HELIUM LEAKS AND LOSS/GAIN DATA

FOR

D-ZERO CRYOGENIC HELIUM SYSTEM

D-ZERO ENGINEERING NOTE # 3823.115-EN-565

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D-Zero Helium leak/loss data

During the summer shutdown and 3 power outages, D-Zero lost a certain amount of gas Helium (the major part of which was due to dry engines swapping out and wet engine rebuilding – we needed a lot of He to purge/warm-up the engines and u-tubes). Because of this, the gas Helium storage pressure dropped below 30 psig. We tried to recover some gas from the TEV through the valve MV-490-H (D-Zero/TEV discharge headers separation, which has a known internal leak). The pressure was lowered to 275 psig at HIDIS – 279 psig at the MYCOM. The TEV compressors discharge pressure is averaging 291 psig. This change worked at the beginning – we started gaining gas, but then the TEV had a couple of quenches, their discharge at that time was below ours, and we lost some gas to TEV again. After the TEV recovery, when D-Zero discharge pressure went below the TEV again, we stopped getting the gas from the TEV side – looks like the ball inside MV-490 moved and a through leak stopped, and because of some leaks in our system, the gas Helium storage pressure started dropping again. At this time we had to manually crank open MV-490 to recover some gas from the TEV header.
After we brought the storage pressure to the normal range, some experiments were made:

1. The HIDIS valve setting was changed to 283 psig (287 psig at MYCOM). TEV discharge pressure was 291 psig. At 4 psig difference, the storage pressure was dropping at an average rate of 1 psig per day (see graphs Jul, 11 to Jul 15; pressure readings are taken at day's high temperature and correlated to the first day's temperature; it may be a certain margin of error, since we don't know the exact temperature of helium inside the storage which is exposed to open sunlight). It confirmed the thought that MV-490 is sealed and the pressure loss is due to the sum of the system leaks. Based on gas helium storage volume of 5845 cubic feet, the total leak is 7.9 l/min (1l/min is a known flow through the ARCCELL analyzer).
2. The discharge pressure was increased to 285 psig at HIDIS (289 psig at MYCOM). TEV discharge stayed at 291 psig. With 2 psig pressure differences, D-Zero started getting gas at the rate of 1.16 psig/day for the first three days and then 4.3 psig/day for the following 2 days (see graphs Jul 16 to Jul 21). During this process, the Tev pressure was mainly above D-Zero, but sometimes momentarily went below ours. I think at this time the ball inside MV-490 moved back to its old position and the internal leak reopened.
3. The discharge pressure was increased to 287 psig (291 psig at MYCOM) – equal to Tev average, and we still continued to get gas from Tev header, but D-Zero pressure control valves (HIDIS, HISUC and LOSUC) started getting too nervous.
4. The discharge pressure was increased to 289 psig (293 psig at MYCOM, 2 psig above the Tev). The storage pressure started to drop at rate of 4 psig/hour – too fast. Discharge pressure set to 288.5 psig (1.5 above Tev) – the drop rate changed to 1.25 psig/hour with respect of day/night temperature fluctuations (Jul 24 to Jul 26). At this time the HIDIS valve setting was put in AUTO mode with high discharge pressure setting of 288.5 psig when the gas helium storage reaches 70 psig, and low discharge pressure settings of 285.5 psig when the storage reaches 50 psig.

5. Gas helium storage, purifier, compressor building and refrigerator in collision hall were checked for leaks with Varian Helitest leak detector. Biggest leaks found (in ppm) are: storage opening cover plate – 400 + 600; purifier connection union – 900; flow to storage meter orifice mounting – 3000; electrical connector – 200; pressure control valves (3) – 30 each; small relief valve – 100; about 5 valves had leaks around 10; MYCOM's relief valve connections – 400 each; Mycom # 2 interstage connection flange – 200. Note that all readings inside the collision hall and the compressor building are above 50 ppm background; we cannot find leaks below this background inside the buildings using a sniffer. The snoop liquid showed only the leak at orifice mounting through the gasket material. We will monitor these leaks in the future to see if they will increase. It is not feasible to fix them at the moment.

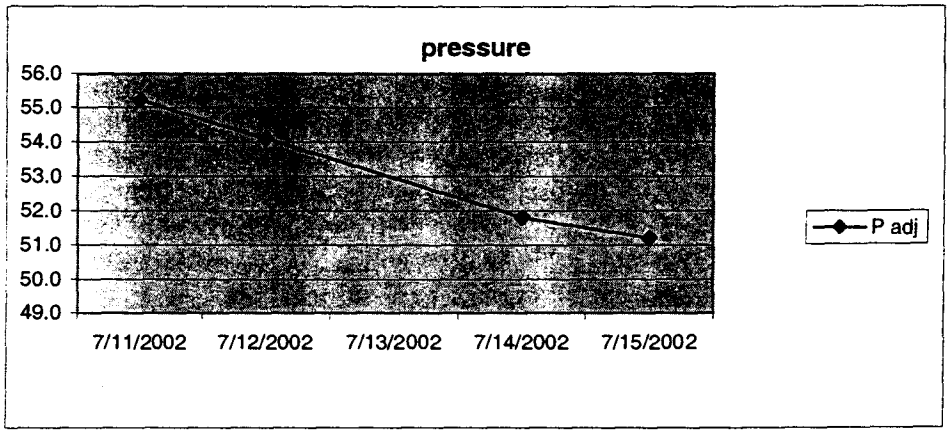
Conclusions:

