Kentech Instruments Ltd.

LOW MAGNIFICATION
X–RAY
STREAK CAMERA

25th. October 1991

PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE CAMERA.

Serial Numbers*****

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CONTENTS

(i) **FIGURE CAPTIONS**

(ii) DISCLAIMER

This equipment contains high voltage power supplies. Although the current supply capacity is small, careless use could result in electric shock. It is assumed that this highly specialised equipment will only be used by qualified personnel.

Kentech Instruments Ltd. accept no responsibility for any electric shock or injury arising from use or misuse of this equipment. It is the responsibility of the user to exercise care and common sense with this highly versatile equipment.

1 INTRODUCTION

This manual describes the operation and use of the Kentech low magnification re-entrant X–ray streak camera. This camera is optimised for the ultra sensitive recording of X–ray images and spectra from laser produced plasmas. The low (approximately X1.2) magnification allows a 25mm length cathode to be used within a 40mm diameter intensifier window. The manual gives the mechanical and electrical specifications and describes the setting up procedure to obtain optimum time resolved data.

The camera is set up for 240 volt A.C. mains supply (120 for cameras sold to U.S.A.). To convert between 240 and 120 volts both the focusing and sweep circuits must be opened and switched. The units are simply opened by removing the four large headed brown screws in the sides of the boxes. Do not remove the screws on the back panels. With the screws removed the tops may be removed and the switches, which are easily identified, switched. **DO NOT ADJUST ANY OTHER CONTROLS WITHIN THE UNITS.** The only other user adjustments are within the focusing supply and should only be moved whilst the camera focus is being adjusted, see section 3f. A few mains voltage labels are supplied and it is recommended that these be used whenever the supply voltage setting is switched, especially when converting to the lower voltage.

1(a) SPECIFICATIONS

Trigger delay	<30ns on fastest speed
Electro-optical magnification	X 1.2(nominal)
Sweep speeds	Six: 15-900p.s/mm
Phosphor	P11 or P20 (interchangeable)
Cathode length	>25mm
Supply	120/240 V a.c.
Trigger input	Normally 5volts, rising in 1ns for min. delay
Spatial resolution	Better than 100 μm at the cathode
Sweep hold off time	approximately 50 μs

2 GETTING TO KNOW THE INSTRUMENT

The **Kentech** low magnification re-entrant X–ray streak camera has been specially designed from the users point of view to optimise the X–ray flux on the photo-cathode. The innovative aspects of the instrument are the 50 Ω line driving sweep electronics, the new electron optics and the advanced mechanical design. The electronics are remote from the electron optics, which are of a new design unique to Kentech, allowing compact mechanics. The optics have been designed to use only three focusing potentials while allowing the use of a zoom electrode to obtain low magnification. The outer diameter of the re-entrant housing is only 145mm. The re-entrant design allows the photocathode to be very close to the plasma. Very high sensitivity results simply from the inverse square law.

2(a) LAYOUT AND PRINCIPLES OF OPERATION

The tube fits into the re-entrant vessel the outside diameter of which is 145mm. The vacuum seal is made to the outside wall of the interaction chamber. Figures 1 and 2 show the internals and connections to the camera.

The X–rays which are incident on the photocathode produce photoelectrons. The photoelectrons are imaged by the focusing electrodes, passing through the hole in the anode and form an image on the phosphor at the end of the streak tube. With a slit in front of the photocathode an image of the slit is formed on the phosphor. This image is swept across the phosphor by a ramp potential applied to deflection plates situated just beyond the anode hole. Position along the photocathode is magnified nominally by a factor of 1.2 onto the phosphor. The direction normal to this corresponds to time. There is an inversion in the electron optics.

2(b) THE ELECTRON OPTIC Focusing

Before the high voltage focusing supply is switched on the vacuum chamber must be at a pressure of less than 10^{-4} torr. At higher pressures electrical breakdown may occur which can damage the cathode, mesh and even the intensifier.

A block diagram of the focusing supply is shown in figure 3. The approximate voltages applied to the focusing electrodes are:

Photocathode	-15.0kV	
Mesh	-10.9kV	(adjustable)
Cone	-11.5kV	(adjustable)

The focusing power supply (the unit with the three high voltage connectors) is set to produce these voltages during the factory test of the camera. (see specifications at end)

The voltages are produced by a resistive divider as illustrated in figure 4. This unit is potted. The total accelerating potential and the two adjustable potentials can be set when the cover is removed.

GREAT CARE MUST BE USED WHEN OPERATING THE SUPPLY WITH THE COVER REMOVED. USE AN INSULATED SCREWDRIVER AND KEEP FINGERS AWAY FROM THE WHITE POTTED BOX.

Figure 1 diagrammatically shows the cathode assembly. Note the high value resistor situated close to the mesh. This limits the current flow in the event of breakdown and can save the mesh/cathode from destruction. The capacitance of the cathode to mesh is sufficient to supply the charge required to form an image. In any case the inductance of the leads effectively isolates the electrodes from the supply.

2(c) THE SWEEP CIRCUIT

The streak voltage is supplied by an external ramp generator. Figure 6 is a block diagram of this unit. This unit supplies balanced linear ramps of magnitude approximately +/- 1.7kV. The slope of the ramps, which determines the sweep rate, is set by the sweep speed switch on the front panel. The start position of the sweep is set by the bias switch. In the normal (N) mode the sweep starts off-screen such that the screen samples the most linear part of the ramp (see figures 13 and 14).

Each plate has two cables connected to it as shown in figures 1 and 2. One cable provides the sweep voltage via the 470pF blocking capacitor. The other cable provides the D.C. bias voltage an can also be used as an output monitor for the sweep voltage.

There are six sweep speeds available with the K **Kentech** sweep unit. The sweep speed and the trigger delay in bias(N) position are tabulated in the specification section. With no bias applied (position C) the image starts in the centre of the phosphor. The bias can be applied in stages up to the normal(N) operating point at which the image starts approximately one screen width off the phosphor. The intermediate positions all start on screen. They can be used to superimpose several *static* images at slightly different positions in order to calibrate spectrally a spectrometer attachment (by moving the crystal between exposures), or to calibrate the magnification of a pinhole camera (by moving the pinhole between exposures).

The nominal streak rates are:

Setting number	Streak rate mm/ns
6	80
5	35
4	20
3	12
2	4
1	1

2(d) MAGNETIC FIELDS

The low magnification electron optics, being longer than earlier designs, are more prone to image displacement under the influence of stray magnetic fields. To remove this effect a mumetal screen, which fits around the re-entrant housing, is supplied. It is not essential to use this screen, however, it is recommended if any magnets are around the chamber (such as ion pumps or gauges).

NOTE

It has come to our notice that the use of screws of magnetic materials in or near the photocathode assembly can give rise to image displacement. If it is necessary to replace screws ensure that they are of unplated brass or non-magnetic stainless steel. The use of nickel (magnetic) plated brass screws has not been found to cause problems but we would advise against it.

2(e) SWEEP PLATE ASSEMBLY

Should it become necessary to remove the sweep plates (highly unlikely) it is essential that silicon 'O' rings are used. Also the grease used must not be electrically conducting (don't use Dow Corning). The bias voltages to the sweep plates are from a high impedance circuit and it has been found that combinations of some greases and 'O' rings can lead to too much leakage current from the sweep plates to ground. The camera as supplied has been measured to have a leakage impedance greater than $10^{10}\Omega$.

When focusing the camera, should this become necessary, it is essential that the sweep plates are grounded. The very low leakage path to ground allows them to pick up radiation and can cause the image to oscillate giving the impression of poor focus. Connecting a load to the plates, will eliminate these problems.

2(f) MECHANICS

Note that the nine screws clamping the inner housing cover with the three crescent shaped clamps are drilled to permit evacuation of the blind holes. Do not mix these screws with others of similar size used elsewhere on the instrument. (A few spares are provided.)

3 USE

3(a) CONNECTIONS AND MECHANICS

The high voltage focusing potentials are taken to the camera via three coaxial leads. The focusing supply may be powered up with no connectors mated. The leads and connectors are colour coded.

White	:	Focus
Red	:	Cathode
Orange	:	Mesh

The sweep unit is connected via four 50 Ω leads. Two carry the sweep potentials and the other two deliver the bias voltages. The leads can be connected or disconnected with the camera fully assembled. These leads have LEMO high voltage connectors. (Type FLO-017250TS5.2 and FO-017250TS5.2 plugs and RA0S250T sockets.) The camera is labelled with the appropriate bias/sweep connections, as is the sweep unit. In addition all the connectors are also colour coded according to the following:-

Ramp/Sweep +ve	:	Red
Bias +ve	:	Yellow
Ramp/Sweep -ve	:	Blue
Bias -ve	:	Green

The four leads have right angled connectors at one end and straight at the other. They may be used either way round as suits the application.

Figure 1 shows the internal connections and figure 2 shows the sense of the connectors on the camera face. The direction of increasing time is also shown on this face. This direction may be reversed by swapping the polarity of the sweep and bias leads. Do not forget that there is a further inversion if a 50/40 type intensifier is used.

The re-entrant design allows complete access to the internal components of the camera without disturbing the re-entrant vessel. Since this vessel is the usual mounting point for any diagnostic attachment, removal of the camera streak tube will not disturb alignment. To remove the streak tube the intensifier must first be detached. The chamber should be vented at the last moment as this will improve the pump down time. There are eight holes in the intensifier mounting flange. A hexagon key can be passed through these holes to remove the eight screws which hold the streak tube to the re-entrant housing. The streak tube must be withdrawn carefully so that the cathode assembly does not strike the re-entrant housing.

The time for which the camera is exposed to the atmosphere should be minimised as; (i) the cathode may degrade under the influence of atmospheric moisture and (ii) the pumpdown time is shorter for a short exposure to air.

N.B. The mechanical versatility allows the camera to be oriented in many ways. Be sure that the slit axis is correctly aligned with respect to any diagnostic attachments.

3(b) SWEEP MONITOR BOX

The sweep monitor consists of a boxed 1K Ω series resistor and a dummy sweep lead, the total length of which equals that of one of the sweep leads plus the cable inside the camera. The dummy lead is used to connect one of the ramp outputs to the monitor box, this is then connected via a 20dB attenuator (not supplied) to a 50 Ω impedance scope input. The output of the monitor into a 50 Ω load is approximately +/-100volts hence the need for an attenuator.

THE MONITOR BOX SHOULD NOT BE CONNECTED TO A HIGH IMPEDANCE (e.g. 1MΩ INPUT SCOPE AS THE RESULTING HIGH OUTPUT VOLTAGE WILL DAMAGE IT. A 50Ω INPUT IMPEDANCE MUST BE USED.

