Estimate of the systematic uncertainties for the 2007 A_p^1 data in $x - Q^2$ bins

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Abstract

In this note a method for estimating the systematic uncertainties of the 2007 data on A_1^p in bins of x and Q^2 is described. This method has been developed to avoid a reanalysis of these data to just calculate the systematic uncertainties.

Contents

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1 Introduction

In our paper on the 2007 results for A_1^p [1] only the values of A_1^p in bins of x are given with their statistical and systematic uncertainties. In case of the A_1^p in bins of x and Q^2 only a plot is shown (figure 1). But these data where used by us to perform our NLO QCD fit to the world data using a table of these data which was produced during analysis. This table is up to now for COMPASS use only and contains the values of A_1^p together with their statistical uncertainties. Unfortunately the systematic uncertainties are missing. To avoid a time consuming reanalysis of these data just for the calculation of this contribution an alternative estimate is used.

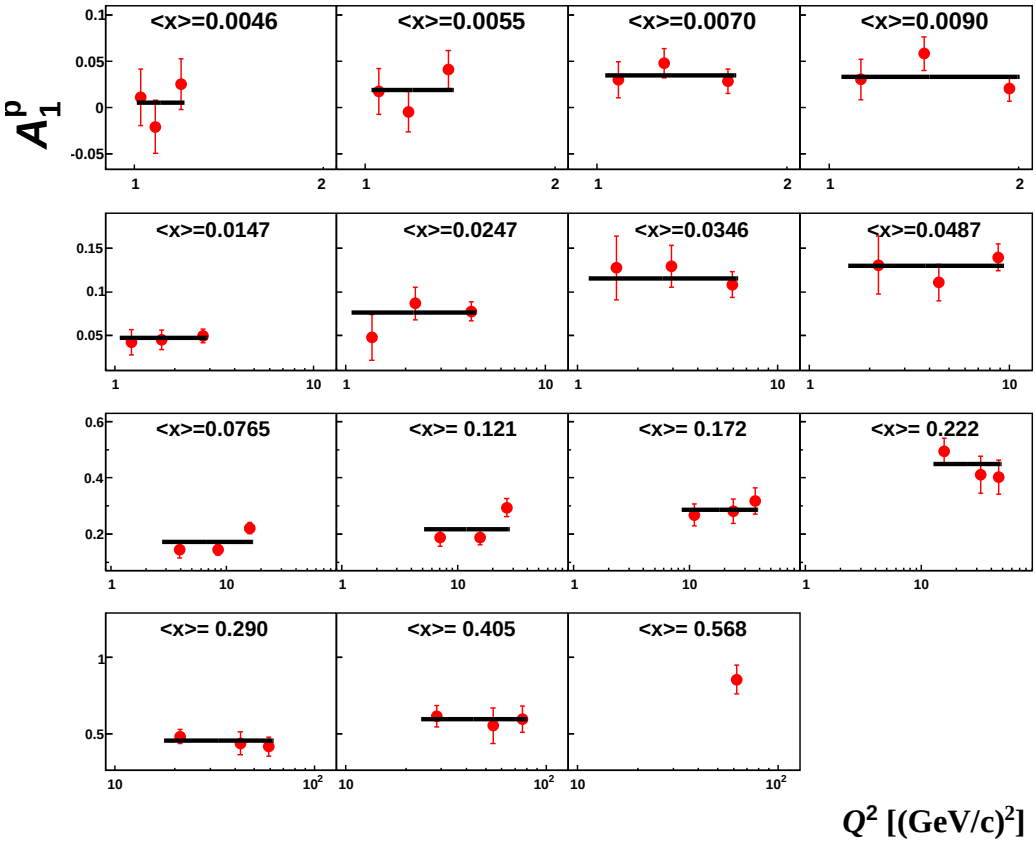

Figure 1: *Plot of A_1^p in bins of x and Q^2 taken from our paper [1].*

2 Method

The basic idea of this method is to use the information, which is already available for the data binned in x. For these data it is possible to calculate both, the multiplicative and additive, contributions to the systematic uncertainty and afterwards use them to estimate the contributions in case of the $x - Q^2$ binning.

