Status of xFitter project

S. Glazov, xFitter workshop,
DESY 26 Feb 2020

What is xFitter

- xFitter is an open source QCD analysis platform, with the primary target to facilitate determination of the parton distribution functions
- Consists of the core interface connecting together several external tools such as QCDNUM, APFEL(++), APPLGRID, FastNLO, Hathor, ...
- Enables full PDF fits and also simplified phenomenological studies of PDF sensitivity
- Developed by community and provides some user support
- Dedicated analyses performed by xFitter developers
- Extended reproducibility: not only the final results but also tools to (re)produce them are aimed to be provided publicly.

Project front page: https://www.xfitter.org/xFitter/

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 process. 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-2.0.1 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

xFitter Meetings

💡 🌐 xFitter Workshop at DESY 26-28 February 2020
- 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)

xFitter representation

- List of results
- List of collected talks

Developers Info (restricted to developers)

- Internal Developments

Organisation

- **Release coordinator/Librarian** (revision of the release candidates): Sasha Glazov, Oleksandr Zenaiev

- **DESY IT Contact:** Yves Kemp

Getting help

💡 See our help forum 🌐 https://groups.google.com/forum/#!forum/xfitter-users
In case of questions or problems, please post a message there (requires a google account) or send it via email ✉ xfitter-users@googlegroups.com (no account required)

Code and data access

xFitter /
DownloadPage

Releases of the xFitter QCD analysis package

- 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-2.0.1
  - New installation script from master branch 📎 install-xfitter-master

- Data and theory files can be downloaded from cernbox 🌐 cernbox

Date	Version	Files	Remarks
05/2019	2.0.1 OldFashioned	📎 xfitter-2.0.1.tgz	update/bug fix to 2.0.0 FrozenFrog
03/2017	2.0.0 FrozenFrog	📎 xfitter-2.0.0.tgz	stable release with decoupled data and theory files

Web access to GIT

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

Previous releases

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).
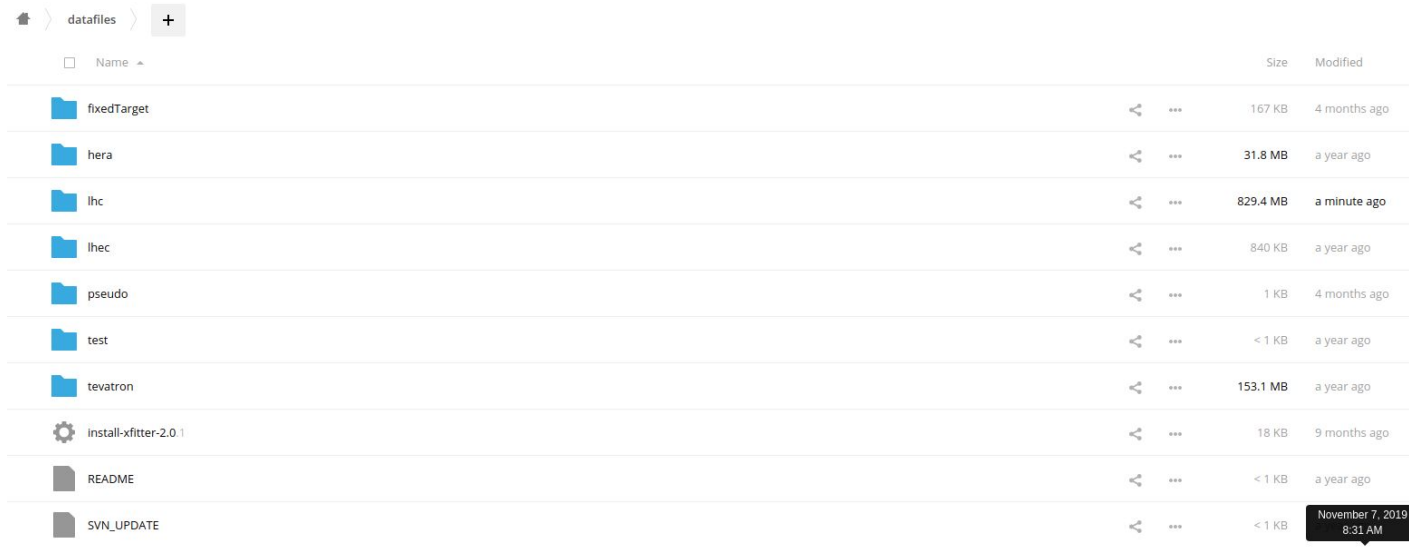
Links to external packages

External packages that could be run with xFitter via configuration flags can be accessed for convenience HERE .

