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9 Dicembre 1974

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G. Barbarino[x], G. Barbiellini, C. Bemporad[o], R. Biancastelli[+], M. Calvetti[o], M. Castellano[x], F. Cevenini[x], F. Costantini[o], G. Di Giugno[x], P. Lariccia[o], G. Nicoletti, P. Parascandolo[x], S. Patricelli[x], E. Sassi[x], L. Tortora[x], G. Troise[x], U. Troya[x] and S. Vitale[x]: PRELIMINARY RESULTS ON THE ENERGY DEPENDENCE OF THE PRODUCTION OF COLINEAR RELATIVISTIC PARTICLES AT ADONE IN THE 3.1 GeV C.M. ENERGY REGION.

We present data on the energy dependence of the production probability of electron pairs around 3.1 GeV total energy at Adone[1-3], in the angular region from 44° to 136° with respect to the direction of the beams.

The apparatus shown in Fig. 1 consists of two symmetrical six counters telescopes. All information on the detected particles, including the colinearity, is extracted from pulse-height and timing analysis on the two photomultiplier tubes mounted on each scintillation counter. In order to minimize the inefficiency due to the finite length of the beam-beam collision region (hereafter called the "source"), the length of the plastic scintillators was made the maximum compatible with the machine geometry.

The longitudinal dimension of the source is typically 60 cm (FWHM) at a beam energy of 1.5 GeV.

All counters have been carefully tested for uniformity and linearity response over the whole surface. As a matter of fact, they had

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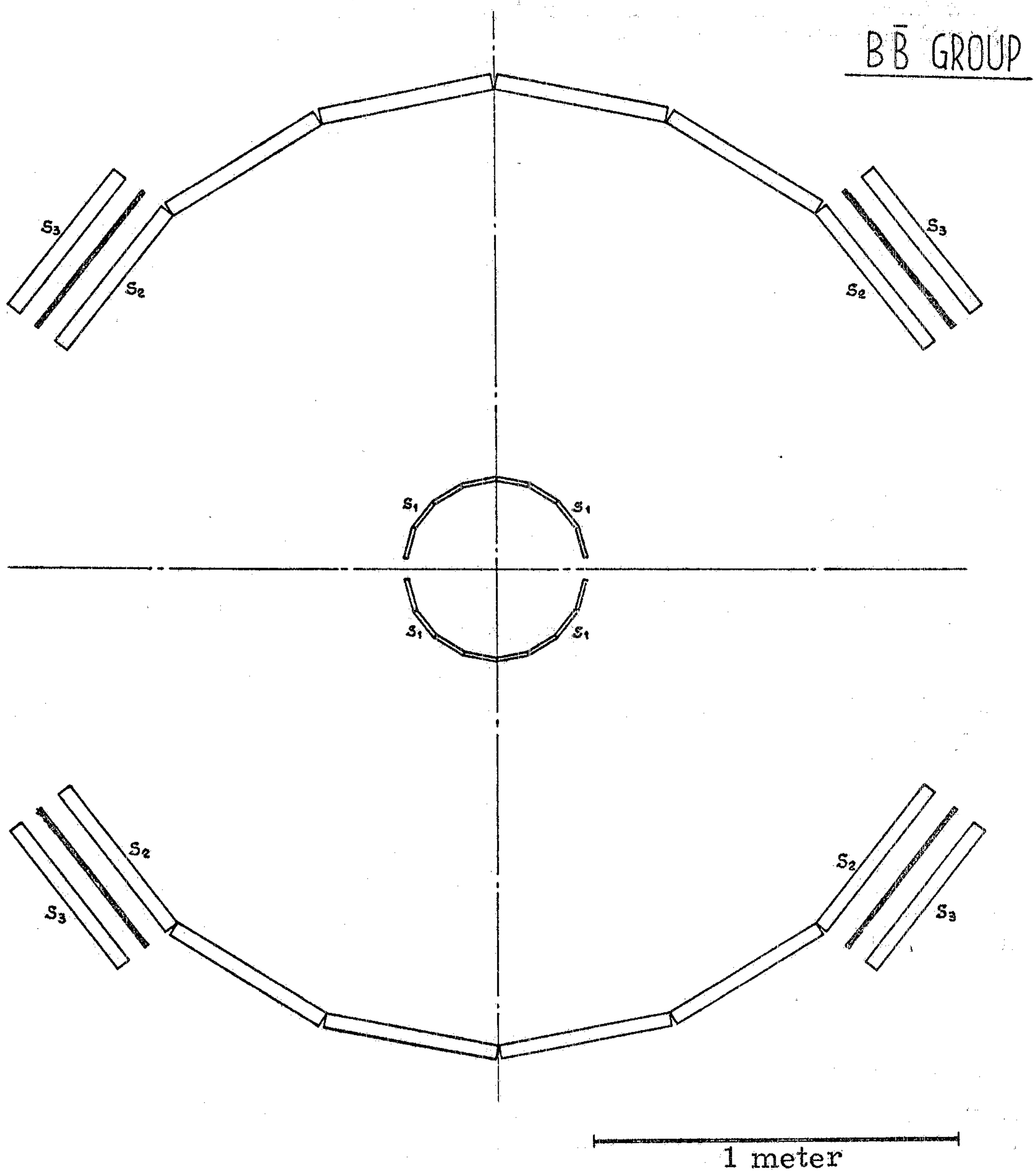


