

To be submitted to
Lett. Nuovo Cimento

ISTITUTO NAZIONALE DI FISICA NUCLEARE
Laboratori Nazionali di Frascati

LNF-76/60(P)
30 Novembre 1976

C. Bacci, R. Baldini Celio, G. Capon, R. DelFabbro, G. De Zorzi,
E. Iarocci, M. Locci, C. Mencuccini, G. P. Murtas, G. Penso, M.
Spinetti, B. Stella and V. Valente: SEARCH FOR THE $J/\psi(3100)$
RADIATIVE DECAY INTO $\eta'(958) + \gamma$.

LNF-76/60(P)
30 Novembre 1976

C. Bacci^(o), R. Baldini Celio, G. Capon, R. Del Fabbro, G. De Zorzi^(x),
E. Iarocci, M. Locci, C. Mencuccini, G. P. Murtas, G. Penso^(o), M.
Spinetti, B. Stella^(o) and V. Valente: SEARCH FOR THE $J/\psi(3100)$
RADIATIVE DECAY INTO $\eta'(958) + \gamma$.

ABSTRACT. -

The radiative decay $J/\psi(3100) \rightarrow \eta'(958) + \gamma$ has been investigated at the Adone Storage Ring looking for the $\eta' \rightarrow \rho\gamma$ decay mode. An upper limit (90% c.l.) of $\Gamma(J/\psi(3100) \rightarrow \eta'\gamma) \leq 230$ eV is obtained.

We report in this letter on a search, performed at the e^+e^- Storage Ring Adone, of the decay mode

$$J/\psi(3100) \rightarrow \eta'(958) + \gamma . \quad (1)$$

Very preliminary results on this research, based on a somewhat different event selection and a much lower integrated luminosity, have already been published⁽¹⁾.

In the framework of the charm model, theoretical and experimental arguments suggest the existence of a mixing between the pseudo scalar partner of the $J/\psi(3100)$ and the η, η' mesons. Therefore it

(o) - Istituto di Fisica, and INFN, Sezione di Roma.

(x) - Permanent address: Istituto di Fisica dell'Università, Genova.