The internal leak in MV-490 may again be used to get/give gas between D-Zero and Tev, considering that D-Zero (DA) Mycoms are running at the edge of Tev discharge pressure (1.5 psig difference) with momentary reverse of flow in opposite direction to prevent the ball inside the valve to seal the internal leak. The pressure difference should never be more than 3 psig for a long period of time (Tev quench recovery is OK). We will use auto set point for HIDIS with 288.5/285.5 psig pressure settings switching at 70/50 psig in the gas helium storage accordingly. These settings allow us to keep the storage pressure within 50-70 psig limits – the pressure switching occurs at about 36 hours interval each way.
D-Zero cryo system leaks to be monitored (for example if the pressure drop rate will increase and pressure rise rate decrease).
Consider the possibility to fix the leak at flowmeter orifice assembly during the shutdown.

Mike Sarychev
08/07/02

Discharge pressure setting (HIDIS) - 283 psi
Mycom discharge - 287 psi
Tev discharge - 291 psi

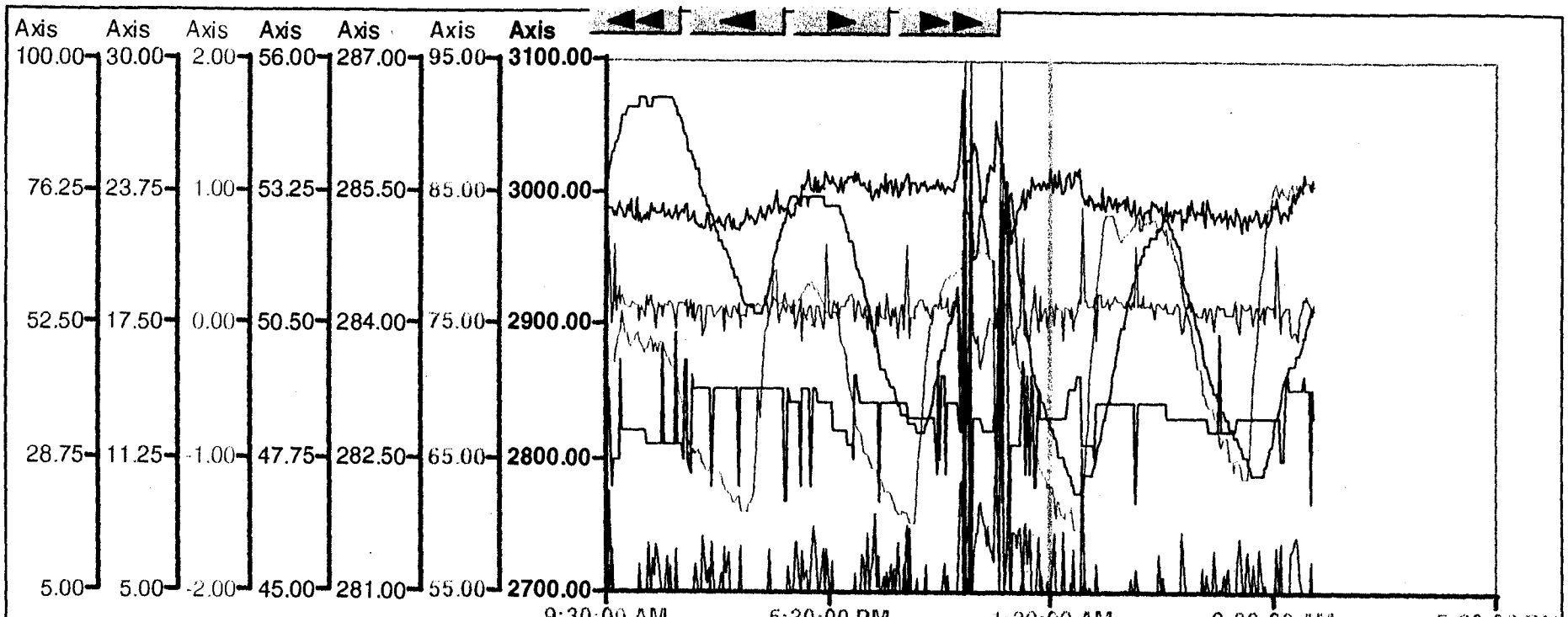
date	T start	t, deg F	T, deg K	T start/T	P	Lhe vol	delta P vol	P adj
11-Jul	296.3	74	296.3	1.000	55.22	2985	0.00	55.2
12-Jul	296.3	78	298.6	0.992	53.2	3005	1.33	54.1
14-Jul	296.3	83	301.3	0.983	52.7	2985	0.00	51.8
15-Jul	296.3	85	302.4	0.980	50.9	3005	1.33	51.2



