Australian National University

14 UD Tank Opening Report

#136

5th March 2024 – 15th of April 2024

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Contents

Reason for tank opening

This was a scheduled opening for normal maintenance activities and to reinstall the gas stripper system. Other items of interest were:

- Terminal stripper foils will be restocked
- Checking the state of the corona needle system as at least two user groups were noticing loss of GVM control accompanied by regular small breakdowns. This may have something to do with the tension on the corona needle inner rod.

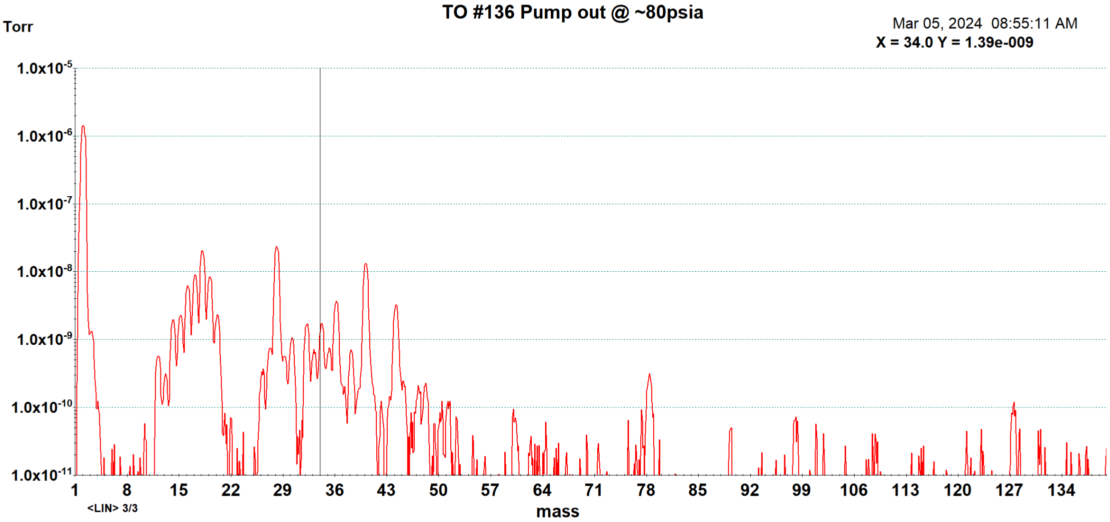

Figure 1 RGA scan during pump out of tank to check for SF_6 levels before reinstalling the gas stripper system. Ideally, this scan should have been before pump out started, but the configuration wasn't appropriate but in any case, it is a good representation of what we should see after stripper installation.

Summary of work

Tank opening #136

5/3/24 Tuesday

- The SF_6 was pumped from the 14UD into the storage vessel.
- The porthole doors were opened and the fresh air ventilation system turned on.

6/3/24 Wednesday

- Platform was deployed and tools loaded on.
- High voltage tests were completed, with some sections requiring investigation:
  - U13 T4 slightly under nominal resistance
  - U15 T3 slightly over nominal resistance
  - U16 T1, T2 and T3 slightly under nominal resistance (note that these are the resistors with the new mounting method and the new EBG resistors)
- Cleaned the column
- Found the bottom ring of U18 is rattling
- Heater was on (?) requested Pat turn it off in the distribution board

7/3/24 Thursday

- Casting covers removed in preparation for terminal opening.
- Mechanical tests performed
    - Chain 1 U25 down idler knocking
    - Chain 1 U16 up idler noisy (but may be just because casting cover was removed)
    - Chain spin down times
        - Chain 1 36s
        - Chain2 47s
        - Chain 3 38s
    - Unit 11 lower shaft bearing noisy
    - Ran shafts to move stripper mechanisms back to zero. HE mid-section stripper is stuck on 4 actual and 5 on EPICS. Need to investigate.
- Terminal was opened
- All radiation measurements at marked points in the terminal were below 0.5μSv/Hr, even with all the proton beams run
- Attempted to assemble Hi-Cube system to pump out interspace and removed terminal stripper foils. Having an issue where the diaphragm pump won't pump past 4Torr, not mTorr, Torr. With the literal steps made to put together the pump, that was enough for today.

8/3/24 Friday

- After a long game of cobble-a-vacuum, we were able to close the Weisser valve and vent the terminal foil stripper section. Stripper foil assembly was removed for inspection and replenishment.
- Vented low-energy end of the machine with N_2
- And that was it, because if you don't take your time venting things, you can cause some serious long-term problems

11/3/24 Monday

- Canberra Day public holiday

12/3/24 Tuesday

- Gas stripper system was meticulously reinstalled. New o-rings and chain clamps were used throughout and the indium seal on the KF16 ports on the turbos were left on.
- Low-energy end of the machine was pumped down slowly using the roughing cart on L5 and then put onto the turbo cart at about 1×10^{-2}Torr (le:vacuum PV)
- The process of baking the gas stripper trap began when the vacuum was at 5×10^{-3}Torr and after a couple of hours, it still had not stabilised with the vacuum at 3.7×10^{-2}Torr, so it was turned off for the day.

13/3/24 Wednesday

- Baking began again and the vacuum had reached 3.2×10^{-4} Torr overnight just on the turbo cart. Temperatures were monitored and the cartridge heater thermocouple reached 700°C (?!?!) with the laser thermometer showing ~200°C. One hour after starting, the vacuum peaked at 4.9×10^{-2}Torr and is slowly coming down.
- A keen eye over the second stripper (HE mid-section) issue discovered spark damage on an idler cog, resulting in damaged teeth and chain. This is highly likely to be the reason for the issue with the stripper. The mechanism also sits very close to the rings, so

measurements are being made for modifications to repositions the system further away from the rings.

Figure 2 Damaged cog in mid-section stripper mechanism

- ANU F&S turned up and assessed the asbestos gaskets around the main tank SF_6 valve . They will return next week for the removal work after submitting the relevant paperwork to Comcare.
- Replaced the corona needles. We may have some issues ("poltergeists") when running that we thought were due to the tension on the needles. Upon disassembly, noticed that there were witness marks on the tank side of the inner rod that lay outside the usual divots. Maybe the tension released as they slipped back to their normal position? Anyway, new needles went in.

14/3/24 Thursday

- Attempted to leak chase the upper turbo with the low energy vacuum at mid 10^{-5} Torr. Bagged the entire turbo and helium leak rate went from a base of XX×10^{-8} mbar/l•s and slowly rose to 1.1×10^{-7} mbar/l•s over XX minutes and it levelled out as the bag was removed. This is sort of consistent with the bench tests with the refurbished turbos, but we are going to have another go after improving the low energy vacuum and in turn, hopefully, the base leak rate.
- Measurements were taken to manufacture new sprockets and replace the chain on the HE stripper counter mechanism. The new system will be configured to move the chain away from the rings to avoid sparking causing wear on the sprocket and chain into the future.

15/3/24 Friday

- Attempted to reinstall the sprockets and chains for the HE stripper counter. The parts went on, however, it was decided to hold off on tightening the grub screws as the motor should be run to ensure it was not stalled half way between foil positions on the last operation. The HE mid section is currently bypassed in the Group 3 circuit so the changer mechanism could not yet be operated.
- Found that one of the spark gaps/standoffs on the terminal box (turbo) was out of place. It was removed and found that the nylon spacer had considerable spark damage. It will need replacing with a new nylon disc.

Figure 3 Damaged stand off/insulator on top of terminal control box

- Leak chased the stripper trap connection to the tube and found no evidence of leakage from the base of 4.8×10^{-8} mbar•l/s. The joint was taped and left for 10 minutes.
- The bottom turbo was leak chased, and a small rise was noted up to 5.5×10^{-8} mbar•l/s over 40 minutes. This was considerably better than the top turbo, which lead us to believe there was an issue with the top turbo. It was noted that the bearing cover seal on the bottom turbo had been fixed (dirt on the or-ring), but the top turbo bearing cover had not been inspected. Bagging was done on the top turbo bearing cover and it confirmed that was the location of the leak. The rest of the top turbo was also bagged, and it showed minimal response, pointing to the bearing cover being the issue.
- To check the bearing cover seal, the LE tube was vented to N_2 and the bearing cover was removed. Dirt and debris was found all around the o-ring area, so it was all cleaned (including the o-ring) and reinstalled with new screws (as the heads on the old screws were chewed out).

