AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14UD TANK OPENING REPORT NO.46

23rd to 28th August 1984

(6 days open; 4 working days)

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

REASON FOR TANK OPENING

The opening was scheduled to change foils. In addition, we prefer not to let closures extend beyond three months without an overall checkup inside the tank, particularly regarding the condition of the chain links.

PREAMBLE

The 14UD was last closed on 18th May. Immediately following this closure, ion source troubles (45/3) kept the machine off the air for a day or so; then it went into service at about 13 MV. As is shown in the monthly plots at the end of the report, June was a fairly full month of high voltage running, with periods at 14 MV.

In the middle of July we began to see high lost charge. For a few hours during a group change the chains had been off; when they were turned on again the lost charge appeared. Previous experiences with this phenomenon have implied presence of breakdown products; these have serious consequences for the chains, therefore we looked very carefully into the condition of our gas. Moisture was less than 2 p.p.m. and the conductivity cell showed a rate of less than 10 kilohms/hr, which we accepted as clean.

All this happened on a Friday and, in view of the moisture and conductivity measurements, we continued operation. By the following Tuesday the lost charge had decreased from 70 microamps at 13 MV to 56 for the same voltage. The Vivalyme in the new, larger purifier (fully described (43/7) was changed without apparent effect. We then reactivated the alumina in the small system; this, in turn, exhibited no noticeable consequences. After 5 more days of almost continuous machine operation, the lost charge had fallen to 17.5 microamps. A log plot yielded a self-induced cleanup rate of 0.24 day^{-1}.

As always (or almost always), the lost charge for a given terminal voltage changed with the position of the stabilizing triode needles. At 13 MV, lost charge was 55 microamps when the needle current was 26 microamps. The lost charge increased to 67 microamps when the needle current was reduced to 9 microamps.

For the next four weeks a variety of observations were made, correlating lost charge with terminal volts, triode current, corona currents, the conductivity cell, the chain pickoff waveforms and the signs of the zodiac.

David Weisser attended the R.F. Superconductivity workshop at CERN during July. While he was there he met Oscar Sala, from Sao Paulo, and they discussed lost charge and fuzzballs (40/8). In Sao Paulo they detect d.c. current from the terminal to the capacitive pickoff as an offset voltage, rather than as an absolute value measured on a picoammeter. They attribute this current to breakdown product contamination of the SF_6.

On his return, David Weisser made some measurements by connecting the pickoff to the beam current metering Keithley picoammeter. He determined the current to our capacitive pickoff to be 0.05 nA when the lost charge was 20 microamps. The pickoff has an area of about 7 x 10^{-5} that of the tank surface area probably involved; thus the pickoff current turns out to be 100 times smaller than might be expected.

We have noticed that problems with lost charge prior to a tank opening often disappear when the tank is closed again. If this is due to our cleaning procedures, including assiduous tacragging, perhaps there is something to be said for Robert Rathmell's fuzzball theory (40/8). While there can be speculation about the origin of lost charge, we are becoming less inclined towards theories based on "bad" gas.

OPERATIONAL TIME

During the 96 days since the last closure, the 14UD operated for 1955 hours. This was 86% of elapsed time, excluding the days for gas transfer (42/2).

THE TANK OPENING

When the doors were opened the smell in the tank was more unpleasant than we usually find it to be. It was not very acrid, but was more of a dank smell, reminiscent of the atmosphere in the newly opened E.N. tandem during the early stages of ventilating after the CO_2/nitrogen mixture had been pumped out. We continue to set great store by the atmosphere in a newly opened tank and contend that the first sniff is something not to be sneezed at.

Exploratory tour

It was immediately clear that the column was very dirty. The rings and casting covers were gritty to the touch and dust particles could be seen clearly between the rings. The rings on units near the terminal had deposits significant enough to have led to lost charge. There was a buildup of material at the entry port and the deposits were heaviest on units near the port, implying that Vivalyme and/or alumina dust was getting through the filter.

While, in general, the corona points were acceptable, column points in units 13 to 16 (two units on each side of the terminal) were worn more than others. There were several badly worn assemblies in units 15 and 16; however, all the tube points in these units were in good condition.

The stain on the terminal, opposite the triode needles, had the usual pattern of a broad, light-brown area with a much darker centre patch. On this occasion the centre patch was almost black and was crazed, as dried mud appears.