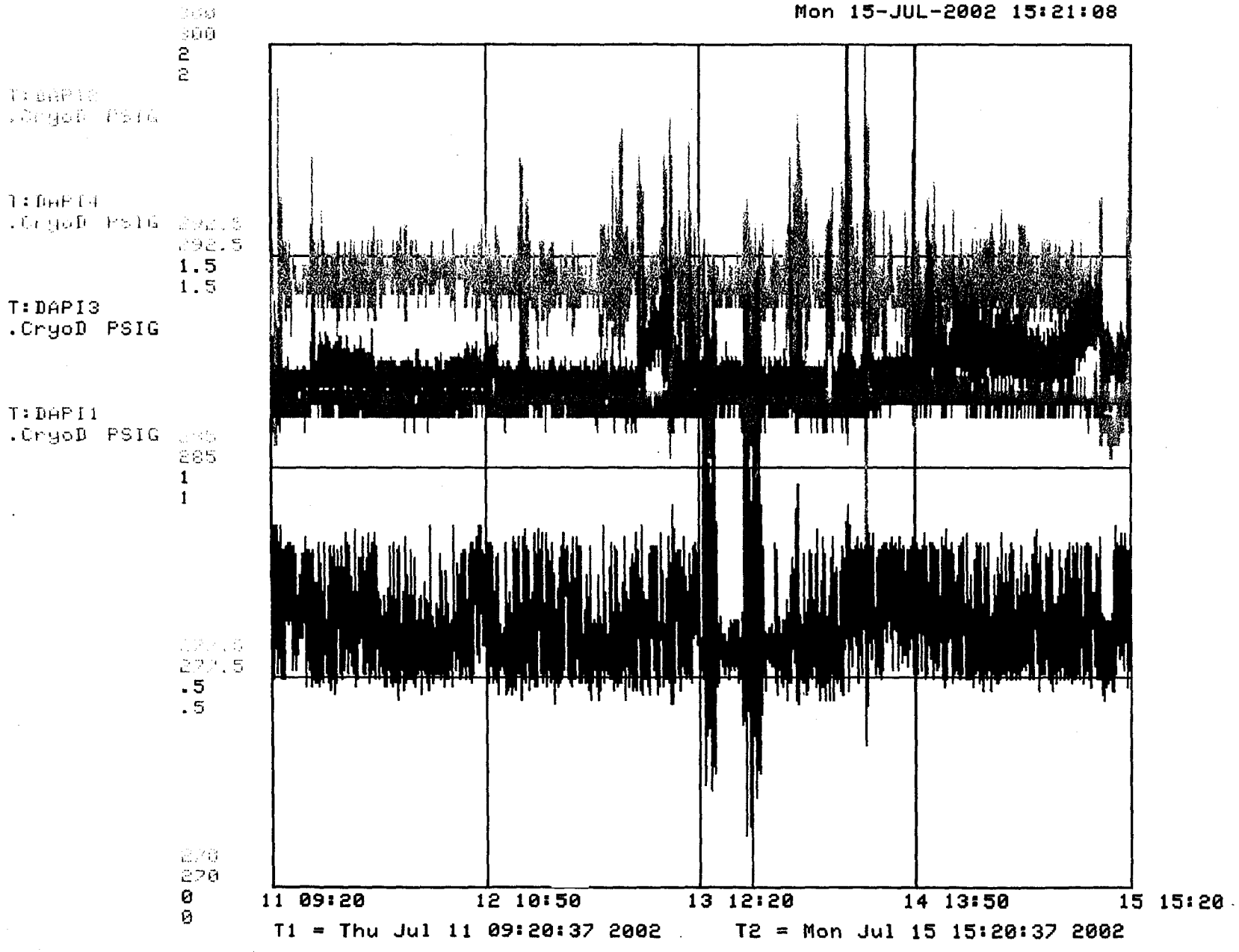
average 1.0 psi/day loss

average loss - 1.0 psi/day
storage - 5845 cub. ft
1 psi=5845/14.5=403 cub.ft

arccell loss = 1l/min
total system leak - 6.9 l/min
average leak 403 x 1.0/24 = 16.8 scfh = 0.2798 scfm = 7.9 l/min

