ISTITUTO NAZIONALE DI FISICA NUCLEARE
Laboratori Nazionali di Frascati

LNF-76/61

C. Bacci, V. Bidoli, G. Penso, B. Stella, R. Baldini-Celio, G. Capon, R. Del Fabbro, G. De Zorzi, E. Iarocci, G. La Rosa, C. Mencuccini, G. P. Murtas, M. Spinetti, and V. Valente : EXPERIMENTAL RESULTS ON A SEARCH FOR NARROW RESONANCES IN e^+e^- ANNIHILATION INTO HADRONS IN THE MASS REGION 2520-2990 MeV

Phys. Letters 64B, 356 (1976)

Servizio Documentazione
dei Laboratori Nazionali di Frascati
Cas. Postale 13 - Frascati (Roma)

EXPERIMENTAL RESULTS ON A SEARCH FOR NARROW RESONANCES IN e^+e^- ANNIHILATION INTO HADRONS IN THE MASS REGION 2520–2990 MeV

C. BACCI, V. BIDOLI, G. PENSO and B. STELLA
Istituto di Fisica dell'Università di Roma,
and Istituto Nazionale di Fisica Nucleare, Sezione di Roma, Roma, Italy

R. BALDINI-CELIO, G. CAPON, R. Del FABBRO, G. De ZORZI *, E. IAROCCI, G. LA ROSA, C. MENCUCCINI, G.P. MURTAS, M. SPINETTI and V. VALENTE
Laboratori Nazionali di Frascati, Frascati, Italy

Received 29 July 1976

A search for possible new resonances produced in e^+e^- annihilation at Adone has been performed in the mass region 2520–2990 MeV. No evidence has been found for new resonances. We obtain an upper limit on the energy integrated resonant cross section of about 6% of the J/ψ (3100) corresponding value.

In this letter we report new results on the systematic search [1] for narrow resonances produced in e^+e^- annihilation into hadrons, performed at Adone. The mass region which has been explored is W = 2520–2990 MeV.

The total energy spread (FWHM) of the machine depends on the total c.m. energy W according to [2] Γ_W (MeV) = 0.32 W^2 (GeV^2); therefore, in order to discover possible narrow resonances ($\Gamma \ll \Gamma_W$), the energy region W = 2520–2990 MeV was explored in 1 MeV steps, with an integrated luminosity of about 0.2 nb^{-1} per step. The machine luminosity was measured by the small angle (3°–6°) Bhabha scattering, in a different interaction region of Adone.

A view of the experimental set-up is shown in fig.1. A detailed description of the apparatus has already been reported elsewhere [3]; we give here only its main features. It consists of two large semi-cylindrical telescopes located above and below the interaction region with their axes perpendicular to the beam line. These telescopes consist of scintillation counters, magnetostrictive and optical spark chambers and lead layers arranged in such a way to optimize electromagnetic shower detection. This part of the set-up covers a total solid angle, for a point-like source, of (0.41 $\times 4\pi$) sr for triggering and (0.66 $\times 4\pi$) sr for tracking. The total thickness of the shower detector is 5.5 radiation lengths (47 g/cm^2 equivalent of iron). The shower detector is complemented by a set of 8 bigap spark chambers sandwiched between 9 iron layers 1.5 cm thick, covering a solid angle of (0.27 $\times 4\pi$) sr. The total thickness in this part of the set-up corresponds to a range of a 300 MeV pion. In addition a pair of circular side telescopes (spark chambers with magnetostrictive read-out, lead absorbers and scintillation counters) complement the detection system covering a further fraction of total solid angle of (0.15 $\times 4\pi$) sr (for point-like source). It is worth noting that the effective source at Adone may be represented, along the beam line, as having a gaussian distribution with a width of 17 $W_{\mathrm{GeV}}^{3/2}$ cm (FWHM).

We have selected events from the reaction $e^+e^- \rightarrow$ hadrons by requiring the detection in the optical sparks chambers of either two charged prongs plus at least one photon, or at least three charged prongs. A total sample of 477 good events was collected during the energy scan of this experiment.

The detection efficiency has been calculated under the assumption that all the produced particles are pions, with an invariant phase space momentum distribution, and with relative weights for the topological [4] cross sections σ_2, σ_4, σ_6, consistent with the observed multiplicities. The calculated efficiency turns

* Permanent address: Istituto di Fisica dell'Università di Genova, Genova, Italy.

