Kentech Instruments Ltd.

LOW MAGNIFICATION
X–RAY
STREAK CAMERA

19th. February 1996

PLEASE READ THIS MANUAL CAREFULLY BEFORE

USING THE CAMERA.

THIS IS A NON STANDARD CAMERA

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Kentech Serial Numbers

J95****/1	X-ray streak camera with MCP cathode option
J95****/2	focussing unit
J95****/3	sweep unit
J95****/4	monitor box

Contents

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.

* Slit curvature in the image plane may limit the usefulness of the extremes of the slit.

1 INTRODUCTION

This manual describes the operation and use of the Kentech Low Magnification 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.

1.1 MAINS SUPPLY VOLTAGE

Units manufactured by Kentech Instruments generally have universal power supplies which work on AC or DC from about 80 to 240 volts. If alternative voltages are required please get in touch with Kentech Instruments and we will endeavour to help.

1.2 SPECIFICATIONS

Trigger delay slow	~30ns
Electro-optical magnification	X 1.2(nominal)
Number of sweep speeds (slow)	six
Phosphor	P20
Cathode length	>25mm*
Supply	See section 1.1
Sweep Trigger input	Normally 10volts, rising in 1ns for minimum delay
Trigger inputs to other units may be triggered from the sweep unit.	
Spatial resolution	Better than 100 µm at the cathode
Sweep hold off time	approximately 50µs

<u>Special non standard feature</u>

This camera has been modified to use sweep leads 1.5 metres long instead of the normal 1 metre. The sweep unit works by charging up the output cable. Consequently more charge is required to charge a longer cable. In addition the longer round trip transit time of the sweep lead reacts with the ramp circuit such that the post ramp oscillation after the ramp is much larger. To overcome both these problems the output of the ramp generator has been increased. This has affected the ramp speed particularly on the fastest ramp (6). The effect of this *may* be to produce non-conservative forces in the sweep region. This will mean that the sweep speed is no longer proportional to the electrical ramp speed. The sweep speeds quoted in this manual all assume that the sweep speed *is* proportional to the ramp speed. The user must therefore establish what the ramp speed is particularly on the fastest speed by direct calibration with a pulsed x-ray source.

2 GETTING TO KNOW THE INSTRUMENT

The Kentech Low Magnification X–ray streak camera with MCP cathode option is based upon the Kentech Low Magnification Streak camera. The main modification is an extra potential available near the cathode for the user to connect a MCP cathode. The potential is adjustable via a control on the focussing unit and supplies up to 1kV above the normal cathode potential. This will allow the user to fit an MCP cathode and control its gain.

The electronics are remote from the electron optics, which are of a design unique to Kentech, allowing compact mechanics. The optics have been designed to use only three focussing 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.

2.1 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 internal parts and connections to the camera.

The X–rays, which are incident on the photocathode, produce photoelectrons. The photoelectrons are imaged by the focussing 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.

2.2 THE ELECTRON OPTIC FOCUSSING

Before the high voltage focussing supply is switched on the vacuum chamber must be at a suitably low pressure. For low time resolution work the extraction field between the cathode and extraction grid can be 15kV/cm and in this case the pressure should be below 10^{-4} torr. In order to obtain higher time resolution it will become necessary to increase the extraction field to >30kV/cm and under these conditions we recommend that the pressure be below 10^{-5} torr, see sections 3.1 & 3.3. At higher pressures electrical breakdown may occur which can damage the cathode, mesh and even the intensifier.

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

Photocathode	-15.05kV
Mesh	-10.34kV (adjustable)
Cone	-10.98kV (adjustable)

The focussing power supply 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 figure4. 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.

2.3 THE SWEEP CIRCUIT

The streak voltage is supplied by an external ramp generator. This provides step switchable streak speeds up to about 9ps/mm. Figure 6 shows a block diagram of the unit.

The ramp generator delivers ramp voltages of about 3000 volts rising in 500ps on the fastest range. Six speeds are available on this unit. In addition there is a control of the start position of the sweep. This gives six start positions ranging from screen centre to off screen.

2.4 MAGNETIC FIELDS

The electron optics are 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

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.

2.5 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

3.1 CONNECTIONS AND MECHANICS

The high voltage focussing potentials are taken to the camera via a single multicore cable.

The sweep unit is connected via two 50 Ω leads. These leads have “N” type connectors. The camera is labelled with the appropriate ramp connections, as is the sweep unit. They may break down if used unmated. Try to avoid unmated use and always keep them clean and free from metal particulates. If necessary regrease the threads to reduce thread wear which leads to brass particles in the connectors.

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 in this figure, time goes from the negative ramp side towards the positive. This direction with respect to the camera housing may be reversed by swapping the polarity of the sweep leads. Do not forget that there is a further inversion in a lens coupled readout system but that this is normally accounted for in the readout head. Flat field intensifiers do not invert the image but intensifiers with cross-over electrostatic lenses do.

Note that it is important to use this camera with an intensifier. If this is not done the electron current required to produce a recordable image will be sufficiently high as to cause electron space charge distortion problems. Generally the higher the sweep speed the more gain should be used as the number of photoelectrons required to obtain an image is fixed but if they are acquired in a shorter time the space charge will be higher.

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 the alignment. To remove the streak tube any intensifier that is fitted should be removed. The chamber should be vented at the last moment as this will improve the pump down time. There are eight holes in the camera on the intensifier mounting flange. An Allen key (supplied) 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 pump down 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.

3.2 CATHODE AND MESH ASSEMBLY

For transit the cathodes and meshes are stored in a protective container. They should be transferred to a more suitable container on receipt, for example an evacuated desiccator. Consequently these need to be inserted before the camera can be used. The instructions that follow refer to components shown in figure 4. 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. 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 regular spacers. Normally the 3mm one should be used. The 1.5mm one is used to obtain greater time resolution but a better vacuum may be required to prevent breakdown. If the vacuum and cathode quality permit, a 1.5mm spacer may be used. The voltage across this gap is about 4.5kV giving extraction fields from 15 to 30 kV/cm.
The spacer may be reduced even further. We have worked with 1.25 and 1mm spacers but only after gaining confidence at larger spacings and establishing a good vacuum. Make sure that when using very high extraction fields that the condition of both the mesh and cathode is good and that there are no spikes protruding. In addition the spacers and snout must be very clean and free from contamination or burn marks. If burn marks occur they must be removed completely. This usually involves machining the damage away or replacement.

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

5 Slit, providing that the cathode is not made on a slit substrate.

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

7 Remaining spacer(s). This must be placed in so that the rebate covers the solder connection to the photocathode contact ring. If reduced thickness spacers have been used between the mesh and cathode more spacers may be necessary here to give enough height to the stack of components so that they are compressed by the outer clamping piece.

