

First synchronous measurement of single-bunched electron and positron beams with a wideband feedthrough-BPM at the positron capture section of the SuperKEKB injector linac

Muhammad Abdul Rehman[#], Tsuyoshi Suwada, Fusashi Miyahara



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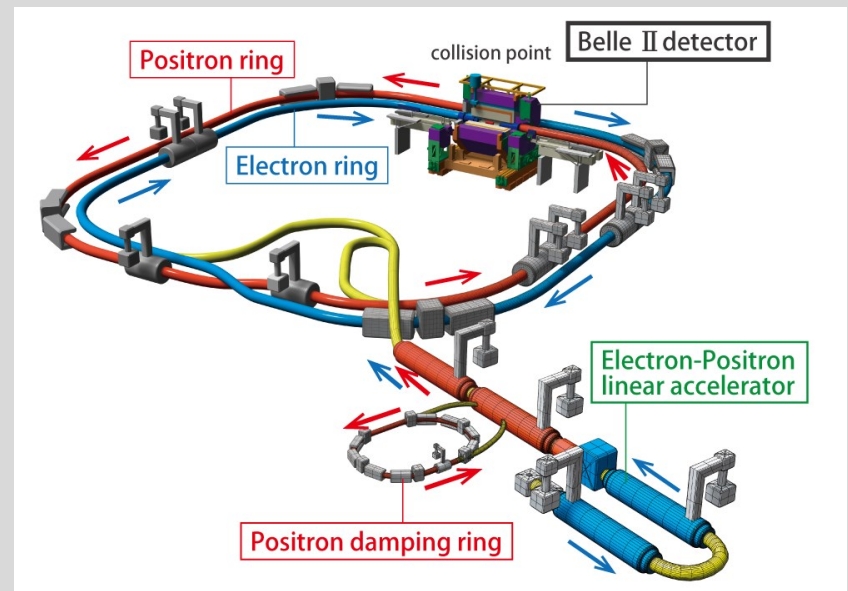
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#rehman@post.kek.jp

1. Introduction

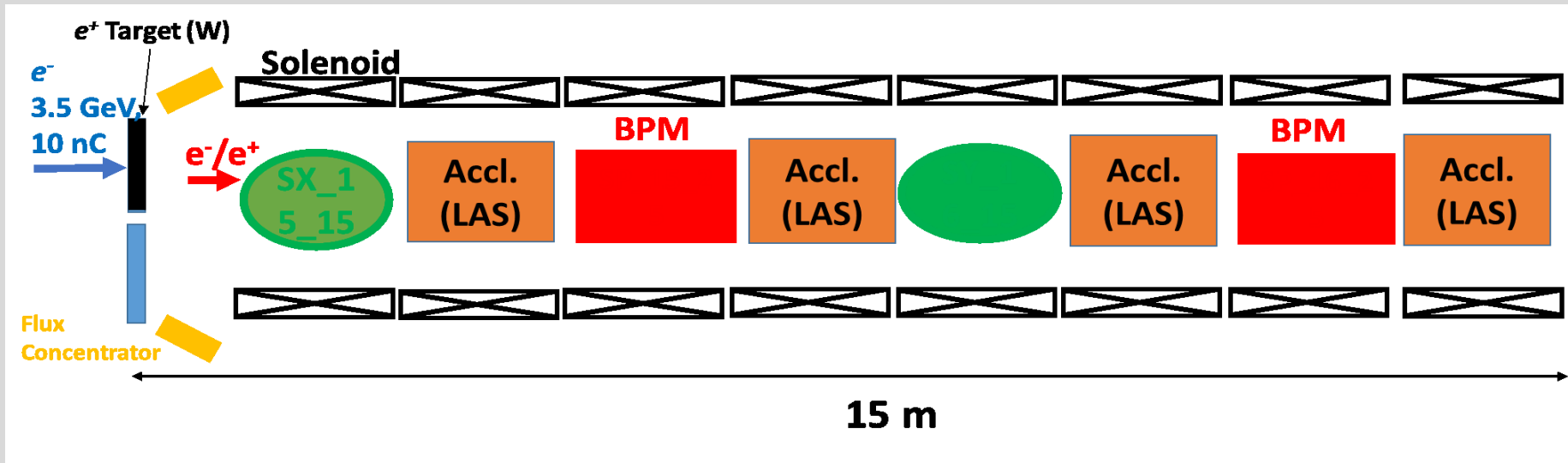
- The SuperKEKB collider is currently in operation to study CP violation in B mesons and also to search for new physics beyond the Standard Model,
- Target luminosity $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$, 40 times higher than its predecessor KEKB.
- High intensity e^- / e^+ beam required to achieve target luminosity.
- Electron beam is produced by photocathode RF gun.
- Positron beam is generated by bombarding Tungsten target with 3.5 GeV/ 10 nC electron beam

