Introduction to Materials Test System

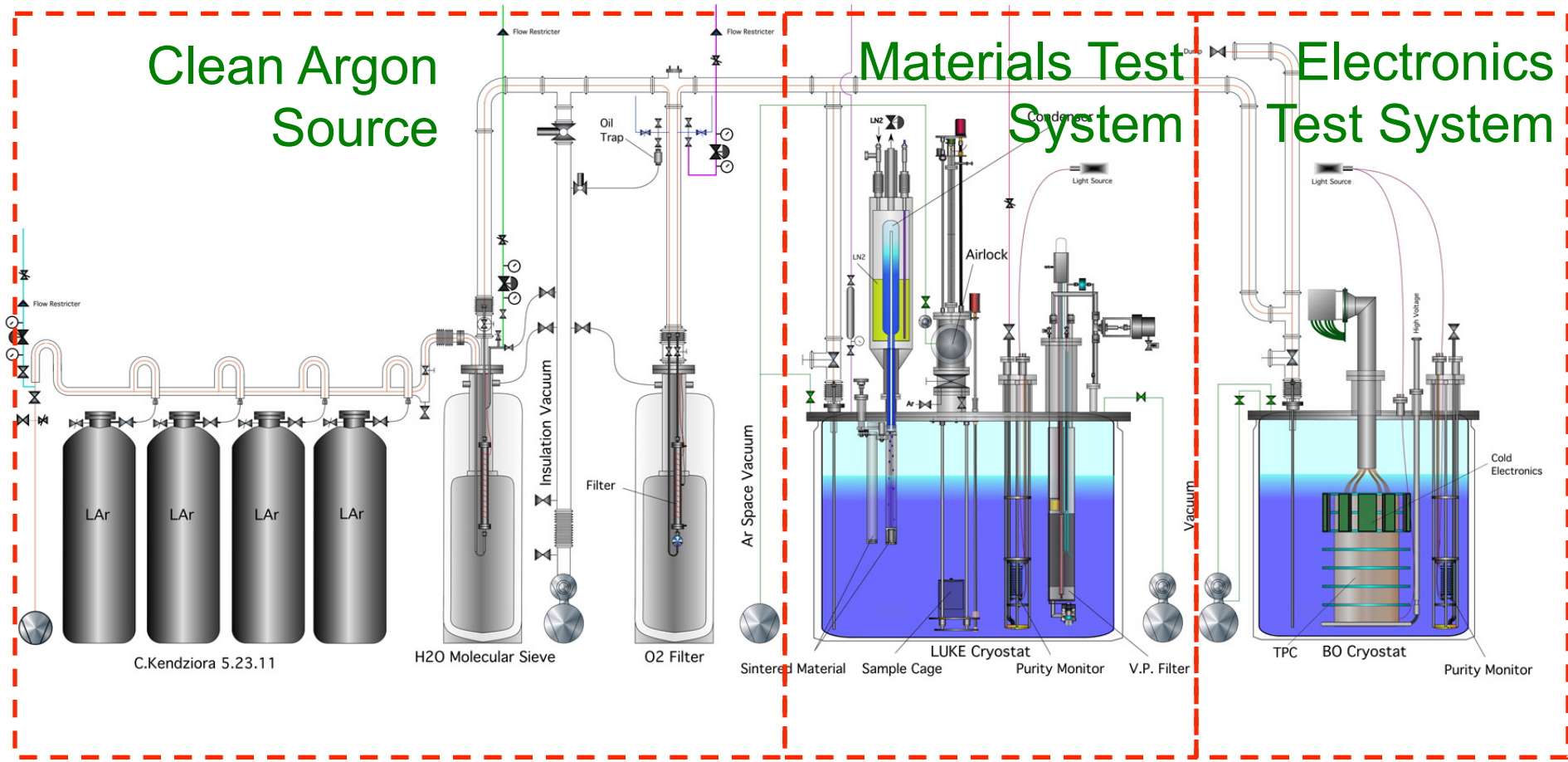
Our first foray into liquid argon for liquid argon TPC

Basic aim – to be able to test candidate detector materials for effect on electron drift lifetime
without pumping on the materials

Reason *cryostat for multi-kiloton detector may not be evacuable and so benefits of pumping on detector would not be available.*

Served as introduction to some of the issues of obtaining and maintaining clean argon

Liquid Argon Setup at the PAB

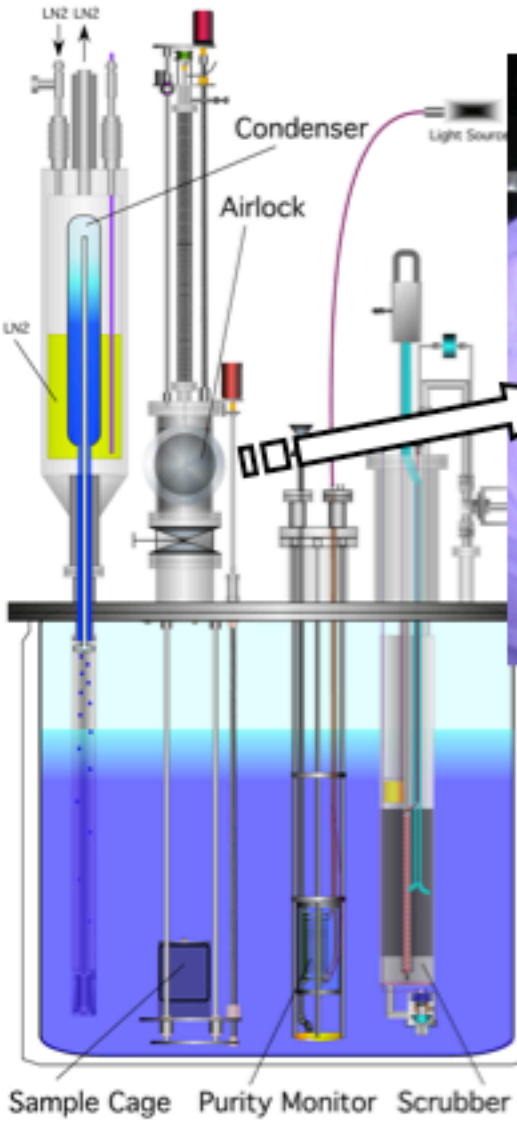


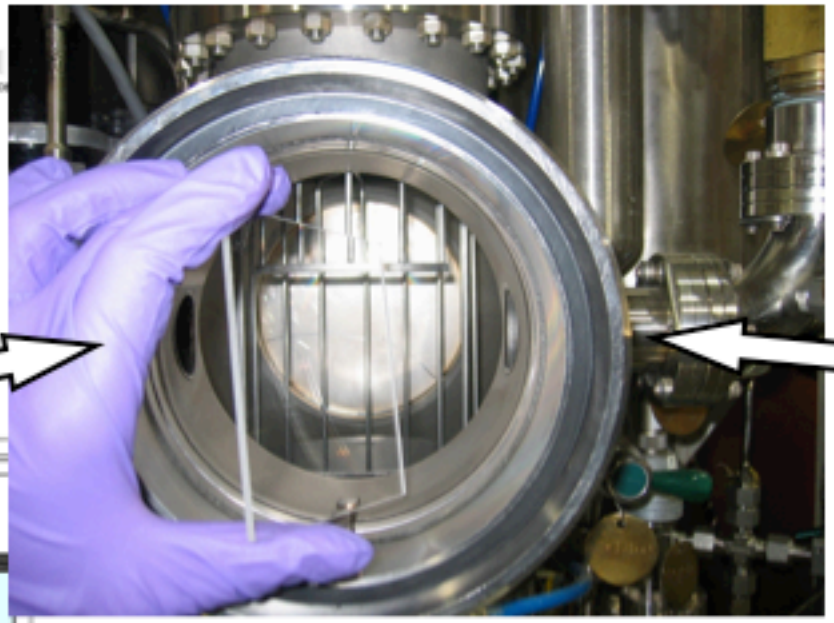
Schematic of Materials and ~~Electronics~~ Light Test Systems


