Present status of KEKB positron source
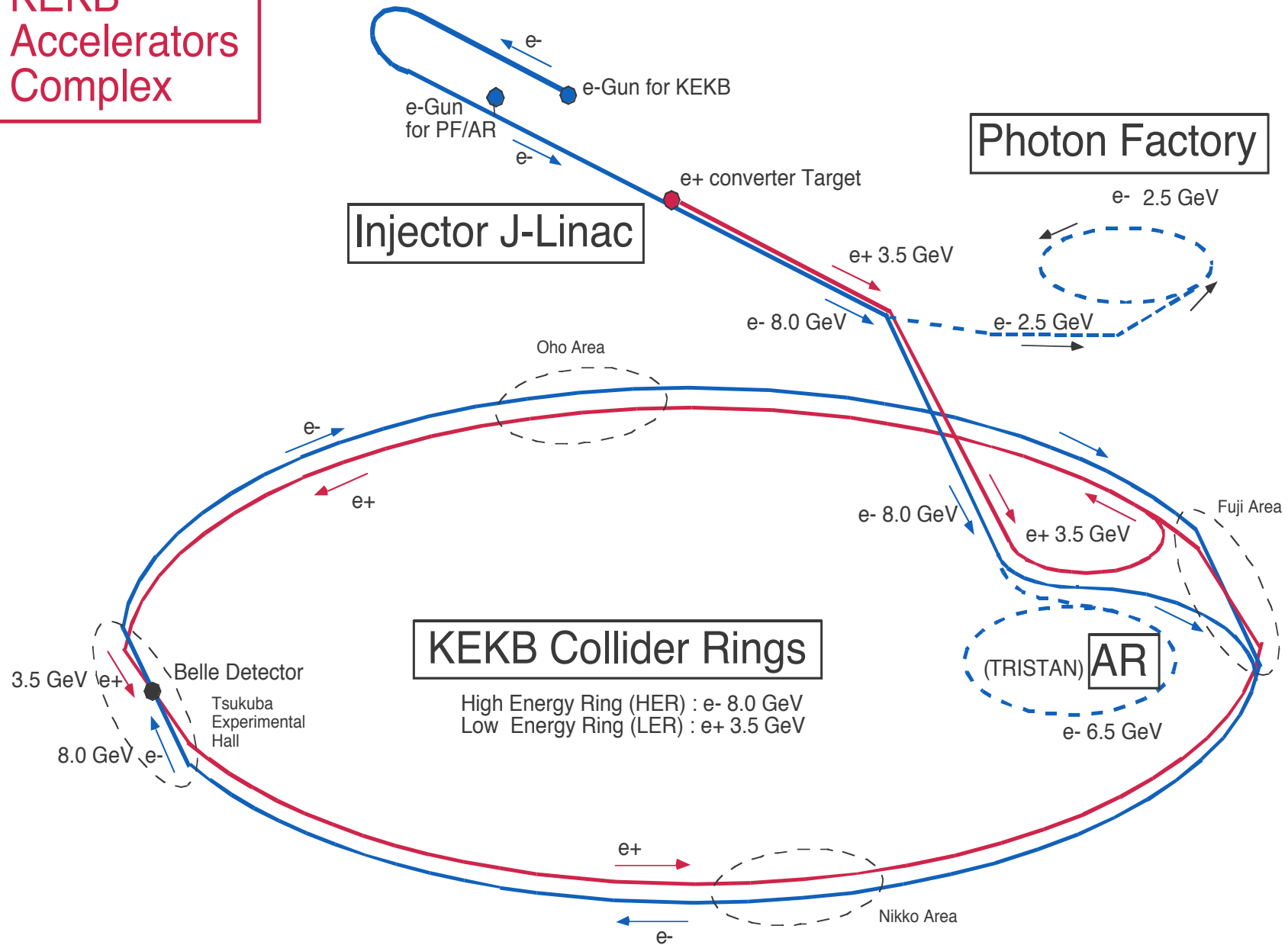