

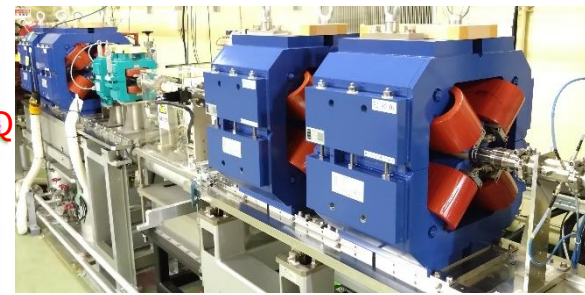
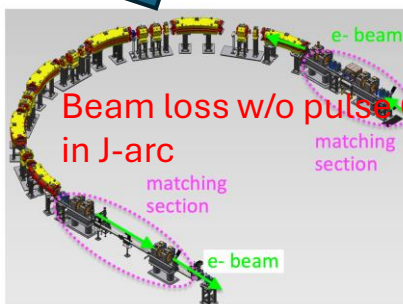
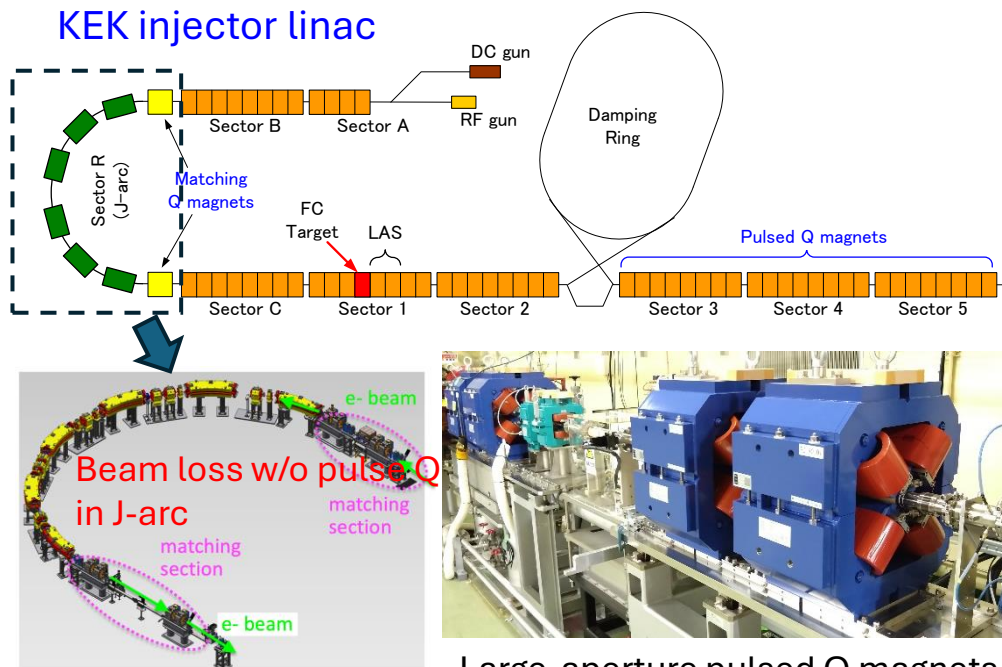
Development of new pulse driver for high power pulsed magnet

