AUSTRALIAN NATIONAL UNIVERSITY
DEPARTMENT OF NUCLEAR PHYSICS
14UD TANK OPENING REPORT No. 51

Two Openings.

25th November to 6th. December 1985
(11 days open; 9 working days)

Re-entry
10th December 1985
1 day open.

REFERENCES: Earlier Tank Opening Reports are referred to by the notation (38/4) etc, meaning Report No. 38, page 4.

REASON FOR THE FIRST TANK OPENING

We ran out of foils. It was about time we went in again, anyway, since the machine had run for 15 weeks and was scheduled for maintenance on 28th November.

PREAMBLE

The 14UD was last closed on 8th August with only the lower shaft operational. The charred perspex shaft sections, discovered in both shafts, (50/5) all had to be taken out and good sections from the upper shaft were borrowed to maintain the lower one in service because of the critical functions for which it provides power. An order was immediately placed with N.E.C. for 28 perspex bars which we, ourselves, would machine according to an N.E.C. drawing.

The accelerator performed well at startup. After a few days of low to middle voltage operation it was required at voltages above 13 MV, the only problem being a faulty control on the terminal lens X. Conductivity measurements were made on the gas at irregular intervals. The most recent, on 14th November, showed a dewpoint of better than -70 deg. C (less than 3 p.p.m.). The conductivity cell showed no significant response in 27 minutes, about as good as we have ever measured. The present load of Vivalyme has been exposed to significantly more microamp hours of b.d.p. generation than its predicted lifetime.

In preparation for the next opening, the new terminal stripper (50/4) was put on a spare beam line (simply because this was somewhere convenient to test it under vacuum) and set to operate automatically 12 times per minute for 60 hours in each direction. There were no jams or failures and the device therefore operated over 21,000 times in each direction. This was without foil frames; we had no spare foil chain and intended to put the chain then in the terminal stripper in the new device.

The perspex bars arrived promptly from N.E.C. Work was begun on them in our main workshop straight away in order to have the new shaft sections ready for fitting at the next tank opening.

Four new column posts arrived and it was also planned to put these in place of those operating with shorted ceramics. We were still

concerned about the findings from the younger author's Post Mortem (49/9) which had revealed a great deal of electrical activity between the surfaces of the aluminium flanges at the ends of the posts and the first titanium electrodes. The spark erosion was due to the fact that contact relied entirely on mechanical pressure between the two components. To correct this problem Alan Cooper suggested bonding the adjacent surfaces with silver loaded araldite. To get a feel for the validity of the idea he removed the flange of one of our damaged posts, blasted the two surfaces with glass beads, made a bond and cured it for 24 hours. Cooper tested his bond by discharging a 1 microfarad capacitor, charged to 10 kV, 21 times through the joint. The joint was then broken apart and no apparent damage was found. We decided to employ these bonds on the four new posts which we had in readiness for installation.

When the flanges on the new posts were removed in order to effect the bonding, sand and swarf were found in the cavities at both ends of all four posts. Cooper bonded the new posts in the same way as his original trials: first shot blasting the contacting surfaces, then painting them with a mixture of equal quantities of A500R Mattheylec resin and A500H Mattheylec hardener, the material being described as 'thermosetting silver cement which is an araldite based preparation'.

Meanwhile, things begin to tell after three month's operation and in mid November the Chain 3 pickoff trace indicated that there was no downcharge. The stripper situation became critical when a group prospected for more foils until, without them realizing it, the foil changing mechanism jammed. After 500 foil operations they gave up. By 19th November we decided to bring ahead the pre-Christmas tank opening which we always organize so that a nice, troublefree machine just might spread a little peace and goodwill around the place throughout the merry, festive season, or, if that should be too much to hope for, then at least during the Christmas barbecue.

OPERATIONAL TIME.

During the 106 days since the last closure, the 14UD operated for 1,870 hours. This was 74.9% of elapsed time, excluding the days for gas transfer (42/2).

THE TANK OPENING.

No first sniffs by reliable assessors have been made during recent tank openings, but on this occasion the older author opened the first door and inhaled deeply. He pronounced that the atmosphere inside was pleasant and invited a watcher standing nearby to sample it for himself. The invitation was declined in a way that was almost ungracious.

Exploratory tour.

The rings were much less gritty than they had been in the past two openings. The stain on the terminal, probably as a result of 15 weeks accumulation, was thick and dark coloured. Hygroscopic, as usual, it had taken up water to the extent that large areas of stain could be slid

about on a film of moisture. There was a distinct brown stain on the triode mushroom and on the wall of the tank surrounding the triode port. In the lower terminal, 3 of the 12 contact springs on d.c. idlers were missing; the two on Chain 2 were too short.