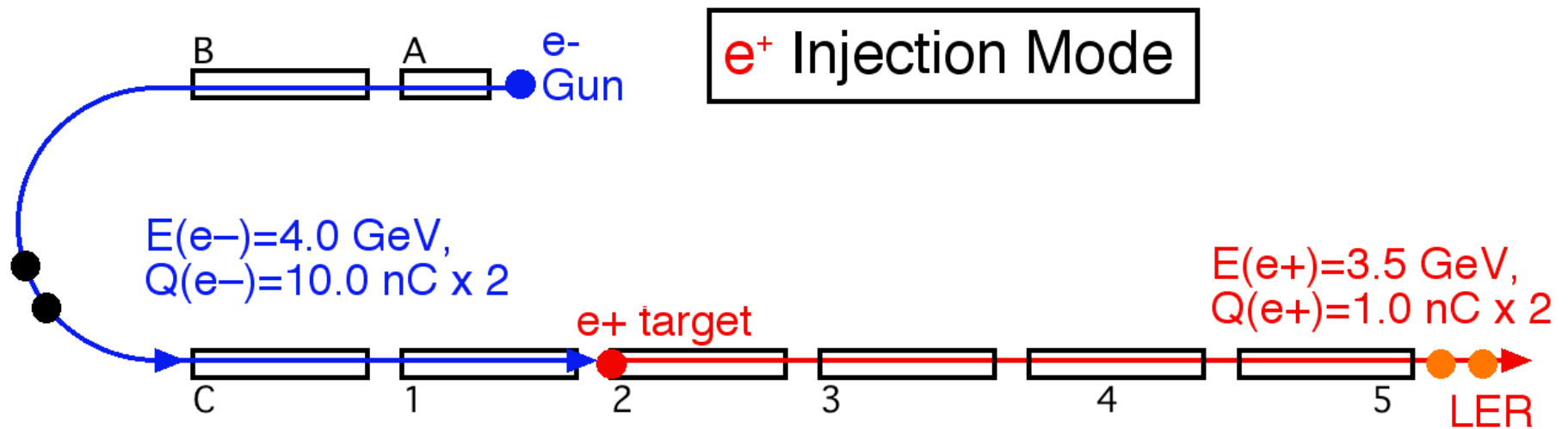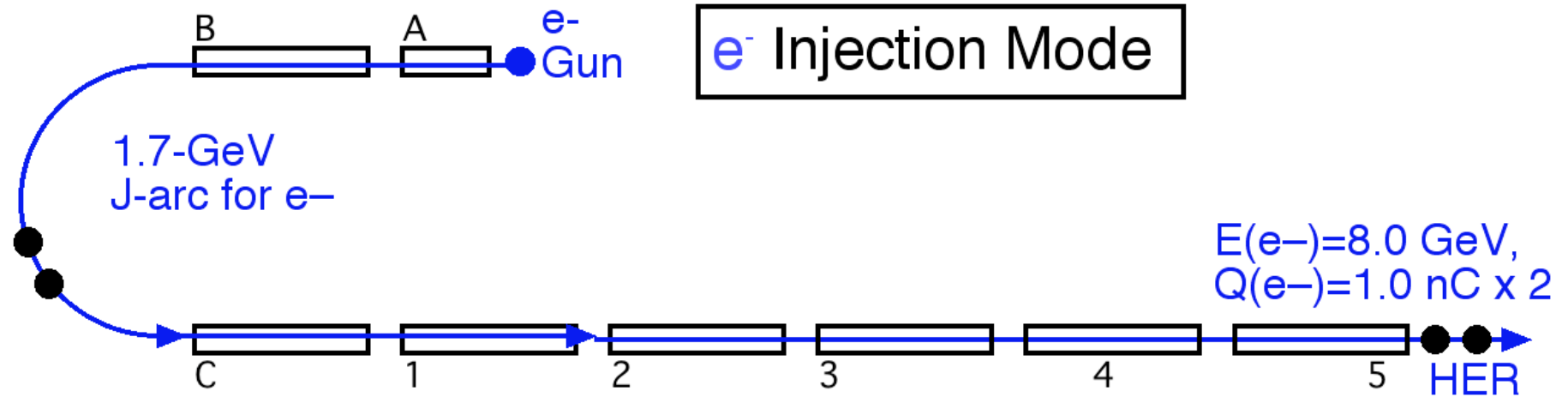
Kamitani Takuya

