AUTOMATIC LATTICE PARAMETERS MEASUREMENT TOOLS AT SRRC

Jenny Chen, C. S. Chen, C. H. Kuo, K. K. Lin, K. T. Hsu
Synchrotron Radiation Research Center
No. 1 R&D Road VI, Hsinchu Science-Based Industrial Park, Hsinchu, Taiwan, R.O.C.

Abstract

In order to acquire necessary machine parameters information within reasonable time, supporting tools for automatic lattice parameters measurement is implemented in SRRC. Signal waveform detection, spectrum analysis, and associated control circuits were installed and tested, and the application programs were developed. These application program tool boxes can be activated with simple pop-up operation on workstation. Detailed functions and their status are presented in this report.

1. INTRODUCTION

Acquiring necessary machine parameters information within reasonable time for machine study is important due to limited available machine shift. Consequently, supporting tools for automatic machine related parameters measurement is implemented in SRRC. Hardware component include devices for signal waveform recording, spectrum analysis, and control circuits. Developed software package consists of tools for instrument control, data acquisition, analysis, and visualization of measured parameters. Typical applications of this package are tune identification, resonance diagram for working point evolution, measured lattice function display, and filling pattern of the stored electron bunched in the ring. Real-time display of absolute orbit and difference orbit with persistence display option have shown to be a powerful tool for orbit study. These tools are planned to be adopted to the injector together with the integration of accelerator control system.

2. CONTROL SYSTEM ENVIRONMENTS

SRRC control system is a two level hierarchical computer system [1,2]. It is connected to the equipments through VME crate system. For complex instruments, such as spectrum analyzer, connection with the control system is made by using GPIB-ENET adapters. NI-488.2M software installed on workstation is used to drive the system. Applications on workstation can access every accelerator device whichever is connected with the VME crates or GPIB-ENET. At presentation layer, UIM/X graphical user interface builder [3] was used to develop the operation interface.

3. TUNE MEASUREMENT UTILITIES

The tune measurement system is currently using HP4396A spectrum/Network analyzer to acquire spectrum information of the beam signal and is running in list scan mode [2,4]. The full screen is divided into three sections for synchrotron frequency, vertical and horizontal betatron frequency measurement respectively without lossing its resolution. The excitation is achieved by using a random noise generator with 5 MHz bandwidth to shake the beam and the power level of the noise was properly adjusted to satisfied the beam condition.

The spectrum analyzer is connected to control system via GPIB-ENET adapter. The tune measurement program is able to give command and to drive the spectrum analyzer with the aid of NI488.2M library. The related parameters setting is done through operator interface as shown in figure 1. The parameters include frequency scanning range, beam excitation enable/disable and power level controlling, ... etc.

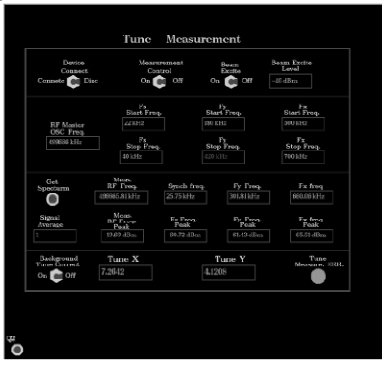

Figure 1. Tune measurement system parameters control page

Figure 2 shows the tune evolution while 1.8 Tesla wiggler closing its gap from 230 mm to 22.5 mm. The vertical tune drifted from 4.1 to 4.15, and the horizontal tune does not change.

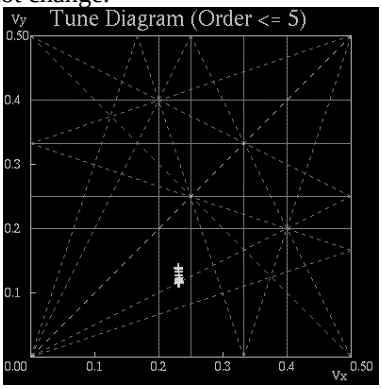

Figure 2. Tune diagram and tune evolution during W20 gap change

0-7803-4376-X/98/$10.00 © 1998 IEEE

3. ORBIT DISPLAY UTILITIES

Orbit display is usually required in routine operation and machine study. A bar chart display of beam position monitor (BPM) reading has been in service since storage ring commissioning. However, requirement for acquiring orbit difference in association with particular machine parameter changes has been raised as the machine study activity increase. Since there are a lots of requirement for orbit display, therefore a real-time display urilities was developed to satisfied various requirements. The utility provides display of absolute and difference orbits supported with persistent mode option. Color grading display will be supported in new versions. The line style can be dot line and line-dot. Data averaging is also supported by the package. The updating period without any average is less than 0.5 sec. Typical example of the display is shown in Figure 2.

