AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14UD TANK OPENING REPORT No. 58

Two Openings.

7th to 9th April 1987 (3 days open)
25th to 28 May 1987 (4 days open)

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REFERENCES: Earlier Tank Opening Reports are referred to by the notation (38/4) etc., meaning Report No. 38, page 4.
A glossary of terms and abbreviations is given at the end of the report.

Reason for the first tank opening:

There were charging efficiency problems with Chain 2 and about 60μA lost charge. The tank cup was operating erratically and in danger of becoming stuck. We were low on foils. Also, the younger author was wandering about the United States, on his way to the Berlin Conference, and we felt like having a bit of fun on our own.

Preamble.

The 14UD was last closed on 26th February. It ran well for a while, then we began to notice negative self-charge on Chains 1 and 2. Early in March Chain 2 exhibited charging troubles. The current fluctuated by about $\pm$15% and the up and down pick-off traces had different characteristics which could have been due to irregular doubling in the terminal. We hypothesized that the reduced chain tension set in the chain during the last tank opening increased the distance between the d.c. idlers and chains while running. At the end of March, voltage instabilities and about 30μA of lost charge led us to open the machine.

Operational time.

During the 40 days since the last closure, the 14UD operated for 666 hours. This was 71% of elapsed time, excluding the days for gas transfer (42/2).

The Tank Opening

Exploratory Tour

The machine was very clean inside. The rings at units near the terminal were more gritty than others, but it was hard to believe that they were bad enough to have caused lost charge. The triode mushroom was free of particulate matter and the tank wall surrounding the triode port was clean.

In the terminal, the inductors and insulators were all clean. Two d.c. idlers were not in firm contact with the pellets; one of these was on Chain 2, the troublesome one.

The corona point assemblies, on both tube and column, were clean and were visually determined to be well set.

The perspex shaft section in Unit 17 had a form of snail track extending 3 to 4 inches upwards from the bottom. The mark had less fine structure than characteristic snail tracks and more resembled the 'rivers' of which we have spoken earlier, (11/6; 13.2; 50/6). The shaft section in the unit below had not so much a river as a mighty Mississippi from top to bottom, the track being half to three quarters of an inch wide, again without the fine structure of traditional snail tracks. We find it curious that these rivers meander, like their fluid counterparts, from side to side and by no means suggest a direct discharge across the length of the shaft. These shafts have only operated for 1,200 hours since their surfaces were skimmed to remove previous snail tracking, (56/4,5). It would seem that the steps taken were not entirely effective.

And so to work!

Charging system

Chains:

All the terminal insulators were tested with a high voltage insulation tester to discover if there was a recurrence of the failures reported (43/5,6; 44/3,4), but they were all in good condition.

Idlers:

All the d.c. idlers were given new contact springs and reset more closely to their chains after noticing that, when turned by hand, the chains barely turned the idlers. With the chains running, they were strobed and it was found that they were not getting up to speed. They were re-adjusted so that they ran at full speed when the chains were on.

Strippers.

Foils:

The foils in the terminal stripper were renewed. Unfortunately, no correlation of use or breakage with foil preparation techniques was noted.

The column

Posts.

Four reconditioned posts were put in Unit 17.

Insulating gas

Moisture measurement of the SF6 before the tank opening showed 40 ppm, even after reactivating the alumina in the small dryer which had been last replaced when the large dryer was first put into use in February 1984. Assuming that the lost charge with which we had been troubled was due to wet gas, we suspected the alumina in the large dryer because it had never been changed, so we put a new load in.

Tank cup.

A filter was put in the SF6 gas line to the tank cup to remove particulate matter which, it was believed, might be causing clogging of the capillary tube through which the pneumatic actuator is operated. No further trouble was experienced.

Cleaning

The column was blown with nitrogen and tacragged.

Button-up

During the charging tests prior to button-up we were puzzled by the charging current for Chain 1 dropping by 30%, from 17μA to 12, when charging volts were increased from 4 to 5 kV. The entire inductor system in the bottom of the tank took 10kV without chains running, and Chains 2 and 3 performed normally. We opened the terminal again and checked the d.c. idlers and inductors, but could find nothing wrong. The tests were repeated, giving the same results. Pressed for time, and not having the least idea what to do next, we decided to close the machine in the devout hope that all would be well when it was gassed up.

Initial performance

Once the gas was in we ran up volts. The performance of Chain 1 was normal and we congratulated ourselves on our intelligent and rational decision to button up.

A moisture measurement on the gas still read 40 ppm, but the lost charge had vanished; this suggests an error in the moisture measurement, but no convincing explanation for the appearance and disappearance of the lost charge.

There were no voltage problems either, and with the lost charge gone, the 14UD ran well at above 13 MV for as long as it was needed.