KEK B-factory

KEKB Injector Linac

e⁻ Injection Mode

B   A   e-
Gun

1.7-GeV
J-arc for e–

E(e–)=8.0 GeV,
Q(e–)=1.0 nC x 2

C   1   2   3   4   5   HER

e⁺ Injection Mode

B   A   e-
Gun

E(e–)=4.0 GeV,
Q(e–)=10.0 nC x 2

e+ target

E(e+)=3.5 GeV,
Q(e+)=1.0 nC x 2

C   1   2   3   4   5   LER

Positron source in the Linac
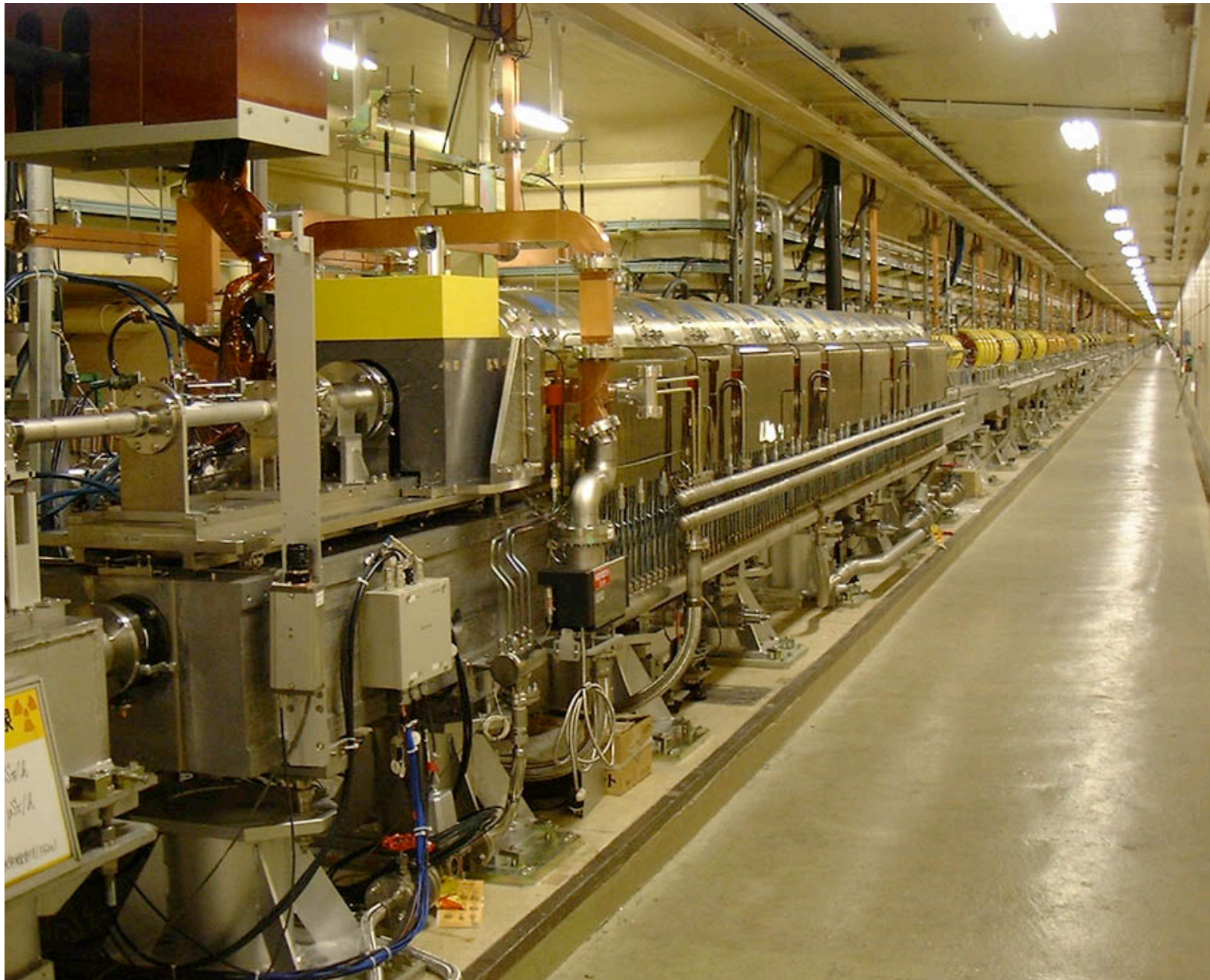
Positron source (cut model)