Liquid Argon Setup at the PAB

Liquid Argon Setup at the PAB

– Materials Test System

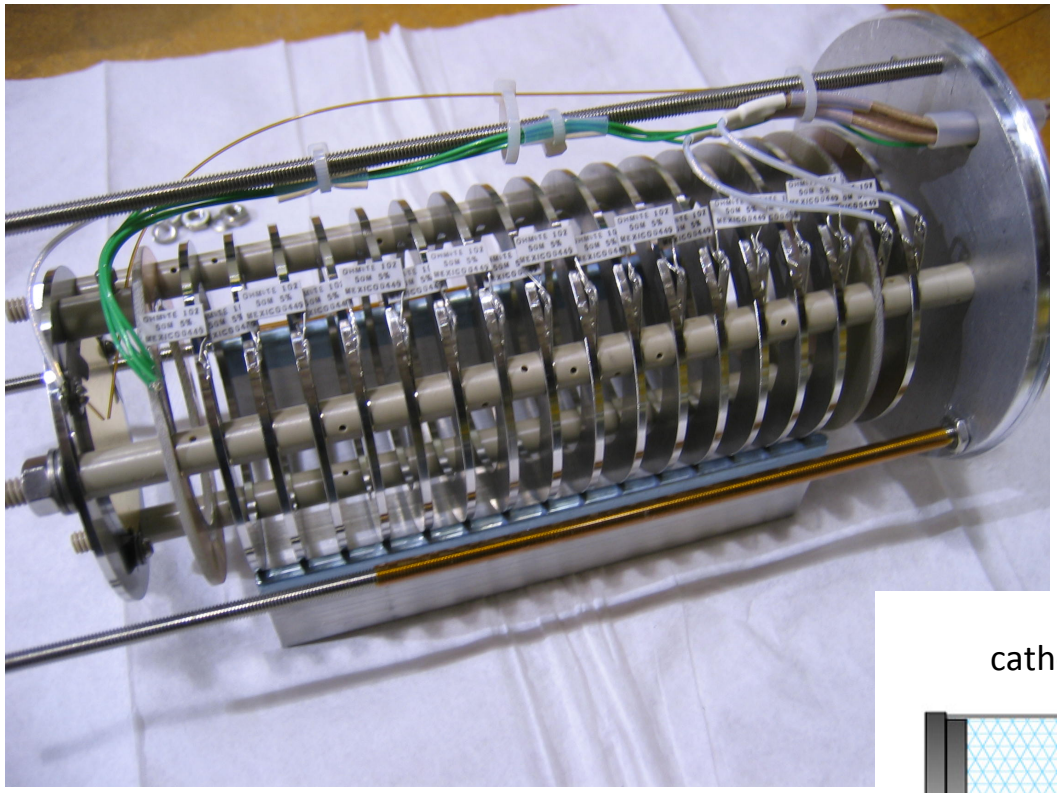




Sample volume 10 cm x 10 cm x 10 cm

Argonlock can be purged with external argon, cryostat argon, and/or evacuated

Lifetime monitor

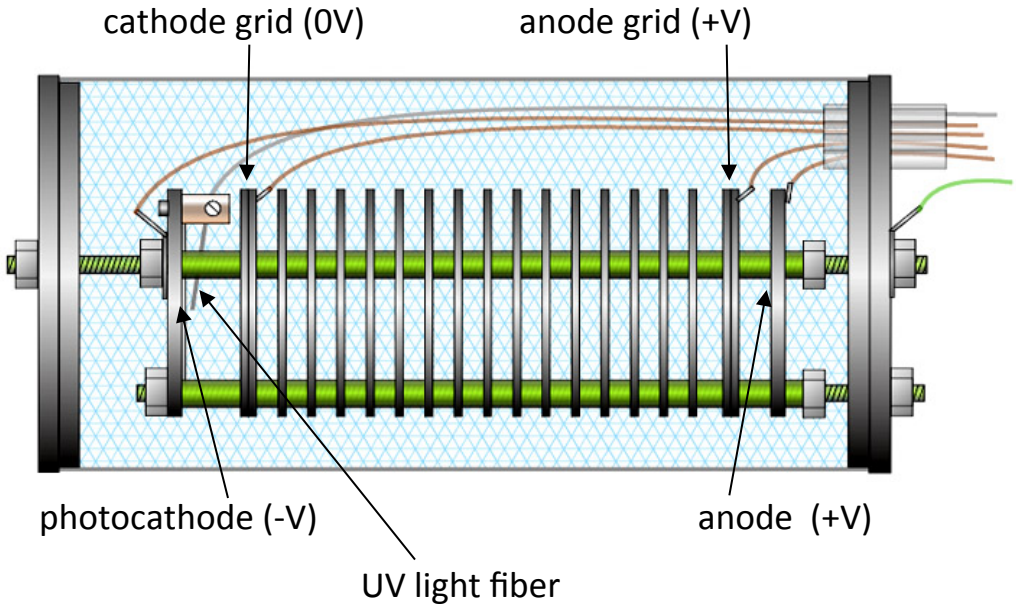


ICARUS clone made at FNAL

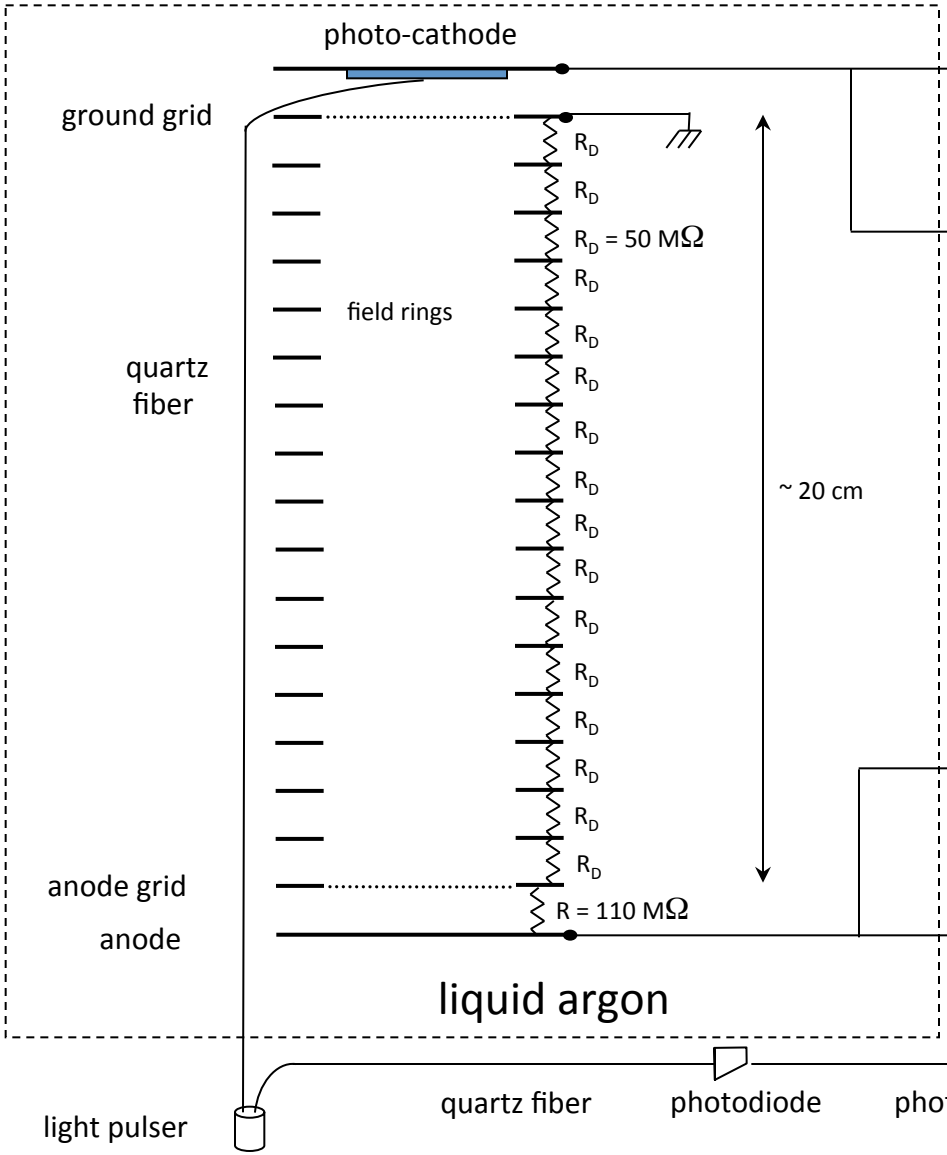
Gridded ionization chamber

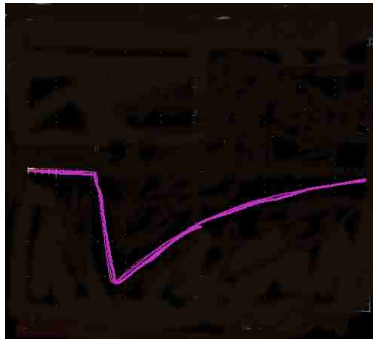
Simulate long drift by reducing electric field and drifting electrons for similar time