The fault in the terminal lens control was traced to damage to a nylon gear wheel which drives the control rod readout. The gear had lost mass, becoming smaller across one diameter than the orthogonal one. Presumably this is due to the dry SF6 and b.d.p. erosion.

And so to work!

THE COLUMN.

Shafts.

New shaft sections were fitted throughout the L.E. column, though renewal of the perspex was not straightforward in all cases; individual tailoring was necessary for some flanges.

Posts.

Two of the four new posts were put in Unit 14 and one was put in each of Units 12 and 18. There is now only one shorted column insulator in the 14UD. The copper-sheathed hose clamps employed to short column elements, still showed some evidence of spark damage. (Daresbury, please note: we copied the hose clamps from you (48/4); sparking continued so we put copper under the clamps. There is still spark damage, but not as bad as without the copper).

CHARGING SYSTEM:

Chains:

A thorough inspection of all nylon links in the three chains was carried out in situ. No cracks were found in Chains 1 and 3, which have operated for 10,127 and 4,147 hours respectively. In Chain 2 three cracks were found. It was taken out of the machine in order to examine the links from all sides after every link had been wiped clean. A further 5 cracks were discovered, all 8 being in a machining mark at the shoulder where the link diameter begins to change. The cracked links were removed and 7 new links put in, thereby shortening the chain by one link. This is our last chain with obsolete link shapes; it has achieved almost 15,000 hours of troublefree performance, 5,774 hours of which it existed in SF6 breakdown products. That it has come second to the 16,666 hours of our so far best chain is taken as a victory.

Because we have learnt the folly of leaving chain tests until close to buttonup, we ran the chains without volts and studied their individual behaviours from the platform. Chain 1 ran beautifully; Chain 2 was 'acceptable', and Chain 3 had wobbles of a quarter of an inch in the stiff direction between Units 16 and 19. We tried a few things such as hand oiling, adjusting d.c. idlers, changing tension etc without gaining an improvement. We then put a dial gauge on the top and bottom pulleys for all chains, measuring on the inside of the tyre where the

chain runs and also on the outside faces of the pulleys. The pulleys for Chain 3 ran nearly perfectly, whereas the others showed irregularities. Confronted with a perfectly running chain on irregular pulleys and a wobbling chain on perfect pulleys we decided that the best diagnostic we could make would be to interchange Chains 1 and 3 to see if the wobble followed the chain or the transport. After the interchange, the chain in the perfect position ran less perfectly and the chain in the wobbling position didn't wobble as much. We haven't the faintest idea what this signified, but we were glad we did it, because otherwise we would always have wondered what would have happened.

Idlers:

The contact springs on the charging d.c. idler for Chain 3 were too short; presumably this accounted for the problems with insufficient downcharge.

Strippers:

The terminal stripper was taken out. Its foil clips were removed from its chain and crimped onto new chain in the new changer. We did not use a vapour degreaser in order to avoid the formation of acids known to occur in this process, giving rise to corrosion of devices cleaned in that way. The entire system was boiled in an aqueous solution of RBS25 for about an hour, then washed thoroughly with water and dried by heat lamp. This well-considered, zealous cleaning caused rust on the bearings and made the chain substantially stiffer anyway, negating our 42,000 test operations with an uncleaned chain and no constricting foil clips as mentioned in the preamble.

We had trouble in getting the terminal foil actuator to work reliably. Eventually a spiral from another actuator was put in as the best thing we could do at the time. It was necessary to "jiggle" the actuator by giving it a brief pulse in the reverse direction before making it go forward, a variation on methods we have used successfully in the past when in trouble.

Points.

Tube and column points were checked for anything obviously wrong; one case of a faulty column assembly was the only thing we noticed.

Button-up.

The doors were closed at 1.30 p.m.. The usual 12 hours or so of pumping on the tank overnight was curtailed to 4 hours, then gassing up began late in the afternoon.

Initial performance.

When the gas pressure reached 30 p.s.i.a. terminal volts were run

up. The machine sparked at 4.5 MV for this pressure, which should have been sufficient for 6 MV. Further tests indicated an overall low threshold limited by ticks and sparks in the H.E. end. Two hours of juggling shorting rods failed to isolate a problem to any one unit, but turned the juggler's legs to jelly because of all the stairs.