2.1 Procedure

For the 2007 data the different contributions to the multiplicative part of the systematic uncertainty are known (see table 1). Using these values the multiplicative part of the systematic uncertainty can be calculated for the data binned only in x and also for the data with the

Beam polarisation	5%
Target polarisation	2%
Depolarisation factor	2%
Dilution factor	1%
Total	$\sim 5.8\%$

Table 1: *Contributions to the multiplicative systematic uncertainty.*

$x - Q^2$ binning. For the data binned in x the total systematic uncertainty is known. Therefore it is possible can calculate the additive contribution to the systematic uncertainty.

$$\Delta A_1^{\text{syst}} = \sqrt{\left(\Delta A_1^{\text{syst,add}}\right)^2 + \left(\Delta A_1^{\text{syst,mult}}\right)^2}$$

The largest contribution to the additive contribution are possible false asymmetries, which were calculated using the method of pulls, and therefore are connected to the statistics in each bin. Taking these into account the ratio of the additive contribution and the statistical uncertainty is calculated in each x bin. These ratio is used to estimate the additive part of the systematic uncertainty for the $x - Q^2$ binning.

$$\Delta A_1^{\text{syst,add}}(x, Q^2) = \frac{\Delta A_1^{\text{syst,add}}(x)}{\Delta A_1^{\text{stat}}(x)} \Delta A_1^{\text{stat}}(x, Q^2)$$

To obtain the final estimate for the systematic uncertainty both contributions were combined.

2.2 Comparison with the 2011 data

In the analysis of the 2011 data the full calculation of the systematic uncertainty was performed and results for the additive and multiplicative contributions are available. These results can be used to check, if the proposed method gives reasonable results for the systematic uncertainty. In figure 2 a comparison between the multiplicative contributions can be seen. In figure 3 the additive contribution is compared. A comparison for the full systematic uncertainty is shown in figure 4. As in case of the 2011 analysis one of the x bins has been split up into two bins the second plot on the second row shows six data points for 2011. This also results in a larger additive contribution, which has contributions proportional to the statistical uncertainty. The comparison shows that reasonable results for the systematic uncertainties were extracted, using just the information given for the data binned in x without doing a full reanalysis of the data.

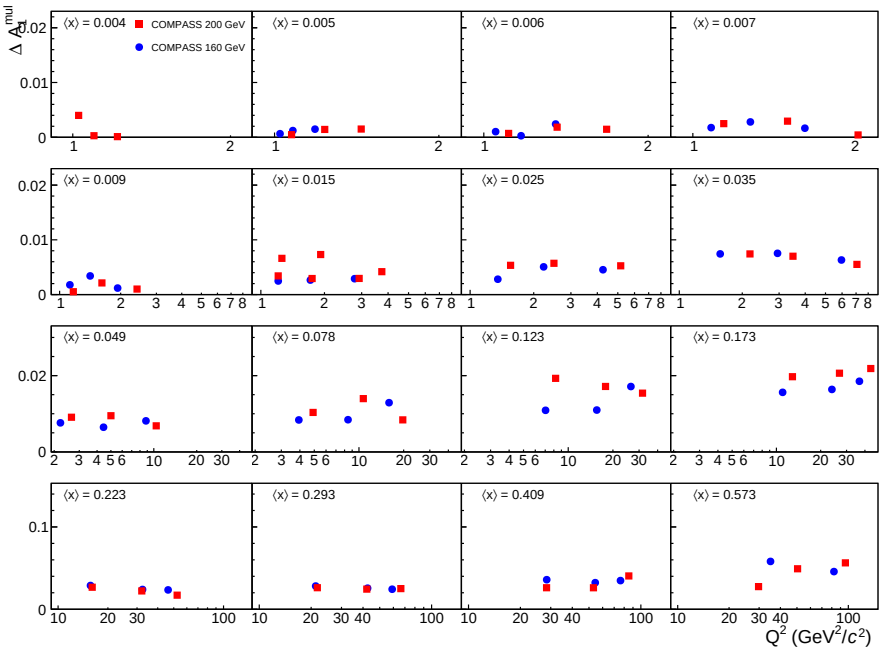

Figure 2: *Comparison of the multiplicative contribution to the systematic uncertainty between 2011 and 2007 asymmetries.*

