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STATUS REPORT ON THE BUENOS AIRES TANDAR FACILITY

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1. Introduction

The installation of the Buenos Aires Tandar Facility, including all buildings and services has been completed in 1983. This facility, located on the outskirts of the City of Buenos Aires, will be operated as a national user facility mainly for research in heavy ion physics.

The facility operates a Pelletron tandem electrostatic accelerator designed to operate at a maximum terminal potential of 20 MV. In addition a number of experimental devices, a data acquisition and analysis computer system, and special users accommodations have been implemented as part of this facility. A summary of the important milestones of the Tandar Project is given in table 1.

The accelerator is a straight through model 20 UD accelerator built by National Electrostatics Corporation (NEC), Wisconsin, USA, under CNEA specifications. A full description of the accelerator, SF_6 gas handling system, and other related subjects has already been published [1–4]. In this paper we will make a brief update of the work performed in the last two years. In sect. 2 we will describe the column voltage tests performed. Sect. 3 gives a description of the ion source and injector systems. Sect. 4 deals with the control system. In sect. 5 we will describe the tube conditioning process and the initial beam tests. Finally, in sect. 6 we will

Table 1
Tandar Project milestones

May 1976	project proposal submitted to President of CNEA
October 1976	20 MV electrostatic accelerator projector authorized by Government
September 1977	contract signed with NEC
September 1978	start of engineering design
December 1979	start of building construction
October 1980	pressure vessel completed
December 1982	building completed
April 1983	column voltage tests performed (maximum voltage: 23.7 MV)
November 1984	first beam accelerated through tandem accelerator ($^{12}C^{3+}$ at 13 MV)

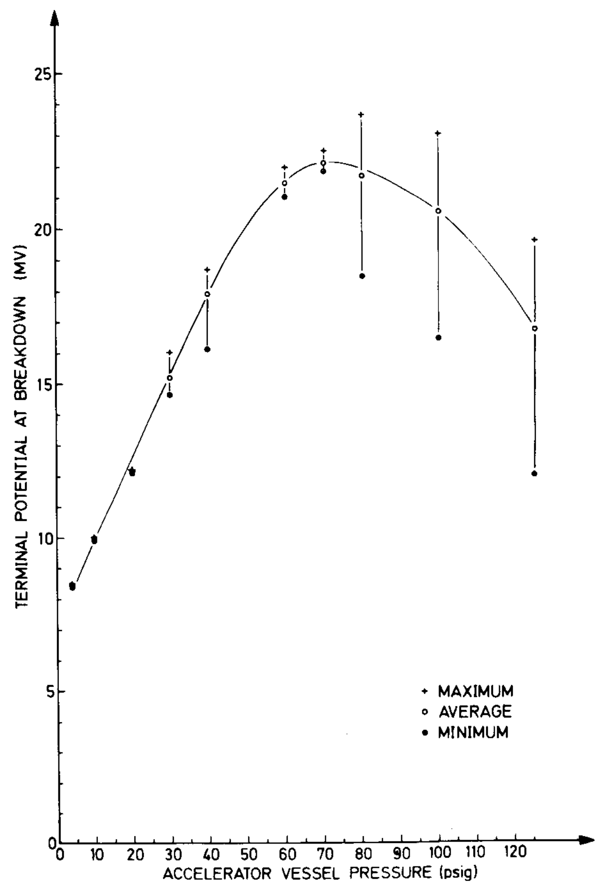

Fig. 1. Plot of terminal potential at breakdown vs SF_6 accelerator vessel pressure obtained during column voltage tests. Details are given in the text.

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outline the initial experimental facilities available for research with the accelerator.

2. Column voltage tests

The column voltage tests on the accelerator were performed in the period April–June, 1983. 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 pressure vessel design and before installation of the acceleration tubes.

To measure the terminal voltage a generating voltmeter (GVM) was installed. It was calibrated using a capacitive divider method described elsewhere in the Proceedings [5]. To set up the calibration point the voltage was raised up to 2 MV with the vessel open to air. The error in the method was estimated to be +5%, −8%. The final values were later corrected using those obtained from an initial calibration with a carbon beam.

The vessel was initially pumped down to 0.5 mbar 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 were produced and no higher terminal potential could be attained.

