LEED

FISONS Instruments

FAX

VG MICROTECH

CUSTOMER CARE

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SHEET 1 OF 5

To: Alan Rice, Iver Lauerman, Teri Longin. : CALTECH

CC: Lee Temple SC

Fax No: 0101 818 585 0147

From: Bob Kenhard, Customer Care Mgr.

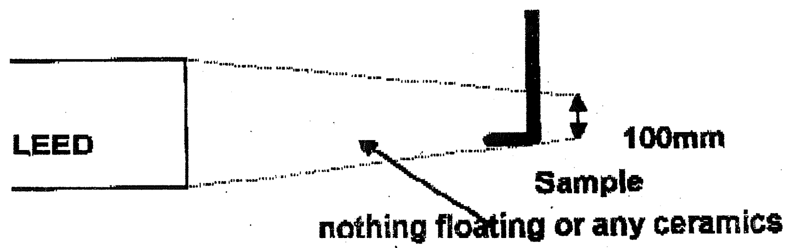
Friday, January 14, 1994

Subject: LEED Problems.

We have been passed some questions by Lee Temple at FI San Carlos:

1. Test Methods for 150eV. Measure the voltages at cable end in accordance with attached power supply specifications.

2. Ensure that there is nothing floating or any exposed ceramics near the sample.



Sample current of between 2 and 10 micro Amps

Possibilities.

Charging in analyser region, exposed ceramics.
Floating mesh connection–power supply failure, cable breakage, internal wiring failure.

Hope this helps
Best regards.
Bob Kenhard.

SPECIFICATION ELECTRON BEAM GUN SUPPLY

UNIT CODE 8011

GENERAL

This 3kV 2mA electron beam gun supply incorporates a constant current controlled filament supply, isolated to 5kV. All outputs except filament and screen*, track the energy reference. The energy output is in two switched ranges, range 1 - 0 to 1000V neg. Range 2 - 0 to 3000V neg.

* Screen inversely tracks energy on range 1 and provides low output fixed voltage on range 2.

ELECTRICAL SPECIFICATION

INPUT	120/240 VOLTS AC 45/65Hz RMS
LINE REGULATION	FROM 99V TO 132V AND 198V TO 264V

1. ENERGY

RANGE 1	VOLTAGE	-	0 TO 1Kv @ 2mA
	LINE REG	-	100ppm OVER RANGE
	LOAD REG	-	30ppm 0 to 2mA
	STABILITY	-	200ppm per day after 30 min warm-up.
	RIPPLE/NOISE	-	10ppm (10mVpp) MAX
RANGE 2	VOLTAGE	-	0 to 3kV @ 2mA
	LINE REG	-	100ppm OVER THE RANGE
	LOAD REG	-	100ppm 0 to 2mA
	STABILITY	-	200ppm per day after 30 min warm-up
	RIPPLE/NOISE	-	10ppm (30mV) MAX

2. FILAMENT SUPPLY

OUTPUT	-	0 to 4.5A @ 6V
REG/STABILITY	-	1% 0.04A to 4.5A
RIPPLE/NOISE	-	1% MAX

REFERENCED TO CATHODE 5kV ISOLATED FROM GROUND

3. A1 SUPPLY

	OUTPUT	-	+1000V = 15V @ 1mA MAX
	REG/STABILITY	-	0.1%
	RIPPLE/NOISE	-	50ppm (30mV) MAX
	REFERENCED TO CATHODE 5kV ISOLATED FROM GROUND		

4. GRID BIAS

RANGE 2	VOLTAGE	-	0 TO - 150V @ 100uA
	REG/STABILITY	-	200ppm
	RIPPLE/NOISE	-	50ppm MAX
RANGE 2	VOLTAGE	-	0 TO -250 @100µA
	REG/STABILITY	-	200ppm
	RIPPLE/NOISE	-	50ppm MAX
	REFERENCED TO CATHODE 5kV ISOLATED FROM GROUND		

5. MESH (1)

RANGE 1	VOLTAGE	-	0 TO 150V @ 100µA
	REG/STABILITY	-	200ppm
	RIPPLE/NOISE	-	50ppm MAX
RANGE 2		-	ZERO OUTPUT
	REFERENCED TO CATHODE 5kV ISOLATED FROM GROUND		

6. MESH 2) 3)

\- ZERO OUTPUT (GROUND CONNECTION)

7. FOCUS

RANGE 1	VOLTAGE	-	+100V TO -1kV @ 100µA
	REG/STABILITY	-	0.1%
	RIPPLE/NOISE	-	50ppm (50mV) MAX
RANGE 2	VOLTAGE	-	+100V TO 3Kv @ 100µA
	REG/STABILITY	-	0.1%
	RIPPLE/NOISE	-	50ppm (150mV) MAX

8. A2

RANGE 1	VOLTAGE	-	-100V @ 100µA TO +2.5kV @2mA
	REG/STABILITY	-	0.1%
	RIPPLE/NOISE	-	30ppm (150mV) MAX
RANGE 2	VOLTAGE	-	ZERO OUTPUT

9. SCREEN

RANGE 1	VOLTAGE	-	+5.5K TO 4.5kV @ 100µA
	REG/STABILITY	-	0.25%
	RIPPLE/NOISE	-	20ppm (50mV) MAX
RANGE 2	VOLTAGE	-	+250v (FIXED) @ 100µA
	REG/STABILITY	-	0.25%
	RIPPLE/NOISE	-	100ppm (25mV)

10. DPM EXT

DEMULITIPLEXED SIGNAL TO DIRECT DRIVE REMOTE 3½ DIGIT SEGMENTS.

11. REMOTE LV SUPPLIES

CONTROLS AND SWITCHES

FRONT PANEL

POWER ON/OFF	-	PUSH BUTTON 'WHITE
HV ON/OFF (TRIP RESET)	-	PUSH BUTTON 'RED'
FIL ON/OFF	-	PUSH BUTTON 'BLACK'
RANGE ENERGY	-	PUSH BUTTON 'BLACK'
COMPUTER CONTROL ENERGY	-	PUSH BUTTON 'BLACK'
RANGE DPM	-	5 POSITION ROTARY
ENERGY VOLTAGE	-	10t POT 0 TO 100% OF RANGE
FILAMENT CURRENT	-	10t POT 0 TO 100% OF SET MAX
GRID VOLTAGE	-	10t POT 0 TO 100% OF RANGE
MESH VOLTAGE	-	10t POT 0 TO 100%
FOCUS VOLTAGE	-	10t POT 0 TO 100% OF RANGE
A2 VOLTAGE	-	10t POT 0 TO 100% RANGE 1

PRESETS

FIL MAX CURRENT	-	20t CERMET 50-100% OF 4.5A
GRID SLOPE	-	20t CERMET 50-100% OF SET MAX
MESH SLOPE	-	20t CERMET 50-100% OF SET MAX
FOCUS OFFSET	-	20t CERMET ± 100V OF SET VOLTAGE
A2 OFFSET	-	20t CERMET ± 100V OF SET VOLTAGE
DPM 3½ DIGIT SWITCHED	-	1.000kV (3.00kV) 4.50A, 2.00nA
	-	10.00µA, AUX- 1.000kV

(3.00kV)

INDICATIORS :

POWER ON		- GREEN LED
HV ON		- RED LED
TRIP		- AMBER LED
DPM IND	FIL	- AMBER LED
	EMMISSION	- AMBER LED
	TARGET	- AMBER LED
	ENERGY	- AMBER LED
	AUX	- AMBER LED
COMPUTER CONTROL		- GREEN LED
	FIL ON	- RED
RANGE 1		- AMBER LED
RANGE 2		- RED LED

REAR PANEL

POWER IN	- FUSED/EURO CHASSIS FILTER PLUG
VOLTAGE SELECTOR 240/120	- SWITCH
MAIN EARTH	- BIND POST
ENERGY TO FIL	- HV BNC
ENERGY TO A1, GRIP, MESH	- HV BNC
FIL/CATHODE	- 2 X HV BNC
A1	- HV BNC
GRID	- HV BNC
MESH 1)	- HV BNC
MESH 2) 3)	- 2 X GROUNDED HV BNC
FOCUS	- HV BNC
A2	- HV BNC
SCREEN	- SHV BNC
EXT DPM	- 15 pin 'D' SOCKET
REMOTE CONTROL+	- 9pin 'D' PLUG

a) ENERGY VOLTAGE MONITOR 0-10V = 0-3kV
b) ENERGY CURRENT MONITOR 0-10V = 0.2mA
c) HV 'ON' TTL 1
d) COMPUTER DEMAND TTL 1
e) COMPUTER ENERGY VOLTAGE CONTROL 0-10V = 0-MAX

MECHANICAL

MODULES 220 X 100mm EURO CARD MAY BE USED IN OTHER SYSTEMS

ALLOY EURO FRAME 3U x300mm DEEP LESS HANDLES

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OPERATING INSTRUCTIONS

REAR VIEW LEED - RVL 900

HA020010 Issue 2 30/9/91

WARNING:- **Do not open the packing before reading these instructions. Severe damage may result from mishandling.**

CONTENTS:-

	Page
Introduction	3
Specifications	4
Mechanical Description	5
Installation	6
LEED OPERATION	
Mesh Operating Modes	7
Viewing hood (optional)	8
Electron Gun	9
Power Supply	10
LEED Optic Operation	13
Filament Replacement	15
RVLO AUGER OPERATION	
Introduction	18
Wiring	19
Spectrometer Control Unit	20
Lock-in amplifier	21
Operation	22
APPENDIX	
Updates	24

INTRODUCTION

The VG Microtech Reverse View LEED optics are designed to give a low energy electron diffraction facility which can be mounted onto a single port on a vacuum chamber. The diffraction pattern is viewed from the rear of the fluorescent screen through a window in the mounting flange of the optics assembly. Two, three and four mesh versions of the optics are available as both fixed length and retractable types.

The Model 8011 Power Supply provides complete power supplies and controls for operation of either version of the optics in LEED mode over the energy range 5 to 1000 volts and in AUGER mode to 3000 volts. A remote potentiometer is provided with the 8011 Power Supply for remote control of the energy.

An optional viewing hood is available with further optional attachments for a video camera or film camera. The viewing hood contains a remote digital display so that the energy can be displayed with diffraction patterns, and recorded on photographs.

SPECIFICATIONS

Optics Assembly

Meshes : 2,3 or 4

Mounting : 200mm conflat flange (FC150)

Mounting flange to specimen spacing: 163.5mm (standard)
Other lengths greater than 163.5mm optional.

End of optics to specimen spacing: 23.5mm (2 mesh)
18.0mm (3 mesh)
13.0mm (4 mesh)

Inner screen radius : 66mm
Thickness : 2mm

Angle subtended by screen to sample : 104 degrees

Shadow projected by electron gun onto screen: 15mm diameter

Electron Gun

Model: LEG24 Electron Gun

Filament Type : Thoria coated rhenium tape. (FIL 36) ELECTRON GUN IS AN LEG 24 ~430$ EACH

Lens Type : Simple EINZEL lens

Energy Range : 5 to 1000eV in LEED mode, to 3keV in Auger mode

Spot size : 500um at 1uA, 100eV

Filament Current : 0 to 3.2A approx.

Emission Current : 0 to 1000 microamps

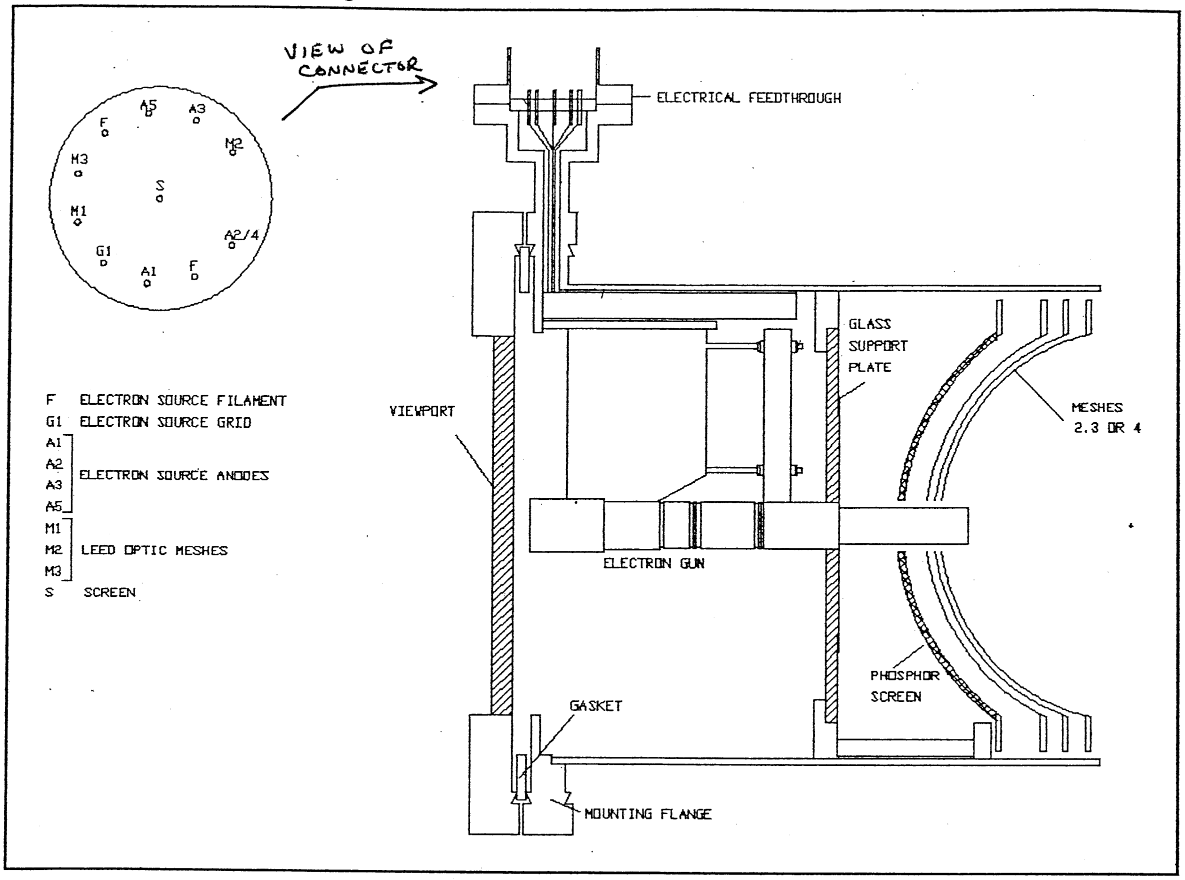
Model 8011 Power Supply

Dimensions 19" (rack mounting) x 13mm x 45.5mm
(approx.)