A happy, stable run was carried out at 2.6 MV by our cheerful alpha particle enthusiasts, who never seem to experience trouble with the accelerator. This was followed by an almost equally happy stable run at 13.6 MV. We felt that all was going nicely until, on 30th April, a very familiar noise, audible in the control room, told us that a bearing on the lower shaft was just about to fail completely. We turned the shaft off and ran without it, scheduling an opening at the end of the current schedule.

The Second Opening.

Exploratory Tour.

The L.E. column was fairly clean, but the H.E. was dusty, probably due to the new alumina put in at the time of the first opening. A considerable amount of oil lay on the floor of the tank; we attributed this to siphoning from overfilled oiler reservoirs. Nothing was seen to be wrong in the machine and we began work.

Charging system.

We did a charging test to see if Chain 1 still suffered from the charging problem, noticed at the last button-up, which vanished when the gas was put in; the effect was still there. Checking the inductors and insulators in the terminal, we found that they were well set and withstood a 10 kV test. In the bottom of the tank, also, everything looked well; however, when charging and suppression volts were turned on, without the chains running, there was breakdown at only 6 kV from the shimstock contact band to the suppression inductor of Chain 1. This test, last time, went to 10 kV in air without breakdown. We realized that the problem could be due to slightly jagged and bowed shimstock and that, previously, by chance, the bad spot was well away from the inductors. We made no attempt to correct the shimstock.

Shafts.

All the H.E. shaft bearings were renewed; the ones taken out had been in since May 1984 and had operated for 15,200 hours, their predicted lifetime.

For some time we have intended to discontinue use of the heater plates at each casting. For one thing, we believe that they do little good, and, for another, we are planning to remove them altogether and increase the effective length of the tube; (see paragraph below on compressed geometry). We took the opportunity, while the bearings were being changed, to remove the stators and magnets from all the casting alternators, with the exception of Unit 19, where power is required for the pump at the second stripper. We also left the alternator in Unit 18 so that we could interchange it with the essential one in Unit 19 in the event of its failure.

While we were in a clean-up mood, we removed all the heater transformers from the H.E. castings and took the feeder straps off the heater plates. When the shafts were tested, without the alternators, we were overjoyed at how quietly they ran. It was well worth the trouble and we recommend it to everyone.

The perspex shaft section in Unit 18, reported above as marked with a wide 'river', appeared not to have worsened. It was inspected for stress with polarized light, as were other unmarked shafts. There was no obvious correlation between the stress pattern and the rivers. The "rivered" shaft was one of those skimmed earlier to remove snail tracks, (56/4,5).

Posts.

Four reconditioned posts were put in Unit 18, in accordance with our plan to recondition them all, (52/4). We have replaced 24 posts so far; including 8 brand new ones were put in units 10 and 15 after we had removed the end caps and carried out our bonding procedure on the posts, (51/2; 52/4; 55/3)

Buttonup.

The machine was closed after cleaning, leaving the defect on Chain 1 driving pulley because we were not prepared to spend time replacing shimstock when we had experience of the fault disappearing with gas up.

Initial performance

There were 7 terminal sparks up to 12.5 MV within the first hour of running. As there were no conditioning precursors, the sparks were attributed to dust disturbed by the clean up.

While monitoring these events, we noted 330 Hz x-ray activity caused by the L.E. midsection sublimer. Turning off the sublimer reduced the x-ray rate by a factor of 10. We wondered if these x-rays were a source of the lost charge seen in the past few months. The electron suppression the midsection must have failed.

Compressed Geometry Tubes.

Compressed geometry tubes will be installed in the 14UD in two stages. Units 1 to 4 will have their heater plates removed and an eight gap tube installed at Casting 1 and Casting 3. The electrode configuration and preparation for these four units have been designed in consultation with Charles Jones at O.R.N.L. and Robert Rathmell at N.E.C. The new eight gap tubes, and replacement electrodes for each end of our existing tubes, will be manufactured by N.E.C. The new electrodes will be inserted at A.N.U. instead of sending the tubes to N.E.C. for a full refurbishment.

The remainder of the tube will be upgraded with compressed geometry components in November. The exact details of electrode design will be decided after evaluation of the exercise with the first four units.

Terminal voltage stability.

While at Chalk River, two months ago, the younger author swapped problems and solutions in regard to terminal voltage stability with Dowdall O'Dakre. The discussion led to considering the troubles that can arise from common mode signals in coaxial cables.

The terminal voltage measuring and stabilizing units on the control console of the A.N.U. 14UD, receive a signal from the GVM by a coaxial cable which is about 63 metres long.

We measured the common mode signals which appear at the output of the cable and found that they could lead to errors of about one part in 1000 in terminal voltage. The components of the signal were frequencies of both 50 Hz and 150 Hz from single and three phase sources of mains noise which operate randomly within sensing range of the coaxial cable and GVM electrodes.

