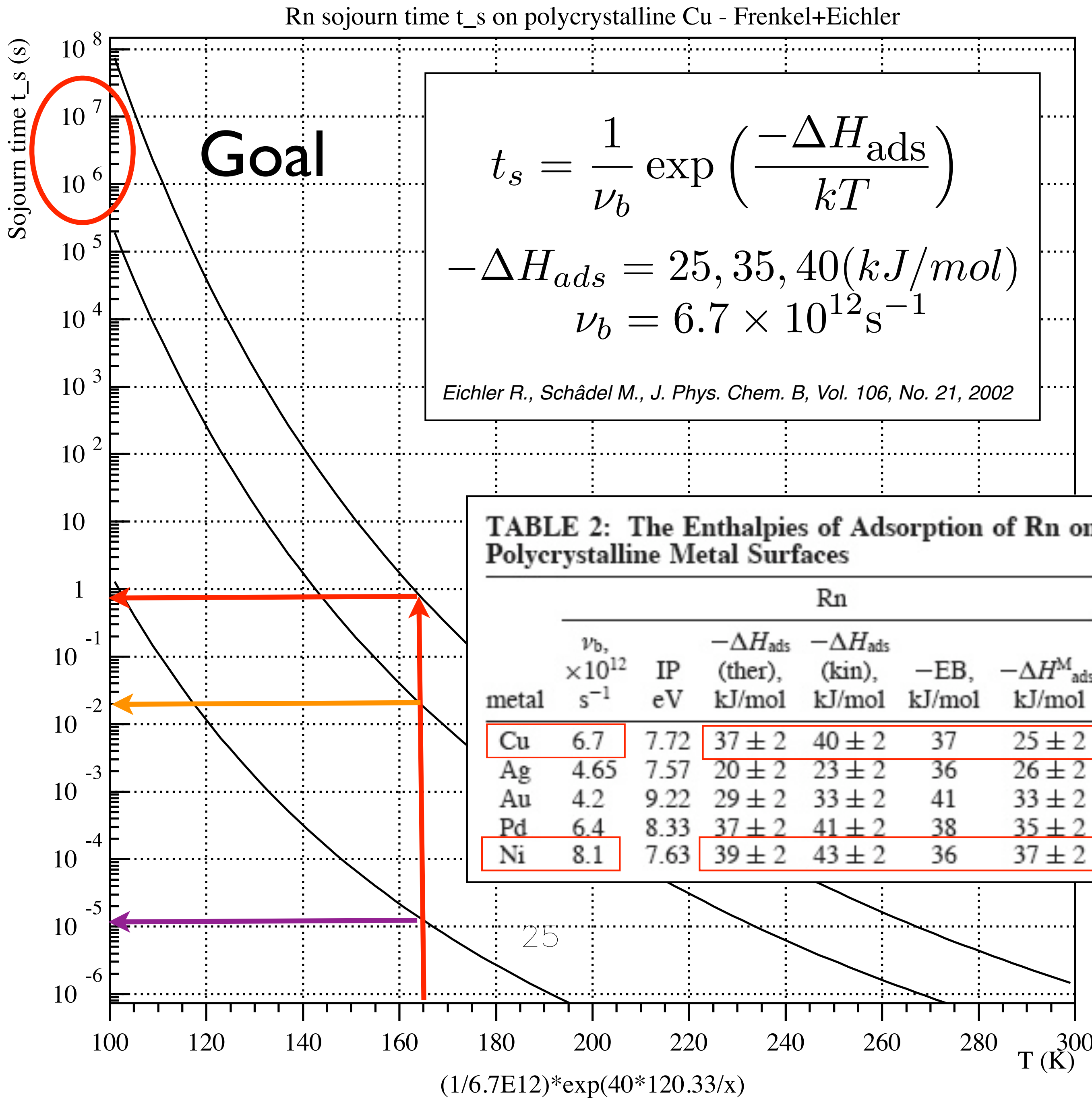
1b) 90% Radon removal, 1 atm Xe ~5 NLPM



2) Next Gen.: copper-based traps

- Heavy atom research uses radon as a test bed for extraction techniques
- Interested in short half-lifes, so need high retention rates > lots of experimental data:
- Polycristalline copper has high affinity for radon (see next slide)
- Nickel even better, but marginally, lus requires complex surface treatment (voided quickly if impurities present in xenon)

