





Figure 2: data acquisition board and PXIe chassis for BTB on-line measurement.

Raw data was processed by FPGA processor, and stored in registers. There are 2 modes for DAQ because of I/O channel limitation: Mode 0 for raw data and Mode 1 for FPGA processed result.

**Data I/O Unit** is a PC-based controller inserted into NI chassis, which controlled Data Processing Board using PXIe interface. We have designed an EPICS IOC running in Linux OS of the controller to implement DAQ control and data publish.

**EXPERIMENT AND DATA ANALYSIS**

From the perspective of beam diagnostics, it was a good observation occasion when beam instability mode to be measured was fully excited. So we have create an experiment condition that parameters of storage ring were kept as stable as possible but IVID gaps or TFB gain.

The experiment consists of two parts: main part was observing and record bunches transverse oscillation during TFB gain variation. After that, we moved ID pole gap and tried to observe the variation of instability mode.

In order to reduce the influence of other factors on the experiment, the beam experiment was scheduled in the accelerator machine research. During the experiment, storage ring ran in Decay mode, beam current is around 170mA, and the filling pattern was shown in Figure 3.

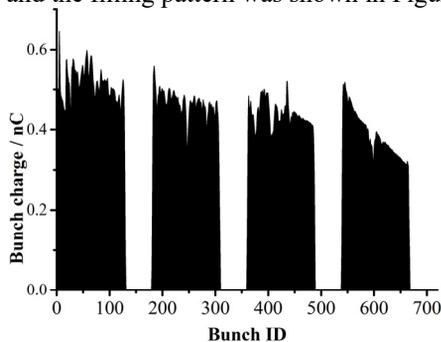


Figure 3: Filling pattern during the experiment.

The bunched beam was composed of 4 bunch-trains, which spaced about 50 empty budgets. In order to facilitate the distinction, the bunch-trains from left to right in the figure were ordered No.1~4.

*TFB Experiment*

In this experiment, we gradually shut down and re-started the TFB and set the initial feedback gain to minimum (0x0001) when the feedback force was inadequate

to suppress the transverse oscillation, then increased the gain value step by step. According to the previous experience, the transverse oscillation could be fully suppressed (well-optimized feedback) when the feedback gain was near 0x0007. In order to observe the variation of beam transverse oscillation from "in-adequate feedback state" to "well-optimized feedback state", the gain was changed from 0x0001 to 0x0010, and the step size was set to 0x0001. After that, if feedback force continues increase until it is greater than well-optimized feedback needed, the forced oscillation of beam would be dominated by feedback force. Due to the limitation of experimental conditions, the feedback gain went on increasing from 0x0060 to 0x00a0, and the step size increased as 0x0008 or 0x0016. 10 sets of BTB position data array and raw sampling signal for each step were acquired in real time by the BTB measurement system.

Normalized frequency spectrum of each bunch was obtained by FFT to position array shown in Figure 4.

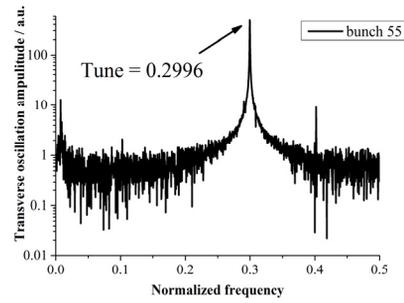


Figure 4: Individual bunch transverse oscillation normalized frequency.

By this way, oscillation amplitude could be tracked, and arranged by bunch ID or by TFB gain. Figure 5 to Figure 7 showed oscillation amplitude distribution in different arrangement method.

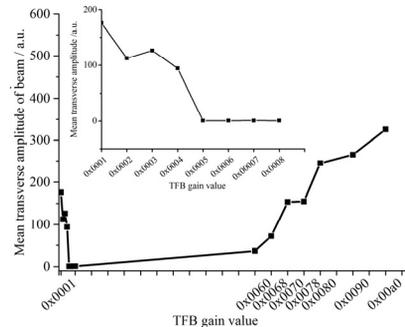
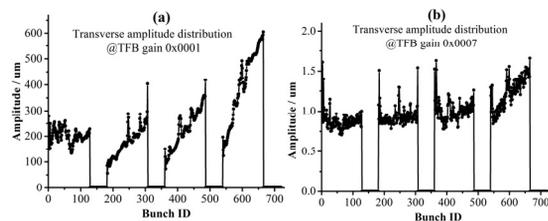


Figure 5: Beam transverse amplitude distribution variation during TFB gain in Horizontal plane.



