

KLOE hadronic cross section data in the HepDATA repository

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PrecisionSM Meeting, June 03, 2020



HZDR



The KLOE hadronic cross section data sets

- **KLOE05**: 60 points between 0.35 and 0.95 GeV², based on 141.4 pb⁻¹ of data taken in 2001^a (small angle photon cuts, normalization to Bhabha and PHOKHARA radiator)
- **KLOE08**: 60 points between 0.35 and 0.95 GeV², based on 240.0 pb⁻¹ data taken in 2002^b (small angle photon cuts, normalization to Bhabha and PHOKHARA radiator)
- **KLOE10**: 75 points between 0.1 and 0.85 GeV², based on 232.6 pb⁻¹ data taken in 2006^c with $\sqrt{s} = 1.00$ GeV (large angle photon cuts, normalization to Bhabha and PHOKHARA radiator)
- **KLOE12**: 60 points between 0.35 and 0.95 GeV², based on 240.0 pb⁻¹ data taken in 2002^d (small angle photon cuts, normalization to $\mu\mu\gamma$ events)

^a Phys. Lett. B**606** (2005) 12,

^b Phys. Lett. B**670** (2009) 285,

^c Phys. Lett. B**700** (2011) 102

^d Phys. Lett. B**720** (2013) 336

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^a Phys. Lett. B**606** (2005) 12, <https://doi.org/10.17182/hepdata.41901>

^b Phys. Lett. B**670** (2009) 285, <https://doi.org/10.17182/hepdata.57088>

^c Phys. Lett. B**700** (2011) 102

^d Phys. Lett. B**720** (2013) 336

The KLOE hadronic cross section data sets

- **KLOE05**: 60 points between 0.25 and 0.95 GeV², based on 141.4 pb⁻¹ data taken in 2001^a (small angle photon cuts, normalization to Bhabha and PHOKHARA radiator) **Superseded by KLOE08!**
- **KLOE08**: 60 points between 0.35 and 0.95 GeV², based on 240.0 pb⁻¹ data taken in 2002^b (small angle photon cuts, normalization to Bhabha and PHOKHARA radiator)
- **KLOE10**: 75 points between 0.1 and 0.85 GeV², based on 232.6 pb⁻¹ data taken in 2006^c with $\sqrt{s} = 1.00$ GeV (large angle photon cuts, normalization to Bhabha and PHOKHARA radiator)
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KLOE hadronic cross section in HEPData

Searching for “KLOE” in the HEPData repository yields 4 entries (3 KLOE, 1 KLOE-2), including the KLOE05 and KLOE08 hadronic cross section data sets for the $E^+ E^- \rightarrow \text{PI}^+ \text{PI}^-$ and $E^+ E^- \rightarrow \text{PI}^+ \text{PI}^- \text{ GAMMA}$ channels:

Rivet Analysis Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^- \gamma)$ and extraction of $\sigma(e^+e^- \rightarrow \pi^+\pi^-)$ below 1-GeV with the KLOE detector

The KLOE collaboration Aloisio, A.; Ambrosino, F.; Antonelli, A.; et al.

Phys.Lett. B606 (2005) 12-24, 2005.

 Inspire Record 655225  DOI 10.17182/hepdata.41901

We have measured the cross section $\sigma(e^+e^- \rightarrow \pi^+\pi^- \gamma)$ at an energy $W = m_\phi = 1.02 \text{ GeV}$ with the KLOE detector at the electron-positron collider DAΦNE. From the dependence of the cross section on the invariant mass of the two-pion system, we extract $\sigma(e^+e^- \rightarrow \pi^+\pi^-)$ for the mass range $0.35 < s < 0.95 \text{ GeV}^2$. From this result, we calculate the pion form factor and the hadronic contribution to the muon anomaly, a_μ .

