



xFitter developments overview

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xFitter External Workshop in Krakow
5.03.2018

<https://wiki-zeuthen.desy.de/xFitter>



Welcome to xFitter (former HERAFitter)

Proton parton distribution functions (PDFs) are essential for precision physics at the LHC and other hadron colliders. The determination of the PDFs is a complex endeavor involving several physics processes. The main process is the lepton proton deep-inelastic scattering (DIS), with data collected by the HERA ep collider covering a large kinematic phase space needed to extract PDFs. Further processes (fixed target DIS, ppbar collisions etc.) provide additional constraining powers for flavour separation. In particular, the precise measurements obtained or to come from LHC will continue to improve the knowledge of the PDF.

The xFitter project is an open source QCD fit framework ready to extract PDFs and assess the impact of new data. The framework includes modules allowing for a various theoretical and methodological options, capable to fit a large number of relevant data sets from HERA, Tevatron and LHC. This framework is already used in many analyses at the LHC.

Downloads of xFitter software package

- 🔔 **xFitter-2.0.0 release is publicly available.**
All the xFitter releases can be accessed [HERE](#).
All the former (HERAFitter) releases can be accessed [HERE](#).
Description: <http://arxiv.org/abs/1410.4412>

→ **Sasha's talk on Tuesday for future plans**

xFitter Meetings

- 🔔 [xFitter Workshop in Krakow](#) 4-7 March 2018
- **User's Meetings:** meetings to enhance communication between users and developers (open access)
- **Developer's Meeting:** technical weekly meetings to ensure communication among developers (restricted access)
- **Steering Group's Meeting** (restricted access)

→ **biweekly now**

xFitter representation

- [List of results](#)
- [List of collected talks](#)

→ **Mandy's overview talk, and further LHC talks**

Developers Info (restricted to developers)

- [Internal Developments](#)

Organisation

Steering Group is composed of:

- **Conveners:** Voica Radescu, Ringaile Placakyte, Amanda Cooper-Sarkar
- **Release coordinator/Librarian** (revision of the release candidates): Sasha Glazov, Oleksandr Zenaiev
- **Contact Persons:** Cristi Diaconu (H1), Klaus Rabbertz (CMS), Bogdan Malaescu (ATLAS), Olaf Behnke (ZEUS), Ronan McNulty (LHCb), Gavin Salam (theory)
- **DESY IT Contact:** Yves Kemp

Getting help

Send email to xFitter-help@desy.de



Status of xFitter releases

<https://wiki-zeuthen.desy.de/xFitter/xFitter/DownloadPage>

Releases of the xFitter QCD analysis package

- Versioning convention: **I,j,k** with
 - **I** - stable release
 - **j** - beta release
 - **k** - bug fixes.
- The release notes can be found in this attachment: @ [xFitter_release_notes.pdf](#) .
- Installation script for xFitter together with QCDNUM, APFEL, APPLGRID, LHAPDF @ [install-xfitter](#)
- The script to download coupled data and theory files @ [xfitter-getdata.sh](#).
- Data and theory files are also stored in [hepforge](#) and can be accessed from there ("List of Data Files").

Date	Version	Files	Remarks
 03/2017	2.0.0 FrozenFrog	@ xfitter-2.0.0.tgz	stable release with decoupled data and theory files
07/2016	1.2.2	@ xfitter-1.2.2.tgz	release with decoupled data and theory files
05/2016	1.2.1	@ xfitter-1.2.1.tgz	release with decoupled data and theory files
02/2016	1.2.0	@ xfitter-1.2.0.tgz	release with decoupled data and theory files

Documentation

- Manual (under continuous improvement) can be accessed @ [here](#).
- **TUTORIALS** adapted for the Frozen Frog release can be downloaded from [here](#).
- The **README** file (accessible via the package) gives an explanation for a quick start.
- The **INSTALLATION** file (accessible via the package) provides information for package installation and usage instructions.
- The package is licensed under GNU GPL, please see **LICENCE** for mode details (accessible via the package).

Web access to GIT

- The master version can be viewed and downloaded from <https://gitlab.cern.ch/fitters/xfitter.git>

Links to external packages

External packages that could be run with xFitter via configuration flags can be accessed for convenience [HERE](#) .