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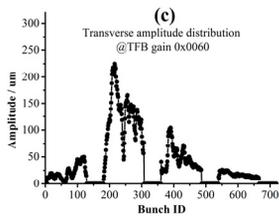


Figure 6: Transverse amplitude distribution during bunch ID in Horizontal plane.

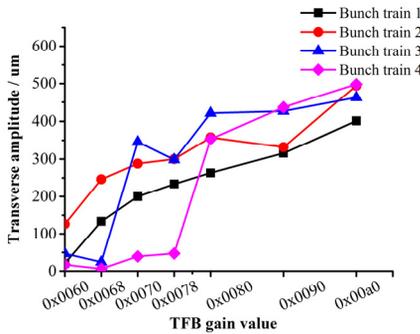


Figure 7: Bunch-train amplitude variation during TFB gain.

Figure 6 (a) showed the amplitude of whole beam in the state of "inadequate feedback". Individual bunches amplitude distribution during bunch ID of No. 2~4 bunch-train increased gradually, which was consistent with the weak-field effect of beam. However, there was no same characteristic for No.1 train, we speculated that it is due to the discontinuous filling of bunches. Figure 6(b) showed the "well-optimized state", and all the oscillation amplitudes are well suppressed. Figure 6(c) was in the state of "feedback forced state", there was no obvious bunch oscillation amplitude difference and no obvious amplitude distribution regularity in a bunch-train, but obvious amplitude difference between different bunch trains. In order to observe the above phenomenon, average oscillation amplitude distribution of individual bunch-train was calculated and curved during gain value variation, as was shown in Figure 7. Jumping of average oscillation amplitude appeared for No.3 train with gain 0x0068~0x0070 and for No.4 train with gain 0x0070~0x0078, While the same jumping for No. 1~2 trains has not yet been observed due to the limitations of the experimental data.

### IVID Experiment

This experiment was not a detailed one because we haven't got enough time after TFB experiment, it is conducted only to observe the IVID gap dependency and current dependency of beam transverse instability, and prepare for the future detailed data acquisition experiment.

First, we changed the pole gap of ID15 undulator in storage ring from 30mm to 10mm, few steps were chosen to record the position data, then kept pole gap unmoved with beam current fall from 170mA down to 132mA. Transverse oscillation data was used to characterize the instability amplitude distribution. The results are shown in Figure 8 and Figure 9.

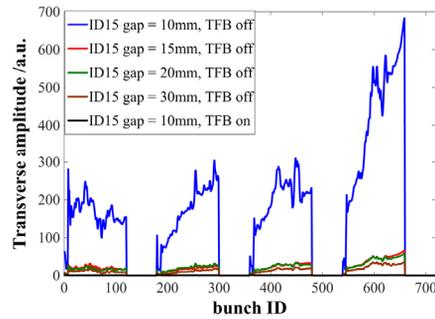


Figure 8: Gap dependency of BTB amplitude distribution.

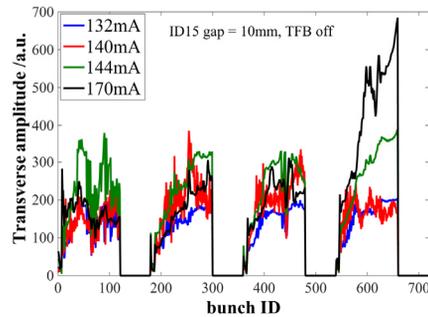


Figure 9: Current dependency of BTB amplitude distribution.

It showed that the transverse instability strength raised with decreasing gap or increasing current. Especially at 10mm setting, the gap disturbance on beam transverse oscillation appeared much greater, but TFB could still damp the instability mode well in this case.

## CONCLUSIONS AND FUTURE INVESTIGATION

By using the newly developed BTB position ADQ system, we have observed transverse oscillation amplitude distributions in BTB mode, and by off-line analysis, we preliminary investigated how the TFB and undulator affected the transverse oscillation. In the future plan, experiment for curving instability mode shift with more careful IVID gap steps would be implemented for a deeper understanding.

## ACKNOWLEDGMENTS

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## REFERENCES

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