Figure 4 Dirt and debris on top bearing cover seal

18/3/24 Monday

- Leak chased the top gas stripper turbo from a base leak rate of 4.3×10^{-8} mbar•l/s and leak rose to 1.2×10^{-7} mbar•l/s within 12 minutes. Attempted to isolate leak by injecting smaller sections of turbo. Isolated leak to rear bearing cover plate. All the leak rate can be attributed to the plate.

- Opened cross pump tee plug to evacuate N2 stripper gas feed line and leak rate jumped to 1.0×10^{-7} mbar•l/s and lsowly coming down.
- Tested operation of stripper valve and gas stripper turbos.

19/3/24 Tuesday

- VCR seal at gas stripper manifold was leaking, tightened.
- There is a very small leak through the Weisser valve.
- Opened N_2 bottle.
- Installed new terminal box standoff.
- The timing seems off, but took measurements of the turbo bearing cover. Must have vented.
- Fitted new bearing and carrier to the U12 alternator assembly and reinstalled.
- Clocked U12 shaft

20/3/24 Wednesday

- Clocked U11 shaft
- Installed new 40x1.5mm o-ring into top turbo (not the default size) and pumped down low-energy end. Leak tested the entire top turbo and managed to get a small reaction. Bagged the turbo and the leak reaction was as before (up to 1.2×10^{-7} mbar•l/s in ~10 minutes) . Decided to change to a glove covering the rear cap in a attempt to get a more consistent result and had a similar reaction.

21/3/24 Thursday

- Given that, gloved the rear cap on the lower turbo and the leak was just as bad, whereas previously we thought it was OK. So the big result is that there is a fundamental problem with the rear cap design (it's not usually designed to hold off pressure). Came up with an idea for new rear cap with clamp rings to get a better seal.

22/3/24 Friday

- Washed the walls down using microfibre mops and RBS solution. A significant amount of dark particulate matter was released and several changes of cleaning water were required to avoid the RBS solution from turning acidic. The difference between cleaned and uncleaned sections was immediately obvious even to the naked eye. Some work will be required to develop a safe work procedure for this operation in order to avoid irritants from breakdown products. Super duper gloves were used along with pH test strips in the wash water, protective glasses to protect against splashes, coveralls and respirators. With 60ml of RBS into 12 litres of water, the pH was about 8.5. After washing one third of the tank, the pH of the wash water was 6. After this, the water was changed more regularly, so that the pH was about 7 or 7.5. A water change every about 5m of wall was required to achieve this.

25/3/24 Monday

- Test fit new parts for gas stripper turbo clamps. Needed some modifications but should be OK to fit today.
- Vented low-energy end of tube, fitted new parts and re-pumped (all at the appropriate slow vent/pump rate)
- Waited for vacuum to get down to about mid 8×10^{-4} Torr and did a preliminary He leak test. "Gloved" and taped both turbo caps. Neither turbo budged from a base leak rate of 3.0×10^{-8} mbar•l/s after ten minutes (tested separately), which is of course a huge

improvement. As a sanity check, helium was injected into the Weisser valve which we know has a small leak and we did get an appropriate reaction from the leak detector.

26/3/24 Tuesday

- Retested for leaks through the rear cap of both turbos and both passed again. So that's a good solution (see section below).
- Baked the gas stripper manifold trap.
- Refit pulleys and chains on the indicator for the HE stripper using the modified parts.
- Powered up terminal

27/3/24 Wednesday

- Started the 300lps ion pump, going through its cycles.
- Installed terminal foil stripper and started pumping out. Did not open the valve though.

28/3/24 Thursday

- Repumped foil stripper space
- Ready to power up terminal to get ion pumps running.

29/4/24 Friday

- Good Friday

1/4/24 Monday

- Easter Monday

2/4/24 Tuesday

- Re-evacuated foil stripper space
- Powered terminal to check ion pumps. The 60lps ion pumps seems to be OK, but the 20lps is pegged to 3×10^{-5} Torr. Could be a problem.
- Ran turbos and get increase in stripper pressure to 1.13mTorr from 0.6mTorr.
- Started clean and close
    - U1 T4 G5 ball ended resistor lead broke.
    - U17 Post G4 resistor pair changed (scorched banana plug)
    - U25 as above

3/4/24 Wednesday

- Cannot start terminal 20lps using several different supplies

4/4/24 Thursday

- Installed new 20lps ion pump. Old pump showed signs of flakes.
- Pumped low energy end
- Leak tested 20lps conflat and was OK.

5/4/24 Friday

- Turned on heater cartridge to bake gas stripper trap again. Pressure levelled out at 8.9×10^{-3} Torr before it was turned off. Opened sublimer pump in the low 10^{-4} Torr
- Cleaned in the bottom of the tank. Lots of oil pooling around chains 1 and 2.

- While there, found that the suppressor on chain 2 was not connected to anything. There was no sign of the screw that normally connects the suppressor and no sign of damage. Really not sure if it happened while cleaning or if it's been like that since last tank opening.
- Checked inductor spacings at the bottom, all OK.
- Chain motor leg spacings are 41mm, 57mm and 53mm respectively for chains 1, 2 and 3
- Cleaned the chains
- Found a rivet on chain 3 that was holding on for dear life. Will have to be repaired.

8/4/24 Monday

- Removed one pellet from chain #3
- Powered up terminal 20lops ion pump using external Terranova. Fires up as expected. Once 60lps pumps were OK, transferred power to 20lps pump to normal terminal supply.
- Removed HiCube form terminal once stripper space was pumped and opened. Capped Weisser valve.

9/4/24 Tuesday

- Turned on shafts to do terminal tests.
- Found spark damage on pneumatic line of terminal faraday cup. Repaired.
- Closed terminal. Noted that the bottom spinning is not sitting flat, with 7mm gap one side 1mm on the other.
- Installed casting covers.
- Removed and tested U16 resistors (which were the new EBG resistors in the new clamp mounting). All values have shifted down and the spread widened (see below).

10/4/24 Wednesday

- Reinstalled U16 resistors back into machine
- Completed clean and close on remaining units.
- Completed clean and close.

11/4/24 Thursday

- Completed HV tests. Found that two resistors touching each other in U22.
- Proceed with all closing tests. All were OK. Unloaded platform and parked it at the top.

12/4/24 Friday

- Closed the porthole doors.

Gas stripper turbo cap modifications

Over a number of He leak tests, it became clear that the rear bearing cover cap of the gas stripper turbos would not be able to hold off a leak, even with changing to a larger section o-ring. This was not surprising in the end as in the operation they are designed for, leaks in this part have no impact.