Note:-Cathodes come in two main formats, normally for slow sweep speeds the cathode and slit are separate items. In this case the slit should go in after the cathode. For faster work we have made the cathode on the slit assembly. This eliminates two main problems, firstly if a laser beam is focussed onto the slit the beam may well have expanded again by the time it reaches the cathode. Secondly, multiple reflections between the cathode and slit may give rise to spurious results. By using a single slit/cathode unit these are overcome, however, at the expense of losing the ability of independent control of the slit and cathode.

3.3 INITIAL POWER-UP

The Fault light will not extinguish if the interlock is not set or if a large current is being drawn due to some fault condition in the system. To set the interlock the rear panel connector must be shorted. This is intended for use with a pressure monitor switch to prevent the application of the focussing potentials when the pressure is too high. A short lead with a shorted end is supplied. Such application could destroy the mesh and/or the cathode. In addition the interlock will not be set if the front panel connector is not mated.

Do not rely on the interlocks to protect the camera. The voltages on the electrostatic lens cannot collapse fast enough to prevent damage caused by chamber venting etc.

The focussing supply must not be turned on if the pressure is higher than 10^{-4} torr. At extraction fields greater than 17kV/mm (3mm spacer and 15kV overall HT) it may be necessary to obtain a better pressure. We recommend that the camera first be timed and set up with a low extraction field (3mm spacer between the cathode and mesh). Once the system is operating satisfactorily at this field the spacer can be reduced and the vacuum improved.

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 <u>with the intensifier removed</u> while watching the phosphor in semi-darkness. At the first application of power there will probably be a slight flash of light. The focussing 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 recording film, if used, exposed to the intensifier for any longer than is necessary as it may pick up noise and degrade the data.

Note that the phosphor will continue to emit light for some time after exposure to fluorescent lights. If possible keep the phosphor in darkness. If it is necessary to expose it to light then leave it for about ten minutes before use. This is not a problem with a gated intensifier as the gate will remove most of the emission, however, in this case the problem may well be transferred to the intensifier phosphor.

3.4 PROCEDURE FOR TIMING THE STREAK CAMERA.

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
(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, i.e. in SYNCH mode progressively narrowing the timing window and then switching to OPERATE mode. Start off with a long trigger 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.

When using the sweep unit SYNCH corresponds to any of the first five image start positions, OPERATE corresponds to the sixth position labelled “Normal” The voltages are not adjustable.

In SYNCH mode if the image does not sweep, i.e. it remains in the static untriggered position, then the trigger arrived after the event and the trigger delay must be reduced. If no image is seen on the screen then the trigger arrived too early and the image was swept off screen before the event. In this case the trigger delay should be increased. Oasionally a shot failure may be interpreted as an early rigger. Users must be aware of this possibility whilst timing the camera as it may have identical results as either an early or late trigger.

3.5 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. However, for optimum focus, the wavelength should match that to be used in the experiment. A suitable test pattern may be needed. We can supply cathodes made onto grids to do this. [Dynamic focussing effects may occur at high sweep speeds. In this case it will be necessary to refocus the camera slightly at the sweep speed in use.]

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. (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. Alternatively a more powerful lamp may be imaged through a quartz window onto the cathode.

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 and reduced lamp to cathode spacing, it is possible to obtain moderately bright images without an intensifier. Remember that the cathode is at 15kV and that the lamp is probably grounded. 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. It is possible to melt the cathode with some types of UV lamp. Also the UV output from UV lamps usually increases significantly as they warm up.

The focus controls may be accessed by removal of the cover of the focussing supply. Great care must be exercised when this cover is removed as high voltages are present. The focussing potentiometers may be adjusted by turning the potentiometers in the potted EHT divider network. The screwdriver used MUST be insulated. The overall voltage (the cathode voltage) may be adjusted using the preset potentiometer adjustment on the inverter supply adjacent to the divider network. It is possible for the sweep plates, if left unconnected, to become charged causing image displacement and also for them to pick up electrical noise. Consequently we recommend that they be grounded during static focussing work.

With the DC source, the focussing supply and the intensifier, 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. The position of the cross-over the lens should also be close to the hole in the anode. If it is not the vignetting will occur. This is obvious when focussing the camera. The magnification should also be close to 1.2. If this is not the case then the focus is not set correctly.

Stray magnetic fields may displace the image slightly. The mu-metal screen may be adequate to remove this if necessary. Otherwise the magnetic field will have to be eliminated.

3.6 POSSIBLE FAULTS.

1 No DC image

Focussing unit not on

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 focussing 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 sweep leads are correctly mated.

Focus voltages have drifted (unlikely). Refocus.

Photocathode and mesh not normal to camera axis.

Ensure clamp screws are tight.

Image is due to x-rays going straight through the tube and exciting the phosphor.

Check that no image is present with the focussing unit switched off. If necessary block the direct x-ray path.

N.B. Poor connections to the mesh or cathode will often result in an apparent drift in the focussing 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.

6 Jitter present in image.

The electronics has a jitter of about 20ps rms. It is necessary to provide a good and stable trigger source for the electronics. This may well not be easy but is left to the user.

4 CIRCUIT DESCRIPTIONS

4.1 SWEEP CIRCUIT

The sweep circuit is based on two high voltage avalanche step generators unique to Kentech. These two generators provide balanced steps of amplitude +/- 1.5kV into 50 Ω loads, with a rise time of <1ns. These generators are fed into the sweep leads via 50Ω reverse terminating resistors, which reduces the amplitude to 0.75kV. When this edge reaches the open circuit end at the sweep plates it doubles up to 1.5kV. 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.

This particular camea has a modified sweep unit so that the sweep leads are 1.5metres intsead of the normal 1 metre. The camera has not been modified. The sweep leads and sweep unit should be used together and these parts should not be mixed with sweep leads or sweep units from any other Kentech Streak camera. It is possible to modify older sweep systems that use the 1 metre leads. The sweep unit should be returned to the factory for this modification.

A further function of the sweep unit is to provide the required bias voltages to define the start of the sweep (see figure12). There are six positions. Position1 starts in the centre of the screen and would normally be used while timing the camera. The Normal position (6) starts just off screen.

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 three output pulses which may be used to trigger an intensifier, frame store etc. 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.

4.3 THE FOCUSSING SUPPLY

Figure 3 is a block diagram of the focussing supply. The focussing potentials are derived from a resistive divider chain, passing a nominal current of 100 µamps. 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 -16kV potential is obtained from a regulated solid state encapsulated supply. This supply is in turn supplied from a regulated low voltage DC source.

The cathode potential is equal to 1kV less than 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 potted box and the high voltage connectors.

The potentials may be measured with a high impedance probe. A 1GΩ 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. It does not give the true voltages which may be obtained with bridge measurements.

The fault indicator light is activated if the camera draws any appreciable current from the supply (see figure 5). The -16kV is obtained from a Astec 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. Depressing the Fault lamp button illuminates the lamp and is intended purely as a lamp test.