SuperKEKB Collider



2. Introduction

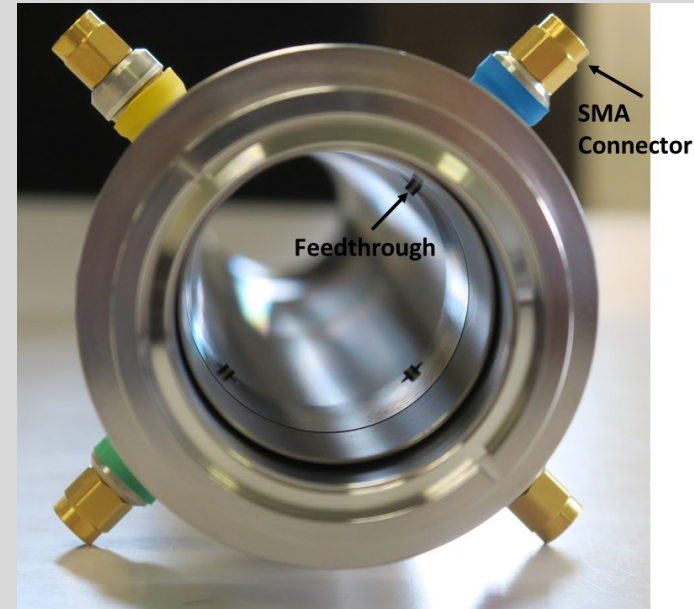
Rough Layout of Positron Capture Section



- The secondary e^- produced during the positron creation process and accelerated.
- Because of phase slipping in the capture section, the secondary electron bunch is only **~ 180 ps** away from the positron.
- **Conventional stripline-type BPM cannot detect** such closely spaced and opposite polarity signals due to slow frequency response and high cable losses.
- **New Wideband BPM** needed for efficient transmission of e^+ beam

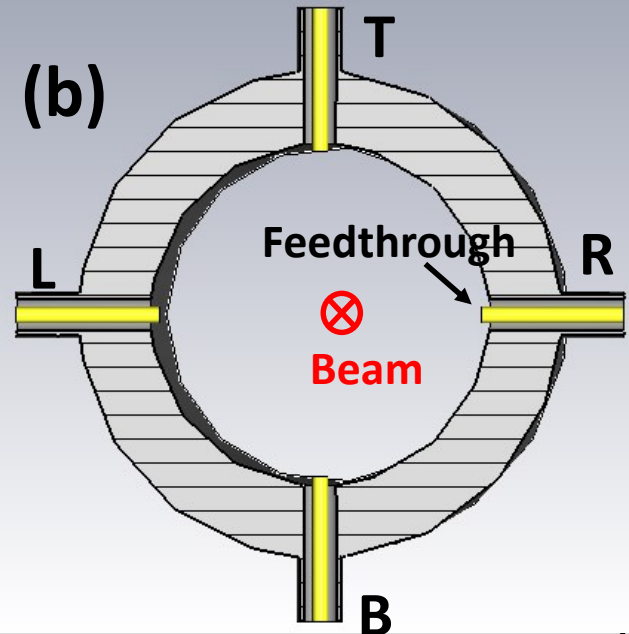
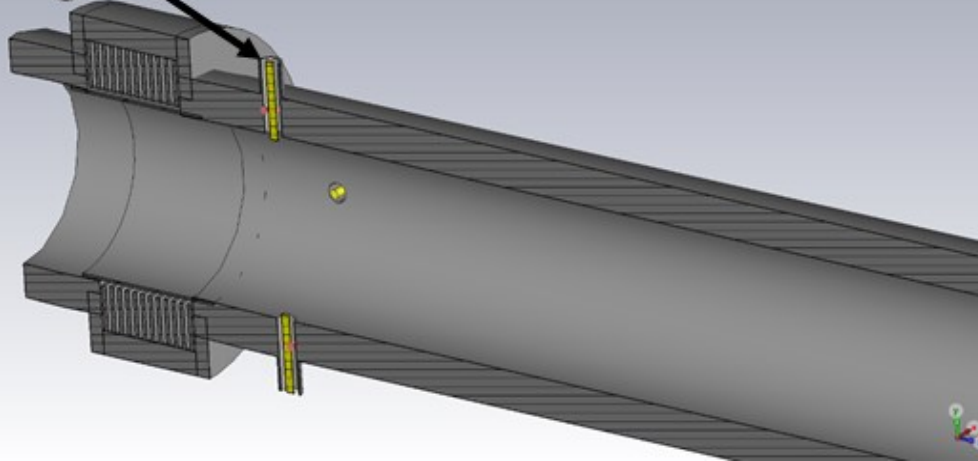
Wideband feedthrough-BPM

- A new **feedthrough beam position monitor (BPM)** developed to detect closely spaced e^-/e^+ bunches
- The feedthrough-BPM consists of a vacuum pipe of **length 431mm** and inner diameter of 38mm
- Four SMA-type feedthroughs having inner conductor made of **Kovar** with $\pi/2$ rotational symmetry
- The diameter of the feedthroughs is **1.8 mm** and they extend 1 mm to the center of the beam pipe.



