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# COMPASS measurement of pion and kaon multiplicities and extraction of quark fragmentation functions into pions

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We present preliminary COMPASS results on pion and kaon multiplicities produced in semi inclusive deep inelastic scattering of 160 GeV muons off an isoscalar ($^6$LiD) target. The results constitute an impressive data set of more than 400 points in p and 400 in K, covering a large x,$Q^2$ and z domain in a fine binning, which will be used in future QCD fits at next to leading order to extract quark fragmentation functions. We show results of a first leading order fit performed to extract the favored and unfavored quark fragmentation functions into pions $D_{fav}^{\pi}$ and $D_{unfav}^{\pi}$.

*Keywords*: nucleon structure; semi inclusive deep inelastic scattering; pion and kaon multiplicities; quark fragmentation functions

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## 1. Introduction

Parton fragmentation functions (FFs), like parton distribution functions (PDFs), are non perturbative objects. They describe the hadronization of partons. The FFs are process independent and are used to describe the probability that a quark of flavor q fragments into a hadron of type *h* ($D_q^h$). They are needed e.g. for the extraction of flavor dependent quark polarization distributions $\Delta q(x)$ [1,2] from semi-inclusive polarized deep inelastic scattering. In particular, to access the strange quark polarization $\Delta s$ from polarized SIDIS, the strange quark FF into kaon $D_s^K$ is needed and it constitutes by far the largest contribution to the uncertainty in the extraction. Data sensitive to FFs exist from $e^+e^-$ and p pbar reactions, but they are unsufficient for a good flavor separation; they also lie at relatively too high $Q^2$ values. This is why it was decided to measure charged hadron multiplicities in SIDIS with a high precision and a fine binning in several variables.

## 2. Charged pion and kaon multiplicities

At leading order (LO), the hadron multiplicities $M(x,Q^2,z)$, defined as the mean number of hadrons *h* produced in a semi inclusive deep inelastic scattering event $\mu\, p \rightarrow \mu\, h\, X$, are simply related to PDFs and quark FFs, as shown in the equation below where *x* is the fraction of momentum carried by the struck quark, $Q^2$ is the momentum transfer and *z* is the energy fraction taken by the hadron

$$M(x,Q^2,z) = \frac{\sum_q e_q^2\ q(x,Q^2)\, D_q^h\,(z,Q^2)}{\sum_q e_q^2\ q(x,Q^2)}$$

Note that apart from the $Q^2$ dependence, PDFs depend upon *x*, while FFs depend upon *z*. This will be useful in the disentanglement of FFs from PDFs, while only the product of both is measured.

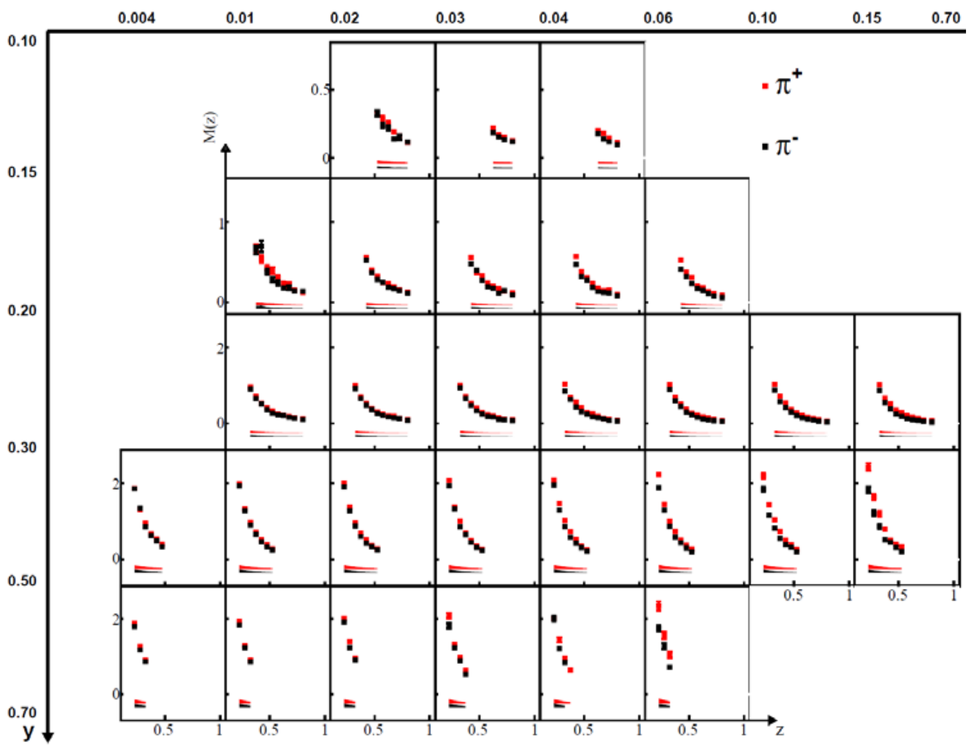


Fig.1: Preliminary results for pion multiplicities Results are shown in up to 8 x bins (columns), 5 y bins (rows), and versus z in each box. $\pi^+$ are in red, and $\pi^-$ in black. Statistical errors are too small to be visible. Systematic errors are shown by horizontal bands.

