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ELASTIC SCATTERING OF  $\pi^+$ -MESONS ON  $^4\text{He}$  AND  $^3\text{He}$   
(Experimental data).

ELASTIC SCATTERING OF  $\pi^\pm$ -MESONS ON  $^4\text{He}$  AND  $^3\text{He}$  (EXPERIMENTAL DATA)

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SUMMARY.

The differential cross sections of the elastic scattering of  $\pi^-$  mesons on  $^4\text{He}$  at 68, 98, 120, 135, 145, 156, 174, 208 MeV, of  $\pi^+$  mesons on  $^4\text{He}$  at 68, 98, 120, 135, 145, 156 MeV, of  $\pi^-$  mesons on  $^3\text{He}$  at 68, 98, 120, 135, 145, 156, 180, 195, 208 MeV, of  $\pi^+$  mesons on  $^3\text{He}$  at 68, 98, 120, 135, 145, 156 MeV have been measured at the synchrocyclotron of the JINR of Dubna. The energy behaviours of the total elastic scattering cross sections have been deduced. The results are in good agreement with those obtained in other ( $\pi^\pm$ ,  $^4\text{He}$ ) experiments. The data on ( $\pi^+$ ,  $^4\text{He}$ ) and ( $\pi^-$ ,  $^3\text{He}$ ) elastic scattering are the only existing up to this day in the considered energy region.

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## 1. - INTRODUCTION.

The Dubna-Torino collaboration for the study of the elastic scattering of  $\pi^+$  and  $\pi^-$  mesons on  $^4\text{He}$  and  $^3\text{He}$ , beginning in 1970 and up to the end of 1979, took about 1.5 million of streamer chamber pictures. In this review paper all the experimental results we obtained<sup>(1)</sup> are presented in the final version, omogeneously analyzed. Our data on the  $\pi^+$  elastic scattering on  $^4\text{He}$  are compared with those previously obtained by Crowe et al.<sup>(2)</sup> at lower energies and with those obtained in the same period by Binon et al.<sup>(3)</sup> for the  $(\pi^-, ^4\text{He})$  scattering. Our results for  $(\pi^+, ^4\text{He})$ ,  $(\pi^+, ^3\text{He})$  and  $(\pi^-, ^3\text{He})$  elastic scattering, up to date, are the only existing in the energy region we considered. At higher energies the LAMPF new results<sup>(4)</sup> are confirming the behaviour of the angular distributions observed at lower energies.

## 2. - EXPERIMENTAL APPARATUS.

The experimental apparatus is sketched in Fig. 1. The pion beams of the synchrocyclotron of JINR passed through the first 1 atm helium filled self shunted streamer chamber of

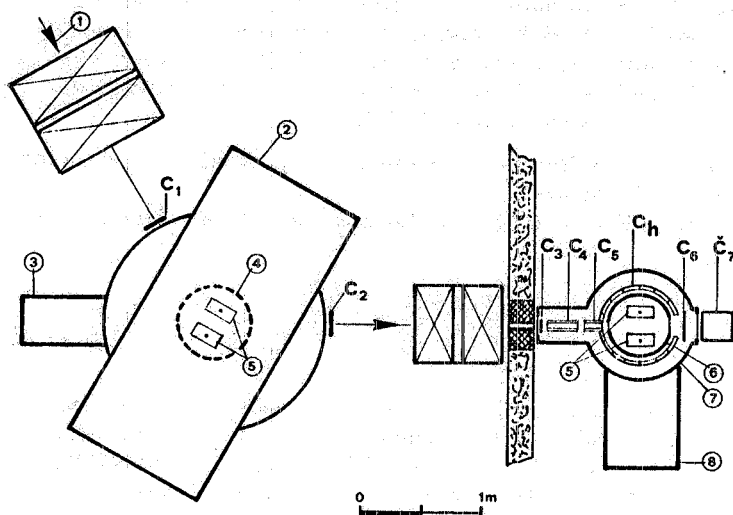


FIG. 1 - Diagram of the experimental set-up: 1)  $\pi^+$  beams; 2) analyzing magnet; 3) h. v. pulse generator; 4)  $^4\text{He}$  filled 1 atm self shunted streamer chamber; 5) stereocameras; 6)  $^4\text{He}$  or  $^3\text{He}$  filled 4 atm self shunted streamer chamber; 7) steel vessel surrounding the high pressure streamer chamber; 8) h. v. pulse generator;  $C_h$ ) hodoscope of scintillation counters;  $C_{1-6}$ ) scintillation counters;  $\check{C}_7$ ) Čerenkov counter.

50 cm diameter and 12 cm high with two thin windows (mylar of  $100 \mu\text{m}$ ) and placed in an electromagnet. The magnetic field values were selected to have pion tracks with a radius of about 1 m in the analyzing streamer chamber (to obtain  $\Delta r/r \sim 1\%$  with stereo reconstruction<sup>(5)</sup>). The characteristics of the self shunted streamer chambers are described in details in ref. (5). The pions after crossing the first chamber were focalized in a high pressure (4 atm) self

shunted streamer chamber of 50 cm diameter and 12 cm high, filled with the gas target ( $^4\text{He}$  or  $^3\text{He}$ ). A lucite Čerenkov counter, at the end of the channel, permitted to measure the beam contamination. The target streamer chamber was surrounded by an hodoscope of scintillation counters, covering the angles of the scattered pions in the  $25^\circ$ - $170^\circ$  range. The vertical plexiglas wall of the high pressure streamer chamber was of  $0.4 \text{ g} \cdot \text{cm}^{-2}$ , for this reason the chamber and the hodoscope were contained in a steel vessel, filled with nitrogen at the same pressure as the target gas. The coincidence of the  $C_1 \cdot C_2 \cdot C_3 \cdot \bar{C}_4 \cdot \bar{C}_5 \cdot C_6 \cdot \check{C}_7$  counters gave the trigger for the h. v. pulse generator of the analyzing streamer chamber. In Fig. 2 the track radius distributions for different beam energies are shown. Their widths

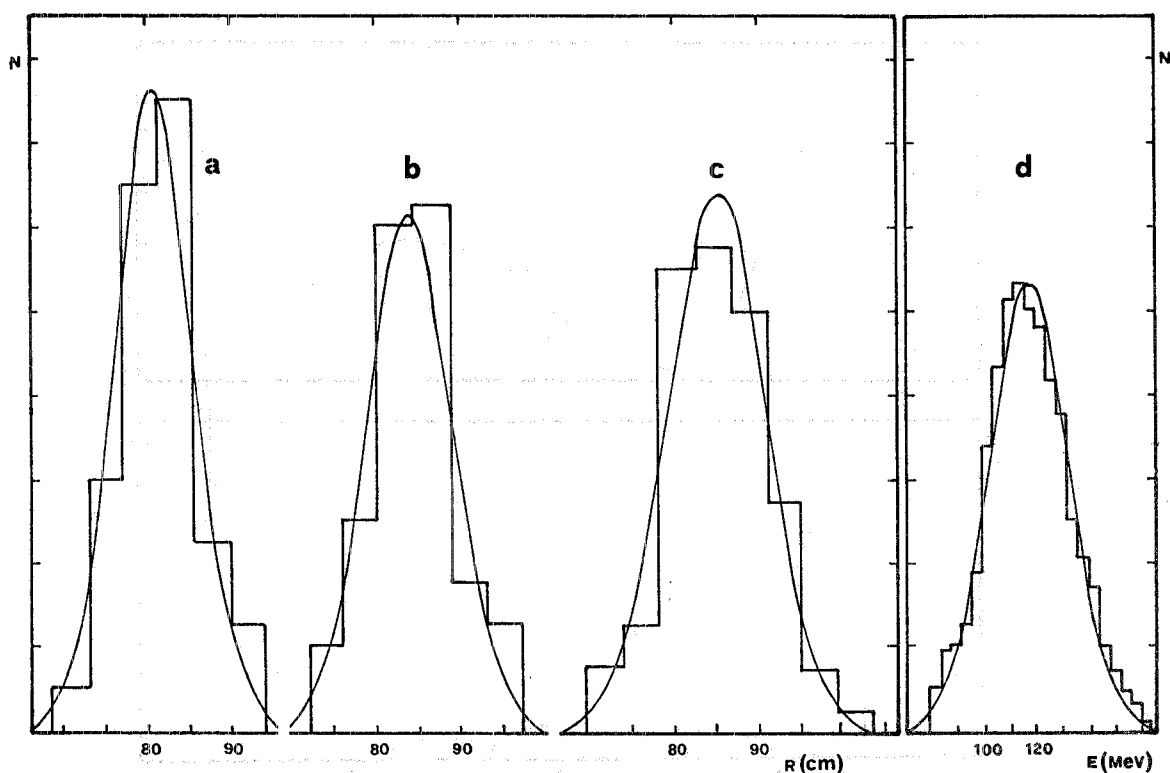


FIG. 2 - Distribution of the radius values of the tracks of the incident pion beam, photographed in the 1 atm streamer chamber; a)  $\pi^-$  of  $(159 \pm 9) \text{ MeV}/c$ ; b)  $\pi^-$  of  $(201 \pm 12) \text{ MeV}/c$ ; c)  $\pi^-$  of  $(264 \pm 18) \text{ MeV}/c$ ; the widths contain also the contribution of the errors of the radius measurements<sup>(4)</sup>. In Fig. 2d) the energy distribution of the incoming  $\pi^+$  beam of 120 MeV deduced from the kinematics of the  $(\pi^+, ^3\text{He})$  elastic events, is shown. The enlargement of the distribution is also due to the contributions of the errors of measurement of the angle and range of the tracks<sup>(5)</sup>.

also contain the contribution of the errors of the radius measurements<sup>(5)</sup>. The average values of the beam energies are in agreement with those deduced from the kinematical reconstruction of the elastic scattering events (taking into account the several absorbers along the channel between the streamer chambers). In Fig. 2d) the energy distribution of the pion beam used during the  $(\pi^+, ^3\text{He})$  scattering runs at 120 MeV, is shown. The width of this distribution

also contains the contribution of the distribution widths of the track angle and range measurement values<sup>(5)</sup>. The coincidence of the  $C_1 \cdot C_2 \cdot C_3 \cdot \bar{C}_4 \cdot \bar{C}_5 \cdot C_h \cdot \bar{C}_6$  counters gave the trigger for the h. v. pulse generator of the target chamber and the  $C_1 \cdot C_2 \cdot C_3 \cdot \bar{C}_4 \cdot \bar{C}_5 \cdot \bar{C}_h \cdot C_6 \cdot \check{C}_7$  coincidence gave the trigger for the analysis of the beam contamination in the total energy loss counter  $\check{C}_7$ . In Fig. 3 the beam composition for  $\pi^-$  of 98 MeV is shown. In the lower part of the figure the composition of the same beam "enriched" with pions, taking into account the different times of flight of the particles along the 4 m base between the counters  $C_1$  and  $C_3$ , is reported. The beam intensities were controlled not to overcome three photographs per second. The spatial coordinate reconstruction of the event vertices allowed to deduce the cylindrical volume size of the gas target in the high pressure streamer chamber.

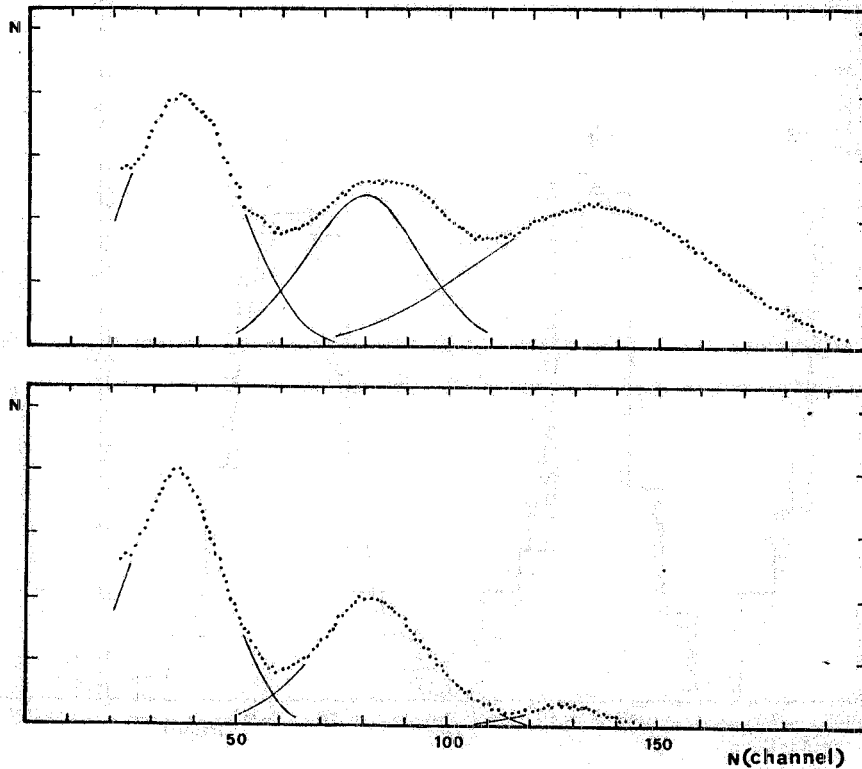


FIG. 3 - Beam composition obtained by using a lucite Čerenkov counter ( $\check{C}_7$  in Fig. 1). For  $\pi^-$  beam of 98 MeV, in the upper part (38% of  $\pi^-$ , 22% of  $\mu^-$ , 40% of  $e^-$ ); in the lower part (61% of  $\pi^-$ , 31% of  $\mu^-$ , 8% of  $e^-$ ). The composition has been "enriched" of pions, taking into account the different times of flight between the counters  $C_1$  and  $C_3$  of Fig. 1 (base of 4 m).

Fig. 4 shows an example of the efficiency of the experimental apparatus, as a function of the angle (in the l. s.) between the incoming and the scattered pion. The experimental values have been obtained from the elastic scattering events (Fig. 4 refers to the case of  $\pi^-$  of 98 MeV), taking into account the vertex position of each event, the dimensions and the efficiency of each counter of the hodoscope. The results are in very good agreement with the Monte Car

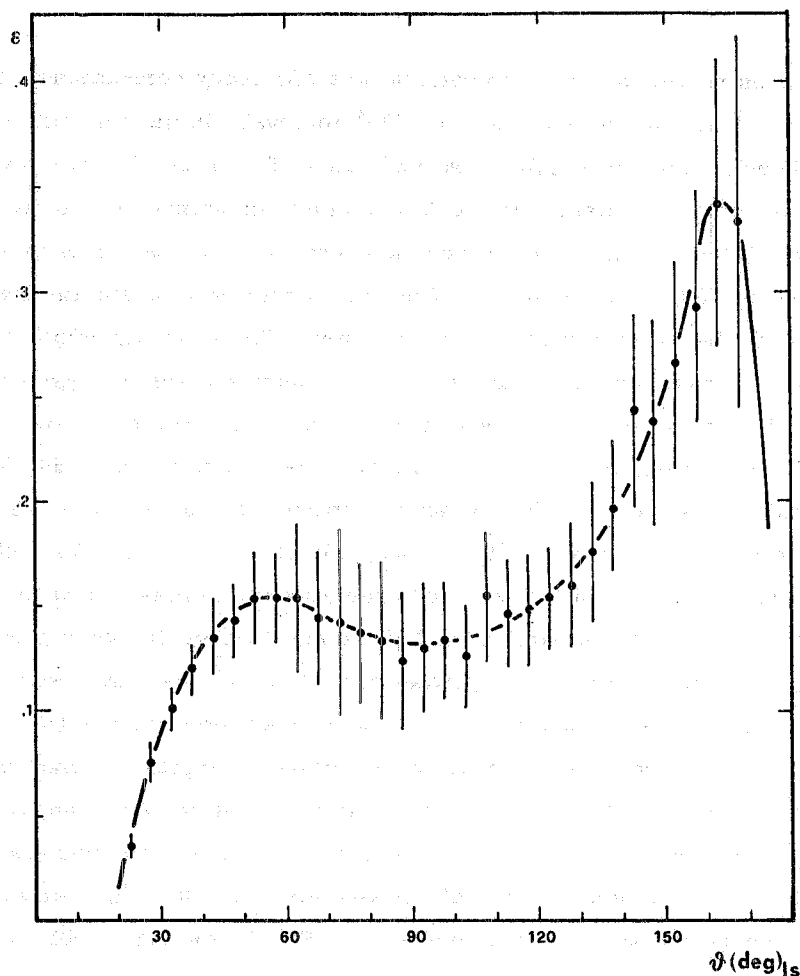


FIG. 4 - Efficiency of the experimental apparatus as a function of the angle between the incoming and the scattered pion. The points have been obtained from the  $(\pi^-, {}^4\text{He})$  elastic scattering events at 98 MeV; the full line curve represents the Monte Carlo calculation result<sup>(6)</sup> performed with the same experimental conditions, that is taking into account the hodoscope counters efficiency, the real volume of the gas target (deduced from the spatial distribution of the vertices of the events), the relative position of the target and of the scintillation counters.

to calculation ones<sup>(6)</sup>, performed with the same experimental data in input, that is the real target volume, the relative position of the target and the scintillation counters and taking into account their efficiency. The runs have been made in the following conditions: gas target purity better than 99.96%; beam energy spreads of (5-7)%; beam peak energy determined within (2-3) MeV; muon and electron contaminations of the beams measured with a precision better than 3%. The shot-rate was 1-3 ph/s, with one elastic scattering event every about 40-50 photographs. The errors in the measurement of the scattering angles of the pion and of the recoil were lower than  $1^\circ$ , and those in the measurement of the recoil ranges (when the  ${}^4\text{He}$  and  ${}^3\text{He}$  nuclei stopped in the chamber) were lower than 1.5 mm, after the spatial reconstruction of the events from the stereophotographs<sup>(5)</sup>.

