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Cross-sections of large-angle hadron production in proton– and pion–nucleus interactions VIII: aluminium nuclei and beam momenta from ± 3 GeV/c to ± 15 GeV/c

Abstract

We report on double-differential inclusive cross-sections of the production of secondary protons, charged pions, and deuterons, in the interactions with a 5% $\lambda_{\rm int}$ thick stationary aluminium target, of proton and pion beams with momentum from ± 3 GeV/c to ± 15 GeV/c. Results are given for secondary particles with production angles $20^\circ < \theta < 125^\circ$. Cross-sections on aluminium nuclei are compared with cross-sections on beryllium, carbon, copper, tin, tantalum and lead nuclei.

The HARP–CDP group

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1 INTRODUCTION

The HARP experiment arose from the realization that the inclusive differential cross-sections of hadron production in the interactions of few GeV/c protons with nuclei were known only within a factor of two to three, while more precise cross-sections are in demand for several reasons.

These are the optimization of the design parameters of the proton driver of a neutrino factory (see Ref. [1] and further references cited therein), but also the understanding of the underlying physics and the modelling of Monte Carlo generators of hadron–nucleus collisions, flux predictions for conventional neutrino beams, and more precise calculations of the atmospheric neutrino flux.

The HARP experiment was designed to carry out a programme of systematic and precise (i.e., at the few per cent level) measurements of hadron production by protons and pions with momenta from 1.5 to 15 GeV/c, on a variety of target nuclei. It took data at the CERN Proton Synchrotron in 2001 and 2002.

The HARP detector combined a forward spectrometer with a large-angle spectrometer. The latter comprised a cylindrical Time Projection Chamber (TPC) around the target and an array of Resistive Plate Chambers (RPCs) that surrounded the TPC. The purpose of the TPC was track reconstruction and particle identification by $\mathrm{d}E/\mathrm{d}x$. The purpose of the RPCs was to complement the particle identification by time of flight.

This is the eighth of a series of cross-section papers with results from the HARP experiment. In the first paper [2] we described the detector characteristics and our analysis algorithms, on the example of $+8.9$ GeV/c and -8.0 GeV/c beams impinging on a 5% λ_{int} Be target. The second paper [3] presented results for all beam momenta from this Be target. The third [4], fourth [5], fifth [6], sixth [7], and seventh [8] papers presented results from the interactions with 5% λ_{int} tantalum, copper, lead, carbon, and tin targets. In this paper, we report on the large-angle production (polar angle θ in the range $20^\circ < \theta < 125^\circ$) of secondary protons and charged pions, and of deuterons, in the interactions with a 5% λ_{int} aluminium target of protons and pions with beam momenta of ± 3.0, ± 5.0, ± 8.0, $+12.9$, -12.0, and ± 15.0 GeV/c.

Our work involves only the HARP large-angle spectrometer.

2 THE BEAMS AND THE HARP SPECTROMETER

The protons and pions were delivered by the T9 beam line in the East Hall of CERN's Proton Synchrotron. This beam line supports beam momenta between 1.5 and 15 GeV/c, with a momentum bite $\Delta p/p \sim 1\%$.

The beam instrumentation, the definition of the beam particle trajectory, the cuts to select 'good' beam particles, and the muon and electron contaminations of the particle beams, are the same as described in Ref. [2].

The target was a disc made of high-purity (99.999%) aluminium, with a radius of 15.1 mm, a thickness of 19.80 mm (5% λ_{int}), and a measured density of 2.69 g/cm^3.

The finite thickness of the target leads to a small attenuation of the number of incident beam particles. The attenuation factor is $f_{\mathrm{att}} = 0.975$.

Our calibration work on the HARP TPC and RPCs is described in detail in Refs. [9] and [10], and in references cited therein.

The momentum resolution $\sigma(1/p_{\mathrm{T}})$ of the TPC is typically 0.2 (GeV/c)$^{-1}$ and worsens towards small relative particle velocity β and small polar angle θ. The absolute momentum scale is determined to be correct to better than 2%, both for positively and negatively charged particles.

The polar angle θ is measured in the TPC with a resolution of $\sim$9 mrad, for a representative angle of $\theta = 60^\circ$. In addition, a multiple scattering error must be considered that is for a proton with $p_{\mathrm{T}} = 500$ MeV/c in the TPC gas $\sim$4.0 mrad at $\theta = 20^\circ$, and $\sim$12.7 mrad at $\theta = 90^\circ$. For a pion with the same characteristics, the multiple scattering errors are $\sim$3.3 mrad and $\sim$6.4 mrad, respectively. The polar-angle scale is correct to better than 2 mrad.

The TPC measures $\mathrm{d}E/\mathrm{d}x$ with a resolution of 16% for a track length of 300 mm.

The intrinsic efficiency of the RPCs that surround the TPC is better than 98%.

The intrinsic time resolution of the RPCs is 127 ps and the system time-of-flight resolution (that includes the jitter of the arrival time of the beam particle at the target) is 175 ps.

To separate measured particles into species, we assign on the basis of $\mathrm{d}E/\mathrm{d}x$ and β to each particle a probability of being a proton, a pion (muon), or an electron, respectively. The probabilities add up to unity, so that the number of particles is conserved. These probabilities are used for weighting when entering tracks into plots or tables.

A general discussion of the systematic errors can be found in Ref. [2]. For the data from the $+15$ GeV/c beam, the systematic error of the momentum measurement was increased by a factor of 1.5 to account for minor problems with the correction for dynamic TPC distortions. For the data from the -5 GeV/c beam, the systematic error arising from the parametrization of the pion abundance in the respective Monte Carlo simulation was doubled, for a less satisfactory description of data distributions in the Monte Carlo simulation with the same number of weight parameters as used in comparable data sets. All systematic errors are propagated into the momentum spectra of secondaries and then added in quadrature. They add up to a systematic uncertainty of our inclusive cross-sections at the few-per-cent level, mainly from errors in the normalization, in the momentum measurement, in particle identification, and in the corrections applied to the data.

3 MONTE CARLO SIMULATION

We used the Geant4 tool kit [11] for the simulation of the HARP large-angle spectrometer.

Geant4's QGSP_BIC physics list provided us with reasonably realistic spectra of secondaries from incoming beam protons with momentum below 12 GeV/c. For the secondaries from beam protons at 12.9 and 15 GeV/c momentum, and from beam pions at all momenta, we found the standard physics lists of Geant4 unsuitable [12].

To overcome this problem, we built our own HARP_CDP physics list. It starts from Geant4's standard QBBC physics list, but the Quark–Gluon String Model is replaced by the FRITIOF string fragmentation model for kinetic energy $E > 6$ GeV; for $E < 6$ GeV, the Bertini Cascade is used for pions, and the Binary Cascade for protons; elastic and quasi-elastic scattering is disabled. Examples of the good performance of the HARP_CDP physics list are given in Ref. [12].

4 CROSS-SECTION RESULTS

In Tables A.1–A.45, collated in the Appendix of this paper, we give the double-differential inclusive cross-sections $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ for various combinations of incoming beam particle and secondary particle, including statistical and systematic errors. In each bin, the average momentum at the vertex and the average polar angle are also given.

The data of Tables A.1–A.45 are available in ASCII format in Ref. [13].

Some bins in the tables are empty. Cross-sections are only given if the total error is not larger than the cross-section itself. Since our track reconstruction algorithm is optimized for tracks with p_{T} above $\sim$70 MeV/c in the TPC volume, we do not give cross-sections from tracks

with p_{T} below this value. Because of the absorption of slow protons in the material between the vertex and the TPC gas, and with a view to keeping the correction for absorption losses below 30%, cross-sections from protons are limited to $p > 450$ MeV/c at the interaction vertex. Proton cross-sections are also not given if a 10% error on the proton energy loss in materials between the interaction vertex and the TPC volume leads to a momentum change larger than 2%. Pion cross-sections are not given if pions are separated from protons by less than twice the time-of-flight resolution.

The large errors and/or absence of results from the $+15$ GeV/c pion beam are caused by scarce statistics because the beam composition was dominated by protons.

We present in Figs. 1 to 7 what we consider salient features of our cross-sections.

Figure 1 shows the inclusive cross-sections of the production of protons, π^+'s, and π^-'s, by incoming protons between 3 GeV/c and 15 GeV/c momentum, as a function of their charge-signed p_{T}. The data refer to the polar-angle range $20^\circ < \theta < 30^\circ$. Figures 2 and 3 show the same for incoming π^+'s and π^-'s.

Figure 4 shows inclusive Lorentz-invariant cross-sections of the production of protons, π^+'s and π^-'s, by incoming protons between 3 GeV/c and 15 GeV/c momentum, in the rapidity range $0.6 < y < 0.8$, as a function of the charge-signed reduced transverse particle mass, $m_{\mathrm{T}} - m_0$, where m_0 is the rest mass of the respective particle. Figures 5 and 6 show the same for incoming π^+'s and π^-'s. We note the good representation of particle production by an exponential falloff with increasing reduced transverse mass.

In Fig. 7, we present the inclusive cross-sections of the production of secondary π^+'s and π^-'s, integrated over the momentum range $0.2 < p < 1.0$ GeV/c and the polar-angle range $30^\circ < \theta < 90^\circ$ in the forward hemisphere, as a function of the beam momentum.

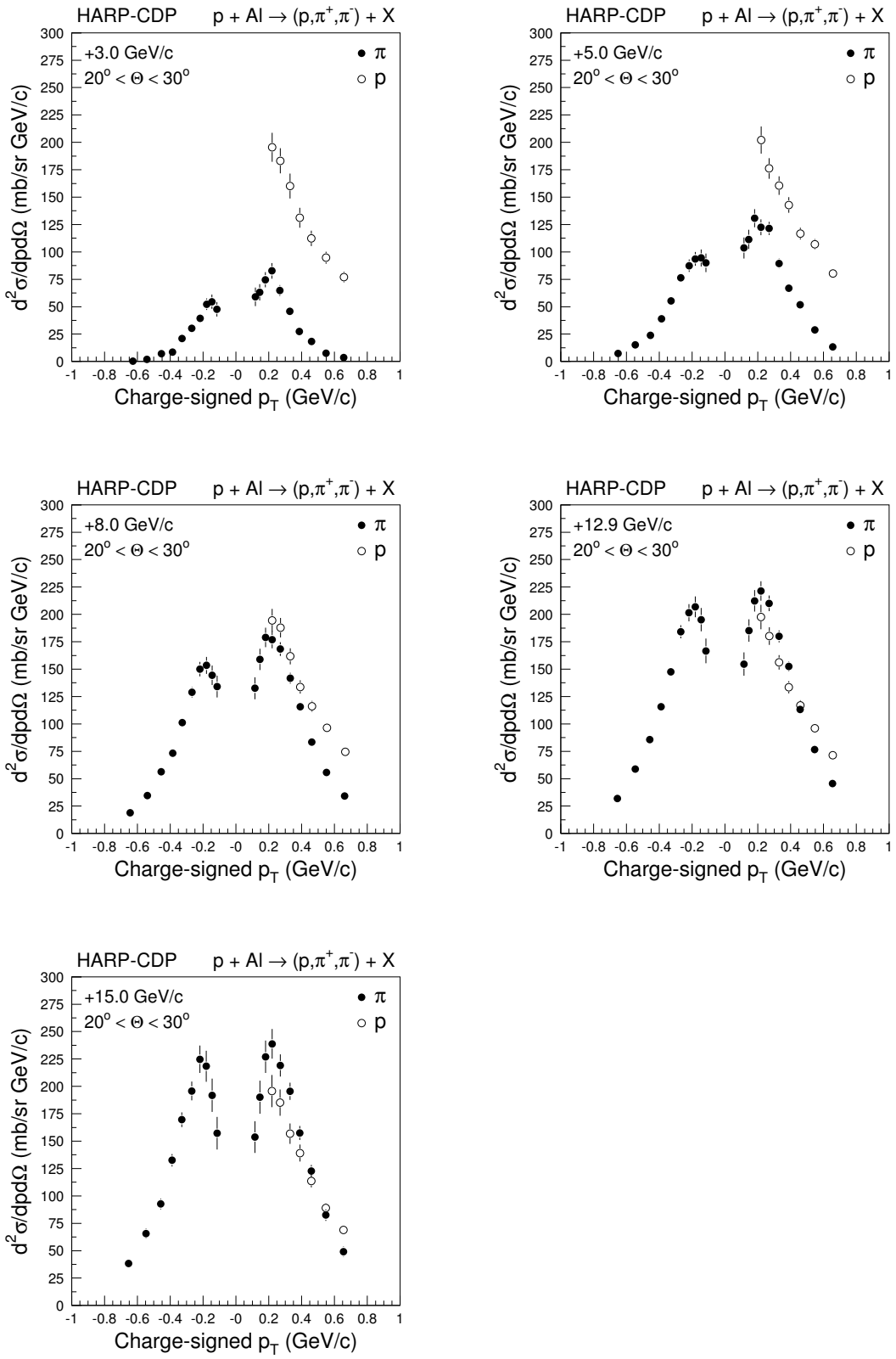

Fig. 1: Inclusive cross-sections of the production of secondary protons, π^+'s, and π^-'s, by protons on aluminium nuclei, in the polar-angle range $20^\circ < \theta < 30^\circ$, for different proton beam momenta, as a function of the charge-signed p_{T} of the secondaries; the shown errors are total errors.

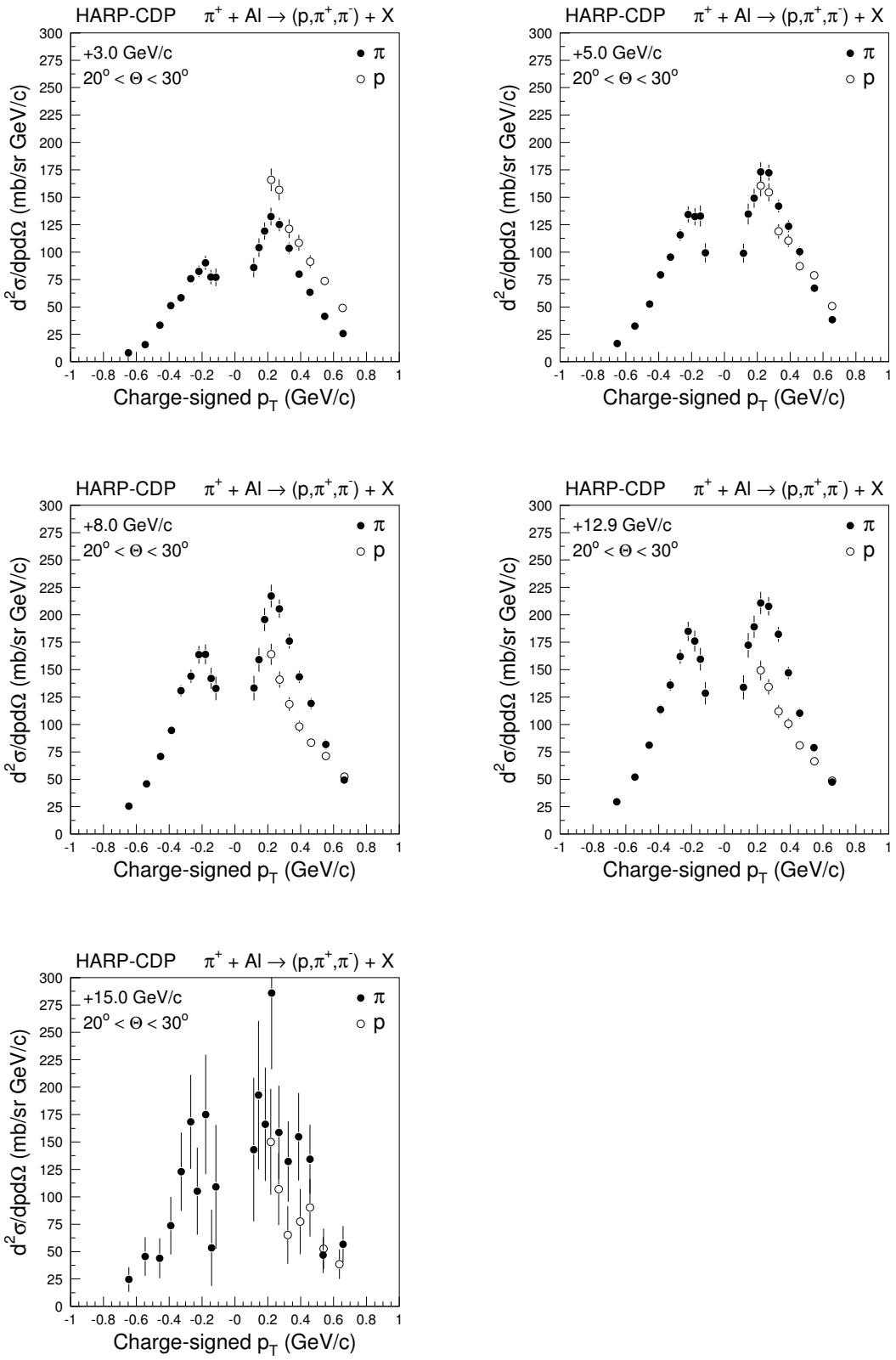

Fig. 2: Inclusive cross-sections of the production of secondary protons, π^+'s, and π^-'s, by π^+'s on aluminium nuclei, in the polar-angle range $20^\circ < \theta < 30^\circ$, for different π^+ beam momenta, as a function of the charge-signed p_{T} of the secondaries; the shown errors are total errors.

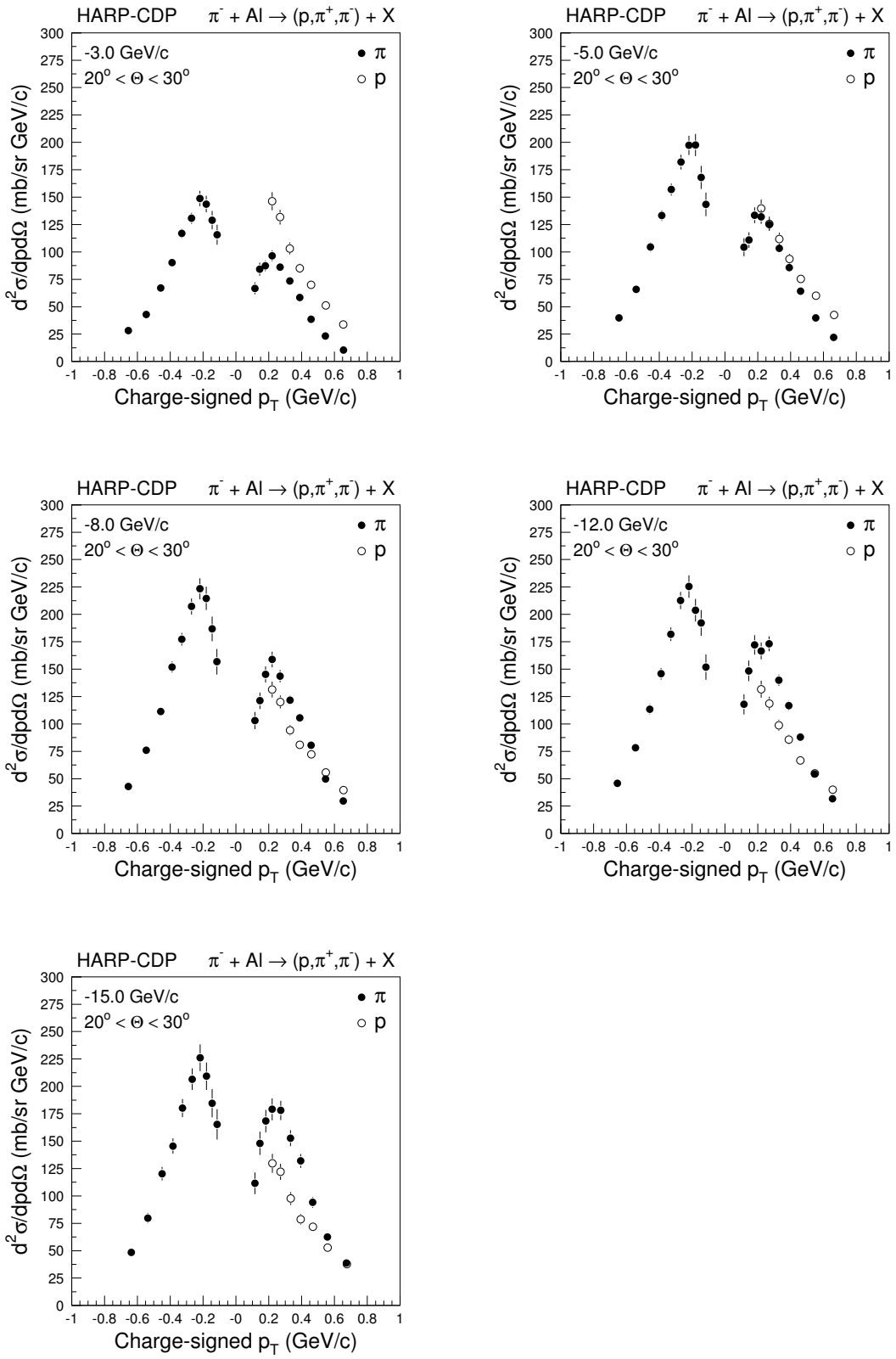

Fig. 3: Inclusive cross-sections of the production of secondary protons, π^+'s, and π^-'s, by π^-'s on aluminium nuclei, in the polar-angle range $20^\circ < \theta < 30^\circ$, for different π^- beam momenta, as a function of the charge-signed $p_{\rm T}$ of the secondaries; the shown errors are total errors.

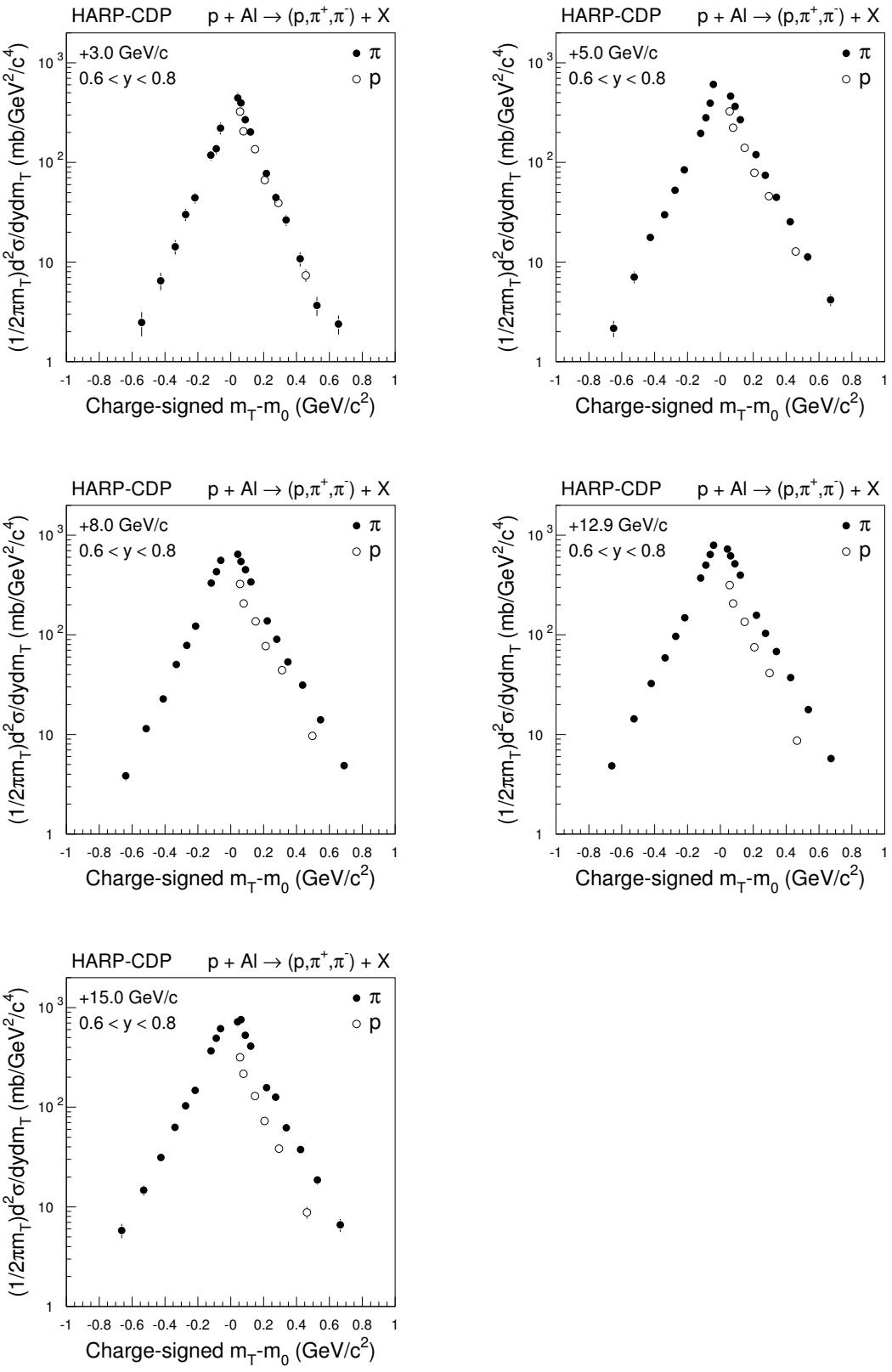

Fig. 4: Inclusive Lorentz-invariant cross-sections of the production of protons, π^+'s and π^-'s, by incoming protons between 3 GeV/c and 15 GeV/c momentum, in the rapidity range $0.6 < y < 0.8$, as a function of the charge-signed reduced transverse particle mass, $m_{\mathrm{T}} - m_0$, where m_0 is the rest mass of the respective particle; the shown errors are total errors.

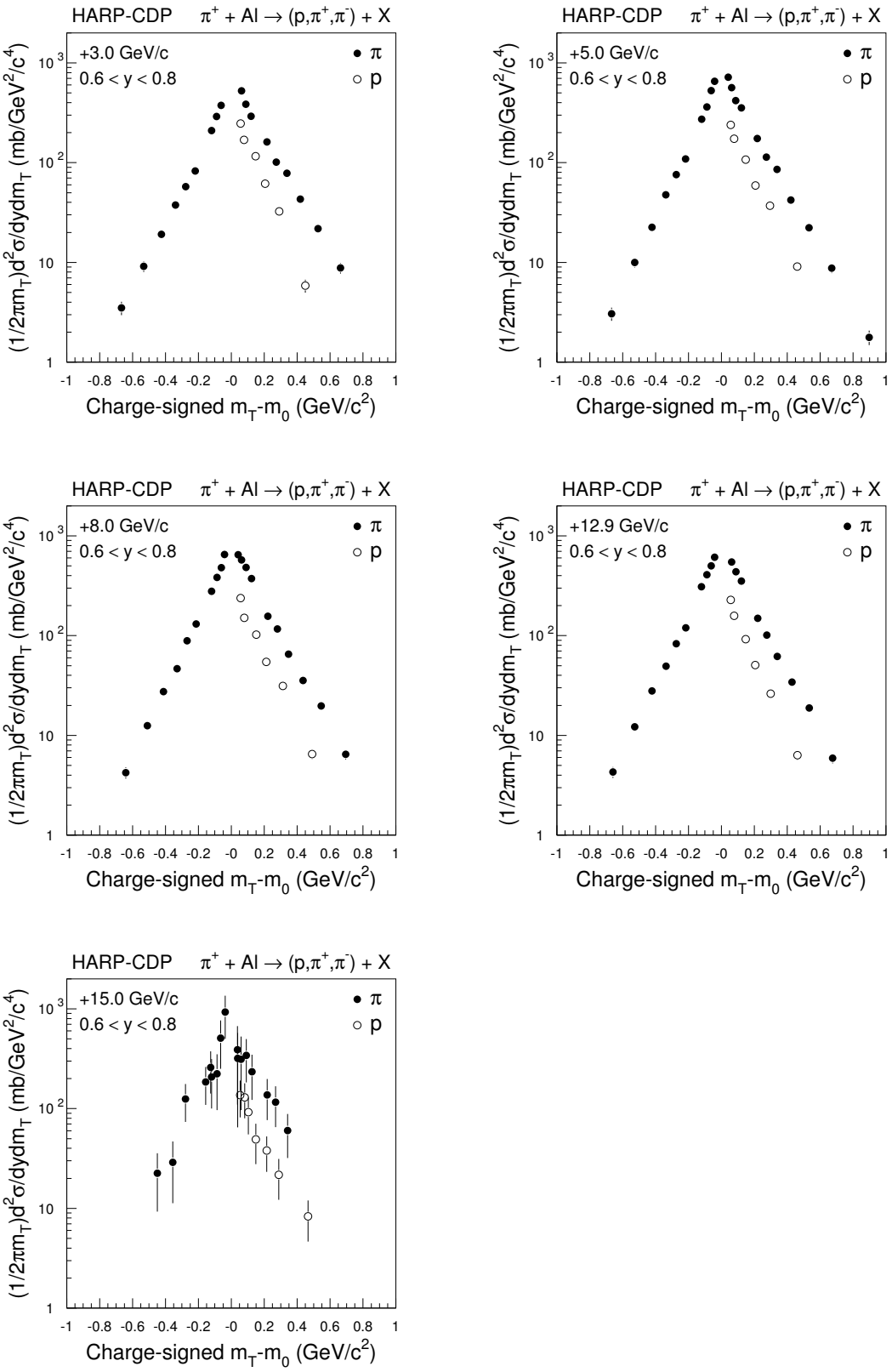

Fig. 5: Inclusive Lorentz-invariant cross-sections of the production of protons, π^+'s and π^-'s, by incoming π^+'s between 3 GeV/c and 15 GeV/c momentum, in the rapidity range $0.6 < y < 0.8$, as a function of the charge-signed reduced transverse pion mass, $m_{\mathrm{T}} - m_0$, where m_0 is the rest mass of the respective particle; the shown errors are total errors.

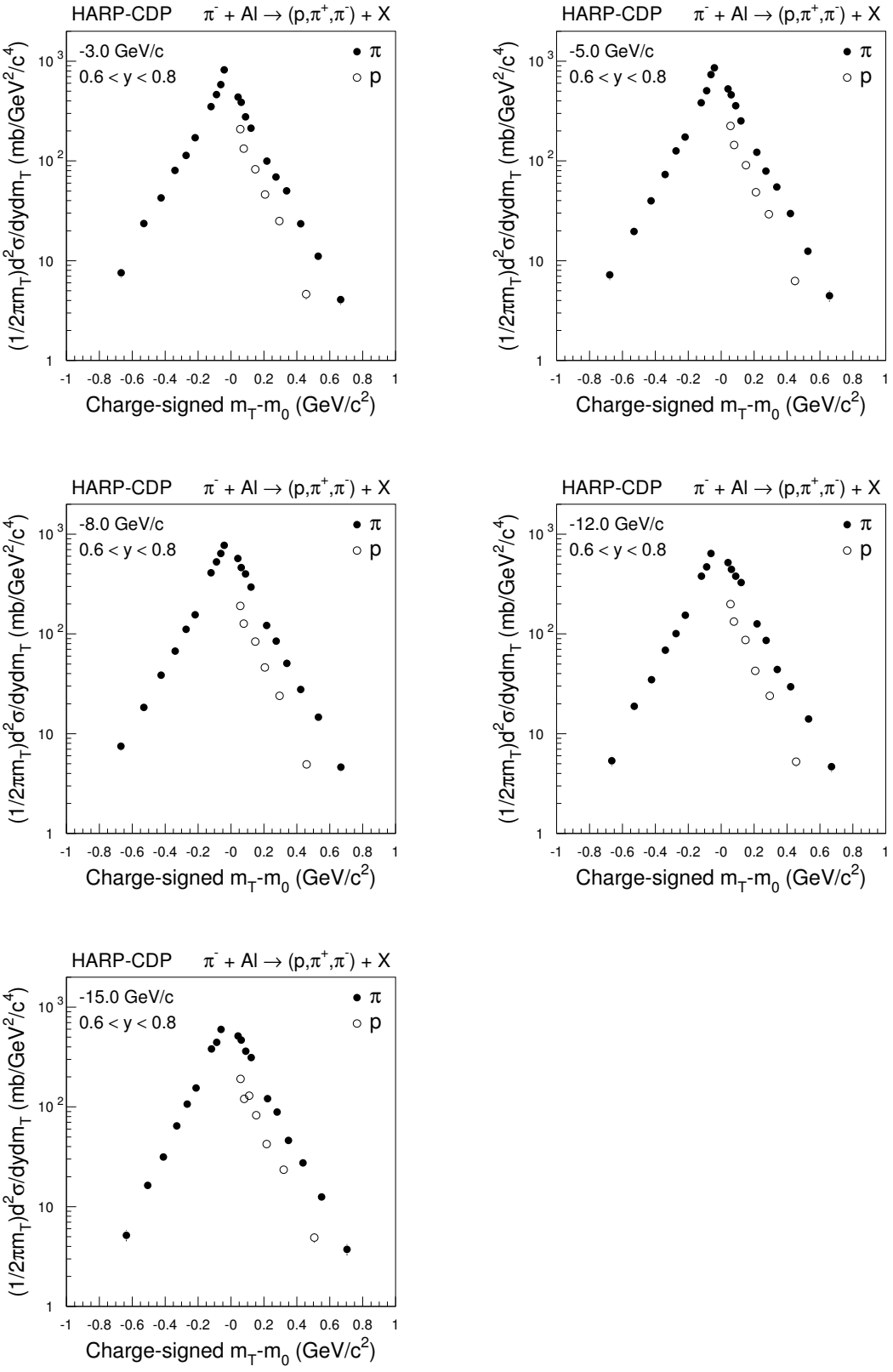

Fig. 6: Inclusive Lorentz-invariant cross-sections of the production of protons, π^+'s and π^-'s, by incoming π^-'s between 3 GeV/c and 15 GeV/c momentum, in the rapidity range $0.6 < y < 0.8$, as a function of the charge-signed reduced transverse pion mass, $m_{\mathrm{T}} - m_0$, where m_0 is the rest mass of the respective particle; the shown errors are total errors.

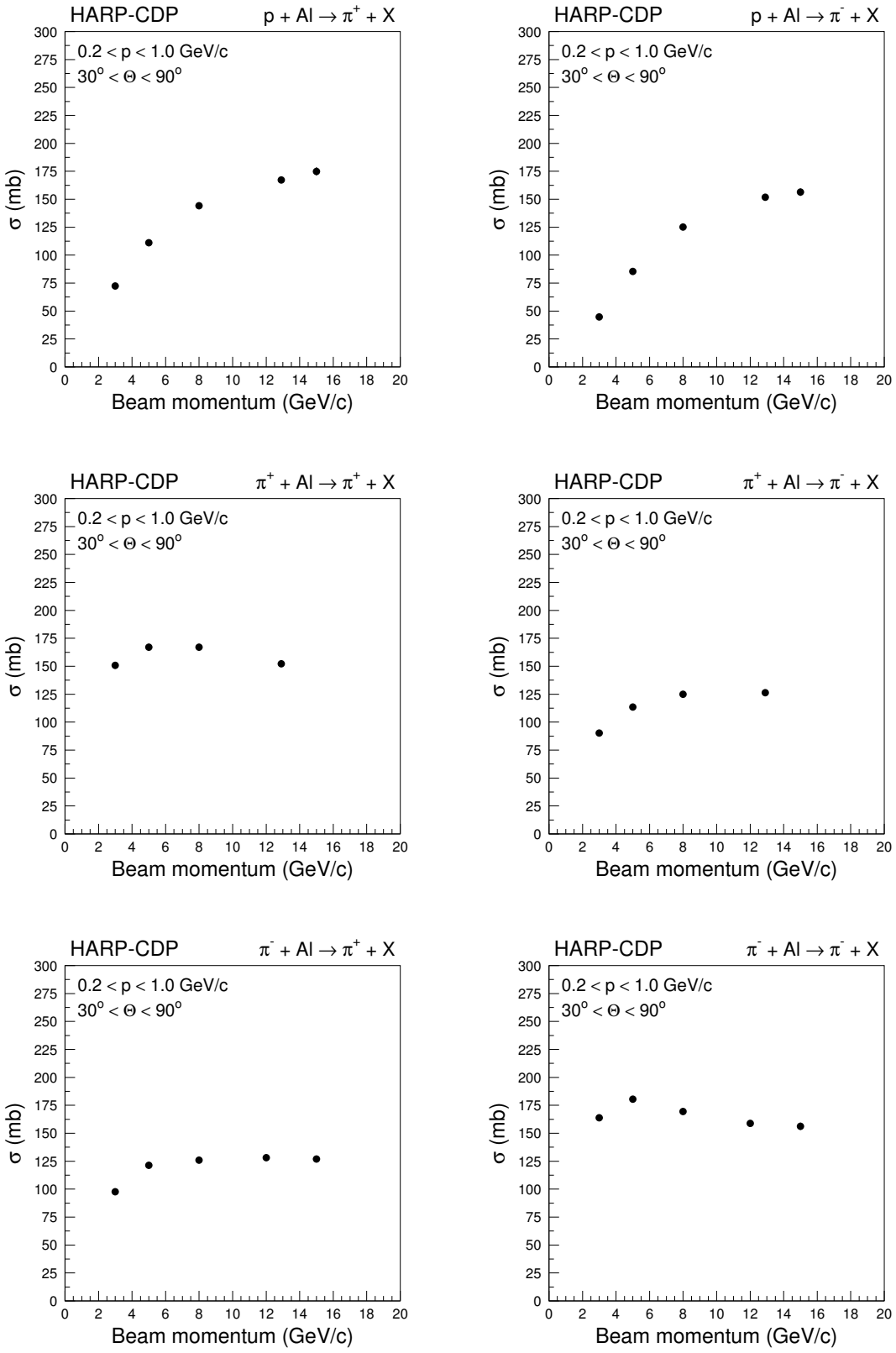

Fig. 7: Inclusive cross-sections of the production of secondary π^+'s and π^-'s, integrated over the momentum range $0.2 < p < 1.0$ GeV/c and the polar-angle range $30^\circ < \theta < 90^\circ$, from the interactions on aluminium nuclei of protons (top row), π^+'s (middle row), and π^-'s (bottom row), as a function of the beam momentum; the shown errors are total errors and mostly smaller than the symbol size.

5 COMPARISON WITH RESULTS FROM THE E802 EXPERIMENT

Experiment E802 [14] at Brookhaven National Laboratory measured secondary $\pi^{\pm}$'s and protons in the polar-angle range $5^{\circ} < \theta < 58^{\circ}$ from the interactions of $+14.6$ GeV/*c* protons with aluminium nuclei.