At the rear of the unit is a connection for an interlock. The centre pin needs to be grounded to the outer connection to enable the high voltage supplies. This is intended for use with vacuum gauges having pressure level switches. This feature should on no account be used to turn the unit on and off as it is likely that the pressure will damage the camera before the switch in the gauge acts. It is intended purely to prevent accidental powering up with the pressure too high.

5 CATHODES

The cathode materials normally recommended for X–ray use are cæsium iodide and gold but for fast cameras the energy spread from these is too great. We recommend the use of potassium bromide or iodide. It has also been noted that low density cæsium iodide cathodes exhibit a tail in the emission after illumination with a very short pulse. Consequently we recommend solid density cathodes for very fast work. As these have a very limited lifetime the user will have to be able to recoat the cathodes supplied regularly or be extremely careful about their exposure to anything but a clean vacuum.

6 SPECIFICATION SHEETS

6.1 STATIC FOCUSSING

Camera type LMXRSC

Camera number J95****

Customer Japan

Date tested 9th. February 1995

Phosphor type (P11 or P20) P20

Focus potentials as measured with 1000MΩ probe.

Cathode 15.05 kV
Mesh 10.34 kV
Focus 10.98 kV

Static deflection sensitivity (with above potentials):
+/- 184 Volts per mm on camera phosphor

6.2 SWEEP CIRCUIT

Sweep speeds, nominal.

Speed 1	14.3	V/ns	Equiv. to	1287.0	ps/mm
Speed 2	85.7	V/ns	Equiv. to	214.6	ps/mm
Speed 3	244.7	V/ns	Equiv. to	75.2	ps/mm
Speed 4	397.5	V/ns	Equiv. to	46.3	ps/mm
Speed 5	883.7	V/ns	Equiv. to	20.82	ps/mm
Speed 6	2670.0	V/ns	Equiv. to	6.9	ps/mm

Delay:

Speed 1	44.0	ns	
Speed 2	14.0	ns	
Speed 3	5.5	ns	DELAY TO SCREEN CENTRE
Speed 4	2.0	ns	RELATIVE TO SPEED 6
Speed 5	0.98	ns	
Speed 6	32.0	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 centre. 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 SYSTEM EQUIPMENT LIST

1 Streak tube assembly in re-entrant housing with flying focussing lead.
2 Monitor box and cable
3 Clamp ring
4 Meshes (7 off)
5 Slit plates (3 off)
6 Cathodes nil
7 PTFE spacer rings 2 standard
8 Sweep/bias feed leads, (1 pair off)
9 Focussing supply
10 Sweep unit
11 Magnetic screen (normally fits round Streak tube assembly.
12 Focussing supply interlock defeat plug (Shorted Lemo 00)
13 Spare screws
14 Tool kit

