



STRONG 2020 Virtual Workshop on "Spacelike
and Timelike determination of the Hadronic
Leading Order contribution to the Muon $g-2$ "

Strong 2020 PrecisionSM DataBase Report

Anna Driutti


(University and INFN Pisa)

on behalf of Strong2020 PrecisionSM Database team


Pisa, 24th November 2021

What is Strong2020?


- European Project that aims to study strong interactions combining knowledge from different research groups and infrastructures and to develop detectors that can be also used beyond fundamental physics
- Activities in many frontiers:




LOW ENERGY



HIGH ENERGY



INSTRUMENTATION

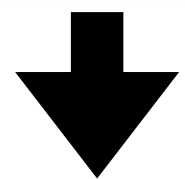


INFRASTRUCTURES
- This talk focus on a precise task of Strong2020: *PrecisionSM: “Hadron Physics for Precision Tests of the Standard Model”*
- Goal of *PrecisionSM*: combine theory and experiment for SM & BSM precision tests
- First deliverable: **Compilation of an annotated database for low-energy hadronic cross sections in e+e- collisions**
- Website: <http://www.strong-2020.eu>

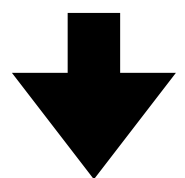
Strong2020 PrecisionSM DataBase

○ Plans:

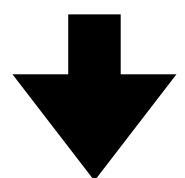
Data Collection



Repository Storage



Website



Tools Development

1. List of low energy precision data
2. Upload all data in a public data repository
3. Catalog data in an easy, detailed and accessible way
4. Provide tools to elaborate the data

Strong2020 PrecisionSM DB Data Collection

1. List of low energy precision data:

- Start with $e^+e^- \rightarrow \pi^+\pi^-$ (most important channel for muon g-2 HVP term)
- Inputs considered so far are $\pi^+\pi^-$ channels from the following experiments:

◆ BaBar (WG contact persons: A. Lusiani, B. Malaescu)



◆ BESIII (WG contact persons: A. Denig, C. Redmer)



◆ KLOE (WG contact person: S. Mueller)



◆ Novosibirsk Exp.: CMD2, CMD3, OLYA, CMD, TOF, VEPP, SND
(WG contact person: F. Ignatov, M. Achasov)

◆ Old Exp. at Frascati and Orsay, CLOE (WG contact person: G. Venanzoni)