Figure 8 shows their published Lorentz-invariant cross-section of π^{+} and π^{-} production by $+14.6$ GeV/*c* protons, in the rapidity range $0.8 < y < 1.0$, as a function of $m_{\mathrm{T}} - m_{\pi}$, where m_{T} denotes the secondary particle's transverse mass. Their data are compared with our respective cross-sections from the interactions of $+15.0$ GeV/*c* protons with aluminium nuclei.

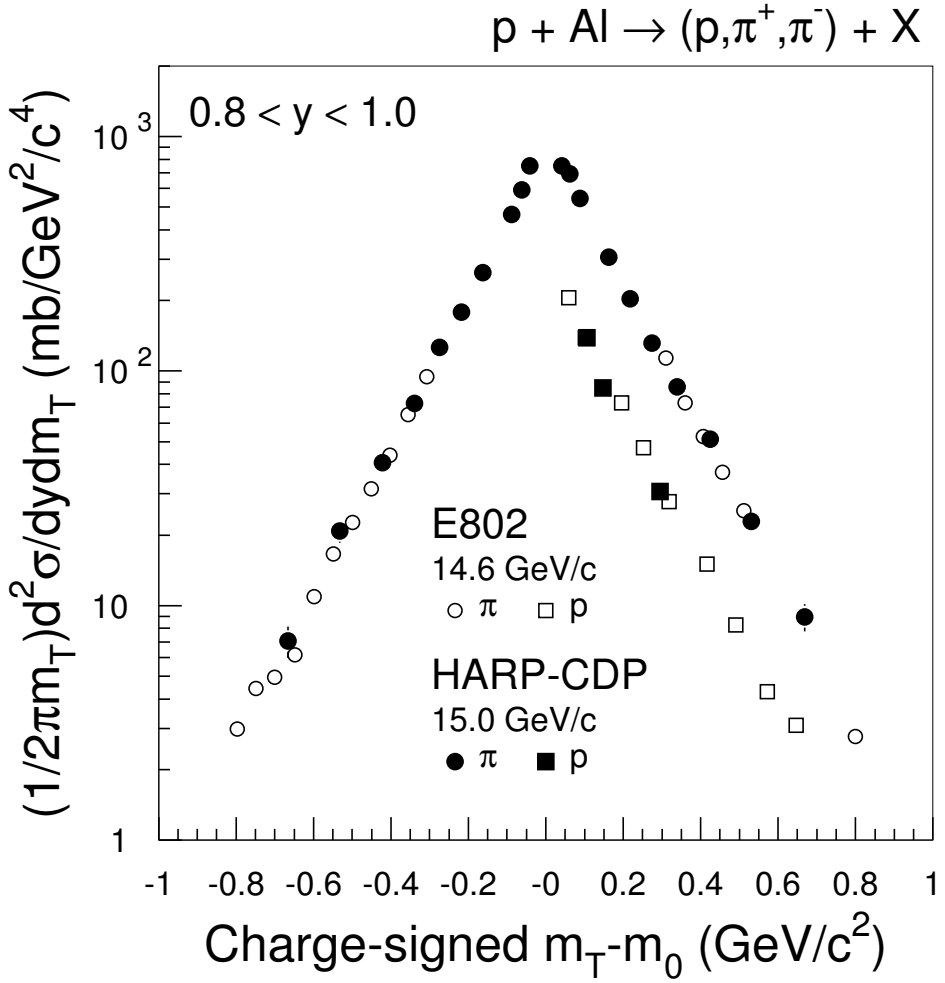

Fig. 8: Comparison of our cross-sections (black symbols) of $\pi^{\pm}$ and proton production by $+15.0$ GeV/*c* protons off aluminium nuclei, with the respective cross-sections published by the E802 Collaboration for the proton beam momentum of $+14.6$ GeV/*c* (open symbols).

The E802 $\pi^{\pm}$ and proton cross-sections are in good agreement with our cross-sections measured nearly at the same proton beam momentum, taking into account the normalization uncertainty of (10–15)% quoted by E802.

6 COMPARISON WITH RESULTS FROM THE HARP COLLABORATION

Figure 9 shows the comparison of our cross-sections of $\pi^{\pm}$ production by protons, π^{+}'s and π^{-}'s of 3.0 GeV/*c* and 8.0 GeV/*c* momentum, off aluminium nuclei, with the ones published by the HARP Collaboration [15, 16], in the polar-angle range $20^{\circ} < \theta < 30^{\circ}$. The latter cross-sections are plotted as published, while we expressed our cross-sections in the unit used by the HARP Collaboration. The errors shown are the published total errors.

The discrepancy between our results and those published by the HARP Collaboration is evident. It shows the same pattern as observed in inclusive cross-sections off other target nuclei [2–8]. We hold that the discrepancy is caused by problems in the HARP Collaboration's data analysis, discussed in detail in Refs [17–21], and summarized in the Appendix of Ref. [2].

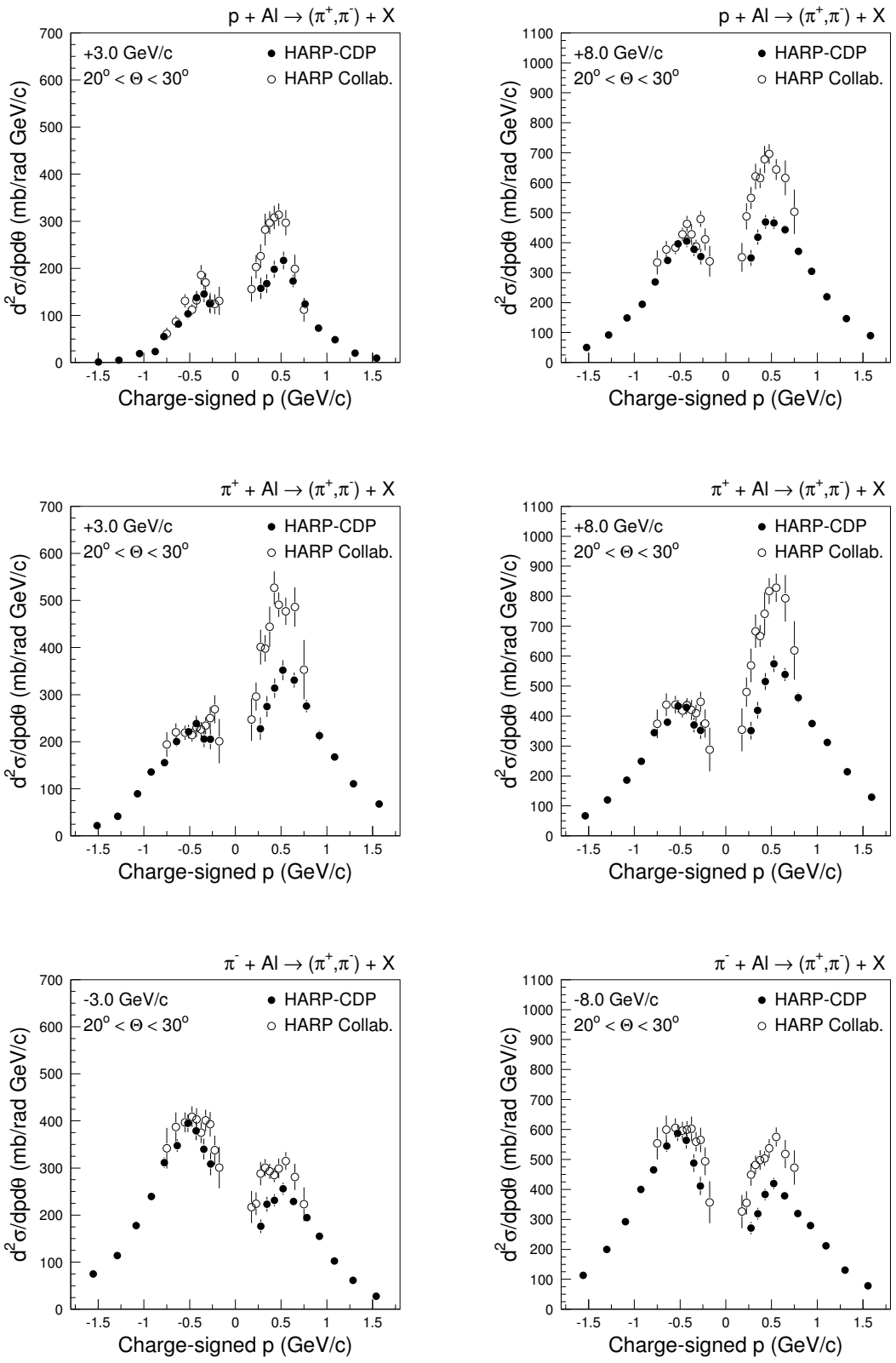

Fig. 9: Comparison of HARP–CDP cross-sections (full circles) of $\pi^{\pm}$ production by protons, π^{+}'s and π^{-}'s of 3.0 GeV/c (left panels) and 8.0 GeV/c momentum (right panels), off aluminium nuclei, with the cross-sections published by the HARP Collaboration (open circles).

7 COMPARISON OF CHARGED-PION PRODUCTION ON BERYLLIUM, CARBON, ALUMINIUM, COPPER, TIN, TANTALUM AND LEAD

Figure 10 presents a comparison between the inclusive cross-sections of π^+ and π^- production, integrated over the secondaries' momentum range $0.2 < p < 1.0$ GeV/c and polar-angle range $30^\circ < \theta < 90^\circ$, in the interactions of protons, π^+ and π^-, with beryllium (A = 9.01), carbon (A = 12.01), aluminium (A = 26.98), copper (A = 63.55), tin (A = 118.7), tantalum (A = 181.0), and lead (A = 207.2) nuclei[1)]. The comparison employs the scaling variable $A^{2/3}$ where A is the atomic mass number of the respective nucleus. We note the approximately linear dependence on this scaling variable. At low beam momentum, the slope exhibits a strong dependence on beam particle type, which tends to disappear with higher beam momentum.

Linearity with $A^{2/3}$ means that inclusive pion production scales with the geometrical cross-section of the nucleus. We note that at the lowest beam momenta the inclusive pion cross-section tends to fall below a linear dependence on $A^{2/3}$, while at the highest beam momenta the cross-sections tend to lie above a linear dependence. We conjecture that this behaviour arises from the production of tertiary pions from the interactions of secondaries in nuclear matter. At high beam momenta, the acceptance cut of $p > 0.2$ GeV/c has a minor effect on the tertiary pions. The transition of the inclusive pion cross-section from an approximate $A^{2/3}$ dependence for light nuclei toward an approximate A dependence for heavy nuclei (owing to the increasing contribution of pions from the re-interactions in nuclear matter) becomes apparent. At low beam momenta, the acceptance cut of $p > 0.2$ GeV/c suppresses a large fraction of the primarily low-momentum tertiaries, thus not only hiding this transition but even reversing its trend.

Figure 11 compares the 'forward multiplicity' of secondary π^+'s and π^-'s in the interaction of protons and pions with beryllium, carbon, aluminium, copper, tin, tantalum, and lead target nuclei. The forward multiplicities are averaged over the momentum range $0.2 < p < 1.0$ GeV/c and the polar-angle range $30^\circ < \theta < 90^\circ$. They have been obtained by dividing the measured inclusive cross-section by the total cross-section inferred from the nuclear interaction lengths and pion interaction lengths, respectively, as published by the Particle Data Group [22] and reproduced in Table 1. The errors of the forward multiplicities are dominated by a 3% systematic uncertainty.

Table 1: Nuclear and pion interactions lengths used for the calculation of pion forward multiplicities.

Nucleus	$\lambda_{\rm int}^{\rm nucl}$ [g cm^{-2}]	$\lambda_{\rm int}^{\rm pion}$ [g cm^{-2}]
Beryllium	77.8	109.9
Carbon	85.8	117.8
Aluminium	107.2	136.7
Copper	137.3	165.9
Tin	166.7	194.3
Tantalum	191.0	217.7
Lead	199.6	226.2

The forward multiplicities display a 'leading particle effect' that mirrors the incoming beam particle. It is also interesting that the forward multiplicity decreases with the nuclear mass at

[1)] The beryllium data with $+8.9$ GeV/c beam momentum [2, 3] have been scaled, by interpolation, to a beam momentum of $+8.0$ GeV/c; analogously, this paper's aluminium data with $+12.9$ GeV beam momentum have been scaled to a beam momentum of $+12.0$ GeV/c

low beam momentum but increases at high beam momentum. Again, we interpret this as the effect of pion re-interactions in the nuclear matter in conjunction with the acceptance cut of $p > 0.2$ GeV/c.

Figure 12 shows the increase of the inclusive cross-sections of π^+ and π^- production by incoming protons of $+3.0$ GeV/c from the light beryllium nucleus to the heavy lead nucleus, for pions in the polar angle range $20^\circ < \theta < 30^\circ$. For comparison, Figure 13 shows the analogous cross sections for incoming protons of $+8.0$ GeV/c (in the case of beryllium target nuclei: +8.9 GeV/c).

We observe that the π^+/π^- ratio depends on the proton beam momentum. We interpret the diminishing preponderance of π^+ over π^- with increasing beam momentum as a consequence of the increase of phase space for particle production. We observe further that the general preponderance of π^+ over π^- decreases with increasing atomic mass number A. For $+8.0$ GeV/c beam momentum, the trend even reverses from light to heavy nuclei. We interpret this feature as follows. The heavier the target nucleus, the larger the neutron-to-proton ratio. While low-energy secondary protons produce in their re-interactions in nuclear matter considerably more π^+ than π^-, the situation is the opposite for low-energy secondary neutrons as shown long ago in a pertinent experiment [23]. The heavier the target nucleus, the larger the neutron-to-proton ratio and therefore the contribution to π^- production by secondary neutrons.

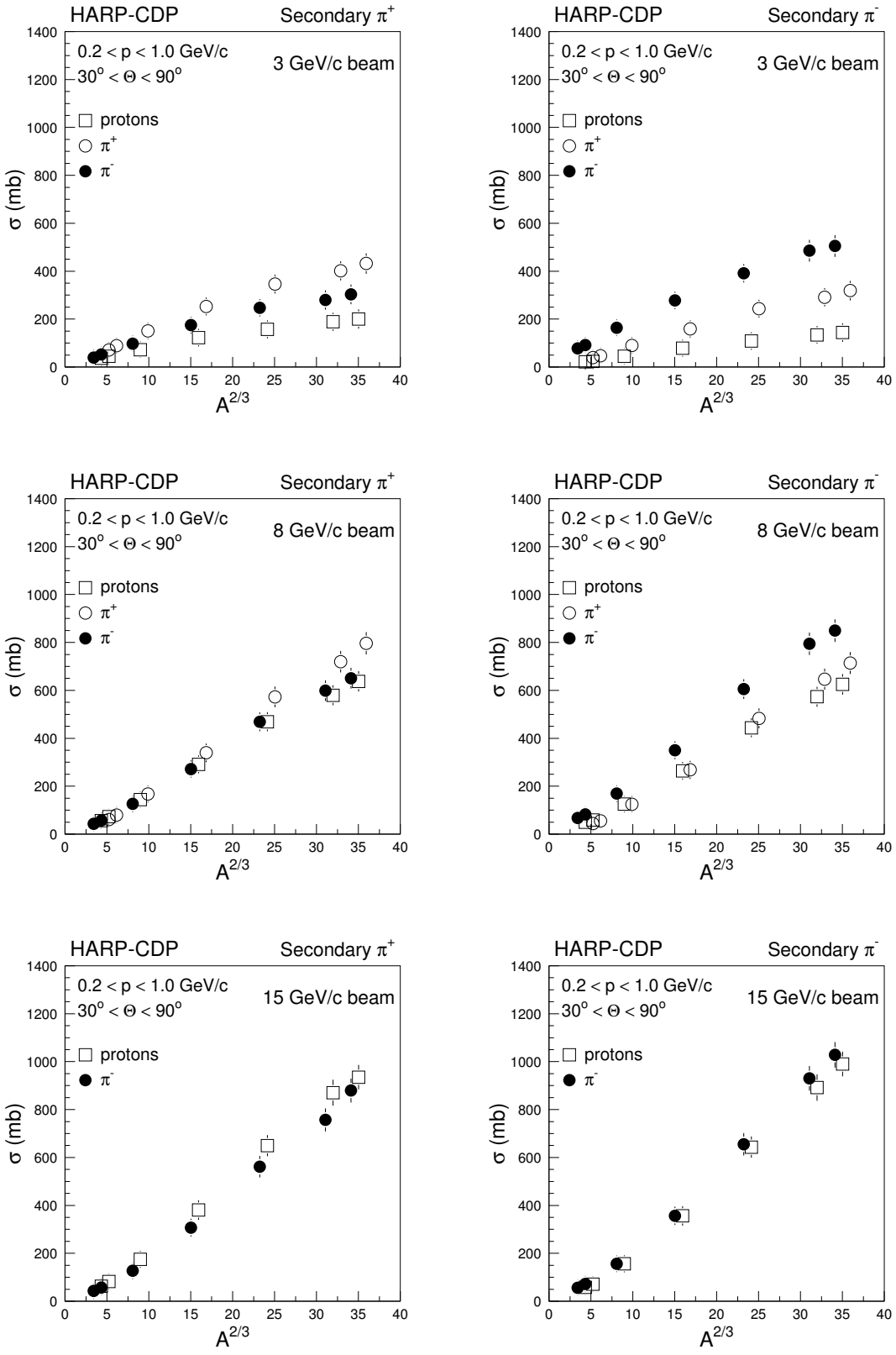

Fig. 10: Inclusive cross-sections of π^+ and π^- production by protons (open squares), π^+'s (open circles), and π^-'s (black circles), as a function of $A^{2/3}$ for, from left to right, beryllium, carbon, aluminium, copper, tin, tantalum, and lead nuclei; the cross-sections are integrated over the momentum range $0.2 < p < 1.0$ GeV/c and the polar-angle range $30^\circ < \theta < 90^\circ$; the shown errors are total errors and often smaller than the symbol size.

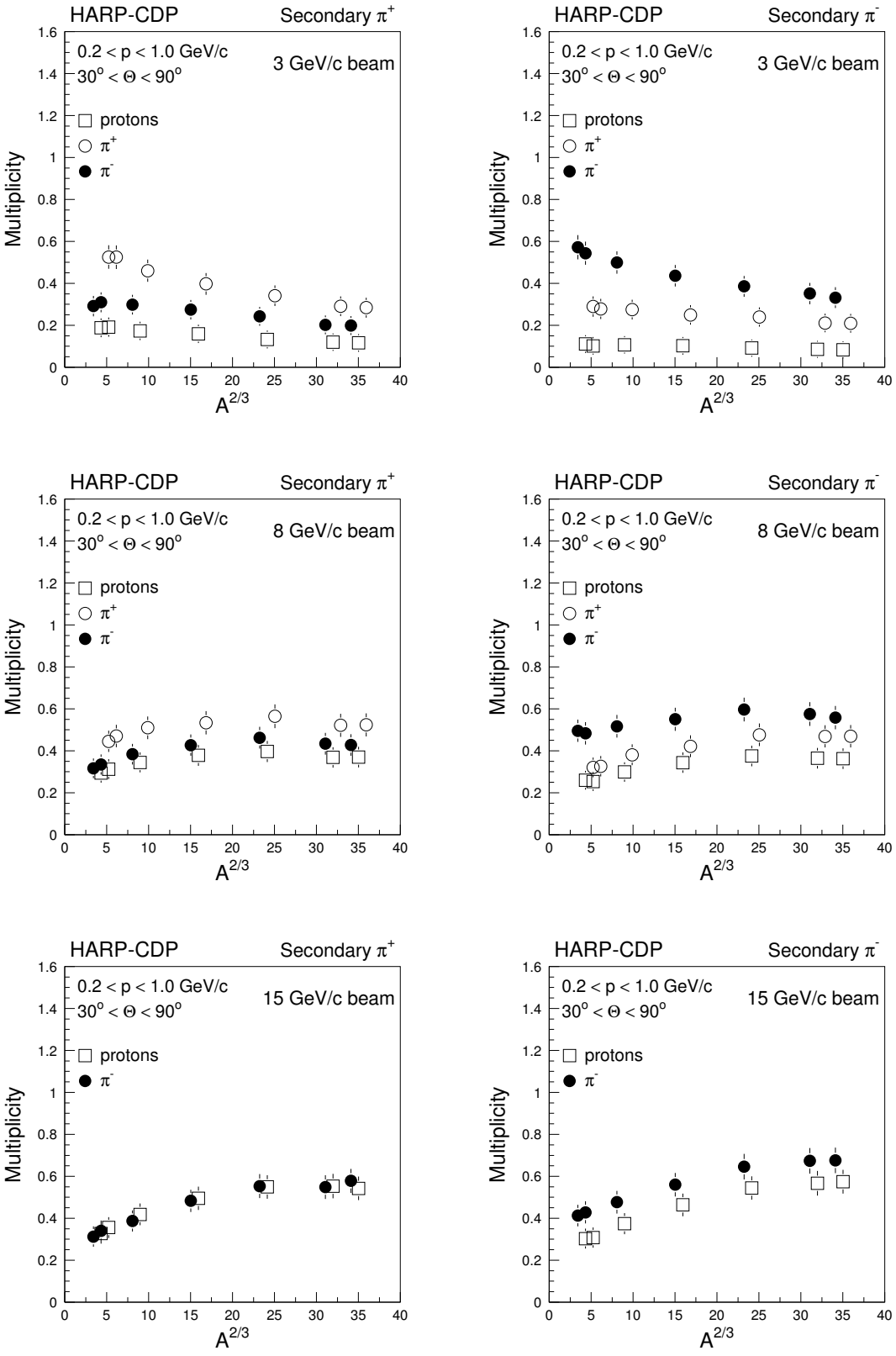

Fig. 11: Forward multiplicity of π^+'s and π^-'s produced by protons (open squares), π^+'s (open circles), and π^-'s (black circles), as a function of $A^{2/3}$ for, from left to right, beryllium, carbon, aluminium, copper, tin, tantalum, and lead nuclei; the forward multiplicity refers to the momentum range $0.2 < p < 1.0$ GeV/c and the polar-angle range $30^\circ < \theta < 90^\circ$ of secondary pions.

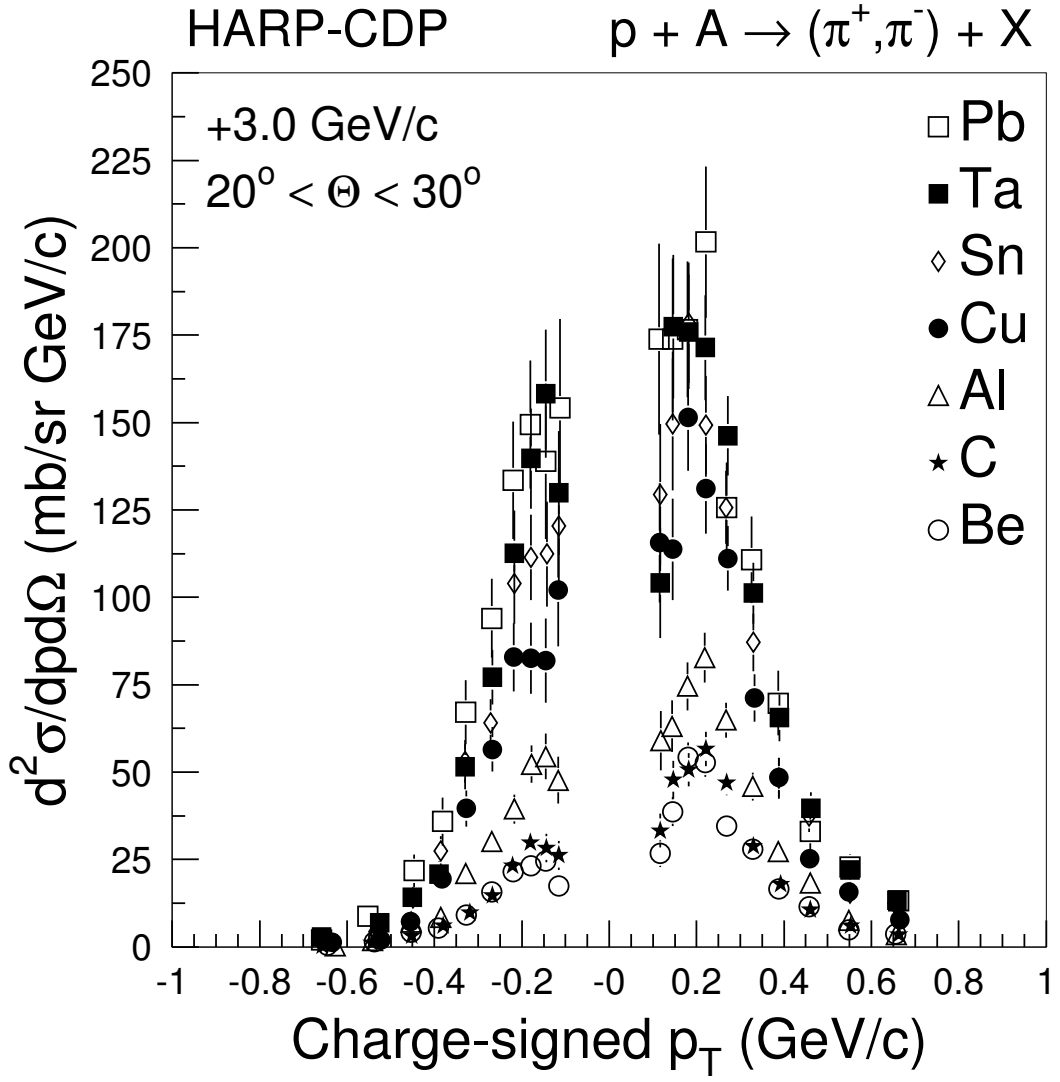

Fig. 12: Comparison of inclusive cross-sections of $\pi^{\pm}$ production by 3 GeV/c protons, in the forward region, between beryllium, carbon, copper, tin, tantalum, and lead target nuclei, as a function of the charge-signed pion p_{T}.

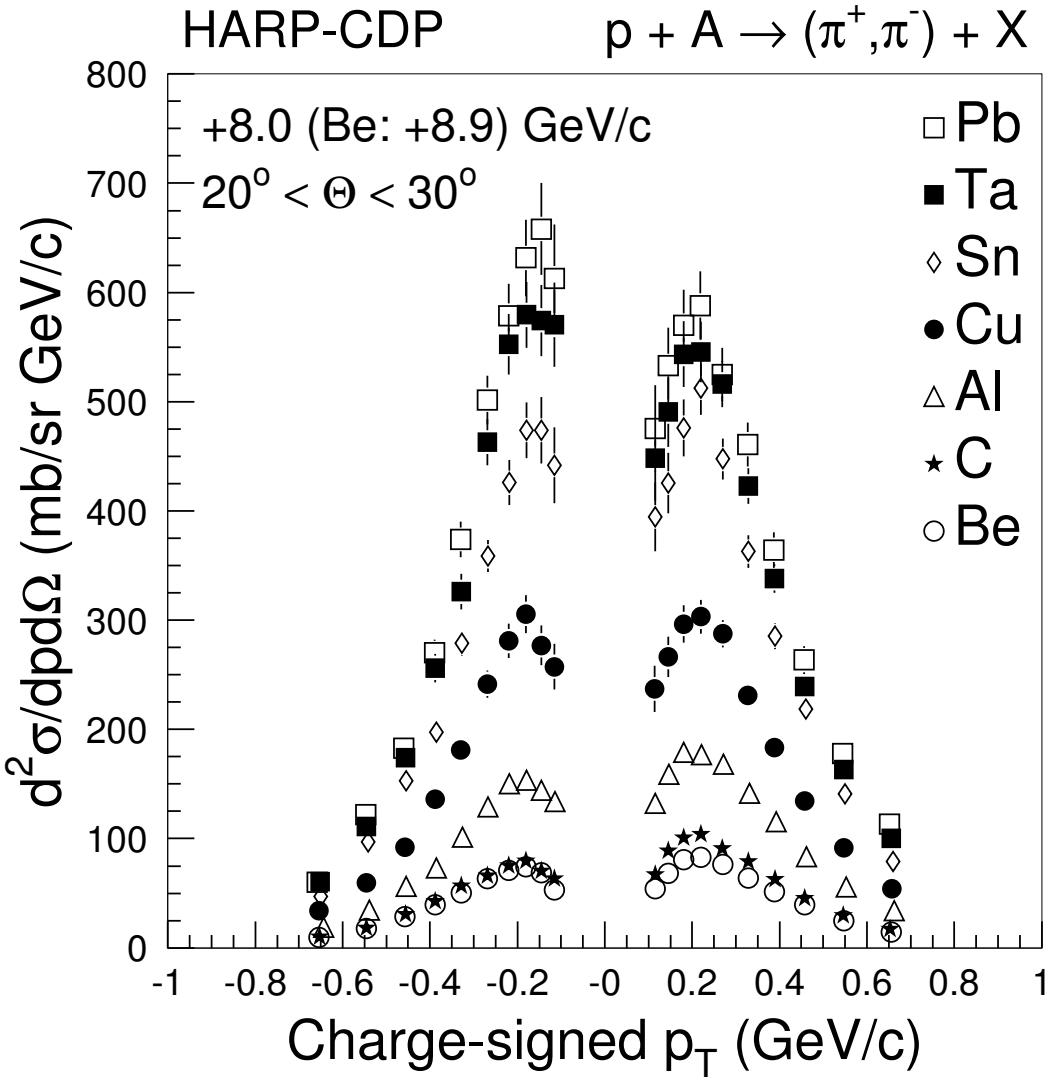

Fig. 13: Comparison of inclusive cross-sections of $\pi^{\pm}$ production by 8 GeV/c protons, in the forward region, between beryllium, carbon, copper, tin, tantalum, and lead target nuclei, as a function of the charge-signed pion p_{T}.

8 DEUTERON PRODUCTION

Besides pions and protons, also deuterons are produced on aluminium nuclei. Up to momenta of about 1 GeV/c, deuterons are easily separated from protons by $\mathrm{d}E/\mathrm{d}x$.

Table 2 gives the deuteron-to-proton production ratio as a function of the momentum at the vertex, for 8 GeV/c beam protons, π^+'s, and π^-'s[2)]. Cross-section ratios are not given if the data are scarce and the statistical error becomes comparable with the ratio itself—which is the case for deuterons at the high-momentum end of the spectrum.

The measured deuteron-to-proton production ratios are illustrated in Fig. 14, and compared with the predictions of Geant4's FRITIOF model. FRITIOF's predictions are shown for π^+ beam particles[3)]. While there is for small polar angles θ good agreement between the data and FRITIOF's estimate, the latter tends to fall short of the data toward large polar angles.

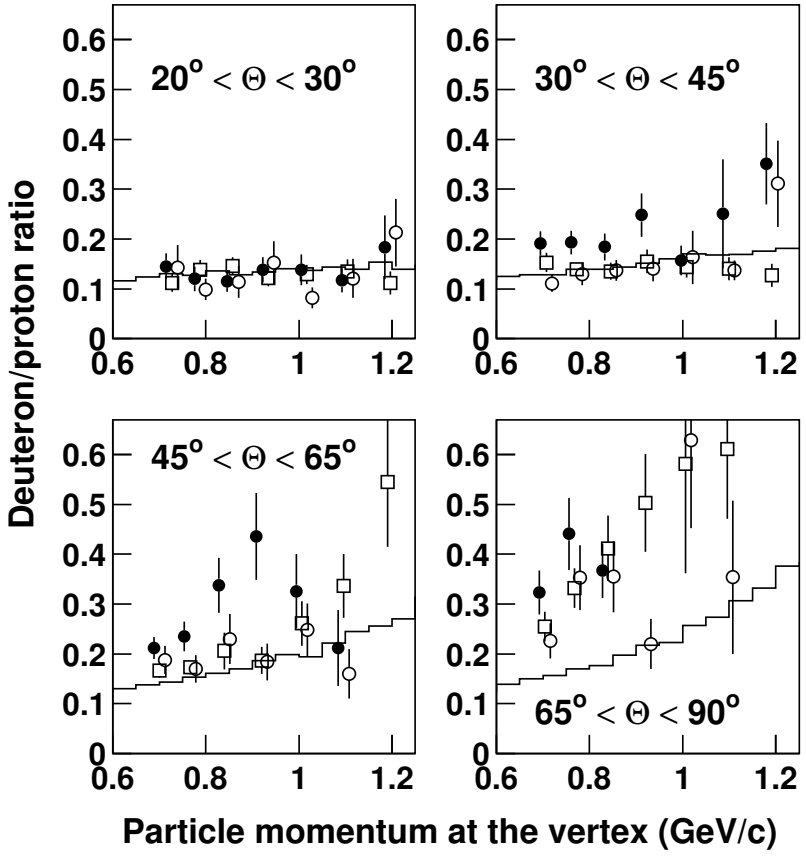

Fig. 14: Deuteron-to-proton production ratios for 8 GeV/c beam particles on aluminium nuclei, as a function of the momentum at the vertex, for four polar-angle regions; open squares denote beam protons, open circles beam π^+'s, and full circles beam π^-'s; the full lines denotes predictions of Geant4's FRITIOF model for π^+ beam particles.

[2)] We observe no appreciable dependence of the deuteron-to-proton production ratio on beam momentum.

[3)] There is less than 10% difference between its predictions for incoming protons, π^+'s and π^-'s.

In Fig. 15 we show, for the polar-angle region $30^\circ < \theta < 45^\circ$, how the deuteron-to-proton ratio varies with the mass of the target nucleus. The ratios are for 8 GeV/c beam protons on beryllium, carbon, aluminium, copper, tin, tantalum and lead nuclei.

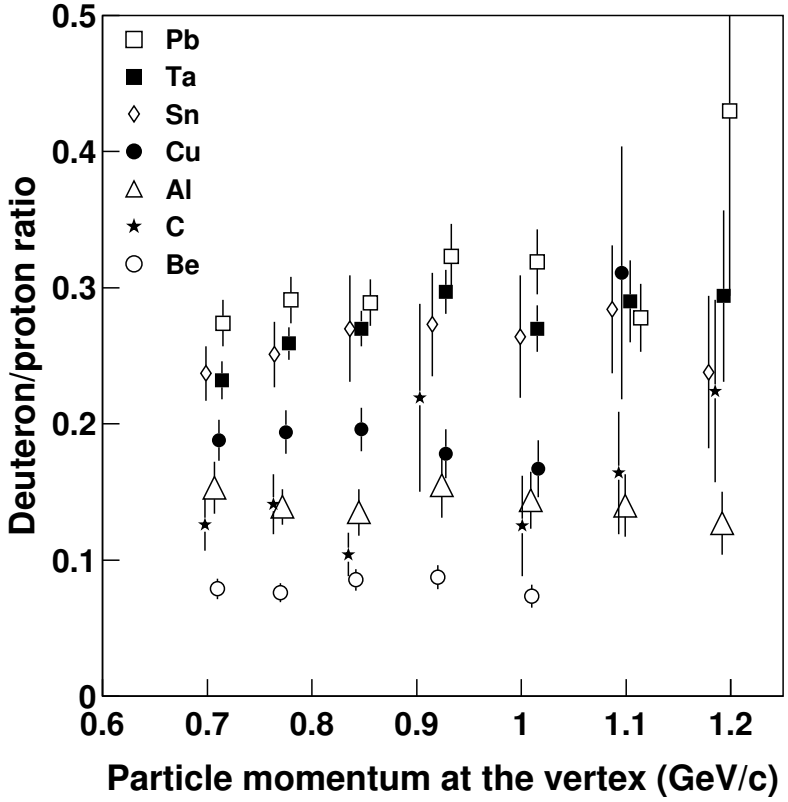

Fig. 15: Deuteron-to-proton production ratios for 8 GeV/c beam protons on beryllium, carbon, aluminium, copper, tin, tantalum and lead nuclei, as a function of the momentum at the vertex, for the polar-angle region $30^\circ < \theta < 45^\circ$.

In Fig. 16 we show how the deuteron-to-proton ratio depends on the atomic mass number A. Since in this ratio the geometrical scaling with $A^{2/3}$ should cancel out, any remaining dependence should reflect re-interactions in the nuclear matter for which $A^{1/3}$ seems the right scaling variable. The ratios are averaged over the $0.65 < p < 1.05$, where p is the particle momentum at the vertex, and shown separately for the polar-angle bins $20^\circ < \theta < 30^\circ$ and $30^\circ < \theta < 45^\circ$. We note an approximately linear increase of the deuteron-to-proton ratio with $A^{1/3}$, and a tendency to increase with polar angle.

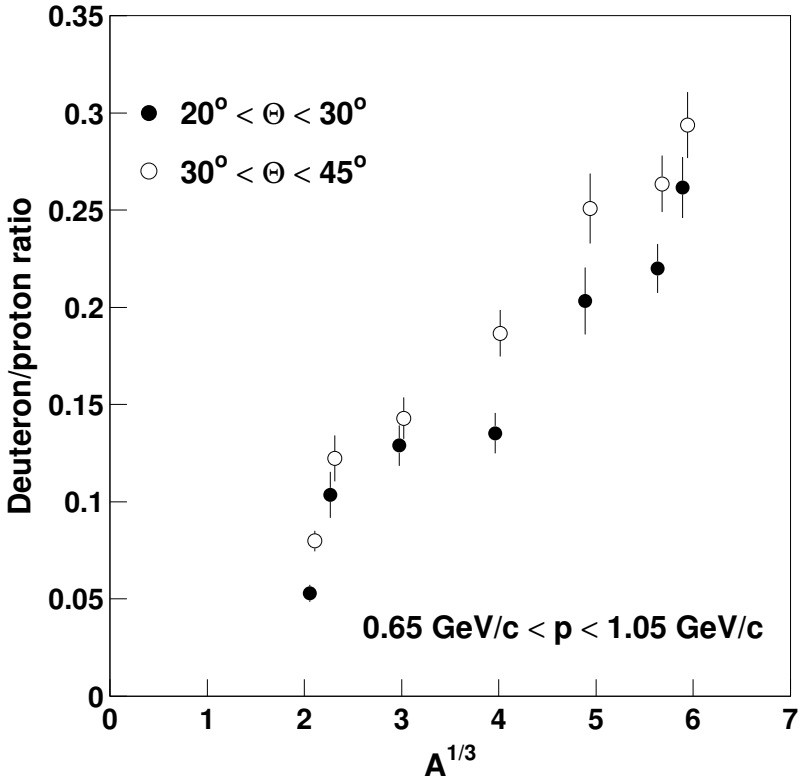

Fig. 16: Momentum-averaged deuteron-to-proton production ratios for 8 GeV/c beam protons on beryllium, carbon, aluminium, copper, tin, tantalum and lead nuclei, as a function of $A^{1/3}$, for the polar-angle regions $20^\circ < \theta < 30^\circ$ (black points) and $30^\circ < \theta < 45^\circ$ (open points).

