A simple algorithm for hadron rejection in Milagro-Addendum

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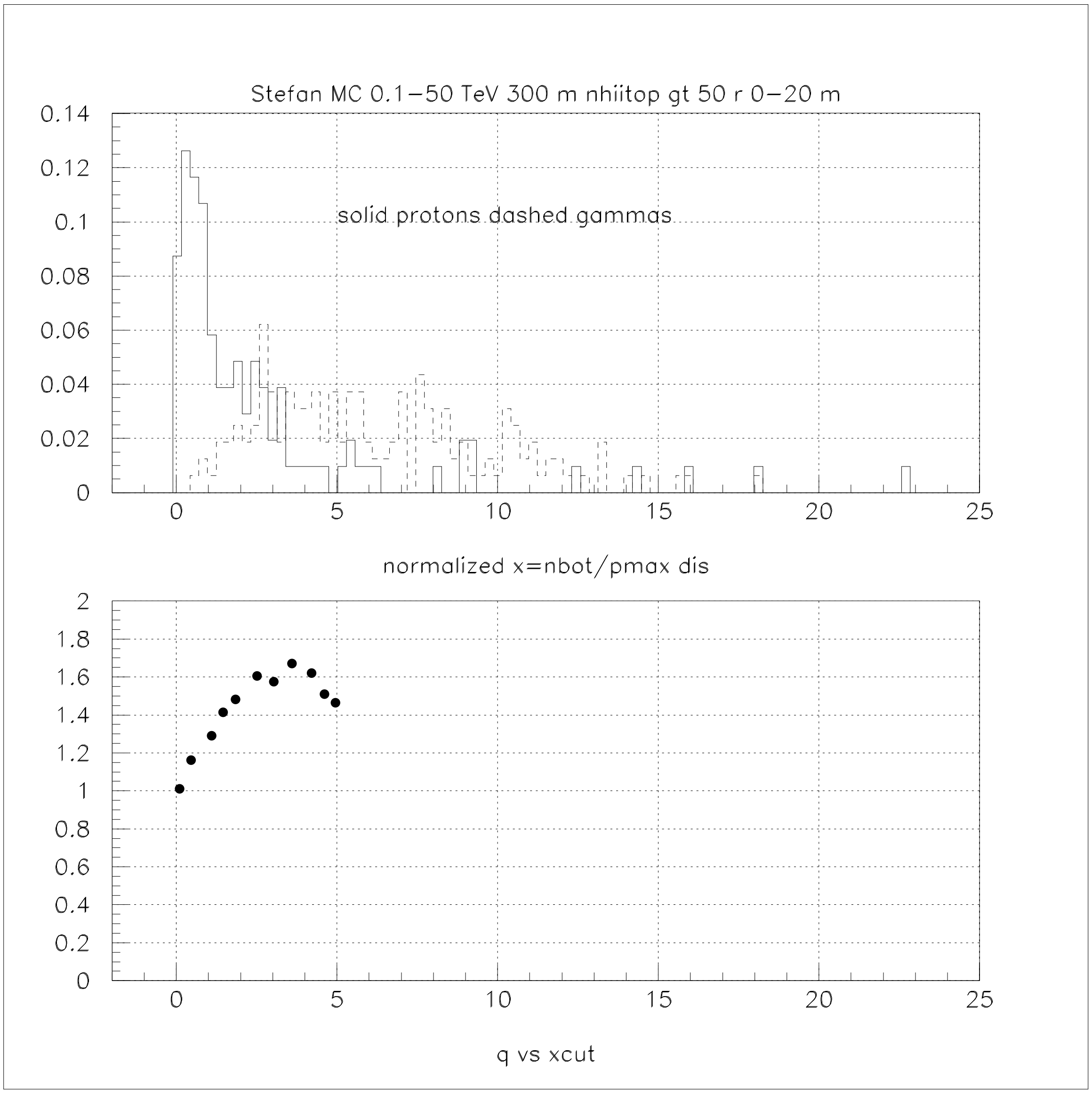
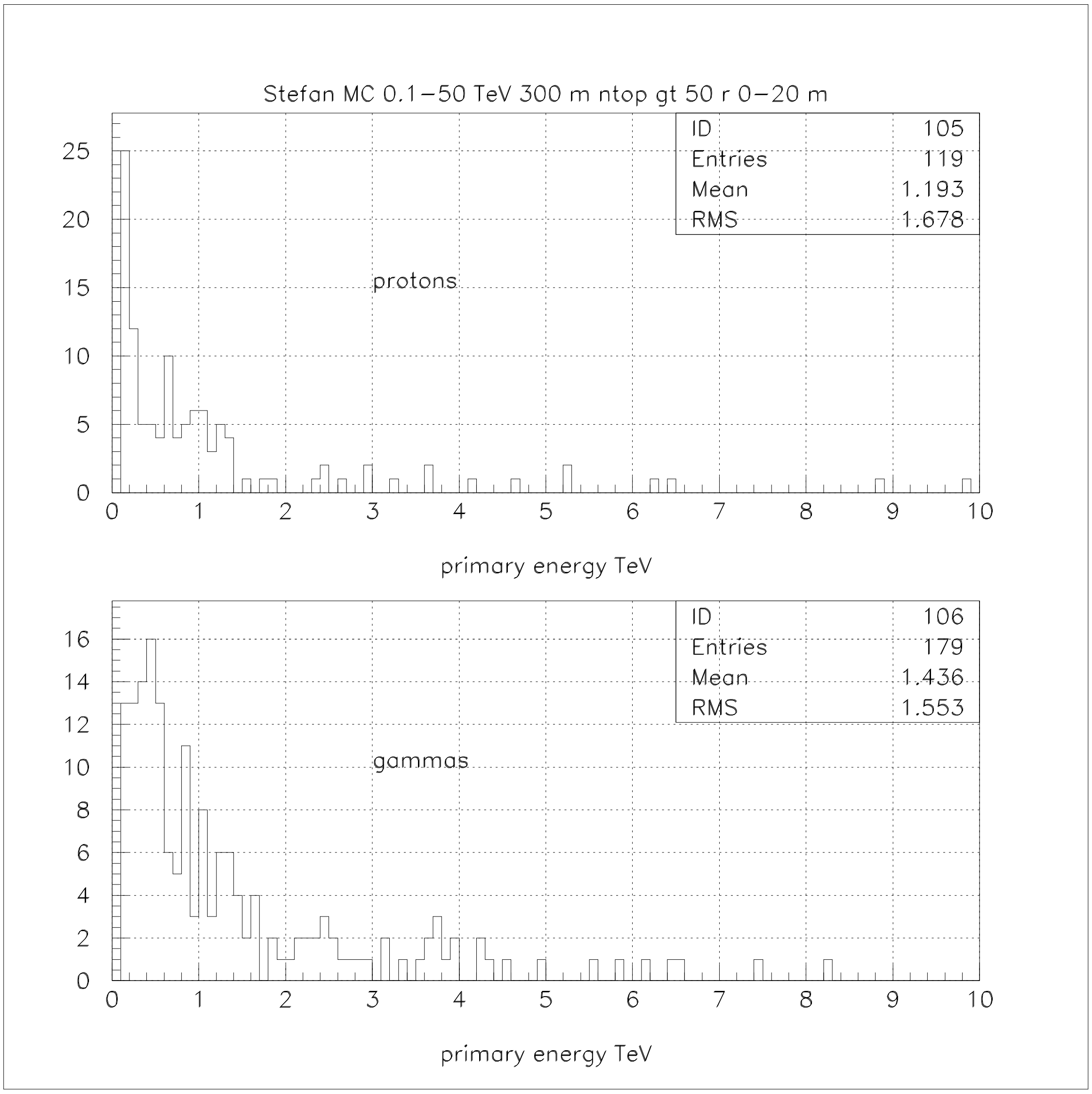
1 More Instructive Dsitributions:

A number of questions have been asked about our analysis: How does hadron rejection depend on nhittop and core distance. Also how does the energy difference between triggers due to gamma rays and protons affect hadron rejection ? What is the hadron-gamma separation if the same energy primaries are selected ? The following figures are an attempt to answer these questions. We should bear in mind that our triggers are based on the hits in shower layer or may be a patch trigger. For this reason we had studied the cuts as a function of reasonably well measured quantities, such as ntop, nbot, core distance (this will be determined by the out-rigger array to about 10 meters, and we have taken bins of rcore which are 20 meters wide) and hit pe distributions. The cut depends on the excess of penetrating particles in proton showers.

