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dE/dx Resolution and Particle Separation in ALICE TPC

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Abstract

The dE/dx resolution for different values of zero-suppression threshold in the ALICE TPC has been obtained. The particle separation power for different particle species has also been discussed.

1 Simulations

To simulate tracks in the ALICE TPC, the GEANT-based package GALICE [1] has been used. In order to obtain a detailed simulation of clusters, the ALICE TPC slow simulator algorithm [2] has been incorporated. As the result, the tracks representation in the pad–time-bucket space has been obtained. In Table 1 the properties of the TPC gas together with the numerical values of the parameters used in simulations are listed.

Gas — Ne-CH_4-CO_2 90/5/5	
N_{prim}	13.3
N_{tot}	42.3
v_{drift}	2.5 cm/μs
$\omega\tau$	0.125
$\sigma_T = \sigma_L$	250 μm/$\sqrt{cm}$
Readout-chamber geometry	
number of pad rows	75
pad size	20 $\times$ 3 mm^2
pad-plane–sense-wire distance	3 mm
sense-wire spacing	4 mm
Electronics	
FWHM of the preamp/shaper response	250 ns
sampling time	200 ns
σ_{noise}	2.5 ADC counts
signal/noise ratio for MIP	28:1
dynamic range	10 bits

Table 1: Gas properties and parameter values used in simulations.

2 dE/dx resolution

The dE/dx resolution has been obtained in the following way:

- for every track, the energy loss per unit length on each pad row was evaluated and the truncated mean was calculated in order to get rid of the Landau tail – this procedure led to a single histogram entry for each track

- this histogram was fitted with a Gaussian and the dE/dx resolution has been calculated as the ratio $\sigma_{dE/dx}/< dE/dx >$.

In Fig. 1, the dE/dx for 2 GeV/c pions (as an example) is plotted:

a) taking all 75 measured points per track,

b) as a truncated mean, taking only the 45 lower points.

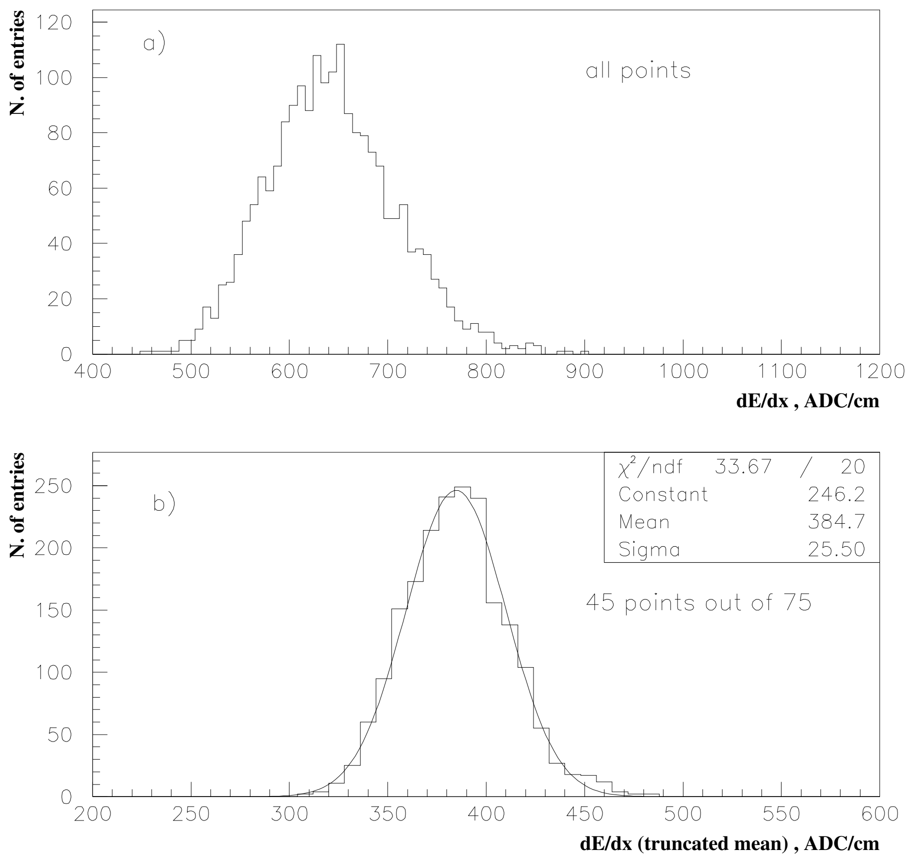

Figure 1: dE/dx distribution for 2 GeV/c pions, obtained by taking into account all measured points per track (a), and as a truncated mean of the 45 lower points, together with a fitted Gaussian, (b).

