VERTICAL TEST FACILITY OPERATING MANUAL

Charly Feldman

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The following notes detail the practical aspects of operating the MPO Vertical Test Facility (VTF).

Space Projects and instrumentation
Space Research Centre
Department of Physics and Astronomy
University of Leicester
University Road
Leicester
LE1 7RH
England

Email: chf@le.ac.uk
Web: http://www.src.le.ac.uk/

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Contents

1 INTRODUCTION

The Vertical Test Facility (VTF) is a vertically orientated chamber for testing the performance of Micro Pore Optics (MPOs). Initially developed for general research and testing, it will also be used to test large batches of MPOs for space missions.

It consists of three isolated chambers; the source chamber, optic chamber and detector chamber. Each chamber has its own turbo pump and can be isolated by the use of gate valves. There is a single backing pump and inter connected backing line. Each section must be isolated before attempting to rough out or pump down any sections.

The VTF strictly operates only in the High Vacuum region and not in the UHV region, as its limiting pressure is of order 2×10^{-8} mbar.

A detailed log is kept of the operation of the VTF. All periods of TMP operation must be recorded in the logbook along with any changes to the configuration of the system (MCP detector, filters, new vacuum components etc). All maintenance should also be recorded. System pressure and general comments should be recorded daily (or as often as possible if daily measurements cannot be made). Any other useful information should also be noted as this helps trouble shooting when problems arise.

This manual should be updated as the system is altered and is designed to aid with the operation and maintenance of the facility.

2 THE VTF

The VTF (Figure 1) is a vertically orientated X-ray beamline of between 1825 mm and 2025 m, designed to test individual Micro Pore Optics (MPOs). MPOs with a focal length of 600 mm to 1000 mm can be tested within the facility. It has a vertical orientation as the MPO is able to rest on three of its four corners under gravity and therefore there are no mounting stresses or deformation. The facility is situated 500 mm off the floor to allow access to the source and for possible future extension. It consists of three sections; the source chamber, MPO chamber and detector chamber. Each section can be isolated and pumped down or let up to air independently. The design is such that when an MPO is tested, the source to optic distance = the optic to detector distance = the focal length of the MPO under test (it is essential that the source to MPO distance is equal to the focal length of the MPO, however the MPO to detector distance can be larger). The MPOs are tested in de-focus mode, with the concave surface towards the source. This is beneficial in two ways; 1. it allows MPOs with an aluminium film to be tested without damage to the film and 2. the beam coming out of the MPO is parallel and allows easier analysis of the form of the MPO in a single image. The analysis method is not discussed in this document.

A crane is positioned above the detector chamber. This is primarily used to support the weight of the structure in case of an issue, but also to allow the removal of the detector for upgrade / maintenance etc.

Figure 1: The Vertical Test Facility

Figure 2: The source chamber. Turbo pump is on the left, gauge on the right, z-drive bellows above and electron gun at the bottom.

2.1 Source Chamber

The source chamber is at the bottom of the VTF. It consists of the electron gun, the z-drive bellows, turbo pump and gate valve. The gate valve is directly above the z-drive bellows and before/below the MPO chamber. The z-drive bellows has 200 mm of travel and when it is in its compressed state, the electron gun is higher than the gate valve. **THE Z-DRIVE BELLOWS MUST BE EXTENDED TO REMOVE THE ELECTRON GUN FROM THE MPO CHAMBER PRIOR TO THE GATE VALVE BEING CLOSED.** The turbo pump, electron gun and pressure gauge are all attached to the bottom of the z-drive bellows via a cross piece. A thin film can be placed over the electron gun via a clamp (see section 7), this acts as a filter to specify the electron energy required. As such, the source chamber has to be let up to air and the electron gun removed in order to change the filter.

