FLUXES OF NEUTRINOS AND ANTINEUTRINOS PRODUCED AT CERN (PRELIMINARY RESULTS)

A. Orkin-Lecourtois,
Laboratoire de l'Accélérateur Linéair,
Orsay, France.

F. Franzinetti, T.I. Pedersen and
H. Yoshiki, CERN.

(presented by A. Orkin-Lecourbois)

The calibration method described here consists of exposing the neutrino copper target to a proton beam inside a heavy liquid bubble chamber, where the tracks emitted are analysed.

Characteristics

Target: Cu 30 cm; 0.4 cm diameter.

Beam : 19 GeV/c protons - 2 mm half-width - one proton per pulse.

Heavy liquid chamber: Ecole Polytechnique $1 \times 0.50 \times 0.50$ m^3 filled with $C^2 F^5 Cl$ ($d = 1.2$ gr cm^{-3}, $X_0 = 25$ cm). Magnetic field $\simeq$ 20 kG.

The experiment was done by the Ecole Polytechnique group [and the picture analysis carried out at CERN in the heavy liquid chamber division (NPA) - 90,000 pictures have been taken (May and October, 1964).]

Method

All negative tracks are measured. For the measurement of a positive track, a delta-ray signature is required, which excludes the proton. In order to separate pions from kaons, all delta-ray signatures excluding either protons or kaons are recorded for both negative and positive tracks. The negative tracks' signatures are also useful for the calibration of the delta-ray method of separation of the particles.

After ~ 2,500 tracks of all momenta (essentially < 3 GeV/c) were measured, a cut-off was introduced for the measurement of tracks above 2 GeV/c only. The recorded number of protons which are observed to enter and interact in the target is used for normalization. A minimum projected track length of ~ 20 cm is required for the measurement of a track, and the corrected number of tracks is obtained from the knowledge of the interaction length of $\pi^{\pm}$ in freon. A sample of ~ 2,000 proton interactions in the target has been analysed in order to correct for the dipping, stopping and interacting tracks not included in the measurements. The scanning efficiencies for the detection of proton interactions, negative tracks and delta-ray signatures have been estimated, together with the measurement errors in the scanning table measurement of the tracks.

Negative tracks can be measured up to 15 GeV. For positive tracks, since a delta-ray signature is needed (probability as $1/P^2$), very few tracks are found above ~ 7 GeV/c, due to the steep shape of the spectrum.

The data can be treated in two ways:

1) Since the probability of a signature against a proton is fairly independent of the mass of the particle (π^+ or K^+), the weighted distribution of positive tracks represents, to a very good approximation, the $(K^+ + \pi^+)$ spectrum. The K^+/π^+ ratio obtained in other experiments can be used to derive the π^+ and K^+ spectra extending up to ~ 7 GeV/c. The neutrino spectrum can be computed up to about the same energy when the π^+, K^+ $\partial N/\partial p \partial \Theta$ distributions ($0 < p < 7$ GeV/c, $0 < \Theta < 60^\circ$) are treated by the horn-focusing and decay-programme of Van der Meer.

Similarly, but with far better statistics, the negative $(\pi^- + K^-)$ and separated π^-, K^- differential distributions are obtained. They yield an antineutrino spectrum up to ~ 15 GeV.

2) In a more elaborate way but in a more restricted range of energies (below ~ 4- 5 GeV/c for ~ 10^5 pictures), a separation of the pions from the $(\pi + K)$ distributions can be achieved with the help of delta-ray signatures, excluding kaons. This subtraction will be done in the final stage of the experiment and will allow a comparison with the existing $K^\pm/\pi^\pm$ ratios below ~ 4 GeV/c, over a wide angular range.

The π^+/π^- ratio in copper, as a function of momentum and angle, will also be obtained from this experiment.

The contribution of secondary interactions in the target can be studied.

Preliminary results

Number of pictures analysed	22,000 (~ 7,000 proton interactions)
Number of tracks measured (negative)	3,614
(positive)	2,180
Number of negative signatures used for calibration of weights	~ 1,400 .

Conclusion

Due to the shape of the π and K spectra produced in the target, most of the neutrino events have energies below 5 GeV and, it is especially important for the determination of cross-sections and form factors, to dispose of neutrinos and antineutrino spectra known to better than 20% in the energy range, which is the purpose of the present experiment. An extrapolation of the results for 24 GeV/c protons will be carried out. However, due to the possibility of increased repetition rate of the Proton Synchrotron, it is quite useful to carry out neutrino experiments at lower energy (19- 20 GeV/c protons), thus enhancing the event rate.

