

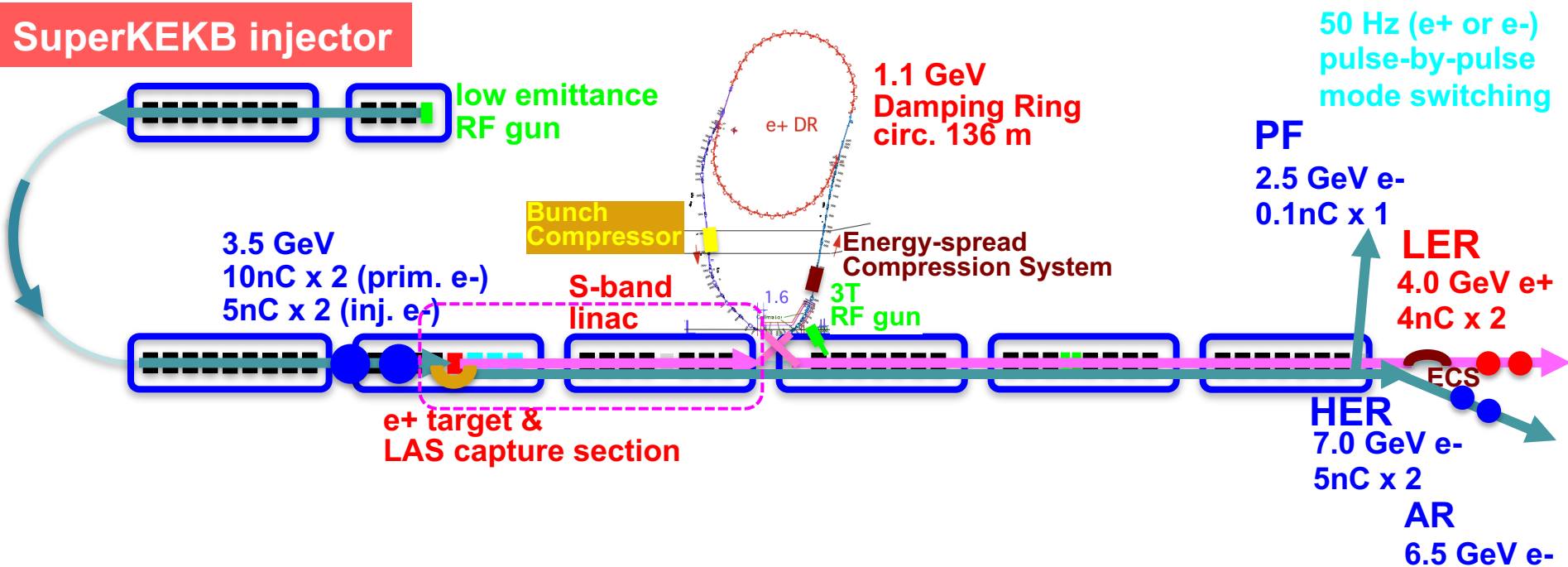
Injector Status

[Positron Source Upgrade]