FIG. 1 - Sketch of the experimental apparatus. $S_{1,2,3}$ are scintillation counters with the following dimensions: $S_1 = 0.5 \times 7 \times 100\ cm^3$; $S_{2,3} = 4 \times 46 \times 300\ cm^3$.

been prepared for an experiment on low proton-antiproton production at Adone, based on pulse height analysis and velocity measurement.

The following factors affecting the efficiency have been calculated :

1) Fractional length of the source seen from the apparatus, for Bhabha scattering events and μ-pair production, for a source length of 52 cm FWHM, η_1;

2) Trigger efficiency, η_2 ;

3) Percentage loss due to misaligment between the telescope axis and the beam direction, η_3 ;

4) Fractional loss due to scattering of the electrons out of the apparatus, η_4 ;

5) Fractional loss due to cuts introduced in the off-line analysis, η_5.

These factors were found to be :

$\eta_1 = 0.67$ for Bhabha scattering and 0.75 for μ-pair production,

$\eta_2 = 0.94$,

$\eta_3 \geq 0.96$,

$\eta_4 = 0.99$,

$\eta_5 = 0.96$.

Cosmic rays are rejected in hardware with an efficiency larger than 99%, by requiring the proper time-of-flight between counters S_1 and S_2. A further suppression of the cosmic rays is made off-line using the recorded values of the time-of-flight.

The colinearity of the detected particles and their common vertex at the source is determined using the measurement of the impact point on the counters. The impact point is related to the difference in the time of arrival of the scintillation light at the two photomultipliers seeing each counter. The colinear particles are divided in two categories. In the first one, we include the events with an energy loss corresponding to minimum ionization in all (six) counters of the telescope. In the second category we include the events which show the same behaviour in the counters before the lead absorber, and an energy loss corresponding to at least twice the minimum in counters S_3, which are behind an average of 3.5 radiation lengths of lead.

Figure 2 shows the colinearity of detected events ; Figure 3 shows the angular distribution of electron pairs compared with the expected rate from Bhabha scattering ; Figure 4 shows the bidimensional pulse height distribution for the two opposite counters S_3.

The number of electron pairs normalized for integrated luminosity versus total c.m. energy is shown in Fig. 5a. Figure 5b shows the energy behaviour for production of two colinear minimum ionizing particles (μ-pairs plus hadrons pairs).