### 3. - RESULTS.

After the reconstruction and the geometrical and efficiency corrections, the events have been grouped in  $5^\circ$  angular bins in the  $(25-170)^\circ$  interval. In the cases of poor statistics the events have been grouped in angular bins multiple of  $5^\circ$ . In the Tables I - XXIX the final results of our experiment are listed. In the first column the number of angular bins is indicated; in the second the central values of each angular bin in the center of mass system are given. In the third and fourth columns the differential cross section and the statistical error values are listed, in the fifth the relative error values. The following columns show the cosine of the center of mass scattering angles, the momentum transfer squared, the corresponding differential cross section with statistical errors. In the case of the  $(\pi^+, {}^4\text{He})$  and  $(\pi^+, {}^3\text{He})$  elastic scattering, the measurements have been performed at 68, 98, 120, 135, 145, 156 MeV; in the case of  $(\pi^-, {}^4\text{He})$  elastic scattering at 68, 98, 120, 135, 145, 156, 174, 208 MeV and in the case of  $(\pi^-, {}^3\text{He})$  at 68, 98, 120, 135, 145, 156, 180, 195, 208 MeV. In the Figures 5-10, 12-15, 17-23 the behaviours of the elastic scattering differential cross sections are shown. In particular Figs. 5 and 12 show the very good agreement between the  $(\pi^+, {}^4\text{He})$  scattering data of Crowe et al.<sup>(2)</sup> at 68 MeV and those we obtained at the same energy. Figs. 6-10 show the very good agreement between the  $(\pi^-, {}^4\text{He})$  scattering data of Binon et al.<sup>(3)</sup> and those we obtained at similar energies. It must be noted that in our experiments with a visualizing detector the statistics in the same angular ranges are lower than in the experiments performed with magnetic spectroscopes and electronic devices as in the case of refs. (2) and (3). In ref. (3) also the total  $(\pi^-, {}^4\text{He})$  elastic scattering cross section energy behaviour has been deduced. In Fig. 11 the data of Binon et al.<sup>(3)</sup> are compared with those obtained by Budagov et al.<sup>(7)</sup> and with those we deduced by integrating (from  $0^\circ$  up to  $180^\circ$ ) the best fit curves of the differential cross sections of ref. (2) and of those measured by us, calculated with Legendre polynomials. The vertical bars represent the ranges of the values calculated by fitting the data with fifth and seventh order polynomials. In Fig. 16 the  $(\pi^+, {}^4\text{He})$  total elastic cross section values, deduced as in the case of  $(\pi^-, {}^4\text{He})$  scattering, are compared with those deduced from the data of ref. (2) and with the data we obtained in a different experiment, using a diffusion cloud chamber filled with helium, as described in ref. (8). As one can see in the upper part of Fig. 16 the  $(\pi^+, {}^4\text{He})$  elastic scattering total cross section values are closed to the  $(\pi^-, {}^4\text{He})$  values. Using the same method we deduced also the total cross sections of the  $(\pi^+, {}^3\text{He})$  and  $(\pi^-, {}^3\text{He})$  elastic scattering. The results are shown in Fig. 24. The  $(\pi^+, {}^3\text{He})$  cross section values are about 1.3-1.6 times the corresponding values of the  $(\pi^-, {}^3\text{He})$  cross section.

Several theoretical analyses of the data have been performed by different authors. In a following paper we will discuss what we have learnt from our experiment.

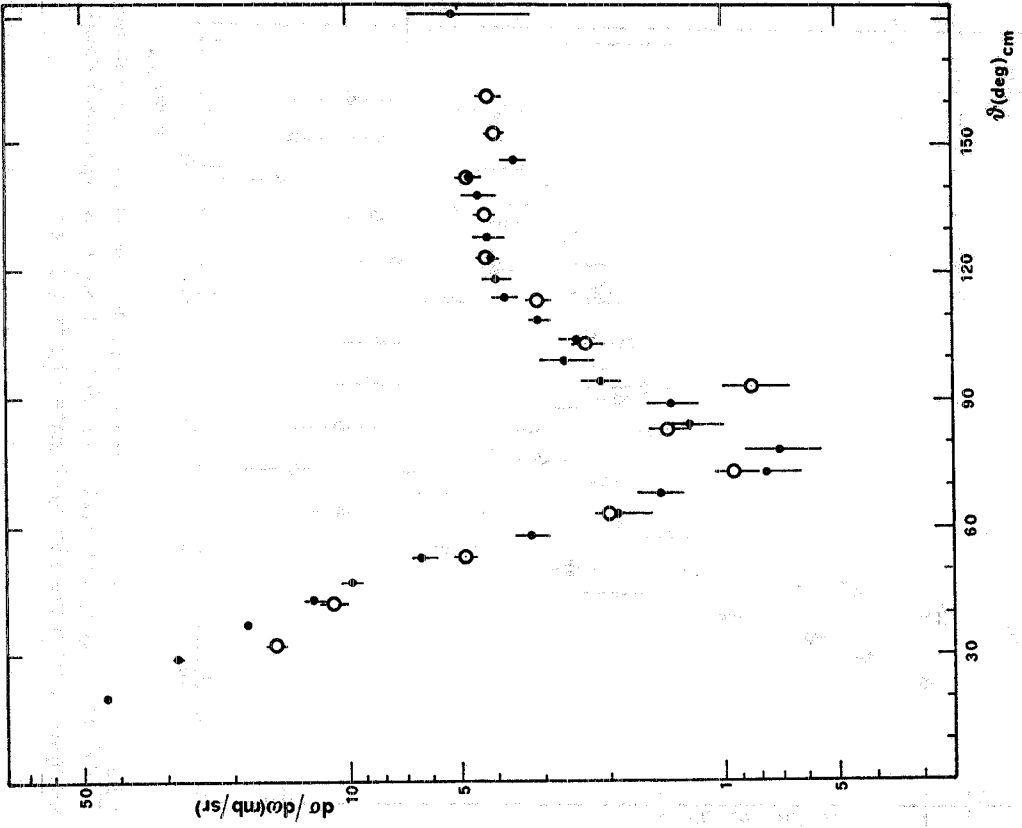


FIG. 6 - ( $\pi^-$ ,  $^4\text{He}$ ) elastic scattering differential cross section at  $E_\pi = 98$  MeV (o - present data) and at 110 MeV (● - Binon et al. (3)).

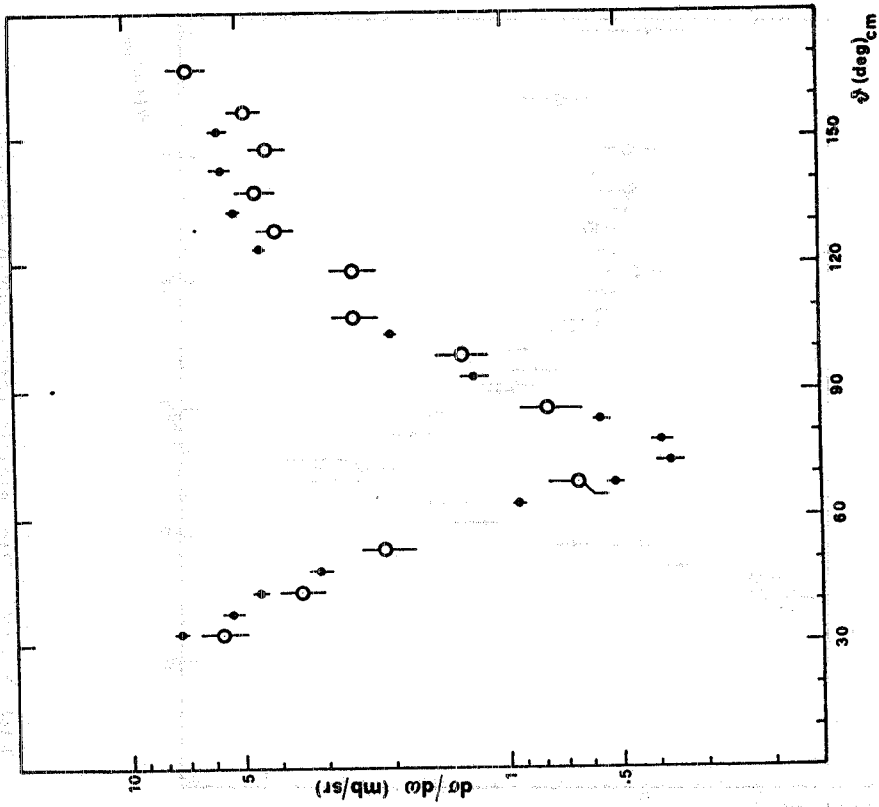


FIG. 5 - ( $\pi^-$ ,  $^4\text{He}$ ) elastic scattering differential cross section at  $E_\pi = 68$  MeV; o - present data; ● - Crowe et al. (2).



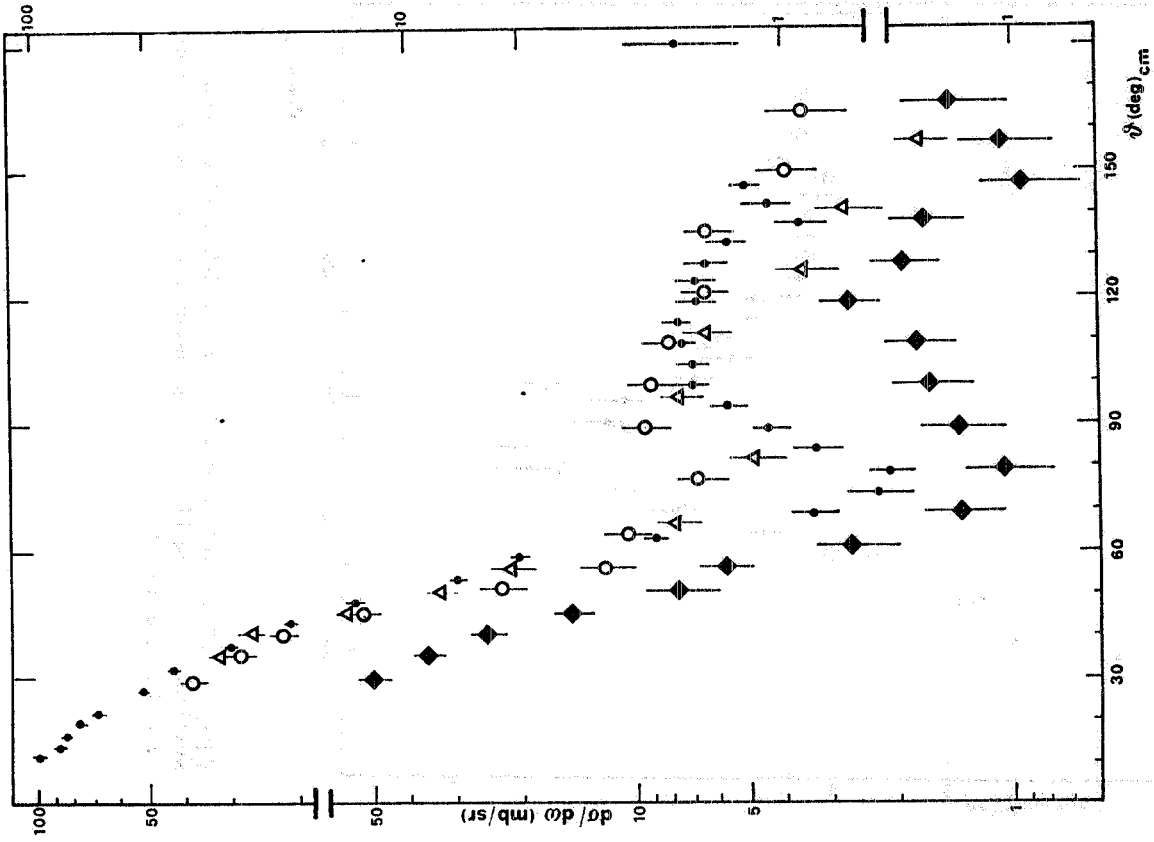


FIG. 8 - ( $\pi^-$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 135 MeV ( $\blacklozenge$ ), 145 MeV (o) and 156 MeV ( $\blacktriangle$ ) (present data) compared with the 150 MeV data of ref. (3) ( $\bullet$ ).

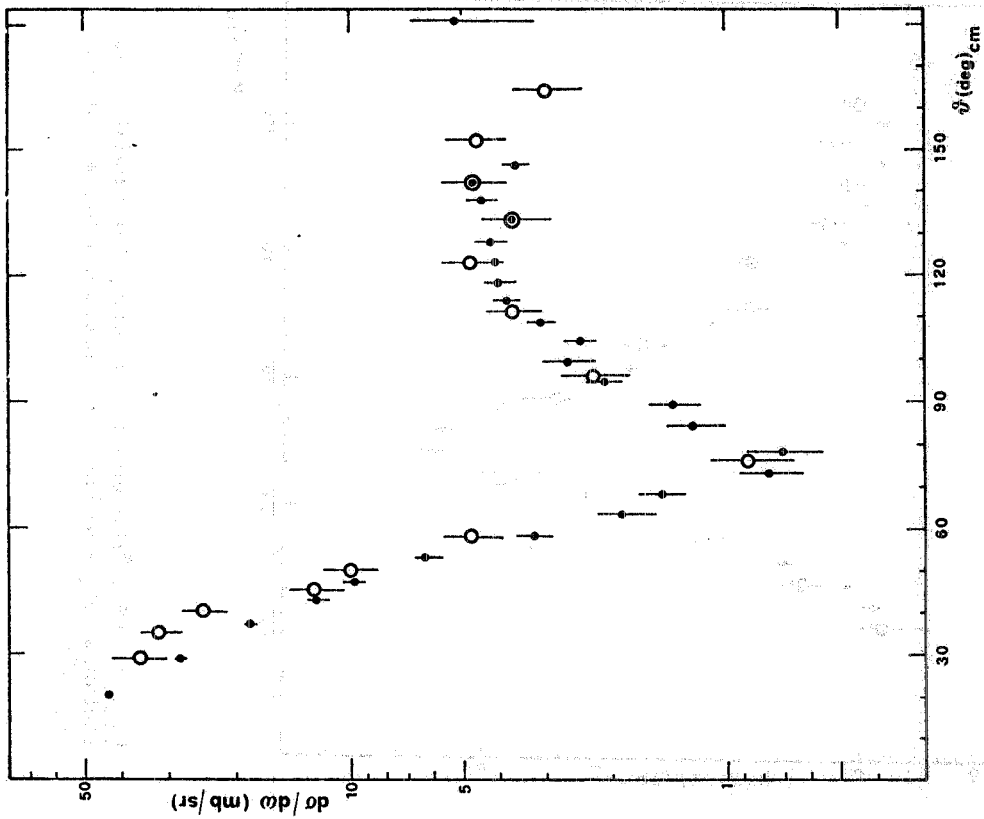


FIG. 7 - ( $\pi^-$ ,  $^4\text{He}$ ) elastic scattering differential cross section at  $E = 120$  MeV (o - present data) and at 110 MeV ( $\bullet$  - Binon et al. (3)).

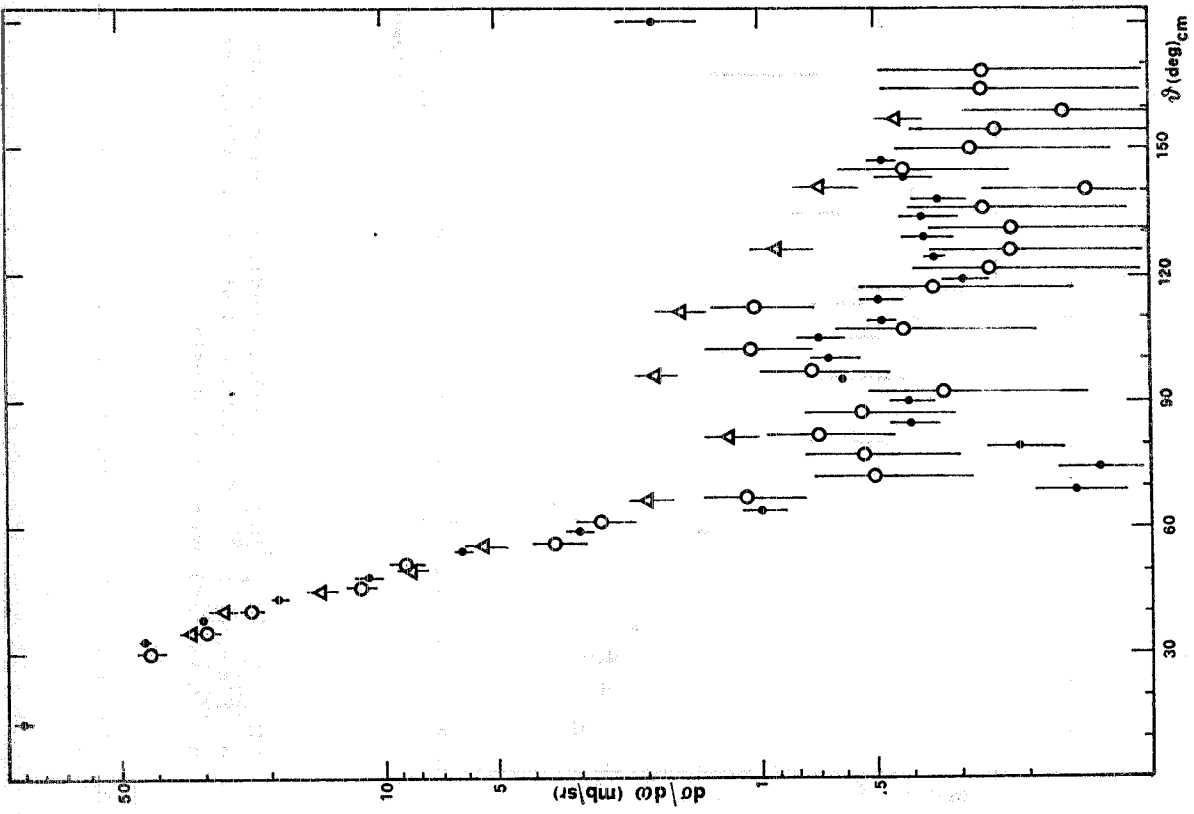


FIG. 9 - ( $\pi^-$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 156 MeV ( $\Delta$ ) and 174 MeV (o) compared with the 180 MeV data ( $\bullet$ ) of ref. (3).

