ENERGY RAMPING IN THE BEPCII

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Abstract

It's an important issue in the BEPCII synchrotron radiation for the magnet power supplies to do synchronously ramping from the injection energy 1.89GeV to 2.5GeV. The ramping of the magnet power supplies has been put into the running of the BEPCII first synchrotron radiation. A software-based synchronization of the current setting on the power supplies is achieved. This paper introduces the schemes developed to perform energy ramping in the BEPCII synchrotron ring and reports on the results of the operation carried out so far..

INTRODUCTION

BEPCII [1] is the upgrade of BEPC, which will provide two rings in the existing tunnel serving high energy physics (HEP) (1.89GeV) and synchrotron radiation (SR) (2.5GeV) research. It uses a full energy linac for injection. In fact, the BEPCII has three logical rings that are called synchrotron ring (BSR), electron ring (BER), positron ring (BPR).

All the power supplies (about 360) in the rings are controlled using the standard power supply controller and interface (PSC/PSI) [2] that are developed by BNL. The BEPCII commissioning started with the BSR, the BER and the BPR respectively. There are about 160 power supplies in the BSR. When the machine works for the SR, the magnet power supplies in the BSR are required to be ramped to the desired current.

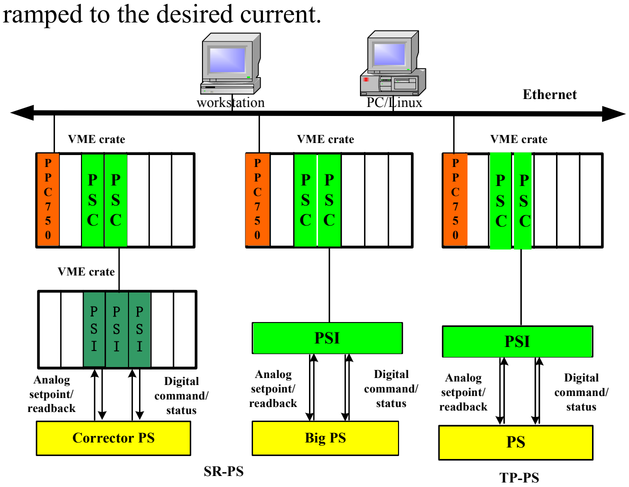

Figure 1: BEPCII PS control system architecture.

POWER SUPPLY CONTROL SYSTEM

The control system of BEPCII follows the "three-layer" standard model [3] of a distributed architecture as shown in the figure 1. The front-ends consist of VME-64x crates, Motorola PowerPC750 CPU boards (MVME5100) and PSC/PSI modules. A SUN workstation and a PC/Linux are used for the EPICS development. We chose the chassis PSI for the big PS control, and economical VME-PSI for the corrector PS. The chassis PSI and the VME-PSI have the same functionality and features. The chassis PSI is powered independently in a 1U rack, and the VME-PSI is a VME bus-sized module inserted in a dedicated VME crate with +/-15volt voltage input from the backplane.

There are total 8 VME crates for dipole, quadrupole, sextupole and corrector power supply control. There are most 11 pieces of PSCs in one crate that can control up to 60 quadrupole or sextupole power supplies.

The hardware installation has been started before May 2006. On one hand, the magnets were installed in the tunnel region by region. One the other hand, the remote control and calibration of the magnet power supplies were done region by region. The ON/OFF operation of the power supplies region by region has been tested on site before the BEPCII commissioning. During the beam commissioning, the ramping and standardization of the magnet power supplies were developed and tested.

ENERGY RAMPING IN BSR

All the power supplies in the BSR need to be standardized (from current setpoints to maximum current, then to zero, finally to the injection energy 1.89GeV) respectively before the energy ramping. The energy ramping of the synchrotron ring requires the current of the magnet power supplies are set synchronously step-by-step from the value at 1.89GeV to the desired value at 2.5GeV.

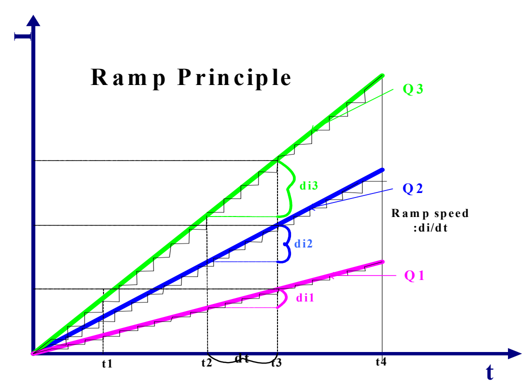

Figure 2: Linear ramping principle.

Ramping Principle

The ramping principle of the magnet power supplies as shown in the figure 2: is that the maximum steps of the power supplies can be calculated according to the given maximum delta per step and given initial and final current.The number of steps is determined by the formula: (desimon-setpoint)/delta. The program sends out different setpoints step by step so that the power supplies can be set to their own desired value.

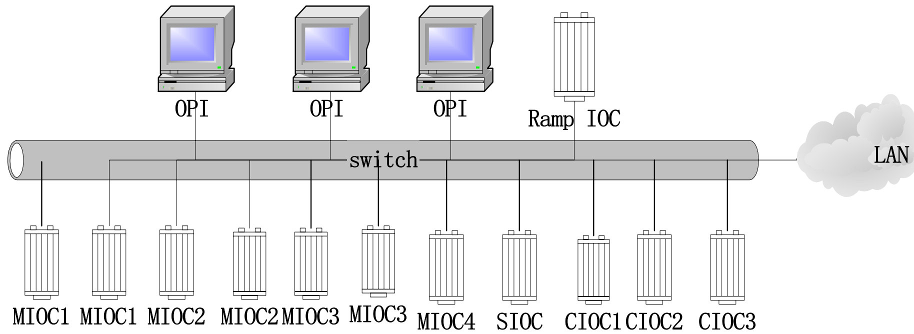

Figure 3: PS IOC Distribution in the network.

