RESULTS ON THE USE OF A SIMPLE GEOMETRY PROGRAM FOR FILTERING HPD DATA

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1. INTRODUCTION

We report here results on the use of a simple geometry program for filtering data from the Paris off-line HPD.

This HPD (Fig. 1) is connected to a small computer (CDC 160 A) which performs all real time operations, including a rough gating and the writing of digital images on magnetic tapes.

These tapes enter as input for the "Filtering", performed off-line on a big computer, now a CDC 6600.

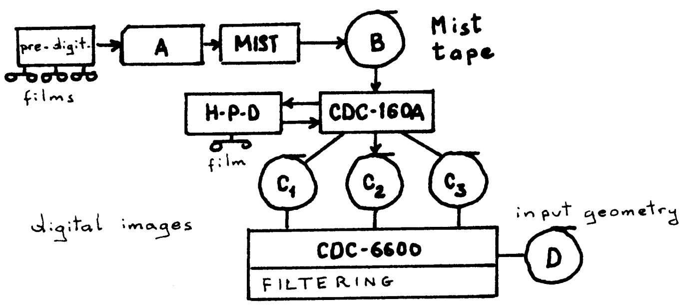

Fig. 1 Block diagram of the HPD system at College de France

Filtering was based on "road guidance", obtained by predigitizing the apex and two points/track during scanning.

Experience with processing 70 000 $\bar{p}p \rightarrow$ four-prong events demonstrated that such premeasurement was a very heavy load.

It seems essential that, in order to maintain the value of our system, we must reduce the level of predigitizing. Such a reduction implies forsaking road guidance, and a complete rewriting of the track processing.

We use a small geometry program to make up for this lack of guidance. In this way we achieve a 50% reduction in predigitizing, while increasing filtering speed by about 30%.

2. PRINCIPLES INVOLVED IN THE USE OF GEOMETRY FOR TRACK FILTERING

It is well known that geometrical relations exist between the images of a track seen by the cameras looking into the bubble chamber. These relations are simple as long as great accuracy is not required. However, they can easily give useful information for finding tracks (often more precise than approximate points coming from premeasurements). Furthermore it gives automatic track-matching between views.

Geometrical relations must be used in a restrained way to save time. Our method relies upon two important properties of the CERN 2 m bubble chamber's geometry.

a) Images (m_1, m_2, m_3, m_4), as seen by the cameras, of a point M in the chamber are obtained by conical projections from the optical centres (O_1, O_2, O_3, O_4), on to an arbitrary plane perpendicular to the optical axis (Fig. 2).

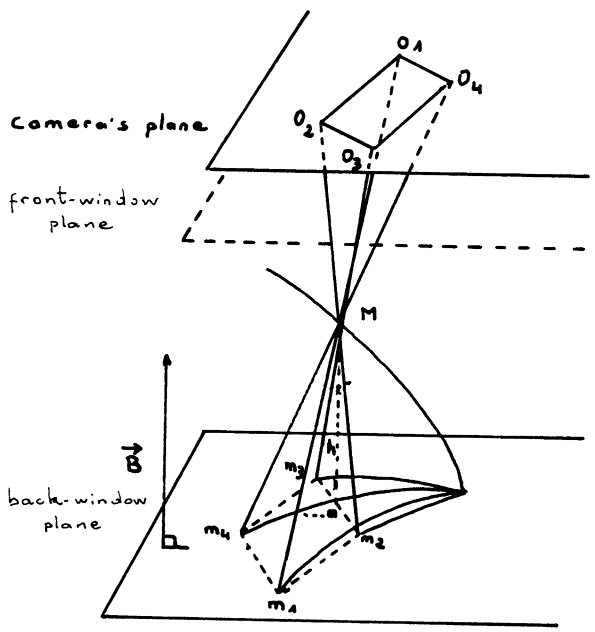

Fig. 2 Principle of geometrical reconstruction in CERN 2 m bubble chamber

We choose the plane of the back window. This means that corresponding fiducials must be superimposed.

The quadrilateral m_1, m_2, m_3, m_4 is a square homothetical to the one constituted by O_1, O_2, O_3, O_4.