(oxygen attachment rate independent of electron energy for fields of interest)



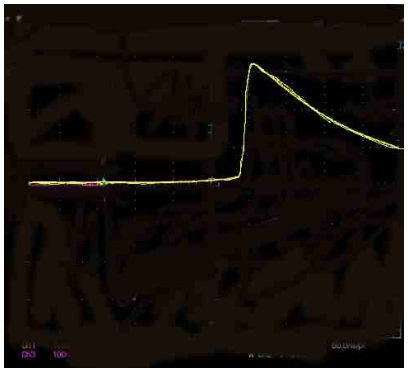
Schematic of Liquid Argon Purity Monitor (PrM)



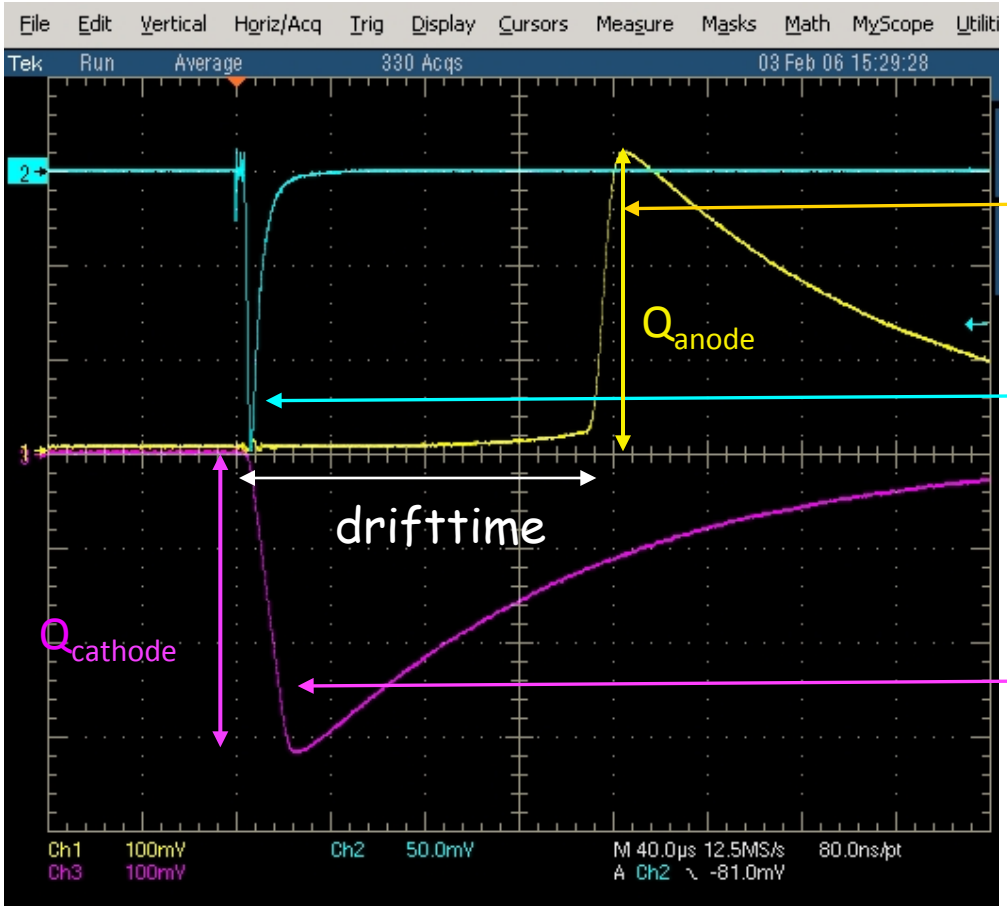


$$Q_{anode}/Q_{cathode} = e^{-t_{drift}/\tau}$$

G. Carugno et al., NIM A292 (1990) and ICARUS-TM/02-14



Purity Monitor Principle of Operation



t_{drift}= 150 µs, $Q_{anode}/Q_{cathode}$= ~1.

$\tau \sim t_{drift} * 1/(1- Q_{anode}/Q_{cathode})$ – not well defined for $Q_{anode} \sim Q_{cathode}$

