EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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Preliminary Results from the L3 Experiment at $\sqrt{s} = 183$ GeV

The L3 Collaboration

Abstract

We summarize preliminary results from the first LEP run at centre-of-mass energies around 183 GeV from July 31 to August 14, 1997. During this period the L3 detector collected a total integrated luminosity of 6.1 pb^{-1}. The data discussed here comprise measurements of total cross sections and forward-backward asymmetries of fermion-pair production $e^+e^- \rightarrow f\bar{f}(\gamma)$, studies of hadronic event shape variables and a measurement of the total W-pair production cross section. In addition, initial studies on photonic final states are presented.

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1 Fermion-pair production

The analysis of fermion-pair production follows the one performed for data collected at 161 and 172 GeV (see reference [1]). Total cross sections and forward-backward asymmetries are measured for the full data samples, defined by the effective centre-of-mass energy $\sqrt{s'} > 0.1\sqrt{s}$, and excluding the radiative return to the Z by requiring $\sqrt{s'} > 0.85\sqrt{s}$. The numbers of selected events are summarized in table 1. The preliminary cross sections and forward-backward asymmetries are shown in figures 1, 2, 3, 4 and 5 where the new results are compared to our measurements at lower energies and the Standard Model expectation as calculated using ZFITTER [2] and TOPAZ0 [3] (for $e^+e^- \to e^+e^-(\gamma)$). Systematic uncertainties on total cross sections and forward-backward asymmetries are estimated to be small compared to the current statistical errors.

2 QCD studies

We extend the study of hadronic event shape variables as described in reference [4] to the data collected at the increased centre-of-mass energy. In figures 6 and 7 we show the evolution of the average thrust and the average charge particle multiplicity. Our new measurements at 183 GeV are compared to results at lower energies and to various QCD models.

3 W-pair production

The selection of $e^+e^- \to W^+W^-(\gamma)$ events follows the procedures applied for the data collected at 161 and 172 GeV (see reference [5, 6]). The numbers of observed events and the measured cross sections in the different W decay channels are reported in table 2. Combining all decay channels we measure the total cross section $e^+e^- \to W^+W^-(\gamma)$ at 183 GeV to be

$$\sigma_{\mathrm{WW}} = 16.9\,^{+2.1}_{-1.9} \pm 0.5(syst)\ \mathrm{pb}.$$

This result is compared to our measurements at lower energies and to different models in figure 8. The Standard Model cross section, as well as the curves assuming no ZWW couplings and only t-channel exchange of ν_e, are calculated with the GENTLE program [7].

4 Photonic final states

We have studied the process $e^+e^- \to n\,\gamma$ $(n \geq 2)$ at $\sqrt{s} = 183$ GeV. Details of the analysis can be found in reference [8] which describes the studies performed at lower energies. Results are summarized in table 3.

We measure the total cross section $e^+e^- \to \gamma\gamma(\gamma)$ with the two photons contained in the angular range $16^\circ \leq \theta_\gamma \leq 164^\circ$ to be

$$\sigma_{\gamma\gamma(\gamma)} = 12.4 \pm 1.7\ \mathrm{pb}.$$

The result is compared in figure 9 to our measurements at lower energies and the QED prediction [9] as function of the centre-of-mass energy.

Acknowledgements

We wish to congratulate the CERN accelerator divisions for the successful upgrade of the LEP machine and to express our gratitude for the excellent performance of the machine. We acknowledge with appreciation the effort of all engineers, technicians and support staff who have participated in the construction and maintenance of this experiment.

References

[1] L3 Collab., M. Acciarri et al., Measurement of Hadron and Lepton-Pair Production at 161 GeV $< \sqrt{s} <$ 172 GeV at LEP, Preprint CERN-PPE/97-052, CERN, 1997, submitted to Phys. Lett. B.

[2] D. Bardin et al., FORTRAN package ZFITTER, Preprint CERN-TH 6443/92;
D. Bardin et al., Zeit. Phys. **C 44** (1989) 493;
D. Bardin et al., Nucl. Phys. **B 351** (1991) 1;
D. Bardin et al., Phys. Lett. **B 255** (1991) 290.

[3] G. Montagna et al., Nucl. Phys. **B 401** (1993) 3;
G. Montagna et al., Comp. Phys. Comm. **76** (1993) 328.

[4] L3 Collab., M. Acciarri et al., QCD Studies and Determination of α_s in e^+e^- collisions at $\sqrt{s}$ = 161 GeV and 172 GeV, Preprint CERN-PPE/97-042, CERN, 1997, submitted to Phys. Lett. B.

[5] L3 Collab., M. Acciarri et al., Phys. Lett. **B 398** (1997) 223.

[6] L3 Collab., M. Acciarri et al., Measurement of W-Pair Cross Sections in e^+e^- Interactions at $\sqrt{s} = 172$ GeV and W-Decay Branching Fractions, Preprint CERN-PPE/97-067, CERN, 1997, submitted to Phys. Lett. B.

[7] The GENTLE version 2.0 is used.
D. Bardin et al., GENTLE/4fan v. 2.0: A Program for the Semi-Analytic Calculation of Predictions for the Process $e^+e^- \to 4f$, DESY 96-233, hep-ph/9612409.

[8] L3 Collab., M. Acciarri et al., Hard-photon production at $\sqrt{s} = 161$ GeV and 172 GeV at LEP, Preprint CERN-PPE/97-077, CERN, 1997, submitted to Phys. Lett. B.

[9] F.A. Berends and R. Kleiss, Nucl. Phys. **B 186** (1981) 22.

