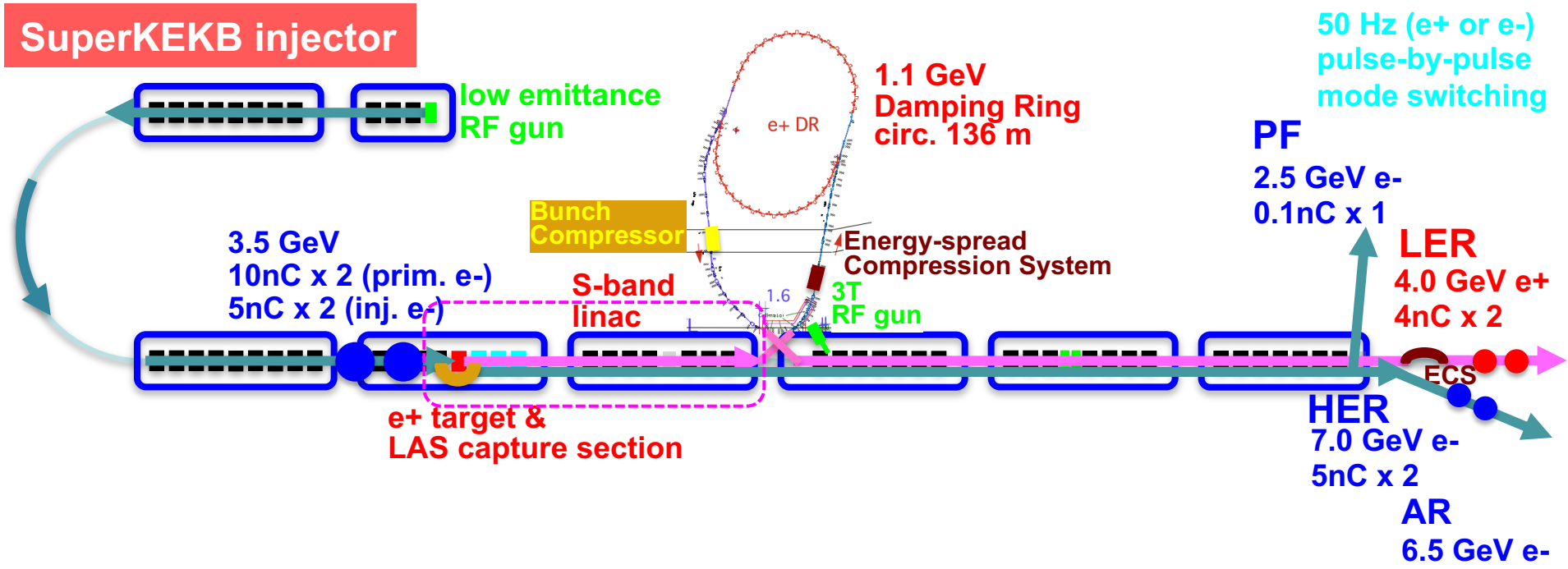
Injector Status

[Positron Source Upgrade]