Takuya Natsui KEK

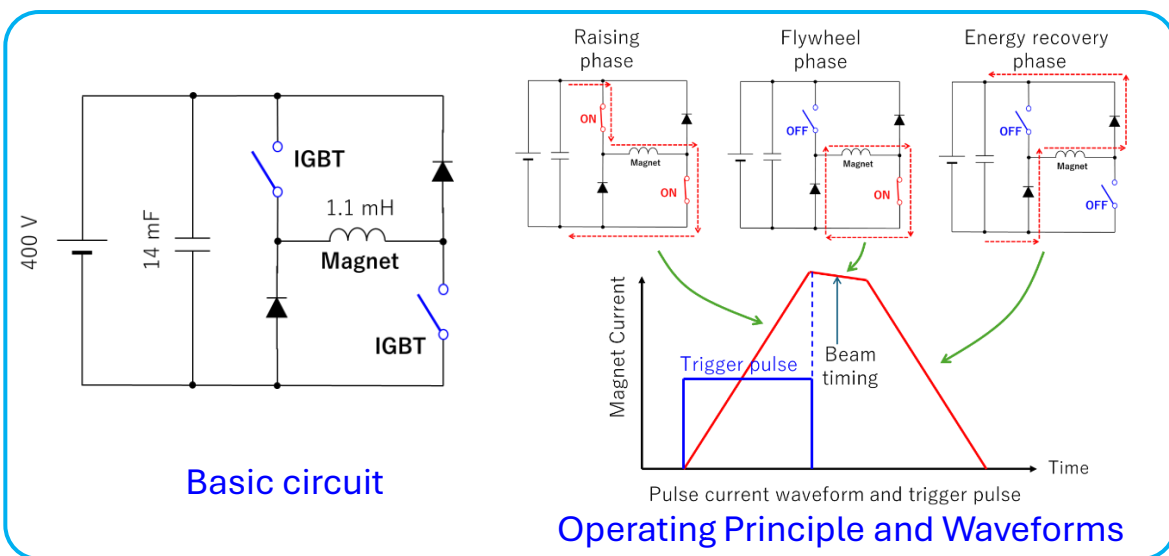
Introduction

The KEK injector linac injects electron and positron beams into four rings: the high-energy ring (HER), low-energy ring (LER), PF ring, and PF-AR. These rings require beams with different charges and energies, with the LER beam being a positron. Simultaneous top-up injections into the four rings were achieved at 50 pps. Pulsed magnets are installed downstream of the linac to inject different beams pulse-to-pulse. Pulsed quadrupole magnets require a pulsed current of 300 A, using an energy-recovery-type pulse driver. However, due to their small aperture, these quadrupole magnets cannot be installed upstream where the beam size is larger, especially for the positron primary electron beam. Therefore, new larger-aperture quadrupole magnets and high-power pulse drivers were installed. The magnet current is 600 A, requiring approximately four times the power of the old driver. In the summer of 2023, large-aperture pulsed Q magnets were installed upstream of the linac. The new pulse driver operates at 600 A and 400 V, achieving high efficiency with simple pulse-width control.

KEK injector linac



Large-aperture pulsed Q magnets

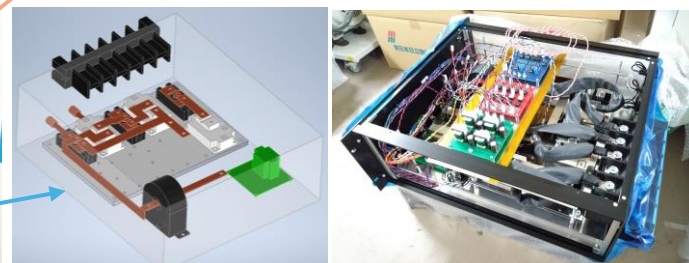
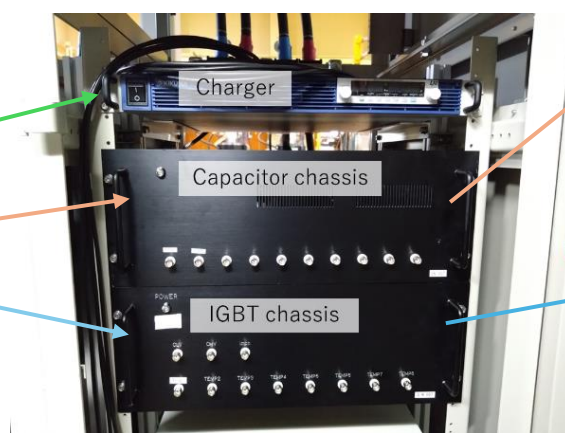
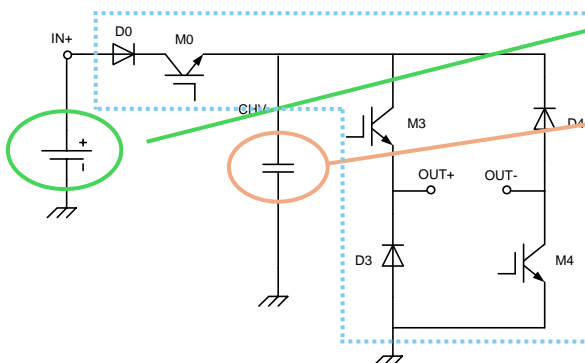