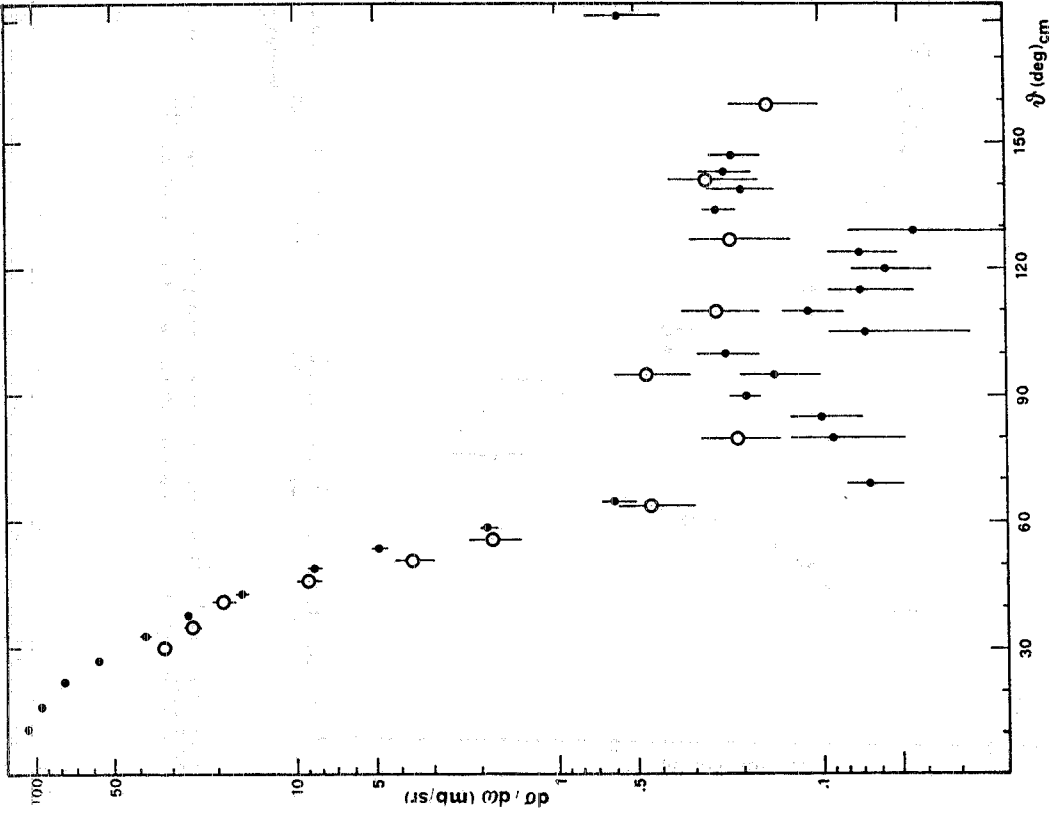


FIG. 10 - ( $\pi^-$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 208 MeV (o) compared with the 220 MeV data ( $\bullet$ ) of ref. (3).

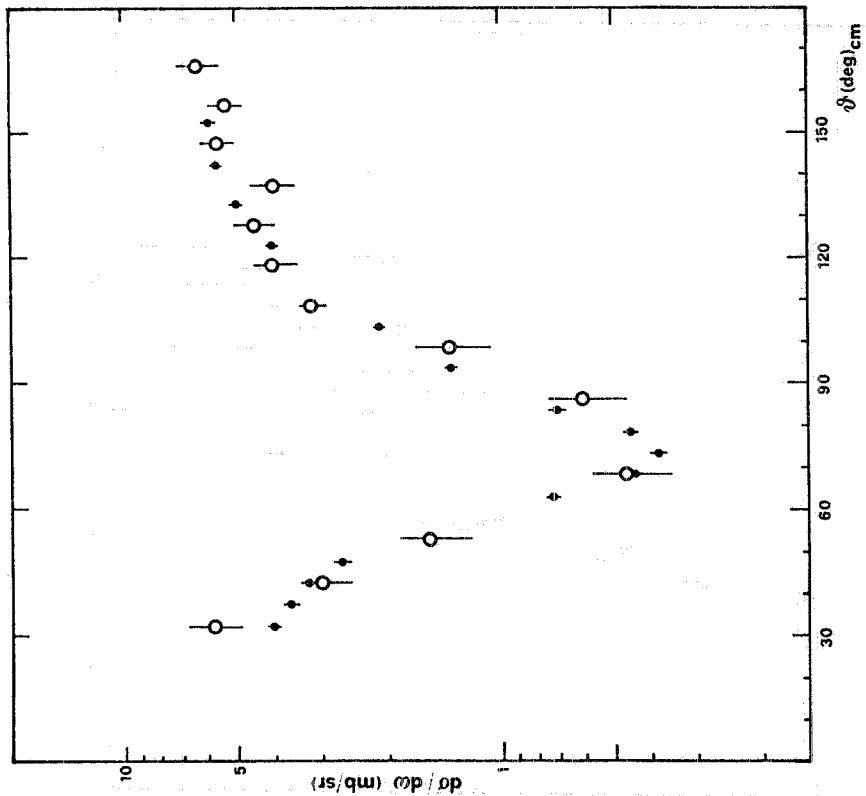


FIG. 12 - ( $\pi^+$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 68 MeV; o - present data; ● - Crowe et al. (2)

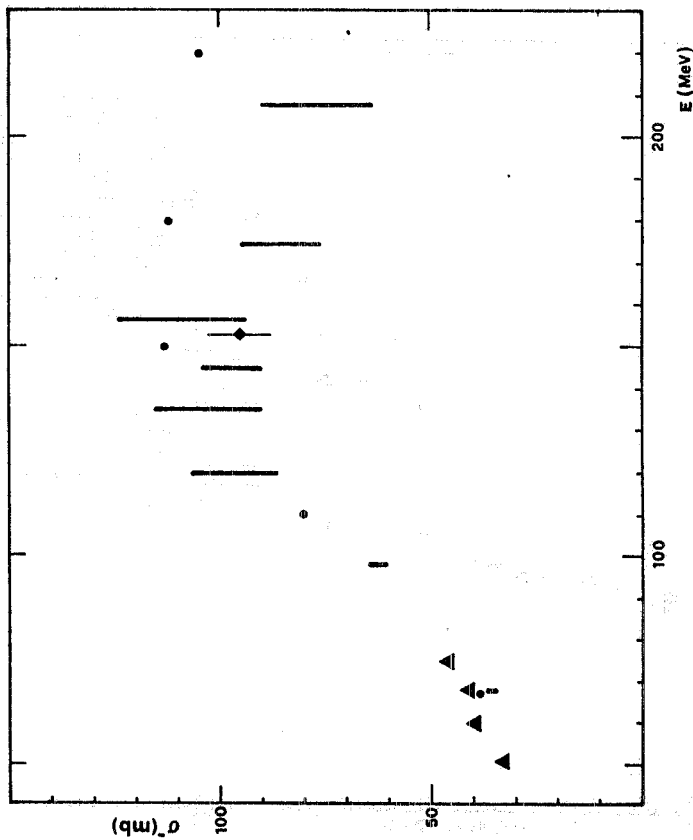


FIG. 11 - ( $\pi^-$ ,  $^4\text{He}$ ) total elastic scattering cross section. ● - Binon et al. (3); ◆ - Budagov et al. (7); ▲ - Crowe et al. (2); vertical bars: present data.

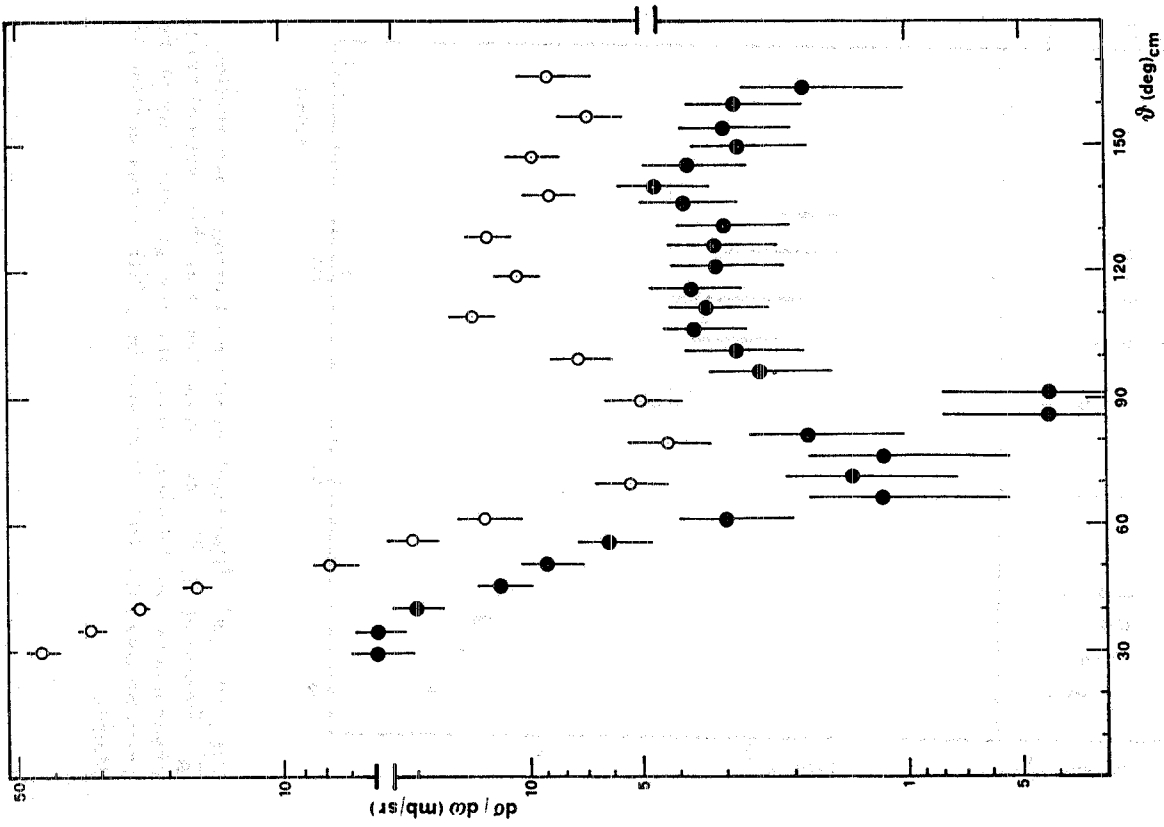


FIG. 14 - ( $\pi^+$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 120 MeV ( $\bullet$ ) and 135 MeV ( $\circ$ ).

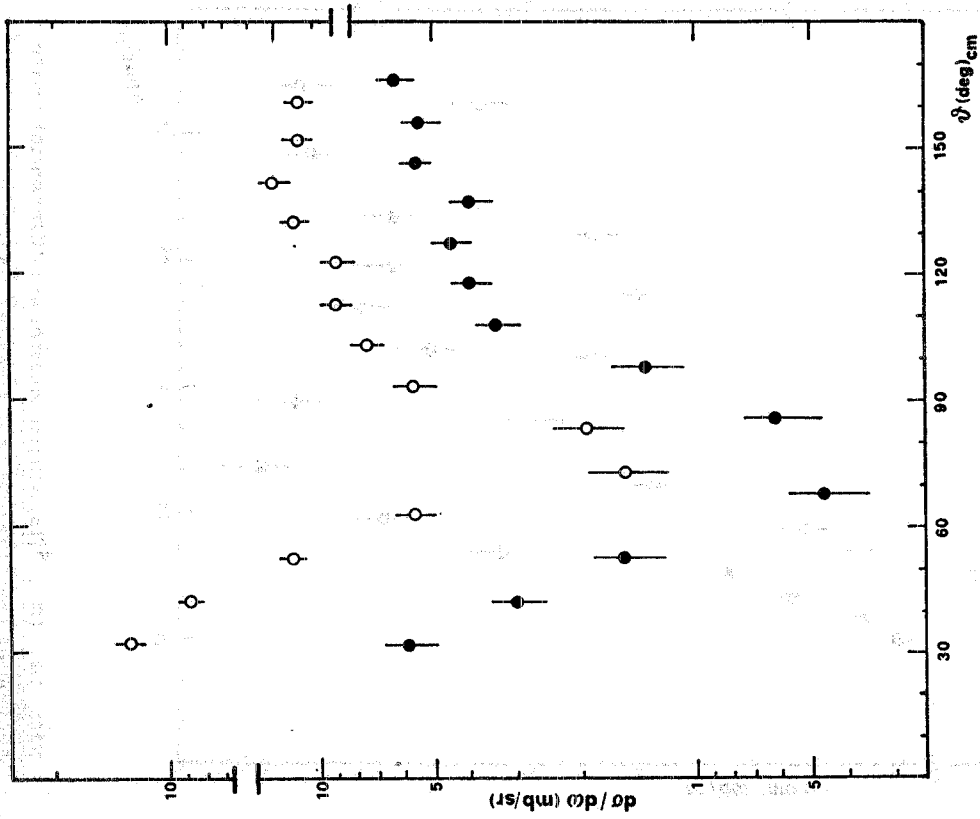


FIG. 13 - ( $\pi^+$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 68 MeV ( $\bullet$ ) and 98 MeV ( $\circ$ ).

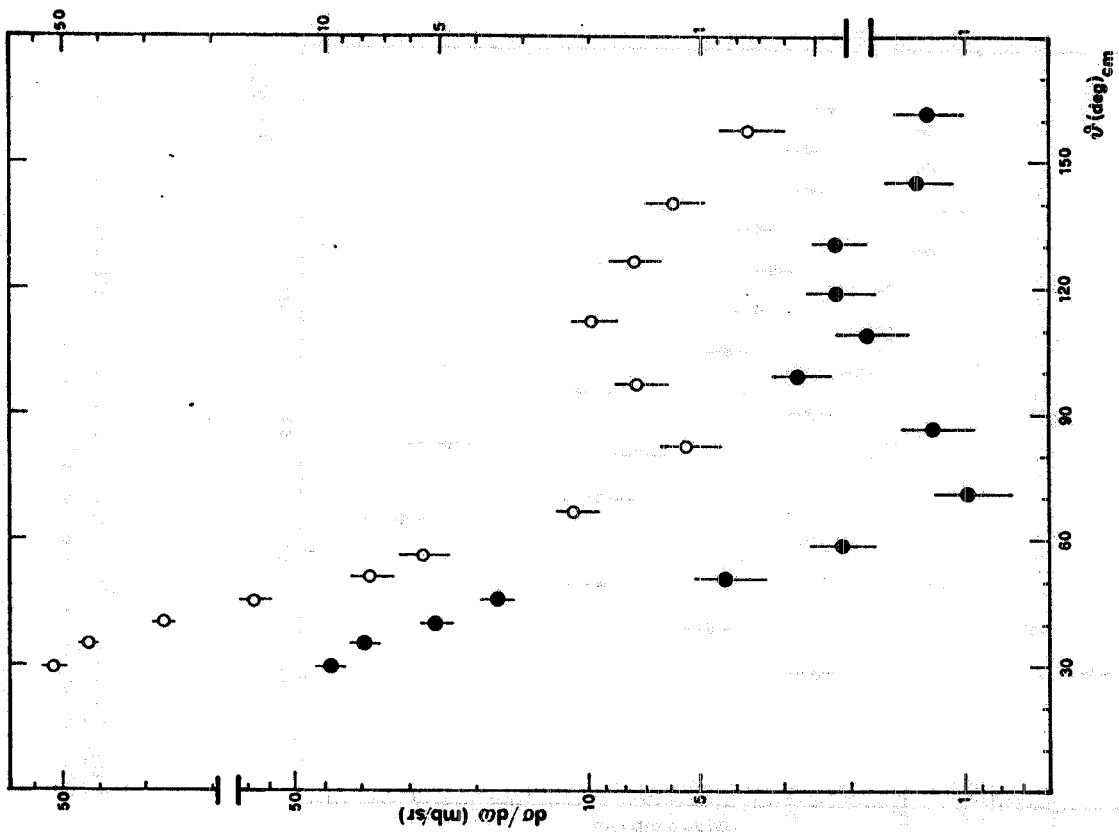


FIG. 15 - ( $\pi^+$ ,  $^4\text{He}$ ) elastic scattering differential cross section at 145 MeV (o) and 156 MeV (●).

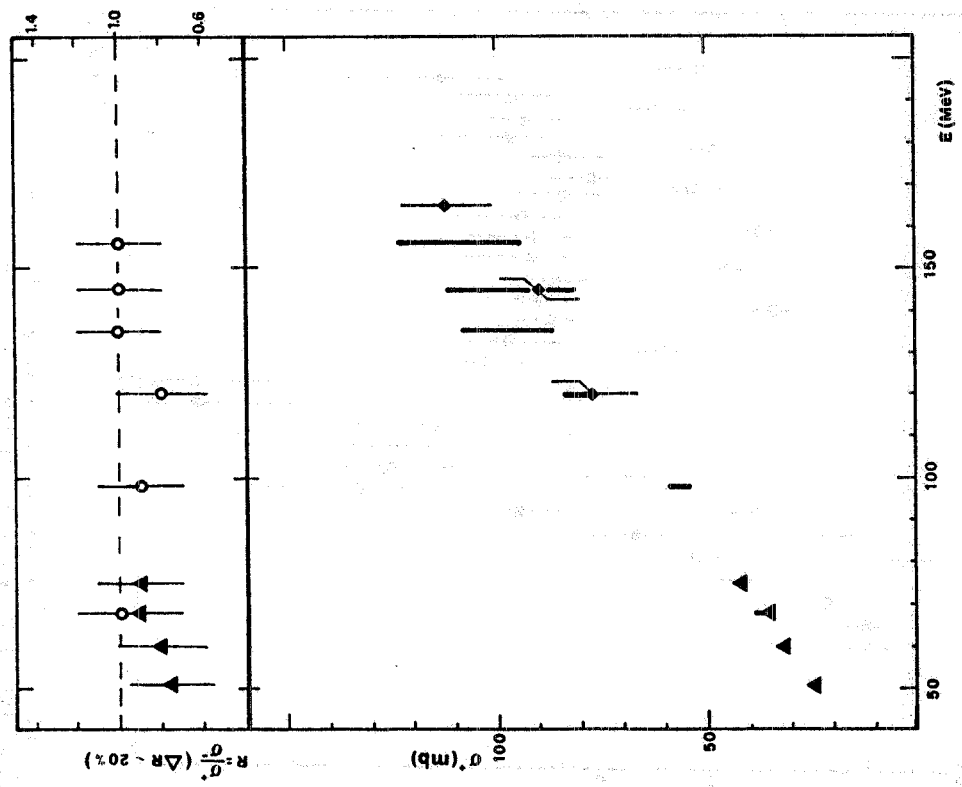


FIG. 16 - ( $\pi^+$ ,  $^4\text{He}$ ) total elastic scattering cross section.  $\blacktriangle$  - Crowe et al. (2);  $\blacklozenge$  - Balestra et al. (8); vertical bars: present data. In the upper part, the energy behaviour of the ratio between the ( $\pi^+$ ,  $^4\text{He}$ ) and ( $\pi^-$ ,  $^4\text{He}$ ) cross section is shown.

