JADE Computer Note No. 97

dE/dx Monte Carlo

E. Elsen

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Introduction Several private versions of dE/dx Monte Carlo generators are already in existence. However, at least to my knowledge, none of them have been incorporated into the standard analysis chain, so that cuts in the selection of hits etc. were only approximately treated like in the data. This note describes the Monte Carlo generator, that was implemented in the standard dE/dx-package on November 17, 1987 and is since then available for all users.

Principle of Simulation The simulation is sufficiently detailed to generate a spectrum of dE/dx amplitudes for the hits associated with a given track, such that a full truncated mean analysis can be performed as for the real data; in fact, identical analysis routines are used. The individual dE/dx amplitudes are determined using the spectra measured by K.Ambrus for the real data. The simulation of a given amplitude is dependent on the properties (i.e. mass and momentum) of the particle that produced the hit and not on the properties of a particle found to reconstruct most hits (the track).

An additional systematic error σ_{sys} seen in the data is accounted for by smearing the generated amplitudes ϵ_i in the Monte Carlo by a common factor according to the prescription laid out in K.Ambrus' thesis: For fixed number of hits the logarithm of the energy loss measurement follows nicely a gaussian distribution.

$$f(\ln\epsilon) \propto e^{-\frac{\ln\frac{\epsilon}{\epsilon_T}}{2\sigma_0^2}}$$

where ϵ_T is the theoretical mean energy loss. This implies a constant relative error ($\sigma_0 = \sigma(\epsilon)/\epsilon = const.$). The experimentally observed error (σ_{exp}) is larger than the value σ_{stat} derived from the statistical analysis of the experimental Landau distribution using the truncated mean technique. The defect observed in Monte Carlo is parameterized in the quantity σ_{sys}:

$$\sigma_{exp}^2 = \sigma_{stat}^2 + \sigma_{sys}^2.$$

It is used to generate random numbers z taken from a gaussian distribution with $\sigma = \sigma_{sys}/\sigma_{exp}$ and mean 1 applied to rescale the amplitudes:

$$\epsilon_i \Rightarrow z \cdot \epsilon_i$$

The values of $\sigma_{sys}/\sigma_{exp}$ are run range dependent and typically around 35%. A total of 39 different periods have been identified for the real data and are used in DEDXBN. The Monte Carlo simulates the effect of the different periods by selecting the matched value of σ_{sys} according to the time specified in COMMON /TODAY/ and translating this time into a run range.

The result of a Monte Carlo simulation for multihadronic events using standard analysis routines is shown in Fig. 1.

The dE/dx generator has not been implemented at the level of the Jet chamber hits stored in bank JETC, which would have been the proper place. The reason for this is simply that the many 'smeared' Monte Carlo events already produced would be unusable for dE/dx analyses.

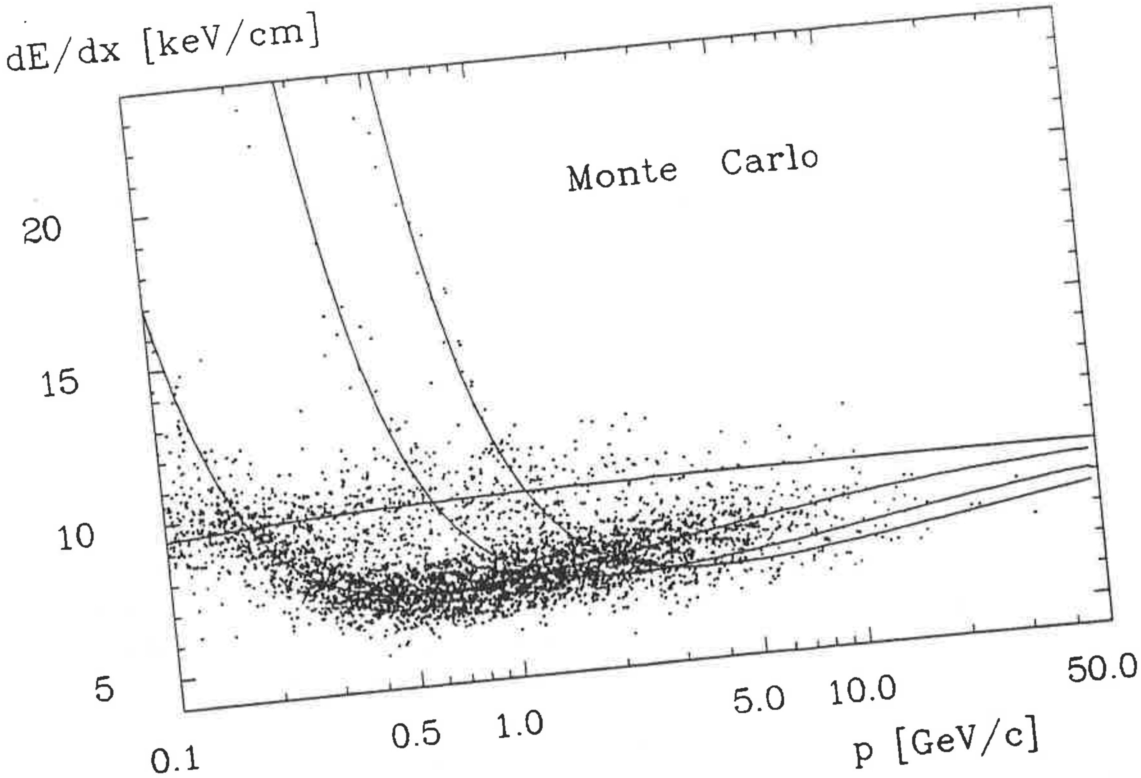

Figure 1: dE/dx vs momentum for multihadronic events. The curves indicate the theoretical values for the standard particles.

