

Cryogenic Operation of RF Gun in B939

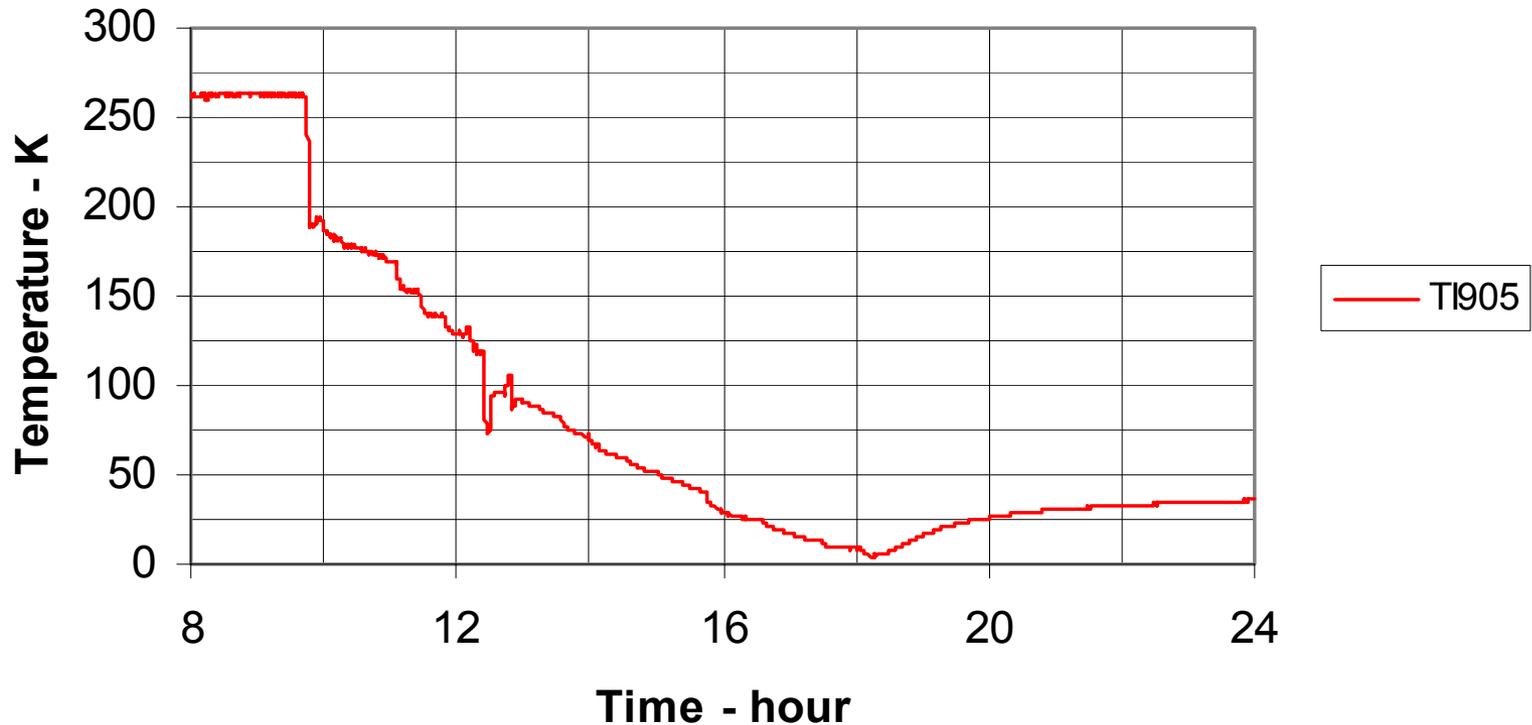
- 7/23/04, Friday – Introduce LN2 to heat shield
- 7/25/04, Sunday – Add LN2
- 7/26/04, Monday – 4.5 K cooldown using 1st 500 L dewar, reach 4.5 K at 6 PM
- 7/27/04, Tuesday – Fill LHe, 2nd 500 L dewar
- 7/28/04, Wednesday – Fill LHe and initial 2 K pumpdown
- 7/29/04, Thursday – Fill LHe, 2nd dewar empty, use remaining LHe from 1st dewar
- 7/30/04, Friday – Fill LHe using 250 L dewar from B902 and later 3rd 500 L dewar. 2 K pumpdown

Cryogenic Operation of RF Gun in B939

- 7/31/04, Saturday – Fill LHe using 3rd 500 L dewar. 2 K pumpdown
- 8/1/04, Sunday – No test
- 8/2/04, Monday – 4.5 K cooldown
- 8/3/04, Tuesday – Fill Lhe, 3rd 500 L dewar
- 8/4/04, Wednesday – Last day of the test.
Use 500 L dewar from B902. Started with ~ 300 L. 902 record is 340 L. The level drops to 260 L in B939. Reading on liquid level is very sensitive to pressure. A few psi in the dewar could causes a drop of more than 50 L in reading. Characteristic of the level gauge and dewar need to be investigated.

Cooldown of RF Gun Cryostat

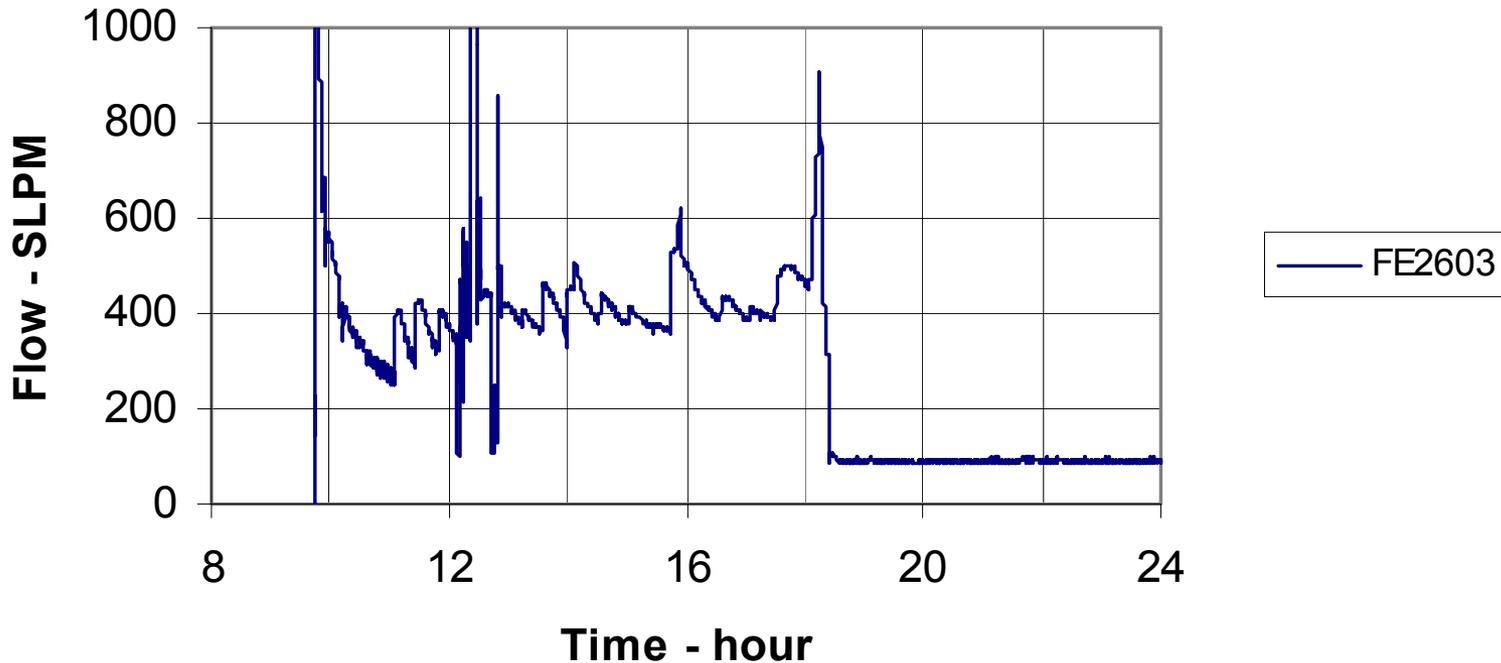
TI905 is located on top of RF - 7/26/04



Temperature on top of the RF gun during cooldown on 7/26/04. This is the first cooldown using top fill. The flow rate is set ~ 400 SLPM as oppose to previous cooldowns with flow greater than 1000 SLPM. It takes ~ 4 hours from 160 to 60 K, (25 K/hr). Typical recommended rate to avoid Q disease is > 10 K/min, (~60 K/hr). Need to double the cooldown flow to ~ 1,000 slpm.