We mentioned earlier, (45/2), that the deposit on the backs of our column corona assemblies was not so thick in the centre of the machine as at the top and bottom of the column; we attributed the effect to a larger gas velocity past the points between the inlet and outlet ports of the large gas recirculator. While we did not expect the thicker deposit at the ends of the machine to clear, it was notable that, after three more months of operation, no buildup had occurred on the points directly in the circulation path.

The chains were dirty and tacky, as must be expected after three months closure. The inductors and capacitive pickoffs were still in position and had not loosened. The chain stabilizing idlers were all checked; no bearings had failed, consequently there was no tyre damage.

The nylon tube for the terminal foil reverse pneumatic actuator was punctured by spark damage near its copper feed pipe in the bottom of the tank. This is only the second failure among these pipes since installation in November 1976 (5/4). The first failure, also on this pipe, occurred in February 1983 (38/4).

And so to work!

CHARGING SYSTEM:

Chains:

The two chains, which were only given a sampling check last time, were examined thoroughly. Chain 1, installed in February this year, has now run for 3,600 hours. This is the world's first N.E.C. "hourglass" chain (41/4; 43/3). Chain 2, put in 18 months ago, has accumulated 9,150 hours. No cracked links, or other defects, were found in either chain.

The chains were cleaned and hand-oiled. Chain 1 was shortened by two links. The spark protection resistors on the pick-offs were renewed because of severe deterioration by sparks.

We have still seen no need to put back a third chain as the 14UD performs beautifully at 14 MV on two chains.

Idlers:

As mentioned in the preamble, there were no problems with any stabilizing idlers. None were removed or adjusted. We were a little surprised to find that both contact springs on all four d.c. idlers were still intact. These things fail with relentless regularity and for none to have broken during a long closure is a tribute to Howard Wallace's method of making them.

Foils:

The terminal foils were renewed where necessary. The foils in the second stripper have not been renewed since November last year. During the nine months since then, the tube has not been let up to atmospheric pressure.

Points:

All column points in units 15 and 16, the units immediately below the terminal, were renewed.

Breakdown products:

Cable ties put in the lower terminal at standard tension in March 1984 broke fairly easily at the knot when wrenched. The broken ties appeared flexible and quite strong when wiggled back and forth (as one wiggles a piece of wire to break it) however, when folded sharply back on themselves, they snapped easily at first go. A new cable tie failed to break after 30 folds through 360 degrees, with strong finger pressure at the fold each time. Nylon cable ties do become brittle after a spell in the tank, but how much this is due purely to drying out we are not prepared to estimate. We shall continue to put cable ties in the machine and break them from time to time. It is a charm against chain breaks which the older author refuses to forsake.

SHEBA

In the last report we mentioned, (45/4), our proposal to upgrade the 14UD with a superconducting linear booster. We stated that we are building a module of four quarterwave resonators, not only to evaluate their performance, but also our own ability to fabricate them in the department.

We began by putting an order for the resonators into the school workshop. While these were getting started, we set up a plating and polishing lab in the department with all the latest innovations, including cleanliness. One of the resonators has been machined and handed over to us for assembly and finishing. This entails making three electron beam welds on the centre donut and stub, brazing the side donuts into the can, then polishing and plating. The following notes, by David Weisser, summarize our progress to date.

1. Electron beam welding.

All electron beam welding has been carried out at Hawker de Havilland and tested for flaws. This was done using ROCOL Fault Finder spray pack and enhancing detection by placing the resonator under vacuum to draw the penetrant out of any flaws. None were detected. Until contrary evidence comes to light, this validates the alterations we have made to the design of the weld joints and preloading during the welds.

2. Copper polishing - tumbling.

A tumbling technique and apparatus has been developed which produces a 2 micron finish, starting with a machined surface. This allows one to use a robust internal weld between the can and end plate because the joint can be ground and polished after welding. Similarly, copper evaporated onto the can wall and stub can be easily and reliably removed. This flexibility has encouraged us to increase the depth of the weld joint to 4 mm.

3. Vacuum brazing - side donuts to the can.

Tests performed with a hidden groove to contain the welding material always resulted in enough trapped gas to blow a hole in the solidifying braze. Using powder braze material and no groove, produces a perfect thin fillet. This is the technique we have adopted. Jerzy Sokolowsky has discovered that the braze material used at the Weizmann Institute discolours at its boundary to the copper when the joint is exposed to lead stripping solution. This flaw might degrade subsequent lead plating, but would be over too small an area to be readily detected. The powder braze, which contains no nickel, causes no such stains.