Items checked

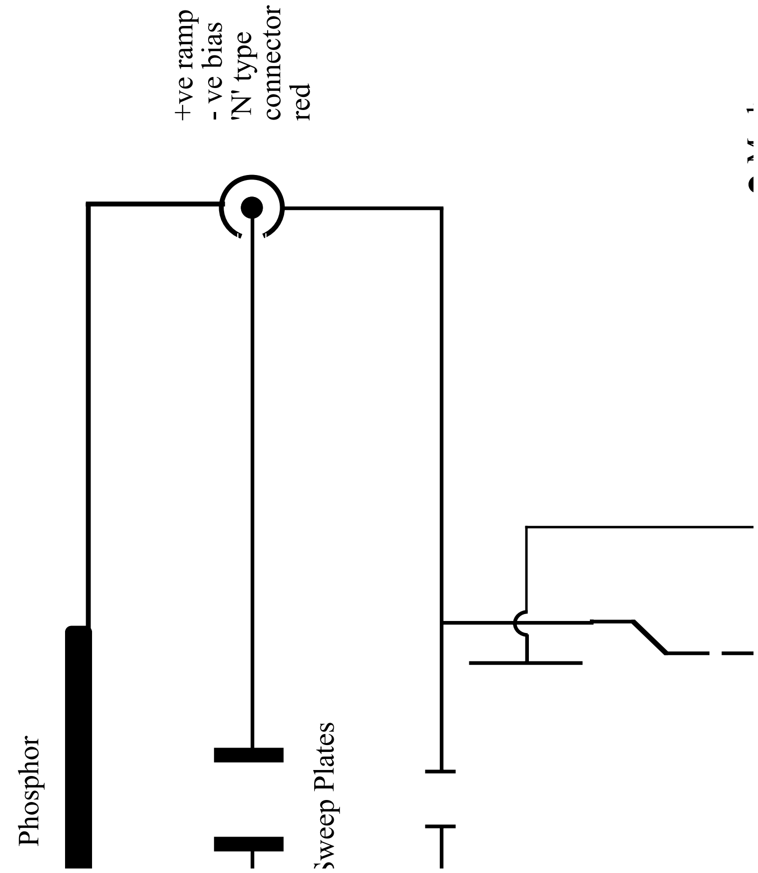


Figure 1 Connections, internal

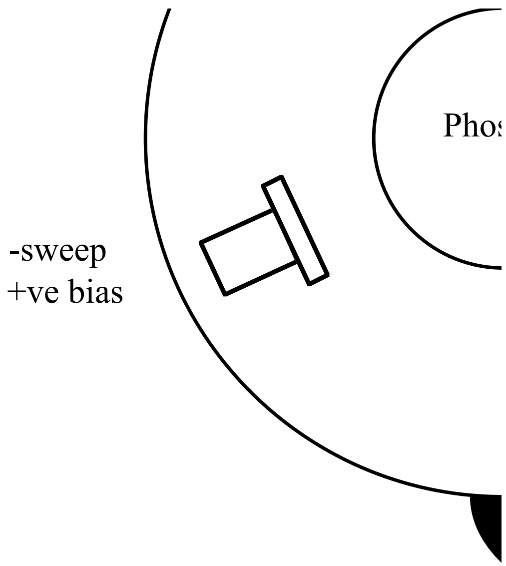


Figure 2 Connections, external

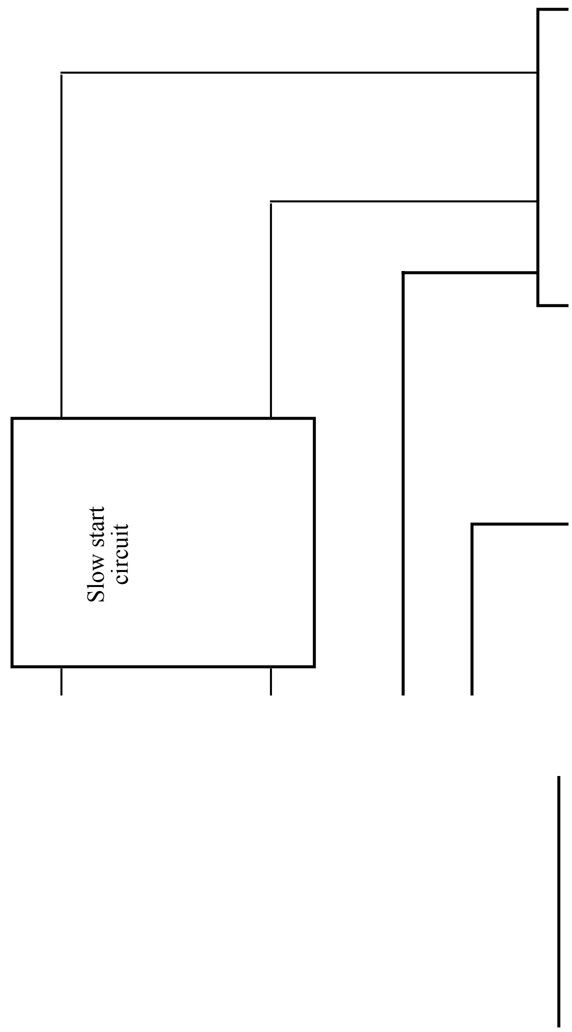


Figure 3 Focussing supply, block diagram

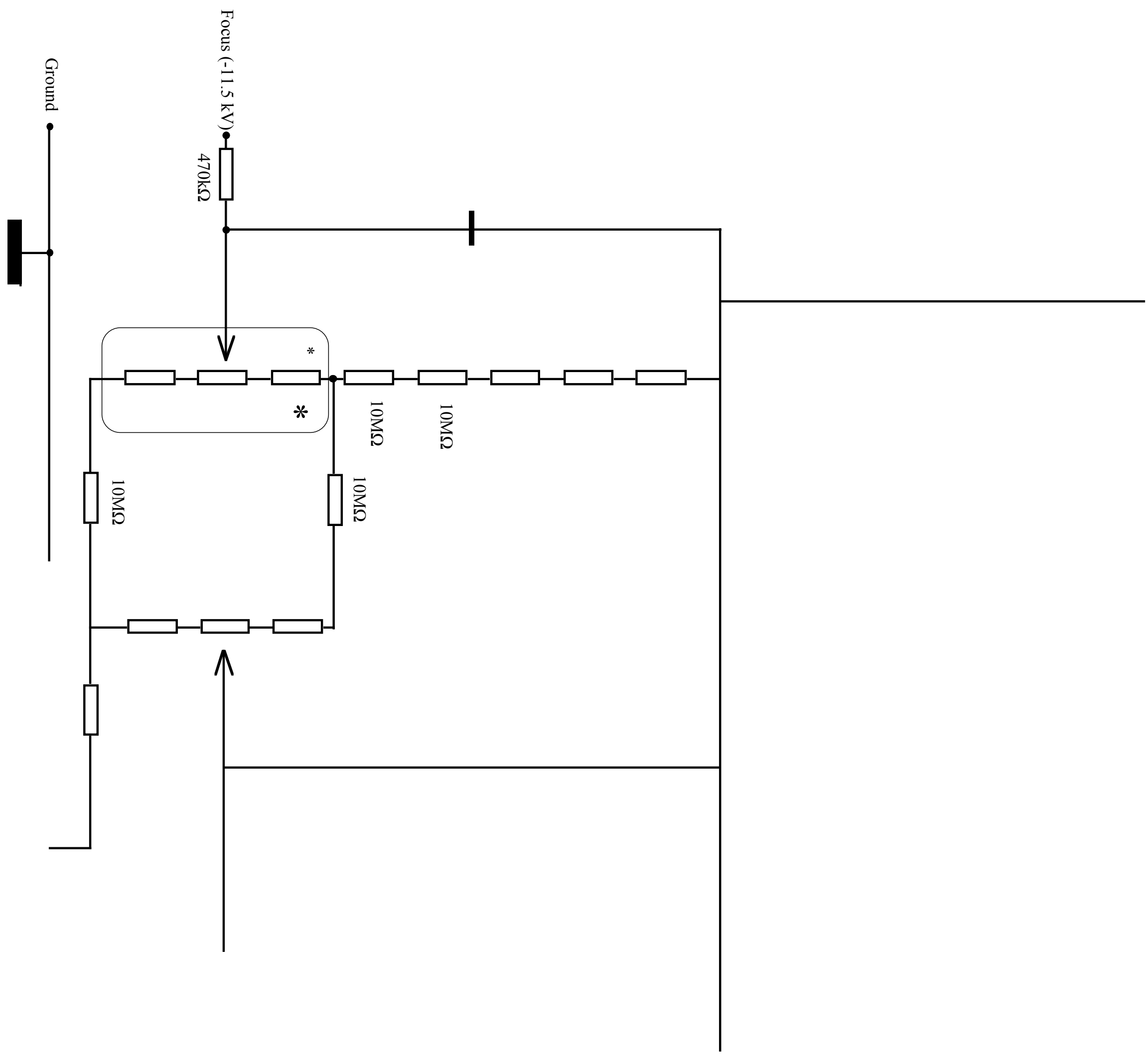


Figure 4 Divider network

