AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14UD TANK OPENING REPORT No. 36

23rd to 26th August 1982

(4 days open.)

REFERENCES: Earlier Tank Opening Reports are referred to by the notation (12/4) etc, meaning Report No. 12, page 4.

REASON FOR TANK OPENING

PREAMBLE

The 14UD was last closed on 21st July. The condition of all three chains made it an uneasy closure (last report, pages 9 to 11). Two of the chains had the new shiny plating of the type which had previously failed, causing us to replace 90 pellets. Because the first shiny chains became unusable after only 400 hours, we expected to run into trouble fairly quickly. The third chain, installed in March, had existed in gas which we had reason to believe was never clear of breakdown products; moreover, one cracked nylon link had already been found and replaced in it.

Conditioning began at 12.7 MV. This level was soon raised to 13.7 MV without a spark and then the machine went into use at 13 MV. All three chains were in use.

After a day or so it became clear that all was not well; there were both instabilities and sparks to contend with. Quite early we had avoided using Chain 2 (the second shiny chain). When we tried it the machine sparked immediately, followed by another spark at 2 MV. Chain 2 was then turned off. About 10 days after closure the 14UD would not hold volts above 10.8 MV, yet there was no sign of conditioning at this voltage. The experimenters were able to run below 10 MV and did so for 5 days without trouble. The next run needed higher volts and the machine stayed at 12 MV on Chains 1 and 3 for three days; there were occasional sparks, decreasing in frequency. At about this time Chain 1 was turned off, just because it was shiny.

Learning of the plating failure of our first shiny chain N.E.C. immediately sent us a new chain, plated as the earlier versions had been. They said that they were especially sorry that A.N.U., after its long bout of breakdown products problems, should be the one to find the fatal flaw in the new plating process. N.E.C. commented that our order for new chains stipulated that the nylon links should not be chamfered. This requirement, and the timing of our order, meant that they had to use the new pellets. They pointed out that a test chain of the new pellets had been running for 2,000 hours in a small machine where no flaking of the plating had occurred. However, this test could not duplicate the 14UD environment.

We decided to carry on for a while with experimental runs which were within the machine's voltage capability and scheduled a tank opening two weeks ahead.

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During this period, the 14UD exhibited spasms of tantrums, but nevertheless permitted a 6 day non-stop experiment at 12 to 12.6 MV on one chain, with the reservation that it had to be profusely punctuated with sparks.

After the last experimental run ended in the evening before the tank opening, we did some tests on all chains. Under normal operation no current is drawn from the charging and suppressing supplies; however, with Chain 2, these currents, and chain current, jumped every 1.3 seconds (chain rotation period) for only 5 kV inductor volts. For Chain 1, only the chain current was so affected, and then not below 30 kV. These symptoms were what one would expect if the plating on the pellets were flaking.

OPERATIONAL TIME

During the 33 days since the last closure, the 14UD operated for 662 hours. This was 86% of elapsed time, excluding the days for gas transfer.

THE TANK OPENING

Exploratory tour.

When the upper door was opened the smell in the tank was close to being the worst on record and, in view of the recent sparking, this was not surprising. Two large plating flakes were found on the inside threshold at the lower door. About 200 flakes were lying on the bottom of the tank, and on the motors. We examined Chain 1 and found spark damage on the rims of many pellets, with plating beginning to lift. At first glance there seemed to be nothing much worse on Chain 2, but when we continued to turn it by hand we came across a string of pellets from which the plating was literally hanging in tatters, half an inch or more long. These would have touched the inductors as they passed. A great deal of plating had already come off and the pellets were spark damaged, (photograph). Some of the spark shields for Chain 2 were badly pitted. With so many bits of plating in sight we checked the column and began to find flakes of all sizes between the electrodes on the tube and the column posts. Opening the H.E. castings we found flakes in every one. It was quite clear that we were in for one of the major clean-ups that we are driven to every now and then, but, as we said in the last report, (35/12), the column was in need of more than our routine cleaning.

And so to work!

Our first step was to get rid of as many plating flakes as possible before putting in the new chains. We took out the shiny ones, flakes and all, and then opened all the H.E. units and vacuum cleaned inside them and inside the castings. Then, with our usual forced draught of filtered air down through the machine, we blew the entire column with nitrogen. This included an individual squirt at every one of the 2,929 tube and post electrode insulators in the machine, (we have only two live tubes in Unit 19!). After blowing we tacragged the floors and ceilings of the units, and inside all the castings; this was necessary because we found the smaller flakes very hard to dislodge with either a vacuum cleaner or the nitrogen jet.