This facility should not be confused with the “monitor” output on the front of the sweep unit. This is a low voltage signal for establishing that the unit is triggering and may be used to trigger ancillary equipment, e.g. an intensifier.

The 1KΩ effective load on the sweep unit will cause the ramp potentials to droop prematurely, with a time constant of approximately 50ns. The monitor output thus appears to retrace the screen too soon. This should be ignored. In the absence of a load the hold off time is approximately 50 μs. The slowest sweep rate (position 1) will start to show this droop late in time during the ramp. Again this should be ignored. The slowest sweep rate is of sufficiently low risetime that it can be monitored with a normal high voltage scope probe.

The 1KΩ load will result in premature recharging and retriggering of the avalanche stack. This will manifest itself as a series of smaller steps appearing some few microseconds after the initial ramp. These should be ignored and do not appear when the monitor box is not connected.

The high voltage signals present in the sweep unit give rise to substantial electrical noise. When using an oscilloscope as a monitor this noise is likely to interfere with the displayed waveform, giving the impression of gross non-linearity. We recommend that a direct access oscilloscope, such as a Textronix 519 be used, if a quantitative measure of the sweep potentials is required, however for timing purposes a noisy signal will suffice.

3(c) CATHODE/MESH ASSEMBLY

For transit a protective container contains the cathodes and meshes. Consequently these need to be inserted before the camera can be used. The instructions that follow refer to components shown in figure 16. In order to access the photocathode assembly four screws around the periphery of the holder should be removed. The end may then be removed. Always take extreme care at this stage. The photocathodes are delicate and subject to contamination. The meshes (underneath) are also very fragile and expensive. These meshes are hand made to special order. They are not commercially available from other sources. With the mesh and photocathode removed there is a direct line to the output phosphor (although there is only a small aperture in the lens assembly). Hence particular care must be taken not to drop small screws or other items into the camera.

The items to be placed into the snout of the camera are as follows and must be in the sequence and orientation specified.

1 mesh contact ring (not actually removable without unsoldering from lead) solder contact side downwards. The contact ring must seat evenly with solder of the connection being in the rebate of the housing

2 mesh with mesh side upwards

3 spacer. There are two spacers. Normally the thicker one should be used. The thinner one is used to obtain greater time resolution but a better vacuum may be required to prevent breakdown.

4 Photocathode with photocathode side downwards i.e. nearest the mesh.

5 Slit plate, one of three sizes supplied according to time resolution requirements.

6 Photocathode contact ring with solder connection upwards away from the photocathode.

7 Second spacer. This must be placed in so that the rebate covers the solder connection to the photocathode contact ring. The clamp cover should now be screwed down evenly. It should be noted that caesium iodide cathodes have a short life when exposed to (particularly damp) air.

3(d) INITIAL POWER-UP

The focusing supply must not be turned on if the pressure is higher than 10^{-4} torr.

When the power is first applied a small breakdown will usually occur as a result of absorbed gas released under the influence of high electric fields. Normal procedure, after the vacuum chamber has been evacuated, is to turn the camera on with the intensifier removed while watching the phosphor in semi-darkness. At the first application of power there will probably be a slight flash of light. The focusing supply should be switched on and off a few times, such that no light is visible on the phosphor. It may be necessary to wait for the pressure to improve before this test is passed. Only after this test is passed satisfactorily should the intensifier be mated and powered up. This test is only required once after venting the vacuum chamber.

It is not a good idea to leave the camera powered up for long periods while waiting for shots as an unexpected rise in the chamber pressure due to accidental venting or possibly running out of liquid nitrogen could result in destruction of the cathode and/or mesh.

It is also undesirable to leave the recording film exposed to the intensifier for any longer than is necessary as it may pick up noise and degrade the data.

3(e) PROCEDURE FOR TIMING THE STREAK CAMERA.

Figures 13 and 14 show the position of the image as a function of time after the trigger signal reaches the sweep unit, for the bias set to position 6(N).

The real time output monitor allows absolute timing of the streak camera. The signal can be obtained from the BIAS feeds, however this is a much attenuated signal and is very noisy. A better method is to use the supplied dummy sweep lead together with the monitor box. The lead is equal in length to the total cable length between the sweep unit and the sweep plates. The monitor box is simply a solid carbon composition 1000 Ω resistor in series with the lead. Thus the output is of magnitude +/-100V into a 50 ohm load, depending on whether the positive or negative sweep is being monitored.

DO NOT CONNECT THIS MONITOR TO A HIGH IMPEDANCE INPUT ON A SCOPE AS THE HIGH VOLTAGE WILL DAMAGE THE SCOPE. THE SIGNAL MUST BE MONITORED WITH A 50Ω INPUT IMPEDANCE. TYPICALLY A 20db ATTENUATOR SHOULD ALSO BE USED.

The half height of the step should appear at the output of the monitor 3ns after the X-ray signal reaches the cathode.

This method of timing should get within approximately 1ns of the correct timing and therefore for sweep speeds in excess of speed 4 (approximately 50ps/mm) the “window narrowing” technique should be used for final timing.

In general the trigger signal should be timed so that it coincides with the X-ray signal on the photocathode, with allowance made for:

(i) the flight time of electrons from the cathode to the sweep plates (approximately. 3ns)

(ii) the time delay from triggering the sweep unit to the image reaching the middle of the screen (see figures 13 and 14)

(iii) the flight time of photons from the plasma to the cathode

(iv) the relative timing of the electrical trigger and the arrival of the laser pulse at the target

Alternatively timing can be performed in the usual manner, viz in centre start mode(C) progressively narrowing the timing window and then switching to normal(N) mode. Start off with a long delay such that a static image is seen, then change the cable length by a halving amount, either negative or positive, depending on the appearance or non-appearance of an image.

3(f) TESTS

The electron optics may be tested with either a DC X-ray source or a DC UV source, such as a mercury vapour lamp with quartz envelope.

The camera must be operated in a vacuum so the user must provide a suitable pumping system. The vacuum requirement is a pressure of not more than 10^{-4} torr. A suitable window and cathode must be provided for UV use. (K**Kentech** can advise on the supply of such a cathode, being either 10nm gold or 100nm aluminium on a quartz substrate) and a UV mercury vapour lamp, which will operate in the vacuum chamber.

A typical mercury vapour lamp operating 20cm from the cathode will give a bright image on an intensifier in contact with the phosphor. With suitable cathodes it is possible to obtain moderately bright images without an intensifier. In normal (swept or short exposure) operation an intensifier should always be used in order to maintain a low electron current in the tube and still obtain a recordable image.

The focus controls may be accessed by removal of the cover of the EHT focusing supply. Great care must be exercised when this cover is removed as high voltages are present. The focusing potentiometers may be adjusted by turning the potentiometers in the potted EHT divider network. An insulated screwdriver MUST be used. The overall voltage (the cathode voltage) may be adjusted using the preset potentiometer adjustment on the Bonar Wallis inverter supply adjacent to the divider network. D **Do not forget to load the sweep plate connections**, see section 2(e).

With the DC source, the focusing supply and the intensifier (not supplied) switched on, the focus should be set for optimum image quality. The two potentials are interdependent and the optimum image quality is obtained by iterating between the two settings. The cathode voltage should first be set to 15kV. Then a best image should be found by adjusting the mesh potential and then the focus voltage should be changed slightly. The mesh voltage should be again set for a best image and the image compared with that obtained with the previous focus setting. The greatest effect of the focus voltage will be on those parts of the image furthest from the axis. The focus should be chosen to give the best edge image quality while always maintaining the mesh potential at a best image position.

Stray magnetic fields, e.g. from Penning gauges, may displace the image slightly. The mu-metal screen may be adequate to remove this if necessary. Otherwise the source of the magnetic field will have to be eliminated.

3(g) **POSSIBLE FAULTS.**

1 No DC image

Insensitive cathode.
Replace.
Bad connections to cathode/mesh assembly. Check.
Short circuit between mesh and cathode. Check.
Breakdown of EHT feed
(indicated by fault light on focusing supply).
Check connectors are mated correctly.Check pressure is low enough. Ensure all connections to cathode/mesh assembly are sound.

2 Bad focus.

Poor connections to cathode/mesh. Check
Old/damaged cathode. Replace.
Poorly mated EHT connector. Check.
Fault in bias/sweep supply. (Confirm by switching off sweep circuit supply, which should restore focus).
Ensure that both bias and both sweep leads are correctly mated.
Focus voltages have drifted (unlikely).
Refocus.
Photocathode and mesh not normal to camera axis.
Ensure clamp screws are tight.

N.B. Poor connections to the mesh or cathode will often result in an apparent drift in the focusing as the electrodes charge up.

3 No streaked image.

Intensifier triggering at wrong time from noise.
Block trigger diode and fire shot.

intensifier should not trigger.
Sweep unit triggering at wrong time from noise.
As above.
Sweep feeds incorrectly connected.
Check.
Inadequate trigger signal causing jitter.
Check with oscilloscope.

4 Spurious blobs of light.

Breakdown in chamber.
Pressure too high.

Perform initial power up test.
Breakdown on shot.
Plasma or target debris getting into electron optics. Is front of re-entrant vessel adequately screened? It is wise to restrict the front aperture as much as possible and cover the X–ray line of sight with as thick a filter as will transmit the desired X–rays.

5 Reduced sweep speed combined with loss of focus
Bad connection of one sweep lead. This reduces applied voltage ramp but also fails to a maintain zero potential in drift tube, hence affecting the focus.

4 CIRCUIT DESCRIPTIONS

4(a) SWEEP CIRCUIT

The sweep circuit is based on two high voltage avalanche step generators unique to K**Kentech**. These two generators provide balanced steps of amplitude +/- 1.6kV into 50 Ω loads, with a risetime of 1ns. These generators are fed into the sweep leads via 50Ω reverse terminating resistors, which reduces the amplitude to 1kV. When this edge reaches the open circuit end at the sweep plates it doubles up to 2kV. The reverse pulse is absorbed by the reverse terminating resistors. A block diagram of the unit is shown in figure 6.

Different sweep rates are obtained by the switchable pulse forming LCR network and selected by the sweep rate switch (see figure 7). The sweep leads form part of this network and their length must therefore not be changed.

A further function of the sweep unit is to provide the required bias voltages to define the start of the sweep (see figure 12). There are six positions. Position C starts in the centre of the screen and would normally be used while timing the camera. The N or normal position starts approximately 4cm off screen such that the portion of the sweep displayed is linear. It should be noted that in “C” mode the sweep starts off non-linearly.

