10th meeting of the WG Radio Monte CarLow

H.Czyz*/G. Venanzoni

Novosibirsk 23 September 2011

*Apologizes from Henryk for not being present

Friday 23 September 2011

Radiative Corrections and MC generators (09:10-10:50)

time	[id] title	presenter
09:10	[0] MC generator of e+e- -> hadrons between 1 and 2 GeV, is it feasible?	Dr. EIDELMAN, Simon
09:30	[1] e+e- -> KKpi and MC generator	IVANOV, V.
09:50	[2] Radiative corrections in K --> pi l+ l- and related decays	KUBIS, Bastian
10:10	[3] A model of $\bar{B}^0\to D^{*+}\omega\pi^-$ decay	MATVIENKO, Dmitry
10:30	[4] Current status of luminosity measurement with the CMD-3 detector at VEPP-2000	FEDOTOVICH, Gennady

Gamma-gamma physics (11:20-12:20)

time	[id] title	presenter
11:20	[5] MC generator for g g -> hadrons at KEDR	TAYURSKY, Valery
11:40	[6] MC generator for g g -> P at BaBar	KARDAPOLTSEV, L.
12:00	[7] Prospects for gamma gamma to pi0 with KLOE-2	IVASHYN, Sergiy

Tau (12:20-13:00)

time	[id] title	presenter
12:20	[8] Precision of tau lepton Monte Carlo, its use in data analysis and bremsstrahlung in decay	WAS, Zbigniew
12:40	[9] From tau->2pi nu_tau to e+e- -> pi+pi-	ROIG, Pablo

Hadronic VP, g-2 and Delta alpha (14:30-16:00)

| time	[id] title	presenter
14:30	[10] VP reloaded	Dr. TEUBNER, Thomas
14:50	[12] Status of luminosity	MONTAGNA, Guido
15:10	[11] Discussion on (g-2)mu	Dr. EIDELMAN, Simon

Coffee Break (16:00-16:30)

Additional Time if needed (16:30-18:30)

At 7.00 pm we will have the dinner in the cafeteria

Usual propaganda:

The paper "Quest for precision in hadronic cross sections at low energy: Monte Carlo tools vs. experimental data" has been published on the **Eur. Phys. J. C. Volume 66, Issue 3 (2010), Page 585**

Remember to quote the paper.
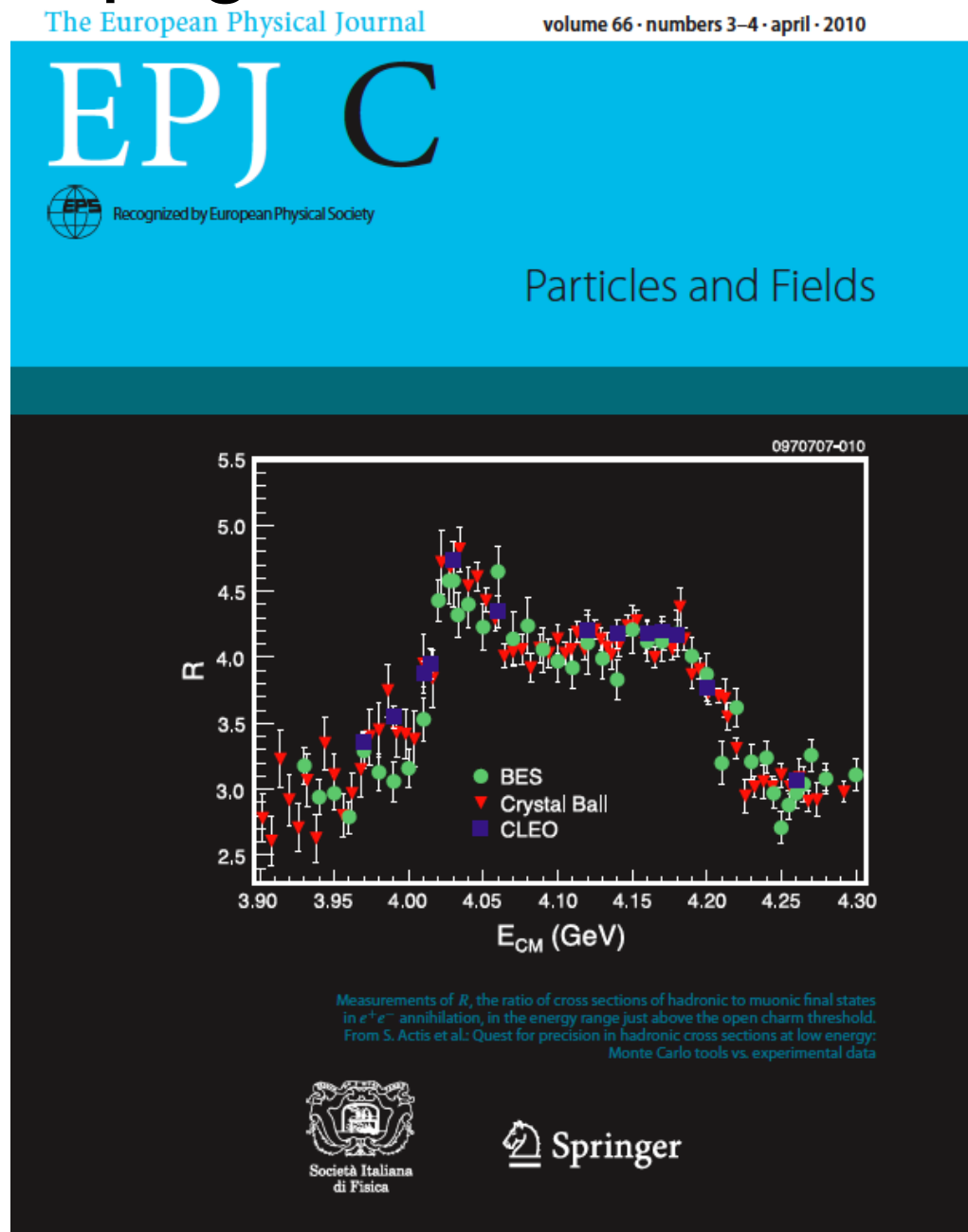
Please acknowledge the RMCWG activity!

A possible way in the acknowledgements:

 "This work is a part of the activity of the "Working Group on Radiative Corrections and Monte Carlo Generators for Low Energies" [http://www.lnf.infn.it/wg/sighad/] ."

