The PHENIX Ancillary Control System

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Abstract

The PHENIX Ancillary Control System will be utilized to regulate and monitor the relevant parameters of the PHENIX detector of the RHIC accelerator at Brookhaven National Laboratory. The Experimental Physics and Industrial Control System (EPICS) will be used to control the approximately 3,500 individual high voltage channels. C++ classes have been created that enable connection/communication between the EPICS database and the Objectivity database. The low voltage control uses Advantech ADAM 5000 distributed data acquisition modules.

Keywords: PHENIX,RHIC,EPICS,Objectivity,ADAM 5000

1 Introduction

When the Relativistic Heavy Ion Collider (RHIC) accelerator begins operation at Brookhaven National Laboratory in the first half of 2000, the PHENIX [1] detector will begin to acquire physics events. Consisting of eleven different subsystems and approximately 300,000 readout channels, the control system for this detector needs to be large and robust. That system, The PHENIX Ancillary Control System [2], is divided into low voltage and high voltage control. The ONline Computing System (ONCS [3]) group is responsible for its creation, maintenance and operation.

2 High Voltage

In Figure 1, we see a diagram of the EPICS high voltage control. This is based on a similar system [4] in use in Hall B of Jefferson Laboratory.

2.1 LeCroy 1458 Mainframe

As can be seen in this figure, the experimental hardware (drift chamber, photo multiplier tube, etc.) is connected to an individual LeCroy High Voltage (HV) module (either a 1461, 1469 or 1471) that occupies one of the sixteen slots of a LeCroy 1458 Mainframe. The mainframe has a 486 processor on board that monitors *changes* (e.g. a trip, or a voltage that deviates from a predetermined 'dead zone') in any of the channels of the HV modules it contains. If a change is detected, this is communicated via a 'global summary' (five four digit hexadecimal numbers) report back to the Input Output Controller (IOC) over arcnet. In this way, the traffic over the network is kept to a minimum.

[1] see http://www.phenix.bnl.gov/ and links therein
[2] see http://www.phenix.bnl.gov/ phoncs/oncs/Anc_sys and links therein
[3] http://www.phenix.bnl.gov/ phoncs/oncs
[4] "EPICS Development: High Voltage Slow Controls for the CLAS Detector at CEBAF", M. W. Swynghedauw, University of South Carolina, 1996

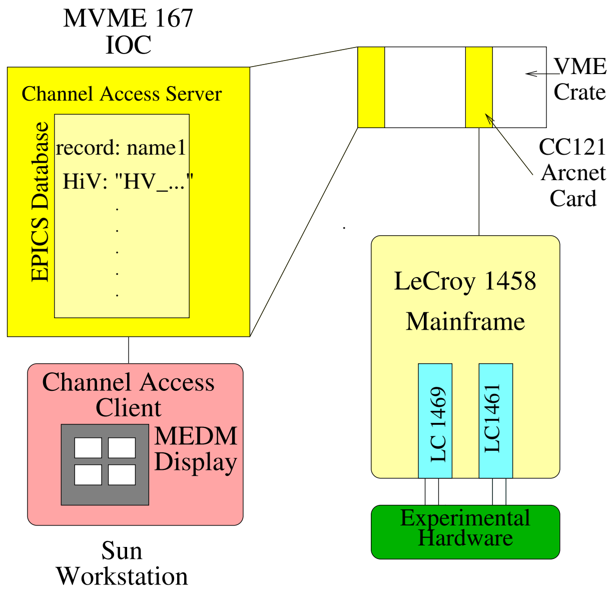

Figure 1: High Voltage Control

2.2 IOC/EPICS database

The IOC is a Motorola MVME 167. It uses a 680xx processor and has memory extension from 4M to 16M. VxWorks 5.3.1 is the operating system. The EPICS database is resident on the IOC. As mentioned above, the final detector configuration will have approximately 3,500 HV channels to control. These will be divided between four IOCs that have a geographical relationship (i.e. north, south, east and west) to the detector. Each of the individual HV channels has a corresponding HV EPICS record. Since the LeCroy modules require multiple inputs and outputs, a custom HV record was designed to accommodate them. This record, the 'EPICSB' *HiV* record has multiple 'val' fields to read and write from and (currently) requires a separate EPICSB area in which to compile the drivers. R3.13.0.beta11 is the version of EPICS in use.

3 Objectivity

PHENIX has chosen Objectivity [5] as the database for the entire experiment. The HV Objectivity implementation consists of three different databases within the Federated Database. The three databases are the Configuration, Readback and Time Tag databases. In Figure 2, we see a subset of this depicted graphically.

