THIRD REPORT ON GEANT SIMULATION
by

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1 Introduction

This is the third GEANT simulation report. It begins where the second report left off. In this report I now include the spectral functions for both the two-body and three-body breakup channels in the simulation. The files that contain the spectral functions are: HE3-SALME-2BBU.DAT and HE3-SALME-CONT.DAT. The internal bremsstrahlung is not yet included in the simulation.

2 Event Generation and GEANT Simulation

As mentioned in the second report, six random numbers are generated for each event: one for the interaction point along z within the gas target (z), two for the x and y coordinates at the electron arm collimator opening (xxe and yye), two for the x and y coordinates at the hadron arm collimator opening (xxh and yyh), and one for the electron momentum (ep). θ_e, ϕ_e, θ_p, and ϕ_p are then calculated from xxe, yye, xxh, yyh, and z. In this report, one additional random number is needed to sample the missing energy (or the excitation energy, Ex) spectrum. Excitation energies between -10 MeV and 20 MeV are randomly sampled. If the sampled excitation energy is less than 2.224 MeV (the continuum threshold energy), it is set to 0.0 MeV. In doing so, the sampled event ratio between two-body and three-body breakups is roughly 1/2. This excitation energy is used in a three-body kinematic program to calculate the proton momentum (pp) and the recoil momentum (pR). As before, the range of pR is limited between 0 and 50 MeV/c.

It turns out the implementation of spectral functions in GEANT simulation is rather trivial. The mechanisms for energy loss are already in place. What remains to be done is to store the appropriate value of the spectral function as weight for each event. File HE3-SALME-2BBU.DAT contains the values of the two-body breakup spectral function as a function of pR, and file HE3-SALME-CONT.DAT contains the values of the three-body breakup spectral function as a function of pR and Ex. After Ex is sampled and pR calculated for a given event, an interpolating subroutine is used to obtain the spectral function for that event. Figure 1 shows the sampled spectral function as a function of pR for two-body breakup, and Fig. 2 shows the lego plot of the sampled spectral function as a fucntion of both pR and Ex (or missing energy).

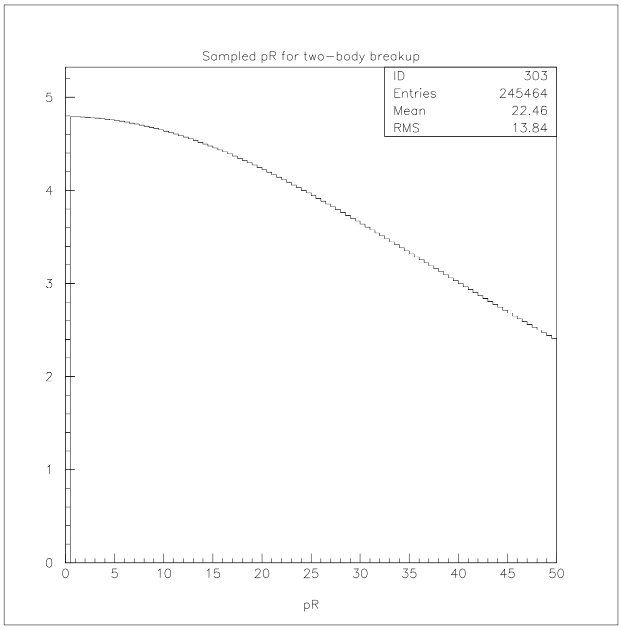

Fig. 1 Sampled spectral function as a function of pR for the two-body breakup.