Next we installed the two replacement non-shiny chains, each of which had been pre-treated by pumping it to micron range with a vacsorb for about 36 hours. We reported doing this recently, (35/7; 35/10). Three people commented

independently that some of the pellets appeared to be as shiny as those which had failed. We swallowed hard, touched wood and crossed our fingers.

Then the new chains in positions 1 and 2 were run and observed. We found no evidence of the mechanical oscillation reported with the shiny chains (35/7; 35/11). The new chain in No. 1 position ran almost perfectly at once and the one in No. 2 position ran almost as well.

Chain No. 3, on which we had survived, was examined with the care that we now apply to all nylon links; four more hairline cracks were found and these pellets were replaced with good, non-shiny spares. These nylon failures are consistent with the enhanced breakdown product level caused by the plating lifting and subsequent instabilities and sparks. When the faulty links were examined on the bench between two high-intensity, narrow beam light pipes, (much as the older author used to "candle" eggs when he stayed on a farm more than half a century ago), the faint cracks could be seen very easily. Nothing but admiration is felt by both authors for the technique and acute perception of Alan Cooper and Howard Wallace who, working in parallel, discover the minute cracks when examining the chains in situ. A new craft is emerging and significant additional time must be devoted to it at each tank opening until we have established that our gas has been rid of breakdown products.

It is clear that our present activated alumina dryer/purifier system cannot keep up with breakdown product evolution in a sick or highly stressed situation. We are requesting funds for the duplication of our present recirculator system and invite suggestions as to what to put in the second "dryer" tower.

Foils

No foils were changed at this opening.

Points

Two instances of drooped assemblies were corrected and it was noted that tube points especially, are becoming dull.

Idlers

No loose shafts were found; one bearing was thought to be a little noisy, but it was not changed. Two slightly worn tyres were left in.

Superconducting resonator

The resonator received from Applied Superconductivity has reproduced all its performance tests here. During this tank opening it was installed in front of the switching magnet. We are planning on providing 100-200 psec pulses on the ±15 degree lines. The room temperature pulsing apparatus continues in ordinary use producing nanosecond pulses at 26.7 and 53.2 nsec separation. Work continues on a phase detector employing a quarter wave resonator.

Miscellaneous

While the tank was open we took the opportunity to renew some seals at the

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gas recirculator because of leaks and as a test case for a reliable sealing technique. The first attempt using Bestobell J55 gasket material, with Dixon's graphite sealant, was not successful. Heroic last minute efforts using Loctite 515, with no gasket material, was a complete success. The baffle in the re-circulator was shortened by 1/16 inch to accommodate the loss of length due to removal of the gasket. It is possible that the baffle may have prevented adequate compression of the gasket as originally assembled.

Nylon cable ties in the terminal, and bottom of the tank, were wrenched to test their brittleness; they were quite strong, but were deliberately broken, then replaced.

Unhappy with the failure of our chemists to tell us what our brown and green deposits were (35/9), we scraped deposits off some more tube and column points, and off the terminal, and intend to try them in a residual gas analyzer. To confirm that the brown terminal stain was not oil related we performed a drip test with three solvents. A drop of chlorothene N.U., one of water and one of oral fluid were caused to traverse the stain. The chlorothene N.U. had no effect while the water exhibited dissolving power; the third substance, possibly because it moved more slowly due to its viscosity, was the most efficacious, proving again our sophistication with wet chemistry.

We said, (35/8), that we intended to leave some nylon cable ties in vacuum for a month or more to observe the effect of drying out in an atmosphere free from SF_6 and breakdown products. On 9th August a number of medium size ties were put on round bars at normal tension in a chamber with a window. They have been under high vacuum now for 25 days and none have broken. We have not yet opened the vessel and tried twisting the cable tie locks.

Cleaning

In spite of the prodigious cleaning mentioned at the start of "And so to work", yet again we went over the entire column with nitrogen jet and tacrags. Our students can be very valiant when valour is indeed needed.

Button-up

Charging and metering tests went excellently, and the 14UD was closed.

Initial performance

The machine went easily to 13.2 MV before the onset of conditioning, then a little later to 13.4 MV. It went into use for a week at the experimenter's requirement of 10 to 11 MV. Then after a successful run at 12 MV with an occasional hour at 13.2 MV, the machine ran steadily at 13.73 MV with an occasional spark to preserve its independence.