HERAverager data combination package

Information can be accessed here <https://wiki-zeuthen.desy.de/HERAverager>.

no new release since 2017 →
but many developments
in repository (this talk)

Analyses using xFitter

<https://wiki-zeuthen.desy.de/xFitter/xFitter/results>

List of analyses by xFitter

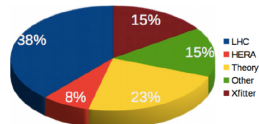
The link to the list of analyses using former HERAFitter can be accessed [here](#)

7/02/2018	xFitter Developers and Marco Bonvini	arXiv:1802.00064	◆ Impact of low- x resummation on QCD analysis of HERA data	
6/07/2017	xFitter Developers	EurPhys.J. C77 (2017) no.12 837, arXiv:1707.05343	◆ Impact of the heavy quark matching scales in PDF fits	■ LHAPDF grids
5/01/2017	F. Gault, xFitter Developers' team and M. Lioy	EurPhys.J. C77 (2017) no.6 408, arXiv:1701.08553	◆ The photon PDF from high-mass Drell-Yan data at the LHC	
4/03/2016	xFitter and APFEL teams and A. Geiser	JHEP 1608 (2016) 050, arXiv:1605.01946	◆ A determination of $m_c(m_c)$ from HERA data using a matched heavy flavor scheme	

List of analyses using xFitter

Number	Date	Group	Reference	Title
2018				
60	02/2018	M. Goharipour, H. Khanpour, V. Guzey.	arXiv:1802.01363	◆ First global next-to-leading order determination of diffractive parton distribution functions and their uncertainties within the xFitter framework
2017				
59	12/2017	V. Bertone, M. Botje	arXiv:1712.08162	◆ A C++ interface to QCDNUM
58	12/2017	A. Kusina et. al.	arXiv:1712.07024	◆ Gluon shadowing and antishadowing in heavy-flavor production at the LHC
57	12/2017	A. Luszczak, W. Schäfer	Phys. Rev. C 97, 024903 (2018) arXiv:1712.04502	◆ Incoherent diffractive photoproduction of Υ/ψ and $\Upsilon\Upsilon$ on heavy nuclei in the color dipole approach
56	11/2017	H-W. Lin et. al.	arXiv:1711.07916	◆ Parton distributions and lattice QCD calculations: a community white paper
55	11/2017	V. Bertone et. al.	arXiv:1711.03355	◆ Heavy-flavor parton distributions without heavy-flavor matching prescriptions
54	10/2017	CHS	arXiv:1711.03143	◆ Measurement of the inclusive ttbar cross section in pp collisions at $\sqrt{s} = 5.02$ TeV using final states with at least one charged lepton
53	10/2017	A. Lalek	arXiv:1710.04114	◆ Collinear and Transverse Momentum Dependent parton densities obtained with a Parton Branching Method
52	09/2017	ATLAS	EurPhys.J. C77 (2017) no.11, 804	◆ Measurement of lepton differential distributions and the top quark mass in ttbar production in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector
51	09/2017	A. Wefae, A.N. Khorramian	arXiv:1709.08402	◆ Impact of Charm H1-ZEUS Combined data and Determination of the Strong Coupling in Two Different Schemes
50	09/2017	A. Aledaneshvaz, A. Khorramian	arXiv:1709.07247	◆ The effect of profiling procedure on PDFs using LHCb data
49	09/2017	J. Gao, L. Harland-Lang, J. Rejo	arXiv:1709.04992	◆ The Structure of the Proton in the LHC Precision Era
48	09/2017	A. Aledaneshvaz, A. Khorramian	Int.J.Mod.Phys. A32 (2017) no.22, 1750134	◆ The Impact of CMS inclusive jet data on parton distribution functions and their uncertainties
47	08/2017	F. Hautmann et. al.	arXiv:1708.03279	◆ Collinear and TMD Quark and Gluon Densities from Parton Branching Solution of QCD Evolution Equations
46	07/2017	Leszek Motyka et. al.	arXiv:1707.05992	◆ Evidence of quasi-partonic higher-twist effects in deep inelastic scattering at HERA at moderate Q^2
45	07/2017	H. Kowalski et. al.	EurPhys.J. C77 (2017) no.11, 777	◆ Decoupling of the leading contribution in the discrete BFKL Analysis of High-Precision HERA Data
44	08/2017	A. Wefae, A.N. Khorramian	Nucl.Phys. B921 (2017) 472	◆ The role of different schemes in the QCD analysis and determination of the strong coupling
43	05/2017	CHS	arXiv:1705.02628	◆ Measurement of the triple-differential dijet cross section in proton-proton collisions at $\sqrt{s}(s) = 8$ TeV and constraints on parton distribution functions
42	03/2017	CHS	arXiv:1703.01630, EPJ C77 (2017) 459 (TDP-14-013)	◆ Measurement of double differential cross sections for top quark pair production in pp collisions at 8 TeV and impact on PDFs
41	02/2017	A. Aledaneshvaz, M. Goharipour, S. Rostami	Chin Phys. C 41, 2 (2017) 023101	◆ Uncertainty of parton distribution functions due to physical observables in a global analysis
40	01/2017	Y.G. Gbedo, M. Mangin-Briet	arXiv:1701.07678	◆ Markov Chain Monte Carlo techniques applied to PDF determination: proof of concept
39	01/2017	ABMP	arXiv:1701.05838	◆ Parton Distribution Functions, as and Heavy-Quark Masses for LHC Run II
2016				