amorphous tungsten target

beam

e+

thickness = 14 mm
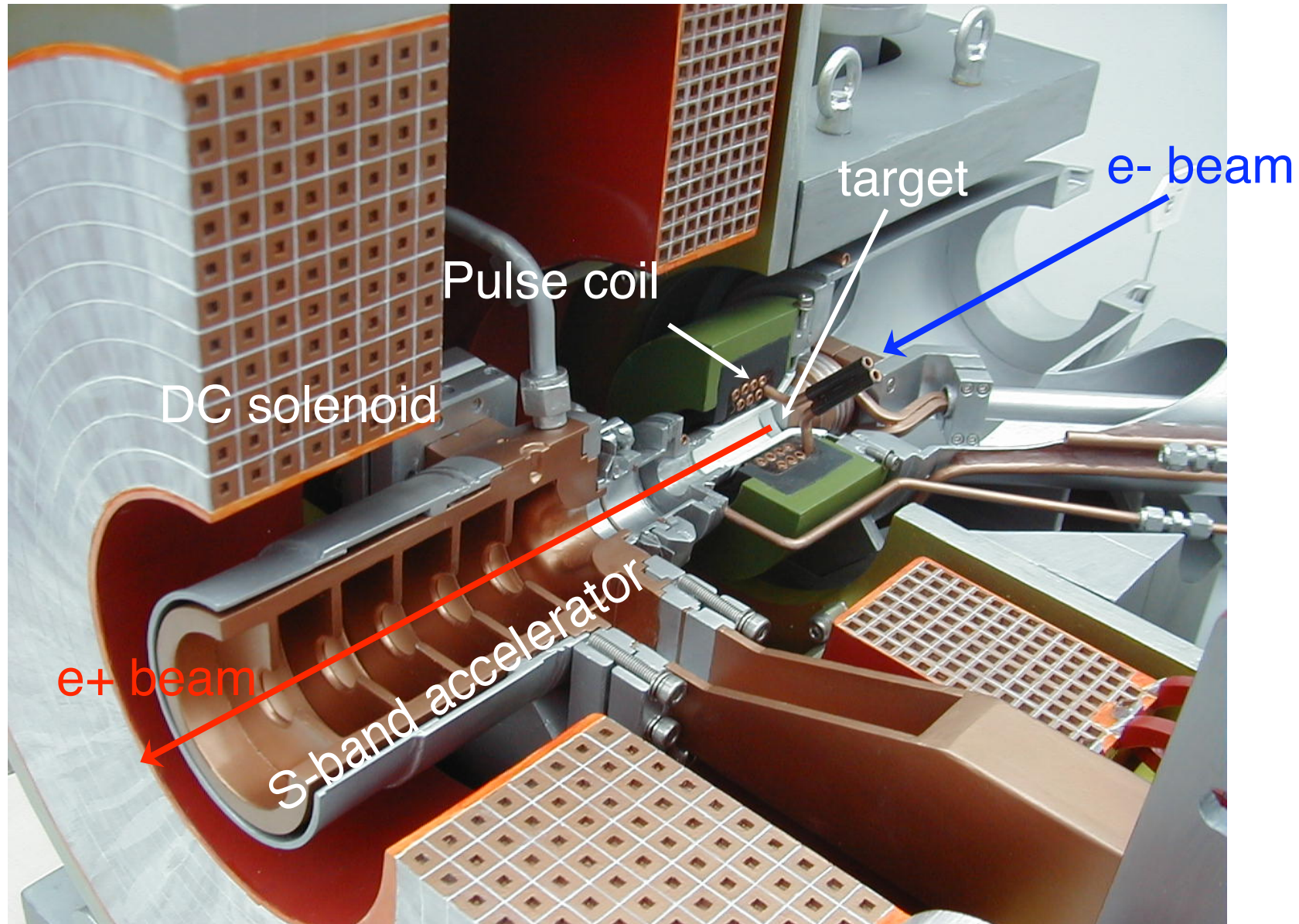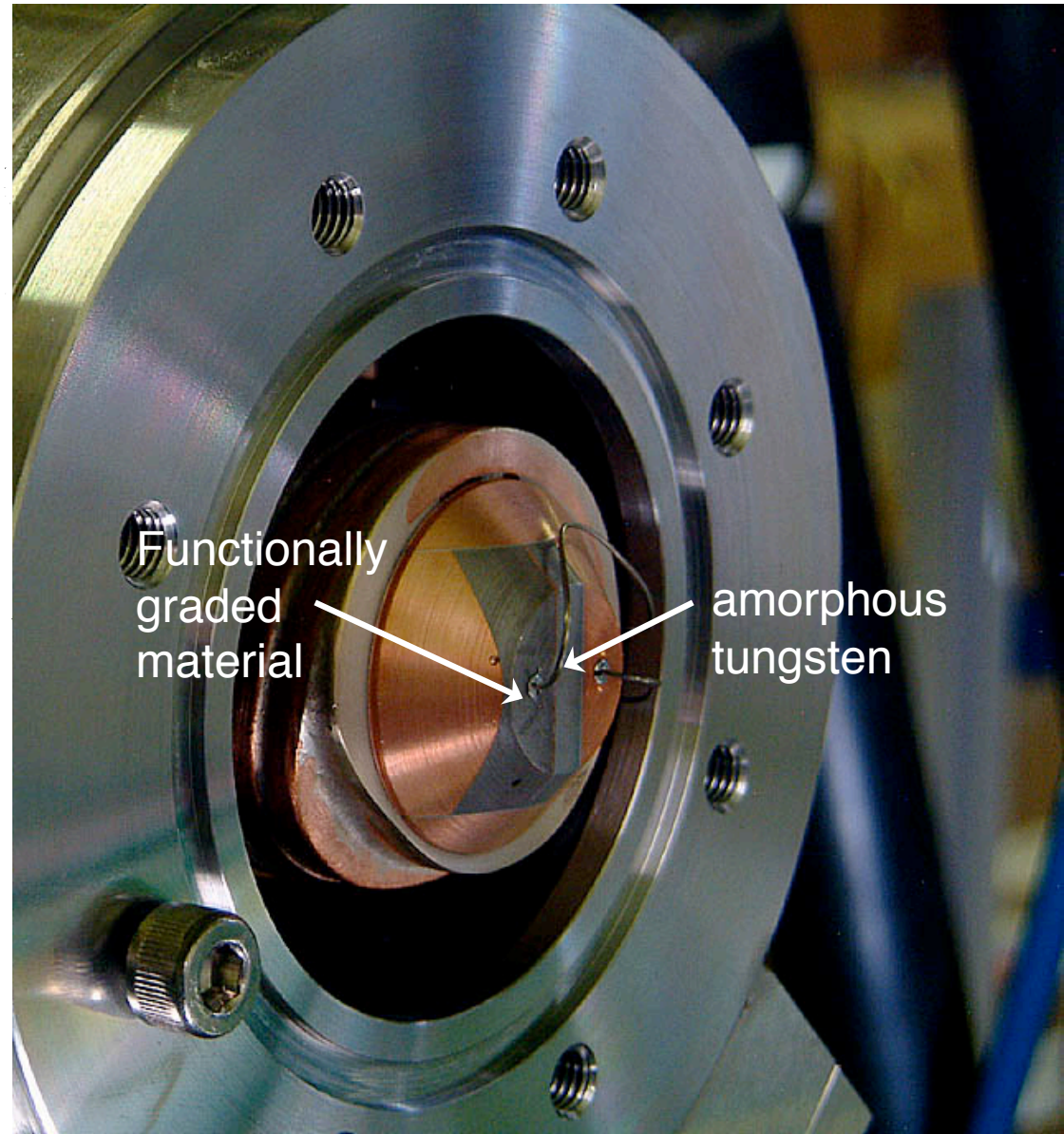(4.0 X_0)

