

# ANU SNEAP 2011 Lab Report - 14UD

**Nuclear Physics Department  
Research School of Physics and Engineering  
Australian National University  
Canberra, AUSTRALIA**

*Alan Cooper, Alistair Muirhead, Allan Harding, John Bockwinkel, Justin Heighway, Tom Kitchen, Gareth Crook, Larry Lariosa, Caleb Gudu, Thomas Tunningley, David Weisser, Nikolai Lobanov, Keith Fifield*

This past year has seen substantial expenditure on upgrades, the hiring of two more technical staff and three tank openings. Nikolai Lobanov will report on the upgrade projects and both he and I will give more detail on selected projects. Here, I will just list the topics and invite your follow up enquiries.

- Accelerator control via EPICS being commissioned
- Vacuum
  - 7 new turbo systems installed 9 to be installed.
  - In-house manufacture of vacuum control units
  - Two RGAs bought and commissioned
  - Electrodes bought for AEI P300 ion pumps
  - Vacuum Gauging and leak detector to be ordered
  - Roots pump ordered – for roughing ion sources
- 14UD and its instruments
  - SF<sub>6</sub> top up to 102 psiA, 1040 kg @ \$38.50/kg.
  - New fast SF<sub>6</sub> containment valves- under investigation.
  - Oxygen depletion monitoring system being commissioned.
  - Terminal Potential Stabilizer being commissioned NEC
  - Slits, Faraday Cups ordered NEC.
  - In-house made slit controllers.
  - NMR ordered Drusch
  - Tube entrance lens control being commissioned- Glassman 150 kV supply
  - Spare Welwyn resistors ordered
  - Eight column posts ordered NEC
  - New charging chains and conducting tires installed NEC
  - New beam lines -under investigation.
  - New SNICS has been commissioned
  - Linac Beam pulse width monitor
  - Fast Faraday cup being commissioned
- AMS enhancement
  - Bouncer for ion source deck and bounce Einzel lens ordered TREK
  - Staff hired
  - Beam transmission optics studied

- Bunching and Chopping
  - Slow chopper upgrade 5 MHz, being commissioned. FID GmbH
  - Fast Chopper stabilization being commissioned
  - High energy normal conducting high energy buncher is being developed.
  - 10 kW 150 MHz amplifier ordered Amplifier Research.
- Magnet power supplies ordered. Integration with new computer control
  - Dipole supplies – 3 Danfysiks
  - Quad supplies – 18 Sorensens
- Superconducting Solenoid – under investigation.

The 14UD has operated for 2227 hours compared to the 2600 hours last year- September to September. Both are below our historic operating time of up to 4500 hours. In part, these lower times are due to more ambitious accelerator upgrades.

There have been three tank openings one of which was unscheduled. As usual, detailed Tank Opening Reports are available at <http://physics.anu.edu.au/nuclear/tor.php>. In January-February the top lid of the tank was removed to deal with a small, persistent SF<sub>6</sub> leak. The accelerator tube was vented and the low energy beam line split. Although no specific cause of the leak could be identified, the o-ring was replaced and significant machining marks on the sealing surfaces polished out. In addition, two beads of Loctite 515 augmented the seal. This belt-and-braces solution was entirely successful. It will be years before we know if the historic SF<sub>6</sub> loss rate of 1% per year has been reduced.

The 14UD has been less willing to operate above 15 MV than it used to be. In part, this is ascribed to more frequent tube venting for upgrades. But three other contributors should be considered.

Some of the degradation in terminal voltage is attributable to chain problems. The new chains have been much more susceptible to spark damage. These chains are nickel plated rather than the historic chrome plating. NEC is investigating the plating issue. These chains also exhibit a twist when hung from one end. This twist causes the chain to rhythmically ride up the side of the pulley tire and fall down again. This could contribute to charging instability. There has also been a failure of a tank wall feed-through for the suppressor supply. This may be a consequence or contributing factor to the chain damage. In any case, the replacement feed-through is made of nylon 6/6 rather than the unknown previous nylon and the sharp corner on the inside of the hole in the tank wall has been radiused. This is where the nylon had been punctured.

In chasing charging instabilities, contact bands were fitted to the two set of main pulleys that did not have them. DC, pick off idlers were also replaced. All in all, the charging currents are now more stable though it is not possible to ascribe the improvement to a single change.

Chain instabilities can trigger sparks thus lowering the safe operating voltage of the machine. Following this attention to chain issues, the machine ran much more stably with fewer sparks.

Another source of instabilities that could lead to sparks is associated with the resistor grading system. The resistor system in the 14UD is unique in that the ends of each pair of resistors are connected via a supple multi-strand wire attached to banana plugs and sockets. This was done to minimize the force pulling the free end of the resistor off center in its metal shield tube. The spark gap/capacitor at the free end of the resistor depends for its spark threshold, on this gap being uniform. Most other labs use transverse rather than coaxial spark gaps. The ANU connection is subject to spark damage which frays the multi-wire cables and burns the banana contacts. This is a chronic problem that became acute when a connecting wire and banana plug set was expelled completely and found in the bottom of the tank. All connecting loops have now been inspected and replaced as needed.

The third possible contributing factor to reduced voltage performance has only been identified in the most recent tank opening. Over many years, oil has been applied to the chains to reduce self charge. Although this is no longer required with the use of conducting tires on the main chain pulleys, the oil legacy remained. Evidence of this oil is that the patch on the terminal opposite the control corona assemble is now only soluble in acetone and not spit, the usual test for SF<sub>6</sub> breakdown products – the historic culprit. All the rings, especially in the high energy end, where the chains are, also had a sticky oily coating. In the last tank opening, all the rings were cleaned with a metal cleaner and lint free wipes used in the auto spray-painting industry. There was not time to also degrease all the spark gaps on the tubes and column. Nevertheless, after the ring cleaning, the machine conditioned to 14.6 MV with tube conditioning only – an improvement over recent experience of sparks un-heralded by any conditioning symptoms.

The 14UD continues to operate well above its nominal limit of 14 MV or 13.67 MV if one invokes the presence of the High Energy foil stripper which reduces by 1/3 the tubes in unit 19. The 14UD continues to be a reliable research tool and is expected to benefit from the suite of upgrades over the next few years.