The maximum terminal voltage achieved was 23.7

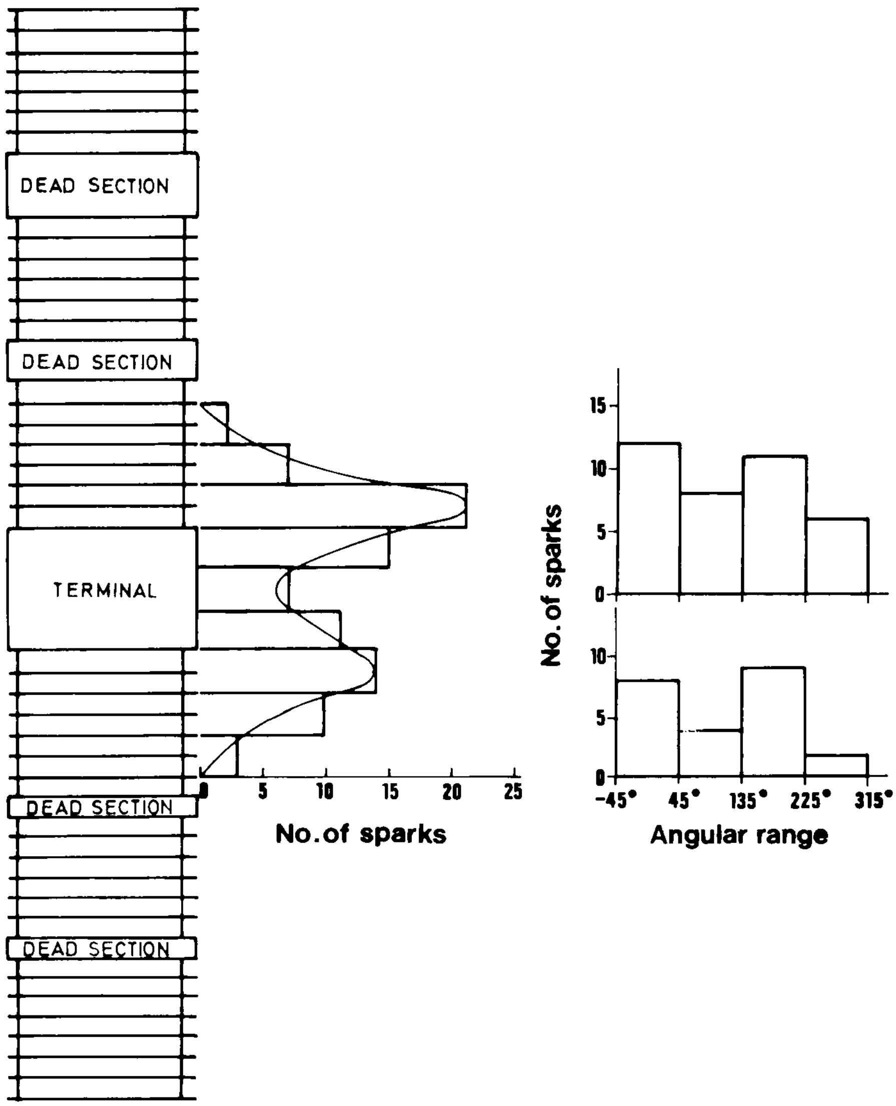

Fig. 2. Spatial distribution of sparks recorded during column voltage tests.

MV at 80 psig SF_6 pressure. Fig. 1 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.

Although the voltage drops at higher pressures, the peak in the curve observed at a SF_6 pressure of 80 psig could be related to the fact that the corona needles were designed to operate at this particular pressure. Hence the question of whether the voltage continues to raise, saturates or drops with higher SF_6 pressures still remains unanswered.

The spatial distribution of sparks is shown in fig. 2. Most sparks occur at or near the terminal edge, as it should be expected, since these are the points of stronger discontinuity. The angular distribution of sparks is quite symmetrical and it may be connected with the position of the corona discharge unit.

3. Ion source and injector system

Three different types of ion sources form part of the injector system. These are (a) a direct extraction duoplasmatron source, (b) a sputtering source and (c) a helium alphatross source.

The direct extraction source has been partially tested. Beams of H^- and F^-, with currents of up to 7 μA, were obtained passed the 90° $ME/Z^2 = 17$ double focusing magnet.

