CERN EXPERIENCE IN USING THRESH FOR HEAVY LIQUID CHAMBERS

by

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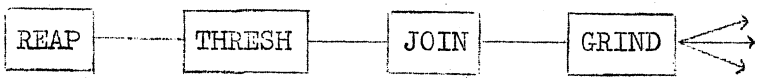
PROGRAMMES USED BY THE HLBC GROUP AT CERN

The following chain of programmes is now used.



REAP reads the paper tape from the measuring machines and prepares the data in a suitable form for input to THRESH. REAP gives an output in BCD onto a magnetic tape. Many checks are made in REAP. Some types of measuring errors are thus detected and there is, furthermore, a control that the same label is not used twice in the same photograph or that a label has not been used without giving a photograph number.

REAP works in most cases very well in our experiment. We have recognised only one minor fault. It cannot treat 13 tracks. When it happens to be 13 tracks in an event, we have therefore to measure one additional dummy track.

A description of how REAP is constructed and how one has to label points and tracks is given in a report by MacLeod (CERN60-11).

THRESH is the geometrical reconstruction programme described by Miss A. M. Cnops (page 5) and by W. G. Moorhead (page 39).

JOIN A particle stopping in heavy liquid is in general scattered so much that it is impossible to fit a long track to one helix. To get the range of such a track one has to divide it in several pieces and to fit each piece separately to a helix. These pieces are then connected to one track in JOIN. It may also be necessary in some cases to measure the track of a high energy particle in many pieces and to add up the information from the different pieces to get a good momentum determination.

The following example illustrates what is calculated in JOIN. In Fig. 1 is shown a track measured in 4 pieces, (3 curved and 1 straight). THRESH gives for each piece the curvature (ρ), dip angle (λ) and azimuth angle (φ) all quantities with errors.
JOIN calculates

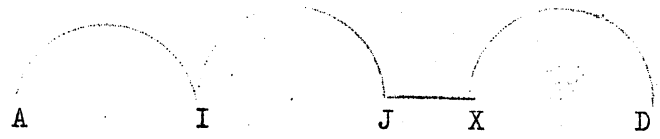


Fig. 1

a) The range AD with errors,

b) λ and φ at production (A),
λ and φ at decay point (D), if we have a $V^{\pm}$,

c) The mean momentum <p> with errors,

d) L^{s}, which is the length, measured from A, which corresponds to the mean momentum.

JOIN starts to combine the first two pieces to one track. This new track is then combined with the third piece to one track, and so on. In the case of two curved pieces we have for instance

$$\begin{cases} \dfrac{1}{P_{AJ}} = \dfrac{1}{P_{AI}} W_{AI} + \dfrac{1}{P_{IJ}} W_{IJ} \\ L^{s}_{AJ} = \dfrac{L_{AI}}{2} W_{AI} + \left(L_{AI} + \dfrac{L_{IJ}}{2}\right) W_{IJ} \\ W_i = \dfrac{L_i \cos^2 \lambda_i}{L_{AI}\cos^2 \lambda_{AI} + L_{IJ}\cos^2\lambda_{IJ}} \qquad i = AI,\ IJ \end{cases}$$

The wieghts (W_i) are thus calculated from the multiple scattering errors in the measured momenta, and the internal errors in ρ_{AI} and ρ_{IJ} are not used. In the present version of JOIN we have assumed implicitly that the decrease of momentum due to ionization along the track is linear. For high momentum tracks this a good approximation; for stopping tracks the momentum determined from range is far more precise than that from curvature.

JOIN works sufficiently well, but it may, of course, still be improved in one or more details. We have earlier had much trouble because the given errors in ranges have been too small. This fault is now eliminated.

GRIND is the kinematic programme used at CERN.

EXPERIENCES IN USING THRESH

THRESH has been used by us for about 6 months, mainly in the analysis of Λ_β's and Ξ^-'s from the T8 experiment. An ordinary Ξ^--event is shown in Fig. 2. We have 7 tracks per event. Some of these are divided in pieces so that the average number of measured pieces per event is 10. All events are measured twice.

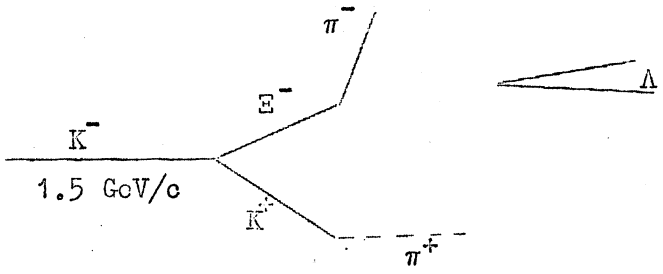


Fig. 2.

We have looked at the results from 150 Ξ^--measurements, i.e. 1500 tracks or pieces which have passed through THRESH. Excluded are all events where REAP has found errors or where REAP does not work well (13 pieces). Of the measured tracks, about 600 were taken as straight and 900 as curved. We find that the fraction of non-converging tracks is 2.9 ± 0.7% for straight tracks, 2.7 ± 0.6% for curved and 2.8± 0.4% for the total number of tracks. The probability that a track, which has not converged in the first measurement, will not converge in the second measurement also, is 20 ± 5%. Only in one case we have had to remeasure a track 3 times before it converged. Of course, these results were obtained only after months of experience in recognizing kinks which would have caused non-convergence.

From the figures above we find that only about 10% of all Ξ^- -events (10 pieces measured twice) have had to be remeasured because tracks do not converge in THRESH. A much greater fraction of all events (about 40%) have, however, been remeasured, mainly because of JOIN and GRIND troubles and to a minor extent because of preparation errors.

There exists now a programme (COMBINE), which can collect good tracks from different measurements and form a good total event. One may here, for instance, take the momentum of a particle from one measurement and the angles from another.

In Table 1. we give some typical internal errors given in THRESH. The measurements are performed on a SOM-machine.

Measured quantity	Percentile		
	25th	50th	75th
Δx, Δy mm	0.09	0.13	0.17
Δz mm	0.50	0.57	1.19
$\Delta \varphi$ degrees	0.15	0.26	0.43
$\Delta \lambda$ "	0.40	0.50	1.20

Table 1.

DISCUSSION FOLLOWING THE TALK OF B. RONNE

Hennessy: How do you succeed in putting together all the pieces measured between kinks on a track? Do you make mass assumptions to take into account energy loss?

Ronne: We do not take into account energy loss.

Esten: You showed the frequency of tracks that did not converge in THRESH for 1500 measured pieces. How many "real tracks" does this correspond to?

Ronne: A little more than 1000 tracks.

Rousset: I would like to comment that the length of measured pieces usually is shorter than the optimum length.

Sparrow: Do you measure a kink as a corresponding point?

Ronne: Yes, we try to do this as much as possible.