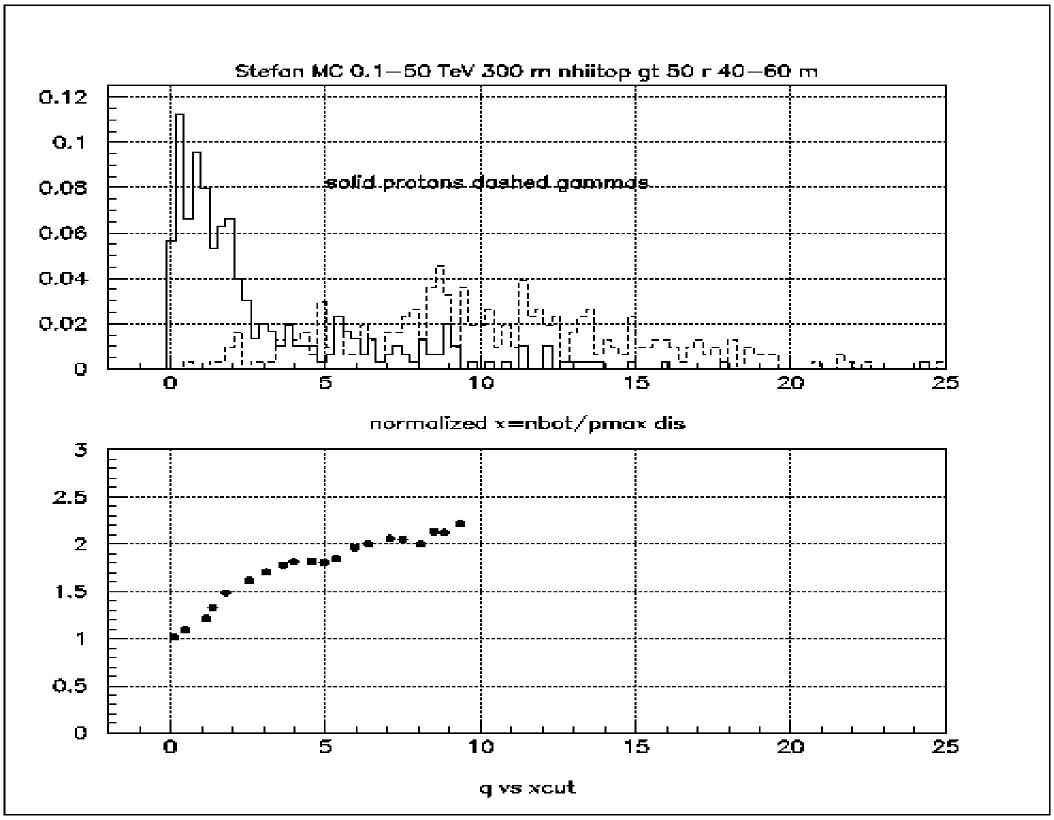
The data sample used was Stefan's Geant MC output. In this both gamma and proton showers are started at an energy of 100 GeV and thrown over 300 m (+- 150m) around the pond. Gamma spectrum is -2.0 and proton of course is -2.7.



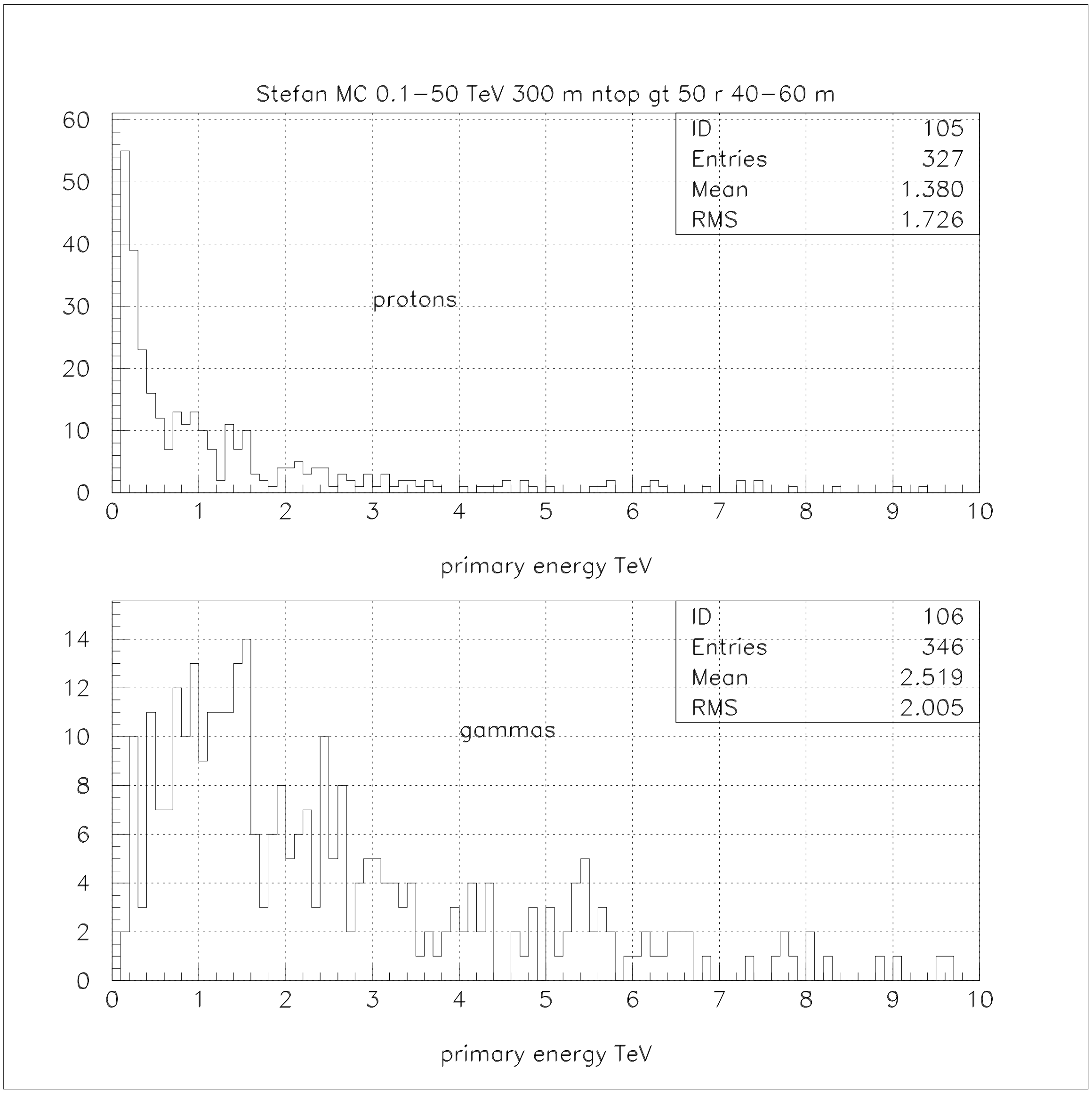