Mains Supply 240Vac or 120 Vac switchable 50/60Hz

MECHANICAL DESCRIPTION

Optics Assembly- fixed length



A general view of the Rear View LEED optics is shown. The optics assembly is mounted on a single 200mm conflat double-sided flange and includes two main components : the electron gun and mesh assembly. Four long rods attached to the mounting flange provide support for the whole assembly. Bolted to the end of the four rods is a mounting ring, which holds a flat glass plate. The mesh assembly is supported from the mounting ring by means of three shorter rods.

The mesh assembly consists of either two, three or four concentric spherical sector meshes and a spherical sector glass screen, mounted on the mesh mounting ring. The glass screen has a fluorescent phosphor coating. The electron gun is located inside the gun mounting tube which is attached, by means of a support strut and flat mounting plate, to two of the main support rods. The end of the gun projects through a hole in the flat glass plate and through a hole in the centre of the screen and meshes.

A mu-metal cylinder surrounds the gun and optics to provide shielding from stray magnetic fields and electrons. All the electrical connections for the optics and electron gun are made through an 11 pin feedthrough located on the mounting flange. When the optics assembly is fitted to a vacuum chamber a viewport is fitted to the outside of the mounting flange. The viewport is held in place by bolts which pass through both the viewport and the mounting flange.

INSTALLATION

General

The Rear View LEED optics assembly is designed to fit onto a standard 200mm conflat flange on a vacuum chamber.The vacuum system should be arranged so that the sample can be held at the centre of curvature of the LEED optics.

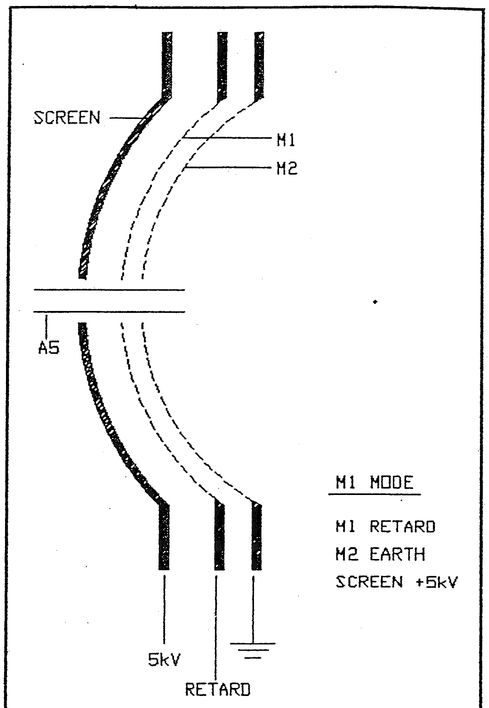
It is important to protect the meshes of the LEED optics from dust. After removing the packaging, the optics assembly should be held with its axis horizontal to prevent dust from settling on the meshes. The plastic bag should NOT be removed until the last possible moment.

Procedure

1.Insert the optics assembly into the port in the vacuum chamber. The optic is shipped from the factory with a new gaskets already in place.
2.Ensure that the bolt holes on the viewport and on the mounting flange are in line.
3.Insert bolts through the holes in both the viewport and the mounting flange, into the holes in the chamber flange. Tighten the bolts.
4.Pump down the system and bake at 180 degrees C for at least 8 hours to reach a pressure better than 10E-8mb.
5.Connect the interconnection lead to the Rear View LEED optics and the 8011 Power Supply.
NB. Take care not to bend the pins on the 11 pin feedthrough,
which are easily deformed. If necessary the position of the plug guide may be adjusted by loosening the two screws with an Allen key.
6.If the optional viewing hood, with remote digital energy display, is fitted connect the 15-way plug to REMOTE on the rear panel of the 8011 Power Supply.
7.If required, connect the ENERGY remote potentiometer by inserting the jack plug into the socket on the front panel of the 8011 Power Supply.
8.Ensure that the 8011 is set to the correct local Voltage. Connect the mains lead to the 3 pin socket on the rear panel of the 8011 Power supply and to the mains supply.

MESH OPERATING MODES

Two, three and four mesh versions of the Rear View LEED optics are available. In operation, a negative potential close in value to the accelerating energy of the electron gun, is applied to one of the meshes. This has the effect of preventing inelastically scattered electrons from reaching the screen. The other meshes are earthed. (In the case of four mesh optics, the two central meshes are connected together by an internal link and behave as one mesh).

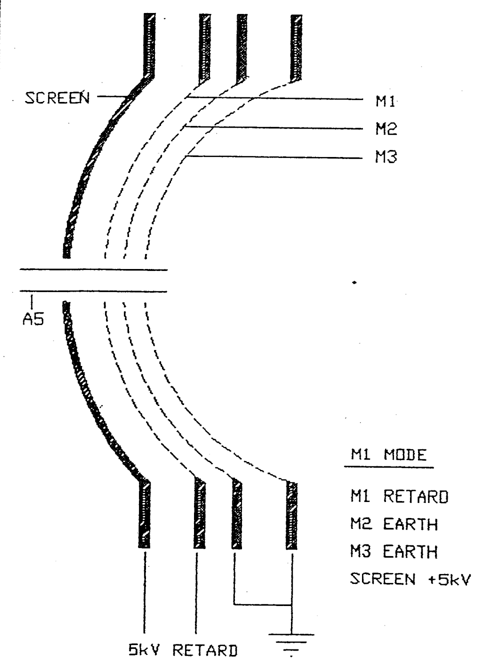


2 MESH OPTICS - MODE OF OPERATION

Two Mesh Optics

The connections for a two mesh optic is shown (right). The mesh closest to the screen, M1, is at the retard potential (slightly higher than the electron gun energy) and the mesh closest to the sample, M2, is earthed. The screen is at a potential of approximately + 5kV. It is field penetration from the screen voltage which allows the diffracted electrons (which have the highest energy being elastically reflected) to pass through the retarding mesh.

Three and Four Mesh Optics



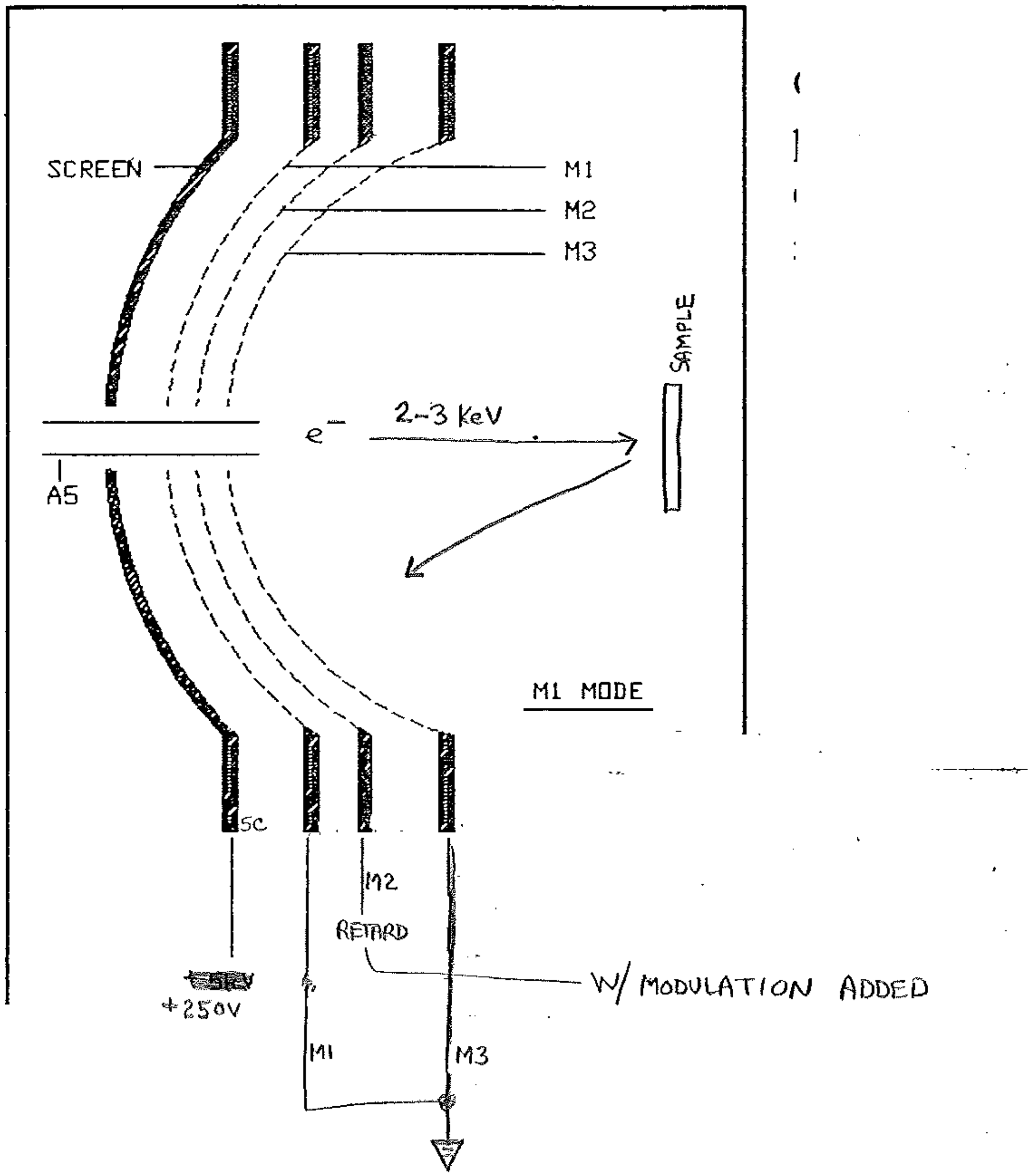
3 MESH OPTICS - MODE OF OPERATION

For three mesh optics (left), the mesh closest to the screen (M1) is at a retarding potential. The middle gird (M2) and the mesh closest to the sample (M3) are both earthed. The screen is at approximately +5kV.

The retard potential which is applied to M1 is adjusted using the MESH BIAS control of the 8011 Power Supply.

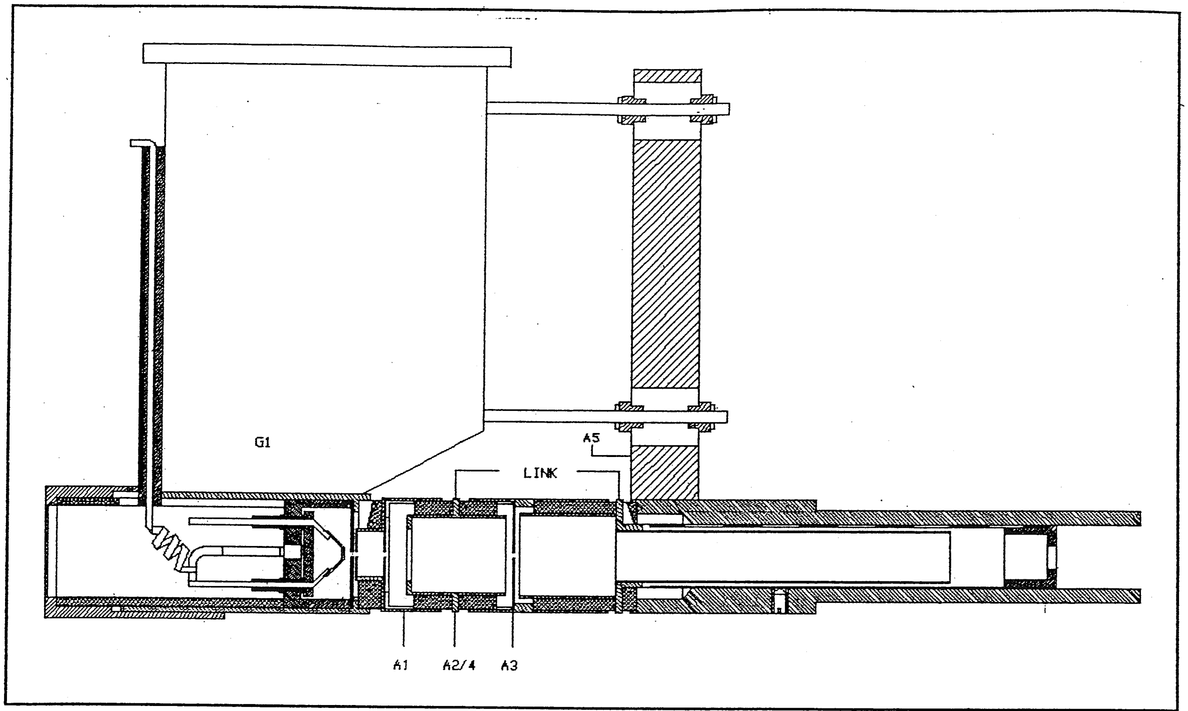
Four mesh optics are operated in the same way as three mesh optics, the central two meshes being connected together by an internal link. This composite mesh is referred to as M2. (For constructional purposes the two meshes are designated M2a and M2b moving outwards from the screen.)

