A MODULAR CONTROL SYSTEM BASED ON ACS FOR PRESENT AND FUTURE ANKA INSERTION DEVICES

K. Cerff, W. Mexner, T. Spangenberg, M. Hagelstein
Forschungszentrum Karlsruhe GmbH, ISS/ANKA, Box 3640, D-76021 Karlsruhe.

Abstract

The 2.5 GeV synchrotron facility ANKA, at Forschungs-zentrum Karlsruhe, Germany has three insertion devices which are in operation now.

The SCU14 was the first superconducting undulator worldwide tested with beam [1]. The successor, SCU15 will be implemented in the ANKA ring in mid 2009.

The paper describes the design and implementation of a modular control system structure, based on object ori-ented (oo) technologies for existing and future ANKA-insertion devices (IDs) with permanent- or supercon-ducting magnets.

It gives the description of a hardware solution, based on Cosylabs MICROIOC MCS8-PMAC2 interface [2] for undulator motion control of gaps and scrapers, main power supply, corrector power supplies, temperature control and Interlocks (ILs).

Last but not least the integration of the housekeeping functions, cooling, vacuum control and Interlocks to SCADA-PVSS II and the communication with ACS are described.

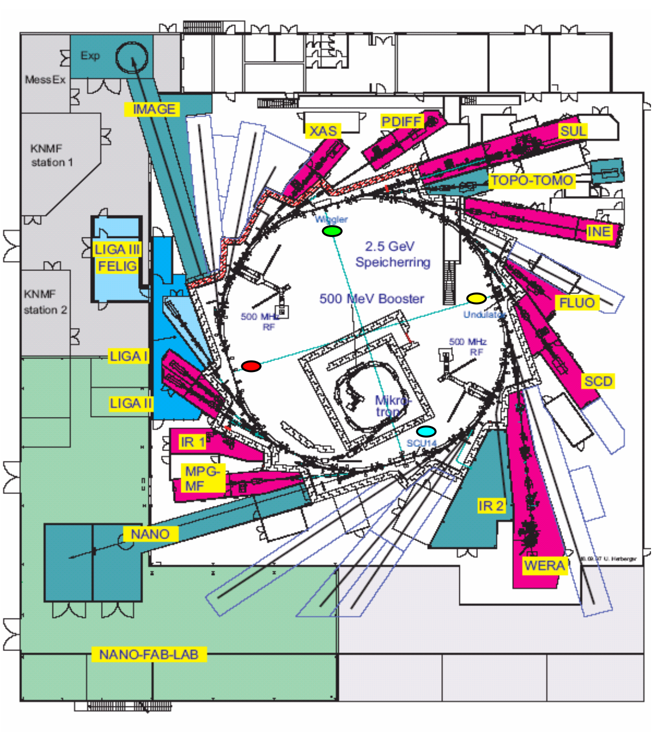

Figure 1: ANKA IDs, 1. SULX-wiggler, 2. WERA-undula-tor/wiggler, 3. SCU14-SC undulator, 4. SCU1X – un-dulator, mid 2009

INTRODUCTION

The present control systems for the ANKA IDs are stand alone, based on proprietary software. They have neither been embedded in the communication layer of the ANKA Control System (ACS) of ANKA storage ring, nor in the Infrastructure of ANKA SCADA-System (PVSS II) [3]. This was changed with the object oriented control system development for SCU-14 ID, which will be extended to ANKA IDs.

The generalized software devices which will be included in ACS are

- motion control, for IDs scraper and gap axes.
- power supply control, for IDs main- and corrector supplies.
- temperature/quench monitor controls.

For the Supervisory Control System PVSS II

- interlock control, local & machine Interlocks (ILs).
- cryocooling control
- vacuum control

The moduls form a control system toolkit which should be portable to other ANKA-Insertion devices.

Table 1: Device-Toolkit for ANKA-IDs

\ devices IDs at ANKA	scraper	gap	mPS	CoPS	TMon.	IL.
SULX-W		x				x
WERA-SCU/W		x		x		x
SCU14-SCU	x	x	x	x	x	x
SCU1X-SCU	x	x	x	x	x	x

Legend:
SCU=superconducting undulator, W=Wiggler, perma-nent magnets

HARDWARE SETUP

The interface hardware is implemented on two MicroIOC (UIOC) controller from Cosylab, one of them equipped with a PMAC 2 motion control for up to eight motor axes.