Strong2020 PrecisionSM DB **Repository**

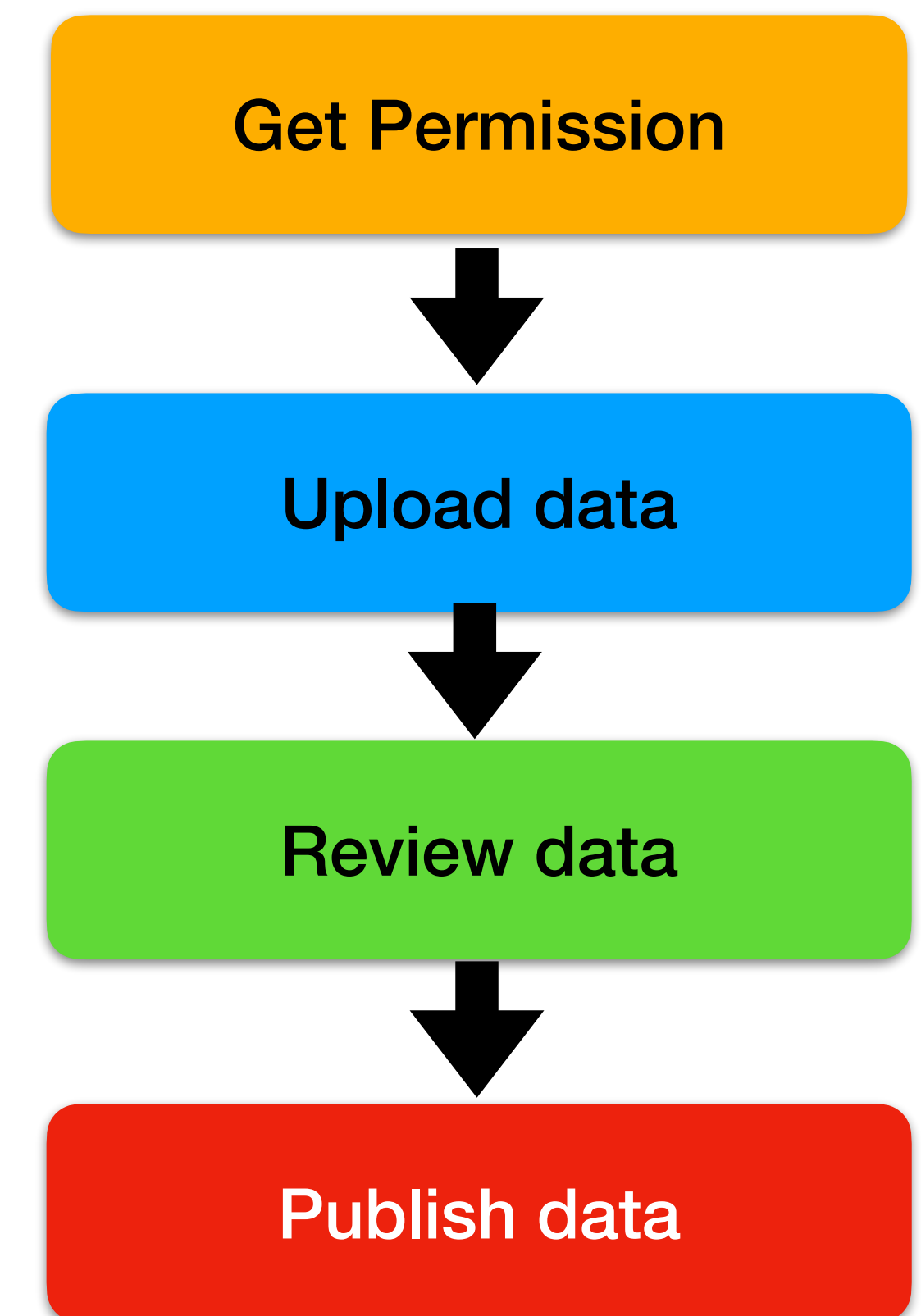
2. Upload all data in a public data repository

- HEPData.net as repository
 - Mainly used by LHC experiments
 - Data's format fits our purpose
 - Measurements in HEPData.net are linked to InspireHEP.net and viceversa
 - Some of our data of interest are already submitted on HEPData.net (but need to be checked), other need to be submitted



Strong2020 PrecisionSM DB **Repository**

- Process to submit data to HEPData.net:
 - Only authorized personal can submit data
 - Collaboration contact persons of the experiments or STRONG-2020 repository coordinator (A. Lusiani)
 - Coordinator give permissions to upload data and appoints a reviewer
 - Data need to follow all HEPDATA.net prescriptions
 - Reviewer checks that there are no mistakes
 - After the reviewer OK data are made public and can be cataloged and used



Strong2020 PrecisionSM DB Repository

✓ Babar Data recently uploaded:

➡ *Precise Measurement of the $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ Cross Section with the Initial-State Radiation Method at BABAR*
[Phys.Rev.D 86 (2012) 032013]

HEPData

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Lees, J.P. et al.

Last updated on 2021-11-23 18:36

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JSON

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Precise Measurement of the $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ Cross Section with the Initial-State Radiation Method at BABAR

The BaBar collaboration

Phys.Rev.D 86 (2012) 032013, 2012.