This figure shows the normalized protons and gamma distributions of the cut parameter x = nhitbot/pemax in bottom for a particular selection of nhittop and core distance. The lower figure shows the variation of q factor with xcut requiring retaining more than 50 percent of gammas. Note that a q factor of about 1.6 is achieved for cores hitting the pond at an xcut of about 4.



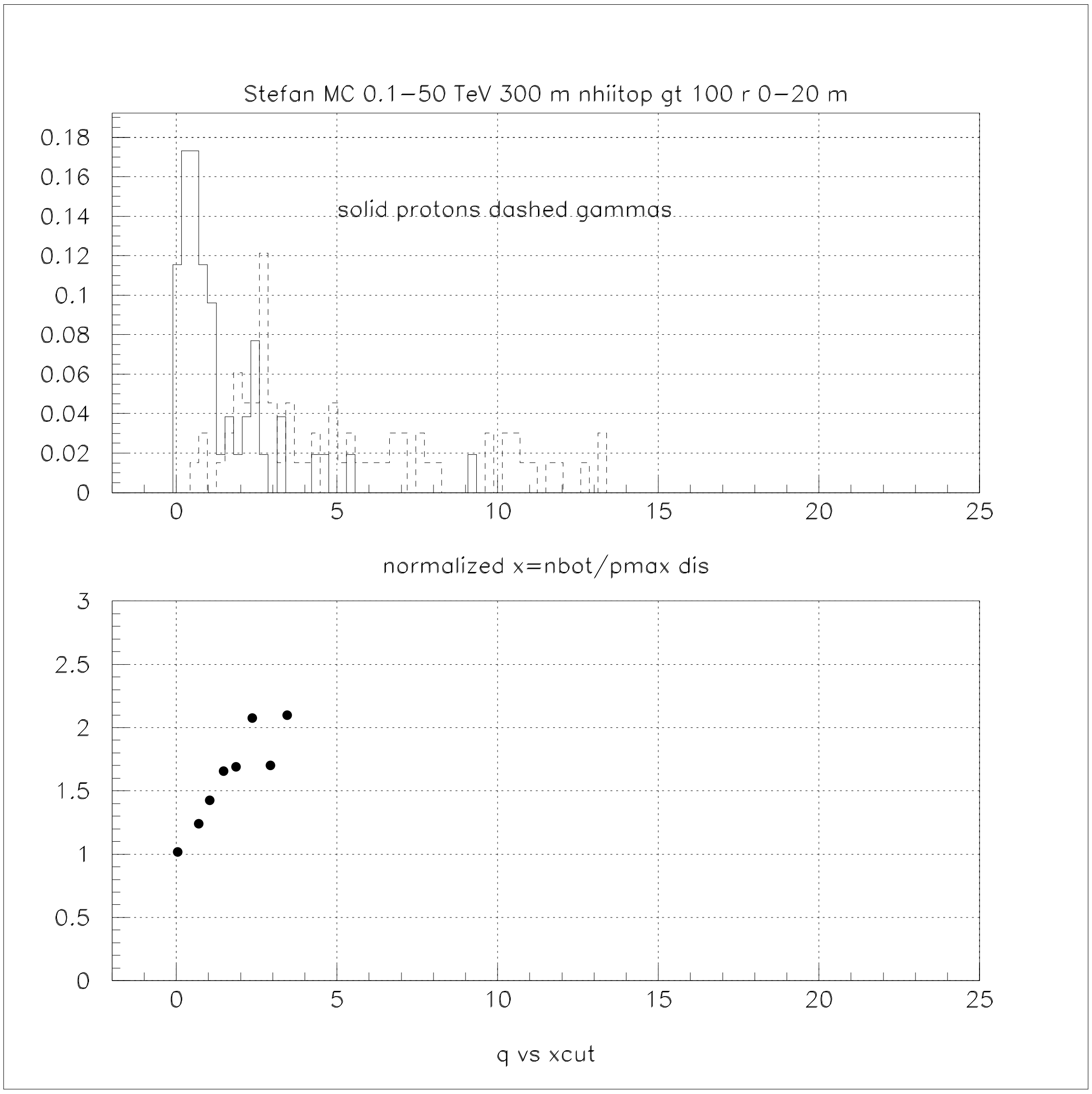
These figures compare the energy distributions of triggers in the previous figure for protons and gammas. Gamma triggers have 20 percent higher energies on the average. The peak of gamma trigger distribution is around 500 GeV.



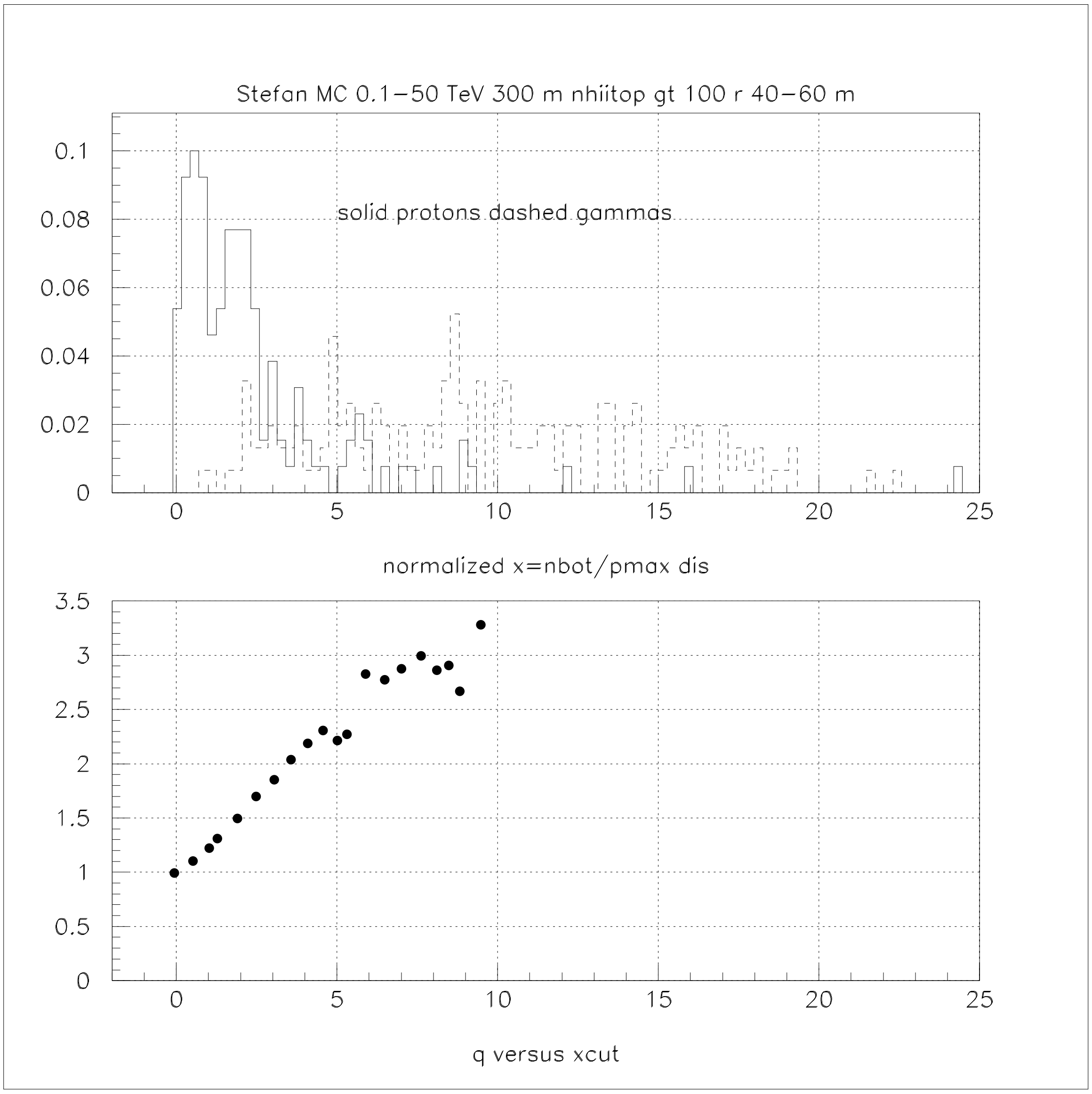