	$\sqrt{s'} > 0.1\sqrt{s}$			$\sqrt{s'} > 0.85\sqrt{s}$		
	# events	σ [pb]	A_{FB}	# events	σ [pb]	A_{FB}
$\mathrm{e^+e^-} \to \mathrm{hadrons}(\gamma)$	588	103.6 ± 4.6	–	153	21.5 ± 2.4	–
$\mathrm{e^+e^-} \to \mu^+\mu^-(\gamma)$	35	8.4 ± 1.4	0.09 ± 0.18	17	2.8 ± 0.7	0.49 ± 0.20
$\mathrm{e^+e^-} \to \tau^+\tau^-(\gamma)$	28	12.1 ± 2.8	0.18 ± 0.20	18	3.9 ± 1.2	$0.99\,^{+0.01}_{-0.15}$
$\mathrm{e^+e^-} \to \mathrm{e^+e^-}(\gamma)$	146	24.0 ± 2.0	0.72 ± 0.07	123	20.7 ± 1.9	0.79 ± 0.07

Table 1: Results on fermion-pair production at $\sqrt{s} = 183$ GeV: The number of events selected in the data, the measured cross sections (σ) and forward-backward asymmetries (A_{FB}) are listed for the total and the high energy event samples.

$\mathrm{e^+e^-} \to \mathrm{W^+W^-}$	# events	σ [pb]
$\to \mathrm{qq\,e}\nu$	15	$3.2\,^{+0.9}_{-0.8} \pm 0.2$
$\to \mathrm{qq}\,\mu\nu$	16	$3.3\,^{+0.9}_{-0.8} \pm 0.2$
$\to \mathrm{qq}\,\tau\nu$	7	$1.6\,^{+1.1}_{-0.9} \pm 0.1$
$\to \ell\nu\,\ell\nu$	5	$1.9\,^{+1.0}_{-0.7} \pm 0.1$
$\to \mathrm{qqqq}$	44	$6.6\,^{+1.3}_{-1.2} \pm 0.3$
Total	87	$16.9\,^{+2.1}_{-1.9} \pm 0.5$

Table 2: Results on W-pair production $\sqrt{s} = 183$ GeV: Number of selected events and measured cross sections in the different $\mathrm{W^+W^-}$ decay channels. The first error is statistical and the second systematic. The total cross section $\mathrm{e^+e^-} \to \mathrm{W^+W^-}(\gamma)$ is obtained assuming Standard Model W branching ratios.

	# events	expected
$2\ \gamma$	52	54
$3\ \gamma$	4	4
$\geq 4\ \gamma$	0	0

Table 3: Number of events observed and expected from QED with 2, 3 and 4 or more photons in the detector.

