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AUTOMATIZED MICROSCOPE FOR NUCLEAR EMULSION ANALYSIS

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ABSTRACT

The purpose of the apparatus is to superimpose on a video graphic terminal a nuclear emulsion event with the expected event provided by the detectors of the experiment WA71 at CERN (a search for Beauty[1]); the time necessary to select the interesting events is thus considerably reduced.

1.- INTRODUCTION

In order to observe particles with a short lifetime the nuclear emulsions are exposed perpendicularly to the high energy beam[2].

The interesting event is triggered by the experimental instrumentation which can determine the position of the interaction vertex on the emulsion surface, together with the angular coordinates of the outcoming particles. These data allow the proper positioning of the emulsion under the microscope objective in order to reconstruct the event topology on the same video-terminal on which the emulsion image, viewed by a TV-camera, is reproduced[3].

The event reconstruction is obtained by computing the track intersections with planes, parallel to the emulsion plane, at different distances from the vertex: such reconstruction is reproduced on the screen when the distance between objective and emulsion is such that any of these planes is focalized.

2.- APPARATUS

The stage of Leitz Orthoplan microscope (Figs. 1 and 2) is motorized with stepping motors controlled by a module Märzhäuser MCC 13. The host computer PDP 11/34 communicates to the control module the proper coordinates; the control module may communicate the actual coordinates of the stage to the computer, even when the movement has been carried out manually by means of the joy-stick.