Functionally graded material

amorphous tungsten
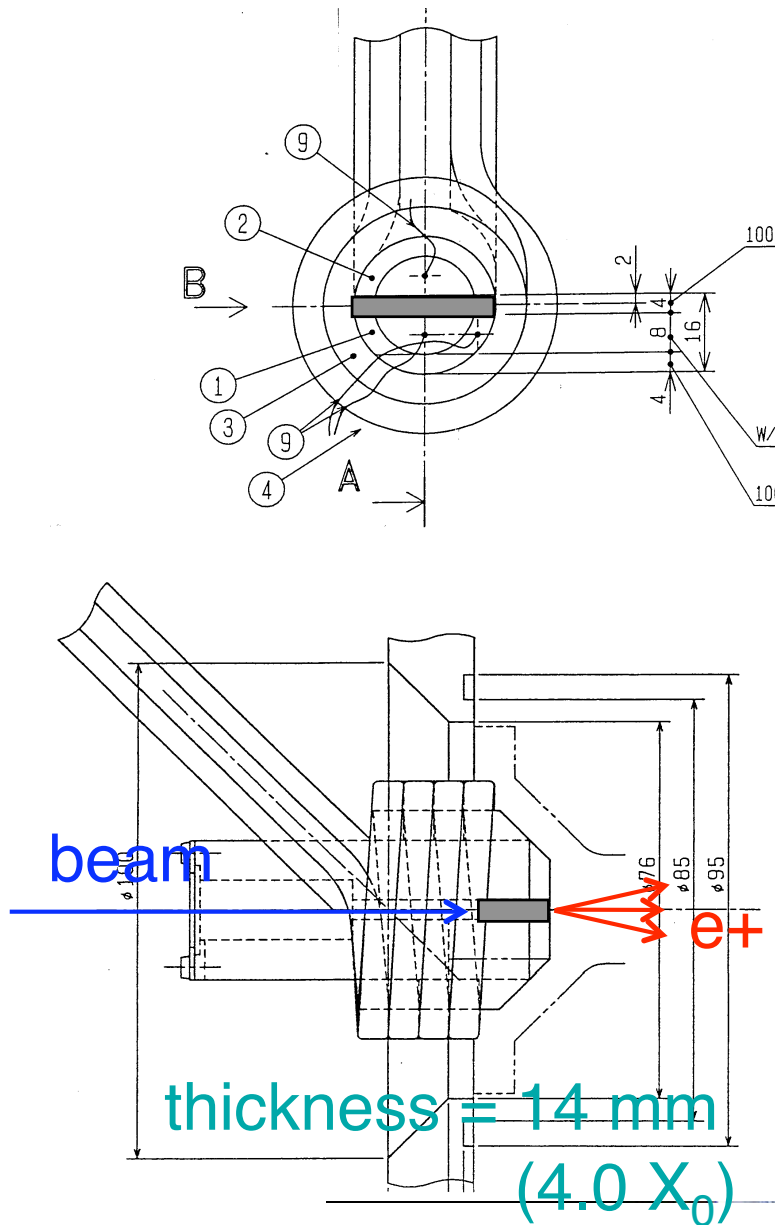
crystal tungsten target