Help

See our help forum 🌐 https://groups.google.com/forum/#!forum/xfitter-users

- Releases can downloaded as tgz files. New release last year: 2.0.1 "Old Fashioned". Mostly bug fix vs 2.0.0 /updates to be compatible with updated external codes
- The data files are still stored on cernbox (plus DESY svn server)
- CERN gitlab to get access to the master branch
- Documentation and tutorial correspond to released versions
- For help we moved to xfitter-users forum.

4

Data access: cernbox

Data can be accessed using cernbox. Probably not optimal, but have not got an update on this since the last workshop

Developers' meetings, support of the project

- Regular biweekly developers' meetings to discuss code development + analyses.
- In many cases remote only, but reasonably well attended.
- DESY provides some support for visitors related to xFitter. However no visitors last year compared to 5 visits in 2018.
- Support for xFitter workshops.
- Computing support: naf-xfitter server, computing accounts, afs space.

Users support

Centralized user support using xFitter-users forum.

Better visibility of the questions compared to the previously used mailing list.

Couple of questions per month.

Conferences

List of Presentations

2020

Date	Conference/Workshop	Presenter	Link	Remarks
23-27.03.2020	DIS 2020		xFitter talk	
28-03.03.2020	Moriond QCD 2020	F. Giuli	xFitter talk	Abstract accepted

2019

Date	Conference/Workshop	Presenter	Link	Remarks
25-06.11.2019	UPHC Saclay	F. Giuli	xFitter talk	
23-29.06.2019	EDS Blois	S. Glazov	xFitter talk	
10-17.06.2019	EPS 2019]	F. Giuli	xFitter talk	
8-12.04.2019	DIS 2019	F. Olness, J. Fiaschi	xFitter talks	
23-30.03.2019	Moriond QCD 2019	I. Novikov	xFitter talk	

- xFitter is well represented at the key QCD conferences.
- We could be giving more talks, but the amount of speakers is limited
- xFitter abstracts are usually welcome: xFitter developers interested to give talks at a particular conference are welcome to take initiative.

Recent papers by xFitter developers

List of analyses by xFitter

The link to the list of analyses using former HERAFitter can be accessed 🌐 here

10	02.2020	xFitter Developers	arXiv:2002.02902	🌐 Parton Distribution Functions of the Charged Pion Within The xFitter Framework	
9	07.2019	Juri Fiaschi and xFitter Developers	JHEP 2019, 176 (2019), arXiv:1907.07727	🌐 PDF Profiling Using the Forward-Backward Asymmetry in Neutral Current Drell-Yan Production	
8	07.2019	xFitter Developers	Eur. Phys. J. C 79, 864 (2019), arXiv:1907.01014	🌐 Probing the strange content of the proton with charm production in charged current at LHeC	
7	02.2018	xFitter Developers and Marco Bonvini	Eur.Phys.J. C78 (2018) no.8, 621, arXiv:1802.00064	🌐 Impact of low-x resummation on QCD analysis of HERA data	LHAPDF6 grid files
6	07.2017	xFitter Developers	Eur.Phys.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. Giuli, xFitter Developers' team and M. Lisovyi	Eur.Phys.J. C77 (2017) no.6 400, arXiv:1701.08553	🌐 The photon PDF from high-mass Drell Yan data at the LHC	📎 LHAPDF6 grids
4	03.2016	xFitter and APFEL teams and A. Geiser	JHEP 1608 (2016) 050, arXiv:1605.01946	🌐 A determination of mc(mc) from HERA data using a matched heavy flavor scheme	

- Three new papers since the last workshop: on CC at LHeC, on DY forward-backward asymmetry sensitivity to PDFs and pion PDFs.
- More studies in the pipeline, and some more ideas may come from this workshop.