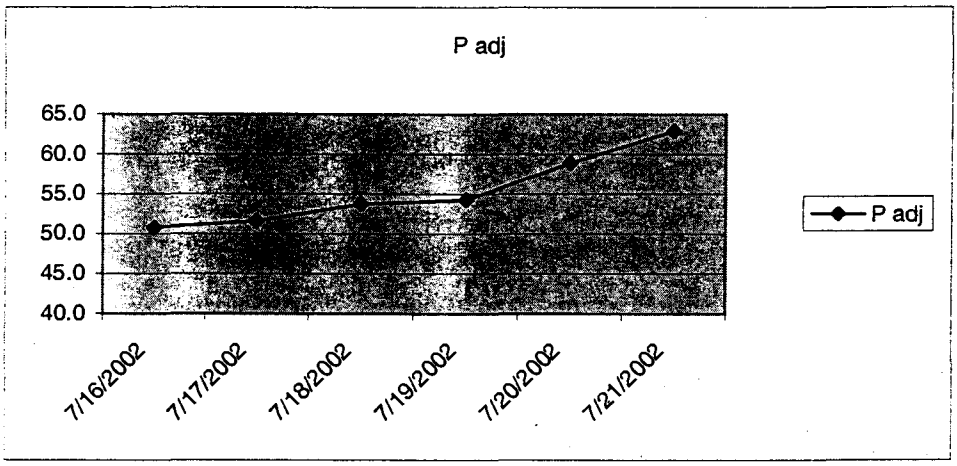


3015.88	**Hist.D0_CCRS1.LHE-VOL.F_CV**	**LHe Dewar volume based on diff. pressur**	**L**
62.92	Hist.D0_CCRS1.TS-1.F_CV	OUTDOOR AIR TEMPERATURE	F
282.97	Hist.D0_CCRS1.D0PCPDIS.F_CV	Compressor dicharge pressure	psig
48.40	Hist.D0_CCRS1.D0BPSTORH.F_CV	GHe storage vessel pressure	psig
0.14	Hist.D0_CCRS1.D0FSTOR.F_CV	GHe Bi-Directional flow from storage	g/s
0.00	Hist.D0_CCRS1.D0EVHISUC.F_CV	Compressor discharge to storage	%
0.91	Hist.D0_CCRS1.D0EVLOSUC.F_CV	Compressor suction make up from storage	%

