Normalization

05.08.2016

Normalization: $\pi^- p$ (Piotr Salabura)

p [MeV/c]	N_{ev} (PE) x 10^6	N_{beam} x 10^9 Corrected for dead time	N_{START} x 10^9 (scalers)	Dead time [%]	N_{el} (61-109^0) corr x 10^6	σ(61-109^0) [mb]	$\frac{\sigma}{N_{el}}$ x 10^{-7}	N_{beam} / N_{START} EXP	N_{beam} / N_{START} SIM
656	42.64	2.13	2.95	16	2.14	2.99	13.97	0.72	0.66
690	778.68	36.59	47.11*	23	34.68	3.077	0.88	0.77	0.66
748	76.90	3.67	4.52	23	3.45	3.055	8.85	0.81	0.67
800	52.66	2.46	3.04	24	1.92	2.57	13.38	0.81	0.67

N_{beam} calculated from:

$$N_{el} = N_{beam}\ 4*10^{23}\ \sigma_{el}$$

* *Does NOT include ~100 MLN events from July*

Remark: N_{beam} vs. N_{START}

- N_{beam}:
  - Number of beam particles
  - Calculated on the basis of elastic scattering
- N_{START}:
  - Number of particles passing START
  - > N_{beam} ($size_{START}$ > $size_{target}$), 25-18% more (dep. p_{beam})
  - Contamination from electrons and muons (dep. p_{beam})

Table 2
Relative abundance of pions and electrons at the HADES target position for different primary beams and central momenta, in the case of negative polarity of the beam-line

Projectile	Energy (A GeV)	P_0 (GeV/c)	e^- (%)	π^- (%)
p	3.5	0.6	31.2	65.4
		1.0	12.4	87.0
^{12}C	1.7	0.4	29.5	62.0
		0.6	8.5	88.6
		0.8	4.5	92.5
		1.0	1.1	96.0
	2.0	0.6	9.8	85.1
		0.8	5.1	93.6
		1.0	2.8	95.8

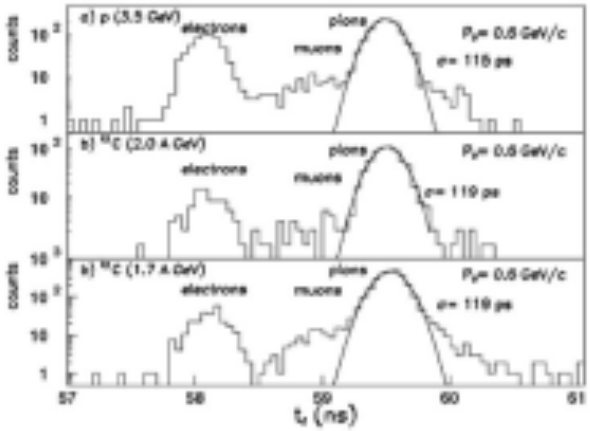


Fig. 15. Time-of-flight spectra of secondary electrons and pions for p at 3.5 GeV and ^{12}C of 1.7 and 2 GeV primary beams for 0.6 GeV/c central momentum of the beam-line.

Normalization Procedure π^-C/W

- Similar to pNb @ 3.5 GeV (HARP: pCu @ 4.15 GeV)
  - On the basis of differential pion multiplicities
  - Extract total reaction cross-section (σ_R) by comparission to the double differential cross-section of HARP (π^-Be/Al/C/Cu/Sn/Pb@ 3, 5, 8, 12 GeV/c) (coverage: 100 MeV/c < p < 800 MeV/c, 20.1° < θ < 123.2°)

arXiv:0907.1428v2: Large-angle production of charged pions with incident pion beams on nuclear targets

$$\sigma_R = \frac{\sigma_\pi(HARP)}{M_\pi(HADES)}$$

  - Evaluate N_{beam} and N_{START}

P_{beam} [GeV/c]	Target	N_{ev} (10^8)	N_{START} (10^9)	DeadTime
1.7	W	1.69	4.16	0.154
1.7	C	2.00	4.76	0.162

