AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

# 14UD TANK OPENING REPORT NO.20

22nd to 24th April 1980 (3 days open)

## REASON FOR TANK OPENING:

The opening was not precipitated by any failure of the machine itself; it was scheduled largely for inspection because one of the authors becomes apprehensive if much more than three months elapses between openings. The other author lets sleeping dogs lie, and so long as the machine runs well, and the experimenters are happy, and keep out of his way, nothing could be nicer. In any case, the decision this time was more or less due to the maximum voltage being limited to 13.4 MV because a steel shorting rod had got lost somewhere in the vicinity of Unit 2. The nylon stud attaching the last steel rod in the L.E. end to a nylon rod snapped off and therefore no rod changes could be made. Fortuitously the rods parted with the last rod exactly in Unit 2 and not part way between units.

It is worth noting that there was no mishap or loss of gas when the nylon rod came out of the tank with nothing on the end of it because the ANU automatic safety valve closed. In the old days, as both authors can testify, when you pulled the last rod out of the machine, you shook with terror and fought on your own to get it back in again before you were overcome by extremely expensive gas. Then you sat down.

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## References:

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

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## PREAMBLE

The 14UD was last closed on November 23rd and ran for five months until this scheduled opening. This is outstandingly the longest "closure", its closest rival being a day or so over three months. During the six years since the 14UD became operational there have been six closures of approximately three months and nearly forty others varying from three months down to one day.

During the 151 days the 14UD ran without any internal malfunctions or persistent difficulties with terminal voltage or stability. One of the authors did, in fact, run the machine at 13 MV for about a week with half a rod sticking into Unit 28. There was perplexing additional lost charge and languid establishment of gradient, but the machine was surprisingly tolerant of the author, doubtless in view of his long absence overseas. In future we shall see to it that the number of rods left in unwittingly will be an integer, when convenient.

The panel on the main console which controls the various functions inside the machine blew fuses until a wire with an ambiguous label was disconnected before it entered the tank. All was then well and all functions continued somewhat surprisingly to operate.

The performance of the glow discharge foils inserted at the last opening, (19/2) was disappointing in terms of both transmission and lifetime. Foil data has been assembled for the last opening and this one, and will be given in a coherent form later in this report.

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The chains behaved well during the five months. They were oiled at more or less every group change with the minimum amount necessary to get rid of negative self charge; this always disappeared from all chains at an early stage of oiling. It was clear that all three reservoirs at least still contained enough oil to be effective, and that very little could have been wasted.

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## THE TANK OPENING

Air was let in at 5 pm and the doors were not opened until 7.30 next morning. As at the last opening there was a strong, acrid smell in the tank; however, once the ventilation system was turned on the smell had cleared by the time the platform was lowered and loaded with paraphernalia of essentials, always either incomplete or overdone, depending on the loader in charge, or his overseer.

### Exploratory cruise:

The characteristic fine grey dust was on all surfaces of rings and casting covers, more thickly than usual but probably in proportion to the five months "closure". The trio of brown deposits on the backs of corona point assemblies had not increased significantly since the last tank opening. The corresponding marks on the ANU assemblies fitted in Unit 2 at the last opening (19/2) were faint in comparison; however, the really noticeable thing in Unit 2 was a solid buildup on the rivets holding the column corona disc to its bracket, and on the "receiving" bracket on the column post. The material was a dry white solid as distinct from the brown stain always associated with a region where corona occurs. Also the upper surfaces of the rings in Unit 2 had a heavier deposit of particulate dust than any other rings in the machine. The ANU corona assemblies on the tube were much less affected than those on the column.

In Unit 19, where the H.E. stripper occupies the lower third of the unit, the copper strips which tie all the dead column electrodes together showed evidence of sparking in the form of dark marks at the connection points. Two screws were loose on the column and the contact was clearly poor. In each case a shakeproof washer had been omitted.

Though all the appropriate castings were not opened the stabilizing idlers seemed to be in good condition.

