

Status of Phokhara, what is missing for NNLO?

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Workshop on muon precision physics
8th November 2022

PHOKHARA MC generator

EVA: $e^+e^- \rightarrow \pi^+\pi^-\gamma$

- tagged photon ($\theta_\gamma > \theta_{cut}$)
- ISR at LO + Structure Function
- FSR: point-like pions

[Binner et al.]

$e^+e^- \rightarrow 4\pi + \gamma$

- ISR at LO + Structure Function

[Czyż, Kühn, 2000]

F. Campanario, H.C., J. Gluza,

A. Grzelińska, M. Gunia, P. Kiszka,

J. H. Kühn, E. Nowak-Kubat, T. Riemann,

G. Rodrigo, Sz. Tracz, A. Wapienik,

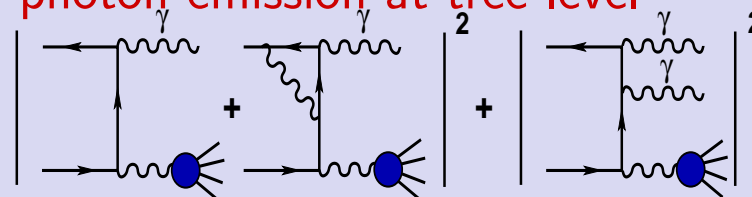
V. Yundin, D. Zhuridov

PHOKHARA 10.0: $\pi^+\pi^-, \mu^+\mu^-,$

$4\pi, \bar{N}N, 3\pi, KK, \Lambda\bar{\Lambda}, P\gamma$

$J/\psi, \psi(2S), \chi_{c1}, \chi_{c2}$

- **ISR at NLO:** virtual corrections to one photon events and two photon emission at tree level



- FSR at NLO: $\pi^+\pi^-, \mu^+\mu^-, K^+K^-, \bar{p}p$
- tagged or untagged photons
- $e^+e^- \rightarrow hadrons (muons)$ ISR at NNLO
- Modular structure