The sputtering source has been fully tested. Several species of beams, including C^-, O^-, B^-, Cu^-, Au^- and I^-, were obtained with currents ranging from 4 to 15 μA for the case of carbon. Figs. 3 and 4 show a mass spectrum obtained with a carbon cone and a copper cone, respectively.

The transmission measured for these beams from the output of the ion source to the accelerator entrance has been found to be better than 85%.

4. Control system

The digital control system is presented in detail elsewhere [6]. After its installation and initial debugging, the system has been working successfully. The use of CAMAC electronics in a double shielded enclosure has shown to be reliable. Fiber optics were not damaged by sparks. Fig. 5 shows a picture of the control system console.

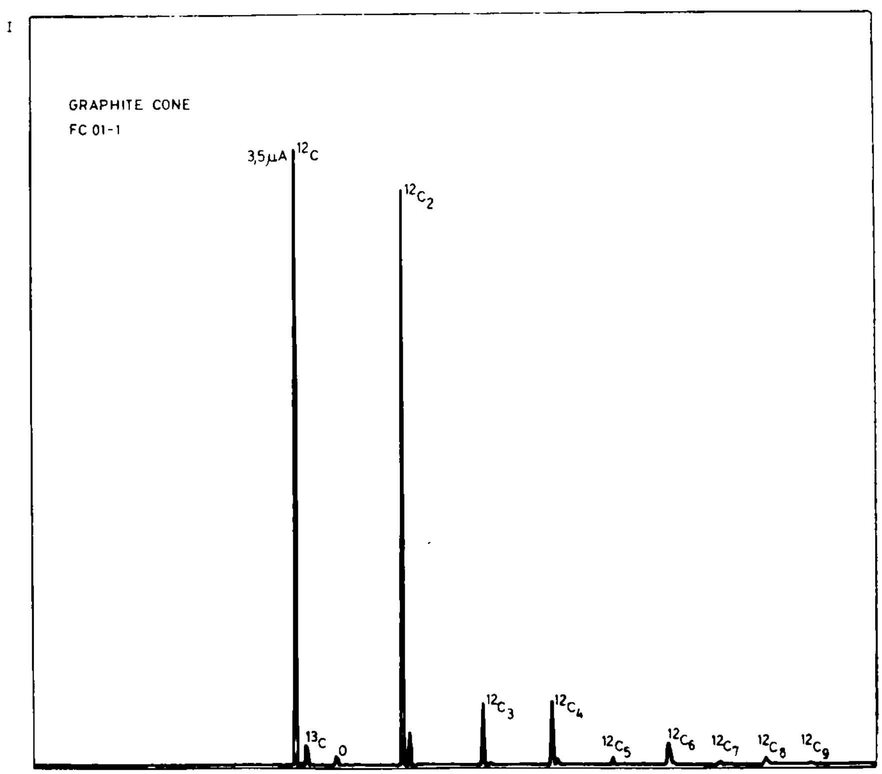

Fig. 3. Mass spectrum of beams obtained with carbon cone (sputtering ion source).