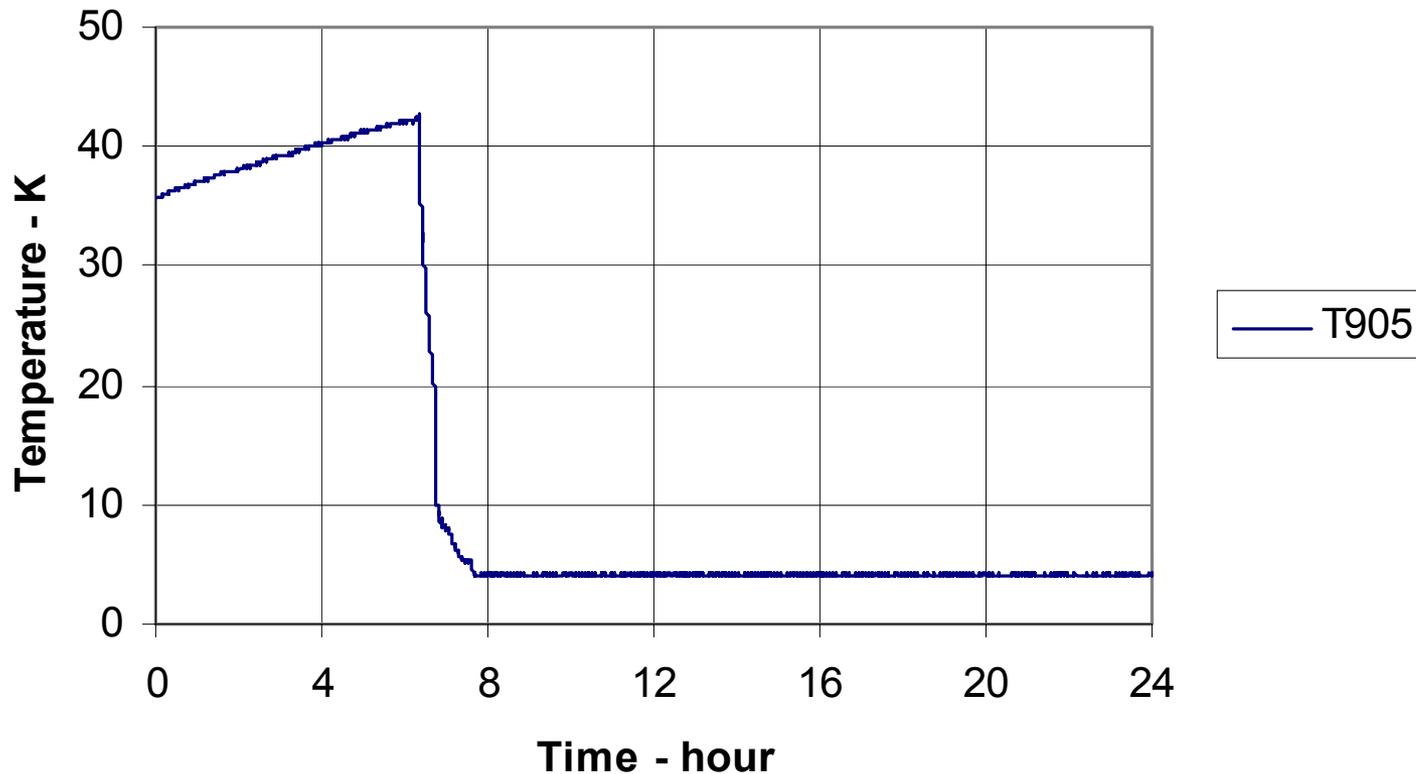
Cooldown flow of RF Gun Cryostat

7/26/04



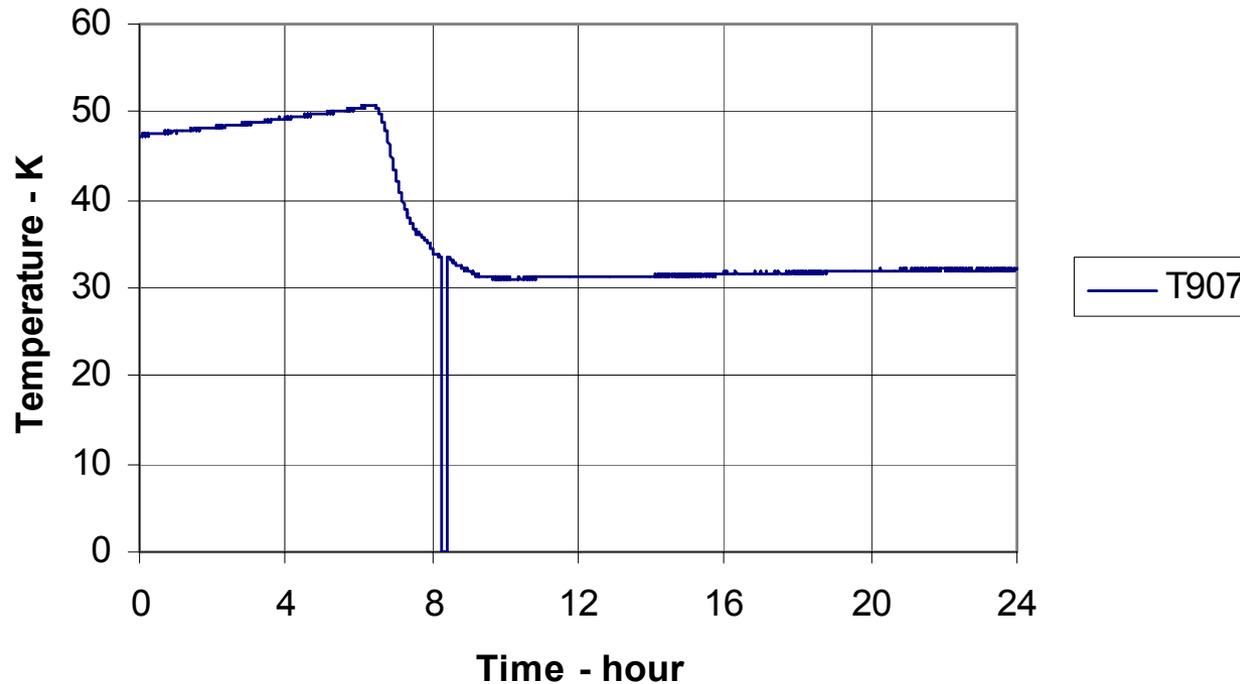
This is the first cooldown using top fill. The flow rate is set ~ 400 SLPM as oppose to previous cooldowns with flow greater than 1000 SLPM. Boil-off flow rate is in the very low range of the flowmeter and cannot be measured accurately. Boil-off rate should be determined from change of liquid level.

TI905 located on top of RF during filling on 7/27/04



Overnight, the gun warms to ~ 42 K. Top filling almost does not increase the gun temperature. The gun was cooled down within half an hour.

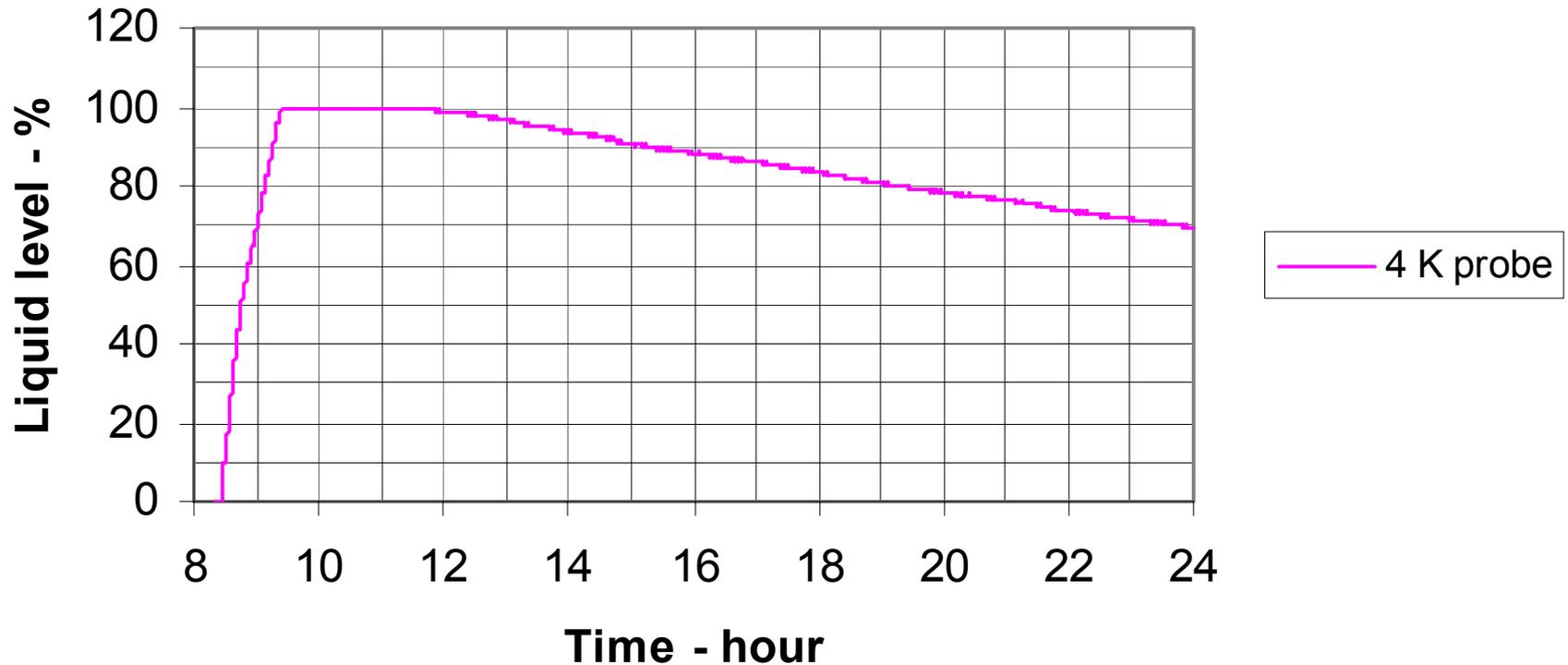
TI907 located at bottom of helium vessel during filling on 7/27/04



Temperature reading from TI907 is inconsistent with other sensors. From the result obtained on 7/27, we conclude TI907 does not give meaningful result. The problem is on the sensor itself. There is no unusual heat load causing TI907 to read temperature greater than 30 K. The connector of TI907 was unplugged for check at 8:15.