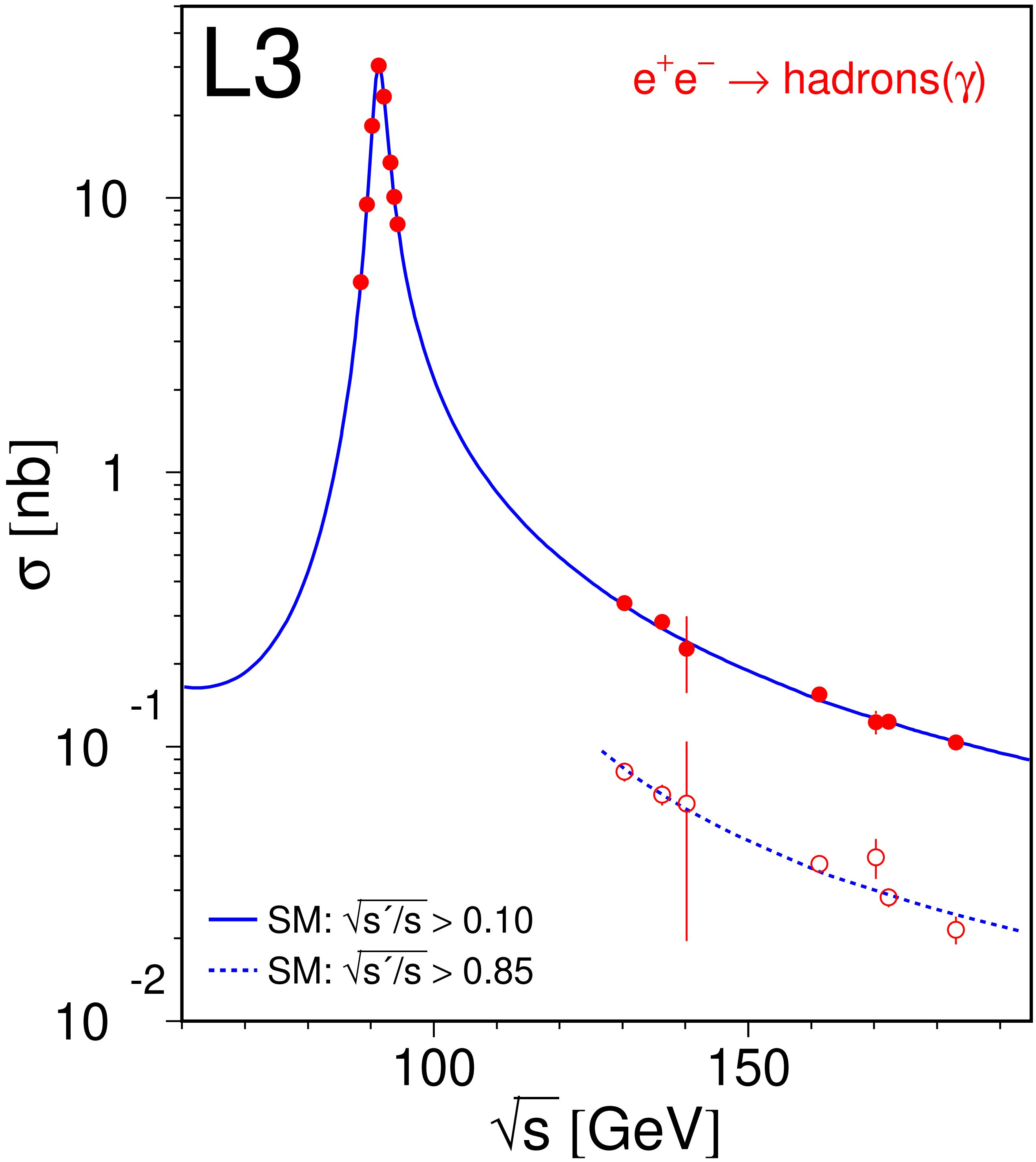

Figure 1: Measured cross sections of the reaction $e^+e^- \rightarrow$ hadrons(γ) as function of the centre-of-mass energy.

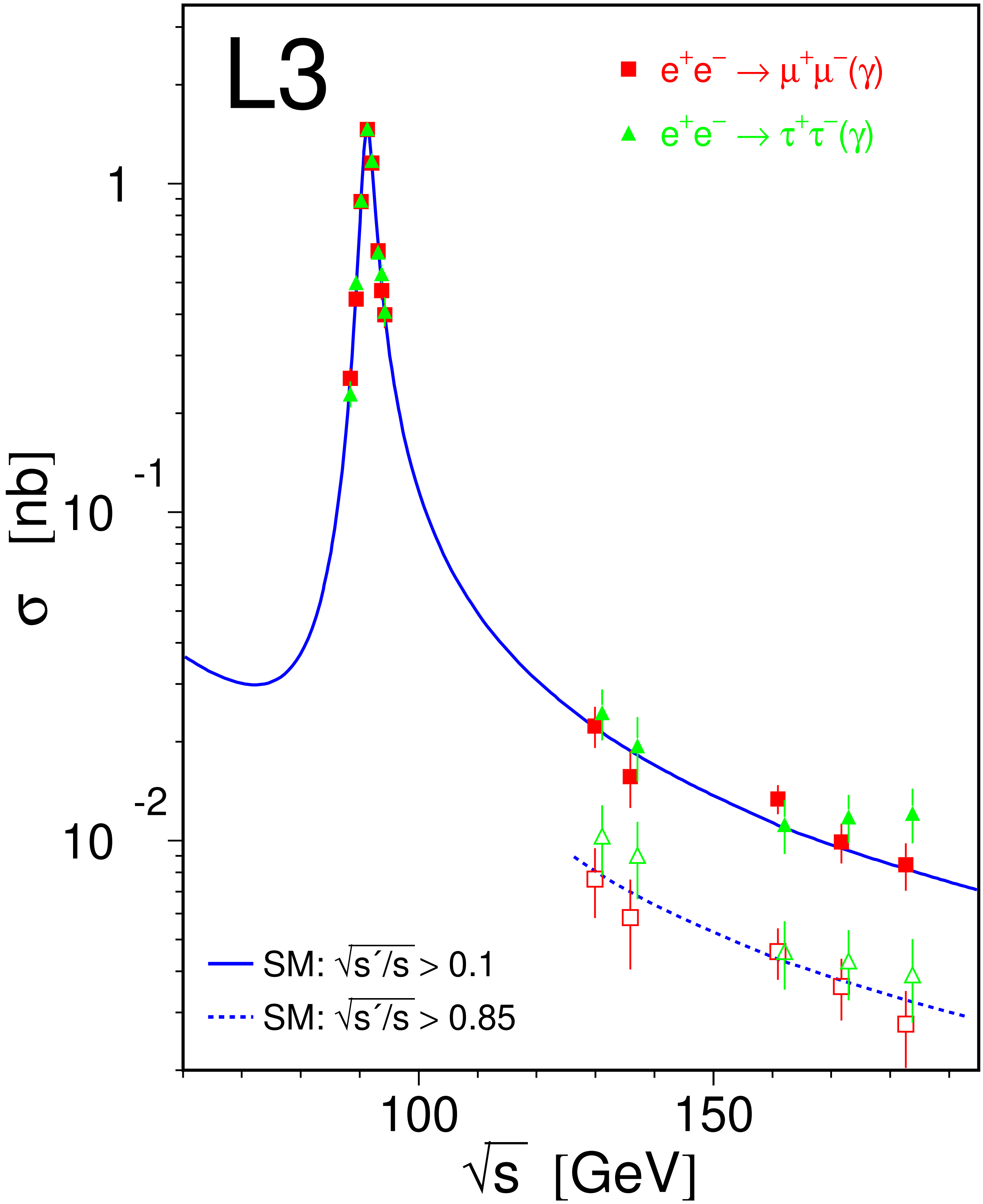

Figure 2: Measured cross sections of the reactions $e^+e^- \to \mu^+\mu^-(\gamma)$ and $e^+e^- \to \tau^+\tau^-(\gamma)$ as function of the centre-of-mass energy.

