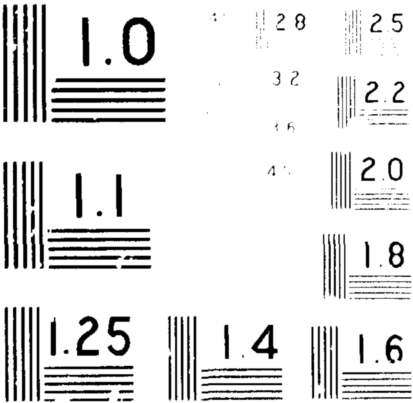
1.0
2.8
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COMITATO NAZIONALE PER L'ENERGIA NUCLEARE
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WIDE ANGLE ELECTRON-POSITRON BREMSSTRAHLUNG AT ADONE. A NEW LIMIT FOR THE EXISTENCE OF A HEAVY ELECTRON.

SUMMARY. -

The cross section for the reaction $e^+ + e^- \rightarrow e^+ + e^- + \gamma$ has been measured at the Adone storage ring. The results in agreement with the QED predictions, establish a new limit for the mass and the coupling constant $e^x e \gamma$ of a heavy electron e^x ([redacted]).

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In this paper we report the results of an experiment performed at the Adone electron-positron storage ring to study the reaction

$$e^+ + e^- \rightarrow e^+ + e^- + \gamma \qquad (1)$$

in the total c.m. energy range $1.4 \div 3.0$ GeV and in the kinematical region where all the angles between any of the incoming and outgoing particles are larger than $\sim 15^\circ$.

The experimental apparatus is basically the same as that de-

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scribed in a previous paper(1). It consists primarily (see Fig. 1) of four blocks (A, B, D, S) of scintillation counters, lead converters and spark chambers which allow us to distinguish with good accuracy between showering and non-showering particles. To identify charged particles and to improve the kinematical reconstruction, two thin cylindrical spark-chambers C_1 and C_2 have been placed close to the doughnut.

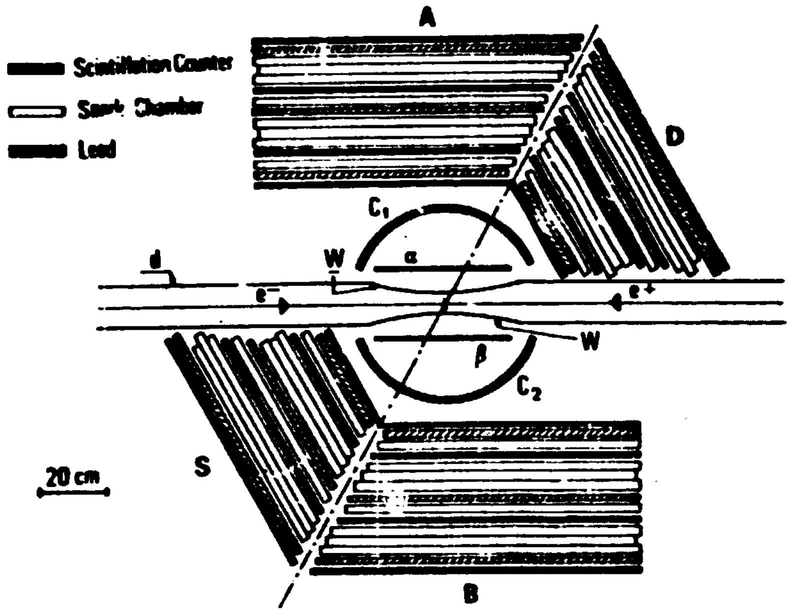

FIG. 1 - Experimental apparatus; front view from the center of the Adone storage ring; d: doughnut; w: 0.15 mm stainless stell window.

The apparatus was triggered whenever three or more particles (at least one charged) had been detected in coincidence in three out of the four blocks A, B, D, S.

To identify events from reaction (1) we require: a) three showering particles, two charged and one neutral; b) coplanarity of the 3 showers; c) kinematical reconstruction consistent with reaction (1) and with our trigger energy threshold.

In this way we have obtained 118 events; they are distributed at various c.m. energies as shown in Table I.

TABLE I

Number of events $e^+ + e^- \to e^+ + e^- + \gamma$ vs. the total c.m. energy. E is the energy of each beam. L is the time integrated luminosity of Adone.