<http://ific.uv.es/~rodrigo/phokhara/>

Disclaimer

I do not plan
any further development of the code

The possible improvements

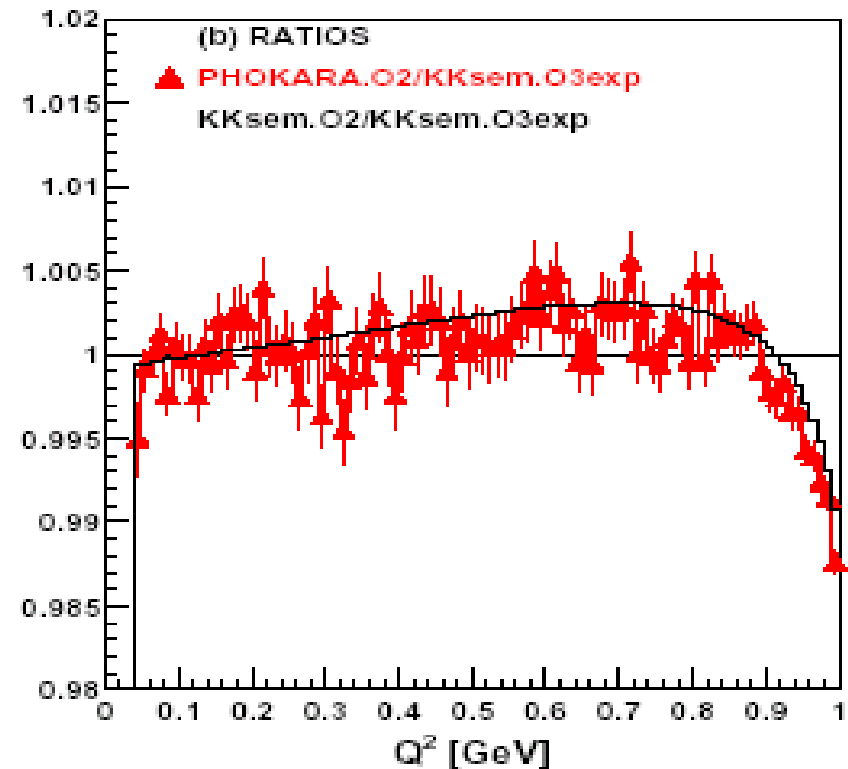
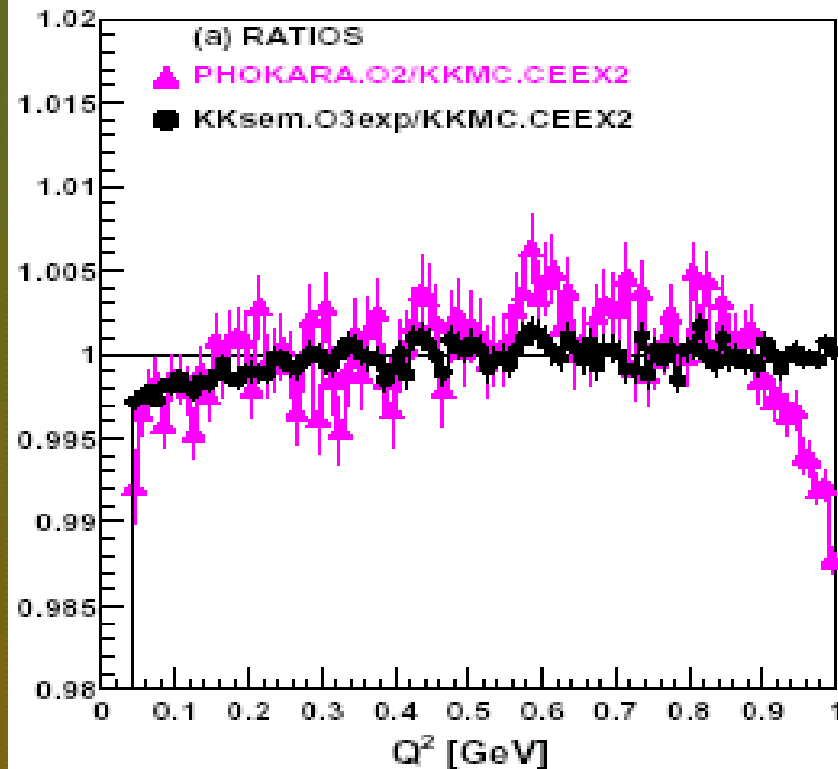
Including NNLO ISR

