Summary of uncertainty projection study

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Fast smearing procedure based on Sooraj's demo code

η	σ_p/p - 3.0 T (%)	σ_p/p - 1.5 T (%)	$\sigma(\mathrm{DCA}_{r\phi})$ (μm)
(-3.0,-2.5)	$0.1 \cdot p \oplus 2.0$	$0.2 \cdot p \oplus 5.0$	$60/p_T \oplus 15$
(-2.5,-2.0)	$0.02 \cdot p \oplus 1.0$	$0.04 \cdot p \oplus 2.0$	$60/p_T \oplus 15$
(-2.0,-1.0)	$0.02 \cdot p \oplus 1.0$	$0.04 \cdot p \oplus 2.0$	$40/p_T \oplus 10$
(-1.0,1.0)	$0.02 \cdot p \oplus 0.5$	$0.04 \cdot p \oplus 1.0$	$30/p_T \oplus 5$
(1.0,2.0)	$0.02 \cdot p \oplus 1.0$	$0.04 \cdot p \oplus 2.0$	$40/p_T \oplus 10$
(2.0,2.5)	$0.02 \cdot p \oplus 1.0$	$0.04 \cdot p \oplus 2.0$	$60/p_T \oplus 15$
(2.5,3.0)	$0.1 \cdot p \oplus 2.0$	$0.2 \cdot p \oplus 5.0$	$60/p_T \oplus 15$

Summary of cuts

DIS

$Q^2 > 2 GeV^2$
$0.05 < y < 0.8$
$W^2 > 4\ GeV^2$

Pion/kaon selection

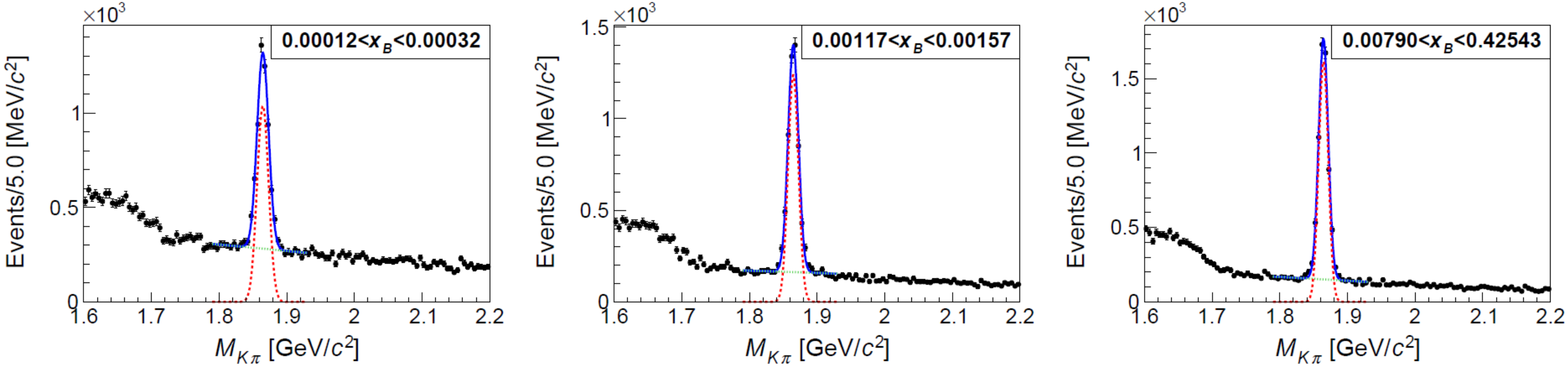
PID acceptance
+
Charge match
Pi+&K- or Pi-&K+

Pseudo-rapidity region	PID Momentum upper limit (GeV)
(-3,-1)	10
[-1, 1)	6
[1, 3)	50
Otherwise	Not analyzed yet

D0 decay topology

Selection criteria	18 GeV x 275 GeV	5 GeV x 100 GeV	5 GeV x 41 GeV
$K\pi$ pair-DCA	$< 80\,\mu m$	$< 80\,\mu m$	$< 80\,\mu m$
Decay-Length$_{r\phi}$	$> 90\,\mu m$	$> 80\,\mu m$	$> 60\,\mu m$
$\cos\theta_{r\phi}$	> 0.983	> 0.982	> 0.982

Fit to the mass spectrum



Form the double spin asymmetry

$$A_{LL}^{\vec{e}+\vec{p}\to e'+D^0+X} = \frac{1}{P_e P_p}\frac{N^{++}-N^{+-}}{N^{++}+N^{+-}}$$

