Nuclear Instruments and Methods in Physics Research 220 (1984) 37–44
North-Holland, Amsterdam

THE BUENOS AIRES TANDEM ACCELERATOR FACILITY

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Construction of the buildings and services for the 20 MV tandem accelerator in Buenos Aires has been completed. The SF_6 gas handling system has been successfully tested up to a pressure of 9.8 kg/cm^2 absolute (125 psig). The accelerator column and injector systems have already been installed. High voltage tests have been conducted. A maximum voltage of $(24.7 \pm 8)\%$ MV has been reached on the terminal, well above the specifications of the system.

1. Introduction

Three years ago at the 5th Tandem Conference in Catania (1980) the project for the construction of a 20 MV heavy ion tandem accelerator facility in Buenos Aires, Argentina, was first reported [1].

Today all civil works and electromechanical installations have been completed. The ion source, the injector and accelerator column have been assembled, together with several electromagnetic focusing elements including the 90° $EM/Z^2 = 500$ analyzing magnet. In addition, the SF_6 gas handling system has been successfully tested and has begun routine operation. During April 1983 high voltage tests were conducted yielding a maximum terminal voltage of $(24.7 \pm 8)\%$ MV.

The purpose of this paper is to give a status report on the project. In §2 we briefly describe the building and services. In §3 we concentrate on the accelerator and related equipment while in §4 we deal with the high voltage tests. The SF_6 gas handling system has been omitted from this paper since it is described in detail in a separate paper at this conference.

2. Description of building and services

The accelerator building with its 73 m high main tower that houses the accelerator is shown in fig. 1. It has been designed with the appropriate shielding to allow work with intense high energy light ion beams, the limit being 20 μA of 40 MeV protons for 16% of the total operational time per year.

Adjacent to the main tower another smaller service tower with one freight and one fast elevator provides access for personnel and equipment to the different levels of the accelerator tower. The control and data handling facilities are located at ground level with direct access to experimental areas. The upper floor accommodates the support laboratories (ion source development, electronics, target preparation, detectors) needed in connection with the accelerator and related experimental work.

Fig. 2 shows a rear view of the building. Clearly shown are the storage vessels for the SF_6 gas. Each sphere has a diameter of 10 m with a capacity of over 500 m^3. They are rated for a maximum working pressure of 23 kg/cm^3 absolute. These spheres are made of 31 mm steel and work in a temperature range of -28°C to 80°C.

On the right, an earth embankment serves as shielding for the two main experimental areas. Both of these have external access doors closed with removable concrete blocks to provide entry for future heavy equipment. In addition there are three other experimental areas including a special laboratory for radiochemistry.

3. Accelerator and related equipment

3.1. Ion sources and injector

The negative ion source system is located at level 56.40 m of the principal tower. The 300 kV high voltage cylinder and the insulating support column have already been positioned. The system consists of an electrostatically smooth cylinder, 3.35 m in diameter, supported from above and below by eight metal bonded alumina-ceramic posts, stainless steel hoops and aluminum castings. An electrostatic x–y steerer, an einzel lens, a 90°, $ME/Z^2 = 12$ double focusing magnet and two variable aperture Faraday cups assemblies, one each at the magnet object and image positions, are aligned inside the