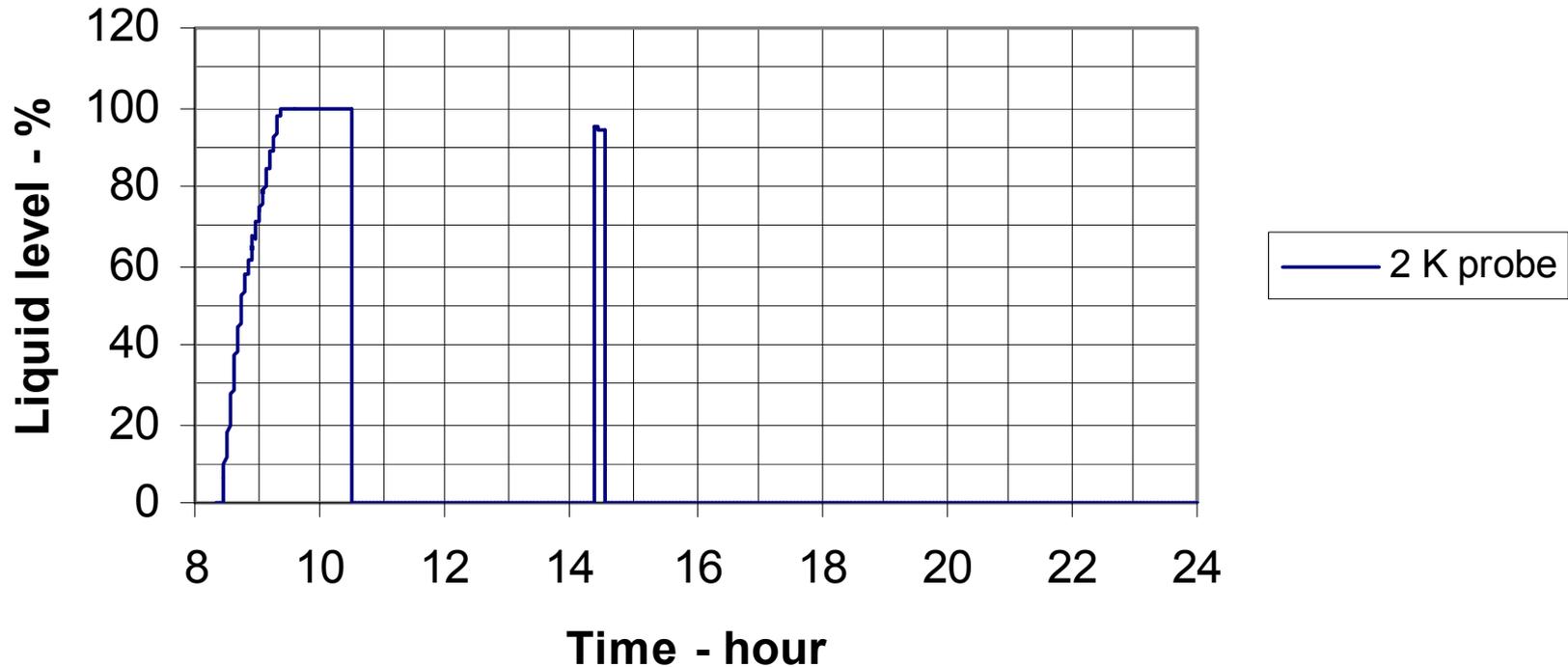
Boil-off Rate for RF Gun Cryostat in B939

7/27/04



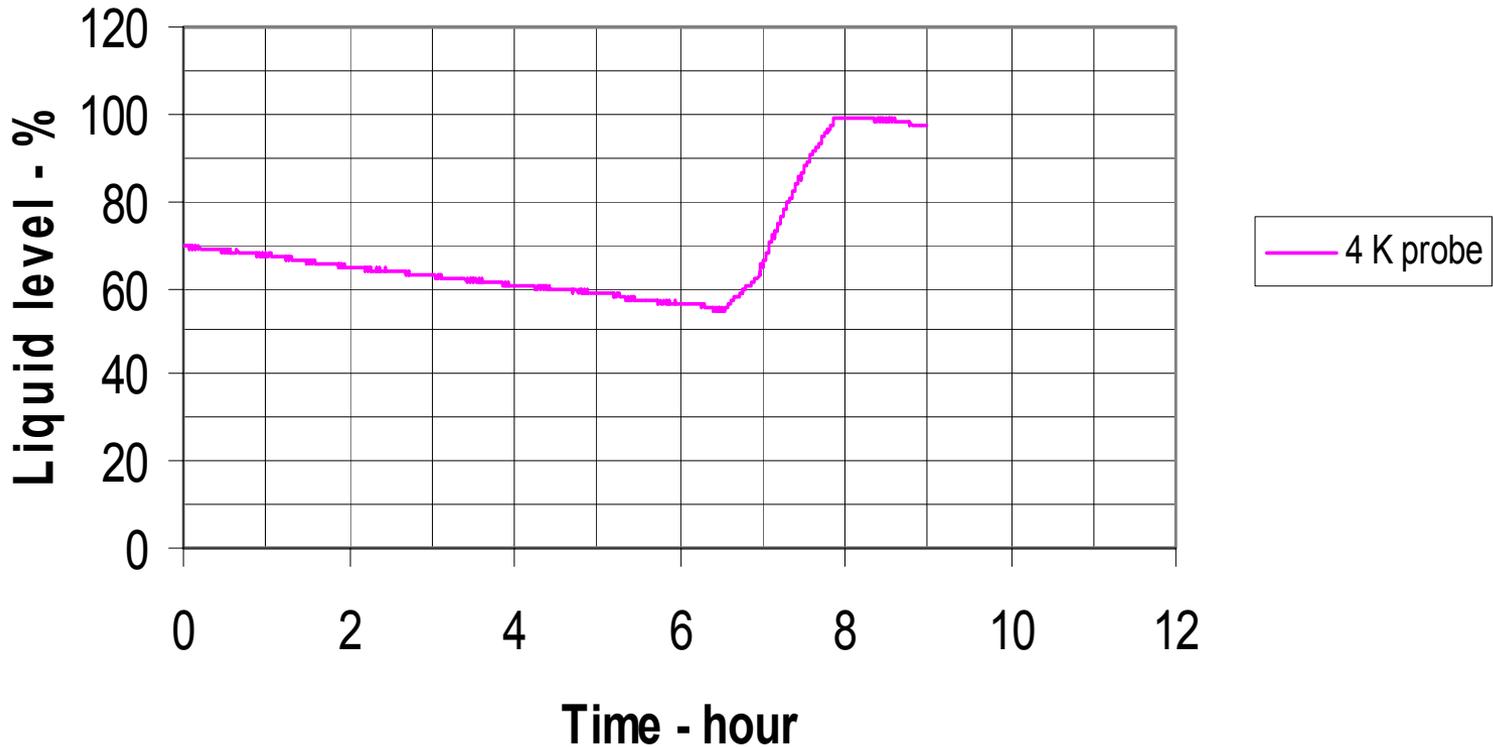
Boil-off rate from noon to midnight is about 30% (100% to 70%).
Amount of helium consumes equal $\sim 0.3 \times 12 \text{ in} \times 2.54 \text{ cm/in} \times 3.5 \text{ L/cm} \sim 32 \text{ L}$. 32 L in 12 hours equals 2.7 L /hr or $\sim 1.6 \text{ W}$.
The boil-off rate and heat load are very close to that of 1st cooldown in May 2003.