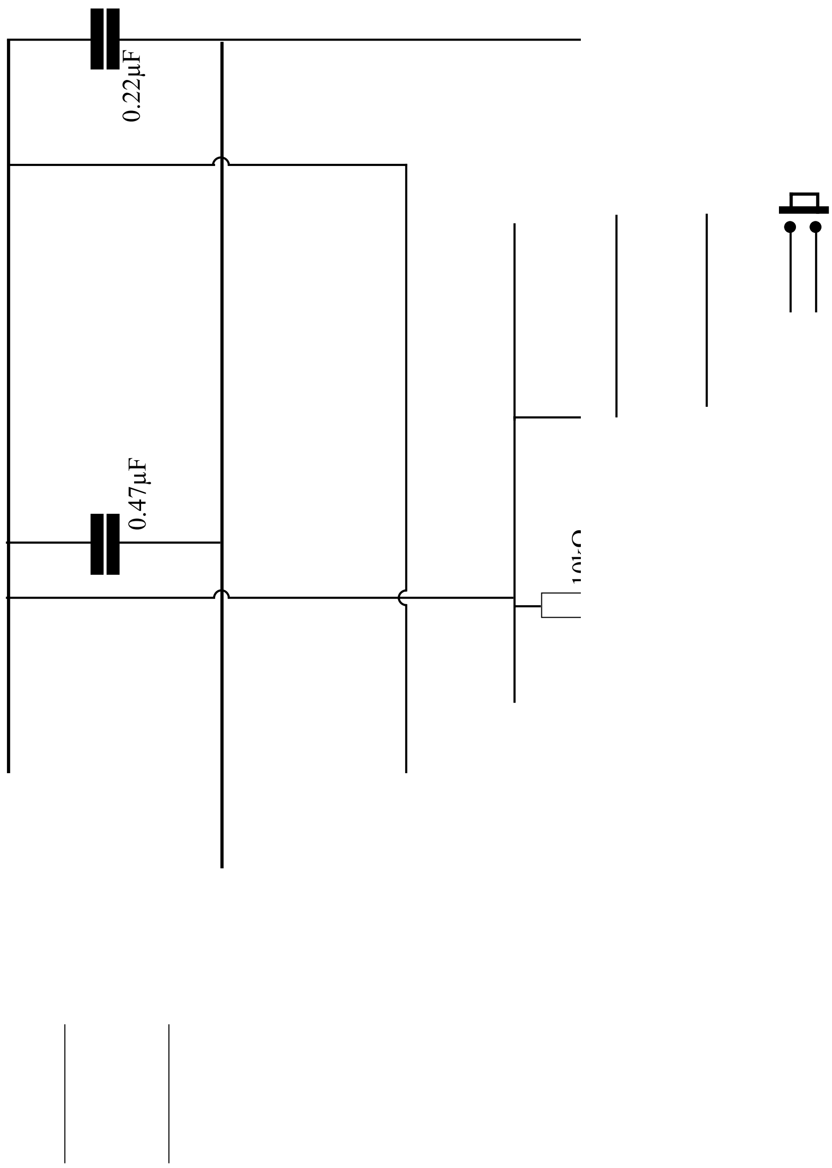


Figure 5 Fault light operation

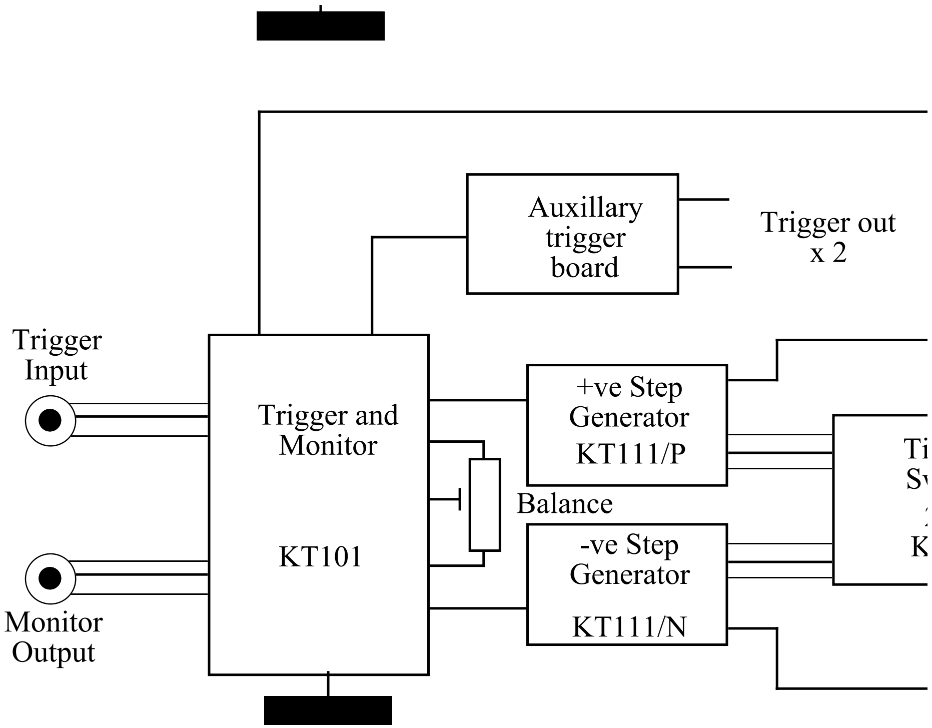
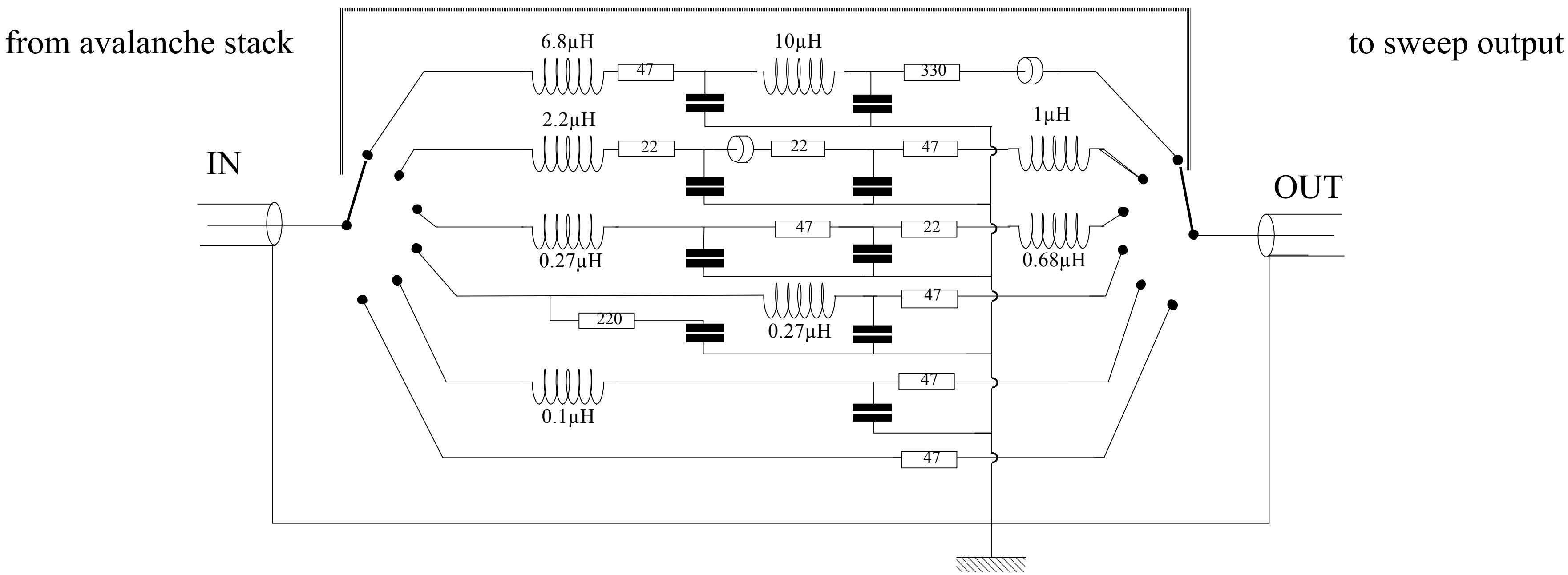


Figure 6   Slow sweep unit, block diagram



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

Figure 7 Slow sweep unit timing switch (KT106)