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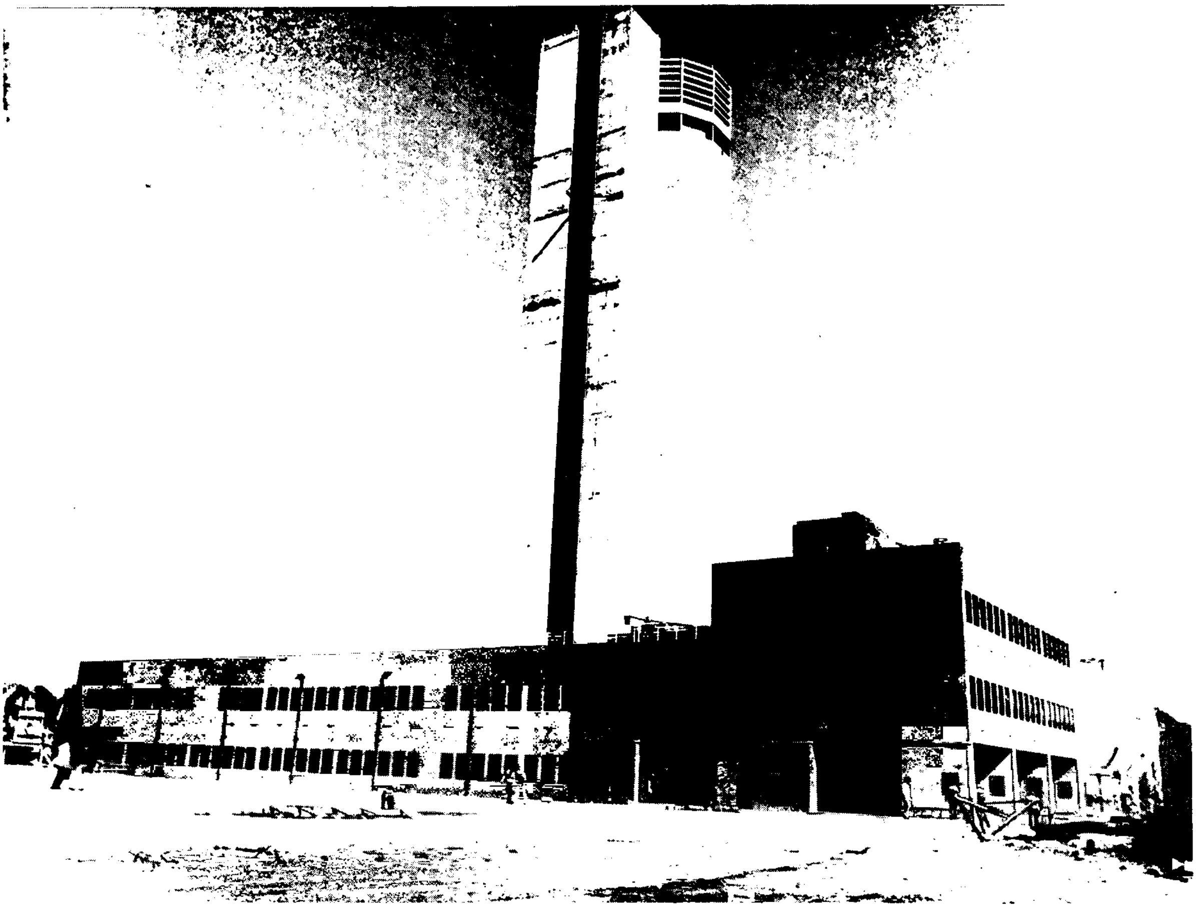

Fig. 1. The accelerator building showing the principal and the service towers.

high voltage cylinder. Fig. 3 shows the injector together with an ion-source.

The system is evacuated by a turbomolecular pumping station. A straight-through valve isolates the vacuum in the cylinder from the ion source module.

An insulating rotating shaft driving an alternator, provides power for components at high voltage. Waste heat is removed by a closed freon heat exchange system.

The direct extraction duoplasmatron ion source module is already operational. It consists of an ion source, a 50 kV acceleration tube extractor einzel lens assembly, a turbomolecular pumping station, isolating valve and power supply. The system has been aligned in the high voltage cylinder.

The sputter cone and the negative-helium (Alphatross) ion source modules are in a bench test status.

Present efforts are devoted to optimize the duoplasmatron ion beams through the injector bending magnet.

3.2. Accelerator vessel and column structure

The cylindrically shaped pressure vessel, 7.6 m in diameter and 36.3 m in height is installed, supported by a skirt at level 13.49 m. Fabricated on site, it has been hydraulically tested up to a pressure of 18 atm. Three side manholes plus two ports on the top and the bottom of the vessel provide access for the accelerator service and ventilation. A number of small ports allow installation of light links, cable entries, viewing windows, etc.

Pressurization of the vessel with SF_6 up to 9.8 kg/cm^2 (125 psig) has been successfully accomplished, and the SF_6 transfer system is ready for routine operation.