	PM_32_4 (3-5 sector)	New PM_R0_01 (J-arc)
L@ 1 kHz	1.0 mH	1.1 mH
Max Current	330 A	600 A
Gap	φ20 mm	φ44 mm
Length	200 mm	300 mm
Magnetic field	60 T/m	20 T/m

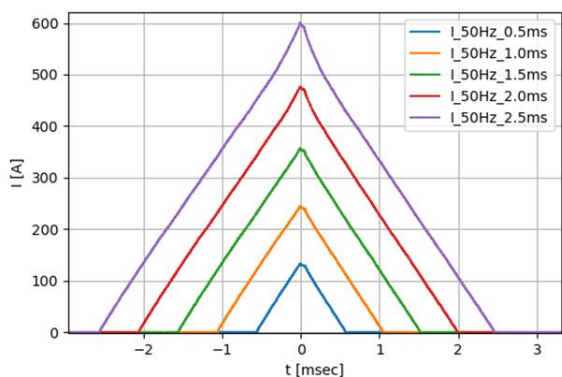


1 mF capacitor x14 in Capacitor chassis

The pulse driver is housed in two 19-inch rack 4U units.

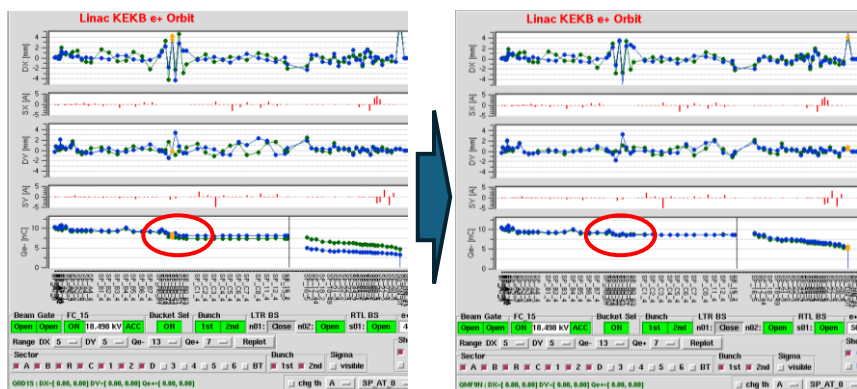


IGBT x3, Diode x3, and control circuit, in IGBT chassis.



Measured current waveform

After the introduction of the pulsed Q magnet, the J-arc section can be adjusted independently, and beam loss has been reduced to almost zero.



Summary

A 600 A 400 V class pulse magnet driver was developed for a KEK electron/positron injector. This high-power pulse driver was used for a large-aperture Q magnet. New drivers and Q magnets were installed in the matching section of the J-arc. The J-arc represents the bending section of the injector linac. The KEK injector performs a 50 pps pulsed operation by injecting individual beams into four rings. For this pulse-to-pulse injection, individual matching in the J-arc is crucial. The large-aperture pulsed Q magnet achieved individual-beam matching. Seven pulsed Q magnets and their high-power drivers were installed in the autumn of 2023. We achieved stable pulse-to-pulse operation with a maximum current of 600 A. Operation with these pulsed Q magnets particularly contributed to an increase in positron beam generation. Thus, high-power pulse drivers contribute to the four-ring high-quality beam injection in KEK.