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A Test of the AGS Ring Vacuum System by Utilizing the E-10 IPM (Vacuum Control Leak) and by Creating Localized Beam Loss

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*   AGS Studies Report   *
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Subject: A test of the AGS Ring Vacuum System by utilizing the E-10 IPM (vacuum control leak) and by creating localized beam loss.

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Reported by : J.W. Glenn and M. Tanaka

Date: 23-08-85 Time: 00:00 - 04:17

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$0. Introduction.

According to the AGS Performance Report in June ,1985 by Th. Sluyters, it appears that the most serious failure of the AGS is vacuum failures. Approximately 30 % of the total unscheduled down time was due to vacuum failures. Extensive radiation exposure to the vacuum maintenance crews is also our concern.

There are several unanswered questions to resolve regarding to the present vacuum system. e.g.,

1) How reliable and accurate is the present vacuum monitoring system which is based on ion pump currents ?
2) Does localized beam loss near indium coated C-rings melt the indium coating and eventually create leaks ?
3) For higher intensity, does the vacuum deteriorate ?
4) Does the vacuum pressure affect beam blowup ?

This study is an attempt to improve our understanding of the vacuum-related phenomena.

All measurements were performed at a 1.40 second repetition rate.

$I. Vacuum Leak Test by Utilizing the E-10 IPM.

The response of the pressure to a vacuum leak created by IPMLK (Control for Calibrated Vacuum Leak at E-10 IPM Box which changes the pressure in the box from 10**-6 to 10**-5 torr.) was measured at E-04. Also for 16 ,8 and 4 *10 **12 ppp, the edge of stable operation was measured by changing RS4A (Radial Shift 4 Amplitude).

The results are summarized in the following table. The present vacuum monitoring system based upon ion pump currents promptly and clearly responded to the vacuum leak. (See VSCAN output at 00:34). The edge of stable operation (i.e. no bunch tearing) strongly depended both on beam intensity and on vacuum condition.

TP	IPMLK	Press. at E-04 (torr)	Comments(RS4A changes)
16	off	1.40 *10**-7	10 OK 12 NO (OK=stable, NO=bunch tearing)
16	1350	11.1	2 OK 4 NO
16	900	1.74	4 to 6 OK 8 NO, Pumps 3 & 4 off
16	1315	24.5	-4 OK 0 NO
16	350	2.50	6 OK 10 NO
16	1350	25.0	-8 OK -6 NO
16	900	3.05	6 OK 8 NO

-> Lowered intensity to 8 TP.
Edge of stable operation moved in, -22 OK & -20 NO !!

TP	IPMLK	Press. at E-04 (torr)	Comments(RS4A changes)
4			-10 OK -6 NO
8			-22 OK -18 NO
16			+12 OK +14 NO

-> Why does lowering the intensity by a factor of 2 move this edge in by about 30 counts and another a factor of 2 move it out about by 10 counts ??? (50 counts = 2.0 mm)

(Leak test at 8 TP)

TP	IPMLK	Press. at E-04 (torr)	Comments(RS4A changes)
8	800	1.09 *10**-7	-22 OK -18 NO
8	1300	23.7	-28 OK -24 NO

Fig. 1 shows the edge of stable operation vs pressure at E-04 which was varied by changing the IPM controled leak at E-10.
There was a siginificant shift in the "edge" of stable operation with the magnitude of the pressure bump at E-10.
The magnitude of the shift appeared to be proportional to intensity, and the location of the edge with no pressure bump was also affected by intensity.

$II. Pressure and Temperature Rise due to Localized Beam Loss near the E-13 Indium Coated C-ring.

The old indium coated C-rings are now being replaced with the newly developed diamond-shaped aluminum seals and it will take a few years to complete the replacement of all C-rings.
It is assumed that the indium coated seals are vulnerable to localized beam heating and continuous or large beam loss near the C-ring could melt the indium coating and eventually create vacuum leaks. In fact, melted spots have been found on some of the removed seals.