In order to derive a cross section for the process $e^+e^- \rightarrow e^+e^-$ at the resonance, one must make use of an absolute monitor. This was provided by our apparatus itself. Its efficiency for detection of e^+e^- pairs was obtained by comparing the expected rate from Bhabha scat

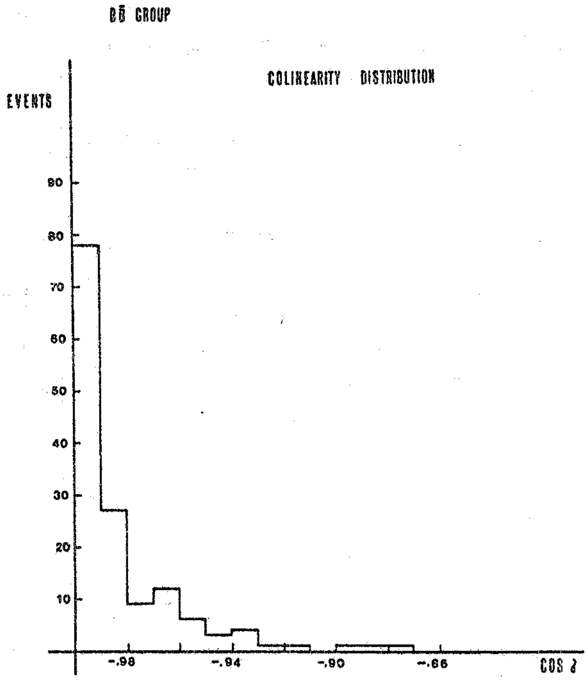


FIG. 2 - Colinearity distribution of e^+e^- events. Colinearity is defined as the cosine of the angle between the two tracks.

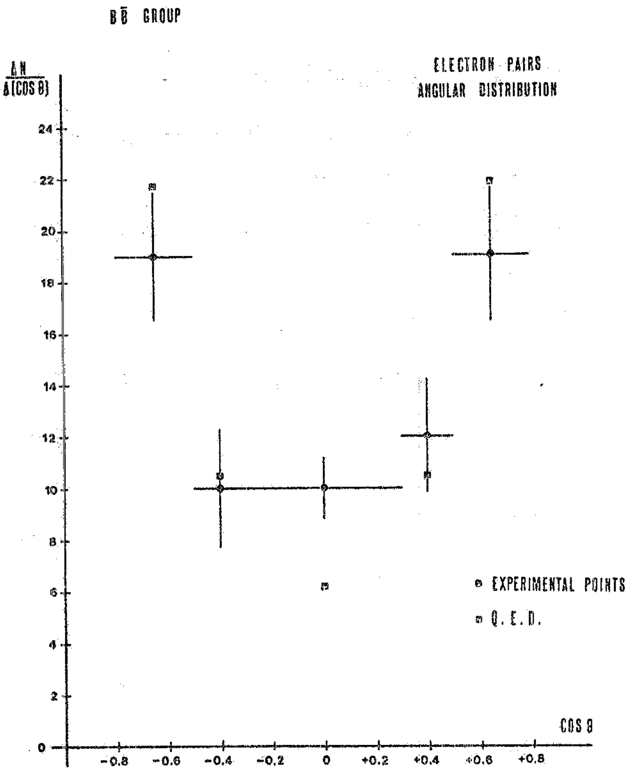


FIG. 3 - Angular distribution of e^+e^- events. ● experimental points ; ▣ Bhabha scattering angular distribution normalized to the total number of events.