2009/02/21 11.23



$$t_s = \frac{1}{\nu_b} \exp\left(\frac{-\Delta H_{\mathrm{ads}}}{kT}\right)$$

$$-\Delta H_{ads} = 25, 35, 40 (kJ/mol)$$

$$\nu_b = 6.7 \times 10^{12} \mathrm{s}^{-1}$$

Eichler R., Schâdel M., J. Phys. Chem. B, Vol. 106, No. 21, 2002

TABLE 2: The Enthalpies of Adsorption of Rn on Polycrystalline Metal Surfaces

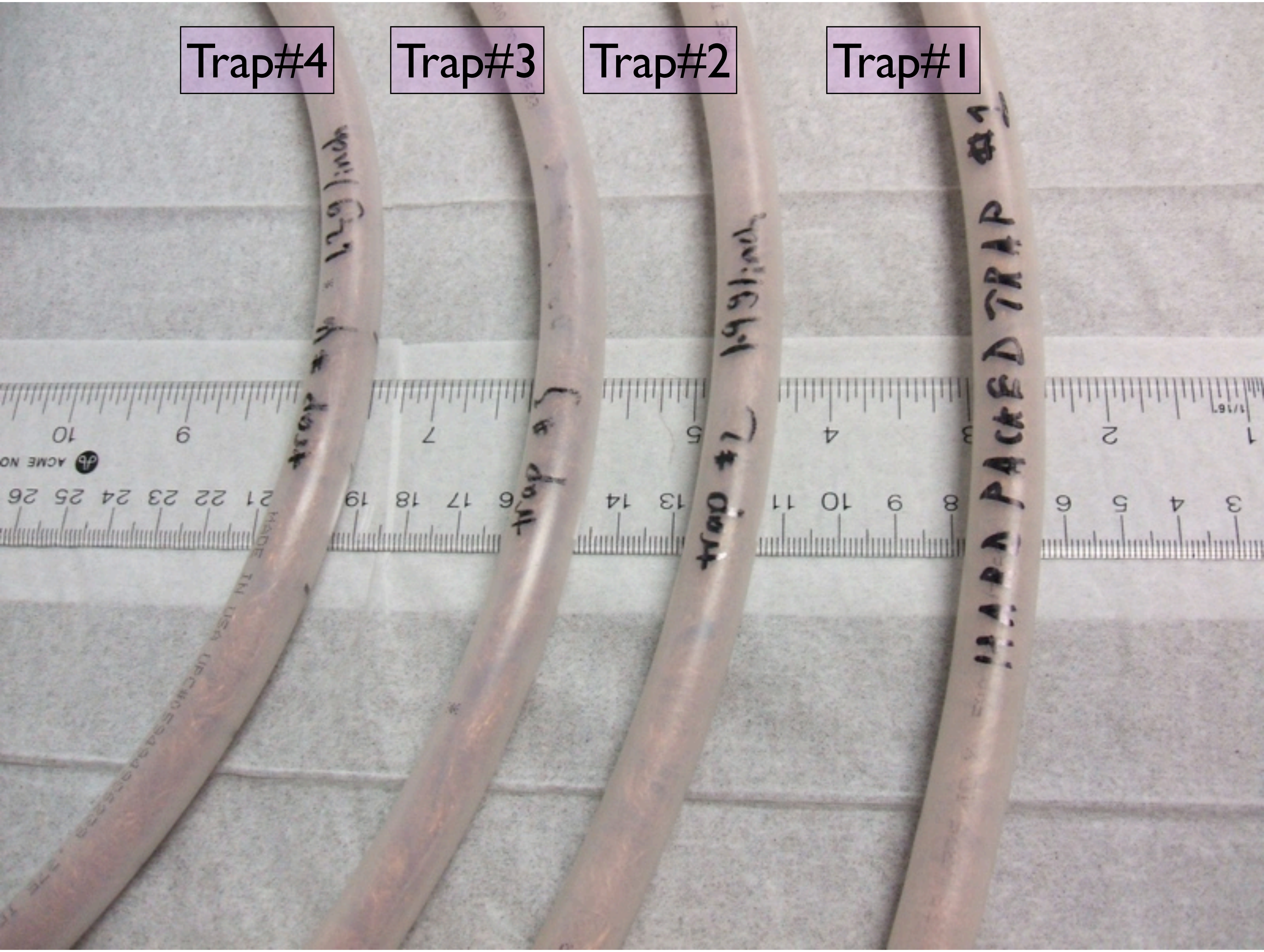
	Rn						Xe
metal	ν_b, $\times 10^{12}$ s^{-1}	IP eV	$-\Delta H_{ads}$ (ther), kJ/mol	$-\Delta H_{ads}$ (kin), kJ/mol	$-$EB, kJ/mol	$-\Delta H^{M}_{ads}$, kJ/mol	$-\Delta H^{M}_{ads}$, kJ/mo
Cu	6.7	7.72	37 ± 2	40 ± 2	37	25 ± 2	21
Ag	4.65	7.57	20 ± 2	23 ± 2	36	26 ± 2	21.5
Au	4.2	9.22	29 ± 2	33 ± 2	41	33 ± 2	27.5
Pd	6.4	8.33	37 ± 2	41 ± 2	38	35 ± 2	29
Ni	8.1	7.63	39 ± 2	43 ± 2	36	37 ± 2	31

“Why not just activated charcoal ??”

