URISYS MESURES

USER'S MANUAL

SILICON. DETECTORS

IPP-IPP 2D

AFAQ ISO 9001

N° QUAL / 1999 / 12875

3 The appearance of micro-plasma breakdown, due to a pollution of the entrance window or to a deterioration of some component of the mounting. In this case, the noise instabilities have a tendency to decrease with the bias voltage.

5.3. RADIATION DAMAGES.

A major effect of radiation is to create defects in the crystalline lattice which behave like donor or acceptor levels within the silicon band structure. As a result, there is a decrease in the charge carriers lifetime which leads to an increase of the leakage current and to an incomplete charge collection. Resolution gets worse and a trail can be observed towards the low energies.

Passivation oxide can also be damaged by radiation which induce a stability problem.

The tab bellow presents some critical doses for which the detector deterioration is sure. The values given represent a number of particles per cm^2.

Radiation	Critical doses (cm^2)
fast e^-	10^{14}
protons	10^{12}
α	10^{11}
neutrons	10^{11}
Fission fragments	10^{8}

Note : For strong radiation doses, the donor level of N type silicon are compensated by vacancies which introduce acceptor levels in the band gap. N type silicon shifts to a P type like material. This effect is called type inversion.

If no increase in the reverse leakage current nor instabilities in the background noise, nor resolution deterioration have been established, causes of defective results must be looked for in the measurement system.

6. RETURNS.

If a detector has been mechanically or chemically damaged, or if its characteristics have deteriorated, it is likely to furnish a maximum of information on the use of this detector when sending it back. These information will be useful to repair or replace the detector.

Important notes :

1. Never exceed the maximal bias voltage indicated on the specification sheet.
2. Bias voltage must increase and decrease gradually.
3. Pressure must not be changed suddenly when the detector is charged.

4.3. Cleaning up the detector.

The entrance window of the detector is extremely fragile but can be cleaned if necessary. However, some precaution must be taken.

Never manipulate the detector bare handed and never make a mechanical contact with the sensitive area of the detector.

- If the detector is slightly dirty, just blow dry air or nitrogen gas on the sensitive area.
- If the detector is very dirty, spray alcohol with a washing bottle and dry it by blowing dry air or nitrogen gas.

5. PROBABLE CAUSES OF TROUBLESHOOTING.

If the detector performances deteriorate or if the resolution doesn't correspond to the one indicated on the specification sheet, it is important to check some points before returning the detector to Eurisys Mesures.

Look at the entrance window to check if any mechanical damage has occurred.

5.1. High reverse leakage current.

The reverse leakage current of the detector increases with the temperature (the current doubles about every 7°C). If temperature has remained constant, the rise in the reverse leakage current can be due to a deterioration of the entrance window. In this case, the background noise should also increase and the detector must be changed.

5.2. Background noise instabilities.

Background noise instabilities, detectable on an oscilloscope or a rms voltmeter can have several sources :

1 A defective electrical contact between the detector and the charge sensitive preamplifier. In this case, the noise instabilities should decrease with the bias voltage.

2 A deterioration of mechanical contacts in the detector's mount, due to a shock for example. In this case, the noise instabilities remain constant in spite of a decrease in the bias voltage.

