STATUS REPORT OF THE VIVITRON

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Abstract : In this article, we will present the status of the Strasbourg Vivitron project in June 1990. We will also report on Vivitron test measurements performed recently on the MP Tandem.

Introduction

The Vivitron is an electrostatic Tandem accelerator of 35 MV actually under construction in Strasbourg. Up to now, a voltage of 25 MV is the highest obtained with beam on a Tandem accelerator, this performance has been achieved at the Oak Ridge National Laboratory (U.S.A.). For the Vivitron, the goal is to reach a nominal voltage of 35 MV and it is thus quite evident that for such an ambituous project new concepts have to be introduced. They concern essentially the voltage repartition through intershields of discrete electrodes and column electrodes and also the machine insulation based on post insulators and composite material. A detailed description of the various aspects of the Vivitron can be found in the proceedings of recent international conferences on electrostatic accelerators [1]. In this paper, we will only give the status of the project and describe the most recent construction developments.

During the last two years, the Strasbourg MP Tandem was partly used as a test bench for the Vivitron. Studies were undertaken on the beam transmission and on the comparison of the current intensities flowing through the resistor chains using devices located inside and outside the discrete electrode intershield. The main results of these measurements will be briefly presented and discussed.

Vivitron Construction

The construction of the new accelerator has started in February 1986. The mounting of the machine internal components began during the summer of 1987 after completion of the building and the tank operations. In 1988, the main Vivitron activity was concentrated on the assembly of the generator structure. This complex operation took 13 months and was completed in December 1988. It went off without major problems and the Vivitron final mechanical structure is shown on Figs. 1 and 2. The 250 post insulators have been installed into the machine and only ~7 % of them have been rejected after mechanical and electrical (up to 5 MV) tests performed at the Strasbourg CN accelerator. In 1989 the activity was focused on the mounting of the main "Van de Graaff" components : the portico voltage divider, the belt charging system, the stabilization system and the interconnexions of the elements inside (with double shielding) and outside of the tank.

The different components of the belt charging system [2] have been installed and the first in situ mechanical tests with a "swedish" belt of 100 m length and used in a decoupled structure mode, have been performed in December 1989 (Fig. 3). The guiding of this long belt was easily achieved using an adjustment procedure developed on the belt test bench [2]. On the other hand, it was found that the belt trajectory was unstable, a side displacement of ~14 mm was observed and is probably due to the non homogeneous nature of the material. It was also found on the CN machine, that the scarf joint of the belt used in the decoupled structure mode was not fully reliable. In spite of these mechanical weaknesses, we have decided to perform

