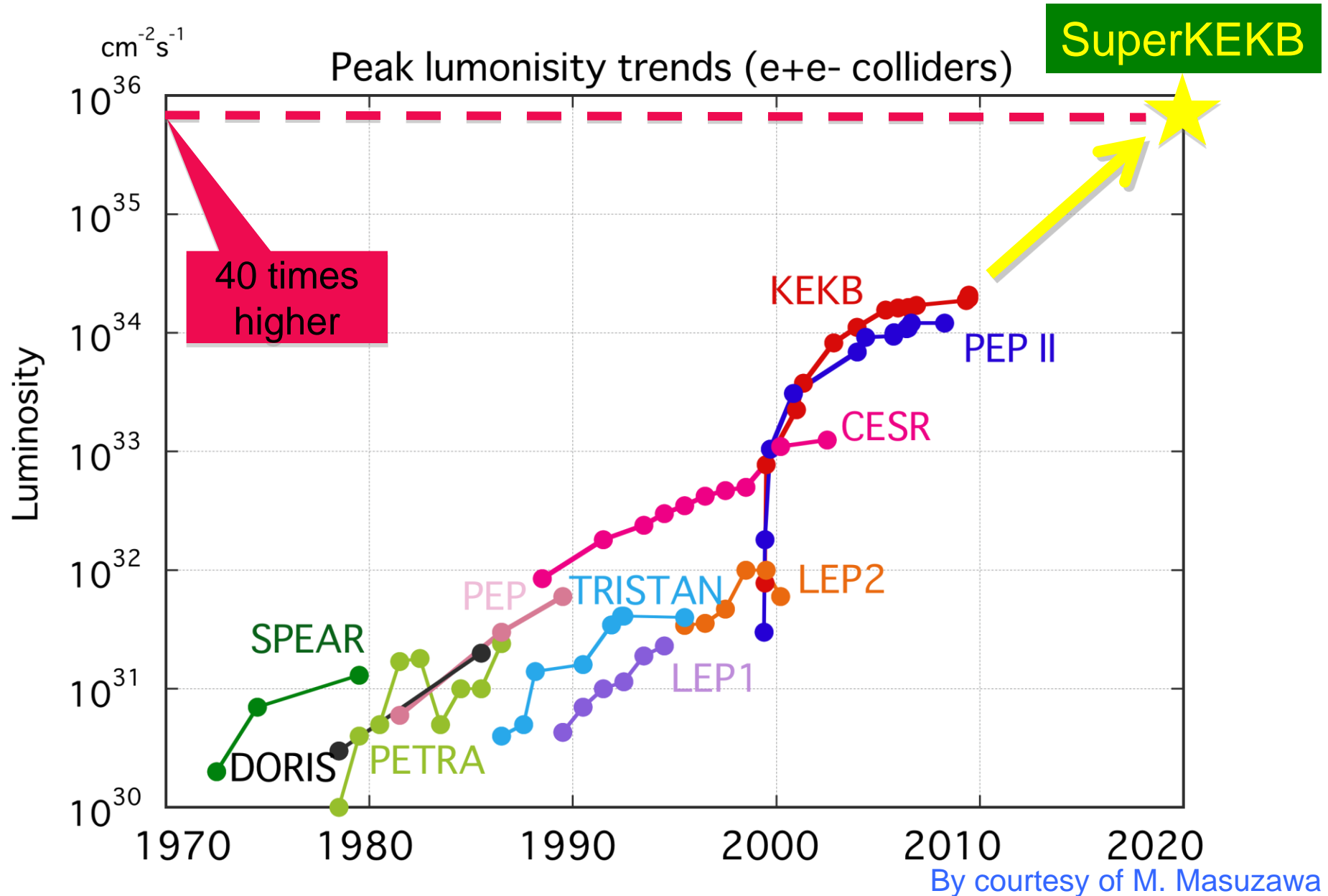


Flux concentrator for SuperKEKB

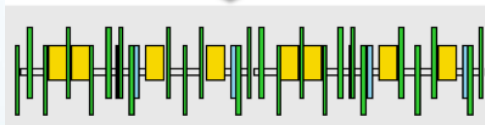
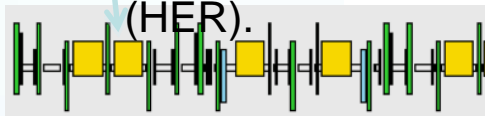
Kamitani Takuya

Luminosity trend

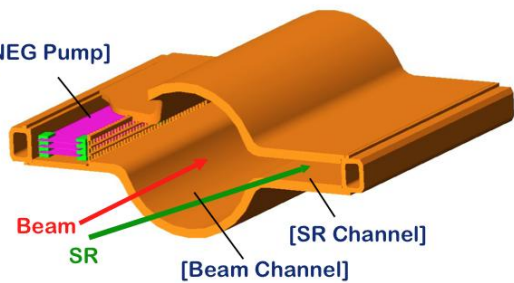




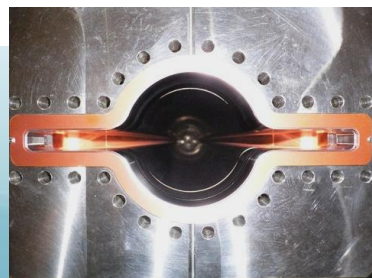
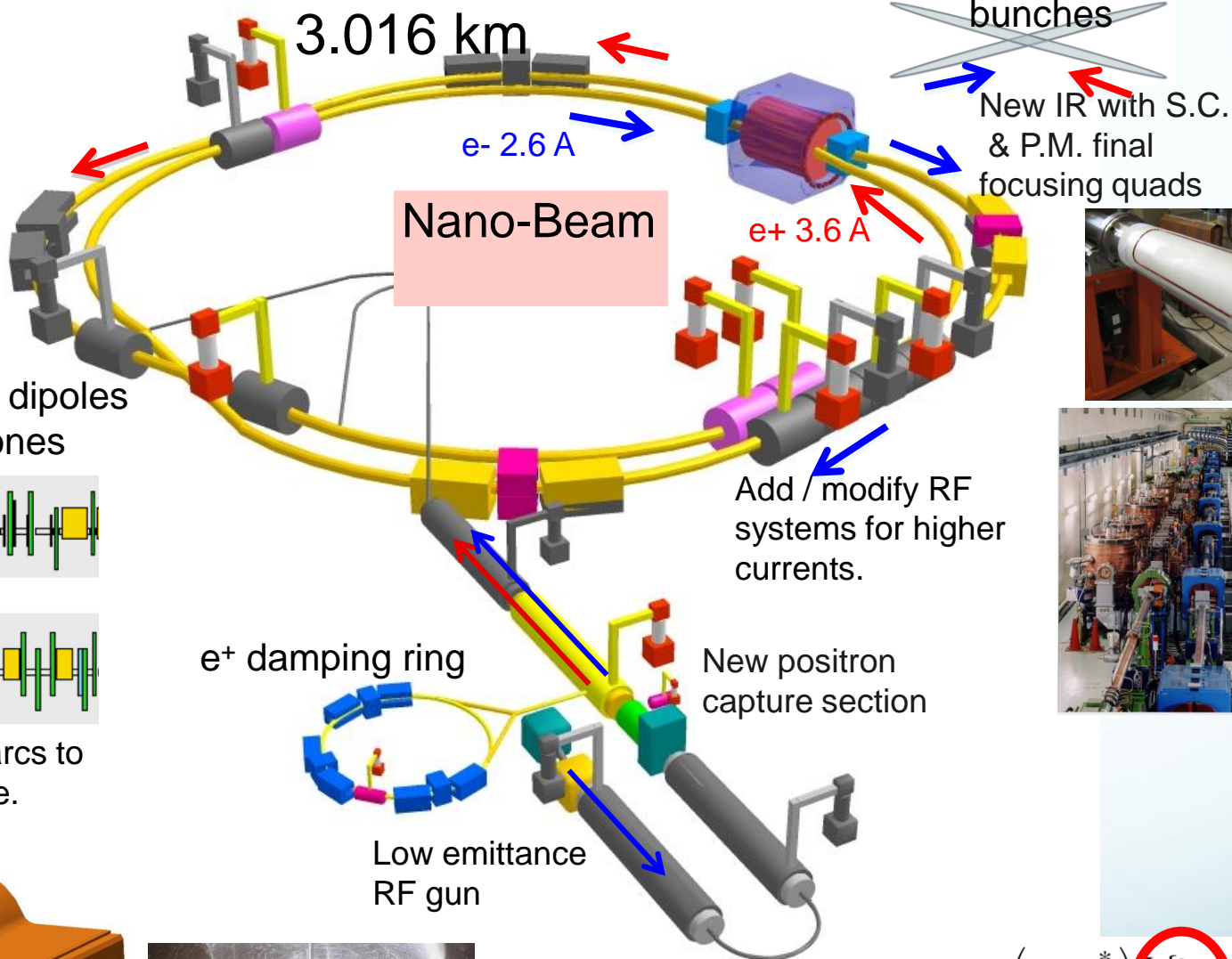
Replace long dipoles with shorter ones (HER).