4. OPERATING INSTRUCTIONS.

4.1. SYNOPTIC SCHEME FOR SPECTROSCOPY MEASUREMENT.

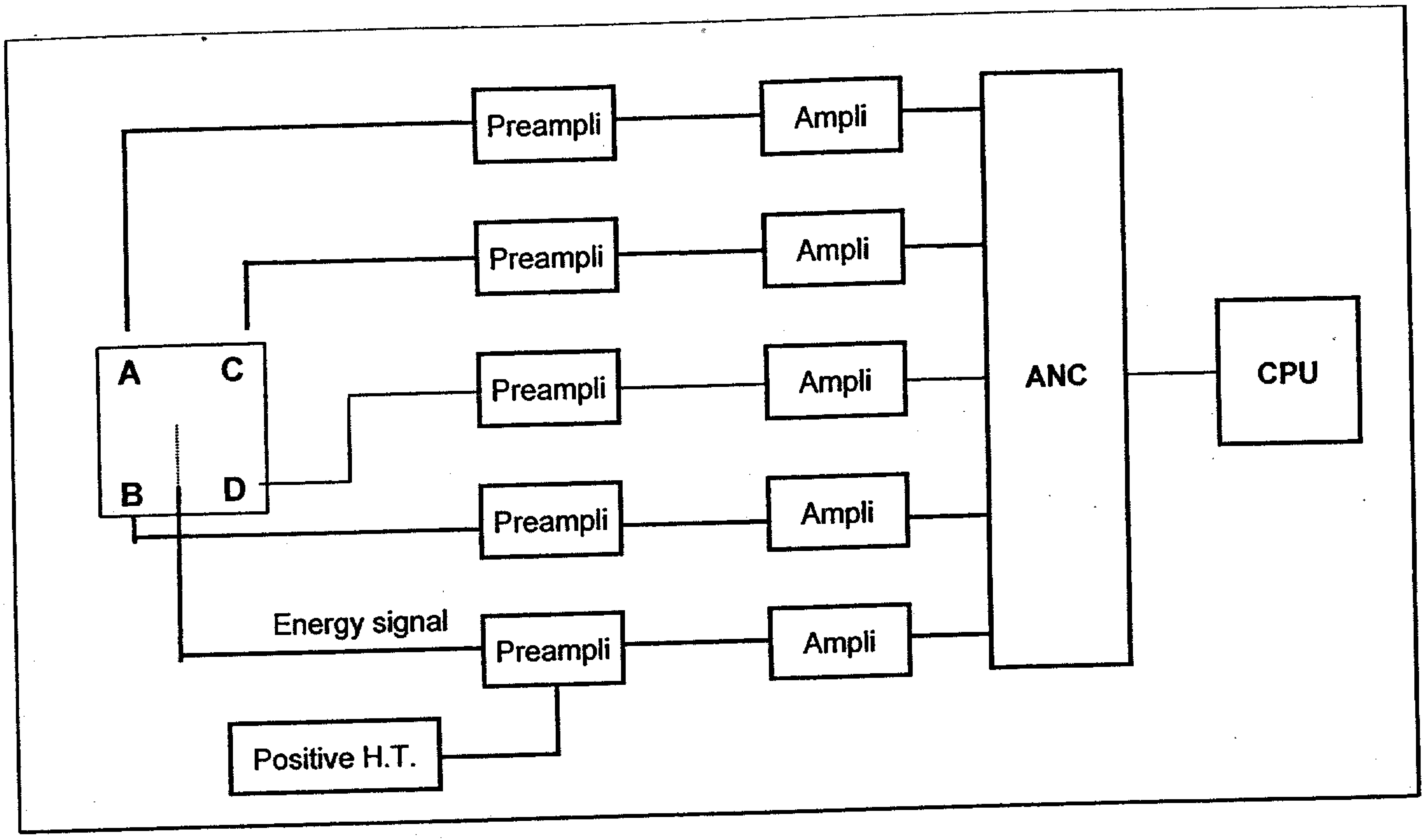


Figure 7: Electronics for measurement

4.2. MEASUREMENT INSTRUCTIONS.

Install the detector into the test chamber.

The measure has to be made under a minimum vacuum of 10^{-2} torr. It is important to have a clean vacuum, free of oil vapour. The entrance window of the detector is very sensitive to all kind of pollution or chemical contamination. If the vacuum system is equipped with a liquid nitrogen trap, make sure that the trap don't warm up.

Before connecting the detector to the charge preamplifier, make sure that the bias voltage supply is off and that its polarisation is positive.

In order to detect any operating failure, the detector's noise should be monitored either on an oscilloscope or on a rms voltmeter. It is also recommended to measure the reverse leakage current when the detector is in use.

Check the measurement system by sending a test signal into the charge sensitive preamplifier.

Bring the bias voltage gradually to the value indicated on the specification sheet and let the noise and the current become steady. Noise should decrease when the bias voltage increase.

$$y = \frac{D_y}{2}\frac{(q_A + q_C) - (q_B + q_D)}{q_A + q_B + q_C + q_D}$$

with : q_A, q_B, q_C, q_D : collected charges from A, B, C and D outputs.

D_x , D_y : of the active area of the detector.

x,y: impinging position.

Note : Expressions for x and y are exact and there is no need to use a distortion correction method.

3.2.4. IPP-2D linearity.

Figure 6 shows the « image » of an alpha source (^{241}Am) placed at 40 mm above the detector. A grid, of 1 mm diameter holes at 5 mm intervals, is set between the source and the detector. The detector used for this experiment is 40x40 mm^2 large.

