6 Electronics, Computing, and Detector Infrastructure

6.1 Electronic Equipment

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The electronics shop designed and constructed new laboratory electronic equipment, and maintained and repaired existing CENPA electronics. The electronics shop also supported ongoing efforts at SNO, both from Seattle as well as on-site support at Sudbury Ontario, Canada.

Other projects undertaken by the electronics shop include the following:

1. A PID temperature controller to make calorimetric measurements for the ^{3}He+^{4}He experiment was developed. The input to the controller is a two thermistor bridge set up to maintain a set temperature differential. The temperature differential is adjustable between 0 and 3°C. The power required to maintain the temperature differential is recorded.
2. Development work on a parametric amplifier continued. A second prototype parametric amplifier and a demodulator board were designed and constructed. The 2.9 keV FWHM measured resolution of the prototype was poorer than the <500 eV FWHM resolution predicted by SPICE simulations. The dominant source of the excess noise has been traced to phase noise on the externally generated local oscillator (LO) signal. A new parametric amplifier board with an on board differential oscillator and several other improvements is currently being designed.
3. Additional development of a low power and low noise charge input preamplifier with a folded cascode JFET input stage was undertaken.
4. The electronics shop was involved in the design and construction of the External Alpha Counter for the NCD array at SNO. The feedback components of several spare SNO NCD current preamps were modified to convert them to charge preamps.
5. The power supply system of a Wiener 9U VME crate failed. The US factory representative was unable to repair it, so they forwarded it to Germany for repair. In the meantime the electronics shop constructed an array of linear power supplies as a temporary replacement.
6. CENPA has received funding for development of a new Shaper-ADC board. Preliminary research to determine the desired features and specifications for the Shaper-ADC board has begun.
7. Two high voltage power supplies for the KATRIN electron gun were repaired and recalibrated.

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8. A vacuum controller was designed and built for the new experiment on the 0° beamline.
9. The analyzing magnet NMR oscillator was completely refurbished.
10. Several steerers, beam sweepers, and quadrupoles will be switched between the 0° and left 45° beamlines using a relay controlled transfer box that has been designed and is under construction.
11. A photo tube base was designed and constructed for the LArGe experiment.
12. Two time base counters were constructed for the ^{3}He+^{4}He experiment.
13. Four adjustable current sources for general lab use were constructed.
14. Clean up and reorganization of electronic parts and components in the electronics stock room continues.

6.2 Additions to the ORCA DAQ system

J. Detwiler, M. A. Howe and J. F. Wilkerson

The Object-oriented Real-time Control and Acquisition (ORCA) system is an application software tool-kit that is designed for quickly building flexible and robust data acquisition systems. In Nov of 2006, ORCA finished a successful three year run as the production DAQ for the SNO NCD experiment and is now being used to readout an alpha counter to study 'hot spots' on the removed NCD tubes. For the last several months of the SNO experiment, it was also used for the muon tracking system. At CENPA, ORCA is installed in several test stands for the development of the KATRIN pre-spectrometer (see Sec. 1.8) and the Majorana electronics (see Sec. 1.14). Since ORCA has been described extensively in past annual reports[1] only the most recent developments will be reported here.

Improvements to the ORCA infrastructure over the last year include the addition of USB hardware support, a built-in log book, and SQL database interfaces. In addition, the alarm system can now email specified alarms to a list of recipients. Complex 'meta' dialogs were developed for the main KATRIN operator interface that show an overview of both the 145 channel main spectrometer and the 64 channel veto system. A similar dialog was developed for the 64 channel prespectrometer tests.

Support for a number of new hardware devices was implemented. New CAMAC cards included the Joerger ADC-L 16 channel scanning system, BiRa 3251 and 2351 I/O cards, and the LeCroy 4532 logic unit. The CCUSB CAMAC controller was also added, but because some throughput limitations have not yet been solved some work remains. For VME, an 8-channel digitizer developed at LBNL for the Gretina experiment as added. In addition, the HP 33220A pulse generator (USB, IP, and GPIB) and ADU200 Relay I/O controller unit (USB) were included. And finally, support for the KATRIN readout cards (Auger hardware) was completed.