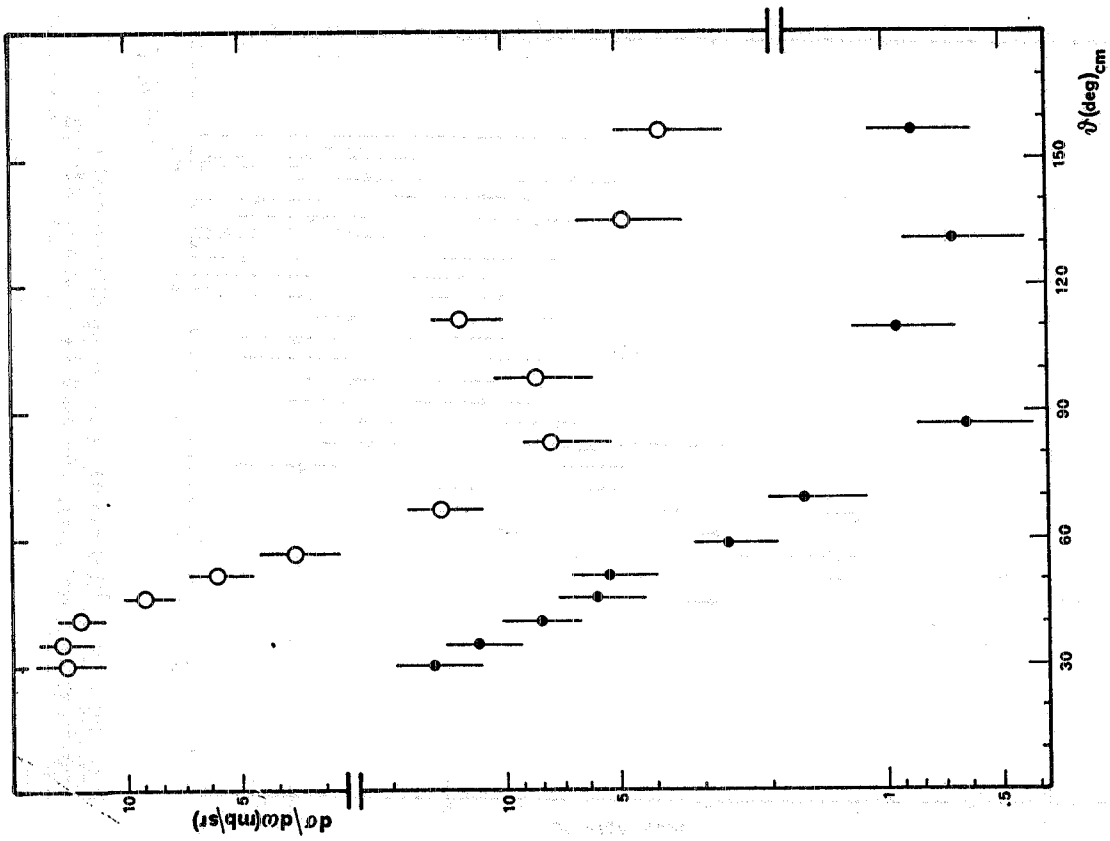


FIG. 18 - ( $\pi^-$ ,  $^3\text{He}$ ) elastic scattering differential cross section at 120 MeV (o) and 135 MeV ( $\bullet$ ).

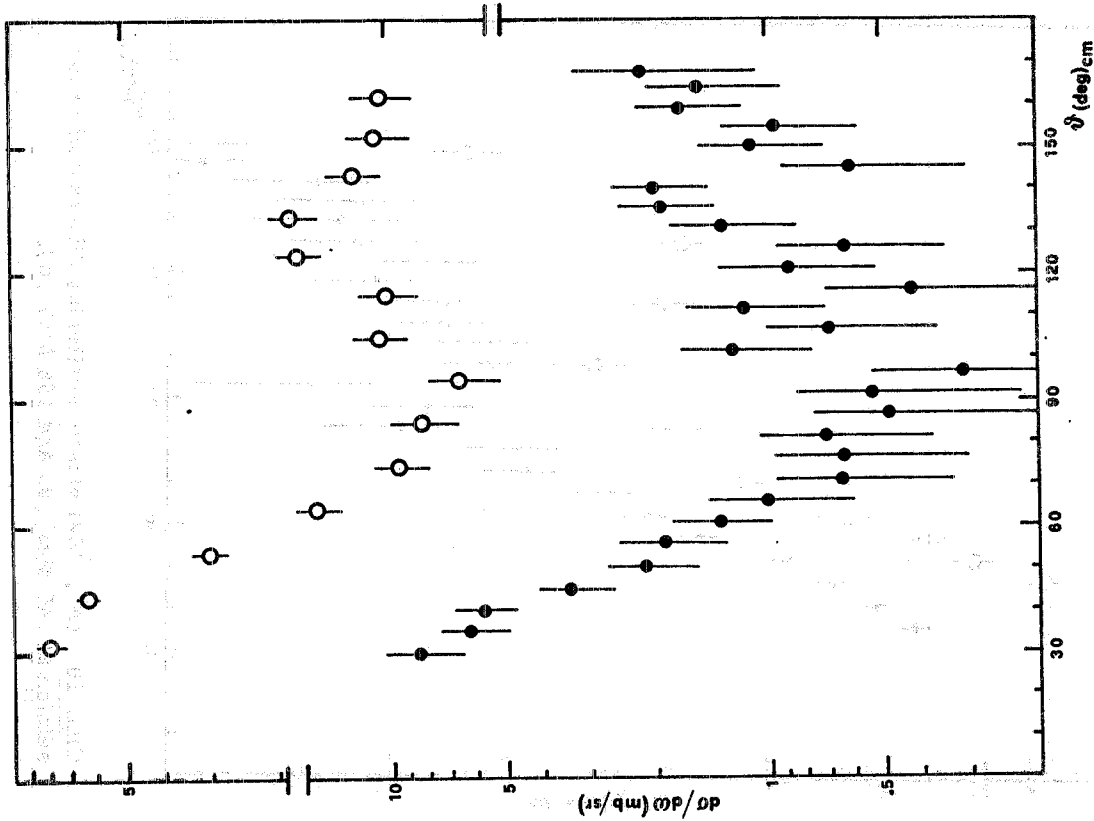


FIG. 17 - ( $\pi^-$ ,  $^3\text{He}$ ) elastic scattering differential cross section at 68 MeV ( $\bullet$ ) and 98 MeV (o).

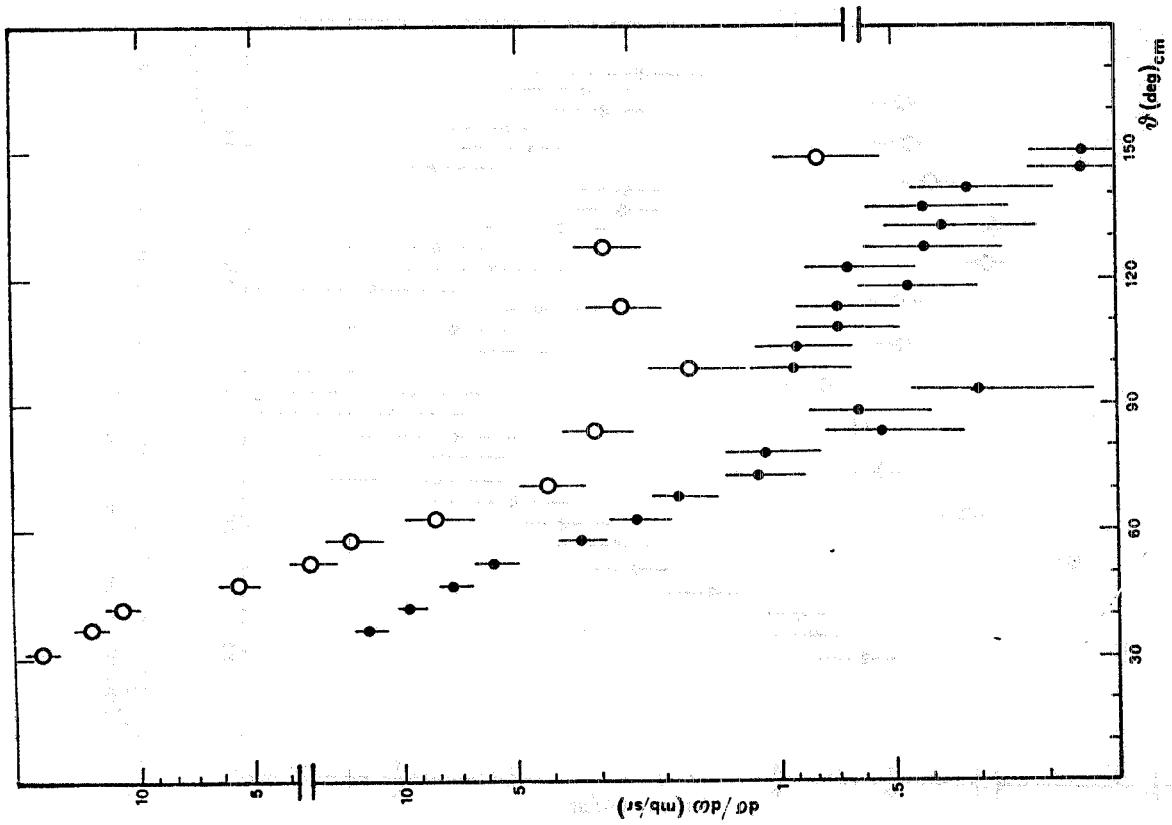


FIG. 19 - ( $\pi^-$ ,  $^3\text{He}$ ) elastic scattering differential cross section at 145 MeV ( $\bullet$ ) and 156 MeV ( $\circ$ ).

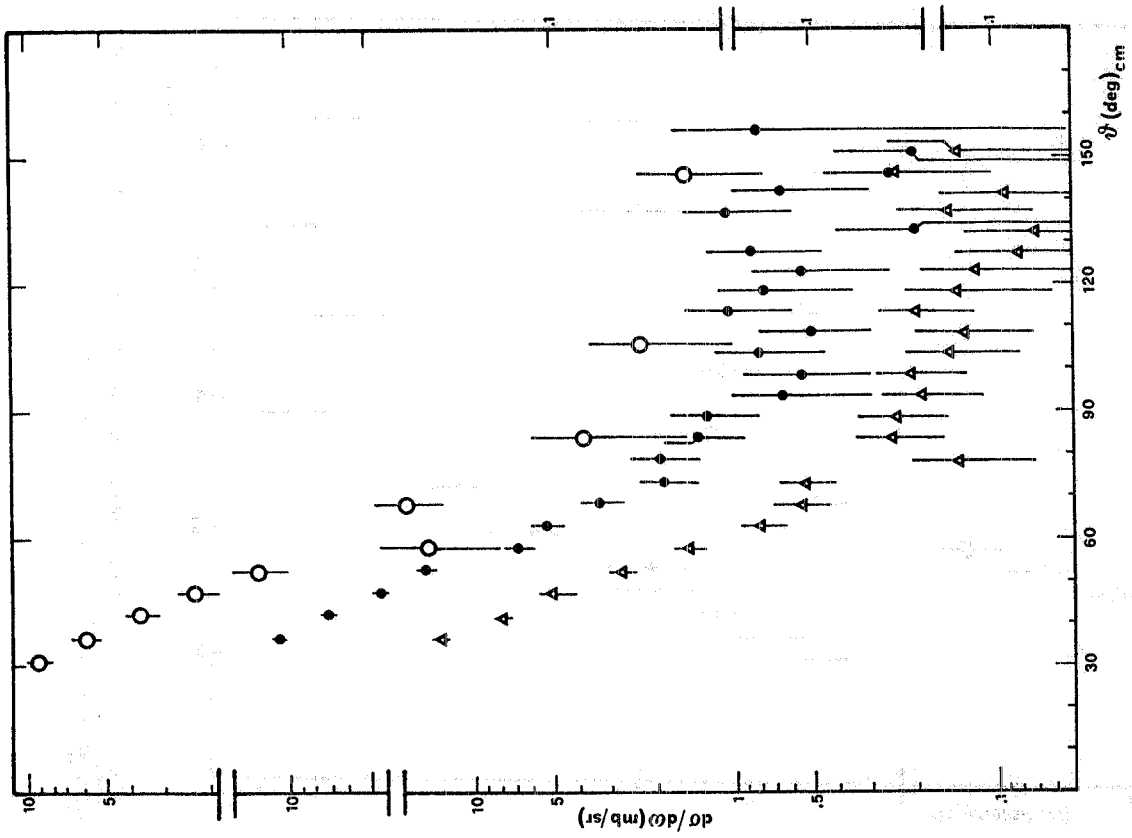


FIG. 20 - ( $\pi^-$ ,  $^3\text{He}$ ) elastic scattering differential cross section at 180 MeV ( $\circ$ ), 195 MeV ( $\bullet$ ) and 208 MeV ( $\blacktriangle$ ).

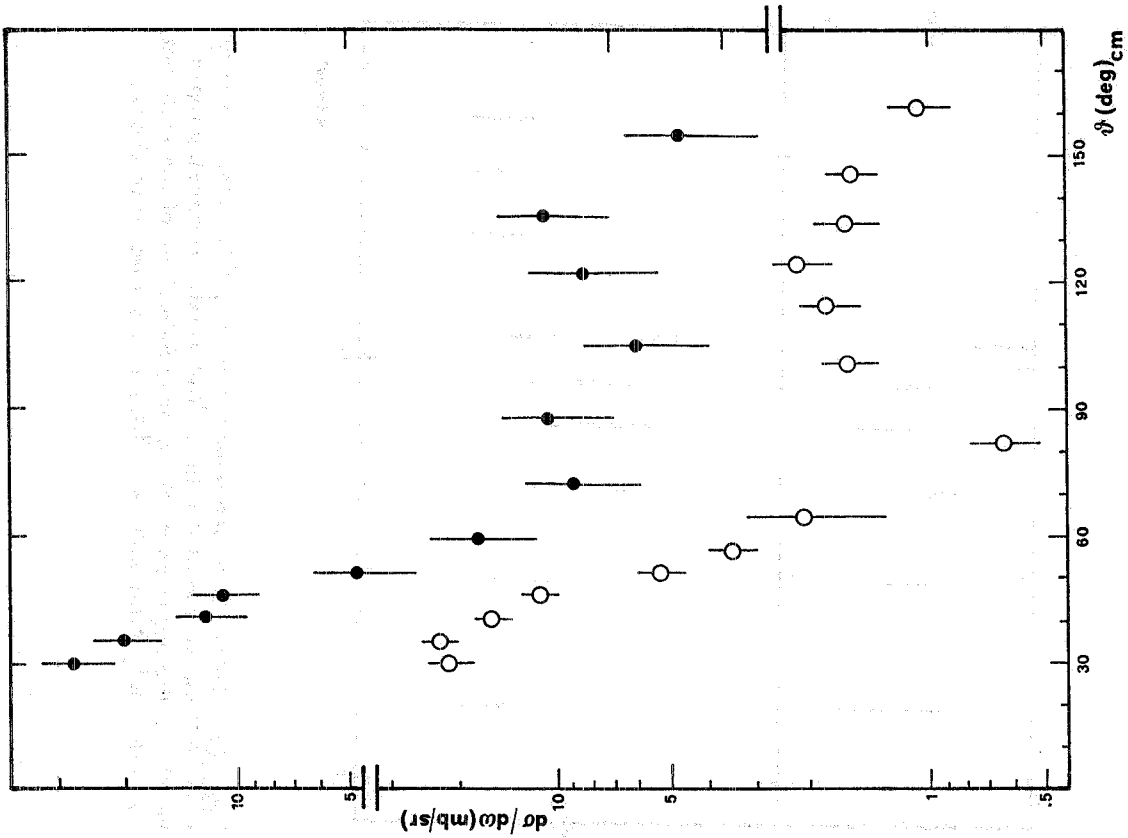


FIG. 22 -  $(\pi^+, {}^3\text{He})$  elastic scattering differential cross at 120 MeV (o) and 135 MeV (●).

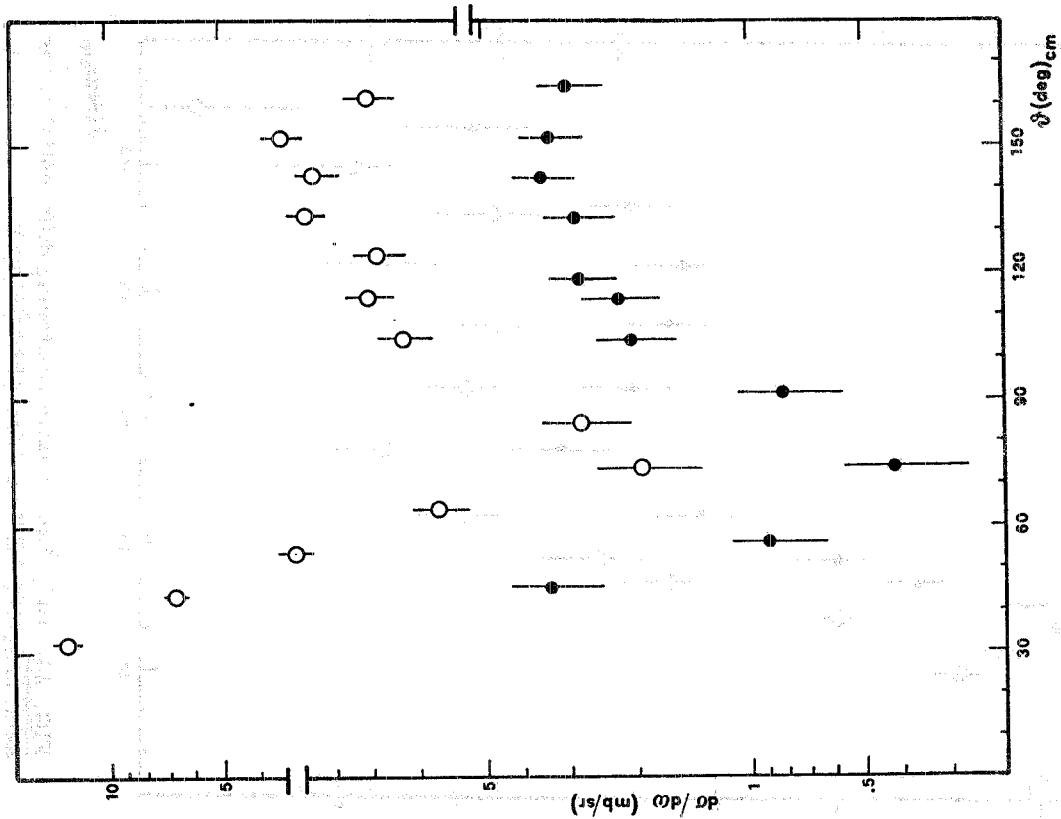


FIG. 21 -  $(\pi^+, {}^3\text{He})$  elastic scattering differential cross at 68 MeV (o) and 98 MeV (●).