The column structure of the accelerator is shown in fig. 4. It was assembled through a large port located at the top of the vessel. The column, 2.13 m in diameter and 32.31 m in height including the terminal, consists of forty 1 MV insulating modules, twenty units on each side of the high potential terminal. Each 1 MV module is made up of six laminated alumina ceramic posts, stainless steel hoops and aluminum castings. The termi-

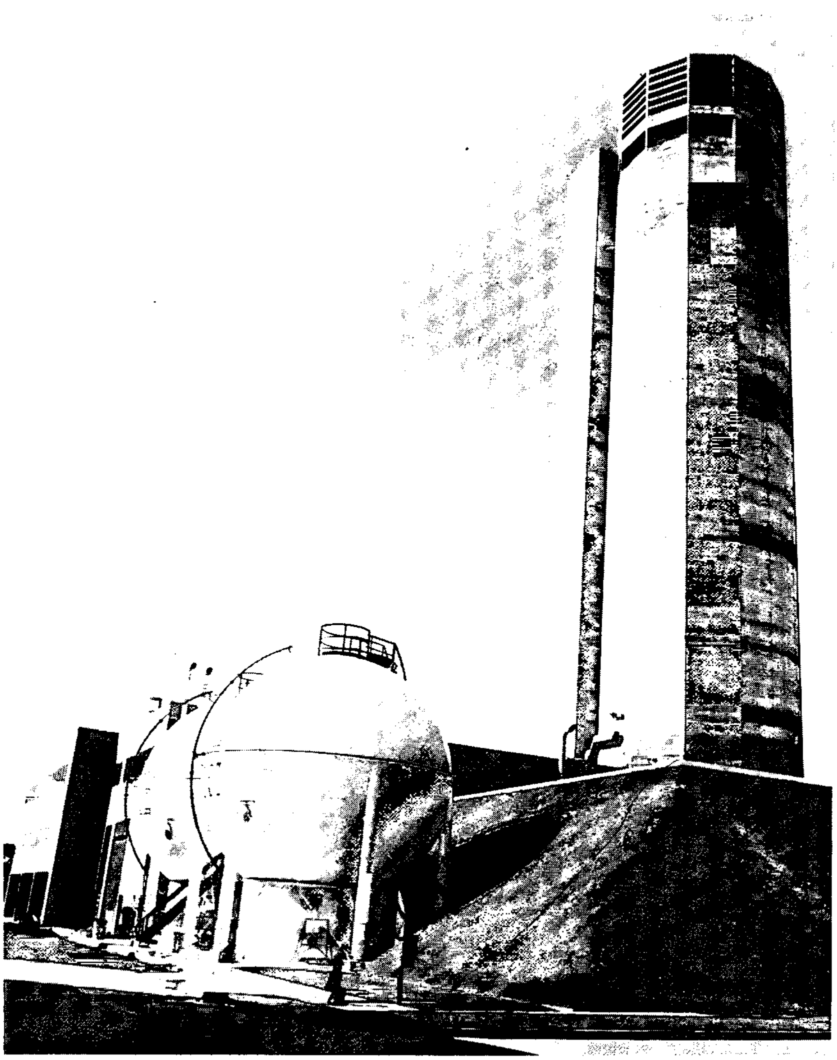

Fig. 2. Rear view of the building. The SF_6 storage vessels are shown; on the right a section of the earth embankment which serves as shielding for the two main experimental areas.

nal is a three piece stainless steel cylinder, 2.44 m in diameter and 4.88 m in height. A major and a minor dead section are positioned in the low energy side of the column, while there are two minor dead sections in the high energy side.

The Pelletron charging system has also been installed. It is built of two independent groups each one with two Pelletron chains, running from the top of the column structure. The corresponding charging power supplies are already operational.

In order to run the column voltage tests, an open corona point system is installed in the high and low energy sides of the structure.

3.3. Analyzing magnet

The 90°, $ME/Z^2 = 500$, double focusing analyzing magnet is supported on its rotatable platform at ground level. By angular displacement of the platform the beam can be directed to the experimental areas through any of the 30 ports existing at the same level in the tower wall. In addition to the 90° bending angle, a 15° exit port allows transport of the beam to a target room under the magnet at level −7.0 m.

