

Production cross-sections of light and charmed mesons in e^+e^- annihilation near 10.58 GeV[†]

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Fragmentation functions are universal objects that describe the formation of hadrons from high-energetic partons. Therefore, they are very useful in accessing the partonic content of the nucleon or of nuclei. Further, they cannot be obtained from first principles of the strong interaction and must instead be measured. Especially e^+e^- annihilation provides a clean environment to access these contents. Thus far, various results have been obtained at the Belle experiment.¹⁾ In this study, new measurements of cross-sections for various light and charmed mesons are reported, with many of them being reported for the first time. These mesons are extracted by fitting the invariant mass peaks of two or three pion or kaon combinations in bins of the momentum fraction $x_p = p_h/p_{\max}$, where p_{\max} represents the maximally available momentum for a certain particle in e^+e^- annihilation, given its mass. The signal functions are typically Breit-Wigner or Gaussian distributions, whereas the background is mostly described by a polynomial distribution with the exception of ϕ and D^* mesons, where a threshold function is applied. Subsequently, the extracted signal yields are corrected for reconstruction efficiencies and acceptance before the effect of initial state radiation is addressed. The results are predominantly dominated by systematics which in turn consists to the largest part from Monte-Carlo tune variations in the corrections and uncertainties from the signal extraction. Initially, cross-sections at center-of-mass energies of 10.52 and 10.58 GeV are analyzed separately; however, after confirming their consistency at high x_p where no $\Upsilon(4S)$ decays can contribute, the higher statistics of the 10.58 GeV data are used for $x_p > 0.55$.

Figure 1 shows the extracted light hadron cross-sections as a function of the momentum fraction while Fig. 2 shows those of D mesons. Further, these are compared to older results from CLEO²⁾ and supersede older Belle results.¹⁾ It can be seen that charm fragmentation contains a large fraction of the initial parton in the hadrons, which peaks at momentum fractions of 0.6–0.7 and increases with mass. For lighter hadrons, the cross-sections peak at significantly lower values, but a mass dependence is also visible.

Comparing the results with various Monte-Carlo tunes indicates that the lighter hadrons can be described reasonably well, while there is room for improvement. For D mesons, the magnitude and peak position can be described by some tunes, while all

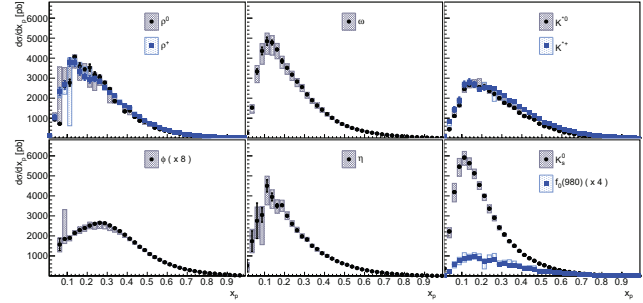


Fig. 1. Light hadron cross-sections as a function of the momentum fraction x_p .

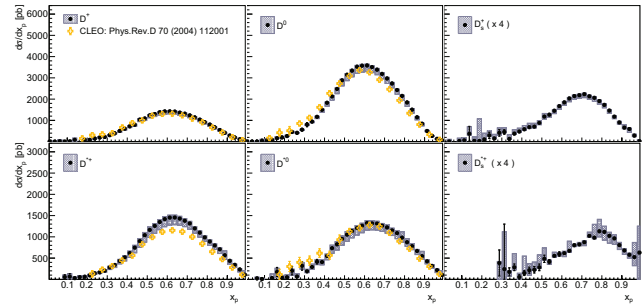


Fig. 2. D mesons cross-sections as a function of the momentum fraction x_p , compared to Ref. 2), where available.

tunes considered in this study fail to describe D_S that are considerably smaller than those in the simulations. The possibility for an increased fraction of vector meson production over pseudo-scalar production was tested by removing all decays from the hadrons considered here. The prompt production yields indicate that for light hadrons, there is no preference for higher vector mesons fractions. For charmed hadrons, vector mesons are clearly preferred.

References

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