Implementation Two main routines had to be modified:

ZSFIT The main task of this routine is to perform $z-s$-fits. It also has to perform a detailed hit selection which is used in DEDXBN (see Jade Computer Note 96). The routine now also provides this information for Monte Carlo data. In fact, the quality of the 'hit cleaning' procedure which is also applied for real data could be verified this way (Fig. 2).

DEDXBN The main routine for the dE/dx calculation had to be modified to execute for Monte Carlo data all parts that are not concerned with the details of the amplitude calibration. The reason for this is that the Monte Carlo amplitude generator produces 'calibrated' amplitudes and no attempt has been made to simulate the behaviour of the raw Jet chamber amplitude. The generator is called within DEDXBN.

The graphics module has been modified to deal with Monte Carlo dE/dx. Note, however, that with every request to recreate a new DEDX bank (command **DEDX -1**) a new Monte Carlo simulation with different random numbers is forced.

DEDXDS The main display routine for dE/dx was changed to place the results of the analysis immediately into a BOS bank. Subsequent commands display the results from this bank rather than calling DEDXBN again, which would cause a new Monte Carlo simulation. For the single track display (command **DEDX n**) the theoretical values are displayed together with the truncated mean analysis.

DEDXB1 This routine was used in earlier single track displays. It was, however, out of date since the last calibration update earlier this summer. It is now obsolete since its function has been integrated into DEDXBN.

Small changes to a few other routines are not mentioned here.

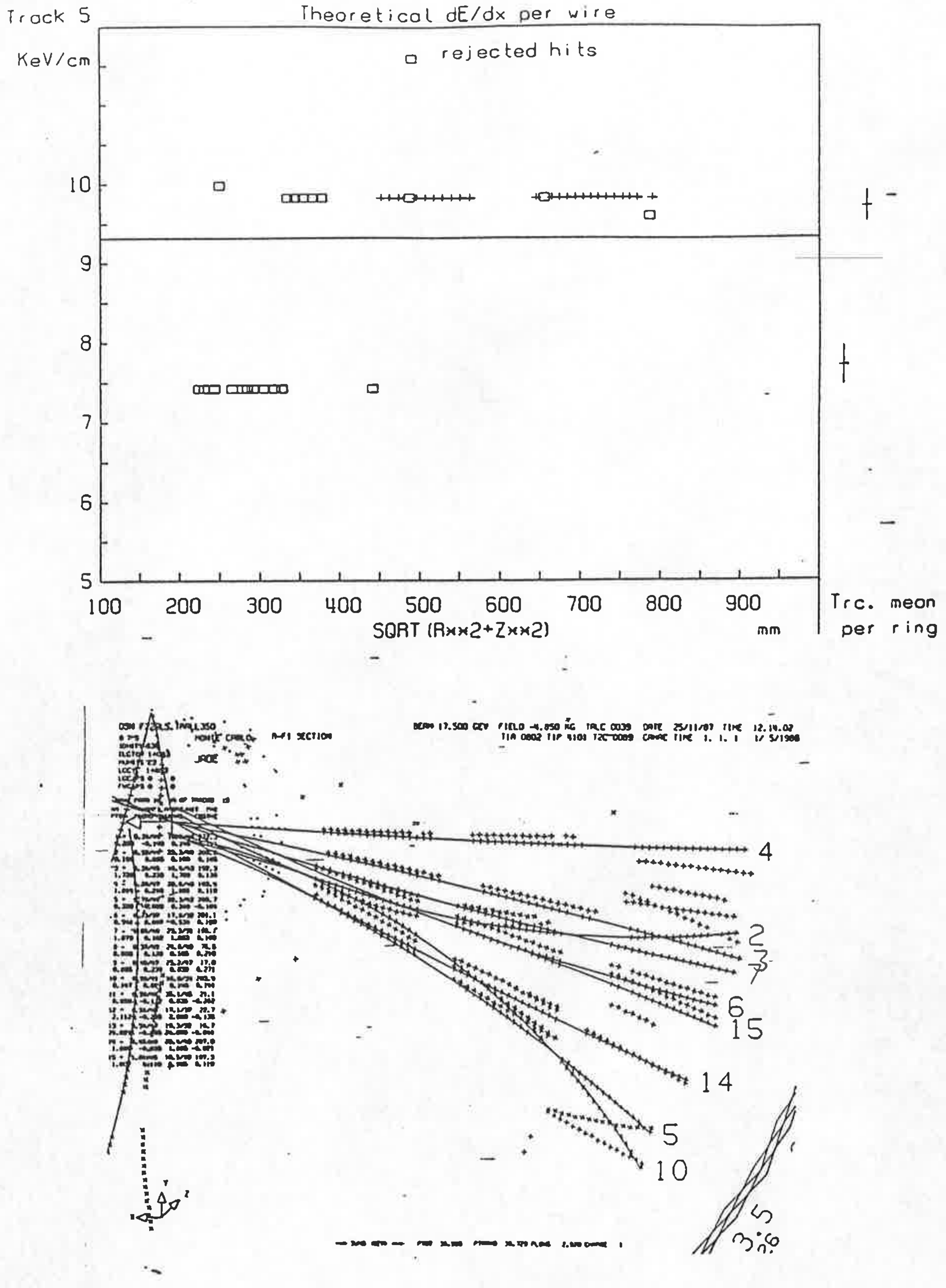

Figure 2: Theoretical mean dE/dx values for the hits associated with a single track (5). The boxes indicate the hits that have been rejected by the 'hit cleaning' procedure. The hit cleaning is based mainly on the proximity of adjacent tracks. The hits of the track have been created by different particles explaining the scattering of the theoretical values. The solid line indicates the value of the truncated mean after full simulation including the extra contribution σ_{sys}.