The rotatable platform has been horizontally adjusted within a precision of 0.3 mm. Alignment of the magnet with respect to the accelerating tube axis is currently taking place.

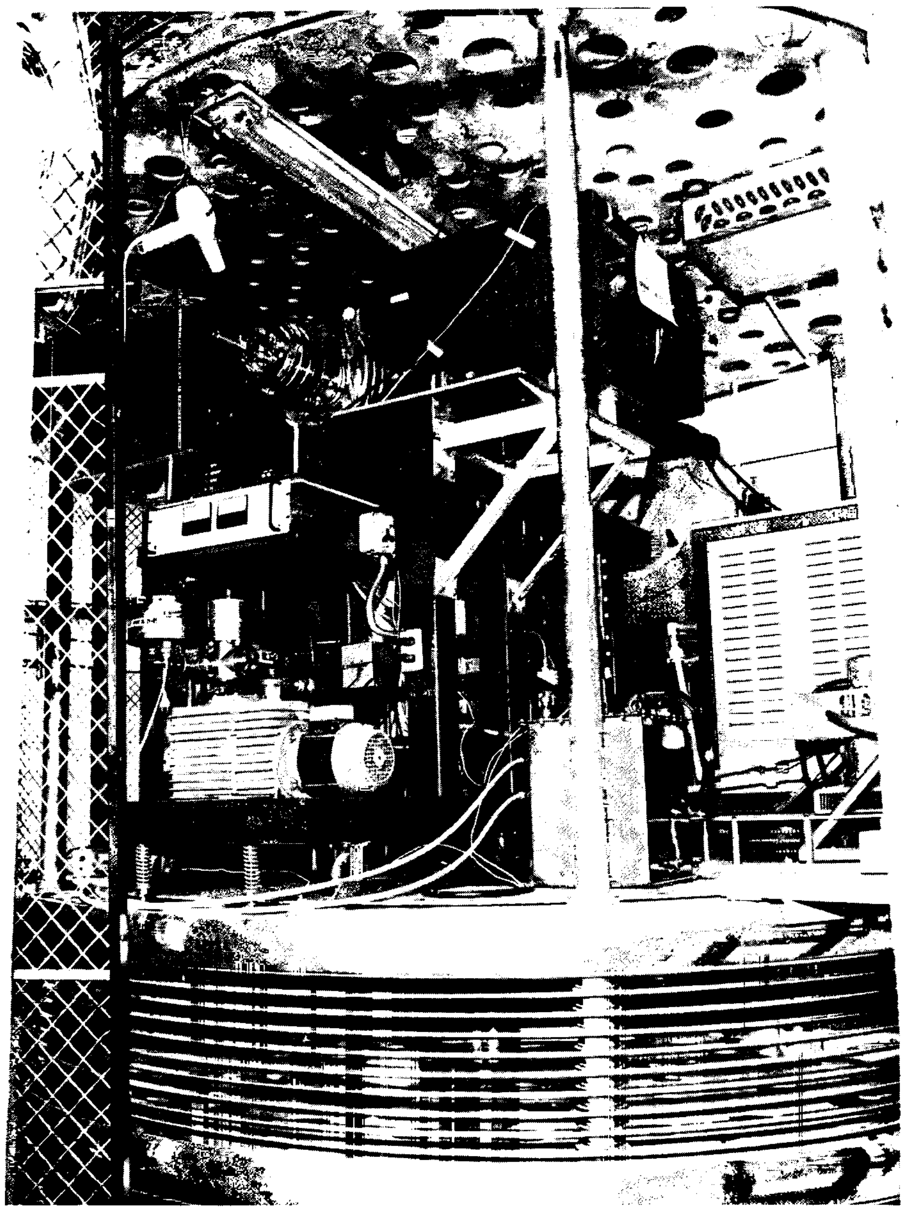

Fig. 3. A view of the injector; a duoplasmatron ion source module is aligned inside the high voltage cylinder.

