Run 99, 22GeV, 20 bunches, Ring 1, 22 FA

Artificial pressure bump in S51

Introduction:

During run 85 an artificial pressure bump was created in SS 533 by heating the chamber to 300°C. Without beam $5.6 \times 10^7$ torr were obtained increasing to $5 \times 10^6$ torr in presence of a 4A beam. (see running-in note ISR-CO/00/jv, from July 15th, 1971). Due to lack of time it was not possible to see whether the beam created pressure bump would disappear in the absence of heating or whether the bump would be maintained by the beam.

Experimental set-up:

The venting valve on the turbomolecular pumping station TM 541 was replaced by a manually adjustable leak valve. Prior to the run, the air leak was adjusted such that a constant pressure of $5 \times 10^8$ torr was obtained in the pump manifold while the pump was running and the roughing valve RV 51 closed. Opening RV 51 produced a pressure bump in S51 which could be adjusted in hight by turning on or off some of the sputter ion pumps. To produce the pressure bump in SS 533 only the pumps SP 533.1 and SP 537 had to be off, while SP 541 was left on in order to maintain the pressure increase with beam in the operating range of the vacuum gauges.

All gauges in S51 were at 1mA emission current, but some had to be changed temporarily to 0.1mA. VG 541 was recorded in A5 while
VG 533.1 and 533.9 were recorded in the SRC. Gauge 533.9 which is located between SP 533.1 and SP 537 was recorded together with beam current as function of time and on the XY recorder as function of beam current.

The residual gas was analyzed at different stages of the experiment to detect changes in gas composition.

Results:

After several attempts which failed since the pressure increased abnormally high so that gauges could no longer be used, stack 3 was made in several steps to about 5A.

Figure 1 gives the pressure distribution before stacking, figure 2 shortly after the maximum of the pressure peak. RGA scans (duration about 13 minutes) were made at the time of both pressure distributions. To observe the pressure at different beam intensities, the beam was scraped several times by about 500 mA.

Figure 3 shows the pressure versus beam current plot for stack 3. For a starting pressure of $3.8 \times 10^{-8}$ torr and 4.98A at the end of stacking a pressure peak of $5 \times 10^{-6}$ torr is obtained.

After having dumped the beam the leak was closed and all pumps turned on to reduce the pressure as quickly as possible to the starting value.

Stack 4 was started at $2.1 \times 10^{8}$ torr but with otherwise identical conditions as stack 3. In fact is was attempted to make both stacks as similar as possible. At 4.93A stacking was stopped and a pressure peak of $2.5 \times 10^{-6}$ torr observed. Figure 4 shows the pressure bump at its maximum. Then the leak was stopped by closing RV 51. There was no visible influence on the pressure. Figure 5 gives the pressure distribution 5 minutes after closing the valve *). The pressure versus beam current recording for stack 4 is shown on figure 6. Figures 3 and 6 are rather similar and the ratio of 2 for the pressure is maintained throughout the experiment.

*) Please note that the pressure is highest in SS 533 and not at the location of the leak.
Three RGA scans were made:

1) in absence of beam and without leak and pressure bump gives the spectrum of a clean, baked sector.

2) with air leak but without beam (Figure 1) gives the spectrum of an unbaked sector with the exception that the water is missing. This can be explained by the high water adsorption on the baked chamber surface.

3) with leak and in presence of beam, is characterized by the appearance of a number of masses in addition to a high contribution of N and CO. The additional lines indicate an important contribution of Hydrocarbons \( C_3H_8 \) and \( C_2H_6 \) which are desorbed from the wall by the action of the beam.

**Pressure minimum during stacking**

On figures 3 and 4 a remarked pressure decrease shows up during the early phase of stacking. This effect could be observed on all 4 stacks made in the presence of the leak.

Taking the equation

\[
\dot{V}P = Q - SP
\]

from Heredia's running-in note (22 May, 1971) and making for \( Q \) the hypothesis

\[
Q = \alpha \cdot I \cdot P + \phi \cdot P
\]

one obtains

\[
\frac{\dot{P}}{P} = \frac{\alpha}{V} \left( I + \frac{\phi - \frac{S}{\alpha}}{\alpha} \right)
\]
\( \alpha \) is assumed to be a constant for a particular region of the ISR and \( \lambda \). \( P \) is the gas load due to the leak which is proportional to the pressure in the chamber. It follows that there exists a critical current for which \( P \) is constant, namely

\[
I_{\text{crit.}} = \frac{8 - \lambda}{\alpha}
\]

For stack 3 and 4 one obtains \( I_{\text{crit.}} = 1.6 \alpha \)

So far such a pressure decrease has not been observed *).