- ◆ 60 external analysis used xFitter (21 in 2017)
- ◆ 7 analysis by xFitter team
- ◆ (more details in Mandy's talk)



Talks at conferences

<https://www.xfitter.org/xFitter/xFitter/xFitterTalks>

2018

Date	Conference/Workshop	Presenter	Link	Remarks
16-20.04.2018	 DIS 2018	A. Glazov, XXX	xFitter talks	
17-24.03.2018	 Moriond QCD 2018	F. Giuli	xFitter talk	

2017

24-29.09.2017	 WE-Heraeus Physics School	A. Luszczak	xFitter talk	@Talk
24-30.08.2017	 Lomonosov 2017	O. Zenaiev	xFitter talk	abstract accepted
05-12.07.2017	 EPS 2017	F. Giuli	xFitter talk	abstract accepted
12-18.06.2017	 Low x	A. Cooper Sarkar	xFitter talk	talk accepted
22-27.05.2017	 PHOTON 2017	V. Bertone	xFitter talk	invited talk
15-20.05.2017	 LHCP 2017	A. Glazov	xFitter talk	abstract accepted
03-07.04.2017	 DIS 2017	F. Olness	xFitter talk	invited talk
03-07.04.2017	 DIS 2017	F. Giuli	xFitter talk	invited talk
25.03-01.04.2017	 Moriond QCD	V. Bertone	xFitter talk	talk accepted
19-22.03.2017	 xFitter workshop Oxford	users and developers	xFitter talks/discussions	
7.03.2017	 PDF4LHC	V. Radescu	xFitter talk	invited talk

- **>10** talks in 2017
- need speakers: let us know if you want to give xFitter talk

xFitter development workflow

- Regular xFitter meetings (biweekly):
 - ▶ discussing development process
 - ▶ discussing ongoing physics analyses
 - on demand dedicated meeting between main analysers
- Using CERN services for code development and support:
 - ▶ **Gitlab**: <https://gitlab.cern.ch/fitters/xfitter>
 - ★ revision control, code review
 - ★ public access to read the code
 - ▶ **JIRA**: <https://its.cern.ch/jira/projects/XFITTER>
 - ★ issue tracking
- Using **Hepforge** to store data:
 - ▶ 49 datasets with corresponding theoretical predictions available at:
<http://xfitter.hepforge.org/data.html>



This page contains the list of publicly available experimental data sets (with corresponding theory grids if available) in the xFitter package.
To download data set, please click on the entry link (and open browser to get it).