No NNLO ISR in the distributed version

Better modeling of FSR

S.Jadach: KKMC

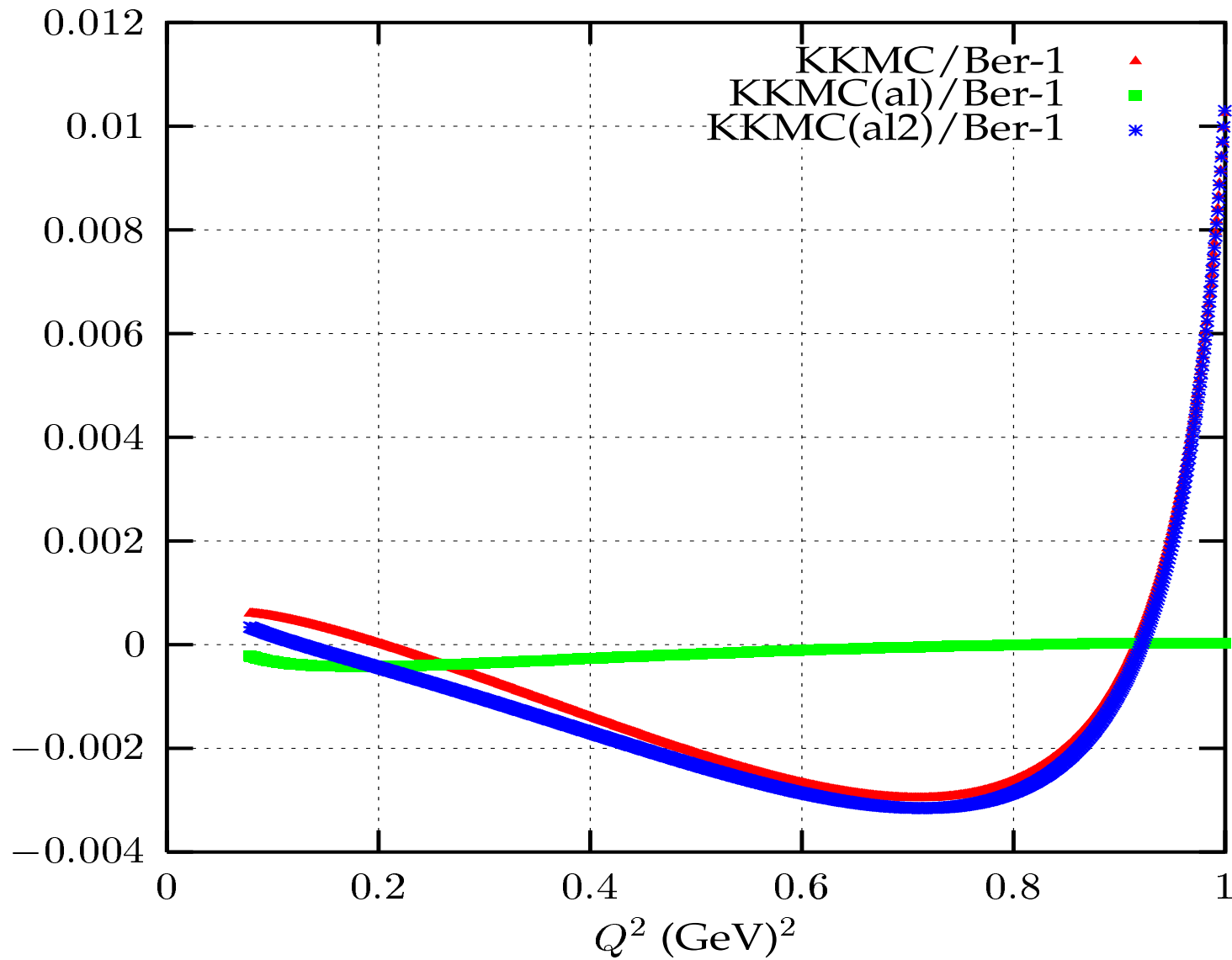
PHOKHARA included in the game, μ -pairs again



PHOKHARA agrees to within 0.3% with KKMC and KKsem.

Discrepancy at high Q^2 reflects lack of exponentiation in PHOKHARA

PHOKHARA vs. KKMC cnd.



References to slides 5-6

S. Jadach et al.

Acta Phys.Polon.B 36 (2005) 2387

Acta Phys.Polon.B 36 (2005) 2379

Phys. Lett. B **605** (2005) 123

Phys. Rev. D **73** (2006) 073001

F.A. Berends et al.

Nucl. Phys. B 297 (1988) 429

Phys. Lett. B 177 (1986) 191

Summary of works done and published

Francisco Campanario, Henryk Czyż , Janusz Gluza, Michał Gunia, Tomasz Jeliński, Tord Riemann, German Rodrigo, Szymon Tracz, Valery Yundin and Dmitry Zhuridov