There are four further positions, distributed between the centre and edge of the screen. These are intended to be used in static or time integrating mode (i.e. no sweep trigger). They enable five images to be recorded on the same piece of film for the purposes of e.g. calibrating a spectrometer (by moving the crystal a known amount between exposures) or measuring the magnification of an imaging system (by moving the pinhole a known amount between exposures).

The sweep unit supplies a monitor pulse which may be used to trigger an intensifier. If performing a non swept test with the sweep unit off do not forget to arrange different triggering of the intensifier, the sweep trigger signal will often suffice. The pulse from the monitor output of the sweep unit is approximately 100ns long and of magnitude 10 volts into 50 Ω.

Ideally the intensifier should be triggered approximately 10μs before the event as otherwise some phosphor light will be lost during the rise of the gain of the intensifier.

The sweep unit also has two ‘Trigger Outputs’. They are derived from a 556 timer chip and consequently have only moderately fast risetimes and appear after a considerable delay. These may be used to trigger intensifiers or readout systems,

There is a ‘Triggered’ lamp on the sweep unit. On receiving a trigger pulse this will light. The light will remain on until the button housing it, is depressed. The circuit may be triggered when this light is already on. There is no ‘trigger inhibit’ circuit. Subsequent triggers should not arrive until at least 100mS later otherwise the sweep circuit may not have finished charging and the ramp speeds may be slower with the possibility of retrace.

4(b) THE FOCUSING SUPPLY

Figure 3 is a block diagram of the focusing supply. The focussing potentials are derived from a resistive divider chain, passing a nominal current of 100 μA. The operation of this network requires no explanation except to say that the high voltage zener diodes are to limit the voltages appearing across resistors in the network in the event of a breakdown, thus stopping damage by excessive dissipation. (The network is shown in Figure 4). The -15kV potential is obtained from a regulated solid state encapsulated supply. This supply is in turn supplied from a regulated low voltage DC source. The primary power source is 240/110 volt AC mains.

The cathode potential is equal to that supplied by the EHT inverter. The focus and mesh potentials can be varied by means of the potentiometer spindles to be found inside the focussing supply. If they are to be adjusted then an insulated screwdriver must be used, taking great care to keep fingers away from the grey potted box and the high voltage connectors.

The potentials may be measured with a high impedance probe. A 1000 MΩ probe will cause significant voltage drop on the mesh and focus outputs and a correction must be made if the true voltages are required. The specification at the end of this manual quotes the indicated voltages measured sequentially with such a probe.

The fault indicator light is activated if the camera draws any appreciable current from the supply (see figure 5). The -15kV is obtained from a Bonar Wallis encapsulated DC/DC converter. A signal is taken from this supply which is a measure of the power output. A trimmer on the low voltage board sets the threshold at which the indicator lights in response to this signal. It is normally set such that the lamp glows dimly in the absence of a load so any increase will be seen. A breakdown is usually accompanied by intermittent changes in the brightness of the fault lamp.

5 CATHODE MANUFACTURE

The cathode materials recommended for X–ray use are caesium iodide and gold.

Photoemission in gold is largely a surface effect and thus the cathode should not be very thick. For X–rays of a few keV a cathode of approximately 500 Å will suffice.

Our best results have been obtained with caesium iodide cathodes. In insulators photoemission is more of a volume effect since electrons can escape from a larger depth, transported in the empty conduction band, without suffering collisions. In general the optimum thickness of solid density caesium iodide for X–rays of a few KeV is the e-folding depth in the cathode for the incident X–rays.

Caesium iodide is prone to pick up atmospheric water vapour and lose sensitivity. Cathodes should thus be stored in a dry environment or better still under vacuum.

The most sensitive cathodes we have used are low density caesium iodide. This material is made by thermal evaporation in a background atmosphere of argon. The cathode is in the form of a foam, with a structure scale length of a few microns. The voids in the material allow electrons to escape from a greater depth. Furthermore the presence of a large electric field in the material causes a cascading effect resulting in a small amount of gain. Ironically the low density material, with a very large effective surface area, is most tolerant of atmospheric water vapour. We believe this is because the absorbed water is quickly lost under vacuum, as a result of the large surface area. Low density cathodes are, however, not very mechanically robust.

A suitable “recipe” for the production of such cathodes is to evaporate approximately 1-2ccs of powdered caesium iodide in a background of 5 millibars of argon. The layout of the deposition chamber should be roughly as shown in figure 15. The caesium iodide is carried in the form of a smoke by convection currents in the background gas. A very uniform cathode can be made by rotating the substrate during the deposition.

6 **SPECIFICATION SHEETS**

6(a) Static focussing

Camera type	LMXRSC
Camera number	91/QUB/C/02
Customer	QUB
Date tested	25th. October 1991
Phosphor type(P11 or P20)	P20

Focus potentials as measured with 1000M Ω probe.

Cathode	15.022	kVolts
Mesh	10.586	kVolts
Focus	11.254	kVolts

Static deflection sensitivity (with above potentials):

+/-190 Volts per cm on camera phosphor

6(b) SWEEP CIRCUIT

Sweep speeds, nominal.

Speed	1	17.3	V/ns	Equiv to	1098	ps/mm
Speed	2	73	V/ns	Equiv to	260	ps/mm
Speed	3	211	V/ns	Equiv to	90	ps/mm
Speed	4	400	V/ns	Equiv. to	47.5	p.s/mm
Speed	5	760	V/ns	Equiv. to	25	p.s/mm
Speed	6	1382	V/ns	Equiv. to	13.8	p.s/mm

Delay:

Speed 1	50.0	ns	
Speed 2	15.6	ns	
Speed 3	6.15	ns	DELAY TO SCREEN CENTER
Speed 4	2.35	ns	RELATIVE TO SPEED 6
Speed 5	1.25	ns	
Speed 6	29.0	ns	RELATIVE TO TRIGGER INPUT

Note:- the delay on speed six is first measured on a 5ns/cm timebase. The delays of the other positions are then measured on fast timebases to give accurate relative delays. The speed 6 delay is the delay from the front panel of the sweep unit to the sweep deflection being a screen center. Do not forget the delays to the cathode and of the photoelectrons to move from the cathode to the sweep plates.

Bias Voltages:

Bias 1(C)	0+/-Volts
Bias 2	40+/-Volts
Bias 3	80+/-Volts
Bias 4	120+/-Volts
Bias 5	160+/-Volts
Bias 6(N)	720+/-Volts

7 STANDARD ITEM LIST

1	Streak tube assembly
2	Re-entrant housing
3	Clamp ring
4	Slit plates (3 off)
5	Meshes (3 off)
6	Cathodes (3 off)
7	PTFE spacer ring (2 off)
8	EHT leads, colour coded (Red, orange and white)
9	Sweep/bias feed leads, (4 off)
10	Focussing supply
11	Sweep unit
12	Mains leads (2 off)
13	Dummy sweep lead plus 1K Ω monitor
14	Magnetic screen
15	Camera back
16	Intensifier mount mechanics

Items checked A.K.L. Dymoke-Bradshaw.

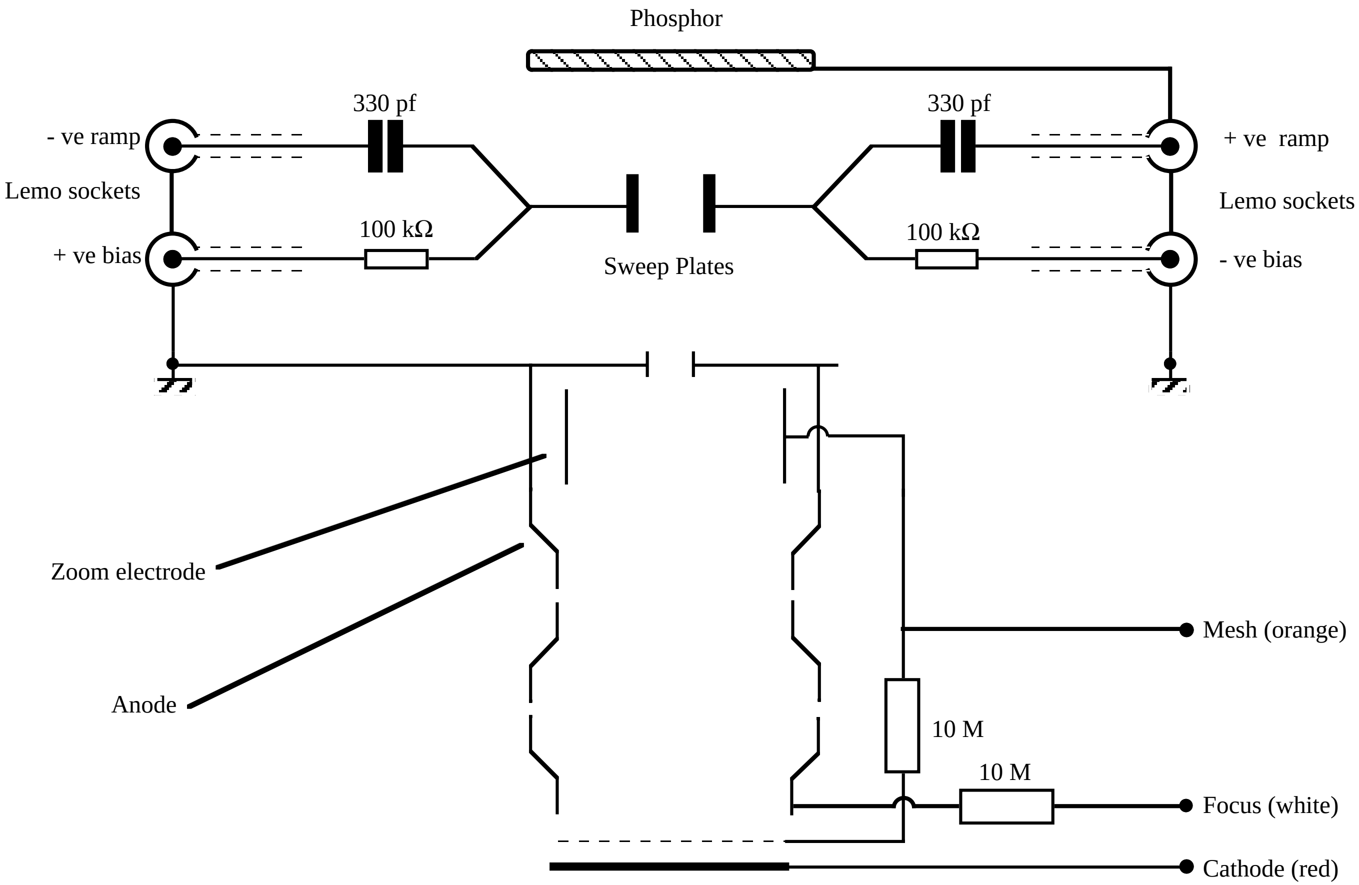


Fig. 1 Internal connections in body

*Note: The direction of the sweep may be reversed depending upon intensifier type.