No.	Collider	Experiment	Base Data	qTils	Readme
1	Hadron	Indirect	IndirectData	0000-00-0000	READ ME
2	Hadron	HL	IndirectData	0000-00-0000	READ ME
3	Hadron	HL	IndirectData	0000-00-0000	READ ME
4	Hadron	HL	IndirectData	0000-00-0000	READ ME
5	Hadron	HL	IndirectData	0000-00-0000	READ ME
6	Hadron	HL	IndirectData	0000-00-0000	READ ME
7	Hadron	HL	IndirectData	0000-00-0000	READ ME
8	Hadron	HL	IndirectData	0000-00-0000	READ ME
9	Hadron	HL	IndirectData	0000-00-0000	READ ME
10	Hadron	HL	IndirectData	0000-00-0000	READ ME
11	Hadron	HL	IndirectData	0000-00-0000	READ ME
12	Hadron	HL	IndirectData	0000-00-0000	READ ME
13	Hadron	HL	IndirectData	0000-00-0000	READ ME
14	Hadron	HL	IndirectData	0000-00-0000	READ ME
15	Hadron	HL	IndirectData	0000-00-0000	READ ME
16	Hadron	HL	IndirectData	0000-00-0000	READ ME
17	Hadron	HL	IndirectData	0000-00-0000	READ ME
18	Hadron	HL	IndirectData	0000-00-0000	READ ME
19	Hadron	HL	IndirectData	0000-00-0000	READ ME
20	Hadron	HL	IndirectData	0000-00-0000	READ ME



xfitter

Star 6 Fork 2 KRBS - <https://gitlab.cern.ch/8443/1> Watch

Leave project

Files (105.5 MB) Commits (2,491) Branches (19) Tag (1) README GNU GPLv3 CI configuration

master xfitler +

History Find file

Jobs Merge branch 'Fix_LHAPDF_Analysis' into 'master' 433ff057
"fix" Oleksandr Zenaiev authored 4 days ago

Name Last commit Last update

Developments in repository: branches

<https://gitlab.cern.ch/fitters/xfitter/branches>

python interface, Sasha's talk →

🐛 **boost_python_th**
→ [ceb475f8](#) · working version · a day ago

contains new theory interface →

🐛 **master** default protected
→ [433ff057](#) · Merge branch 'Fix_LHAPDF_Analysis' into 'master' · 4 days ago

meson PDFs with COMPAS DY →
and direct photon (Ivan)

🐛 **SumRuleSteering**
→ [5d1e859e](#) · Work on exporting sum rules to steering · 2 weeks ago

🐛 **resum-interfaces**
→ [3344f0f4](#) · Update to new QCDNUM version · 3 weeks ago

fastNLO develop., Daniel, Klaus' talk →

🐛 **fastNLO_update**
→ [bf131f42](#) · updates · 4 weeks ago

🐛 **testBLAS**
→ [9d6c5ef0](#) · prepare for cuda test · 5 months ago

Markov chain MC techniques →

🐛 **MCMC**
→ [41af21cf](#) · removing check message · 5 months ago

🐛 **fix_process_for_---_delimiter**
→ [74245627](#) · Allow for -- separator to be not at the beginning of the string · 6 months ago

🐛 **z3d**
→ [81fa8777](#) · add data files · 7 months ago

🐛 **chiscan-uncdec**
→ [58468f92](#) · gauss plot for MC replica chi2 scan · 9 months ago

🐛 **TensorPomeron**
→ [c230203b](#) · Merge branch 'theory-interface' into TensorPomeron · 10 months ago

Developments in repository: pull requests into master

https://gitlab.cern.ch/fitters/xfitter/merge_requests

bug fix →

Do not call getextraparsconstrchi2 for LHAPDF Analysis mode since MINUIT is not called in this case
!100 · opened 4 days ago by Alexander Glazov

developments for small-x resum. →
[1802.00064]: now publicly available

Smallx resummation
!99 · opened 2 weeks ago by Francesco Giuli

newest yaml version →

Update dep versions
!92 · opened 3 weeks ago by Alexander Glazov

bug fix, continuous integration →

Resolve External Issue
!91 · opened 2 months ago by Alexander Glazov

Update .gitlab-ci.yml to install yaml-cpp dependency
!90 · opened 2 months ago by Andrey Sapronov

fix LHAPDF improvement
!89 · opened 2 months ago by Oleksandr Zenaiev

Xfitter 42
!81 · opened 8 months ago by James Edward Ferrando

!!! theory interface !!! →

Resolve External Issue
!88 · opened 2 months ago by Oleksandr Zenaiev

update to ACOT scheme →

Fred: fix for ACOT N3LO: nordACOT
!84 · opened 4 months ago by Fred Olness

newest Hoppet version →

install script updated to Hoppet-1.2.0
!87 · opened 4 months ago by Oleksandr Zenaiev

newest OPENQCDRAD (ABMP16) →

update of OPENQCDRAD code to version 2.1
!85 · opened 4 months ago by Oleksandr Zenaiev