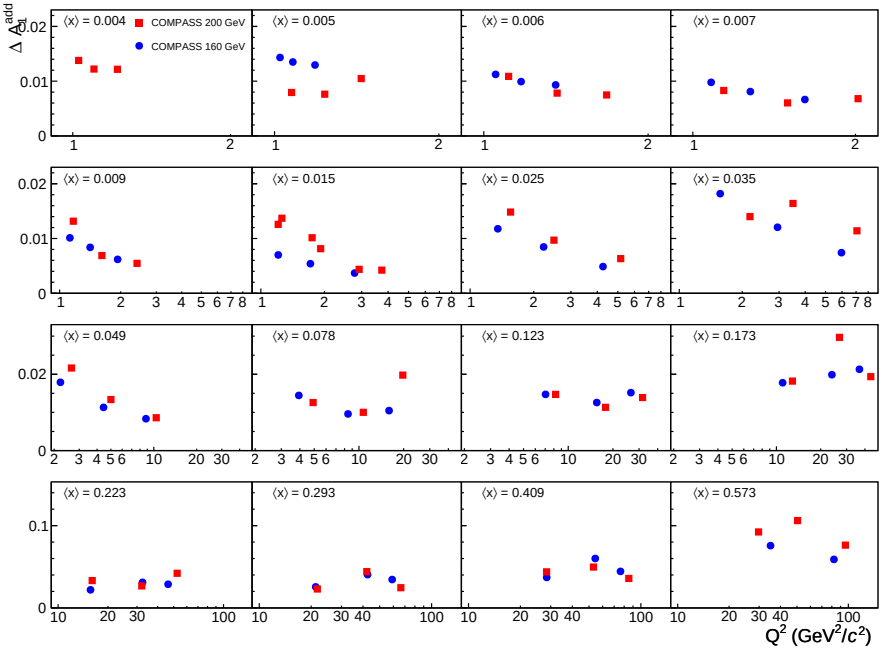

Figure 3: *Comparison of the additive contribution to the systematic uncertainty between 2011 and 2007 asymmetries.*

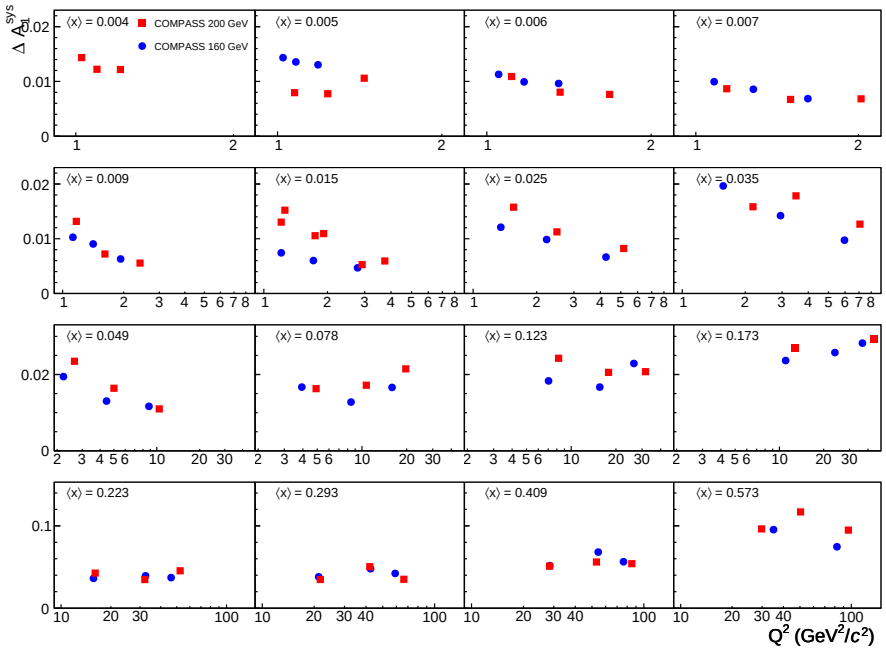

Figure 4: *Comparison of the full systematic uncertainty between 2011 and 2007 asymmetries.*

A Tables

x-Bin	$\langle x \rangle$	$\langle Q^2 \rangle$	A_1^p	$\Delta A_1^p(stat)$	$\Delta A_1^p(syst)$	$\Delta A_1^p(syst, mult)$	$\Delta A_1^p(syst, add)$	$\frac{\Delta A_1^p(syst,add)}{\Delta A_1^p(stat)}$
0.004 – 0.005	0.0046	1.1	0.006	0.017	0.008	0.000	0.008	0.470
0.005 – 0.006	0.0055	1.2	0.019	0.013	0.006	0.001	0.006	0.454
0.006 – 0.008	0.007	1.37	0.035	0.009	0.005	0.002	0.005	0.507
0.008 – 0.01	0.009	1.59	0.033	0.01	0.005	0.002	0.005	0.461
0.01 – 0.02	0.0147	2.14	0.047	0.006	0.004	0.003	0.003	0.486
0.02 – 0.03	0.0247	3.24	0.076	0.009	0.006	0.004	0.004	0.449
0.03 – 0.04	0.0346	4.36	0.115	0.012	0.009	0.007	0.006	0.500
0.04 – 0.06	0.0487	6.05	0.13	0.012	0.01	0.008	0.007	0.544
0.06 – 0.1	0.0765	9.42	0.172	0.013	0.012	0.010	0.007	0.507
0.1 – 0.15	0.122	14.9	0.218	0.017	0.015	0.013	0.008	0.468
0.15 – 0.2	0.172	20.9	0.286	0.024	0.02	0.017	0.011	0.460
0.2 – 0.25	0.222	26.7	0.446	0.032	0.03	0.026	0.015	0.467
0.25 – 0.35	0.29	34.6	0.453	0.033	0.032	0.026	0.018	0.547
0.35 – 0.5	0.405	47.1	0.594	0.049	0.043	0.035	0.025	0.520
0.5 – 0.7	0.568	62.1	0.855	0.094	0.068	0.050	0.046	0.492