⇒ PRD 100, 076004 (2019) and JHEP 1402 (2014) 114

show that missing NLO radiative corrections

cannot be the source of the discrepancies between

the different extractions of the pion form factor

performed by BaBar, BES and KLOE

Status of works done and not shown

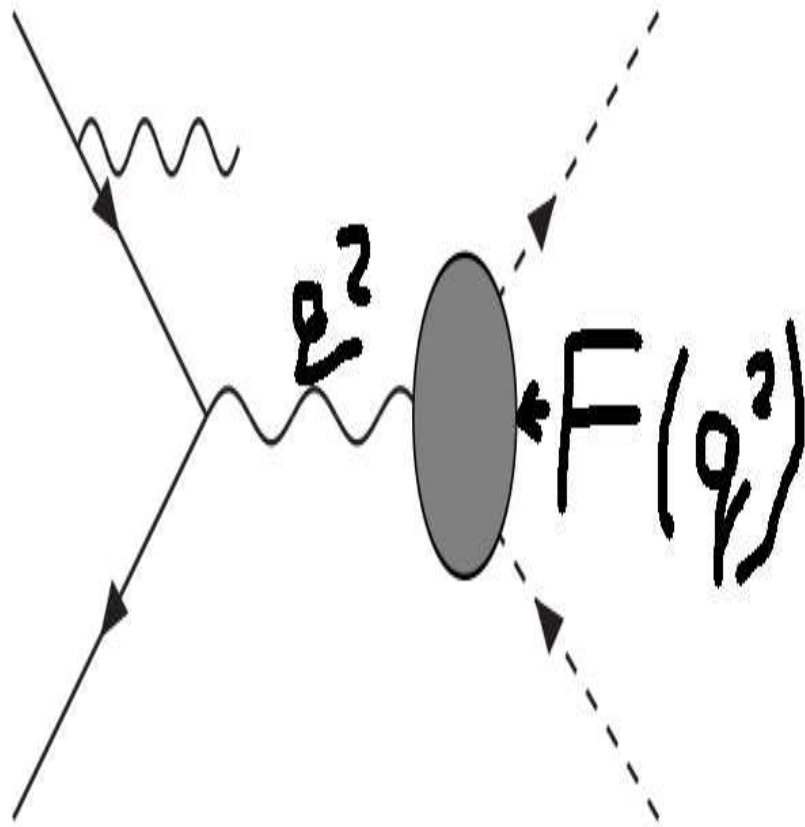
the work done mostly by Szymon Tracz

- matrix element of 3 real photons (ISR) coded and tested
- mapping of 3 real photon phase space (ISR) coded and tested
- the tests were performed for $\pi - \pi$ hadronic state
- as both matrix element and mapping are 'the same' for all (ISR) hadronic states the code will work for all the hadronic states coded
- missing soft photon corrections were added in 1- and 2- photons parts and partly tested
- we have inserted 'LL' in 1- and 2- photons parts but the results of p.5-6 were not reproduced

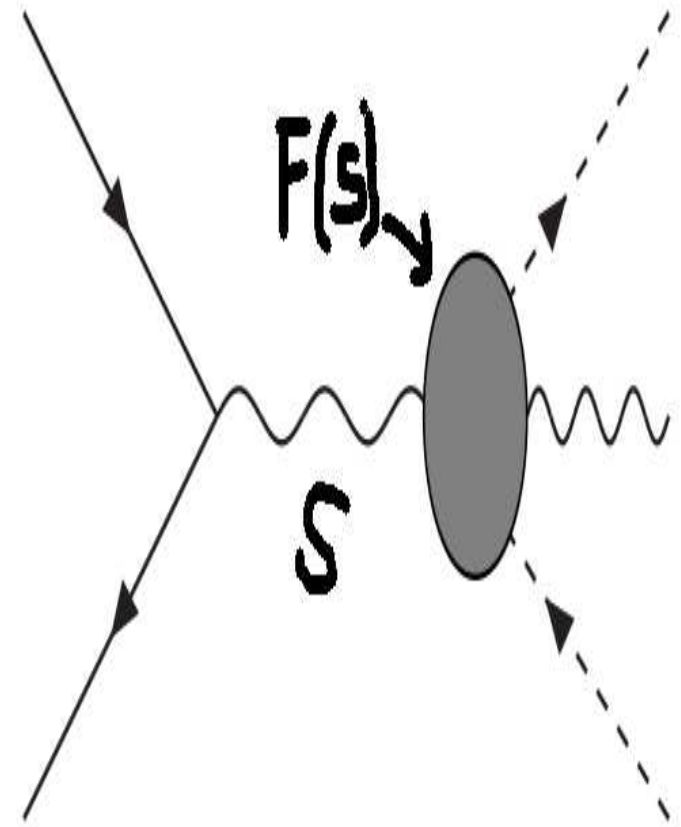
Missing parts

- ISR NNLO to $e^+e^- \rightarrow \gamma\gamma^*$
- ISR NLO to $e^+e^- \rightarrow \gamma\gamma\gamma^*$