2.1.1 Components

The source chamber section comprises of:

Figure 3: The MPO chamber

1. Electron gun
2. Turbo pump - what type?
3. Pressure gauge - what type?
4. Z-drive bellows - details
5. Manual gate valve

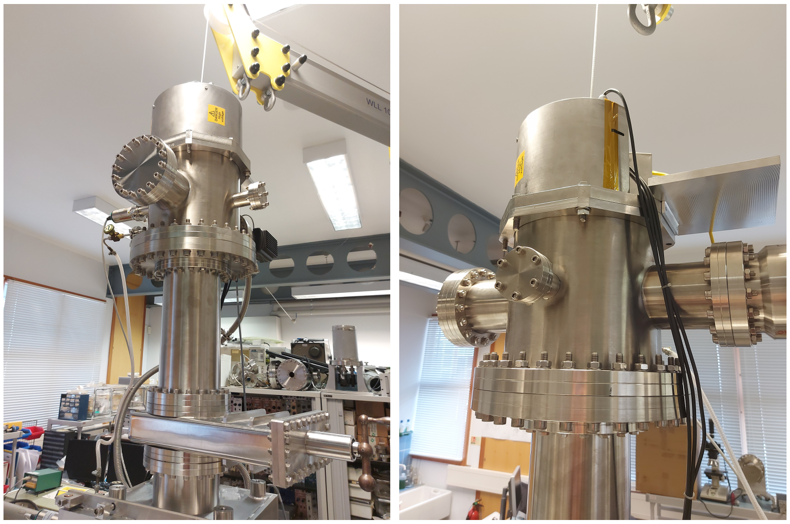

Figure 4: The detector chamber

2.1.2 Pumping down

2.1.3 Let up to air

2.2 MPO Chamber

2.2.1 Components

2.2.2 Pumping down

2.2.3 Let up to air

2.3 Detector Chamber

2.3.1 Components

2.3.2 Pumping down

2.3.3 Let up to air

3 OPERATION OF VTF PUMPING SYSTEM

3.1 Startup of TMP

1. Ensure that all dry nitrogen valves are closed and all flanges are sealed.

2. Ensure isolation, backing and roughing valves are closed. Mains control box system 1 (vacuum components) and system 2 (electronics) must be set on override.

3. Start rotary pump and leave on ballast for 15-20 minutes to warm up. Adjust leak valve to give the required ultimate backing pressure (6×10^{-3} to 10^{-2} mbar). The pump should remain on ballast if a large quantity of water vapour is to be pumped.

4. Start the TMP cooling fan. Open the backing valve and rough out the TMP to approximately 1 mbar. The TMP cooling fan must be started at this time to allow it to get up to speed.

5. Start the TMP and note the time in the log book along with the current operating hours displayed on the clock.

6. Observe TMP operation and cold trap pressure on the Penning gauge until the pressure drops rapidly into the high vacuum region and the TMP switches to normal operation as shown by the indicator LEDs on the controller. Note any comments in the logbook. Remove override on electrical system 1 so that if the TMP fails the system will be shut down.

7. Mains system 2 failure light will go out when the pressure measured on the Penning gauge is $< 8 \times 10^{-6}$ mbar.

8. If using LN_2 allow system to pump for at least 15-20 minutes before adding LN_2 to the cold trap. In many cases the system can be pumped overnight to get rid of excess water vapour before adding LN_2. LN_2 should be added slowly to avoid stressing the components. Enhanced boil off is observed for 45-60 minutes while the trap is cooling.

3.2 BACKING LINE

3.3 Pumpdown of main chamber

This is the normal mode of operation when alterations have been made to the detector or filter wheel.

1. Ensure all flanges are sealed and dry nitrogen valve is closed. Close backing valve to TMP and open roughing valve. Pump down to approximately 8×10^{-1} mbar. Note time pumpdown is started in the logbook.

2. Close roughing valve, allow backing pressure to drop to 2×10^{-2} mbar and then open backing valve. Ensure that mains system 2 is switched to override.

3. While monitoring the backing pressure on T1 slowly open the isolation valve until the pressure is observed to rise. Switch over to the Penning gauge ('P' setting) and open the isolation valve until the pressure rises to 4×10^{-4} mbar. The Penning gauge does not always fire straight away but will do so within 30-60 seconds. Tapping the gauge head gently can help it to fire.

4. Keep opening the isolation valve to maintain a pressure of between $1 - 4 \times 10^{-4}$ mbar until the main chamber is pumped out and the isolation valve is fully open. Note the time the isolation valve is fully open in the logbook. Pumpdown normally takes 10-15 minutes for a clean system.