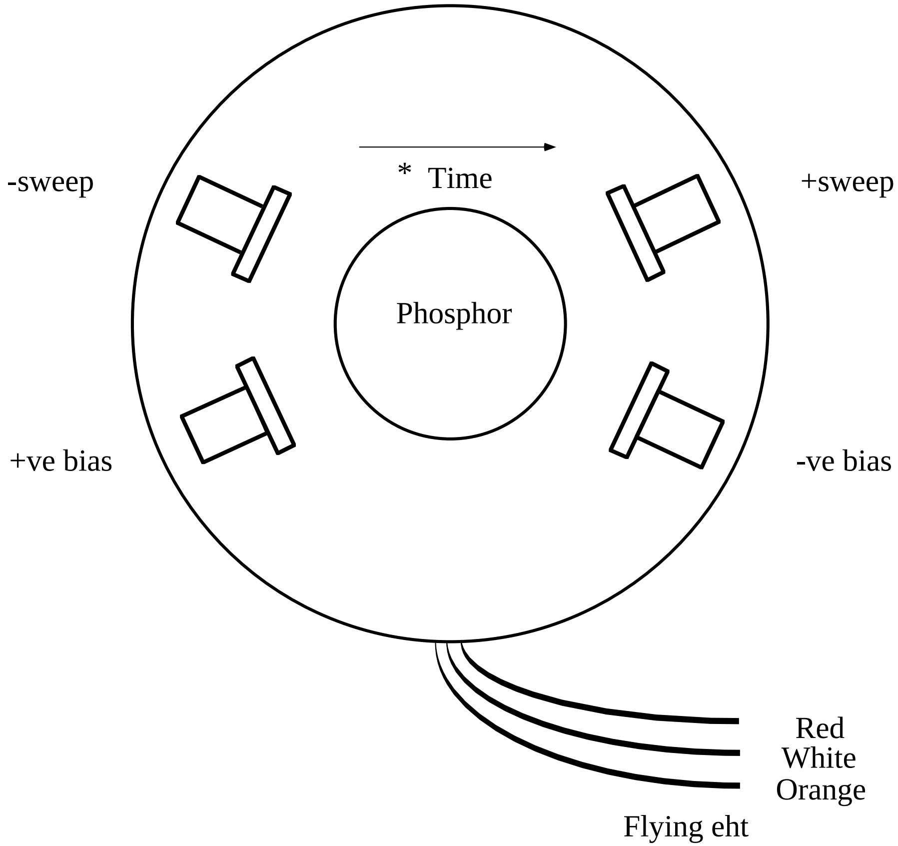


Fig. 2 Connections, External

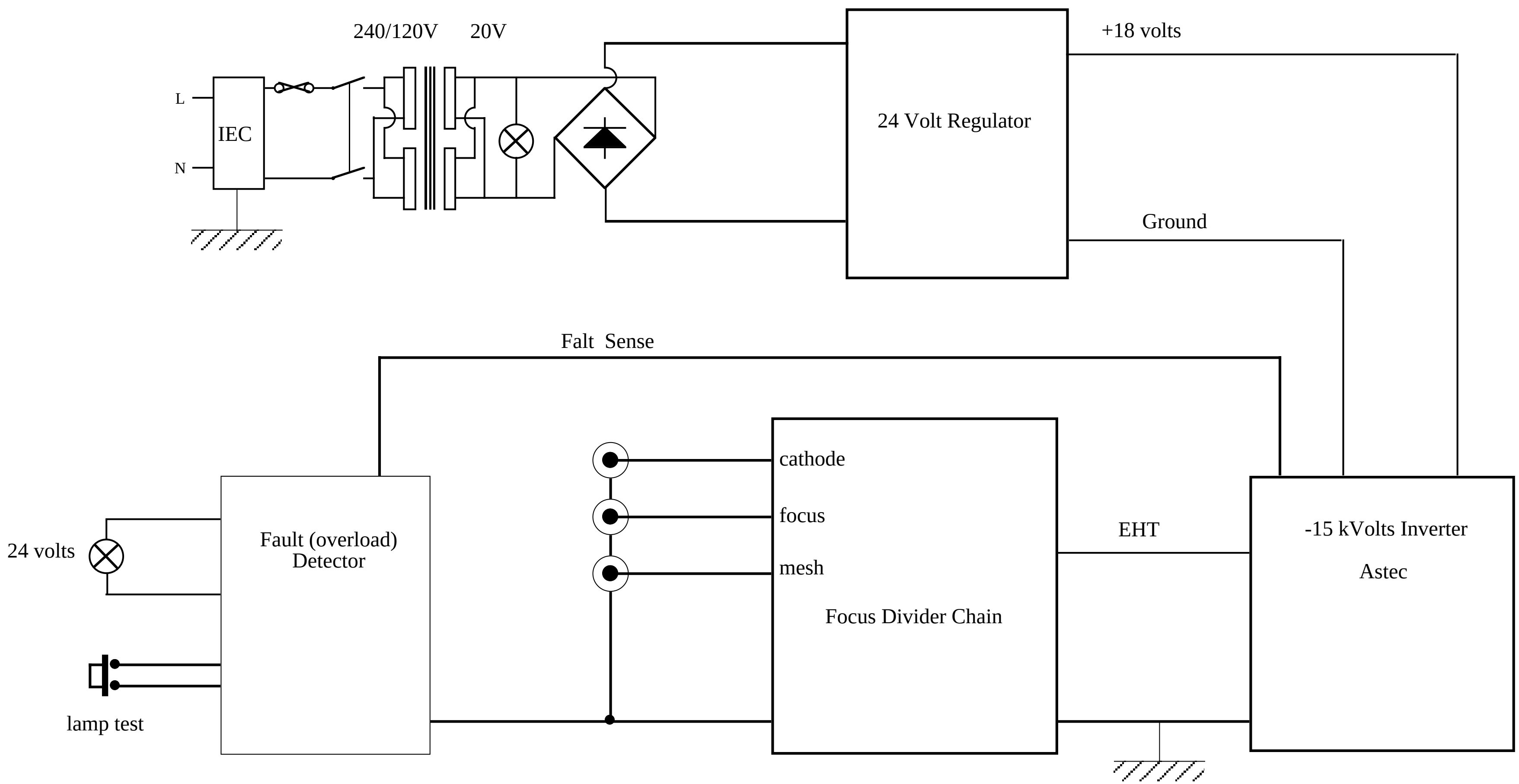


Figure 3 Focussing Supply - Block Diagram

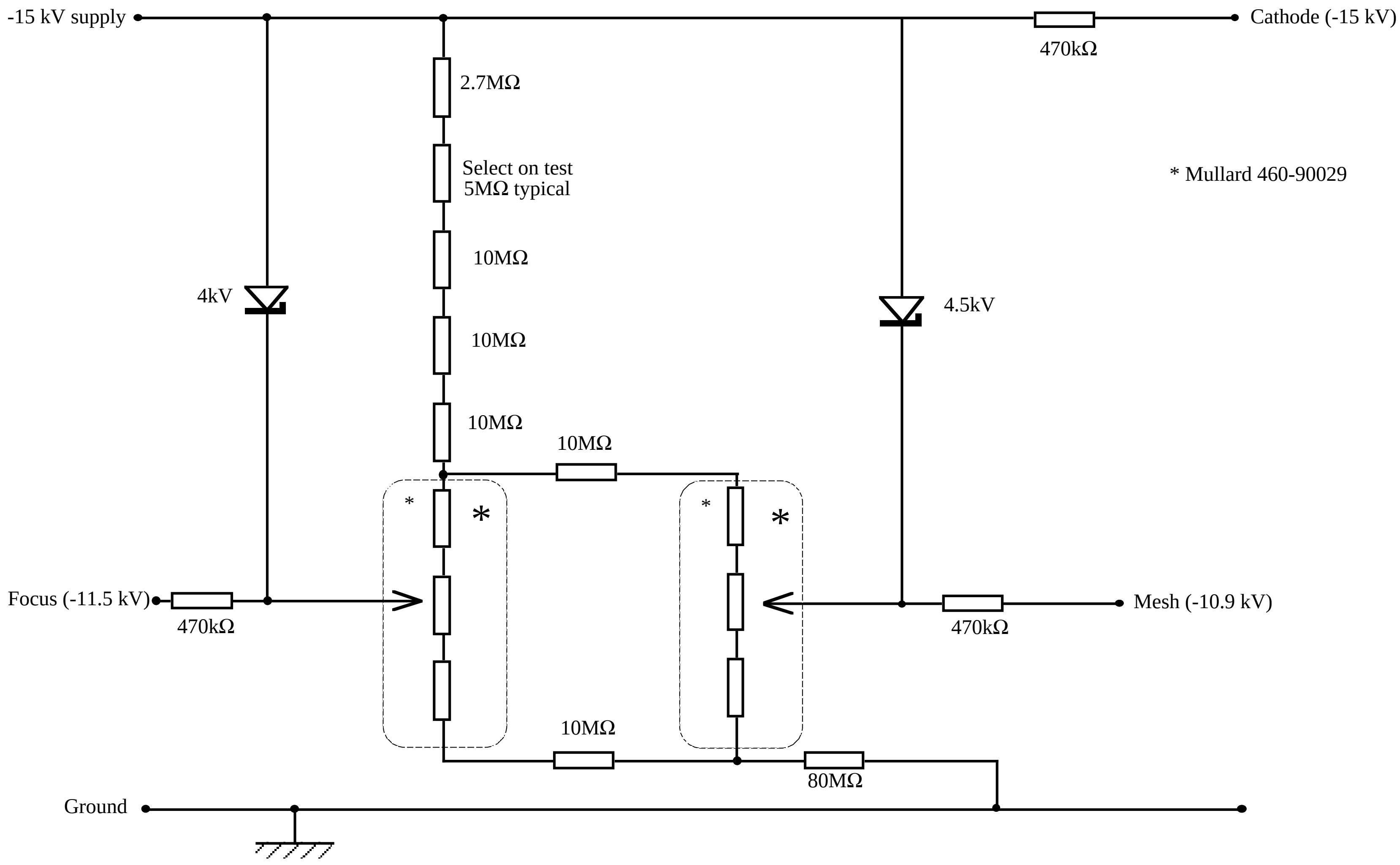


Figure 4 Focus Divider Chain (Low Magnification Camera)

