SEARCH FOR NARROW RESONANCES IN e^+e^- ANNIHILATION INTO HADRONS AT ADONE

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A search for narrow resonances in the reaction $e^+e^- \to$ hadrons in the mass regions 1915–2545 MeV and 2970–3090 MeV has been performed at ADONE, the Frascati storage ring. With 90% confidence level our data exclude the production of narrow resonances with integrated cross section larger than 20% of the integrated cross section for production of the J/ψ (3100 MeV).

A systematic search for narrow resonances in the reaction

$$e^+e^- \to \text{hadrons} \qquad (1)$$

has been performed with the MEA magnetic detector at Adone, the Frascati storage ring. We present here results obtained in the mass regions 1915–2545 MeV and 2970–3090 MeV. This search was stimulated by the discovery [1, 3] of the J/ψ(3100 MeV) resonance, the aim being to evidentiate possible other narrow (width $\lesssim$ 1 MeV) resonances. No evidence for such resonances in the explored energy range has been found.

The MEA magnetic apparatus has already been described in ref. [4]. Events from reaction (1) are required to present: a) at least two non collinear ($\Delta\theta > 10°$) charged particles, which must also be acoplanar ($\Delta\phi \geqslant 15°$) with respect to the beam direction, with minimum kinetic energy of ~130 MeV if pions; b) proper position of the source point; c) correct timing with respect to the crossing time of the two bunched beams.

The $e^+e^- \to e^+e^-$ scattering rate at small angles (3°–6°), as measured by the Adone machine group in a different interaction region has been used to provide a fast relative luminosity monitor. The $e^+e^- \to e^+e^-$ scattering rate at large angles ($|\cos\theta| \lesssim 0.7$), as detected by the MEA apparatus, has been used to provide an absolute luminosity monitor.

At Adone the mass resolution depends on the beam energy E according to [5]:

$$\Gamma_W\,(\text{MeV}) = 0.32\, W^2 \qquad \text{(FWHM)}$$

where $W = 2E$ is measured in GeV. Γ_W ranges from 1.3 MeV at W = 2 GeV to 2.8 MeV at W = 3 GeV. Therefore it has been chosen to explore the energy intervals 1915–2545 MeV and 2970–3090 MeV with 1 MeV and 2 MeV mass steps respectively. A typical integrated luminosity of about 0.1 nb^{-1} has been collected at each mass bin. A few mass regions have been explored with higher integrated luminosity (0.2–0.5 nb^{-1}). The total number of observed multi-