Table 2: Ratio d/p of deuterons to protons produced by beam protons, π^+'s and π^-'s of 8 GeV/c momentum, as a function of the particle momentum p [GeV/c] at the vertex, for bins of polar angle θ.

p	Beam p d/p	Beam π^+ d/p	Beam π^- d/p
$\theta = 20^\circ - 30^\circ$			
0.73	0.112 ± 0.018	0.143 ± 0.045	0.145 ± 0.026
0.79	0.138 ± 0.020	0.099 ± 0.021	0.120 ± 0.025
0.86	0.146 ± 0.018	0.114 ± 0.032	0.115 ± 0.021
0.93	0.122 ± 0.017	0.152 ± 0.044	0.138 ± 0.025
1.02	0.129 ± 0.019	0.082 ± 0.021	0.138 ± 0.031
1.10	0.135 ± 0.024	0.121 ± 0.039	0.117 ± 0.024
1.20	0.112 ± 0.023	0.213 ± 0.068	0.183 ± 0.064
$\theta = 30^\circ - 45^\circ$			
0.71	0.153 ± 0.019	0.111 ± 0.017	0.191 ± 0.024
0.77	0.139 ± 0.013	0.129 ± 0.022	0.193 ± 0.024
0.85	0.135 ± 0.017	0.137 ± 0.021	0.184 ± 0.027
0.92	0.155 ± 0.024	0.140 ± 0.025	0.248 ± 0.044
1.01	0.144 ± 0.021	0.163 ± 0.053	0.157 ± 0.030
1.10	0.140 ± 0.023	0.137 ± 0.020	0.251 ± 0.109
1.19	0.127 ± 0.023	0.311 ± 0.087	0.351 ± 0.082
$\theta = 45^\circ - 65^\circ$			
0.70	0.167 ± 0.015	0.188 ± 0.028	0.212 ± 0.022
0.77	0.173 ± 0.014	0.170 ± 0.028	0.235 ± 0.030
0.84	0.206 ± 0.037	0.230 ± 0.050	0.338 ± 0.055
0.92	0.187 ± 0.027	0.184 ± 0.037	0.436 ± 0.087
1.01	0.261 ± 0.045	0.248 ± 0.053	0.326 ± 0.074
1.10	0.336 ± 0.064	0.160 ± 0.050	0.212 ± 0.076
1.19	0.545 ± 0.130		
$\theta = 65^\circ - 90^\circ$			
0.70	0.255 ± 0.030	0.226 ± 0.035	0.323 ± 0.044
0.77	0.332 ± 0.040	0.353 ± 0.065	0.441 ± 0.072
0.84	0.412 ± 0.066	0.355 ± 0.071	0.367 ± 0.055
0.92	0.503 ± 0.098	0.220 ± 0.050	
1.01	0.581 ± 0.219	0.629 ± 0.177	
1.10	0.611 ± 0.140	0.354 ± 0.154	
1.19	0.879 ± 0.351		
$\theta = 90^\circ - 125^\circ$			
0.77	0.470 ± 0.069	0.441 ± 0.127	0.594 ± 0.101
0.84	0.562 ± 0.112	0.548 ± 0.142	0.620 ± 0.118
0.92	0.989 ± 0.393	0.579 ± 0.223	
1.01	1.053 ± 0.317		

9 SUMMARY

From the analysis of data from the HARP large-angle spectrometer (polar angle θ in the range $20^\circ < \theta < 125^\circ$), double-differential cross-sections $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ of the production of secondary protons, π^+'s, and π^-'s, and of deuterons, have been obtained. The incoming beam particles were protons and pions with momenta from ± 3 to ± 15 GeV/c, impinging on a 5% λ_{int} thick stationary aluminium target.

We have compared the inclusive aluminium π^+ and π^- production cross-sections with those on beryllium, carbon, copper, tin, tantalum, and lead and find an approximately linear dependence on the scaling variable $A^{2/3}$.

We also observe a significant production of deuterons off aluminium nuclei that we compared to the deuteron production on beryllium, carbon, copper, tin, tantalum, and lead.

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We are greatly indebted to many technical collaborators whose diligent and hard work made the HARP detector a well-functioning instrument. We thank all HARP colleagues who devoted time and effort to the design and construction of the detector, to data taking, and to setting up the computing and software infrastructure. We express our sincere gratitude to HARP's funding agencies for their support.

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APPENDIX A: CROSS-SECTION TABLES

Table A.1: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in p + Al $\rightarrow$ p + X interactions with $+3.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.220	25.0	195.44 ± 8.79 ± 9.96			
0.24–0.30	0.270	25.2	183.12 ± 6.94 ± 9.18	0.272	35.0	178.43 ± 6.52 ± 7.48
0.30–0.36	0.329	25.1	160.12 ± 6.71 ± 9.08	0.330	35.0	159.78 ± 6.31 ± 6.53
0.36–0.42	0.389	25.1	131.22 ± 6.08 ± 6.84	0.387	34.9	129.63 ± 5.94 ± 6.98
0.42–0.50	0.460	25.1	112.36 ± 4.75 ± 5.29	0.459	35.1	114.53 ± 4.96 ± 6.69
0.50–0.60	0.549	24.8	94.74 ± 3.84 ± 3.89	0.548	35.0	92.37 ± 3.99 ± 5.06
0.60–0.72	0.658	25.0	77.09 ± 3.20 ± 3.66	0.657	35.0	59.15 ± 2.88 ± 3.31
0.72–0.90				0.797	35.1	38.49 ± 1.92 ± 2.61

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.330	45.1	169.27 ± 6.17 ± 5.44			
0.36–0.42	0.387	45.0	148.88 ± 5.84 ± 4.88	0.388	55.1	160.26 ± 5.88 ± 4.75
0.42–0.50	0.457	45.0	118.61 ± 4.88 ± 5.28	0.456	54.8	127.45 ± 4.78 ± 4.24
0.50–0.60	0.542	45.1	83.93 ± 3.80 ± 4.94	0.545	54.9	81.01 ± 3.73 ± 5.32
0.60–0.72	0.652	45.0	66.11 ± 3.16 ± 4.33	0.649	55.0	54.18 ± 2.95 ± 4.61
0.72–0.90	0.791	45.1	33.58 ± 1.85 ± 2.75	0.789	55.0	23.12 ± 1.64 ± 2.68
0.90–1.25	1.031	44.7	9.12 ± 0.67 ± 1.12			

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.458	67.4	129.36 ± 3.81 ± 3.68	0.457	82.2	97.77 ± 3.25 ± 3.46
0.50–0.60	0.545	67.2	81.81 ± 2.92 ± 4.18	0.543	81.8	55.80 ± 2.24 ± 2.69

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.455	96.9	59.88 ± 2.54 ± 3.10	0.455	112.9	26.97 ± 1.53 ± 1.47
0.50–0.60	0.545	96.9	31.03 ± 1.70 ± 2.06			

Table A.2: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in p + Al $\to \pi^+$ + X interactions with $+3.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.118	25.1	59.07 ± 6.41	±	5.55	0.116	34.8	63.24 ± 6.50	±	4.90
0.13–0.16	0.144	25.0	63.15 ± 5.95	±	4.50	0.145	35.1	64.44 ± 5.97	±	4.22
0.16–0.20	0.180	25.0	74.55 ± 5.52	±	4.15	0.180	34.9	67.91 ± 5.13	±	3.88
0.20–0.24	0.219	24.7	82.70 ± 5.74	±	4.17	0.221	34.8	59.54 ± 4.80	±	2.99
0.24–0.30	0.268	25.1	64.86 ± 4.08	±	2.79	0.271	34.8	61.46 ± 3.87	±	2.73
0.30–0.36	0.329	25.5	45.86 ± 3.43	±	2.01	0.329	34.8	44.95 ± 3.34	±	1.90
0.36–0.42	0.387	25.2	27.32 ± 2.56	±	1.35	0.389	35.0	30.80 ± 2.73	±	1.49
0.42–0.50	0.461	25.0	18.29 ± 1.75	±	1.11	0.455	35.1	21.14 ± 1.95	±	1.09
0.50–0.60	0.549	24.8	7.55 ± 0.91	±	0.62	0.548	35.0	9.38 ± 1.10	±	0.60
0.60–0.72	0.657	25.2	3.57 ± 0.49	±	0.41	0.660	34.9	4.73 ± 0.66	±	0.41
0.72–0.90						0.781	35.0	2.07 ± 0.33	±	0.28

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	45.2	55.51 ± 6.15	±	4.32					
0.13–0.16	0.145	44.8	67.20 ± 6.09	±	4.06	0.145	54.7	58.46 ± 5.75	±	3.69
0.16–0.20	0.179	45.1	59.56 ± 4.82	±	3.14	0.178	54.9	62.03 ± 4.88	±	3.14
0.20–0.24	0.219	44.8	57.59 ± 4.70	±	2.85	0.219	54.8	53.81 ± 4.51	±	2.57
0.24–0.30	0.269	44.6	44.31 ± 3.35	±	1.97	0.267	54.8	37.11 ± 3.02	±	1.60
0.30–0.36	0.328	44.8	36.57 ± 3.01	±	1.58	0.327	54.8	29.26 ± 2.70	±	1.25
0.36–0.42	0.389	45.3	24.04 ± 2.43	±	1.17	0.389	55.0	20.25 ± 2.18	±	0.95
0.42–0.50	0.457	44.3	16.19 ± 1.72	±	0.84	0.456	55.0	14.27 ± 1.66	±	0.81
0.50–0.60	0.544	43.6	10.21 ± 1.17	±	0.66	0.544	54.7	7.04 ± 1.01	±	0.48
0.60–0.72	0.648	45.2	5.38 ± 0.78	±	0.47	0.649	54.3	2.90 ± 0.56	±	0.26
0.72–0.90	0.791	44.7	2.56 ± 0.41	±	0.31	0.782	54.1	2.29 ± 0.42	±	0.27
0.90–1.25						1.023	54.0	0.38 ± 0.08	±	0.07

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	67.6	56.88 ± 4.73	±	3.60	0.144	82.4	48.05 ± 4.47	±	3.27
0.16–0.20	0.179	67.6	53.05 ± 3.75	±	2.61	0.179	82.1	49.03 ± 3.60	±	2.45
0.20–0.24	0.218	67.4	42.16 ± 3.24	±	1.88	0.219	82.8	34.72 ± 2.93	±	1.58
0.24–0.30	0.268	66.9	29.02 ± 2.22	±	1.23	0.265	81.3	20.70 ± 1.87	±	1.03
0.30–0.36	0.328	66.9	18.83 ± 1.77	±	0.84	0.328	81.2	11.82 ± 1.40	±	0.69
0.36–0.42	0.387	67.3	13.43 ± 1.50	±	0.68	0.389	81.2	8.36 ± 1.21	±	0.63
0.42–0.50	0.454	66.3	8.60 ± 1.02	±	0.52	0.456	81.8	5.49 ± 0.82	±	0.45
0.50–0.60	0.540	66.3	4.73 ± 0.68	±	0.37	0.538	83.5	2.33 ± 0.49	±	0.23
0.60–0.72	0.656	65.7	3.09 ± 0.49	±	0.31	0.663	81.8	1.28 ± 0.33	±	0.16
0.72–0.90	0.809	66.8	1.19 ± 0.23	±	0.15	0.765	81.6	0.40 ± 0.12	±	0.07
0.90–1.25	1.047	67.4	0.13 ± 0.04	±	0.03	1.089	82.9	0.03 ± 0.02	±	0.02

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.7	48.44 ± 4.35	±	3.08	0.145	115.3	36.54 ± 3.25	±	1.98
0.16–0.20	0.181	96.7	41.14 ± 3.30	±	2.01	0.180	113.6	28.09 ± 2.36	±	1.17
0.20–0.24	0.219	97.5	23.20 ± 2.42	±	1.08	0.216	114.5	16.05 ± 1.80	±	0.73
0.24–0.30	0.268	97.3	15.95 ± 1.67	±	0.89	0.264	113.3	8.04 ± 0.99	±	0.50
0.30–0.36	0.327	97.6	5.35 ± 0.95	±	0.44	0.319	113.4	2.29 ± 0.54	±	0.22
0.36–0.42	0.387	97.2	4.65 ± 0.91	±	0.52	0.391	116.0	1.62 ± 0.47	±	0.24
0.42–0.50	0.465	96.1	2.26 ± 0.56	±	0.30	0.450	108.6	0.28 ± 0.17	±	0.06
0.50–0.60	0.550	98.5	1.32 ± 0.38	±	0.19	0.525	113.1	0.33 ± 0.15	±	0.09
0.60–0.72	0.651	95.7	0.44 ± 0.16	±	0.09					
0.72–0.90	0.786	95.5	0.12 ± 0.06	±	0.04					

Table A.3: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in p + Al $\to \pi^-$ + X interactions with $+3.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.6	47.65 ± 5.49	±	3.81	0.114	35.2	49.54 ± 5.56	±	3.95
0.13–0.16	0.146	25.1	54.47 ± 5.47	±	3.55	0.146	35.3	54.70 ± 5.52	±	3.96
0.16–0.20	0.178	24.8	52.28 ± 4.51	±	2.87	0.181	34.9	47.42 ± 4.25	±	2.76
0.20–0.24	0.217	24.7	39.41 ± 3.70	±	1.93	0.219	34.9	41.96 ± 3.83	±	2.15
0.24–0.30	0.268	25.5	30.17 ± 2.75	±	1.31	0.270	35.1	35.12 ± 2.85	±	1.52
0.30–0.36	0.329	24.9	20.93 ± 2.22	±	0.99	0.329	34.8	23.96 ± 2.34	±	1.06
0.36–0.42	0.386	26.1	8.48 ± 1.48	±	0.50	0.387	34.9	15.28 ± 1.92	±	0.78
0.42–0.50	0.453	25.7	7.05 ± 1.16	±	0.49	0.456	35.4	7.93 ± 1.20	±	0.46
0.50–0.60	0.542	25.2	1.87 ± 0.52	±	0.17	0.540	35.1	4.91 ± 0.84	±	0.37
0.60–0.72	0.628	24.8	0.36 ± 0.21	±	0.04	0.645	34.0	1.18 ± 0.37	±	0.12
0.72–0.90						0.742	32.7	0.16 ± 0.12	±	0.02

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.117	45.4	27.87 ± 4.25	±	2.33					
0.13–0.16	0.145	44.6	37.92 ± 4.50	±	2.62	0.145	54.8	41.97 ± 4.74	±	2.95
0.16–0.20	0.180	45.1	30.63 ± 3.32	±	1.77	0.182	55.0	38.26 ± 3.68	±	2.19
0.20–0.24	0.221	44.5	34.10 ± 3.44	±	1.78	0.220	54.8	34.39 ± 3.42	±	1.85
0.24–0.30	0.269	44.7	27.70 ± 2.57	±	1.23	0.269	55.0	22.98 ± 2.29	±	1.04
0.30–0.36	0.327	44.8	20.57 ± 2.19	±	0.90	0.329	54.3	16.95 ± 1.97	±	0.78
0.36–0.42	0.386	45.8	13.74 ± 1.83	±	0.68	0.390	55.2	13.68 ± 1.81	±	0.74
0.42–0.50	0.458	45.0	12.15 ± 1.45	±	0.69	0.456	55.4	7.68 ± 1.16	±	0.46
0.50–0.60	0.552	45.1	4.05 ± 0.77	±	0.31	0.548	54.1	4.30 ± 0.79	±	0.33
0.60–0.72	0.651	44.6	1.42 ± 0.41	±	0.15	0.666	53.9	2.02 ± 0.50	±	0.22
0.72–0.90	0.782	44.8	0.57 ± 0.21	±	0.09	0.840	56.2	0.40 ± 0.18	±	0.06

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	67.2	46.30 ± 4.34	±	3.07	0.145	82.6	34.04 ± 3.61	±	2.21
0.16–0.20	0.180	66.4	31.22 ± 2.80	±	1.59	0.178	81.3	34.18 ± 3.01	±	1.75
0.20–0.24	0.219	67.4	27.31 ± 2.48	±	1.29	0.221	82.3	24.00 ± 2.44	±	1.17
0.24–0.30	0.270	67.2	21.32 ± 1.82	±	0.89	0.267	82.2	15.42 ± 1.56	±	0.71
0.30–0.36	0.330	67.4	14.51 ± 1.53	±	0.65	0.329	82.6	8.80 ± 1.18	±	0.49
0.36–0.42	0.389	67.6	8.59 ± 1.18	±	0.46	0.381	81.7	4.64 ± 0.88	±	0.35
0.42–0.50	0.453	67.0	4.50 ± 0.73	±	0.29	0.460	82.5	2.65 ± 0.57	±	0.24
0.50–0.60	0.551	67.4	3.52 ± 0.59	±	0.29	0.552	82.7	2.08 ± 0.45	±	0.23
0.60–0.72	0.660	66.9	1.25 ± 0.32	±	0.13	0.651	83.2	1.06 ± 0.29	±	0.14
0.72–0.90	0.791	67.7	0.45 ± 0.15	±	0.06					

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	97.7	29.90 ± 3.33	±	1.96	0.144	114.6	29.03 ± 2.92	±	1.79
0.16–0.20	0.180	97.7	25.43 ± 2.60	±	1.33	0.177	114.8	20.13 ± 1.99	±	0.99
0.20–0.24	0.221	97.0	18.57 ± 2.18	±	0.94	0.218	114.6	10.35 ± 1.38	±	0.60
0.24–0.30	0.269	96.3	12.06 ± 1.39	±	0.64	0.269	112.2	5.67 ± 0.82	±	0.40
0.30–0.36	0.331	95.5	4.37 ± 0.86	±	0.33	0.324	113.2	1.99 ± 0.50	±	0.20
0.36–0.42	0.384	96.1	3.57 ± 0.78	±	0.37	0.384	112.3	1.18 ± 0.37	±	0.16
0.42–0.50	0.450	97.1	0.77 ± 0.31	±	0.10	0.447	113.8	0.43 ± 0.19	±	0.08
0.50–0.60	0.548	97.3	0.32 ± 0.18	±	0.05	0.530	113.0	0.21 ± 0.12	±	0.06
0.60–0.72	0.666	94.8	0.29 ± 0.13	±	0.07					
0.72–0.90	0.800	97.1	0.05 ± 0.04	±	0.02					

Table A.4: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^+ + Al $\rightarrow$ p + X interactions with $+3.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.20–0.24	0.221	25.0	165.87	5.85	8.55					
0.24–0.30	0.269	25.1	156.82	4.74	8.16	0.271	34.9	168.78	4.64	7.14
0.30–0.36	0.329	25.2	121.35	4.29	7.36	0.329	35.0	144.78	4.40	6.01
0.36–0.42	0.389	25.1	108.39	4.05	6.07	0.389	35.0	118.77	4.16	6.47
0.42–0.50	0.458	25.0	91.27	3.12	4.78	0.459	35.1	92.62	3.25	5.47
0.50–0.60	0.546	25.3	73.59	2.46	3.39	0.546	35.0	78.74	2.67	4.44
0.60–0.72	0.655	25.3	49.11	1.82	2.46	0.654	35.0	54.15	1.98	3.20
0.72–0.90						0.800	35.2	30.75	1.23	2.20

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.30–0.36	0.329	45.0	169.77	4.53	5.52					
0.36–0.42	0.388	45.1	129.06	3.99	4.30	0.388	55.1	156.83	4.27	4.74
0.42–0.50	0.457	45.2	102.88	3.33	4.67	0.457	55.1	119.55	3.41	4.08
0.50–0.60	0.544	45.1	80.03	2.71	4.85	0.543	55.0	72.08	2.59	4.99
0.60–0.72	0.650	45.0	56.32	2.13	3.83	0.651	54.9	43.11	1.94	3.91
0.72–0.90	0.795	44.9	28.05	1.22	2.45	0.791	54.9	20.03	1.12	2.52
0.90–1.25	1.023	44.8	7.13	0.43	0.96					

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.42–0.50	0.458	67.6	121.03	2.71	3.51	0.457	82.0	98.83	2.40	3.52
0.50–0.60	0.545	67.2	71.38	2.01	3.74	0.546	82.1	59.49	1.69	2.87

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.42–0.50	0.456	96.9	71.71	2.04	3.69	0.456	113.5	35.70	1.28	1.84
0.50–0.60	0.545	96.8	36.12	1.33	2.36	0.542	112.4	12.73	0.82	1.66

Table A.5: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^+ + Al $\to \pi^+$ + X interactions with $+3.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	24.9	85.88 ± 5.65 ± 6.95	0.115	34.9	91.52 ± 5.56 ± 6.78
0.13–0.16	0.146	24.9	104.04 ± 5.56 ± 6.37	0.145	34.7	74.24 ± 4.59 ± 4.53
0.16–0.20	0.180	24.8	119.19 ± 5.05 ± 6.00	0.180	34.9	95.73 ± 4.42 ± 4.94
0.20–0.24	0.220	25.0	132.48 ± 5.35 ± 6.01	0.220	34.9	114.26 ± 4.83 ± 5.11
0.24–0.30	0.270	24.9	125.17 ± 4.10 ± 4.59	0.270	34.9	109.25 ± 3.75 ± 4.08
0.30–0.36	0.329	25.1	103.51 ± 3.71 ± 3.47	0.329	34.9	92.67 ± 3.48 ± 3.09
0.36–0.42	0.390	25.1	79.93 ± 3.23 ± 2.72	0.389	34.5	68.93 ± 2.94 ± 2.34
0.42–0.50	0.457	24.9	63.40 ± 2.44 ± 2.49	0.458	34.9	59.36 ± 2.38 ± 2.15
0.50–0.60	0.546	25.1	41.52 ± 1.70 ± 2.19	0.547	34.9	40.56 ± 1.71 ± 1.92
0.60–0.72	0.658	24.8	25.65 ± 1.20 ± 2.00	0.655	34.8	22.47 ± 1.10 ± 1.53
0.72–0.90				0.799	34.9	14.76 ± 0.74 ± 1.66

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	45.0	75.43 ± 5.17 ± 5.66			
0.13–0.16	0.145	44.9	88.63 ± 5.02 ± 5.20	0.146	54.6	81.58 ± 4.95 ± 5.03
0.16–0.20	0.180	45.0	86.39 ± 4.18 ± 4.33	0.179	54.9	82.24 ± 4.06 ± 4.03
0.20–0.24	0.220	44.9	82.86 ± 4.09 ± 3.70	0.219	54.9	76.55 ± 3.90 ± 3.35
0.24–0.30	0.269	44.9	85.18 ± 3.40 ± 3.23	0.268	54.8	69.80 ± 2.99 ± 2.59
0.30–0.36	0.328	45.1	65.46 ± 2.92 ± 2.23	0.328	54.9	61.00 ± 2.85 ± 2.08
0.36–0.42	0.388	44.9	60.41 ± 2.79 ± 2.09	0.389	54.7	46.35 ± 2.38 ± 1.62
0.42–0.50	0.457	44.9	48.43 ± 2.17 ± 1.77	0.456	55.0	42.34 ± 2.08 ± 1.75
0.50–0.60	0.544	44.9	36.81 ± 1.66 ± 1.69	0.541	54.8	27.92 ± 1.46 ± 1.37
0.60–0.72	0.651	45.0	24.00 ± 1.22 ± 1.55	0.651	54.8	17.14 ± 1.03 ± 1.14
0.72–0.90	0.790	44.5	11.55 ± 0.66 ± 1.13	0.791	54.2	8.51 ± 0.59 ± 0.85
0.90–1.25				1.017	54.5	1.62 ± 0.15 ± 0.25

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.5	76.95 ± 4.02 ± 4.73	0.146	81.9	68.94 ± 3.85 ± 4.30
0.16–0.20	0.180	67.4	79.59 ± 3.32 ± 3.81	0.180	82.4	69.41 ± 3.11 ± 3.23
0.20–0.24	0.220	67.3	67.78 ± 2.97 ± 2.81	0.219	82.3	55.30 ± 2.68 ± 2.23
0.24–0.30	0.268	67.1	54.00 ± 2.20 ± 1.96	0.268	82.1	40.12 ± 1.90 ± 1.50
0.30–0.36	0.329	67.0	45.27 ± 2.00 ± 1.55	0.329	82.0	27.62 ± 1.57 ± 1.09
0.36–0.42	0.390	66.8	33.44 ± 1.73 ± 1.25	0.388	81.9	21.97 ± 1.41 ± 1.04
0.42–0.50	0.461	67.1	24.53 ± 1.26 ± 1.07	0.459	81.1	15.50 ± 1.00 ± 0.86
0.50–0.60	0.547	66.4	18.97 ± 1.00 ± 1.10	0.543	81.8	9.14 ± 0.70 ± 0.66
0.60–0.72	0.655	66.7	9.72 ± 0.65 ± 0.76	0.652	80.9	5.41 ± 0.50 ± 0.54
0.72–0.90	0.795	66.6	4.73 ± 0.36 ± 0.52	0.782	81.2	1.61 ± 0.19 ± 0.22
0.90–1.25	1.018	66.1	0.64 ± 0.07 ± 0.12	1.023	82.2	0.11 ± 0.02 ± 0.03

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.147	97.6	65.04 ± 3.59 ± 3.89	0.145	115.0	53.54 ± 2.89 ± 2.82
0.16–0.20	0.180	97.2	64.43 ± 3.00 ± 2.85	0.179	114.4	49.83 ± 2.30 ± 1.95
0.20–0.24	0.219	97.5	43.63 ± 2.40 ± 1.70	0.218	113.8	29.77 ± 1.78 ± 1.19
0.24–0.30	0.267	97.0	30.25 ± 1.67 ± 1.20	0.268	113.4	16.72 ± 1.06 ± 0.77
0.30–0.36	0.328	96.6	18.47 ± 1.28 ± 0.89	0.330	114.7	10.47 ± 0.84 ± 0.63
0.36–0.42	0.388	96.8	14.76 ± 1.16 ± 0.90	0.387	114.3	6.98 ± 0.70 ± 0.55
0.42–0.50	0.457	96.8	10.67 ± 0.85 ± 0.82	0.456	112.7	4.12 ± 0.44 ± 0.42
0.50–0.60	0.550	96.4	5.20 ± 0.53 ± 0.53	0.538	111.2	1.57 ± 0.24 ± 0.22
0.60–0.72	0.649	96.8	2.04 ± 0.27 ± 0.30	0.650	111.9	0.32 ± 0.07 ± 0.09
0.72–0.90	0.783	96.2	0.44 ± 0.09 ± 0.10	0.772	113.2	0.06 ± 0.02 ± 0.03
0.90–1.25	1.056	95.8	0.03 ± 0.01 ± 0.02			

Table A.6: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^+ + Al $\to$ π^- + X interactions with $+3.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	25.1	76.99 ± 5.15 ± 6.14	0.115	34.9	64.52 ± 4.49 ± 5.02
0.13–0.16	0.146	25.1	77.24 ± 4.62 ± 4.72	0.145	34.8	79.40 ± 4.75 ± 5.20
0.16–0.20	0.179	24.9	90.20 ± 4.29 ± 4.68	0.178	35.0	80.88 ± 4.02 ± 4.28
0.20–0.24	0.219	25.3	82.45 ± 3.93 ± 3.59	0.220	35.0	71.14 ± 3.66 ± 3.20
0.24–0.30	0.269	24.8	75.86 ± 3.12 ± 2.80	0.268	34.5	65.75 ± 2.83 ± 2.45
0.30–0.36	0.328	25.1	58.47 ± 2.71 ± 1.98	0.330	35.1	59.04 ± 2.68 ± 2.06
0.36–0.42	0.390	25.1	51.08 ± 2.59 ± 1.94	0.388	35.0	45.29 ± 2.41 ± 1.70
0.42–0.50	0.457	25.3	33.31 ± 1.81 ± 1.41	0.456	35.0	30.37 ± 1.69 ± 1.26
0.50–0.60	0.546	25.1	15.55 ± 1.06 ± 0.85	0.545	35.1	17.10 ± 1.14 ± 0.91
0.60–0.72	0.648	25.4	8.14 ± 0.71 ± 0.61	0.652	34.7	9.79 ± 0.78 ± 0.70
0.72–0.90				0.798	34.8	3.17 ± 0.37 ± 0.32

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.114	45.2	67.50 ± 4.88 ± 5.33			
0.13–0.16	0.145	45.0	63.52 ± 4.21 ± 3.98	0.146	55.1	65.61 ± 4.31 ± 4.22
0.16–0.20	0.182	44.8	66.14 ± 3.55 ± 3.47	0.180	55.2	50.08 ± 3.07 ± 2.63
0.20–0.24	0.219	44.7	59.63 ± 3.27 ± 2.77	0.220	54.8	48.56 ± 2.93 ± 2.32
0.24–0.30	0.270	44.8	56.13 ± 2.66 ± 2.23	0.269	54.8	40.17 ± 2.19 ± 1.59
0.30–0.36	0.331	44.9	45.63 ± 2.36 ± 1.63	0.331	54.6	31.76 ± 1.95 ± 1.19
0.36–0.42	0.391	44.8	34.64 ± 2.08 ± 1.34	0.393	55.1	26.43 ± 1.85 ± 1.13
0.42–0.50	0.461	44.6	24.85 ± 1.51 ± 1.08	0.458	54.8	20.49 ± 1.37 ± 0.94
0.50–0.60	0.547	45.0	15.09 ± 1.07 ± 0.85	0.547	54.5	12.60 ± 0.98 ± 0.74
0.60–0.72	0.655	45.2	7.05 ± 0.67 ± 0.53	0.656	54.7	7.26 ± 0.69 ± 0.58
0.72–0.90	0.804	45.1	3.18 ± 0.37 ± 0.33	0.795	54.9	3.37 ± 0.37 ± 0.36
0.90–1.25				1.034	54.2	0.56 ± 0.09 ± 0.10

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.144	67.1	55.66 ± 3.42 ± 3.48	0.145	82.6	47.34 ± 3.14 ± 3.03
0.16–0.20	0.180	67.1	51.49 ± 2.61 ± 2.48	0.179	82.2	44.56 ± 2.47 ± 2.17
0.20–0.24	0.220	67.3	39.16 ± 2.15 ± 1.69	0.219	82.4	33.52 ± 2.11 ± 1.52
0.24–0.30	0.270	67.1	31.57 ± 1.61 ± 1.18	0.266	82.3	25.53 ± 1.47 ± 1.00
0.30–0.36	0.330	67.0	26.69 ± 1.51 ± 1.01	0.327	82.7	17.38 ± 1.20 ± 0.74
0.36–0.42	0.389	67.1	20.99 ± 1.34 ± 0.88	0.386	82.2	12.64 ± 1.04 ± 0.66
0.42–0.50	0.459	67.0	15.26 ± 0.98 ± 0.75	0.454	82.3	9.78 ± 0.77 ± 0.62
0.50–0.60	0.547	67.1	9.94 ± 0.71 ± 0.64	0.546	82.0	6.59 ± 0.58 ± 0.54
0.60–0.72	0.651	67.3	5.15 ± 0.47 ± 0.44	0.658	82.2	2.84 ± 0.34 ± 0.31
0.72–0.90	0.783	67.1	1.62 ± 0.20 ± 0.19	0.790	83.0	0.58 ± 0.11 ± 0.09
0.90–1.25	1.016	67.5	0.19 ± 0.04 ± 0.04	1.057	81.5	0.08 ± 0.02 ± 0.02

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.3	41.87 ± 2.94 ± 2.71	0.145	114.4	33.49 ± 2.27 ± 1.81
0.16–0.20	0.180	97.6	40.77 ± 2.39 ± 2.01	0.178	114.4	28.87 ± 1.74 ± 1.25
0.20–0.24	0.219	96.4	29.83 ± 2.01 ± 1.38	0.219	113.7	21.27 ± 1.46 ± 1.00
0.24–0.30	0.268	96.8	19.14 ± 1.28 ± 0.83	0.267	113.6	11.86 ± 0.86 ± 0.64
0.30–0.36	0.326	96.4	11.22 ± 0.99 ± 0.62	0.328	114.3	7.22 ± 0.68 ± 0.52
0.36–0.42	0.390	97.2	8.57 ± 0.86 ± 0.60	0.389	114.8	4.17 ± 0.51 ± 0.39
0.42–0.50	0.457	97.1	5.45 ± 0.59 ± 0.47	0.457	112.5	2.13 ± 0.31 ± 0.26
0.50–0.60	0.541	96.1	3.27 ± 0.42 ± 0.38	0.547	111.2	1.18 ± 0.21 ± 0.20
0.60–0.72	0.664	96.1	0.97 ± 0.17 ± 0.17	0.650	112.6	0.38 ± 0.08 ± 0.11
0.72–0.90	0.796	95.7	0.32 ± 0.08 ± 0.08			

Table A.7: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^- + Al $\rightarrow$ p + X interactions with -3.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.221	25.1	146.24 ± 3.93 ± 7.34			
0.24–0.30	0.269	25.0	131.75 ± 2.81 ± 6.14	0.271	34.8	141.35 ± 2.88 ± 5.86
0.30–0.36	0.329	25.1	103.08 ± 2.53 ± 4.87	0.329	35.1	123.79 ± 2.66 ± 4.65
0.36–0.42	0.388	25.1	85.00 ± 2.29 ± 3.84	0.389	35.0	104.97 ± 2.54 ± 4.23
0.42–0.50	0.458	25.1	70.01 ± 1.79 ± 3.02	0.458	35.1	77.10 ± 1.90 ± 3.38
0.50–0.60	0.547	25.3	51.24 ± 1.35 ± 2.06	0.548	35.1	56.03 ± 1.45 ± 2.54
0.60–0.72	0.654	25.6	33.83 ± 1.01 ± 1.54	0.655	35.1	40.60 ± 1.14 ± 2.07
0.72–0.90				0.796	35.1	22.16 ± 0.69 ± 1.43

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.329	44.9	125.45 ± 2.57 ± 4.02			
0.36–0.42	0.390	45.0	108.15 ± 2.44 ± 3.26	0.389	55.0	110.19 ± 2.37 ± 3.30
0.42–0.50	0.458	45.0	83.63 ± 1.93 ± 3.06	0.458	55.0	88.88 ± 1.93 ± 2.75
0.50–0.60	0.547	45.0	60.16 ± 1.53 ± 2.95	0.547	55.0	58.58 ± 1.50 ± 3.05
0.60–0.72	0.656	45.0	41.38 ± 1.19 ± 2.33	0.654	55.0	37.19 ± 1.15 ± 2.58
0.72–0.90	0.799	45.0	21.68 ± 0.70 ± 1.54	0.794	54.9	20.58 ± 0.73 ± 1.84
0.90–1.25	1.032	45.0	5.67 ± 0.24 ± 0.62			

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.461	67.6	90.69 ± 1.56 ± 2.52	0.460	82.0	73.18 ± 1.37 ± 2.60
0.50–0.60	0.550	67.3	56.08 ± 1.15 ± 2.43	0.549	82.0	48.71 ± 1.03 ± 2.30
0.60–0.72	0.657	67.1	27.21 ± 0.83 ± 2.61	0.658	82.1	17.46 ± 0.68 ± 2.19

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.459	97.1	52.38 ± 1.15 ± 2.70	0.458	113.7	28.65 ± 0.76 ± 1.40
0.50–0.60	0.549	97.0	29.50 ± 0.80 ± 1.88	0.547	113.0	11.08 ± 0.47 ± 1.10

Table A.8: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^- + Al $\to \pi^+$ + X interactions with -3.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.9	66.75 ± 3.09 ± 4.56	0.115	35.2	67.62 ± 3.19 ± 4.85
0.13–0.16	0.145	24.9	84.22 ± 3.33 ± 4.92	0.145	34.8	68.02 ± 2.93 ± 3.93
0.16–0.20	0.180	24.9	87.38 ± 2.75 ± 4.09	0.180	35.0	73.61 ± 2.51 ± 3.47
0.20–0.24	0.220	25.0	96.43 ± 2.88 ± 4.00	0.220	34.7	76.96 ± 2.52 ± 3.15
0.24–0.30	0.269	25.0	86.08 ± 2.21 ± 3.00	0.270	34.8	68.80 ± 1.93 ± 2.37
0.30–0.36	0.329	24.9	73.49 ± 2.04 ± 2.38	0.329	34.8	59.85 ± 1.81 ± 1.86
0.36–0.42	0.388	25.0	58.44 ± 1.81 ± 1.94	0.388	34.8	50.71 ± 1.66 ± 1.56
0.42–0.50	0.457	25.0	38.52 ± 1.23 ± 1.42	0.458	34.7	34.86 ± 1.19 ± 1.19
0.50–0.60	0.545	25.1	23.14 ± 0.83 ± 1.20	0.544	34.9	20.67 ± 0.80 ± 0.96
0.60–0.72	0.654	25.2	10.39 ± 0.47 ± 0.79	0.652	35.1	11.13 ± 0.51 ± 0.76
0.72–0.90				0.790	34.9	4.64 ± 0.25 ± 0.50

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	45.0	55.01 ± 2.94 ± 4.03			
0.13–0.16	0.145	44.8	66.19 ± 2.87 ± 3.77	0.145	54.8	56.93 ± 2.70 ± 3.38
0.16–0.20	0.180	44.9	62.00 ± 2.32 ± 3.00	0.180	54.8	62.36 ± 2.32 ± 2.96
0.20–0.24	0.220	44.7	60.78 ± 2.24 ± 2.53	0.219	54.9	53.46 ± 2.11 ± 2.21
0.24–0.30	0.269	44.9	58.86 ± 1.82 ± 2.05	0.268	54.7	44.78 ± 1.55 ± 1.55
0.30–0.36	0.330	44.7	47.44 ± 1.60 ± 1.49	0.329	54.9	37.92 ± 1.44 ± 1.21
0.36–0.42	0.389	44.8	38.00 ± 1.44 ± 1.20	0.389	54.8	31.47 ± 1.31 ± 1.04
0.42–0.50	0.456	44.7	28.37 ± 1.09 ± 1.03	0.457	54.6	27.30 ± 1.11 ± 1.20
0.50–0.60	0.546	44.8	17.77 ± 0.75 ± 0.80	0.545	54.5	15.40 ± 0.69 ± 0.74
0.60–0.72	0.654	44.9	11.08 ± 0.54 ± 0.70	0.655	54.9	8.74 ± 0.49 ± 0.59
0.72–0.90	0.792	44.8	4.52 ± 0.26 ± 0.43	0.793	54.3	3.95 ± 0.25 ± 0.37
0.90–1.25				1.031	54.3	0.73 ± 0.06 ± 0.12