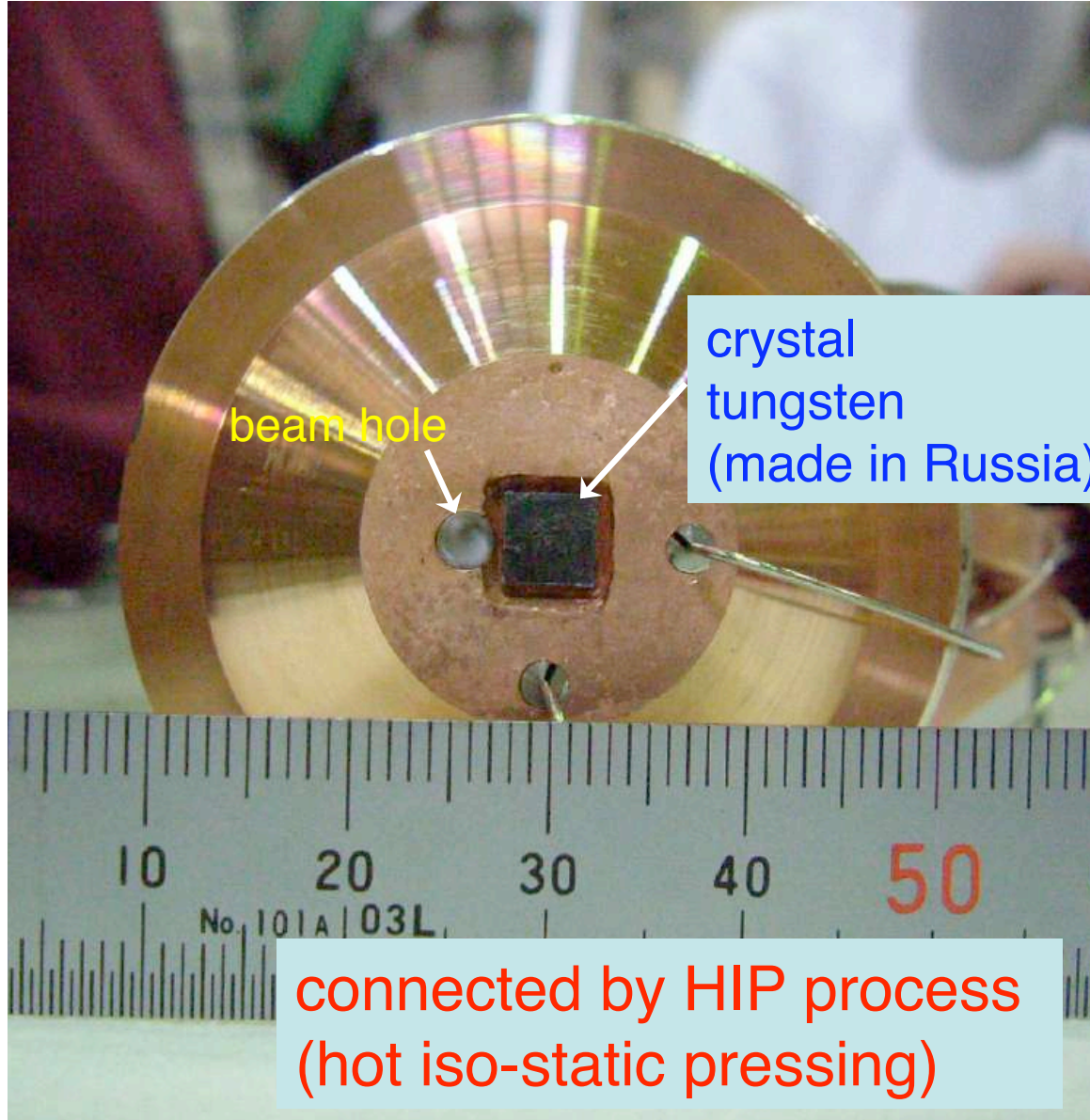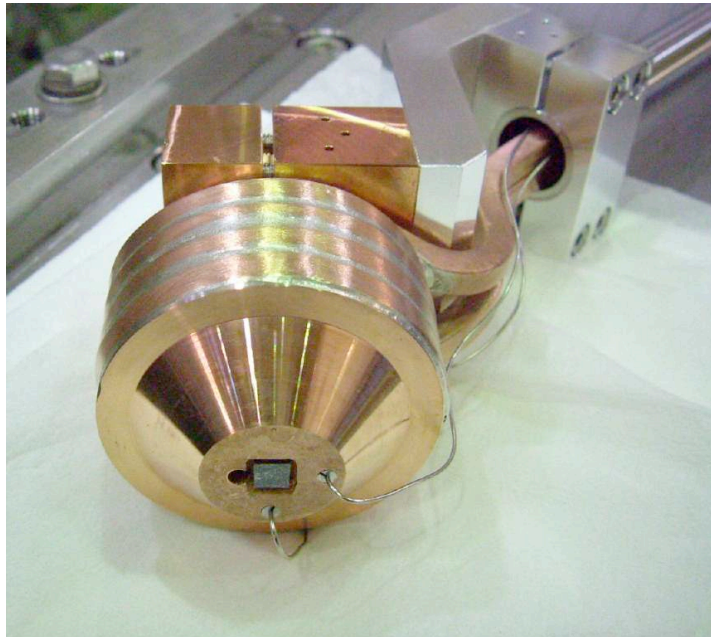
crystal thickness
= 10 mm
(~ 3.0 X_0)

