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ABSTRACT

Pumping tests have been conducted on a simulated accelerator dead section. The behavior of different pump types are compared and analyzed. Vacuum conditions to be expected in the Vivitron are reached and several parameters are verified. Selection of a pump for the Vivitron dead section is confirmed.

1. Introduction

The Vivitron accelerating tube is more than 40 m long and is composed of 18 VHV (Vivirad High Voltage Corporation) type inclined field tube sections. The tube vacuum system includes pumps inside and outside the tank. Outside the tank pumping is provided by turbomolecular pump units giving at the entrance of tube section 1 and at the exit of tube section 18 a pumping speed for air of about 200 l/s. Inside the tank a terminal stripper with its housing and pumping system is designed [1] to provide at each accelerating tube connection a pumping speed of about 200 l/s. Beam transmission calculations [2] have shown that the best intermediate locations inside the tank for tube pumping are at dead section 4 on the L.E. side and dead section 14 on the H.E. side.

A test bench was built to simulate a pumped dead section separated from a non-pumped dead section by a real accelerating tube section of nearly full scale size. The test parameters are those mentioned for the Vivitron pumping system. The behavior of three different pump types was examined. Based on the results, arguments are presented for the selection of a dead section pump.

2. The Experimental Procedure

2.1. The Test Bench

Tests were performed with the equipment shown in figure 1. A typical 14 in. diameter, 96 in. long inclined field tube section separates two dead section housings.

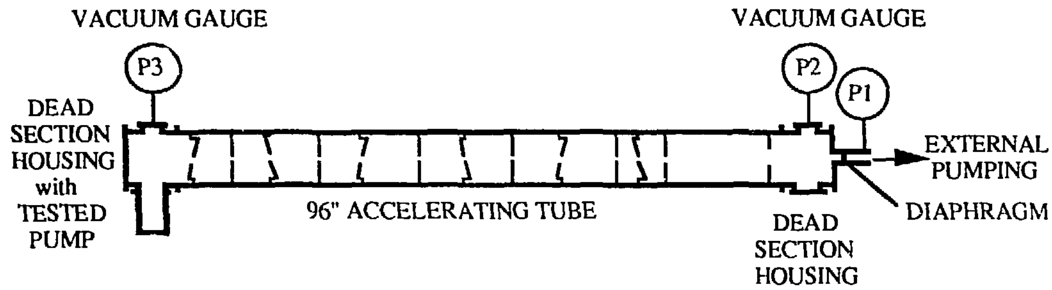

Fig. 1 Experimental equipment used for the dead section pump tests.

One housing is connected to the pump under test. The non-pumped dead section is connected to an external turbomolecular pumping system through a diaphragm adjusted for a pumping speed of 3.6 l/s (the equivalent estimated pumping speed for the Vivitron is 4.5 l/s).

Pressures are measured at both ends of the accelerating tube section (P3 and P2) and on both sides of the diaphragm (P2 and P1) by three identical vacuum gauges. In addition, a residual gas analyser is connected to the pumped dead section to monitor vacuum conditions during the tests.

2.2 The Procedure

The first step consists of running the external pump to reach the calculated vacuum level for the Vivitron, without dead section pumping, in the range of 10^{-5} mbar. Outgasing at this time is in the range of 5×10^{-5} mbar l/s. Pressures P1, P2 and P3 are recorded as a function of time ; total outgasing is estimated by means of the relation : $Q = C\,(P2 - P1)$ mbar l/s (C is the adjusted diaphragm connection conductance).

The second step begins with the startup of the test pump. Pressures are recorded and different parameters are calculated (outgasing, available pumping speed, etc.). This step is limited to a length of time that depends on the capacity of the pump to retain gas (the period of autonomous pumping).

The third step is to stop the test pump. Pressures and calculated parameters are recorded as previously.