Inspection in the bottom of the tank showed Chain 1 was tacky without being moist; Chains 2 and 3 were tacky, but moist to some degree. Rims of all driving pulleys were something between moist and tacky. In no case was there either a dry chain or a dry pulley. All oiler reservoirs were at least half full and the puddle of oil on the bottom of the tank was about the same size as usual. Oil had sprayed from the chains onto support posts under the column, and around various inductors, but it was a film and not an accumulation. It is interesting to note that oil on surfaces in the vicinity of the charging pulleys is never tacky like the surfaces of the chains; when touched it has an oily feel, and it wipes easily.

There were spark marks at the top edges of most of the L.E. shaped casting covers and we wondered if perhaps they were too sharp.

The H.E. column was generally cleaner than the L.E. There was a golden cast to the mushroom of the stabilizing needle assembly. Later the mushroom was removed and polished.

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Between two rings near the bottom of Unit 16 a small pad of Kimwipe was wedged peacefully. How it escaped the tac-raggers is hard to understand but it did not seem possible that it could have been blown there, either by gas handling or sparking. It exhibited no evidence of spark damage.

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And so to work!

Points:

The ANU column point assemblies in Unit 2 were removed and scrubbed with a pink toothbrush dipped in water (12/3); the post brackets were cleaned in the same way. The photographs enclosed show the solid buildup on the brackets. The ANU tube point assemblies were not cleaned.

The needles of the ANU points were still sharp, and all other needles throughout the tube and column are detectably dull, yet performance suggests that they are presenting no problems.

Unit 19:

The copper shorting straps were taken off, cleaned and put back tightly using shakeproof washers throughout.

Chains:

The three chains were cleaned with alcohol and hand oiled. Chain 1 was shortened by one pellet. The oil reservoirs were topped up.

In discussion between the two authors it was suggested by one that there was no need to remove the lower terminal spinning in view of the fact that all was well in the machine and a major shutdown is to take place in a few weeks. The other author objected on the grounds that some contact springs on d.c. idlers were bound to have failed and received the reply that we know perfectly well that these springs fail almost as soon as they are renewed; that we are never able to notice any difference whether there are contact springs or not; that d.c. idlers without contact springs didn't suffer and that we were not going to waste time during a short exploratory shutdown. There was a counter-offensive that perhaps an inductor was about to fall off, or there were mice in the lower terminal, but the spinning was not removed.

Foils:

Before attempting to remove the foil changer earlier experience with leaks of the Weisser isolation valve (19/2; 18/3) were remembered, and their association with the position of part of the external mechanism which moves slightly under the considerable torque which is exerted. Accordingly before closing the Weisser valve the mechanism was readjusted, and this led to a near perfect seal since the tube pressures only moved from mid $10^{-8}$ range to about $2 \times 10^{-7}$. It is interesting to record that a foul-up six or eight months ago led to the Weisser valve being closed when a foil instead of a blank was in position. On this current occasion careful reasoning led us to forget the theory and wind the foils all the way back to zero on the counter in order that there could be no mistake in arriving in the middle of the series of blank positions. Unfortunately some elusive parameter or other had entered the situation and once more the Weisser valve was closed on a foil holder. The most likely explanation is that reverse and forward had become interchanged when mechanical and electronic technicians were competing for platform time, or some other honour. No harm was done apart from heightening still further the anxiety which now inevitably accompanies a simple foil change with a beautiful isolation valve. Bets in the darkroom run at fever level and this urgency does little to dispel "foil change nerves".

Foil types:

Our efforts to exploit the apparent superiority of glow discharge ethylene foils have not been very systematic. The glow foils installed hastily at the last tank opening (19/1) were inferior in performance to our standard foils. The excuse for this currently accepted is that the glow foils were too thick. As measured by use of our light transmission device used for carbon foils the glow foils had transparencies of 37% to 71%. Experience with similar foils at Oak Ridge suggests that glow foils transmit twice the light of equal thickness evaporated foils. Some desultory efforts to confirm this were inconclusive. Nevertheless accepting it as a rule of thumb implies that the foils previously tested varied from 7 to 20 micrograms/cm$^2$. Since our standard foils are 3 to 5 micrograms/cm$^2$, 60% to 74% transmission, the poorer performance of the glow foils can be ascribed to their excessive thickness.