In an attempt to improve our situation, Doug Stewart approached the problem by taking a proportion of the common mode signal and applying it to the positive input of the charge amplifier for the GVM, causing a null in the spurious component. As a result, the common mode signal was attenuated by 100 db, reducing this contribution to terminal voltage measurement uncertainty to about one part in 10^5. We chose to retain the preamplifier in the control room, even though this results in the cable capacitance contributing half of the input capacity. Thus temperature induced capacitance changes could lead to GVM readout errors. We would rather accept these than suffer spark damaged preamps.

A.N.U.
1st June 1987

Enclosures
Plots 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.

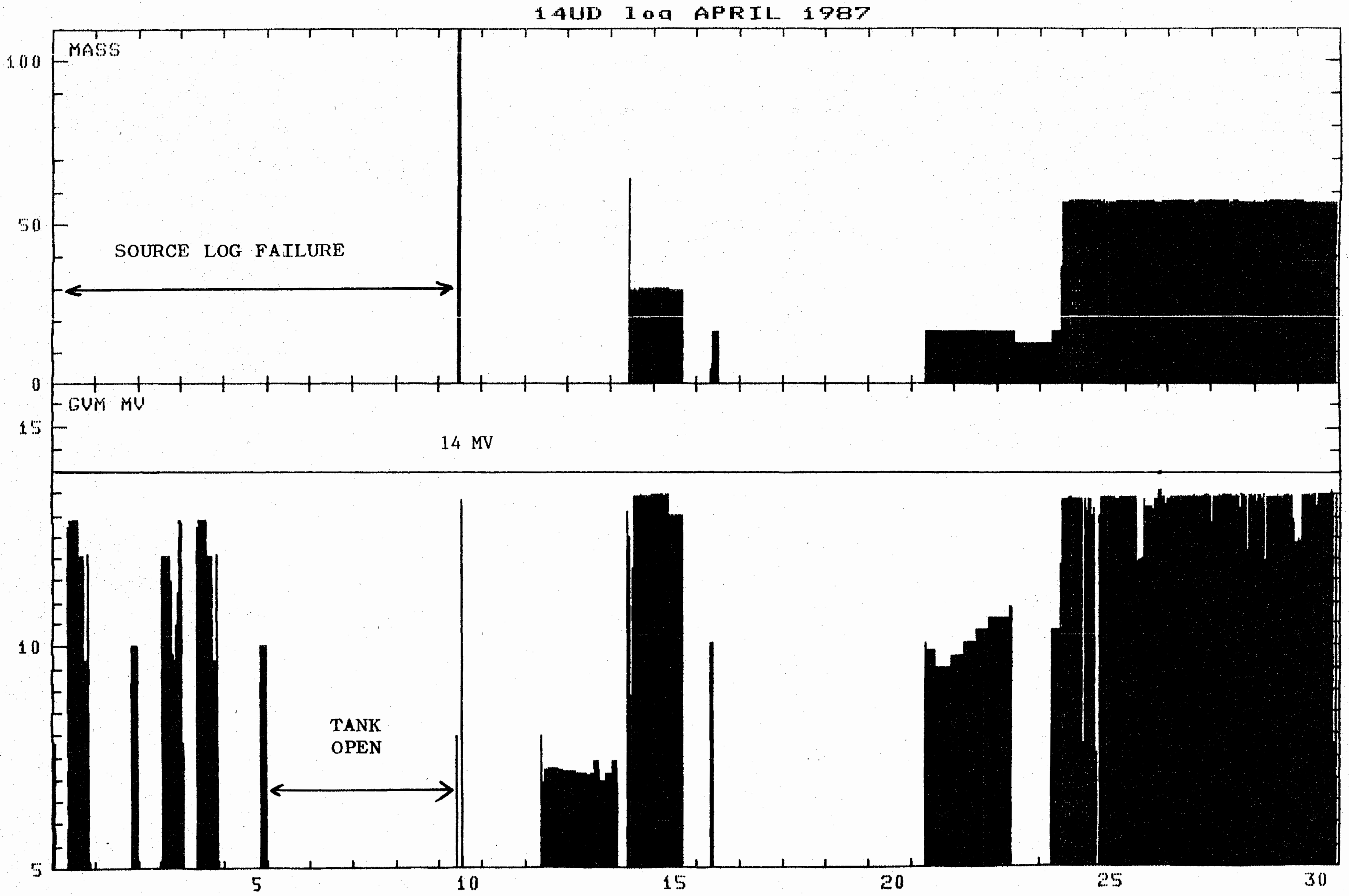
Glossary of terms and abbreviations:

The order in which an accelerated particle passes positions in the machine is used to number them, thus Unit 1 is the first unit and units 14 and 15 are each side of the terminal, Unit 28 is the last. Tube electrode 19/2/7 is Unit 19, tube section 2 and electrode 7.