3. The Pumping Tests

3.1. Using a Turbomolecular Pump

The pumping unit consists of an Alcatel turbomolecular pump PTM 5150 associated with a molecular drag pump MDP 5010. This hybrid pump has a nominal pumping speed of 110l/s and should provide 90 l/s at the housing connection. The maximum allowed foreline pressure is 30 mbar. The foreline terminates in a reservoir of 3 liter capacity whose pressure PR is also recorded as a function of time. A bypass line opened by an electrovalve connects the reservoir to the dead section housing. The reservoir thus can be pumped out through the bypass valve and down the accelerating tube using the external pumping system. It is obvious that during this operation the tube will be inoperable. The calculated pumping lifetime for this unit is about 20 days between recycling. Figures 2 and 3 represent the recorded pressures in the pumped dead section and in the reservoir during this test.

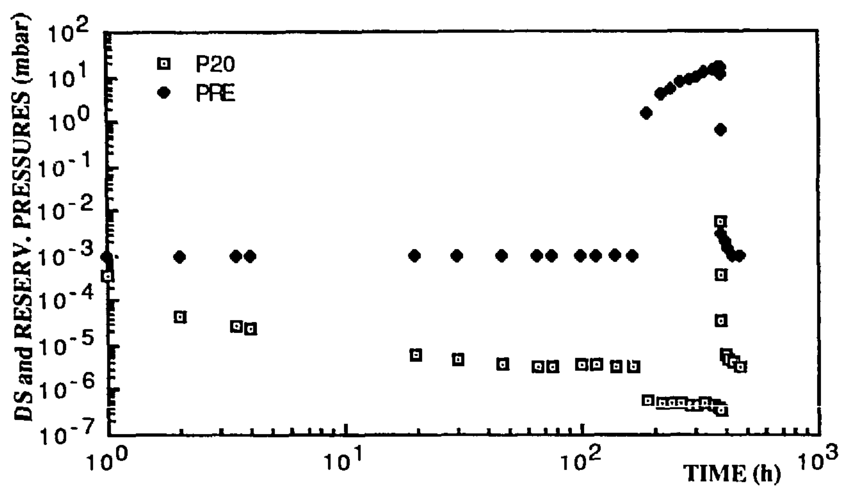

Fig. 2 Pressures during the three steps of the turbomolecular pumping test.

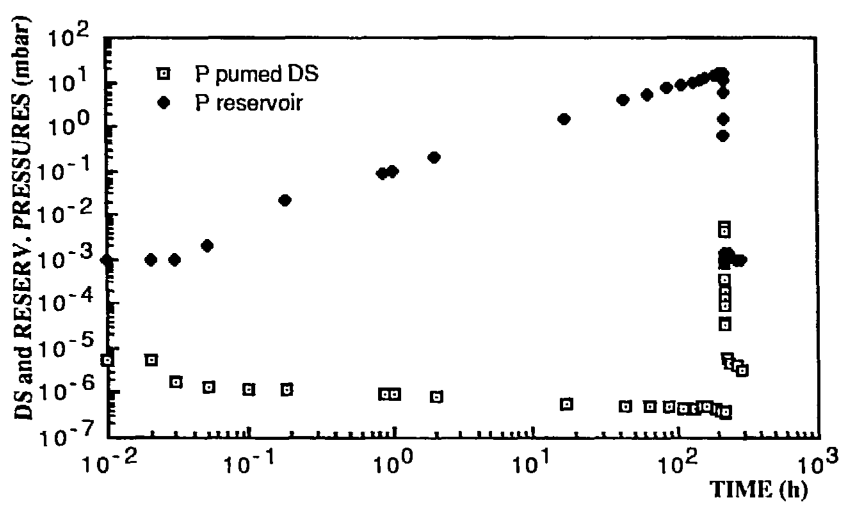

Fig. 3 Dead section and reservoir pressures during the second and third step of the turbomolecular pumping test.

3.2. Using an Ion Getter Pump

The pump housing is homemade. The design is similar to those built for the Heidelberg MP tandem dead sections. The pump is assembled using two Varian "StarCell" getter modules of 60 l/s. The estimated pumping speed at the tube connection is 100 l/s. This unit is powered with a homemade supply of 7 kV DC, 50 µA. The recorded dead section pressure for this test is shown in figure 4.