Probing the strange content of the proton with charm production in charged current at LHeC
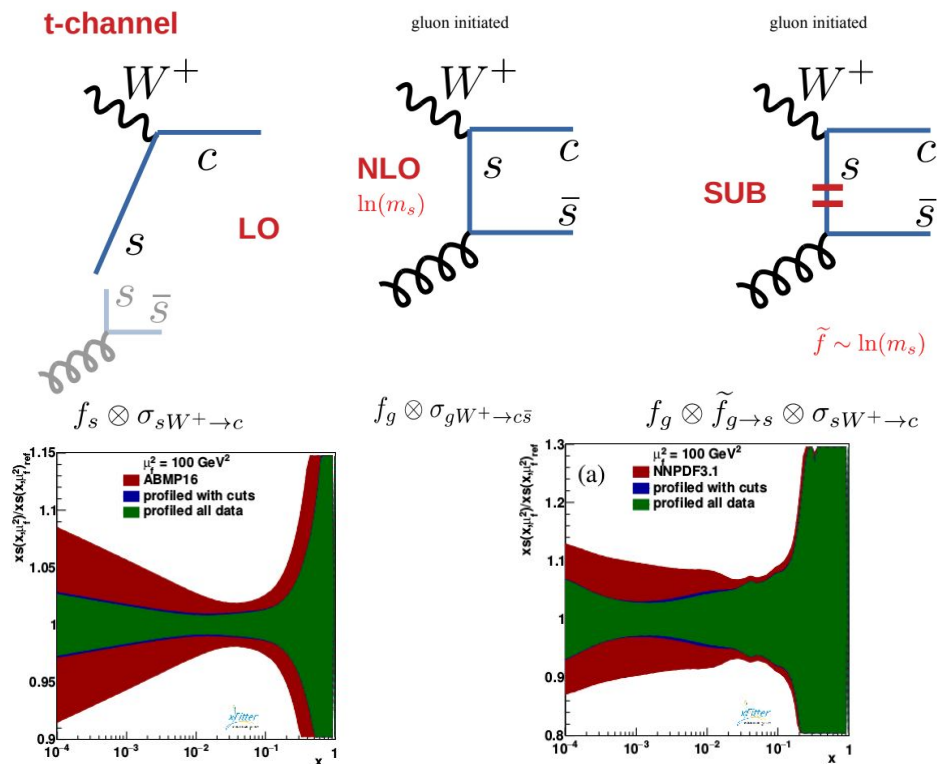
- Strange quark distribution can be measured in e-p CC process, e.g. at LHeC.
- Theoretical uncertainties related to the usage of the scheme FFNS or VFNS.
- Strong constraining power despite uncertainties.

PDF Profiling Using the Forward-Backward Asymmetry in Neutral Current Drell-Yan Production

$$\frac{d^3\sigma}{dM_{\ell\ell}dy_{\ell\ell}d\cos\theta^*} = \frac{\pi\alpha^2}{3M_{\ell\ell}s}\sum_q P_q\left[f_q(x_1,Q^2)f_{\bar{q}}(x_2,Q^2) + f_{\bar{q}}(x_1,Q^2)f_q(x_2,Q^2)\right]$$

$$P_q = e_\ell^2 e_q^2(1+\cos^2\theta^*) \qquad\qquad (1.2)$$

$$+ \frac{2M_{\ell\ell}^2(M_{\ell\ell}^2-M_Z^2)}{\sin^2\theta_W\cos^2\theta_W\left[(M_{\ell\ell}^2-M_Z^2)^2+\Gamma_Z^2 M_Z^2\right]}(e_\ell e_q)\left[v_\ell v_q(1+\cos^2\theta^*)+2a_\ell a_q\cos\theta^*\right]$$

$$+ \frac{M_{\ell\ell}^4}{\sin^4\theta_W\cos^4\theta_W\left[(M_{\ell\ell}^2-M_Z^2)^2+\Gamma_Z^2 M_Z^2\right]}[(a_\ell^2+v_\ell^2)(a_q^2+v_q^2)(1+\cos^2\theta^*)$$

