

INTEGRATION OF UE212 ELECTROMAGNETIC DOUBLE UNDULATOR INTO THE SLS CONTROL SYSTEM

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Abstract

The UE212 is a long electromagnetic double undulator the fourth insertion device (ID) has been recently installed in the Swiss Light Source storage ring and comprises two identical devices. This ID can be operated in different modes by applying different patterns of currents to its electromagnet arrays. By fine control of the currents in these arrays it is possible to produce different types of the polarization on the photon beam. To bring the device into any of its operating modes we have developed software applications and algorithms in our control system using EPICS software toolkit on top of the standard power supply controllers of the SLS [1]. Intelligent algorithms determine which curve each corrector in the device has to follow in order to compensate the effect of the magnetic fields on the path of the beam in each of the operating modes. The two identical devices are synchronized using global timing signals of the machine [2] and they can be controlled to operate each in a different mode simultaneously. The structure and controls of the device are described in this paper.

1 INTRODUCTION

At present the SLS is running with four Beamlines, the material science, protein crystallography, micro/nano structure and surface interface spectroscopy (SIS), which all make use of insertion devices. The SIS beamline is using synchrotron light produced by a double polarized electromagnetic undulator (UE212), which is installed in a long straight section (11 m) of the SLS storage ring.

The motivation for using such a complicated insertion device was to have the quasi-periodic mode, beside the other possible polarizations like linear and circular. This quasi-periodic scheme is used for the higher harmonic radiation rejection required for high-resolution photoemission experiment.

2 STRUCTURE OF THE DEVICE

The UE212 has two identical devices ID1 and ID2 that can be controlled independently or together in synchronism (Figure 1). There are no moving parts in these devices and they are controlled fully by controlling the currents of their power supplies. Each ID has one main horizontal (MH) and two main vertical (MV1 and MV2) power supplies. There are also eight end correctors at upstream and downstream to compensate for effects of the applied fields on the beam. There are also four other correctors for earth field corrections.

The MH power supply is bipolar in order to provide us with different helicities of the circular polarization and by

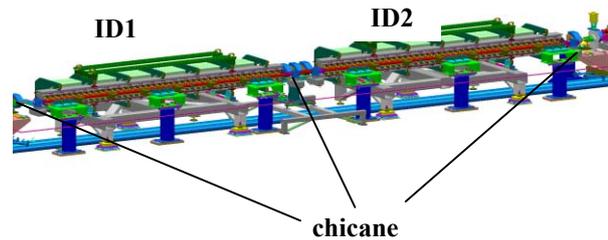


Figure 1: structure of the UE212 twin polarized undulator having two MV power supplies we were able to implement quasi-periodic mode.

Using two identical devices makes it possible to switch between the two IDs and provides the beamline with different helicities of photon beam at the same time and even to have different polarizations along each device.

3 MODES OF OPERATION

Because of the different physics applications and special behaviour of the device, it has to be controlled in number of modes, most of which are needed for daily operations of the beamline. Because of large amount of iron in the device, the remnant fields and hysteresis effects are large thus every setting must be done in such a way that the fields are minimal.

It is necessary to bring the device in a defined state when it is coming into operation for the first time therefore all main power supplies (MV1, MV2 and MH) are cycled for three times from maximum to minimum of their settings. To switch off the UE212 the remnant fields have to be minimized. The power supplies are cycled but the maximum amplitudes are reduced from cycle to cycle till they reach to zero.

3.1 Vertical Periodic

The MV1 and MV2 power supplies are driven with the same currents and simultaneously. To set the value of the power supplies it is always necessary to reach the desired value from the higher side. The setting of the MH is zero in this mode.

3.2 Vertical Quasi Periodic

The MV1 and MV2 have different settings, but shall be driven simultaneously. The MH setting is zero.

3.3 Horizontal

The MH will be driven to set values from the higher side. The settings of the vertical power supplies are at zero.

3.5 Circular

All the main power supplies work together. The MV1 and MV2 have the same settings but follow different curves than MH and all of them are driven simultaneously.

4 CONTROLS

All the controls in the UE212 are related to its power supplies. We use standard SLS power supplies and power supply controllers, which have been developed in house and are fully integrated to the control system and timing of the machine. On top of the PS controllers we have designed algorithms and software applications using EPICS control system tools and a high level programming language (Tcl/Tk) for some graphical user interface features.

