

## ISIS OPERATING INSTRUCTION No. 107

### PROCEDURE TO BE FOLLOWED BEFORE INSPECTING OR CHANGING AN INJECTION STRIPPING FOIL

Changing a Stripping Foil presents potential hazards through radiation exposure and contamination due to possible airborne foil particles. The removal and insertion operation is delicate in nature and requires a high degree of control. New foils can be readily damaged by not following the instructions below or by careless handling.

**Health Physics and Vacuum support is required if the foil is suspect and should be called immediately after beam has been turned off.** Health Physics support is required such that proper contamination controls are adhered to. In addition air sampling may be required to be undertaken at the discretion of the Health Physicist. Vacuum support must be requested. This is to limit machine down time should re-sealing the V band clamp or ring vacuum system cause problems.

- a. Run down the Main Magnet Power Supply – See separate Electrical Engineering document for MMPS shutdown and run-up procedure.
- b. To allow for adequate decay of short lived nuclides, a minimum delay of 1 hour must elapse before entry to the Outer Synchrotron is permitted. After this time, evaluation of the foil condition may be made.
- c. If it is deemed necessary to change the foil the Duty Officer, or RPS, must issue a Radiological Permit to Work before the procedure commences. All persons involved in/attending the foil change procedure should be named.
- d. Withdraw the suspect foil into the foil chamber using the ISIS Controls Menu and observe the readout for correct operation. Fully in is approximately 228 and fully out is 25 but these may vary slightly. Note these values for future reference.  
*Root\_Synchrotron\_Injection\_Foil, Mirror & Scints\_Withdraw Foil.*
- e. Switch off the Injection Dipole from the ISIS Controls Menu and observe the readout and the oscilloscope current waveform for correct operation.  
*Root\_Synchrotron\_Injection\_Injection Dipole\_ON/OFF*
- f. Close both sets of Roller Shutter doors in R6 (East and West side of EPB2) and post signs at the controls to forbid the opening during a foil change.
- g. Switch off ventilation fans for EPB1 and EPB2 at controllers located in R55 and R6 respectively. Photographs are shown in Appendix B.
- h. Switch off the synchrotron room air conditioning in order to reduce the risk of damage to delicate foils. Photographs are shown in Appendix B.
- i. Collect 2 respirators and four associated batteries (two spare) from the target station changing room (Fig.2).
- j. All procedure participants must be issued with a personal dosimeter (RADOS) but the foil changer should wear the dosimeter and film badge placed, ideally, at upper body level to accurately measure radiation dosage.

- k. Take a suitable torch and batteries to view old and newly installed foil
- l. Collect the foil tool box key, from the MCR high security key press, and the motor drive assembly from the MCR lower store (Fig.1) and proceed to Synchrotron Outer.
- m. Switch off the cooling fan to the Injector Dipole Transmission Line. This is located opposite the Injection Dipole on the 'outer' wall and shown in Appendix B.

*Before the foil change commences Health Physics should ensure that the following are in place:*

- *Box of gloves - frequent changes may be necessary*
- *Coveralls and 2 pairs of overshoes for the foil changer and persons at the machine side of the barrier*
- *Paper face mask – for the new foil cutting operation*
- *Tacky Mats at foil change area barrier – should be in place and in good condition*
- *Absolute Alcohol & Lint Free cloths (do not use Tacky Cloths) or isopropanol wipes*
- 

*Crew members should check the foil change toolbox for the following:*

- *Short length of plastic disposable rod (coffee stirrer)*
- *Size 11 scalpel blades and scalpel*

- n. **Follow the 'Instructions for Changing the Foil, Revision 13' found in Appendix A.** One of the crew members shall conduct the foil change whilst the other observes the process and is 'kitted out' to act as 'emergency standby person' with respirator at the ready.
- o. After the installation of a new foil and before leaving the synchrotron, the cooling fan to the Injection Dipole Transmission Line must be switched on.
- p. The air conditioning system to the synchrotron room and the ventilation fans for EPB1 and EPB2 should also be switched on. The notices placed on the roller shutter doors in R6 can now be removed.
- q. The Injection Dipole should now be switched on from the MCR control screen.
- r. The Synchrotron outer can now be vacated and normal operating conditions restored.
- s. Beam intensity should be progressively increased in steps from Base Rate to MS over a period of an hour. This should prevent undue thermal shock from destroying the foil and hence improve longevity.