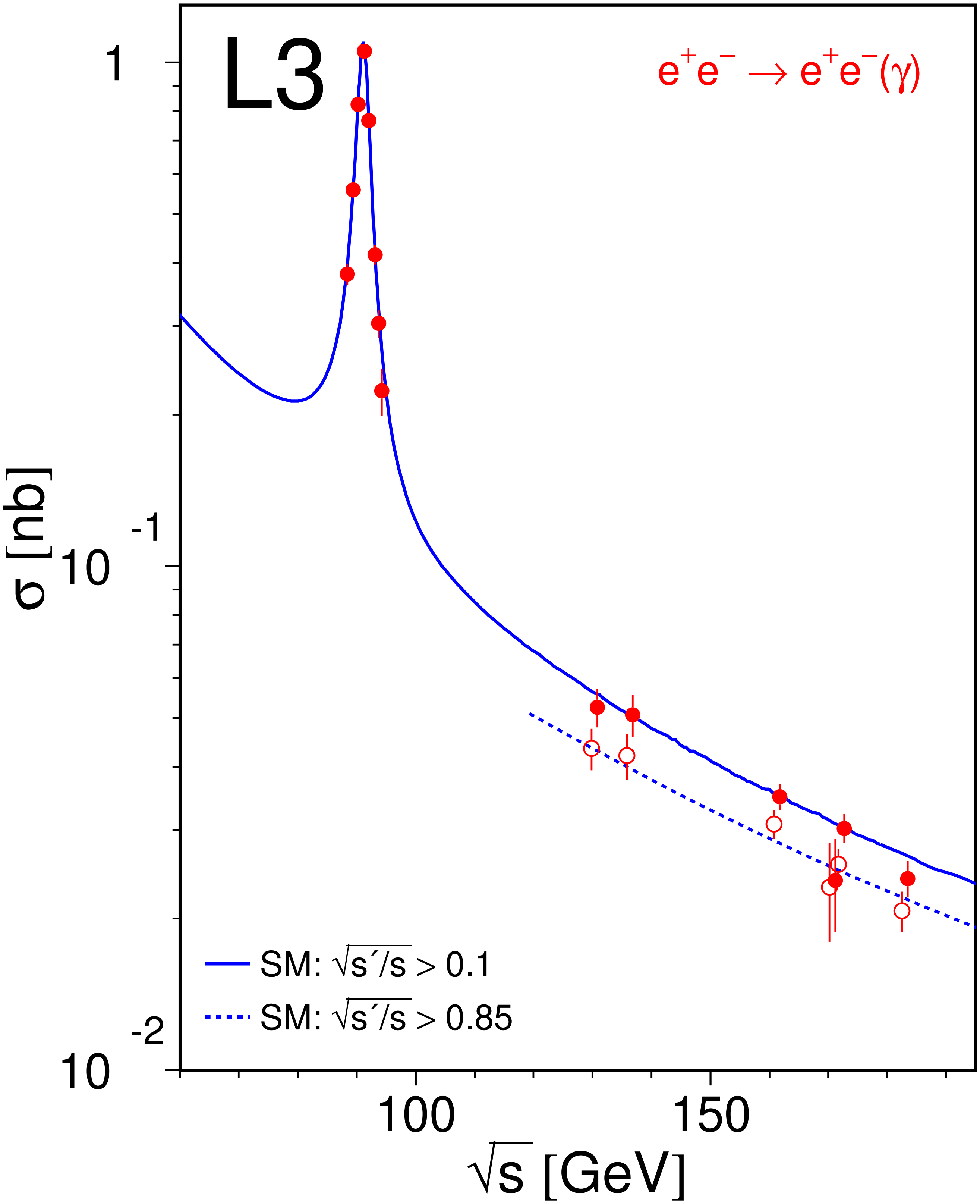

Figure 3: Measured cross sections of the reaction $e^+e^- \to e^+e^-(\gamma)$ as function of the centre-of-mass energy.