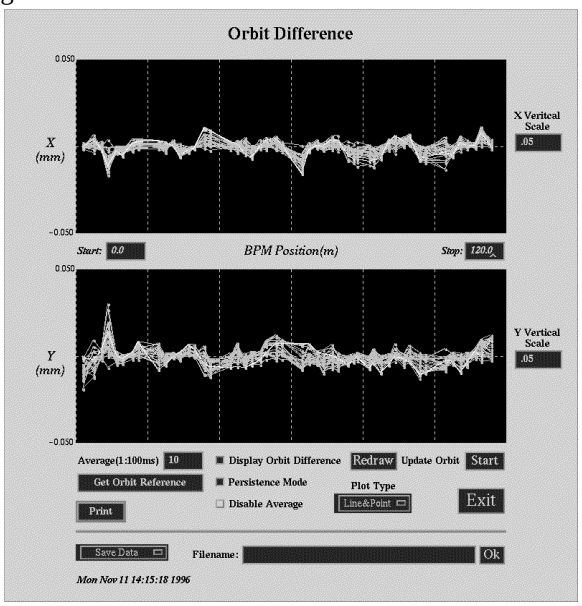

Figure 3. Real-time difference orbit display

4. LATTICE FUNCTION MEASUREMENT TOOLS

Lattice functions information is very important for machine optimization especially for low emittance ring. Measuring lattice function is a tedious work without automation. In order to solve this problem, tools to support lattice function measurement has been developed recently. The package provides betatron function, dispersion function, eta function, and chromaticity measurement. Figure 4 gives typical display for betatron function measurement. The measured raw data as well as processed data can be save for later use.

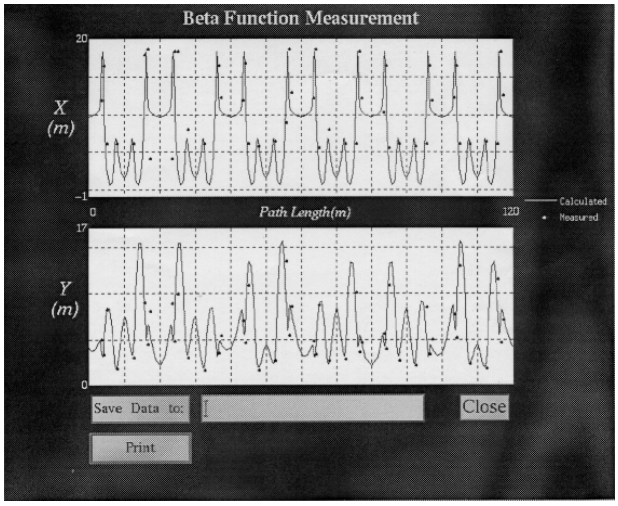

Figure 4. Measured betatron function (point) and theoretical betatron function (line).

5. FILLING PATTERN MEASUREMENT

Filling pattern plays a crucial role which affects the performance of the accelerator system due to coupled-bunch instabilities. A real-time filling pattern diagnostic tool is in developing stage. The system is composed of a VMEbus form factor 500 MHz digitizer using external clock comes from master oscillator. The signal picked up by the stripline electrode is digitized by the fast ADC. Each data point reading value of the acquired data is proportional to the amount of charge accumulated inthe corresponding bunch. The data is then sent to workstation to display the filling pattern and for various uses. Figure 5 shows a preliminary result of the acquired filling pattern. There are 200 buckets in the TLS.

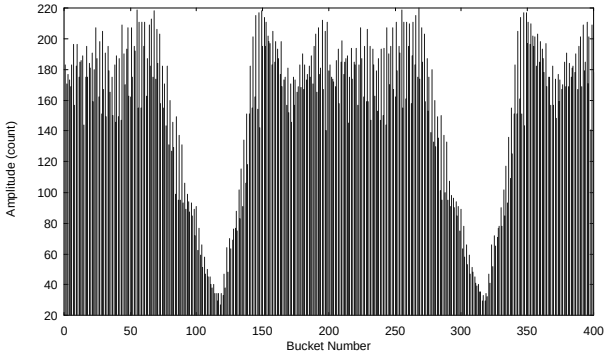

Figure 5. Preliminary real-time filling pattern acquisition results

6. DISCUSSIONS AND CONCLUSIONS

Automatic machine parameters measurement system is developed in SRRC. The system provides a convenient way to measured some of the major lattice related parameters for beam physics study. The system includes various data instruments interface and presentation tools. Extending its functions and improving its performance will be one of the major work in the coming months. It will also be implemented in the renewed control system

which will integrate both the injector and the storage ring operation. A digital receiver based tune meter is under developing in order to further improve the time required of tune measurement related study. Commercial available visualization tools is planned to integrate with the control system to provide various display option and manipulation of the raw data. The tools kits is expected to be very useful to save precious machine time and increase the productivity of machine specilists

7. ACKNOWLEDGMENTS

The authors express their thanks the staff of the instrumentation and control group and operation group for their collaboration. The helps from H. P. Peace, C. H. Kuo and Richard Sah are also highly appreciated.

REFERENCES

[1] C. J. Wang, et al., "The design schemes of graphic user interface database and intelligent local controller in the SRRC control system", Nucl. Instrum. and Meth. in Phys. Res. A352 (1994) 300- 305).

[2] Jenny Chen, et al., "Virtual Instrumentation Interface for SRRC Control System", Proceedings of the 1995 IEEE Particle Accelerator Conference, 2256, May 1995.

[3] UIM/X are trademarks of Visual Edge Software Ltd.

[4] J. A. Hinkson, M. Chin, C. H. Kim, H. Nishimura, "Automatic Tune Measurement in the Advanced Light Source Storage Ring Using LabVIEW APPLICATION", Proceedings of the 1994 European Accelerator Conference.