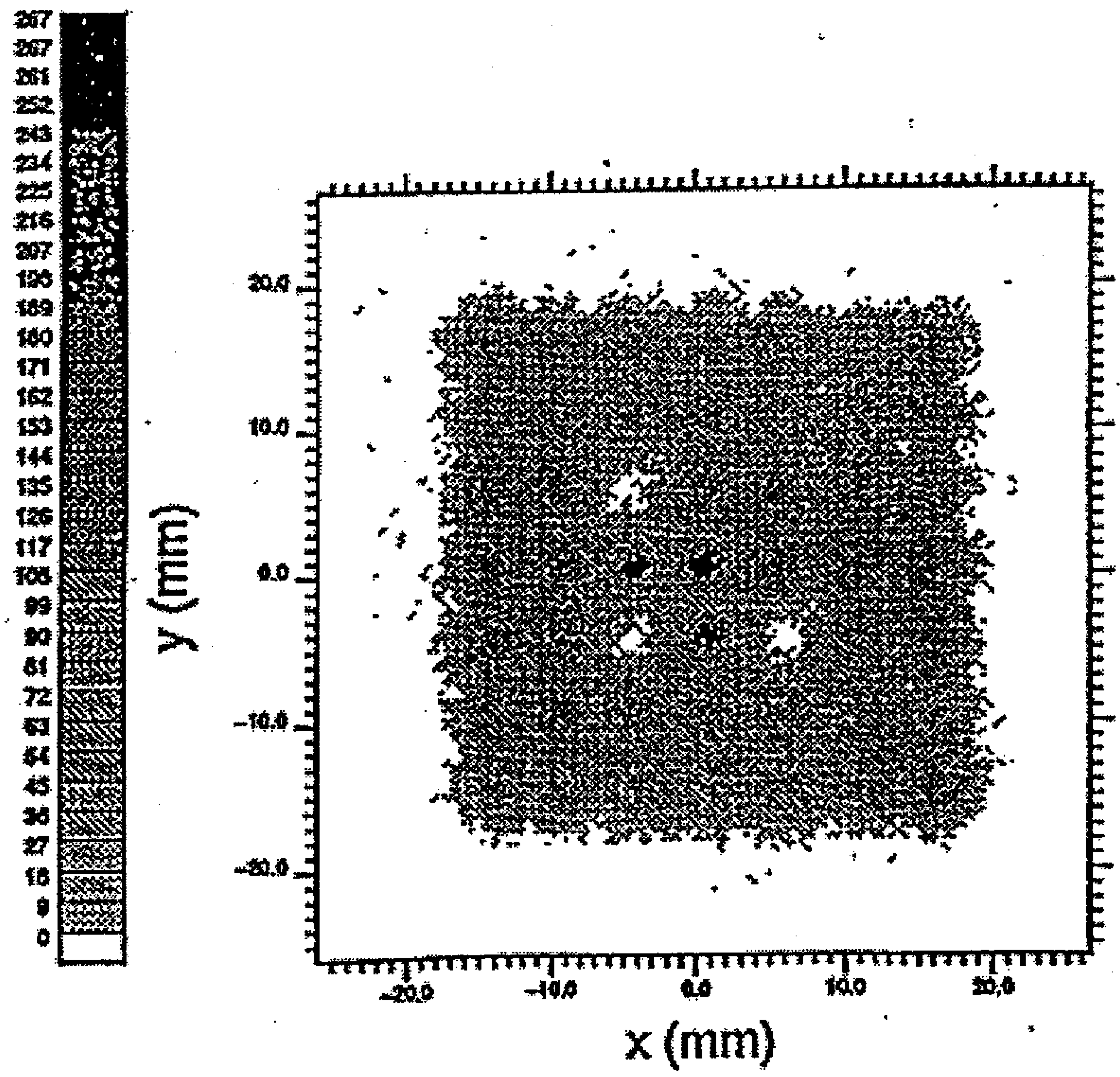


Figure 6: Image of an alpha source.

