EPICS AT THE SYNCHROTRON RADIATION SOURCE DELTA

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Abstract

Since 1999 the control system at the synchrotron radiation source DELTA, located at the University of Dortmund, Germany, is operated under EPICS. The change from a nonstandard, handmade system to EPICS has been made stepwise till 2001 [1]. Since 2002 the first two beamlines in the soft X-ray regime are operated under EPICS, too, to benefit from the easy communication with the accelerator control system. The easy and fast exchange of the necessary data with the accelerator control system is an advantage as is the benefit from the EPICS community.

A complete plane-grating-monochromator-beamline (PGM-beamline U55) with its experiment is operated under EPICS, including stepper motors and device readout. A toroidal-grating-monochromator-beamline (TGM-beamline) has been completely changed from the old system (EMP, BESSYI) to EPICS.

At both beamlines new photon-bpm-readout systems from the company ENZ are tested. A compact stepper motor driver unit with a small LINUX-PC has succesfully been developed in this cooperation. DELTA works as a test facility for these new developments, which are now in use at the Australian Synchrotron in Melbourne, too.

INTRODUCTION

After the change-over of the DELTA control system to EPICS in 2001 further developments and improvements have been performed [2]. Beside the accelerator control system, the beamline control system had to be installed parallel to the installation of the beamlines. For the soft X-ray regime the decision was made towards EPICS because of the necessary and easy communication with the accelerator control system. Both systems could benefit from the development of new software in a very easy and comfortable way. Due to less manpower in the beamline controls and the problems with the old hand-made control-system of the accelerator, a complete new own development was no option. The adaption of existing software under EPICS from the SLS, Switzerland for beamlines in the soft X-ray regime , allowed a fast and easy first operation of the beamline. The hardware was chosen to be compatible with the accelerator control system to use a common hard- and software pool wherever possible.

The used VME computers are Power-PC, combined with one PC per beamline operated under LINUX working as a boot server for the VME computers and as beamline operation PC. In between the system has been expanded by several embedded PC's working under LINUX for dedicated tasks and a second LINUX-PC per beamline working as a boot server for the embedded ioc's.

THE SOFT X-RAY BEAMLINE CONTROL SYSTEM

At DELTA both beamlines in the soft X-ray regime are operated independently from each other. This makes in total four PC's necessary for the beamlines. A fifth PC is working as a gateway between accelerator and beamline control system, handling the exchanging of the informations between the two systems. The VME part is operated under EPICS 3.13.6, the embedded ioc's are working under EPICS 3.14.6.

At the PGM-beamline [3], one main task is to control the monochromator and insertion device to fix the energy of the synchrotron radiation. This is done by a dedicated Power-PC VME-ioc. It handles eight motorized axis (monochromator, insertion device and exit slit size) with their external position readback devices and the communication with some serial devices via CAN. The second VME-ioc handles the movement of 24 motorized axis (movements of three mirrorchambers, blades and intensity monitors) and the communication with a plc concerning the vacuum system valve status of the beamline. There are two photon beam position monitors (XBPM) according to the BESSYII-design in this beamline, which are motorized in the two transverse directions of the photon beam. Their motors are controlled by an embedded ioc. The four bladecurrents of each XBPM are measured and amplified by a LowCurrentMonitor (LoCuM) of the company ENZ. The integration of them into the beamline control system is done by another dedicated embedded ioc via RS232 and an AD-board. A third embedded ioc works as an diagnostic ioc, handling the readout of several Keithley current amplifier via RS232 representing intensity signals of the incoming photon beam from a photodiode, gold mesh, mirror coating, integrated gas cell or blade currents. This ioc takes over the scantask of these signals, too. For example time plots or photon energy or intensity scans are handled here. The in house experimental endstation has its own PC and control system. As an upgrade program, the integration into the beamline control system is done parallel to the routine operation.

The TGM-beamline [4] is less complicated. It has one VME-ioc to control eight motorized axis (rotation of grating, intensity motor and movements of two mirrorchambers). So this VME-ioc is responsible for the energy of the photon beam. An embedded ioc is used for the XBPM-readout, another one works as diagnostic ioc, too. In the future a motorization of more axis of the mirrorchambers due to chamberreplacement is planned as an upgrade program, as a motorization of the entrance and exit slits. The motorization of the axis allows a more easy and reproducible control of the beamline.

XBPM-READOUT

The readout of the LoCuM4 is done by an dedicated embedded PC, called bpm-eioc. This is an 1HE 19" rack case with an EPIA mini-itx 600 MHz cpu with two serial interfaces RS232 and one Meilhaus ME4660-PCI multifunction board. The ME4660 offers 8 channel 16 bit ADC and 4 channel 16 bit DAC and several TTL digital IOs. The embedded PC has a flash memory. It runs a RedHat9 Linux version. Via NFS mount from a boot server, an EPICS softioc is started automatically. The four analog LoCuM channels and the serial RS232 port of the LoCuM are connected to the beamline control system by this embedded PC. This enables a continuous readout of the four XBPM blade currents with 10 Hz. From this information, the horizontal and vertical asymmetry is either calculated (Undulatorbeamline) or the vertical photon beam position (dipole or wiggler beamline). The readout can online be configured to read a single block of maximum 4000 blade current quadletts. This allows an analysis of fast orbit movements up to 1 kHz frequency range. Due to software problems of the embedded PC Linux driver, only two analog output channels of the ME4660 are available. They are used to provide some photon beam intensity information (electron beam current, goldmesh current or refocusing mirror current) as an analog signal between 0 and 10 V to the experiment at the end of the beamline, used for normalization purposes there.

