Laboratori Nazionali di Frascati

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G. Di Giugno, I. Peruzzi, G. Troise, F. Vanoli, M. Giorgi, P. Schiavon and V. Silvestrini : A MEASUREMENT OF THE BRANCHING RATIO $\frac{\omega \to \text{neutrals}}{\omega \to \pi^+ + \pi^- + \pi^0}$.

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A Measurement of the Branching Ratio $\dfrac{\omega \to \text{neutrals}}{\omega \to \pi^+ + \pi^- + \pi^0}$.

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We have measured the branching ratio $(\omega \to \text{neutrals})/(\omega \to \pi^+ + \pi^- + \pi^0)$. The experiment was performed at CERN using a counter technique. Our result is

$$\frac{\omega \to \text{neutrals}}{\omega \to \pi^+ + \pi^- + \pi^0} = (13.4 \pm 2.6)\% ,$$

to be compared with the world average (1)

$$R = \frac{\omega \to \text{neutrals}}{\omega \to \pi^+ + \pi^- + \pi^0} = (10.6 \pm 1)\% \; (*) .$$

Since our efficiency of detection of the neutral modes was computed in the

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(1) A. H. Rosenfeld, A. Barbaro-Galtieri, W. H. Barkas, P. L. Bastien, J. Kirz and M. Roos: *Rev. Mod. Phys.*, **37**, 633 (1965).

(*) This average value comes from the following results:

$R = (10 \pm 4)\%$ (2),
$R = (10 \pm 3)\%$ (3),
$R = (17 \pm 4)\%$ (4),
$R = (11 \pm 2)\%$ (5),
$R = (8 \pm 3)\%$ (6)
$R = (13 \pm 3.5)\%$ (7),
$R = (9.7 \pm 1.6)\%$ (8).

Our measurement, performed with a completely different technique, has thus a precision which is comparable or better than most of the previous results.

(2) C. Alff, D. Berley, D. Colley, N. Gelfand, U. Nauenberg, D. Miller, J. Schultz, J. Steinberger, T. H. Tan, H. Brugger, P. Kramer and R. Plano: *Phys. Rev. Lett.*, **9**, 325 (1962).

(3) J. J. Murray jr., M. Ferro-Luzzi, D. O. Huwe, J. B. Shafer, F. T. Solmitz and M. L. Stevenson: *Phys. Lett.*, **7**, 358 (1963).

(4) R. Armenteros, N. D. Edwards, T. Jacobsen, A. Shapira, J. Vandermeulen, Ch. D'Andlau, A. Astier, P. Baillon, H. Briand, J. Cohen-Ganouna, C. Defoix, T. Siaud, C. Ghesquiere and P. Rivet: *Proc. Sienna Int. Conf. on Elementary Particles*, vol. 1 (1963), p. 296.

hypothesis that the only neutral mode is the mode $\omega \to \pi^0 + \gamma$ (*), the agreement of our result with the world average can be considered a further indication (9) that the mode $\omega \to \pi^0 + \gamma$ is the dominant among the neutral decay-modes. Including our result the world average becomes

$$\frac{\omega \to \text{neutrals}}{\omega \to \pi^+ + \pi^- + \pi^0} = (10.8 \pm 0.9)\% .$$

We give in the following some detail on our experimental technique and method.