KEKB injector linac

Takuya Kamitani

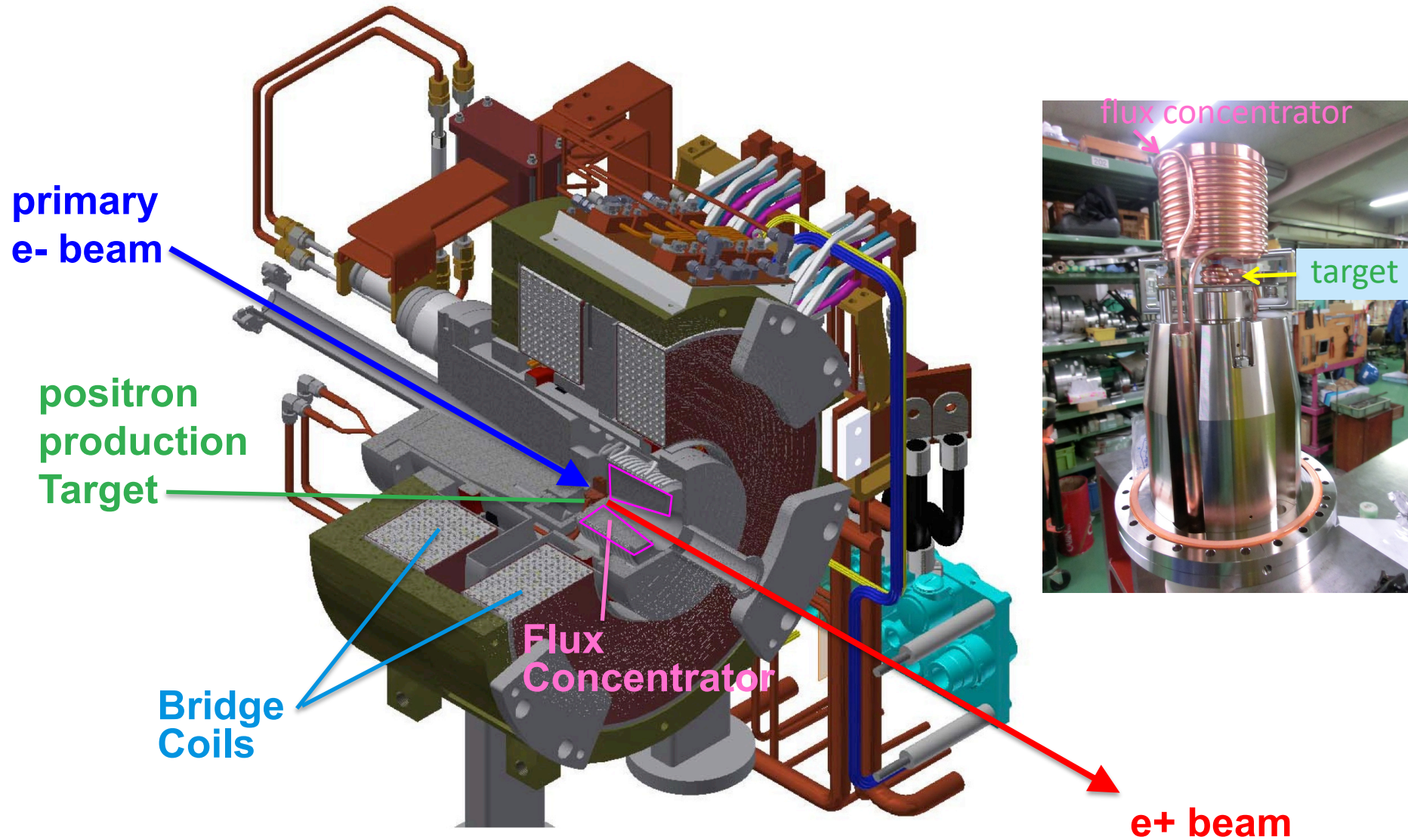
SuperKEKB Injector



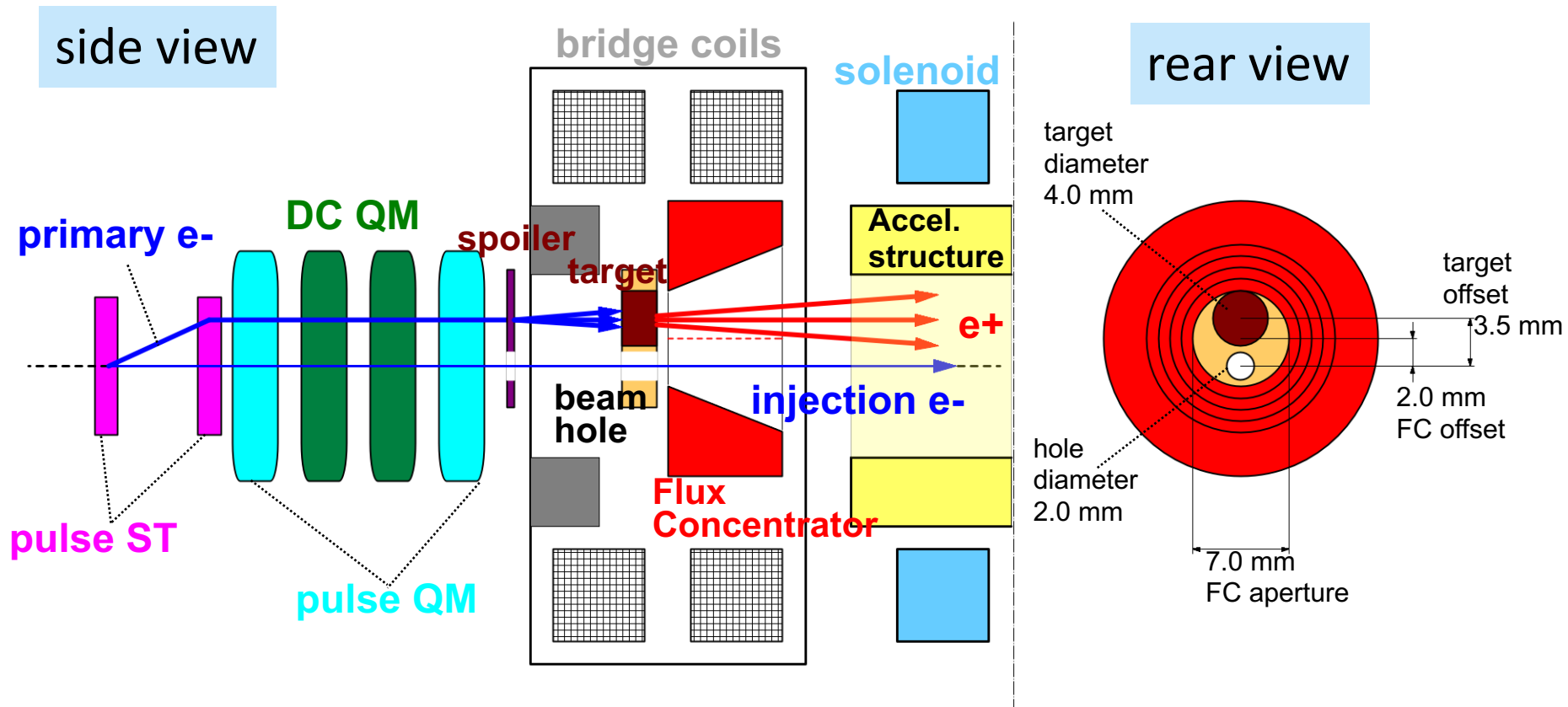
Key issues in Positron Source Upgrade

- **Damping ring for lower emittance** ($2000 \rightarrow 92_{[H]}/7_{[V]} \mu\text{m}$)
- **Capture section upgrade for higher intensity** ($1 \rightarrow 4 \text{ nC}$)
 - ❖ **flux concentrator (e+ focusing pulsed solenoid)**
 - ❖ **LAS [Large Aperture S-band accelerating structure]**