KEKB injector linac

Takuya Kamitani

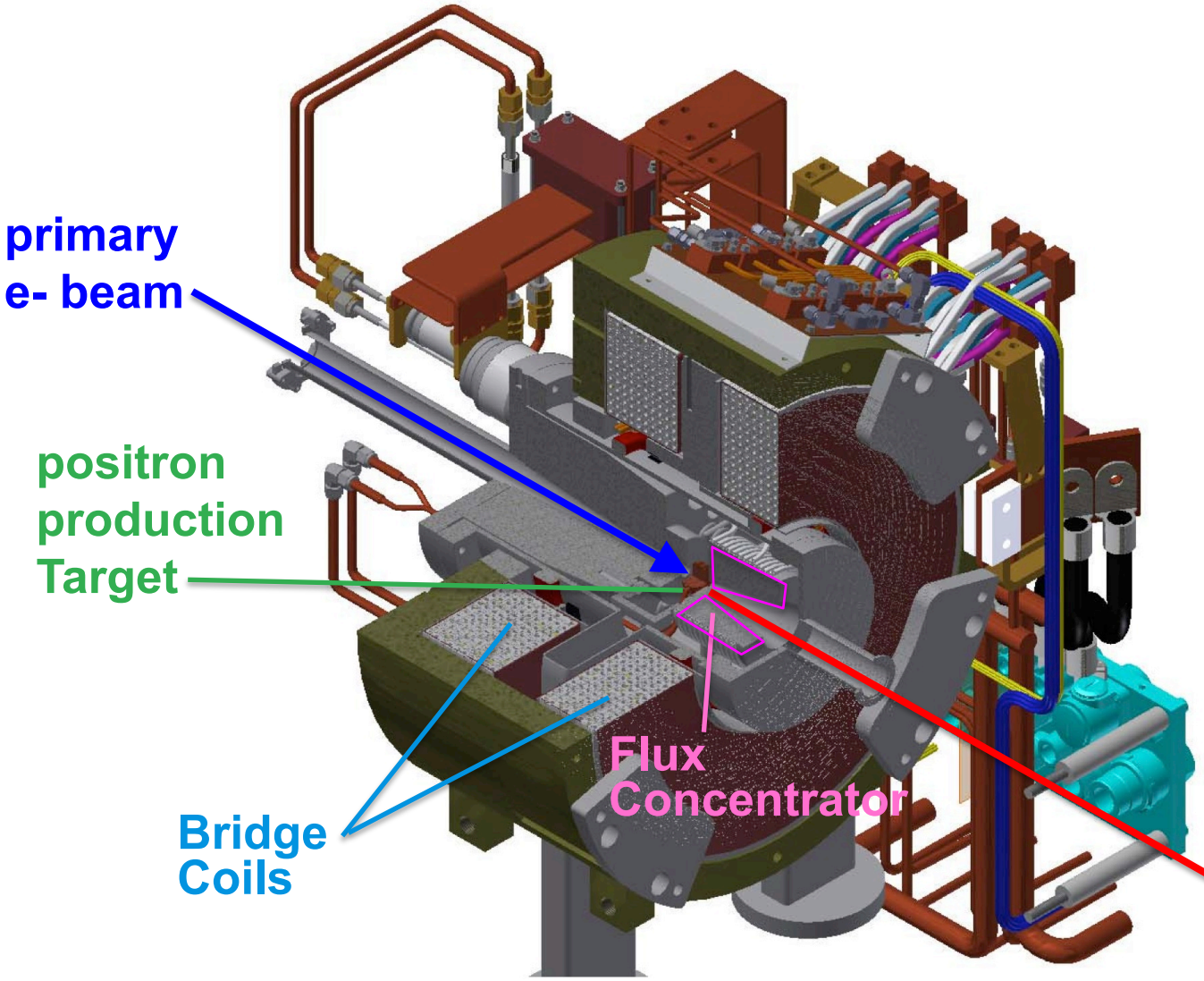
SuperKEKB Injector



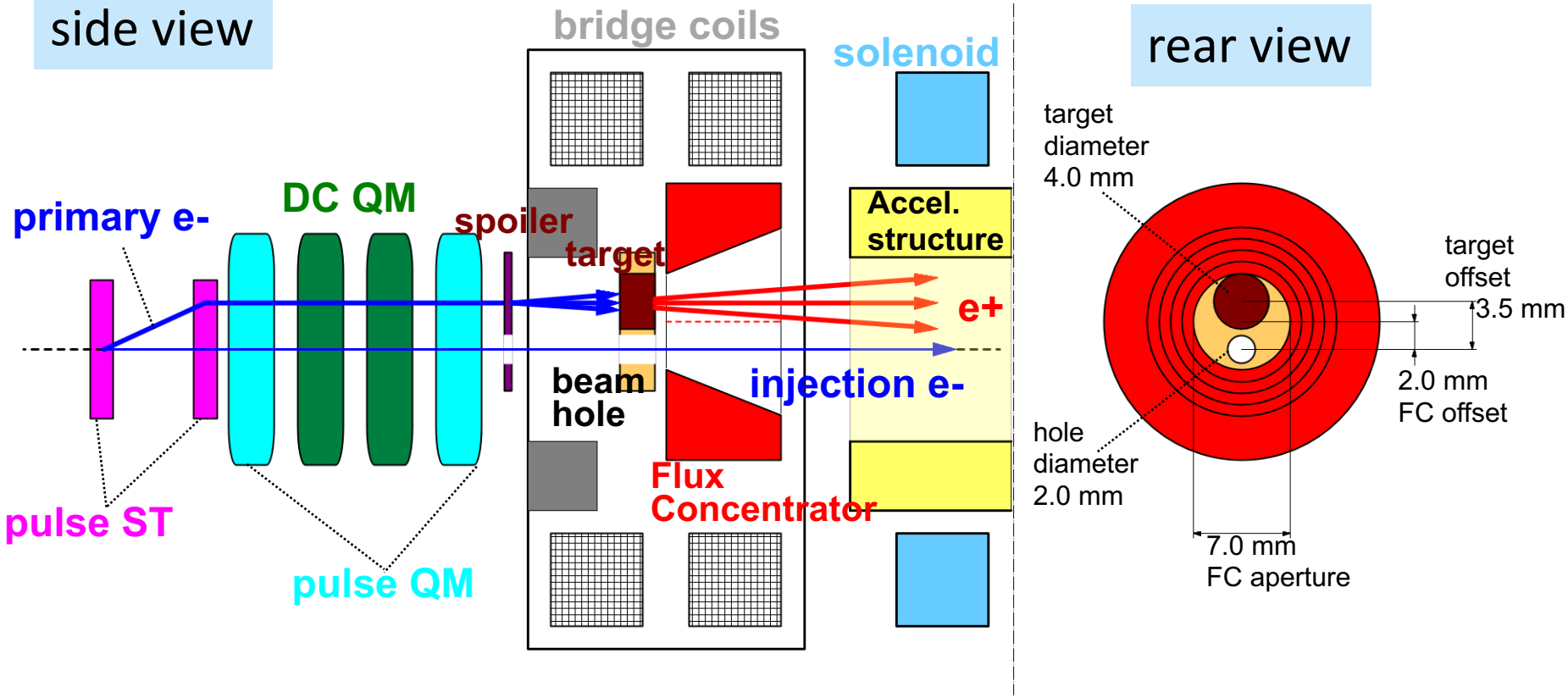
Key issues in Positron Source Upgrade

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

SuperKEKB positron station



