POSSIBILITY STUDY OF GENERATING LONG SR PULSE IN HLS

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Abstract

Hefei Light Source (HLS) is a low energy Synchrotron Radiation (SR) facility. The interval of SR pulses is in the range of 5~220ns. But some experiments need very long interval SR pulses with strict time structure that HLS cannot provide. To meet the needs of these experiments, a scheme of local vertical bump is studied. Physical calculation and numerical simulation demonstrate the theoretical possibility, and a prototype fast kicker system has been built to demonstrate the technical possibility.

1 INTRODUCTION

The circumference of HLS storage ring is 66.13m and in which 45 e-bunches can be filled at most, so the interval of SR pulse is in the range of 5~220ns. **T**ime **R**esolved **S**pectroscopy(TRS) studies the dynamic process in interaction between SR and materials. If the dynamic process is very slow, very long interval SR pulse is needed which beyond HLS can produce. Thus, how to increase the SR interval for one experimental station while not interfering other experimental stations is a valuable subject. As the interval is less than 220ns, use mechanical chopper in beamline can not get SR pulse with strict time structure.

2 SCHEME

There is a slit between beamline and storage ring, and SR pulse should pass through the slit first and then enter into beamline. The slit and the central orbit are situated at the same horizontal plane. As SR pulse is emited from electron beam horizontally with a very small divergence, so only SR pulse from central orbit can enter into the beamline and experimental station. If the beam orbit away from the horizontal plane, SR pulse will be shielded off. Thus, the interval of SR pulse can be adjusted by changing the relative position of beam orbit and slit vertically. So, the local vertical bump[1] scheme is adopted to fulfil this contrive. To decrease the technical difficulties the local bump consists of DC bump and pulse bump. Figure 1 shows the scheme.

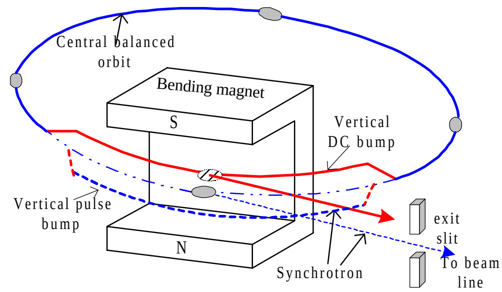

Figure 1: DC bump and pulse bump

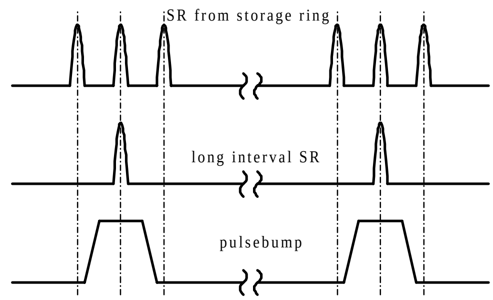

Figure 2: Relationship between bump and SR

If the DC bump is high enough, when e-bunches pass by the vertical DC bump, SR pulse can not pass through the slit. When SR pulse is needed, a fast vertical pulse bump with inverse polarity is formed. As the amplitude of the two bumps are equal, the height of their synthetical orbit is zero. So, e-bunch come back from DC bump to central balanced orbit and SR pulse can pass through the slit and enter into the station. So, we can adjust the interval by controlling the frequency of pulse bump. Fig.2 shows the relationship of pulse bump and needed long interval SR pulse.

3 FORMATION OF LOCAL BUMP

The layout of the beamline of TRS Station is shown in Figure 3. If the vertical local bump spans the bending magnet B11 only, it will not interfere other beamlins and stations. Four DC magnets are used to produce DC bump, and four fast kickers to make pulse bump. As the ring is compact and there is little space available for many magnets, the DC bump uses four correcting trim coils that already installed in Q_3~Q_6, and four kickers will be installed in the position K_1~K_4 shown in Fig.3.