The temperature rise of the indium coated C-ring due to localized beam loss was measured with a thermocouple attached on the E-13 C-ring flange for various beam intensities. The localized beam loss near the C-ring was produced by creating an inside beam bump at E-13 and G-01. (See RLRM output at 02:57). The vacuum pressure change was monitored at E-18 and at the FG vacuum section.

The results are summarized in the following table. The temperature rose only ~2 °C during a study period of 1&1/2 hours in spite of our expectation. Surprisingly about a half of the temperature rise appeared to be due to accelerated beam in the AGS, without local losses (See temperature rise without E-13 loss from 03:51 to 04:07).

It should be noted that the exact location of the beam loss at E-13 is not clear and the thermocouple reading might underestimate the true temperature of the seal. On the other hand, the vacuum pressure at E-18 and at FG reflected the beam loss by a factor of 10 and 3 respectively. (See VSCAN output at 03:28).
The pressure quickly recovered when the beam was turned off during the test, implying that the losses were causing outgassing but not damaging the seals. Without beam loss at at E-13 the vacuum pressure there did not seem to be affected by beam intensity.

Time	Beam(TP)	Press. at E-18(Torr)	Temp.(°C)
02:00	-) Shutdown to install a thermocouple on the E-13 (u/s) oval C-ring. Set up Beddler thermocouple readout in the MCR.		
02:51	8	1.68 *10**-7 (1.87)@	24.8
	-) Tune to 4 TP with 150 msec turn off,25.0 deg.		
03:03	-) Moved RS6A to -40 with 2 V on F-10 Bump's shunt to build a bump near E-13. Approximately 40 % of		

the beam was lost here, another 40 % near G-01 and the rest elsewhere. (See the RLRM output at 02:57)

03:06	4	2.90		25.0	
03:09	4	2.60		25.1	
03:14	4	2.60	(1.86)@	25.4	
03:17	8				
03:20	8	5.40	(5.17)	25.8	
03:21	0	13.2	(6.90)	25.8	beam off
03:24	0	2.90		25.6	R.F. off
03:27	0	2.50		25.6	R.F. off
03:34	8				
03:35	0	3.60		26.1	R.F. off
03:38	8	2.80		26.1	
03:40	8	4.00	(1.52)	26.2	
03:41	8	9.90	(1.79)	26.4	
03:42	8	24.2	(2.45)	26.4	
03:43	0				R.F. off
03:44	0	9.17	(1.99)	26.3	
03:46	0	6.15	(1.66)	26.2	
03:48	0	3.83	(1.52)	26.1	
03:51	8 -> Moved a bump to E-20, (See RLRM output at 03:51)				PBLW off
03:54	8	3.20		26.4	PBLW off
03:56	8	3.31		26.4	
03:59	16	3.36		26.5	
04:02	16	3.60		26.6	
04:07	16	3.00		26.6	
04:08	0			26.6	beam off
04:18	0			26.7	
04:31	0			26.5	

@ Average pressure at the FG vacuum section.

(Temperature at the E-20 beam catcher):

TIME	RZET1	RZET2	RZET3 (°C)	
04:07	81	93	48	beam on
04:10	51	46	39	
04:17	36	34	32	

The E-20 beam catcher did not appear to be overheated with 16*10**12 ppp dumped into it.

$III. Conclusions

A. The present AGS vacuum monitoring system based on ion current responded to the vacuum leak and localized beam loss, though probably due to missing and "dirty" pumps, the scan did not indicate the pressure at E-10 was as high as 10**-5 torr nor did the VSCAN system reveal beam losses with accuracy comparable to the RLRM system.

B. The test of temperature rise of the E-13 indium coated C-ring with large high energy proton losses(3*10**12 ppp) in the area was not significant. It is possible that other seals in the area were heated to a greater extent but vacuum excursions caused by beam loss did not appear to be permanent.

C. When the beam was stable, no significant changes in the vacuum pressure around the ring have been observed for various beam intensities ; 8,12 & 16 *10 **12 ppp. (This was observed only over the 24 hour period while the AGS studies were taking place.)