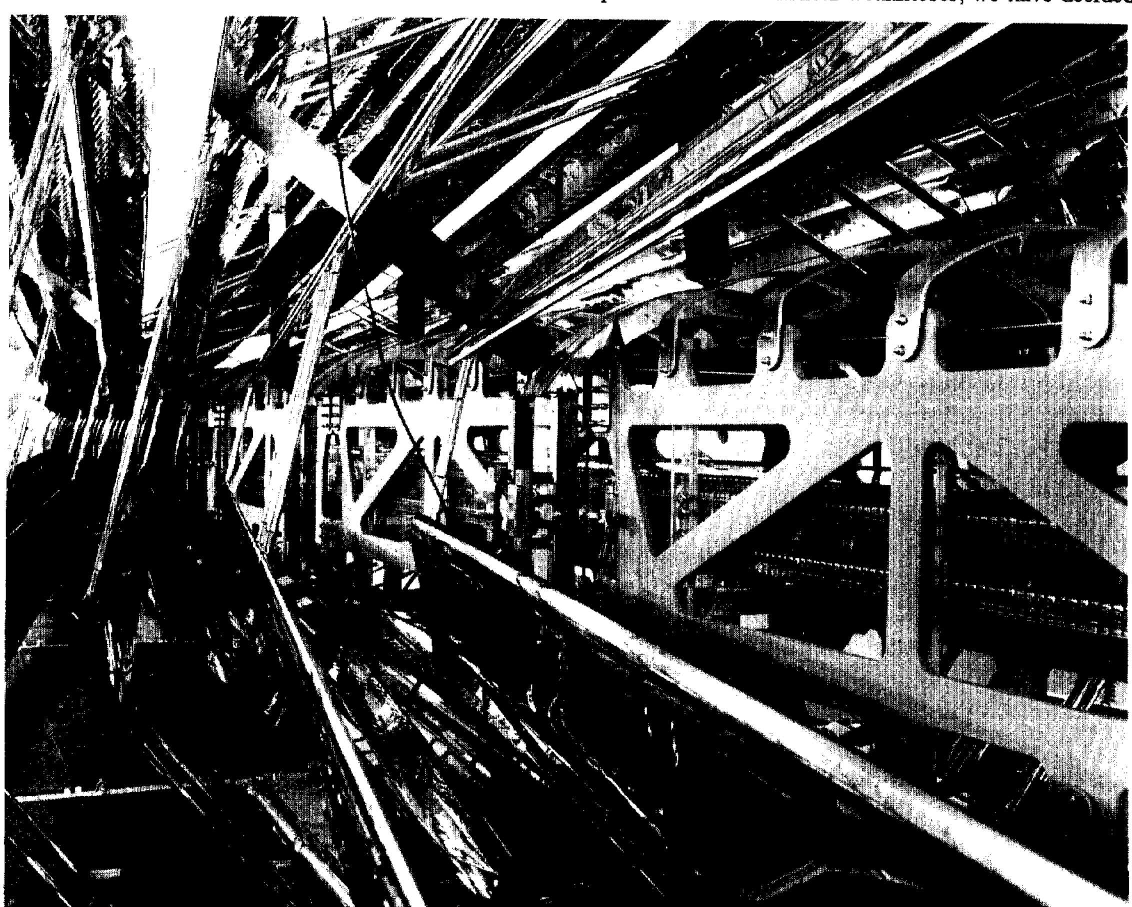

Fig. 1 : Side view of the Vivitron internal structure : discrete electrode intershields, piles of post insulators, column electrodes, boards of fiberglas-epoxy insulating material and voltage divider resistor chain. The column electrodes are actually (June 1990) being mounted in the central part of the machine.

the first Vivitron generator tests with the "swedish" belt. Meanwhile, we have asked the VHV company (Vivirad-High Voltage) to make a feasibility study of a HVEC type belt for the Vivitron.

The 60 tons of SF6 has have been delivered and are actually stored (liquid phase) in two tanks located underneath the main vessel. The transfer system is operational and the final tests will be made with compressed air after tank closure in August 1990.

Special devices [3] conceived to measure the currents flowing through the resistor chains have been successfully tested inside the MP Tandem. They will be used (2 per section) for the first Vivitron generator tests.

The general trend of the experimental program on the MP has been to accelerate heavier masses and this will certainly continue with the Vivitron for which we have conceived and are actually building an injector with an excellent mass resolution [4], a versatile gas-foil stripping system and a charge state selector in the terminal. An analysing magnet with K ~400 has been recently purchased from the Oxford Laboratory, this instrument will allow us to analyse almost all the beams delivered by the Vivitron.

The MP Tandem as a Test Bench for the Vivitron

During recent years, we were able on the Strasbourg Tandem to continue to develop a strong research program in nuclear physics while at the same time making crucial machine tests for the Vivitron under construction. New informations were obtained on the beam transmission in long Tandems and also on the influence of discrete electrode porticos and radioactive sources on the machine operation.

The Vivitron will be two times as long as the actual MP Tandem and problems related with the beam have to be examined carefully. Extensive transmission measurements were thus performed on