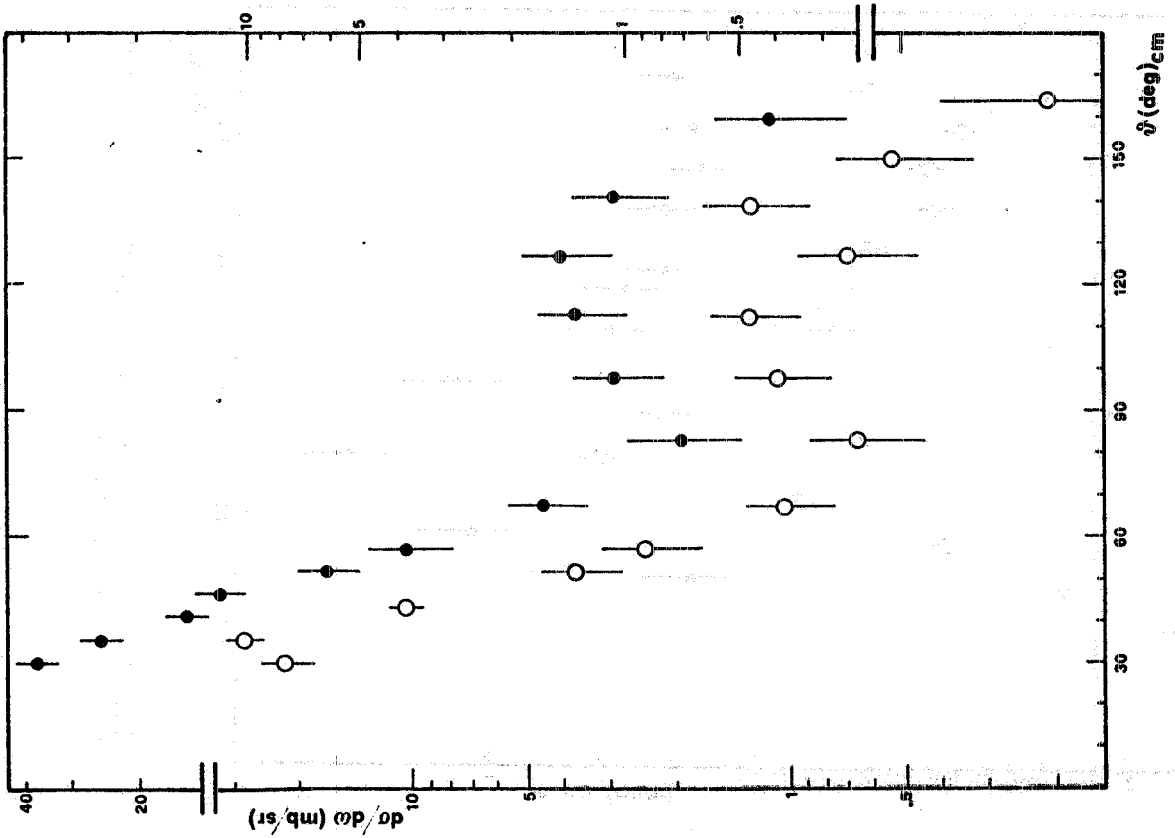


FIG. 23 - ( $\pi^+$ ,  $^3\text{He}$ ) elastic scattering differential cross section at 145 MeV (o) and 156 MeV ( $\bullet$ ).

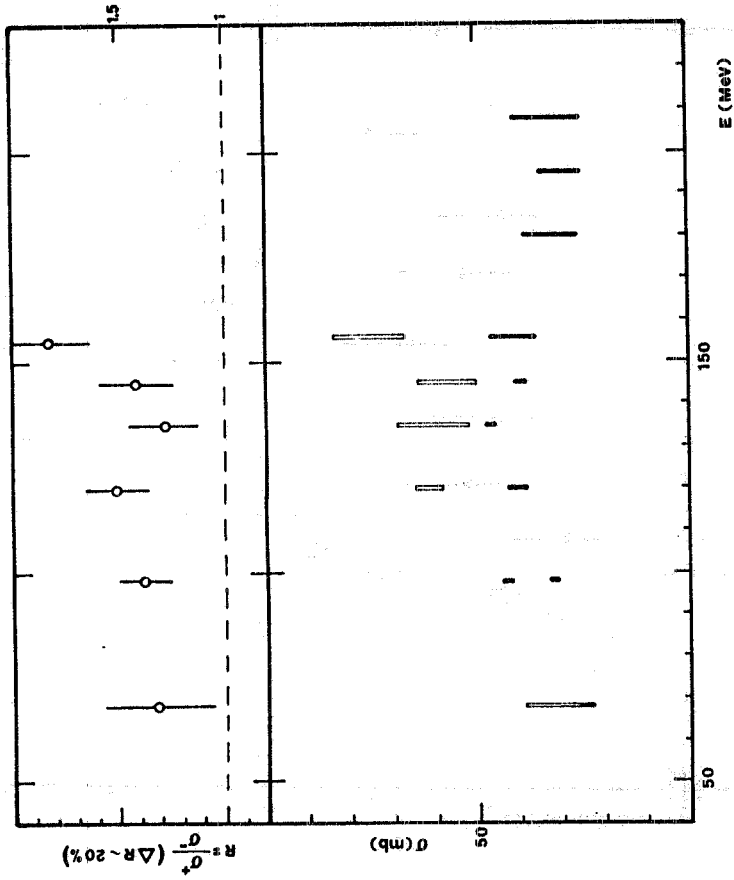


FIG. 24 - Total cross sections of the ( $\pi^-$ ,  $^3\text{He}$ ) elastic scattering (full bars) and of the ( $\pi^+$ ,  $^3\text{He}$ ) elastic scattering (open bars). In the upper part, the energy behaviour of the ratio between the ( $\pi^+$ ,  $^3\text{He}$ ) and ( $\pi^-$ ,  $^3\text{He}$ ) cross section is shown.

TABLE I :REACTION PI- ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

\*\*\*\*\*

\* ENERGY(LAB) 68. MEV ENERGY(CM) 3.931888 GEV

\* MOMENT(LAB) 153.6403 MEV/C MOMENT(CM) 145.6468 MEV/C MAX.MOM.TR.SQ. -0.84852D+05 (MEV/C)<sup>2</sup>

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THETA	SIGMA	ERROR		COS(THETA)	MOM.TRAN.	SIGMA	ERROR
	MB/SR	MB/SR	(%)		(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>
* 1	31.6	5.74	0.82	14.3	0.8517	-0.6291D+04	0.8501D-03
* 2	42.0	3.53	0.48	13.6	0.7431	-0.1090D+05	0.5228D-03
* 3	52.4	2.08	0.32	15.4	0.6101	-0.1654D+05	0.3080D-03
* 4	67.8	0.65	0.12	18.5	0.3778	-0.2640D+05	0.9626D-04
* 5	85.5	0.77	0.14	18.2	0.0785	-0.3910D+05	0.1140D-03
* 6	98.0	1.30	0.21	16.2	-0.1392	-0.4833D+05	0.1925D-03
* 7	107.9	2.47	0.34	13.8	-0.3074	-0.5547D+05	0.3658D-03
* 8	117.8	2.52	0.35	13.9	-0.4664	-0.6221D+05	0.3732D-03
* 9	127.5	3.99	0.44	11.0	-0.6088	-0.6825D+05	0.5909D-03
* 10	137.3	4.47	0.47	10.5	-0.7349	-0.7361D+05	0.6620D-03
* 11	146.7	4.16	0.45	10.8	-0.8358	-0.7789D+05	0.6161D-03
* 12	156.2	4.75	0.49	10.3	-0.9150	-0.8124D+05	0.7035D-03
* 13	165.8	6.79	0.74	10.9	-0.9694	-0.8356D+05	0.1006D-02

\*\*\*\*\*

TABLE II :REACTION PI- ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

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\* ENERGY(LAB) 98. MEV ENERGY(CM) 3.960225 GEV

\* MOMENT(LAB) 192.2485 MEV/C MOMENT(CM) 180.9422 MEV/C MAX.MOM.TR.SQ. -0.13096D+06 (MEV/C)<sup>2</sup>

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THETA	SIGMA	ERROR		COS(THETA)	MOM.TRAN.	SIGMA	ERROR
	MB/SR	MB/SR	(%)		(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>
* 1	31.8	15.42	0.87	5.6	0.8499	-0.9829D+04	0.1480D-02
* 2	42.2	10.72	0.59	5.5	0.7408	-0.1697D+05	0.1029D-02
* 3	52.7	4.92	0.34	6.9	0.6060	-0.2580D+05	0.4723D-03
* 4	63.0	1.96	0.20	10.2	0.4540	-0.3575D+05	0.1881D-03
* 5	73.3	0.96	0.16	16.6	0.2874	-0.4666D+05	0.9231D-04
* 6	83.4	1.39	0.18	12.9	0.1149	-0.5795D+05	0.1334D-03
* 7	93.5	0.84	0.17	20.2	-0.0610	-0.6948D+05	0.8060D-04
* 8	103.4	2.28	0.23	10.1	-0.2317	-0.8066D+05	0.2188D-03
* 9	113.2	3.06	0.27	8.8	-0.3939	-0.9128D+05	0.2936D-03
* 10	123.0	4.21	0.28	6.7	-0.5446	-0.1011D+06	0.4040D-03
* 11	132.6	4.25	0.30	7.1	-0.6769	-0.1098D+06	0.4078D-03
* 12	142.2	4.70	0.32	6.8	-0.7902	-0.1172D+06	0.4510D-03
* 13	151.7	3.96	0.29	7.3	-0.8805	-0.1231D+06	0.3800D-03
* 14	161.1	4.17	0.32	7.7	-0.9461	-0.1274D+06	0.4001D-03

\*\*\*\*\*

TABLE III :REACTION PI- ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

\*\*\*\*\*

\* ENERGY(LAB) 120. MEV ENERGY(CM) 3.980878 GEV

\* MOMENT(LAB) 218.8527 MEV/C MOMENT(CM) 204.9131 MEV/C MAX.MOM.TR.SQ. -0.16796D+06 (MEV/C)<sup>2</sup>

-----

THETA	SIGMA	ERROR		COS(THETA)	MOM.TRAN.	SIGMA	ERROR
	MB/SR	MB/SR	(%)		(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>
* 1	29.3	36.36	5.85	16.1	0.8720	-0.1075D+05	0.2720D-02
* 2	34.6	32.37	4.27	13.2	0.8231	-0.1485D+05	0.2422D-02
* 3	39.9	24.48	3.18	13.0	0.7671	-0.1956D+05	0.1832D-02
* 4	45.1	12.42	2.03	16.3	0.7059	-0.2470D+05	0.9292D-03
* 5	50.4	10.23	1.74	17.0	0.6373	-0.3046D+05	0.7654D-03
* 6	58.1	4.76	0.81	17.0	0.5284	-0.3960D+05	0.3561D-03
* 7	76.1	0.88	0.22	25.0	0.2401	-0.6382D+05	0.6584D-04
* 8	96.3	2.25	0.48	21.3	-0.1097	-0.9319D+05	0.1683D-03
* 9	111.1	3.68	0.62	16.8	-0.3600	-0.1142D+06	0.2753D-03
* 10	123.2	4.77	0.88	18.4	-0.5476	-0.1300D+06	0.3569D-03
* 11	132.9	3.67	0.77	21.0	-0.6807	-0.1411D+06	0.2746D-03
* 12	142.4	4.73	0.90	19.0	-0.7923	-0.1505D+06	0.3539D-03
* 13	151.9	4.61	0.90	19.5	-0.8821	-0.1581D+06	0.3449D-03
* 14	163.6	3.04	0.64	21.1	-0.9593	-0.1645D+06	0.2274D-03

\*\*\*\*\*

TABLE IV :REACTION  $\pi^-$  ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)135. MEV          ENERGY(CM)3.994897 GEV
*
* MOMENT(LAB) 236.4499 MEV/C    MOMENT(CM) 220.6126 MEV/C    MAX.MOM.TR.SQ. -0.19468D+06 (MEV/C)
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)        (MEV/C)    MB/(MEV/C)  MB/(MEV/C)
*-----*
* 1  29.4    50.23     5.65     11.2      0.8712    -0.1254D+05  0.3242D-02  0.3647D-03
* 2  34.7    35.84     3.57     10.0      0.8221    -0.1731D+05  0.2313D-02  0.2304D-03
* 3  40.0    24.82     2.59     10.4      0.7660    -0.2277D+05  0.1602D-02  0.1672D-03
* 4  45.3    14.66     1.74     11.9      0.7034    -0.2887D+05  0.9463D-03  0.1123D-03
* 5  50.5     7.69     1.71     22.2      0.6361    -0.3542D+05  0.4964D-03  0.1104D-03
* 6  55.7     5.77     0.97     16.8      0.5635    -0.4249D+05  0.3724D-03  0.6261D-04
* 7  60.9     2.65     0.65     24.5      0.4863    -0.5000D+05  0.1711D-03  0.4196D-04
* 8  68.7     1.37     0.32     23.4      0.3633    -0.6198D+05  0.8843D-04  0.2066D-04
* 9  78.9     1.05     0.28     26.7      0.1925    -0.7860D+05  0.6778D-04  0.1807D-04
* 10 89.0     1.40     0.34     24.3      0.0175    -0.9564D+05  0.9037D-04  0.2195D-04
* 11 99.0     1.66     0.38     22.9     -0.1564    -0.1126D+06  0.1072D-03  0.2453D-04
* 12 108.8    1.78     0.37     20.8     -0.3223    -0.1287D+06  0.1149D-03  0.2388D-04
* 13 118.6    2.72     0.48     17.6     -0.4787    -0.1439D+06  0.1756D-03  0.3098D-04
* 14 128.2    1.96     0.42     21.4     -0.6184    -0.1575D+06  0.1265D-03  0.2711D-04
* 15 137.8    1.72     0.39     22.7     -0.7408    -0.1694D+06  0.1110D-03  0.2517D-04
* 16 147.2    0.94     0.28     29.8     -0.8406    -0.1792D+06  0.6068D-04  0.1807D-04
* 17 156.6    1.06     0.31     29.2     -0.9178    -0.1867D+06  0.6842D-04  0.2001D-04
* 18 166.0    1.47     0.46     31.3     -0.9703    -0.1918D+06  0.9489D-04  0.2969D-04
*****

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TABLE V :REACTION  $\pi^-$  ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)145. MEV          ENERGY(CM)4.004217 GEV
*
* MOMENT(LAB) 247.9918 MEV/C    MOMENT(CM) 230.8429 MEV/C    MAX.MOM.TR.SQ. -0.21315D+06 (MEV/C)
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)        (MEV/C)    MB/(MEV/C)  MB/(MEV/C)
*-----*
* 1  29.5    38.46     3.23     8.4      0.8704    -0.1382D+05  0.2267D-02  0.1904D-03
* 2  34.8    28.55     2.25     7.9      0.8211    -0.1906D+05  0.1683D-02  0.1326D-03
* 3  40.1    22.11     1.76     8.0      0.7649    -0.2505D+05  0.1303D-02  0.1038D-03
* 4  45.4    13.24     1.24     9.4      0.7022    -0.3174D+05  0.7806D-03  0.7310D-04
* 5  50.6     5.68     0.80     14.1     0.6347    -0.3893D+05  0.3349D-03  0.4716D-04
* 6  55.8     2.95     0.56     19.0     0.5621    -0.4667D+05  0.1739D-03  0.3301D-04
* 7  63.6     2.62     0.36     13.7     0.4446    -0.5919D+05  0.1545D-03  0.2122D-04
* 8  76.4     1.68     0.25     14.9     0.2351    -0.8152D+05  0.9904D-04  0.1474D-04
* 9  89.1     2.34     0.36     15.4     0.0157    -0.1049D+06  0.1380D-03  0.2122D-04
* 10 99.1     2.26     0.35     15.5     -0.1582    -0.1234D+06  0.1332D-03  0.2063D-04
* 11 109.0    2.01     0.33     16.4     -0.3256    -0.1413D+06  0.1185D-03  0.1945D-04
* 12 121.1    1.62     0.24     14.8     -0.5165    -0.1616D+06  0.9551D-04  0.1415D-04
* 13 135.5    1.57     0.23     14.6     -0.7133    -0.1826D+06  0.9256D-04  0.1356D-04
* 14 149.7    0.98     0.18     18.4     -0.8634    -0.1986D+06  0.5778D-04  0.1061D-04
* 15 163.7    0.87     0.21     24.1     -0.9598    -0.2089D+06  0.5129D-04  0.1238D-04
*****

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TABLE VI :REACTION PI- ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)156. MEV          ENERGY(CM)4.014443 GEV
*
* MOMENT(LAB) 260.5407 MEV/C    MOMENT(CM) 241.9062 MEV/C    MAX.MOM.TR.SQ. -0.23407D+06 (MEV/C) 2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.    SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)     MB/(MEV/C)  MB/(MEV/C)
*-----*
* 1  34.9     32.33     2.75     8.5         0.8202     -0.2105D+05  0.1736D-02  0.1476D-03
* 2  40.2     27.14     2.21     8.1         0.7638     -0.2764D+05  0.1457D-02  0.1186D-03
* 3  45.5     14.29     1.41     9.9         0.7009     -0.3500D+05  0.7672D-03  0.7570D-04
* 4  50.7     8.40      1.02    12.1        0.6334     -0.4291D+05  0.4510D-03  0.5476D-04
* 5  56.0     5.49      0.77    14.0        0.5592     -0.5159D+05  0.2947D-03  0.4134D-04
* 6  66.3     1.95      0.25    12.8        0.4019     -0.6999D+05  0.1047D-03  0.1342D-04
* 7  81.7     1.19      0.19    16.0        0.1444     -0.1001D+06  0.6389D-04  0.1020D-04
* 8  96.7     1.90      0.24    12.6       -0.1167     -0.1307D+06  0.1020D-03  0.1288D-04
* 9 111.5     1.63      0.22    13.5       -0.3665     -0.1599D+06  0.8751D-04  0.1181D-04
*10 126.0     0.89      0.16    18.0       -0.5878     -0.1858D+06  0.4778D-04  0.8590D-05
*11 140.3     0.68      0.14    20.6       -0.7694     -0.2071D+06  0.3651D-04  0.7516D-05
*12 156.7     0.39      0.10    25.6       -0.9184     -0.2245D+06  0.2094D-04  0.5369D-05
*****