<https://doi.org/10.17182/hepdata.115140>

Journal

INSPIRE

Resources

Abstract (data abstract)

A precise measurement of the cross section of the process $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ from threshold to an energy of 3 GeV is obtained with the initial-state radiation (ISR) method using 232 fb⁻¹ of data collected with the BaBar detector at e^+e^- center-of-mass energies near 10.6 GeV. The ISR luminosity is determined from a study of the leptonic process $e^+e^- \rightarrow \mu^+\mu^-(\gamma)\gamma_{\text{ISR}}$, which is found to agree with the next-to-leading-order QED prediction to within 1.1%. The cross section for the process $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ is obtained with a systematic

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Bare cross-section

Data from http://ftp.aip.org/epaps/phys_rev_lett/PRLTAO-103-045950/BABAR_ISR2pi_EPAPS.txt

10.17182/hepdata.115140.v1/t1

Bare cross section of $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$

to be reviewed

Systematic uncertainty of bare cross-section

Data from http://ftp.aip.org/epaps/phys_rev_lett/PRLTAO-103-045950/BABAR_ISR2pi_EPAPS.txt

10.17182/hepdata.115140.v1/t2

Systematic uncertainty of bare cross-section of $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$

to be reviewed

Bare cross-section

10.17182/hepdata.115140.v1/t1

<https://www.hepdata.net/reco>

Data from http://ftp.aip.org/epaps/phys_rev_lett/E-PRLTAO-103-045950/BABAR_ISR2pi_EPAPS.txt

Bare cross section of $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$

cmenergies

0.3-3.0

observables

SIG

phrases

Exclusive

E+E- Scattering

Integrated Cross

reactions

E+ E- --> PI+ PI-

Showing 50 of 337 values

Show All 337 values

SQRT(S)	0.3-3.0 GeV
RE	E+ E- --> PI+ PI-
SQRT(S) [GeV]	$\sigma_{\pi^+\pi^-(\gamma)}$ [nb]
0.3 - 0.31	25.49 ±2.6994 total
0.31 - 0.32	35.48 ±2.9146 total
0.32 - 0.33	45.486 ±3.0467 total
0.33 - 0.34	51.782 ±3.1336 total
0.34 - 0.35	64.416 ±3.4995 total

Visualize

Strong2020 PrecisionSM DB Repository

✓ Novosibirsk Data recently uploaded:

- ➡ *Investigation of the ρ –meson resonance with electron-positron colliding beams*
[Phys.Lett.B 25 (1967) 433-435] [Yad.Fiz. 9 (1969) 114-119]
- ➡ *Electromagnetic Pion Form-Factor in the Timelike Region* [Nucl.Phys.B 256 (1985) 365-384]
- ➡ *Measurement of the pion form-factor in the range 1.04 GeV to 1.38 GeV with the CMD-2 detector* [JETP Lett. 82 (2005) 743-747]
- ➡ *Pion Form-factor Measurement in the Reaction $e^+e^- \rightarrow \pi^+\pi^-$ for Energies Within the Range From 0.4 GeV to 0.46 GeV* [Yad.Fiz. 33 (1981) 709-714]
- ➡ *Measurement of the $e^+e^- \rightarrow \pi^+\pi^-$ process cross section with the SND detector at the VEPP-2000 collider in the energy region $0.525 < s < 0.883$ GeV* [JHEP 01 (2021) 113]

Strong2020 PrecisionSM DB Repository

✓ KLOE Data recently uploaded:

- ➡ *Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^-)$ from threshold to 0.85 GeV^2 using Initial State Radiation with the KLOE detector [Phys.Lett.B 700 (2011) 102-110]*
- ➡ *Measurement of $\sigma(e^+e^- \rightarrow \pi^+\pi^-\gamma(\gamma))$ and the dipion contribution to the muon anomaly with the KLOE detector [Phys.Lett.B 670 (2009) 285-291]*
- ➡ *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 [Phys.Lett.B 606 (2005) 12-24]*

Strong2020 PrecisionSM DB Website

3. Catalog data and details in an easy, transparent and accessible way

✓ Webpage: <https://precision-sm.github.io>

- Website generator is Nikola static site generator (<https://getnikola.com>)
- Website files are on Github
- Clear instructions on how to start develop the webpages

✓ Recently started to catalog some $e^+e^- \rightarrow \pi^+\pi^-$ measurements that were available in the webpages

List of Channels

- [π+π- Channels](#)