$$+ 8a_\ell v_\ell a_q v_q\cos\theta^*],$$
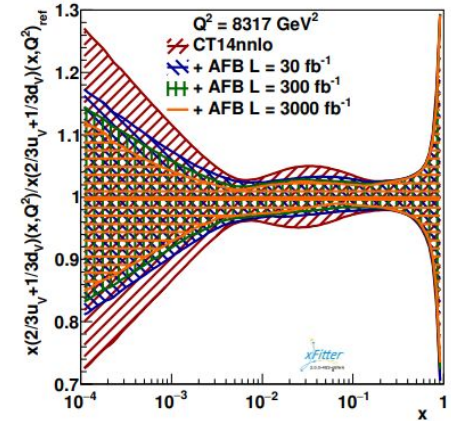
FBA in pp interactions at the LHC is sensitive to valence quark density at intermediate and low x, mostly due to gamma*-Z interference term. The uncertainties can be reduced significantly with future LHC data.

Parton Distribution Functions of the Charged Pion Within The xFitter Framework
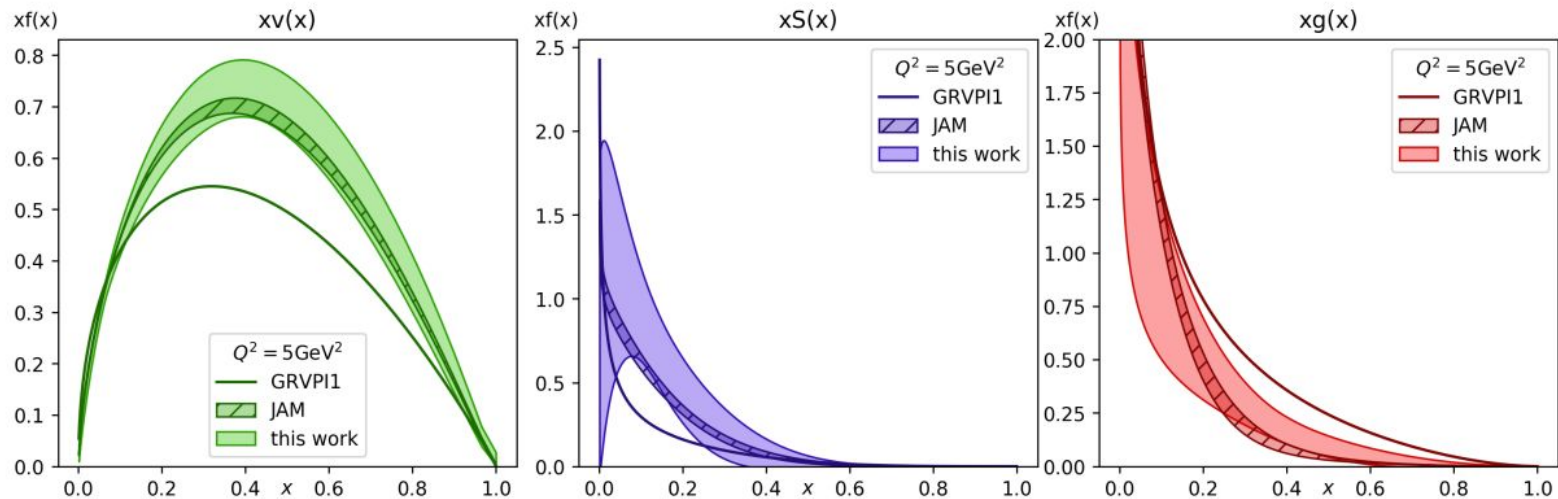
No PDF set with uncertaitnies on LHAPDF6: repeat analysis of the (old) data using new tools. Large uncertainties in the gluon and sea while valence is reasonably constraint. Results consistent with JAM, significantly different vs GRV.