AUGER MODE


SCREEN
M1
M2
M3
SAMPLE
e⁻
2-3 KeV
A5
M1 MODE
SC
M2
RETARD
W/ MODULATION ADDED
+250V
M1
M3

VIEWING HOOD (Optional)

The optional viewing hood is designed to make photographic recording of diffraction patterns easier. The viewing hood is held in place by a flange which slides over the viewport of the optics assembly. The viewing hood has two windows positioned at right-angles to each other. One window is used for viewing the diffraction pattern and the other window is used for mounting a camera (using a suitable adaptor). The operator may choose which window is used for each purpose. The lever on the outside of the hood selects the position of a mirror inside the viewing hood. In position 1 the mirror is held flat against the side of the viewing hood so that light from the viewport travels directly to the window opposite. In position 2 the mirror is held at 45 so that the light is reflected from the viewport into the side window. A digital display inside the viewing hood enables the beam energy to be displayed with the diffraction pattern, and recorded on photographs. Connection must be made to the 8011 Power Supply through the 15 way socket and connecting cable. The potentiometer controls the brightness of the digital display. The small toggle switch laterally inverts the digital display so that the energy can be read when the display is reflected by the mirror into the side window.



LEG24 Electron Gun

The LEG24 electron gun is operated over an energy range of 5 to 1000V for Low Energy Electron Diffraction. Acceleration is achieved by the filament being at a negative potential with respect to earth. The acceleration potential, or beam energy, is varied by the ENERGY control of the 8011 Power Supply and may be displayed on the digital meter. The emission current is controlled by varying the potential applied to the gun grid, G1, within the range [ENERGY - (0 to 200V)].

Focus is by means of a simple Einzel lens arrangement. A constant potential of +600V relative to the filament is applied to the first anode A1, to ensure that there is sufficient emission current. The focus voltages applied to A2/A4 and A3 are slaved to the Energy power supply so that the focus is maintained over a large energy range. The zero offsets of the focus voltages are set using two potentiometers accessible at the front of the 8011 Power Supply. These controls are useful for maintaining focus at low beam energies. The gains are user controlled by potentiometers on the front panel.

Front Panel
The functions of the front panel controls are described briefly.

POWER
The mains power is switched on by depressing the white button. The LED illuminates when the mains power is switched on. Pressing the button a second time will turn power off. Interruption to mains power will reset the control to off.

DIGITAL PANEL METER
The DPM may be switched to read operational parameters as required.It will also display the target current in the range 0 to 3.999uA. In order to measure the target current the sample must be electrically conducting and isolated from earth.

FILAMENT CURRENT
The heater current through the filament is variable in the normal operating range of 2.2 to 3.2A, using the potentiometer. The value of the filament current may be displayed on the Digital Panel meter.
The filament is switched on and off by the black button. An LED indicates that the filament is on.

EMISSION
The emission of the electron gun is controlled by varying the potential applied to the grid of the electron gun, in the range [ENERGY - (0 to 200V)], using the front panel potentiometer. The value of the resultant emission current may be displayed on the DPM meter.

MESH
The MESH control adjusts the retarding potential applied to the optic retarding mesh This control may be adjusted to optimise the diffraction pattern which appears on the screen.

ENERGY
The accelerating energy applied to the filament of the electron gun is variable in the range -5 to -1000V. The energy may be varied using either the potentiometer on the front panel or the remote potentiometer which is supplied with the 8011 Power Supply. When the jack plug is inserted in the front panel socket the front panel potentiometer is disabled and the energy is controlled by the remote potentiometer.
The energy control may also be transferred to a rear panel input by means of the button labelled 'computer select'.

HV ON RESET
The EHT supply to the screen (approx. +5kV) and the energy supply to the electron gun are controlled by this button.

RANGE
This button provides switching of the Gun energy range between 0-1keV and 0-3keV. It works in conjunction with the HV ON RESET button in that pressing the HV ON RESET

button selects the voltage range pre-set by the RANGE button.* The range selected is indicated by LEDs.

At power up, the range defaults to 1keV. The 3keV range is selected for AUGER applications.

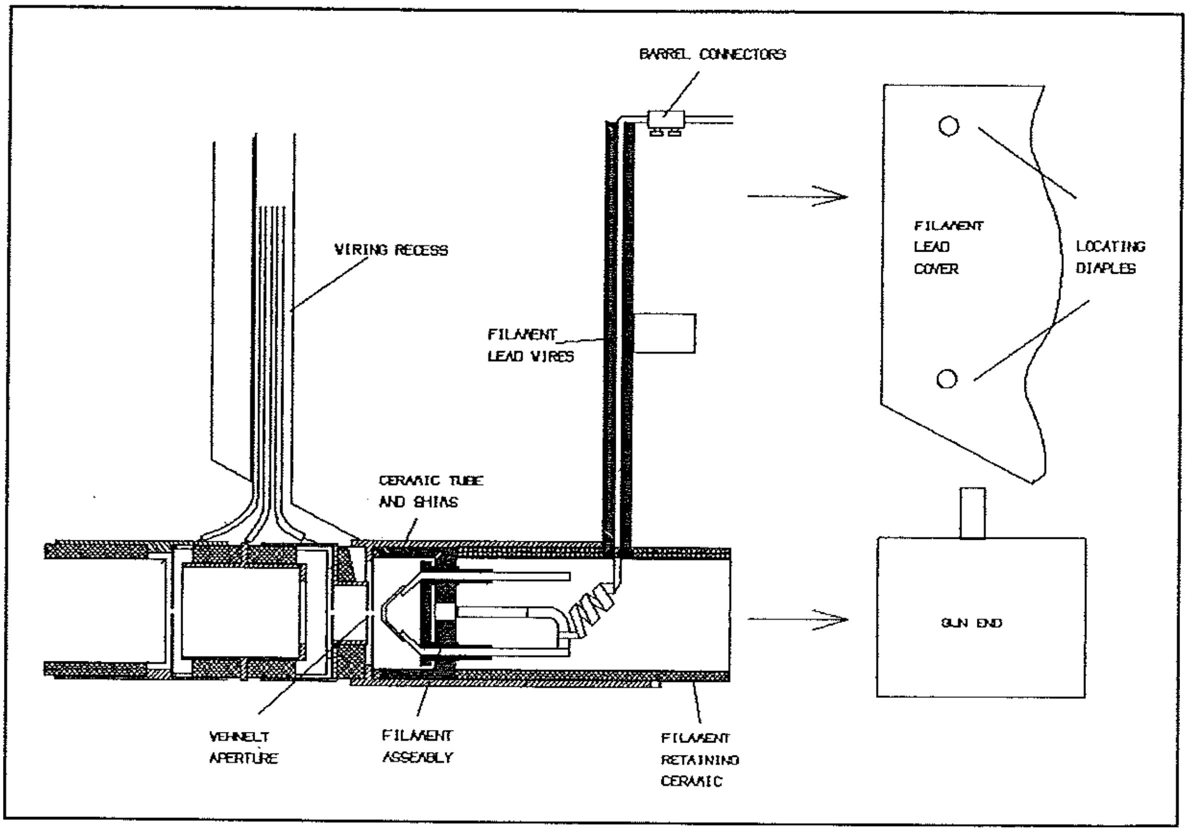
FOCUS

The two focus controls vary the potential of elements A2/A4 and A3 relative to the Kinetic Energy. It is therefore possible to keep the gun in focus over a larger energy range. A3 acts as a condenser lens and will also vary the total gun current.

* HV MUST BE SWITCHED OFF BEFORE CHANGING RANGES. RANGE CHANGE WITH HV ON HAVE NO EFFECT.

FILAMENT REPLACEMENT

CAUTION:- The filament is thoria coated. Thoria is harmful if ingested. Observe local regulations for disposal of old filament.



General

The filament of the electron gun can be replaced through the window in the mounting flange of the optics assembly, after removing the viewport. It is not normally necessary to dismount the gun from the optics assembly or to remove the assembly from the chamber. However, it is usual to replace the copper gaskets at the same time as the filament, in which case the assembly must be removed from the chamber for a short time.

NOTE If the optics assembly is removed from the chamber, access to the electron gun can be improved by sliding the cylindrical shield forwards. The screws holding the shield to the mesh support ring must first be removed. This will not affect the mounting of the meshes themselves.

PRECAUTIONS

Cleanliness

It is important to protect the meshes of the LEED optics from dust. If the optics

2 Bend the filament leads to match the old filament. If necessary cut the lead wires to the same length as the old filament.

3 Carefully insert the new filament assembly into the gun mount and make sure that it is fully seated.

4 Fix the filament in place by bending the retaining tag over the ceramic insulator.

5 Replace the filament retaining ceramic. It may be necessary to adjust the filament leads slightly to clear the ceramic. Ensure that the leads do not short together.

6 Refit end cap (push fit).

7 Slide the filament lead cover back into place ensuring that the gun wires are retained in the recess in the gun mount.

8 Slide the barrel connectors over the filament wires and tighten. To secure, check that the leads and barrel connectors cannot touch each other or the gun mount.

9 Check electrically that the filament has continuity and does not short to the wehnelt.

Gasket Replacement

1. Carefully lift the optics assembly from the vacuum chamber, holding it horizontally to prevent dust settling on the meshes.

2. Remove the copper gasket which is located between the mounting flange and the chamber flange, and replace it with a new gasket.

3. Replace the optics assembly into the vacuum chamber.

4. Replace the viewport, using a new copper gasket between the viewport and the mounting flange.

5. Replace the flange bolts and tighten.

6. Check again for electrical continuity of the filament by connecting a meter to the two pins on the electrical feedthrough, marked F in the general assembly diagram (refer to MECHANICAL DESCRIPTION section).

Filament Degassing

After fitting a new filament, it must be degassed **very** carefully. Refer to the section entitled OPERATION.

LEED OPTIC OPERATION

Initial Settings

Before switching on the 8011 Power Supply set the controls as follows:-

1. Set the FILAMENT CURRENT control to minimum (fully anti-clockwise).
2. Set the ENERGY control to minimum (fully anti-clockwise).
3. Set the GRID control to maximum (fully clockwise).
4. Set the MESH BIAS control to maximum (fully clockwise).
5. Set the FOCUS control to maximum (fully clockwise).

Operation

NOTE:- Special care should be taken whenever the filament of the electron gun is replaced or the filament has been exposed to air for a long period of time. In either of these circumstances it is recommended that the vacuum system is baked before running the filament. Particular attention should be paid to steps 6 to 9 to ensure adequate degassing and activation of the filament, which may take up to four hours to complete.

1. Check that the pressure of the vacuum system is less than 1x10E-8 mbar.
2. Switch on the main supply by depressing the white button. The LED should illuminate.
3. Wait for one minute for the electronics to stabilise.
4. Switch on the filament control by pressing the black button. The LED should illuminate.
5. Switch the DPM to read filament current.
6. Slowly turn the FILAMENT CURRENT control clockwise to increase the filament current, while observing the pressure of the vacuum system. If the pressure increases suddenly, do not increase the filament current until the pressure starts to recover. Avoid large pressure bursts, greater than half an order of magnitude, as the thoria coating may be blown off the surface of the filament. Ensure that the pressure is less than 5x10E-8mbar before continuing.
7. When the filament current reaches 2A, as displayed on the meter, switch on the EHT. (HV) Switch the meter to read ENERGY (Beam Energy)
8. Turn the ENERGY control clockwise slowly until the digital ENERGY meter reads 1000eV. Switch the meter to read EMISSION CURRENT.
9. Increase the filament current slowly, while continuing to monitor the pressure, until the emission current just reaches a plateau or a maximum of 0.5mA (or the filament current reaches 3.2 A). Operation at high filament currents will significantly shorten the life of the filament. Therefore it is advisable to run the filament on the 'knee' of the plateau.