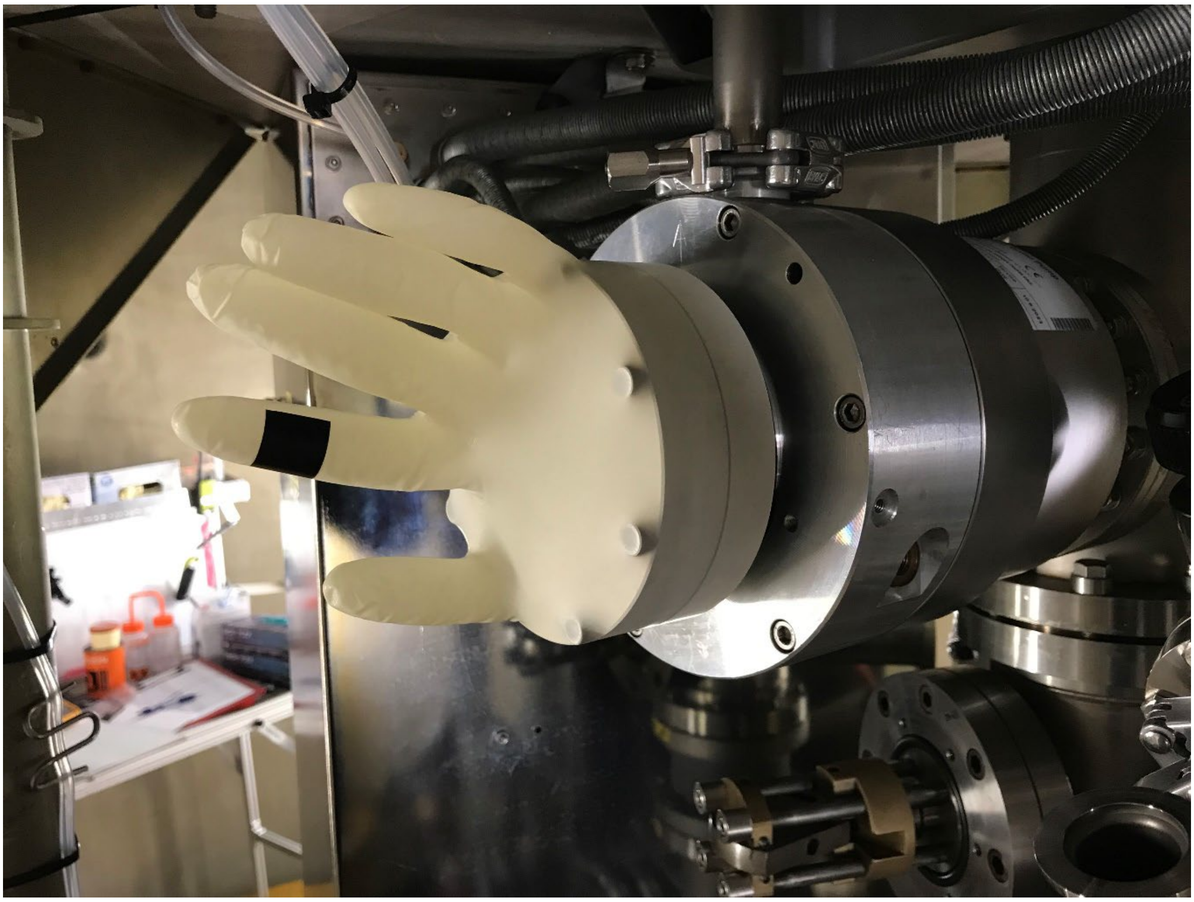

Figure 5 Leak testing of bearing covers using a Helium pressurised glove

A new cap with improved o-ring grooves, additional backup o-rings and a clamping mechanism was designed. This is project A64-XXX 14UD GAS STRIPPER TURBO in T:\030 TANK\GAS STRIPPER and is shown in Figure 6.

Figure 7 shows the turbos with the bearing cover removed. The small o-ring is the only mechanism that seals this section and there are only three screws into aluminium, which limits the clamping force. The new assembly adds another o-ring to the bearing cover and adds clamp rings to allow a higher clamping force. A half and full assembly is shown in Figure 8 and Figure 9.

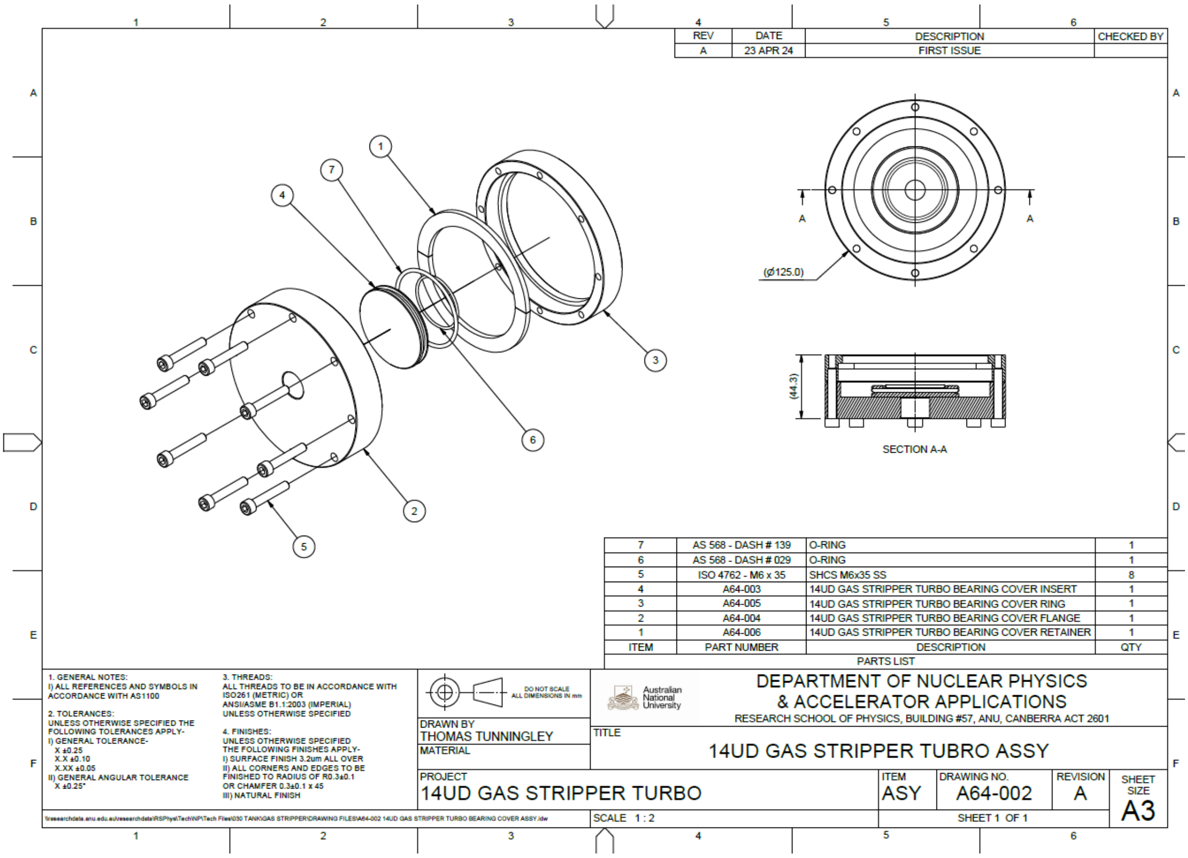

Figure 6 Assembly of modified bearing cover and clamping rings (A64-002)

Figure 7 View of rear of gas stripper turbos with bearing cap removed. There is a single small cross section o-ring that always leaks.