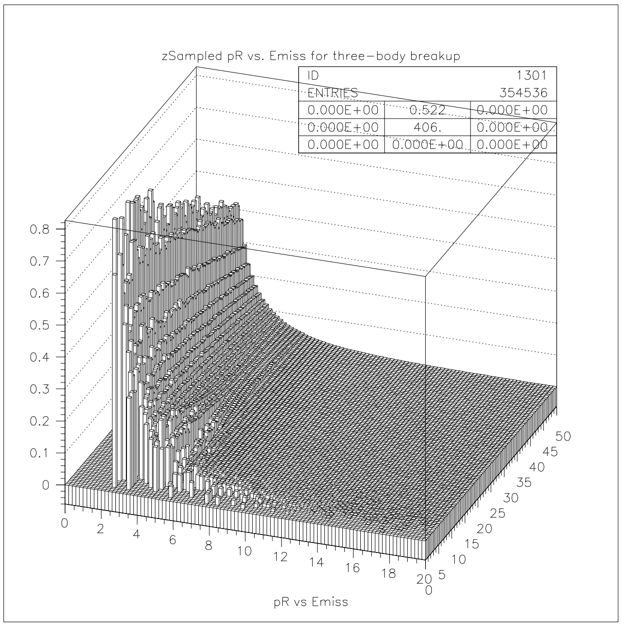

Fig. 2 Sampled spectral function as a function of pR and Ex for the continuum.

3 Missing Energy Resolution

Figure 3 shows the sampled missing energy spectrum. Each bin is obtained by suming the weights (values of the spectral function) of those events that fall within the bin divided by the total number of events within that bin. In other words, the weight, w_i, for each event is equal to the value of its spectral function divided by the total number of events that fall within the same bin as the event. For this simulation, the bin size is 0.2 MeV (20 MeV over 100 bins)

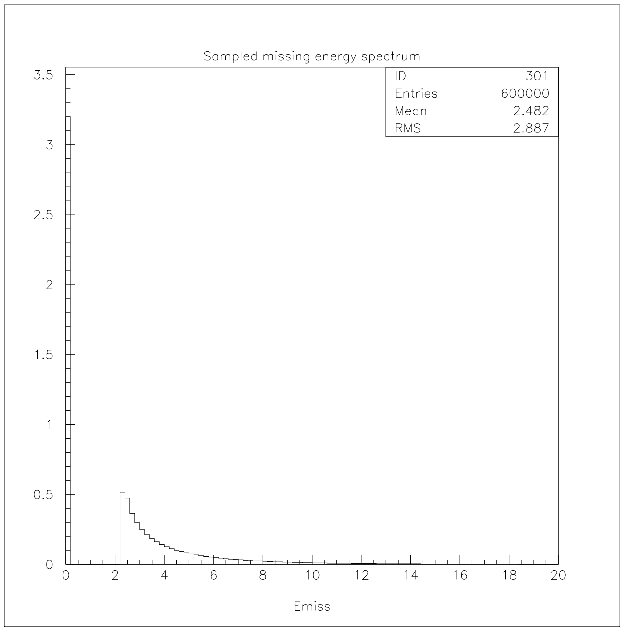

Fig. 3 Sampled missing energy spectrum.

The next step is to "smear" the sampled missing energy spectrum by the energy loss processes. But all the ingredient needed for this step has already been computed and storeded, as discussed in the second report. For example, in constructing the missing energy spectrum similar to Fig. 6 shown in the second report, one simply needs to multiply each event by its weight w_i. Since the spectral function for the continuum is in unit of per MeV and the two-body channel is given as a delta function (in missing energy), the weighting for each two-body event is further multiplied by the reciprocal of the bin size, *i.e.*, 5 (1/0.2) in this simulation. Figure 4 shows the missing energy spectra with cuts on zc.

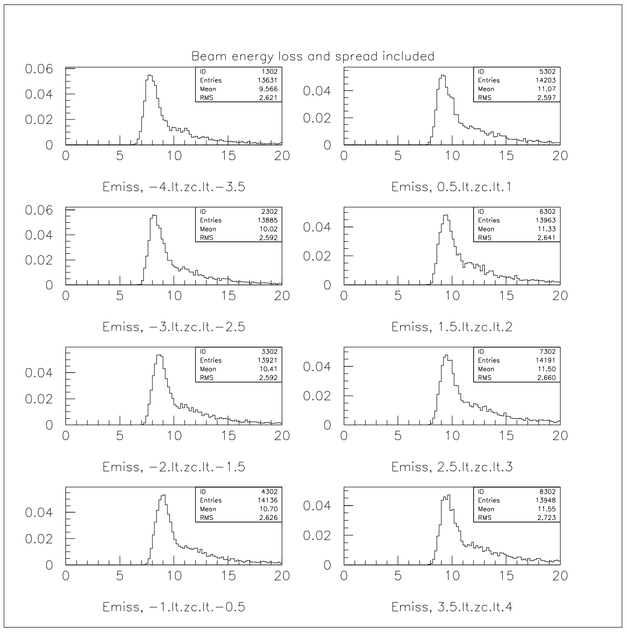

Fig. 4 Missing energy spectrum with cuts on the reconstructed z.