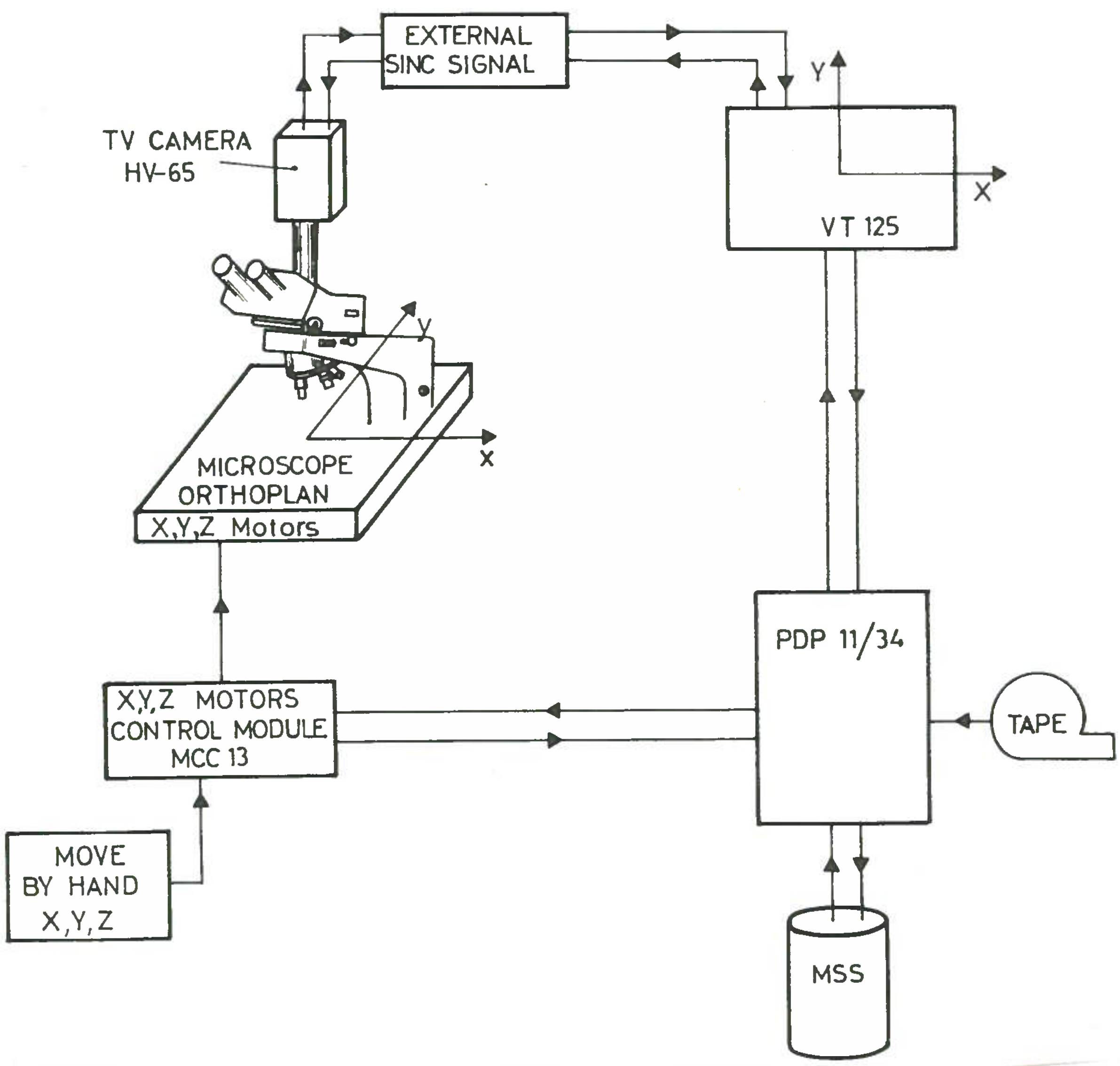

FIG. 1 - General block diagram.

(a)

(b)