This has been already done in two papers

e+e- current activities

- First of all congratulations to our Russian colleagues for the very promising results from VEPP-2000 shown at the Conference !
- Unfortunately this is not the same for Dafne, where for series of impressive series of hardware failures, KLOE-2 was not yet able to start real data taking. However the detector is ready and all of us expect to start data taking soon!
- BESIII is proceeding very well with plenty of new data. Soon the $\gamma\gamma$ and ISR programs will become an important part if its activities.
- Still KLOE, BaBar and Belle can give important results on hadronic cross sections, $\gamma\gamma$, and flavour physics.

…and planned activities

- SuperB is becoming a reality at Tor Vergata (Cabibbo Lab) near Rome. Together with SUPER-KEKB and possibly a Tau-Charm factory in Novosibirsk they will provide us a bright future!

- The muon g-2 at FNAL has got a first-stage proposal and starting money from DOE. Data taking is expected in 2016. Another g-2 experiment with a different concept is planned at J-PARC. FNAL expected accuracy $\delta a_\mu^{EXP} : 6 \rightarrow 1.4\ 10^{-10}$

  Can a_μ^{SM} meet a similar accuracy? Improvement of σ_{HAD} at low/intermediate energy will be needed. MC tools very important!
  Improving HLbL (by using also $\gamma\gamma$ data) will also be mandatory!

Important news!

- "2π Tau vs e$^+$e$^-$" seems reconciled (F. Jegerlehner and R. Szafron, Eur. Phys. J. C71 (2011) 1632, M. Benayoun *et al.* **arXiv:1106.1315**)

- New parametrization(s) for F$_\pi$ (JS, A. A. Kozhevnikov's talk at phipsi11, N. N. Achasov and A. A. Kozhevnikov. Phys. Rev. D83, 113005 (2011), P. Roig's talk)

  Important for g-2 prediction and model building
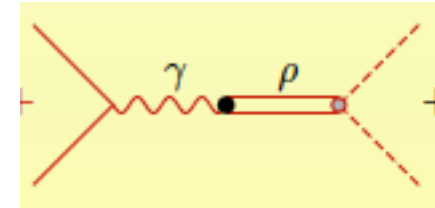
Two-pion e^+e^- vs τ spectral functions

A. Hoecker LP11
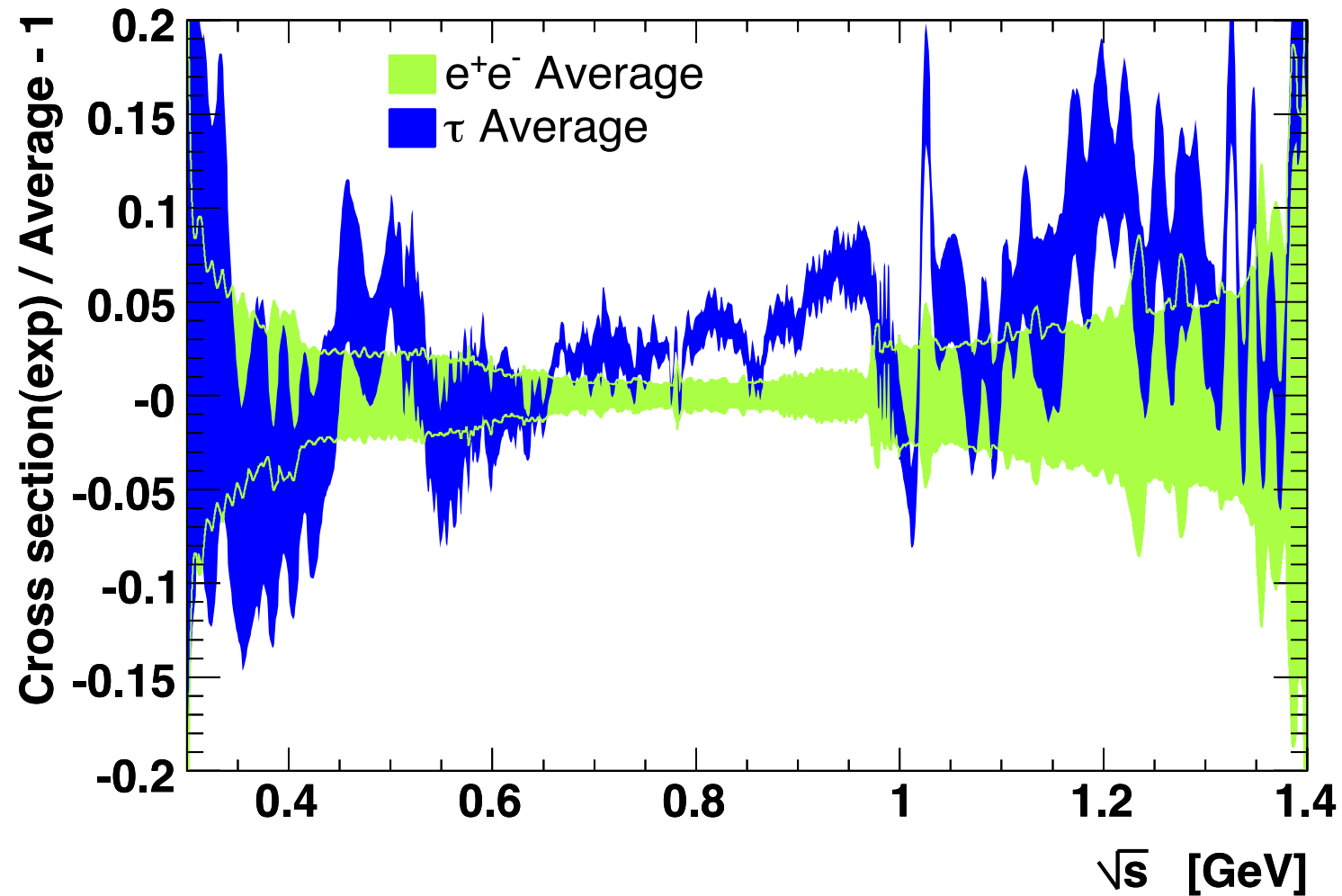
Jegerlehner and Szafron claim that the e^+e^- vs τ is solved if an additional correction ($\rho{-}\gamma$ mix.) is included