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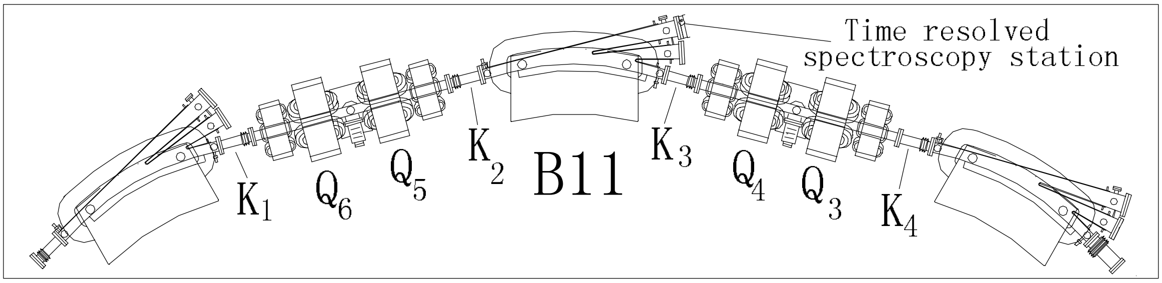

Figure 3: Layout of storage ring at bump area

There are 3 different lattice configurations in HLS: GPLS, HBLS_1 and HBLS_2. As an illustration, local vertical bump schemes of 2 different lattice configurations are shown in Figure 4, 5.

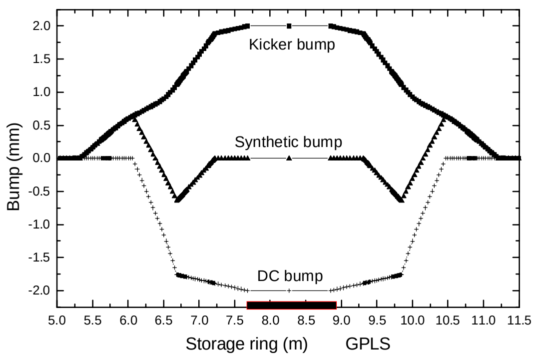

Figure 4: Local bump scheme of GPLS

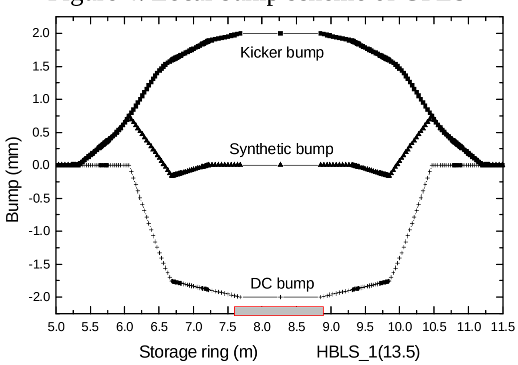

Figure 5: Local bump scheme of HBLS_1

If SR pulse from DC bump enter into the experimental station it will bring background noise to the experiment and will affect the accuracy of result. So, the DC bump must have sufficient height. Calculation shows that the 2mm bump height is enough.

4 THE EFFECT OF DC BUMP

Using DC magnets to make vertical DC bump will affect the parameters of the ring because of their fringe effect. The larger the amplitude of DC bump is, the more effect on storage ring will be. The pulse bump is transient, so its effect can be neglected.

With the help of New_PATRICIA[2,3], we can find the changes of the dynamic aperture and other parameters of storage ring. Assume the maximal momentum dispersion $\delta = \Delta p / p$ is 1%, Dynamic apertures of two different lattices in two different conditions are calculated, shown in Figure 6,7.