The RAL Radiation Protection Advisor (RPA) was consulted about the content of this OPI.

David Findlay

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## Appendix A

### INSTRUCTIONS FOR CHANGING THE FOIL

Rev 13

At least one competent individual should be present and take responsibility for the safe completion of the foil change and clean up operation.

The foil changing carriage, mechanism and support bed consists of a semi-automatic motorised transport system for withdrawing the foil with a remote method of breaking and making the main vacuum seal. To reduce the risk of contamination a fan driven extract system is employed whilst a hopper unit collects and stores the used foils. A series of limit switches control the operation of the drive system which prevents the carriage nearing the support rail end stops and an automatic vacuum valve controls the speed of pump down of the foil chamber vacuum system. (*The transport mechanism can be operated manually in the event of a motorised drive failure*).

Note that all operations, except those numbered 1, 4, 12, 13, 14, 23, 30 and 31, are carried out within the shielded area.

- 1 Remove foil drive motor cable (BNC) and the adjacent size 0 Lemo connector labelled 15V (Fig. 3).
- 2 Move the Vacuum Pumping Rig (stored behind the Collector shielding (Fig. 4)) into position and connect to foil box/vacuum system as follows:
  - a) Make the vacuum connection by connecting the 40 mm flexible tube on the Vacuum Rig to green colour coded Valve V2 (Figs 4 & 5).
  - b) Connect the air line, using the schraeder push fitting lying on the floor, into the mating piece on the Vacuum Rig (Fig. 6).
  - c) Connect the Penning and Pirani cables to the rear of the TPG300 vacuum control box. These are high voltage BNC connectors and a 5pin DIN plug and are colour coded (Figs. 6 & 7).
  - d) Connect the 18 way Burndy socket from the rear of the VP6 valve controller on the Vacuum Rig to the VAT Solenoid Box (Fig 8 & 9).
  - e) Plug in the Vacuum Rig mains lead and switch on. The TPG300 control box Penning readouts, A1 and B1, should read in the 10E-6 mbar range or lower. The Pirani readout, A2, should be reading UR 10E-4 and the VP6 valve controller should be showing the green light indicating the valve is open. If the controller shows a red light then an interlock is in operation which will prevent valve closure. The following letter code indicates the interlock of interest:-
  - f) If an 'E' shows, switch the mains to the VP6 off then on again. This should clear the error.

- g) If an 'r' shows, check the TPG300 and ensure that A1, A2 and B1 are reading as indicated above. If not, switch to A2 and if it shows P1 then the pirani is switched off. This controls the Penning gauges (A1 and B1) which will show AU-9. The Pirani can be switched on by pressing the front panel buttons 1 and 3 together. It should now all work.
- h) If a flashing 'P' shows, check the compressed air connection.

Please note the vacuum gauges are identified as follows:-

A1 foil chamber Penning, A2 foil chamber Pirani,  
B1 dipole box Penning and B2 backing pressure (Pirani) of turbo pump.

- 3 Clip the motor drive assembly to the foil changing framework and attach to it the 4 flying Burndy leads (Fig. 11). These are 'keyed' to avoid mis-connection. Connect the 13 amp plug to a suitable mains socket and switch on. Ensure the foil extract fan switch (Fig. 12) is in the 'OFF' (up) position and the switch on the motor drive assembly (fig. 13) is in the 'OUT' position.
- 4 Ensure that the foil has physically been withdrawn into the foil chamber by observing that the moving 'tabs' have hit the limit switches mounted on top of the foil drive motor assembly. If necessary the motor may be turned by hand to effect this. Alternatively the mechanism can be moved to the 'limit' by releasing the locking pin, engaging the worm drive and by operating the hand wheels, clockwise or 'OUT', such that the carriage is moved to its limit (Fig. 15).
- 5 Ask the MCR to monitor the ring vacuum as a precaution before closing the gate valve via the valve controller red push button (Fig 10). The valve open and closed lights flash during operation and the appropriate light will remain lit when operation complete. (The open/close cycle takes approximately 10 seconds to complete).
- 6 Fully open the hand operated UHV vacuum valve on the foil chamber (V1) fully and then the red coloured Air Admittance Valve (Fig. 5) but do NOT remove the disc placed in the top of the AAV. The foil chamber will be gently let up to atmosphere at a controlled rate through the hole in the disc. The hand operated vacuum valve V2 (green) must be kept closed. The red interlock LED lights on the VP-6 controller will begin to flash to indicate that the gate valve cannot now be operated. (Held closed by external vacuum interlocks).