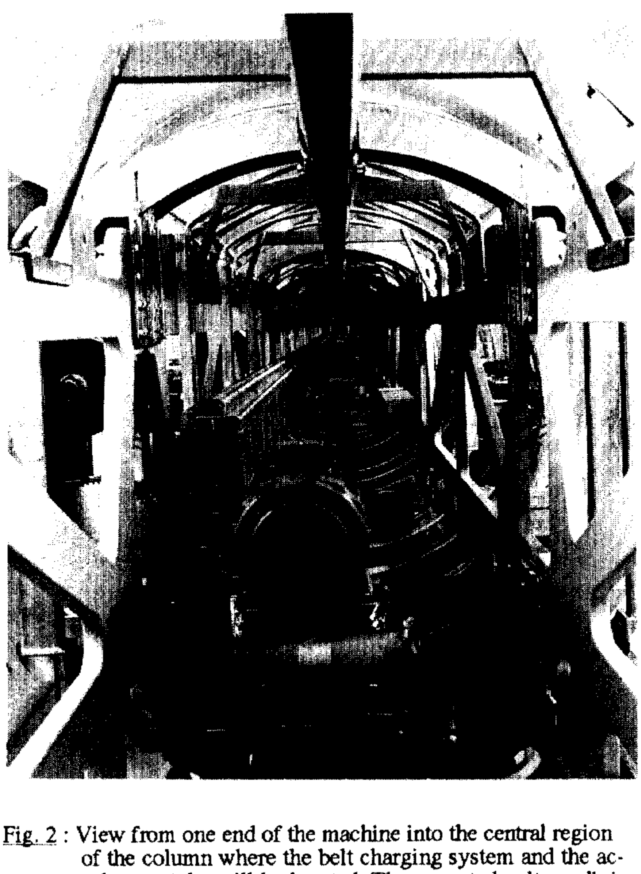

Fig. 2 : View from one end of the machine into the central region of the column where the belt charging system and the accelerator tube will be located. The mounted voltage divider resistor chain will be used for the generator tests.

the MP and the contributions of the low and high energy accelerator sections could be determined separately. The measurements were made possible by the installation inside the terminal electrode [3] of a vacuum gauge and of two Faraday cups located in front and after the gas and foil strippers. These protected equipments are controlled and red out by a microcomputer via plastic fibers, the system has been in operation for the last two years despite machine breakdowns at voltages up to 16 MV. Measurements were performed at terminal voltages from 9 to 15 MV using gas and foil strippings and ions of masses between 1 (H) and 197 (Au). The complete results of these studies are reported elsewhere [5], in this paper only the main conclusions will be given :

- for the low energy section and under the experimental vacuum conditions, the transmission is independent of terminal voltage and of the ion mass. An average and very good transmission value of 0.85 (not corrected for the gridded lens effect) was obtained for foil stripping. For gas stripping, the transmission decreased to 0.65, this is due to the negative ion neutralization in the residual gas which has escaped from the stripper canal into the accelerator tube ;
- for the high energy section, the main cause of transmission loss in the case of foil stripping can be attributed to the beam emittance growth which is a consequence of the multiscattering effect in the foil. This effect is small in the case of gas stripping where an average transmission of 0.9 was measured.

The first Vivitron tests will be focused on the high voltage generator and the terminal voltage has to be known quite accurately. From the experience gained with the MP Tandem, it is established that operating the generating voltmeter (GVM) with an intershield and radioactive sources is reliable only if the GVM can be calibrated using beams of well defined energies. This will not be the case at the time of the first Vivitron tests and it was thus decided to design special current measuring devices to be inserted into the resistor chains and which need no power supply [3]. Prototypes of such devices have been built and used in the MP Tandem.

In the Strasbourg MP Tandem, we are using two Cs radioactive sources of total intensity 6 Ci and located on the tank wall in the central region of the machine. The current measuring devices were installed in the column resistor chain and in sections 1, 2, 3 and 4 (outside and inside the portico). Current intensities were recorded at different terminal voltages V between 0 and 15 MV with and without radioactive sources. The following observations could be made :

- there is a perfect linear variation of the currents in all 4 sections as a function of terminal voltages ;
- at V = 12 MV, the column current inside the portico is 20 % higher with sources than without, the column current outside the portico is 10 % lower with sources than without. There is thus an important leakage current between the terminal and the portico and/ or between the portico and the tank ;
- at V = 12 MV and without sources, the column currents in all 4 sections have almost the same value ; with sources the column current inside the portico (section 4) is 30 % higher than outside (section 1). Larger voltages are thus applied on the section inside the portico, if the resistors of the chain have the same value ;
- due to the portico of discrete electrodes, the generating voltmeter placed on the tank wall indicates the voltage of the portico and not of the terminal electrode. It is impossible to operate the Strasbourg MP Tandem at V ≥ 12 MV without sources. Without sources, the indication of the GVM (portico potential) is 600 kV higher than with sources for the same terminal potential.