Pion PDFs: momentum fractions
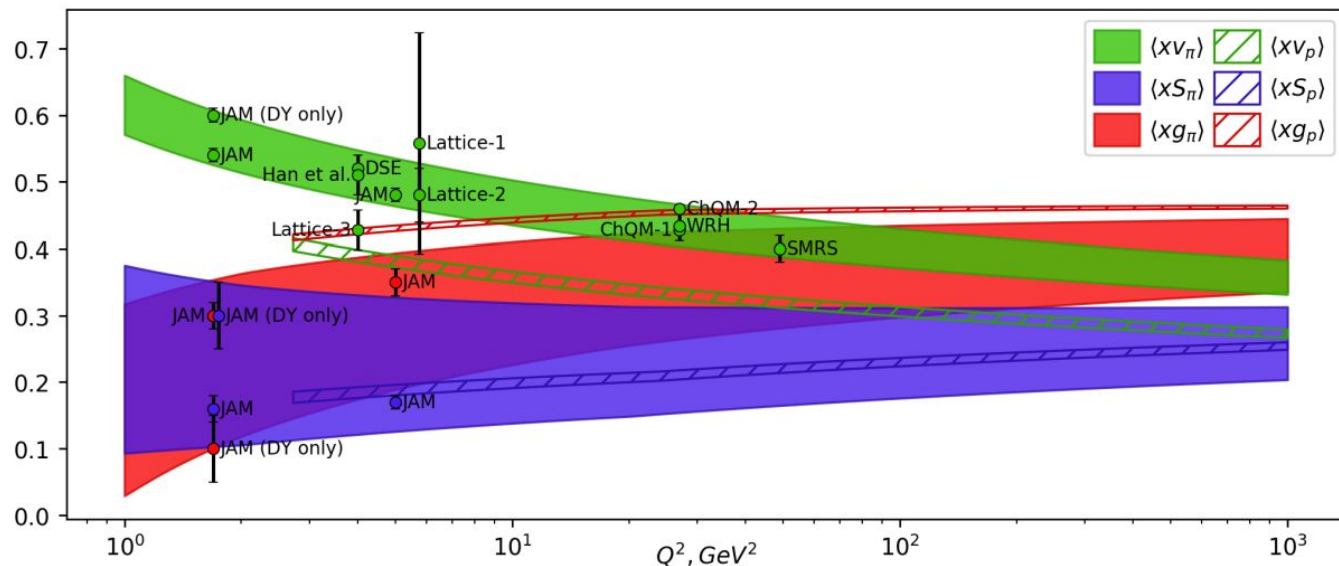
Compared to proton, valence quarks carry significantly larger momentum fraction vs gluon. The results are consistent with lattice QCD and other expectations.

Analyses using xFitter

- Total number of citations: 200, up from 149 since the last workshop
- Most of the new analyses are from phenomenological groups, some of the citations refer to methods/results used/obtained in xFitter but do not use the package.
- Majority of publications are based on old versions of xFitter, probably most use versions before 2.0.0.
- Some develop extensions of xFitter for specific purposes, such as nuclear PDFs.

Example analysis: alphaS from Z-boson pT
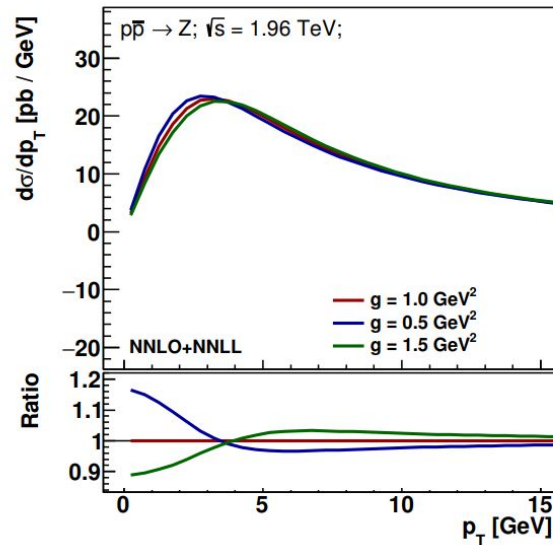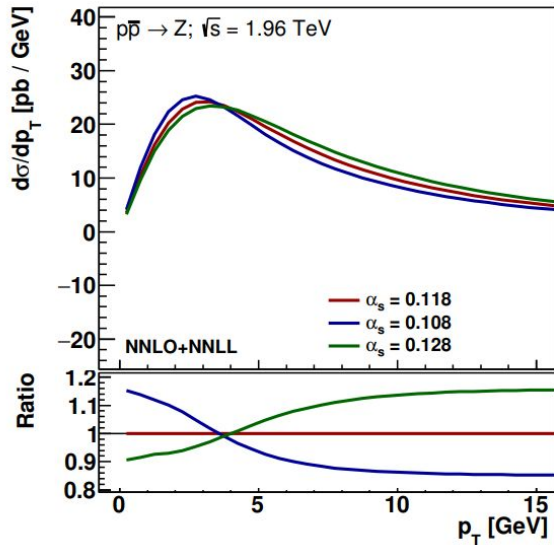
- Z transverse momentum distribution is measured with high accuracy
- Full spectrum is sensitive to PDFs, alphaS, resummation, non-perturbative corrections
- Fit using xFItter + DYTURBO (NNLO+NNLL), floating all relevant parameters at the same time

