STATUS OF THE PHOTON FACTORY 2.5 GEV LINAC

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The general picture and special feature of the Photon Factory 2.5 GeV injector electron linac are described. This report also describes the status of construction and the results of the test operation of some components of the linac.

1. Introduction

The Photon Factory accelerator consists of a 2.5 GeV injector linac and a 2.5 GeV storage ring. The linac will be used not only for the injector of the storage ring but also for the electron and positron injector of the TRISTAN and for other purposes; injector for lower energy small storage rings, for example, 400 MeV, 1 GeV, etc. and for undulators. In addition to the ordinary pulse width (μ second range) beams, the linac is capable of producing very short (ps range) single pulses of electrons and light which will be useful not only for studies of transient phenomena but also for studies of accelerator itself and for development of fast detectors.

2. General description

The linac was designed to accelerate electron beams of 50 mA to energies of 2.5 GeV with a total rf power of 840 MW and to 3.0 GeV with 1,200 MW.

It consists of an injection system, a main accelerator and an energy compression system (E.C.S.). The E.C.S. is added down stream of the main accelerator in order to get stable and narrow energy spread beams. For single bunch beam acceleration, a special injection system and a low jitter trigger system synchronized with an rf wave are provided. The main accelerator is composed of five sectors, each of which contains eight acceleration units. One acceleration unit consists of four 2 m long accelerator guides mounted on a 9 m long cylindrical supporting girder, a 30 MW klystron and a pulse modulator with controller. The power from the klystron is split and fed into the four accelerator guides. The phase lengths of the four feed lines are made so precisely equal that high power phase shifters in the feed lines are eliminated. The results of various tests on a prototype acceleration unit showed that the structure was satisfactory and the phase differences of the four feed lines were within 2.5 degrees. At the end of June 1980, the first acceleration unit was installed in the linac tunnel as shown in Fig. 1.

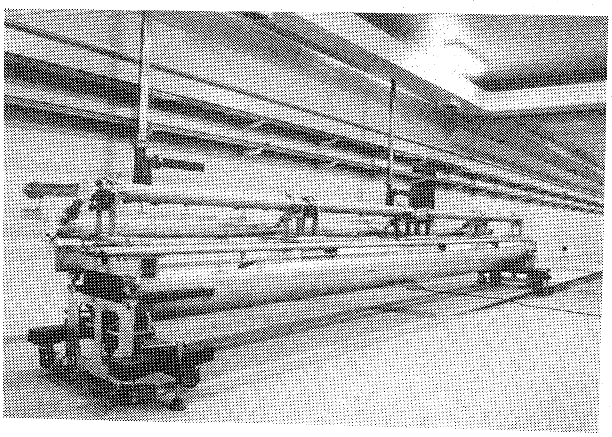

Fig.1 Accelerator unit.

3. Accelerator guide

The accelerator guide is a conventional $2\pi/3$ mode quasi-constant gradient type; the disk hole diameter decreases linearly along the length. This structure makes possible mass production of the accelerator guides in precision, and also makes division of the accelerator guides into five different types (A ∿ E) easy, so as to reduce beam blow up effects. The accelerator guide are made by means of an electro-plating method. In order to fabricate many accelerator guides in a limitted period, automation was widely introduced into the production processes. Due to the method, the phase shift error of each cell of the completed guide is less than ±2 degrees without any tuning process. As the results of high power rf tests, 30 MW was successfully fed into one of the accelerator guide which is five times as large as the designed value for 2.5 GeV acceleration at 50 mA loading. 37 accelerator guides were completed in the 1979 fiscal year.

4. RF power source

The rf system is composed of following stages; a 476 MHz master oscillator, a 476 MHz C. W. booster klystron, frequency multipliers, 2856 MHz booster klystrons (pulsed) and final 30 MW klystrons.

Pulse modulated 476 MHz waves are also suitable as low jitter (<20 ps) trigger signals which are especially important for single bunch beam acceleration and detection.

High power klystron with focusing permanent magnet was developed. The performance of the klystron was successful and more than 30 MW of rf power was obtained at 270 kV and 280 A. The focusing magnet is composed of numerous Alnico 9 rods packed cylindrically. The charging test was successfully performed and desired maximum field and field distribution were obtained.

Test operation of the prototype pulse modulator has been continued since April 1979, and the pulse to pulse variation of less than 0.1 % was obtained. In April 1980, 12 modulators were installed in the klystron gallery.

5. Injection system

The injection system has two functions. The first is production and acceleration of μs range electron beam pulses. After acceleration to an energy of 30 MeV, the beam is injected into the main accelerator. The second is to produce intense single bunches isolated from the finestructure of 2856 MHz or the satellites. In order to satisfy these requirments, the injection system has a special composition; an intense and fast (<2 ns) electron gun, a subharmonic buncher, a prebuncher, a short buncher, two-2 m long accelerator guides, beam focusing system and beam diagnostic system.

6. Control system

The control system consists of a distributed processor network interconnected in loops by serial communication circuits which are classified into three ranks: Loop-I (5Mbit/s), Loop-II (500kbit/s) and Loop-III (48kbit/s). Nodes of Loop-I are seven minicomputer stations. Terminal nodes of Loop-II and III are various microprocessor-controlled units: Gun and klystron-pulse modulator controllers (Loop-II), focusing system controllers, vacuum system controllers, etc. (Loop-III). In order to avoid troubles due to intense noises, optical fiber is used for the communication loops.

At present, Loop-I with seven minicomputer stations, camac modules connected to the minicomputers, pulse modulator controllers, etc. are in test operation.