Studies of Pre-injector Linac

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1. Introduction

A pre-injector linac from an electron gun to a buncher had been set up in Tokai JAERI past two years and a half. This report describes the results of the efficiency tests at the gun and the bunching section.

2. The Characteristics of Electron Gun

The Y796 grid-cathode assembly (EIMAC) is used in our electron gun which can generate a nano second pulse and a high current beam. The gun is the thermoisonic type with a Ba impregnated dispenser cathode and the distance between the grid and the cathode is 0.15mm. The maximum anode voltage is 200kV and its FWHM is 4ms. Three grid pulsers whose pulse widths are 1ms, 10 to 40ns and 1ns are prepared. The pulse is driven to the cathode through a 12Ω transmission line matched to the cathode impedance.

Some efficiency tests were investigated to evaluate the gun system, for example space charge limited current, temperature limited current, 1ns current characteristics and current stability.

Figure 1 shows the anode voltage vs. the emission current. The emission current, as well known, is proportional to the three-halves power of the anode voltage. The average perviance from Fig. 1 was 0.316 μPV which was a little higher than the design value.

The anode voltage in Fig. 1 was changed, however, to be as high as possible to extract low emittance and high current beam. The cathode could supply the emission current of about 2.5 to 15.5A with the grid voltage of 50 to 220V, and then the emission current varied in proportion to the grid voltage, when the anode voltage was 180kV which was the highest voltage in Fig. 1.

The pulse response of the Y796 was rapider than that of the Pierce type gun, in addition, the high current beam is obtained lower grid driving voltage of the Y796 by an order of magnitude than that of the Pierce type gun.

We have to solve some problems such as the increase of the grid emission by the evaporation of Ba and the decrease of the emission current with time.

3. The Characteristics of Bunching Section

The bunching section consists of two pre-bunchers and a buncher. In the pre-bunchers, we designed that the electron beam of 14A with 40 degrees spread in phase space at an entrance is bunched into 5ps at the end of the buncher. The buncher and the pre-bunchers are supplied with RF power from PV2012 klystron (max. power 7MW) independently.

In order to evaluate the performance of the bunching section, we had to determine the bunch length with accuracy of the order of a few ps at the end of the bunching section with the beam energy of MeV level. However, the energy was too low to observe air Cherencov light. So, Cherencov light from a quartz was measured, however it is difficult to determine the bunch length with accuracy because of the jitter, the small intensity and the length of the light.

An energy spectra at the emission current of 10A with the single pulse of 1ns width is shown in Fig. 2. The data was measured after a 90-degree-bending magnet.

It is important to adjust a power of two pre-

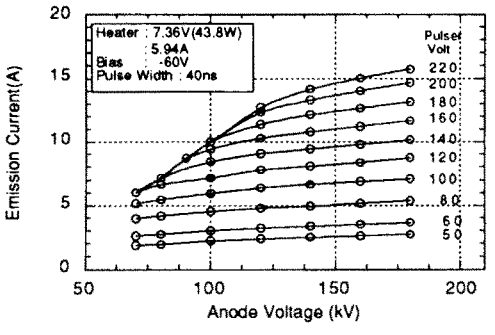

Fig. 1 The anode voltage dependence of the emission current

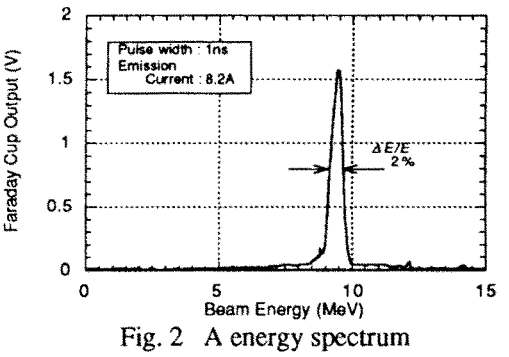

Fig. 2 A energy spectrum

bunchers and the phase to obtain a sharp energy spectrum without the deterioration of the bunching efficiency. To obtain large bunching efficiency, the gap voltage of the pre-buncher was increased; but debunching was occurred in the pulse by the space charge effect. The optimum parameter has to be determinate in full consideration of these effect. However, the data are too complicated to survey all parameters.

To make the problem clear, at first, the RF power was not supplied to the pre-buncher2, and the RF power and the phase was optimized between the pre-buncher1 and the buncher. After this procedure, the phase was fixed and the power was decreased a little of the pre-buncher1, and then the power and the phase of the pre-buncher2 was optimized.

As the result, good energy spectrum with $\Delta E/E$ of 2% was obtained both in the low current mode and in