Redesign the HER arcs to reduce the emittance.



TiN coated beam pipe with antechambers



$$L = \frac{\gamma_{\pm}}{2e r_e} \left(1 + \frac{\sigma_y^*}{\sigma_x^*} \right) \frac{I_{\pm} \xi_{\pm y}}{\beta_y^*} \left(\frac{R_L}{R_y} \right) \div$$

~40 times gain in luminosity

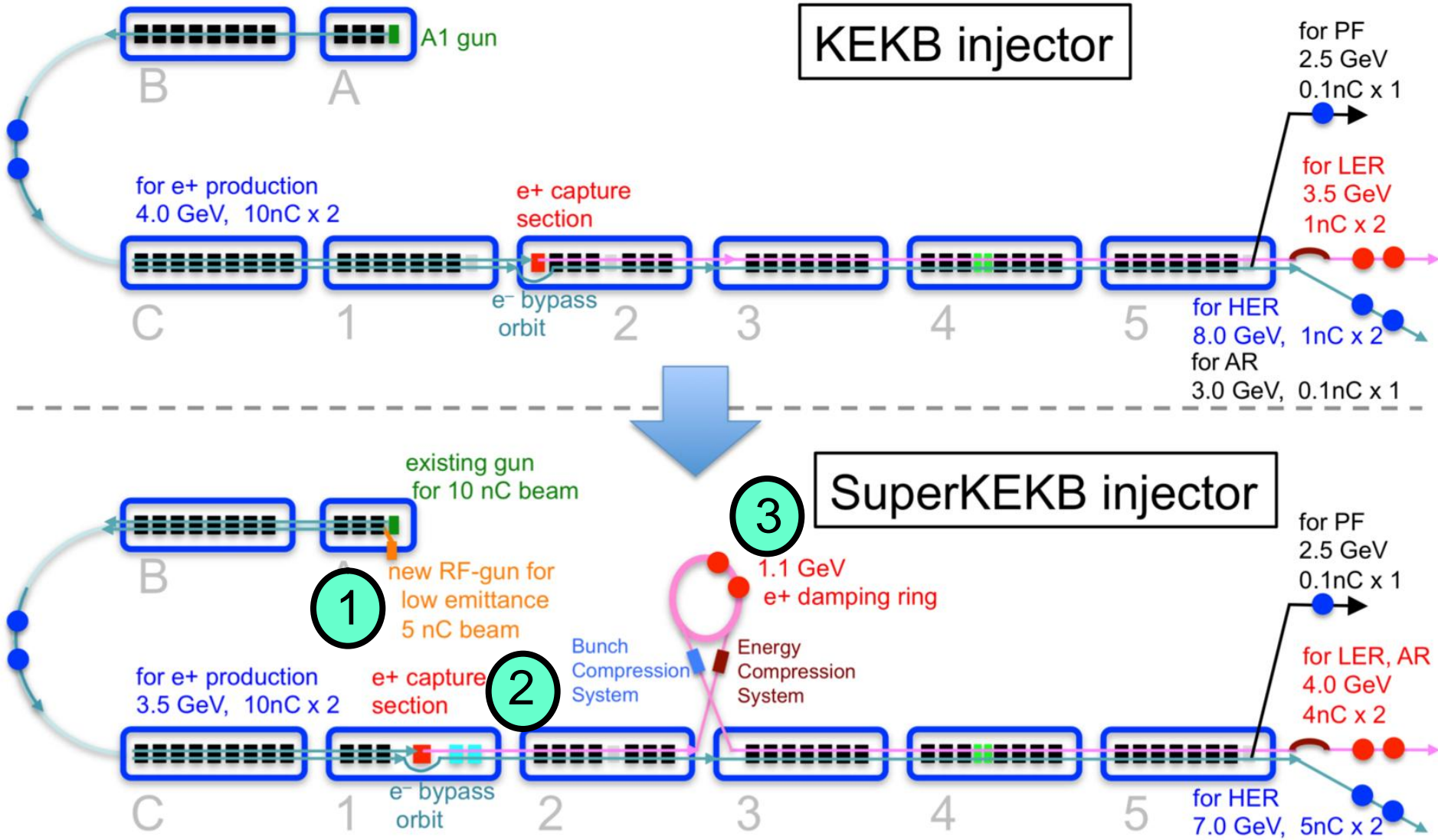
By courtesy of M. Masuzawa

Machine parameters

	KEKB (e+/e-) achieved	SuperKEKB (e+/e-) required
beam energy	3.5 GeV / 8.0 GeV	4.0 GeV / 7.0 GeV
stored current	1600 mA / 1200 mA	3600 mA / 2620 mA
beam lifetime	150 min / 200 min	10 min / 10 min
bunch charge	10 -> 1.0 nC / 1.0 nC	10 -> 4.0 nC / 5.0 nC
# of bunches	2 / 2 ($\Delta t=96\text{ns}$)	2 / 2 ($\Delta t=96\text{ns}$)
beam emittance ($\gamma\varepsilon$)[1 σ]	2100 mm / 100 mm	10 mm / 20 mm
energy spread σ_E/E	0.125 % / 0.05 %	0.07 % / 0.08 %
bunch length σ_z	2.6 mm / 1.3 mm	0.8 mm / 1.3 mm

