



Top++ and HATHOR interfaces in xFitter

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DESY

xFitter External Meeting in Oxford 2017

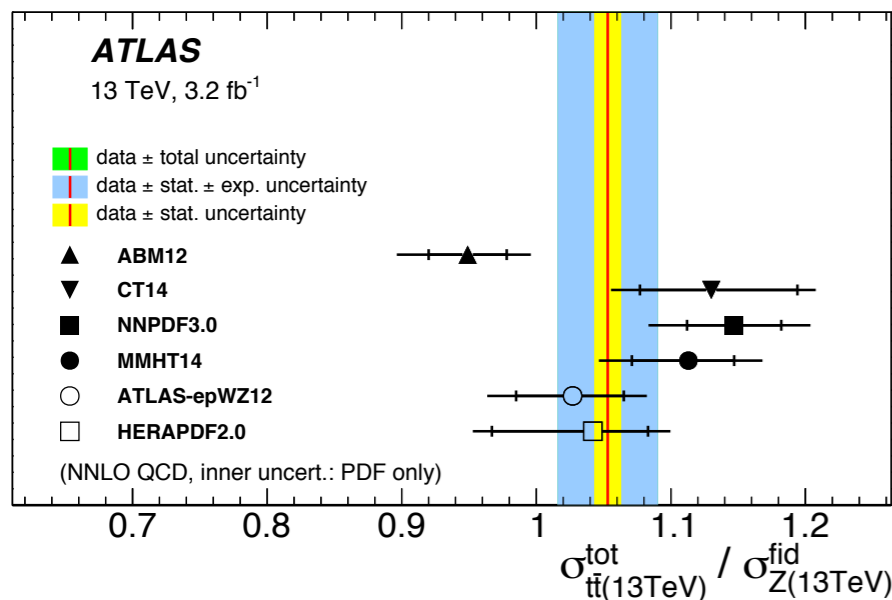
Outline

- **Motivation**
- **xFitter interface to another packages**
- **HATHOR**
 - ▶ **Parameters and settings**
 - ▶ **Interface in xFitter**
- **Top++**
 - ▶ **Parameters and settings**
 - ▶ **Interface in xFitter**
- **Plans**

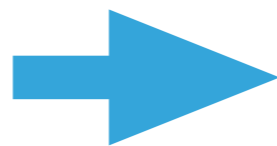
Motivation

ATLAS measurements ($t\bar{t}/Z$ ratios)

JHEP 02 (2017)117



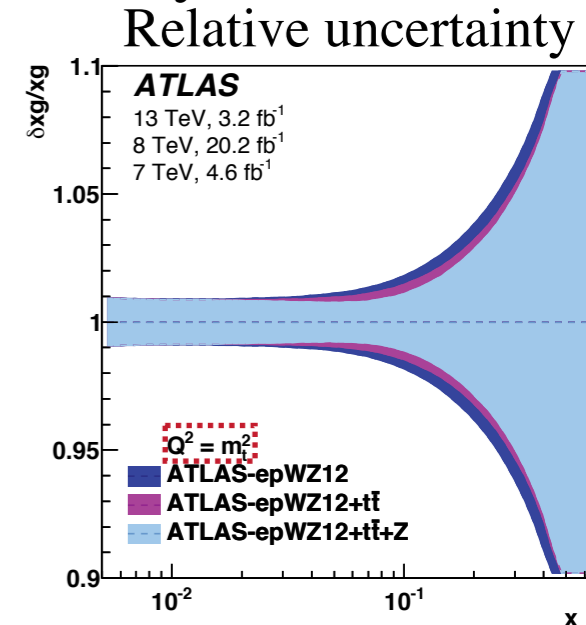
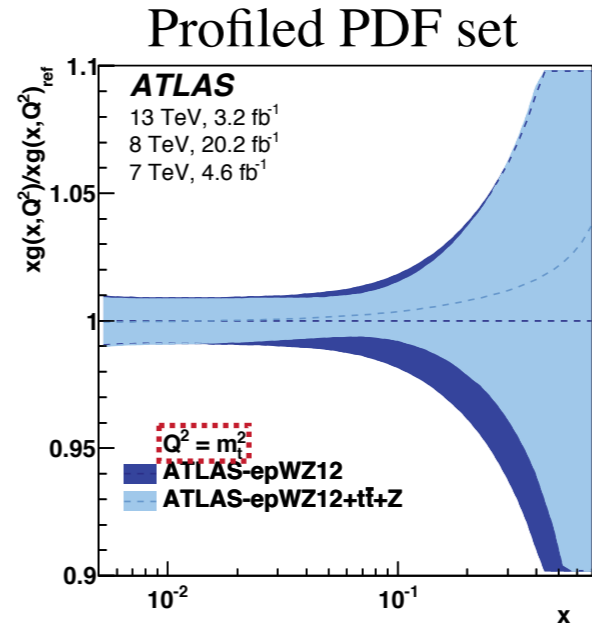
PDF profiling
(ATLAS-epWZ12)