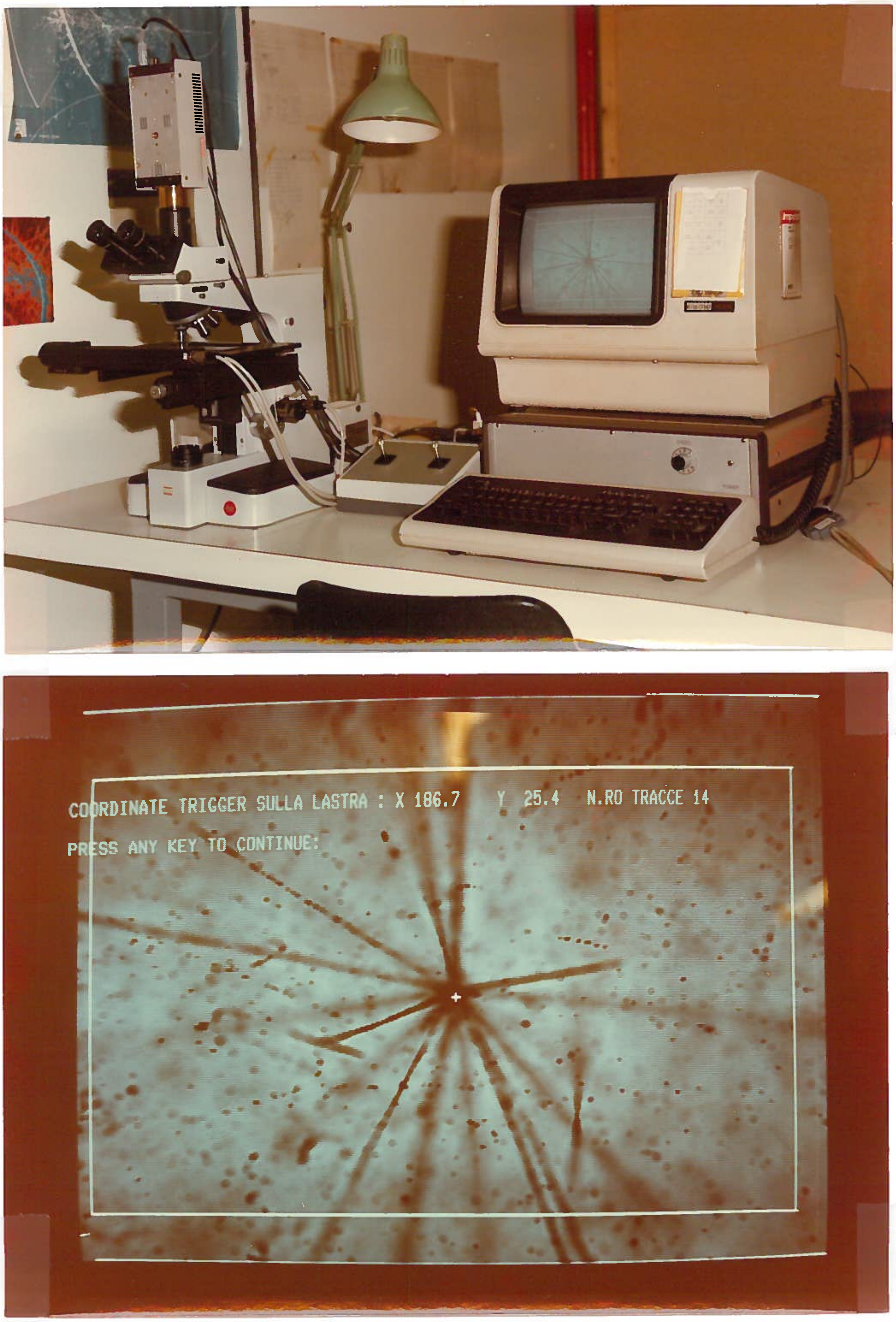

FIG. 2 - (a) The apparatus; (b) An event seen on the screen of the video graphic terminal VT 125.

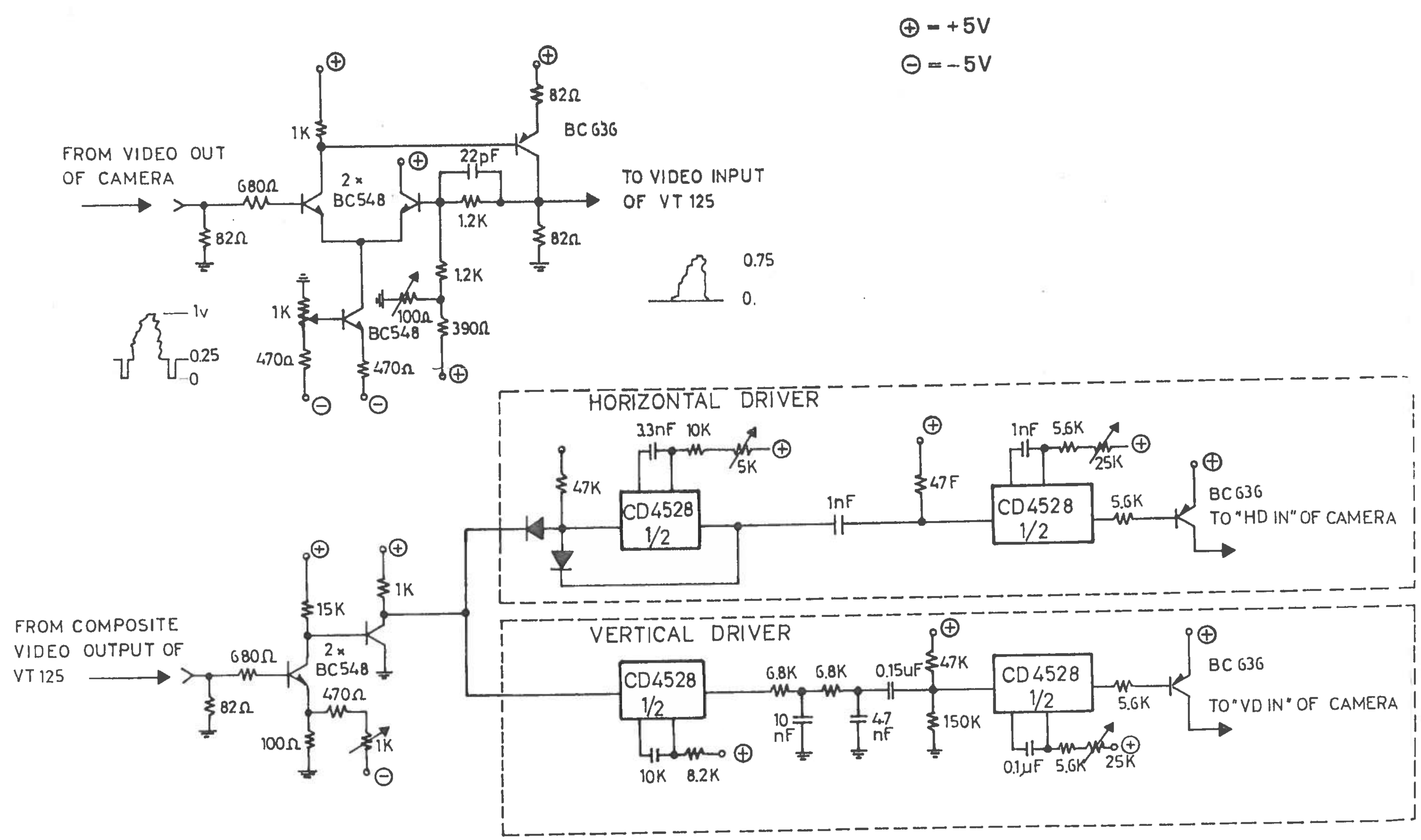

FIG. 3 - The synchronization circuit.