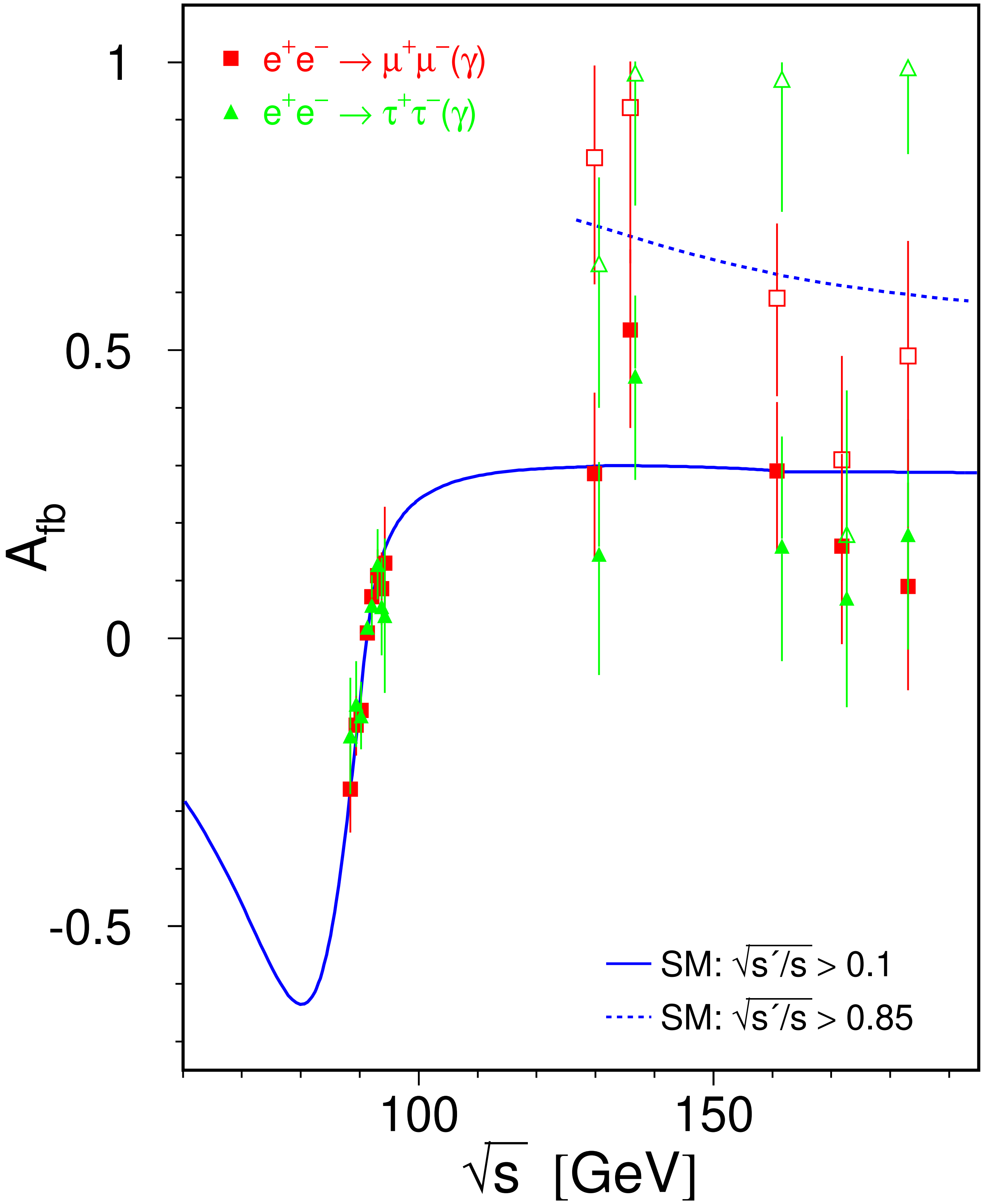

Figure 4: Measured forward-backward asymmetry in $e^+e^- \rightarrow \mu^+\mu^-(\gamma)$ and $e^+e^- \rightarrow \tau^+\tau^-(\gamma)$ as function of the centre-of-mass energy.

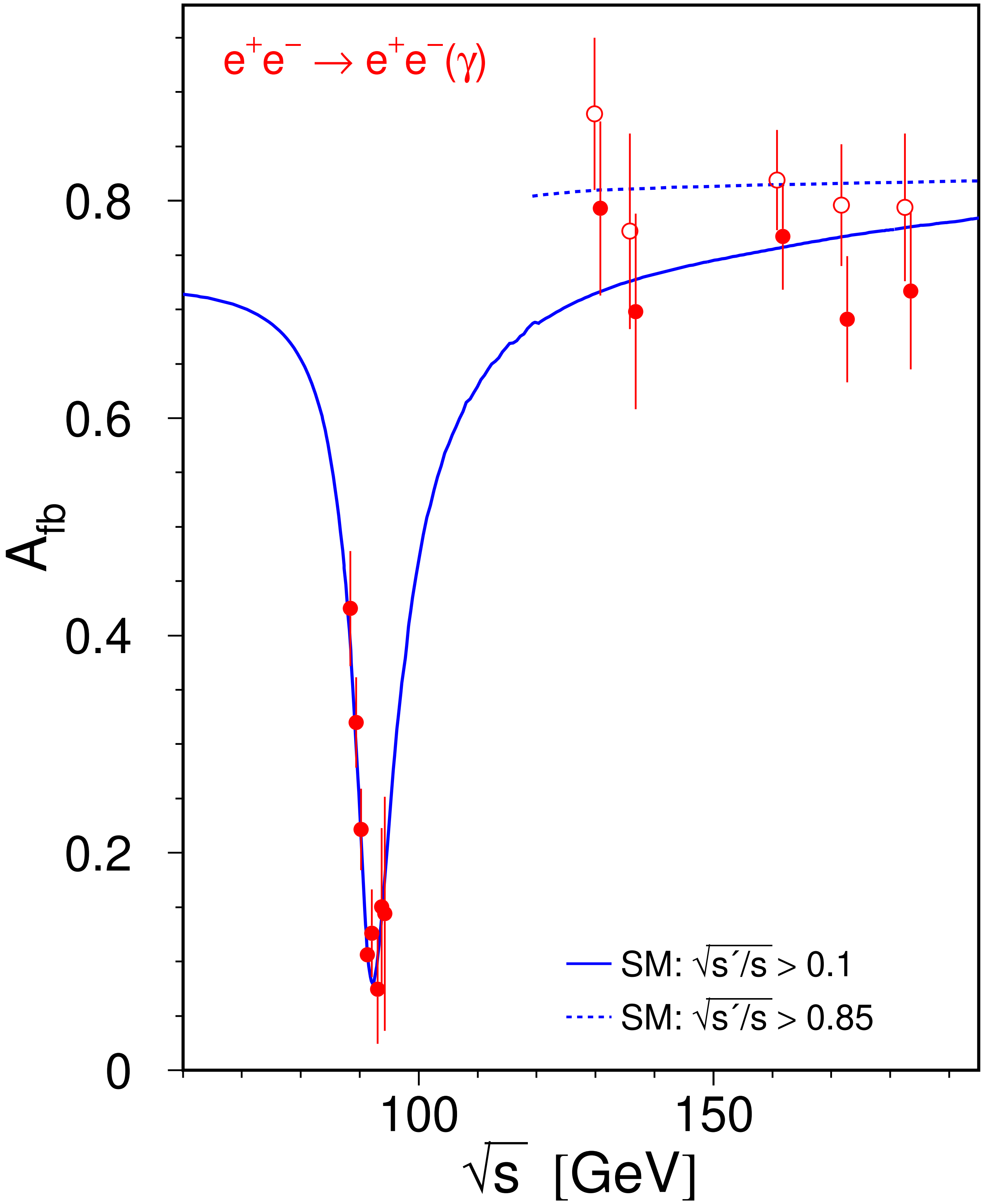

Figure 5: Measured forward-backward asymmetry in $e^+e^- \to e^+e^-(\gamma)$ as function of the centre-of-mass energy.

