PRESENT STATUS OF UTTAC TANDEM ACCELERATOR

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ABSTRACT

The pelletron 12UD has been reliably operated up to 11 MV on terminal. The highest terminal voltage available in experiments is limitted by deconditioning of a few accelerator tube sections. These tube sections can be conditioned up to above rated voltage gradient by applying voltage to 2 or 3 units alive.

Low beam transmission of the polarized ions is considered due to misalignment of the accelerator tube. Alteration of the beam injection system is now in progress.

INTRODUCTION

The pelletron 12UD installed at the University of Tsukuba Tandem Accelerator Center (UTTAC) has been in operation for more than eight years. As of July 31,1984, the accelerator had logged a total of 27700 hours of operation with beam acceleration for 20260 hours. Though substantial alteration has not been made on the machine, reliability is considerably improved recently as a result of careful handling and maintenance. In this paper, operation experience is shown along with a discussion of tube conditioning and planned alteration of the beam injection system.

ACCELERATOR OPERATION

During the year from August 1, 1983 to July 31,1984, the pelletron 12UD had been running quite reliably with many experiments up to 11 MV on terminal. Charging chains were running for 3612 hours with beam available for 3260 hours. The tank was opened only twice for scheduled maintenance. All the research experiments were proceded exactly on scheduled machine time. Major maintenance works at the tank opening were replacement of stripper foils and cleaning or replacement of corona points used as a means for voltage division along the tube and column posts as opposed to the use of resistors.

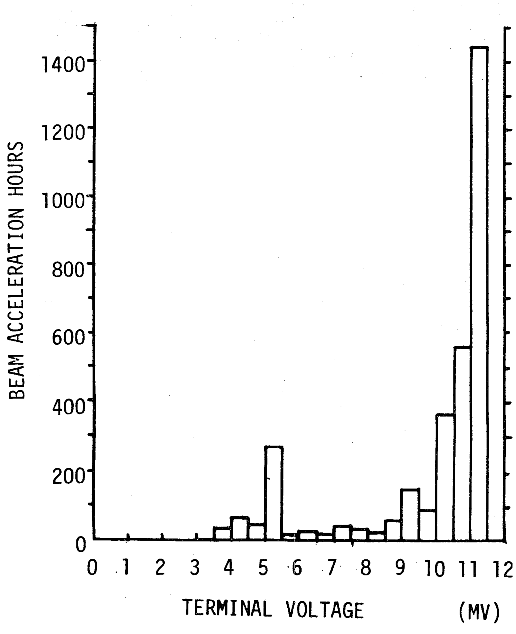

Fig. 1. Distribution of beam acceleration hours at different terminal voltages. (Aug. 1,1983--July 30, 1984)

Beam acceleration hours at various terminal voltages divided in 0.5 MV are shown in Fig.1. Most experiments were carried out at the highest voltage, but wide energy variability of the tandem satisfied the users' request as low as 3.7 MV on terminal.

Tabe 1 summarises ion beams provided for experiments.

Table 1. ACCELERATED IONS

ION SOURCE	Ions	Beam Hours
POLARIZED ION SOURCE	p	58
	$\vec{p}$	34
	d	64
	$\vec{d}$	1628
	^{4}He	270
SPUTTER ION SOURCE	^{7}Li	35
	^{9}Be	99
	^{12}C	69
	^{16}O	362
	^{19}F	128
	^{28}Si	55
	^{32}S	17
	^{35}Cl	243
	^{37}Cl	127
	^{63}Cu	31
	^{93}Nb	17
	^{127}I	23
TOTAL		3260

Use of the polarized beam, particularly polarized deuteron beam showed great percentage. It is a prominent feature of our laboratory that the beams of vector and tensor polarized deuterons with any spin direction are available with a combination of tandem and a Lamb-shift polarized ion source with an rf spin filter.

A heavy ion post accelerator of interdigital H structure linac has been installed in one of the beam line in the target room. Details of this booster linac is described in a separate paper[1].

A General Ionex Corporation (GIC) Model 860 sputter ion source was purchased and is being tested.

VOLTAGE PERFORMANCE

As shown in Fig.2, each of the low energy(LE) and the high energy(HE) column of the pelletron 12UD is composed of 12 modular units, each of which contains three tube sections and nominally holds 1MV. As mentioned above the accelerator was running at the terminal voltage up to 11MV, slightly lower than the nominal 12 MV. The highest available voltage is limitted by deconditioning of a few tube sections in the LE column adjacent to the terminal. Operation up to 11 MV is very stable so that almost no conditioning operation is needed in routine operation. Terminal potential easily goes up to this value within 30 min from starting. Even at the first operation after the tank opening,this voltage can be realized by six hours.

Vacuum discharge in the tube and dust in insulating gas (SF_6) are possible causes of accelerator sparks. Since dust in the pelletron is much less than in an ordinary Van de Graaf which uses a belt charging system, effect of dust is less important provided that careful cleaning is made when the tank is opened. Dust induced sparks were often observed at the first voltage elevation after the tank opening. Several radial sparks occured at the terminal voltage apparently lower than the tube conditioning threshold. However, these sparks caused no deconditioning. Sparking voltage went up gradually at each spark.