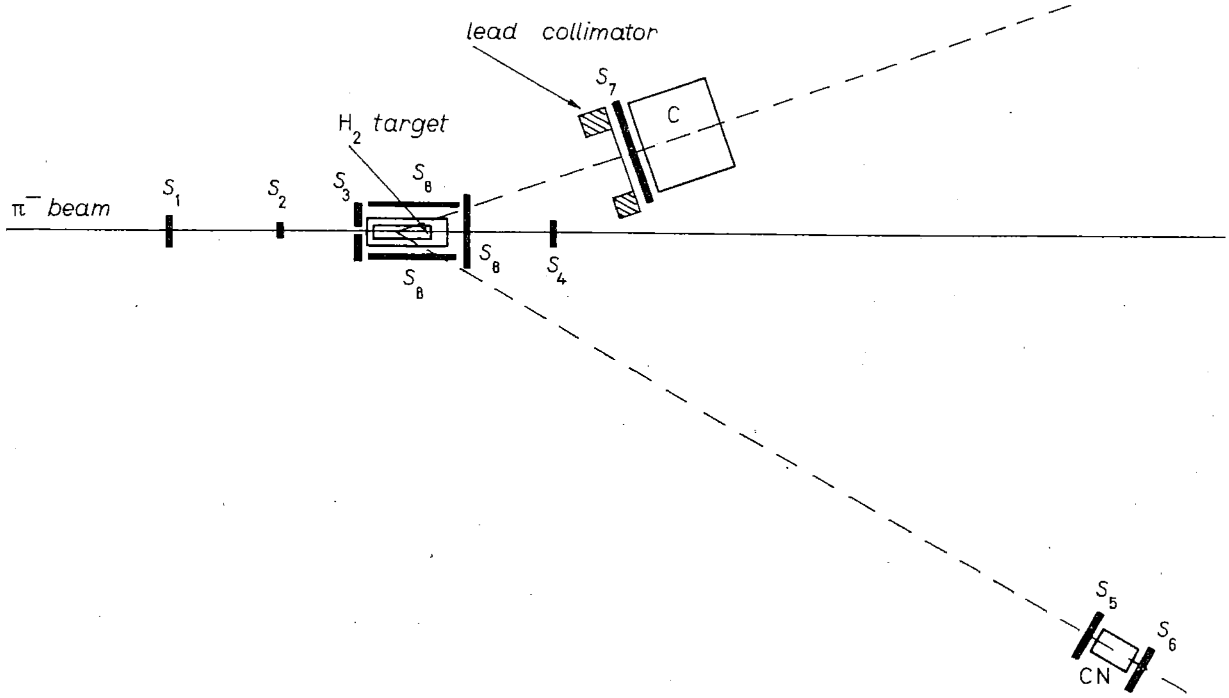

Fig. 1. – Experimental lay-out.

The experimental arrangement (Fig. 1) is essentially the same as used by us in a previously described experiment (10): the present results were in fact obtained during check-runs for that main experiment.

A π^- beam (momentum $P_{\pi^-} = 1.35$ GeV/c) from the CERN Protonsynchrotron is incident upon a liquid hydrogen target, 20 cm long. The beam is monitored by the counters S_1, S_2, S_3. Counter S_4 in anticoincidence monitors pions interacting in the hydrogen target.

At 30° (the maximum angle allowed by kinematics to neutrons from reaction

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(5) B. Buschbeck-Czapp, I. Wacek, W. A. Cooper, A. Fridman, E. Malamud, G. Otter, E. Gelsema and A. Tenner: *Proc. Sienna Int. Conf. on Elementary Particles*, vol. 1 (1963), p. 166.

(6) R. Kraemer, L. Madansky, M. Meer, M. Nussbaum, A. Pevsirer, C. Richardson, R. Strand, R. Zdamis, T. Fields, S. Orenstein and T. Tooking: *Phys. Rev.*, **136**, B 496 (1964).

(7) D. C. Miller: *Thesis* (Columbia University).

(8) S. M. Flatté, D. O. Huwe, J. J. Murray, J. Button Shafer, F. T. Solmitz, M. L. Stevenson and C. Wohl: *Phys. Rev. Lett.*, **14**, 1095 (1965).

(*) The efficiency of detection of our apparatus for the mode $\omega \to \pi^0 + \pi^0 + \gamma$ is approximately 5/3 of the efficiency to detect the mode $\omega \to \pi^0 + \gamma$.

(9) V. V. Barmin, A. G. Dolgolenko, Yu. S. Krestnikov, A. G. Meshkovsky, Yu. P. Nikitin and V. A. Shebanov: *Sov. Phys. JEPT*, **18**, 1289 (1964).

(10) G. Di Giugno, R. Querzoli, G. Troise' F. Vanoli, M. Giorgi, P. Schiavon and V. Silvestrini: *Phys. Rev. Lett.*, **16**, 767 (1966).

$\pi^- + p \to \omega + n$) there is a neutron counter C_N, 3 m from the target, 10 cm wide × 50 cm high × 15 cm thick, protected by anticoincidences (S_5 and S_6).

On the line of flight of the ω (20°) a total absorption lead glass Čerenkov counter C protected by an anticoincidence (S_7) detects γ-rays from the decays of the ω, in order to reduce background from other reactions.

When a coincidence between a neutron and a γ-ray occurs, we print the neutron time of flight: in addition we mark if or not the hut of counters S_8