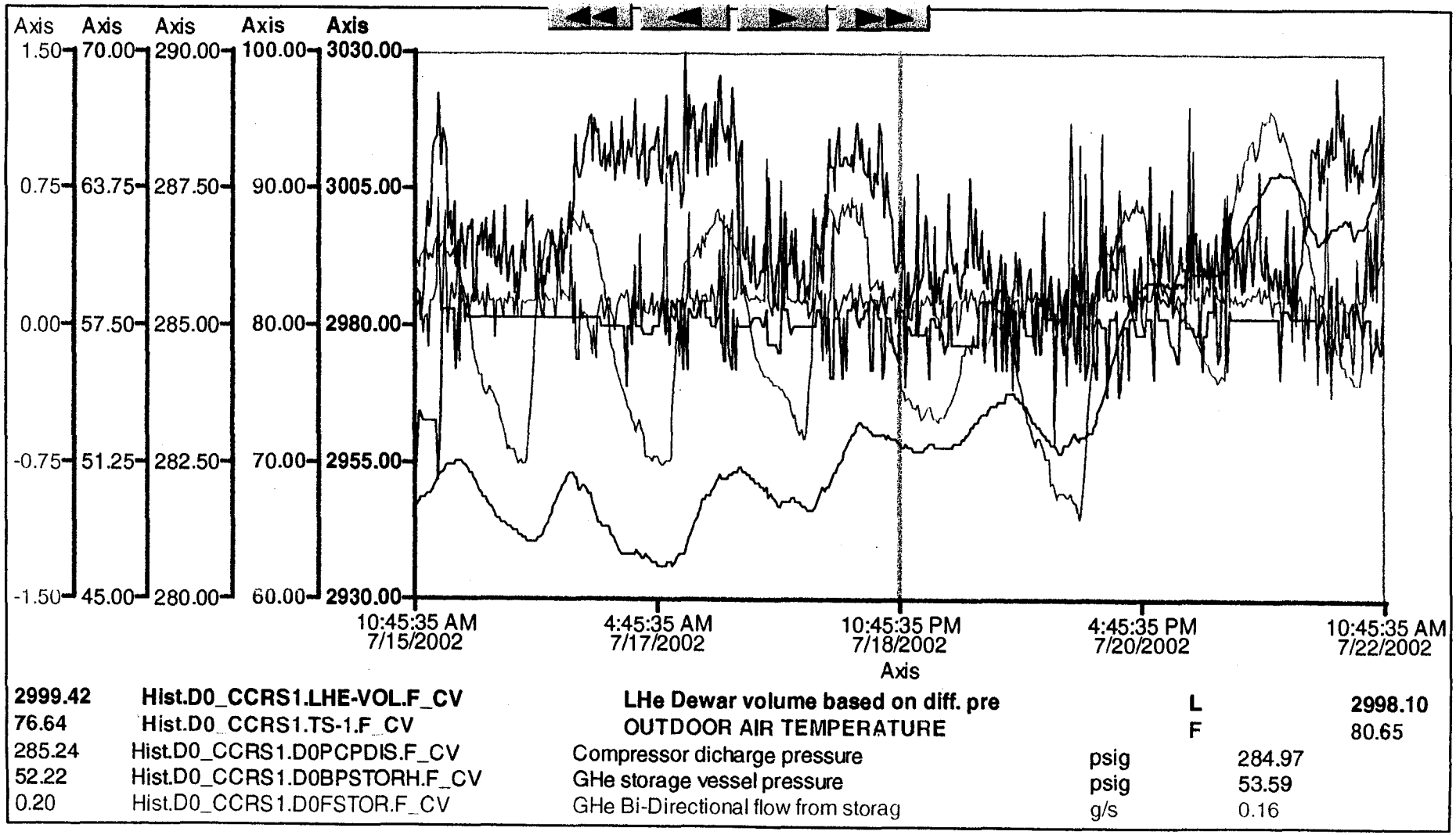

Mon 15-JUL-2002 15:21:08
T:DAPI4
.CryoD PSIG
T:DAPI3
.CryoD PSIG
T:DAPI1
.CryoD PSIG
1.5
1.5
285
1
1
.5
.5
270
0
0
11 09:20
12 10:50
13 12:20
14 13:50
15 15:20
T1 = Thu Jul 11 09:20:37 2002
T2 = Mon Jul 15 15:20:37 2002

Discharge pressure setting (HIDIS) - 285 psi
Mycom discharge - 289
Tev discharge - 291 psi

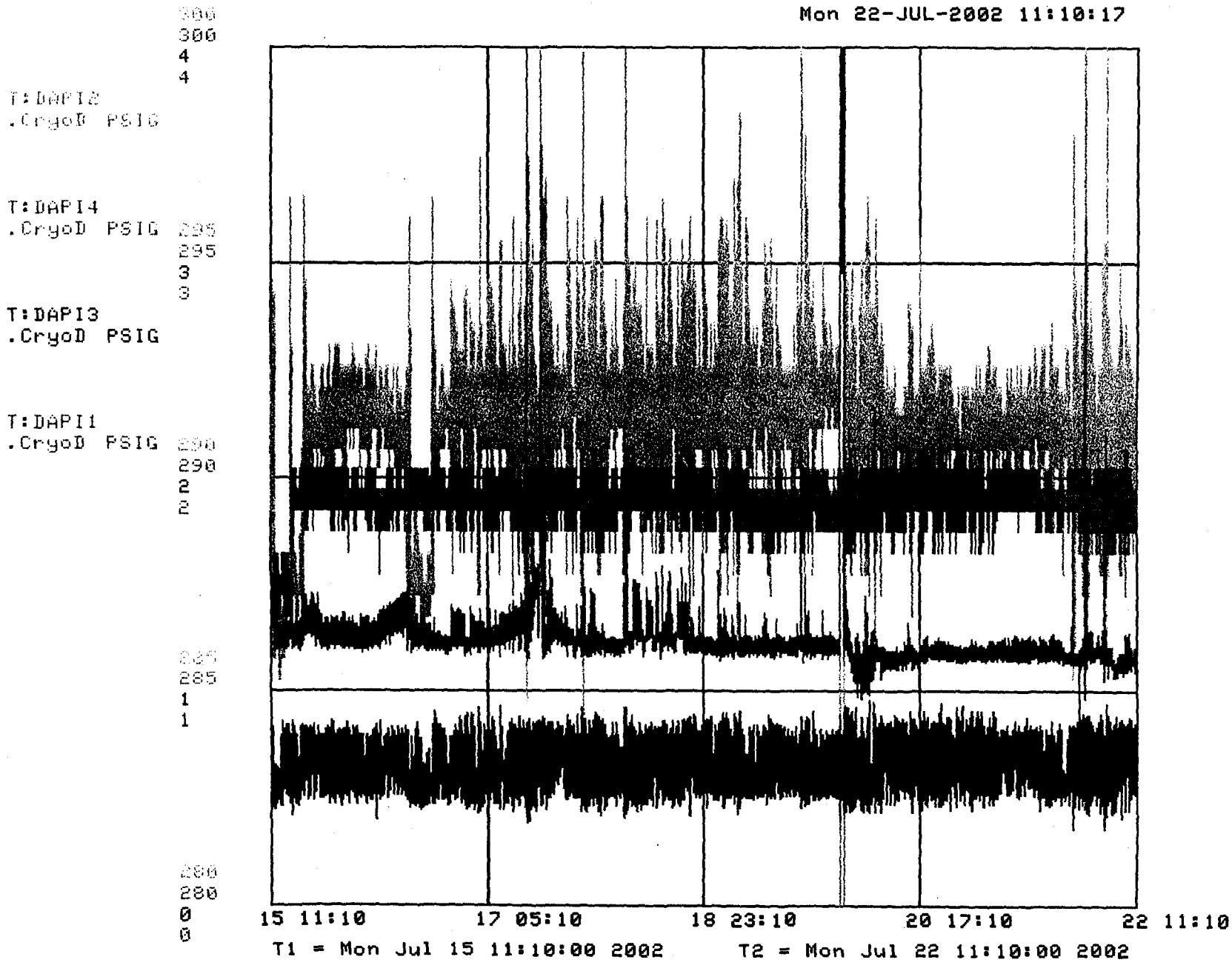
date	T start	t, deg F	T, deg K	T start/T	P	Lhe vol	delta P vol	P adj
16-Jul	303.8	87.5	303.8	1.000	50.76	3000	0.00	50.8
17-Jul	302.4	86.16	303.1	0.998	50.72	3015	1.00	51.6
18-Jul	302.4	86.97	303.5	0.996	53.16	3012	0.80	53.8
19-Jul	302.4	80.23	299.8	1.009	54.47	2990	-0.67	54.3
20-Jul	302.4	85	302.4	1.000	59.53	2990	-0.67	58.9
21-Jul	302.4	94.69	307.8	0.982	64.59	2991	-0.60	62.9