The π and K multiplicities were calculated using COMPASS [3] SIDIS data taken in 2006 with an isoscalar target ($^6$LiD). They were corrected by the value of the global acceptance of the apparatus estimated in each (x,y,z) bin. The acceptance was evaluated from a Monte Carlo simulation, comparing the number of generated and reconstructed events in the whole chain of analysis. For this study, the y variable is chosen instead of the $Q^2$ one, since $Q^2$ is too much correlated to *x*. For the π and K identification a RICH detector is used. Additional corrections including RICH unfolding and radiative corrections were applied. Final multiplicities [4] are shown in Fig.2 for pions and Fig.3 for kaons. The vector meson contribution was also estimated, but is not shown here.

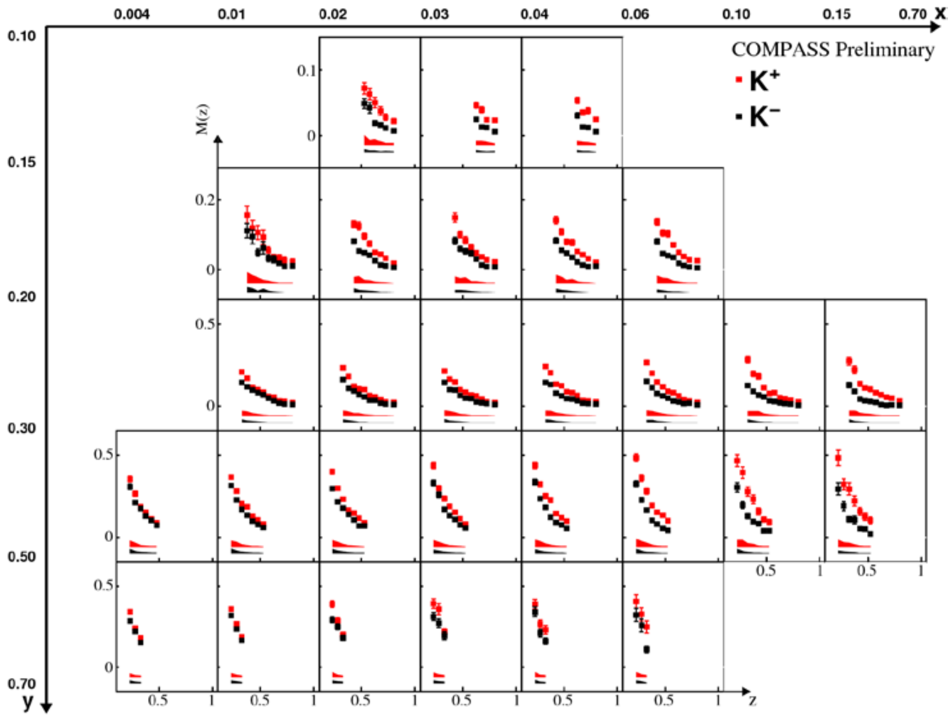


Fig.2. Same as Fig.1 for kaon multiplicities.

With a total of ~ 400 data points for π and the same number for K, the data cover the kinematical range 0.004< x <0.7, $Q^2$ > 1, 0.1< y < 0.7, 0.2 < z <0.85 and 5 <W < 17 GeV.

## 3. Quark fragmentation functions into pions from a LO fit

We study here the pion case. Starting from the equation given above at LO, FFs can be extracted once PDFs are taken from the literature. In each (x,y,z) bin, two equations are given by the $\pi^+$ and $\pi^-$ multiplicity measured in that bin. We can extract two FFs, namely the favored and unfavored quark FFs into pions. They correspond to valance and sea quarks respectively. They are the two independent FFs left after applying isospin and charge symmetry relations between FFs, and assuming in addition that the strange quark FF is equal to the unfavored one. In order to use simultaneously all data measured at various $Q^2$, a LO fit is performed. For this, functional forms are chosen for the shape of the two FFs at an initial $Q_0^2$ value, and the DGLAP equations are used for the evolution to the measured $Q^2$ of each data point. Results for the favored and unfavored quark FF into pions obtained from the fit of the pion multiplicities are shown in Fig.3. The statistical error band was obtained with a replica method, varying the data points within their error. Our result [4] is in fair agreement with fits realized at NLO on similar SIDIS data [5]. They differ, as expected from fits including only $e^+ e^-$ data [6].

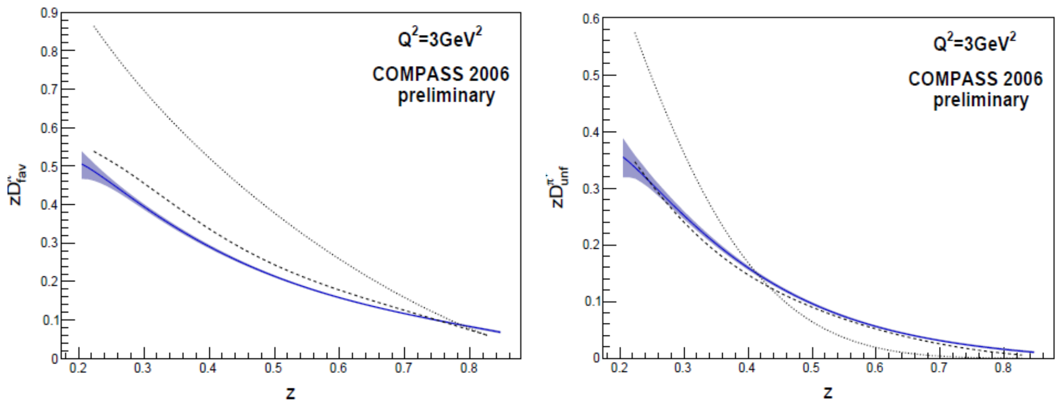


Fig.. Favored (left) and unfavored (right) quark fragmentation functions into pions extracted from a LO fit to COMPASS $\pi$ multiplicities

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