D. A procedure to identify beam loss generated vacuum excursions should be developed to locate beam loss / vacuum problem areas.

E. As the vacuum pressure apparently affects beam blowup, it is vital to be able to measure the pressure distribution in the AGS ring accurately with confidence. In this matter having current readback from an individual ion pump would be helpful.

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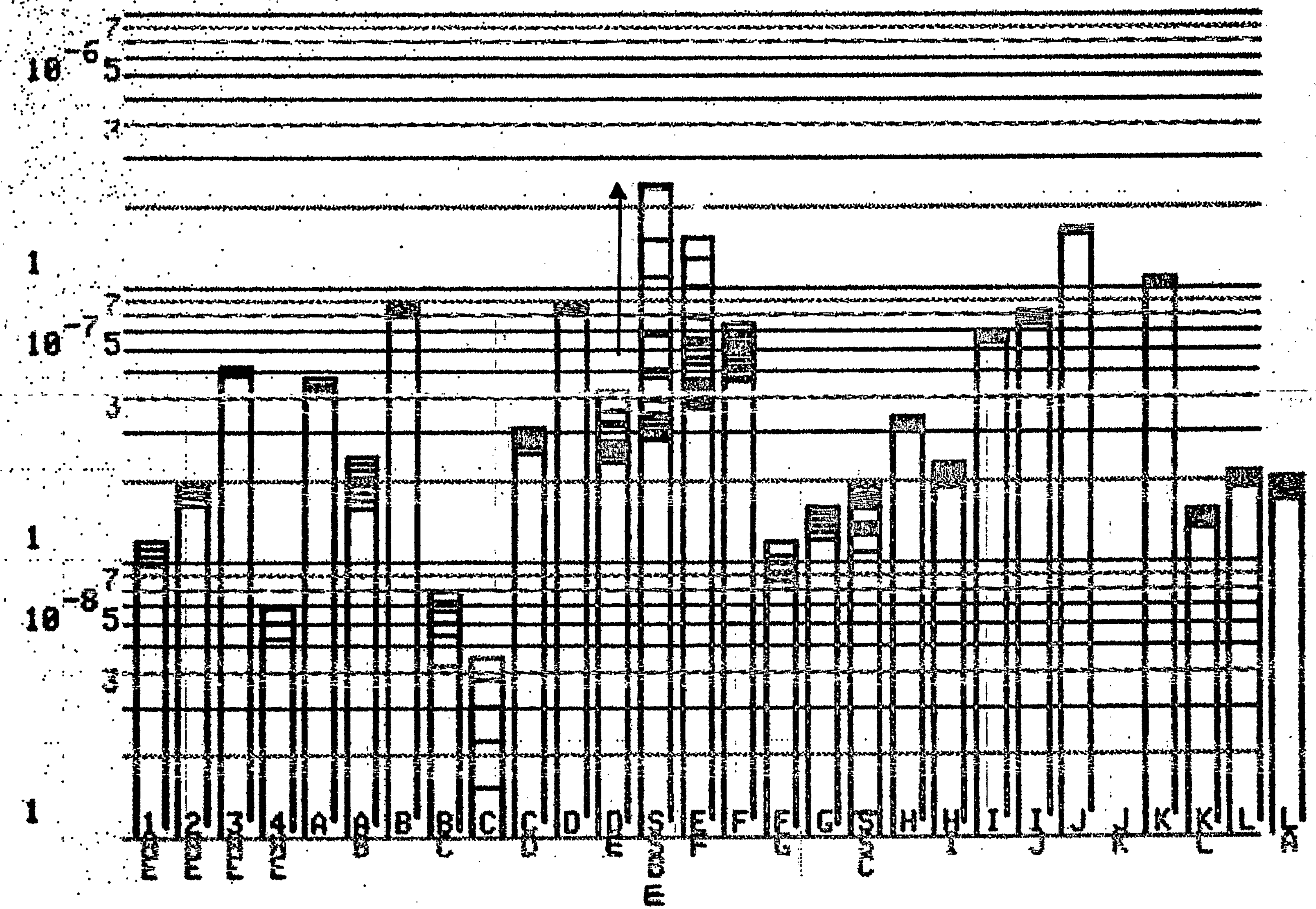
VSCAN