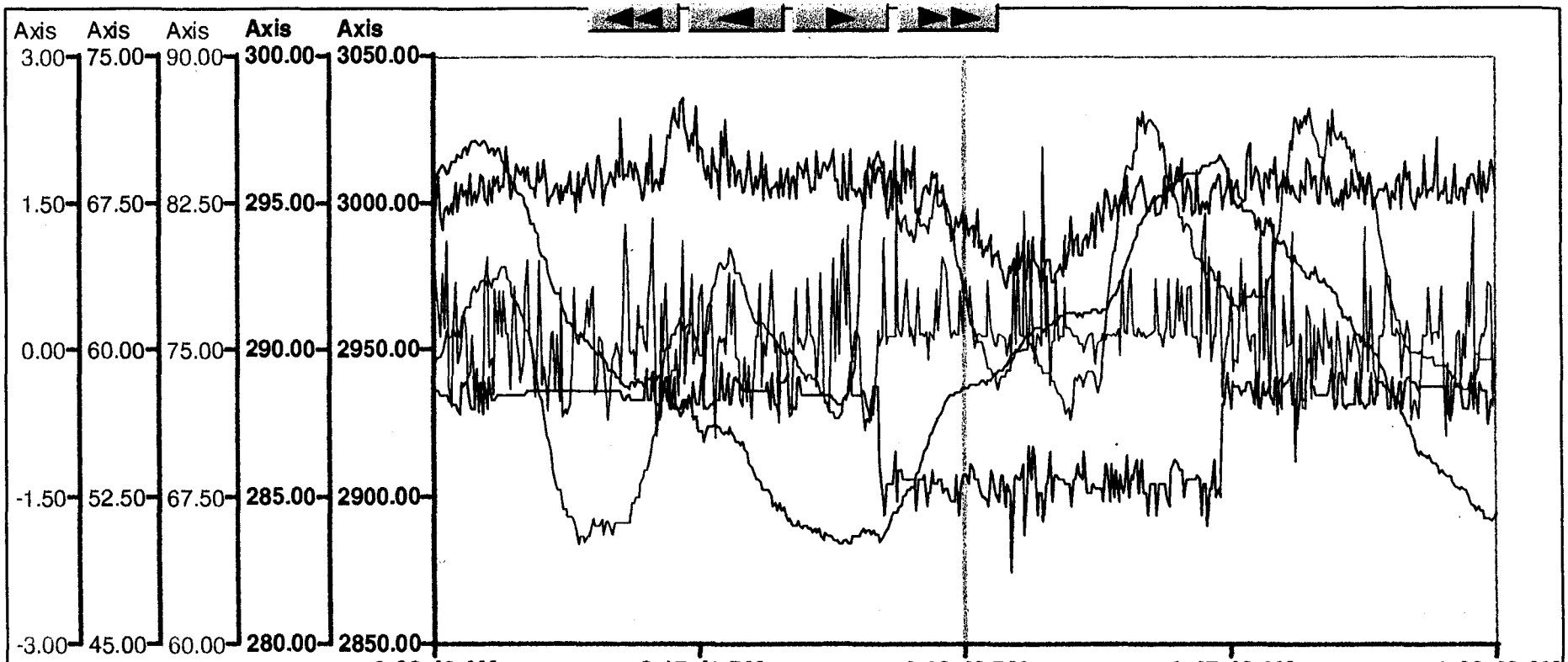


2.4 psi/day
average ga

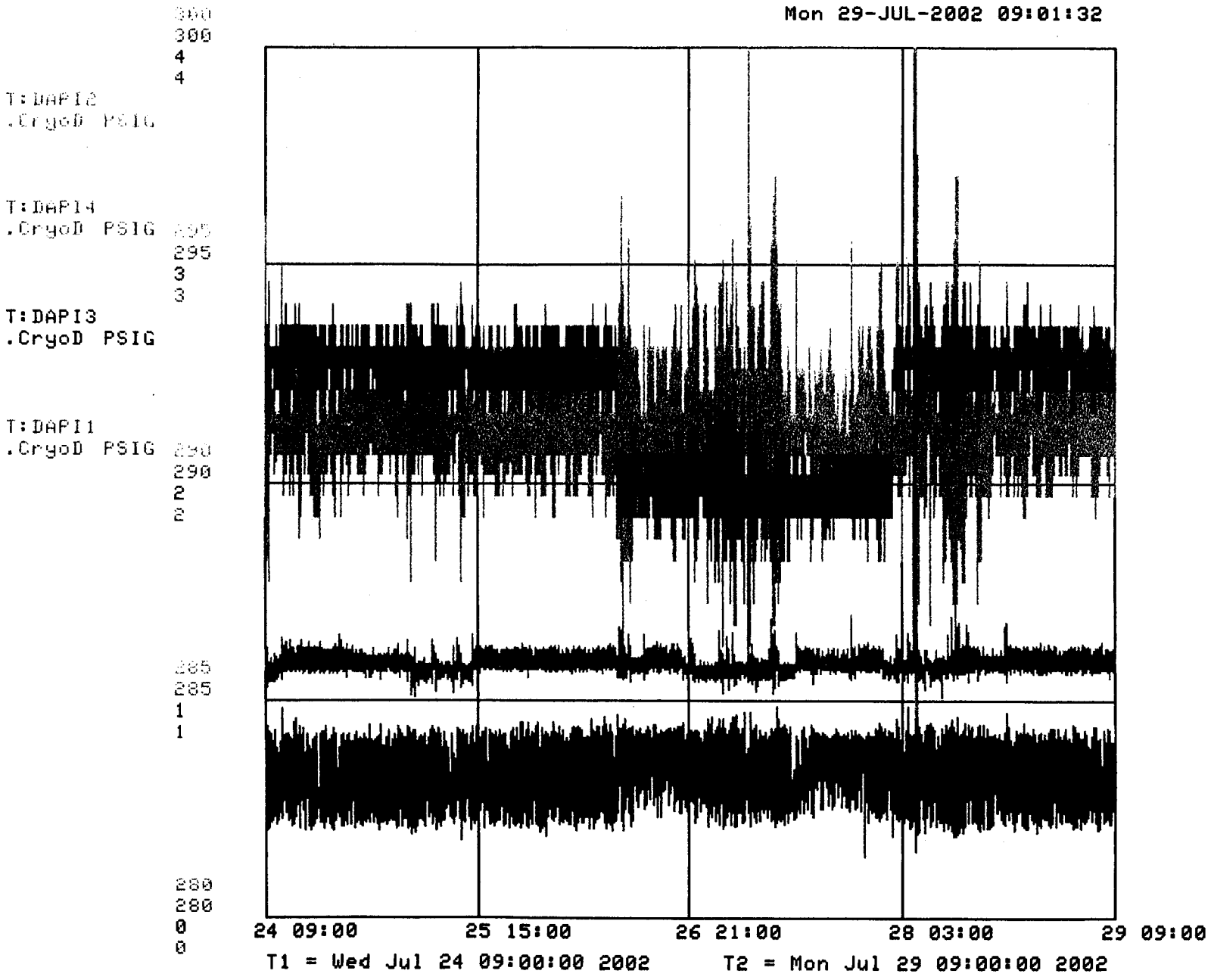


2999.42	**Hist.D0_CCRS1.LHE-VOL.F_CV**	**LHe Dewar volume based on diff. pre**		**L**	**2998.10**
76.64	**Hist.D0_CCRS1.TS-1.F_CV**	**OUTDOOR AIR TEMPERATURE**		**F**	**80.65**
285.24	Hist.D0_CCRS1.D0PCPDIS.F_CV	Compressor dicharge pressure	psig		284.97
52.22	Hist.D0_CCRS1.D0BPSTORH.F_CV	GHe storage vessel pressure	psig		53.59
0.20	Hist.D0_CCRS1.D0FSTOR.F_CV	GHe Bi-Directional flow from storag	g/s		0.16