SuperKEKB requires higher beam intensity &
lower beam emittance for injection

Injector Upgrade

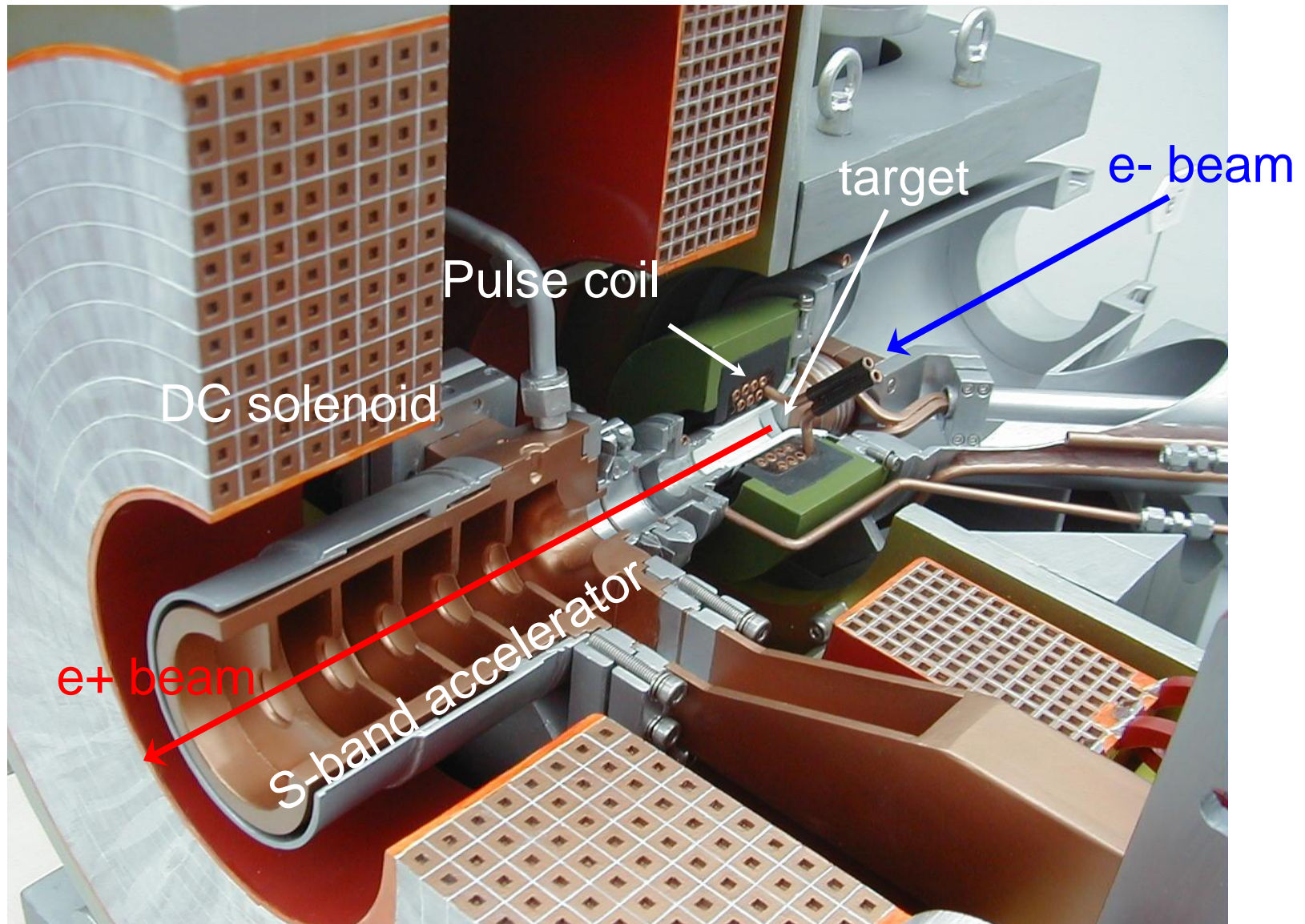


Positron source in the KEKB linac

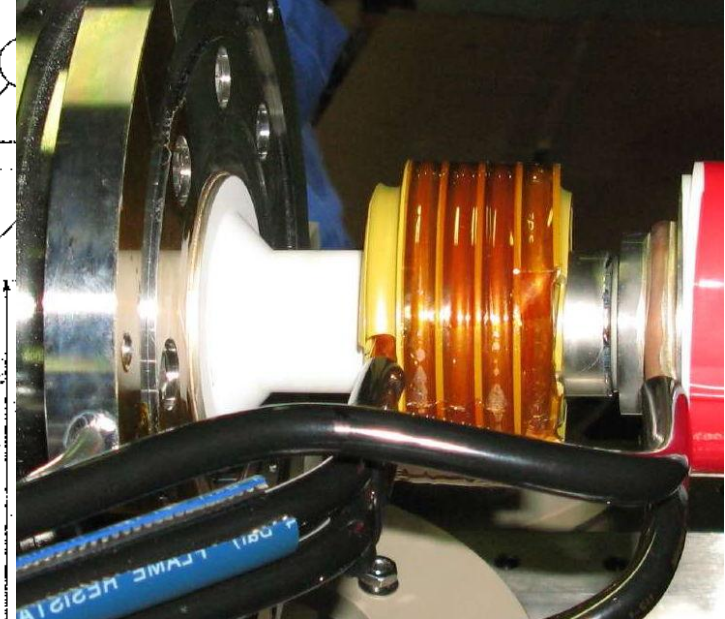
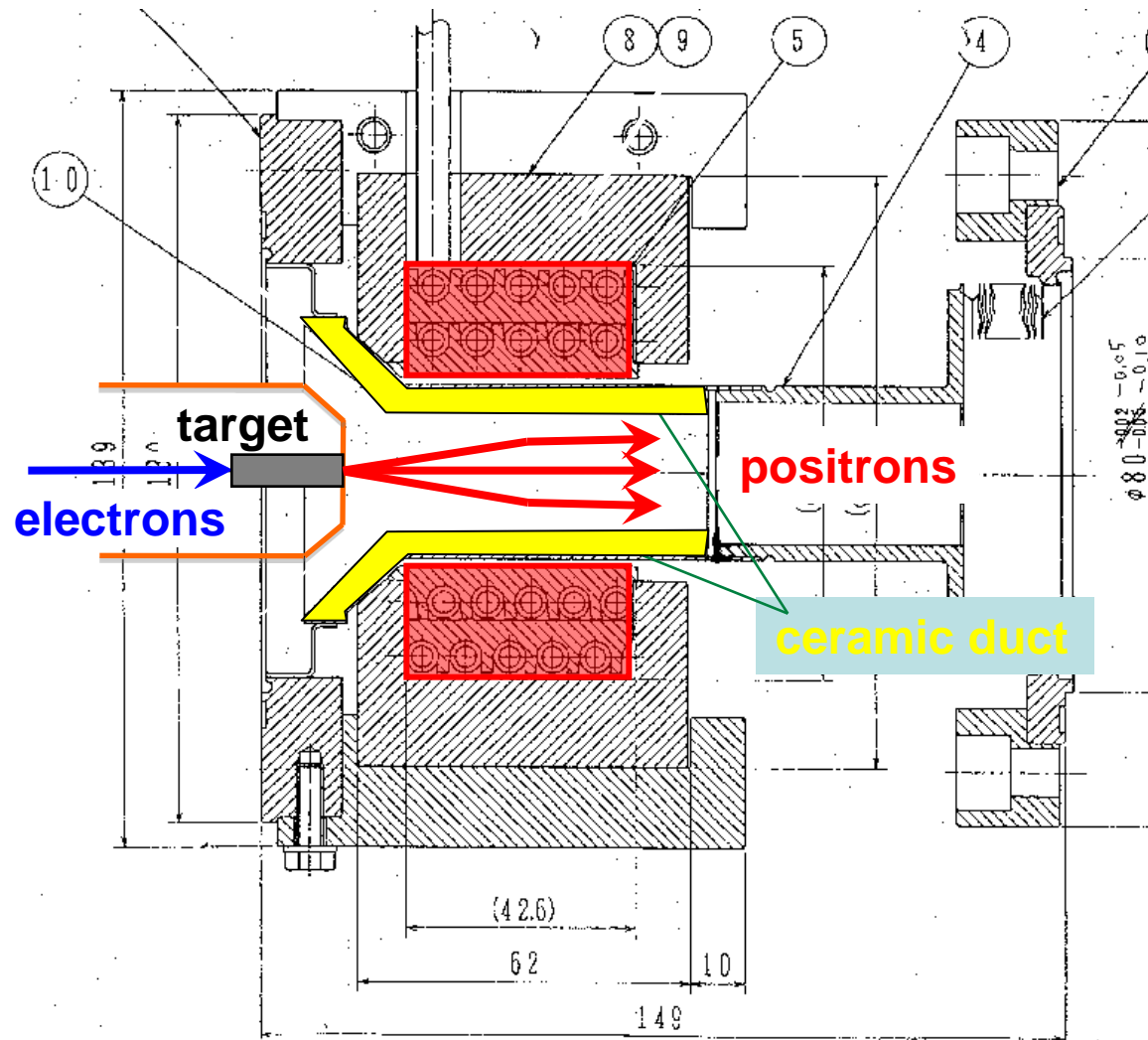