SuperKEKB positron station



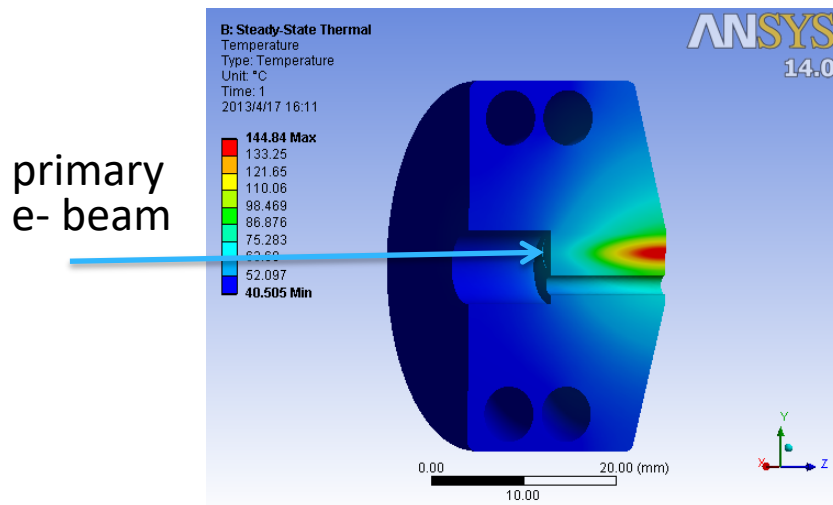
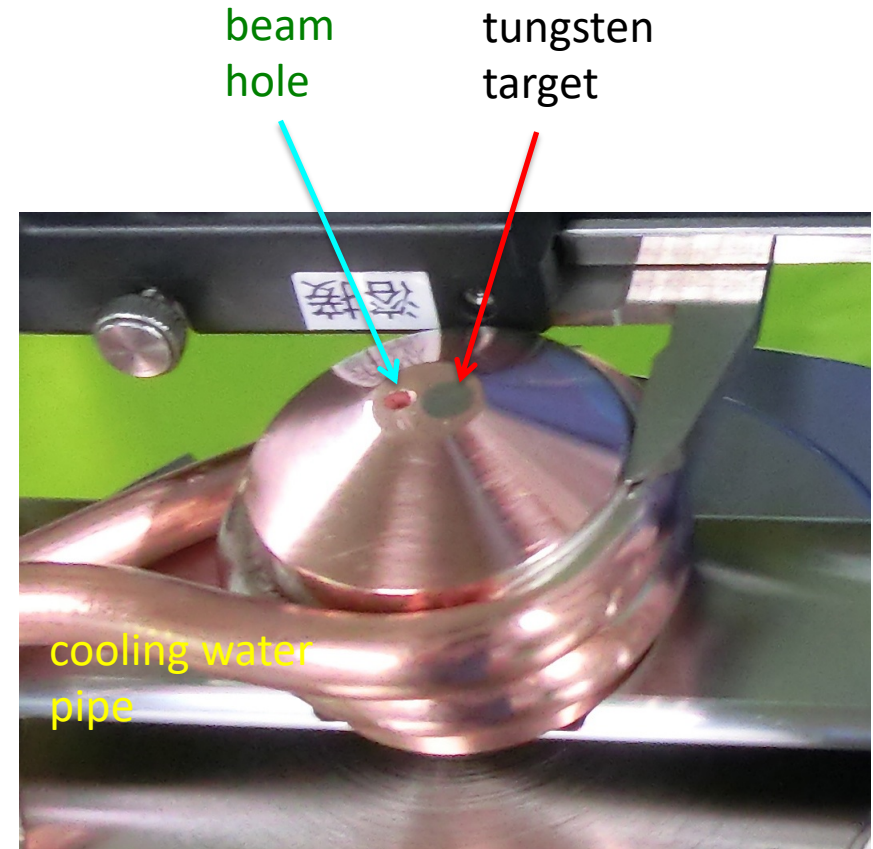
e⁺/e⁻ beam switching & target hole



- injection e⁻ beam ON-axis for low emittance preservation
- primary e⁻ beam OFF-axis with positron yield degradation