One may explain this by the low effective pumping speed at normal working pressures corresponding to a very small critical current or by the coefficient \( \alpha \) being drastically different due to the air leak.

*) Looking through the recordings of the "vacuum cleaning" experiment (Run 91) it is not excluded that this effect has occurred.

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Figure 1

--- PRESSURE PLOT OF ULTRA-HIGH VACUUM GAUGES. ---
--- IN TORR ---

1.0E-11  1.0E-10  1.0E-9  1.0E-8  1.0E-7

**SECTOR 50**

VG463:  1.69E-10
VG465:  1.66E-10
VG469.1: 9.94E-11
VG469.6: 1.08E-10
VG501.6: 1.44E-10

**SECTOR 51**

VG517.7: 3.40E-10
VG525:  1.69E-09
VG533.1: 2.42E-08
VG533.9: 2.57E-08
VG541:  2.34E-09

**SECTOR 60**

VG613:  4.40E-11
VG615.1: 1.17E-10
VG601.6: 1.89E-10
VG605:  1.34E-10
VG607:  1.59E-10

**SECTOR 61**

VG617:  1.32E-10
VG621:  1.80E-10
VG625:  1.30E-10
VG627:  3.20E-10
VG637:  1.33E-10
VG641:  3.07E-10
VG645:  1.38E-10
VG651:  4.52E-10
VG653:  2.32E-10
VG655:  2.72E-10
VG657:  3.83E-10

--- BEAM CURRENT: I = 0.005 A ---

TIME: 14 14 246  DATE: 1971-08-12  --- END PLVG ---

RV 51 open, ST 541 on
ST 532 off
ST 533.1 off before start 64
--- PRESSURE PLOT OF ULTRA-HIGH VACUUM GAUGES ---
-- IN TORR --

1.0E-11  1.0E-10  1.0E-9  1.0E-8  1.0E-7

--- BEAM CURRENT: I = 4.705 A ---

TIME: 00 26 M 25 S   DATE: 1971-03-12   --- END FILE ---
Figure 3

Stack II: ST 541 ON
leak at 541
VG 533.9
--- PRESSURE PLOT OF ULTRA-HIGH VACUUM GAUGES ---

SECTOR 50
VG463 2.62E-10
VG465 1.88E-10
VG469.1 1.12E-10
VG469.6 9.94E-11
VG501.6 1.12E-10
VG505 1.83E-10

SECTOR 51
VG517.7 3.14E-09
VG525 8.27E-08
VG533.1 4.15E-06
VG533.9 2.29E-06
VG541 3.27E-07
VG543.1 1.44E-03

SECTOR 60
VG561 3.60E-10
VG565.1 1.33E-10
VG601.6 4.23E-11
VG605 7.17E-10
VG607 1.53E-10

SECTOR 61
VG617 1.39E-10
VG621 1.80E-10
VG625 1.73E-10
VG627 1.20E-10
VG637 1.33E-10
VG641 2.90E-10
VG645 1.98E-10
VG651 4.52E-10
VG653 2.38E-10
VG655 2.68E-10
VG657 3.88E-10

--- BEAM CURRENT: I = 4.765 A ---

TIME: 1H 27M 46S DATE: 1971-03-12 --- END P: VG ---
--- PRESSURE PLOT OF ULTRA-HIGH VACUUM GAUGES ---
--- IN TORR ---

1.0E-11  1.0E-10  1.0E-9  1.0E-8  1.0E-7

SECTOR 50 . . .
VG463  2.68E-10
VG465  1.88E-10
VG469.1  1.17E-10
VG469.6  6.55E-11
VG501.6  1.08E-10
VG505  1.76E-10

SECTOR 51 . . .
VG517.7  2.90E-09
VG525  6.95E-08
VG533.1  3.54E-06
VG533.9  1.95E-06
VG541  2.79E-07
VG549.1  1.27E-08

SECTOR 60 . . .
VG561  3.40E-10
VG565.1  1.27E-10
VG569.6  4.23E-11
VG501  1.17E-10
VG607  1.57E-10

SECTOR 61 . . .
VG617  1.34E-10
VG621  1.89E-10
VG623  1.89E-10
VG627  3.14E-10
VG637  1.90E-10
VG641  3.07E-10
VG645  1.95E-10
VG651  4.33E-10
VG653  2.33E-10
VG656  2.63E-10
VG657  3.83E-10

--- BEAM CURRENT: I = 4.540 A ---

TIME: 1H 36M 25S  DATE: 1971-03-12  --- END PLVG ---
Stock 4, SP 541 on
RV 51 closed after shocking
leak at 541: VG 533.9

Figure 6