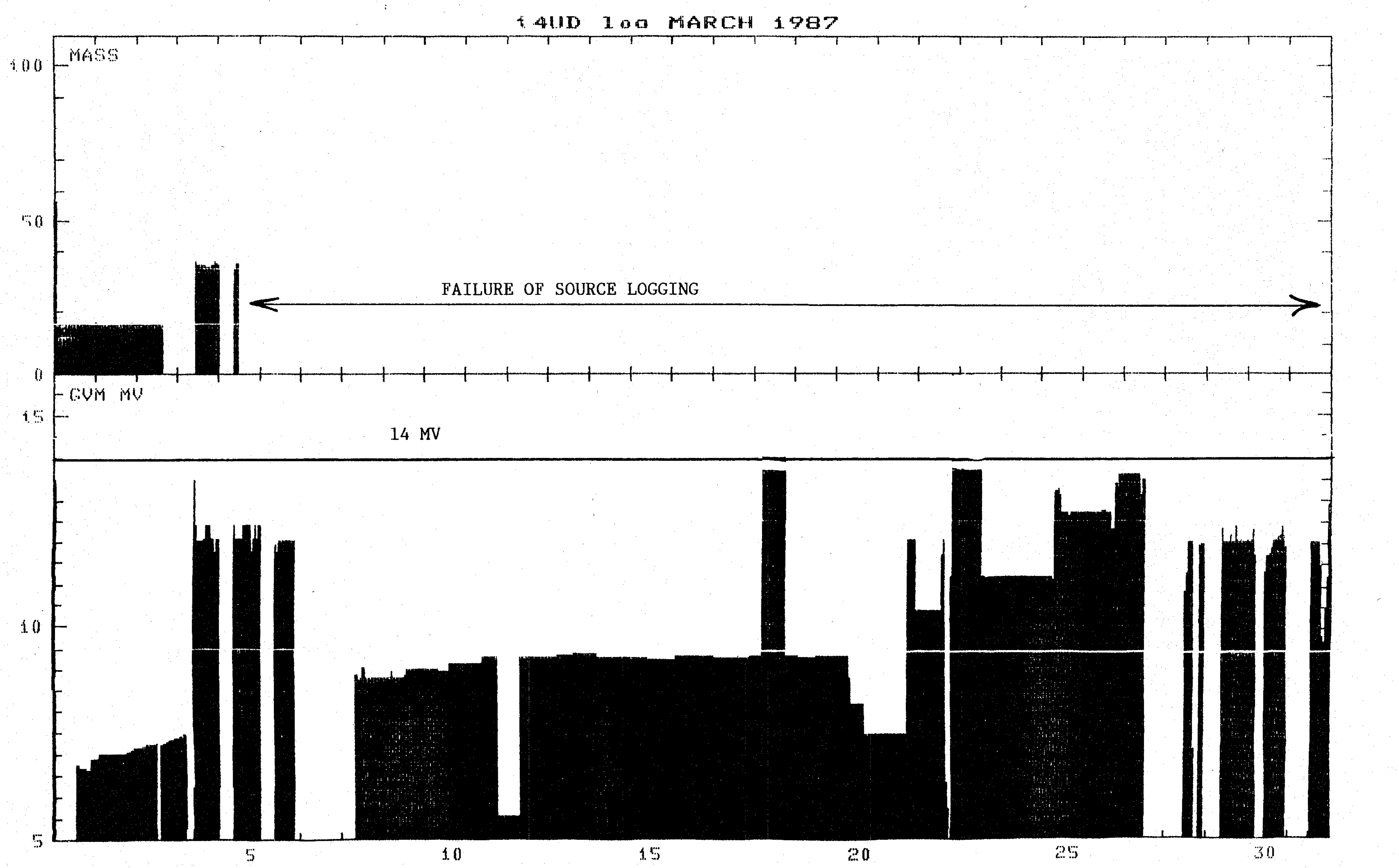
- BDP or bdp - breakdown products.
- Conductivity cell - the breakdown product detector described 37/10.
- Vivalyme - assumed to be soda lime, $CaO + NaOH$

Operational time: We subtract tank opening time from elapsed time and quote the percentage of the remainder that the machine has volts on terminal. Sometimes, when the source is down, the column is voltage conditioned, leading to an overestimate. Comparison of the source and terminal plots shows that the difference is rarely noticeable.

Finally, to avoid confusion, David Weisser and the older author often eat lunch together.



14UD log APRIL 1987
MASS
100
50
0
SOURCE LOG FAILURE
GVM MV
15
14 MV
10
5
TANK
OPEN
5
10
15
20
25
30


14UD log MARCH 1987
MASS
100
50
0
FAILURE OF SOURCE LOGGING
GVM MV
15
14 MV
10
5
5
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20
25
30