Developments and Upgrades of Linac

Accelerator stabilization

A klystron modulator used for the SPring-8 linac employs the de-Q'ing type voltage regulation technique. In this kind of circuit, an induction voltage regulator (IVR) coarsely adjusts a dc high voltage and the following de-Q'ing trigger circuit finely controls the charging voltage of a PFN. If the dc high voltage could not sufficiently stabilized, the de-Q'ing circuit cannot accurately regulate the PFN voltage. We recently observed a maximum voltage variation of 5% throughout a day in a 400 V ac line at the SPring-8 site. The de-Q'ing circuit cannot sufficiently suppress the PFN voltage variation caused by this large line variation, which often results in negligible klystron's RF-power and phase variations. Therefore we have reexamined the entire regulation circuit to improve the IVR control. The improved controller coarsely regulates the IVR's output voltage in order to maintain the variation within ±1%. This improved regulation consequently reduced the previous long-term variation to 0.03% rms throughout a week, which corresponded to the RF power and phase variation of about 0.08% rms and 0.2 degrees rms, respectively.

Reduction of dark currents

The SPring-8 linac accelerates electron beams by dark currents from a gun or accelerating structures, as well as main electron beams with a pulse width of 1 or 40 ns. These dark currents can be the background of an electron beam injection into a booster synchrotron, and then it consequently spoils the purity of a single bunch circulating in the storage ring. The 1 GeV dark currents originate mainly from two components: electron emissions from a gun grid and field emissions in accelerating cavities of the injector section. We have first tried to reject the former emission currents using a beam deflector [11] before it is accelerated by linac's buncher cavities. The deflector itself is composed of a rectangular chamber with two parallel-plate electrodes inside it, as shown in Fig. 8. The 180 keV electron beam is horizontally deflected with an angle of 110 mrad when a pulsed electric field of 7 kV is applied between both electrodes; then, it is blocked by an iris plate placed 150 mm downstream.

We have measured the purity of the single bunched beam stored in the 8 GeV storage ring by a photon counting technique. Figure 9 shows the charge distributions around the main bunch circulating in the storage ring when the deflector is in or out of operation. These experimental results clearly prove that the deflector has filtered out the faint charges around the main bunch, which were observed when the deflector was not in operation.

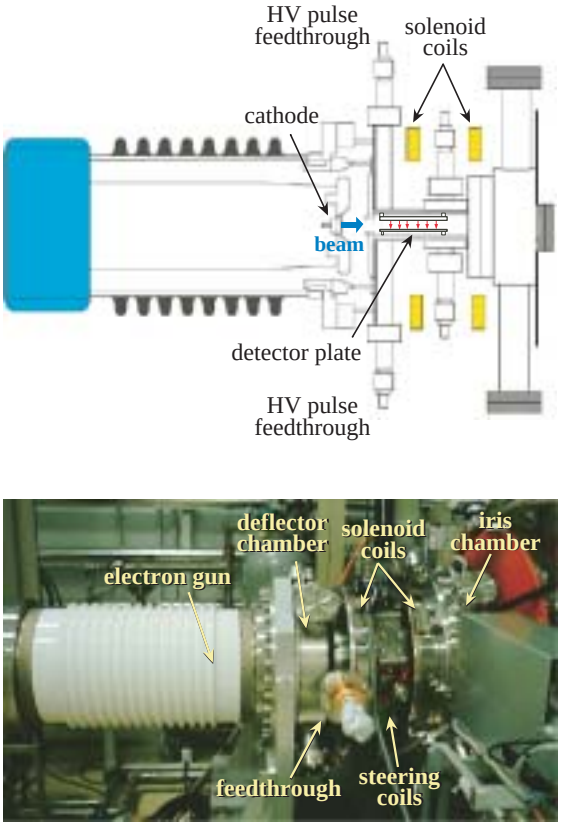

Fig. 8. Electron gun and beam deflector.

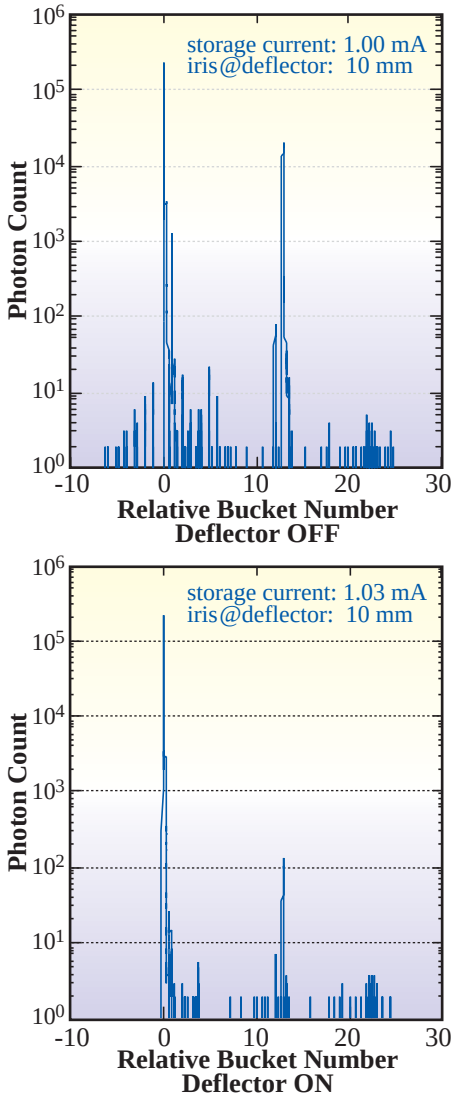

Fig. 9. Charge distribution of the single bunch beam stored in the 8-GeV storage ring.

RF gun development

We have started the development of a cartridge-type photocathode in collaboration with Hamamatsu Photonics and the University of Tokyo [12]. The cartridge-type photocathode, which is manufactured in a factory, is expected to have reproducible high quantum efficiency (QE) and be easy to handle even in small laboratories. The first prototype is a Cs_2Te cathode encapsulated in a glass cartridge, as shown in Fig. 10. A revolver system, which can hold four cartridges, is attached to a cathode plate of an RF gun cavity. The procedure for charging the cavity with a cathode plug is as follows: A coaxial mover slides a cartridge out of the revolver and then a Kovar foil sealing the cartridge is broken by a pair of cutters similar to a bird's bill. An inner rod of the mover pushes the cathode plug out of the cartridge and mounts it into a cathode-plug hole of the cavity. Conditioning and high-field tests have been carried out on the prototype cartridges. The maximum accelerating field reached 90 MV/m, however, the QE of the photocathode deteriorated from 3% to 1% in one day. We are improving the fabrication method of the photocathode surface to control the deterioration of the QE. A new cathode will be tested in 2004.

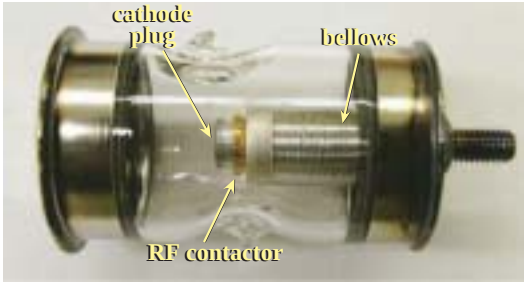

Fig. 10. Prototype cathode cartridge.

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Haruo Ohkuma, Hiroto Yonehara, Hirofumi Hanaki and Noritaka Kumagai
SPring-8 / JASRI