Feedthrough

(a)



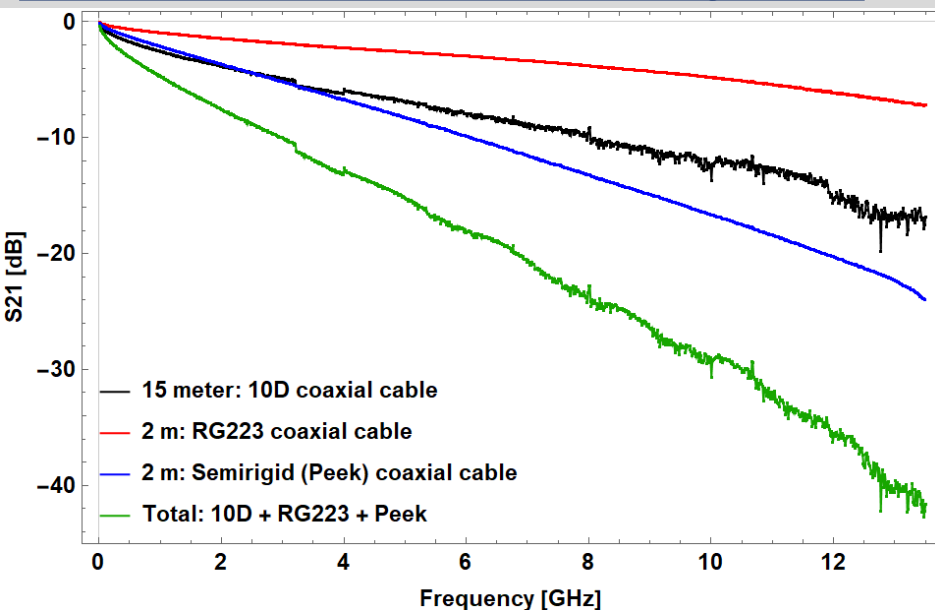
1. Synchronous Measurement of e^-/e^+ bunch

Several kind of Coaxial cables have used to transmit signal from new feedthrough-BPM to Oscilloscope

- 2m: long semirigid coaxial cable
- 15m: long 10D
- 2m: RG223

High-frequency losses of coaxial cables were measured by VNA in advance.

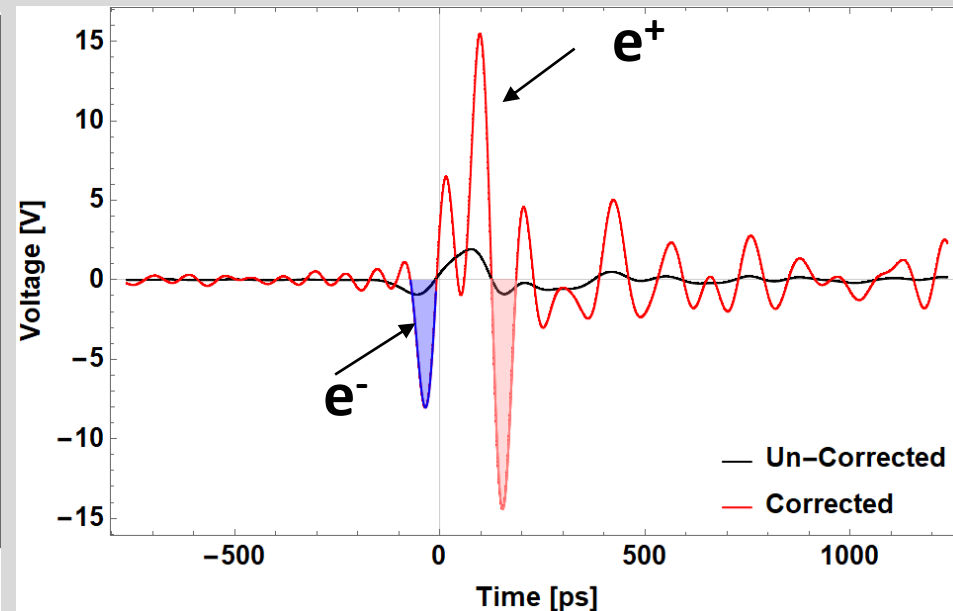
Cable Losses: Measured by VNA



The coaxial cables connected to real-time Keysight oscilloscope of bandwidth 33 GHz and a sampling rate of 128 GS/s.