### **FOIL REMOVAL (Health Physics support necessary)**

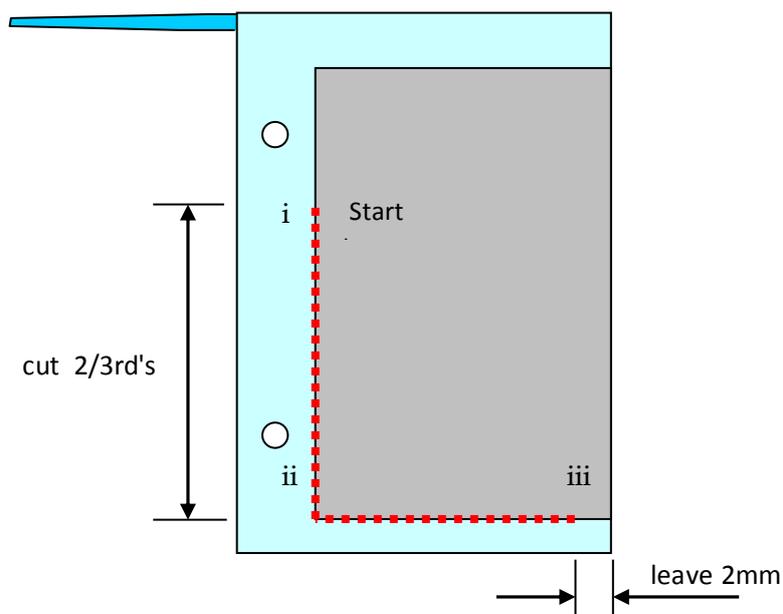
- 7 Ensure that all foil changing personnel are wearing coveralls, 2 pairs of disposable gloves, 2 pairs of overshoes and a respirator. Health Physics will set up and run an air sampler in the area as required. This activity must cease before the new foil is removed from its box.

- 8 Loosen the vacuum V band clamp using the two hand wheels at the rear of the support bed (Fig. 14). Rotate both hand wheels clockwise, evenly and together, until the end stop is reached. This procedure takes approximately 2 minutes.
- 9 Push in the hopper shroud mechanism (part of the extract fan system, Fig. 14) via the push rod.
- 10 Engage the manual worm drive ensuring that the locking pin is released. Turning the handle clockwise 'Carriage Out' until the white mark on the drive chain is aligned with the 'FAN ON' label on the support bed plate (Fig. 16). This withdraws the foil to a position above the extract/hopper assembly for subsequent disposal. Disengage the worm drive and engage the locking pin.  
*(NOTE: Engaging and disengaging the manual worm drive automatically disengages/engages the motor clutch but there may be some resistance to withdrawing the foil if there is still a slight vacuum in the foil chamber).*
- 11 Switch the extract fan 'ON' (switch in the down position) to allow loose remnants of foil to be sucked into the hopper. Audibly check that the fan is on before proceeding.
- 12 Allow sufficient time for the foil extract fan to perform its function then proceed to the right hand side front of the shielding, nearest to the Injection Dipole magnet, remove the hopper shield (aluminium 'handled' shield in Fig. 17) and proceed with decontaminating the inside of the hopper lid before placing in a suitable temporary storage location. Health Physics will dispose of contaminated wipes.
- 13 With the extractor fan still running, loosen any remaining foil from the frame with a short length of plastic rod. Loosen the foil retaining screw and, with the rod, ease the foil frame away from its support and allow it to drop into the hopper. The rod must also be discarded and dropped into the hopper.
- 14 Visually check the frame for contamination and wipe the foil base plate and surrounding mechanism with isopropanol wipes (or equivalent) as necessary and dispose of appropriately in accordance to Health Physics decontamination guidance. Gloves should be changed after this operation and disposed of appropriately. The respirator can be removed, if clearance is given by Health Physics, and replaced with a paper mask.
- 15 On the Motor Drive Assembly ensure that the drive switch is in the 'Out' position. The foil carriage can now be withdrawn completely by pressing the START button. The carriage withdraws to a predetermined position suitable for installing a new foil.

