PHENIX South Muon Tracker Ancillary Monitoring and Controls

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And a host of others…

1. Introduction

The overall readout and control of PHENIX south muon tracking ancillary systems is proposed. In order to reduce costs, we have chosen technologies that are commercially available as much as possible, with the constraint that the required software development effort also be minimized. The resulting system is somewhat heterogeneous, but we believe that it will serve the purposes of the PHENIX muon tracker.

We assume that (3,3,2) gaps are to be built in (Station 1, Station 2, Station 3) in the south tracker and no anode readout. This document will not discuss the north arm.

2. System Goals
   - 2.1. To provide the minimum information necessary to judge the operating status of the muon tracker front end electronics (FEE), alignment, and gas systems.
   - 2.2. To provide a means of turning off the minimum amount of electronics in case of operational problems.
   - 2.3. To provide a conduit for status information to flow from the hardware to the permanent PHENIX Objectivity database, for subsequent data quality analysis.

3. Description by System Component
   - 3.1. Front End Electronics
     - 3.1.1. Low Voltage Power Supplies: There will be 21 low voltage power channels for each arm's FEE. The on/off state of these supplies will be controlled by Rack Monitoring and Control (RMC), a PHENIX-wide technology for control of rack electronics. In addition, these supplies provide an analog readout of the current flow and a binary OK/not-OK status bit for the supply voltage value. These values will be exported to a database in the same manner as the rest of PHENIX.
     - 3.1.2. Low Voltage Distribution to the FEM: UNM is developing a set of cards for distributing the low voltage to the FEM. The cards will contain relays connecting low voltage to particular FEM. The state of these relays will be controlled using XYCOM XVME-240 Binary I/O units. Each of these provides 32 input and 32 output bits. As there are 200 FEM, we will need 7 of the XVME-240 units.
     - 3.1.3. Cathode Front End Modules (FEM): There are 200 cathode FEM's in the south arm. Each FEM is composed of three cards – one controller card and up to two readout (CROC) cards. The actual number of CROCs is 368. For each controller card, we will measure 6 supply voltages, 1 current, and up to

3 temperatures. On each readout card we will measure 4 voltages and 2 temperatures. [Some voltages are used to deduce currents, but we only list here what is actually initially measured, not any computed values.] For each FEM, then, we measure up to 14 voltages, 1 current, and up to 7 temperatures. The digitized values of these analog parameters are to be read via an ARCNET interface.

3.1.4. Anode FEM: All anode FEE has been descoped.

3.1.5. Fiber-Optic-to-Copper Translator Cards: There are 20 translators in each arm (4 in Station 1, 8 in Station 2, 8 in Station 3) that send and receive information to and from the FEM's. Each translator consists of two CTX (timing) cards and one CRX (data) card. At each card we measure 2 supply voltages, 2 currents, and 2 temperatures, again via ARCNET. Thus, for each translator we measure 6 voltages, 6 currents and 6 temperatures.

3.1.6. Cooling water temperatures: There are 20 cooling water flows in each magnet (4 in Station 1, 8 in Station 2, 8 in Station 3) and we will measure the temperature of this water at the exterior return manifold inputs. We will also measure the temperature at the three input manifolds, one for each station, making a total of 23 cooling water temperature measurements in each arm. These temperatures will be read using thermocouples linked to an ADAM module.

3.1.7. Cooling water flows: An analog flow meter will be attached to the main cooling water manifold outside the magnet. This flow will be recorded in EPICS.

3.1.8. Dry gas flows: An analog flow meter will be attached at the gas source for the magnet. This flow will be recorded in EPICS.

3.1.9. Magnet Moisture: We will use a TraceTek sensor to detect water in the low sections of the magnet. This provides contact closure when water is detected – these closures can send alarms to the counting house and set a bit in an EPICS binary i/o module.

3.2. Tracker Gas System: This system is detailed in web page documents of Jiro Murata, http://spin.riken.bnl.gov/~jiro/mutrgas.html.We mention here only those components of the gas system that need to be read out remotely.

3.2.1. Gas Composition Monitors (3 in the gas house): The amount of oxygen, water, and other components in the gas volume will be monitored. These will be reflected by voltage outputs, which will be sensed by VME hardware controlled by EPICS.

3.2.2. Gas Valves: No remotely controlled valves.

3.2.3. Gas Pressures (5 in the IR, 6 in the gas house): A variety of gas pressure sensors will produce analog voltage signals to be read in VME hardware by EPICS.

3.2.4. Gas Flow (5 in the IR, 1 in the gas house): Mass flow rate sensors will produce analog voltage signals to be read in VME hardware by EPICS.

