Low energy hadronic contribution to the QED vacuum polarization

B. Pietrzyk, H. Burkhardt

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B. Pietrzyk
Laboratoire de Physique des Particules LAPP, IN2P3-CNRS, F-74941 Annecy-le-Vieux Cedex, France
and H. Burkhardt
CERN, AB Division, CH-1211 Geneva 23, Switzerland

Abstract

Recent improvements in the low energy e^+e^- annihilation data and their influence on the determination of the hadronic contribution to the determination of the QED fine structure constant at m_Z are discussed.

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Contact persons: B. Pietrzyk (pietrzyk@lapp.in2p3.fr)
and H. Burkhardt (Helmut.Burkhardt@cern.ch)

In the year 2001, we published an updated evaluation of the hadronic contribution to the running of the QED fine structure constant [1]. It was obtained from a dispersion integral over a parametrization of the measured cross section of $e^+e^- \to$ hadrons. We obtained a hadronic contribution of $\Delta\alpha^{(5)}_{\rm had}(s) = 0.02761 \pm 0.00036$ at s $= m_Z^2$.

Our parametrization in the c.m.s. energy region between 0.61 and 0.96 GeV was based on pion form factor factor results obtained with the CMD-2 detector at the VEPP-2M collider [2]. The overall uncertainty of the ρ region integral, including the statistical uncertainty, is 2.3% (that of Γ_{ee} in [2]) in our analysis.

Since then, the CMD-2 Collaboration improved the treatment of radiative corrections twice. An intermediate improvement has appeared in the published document [3] and an additional improvement has just become available [4]. In this contribution, we evaluated the impact of these improvements on our result at s $= m_Z^2$.

The changes in the result of $\Delta\alpha^{(5)}_{\rm had}(m_Z^2)$ are illustrated in Fig. 1. Going from the preprint [2] to the published version [3] of the CMD-2 results lowers the value of $\Delta\alpha^{(5)}_{\rm had}(s)$ by about 10% of the total uncertainty of 0.00036.

Going from the published to the recent revised CMD-2 results [4] moves $\Delta\alpha^{(5)}_{\rm had}(s)$ in the opposite direction by about 28%, which is about 18% of the total uncertainty of our published analysis.

We conclude that the most recent CMD-2 results imply a small change in the estimate of the hadronic contribution which becomes $\Delta\alpha^{(5)}_{\rm had}(s) = 0.02768 \pm 0.00036$ at s $= m_Z^2$.

We would like to encourage efforts to further clarify and improve the knowledge of the low energy hadronic cross sections, using independent information from measurements of the "radiative return" to the rho resonance (see, for example, talk [5] at this conference), measurements of BABAR and BELLE using similar techniques, and further direct measurements in an enlarged energy range which extends into the 1.2 GeV region.

References

[1] H. Burkhardt and B. Pietrzyk, Phys. Lett. **B513** (2001)46.

[2] R.R. Akhmetshin et al., CMD-2 Collaboration, hep-ex/9904027.

[3] R.R. Akhmetshin et al., CMD-2 Collaboration, Phys. Lett. **B527** (2002)161.

[4] CMD-2 Collaboration, July 2003, preliminary reanalysed numbers.

[5] M. Incagli, talk in the 'Test of the Standard Model' session at this conference.

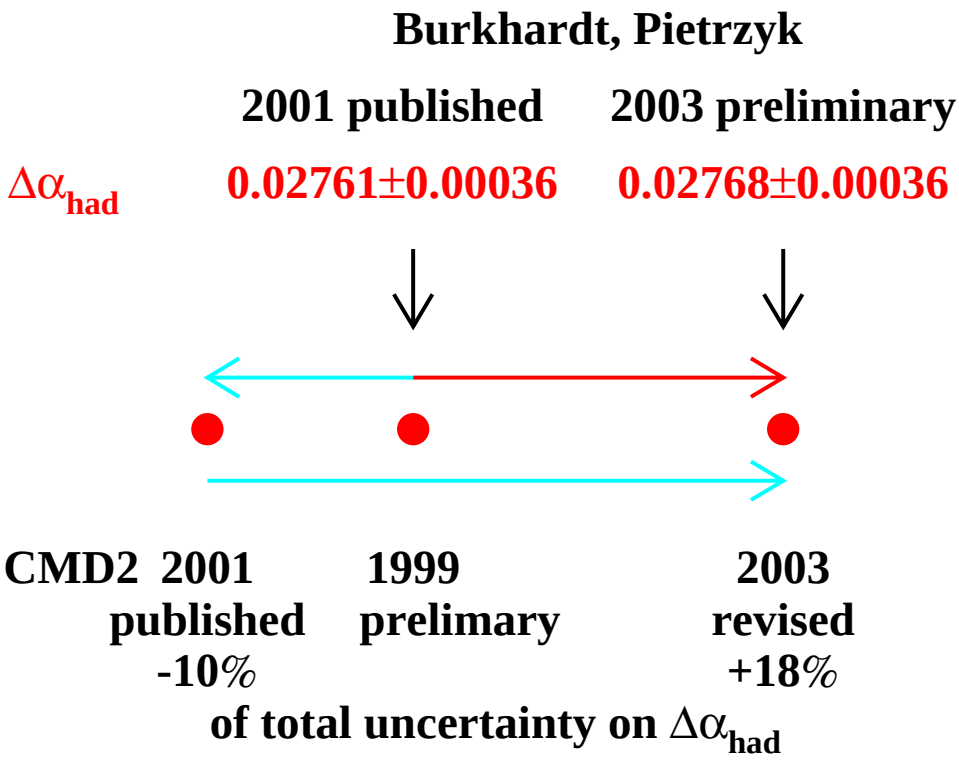

Figure 1: Changes of the value of $\Delta\alpha^{(5)}_{\rm had}(s)$ caused by improvements in calculations of radiative corrections by the CMD-2 Collaboration in units of the total uncertainty of $\Delta\alpha^{(5)}_{\rm had}(s)$.