PrecisionSM Group — [2021-10-12 13:16](#)

Index of $\pi^- \pi^+$ Channels

- **BCF Experiment (ADONE, Frascati):**
 - Direct Method with Energy range 1.44-9 GeV [HEPData link 100180](#)
- **MEA Experiment (ADONE, Frascati):**
 - Direct Method with Energy 1.6 GeV [HEPData link 124109](#)
 - Direct Method with Energy range 1.45-1.52 GeV [HEPData link 158183](#)
- **CLEOc Experiment (CESR, Cornell):**
 - Direct Method with Energy 3.671 GeV HEPData link: NO [InSPIRE link 693873](#)
 - Direct Method with Energy 3.772 GeV 4.170GeV HEPData link: NO [InSPIRE link 693873](#)
 - ISR Method with Energy 0.3-1 GeV HEPData link: NO [InSPIRE link 693873](#)

This version
of the website
is not in
GitHub yet

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- **BCF Experiment (ADONE, Frascati):**
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 - Direct Method with Energy 1.44-9 GeV
 - Direct Method with Energy range 1.44-9 GeV
- **CLEOc Experiment (CESR, Cornell):**
 - Direct Method with Energy 3.0-3.6 GeV
 - Direct Method with Energy 3.0-3.6 GeV
 - ISR Method with Energy 0.3-3.6 GeV

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[HEPData link 100180](#)

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Bollini, D. et al.

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Accessed 671 times

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Filter 1 data tables

Bollini, D. , Giusti, P. , Massam, T. , Monari, L. , Palmonari, F. , Valenti, G. , Zichichi, A.

Lett.Nuovo Cim. 14 (1975) 418, 1975.

<https://doi.org/10.17182/hepdata.37445>

Journal

INSPIRE

Abstract (data abstract)

FRASCATI-ADONE, BCF GROUP.

Table 1

>

Data from T 1

10.17182/hepdata.37445.v1/t1

No description provided.

Table 1

10.17182/hepdata.37445.v1/t1

Data from T 1

No description provided.

cmenergies

1.2-3.0

observables

FORM-FACTOR

phrases

Exclusive

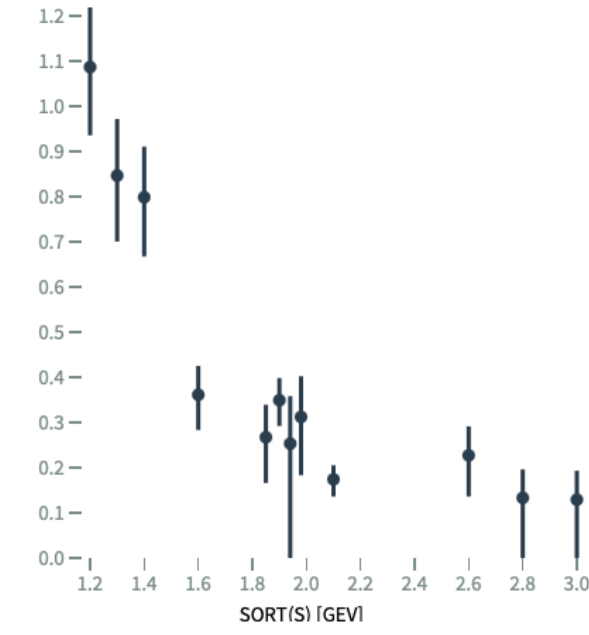
E+ E- Scattering

reactions

E+ E- --> PI+ PI-

RE	E+ E- --> PI+ PI-
SQRT(S)	1.2-3.0 GeV
SQRT(S) [GEV]	ABS(FORM-FACTOR(NAME=PION))
1.2	1.086 ^{+0.132} _{-0.151}
1.3	0.846 ^{+0.125} _{-0.146}
1.4	0.798 ^{+0.112} _{-0.131}
1.5 - 1.7	0.361 ^{+0.064} _{-0.078}
1.85	0.267 ^{+0.072} _{-0.101}
1.9	0.349 ^{+0.049} _{-0.057}
1.94	0.253 ^{+0.105} _{-0.253}
1.98	0.312 ^{+0.09} _{-0.129}
2.1	0.174 ^{+0.031} _{-0.038}
2.4	<0.16
2.6	0.227 ^{+0.064} _{-0.091}
2.8	0.133 ^{+0.063} _{-0.133}
3.0	0.129 ^{+0.064} _{-0.129}