Measured asymmetry, containing signal and background

Signal asymmetry extraction

$$A_{signal} = \frac{1}{f_{Purity}} A_{measure} - (\frac{1}{f_{Purity}} - 1) A_{background}$$

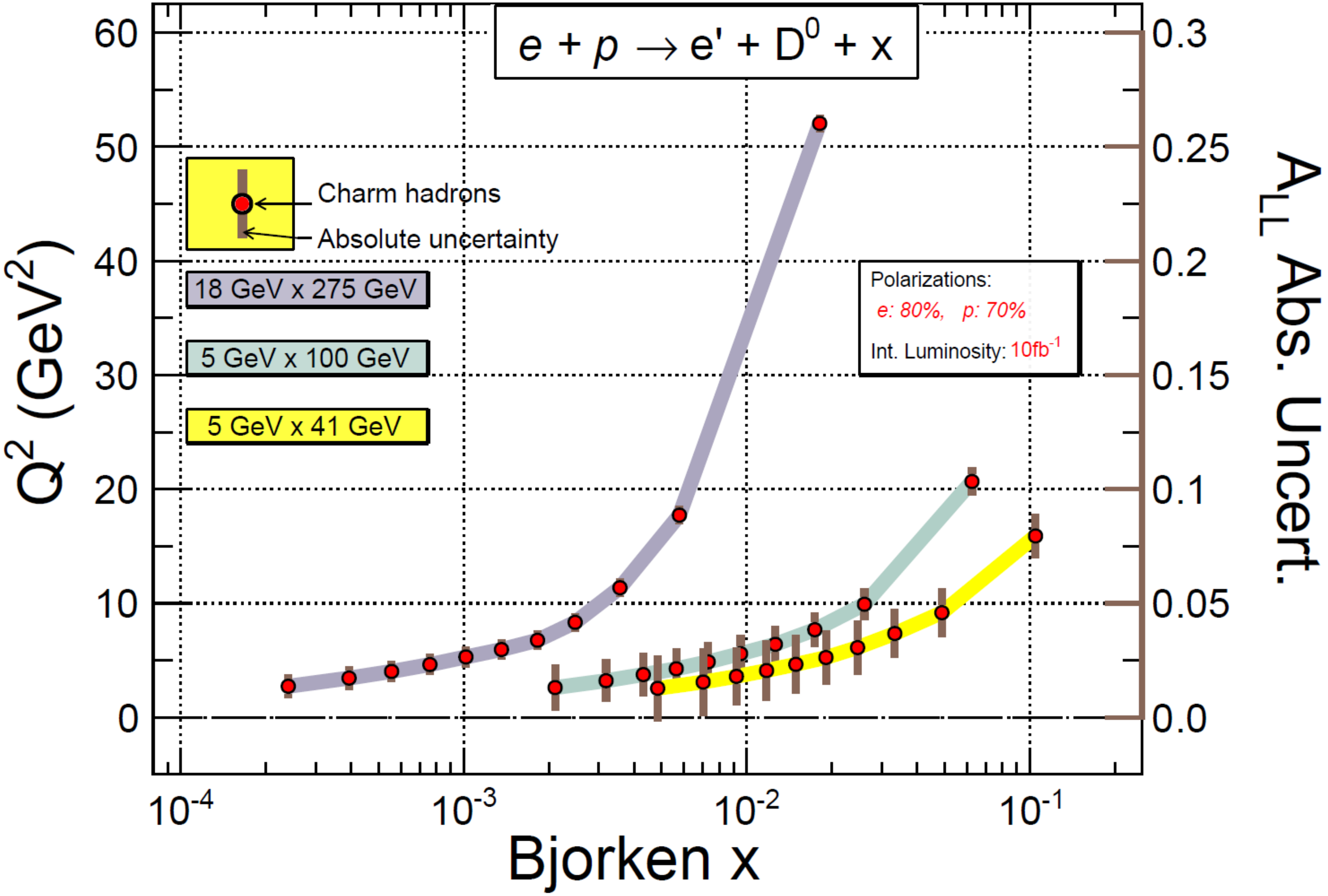
where f_{Purity} is the D^0 purity, which can be estimated by $\frac{N_{signal}}{N_{total}}$, with N_{signal} (N_{total}) as the number of signal ($N_{signal} + N_{background}$) under the D^0 mass peak (within $\pm 3\sigma$ region). In real data analysis, the uncertainty on f_{Purity} can be significantly reduced by increasing the MC sample comparing to data. The uncertainties for $A_{measure}$ and $A_{background}$ can be written as:

$$\sigma_{A_{measure}} = \frac{1}{\sqrt{N_{total}}}, \sigma_{A_{background}} = \frac{1}{\sqrt{N_{side\ band}}}, \tag{9}$$

where $N_{side\ band}$ is the number of background counts in the "side band" region. In this scenario, one has

$$\sigma_{A_{signal}} = \frac{\sqrt{N_{total}}}{N_{signal}} \sqrt{1 + \frac{N^2_{background}}{N_{total} \cdot N_{side\ band}}}. \tag{10}$$