beam hole

crystal
tungsten
(made in Russia)

connected by HIP process
(hot iso-static pressing)

e⁺ yield ⇧ with crystal tungsten

Physical processes for channeling radiation and coherent bremsstrahlung

Crystal Nucleus
Beam
Channel

Channeling Radiation

Coherent Bremsstrahlung

(Thanks to T. Suwada)

optimum thickness

crystal

amorphous

e+ yield (=Ne+/Ne-)

amorphous
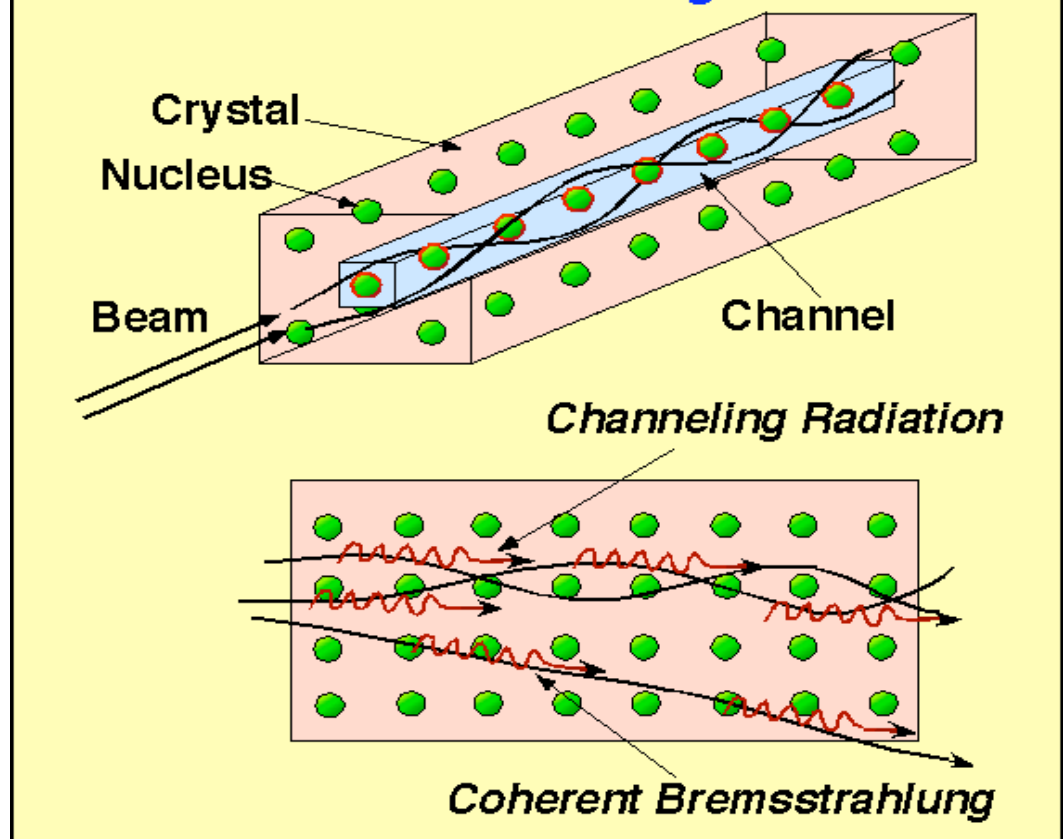
crystal

e+ yield is improved 25 % with crystal tungsten (W) target

upgrade of e+/e- switching

1. e+/e- mode switch cycle is every 3 minutes (limited by bellows lifetime)

2. target IN/OUT takes a few seconds

3. pulse-to-pulse switching desired to keep stored current constant

4. small hole beside tungsten

5. orbit-bump by pulse steering magnets

6. e+/e- compatible beam optical setting of Q magnets

7. preliminary beam test starts soon

tungsten

beam hole

bump-orbit

Pulse coil

2.3 tesla peak field generated by 10 kA pulse current

positrons

ceramic duct
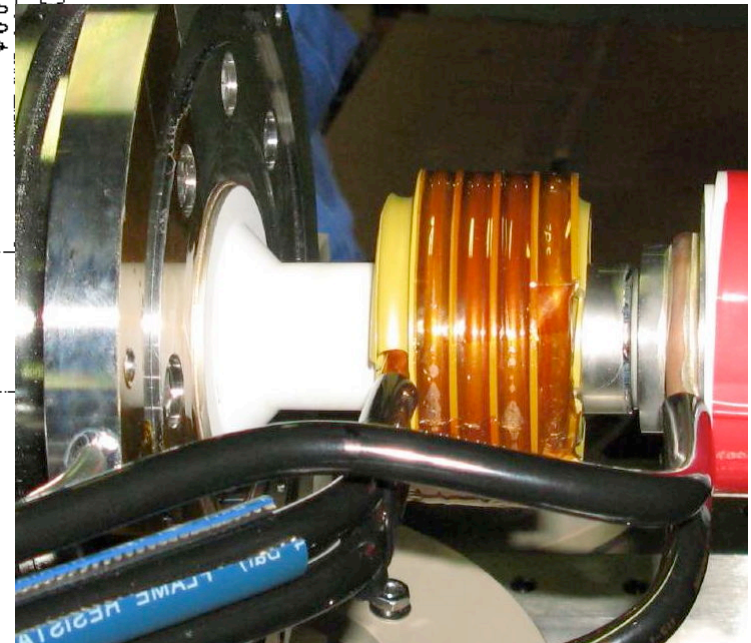
Solenoid field distribution

KEKB e+ generator Solenoidal field profile

Pulsed Coil
2.3 Tesla * 45 mm

QWT system

Bi

Bf

Px

Px

X

X

Bi = 2.3 T

Bf = 0.4 T

Xi (max) = 1.7 mm
Pi (max) = 3.4 MeV/c
$8.2 \leq E \leq 11.6$ MeV

Xf (max) = 10 mm
Pf (max) = 0.60 MeV/c

$(Px^2 + Py^2)/Pi(max)^2 + (x^2 + y^2)/Xi(max)^2 <= 1$

DC Solenoids   0.4 Tesla * 8 m

Accelerating structures

Solenoid Field (Tesla)