HARP: π^-C

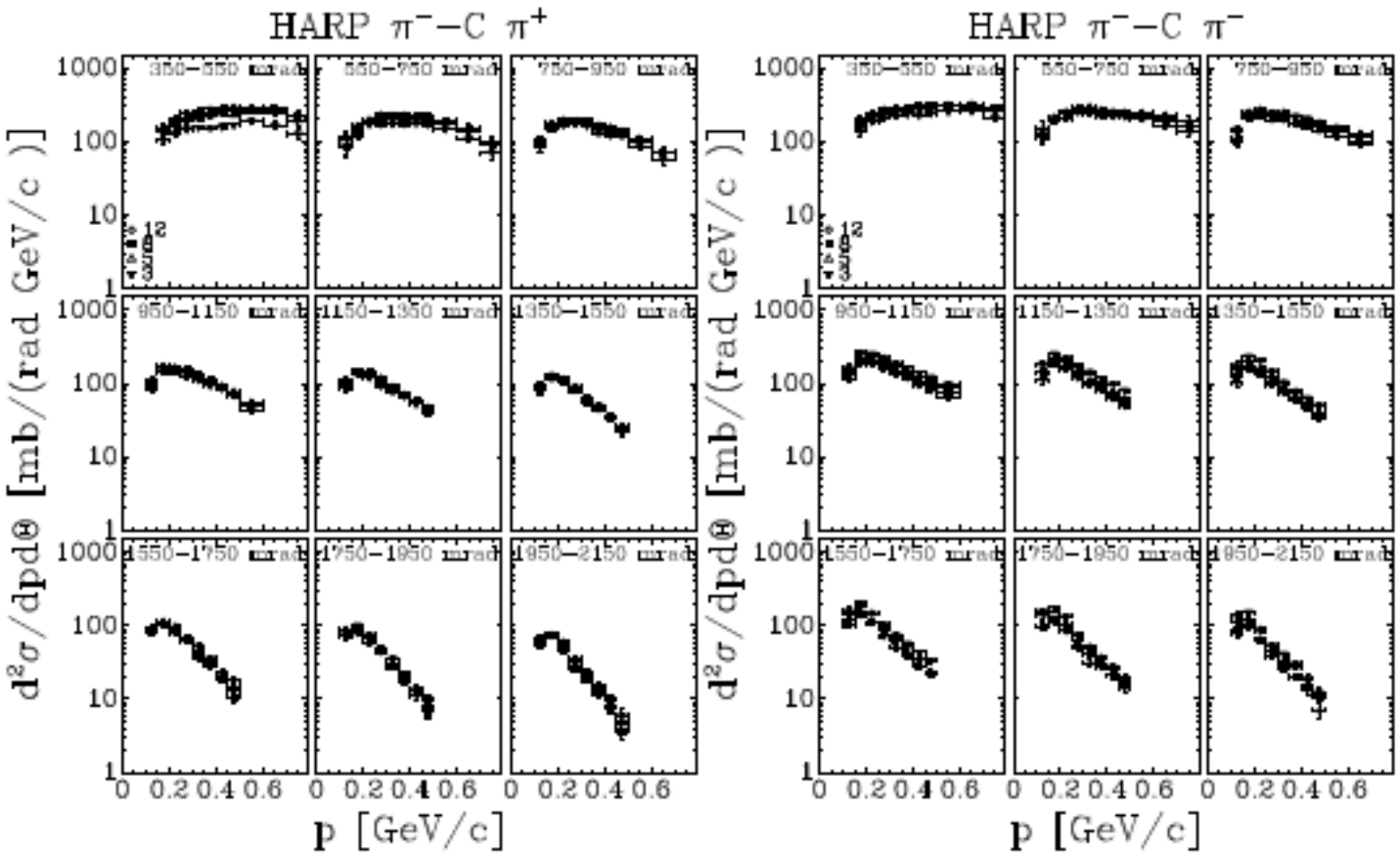


FIG. 11: Double-differential cross-sections for π^+ production (left) and π^- production (right) in π^-–C interactions as a function of momentum displayed in different angular bins (shown in mrad in the panels). The error bars represent the combination of statistical and systematic uncertainties.