ACKNOWLEDGEMENTS

We have pleasure in thanking Professor A. Lagarrigue and his group for making available the bubble chamber of the Ecole Polytechnique, and running it. In particular, thanks are due to Drs. J.J. Veuillet and G. Huson for setting up the primary proton beam; to Dr. S. Van der Meer for computing the final neutrino spectrum and to the NPA scanners for their painstaking effort.

FIGURE CAPTIONS

Figure 1 : Integral momentum distribution of positive and negative total (π+ K) (partial results).

Figure 2 and 3 : Neutrino and antineutrino spectra. The cut-off due to small statistics has been imposed also on the previous data used by Van der Meer, for comparison of the results. Our results are only partly corrected here.

Figure 4 : The "error" band shown was derived using statistical errors on the differential $\partial N(p)/\partial\Theta$ distribution.

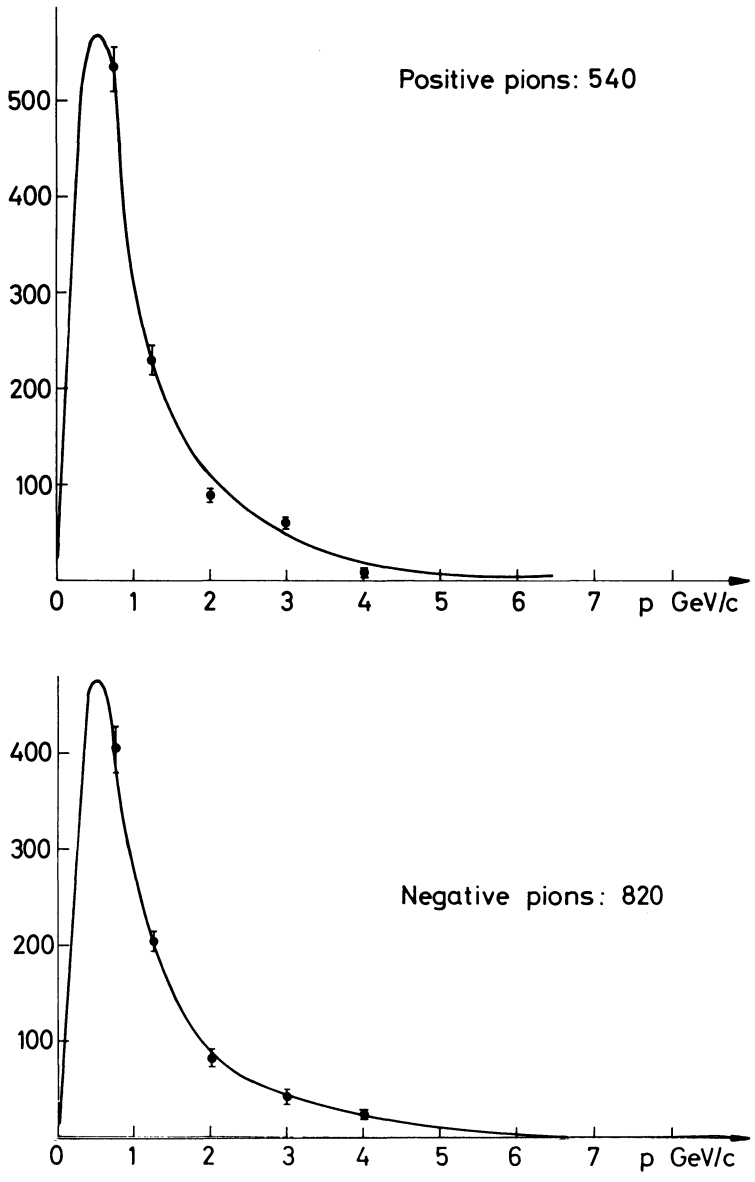
Positive pions: 540
500
400
300
200
100
0
1
2
3
4
5
6
7
p GeV/c
Negative pions: 820
400
300
200
100
0
1
2
3
4
5
6
7
p GeV/c