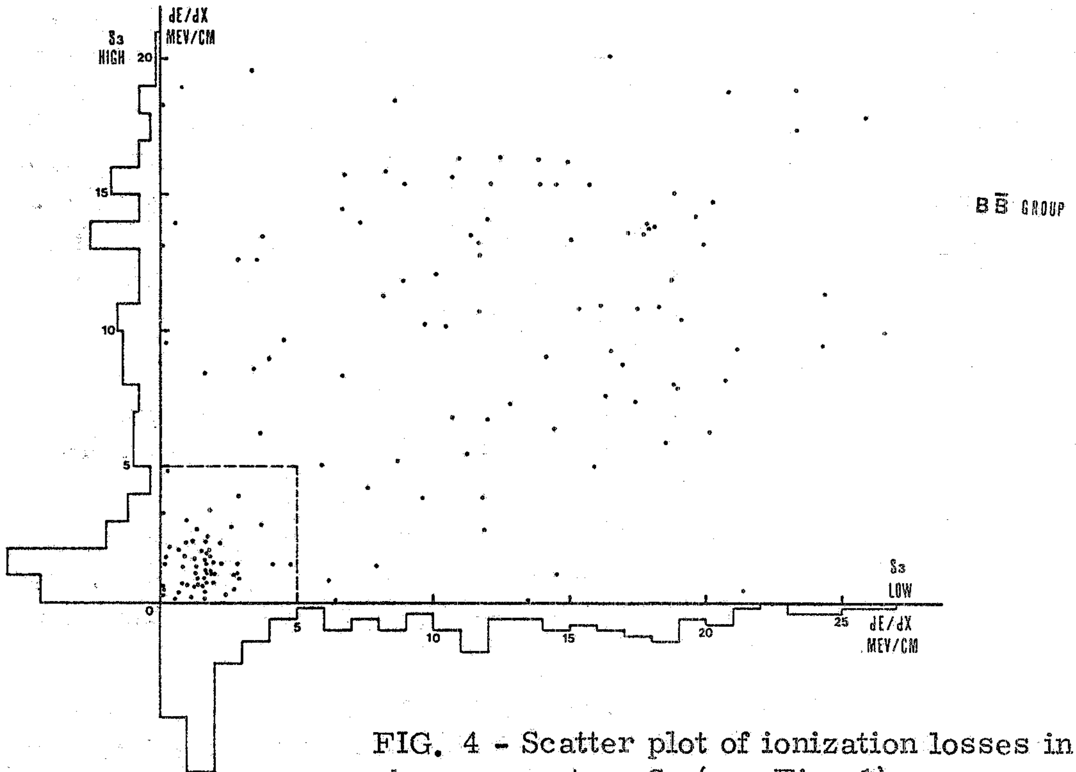
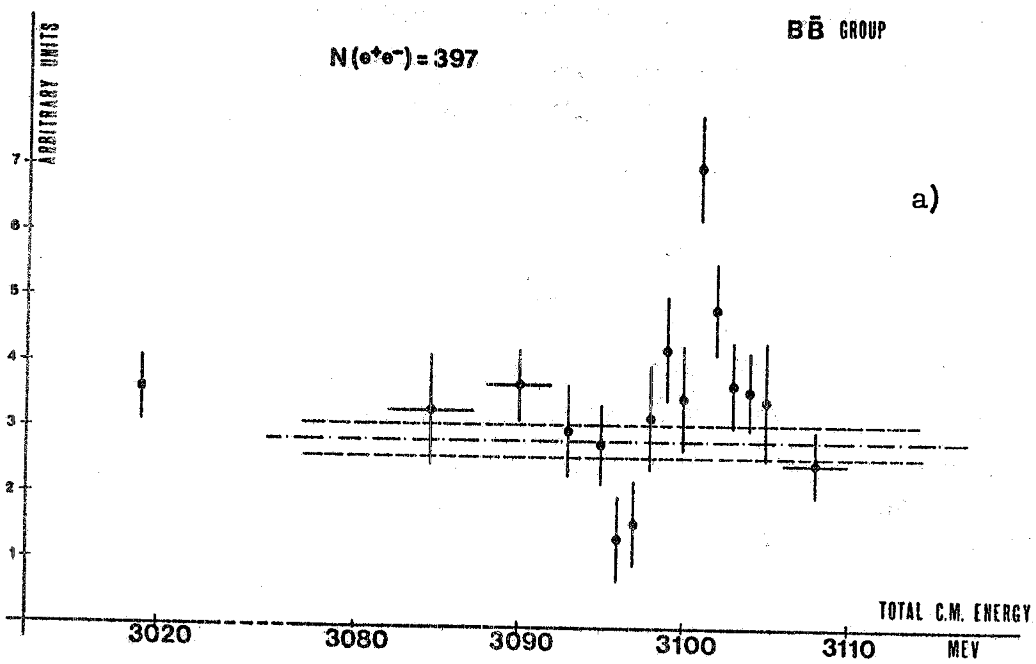


FIG. 4 - Scatter plot of ionization losses in shower counters S_3 (see Fig. 1).