Typical dimensions, such as m_1m_2, called parallaxes, are proportional to h (distance of M to plane). Connecting lines (m_1m_2, m_1m_3, ...) Make 0°, ±45°, 90° angles with the chamber's longitudinal axis.

b) The magnetic field B being perpendicular to the windows, the dip of the tracks is constant. We have therefore, in projection, the approximate linear relation

$$\Delta z = \alpha \, \Delta s \ ,$$

when z is the parallax, and s the curvilinear abcissa of corresponding points. How one combines these two properties depends upon the amount of information available at the time of the processing.

We take (Fig. 3) the example of one track found already on two views, the problem being to locate this track on the third view.

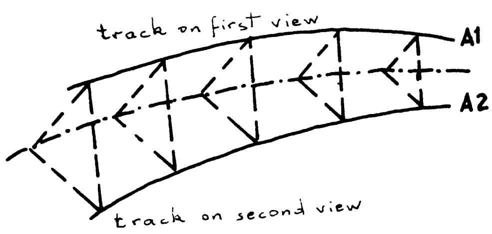

Fig. 3 Use of corresponding points to find an approximate location of a track, already found on two previous views.

By superposition of the back window fiducials, curves corresponding to the two first views are calculated for the plane of the digital image.

Then a pair of corresponding points are easily obtained. Each pair gives an approximate point. This set of points defines with fairly good accuracy a narrow road where actual digitizations are situated.

Our results show that 90% of tracks lie within a width of ±30 least counts (HPD length unit), and this is far less than the road width of ±250 L.C. used with our former road guidance program.

The background level is small with such narrow roads; and, if one is not interested in ionization data, one can get accurate information on the position of the track very quickly by only sampling digitizations within the road.

3. EFFICIENCY OF GEOMETRICAL RECONSTRUCTION

The following example, involving the second property, gives an illustration of the geometrical reconstruction's efficiency for filtering.

We shall suppose that the following data are available in the image plane (second view):

- apex position (given by premeasurements, or other tracks)
- accurate position of one track found on the first view.

(In HPD slang: minimum guidance.)

Finding the track requires three steps (Fig. 4):

a) Sample digitizations inside the area of corresponding points. Boundaries are obtained from two limits of spatial slope α according to whether the track reaches the front or back window.

Sampling is made along narrow strips following several reconstruction lines. Here, reconstruction and scan lines are parallel.

b) Coordinates of each digitization are computed in the (s,z) plane. One can see that several points are fitted by a straight line on Fig. 4B.

c) The conjugate curve in the HPD plane gives an accurate approximation of the track. Figure 4C shows the neighbourhood of this curve. The exact localization is then easy to perform.

Systematic use of the method allows one to reduce the premeasurement to:

- some road guidance on the first view,
- apex or nothing on the second view.

A limitation can come into our system from the greater number of digitizings one has to store. With predigitizing the apex and one point/track on the second view it is possible to obtain a good reduction of the number of digitizings (the same as with road guidance). We choose this intermediate solution as a first step which already gives a 50% reduction in the amount of predigitizing.

Comparison of the time necessary for track processing on the CDC 3600 between the three views shows no strong influence due to the geometrical reconstruction:

View	1	2.84 sec	apex + 2 points/track guidance
	2	2.81 sec	apex + 1 point/track guidance + geometry
	3	2.55 sec	geometry
Total		8.20 sec	