Distance from the target (m)
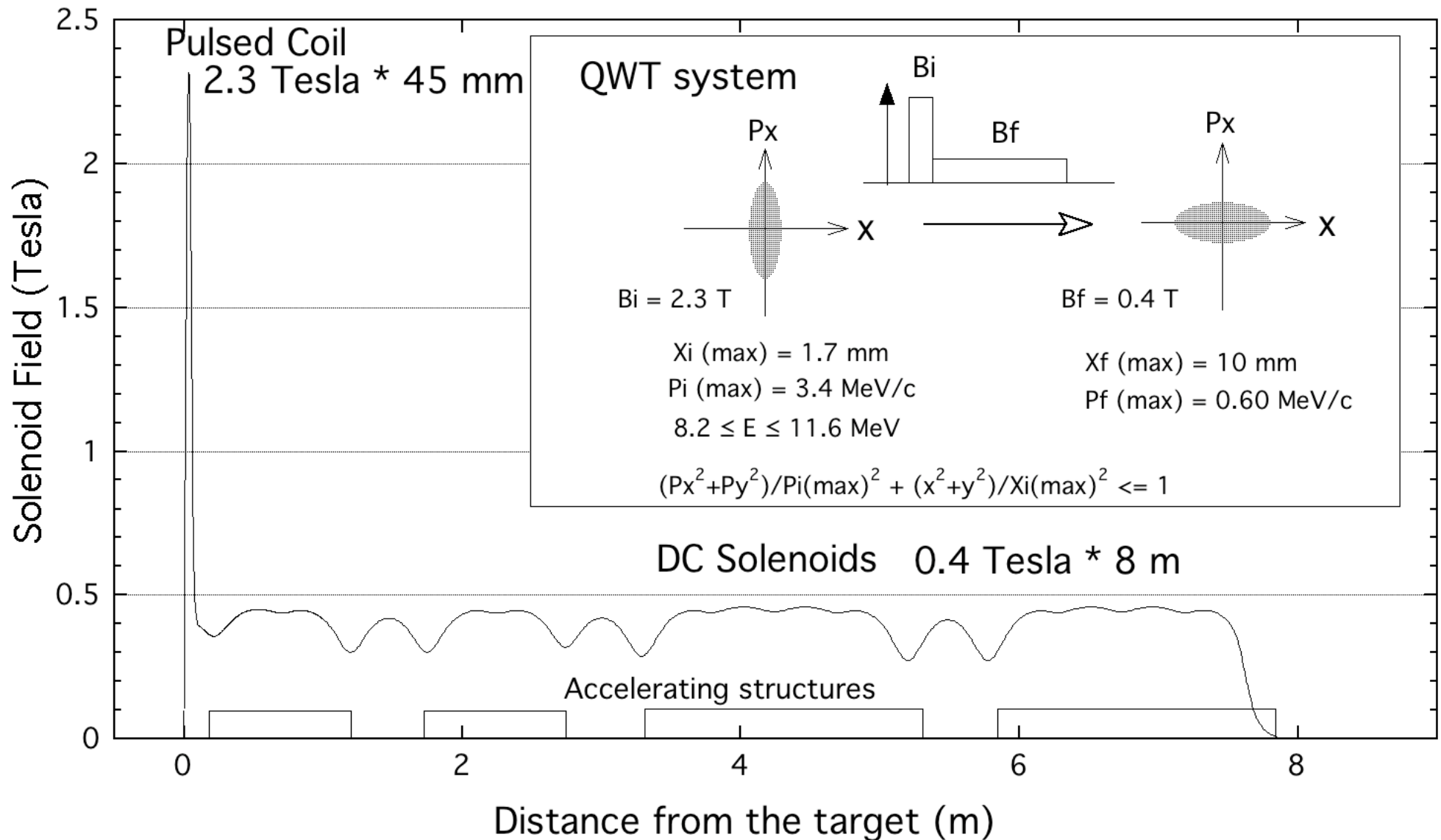
QWT acceptance

$$X_f(\text{max}) = a$$

$$P_f(\text{max}) = \tfrac{1}{2} e B_f a$$

$$X_i(\text{max}) = \frac{B_f}{B_i} a$$

$$P_i(\text{max}) = \tfrac{1}{2} e B_i a$$

$$E_i = \frac{e}{\pi} B_i L_i$$

$$dE_i = \frac{B_f}{B_i} E_i$$

a: aperture radius of capture section = 10 [mm]

e: unit charge ~ 0.2998 [GeV/c/T/m], π: 3.14….

B_i: pulse solenoid field strength = 2.3 [T]

L_i: pulse solenoid field length = 45 [mm]

B_f: DC solenoid field strength = 0.4 [T]

X_f(max): radius acceptance at B_f region (= a = 10 [mm])

P_f(max): transverse momentum acceptance at B_f region
        = 0.6 [MeV/c]

X_i(max): radius acceptance at B_i region
        = 3.4 [mm]

P_i(max): transverse momentum acceptance at B_i region
        = 1.7 [MeV/c]

E_i: central value of energy acceptance = 9.9 MeV

dE_i: half-width of energy acceptance = 1.7 MeV

flux concentrator R & D with BINP

1. For future KEKB upgrade, R&D of flux concentrator type of focusing is going on in a collaboration with BINP

2. Some prototypes are fabricated already.

3. It can generate 10 tesla field by 30 kA pulse current.

4. A full-power operation test of the latest prototype will start soon.

Summary

- KEKB injector linac supplies: e-: 8.0 GeV, 1 nC x 2
  e+: 3.5 GeV, 1 nC x 2

- Target:
  amorphous W (14 mm) -> crystal W (10 mm)
  e+ yield 25 % improved by
  channeling & coherent bremsstrahlung radiation

- e+/e- switching
  target IN/OUT -> pulse bump orbit
  3 min cycle -> pulse-to-pulse switching
  preliminary beam test starts soon

- Matching section:
  pulse coil (2.3 T) + DC solenoids (0.4 T)
  R & D of flux concentrator (10 T) with BINP
  prototype test starts soon