5. Remove override on mains system 2 when pressure has dropped safely below the trip level, or just before powering up a detector.

3.4 Closedown of VTF

1. Ensure gate valve to X-ray source is closed and that the PC is isolated under vacuum.
2. Ensure that all high voltages and high vacuum gauges are off. Mains failure box system 2 should be switched to override.
3. Close isolation valve.
4. Slowly open the dry nitrogen valve and let the chamber come up to approximately 200 mbar. A higher pressure can be used but 200 mbar is enough to remove any problems with water vapour.
5. If the LN_2 trap is in use allow the liquid nitrogen to evaporate with the TMP still running (e.g. overnight).
6. Place mains failure box system 1 on override.
7. Close the backing valve, stop the TMP, switch off the power failure inlet valve and stop the cooling fan. Note the time and the current TMP operating hours in the logbook.
8. Close backing line leak valve and stop rotary pump.
9. Unplug the TMP controller (Turbotronik) as it gets hot if left switched on.

On no account must the TMP be left under vacuum when stopped since hydrocarbons can migrate from the bearings into the vacuum chamber. The TMP should be let up to dry nitrogen as soon as possible after switching off by switching of the electromagnetic power failure airing valve. Do not leave the vacuum system being pumped by a rotary pump at its ultimate vacuum as this will cause oil backstreaming. If the VTF must be pumped at rough vacuum then adjust the dry nitrogen leak valve to produce an ultimate pressure of 0.5-1 mbar. In practically all cases it is very much better to leave the system under a few hundred mbar of dry nitrogen.

3.5 Pressure measurement

The pressure inside the VTF can be measured on five different types of gauges. Rough vacuums are measured using Thermovac (Pirani) and Bourdon gauges and high vacuum is measured using a Penning gauge an Ion gauge and a Quadrupole mass spectrometer (Anavac). The vacuum should be checked for quality, e.g. leaks and contamination, periodically using the Anavac.

4 VACUUM SYSTEM COMPONENTS

Some of the major components of the VTF are listed below. This list is intended as an aid to maintenance on and modification of the VTF.

1. Leybold-Heraeus Trivac D4B two stage rotary pump 80 litres per second; (112-45); 16KF vacuum flanges
2. Leybold-Heraeus exhaust filter; (189-05); 16KF vacuum flanges
3. Edwards LV5 leak valve; (08-C370-01-000); SC5 vacuum flanges
4. Leybold-Heraeus secuvac valve; (273-03); 32KF vacuum flanges
5. Leybold-Heraeus adsorption trap; (854-15); 25KF vacuum flanges
6. Leybold-Heraeus thermovac gauge TR201; (162-02); 10KF vacuum flanges
7. Leybold-Heraeus turbovac 150; (854-71); FC100 vacuum flanges
8. Edwards power failure airing valve PVA5E; (08-C310-03-000); SC5 vacuum flanges
9. VG cold trap; (CCTH100); FC100 and FC150 vacuum flanges
10. VAT series 01 gate valve (01032-CE01) FC38 vacuum flanges
11. Leybold-Heraeus Penning gauge PR31; (162-85); 40KF vacuum flange
12. VG gate valve; (MGV150); FC150 vacuum flanges
13. VG PC movement; (special NS.1535/1D); FC150 vacuum flanges
14. Fortex MCP detector body; (special A1-58-210)
15. VG mass spectrometer; (Anavac); FC38 vacuum flanges
16. VG gate valve; (CST28); FC38 vacuum flanges
17. VG all metal valve; (CRD919R); FC16 vacuum flanges
18. VG rotary drive; (RD6); FC38 vacuum flanges
19. VG rotary drive; (RD7); FC38 vacuum flanges
20. VG linear motion thimble; (LM50); FC38 vacuum flanges
21. Ferranti ion pump; (FJD15); FC38 vacuum flanges (no longer used)
22. VG ion pump power supply; (VPS60); (no longer used)
23. AXAF chamber; (E.XAF.3246, C.XAF.3610)
24. AXAF MCP detector; (C.XAF.3472, C.XAF3479)
25. Filter wheel and collimating hole (E.XAF.4478)

5 X-RAY GENERATION - ELECTRON GUN SOURCE

An electron gun was bought to produce 100μm source spot sizes (see table 1) to support the optics work.