Uncertainty projection for the DSA



Reweighting to look at impact on delta_g at NLO

Pseudo-data table

A_{LL} calculation bin by bin at NLO
Using DSSV14 1000 replicas

A new weight for each of replicas

Update uncertainty band on delta_g or any physical quantity

Daniele will talk about it

Backups

18 GeV x 275 GeV

200 million e-p collisions

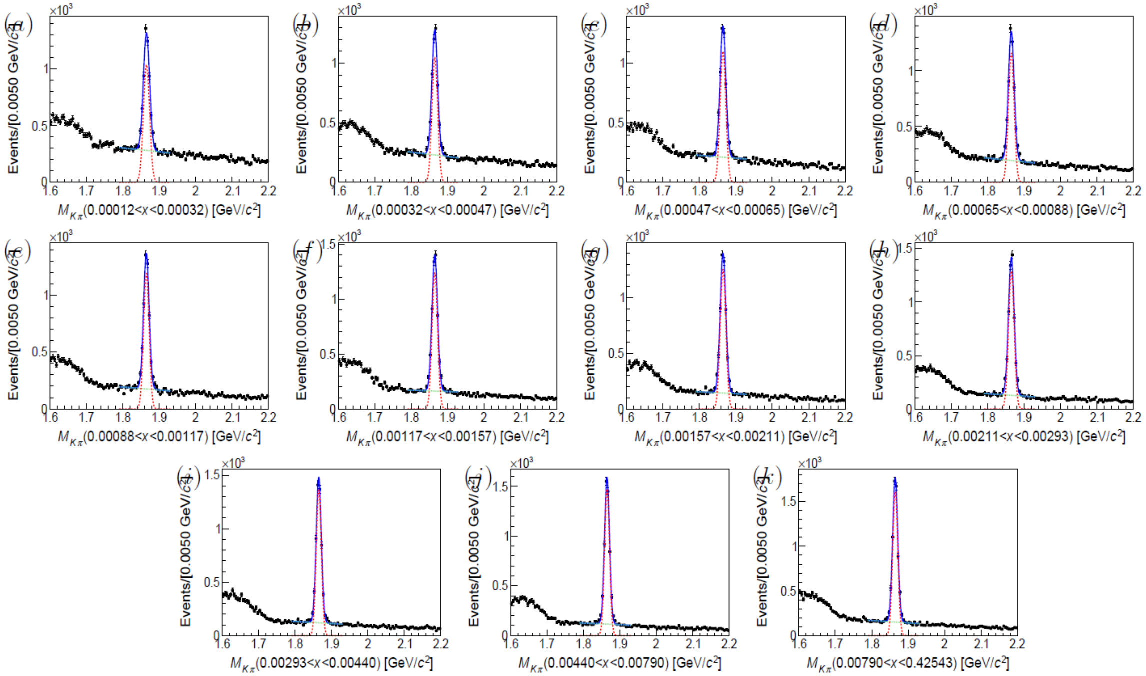


Figure 2: Fitting of the invariant mass of $K\pi$ in different Bjorken x bins at 18 GeV×275 GeV, 3T. The black plots is MC reconstruction, the blue curve is the nominal fit, the red dashed curve is the signal shape, the green dotted curve is the background shape. The background region is $(\mu - 3\sigma,\ \mu + 3\sigma)$, where μ and σ are the mean value and width of the fitted result of Gaussian function respectively.

Table 1: Fitting results of the invariant mass of $K\pi$ in different Bjorken x bins 18 GeV×275 GeV, 3T.