## FOIL INSTALLATION

(All operations should be carried out very slowly and carefully to prevent air movements from breaking up the foil)

- 16 Place the aluminium support table (Fig. 18) over the rails and downstream of the foil support mechanism.
- 17 Ensure that the foil changer is wearing a paper face mask or, if preferred, continue wearing the respirator. Carefully place the box of foils onto the support table aligning an appropriate good foil with the foil support assembly so as to minimise foil transit distance.
- 18 Slowly remove the lid and place it to one side. Fit the new foil and rotate it with the top pin towards from you so that the foil bows away from you very slightly and against its bottom support. Tighten the clamp screw. Very carefully replace the foil box lid and return the box to its storage location. With extreme caution remove the table from the rails and return it to its storage area.
- 19 Very carefully return to the mounted foil (Fig. 20) and, with a **NEW** scalpel blade, prepare to cut the foil (Fig. 19). The cutting action is a series of 'stitch' cuts as indicated by the dotted line below and should be approximately 1 mm from the frame edge. Care should be taken not to insert the scalpel blade more than 2mm depth with each insertion. Repeat the cut downwards from approx. 2/3rds up the left hand side frame (from point i) then down to within 2 mm of the bottom left corner (point ii). Start a second cut 2mm away from the right hand edge (point iii) and continue towards the left to the corner of the frame. Now cut from point ii to the corner of the frame to complete the process. The finish must be continuous and into the corner as illustrated below. This leaves the foil attached only along the top edge, the left hand side top 1/3rd and the last 2mm at the bottom right hand edge.



- 20 Ensuring that the extract fan is switched off put motor drive assembly switch to the 'In' position and press START. The transport mechanism will be driven to within 100 mm of its final position. Alternatively this may be achieved by hand using the worm drive.

- 21 To complete the operation engage the worm drive and turning very slowly anti clockwise move the foil forward until resistance is felt. This resistance is the vacuum flanges mating. Disengage the worm drive and move the hopper shroud to the out position by pulling the 'push rod' fully out.
- 22 Close the V band vacuum clamp by rotating the two hand wheels together anti clockwise. Apply maximum hand force on each wheel to give the necessary sealing torque on the V band clamp.
- 23 Replace Hopper shield

### PUMPING DOWN THE FOIL CHAMBER

- 24 Fully close the red coloured air admittance valve.
- 25 Check the turbo vent valve, located on the right hand side panel of the Vacuum Rig, is closed.
- 26 Slowly open V2 (green) fully (V1 should still be open) to allow the scroll pump to evacuate the line and the foil chamber. Allow the foil chamber Pirani (A2 on the Balzer TPG300) to reduce to 5E-1 mbar.
- 27 Start the turbo pump (Fig 20) and wait until it reaches full speed (~ 860Hz indicated). The control valve automatically controls the pumping speed into the foil chamber.
- 28 The TPG300 gauge controller must now be switched to B1 in order to read the ring pressure. If this pressure is seen to increase then there is a possibility of a leak in the foil chamber. The gate valve (VP-6) should be closed and the vacuum technician consulted.
- 29 When the pressure in the foil chamber has reached a predetermined limit 2E-4 mbar a vacuum interlock in the valve controller will make and the red light on the valve controller will cease to flash. This can take up to an hour. Close valves V1 and V2. The gate valve should now be opened using the 'green' push button on the VP-6 controller.
- 30 If all is well wind the foil in by hand by rotating the gear wheel, on the motor itself, such that the limit switches are cleared. Now plug in the BNC motor drive cable and 15V lemo connector and ask the MCR to drive the foil into its normal operational position (use previous values noted for fully IN position).
- 31 With a torch check, through the foil window, that the foil has been 'posted' and is in good condition.
- 32 Ensure that the area is clean and decontaminated as necessary before leaving the foil changing area. Health Physics should conduct this operation.