2 K level probe - 7/27/04



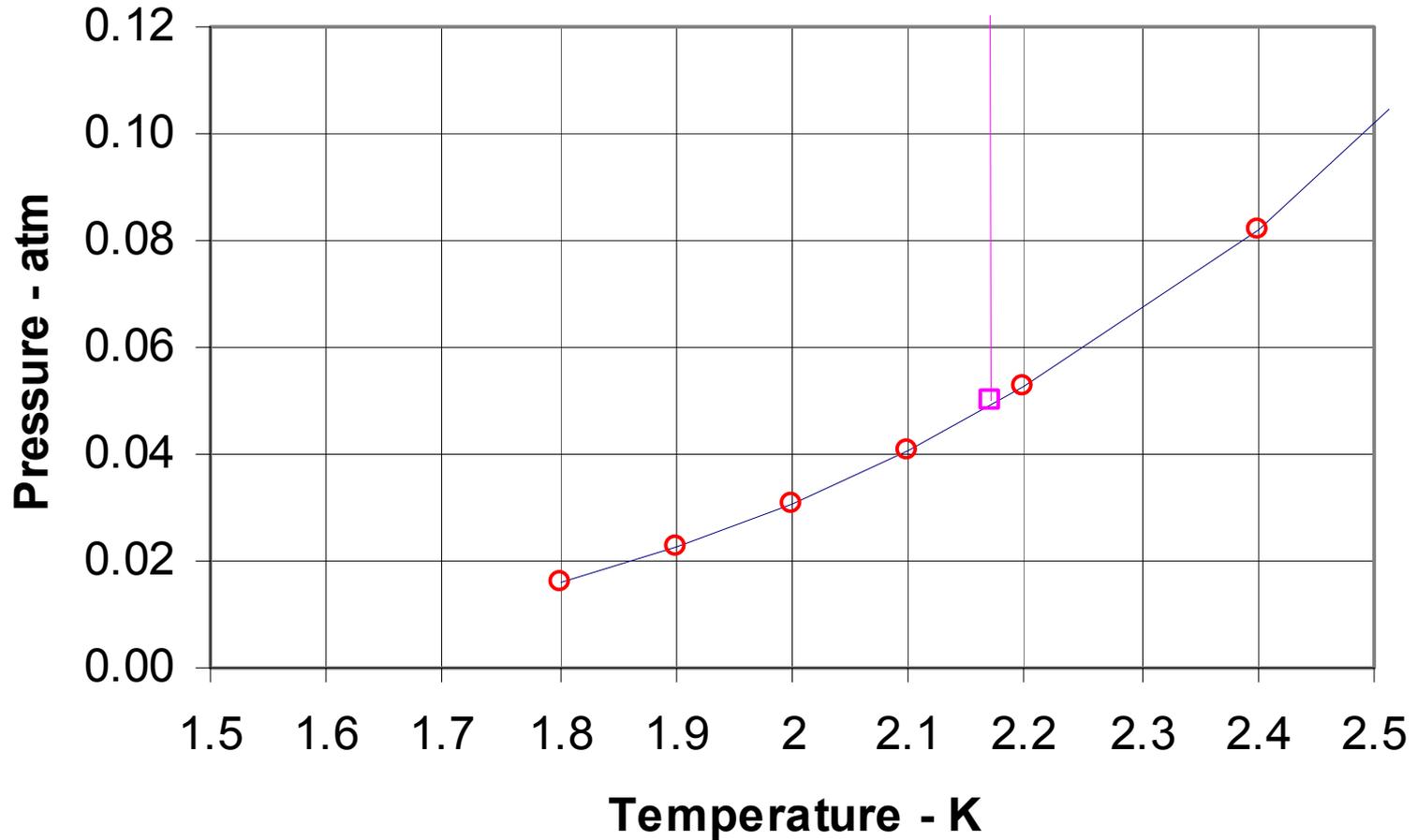
The 2 K level probe gives essentially the same reading as the 4 K probe as seen during filling, at 10:30 and at 14:30. 2 K probe was turned off in the remaining time.

Boil-off Rate and Helium Refill for RF Gun Cryostat in B939 - 7/28/04



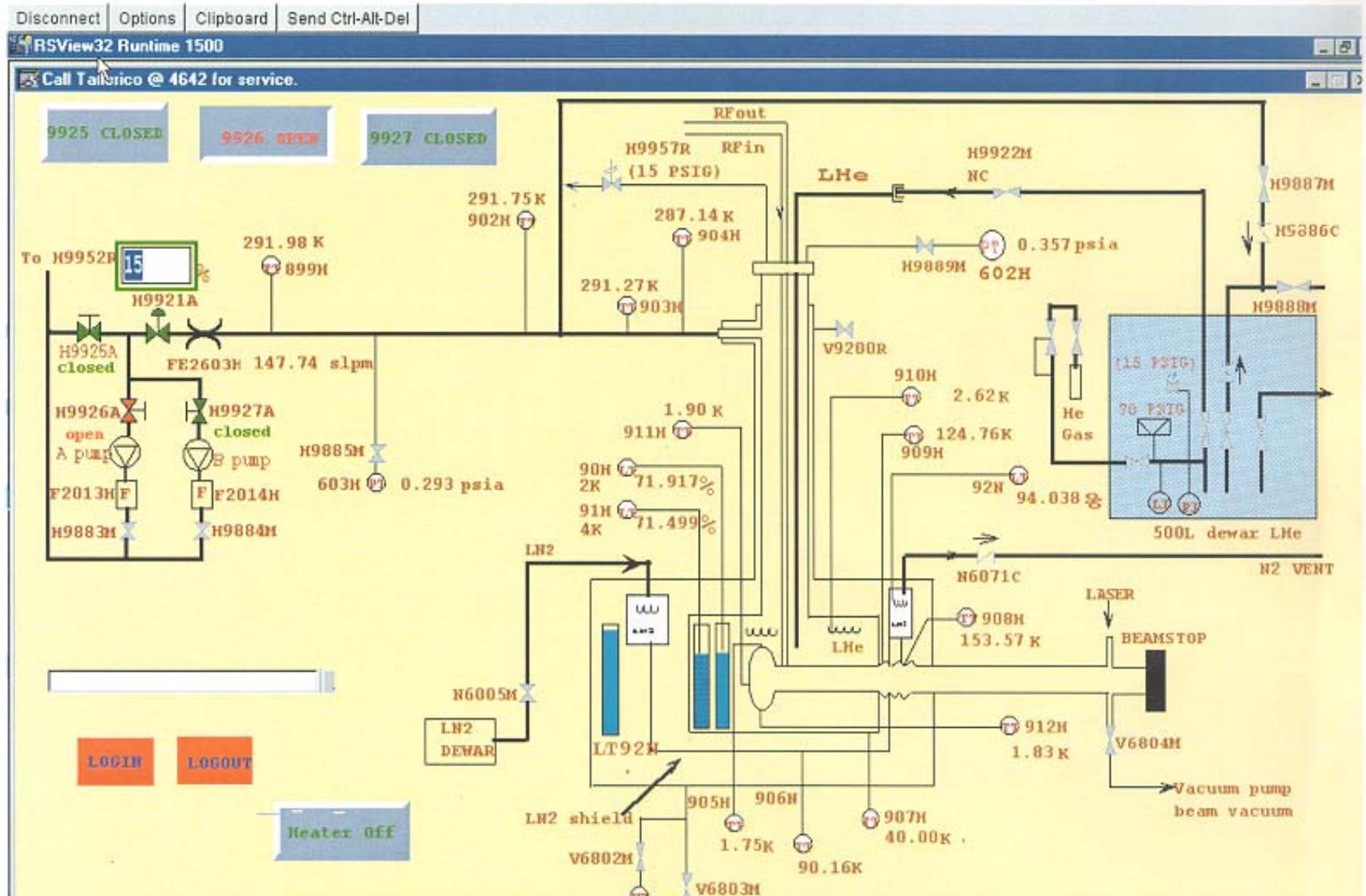
Boil-off rate is low overnight. With top filling, loss of liquid level during initial transfer is only a few % (or Liter). Liquid level can be re-established in 1.5 hour.

Saturation curve for Helium



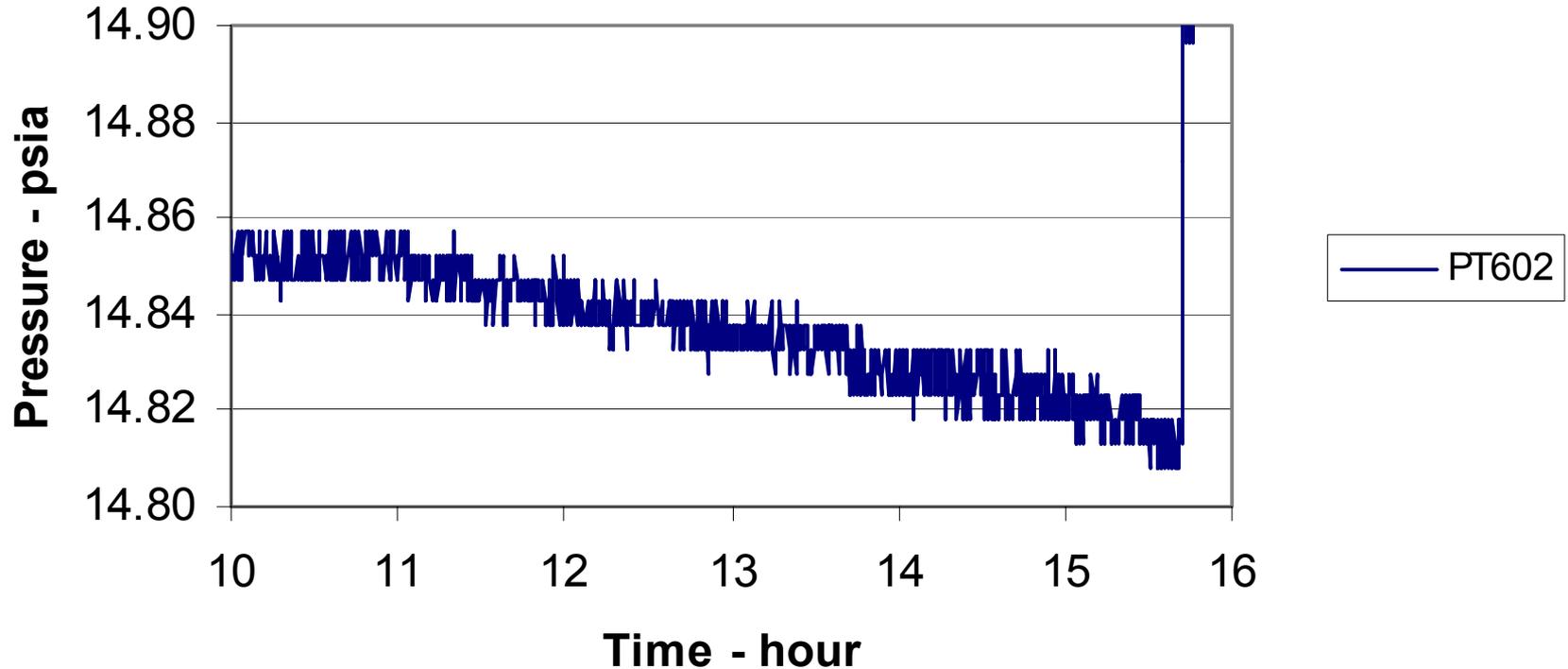
The lambda point is 2.18 K and 0.0497 atm (~ 0.73 psia)