When fully gassed up, however, the machine improved and an experiment began at 10.5 MV, moving to 11 MV after a few hours. During the evening of Sunday, 8th December, the terminal foil changer refused to operate and the experiment was abandoned. The next day, having no alternative, we took out the gas and opened the tank.

The Re-entry.

We found nothing on the column to explain the sparking at relatively low voltages. The chains were examined to see if there was anything to account for the poor trace seen on the down side of Chain 2. There were some sharp burrs on the heads of removable link screws caused by allen keys; these were smoothed off.

The terminal foil pneumatic actuator had jammed. It was taken out and the "scroll" which provides the two-way action was changed for the one in use up until December. In addition, the piston seal was changed from an O-ring to a square section seal. By including the best bits and pieces from two actuators, we eventually contrived one which was very reliable in the forward direction and useless in reverse.

A brief charging test was made by running all three chains together at 7 kV; charging currents were all good and both traces for each chain clean. The machine was closed at least an hour before the start of the departmental Christmas barbecue.

THE RESONATOR

On Friday, 13th December 1985, we finally tested our first coaxial quarterwave resonator at liquid helium temperature. This, our firstborn, has suffered a traumatic life. Its stubs to plate and plate to can welds were found to be porous after the first lead plating. It was replated, with unaesthetic results, on 25th July. Since then the resonator has kicked around, spending weeks in indifferent atmospheres with intermittent protectve flow of liquid nitrogen. To counter these and other evils, it was gas discharge treated with CO2 to oxidize carbon in the plating and hydrogen to reduce oxides. We are very encouraged, given its history, that its low field Q is 6 to 9 x 10 . (If I forget to type the exponent in, then it's +7, i.e. 6E+07 to 9E+07. T.A.B.)

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The year's performance.

It was a poor year for the 14UD. The discovery of cracked post ceramics, leading to lengthy searches and examinations, caused a 3 week opening with a flow on to a later one. During February and March the tank was open for a total of 5 weeks.

In all, there were 9 tank openings, including re-entries, varying in duration between 1 and 21 days. From 1st January to the button-up of this opening, the 14UD operated for 4,589 hours. It was open for a total of 62 days; allowing 2 days gas transfer time for each opening, and discounting the 4 days at Easter when the tank remained closed, but not gassed up, then the accelerator operated for 67% of elapsed time. These openings were covered by the four Tank Opening Reports, 49 to 51.

We send our best wishes for Christmas and a happy and successful New Year to all of you in the laboratories which receive these reports.

D. C. Weisser.

T. A. Brinkley

16th December 1985.

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.