D.C. Weisser

T.A. Brinkley

6 September 1982.

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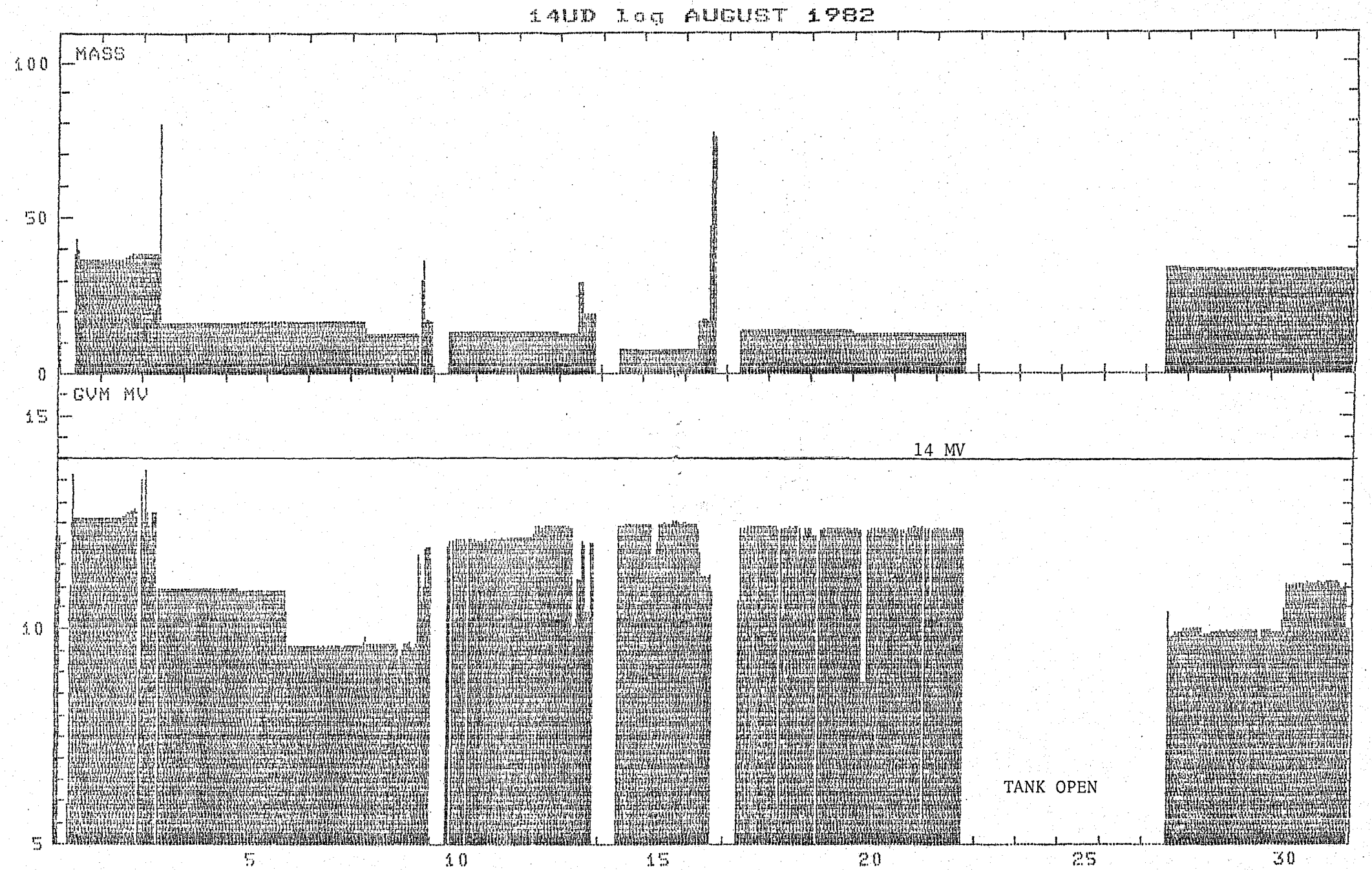
Enclosures:

Plot of particle masses accelerated, and operating terminal voltages.

NOTE: On the plot of terminal voltages we have drawn a horizontal line at 14 MV for easy reference to performance near the nominal voltage limit of the 14UD.

Photographs:

Failure of plating on shiny pellets of Chain 2.


14UD log AUGUST 1982
MASS
100
50
0
GVM MV
15
14 MV
10
5
TANK OPEN
5
10
15
20
25
30