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Present Status of PNC High Power CW Electron LINAC

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Abstract

Pre-commissioning of the PNC high power electron accelerator, a 10 MeV CW(Continuous Wave) TWRR(Traveling Wave Resonant Ring) electron linac, has been started. All the major components of the injector are installed and aligned. After pre-commissioning, the rest of six accelerating TWRR tubes will be installed by the end of the 1996 fiscal year. Commissioning of the entire machine will begin in April 1997.

1. Introduction

Design and construction of a high power CW electron linac to study feasibility of nuclear waste transmutation [1] was started in 1989 at PNC.

A high power L-band klystron and a prototype high power TWRR accelerating tube were built and successfully validated many of design concepts by the end of 1992 at KEK facility. The injector, first accelerating tube and utility equipments were installed. These portion is ready to accelerate beam by winter 1995 at beam energy of 3 MeV. The whole facility will be completed in March 1997 at energy of 10 MeV.

The accelerator facility building has been completed in August, 1991. The facility has three floors, where there are the accelerator in the basement, klystrons and their power supply in the first floor. The accelerator room is surrounded with 2.3 m concrete shielding on its roof and wall. The utility facility such as a gas processing equipment and a cooling-water system are in the basement and first floor, respectively. A schematic isometric view of the building is shown in Fig. 1A.

PNC linac is a 10MeV, 20mA (average current, 20%duty) CW accelerator with eight normal conducting TWRR disk loaded accelerating tubes[2]. The linac uses 1249.135 MHz constant gradient of 1.2 MeV/m and a Q_o of about 5800 (with beam loading). The L-band as accelerating frequency was chosen to be suppressed the regenerative beam break up. In order to achieve the high accelerating efficiency, the TWRR (or Feedback of rf power) is adopted. In this manner, the rf power entering the accelerator can be increased to the value above that available from the rf source.

The injector consists of a 200kV DC gun with thermionic cathode, a rf chopper, a prebuncher, and a buncher. Solenoid coils cover these elements from the gun exit to the first accelerating tube except the rf chopper and chopper slits. A beam dump is located in the end of accelerator. The high power low energy (200kW of 10MeV electron) beam dump poses some challenging problems because of very short electron range in a beam dump target.

2. Present status of the PNC facility

Fig. 1(A) to 1(H) show recent pictures of major components of each system with a schematic isometric view of the whole facility.

As of October, 1995, all construction works of the building and utility facility has been completed. The injector, the first accelerating tube, and a beam dump are installed in the accelerating room.

The cooling-water system for the accelerating tubes and the klystrons has been optimizing for the injector test.

The new klystron designed specifically for this project and the rf power supply, 90kV 4 msec 50Hz, can be produced the power of 200kW. The klystron development includes much effort to make a L-band 1MW CW klystron with one pill-box type rf window. The klystron is able to handle continuous power of about 1MW at factory test. Fig. 1(B) shows picture of the klystron and the power supply in the klystron gallery.

Fig. 1(G) shows the electron gun and power supply. At present, the electron gun is under the conditioning up to 200kV. The injector is shown in Fig. 1(E) and 1(F) with view of solenoid coils and TWRR. To reduce the transverse momentum to the part of beam, the rf chopper cavity is driven at fundamental frequency with TM_{210} mode and second harmonic with TM_{410} mode, and DC magnetic bias. Adjusting rf field amplitude and phase, a superposed magnetic field can be equal to nearly zero on the beam center line in 120 degree phase length[3]. The aluminum mock up cavity has shown good results but the feeding rf power and tuning the cavity with different frequency very critical. A copper made cavity was fabricated with the results of prototype. The beam dump core and cooling plumbing is shown in Fig.1(D) without a vacuum jacket.

The beam line components such as profile monitors, position monitors, and current monitors were installed and have been adjusted.

The injector beam acceleration test (as pre-commissioning)will be started with short pulse (~100μsec) and few repetition rate (~1Hz) to avoid the temperature changes of accelerating tubes by feeding high power rf.

3. Summary

All components for the injector has been adjusted and tested at the PNC site to confirm the performance toward injector test.

Presently the PNC accelerator facility is coming to the injector commissioning. This partial operation is necessary for verification of a few new ideas such as two frequency driven rf chopper and the studies of the accelerator that has no existence in the past.

After commissioning of the injector, the rest of six accelerating TWRR tubes are going to be installed by the end of the 1996 fiscal year.