Positron source (cut model)

7



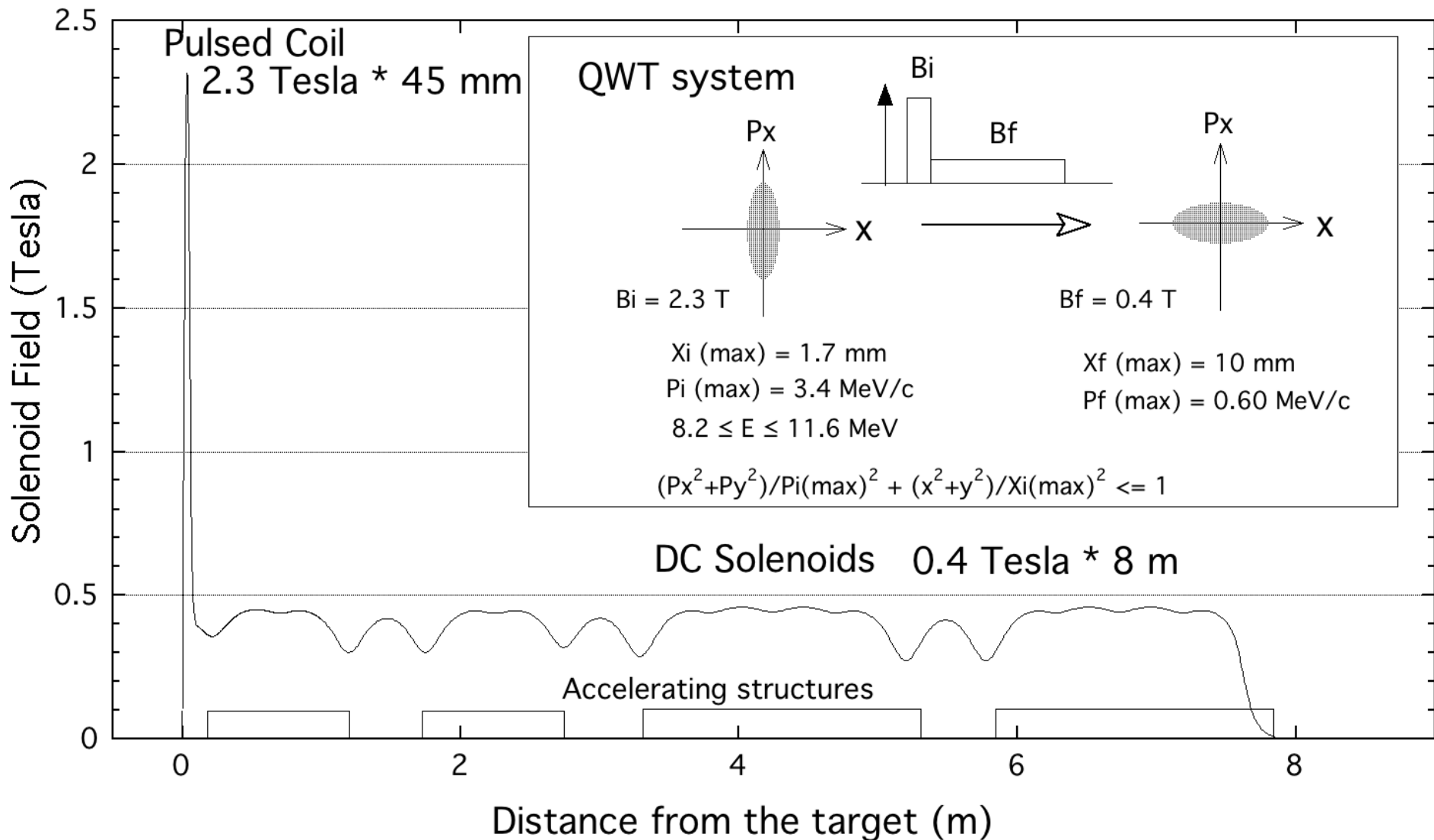
air-core pulse coil



- Peak Voltage 2.0 kV
- Peak current 10 kA
- Pulse duration 100 μ s
- Magnetic field 2.3 T
- Effective length 45 mm
- inductance 4 μ H
- Repetition rate 50 Hz