This figure shows that for the same trigger threshold, of 50 nhit, events with cores landing between 40 and 60 meters have a qfactor which is excess of 2 for xcut greater than about 6.



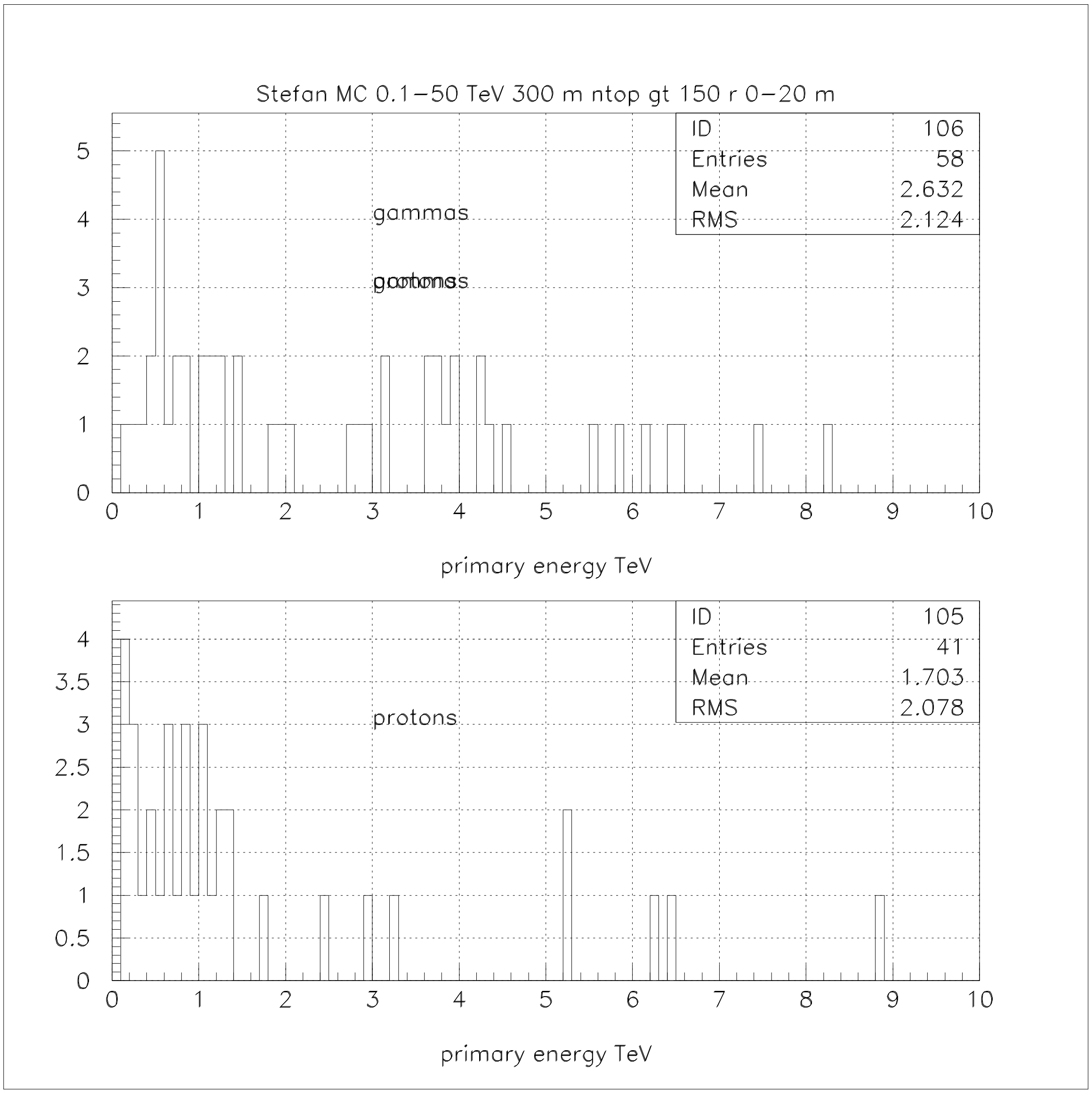
This figure compares the energies of triggers shown in the previous figure for protona and gamma showers