 3 data tables match query

- | | |
|---------|---|
| Table 1 | The differential cross section as a function of the invariant mass of the di-pion system in the angular region $\text{THETA}(\text{PIPI}) \in [15 \text{ DEGREES or THETA}(\text{PIPI}) \in [65 \text{ DEGREES and THETA}(\text{PIPI}) \in [0 \text{ and } 180 \text{ DEGREES}$. |
| Table 2 | The physical cross section for $E^+ E^- \rightarrow \text{PI}^+ \text{PI}^-$ including FSR and vacuum polarization effects. |
| Table 3 | The pion form factor with FSR and vacuum polarization effects removed. |


Rivet Analysis Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^-\gamma(\gamma))$ and the dipion contribution to the muon anomaly with the KLOE detector

The KLOE collaboration Ambrosino, F.; Antonelli, A.; Antonelli, M.; et al.

Phys.Lett. B670 (2009) 285-291, 2009.

 Inspire Record 797438  DOI 10.17182/hepdata.57088

We have measured the cross section $\sigma(e^+e^- \rightarrow \pi^+\pi^-\gamma(\gamma))$ at DAΦNE, the Frascati phi-factory, using events with initial state radiation photons emitted at small angle and inclusive of final state radiation. We present the analysis of a new data set corresponding to an integrated luminosity of 240 pb^{-1} . We have achieved a reduced systematic uncertainty with respect to previously published KLOE results. From the cross section we obtain the pion form factor and the contribution to the muon magnetic anomaly from two pion states in the mass range...

 3 data tables match query

- | | |
|---------|---|
| Table 1 | Differential cross section for $E^+ E^- \rightarrow \text{PI}^+ \text{PI}^- \text{ GAMMA}$ (GAMMA). |
|---------|---|

KLOE05 in HEPData repository

<https://www.hepdata.net/record/ins655225>

◀ Hide Publication Information

Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^- \gamma)$ and extraction of $\sigma(e^+e^- \rightarrow \pi^+\pi^-)$ below 1-GeV with the KLOE detector

The KLOE collaboration

Aloisio, A., Ambrosino, F., Antonelli, A., Antonelli, M., Bacci, C., Barva, M., Bencivenni, G., Bertolucci, S., Bini, C., Bloise, C.

Phys.Lett. B606 (2005) 12-24, 2005.

<https://doi.org/10.17182/hepdata.41901>

Journal INSPIRE HepData Resources

arXiv Analysis

Abstract (data abstract)

FRASCATI-DAPHNE. Measurement of the cross section for the process $E^+E^- \rightarrow \pi^+\pi^- \gamma$; Pi^+Pi^- GAMMA at a centre-of-mass energy of 1.02 GeV. The cross section for the $E^+E^- \rightarrow \pi^+\pi^-$; Pi^+Pi^- process is extracted from the dependence on the invariant mass of the two-pion system. The form factor is also calculated.

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Filter 3 data tables

Table 1

Data from T.1
10.17182/hepdata.41901.v1/r1
The differential cross section as a function of the invariant mass of the di-pion system in the angular region THETA(PIPI)...

Table 2

Data from T.1
10.17182/hepdata.41901.v1/r2
The physical cross section for $E^+E^- \rightarrow Pi^+Pi^-$ including FSR and vacuum polarization effects.

Table 3

Data from T.1
10.17182/hepdata.41901.v1/r3
The pion form factor with FSR and vacuum polarization effects removed.

The differential cross section as a function of the invariant mass of the di-pion system in the angular region THETA(PIPI) <15 DEGREES or THETA(PIPI) >165 DEGREES and THETA(PI) in the region 0 to 180 DEGREES.

cmenergies

0.023

observables

OSIG/OM

phrases

Exclusive

Single Differential

E+ E- Scattering

reactions

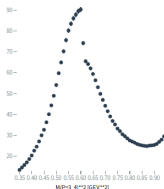
E+ E- -> Pi+ Pi-

Showing 50 of 60 values

Show All 60 values

RE	E+ E- -> Pi+ Pi- GAMMA
SQRT(S)	0.023 GeV
M[P=3_4]**2 [GEV**2]	D(SIG)/DM[P=3_4]**2 [NB/GEV**2]
0.35	13.4 20.24 20.9% sys,Additional experimental systematic 20.9% sys,Additional theory systematic error
0.36	14.59 20.24 20.9% sys,Additional experimental systematic 20.9% sys,Additional theory systematic error
0.37	15.78 20.24 20.9% sys,Additional experimental systematic 20.9% sys,Additional theory systematic error
0.38	17.04 20.24 20.9% sys,Additional experimental systematic