4. Lead plating.

Until now, no resonator has been plated, only test pieces. The information from plating suppliers is that additives needed to produce a satisfactory coverage necessarily result in co-deposited hydrocarbon in the region of 0.4% to 0.04% by weight. One would not expect the ultimate performance from such deposits and we are making efforts to reduce them. Reducing the Shinol concentration down to 0.2% by volume still gives satisfactory coverage. We don't know whether this will affect the hydrocarbons co-deposited.

<u>Miscellaneous</u>

We improved the gas filter by sealing with Silastic at the places where the filter is bolted on.

Cleaning

In view of the dirty condition of the column, every unit was opened and tacragged inside. Particular care was paid to surfaces between the rings.

Button-up

The chains ran beautifully and the charging tests indicated full efficiency.

Initial performance

Gas tests with the conductivity cell were satisfactory and the dewpoint was -58 deg.C. Traces from the pickoffs were good. There was a change of sensitivity scale due to our having renewed the resistors because the old ones had clearly gone open circuit or high.

After startup there was a curious episode with lost charge. Following a spark at 12.2 MV the lost charge went to 50 microamps at 11.34 MV and there was interference on the T.V. and N.M.R. Turning the volts down, then up again, reduced the lost charge. After this was repeated a few times no lost charge was evident.

The H.E. tube was very gassy and began conditioning at 12.2 MV with large pressure excursions on the H.E. gauge. Vacuum improved after beam had been run for a few hours. This was hard to understand since the tube had not been opened and there had been no report of a vacuum mishap which would have disturbed "conditioned" particulate matter inside the tube.