$$\alpha_s(m_Z) = 0.119^{+0.004}_{-0.003}$$

$$g = 0.51^{+0.64}_{-0.34} \ \text{GeV}^2$$

→ alphaS uncertainties is dominated by scale variations, should improve with N3LL

S. Camarda, PoS ALPHAS2019 (2019) 014

Example analysis: nuclear PDFs
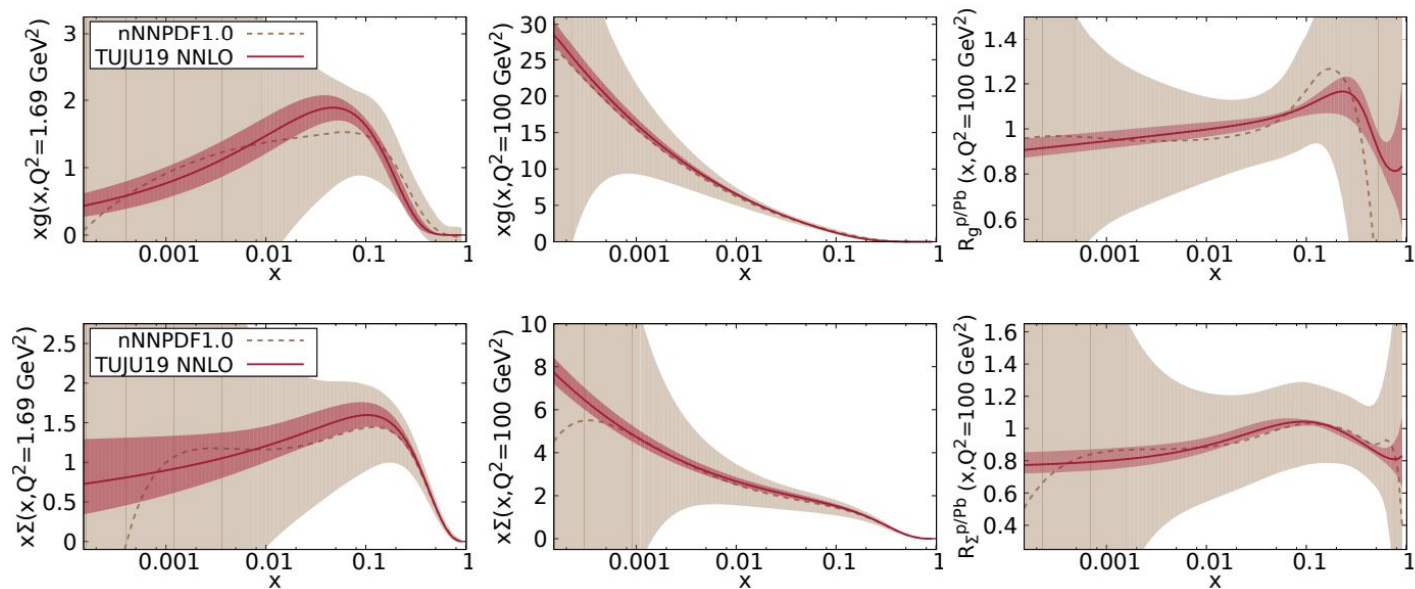
NLO and NNLO analysis of nuclear DIS data, including neutrino scattering.

M. Walt et al, Phys. Rev. D 100, 096015 (2019)

Key new developments in the master branch

- Re-written code flow: much improved modularity
- Modular evolution, parameterisation, minimization. Much improved interface for new reactions.
- User interface migrates from namelists to yaml
- Build system is moved to cmake
- A few additional features are present in the master branch only, however some were not migrated yet.