- 33** If no further action is required switch off the turbo pump and open the vent valve on the right hand side of the Vacuum Pumping Rig. The vacuum system, drive controller and all accessories can now be switched off. Disconnect the Vacuum Pumping Rig at valve V2, the 4 off flying leads and mains lead from the motor drive assembly and remove the airline. Return the Vacuum Pumping Rig to the storage area behind the Collector shielding and the foil change tool kit underneath the foil barrier/seating area. The foil motor drive assembly should be returned to the MCR lower store and the tool box key to the MCR.
- 34** Record, in the log book provided and located adjacent to foil box, the appropriate foil identifier. This can be obtained from the letter marked on each box (A, B, C etc.) and the number adjacent to the foil support hole (1- 8). All foils removed should be recorded whether installed successfully or not. Appropriate comments should be entered e.g. foil broke on handling - foil good etc.
- 35** All personnel involved with the foil change procedure should be checked for contamination prior to leaving the Synchrotron. Health Physics shall take responsibility for this procedure.



Fig 1. Motor Drive Assembly



Fig 2. Respirators

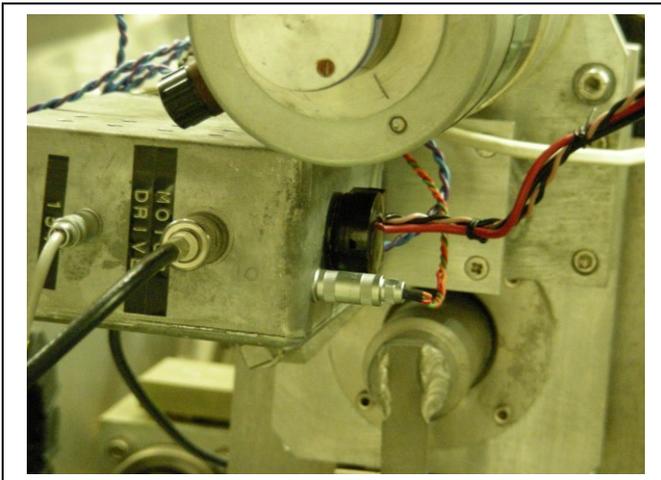


Fig 3. Motor Drive BNC Cable & 15V Lemo

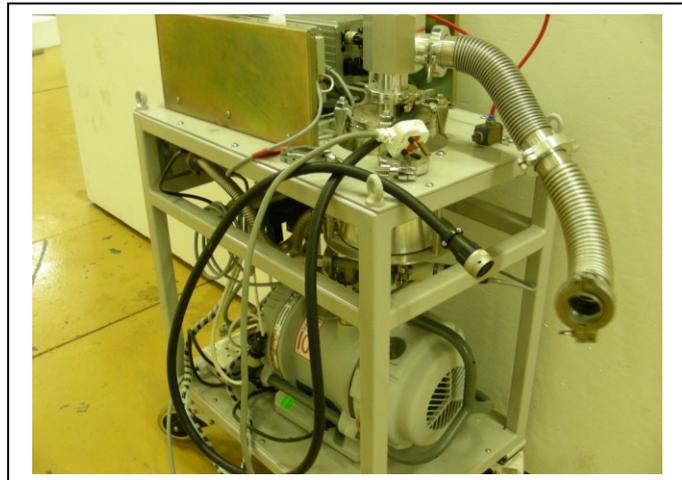


Fig 4. Vacuum Pumping Rig

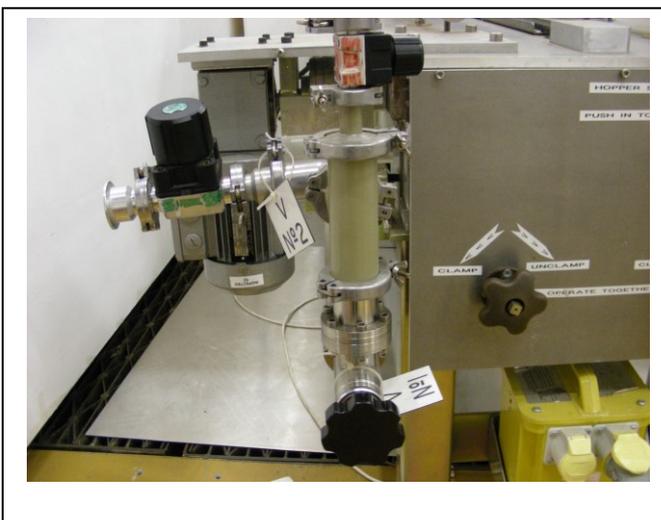


Fig 5  
Vacuum valves V1, V2 and AAV



Fig 6  
Schraeder, Penning & Pirani connections



Fig. 7 TPG300 Penning & Pirani Connections



Fig. 8 18 Way Burndy & 40mm Vacuum hose

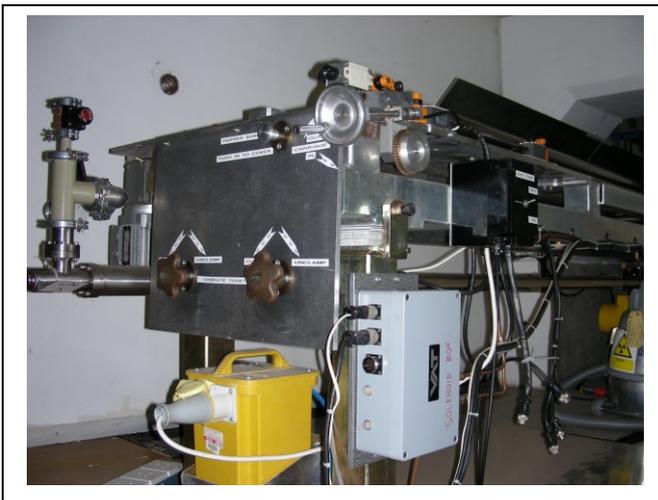


Fig. 9  
VAT VP-6 Solenoid box



Fig. 10  
VP6 Valve controller & TPG 300

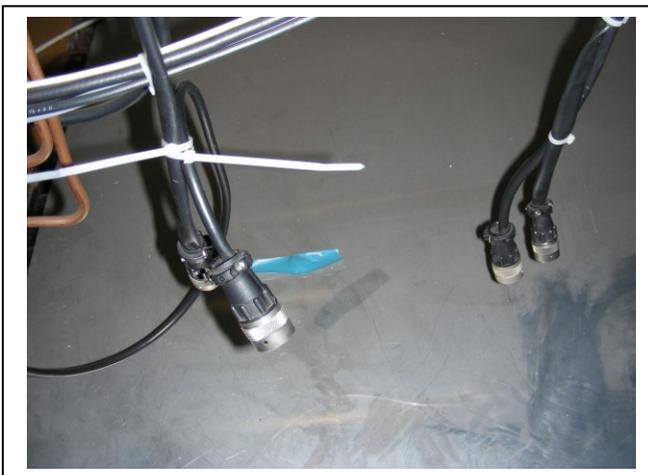


Fig. 11  
Flying Burndy leads



Fig. 12  