Generally, the dE/dx resolution depends on the Landau tail truncation. In Fig. 2, the ratio, $\sigma_{dE/dx}/< dE/dx >$ is shown for the truncation varying from 20 to 65 (out of 75) lower points. This plot shows that the optimal truncation is for 40 to 45 (which corresponds to about 60%) points. The dE/dx resolution depends also on the zero-suppression threshold. In Table 2 the dE/dx resolution is shown for different zero-suppression thresholds and the truncation around the minimum of $\sigma_{dE/dx}/(< dE/dx >)$, as indicated in Fig. 2.

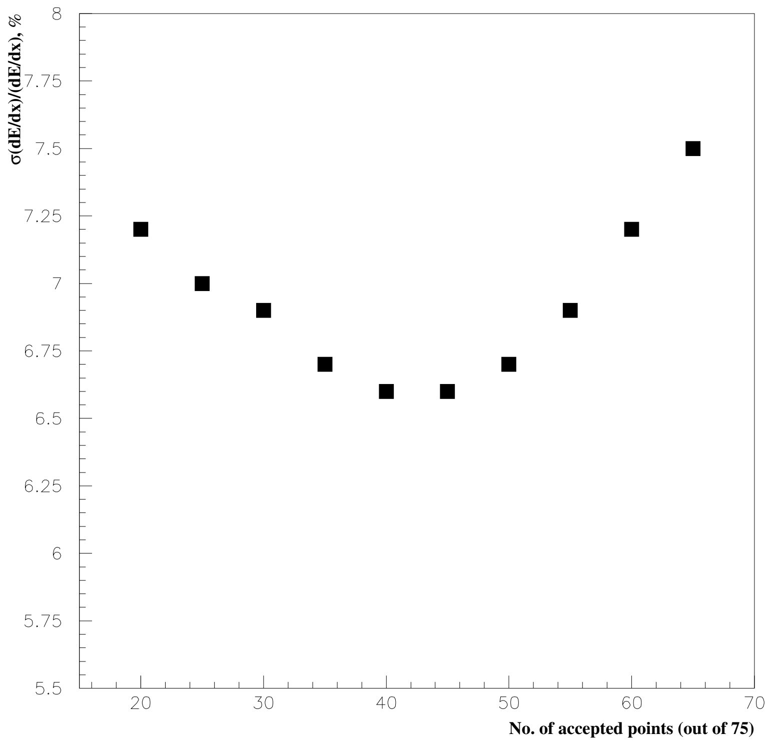

Figure 2: dE/dx resolution as a function of the number of accepted points. Zero-suppression threshold = 5 ADC counts.

truncation (no. of accepted points out of 75)	zero-suppression threshold (ADC counts)	$\sigma_{(dE/dx)}/ < dE/dx >$ (in %)
35	5	6.7
	7	6.9
	10	7.3
40	5	6.6
	7	6.8
	10	7.1
45	5	6.6
	7	6.8
	10	7.1
50	5	6.7
	7	6.9
	10	7.1

Table 2: dE/dx resolution as a function of the truncation and the zero-suppression threshold.

3 Particle separation

To calculate the separation power for different particle species, the energy loss curve was parametrized according to the formula given in [4]. This paramerization has been done for Ar-CH_4 (90/10) data [3, 4]. However, according to [3], the behaviour of the Ne-based mixtures is very similar to the Ar-based ones, and such approach seems to be justified. In Fig. 3 the energy loss is plotted against the total momentum for electrons, pions, kaons and protons.