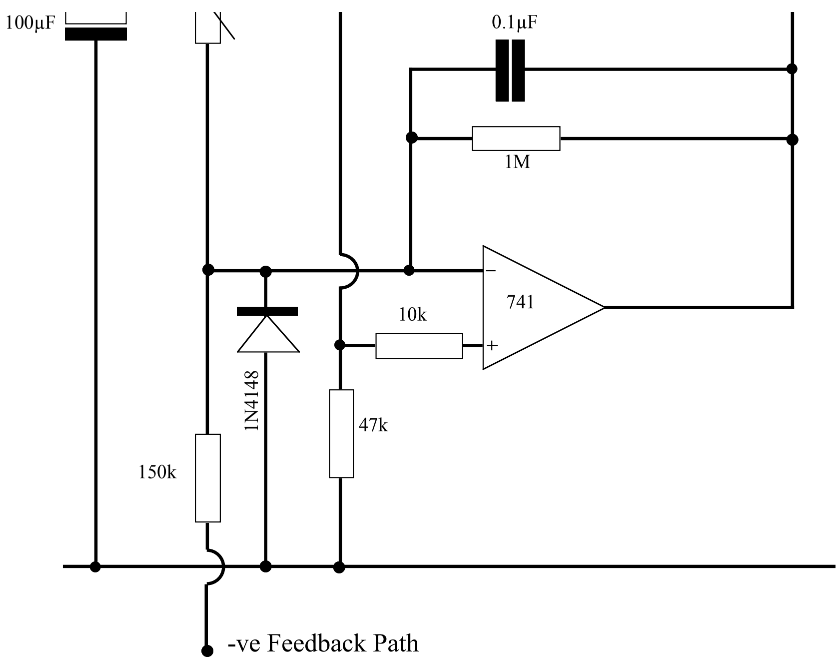


Figure 8   Slow sweep unit Inverter drive

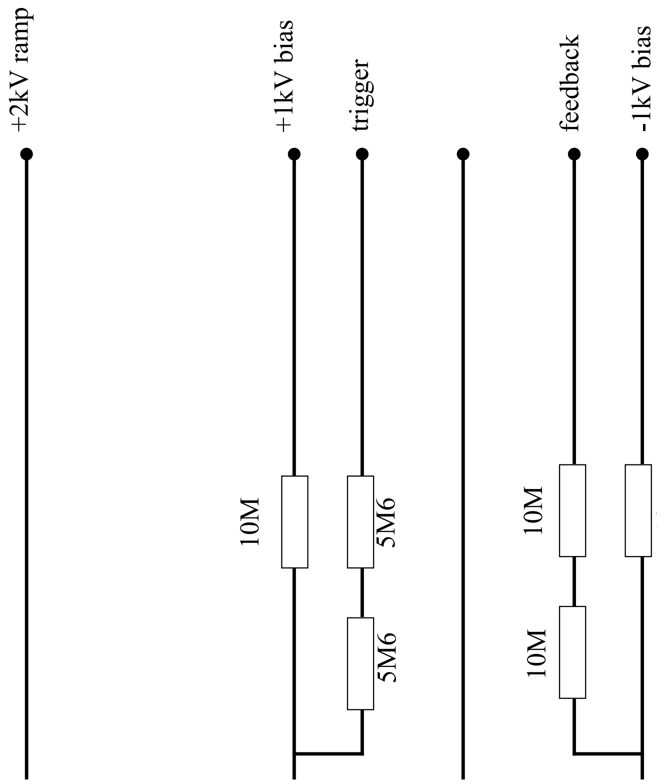


Figure 9 Slow sweep unit Multiplier (KT112)

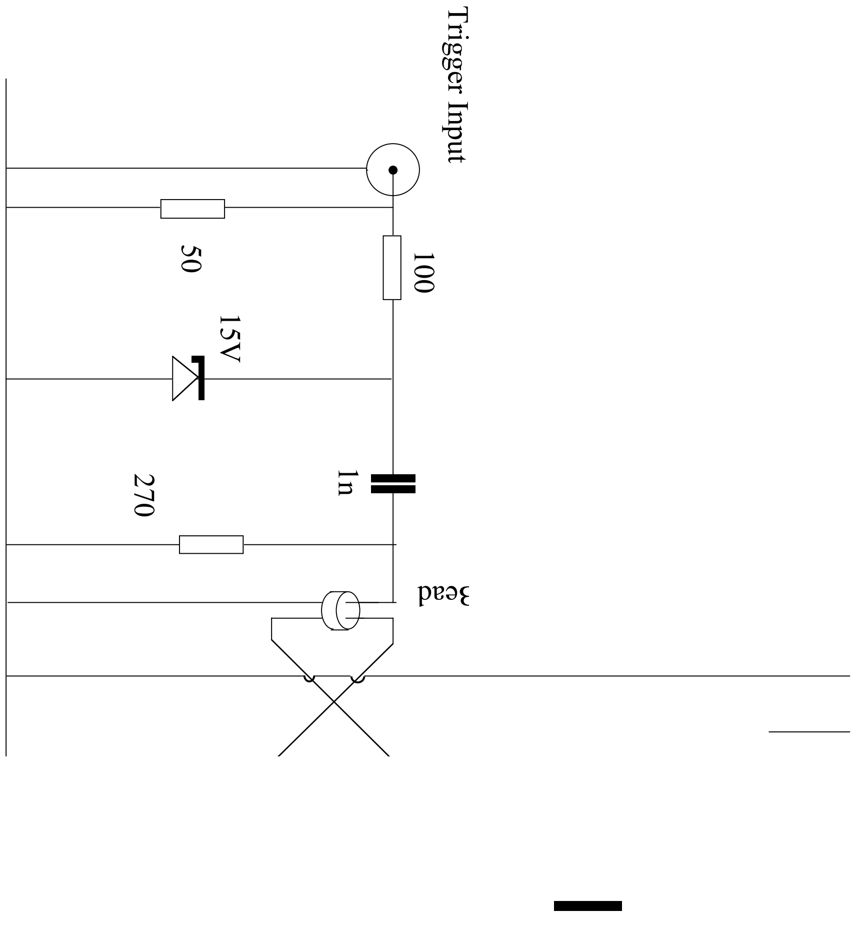


Figure 10 Slow sweep unit Trigger board (KT101)