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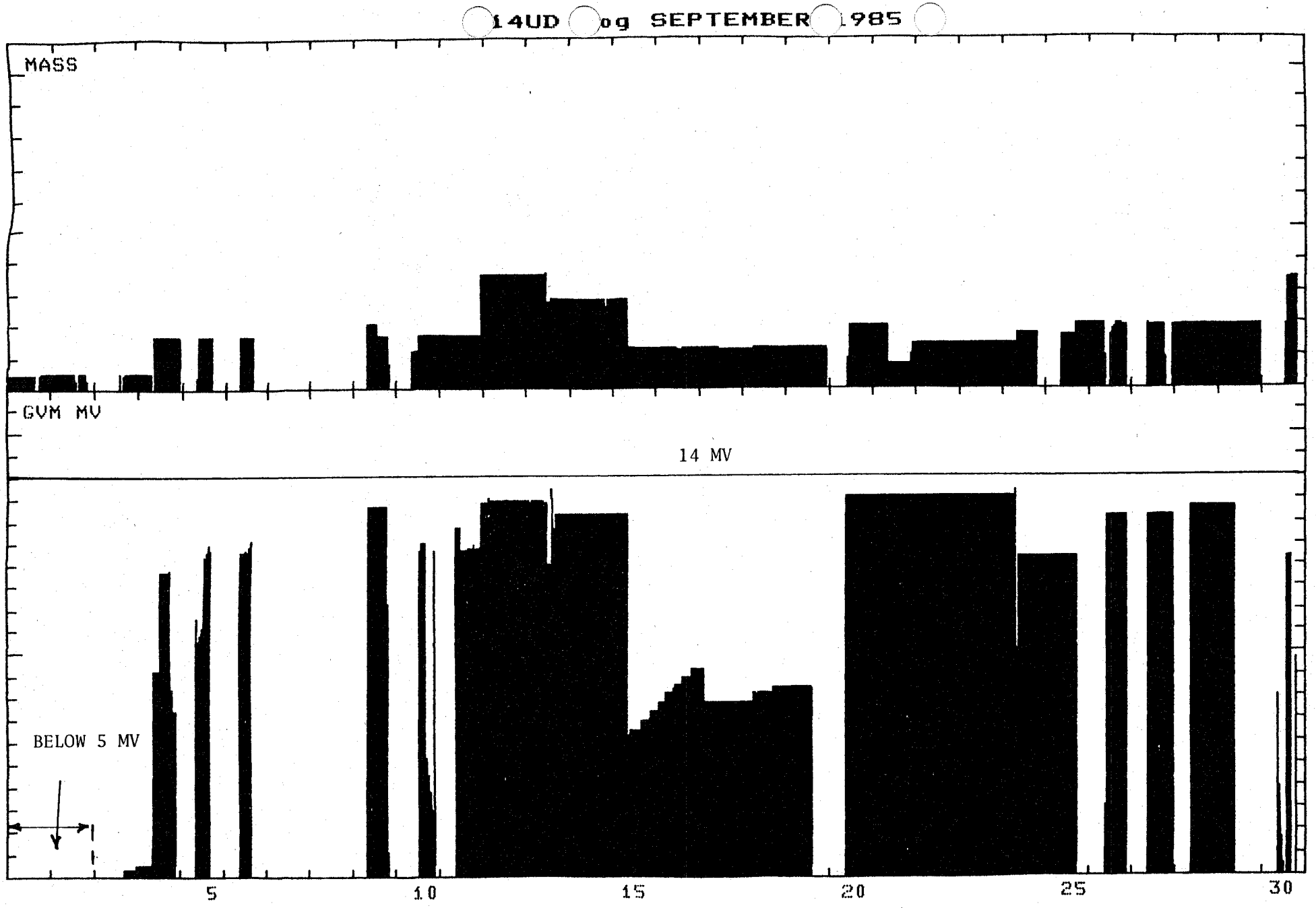
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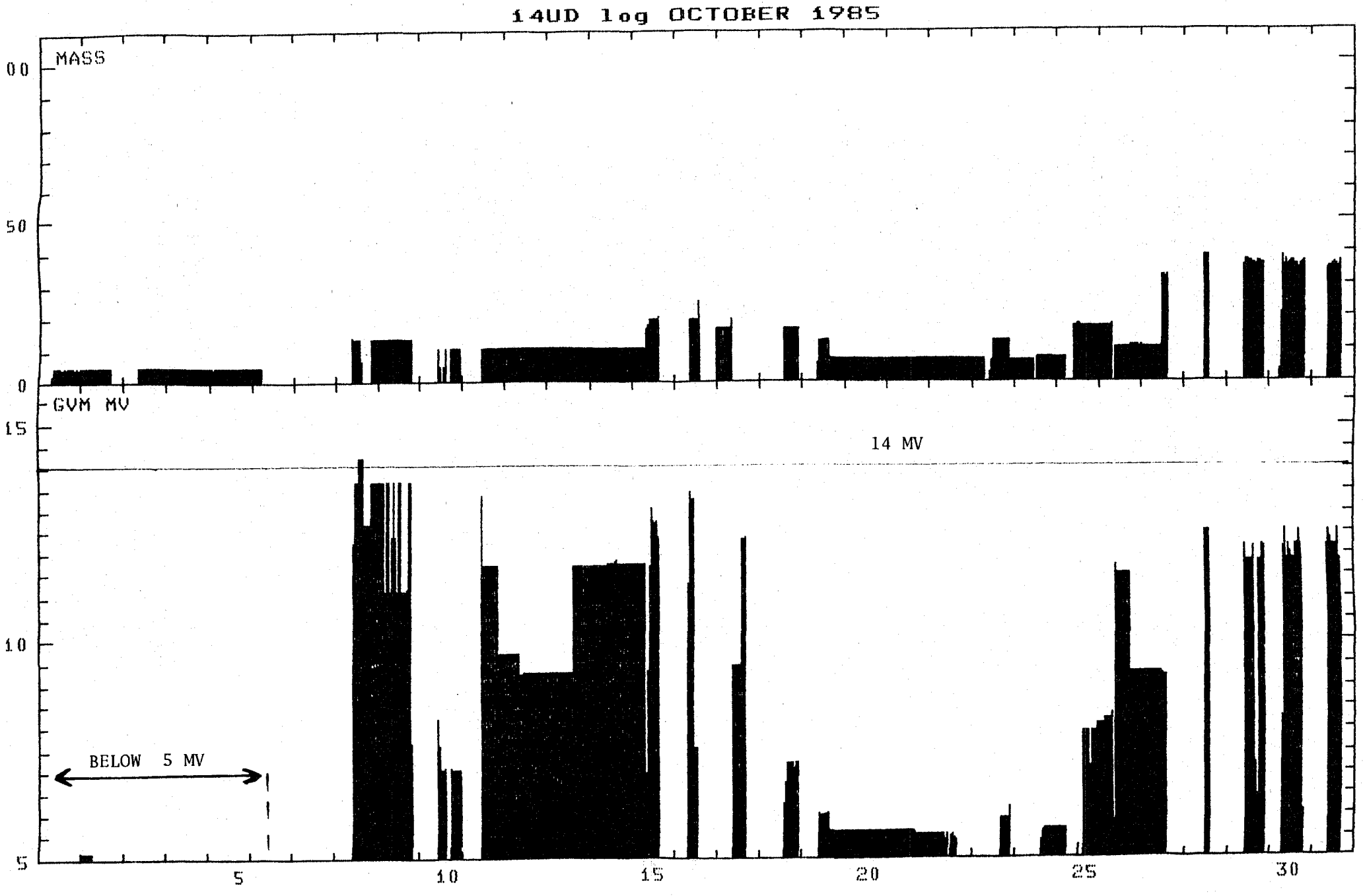
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