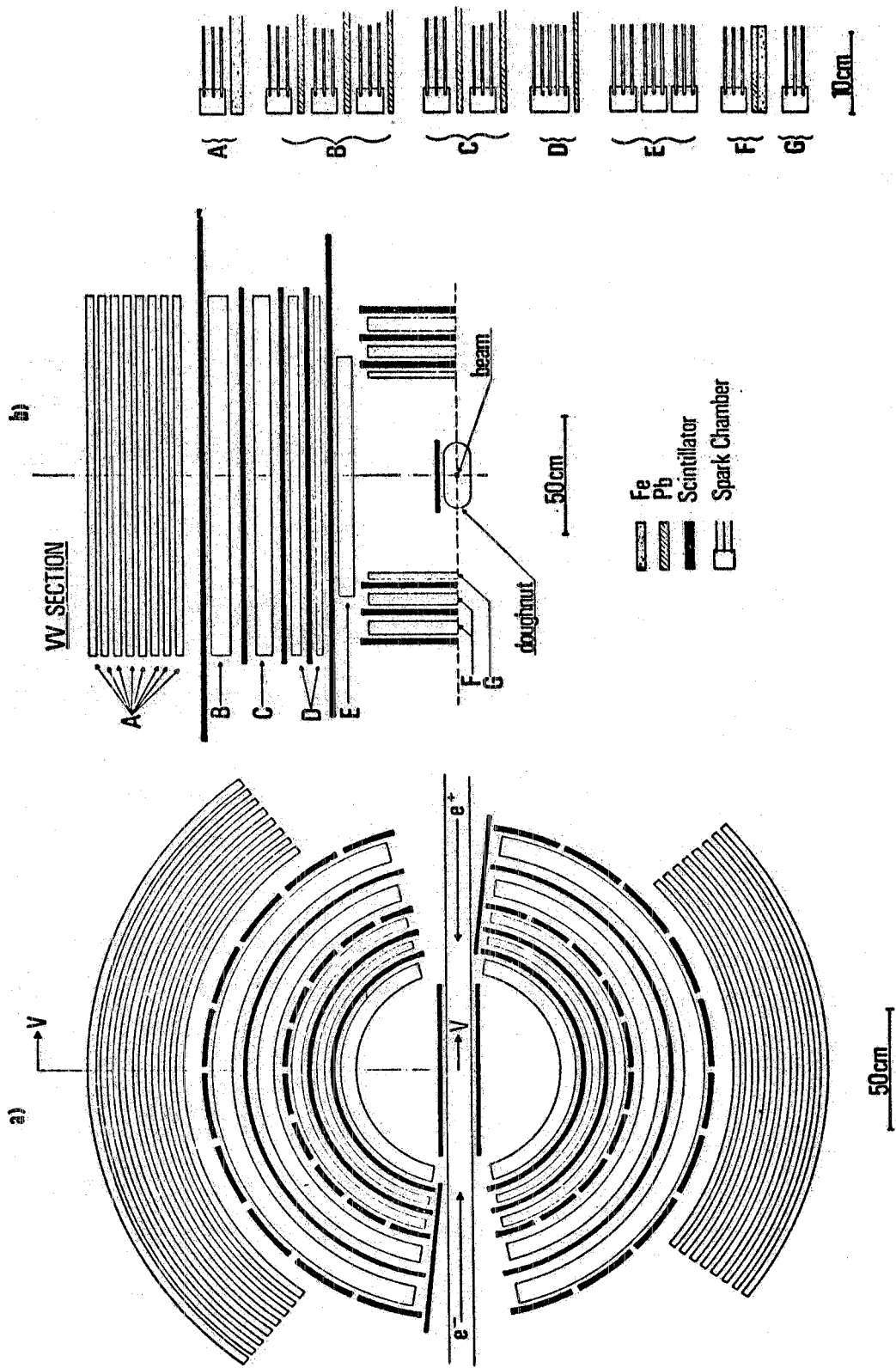


FIG. 1 - Schematic view of the experimental set-up: a) front view from the center of Adone; b) cross-sectional view in the plane normal to the beams. (For the sake of clearness, the side telescopes are not shown in the front view of the apparatus).

The trigger logic was modified to improve, respect to the previous experiment, both photon detection and geometrical efficiency.

Only events with two tracks and two photons detected in the apparatus were considered. In order to reduce that background due to ordinary $J/\psi(3100)$ hadronic decays, the candidate events were further required to have the hard monoenergetic photon recoiling against the η' in one of the large optical telescopes and the two pions and the photon from the η' decay in the opposite one, with no additional particles in the side telescopes.

For this configuration the detection efficiency $\varepsilon_{\eta'\gamma}$ has been calculated to be 5%, according to a Monte Carlo program developed for the apparatus which takes into account the proper angular distributions of the decay products.

Good events were selected by requiring also :

- 1) the measured directions to be compatible with momentum conservation ;
- 2) the calculated kinetic energy of the tracks to be greater than that deduced from the observed range ;
- 3) the observed shower development of the energetic photon to be compatible with its expected energy of 1.40 GeV (the criteria for this test derive from the study of $e^+e^- \rightarrow \gamma\gamma$ events in our apparatus⁽³⁾);
- 4) the above mentioned selection criteria to be still satisfied when varying any measured direction within the experimental angular resolution, which ranges between 0.5° and 1° .

Seven events satisfying all these conditions have been found. The candidates for the process (1) are then selected by further requiring that the $\pi\pi$ and the $\pi\pi\gamma$ invariant mass (γ being the less energetic photon) is compatible with the ρ mass and the η' mass respectively.

The scatter plot versus $M_{\pi\pi}$ and $M_{\pi\pi\gamma}$ for the 7 "good" events is shown in Fig. 2. Here the dashed area shows the region where the candidate events for process (1) are expected to fall (with 95% probability) when taking into account the experimental angular re

