

# A Preliminary Design of Bunch-by-bunch 3D Positions Measurement

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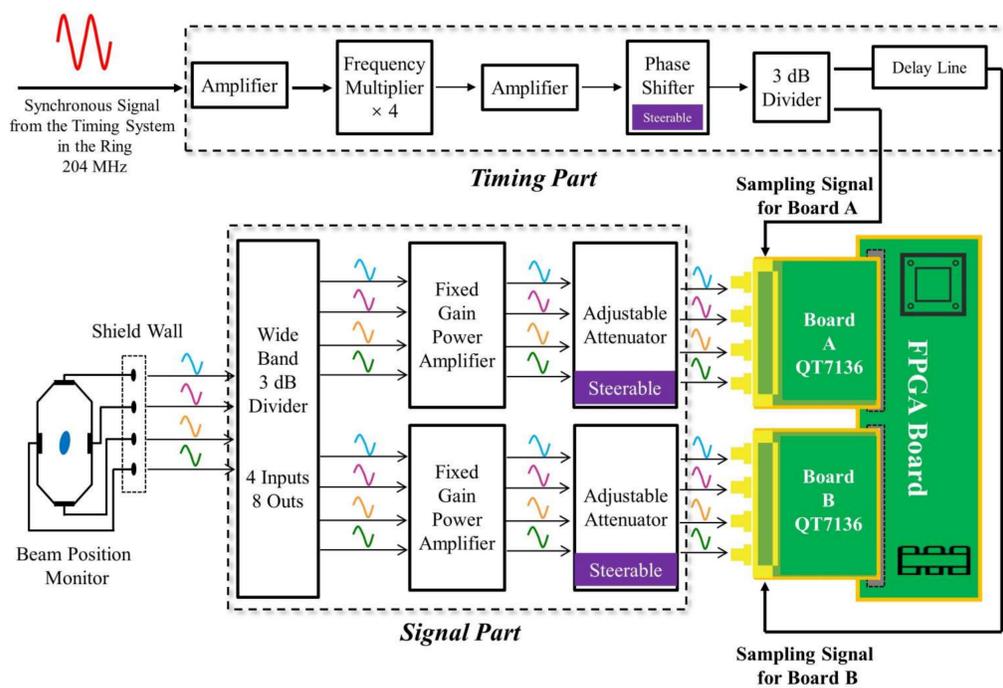
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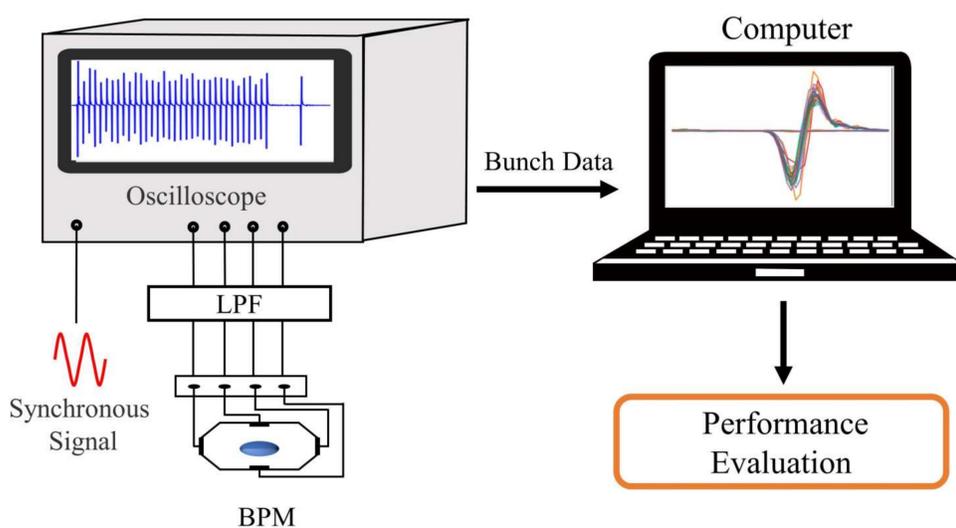
## Abstract

The decrease of beam emittance in the 4th generation light source greatly increases the electron density, thus the wakefields and beam impedance in the storage ring are significantly enhanced, resulting in various beam instabilities. Therefore, it is necessary to observe the transient state of beams using the bunch-by-bunch technique, so as to dig into these instabilities. Here a three-dimensional (3D) positions measurement instrument is designed based on data synchronization module (DSM) to acquire the transverse positions and longitudinal phases of beams in real-time.