Fig. 1

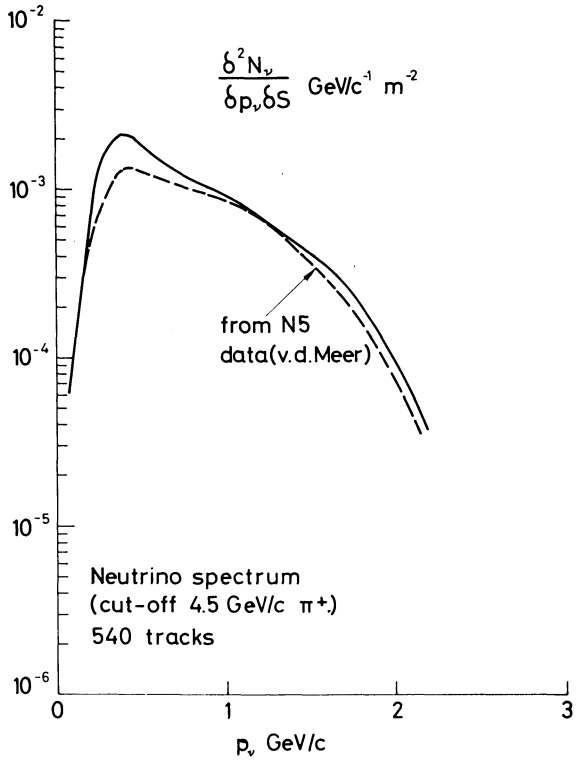

Fig. 2

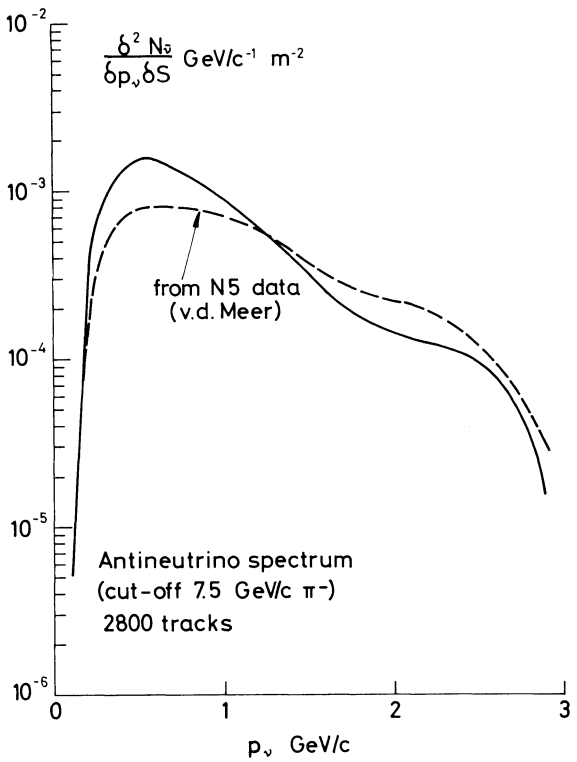

Fig. 3

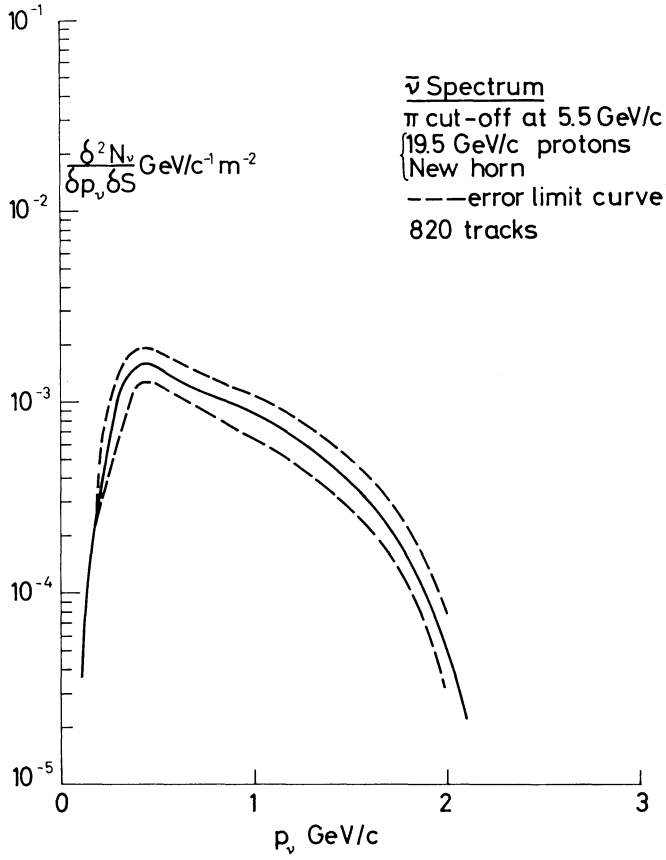

Fig. 4