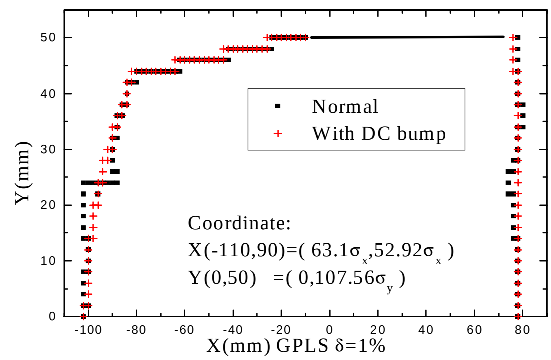

Figure 6: Dynamic aperture of GPLS

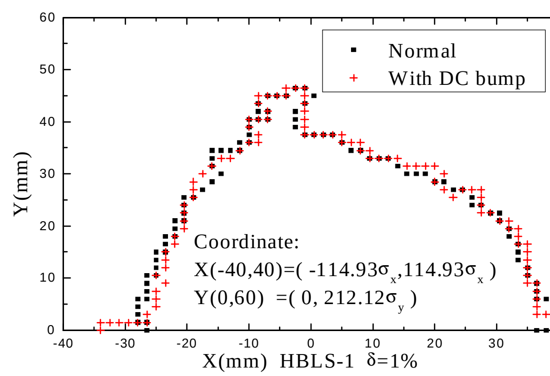

Figure 7: Dynamic aperture of HBLS-1

Figure 6,7 indicate that the effect of DC bump on storage ring is quite small and can be neglected if the amplitude of bump orbit is in the designed range.

5 FAST KICKER SYSTEM

To get long interval SR pulse with strict time structure, the key problem is how to produce a very fast pulse bump, which only works on one e-bunch. A prototype PFL pulse modulator and an air-core kicker have been made to demonstrate the technical posibility. To decrease the stray inductance, the system should be designed carefully. The maximum discharge current is about 950A, and Figure 8 shows the current wave,(Rogovski coil, Person Co. 10:1) which has the width of 200ns (10%~90%), and 55ns rise time and 65ns fall time.

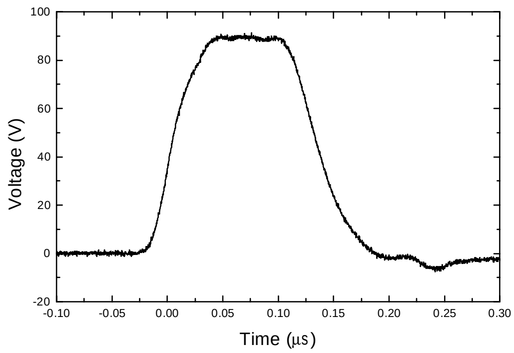

Fig.8 Waveform of discharge current(950A)

6 CONCLUSION

Physical calculation indicates that it is feasible to produce long interval SR pulse with strict time structure by using vertical local bump orbit in HLS, and there isn't any unconquerable difficulty technically.

As to HLS, we can use fast (ns) timing system and RFKO system to make the e-bunches distributed symmetrically in storage ring shown in Figure 9. If there are 7 e-bunches in storage ring, the prototype fast kicker system with a little improving can meet the request of fast local bump. That is, when HLS provide long interval SR pulse for TRS station, the other experimental stations can work well with enough strength of optical flux.

This method is very valuable especially for light source with small storage ring, because it will broaden the research area of SR pulse. So, by this method, some experiments can be finished successfully in small light source, which can only be done at light source with very large storage ring before.

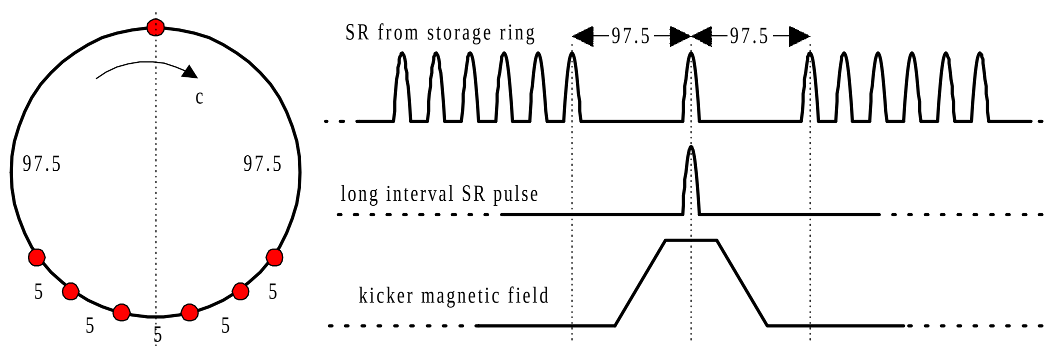

Fig.9. Electron bunches in storage ring with asymmetry (reference coordinate: time ns)

7 REFERENCS

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