PRESENT STATUS OF THE JAERI 20MV TANDEM ACCELERATOR

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The 20MV heavy ion tandem accelerator is being installed at Tokai Research Establishment of Japan Atomic Energy Research Institute. It is the Model 20UR folded tandem electrostatic accelerator manufactured by National Electrostatics Corp.(NEC)in Wisconsin, U.S.A. This project started in late 1975 and is now in the final stage.

The accelerator system is designed to produce energetic ions with masses from 1 to 240 amu at terminal voltages of 2.5 to 20MV with four different negative ion sources; the direct extraction duoplasmatron, the Heinicke-Penning source, the sputter-cone source, and the charge-exchange helium source. It is equipped with a nanosecond klystron bunching system in the low energy beam line for high energy pulsed beams of light and heavy ions and a nanosecond bunched positive ion source in the high voltage terminal to produce intense pulsed proton or deuterons. It is also equipped with dry high vacuum system of all metal and ceramic construction bakable in place to over 200°C, including the accelerating tubes. The vacuum system includes forty-one sputter ion pumps, two getter pumps, and two turbo-molecular pumps.

The column structure of the high voltage generator is housed in a accelerator tank which is 26m in height and 8.2m in inner diameter and designed for pure SF_6 gas at a maximum pressure of $8.8Kg/cm^2$. The 4m-long high voltage terminal is on the vertical column structure of modular design 13.7m in length and 2.7m in diameter, and it houses a double focusing 180° magnet with a mass energy product of 55 amu-MeV and a radius of curvature of 71cm. There are six 1.25" diameter Pelletron Chains in the column to deliver a maximum charging current of 600μA from grund to the terminal. The chains are charged from drive sheaves at ground potential by the electrostatic induction.

The low energy and high energy accelerating tubes are installed in parallel in the column and connected with the 180° magnet to make the folded configuration. The foil and gas strippers are located before the magnet. There are two dead sections at the 7MV and 13MV levels of the column. They house the ion pumps, electron traps, and beam monitoring components. The lower dead section also houses two electrostatic quadrupole triplet lenses on the both accelerating tubes, and the upper dead section the second foil stripper.

There are three separate corona needle potential grading systems along the accelerating tubes and the column. Drain current during normal operation is around 20μA in each system. Two rotating shafts provide power to the compornents in the terminal and the dead sections and to the baking heater plates in the accelerating tubes.

An Interdate 7/32 computer system takes care of digital communication between a control console and end controllers or monitoring devices at accelerator site by using serial CAMAC highways at a maximum rate of 5MHz. Light links between the pressure vessel wall to the terminal and the dead sections extend the CAMAC highways to the high potential region.

High Voltage Tests

The column voltage test without the accelerating tubes was performed in December, 1978. After column conditioning of 80 hours over 8 days, the terminal potential reached 23.4MV at a SF_6 gas pressure of $6Kg/cm^2$, which was estimated from current drain through the column corona needle system. During the conditioning 160 terminal-to-tank sparks and one charging chain spark were experienced, but none of column spark. A lot of tank spark marks and continuous corona discharge marks were found on the terminal shell and the column modules higher than 15MV level.

Accelerating tube conditioning was tried in the period from December, 1979 to March, 1980. In the course of this conditioning the corona needle systems were frequently damaged by sparks and the highest terminal voltage reached was 17.4MV. The needles seemed to be too week to be used in 20MV accelerators whose stored energy is three times as much as that of existing 14MV accelerators. In April, 1980 the three corona needle systems were replaced by the new ones which have been improved by NEC and were equipped with much thicker needles. Afterwards any serious damage has not been observed with the improved corona needle systems during the tube conditioning and the terminal potential reached 19MV late June.

Beam Tests

In parallel with the voltage conditioning, beam tests were conducted since September, 1979. An initial ion beam was transmitted through the whole accelerator at a terminal voltage of 9.8MV on October 30, 1979, which was an O^{+6} beam of 2μA and 68.6MeV. In the following test at a terminal potential of 16MV, almost same amount of O^{+6} beam was also observed. Concerning protons, a beam current of 2.5μA was measured in a target room at 13MV, and a beam of 4μA exceeding the guaranteed valve (3μA) was successfully obtained at 2.5MV with a good transmission. This is the lowest voltage in the guaranteed performances specified to connect the existing 5.5MV Van de Graaff accelerator to the tandem accelerator. To date an I^{+11} beam of 50 nA was accelerated up to a beam energy of 180MV. During the beam tests an instability of ion beams due to an inadequate operation of the terminal potential stabilizer was found and it is now under improvement.

In general electronic circuits including CAMAC crates in the accelerator tank are much stronger for high voltage discharges than expected. Double shielding and grounding design seem to be very effective. Damages of integration circits due to the SF_6 gas pressure were experienced in the early stage of the accelerator tests. More primitive technical troubles have caused many tank openings, for example troubles in the terminal water cooling system or in the rotating shaft mechanism.