The DeltaTau PMAC 2 uses the same puls/direction Interface to the power amplifiers as the recent motion controller, so the adaption was straightforward.

The second UIOC is equipped with three analog digital input/output converters (ADIOs) providing six serial interfaces, one for communication with the main power supply and five for the corrector power supplies

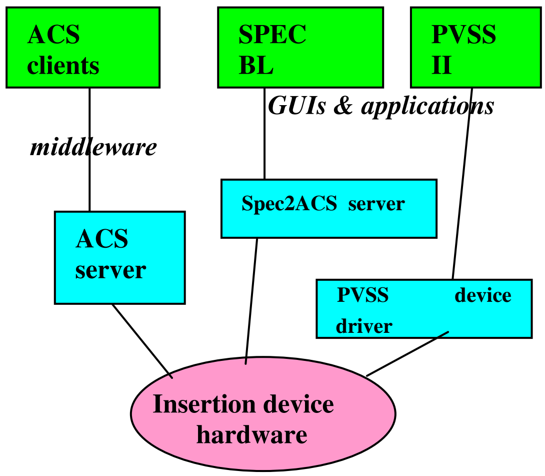

Figure 2: Generic Server-Client structure, of ANKA SCU1x devices connected via TCP/IP.

Most of the Infrastructure, rack and cabling is still used for the new SCU14 controlsystem. The former Labview control PC is now hosting the undulator-GUIs and is connected via Ethernet to the ACS Server back to the UIOCs.

The design of future SCU15 undulator uses Servo motors to move the gap axes, instead of the stepper motors of SCU14 Insertion Device. The interfacing to UIOC Box is done by puls/direction signals, matching ANKA-stepper motor specifications.

The advantage will be that servo motors as well as the stepper motors of SCU14 can be driven with the same software driver setup

An ´intelligent` controller will be used, which monitors motor current and torque, and shuts down the motor current in case of an asymmetric axis movement of the gap mechanics.

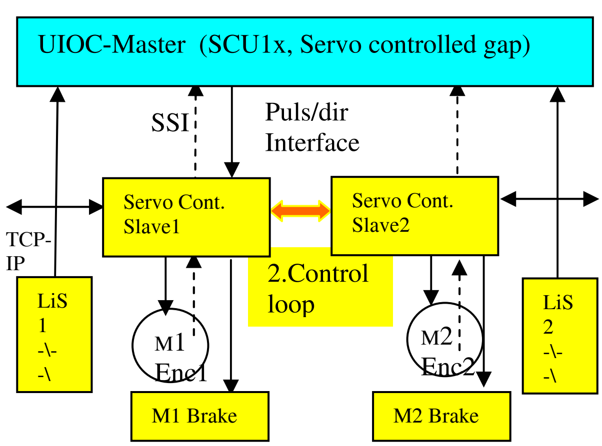

Figure 3: SCU1x, servo motor gap control with 2nd control loop.

The use of this type of Servo controller also allows the Introduction of Safety integration Level (SIL) 2 for the newest ANKA-ID SCU15. This means enhanced machine safety in case of malfunction of the master control system due to introduction of backup, using a 2nd independent control loop.

A further benefit will be the standardization of ANKA- axes motion control, the drivers developed for SCU14-UIOC can also be adapted for servo motor control of future ANKA-IDs. The controller is equipped with an Ethernet Interface, so configuration and maintenance by diagnostic software of the manufacturer is straight-for-ward.

The encoders are equipped with Syncronized Serial Interfaces (SSIs), a digital standard for absolute encoders They maintain performance as they do not forget position values after a power loss.

The Injection request signal from the ANKA-machine Safety System starts an automatic sequence of insertion device default procedures,

- undulator main and corrector power supplies are ramped down to zero current,
- gaps will be fully opened,
- scrapers will be opened.