The TV camera Hitachi HV-65 with a 700 lines horizontal resolution is connected, via a synchronization circuit (Fig. 3) to the graphic terminal Digital VT 125. Using a x 100 objective on the microscope, a 60 x 40 μm^2 emulsion surface is reproduced on the whole screen. Following proper alignment of TV camera and emulsion, the cartesian axes defined by the emulsion grid will result in the same direction as the microscope and video axes.

The event coordinates in the emulsion are referred to the spot centre obtained with a longer exposure to the beam. This allows the automatic emulsion positioning under the microscope objective within a spot half width (~ 1 mm). At this stage the scanning is driven either manually (joy-stick) or by means of a semiautomatic procedure in which a spiral motion is realized, step by step with the computer aid: at the end of each step the manual control is enabled.

3.- RECONSTRUCTION OF EVENT TOPOLOGY

The intersection of the track at angles (φ, λ) (Fig. 4) with the plane parallel to the emulsion plane and at a distance D from the vertex is given, in the unprocessed emulsion, by:

$$x_o = D(\mathrm{tg}\,\varphi \cos\delta + \frac{\mathrm{tg}\,\lambda}{\cos\varphi} \sin\delta) \qquad (1)$$

$$y_o = D(\frac{\mathrm{tg}\,\lambda}{\cos\varphi} \cos\delta - \mathrm{tg}\,\varphi \sin\delta)$$

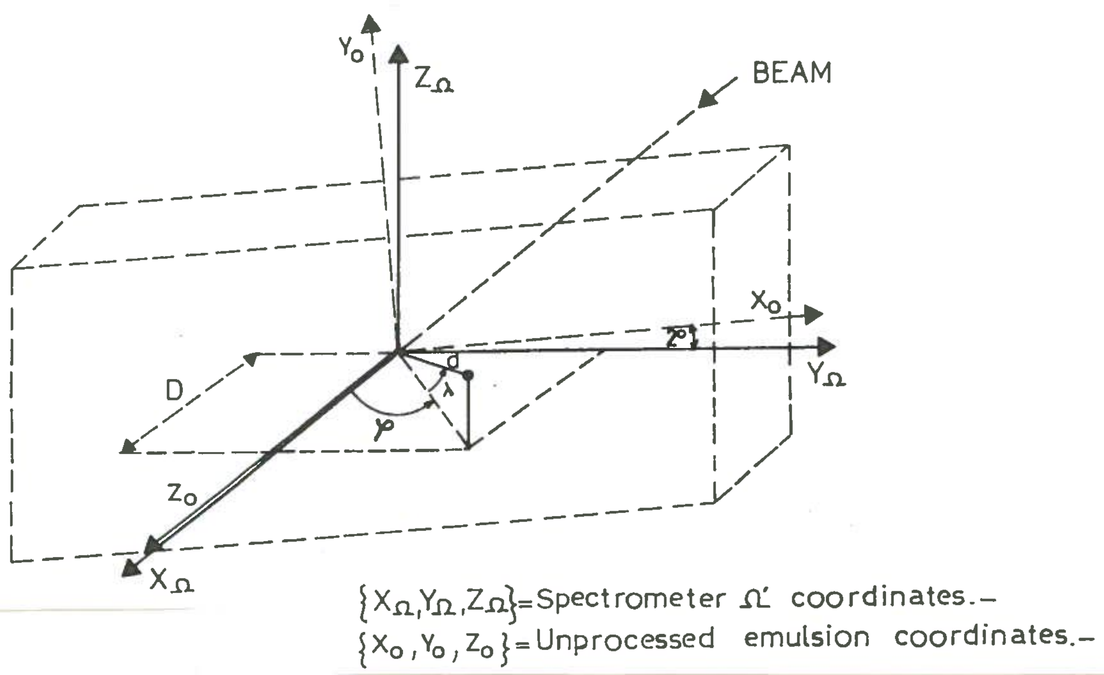

FIG. 4 - Emulsion orientation.

the angle δ ($\cong 2°$) is the one between the x_o emulsion axis and the horizontal y_Ω spectrometer axis (Fig. 4).