Manufacturer	PSP Vacuum Technology
Telephone	01625-500154
Model	ELS5000
Delivered	February 2001
Serial Number	00120119
Maximum energy	5000V
Maximum current	30μ
Minimum spot size (spec)	25μm
Minimum spot size in situ	130μm
Nominal working distance	75mm

Table 1: Details of the electron gun used in the small spot size X-ray source

5.1 Installation and preparation

When using and handling the electron gun you must remember that it was designed for UHV operation, and is typically used on surface science type experiments. All vacuum surfaces should be kept clean and ALWAYS handled with gloves. The pressure in the vacuum chamber must be better than a few$\times 10^{-9}$ mbar before it is switched on. In practice this means that the chamber must be vacuum baked after it has been let up to air.

The gun emits low energy electrons and as such the performance of the X-ray source is sensitive to magnetic fields. Do not bring magnets close to the gun or the chamber, since this will move and degrade the electron spot and hence degrade the operation of the X-ray source.

The gun has been mechanically aligned so that the X and Y controls on the power supply correspond (approximately) to X and Y on the source.

It is not normally necessary to remove the electron gun from the vacuum pipe. If for some reason (eg broken filament) the tube is taken apart, then it should be re-assembled with the flange alignment marks correctly lined up to preserve the X and Y alignment.

To install and pump down the electron gun proceed as follows:

1. Place a new copper gasket on the source chamber flange, remove the old gasket from the top flange (if necessary), place the electron gun assembly on the source chamber, ensure alignment marks match up and insert bolts.
2. Ensure that the dry nitrogen inlet valves are closed
3. Turn on TMP backing pump (by plugging it in) and allow to pump for 5-10 minutes
4. Switch on TMP and monitor controller to ensure it gets up to full speed.
5. Allow to pump for approximately 1 hour and then turn on mass spectrometer to monitor pressure. The mass spectrometer should cut out if the pressure is too high, but switching it on regularly at high pressures will shorten the filament life.
6. The chamber is normally allowed to pump overnight before bakeout starts, but in all cases the pressure should be below 2×10^{-6} mbar before heat is applied.

7. The chamber should be baked with the bypass valve closed and the gate valve open so that outgassing from the bypass line does not degrade the ultimate vacuum achievable in the source chamber.
8. Fit orange heater tape around the electron gun chamber, X-ray source chamber, mass spectrometer pipe and TMP port. Do not place any heater tape close to the plastic window by the gate valve in case it fails.
9. Place PRT onto top of chamber flange and secure with Al tape. Try to ensure good thermal contact is made with the flange and do not place too closely to a section of heater tape.
10. Cover all sections of the system that have heater tape with several layers of aluminium foil to provide thermal insulation. The foil will increase the efficiency of the bake and help to ensure an even temperature distribution.
11. Place bakeout notice on outside of laboratory door and display 'Hot surfaces' sign by the X-ray source.
12. In normal circumstances the chamber should be baked for a whole day, eg 9-5, and then allowed to cool overnight. If modifications have been made or the chamber has been at atmospheric pressure for a long time a longer bake may be needed.
13. The measured temperature on the PRT has been between 50 and 180 degrees centigrade. The better the thermal contact made by the PRT the more accurate the measurement will be.
14. When chamber has cooled remove sign from door and put away 'Hot surfaces sign'.
15. The system pressure when cold should be better than 5×10^{-9} mbar.

5.2 Removal of electron gun

The electron gun needs to be removed from the chamber for the following reasons:

1. To clean or replace the anode tip
2. Install a foil on the anode generate characteristic X-rays
3. To replace a filament
4. To carry out a re-calibration

Note that the practice of 'painting' on compounds to generate characteristic X-rays is discouraged on this source in order to keep the gun clean.

The electron gun should be kept under vacuum if at all possible, even when the system is not in day to day use . It should only be let up to atmospheric pressure if one of the above apply.

To remove the gun and gain access to the source chamber proceed as follows:

1. Switch off the electron gun and unplug the connector from the top of the gun.

2. Remove the mu metal shield and place carefully to one side. Do not drop or otherwise shock the shield as this will affect its magnetic shielding properties.

