TUPB035

Bunch-by-Bunch Study of the Transient State of Injection at the SSRF

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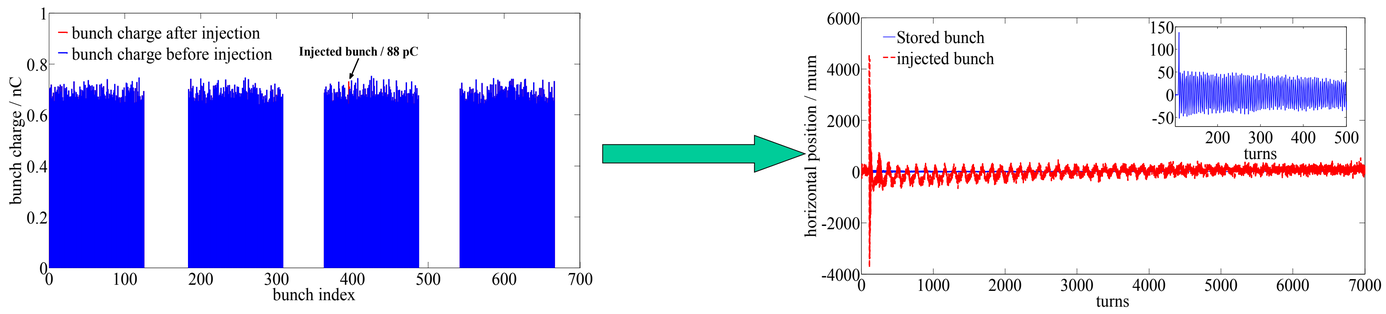
Introduction

High current and stable beams are preferred to a light source, so the suppression of the oscillations due to the frequent injections during top-off operations get the attention at the Shanghai Synchrotron Radiation Facility (SSRF). To evaluate the possibility of further optimizations, a bunch-by-bunch position monitor is used to study the behavior of the injected bunch.

The SSRF is a third generation light source aiming to provide stable and brilliant synchrotron radiation. The high brilliance target was achieved by operating under top-off mode. But the frequent injections required by the top-off mode will decrease the stability of the beams. The behavior of the injected bunch has to be studied before finding a solution to minimize the effect of the injection.

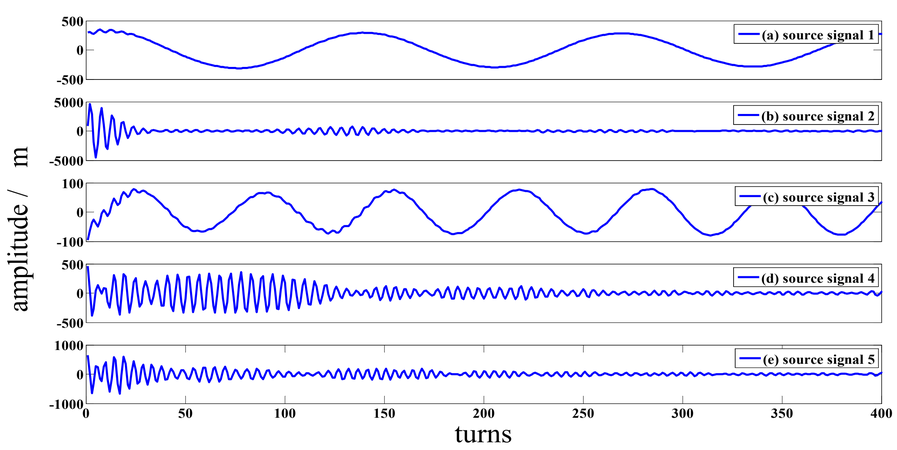
Separating Injected bunch from Stored one

The injected bunch can be found by using the filling patterns. The adjacent bunches are used to interpolate the orbit of the stored bunch and the position of the injected bunch can be obtained by deducting the weighted stored part from the raw position data. The injected bunch can also be separated by decomposing the motion matrix of all bunches by using the singular value decomposition (SVD). Both methods gave the same results.