T.R. Ophel

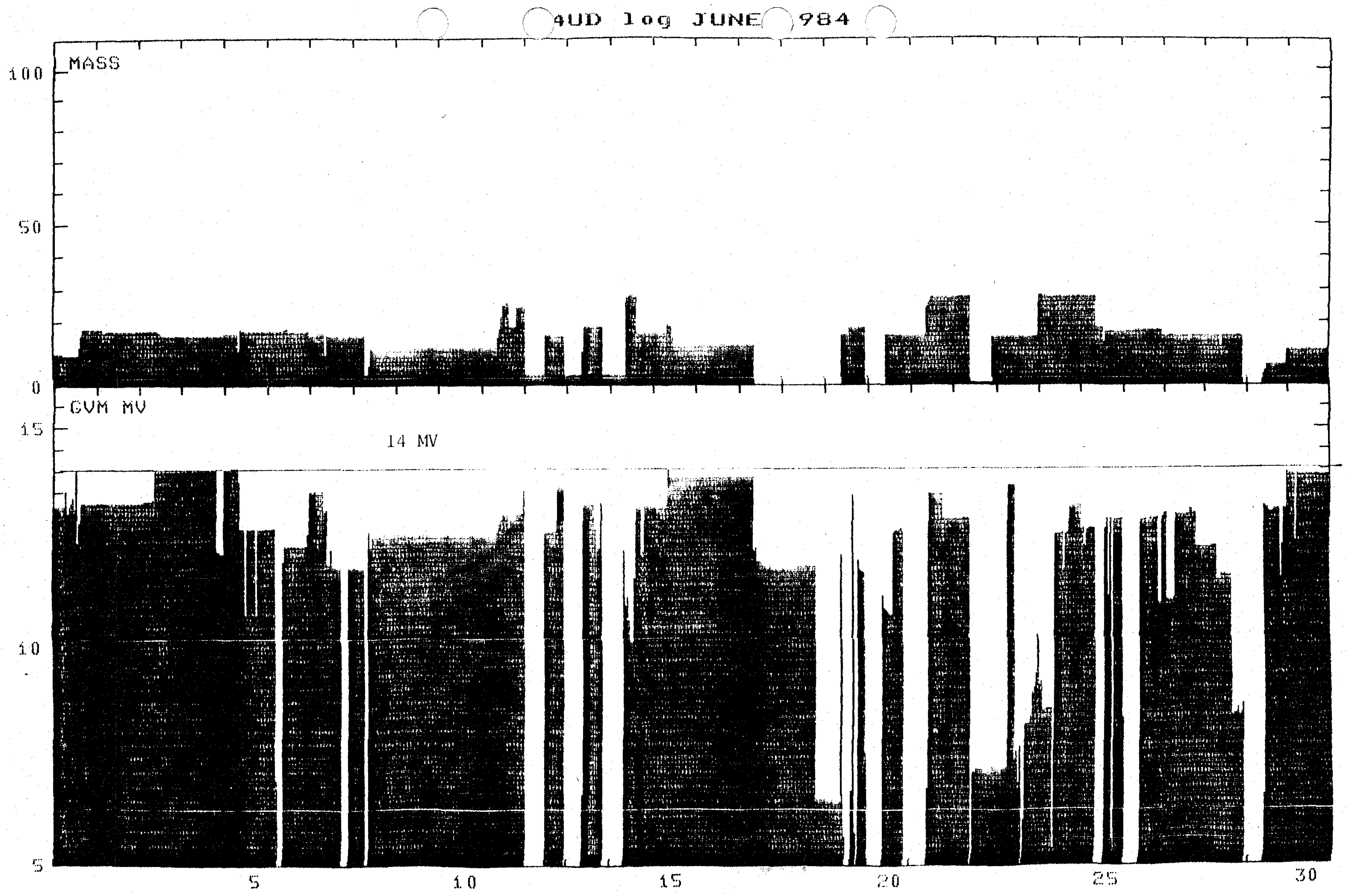
T.A. Brinkley

7th September 1984

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 14UD.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