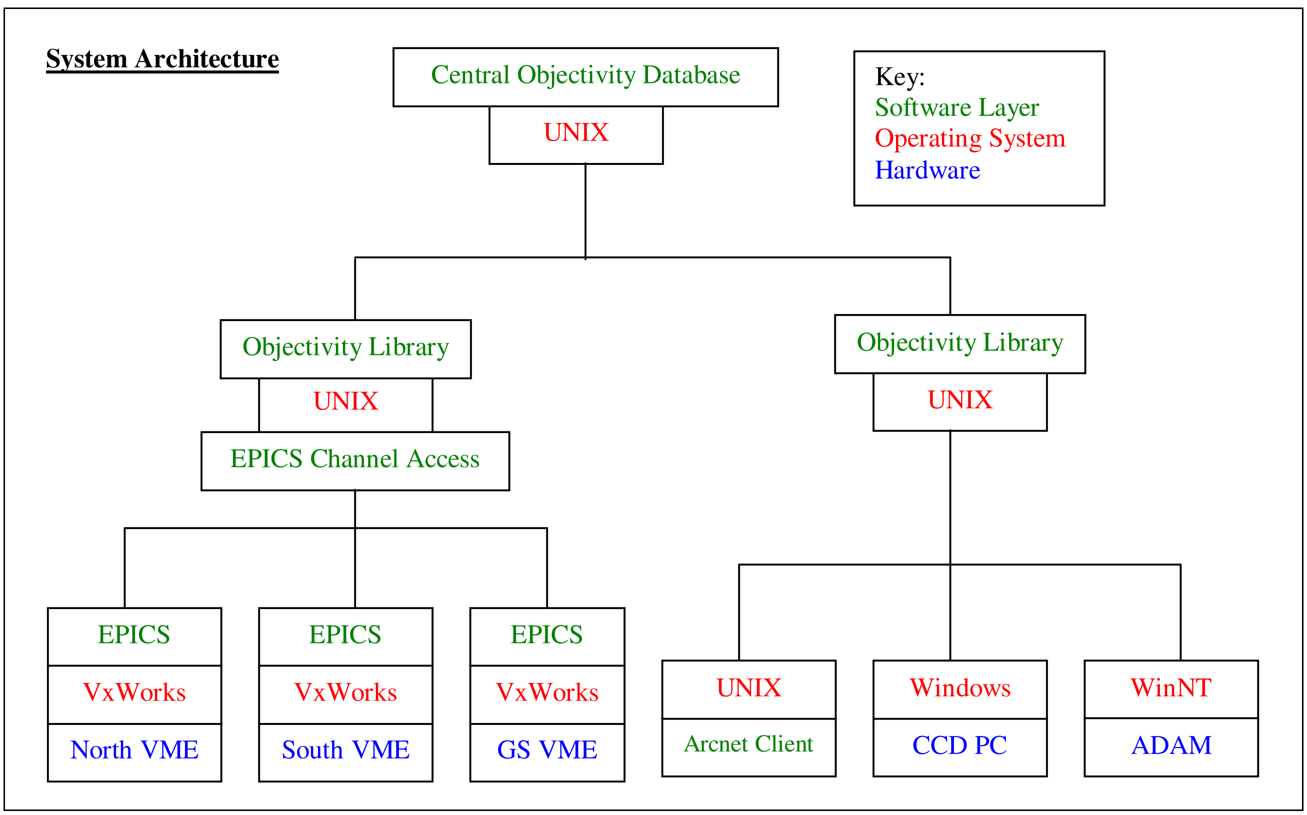
3.2.5. We will use the BiRa 7305 VME Smart Analog Monitor to monitor the analog voltages of the gas system. The BiRa 7305 provides 32 analog inputs. We will need two, one in the gas house and one in the IR.

3.3. Alignment System: The alignment system is composed of light sources on station 1, lenses on station 2, and CCD cameras on station 3. There will be 7 source/lens/CCD triplets per octant, for a total of 56 CCDs to be read in each arm. A Scion frame grabber in a Windows98 PC will read out each camera. The CCD's will be multiplexed (using a video switch controlled by the frame grabber) so that only one frame grabber will be required. The PC will compute the x- and y-centroids of each CCD image and report these centroids to the experiment.

4. System Architecture: There are clearly a number of technologies providing information for the muon tracker ancillary systems database. In the end, all of that information will be gathered into the Objectivity database system of PHENIX. The exact method for doing so will be considered at a later time.

 4.1. The VME crates will each have a standard I/O Controller (IOC) which will be running the VxWorks operating system. The EPICS software package will run under the VxWorks OS and be used to monitor hardware, as well as to maintain the local database inside the IOC.

 4.2. The processors that perform the Arcnet Client, CCD I/O, and ADAM functions will report data directly to the central database, perhaps through an intervening Unix processor. If a version of Objectivity were running on these processors, then the intervening Unix processor would be unnecessary.



5. System Cost:
   5.1. VME
      5.1.1. The VME binary I/O module we have chosen is the XYCOM XVME-240. This device provides 64 channels of binary I/O in a single slot 6U VME module. The 64 channels are broken into 8 8-bit bytes. The cost of this module is $630 (priced quoted one year ago). EPICS software support for this module already exists. In the EPICS support for this module, 32 of the bits are inputs and the other 32 are outputs. We need 7 of these modules.
      5.1.2. The VME analog input module we have chosen is the BiRa 7305 VME Smart Analog Monitor. This device provides 32 differential input channels with 16-bit conversion and programmable gain, in a single slot 6U VME module. The price of this device is $1800. EPICS software support for this module already exists. We need two of these modules.
      5.1.3. VME Crates and Controllers: One VME crate and controller will be located in the electronics racks near the magnet for each arm. These crates will perform the controls for the front-end electronics and other systems inside each magnet. Another crate and controller will be located near the muon tracker gas system. Sufficient numbers of crates and controllers are already in the possession of the muon tracking group for the implementation of the South magnet and the gas system.
      5.1.4. The VME hardware cost for installing the South arm and the gas panel is $8010.
   5.2. ADAM: One ADAM-5000 rack unit costs $375. For thermocouples, we will need four ADAM-5018 modules, which cost $220 each. We find that a typical thermocouple and leads costs about $20. So the cost of the ADAM system for reading the 23 thermocouples is about $375 + 4($220) + 23($20) = $1715.
   5.3. TraceTek: The single channel TraceTek alarm unit (TTC-1) costs $610 each. The water sensitive cord (TTC-3000-SC) is $6.25/foot. So the cost here will be not more than $1000.
   5.4. Flow meters: A typical gas or liquid flow meter, with readout unit, costs $500 or less. So the cost for the two flow meters will not exceed $1000.
   5.5. OVERALL COST ESTIMATE: Not more than $12,000.