A.G.S. RING VACUUM 23-AUG-85 AT 00:34 29.5 →



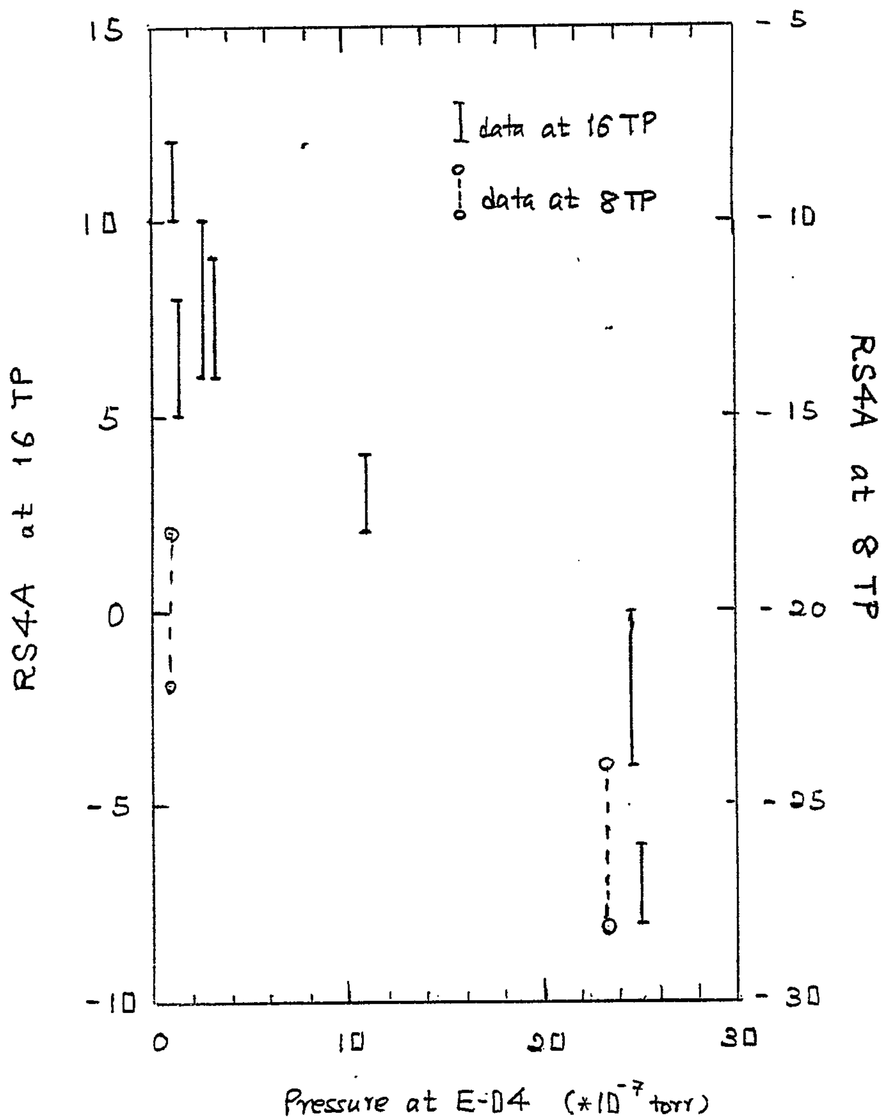
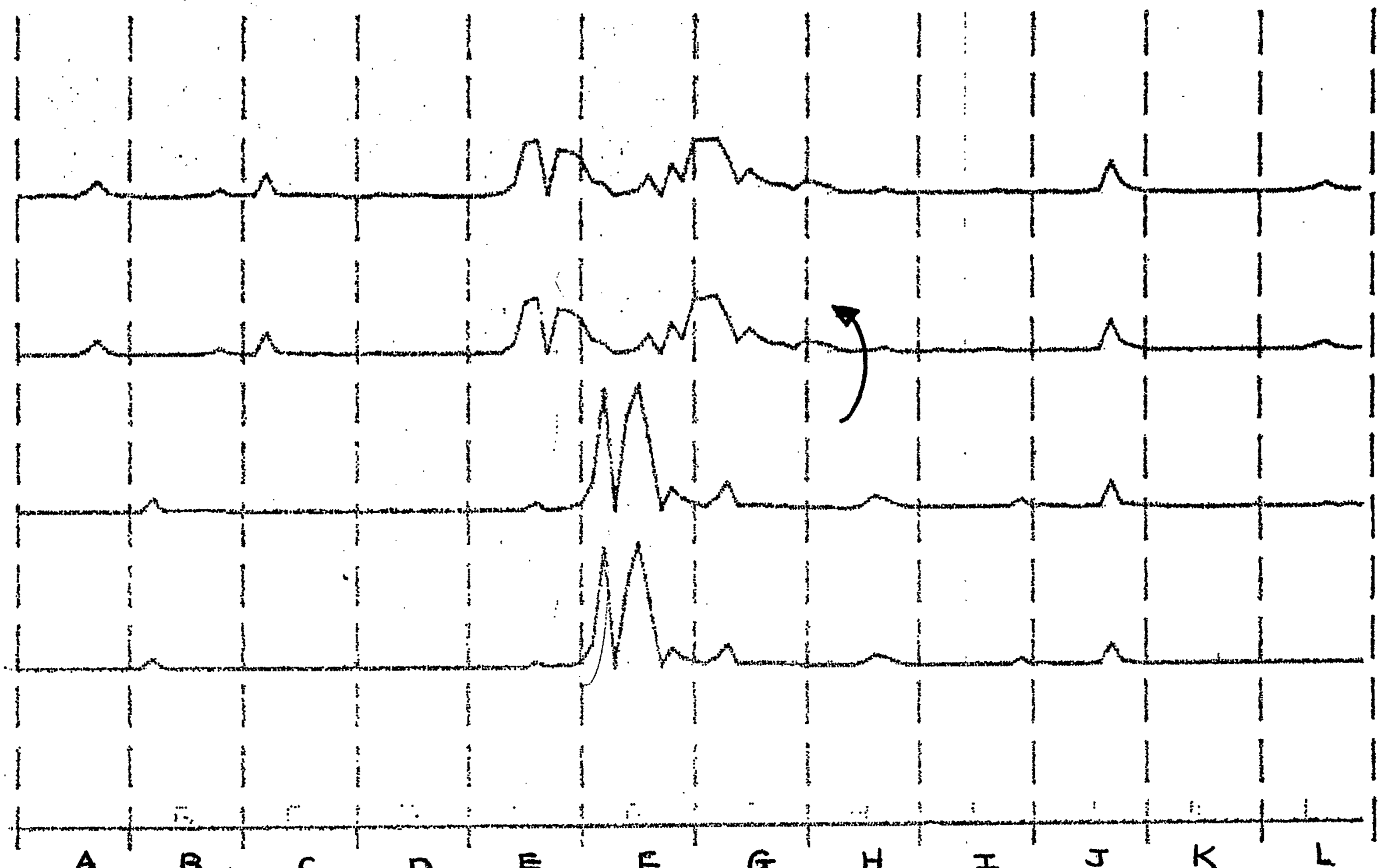


