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SEARCH FOR NARROW RESONANCES IN  $e^+e^-$  ANNIHILATION  
INTO HADRONS IN THE MASS REGIONS 1910 - 2545 MeV  
AND 2970 - 3090 MeV.

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SEARCH FOR NARROW RESONANCES IN  $e^+e^-$  ANNIHILATION INTO HADRONS IN THE MASS REGIONS 1910-2545 MeV AND 2970-3090 MeV.

ABSTRACT. -

We have searched for possible narrow resonances produced in  $e^+e^-$  annihilation at Adone, in the mass regions 1910-2545 MeV and 2970-3090 MeV. No evidence has been found for narrow resonances, within the sensitivity of the present work: we deduce an upper limit on the energy integrated resonant cross section of about 10% of the  $J/\psi(3100)$  corresponding value.

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Following the discovery of the  $J/\psi(3100)$  particle<sup>(1)</sup>, a systematic search for other narrow resonances has been performed at the Adone  $e^+e^-$  storage ring in the reaction

$$e^+e^- \rightarrow \text{hadrons} . \quad (1)$$

In this paper we present results relative to the total c. m. energy ( $W$ ) intervals 1910-2545 MeV and 2970-3090 MeV.

The experimental set-up has been already described elsewhere<sup>(2)</sup>. Events from reaction (1) have been selected by requiring the detection in the optical spark chambers of either two charged prongs plus at least two photons, or at least three charged prongs. With these selection criteria, the background contamination turns out to be negligible. The detection efficiency has been calculated by Monte Carlo method, assuming all the particles being pions, with an invariant phase space momentum distribution, and relative weights for the topological cross sections  $\sigma_2$ ,  $\sigma_4$ ,  $\sigma_6$ <sup>(2)</sup> consistent with the observed multiplicities. The calculated efficiency turns out to be  $\sim 20\%$ , and is practically independent on the energy. The absolute luminosity of the machine is measured by the small angle Bhabha scattering and the double bremsstrahlung as detected in a different straight section of Adone.

The total c. m. energy interval 1910-2545 MeV was explored in 1 MeV steps, and the interval 2970-3090 MeV in 2 MeV steps. The total c. m. energy spread  $\Gamma_W$  (FWHM) of the beams depends on the energy itself, according to  $\Gamma_W(\text{MeV}) = 0.32 W^2 (\text{GeV}^2)$ <sup>(3)</sup>. Therefore in the explored range of masses, the chosen energy steps are adequate to detect also very narrow resonances. The present work refers to a sample of 825 multihadronic events collected in a total integrated luminosity of  $153 \text{ nb}^{-1}$ . Some regions of the mass interval 1910-2200 MeV, where fluctuations in the number of events were found at the first scan, have been scanned more than once.

In Fig. 1 the relative yield for the reaction (1) is shown; for comparison also the excitation curve in the  $J/\psi(3100)$  region is reported in the same scales. The quoted errors are statistical only. No significant structure appears in the explored energy regions. A relevant quantity when producing resonances whose width is less than the mass resolution, is the integrated cross section

$$\int_{\Delta W} [\sigma(W) - \sigma_{NR}(W)] dW$$

where  $\sigma$  is the measured cross section in the energy interval  $\Delta W$  ( $\Delta W \simeq \Gamma_W$  in our case) and  $\sigma_{NR}$  is the non-resonant background as deduced from outside the energy interval  $\Delta W$ . In order to set upper limits on this integrated cross section, the whole explored energy region has been divided into three intervals differing for statistics and mass resolution (see Table I). In each of these three energy regions,

TABLE I - Upper limits at the 90% confidence level for the integrated resonant cross section for a resonance whose width is less than the mass resolution. The radiative corrections have been taken into account.

Total c. m. energy range $W$ (MeV)	$\Delta W$ (MeV)	$\int_{\Delta W} [\sigma(W) - \sigma_{NR}(W)] dW$ upper limit (90% c. l.) (nb·MeV)	Non resonant background $\sigma_{NR}$ (nb)
1910 - 2200	2	950	$29 \pm 9$
2200 - 2545	2	660	$30 \pm 9$
2970 - 3090	4	830	$25 \pm 8$

we have looked for the maximum value of the experimental cross section averaged over  $\Delta W$ . After non resonant background subtraction (see Table I), we have estimated the upper limits (90% c. l.) for the integrated resonant cross section. The radiative corrections have been taken into account<sup>(4)</sup>.