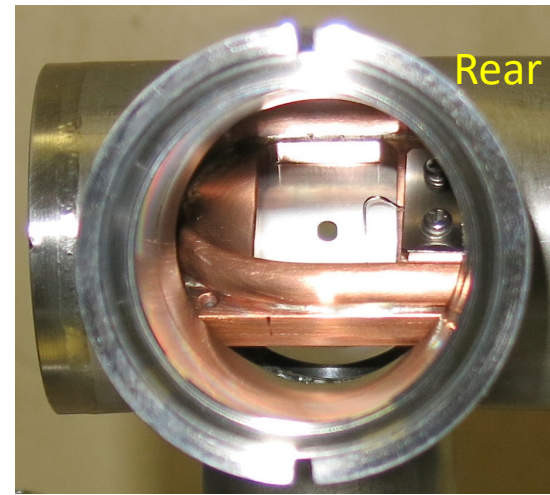
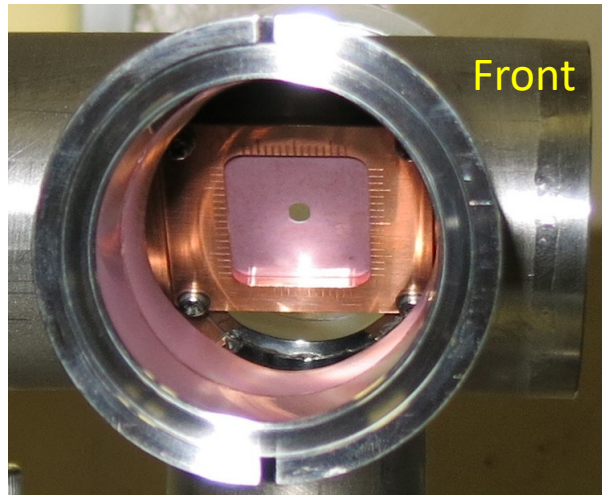
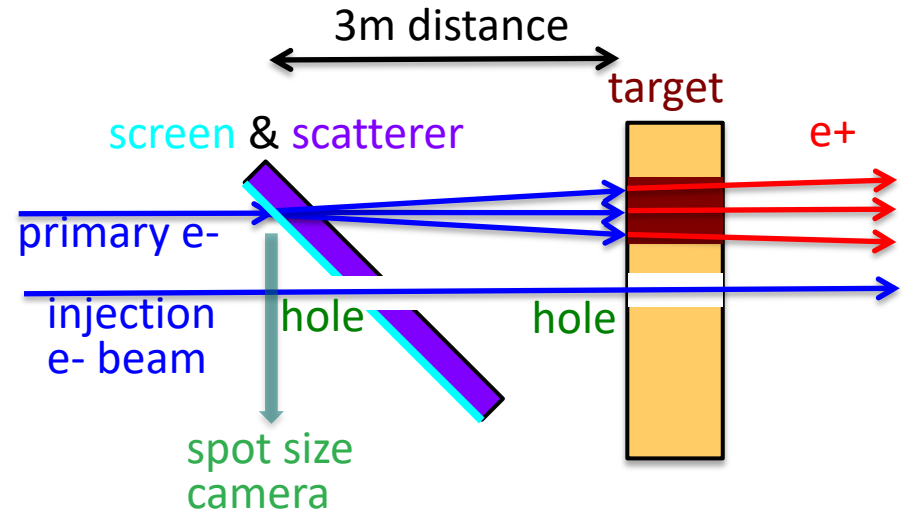
Positron production target

- target material selection
 - ◆ high Z material
 - ◆ high melting point
 - ◆ high tensile strength
- => tungsten
 - 14 mm long = $4.0 X_0$
 - 4 mm diameter
- beam hole for injection e-

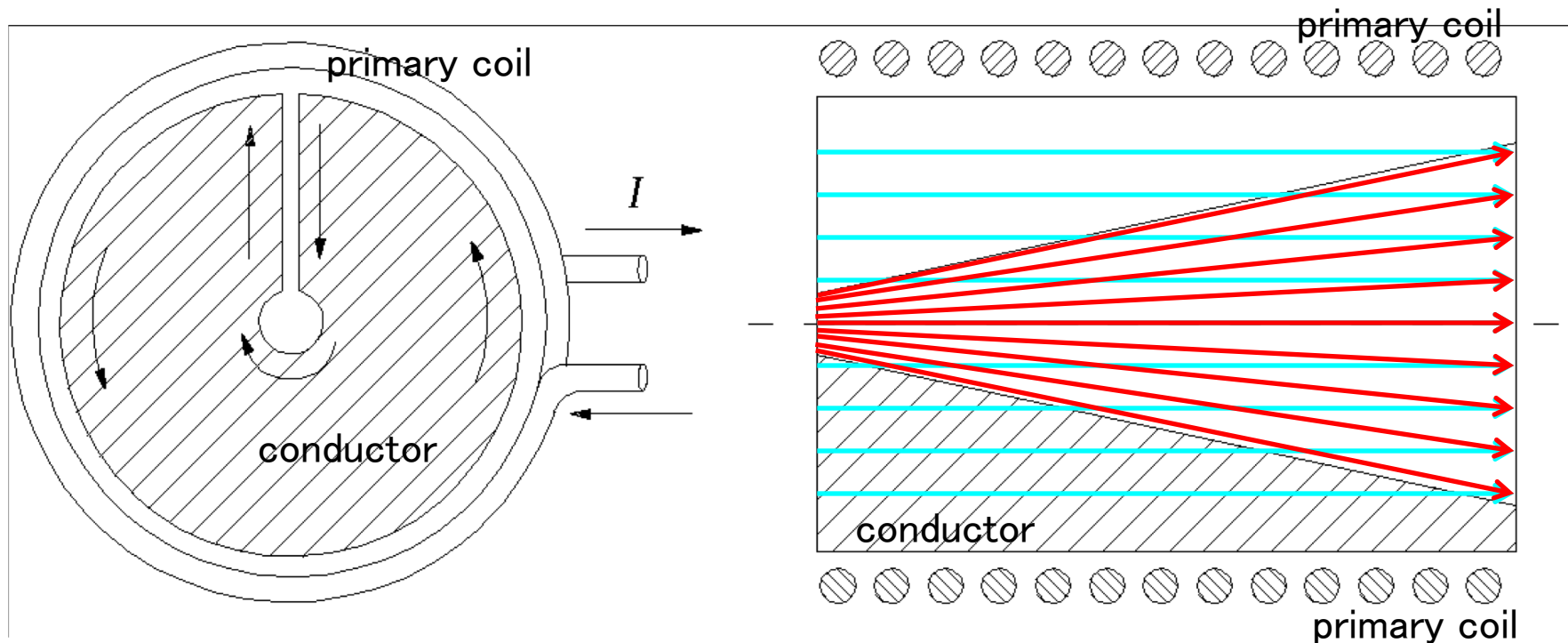


Beam spoiler for target protection

- **beam spoiler** to enlarge beam spot on target to be $\sigma_x, \sigma_y > 0.7$ mm to **avoid target destruction**
- spot size monitoring screen Al_2O_3 (0.14 mm thick)
+ scattering Al foil (0.25 mm thick)
[total material thickness = $0.05 X_0$]
- **beam hole** for injection e-



