6 Electronics, Computing and Detector Infrastructure

6.1 Status of advanced object oriented real-time data acquisition system

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We are developing an advanced object oriented real-time data acquisition (DAQ) system which will implement a multiple platform, fast, scaleable, distributed DAQ system suitable for both small and large experiments. By using a client/server model to totally separate the hardware controlling computers (the servers) from the user interface computers (the clients), we are building in the flexibility to have multiple server computers taking and processing data while being controlled and/or viewed by multiple remote clients. We will support both the common crate-based DAQ hardware systems (VME and CAMAC) as well as PC-based DAQ cards. The server and client frameworks are designed in such a way that it is easy to add support for new DAQ objects as the need arises. The framework is also suited for the inclusion of data analysis modules.

Both the client and the server are written in C++ using the gnu compiler running under the Linux operating system using the Qt widget set to provide a cross platform capability for both Windows and Unix. For communication between the client and server, we are using CORBA (Common Object Request Broker Architecture) which is an industry-wide standard for implementing client/server communication.

The client provides an easy-to-use graphic user interface to the hardware servers. To set up a hardware configuration, the user selects hardware or data processing modules from a list of available objects in a catalog and drags that module to a configuration window. The desired object is created on the server when the drag is completed, and appears in the configuration window as an icon. The data flow between objects is set up at run time by dragging lines from object to object. Double clicking on an icon brings up a dialog for controlling and/or viewing the status of the represented server object.

The servers, after being set up by a controlling client, do all data acquisition and processing. They have no external user interface at all, only a low-level programming interface. Objects existing at the server level implement all of the functionality of the hardware objects that they represent. All of the hardware objects that have been implemented so far are Vme modules and include the low-level PCI driver, the 617 controller, FIFO buffer card, 408 I/O card, and Emit/Ncd shaper adc cards. A Vme crate object contains and controls the interactions between the cards.

A well-developed run control system has been completed which allows the users to start and stop data runs. The length of a run and whether it is to be automatically repeated can also be specified. Multiple runs can be done at the same time using different sets of hardware. Data from a run can be sent to histogram objects that build catalogs of the existing histograms. Client-side plot objects can then select histograms to view from the data catalogs. A data storage object allows the user select where the data is to be stored.

In the near future we will be finalizing the details of the core framework in preparation for adding support for many more types of hardware modules.

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6.2 Shaper board electronics development

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In previous annual reports,[1] we have discussed the UW Shaper/ADC Board. There are now two versions of this board. The "Standard Board" which will be used in the SNO and the emiT experiments and the "TimeTag" board, developed for use at Los Alamos National Laboratory.

The "Standard Board" Altera chip houses 8 independent scalers and an overall scaler. The benefit of these scalers is mitigated by the presence of TTL-level trigger outputs for each channel, enabling off-board scalers to be incorporated if necessary.

The "TimeTag" board Altera chip has 8 independent 32-bit timetag modules clocked by the VME bus clock, instead of the scalers. Los Alamos National Laboratory has used the "TimeTag" board in several new experiments for nuclear nonproliferation work. The timetagged data was used to recombine events distributed among arrays of detectors, to provide 2-dimensional analysis of pulse shape and total energy deposition in detectors, and to investigate geometrically correlated fission neutron emission.

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[1]Nuclear Physics Lab Annual Report, University of Washington (1998) p. 55; (1999) p. 55; p. 73 (2000).

6.3 Laboratory computer systems

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This year continued the replacement and addition of systems in the form of G4 Macintoshes for SNO/EWI/NCD tasks, generic PCs as Windows98-based normal desktop workstations, a Windows 2000 system, a 1.5GHz Pentium 4 Windows system, and three more dual-processor Linux systems. As described in Section 1.4, many of the systems are used to provide a loose "parallel" Mathematica computing matrix.

Our computing and analysis facility consists of:

- Our principal central compute-server base: a pair of dual-CPU Digital AlphaServer 4000/466s running Digital Unix, each with a gigabyte of ram and a total of 260 gigabytes of disk space. Our dual-controller, 288 gigabyte RAID system had a drive failure, but the RAID and hot-swap features permitted seamless continued operation throughout the event. The lab's other Unix and VMS systems route their backup load through the RAID system, and from there they are backed up to our DLT4000 and DLT8000 tape drives.

- Our VMS cluster, holding at three VAXstation 3100s, three 3200s and a single Alpha 3000/400. The cluster shares 26 gigabytes of disk space. In addition, we have a standalone OpenVMS AlphaStation 433au with a dedicated 27 gigs.