Normalized to
central val. of
(ATLAS-epWZ12)

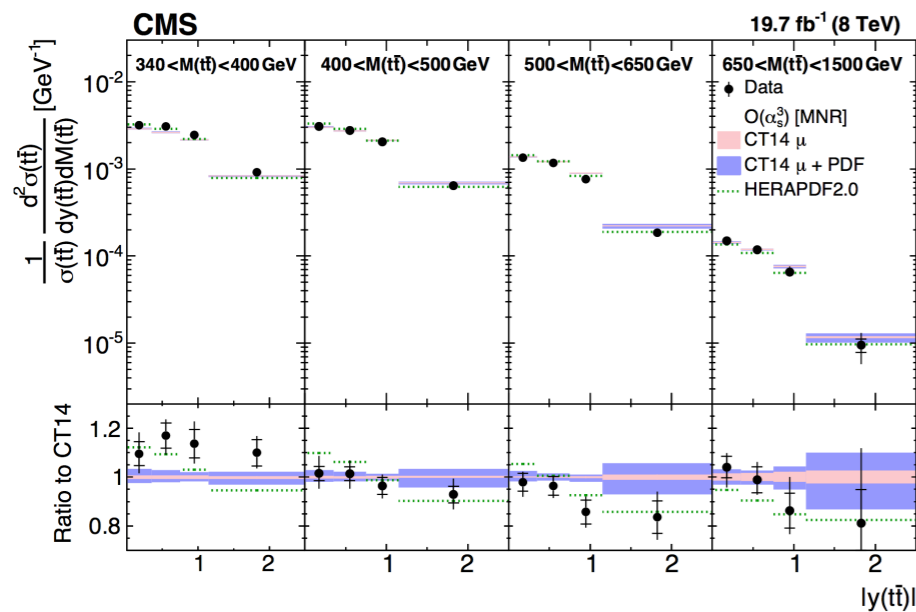
done with xFitter

Gluon density

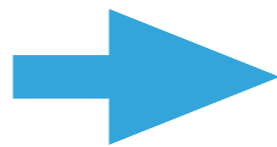


CMS measurements ($t\bar{t}$ double-differential cross-section)