- Generates particulates
- You get want you can buy – how to you clean it fruther ?
- Relies on different atom size / polarizability, and xenon is the closest to radon in size
- Very good work on the topic by Hardy Simgen et.al. at Heidelberg (Hardy’s PhD thesis is a must-read). I came to the conclusion that the pore size distribution in the charcoal was paramount for removal – range of pore size required is unclear in Xe-Rn system

Copper wool traps

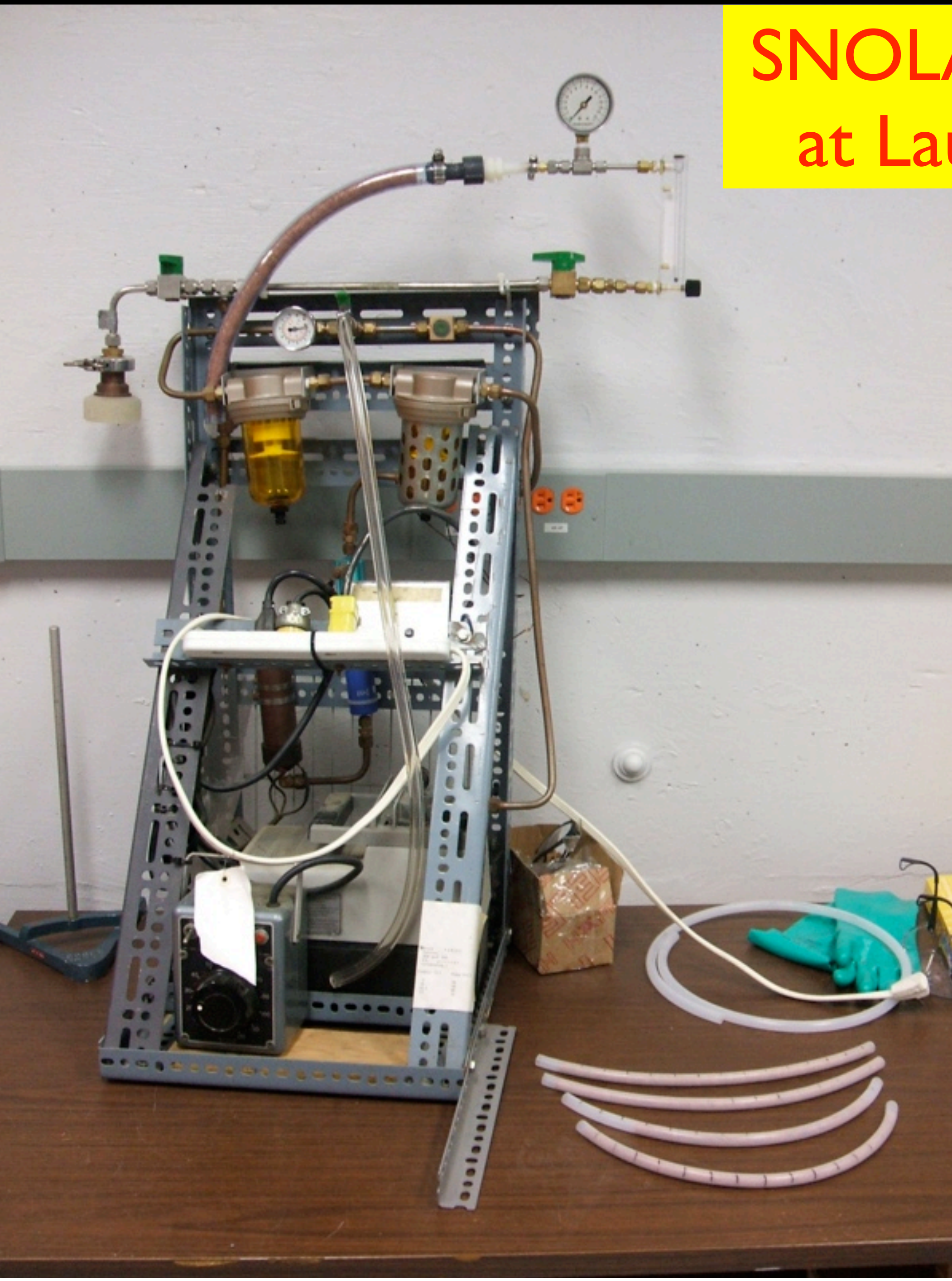
- Five sections of ~14” of clear plastic tubing
- All same diameter except Trap5: 3x larger
- Goals:
  - learn how to pack at constant density
  - measure pressure vs. flow curves
- Trap#1 – #4: max. to min. packing (2.5–1.2g/in)
- Trap#5 same packing as Trap#1
- Trap#4 very unhomogeneous, not measured