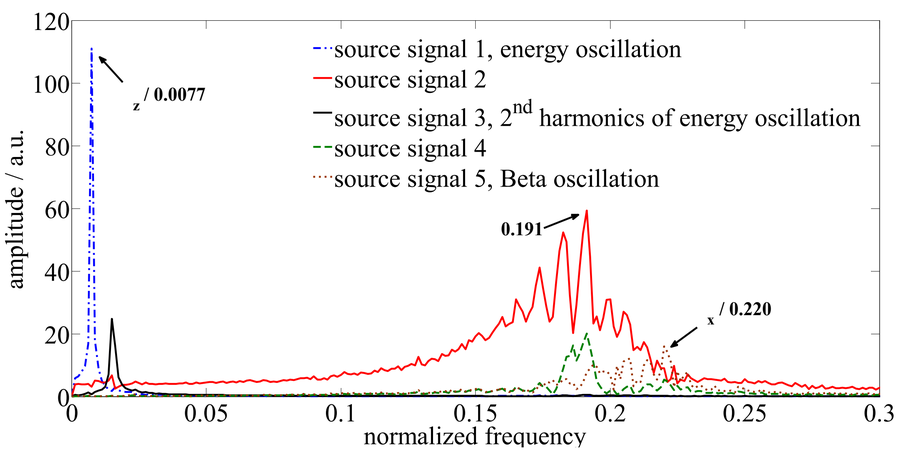


Extracting Modes

source signals extracted by using ICA



source signals' waveforms

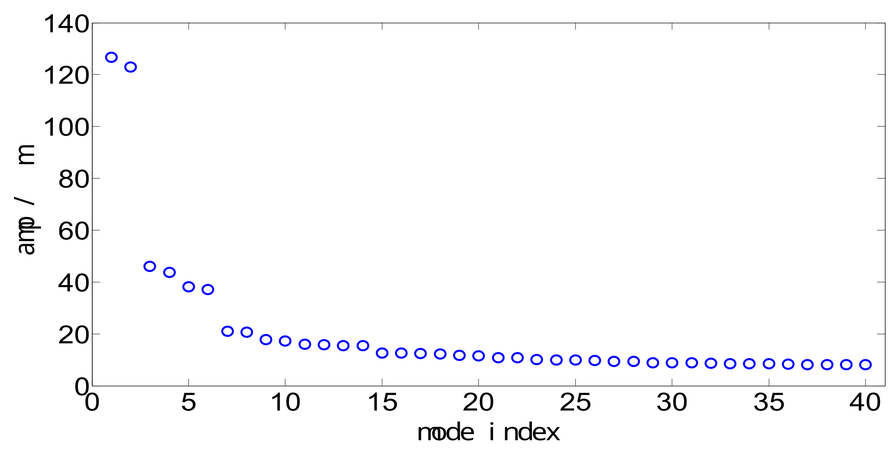


source signals' spectra

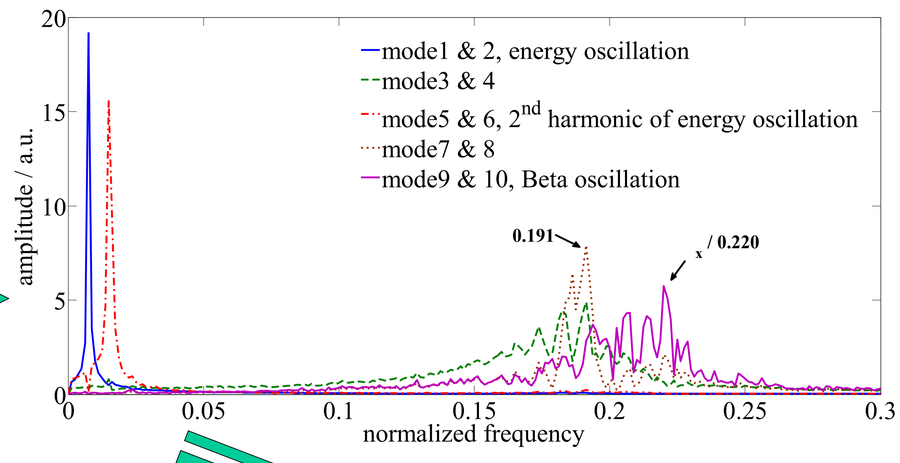
separated modes are close enough by using ICA and using SVD

It is safe to say that the ICA procedure can be replaced by the SVD method in this situation.

modes' spectra extracted by using SVD



Singular values of different modes



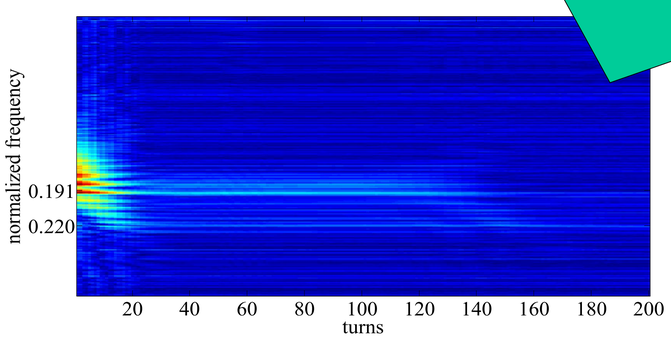
modes' spectra

Mode Evolution

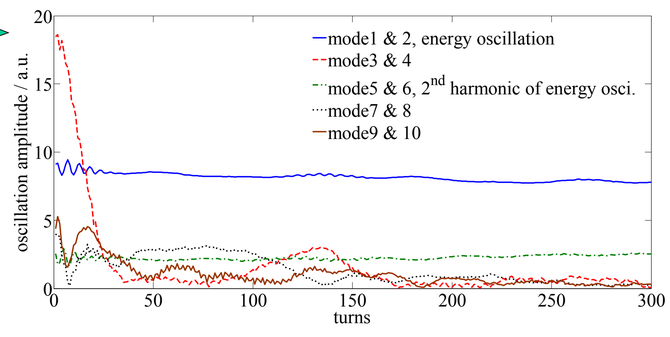
The spectrum of the injected bunch is not constant. The waterfall plot of the spectra shows that the distribution of the modes varies with time.

Some of the modes vanished after 20 turns. Some of them were invoked after 10 turns and vanished with the other modes. And some modes lasted more than 100 turns.

The energy oscillation mode and its second harmonic seem to be constant.



spectra waterfall of the motion of the injected bunch



detailed evolution of the modes obtained by using the right-singular vectors of the motion matrix

Conclusion

The motion of the injected bunch can be extracted from the stored bunch by singular value decomposing. It can be separated into the energy oscillations and the betatron oscillations on-line based on the SVD method. The betatron oscillation due to the mismatch between the transport line and the storage ring decays rapidly within 20 turns.

The second harmonic of the energy oscillation is obvious. The reason might be that the stored bunch and the injected bunch forms a two-body system, so the two parts are interfering with each other.

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