Since the shift in two-body peak energy does not depend strongly on zc, it would be nice to sum all the spectra in Fig. 4 in order to increase the event statistics. This is shown in Fig. 5.

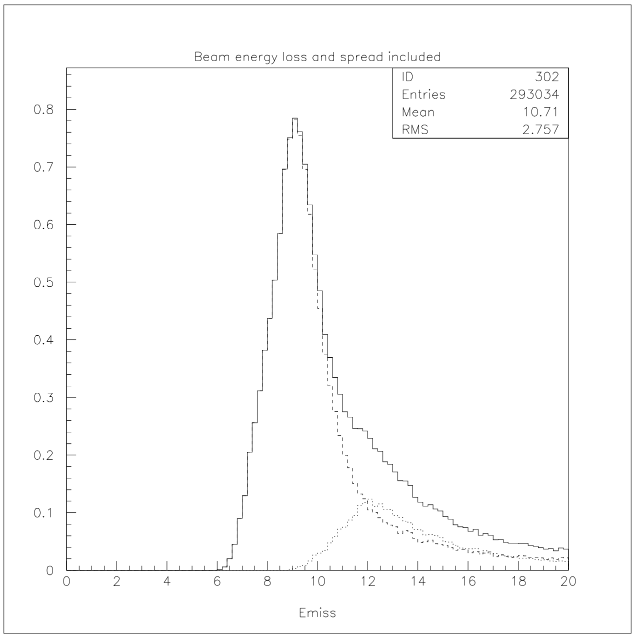

Fig. 5 Plot of the missing energy spectrum.

The solid line is for the sum of both the two-body and the continuum, the long dashed line is for the two-body channel only, and the dotted line is for the continuum.

As one can see, the separation between two-body breakup and the continuum is hardly discernible.

4 Half Gas Density

Another useful thing to study is to repeat the simulation with, for example, half of the ^{3}He gas density just to see how much the lower gas density will improve the missing energy resolution. Figures 6 and 7 show the results for half gas density. This is to be compared with Figs. 4 and 5. As one can see, the separation between two-body and continuum is much improved as expected.

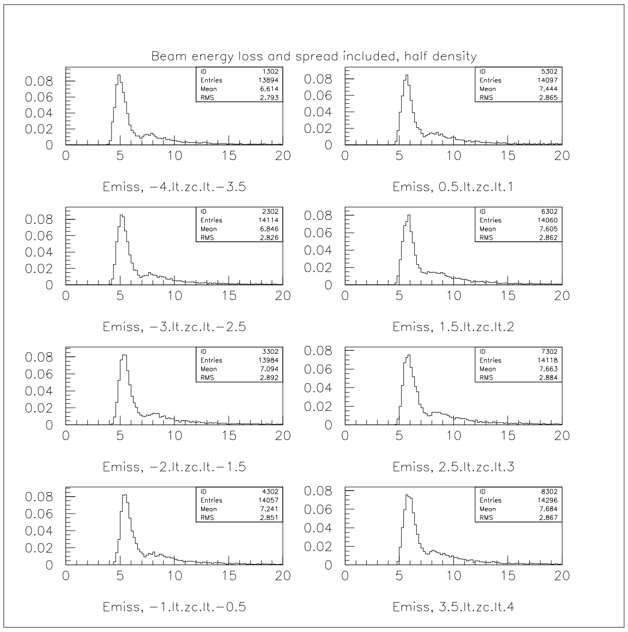

Fig. 6 Missing energy spectrum with cuts on the reconstructed z for half gas density.