HARP: π^-Pb

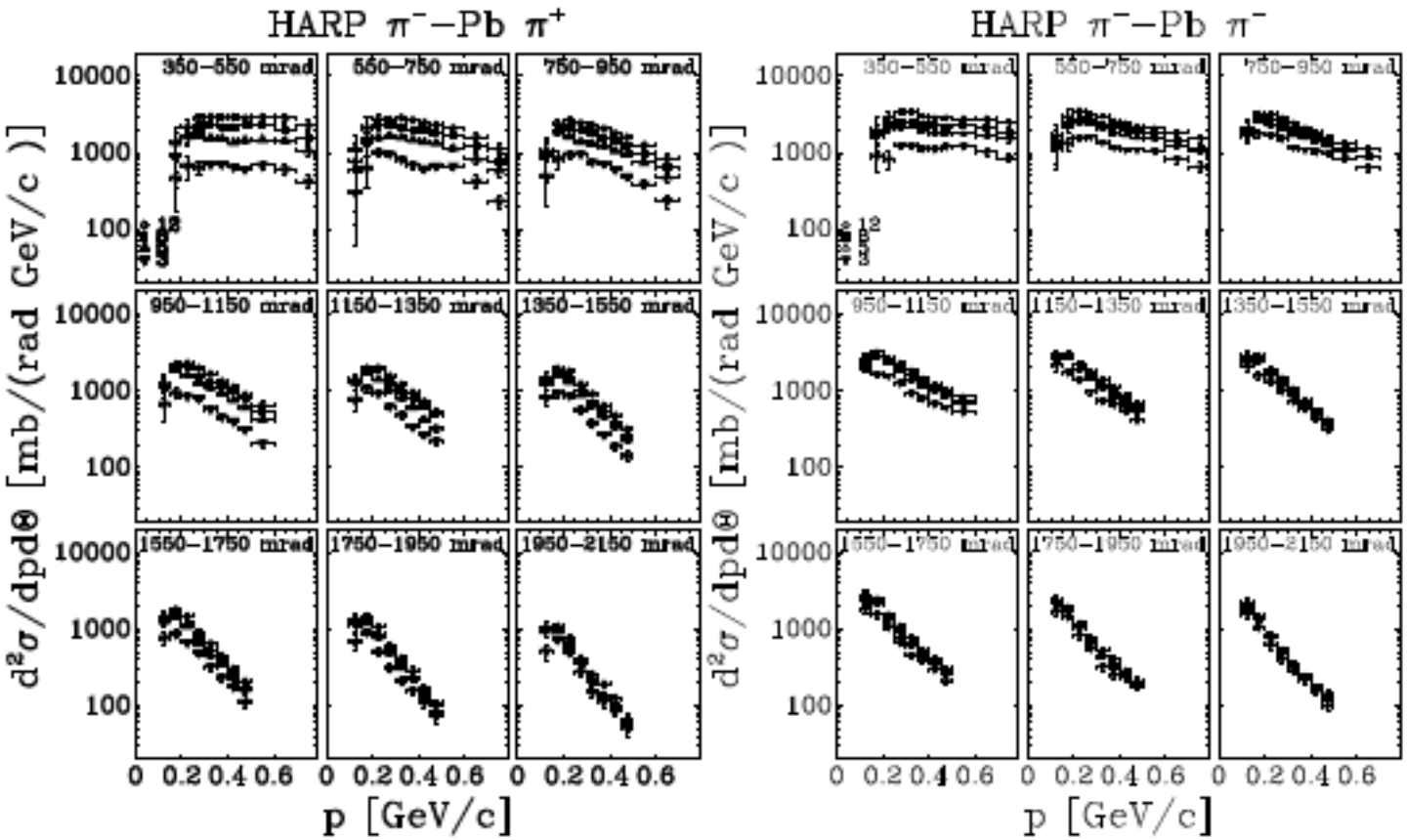
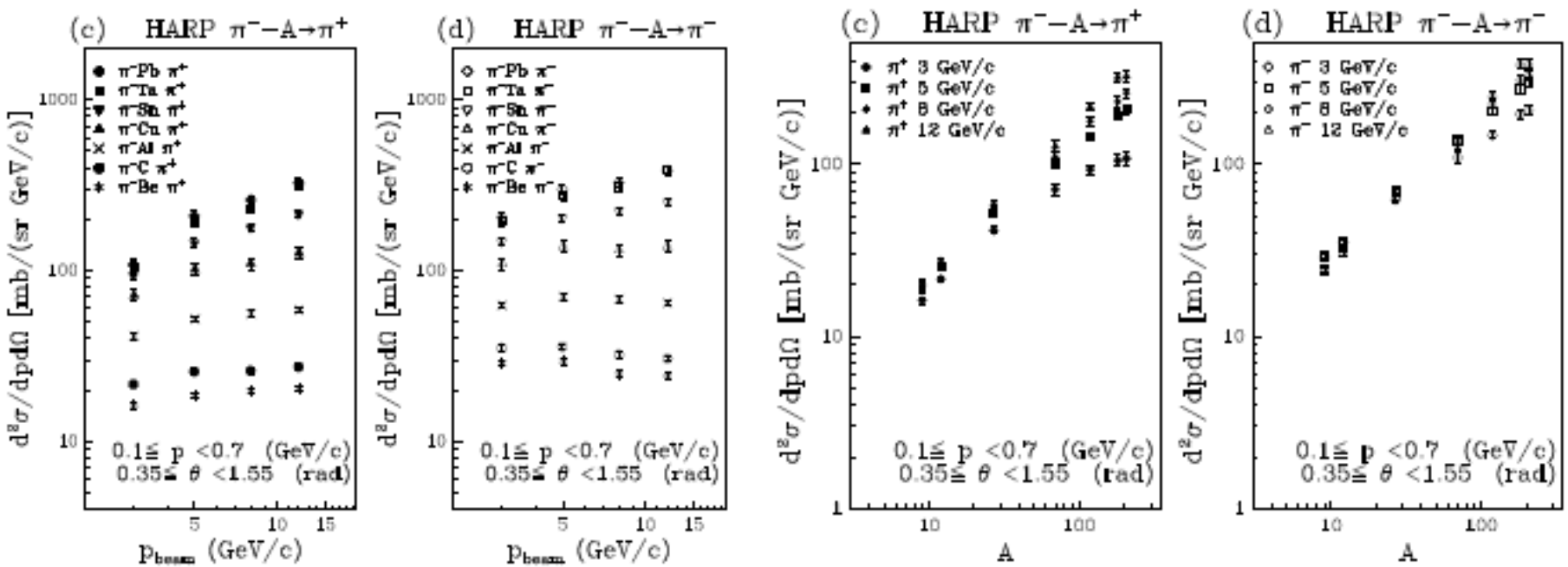