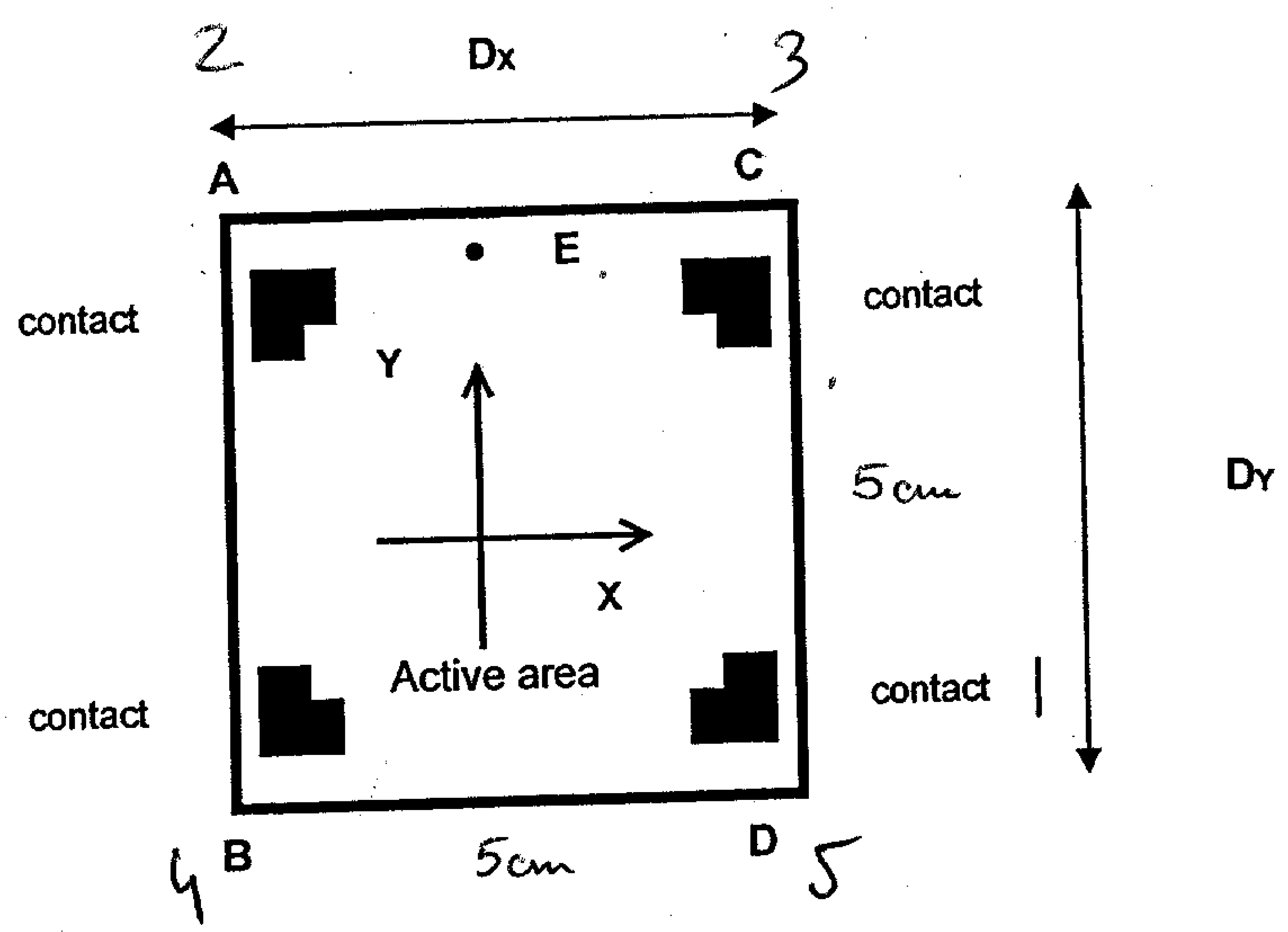
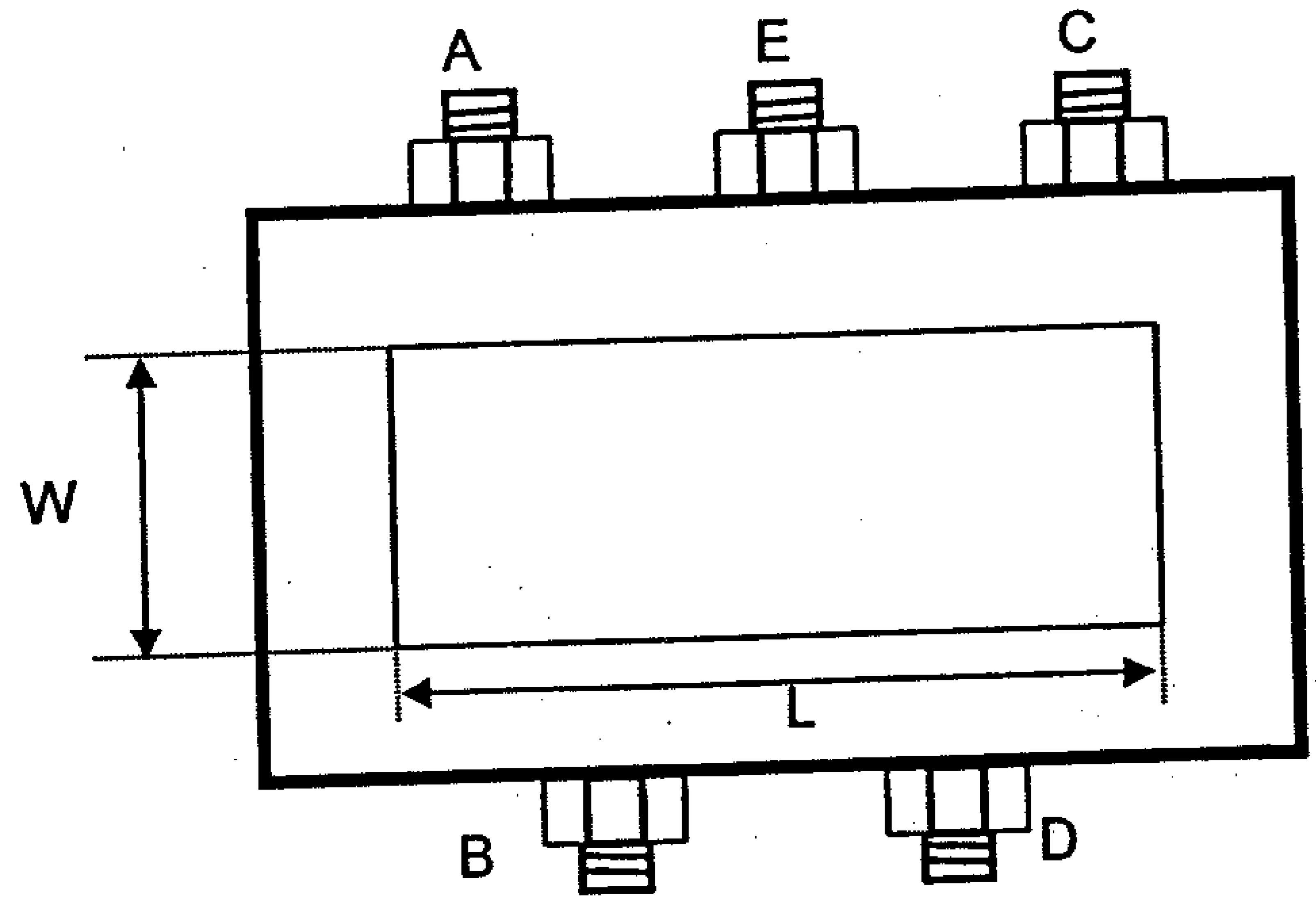