QWT system

KEKB e+ generator Solenoidal field profile



Positron intensity upgrade

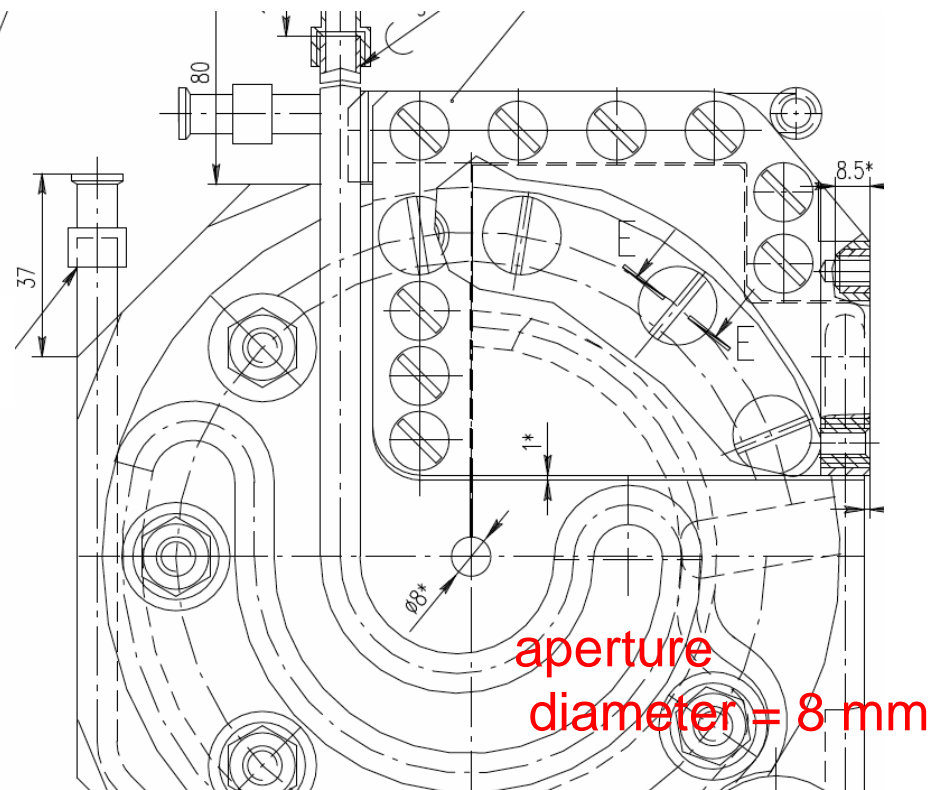
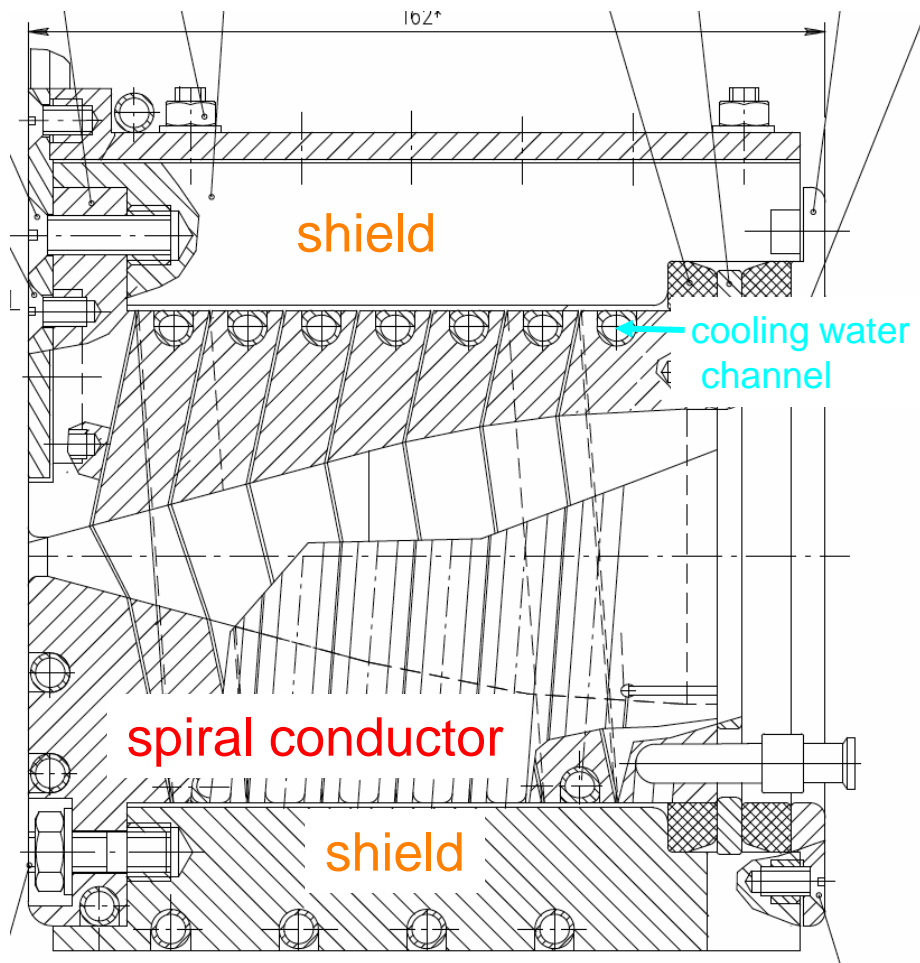
1. stronger focusing solenoid
(adiabatic matching device)
[two candidates]
 - A) FLux Concentrator (FLC) ← this talk
 - B) Superconducting solenoid

2. larger transverse acceptance
with larger aperture accelerating structures
[two candidates]
 - A) L-band structure ($f=1298\text{MHz}$, $2a_{\min}=35\text{mm}$)
 - B) larger-aperture S-band structure ($2a_{\min}=30\text{mm}$)

Collaboration with BINP

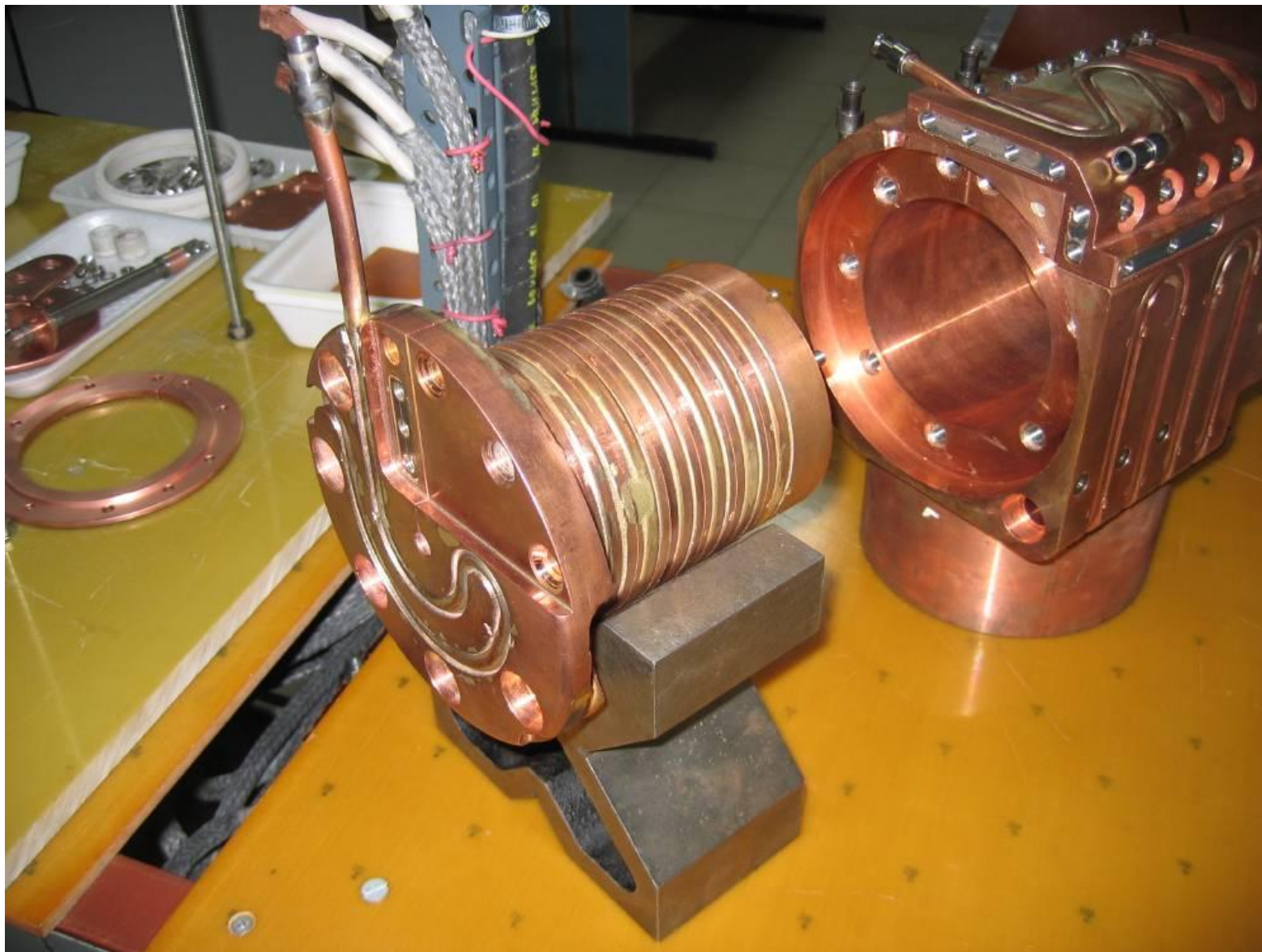
1. BINP has been working on R&D of flux concentrator for the VEPP5 linac and for Linear colliders.
2. BINP suggested a possibility to use flat-face type of flux concentrator for the KEKB injector linac.
3. KEK and BINP started a collaboration on flux concentrator from 2004.