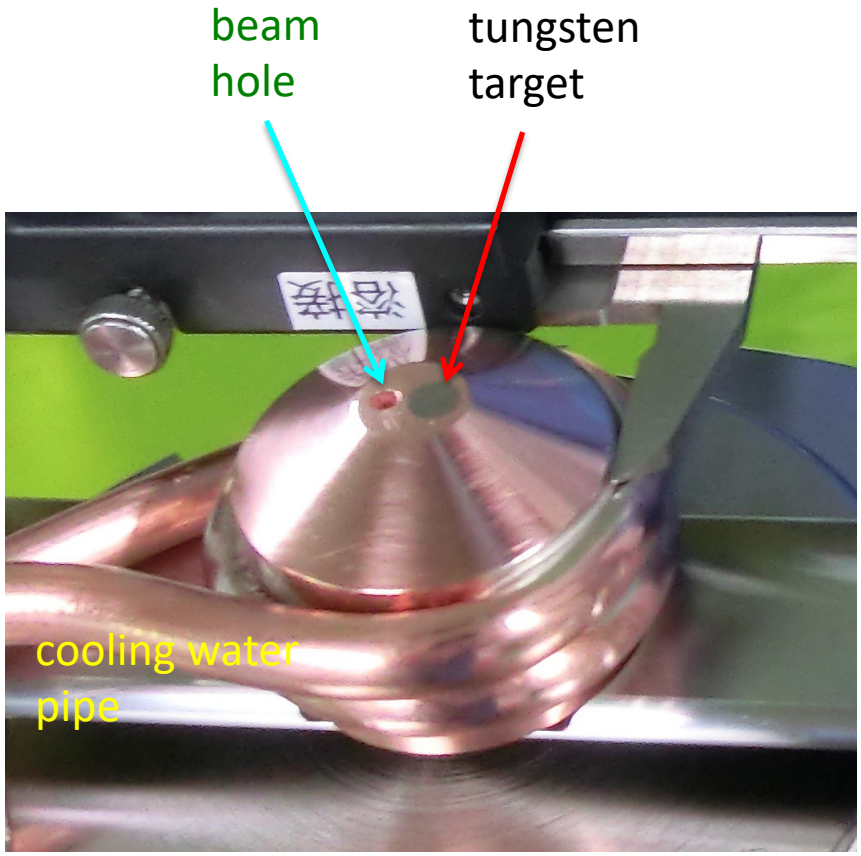
e+/e- beam switching & target hole



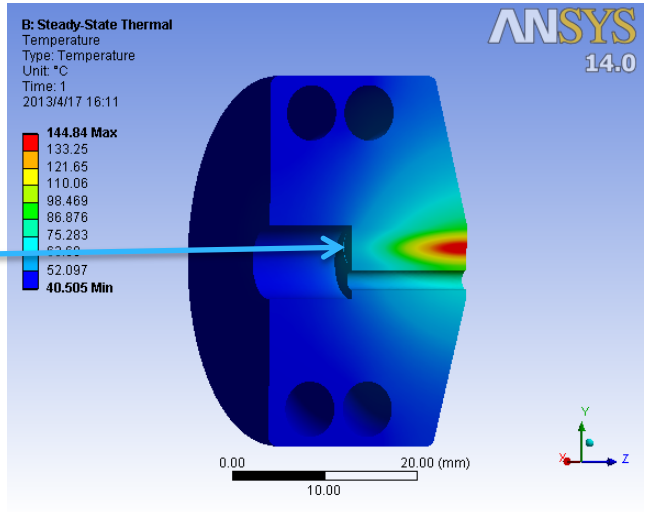
- injection e- beam ON-axis for low emittance preservation
- primary e- beam OFF-axis with positron yield degradation