flux concentration concept

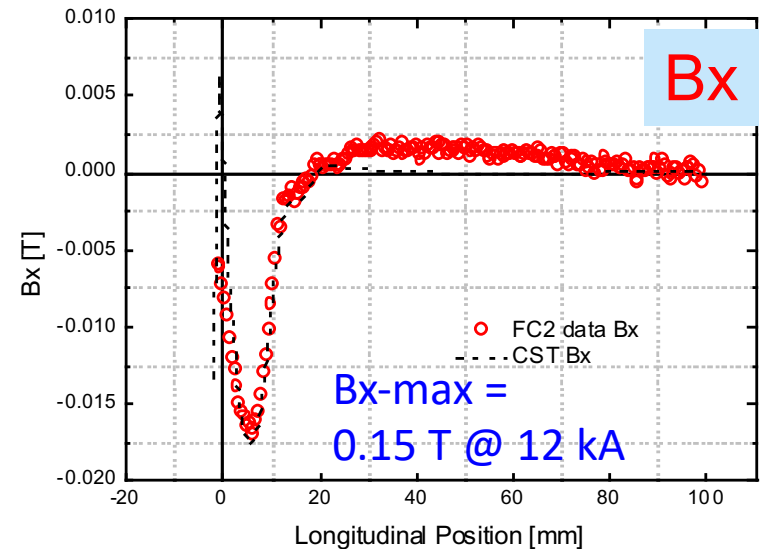
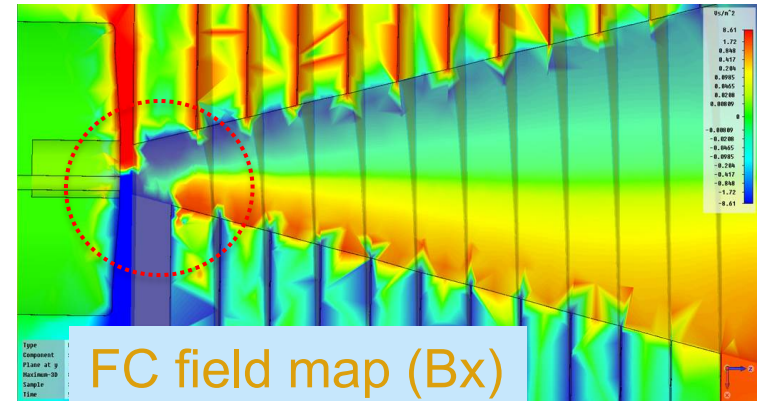
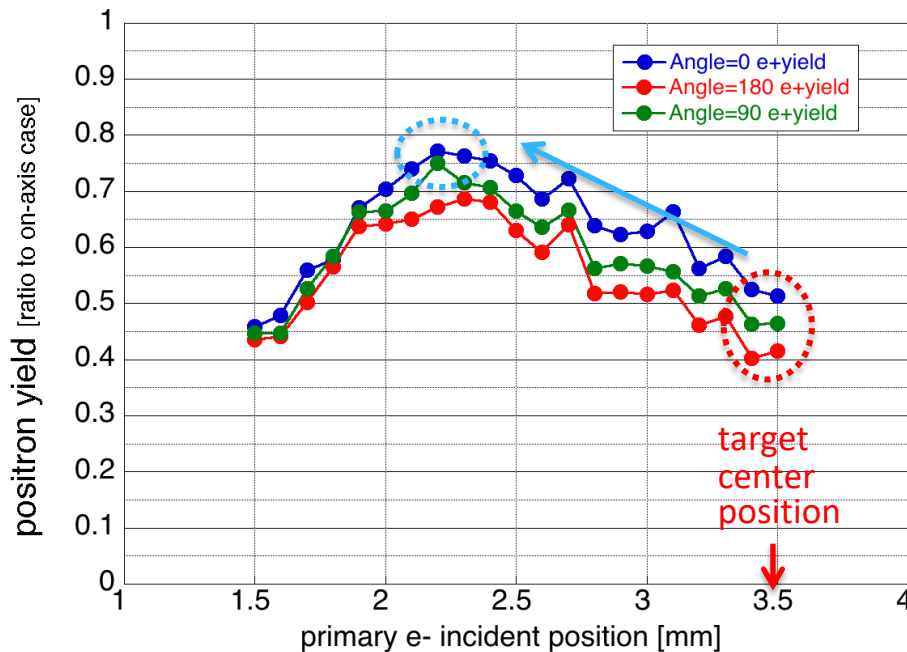


- DC current in primary coil produce **uniform solenoidal field**
- Pulsed current & Conductor with slit
=> eddy current flows inner surface
to generate high magnetic flux density (**flux concentration !**)

