Abstract

In this work, we perform a *quantum chromodynamics* (QCD) analysis on hadronic τ lepton decays. We make use of the ALEPH data to fit the strong coupling and higher order *operator product expansion* (OPE) contributions. Our approach is based on the QCD *sum rules* (QCDSR), especially the framework of *fixed-order perturbation theory* (FOPT), which we apply for the *vector* + *axial-vector* (V+A) channel of the inclusive Cabibbo-allowed hadronic τ decay data. We perform fits using a new set of analytic weight functions to shed light on the discussion of the importance of *duality violation* (DV). Since the inclusion of a model to parametrise contributions of DV by Boito et al. [**2011a**] there has been an ongoing discussion, especially with the group around Pich [**Pich2016**], which disfavours the usage of the DV model. Within this work, we want to give a third opinion arguing that DV are not present in double pinched weights. Even for single pinched weights, we find that DV are sufficiently suppressed for high precision measurements of the strong coupling. Another unsolved topic is the discussion of FOPT vs *contour-improved perturbation theory* (CIPT). Beneke et al. [**Beneke2008**] have found that CIPT cannot reproduce the *Borel summation* (BS), while the creators of CIPT [**Pivovarov1991**, **LeDiberder1992a**] are in favour of the framework. To investigate the validity of FOPT we apply the BS. The parameters we obtain from both frameworks are in high agreement. Performing fits in the framework of CIPT lead to different results. Consequently, in the discussion of FOPT vs CIPT we argue for FOPT being the favoured framework. For our final result of the strong coupling we perform fits for ten different weights. For each weight, we further fit 20 different moments by varying the

energy limit s_0. We select the best fit of each weight in a final comparison. The fits are in high agreement and the average of the parameters we obtain yields a value of $\alpha_s(m_\tau^2) = 0.3261(51)$ for the strong coupling, $\rho^{(6)} = -0.68(20)$ for the dimension six OPE contribution and $\rho^{(8)} = -0.80(38)$ for the dimension eight OPE contribution.