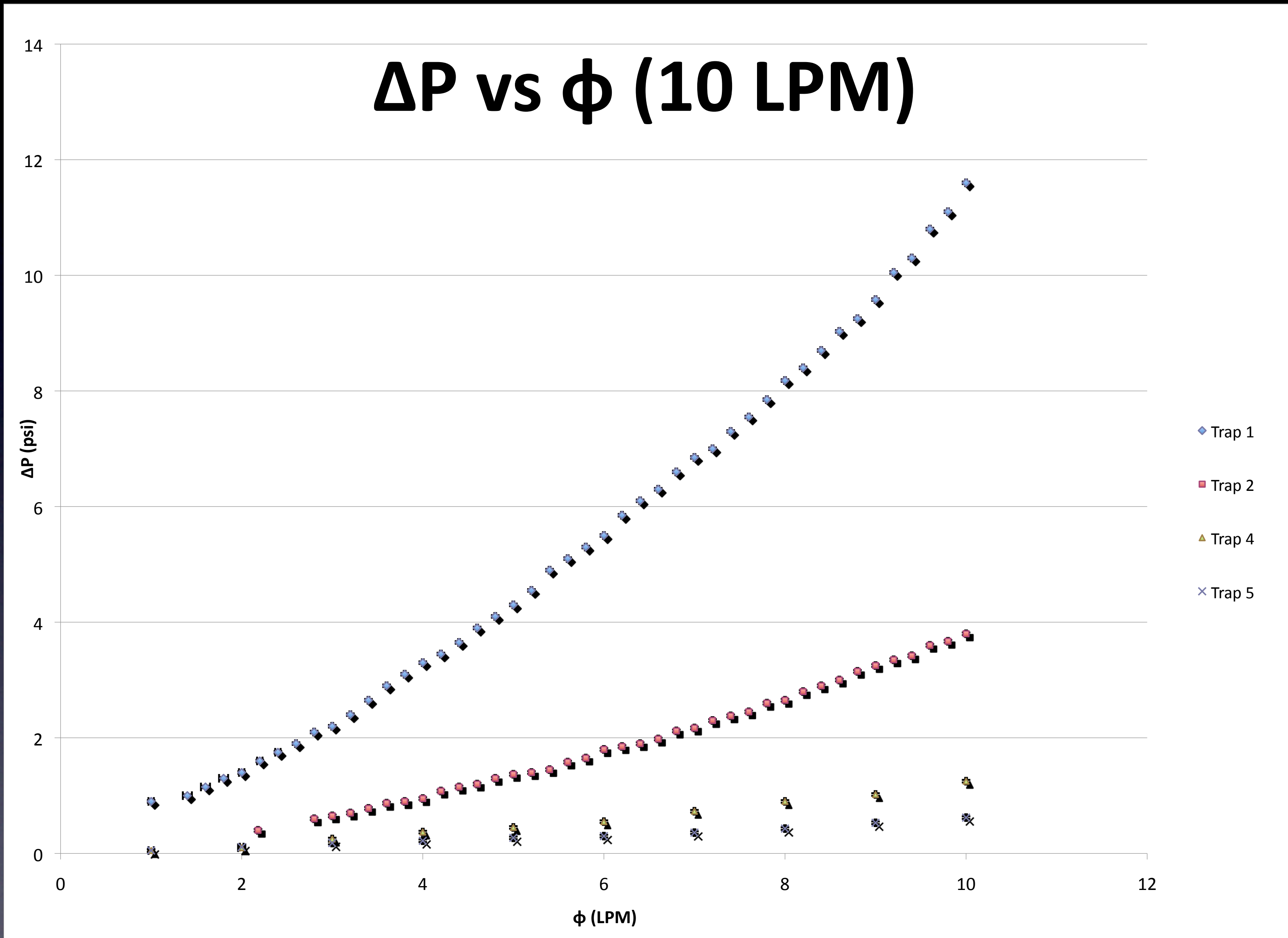

Trap#4
Trap#3
Trap#2
Trap#1
HARD PACKED TRAP #1


Trap#5

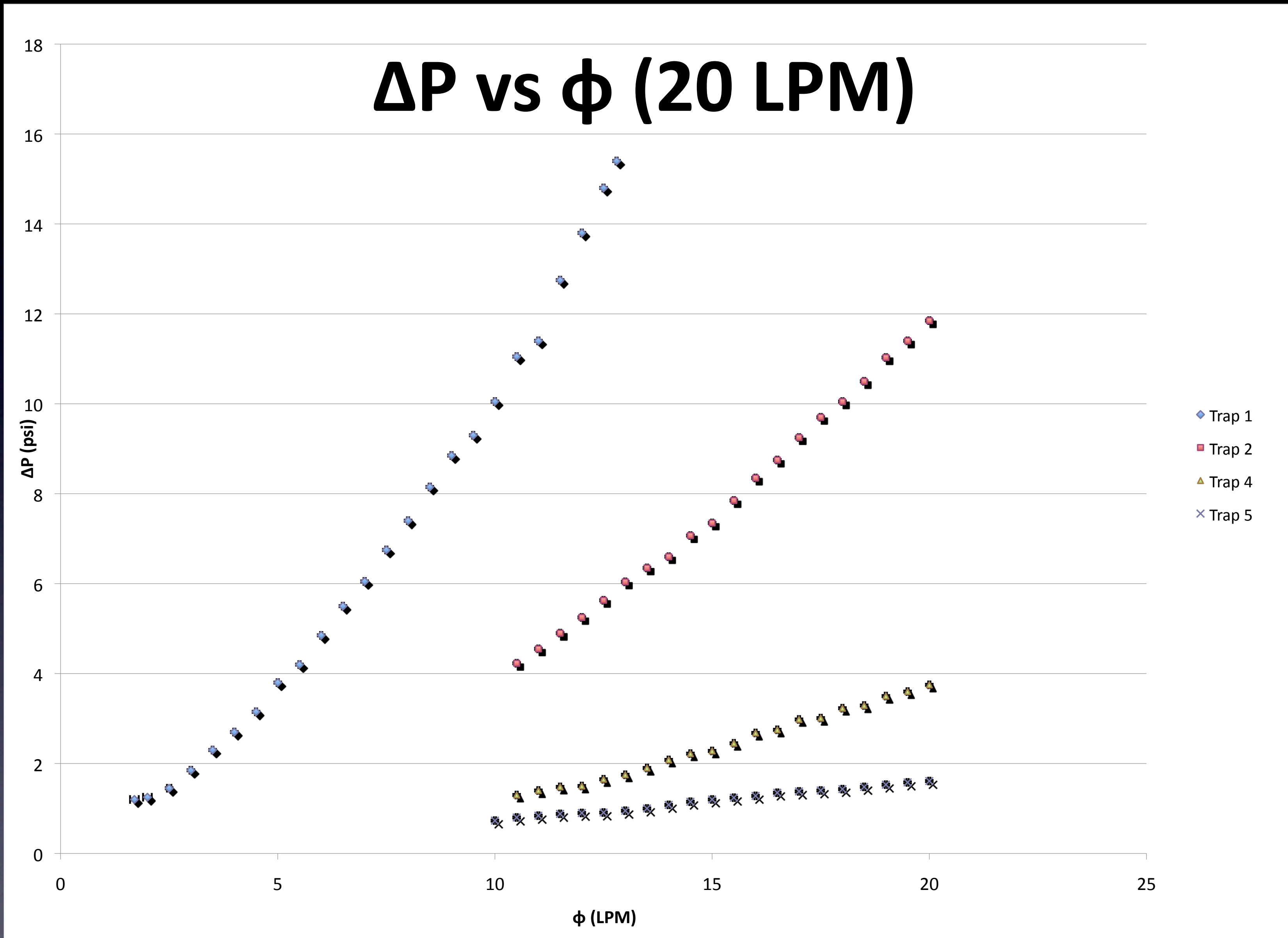
Recycle MnOx compressor to measure impedance

SNOLAB Facility at Laurentian





ΔP vs ϕ (10 LPM)
ΔP (psi)
ϕ (LPM)
0
2
4
6
8
10
12
14
Trap 1
Trap 2
Trap 4
Trap 5



ΔP vs ϕ (20 LPM)
ΔP (psi)
ϕ (LPM)
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25
Trap 1
Trap 2
Trap 4
Trap 5