New batches of glow foils have been made using a bell jar based system. Two sets were installed during this foil change in addition to the majority of standard foils. One set comprises only two foils, each of which transmits 87% light and is estimated to be about 5 micrograms/cm$^2$. (These foils were used with a silicon beam during the first run; their apparent lifetimes, i.e. 50% beam, is about 12 hours, quite comparable to our standard foils. The remaining glow foils are 77% light transmission or about 5.2 micrograms/cm$^2$ and have not yet been exposed to beam.)

Collodion:

Up to the present the strengthening layer of collodion applied to all stripper foils has been removed from the centres of the foils using the heat from a projector lamp. This technique is laborious as each foil must be handled individually; it is also unreliable because the temperature to which the foil rises under the lamp depends on the opacity, that is the thickness of the carbon. Thus, if the lamp intensity is high enough to burn collodion off a 3 microgram/cm$^2$ foil then for a 5 microgram/cm$^2$ foil the lamp will tend to burn the carbon itself. Such pockmarking of foils is easily observed.

At Oak Ridge we discovered that heating the mounted foil in air in an oven at 260°C was sufficient to burn off the collodion. An adaptation of this procedure was used for the foils loaded at ANU on this current occasion. After the foils had been mounted on the changer mechanism, the end of the device containing about 50 foils was inserted into an oven at 320°C and the changer actuator was operated sequentially to cycle through the full load of foils.

A word is in order about the removal of collodion: the criterion used to date has been to observe relaxation of the foil where collodion has been removed. Tests performed with an oxygen beam and the Enge spectrometer indicate that even these burnt-off foils still have a residual collodion thickness equal to about 20% of its 10 micrograms/cm$^2$ initial value. With continued exposure to beam of sufficient intensity the residual collodion was removed. Subsequent exposure to beam resulted in a gradual decreasing in elastic scattering counting rate. This apparent initial reduction in foil thickness with exposure is in contradiction to the experience at Oak Ridge with much higher intensities. Whether this is an intensity dependent effect, or the foils made at Oak Ridge were in an important way different to those made here, is not known.

The rationale for removing the collodion at all is based on the apparent dependence in the "burn-off" rate to beam intensity. A significant amount of

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operation time at ANU is spent on low intensity gamma ray work; such intensities might not be sufficient to eliminate the collodion quickly. We don't know the efficiency of our adopted technique either.

Further work is under way to repeat absolute thickness determinations for all our foil types.

Shafts:

As usual the shafts were run and bearings listened to. The alternator bearings in the castings were satisfactory but a bearing in the upper shaft motor was very bad. It sounded like several examples of failed bearings on Joe Bair's tape, but more than anything as though it had square balls. The bearings have not been changed for several years. During examination of the shaft motor it was noticed that the pyrotenax taking power to the motor was running very hot. Although this turned out to be due to pyrotenax of too low current carrying capacity which was installed initially, subsequent investigation of the terminal box in the motor revealed a melted coupling on one phase. Otherwise the motor was fine.

Apart from the L.E. tube heater plates the upper shaft drives only the midsection pump and the upper sublimer pump in the terminal. Since we know that all the sublimers in the machine are now useless (18/2) there was little point in spending time on the upper shaft motor if absence of tube heater plates was tolerable, therefore the upper shaft motor was left until the shutdown which is to occur shortly.

Charging tests:

After the column had been blown with nitrogen and tacragged, the chains were run to check their mechanical stability. A bearing on the driving pulley of Chain 2 was bad (triangular balls) and Chain 2, as with the upper shaft, was put on justifiable sick leave until the next shutdown. The bearings have been in at least three years.

Chains 1 and 3 behaved normally and the 14UD was buttoned up.

Miscellaneous:

The H.E. iris, which has waited for some time to be fitted, was installed just before the quadrupole lens preceding the switching magnet.

The mysterious wire referred to earlier, which blew fuses when connected and didn't upset anything when disconnected, was traced to an obsolete control rod microswitch. The wire had been squeezed under a cover plate and shorted. The wire was excised.

Voltage Tests:

After gassing up, the 14UD went almost straight to 14.1 MV and a good deal of contentment was expressed in the half hour or so before a tank spark dropped the ceiling to a particularly stubborn 13 MV. A number of rod configurations were used for about half a day of systematic conditioning.