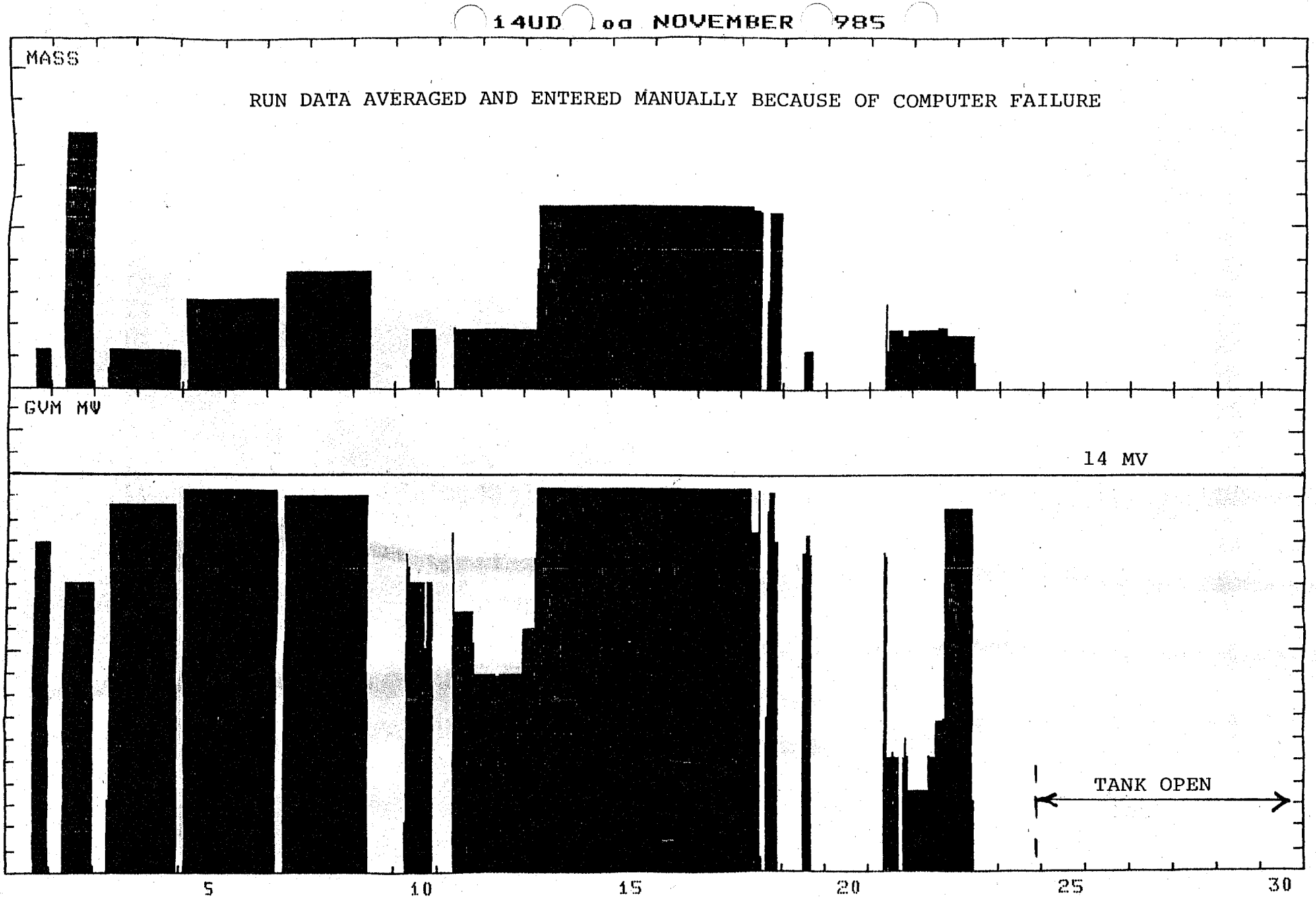
14UD oo NOVEMBER 985
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RUN DATA AVERAGED AND ENTERED MANUALLY BECAUSE OF COMPUTER FAILURE
GVM MV