- The Ultra-Relativistic Heavy Ion group's seven Hewlett Packard 9000 Unix systems, all running HP-UX v10.2, sharing 62 gigabytes of distributed disks. Three of the systems are serving as workstations at STAR. One of the HPs is the lab's World Wide Web server (www.npl.washington.edu).

- The SNO and emiT group have Macintoshes, Apple G3 and G4's, and Power Computing PowerPC Mac "clones. Many of the older Macs and clones are being retired and replaced with G4's. They also have a Sun SparcStation 20 running Solaris 2.5.1 to provide CADENCE circuit layout facilities to our electronics shop. The two Sun Ultras have been moved to the Sudbury site.

- Linux's presence continues to grow, from our first 233 MHz Pentium II system used for compatibility with RHIC's RCF facility, through a dual-processor 400MHz Pentium II system serving as the development platform for the NCD and our next data acquisition system (see Sec. 6.1), two 500-MHz dual Pentium II systems serving as NCD testbeds and slated to become our next DAQ system, and a gigahertz dual-PIII system for analysis. The two "future-DAQ" systems are taking over compute loads from the twin Alphas. Linux's development curve, 32-bit structure and utilities continue to create some minor inconveniences, but for the most part it provides the computing flexibility and value which has led to its widespread acceptance.

- Three MBD-11 equipped VMS VAXstation 3200s still serve as the Lab's primary data acquisition systems running acquisition software based upon TUNL's XSYS, with major modifications to their DISPLAY program. Another VAXstation is the Linac's control and display system, with three LSI-11/23s and six LSI-11/21s built into the Linac for cryogenics, vacuum and resonator control. Four PCs are serving as controllers for the rest of the accelerator systems' interlocks, safety and vacuum system.

- Although not directly used by Lab personnel, we provide co-location services for Nuclear Theory and the Physics Nuclear Theory group in the form of two VMS VAXstation 3200s. The Astronomy Department is installing a 64-processor Xeon-based Beowulf cluster for simulation of galactic formation by performing N-body gravitational modeling.

- The Lab's network is a mixture of 100baseTX and 10baseT ethernet ports, and our existing legacy 10base2 net. We use HP 800T, Compex and Hawking switches to partition the network and provide full-duplex ports to the larger systems.

  We have a full duplex 100baseFX fiber uplink to the campus routers, recently upgraded to gigabit capability in support of the Astronomy Linux cluster.

6.4 Electronic equipment

T. A. Anderson, G. C. Harper, A. W. Myers and T. D. Van Wechel

Along with the normal maintenance and repair of the Nuclear Physics Laboratory's electronic equipment, projects undertaken by the electronics shop included the following:

1. The SNO NCD MUX boards, Shaper/ADC boards, Controller boards, and DAC boards have been completed and tested. A HV interface board was designed and constructed for interfacing the high voltage power supplies to the HV controller board and HV DAC board. A MUX voltage regulator board was constructed to provide power to each MUX board. The Altera chip program for the controller boards was modified for the HV control boards.

2. Three rack mounted systems are being constructed: the main underground system, a second above ground system at Sudbury, and a system at the University of Washington for software development and testing. Linear power supplies were constructed for each system. Also the VME crate power supplies were converted to linear power supplies. The two systems for Sudbury are nearly complete and will be shipped to site in May.

3. An AMP-TEK A250 charge sensitive preamplifier was set up and tested for use in the SNO tagged neutron source.

4. After testing of the prototype low power emiT pre amp modules constructed last year it was determined that the resolution was significantly worse than the original emiT pre amps. The open loop gain and bandwidth was much lower than required so we decided to redesign the low power pre amp module. The input stage was changed from a folded cascode to a configuration with the drain of the input FET driving a differential amplifier with an emitter follower output. The gain of the output stage was improved by using a cascode amplifier buffered with an double emitter follower. Also, the layout of the motherboard was improved by minimizing breaks in the ground plane which were causing undesired positive feedback.

5. An isolated power supply system for the emiT experiment was constructed. This consisted of a HV isolation transformer and power supplies for the emiT pre amps and fiber-optic drivers that are elevated to approximately 30KV.

6. A prototype laser diode driver was designed and constructed and is currently undergoing testing for the New-Wash torsion balance instrument. Also a two channel optical sensor preamplifier with sum and difference outputs has been designed and constructed.

7. The electronics shop assisted in the design and installation of the TIS gas manifold and control system for the Van de Graaff.

8. Eight photomultiplier tube bases were designed and constructed for the Be^7 experiment.