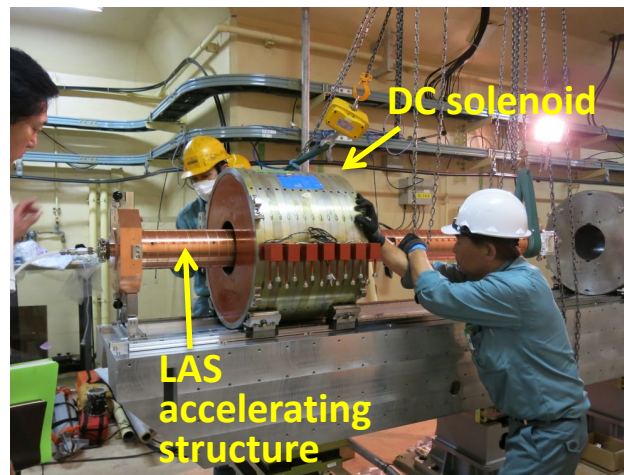
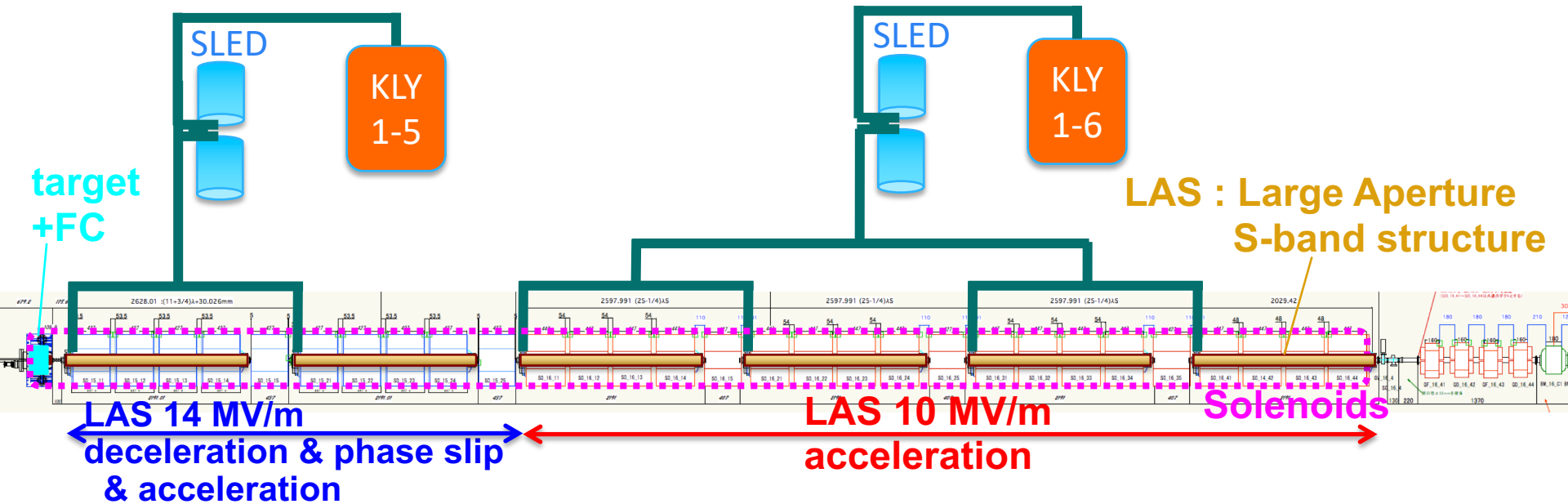
but with non-axial symmetric transverse field !
=> transverse kick to positrons ! beam loss !

e+ yield degradation by target offset

- e+ yield degrades $\sim 50\%$ by offset e+ generation
- it can be improved to 78% by
 - ◆ utilizing transverse kick by proper orientation of FC slit
 - ◆ e- incident position optimization