In normal operation a suitable emission current should occur at a filament current in the range 2.2 to 2.6A. However it may be necessary to increase the current up to 3.2A in order to activate a new filament. The emission current will increase as the filament current is increased, although the relationship may not be linear. During activation, the emission current may be seen to increase and then subsequently decrease when the filament current is

held steady. Once
the filament has been activated the filament current can be adjusted back to run at a lower current. A new filament may have unstable emission over the first few minutes and need some time to stabilise.

Under no circumstances should the filament current be increased to above 3.2A.

10. If the sample is conducting and isolated from earth, the target current can be displayed on the digital meter. As there is a 15V bias on the sample when measuring target current, the energy of the beam will be affected. The target current can be reduced by turning the EMISSION control anticlockwise to reduce the emission current.

11. To set up the optics initially, turn down the energy of the gun to 100eV and set the grid, focus, A2 and Mesh controls fully clockwise. Using the focus control, set a sample(target) current of 2 microamps. A LEED pattern should now be visible and the spots may be focused using the A2 potentiometer. The Grid control will change the gun emission and can be used for optimising the spot size. The mesh control adjusts the retarding voltage and is used to reduce the background glow on the screen caused by secondary electrons from the sample.

12. In cases where the user is uncertain whether the optics is operating correctly or the sample is too contaminated to give a pattern, a sample of freshly cleaved mica will be certain to give a diffraction pattern above 150eV although it will not be possible to observe a sample current. Mica is an insulator.

Precautions

1. Turn the EHT off before switching off the mains power.

2. Turn the filament down slowly to zero before switching off.

3. Do not allow the meshes or the screen to be contaminated by evaporated or sputtered material.

4. Take care when admitting gas to the vacuum system:-

    a) allow 20 minutes for the filament to cool before admitting gas.

    b) admit only clean, dry, dust free gas.

assembly is removed from the chamber to change the gasket, it should be held horizontally to prevent dust settling on the meshes. If the optics remain outside the chamber for more than a few seconds, the front of the optics should be covered with a clean polythene bag.

Screw Threads

Screws and screw threads inside the vacuum may become tight after bakeout, and may seize if forced. If any difficulty is experienced turning screws, the screw thread should be lubricated with a little isopropyl or methyl alcohol.

PROCEDURE

Filament Removal

1. Unscrew the bolts around the mounting flange of the optics assembly. Remove the viewport and the copper gasket. It is not necessary to remove the optics assembly from the chamber and this may be the best way of protecting the optic meshes from dust. The assembly may be retained by replacing two of the bolts (diametrically opposite each other).

2 Loosen all four screws on the two barrel connectors. Slide the barrel connectors along the wire to release the filament legs.

3 Remove the filament lead cover by sliding it toward the rear. It may be necessary to pull the sides of the cover away from the gun mount in order to disengage the locating dimples.

4 Pull the end cap from the rear of the gun mount.

5 Take out the filament retaining ceramic.

6 Bend the retaining tag to one side

7 Remove the filament assembly by sliding backwards from the rear of the gun.

8 The filament assembly is spaced back from the G1 aperture by a ceramic tube and shims. Remove the tube and shims. The old shims should be discarded and replaced by the new set supplied with the replacement filament.

9 Re-insert the ceramic tube and new shims.

Filament insertion

Extreme care should be exercised when handling the filament assembly, especially when inserting it into the gun mount. The filament ribbon is very fragile and easily damaged.

1 Examine the new filament. Check that the filament ribbon is undamaged and that the thoria coating is intact. Check also that the spot welds holding the filament leads are secure.

Rear Panel

MAINS

The 3 pin mains socket is located at the lower left hand side of the rear panel. The unit may be switched between 240 and 120 volt operation by an adjacent switch.

REMOTE

A 16 pin 'D' plug connects the remote DPM display of the viewing hood attachment to the internal DPM circuitry.

AUGER PRE-AMP

This socket provides power to the pre-amp in AUGER applications.

AUX

The auxiliary input for the DPM (millivolts). This input is used primarily for AUGER energy display.

RAMP

External input to the unit for AUGER energy scan drive to the retard mesh.

MOD

Modulation input for AUGER applications.

TARGET

Sample current monitoring input.

COM

Rear panel input to the gun energy control selected by the computer select switch. (0-10V input gives 0-1000V output)

BNC OPTIC CONNECTIONS

The remaining connectors are all inputs to the LEED optic through cable No.CE000011D as follows:-

H	Heater (filament)
A1	First Anode
G1	Grid (Emission control)
F	Focus (Lens Element)
A2/A4	Second Anode
SC	Screen
MESH	Retard Potential (active mesh)
EARTH	Earth connections (inactive meshes)
E	System ground
A5	Earthed gun element

REAR VIEW LEED

ALSO SEE LOG IN SCHEMATIC FOLDER

1-21-94
1-94 FILAMENT EMISSION FAILURE. WHILE IN NORMAL OPERATION OVER

AN IODINE COATED SAMPLE THE FILAMENT ELECTRON EMISSION CURRENT SLOWLY FELL TO ZERO mA. SEVERAL ATTEMPTS WERE MADE TO RE-ACTIVATE THE FILAMENT BY RUNNING LONG PERIODS AT FILAMENT CURRENTS RANGING FROM 1.0 TO 3.2 AMPS. NO LUCK.

POWER SUPPLY DIAGNOSTICS: THE ELECTRIC CABLE WAS UNPLUGGED FROM THE THE LEED CHAMBER AND THE CABLE PINS LABELLED FIL WERE SHORTED TOGETHER WITH A SIMPLE WIRE JUMPER.

WITH ENERGY = 0, FILAMENT TO A1 VOLTAGE WAS 1,000V OPEN CIRCUIT. WITH A 1MΩ RESISTOR BETWEEN ONE FILAMENT LEAD (STILL SHORTED) AND A1 THE A1 VOLTAGE DROPPED TO 837V. THE LEED P.S. DVM INDICATED ~~AR~~ A SIMULATED EMISSION CURRENT OF −0.80 mA. FILAMENT TO GROUND MEASURED −2.3V.

AN AMMETER WAS CONNECTED BETWEEN THE TWO FILAMENT PINS AND A COMPARISON WAS MADE WITH THE P.S. DVM READING.

EXTERNAL FILAMENT CURRENT	INTERNAL ~~DVM~~ DPM INDICATION
0.5	0.381
1.0	0.911
1.5	1.48
1.98	1.98
2.0	2.03
3.0	3.07
3.2	3.27

WITH THE CABLE RECONNECTED THE G1 LEAD WAS REMOVED FROM THE POWER SUPPLY. THE G1 WAS BIASED AT +600V TO COLLECT ELECTRONS AND THE FILAMENT SLOWLY HEATED. A 10MΩ DVM IN SERIES WITH THE BIAS BATTERY WAS USED TO MONITOR THE LOW EMISSION CURRENT.

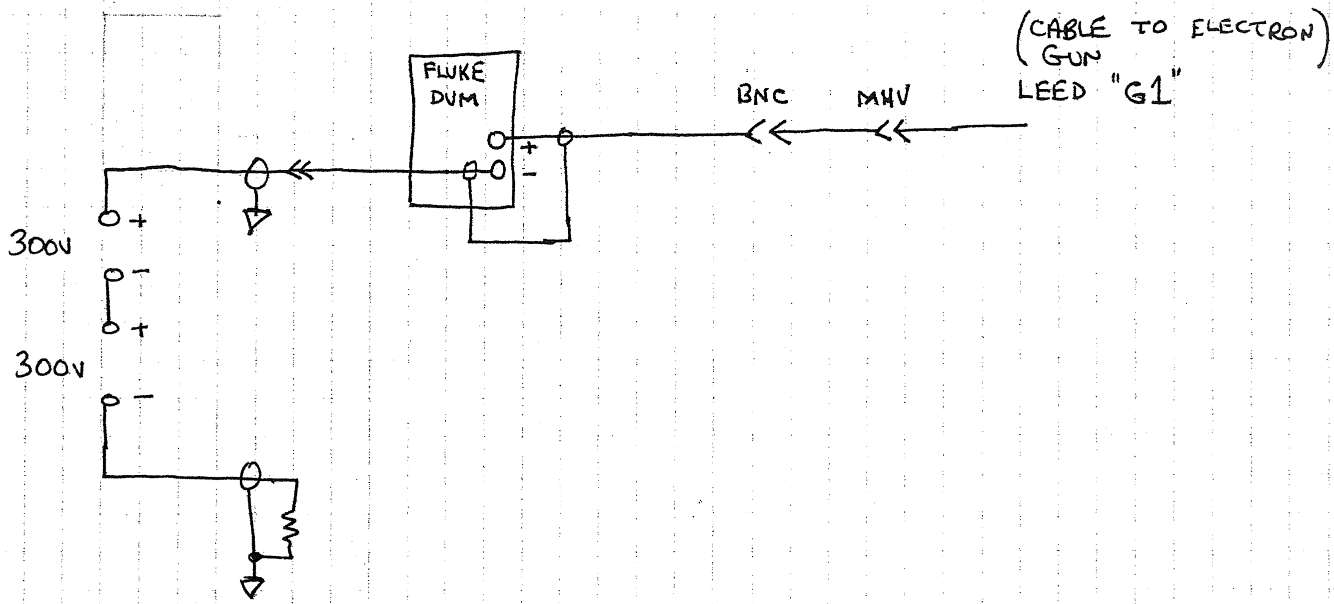
FIRST EMISSION SEEN @ 2.0A.

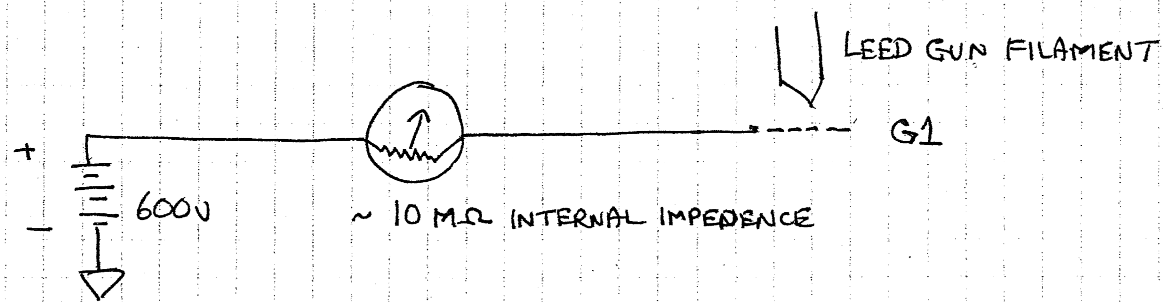
	TIME	FILAMENT CURRENT	DVM READING
21	5:30pm	+ 2.01	− 0.075
	2100	2.01	− 7.6
	1600	2.10	− 18.5
		~~2.80~~ 2.60	~~[illegible]~~ 47

1-31-94 FILAMENT CURRENT BOOSTED TO 3.25A, EXTERNAL DVM WIRED AS ABOVE READ −888. STILL NO READING ON INTERNAL DPM ~~AS~~ EMISSION.
SYSTEM VENTED TO AIR.
NEED TO DISCONNECT ABOVE DIAGNOSTIC BEFORE TRYING INTERNAL DPM

LEED GUN EMISSION CURRENT MONITOR

A SENSITIVE METHOD FOR MEASURING SMALL AMOUNTS OF EMISSION CURRENT IS SHOWN BELOW. THE ELECTRON GUN GRID 1 IS BIASED POSITIVE AT 600V TO COLLECT ELECTRONS FROM THE HOT FILAMENT. THE G1 CABLE FROM THE GUN IS REMOVED FROM THE POWER SUPPLY UNIT AND CONNECTED TO A 600V BATTERY IN SERIES WITH A HIGH SENSITIVITY DIGITAL VOLTMETER.





THE INTERNAL IMPEDENCE OF THE VOLTMETER BECOMES THE CURRENT METER SHUNT RESISTANCE AND THE EMISSION CURRENT CAN BE CALCULATED FROM

$$E = IR \qquad I = \frac{E}{R} = \frac{\text{VOLTAGE INDICATED}}{10\,M\Omega}.$$

THIS IS VERY SENSITIVE AS 1mV INDICATED VOLTAGE CORRESPONDS TO 100 pA.
1 VOLT ≡ 0.1 μA

ALL OTHER LEADS REMAIN CONNECTED TO THE LEED POWER SUPPLY.

TO BEGIN REACTIVATION OF THE FILAMENT INCREASE THE FILAMENT CURRENT UNTIL A SMALL AMOUNT OF EMISSION IS SEEN. BY TRIAL AND ERROR IT SHOULD BE POSSIBLE TO FIND A FILAMENT TEMPERATURE AT WHICH THE EMISSION CURRENT SLOWLY RISES WITH TIME. IF PURSUED LONG ENOUGH THIS APPROACH CAN BE USED TO BUILD UP USABLE AMOUNTS OF EMISSION CAPABILITY.

1-21-94

REAR VIEW LEED

ALSO SEE LOG IN SCHEMATIC FOLDER

1-21-94

1-94 FILAMENT EMISSION FAILURE. WHILE IN NORMAL OPERATION OVER AN IODINE COATED SAMPLE THE FILAMENT ELECTRON EMISSION CURRENT SLOWLY FELL TO ZERO mA. SEVERAL ATTEMPTS WERE MADE TO RE-ACTIVATE THE FILAMENT BY RUNNING LONG PERIODS AT FILAMENT CURRENTS RANGING FROM 1.0 TO 3.2 AMPS. NO LUCK.