F. Jegerlehner and R. Szafron, Eur. Phys. J. C71 (2011) 1632
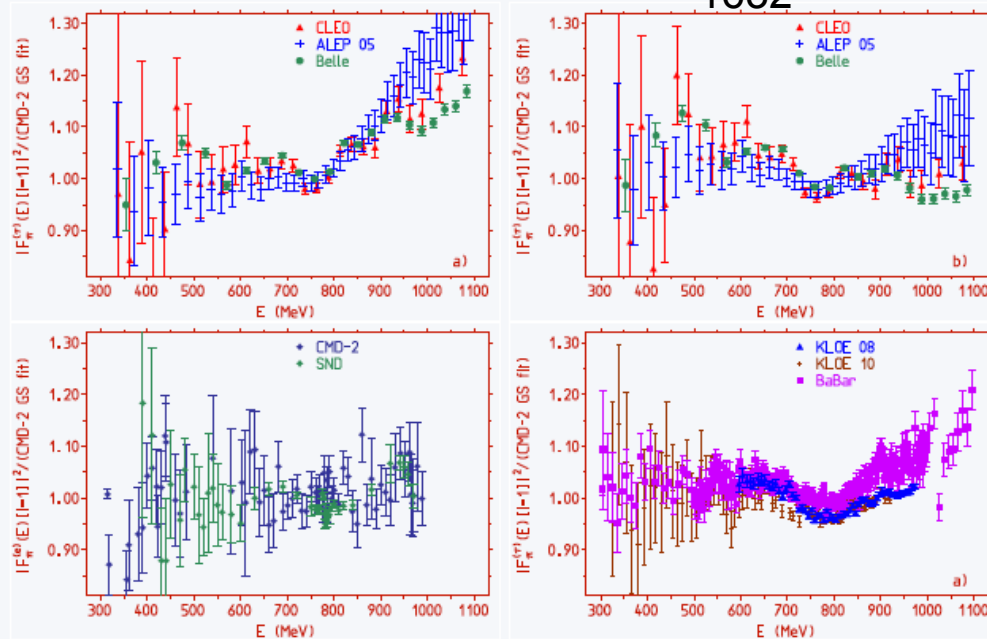
$|F_\pi(E)|^2$ in units of e^+e^- I=1 (CMD-2 GS fit): a) τ data uncorrected for $\rho - \gamma$ mixing, and b) after correcting for mixing. Lower panel: e^+e^- energy scan data [left] and e^+e^- radiative return data [right]

$$a_\mu^{\text{had,LO}}[e,\tau] = 690.96(1.06)(4.63) \times 10^{-10} \quad (e+\tau) \quad \text{JS 11}$$

$$a_\mu^{\text{had,LO}}[e^+e^-] = (692.3 \pm 4.2_{\text{ee+QCD}}) \times 10^{-10}$$

$$a_\mu^{\text{had,LO}}[\tau] = (701.5 \pm 3.5_\tau \pm 1.9_{\text{SU(2)}} \pm 2.4_{\text{ee+QCD}}) \times 10^{-10}$$

DHMZ 11

Some issues

- Is the 3 sigma discrepancy on g-2 btw SM and Exp. real? Are data and theory under control? Are there some new (crazy) ideas? (As WG) can we contribute on that? Simon will chair the discussion at the end of the meeting.

- Set of precise data (hadronic cross section or $\gamma\gamma$) not always in good agreement (see next slides).
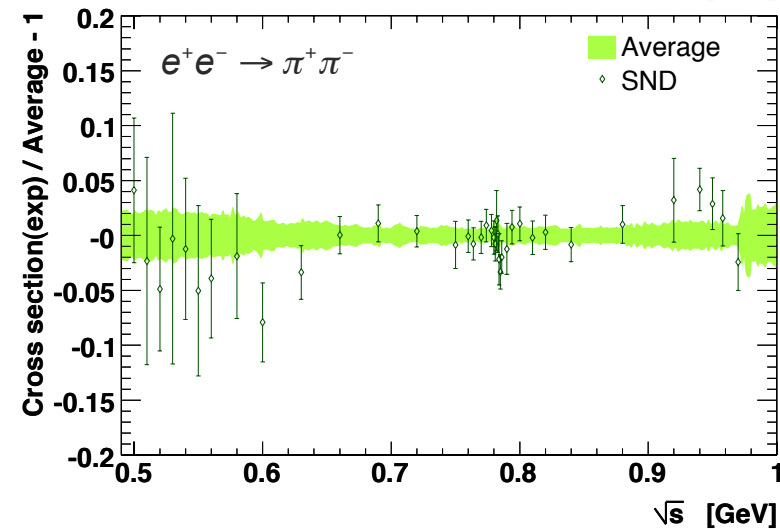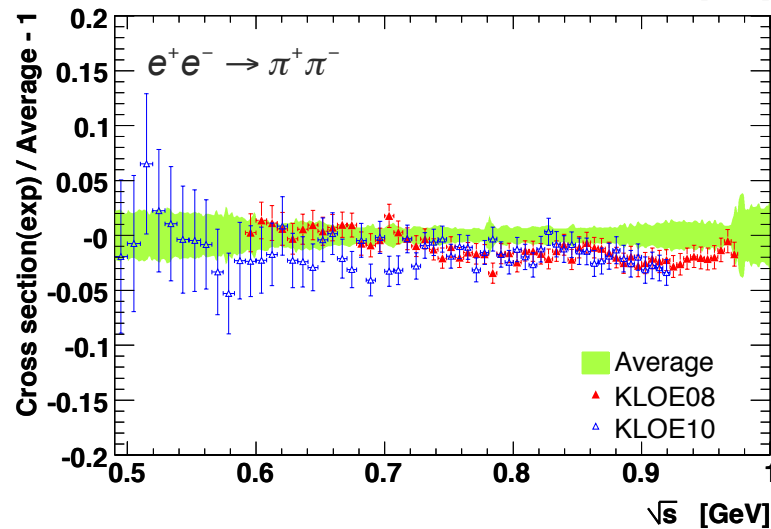
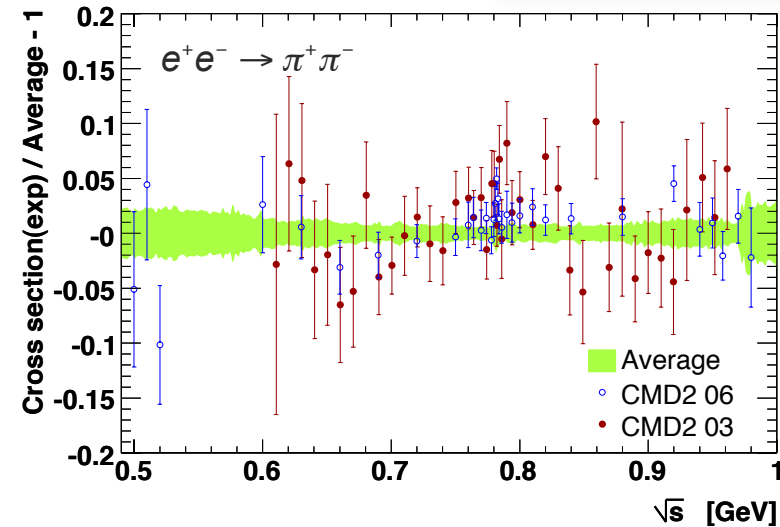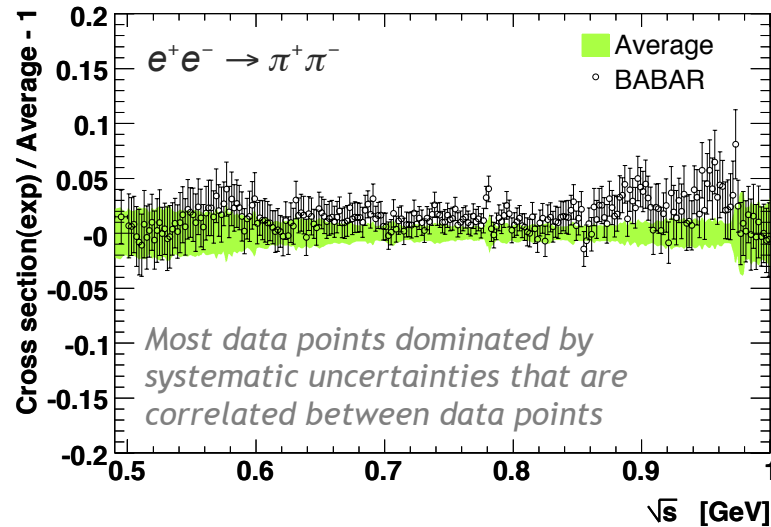- Exclusive vs inclusive data (between 1 and 2.5 GeV)

