PROCEEDINGS OF SCIENCE

PrecisionSM: an annotated database for low-energy positron-electron hadronic cross sections

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Developed within the European Project STRONG2020, PrecisionSM is an annotated database that compiles the available data on low-energy hadronic cross sections in electron-positron collisions. It is important to collect and organize these experimental measurements since they are used to perform precise tests of the Standard Model, such as in the anomalous magnetic moment of the muon. In addition to the datasets, the database also contains details regarding the systematic uncertainties and the treatment of Radiative Corrections. The database is accessible through a custom website (https://precision-sm.github.io) which lists all published measurements and the links to their location on HEPData. Moreover, the website displays some examples of tools to elaborate the data listed. This proceeding discusses the current status of this project and provides examples on how to display the information of the database.

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1. Introduction

The available data on low-energy hadronic cross sections in electron-positron collisions ($e^+e^- \to$ hadrons) play an important role in probing the Standard Model (SM) of Particle Physics and in investigating physics effects not yet explained by it. An example is the anomalous magnetic moment of the muon ($a_\mu = (g-2)/2$, where g is the muon gyromagnetic factor). In fact, the $e^+e^- \to$ hadrons cross-sections are used as input for the dispersive approach calculation of the leading-order hadronic-vacuum-polarization term. This term contributes to the theoretical prediction of a_μ, and currently limits its precision due to discrepancies among experimental results and tension between the two calculation methods: the dispersive approach and lattice QCD [1]. To help address these discrepancies and facilitate information exchange between experimental and theoretical groups, the Strong2020 Working Group focuses on understanding the current status of Monte Carlo (MC) generators and measurements in hadronic physics. One of the group's specific activities is to create an annotated database for low-energy $e^+e^- \to$ hadrons cross-sections measured by the various experiments (Strong2020 PrecisionSM Joint Research Group WebPage).

2. The PrecisionSM annotated database

The steps involved in creating the Strong2020 PrecisionSM annotated database for low-energy cross sections in $e^+e^- \to$ hadrons include [2, 3]:

1. List all the published measurements from all experiments and check if they are uploaded in the public repository HEPData. For example, Table 1 shows the list of the $e^+e^- \to \pi^+\pi^-\pi^0$ measurements with links to the relevant publications (InspireHEP) and datasets.
2. Upload any absent measurements to the public repository HEPData and catalog all measurements in the PrecisionSM Website. On the website, each dataset also has annotated comments regarding the measurement, such as information about the radiative corrections applied and the energy. Figure 1(a) shows a screenshot of the webpage where the $e^+e^- \to \pi^+\pi^-$ measurements are cataloged.
3. The PrecisionSM website provides also examples on how to read HEPData measurements and prepare responsive plots. An example is shown in figure 1(b), more examples can be found at this webpage.

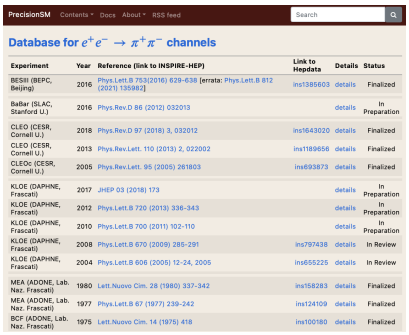
At present, the $e^+e^- \to \pi^+\pi^-$ measurements, crucial for the calculation of the Muon $g-2$ theoretical value, are fully cataloged.

3. Conclusions

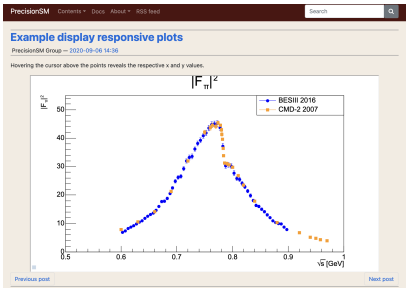
The activities of the Strong2020 PrecisionSM Joint Research Group focus on combining information from theory and experiment for precision tests of the Standard Model and beyond. In particular, the required precision necessitates to account for the effects of the hadronic structure in the low-energy region, where the QCD is non-perturbative. One of the activities is to provide an annotated database for low-energy $e^+e^- \to$ hadrons cross-section data. The database contains the cross sections relevant for the evaluation of the muon g-2 leading-order hadronic-vacuum-polarization contribution that uses the dispersive approach [1]. This is important for the comparison with the latest high-precision measurements of the muon anomalous magnetic moment at Fermilab [4, 5].

Accelerator	Experiment	Year	References with InspireHEP link	HEPData
SLAC (Standford U.)	BaBar	2021	Phys. Rev. D **104** (2021) 11, 112003	
Adone (Frascati)	GG2	1981	Nucl. Phys. B **184** (1981) 31-39	ins158474
		1973	Phys. Lett. B **44** (1973) 533-536	ins84794
	MEA	1980	Lett. Nuovo Cim. **28** (1980) 195-200	ins158282
		1979	Lett. Nuovo Cim. **25** (1979) 5-12	ins145867
ACO (Orsay)	DM1	1980	Nucl. Phys. B **172** (1980) 13-24	ins140174
	ACO	1976	Phys. Lett. B **63** (1976) 357-361	ins99834
		1974	Phys. Lett. B **48** (1974) 155-158	ins95375
		1972	Phys. Lett. B **42** (1972) 507-510	ins84977
		1970	Phys. Lett. B **32** (1970) 416-420	ins63115
		1969	Phys. Lett. B **28** (1969) 513-516	ins56682
DCI (Orsay)	DM2	1992	Z. Phys. C **56** (1992) 15-20	ins339265
VEPP-2M (Novosibirsk)	SND	2020	Eur. Phys. J. C **80** (2020) 10, 993	
		2003	Phys. Rev. D **68** (2003) 052006	ins619011
		2002	Phys. Rev. D **66** (2002) 032001	ins582183
		2001	Phys. Rev. D **63** (2001) 072002	ins533574
		1999	Phys. Lett. B **462** (1999) 365-370	ins508003
	SND-2k	2015	J. Exp. Theor. Phys. **121** (2015) 1, 27-34 Zh. Eksp. Teor. Fiz. **148** (2015) 1, 34-41	
	CMD2	2006	Phys. Lett. B **642** (2006) 203-209	
		2004	Phys. Lett. B **578** (2004) 285-289	
		2000	Phys. Lett. B **476** (2000) 33-39	ins523691
		1998	Phys. Lett. B **434** (1998) 426-436	ins480170
		1995	Phys. Lett. B **364** (1995) 199-206	ins406880
	ND	1991	Phys. Rept. **202** (1991) 99-170	ins321108
	CMD	1987	JETP Lett. **46** (1987) 164-167 Pisma Zh. Eksp. Teor. Fiz. **46** (1987) 132-134	ins255953
	OLYA	1984	Preprint INP 84-7, Novosibirsk, 1984	ins1408355
		1982	JETP Lett. **36** (1982) 274-276 Pisma Zh. Eksp. Teor. Fiz. **36** (1982) 221-223	ins185895
	OLYA	1978	Yad. Fiz. **27** (1978) 976-984	ins137035
	VEPP-2	1971	Phys. Lett. B **34** (1971) 328-332	ins69313

Table 1: Summary of the published $e^+e^- \to \pi^+\pi^-\pi^0$ measurements with links to the datasets.



(a) Link to the table webpage



(b) Link to the plot webpage

Figure 1: Pictures of the PrecisionSM website page showing (a) the beginning of the $e^+e^- \to \pi^+\pi^-$ measurements list, and (b) an example of a responsive plot generated with the database information.

Acknowledgments

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References

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