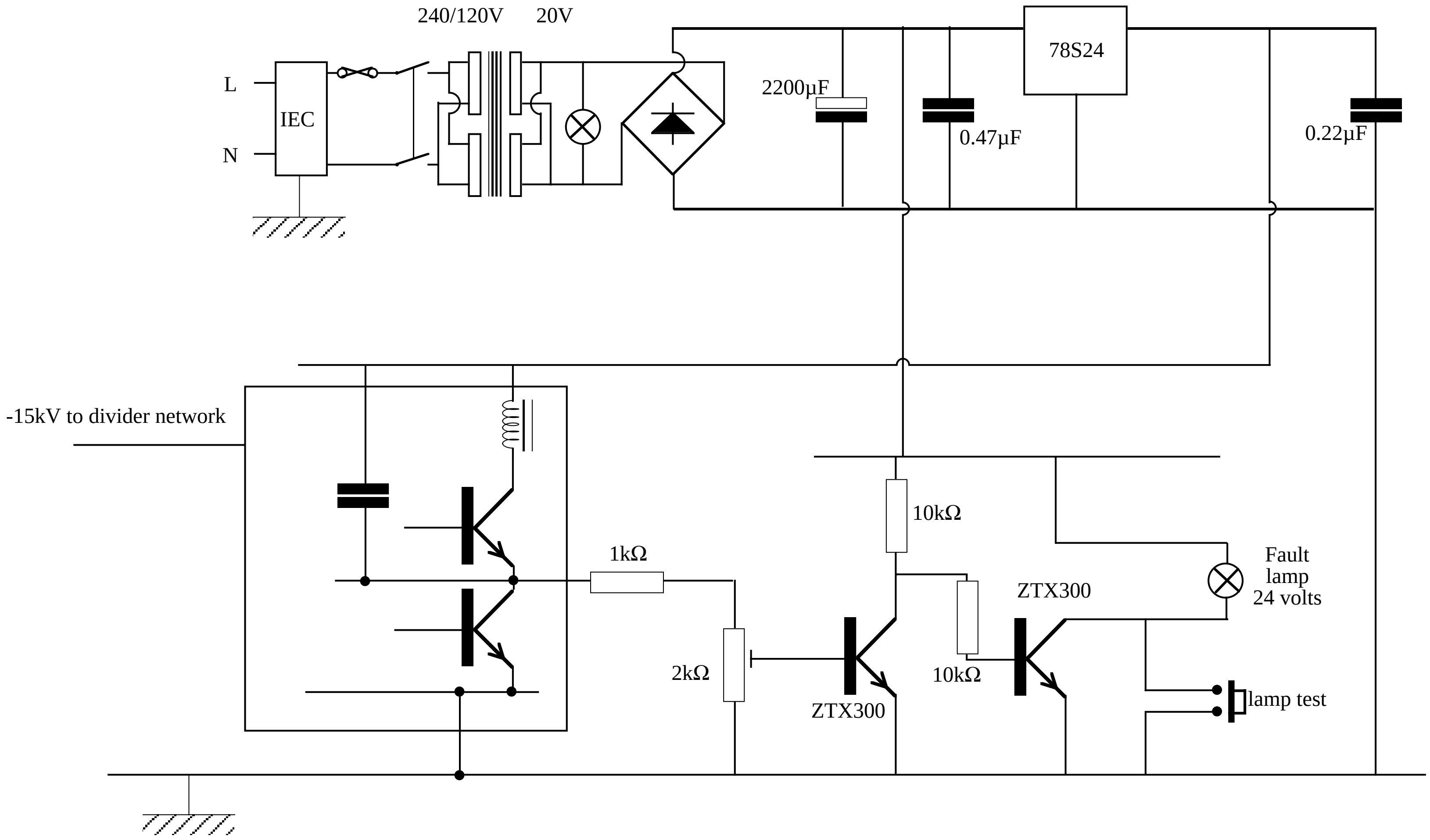


Figure 5 Focussing Supply, showing low voltage supply and fault light operation

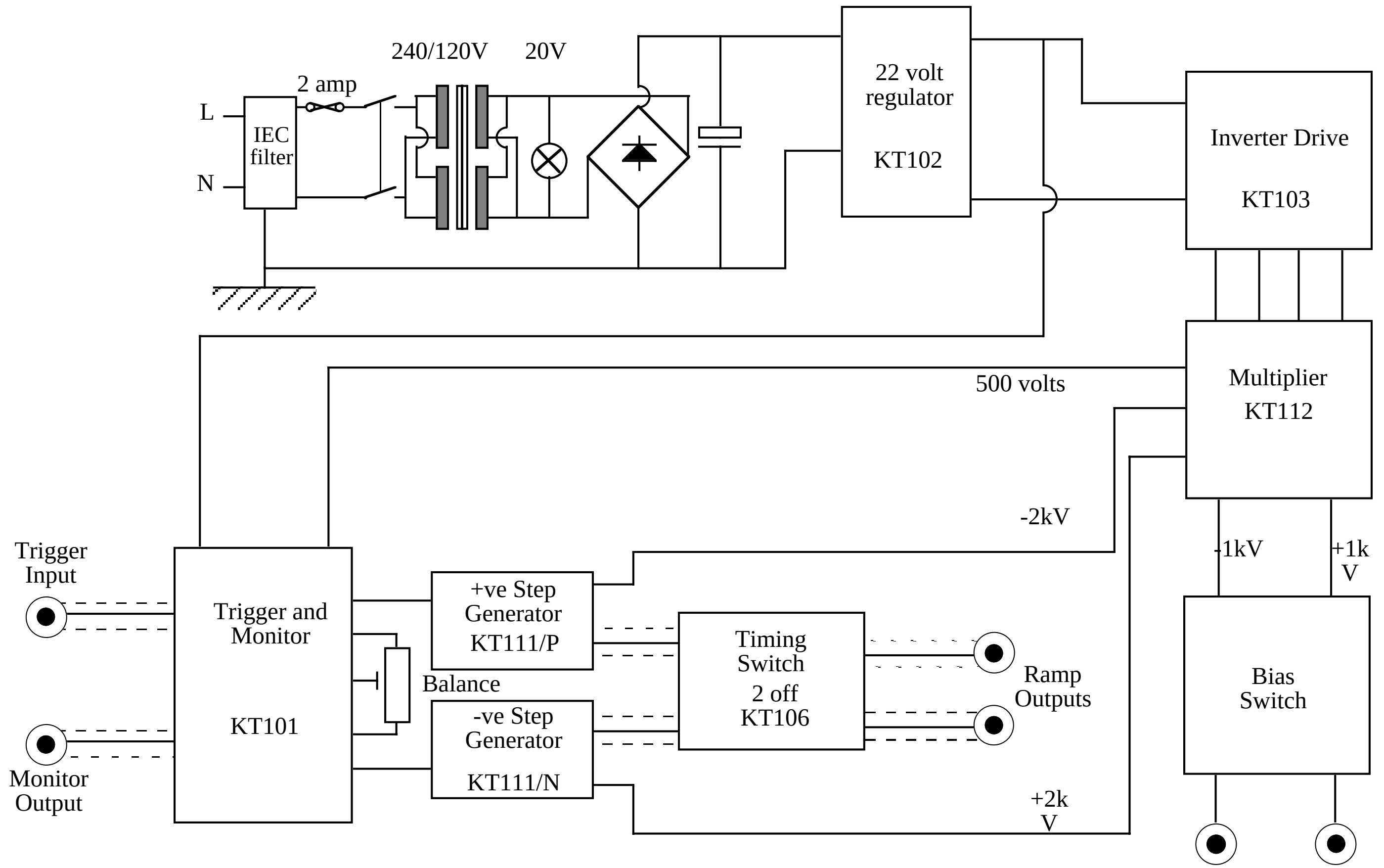
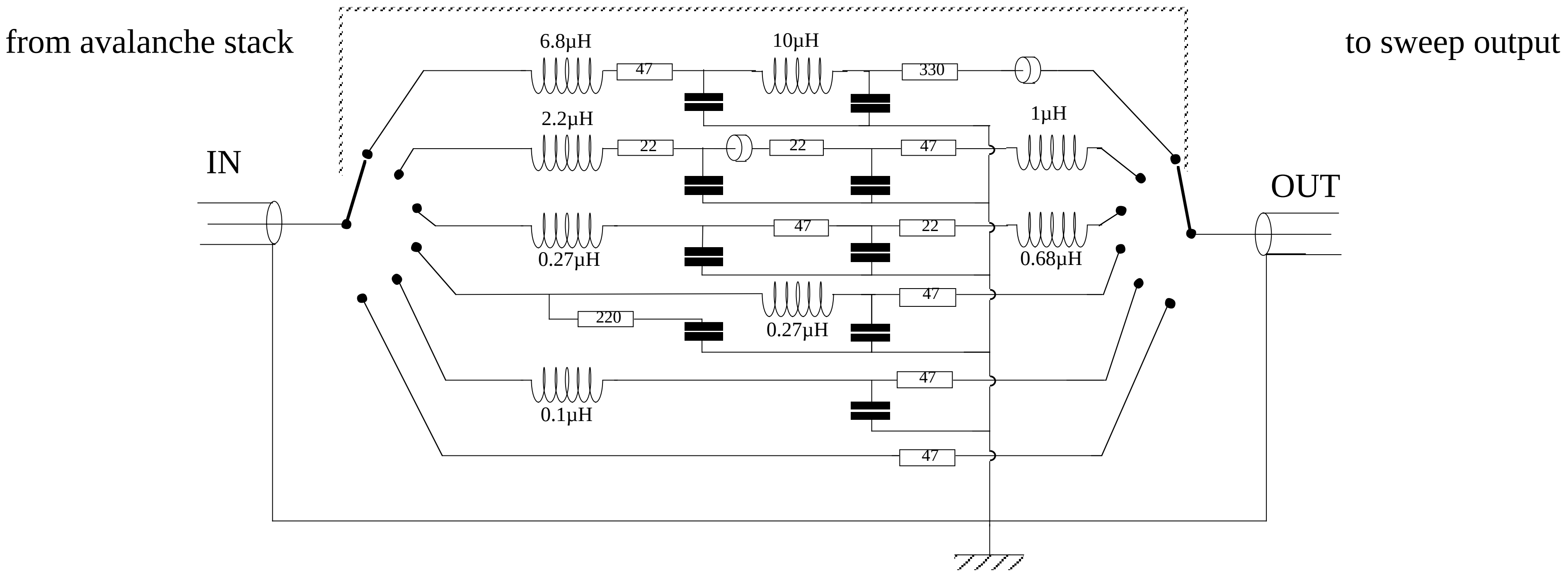