Process Condition for RF Gun at ~ 2 K, 7/30/04



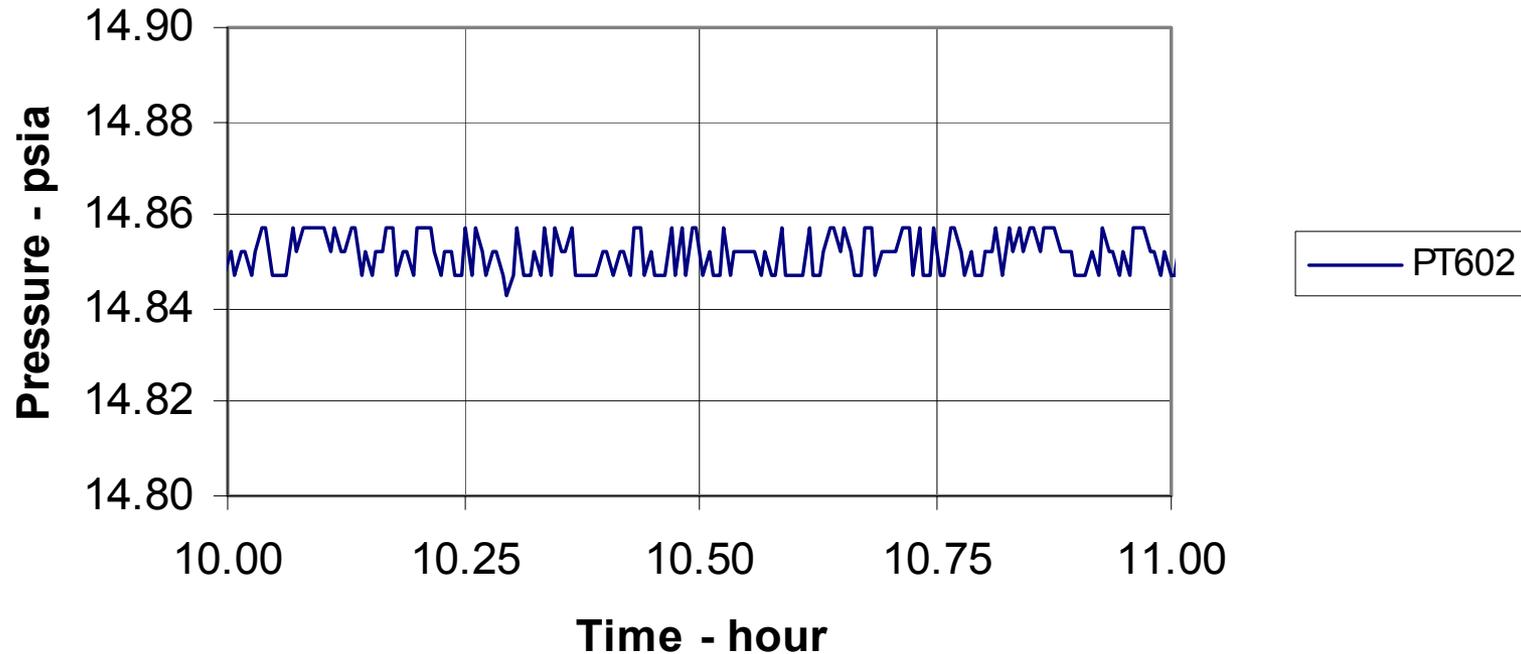
Pressure in the RF Gun Cryostat in B939

7/27/04



Pressure in the RF gun cryostat varies with time. From 10 AM to 3:30 PM, the pressure decrease from 14.85 to 14.81 psia. There are small fluctuations in the pressure reading. The amplitude is ~ 0.02 psia, 0.0013 atm, or 1 Torr.

Pressure in the RF Gun Cryostat in B939 7/27/04



Pressure in the RF gun cryostat as a function of time between 10 and 11 AM. Small pressure fluctuation has an amplitude less than 0.02 psia, 0.0013 atm, or 1 Torr. The period is roughly 1 minute.

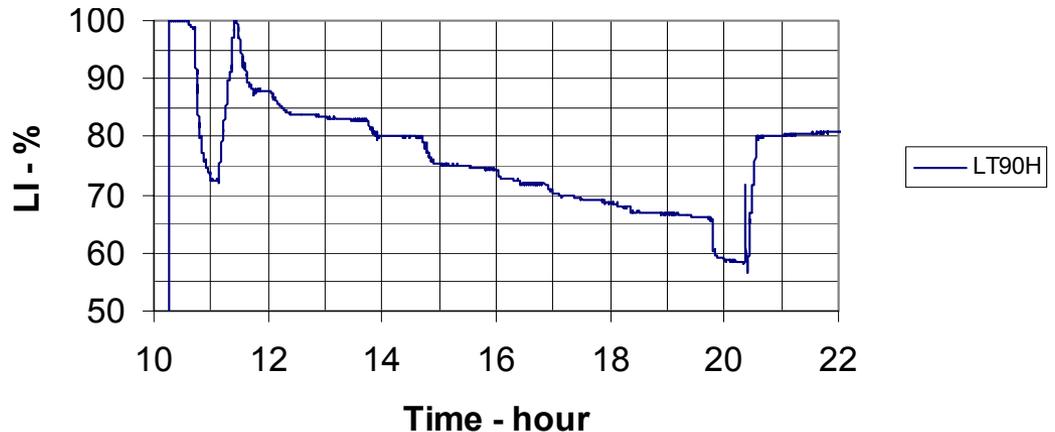
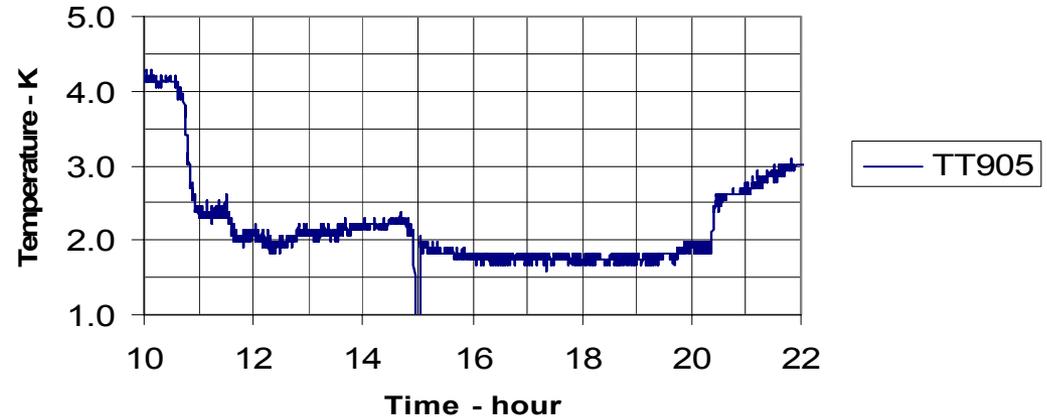
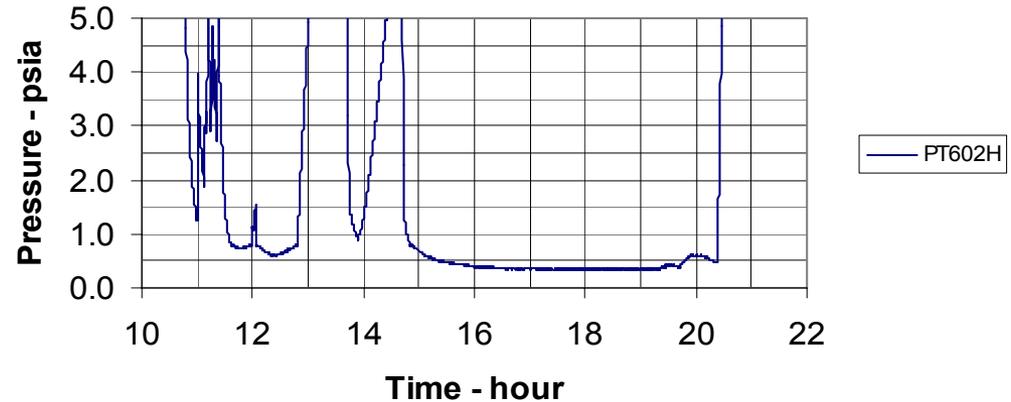
2 K pump down – 7/30/04