The initial conditioning onset voltage and conditioned voltages achieved for groups of units were:

| Units | Initial conditioning Volts/Units | Achieved volts/unit |
|---|---|---|
| 1- 4 | 1.07 | O.K |
| 4- 8 | 1.00 | 1.05 |
| 8-14 | 1.00 | 1.06 |
| 15-20 | 1.13 | O.K. |
| 15-22 | 1.07 | O.K. |
| 23-28 | 1.07 | O.K. |

These gradients are consistent with a terminal voltage of from 14.7 to 15.5 MV. When all units were live, instabilities recurred at 14.2 MV. Clearly short lengths can cope with higher longitudinal gradients than the total structure. The spontaneous onset of sparks is consistent with the dirt troubles we encountered about three years ago (9/2). The generally poorer performance of the L.E. units is consistent with the greater amount of dirt on them than the H.E. units, and the generally lower gradient (14 units rather than 13⅔ in the H.E. end).

All conditioned gradients are less than the 1.10 to 1.15 MV/U achieved last April (15/3).

Even this success was shortlived. Spontaneous tank sparks, not preceded by conditioning, plagued operation for the first 48 hours. The machine is now operating at 13.7 MV but sparks still occur occasionally.

Ion sources:

The lithex source was last used early in November and there are no plans for helium runs for some time to come. We decided that there was little point in running two expensive turbine pumps incessantly and consequently the lithex source was let up to argon and turned off completely.

Recently the sputter source ran out of cesium after nearly 2,500 hours since the last load. There have been no further frit blockages. We have always found that the molybdenum suppressor electrode suffered considerably from pitting and erosion, and it was quite frequently replaced. We have recently fitted an electrode made of titanium and so far the results have been encouraging.

Cyclotron and EN Tandem

The cyclotron was taken out and shipped to Japan a week or so ago. The EN Tandem is now merely a tank and contents as the ion source, analyzing magnets, control console etc. are on their way to New Zealand. The column will be dismantled later this year and then the tank will be shipped as well.

MAJOR SHUTDOWN:

It is planned to carry out a variety of modifications during a shutdown beginning some time in June and expected to extend for about six weeks.

The new terminal spinnings will replace the original ones and this means, of course, that the top of the tank will have to be taken off for the first time since installation. The column will need to be stayed appropriately because the crossmembers at the top must be removed.

The tube has not been opened for almost exactly two years and since it will be opened in June we shall take the opportunity to open all the pumps in the

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machine, clean their bodies and fit new sublimers throughout. A 300 litre/sec ion pump will be fitted to the tube inside the tank at the top of the column. All casting covers will be removed and the entire machine will receive a very thorough cleaning.

These, and a backlog of other matters, represent a formidable effort ahead in the near future. As Pogo said, as far back as 1954: "Up to now we been jes <u>talkin</u>, but when we start <u>thinkin</u> bout this - STAND BACK!"

D.C. WEISSER

T.A. BRINKLEY

30th April 1980

Enclosures:

Photograph of corrosion buildup on column point assemblies and post brackets.
Photograph of spark pattern on rings.
Photograph of brown stain on terminal opposite stabilizing needles.