Fig. 6 Sweep Circuit, Block Diagram



All capacitors approx 8pf , formed from double sided pcb 15mm by 20mm

Fig. 7 Timing Switch (KT106), one polarity only

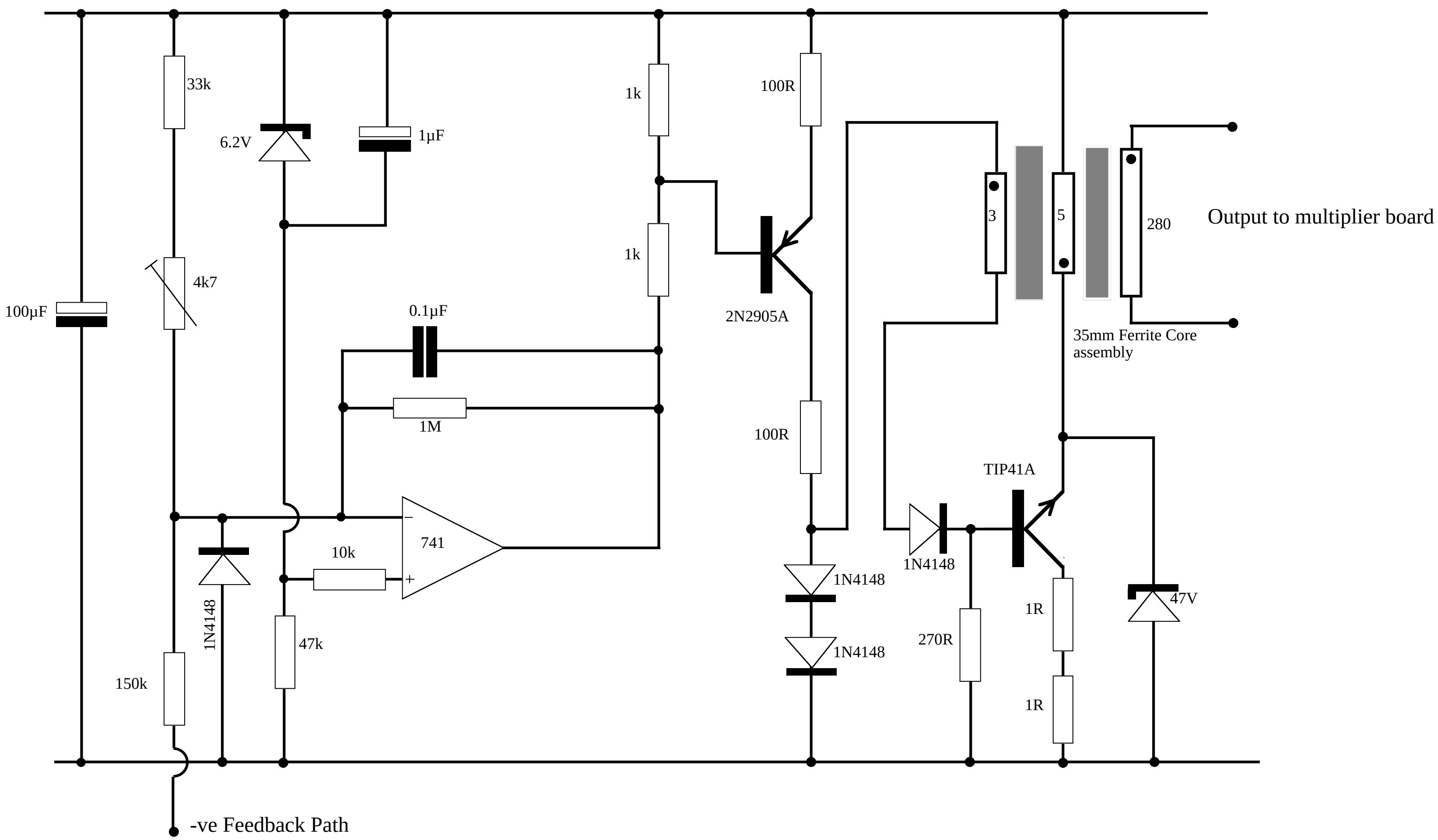


Fig. 8 Inverter Drive (KT103)

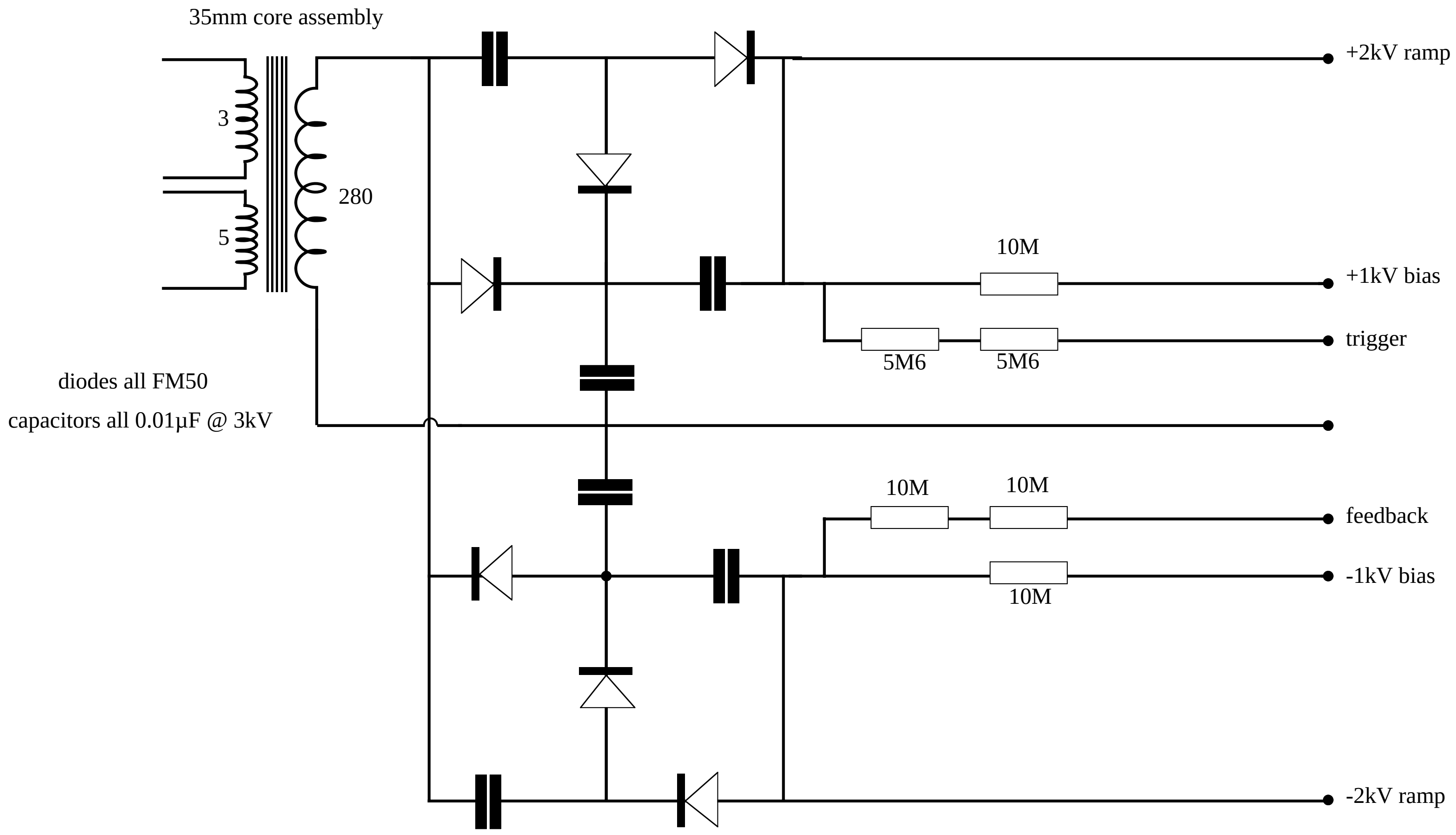


Fig.9 Multiplier (KT112)