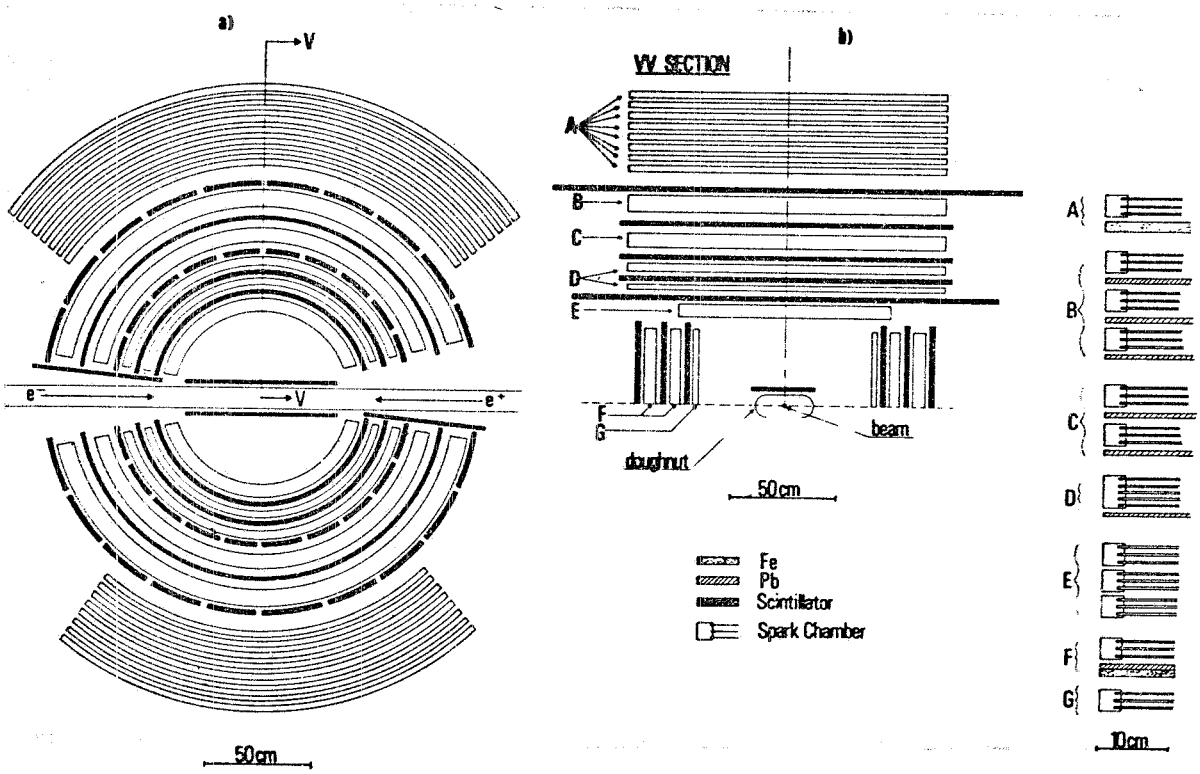

Fig. 1. Schematic view of the experimental set-up: (a) front view from the center of Adone; (b) cross sectional view in the plane normal to the beams. (For the sake of clearness, the circular side telescopes are not shown in the front view of the apparatus).

out to be ~ 20% and is weakly dependent on the energy.

The relative yield of the events as a function of energy is shown in fig. 2. In the same figure we report, for comparison, data from our previous measurements [1] which included the $J/\psi(3100)$ region. The quoted errors are statistical only.

No significant structure is evident in the explored energy region. Following our previous [1] analysis, we define the quantity

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

where ΔW is an energy interval of 3 MeV which is slightly larger than the machine energy spread, $\sigma(W)$ is the measured cross section and σ_{NR} is the non-resonant hadronic cross section. For σ_{NR} we have used an average constant value of 30 nb, following our preliminary evaluation of the total cross section. The maximum value for Σ obtained in the energy region 2520–2990 MeV was used to estimate the upper limit, at 90% confidence level, of the energy integrated resonant cross section. This limit, after applying the radiative corrections [5], turns out to be 550 nb · MeV, which corresponds to about 6% of the integrated cross section of the $J/\psi(3100)$ measured with the same experimental apparatus. This 6% limit is practically independent of systematic errors on the luminosity and on the evaluation of the detection efficiency which altogether amounts to about 20%.

Work is in progress in order to extend this search to lower energies of Adone ($W \leqslant 1900$ MeV).

We would like to express our thanks to Professor M. Grilli for his contribution in the early part of this research. Also we thank the group of Adone for the operation of the machine. Finally we would like to express our appreciation to Mrs. M.A. Melorio for her expert analysis of the film.