Visualize



Sum errors ☒ Log Scale (X) ☐ Log Scale (Y) ☐

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

Variables

ABS(FORM-FACTOR(NAME=PION))

SQRT(S):1.2-3.0 GeV

Summed error

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 - ISR Method with Energy 0.3-1 GeV HEPData link: NO [InSPIRE link 693872](#)

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Precision measurements of the timelike electromagnetic form-factors of pion, kaon, and proton

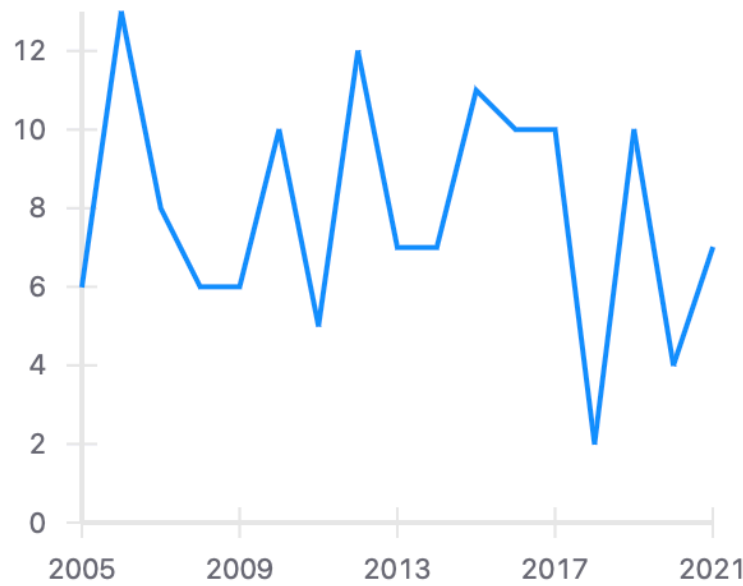
CLEO Collaboration • T.K. Pedlar (Luther Coll.) [Show All\(136\)](#)
Oct, 2005

8 pages
Published in: *Phys.Rev.Lett.* 95 (2005) 261803
e-Print: [hep-ex/0510005](#) [hep-ex]
DOI: [10.1103/PhysRevLett.95.261803](#)
Report number: CLNS-05-1936, CLEO-05-24
Experiments: [CESR-CLEO](#)
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↻ 134 citations

Citations per year



Abstract:

Using 20.7 pb⁻¹ of e+e- annihilation data taken at sqrt{s} = 3.671 GeV with the CLEO-c detector, precision measurements of the electromagnetic form factors of the charged pion, charged kaon, and proton have been made for timelike momentum transfer of |Q²| = 13.48 GeV² by the reaction e+e- to h+h-. The measurements are the first ever with identified pions and kaons of |Q²| > 4 GeV², with the results F_{pi}(13.48 GeV²) = 0.075+-0.008(stat)+-0.005(syst) and F_K(13.48 GeV²) = 0.063+-0.004(stat)+-0.001(syst). The result for the proton, assuming G^p_E = G^p_M, is G^p_M(13.48 GeV²) = 0.014+-0.002(stat)+-0.001(syst), which is in agreement with earlier results.