2 E (GeV)	1.4	1.6	1.7	1.87	1.96	2.1	2.4	2.8	3.0
L (nb^{-1})	51.9	35.3	31.2	84.8	65.1	248	46	158	249
Events	11	10	9	12	10	31	5	10	20

We have compared our experimental results with a Montecarlo calculation based on QED predictions. These calculations used pure quantum electrodynamics, to evaluate the cross section of process (1), which is of third order in α(2). The diagrams taken into account are the same ones used in ref. (2).

We have disregarded radiative corrections. A tentative estimate of this contribution based on calculations for similar processes gives a possible uncertainty of ~ 10% in the theoretical predictions for the yield.

In Fig. 2a we give the experimental yield from process (1) in the c.m. total energy range 1.4 ÷ 3 GeV, together with the theoretical prediction.

The smooth curve indicates the absolute prediction of QED on the basis of our measured luminosity, without any normalization. The errors on the experimental points are statistical only. The maximum around 1.6 GeV is due only to our particular geometry and trigger requirements.

Since we measure the direction of all three particles produced in reaction (1), we can calculate the energy of each of them from the measured angles and compare our experimental energy distribution with that predicted by QED. This comparison is shown in Fig. 2b.

The good agreement between experiment and theory shown in Figg. 2a and 2b makes us confident of the validity of QED in this third order process. Furthermore we point out that due to our trigger, we detect process (1) in the kinematical region characterized by one γ with energy greater than 100 MeV emitted at wide angle with respect to the directions of the incident and the scattered electrons. This puts a rather hard cut on the electron propagator.

The experimental data can also be analysed in order to set a limit on the existence of a possible heavy electron (e^*) produced in the reaction

$$e^+ + e^- \to e^\pm + \underset{\hookrightarrow e^\mp + \gamma}{e^{*\mp}} \qquad (2)$$

This kind of heavy electron was suggested by F.E. Low(3) and several experiments have been carried out to look for its existence(4, 5, 6).

To evaluate the possible contribution to our data from reaction (2), we have calculated for each event the two possible values for the $(e^\mp, \gamma)$ invariant mass.