Visualize



Sum errors Log Scale (X)

KLOE05 in HEPData repository

The entry contains 3 tables:

- the differential cross section $d\sigma(e^+e^- \rightarrow \pi^+\pi^-\gamma)/ds_\pi$ as a function of the invariant mass of the di-pion system, s_π , in the angular region $\theta_{\pi\pi} < 15^\circ$ or $\theta_{\pi\pi} > 165^\circ$, $0^\circ < \theta_\pi < 180^\circ$
 - 60 points with (diagonal) stat. uncertainty and a flat syst. uncertainty of $0.9\%(\text{exp}) \oplus 0.9\%(\text{th})$
- the physical cross section $\sigma(e^+e^- \rightarrow \pi^+\pi^-)$ including FSR and vacuum polarization effects
 - 60 points with (diagonal) stat. uncertainty and a flat syst. uncertainty of $0.9\%(\text{exp}) \oplus 0.9\%(\text{th})$
- the pion form factor with FSR and vacuum polarization effects removed.
 - 60 points with (diagonal) stat. uncertainty

The syst. uncertainties given are not correct - the $0.9\%(\text{exp}) \oplus 0.9\%(\text{th})$ uncertainty is on the a_μ -value, not on the individual points.

No covariance matrices are listed, and no breakdown of systematical contributions (additional tables in the paper).

KLOE08 in HEPData repository

<https://www.hepdata.net/record/ins797438>

< Hide Publication Information

Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^-\gamma(\gamma))$ and the dipion contribution to the muon anomaly with the KLOE detector

The KLOE collaboration

Ambrosino, F., Antonelli, A., Antonelli, M., Archilli, F., Bacci, C., Beltrame, P., Benvenuti, G., Bertolucci, S., Bini, C., Bloise, C.

Phys.Lett. B670 (2009) 285-291, 2009.

<https://doi.org/10.17182/hepdata.57088>

Journal INSPIRE HepData Resources

arXiv:Analysis

Abstract (data abstract)

FRASCATI-DAPHNE. Measurement of the cross section for the process $E^+E^- \rightarrow \pi^+\pi^-$ GAMMA (GAMMA) in the energy region 0.35 to 0.95 GeV. The data set has an integrated luminosity of 240 pb⁻¹. The four DSYS errors in the tables are the systematic errors (in percent) from background subtraction, acceptance, detector resolution and radiator function respectively.

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Filter 3 data tables

DSIG,DM

Exclusive

Single Differential

E+ E- Scattering

0.51000,0.51000

E+ E- -> Pi+ Pi-

Table 1

Data from T_7,F_4

10.17182/hepdata.57088.v1/t1

Differential cross section for $E^+E^- \rightarrow \pi^+\pi^-$ GAMMA (GAMMA).

Table 2

Data from T_7,F_4

10.17182/hepdata.57088.v1/t2

Total cross section for $E^+E^- \rightarrow \pi^+\pi^-$.

Table 3

Data from T_7,F_6

10.17182/hepdata.57088.v1/t3

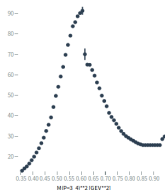
Pion form factor.

