JET RATES IN e^+e^- ANNIHILATION BETWEEN $\sqrt{s} = 22$ GeV AND 172 GeV

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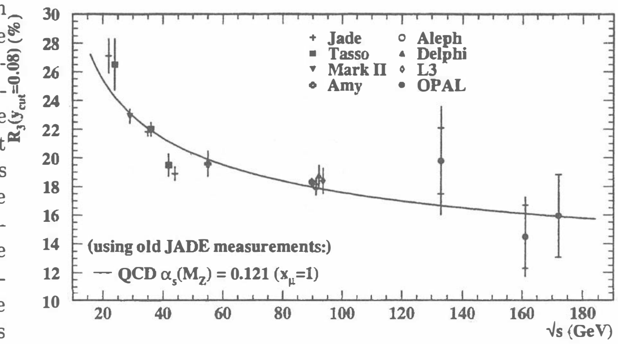
(presenting results of the OPAL collaboration, P. Movilla-Fernández and former members of the JADE collaboration)

Abstract

An overview of measurements using jet rates in e^+e^- annihilation events at center-of-mass energies ranging from 22 GeV through 172 GeV is given. Results on determinations of the strong coupling from the OPAL experiment at LEP1 and LEP2 are presented in connection with preliminary results obtained from a recent reanalysis of data taken at the JADE experiment at PETRA using similar techniques as in OPAL. It is seen that the application of LEP methods significantly reduce the total errors with respect to older measurements at low energies.

Measurements of jet rates in e^+e^- annihilation events have been a means not only to observe asymptotic freedom qualitatively, but also to determine the strong coupling constant with good precision at various center-of-mass energies. The decline of the 3-jet rate using the E0 scheme over a wide range of center-of-mass energies, as shown in the figure on the right, clearly reflects asymptotic freedom [1].



For the differential 2-jet rate, as obtained using the Durham jet algorithm, there exist both theoretical predictions in second order in α_s as well as next-to-leading logarithm calculations. This distribution is therefore particularly suited for comparisons with QCD. The OPAL collaboration has used the 'ln(R) matching' scheme to combine both types of predictions and perform fits for α_s at center-of-mass energies $\sqrt{s}$ between 91 and 172 GeV. The results of the single measurements are summarized in the lower part of the table below [1]. The errors stated are the quadratic sums of the statistical and the systematic component. The systematic errors include variations of the selection, fragmentation modelling and of the QCD scale x_μ.

At the PETRA accelerator, e^+e^- collisions were observed from 1978 through 1986 at center-of-mass energies varying between 14 and 45 GeV. At that time, combined calculations as described above did not exist, and α_s measurements were mainly done using the energy evolution of some event shape variables.

$\sqrt{s}$ [GeV]	$\alpha_s(\sqrt{s})$	$\alpha_s(M_{Z^0})$
22	* $0.161 ^{+0.016}_{-0.015}$	0.124 ± 0.009
35	* $0.145 ^{+0.009}_{-0.007}$	$0.123 ^{+0.006}_{-0.005}$
44	* $0.134 ^{+0.009}_{-0.007}$	$0.119 ^{+0.007}_{-0.006}$
91	$0.123 ^{+0.008}_{-0.007}$	
133	0.104 ± 0.011	0.109 ± 0.013
161	0.102 ± 0.009	0.110 ± 0.011
172	* 0.088 ± 0.019	0.095 ± 0.022

A reanalysis of data taken at the JADE experiment at PETRA using the same techniques as in the OPAL analyses is currently being performed by P. Movilla-Fernández et al. [3]. Preliminary determinations of the strong coupling at energies of 22, 35 and 44 GeV are also listed in the table with their total errors. Values marked with a star are preliminary. A comparison with a previously published value of $\alpha_s = 0.14 \pm 0.02$ at $\sqrt{s} =$ 35 GeV [2], incorporating results from various different experiments, indicates that the application of LEP techniques is in fact able to significantly reduce the total errors.

[1] OPAL Collaboration, P.D. Acton et al., Z. Phys. **C59** (1993) 1;
OPAL Collaboration, G. Alexander et al., Z. Phys. **C72** (1996) 191;
OPAL Collaboration, K. Ackerstaff et al., CERN-PPE 97-015 (accpeted by Z.Phys. C);
OPAL Collaboration, K. Ackerstaff et al., OPAL Physics Note 281

[2] S. Bethke, *Proc. of the Workshop on the Standard Model at the Energy of Present and Future Accelerators, June 1989, Budapest*, LBL-28112 (1989)

[3] P. Movilla-Fernández et al., PITHA report, RWTH Aachen, in preparation