Fragmentation function measurements in Belle

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The fragmentation from asymptotically free partons into confined hadrons is described by fragmentation functions (FF). Since FFs are nonperturbative objects they cannot be calculated from first principles in QCD and need to be measured experimentally. Especially the electron-positron annihilation process such as studied at the Belle experiment on the KEKB accelerator is well suited for such measurements since no hadrons exist in the initial state. Once fragmentation functions are extracted universality and factorization allow its application to other processes such as semi-inclusive deep-inelastic scattering or hadron collisions in order to gain flavor as well as spin information in parton distribution functions. The transversity distribution function, for example, can be accessed using spin dependent di-hadron FFs, also called interference FFs.

Belle has obtained those previously[1)] but the unpolarized baseline is still missing. In this analysis we extract di-hadron cross sections for various pion, kaon and charge combinations differential in their fractional energy $z = 2E_{hh}/\sqrt{s}$ relative to the initial parton energy and the invariant mass of the pair. Unlike the previous publication[2)], this analysis concentrates on two hadrons from the same hemisphere in order to increase the likelihood of both emerging from the same initial parton. The various corrections reported previously have been adapted to this analysis and results are already in the Belle-internal refereeing process and are expected to be published soon.

Figure 1 displays the expected sensitivities for dipions as a function of invariant mass and in bins of fractional energy. In the opposite-sign pion pairs one clearly can identify various resonances such as the K^0_S and ρ mesons as well as the Cabbibo-suppressed decay of the D^0 meson. The same-sign pion pair cross sections display a more continuous mass distribution. All other pion, kaon and charge combinations are similarly prepared.

Other ongoing measurements include the surprising discovery of a nonzero Λ baryon polarization originating from an unpolarized parton when correlating it with the transverse momentum the Λ carries with respect to the thrust axis[3)]. Preliminary results have been shown and the results are currently being finalized.

Also other explicitly transverse momentum dependent fragmentation functions are currently being extracted. Two teams extract different types of such. One analysis concentrates on measuring the transverse momentum between two nearly back-to-back hadrons relative to one hadron's momentum direction while the other analysis studies single hadrons' transverse momenta relative to the thrust axis. While the first method is experimentally straightforward, convolutions of the intrinsic transverse momenta of both hadrons complicate the extraction of the intrinsic transverse momentum dependence. The single hadron method extracts directly the transverse momentum but the thrust axis is only approximating the initial parton's axis. Both types of analysis are progressing and are expected to be ready for publication soon.

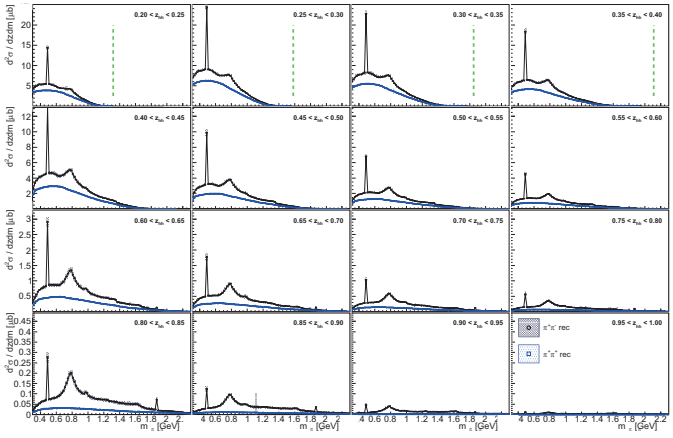

Fig. 1. Expected di-pion cross sections as a function of $m_{\pi\pi}$ in bins of z as expected by fully tracked and reconstructed Belle MC. Same sign pion pairs are displayed by blue squares while opposite-sign pion pairs are displayed by black circles.The green vertical lines represent the kinematic mass boundaries for each z bin.

References

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