Figure 4: Scheme of a two dimensions position detector.

3.2.2. Mounting of an IPP-2D detector.

The IPP detector is delivered in a 10 mm thick brass gold plated mount with three lateral « microdots » connectors. The mount dimensions vary with the active area of the detector.



with : L x W: detector active area.

Figure 5: Mounting of a two dimensions position sensitive detector.

3.2.3. Impinging position calculation.

Co-ordinates are set to the centre of the active area of the detector. The impinging position is given by the following expressions :

$$x = \frac{D_x}{2} \frac{(q_C + q_D) - (q_A + q_B)}{q_A + q_B + q_C + q_D}$$

3.1.3. Impinging position calculation.

Signals obtained through charge preamplifiers are proportional to the collected charge and allow to calculate the impinging position with the following expressions :

$$q_a = q_0\left(1 - \frac{x}{L}\right)$$

$$q_b = q_0 \frac{x}{L}$$

$$q_e = -q_0$$

with : q_a, q_b, q_e : collected charges from A, B and E outputs.

q_0 : total charge created by the incident particle in the active bulk of the detector.

L : length of the active area of the detector.

x : impinging position

3.2. TWO DIMENSIONS POSITION DETECTOR.

3.2.1. Structure of a two dimensions position detector.

Figure 4 shows the IPP-2D structure with the electrodes configuration.

Position information signals come from the four corners of the front side of the detector and are collected by the A, B, C and D outputs.

The energy of the incident particle is given by the output E which is connected to the rear side of the detector.

