INTRODUCTION

Synchrotron SOLEIL is a 2.75 GeV third generation synchrotron light source delivering beam to user since January 2007. Its intermediate energy has been chosen to satisfy a very broad range of photon energies from a few electron volts with long period insertion devices to a few tens of kilo-electron volts with in-vacuum undulators and wigglers [2]. It deserves several user communities asking for either high flux/brilliance based experiments or time resolved experiments. To answer the later demand, SOLEIL operates every year with different filling patterns: 8 bunches spaced by 146 ns with a full current of 100 mA and single bunch operation with 11 mA. The increasing user demands for a few bunch operation few weeks a year. Meanwhile most of the multi-bunch filling pattern based experiments are not possible due to the low photon flux.

In the present location of the horizontal kicker, our degrees of the horizontal orbit shift of 2.8 mm at CRISTAL beamline for a TEMPO requirement for PSB mode is to separate the background radiation [3-5] on the user side. Mainly questions are still opened concerning the use of PSB mode at SOLEIL. How many fast kickers to use to satisfy one or several beamlines? What repetition rate? What are the drawbacks of PSB if operating at different frequencies? What is the closed orbit bump achievable and compatible with maintaining high orbit stability and beam performances?

To answer these questions, we decided to start simulations and beam experiments using the available fast kicker magnet used for frequency map analysis [6]. The following sections, first simulations are described. Then we discuss the modification of the machine study dedicated kicker magnets and timing system to carry out a first experiment with the TEMPO beamline.

ORBIT SIMULATION

TEMPO requirement for PSB mode is to separate the radiation from the normal beam orbiting on the almost zero closed orbit and that of the single bunch. The first mirror is located 10 m downstream of the source point (an APPLE2 type undulator). The maximum separation is 1 mm FWHM (four times the normal radiation emission cone from normal beam). The typical closed orbit followed by the isolated bunch is displayed on Fig. 1 for a horizontal orbit shift of 2.8 mm at CRISTAL beamline for the present location of the horizontal kicker. Our degrees...
of freedom are limited to the kicker amplitude and the choice of the working tunes. In addition since the kickers are running at a frequency much lower than revolution frequency, the single bunch will cross the beamline at different position and diverge over the turn number. The beam will get slowly damped to the zero amplitude. This gives another degree of freedom for selecting the radiation of the single bunch.

Figure 1: Closed orbit followed by the single bunch with four source-points for an orbit deviation of 2.8 mm in the undulator of CRISTAL beamline.

**FAST KICKER MAGNET**

Presently two fast kicker magnets [6] are installed in the injection straight section for kicking the electron in both transverse planes and analyzing transverse beam dynamics using beam turn by turn data.

In order to start our exploratory studies, the kicker pulzers have been modified. The requirements were to increase the trigger frequency from 3 Hz to 1 kHz and to shorten their time response duration down to 800 ns while keeping the maximum deviation strength compatible with TEMPO and CRISTAL experiments. A new pulse forming line whose length is reduced to 15 m, has been installed to replace the existing one used to operate the kicker for standard turn-by-turn measurements. Figure 2 gives the waveform obtained for the horizontal kicker; the reached performances are summed up in the Table 1 with respect to the original design kicker performances.

Table 1: Fast horizontal (H) and vertical (V) kicker performances for PSB mode versus design values.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Design Value (H/V)</th>
<th>Value for PSB experiment (H/V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rising time</td>
<td>380/400 ns</td>
<td>280/400 ns</td>
</tr>
<tr>
<td>Flat top time</td>
<td>420/480 ns</td>
<td>&lt;40 ns</td>
</tr>
<tr>
<td>Falling time</td>
<td>450/380 ns</td>
<td>580/400 ns</td>
</tr>
<tr>
<td>Max. frequency</td>
<td>3 Hz</td>
<td>1 kHz</td>
</tr>
<tr>
<td>Max. deviation</td>
<td>2.8/1.1 mrad</td>
<td>270/100 µrad</td>
</tr>
</tbody>
</table>

**TIMING SYSTEM**

The beamline timing system was modified in order to accommodate high trigger frequency for the kicker. The TIMBEL timing board was in-house developed [7] for providing users with timing signals. It allows us to synchronize the acquisition devices to electron bunch inside the storage ring. This board divides the RF clock and enables to tune the frequency in the 88-2.7 kHz range and to compensate the delay offsets. To meet the PSB specification sheet it was successfully upgraded in order to reach frequencies as low as 334 Hz for triggering the fast kickers.

Figure 3: TIMBEL board’s architecture.

**PRELIMINARY RESULTS**

**Kicker Commissioning**

Beam-based experiments have been carried out during the year 2010 to first validate the performances of the kicker and timing system.

The new modified kickers were successfully commissioned. Their response versus current is quite linear as soon as deviation angle is large enough with characteristics close to the expectations. In the horizontal plane the deviation range is from 70 to 270 µrad. The Figure 4 gives an example of comparison between the simulated orbit and the one built from the turn-by-turn data. The reproducibility is good but a factor two discrepancy between measurement and model needs to be further investigated. Operation at 827 Hz meets the baseline for a first experiment with users.

Figure 4: Example of comparison between the simulated orbit and the one built from the turn-by-turn data.
First Results on TEMPO beamline

A first experiment was performed with the TEMPO beamline and the experimental station dedicated to time resolved photoelectron spectroscopy experiments [8]. The purpose was to synchronize to the data acquisition with the kicker excitation and to verify the pseudo single bunch operation at the experimental station level. During this experience the storage ring was injected with a 20 mA current in a hybrid filling pattern consisting of ¼ in multi-bunch and 1 single bunch in the rest of the machine.

In the inset of Fig. 5 we present the time resolved photoemission intensity measured at the TEMPO experimental station on the time interval of the SOLEIL orbit. If the data acquisition is synchronized with the kick excitation frequency, the intensities associated to the ¼ multi-bunch and to the single bunch indicated with the red and blue regions respectively can be used to monitor the kicker operation and the effects on the hybrid intensity for each turn of the electrons in the storage ring. The integrated intensities are presented in Fig.5. The hybrid photoemission intensity (red curve) is not affected by the kicker operation, while the oscillations of the single bunch described in Fig. 5, are seen at the experimental station as damped periodic oscillations in the photon beam intensity.

PERSPECTIVE

After first encouraging experimental results another set of experiments is foreseen with the TEMPO beam-line before the end of the year. The aim is to validate the principle of PSB mode with a final user. If the results are positive enough a dedicated strip-line will be designed with a flat top of few tens of nanoseconds and higher repetition rate.

ACKNOWLEDGMENT

The first author would like to thank G. Portmann for fruitful discussions and guidance during this work. The TEMPO team, the power supply and pulsed magnet group, the control group and diagnostics group are deeply thanked for their support during all this work.

REFERENCES