Model assumptions - pions

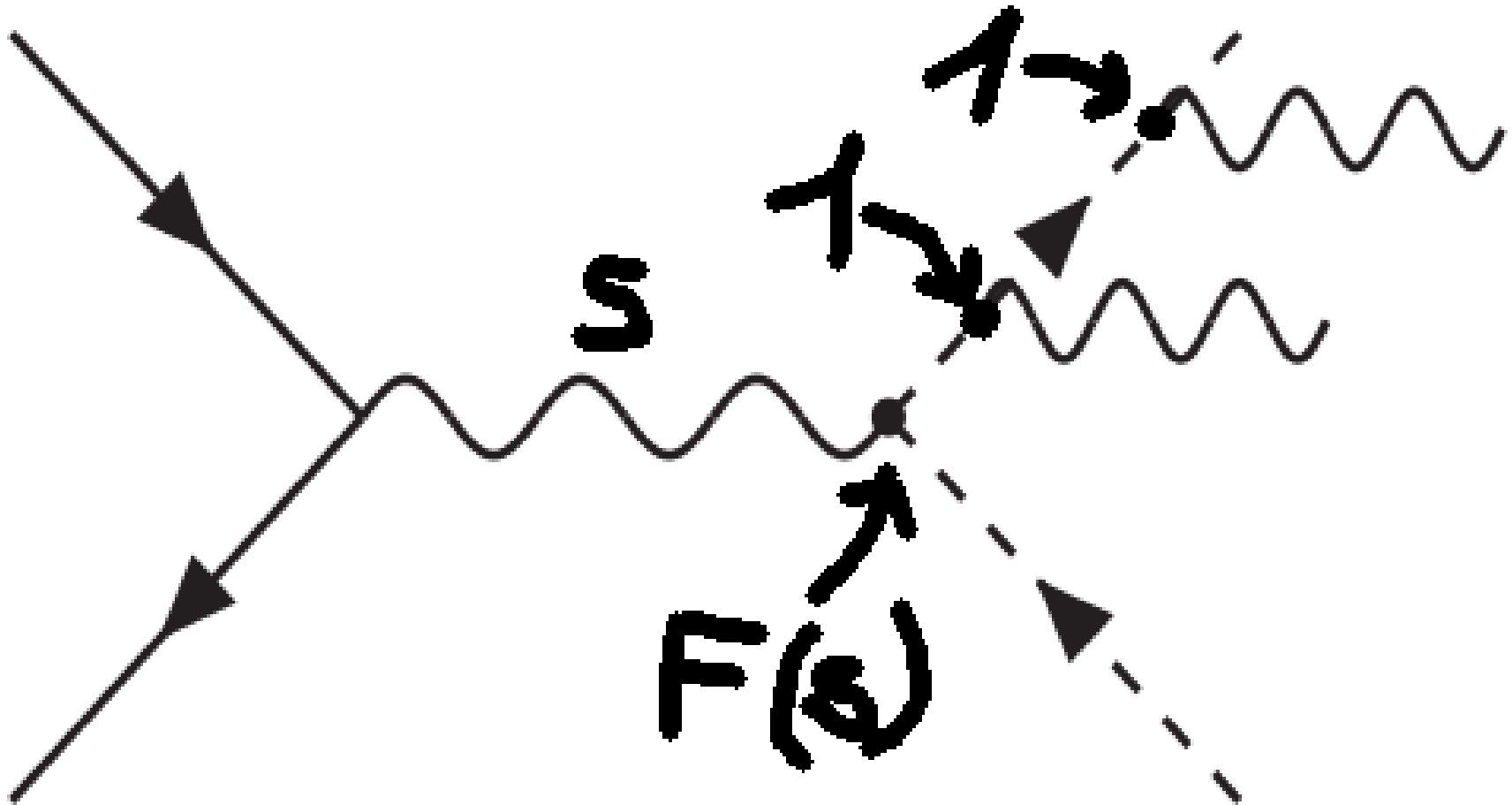


a)



b)

Model assumptions - pions



Model assumptions - pions