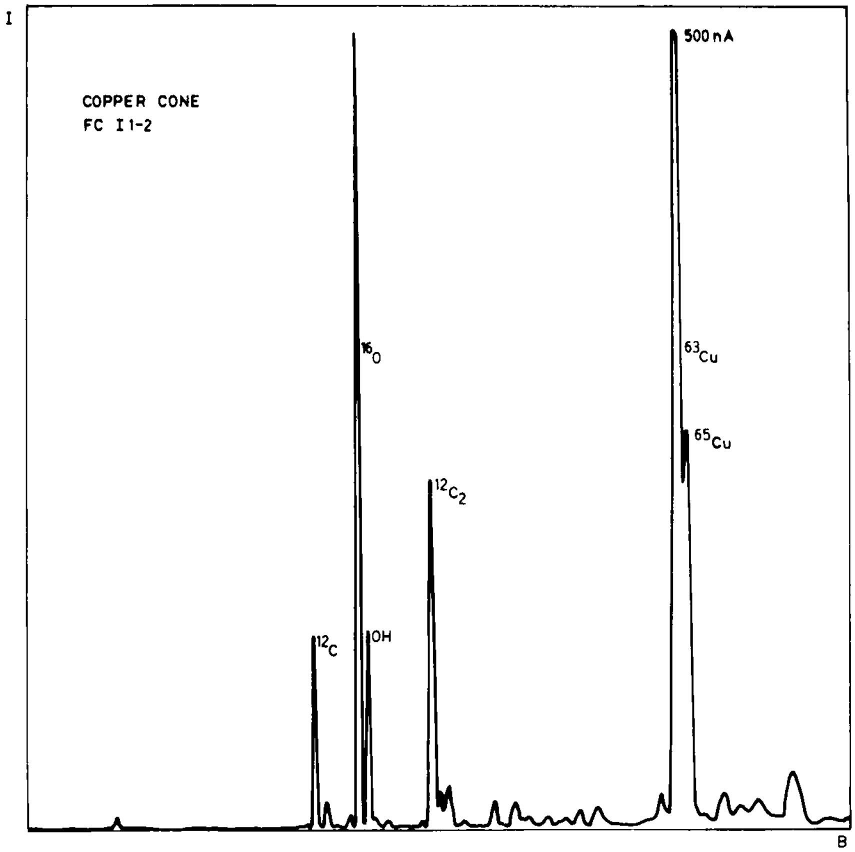

Fig. 4. Mass spectrum of beams obtained with copper cone (sputtering ion source).