3.4. Accelerator control and data acquisition systems

The accelerator control system developed by NEC, is of a mixed design. It is based on a digital communication link providing a reliable system to monitor a large number of parameters. In addition, some basic components, such as foil strippers and the terminal matching quadrupole, may also be operated via conventional control rods. This is intended as a back-up to allow limited operation of the accelerator in the event of a system failure.

Digital communication is achieved through a CAMAC system interfaced to a PDP 11/23 computer.

Within the accelerator column a CAMAC crate in the terminal communicates radially with the outside via optical light links. The optical transmitter and receiver outside the vessel are connected to the control console by fiber optics. The individual dead sections do not contain any CAMAC crate; dedicated fiber optic links are used for their communication with the terminal crate.

Wiring of the control console to the accelerator and

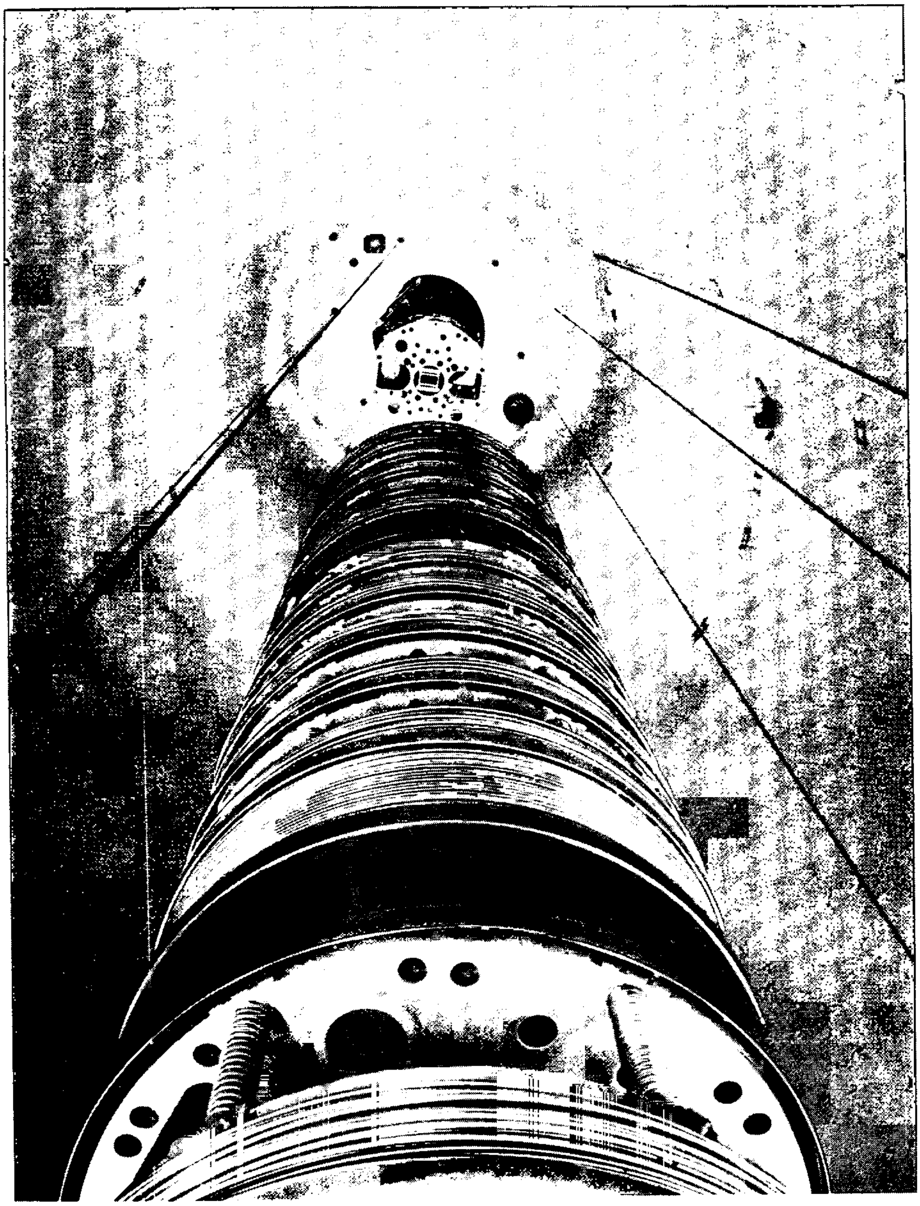

Fig. 4. The column structure of the accelerator being installed inside the vessel.

installation of the control room at ground level are currently being implemented.