These discrepancies can become a limiting factor for a real progress on a_μ^{SM}

Measured cross section for $e^+e^- \to \pi^+\pi^-$
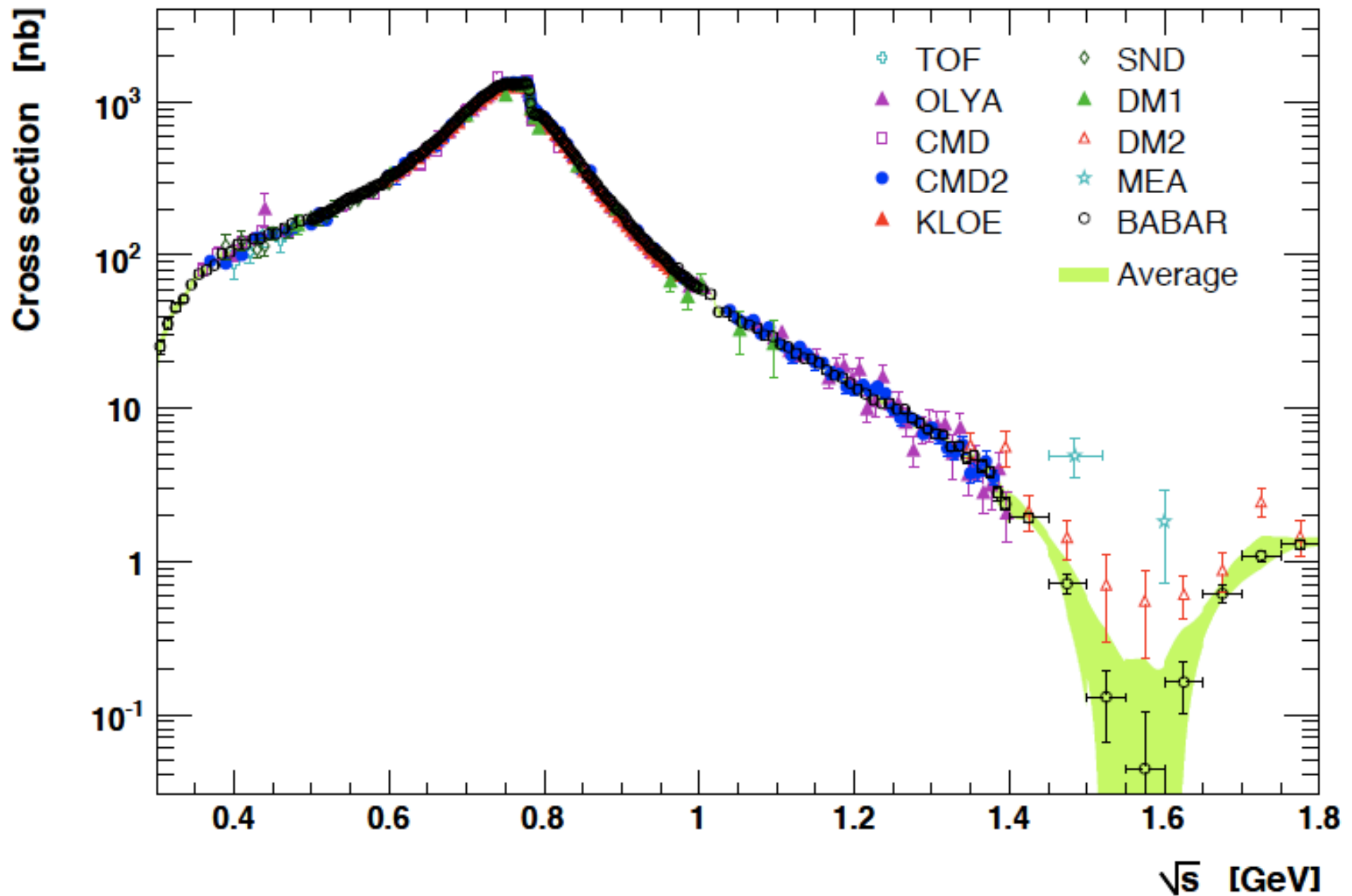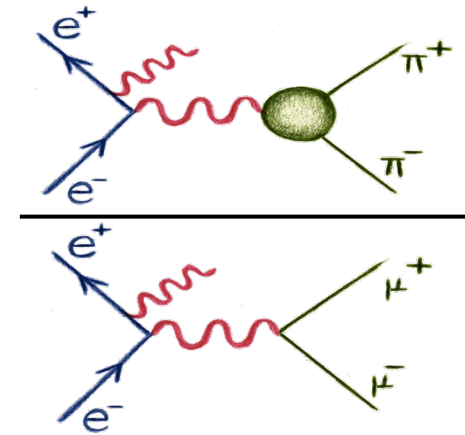
Situation of Two-pion channel