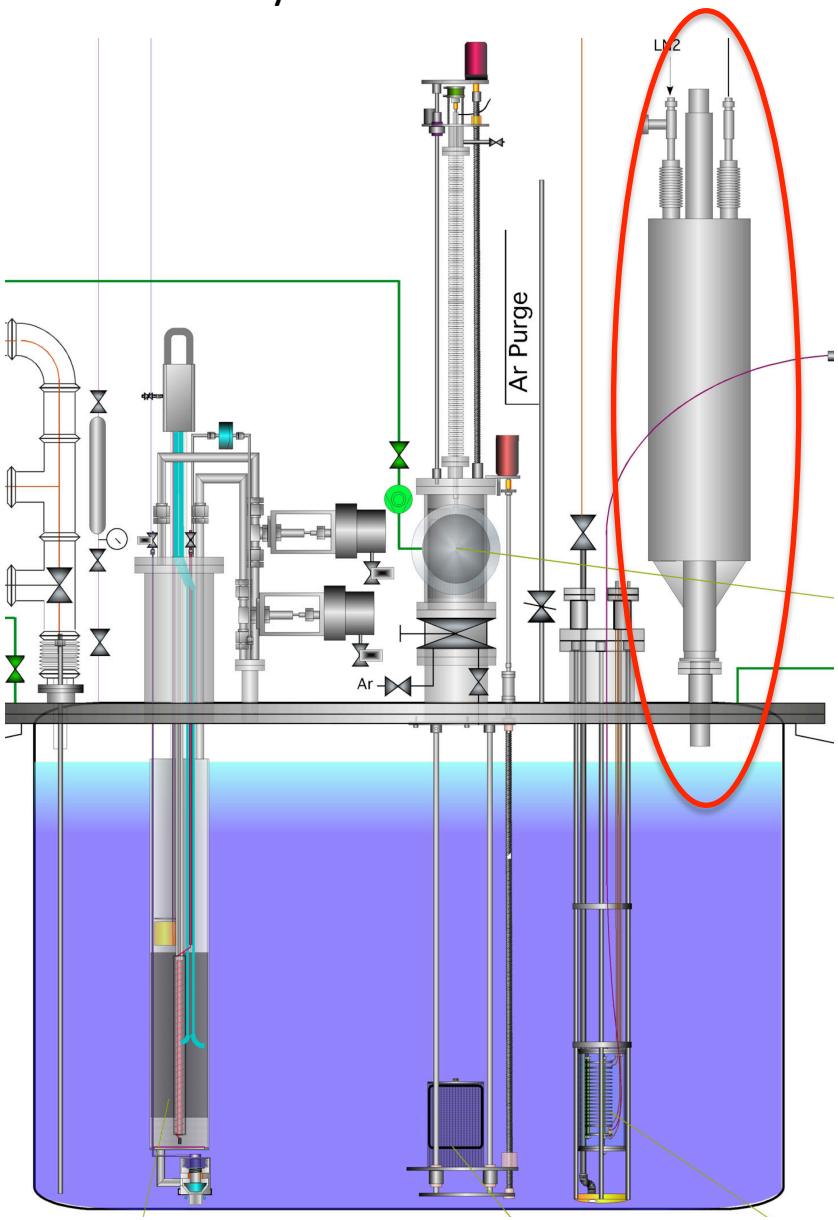
Materials Test System

`A system to test the effects of materials on the electron drift lifetime in liquid argon and observations on the effect of **water**' R. Andrews *et al.,* Nucl.Instrum.Meth.A608:251-258,2009.

Material	Date test started	Preparation	Tests	Water [ppb]	Lifetime [ms]	LogBook #
Cleaning Solution	6/29/09	evac. 24 h	vapor/liquid	4	5	946
Vespel	7/9/09	evac. overnite	liquid/vapor	5-7	2-5, 4-6	960
MasterBond glue	7/16/09	purged 18 h	vapor/liquid	1.6	1.3- 2.9	974
LEDs	7/31/09	purged 38 h	vapor	3.5	5	993
Carbon filter material	8/12/09	evac. 24 h	liquid/vapor	2	4-9	1000
962 FeedTru Board V2	10/12/09	evac. 24 h	vapor/warm	85	1-5	1062
Teflon cable	1/9/10	purged 28 h	warm/liquid/vapor	8-20	2-5	1175
3M "Hans" connectors	1/29/10	purged 46 h	warm/liquid/vapor	5-12	3	1198
962 capacitors	3/2/10	evac. 24 h	warm/liquid/vapor	6-14	3-6	1228
962 polyolefin cable	4/12/10	evac. 16 days	warm	25-60	2	1237
Rigaku feedthrough	4/20/10	purged 7.5 h	warm	15	3	1250
Rogers board (Teppei)	4/23/10	purged 26 h	warm/liquid/vapor	40	2, 6-10	1254
Arlon Board (Teppei)	5/14/10	evac. 0.5 h, pur.2 days	warm/vapor	300, 80	1.3, 3.5	1263
Polyethylene tubing	5/24/10	evac. 6 h, pur. 66 h	warm	300-500	1	1278
Teflon tubing	5/27/10	evac. 1 h, pur.17 h	warm	9-13	4-5	1283
Jonghee board	5/28/10	evac. 6 h, pur. 1.5 h	warm/vapor	100,28	1.2, 5-8	1285
Jonghee connectors	6/4/10	evac. 3.5 h, pur. 16 h	warm/vapor	50	2-3	1290
PVC cable	6/14/10	evac. 29 h, pur.1 h	warm	120	1-2	1296
Teppei TPB samples	8/3/10	purged 26 h	warm	600-1600	0.7	1342
Teppei TPB samples	9/4/10	purged 37 h	liquid /vapor	15, 300	6	
PrM feed tru (baked)	10/5/10	purged 25 h	warm/vapor	35, 20	3, 2	1396
Copper foil on mylar film	10/14/10	purged 26 h	warm/liquid/vapor	15, 10, 9	3, 8, 7	1409
Teppei SHV connector	10/25/10	purged 25 h	warm/vapor/liquid	35, 11, 0	2, 6, 6	1415
FR4	11/16/10	purged 25 h	warm/liquid/vapor	180, 20, 65	1.5, 6, 2.5	1429
Gaskets	3/11/11	purged 24 h	warm/liquid/vapor	8, 10	2.5, 8 , 7	1521
LBNE AP-219 Color. Developer	4/13/11	purged 25 h	warm/vapor	65, 15	4, >6	1722
LBNE RPUF Foam	4/22/11	evac. 26 h, pur.1 h.	warm	800	0.2	1729
LAPD LEDs	5/12/11	purged 49 h	vapor	0.6 ppb	10	1769

Sample data on different materials (bad, good,OK in liquid)

A little story



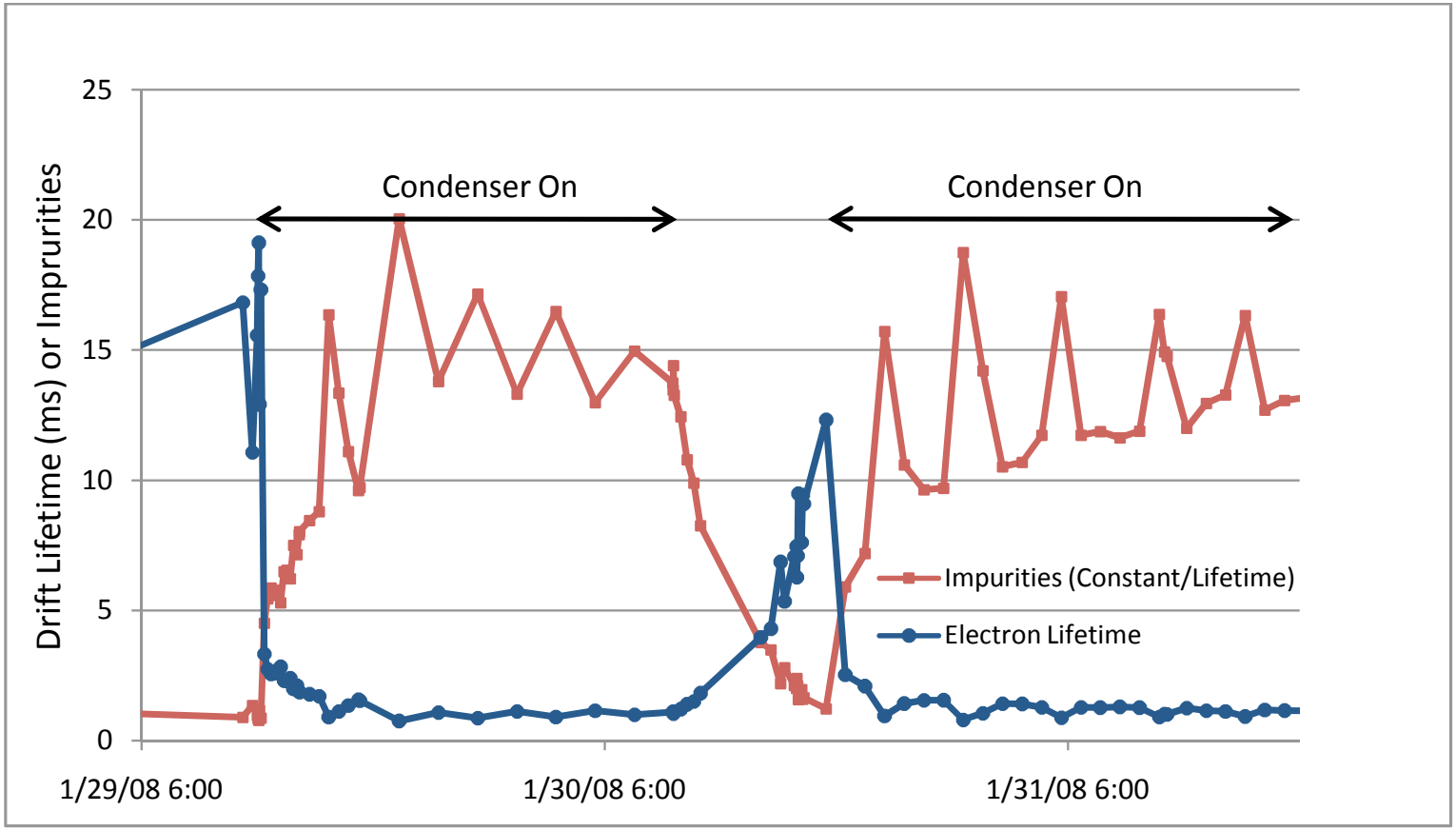
LN Condenser ..