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	67.6	51.15 ± 2.17 ± 3.05	0.145	82.7	41.20 ± 1.94 ± 2.49
0.16–0.20	0.180	67.2	50.56 ± 1.73 ± 2.36	0.180	82.2	47.20 ± 1.70 ± 2.16
0.20–0.24	0.221	67.2	40.45 ± 1.49 ± 1.61	0.220	82.4	37.56 ± 1.48 ± 1.45
0.24–0.30	0.269	67.1	35.38 ± 1.14 ± 1.18	0.268	81.9	26.29 ± 0.99 ± 0.87
0.30–0.36	0.330	66.9	28.55 ± 1.03 ± 0.89	0.330	82.2	18.32 ± 0.83 ± 0.64
0.36–0.42	0.389	67.1	23.16 ± 0.95 ± 0.89	0.389	81.6	13.95 ± 0.73 ± 0.61
0.42–0.50	0.459	67.1	16.96 ± 0.69 ± 0.72	0.458	82.0	10.29 ± 0.52 ± 0.54
0.50–0.60	0.550	66.6	10.43 ± 0.48 ± 0.59	0.547	81.9	6.90 ± 0.40 ± 0.49
0.60–0.72	0.661	66.4	5.57 ± 0.32 ± 0.43	0.660	81.8	2.95 ± 0.22 ± 0.28
0.72–0.90	0.796	67.0	1.85 ± 0.13 ± 0.20	0.800	81.0	1.03 ± 0.10 ± 0.14
0.90–1.25	1.027	65.7	0.32 ± 0.03 ± 0.06	1.031	81.5	0.14 ± 0.02 ± 0.03

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	97.0	42.88 ± 1.97 ± 2.52	0.145	114.4	36.78 ± 1.59 ± 1.86
0.16–0.20	0.179	97.5	36.05 ± 1.48 ± 1.58	0.179	114.0	31.63 ± 1.23 ± 1.20
0.20–0.24	0.220	97.1	29.85 ± 1.32 ± 1.11	0.220	114.1	18.63 ± 0.90 ± 0.69
0.24–0.30	0.269	97.0	21.35 ± 0.90 ± 0.75	0.270	113.4	13.09 ± 0.61 ± 0.55
0.30–0.36	0.329	97.0	12.70 ± 0.69 ± 0.55	0.328	114.0	7.61 ± 0.46 ± 0.44
0.36–0.42	0.390	97.0	9.30 ± 0.59 ± 0.54	0.391	113.2	4.42 ± 0.36 ± 0.34
0.42–0.50	0.460	96.8	6.15 ± 0.41 ± 0.45	0.455	112.4	2.86 ± 0.24 ± 0.28
0.50–0.60	0.547	96.7	3.00 ± 0.25 ± 0.29	0.540	112.7	0.77 ± 0.10 ± 0.11
0.60–0.72	0.650	95.3	1.19 ± 0.13 ± 0.16	0.666	111.3	0.20 ± 0.04 ± 0.04
0.72–0.90	0.801	95.6	0.27 ± 0.04 ± 0.06	0.824	112.3	0.03 ± 0.01 ± 0.01

Table A.9: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^- + Al $\to \pi^-$ + X interactions with -3.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	25.1	115.61 ± 4.23 ± 8.05	0.115	35.0	97.00 ± 3.79 ± 6.96
0.13–0.16	0.145	24.8	128.96 ± 4.13 ± 7.32	0.145	34.9	108.35 ± 3.69 ± 6.12
0.16–0.20	0.180	24.8	143.67 ± 3.63 ± 6.68	0.180	34.8	112.83 ± 3.12 ± 5.30
0.20–0.24	0.219	25.0	148.85 ± 3.67 ± 6.01	0.220	34.8	127.44 ± 3.32 ± 5.06
0.24–0.30	0.270	25.1	130.68 ± 2.76 ± 4.25	0.269	34.8	113.60 ± 2.52 ± 3.73
0.30–0.36	0.329	25.1	116.89 ± 2.60 ± 3.37	0.329	34.8	101.28 ± 2.39 ± 2.94
0.36–0.42	0.389	25.0	90.22 ± 2.28 ± 2.67	0.389	34.8	75.78 ± 2.05 ± 2.24
0.42–0.50	0.457	24.9	67.13 ± 1.71 ± 2.40	0.458	35.0	62.57 ± 1.65 ± 2.19
0.50–0.60	0.545	25.0	42.93 ± 1.21 ± 2.02	0.546	34.9	41.29 ± 1.18 ± 1.89
0.60–0.72	0.655	24.9	28.28 ± 0.94 ± 1.98	0.654	35.0	25.58 ± 0.87 ± 1.61
0.72–0.90				0.798	35.0	15.83 ± 0.60 ± 1.57

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	44.9	102.00 ± 4.10 ± 7.68			
0.13–0.16	0.145	44.9	99.38 ± 3.58 ± 5.65	0.145	55.0	90.60 ± 3.47 ± 5.34
0.16–0.20	0.180	45.0	103.73 ± 3.05 ± 4.90	0.180	55.0	90.96 ± 2.87 ± 4.28
0.20–0.24	0.220	44.9	99.94 ± 2.90 ± 4.05	0.219	54.8	84.16 ± 2.67 ± 3.35
0.24–0.30	0.269	44.7	91.27 ± 2.27 ± 3.01	0.270	54.9	72.45 ± 2.02 ± 2.37
0.30–0.36	0.330	44.8	78.58 ± 2.11 ± 2.30	0.329	54.9	65.10 ± 1.90 ± 1.94
0.36–0.42	0.388	45.0	64.33 ± 1.89 ± 1.96	0.388	54.7	51.83 ± 1.71 ± 1.63
0.42–0.50	0.459	44.8	52.15 ± 1.50 ± 1.91	0.459	55.0	43.60 ± 1.40 ± 1.76
0.50–0.60	0.548	44.8	35.18 ± 1.08 ± 1.70	0.547	54.7	28.06 ± 0.96 ± 1.41
0.60–0.72	0.656	44.8	24.74 ± 0.86 ± 1.70	0.654	54.7	18.62 ± 0.75 ± 1.34
0.72–0.90	0.795	44.6	11.08 ± 0.48 ± 1.06	0.794	54.6	7.31 ± 0.39 ± 0.71
0.90–1.25				1.029	54.8	1.11 ± 0.09 ± 0.17

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.2	86.74 ± 2.81 ± 4.90	0.145	82.5	71.75 ± 2.58 ± 4.11
0.16–0.20	0.179	67.4	84.93 ± 2.31 ± 3.83	0.179	82.4	73.39 ± 2.15 ± 3.17
0.20–0.24	0.218	67.2	69.41 ± 1.98 ± 2.58	0.219	82.2	58.29 ± 1.86 ± 2.08
0.24–0.30	0.268	67.2	56.43 ± 1.47 ± 1.79	0.269	82.1	43.36 ± 1.30 ± 1.36
0.30–0.36	0.327	67.1	43.32 ± 1.28 ± 1.29	0.328	82.0	31.66 ± 1.10 ± 1.07
0.36–0.42	0.387	67.1	34.82 ± 1.14 ± 1.17	0.387	82.0	23.55 ± 0.95 ± 0.99
0.42–0.50	0.456	66.9	26.84 ± 0.87 ± 1.13	0.454	82.1	18.62 ± 0.74 ± 1.02
0.50–0.60	0.543	66.9	20.35 ± 0.69 ± 1.17	0.541	81.5	11.87 ± 0.54 ± 0.89
0.60–0.72	0.647	66.7	11.51 ± 0.48 ± 0.90	0.649	81.8	5.70 ± 0.33 ± 0.55
0.72–0.90	0.791	66.9	4.84 ± 0.25 ± 0.52	0.783	81.6	1.77 ± 0.14 ± 0.24
0.90–1.25	1.004	66.8	0.67 ± 0.05 ± 0.12	1.001	81.0	0.23 ± 0.03 ± 0.05

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.4	71.17 ± 2.58 ± 4.08	0.145	114.3	63.52 ± 2.14 ± 3.09
0.16–0.20	0.179	97.4	65.56 ± 2.05 ± 2.74	0.179	114.6	48.31 ± 1.53 ± 1.74
0.20–0.24	0.219	97.1	47.29 ± 1.68 ± 1.63	0.218	114.0	31.84 ± 1.19 ± 1.14
0.24–0.30	0.267	97.2	32.87 ± 1.14 ± 1.12	0.267	114.2	18.43 ± 0.73 ± 0.82
0.30–0.36	0.327	97.3	19.42 ± 0.86 ± 0.84	0.329	113.3	11.93 ± 0.60 ± 0.75
0.36–0.42	0.388	97.0	14.39 ± 0.74 ± 0.84	0.386	113.4	7.19 ± 0.46 ± 0.59
0.42–0.50	0.455	96.7	10.65 ± 0.56 ± 0.83	0.456	113.4	4.53 ± 0.31 ± 0.49
0.50–0.60	0.540	96.5	5.68 ± 0.37 ± 0.59	0.539	111.4	2.03 ± 0.17 ± 0.29
0.60–0.72	0.649	96.4	2.34 ± 0.20 ± 0.33	0.641	111.5	0.51 ± 0.07 ± 0.10
0.72–0.90	0.794	96.2	0.55 ± 0.07 ± 0.11	0.783	111.0	0.04 ± 0.01 ± 0.02
0.90–1.25	1.030	96.6	0.03 ± 0.01 ± 0.02			

Table A.10: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in p + Al $\rightarrow$ p + X interactions with $+5.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.220	24.9	202.12 $\pm$ 7.25 $\pm$ 10.04			
0.24–0.30	0.269	25.0	176.21 $\pm$ 5.06 $\pm$ 8.00	0.262	36.0	292.01 $\pm$ 96.75 $\pm$ 11.95
0.30–0.36	0.330	25.2	160.61 $\pm$ 4.86 $\pm$ 7.00	0.329	35.0	162.01 $\pm$ 4.70 $\pm$ 5.88
0.36–0.42	0.389	25.1	142.79 $\pm$ 4.57 $\pm$ 5.50	0.389	35.0	135.28 $\pm$ 4.44 $\pm$ 5.05
0.42–0.50	0.460	25.1	116.71 $\pm$ 3.48 $\pm$ 4.13	0.458	35.0	117.70 $\pm$ 3.59 $\pm$ 4.48
0.50–0.60	0.548	25.0	106.96 $\pm$ 2.99 $\pm$ 3.62	0.547	35.1	95.10 $\pm$ 2.89 $\pm$ 3.53
0.60–0.72	0.658	24.9	80.34 $\pm$ 2.31 $\pm$ 3.16	0.657	34.9	70.09 $\pm$ 2.24 $\pm$ 2.96
0.72–0.90				0.800	35.0	49.44 $\pm$ 1.55 $\pm$ 2.71

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.330	45.0	170.31 $\pm$ 4.76 $\pm$ 5.25			
0.36–0.42	0.389	45.0	146.66 $\pm$ 4.43 $\pm$ 4.24	0.388	55.1	157.07 $\pm$ 4.49 $\pm$ 4.36
0.42–0.50	0.459	45.1	120.78 $\pm$ 3.58 $\pm$ 3.90	0.458	55.2	122.34 $\pm$ 3.52 $\pm$ 3.54
0.50–0.60	0.550	44.9	89.03 $\pm$ 2.80 $\pm$ 3.68	0.546	54.9	90.54 $\pm$ 2.86 $\pm$ 4.05
0.60–0.72	0.655	45.0	67.28 $\pm$ 2.28 $\pm$ 3.16	0.655	55.0	56.01 $\pm$ 2.14 $\pm$ 3.27
0.72–0.90	0.801	45.0	40.01 $\pm$ 1.46 $\pm$ 2.39	0.798	54.9	34.98 $\pm$ 1.40 $\pm$ 2.57
0.90–1.25	1.034	44.9	15.80 $\pm$ 0.65 $\pm$ 1.36	1.029	54.7	10.56 $\pm$ 0.54 $\pm$ 1.14

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.459	67.3	118.68 $\pm$ 2.78 $\pm$ 3.21	0.460	82.4	87.15 $\pm$ 2.35 $\pm$ 3.05
0.50–0.60	0.551	67.3	82.44 $\pm$ 2.17 $\pm$ 3.24	0.550	82.0	61.91 $\pm$ 1.82 $\pm$ 2.88
0.60–0.72	0.660	66.8	42.49 $\pm$ 1.55 $\pm$ 3.31	0.657	82.0	25.22 $\pm$ 1.25 $\pm$ 2.76
0.72–0.90	0.804	67.0	21.68 $\pm$ 0.95 $\pm$ 2.42			

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.458	96.9	61.39 $\pm$ 1.98 $\pm$ 3.12	0.460	113.6	32.96 $\pm$ 1.28 $\pm$ 1.63
0.50–0.60	0.550	96.8	34.73 $\pm$ 1.37 $\pm$ 2.20	0.548	112.8	12.31 $\pm$ 0.77 $\pm$ 1.24

Table A.11: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in p + Al $\to \pi^+$ + X interactions with $+5.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	25.0	103.61 ± 6.31 ± 7.22	0.116	34.8	83.96 ± 5.53 ± 5.94
0.13–0.16	0.145	24.8	111.38 ± 6.09 ± 6.31	0.145	35.0	89.27 ± 5.30 ± 5.00
0.16–0.20	0.180	24.9	130.75 ± 5.48 ± 6.18	0.180	34.7	92.51 ± 4.52 ± 4.37
0.20–0.24	0.220	24.8	122.56 ± 5.18 ± 5.03	0.220	34.7	91.15 ± 4.42 ± 3.72
0.24–0.30	0.269	24.9	121.43 ± 4.19 ± 4.21	0.269	34.8	87.65 ± 3.52 ± 3.03
0.30–0.36	0.329	24.7	89.39 ± 3.50 ± 2.79	0.329	34.7	73.95 ± 3.19 ± 2.28
0.36–0.42	0.389	24.9	66.86 ± 3.02 ± 2.13	0.389	34.8	52.41 ± 2.70 ± 1.61
0.42–0.50	0.458	25.2	51.75 ± 2.30 ± 2.01	0.457	34.9	41.23 ± 2.07 ± 1.46
0.50–0.60	0.548	24.8	28.77 ± 1.43 ± 1.50	0.546	34.9	29.22 ± 1.50 ± 1.37
0.60–0.72	0.657	25.1	13.32 ± 0.78 ± 1.04	0.655	34.9	13.14 ± 0.84 ± 0.90
0.72–0.90				0.790	34.6	6.18 ± 0.41 ± 0.66

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	45.2	75.39 ± 5.40 ± 5.47			
0.13–0.16	0.145	44.7	79.23 ± 5.05 ± 4.57	0.146	54.8	60.47 ± 4.40 ± 3.58
0.16–0.20	0.181	44.8	82.67 ± 4.25 ± 3.95	0.180	54.7	64.32 ± 3.74 ± 3.08
0.20–0.24	0.220	44.9	76.21 ± 4.01 ± 3.18	0.219	55.0	65.74 ± 3.78 ± 2.82
0.24–0.30	0.270	44.7	68.06 ± 3.14 ± 2.39	0.269	54.5	47.99 ± 2.61 ± 1.70
0.30–0.36	0.330	44.7	54.42 ± 2.76 ± 1.68	0.328	54.7	45.36 ± 2.56 ± 1.44
0.36–0.42	0.388	44.7	42.87 ± 2.45 ± 1.31	0.388	54.8	33.94 ± 2.21 ± 1.11
0.42–0.50	0.457	44.5	35.37 ± 1.93 ± 1.20	0.459	54.5	24.45 ± 1.61 ± 0.92
0.50–0.60	0.550	44.7	21.34 ± 1.29 ± 0.96	0.547	54.4	16.74 ± 1.16 ± 0.82
0.60–0.72	0.658	44.9	11.49 ± 0.85 ± 0.73	0.655	54.4	8.95 ± 0.77 ± 0.61
0.72–0.90	0.788	44.7	4.76 ± 0.40 ± 0.45	0.797	54.4	4.07 ± 0.40 ± 0.39
0.90–1.25				1.005	54.7	0.90 ± 0.12 ± 0.14

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	66.8	63.84 ± 3.73 ± 3.79	0.146	82.7	53.03 ± 3.41 ± 3.17
0.16–0.20	0.181	67.4	58.61 ± 2.95 ± 2.76	0.180	82.4	53.50 ± 2.84 ± 2.42
0.20–0.24	0.221	67.2	52.01 ± 2.75 ± 2.11	0.220	82.7	40.61 ± 2.42 ± 1.56
0.24–0.30	0.270	67.2	38.89 ± 1.92 ± 1.32	0.267	82.0	28.50 ± 1.67 ± 0.96
0.30–0.36	0.329	66.9	30.70 ± 1.74 ± 0.99	0.330	81.9	19.39 ± 1.36 ± 0.71
0.36–0.42	0.391	66.9	24.55 ± 1.51 ± 0.86	0.390	81.3	14.83 ± 1.20 ± 0.64
0.42–0.50	0.460	67.0	16.17 ± 1.06 ± 0.69	0.458	81.7	8.33 ± 0.76 ± 0.44
0.50–0.60	0.548	67.1	9.91 ± 0.74 ± 0.57	0.541	81.4	5.69 ± 0.57 ± 0.40
0.60–0.72	0.650	66.3	6.48 ± 0.55 ± 0.51	0.657	79.7	2.18 ± 0.32 ± 0.21
0.72–0.90	0.793	65.8	1.79 ± 0.22 ± 0.20	0.792	80.9	0.74 ± 0.14 ± 0.10
0.90–1.25	1.016	65.0	0.37 ± 0.06 ± 0.07	1.006	80.3	0.07 ± 0.02 ± 0.02

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.6	52.33 ± 3.43 ± 3.05	0.145	114.8	45.32 ± 2.82 ± 2.34
0.16–0.20	0.180	97.3	45.94 ± 2.69 ± 1.95	0.180	114.1	33.65 ± 1.97 ± 1.31
0.20–0.24	0.219	97.2	32.08 ± 2.16 ± 1.16	0.220	114.0	19.97 ± 1.49 ± 0.79
0.24–0.30	0.267	96.7	21.85 ± 1.46 ± 0.78	0.269	112.9	12.83 ± 0.99 ± 0.58
0.30–0.36	0.327	97.0	13.24 ± 1.13 ± 0.59	0.327	113.7	5.95 ± 0.66 ± 0.36
0.36–0.42	0.390	96.8	8.53 ± 0.90 ± 0.49	0.390	112.6	3.79 ± 0.54 ± 0.30
0.42–0.50	0.459	96.1	5.64 ± 0.64 ± 0.42	0.453	112.6	2.45 ± 0.38 ± 0.25
0.50–0.60	0.546	96.6	3.47 ± 0.45 ± 0.34	0.550	109.9	0.63 ± 0.16 ± 0.10
0.60–0.72	0.655	95.9	1.11 ± 0.22 ± 0.15	0.645	113.0	0.37 ± 0.10 ± 0.11
0.72–0.90	0.799	96.6	0.19 ± 0.06 ± 0.04			

Table A.12: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in p + Al $\to \pi^-$ + X interactions with $+5.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.7	89.93 ± 5.64 ± 6.32	0.115	34.7	71.83 ± 5.07 ± 5.25
0.13–0.16	0.145	25.0	94.50 ± 5.42 ± 5.49	0.145	34.9	79.95 ± 4.88 ± 4.65
0.16–0.20	0.180	24.9	93.59 ± 4.45 ± 4.42	0.179	34.9	79.18 ± 4.08 ± 3.83
0.20–0.24	0.218	24.8	87.40 ± 4.33 ± 3.67	0.221	34.9	73.75 ± 3.89 ± 3.05
0.24–0.30	0.269	24.9	76.36 ± 3.22 ± 2.61	0.268	34.9	65.48 ± 2.99 ± 2.24
0.30–0.36	0.328	25.0	55.36 ± 2.76 ± 1.73	0.328	35.1	51.13 ± 2.62 ± 1.61
0.36–0.42	0.386	24.9	39.00 ± 2.32 ± 1.30	0.389	35.0	39.33 ± 2.29 ± 1.30
0.42–0.50	0.454	25.1	23.78 ± 1.59 ± 0.95	0.454	35.3	25.90 ± 1.66 ± 0.98
0.50–0.60	0.545	24.9	15.23 ± 1.10 ± 0.79	0.544	34.8	14.37 ± 1.08 ± 0.72
0.60–0.72	0.650	25.3	7.38 ± 0.72 ± 0.53	0.653	35.3	8.04 ± 0.73 ± 0.56
0.72–0.90				0.776	35.4	2.61 ± 0.35 ± 0.25

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	45.1	76.12 ± 5.42 ± 5.77			
0.13–0.16	0.146	44.8	67.67 ± 4.56 ± 3.95	0.145	55.2	60.75 ± 4.44 ± 3.66
0.16–0.20	0.179	45.2	62.34 ± 3.60 ± 3.05	0.178	55.0	64.36 ± 3.72 ± 3.13
0.20–0.24	0.219	44.7	55.82 ± 3.38 ± 2.39	0.218	55.0	52.37 ± 3.20 ± 2.24
0.24–0.30	0.270	44.8	55.95 ± 2.74 ± 1.95	0.269	54.7	41.67 ± 2.39 ± 1.46
0.30–0.36	0.330	44.9	42.49 ± 2.36 ± 1.35	0.330	55.1	32.06 ± 2.09 ± 1.04
0.36–0.42	0.389	44.9	33.69 ± 2.19 ± 1.17	0.391	55.2	24.02 ± 1.83 ± 0.84
0.42–0.50	0.460	45.1	21.38 ± 1.49 ± 0.84	0.458	54.8	16.24 ± 1.28 ± 0.69
0.50–0.60	0.545	45.0	13.66 ± 1.04 ± 0.72	0.548	54.7	11.64 ± 0.97 ± 0.65
0.60–0.72	0.660	44.9	6.26 ± 0.66 ± 0.45	0.648	55.2	5.51 ± 0.61 ± 0.42
0.72–0.90	0.781	45.0	2.31 ± 0.33 ± 0.23	0.776	55.0	2.03 ± 0.31 ± 0.21
0.90–1.25				1.042	54.2	0.45 ± 0.10 ± 0.07

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	66.8	59.57 ± 3.62 ± 3.42	0.145	82.5	59.48 ± 3.68 ± 3.48
0.16–0.20	0.179	67.2	56.19 ± 2.85 ± 2.53	0.179	82.9	48.41 ± 2.69 ± 2.13
0.20–0.24	0.219	67.2	46.60 ± 2.54 ± 1.81	0.218	82.3	39.45 ± 2.41 ± 1.51
0.24–0.30	0.268	67.4	32.20 ± 1.73 ± 1.06	0.266	82.3	27.83 ± 1.61 ± 0.94
0.30–0.36	0.327	67.1	27.95 ± 1.62 ± 0.90	0.326	81.9	14.55 ± 1.13 ± 0.56
0.36–0.42	0.387	67.0	17.70 ± 1.27 ± 0.67	0.382	81.9	10.07 ± 0.96 ± 0.48
0.42–0.50	0.453	66.7	11.68 ± 0.89 ± 0.54	0.455	81.7	7.36 ± 0.71 ± 0.44
0.50–0.60	0.542	66.9	6.24 ± 0.58 ± 0.39	0.540	81.3	3.61 ± 0.45 ± 0.29
0.60–0.72	0.645	66.2	2.89 ± 0.37 ± 0.24	0.651	80.2	1.20 ± 0.24 ± 0.13
0.72–0.90	0.782	67.2	1.20 ± 0.20 ± 0.14	0.763	80.7	0.31 ± 0.10 ± 0.05
0.90–1.25	0.998	66.3	0.21 ± 0.05 ± 0.04	1.003	82.3	0.05 ± 0.02 ± 0.02

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	97.2	54.73 ± 3.54 ± 3.23	0.144	114.0	45.97 ± 2.85 ± 2.29
0.16–0.20	0.179	97.0	39.44 ± 2.46 ± 1.71	0.178	114.0	28.11 ± 1.80 ± 1.08
0.20–0.24	0.219	97.6	28.91 ± 2.06 ± 1.11	0.217	113.8	15.79 ± 1.30 ± 0.65
0.24–0.30	0.267	97.2	16.88 ± 1.25 ± 0.65	0.269	114.2	8.52 ± 0.77 ± 0.42
0.30–0.36	0.325	97.2	11.85 ± 1.04 ± 0.59	0.324	113.1	5.53 ± 0.64 ± 0.38
0.36–0.42	0.390	96.5	5.89 ± 0.73 ± 0.38	0.385	113.0	2.87 ± 0.45 ± 0.26
0.42–0.50	0.449	97.9	2.91 ± 0.45 ± 0.24	0.447	114.1	1.05 ± 0.24 ± 0.13
0.50–0.60	0.531	96.0	1.46 ± 0.28 ± 0.17	0.535	109.9	0.41 ± 0.12 ± 0.07
0.60–0.72	0.641	95.0	0.55 ± 0.16 ± 0.10	0.641	109.4	0.07 ± 0.04 ± 0.03
0.72–0.90	0.793	96.5	0.27 ± 0.14 ± 0.15			

Table A.13: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^+ + Al $\rightarrow$ p + X interactions with $+5.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.220	25.0	160.55 ± 5.42 ± 8.01			
0.24–0.30	0.270	25.2	154.49 ± 4.25 ± 7.06	0.270	35.0	159.32 ± 4.30 ± 6.56
0.30–0.36	0.329	25.0	118.90 ± 3.72 ± 5.29	0.329	35.1	130.20 ± 3.78 ± 4.78
0.36–0.42	0.388	25.2	110.40 ± 3.59 ± 4.40	0.389	34.9	112.22 ± 3.62 ± 4.30
0.42–0.50	0.458	25.1	87.13 ± 2.66 ± 3.25	0.458	35.0	92.95 ± 2.86 ± 3.70
0.50–0.60	0.547	25.1	78.88 ± 2.26 ± 2.81	0.548	35.0	73.31 ± 2.26 ± 2.88
0.60–0.72	0.655	25.1	50.79 ± 1.58 ± 2.08	0.656	34.9	52.37 ± 1.71 ± 2.33
0.72–0.90				0.802	35.1	34.02 ± 1.12 ± 1.92

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.329	45.1	151.31 ± 4.02 ± 4.72			
0.36–0.42	0.388	45.0	119.42 ± 3.59 ± 3.51	0.389	55.1	126.97 ± 3.62 ± 3.59
0.42–0.50	0.458	44.8	94.69 ± 2.84 ± 3.15	0.458	55.0	107.29 ± 2.96 ± 3.16
0.50–0.60	0.549	45.0	71.66 ± 2.25 ± 3.10	0.548	54.9	70.48 ± 2.27 ± 3.24
0.60–0.72	0.655	45.0	50.15 ± 1.76 ± 2.46	0.656	55.1	48.76 ± 1.80 ± 2.94
0.72–0.90	0.799	45.0	32.30 ± 1.16 ± 1.99	0.798	54.8	26.10 ± 1.08 ± 1.98
0.90–1.25	1.037	45.0	11.27 ± 0.48 ± 0.99	1.034	54.8	7.55 ± 0.41 ± 0.85

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.461	67.4	98.81 ± 2.27 ± 2.72	0.460	81.9	80.27 ± 2.03 ± 2.83
0.50–0.60	0.549	67.3	70.62 ± 1.80 ± 2.79	0.549	82.0	56.60 ± 1.56 ± 2.64
0.60–0.72	0.658	67.1	36.58 ± 1.29 ± 2.87	0.657	82.1	21.90 ± 1.03 ± 2.30
0.72–0.90	0.805	67.1	17.69 ± 0.77 ± 2.01			

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.458	97.0	61.38 ± 1.78 ± 3.12	0.458	113.7	32.08 ± 1.13 ± 1.57
0.50–0.60	0.550	96.9	38.32 ± 1.29 ± 2.42	0.549	113.3	15.32 ± 0.75 ± 1.43
0.60–0.72	0.658	96.9	13.32 ± 0.85 ± 1.88			

Table A.14: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^+ + Al $\to \pi^+$ + X interactions with $+5.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.5	98.99 ± 5.43 ± 6.65	0.115	35.0	100.38 ± 5.52 ± 7.09
0.13–0.16	0.145	24.8	134.73 ± 5.93 ± 7.42	0.145	34.6	114.19 ± 5.38 ± 6.27
0.16–0.20	0.181	24.7	149.18 ± 5.21 ± 6.92	0.180	34.9	122.87 ± 4.68 ± 5.65
0.20–0.24	0.221	24.8	173.11 ± 5.45 ± 6.92	0.220	34.8	122.49 ± 4.59 ± 4.85
0.24–0.30	0.270	24.7	172.39 ± 4.43 ± 5.87	0.271	34.7	124.90 ± 3.74 ± 4.18
0.30–0.36	0.329	24.8	141.96 ± 3.96 ± 4.24	0.329	34.7	113.48 ± 3.55 ± 3.34
0.36–0.42	0.389	24.7	123.53 ± 3.70 ± 3.78	0.389	34.7	98.27 ± 3.30 ± 2.82
0.42–0.50	0.458	24.8	100.42 ± 2.88 ± 3.78	0.458	34.8	78.89 ± 2.59 ± 2.69
0.50–0.60	0.547	24.8	67.12 ± 2.01 ± 3.33	0.548	34.9	51.07 ± 1.78 ± 2.26
0.60–0.72	0.657	24.8	38.22 ± 1.29 ± 2.83	0.655	34.6	32.35 ± 1.23 ± 2.13
0.72–0.90				0.798	34.7	15.37 ± 0.64 ± 1.61

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	44.9	89.21 ± 5.38 ± 6.57			
0.13–0.16	0.145	44.7	96.41 ± 5.03 ± 5.49	0.145	55.1	83.12 ± 4.68 ± 4.82
0.16–0.20	0.179	44.7	93.30 ± 4.05 ± 4.36	0.180	54.7	87.38 ± 3.91 ± 4.07
0.20–0.24	0.220	45.0	100.36 ± 4.13 ± 4.05	0.220	54.9	81.92 ± 3.75 ± 3.33
0.24–0.30	0.269	44.8	91.96 ± 3.27 ± 3.11	0.269	54.6	76.24 ± 2.96 ± 2.57
0.30–0.36	0.330	44.8	82.33 ± 3.04 ± 2.44	0.329	54.6	66.78 ± 2.78 ± 2.05
0.36–0.42	0.390	44.8	71.00 ± 2.85 ± 2.06	0.388	54.7	51.83 ± 2.45 ± 1.63
0.42–0.50	0.459	44.6	56.72 ± 2.19 ± 1.84	0.457	54.7	46.58 ± 2.00 ± 1.65
0.50–0.60	0.546	44.6	39.69 ± 1.58 ± 1.69	0.544	54.5	27.63 ± 1.35 ± 1.28
0.60–0.72	0.653	44.5	23.43 ± 1.10 ± 1.41	0.657	55.0	17.60 ± 0.99 ± 1.12
0.72–0.90	0.798	44.3	11.28 ± 0.58 ± 1.04	0.797	54.4	8.51 ± 0.53 ± 0.78
0.90–1.25				1.028	54.8	2.22 ± 0.18 ± 0.32

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	67.4	71.20 ± 3.52 ± 4.15	0.146	82.0	56.74 ± 3.17 ± 3.35
0.16–0.20	0.180	67.4	71.52 ± 2.91 ± 3.29	0.181	82.0	61.54 ± 2.75 ± 2.74
0.20–0.24	0.220	66.9	63.79 ± 2.72 ± 2.48	0.221	82.0	53.74 ± 2.52 ± 2.00
0.24–0.30	0.269	66.9	52.49 ± 2.00 ± 1.69	0.268	82.2	40.25 ± 1.77 ± 1.27
0.30–0.36	0.331	67.1	41.92 ± 1.81 ± 1.29	0.330	81.9	28.31 ± 1.47 ± 0.94
0.36–0.42	0.389	66.8	35.63 ± 1.63 ± 1.16	0.391	82.0	20.90 ± 1.26 ± 0.82
0.42–0.50	0.461	66.5	26.95 ± 1.22 ± 1.08	0.461	81.7	15.48 ± 0.93 ± 0.77
0.50–0.60	0.549	67.0	17.51 ± 0.87 ± 0.95	0.547	82.2	9.25 ± 0.64 ± 0.62
0.60–0.72	0.656	66.8	10.93 ± 0.64 ± 0.82	0.655	81.4	6.01 ± 0.48 ± 0.55
0.72–0.90	0.797	66.4	5.05 ± 0.34 ± 0.53	0.795	81.5	1.73 ± 0.19 ± 0.22
0.90–1.25	1.036	66.6	0.98 ± 0.09 ± 0.17	1.023	81.1	0.22 ± 0.04 ± 0.05

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.6	61.96 ± 3.41 ± 3.65	0.145	114.7	50.79 ± 2.62 ± 2.49
0.16–0.20	0.180	97.5	62.62 ± 2.84 ± 2.73	0.179	114.1	42.52 ± 1.99 ± 1.56
0.20–0.24	0.220	97.2	44.11 ± 2.28 ± 1.58	0.219	113.7	28.72 ± 1.60 ± 1.02
0.24–0.30	0.269	96.9	28.65 ± 1.50 ± 0.98	0.270	114.1	16.90 ± 1.00 ± 0.69
0.30–0.36	0.330	96.8	18.00 ± 1.18 ± 0.76	0.330	114.1	10.37 ± 0.77 ± 0.57
0.36–0.42	0.388	96.4	12.67 ± 0.98 ± 0.68	0.392	113.6	6.03 ± 0.60 ± 0.44
0.42–0.50	0.459	96.9	10.16 ± 0.76 ± 0.71	0.459	113.9	3.96 ± 0.42 ± 0.38
0.50–0.60	0.548	97.0	5.72 ± 0.52 ± 0.54	0.552	113.0	1.38 ± 0.20 ± 0.19
0.60–0.72	0.659	97.7	1.95 ± 0.26 ± 0.25	0.652	112.2	0.42 ± 0.10 ± 0.09
0.72–0.90	0.790	95.3	0.78 ± 0.12 ± 0.15	0.803	112.1	0.05 ± 0.02 ± 0.02
0.90–1.25	1.021	96.5	0.04 ± 0.02 ± 0.02			

Table A.15: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^+ + Al $\to \pi^-$ + X interactions with $+5.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	25.0	99.29 ± 5.31 ± 6.92	0.115	34.8	76.82 ± 4.67 ± 5.58
0.13–0.16	0.146	25.2	132.90 ± 5.82 ± 7.59	0.146	34.9	91.73 ± 4.71 ± 5.22
0.16–0.20	0.180	24.8	132.38 ± 4.77 ± 6.13	0.181	34.9	98.03 ± 4.07 ± 4.63
0.20–0.24	0.220	24.8	134.35 ± 4.82 ± 5.49	0.220	34.6	108.04 ± 4.25 ± 4.33
0.24–0.30	0.269	24.8	115.60 ± 3.56 ± 3.80	0.270	34.9	93.04 ± 3.20 ± 3.09
0.30–0.36	0.329	24.8	95.45 ± 3.24 ± 2.79	0.329	34.9	71.40 ± 2.79 ± 2.12
0.36–0.42	0.388	24.7	79.37 ± 2.99 ± 2.44	0.389	34.9	60.97 ± 2.57 ± 1.86
0.42–0.50	0.455	24.7	52.66 ± 2.12 ± 1.95	0.458	34.9	41.53 ± 1.87 ± 1.47
0.50–0.60	0.545	24.8	32.51 ± 1.45 ± 1.56	0.544	34.7	27.06 ± 1.33 ± 1.27
0.60–0.72	0.653	25.0	16.60 ± 0.97 ± 1.10	0.652	34.8	15.47 ± 0.91 ± 1.00
0.72–0.90				0.790	34.7	6.07 ± 0.48 ± 0.55

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	45.0	81.81 ± 5.05 ± 6.16			
0.13–0.16	0.145	45.2	88.95 ± 4.73 ± 5.11	0.145	55.0	73.12 ± 4.34 ± 4.35
0.16–0.20	0.179	44.8	80.85 ± 3.71 ± 3.88	0.180	54.9	69.41 ± 3.45 ± 3.32
0.20–0.24	0.220	44.8	77.57 ± 3.59 ± 3.21	0.219	54.7	64.80 ± 3.24 ± 2.69
0.24–0.30	0.269	44.8	69.01 ± 2.75 ± 2.33	0.270	54.6	50.20 ± 2.37 ± 1.70
0.30–0.36	0.329	44.7	54.92 ± 2.41 ± 1.66	0.329	54.8	41.50 ± 2.15 ± 1.28
0.36–0.42	0.388	44.9	44.59 ± 2.27 ± 1.48	0.389	54.5	34.92 ± 1.99 ± 1.15
0.42–0.50	0.458	44.8	35.28 ± 1.72 ± 1.30	0.457	54.5	25.99 ± 1.46 ± 1.03
0.50–0.60	0.546	44.6	19.68 ± 1.13 ± 0.98	0.544	55.0	14.64 ± 0.98 ± 0.77
0.60–0.72	0.652	44.7	11.06 ± 0.79 ± 0.76	0.652	54.8	7.85 ± 0.65 ± 0.56
0.72–0.90	0.802	45.0	4.90 ± 0.43 ± 0.47	0.795	54.4	2.96 ± 0.34 ± 0.29
0.90–1.25				1.021	54.8	0.89 ± 0.13 ± 0.13

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.0	64.94 ± 3.39 ± 3.70	0.146	82.2	53.57 ± 3.11 ± 3.12
0.16–0.20	0.179	67.3	53.90 ± 2.50 ± 2.41	0.179	82.4	53.01 ± 2.52 ± 2.32
0.20–0.24	0.219	67.3	48.50 ± 2.34 ± 1.85	0.219	82.1	42.72 ± 2.25 ± 1.60
0.24–0.30	0.268	67.0	40.85 ± 1.75 ± 1.31	0.267	81.9	29.34 ± 1.47 ± 0.95
0.30–0.36	0.327	67.3	35.72 ± 1.64 ± 1.10	0.326	81.8	18.74 ± 1.16 ± 0.67
0.36–0.42	0.387	66.7	23.17 ± 1.30 ± 0.82	0.387	81.5	14.55 ± 1.04 ± 0.64
0.42–0.50	0.455	66.6	17.10 ± 0.97 ± 0.75	0.457	81.7	10.74 ± 0.77 ± 0.60
0.50–0.60	0.541	66.4	10.54 ± 0.68 ± 0.62	0.545	81.7	6.17 ± 0.54 ± 0.46
0.60–0.72	0.645	67.0	5.69 ± 0.46 ± 0.45	0.646	81.8	2.17 ± 0.28 ± 0.22
0.72–0.90	0.778	67.0	2.25 ± 0.24 ± 0.25	0.787	82.4	0.81 ± 0.14 ± 0.11
0.90–1.25	1.036	65.7	0.28 ± 0.05 ± 0.05	0.998	81.2	0.07 ± 0.02 ± 0.02