A. Hoecker LP11

New KLOE result on $e^+e^- \to \pi^+\pi^-$ by $\pi\pi\gamma/\mu\mu\gamma$ ratio (ISR)

$$\left|F_\pi(s')\right|^2 \approx \frac{4\left(1 + 2m_\mu^2/s'\right)\beta_\mu}{\beta_\pi^3} \frac{d\sigma_{\pi\pi\gamma}/ds'}{d\sigma_{\mu\mu\gamma}/ds'}$$
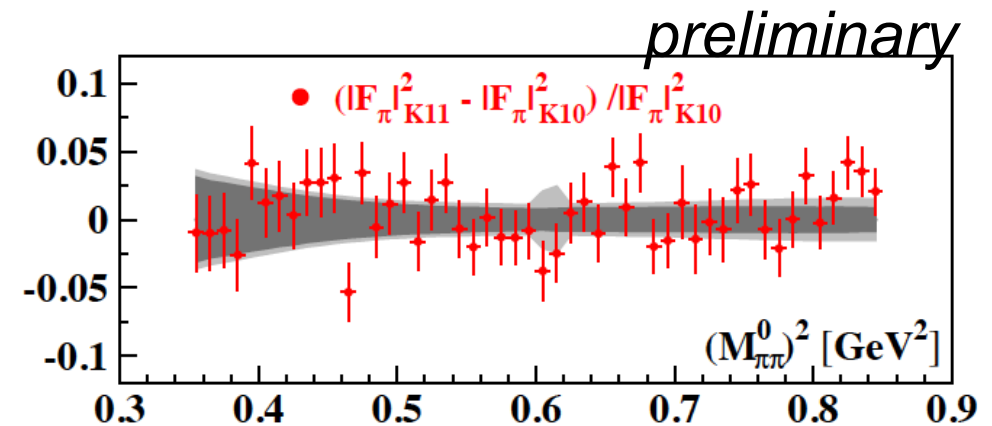
meas.
quantities

Many radiative corrections drop out:
- *radiator function*
- *int. luminosity from Bhabhas*
- *Vacuum polarization*
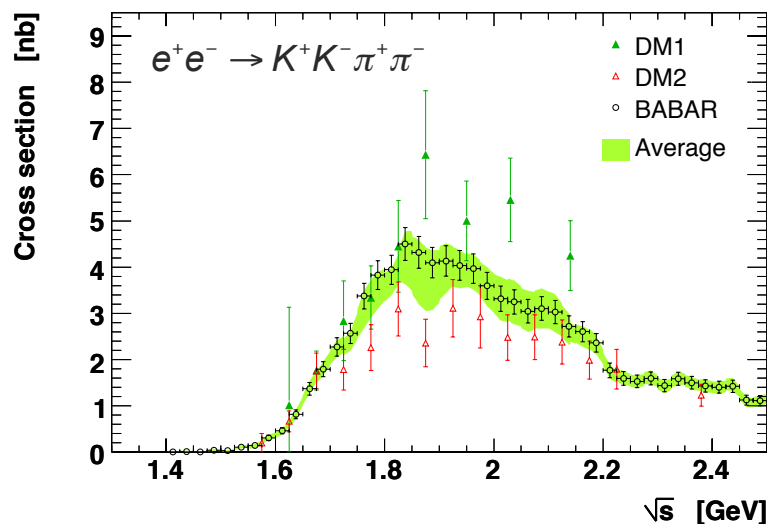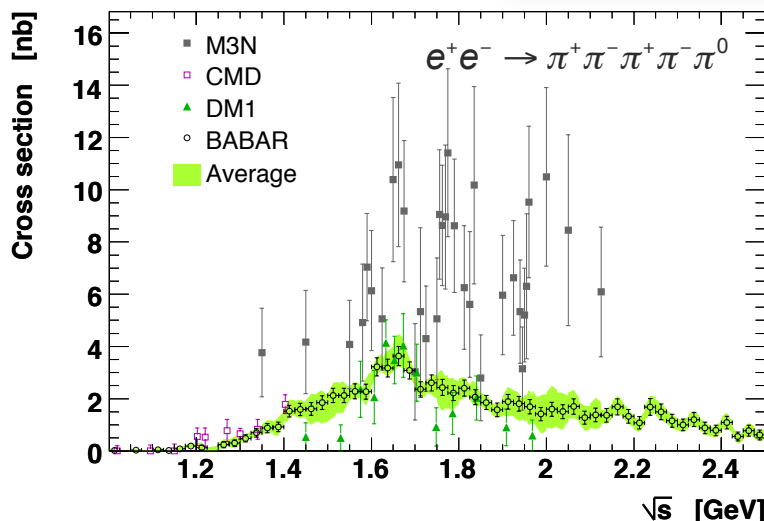
preliminary

New (preliminary) KLOE data confirms previous results!
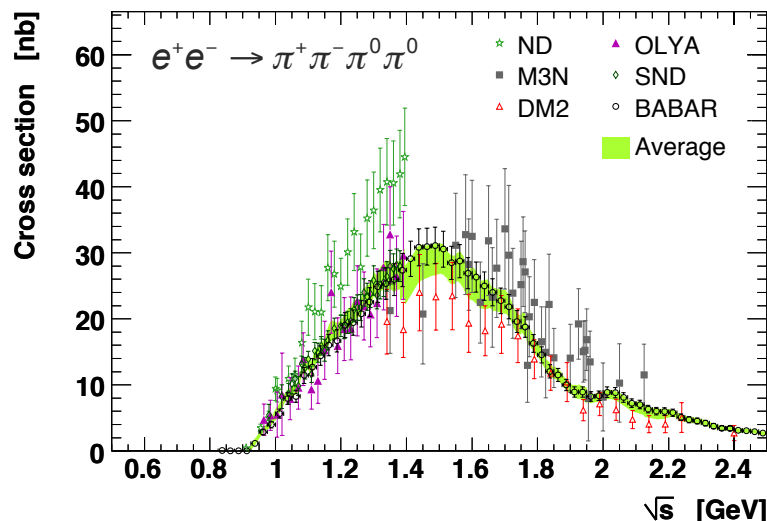
Good agreement with previous measurement!

