

High Charge Low Emittance RF Gun for SuperKEKB

Takuya Natsui, Mitsuhiro Yoshida, Xiangyu Zhou, Yujiro Ogawa
High Energy Accelerator Research Organization (KEK)

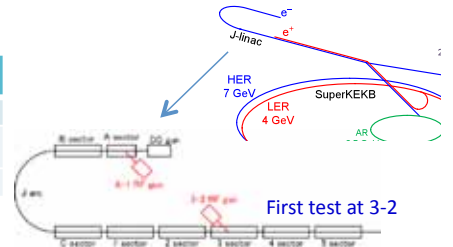


Abstract

We are developing a new RF gun for SuperKEKB. We are upgrading KEKB to SuperKEKB now. High charge low emittance electron and positron beams are required for SuperKEKB. We will generate 7.0 GeV electron beam at 5 nC 20 mm-mrad by J-linac. In this linac, a photo cathode S-band RF gun will be used as the electron beam source. For this reason, we are developing an advanced RF gun. Now, we are testing a Disk and Washer (DAW) type RF gun. Its photo cathode material is LaB₆ or Ir₃Ce. Normally, LaB₆ or Ir₃Ce are used as a thermionic cathode, but they are suitable for long-life photo cathode operation. This gun has a strong focusing field at the cathode and the acceleration field distribution also has a focusing effect. We obtained 3.0 nC beam charge with the RF gun.

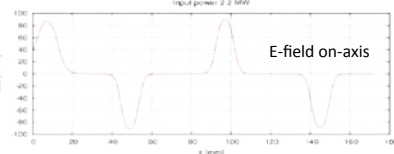
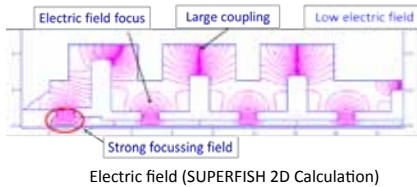
SuperKEKB Beam parameter

	KEKB obtained (e+/e-)	SuperKEKB required (e+/e-)
Energy	3.5 GeV / 8.0 GeV	4.0 GeV / 7.0 GeV
Charge	e- → e+ / e- 10 → 1.0 nC / 1.0 nC	e- → e+ / e- 10 → 4.0 nC / 5.0 nC
Emittance (μm)-mrad	2100 μm / 300 μm	6 μm / 20 μm



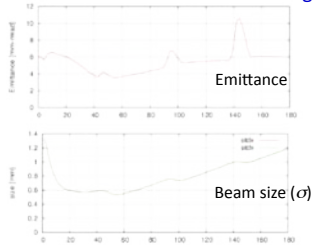
Design of DAW type RF gun

The idea of DAW type accelerating cavity is older method of accelerator. However, DAW type cavity was off from practical use, since it has complicate structure. Fortunately, the machining and calculation technical improvement of these days makes it possible to develop a DAW type accelerating cavity. We adopt DAW type RF gun to achieve high charge low emittance beam generation.



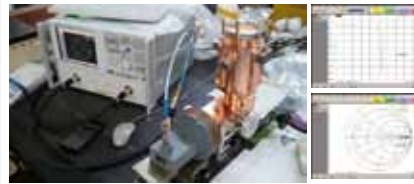
The RF gun has four cavities. These cavities have strong coupling value. It has cathode rod, 3 disks and coaxial coupler. The cathode diameter is 6 mm.

Beam tracking simulation (GPT)



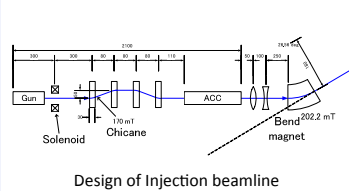
Emittance	6 mm-mrad
Size (σ)	1.2 mm
Bunch length	8 psec
Energy	3.2 MeV

Cavity measurement



Coupling	$\beta = 1.27$
Loaded Q	$Q_L = 2646.4$
Unloaded Q	$Q_0 = 6007.3$

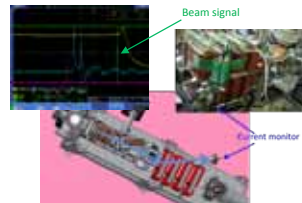
RF gun install



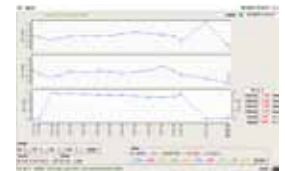
Ir₃Ce cathode

Beam study

Succeed in beam transportation to end of J-linac

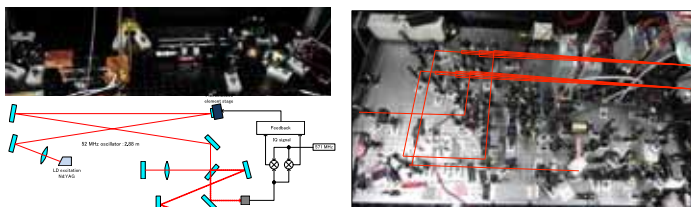


Beam charge measurement



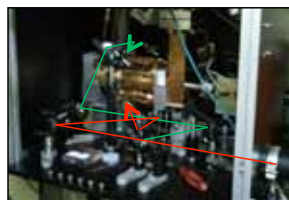
BPM measurement data of beam transport. Beam energy from RF gun is 3.4 MeV with 4.0 MW RF at 2 pps. Beam energy at end of linac is 2.5 GeV.

Laser system



30 psec 1.5 mJ at 266 nm

We were testing a two way laser injection angle which is 0 degree injection and 60 degree injection. The angled injection was expected to improve QE by schottky effect. As a result of RF gun beam measurement, 60 degree injection is effective for QE increase. The measured QE of this cathode is 4e-5. (0 degree injection QE was 1e-5.)



Summary

- Developing a photo cathode Disk and Washer (DAW) type RF gun for SuperKEKB
- In the simulation, 5 nC 6 mm-mrad beam can be generated
- 3.0 nC beam was obtain with Ir₃Ce cathode (QE=4e-5)
- Succeed in PF injection with the RF gun