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.144	97.3	51.10 ± 3.10 ± 3.01	0.144	114.8	37.63 ± 2.30 ± 1.86
0.16–0.20	0.178	97.2	45.02 ± 2.37 ± 1.93	0.179	113.7	32.06 ± 1.73 ± 1.20
0.20–0.24	0.218	97.1	32.73 ± 1.97 ± 1.21	0.218	113.8	19.66 ± 1.30 ± 0.76
0.24–0.30	0.266	97.2	21.45 ± 1.27 ± 0.78	0.265	113.2	11.84 ± 0.82 ± 0.55
0.30–0.36	0.329	97.0	15.20 ± 1.08 ± 0.71	0.326	114.0	6.51 ± 0.62 ± 0.42
0.36–0.42	0.385	96.7	9.50 ± 0.84 ± 0.58	0.383	113.3	5.32 ± 0.55 ± 0.45
0.42–0.50	0.457	96.7	6.05 ± 0.59 ± 0.48	0.454	113.4	2.18 ± 0.31 ± 0.24
0.50–0.60	0.537	96.8	3.48 ± 0.40 ± 0.37	0.529	110.7	0.80 ± 0.15 ± 0.13
0.60–0.72	0.640	95.5	1.01 ± 0.19 ± 0.15	0.639	111.9	0.24 ± 0.07 ± 0.07
0.72–0.90	0.770	95.3	0.23 ± 0.06 ± 0.06			

Table A.16: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^- + Al $\rightarrow$ p + X interactions with -5.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.221	25.1	139.73 ± 3.81 ± 7.00			
0.24–0.30	0.271	25.2	125.66 ± 2.91 ± 5.82	0.272	34.8	133.09 ± 2.92 ± 5.51
0.30–0.36	0.331	25.2	111.65 ± 2.80 ± 5.17	0.331	35.0	116.52 ± 2.72 ± 4.34
0.36–0.42	0.393	25.2	93.50 ± 2.53 ± 4.04	0.392	35.0	97.46 ± 2.57 ± 3.82
0.42–0.50	0.462	25.1	75.29 ± 1.94 ± 3.01	0.462	35.0	78.89 ± 2.02 ± 3.33
0.50–0.60	0.554	25.1	59.94 ± 1.51 ± 2.27	0.552	35.0	62.69 ± 1.59 ± 2.66
0.60–0.72	0.665	25.2	42.51 ± 1.14 ± 1.82	0.664	35.0	43.62 ± 1.22 ± 2.04
0.72–0.90				0.812	35.0	24.62 ± 0.73 ± 1.44

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.329	45.0	125.63 ± 2.77 ± 3.95			
0.36–0.42	0.386	45.0	108.71 ± 2.60 ± 3.24	0.388	55.0	110.16 ± 2.55 ± 3.10
0.42–0.50	0.456	45.1	79.33 ± 1.95 ± 2.77	0.456	55.0	85.20 ± 1.99 ± 2.60
0.50–0.60	0.544	45.0	59.20 ± 1.59 ± 2.77	0.545	55.0	55.56 ± 1.52 ± 2.81
0.60–0.72	0.650	44.9	41.62 ± 1.23 ± 2.23	0.650	55.0	34.74 ± 1.16 ± 2.38
0.72–0.90	0.793	44.9	25.15 ± 0.79 ± 1.67	0.792	55.0	19.93 ± 0.73 ± 1.73
0.90–1.25	1.021	45.0	7.60 ± 0.30 ± 0.72	1.021	55.1	5.78 ± 0.29 ± 0.77

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.457	67.5	85.69 ± 1.59 ± 2.40	0.457	82.1	71.68 ± 1.43 ± 2.60
0.50–0.60	0.546	67.2	56.07 ± 1.22 ± 2.36	0.546	81.9	46.07 ± 1.05 ± 2.17
0.60–0.72	0.655	67.1	28.29 ± 0.89 ± 2.57	0.651	81.8	18.08 ± 0.74 ± 2.13
0.72–0.90	0.796	66.9	11.65 ± 0.48 ± 1.60			

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.457	97.0	51.45 ± 1.22 ± 2.63	0.457	113.7	27.82 ± 0.79 ± 1.38
0.50–0.60	0.547	97.0	30.41 ± 0.86 ± 1.93	0.543	113.5	12.17 ± 0.51 ± 1.19

Table A.17: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^- + Al $\to \pi^+$ + X interactions with -5.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	25.0	104.30 ± 4.15 ± 7.11	0.115	34.8	80.61 ± 3.63 ± 5.70
0.13–0.16	0.146	24.8	110.88 ± 3.90 ± 6.00	0.146	34.8	86.56 ± 3.41 ± 4.76
0.16–0.20	0.181	24.9	133.38 ± 3.65 ± 6.23	0.181	34.8	100.46 ± 3.09 ± 4.63
0.20–0.24	0.221	24.8	132.08 ± 3.55 ± 5.35	0.221	34.7	96.65 ± 3.00 ± 3.87
0.24–0.30	0.271	24.7	125.05 ± 2.75 ± 4.30	0.271	34.7	97.40 ± 2.46 ± 3.29
0.30–0.36	0.331	24.9	103.30 ± 2.53 ± 3.27	0.331	34.8	77.68 ± 2.17 ± 2.35
0.36–0.42	0.392	24.6	85.61 ± 2.28 ± 3.00	0.392	34.7	64.53 ± 1.99 ± 1.95
0.42–0.50	0.460	24.9	64.14 ± 1.71 ± 3.23	0.463	34.7	52.59 ± 1.57 ± 2.02
0.50–0.60	0.553	24.8	39.70 ± 1.15 ± 3.01	0.551	34.8	32.80 ± 1.06 ± 1.91
0.60–0.72	0.662	24.9	21.90 ± 0.74 ± 2.63	0.664	34.7	17.90 ± 0.68 ± 1.72
0.72–0.90				0.805	34.7	8.40 ± 0.35 ± 1.41

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	44.6	66.32 ± 3.44 ± 4.83			
0.13–0.16	0.144	44.9	77.75 ± 3.33 ± 4.32	0.145	55.0	65.23 ± 3.08 ± 3.80
0.16–0.20	0.180	44.9	79.75 ± 2.75 ± 3.75	0.179	55.0	67.15 ± 2.55 ± 3.16
0.20–0.24	0.219	44.7	71.89 ± 2.58 ± 2.93	0.219	54.7	63.81 ± 2.43 ± 2.62
0.24–0.30	0.269	44.8	68.07 ± 2.06 ± 2.32	0.268	54.8	56.23 ± 1.86 ± 1.92
0.30–0.36	0.328	44.8	59.40 ± 1.90 ± 1.80	0.328	54.7	46.41 ± 1.74 ± 1.53
0.36–0.42	0.387	44.7	50.52 ± 1.79 ± 1.55	0.387	54.5	36.05 ± 1.49 ± 1.13
0.42–0.50	0.456	44.7	39.88 ± 1.38 ± 1.39	0.456	54.9	29.59 ± 1.18 ± 1.07
0.50–0.60	0.545	45.0	27.56 ± 1.01 ± 1.32	0.542	54.9	19.30 ± 0.84 ± 0.93
0.60–0.72	0.651	44.6	14.33 ± 0.63 ± 1.04	0.651	54.6	9.81 ± 0.54 ± 0.69
0.72–0.90	0.791	44.5	6.10 ± 0.32 ± 0.78	0.785	55.0	4.22 ± 0.27 ± 0.47
0.90–1.25				1.021	54.3	1.00 ± 0.08 ± 0.20

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.2	59.93 ± 2.45 ± 3.52	0.145	82.3	46.83 ± 2.19 ± 2.79
0.16–0.20	0.180	67.4	57.51 ± 1.96 ± 2.67	0.179	82.2	49.66 ± 1.82 ± 2.24
0.20–0.24	0.219	67.2	47.39 ± 1.71 ± 1.88	0.220	82.2	39.86 ± 1.62 ± 1.50
0.24–0.30	0.269	67.1	42.55 ± 1.33 ± 1.40	0.269	82.3	29.40 ± 1.12 ± 0.95
0.30–0.36	0.330	67.0	33.56 ± 1.19 ± 1.03	0.329	81.7	20.15 ± 0.91 ± 0.68
0.36–0.42	0.389	66.9	27.89 ± 1.08 ± 0.94	0.390	81.7	16.28 ± 0.82 ± 0.66
0.42–0.50	0.458	66.6	19.15 ± 0.77 ± 0.79	0.459	81.5	11.36 ± 0.59 ± 0.58
0.50–0.60	0.544	66.6	13.93 ± 0.59 ± 0.78	0.546	81.7	7.41 ± 0.43 ± 0.51
0.60–0.72	0.654	66.5	6.29 ± 0.35 ± 0.50	0.653	82.0	3.59 ± 0.26 ± 0.34
0.72–0.90	0.790	66.4	2.71 ± 0.18 ± 0.32	0.795	81.8	1.12 ± 0.11 ± 0.16
0.90–1.25	1.008	65.6	0.41 ± 0.04 ± 0.09	1.015	81.0	0.09 ± 0.02 ± 0.03

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.6	41.71 ± 2.07 ± 2.43	0.144	114.4	41.13 ± 1.83 ± 2.10
0.16–0.20	0.179	97.1	41.83 ± 1.72 ± 1.78	0.179	114.0	29.79 ± 1.25 ± 1.14
0.20–0.24	0.219	97.3	34.38 ± 1.50 ± 1.25	0.218	114.0	20.32 ± 1.00 ± 0.76
0.24–0.30	0.268	97.2	22.80 ± 0.99 ± 0.78	0.267	113.7	11.82 ± 0.62 ± 0.50
0.30–0.36	0.329	96.9	14.07 ± 0.76 ± 0.59	0.327	114.3	7.51 ± 0.49 ± 0.42
0.36–0.42	0.388	97.0	10.14 ± 0.64 ± 0.56	0.388	113.6	5.45 ± 0.41 ± 0.41
0.42–0.50	0.458	96.8	7.03 ± 0.48 ± 0.50	0.454	112.8	2.88 ± 0.26 ± 0.28
0.50–0.60	0.546	96.1	3.98 ± 0.31 ± 0.38	0.537	112.3	1.36 ± 0.15 ± 0.19
0.60–0.72	0.652	96.3	1.52 ± 0.16 ± 0.21	0.647	109.7	0.32 ± 0.06 ± 0.07
0.72–0.90	0.800	95.8	0.28 ± 0.05 ± 0.06	0.798	112.4	0.04 ± 0.02 ± 0.02

Table A.18: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^- + Al $\to \pi^-$ + X interactions with -5.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.8	143.35 ± 4.88 ± 9.63	0.115	34.8	126.60 ± 4.64 ± 9.04
0.13–0.16	0.145	24.7	168.01 ± 4.95 ± 9.27	0.145	34.8	135.04 ± 4.39 ± 7.49
0.16–0.20	0.180	24.8	197.54 ± 4.50 ± 9.10	0.180	34.9	139.87 ± 3.74 ± 6.47
0.20–0.24	0.219	24.8	197.26 ± 4.44 ± 7.68	0.219	34.7	155.56 ± 3.89 ± 6.08
0.24–0.30	0.268	24.8	181.96 ± 3.41 ± 5.85	0.268	34.7	138.43 ± 2.96 ± 4.47
0.30–0.36	0.327	24.8	156.96 ± 3.18 ± 4.42	0.327	34.6	113.70 ± 2.65 ± 3.22
0.36–0.42	0.385	24.9	133.17 ± 2.95 ± 3.86	0.386	34.8	101.23 ± 2.55 ± 2.89
0.42–0.50	0.454	24.9	104.59 ± 2.28 ± 3.79	0.453	34.7	85.81 ± 2.04 ± 2.88
0.50–0.60	0.540	24.8	65.93 ± 1.57 ± 3.06	0.540	34.8	53.61 ± 1.42 ± 2.42
0.60–0.72	0.645	24.9	39.68 ± 1.10 ± 2.55	0.646	34.7	29.97 ± 0.95 ± 1.87
0.72–0.90				0.785	34.7	17.57 ± 0.61 ± 1.53

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	44.8	108.04 ± 4.46 ± 8.09			
0.13–0.16	0.146	44.9	125.19 ± 4.38 ± 7.39	0.145	55.0	102.06 ± 3.94 ± 5.99
0.16–0.20	0.181	44.8	113.90 ± 3.38 ± 5.34	0.180	54.7	92.53 ± 3.03 ± 4.34
0.20–0.24	0.220	44.8	109.38 ± 3.23 ± 4.38	0.220	54.7	92.64 ± 3.00 ± 3.68
0.24–0.30	0.271	44.6	105.13 ± 2.59 ± 3.43	0.271	54.7	82.05 ± 2.30 ± 2.67
0.30–0.36	0.330	44.8	94.49 ± 2.45 ± 2.70	0.331	55.0	66.11 ± 2.07 ± 1.93
0.36–0.42	0.391	44.7	78.01 ± 2.25 ± 2.30	0.390	54.9	57.98 ± 1.96 ± 1.88
0.42–0.50	0.460	44.8	61.62 ± 1.74 ± 2.22	0.459	54.9	39.81 ± 1.38 ± 1.50
0.50–0.60	0.549	44.8	38.71 ± 1.20 ± 1.86	0.548	54.6	26.26 ± 0.99 ± 1.33
0.60–0.72	0.658	44.9	21.64 ± 0.82 ± 1.44	0.654	54.8	15.48 ± 0.70 ± 1.07
0.72–0.90	0.801	44.8	11.09 ± 0.49 ± 1.03	0.804	54.6	7.06 ± 0.40 ± 0.68
0.90–1.25				1.035	54.4	1.76 ± 0.14 ± 0.25

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.4	83.16 ± 2.92 ± 4.67	0.145	82.2	74.68 ± 2.79 ± 4.26
0.16–0.20	0.179	67.3	85.05 ± 2.40 ± 3.73	0.180	82.2	74.94 ± 2.31 ± 3.20
0.20–0.24	0.220	67.2	75.11 ± 2.22 ± 2.76	0.220	82.2	60.60 ± 2.03 ± 2.16
0.24–0.30	0.269	67.0	59.67 ± 1.60 ± 1.83	0.268	82.1	45.49 ± 1.41 ± 1.39
0.30–0.36	0.329	66.9	46.04 ± 1.42 ± 1.39	0.330	81.9	29.35 ± 1.12 ± 0.99
0.36–0.42	0.388	66.9	36.18 ± 1.24 ± 1.21	0.388	81.7	20.44 ± 0.93 ± 0.85
0.42–0.50	0.459	66.9	27.66 ± 0.93 ± 1.17	0.458	81.8	15.58 ± 0.70 ± 0.84
0.50–0.60	0.545	66.9	18.89 ± 0.69 ± 1.08	0.547	81.5	10.25 ± 0.52 ± 0.74
0.60–0.72	0.653	66.5	10.50 ± 0.48 ± 0.81	0.652	81.6	5.55 ± 0.36 ± 0.55
0.72–0.90	0.793	66.5	4.49 ± 0.26 ± 0.49	0.785	81.1	1.91 ± 0.16 ± 0.25
0.90–1.25	1.031	66.8	0.85 ± 0.07 ± 0.14	1.012	81.7	0.18 ± 0.03 ± 0.04

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.4	71.31 ± 2.79 ± 4.12	0.144	114.5	56.43 ± 2.13 ± 2.72
0.16–0.20	0.178	97.4	67.41 ± 2.21 ± 2.81	0.179	113.9	45.30 ± 1.55 ± 1.63
0.20–0.24	0.219	97.2	47.39 ± 1.79 ± 1.63	0.218	114.0	31.91 ± 1.28 ± 1.15
0.24–0.30	0.267	96.7	33.05 ± 1.19 ± 1.12	0.267	114.0	16.81 ± 0.74 ± 0.75
0.30–0.36	0.328	97.1	20.79 ± 0.95 ± 0.90	0.329	113.5	10.77 ± 0.60 ± 0.66
0.36–0.42	0.387	97.3	13.92 ± 0.77 ± 0.80	0.388	114.1	6.33 ± 0.46 ± 0.52
0.42–0.50	0.458	97.1	8.63 ± 0.53 ± 0.66	0.453	113.2	3.99 ± 0.31 ± 0.42
0.50–0.60	0.543	95.9	5.70 ± 0.39 ± 0.59	0.543	112.7	1.79 ± 0.18 ± 0.26
0.60–0.72	0.648	96.2	2.07 ± 0.21 ± 0.29	0.639	111.8	0.36 ± 0.06 ± 0.08
0.72–0.90	0.784	97.1	0.42 ± 0.06 ± 0.09	0.768	112.2	0.06 ± 0.02 ± 0.02
0.90–1.25	1.067	98.1	0.03 ± 0.01 ± 0.02			

Table A.19: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in p + Al $\rightarrow$ p + X interactions with $+8.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.221	25.1	$194.56 \pm 4.11 \pm 9.52$			
0.24–0.30	0.271	25.1	$187.78 \pm 3.14 \pm 8.30$	0.271	34.8	$189.14 \pm 3.14 \pm 7.64$
0.30–0.36	0.331	25.1	$161.71 \pm 2.91 \pm 6.79$	0.332	35.0	$169.04 \pm 2.88 \pm 5.95$
0.36–0.42	0.392	25.1	$133.70 \pm 2.66 \pm 5.45$	0.393	34.9	$142.22 \pm 2.70 \pm 4.78$
0.42–0.50	0.463	25.1	$116.17 \pm 2.10 \pm 4.49$	0.463	35.0	$117.09 \pm 2.14 \pm 4.16$
0.50–0.60	0.554	25.0	$96.49 \pm 1.71 \pm 3.81$	0.553	35.0	$94.53 \pm 1.74 \pm 3.74$
0.60–0.72	0.665	25.0	$74.50 \pm 1.34 \pm 3.27$	0.665	35.0	$69.58 \pm 1.36 \pm 3.25$
0.72–0.90				0.813	35.0	$44.75 \pm 0.88 \pm 2.71$

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.334	45.0	$167.96 \pm 2.83 \pm 5.06$			
0.36–0.42	0.395	45.1	$148.36 \pm 2.67 \pm 4.09$	0.396	54.9	$145.15 \pm 2.57 \pm 3.78$
0.42–0.50	0.467	45.1	$121.57 \pm 2.14 \pm 3.60$	0.467	55.0	$121.14 \pm 2.09 \pm 3.32$
0.50–0.60	0.560	45.0	$94.87 \pm 1.75 \pm 3.59$	0.559	55.0	$87.23 \pm 1.67 \pm 3.49$
0.60–0.72	0.673	44.9	$66.88 \pm 1.36 \pm 3.24$	0.673	55.0	$58.59 \pm 1.29 \pm 3.28$
0.72–0.90	0.826	45.0	$40.40 \pm 0.87 \pm 2.59$	0.827	54.9	$32.46 \pm 0.82 \pm 2.44$
0.90–1.25	1.086	44.8	$12.77 \pm 0.34 \pm 1.22$	1.078	54.9	$9.07 \pm 0.30 \pm 1.06$

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.463	67.4	$113.15 \pm 1.61 \pm 3.01$	0.462	82.1	$95.48 \pm 1.46 \pm 3.31$
0.50–0.60	0.552	67.3	$81.28 \pm 1.27 \pm 3.06$	0.552	82.0	$64.78 \pm 1.11 \pm 2.98$
0.60–0.72	0.663	67.0	$46.94 \pm 0.97 \pm 3.34$	0.662	81.9	$27.83 \pm 0.75 \pm 2.39$
0.72–0.90	0.811	66.8	$22.15 \pm 0.56 \pm 2.19$	0.805	81.7	$12.26 \pm 0.42 \pm 1.42$
0.90–1.25	1.052	66.2	$5.63 \pm 0.21 \pm 0.89$	1.049	81.7	$2.70 \pm 0.15 \pm 0.47$

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.462	97.0	$68.33 \pm 1.24 \pm 3.42$	0.459	113.5	$33.56 \pm 0.76 \pm 1.62$
0.50–0.60	0.551	96.9	$38.48 \pm 0.86 \pm 2.40$	0.547	112.6	$14.47 \pm 0.48 \pm 1.22$
0.60–0.72	0.661	96.4	$13.80 \pm 0.55 \pm 1.57$	0.656	112.4	$4.42 \pm 0.28 \pm 0.69$
0.72–0.90	0.807	96.4	$5.23 \pm 0.29 \pm 0.75$	0.806	111.9	$1.25 \pm 0.13 \pm 0.27$

Table A.20: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in p + Al $\to \pi^+$ + X interactions with $+8.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.8	132.56 ± 4.29	±	9.11	0.116	34.9	96.85 ± 3.47	±	6.65
0.13–0.16	0.146	24.8	158.99 ± 4.35	±	8.69	0.146	34.7	120.16 ± 3.69	±	6.39
0.16–0.20	0.181	24.7	178.94 ± 3.80	±	8.10	0.181	34.9	127.84 ± 3.23	±	5.77
0.20–0.24	0.221	24.8	176.91 ± 3.73	±	6.90	0.221	34.6	135.22 ± 3.28	±	5.27
0.24–0.30	0.271	24.7	168.40 ± 2.94	±	5.59	0.271	34.8	121.27 ± 2.49	±	3.96
0.30–0.36	0.331	24.6	141.75 ± 2.65	±	4.10	0.331	34.8	100.86 ± 2.26	±	2.89
0.36–0.42	0.392	24.7	115.75 ± 2.36	±	3.32	0.392	34.7	80.12 ± 2.00	±	2.23
0.42–0.50	0.462	24.7	83.46 ± 1.70	±	2.88	0.463	34.7	59.53 ± 1.48	±	1.89
0.50–0.60	0.552	24.8	55.61 ± 1.19	±	2.73	0.552	34.6	41.41 ± 1.06	±	1.82
0.60–0.72	0.662	24.8	34.18 ± 0.80	±	2.51	0.663	34.8	23.41 ± 0.68	±	1.53
0.72–0.90						0.808	34.6	11.08 ± 0.34	±	1.16

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.117	44.9	81.02 ± 3.28	±	5.73					
0.13–0.16	0.146	44.9	93.43 ± 3.17	±	5.03	0.146	54.8	80.51 ± 2.96	±	4.56
0.16–0.20	0.182	44.9	102.37 ± 2.86	±	4.62	0.181	55.0	81.21 ± 2.47	±	3.65
0.20–0.24	0.222	44.8	97.82 ± 2.79	±	3.84	0.222	54.7	77.31 ± 2.44	±	2.98
0.24–0.30	0.272	44.7	89.17 ± 2.12	±	2.95	0.271	54.7	65.60 ± 1.83	±	2.14
0.30–0.36	0.333	44.7	70.77 ± 1.88	±	2.05	0.334	54.8	53.43 ± 1.63	±	1.56
0.36–0.42	0.394	44.6	58.96 ± 1.74	±	1.70	0.395	54.7	41.98 ± 1.46	±	1.27
0.42–0.50	0.467	44.8	45.44 ± 1.30	±	1.48	0.466	54.7	29.62 ± 1.04	±	1.04
0.50–0.60	0.558	44.6	28.10 ± 0.88	±	1.20	0.559	54.5	21.04 ± 0.79	±	0.97
0.60–0.72	0.673	44.5	16.58 ± 0.60	±	0.99	0.671	54.6	11.39 ± 0.51	±	0.72
0.72–0.90	0.820	44.7	7.95 ± 0.31	±	0.73	0.816	54.7	4.83 ± 0.25	±	0.45
0.90–1.25						1.065	54.4	1.25 ± 0.07	±	0.19

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.146	67.2	66.21 ± 2.16	±	3.84	0.146	82.6	55.83 ± 1.97	±	3.39
0.16–0.20	0.181	67.2	69.96 ± 1.83	±	3.21	0.181	82.4	51.97 ± 1.56	±	2.40
0.20–0.24	0.220	67.1	60.98 ± 1.73	±	2.27	0.220	82.4	46.59 ± 1.47	±	1.72
0.24–0.30	0.271	67.1	50.15 ± 1.30	±	1.59	0.270	81.9	32.92 ± 1.05	±	1.01
0.30–0.36	0.331	67.0	37.79 ± 1.12	±	1.10	0.330	82.0	22.83 ± 0.88	±	0.73
0.36–0.42	0.392	67.0	30.07 ± 1.00	±	0.97	0.392	81.7	17.00 ± 0.75	±	0.66
0.42–0.50	0.461	66.7	20.24 ± 0.71	±	0.81	0.461	81.9	11.68 ± 0.54	±	0.58
0.50–0.60	0.554	66.6	12.96 ± 0.50	±	0.70	0.553	81.4	7.32 ± 0.38	±	0.49
0.60–0.72	0.660	66.4	6.68 ± 0.33	±	0.50	0.661	81.2	3.51 ± 0.23	±	0.32
0.72–0.90	0.809	66.5	2.59 ± 0.15	±	0.28	0.804	81.0	1.07 ± 0.10	±	0.14
0.90–1.25	1.049	65.9	0.57 ± 0.04	±	0.10	1.046	81.0	0.23 ± 0.03	±	0.04

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.5	42.54 ± 1.67	±	2.73	0.145	114.5	38.76 ± 1.36	±	2.36
0.16–0.20	0.180	97.4	46.62 ± 1.46	±	2.15	0.179	114.2	35.06 ± 1.09	±	1.60
0.20–0.24	0.220	97.1	33.85 ± 1.24	±	1.23	0.219	113.4	23.99 ± 0.94	±	0.81
0.24–0.30	0.269	96.7	24.00 ± 0.91	±	0.77	0.269	113.0	12.86 ± 0.58	±	0.51
0.30–0.36	0.330	96.6	14.57 ± 0.70	±	0.58	0.329	113.4	6.81 ± 0.41	±	0.37
0.36–0.42	0.390	96.6	10.24 ± 0.57	±	0.55	0.388	112.6	4.55 ± 0.34	±	0.33
0.42–0.50	0.459	96.6	5.29 ± 0.36	±	0.37	0.456	113.2	2.49 ± 0.22	±	0.24
0.50–0.60	0.550	96.1	2.65 ± 0.23	±	0.25	0.549	111.6	0.80 ± 0.11	±	0.10
0.60–0.72	0.660	96.4	1.49 ± 0.15	±	0.19	0.659	111.2	0.37 ± 0.07	±	0.06
0.72–0.90	0.810	95.6	0.34 ± 0.05	±	0.06	0.790	111.2	0.04 ± 0.02	±	0.01
0.90–1.25	1.048	95.8	0.06 ± 0.02	±	0.02					

Table A.21: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in p + Al $\rightarrow \pi^-$ + X interactions with $+8.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	24.8	134.10 ± 4.16 ± 9.08	0.116	35.0	110.34 ± 3.71 ± 7.79
0.13–0.16	0.145	24.6	144.41 ± 4.00 ± 7.85	0.145	34.8	117.62 ± 3.55 ± 6.44
0.16–0.20	0.179	24.8	153.44 ± 3.44 ± 6.91	0.179	34.8	123.28 ± 3.08 ± 5.62
0.20–0.24	0.219	24.9	150.04 ± 3.37 ± 5.72	0.219	34.7	110.96 ± 2.86 ± 4.26
0.24–0.30	0.267	24.9	128.95 ± 2.52 ± 4.07	0.268	34.7	105.42 ± 2.26 ± 3.34
0.30–0.36	0.326	25.0	101.14 ± 2.24 ± 2.79	0.327	34.8	84.50 ± 2.05 ± 2.33
0.36–0.42	0.385	24.9	73.22 ± 1.89 ± 2.07	0.385	34.8	65.00 ± 1.77 ± 1.82
0.42–0.50	0.454	24.9	56.27 ± 1.45 ± 1.91	0.453	34.8	48.19 ± 1.31 ± 1.60
0.50–0.60	0.539	24.9	34.69 ± 1.02 ± 1.61	0.539	34.8	28.92 ± 0.90 ± 1.30
0.60–0.72	0.644	25.0	18.83 ± 0.67 ± 1.21	0.646	34.6	14.17 ± 0.56 ± 0.90
0.72–0.90				0.778	34.7	6.55 ± 0.30 ± 0.60

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.115	45.2	94.57 ± 3.57 ± 6.87			
0.13–0.16	0.144	45.0	94.24 ± 3.13 ± 5.24	0.144	55.0	75.65 ± 2.82 ± 4.37
0.16–0.20	0.178	44.7	95.54 ± 2.69 ± 4.39	0.178	54.8	78.71 ± 2.41 ± 3.62
0.20–0.24	0.218	45.0	92.60 ± 2.61 ± 3.61	0.218	55.0	75.86 ± 2.38 ± 2.90
0.24–0.30	0.265	44.8	78.43 ± 1.96 ± 2.49	0.266	54.7	60.23 ± 1.71 ± 1.88
0.30–0.36	0.324	44.8	62.83 ± 1.73 ± 1.75	0.324	54.6	45.97 ± 1.47 ± 1.30
0.36–0.42	0.383	44.9	48.74 ± 1.51 ± 1.42	0.382	54.6	35.23 ± 1.29 ± 1.07
0.42–0.50	0.451	44.9	34.37 ± 1.10 ± 1.21	0.449	54.9	26.85 ± 0.96 ± 1.00
0.50–0.60	0.535	44.7	20.14 ± 0.72 ± 1.03	0.532	54.7	14.49 ± 0.63 ± 0.74
0.60–0.72	0.634	44.7	10.05 ± 0.46 ± 0.71	0.638	54.7	8.81 ± 0.44 ± 0.63
0.72–0.90	0.771	45.1	4.98 ± 0.27 ± 0.48	0.765	54.7	3.57 ± 0.23 ± 0.35
0.90–1.25				0.977	54.8	0.76 ± 0.07 ± 0.11

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.1	63.14 ± 2.10 ± 3.59	0.145	82.4	50.68 ± 1.86 ± 3.05
0.16–0.20	0.179	67.1	66.35 ± 1.78 ± 2.91	0.179	82.4	50.20 ± 1.52 ± 2.27
0.20–0.24	0.218	67.2	56.07 ± 1.65 ± 2.00	0.218	82.4	42.65 ± 1.41 ± 1.46
0.24–0.30	0.267	67.3	44.10 ± 1.18 ± 1.31	0.267	82.3	32.32 ± 1.01 ± 0.95
0.30–0.36	0.327	67.1	33.31 ± 1.02 ± 0.95	0.326	81.8	20.83 ± 0.81 ± 0.67
0.36–0.42	0.386	66.7	24.47 ± 0.87 ± 0.80	0.384	82.1	15.39 ± 0.68 ± 0.63
0.42–0.50	0.454	67.1	15.78 ± 0.60 ± 0.66	0.452	81.8	10.16 ± 0.49 ± 0.55
0.50–0.60	0.538	66.7	9.58 ± 0.41 ± 0.56	0.536	81.5	6.10 ± 0.34 ± 0.44
0.60–0.72	0.642	67.1	5.31 ± 0.29 ± 0.41	0.641	81.7	2.69 ± 0.20 ± 0.26
0.72–0.90	0.779	67.0	1.55 ± 0.12 ± 0.17	0.783	81.6	1.12 ± 0.11 ± 0.15
0.90–1.25	1.012	66.5	0.36 ± 0.04 ± 0.06	0.994	82.1	0.22 ± 0.03 ± 0.04

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.144	97.6	45.32 ± 1.70 ± 3.02	0.144	114.4	35.99 ± 1.30 ± 2.17
0.16–0.20	0.179	97.2	44.08 ± 1.42 ± 2.01	0.178	114.4	30.92 ± 1.02 ± 1.33
0.20–0.24	0.218	97.2	31.30 ± 1.18 ± 1.15	0.218	113.4	20.68 ± 0.87 ± 0.71
0.24–0.30	0.266	97.0	21.72 ± 0.83 ± 0.69	0.266	113.6	11.41 ± 0.53 ± 0.49
0.30–0.36	0.326	96.9	13.10 ± 0.64 ± 0.55	0.325	113.7	8.15 ± 0.44 ± 0.50
0.36–0.42	0.384	96.9	8.52 ± 0.51 ± 0.49	0.383	113.8	4.54 ± 0.33 ± 0.38
0.42–0.50	0.452	96.6	5.43 ± 0.35 ± 0.42	0.450	112.2	2.01 ± 0.19 ± 0.22
0.50–0.60	0.536	96.5	2.88 ± 0.23 ± 0.30	0.532	112.5	1.11 ± 0.13 ± 0.16
0.60–0.72	0.642	97.1	1.52 ± 0.16 ± 0.21	0.643	110.6	0.25 ± 0.06 ± 0.05
0.72–0.90	0.779	96.1	0.32 ± 0.06 ± 0.06	0.772	111.1	0.07 ± 0.02 ± 0.02
0.90–1.25	1.005	100.2	0.04 ± 0.02 ± 0.02			

Table A.22: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^+ + Al $\to$ p + X interactions with $+8.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$						$30 < \theta < 40$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.20–0.24	0.221	25.0	163.97	±	5.12	± 8.10						
0.24–0.30	0.271	25.1	140.86	±	3.83	± 6.31	0.272	34.8	144.64	±	3.85	± 5.93
0.30–0.36	0.331	25.2	118.62	±	3.52	± 5.09	0.332	35.1	128.82	±	3.56	± 4.63
0.36–0.42	0.392	25.0	98.19	±	3.19	± 4.09	0.392	35.0	114.73	±	3.44	± 3.99
0.42–0.50	0.463	25.1	83.43	±	2.47	± 3.30	0.463	34.9	90.42	±	2.66	± 3.32
0.50–0.60	0.553	25.0	71.20	±	2.02	± 2.86	0.555	35.0	71.05	±	2.11	± 2.87
0.60–0.72	0.665	25.0	52.30	±	1.54	± 2.33	0.665	35.0	49.19	±	1.60	± 2.33
0.72–0.90							0.813	35.0	30.87	±	1.00	± 1.89

	$40 < \theta < 50$						$50 < \theta < 60$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.30–0.36	0.334	45.0	132.87	±	3.56	± 4.11						
0.36–0.42	0.396	45.0	119.21	±	3.38	± 3.40	0.396	55.1	120.19	±	3.31	± 3.26
0.42–0.50	0.467	45.1	91.84	±	2.63	± 2.82	0.467	55.1	94.29	±	2.61	± 2.67
0.50–0.60	0.560	45.1	71.18	±	2.14	± 2.76	0.560	55.0	65.71	±	2.05	± 2.68
0.60–0.72	0.676	45.0	48.31	±	1.63	± 2.37	0.672	55.1	43.21	±	1.57	± 2.45
0.72–0.90	0.828	45.0	28.58	±	1.02	± 1.84	0.825	54.9	23.51	±	0.98	± 1.78
0.90–1.25	1.079	44.9	8.45	±	0.38	± 0.81	1.077	54.8	5.85	±	0.34	± 0.68

	$60 < \theta < 75$						$75 < \theta < 90$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.42–0.50	0.462	67.4	95.24	±	2.09	± 2.64	0.461	82.4	80.03	±	1.89	± 2.84
0.50–0.60	0.551	67.6	65.60	±	1.62	± 2.51	0.553	82.2	51.31	±	1.39	± 2.38
0.60–0.72	0.664	67.3	34.17	±	1.17	± 2.47	0.660	81.7	23.86	±	0.99	± 2.08
0.72–0.90	0.809	67.0	17.00	±	0.69	± 1.70	0.808	81.7	9.96	±	0.54	± 1.17
0.90–1.25	1.050	66.5	4.22	±	0.26	± 0.67	1.040	81.2	2.33	±	0.20	± 0.40

	$90 < \theta < 105$						$105 < \theta < 125$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.42–0.50	0.461	96.9	54.94	±	1.58	± 2.77	0.461	113.4	32.09	±	1.06	± 1.56
0.50–0.60	0.552	96.9	35.69	±	1.17	± 2.24	0.550	112.9	14.23	±	0.67	± 1.20
0.60–0.72	0.658	96.5	13.16	±	0.76	± 1.47	0.657	112.4	4.36	±	0.39	± 0.67
0.72–0.90	0.807	95.6	4.61	±	0.39	± 0.64	0.799	113.1	1.02	±	0.16	± 0.22

Table A.23: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^+ + Al $\to \pi^+$ + X interactions with $+8.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.8	133.16 ± 6.22 ± 9.40	0.116	34.7	103.03 ± 5.13 ± 7.09
0.13–0.16	0.146	24.8	159.01 ± 6.21 ± 8.83	0.146	34.7	122.97 ± 5.32 ± 6.61
0.16–0.20	0.181	24.8	195.65 ± 5.64 ± 8.95	0.181	34.7	135.65 ± 4.73 ± 6.19
0.20–0.24	0.221	24.9	217.22 ± 5.86 ± 8.58	0.221	34.6	148.05 ± 4.87 ± 5.85
0.24–0.30	0.271	24.7	205.48 ± 4.61 ± 6.95	0.270	34.6	143.18 ± 3.84 ± 4.75
0.30–0.36	0.331	24.7	176.01 ± 4.20 ± 5.21	0.332	34.7	126.89 ± 3.60 ± 3.70
0.36–0.42	0.392	24.6	143.35 ± 3.72 ± 4.18	0.392	34.7	106.54 ± 3.27 ± 3.00
0.42–0.50	0.463	24.7	119.09 ± 2.91 ± 4.15	0.461	34.8	83.71 ± 2.50 ± 2.68
0.50–0.60	0.553	24.6	81.69 ± 2.09 ± 4.02	0.553	34.7	51.66 ± 1.69 ± 2.27
0.60–0.72	0.664	24.7	49.25 ± 1.42 ± 3.62	0.663	34.7	28.90 ± 1.09 ± 1.89
0.72–0.90				0.813	34.7	16.11 ± 0.62 ± 1.68

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	45.0	81.24 ± 4.73 ± 5.75			
0.13–0.16	0.146	44.7	98.71 ± 4.64 ± 5.34	0.146	54.8	85.41 ± 4.32 ± 4.85
0.16–0.20	0.181	44.8	108.61 ± 4.20 ± 4.95	0.181	54.6	82.21 ± 3.53 ± 3.72
0.20–0.24	0.222	44.7	107.66 ± 4.16 ± 4.29	0.222	54.8	76.84 ± 3.47 ± 3.01
0.24–0.30	0.272	44.6	105.65 ± 3.29 ± 3.56	0.272	54.9	71.86 ± 2.74 ± 2.47
0.30–0.36	0.333	44.7	85.68 ± 2.93 ± 2.53	0.334	54.9	60.42 ± 2.48 ± 1.80
0.36–0.42	0.395	44.6	73.44 ± 2.76 ± 2.14	0.395	54.8	54.27 ± 2.36 ± 1.66
0.42–0.50	0.466	44.8	55.09 ± 2.03 ± 1.80	0.466	54.6	36.20 ± 1.64 ± 1.30
0.50–0.60	0.557	44.6	36.03 ± 1.42 ± 1.53	0.558	54.8	23.77 ± 1.19 ± 1.09
0.60–0.72	0.672	44.6	22.27 ± 1.01 ± 1.33	0.671	54.6	16.01 ± 0.87 ± 1.01
0.72–0.90	0.825	44.6	11.37 ± 0.55 ± 1.05	0.823	54.5	6.48 ± 0.41 ± 0.60
0.90–1.25				1.078	54.2	1.41 ± 0.12 ± 0.21