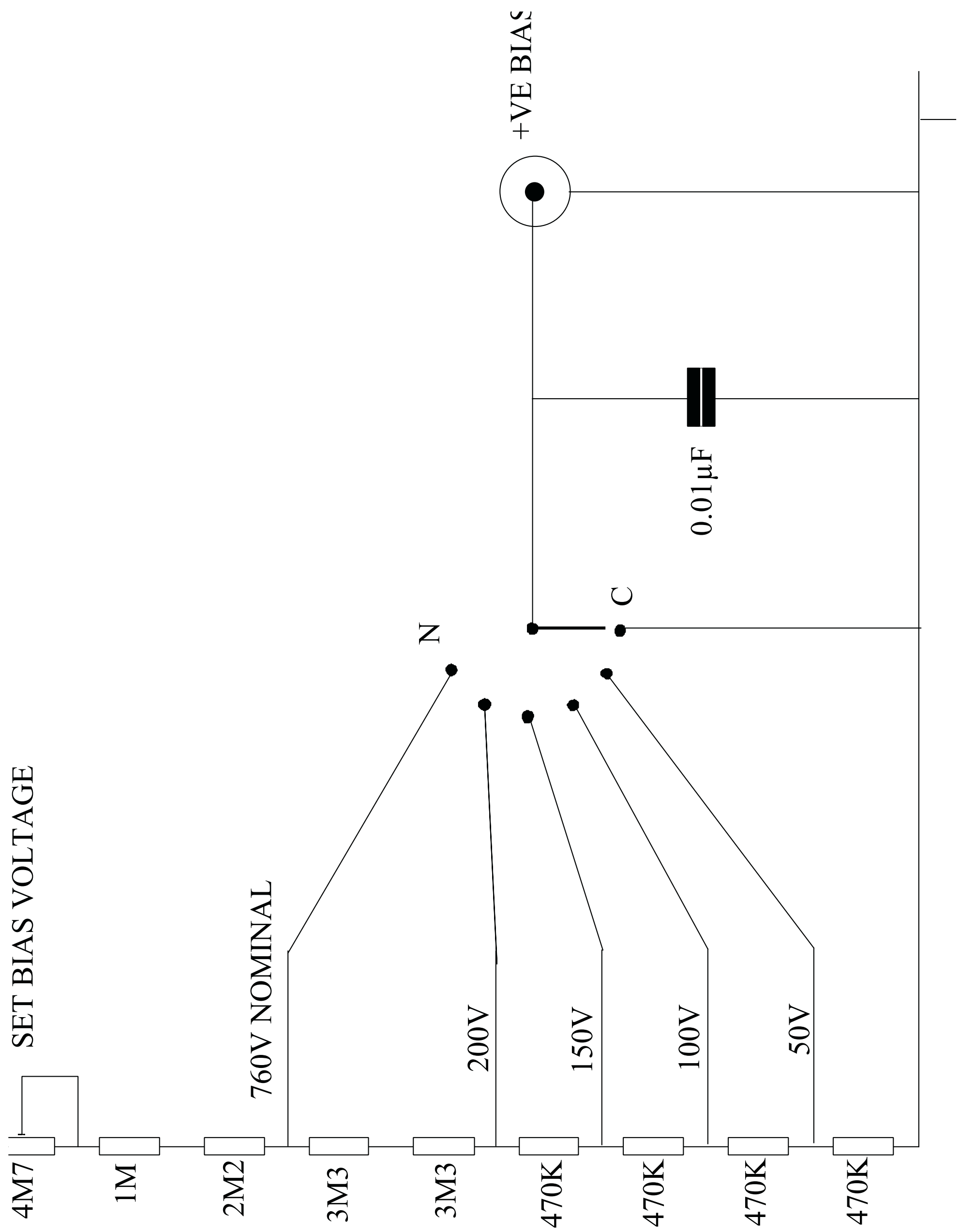


Figure 11 Slow sweep unit Bias switch

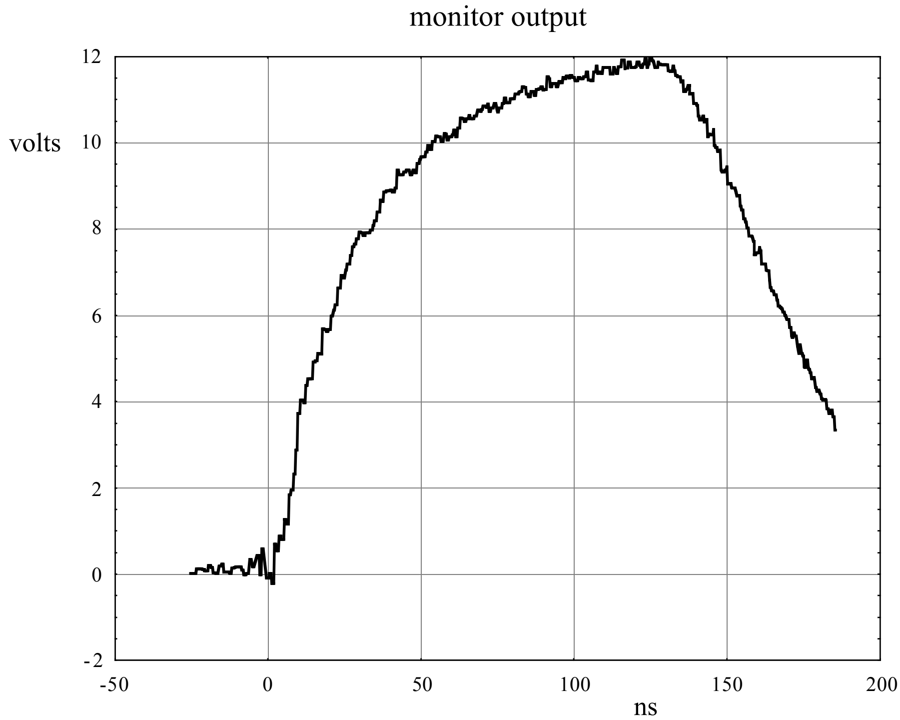


Figure 12 Monitor output

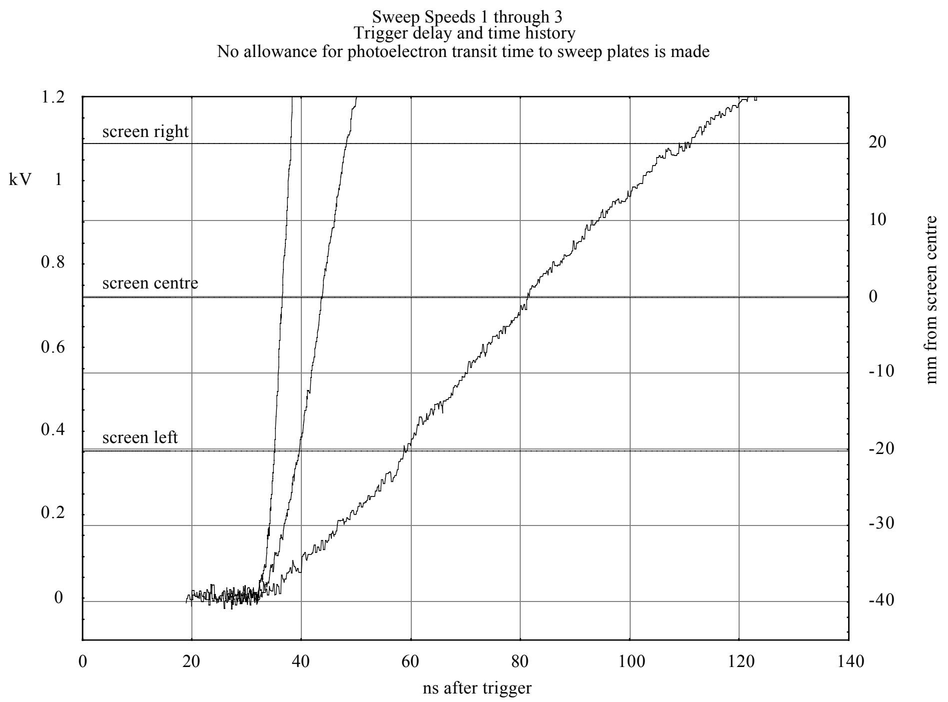