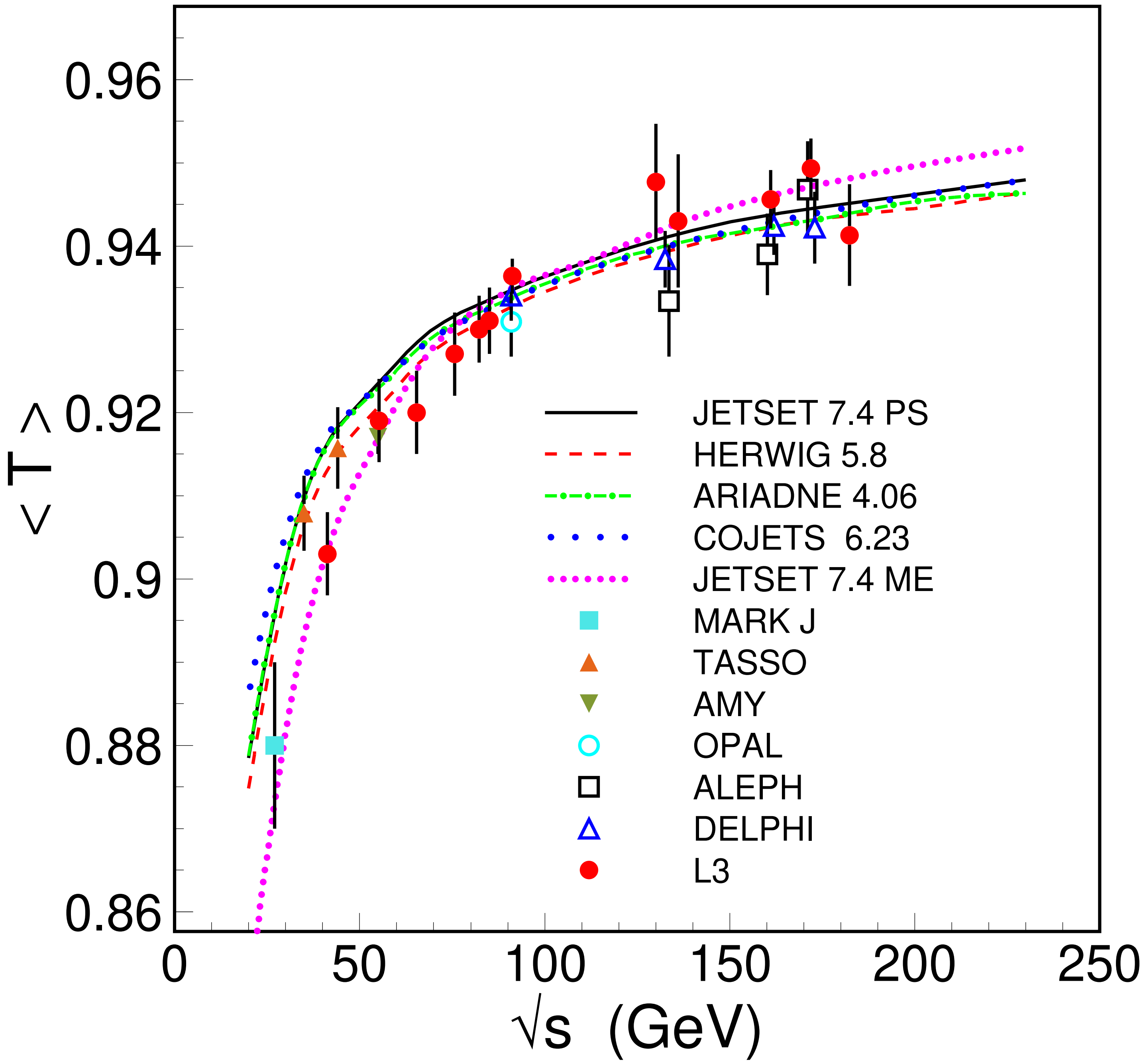

Figure 6: Evolution of the mean thrust value with the centre-of mass energy.