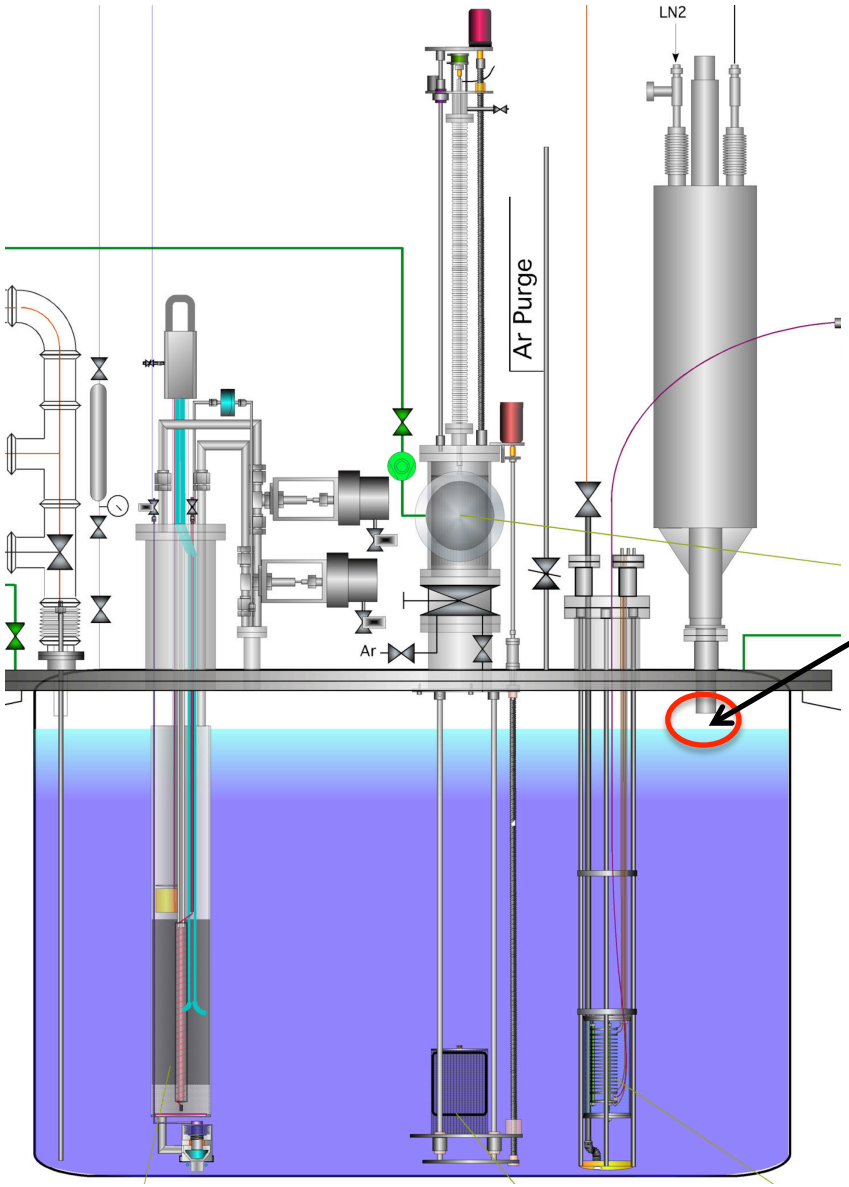
Clean argon

Closed system

- off we go ..

Off we went

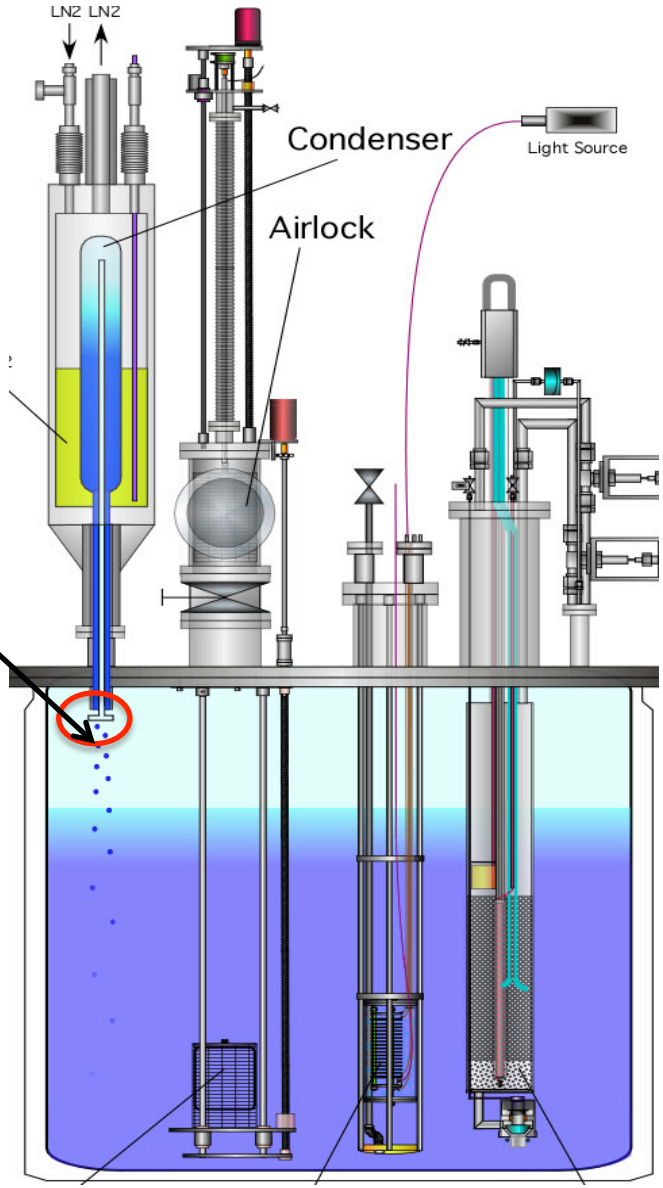

25
20
15
10
5
0
Drift Lifetime (ms) or Imprurities
Condenser On
Condenser On
Impurities (Constant/Lifetime)
Electron Lifetime
1/29/08 6:00
1/30/08 6:00
1/31/08 6:00