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FIRST EMISSION SEEN @ 2.0A.

	TIME	FILAMENT CURRENT	DVM READING
21	5:30pm	+ 2.01	− 0.075
	2100	2.01	− 7.6
	1600	2.10	− 18.5
		~~2.80~~ 2.60	~~12.4~~ 47

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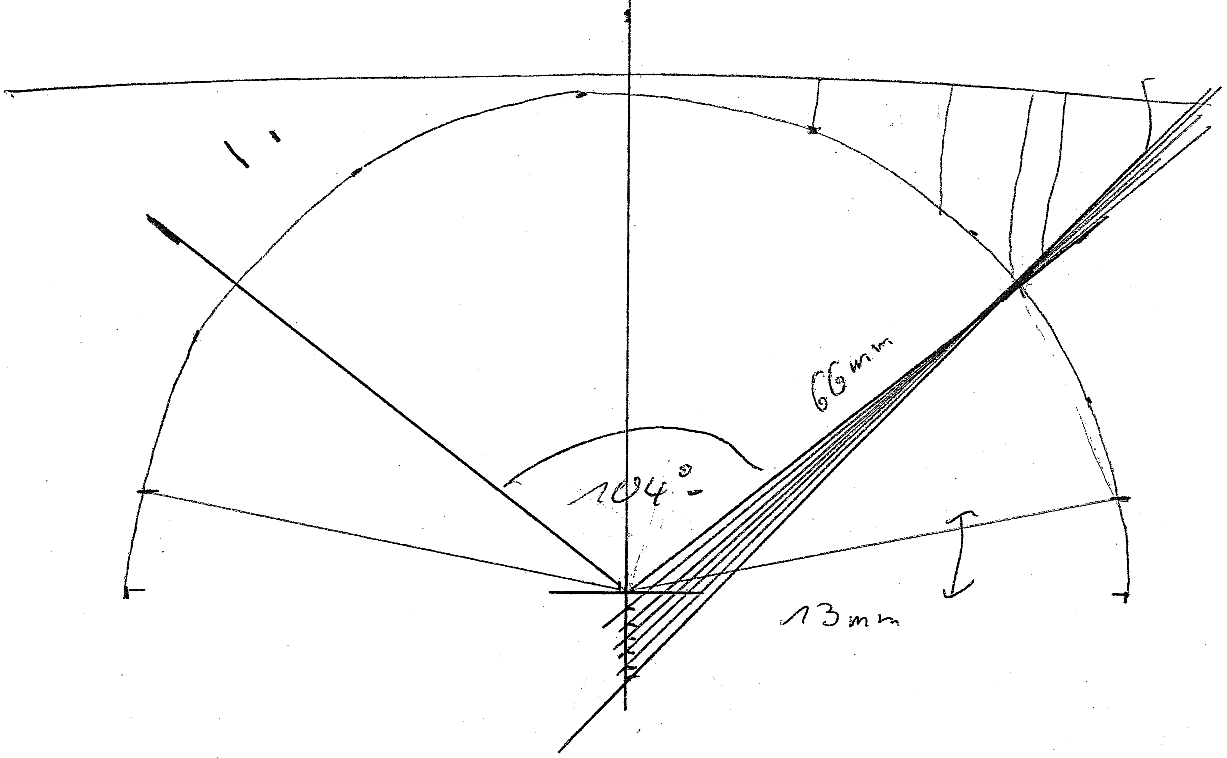
SYSTEM VENTED TO AIR.

NEED TO DISCONNECT ABOVE DIAGNOSTIC BEFORE TRYING INTERNAL DPM

LEED



13 mm optics distance = 104°

15 mm 100°

17 mm 98°

19 mm 96°

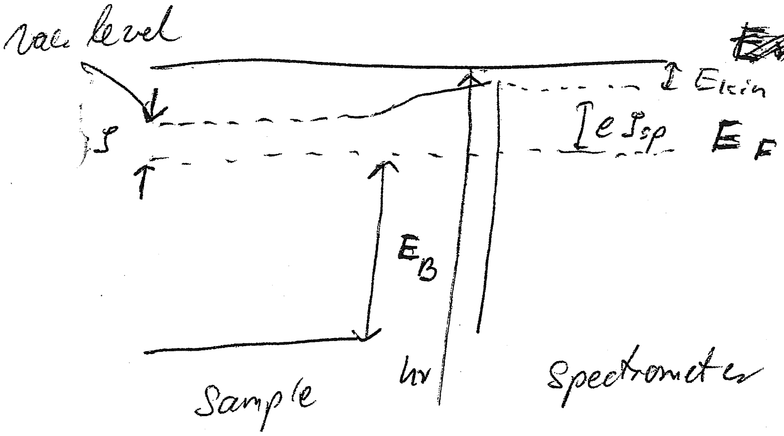
21 mm 93°

23 mm 90°

24 mm ~ 90°

.. Ideal stub, 1.35" has sample distance of 22 mm

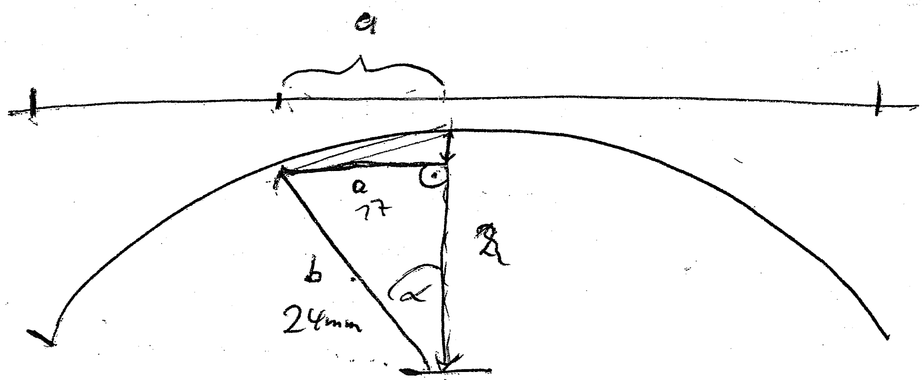
to shield end = <u>24 mm</u> to optics ≃ 90° angle full screen



In solid state measurements E_B is referenced to to E_F of the solid!

$$E_{kin} = h\nu - E_B - e\varphi_{sp}$$

work function of spectrometer



$15mm \mathrel{\hat=} 23mm$

$$26 \cdot \frac{15}{23} = \frac{390}{23} = 16{,}956$$

26 mm 37mm

26mm 37

160

for $b = 26$

$d_{hk} \rightarrow 0{,}102$

$$\sin\alpha = \frac{17}{24} = 0{,}707 = \frac{1}{d_{hk}} \cdot \sqrt{\frac{7{,}5}{4}}$$

$$\alpha = 45^\circ \qquad d_{hk} = \frac{\sqrt{\frac{7{,}5}{4}}}{0{,}707} = 0{,}094\,nm$$

$$= 0{,}94\,\text{Å}$$

Alan 818 356 4668
4312

397 2718

Microted

Distance sample – grid

proper distance 12,2 mm – shell
15,2 – grid
+ 10 = 25

closer : no more intensity
further : lose intensity
pattern moves in or out – 0 → +10 mm

→ 20 mm distance to grid

.078"

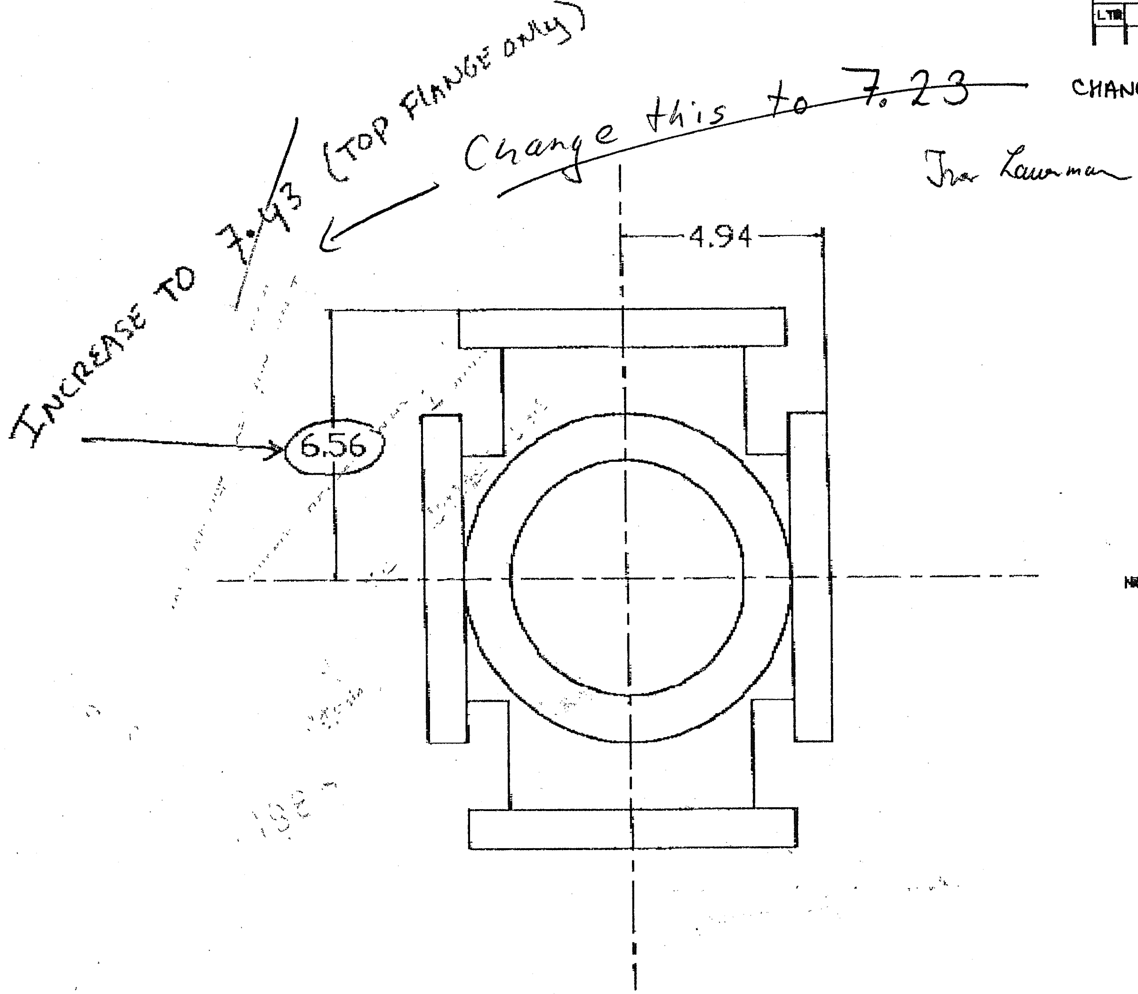
.87" → 23 mm
– .118"

$\cancel{.7}5$" <u>add</u> to flange

⇒ 6.56" + .75

= $\boxed{7,31}$"

LTR	DESCRIPTION	ECO	DATE	APPROVE



NOTES:

1. MATERIAL IS STAINLESS STEEL (CAN BE MADE FROM 5-WAY 8" FLANGED CROSS REF. #601-5)
2. ALL WELDS MUST BE LEAK TIGHT AND VERIFIED ON A HELIUM LEAK CHECKER.

FILE: HAGREG\003772_2

ITEM	PART NO.	DESCRIPTION	QTY

SURFACE SCIENCE INSTRUMENTS	
TITLE	8" FLANGE 5-WAY CROSS MODIFIED
APPROVALS: DRAWN HOOVER	DATE: SEPT 23 91
MATERIAL	SEE NOTES
CUST CODE	CALTECH
SIZE	C
DRAWING NUMBER	003772-00
REV	2
SCALE	NONE
SHEET	1 OF 1
NEXT ASSY / USED ON	APPLICATION
DO NOT SCALE DRAWING	

7,43	188.7
− 6,56	166.6
0,87	22.10
− 0,197	− 5.0
0,673	17.10
+ 6,56	+ 166.6
7,23	183.7mm

5mm ≡ 0,197"

Pt target 27.4mm HIGH

~~IDENTICAL~~

STANDARDS DISK ~8–9 mm ABOVE ℄

10/23/96
APR

DISTANCE FROM TEE ℄ TO MATING SURFACE OF TOP FLANGE ON TEE.

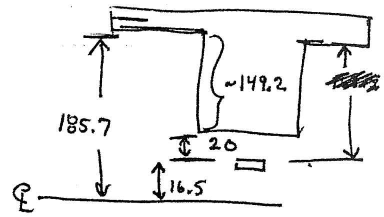
OLD @ 7.43" (188.7mm)

1) SAMPLE TO OPTICS DISTANCE WAS 23mm
2) SAMPLE HEIGHT WAS INTERSECTION OF ION GUN + RGA AXIS.

MAX RECOMMENDED SAMPLE DISTANCE FOR 4 MESH LEED.