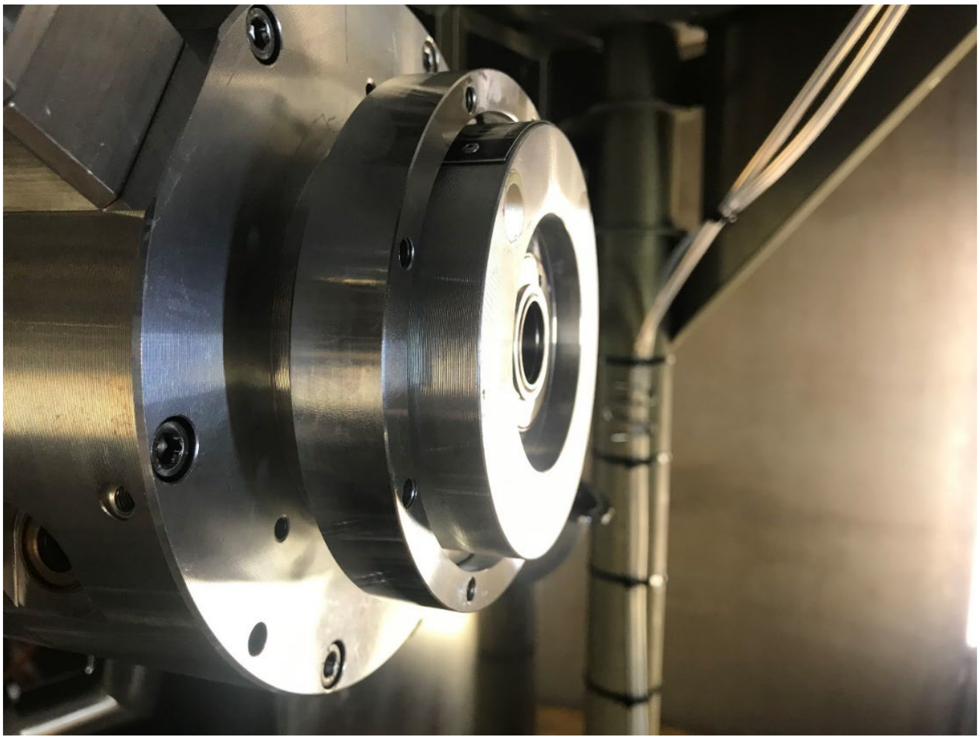

Figure 8 Rear clamp ring of new bearing cap arrangement on gas stripper turbos

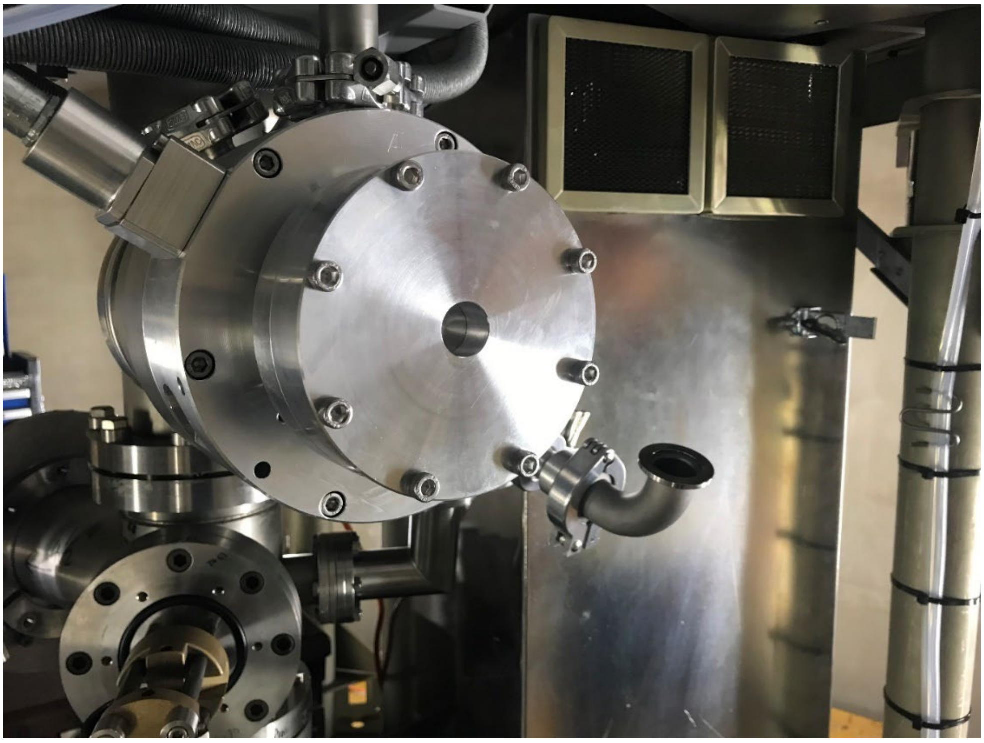

Figure 9 Assembled new bearing cap arrangement on gas stripper turbos

EBG resistor testing

During the entry HV tests, we noted that the resistance of the new EBG resistor equipped unit had dropped. All resistors were removed and tested on the bench. We were able to compare to the values measured before installation in TO #134. Data is stored in \researchdata.anu.edu.au\researchdata\RSPhys\Tech\NP\Tech Files\030 TANK\RESISTORS\MAINTENANCE\EBG RESISTOR TEST TO#136.xlsx.

Nominal values are 980MΩ and 300MΩ respectively with a nominal tolerance of 2%. The changes are shown in Table 1, Figure 10 and Figure 11.

Resistors were reinstalled because we need to determine if the resistances will settle over time.

Table 1 Statistics for resistances for EBG resistors in U16

			Mean (MΩ)	Sigma (Ω - sample)	1σ (%)	3σ (%)
Post	N=30	Initial	976.7	8.39	0.86	2.58
		TO#136	959.4	10.39	1.08	3.25
Tube	N=65	Initial	299.21	0.96	0.32	0.96
		TO#136	293.28	2.08	0.71	2.13

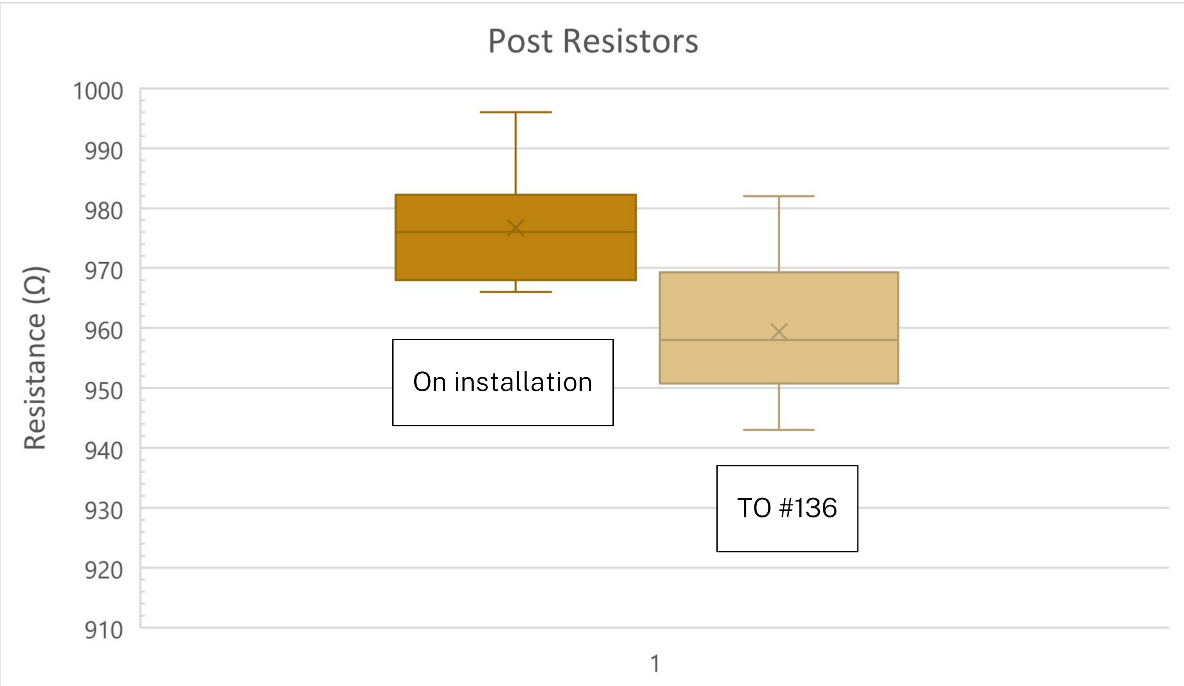

Figure 10 Quartile representation of U16 post resistors before installation in TO #134 and after use during TO #136

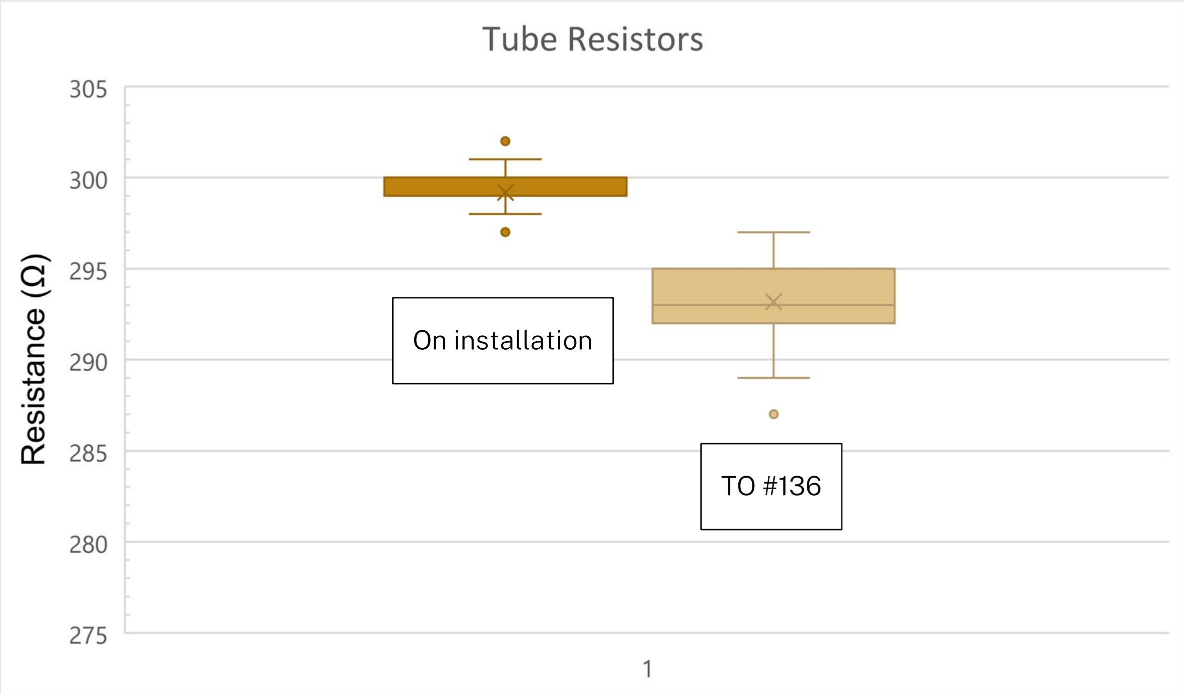

Figure 11 Quartile representation of U16 tube resistors before installation in TO #134 and after use during TO #136. Note the appearance of outliers.