KLOE11: $a_\mu^{\pi\pi,}(0.35\text{-}0.85\,\text{GeV}^2) = (376.4 \pm 1.2_{stat} \pm 4.1_{sys\,tot}) \cdot 10^{-10}$

KLOE10: $a_\mu^{\pi\pi}(0.35\text{-}0.85\,\text{GeV}^2) = (376.6 \pm 0.9_{stat} \pm 3.3_{sys\,tot}) \cdot 10^{-10}$

Multihadron channels between 1 and 2.5 GeV

BABAR measured (almost) all the exclusive $e^+e^- \rightarrow$ hadrons modes

Many inconsistencies resolved

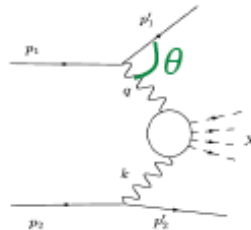**Huge impact on hadronic vacuum polarisation calculation**

A.Hoecker LP 11

π^0 transition form factor $F_{\pi 0 \gamma * \gamma}(q^2, 0)$

Process $e^+e^- \to e^+e^- + PS$ with one e emitted at large angle

$q^2 = -2EE'(1-\cos\theta)$
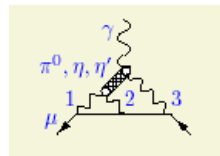
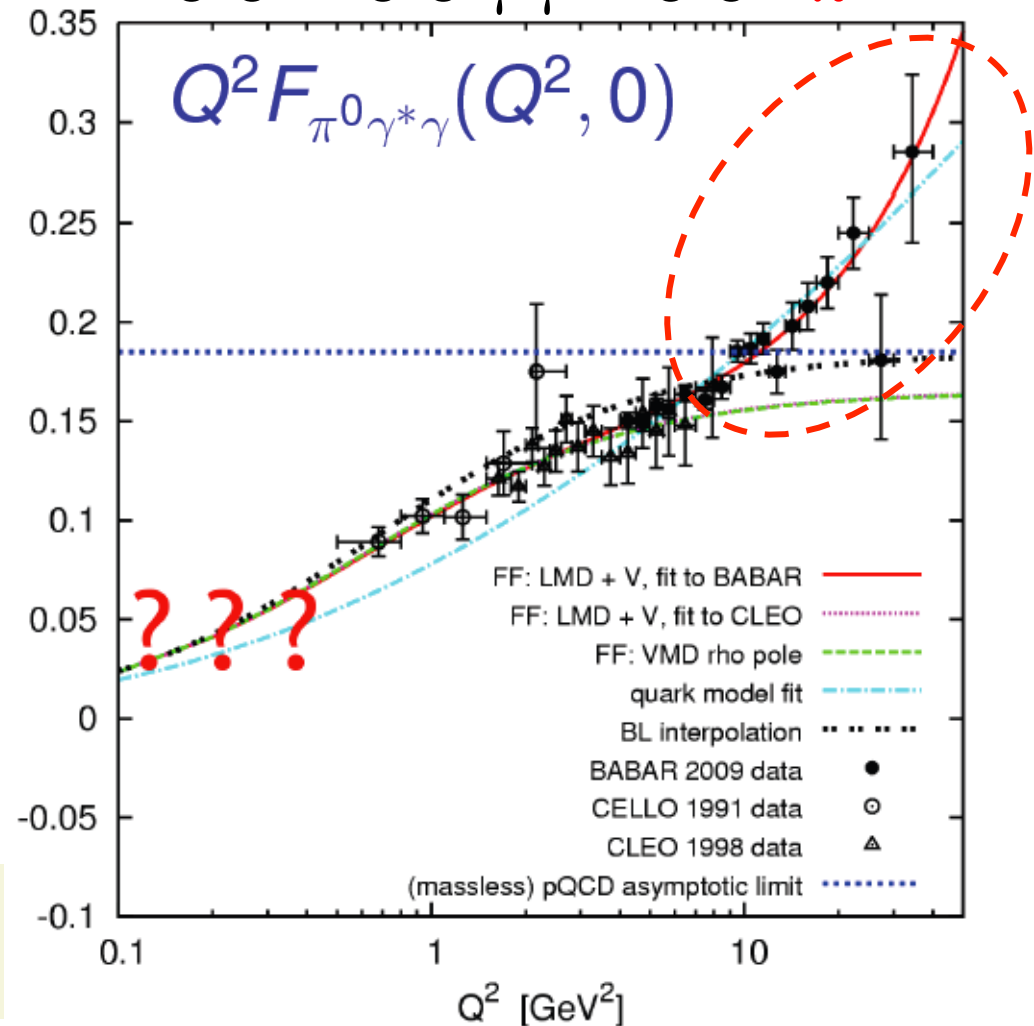TH: TFF constrained at $Q^2=0$, $Q2 \to \infty$; in the intermediate range "empirical" formula (Brodsky-Lepage)

Exp: data at high energy (CLEO, CELLO, BaBar).

BaBar violates the BL limit (differently from η TFF)

Model used in HLbL for a_μ

$e^+e^- \to e^+e^- \gamma*\gamma \to e^+e^- + \pi^0$

$Q^2 F_{\pi^0 \gamma * \gamma}(Q^2, 0)$

FF: LMD + V, fit to BABAR ———
FF: LMD + V, fit to CLEO ·········
FF: VMD rho pole – – – –
quark model fit – · – · –
BL interpolation ·· ·· ··
BABAR 2009 data •
CELLO 1991 data ⊙
CLEO 1998 data △
(massless) pQCD asymptotic limit ·········

Q^2 [GeV^2]

Courtesy of S. Ivashyn

- More data at high energy (Belle?)
- Lack of data below 1 GeV^2 (KLOE-2,BESIII can help)

In both cases experimental and theoretical activities are essential!

Still a lot of work for our WG!