$x_{\min}$	$x_{\max}$	N_{Signal}	$N_{\text{Background}}$
0.00012	0.00032	4413^{+94}_{-94}	2881^{+184}_{-182}
0.00032	0.00047	4081^{+86}_{-85}	2149^{+156}_{-154}
0.00047	0.00065	4366^{+86}_{-86}	2015^{+152}_{-151}
0.00065	0.00088	4543^{+87}_{-86}	1850^{+146}_{-145}
0.00088	0.00117	4529^{+84}_{-83}	1606^{+135}_{-134}
0.00117	0.00157	4719^{+84}_{-84}	1488^{+132}_{-130}
0.00157	0.00211	4888^{+84}_{-83}	1340^{+125}_{-122}
0.00211	0.00293	5006^{+83}_{-83}	1190^{+118}_{-116}
0.00293	0.00440	4779^{+80}_{-79}	1009^{+107}_{-104}
0.00440	0.00790	5008^{+81}_{-79}	940^{+104}_{-101}
0.00790	0.42543	5698^{+88}_{-87}	1284^{+120}_{-118}

5 GeV x 100 GeV

200 million e-p collisions

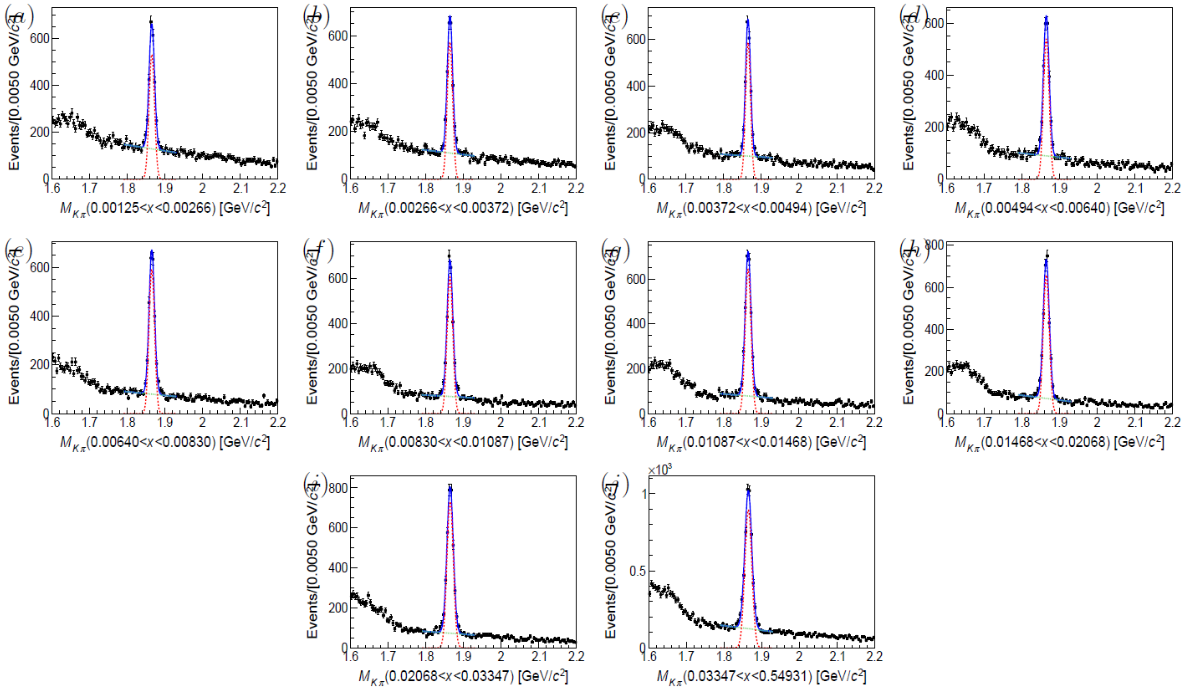


Figure 4: Fitting of the invariant mass of $K\pi$ in different Bjorken x bins at 5 GeV×100 GeV, 3T. The black plots is MC reconstruction, the blue curve is the nominal fit, the red dashed curve is the signal shape, the green dotted curve is the background shape. The background region is $(\mu - 3\sigma, \mu + 3\sigma)$, where μ and σ are the mean value and width of the fitted result of Gaussian function respectively.

Table 2: Fitting results of the invariant mass of $K\pi$ in different Bjorken x bins 5 GeV×100 GeV, 3T.

x_{min}	x_{max}	N_{Signal}	$N_{\mathrm{Background}}$
0.00125	0.00266	1935^{+60}_{-59}	1136^{+112}_{-110}
0.00266	0.00372	2028^{+58}_{-58}	934^{+102}_{-100}
0.00372	0.00494	1938^{+56}_{-55}	794^{+93}_{-91}
0.00494	0.00640	2038^{+57}_{-56}	818^{+96}_{-94}
0.00640	0.00830	2165^{+57}_{-56}	702^{+89}_{-87}
0.00830	0.01087	2302^{+59}_{-58}	692^{+90}_{-88}
0.01087	0.01468	2495^{+60}_{-59}	731^{+91}_{-90}
0.01468	0.02068	2632^{+62}_{-61}	694^{+90}_{-88}
0.02068	0.03347	3100^{+66}_{-66}	747^{+95}_{-94}
0.03347	0.54931	4159^{+82}_{-81}	1394^{+132}_{-130}

