Radiative corrections to $e^+e^- \to \pi^+\pi^-\gamma$

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Outline

$$a_\mu = (g-2)/2$$

results in units 10^{-10}

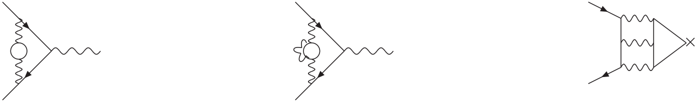
$$a_\mu^{SM} = 11659182.04 \pm 3.56$$
$$a_\mu^{exp} = 11659208.9 \pm 5.4 \pm 3.3$$

Fermilab and JPARC - will improve precision about 4 times

$$a_\mu^{exp} - a_\mu^{SM} = 27.06 \pm 7.26$$
$$a_\mu^{SM} = a_\mu^{QED} + a_\mu^{EW} + a_\mu^{had}$$

$$a_\mu^{QED} = 11658471.8971 \pm 0.007$$
$$a_\mu^{EW} = 15.36 \pm 0.10$$

A.Keshavarzi, D.Nomura and T.Teubner, Phys. Rev. D 97, 114025 (2018),
Muon g-2 Collaboration (G.W. Bennett et al.), Phys. ReV. D 73, 072003 (2006) [hep-ex/0602035].



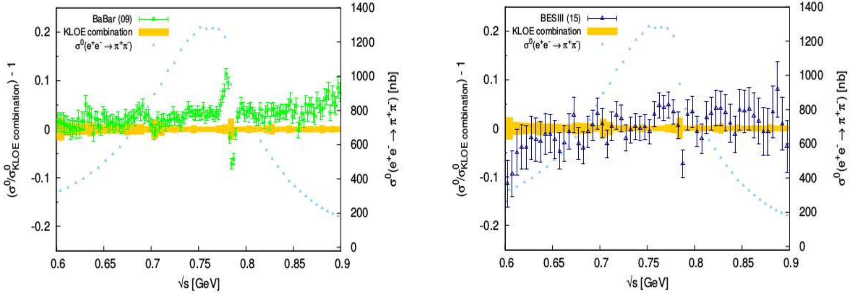
$$a_\mu^{had} = a_\mu^{had,LO} + a_\mu^{had,NLO} + a_\mu^{had,LBL}$$

$$\begin{aligned} a_\mu^{had,NLO} &= -9.82 \pm 0.04 \\ a_\mu^{had,LO} &= 684.68 \pm 2.42 \\ a_\mu^{had,LBL} &= 9.8 \pm 2.6 \end{aligned}$$

$$a_\mu^{had,LO} = \frac{\alpha^2}{3\pi^2} \int_{m_\pi^2}^{\infty} \frac{ds}{s} K(s) R(s)$$

$$R(s) = \frac{\sigma(e^+e^- \to hadrons)}{\sigma_0}$$

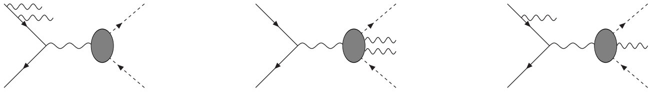
BaBar, BES and KLOE measurements



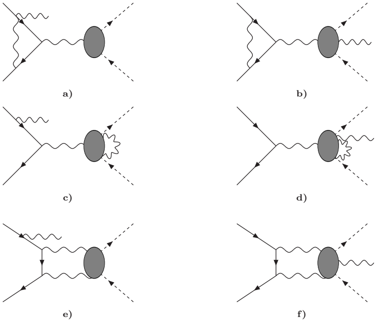
Results based on approximate NLO radiative corrections from PHOKHARA MC generator.

A. Anastasi *et al.* [KLOE-2 Collaboration], JHEP **1803** (2018) 173

NLO corrections to $e^+e^- \to \pi^+\pi^-\gamma$

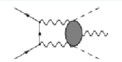


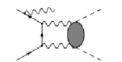
a) b) c)



Modeling pion-photon interaction

-Factorization of the form factor:

 $= \mathbf{F_\pi(s) \times sQED}$

 $= \mathbf{F_\pi(q^2) \times sQED}$

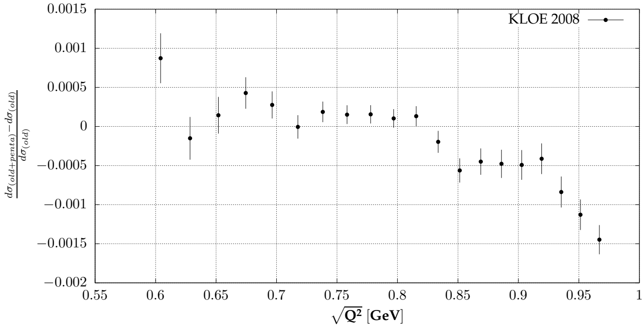
-Real emission proportional to the form factor

-Form factor:

$$F_\pi(q^2) = \sum_n c^\pi_{\rho_n} BW_{\rho_n}(q^2)$$

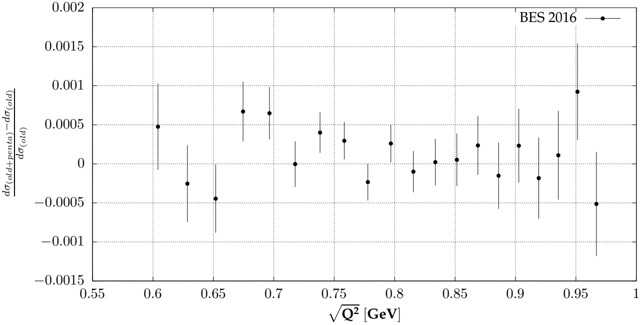
F. Campanario, H. Czyż, J. Gluza, T. Jeliński G. Rodrigo, S. Tracz and D. Zhuridov (in preparation)
H. Czyz, A. Grzelinska and J. H. Kuhn, Phys. Rev. D **81** (2010) 094014