From all these observations, it can be concluded that current measuring devices can be used in the Vivitron but that there will be a strong perturbation of the resistor chain currents if we have to use radioactive sources with the Vivitron complex portico structure.

Conclusion

The closing procedure of the Vivitron tank has begun, our present timetable is to run voltage generator tests in fall 1990. The accelerator tubes will be delivered during the summer 1990. The first tests with beam are now expected in the second semester of 1991. The proposed schedule signifies that to construct the Vivitron and to bring it into commission will have taken between five and six years.

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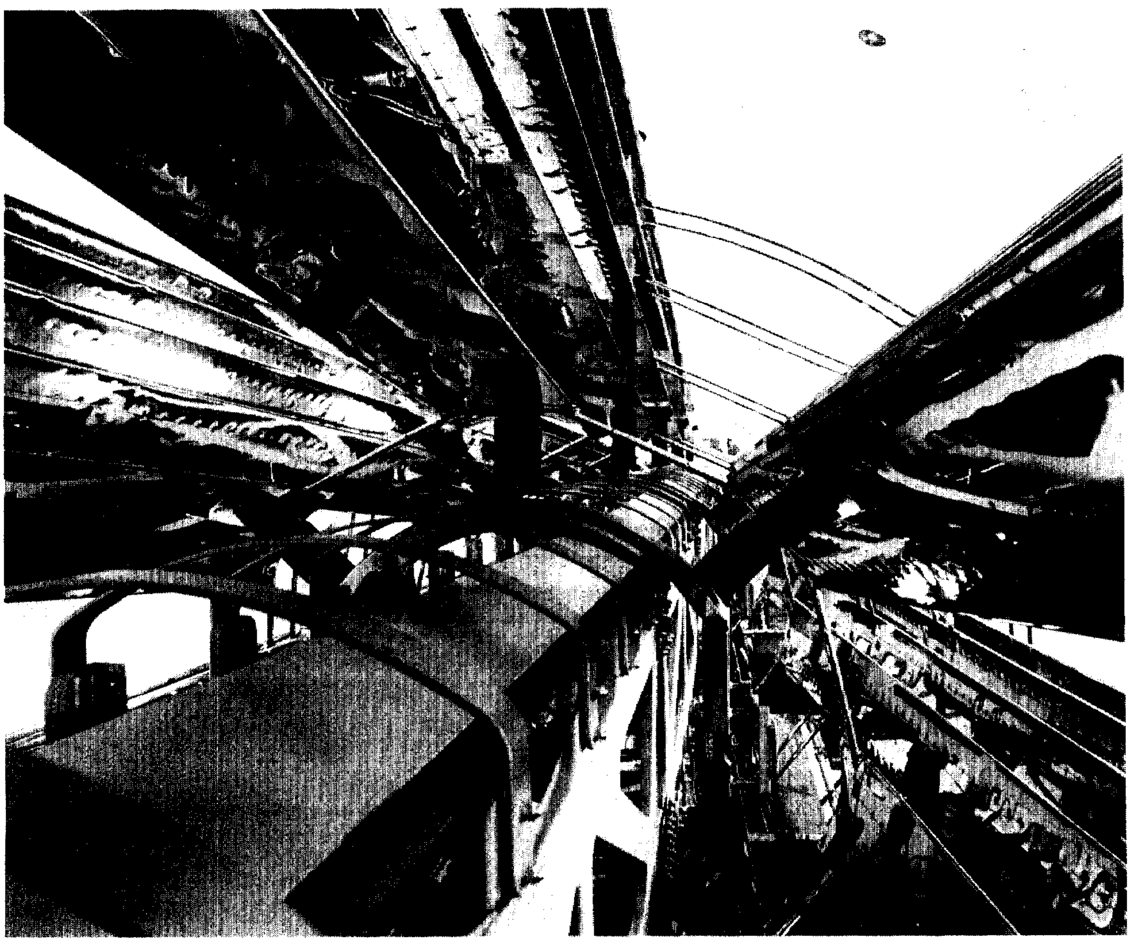

Fig. 3 : View of the belt charging system with its 100 m long "swedish" belt and before the mounting of the column electrodes.