| MONTH | DATE | DAY | GROUP | LINE | |
|---|---|---|---|---|---|
| | | MON | | | |
| | | TUES | | | |
| NOV. | 7 | WED | DRACOULIS ET AL. | 2 | $\alpha$ |
| | 8 | THURS | HINDE ET AL | 6 | $^{28}Si$ |
| | 9 | FRI | | | 160 MeV |
| | 10 | SAT | | | |
| | 11 | SUN | | | |
| | 12 | MON | HAY ET AL | 7 | $^{63}Cu$ |
| | 13 | TUES | | | (100 MeV) |
| | 14 | WED | LEIGH & OPHEL Detector Tests | | |
| | 15 | THURS | ~~DETECTOR TESTS~~ Newton et al | 5 | $^{30}Si$ |
| | 16 | FRI | | 4 | |
| | 17 | SAT | | | |
| | 18 | SUN | | | |
| | 19 | MON | | | |
| | 20 | TUES | T A N K O P E N I N G | | |
| | 21 | WED | | | |
| | 22 | THURS | NEW FOILS ETC. | | |
| | 23 | FRI | | | |
| | 24 | SAT | | | |
| | 25 | SUN | | | |
| | 26 | MON | DRACOULIS, FAHLANDER | 1/2 | $^{16}O$ |
| | 27 | TUES | | | |
| | 28 | WED | | | |
| | 29 | THURS | ~~CLARK, ATWOOD, NURZYNSKI, HEBBARD & OPHEL~~ | 5 | $^{28}Si$ |
| | 30 | FRI | LEIGH | | |
| DEC. | 1 | SAT | | | |
| | 2 | SUN | HAY ET AL | 7 | $^{63}Cu$ |
| | 3 | MON | | | |
| | 4 | TUES | DRACOULIS, FAHLANDER | 1/2 | $^{16}O$, $^{10}$, |
| | 5 | WED | | | |
| | 6 | THURS | ~~LEIGH~~ CLARK, ATWOOD, NURZYNSKI | 5 | ~~$^{28}Si$~~ $^{7}Li$ |
| | 7 | FRI | ~~HEBBARD~~ & OPHEL | | |
| | 8 | SAT | | | |
| | 9 | SUN | | | |
| | 10 | MON | SIE ET AL (MELBOURNE GROUP) | 4/2 | $^{58}Ni$ |
| | 11 | TUES | | | (200 MeV) |
| | 12 | WED | | | |
| | | THURS | DRACULA | 1 | $^{10,11}B$ & $^{9}Be$ |
| | | FRI | | | |

14UD SCHEDULE - 14/1/80 - 31/1/80

| MONTH | DATE | DAY | GROUP | LINE | |
|---|---|---|---|---|---|
| JAN | 14 | MON | CONLEY, SIE, NEWTON, GALSTER, HINDE | L?0 | $^{13}C$ |
| | 15 | TUES | | | |
| | 16 | WED | | | |
| | 17 | THURS | SIE, LEIGH, KERR | 2/1 | $^{58}Ni$ |
| | 18 | FRI | | | 220 MeV |
| | 19 | SAT | | | |
| | 20 | SUN | | | |
| | 21 | MON | ION SOURCE MEINTENANCE AND MODS | AND | TESTS |
| | 22 | TUES | ~~SUSI~~L | ~~5~~ | ~~$^{10}B$~~ |
| | 23 | WED | | | ~~36-50 MeV~~ |
| | 24 | THURS | | | |
| | 25 | FRI | | | |
| | 26 | SAT | | | |
| | 27 | SUN | | | |
| | 28 | MON | | | |
| | 29 | TUES | HAY ET AL RUN COMPLETED | 7 | (Ti) |
| | 30 | WED | SOURCE TESTS | | |
| | 31 | THURS | ATWOOD ET AL | 5 | $^{7}Li$ |
| | Feb 1 | FRI | | | |
| | 2 | SAT | | | |
| | 3 | SUN | | | |
| | 4 | MON | AINSE CONFERENCE | | |
| | 5 | TUES | | | |
| | 6 | WED | | | |
| | 7 | THURS | CLARK, OPHEL, NURZYNSKI | | |
| | 8 | FRI | ATWOOD | 5 | $^{7}Li$ |
| | 9 | SAT | | | |
| | 10 | SUN | Poletti & | | |
| | 11 | MON | Dracoulis | | |
| | | TUES | | | |
| | | WED | | | |
| | | THURS | | | |
| | | FRI | | | |
| | | SAT | | | |
| | | SUN | | | |
| | | MON | | | |
| | | TUES | | | |
| | | WED | | | |
| | | THURS | | | |
| | | FRI | | | |
| | | SAT | | | |