3. Close the X-ray source gate valve and open the by-pass valve to protect the plastic window.

4. switch off the mass spectrometer and remove the RF head.

5. Turn off X-ray source TMP and allow it to slow down for 5 minutes. The TMP will start to whine as its slows.

6. Turn off X-ray source TMP backing pump (the pump in use at present has to be unplugged to switch it off).

7. Wait for TMP to stop spinning (15-20 minutes).

8. Open the two valves on the X-ray source dry nitrogen line and allow the chamber to come up to atmospheric pressure (will not take long).

9. Disconnect backing line to TMP.

10. Remove bolts from chamber flange and carefully lift off electron gun assembly. If the copper gasket remains on the flange then the assembly can be safely placed on a suitable surface. If the gasket remains on the source body, use some means of protecting the knife edge before placing the flange on a surface.

5.3 Operation

After the gun has been baked out and the chamber pressure is $< 5 \times 10^{-9}$ mbar the gun can be switched on. The chamber pressure during operation should never rise above 1×10^{-7} mbar, if it does the gun should be turned down or switched off and additional pumping or bakeout carried out.

The electron gun manual should be read and understood before using the electron gun for the first time.

The electron gun is operated as follows:

1. Switch on power supply and power up as described in the gun manual. Note that once a filament has been used a few times and is 'burnt in' a faster switch on sequence can be followed.

2. Set operating parameters as required, a typical set of values is given in table 2. Note that the actual value of the sample bias is not important but to prevent the anode charging up a nominal setting is needed.

3. For approximately the first hour of operation the measured sample current will increase gradually. After this the gun will become much more stable.

4. The measured sample current is a function of the sample bias voltage although changing the bias does not make much difference to the X-ray yield.

Kinetic energy	As required for X-ray generation
Focus	6.35
Typical filament current	2.3-2.5 Amps
Wehnelt	mid range
Typical X	6.0
Typical Y	8.0
Typical sample current	
Typical sample bias	3V

Table 2: Typical operating values for the electron gun

5.4 Calibration

When measuring the properties of MCP optics it is useful to have a feel for the flux that is falling on the input face of the optic. In general it has been found that provided none of the other controls, ie focus, X and Y deflection etc, are changed, the output flux from the source for a given emission current is approximately constant from one switch on to another.

It is possible to calculate the X-ray flux $s^{-1}sr^{-1}$ using the technique detailed below. A small pin hole is used in order to keep down the count rate on the detector and avoid errors from count rate statistics and problems with computer buffers filling up.

1. Install a 1mm diameter pin hole on the linear drive opposite the filter wheel and wind in to centre the x-ray spot on the detector. Table 3 gives typical solid angles.
2. Accumulate a series of images with different values of emission current. Note the integration time for each image.
3. Linearise images using a current linearisation table. Normally use 1024 pixel images but 512 or 2048 can be used (table 4).
4. Analyse the image using Q. The W90 value is the diameter of the circle that encompases 90% of the energy (counts) and is obtained using beamdata.
5. Calculate the spot size on the X-ray source anode and check that it is comparable to previous occasions.
6. Calculate count rate in X-ray spot and using solid angle convert to a count rate per steradian. Using this the expected count rate on a fully illuminated detector can be calculated.

Object	Distance from source (mm)	Solid angle (sr)
1mm pin hole	444.5	3.97×10^{-6}
AXAF detector 93mm sq	1382	4.528×10^{-3}

Table 3: Solid angles for typical calibration setups on the VTF.

A typical set of results from a calibration done using the X9 detector are shown in table 5.

Detector resolution	Pixel size (μm)
512	304
1024	152
2048	76

Table 4: Bined up pixel sizes for an AXAF detector using the 11 bit Ortec octal ADC

Parameter	Value
Image	IMG326
Pixel resolution	1024
Linearisation table	lin231.data_array
Kinetic energy	1.5kv
Filter	None
Emision current	0.25μA
Integration time	258 seconds
Counts in W90 of circle	1109
count rate in circle	4.2 s^{-1}
Flux through pin hole	1082732 $s^{-1}sr^{-1}$
Flux on detector	4959 s^{-1}

Table 5: Results from a typical flux calibration done using the X9 detector in the VTF

5.4.1 Focusing gun

To get the optimum source size, ie as small an electron spot as possible, PSP use a video monitor unit and raster the electron beam. Optimum focus is achieved when you get a sharp image of the anode.