The data acquisition system is based on a PDP 11/34 plus VAX-11/780 combination. The front-end handling of electronic signals from the experimental areas will be CAMAC based. An auxiliary controller and a local buffer memory is used at the CAMAC level to speed up the recognition of significant events and the handling of the corresponding signals. The connection of the CAMAC branch to the PDP 11 I/O bus is provided by a BiRa branch driver; it will handle the transfer of collected data to the PDP 11 memory or other peripheral device.

3.5. Experimental areas

The beam can be deflected into any one of five different target areas. The two main ones, one of which is shown in fig. 5, are 20 m × 22 m each. Two other experimental rooms are located at each side of the tower. One of them, unshielded, is designed for heavy ion experiments, the other has a special cave for produc-

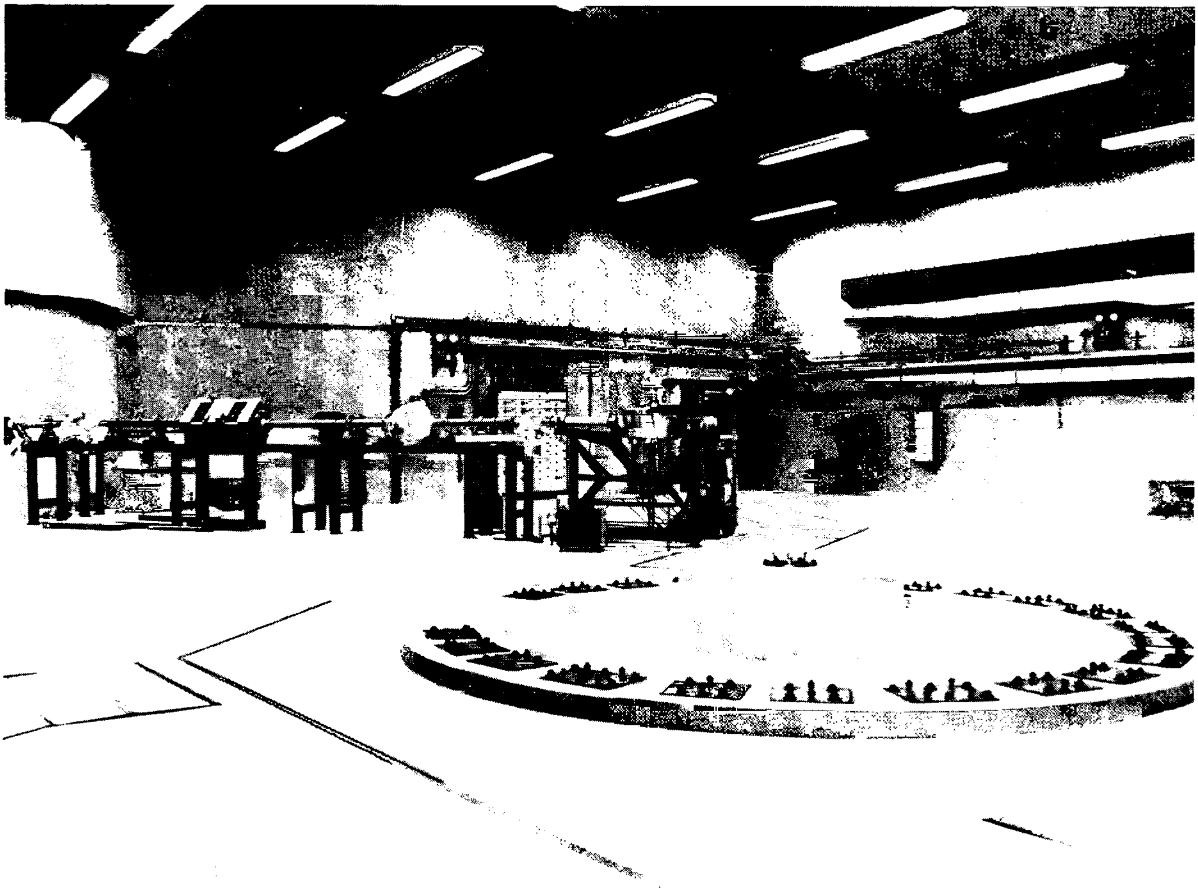

Fig. 5. One of the main experimental areas. One scattering chamber and the beam line extension are being assembled. The base for the magnetic spectrometer is shown.

tion of neutrons in connection with the mass separator facility. The fifth area is at 7.0 m below ground level, under the analyzing magnet. Heavy molecular beams can be deflected into this area through the magnet 15° port.

All services are channeled under the floor by means of trenches. They also provide connection of the experimental apparatus with the data handling rooms. Present activities are devoted to implementation of two scattering chambers, one for heavy ions and the other for light ion experiments, a general purpose gamma-ray facility, a special chamber designed to measure on-line conversion electrons and an isotope separator facility. They are all being assembled together with their respective beam line extensions. The base for the magnetic spectrometer is already built, although the characteristics of this piece of equipment have not yet been completely finalized.