for cores landing between 40 and 60 meters away from pond center. Gamma energies needed to get nhit greater than 50 are almost 80 percent higher than protons showers on the average.



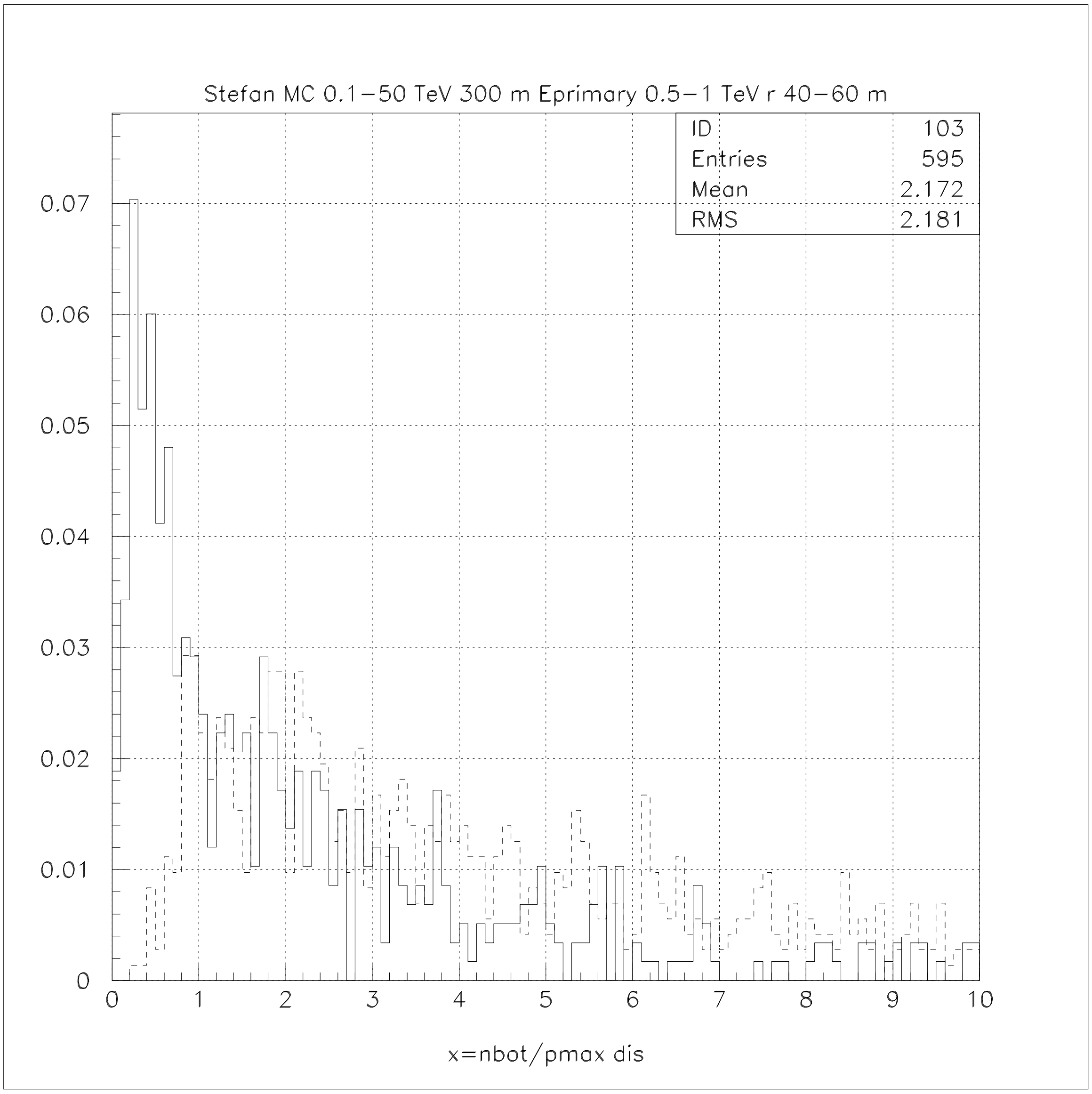
For nhit greater than 100 and cores landing on the pond, q-factors of about 2 are obtained with xcut aroun 4.