FIG. 16: Double-differential cross-sections for π^+ production (left) and π^- production (right) in π^-–Pb interactions as a function of momentum displayed in different angular bins (shown in mrad in the panels). The error bars represent the combination of statistical and systematic uncertainties.

HARP: π^-A


(c) HARP π⁻−A→π⁺
π⁻Pb π⁺
π⁻Ta π⁺
π⁻Sn π⁺
π⁻Cu π⁺
π⁻Al π⁺
π⁻C π⁺
π⁻Be π⁺
0.1≦ p <0.7 (GeV/c)
0.35≦ θ <1.55 (rad)
d²σ/dpdΩ [mb/(sr GeV/c)]
p_beam (GeV/c)
(d) HARP π⁻−A→π⁻
π⁻Pb π⁻
π⁻Ta π⁻
π⁻Sn π⁻
π⁻Cu π⁻
π⁻Al π⁻
π⁻C π⁻
π⁻Be π⁻
0.1≦ p <0.7 (GeV/c)
0.35≦ θ <1.55 (rad)
d²σ/dpdΩ [mb/(sr GeV/c)]
p_beam (GeV/c)
(c) HARP π⁻−A→π⁺
π⁺ 3 GeV/c
π⁺ 5 GeV/c
π⁺ 8 GeV/c
π⁺ 12 GeV/c
0.1≦ p <0.7 (GeV/c)
0.35≦ θ <1.55 (rad)
d²σ/dpdΩ [mb/(sr GeV/c)]
A
(d) HARP π⁻−A→π⁻
π⁻ 3 GeV/c
π⁻ 5 GeV/c
π⁻ 8 GeV/c
π⁻ 12 GeV/c
0.1≦ p <0.7 (GeV/c)
0.35≦ θ <1.55 (rad)
d²σ/dpdΩ [mb/(sr GeV/c)]
A