Fragmentation function measurements in Belle†

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Fragmentation functions (FFs) tell us about the transition of asympotically free, nearly massless partons into confined, massive final-state hadrons. They therefore provide important information on some of the main open questions in nuclear physics, confinement and chiral symmetry breaking. Furthermore, FFs can be used as a tool to extract parton distribution functions in semi-inclusive DIS and hadron-hadron collisions. Belle has previously measured polarization dependent interference fragmentation functions,[1)] needed to access the quark transversity distribution in a collinear factorization framework. The related unpolarized baseline FF was not available. Recently, inclusive di-hadron cross sections were extracted as a function of invariant mass and fractional energy $z = 2E_{hh}/\sqrt{s}$ for any hadron and charge combination.[2)] The di-hadrons had to emerge in the same hemisphere as calculated via the event-shape variable thrust in order to be sensitive to the fragmentation of predominantly one parton into two hadrons, unlike the previous di-hadron publication[3)] which focused more on single hadron fragmentation. The cross sections for unlike-sign pion pairs can be seen in Fig. 1 where they are compared to various PYTHIA fragmentation tunes. The overall fractional energy behavior is generally well reproduced in the PYTHIA default tune, while the mass structure above 1 GeV is better described by tunes with larger fragmentation into higher spin states.

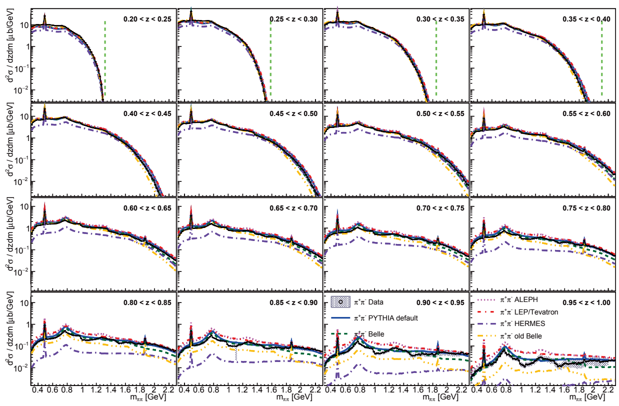

Fig. 1. Unlike-sign di-pion cross sections as a function of $m_{\pi\pi}$ in bins of z (black circles), compared to various fragmentation tunes in PYTHIA.

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Various resonances are visible in the extracted cross sections for opposite-sign pion pairs. Using MC their origin can be resolved as shown in Fig. 2. One 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. In the data also the $f_0(980)$ is clearly visible while it is not well modeled in the MC. Additionally, di-pions from a common origin, such as from η or ω decays or pions from different levels of the same decay chain can also show up as enhancements. Direct fragmentation with no common ancestors provide the generally smooth and dominant contribution to the mass spectra. Similar figures for other hadron combinations and details on the correction chain leading from raw yields to cross sections can be found in the actual publication. For unlike-sign pion-kaon combinations the K^* and the D^0 decays stand out while for the unlike-sing kaon pairs the ϕ^0 contributes prominently. For all like-sign combinations no resonances exist while some enhancements from common decays are visible.

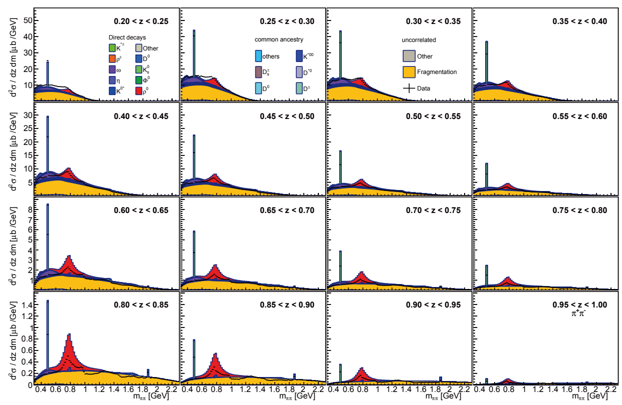

Fig. 2. Comparison of unlike-sign di-pion cross sections (data points) as a function of $m_{\pi\pi}$ in bins of z with the relative contribution from various parents in MC.

Other fragmentation function measurements are currently ongoing such as explicit transverse momentum dependent fragmentation functions, Λ polarizing fragmentation[4)] and various spin dependent fragmentation functions.

References

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