## Layout of the Bunch-by-Bunch 3D Positions Measurement Instrument

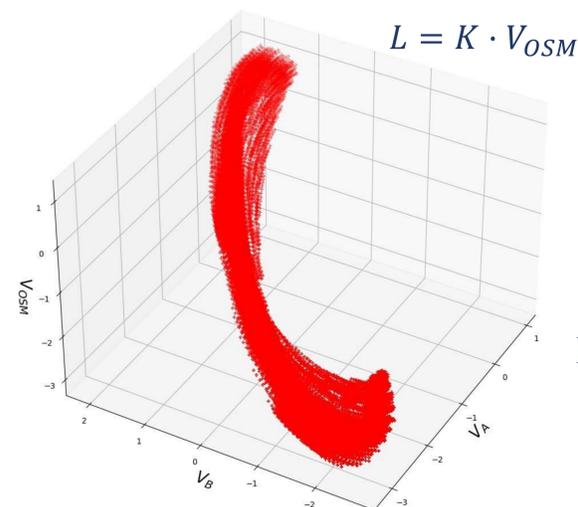
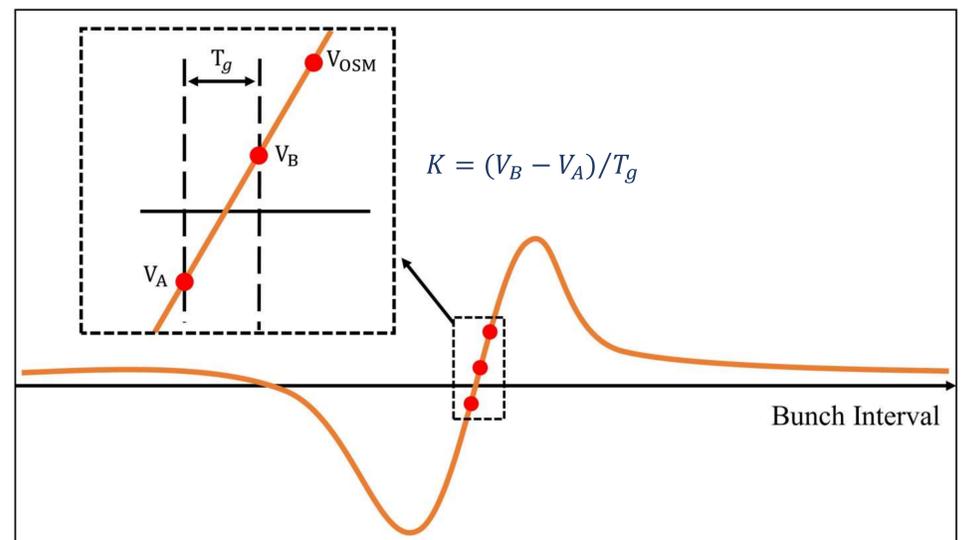


## Performance Evaluation System



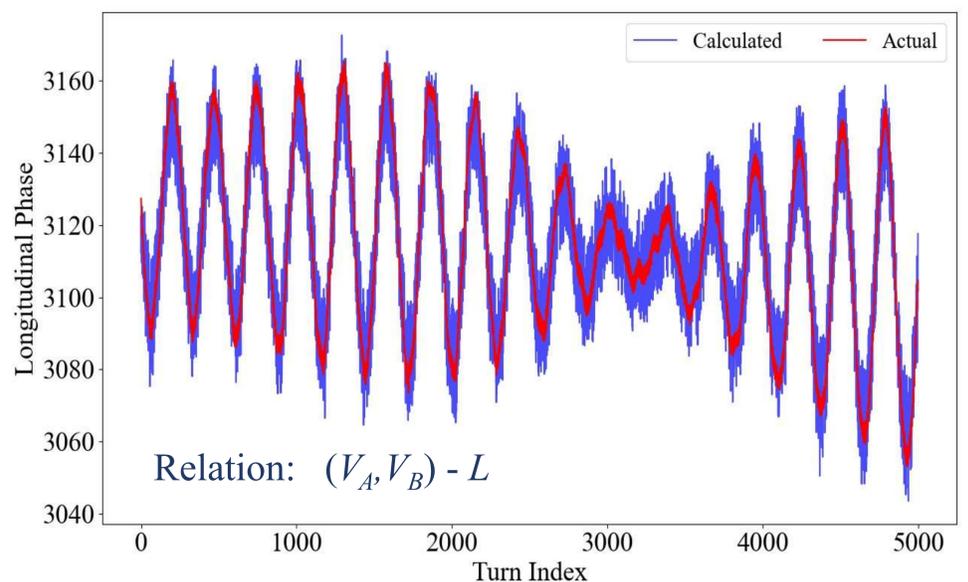
In order to determine the measurement performance in the 3D positions, an oscilloscope-based performance evaluation system was constructed. With the help of the low-pass filter, the bandwidth of the oscilloscope is equivalent to that of the acquisition board, so that the data obtained by the oscilloscope and the data acquisition board are consistent. After the acquisition, these data will be sent to the computer for processing, and finally obtain the signals of each bunch during the bunch interval. Finally, the corresponding measurement performance can be obtained by analyzing the signals in the bunch interval.

## Vector Matching



$$M = (V_M \cdot V_D) / (|V_M| \cdot |V_D|)$$

$$\text{Relation: } (V_A, V_B) - V_{OSM}$$



## References

- [01] Lee, Jaeyu, et al. "Bunch-by-bunch position measurement and analysis at PLS-II." *Journal of Synchrotron Radiation* 24.1 (2017): 163-167.
- [02] Zhou, Yi-Mei, et al. "Bunch-by-bunch longitudinal phase monitor at SSRF." *Nuclear Science and Techniques* 29.8 (2018): 113.
- [03] Chen, Fang-Zhou, et al. "Touschek lifetime study based on the precise bunch-by-bunch BCM system at SSRF." *Nuclear Science and Techniques* 30 (2019): 1-8.
- [04] Drago, A., et al. "Bunch-by-bunch profile diagnostics in storage rings by infrared array detection." *Measurement Science and Technology* 26.9 (2015): 094003.
- [05] Duan, Li-Wu, et al. "Injection transient study using a two-frequency bunch length measurement system at the SSRF." *Nuclear Science and Techniques* 28.7 (2017): 93.
- [06] Wu, Ruizhe, et al. "Data synchronization module for multi-dimensional bunch-by-bunch measurement in a storage ring." *Review of Scientific Instruments* 93.12 (2022).
- [07] Wu, Ruizhe, et al. "A one-time sampling method for the real-time measurement of bunch-by-bunch three-dimensional positions in storage rings." *Journal of Instrumentation* 17.11 (2022): P11001.