5 GeV x 41 GeV

100 million e-p collisions

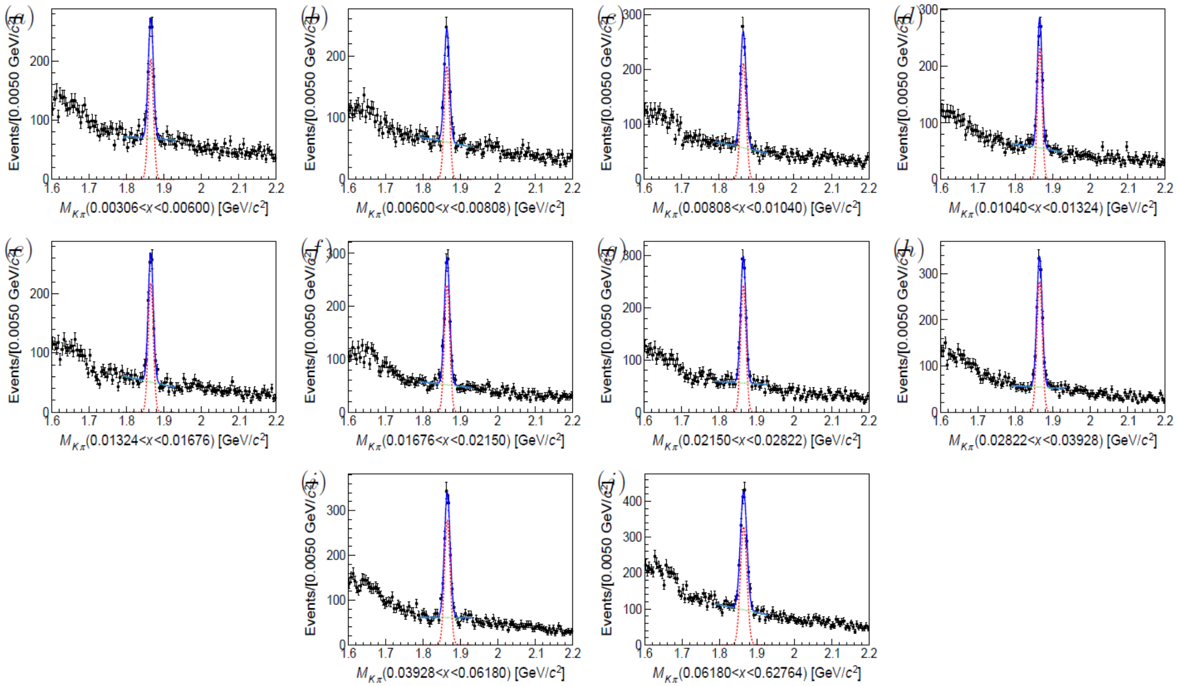


Figure 6: Fitting of the invariant mass of $K\pi$ in different Bjorken x bins at 5 GeV×41 GeV, 3T. The black plots is MC reconstruction, the blue curve is the nominal fit, the red dashed curve is the signal shape, the green dotted curve is the background shape. The background region is $(\mu - 3\sigma,\ \mu + 3\sigma)$, where μ and σ are the mean value and width of the fitted result of Gaussian function respectively.

Table 3: Fitting results of the invariant mass of $K\pi$ in different Bjorken x bins 5 GeV×41 GeV, 3T.

x_{min}	x_{max}	N_{Signal}	$N_{\mathrm{Background}}$
0.00306	0.00600	704^{+39}_{-38}	575^{+79}_{-78}
0.00600	0.00808	651^{+36}_{-36}	514^{+74}_{-72}
0.00808	0.01040	800^{+39}_{-39}	522^{+76}_{-74}
0.01040	0.01324	731^{+37}_{-36}	422^{+68}_{-66}
0.01324	0.01676	743^{+37}_{-36}	416^{+68}_{-65}
0.01676	0.02150	860^{+39}_{-38}	444^{+70}_{-68}
0.02150	0.02822	853^{+39}_{-38}	470^{+72}_{-70}
0.02822	0.03928	1026^{+42}_{-41}	469^{+73}_{-71}
0.03928	0.06180	1057^{+43}_{-43}	554^{+79}_{-77}
0.06180	0.62764	1430^{+55}_{-54}	1016^{+110}_{-106}