Theory interface

- A new interface for theoretical predictions:
 - ▶ to facilitate developments of new calculations
 - ▶ to simplify integration of new tools
 - ▶ ... without modifying the core xFitter code
- Developed since 2016, in December 2017 merged into master
- More details in Sasha's talk, here just status and some highlights:
 - ▶ implemented for vast majority of existing theory & data
 - ▶ available in master, correspondingly updated data files available at Hepforge with '-thexp' name suffix
 - ▶ **need extensive testing and feedback!**

C++ header for NC DIS

```
class ReactionBaseDISNC : public ReactionTheory
{
public:
    ReactionBaseDISNC(){};
public:
    virtual string getReactionName() const { return "BaseDISNC" };
    int initAtStart(const string &);
    virtual void setDatasetParameters( int dataSetID, map<string,string> pars, map<string,double> parsDataset) override ;

    //!< Initialize all EWK couplings here:
    virtual void initAtIteration() override;
    virtual int compute(int dataSetID, valarray<double> &val, map<string, valarray<double> > &err) override ;
protected;
```

NC DIS data file

```
4 &Data
5   Name = "HERA1+2 NCep 920"
6   IndexDataset = 105
7   Reaction = "NC e+-p"
8
9   TheoryType = 'expression'
10  TermName = 'R'
11  TermType = 'reaction'
12  TermSource = 'use:hf_scheme_DISNC'
13  TermInfo = 'type=sigred:flav=incl:echarge=1:epolarity=0'
14  TheorFxnR = 'R'
```

Theory interface: available processes

<https://gitlab.cern.ch/fitters/xfitter/tree/master/reactions>

APPLgrid

BaseDISCC

BaseDISNC

BaseHVQMNR

FFABM_DISCC

FFABM_DISNC

FONLL_DISCC

FONLL_DISNC

Fractal_DISNC

HVQMNR_LHCb_7TeV_beauty

HVQMNR_LHCb_7TeV_charm

Hathor

KFactor

RT_DISNC

fastNLO

testZMVFNS

- Hathor:
 - ▶ updated to version 2.0
- ApplGrid:
 - ▶ option to use reference histogram for validation
- KFactor:
 - ▶ option to read values from:
 - ★ data file (via column name)
 - ★ separate file (via column and line number)
 - ▶ possible usage:
 - ★ various corrections to all bins (non-perturbative corr. for jets etc.)
 - ★ various corrections to **specific** bins only
 - one can have data from different processes in one file, enabling treatment of various correlations
 - ★ normalisation by bin width (using bins from data file)

Theory interface: example of KFactor usage

Data file:

```
TheoryType = 'expression'  
TermName = 'Process1','Process2','Mask1','Mask2'  
TermType = 'reaction','reaction','reaction','reaction'  
TermSource = 'ReactionA','ReactionB','KFactor','KFactor'  
TermInfo =  
'keyA=valueA','keyA=valueA','keyA=valueA','FileName=maskA.txt','FileName=maskB.txt'  
TheorExpr = 'Process1*Mask1+Process2*Mask2'  
  
NData = 2  
...
```

maskA.txt:

1
0

maskB.txt:

0
1

- 'ProcessA' is used for 1st data point, 'Process B' for 2nd
- one can further e.g. normalise to the sum of 1st + 2nd data points
- ...
- such things are done by playing with text files, not touching core code, recompiling etc.