Tank main valve replacement

During routine SF_6 leak chasing in May 2023, a leak was discovered around the stem of the main tank valve of the 14UD pressure vessel,

Attempts were made to quantify the leak rate by bagging around the stem which proved difficult. We did manage to seal enough around the valve body to attach a plastic garbage bag. No obvious inflation of the bag was observed over several days so we could assume that the leak was quite small.

The valve was original equipment from the 1970s so we decided to order a new replacement. The bellows below the valve was of the same vintage and would need to be removed for access so it was also renewed. An 8-inch ball valve, JC brand, was ordered from Global Supply Line and custom length 8" flexible bellows from Radcoflex.

Another consideration was the gaskets used in the original installation. Other gaskets in the gas handling plant room were found to contain asbestos and these looked suspect. WSP were called in to test the gasket material and found the gaskets contained chrysolite asbestos so would need removing by hazardous waste specialists. This process was particularly difficult due to the location of the tank valve at "Level 1 ¾" which is 12m from ground level, and also its weight which was believed to be around 90kg. Special jigs were designed by Cooper and manufactured by Tranter to enable gasket removal with the valve and bellows still in place by lowering them down threaded rods. Aztec building services asbestos team was called in. They were able to remove and clean the gasket material and leave the heavy lifting for us when the area was declared decontaminated.

A new long lift chain hoist was installed to allow lowering the old valve to the ground and lifting the new one into place. Final positioning of the new valve was achieved by lifting on threaded rods. The upper flange was sealed with Loctite 518 applied to each face and torqued to specifications of 80 ft/lbs .

An issue with the bellows length was discovered at this stage. The specified length compared to actual manufactured length was ~ 20 mm short. After consulting with Radcoflex it was decided not to stretch the flexible bellows but instead manufacture two disks of aluminium to install on each pair of gasket faces to make up the difference. Loctite Master Gasket 518 was used for all the gasket face seals, with a generous bead applied to each face.

An adaptor piece was made to allow our key interlock system to mate to the new ball valve. The actuator that was sized for the old ball valve was not quite able to open/close the new stiffer ball valve. With the assistance of a big shifter we are able to operate it if necessary. A new larger actuator was ordered through Global Supply and is in stock ready to be installed at the next opportunity.

After Gas-up of the 14UD tank, a thorough leak chase was conducted around the new gaskets and valve stem, all was leak tight.

Figure 12 Old valve and bellows before removal

Figure 13 Threaded rods for squeezing bellows to allow removal

Figure 14 Old valve after asbestos gasket removal

Figure 15 Using hoist to lower the old valve to ground level

Figure 16 Scratches and scuffs on old ball valve

Figure 17 New valve lifted in place, final lift using threaded rods

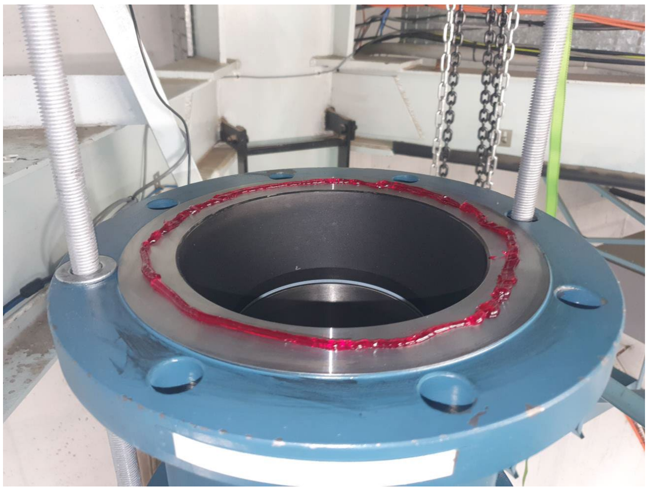

Figure 18 Loctite 518 on upper gasket face of new valve

Figure 19 New bellows lower flange with Loctite 518 on both sides of al spacer disk

Figure 20 Final assembled new ball valve and bellows

HE Stripper Mechanism

In a random inspection, it was noted that there was spark damage to the sprocket on the foil change mechanism, and this could explain the difficulty in changing foils, especially when attempting to move several in one go. When operating the foil changer, it could be seen rubbing on the ring. Further investigation revealed the extent of damage to the sprocket, so it was decided to replace it.

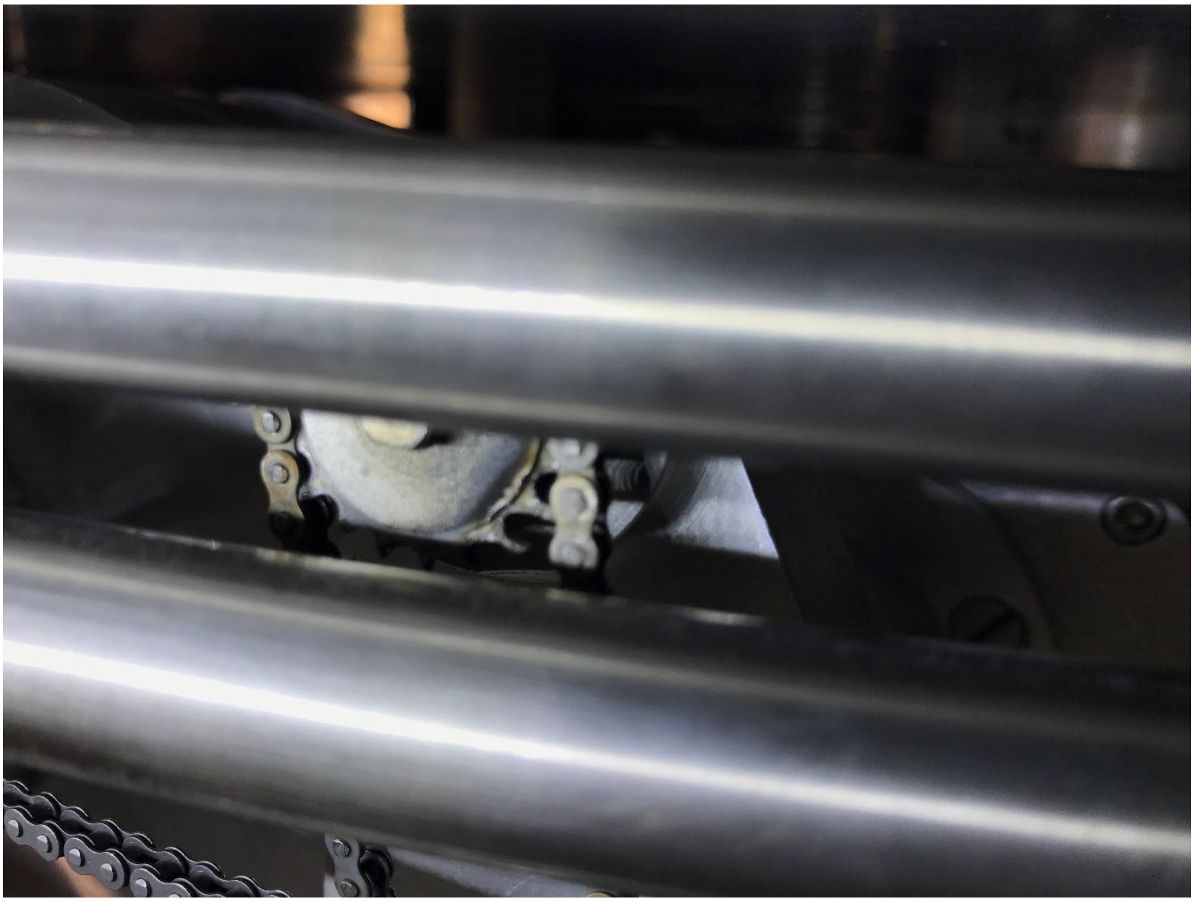

Figure 21 HE stripper sprocket in situ

Figure 22 HE stripper sprocket spark damage

In making a replacement sprocket, we could move the chain back away from the ring, and a new sprocket was designed to do that. It was made from some blank already machined and kept with the micro pitch chain bits. The freshly manufactured sprocket was a little 'sticky' with the chain and would occasionally grab, which seemed to be because the root of the teeth was quite deep. Some finishing and run-in was performed on the sprocket and its performance was improved. It was also decided that the chain be replaced as it was likely that the old chain had also suffered spark damage. Fitting the sprocket was somewhat difficult. After the initial fitting, it was noticed that the chain was still quite loose, but removing another link would make it too tight, so a nylon idler was made with an eccentric mounting hole to adjust the tension. Before refitting the chain, the mechanism and motor were synchronised to ensure that the motor was not stalled midway between counts.