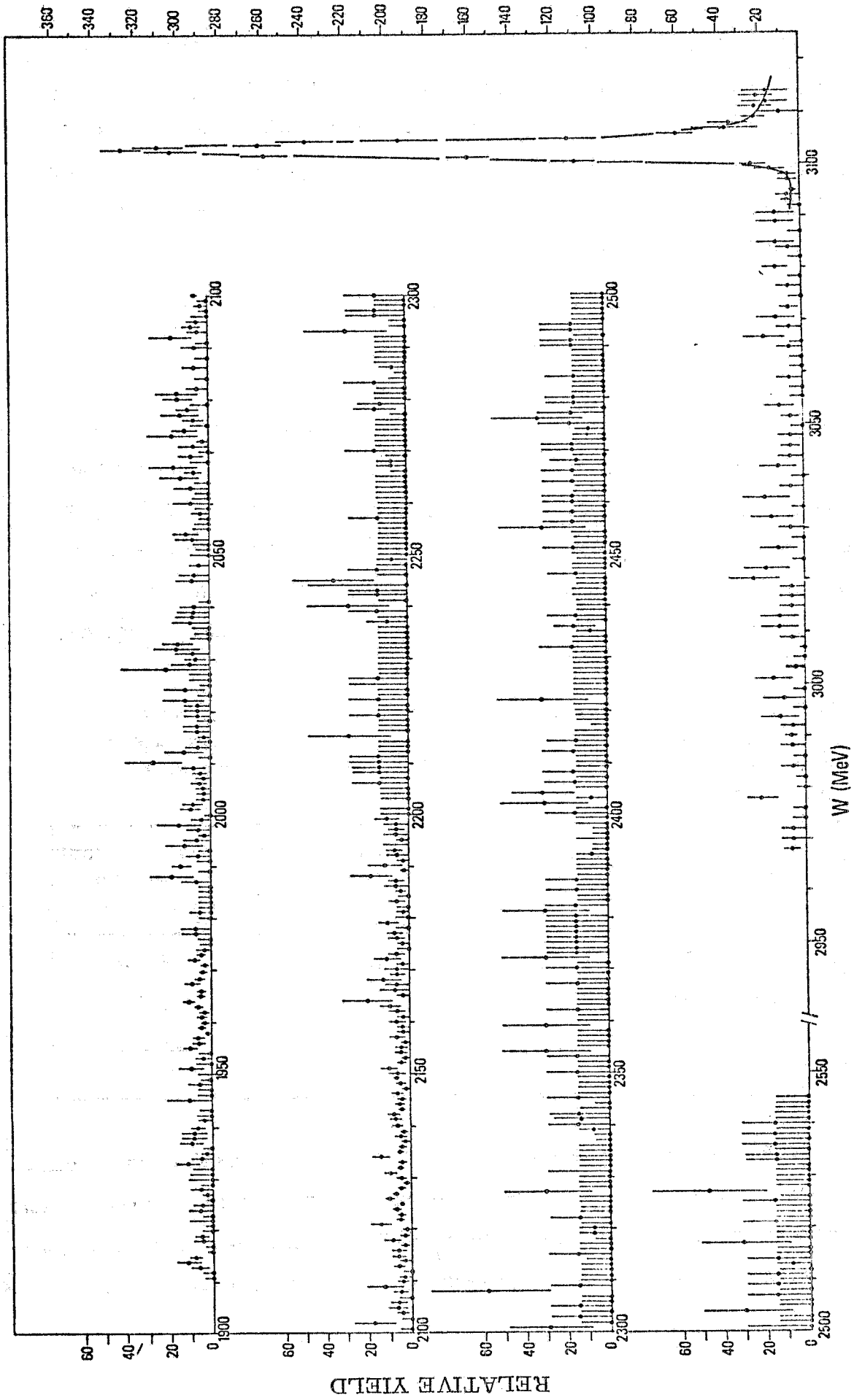


FIG. 1 - Relative yield for the reaction  $e^+e^- \rightarrow$  hadrons as a function of the total c.m. energy  $W$ .

The results are reported in Table I. It appears that, in the whole explored energy range and within the sensitivity of the present work, no narrow resonance is present with an integrated cross section exceeding  $\sim 10\%$  of the corresponding  $J/\psi(3100)$  value ( $9600 \pm 1900$  nb MeV) measured in the same experimental set-up<sup>(20)</sup>. Beside the statistical errors, systematical uncertainties are present, due to those affecting the absolute monitoring ( $\pm 10\%$ ) and the detection efficiency calculation ( $\pm 15\%$ ).

Work is in progress in order to extend this research to unexplored energies and to improve the statistics in the already explored regions.

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