Magnetic emittance correction with a bucking-coil for JAEA-250KV electron gun

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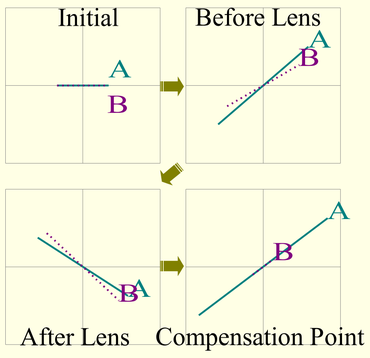
Abstract

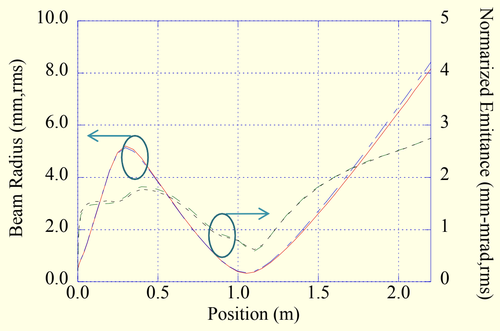
ERL-based next-generation light-sources require an electron beam with an extremely small emittance to generate high brightness, coherent and ultra-short X-rays. In order to satisfy such requirement, the NEA-GaAs photo-cathode DC electron gun has been employed and the development is in progress. It is necessary to take account of so-called magnetic emittance to obtain the electron beam with an extremely small emittance. We have utilized a bucking-coil to suppress leakage magnetic field by a solenoid lens on the surface of the cathode. Correction of the emittance by the exciting current of the bucking coil was measured and calculated.

Solenoid Lens and Magnetic Emittance

- Compensation of linear emittance growth by a solenoid lens



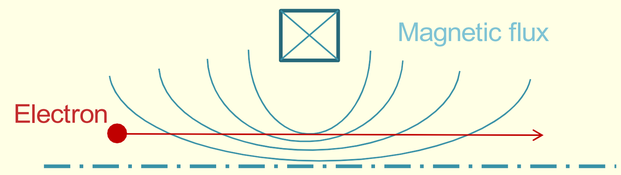
Motion in phase space
(A＞B：Space charge force)



Example of emittance compensation of the beam of 77pC and 40ps (Parmela)

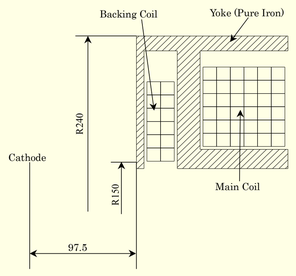
Need bucking coil to cancel Bz at the cathode

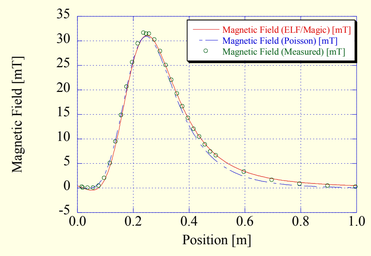
- From Busch's theorem,
  Magnetic emittance is given by $\varepsilon_{mag} = \sigma^2 e|B_z|/2m_0c$



The electron remembers the number of the crossed magnetic flux.

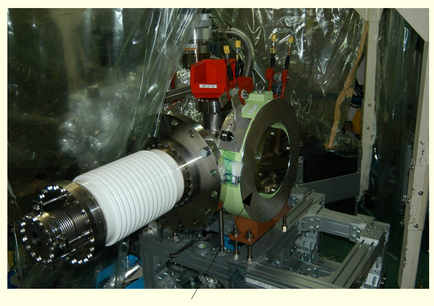
- Size of the solenoid lens





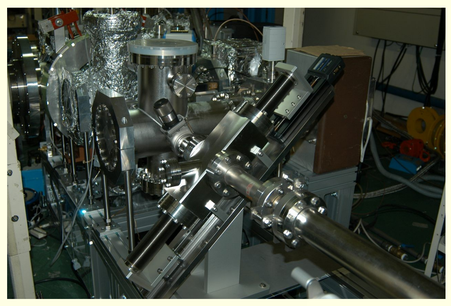
Magnetic field distribution
(Poisson、ELF/magic、Mesured)

