CERN/TC/30 62/15
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LOW ENERGY PARTICLES FROM THE CERN PS

The production of low energy particles by 19.2 GeV/c protons from an internal Be target was studied at the CERN PS. The K1-beam in the North experimental hall was used to separate the different kind of particles ($\pi^{\pm}$, $K^{\pm}$, p, $\bar{p}$) from each other. The target emission angle varied according to the beam momentum and charge. At 0.8 GeV/c, it was $\sim 14^{o}$ for positive particles, $\sim 16^{o}$ for negative particles, but the angle for higher energy particles for both signs was nearly 15^{o}. The purity of the different separated beams was determined by measuring the time of flight of the particles with scintillation counters[*)]. The beam set up with the counter positions is shown in Fig. 1, some characteristic data of the K1-beam and the experimental arrangement are summarized in Table I [1)].

The PS-machine was operated at 19.2 GeV/c with a 2 second repetition cycle. For most of the measurements the secondary particle burst had a duration of 100-200 msec. A few measurements were obtained during the exposure of the CERN hydrogen bubble chamber in the K1-beam, using short burst (1-2 msec) operation. These points are indicated in the Table II below, they might be influenced by saturation effects of the counters. However at 1.5 GeV/c we have obtained with short and long particle bursts the same ratios K^-/π^-. The particle fluxes refer to an internal Be-target 3 mm high, 4 mm wide, 38 mm long aligned on the optical axis of the K1 beam. For some of the measurements we have used as well an Al-target of the same dimensions as the Be-target.

$$\text{We found} \left(\frac{d^2N}{dp\, d\Omega}\right)_{Be} = 1.2 \left(\frac{d^2N}{dp\, d\Omega}\right)_{Al}$$

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*) The π and μ contamination was also measured on the hydrogen bubble chamber photographs.

1) See note CERN/TC/30, 62-8.

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The errors quoted on the measurements are combined from the statistical errors and the spread of different measurements at different times. Especially the absolute values suffer from the uncertainties of the solid angle element Ω, the momentum spread Δp of the beam particles and the target efficiency. All the absolute fluxes given refer to long burst conditions in the PS and are the fluxes which were found to reproduce over a period of months. It was observed under these conditions that the PS internal beam was completely used up by the target. The yield with short burst operation was less by 30-70 o/o depending on the particular target operation.

For monitoring our coincidence rates we used 2 scintillation counters positioned outside the main shielding wall at about 15 m from the target, seeing the target at an angle of 90° through a hole of $\sim$ 5 x 10 cm in the wall.

The results of these measurements are summarized in Table II and in the Fig. 2 to 5. The steep rise of the K fluxes and the K/π ratios with increasing momentum is very remarkable. Between 0.8 GeV/c and 1.5 GeV/c the K^-/π^- changes from 1 o/o up to 4 o/o and the K^+/π^+ from 2 o/o to 9 o/o. At 2 GeV/c Fidecaro et al.[2)] has measured for a 16° emission angle K^-/π^- = 12 o/o and K^+/π^+ = 25 o/o.

We would like to acknowledge the staff of the PS and of the NPA divisions for the invaluable cooperation. Without their support and patience the setting up of the K1-beam, the measurements of the particle fluxes and the success of the hydrogen bubble chamber runs would not have been possible. Also the help of the CERN emulsion group and of our colleagues of the Ecole Polytechnique (Paris), the Universities of Padua, Rome and Oxford, is gratefully acknowledged.

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2) P.R.L. Vol. 5, No. 1, 19, 1960.

TABLE I

K1-beam characteristics

For $p = 1,5$ GeV/c

$\left(\frac{\Delta p}{p}\right)_{tot} = 1.95$ o/o

$\Omega = 0,11$ msterad

Number of π^--mesons/10^{11} protons	18000 } at 41 m distance
Number of K^- mesons/10^{11} protons	31 } from target
Separation of K^--π^- at mass slit	8 mm
Image at mass slit	vert. 3.3 mm, hor. 10 mm
Field inside separator	57 KV/cm
Target	Be, 3 mm high, 4 mm wide, 38 mm long

Counter		Cross section	Distance from target
	1	1×1 cm^2	9 m
photo multipl.	2	4×5 cm^2	33 m
56 AVP			
	3	0.2×1 cm^2	32.5 m
	4	5×10 cm^2	41 m

TABLE II

Particles/proton/GeV/c/steradian

Momentum (GeV/c)	$\pi^{\pm}$	K^{+}	K^{-}	p	$\bar{p}$	K^{+}/π^{+}	K^{-}/π^{-}	p/π^{+}	$\bar{p}/\pi^{-}$
0.8	0.13 ± 0.010	$(2.7 \pm 0.5) .10^{-3}$	$(1.3 \pm 0.25) .10^{-3}$	$(1.8 \pm 0.1) .10^{-2}$		$(2.1 \pm 0.4) .10^{-2}$	$(1.0 \pm 0.2) .10^{-2}$	0.14 ± 0.07	
1.0	0.16 ± 0.010		$(2.3 \pm 0.4)^{*} .10^{-3}$				$(1.4 \pm 0.25)^{*} .10^{-2}$		
1.3	0.12 ± 0.006	$(9.2 \pm 1.0) .10^{-3}$	$(2.3 \pm 0.4) .10^{-3}$	$(3.8 \pm 0.2) .10^{-2}$		$(7.8 \pm 0.8) .10^{-2}$	$(1.9 \pm 0.40) .10^{-2}$	0.34 ± 0.20	
1.5	0.086 ± 0.004	$(7.7 \pm 1.5)^{*} .10^{-3}$	$(3.4 \pm 0.4) .10^{-3}$	$(3.4 \pm 0.2) .10^{-2}$	$(1.02 \pm 0.1) .10^{-4}$	$(9.0 \pm 2.0)^{*} .10^{-2}$	$(4.0 \pm 0.6) .10^{-2}$	0.40 ± 0.20	$(1.2 \pm 0.1) .10^{-3}$
2.0	0.053 ± 0.003								

Production rates of particles by 19.2 GeV/c protons from a Be target. Emission angle approx. 15^{o} (see text). The data are corrected for π and K-decay between target and detector. All absolute rates are uncertain by about $\pm$ 20 o/o because the solid angle and momentum band accepted by the beam are not better known. The error on the 0.8 GeV/c absolute fluxes may even be larger. The π^{+} and π^{-} fluxes were always found equal to $\pm$ 5 o/o.

* These values are obtained from short particle burst operation.