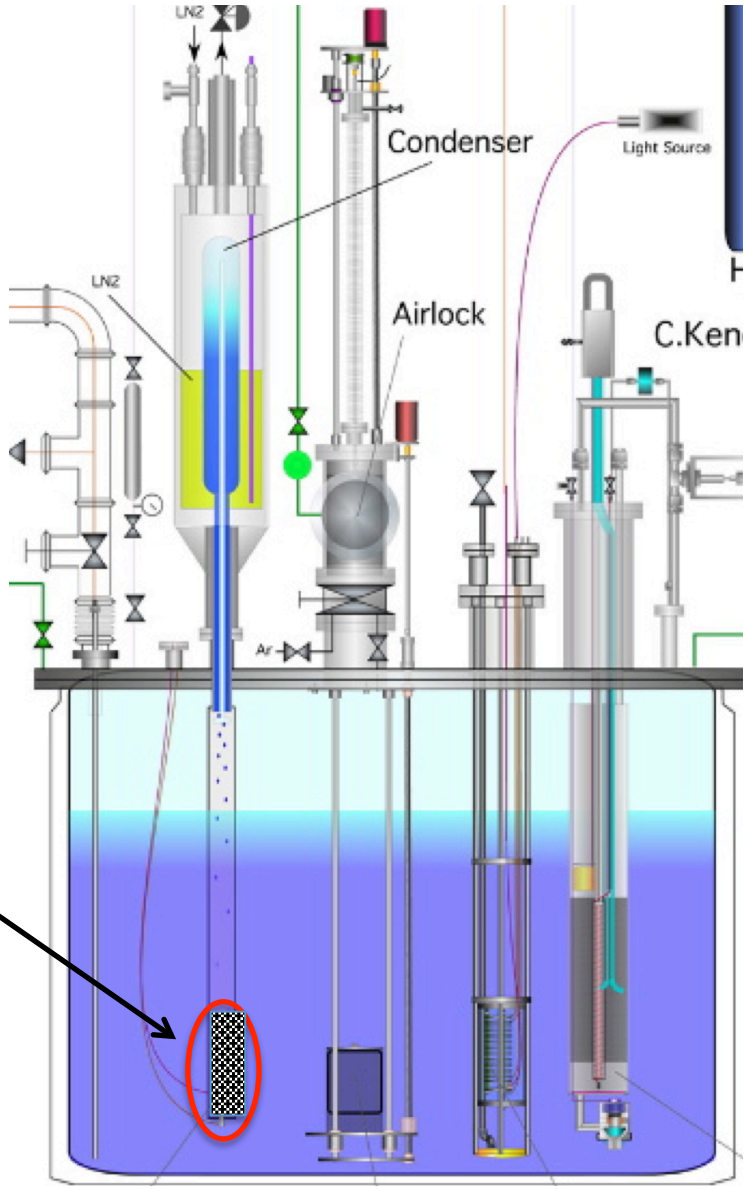
Attention focused here

charge build-up from flowing liquid

The `soft' landing

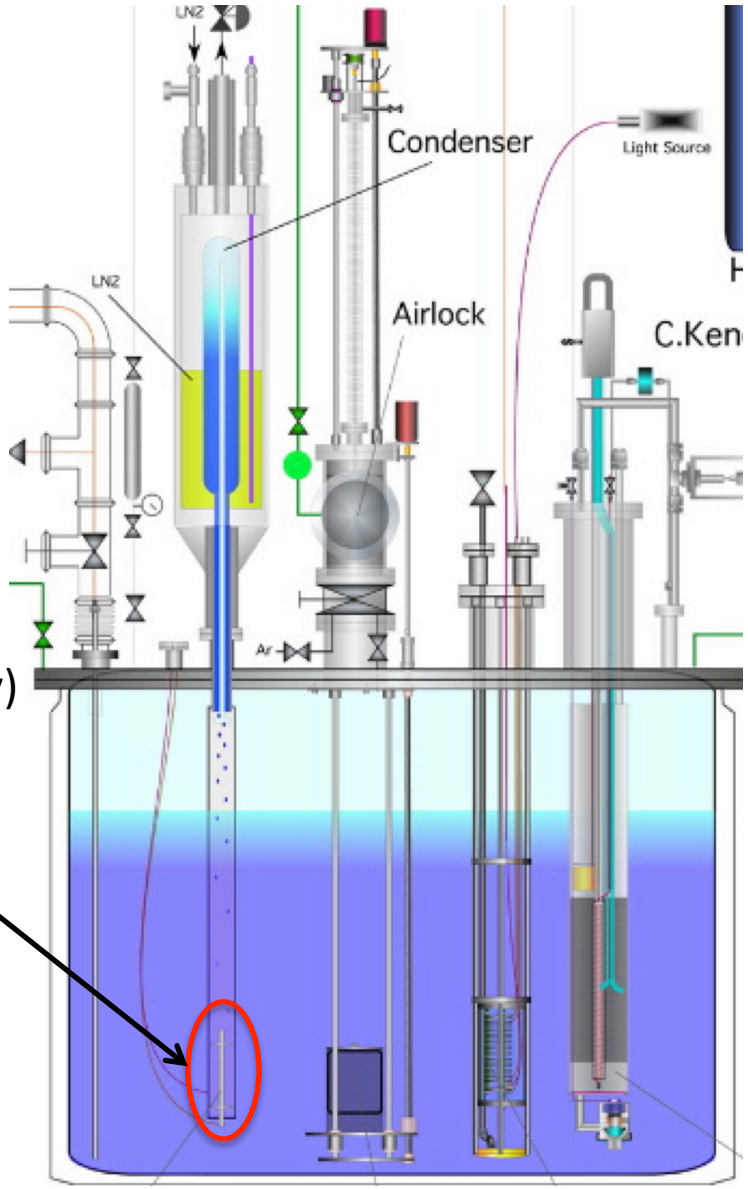


Steel wool
(to discharge any ions)



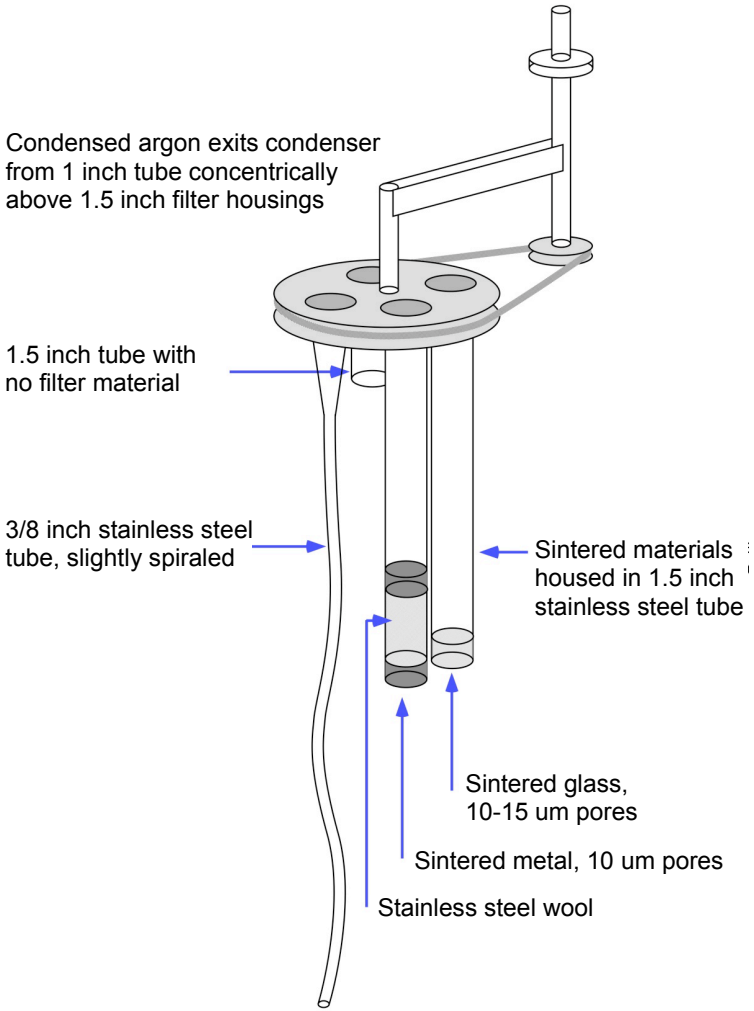
It worked ..