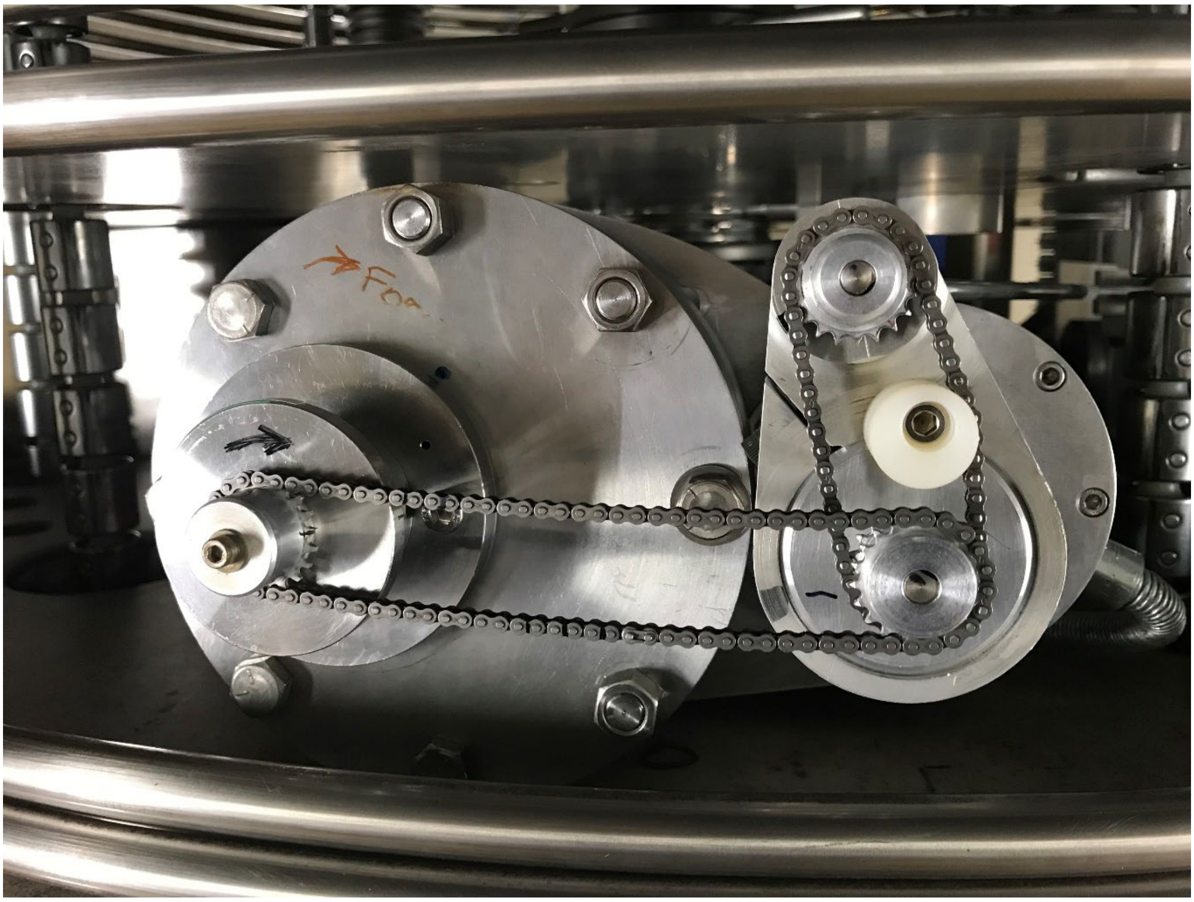

Figure 23 HE stripper assembled with new sprocket and nylon idler

With the new sprocket, chain, and idler installed, the mechanism was extensively tested in both forward and backwards directions and seemed to operate well, and the gap between the ring and sprocket looked acceptable.

Terminal cup pneumatic line

It was a known issue that the terminal cup had not been operating properly for a while. With the shafts on to power the terminal and the external SF6 bottle turned on, the cup was actuated. In the activated position, the mechanism did not trigger the limit switch. The mechanism was not at a hard stop as it could easily be pushed by hand to hit the limit switch. It seemed to actuate and relax. An increase in bottle pressure did not help. A later attempt was made to operate the cup, this time without being powered by the shafts. During this test we found an audible leak previously disguised by the shaft noise. The leak was quickly traced down to the pneumatic supply line, possibly because of spark damage. A section of tube was cut and removed, then replaced with a new piece of tubing (PFA to match) joined with a Swagelok union. The cup was then tested and operated correctly.