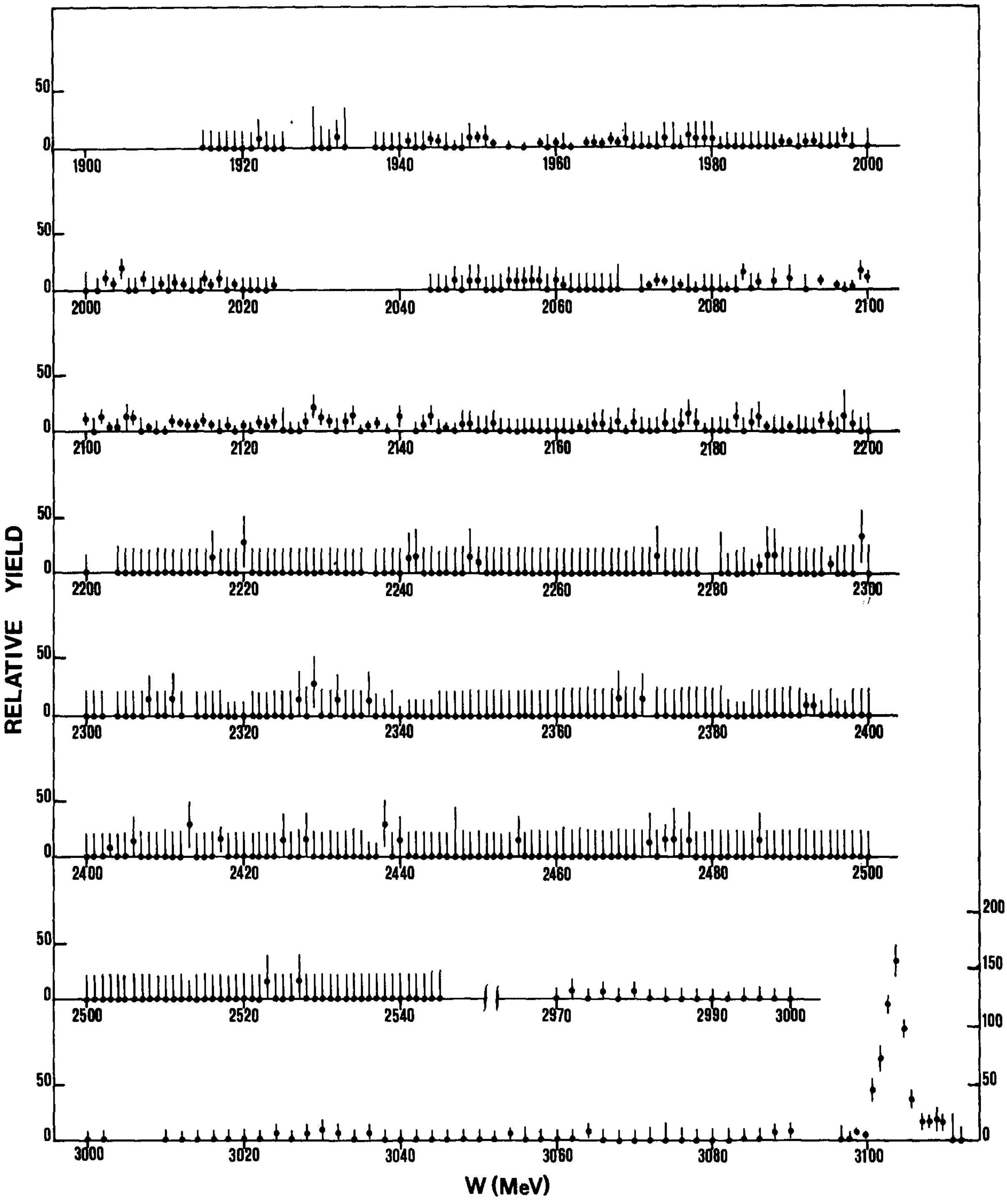

Fig. 1. Relative yields for the reaction $e^+e^- \to$ hadrons versus the total c.m. energy W.

Table 1
Upper limits with 90% C.L. (column 3) for the cross section integrated over energy intervals of size Δ(column 5). In column 4 the ratios of the obtained upper limits to the $J/\psi(3100)$ integrated cross section are given.

(1)	(2)	(3)	(4)	(5)
Total energy W (MeV)	$\mathcal{L}$ (nb^{-1})	$\int_\Delta [\sigma(W) - \langle\sigma_{NP}\rangle]\, dW$ upper limit with 90° confidence level (nb • GeV)	$\frac{\int[\sigma(W) - \langle\sigma_{NR}\rangle]\, dW}{\int \sigma_{J/\psi}(W)\, dW}$	Δ (MeV)
1915–2024	21.3	1.2	0.18	2
2044–2200	30.6	0.8	0.12	2
2204–2545	29.1	1.2	0.18	2
2970–3090	14.4	0.5	0.07	4

hadron events is 236 corresponding to an integrated luminosity $\mathcal{L} = 96\ nb^{-1}$.

The relative yield for reaction (1) as a function of W is shown in fig. 1; for comparison the $J/\psi(3100)$ peak as seen by our apparatus is reported on the same scale. The errors are statistical only and are calculated on the basis of Poisson distribution. No significant structure can be seen in the explored energy range.

In order to derive from the yields shown in fig. 1 the cross section for reaction (1) we have evaluated with a Monte carlo calculation the detection efficiencies of the apparatus for a number of produced poin states ($e^+e^- \to \pi^+\pi^-\pi^0$, $\pi^+\pi^-\pi^0\pi^0$, $\pi^+\pi^-\pi^+\pi^-$, $\pi^+\pi^-\pi^+\pi^-\pi^0$, $\pi^+\pi^-\pi^+\pi^-\pi^+\pi^-$ ...). Phase space momentum distribution has been assumed. The detection efficiency for each final state turned out to be practically independent on energy in the energy range explored by the experiment. Assuming for the relative weights of channels with two, four and six charged pions the values $\sigma_2 : \sigma_4 : \sigma_6 = 45 : 45 : 10$, ref. [6, 7], we obtain an averaged detection efficiency $\epsilon = 0.06$.

The total cross section for reaction (1) averaged over the energy interval 1915–2545 MeV turns out to be $\langle\sigma(e^+e^- \to \text{hadrons})\rangle = 42 \pm 4$ nb.

In order to set upper limits for the production of narrow resonances, we looked at each fluctuation extended over an energy interval of size similar to the machine energy resolution, and compared the observed and the expected (90% C.L.) yields. The explored energy range was divided into four different regions and the maximum expected yield in each region was taken as the upper limit in that region. The results are given in table 1. In column 3, the upper limits for the integrated cross section are given; a constant non resonant contribution $\langle\sigma_{NR}\rangle = 42$ nb has been subtracted. The ratios of these upper limits to the J/ψ integrated cross section [8] are given in column 4. Since we were aiming to obtaining an order of magnitude for the upper limit of the resonant cross sections, in the calculation of the integrated cross sections we did not apply any radiative correction.

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