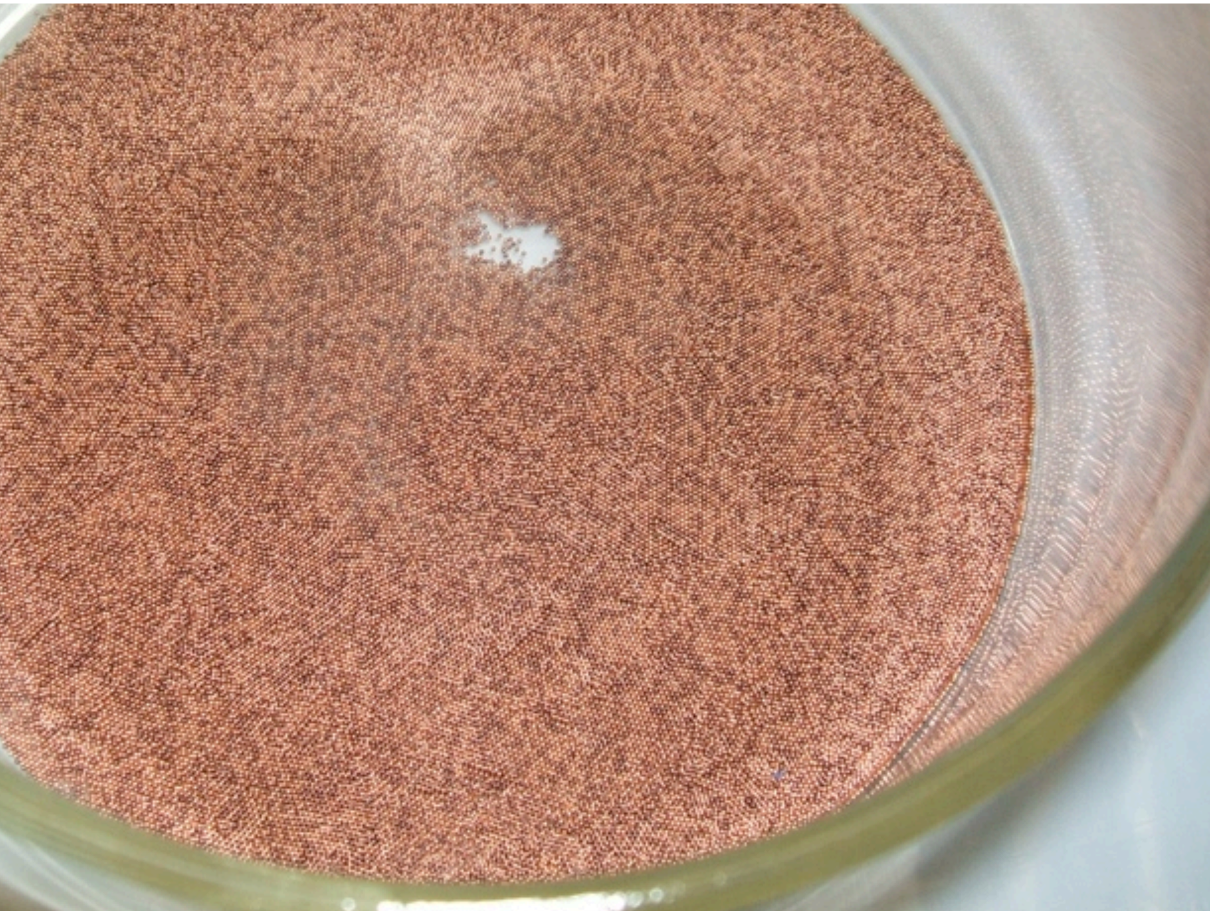
Copper wool traps status

- Extracted packing impedance k from
- $dP = k A \Phi / L$
- Choose low packing
- Trap built 16"L 1/2" OD
- Ready for testing cold

OFHC Copper spheres

- Litterature abounds with analytical treatment of flow in "columns packed with spherical particles of uniform size" – easier to model
- Identified supplier: Industrial Tectonics
- Acquired 500k spheres 20+-0.5th dia

  (1th = 1 mil = 1E-3 inch = 25.4 μm) so ~0.5 mm dia
- Filled one trap 16" long, 1/2" OD
- Ready to be tested



Industrial Tectonics Inc
7222 W. Huron River Drive
Dexter MI 48130734-426-4681

500k
COPPER-OFHC
0.020"+/-.0005

Industrial Tectonics Inc
7222 W. Huron River Drive
31

500k
COPPER-OFHC
0.020"+/-.0005

Industrial Tectonics Inc
7222 W. Huron River Drive
Dexter MI 48130734-426-4681

500k
COPPER-OFHC
0.020"+/-.0005

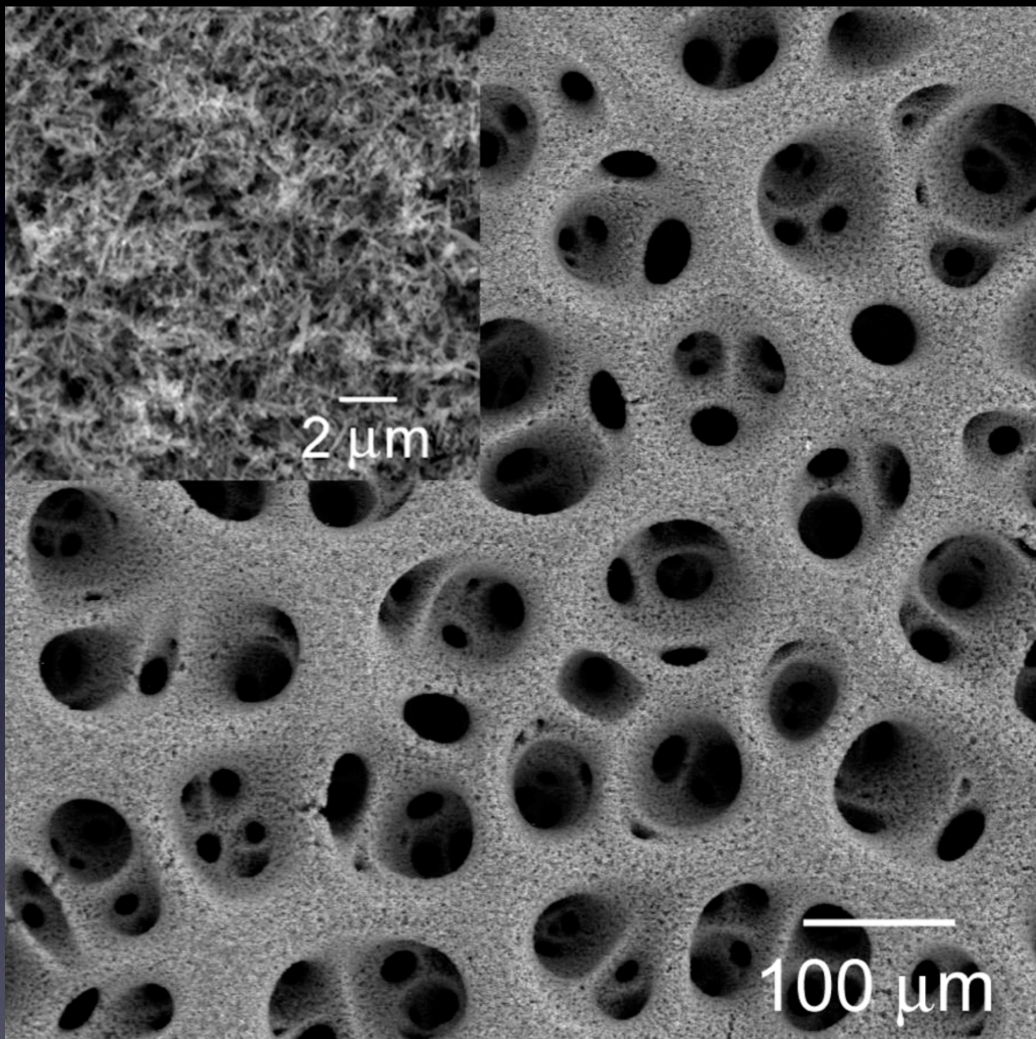
Open Cell Copper Foam

- void fraction up to 97%vol
- min. pore size depends on manufacturer
- e.g. READE Advanced Materials
- Typical orders are >1M$; not interested in smaller contracts yet
- Similar experience w/ company in Québec
- Asia a major client - used for advanced µP cooling
- Aspect ratio not trivial (sheets 20x20 cm^2, 2 mm thick)
- Clean in ^{226}Ra ? Integrity kept after EXO-cleaning (HCl, $HN0_3$) ?
  - on hold for now