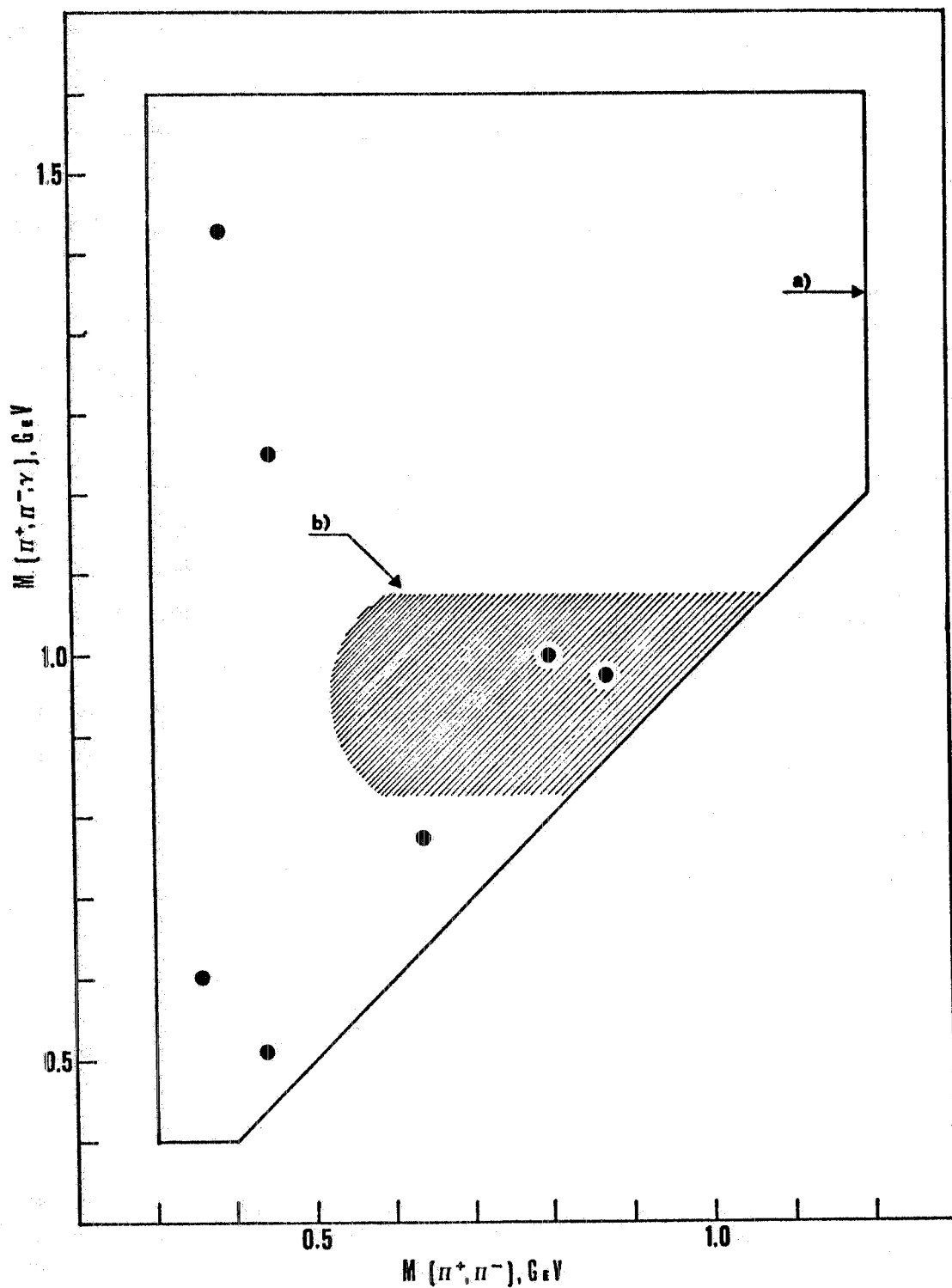


FIG. 2 - Scatter plot of the events versus the invariant masses $M_{\pi\pi}$ and $M_{\pi\pi\gamma}$, γ being the less energetic photon. The contour a) represents the acceptance of the apparatus. The dashed area b) represents the region where events from the $J/\psi(3100) \rightarrow \eta'\gamma$ decay should fall, with 95% probability, if one keeps into account the experimental angular resolution and the ρ meson width.

solution and the ρ width. We find 2 events inside this area and 5 events outside. Assuming an isotropic angular distribution for the tracks and the photons, from the 5 events on the outside region less than one event in the dashed area should be expected.