The equipment list and basic connection information is given below:

1. One monitor unit
2. One TV scan unit
3. One video pre-amplifier box
4. One short BNC - BNC cable to Connect the TV scan unit composite video output to the monitor unit video in.
5. One 15 way D-type cable for video pre-amplifier (power ±15V)
6. One 4 way QM to 5 pin DIN deflector cable + "MOD". Connections are DIN (1, 2, 3, 4) to QM (D, C, B, A)
7. Connect the X-ray source anode to the video pre-amplifier signal input BNC
8. Use a BNC - BNC cable to connect the pre-amplifier video output to the TV scan unit EVIC signal.

The above approach is only possible with the use of the PSP equipment, which in general we will only have for the initial setup. For in house re-calibration a 100μm hole is inserted into the X-ray source as described in section 5.4.2 and an image taken for each setting of the beam focus. By analysing each image in Q using 'beam' and using the pinhole camera equation the optimum focus setting can be determined.

When it is not practical to open up the X-ray source it is possible to do the calibration using a 1mm diameter hole on the normal linear drive. The sensitivity is rather low in this position but optimisation is possible.

5.4.2 X-ray spot size calibration

The size of the X-ray spot can be determined in a number of ways:

1. Pin hole camera using a small spot
2. Larger pin hole and make allowance for hole size using the pin hole equation
3. Look at the shadow of a straight edge

The most straight forward way to do this is to use a pin hole which is small with respect to the source size (eg 10μm). Unfortunately this also severely reduces the count rate from the source and is not a practical option.

The approach adopted is to place a 100μm hole in the X-ray source close to the anode (where the original collimating apertures were placed). By using the pin hole camera equation (equation 1) the size of the X-ray spot can be calculated.

$$d_s = \frac{(d_I - d_p)L_s}{L_I} - d_p \tag{1}$$

Where:

d_s	X-ray source diameter
d_I	Diameter of image of X-ray source on detector
d_p	Diameter of pinhole
L_s	Source to pin hole distance
L_I	Pin hole to detector distance

Note that the measured size of the X-ray spot does not seem to depend on the X-ray energy selected. To maximise the count rate through the small pin holes select either the macrofol filter or even no filter at all. When these filters are used a ring will be seen on the detector which is due to reflections off the vacuum tubing, this can be safely ignored.

5.5 Typical X-ray properties

Typical operating conditions and results are shown in table 6.

X-ray line	Cu-L	Ti-L	Mo-L
Energy (keV)	0.93	0.45	2.3
Kinetic energy (keV)	2	1.5	3.5
Anode Material	Cu	100μm Ti	100μm Mo
X-ray filter	4μm Al	none	1μm Ag
Approx emission current (μA)	1.3	0.3	2
X-ray flux $s^{-1}sr^{-1}$		1300000	1600000
Typical spot size μm		80	250

Table 6: Typical set up of the electron gun X-ray source

5.6 Magnetic shielding

The X-ray source chamber has been next to a large ion pump magnet for approximately 20 years and hence is slightly magnetic. There are also other electric and magnetic fields in the laboratory that can interfere with the focusing properties of the electron gun. To help shield the gun from these fields and allow small spot sizes to be obtained, a Mu metal shield is placed around the gun when it is being used.

The magnetic shielding effects of Mu metal can be easily destroyed if it suffers any shocks. The shield must be handled very carefully otherwise it will have to be re-annealed. Re-annealing can be done by ???

6 OPERATION OF MCP DETECTOR

6.1 AXAF detector general

The AXAF detector is designed to accept flight style AXAF MCPs which are 100mm$\times$100mm square and 1.0 to 1.5mm thick. The detector is a standard chevron configuration with a resistive anode readout and is a lab design only. A list of the available resistive anodes is given in table 7 together with some quality measurements. The target resistance per square value was 66kΩ, td is ??? and ΔR_1 is a measure of the spread in the four single terminal resistances. The anode in use at present is the 6A. The best anode was not chosen for the initial work in case there was any problems with the detector construction which resulted in damage to the anode.