References

[1] S.Toyama et. al., "Transmutation of long-lived Fission Product (^{137}Cs, ^{90}Sr) by a Reactor-Accelerator System", Proceeding of the 2nd International Symposium on Advanced Nuclear Energy Research (1990)

[2] Y.L.Wang et.al.,"Design of High Power Electron Linac at PNC", Journal of Nuclear Science and Technology, **30** [12] 1261 (1993).

[3] Y.L.Wang et.al., "A Novel Chopper System for High Power CW Linac", Proceeding of the 1994 International Linac Conference, 205 (1994)

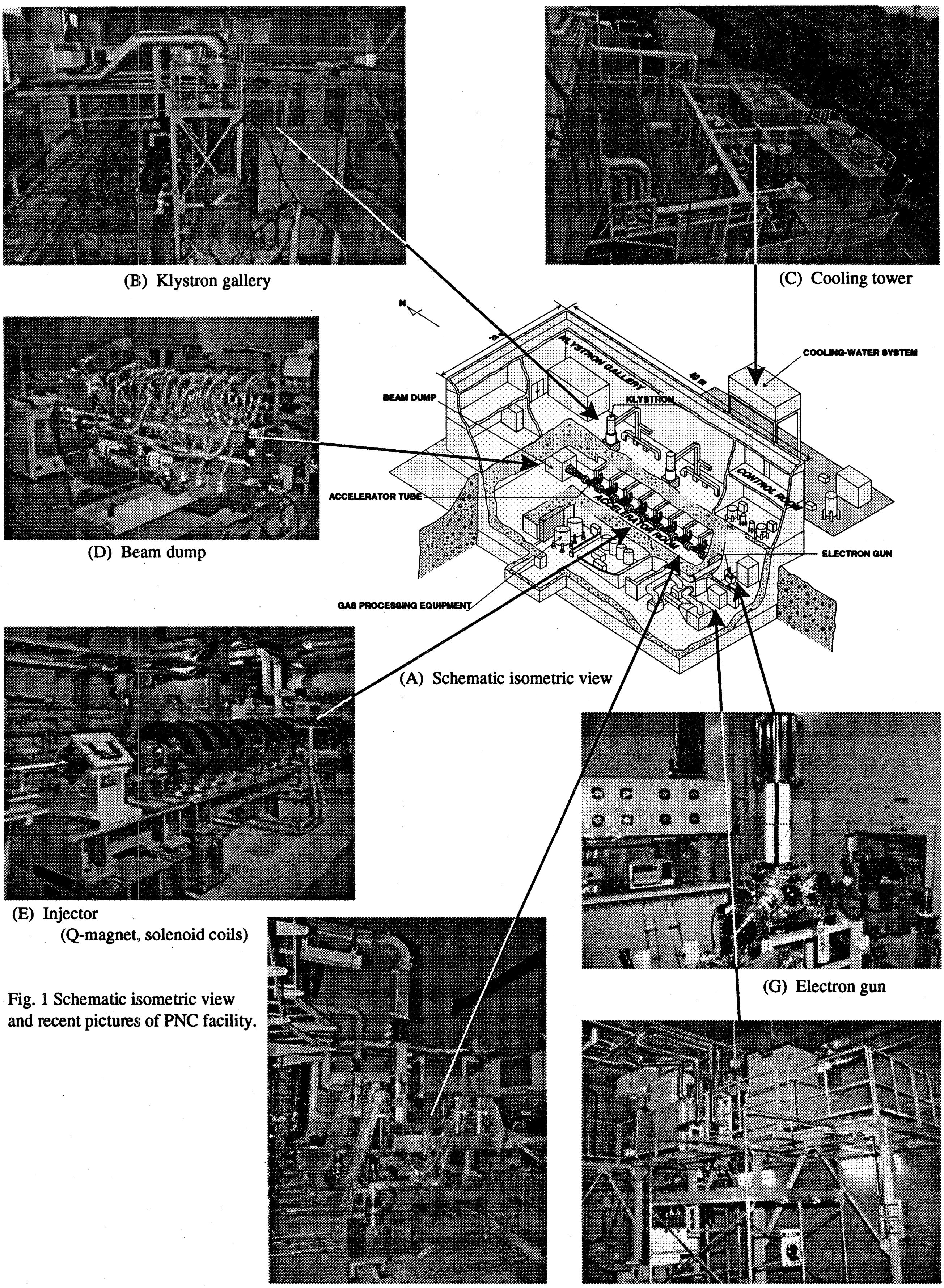

Fig. 1 Schematic isometric view and recent pictures of PNC facility.