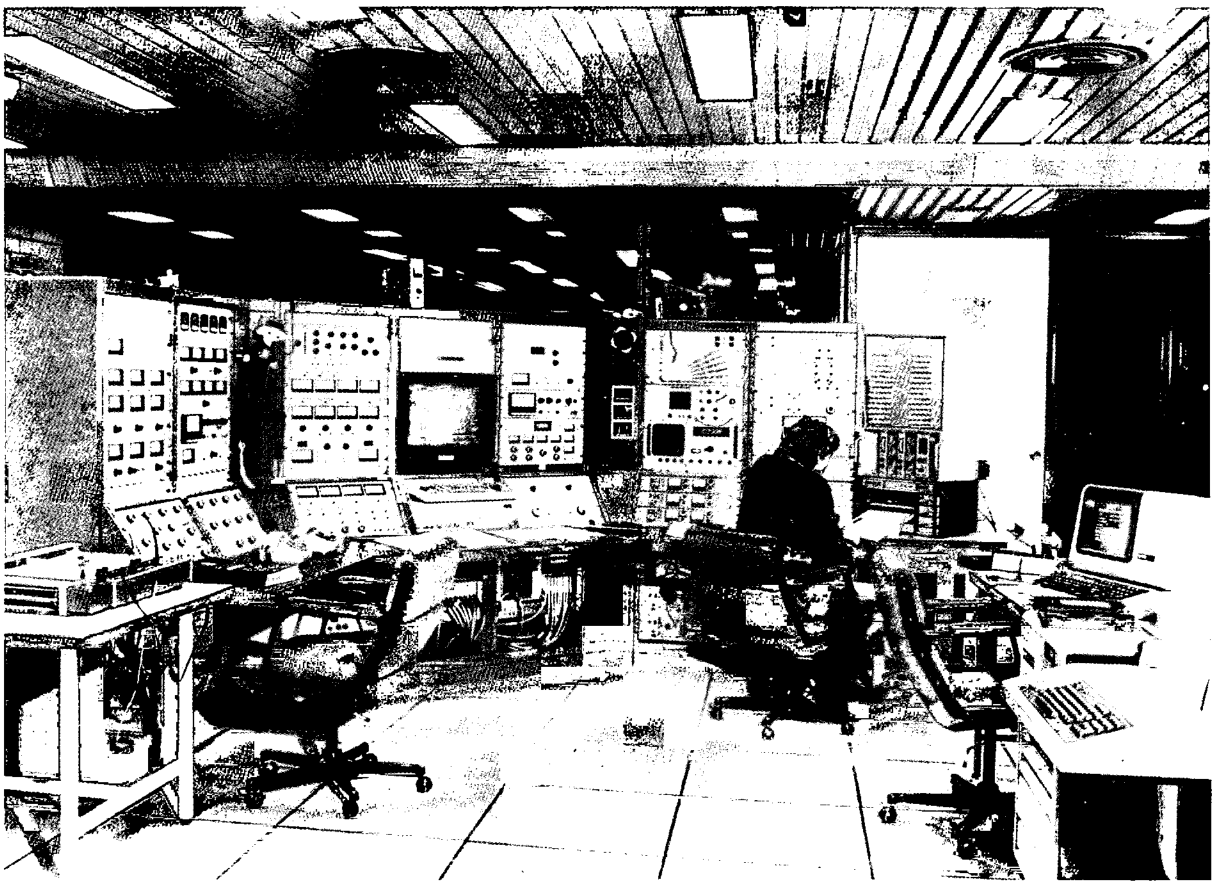

Fig. 5. View of the central console for the 20 MV electrostatic accelerator.

5. Tube conditioning and initial beam tests

5.1. Accelerator tube conditioning

After completing the column voltage tests described in sect. 2, the accelerator tubes were mounted and vacuum tested.

Due to the high vacuum needed for beam operation, and since at the operational pressure the dominant effect is the accelerating tube internal surface condition, the whole system must be baked at temperatures between 250 and 300°C. This is done by means of heater plates fixed at the end of each ceramic tube and heat tapes surrounding the accelerator units. With this procedure, and after eliminating leaks, a pressure of 10^{-8} Torr was reached.

The most serious problem in reaching the desired vacuum readings was the outgassing produced by the steerer insulators inside the high voltage terminal, which had to be replaced. In addition the isolation gate valves connected with the two solid stripper units had to be removed and were sent back for repair.

Once the vacuum readings throughout the entire machine were in the 10^{-8} Torr range, conditioning of the accelerating tubes began. At first this was done in a complete form, that is with voltage in all active accelerator sections.