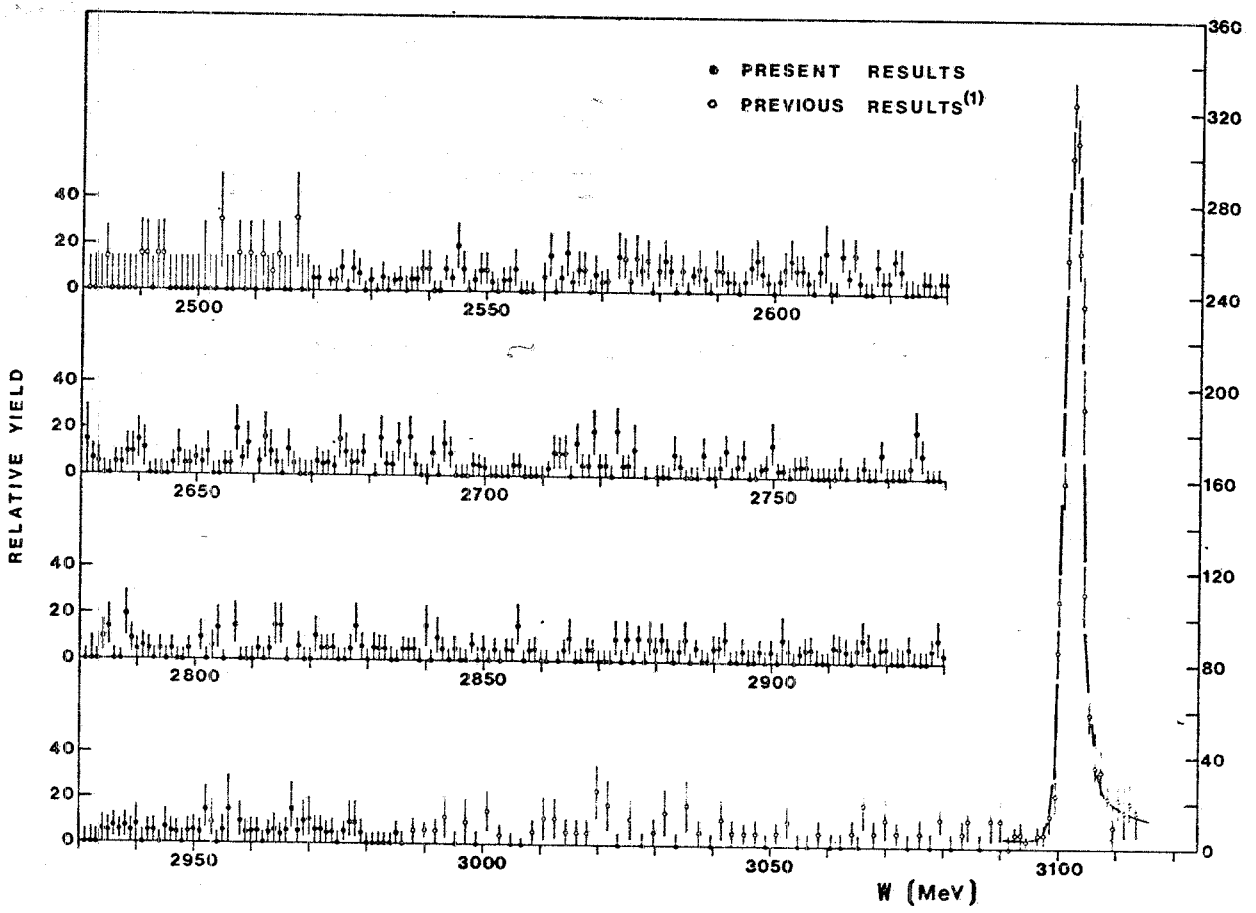

Fig. 2. Relative yield for the reaction $e^+e^- \to$ hadrons as a function of the total c.m. energy W.

References

[1] C. Bacci et al., Phys. Lett. 58B (1975) 481.
[2] M. Bassetti, Adone Mem. E-15 (1974); Gruppo Adone, Status Report on Adone, Frascati Report LNF-71/7 (1971); and Particle Accelerator Conference, Chicago (1971).
[3] R. Baldini-Celio et al., Lett. Nuovo Cim. 11 (1974) 711; C. Bacci et al., Lett. Nuovo Cim. 12 (1975) 269.
[4] R. Baldini-Celio et al., Phys. Lett. 58B (1975) 471.
[5] M. Greco, G. Pancheri-Srivastava and Y. Srivastava, Phys. Lett. 56B (1975) 367.