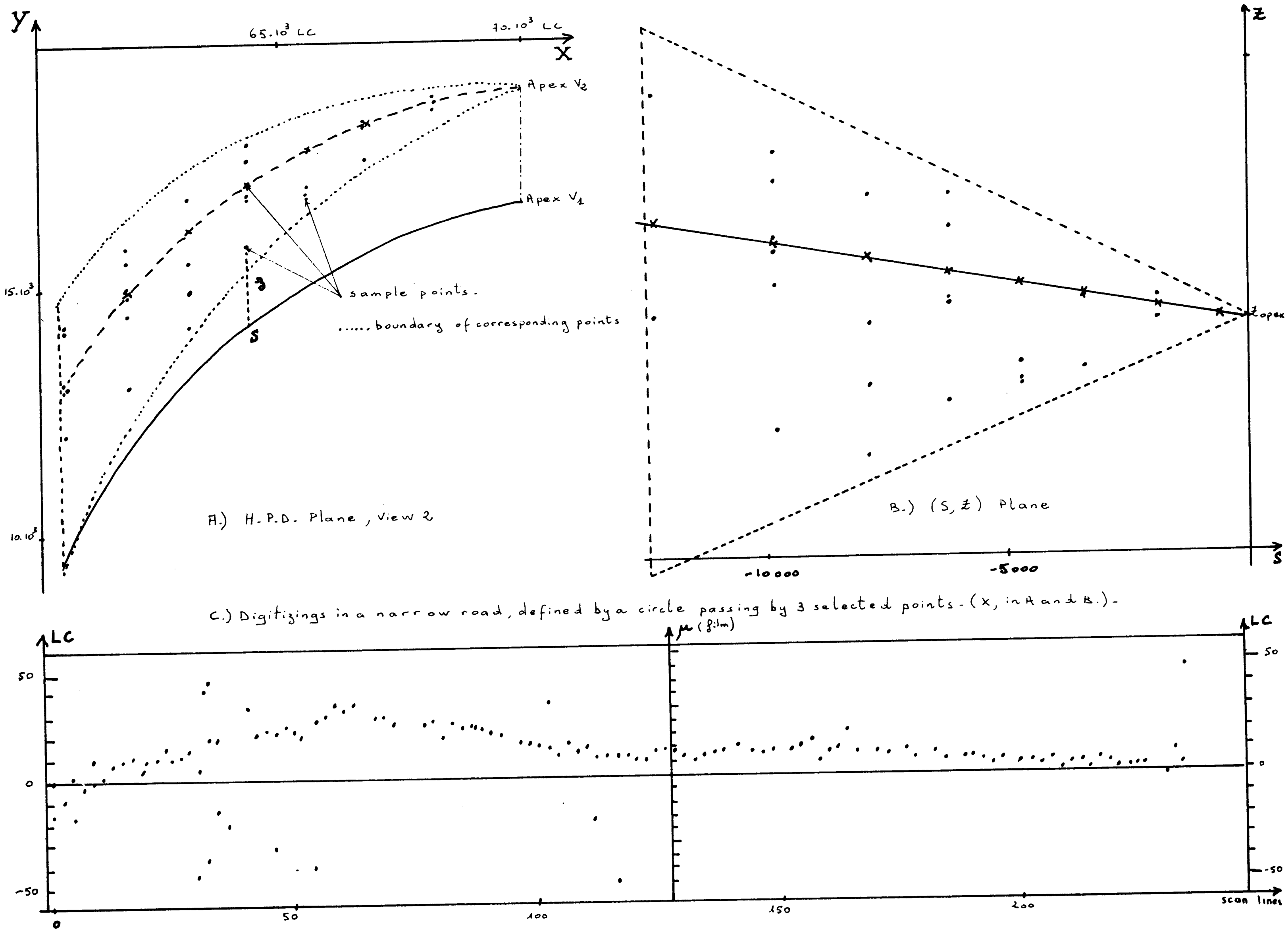

Fig. 4 Searching a track on second view in a HPD plane if the track on first view and apex on second view are given. Lengths in HPD least counts: 1 LC = 1.6 μ on the film.

(The time for the same four-prong event with the old program: 14 sec).

We still do not have much information on the rejection rate. We hope that it will be smaller than the present rate when the debugging is finished.

4. CONCLUSION

We intend to put an operational program into service in the next few months. This new program will be designed to allow a further reduction of the predigitized information.

It seems to us that simple geometry can be efficiently used to save time in HPD minimum guidance filtering. We think that it can also give good results in processing data from devices other than an off-line HPD.

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DISCUSSION

A.J. OXLEY *(RHEL):* Have you tried out this method on multi-prong events? If so, at what energy?

C. de La VAISSIERE: Yes, on 4 prong events at 2.3 GeV/c.