Ramping Program

This ramp program is created using SNL[4] and running on an IOC. It is responsible for monitoring the ramp trigger record and ramp speed record. Then it sends different setpoints to every power supply step by step.

During ramping, this program can be aborted by the Abort button. It has six state sets: Initiation, RampUp, RampDown, Standardize, TRampup and END.

There is an IOC configuration file created by EXCEL for 60 PSs. The Initiation state will read this configuration file to get the PS name, and then dynamically assign variables to the PVs corresponding to the setpoint and current record. The advantage of dynamic assignment of channels is to make the program flexible and expandable. RampUp is to make the power supplies go to their own desired values at the same time. RampDown is to make them go to zero at the same time. Standardize is to make them first go to their own maximum values, then to zero at the same time. TRampUp is to make the power supplies first go to their own desired values at 2.3GeV, then go to their own desired values at 2.5GeV the same time. Abort is to let the program stop any action.

Testing Result

During the ramping test, we found that writing the current setpoint onto the PSC takes time and slower. During the first synchrotron radiation running, ramping test was divided into 4 stages. In the first stage (the first half of the December of 2006), ramping and STDZ program are loaded into every IOC. The execution of the every ramping program on IOC is triggered by the EPICS event. Consequently, the processing of the ramping was slow and not synchronized. In the second stage (the second half of the December of 2006), ramping and STDZ program are loaded into an dedicated IOC, all IOCs as shown in the figure 3 are connected to the same switch with one way out to minimize the unrelated network traffic as shown in the figure 3 [5]. The ramping execution is still trigged by the EPICS event. In this case, the only different is one IOC sending setpoint to setpoint record of the all related IOCs step by step through the network. The execution of the ramping program couldn't send setpoint too fast due to the slow processing of writing setpoint to the PSC board. As a result, there was no synchrotron problem, but with slow processing. In the third stage, by changing Vxworks clock from 60Hz to 600Hz, the processing of the related PSC driver and database record on every IOC are getting fast. The ramping procedure from 1.89GeV to 2.5GeV took about 1.5minutes.

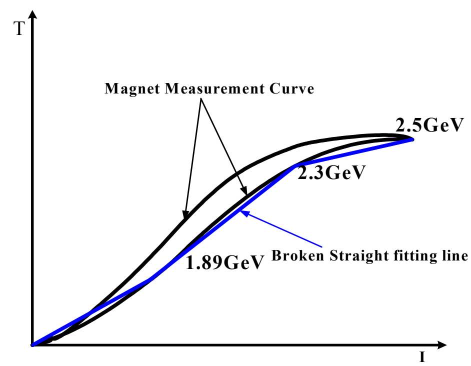

Figure 4: Table Ramping Principle.

After changing physical working path, the ramping program has been tested with the beam. Continuing the ramping, a rapid beam loss was encountered when the energy reached to 2.4GeV. So, the ramping procedure is divided into two steps: from 1.89GeV to 2.3GeV, 2.3GeV to 2.5GeV. In this case, there was no beam loss happened.

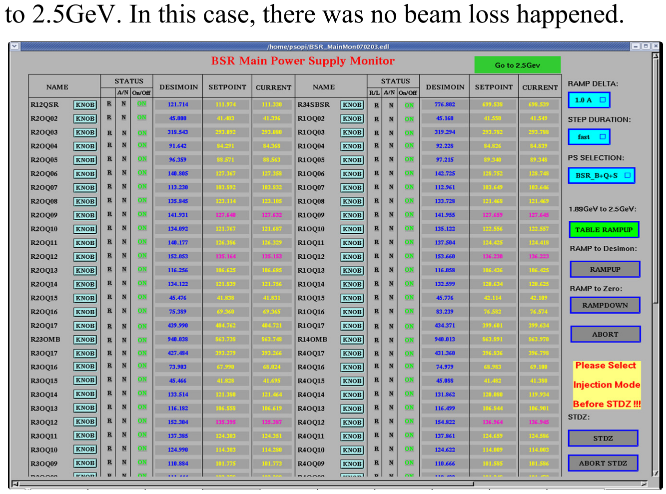

Figure 5: BSR Monitor and ramping OPI.

Table Ramping

In order to ensure continuous ramping without the beam loss, we used two broken straight line instead of one to fit the magnet measurement curve as shown in the figure 4. One broken straight line is for 1.89GeV to 2.3GeV, another is for 2.3GeV to 2.5GeV. The advantage of this way is that the current setpoints are closer to the magnet measurement data. The energy and designed current values are saved the database running on a soft IOC. The ramping program can get the designed current value by setting the energy. For eg. The ramping program set 2.3GeV energy to the energy PV, then get the designed current values at 2.3GeV, calculate delta from the current setpoint values to the designed current values, linear ramping to 2.3GeV, then get the designed current values at 2.5GeV, go same way, up to 2.5GeV. The whole procedure is done by one button " Table Ramp" as shown in the figure 5. By testing with the beam, there was no beam loss happened. It took about 2 minutes. The ramping program was put into the second synchrotron running. It was going very well.

CONCLUSION

Up till now, the energy ramping in BSR has been running very well. It plays an important role in BEPCII synchrotron radiation running. At the same time, it proved that the magnet power supply control system with PSC/PSI is reliable.

ACKNOWLEDGEMENT

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