Study of Backscattering Effects on Particle Identification

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"Backscatter effect" can interfere severely with accurate charge measurement of the primary nucleus, especially at high energies, as the number of backscattered particles increases with the incident energy. In this analysis, we studied the effect of backscattered particles on particle identification by simulating the ISS-CREAM instrument detector response using the GEANT3 simulation package with the FLUKA hadronic model. To determine the incident particle charge, the reconstructed shower axis from the calorimeter was extrapolated to the charge detector (SCD) and about 10 × 10 cm^2 area of circle of confusion, centered on the extrapolated position, was scanned to select the pixel with the highest signal. Then the highest signal was corrected for the particle path length. Events with $Z \leq 1.732$ were identified as a proton.

Figure 1 shows the mis-identified proton ($Z > 1.732$) fraction among the reconstructed events with $Z>0$, over incident energy. Up to ~3 TeV incident energy the mis-identified fraction is ~2.75 %, almost flat. However, over the higher energy ranges the mis-identified fraction increases as energy increases due to more backscattered secondary particles with higher incident energy. The fraction in % is proportional (slope of $0.58e^{-4}$) to the incident energy in log scale. The mis-identified fraction is 2.71 % at 1 TeV and increases up to 12.93 % with 200 TeV with ISS-CREAM SCD (2.12 cm^2 of fine segment). To check segment size dependance, backscattering effect with bigger segments is compared in *Figure2*. Backscattering effect would increase as a segment size increases. With 256.82 cm^2 of large segment, mis-identified fraction would be 8.57 % at 1 TeV and increase up to 69.03 % at 200 TeV. For the larger segment the energy dependence is even stronger.

Our study shows that fine segmentation of charge detector can limit backscattering effect quite significantly. Simulation run with GEANT4 is in progress. The next step should compare GEANT3 simulation results with GEANT4.

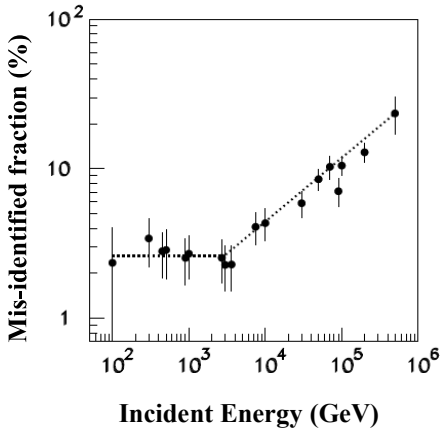

Figure 1: mis-identified fraction over incident energy with 2.12 cm^2 of fine segment: The dotted line is a guide to the eye.

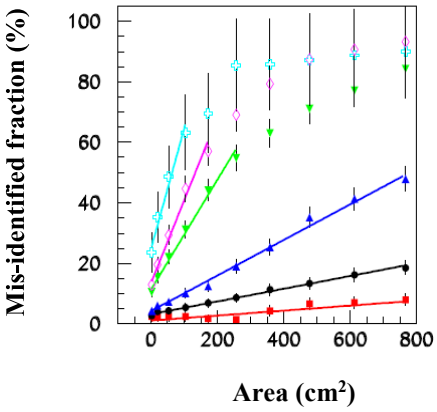

Figure 2: mis-identified fraction over segment size: incident energy 100 GeV (red), 1 TeV (black), 10 TeV (blue), 100 TeV (green), 200 TeV (pink), 500 TeV (light blue), and linear fit (solid line)