3.1. ONE DIMENSION POSITION DETECTOR.

3.1.1. Structure of an IPP detector.

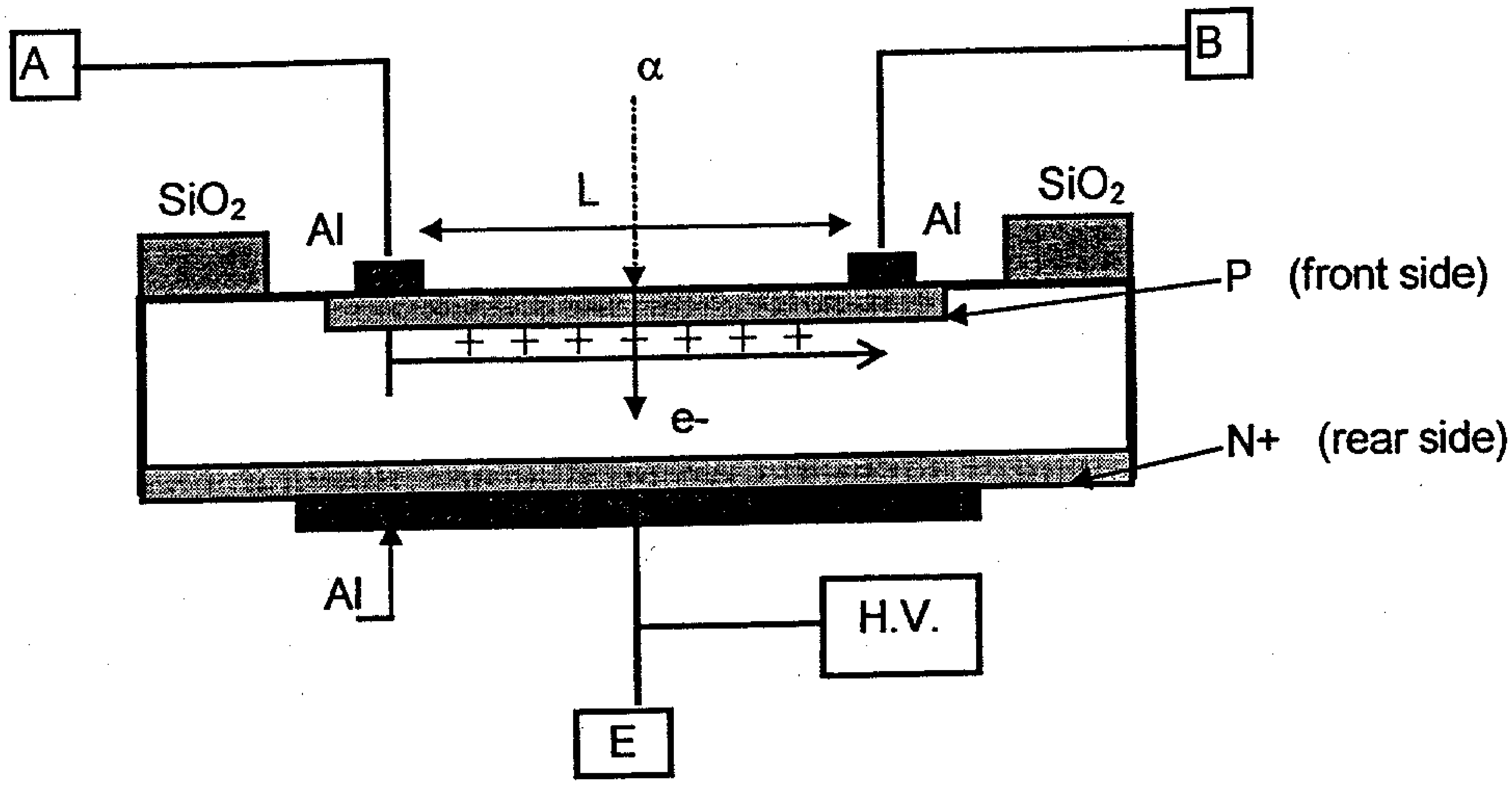


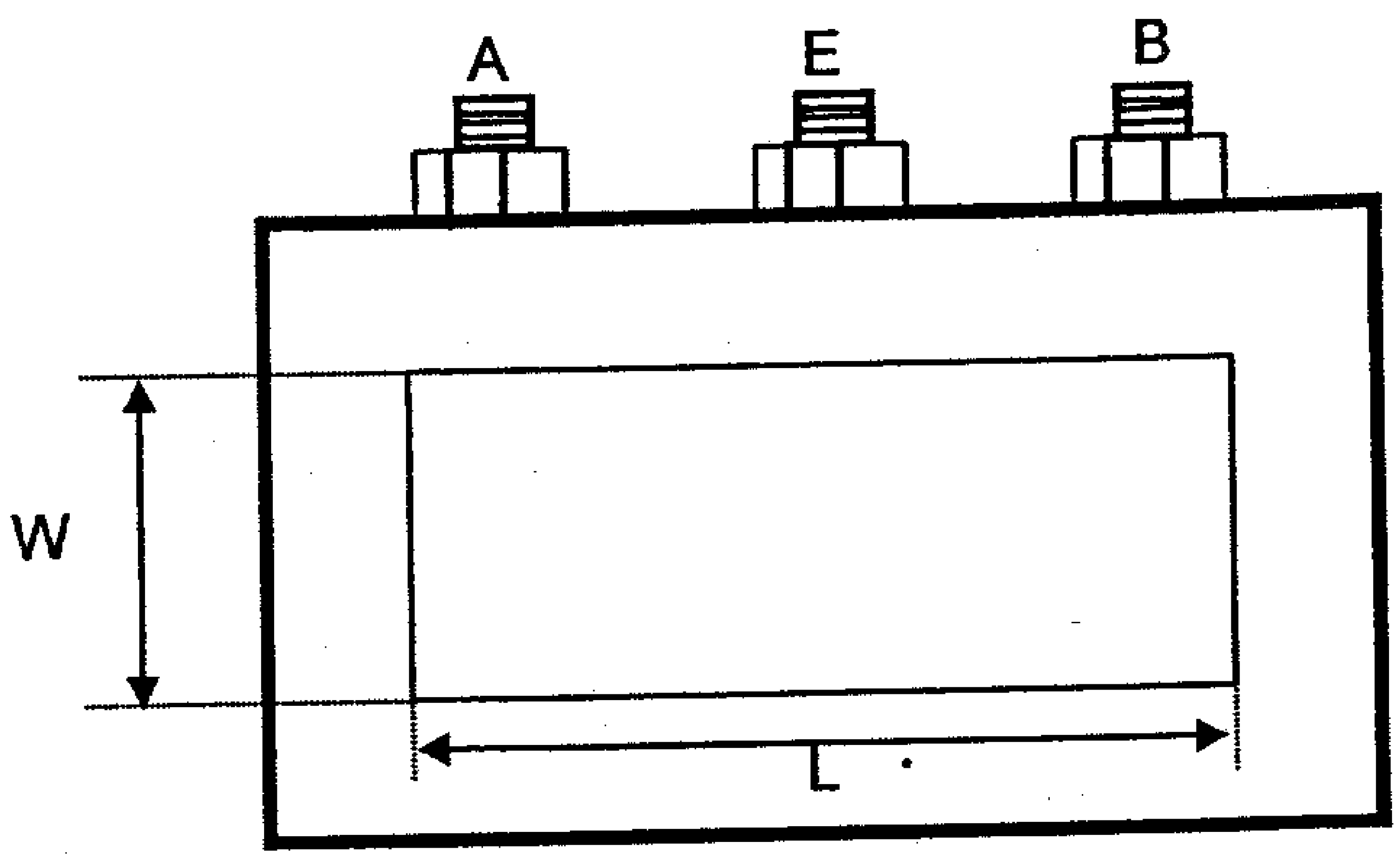
Figure 2: Cross section of a one dimension position detector.

The one dimension position sensitive detector can be considered as a linear charge divider. The charge collected from the position contacts A and B is a linear function of the impinging position (x) of the particle.

The charge collected from the central connector E, connected to the rear side of the detector, represents the total charge deposited by the incident particle and gives the particle energy which is, of course, independent from the impinging position.

3.1.2. Mounting of an IPP detector.

The IPP detector is delivered in a 10 mm thick brass gold plated mount with three lateral « microdots » connectors. The mount dimensions vary with the active area of the detector.



with : L x W: detector active area.

Figure 3: Mounting of an IPP detector.