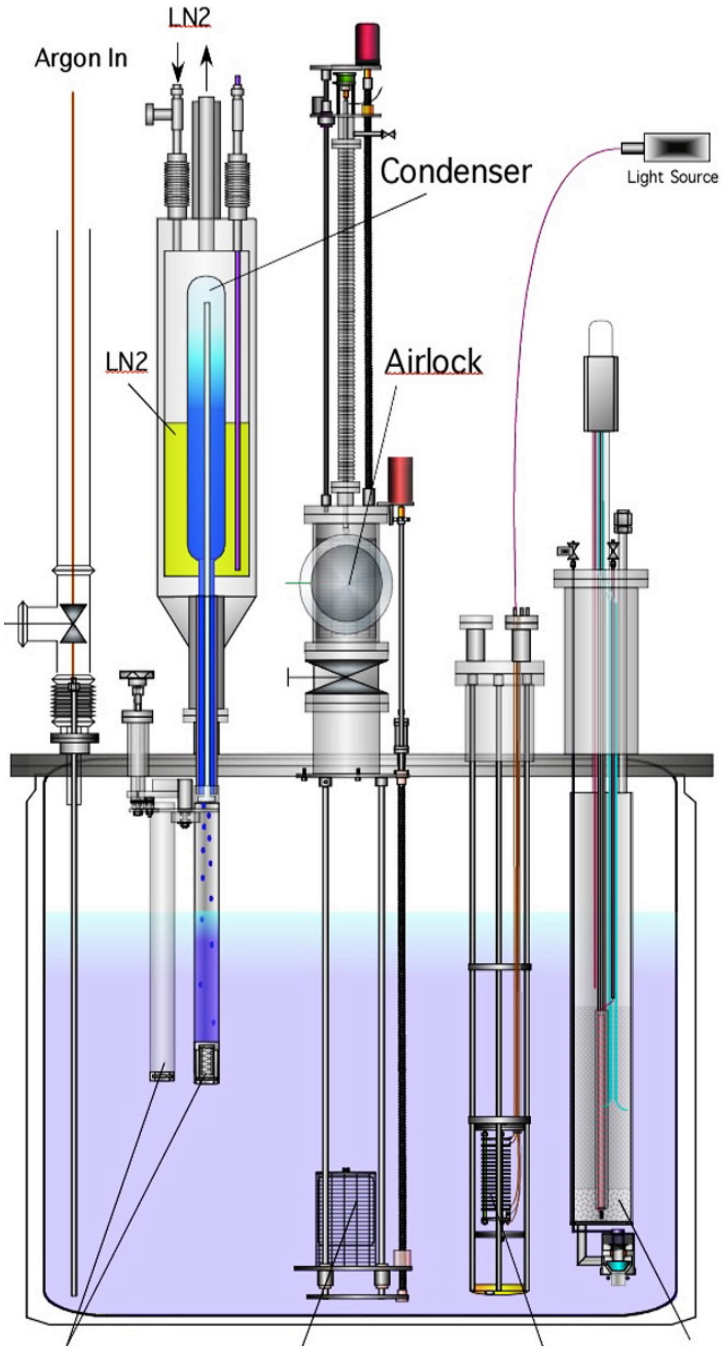
Ion rod (-10 kV)
(to check discharge theory)



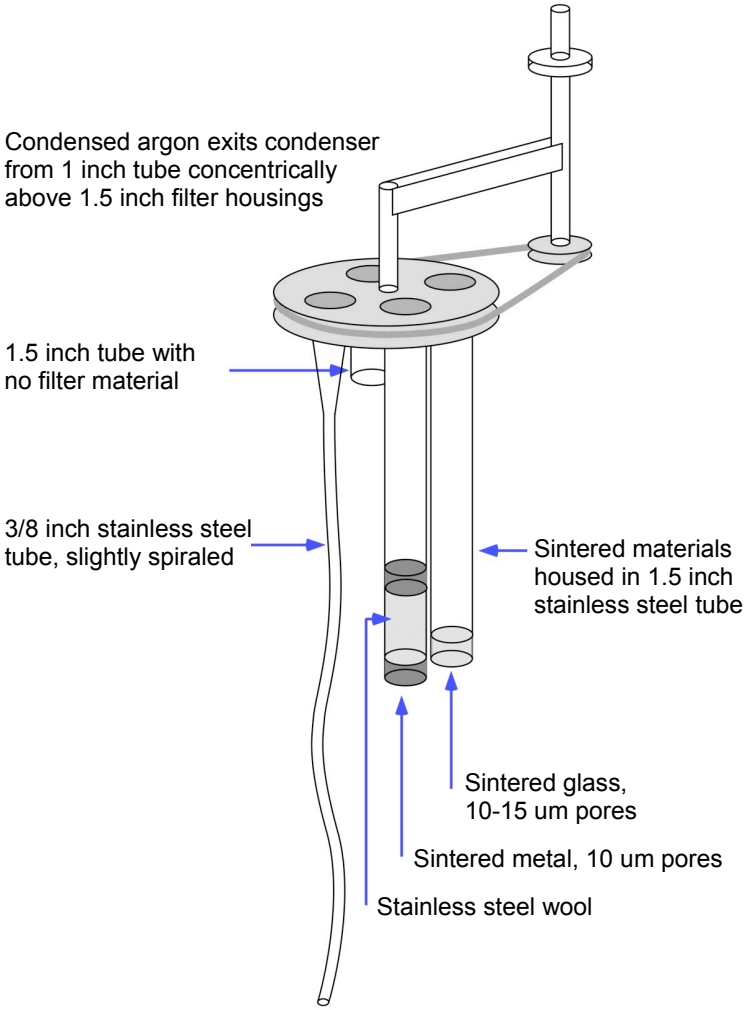
It did not work at all

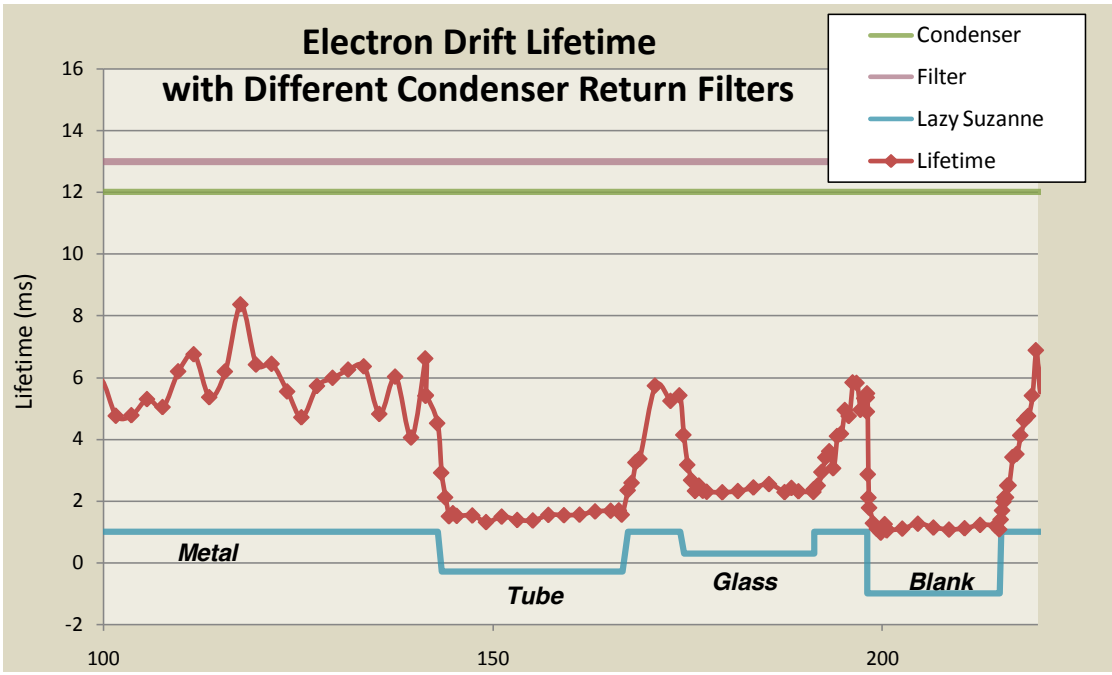
The one that works ..