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TANK OPEN
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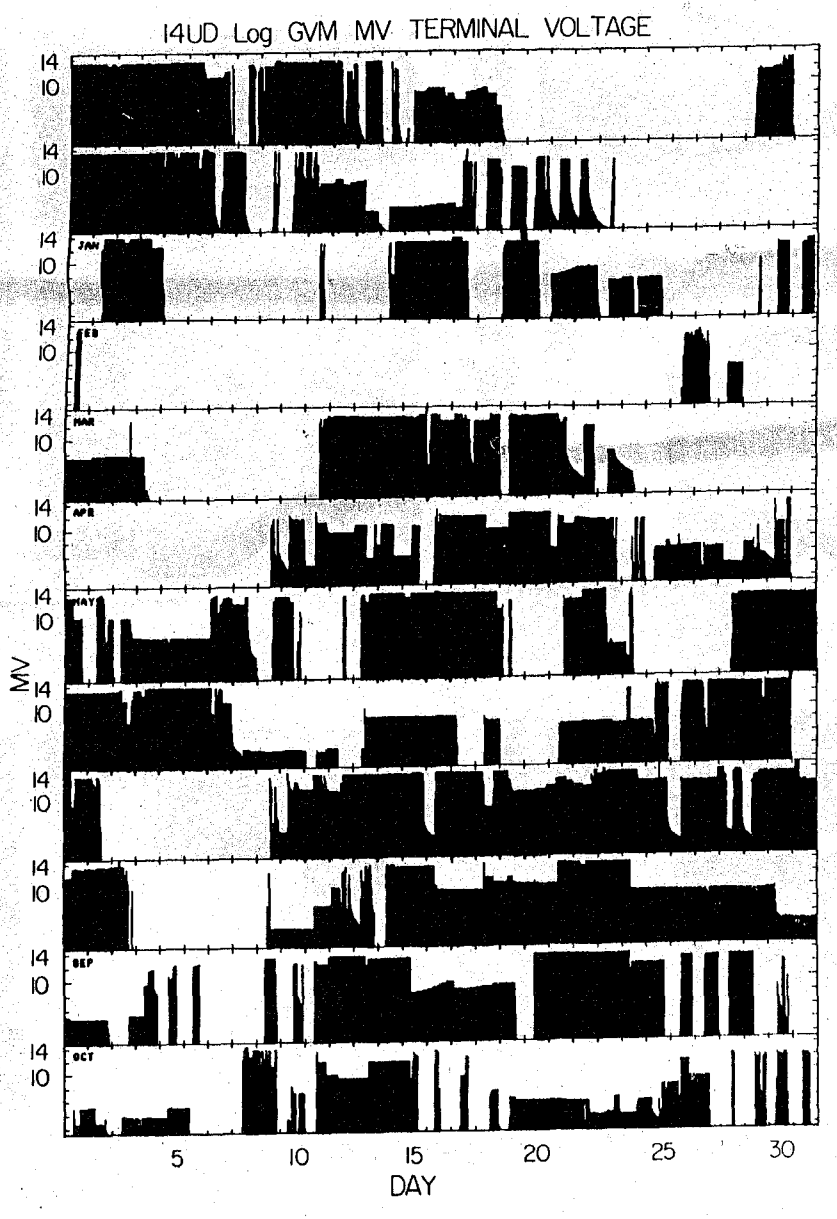
TERMINAL VOLTAGE: NOVEMBER 1984 to OCTOBER 1985

By the month



For the year