OLD @ 7.23" (183.6mm)

1) SAMPLE TO OPTICS = 18mm



~~FLANGE FLANGE TO OPTICS = 188.7~~

~~NOW @ 7.23" (183.6mm) 1) SAMPLE TO OPTICS = 17.9mm~~

CURRENT @ 7.31" (185.7mm) 1) SAMPLE ⟷ OPTICS DISTANCE = 20mm from J.L.

185.7 − 20.0 = 165.7mm { FLANGE TO OPTICS SHOULD BE ABOUT 150 minimum

SAMPLE WAS TO BE 0.650" (16.5mm) ABOVE ℄ OF CHAMBER.

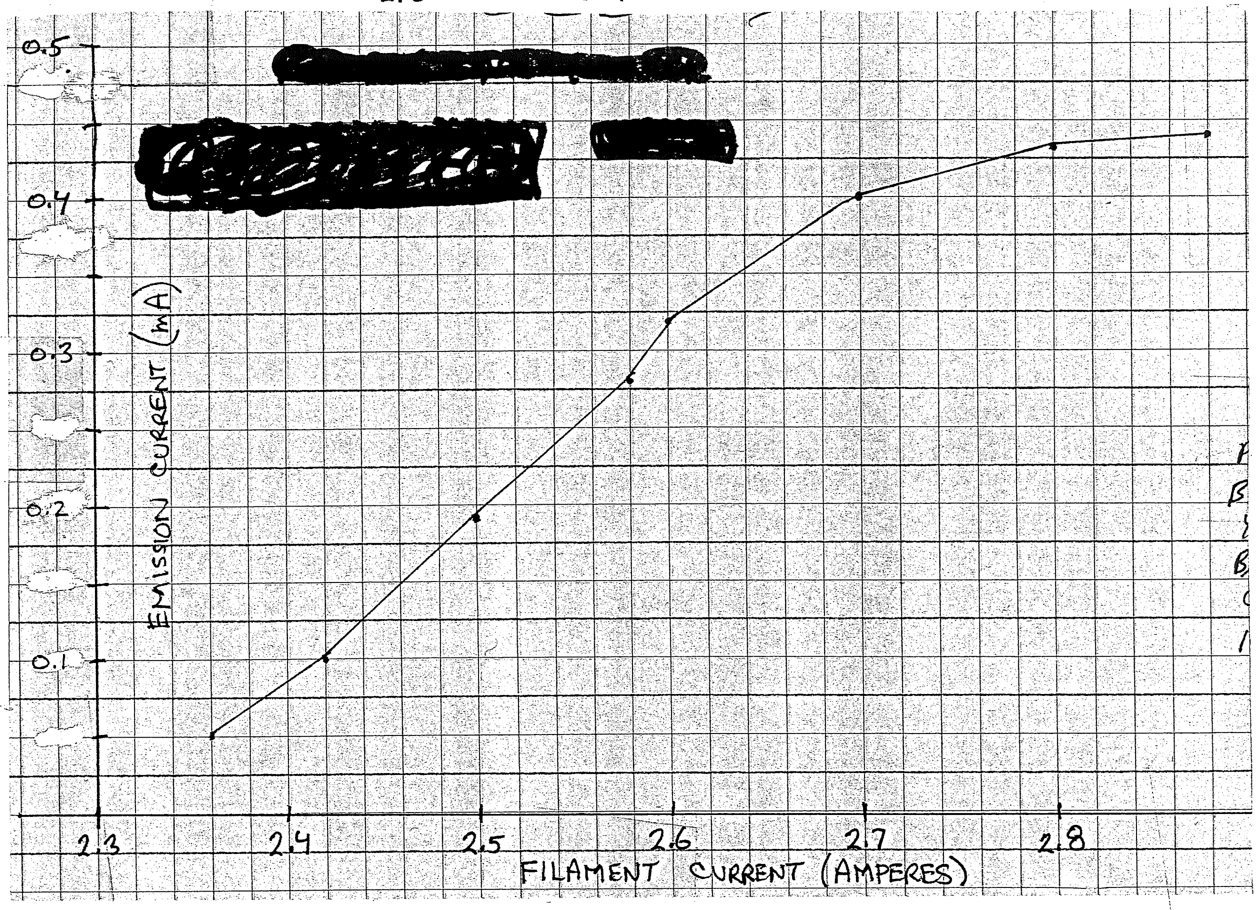
10-23-96

LEED HAS BEEN INACTIVE FOR ALMOST 1 YEAR. OUTGAS FILAMENT SLOWLY. ABOUT 6-7 HOURS TO ACHIEVE 2.2 Amps @ 2.5×10^{-9} torr (max 6×10^{-9} torr).

EMISSION BEGAN @ ~2.4A

FIL (Amps)	EMISSION (mA)
2.58	0.28
2.50	0.19
2.42	~~1.00~~ 0.10
2.36	0.05
2.60	0.32
2.70	0.40
2.80	0.43
2.88	0.44

PLATEAU



@ E=900 eV

ELECTRON BEAM CAN BE IMAGED ON A PHOSPHOR SCREEN. VERY LITTLE EMISSION CURRENT (< 0.00 mA ON DPM) IS REQUIRED. UNFOCUSED SPOT IS ~ 0.4 cm DIAMETER. FOCUSED SPOT CAN BE PINPOINT SHARP VIEWED FROM OUTSIDE,

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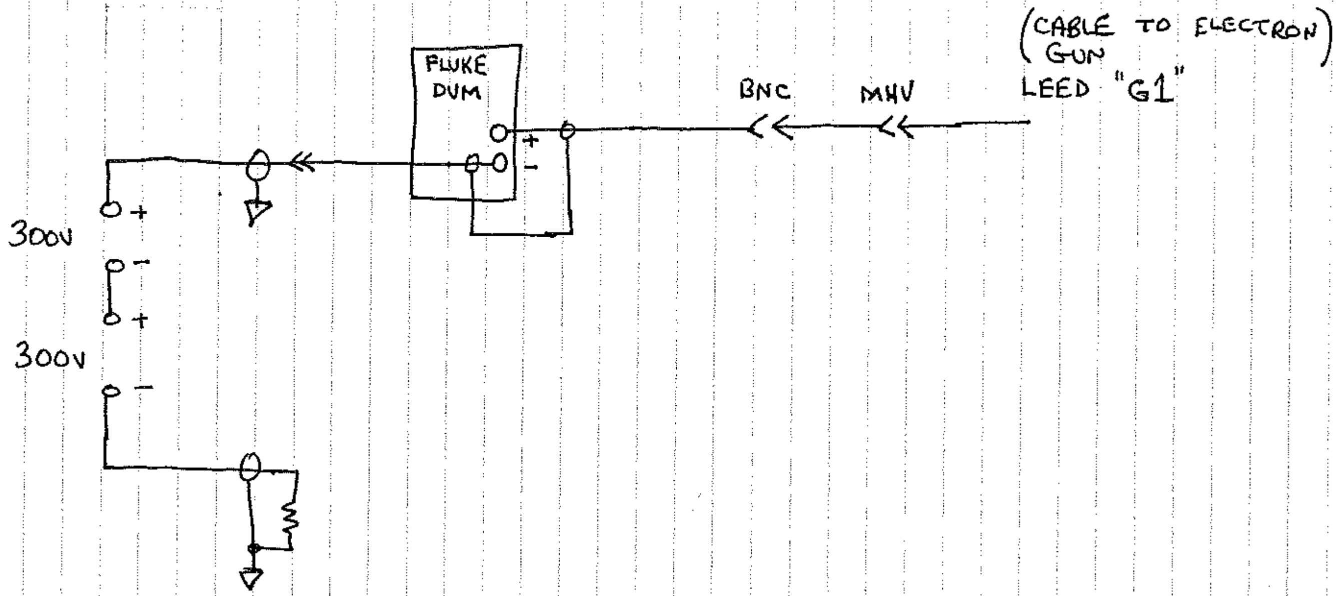

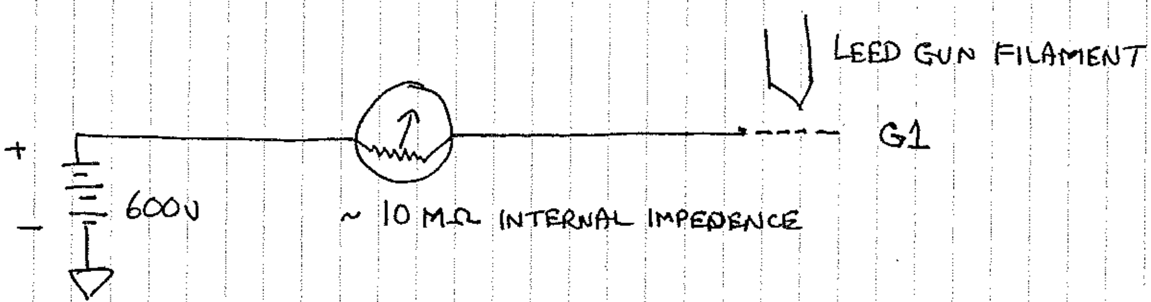

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THIS IS VERY SENSITIVE AS 1mV INDICATED VOLTAGE CORRESPONDS TO 100 pA.
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1-21-94
APR

REAR VIEW LEED

ALSO SEE LOG IN SCHEMATIC FOLDER

1-21-94
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	TIME	FILAMENT CURRENT	DVM READING
21	5:30pm	+ 2.01	− 0.075
	2100	2.01	− 7.6
	1600	2.10	− 18.5
		~~2.80~~ 2.60	~~[illegible]~~ 47

1-31-94 FILAMENT CURRENT BOOSTED TO 3.25A, EXTERNAL DVM WIRED AS ABOVE READ −888. STILL NO READING ON INTERNAL DPM ~~AS~~ EMISSION.
SYSTEM VENTED TO AIR.
NEED TO DISCONNECT ABOVE DIAGNOSTIC BEFORE TRYING INTERNAL DPM AGAIN.

studied with LEED. If the electron accelerating voltage exceeds about 30 to 80 V depending on the sample, the surface discharges almost instantaneously and the diffraction pattern can then be viewed. The surface can be recharged by lowering the electron energy below a certain threshold and this cycle repeated any number of times. This threshold is clearly related to the "cross-over" well known in secondary emission.

3.2. Diffraction patterns

Having discharged the surface (or avoided charging) one obtains a diffraction pattern. In an earlier letter[4]) we had reported that diffraction patterns from vacuum cleaved mica often showed unusual spot shapes. An "ordinary" pattern consisting of round spots is shown in fig. 1a, taken from a sample cleaved in air at 1 atm. The observed hexagonal unit mesh corresponds to the known crystallography of the mica cleavage plane, as reported by Müller[5]) and also by Deville et al.[6–7]).

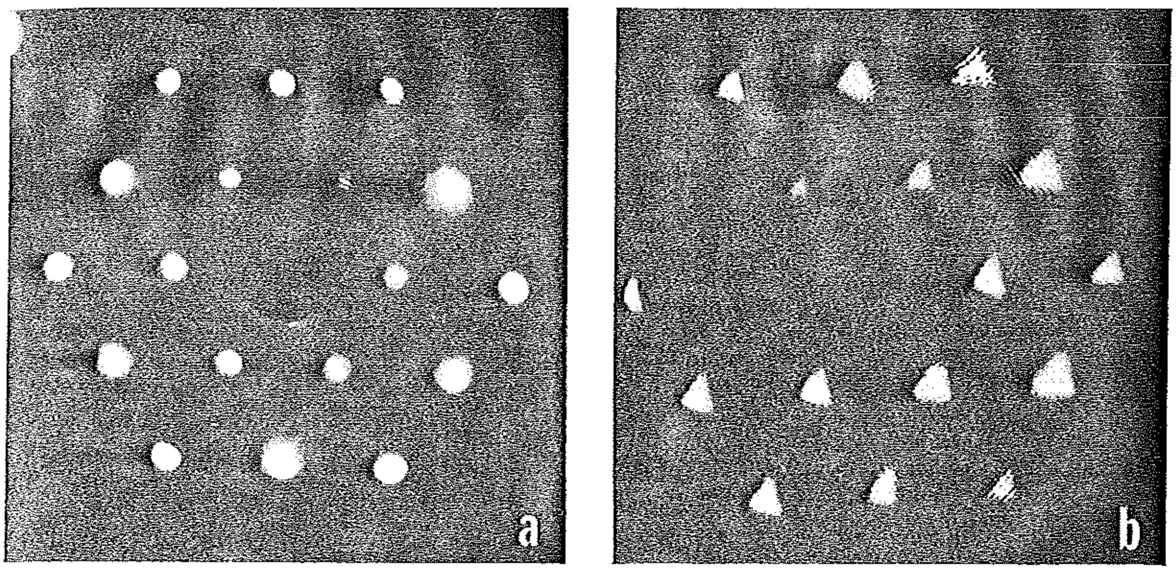


Fig. 1. Diffraction patterns from mica: (a) air cleaved, 105 V; (b) vacuum cleaved, showing triangular spots, 100 V.