Table 2: *Different contributions to the systematic uncertainty for A_1^p in x bins.*

x-Bin	$\langle x \rangle$	$\langle Q^2 \rangle$	A_1^p	$\Delta A_1^p(stat)$	$\Delta A_1^p(syst, mult)$	$\Delta A_1^p(syst, add)$	$\Delta A_1^p(syst)$
$0.004 - 0.005$	0.005	1.023	0.011	0.030	0.001	0.014	0.014
	0.005	1.080	-0.021	0.029	0.001	0.014	0.014
	0.005	1.186	0.025	0.028	0.001	0.013	0.013
$0.005 - 0.006$	0.005	1.051	0.017	0.025	0.001	0.011	0.011
	0.005	1.170	-0.005	0.022	0.000	0.010	0.010
	0.006	1.354	0.041	0.021	0.002	0.009	0.010
$0.006 - 0.008$	0.007	1.081	0.030	0.019	0.002	0.010	0.010
	0.007	1.278	0.048	0.016	0.003	0.008	0.009
	0.007	1.612	0.028	0.013	0.002	0.007	0.007
$0.008 - 0.01$	0.009	1.124	0.030	0.022	0.002	0.010	0.010
	0.009	1.414	0.058	0.018	0.003	0.008	0.009
	0.009	1.932	0.020	0.013	0.001	0.006	0.006
$0.01 - 0.02$	0.014	1.209	0.043	0.014	0.002	0.007	0.007
	0.015	1.716	0.045	0.011	0.003	0.005	0.006
	0.015	2.778	0.050	0.008	0.003	0.004	0.005
$0.02 - 0.03$	0.025	1.352	0.048	0.026	0.003	0.012	0.012
	0.025	2.228	0.087	0.019	0.005	0.008	0.010
	0.025	4.255	0.078	0.011	0.005	0.005	0.007
$0.03 - 0.04$	0.034	1.569	0.127	0.036	0.007	0.018	0.020
	0.035	2.949	0.129	0.024	0.008	0.012	0.014
	0.035	5.961	0.108	0.015	0.006	0.007	0.010
$0.04 - 0.06$	0.048	2.213	0.131	0.033	0.008	0.018	0.019
	0.049	4.440	0.111	0.021	0.006	0.011	0.013
	0.050	8.809	0.139	0.015	0.008	0.008	0.012
$0.06 - 0.1$	0.075	3.936	0.144	0.029	0.008	0.014	0.017
	0.079	8.439	0.145	0.019	0.008	0.010	0.013
	0.081	15.946	0.221	0.021	0.013	0.010	0.017
$0.1 - 0.15$	0.121	7.037	0.187	0.031	0.011	0.015	0.018
	0.124	15.572	0.188	0.027	0.011	0.013	0.017
	0.127	26.430	0.294	0.032	0.017	0.015	0.023
$0.15 - 0.2$	0.172	11.024	0.268	0.039	0.016	0.018	0.024
	0.174	23.854	0.281	0.043	0.016	0.020	0.026
	0.176	36.696	0.318	0.046	0.019	0.021	0.028
$0.2 - 0.25$	0.222	15.700	0.494	0.047	0.029	0.022	0.036
	0.224	32.383	0.411	0.066	0.024	0.031	0.039
	0.226	46.228	0.402	0.061	0.023	0.029	0.037
$0.25 - 0.35$	0.290	21.255	0.483	0.047	0.028	0.026	0.038
	0.294	42.515	0.438	0.074	0.026	0.040	0.048
	0.300	59.046	0.417	0.063	0.024	0.034	0.042
$0.35 - 0.5$	0.403	28.429	0.615	0.071	0.036	0.037	0.052
	0.410	54.354	0.553	0.115	0.032	0.060	0.068
	0.418	76.174	0.597	0.085	0.035	0.044	0.056
$0.5 - 0.7$	0.566	34.994	0.996	0.154	0.058	0.076	0.095
	0.580	82.365	0.784	0.120	0.046	0.059	0.075

Table 3: *Different contributions to the systematic uncertainty for A_1^p in x and Q^2 bins.*

References

[1] Alekseev, M. *et al.* The spin-dependent structure function of the proton and a test of the bjorken sum rule. *Physics Letters B* **690**, 466 – 472 (2010). URL `http://www.sciencedirect.com/science/article/pii/S0370269310006726`.