In Fig. 3 we report this invariant mass spectrum, together with

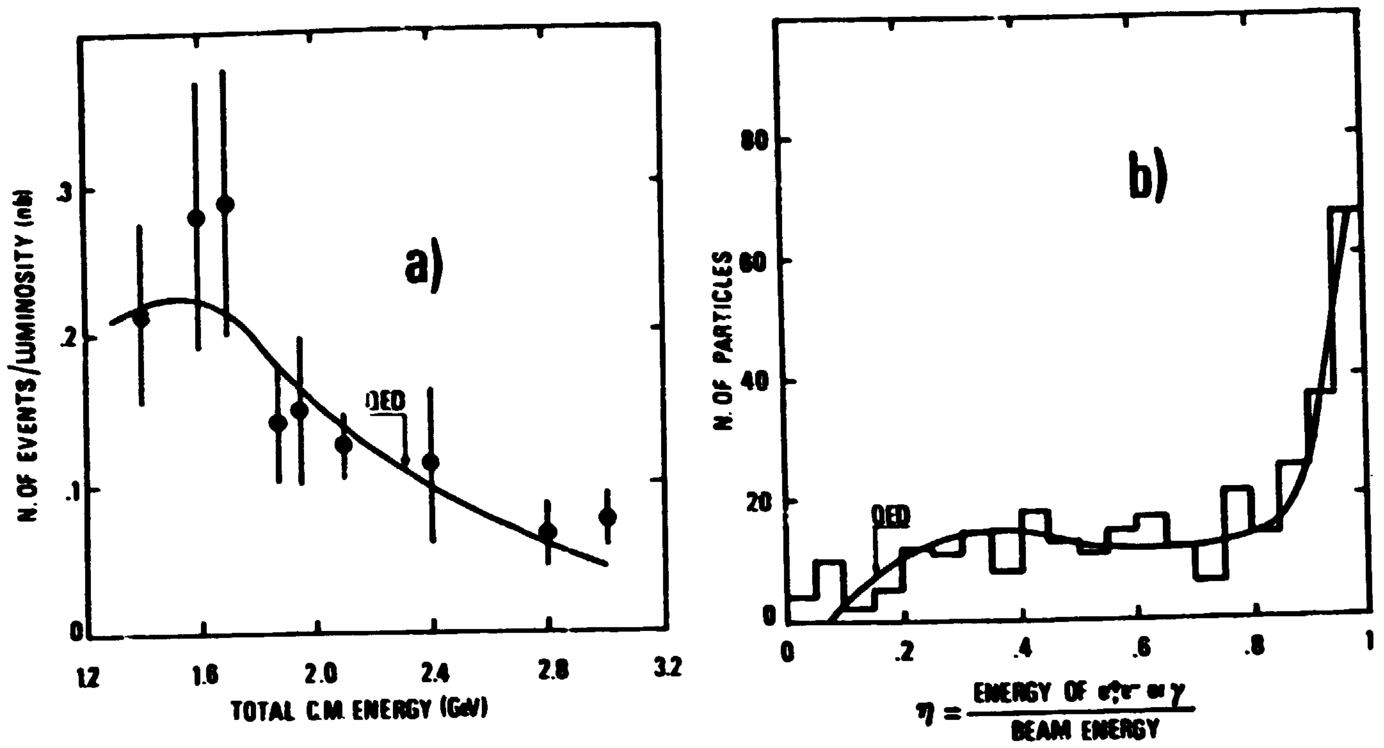

FIG. 2 - Comparison of experimental results with the absolute predictions of QED without radiative corrections. a) Yield of reaction (1) vs. total c.m. energy. b) Number of particles (electron or gamma) vs. the fractional energy η of each final state particle.

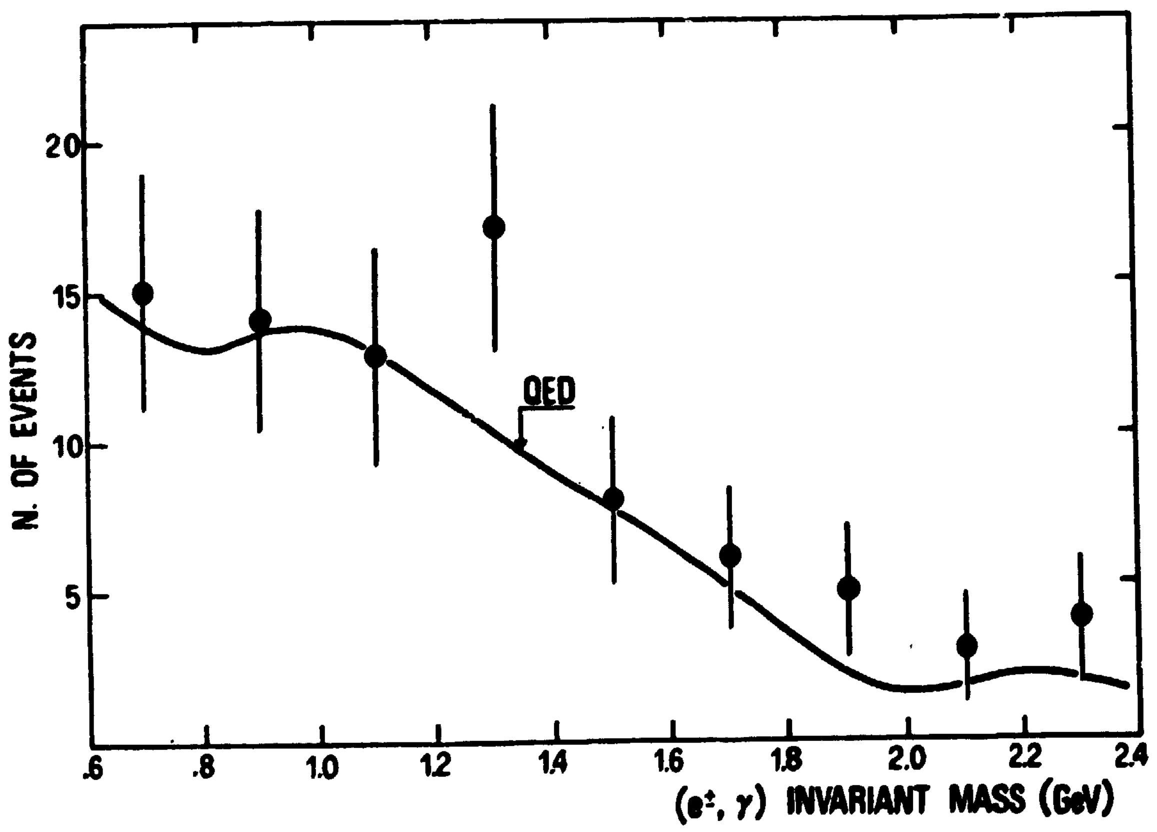

FIG. 3 - Experimental distribution of the $(e^\pm, \gamma)$ invariant mass for the outgoing particles. The curve is the absolute QED prediction for reaction (1).

the absolute QED prediction for reaction (1).