Emittance measurement setup

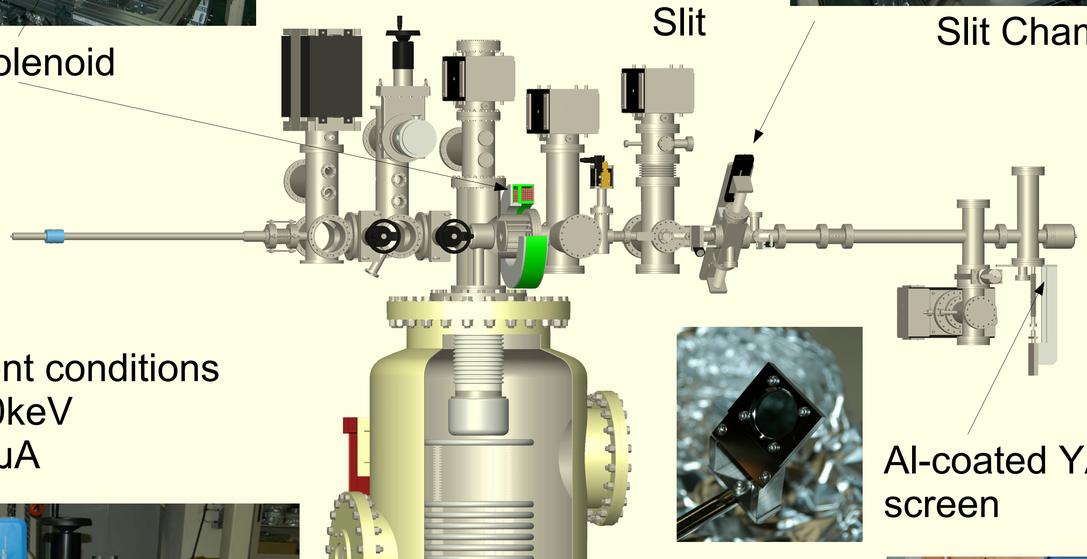


Solenoid

Slit

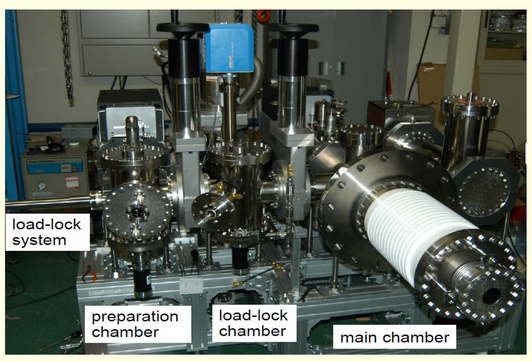


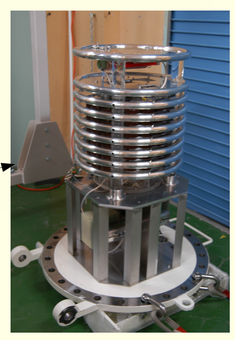
Slit Chamber



Measurement conditions
Energy: 180keV
Current: <1μA

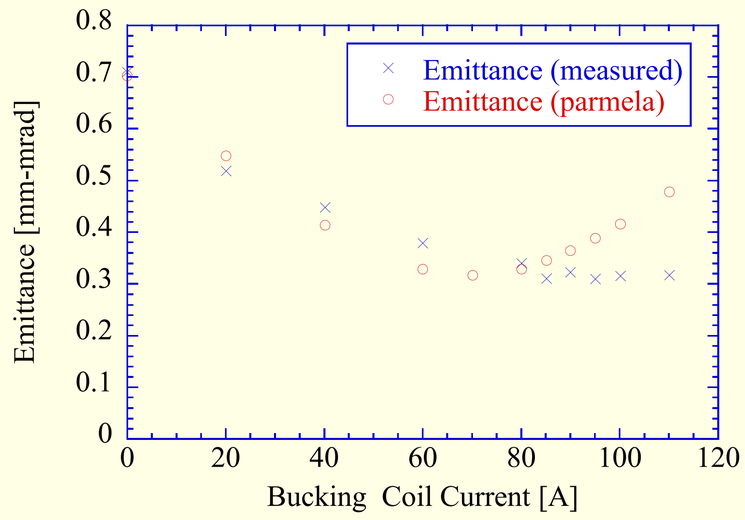
Al-coated YAG screen

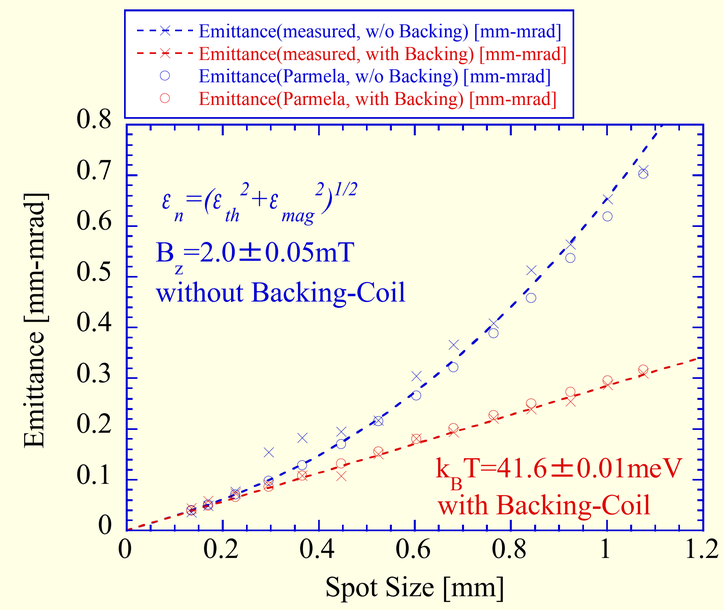




250kV-50mA
Power Supply

Results





Summary

☆The magnetic emittance correction has been successfully demonstrated in JAEA-250kV photo-cathode gun.

☆The leakage magnetic field on the surface of the cathode was fully suppressed by the bucking-coil.