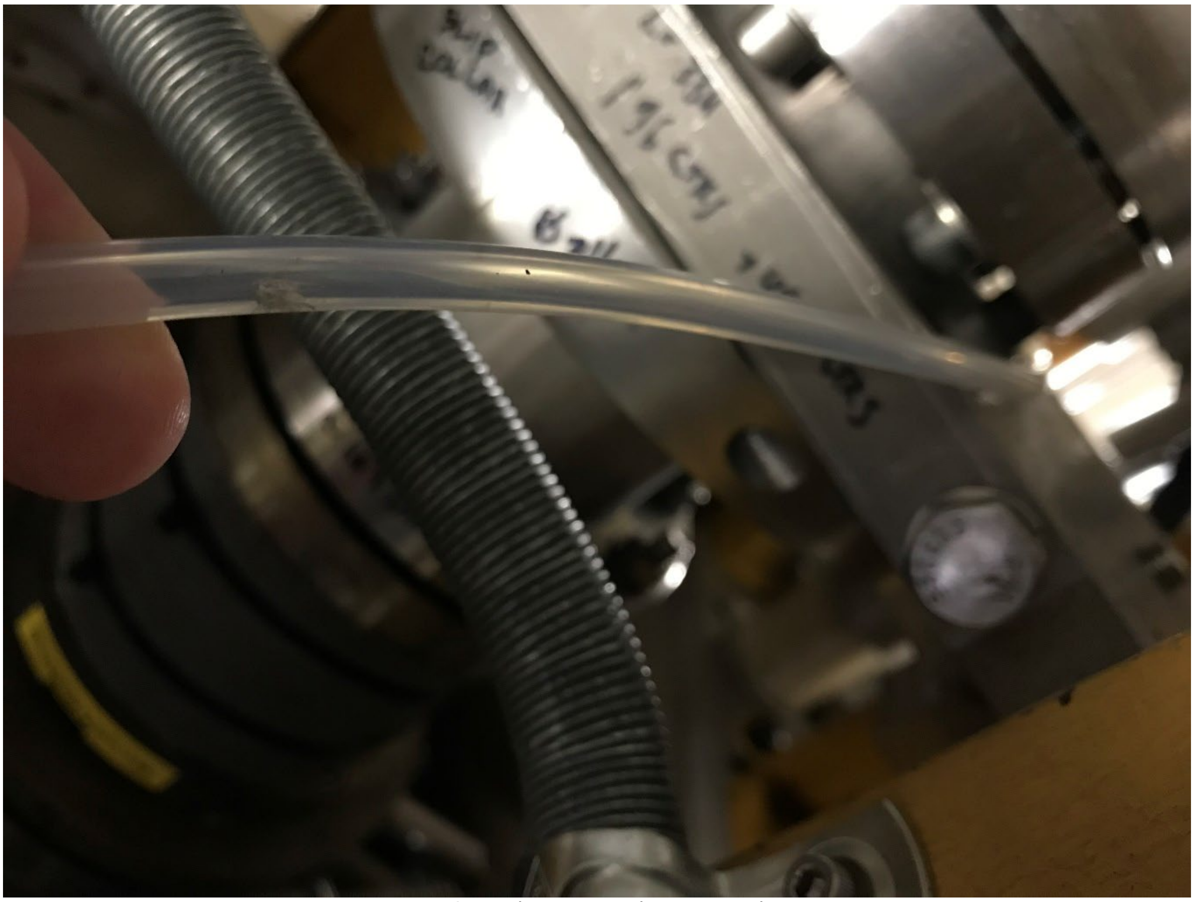

Figure 24 Holein PFA tubing to tank cup

SF_6 RGA traces

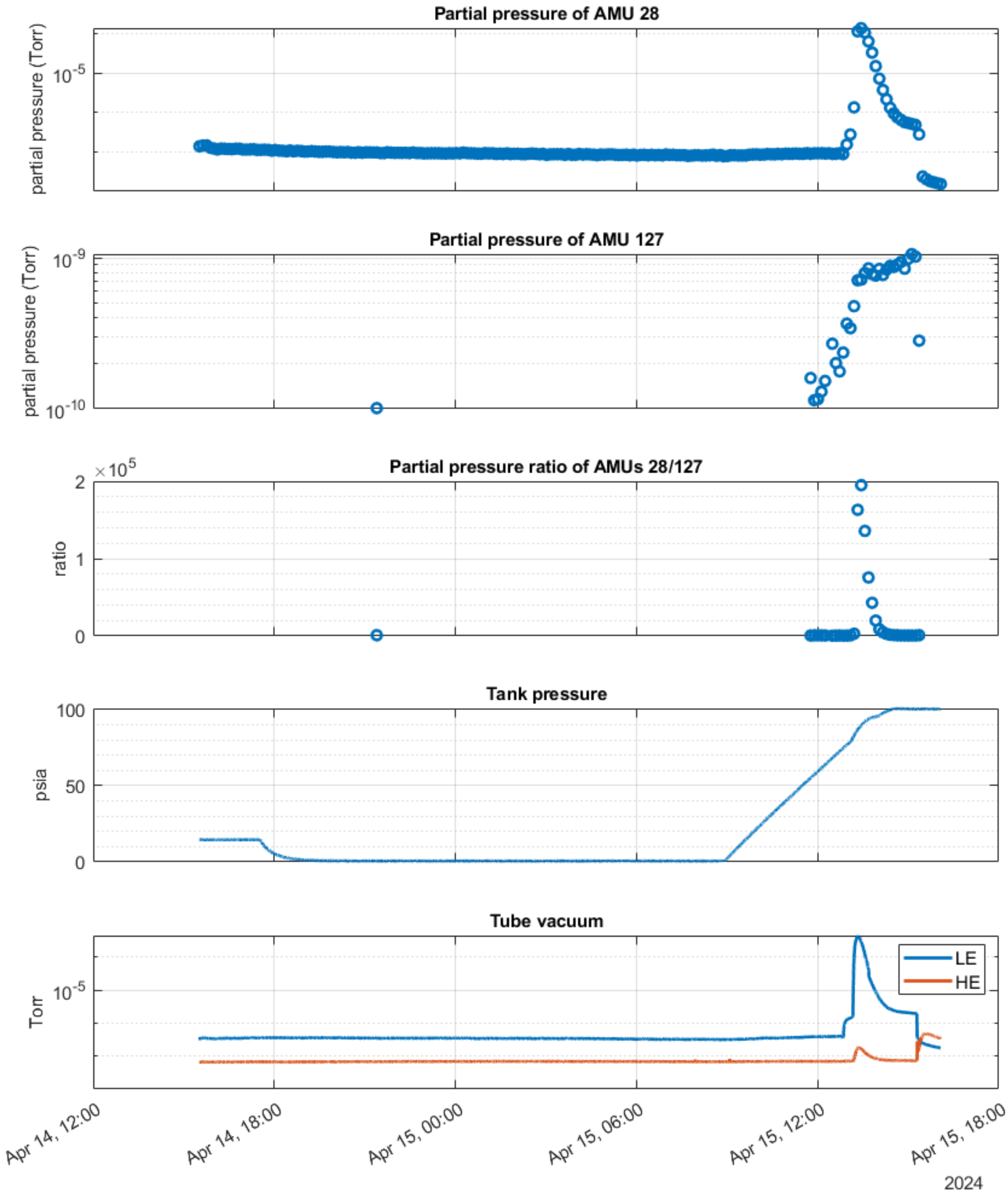

Figure 25 Recording of SF_6 levels during gas up at the end of the tank opening. SF_6 starts being detected at a tank pressure of about 60psia. This is expected but does rise to the 10^{-9} Torr level which is very slightly higher than we would like. The large increase in low energy vacuum is due to a leak in the inflection valve at level 5 during a swing of the inflection magnet and is not related to SF_6 issues in the tank.

Tube ceramic insulator current leakage

The current state of shorted tube ceramic gaps is shown in Table 2. No new shorts were added in this tank opening.

Table 2 Summary of tube ceramic current leakage in the 14UD

Unit	Tube	Gap	Leakage though insulator @5kV (µA)				Discovery	Repair
			TO #123	TO #129	TO #132	TO #134		
3	2	2	8	8.8			TO #121	Dummy resistors top and bottom, dummy on post gap ????
6	1	2	1.1	1.2		1.1	TO #123	Dummy resistors top and bottom, dummy on post gap 5, top
6	1	3	60	80		430	TO#128	Dummy resistors top and bottom, dummy on post gap 4, top
7	3	10	12	14		8.7	TO #120	Dummy resistors top and bottom, dummy on post gap 10, top
12	1	1		32	10		TO #129	Dummy resistors top and bottom
12	1	2	0.25	43	13		TO #123	Dummy resistors top and bottom, dummy on post gap 5, top
12	1	3		4	0.02		TO #129	Dummy resistors top and bottom
12	1	4		73	4		TO #129	Dummy resistors top and bottom
12	1	9		7.2	1		TO #129	Dummy resistors top and bottom
13	1	10	0	0			TO #120	Dummy resistors top and bottom, dummy on post gap 3, top

13	2	1	0.05	0.02			TO #120	Unshorted TO#129, deemed too small. Monitor.
13	2	2		95			TO #129	Dummy resistors top and bottom, dummy on post gap 8, top
24	3	10		18			TO #129	Dummy resistors top and bottom, dummy on post gap 14, top
25	3	10	7	7.2			TO #120	Dummy resistors top and bottom, dummy on post gap 16, top
26	3	5	0.15	>100			TO #123	Dummy resistors top and bottom, dummy on post gap 12, bottom
26	3	9		0.25			TO #129	Dummy resistors top and bottom,
26	3	10	0.01	>100			TO # 123	Dummy resistors top and bottom,
26	3	11	2.5	16			TO # 123	Dummy resistors top and bottom, dummy on post gap 14, bottom
28	3	1	0.01				TO # 123	None, deemed too small. Monitor
28	3	5	0.47				TO # 123	Dummy resistors top and bottom, dummy on post gap 12, top
28	3	7	0.1				TO # 123	Dummy resistors top and bottom, dummy on post gap 13, top
28	3	9	0.02				TO # 123	None, deemed too small. Monitor
28	3	10	0.05				TO # 123	None, deemed too small. Monitor
28	3	11	0.28				TO # 123	Dummy resistors top and bottom, dummy on post gap 14, top

Machine hour meter readings

Table 3 Machine hour meter readings

Date compiled	1/03/2024					
Team member(s)	PL					
Reading	**Chain #1 (1O)**	**Chain #2 (2N)**	**Chain #3 (3P)**	**LE shaft**	**HE shaft**	**Ch. volts**
Notes	New @TO121	New @TO121	New @TO118			
Change in hours	2738	2738	2738	3496	3541	
Previous total hours	38257	38179	40675			
Current total hours	40995	40917	43413			

The change in hours is now able to be calculated from EPICS using the "tank:chain:X:motor:status" and "tank:shaft:XX:motor:status" PVs for each. This was checked to be accurate against the Chain 1 and Chain 2 meter readings. The Chain 3 meter is not well and does not read accurately.