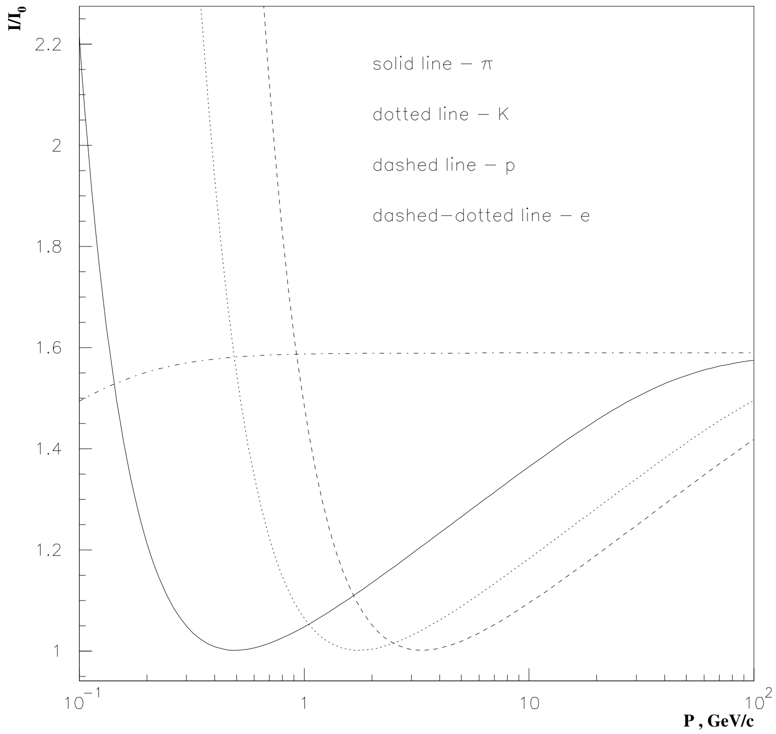

Figure 3: Energy loss in Ar-CH_4 90/10 for different particle species.

In Fig. 4 – 6 the separation power between two different particle species in terms of standard deviations is plotted as a function of the momentum for different dE/dx resolution. The two particle species were considered to be well separated if the separation was larger that 3 standard deviations. Having this in mind and taking into account the numbers from Table 2 one can see that in the ALICE TPC the particle ID for hadrons is restricted to the low-momentum range, 100–800 MeV/c. This result is not sensitive to the dE/dx resolution. Given a dE/dx resolution between 7 and 8%, one can conclude that electrons can be identified for momenta below 4.5–6 GeV/c

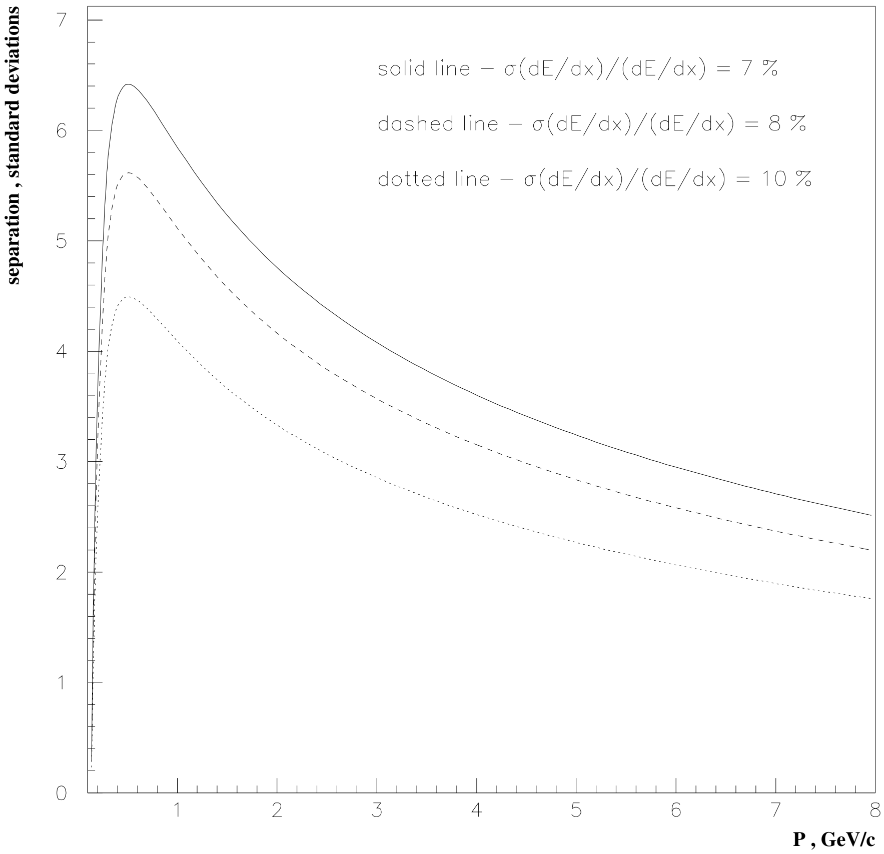

Figure 4: Separation power for e–π.