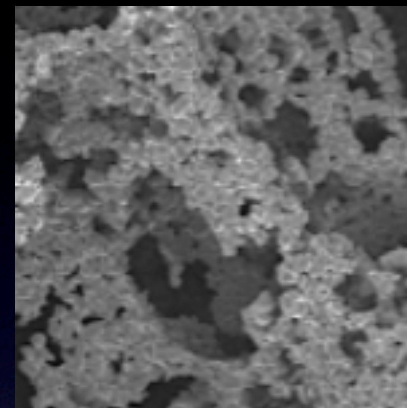
Table 1.4: Parameters for copper foam

Nominal Pore Size (µm)	600	300	150	50
Standard Thickness (mm)	2	1	0.5	0.5
Standard Porosity (%)	95-97	94-96	80-90	80-90

Examples from other manufacturers



Grain based >



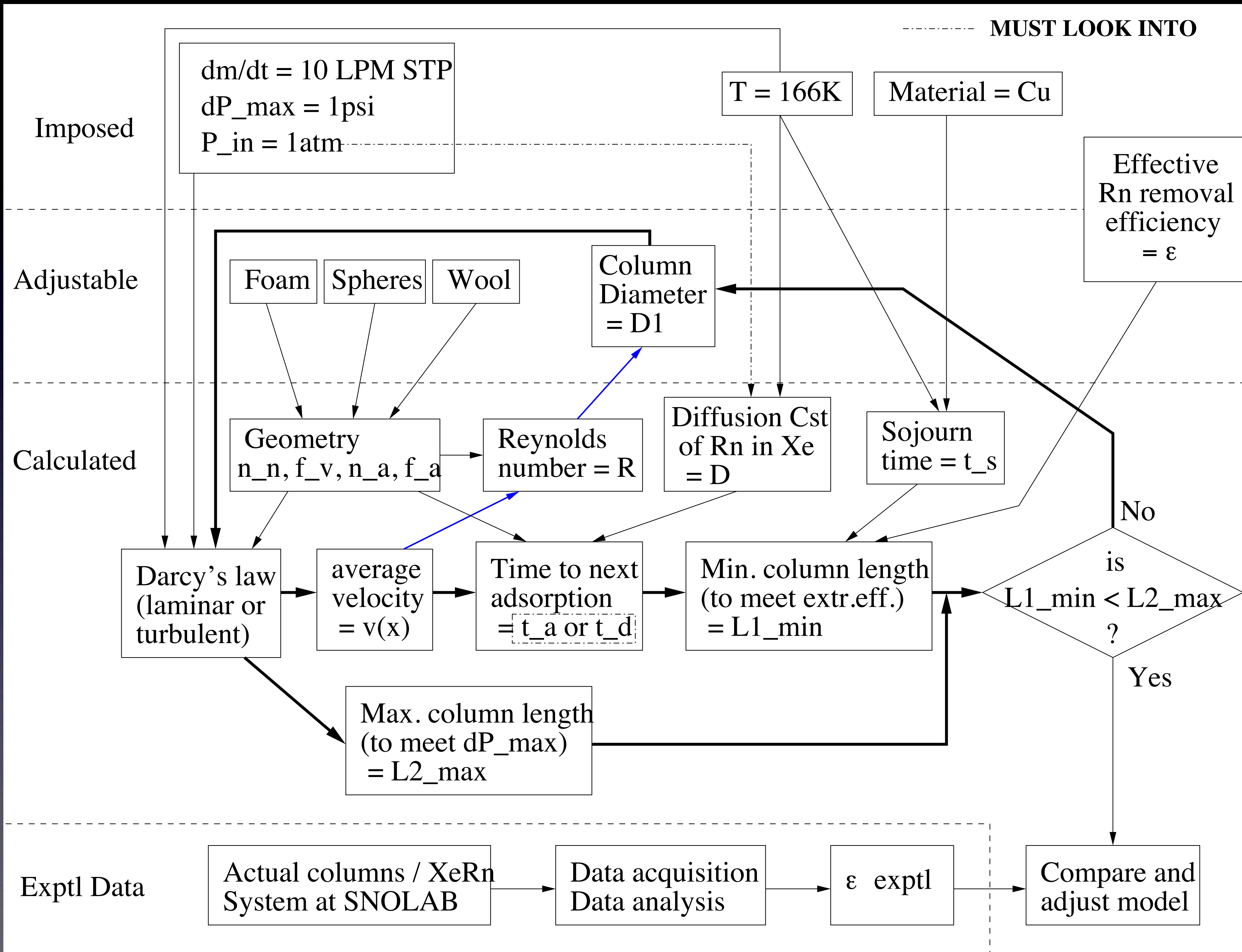