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-

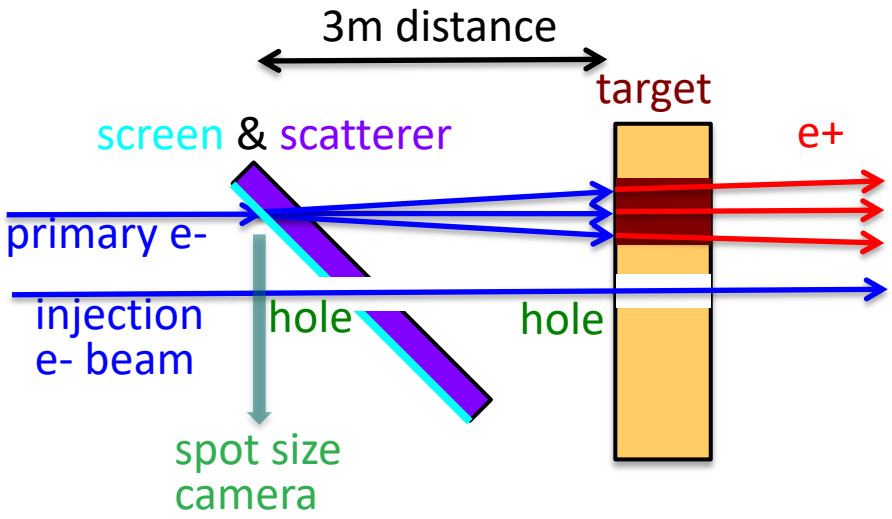


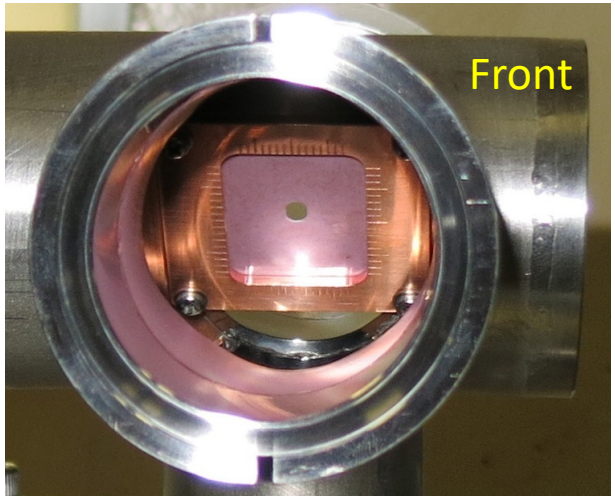
primary e- beam

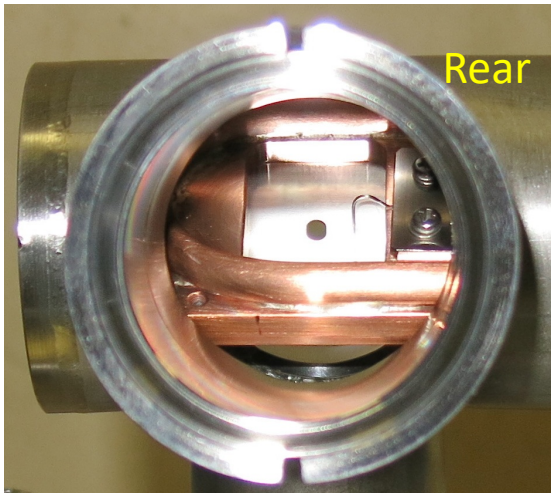


Beam spoiler for target protection

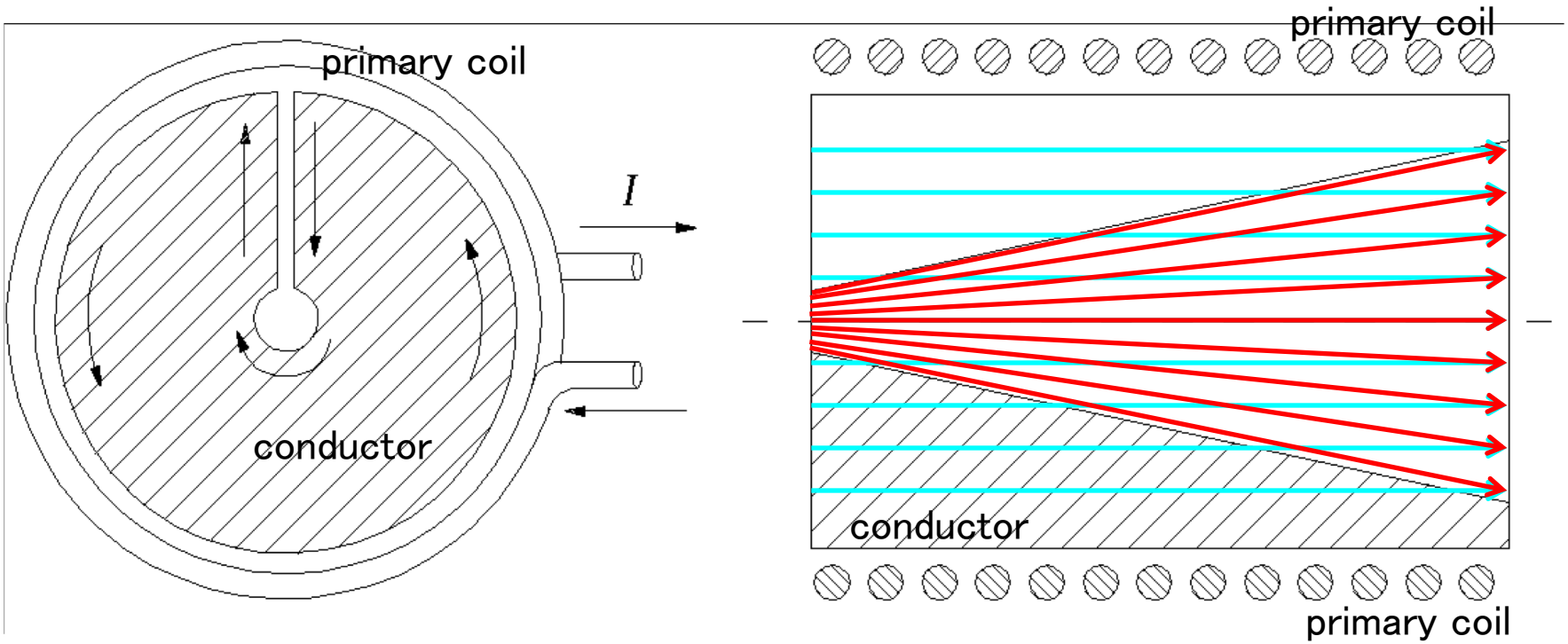
- **beam spoiler** to enlarge beam spot on target to be $\sigma_x, \sigma_y > 0.7$ mm to avoid target destruction
- spot size monitoring screen Al_2O_3 (0.14 mm thick)
  + scattering Al foil (0.25 mm thick)
  [total material thickness = 0.05 X_0]
- beam hole for injection e-