4. Column voltage tests

The column voltage tests on the accelerator have recently been performed (April/83). The experiment was designed to demonstrate the voltage holding capabilities of the column structure at or near the maximum SF_6 pressure consistent with the vessel design and before installation of the acceleration tubes.

Prior to the experiment the generating voltmeter (GVM) was calibrated using a capacitive divider method [2]. The calibration point was set at 2 MV with the vessel open to air. The error in the method was estimated to be +5%, −8%.

The vessel was pumped down to 0.5 mb and pressurized in ten steps with pure SF_6 from 1.3 kg/cm^2 absolute (4.2 psig) up to 9.8 kg/cm^2 absolute (125 psig). The terminal potential was then slowly raised up to the point of breakdown. This procedure was repeated for each SF_6 pressure until a reasonable number of sparks was produced and no higher terminal potential could be attained.

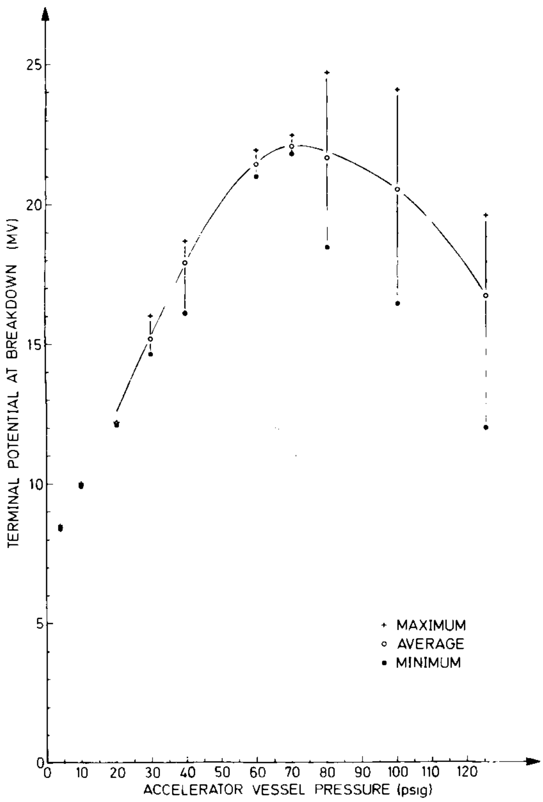

Fig. 6. Plot of "terminal potential at breakdown versus Accelerator vessel pressure", obtained during the column voltage tests (April '83). Details are given in the text.

The corona current readings of the 20 UD column grading system were compared with the data taken by NEC for a single gap of three needles and with extrapolation of the data obtained in the 25 UR (ORNL) and 20 UR (JAERI) accelerators. The 20 UD terminal potentials established form the plots "corona current versus gradient percentage", were within +7%, −15% of the GVM readings. In these conditions the GVM was considered to be representative of the actual terminal potential.