Samples cleaved in vacuum showed patterns with the same unit mesh, but generally with triangular spots as shown in fig. 1b. At a given primary energy all the triangles have the same size and are similarly oriented. Besides triangles, there are three-winged stars, the wings not necessarily equally long (fig. 2a). Also the triangles are not always equilateral and can be narrow (2b). Sometimes the triangles resolve into triple spots (2c), one or even two

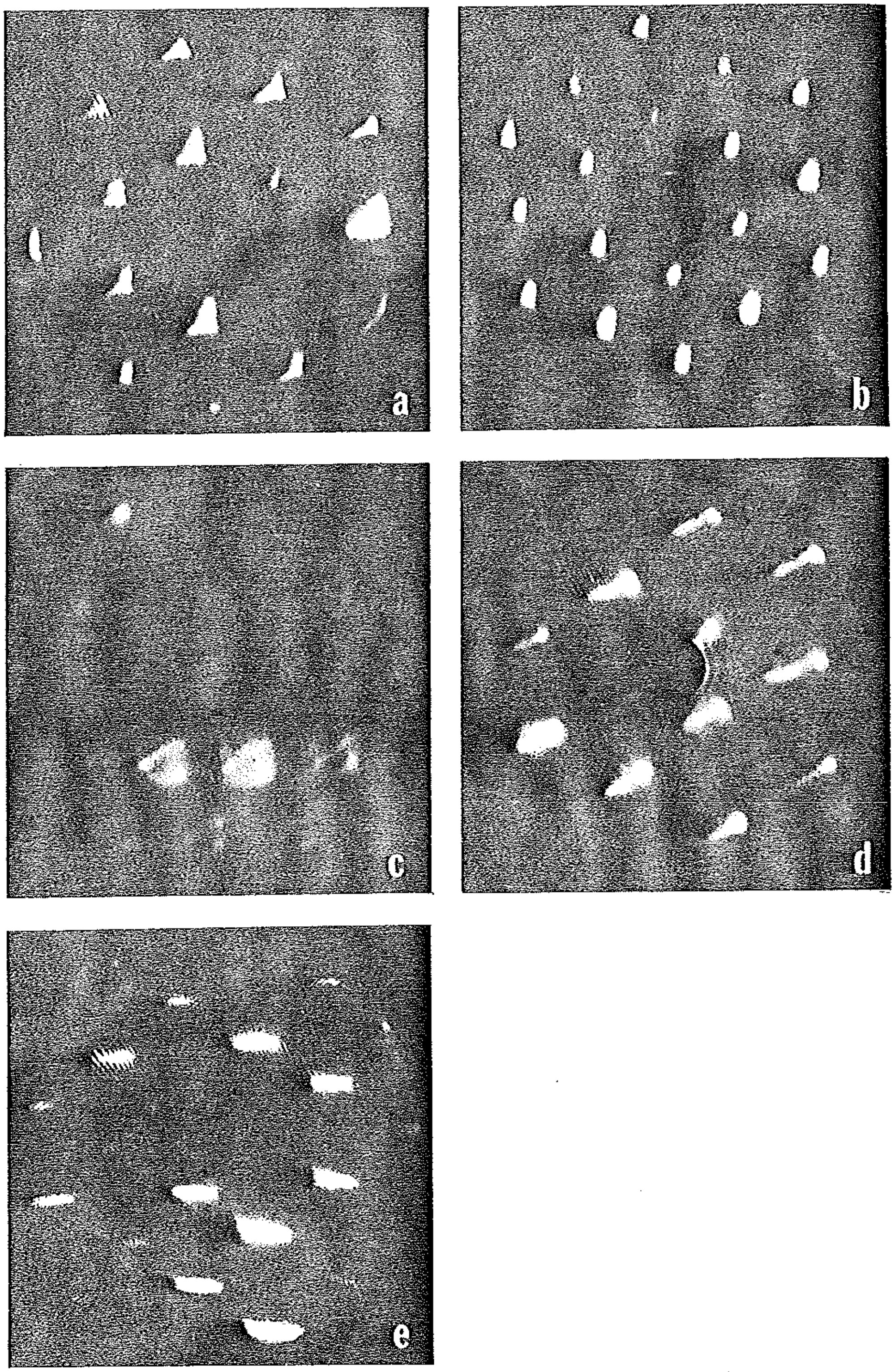


Fig. 2. Diffraction patterns from different samples of vacuum cleaved mica showing various spot shapes: (a) 60 V; (b) 100 V; (c) 66 V; (d) 50 V; (e) 120 V.

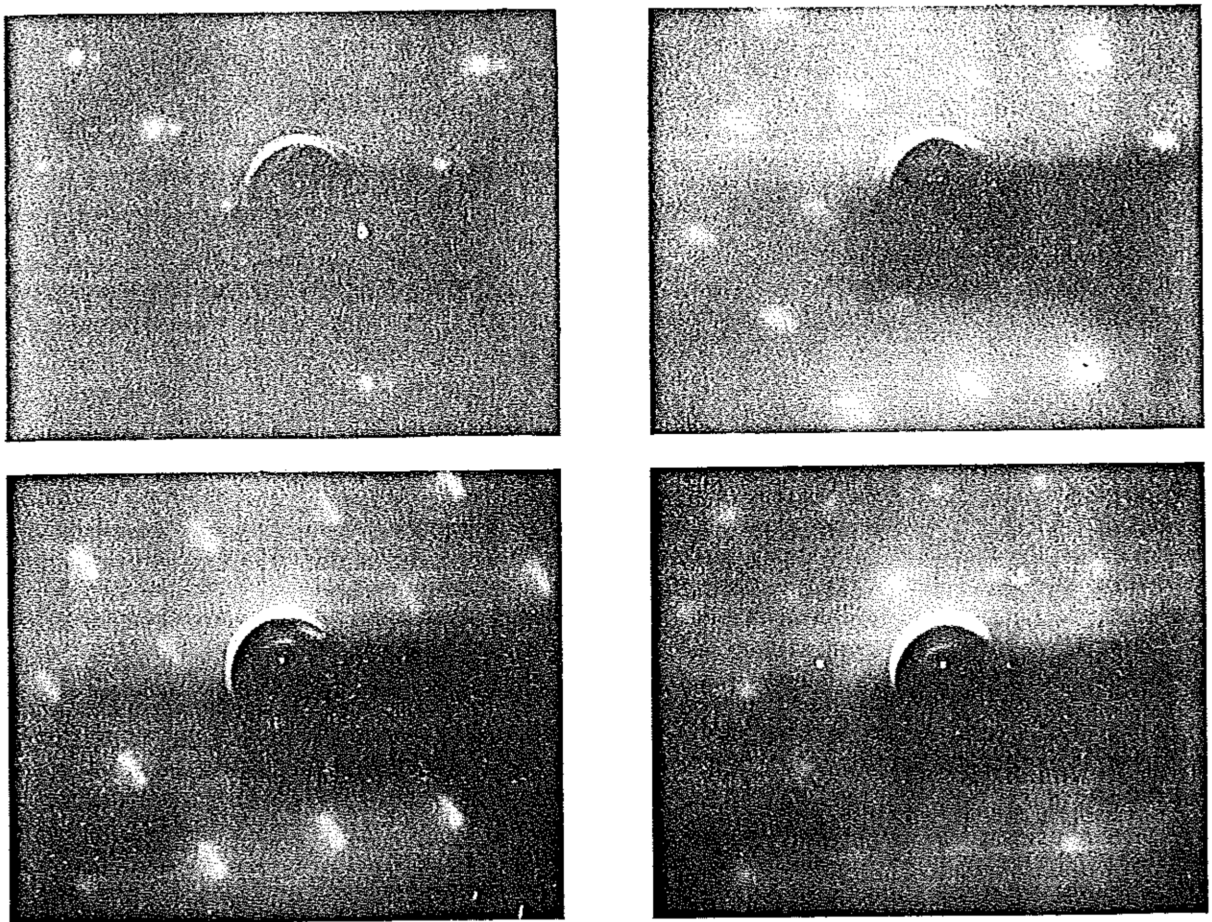


Fig. 2—LEED patterns from a mica surface cleaved in 1 atmosphere argon at beam energy (a) 90V, (b) 100V, (c) 115V and (d) 135V

LEED has not been much used to study the mica surface because of the problem of surface-charging associated with mica. However, Muller[10] and Deville *et al.*[11] did observe the hexagonal unit mesh of mica surface with LEED. Muller and Chang[7,8] found normal round spots for the air-cleaved mica surface which deteriorated and blanked out after some time. For the vacuum-cleaved surface, these authors noticed unusual patterns of triangular spots, three-winged stars, triple or double spots or streaks, all having similar orientation. The present investigation was aimed at having a closer look at the unusual LEED patterns of mica.

Materials and Methods

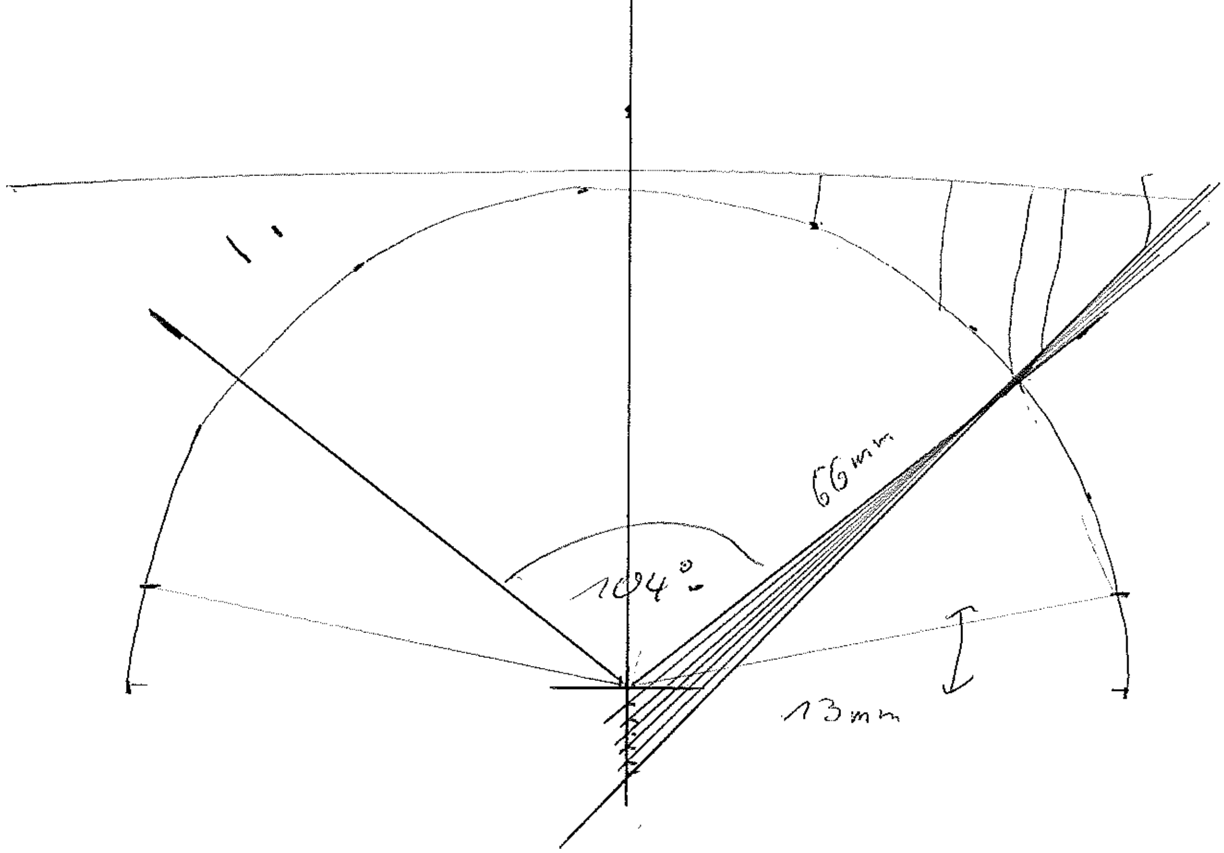
LEED patterns from mica surfaces were studied in an ESCALAB MK II system (Vacuum Generators, U.K.) fitted with LEED facility and a high precision sample manipulator in the preparation chamber. The chamber was routinely maintained at a pressure of $10^{-9}-10^{-10}$ torr (1 torr = 133.3 Nm^{-2}). One cm^2 mica samples (0.25 mm thick) were made from muscovite mica of highest purity (grade 5) and were mounted on nickel stubs with tantalum clips at the four corners. The top face of the sample could be cleaved *in situ* with a wabble stick and a small silver wire loop attached to the sample. The sample could be annealed by placing it in the P8 heating probe inside the UHV chamber.

Results and Discussion

Because of surface charging, stable LEED patterns could be seen only with an electron beam energy of 70 V or more. Good patterns were obtained with 90-150 V beam energy. The air-cleaved mica surface produced very faint patterns which could not be photographed. Annealing the surface to a temperature of 700 K did not improve the LEED patterns. The carbonaceous overlayers of the air-cleaved mica surface[12-14] could be responsible for this.

