INITIAL OPERATION OF THE PHOTON FACTORY 2.5 GeV ELECTRON LINAC

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Abstract

An initial performance of the Photon Factory 2.5 GeV injector electron linac is described. Construction of the linac had been well advanced since the foundation of the Photon Factory in April 1978. The linac was almost completed in January 1982, and initial operation was started at the end of the month. The design values of 2.5 GeV, 50 mA were successfully satisfied with the measured energy and beam current of 2.54 GeV and 55 mA, respectively. The highest beam current obtained during the run was 300 mA (2.5 μs) at the energy of 1.81 GeV.

1. Introduction

Construction of the Photon Factory (PF), a synchrotron radiation facility at the KEK, was started in April 1978, as a four year program. The PF radiation source consists of a 2.5 GeV injector electron linac and a 2.5 GeV storage ring dedicated to synchrotron radiation research.

The linac was designed to accelerate an electron beam of 50 mA peak current to an energy of 2.5 GeV with a total rf power of 840 MW.

In July 1981, prior to assembling of the whole linac, beam test of the first 500 MeV sector was carried out. The expected 500 MeV beam was accelerated at a beam current of 50 mA and at 87 mA the beam energy was 470 MeV with a total rf power of 180 MW.

2. Initial Performance

As an assembling of the whole linac was almost completed in the middle of January 1982, initial operation of the linac was started in the last week of January. At the end of the month, the first beam was successfully accelerated. After 2.34 GeV, 57 mA (1.5 μs) was achieved on February 10, the linac beam was

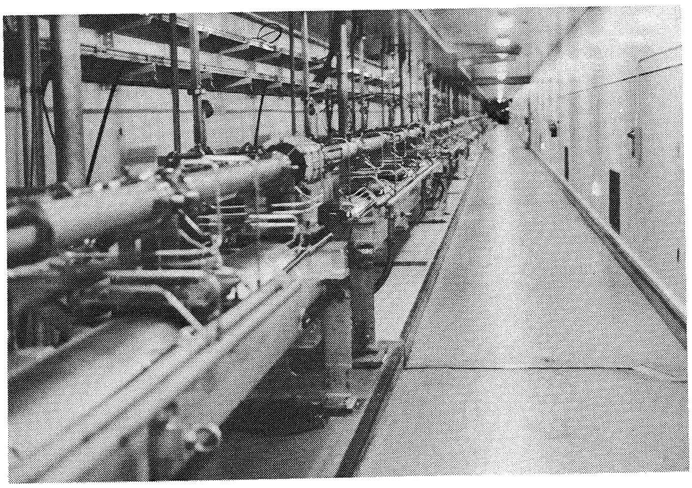

Fig.1 View of the PF electron linac tunnel.

mainly used for injection into the storage ring. On March 11, 2.5 GeV, 31 mA beam was injected into the storage ring and the first 2.5 GeV, 6.2 mA beam was successfully stored.

The design values of 2.5 GeV, 50 mA were completely satisfied on March 16 with the measured energy and beam current of 2.54 GeV and 55 mA, respectively. At the end of the initial run, the beam intensity was increased as high as possible and a beam current of 300 mA was obtained at the energy of 1.81 GeV. The current of 300 mA with a pulse duration of 2.5 μs was the beam-blow up threshold of the linac for the present operational condition and is the highest ever obtained with existing high energy electron linacs.

The relation between energy and beam current was measured and it is shown in Fig. 2. The parameter is a total rf power.

At the specified beam current, the beam energy can be changed continuously without serious influence on the beam quality. Depending on energy, timing pulses for some of the klystrons placed in the downstream sectors are changed from "Acceleration mode" to "Stand-by mode". Fine tuning of energy is performed by shifting rf phase of the endmost klystron.

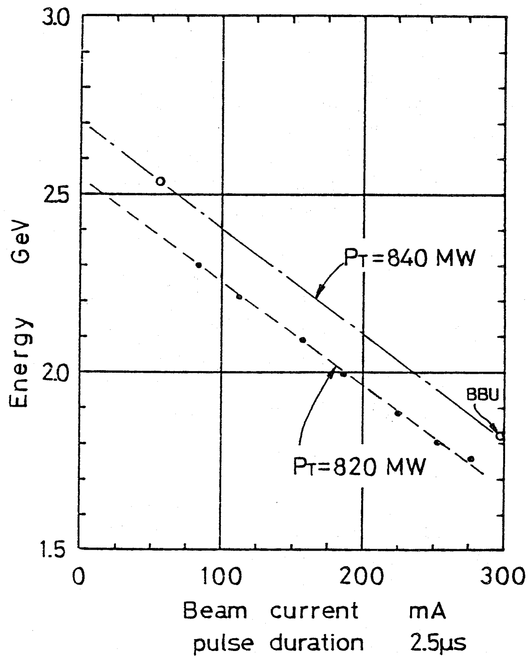

Fig.2 Measured beam energy versus beam current for constant rf power.

With the advance of adjustment for the injection system, beam trapping efficiency was increased up to the expected value of 70%. The beam spill over the five accelerator sectors was reduced to within 1% owing to the improvement of the beam monitoring system and the adjustment of the beam focusing system.

In a high energy or long multi-plefeed electron linac, the beam energy and the energy spread are influenced by a phasing of the respective accelerator guide's rf waves. Conventionaly, the rf waveform at each accelerator guide is displayed on a scope and the rf phase is adjusted so that the beam loading effect on the rf waveform gives the maximum. However, the phasing error using the method is rather large (±5 degrees).

A new phasing system was developed and tested. In this, the phases of an accelerating wave and a wave excited by beam are compaired with a reference wave and the phase difference between them is adjusted to be just 180 degrees. The phasing error using the system was within ±1 degree. In near future, the system will be used for automatic phasing of each accelerator guide's rf wave.