flux concentration concept

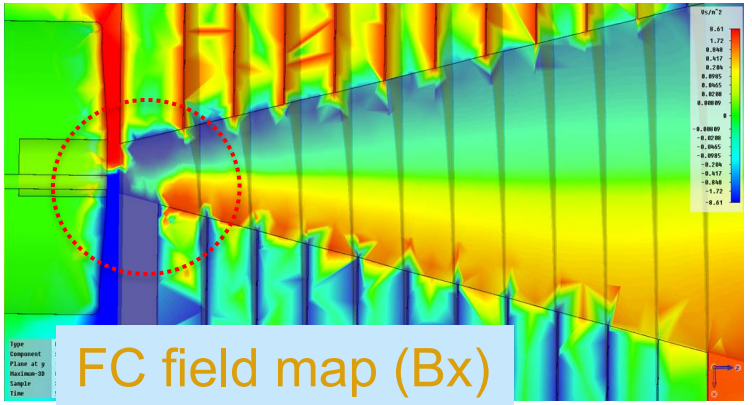


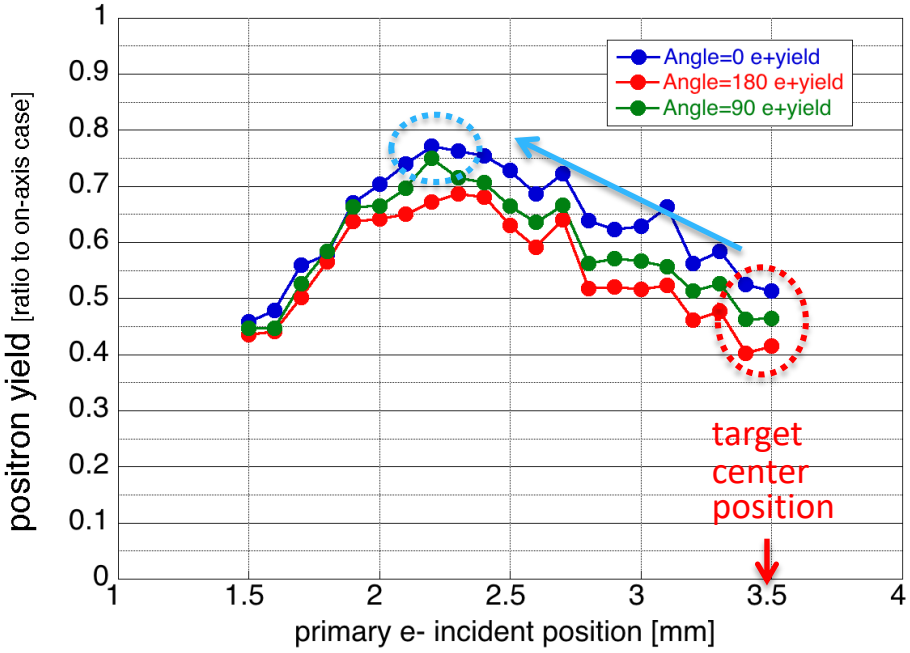
- DC current in primary coil produce uniform solenoidal field
- Pulsed current & Conductor with slit
  => eddy current flows inner surface
  to generate high magnetic flux density (flux concentration !)

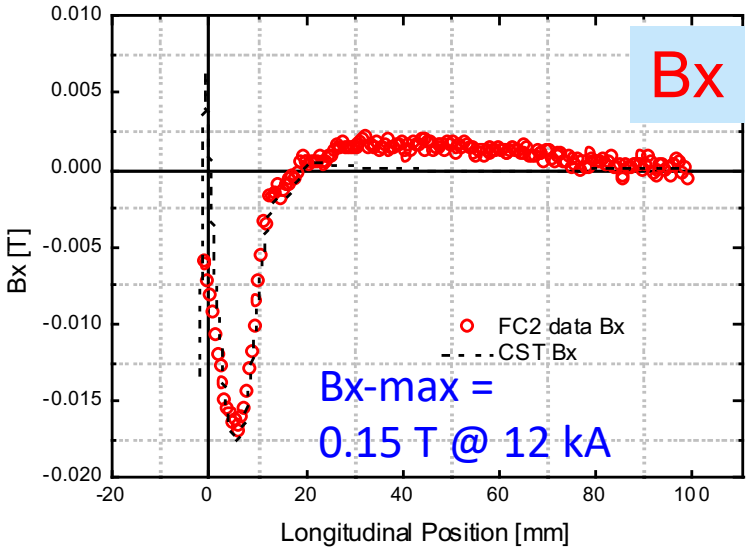
but with non-axial symmetric transverse field !
=> transverse kick to positrons ! beam loss !

e+ yield degradation by target offset

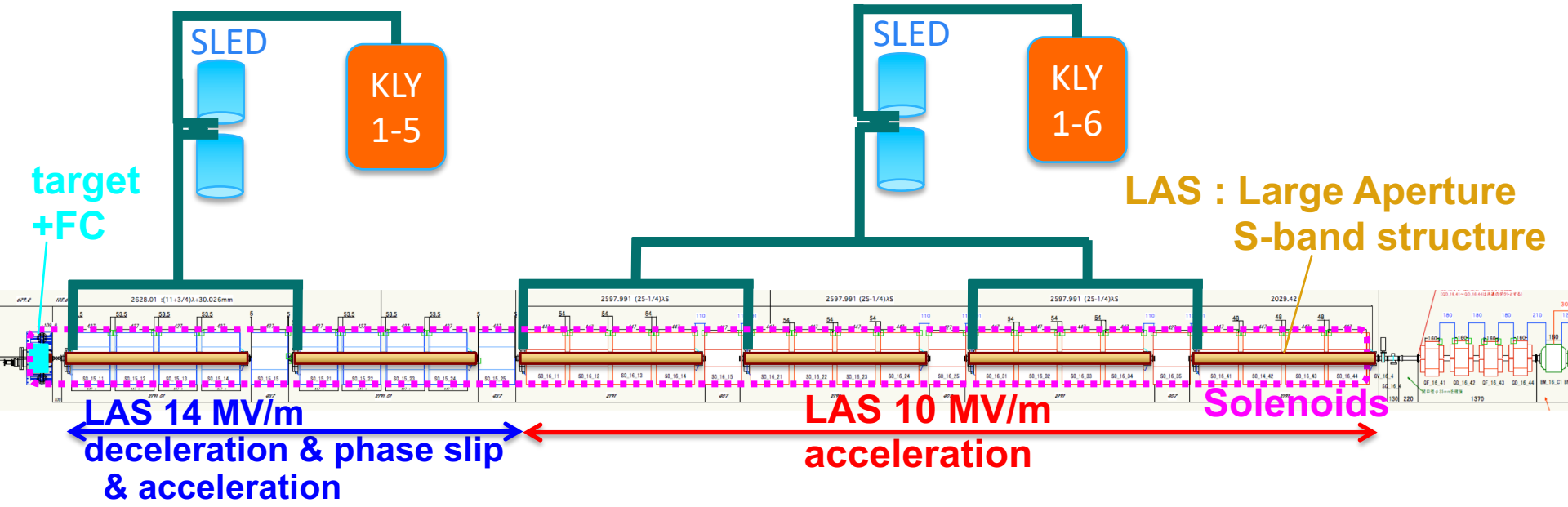
- e+ yield degrades ~50 % by offset e+ generation
- it can be improved to 78 % by
  - utilizing transverse kick by proper orientation of FC slit
  - e- incident position optimization

