Lab report of the Accelerator Facilities

For the period 2004-2005

National Isotope Centre, New Zealand

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I. Introduction

The National Isotope Centre at the New Zealand Institute of Geological and Nuclear Sciences has two HVEC Van de Graaff accelerators. The KN single-ended machine, installed in 1965, is used for ion-beam analysis (IBA) applications in materials and environmental research. The EN-tandem, commissioned in 1986, is primarily used for ^{14}C and ^{10}Be accelerator mass spectrometry (AMS) and for thin-layer activation (TLA) in corrosion studies.

II. EN-tandem accelerator system

A. New Wien Filter Beam Line

A new beamline was constructed for the suppression of isotopic interferences when detecting the rare isotope in AMS measurements. The zero-degree line out of the switching magnet was chosen for this beam line as this enabled much easier optical alignment and allowed us to carry on with AMS measurements using the 25-degree axis beam line while the upgrade was occurring.

All components were made from stainless steel with CF flanges. This line includes two new Varian Turbo V-301 pumps and a new Varian Turbo V550. All three turbos are backed by a single Varian Scroll pump at present but we will change this to a maximum of two turbos per Scroll pump in the next stage of the upgrade. We have chosen to use Fischer Quad micrometer slits because of their small compact size and cost. They use a small O-ring on each shaft (we have had one unit stick causing its miniature drive motor to failure.) The pneumatic gate valves chosen for the beamline are CF 6” by MDC, Model MDC-301016

The main component of this system is a Wien Velocity Filter by Danfysik, Model No. 623 which uses a 12kW Power Supply to produce up to 0.3 Tesla and Electrostatic Deflector capable of up to +/- 75kV per plate. As with the previous beamline that featured a 10-degree electrostatic analyser, beam focussing onto the acceptance of the particle detector is achieved by placing a quadrupole doublet in front of the Wien filter.

One issue encountered with this installation was the water cooling requirements. The Danfysik specifications required that we use very low conductivity water because of possible scale build-up in the hollow copper wire of the core through which the water flows. We decided to use a stainless steel heat exchanger secondary water cooling circuit off our main building closed circuit system. A Myron conductivity controller has been installed to monitor and automatically adjust the conductivity from a mixed anion/cation resin reservoir. To get the required flow rate for both the Magnet and its power supply we had to add a Grundfos CR21 booster pump. The rotating finger water flow sensor’s used initially, failed after a short time and have been replaced with Vortex EGGS Delta- Pulse flow meters.

When commissioning the new Wien Filter, we encountered serious sparking from the earthed braid of the High Voltage coax cable feeding the Wien Electrostatic Deflector plates. The HV RF generated resulted in nearby electronic equipment components failing. This problem was solved by adding Ferric beads to the coax outer and inner core to increase the inductance, hence suppressing the RF pulse rise time (particularly effective during conditioning). In addition, the earth connection from the braid end to the Wien filter frame was made as short as possible by building a shield box around the connection area on the Electrostatic Deflector chamber.

This new AMS beamline was commissioned in December 2004 and provides a significantly better rejection of interfering beams and optimal transmission.

B. Supervisory Parameter Control

The automation and control upgrade has continued with the commissioning of the new Wien Filter Beam Line. This new line features some custom hardware that is designed to integrate new components into our existing Group3 control system. Hardware interfaces have been designed for the Fischer slit system, NEC faraday cups, Eggs delta water flow meters, and a generic device for controlling simple switched devices like gate valves. Expansion to our Group3 system has also been aided by a standardised instrumentation box that houses the Group3 hardware in a 19" rack. Software development for the control system has also been ongoing with improvements to the Group3 server software in National Instruments LabView V6.2. The new software allows dynamic loading and unloading of instrument modules and has improved support for debugging and maintenance. A change to the control software is also being made to remove all National Instruments Data Socket interfaces. Data Sockets were the initial method we used to remotely control the Group3 server software. However, we found that the Data Sockets exhibited uncontrollable behaviour under some conditions.

C. Maintenance

In March 2005, annual maintenance was carried out inside the Tank. Included in this maintenance were the following points:
* Upon entering the Tank, we found a small oil "run" on L.E. tank floor which had come from the bearings in the pendulum pillow block (double set). We feel this is O.K. It probably happens when using the Kinney Vacuum Pump to evacuate the tank. It has been cleaned off.
* We found the reason why the L.E. column current read zero current after the previous Tank Opening. The last Ring at the L.E. end, which is connected to ground, was off one saddle (South Top one) and was touching the 2nd L.E. ring, hence shorting the column current circuit to ground.
* The Terminal Spinning fixture Half Clamps (H.E. end of Terminal) had helicoils M6 installed as the threads were nearly stripped.

III. 3MV Van de Graaff accelerator

The 3MV accelerator (KN-38) has operated successfully during 2004-05 with only occasional problems. Its main use was for IBA measurements (PIXE, NRA, RBS) using deuteron, proton and $^4He^+$ beams.

A. Belt screen improvements.

After observing the screen construction at the Vivirad accelerator in Strasbourg, we decided to experiment with our own arrangement.

Leaving the standard HVEE supplied mesh screen in place (to act as a flexible support only), we added a 4thou thick stainless steel shim sheet which protrudes beyond the mesh screen by 5/8". Then, at ¾" intervals all the way across, we cut slices in the shim sheet. This way each section of shim is semi-free to follow the belt irregularities.

Because each section of the shim sheet lies against the belt with a long moment arm, there is full contact all the time with a lot less pressure. Hence not only was the ripple reduced slightly but the wear and hence dust production was greatly reduced, hopefully extending the life of the belt.

B. 3MV Van de Graaff Belts.

After witnessing the fibre wear and hearing about the life time problems ANSTO Australia have had with their new Siegling belts on their 3 MV machine, we decided not to purchase this type of belt.
Instead, after receiving very favourable information from Utecht University about a new Nitril surfaced belt that they are now using successfully, we have also purchased this type as a spare for the future.
It is made by Wennerlund in Sweden and the part number is WE 82 /0 +10 Nitril.
As an added precaution, we have also decided to store the belt in a pneumatically sealed plastic drum under a monitored pressure of 5psi dry nitrogen, in case Nitril based belts are no longer available in the distant future. It seems other manufacturers are only making synthetic type conveyor belts these days.

C. Ion Source refurbishments

We have always sent our RF Ion Sources away for reconditioning. But we have now decided to recondition them ourselves. A small stainless steel vacuum vessel for the base and a separate pressure vessel were constructed so we could Helium leak test while having the outside of the bottle at 400psi He pressure. We replace both the canal which is made of 6101 Aluminium and the boron nitride insulator. At this stage we are also renewing the glass bottle each time to ensure we get maximum possible life out of the source.

D. Maintenance

* After a long run of the machine with a Hydrogen beam, it would suddenly switch to Deuterium. After a period of experimentation we deduced that the micro-switch settings were such that if there was a small temperature change over the day it allowed the Perspex control rods to expand just enough to switch to another gas. A repositioning of the micro-switch solved the problem.

* A new externally reconditioned ion source only lasted 1.5 days before starting to leak. This was replaced. Recently we have had this problem occur twice before with externally reconditioned ion sources. As a result we are now reconditioning our own as described above.
* Other maintenance included the replacement of a spark damaged column resistor and two burnt out relays plus two selsyn drive units

REFERENCES Lab Report for SNEAP 2003