One big advance for ORCA was the development of a scripting language called ORCA-Script. It is a minimalistic interpreted programming language that can be used to automate some ORCA run-time tasks. Among its design goals were that it could be interpreted using a relatively simple lex/yacc based interpreter, provide a C-like language that would be easy to learn, and provide full access to most of the objects in an ORCA configuration without having to add code to those objects. ORCAScripts are created and edited using the ScriptTask object. Scripts are automatically entered into the list of tasks managed by the Task Master and can be executed either from there or from the ScriptTask object itself. Scripts can be chained together to run one after another passing results forward to the next script in the chain. Most C library math functions are included as well as functions that allow scripts to synchronize operations with ORCA run control.

ORCARoot continues to be developed in lock-step with ORCA to fully support ROOT analysis of all of the data that ORCA supported hardware can generate.

[1] CENPA Annual Report, University of Washington (2001) 83; (2002) 81; (2003) 70; (2004) 66; (2005) 85; (2006) 80.

6.3 Laboratory computer systems

M. A. Howe, R. J. Seymour, H. E. Swanson and J. F. Wilkerson

This year continued a fairly low rate of additions, upgrades and replacements of existing systems.

Intel's low cost multi-core systems have allowed reasonable performance to be achieved at a $500 price point. A dual 1GHz Pentium III system was retired from central compute serving to become a project's file and web server.

As a part of that rearrangement, all of our central Linux compute servers were brought up to Fedora 6.

We continue using DenyHosts (http://denyhosts.sourceforge.net) on our externally accessible Linux systems to aggressively block access by various attack profiles within a few seconds of their initial probing.

Windows Vista and Office 2007 have been installed on one testbed. So far no unexpected issues have been seen.

Our computing and analysis facility consists of:

- A mix of Linux systems, RedHat v7.3 through v9.0 and Fedora Core 6.
- Twin dual-processor DEC/Compaq/HP Unix AlphaServer 4000s.
- Three VMS/Vaxes and two VMS Alphas for "legacy" computing.
- The SNO, NCD, KATRIN and emiT groups rely upon Macintosh systems.
- One SunBlade 100 workstation serves CADENCE circuit design, analysis and layout duties.
- A VAXstation is the Linac and Vacuum systems' control and display system.
- Three WindowsXP desktop JAM acquisition and analysis systems, plus two laptops for taking to other installations.
- The bulk of CENPA's Windows-based PCs are behind a Gibraltar Linux-based logical firewall using an automated setup procedure developed by Corey Satten of the University's Networks and Distributed Computing group (http://staff.washington.edu/corey/fw/).
- Although not directly used by Lab personnel, we provide co-location services for the Institute for Nuclear Theory (INT) and the Physics Nuclear Theory group in the form of one VMS Alphastation 500. The Astronomy Department has located a 64-processor Xeon-based Beowulf cluster in our machine room.
- Since the superconducting Linac was mothballed, CENPA is blessed with an excess of power and cooling capacity compared to our current needs. This is a rare commodity on the UW campus. We are working with Physics, INT and Astronomy for providing co-location of a 2.5 to 3.5 teraflop compute facility in our computing room.

6.4 Studies of energy losses of fast charged particles

H. Bichsel

The purpose of these studies is to derive energy loss functions $\phi(T,x)$ for charged particles with kinetic energies T traversing absorbers of thickness x. In order to explore the uncertainties in Monte Carlo calculations I use computer-analytic methods (for thin absorbers, see http://faculty.washington.edu/hbichsel for a description of such methods). For energy losses in thick absorbers, successive thin layers ξ are combined. Assuming that the function $\phi(T,x)$ is known at a depth x in the absorber, a straggling function $V(T,\xi)$ is calculated for a thin layer ξ and the energy loss functions $\phi(T,x+\xi)$ is calculated with

$$\phi(T,x+\xi) \;=\; \int \phi(T+\chi,x) \;\; V(\chi,\xi;T+\chi)\; d\chi \qquad (1)$$

where the energy $T+\chi$ before the layer ξ is reduced to T after this layer.

This method has been used to calculate the results described in Sec. 1.3. No direct comparisons with MC calculations have been made so far. Major applications are for planning of radiation fields for heavy ion cancer therapy.