The procedure consisted in charging the high voltage

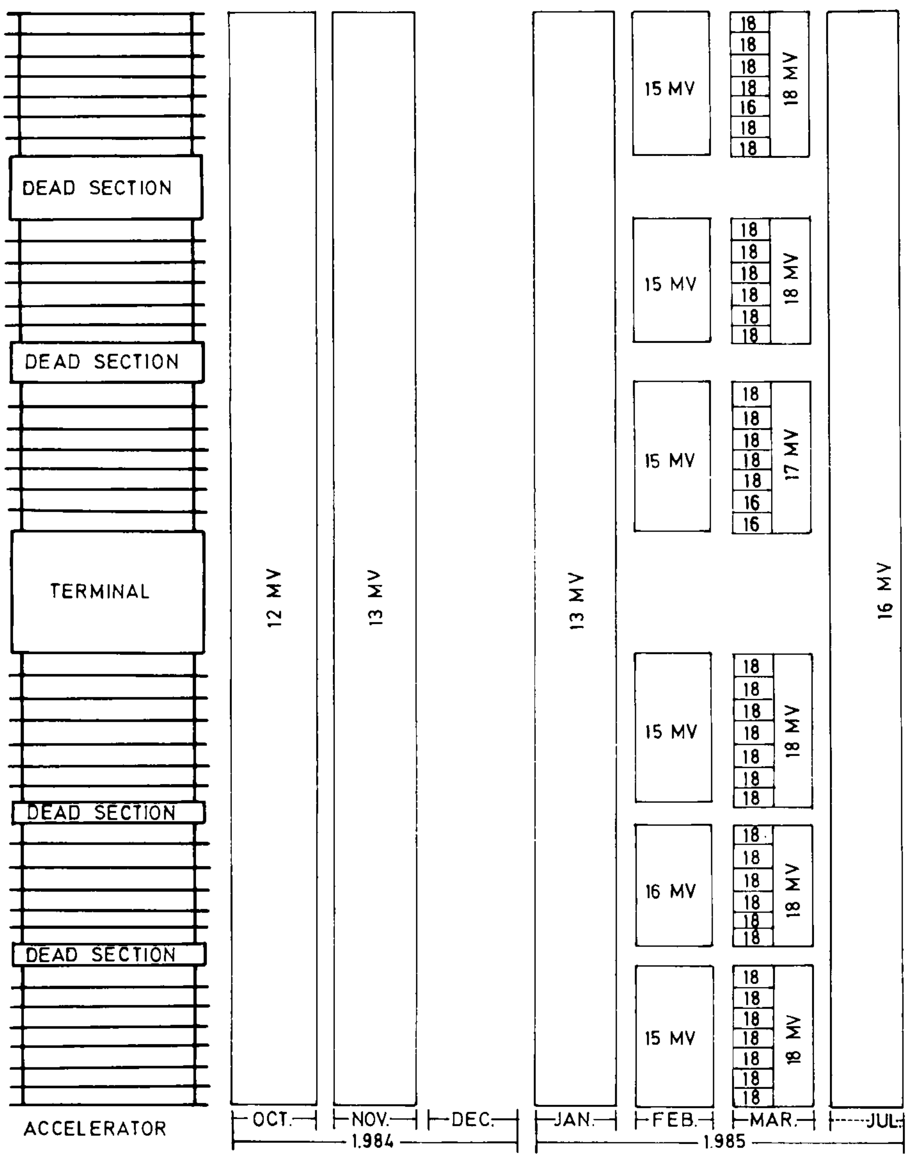

Fig. 6. Summary of the results obtained for the tube conditioning process described in the text.

Table 2
Initial experimental facilities

Beam line	Purpose
Gamma-ray spectroscopy	gamma-ray angular distribution and gamma–gamma particle–gamma coincidences
Conversion electrons	in- and off-beam conversion electron and gamma-ray spectroscopy. e^-, e^-, gamma coincidences
30″ scattering chamber	all purpose ORTEC design scattering chamber built by General Ionex Corporation
50″ heavy ion chamber	particle coincidence events. Time of flight measurements
ISOL facility (on line isotope separator)	studies of neutron rich nuclei using nuclear spectroscopy techniques. Fast neutron induced fission of heavy elements coupled to mass separator
Atomic physics	under construction, atomic physics studies
Magnetic spectrometer	under construction, split pole type; large acceptance solid angle

terminal until some kind of activity showed up in the graphic registers connected with the vacuum monitors. As soon as this activity was seen to decrease and stabilize, the terminal voltage was slowly increased until the activity reappeared.

In this way the accelerator was conditioned up to a voltage of 13 MV at a SF_6 pressure of 40 psig. Because of problems arising above this value it was recommended to continue with the conditioning process in groups of units. This was done at pressures of 40–50 psig until an equivalent voltage of 15 MV was reached.

At this point, due to the high frequency of sparks observed and the long period of time needed for the vacuum to recuperate after each spark, the conditioning was continued unit by unit. This procedure allowed to reach equivalent voltages of 18 MV at SF_6 pressures of 70 psig in all but three units which showed to be defective. The accelerating tubes in two of these units were replace by new ones.

Finally, the whole accelerator was raised up to voltage, reaching a maximum value slightly above 16 MV.

Throughout the entire process the total corona current (tubes + column) was maintained below 80 μA,