flat-face FLC developed at BINP

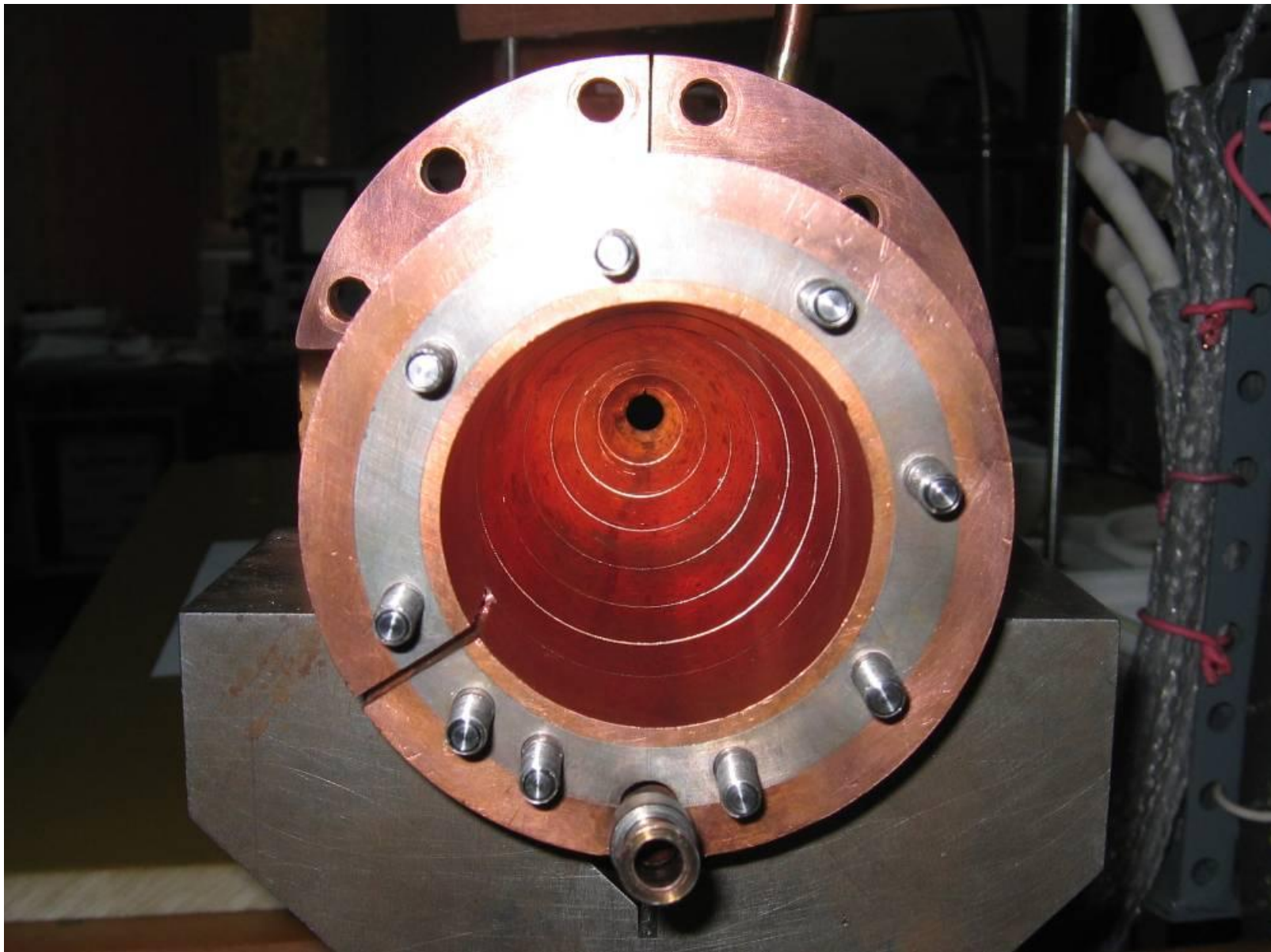


•Peak Voltage	2.0 kV
•Peak current	30 kA
•Pulse duration	25 μ s
•Magnetic field	10 T
•aperture diameter	8 mm
•inductance	0.35 μ H
•Repetition rate	50 Hz