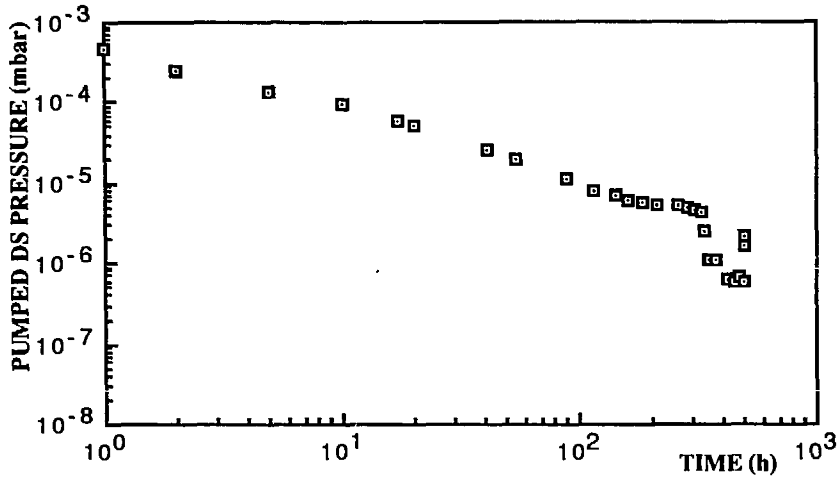

Fig. 4 Dead section pressure during the ion getter pumping test.

3.3. Using a Cryogenic Pump

A cryogenic pump unit using a closed cycle refrigerator similar to the system that has thousands of running hours in the Strasbourg MP tandem terminal was also tested. The pump is a standard CTI type CRYO-TORR 100 unit. The compressor is an air cooled, home-rebuilt unit adapted to the available Vivitron dead section space. The nominal pumping speed for air is 350 l/s, the estimated speed at the tube connection is 200 l/s. The recorded pressures for this test are given in figures 5 and 6.

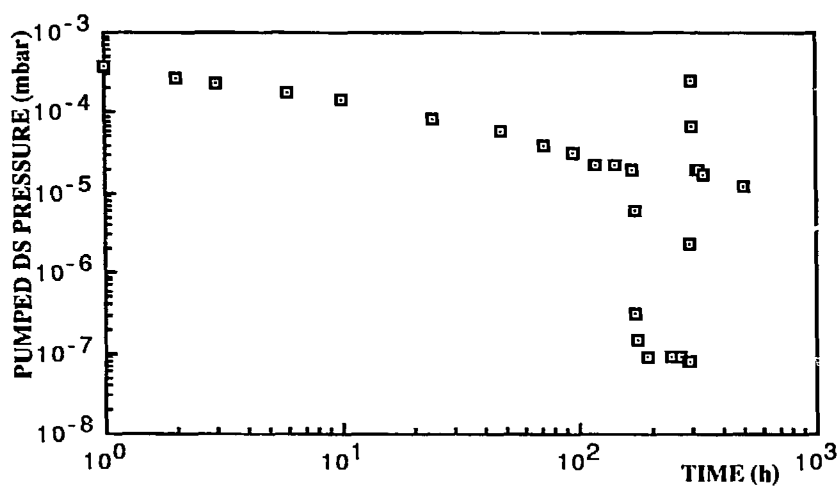

Fig. 5 Dead section pressure during the cryogenic pumping test.

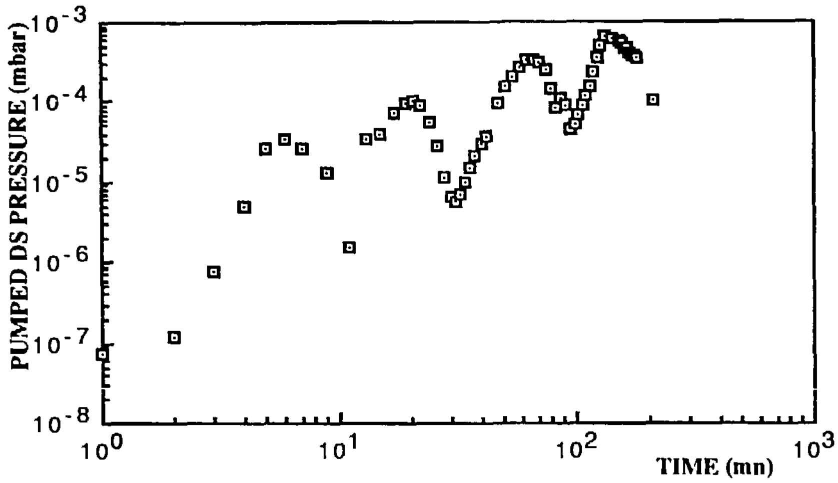

Fig. 6 Dead section pressure during the outgasing step of the cryogenic pump.