Next meeting most likely in Frascati in March/April 2012 (date to be defined)

Have a nice meeting!

Thanks to BINP for the local support!

spare

How to reach <1% on σ_{HAD} ?

- **Improve experimental accuracy**
  - Systematic errors under control?
- **Improve theory:**
  - RC?
  - Modelling of hadron-photon interaction?
- **Tuning comparison of MC generator very important:**
  - For luminosity this was done;
  - For ISR and scan still the situation is unsatisfactory, and we should try to improve it.
  - FSR modelling should be improved

This will be more important at Super Flavour factories…

HLbL contribution can be a limiting factor for the calculation of a_μ

- As today $\delta a_\mu^{LbL} = [2.5\text{-}4]10^{-10}$
- $\delta a_\mu^{BNL} = 610^{-10} \rightarrow 1.5 \, 10^{-10}$
- How to improve? $\gamma\gamma$ physics can help?
- $\gamma\gamma$ physics (will) is done at (Super) Bfactories. It will also be done at KEDR, KLOE-2 and BESIII with dedicated detectors, in a region where data are scarse
- Also e+e- $\rightarrow$ PSγ

An important meeting
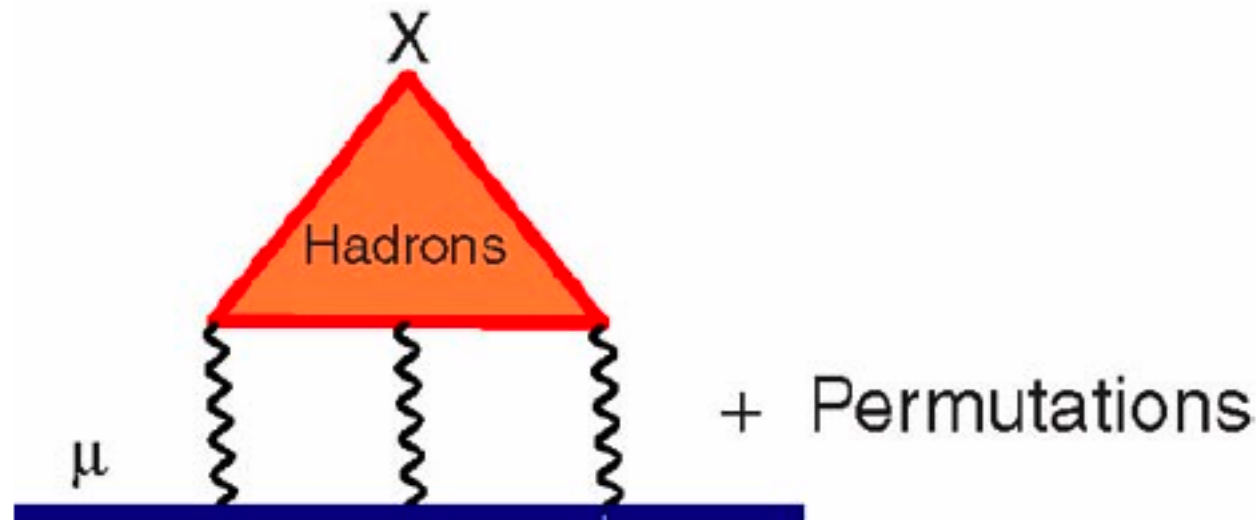
- Almost all the experts on the field
- More news from Fred, Henryk, Simon, etc…

Structure of the WG

- **Luminosity (G. Montagna, F. Nguyen)**
- **R scan (A. Arbuzov, G. Fedotovich)**
- **ISR (H. Czyz, G. Venanzoni)**
- **Tau (Z. Was, D. Epifanov)**
- **Hadronic VP, g-2 and Δa_{em} (T. Teubner, S. Eidelman)**
- **gamma-gamma physics(S. Ivashin, D. Moricciani)**
- **FSR models (S. Gorini, A. Denig)**

The usual question:

How to improve the critical mass: can we access to European funds (especially for positions)?

Any idea/suggestion ?

- Next meeting in Novosibirsk on 23 September 2011 as satellite of PHIPSI11 Conference. Please contact Simon for more information

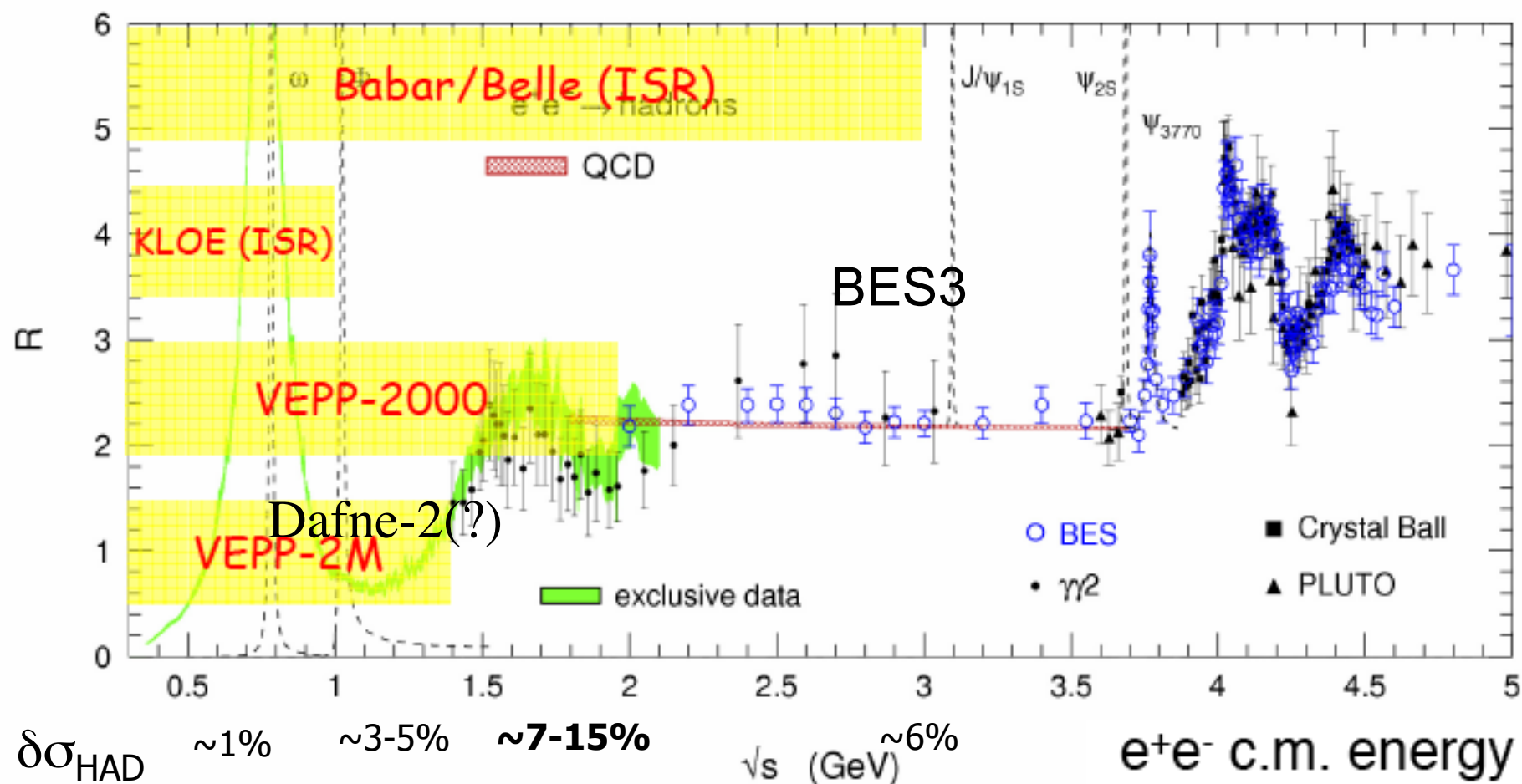**International Workshop on e+e- collisions from Phi to Psi**