We describe the processed emulsion distortion[4] by:

$$\alpha(z) = \frac{1}{S}\left(\frac{\partial x}{\partial z}\right)_z \cong \frac{1}{S}\,\frac{x(z) - x(z - \Delta z)}{\Delta z}$$

$$\beta(z) = \frac{1}{S}\left(\frac{\partial y}{\partial z}\right)_z \cong \frac{1}{S}\,\frac{y(z) - y(z - \Delta z)}{\Delta z} \qquad (2)$$

where S is the shrinkage factor (Fig. 5), x(z), y(z) are the coordinates of a beam track (perpendicular to the unprocessed emulsion plane) measured by means of VT 125 graphic cursor, while the plane at height z, from glass, is focalized onto the screen. The Δz displacement given by the PDP 11/34, is obtained by means of MCC 13.

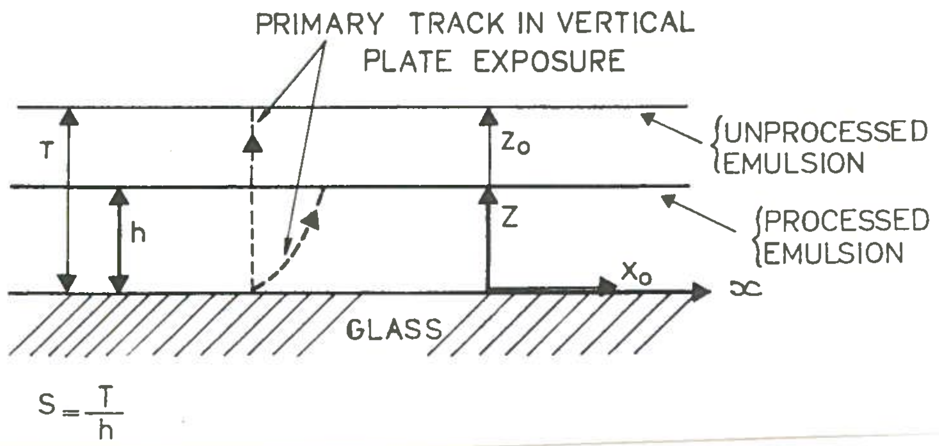

FIG. 5 - Unprocessed and processed emulsion.

A point to be remarked is that this procedure takes into account the eventual small distortions due both to microscope and video camera optics.

The intersection of a track (φ, λ) with a plane at a distance kD/S from the vertex in the processed emulsion is

$$x(k) = D\left[k\left(\mathrm{tg}\,\varphi\cos\delta + \frac{\mathrm{tg}\,\lambda}{\cos\varphi}\sin\delta\right) + \sum_{i=1}^{k}\alpha\left(z_v + \frac{iD}{S}\right)\right]$$

$$y(k) = D\left[k\left(\frac{\mathrm{tg}\,\lambda}{\cos\varphi}\cos\delta - \mathrm{tg}\,\varphi\sin\delta\right) + \sum_{i=1}^{k}\beta\left(z_v + \frac{iD}{S}\right)\right] \qquad (3)$$

where z_v is the vertex coordinate referred to the glass.

In short, after the identification of the candidate event, the vertex is focalized and centered on the VT 125 screen. The computer reads the vertex height z_v referred to the glass, then it focalizes the plane of the height (z_v + kD/S); next, by means of (3), it computes the intersection coordinates of all tracks with this plane and makes a drawing of the computed points with proper symbols on VT 125 screen. At operator's demand it goes to a different height and draws the new intersections with a different symbol, after erasing the preceding ones.

It must be remarked that, if this procedure is applied to a beam track ($\varphi = \lambda = 0$), imposing that the glass must be focalized with the track centered in VT 125 screen, the symbols drawn at the different heights follow the image of the beam track.

ACKNOWLEDGEMENTS

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(4) - W.H.Barkas, Nuclear Research Emulsion, Vol. I, pag. 194.