⇒ this makes xFitter very flexible and handy tool

- contains new theory interface:
 - ▶ available for majority of processes
 - ▶ enabled by default now
 - ▶ comes with new file `parameters.yaml` (replaced `ewparam.txt`)
 - ▶ requires YAML: providing script to install it `tools/install-yaml`
 - ▶ requires compiler version compatible with C++11 standard
 - ▶ **please test and report any problems! [xfitter-help@desy.de]**
- contains other developments:
 - ▶ small-x resummation with HELL [1802.00064]
 - ▶ option to change heavy-flavour matching threshold [1707.05343]
→ **our policy: release in xFitter new features which have been used for papers done by xFitter team**

- xFitter: open source QCD fit framework
 - ▶ `xfitter.org`
 - ▶ actively used in phenomenological analyses
- xFitter-2.0.0 **Frozen Frog** is our production version:
 - ▶ this is latest stable release
 - ▶ actively used now, receiving feedback
- Work towards next release:
 - ▶ many updates already available in master branch at <https://gitlab.cern.ch/fitters/xfitter>
 - ▶ **theory interface** is main new feature
 - ▶ requires your tests and feedback

Agenda

Monday 05 March 2018

Registration - Gallery Gil, Bldg.10 (09:00-09:40)

Welcome - Gallery Gil, Bldg.10 (09:40-10:00)

- Conveners: Dr. Luszczak, Agnieszka

time	[id]	title	presenter
09:40	[0]	Welcome	Dr. LUSZCZAK, Agnieszka Dr. KUSINA, Aleksander

Overview of xFitter developments - Gallery Gil, Bldg.10 (10:00-11:00)

time	[id]	title	presenter
10:00	[1]	xFitter developments overview	Mr. ZENAIEV, Oleksandr
10:30	[2]	xFitter results overview	Prof. COOPER-SARKAR, Amanda

Experimental overview - Gallery Gil, Bldg.10 (11:30-12:30)

time	[id]	title	presenter
11:30	[3]	ATLAS results with xFitter	
12:00	[4]	CMS results with xFitter	Mr. EREN, Engin

Afternoon session - Gallery Gil, Bldg.10 (14:00-18:00)

time	[id]	title	presenter
14:00	[5]	Visualizing sensitivity of experiments to PDFs + CT developments	NADOLSKY, Pavel
14:30	[6]	Phase II LHC	
15:00	[7]	Photon PDFs	Dr. DYNDAL, Mateusz
15:20	[8]	Production of WW pairs via photon-photon fusion	Prof. SZCZUREK, Antoni
15:40		Coffee break	
16:10	[9]	Discussion/work	

Tuesday 06 March 2018

xFitter release plans - Gallery Gil, Bldg.10 (09:00-11:00)

time	[id]	title	presenter
09:00	[10]	xFitter release plans	GLAZOV, Alexander
09:45	[11]	QCDNUM developments	BOTJE, Michiel
10:15	[12]	APFEL developments	Dr. BERTONE, Valerio

Developers session - Gallery Gil, Bldg.10 (11:30-12:50)

time	[id]	title	presenter
11:30	[16]	xFitter beyond LHC	Prof. OLNESS, Fred
11:50	[17]	LHeC	KLEIN, Uta
12:20	[18]	Developments in FastNLO/APPLGRID	RABBERTZ, Klaus

Afternoon session - Gallery Gil, Bldg.10 (14:00-18:00)

time	[id]	title	presenter
14:00	[19]	nPDFs with xFitter	Mrs. WALT, Marina
14:20	[20]	Dipol model, lambda fit	KOWALSKI, Henri
14:40	[21]	New fits with saturation models	GOLEC-BIERNAT, Krzysztof
15:00	[22]	Diffraction J/psi	SCHAFER, Wolfgang
15:20	[23]	Charmonium	Dr. CISEK, Anna
15:40		Coffee break	
16:10	[24]	Discussion/work	

Wednesday 07 March 2018

Morning session - Gallery Gil, Bldg.10 (09:00-10:40)

time	[id]	title	presenter
09:00	[25]	Strangeness, higher twist studies	Dr. WICHMANN, Katarzyna
09:30	[26]	Low x resummation impact on fits to HERA data	Mr. GIULI, Francesco
09:50	[27]	TMDs in xFitter	JUNG, Hannes
10:20	[28]	Calculations with off-shell matrix elements, TMD parton densities and TMD parton showers	Mr. BURY, Marcin

xFitter closed session (future plans) - Gallery Gil, Bldg.10 (11:10-12:30)