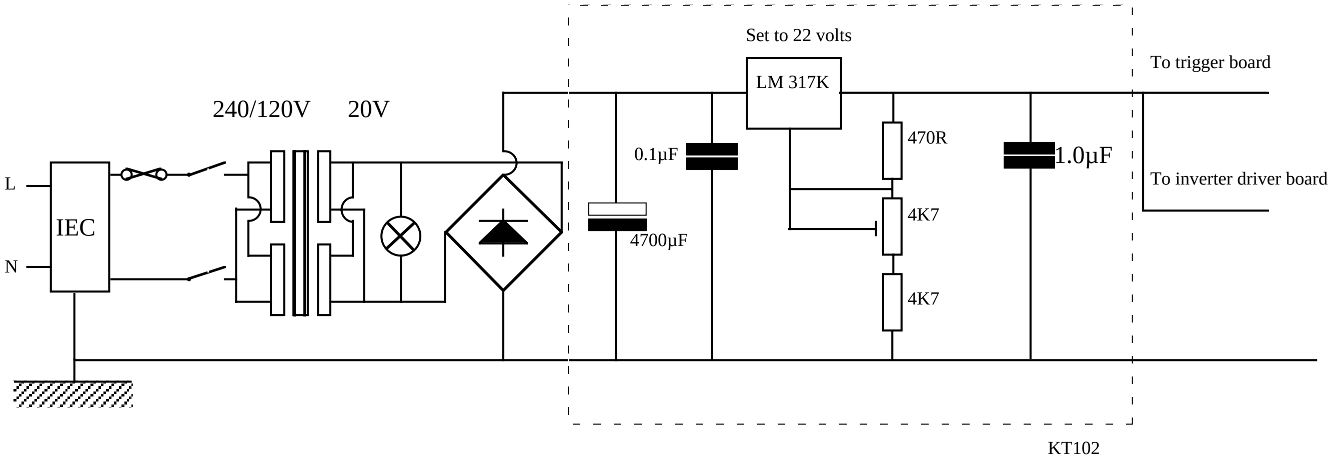


Fig 10 Low Voltage Supply

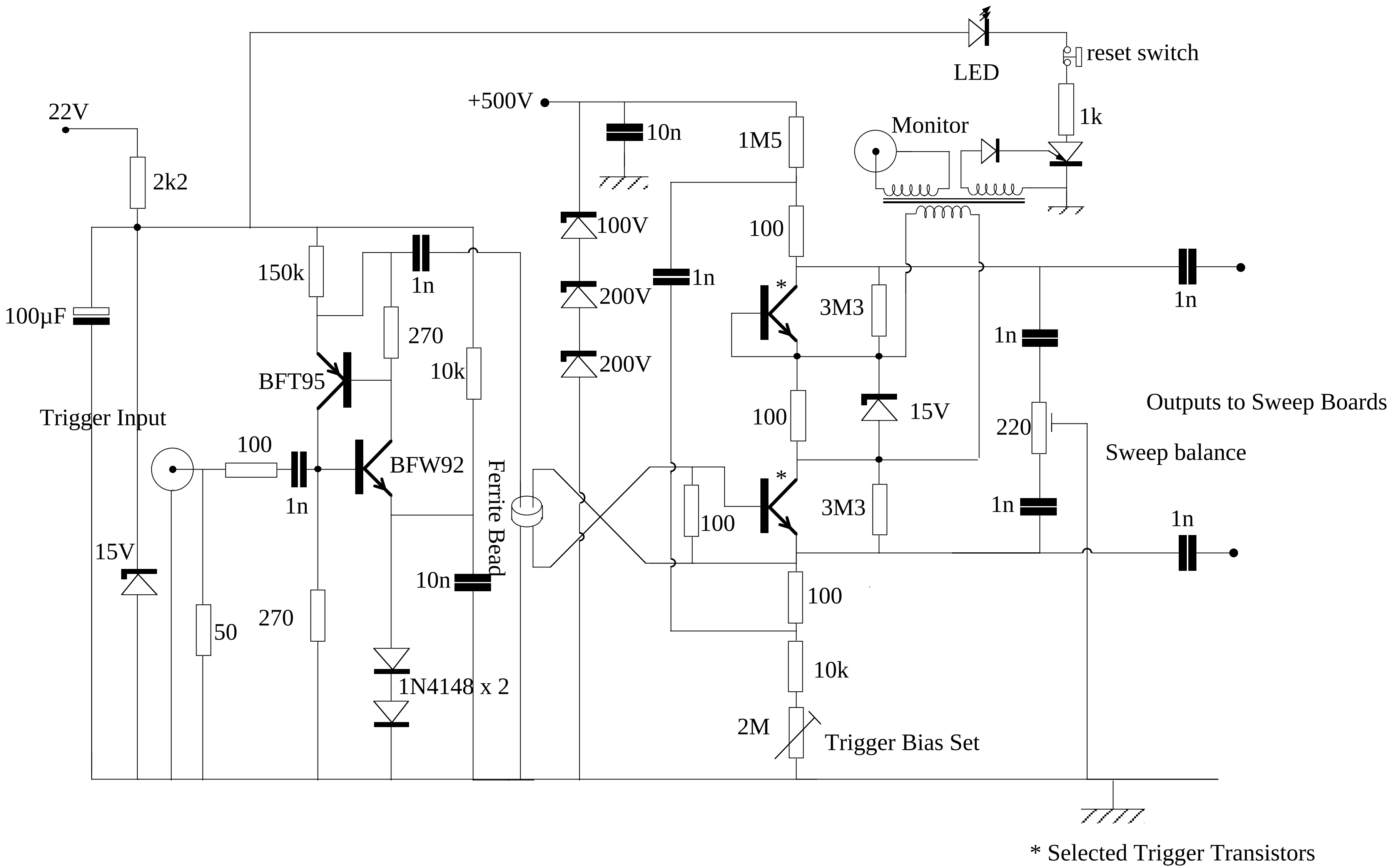


Fig. 11 Trigger Board (KT101)