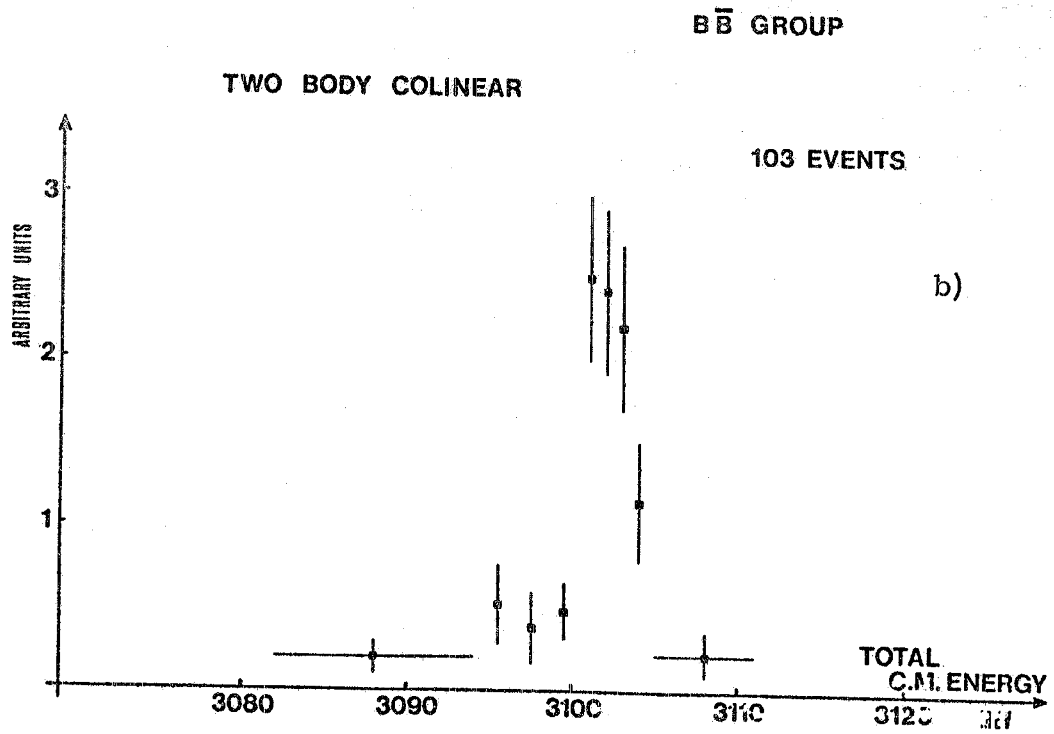


FIG. 5 - a) Yield of e^+e^- events. The dotted line gives the extrapolated values of Bhabha scattering as measured in our apparatus outside the resonance region; b) Yield of two body colinear minimum ionizing particles.

tering with the experimental rate of e^+e^- pairs, at energies well outside the resonance. The small-angle Bhabha scattering monitor of Adone machine group was used as relative monitor.

With this procedure the effect of systematic errors due to detection efficiency and source length are reduced.

In this way we can derive

$$\int (\sigma - \sigma_{QED})\, dW = \frac{6\pi^2 \Gamma_e^2}{M^2 \Gamma} = 459 \pm 110 \text{ nb MeV}$$

and evaluate $\Gamma_e^2/\Gamma = (0.187 \pm 0.05)$ keV with the assumption of spin 1 resonance (systematic errors and radiative corrections are not included).

It should be observed, however, also in view of the peculiar shape of the structure seen in Fig. 5a, that the previous quantity is very sensitive to the Bhabha scattering subtraction.

We would like to thank all the Adone staff members for the hard effort made in running the machine under the very hard conditions required by this investigation. Very useful suggestions in dealing with narrow resonances have been given to us by the Frascati and Roma Theoretical Groups. Finally we are very grateful to all technicians of Frascati National Laboratories and Naples and Pisa who have been of great help in modifying our apparatus for the study of this phenomenon.

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