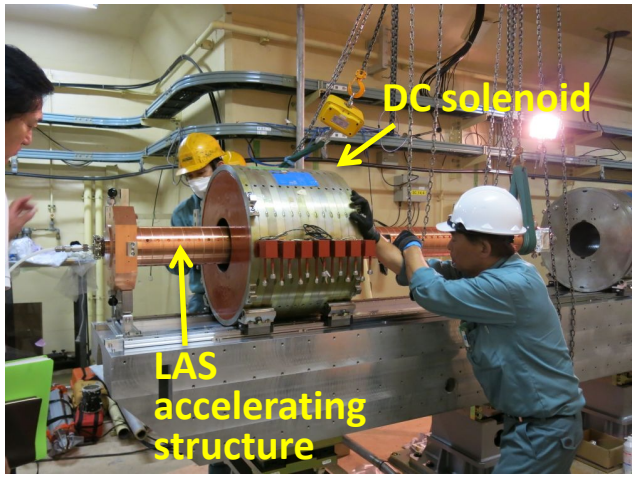






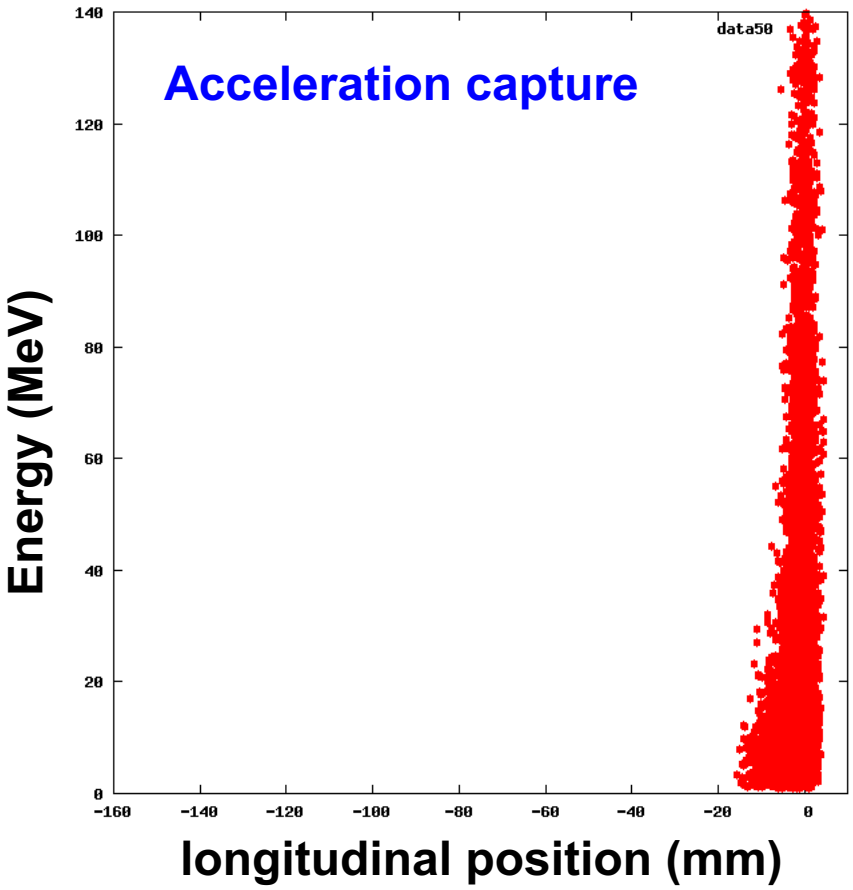
Positron Capture Section





positron capture animation

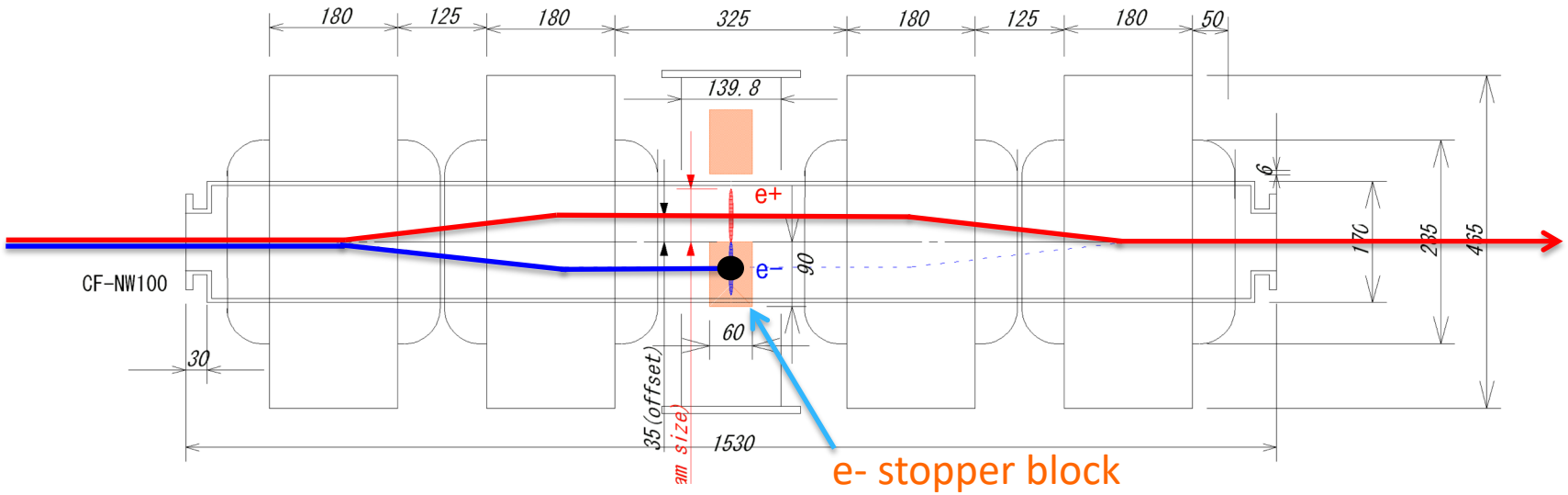
from target to capture section exit (120 MeV)



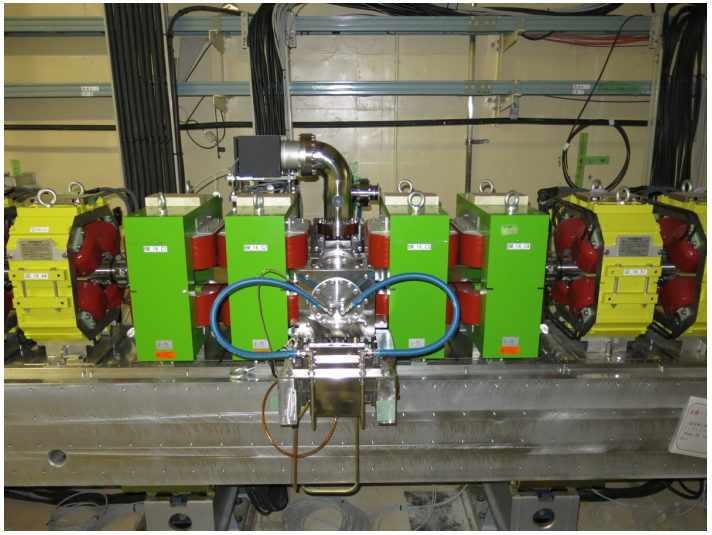
You are watching longitudinal particle motion (z-position vs energy) in a moving frame riding on a microwave !

Positrons with deceleration capture favored for less halo and satellites !