Showing 50 of 60 values

Show All 60 values

RE	E+ E- -> Pi+ PION GAMMA (GAMMA)								
THETA(P=5)	> 15 DEGREES								
M([P=3_4])**2 [GEV**2]	D(SIG)/DM([P=3_4])**2 [NB/GEV**2]								
0.35 - 0.36	13.07	20.16	10.81	20.9%	19.1_3	20.6%	19.1_3	20.0%	19.1_3
0.36 - 0.37	14.21	20.18	10.81	20.6%	19.1_3	20.6%	19.1_3	20.0%	19.1_3
0.37 - 0.38	15.2	20.18	10.81	20.6%	19.1_3	20.6%	19.1_3	20.0%	19.1_3
0.38 - 0.39	16.6	20.18	10.81	20.6%	19.1_3	20.6%	19.1_3	20.0%	19.1_3
0.39 - 0.4	18.23	20.17	10.81	20.6%	19.1_3	20.6%	19.1_3	20.0%	19.1_3
0.4 - 0.41	19.97	20.18	10.81	20.6%	19.1_3	20.6%	19.1_3	20.0%	19.1_3

Visualize



Sum errors Log Scale (X)

Log Scale (Y)

Deselect variables or hide different error bars by clicking on them.

KLOE08 in HEPData repository

<https://www.hepdata.net/record/ins797438>

< Hide Publication Information

Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^-\gamma(\gamma))$ and the dipion contribution to the muon anomaly with the KLOE detector

The KLOE collaboration

Ambrosino, F., Antonelli, A., Antonelli, M., Archilli, F., Bacci, C., Beltrame, P., Benvenuti, G., Bertolucci, S., Bini, C., Bloise, C.

Phys.Lett. B670 (2009) 285-291, 2009.
<https://doi.org/10.17182/hepdata.57088>

Journal INSPIRE HepData Resources

arXiv:0809.4269

Abstract (data abstract)
FRASCATI-DAPHNE. Measurement of the cross section for the process $E^+E^- \rightarrow \pi^+\pi^-$ GAMMA (GAMMA) in the energy region 0.35 to 0.95 GeV. The data set has an integrated luminosity of 240 pb⁻¹. The four DSYS errors in the tables are the systematic errors (in percent) from background subtraction, acceptance, detector resolution and radiator function respectively.

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View Analyses

Filter 3 data tables

DSIG,DM

Exclusive

Single Differential

E+ E- Scattering

0.51000,0.51000

E+ E- -> Pi+ Pi-

Table 1

Data from T,F,4
10.17182/hepdata.57088.v1/t1
Differential cross section for E+ E- -> Pi+ Pi- GAMMA (GAMMA).

Table 2

Data from T,F,4
10.17182/hepdata.57088.v1/t2
Total cross section for E+ E- -> Pi+ Pi-

Table 3

Data from T,F,6
10.17182/hepdata.57088.v1/t3
Pion form factor.

Showing 50 of 60 values Show All 60 values

RE	E+ E- -> Pi+ PION GAMMA (GAMMA)
THETA(P=5) > 15 DEGREES	
M([P=3_4])**2 D(SIG)/DM([P=3_4])**2 [NB/GEV**2]	
0.35 - 0.36	13.07 20.16 10.81 20.9% 191.1 20.6% 191.2 20.0% 191.3 20.0% 191.4
0.36 - 0.37	14.21 20.18 10.81 20.6% 191.1 20.6% 191.2 20.0% 191.3 20.0% 191.4
0.37 - 0.38	15.2 20.18 10.81 20.6% 191.1 20.6% 191.2 20.0% 191.3 20.0% 191.4
0.38 - 0.39	16.6 20.18 10.81 20.6% 191.1 20.6% 191.2 20.0% 191.3 20.0% 191.4
0.39 - 0.4	18.23 20.17 10.81 20.6% 191.1 20.6% 191.2 20.0% 191.3 20.0% 191.4
0.4 - 0.41	19.97 20.16 10.81 20.6% 191.1 20.6% 191.2 20.0% 191.3 20.0% 191.4

Visualize

Sum errors Log Scale (X)

Log Scale (Y)

Deselect variables or hide different error bars by clicking on them.

Values between 0.86 and 0.92 GeV² for diff. cross section are incorrect!