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	67.1	73.94 ± 3.34 ± 4.24	0.145	82.4	50.70 ± 2.70 ± 2.97
0.16–0.20	0.180	67.1	69.08 ± 2.58 ± 3.18	0.180	82.3	53.89 ± 2.26 ± 2.47
0.20–0.24	0.221	67.2	64.61 ± 2.54 ± 2.43	0.221	82.1	48.65 ± 2.13 ± 1.79
0.24–0.30	0.269	67.1	55.13 ± 1.95 ± 1.83	0.270	82.1	35.41 ± 1.55 ± 1.20
0.30–0.36	0.332	67.1	39.01 ± 1.63 ± 1.19	0.331	82.2	28.22 ± 1.39 ± 0.94
0.36–0.42	0.392	66.9	30.40 ± 1.43 ± 0.99	0.393	81.8	19.08 ± 1.12 ± 0.74
0.42–0.50	0.461	67.1	22.18 ± 1.05 ± 0.90	0.459	82.2	13.48 ± 0.82 ± 0.67
0.50–0.60	0.552	66.7	16.57 ± 0.80 ± 0.90	0.552	81.6	8.80 ± 0.58 ± 0.58
0.60–0.72	0.661	66.6	9.47 ± 0.56 ± 0.70	0.658	81.4	3.92 ± 0.35 ± 0.35
0.72–0.90	0.805	66.8	3.27 ± 0.24 ± 0.35	0.802	80.9	1.61 ± 0.17 ± 0.20
0.90–1.25	1.044	66.0	0.81 ± 0.08 ± 0.14	1.056	80.5	0.26 ± 0.04 ± 0.05

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.3	53.67 ± 2.71 ± 3.24	0.145	114.4	41.94 ± 2.01 ± 2.52
0.16–0.20	0.179	97.0	44.69 ± 2.05 ± 2.00	0.178	114.5	32.60 ± 1.53 ± 1.46
0.20–0.24	0.220	97.5	37.22 ± 1.87 ± 1.33	0.219	113.9	26.28 ± 1.42 ± 0.89
0.24–0.30	0.269	97.0	25.95 ± 1.35 ± 0.94	0.270	114.1	14.06 ± 0.86 ± 0.57
0.30–0.36	0.328	96.9	17.05 ± 1.08 ± 0.71	0.329	113.6	8.80 ± 0.67 ± 0.49
0.36–0.42	0.391	96.9	11.89 ± 0.87 ± 0.62	0.392	113.5	7.50 ± 0.62 ± 0.53
0.42–0.50	0.460	95.9	7.97 ± 0.63 ± 0.56	0.456	112.8	2.64 ± 0.31 ± 0.25
0.50–0.60	0.549	96.1	4.14 ± 0.40 ± 0.38	0.537	113.2	1.24 ± 0.19 ± 0.15
0.60–0.72	0.659	96.5	2.03 ± 0.25 ± 0.25	0.652	111.2	0.48 ± 0.11 ± 0.08
0.72–0.90	0.800	94.9	0.53 ± 0.10 ± 0.09	0.835	113.4	0.03 ± 0.02 ± 0.01
0.90–1.25	1.054	96.1	0.08 ± 0.03 ± 0.02			

Table A.24: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^+ + Al $\rightarrow \pi^-$ + X interactions with $+8.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.9	132.90 ± 5.84 ± 9.06	0.116	34.9	98.96 ± 5.03 ± 7.01
0.13–0.16	0.144	24.5	141.99 ± 5.58 ± 7.77	0.146	34.7	114.00 ± 4.95 ± 6.27
0.16–0.20	0.179	24.6	163.95 ± 5.02 ± 7.44	0.180	34.8	110.25 ± 4.11 ± 5.06
0.20–0.24	0.219	24.9	163.73 ± 4.99 ± 6.31	0.219	34.7	114.35 ± 4.12 ± 4.44
0.24–0.30	0.268	24.8	144.01 ± 3.77 ± 4.62	0.267	34.8	106.79 ± 3.23 ± 3.44
0.30–0.36	0.328	24.8	130.80 ± 3.60 ± 3.67	0.327	34.9	89.85 ± 3.00 ± 2.52
0.36–0.42	0.386	24.7	94.67 ± 3.03 ± 2.71	0.386	34.7	69.08 ± 2.58 ± 1.96
0.42–0.50	0.452	24.7	70.89 ± 2.29 ± 2.43	0.453	34.8	53.63 ± 1.96 ± 1.80
0.50–0.60	0.538	24.6	45.80 ± 1.65 ± 2.13	0.538	34.6	34.56 ± 1.39 ± 1.55
0.60–0.72	0.645	24.8	25.54 ± 1.09 ± 1.64	0.642	34.8	16.49 ± 0.85 ± 1.04
0.72–0.90				0.783	34.6	7.68 ± 0.46 ± 0.69

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	44.8	81.60 ± 4.70 ± 5.95			
0.13–0.16	0.144	44.6	81.28 ± 4.12 ± 4.55	0.144	55.0	68.26 ± 3.81 ± 3.97
0.16–0.20	0.179	44.6	85.55 ± 3.60 ± 3.96	0.178	54.9	76.48 ± 3.36 ± 3.55
0.20–0.24	0.218	44.8	78.50 ± 3.40 ± 3.09	0.217	54.9	69.64 ± 3.24 ± 2.69
0.24–0.30	0.266	44.8	79.79 ± 2.81 ± 2.58	0.266	54.6	56.83 ± 2.34 ± 1.81
0.30–0.36	0.323	44.9	64.71 ± 2.48 ± 1.83	0.324	54.8	49.02 ± 2.16 ± 1.41
0.36–0.42	0.382	44.7	54.89 ± 2.27 ± 1.61	0.383	54.9	39.83 ± 1.96 ± 1.22
0.42–0.50	0.448	44.8	37.17 ± 1.63 ± 1.31	0.448	54.9	24.68 ± 1.31 ± 0.92
0.50–0.60	0.532	44.9	21.29 ± 1.05 ± 1.08	0.534	54.5	17.59 ± 0.97 ± 0.89
0.60–0.72	0.636	45.1	10.79 ± 0.67 ± 0.76	0.634	54.7	9.59 ± 0.65 ± 0.67
0.72–0.90	0.769	44.7	4.71 ± 0.37 ± 0.45	0.768	54.5	3.96 ± 0.34 ± 0.38
0.90–1.25				0.977	54.3	0.82 ± 0.10 ± 0.12

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	67.1	56.48 ± 2.81 ± 3.20	0.145	82.0	48.72 ± 2.61 ± 2.86
0.16–0.20	0.179	67.0	53.66 ± 2.27 ± 2.37	0.179	82.3	41.75 ± 1.97 ± 1.87
0.20–0.24	0.219	66.8	53.49 ± 2.28 ± 1.94	0.218	82.2	37.77 ± 1.89 ± 1.31
0.24–0.30	0.267	66.7	43.52 ± 1.66 ± 1.32	0.266	81.9	28.84 ± 1.36 ± 0.86
0.30–0.36	0.326	66.9	30.17 ± 1.38 ± 0.87	0.326	82.1	21.68 ± 1.17 ± 0.71
0.36–0.42	0.386	66.8	25.30 ± 1.26 ± 0.83	0.387	82.0	13.77 ± 0.91 ± 0.56
0.42–0.50	0.455	67.0	16.70 ± 0.87 ± 0.70	0.451	82.0	11.77 ± 0.74 ± 0.63
0.50–0.60	0.541	66.8	10.68 ± 0.61 ± 0.62	0.542	81.7	5.22 ± 0.44 ± 0.38
0.60–0.72	0.642	66.6	5.78 ± 0.43 ± 0.44	0.639	81.5	3.03 ± 0.30 ± 0.29
0.72–0.90	0.776	66.8	2.09 ± 0.19 ± 0.23	0.776	81.1	1.14 ± 0.15 ± 0.15
0.90–1.25	0.991	66.3	0.60 ± 0.08 ± 0.09	1.040	81.7	0.21 ± 0.05 ± 0.04

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.145	97.2	38.43 ± 2.25 ± 2.43	0.143	114.2	31.30 ± 1.74 ± 1.82
0.16–0.20	0.179	97.1	38.84 ± 1.90 ± 1.73	0.178	114.5	24.78 ± 1.31 ± 1.03
0.20–0.24	0.218	96.2	27.23 ± 1.57 ± 0.98	0.218	114.2	22.26 ± 1.29 ± 0.78
0.24–0.30	0.268	96.7	20.94 ± 1.16 ± 0.67	0.266	113.4	9.94 ± 0.70 ± 0.43
0.30–0.36	0.325	96.7	14.35 ± 0.96 ± 0.60	0.324	113.4	8.49 ± 0.64 ± 0.52
0.36–0.42	0.385	96.8	10.36 ± 0.81 ± 0.58	0.383	113.1	4.56 ± 0.47 ± 0.37
0.42–0.50	0.450	96.9	6.11 ± 0.53 ± 0.46	0.451	113.6	2.87 ± 0.31 ± 0.30
0.50–0.60	0.543	97.0	2.59 ± 0.31 ± 0.26	0.538	112.6	1.47 ± 0.21 ± 0.20
0.60–0.72	0.634	98.9	1.43 ± 0.22 ± 0.20	0.646	111.2	0.62 ± 0.12 ± 0.11
0.72–0.90	0.777	96.9	0.45 ± 0.10 ± 0.08	0.761	107.5	0.14 ± 0.05 ± 0.03
0.90–1.25	1.032	96.0	0.06 ± 0.02 ± 0.02			

Table A.25: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^- + Al $\rightarrow$ p + X interactions with -8.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.221	25.0	131.35 ± 3.27 ± 6.50			
0.24–0.30	0.270	25.2	120.09 ± 2.52 ± 5.37	0.271	34.9	127.10 ± 2.56 ± 5.22
0.30–0.36	0.329	25.2	94.11 ± 2.24 ± 4.16	0.329	35.0	110.94 ± 2.36 ± 4.00
0.36–0.42	0.389	25.2	81.02 ± 2.09 ± 3.47	0.390	35.0	90.62 ± 2.19 ± 3.25
0.42–0.50	0.459	25.1	72.20 ± 1.67 ± 2.85	0.459	35.0	73.95 ± 1.73 ± 2.84
0.50–0.60	0.548	25.1	55.79 ± 1.30 ± 2.30	0.547	35.0	57.00 ± 1.36 ± 2.34
0.60–0.72	0.655	25.2	39.55 ± 0.97 ± 1.81	0.654	34.9	40.67 ± 1.04 ± 1.94
0.72–0.90				0.801	35.0	22.63 ± 0.63 ± 1.39

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.329	45.1	120.42 ± 2.45 ± 3.73			
0.36–0.42	0.389	45.0	97.94 ± 2.18 ± 2.80	0.388	55.1	99.33 ± 2.15 ± 2.78
0.42–0.50	0.458	45.1	78.70 ± 1.74 ± 2.50	0.458	55.1	83.77 ± 1.74 ± 2.39
0.50–0.60	0.547	45.0	57.92 ± 1.39 ± 2.34	0.548	55.1	55.21 ± 1.35 ± 2.41
0.60–0.72	0.656	44.9	37.72 ± 1.03 ± 1.88	0.655	55.0	33.01 ± 0.98 ± 1.94
0.72–0.90	0.800	44.7	21.06 ± 0.63 ± 1.37	0.797	55.0	19.07 ± 0.63 ± 1.44
0.90–1.25	1.035	44.8	6.10 ± 0.24 ± 0.59	1.033	54.9	4.28 ± 0.21 ± 0.53

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.449	67.4	79.63 ± 1.36 ± 2.27	0.449	82.3	67.16 ± 1.24 ± 2.42
0.50–0.60	0.535	67.3	53.34 ± 1.04 ± 2.08	0.534	82.1	44.97 ± 0.93 ± 2.09
0.60–0.72	0.637	67.2	27.51 ± 0.76 ± 2.17	0.637	81.8	19.91 ± 0.65 ± 1.87
0.72–0.90	0.774	66.9	13.28 ± 0.44 ± 1.41	0.768	81.9	7.82 ± 0.35 ± 0.96
0.90–1.25	0.986	66.6	3.07 ± 0.16 ± 0.51			

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.449	97.0	49.43 ± 1.07 ± 2.51	0.446	113.2	27.52 ± 0.70 ± 1.34
0.50–0.60	0.533	96.8	29.55 ± 0.75 ± 1.85	0.531	113.0	11.92 ± 0.45 ± 1.04
0.60–0.72	0.635	96.5	9.67 ± 0.47 ± 1.18	0.633	112.3	3.35 ± 0.25 ± 0.57
0.72–0.90	0.771	96.2	3.43 ± 0.24 ± 0.52			

Table A.26: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^- + Al $\to \pi^+$ + X interactions with -8.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$				$30 < \theta < 40$			
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	
0.10–0.13	0.116	24.8	103.05 ± 3.66 ± 6.85		0.116	34.9	78.47 ± 3.18 ± 5.44	
0.13–0.16	0.146	24.7	121.20 ± 3.68 ± 6.56		0.145	34.6	99.03 ± 3.27 ± 5.30	
0.16–0.20	0.181	24.8	145.20 ± 3.35 ± 6.55		0.180	34.7	109.96 ± 2.92 ± 4.93	
0.20–0.24	0.220	24.9	158.84 ± 3.48 ± 6.22		0.220	34.7	109.84 ± 2.84 ± 4.25	
0.24–0.30	0.269	24.8	143.59 ± 2.67 ± 4.80		0.270	34.7	110.08 ± 2.36 ± 3.61	
0.30–0.36	0.329	24.7	121.62 ± 2.44 ± 3.57		0.329	34.7	88.40 ± 2.07 ± 2.53	
0.36–0.42	0.389	24.9	105.60 ± 2.26 ± 3.07		0.389	34.7	76.15 ± 1.92 ± 2.12	
0.42–0.50	0.458	24.7	80.58 ± 1.67 ± 2.79		0.457	34.7	58.16 ± 1.46 ± 1.83	
0.50–0.60	0.546	24.8	49.67 ± 1.13 ± 2.44		0.547	34.9	35.99 ± 0.98 ± 1.57	
0.60–0.72	0.654	24.9	29.70 ± 0.76 ± 2.18		0.656	34.6	22.12 ± 0.67 ± 1.44	
0.72–0.90					0.798	34.6	9.14 ± 0.30 ± 0.99	

	$40 < \theta < 50$				$50 < \theta < 60$			
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	
0.10–0.13	0.115	44.9	70.66 ± 3.11 ± 5.04					
0.13–0.16	0.145	44.9	78.71 ± 2.94 ± 4.28		0.145	55.0	64.99 ± 2.66 ± 3.71	
0.16–0.20	0.180	44.8	89.99 ± 2.66 ± 4.08		0.179	54.8	68.06 ± 2.25 ± 3.08	
0.20–0.24	0.220	44.9	83.85 ± 2.50 ± 3.26		0.220	54.8	66.51 ± 2.22 ± 2.55	
0.24–0.30	0.270	44.6	76.49 ± 1.97 ± 2.51		0.269	54.8	57.21 ± 1.69 ± 1.84	
0.30–0.36	0.329	44.9	66.74 ± 1.80 ± 1.93		0.327	54.8	46.04 ± 1.49 ± 1.33	
0.36–0.42	0.388	44.8	53.64 ± 1.64 ± 1.52		0.390	54.8	38.74 ± 1.37 ± 1.15	
0.42–0.50	0.460	44.7	39.19 ± 1.17 ± 1.25		0.459	54.6	27.70 ± 0.98 ± 0.95	
0.50–0.60	0.544	44.6	23.38 ± 0.78 ± 1.01		0.545	54.6	18.15 ± 0.71 ± 0.82	
0.60–0.72	0.653	44.5	14.46 ± 0.54 ± 0.89		0.655	54.6	11.59 ± 0.51 ± 0.73	
0.72–0.90	0.799	44.5	6.22 ± 0.26 ± 0.60		0.795	54.9	4.45 ± 0.23 ± 0.42	
0.90–1.25					1.038	54.6	1.13 ± 0.07 ± 0.18	

	$60 < \theta < 75$				$75 < \theta < 90$			
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	
0.13–0.16	0.145	67.3	49.32 ± 1.89 ± 2.87		0.145	82.0	39.95 ± 1.67 ± 2.48	
0.16–0.20	0.179	67.2	50.52 ± 1.53 ± 2.50		0.178	82.1	43.42 ± 1.43 ± 2.04	
0.20–0.24	0.218	67.3	49.30 ± 1.54 ± 1.86		0.218	81.8	36.18 ± 1.28 ± 1.40	
0.24–0.30	0.266	67.0	40.69 ± 1.16 ± 1.27		0.264	81.9	28.94 ± 0.98 ± 0.87	
0.30–0.36	0.324	67.2	31.94 ± 1.01 ± 0.91		0.324	81.8	21.27 ± 0.82 ± 0.66	
0.36–0.42	0.383	66.9	25.49 ± 0.89 ± 0.80		0.384	81.7	14.49 ± 0.67 ± 0.55	
0.42–0.50	0.450	67.0	17.75 ± 0.64 ± 0.70		0.450	81.8	9.96 ± 0.47 ± 0.50	
0.50–0.60	0.534	66.7	11.06 ± 0.44 ± 0.59		0.531	81.4	6.54 ± 0.35 ± 0.43	
0.60–0.72	0.638	66.5	6.30 ± 0.30 ± 0.47		0.638	81.1	3.38 ± 0.22 ± 0.31	
0.72–0.90	0.772	66.7	2.99 ± 0.16 ± 0.31		0.763	81.5	1.04 ± 0.09 ± 0.13	
0.90–1.25	0.985	66.6	0.52 ± 0.04 ± 0.09		0.974	80.6	0.30 ± 0.04 ± 0.06	

	$90 < \theta < 105$				$105 < \theta < 125$			
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	
0.13–0.16	0.144	97.5	33.48 ± 1.51 ± 2.13		0.144	114.5	28.54 ± 1.16 ± 1.79	
0.16–0.20	0.178	97.0	33.90 ± 1.24 ± 1.69		0.177	114.3	22.56 ± 0.86 ± 1.13	
0.20–0.24	0.217	97.0	27.62 ± 1.12 ± 1.04		0.217	113.9	19.00 ± 0.82 ± 0.66	
0.24–0.30	0.265	97.0	22.46 ± 0.85 ± 0.70		0.266	113.6	11.54 ± 0.53 ± 0.45	
0.30–0.36	0.323	97.4	14.32 ± 0.69 ± 0.55		0.323	113.3	6.62 ± 0.40 ± 0.36	
0.36–0.42	0.382	96.5	9.71 ± 0.54 ± 0.51		0.382	113.2	4.39 ± 0.32 ± 0.32	
0.42–0.50	0.449	97.0	5.61 ± 0.35 ± 0.40		0.448	112.4	2.14 ± 0.19 ± 0.20	
0.50–0.60	0.531	96.2	3.21 ± 0.25 ± 0.30		0.528	112.2	1.00 ± 0.12 ± 0.13	
0.60–0.72	0.644	96.4	1.22 ± 0.14 ± 0.15		0.630	112.1	0.19 ± 0.05 ± 0.03	
0.72–0.90	0.763	95.0	0.40 ± 0.06 ± 0.07		0.745	112.6	0.05 ± 0.02 ± 0.02	
0.90–1.25	0.976	95.4	0.09 ± 0.02 ± 0.02					

Table A.27: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^- + Al $\to \pi^-$ + X interactions with -8.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.7	156.75 ± 4.61	±	10.77	0.116	34.6	114.00 ± 3.86	±	8.05
0.13–0.16	0.145	24.6	186.78 ± 4.66	±	10.26	0.145	34.8	135.76 ± 3.92	±	7.43
0.16–0.20	0.180	24.7	214.58 ± 4.16	±	9.75	0.180	34.7	154.21 ± 3.51	±	7.05
0.20–0.24	0.220	24.7	223.32 ± 4.20	±	8.67	0.220	34.8	154.16 ± 3.46	±	5.95
0.24–0.30	0.270	24.7	207.25 ± 3.25	±	6.61	0.270	34.7	146.89 ± 2.73	±	4.70
0.30–0.36	0.329	24.7	177.37 ± 2.99	±	4.94	0.329	34.5	127.90 ± 2.54	±	3.55
0.36–0.42	0.389	24.7	151.94 ± 2.79	±	4.30	0.389	34.6	100.24 ± 2.24	±	2.81
0.42–0.50	0.458	24.7	111.41 ± 2.06	±	3.79	0.457	34.6	79.61 ± 1.75	±	2.64
0.50–0.60	0.545	24.8	75.92 ± 1.51	±	3.50	0.545	34.6	50.41 ± 1.20	±	2.25
0.60–0.72	0.654	24.8	42.84 ± 1.02	±	2.74	0.655	34.7	30.43 ± 0.86	±	1.87
0.72–0.90						0.798	34.8	14.32 ± 0.48	±	1.24

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	44.9	96.67 ± 3.67	±	7.03					
0.13–0.16	0.145	44.9	109.35 ± 3.51	±	6.09	0.146	54.7	82.54 ± 3.01	±	4.77
0.16–0.20	0.180	44.8	118.13 ± 3.06	±	5.44	0.180	54.9	85.24 ± 2.57	±	3.92
0.20–0.24	0.220	44.7	116.78 ± 3.04	±	4.56	0.220	54.9	86.30 ± 2.56	±	3.30
0.24–0.30	0.269	44.7	101.52 ± 2.25	±	3.26	0.269	54.7	74.95 ± 1.93	±	2.37
0.30–0.36	0.329	44.7	87.73 ± 2.10	±	2.46	0.329	54.9	59.07 ± 1.71	±	1.67
0.36–0.42	0.389	44.7	71.01 ± 1.89	±	2.05	0.388	54.7	50.67 ± 1.60	±	1.52
0.42–0.50	0.457	44.7	50.60 ± 1.36	±	1.76	0.459	54.8	36.61 ± 1.16	±	1.34
0.50–0.60	0.545	44.7	32.82 ± 0.98	±	1.55	0.547	54.7	25.37 ± 0.85	±	1.25
0.60–0.72	0.654	44.9	22.04 ± 0.73	±	1.44	0.654	54.6	14.52 ± 0.59	±	0.98
0.72–0.90	0.793	44.7	10.05 ± 0.40	±	0.92	0.797	54.7	7.24 ± 0.34	±	0.68
0.90–1.25						1.029	54.4	1.59 ± 0.10	±	0.24

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.146	67.0	68.45 ± 2.18	±	4.02	0.147	82.4	53.08 ± 1.93	±	3.18
0.16–0.20	0.181	67.1	70.25 ± 1.88	±	3.05	0.182	82.5	56.23 ± 1.64	±	2.51
0.20–0.24	0.221	67.1	65.13 ± 1.81	±	2.34	0.221	82.3	46.57 ± 1.51	±	1.60
0.24–0.30	0.271	67.1	56.30 ± 1.39	±	1.69	0.271	82.1	37.97 ± 1.11	±	1.12
0.30–0.36	0.333	67.1	43.40 ± 1.19	±	1.24	0.332	82.0	24.83 ± 0.91	±	0.80
0.36–0.42	0.394	66.7	30.81 ± 0.99	±	1.00	0.395	81.9	21.18 ± 0.84	±	0.85
0.42–0.50	0.466	66.9	22.87 ± 0.74	±	0.95	0.467	81.7	12.99 ± 0.56	±	0.68
0.50–0.60	0.557	66.8	16.16 ± 0.56	±	0.90	0.559	81.8	8.13 ± 0.40	±	0.58
0.60–0.72	0.670	66.6	8.99 ± 0.38	±	0.68	0.669	81.3	4.78 ± 0.28	±	0.46
0.72–0.90	0.815	66.3	3.74 ± 0.19	±	0.39	0.818	81.7	1.52 ± 0.12	±	0.20
0.90–1.25	1.066	66.3	0.65 ± 0.05	±	0.11	1.070	81.2	0.26 ± 0.04	±	0.05

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.146	97.2	52.26 ± 1.90	±	3.26	0.145	114.5	41.41 ± 1.43	±	2.47
0.16–0.20	0.181	97.4	43.90 ± 1.45	±	1.98	0.181	113.7	31.48 ± 1.08	±	1.24
0.20–0.24	0.221	97.2	38.69 ± 1.38	±	1.28	0.221	113.9	23.65 ± 0.94	±	0.80
0.24–0.30	0.270	97.0	26.53 ± 0.95	±	0.84	0.271	113.5	15.31 ± 0.62	±	0.65
0.30–0.36	0.333	96.9	16.43 ± 0.74	±	0.67	0.331	113.6	8.56 ± 0.46	±	0.51
0.36–0.42	0.395	96.7	12.23 ± 0.64	±	0.68	0.393	113.5	6.17 ± 0.38	±	0.50
0.42–0.50	0.466	96.9	7.30 ± 0.42	±	0.55	0.463	113.6	3.46 ± 0.25	±	0.36
0.50–0.60	0.554	96.9	4.51 ± 0.30	±	0.46	0.559	112.7	1.75 ± 0.17	±	0.24
0.60–0.72	0.661	96.6	1.77 ± 0.17	±	0.24	0.671	110.3	0.63 ± 0.09	±	0.11
0.72–0.90	0.820	97.3	0.57 ± 0.08	±	0.10	0.827	110.7	0.12 ± 0.03	±	0.03
0.90–1.25	1.098	96.4	0.13 ± 0.03	±	0.03	1.063	109.0	0.04 ± 0.02	±	0.02

Table A.28: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in p + Al $\rightarrow$ p + X interactions with $+12.9$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.20–0.24	0.220	25.1	197.63 ± 5.64	±	9.62					
0.24–0.30	0.270	25.1	180.23 ± 1.74	±	7.92	0.271	34.9	184.83 ± 1.75	±	7.44
0.30–0.36	0.329	25.1	156.23 ± 1.63	±	6.49	0.329	35.0	168.84 ± 1.64	±	5.90
0.36–0.42	0.389	25.0	133.49 ± 1.49	±	5.36	0.389	35.0	141.55 ± 1.53	±	4.78
0.42–0.50	0.459	25.0	116.86 ± 1.20	±	4.57	0.458	35.0	119.66 ± 1.24	±	4.20
0.50–0.60	0.548	25.0	96.07 ± 0.96	±	3.76	0.548	35.0	92.26 ± 0.97	±	3.51
0.60–0.72	0.656	25.0	71.39 ± 0.73	±	3.13	0.656	35.0	66.43 ± 0.75	±	3.13
0.72–0.90						0.800	34.9	39.75 ± 0.47	±	2.42

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.30–0.36	0.331	45.0	174.44 ± 1.65	±	5.21					
0.36–0.42	0.391	45.1	149.24 ± 1.53	±	4.07	0.391	55.0	149.25 ± 1.50	±	3.87
0.42–0.50	0.461	45.1	120.04 ± 1.21	±	3.48	0.461	55.0	118.05 ± 1.17	±	3.20
0.50–0.60	0.551	45.0	89.81 ± 0.96	±	3.35	0.550	54.9	83.84 ± 0.93	±	3.36
0.60–0.72	0.660	44.9	63.10 ± 0.75	±	2.96	0.660	54.9	55.28 ± 0.72	±	3.08
0.72–0.90	0.806	45.0	36.46 ± 0.47	±	2.28	0.806	54.9	30.27 ± 0.44	±	2.20
0.90–1.25	1.044	44.8	10.85 ± 0.18	±	1.06	1.041	54.8	8.07 ± 0.16	±	0.92

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.42–0.50	0.453	67.4	114.08 ± 0.92	±	3.24	0.454	82.1	92.82 ± 0.82	±	3.30
0.50–0.60	0.540	67.3	78.68 ± 0.71	±	2.94	0.540	82.0	62.19 ± 0.62	±	2.85
0.60–0.72	0.646	67.1	44.51 ± 0.54	±	3.23	0.645	81.9	28.23 ± 0.44	±	2.47
0.72–0.90	0.785	66.9	21.96 ± 0.32	±	2.14	0.781	81.7	12.04 ± 0.24	±	1.38
0.90–1.25	1.006	66.6	5.62 ± 0.12	±	0.86	1.003	81.5	2.92 ± 0.09	±	0.49

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.42–0.50	0.453	97.0	66.07 ± 0.70	±	3.34	0.452	113.4	34.76 ± 0.44	±	1.69
0.50–0.60	0.539	96.8	39.46 ± 0.49	±	2.45	0.538	112.9	16.19 ± 0.29	±	1.37
0.60–0.72	0.643	96.7	14.65 ± 0.32	±	1.63	0.642	112.5	5.51 ± 0.18	±	0.84
0.72–0.90	0.783	96.2	5.68 ± 0.17	±	0.79	0.777	112.6	1.62 ± 0.08	±	0.34

Table A.29: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in p + Al $\to \pi^+$ + X interactions with $+12.9$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.8	154.62 ± 2.64	±	10.35	0.116	34.8	116.65 ± 2.20	±	7.95
0.13–0.16	0.146	24.7	185.20 ± 2.67	±	9.90	0.145	34.8	136.67 ± 2.25	±	7.22
0.16–0.20	0.180	24.7	212.34 ± 2.37	±	9.54	0.180	34.8	147.32 ± 1.98	±	6.63
0.20–0.24	0.220	24.7	221.40 ± 2.36	±	8.56	0.220	34.7	153.42 ± 1.97	±	5.91
0.24–0.30	0.269	24.7	210.03 ± 1.87	±	6.89	0.269	34.7	147.27 ± 1.58	±	4.79
0.30–0.36	0.329	24.7	179.89 ± 1.72	±	5.15	0.329	34.7	123.26 ± 1.42	±	3.49
0.36–0.42	0.389	24.7	152.58 ± 1.57	±	4.31	0.389	34.8	99.08 ± 1.27	±	2.73
0.42–0.50	0.458	24.7	113.22 ± 1.15	±	3.87	0.458	34.7	75.85 ± 0.94	±	2.37
0.50–0.60	0.547	24.7	76.61 ± 0.82	±	3.74	0.547	34.7	53.87 ± 0.71	±	2.35
0.60–0.72	0.655	24.7	45.54 ± 0.55	±	3.34	0.656	34.7	30.39 ± 0.45	±	1.98
0.72–0.90						0.797	34.7	15.62 ± 0.24	±	1.63

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	44.8	91.63 ± 1.98	±	6.43					
0.13–0.16	0.146	44.8	106.38 ± 1.95	±	5.68	0.145	54.9	84.95 ± 1.73	±	4.77
0.16–0.20	0.181	44.9	115.82 ± 1.73	±	5.19	0.180	54.8	88.87 ± 1.47	±	3.95
0.20–0.24	0.220	44.8	113.34 ± 1.70	±	4.40	0.220	54.8	84.64 ± 1.44	±	3.21
0.24–0.30	0.270	44.8	103.47 ± 1.31	±	3.40	0.270	54.8	76.85 ± 1.14	±	2.50
0.30–0.36	0.330	44.8	86.63 ± 1.20	±	2.50	0.330	54.8	59.99 ± 0.98	±	1.75
0.36–0.42	0.390	44.8	69.03 ± 1.06	±	1.96	0.390	54.7	47.51 ± 0.88	±	1.41
0.42–0.50	0.460	44.6	53.90 ± 0.81	±	1.73	0.460	54.6	37.19 ± 0.67	±	1.28
0.50–0.60	0.549	44.7	33.86 ± 0.56	±	1.43	0.549	54.6	24.54 ± 0.48	±	1.11
0.60–0.72	0.659	44.5	21.61 ± 0.40	±	1.29	0.660	54.5	14.23 ± 0.33	±	0.89
0.72–0.90	0.801	44.5	9.92 ± 0.20	±	0.91	0.801	54.5	5.57 ± 0.15	±	0.52
0.90–1.25						1.041	54.3	1.48 ± 0.05	±	0.23

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	67.3	69.07 ± 1.27	±	3.99	0.145	82.3	53.82 ± 1.09	±	3.38
0.16–0.20	0.179	67.2	68.91 ± 1.03	±	3.28	0.179	82.4	53.03 ± 0.89	±	2.56
0.20–0.24	0.219	67.2	65.07 ± 1.01	±	2.39	0.218	82.1	47.41 ± 0.84	±	1.81
0.24–0.30	0.267	67.0	53.70 ± 0.77	±	1.70	0.267	82.0	37.05 ± 0.63	±	1.12
0.30–0.36	0.326	67.0	42.18 ± 0.68	±	1.22	0.326	81.8	26.40 ± 0.54	±	0.81
0.36–0.42	0.386	66.7	30.78 ± 0.57	±	0.97	0.385	81.9	18.47 ± 0.44	±	0.69
0.42–0.50	0.454	66.8	23.45 ± 0.43	±	0.92	0.453	81.7	13.62 ± 0.33	±	0.67
0.50–0.60	0.540	66.6	14.60 ± 0.30	±	0.79	0.539	81.7	7.74 ± 0.22	±	0.52
0.60–0.72	0.645	66.7	7.79 ± 0.20	±	0.58	0.643	81.3	3.87 ± 0.14	±	0.35
0.72–0.90	0.781	66.1	3.28 ± 0.10	±	0.35	0.782	81.3	1.42 ± 0.06	±	0.18
0.90–1.25	1.006	66.0	0.75 ± 0.03	±	0.13	1.007	81.1	0.28 ± 0.02	±	0.05

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.4	48.98 ± 1.04	±	2.99	0.144	114.5	40.58 ± 0.79	±	2.51
0.16–0.20	0.179	97.2	45.20 ± 0.82	±	2.14	0.179	114.2	32.26 ± 0.58	±	1.66
0.20–0.24	0.218	97.2	35.72 ± 0.72	±	1.36	0.218	113.8	24.42 ± 0.54	±	0.81
0.24–0.30	0.267	97.0	25.01 ± 0.52	±	0.78	0.265	113.5	13.57 ± 0.34	±	0.52
0.30–0.36	0.326	96.8	16.29 ± 0.42	±	0.63	0.325	113.5	8.11 ± 0.25	±	0.44
0.36–0.42	0.385	96.9	10.77 ± 0.34	±	0.56	0.385	113.6	4.74 ± 0.19	±	0.34
0.42–0.50	0.452	96.9	6.75 ± 0.23	±	0.47	0.449	112.4	2.98 ± 0.13	±	0.28
0.50–0.60	0.539	96.5	3.86 ± 0.15	±	0.36	0.536	113.0	1.23 ± 0.08	±	0.15
0.60–0.72	0.642	96.0	1.62 ± 0.09	±	0.20	0.634	112.5	0.39 ± 0.04	±	0.06
0.72–0.90	0.783	95.5	0.56 ± 0.04	±	0.09	0.784	111.6	0.10 ± 0.02	±	0.02
0.90–1.25	1.001	95.9	0.10 ± 0.02	±	0.03					

Table A.30: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in p + Al $\to \pi^-$ + X interactions with $+12.9$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.8	166.61 ± 2.61	±	10.95	0.115	34.8	122.89 ± 2.21	±	8.62
0.13–0.16	0.145	24.8	195.17 ± 2.63	±	10.36	0.145	34.7	140.99 ± 2.22	±	7.64
0.16–0.20	0.180	24.7	206.82 ± 2.28	±	9.24	0.180	34.8	142.91 ± 1.88	±	6.45
0.20–0.24	0.220	24.8	201.48 ± 2.20	±	7.60	0.220	34.7	147.31 ± 1.89	±	5.58
0.24–0.30	0.269	24.9	184.10 ± 1.73	±	5.73	0.269	34.7	131.00 ± 1.43	±	4.09
0.30–0.36	0.329	24.7	147.56 ± 1.54	±	3.98	0.329	34.8	111.14 ± 1.32	±	2.99
0.36–0.42	0.389	24.8	115.76 ± 1.37	±	3.17	0.388	34.8	84.31 ± 1.14	±	2.29
0.42–0.50	0.458	24.7	85.73 ± 1.01	±	2.86	0.458	34.7	63.67 ± 0.86	±	2.06
0.50–0.60	0.547	24.8	58.74 ± 0.76	±	2.68	0.546	34.7	39.54 ± 0.59	±	1.74
0.60–0.72	0.655	24.8	31.87 ± 0.49	±	2.02	0.654	34.7	23.09 ± 0.41	±	1.43
0.72–0.90						0.798	34.7	11.05 ± 0.23	±	0.97

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	44.9	98.71 ± 2.04	±	7.12					
0.13–0.16	0.145	44.8	108.86 ± 1.93	±	5.99	0.145	54.9	87.88 ± 1.74	±	5.09
0.16–0.20	0.180	44.8	111.84 ± 1.65	±	5.08	0.179	54.8	87.24 ± 1.46	±	3.96
0.20–0.24	0.219	44.8	105.69 ± 1.58	±	4.06	0.219	54.7	84.06 ± 1.42	±	3.15
0.24–0.30	0.268	44.8	95.65 ± 1.23	±	2.99	0.268	54.7	71.44 ± 1.06	±	2.19
0.30–0.36	0.328	44.7	77.89 ± 1.10	±	2.11	0.327	54.7	56.08 ± 0.93	±	1.54
0.36–0.42	0.387	44.7	62.92 ± 0.98	±	1.76	0.387	54.8	43.96 ± 0.81	±	1.29
0.42–0.50	0.456	44.8	44.42 ± 0.71	±	1.52	0.455	54.7	31.82 ± 0.59	±	1.17
0.50–0.60	0.543	44.8	26.75 ± 0.48	±	1.34	0.542	54.7	21.10 ± 0.44	±	1.03
0.60–0.72	0.649	44.7	15.98 ± 0.34	±	1.06	0.650	54.7	11.24 ± 0.29	±	0.76
0.72–0.90	0.790	44.7	7.67 ± 0.19	±	0.71	0.788	54.5	4.66 ± 0.15	±	0.45
0.90–1.25						1.008	54.6	0.96 ± 0.04	±	0.15