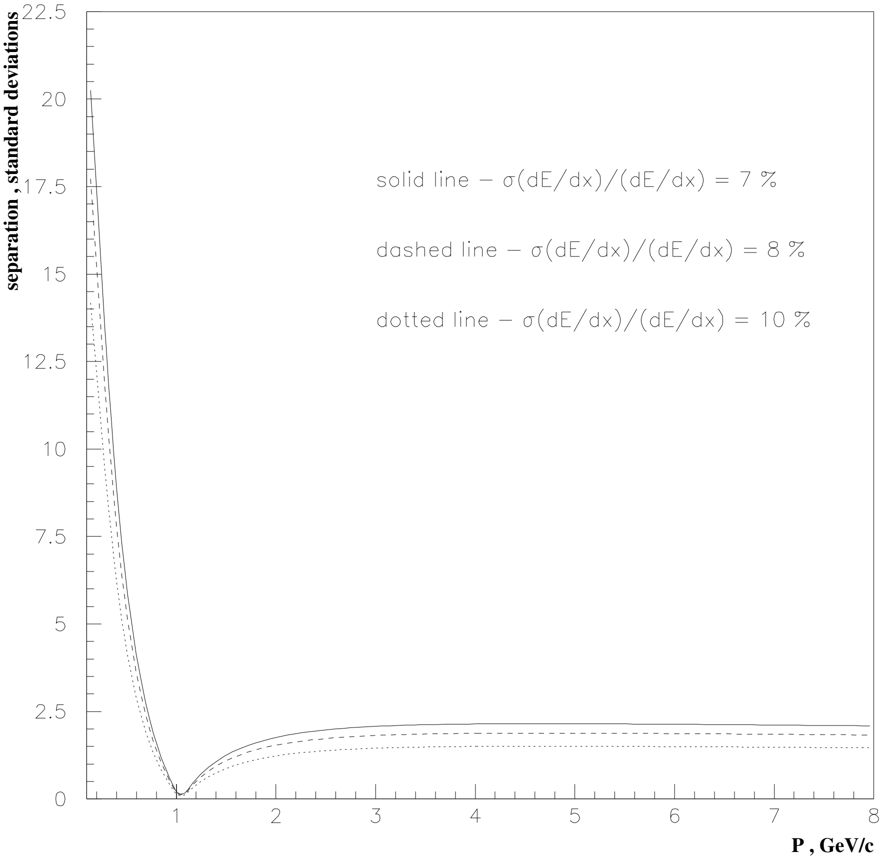

Figure 5: Separation power for π–K.

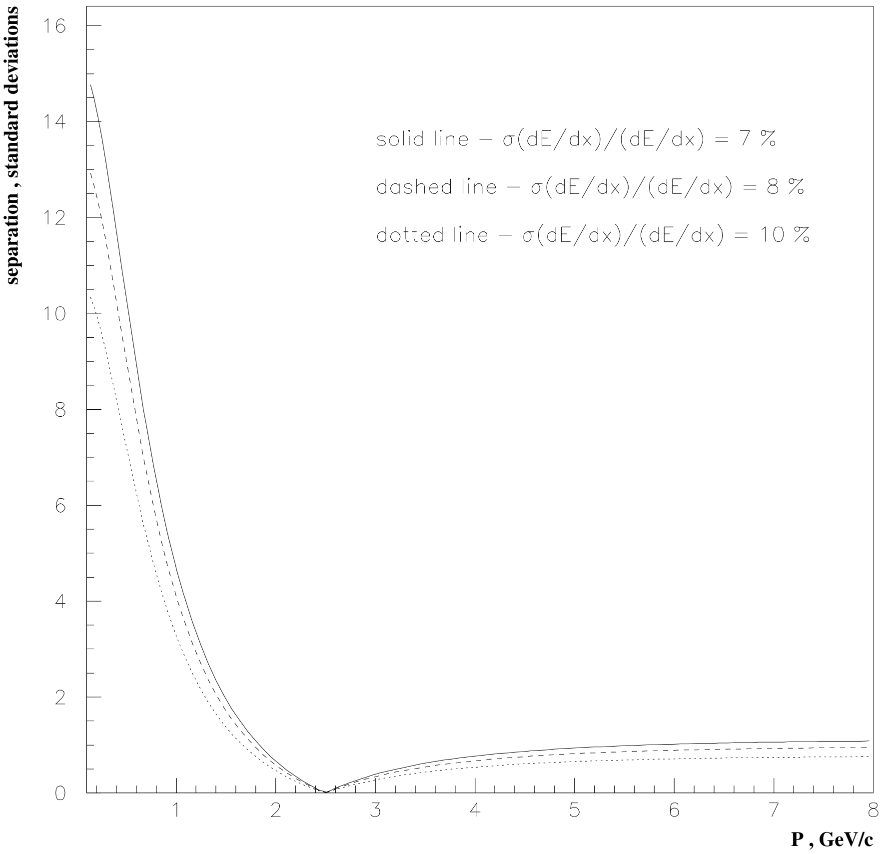

Figure 6: Separation power for K–p.

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References

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