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TABLE VII :REACTION PI- ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)174. MEV          ENERGY(CM)4.031121 GEV
*
* MOMENT(LAB) 280.7952 MEV/C    MOMENT(CM) 259.6334 MEV/C    MAX.MOM.TR.SQ. -0.26964D+06 (MEV/C) 2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.    SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)     MB/(MEV/C)  MB/(MEV/C)
*-----*
* 1  29.7     41.63     3.24     7.8         0.8686     -0.1771D+05  0.1940D-02  0.1510D-03
* 2  35.0     29.45     2.24     7.6         0.8192     -0.2438D+05  0.1373D-02  0.1044D-03
* 3  40.3     22.41     1.73     7.7         0.7627     -0.3200D+05  0.1044D-02  0.8063D-04
* 4  45.6     11.53     1.11     9.6         0.6997     -0.4049D+05  0.5374D-03  0.5173D-04
* 5  50.9     8.66      0.90    10.4        0.6307     -0.4979D+05  0.4036D-03  0.4194D-04
* 6  56.2     3.48      0.56    16.1        0.5563     -0.5982D+05  0.1622D-03  0.2610D-04
* 7  61.4     2.65      0.50    18.9        0.4787     -0.7028D+05  0.1235D-03  0.2330D-04
* 8  66.6     1.08      0.32    29.6        0.3971     -0.8128D+05  0.5033D-04  0.1491D-04
* 9  71.8     0.50      0.22    44.0        0.3123     -0.9271D+05  0.2330D-04  0.1025D-04
*10  76.9     0.54      0.22    40.7        0.2267     -0.1043D+06  0.2517D-04  0.1025D-04
*11  82.0     0.70      0.26    37.1        0.1392     -0.1161D+06  0.3262D-04  0.1212D-04
*12  87.0     0.54      0.23    42.6        0.0523     -0.1278D+06  0.2517D-04  0.1072D-04
*13  92.0     0.33      0.19    57.6       -0.0349     -0.1395D+06  0.1538D-04  0.8855D-05
*14  97.0     0.73      0.27    37.0       -0.1219     -0.1512D+06  0.3402D-04  0.1258D-04
*15 102.0     1.06      0.33    31.1       -0.2079     -0.1628D+06  0.4940D-04  0.1538D-04
*16 106.9     0.51      0.22    43.1       -0.2907     -0.1740D+06  0.2377D-04  0.1025D-04
*17 111.8     1.04      0.32    30.8       -0.3714     -0.1849D+06  0.4847D-04  0.1491D-04
*18 116.6     0.35      0.20    57.1       -0.4478     -0.1952D+06  0.1631D-04  0.9321D-05
*19 121.5     0.25      0.15    60.0       -0.5225     -0.2053D+06  0.1165D-04  0.6991D-05
*20 126.3     0.22      0.14    63.6       -0.5920     -0.2146D+06  0.1025D-04  0.6525D-05
*21 131.0     0.22      0.14    63.6       -0.6561     -0.2233D+06  0.1025D-04  0.6525D-05
*22 135.8     0.26      0.15    57.7       -0.7169     -0.2315D+06  0.1212D-04  0.6991D-05
*23 140.5     0.14      0.12    85.7       -0.7716     -0.2388D+06  0.6525D-05  0.5593D-05
*24 145.2     0.42      0.20    47.6       -0.8211     -0.2455D+06  0.1957D-04  0.9321D-05
*25 149.9     0.28      0.16    57.1       -0.8652     -0.2515D+06  0.1305D-04  0.7457D-05
*26 154.5     0.24      0.16    66.7       -0.9026     -0.2565D+06  0.1119D-04  0.7457D-05
*27 159.2     0.16      0.13    81.3       -0.9348     -0.2609D+06  0.7457D-05  0.6059D-05
*28 163.8     0.26      0.22    84.6       -0.9603     -0.2643D+06  0.1212D-04  0.1025D-04
*29 168.5     0.26      0.22    84.6       -0.9799     -0.2669D+06  0.1212D-04  0.1025D-04
*****

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TABLE VIII :REACTION PI- ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB) 208. MEV          ENERGY(CM) 4.062437 GEV
* MOMENT(LAB) 318.3153 MEV/C    MOMENT(CM) 292.0569 MEV/C    MAX.MOM.TR.SQ. -0.34119D+06 (MEV/C)
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)    MB/(MEV/C) MB/(MEV/C)
*-----*
* 1  29.9    30.50    2.95    9.7    0.8669  -0.2271D+05  0.1123D-02  0.1087D-03
* 2  35.2    24.93    2.13    8.5    0.8171  -0.3119D+05  0.9182D-03  0.7845D-04
* 3  40.6    18.91    1.63    8.6    0.7593  -0.4107D+05  0.6965D-03  0.6003D-04
* 4  45.9     9.15    1.00   10.9    0.6959  -0.5188D+05  0.3370D-03  0.3683D-04
* 5  51.2     3.58    0.57   15.9    0.6266  -0.6370D+05  0.1319D-03  0.2099D-04
* 6  56.5     1.83    0.40   21.9    0.5519  -0.7644D+05  0.6740D-04  0.1473D-04
* 7  64.4     0.44    0.14   31.8    0.4321  -0.9688D+05  0.1621D-04  0.5156D-05
* 8  79.8     0.21    0.07   33.3    0.1771  -0.1404D+06  0.7735D-05  0.2578D-05
* 9  94.9     0.46    0.15   32.6   -0.0854  -0.1852D+06  0.1694D-04  0.5525D-05
* 10 109.7    0.25    0.08   32.0   -0.3371  -0.2281D+06  0.9208D-05  0.2946D-05
* 11 126.6    0.22    0.09   40.9   -0.5962  -0.2723D+06  0.8103D-05  0.3315D-05
* 12 140.7    0.27    0.10   37.0   -0.7738  -0.3026D+06  0.9944D-05  0.3683D-05
* 13 159.3    0.16    0.06   37.5   -0.9354  -0.3302D+06  0.5893D-05  0.2210D-05
*****
    
```

TABLE IX :REACTION PI+ ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB) 68. MEV          ENERGY(CM) 3.931888 GEV
* MOMENT(LAB) 153.6403 MEV/C    MOMENT(CM) 145.6468 MEV/C    MAX.MOM.TR.SQ. -0.84852D+05 (MEV/C)
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)    MB/(MEV/C) MB/(MEV/C)
*-----*
* 1  31.6     5.84    0.97   16.6    0.8517  -0.6291D+04  0.8649D-03  0.1437D-03
* 2  42.0     3.00    0.52   17.3    0.7431  -0.1090D+05  0.4443D-03  0.7701D-04
* 3  52.4     1.53    0.32   20.9    0.6101  -0.1654D+05  0.2266D-03  0.4739D-04
* 4  67.8     0.46    0.11   23.9    0.3778  -0.2640D+05  0.6812D-04  0.1629D-04
* 5  85.5     0.60    0.14   23.3    0.0785  -0.3910D+05  0.8886D-04  0.2073D-04
* 6  98.0     1.36    0.30   22.1   -0.1392  -0.4833D+05  0.2014D-03  0.4443D-04
* 7  107.9    3.35    0.47   14.0   -0.3074  -0.5547D+05  0.4961D-03  0.6961D-04
* 8  117.8    3.95    0.49   12.4   -0.4664  -0.6221D+05  0.5850D-03  0.7257D-04
* 9  127.5    4.46    0.55   12.3   -0.6088  -0.6825D+05  0.6605D-03  0.8145D-04
* 10 137.3    3.95    0.52   13.2   -0.7349  -0.7361D+05  0.5850D-03  0.7701D-04
* 11 146.7    5.62    0.62   11.0   -0.8358  -0.7789D+05  0.8323D-03  0.9182D-04
* 12 156.2    5.35    0.61   11.4   -0.9150  -0.8124D+05  0.7923D-03  0.9034D-04
* 13 165.8    6.27    0.82   13.1   -0.9694  -0.8356D+05  0.9286D-03  0.1214D-03
*****
    
```

TABLE X :REACTION PI+ ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB) 98. MEV          ENERGY(CM) 3.960225 GEV
* MOMENT(LAB) 192.2485 MEV/C    MOMENT(CM) 180.9422 MEV/C    MAX.MOM.TR.SQ. -0.13096D+06 (MEV/C)
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)    MB/(MEV/C) MB/(MEV/C)
*-----*
* 1  31.8    12.70    0.99    7.8    0.8499  -0.9829D+04  0.1219D-02  0.9500D-04
* 2  42.2     8.76    0.65    7.4    0.7408  -0.1697D+05  0.8406D-03  0.6237D-04
* 3  52.7     4.65    0.41    8.8    0.6060  -0.2580D+05  0.4462D-03  0.3934D-04
* 4  63.0     2.17    0.27   12.4    0.4540  -0.3575D+05  0.2082D-03  0.2591D-04
* 5  73.3     0.60    0.14   23.3    0.2874  -0.4666D+05  0.5757D-04  0.1343D-04
* 6  83.4     0.76    0.17   22.4    0.1149  -0.5795D+05  0.7293D-04  0.1631D-04
* 7  93.5     2.19    0.27   12.3   -0.0610  -0.6948D+05  0.2101D-03  0.2591D-04
* 8  103.4    2.90    0.32   11.0   -0.2317  -0.8066D+05  0.2783D-03  0.3071D-04
* 9  113.2    3.52    0.35    9.9   -0.3939  -0.9128D+05  0.3378D-03  0.3358D-04
* 10 123.0    3.47    0.34    9.9   -0.5446  -0.1011D+06  0.3330D-03  0.3282D-04
* 11 132.6    4.50    0.39    8.7   -0.6769  -0.1098D+06  0.4318D-03  0.3742D-04
* 12 142.2    5.07    0.43    8.5   -0.7902  -0.1172D+06  0.4865D-03  0.4126D-04
* 13 151.7    4.40    0.39    8.9   -0.8805  -0.1231D+06  0.4222D-03  0.3742D-04
* 14 161.1    4.39    0.40    9.1   -0.9461  -0.1274D+06  0.4212D-03  0.3838D-04
*****
    
```

TABLE XI :REACTION PI+ ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)120. MEV          ENERGY(CM)3.980878 GEV
* MOMENT(LAB) 218.8527 MEV/C    MOMENT(CM) 204.9131 MEV/C    MAX.MOM.TR.SQ. -0.16796D+06 (MEV/C)
*
*-----*
*   THETA   SIGMA   ERROR           COS(THETA)   MOM.TRAN.   SIGMA       ERROR
*           MB/SR   MB/SR   (%)           (MEV/C)    MB/(MEV/C)  MB/(MEV/C)
*-----*
* 1  29.3   25.21   4.84   19.2   0.8721  -0.1074D+05  0.1886D-02  0.3621D-03
* 2  34.6   25.30   3.75   14.8   0.8231  -0.1485D+05  0.1893D-02  0.2806D-03
* 3  39.9   20.20   2.95   14.6   0.7672  -0.1955D+05  0.1511D-02  0.2207D-03
* 4  45.1   11.91   2.01   16.9   0.7059  -0.2470D+05  0.8911D-03  0.1504D-03
* 5  50.4    8.87   1.65   18.6   0.6374  -0.3045D+05  0.6636D-03  0.1235D-03
* 6  55.6    6.09   1.40   23.0   0.5650  -0.3653D+05  0.4556D-03  0.1047D-03
* 7  60.8    3.01   1.00   33.2   0.4879  -0.4301D+05  0.2252D-03  0.7482D-04
* 8  65.9    1.15   0.62   53.9   0.4083  -0.4969D+05  0.8604D-04  0.4639D-04
* 9  71.0    1.41   0.68   48.2   0.3256  -0.5664D+05  0.1055D-03  0.5088D-04
* 10 76.2    1.16   0.63   54.3   0.2385  -0.6395D+05  0.8679D-04  0.4714D-04
* 11 81.2    1.79   0.79   44.1   0.1530  -0.7113D+05  0.1339D-03  0.5911D-04
* 12 86.3    0.42   0.37   88.1   0.0645  -0.7856D+05  0.3142D-04  0.2768D-04
* 13 91.3    0.42   0.37   88.1  -0.0227  -0.8588D+05  0.3142D-04  0.2768D-04
* 14 96.3    2.43   0.88   36.2  -0.1097  -0.9319D+05  0.1818D-03  0.6584D-04
* 15 101.3   2.81   0.96   34.2  -0.1959  -0.1004D+06  0.2102D-03  0.7183D-04
* 16 106.2   3.65   1.08   29.6  -0.2790  -0.1074D+06  0.2731D-03  0.8080D-04
* 17 111.1   3.35   1.04   31.0  -0.3600  -0.1142D+06  0.2506D-03  0.7781D-04
* 18 116.0   3.66   1.09   29.8  -0.4384  -0.1208D+06  0.2738D-03  0.8155D-04
* 19 120.8   3.14   1.02   32.5  -0.5120  -0.1270D+06  0.2349D-03  0.7632D-04
* 20 125.7   3.21   1.04   32.4  -0.5835  -0.1330D+06  0.2402D-03  0.7781D-04
* 21 130.5   3.02   0.98   32.5  -0.6494  -0.1385D+06  0.2260D-03  0.7332D-04
* 22 135.8   3.85   1.10   28.6  -0.7169  -0.1442D+06  0.2881D-03  0.8230D-04
* 23 140.0   4.54   1.21   26.7  -0.7660  -0.1483D+06  0.3397D-03  0.9053D-04
* 24 144.8   3.73   1.11   29.8  -0.8171  -0.1526D+06  0.2791D-03  0.8305D-04
* 25 149.5   2.76   0.95   34.4  -0.8616  -0.1563D+06  0.2065D-03  0.7108D-04
* 26 154.2   2.97   0.97   32.7  -0.9003  -0.1596D+06  0.2222D-03  0.7257D-04
* 27 158.9   2.79   0.96   34.4  -0.9330  -0.1623D+06  0.2087D-03  0.7183D-04
* 28 163.6   1.84   0.85   46.2  -0.9593  -0.1645D+06  0.1377D-03  0.6360D-04
*****

```

TABLE XII :REACTION PI+ ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)135. MEV          ENERGY(CM)3.994897 GEV
* MOMENT(LAB) 236.4499 MEV/C    MOMENT(CM) 220.6126 MEV/C    MAX.MOM.TR.SQ. -0.19468D+06 (MEV/C)
*
*-----*
*   THETA   SIGMA   ERROR           COS(THETA)   MOM.TRAN.   SIGMA       ERROR
*           MB/SR   MB/SR   (%)           (MEV/C)    MB/(MEV/C)  MB/(MEV/C)
*-----*
* 1  29.4   43.17   3.93   9.1   0.8712  -0.1254D+05  0.2787D-02  0.2537D-03
* 2  34.7   31.98   2.66   8.3   0.8221  -0.1731D+05  0.2064D-02  0.1717D-03
* 3  40.0   23.76   2.01   8.5   0.7660  -0.2277D+05  0.1534D-02  0.1297D-03
* 4  45.3   16.76   1.50   8.9   0.7034  -0.2887D+05  0.1082D-02  0.9682D-04
* 5  50.5    7.15   0.91   12.7   0.6361  -0.3542D+05  0.4615D-03  0.5874D-04
* 6  55.7    4.55   0.71   15.6   0.5635  -0.4249D+05  0.2937D-03  0.4583D-04
* 7  60.9    2.87   0.57   19.9   0.4863  -0.5000D+05  0.1853D-03  0.3679D-04
* 8  68.7    1.19   0.26   21.8   0.3633  -0.6198D+05  0.7681D-04  0.1678D-04
* 9  78.9    0.94   0.23   24.5   0.1925  -0.7860D+05  0.6068D-04  0.1485D-04
* 10 89.0    1.10   0.25   22.7   0.0175  -0.9564D+05  0.7100D-04  0.1614D-04
* 11 99.0    1.60   0.30   18.7  -0.1564  -0.1126D+06  0.1033D-03  0.1936D-04
* 12 108.8   3.13   0.42   13.4  -0.3223  -0.1287D+06  0.2020D-03  0.2711D-04
* 13 118.6   2.34   0.37   15.8  -0.4787  -0.1439D+06  0.1510D-03  0.2388D-04
* 14 128.2   2.77   0.41   14.8  -0.6184  -0.1575D+06  0.1788D-03  0.2647D-04
* 15 137.8   1.92   0.33   17.2  -0.7408  -0.1694D+06  0.1239D-03  0.2130D-04
* 16 147.2   2.13   0.36   16.9  -0.8406  -0.1792D+06  0.1375D-03  0.2324D-04
* 17 156.6   1.52   0.30   19.7  -0.9178  -0.1867D+06  0.9811D-04  0.1936D-04
* 18 166.0   1.88   0.44   23.4  -0.9703  -0.1918D+06  0.1214D-03  0.2840D-04
*****

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TABLE XIII :REACTION PI+ ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)145. MEV          ENERGY(CM)4.004217 GEV
* MOMENT(LAB) 247.9918 MEV/C    MOMENT(CM) 230.8429 MEV/C    MAX.MOM.TR.SQ. -0.21315D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)         (MEV/C)2  MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  29.5    48.54    4.76    9.8      0.8704  -0.1382D+05  0.2862D-02  0.2806D-03
* 2  34.8    39.41    3.53    9.0      0.8211  -0.1906D+05  0.2323D-02  0.2081D-03
* 3  40.1    25.46    2.51    9.9      0.7649  -0.2505D+05  0.1501D-02  0.1480D-03
* 4  45.4    17.73    1.93   10.9     0.7022  -0.3174D+05  0.1045D-02  0.1138D-03
* 5  50.6    4.24     0.89   21.0     0.6347  -0.3893D+05  0.2500D-03  0.5247D-04
* 6  58.4    2.13     0.44   20.7     0.5240  -0.5073D+05  0.1256D-03  0.2594D-04
* 7  71.3    0.98     0.24   24.5     0.3206  -0.7241D+05  0.5778D-04  0.1415D-04
* 8  86.6    1.21     0.27   22.3     0.0593  -0.1003D+06  0.7133D-04  0.1592D-04
* 9  99.1    2.75     0.51   18.5    -0.1582  -0.1234D+06  0.1621D-03  0.3007D-04
* 10 109.0    1.80     0.41   22.8    -0.3256  -0.1413D+06  0.1061D-03  0.2417D-04
* 11 118.7    2.17     0.45   20.7    -0.4802  -0.1578D+06  0.1279D-03  0.2653D-04
* 12 130.7    2.18     0.36   16.5    -0.6521  -0.1761D+06  0.1285D-03  0.2122D-04
* 13 144.9    1.35     0.28   20.7    -0.8181  -0.1938D+06  0.7959D-04  0.1651D-04
* 14 161.4    1.26     0.29   23.0    -0.9478  -0.2076D+06  0.7428D-04  0.1710D-04
*-----*
*****