Budker Institute of
Nuclear Physics,
Siberian Branch of Russian
Academy of Science,
Novosibirsk, Russia
September 19-22, 2011

PHIPSI11
BINP, Novosibirsk

http://phipsi11.inp.nsk.su/

Have a nice meeting!!!!

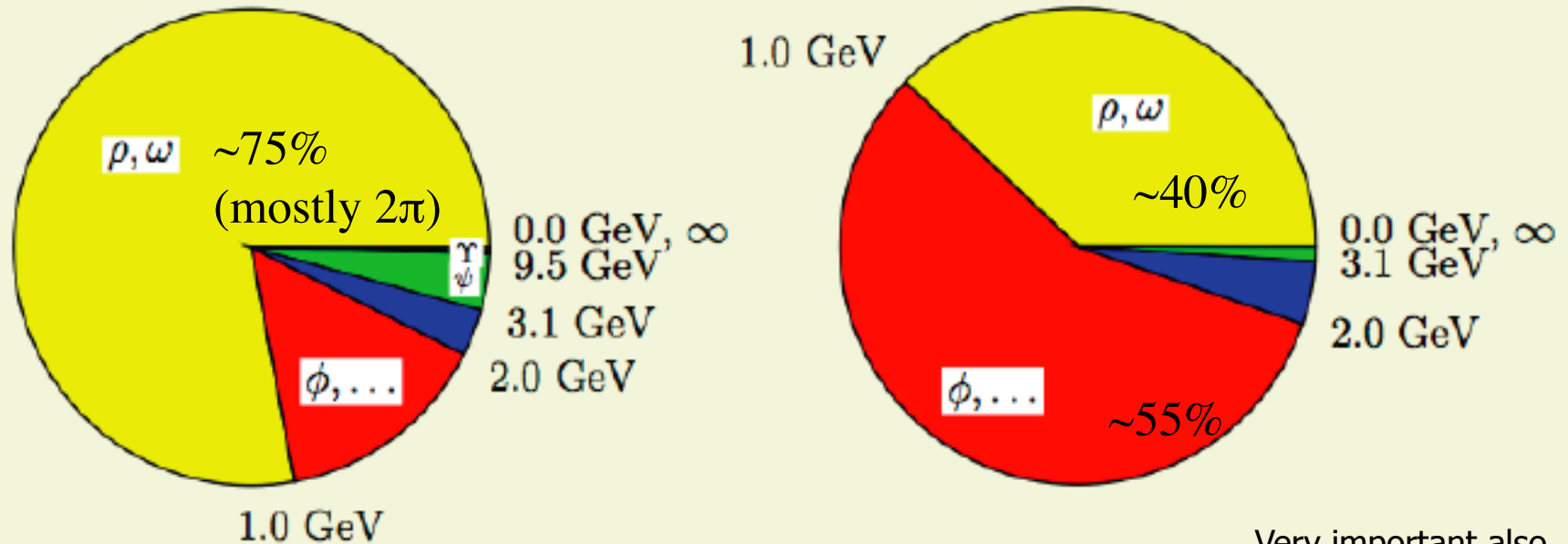Ultimate goal of σ_{HAD}: 1% up to J/ψ (Ψ(4s)?)

Which is the situation on MC above 1 GeV?

(see S. Eidelman presentation)

Contribution of different energy regions to the dispersion integral and the error to a_μ^{had}

F. Jegerlehner, Talk at PHIPSI08

contributions

error²

Very important also the region 1-2 GeV

Experimental errors on σ^{had} translate into theoretical uncertainty of a_μ^{had}!
➝ Needs precision measurements!

A rough estimate for g-2

$a_\mu^{exp} - a_\mu^{theo,SM} = (27.7 \pm 8.4)10^{-10}$ (3.3σ) [Eidelman, TAU08]

$8.4 = \sim5_{HLO} \oplus \sim3_{LbL} \oplus 6_{BNL}$

4   3   3 $1.6_{NEW\ G-2}$ $7-8\sigma$ (if 27.7 will remain the same))

$\delta a_\mu^{HLO} = 5.29 = 3.0(\sqrt{s}<1GeV) \oplus 3.9(1<\sqrt{s}<2GeV)$ FJ08

$\delta a_\mu^{HLO} \rightarrow 3 = 2.5\ (\sqrt{s}<1GeV) \oplus 1.5\ (\sqrt{s}<1GeV)$
    This means:
    $\delta\sigma_{HAD} \sim 0.4\%\ \sqrt{s}<1GeV$ (instead of 0.7% as now))
    $\delta\sigma_{HAD} \sim 2\%\ 1<\sqrt{s}<2GeV$ (instead of 6% as now))

Precise measurement of σ_{HAD} at low energies very
important also for α_{em} !!!