4.1 Hardware

There hardware comprises three VME crates. We have dedicated one crate to each of the devices (ID1 and ID2) to make their controls independent. The most important control hardware is power supply Industrial Pack (IP) module developed at PSI that provides the ability to communicate with power supply controllers (DSP units) by EPICS channel access. The communication is done serially via fibre optic links that connect VME cards carrying the IP modules to the power supply controllers [3]. Waveforms of the currents can be loaded as arrays of set points and written to the power supply controllers. The power supply controller can execute these waveforms upon receiving triggers from timing system. Each crate has been equipped with an event receiver card [4], which is receiving timing events from timing system. Using timing events both devices can be operated in synchronism and furthermore to synchronized with beamline components.

4.2 Software

The control system of the SLS machine and Beamlines are based on Experimental Physics and Industrial Control System (EPICS) [5] and much effort has been done to control all the devices by existing software tools.

The core of the software, which controls the UE212, is the EPICS run time databases. They provide I/O controls to power supply controllers, However, to implement the operation for the device we made use of State Notation Language (SNL) [5] in which we can define the states and transition between states for driving the device to the desired modes.

A schematic of the software structure of the UE212 controls has been shown in Figure 2. The Tcl/Tk scripting language has been adopted to provide the desired GUI and also it is part of the software framework of the SLS. The CDEV (Common DEVice) layer makes the interface between high-level software and EPICS process variables.

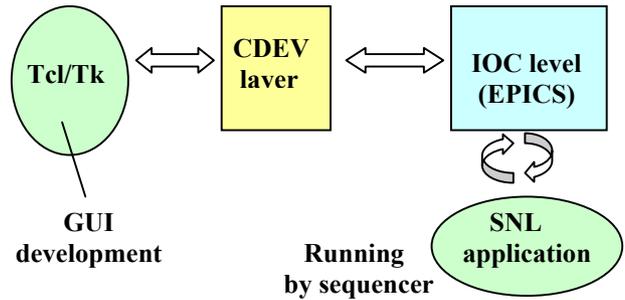


Figure 2: The software structure of the UE212 controls

The SNL application is running (by the sequencer) at the IOC level and contains the intelligence of the controls. With this approach even if the Tcl/Tk application crashes for whatever reasons, there would be no interruption to the program running on the IOC.

In the control panel the user has the possibility to choose the mode of the operation (massage, horizontal, circular...) and also to determine the desired harmonic of the energy. There is an option called Auto, which lets the user to have always the maximum light intensity, it means the program takes care of changing the harmonics during movement to desired energy (Figure 3).

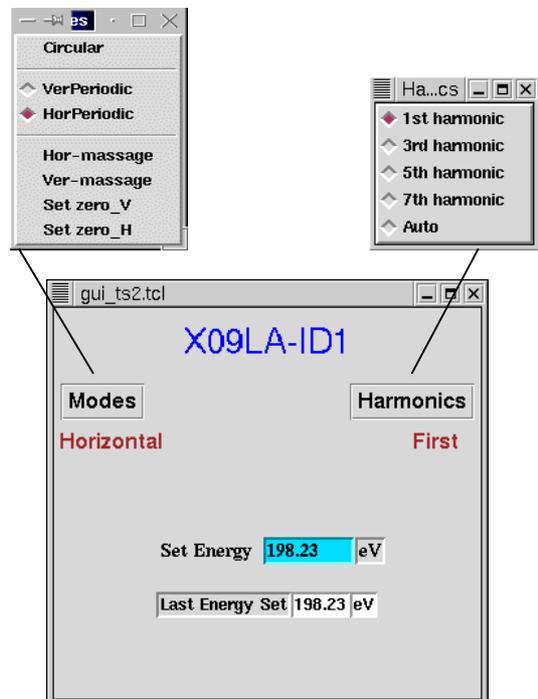


Figure 3: Tcl/Tk GUI for the UE212

During machine shifts we have done a large number of scans to find settings each corrector has to follow when currents in main power supplies are changing. We had to take into account the effects of the device operation on the orbit and to operate it somehow the orbit feedback can recover the disturbances. Therefore the power supplies have to go to their settings with different rate of change to minimize the undesired effects on the orbit and let it to handle these variations. The rate of change (steps/ Amp/ second) depends on the areas of the currents. That means for example main vertical power supplies have to move with the speed of 4 steps/ Amp/ second from 0 to 100 Amps and slower down when they reach their extreme settings.

5 CONCLUSION

We reused the common components of the SLS control system. The approach for the control of the device has

shown that is quite flexible and satisfactory. The UE212 is a sophisticated and flexible device, which enables many new possibilities the experiments at the beamline.

REFERENCES

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- [5] <http://www.aps.anl.gov/epics/>