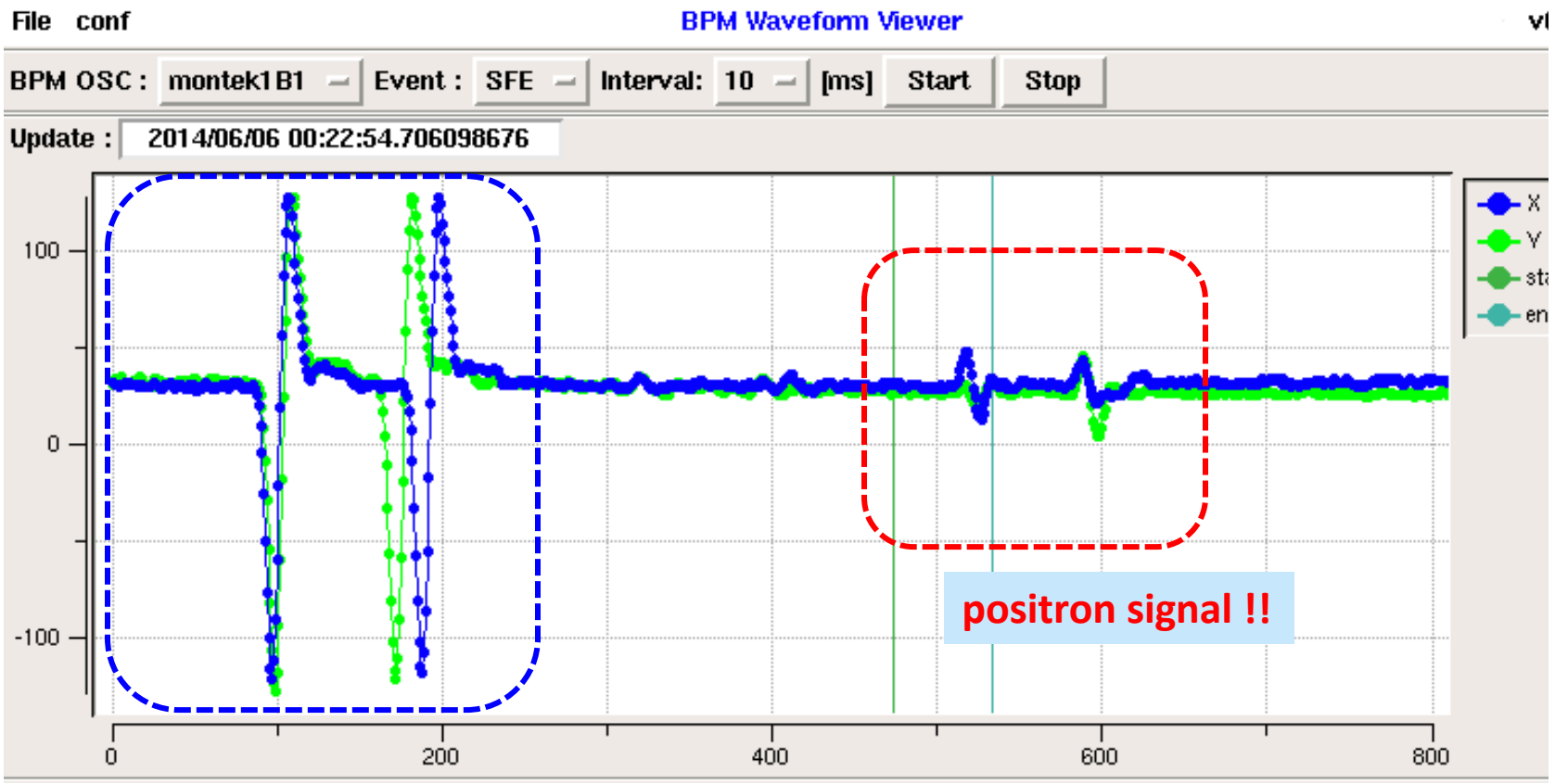
e+/e- separator chicane



- both secondary e+/e- are captured
- to avoid disturbance of
  beam position monitors
  by mixture of e+/e- signals,
  only secondary e- are absorbed
- pure e+ beam is transmitted



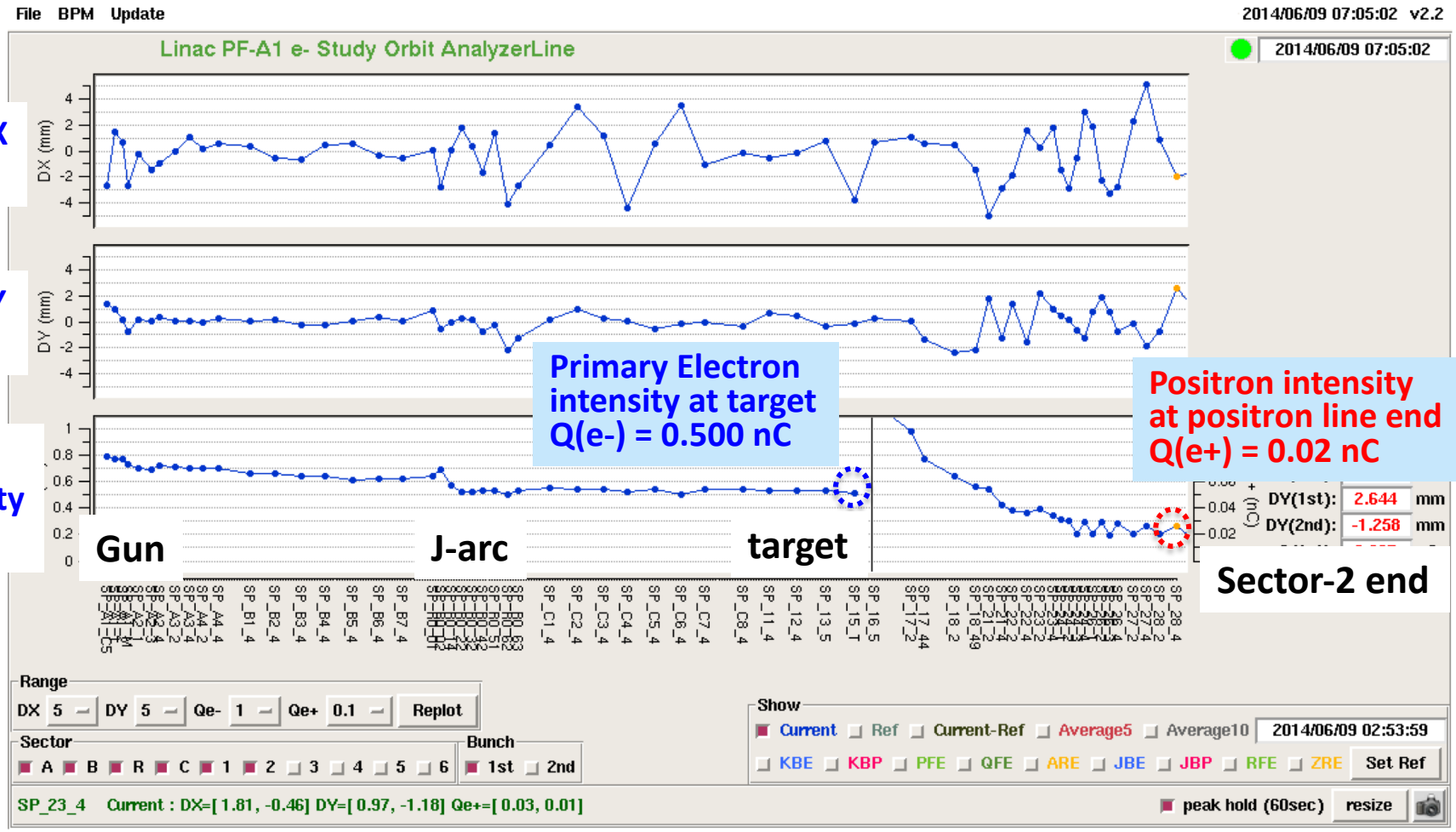
The first positron beam after the upgrade



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



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 nC @sector-2 end for Q_{e-} = 0.5 nC @target)

x200 ⇩ Q_{e+} = 4 nC

x20 ⇩ Q_{e-} = 10 nC

SuperKEKB full spec.