When the gap is successfully opened an enable flag will be sent to the machine to proceed with the injection., in case of failure of mechanical components, the vacuum loss, the quench temperature of the superconductor or loss of cooling, the flag is inhibited and an undulator or machine shut-down is triggered.

Figure 4: Updated SCU14 control system. On the right, the temperature controller, both UIOCs, five corrector power supplies and the TPG-vacuum controller can be

seen. The control system-PC below the UIOC-boxes now serves as a terminal. The rack on left includes the main power supply, theQuench detector and interlock interrupt logic.

SOFTWARE SETUP

The software devices are summarized in Table 1, they built a toolkit for the setup of ANKA sertion devices.

The device properties can be categorized as follows

- motion properties of undulators, as part of motion programms for gap and scraper devices.

these describe the motion of an undulator axe under normal conditions like start/stop/limit switches reached, homing and accelaration rates.

- Data readback and logging

The data readback function updates the data base with actual state variables of the undulator devices under operation and also the GUI indication of status change.

- emergency properties, as part of PMAC 2-PLC programs

The failure of mechanics, the lack of synchronous motor movement or a controller failure, as mentioned in the hardware section, will also be monitored for the SCU-15 gap axes on the PMAC 2 side.

The properties are defined with help of an Application Programming Interface (API) as ASCII files.

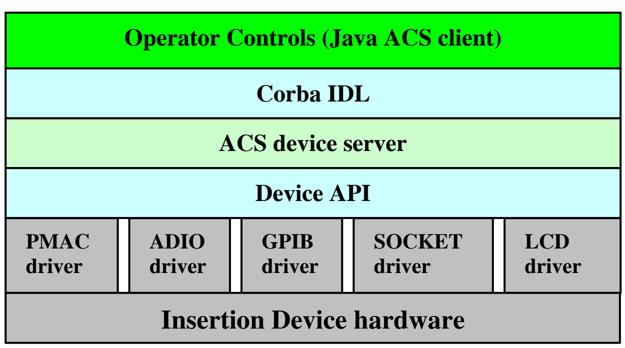

Figure 5: program layers realized on the two Cosylab MicroIOCs [4,5].

The software is implemented by Cosylab in form of three ACS device server, distributed on the two SCU-UIOC-controller [5]. The software layers matches with the ANKA-ACS structure.

The GUI Java Applets were interfaced by CORBA Interface Definition Language (IDL) to the ACS device servers. The ACS device server exchange data with the ANKA-ACS-manager which connects some 200 ANKA-ring devices.

HOUSEKEEPING

The software development includes the motion control, the control of power supplies and the monitoring of superconducting coils.

It does not include the status control of interlock logic - which is purely hardware based - and the monitoring of vacuum, water- and cryocooler status of the insertion devices.

This will become the a solution based on the ANKA-Supervisory Control and Data Aqisition system PVSSII [3].

CONCLUSION

The setup of ACS-Servers and PMAC 2 Controllers for the ANKA-insertion devices gives an operator friendly access to the features of this devices in the ANKA-ring.

The control and improvement of beam parameters of beam optics and beam lifetime needs instant and failsafe control of insertion device settings, this can only be accomplished with the embedded, ACS based control system for the ANKA insertion devices.

REFERENCES

[1] R.Rossmanith, “Generation of X-rays with a high degree of coherence”, Forschungszentrum Karlsruhe, GmbH., Box 3640, D-76021 Karlsruhe, International Journal of Modern Physics B, Vol. 21, Nos. 3 &4 (2007) 513-518, FZK/ISS

[2] G. Jansa, R. Gajsek, M. Kobal, “MCS-8 Eight Axis Embedded Motion Control System”, Cosylab, Ljubjana, Slovenia

[3] W. Mexner, T. Spanngenberg, K. Cerff, M. Hagelstein, “A manageable control system for ANKA”, Forschungszentrum Karlsruhe GmbH, ISS, Box3640, D-76021Karlsruhe.

[4] M. Kobal, “ANKA SCU-14 undulator control, control system manual”, Cosylab, Ljubjana, internal communication.

[5] P. Medvescek, “ANKA SCU-14 undulator control, technical manual”, Cosylab, Ljubjana, internal communication.