- $\sqrt{s} = 1.02$ GeV
- Pion tracks: $50^o < \theta_{\pi^\pm} < 130^o$, $|p_{z_{\pi^\pm}}| > 90$ MeV
- Missing photon angle: $|\cos\theta_\gamma| > \cos 15^o$
- Track mass: $m_{trk} > 130$ MeV
- $q^2 \in (0.35, 0.95)$



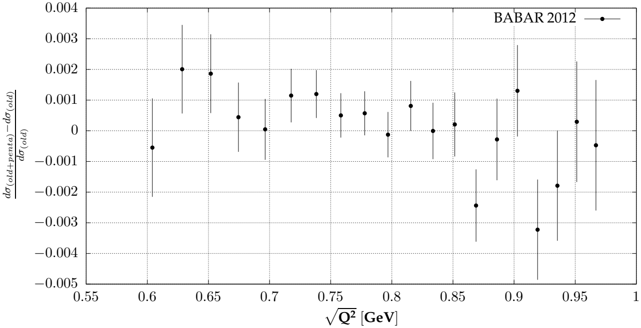
F. Campanario, H. Czyż, J. Gluza, T. Jeliński G. Rodrigo, S. Tracz and D. Zhuridov (in preparation)

- $\sqrt{s} = 3.773$ GeV
- Pion tracks: $22.9^o < \theta_{\pi^\pm} < 157.1^o$, $|p_{T_{\pi^\pm}}| > 300$ MeV
- Minimal photon energy: $E_\gamma > 400$ MeV
- Missing photon angle: $|\cos\theta_\gamma| < 0.8$ or $0.86 < |\cos\theta_\gamma| < 0.92$
- $q^2 \in (0.35, 0.95)$



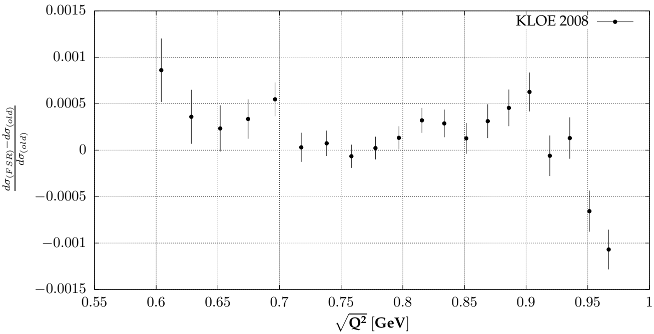
F. Campanario, H. Czyż, J. Gluza, T. Jeliński G. Rodrigo, S. Tracz and D. Zhuridov (in preparation)

- $\sqrt{s} = 10.56$ GeV
- Pion tracks: $20^o < \theta_{\pi^\pm} < 160^o$, $|p_{T_{\pi^\pm}}| > 300$ MeV
- Minimal photon energy: $E_\gamma > 3$ GeV
- Missing photon angle: $20^o < \theta_\gamma < 160^o$
- $q^2 \in (0.35, 0.95)$, $|q_1| > 1$ GeV (π^-) and $|q_2| > 1$ GeV (π^+)



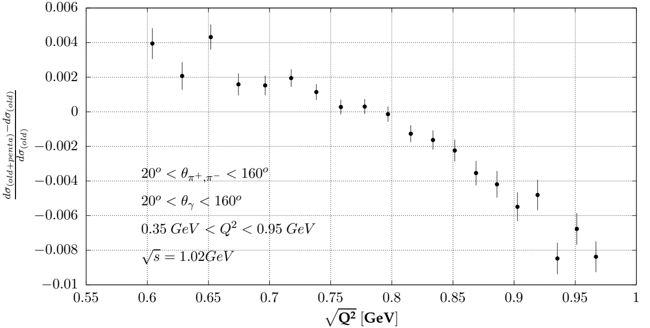
F. Campanario, H. Czyż, J. Gluza, T. Jeliński G. Rodrigo, S. Tracz and D. Zhuridov (in preparation)

- $\sqrt{s} = 1.02$ GeV
- Pion tracks: $50^o < \theta_{\pi^\pm} < 130^o$, $|p_{z_{\pi^\pm}}| > 90$ MeV
- Missing photon angle: $|\cos\theta_\gamma| > \cos 15^o$
- Track mass: $m_{trk} > 130$ MeV
- $q^2 \in (0.35, 0.95)$



F. Campanario, H. Czyż, J. Gluza, T. Jeliński G. Rodrigo, S. Tracz and D. Zhuridov (in preparation)

- $\sqrt{s} = 1.02$ GeV
- Pions and one of the photon polar angle: $20^o < \theta_{\pi^{\pm},\gamma} < 160^o$
- $q^2 \in (0.35, 0.95)$



F. Campanario, H. Czyż, J. Gluza, T. Jeliński G. Rodrigo, S. Tracz and D. Zhuridov (in preparation)

Conclusions

- The size of missing radiative corrections is too small to be able to explain discrepancies between KLOE and BABAR data. It means that the source of the difference can only be of the experimental origin.