A presentation/discussion of the status and plans will be given by Ivan tomorrow

Release strategy

P	T	Key	Summary	Assignee	Status
⊖	➕	XFITTER-68	Theory reaction for Difftop fastNLO	Andrey Sapronov	OPEN
⊖	⬆	XFITTER-113	Theory errors	Alexander Glazov	CLOSED
⊖	⬆	XFITTER-78	Parameters parsing logic	Ivan Novikov	CLOSED
⊖	⬆	XFITTER-82	Update testing modules	Oleksandr Zenaiev	CLOSED
⊖	◻	XFITTER-100	Storing LHAPDF6 grids fails if QCDNUM is not used for evolution	Ivan Novikov	CLOSED
⊖	◻	XFITTER-103	Make BaseDISNC and BaseDISCC reactions to work with arbitrary evolution	Alexander Glazov	CLOSED
⊖	⬆	XFITTER-104	Introduce evolution "copy" for QCDNUM evolution	Alexander Glazov	CLOSED
🔺	☑	XFITTER-107	Include example profiler settings in parameters.yaml	Alexander Glazov	CLOSED
🔺	◻	XFITTER-115	Behavior of QCDNUM EvolutionCopy depends on order of evolution initialization	Ivan Novikov	CLOSED
⏫	➕	XFITTER-88	Reproducing HERAPDF fits in test_ceres	Ivan Novikov	CLOSED
⏫	◻	XFITTER-99	Update examples/ directory to match release.	Oleksandr Zenaiev	CLOSED
⏫	☑	XFITTER-105	Check photon evolution in APFEL fortran	Francesco Giuli	OPEN
⏫	☑	XFITTER-106	Check resummation predictions	Francesco Giuli	CLOSED
⏫	◻	XFITTER-108	Random behavior of "Fix" in MINUIT Commands	Ivan Novikov	CLOSED
⏫	➕	XFITTER-20	New evolution code	Valerio Bertone	CLOSED
⏫	➕	XFITTER-64	implement virtgrid theory interface	Oleksandr Zenaiev	CLOSED
⏫	◻	XFITTER-69	Charm/beauty DIS cross section in ZMVFNS (BaseDISNC), FONLL and RT	Unassigned	CLOSED
⏫	➕	XFITTER-77	Profiler	Ivan Novikov	CLOSED
⏫	⬆	XFITTER-79	Wrappers for up to two evolutions in the base class	Ivan Novikov	CLOSED
⏫	◻	XFITTER-80	Compilation problem with newer yaml and ROOT(?)	Ivan Novikov	CLOSED
⏫	➕	XFITTER-86	cannot fit parameters in test_ceres	Ivan Novikov	CLOSED
⏫	◻	XFITTER-87	Random problems when changing parameters in test_ceres	Ivan Novikov	CLOSED
⏫	◻	XFITTER-95	cannot compile with APFEL++	Ivan Novikov	CLOSED
⏫	◻	XFITTER-102	cannot use ApplGrid/fastNLO reaction and QED LHAPDF sets	Alexander Glazov	OPEN
⏫	◻	XFITTER-120	copy alphas when copying evolutions	Ivan Novikov	CLOSED
⏫	☑	XFITTER-124	add APFEL++ to installation script and provide example (test) with it	Alexander Glazov	CLOSED

Next big release will be based on the current master branch: major update which breaks backward compatibility.

What is required to be present in the release is to be discussed tomorrow

Target for the release: summer 2020.

Workshop goals

- Inform developers and users about recent updates in xFitter code, decide on few open items, split the work, converge on next release
- Collect input from the users, to see what can be improved
- Review recent analyses performed using xFitter, see what are possible future analyses. Decide on related developments of the code, to achieve them.