The maximum voltage achieved was 24.7 MV at 80 psig SF_6 pressure Fig. 6 shows a plot of the terminal potential at breakdown (MV) as a function of the SF_6 accelerator vessel pressure (psig). The maximum and minimum breakdown potentials are indicated for each pressure; for the sake of clarity individual points for each spark are not shown; vertical lines indicate the potential range spread. The average has been calculated taking into account all breakdown potentials. Column conditioning considerations may change the shape of the average line.

Fig. 7 shows a terminal spark at 24.7 MV.

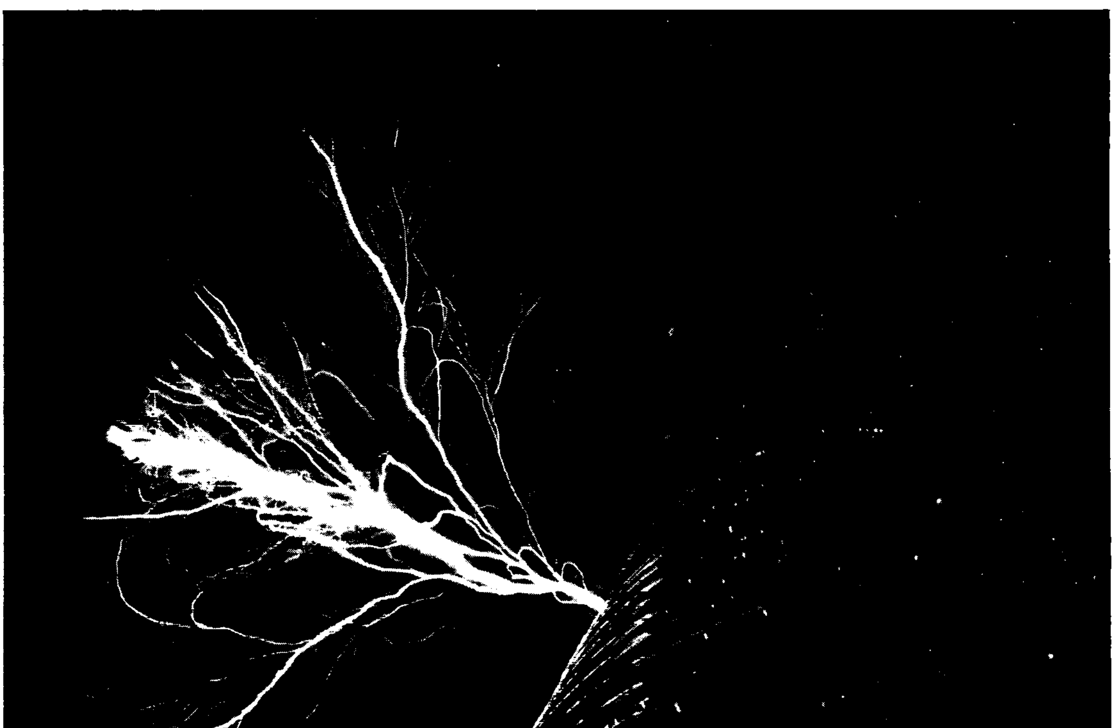

Fig. 7. Terminal spark against the accelerator vessel at a voltage of approximately 23 MV, 80 psig SF_6 pressure.

5. Summary

The Tandem Project whose construction started three years ago is now approaching completion. It has not been completed according to the 1979 schedule which was somewhat optimistic. However, the delay is considered by many to be only a small inconvenience for such an enterprise.

The column high voltage tests have been carried out. It was planned to exceed the operating gas working pressure specified by NEC in order to determine if the addition of SF_6 resulted in a higher voltage since the tank has been designed to withstand a higher pressure.

After the high voltage tests the mounting of the accelerator tubes will begin. It is hoped to finish this task in two or three months and be ready to pass a beam through the machine by the end of 1983. This may again be somewhat optimistic, but then we scientists always are.

References

[1] E. Pérez Ferreira et al., Nucl. Instr. and Meth. 184 (1981) 161.
[2] D. Camín and S. Tau, private communication.