Fig. 1 Stable Operation vs Pressure

RLRM

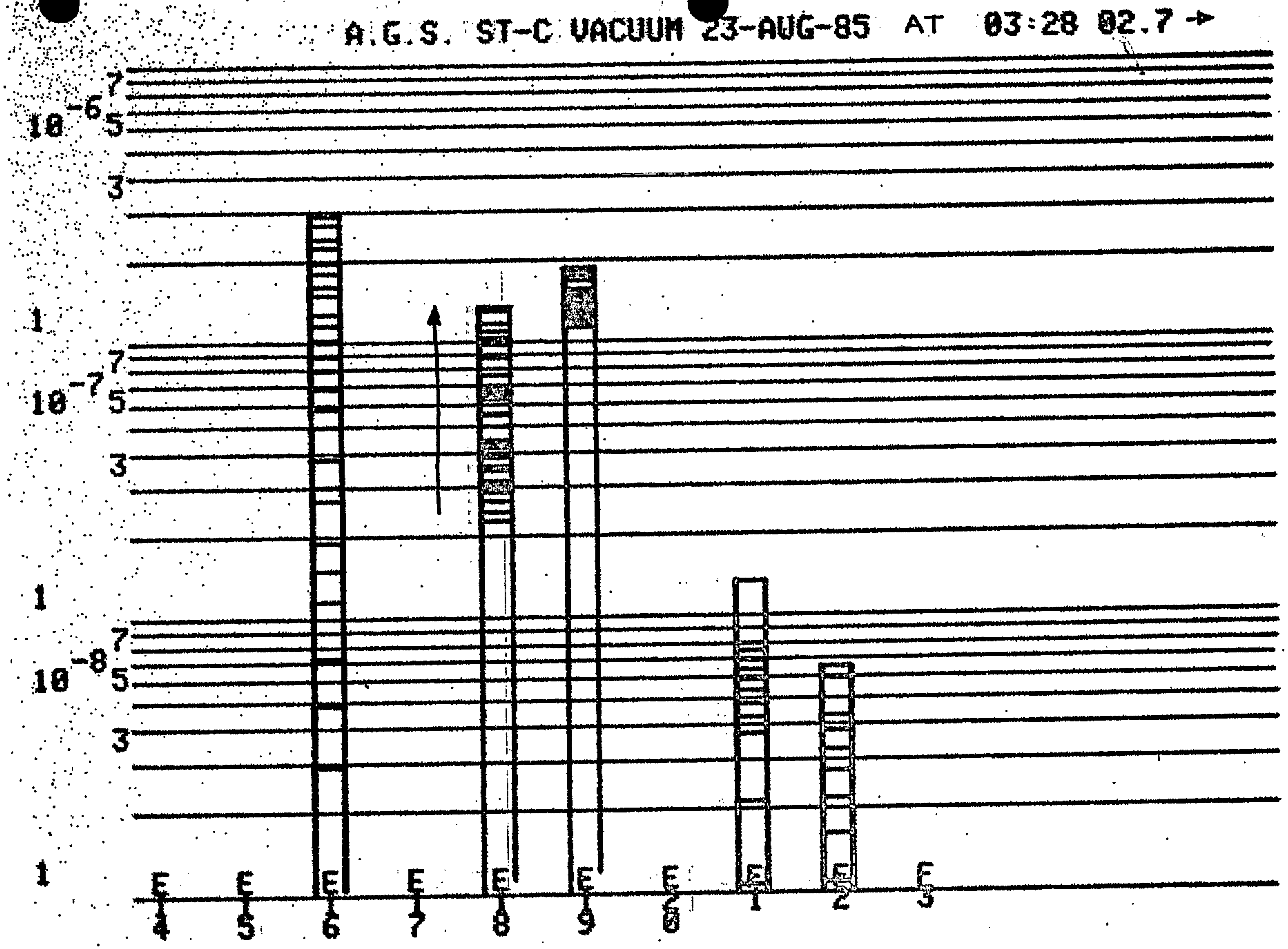
23-AUG-85 TIME=02:57 47 9

SCALE= 3000



DATA?

VSCAN


A.G.S. ST-C VACUUM 23-AUG-85 AT 03:28 02.7
10-6
10-7
10-8
7
5
3
1
E14
E15
E16
E17
E18
E19
E20
E21
E22
E3

23-AUG-85 TIME=03:50 [illegible]

[illegible] SCALE= [illegible]