Workshop agenda

Tuesday

Time		
Registration		
Build. 35, room 108, DESY-Hamburg		09:00 - 09:30
xFitter project status		Sasha GLAZOV
Build. 35, room 108, DESY-Hamburg		09:30 - 10:00
Prosa analyses		Sasha ZENAIEV
Build. 35, room 108, DESY-Hamburg		10:00 - 10:30
Coffee break		
Build. 35, room 108, DESY-Hamburg		10:30 - 10:50
Defiducialisation		Sasha GLAZOV
Build. 35, room 108, DESY-Hamburg		10:50 - 11:20
A0 fits		
Build. 35, room 108, DESY-Hamburg		11:20 - 11:50

Time		
ATLAS report		
Build. 35, room 108, DESY-Hamburg		13:30 - 14:00
CMS report		
Build. 35, room 108, DESY-Hamburg		14:00 - 14:30
PDF benchmarking		
Build. 35, room 108, DESY-Hamburg		14:30 - 14:50
Coffee		
Build. 35, room 108, DESY-Hamburg		15:00 - 15:20
TMDs		Sara TAHERI
Build. 35, room 108, DESY-Hamburg		15:20 - 15:50
APPLGRID		Pavel STAROVOITOV
Build. 35, room 108, DESY-Hamburg		15:50 - 16:20
xFitter examples		Oleksandr ZENAIEV
Build. 35, room 108, DESY-Hamburg		16:20 - 16:50
Lambda fits to HERA data		Agnieszka LUSZCZAK
Build. 35, room 108, DESY-Hamburg		16:50 - 17:10

Thursday

Time		
master branch status		Ivan NOVIKOV
Build. 35, room 108, DESY-Hamburg		09:00 - 10:00
Coffee		
Build. 35, room 108, DESY-Hamburg		10:30 - 10:50
QCDNUM		Michiel BOTJE
Build. 35, room 108, DESY-Hamburg		10:50 - 11:20
Release planning discussion		
Build. 35, room 108, DESY-Hamburg		11:20 - 12:20

Time		
Tensor pomeron and odderon phenomenology		Otto NACHTMANN
Build. 35, room 108, DESY-Hamburg		13:30 - 14:30
Global DIS+EWK fits		Simone AMOROSO
Build. 35, room 108, DESY-Hamburg		14:30 - 15:30
Coffe		
Build. 35, room 108, DESY-Hamburg		15:30 - 16:00

Friday

Working session

Time		
nPDFs in xFitter		Marina WALT
Build. 35, room 108, DESY-Hamburg		09:30 - 10:00
Coffee		
Build. 35, room 108, DESY-Hamburg		10:30 - 10:50

Tuesday: project status, xFitter usage, current xFitter analyses

Thursday morning: development

Thursday afternoon: future analyses brainstorming

Friday: technical

Dinner

Conference dinner

1. Aperitif

2. Appetizer
-Assemblage of different Lebanese starters

3. Main course of your choice

- Oriental rice dish with aubergine, apricot- vanilla-harissa-sauce, vegetables saute and dates;

- Sea bass fillet on mashed potatoes with coriander-garlic-chili, glazed mangetout, lobster-tarragon sauce;

-Corn chicken breast with pistachio crust, on goat's cheese and leek, fresh figs, sweet potatoes frites;

-Duck breast with vegetables saute, dates-orange sauce and cinnamon-cardamon rice;

-Lamb fillet on sheep's cheese sauce, vegetables saute and rice.

4. Drinks:
Mocha or peppermint tea will round off this oriental menu.

The total price is 28 EUR/person.
All other drinks are not included in this price.
^^^

Important:
Please let the participants know that it is preferable to pay in cash there.
But there is no problem because there are a lot of banks in the Waitzstrasse,
where one can withdraw some cash.
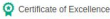

Restaurant Hala ✓ Claimed

◉◉◉◉◉ 527 reviews   **#8** of 3,160 Restaurants in Hamburg $$ - $$$, Lebanese, Mediterranean, Middle Eastern

📍 Beselerplatz 11, 22607 Hamburg, Germany   📞 +49 40 88167787   💻 Website   🕐 Opens in 20 min: See all hours ⓘ

♡ Save   ➤ Share

Reserve a Table   **Bookatable**

Reserve

◉ Certificate of Excellence

📷 All photos (251)

Ratings and reviews

5.0 ◉◉◉◉◉ 527 reviews

#1 of 16 Lebanese in Hamburg
#8 of 2,843 Restaurants in Hamburg

🏆 **Certificate of Excellence 2016 - 2019 Winner**

Details

CUISINES
Lebanese, Mediterranean, Middle Eastern

SPECIAL DIETS
Vegetarian Friendly, Vegan Options, Halal, Gluten Free Options

Location and contact