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.146	67.3	71.39 ± 1.26	±	4.22	0.145	82.3	56.74 ± 1.10	±	3.69
0.16–0.20	0.180	67.1	71.53 ± 1.05	±	3.16	0.180	82.3	54.28 ± 0.89	±	2.64
0.20–0.24	0.221	67.2	61.26 ± 0.96	±	2.17	0.220	82.1	46.08 ± 0.82	±	1.68
0.24–0.30	0.270	66.9	50.05 ± 0.72	±	1.46	0.270	82.1	35.62 ± 0.60	±	1.02
0.30–0.36	0.331	66.9	38.73 ± 0.63	±	1.07	0.330	81.9	24.36 ± 0.50	±	0.76
0.36–0.42	0.391	66.9	29.69 ± 0.55	±	0.94	0.392	81.9	17.87 ± 0.43	±	0.71
0.42–0.50	0.462	66.9	20.07 ± 0.39	±	0.82	0.461	81.7	11.30 ± 0.29	±	0.60
0.50–0.60	0.552	66.8	12.01 ± 0.26	±	0.69	0.552	81.6	6.56 ± 0.19	±	0.48
0.60–0.72	0.662	66.6	6.50 ± 0.18	±	0.50	0.660	81.6	3.13 ± 0.12	±	0.30
0.72–0.90	0.807	66.8	2.47 ± 0.09	±	0.26	0.803	81.3	1.09 ± 0.06	±	0.14
0.90–1.25	1.040	66.8	0.61 ± 0.03	±	0.10	1.031	81.0	0.21 ± 0.02	±	0.04

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.2	50.88 ± 1.02	±	3.52	0.145	114.4	39.03 ± 0.77	±	2.49
0.16–0.20	0.179	97.3	45.75 ± 0.82	±	2.24	0.179	114.4	31.84 ± 0.59	±	1.43
0.20–0.24	0.220	97.1	35.76 ± 0.73	±	1.22	0.219	113.5	21.33 ± 0.49	±	0.75
0.24–0.30	0.269	97.0	23.63 ± 0.49	±	0.72	0.269	113.6	13.41 ± 0.32	±	0.56
0.30–0.36	0.329	96.7	15.61 ± 0.39	±	0.63	0.331	113.4	7.64 ± 0.24	±	0.46
0.36–0.42	0.391	96.8	10.65 ± 0.33	±	0.59	0.391	113.2	4.38 ± 0.18	±	0.36
0.42–0.50	0.459	96.5	6.28 ± 0.21	±	0.48	0.460	112.7	2.51 ± 0.12	±	0.26
0.50–0.60	0.550	96.7	3.26 ± 0.14	±	0.33	0.544	112.1	1.02 ± 0.07	±	0.14
0.60–0.72	0.662	95.8	1.37 ± 0.08	±	0.19	0.658	111.5	0.39 ± 0.04	±	0.07
0.72–0.90	0.792	96.1	0.35 ± 0.03	±	0.06	0.788	110.5	0.08 ± 0.02	±	0.02
0.90–1.25	1.005	95.4	0.06 ± 0.01	±	0.02					

Table A.31: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^+ + Al $\rightarrow$ p + X interactions with $+12.9$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.220	24.9	149.28 ± 5.08 ± 7.36			
0.24–0.30	0.268	25.2	134.37 ± 3.65 ± 5.99	0.271	34.9	143.35 ± 3.80 ± 5.88
0.30–0.36	0.329	25.2	111.88 ± 3.37 ± 4.78	0.330	35.0	131.60 ± 3.54 ± 4.72
0.36–0.42	0.389	25.2	100.59 ± 3.16 ± 4.16	0.388	35.0	106.92 ± 3.26 ± 3.77
0.42–0.50	0.457	25.0	81.01 ± 2.43 ± 3.25	0.458	35.0	83.82 ± 2.54 ± 3.06
0.50–0.60	0.547	25.1	66.51 ± 1.93 ± 2.66	0.547	34.9	62.93 ± 1.94 ± 2.45
0.60–0.72	0.655	25.0	48.69 ± 1.46 ± 2.17	0.655	35.0	44.83 ± 1.50 ± 2.14
0.72–0.90				0.799	35.0	27.88 ± 0.95 ± 1.72

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.330	45.0	135.22 ± 3.53 ± 4.18			
0.36–0.42	0.391	45.1	112.34 ± 3.24 ± 3.19	0.391	55.0	113.40 ± 3.19 ± 3.10
0.42–0.50	0.460	45.1	89.61 ± 2.56 ± 2.72	0.460	55.0	88.64 ± 2.47 ± 2.51
0.50–0.60	0.551	44.9	61.81 ± 1.95 ± 2.38	0.548	54.9	57.95 ± 1.89 ± 2.40
0.60–0.72	0.659	44.9	44.90 ± 1.55 ± 2.14	0.659	54.8	41.09 ± 1.51 ± 2.33
0.72–0.90	0.806	45.1	23.10 ± 0.90 ± 1.46	0.804	55.0	20.89 ± 0.90 ± 1.54
0.90–1.25	1.040	45.0	7.84 ± 0.37 ± 0.77	1.042	55.0	5.62 ± 0.33 ± 0.64

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.455	67.5	86.50 ± 1.95 ± 2.57	0.453	82.3	71.36 ± 1.76 ± 2.59
0.50–0.60	0.540	67.2	57.46 ± 1.49 ± 2.20	0.541	82.1	47.13 ± 1.32 ± 2.19
0.60–0.72	0.647	67.0	29.00 ± 1.06 ± 2.15	0.646	82.2	20.10 ± 0.90 ± 1.77
0.72–0.90	0.783	66.7	14.81 ± 0.64 ± 1.46	0.780	81.5	9.85 ± 0.53 ± 1.13
0.90–1.25	1.008	66.5	3.87 ± 0.24 ± 0.59	1.007	81.2	2.33 ± 0.19 ± 0.39

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.453	97.2	55.26 ± 1.56 ± 2.83	0.451	113.3	29.90 ± 1.00 ± 1.47
0.50–0.60	0.539	96.9	31.74 ± 1.09 ± 1.99	0.539	113.0	13.78 ± 0.66 ± 1.17
0.60–0.72	0.646	96.6	11.66 ± 0.71 ± 1.28	0.641	112.8	4.59 ± 0.40 ± 0.70
0.72–0.90	0.780	96.9	4.64 ± 0.38 ± 0.64	0.777	112.3	1.31 ± 0.18 ± 0.28

Table A.32: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^+ + Al $\to \pi^+$ + X interactions with $+12.9$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.8	133.85 ± 6.05	±	9.10	0.116	35.1	105.43 ± 5.11	±	7.23
0.13–0.16	0.145	24.6	172.26 ± 6.29	±	9.33	0.145	34.8	121.95 ± 5.19	±	6.52
0.16–0.20	0.181	24.7	189.11 ± 5.45	±	8.63	0.180	34.8	130.18 ± 4.55	±	5.95
0.20–0.24	0.220	24.6	210.80 ± 5.64	±	8.31	0.220	34.7	126.50 ± 4.37	±	4.97
0.24–0.30	0.269	24.8	207.79 ± 4.55	±	7.01	0.269	34.6	135.09 ± 3.70	±	4.52
0.30–0.36	0.329	24.6	182.30 ± 4.22	±	5.41	0.329	34.5	115.74 ± 3.35	±	3.40
0.36–0.42	0.389	24.6	147.02 ± 3.75	±	4.30	0.389	34.6	94.99 ± 3.03	±	2.71
0.42–0.50	0.458	24.7	110.33 ± 2.80	±	3.86	0.458	34.7	72.26 ± 2.26	±	2.32
0.50–0.60	0.545	24.7	78.90 ± 2.06	±	3.89	0.545	34.6	51.82 ± 1.70	±	2.29
0.60–0.72	0.654	24.6	47.44 ± 1.40	±	3.50	0.656	34.7	29.83 ± 1.11	±	1.95
0.72–0.90						0.797	34.7	14.42 ± 0.59	±	1.51

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	45.1	75.31 ± 4.41	±	5.31					
0.13–0.16	0.145	44.8	93.61 ± 4.47	±	5.06	0.146	55.0	77.18 ± 4.03	±	4.37
0.16–0.20	0.180	44.9	97.33 ± 3.88	±	4.43	0.180	55.0	79.74 ± 3.42	±	3.59
0.20–0.24	0.221	44.9	100.78 ± 3.92	±	4.01	0.220	54.8	77.74 ± 3.40	±	3.03
0.24–0.30	0.271	44.6	93.34 ± 3.05	±	3.17	0.270	54.6	68.81 ± 2.63	±	2.30
0.30–0.36	0.330	44.8	79.90 ± 2.82	±	2.39	0.332	54.6	57.41 ± 2.35	±	1.73
0.36–0.42	0.391	44.6	61.95 ± 2.46	±	1.82	0.391	54.6	46.68 ± 2.13	±	1.43
0.42–0.50	0.460	44.7	49.30 ± 1.90	±	1.62	0.458	54.5	33.76 ± 1.55	±	1.19
0.50–0.60	0.549	44.8	33.87 ± 1.37	±	1.45	0.550	54.7	22.60 ± 1.13	±	1.03
0.60–0.72	0.657	44.5	19.44 ± 0.93	±	1.16	0.659	54.6	14.99 ± 0.83	±	0.94
0.72–0.90	0.802	44.5	9.52 ± 0.50	±	0.88	0.803	54.6	5.78 ± 0.38	±	0.54
0.90–1.25						1.049	54.5	1.29 ± 0.11	±	0.20

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	67.4	54.93 ± 2.79	±	3.16	0.145	82.1	44.29 ± 2.42	±	2.75
0.16–0.20	0.179	67.1	62.05 ± 2.38	±	2.98	0.178	82.0	49.78 ± 2.11	±	2.42
0.20–0.24	0.219	66.9	58.58 ± 2.34	±	2.20	0.218	82.4	41.85 ± 1.92	±	1.62
0.24–0.30	0.268	66.8	45.27 ± 1.73	±	1.51	0.266	82.2	31.67 ± 1.44	±	1.03
0.30–0.36	0.326	67.1	35.07 ± 1.53	±	1.06	0.326	81.7	24.29 ± 1.27	±	0.78
0.36–0.42	0.388	67.0	28.61 ± 1.35	±	0.93	0.384	81.6	16.57 ± 1.03	±	0.64
0.42–0.50	0.454	67.0	20.86 ± 1.00	±	0.83	0.453	81.7	11.35 ± 0.74	±	0.56
0.50–0.60	0.541	66.7	14.24 ± 0.73	±	0.77	0.538	81.8	7.47 ± 0.52	±	0.51
0.60–0.72	0.644	66.7	7.58 ± 0.48	±	0.56	0.649	81.5	3.58 ± 0.33	±	0.32
0.72–0.90	0.782	66.3	3.24 ± 0.24	±	0.35	0.788	81.7	1.42 ± 0.16	±	0.18
0.90–1.25	1.016	66.0	0.81 ± 0.07	±	0.14	1.003	82.8	0.30 ± 0.05	±	0.06

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	97.0	45.56 ± 2.48	±	2.76	0.143	114.3	36.49 ± 1.86	±	2.17
0.16–0.20	0.179	97.1	41.81 ± 1.93	±	1.99	0.178	114.1	26.67 ± 1.31	±	1.35
0.20–0.24	0.218	97.4	32.40 ± 1.69	±	1.23	0.218	114.0	20.05 ± 1.20	±	0.67
0.24–0.30	0.266	97.2	24.45 ± 1.27	±	0.81	0.266	113.9	12.77 ± 0.80	±	0.52
0.30–0.36	0.326	97.1	15.02 ± 0.99	±	0.60	0.326	113.5	8.79 ± 0.65	±	0.47
0.36–0.42	0.385	96.8	10.16 ± 0.80	±	0.53	0.385	113.5	4.90 ± 0.48	±	0.35
0.42–0.50	0.450	96.6	7.49 ± 0.58	±	0.53	0.452	112.5	2.88 ± 0.32	±	0.27
0.50–0.60	0.541	96.7	3.89 ± 0.38	±	0.36	0.536	112.1	1.58 ± 0.22	±	0.19
0.60–0.72	0.647	96.3	1.43 ± 0.21	±	0.18	0.634	109.4	0.35 ± 0.09	±	0.06
0.72–0.90	0.774	96.6	0.29 ± 0.07	±	0.05	0.761	111.0	0.15 ± 0.05	±	0.03
0.90–1.25	1.010	94.1	0.11 ± 0.03	±	0.03					

Table A.33: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^+ + Al $\to \pi^-$ + X interactions with $+12.9$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.6	128.55 ± 5.54	±	8.47	0.116	34.9	96.69 ± 4.80	±	6.82
0.13–0.16	0.146	24.7	159.43 ± 5.81	±	8.56	0.146	34.9	125.46 ± 5.15	±	6.87
0.16–0.20	0.180	24.6	176.04 ± 5.11	±	7.98	0.181	34.7	124.45 ± 4.28	±	5.70
0.20–0.24	0.220	24.7	184.88 ± 5.16	±	7.11	0.220	34.8	122.97 ± 4.24	±	4.76
0.24–0.30	0.269	24.7	161.93 ± 3.95	±	5.20	0.269	34.7	109.06 ± 3.20	±	3.51
0.30–0.36	0.329	24.7	136.02 ± 3.61	±	3.81	0.328	34.5	96.63 ± 3.01	±	2.70
0.36–0.42	0.389	24.7	113.56 ± 3.30	±	3.23	0.389	34.8	74.49 ± 2.62	±	2.10
0.42–0.50	0.458	24.7	81.15 ± 2.41	±	2.77	0.458	34.7	54.47 ± 1.95	±	1.81
0.50–0.60	0.545	24.8	51.99 ± 1.74	±	2.40	0.548	34.8	36.08 ± 1.39	±	1.61
0.60–0.72	0.654	24.8	29.53 ± 1.16	±	1.89	0.653	34.7	20.96 ± 0.96	±	1.30
0.72–0.90						0.798	34.9	8.42 ± 0.49	±	0.74

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	44.7	76.39 ± 4.42	±	5.55					
0.13–0.16	0.145	44.7	84.99 ± 4.17	±	4.73	0.146	55.1	68.65 ± 3.74	±	4.01
0.16–0.20	0.180	44.8	91.58 ± 3.64	±	4.22	0.181	55.0	64.28 ± 3.06	±	2.96
0.20–0.24	0.220	44.8	88.14 ± 3.52	±	3.45	0.219	54.8	68.20 ± 3.13	±	2.61
0.24–0.30	0.268	44.9	75.50 ± 2.68	±	2.43	0.270	54.7	55.65 ± 2.27	±	1.76
0.30–0.36	0.328	44.8	61.96 ± 2.40	±	1.75	0.328	54.5	45.54 ± 2.05	±	1.30
0.36–0.42	0.386	44.9	51.50 ± 2.17	±	1.50	0.389	54.8	37.99 ± 1.86	±	1.15
0.42–0.50	0.456	44.8	38.36 ± 1.61	±	1.34	0.456	55.0	26.67 ± 1.33	±	0.99
0.50–0.60	0.542	44.9	22.50 ± 1.07	±	1.14	0.544	54.7	18.19 ± 0.99	±	0.90
0.60–0.72	0.651	44.4	13.99 ± 0.77	±	0.94	0.651	54.5	9.61 ± 0.65	±	0.66
0.72–0.90	0.798	44.8	6.57 ± 0.44	±	0.61	0.786	54.2	4.11 ± 0.34	±	0.40
0.90–1.25						1.011	54.7	0.95 ± 0.10	±	0.15

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	67.5	52.04 ± 2.63	±	3.11	0.145	82.5	48.11 ± 2.48	±	3.13
0.16–0.20	0.180	67.3	54.85 ± 2.26	±	2.44	0.180	81.9	38.04 ± 1.83	±	1.83
0.20–0.24	0.220	67.3	47.82 ± 2.09	±	1.73	0.221	82.0	37.54 ± 1.82	±	1.38
0.24–0.30	0.271	67.1	41.44 ± 1.60	±	1.25	0.269	82.2	28.18 ± 1.31	±	0.84
0.30–0.36	0.330	66.8	31.30 ± 1.39	±	0.90	0.331	81.8	20.69 ± 1.12	±	0.66
0.36–0.42	0.391	67.2	23.70 ± 1.20	±	0.77	0.392	81.5	14.34 ± 0.94	±	0.57
0.42–0.50	0.463	66.9	16.52 ± 0.86	±	0.68	0.463	81.8	9.56 ± 0.65	±	0.51
0.50–0.60	0.553	67.2	10.65 ± 0.61	±	0.61	0.551	82.3	5.73 ± 0.44	±	0.42
0.60–0.72	0.663	67.1	5.34 ± 0.40	±	0.41	0.657	81.2	2.97 ± 0.29	±	0.29
0.72–0.90	0.805	66.9	2.14 ± 0.20	±	0.23	0.811	82.4	1.12 ± 0.15	±	0.15
0.90–1.25	1.052	66.9	0.51 ± 0.07	±	0.08	1.031	80.4	0.21 ± 0.04	±	0.04

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.2	39.10 ± 2.21	±	2.65	0.145	114.3	31.20 ± 1.68	±	1.95
0.16–0.20	0.179	97.2	32.46 ± 1.68	±	1.58	0.179	114.4	22.46 ± 1.21	±	1.00
0.20–0.24	0.220	96.9	26.69 ± 1.55	±	0.92	0.219	114.0	16.98 ± 1.08	±	0.61
0.24–0.30	0.269	97.3	19.22 ± 1.09	±	0.61	0.269	113.2	11.44 ± 0.73	±	0.49
0.30–0.36	0.328	97.0	12.13 ± 0.85	±	0.50	0.328	114.2	5.98 ± 0.52	±	0.36
0.36–0.42	0.391	96.7	10.42 ± 0.80	±	0.58	0.393	113.5	3.84 ± 0.41	±	0.31
0.42–0.50	0.458	96.9	6.12 ± 0.52	±	0.46	0.461	112.3	2.25 ± 0.28	±	0.24
0.50–0.60	0.551	96.9	2.74 ± 0.31	±	0.28	0.547	111.1	0.93 ± 0.16	±	0.13
0.60–0.72	0.657	96.6	0.84 ± 0.16	±	0.11	0.652	113.2	0.19 ± 0.07	±	0.03
0.72–0.90	0.796	96.3	0.36 ± 0.09	±	0.06	0.828	114.4	0.10 ± 0.04	±	0.02
0.90–1.25	1.026	93.9	0.08 ± 0.03	±	0.02					

Table A.34: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^- + Al $\rightarrow$ p + X interactions with -12.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.220	25.1	131.64 ± 4.14 ± 6.61			
0.24–0.30	0.270	25.1	118.61 ± 2.87 ± 5.42	0.271	34.9	124.18 ± 2.92 ± 5.17
0.30–0.36	0.329	25.0	98.76 ± 2.61 ± 4.30	0.329	35.0	110.23 ± 2.69 ± 4.05
0.36–0.42	0.389	25.0	85.76 ± 2.45 ± 3.66	0.390	35.1	91.82 ± 2.51 ± 3.30
0.42–0.50	0.459	24.9	66.70 ± 1.82 ± 2.79	0.459	35.1	73.43 ± 1.98 ± 2.81
0.50–0.60	0.548	25.0	54.86 ± 1.46 ± 2.25	0.547	35.0	59.25 ± 1.59 ± 2.50
0.60–0.72	0.656	25.0	40.06 ± 1.11 ± 1.83	0.656	35.0	37.65 ± 1.14 ± 1.88
0.72–0.90				0.798	35.0	22.91 ± 0.73 ± 1.47

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.329	45.1	110.66 ± 2.65 ± 3.52			
0.36–0.42	0.389	45.1	99.85 ± 2.54 ± 2.96	0.389	55.0	94.56 ± 2.40 ± 2.83
0.42–0.50	0.458	45.0	78.18 ± 1.99 ± 2.49	0.457	55.1	77.19 ± 1.92 ± 2.26
0.50–0.60	0.547	45.0	57.31 ± 1.59 ± 2.35	0.548	55.1	55.40 ± 1.55 ± 2.43
0.60–0.72	0.655	44.9	37.69 ± 1.17 ± 1.85	0.655	55.0	33.45 ± 1.13 ± 1.97
0.72–0.90	0.800	45.0	20.83 ± 0.73 ± 1.37	0.797	55.0	17.76 ± 0.70 ± 1.34
0.90–1.25	1.030	44.9	6.45 ± 0.28 ± 0.66	1.031	54.9	5.05 ± 0.27 ± 0.59

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.454	67.6	77.10 ± 1.54 ± 2.30	0.453	82.1	68.47 ± 1.44 ± 2.48
0.50–0.60	0.541	67.3	52.30 ± 1.19 ± 2.05	0.541	81.9	41.21 ± 1.02 ± 1.94
0.60–0.72	0.645	67.1	25.48 ± 0.83 ± 2.01	0.644	81.9	17.74 ± 0.70 ± 1.62
0.72–0.90	0.786	66.6	12.31 ± 0.48 ± 1.25	0.780	81.9	6.29 ± 0.35 ± 0.76
0.90–1.25	1.011	66.2	3.25 ± 0.19 ± 0.52	0.992	81.7	1.55 ± 0.13 ± 0.27

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.452	97.0	46.27 ± 1.18 ± 2.42	0.451	113.2	24.84 ± 0.76 ± 1.23
0.50–0.60	0.539	96.8	28.09 ± 0.85 ± 1.78	0.537	113.0	10.83 ± 0.49 ± 0.94
0.60–0.72	0.643	96.7	9.19 ± 0.54 ± 1.12	0.640	112.9	3.19 ± 0.28 ± 0.53
0.72–0.90	0.780	96.4	3.34 ± 0.27 ± 0.49			

Table A.35: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^- + Al $\to \pi^+$ + X interactions with -12.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.8	117.87 ± 4.56	±	8.05	0.116	34.7	82.79 ± 3.65	±	5.79
0.13–0.16	0.145	24.5	148.44 ± 4.73	±	8.03	0.145	34.8	106.88 ± 3.93	±	5.80
0.16–0.20	0.180	24.7	172.17 ± 4.19	±	7.86	0.181	34.6	116.47 ± 3.45	±	5.31
0.20–0.24	0.220	24.8	166.62 ± 4.07	±	6.62	0.220	34.7	123.06 ± 3.51	±	4.85
0.24–0.30	0.269	24.7	173.18 ± 3.40	±	5.87	0.269	34.5	110.34 ± 2.69	±	3.69
0.30–0.36	0.328	24.6	139.96 ± 3.01	±	4.19	0.329	34.8	96.54 ± 2.52	±	2.84
0.36–0.42	0.388	24.6	116.69 ± 2.75	±	3.49	0.389	34.8	79.63 ± 2.23	±	2.30
0.42–0.50	0.458	24.7	87.90 ± 2.02	±	3.10	0.457	34.6	59.17 ± 1.64	±	1.92
0.50–0.60	0.546	24.7	54.29 ± 1.35	±	2.69	0.545	34.7	36.49 ± 1.13	±	1.62
0.60–0.72	0.655	24.8	31.78 ± 0.89	±	2.35	0.653	34.7	23.05 ± 0.77	±	1.55
0.72–0.90						0.798	34.5	9.12 ± 0.36	±	0.97

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	44.9	64.63 ± 3.36	±	4.66					
0.13–0.16	0.145	44.6	75.94 ± 3.35	±	4.20	0.146	55.0	59.50 ± 2.94	±	3.46
0.16–0.20	0.180	44.9	84.70 ± 2.92	±	3.92	0.180	54.7	65.37 ± 2.48	±	3.15
0.20–0.24	0.220	44.9	93.03 ± 3.07	±	3.71	0.219	54.9	65.91 ± 2.56	±	2.62
0.24–0.30	0.269	44.7	77.22 ± 2.24	±	2.60	0.269	54.7	56.47 ± 1.91	±	1.88
0.30–0.36	0.329	44.6	71.01 ± 2.16	±	2.11	0.329	54.7	48.06 ± 1.75	±	1.45
0.36–0.42	0.388	44.7	54.16 ± 1.84	±	1.61	0.388	54.7	39.19 ± 1.61	±	1.22
0.42–0.50	0.459	44.6	40.56 ± 1.38	±	1.34	0.459	54.9	24.00 ± 1.03	±	0.90
0.50–0.60	0.546	44.7	25.81 ± 0.94	±	1.18	0.544	54.6	19.31 ± 0.82	±	0.92
0.60–0.72	0.657	44.5	15.23 ± 0.65	±	0.92	0.655	54.6	11.14 ± 0.58	±	0.71
0.72–0.90	0.797	44.7	6.66 ± 0.31	±	0.66	0.797	54.7	4.52 ± 0.27	±	0.43
0.90–1.25						1.026	54.5	1.12 ± 0.08	±	0.18

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	67.2	50.57 ± 2.17	±	3.10	0.145	82.6	42.18 ± 1.98	±	2.66
0.16–0.20	0.178	67.4	53.76 ± 1.83	±	2.66	0.179	82.6	39.49 ± 1.55	±	2.01
0.20–0.24	0.218	67.2	45.04 ± 1.67	±	1.78	0.218	82.4	34.28 ± 1.41	±	1.51
0.24–0.30	0.268	67.1	41.93 ± 1.34	±	1.36	0.266	82.2	29.06 ± 1.13	±	0.92
0.30–0.36	0.328	66.9	30.54 ± 1.14	±	0.92	0.325	82.1	19.81 ± 0.91	±	0.66
0.36–0.42	0.385	66.8	25.46 ± 1.03	±	0.84	0.386	82.0	15.88 ± 0.81	±	0.64
0.42–0.50	0.454	67.1	18.16 ± 0.76	±	0.74	0.452	81.9	10.12 ± 0.55	±	0.52
0.50–0.60	0.540	66.5	11.12 ± 0.51	±	0.62	0.540	81.1	5.60 ± 0.36	±	0.38
0.60–0.72	0.645	66.9	6.26 ± 0.35	±	0.47	0.644	81.9	2.97 ± 0.24	±	0.27
0.72–0.90	0.780	66.2	2.82 ± 0.18	±	0.31	0.774	82.3	1.11 ± 0.11	±	0.14
0.90–1.25	1.007	65.7	0.58 ± 0.05	±	0.10	0.989	81.3	0.22 ± 0.03	±	0.04

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	97.2	34.49 ± 1.72	±	2.39	0.144	114.4	29.36 ± 1.33	±	2.02
0.16–0.20	0.178	97.1	36.34 ± 1.43	±	2.09	0.179	114.5	20.81 ± 0.96	±	1.02
0.20–0.24	0.219	97.0	24.17 ± 1.18	±	1.04	0.217	113.3	18.40 ± 0.94	±	0.69
0.24–0.30	0.266	97.0	18.99 ± 0.90	±	0.63	0.266	113.8	11.24 ± 0.60	±	0.45
0.30–0.36	0.325	97.0	13.11 ± 0.74	±	0.54	0.327	113.3	7.45 ± 0.50	±	0.42
0.36–0.42	0.386	96.5	9.50 ± 0.62	±	0.52	0.385	113.0	4.77 ± 0.39	±	0.36
0.42–0.50	0.450	97.4	5.59 ± 0.41	±	0.41	0.454	112.2	2.61 ± 0.25	±	0.26
0.50–0.60	0.540	97.3	3.05 ± 0.27	±	0.30	0.535	112.5	1.14 ± 0.15	±	0.15
0.60–0.72	0.646	96.2	1.24 ± 0.16	±	0.16	0.645	113.3	0.34 ± 0.07	±	0.06
0.72–0.90	0.792	95.1	0.42 ± 0.07	±	0.07					
0.90–1.25	1.031	95.8	0.07 ± 0.02	±	0.02					

Table A.36: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^- + Al $\to \pi^-$ + X interactions with -12.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	24.6	151.84 ± 5.12	±	10.35	0.115	34.8	117.62 ± 4.48	±	8.38
0.13–0.16	0.145	24.7	192.16 ± 5.40	±	10.52	0.145	34.6	135.30 ± 4.43	±	7.50
0.16–0.20	0.180	24.6	203.73 ± 4.60	±	9.32	0.181	34.6	143.09 ± 3.83	±	6.63
0.20–0.24	0.220	24.6	225.38 ± 4.86	±	8.90	0.220	34.8	147.37 ± 3.86	±	5.79
0.24–0.30	0.270	24.7	212.74 ± 3.76	±	6.89	0.269	34.6	135.81 ± 3.00	±	4.44
0.30–0.36	0.330	24.6	181.80 ± 3.48	±	5.17	0.329	34.7	119.51 ± 2.81	±	3.42
0.36–0.42	0.389	24.6	145.78 ± 3.15	±	4.27	0.389	34.7	100.03 ± 2.57	±	2.89
0.42–0.50	0.458	24.6	113.49 ± 2.39	±	3.92	0.457	34.8	70.59 ± 1.85	±	2.39
0.50–0.60	0.545	24.7	78.26 ± 1.79	±	3.64	0.546	34.7	48.24 ± 1.36	±	2.18
0.60–0.72	0.655	24.8	45.79 ± 1.22	±	2.94	0.655	34.6	30.77 ± 1.00	±	1.91
0.72–0.90						0.798	34.5	13.48 ± 0.53	±	1.18

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	45.0	90.03 ± 4.07	±	6.60					
0.13–0.16	0.146	44.9	109.82 ± 4.06	±	6.20	0.145	54.8	80.84 ± 3.43	±	4.75
0.16–0.20	0.181	44.9	105.52 ± 3.30	±	4.95	0.180	54.8	84.14 ± 2.90	±	3.96
0.20–0.24	0.219	44.8	107.48 ± 3.32	±	4.30	0.220	54.8	83.99 ± 2.94	±	3.31
0.24–0.30	0.269	44.8	91.47 ± 2.42	±	3.01	0.269	54.8	70.35 ± 2.17	±	2.30
0.30–0.36	0.329	44.7	85.84 ± 2.38	±	2.49	0.328	54.8	58.42 ± 1.94	±	1.73
0.36–0.42	0.388	44.8	65.42 ± 2.05	±	1.97	0.389	54.8	45.96 ± 1.71	±	1.45
0.42–0.50	0.458	44.7	49.54 ± 1.56	±	1.78	0.458	54.7	37.49 ± 1.36	±	1.42
0.50–0.60	0.548	44.7	32.29 ± 1.09	±	1.55	0.546	54.6	22.81 ± 0.92	±	1.15
0.60–0.72	0.654	44.8	18.76 ± 0.78	±	1.24	0.653	54.7	14.85 ± 0.69	±	1.02
0.72–0.90	0.793	44.7	9.19 ± 0.44	±	0.85	0.792	54.5	5.16 ± 0.33	±	0.49
0.90–1.25						1.014	54.7	1.23 ± 0.10	±	0.19

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.146	67.2	61.58 ± 2.40	±	3.64	0.146	82.2	46.06 ± 2.05	±	2.95
0.16–0.20	0.181	67.4	65.47 ± 2.08	±	2.92	0.181	82.1	52.17 ± 1.80	±	2.50
0.20–0.24	0.221	66.8	60.10 ± 1.96	±	2.24	0.220	82.0	39.61 ± 1.57	±	1.49
0.24–0.30	0.270	66.7	51.49 ± 1.50	±	1.61	0.269	82.1	32.56 ± 1.19	±	1.01
0.30–0.36	0.332	66.9	38.14 ± 1.28	±	1.14	0.332	82.2	23.82 ± 1.01	±	0.81
0.36–0.42	0.392	67.1	31.20 ± 1.15	±	1.06	0.392	81.8	18.51 ± 0.89	±	0.77
0.42–0.50	0.462	66.7	20.46 ± 0.80	±	0.87	0.460	81.7	12.65 ± 0.64	±	0.68
0.50–0.60	0.552	66.7	14.83 ± 0.62	±	0.84	0.551	81.8	7.47 ± 0.42	±	0.56
0.60–0.72	0.662	67.2	8.13 ± 0.41	±	0.63	0.664	81.2	3.68 ± 0.27	±	0.36
0.72–0.90	0.808	66.9	3.26 ± 0.21	±	0.35	0.807	81.9	1.93 ± 0.17	±	0.25
0.90–1.25	1.035	66.6	0.70 ± 0.07	±	0.11	1.039	82.4	0.32 ± 0.04	±	0.06

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.5	46.11 ± 2.01	±	3.13	0.145	114.5	37.77 ± 1.58	±	2.30
0.16–0.20	0.181	97.5	42.92 ± 1.64	±	2.04	0.179	114.1	31.56 ± 1.23	±	1.37
0.20–0.24	0.221	97.3	31.47 ± 1.38	±	1.22	0.219	113.9	20.89 ± 1.00	±	0.76
0.24–0.30	0.269	97.1	24.12 ± 1.02	±	0.80	0.268	114.3	13.87 ± 0.67	±	0.61
0.30–0.36	0.330	96.9	16.97 ± 0.86	±	0.73	0.329	113.5	7.79 ± 0.50	±	0.49
0.36–0.42	0.393	97.1	11.28 ± 0.70	±	0.66	0.390	113.6	4.78 ± 0.40	±	0.40
0.42–0.50	0.460	96.7	7.70 ± 0.49	±	0.60	0.460	112.5	3.34 ± 0.28	±	0.36
0.50–0.60	0.548	97.1	4.51 ± 0.34	±	0.47	0.547	112.9	1.47 ± 0.18	±	0.21
0.60–0.72	0.658	96.4	2.07 ± 0.21	±	0.29	0.659	111.7	0.68 ± 0.10	±	0.12
0.72–0.90	0.805	94.7	0.86 ± 0.12	±	0.16	0.787	111.5	0.11 ± 0.04	±	0.03
0.90–1.25	1.027	96.7	0.11 ± 0.03	±	0.03					

Table A.37: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in p + Al $\rightarrow$ p + X interactions with $+15.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.20–0.24	0.220	25.2	195.69 ± 6.57	±	13.19					
0.24–0.30	0.269	25.1	185.22 ± 5.01	±	10.88	0.270	34.8	179.29 ± 4.92	±	9.57
0.30–0.36	0.329	25.2	156.81 ± 4.64	±	8.08	0.330	34.9	162.74 ± 4.59	±	7.15
0.36–0.42	0.390	25.1	139.06 ± 4.40	±	6.40	0.389	35.0	142.01 ± 4.35	±	5.44
0.42–0.50	0.459	25.0	113.64 ± 3.38	±	4.79	0.457	35.1	119.21 ± 3.52	±	4.35
0.50–0.60	0.547	25.0	89.03 ± 2.60	±	3.58	0.547	35.1	87.80 ± 2.70	±	3.48
0.60–0.72	0.654	25.1	69.02 ± 2.06	±	3.30	0.655	35.0	64.37 ± 2.10	±	3.39
0.72–0.90						0.800	35.0	35.42 ± 1.24	±	2.68

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.30–0.36	0.329	45.1	162.68 ± 4.62	±	5.84					
0.36–0.42	0.388	44.8	149.27 ± 4.37	±	4.44	0.390	54.9	150.85 ± 4.25	±	4.43
0.42–0.50	0.458	45.0	123.70 ± 3.49	±	3.70	0.456	55.2	116.01 ± 3.30	±	3.39
0.50–0.60	0.547	45.0	84.52 ± 2.68	±	3.40	0.546	55.0	82.84 ± 2.63	±	3.74
0.60–0.72	0.654	45.1	63.40 ± 2.14	±	3.46	0.654	55.1	53.48 ± 2.02	±	3.53
0.72–0.90	0.799	44.9	33.56 ± 1.27	±	2.66	0.798	55.0	28.02 ± 1.20	±	2.52
0.90–1.25	1.041	45.0	10.91 ± 0.51	±	1.39	1.038	54.9	8.48 ± 0.48	±	1.21

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.42–0.50	0.458	67.4	117.20 ± 2.66	±	3.47	0.458	82.2	86.88 ± 2.27	±	3.86
0.50–0.60	0.547	67.1	76.34 ± 2.01	±	3.44	0.547	82.1	61.41 ± 1.77	±	3.86
0.60–0.72	0.652	67.2	42.71 ± 1.50	±	3.63	0.653	81.6	25.08 ± 1.15	±	2.68
0.72–0.90	0.797	66.9	20.81 ± 0.88	±	2.54	0.796	81.7	11.66 ± 0.68	±	1.75
0.90–1.25	1.032	66.8	5.55 ± 0.34	±	1.11	1.023	81.2	2.69 ± 0.24	±	0.60

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.42–0.50	0.458	97.0	67.41 ± 2.01	±	4.71	0.455	113.4	34.85 ± 1.26	±	2.29
0.50–0.60	0.545	97.0	38.60 ± 1.40	±	3.44	0.541	112.9	15.07 ± 0.80	±	1.79
0.60–0.72	0.651	96.3	13.94 ± 0.91	±	1.94	0.649	112.4	4.77 ± 0.48	±	0.98
0.72–0.90	0.787	96.5	5.24 ± 0.47	±	0.93	0.784	111.9	1.40 ± 0.21	±	0.41

Table A.38: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in p + Al $\to \pi^+$ + X interactions with $+15.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	24.8	153.74 ± 7.37	±	12.42	0.116	34.8	124.70 ± 6.49	±	10.31
0.13–0.16	0.146	25.1	190.18 ± 7.68	±	12.95	0.146	34.8	155.00 ± 6.89	±	10.43
0.16–0.20	0.180	24.7	227.01 ± 6.91	±	13.07	0.180	34.7	157.07 ± 5.83	±	8.94
0.20–0.24	0.220	24.8	238.81 ± 7.03	±	11.60	0.220	34.7	169.67 ± 5.96	±	8.13
0.24–0.30	0.271	24.8	219.09 ± 5.41	±	8.51	0.269	34.7	153.46 ± 4.57	±	5.86
0.30–0.36	0.329	24.8	195.47 ± 5.11	±	6.04	0.331	34.8	128.71 ± 4.18	±	3.93
0.36–0.42	0.389	24.8	157.44 ± 4.57	±	4.60	0.389	34.7	103.01 ± 3.64	±	2.97
0.42–0.50	0.459	24.7	122.68 ± 3.39	±	4.53	0.458	34.6	80.86 ± 2.80	±	2.86
0.50–0.60	0.547	24.7	82.50 ± 2.43	±	4.66	0.547	34.5	50.66 ± 1.89	±	2.71
0.60–0.72	0.655	24.5	49.17 ± 1.61	±	4.29	0.655	34.6	35.38 ± 1.42	±	2.89
0.72–0.90						0.795	34.6	17.81 ± 0.77	±	2.28