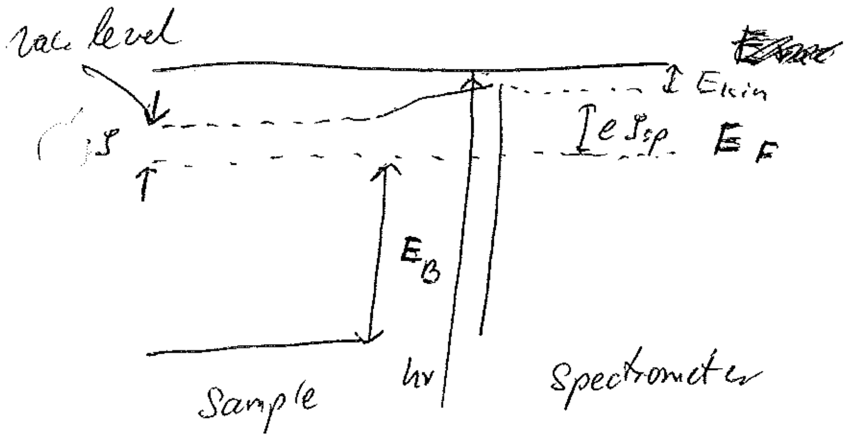
Best LEED patterns were seen when mica was cleaved in flowing argon at atmospheric pressure and the cleaved face was introduced into the LEED chamber immediately. The patterns obtained are shown in Fig. 2(a), (b), (c) and (d) for beam energies of 90, 100, 115

LEED



13mm optics distance	= 104°
15 mm	100°
17 mm	98°
19 mm	96°
21 mm	93°
23mm	90°
24 mm	~ 90°

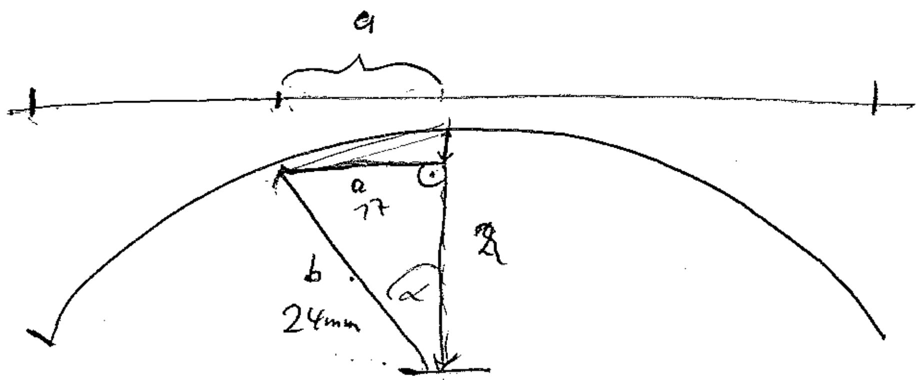
∴ Ideal stub, 1.35'' has sample distance of 22 mm to shield end = <u>24 mm</u> to optics ≈ 90° angle full screen



In solid state measurements E_B is referenced to to E_F of the solid!

$$E_{kin} = h\nu - E_B - e\,\varphi_{sp}$$

work function of spectrometer



$15\,mm \mathrel{\hat{=}} 23\,mm$

$$26 \cdot \frac{15}{23} = \frac{390}{23} = 1\cancel{6},956$$

26 mm	37 mm
26 mm	37

160

for $b = 26$

$d_{hkl} \rightarrow 0,102$

$$\sin\alpha = \frac{17}{24} = 0,707 = \frac{1}{d_{hk}} \cdot \sqrt{\frac{7,5}{u}}$$

$$\alpha = 45^\circ \qquad d_{hkl} = \frac{\sqrt{\frac{7,5}{u}}}{0,707} = 0,094\,nm$$

$$= 0,94\,Å$$

Alan 818 356 4668
4312

397 2718

Microtech

Distance sample – grid

proper distance 12,2 mm – shielle
15,2 – grid
+ 10 = 25

closer : no more intensity
further : lose intensity
pattern moves in or out –0 – +10 mm

→ 20 mm distance to grid

.078"

.87" → 23 mm
– .118"
.75" add to flange

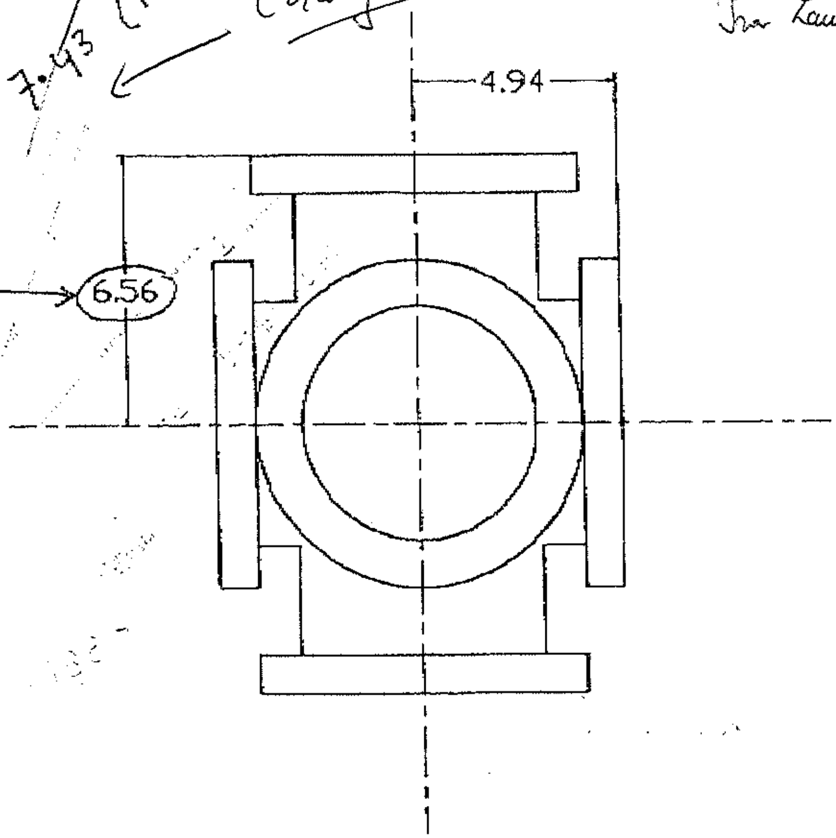
⇒ 6,56" + .75

= $\boxed{7,31}$"

INCREASE TO ~~7.43~~ (TOP FLANGE ONLY)

Change this to ~~7.23~~ CHANGED TO 7.31" AER

Jim Lawman



NOTES:

1. MATERIAL IS STAINLESS STEEL (CAN BE MADE FROM 5-WAY 8" FLANGED CROSS REF. #601-5)
2. ALL WELDS MUST BE LEAK TIGHT AND VERIFIED ON A HELIUM LEAK CHECKER.

FILE HAGREG\003772_2

LTR	DESCRIPTION	ECO	DATE	APPROVE

SEE NOTES

NEXT ASSY	USED ON
APPLICATION	

SURFACE SCIENCE INSTRUMENTS

TITLE: 8"FLANGE 5-WAY CROSS MODIFIED

SIZE: C DRAWING NUMBER: 003772-00 REV: 2

CUST CODE: CALTECH

7,43	188.7
− 6,56	166.6
0,87	22.10
− 0,197	− 5.0
0,673	17.10
+ 6,56	+ 166.6
7,23	183,7 mm

5mm ≡ 0,197"

Pt target 27.4mm HIGH

↕ ~~IDENTICAL~~

STANDARDS DISK ~ 8–9 mm ABOVE ℄

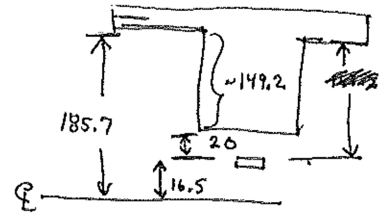
10/23/96
APR

DISTANCE FROM TEE ℄ TO MATING SURFACE OF TOP FLANGE ON TEE.

MAX RECOMMENDED SAMPLE DISTANCE FOR 4 MESH LEED.

OLD @ 7.43" (188.7 mm) 1) SAMPLE TO OPTICS DISTANCE WAS 23mm
2) SAMPLE HEIGHT WAS INTERSECTION OF ION GUN + RGA AXIS.

OLD @ 7.23" (183.6mm) 1) SAMPLE TO OPTICS = 18mm



~~HENCE FLANGE TO OPTICS = 188.7~~

~~NOW @ 7.23" (183.6mm) 1) SAMPLE TO OPTICS ≈ 17.9mm~~

CURRENT @ 7.31" (185.7mm) 1) SAMPLE ⟷ OPTICS DISTANCE = 20mm from I.L.

185.7 − 20.0 = 165.7mm { FLANGE TO OPTICS SHOULD BE ABOUT 150 minimum

SAMPLE WAS TO BE 0.650" (16.5mm) ABOVE ℄ OF CHAMBER.

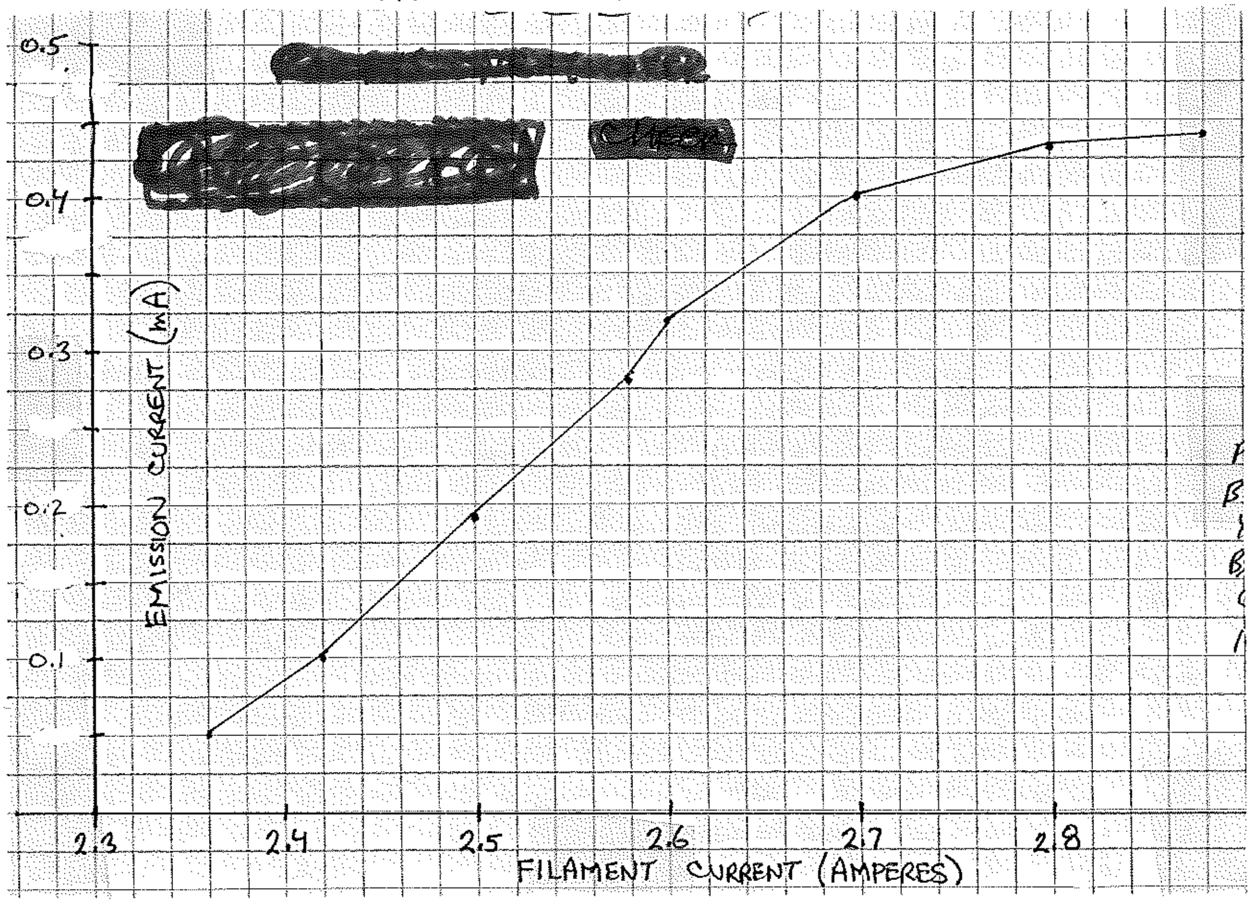
10-23-96

LEED HAS BEEN INACTIVE FOR ALMOST 1 YEAR. OUTGAS FILAMENT SLOWLY. ABOUT 6-7 HOURS TO ACHIEVE 2.2 Amps @ 2.5×10^{-9} torr (MAX 6×10^{-9} torr).

EMISSION BEGAN @ ~2.4A

FIL (Amps)	EMISSION (mA)
2.58	0.28
2.50	0.19
2.42	~~1.00~~ 0.10
2.36	0.05
2.60	0.32
2.70	0.40
2.80	0.43
2.88	0.44

PLATEAU



E=900 eV

ELECTRON BEAM CAN BE IMAGED ON A PHOSPHOR SCREEN. VERY LITTLE EMISSION CURRENT (< 0.00 mA ON DPM) IS REQUIRED. UNFOCUSED SPOT IS ~ 0.4 cm DIAMETER. FOCUSED SPOT CAN BE PINPOINT SHARP VIEWED FROM OUTSIDE,