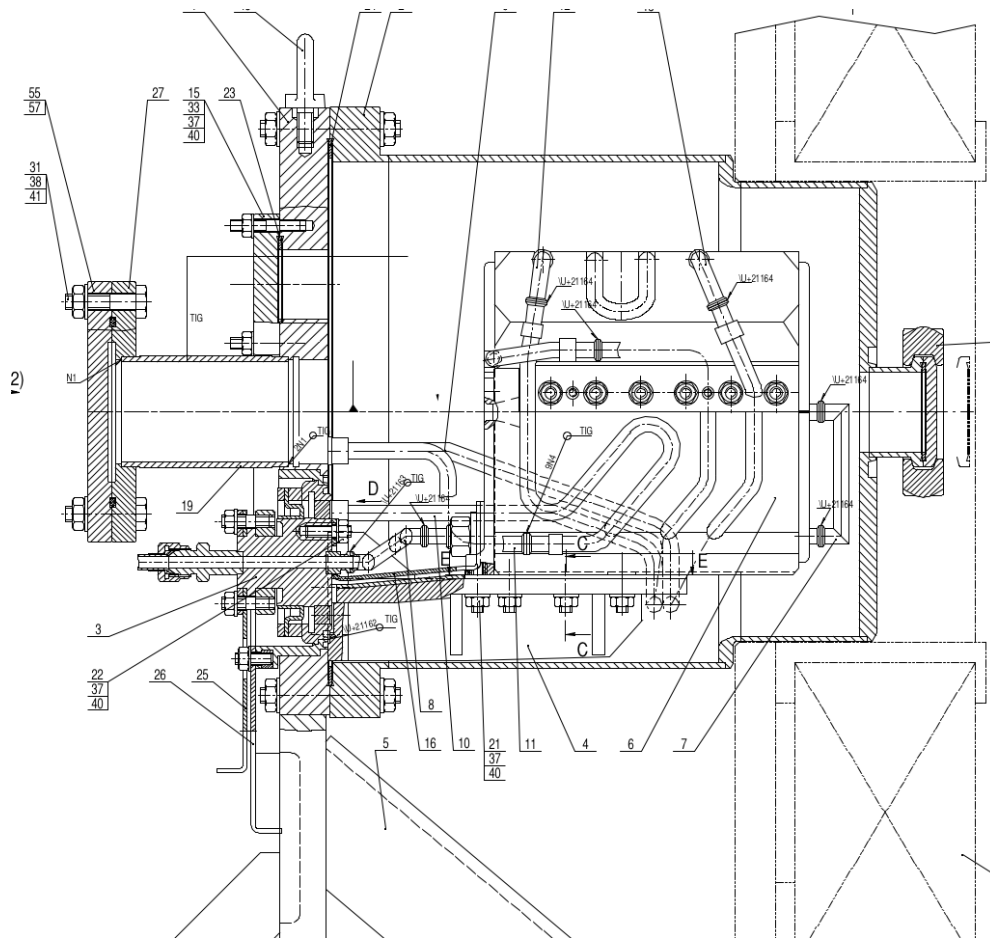
FLC prototype



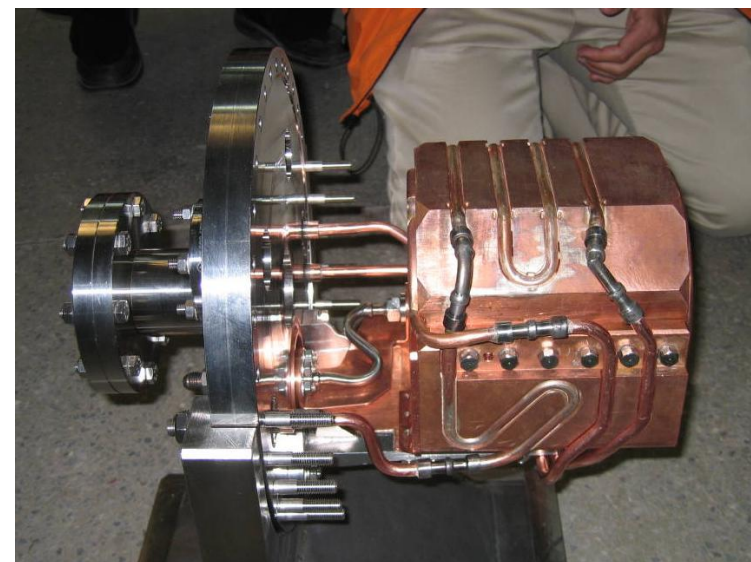
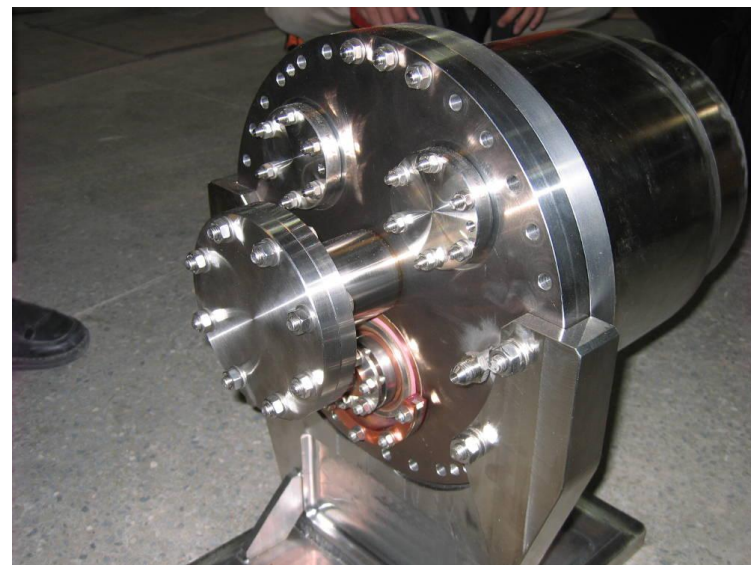
FLC prototype



Installed in a vacuum chamber



Modified vacuum chamber was fabricated at BINP to fit for KEKB linac.



operation test at BINP



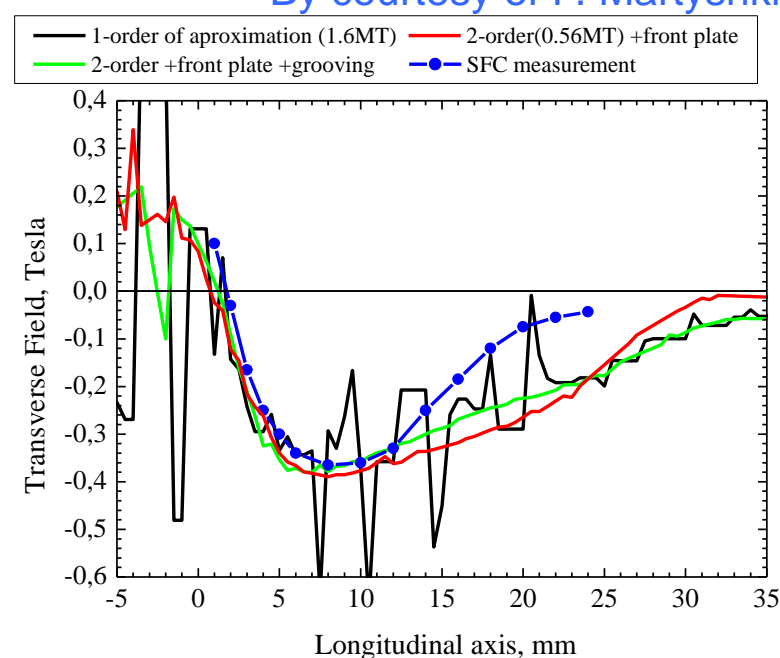
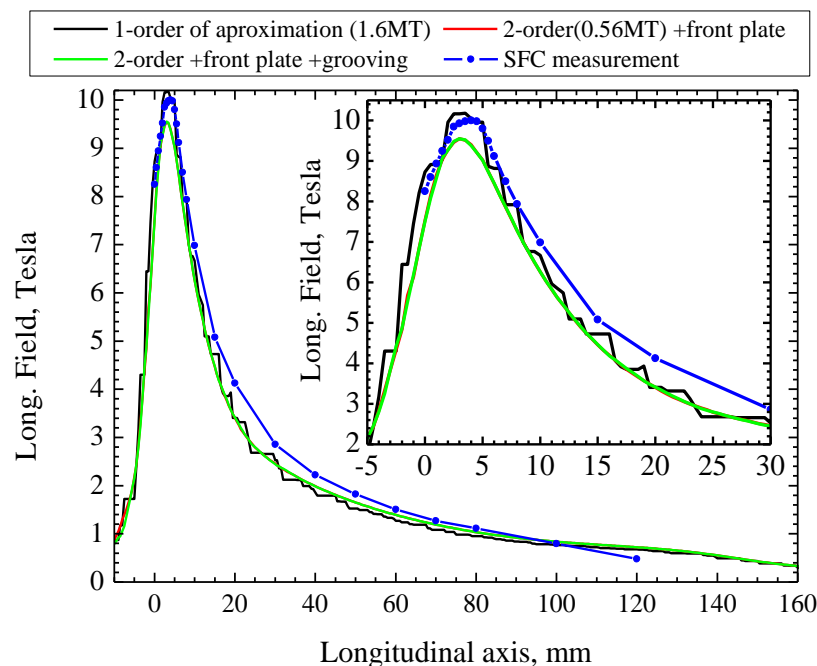
Test result at BINP before shipping to KEK

1. Operation test has been performed for two weeks in September, 2010.
2. In first 5 days, field strength was raised from 5 T to 8 T. Later, operation has been performed at 8.5 to 9.0 T. ($I_{\text{pulse}}=29$ kA at 9 T)
3. 6 to 8 hours operation in a day (only in daytime) at 50 Hz repetition
4. No breakdowns in the FLC magnet and no problems in the power supply for two weeks.