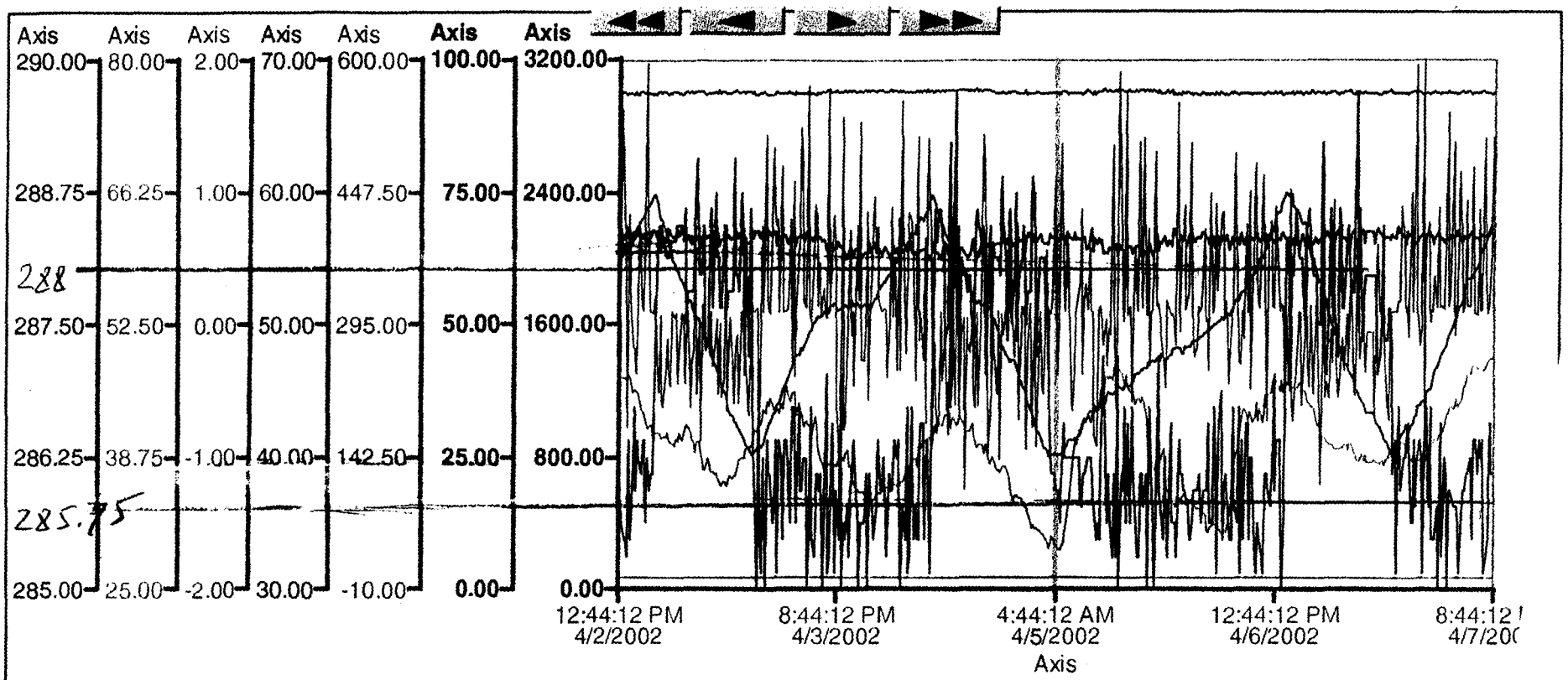

Mon 22-JUL-2002 11:10:17
T:DAPI2
.CryoD PSIG
T:DAPI4
.CryoD PSIG
T:DAPI3
.CryoD PSIG
T:DAPI1
.CryoD PSIG
300
300
4
4
295
295
3
3
290
290
2
2
285
285
1
1
280
280
0
0
15 11:10
17 05:10
18 23:10
20 17:10
22 11:10
T1 = Mon Jul 15 11:10:00 2002
T2 = Mon Jul 22 11:10:00 2002



2987.79	**Hist.D0_CCRS1.LHE-VOL.F_CV**	**LHe Dewar volume based on diff. pre**		**L**	**3003.58**
285.78	**Hist.D0_CCRS1.D0PCPDIS.F_CV**	**Compressor dlcharge pressure**		**psig**	**287.51**
77.79	Hist.D0_CCRS1.TS-1.F_CV	OUTDOOR AIR TEMPERATURE	F	76.93	
58.03	Hist.D0_CCRS1.D0BPSTORH.F_CV	GHe storage vessel pressure	psig	59.99	
0.56	Hist.D0_CCRS1.D0FSTOR.F_CV	GHe Bi-Directional flow from storag	g/s	0.13	


Mon 29-JUL-2002 09:01:32
T:DAPI2
.CryoD PSIG
T:DAPI4
.CryoD PSIG
T:DAPI3
.CryoD PSIG
T:DAPI1
.CryoD PSIG
300
4
4
295
3
3
290
2
2
285
1
1
280
0
0
24 09:00
25 15:00
26 21:00
28 03:00
29 09:00
T1 = Wed Jul 24 09:00:00 2002
T2 = Mon Jul 29 09:00:00 2002

Before



2996.98	**Hist.D0_CCRS1.LHE-VOL.F_CV**	**LHe Dewar volume based on diff. pressur**	**L**
65.83	**Hist.D0_CCRS1.D0EVDEW.F_CV**	**Helium Dewar Bypass Return Control Valv**	**%**
3.75	Hist.D0_CCRS1.HEDEW_WATTS.F_CV	Helium Dewar Wattage to Heater	Watt
40.22	Hist.D0_CCRS1.D0BPSTORH.F_CV	GHe storage vessel pressure	psig
-0.02	Hist.D0_CCRS1.D0FSTOR.F_CV	GHe Bi-Directional flow from storage	g/s
29.52	Hist.D0_CCRS1.TS-1.F_CV	OUTDOOR AIR TEMPERATURE	F
285.95	Hist.D0_CCRS1.D0PCPDIS.F_CV	Compressor dicharge pressure	psig