Study of the Electron Energy Losses in the TRD

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We analyze and compare the electron energy losses obtained during the test-beam with p=1.5 GeV/c in GSI (Darmstadt, February 2006) for a single layer TRD prototype and Monte Carlo (MC) simulations for the n-layered TRD realized in frames of the CBM ROOT for momenta in the range of 1 GeV/c to 13 GeV/c.

The distribution of electron overall energy losses (dE/dx and the transition radiation (TR)) in the TRD layer is approximated with a high accuracy by a weighted sum of two log-normal distributions [1]

$$f(x) = A\left(\frac{a}{\sqrt{2\pi}\sigma_1 x}\exp^{-\frac{1}{2\sigma_1^2}(\ln x-\mu_1)^2} + \frac{b}{\sqrt{2\pi}\sigma_2 x}\exp^{-\frac{1}{2\sigma_2^2}(\ln x-\mu_2)^2}\right) + c, \quad (1)$$

where σ_1 and σ_2 are dispersions, μ_1 and μ_2 are mean values, a and $b = 1 - a$ are contributions of the first and second log-normal distributions, correspondingly, c is a shift parameter and A is a normalizing factor.

As the behavior of the ionization losses of charged particles in a medium is well known, one can fix the parameters σ_1 and μ_1 in (1); they are obtained by fitting the dE/dx distribution for electrons. However, the TR losses are of more complicated character.

The approximation of the overall energy losses of electrons by formula (1) permits one to extract the individual contributions on dE/dx and TR (Fig. 1).

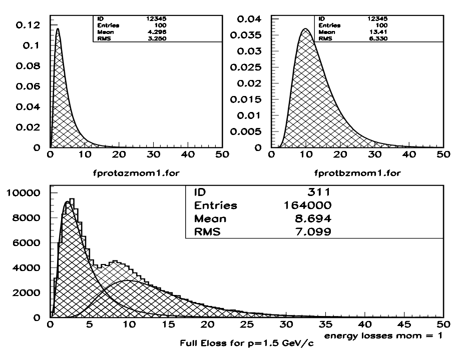

Figure 1: Distribution of e energy losses (bottom plot): contributions of dE/dx (top left plot) and TR (top right plot)

Table (1) shows that the statistical characteristics for MC simulation and for the approximation by a weighted sum of two log-normal distributions with fixed parameters are very close. This demonstrates that our procedure of extraction of the TR contribution into the distribution of the overall electron energy losses is correct.

A similar procedure was applied to the measurements obtained with the TRD prototype. In this case, the values of parameters σ_1 and μ_1 were taken from approximation of the dE/dx distribution for electrons with p =1.5 GeV/c obtained by the MC simulation.

Table 1: Comparison of mean value (m.v.) and RMS of electron energy losses

p, GeV/c	1.5	3	5	7	11
m.v.(MC)	8.694	9.232	9.379	9.422	9.421
m.v.(fit)	8.717	9.255	9.400	9.446	9.445
RMS (MC)	7.099	7.411	7.475	7.527	7.517
RMS(fit)	7.092	7.409	7.472	7.525	7.511

We compared the TR part for real measurements obtained on the TRD prototype with the MC simulation and found that in the region of $p = 1.5$ GeV/c both the statistical characteristics (mean value and RMS) and the TR contributions into the overall energy losses for real measurements and MC simulation significantly differ (Figs. 2 and 3). As a result, we may lose in the pion suppression factor (around 10 times) and in the efficiency of the electron identification.

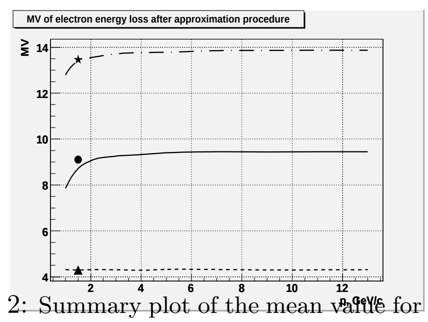

Figure 2: Summary plot of the mean value for different momenta: dash line - dE/dx, dash-dot line - TR, solid line - overall energy losses; for the prototype: triangle - dE/dx, asterisk - TR, circle - overall energy losses

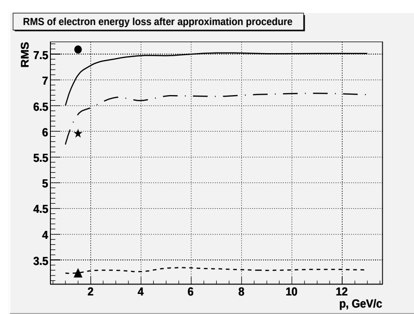

Figure 3: Summary plot of the root mean squared (RMS) for different momenta: dash line - dE/dx, dash-dot line - TR, solid line - overall energy losses; for the prototype: triangle - dE/dx, asterisk - TR, circle - overall energy losses

References

[1] E.P. Akishina et. all: *Distribution of energy losses for electrons and pions in the CBM TRD*, JINR Communications, E10-2007-158, Dubna, 2007.