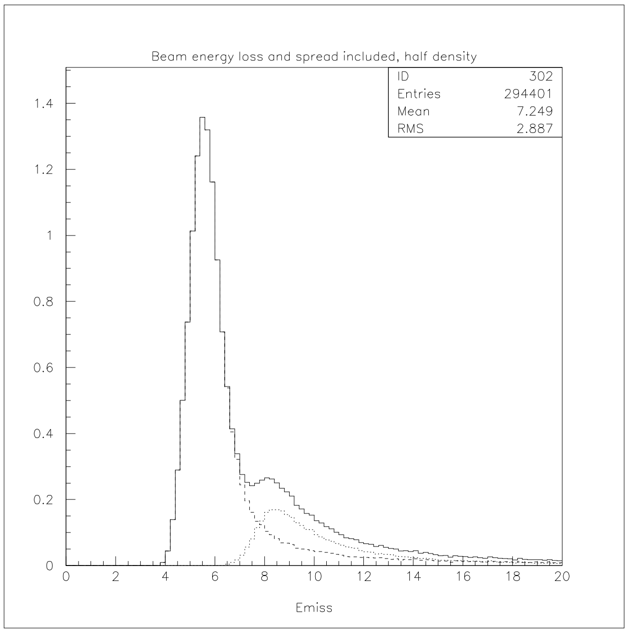

Fig. 7 Plot of the missing energy spectrum for half gas density.

5 The Effects of Radiative Tail

Figure 8 shows the missing energy spectra for half gas density with and without external bremsstrahlung energy loss process included. The solid line is for the case without the bremsstrahlung and the dashed line is for the case with the bremsstrahlung.

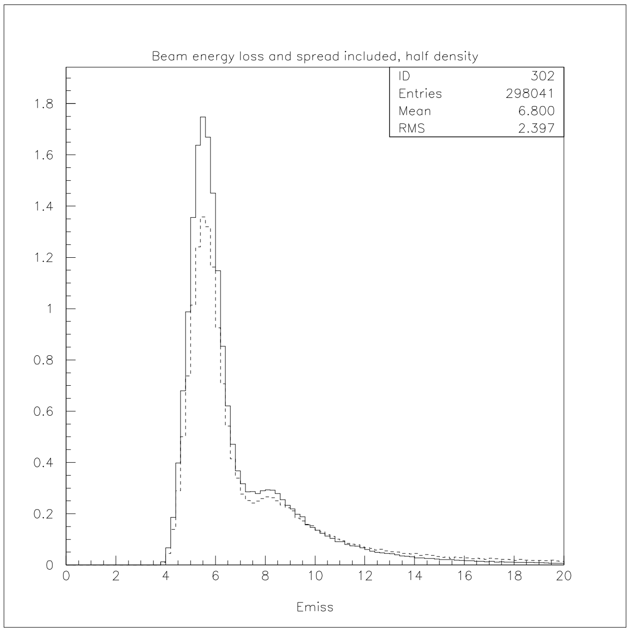

Fig. 8 Plot of the missing energy spectrum for half gas density with and without external bremsstrahlung.

If one divides the spectrum shown as solid line by the one shown as dashed line, one obtains the bin by bin radiative tail correction factor (see Fig. 9). This offers an alternative way to correct for the radiative tail effects.

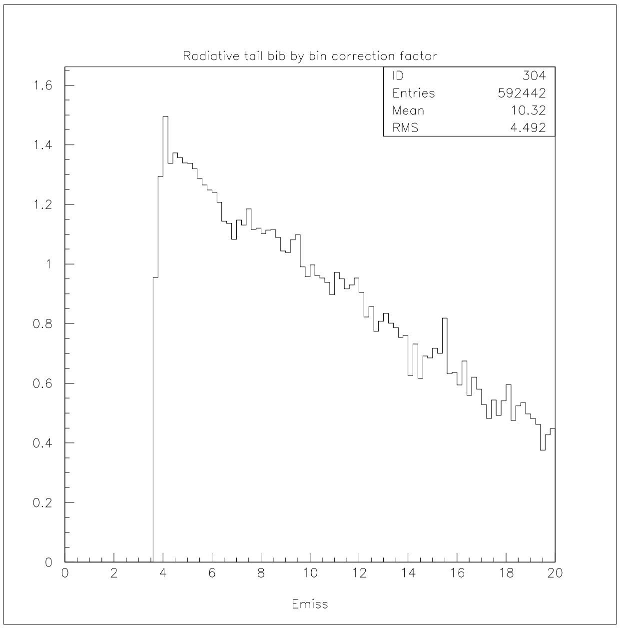

Fig. 9 Bin by bin radiative tail correction factor.