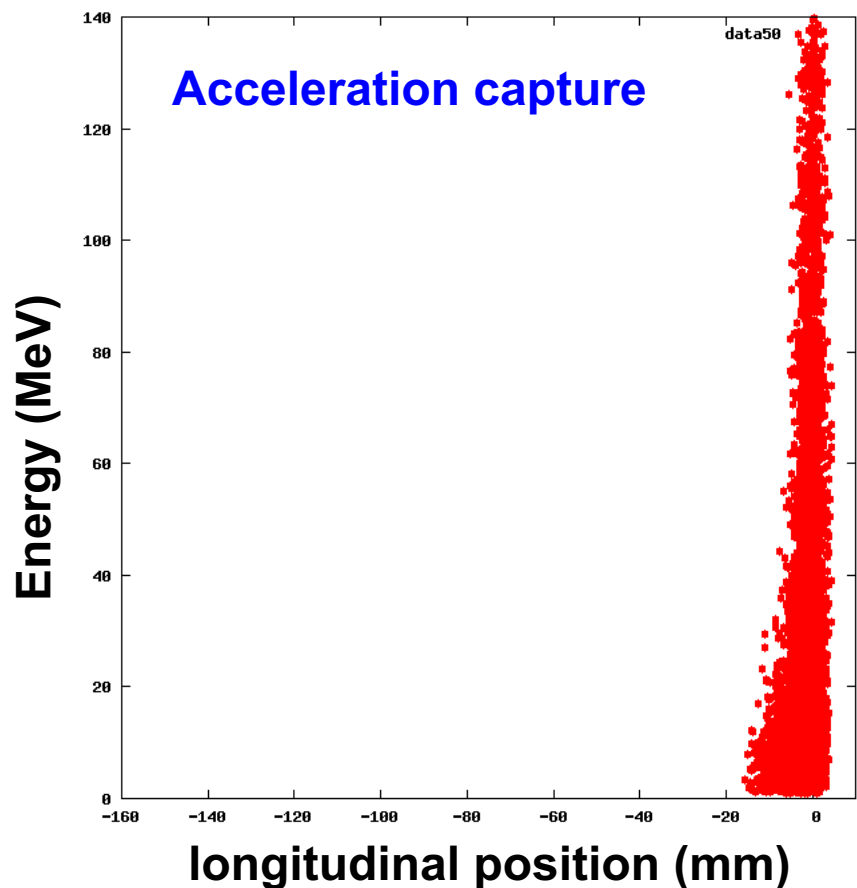


Positron Capture Section



positron capture animation

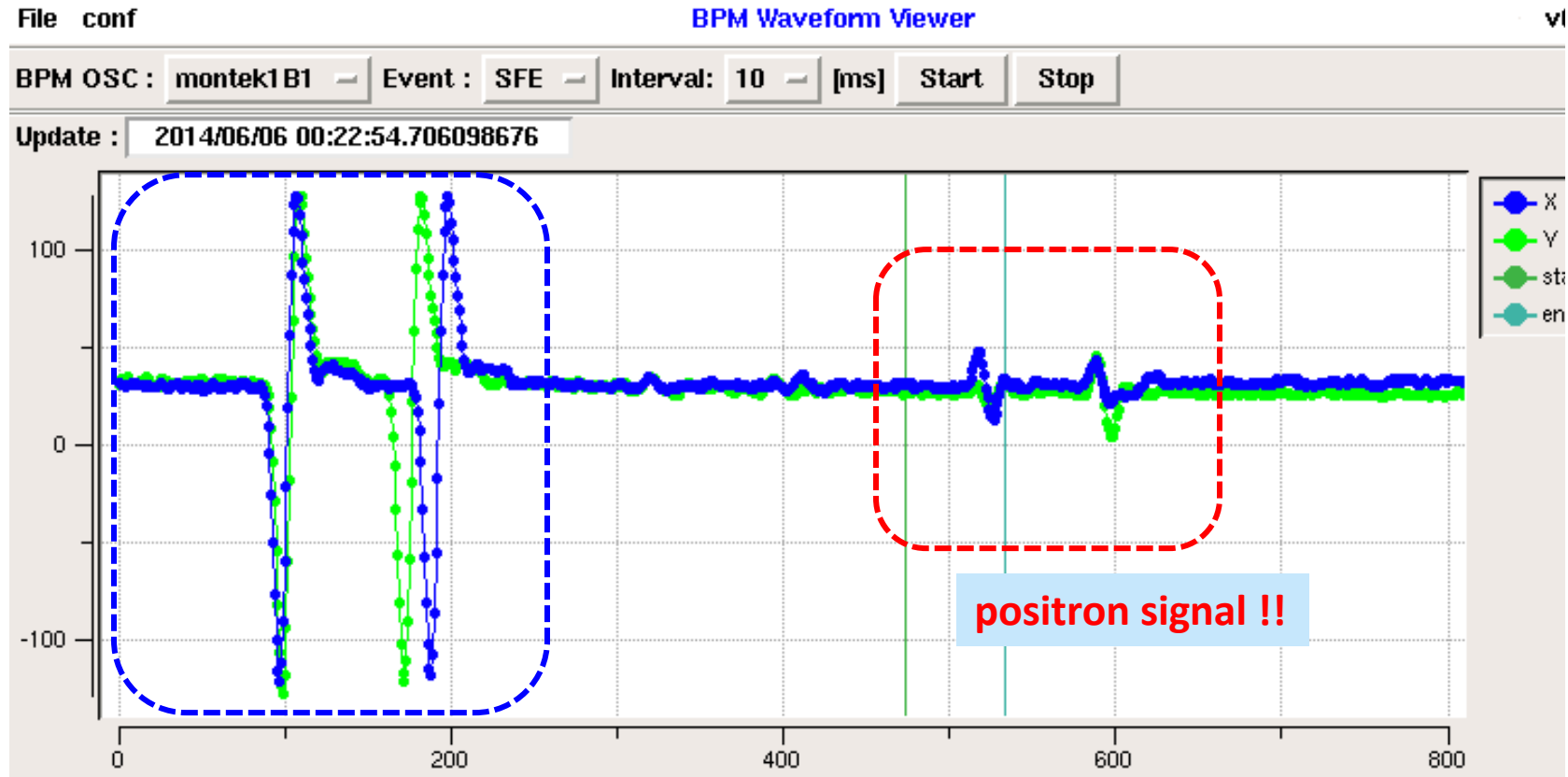
from target to capture section exit (120 MeV)



You are watching longitudinal particle motion (z-position vs energy) in a moving frame riding on a microwave !

Positrons with deceleration capture favored for less halo and satellites !