Anode number	1	2	3	4	R_{tot}	R_{gem}	R_{square}	td	ΔR_1
1A	106.4	103.8	100.7	103.5	414.4	103.6	65.7	5.5	-0.3
2A	124.5	120.0	121.2	130.5	496.2	124.05	78.5	8.46	12.5
3A	111.1	112.6	113.1	113.7	450.5	112.6	71.3	2.3	5.3
4A	108.3	106.5	110.0	112.4	437.2	109.3	69.2	5.39	3.2
5A	123.4	116.4	113.2	121.0	474.0	118.5	75.0	8.6	9.0
6A	109.3	108.0	106.0	107.7	431.0	107.75	68.2	3.1	2.2
7A	112.8	116.0	111.4	110.0	450.2	112.55	71.2	5.3	5.2
8A	125.7	115.2	113.2	116.8	470.9	117.7	74.5	10.6	8.5
9A	109.1	103.2	99.1	107.6	419.0	104.75	66.3	9.5	0.3
10A	108.5	104.8	102.0	109.0	424.3	106.07	67.1	6.6	1.1
11A	106.2	104.2	106.2	107.3	423.9	105.98	67.1	2.9	1.1
12A	100.0	96.4	93.9	99.5	389.8	97.48	61.7	6.2	-4.3
13A	100.8	100.1	97.8	100.2	398.9	99.72	63.1	3.0	-2.9
14A	114.8	120.3	126.6	121.8	482.7	120.68	76.4	9.8	10.4
15A	102.2	102.8	98.6	100.5	404.1	101.0	63.9	4.2	-2.1

Table 7: AXAF resistive anode data

6.2 Detector details

Refer to technical reference manual MCP055 'MCP general laboratory manual' for details on detector naming schemes and assembly instructions.

6.3 Removing/installing the detector from the VTF

1. Power down the detector and remove HT cables.
2. Switch off power to the pre-amplifiers and disconnect signal cables.
3. Let vacuum chamber up to atmospheric pressure.
4. Install support post onto linear slide.
5. Adjust X, Y and θ drives to allow post to be attached to detector flange. Nominal positions are X=****, Y=****, θ=****.
6. Unbolt flange, draw back flange on slide and rotate through 90 degrees.
7. Fit dry nitrogen cover, and flow nitrogen over the detector if a photocathode is present.
8. Disconnect electrical connections and unbolt detector.
9. Transfer detector to dry box or laminar flow cabinet.

The detector is installed in the reverse order and the system pumped down.

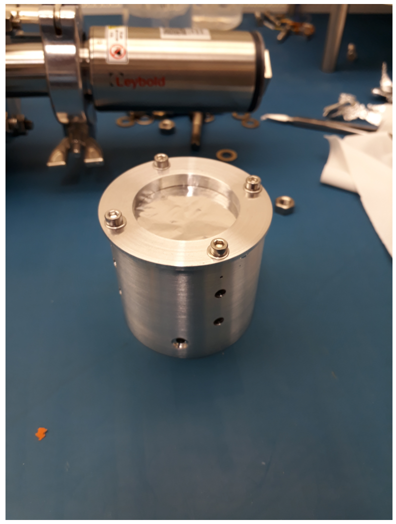

Figure 5: The source filter

6.4 Detector connections

6.5 Operating the detector

See technical reference manual MCP055 for details on power up procedures.

7 SOURCE FILTER

8 GENERAL OPERATING INFORMATION

8.1 Mains power

All the mains power to the VTF is provided by a dedicated 30 Amp main and is filtered by a integral RF interference filter. Power is distributed to the various sockets by the mains control box. The output is protected by circuit breakers mounted on the rear of the box.

The mains control box is designed to ensure that the system fails safe. If the mains supply is interrupted no power is applied to the equipment until the box has been manually reset. This avoids the possibility of the rotary pump pumping down the system after a failure and leaving the TMP under vacuum while stopped (section 3.4). Power will also be removed from the system if the TMP stops for any reason.

Mains system 2 only is controlled by using the Penning gauge chart recorder output from the combitron. This allows the electronics to be switched off if the pressure inside the system rises too high. The circuit has some hysteresis built in so that the switch on point is lower than the switch off point.