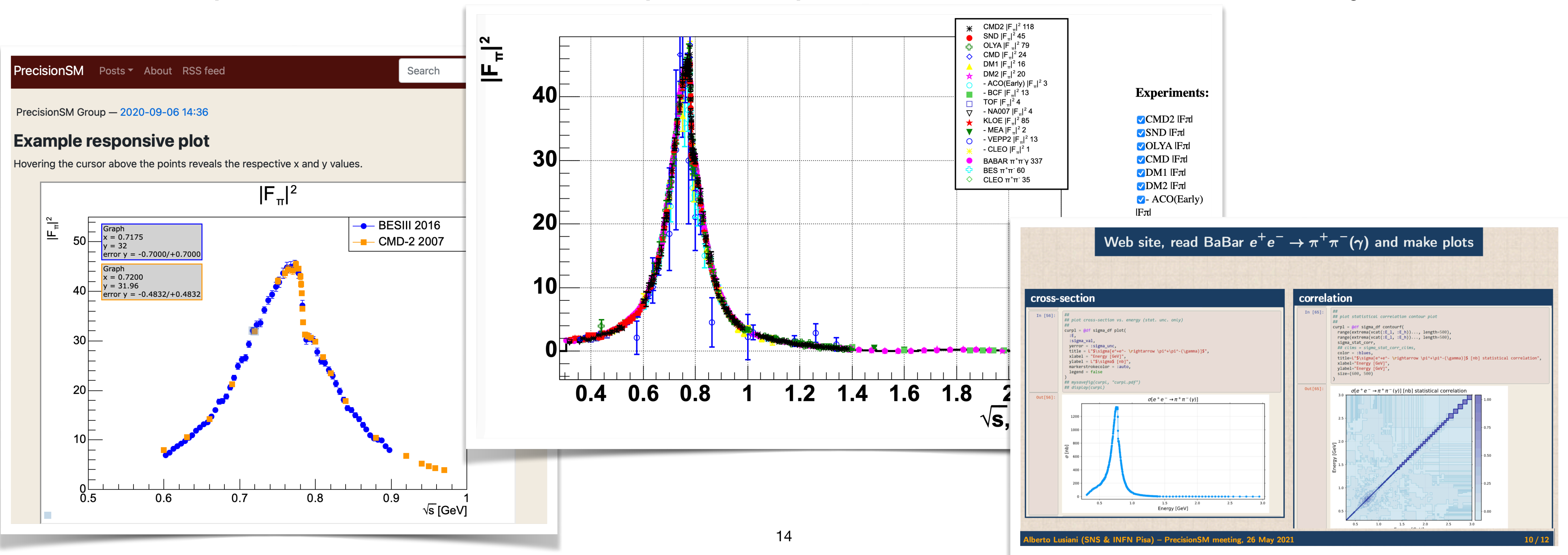
Note: 9 pages postscript,also available through this<http://www.ins.cornell.edu/public/CLNS/2005/>, Submitted to PRL Report-no: CLNS 05/1936, CLEO 05-24

[14.40.Aq](#) [13.40.Gp](#) [14.20.Dh](#) [electron positron: colliding beams](#) [electron positron: annihilation](#) [hadron: pair production](#) [pi: form factor](#) [K: form factor](#)
[p: form factor](#) [channel cross section](#) [Show all \(15\)](#)

Strong2020 PrecisionSM DB Tools

4. Tools to elaborate the data

- Examples of code to build responsive plots and notebooks are already available:



Strong2020 PrecisionSM DB Summary&Outlook

- ✓ Compilation of an annotated database for low-energy hadronic cross sections in e^+e^- collisions
- ✓ The database will contain information about the reliability of the data sets, their systematic errors, and the treatment of radiative corrections
- ✓ Collected list of $e^+e^- \rightarrow \pi^+\pi^-$ cross section measurements
- ✓ Started a process to uploading them to [HEPData.net](https://hepdata.net) and reviewing them (thanks to repository coordinator, uploaders and reviewers: M. Achasov, G.V. Fedotov, F.V. Ignatov, A. Lusiani, B. Malaescu, S. Mueller, B.A. Shwartz, G. Venanzoni)
- ✓ Cataloging the measurements into the website is in progress
- ✓ Next: work on the tools to perform data downloading and data elaboration
- ✓ Next: Proceed with the other channels

- Indico webpage for STRONG2020 meetings on e^+e^- DataBase (2-3 meetings per years):

<https://agenda.infn.it/category/1420/>

- Mailing List:

strong2020-db@lists.infn.it

If you are interested please let us know!

Thank you!