The first positron beam after the upgrade



BPM: SP_15_T in front of target
 negative charged particles (e^- beam)
 give (-) (+) bipolar signal

BPM: SP_16_5 after e^+ capture section
 positive charged particles (e^+ beam)
 give (+) (-) signal

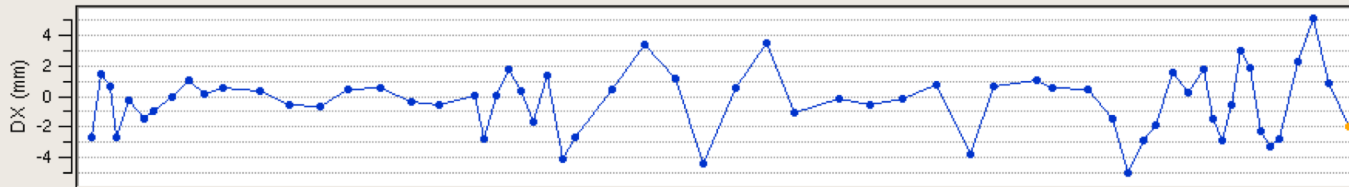
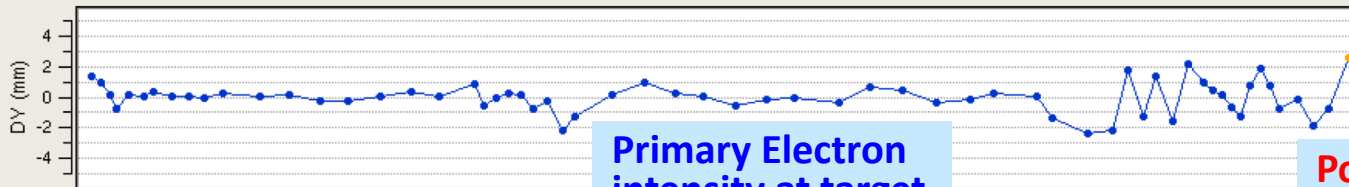
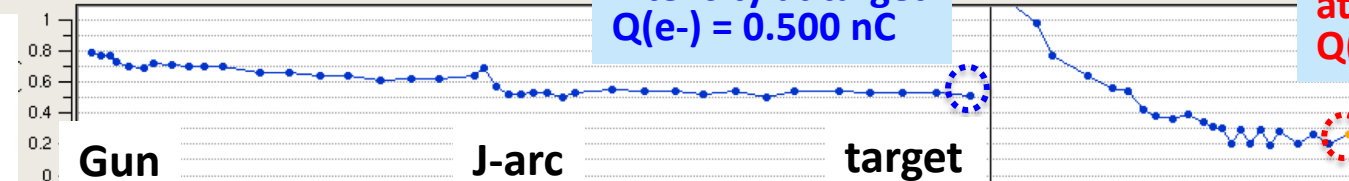
observed positron intensity

File BPM Update

2014/06/09 07:05:02 v2.2

● 2014/06/09 07:05:02

Linac PF-A1 e- Study Orbit AnalyzerLine

orbit-X
[mm]orbit-Y
[mm]beam
intensity
[nC]

Primary Electron
intensity at target
 $Q(e^-) = 0.500$ nC

Positron intensity
at positron line end
 $Q(e^+) = 0.02$ nC

DY(1st): 2.644 mm
DY(2nd): -1.258 mm

Sector-2 end

SP_23_4 SP_24_4 SP_25_4 SP_26_4 SP_27_4 SP_28_4 SP_29_4 SP_30_4 SP_31_4 SP_32_4 SP_33_4 SP_34_4 SP_35_4 SP_36_4 SP_37_4 SP_38_4 SP_39_4 SP_40_4 SP_41_4 SP_42_4 SP_43_4 SP_44_4 SP_45_4 SP_46_4 SP_47_4 SP_48_4 SP_49_4 SP_50_4 SP_51_4 SP_52_4 SP_53_4 SP_54_4 SP_55_4 SP_56_4 SP_57_4 SP_58_4 SP_59_4 SP_60_4 SP_61_4 SP_62_4 SP_63_4 SP_64_4 SP_65_4 SP_66_4 SP_67_4 SP_68_4 SP_69_4 SP_70_4 SP_71_4 SP_72_4 SP_73_4 SP_74_4 SP_75_4 SP_76_4 SP_77_4 SP_78_4 SP_79_4 SP_80_4 SP_81_4 SP_82_4 SP_83_4 SP_84_4 SP_85_4 SP_86_4 SP_87_4 SP_88_4 SP_89_4 SP_90_4 SP_91_4 SP_92_4 SP_93_4 SP_94_4 SP_95_4 SP_96_4 SP_97_4 SP_98_4 SP_99_4 SP_100_4

Range

DX 5 - DY 5 - Qe- 1 - Qe+ 0.1 - Replot

Sector

 A B R C 1 2 3 4 5 6

Bunch

 1st 2nd

Show

 Current Ref Current-Ref Average5 Average10 2014/06/09 02:53:59
 KBE KBP PFE QFE ARE JBE JBP RFE ZRE Set Ref

SP_23_4 Current : DX=[1.81, -0.46] DY=[0.97, -1.18] Qe+=[0.03, 0.01]

 peak hold (60sec) resize

Summary

1) Positron source components have been installed in the beam line

(a target, a beam spoiler, a flux concentrator, bridge coils, DC solenoids, LAS accelerating structures, e+/e- separator chicane, plenty of quads)

2) Still in low spec. operation due to various constraints

	design	full spec.	achieved
◆ flux concentrator	12 kA		6 kA
◆ bridge coils	750 A		600 A
◆ DC solenoids	650 A		370 A
◆ LAS field gradient	14, 10 MV/m		10, 7 MV/m

3) We have observed the first positron beam after the upgrade !

2014.06.09

($Q_{e+} = 0.02 \text{ nC}$ @sector-2 end for $Q_{e-} = 0.5 \text{ nC}$ @target)

↓ x200

$Q_{e+} = 4 \text{ nC}$

↓ x20

$Q_{e-} = 10 \text{ nC}$

SuperKEKB
full spec.