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	44.9	89.74 ± 5.62	±	7.60					
0.13–0.16	0.145	45.0	128.86 ± 6.10	±	8.72	0.146	54.7	85.20 ± 4.89	±	5.90
0.16–0.20	0.180	44.8	118.53 ± 4.95	±	6.76	0.179	54.9	100.82 ± 4.39	±	5.70
0.20–0.24	0.220	45.1	116.27 ± 4.93	±	5.66	0.220	54.7	85.18 ± 4.19	±	3.98
0.24–0.30	0.269	44.6	109.84 ± 3.87	±	4.23	0.268	54.8	79.64 ± 3.28	±	2.97
0.30–0.36	0.329	44.7	91.20 ± 3.54	±	2.84	0.329	54.7	59.92 ± 2.81	±	1.87
0.36–0.42	0.390	44.5	71.01 ± 3.04	±	2.18	0.387	54.5	57.57 ± 2.82	±	1.90
0.42–0.50	0.459	44.7	54.60 ± 2.30	±	2.04	0.456	54.7	33.74 ± 1.77	±	1.46
0.50–0.60	0.547	44.8	39.18 ± 1.73	±	2.13	0.546	54.4	24.75 ± 1.36	±	1.51
0.60–0.72	0.655	44.5	21.12 ± 1.10	±	1.69	0.651	54.4	14.73 ± 0.93	±	1.30
0.72–0.90	0.796	44.3	10.15 ± 0.58	±	1.23	0.793	54.4	6.36 ± 0.46	±	0.81
0.90–1.25						1.012	54.5	1.84 ± 0.15	±	0.38

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	67.4	74.76 ± 3.75	±	5.36	0.145	82.1	56.30 ± 3.20	±	4.12
0.16–0.20	0.180	67.3	80.88 ± 3.17	±	4.74	0.180	81.9	56.84 ± 2.60	±	3.30
0.20–0.24	0.219	66.7	67.55 ± 2.97	±	3.03	0.219	82.3	54.07 ± 2.56	±	2.35
0.24–0.30	0.269	66.9	57.54 ± 2.28	±	2.05	0.268	82.1	37.72 ± 1.86	±	1.26
0.30–0.36	0.330	66.8	41.37 ± 1.93	±	1.28	0.328	82.4	25.22 ± 1.49	±	0.90
0.36–0.42	0.388	67.1	27.42 ± 1.54	±	1.02	0.389	81.8	18.41 ± 1.25	±	0.90
0.42–0.50	0.459	66.8	24.14 ± 1.23	±	1.25	0.457	82.0	13.15 ± 0.91	±	0.89
0.50–0.60	0.547	66.5	15.91 ± 0.90	±	1.18	0.542	81.0	7.50 ± 0.60	±	0.73
0.60–0.72	0.653	66.8	8.18 ± 0.56	±	0.88	0.653	81.6	4.15 ± 0.41	±	0.55
0.72–0.90	0.791	66.2	2.89 ± 0.25	±	0.44	0.783	81.6	1.35 ± 0.18	±	0.25
0.90–1.25	1.022	65.8	0.82 ± 0.08	±	0.19	1.038	80.8	0.27 ± 0.05	±	0.07

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.145	97.2	48.14 ± 2.85	±	3.64	0.145	114.0	45.61 ± 2.44	±	2.90
0.16–0.20	0.179	97.2	48.90 ± 2.40	±	2.75	0.179	113.8	30.32 ± 1.59	±	1.72
0.20–0.24	0.218	97.1	38.54 ± 2.17	±	1.55	0.218	113.7	22.18 ± 1.46	±	0.90
0.24–0.30	0.265	97.6	24.29 ± 1.47	±	0.89	0.268	113.1	14.89 ± 1.00	±	0.76
0.30–0.36	0.326	97.2	15.63 ± 1.17	±	0.79	0.329	114.4	6.85 ± 0.67	±	0.53
0.36–0.42	0.391	96.9	11.38 ± 0.96	±	0.85	0.391	112.9	4.60 ± 0.53	±	0.49
0.42–0.50	0.460	96.6	7.57 ± 0.70	±	0.77	0.451	113.1	2.97 ± 0.37	±	0.42
0.50–0.60	0.548	96.4	3.88 ± 0.43	±	0.54	0.543	111.8	1.21 ± 0.22	±	0.22
0.60–0.72	0.656	96.1	1.44 ± 0.25	±	0.27	0.643	112.5	0.30 ± 0.10	±	0.07
0.72–0.90	0.792	96.6	0.43 ± 0.10	±	0.11	0.816	113.6	0.09 ± 0.04	±	0.03
0.90–1.25	0.988	96.6	0.04 ± 0.02	±	0.02					

Table A.39: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in p + Al $\to \pi^-$ + X interactions with $+15.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	24.7	157.25 ± 7.30	±	13.03	0.116	34.8	125.55 ± 6.50	±	10.83
0.13–0.16	0.145	24.9	191.84 ± 7.51	±	13.19	0.145	34.6	133.02 ± 6.10	±	9.25
0.16–0.20	0.180	24.6	218.41 ± 6.63	±	12.54	0.180	34.5	135.91 ± 5.25	±	7.86
0.20–0.24	0.220	24.7	224.74 ± 6.70	±	10.53	0.220	35.0	155.94 ± 5.52	±	7.39
0.24–0.30	0.269	24.7	195.78 ± 5.09	±	6.99	0.269	34.7	127.39 ± 4.07	±	4.62
0.30–0.36	0.329	24.6	169.55 ± 4.74	±	4.74	0.329	34.7	113.81 ± 3.82	±	3.24
0.36–0.42	0.388	24.6	132.60 ± 4.12	±	3.91	0.389	34.8	84.07 ± 3.30	±	2.48
0.42–0.50	0.457	24.8	92.66 ± 3.01	±	3.80	0.457	34.6	71.68 ± 2.60	±	2.86
0.50–0.60	0.548	24.7	65.70 ± 2.28	±	4.09	0.546	34.6	48.98 ± 1.91	±	2.93
0.60–0.72	0.653	24.8	38.33 ± 1.59	±	3.49	0.654	34.9	28.28 ± 1.34	±	2.48
0.72–0.90						0.799	34.8	11.94 ± 0.68	±	1.53

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.116	45.1	99.83 ± 5.95	±	8.83					
0.13–0.16	0.146	45.0	104.65 ± 5.35	±	7.39	0.145	54.6	82.53 ± 4.82	±	5.88
0.16–0.20	0.180	44.9	109.92 ± 4.65	±	6.42	0.180	54.8	85.51 ± 4.05	±	4.90
0.20–0.24	0.219	44.7	104.54 ± 4.54	±	5.01	0.220	55.2	90.10 ± 4.20	±	4.18
0.24–0.30	0.269	44.9	94.03 ± 3.43	±	3.42	0.270	54.7	73.43 ± 3.07	±	2.59
0.30–0.36	0.329	44.8	80.08 ± 3.17	±	2.32	0.328	54.5	56.23 ± 2.65	±	1.67
0.36–0.42	0.389	44.7	67.61 ± 2.95	±	2.13	0.389	54.8	47.26 ± 2.49	±	1.60
0.42–0.50	0.458	44.8	46.31 ± 2.04	±	2.04	0.458	54.8	34.10 ± 1.74	±	1.65
0.50–0.60	0.544	44.9	30.88 ± 1.49	±	2.02	0.546	54.5	20.61 ± 1.20	±	1.44
0.60–0.72	0.658	44.8	19.22 ± 1.09	±	1.80	0.654	54.9	11.59 ± 0.84	±	1.13
0.72–0.90	0.793	44.7	7.91 ± 0.55	±	1.08	0.791	54.7	5.55 ± 0.46	±	0.78
0.90–1.25						1.026	54.9	1.47 ± 0.17	±	0.32

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	67.3	71.18 ± 3.57	±	5.11	0.145	83.0	54.93 ± 3.13	±	3.94
0.16–0.20	0.178	67.2	73.42 ± 3.04	±	3.98	0.179	82.1	49.84 ± 2.41	±	2.88
0.20–0.24	0.220	67.2	66.49 ± 2.89	±	2.80	0.220	81.9	46.36 ± 2.39	±	1.85
0.24–0.30	0.268	67.2	50.61 ± 2.07	±	1.62	0.267	82.3	36.29 ± 1.73	±	1.14
0.30–0.36	0.330	66.9	41.45 ± 1.86	±	1.26	0.329	81.8	24.84 ± 1.45	±	0.93
0.36–0.42	0.388	66.7	29.82 ± 1.57	±	1.15	0.387	81.7	17.37 ± 1.22	±	0.92
0.42–0.50	0.460	66.6	19.72 ± 1.10	±	1.08	0.459	81.4	12.70 ± 0.89	±	0.94
0.50–0.60	0.546	67.0	12.24 ± 0.76	±	0.99	0.544	82.1	5.88 ± 0.51	±	0.63
0.60–0.72	0.654	66.4	7.37 ± 0.54	±	0.82	0.650	81.2	3.68 ± 0.39	±	0.52
0.72–0.90	0.788	66.8	2.81 ± 0.26	±	0.44	0.783	80.0	1.38 ± 0.19	±	0.27
0.90–1.25	1.021	66.4	0.64 ± 0.09	±	0.15	1.011	79.7	0.27 ± 0.06	±	0.08

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.144	96.7	46.16 ± 2.89	±	3.36	0.144	115.1	37.35 ± 2.14	±	2.57
0.16–0.20	0.179	97.8	41.63 ± 2.18	±	2.42	0.178	113.6	32.12 ± 1.70	±	1.55
0.20–0.24	0.219	96.9	38.95 ± 2.16	±	1.57	0.218	113.3	21.96 ± 1.43	±	0.91
0.24–0.30	0.267	97.2	26.02 ± 1.48	±	0.93	0.268	112.9	15.40 ± 0.99	±	0.88
0.30–0.36	0.329	97.1	14.81 ± 1.12	±	0.80	0.327	113.4	8.23 ± 0.72	±	0.71
0.36–0.42	0.386	96.9	10.03 ± 0.91	±	0.80	0.388	113.7	5.06 ± 0.56	±	0.60
0.42–0.50	0.458	96.4	5.68 ± 0.59	±	0.62	0.452	113.3	2.66 ± 0.36	±	0.42
0.50–0.60	0.543	96.9	3.64 ± 0.42	±	0.55	0.538	111.9	0.84 ± 0.17	±	0.17
0.60–0.72	0.658	96.8	1.60 ± 0.26	±	0.32	0.637	112.7	0.48 ± 0.13	±	0.13
0.72–0.90	0.785	94.3	0.59 ± 0.13	±	0.16	0.813	111.0	0.08 ± 0.04	±	0.03
0.90–1.25	1.020	97.8	0.16 ± 0.05	±	0.07					

Table A.40: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^+ + Al $\rightarrow$ p + X interactions with $+15.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.218	22.6	150.08 ± 47.10 ± 10.98			
0.24–0.30	0.266	23.4	106.94 ± 32.13 ± 6.96	0.266	33.0	126.31 ± 35.11 ± 7.63
0.30–0.36	0.322	25.1	65.20 ± 25.90 ± 3.86	0.330	35.7	58.15 ± 24.36 ± 3.04
0.36–0.42	0.398	27.0	77.45 ± 29.47 ± 4.24	0.387	32.9	81.00 ± 27.58 ± 3.88
0.42–0.50	0.457	25.8	90.16 ± 25.92 ± 4.64	0.454	33.9	48.93 ± 19.47 ± 2.29
0.50–0.60	0.539	26.1	52.61 ± 18.29 ± 2.64	0.549	35.4	33.16 ± 14.33 ± 1.64
0.60–0.72	0.635	26.0	38.49 ± 13.24 ± 2.18	0.671	33.9	35.99 ± 13.80 ± 2.17
0.72–0.90				0.823	34.6	25.05 ± 8.94 ± 2.04

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.332	44.8	141.67 ± 36.42 ± 6.53			
0.36–0.42	0.389	45.9	105.45 ± 32.62 ± 4.33	0.383	54.6	83.72 ± 27.45 ± 3.46
0.42–0.50	0.457	44.6	130.27 ± 31.36 ± 5.42	0.461	55.0	42.08 ± 17.20 ± 1.72
0.50–0.60	0.549	45.2	41.90 ± 16.75 ± 2.09	0.545	54.3	39.57 ± 15.94 ± 2.15
0.60–0.72	0.655	45.1	22.84 ± 11.18 ± 1.41	0.645	55.3	12.31 ± 8.53 ± 0.89
0.72–0.90	0.789	44.2	18.93 ± 8.15 ± 1.60	0.816	54.1	7.92 ± 5.62 ± 0.75
0.90–1.25	1.044	45.9	10.16 ± 4.29 ± 1.33			

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.456	66.8	85.01 ± 19.85 ± 3.47	0.465	81.8	61.02 ± 16.59 ± 3.20
0.50–0.60	0.541	68.5	48.18 ± 14.09 ± 2.61	0.543	84.8	15.51 ± 7.82 ± 1.07
0.60–0.72	0.651	66.2	40.67 ± 12.83 ± 3.64	0.632	80.8	17.58 ± 8.40 ± 1.94
0.72–0.90	0.772	68.1	10.10 ± 5.43 ± 1.26	0.794	82.2	8.10 ± 4.96 ± 1.22
0.90–1.25	1.067	68.0	7.03 ± 3.38 ± 1.42			

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.474	99.2	41.31 ± 13.85 ± 3.11	0.453	113.9	13.12 ± 6.78 ± 0.94
0.50–0.60	0.537	99.8	26.32 ± 10.14 ± 2.46	0.534	112.4	19.87 ± 8.28 ± 2.47
0.60–0.72	0.681	96.7	14.37 ± 8.07 ± 2.00			
0.72–0.90	0.780	95.8	4.59 ± 3.81 ± 0.80			

Table A.41: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^+ + Al $\to \pi^+$ + X interactions with $+15.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.114	24.5	142.98 ± 64.30	±	12.31	0.108	34.7	59.49 ± 42.48	±	5.17
0.13–0.16	0.144	25.1	192.72 ± 66.15	±	14.27	0.146	36.3	90.51 ± 45.90	±	6.63
0.16–0.20	0.185	23.8	166.13 ± 50.57	±	10.60	0.176	34.0	179.40 ± 56.16	±	11.40
0.20–0.24	0.223	24.9	285.90 ± 67.60	±	15.96	0.218	35.2	157.20 ± 52.02	±	8.71
0.24–0.30	0.267	25.2	158.73 ± 41.79	±	7.57	0.270	35.7	143.80 ± 39.09	±	6.81
0.30–0.36	0.323	24.2	132.19 ± 36.31	±	5.49	0.343	34.7	52.05 ± 22.86	±	2.16
0.36–0.42	0.387	23.9	154.83 ± 39.43	±	6.23	0.387	34.6	56.80 ± 23.81	±	2.29
0.42–0.50	0.456	24.6	134.19 ± 30.90	±	6.21	0.470	32.0	29.36 ± 14.22	±	1.33
0.50–0.60	0.536	23.0	46.82 ± 16.08	±	2.95	0.542	34.2	41.35 ± 15.11	±	2.52
0.60–0.72	0.658	23.6	56.74 ± 15.71	±	5.20	0.633	36.3	26.63 ± 11.63	±	2.31
0.72–0.90						0.800	32.9	14.79 ± 5.99	±	1.95

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.110	43.6	38.45 ± 30.45	±	3.41					
0.13–0.16	0.142	45.2	51.38 ± 35.32	±	3.77					
0.16–0.20	0.184	45.4	77.64 ± 35.48	±	4.96	0.178	53.4	110.65 ± 40.04	±	6.98
0.20–0.24	0.226	43.9	70.04 ± 33.30	±	3.95	0.215	53.0	29.76 ± 22.16	±	1.63
0.24–0.30	0.269	44.2	73.60 ± 27.58	±	3.51	0.254	56.5	20.05 ± 15.02	±	0.94
0.30–0.36	0.329	43.5	67.84 ± 26.86	±	2.86	0.329	54.8	52.24 ± 22.89	±	2.21
0.36–0.42	0.390	42.6	74.20 ± 26.83	±	3.12	0.384	54.4	52.53 ± 22.97	±	2.31
0.42–0.50	0.463	46.4	34.40 ± 16.18	±	1.63	0.461	56.4	32.42 ± 15.10	±	1.72
0.50–0.60	0.555	43.4	16.13 ± 9.84	±	1.00					
0.60–0.72	0.651	44.0	8.24 ± 5.74	±	0.71					
0.72–0.90	0.773	43.7	8.73 ± 4.77	±	1.11					

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.154	68.5	60.17 ± 30.10	±	4.62	0.157	85.1	26.09 ± 18.47	±	2.03
0.16–0.20	0.183	67.6	38.78 ± 19.53	±	2.51	0.189	86.7	38.61 ± 19.32	±	2.48
0.20–0.24	0.229	61.7	30.11 ± 17.13	±	1.60					
0.24–0.30	0.261	68.2	39.27 ± 16.90	±	1.77	0.262	79.3	46.07 ± 18.32	±	1.97
0.30–0.36	0.323	70.4	33.38 ± 15.71	±	1.39	0.331	80.8	12.59 ± 9.35	±	0.56
0.36–0.42	0.385	67.9	62.42 ± 20.64	±	2.92	0.386	83.4	8.68 ± 6.62	±	0.48
0.42–0.50						0.446	88.1	9.42 ± 7.02	±	0.68
0.50–0.60	0.549	64.8	19.43 ± 8.68	±	1.56	0.559	82.0	6.76 ± 5.06	±	0.68

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.147	95.5	39.12 ± 22.64	±	3.11	0.136	108.5	23.11 ± 16.37	±	1.61
0.16–0.20	0.186	95.9	37.14 ± 18.60	±	2.31	0.184	112.4	34.69 ± 15.23	±	2.11
0.20–0.24	0.225	97.4	28.80 ± 16.75	±	1.38	0.218	113.3	42.90 ± 17.37	±	1.99
0.24–0.30	0.259	97.4	31.63 ± 14.89	±	1.38	0.253	111.7	13.38 ± 8.22	±	0.73
0.30–0.36	0.331	96.0	24.24 ± 12.85	±	1.35	0.332	111.6	18.96 ± 10.05	±	1.46
0.36–0.42						0.370	116.3	8.63 ± 6.47	±	0.91
0.42–0.50	0.462	96.0	9.39 ± 7.04	±	0.96	0.429	109.3	7.23 ± 5.19	±	0.99

Table A.42: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^+ + Al $\to \pi^-$ + X interactions with $+15.0$ GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$					$30 < \theta < 40$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.115	26.4	109.12 ± 55.69	±	9.44	0.108	35.5	138.39 ± 62.64	±	12.45
0.13–0.16	0.142	24.6	53.45 ± 34.55	±	3.96	0.142	34.3	63.20 ± 36.76	±	4.72
0.16–0.20	0.178	25.3	175.12 ± 53.26	±	11.16	0.179	35.4	72.56 ± 34.53	±	4.66
0.20–0.24	0.229	23.9	105.04 ± 39.28	±	5.72	0.220	35.4	108.60 ± 41.17	±	5.98
0.24–0.30	0.269	25.3	168.34 ± 42.15	±	7.63	0.264	35.9	74.47 ± 27.07	±	3.42
0.30–0.36	0.327	24.2	122.91 ± 35.49	±	4.86	0.336	36.0	89.60 ± 30.13	±	3.60
0.36–0.42	0.390	23.0	73.76 ± 26.08	±	3.00	0.384	34.8	69.94 ± 26.44	±	2.88
0.42–0.50	0.458	25.4	43.94 ± 18.02	±	2.19	0.452	35.7	74.35 ± 23.52	±	3.67
0.50–0.60	0.546	26.5	45.60 ± 17.24	±	3.12	0.554	32.9	21.81 ± 10.90	±	1.46
0.60–0.72	0.645	24.1	24.62 ± 11.01	±	2.35	0.644	35.9	25.14 ± 11.24	±	2.34

	$40 < \theta < 50$					$50 < \theta < 60$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.10–0.13	0.108	46.7	121.84 ± 61.39	±	11.19					
0.13–0.16	0.150	44.5	90.95 ± 45.48	±	6.90	0.144	57.8	27.30 ± 24.07	±	2.08
0.16–0.20	0.178	45.9	48.41 ± 27.33	±	3.14					
0.20–0.24	0.225	44.7	75.99 ± 34.18	±	4.23	0.219	52.5	51.04 ± 26.24	±	2.78
0.24–0.30	0.261	46.9	61.67 ± 25.19	±	2.84	0.268	54.6	49.35 ± 22.13	±	2.24
0.30–0.36	0.332	45.7	37.91 ± 19.08	±	1.54	0.307	56.8	40.89 ± 20.45	±	1.69
0.36–0.42	0.381	44.2	55.05 ± 22.60	±	2.37	0.394	52.8	59.52 ± 24.30	±	2.67
0.42–0.50	0.440	43.4	40.95 ± 16.72	±	2.20	0.475	53.9	16.61 ± 10.11	±	0.95
0.50–0.60	0.548	43.8	21.91 ± 10.96	±	1.60	0.572	55.7	15.26 ± 8.87	±	1.18
0.60–0.72	0.654	45.5	24.04 ± 10.75	±	2.40					
0.72–0.90	0.848	43.9	5.52 ± 3.91	±	0.79					

	$60 < \theta < 75$					$75 < \theta < 90$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.141	68.5	60.21 ± 29.41	±	4.66	0.140	82.5	55.84 ± 27.98	±	4.34
0.16–0.20	0.178	67.2	31.51 ± 17.83	±	1.92	0.185	80.2	72.15 ± 25.20	±	4.61
0.20–0.24	0.226	68.0	39.93 ± 19.99	±	2.03	0.223	78.8	41.36 ± 19.14	±	2.02
0.24–0.30	0.266	63.6	26.39 ± 13.19	±	1.13	0.270	83.5	19.83 ± 11.45	±	0.84
0.30–0.36	0.322	65.1	12.87 ± 9.10	±	0.54	0.328	83.6	19.80 ± 11.44	±	0.92
0.36–0.42						0.382	80.5	13.48 ± 9.53	±	0.80
0.42–0.50	0.463	66.7	38.54 ± 13.63	±	2.39					
0.50–0.60	0.540	68.1	7.40 ± 5.23	±	0.64	0.541	81.0	6.92 ± 4.89	±	0.77
0.60–0.72	0.654	63.3	5.97 ± 4.22	±	0.69					

	$90 < \theta < 105$					$105 < \theta < 125$				
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$		
0.13–0.16	0.143	95.9	81.15 ± 33.65	±	6.44					
0.16–0.20	0.169	95.9	26.54 ± 15.39	±	1.69	0.167	107.9	15.38 ± 10.88	±	0.85
0.20–0.24						0.208	113.1	12.02 ± 8.51	±	0.58
0.24–0.30	0.258	92.1	12.30 ± 8.73	±	0.55					
0.30–0.36						0.322	117.5	8.97 ± 6.35	±	0.80
0.42–0.50	0.490	94.3	9.68 ± 6.85	±	1.08					

Table A.43: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of protons in π^- + Al $\rightarrow$ p + X interactions with -15.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.20–0.24	0.222	24.9	129.77 ± 4.54 ± 7.39			
0.24–0.30	0.272	25.1	122.02 ± 3.56 ± 6.42	0.274	34.7	118.48 ± 3.48 ± 5.88
0.30–0.36	0.334	25.0	97.64 ± 3.19 ± 5.00	0.333	34.7	103.98 ± 3.21 ± 4.73
0.36–0.42	0.394	25.1	78.73 ± 2.83 ± 3.94	0.396	35.0	88.68 ± 3.00 ± 4.01
0.42–0.50	0.468	25.2	71.87 ± 2.31 ± 3.50	0.468	34.9	69.54 ± 2.34 ± 3.25
0.50–0.60	0.559	25.2	52.89 ± 1.73 ± 2.58	0.558	35.0	57.95 ± 1.92 ± 2.78
0.60–0.72	0.675	25.1	37.71 ± 1.29 ± 2.01	0.674	34.9	39.23 ± 1.44 ± 2.21
0.72–0.90				0.825	34.9	22.21 ± 0.87 ± 1.54

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.30–0.36	0.335	45.0	112.04 ± 3.28 ± 4.71			
0.36–0.42	0.397	45.0	91.90 ± 2.99 ± 3.67	0.397	55.1	94.43 ± 2.96 ± 3.80
0.42–0.50	0.470	44.9	75.83 ± 2.40 ± 3.14	0.470	55.0	76.32 ± 2.37 ± 3.04
0.50–0.60	0.560	45.0	56.56 ± 1.93 ± 2.74	0.564	55.1	51.53 ± 1.82 ± 2.58
0.60–0.72	0.677	44.9	38.08 ± 1.46 ± 2.14	0.679	54.8	33.95 ± 1.41 ± 2.16
0.72–0.90	0.838	45.1	21.75 ± 0.91 ± 1.54	0.835	54.9	19.10 ± 0.88 ± 1.50
0.90–1.25	1.099	45.1	6.51 ± 0.35 ± 0.66	1.096	54.9	5.95 ± 0.36 ± 0.70

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.467	67.5	74.28 ± 1.86 ± 3.00	0.467	82.5	55.03 ± 1.59 ± 2.53
0.50–0.60	0.559	67.3	50.07 ± 1.43 ± 2.37	0.558	81.9	38.99 ± 1.22 ± 2.12
0.60–0.72	0.673	67.1	29.12 ± 1.08 ± 2.25	0.669	82.1	18.90 ± 0.88 ± 1.68
0.72–0.90	0.827	67.0	14.85 ± 0.66 ± 1.52	0.825	81.9	9.80 ± 0.54 ± 1.14
0.90–1.25	1.074	66.6	4.10 ± 0.26 ± 0.65	1.071	81.8	2.63 ± 0.22 ± 0.47

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.42–0.50	0.466	96.8	43.23 ± 1.41 ± 2.54	0.465	114.0	22.80 ± 0.89 ± 1.30
0.50–0.60	0.558	97.2	28.01 ± 1.05 ± 1.93	0.556	113.0	11.94 ± 0.62 ± 1.06
0.60–0.72	0.671	96.6	12.48 ± 0.75 ± 1.40	0.666	112.4	5.04 ± 0.43 ± 0.77
0.72–0.90	0.823	95.9	4.67 ± 0.39 ± 0.65	0.823	113.0	1.36 ± 0.19 ± 0.29

Table A.44: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^+'s in π^- + Al $\rightarrow \pi^+$ + X interactions with -15.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$			$30 < \theta < 40$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.116	24.8	111.52 ± 5.42 ± 8.26	0.116	34.8	79.14 ± 4.49 ± 5.93
0.13–0.16	0.147	24.7	147.98 ± 5.73 ± 8.97	0.146	34.9	108.57 ± 4.88 ± 6.58
0.16–0.20	0.182	24.6	168.38 ± 5.07 ± 8.90	0.182	34.7	105.82 ± 3.95 ± 5.60
0.20–0.24	0.221	24.8	179.07 ± 5.17 ± 8.57	0.222	34.7	119.19 ± 4.21 ± 5.68
0.24–0.30	0.272	24.6	178.03 ± 4.24 ± 7.69	0.273	34.6	115.48 ± 3.39 ± 4.94
0.30–0.36	0.333	24.6	152.76 ± 3.83 ± 6.14	0.333	34.7	96.87 ± 3.07 ± 3.86
0.36–0.42	0.395	24.5	131.91 ± 3.58 ± 5.27	0.395	34.7	77.34 ± 2.73 ± 3.04
0.42–0.50	0.467	24.7	94.13 ± 2.54 ± 4.16	0.466	34.9	61.36 ± 2.11 ± 2.58
0.50–0.60	0.557	24.6	62.58 ± 1.80 ± 3.52	0.558	34.7	38.82 ± 1.39 ± 2.04
0.60–0.72	0.672	24.7	38.69 ± 1.22 ± 3.03	0.674	34.6	24.02 ± 0.97 ± 1.70
0.72–0.90				0.819	34.3	11.06 ± 0.49 ± 1.19

	$40 < \theta < 50$			$50 < \theta < 60$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.10–0.13	0.117	44.8	65.08 ± 4.14 ± 5.02			
0.13–0.16	0.146	44.9	80.08 ± 4.08 ± 4.94	0.147	54.7	61.37 ± 3.57 ± 3.99
0.16–0.20	0.182	44.7	82.04 ± 3.56 ± 4.39	0.181	54.8	62.56 ± 3.04 ± 3.35
0.20–0.24	0.223	44.7	90.58 ± 3.71 ± 4.36	0.223	55.0	60.06 ± 2.95 ± 2.87
0.24–0.30	0.273	44.6	79.24 ± 2.79 ± 3.41	0.274	54.8	55.30 ± 2.31 ± 2.37
0.30–0.36	0.335	44.6	65.43 ± 2.51 ± 2.63	0.333	54.5	46.99 ± 2.12 ± 1.90
0.36–0.42	0.397	44.7	52.89 ± 2.24 ± 2.12	0.396	54.7	41.51 ± 2.00 ± 1.71
0.42–0.50	0.467	44.8	42.91 ± 1.74 ± 1.82	0.468	54.7	25.74 ± 1.30 ± 1.24
0.50–0.60	0.558	44.7	23.84 ± 1.10 ± 1.26	0.559	54.8	18.43 ± 1.00 ± 0.99
0.60–0.72	0.672	44.4	14.72 ± 0.77 ± 0.98	0.676	54.3	10.26 ± 0.67 ± 0.71
0.72–0.90	0.826	44.4	7.56 ± 0.42 ± 0.74	0.832	54.5	3.78 ± 0.29 ± 0.38
0.90–1.25				1.080	54.5	1.16 ± 0.10 ± 0.19

	$60 < \theta < 75$			$75 < \theta < 90$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.147	67.0	49.70 ± 2.63 ± 3.34	0.146	82.1	37.94 ± 2.33 ± 2.57
0.16–0.20	0.182	66.9	54.29 ± 2.26 ± 3.03	0.181	82.6	38.65 ± 1.85 ± 2.34
0.20–0.24	0.221	66.9	48.30 ± 2.14 ± 2.28	0.222	82.5	33.01 ± 1.71 ± 1.69
0.24–0.30	0.271	67.2	40.52 ± 1.61 ± 1.70	0.272	82.1	26.42 ± 1.29 ± 1.11
0.30–0.36	0.333	66.9	30.74 ± 1.40 ± 1.24	0.333	81.7	19.78 ± 1.14 ± 0.84
0.36–0.42	0.395	67.3	23.16 ± 1.21 ± 0.98	0.395	82.1	14.52 ± 0.94 ± 0.71
0.42–0.50	0.466	66.6	18.01 ± 0.90 ± 0.88	0.466	81.6	11.32 ± 0.71 ± 0.66
0.50–0.60	0.558	67.1	11.08 ± 0.63 ± 0.69	0.557	81.3	7.16 ± 0.51 ± 0.53
0.60–0.72	0.670	66.4	7.20 ± 0.46 ± 0.58	0.673	81.5	3.27 ± 0.30 ± 0.32
0.72–0.90	0.819	66.4	2.30 ± 0.19 ± 0.26	0.819	80.2	0.99 ± 0.14 ± 0.13
0.90–1.25	1.070	66.2	0.61 ± 0.06 ± 0.10	1.027	81.4	0.23 ± 0.04 ± 0.05

	$90 < \theta < 105$			$105 < \theta < 125$		
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$
0.13–0.16	0.146	97.1	28.63 ± 1.93 ± 2.12	0.147	115.0	26.73 ± 1.54 ± 1.97
0.16–0.20	0.180	97.0	28.22 ± 1.57 ± 1.72	0.180	114.3	23.08 ± 1.20 ± 1.42
0.20–0.24	0.221	97.7	25.31 ± 1.49 ± 1.32	0.221	114.0	14.70 ± 0.99 ± 0.74
0.24–0.30	0.271	97.0	20.53 ± 1.15 ± 0.89	0.270	113.5	12.40 ± 0.78 ± 0.61
0.30–0.36	0.334	97.5	13.25 ± 0.94 ± 0.66	0.329	113.4	6.29 ± 0.54 ± 0.40
0.36–0.42	0.397	96.8	7.76 ± 0.67 ± 0.49	0.396	114.3	4.54 ± 0.47 ± 0.36
0.42–0.50	0.464	97.2	6.01 ± 0.52 ± 0.46	0.468	111.9	2.57 ± 0.30 ± 0.26
0.50–0.60	0.559	96.7	3.65 ± 0.37 ± 0.36	0.550	112.5	0.73 ± 0.14 ± 0.10
0.60–0.72	0.671	95.9	1.70 ± 0.22 ± 0.23	0.686	111.4	0.28 ± 0.08 ± 0.05
0.72–0.90	0.809	94.9	0.60 ± 0.11 ± 0.10	0.830	107.4	0.10 ± 0.04 ± 0.02
0.90–1.25	1.050	96.7	0.08 ± 0.02 ± 0.02			

Table A.45: Double-differential inclusive cross-section $\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$ [mb/(GeV/c sr)] of the production of π^-'s in π^- + Al $\to \pi^-$ + X interactions with -15.0 GeV/c beam momentum; the first error is statistical, the second systematic; p_T in GeV/c, polar angle θ in degrees.

	$20 < \theta < 30$						$30 < \theta < 40$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.10–0.13	0.115	24.7	165.33	± 6.67	±	12.11	0.116	34.6	124.45	± 5.72	±	9.47
0.13–0.16	0.145	24.7	184.59	± 6.43	±	11.16	0.144	34.8	130.40	± 5.38	±	8.03
0.16–0.20	0.179	24.6	209.35	± 5.79	±	11.09	0.179	34.8	149.63	± 4.91	±	8.01
0.20–0.24	0.218	24.7	226.03	± 5.89	±	10.67	0.218	34.6	145.14	± 4.63	±	6.90
0.24–0.30	0.266	24.6	206.49	± 4.60	±	8.68	0.267	34.6	138.70	± 3.75	±	5.86
0.30–0.36	0.325	24.6	180.19	± 4.27	±	7.04	0.324	34.7	114.24	± 3.36	±	4.47
0.36–0.42	0.383	24.6	145.49	± 3.84	±	5.73	0.383	34.6	97.42	± 3.13	±	3.84
0.42–0.50	0.450	24.5	120.28	± 3.06	±	5.35	0.450	34.8	72.15	± 2.33	±	3.12
0.50–0.60	0.536	24.6	79.65	± 2.21	±	4.27	0.535	34.7	45.33	± 1.61	±	2.38
0.60–0.72	0.637	24.4	48.48	± 1.56	±	3.37	0.638	34.8	31.34	± 1.26	±	2.12
0.72–0.90							0.771	34.5	14.02	± 0.68	±	1.28

	$40 < \theta < 50$						$50 < \theta < 60$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.10–0.13	0.115	45.0	97.70	± 5.19	±	7.64						
0.13–0.16	0.144	45.0	100.53	± 4.76	±	6.28	0.145	54.8	82.53	± 4.31	±	5.33
0.16–0.20	0.178	44.9	97.98	± 3.90	±	5.28	0.178	55.0	81.14	± 3.50	±	4.38
0.20–0.24	0.217	44.7	107.32	± 4.01	±	5.16	0.217	54.8	85.17	± 3.64	±	4.06
0.24–0.30	0.266	44.7	99.85	± 3.18	±	4.24	0.266	55.0	72.19	± 2.67	±	3.05
0.30–0.36	0.324	44.7	83.25	± 2.87	±	3.29	0.324	54.9	57.78	± 2.36	±	2.31
0.36–0.42	0.381	44.8	66.30	± 2.51	±	2.67	0.381	54.8	47.64	± 2.22	±	1.97
0.42–0.50	0.448	44.7	50.95	± 1.91	±	2.28	0.447	54.7	34.21	± 1.55	±	1.59
0.50–0.60	0.531	44.6	34.55	± 1.42	±	1.90	0.533	54.8	20.08	± 1.06	±	1.16
0.60–0.72	0.632	44.7	18.97	± 0.95	±	1.36	0.630	54.6	12.48	± 0.78	±	0.92
0.72–0.90	0.765	44.5	8.42	± 0.51	±	0.82	0.762	54.5	4.79	± 0.37	±	0.50
0.90–1.25							0.957	54.6	1.30	± 0.13	±	0.20

	$60 < \theta < 75$						$75 < \theta < 90$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.13–0.16	0.144	67.4	67.84	± 3.11	±	4.43	0.145	82.4	50.55	± 2.63	±	3.50
0.16–0.20	0.177	67.3	66.20	± 2.55	±	3.52	0.178	82.2	48.46	± 2.12	±	2.73
0.20–0.24	0.217	66.9	60.65	± 2.43	±	2.77	0.217	82.3	45.55	± 2.07	±	2.11
0.24–0.30	0.265	67.1	50.43	± 1.81	±	2.07	0.265	81.9	32.89	± 1.46	±	1.35
0.30–0.36	0.324	66.7	37.05	± 1.55	±	1.49	0.326	81.6	24.31	± 1.26	±	1.05
0.36–0.42	0.383	66.5	28.94	± 1.37	±	1.25	0.382	81.7	16.87	± 1.04	±	0.84
0.42–0.50	0.449	67.2	21.33	± 1.00	±	1.08	0.451	81.6	11.76	± 0.74	±	0.73
0.50–0.60	0.536	67.1	11.98	± 0.66	±	0.78	0.534	81.5	5.80	± 0.45	±	0.47
0.60–0.72	0.634	67.0	6.97	± 0.47	±	0.57	0.637	81.5	2.93	± 0.31	±	0.30
0.72–0.90	0.766	65.9	2.45	± 0.22	±	0.28	0.774	81.0	1.16	± 0.16	±	0.16
0.90–1.25	0.981	65.4	0.25	± 0.04	±	0.04	0.965	82.3	0.20	± 0.04	±	0.04

	$90 < \theta < 105$						$105 < \theta < 125$					
p_T	$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$				$\langle p_\mathrm{T}\rangle$	$\langle\theta\rangle$	$\mathrm{d}^2\sigma/\mathrm{d}p\mathrm{d}\Omega$			
0.13–0.16	0.144	97.5	47.20	± 2.53	±	3.40	0.143	114.5	37.88	± 1.92	±	2.57
0.16–0.20	0.178	96.9	43.81	± 2.01	±	2.51	0.178	113.7	31.41	± 1.51	±	1.58
0.20–0.24	0.216	97.0	36.65	± 1.87	±	1.68	0.217	114.0	21.15	± 1.23	±	1.00
0.24–0.30	0.265	97.0	24.65	± 1.29	±	1.06	0.265	114.2	13.95	± 0.83	±	0.72
0.30–0.36	0.324	97.0	16.05	± 1.04	±	0.81	0.326	113.5	7.42	± 0.60	±	0.50
0.36–0.42	0.381	96.9	11.77	± 0.86	±	0.76	0.380	112.9	5.54	± 0.52	±	0.48
0.42–0.50	0.446	96.7	6.54	± 0.55	±	0.54	0.451	113.5	3.23	± 0.34	±	0.36
0.50–0.60	0.535	97.0	4.17	± 0.41	±	0.45	0.530	113.4	1.14	± 0.18	±	0.16
0.60–0.72	0.630	95.5	1.28	± 0.19	±	0.18	0.625	112.8	0.24	± 0.07	±	0.05
0.72–0.90	0.770	94.7	0.41	± 0.09	±	0.08						
0.90–1.25	1.002	96.8	0.11	± 0.04	±	0.03						