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ALEPH TPC: Coordinate measurements along the drift direction - changes expected when sense wires are connected in pairs

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1. Two-track separation

This is given by the width $\pm W_s$ of the signal. W_s is the quadratic sum of the r.m.s. width W_c of the electron cloud and the pulse width W_p ($W_p = \pm 140$ ns or ± 7 mm). The width of the cloud is given by a diffusion term which depends on the drift length L and an angle term which depends on the cell length a (a = 4 mm or 8 mm) and the polar angle Θ :

$$W_c = 0.4 \text{ mm} \times \sqrt{(L/1 \text{ cm})} + \frac{a}{\sqrt{(12)}\tan\Theta}$$

The longitudinal diffusion of 0.4 mm for 1 cm is based on the TPC90 measurements of A. Peisert [1]. (In comparison to the transverse diffusion measured also in TPC90 [2], there is an electric anisotrophy.)

Examples :

a(mm)	L(m)	Θ (deg.)	W_c(mm)	W_s(mm)
-	2	90	5.6	9.0
4	2	45	5.7	9.0
8	2	45	6.1	9.3
4	0	20	1.2	7.1
8	0	20	2.3	7.4

The differences are negligible.

2. Accuracy in z for each point

This is given by the width of the electron cloud W_c and the statistics of electrons plus a contribution C from electronics. C contains cable variations, phase of measurement, variation of pulse rise time, $C \approx \pm 10$ ns or 0.5 mm.

$$\sigma_z^2 = \frac{(0.4 \text{ mm})^2 \cdot (L/1 \text{ cm})}{n_{tot}} + \frac{a^2}{12 \tan^2\Theta \, n_{eff}} + C^2$$

$n = n^{(o)} \cdot (a/1 \text{ cm}) \cdot (1/\sin\Theta)$

$n^{(o)}$ = effective number of electrons/cm created along the track, $n_{tot}^{(o)} = 100$, $n_{eff}^{(o)} = 10$; here we take into account the clustering of ionisation along the track.

Examples :

a(mm)	L(m)	Θ (deg.)	diffusion term(mm)	angular term(mm)	σ_z(mm)
4	2	90	0.89	0	1.0
8	2	90	0.63	0	0.8
4	2	45	0.70	0.48	1.0
8	2	45	0.53	0.69	1.0
4	0	20	0	0.93	1.1
8	0	20	0	1.30	1.4

The differences are very small. There are half as many points when a goes from 4 to 8 mm.

3. Capability of detecting small kinks in a track

Using the "χ^2 difference test with condensation" [3] for 10 GeV/c $\pi \rightarrow \mu+\nu$ and assuming a constant drift length L = 1 m we find about 8% less kinks at the polar angle Θ = 40° and almost no difference at Θ = 90° (see figure).

References

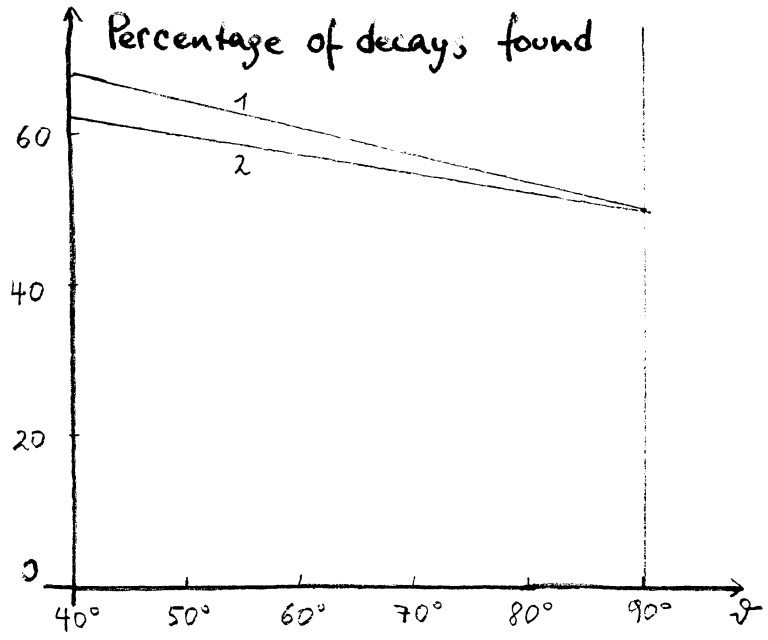
1. Preliminary results of the two-track resolution in TPC90 by A. Peisert, ALEPH-TPC Note 85-16.

2. Dependence of the transverse diffusion of drifting electrons on magnetic field by S.R. Amendolia et al., Nucl. Instr. Meth. Phys. Res. A244 516 (1986).

3. Kink search for muon candidates in the TPC by G. Stimpfl, ALEPH-TPC Note 86-48.

Figure Caption

Percentage of found decays 10 GeV/c $\pi \rightarrow \mu+\nu$ in the polar angle range $40° < \Theta < 90°$ for the wire distance a = 4 mm (1) and a = 8 mm (2) assuming L = 1 m.


Percentage of decays found
60
40
20
0
1
2
40°
50°
60°
70°
80°
90°
ϑ