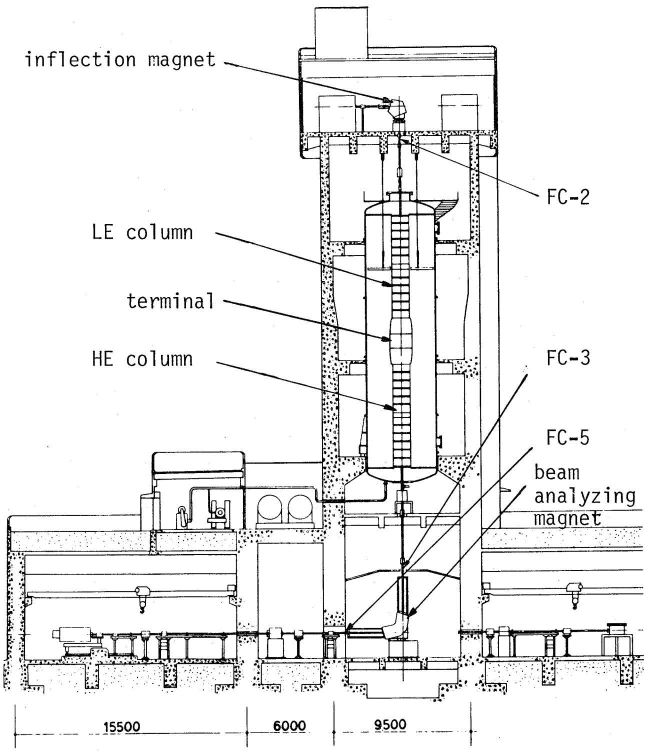

Fig. 2 Layout of pelletron 12UD

Sparks induced by vacuum discharge in the tube can only be eliminated by tube conditioning. Experience so far suggests that the tube conditioning is most efficiently made by applying voltage to 2 or 3 units at a time while the other units shorted. In this case, sparks seldom caused deconditioning or damage of the tube.

Unhealthy tube sections mentioned above could also be conditioned up to 1.1 MV per unit by this procedure. However, these sections were liable to be deconditioned gradually during normal operation or suddenly by a spark along the column. Replacement of these unhealthy tube sections will be done in the next year.

Isoya et al. suggested that hydrogen glow discharge in the tube was effective for improving voltage holding capability as opposed to the high voltage conditioning 2. It was reported that the hydrogen discharge technique was succesfully applied to the "NEC" accelerator tubes in a small test equipment3. Still several problems lie for application of this technique to existing large pelletron accelerators. We are preparing a test equipment to investigate the effect of this technique on our accelerator tube configuration.

BEAM TRANSMISSION

At present, one of our greatest concern in accelerator operation is low beam transmission, in particular when the polarized ion source is used. Last year, we checked accelerator tube alignment by using a laser beam and found serious misalignment of the LE tube. The laser beam, about 1 cm in diameter well aligned with centers of entrance and exit apertures of the HE tube was elipsed by nearly a quarter of its diameter through the LE tube. Since the smallest aperture of each tube section is 25.4 mm in diameter, distortion of the LE tube is estimated to be about 18 mm. Alignment was roughly corrected last year. In order to make fine correction, all the accelerator tube should be reconstructed from the begining. This work will be scheduled in the next year.

Beam currents are monitored by Faraday cup located at every slit sustem of the image of inflection magnet (FC-2), object and image of beam analyzing magnet (FC-3 and FC-5, respectively). Beam transmission is defined as a ratio of the currents read on FC-3 to FC-2. Average beam transmission of the polarized protons at 22 MeV is about 30%. Since beam emittance of the polarized ion source is expected to be larger than acceptance of the tandem, it is suspected that the acceptance of the accelerator has decreased by distortion of the tube alignment. A beam emittance measuring system will soon be installed in the vertical beam line between the inflection magnet and the accelerator.

ALTERATION OF BEAM INJECTION SYSTEM

Alteration of the beam injection system is underway. At present, two ion sources, a polarized source and a sputter source, are alternatively operated. The GIC sputter source will soon be in operation. Switching of the injection beam line from one ion source to another is made by truning the inflection magnet about the vertical beam line.

Recently an experiment was proposed which aimed searching for fractionally charged ions with the use of tandem acceletator as a mass analyzer4. Quarked nuclei, if exist, should have fractional charge but their mass is unknown. Such ions are equally transported if the beam line was composed of only electrostatic elements. A plan was proposed to replace the present inflection magnet by an electrostatic deflector and electrostatic quadrupole lenses.

In addition to the search for fractionally charged ions. employment of the electrostatic deflector system is prefered for switching the ion sources because the deflector installed in a vacuum chamber can be rotated without breaking vacuum. Detailed desigh of the system is completed.

REFERENCES

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