Fragmentation function measurements with the Belle detector

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The transition of quasi-free, high-energetic partons into confined hadrons cannot be described from first principle QCD as the related parton and hadron masses are typically too low to apply perturbative QCD. The fragmenation functions (FF), describing this transition, therefore need to be measured experimentally, similarly to the parton distribution functions (PDFs) in the nucleon. Their definition is also rather similar as for example the fragmentation function $D^h_{1,q}(z,Q)$ describes the number density of producing a hadron h from a parton q with fractional energy $z = E_h/E_q$ and at an energy scale Q. Until recently most data was obtained close to the Z resonance in e^+e^- annihilation, while little data at smaller scales was available and therefore the gluon fragmenation was not well constrained. The Belle experiment at KEK has collected more than a 1 ab^{-1} of luminosity close to the $\Upsilon(4S)$ resonance at $\sqrt{s} = 10.58$ GeV and about 63 pb^{-1} were used to extract unpolarized fragmenation functions in the process $e^+e^- \to hX$ which was published recently[1]. The results can be seen in Fig. 1 as a function of the fractional energy $z = 2E_h/\sqrt{s}$. Before this measurement very little low-energy scale data and almost no high-z data was available. It is expected that this data will soon be used in a global QCD analysis to parametrize the flavor dependence of pion and kaon fragmenation functions. In addition the analysis of unpolarized fragmenation functions continues in Belle with the aim to extract direct flavor information via the use of di-hadrons in opposite hemispheres. In this case the different combinations of favored (eg. $u \to \pi^+$) and disfavored (eg. $u \to \pi^-$) fragmenation functions can be disentangled by the various charge combinations of the two detected hadrons. It is expected that preliminary results will be available soon. Also the extraction of the explicit transverse momentum dependence of fragmenation functions is ongoing which so far is only assumed to be of a certain form in various global fits, but explicit measurements are not available so far.

Furthermore, the published results on the spin dependent fragmentation function measurements[2] are in the process to be augmented to also access the flavor dependence by not only concentrating on charged pions, but also on charged kaons and neutral mesons as well as their transverse momentum dependence. Also here the inclusion of various hadron types allows the flavor decomposition of the corresponding spin dependent fragmenation functions. By making use of them, the flavor decomposition of the quark transversity distribution of the nucleon in semi-inclusive deep-inelastic scattering and proton-proton experiments. Also here a QCD gobal transversity analysis for either the Collins function related measurements[3] or the interference related measurements[4] is available with the present data.

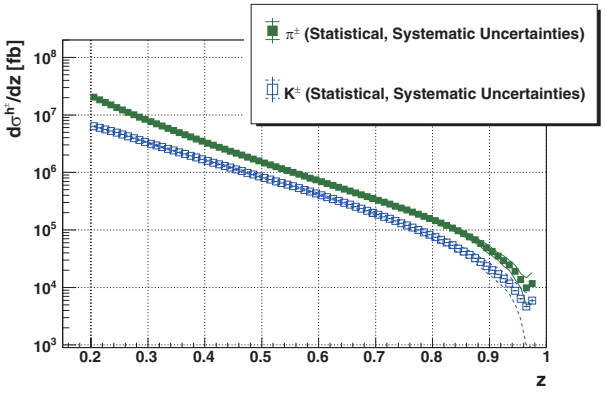

Fig. 1. Charged pion and kaon differential cross sections as a function of the fractional energy z. The error bands describe the total systematic uncertainties.

References

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