3.1 Configuration

The Configuration database contains the information about what type of module is contained in which slot of what mainframe. This database is expected to remain relatively constant in size, increasing slowly as different modules and/or mainframes are swapped in and out in the event of device failure. As can be seen in the Figure 2, the EPICS database is produced from the Configuration database. In practice, this involves a C++ program that reads the contents of a given configuration in the Objectivity database and produces an ascii output file. This file then serves as the input to a Perl script which then produces the actual EPICS database to be loaded onto the

[5] http://www.objectivity.com

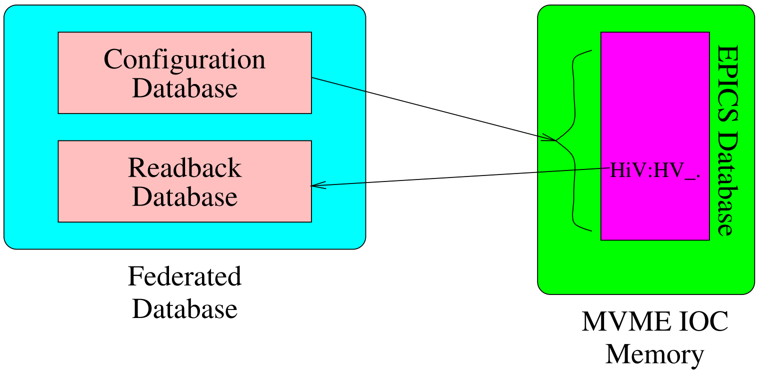

Figure 2: Objectivity - EPICS Database Relationship

IOC.

3.2 Readback

The Readback database contains the information about the HV channels of a particular subsystem at a given time. In particular, the measured voltage and the measured current will be recorded at regular times. In distinction from the Configuration database, the Readback database is expected to grow rapidly as more HV data is taken. It is expected that this will be backed up onto tape and then deleted periodically.

3.3 Time Tag

Finally, there will be a Time Tag database that will contain the time stamp information for quick and easy access.

4 Low Voltage

The Advantech [6] ADAM 5000 distributed data acquisition module is central to the PHENIX low voltage control system. In Figure 3 we see a diagram of the low voltage control system.

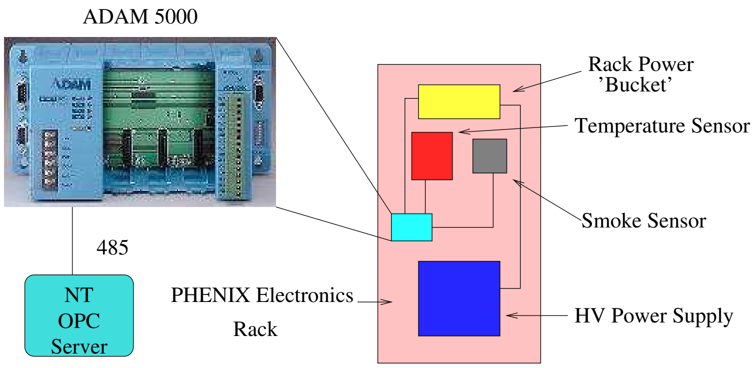

Figure 3: Low Voltage Control - OPC Server

[6] http://adirect.advantech.com/

4.1 ADAM 5000

As can be seen in this diagram, the ADAM 5000s will be located remotely within the electronic racks located in the experimental hall. There are approximately 36 racks for the entire detector and each rack contains at least one ADAM. The ADAM 5000 provides for relatively low cost ($\approx$ \$400.00 US each) remote control of the electronics racks. The ADAM 5000 can be configured with different modules for different functions. In Table 1, we see listed the different modules and

Table I: ADAM Modules

Module	Function	Use	Number of Channels
5017	Analog Input	Magnetic Field Measurement, etc.	eight
5018	Thermocouple	Temperature Monitoring	seven
5051	Digital Input	Readback of Crate Status	sixteen
5056	Relay Output	Cycle Power on Rack	six
5068	Relay Output	Cycle Power on Rack	eight

how they are used within the experiment.

4.2 OPC Server

For control of the ADAM 5000s, an Object Linking and Embedding (OLE) for Process Control (OPC) server running on a Microsoft Windows NT machine is utilized. This server makes available the relevant data from the individual ADAM modules. OPC clients can then monitor and display the data as necessary. In the future, an OPC client will be written that will write relevant data to the Objectivity database.

5 Conclusion

As of the time of this writing, there is significant work in progress regarding the testing of the PHENIX Ancillary Control System. While individual components have been tested extensively, the functionality of the entire system remains to be demonstrated. While we are confident of success, we anticipate and look forward to many interesting and challenging problems.

References

1 T. Auger “Elements of EPICS and the High Voltage Control System for the CLAS Detector”, Master’s Thesis, University of South Carolina, 1996.

2 Fastwel ADAM-4000/5000 OPC Server User’s Manual, Feb 17, 1999.

3 LeCroy Research Systems 1454/1458 HV Mainframe User’s Guide V3.04.

4 Using Objectivity/C++, Version 4.0, July 16, 1996.