< Needles based

MetaFoam

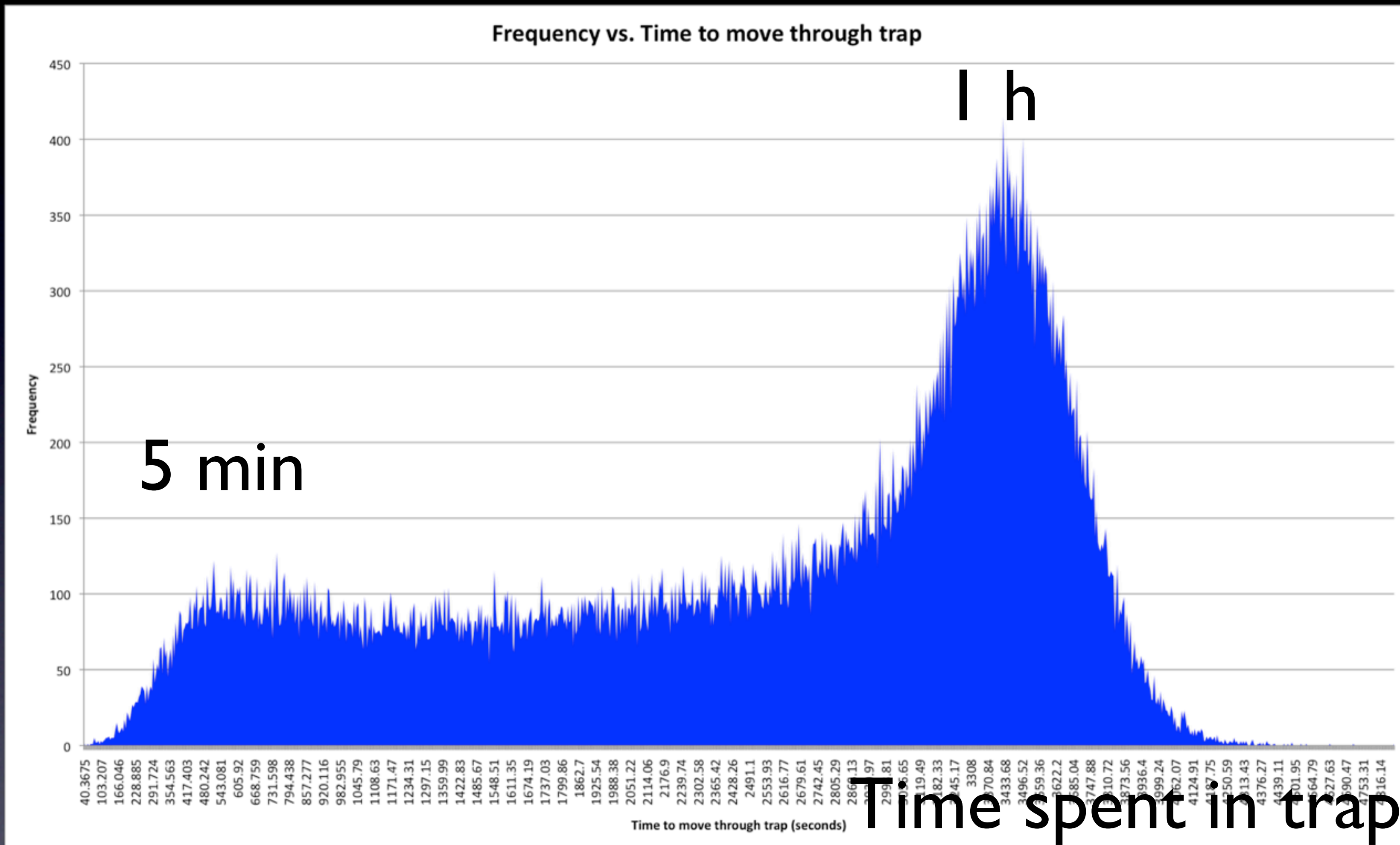
Center for Innovative Fuel Cell and Battery Technologies
School of Materials Science and Engineering
Georgia Institute of Technology, Atlanta, Georgia
Chem. Mater., 2004, 16 (25), pp 5460–5464