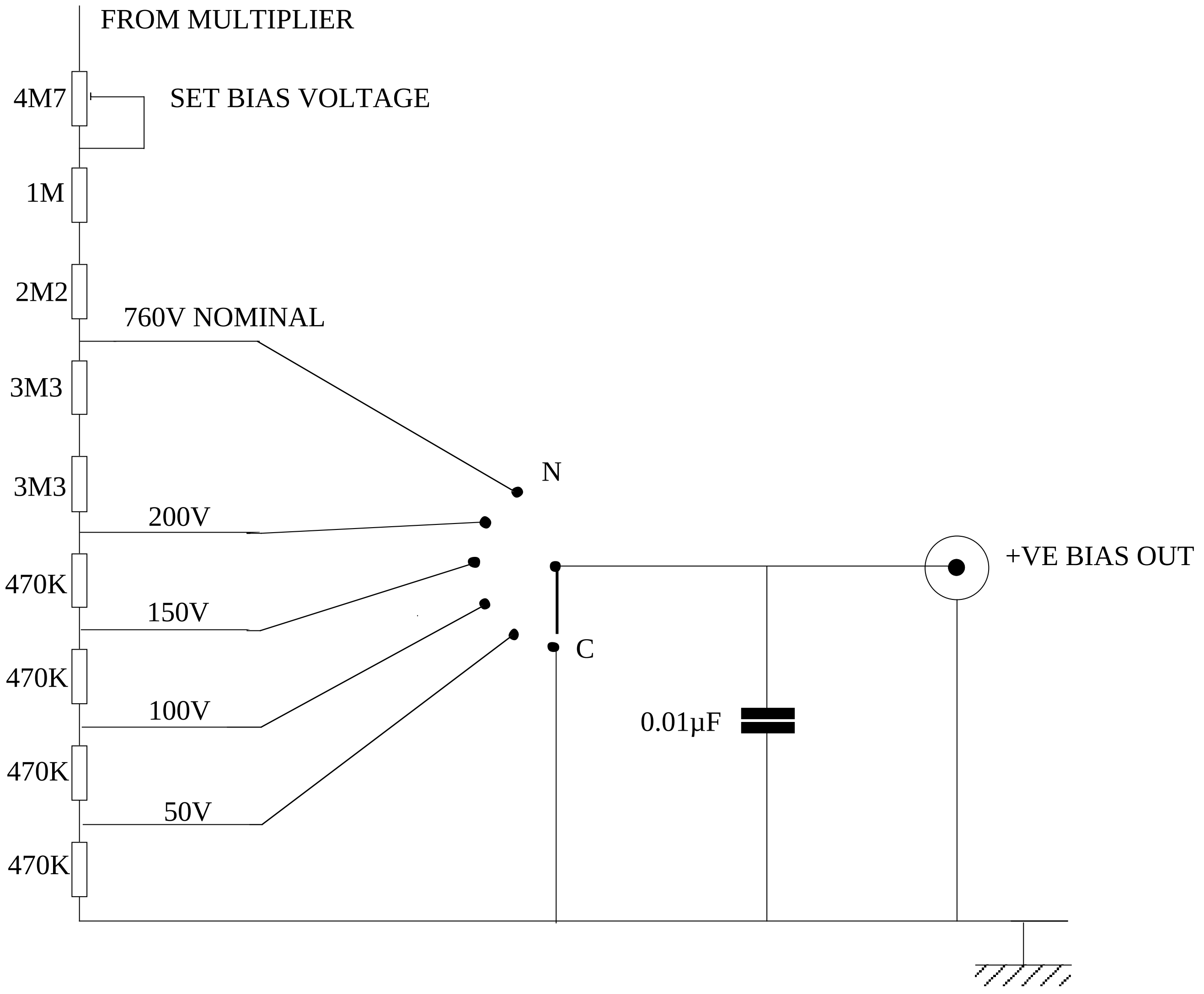


Fig. 12 Bias Switch

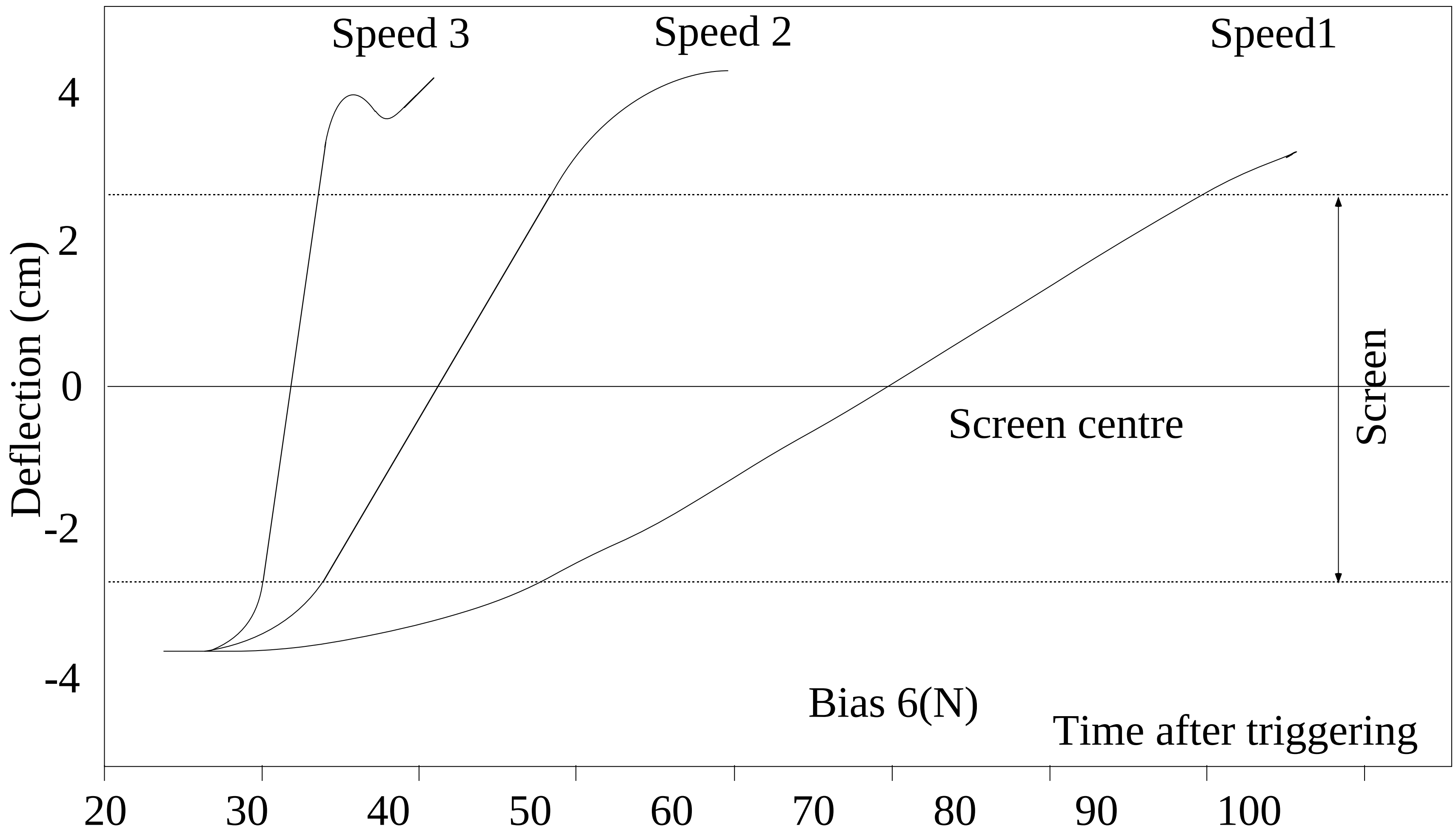


Fig.13 Image Position Versus Time. Speeds 1-3

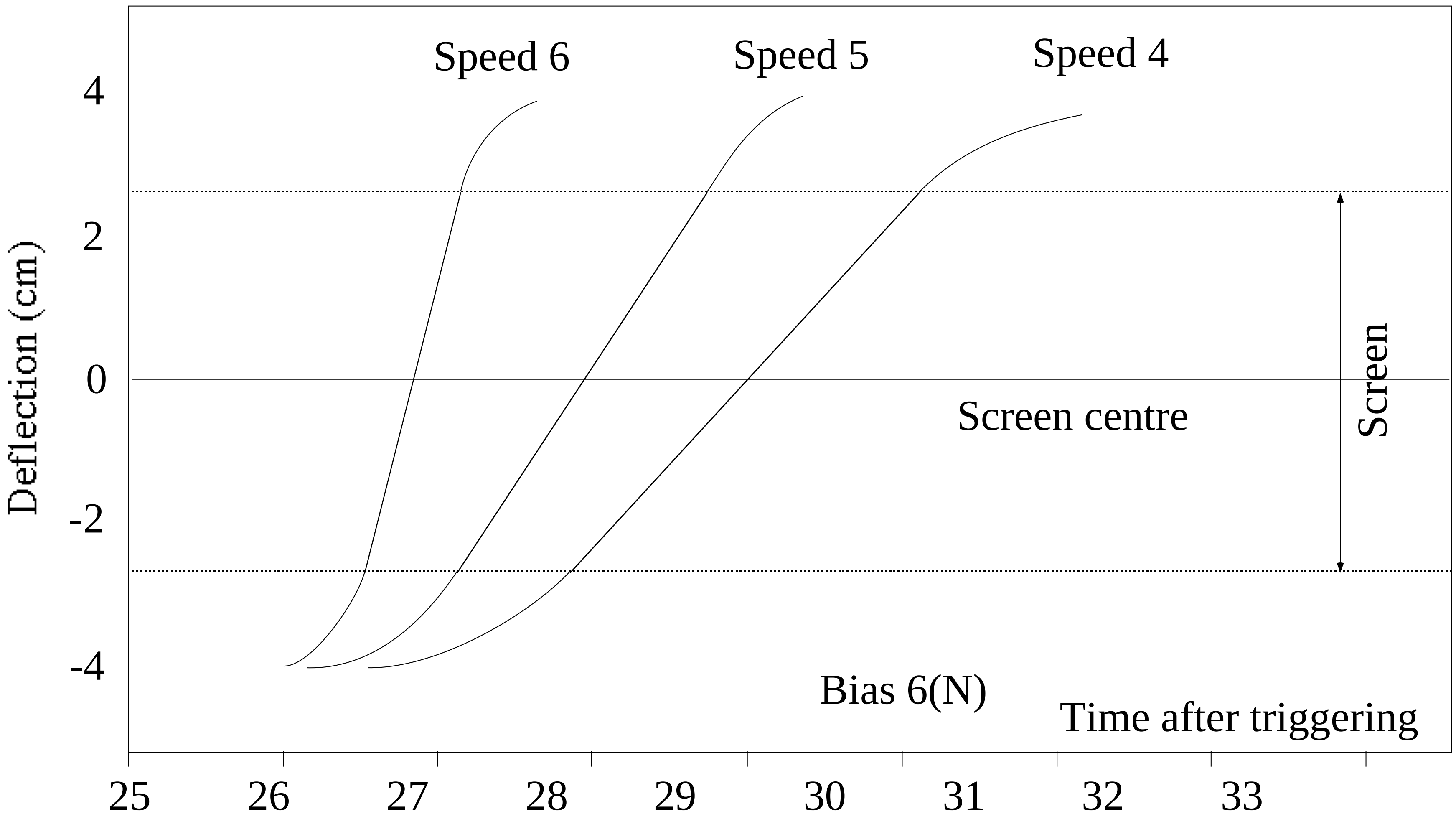


Fig.14 Image Position Versus Time. Speeds 4-6

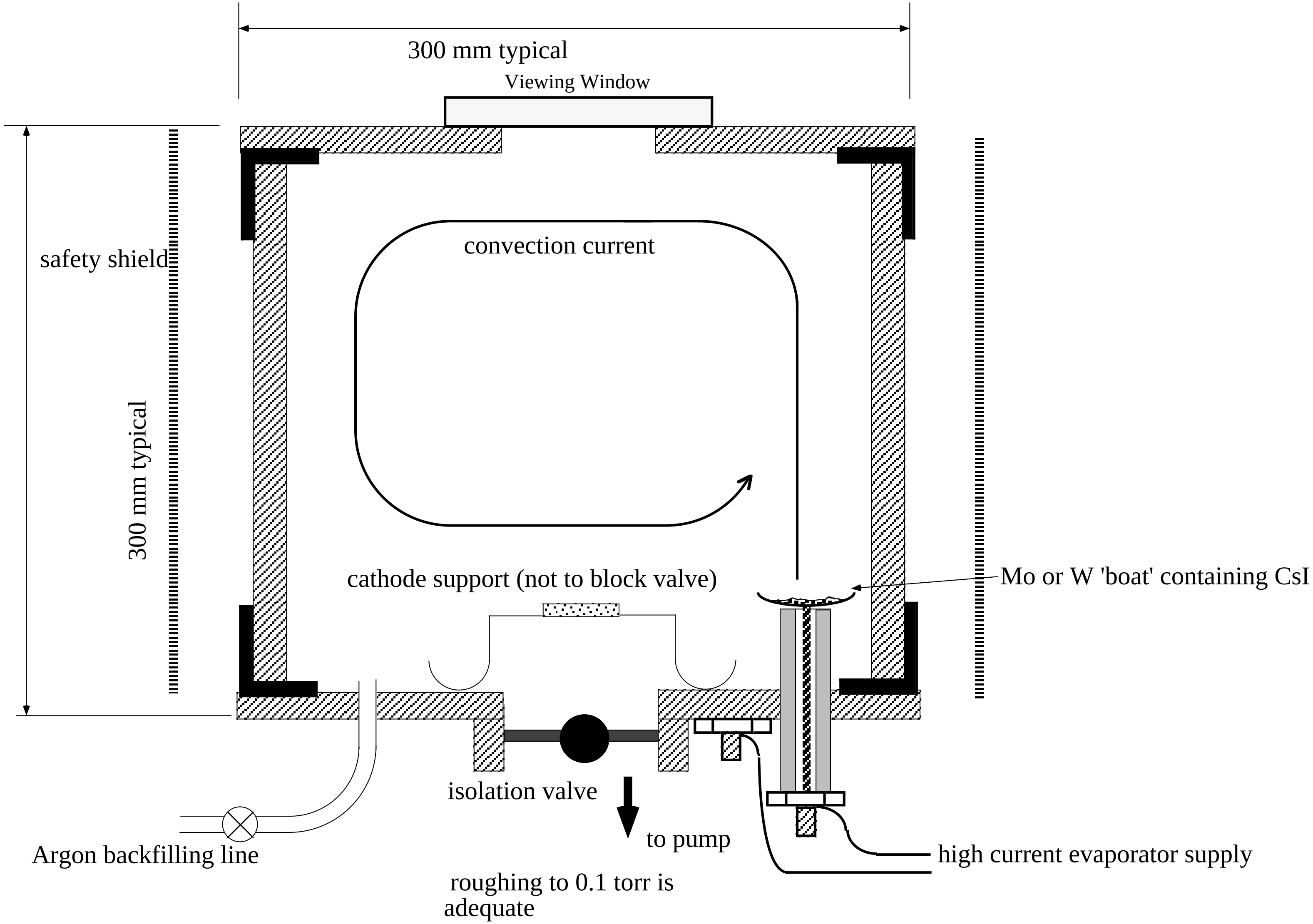
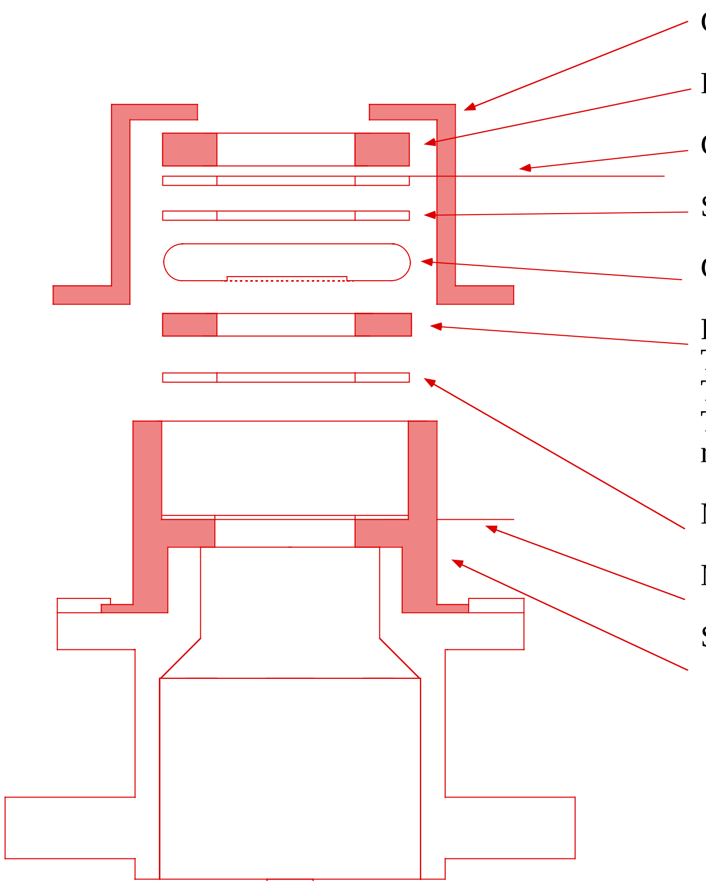
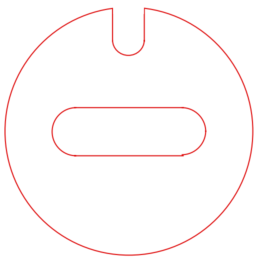


Fig.15 Low Density Caesium Iodide Cathode Manufacture





cathode and mesh outline

Figure 16 Cathode Mesh Assembly