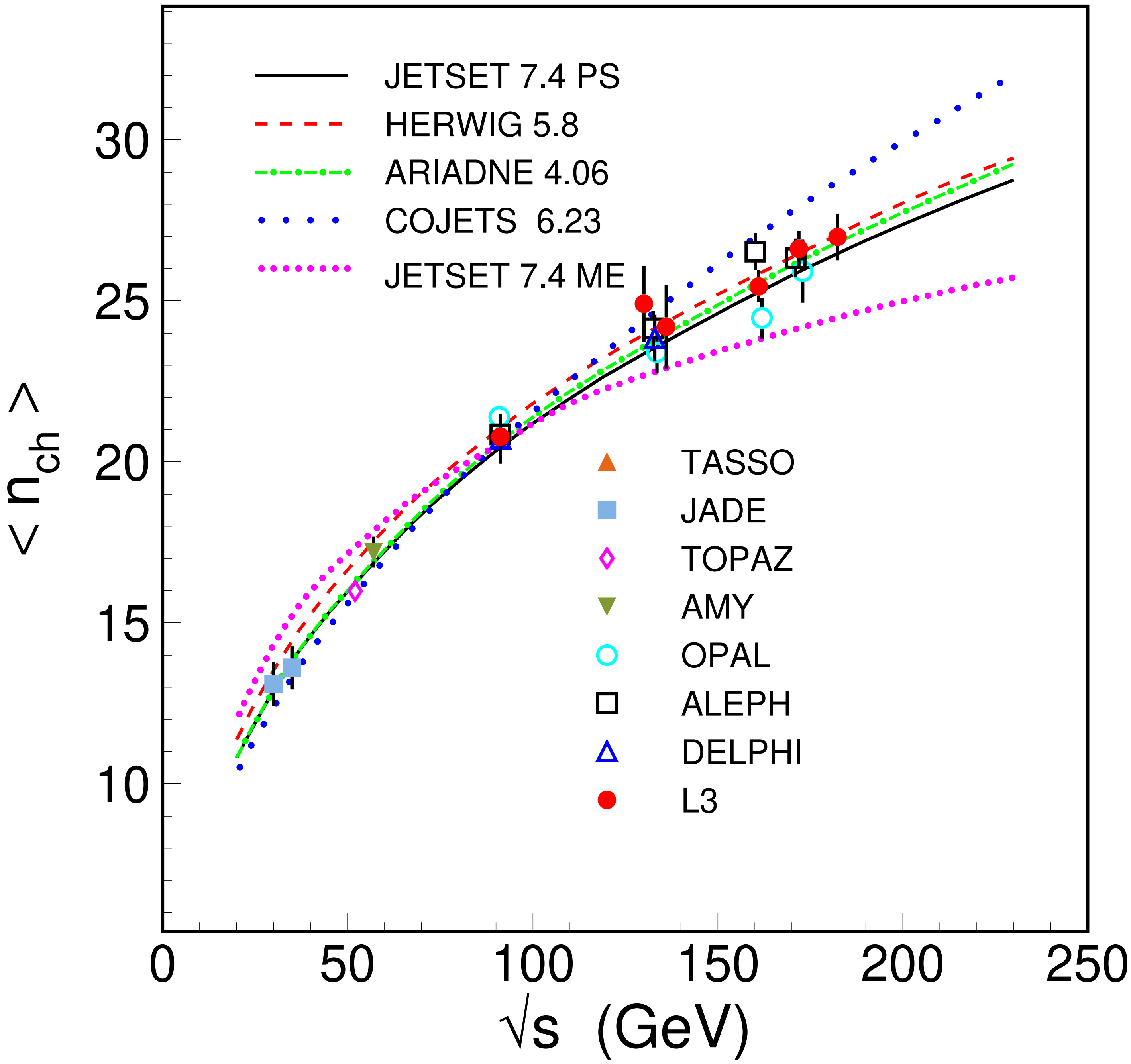

Figure 7: Evolution of the mean charge multiplicity with the centre-of mass energy.