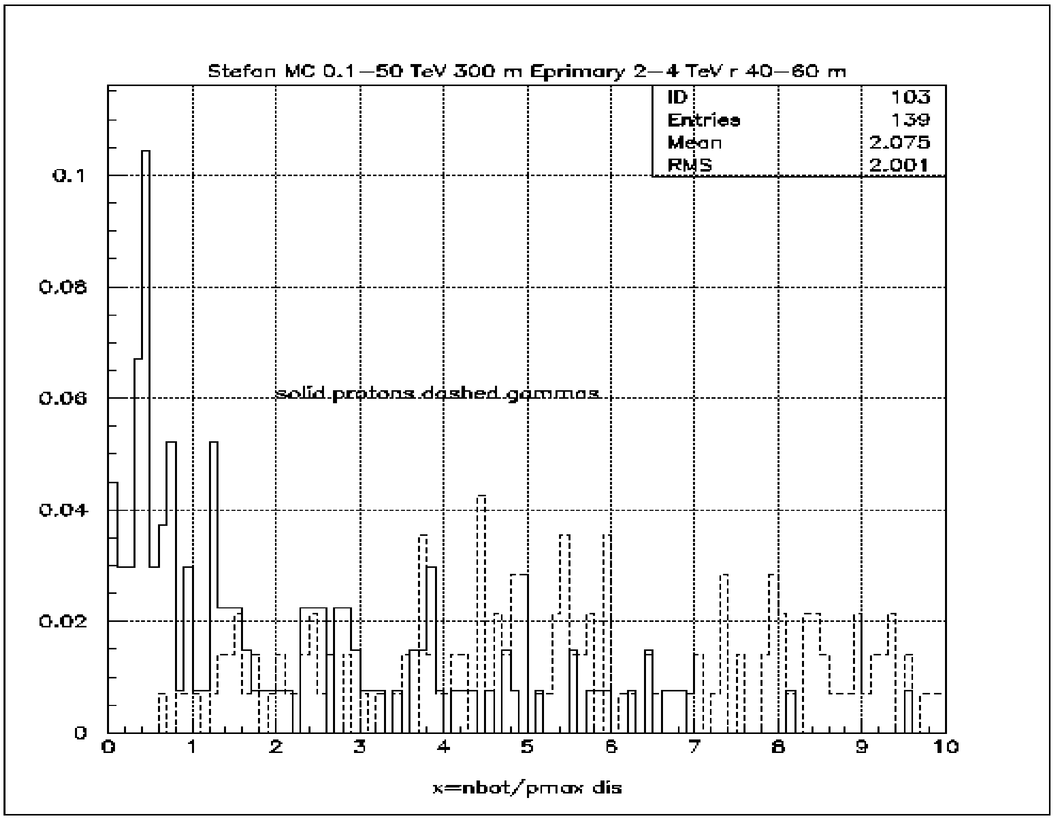
For cores off the pond and nhit greater than 100 pmts Q as high as 2.5 can be obtained with xcut greater than about 6.



Energy distribution of triggers for nhit ≥ 150 and cores landing on the ponds are compared for proton and gamma triggers. Gammas on the average have a 50 percent larger energy.



Next two figures show the separation obtained using the variable x = nbot/pmax for two different energy ranges and cores landing off the pond. For the events in this figure energy must lie between 0.5 and 1 TeV and core distance between 50 and 60 meters.



Same as the previous figure but for primary energies between 2 and 4 TeV. In both these figures hadron rejection is possible.