Before power is restored after a failure situation all electrical equipment should be switched off and appropriate valves closed. If any problems occur with the mains box see the departmental electronics workshop.

9 ELECTRONICS

All the electronics for the VTF are located outside the vacuum chamber for ease of access, only the readout element itself is under vacuum. For circuit diagrams and calibration details refer to the folder entitled Equipment Calibrations (VTF). When problems occur with commercial equipment then the appropriate manufacturers manual should be consulted. Some electronic manuals may be found in the office filling cabinet others are kept by the departmental and electronics groups.

9.1 NIM

Pre-Amps The pre-amplifiers are sited outside the vacuum system and are connected to the readout via triaxial cable to minimise the pickup of electrical noise. They were designed and made by the departmental electronic workshop and are housed in two boxes. The two X axis preamps (1 and 3) are in one box and the two Y axis pre-amps (2 and 4) are in another. The pre-amps interface via a multi wire cable to the interface module. Test capacitors are 1 μF.

Interface module This module provides power to the pre-amps and routes the signals to the various amplifiers. A single pulser input can also be routed to any combination of the four pre-amps, using front panel switches, for electronic testing.

Four way amplifier This is a unit which was specially designed by Chris Whitford for the AXAF system. Due to constraints on Chris's time the final testing and construction of the amplifier was done by the departmental electronics workshop. The four channels are designed for an imaging chain and have a common time constant control, normally 2.2μs. Other timeconstants are available but they cannot be adjusted from the front panel, instead internal links must be resoldered. The output of the amplifiers are fed to the Octal ADC.

Four input summing amp This unit sums the four pre-amp signals

Summing amplifier The design of this unit is identical to the four way unit and is used to amplify the summed pre-amp signal. The time constant is again 2.2 μs. The signal is then fed into the imaging SCA which then produces a strobe for the ADCs

Counting SCA Two Single Channel Analysers (SCA) are used on the system, one for the counting chain and one for the imaging chain. This is done so that the counting channel is not constrained by the relatively narrow limits required for imaging. The output normally used is LL out which records all pulses above the lower level.

Imaging SCA This is a home built SCA which is used to strobe the Octal ADC. In order to get over the problem of different time constants producing different gains the SCA will always strobe the ADC if an event crosses the lower level threshold. If an event also crosses the upper level threshold the ADC is reset through the fast reset input. If an event is accepted further strobe pulses are disabled for a period of 90μs.

Pulser A tail pulse generator is used on the system to simulate the shape of the pulses coming from the resistive anode. It is used to calibrate the gain of the electronic chain and to generally check the operation of the electronics.

9.2 Other

SCALER A continuously recycling scaler is used to give a visual indication of the instantaneous count rate.

X-RAY SOURCE POWER SUPPLY The X-ray source is powered by a commercial Wallis-Hivolt power supply (5KV 6mA) together with a home built emission stabilizer. The power supply sits close to the X-ray source and the emission stabilizer sits in the electronic rack with control wiring connecting the two.

MCA A Canberra series 30 MCA is used to accumulate MCP PHDs. The MCA is connected to both the plotter and the R140 and PHDs can be transferred to both. Data from the MCA to the R140 is transferred via the RS423 line. Computer control of the MCA is also possible from the R140 user port, which allows the MCA to be remotely started, stopped, read out and cleared. The MCA was modified in house to allow computer control and consisted of mimicking the operation of the front panel switches using relays.

PLOTTER The plotter is normally connected to the MCA to allow plots to be taken of PHDs, but it is also used to get hard copy of mass spectrometer scans. The plotter incorporates a null detector for used with the MCA to speed up the plotting by allowing less time for the pen to move when it does not have to move very far. The null detector and the MCA connection must be removed when it is connected to the Anavac otherwise it will effect the resolution of the mass spectrum.

CRO A scope is used to monitor the output of the electronics and is especially useful when tracking down problems. Used to measure pulse heights when calibrating the electronic gain.

10 HOW TO TEST AN MPO

11 MANUAL REVISION INFORMATION

All revisions to the manual should be recorded here.

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OUTSTANDING ITEMS

- Everything