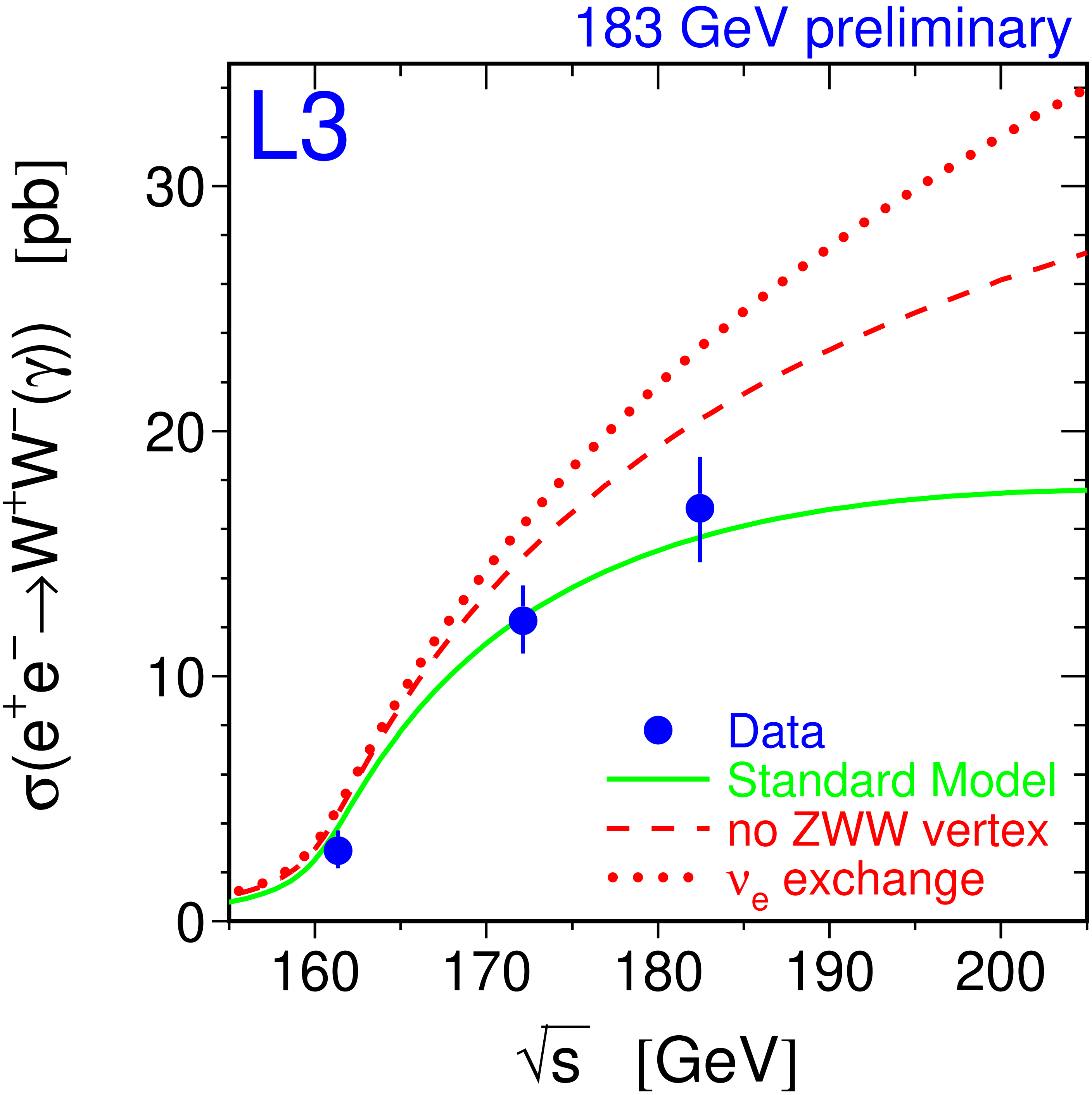

Figure 8: Measured cross section $e^+e^- \to W^+W^-(\gamma)$ as function of the centre-of-mass energy compared to various models.

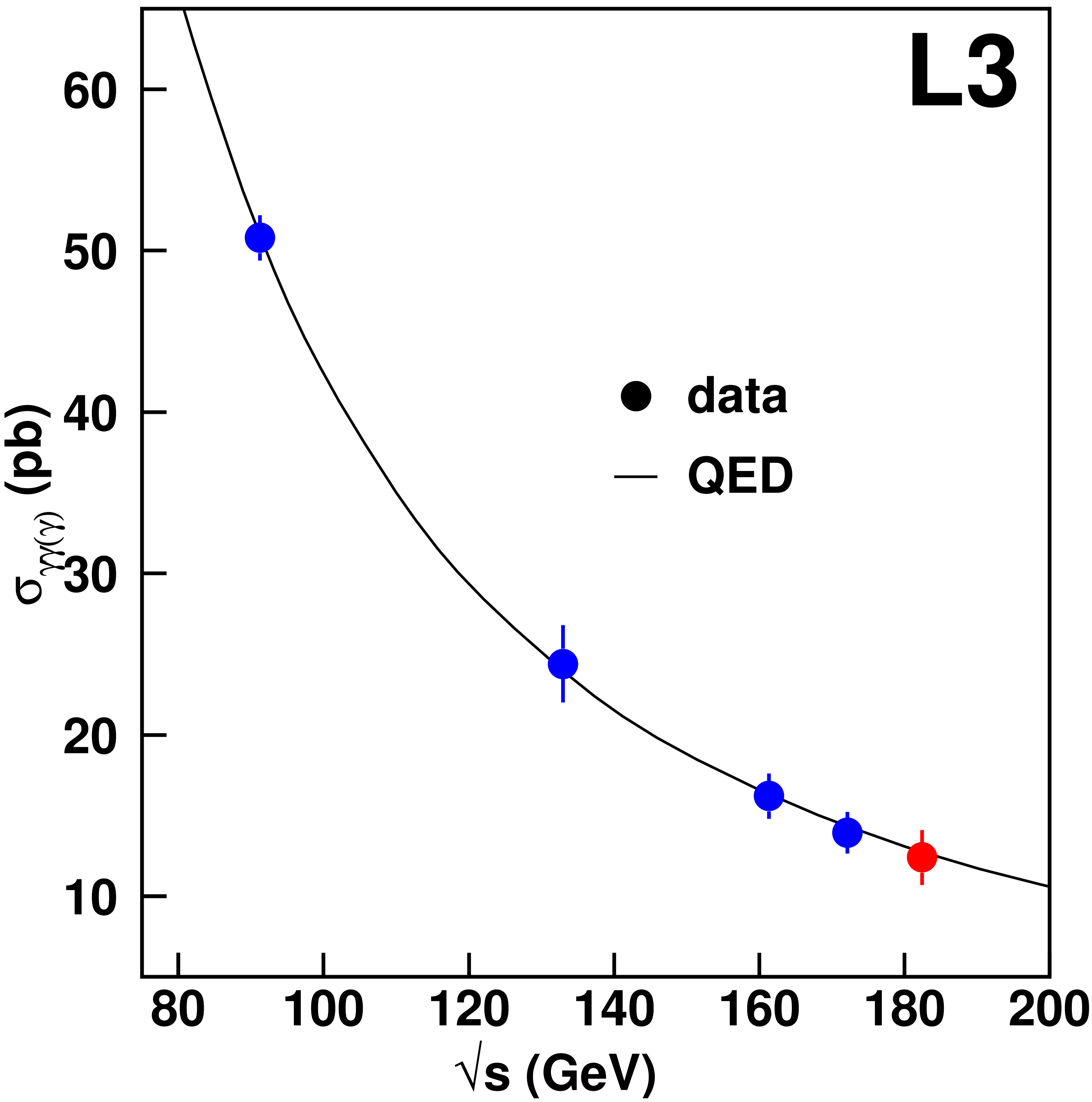

Figure 9: Measured cross-section $e^+e^- \to \gamma\gamma(\gamma)$ for θ_γ between 16° and 164° as function of the centre-of-mass energy and compared to the QED prediction.