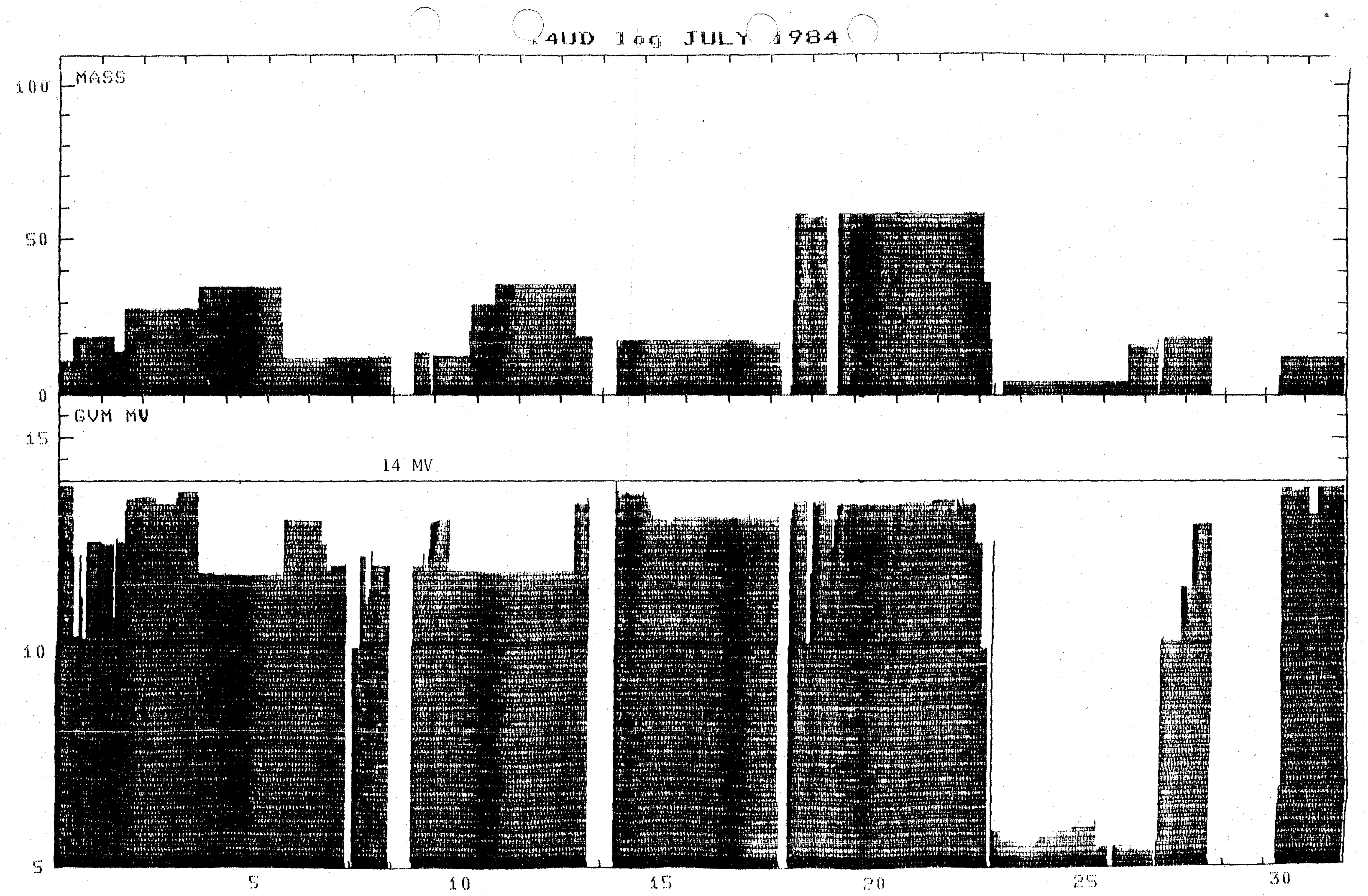
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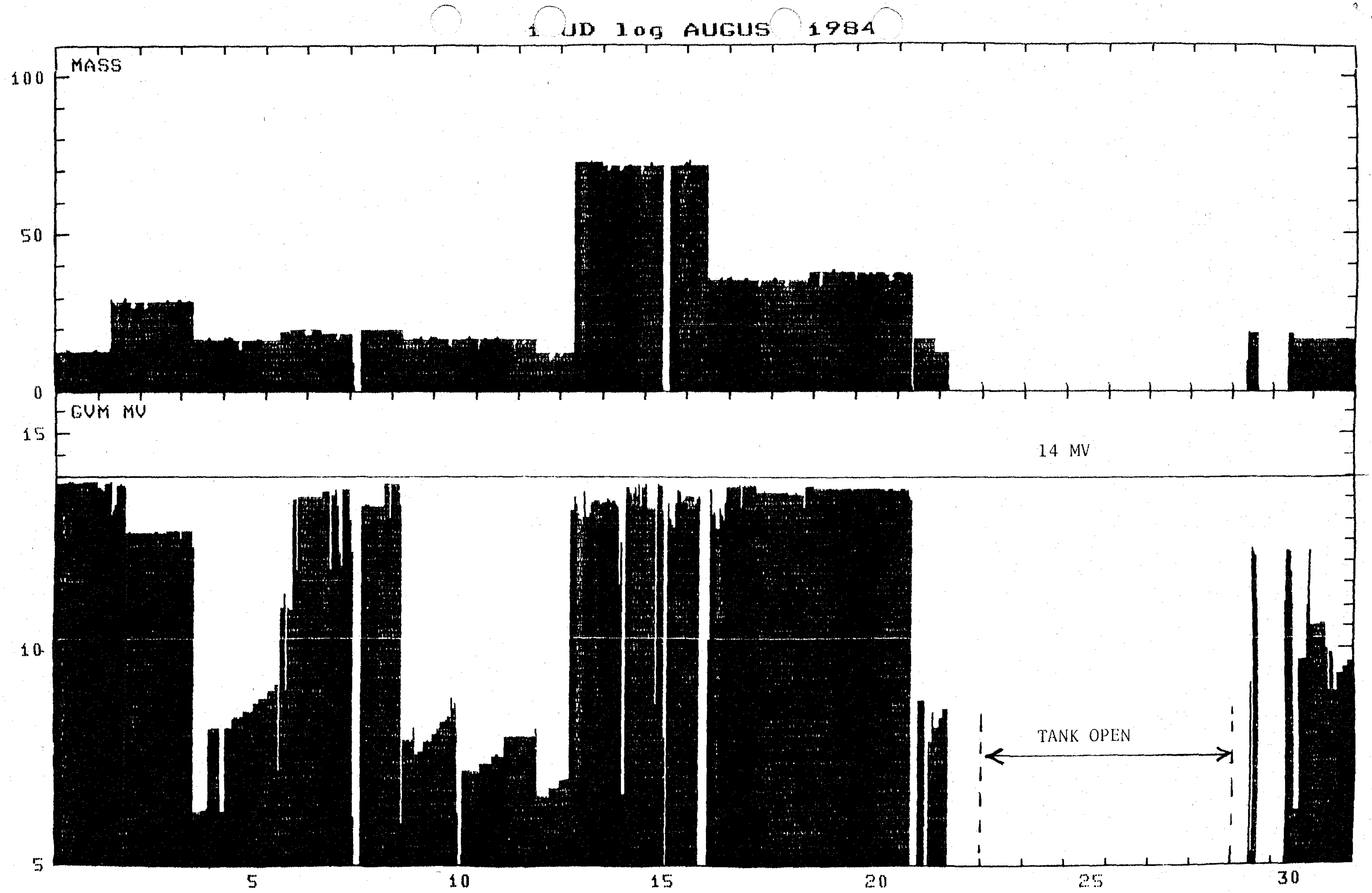
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