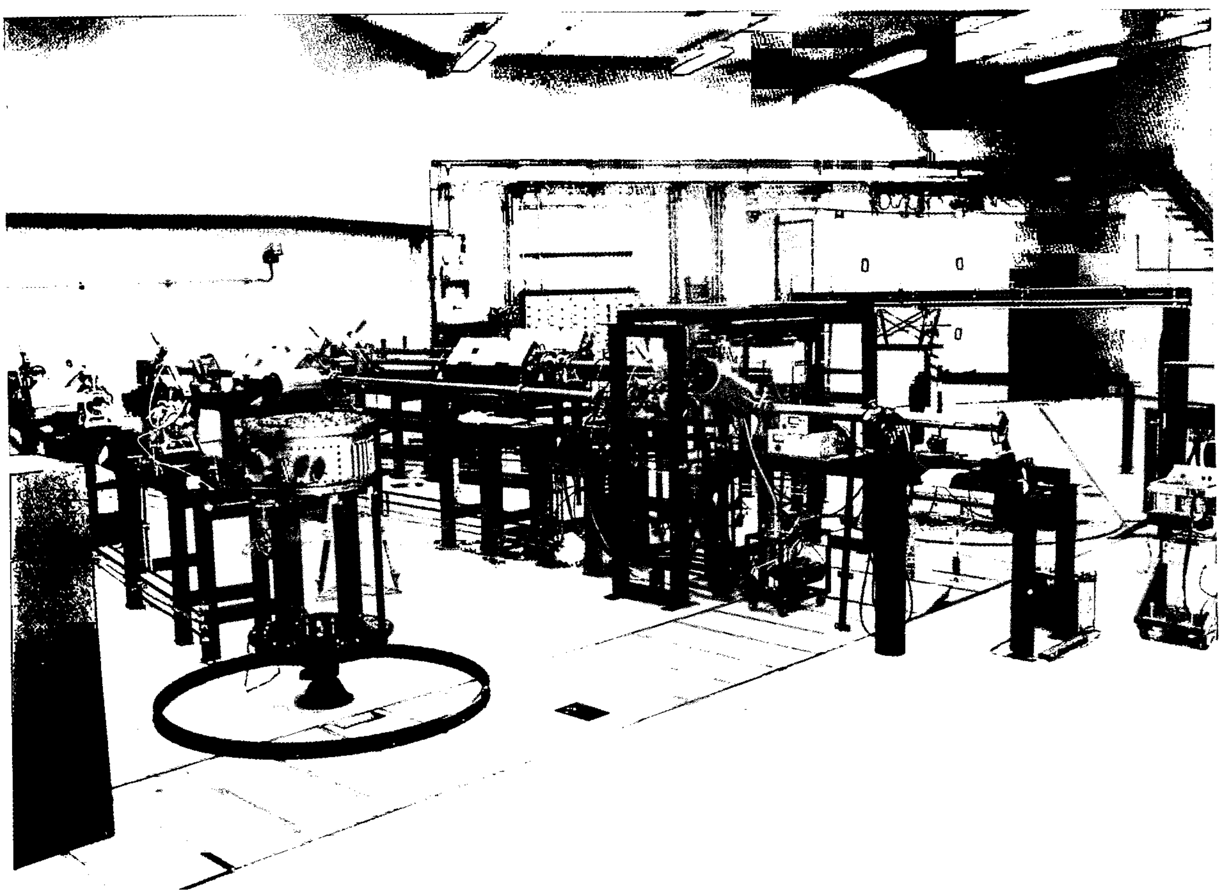

Fig. 7. View of one of the main experimental rooms.

increasing the SF_6 pressure when the current surpassed this value. Fig. 6 shows a summary of the results of the tube conditioning process for the different sections of the accelerator.

5.2. *Initial beam tests*

The initial trials for accelerating particle beams were started in October 1984.

The first task was to check that all focusing and service elements (such as quadrupoles, magnetic steerers, strippers, etc.) inside the accelerator were operational. Only the charge selector off-set quadrupole triplet lens and the pulsing system remain non-operational.

Once the tubes were conditioned at 13 MV, a carbon beam was produced by the sputtering ion source and injected into the accelerator. This first accelerator beam was obtained on November 13, 1984. The accelerated particle was $^{12}C^{3+}$ at a voltage of 12 MV and a current of 50 particle nA. The gas stripper system was used in this case.

More recently beams of $^{12}C^{5+}$ and $^{197}Au^{13+}$ were successfully run at a terminal voltage of 15.5 MV and currents of 140 particle nA and 12 particle nA, respectively.

6. Initial experiments facilities

A total of five beam lines will become active for experimental work in September, 1985. At this point a six-month interim period of operation of scheduled experiments will become available, after which NEC will resume work towards passing beam tests scheduled at the maximum terminal potential of 20 MV.

A list of the available experimental facilities including two additional ones, currently under construction, is shown in table 2. Fig. 7 shows a view of one of the main experimental rooms.

The first nuclear physics experiments planned include studies on heavy-ion fusion at Coulomb barrier energies, spectroscopy of high-spin states populated with (HI, $xnypz\alpha$) reactions, spectroscopy studies in the transplumbic region with special emphasis on doubly-odd nuclei, and studies of nuclear fusion cross-sections vs deep inelastic reaction cross sections as a function of Z_1Z_2.

Non-nuclear physics research includes studies in radiobiology and material sciences.

7. Conclusions

The Tandar Facility has been totally completed. Beam tests designed at a terminal potential of 17 MV are currently underway. An initial set of experimental work will begin starting September 15, 1985 for a period of six months, before attempting to pass beam tests designed at the maximum terminal voltage of 20 MV.

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