As with last time, the charging volt meter has been removed completely to remove 240VAC from the control console and charging hours can be inferred from the terminal voltage hours below. It remains in the table so that next time it will be filled from the charging system EPICS PVs

Terminal voltage distribution for period of service

The total hours with voltage on the terminal was at least 2688 hrs. This is consistent with the chain hours in the previous section

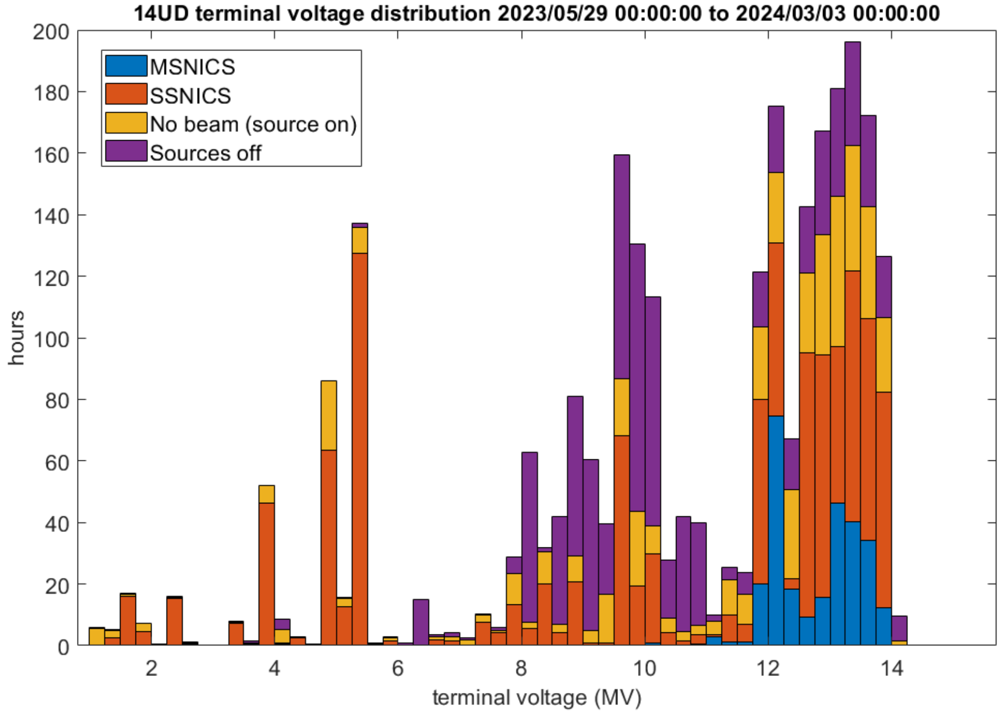

Figure 26 Terminal voltage distribution for period of operation from the end of tank opening 134 to the start of tank opening 136 with breakdown in type of usage (there was no operation before tank opening 135)

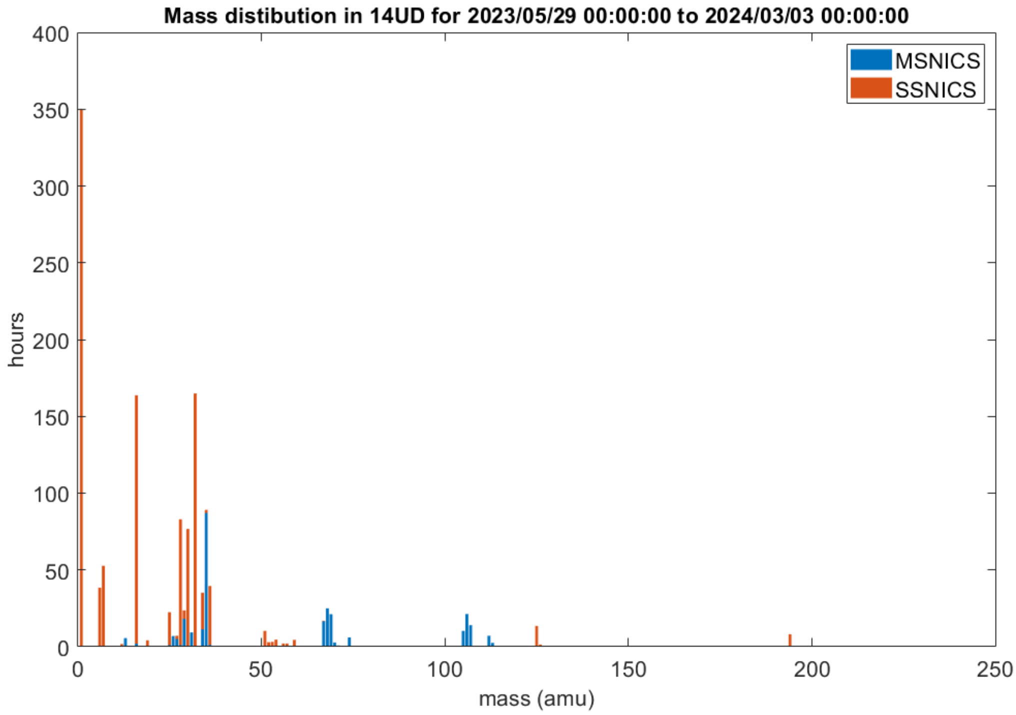

Figure 27 Ion mass distribution for period of operation from the end of tank opening 134 to the start of tank opening 136 with breakdown in type of usage (there was no operation before tank opening 135)

Initial performance

After tank closing, the gas stripper turbos were run to full speed and we observed a 0.7mTorr stripper pressure (ie no change from base). This matches what was observed during tank closing tests but of course it is reassuring to see it now when everything is closed

The tube vacuums have steadily been improving into the mid 10^{-8} Torr range. The new 20 lps ion pump in the mid-section is perhaps reading a touch higher than the old one, but there is some uncertainty of the validity of a direct comparison, given that the current calibration may differ slightly, the old pump may not have bene operating correctly etc. Anyway, something to keep an eye on as always.

On May 3, another SF_6 RGA was performed as shown below. The 127 mass peak (SF_5) was at a very low 10^{-10} range which is a particularly good background for the current state of the machine. It matches the SF_6 levels observed without the gas stripper system installed.

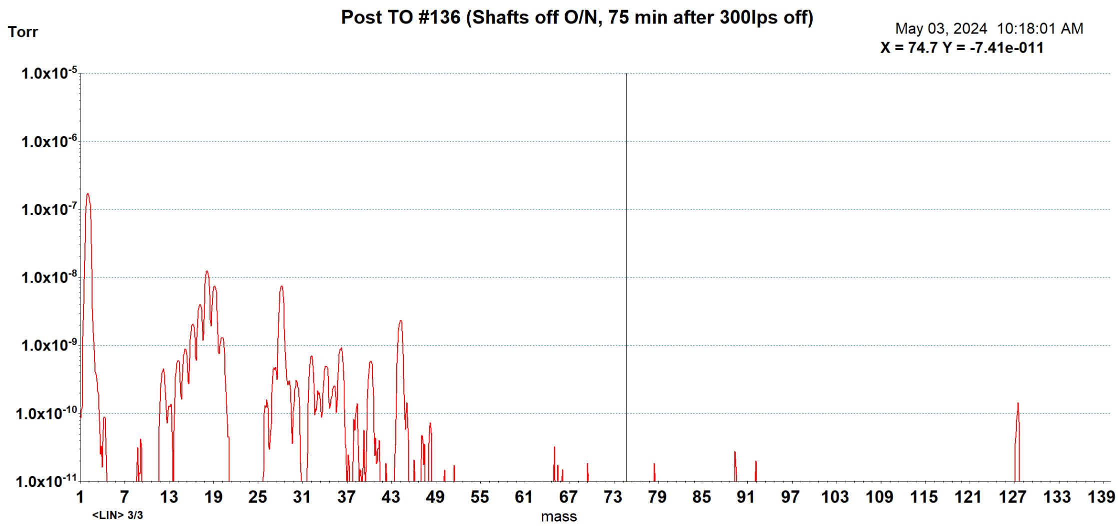

Figure 28 SF_6 trace (single, average of 3) taken on May 3 after a couple of weeks of operation. The SF_5 peak is at 1.3×10^{-10} Torr, which is back to historically "best" levels.

The 14UD initially conditioned only to 12.5MV and this has steadily been increasing. As of 29th May, it appears to condition at 13.4MV. This is without an intense conditioning effort using shorting rods, which should be the next step when time is available.