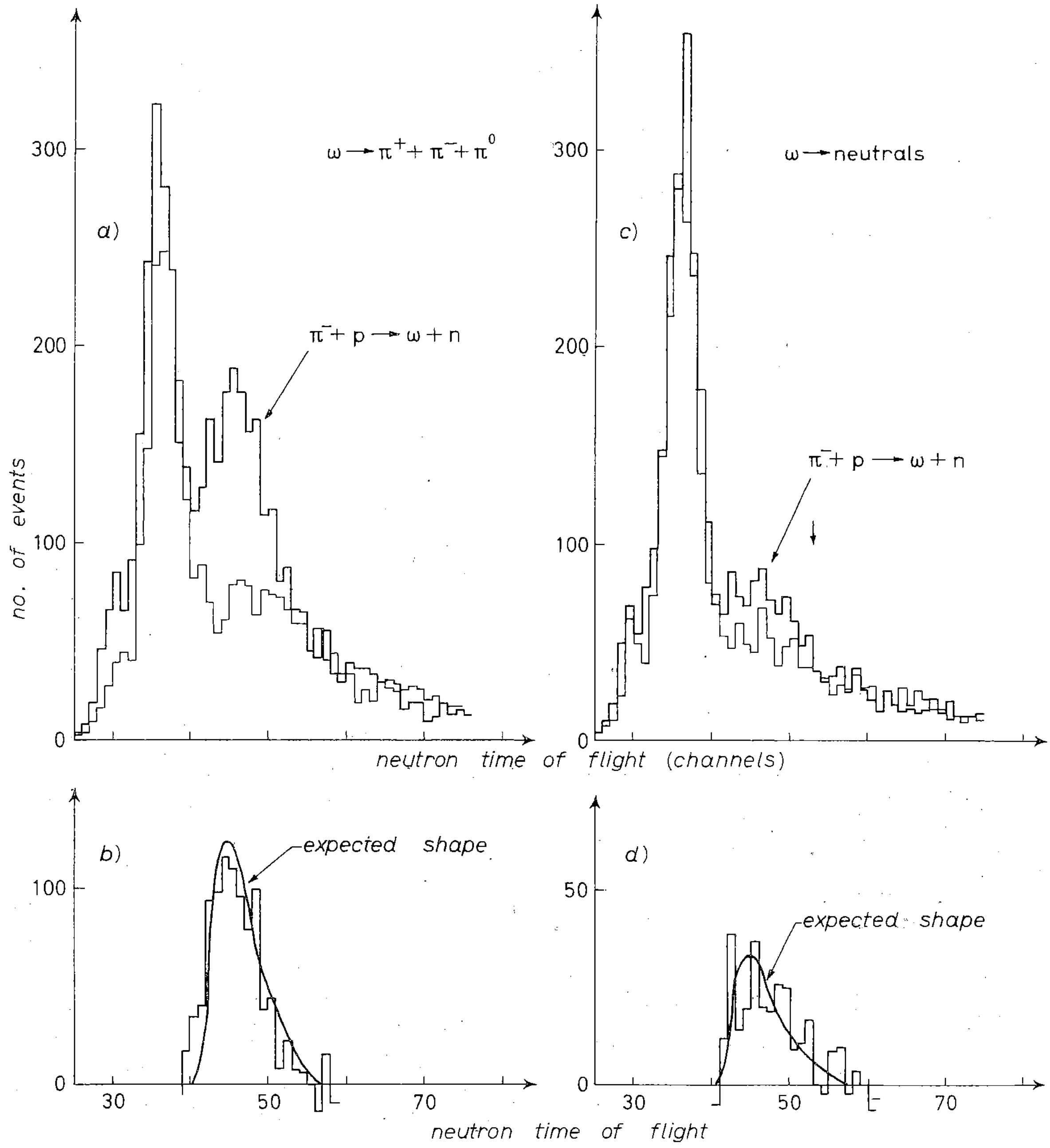

Fig. 2. – Neutron time-of-flight spectra. *a*) Time-of-flight spectra of neutrons in coincidence with a γ-ray in C and at least a charged particle in S_8: unshaded spectrum: « ω-measurement » (C_n at 30° and $P_{\pi^-} = 1.35$ GeV/c); shaded spectrum: background measurement (C_n at 31° and $P_{\pi^-} = 1.3$ GeV/c). *b*) Difference between the unshaded and shaded spectra of Fig. 2*a*): the experimental spectrum is compared with the expected one. Figures 2*c*) and 2*d*) have the same meaning as Fig. 2*a*) and 2*b*), but referring now to ω's decaying into neutrals (no charged particles in S_8).

surrounding the target, had a pulse in coincidence with the event, so that the time-of-flight spectra for neutral and charged decays are collected together.

In Fig. 2 the neutron time-of-flight spectra are shown. Figure 2*a* shows spectra referring to charged decays. The unshaded spectrum (« ω-measurement ») has been collected in the specified conditions, and the ω peak is visible. The shaded spectrum has been collected with the neutron counter at 31°, and at a beam momentum of 1.3 GeV/c. In this case recoil neutrons from the reaction $\pi^-+p\to\omega+n$ cannot reach the neutron counter: it is therefore a background measurement. In Fig. 2*b* the difference between the unshaded and shaded spectra of Fig. 2*a*, in the region of interest for us, is shown, and compared with the expected shape. Figures 2*c* and 2*d* have the same meaning as Fig. 2*a* and 2*b*, but referring now to neutral decays.

« ω measurements » and background measurements were alternatively made, changing from one situation to the other every ~ 3 h.

The efficiencies of our Čerenkov to detect the modes

$$\omega\to\pi^0+\gamma \quad\text{and}\quad \omega\to\pi^++\pi^-+\pi^0,$$

were computed by a Montecarlo calculation, taking into account finite dimensions of the target and counters and angular and momentum spread of the incident beam.

A possible polarization of the ω does not affect our results, since the ratio between the efficiencies of detection of the concerned decay modes would be left unchanged.

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