Cavity is stabilized at 2
K between 16:00 and
20:00

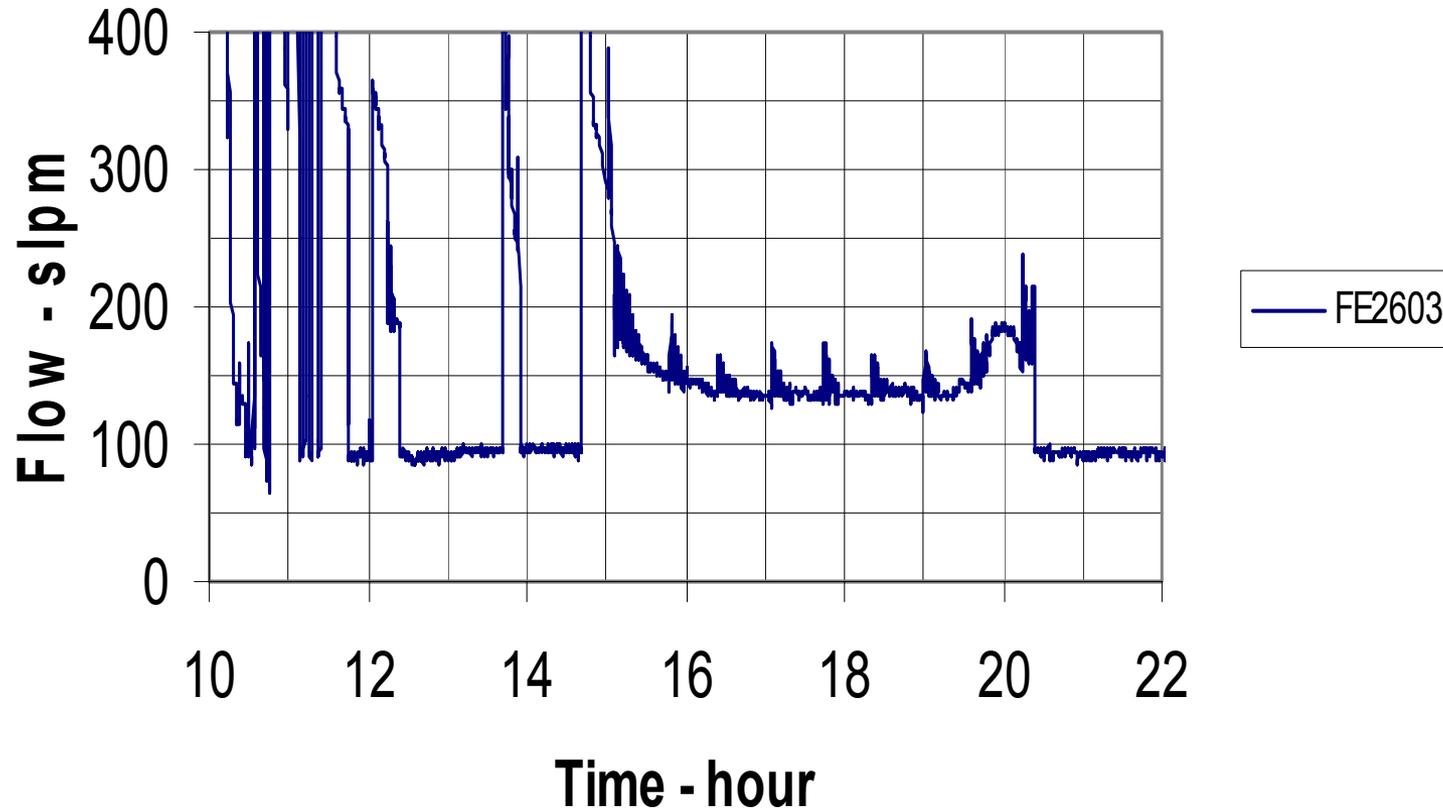
Liquid level drop from
75% to ~ 65% in 4
hours

Boil-off volume ~ 3.5
L/cm x 12 x 2.54 x
0.1 ~ 10.7 L

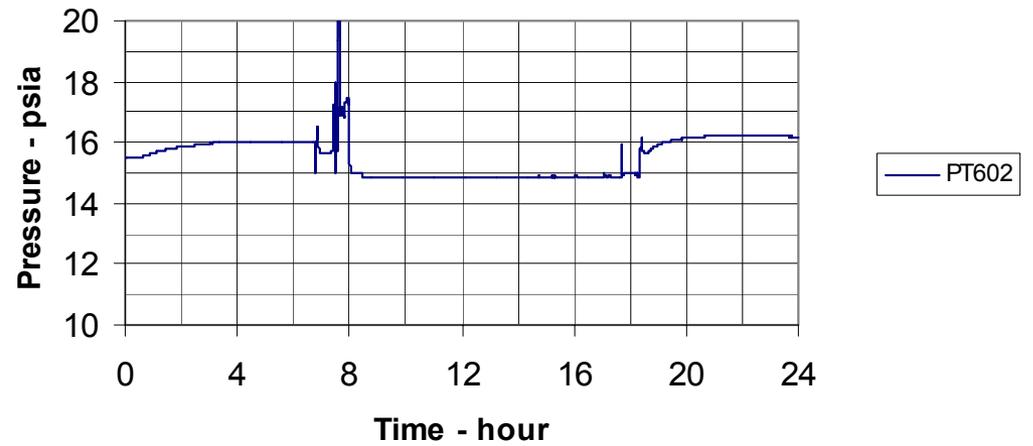
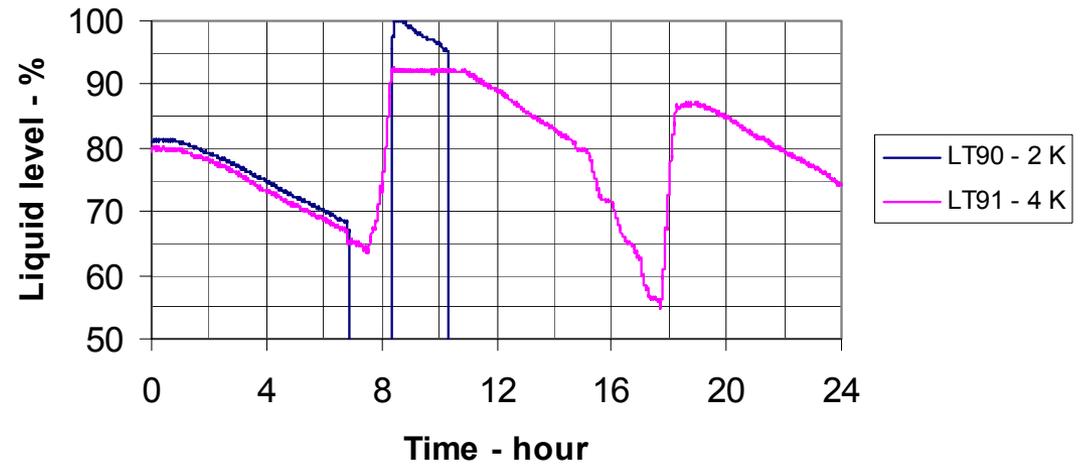
Boil-off rate ~ 2.7 L/hr