4. The Results

4.1. Tabulated Parameters

Typical measured and calculated parameters for the different tests are collected in table1 and can be compared for the three tested pump types. Outgasing and conductance for the 96 in. accelerator tube section measured previously [1] have been confirmed.

4.2. Conclusions

A significant difference appears between estimated and measured pumping speeds for the turbo pump and the ion getter pump. Nevertheless, the pumped dead section stays in the predicted pressure range when any of these pump units is used. Gas

Table 1 Main measured and calculated parameters for the three tested pumps

MEASURED and CALCULATED PARAMETERS		TURBO PUMP	ION PUMP	CRYO PUMP
Estimated pumping speed	(l/s)	110	100	200
Measured pumping speed	(l/s)	70	45	240
Outgasing level before starting	(mbarl/s)	7 x 10-5	6 x 10-5	2.5 x 10-4
Vacuum level before starting	(mbar)	4 x 10-6	5 x 10-6	2 x 10-5
Vacuum after a couple of hours	(mbar)	8 x 10-7	2 x 10-6	2 x 10-7*
Vacuum after a couple of days	(mbar)	4 x 10-7	6 x 10-7	1 x 10-7*
Maximum outgasing pressure	(mbar)	6 x 10-3	no	7 x 10-4
Recovery time	(hours)	40	2	20
Autonomy	(days)	20	very long	very long
Main residual gases		water oil traces	hydrogen	hydrogen

* these values are in good agreement with the calaculated results

analysis was an interesting source of information during these tests in spite of the difficulty in identifying the mass spectrum. The presence of water and oil traces with a turbomolecular pumping system is confirmed.

Best results are achieved with the cryogenic pump. When this unit is stopped, the pumping time needed to restore the starting pressure level, is quite long. This problem is caused by outgasing of the solid adsorbents (activated charcoal) used at the cold surface for cryosorption. It can be solved easely by removing the sorption agent but with attendant loss of pumping capacity.

The turbomolecular pump is of course an interesting volumetric pumping unit. However, evacuation of the reservoir through the accelerating tube is an unacceptable procedure. Indeed, the brutal destruction of the vacuum, the amazingly long outgasing time and the high level of water and oil traces in the residual gas are incompatible with the operation of an electrostatic accelerating tube.

The ion getter pump provides a very clean and convenient pumping system. The low measured pumping speed is the result of the difficulty of placing this pump in the available dead section space. This pumping mode is also handicaped by the lack of volumetric pumping capacity.

The selection of a Vivitron dead section pump is guided by some other significant arguments concerning the pump behavior (Table 2). It appears that the restricted space available in the dead section corresponds to a major inconvenience whatever the choice will be.

Table 2 Comments concerning the behavior of the three tested pumps

TURBO PUMP	ION PUMP	CRYO PUMP
- poor vacuum level when stopped - long recovring time - water and oil traces	- no volumetric pumping - minimum vacuum before starting - housing too large for the dead section - heavy to handle in a restricted space - low level of service	- compressor unit takes the place of the dead section electronic control crate - high level of service required - reached the best vacuum

Finally, the selection is in favor of the efficient cryopump. Also, the long and satisfactory experience established with this type of pump in the MP tandem is an important criterion in guiding the selection process.

References

1. J. Heugel and al, *Vacuum Distribution in the Vivitron Accelerating Tube*, Proceedings of the 5th International Conference on Electrostatic Accelerators and Associated Boosters, Strasbourg and Heidelberg, May 24-30, 1989.
   J. Heugel and al, *Vacuum Studies for the Vivitron Accelerator*, Proceedings of the SNEAP'89, Oak Ridge, October 23-26, 1989.
2. R. Rebmeister and al, *Extensive Beam Transmission Measurements in the Strasbourg MP Tandem*, Proceedings of the 5th International Electrostatic Accelerators, and Associated Boosters, Strasbourg and Heidelberg, May 24-30, 1989.