The number N of expected events from reaction (1) is related to the partial width $(J/\psi(3100) \rightarrow \eta'\gamma)$ by :

$$N = \epsilon_{\eta'\gamma} B(\eta' \rightarrow \rho\gamma) \frac{\Gamma(J/\psi \rightarrow \eta'\gamma)}{\Gamma(J/\psi \rightarrow \text{hadrons})} \mathcal{L}_I \langle \sigma_{\text{Had}} \rangle ,$$

where $B(\eta' \rightarrow \rho\gamma)$ is the $\eta' \rightarrow \rho\gamma$ branching ratio⁽⁴⁾, $\langle \sigma_{\text{Had}} \rangle$ is the total cross section for $e^+e^- \rightarrow \text{hadrons}$ as measured by our apparatus (weighted in the energy interval $W = M_{J/\psi} \pm 2 \text{ MeV}$) and $\Gamma(J/\psi(3100) \rightarrow \text{hadrons})$ is the partial decay width of the $J/\psi(3100)$ into hadrons already measured at Spearg⁽⁵⁾ and by this apparatus⁽⁶⁾.

Accepting as real the 2 observed candidate events we can derive the following upper limit for the partial decay width of $J/\psi(3100)$ into $\eta'\gamma$ of

$$\Gamma(J/\psi(3100) \rightarrow \eta'\gamma) \leq 230 \text{ eV} \quad (90\% \text{ c.l.})$$

or, for the branching ratio of

$$B(J/\psi(3100) \rightarrow \eta'\gamma) \leq 3.3 \times 10^{-3} \quad (90\% \text{ c.l.}).$$

We would like to thank Dr. S. Moriggi for his help in handling magnetostrictive information, Prof. M. Grilli for his contribution in the early part of this experiment. Also we thank the Adone group for the operation of the machine. Finally we gratefully acknowledge Mrs. M. A. Melorio and V. Bidoli for their continuous technical assistance.

REFERENCES. -

- (1) - R. Baldini Celio, G. Capon, R. Del Fabbro, M. Grilli, E. Iarocci, M. Locci, C. Mencuccini, G. P. Murtas, M. A. Spano, M. Spinetti, V. Valente, C. Bacci, G. Penso and B. Stella, Phys. Letters 58B, 475 (1975).
- (2) - V. S. Mathur, S. Okubo and S. Borchardt, Phys. Rev. D11, 2572 (1975); R. N. Cahn and M. S. Chanowitz, Phys. Letters 59B, 277 (1975); H. Harari, Phys. Letters 60B, 172 (1976); H. Chan, K. Konishi, J. Kwiecinski and R. G. Roberts, Phys. Letters 60B, 469 (1976).
- (3) - R. Baldini Celio, M. Bernardini, G. Capon, R. Del Fabbro, M. Grilli, E. Iarocci, L. H. Jones, M. Locci, C. Mencuccini, M. A. Spano, M. Spinetti, V. Valente, C. Bacci, V. Bidoli, G. Penso and B. Stella, Lett. Nuovo Cimento 11, 711 (1974); C. Bacci, G. Penso, B. Stella, R. Baldini Celio, M. Bernardini, M. Bozzo, G. Capon, R. Del Fabbro, M. Grilli, E. Iarocci, L. H. Jones, C. Mencuccini, G. P. Murtas, M. Spinetti and V. Valente, Lett. Nuovo Cimento 12, 269 (1975); 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, Phys. Letters 64B, 356 (1976).
- (4) - Review of Particle Properties, Particle data group (April, 1976).
- (5) - A. M. Boyarsky, M. Breidenbach, F. Bulos, G. J. Feldman, G. E. Fischer, D. Fryberger, G. Hanson, B. Jean-Marie, R. R. Larsen, D. L \ddot{u} ke, V. L \ddot{u} th, H. L. Lynch, D. Lyon, C. C. Morehouse, J. M. Paterson, M. L. Perl, P. Rapidis, B. Richter, R. F. Schwitters, W. Tanenbaum, F. Vannucci, G. S. Abrams, D. D. Briggs, W. Chiniowsky, C. C. Friedberg, G. Goldhaber, J. A. Kadyk, A. M. Litke, B. A. Lulu, F. M. Pierre, B. Sadoulet, G. H. Trilling, J. S. Whitaker, F. Winkelman and J. E. Wiss, Phys. Rev. Letters 34, 1357 (1975).
- (6) - R. Baldini Celio, M. Bozzo, G. Capon, R. Del Fabbro, M. Grilli, E. Iarocci, M. Locci, C. Mencuccini, G. P. Murtas, M. A. Spano, M. Spinetti, V. Valente, C. Bacci, G. Penso and B. Stella, Phys. Letters 58B, 471 (1975).