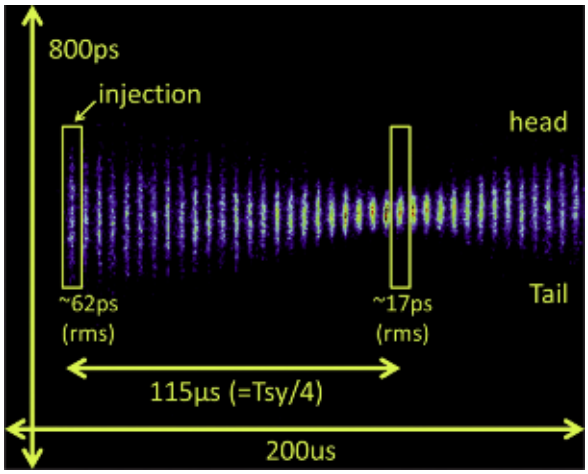

Fig. 9. Example of the results of turn-by-turn bunch length measurement of injection beam from booster synchrotron by VSC at diagnostics beamline I.

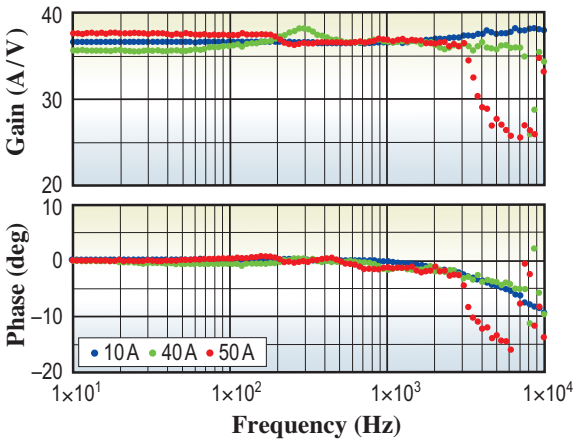

Fig. 10. Measured frequency responses of power supply.

Research and development of femtosecond pulse X-ray generation

An X-ray with an energy of 10.7 keV and a pulse width of 600 fs in two standard deviations can be generated with a short-pulse generator using superconducting crab cavities in one of the long straight sections of the storage ring. A phase stability within 14 mdeg among the crab cavities is required to realize this scheme [10]. We developed a 300 kW phase shifter to stabilize the phase fluctuation and found that its performance could satisfy this requirement [11]. In this report, we describe a power supply developed as a driver of this phase shifter, which is an inductive load of 50 μH/40 mΩ.

The power supply consists of DC power supplies whose voltages are powers of 2, such as 4 V, 8 V ... and 256 V, and power MOSFET switches. Its driving frequency range is from DC to 10 kHz with a current of 50 A and a voltage of 550 V. We measured the frequency response of the power supply in an offline test using a load with the same impedance as that of the phase shifter. Preliminary results for driving currents of 10 A, 40 A and 50 A are shown in Fig. 10. Although several improvements in the stability and reliability are needed for the power supply, tests on the important parameters have already been completed.

Developments and Upgrades of Linac

Development of RF isolator for vacuum waveguide system

Although the RF waveguide systems for the regular section of the linac are evacuated by ion pumps, the waveguide system for the injector section, which is equipped with circulators, is filled with a pressurized SF_6 gas because a vacuum-type circulator has not yet been developed.

An RF phase of a microwave propagated in such a pressurized waveguide varies along with fluctuations in its insulation gas pressure, the atmospheric pressure and its body temperature. This RF phase variations result in non-negligible beam instability. Now, we are planning to update the SF_6 waveguide system to a vacuum-type one to improve its RF phase stability and renew its aged components. As SF_6 is a type of global greenhouse gas, its usage should also be reduced. We thus started an R&D of vacuum-type circulators and isolators.

Since the outgassing rate from garnet ferrites used in a circulator was expected to be very large, we measured it at an estimated operation temperature of 100°C. It was found that the outgassing rate is only about 34 times larger than that of typical stainless steel and is acceptable for evacuation by ion pumps.

Next, we examined various methods of bonding of ferrite and copper. It was found that solder bonding with a holder ring and the segmentation of ferrite could realize sufficient mechanical strength and good thermal conductivity.

As the RF power for pre-bunchers is low, we first developed an isolator in which a ferrite plate transmits the forward RF power and absorbs the backward one. The isolation of 13 dB and an insertion loss of 0.3 dB for a power lower than 100 kW were achieved with the prototype isolator shown in Fig. 11. We expect that the isolation can be improved by lengthening ferrites and magnets. Actual models of the isolator are under production.

Fig. 11. **(a)** Prototype isolator composed of waveguide and permanent magnets. **(b)** Rectangular ferrite plate bonded to internal surface of waveguide.

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