The typical bipolar waveform at the nominal rf-phase from feedthrough-BPM is shown below

e^-/e^+ signal: keysight UXR0334A



2. Synchronous Measurement of e⁻/e⁺ bunch

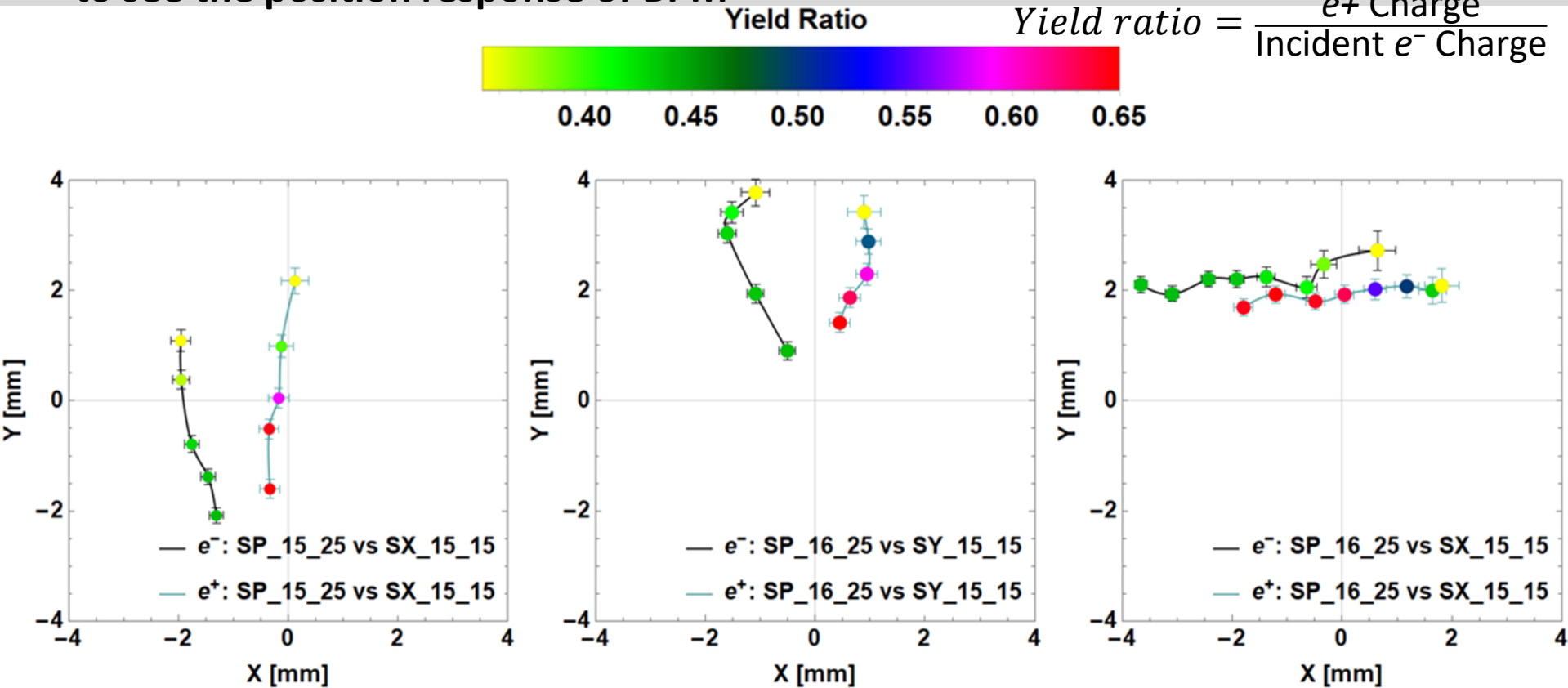
- Where beam position was determined the difference-over-sum method
- Intensity was determined by the sum of four electrode voltage
- Steering magnet currents have changed to see the position response of BPM

$$x(y) = s_b \frac{A_r(A_t) - A_l(A_b)}{A_r(A_t) + A_l(A_b)} \quad Q = G \sum V_i$$

$$s_b = \frac{R}{2}$$

G is conversion factor.

$$\text{Yield ratio} = \frac{e^+ \text{ Charge}}{\text{Incident } e^- \text{ Charge}}$$



Conclusions

- The first synchronous measurement of e^-/e^+ bunches have been performed with the wideband feedthrough-BPM system at the positron capture section of the SuperKEKB factory.
- The synchronous transverse position and intensity of the e^-/e^+ bunches were measured.
- The new wideband feedthrough-BPM proved as an excellent monitor to optimize e^+ transmission through e^+ capture section.

backup

3. Synchronous Measurement of e-/e+ bunch Position