KLOE08 in HEPData repository

The entry contains 3 tables:

- the **observed differential cross section** $d\sigma_{e^+e^- \rightarrow \pi^+\pi^-\gamma} / dM_{\pi\pi}^2$ as a function of the invariant mass of the dipion system, in the angular region $\theta_{\pi\pi}(\pi - \theta_{\pi\pi}) < 15^\circ$
 - 60 points with (diagonal) stat. uncertainty and 4 contributions to the systematic uncertainty (background subtr., acceptance, unfolding, radiator function)
- the **bare cross section** $\sigma_{\pi\pi}^0$ inclusive of FSR and with vac. pol. effects removed
 - 60 points with (diagonal) stat. uncertainty and 4 contributions to the systematic uncertainty (background subtr., acceptance, unfolding, radiator function)
- the **pion form factor** without FSR and with vac. pol. effects included.
 - 60 points with (diagonal) stat. uncertainty and 4 contributions to the systematic uncertainty (background subtr., acceptance, unfolding, radiator function)

No covariance matrices are listed, and no constant systematical contributions.

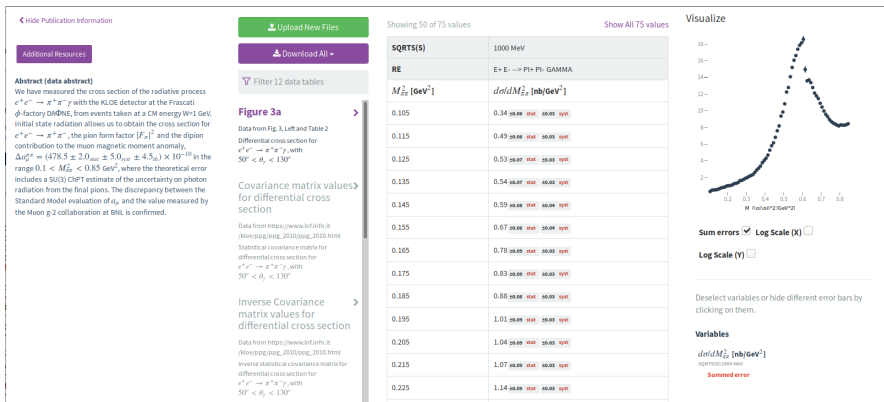
KLOE10 HEPData preparations

I used the `hepdata_lib` Python library to convert the KLOE10 `.txt`-files into the HEPData YAML format.

- about 600 lines of Python script, which produces a `submission.tar.gz` which I uploaded to my sandbox on the HEPdata site (using my OrcID as login)
- the upload contains:
 - 75 points each for the differential cross section with (diagonal) stat. uncertainty and total syst. uncertainty, the bare cross section and the pion form factor (both with (diagonal) stat. uncertainty)
 - Statistical covariance matrices and their inverse for all three data sets
 - tabulated breakdown of up to 16 individual systematic uncertainty contributions for each of the 3 data sets
 - original figures from the paper
 - links to additional documentation (unpublished, but publicly available KLOE note) and KLOE ppg homepage
- Looks good in the sandbox, but would need a coordinator to initiate HEPData review process

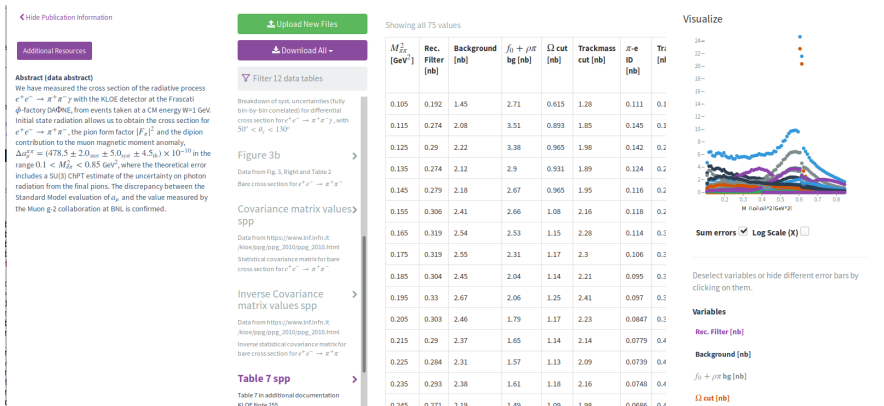
KLOE10 HEPData preparations

Differential cross section with (diagonal) stat. uncertainty and total syst. uncertainty:



KLOE10 HEPData preparations

Breakdown of systematics for bare cross section:



KLOE10 HEPData preparations

Statistical covariance matrix for pion form factor:

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Additional Resources

Abstract (data abstract)

We have measured the cross section of the radiative process $e^+e^- \rightarrow \pi^+\pi^-\gamma$ with the KLOE detector at the Frascati ϕ -factory DAΦNE, from events taken at a CM energy $W=1$ GeV. Initial state radiation allows us to obtain the cross section for $e^+e^- \rightarrow \pi^+\pi^-$, the pion form factor $|F_\pi|^2$ and the dipion contribution to the muon magnetic moment anomaly, $\Delta a_\mu^{\text{had}} = (478.5 \pm 2.0_{\text{stat}} \pm 5.0_{\text{sys}} \pm 4.5_{\text{th}}) \times 10^{-10}$ in the range $0.1 < M_{\text{th}}^2 < 0.85$ GeV², where the theoretical error includes a SU(3) ChPT estimate of the uncertainty on photon radiation from the final pions. The discrepancy between the Standard Model evaluation of a_μ and the value measured by the Muon g-2 collaboration at BNL is confirmed.

Figure 4

Data from Fig. 4
Pion form factor $|F_\pi|^2$

Covariance matrix values fpi

Data from https://www.inf.infn.it/kloe/ppg/ppg_2010/ppg_2010.html
Statistical covariance matrix for pion form factor $|F_\pi|^2$

Inverse Covariance matrix values fpi

Data from https://www.inf.infn.it/kloe/ppg/ppg_2010/ppg_2010.html

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Filter 12 data tables

Table 7 spp

Table 7 in additional documentation
KLOE Note 255
Breakdown of syst. uncertainties (fully bin-by-bin correlated) for the cross section for $e^+e^- \rightarrow \pi^+\pi^-$

Covariance matrix values fpi

Data from https://www.inf.infn.it/kloe/ppg/ppg_2010/ppg_2010.html
Statistical covariance matrix for pion form factor $|F_\pi|^2$

Inverse Covariance matrix values fpi

Data from https://www.inf.infn.it/kloe/ppg/ppg_2010/ppg_2010.html

Covariance matrix values fpi

Data from https://www.inf.infn.it/kloe/ppg/ppg_2010/ppg_2010.html

Statistical covariance matrix for pion form factor $|F_\pi|^2$

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Showing 50 of 5625 values

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Bin I M_{th}^2 [GeV ²]	Bin J M_{th}^2 [GeV ²]	Covariance values for $ F_\pi ^2$
0.1 - 0.11	0.1 - 0.11	0.072245
0.1 - 0.11	0.11 - 0.12	0.0030185
0.1 - 0.11	0.12 - 0.13	4.7215e-05
0.1 - 0.11	0.13 - 0.14	5.4196e-05
0.1 - 0.11	0.14 - 0.15	8.2468e-05
0.1 - 0.11	0.15 - 0.16	3.5632e-05
0.1 - 0.11	0.16 - 0.17	6.2429e-06
0.1 - 0.11	0.17 - 0.18	5.8387e-05

Visualize

Conclusions/Open questions

- existing HEPData KLOE entries need revision:
 - incorrect systematic uncertainties for KLOE05 entry
 - wrong data points for differential cross section of KLOE08 entry
 - missing covariance matrices
 - additional systematic contributions
 - what if data is considered “superseded”? Entry should be flagged accordingly (or removed?)
- entry for KLOE10 data has been prepared
 - needs a coordinator to initiate review process (green light from KLOE-2 policy board)
- To be done:
 - KLOE12 entry
 - KLOE17 entry (paper on combination of all 3 relevant KLOE data sets)