transverse field component

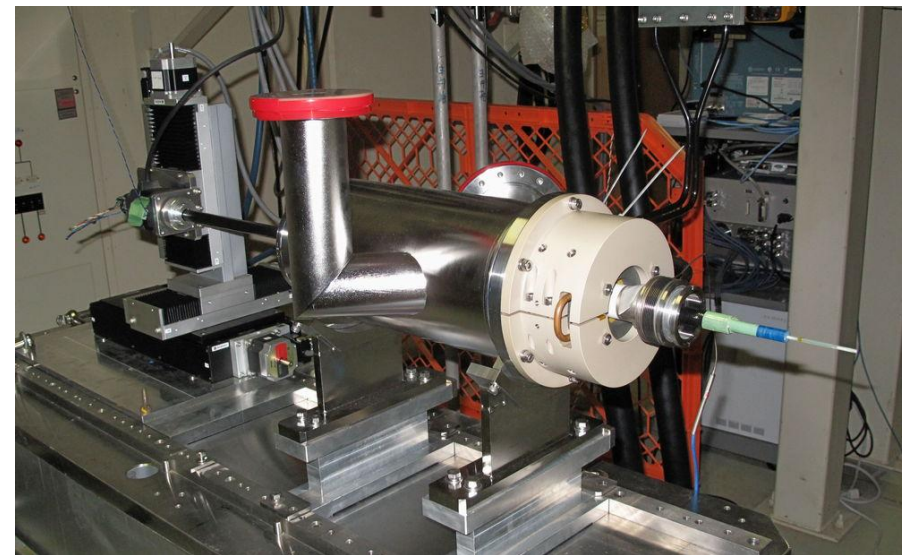
1. non-axially symmetric eddy currents generate **strong transverse field component**
2. transverse kick by that component gives significant beam loss in the magnet
3. tracking simulation with the transverse component is necessary for realistic positron yield estimation.

By courtesy of P. Martyshkin

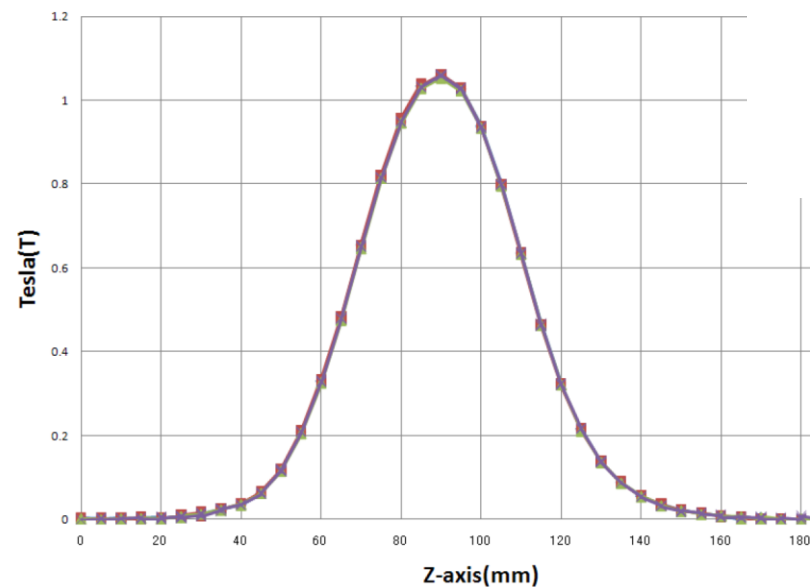
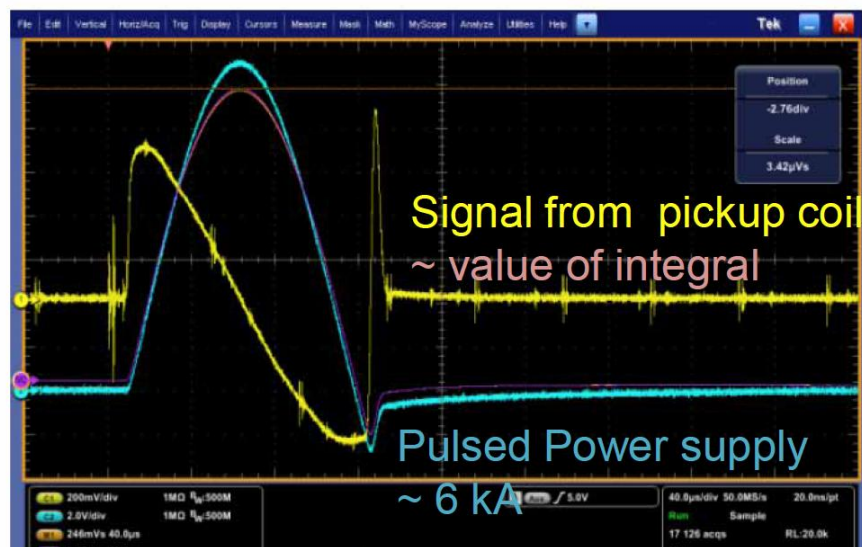


Field mapping system at KEK

1. Field mapping system with a pickup coil on a 3D(x,y,z) movable stage has been developed.
2. Test measurement for a spare air-core pulse coil was successful.

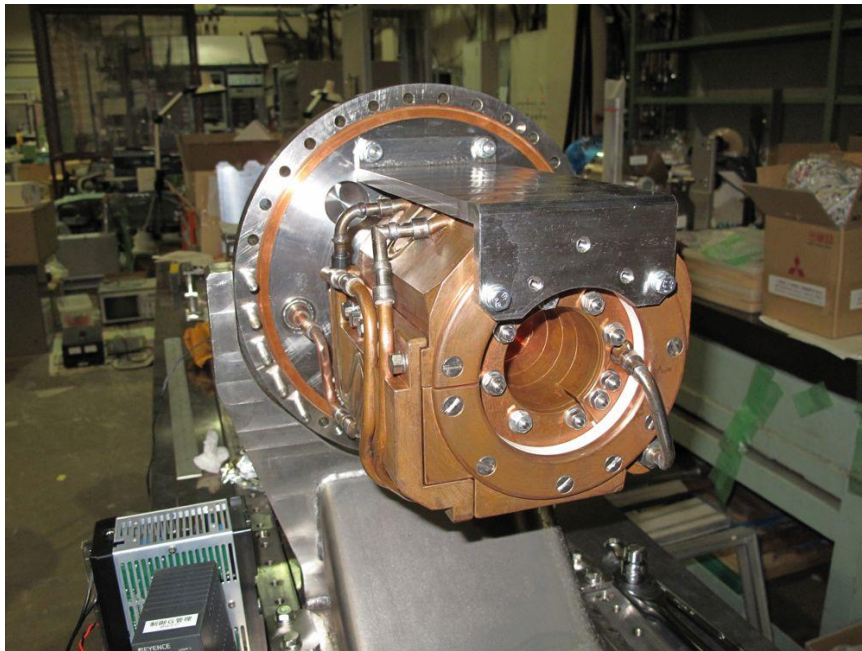


2010/7/22 PulseCoil($I=5.9\text{kA}$)



arrived at KEK

The prototype FLC and the pulse power supply have just arrived at KEK.



Schedule

1. 2010.Oct -> Nov
 - re-assembling the power supply, the FLC magnet and HV cables
 - field mapping measurement
(longitudinal & transverse components)
2. 2010.Dec -> 2011.Jan
 - stand-alone operation test for a reliability check
3. 2011.Feb -> Mar
 - installation into KEKB linac positron source
by replacing the existing air-core pulse coil
 - beam study of positron generation

Summary

- KEK & BINP are collaborating on flux concentrator R&D for upgrade of KEKB injector linac positron source
- **Short-term operation test** has been successfully performed at BINP with a full-power prototype FLC.
- The prototype FLC and the power supply have been **sent to KEK. [arrived today!]**
- After **re-assembling** the power supply and magnet, field mapping measurement will be performed to get a detailed information of the transverse component.
- **Long term operation test** and positron generation **beam study** will be performed at KEK.
- With the results of these test and study, **performance comparison with superconducting solenoid** will be done for final decision of matching device for SuperKEKB.