Figure 13a Sweep unit Image position vs time. Speeds 1-3

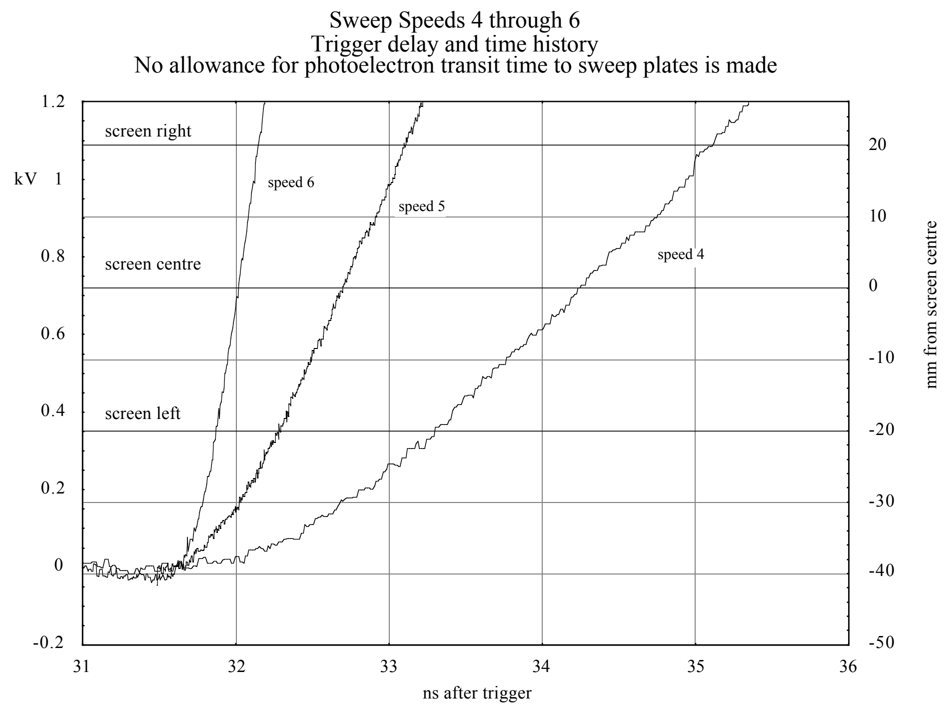


Figure 13b Sweep unit Image position vs time. Speeds 4-6

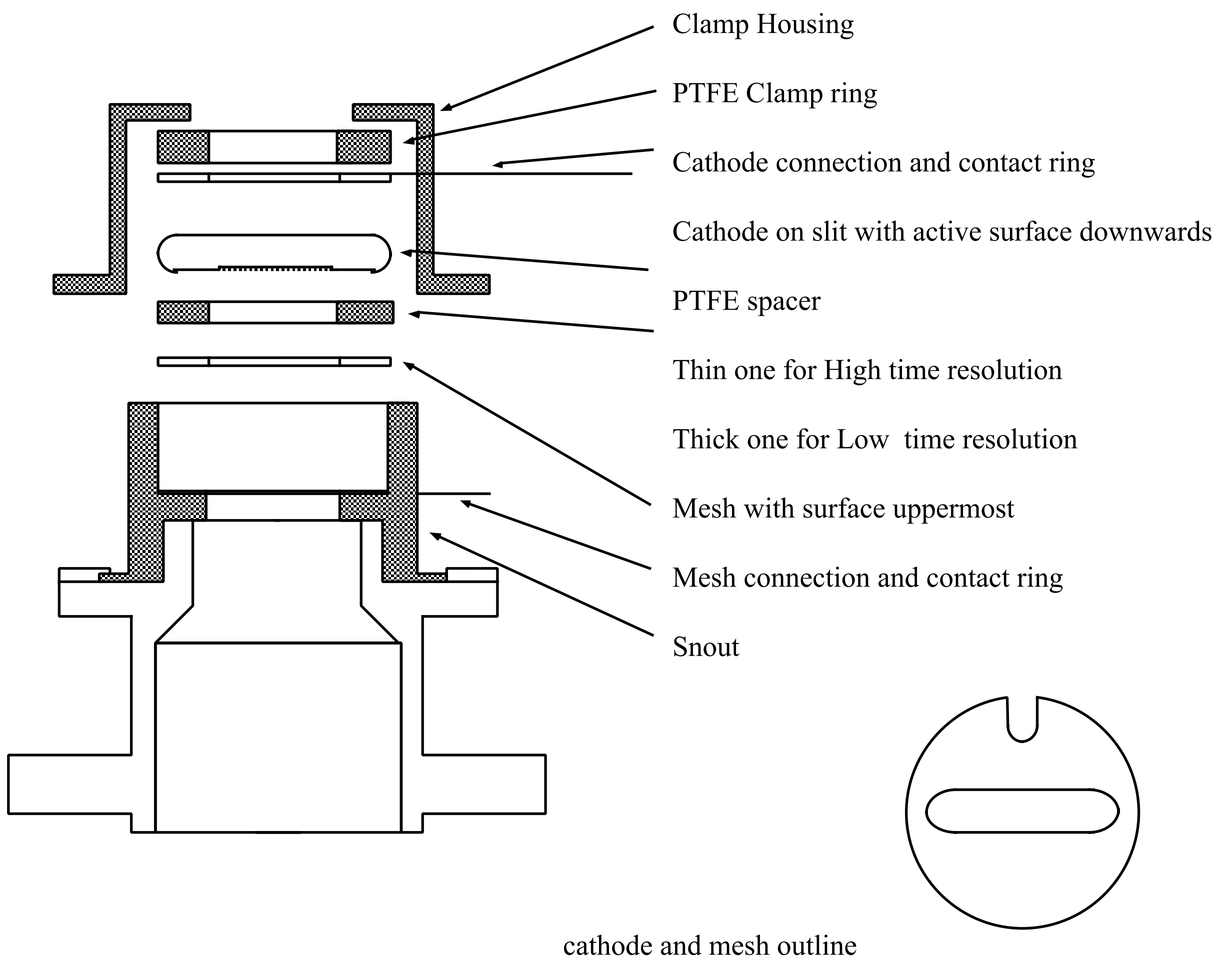


Figure 14 Cathode/mesh assembly