MOTOR AXIS MOTION

The motorized axis of the stage of the XBPM are controlled by another dedicated embedded PC, called motion-eioc. This is an 1HE 19" rack case with an EPIA mini-itx 600 MHz cpu with one serial interface RS232 and one or two Adlink PCI 8134 stepper motor cards, depending on the desired number of axis. The Adlink 8134 offers 4 axis stepper motor control including readback of soft limit switches and incremental encoders such as Renishaw RGH24X or AMO LMK-112.2-01-4, providing a digital output and reference signal. As an alternative an external encoder can be connected via an epics soft link. The embedded PC has a flash memory. It runs a RedHat9 Linux version. Via NFS mount from a boot server, an EPICS softioc is started automatically. This system can control up to four or eight stepper motor axis, depending on the number of Adlink cards. A software upgrade to integrate motors without any encoders only with a precision switch to get a reference position is planned.

In addition we use another motion eioc to control the eight motors of two blade units of this beamline, defining a photon beam aperture in horizontal and vertical direction at the beginning of the beamline and in front of the monochromator. Derived from the EPICS synApps package is a software in use which allows to access width and center position of a slit system in one direction instead of moving the single blade motors.

DIAGNOSTIC EIOC

The readout of several Keithley current amplifiers model 6485 and 6514 is done by a so called diagnostic eioc. It is a dedicated embedded PC of the same type as mentioned above, but without any additional PCI cards (neither Adlink nor Meilhaus). The Keithleys are read out via their RS232 serial interface which is connected to a serial to LAN converter (Moxa Netport 5610-16 or 5410). These converter provide between four and 16 RS232 ports. The Keithleys are then accessed via the asyndriver for ipportconfiguration under EPICS 3.14.6. This option is used to get access to several other serial devices such as Varian Dual Ion Pump Controller, MKS vacuum measurement gauges, Pfeiffer vacuum measurement gauges and Newport Strain Gauges. Furthermore the diagnostic eioc has access to a Modicon PLC with its own LAN-port.

The diagnostioc eioc gives the possibility to show a time plot of a Keithley readout. Additionally it uses the sscan package to perform so called photon scans and energy scans. This means that a Keithley readout is taken as a function of other epics records. At the PGM-beamline this is the case, if you want to characterize the insertion device (undulator) or the monochromator (energy of the photon beam) or the position of the slit systems.

PGM MONOCHROMATOR CONTROL

DELTA uses at the moment a VME-ioc to control the plane-grating-monochromator and undulator gap at the PGM-beamline. The VME-Crate is equipped with a Power-PC board, two OMS VME58-4E boards to drive eight motor axis, four IK320 cards of the company Heidenhain to read the angular position of the mirror and grating by UHV905 RONs, one ESD VME-CAN2 board and an IK342 board of the company Heidenhain to access a linear encoder measuring the undulator gap. The OMS VME58-4E boards provide the opportunity to drive four stepper motor axis. They offer the same encoder input as the Adlink PCI cards do. The used software offers the possibility to integrate a reference switch without using an encoder. Another advantage is that they have an internal loop to reach the desired encoder position with a programmable bandwidth.

At the soft X-ray beamline at the Australian synchrotron the company ENZ developed a dedicated PC based on the mentioned software above to control the plane grating monochromator. It is planned to integrate this system into the beamline control system at the PGM-Beamline at DELTA. The PC at DELTA will contain the Adlink cards mentioned above to drive the motors responsible for the rotation and translation of the optical components within the monochromator vacuum tank and to drive the undulator gap and the exit slit size. The readout of the rotation angle will be performed by UHV RONs and IK220 PCI cards of the company Heidenhain. This PCI card will be used to read the encoder measuring the undulator gap, too.

The new system can be build up parallel to the existing system. So an easy switch over should be possible, since only a few cable connections have to be changed.

VME MOTION CONTROL

Up to the integration of the new motion control via embedded PCs the motors at the DELTA beamlines were completely controlled by a VME system. This system is still in use. It is planned to keep it, if the hardware is still OK. Up to now the reliability of the OMS VME58-4E cards was sufficient, but some problems occurred and could hardly be solved. On the other hand only the software of this system provides the possibility to integrate motors only with a reference switch without any encoders. The motor movements of the translation and rotation of the collimating, focusing and refocusing mirrors are performed by the VME-ioc. Furthermore some screens and intensity monitors along the beamline working without encoders are operated by this system. The rotational movements of the mirrors are controlled by a multiturn absolute encoder with a SSI-interface. These encoders are integrated by an ECM 505 VME-board from Kramert, Switzerland, which work very reliable.

We have the opportunity to exchange motor axis very easy. This is helpful to detect some problems with a certain configuration. For this an interface panel was developed from ENZ, connecting the VME-boards, the stepper driver unit and the cables towards the motor, limitswitches and encoder. The same connection principle was kept for the Adlink cards with a small modification due to the modified pin assignment towards the motion card. This allows a very flexible use of the channel assignment together with the software.

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