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TABLE XIV :REACTION PI+ ON HE-4 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)156. MEV          ENERGY(CM)4.014443 GEV
* MOMENT(LAB) 260.5407 MEV/C    MOMENT(CM) 241.9062 MEV/C    MAX.MOM.TR.SQ. -0.23407D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*            MB/SR      MB/SR      (%)         (MEV/C)2  MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  29.5    52.91    4.07    7.7      0.8704  -0.1517D+05  0.2840D-02  0.2185D-03
* 2  34.9    42.70    2.84    6.7      0.8202  -0.2105D+05  0.2292D-02  0.1525D-03
* 3  40.2    26.86    2.03    7.6      0.7638  -0.2764D+05  0.1442D-02  0.1090D-03
* 4  45.5    15.60    1.44    9.2      0.7009  -0.3500D+05  0.8375D-03  0.7731D-04
* 5  50.7    7.70     0.98   12.7     0.6334  -0.4291D+05  0.4134D-03  0.5261D-04
* 6  56.0    5.58     0.82   14.7     0.5592  -0.5159D+05  0.2996D-03  0.4402D-04
* 7  66.3    2.19     0.29   13.2     0.4019  -0.6999D+05  0.1176D-03  0.1557D-04
* 8  81.7    1.09     0.21   19.3     0.1444  -0.1001D+06  0.5852D-04  0.1127D-04
* 9  96.7    1.48     0.23   15.5    -0.1167  -0.1307D+06  0.7945D-04  0.1235D-04
* 10 111.5    1.94     0.28   14.4    -0.3665  -0.1599D+06  0.1041D-03  0.1503D-04
* 11 126.0    1.52     0.24   15.8    -0.5878  -0.1858D+06  0.8160D-04  0.1288D-04
* 12 140.3    1.19     0.21   17.6    -0.7694  -0.2071D+06  0.6389D-04  0.1127D-04
* 13 156.7    0.75     0.15   20.0    -0.9184  -0.2245D+06  0.4026D-04  0.8053D-05
*-----*
*****

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TABLE XV :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB) 68. MEV          ENERGY(CM) 3.011993 GEV
* MOMENT(LAB) 153.6403 MEV/C    MOMENT(CM) 143.2521 MEV/C    MAX.MOM.TR.SQ. -0.82085D+05 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  29.4     8.44     1.94     23.0     0.8712  -0.5286D+04  0.1292D-02  0.2970D-03
* 2  34.7     6.20     1.26     20.3     0.8221  -0.7300D+04  0.9492D-03  0.1929D-03
* 3  40.0     5.75     1.07     18.6     0.7660  -0.9602D+04  0.8803D-03  0.1638D-03
* 4  45.3     3.37     0.75     22.3     0.7034  -0.1217D+05  0.5159D-03  0.1148D-03
* 5  50.5     2.12     0.59     27.8     0.6361  -0.1494D+05  0.3246D-03  0.9032D-04
* 6  55.8     1.89     0.60     31.7     0.5621  -0.1797D+05  0.2893D-03  0.9185D-04
* 7  60.9     1.34     0.47     35.1     0.4863  -0.2108D+05  0.2051D-03  0.7195D-04
* 8  66.2     1.02     0.43     42.2     0.4035  -0.2448D+05  0.1562D-03  0.6583D-04
* 9  71.3     0.64     0.31     48.4     0.3206  -0.2788D+05  0.9798D-04  0.4746D-04
* 10 76.4     0.63     0.33     52.4     0.2351  -0.3139D+05  0.9645D-04  0.5052D-04
* 11 81.5     0.70     0.33     47.1     0.1478  -0.3498D+05  0.1072D-03  0.5052D-04
* 12 86.5     0.48     0.28     58.3     0.0610  -0.3854D+05  0.7348D-04  0.4287D-04
* 13 91.6     0.53     0.31     58.5     -0.0279 -0.4219D+05  0.8114D-04  0.4746D-04
* 14 96.6     0.31     0.22     71.0     -0.1149 -0.4576D+05  0.4746D-04  0.3368D-04
* 15 101.5    1.23     0.47     38.2     -0.1994 -0.4922D+05  0.1883D-03  0.7195D-04
* 16 106.5    0.68     0.32     47.1     -0.2840 -0.5270D+05  0.1041D-03  0.4899D-04
* 17 111.4    1.14     0.45     39.5     -0.3649 -0.5602D+05  0.1745D-03  0.6889D-04
* 18 116.2    0.44     0.26     59.1     -0.4415 -0.5916D+05  0.6736D-04  0.3980D-04
* 19 121.1    0.87     0.36     41.4     -0.5165 -0.6224D+05  0.1332D-03  0.5511D-04
* 20 125.9    0.62     0.32     51.6     -0.5864 -0.6511D+05  0.9492D-04  0.4899D-04
* 21 130.7    1.30     0.47     36.2     -0.6521 -0.6781D+05  0.1990D-03  0.7195D-04
* 22 135.4    1.91     0.54     28.3     -0.7120 -0.7027D+05  0.2924D-03  0.8267D-04
* 23 140.2    1.97     0.58     29.4     -0.7683 -0.7257D+05  0.3016D-03  0.8879D-04
* 24 144.9    0.60     0.31     51.7     -0.8181 -0.7462D+05  0.9185D-04  0.4746D-04
* 25 149.6    1.09     0.39     35.8     -0.8625 -0.7644D+05  0.1669D-03  0.5971D-04
* 26 154.4    0.94     0.37     39.4     -0.9018 -0.7806D+05  0.1439D-03  0.5664D-04
* 27 159.0    1.67     0.52     31.1     -0.9336 -0.7936D+05  0.2557D-03  0.7961D-04
* 28 163.7    1.48     0.57     38.5     -0.9598 -0.8043D+05  0.2266D-03  0.8726D-04
* 29 168.4    2.13     1.08     50.7     -0.9796 -0.8125D+05  0.3261D-03  0.1653D-03
*-----*
*****

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TABLE XVI :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB) 98. MEV          ENERGY(CM) 3.039836 GEV
* MOMENT(LAB) 192.2485 MEV/C    MOMENT(CM) 177.6080 MEV/C    MAX.MOM.TR.SQ. -0.12618D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  32.3     7.93     0.75     9.5     0.8453  -0.9762D+04  0.7898D-03  0.7469D-04
* 2  43.0     6.35     0.50     7.9     0.7314  -0.1695D+05  0.6324D-03  0.4980D-04
* 3  53.5     3.02     0.31     10.3    0.5948  -0.2556D+05  0.3008D-03  0.3087D-04
* 4  64.0     1.56     0.22     14.1    0.4384  -0.3543D+05  0.1554D-03  0.2191D-04
* 5  74.3     0.94     0.17     18.1    0.2706  -0.4602D+05  0.9362D-04  0.1693D-04
* 6  84.5     0.81     0.16     19.8    0.0958  -0.5704D+05  0.8067D-04  0.1593D-04
* 7  94.5     0.64     0.14     21.9    -0.0785 -0.6804D+05  0.6374D-04  0.1394D-04
* 8  104.5    1.06     0.19     17.9    -0.2504 -0.7889D+05  0.1056D-03  0.1892D-04
* 9  114.3    1.01     0.18     17.8    -0.4115 -0.8905D+05  0.1006D-03  0.1793D-04
* 10 123.9    1.73     0.24     13.9    -0.5577 -0.9828D+05  0.1723D-03  0.2390D-04
* 11 133.4    1.78     0.25     14.0    -0.6871 -0.1064D+06  0.1773D-03  0.2490D-04
* 12 142.9    1.24     0.21     16.9    -0.7976 -0.1134D+06  0.1235D-03  0.2091D-04
* 13 152.2    1.07     0.20     18.7    -0.8846 -0.1189D+06  0.1066D-03  0.1992D-04
* 14 161.5    1.04     0.19     18.3    -0.9483 -0.1229D+06  0.1036D-03  0.1892D-04
*-----*
*****