## 14UD SCHEDULE - 11 Feb - 11 Mar. 1980

| MONTH | DATE | DAY | GROUP | LINE | |
|---|---|---|---|---|---|
| FEB. | 11 | MON | DRACOULIS, POLETTI | 1 | $^{18}O$, 120 MeV |
| | 12 | TUES | LEIGH, OPHEL | 5 | $^{16}O$ |
| | 13 | WED | | | |
| | 14 | THURS | | | |
| | 15 | FRI | | | |
| | 16 | SAT | | | |
| | 17 | SUN | | | |
| | 18 | MON | LEIGH, SIE | 2 | 220 MeV $^{58}Ni$ |
| | 19 | TUES | | | |
| | 20 | WED | | | |
| | 21 | THURS | CLARK, ATWOOD, NURZYNSKI, HEBBARD, OPHEL, WEISSER | 5 | $^{7}Li$ 52 MeV |
| | 22 | FRI | | | |
| | 23 | SAT | HEBBARD ET AL | 5 | $^{16}O$ |
| | 24 | SUN | | | |
| | 25 | MON | NEWTON ET AL | 2 | Si 175 MeV |
| | 26 | TUES | LEIGH, GALSTER, HINDE & OPHEL | 6 | $^{28}Si$, $^{32}S$ |
| | 27 | WED | | | |
| | 28 | THURS | | | |
| | 29 | FRI | ~~ION SOURCE TESTS~~ | | |
| MAR. | 1 | SAT | ~~HEBBARD~~ | 5 | $^{16}O$, $^{12}C$ |
| | 2 | SUN | HEBBARD | 5 | $^{16}O$, $^{12}C$ |
| | 3 | MON | ION SOURCE TEST | | |
| | 4 | TUES | | | |
| | 5 | WED | LEIGH, OPHEL | 5 | $^{28}Si$ |
| | 6 | THURS | | | |
| | 7 | FRI | | | |
| | 8 | SAT | | | |
| | 9 | SUN | | | |
| | 10 | MON | ION SOURCE TESTS | | |
| | 11 | TUES | OPHEL / LEIGH | ~~5~~ | ~~$^{24}Mg$~~ Mg |
| | | WED | | | |
| | | THURS | | | |
| | | FRI | | | |
| | | SAT | | | |
| | | SUN | | | |
| | | MON | | | |
| | | TUES | | | |
| | | WED | | | |
| | | THURS | | | |
| | | FRI | | | |

14UD SCHEDULE - 12 Mar - 16 Apr. 1980

| MONTH | DATE | DAY | GROUP | LINE | |
|---|---|---|---|---|---|
| | | MON | ION SOURCE WORK $^{26}Mg$, $^{11}B$ | | |
| | | TUES | ENGE TESTS | | |
| Mar. | 12 | WED | DRACOULIS, FAHLANDER | 1 | $^{16}O$ |
| | 13 | THURS | | | 95 MeV |
| | 14 | FRI | | | |
| | 15 | SAT | | | |
| | 16 | SUN | | | |
| | 17 | MON | CANBERRA DAY | | |
| | 18 | TUES | LEIGH, HINDE, GALSTER | 6 | $^{19}F$ |
| | 19 | WED | | | 95 MeV |
| | 20 | THURS | CONLEY ET AL. | 1 | $^{13}C$ |
| | 21 | FRI | | | 68 MeV |
| | 22 | SAT | | | |
| | 23 | SUN | | | |
| | 24 | MON | NURZYNSKI, HEBBARD ET AL. | 5 | $^{16}O$ |
| | 25 | TUES | | | $^{24}Mg$ |
| | 26 | WED | | | 120 MeV |
| | 27 | THURS | BAXTER, SPEAR ET AL. | 6 | p,d |
| | 28 | FRI | | | 18 MeV |
| | 29 | SAT | | | |
| | 30 | SUN | | | |
| | 31 | MON | ION SOURCE TEST | | |
| Apr. | 1 | TUES | | 5 | 60 MeV |
| | 2 | WED | ENGE TESTS | | $^{16}O$ |
| | 3 | THURS | | | |
| EASTER | 4 | FRI | EASTER | | |
| | 5 | SAT | | | |
| | 6 | SUN | | | |
| | 7 | MON | | | |
| | 8 | TUES | SUPER DOOPER | 6 | $^{26}Mg$ |
| | 9 | WED | | | 100 MeV |
| | 10 | THURS | CONLEY ET AL | 1 or 2 | 68 MeV |
| | 11 | FRI | | | $^{13}C$ |
| | 12 | SAT | | | |
| | 13 | SUN | | | |
| | 14 | MON | NURZYNSKI, HEBBARD ET AL | 5 | $^{24}Mg$ |
| | 15 | TUES | | | 120 MeV |
| | 16 | WED | | | |
| | 17 | THURS | TANK OPENING | | |
| | 18 | FRI | FOIL CHANGE | | |
| | | SAT | | | |
| | | SUN | | | |