Dalian Victory Metallurgy
Imp.& Exp., Ltd

EXO-200 Radon Trap Model#1

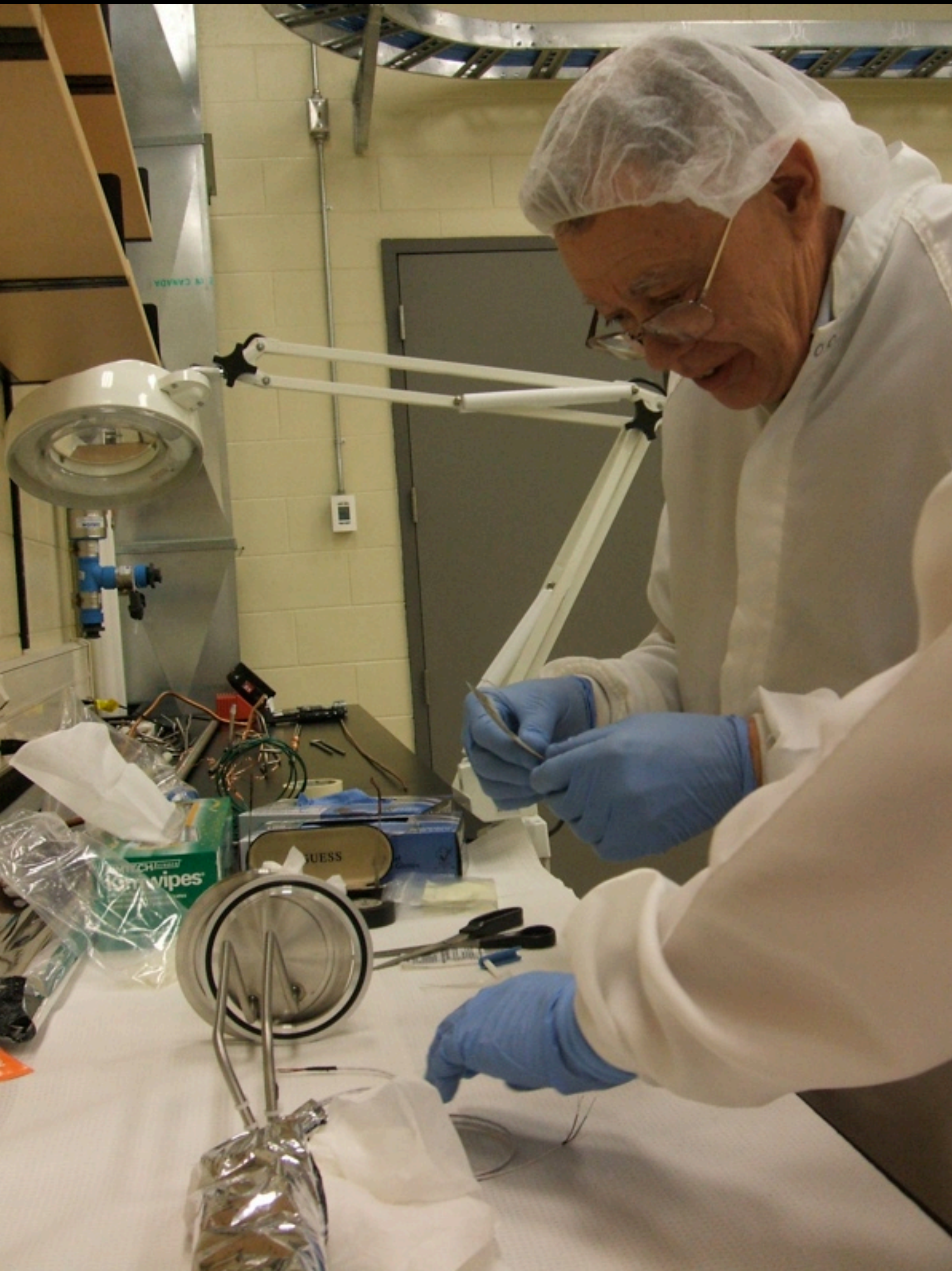


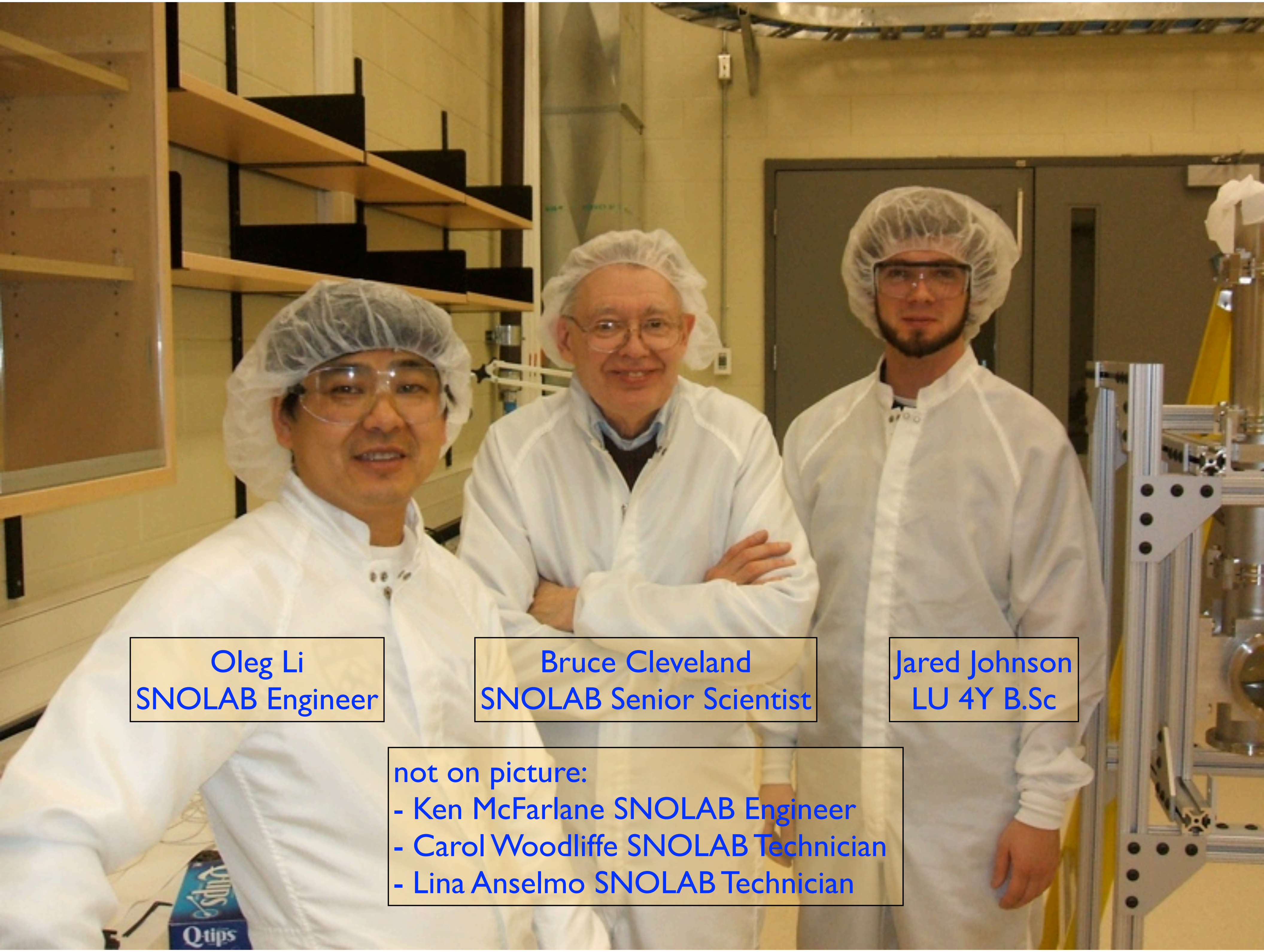
Model#2: random walk simulation



Need 51 days.. model needs improvements

Need data, but clear: need wider+longer trap geometry


GUESS


Oleg Li
SNOLAB Engineer
Bruce Cleveland
SNOLAB Senior Scientist
Jared Johnson
LU 4Y B.Sc
not on picture:
- Ken McFarlane SNOLAB Engineer
- Carol Woodliffe SNOLAB Technician
- Lina Anselmo SNOLAB Technician
Q-tips

Conclusions

- Very low level assay capability for emanation of radon, thoron and actinon
- Development of trap for Rn in Xe at 1 atm, 20LPM and 99.99% removal efficiency
- Promising first tests
- Pursue copper, acquire data while refining model