This experimental distribution has also been fitted with the theoretical prediction calculated by standard QED, taking into account both reaction (1) and (2). The cross section for reaction (2) has been evaluated$^{(7)}$ from the Hamiltonian

$$H_I = (e\lambda/m^x)\,\bar{\psi}_{e^x}\,\sigma_{\mu\nu}\,\psi_e\,F^{\mu\nu} + H.C.$$

where λ is the $(e\,e^x\,\gamma)$ coupling constant and m^x is the mass of e^x.

From this analysis we have obtained a new upper limit on λ^2 in the e^x mass range from 0.6 to 2.2 GeV with 95% confidence level.

In Fig. 4 we report this upper limit and present a comparison with results of previous experiments$^{(5,6)}$.

We wish to thank Dr. A.F. Grillo for useful discussions.

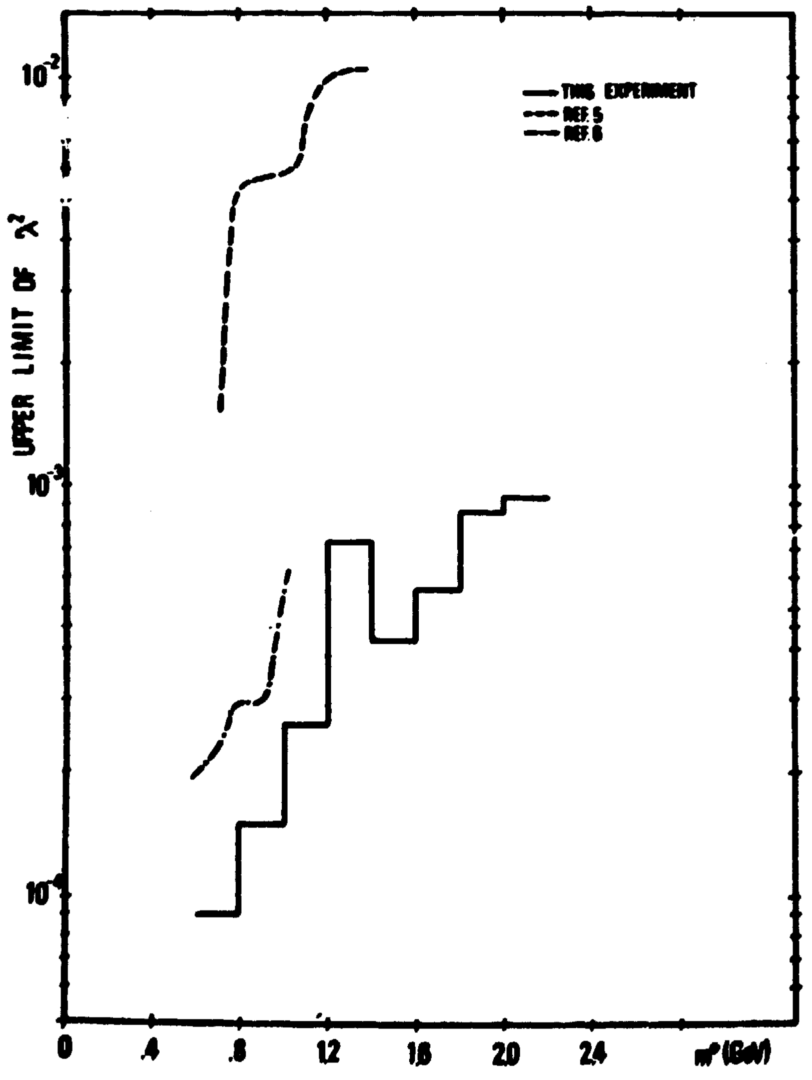

FIG. 4 - Comparison of upper limits (95% conf. level) on λ^2 vs. the e^x mass, from this experiment and previous ones.

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