2 K pump down – 7/30/04

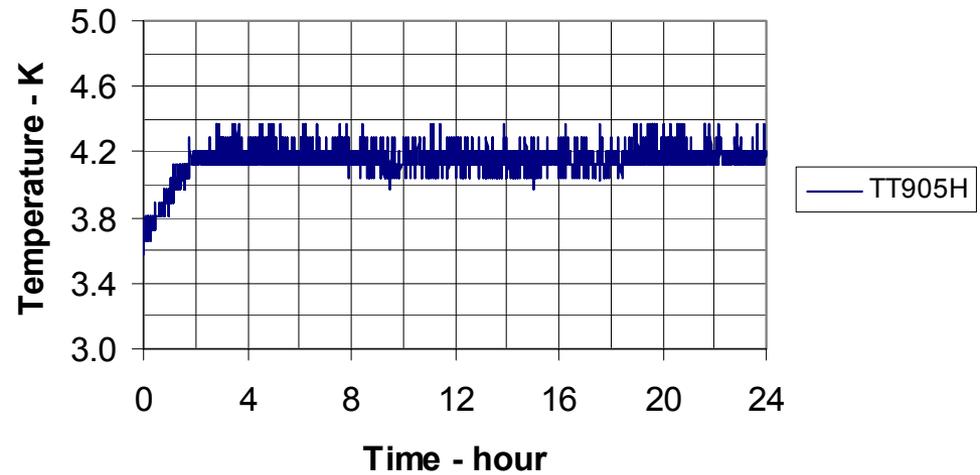


Saturday – 7/31/04

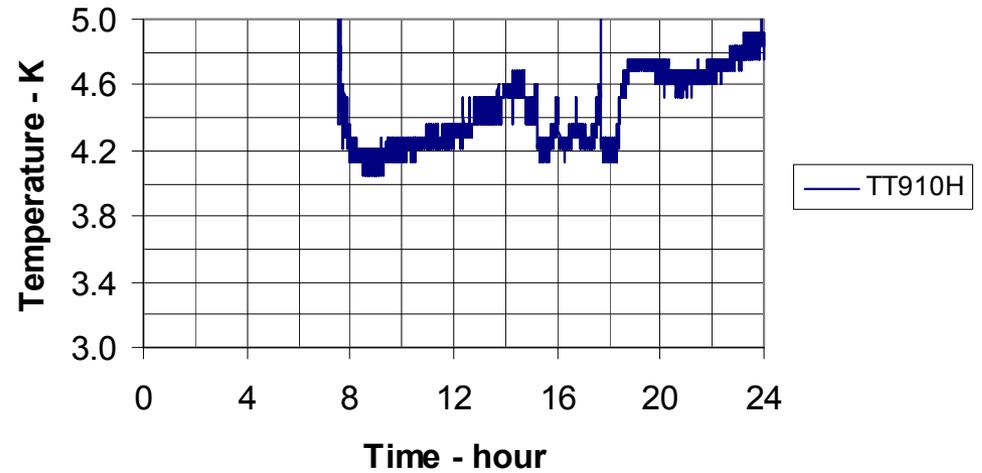


Saturday –
7/31/04

TT905H Top of RF Gun - 7/31/04

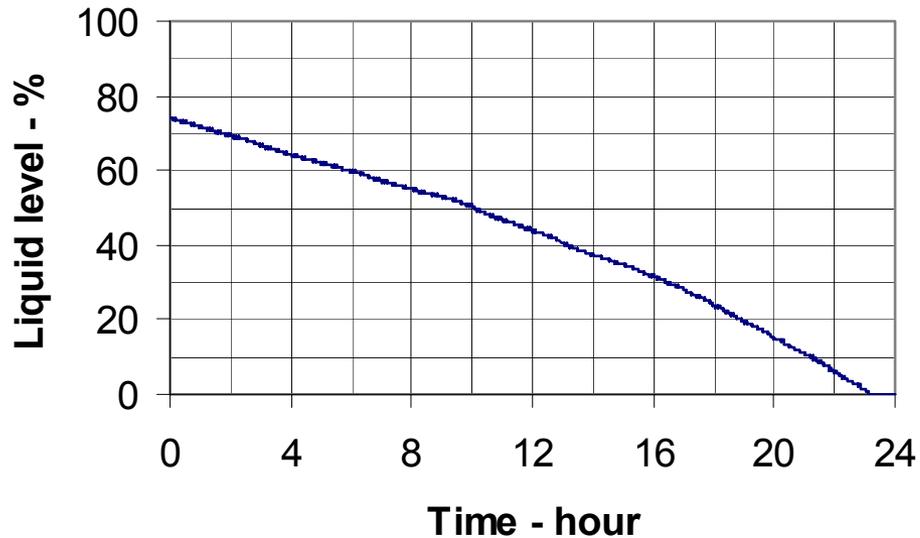


TT910H Top of He Vessel - 7/31/04

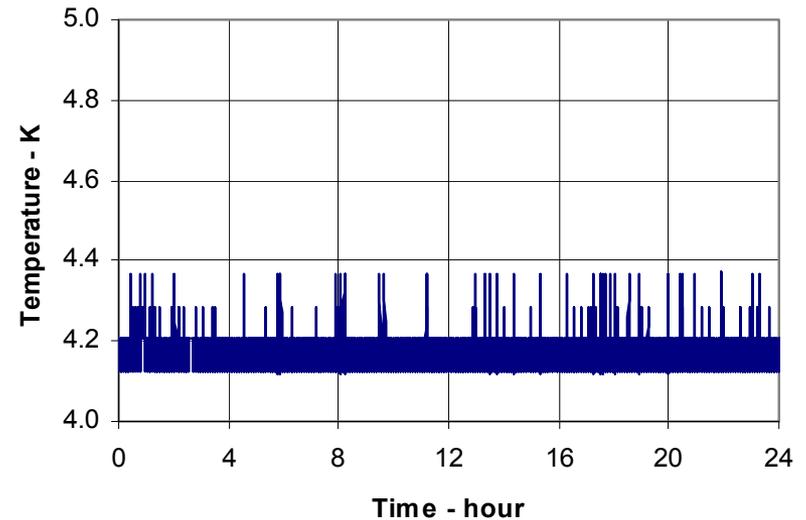


RF Gun Cryostat in B939 on Sunday - 8/1/04

4 K probe - 8/1/04



TT905H Top of RF gun - 8/1/04

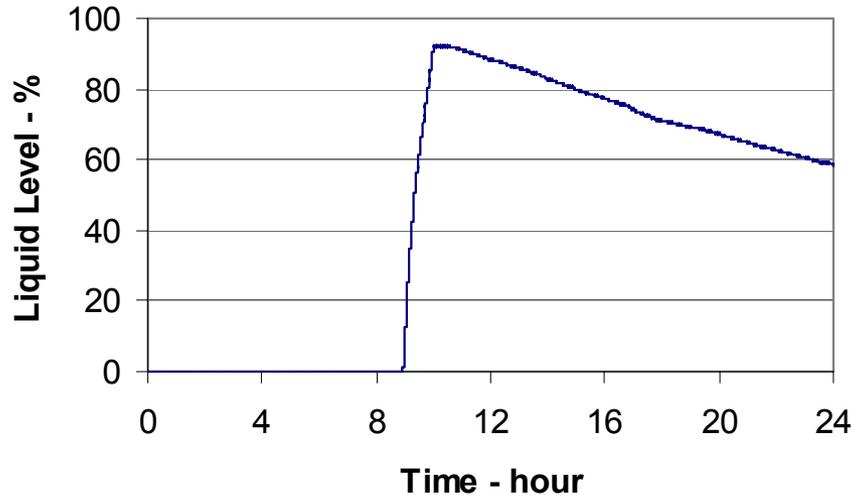


Boil-off rate $\sim 75\%$ in 23 hours. Roughly 50 L, or ~ 2.2 L/hr?

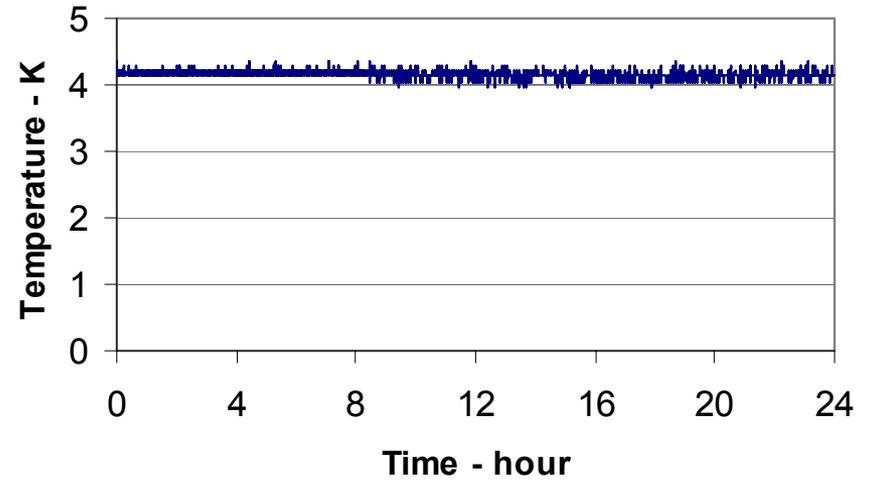
RF gun remains at 4.2 K.