Extract fan control switch



Fig. 13  
Motor Drive Assembly Switch

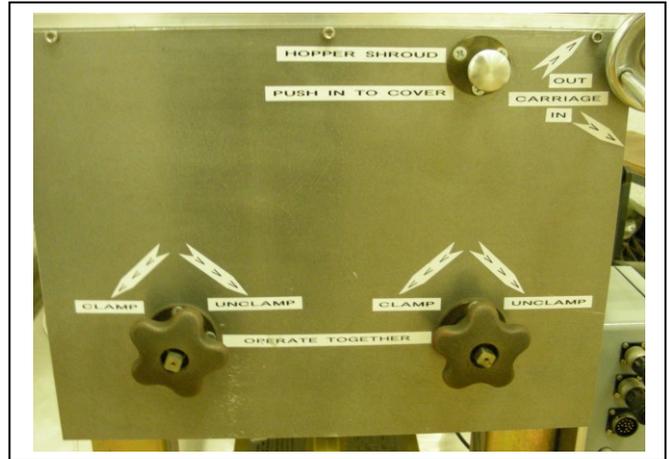


Fig. 14  
V band clamp hand wheels  
& Hopper shroud push rods

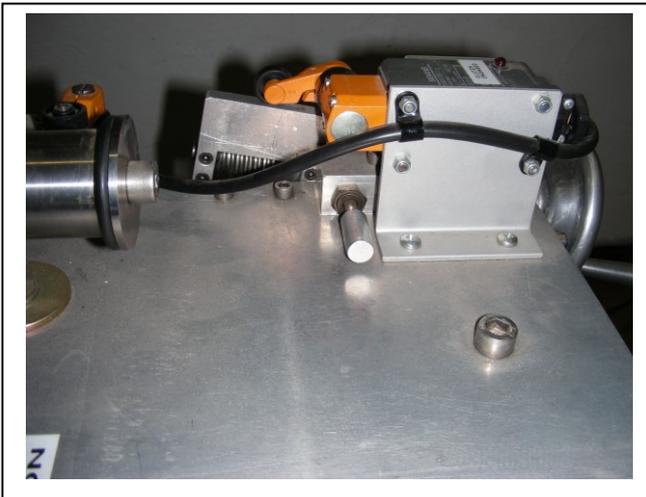


Fig. 15  
Worm Drive & Locking pin

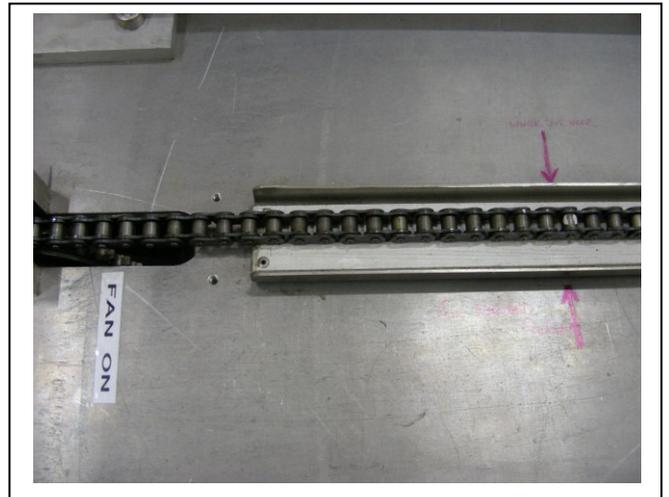


Fig. 16  
Drive Chain & 'FAN ON' label

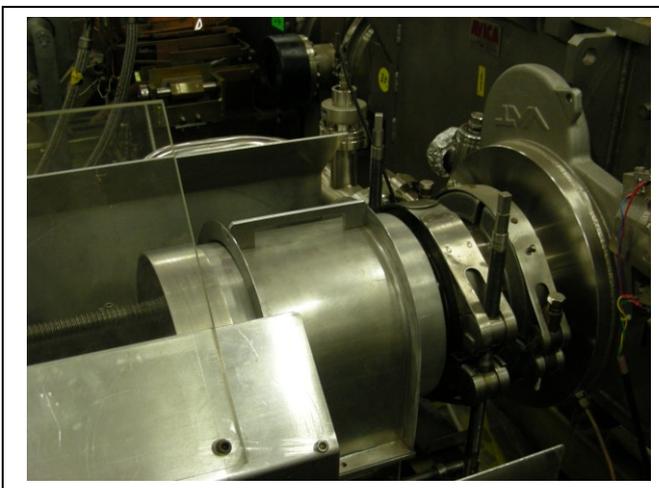


Fig.17  
Hopper Shield (with handle)

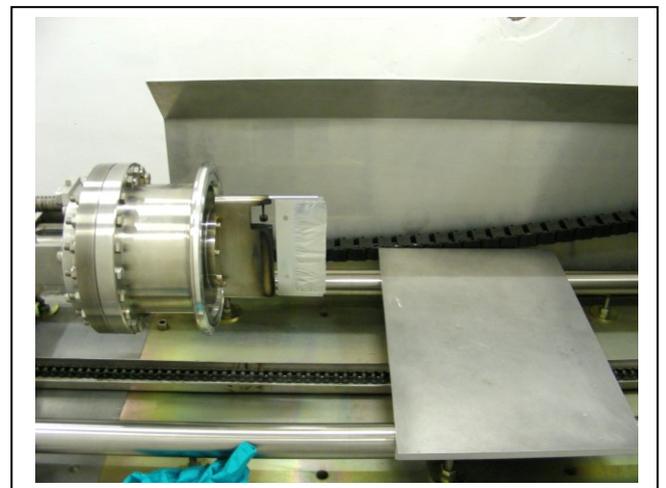


Fig. 18  
Support Table for Foil box  
& New Foil in Place



Fig. 19  
Foil Changer preparing to cut new foil



Fig. 20  
Turbo Pump Control (Bottom Unit)

APPENDIX B



EPB 1 Ventilation Controller  
(North side EPB1 opposite lift)



EPB 2 Ventilation Controller  
(R6 Dance Floor - Bat Cave)



Synchrotron Air Conditioning Controller  
(R4 Ventilation Plant Room)



Injection Dipole Transmission Line Fan Isolator  
(Outer Synchrotron - Straight 0)