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TABLE XVII :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)120. MEV          ENERGY(CM)3.060093 GEV
*
* MOMENT(LAB) 218.8527 MEV/C    MOMENT(CM) 200.8478 MEV/C    MAX.MOM.TR.SQ. -0.16136D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  29.9    15.47    3.92    25.3    0.8669  -0.1074D+05  0.1205D-02  0.3053D-03
* 2  35.2    11.78    2.68    22.8    0.8171  -0.1475D+05  0.9174D-03  0.2087D-03
* 3  40.6     8.14    1.98    24.3    0.7593  -0.1942D+05  0.6339D-03  0.1542D-03
* 4  45.9     5.71    1.47    25.7    0.6959  -0.2453D+05  0.4447D-03  0.1145D-03
* 5  51.2     5.27    1.32    25.0    0.6266  -0.3013D+05  0.4104D-03  0.1028D-03
* 6  59.1     2.56    0.64    25.0    0.5135  -0.3925D+05  0.1994D-03  0.4984D-04
* 7  69.6     1.60    0.51    31.9    0.3486  -0.5256D+05  0.1246D-03  0.3972D-04
* 8  87.3     0.61    0.20    32.8    0.0471  -0.7688D+05  0.4751D-04  0.1558D-04
* 9 109.7     0.92    0.28    30.4   -0.3371  -0.1079D+06  0.7165D-04  0.2181D-04
*10 131.3     0.65    0.22    33.8   -0.6600  -0.1339D+06  0.5062D-04  0.1713D-04
*11 157.0     0.83    0.25    30.1   -0.9205  -0.1549D+06  0.6464D-04  0.1947D-04
*****

```

TABLE XVIII :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)135. MEV          ENERGY(CM)3.073828 GEV
*
* MOMENT(LAB) 236.4499 MEV/C    MOMENT(CM) 216.0277 MEV/C    MAX.MOM.TR.SQ. -0.18667D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  30.0    14.28    2.90    20.3    0.8660  -0.1250D+05  0.9613D-03  0.1952D-03
* 2  35.4    14.50    2.30    15.9    0.8151  -0.1726D+05  0.9761D-03  0.1548D-03
* 3  40.8    13.22    1.93    14.6    0.7570  -0.2268D+05  0.8899D-03  0.1299D-03
* 4  46.1     8.75    1.40    16.0    0.6934  -0.2862D+05  0.5890D-03  0.9425D-04
* 5  51.4     5.69    1.07    18.8    0.6239  -0.3511D+05  0.3830D-03  0.7203D-04
* 6  56.7     3.54    0.85    24.0    0.5490  -0.4209D+05  0.2383D-03  0.5722D-04
* 7  67.2     1.47    0.32    21.8    0.3875  -0.5717D+05  0.9896D-04  0.2154D-04
* 8  82.6     0.75    0.23    30.7    0.1288  -0.8131D+05  0.5049D-04  0.1548D-04
* 9  97.7     0.82    0.24    29.3   -0.1340  -0.1058D+06  0.5520D-04  0.1616D-04
*10 112.4     1.31    0.31    23.7   -0.3811  -0.1289D+06  0.8819D-04  0.2087D-04
*11 135.5     0.48    0.15    31.2   -0.7133  -0.1599D+06  0.3231D-04  0.1010D-04
*12 157.1     0.38    0.12    31.6   -0.9212  -0.1793D+06  0.2558D-04  0.8078D-05
*****

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TABLE XIX :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

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*****
* ENERGY(LAB)145. MEV          ENERGY(CM)3.082951 GEV
* MOMENT(LAB) 247.9918 MEV/C    MOMENT(CM) 225.9022 MEV/C    MAX.MOM.TR.SQ. -0.20413D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2  MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  35.5    12.22    1.16    9.5      0.8141  -0.1897D+05  0.7523D-03  0.7141D-04
* 2  40.9     9.60    0.89    9.3      0.7559  -0.2492D+05  0.5910D-03  0.5479D-04
* 3  46.2     7.40    0.74   10.0     0.6921  -0.3142D+05  0.4556D-03  0.4556D-04
* 4  51.6     5.75    0.72   12.5     0.6211  -0.3867D+05  0.3540D-03  0.4432D-04
* 5  56.9     3.38    0.50   14.8     0.5461  -0.4633D+05  0.2081D-03  0.3078D-04
* 6  62.1     2.40    0.45   18.7     0.4679  -0.5431D+05  0.1477D-03  0.2770D-04
* 7  67.4     1.84    0.38   20.7     0.3843  -0.6284D+05  0.1133D-03  0.2339D-04
* 8  72.6     1.14    0.28   24.6     0.2990  -0.7154D+05  0.7018D-04  0.1724D-04
* 9  77.7     1.09    0.31   28.4     0.2130  -0.8032D+05  0.6710D-04  0.1908D-04
* 10 82.8     0.54    0.21   38.9     0.1253  -0.8927D+05  0.3324D-04  0.1293D-04
* 11 87.8     0.62    0.22   35.5     0.0384  -0.9815D+05  0.3817D-04  0.1354D-04
* 12 92.9     0.30    0.15   50.0     -0.0506  -0.1072D+06  0.1847D-04  0.9234D-05
* 13 97.9     0.92    0.27   29.3     -0.1374  -0.1161D+06  0.5664D-04  0.1662D-04
* 14 102.8    0.90    0.26   28.9     -0.2215  -0.1247D+06  0.5541D-04  0.1601D-04
* 15 107.7    0.82    0.24   29.3     -0.3040  -0.1331D+06  0.5048D-04  0.1477D-04
* 16 112.6    0.69    0.21   30.4     -0.3843  -0.1413D+06  0.4248D-04  0.1293D-04
* 17 117.4    0.46    0.16   34.8     -0.4602  -0.1490D+06  0.2832D-04  0.9850D-05
* 18 122.2    0.66    0.22   33.3     -0.5329  -0.1565D+06  0.4063D-04  0.1354D-04
* 19 127.0    0.43    0.17   39.5     -0.6018  -0.1635D+06  0.2647D-04  0.1047D-04
* 20 131.7    0.37    0.16   43.2     -0.6652  -0.1700D+06  0.2278D-04  0.9850D-05
* 21 136.4    0.42    0.17   40.5     -0.7242  -0.1760D+06  0.2586D-04  0.1047D-04
* 22 141.1    0.32    0.13   40.6     -0.7782  -0.1815D+06  0.1970D-04  0.8003D-05
* 23 145.7    0.16    0.06   37.5     -0.8261  -0.1864D+06  0.9850D-05  0.3694D-05
* 24 150.3    0.16    0.06   37.5     -0.8686  -0.1907D+06  0.9850D-05  0.3694D-05
*-----*
*****

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TABLE XX :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

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*****
* ENERGY(LAB)156. MEV          ENERGY(CM)3.092955 GEV
* MOMENT(LAB) 260.5407 MEV/C    MOMENT(CM) 236.5657 MEV/C    MAX.MOM.TR.SQ. -0.22385D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.  SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2  MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  30.2    18.37    1.93   10.5     0.8643  -0.1519D+05  0.1031D-02  0.1083D-03
* 2  35.6    13.58    1.32    9.7     0.8131  -0.2092D+05  0.7623D-03  0.7410D-04
* 3  41.0    11.28    1.05    9.3     0.7547  -0.2745D+05  0.6332D-03  0.5894D-04
* 4  46.4     5.52    0.68   12.3     0.6896  -0.3474D+05  0.3099D-03  0.3817D-04
* 5  51.7     3.47    0.51   14.7     0.6198  -0.4256D+05  0.1948D-03  0.2863D-04
* 6  57.0     2.77    0.44   15.9     0.5446  -0.5097D+05  0.1555D-03  0.2470D-04
* 7  62.3     1.66    0.34   20.5     0.4648  -0.5990D+05  0.9319D-04  0.1909D-04
* 8  70.1     0.84    0.17   20.2     0.3404  -0.7383D+05  0.4715D-04  0.9543D-05
* 9  83.0     0.63    0.13   20.6     0.1219  -0.9829D+05  0.3537D-04  0.7298D-05
* 10 98.0     0.35    0.10   28.6     -0.1392  -0.1275D+06  0.1965D-04  0.5614D-05
* 11 112.7    0.53    0.12   22.6     -0.3859  -0.1551D+06  0.2975D-04  0.6736D-05
* 12 127.1    0.58    0.12   20.7     -0.6032  -0.1794D+06  0.3256D-04  0.6736D-05
* 13 148.0    0.16    0.05   31.2     -0.8480  -0.2068D+06  0.8982D-05  0.2807D-05
*-----*
*****

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TABLE XXI :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

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*****
* ENERGY(LAB)180. MEV          ENERGY(CM)3.114670 GEV
* MOMENT(LAB) 287.4800 MEV/C    MOMENT(CM) 259.2062 MEV/C    MAX.MOM.TR.SQ. -0.26875D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  35.8    13.68    0.96    7.0      0.8111  -0.2539D+05  0.6397D-03  0.4489D-04
* 2  41.3    7.87     0.64    8.1      0.7513  -0.3342D+05  0.3680D-03  0.2993D-04
* 3  46.7    4.94     0.46    9.3      0.6858  -0.4222D+05  0.2310D-03  0.2151D-04
* 4  52.0    2.68     0.31   11.6     0.6157  -0.5165D+05  0.1253D-03  0.1450D-04
* 5  57.4    1.51     0.22   14.6     0.5388  -0.6198D+05  0.7061D-04  0.1029D-04
* 6  62.7    0.79     0.16   20.3     0.4586  -0.7274D+05  0.3694D-04  0.7481D-05
* 7  67.9    0.56     0.13   23.2     0.3762  -0.8382D+05  0.2618D-04  0.6079D-05
* 8  73.1    0.54     0.13   24.1     0.2907  -0.9531D+05  0.2525D-04  0.6079D-05
* 9  78.3    0.14     0.07   50.0     0.2028  -0.1071D+06  0.6546D-05  0.3273D-05
* 10 83.4    0.25     0.09   36.0     0.1149  -0.1189D+06  0.1169D-04  0.4208D-05
* 11 88.5    0.24     0.09   37.5     0.0262  -0.1309D+06  0.1122D-04  0.4208D-05
* 12 93.5    0.19     0.08   42.1     -0.0610  -0.1426D+06  0.8884D-05  0.3741D-05
* 13 98.5    0.21     0.08   38.1     -0.1478  -0.1542D+06  0.9819D-05  0.3741D-05
* 14 103.4   0.15     0.07   46.7     -0.2317  -0.1655D+06  0.7014D-05  0.3273D-05
* 15 108.3   0.13     0.07   53.8     -0.3140  -0.1766D+06  0.6079D-05  0.3273D-05
* 16 113.1   0.20     0.08   40.0     -0.3923  -0.1871D+06  0.9352D-05  0.3741D-05
* 17 117.9   0.14     0.08   57.1     -0.4679  -0.1973D+06  0.6546D-05  0.3741D-05
* 18 122.7   0.12     0.07   58.3     -0.5402  -0.2070D+06  0.5611D-05  0.3273D-05
* 19 127.4   0.08     0.06   75.0     -0.6074  -0.2160D+06  0.3741D-05  0.2806D-05
* 20 132.1   0.07     0.06   85.7     -0.6704  -0.2245D+06  0.3273D-05  0.2806D-05
* 21 136.8   0.15     0.08   53.3     -0.7290  -0.2323D+06  0.7014D-05  0.3741D-05
* 22 141.4   0.09     0.07   77.8     -0.7815  -0.2394D+06  0.4208D-05  0.3273D-05
* 23 146.0   0.28     0.17   60.7     -0.8290  -0.2458D+06  0.1309D-04  0.7949D-05
* 24 150.6   0.14     0.11   78.6     -0.8712  -0.2514D+06  0.6546D-05  0.5143D-05
*****

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TABLE XXII :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)195. MEV          ENERGY(CM)3.128165 GEV
* MOMENT(LAB) 304.0672 MEV/C    MOMENT(CM) 272.9792 MEV/C    MAX.MOM.TR.SQ. -0.29807D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  36.1    11.00    0.63    5.7      0.8080  -0.2862D+05  0.4637D-03  0.2656D-04
* 2  41.6    7.33     0.47    6.4      0.7478  -0.3759D+05  0.3090D-03  0.1981D-04
* 3  47.0    4.59     0.35    7.6      0.6820  -0.4739D+05  0.1935D-03  0.1476D-04
* 4  52.4    3.04     0.27    8.9      0.6101  -0.5810D+05  0.1282D-03  0.1138D-04
* 5  57.8    1.33     0.17   12.8     0.5329  -0.6962D+05  0.5607D-04  0.7167D-05
* 6  63.1    1.04     0.16   15.4     0.4524  -0.8161D+05  0.4385D-04  0.6745D-05
* 7  68.4    0.64     0.12   18.7     0.3681  -0.9417D+05  0.2698D-04  0.5059D-05
* 8  73.6    0.36     0.09   25.0     0.2823  -0.1070D+06  0.1518D-04  0.3794D-05
* 9  78.7    0.38     0.11   28.9     0.1959  -0.1198D+06  0.1602D-04  0.4637D-05
* 10 83.9    0.27     0.09   33.3     0.1063  -0.1332D+06  0.1138D-04  0.3794D-05
* 11 88.9    0.25     0.09   36.0     0.0192  -0.1462D+06  0.1054D-04  0.3794D-05
* 12 94.0    0.13     0.07   53.8     -0.0698  -0.1594D+06  0.5481D-05  0.2951D-05
* 13 98.9    0.11     0.07   63.6     -0.1547  -0.1721D+06  0.4637D-05  0.2951D-05
* 14 103.9   0.16     0.07   43.8     -0.2402  -0.1848D+06  0.6745D-05  0.2951D-05
* 15 108.7   0.10     0.06   60.0     -0.3206  -0.1968D+06  0.4216D-05  0.2530D-05
* 16 113.6   0.21     0.09   42.9     -0.4003  -0.2087D+06  0.8853D-05  0.3794D-05
* 17 118.4   0.15     0.07   46.7     -0.4756  -0.2199D+06  0.6324D-05  0.2951D-05
* 18 123.1   0.11     0.06   54.5     -0.5461  -0.2304D+06  0.4637D-05  0.2530D-05
* 19 127.8   0.17     0.08   47.1     -0.6129  -0.2404D+06  0.7167D-05  0.3373D-05
* 20 132.5   0.04     0.04   100.0    -0.6756  -0.2497D+06  0.1686D-05  0.1686D-05
* 21 137.1   0.21     0.09   42.9     -0.7325  -0.2582D+06  0.8853D-05  0.3794D-05
* 22 141.7   0.13     0.07   53.8     -0.7848  -0.2660D+06  0.5481D-05  0.2951D-05
* 23 146.3   0.05     0.06   120.0    -0.8320  -0.2730D+06  0.2108D-05  0.2530D-05
* 24 150.8   0.04     0.04   100.0    -0.8729  -0.2791D+06  0.1686D-05  0.1686D-05
* 25 155.4   0.16     0.16   100.0    -0.9092  -0.2845D+06  0.6745D-05  0.6745D-05
*****

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TABLE XXIII :REACTION PI- ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

ENERGY(LAB) 208. MEV ENERGY(CM) 3.139815 GEV  
 MOMENT(LAB) 318.3153 MEV/C MOMENT(CM) 284.7103 MEV/C MAX.MOM.TR.SQ. -0.32424D+06 (MEV/C)<sup>2</sup>

	THETA	SIGMA	ERROR		COS(THETA)	MOM. TRAN.	SIGMA	ERROR
		MB/SR	MB/SR	(%)		(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>
1	30.6	17.96	2.32	12.9	0.8607	-0.2258D+05	0.6961D-03	0.8991D-04
2	36.1	11.92	1.57	13.2	0.8080	-0.3113D+05	0.4620D-03	0.6085D-04
3	41.6	7.48	1.12	15.0	0.7478	-0.4089D+05	0.2899D-03	0.4341D-04
4	47.0	4.57	0.83	18.2	0.6820	-0.5155D+05	0.1771D-03	0.3217D-04
5	52.4	2.67	0.64	24.0	0.6101	-0.6320D+05	0.1035D-03	0.2480D-04
6	57.8	0.60	0.31	51.7	0.5329	-0.7573D+05	0.2325D-04	0.1201D-04
7	68.3	0.73	0.20	27.4	0.3697	-0.1022D+06	0.2829D-04	0.7751D-05
8	83.8	0.15	0.09	60.0	0.1080	-0.1446D+06	0.5813D-05	0.3488D-05
9	106.1	0.09	0.05	55.6	-0.2773	-0.2071D+06	0.3488D-05	0.1938D-05
10	145.9	0.06	0.03	50.0	-0.8281	-0.2964D+06	0.2325D-05	0.1163D-05

TABLE XXIV :REACTION PI+ ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

ENERGY(LAB) 68. MEV ENERGY(CM) 3.011993 GEV  
 MOMENT(LAB) 153.6403 MEV/C MOMENT(CM) 143.2521 MEV/C MAX.MOM.TR.SQ. -0.82085D+05 (MEV/C)<sup>2</sup>

	THETA	SIGMA	ERROR		COS(THETA)	MOM. TRAN.	SIGMA	ERROR
		MB/SR	MB/SR	(%)		(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>
1	45.3	3.39	0.94	27.7	0.7034	-0.1217D+05	0.5190D-03	0.1439D-03
2	55.7	0.88	0.25	28.4	0.5635	-0.1791D+05	0.1347D-03	0.3827D-04
3	73.8	0.42	0.15	35.7	0.2790	-0.2959D+05	0.6430D-04	0.2296D-04
4	91.5	0.82	0.25	30.5	-0.0262	-0.4212D+05	0.1255D-03	0.3827D-04
5	104.0	2.04	0.49	24.0	-0.2419	-0.5097D+05	0.3123D-03	0.7501D-04
6	113.8	2.22	0.52	23.4	-0.4035	-0.5760D+05	0.3399D-03	0.7961D-04
7	123.5	2.77	0.58	20.9	-0.5519	-0.6370D+05	0.4241D-03	0.8879D-04
8	133.1	2.86	0.60	21.0	-0.6833	-0.6909D+05	0.4378D-03	0.9185D-04
9	142.6	3.52	0.67	19.0	-0.7944	-0.7365D+05	0.5389D-03	0.1026D-03
10	152.0	3.34	0.63	18.9	-0.8829	-0.7728D+05	0.5113D-03	0.9645D-04
11	163.7	2.96	0.58	19.6	-0.9598	-0.8043D+05	0.4531D-03	0.8879D-04

TABLE XXV :REACTION PI+ ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

ENERGY(LAB) 98. MEV ENERGY(CM) 3.039836 GEV  
 MOMENT(LAB) 192.2485 MEV/C MOMENT(CM) 177.6080 MEV/C MAX.MOM.TR.SQ. -0.12618D+06 (MEV/C)<sup>2</sup>

	THETA	SIGMA	ERROR		COS(THETA)	MOM. TRAN.	SIGMA	ERROR
		MB/SR	MB/SR	(%)		(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>	MB/(MEV/C) <sup>2</sup>
1	32.3	13.05	1.08	8.3	0.8453	-0.9762D+04	0.1300D-02	0.1076D-03
2	43.0	6.66	0.58	8.7	0.7314	-0.1695D+05	0.6633D-03	0.5776D-04
3	53.5	3.21	0.36	11.2	0.5948	-0.2556D+05	0.3197D-03	0.3585D-04
4	64.0	1.33	0.22	16.5	0.4384	-0.3543D+05	0.1325D-03	0.2191D-04
5	74.3	0.39	0.12	30.8	0.2706	-0.4602D+05	0.3884D-04	0.1195D-04
6	84.5	0.56	0.15	26.8	0.0958	-0.5704D+05	0.5577D-04	0.1494D-04
7	94.5	1.67	0.26	15.6	-0.0785	-0.6804D+05	0.1663D-03	0.2589D-04
8	104.5	1.63	0.26	16.0	-0.2504	-0.7889D+05	0.1623D-03	0.2589D-04
9	114.3	2.02	0.30	14.9	-0.4115	-0.8905D+05	0.2012D-03	0.2988D-04
10	123.9	1.89	0.29	15.3	-0.5577	-0.9828D+05	0.1882D-03	0.2888D-04
11	133.4	2.94	0.36	12.2	-0.6871	-0.1064D+06	0.2928D-03	0.3585D-04
12	142.9	2.77	0.35	12.6	-0.7976	-0.1134D+06	0.2759D-03	0.3486D-04
13	152.2	3.43	0.40	11.7	-0.8846	-0.1189D+06	0.3416D-03	0.3984D-04
14	161.5	2.00	0.31	15.5	-0.9483	-0.1229D+06	0.1992D-03	0.3087D-04

TABLE XXVI :REACTION PI+ ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)120. MEV          ENERGY(CM)3.06093 GEV
* MOMENT(LAB) 218.8527 MEV/C    MOMENT(CM) 200.8478 MEV/C    MAX.MOM.TR.SQ. -0.16136D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM. TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  29.9    19.50    2.71    13.9    0.8669  -0.1074D+05  0.1519D-02  0.2110D-03
* 2  35.2    20.86    2.21    10.6    0.8171  -0.1475D+05  0.1625D-02  0.1721D-03
* 3  40.6    15.01    1.66    11.1    0.7593  -0.1942D+05  0.1169D-02  0.1293D-03
* 4  45.9    11.17    1.26    11.3    0.6959  -0.2453D+05  0.8699D-03  0.9813D-04
* 5  51.2     5.24    0.80    15.3    0.6266  -0.3013D+05  0.4081D-03  0.6230D-04
* 6  56.5     3.43    0.63    18.4    0.5519  -0.3615D+05  0.2671D-03  0.4906D-04
* 7  64.4     2.17    0.86    39.6    0.4321  -0.4582D+05  0.1690D-03  0.6698D-04
* 8  82.3     0.64    0.13    20.3    0.1340  -0.6987D+05  0.4984D-04  0.1012D-04
* 9 102.4     1.64    0.27    16.5   -0.2147  -0.9800D+05  0.1277D-03  0.2103D-04
*10 114.6     1.86    0.35    18.8   -0.4163  -0.1143D+06  0.1449D-03  0.2726D-04
*11 124.2     2.22    0.39    17.6   -0.5621  -0.1260D+06  0.1729D-03  0.3037D-04
*12 133.7     1.67    0.34    20.4   -0.6909  -0.1364D+06  0.1301D-03  0.2648D-04
*13 145.4     1.61    0.27    16.8   -0.8231  -0.1471D+06  0.1254D-03  0.2103D-04
*14 161.6     1.07    0.20    18.7   -0.9489  -0.1572D+06  0.8333D-04  0.1558D-04
*****

```

TABLE XXVII :REACTION PI+ ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

```

*****
* ENERGY(LAB)135. MEV          ENERGY(CM)3.073828 GEV
* MOMENT(LAB) 236.4499 MEV/C    MOMENT(CM) 216.0277 MEV/C    MAX.MOM.TR.SQ. -0.18667D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM. TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  30.0    27.03    5.90    21.8    0.8660  -0.1250D+05  0.1820D-02  0.3972D-03
* 2  35.4    19.92    3.98    20.0    0.8151  -0.1726D+05  0.1341D-02  0.2679D-03
* 3  40.8    12.08    2.73    22.6    0.7570  -0.2268D+05  0.8132D-03  0.1838D-03
* 4  46.1    10.96    2.32    21.2    0.6934  -0.2862D+05  0.7378D-03  0.1562D-03
* 5  51.4     4.80    1.45    30.2    0.6239  -0.3511D+05  0.3231D-03  0.9761D-04
* 6  59.4     2.31    0.73    31.6    0.5090  -0.4582D+05  0.1555D-03  0.4914D-04
* 7  72.4     1.28    0.44    34.4    0.3024  -0.6511D+05  0.8617D-04  0.2962D-04
* 8  87.7     1.47    0.48    32.7    0.0401  -0.8959D+05  0.9896D-04  0.3231D-04
* 9 105.1     0.87    0.32    36.8   -0.2605  -0.1177D+06  0.5857D-04  0.2154D-04
*10 122.0     1.19    0.44    37.0   -0.5299  -0.1428D+06  0.8011D-04  0.2962D-04
*11 136.2     1.50    0.49    32.7   -0.7218  -0.1607D+06  0.1010D-03  0.3299D-04
*12 154.8     0.66    0.26    39.4   -0.9048  -0.1778D+06  0.4443D-04  0.1750D-04
*****

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TABLE XXVIII:REACTION PI+ ON HE-3 DIFFERENTIAL ELASTIC CROSS SECTION

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*****
* ENERGY(LAB)145. MEV          ENERGY(CM)3.082951 GEV
* MOMENT(LAB) 247.9918 MEV/C    MOMENT(CM) 225.9022 MEV/C    MAX.MOM.TR.SQ. -0.20413D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM. TRAN.      SIGMA      ERROR
*           MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  30.1    22.08    3.65    16.5    0.8652  -0.1376D+05  0.1359D-02  0.2247D-03
* 2  35.5    28.15    3.20    11.4    0.8141  -0.1897D+05  0.1733D-02  0.1970D-03
* 3  43.6    10.60    1.16    10.9    0.7242  -0.2815D+05  0.6526D-03  0.7141D-04
* 4  51.6     3.70    0.89    24.1    0.6211  -0.3867D+05  0.2278D-03  0.5479D-04
* 5  56.9     2.43    0.72    29.6    0.5461  -0.4633D+05  0.1496D-03  0.4432D-04
* 6  67.3     1.03    0.28    27.2    0.3859  -0.6268D+05  0.6341D-04  0.1724D-04
* 7  82.8     0.66    0.22    33.3    0.1253  -0.8927D+05  0.4063D-04  0.1354D-04
* 8  97.8     1.06    0.29    27.4   -0.1357  -0.1159D+06  0.6526D-04  0.1785D-04
* 9 112.6     1.25    0.32    25.6   -0.3843  -0.1413D+06  0.7695D-04  0.1970D-04
*10 126.9     0.69    0.24    34.8   -0.6004  -0.1633D+06  0.4248D-04  0.1477D-04
*11 138.7     1.26    0.40    31.7   -0.7513  -0.1787D+06  0.7757D-04  0.2462D-04
*12 150.3     0.53    0.21    39.6   -0.8686  -0.1907D+06  0.3263D-04  0.1293D-04
*13 164.1     0.24    0.15    62.5   -0.9617  -0.2002D+06  0.1477D-04  0.9234D-05
*****

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TABLE XXIX : REACTION  $\text{PI}^+$  ON  $\text{HE-3}$  DIFFERENTIAL ELASTIC CROSS SECTION

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*****
* ENERGY(LAB) 156. MEV          ENERGY(CM) 3.092955 GEV
* MOMENT(LAB) 260.5407 MEV/C    MOMENT(CM) 236.5657 MEV/C    MAX.MOM.TR.SQ. -0.22385D+06 (MEV/C)2
*
*-----*
* THETA      SIGMA      ERROR      COS(THETA)  MOM.TRAN.      SIGMA      ERROR
*            MB/SR      MB/SR      (%)          (MEV/C)2      MB/(MEV/C)2  MB/(MEV/C)2
*-----*
* 1  30.2    37.65    4.83    12.8    0.8643  -0.1519D+05  0.2114D-02  0.2711D-03
* 2  35.6    25.40    3.26    12.8    0.8131  -0.2092D+05  0.1426D-02  0.1830D-03
* 3  41.0    15.08    2.14    14.2    0.7547  -0.2745D+05  0.8465D-03  0.1201D-03
* 4  46.4    12.23    1.79    14.6    0.6896  -0.3474D+05  0.6866D-03  0.1005D-03
* 5  51.7     6.34    1.26    19.9    0.6198  -0.4256D+05  0.3559D-03  0.7073D-04
* 6  57.0     3.89    0.99    25.4    0.5446  -0.5097D+05  0.2184D-03  0.5558D-04
* 7  67.5     1.69    0.39    23.1    0.3827  -0.6909D+05  0.9487D-04  0.2189D-04
* 8  83.0     0.73    0.25    34.2    0.1219  -0.9829D+05  0.4098D-04  0.1403D-04
* 9  98.0     1.11    0.32    28.8   -0.1392  -0.1275D+06  0.6231D-04  0.1796D-04
* 10 112.7     1.38    0.35    25.4   -0.3859  -0.1551D+06  0.7747D-04  0.1965D-04
* 11 127.1     1.51    0.38    25.2   -0.6032  -0.1794D+06  0.8477D-04  0.2133D-04
* 12 141.1     1.08    0.31    28.7   -0.7782  -0.1990D+06  0.6063D-04  0.1740D-04
* 13 159.5     0.42    0.16    38.1   -0.9367  -0.2168D+06  0.2358D-04  0.8982D-05
*****

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