RF Gun Cryostat in B939 on Monday - 8/2/04

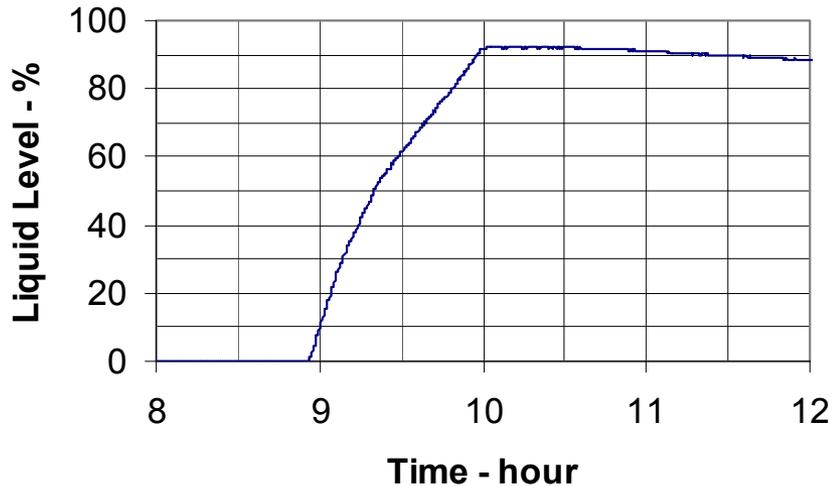
LT91H - 8/2/04



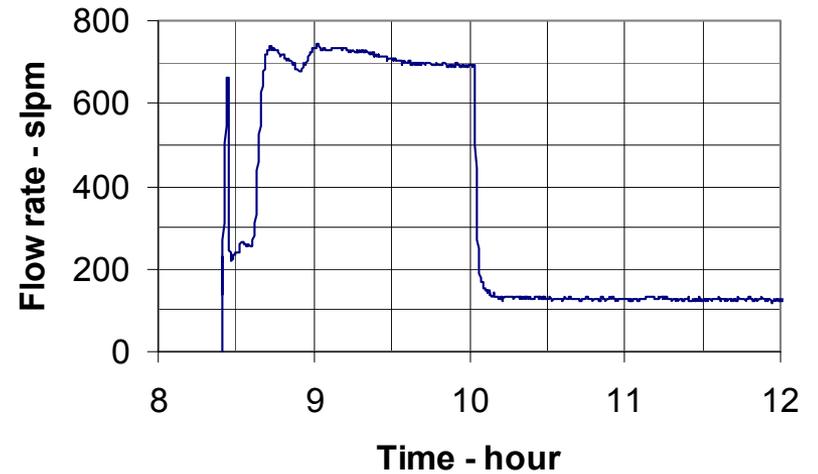
TT905H - Top of RF gun - 8/2/04



LT91H - 8/2/04

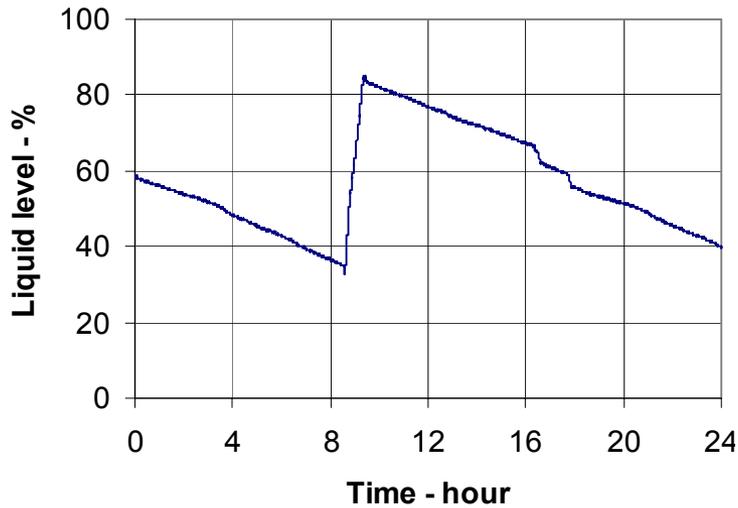


Flow rate - 8/2/04

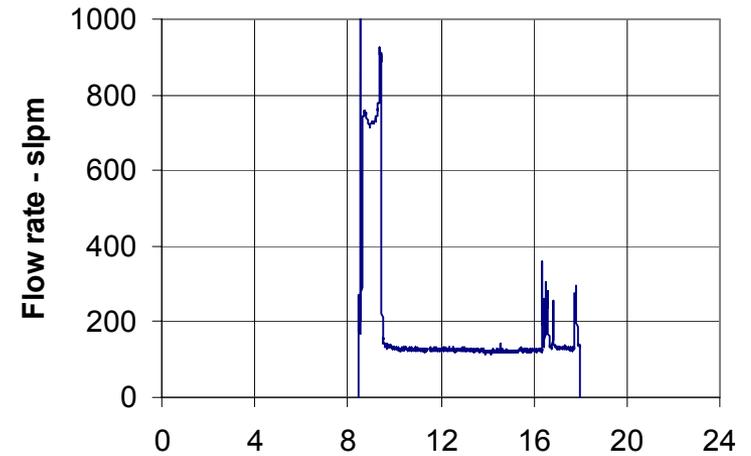


RF Gun Cryostat in B939 on Tuesday - 8/3/04

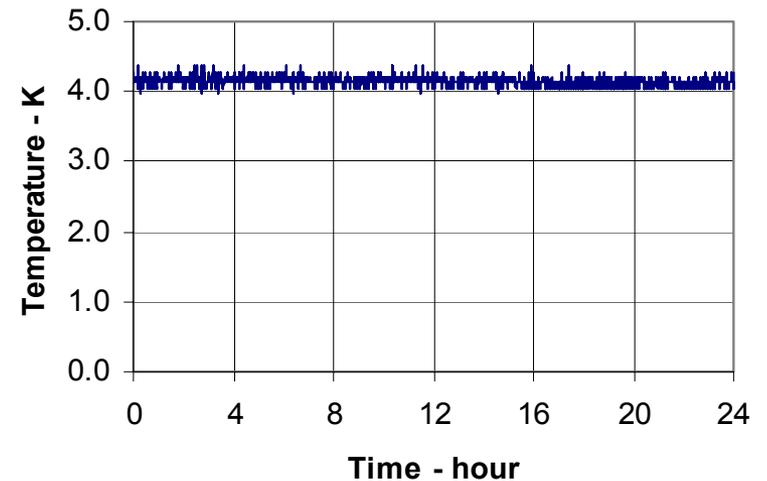
LT91H - 8/3/04



Flow rate - 8/3/04

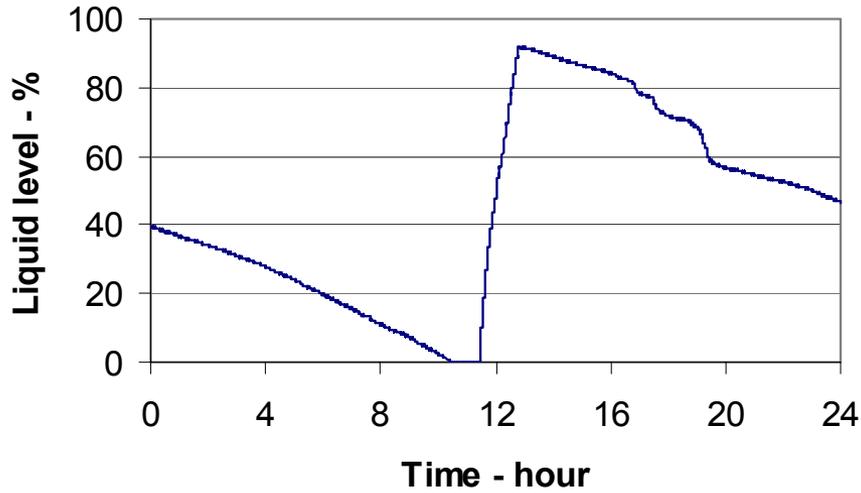


TT905H - 8/3/04

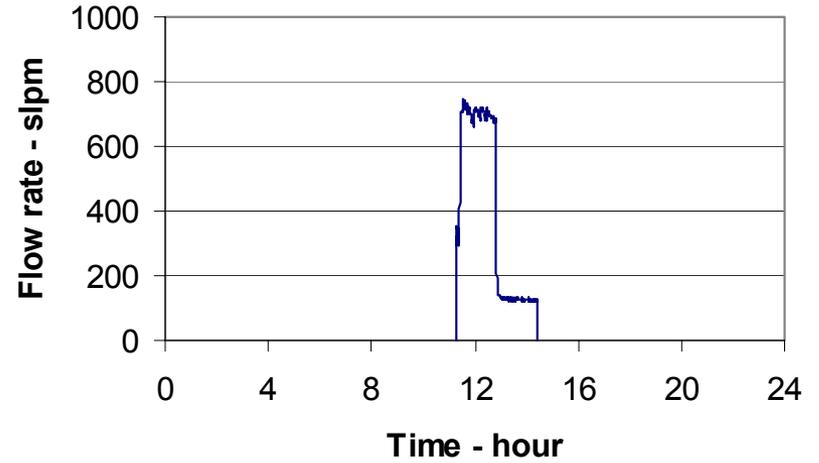


RF Gun Cryostat in B939 on Wednesday - 8/4/04

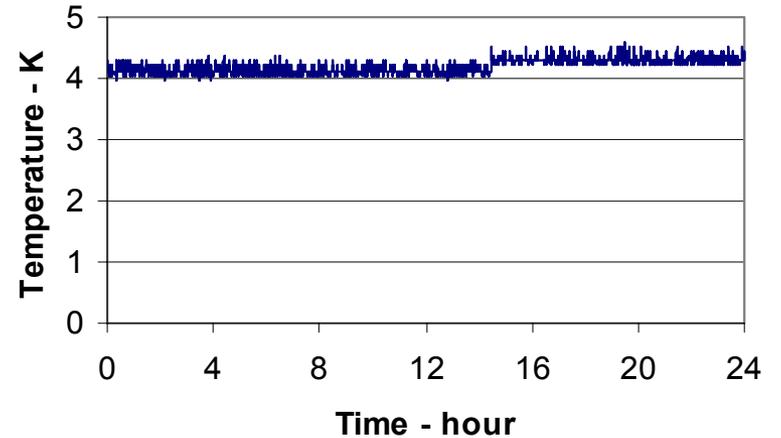
LT91H - 8/4/04



Flow rate - 8/4/04



TT905H - 8/4/04



Liquid Transfer System

Top: Transfer line from 500 L dewar to Chimney



Bottom: Connection of transfer line to Chimney including a short bayonet with heat load higher than similar applications



7/30/04 Filling LHe using a 250 L dewar with level gauge, use ~ 120 L to fill from 38 to 92%

Date	Time	Flow SLPM	Dewar Pressure psi	PT602 psi	TI911H K	Vacuum at turbo 10-7 Torr	4 K probe ?		
7/30/2004	8:10	LN2 at 85% added LN2 to 100%							
					4.21		40%	6.59	
	8:45	Started filling LHe Dewar level 235L							235
		250		15.27	Came off 2ib check valve				
	8:50	320	4	14.94	4.21	4	38%		
	8:55	550	4	14.98	4.21	4.5	40%	225	
	9:00	690	4	15.01	4.21	7	48%	215	
	9:05	690	4	15.01	4.21	8	50%	210	
	9:15	687	4	15.01	4.21	9	60%	195	
	9:30	680	4	15.01	4.21	9	70%	175	
	9:43	683	4	15.08	4.21	9	80%	150	
	9:55	687	4	15.08	4.21	9	90%	135	
	10:00	683	4	15	4.21	9	91%	125	
	10:10	688	4	15.01	4.21	9	92%	110	
	10:12	Slow flow rate to see if we can accumulate above 92%							
	10:13	350		14.94	4.21	8	92%	105	
	10:15	2K probe turned on 99.999%							

7/30/04 Estimate heat load during liquid fill

Above	66%		
Vol.	3.5	L / cm	
Below	66%		
	2.2	L / cm	
92 - 66 %	27.7	Liter	
66 - 38 %	18.8	Liter	
Total vol.	46.5	Liter	
Possible error			
92 - 100 %			
Vol.	8.5	Liter	
Max. vol.	55	Liter	
Change of vol. From liquid storage		130	
Liquid waste		75	Liter
Filling Time ~		1.5	hours
Rate of liquid waste		50	L / hour
Equivalent to		30	Watt