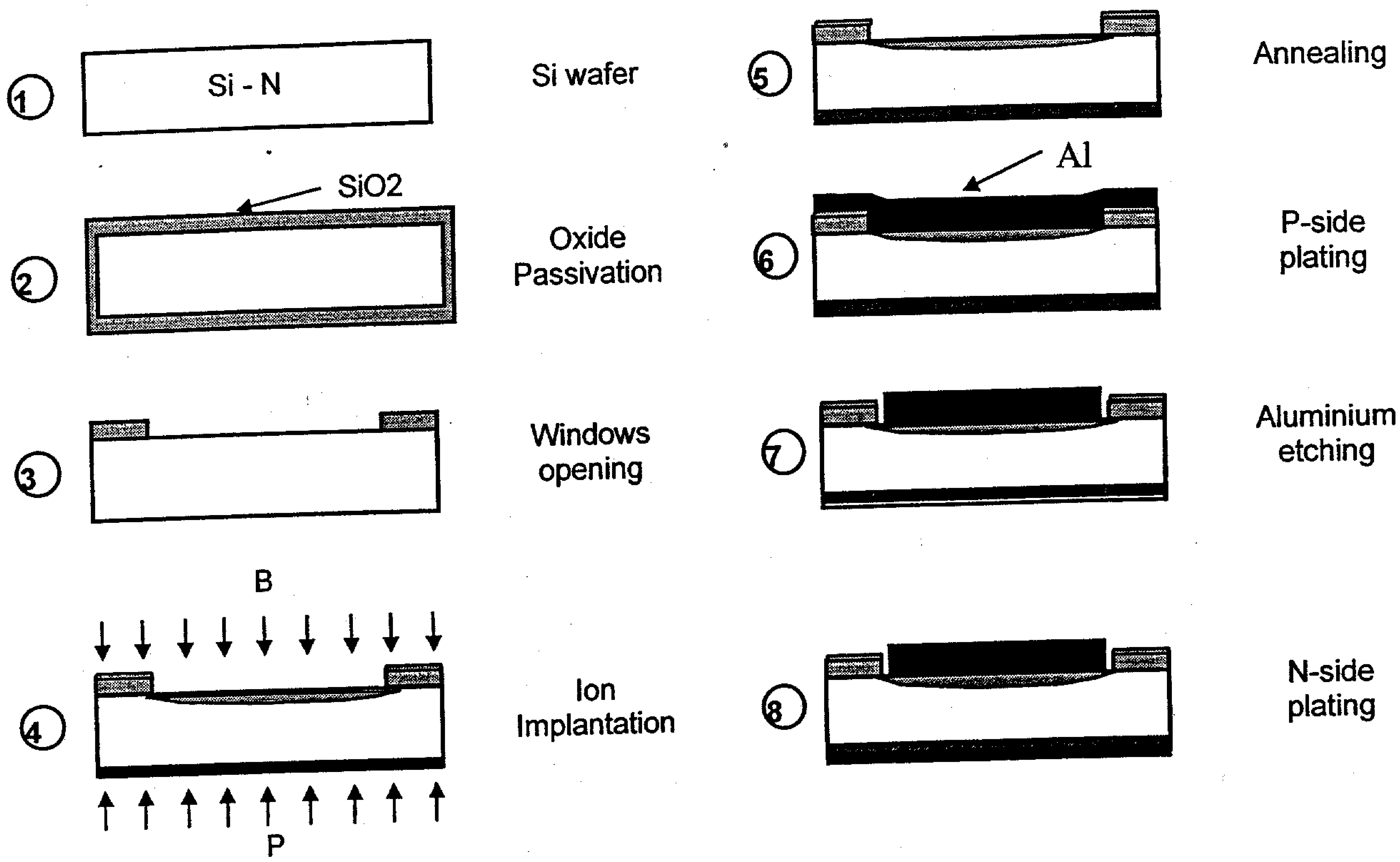


Figure 1: Planar process

3. PHYSICAL CHARACTERISTICS OF POSITION SENSITIVE DETECTORS.

Position measurement is made for one dimension (IPP detector) or two dimensions (IPP-2D detector).

You have just received a passivated ion-implanted junction silicon detector. Its use requires some precautions. Please take the time to read carefully this manual and follow the operating instructions.

1. RECEIPT AND UNPACKING.

The silicon detectors made by EURISYS MESURES are packed in small boxes designed to prevent them from any mechanical or chemical damage during transit.

Upon receipt, examine the package to check if any damage has occurred during carriage. If traces of shocks are observed, notify the carriage company and advise EURISYS MESURES before sending back the equipment.

Unpack the detector carefully. Don't touch the active area neither with fingers nor with any objet. The protection cap should be removed only when the detector is being used.

Each detector is supplied with a specification sheet indicating the detector type, the serial number and the main performances.

Note : We recommend that you keep the box in which the detector has been sent. It can be used to store the detector while not in use, or to send it back to EURISYS MESURES if necessary.

The detector must be stored in a clean and dry place.

2. MANUFACTURING TECHNOLOGY

The passivated ion-implanted junction silicon detectors are manufactured following a planar process. The basic material is a high resisting N-type silicon of high purity. The silicon wafer thickness generally varies between 300 and 500 µm.

SOMMAIRE / *SUMMARY*