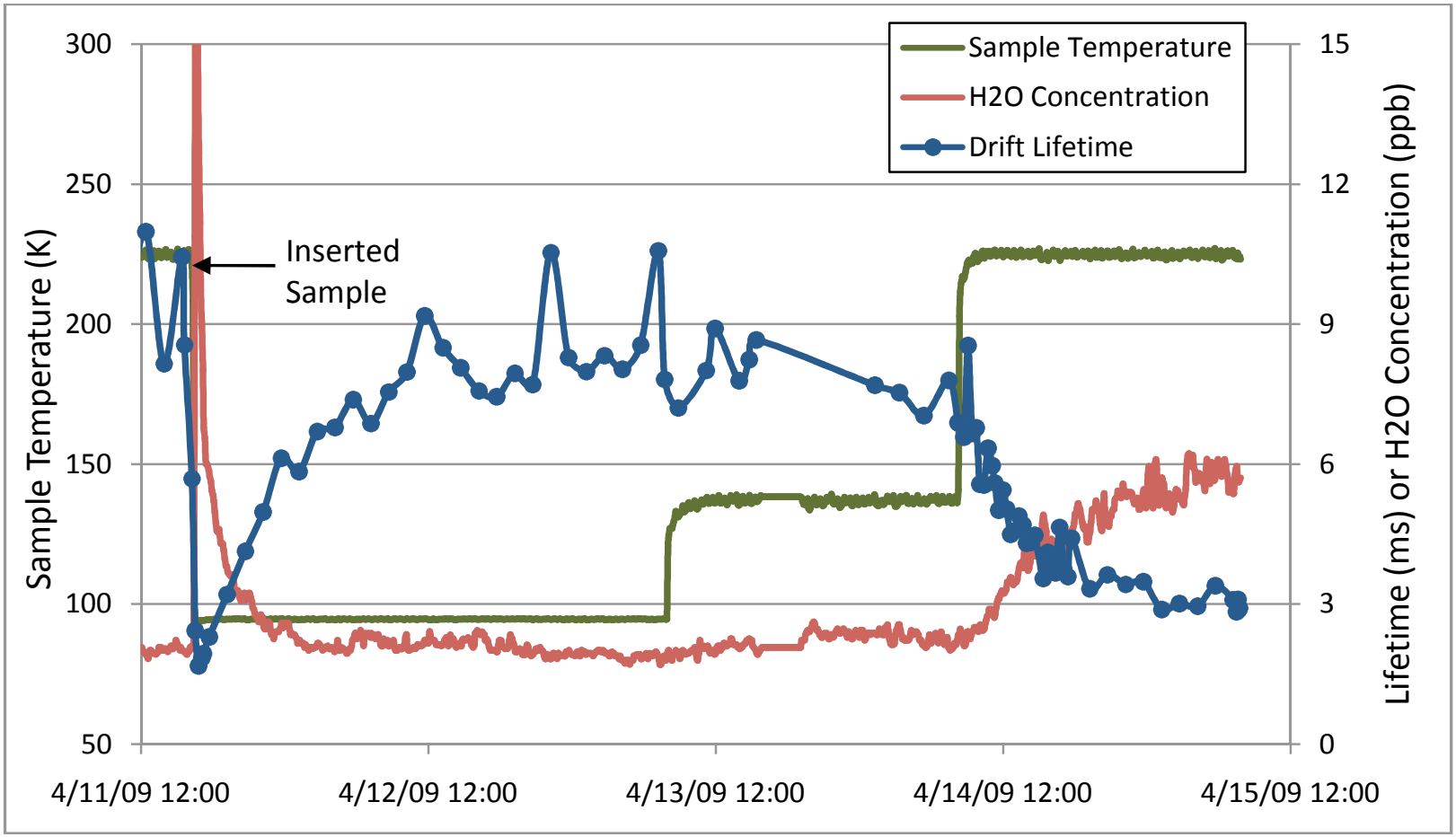
Effect of different return lines ..





Reed Andrews (U of Colorado)

Effect of water vapor in the gas being fed into the liquid ..
Sample was 100 square inches of FR-4



Lessons learned :

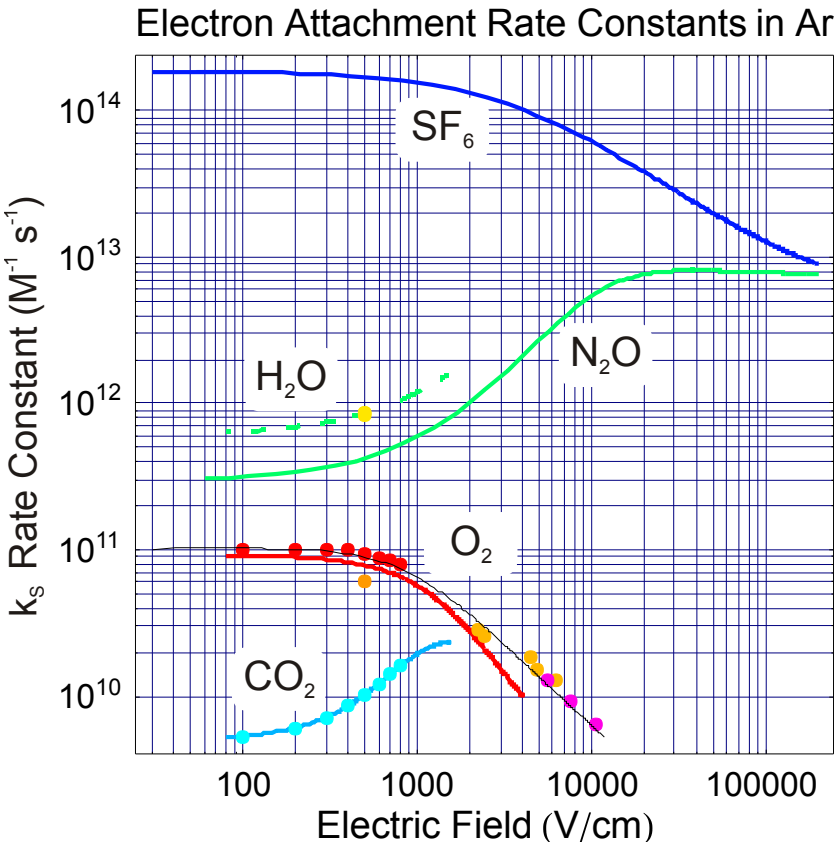
Have not found a material that affects the lifetime when in the liquid:

Outgassed water is primary source of reduction of drift lifetime:

Some materials outgas more water than others ..

Warm (moderately cold) metal surfaces outgas water for ever ..

Effect of outgassing depends critically on rate of mixing into liquid …



From Craig Thorn (BNL)