arXiv:1703.01630



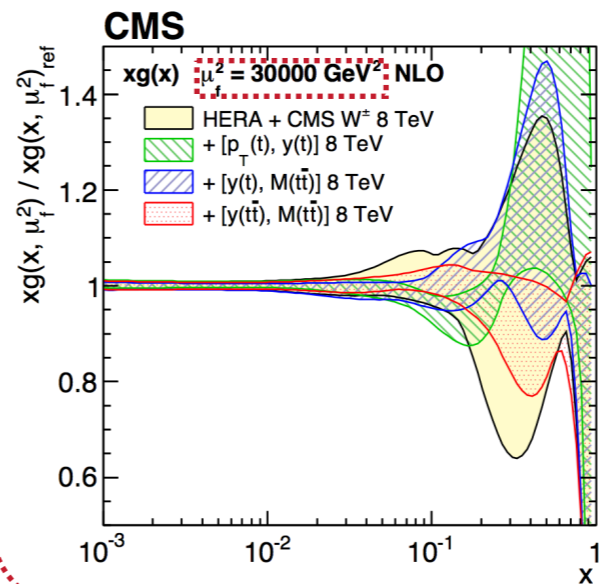
PDF fit



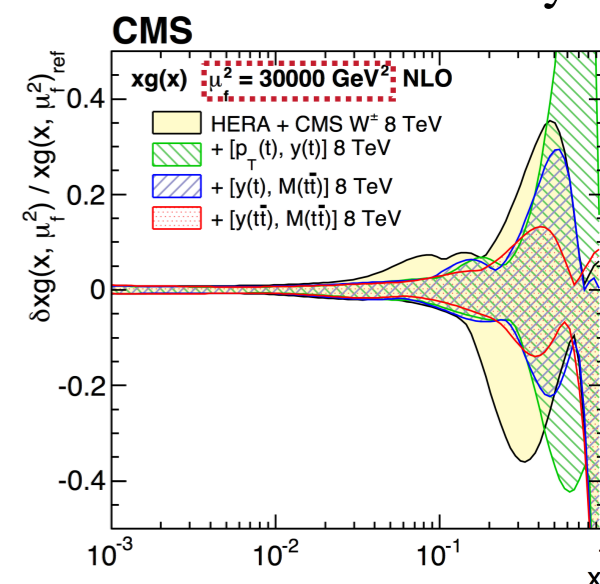
Normalized to
result from fit
using only DIS and
 W^\pm asym. data

Gluon density

PDF fit

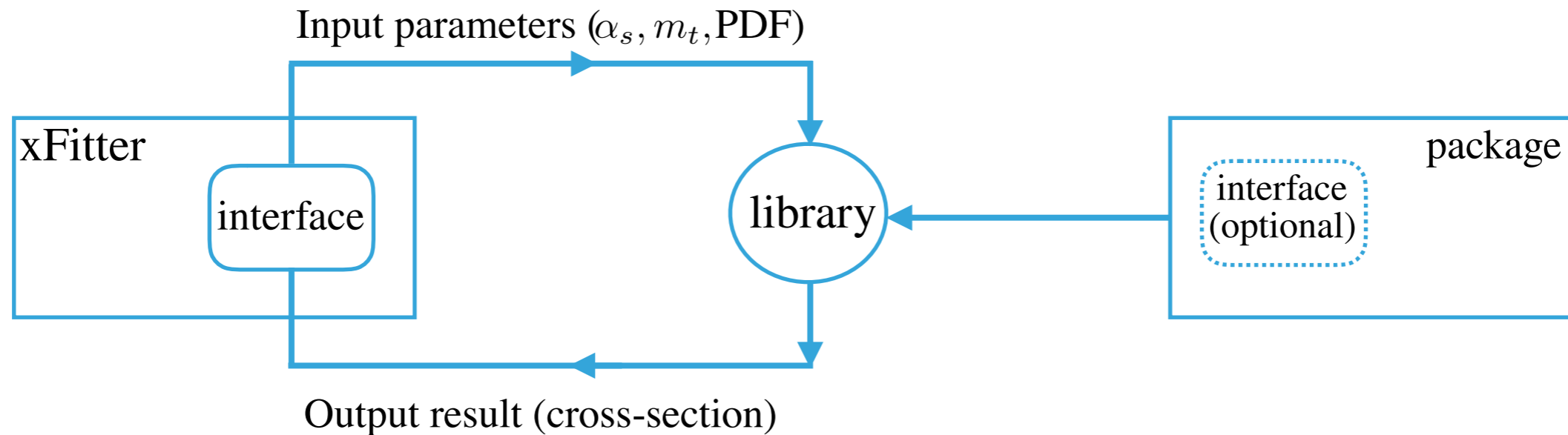


Relative uncertainty



xFitter (interaction with other packages)

- **General scheme**



- **xFitter interface specifications**

- ▶ Provide connection between xFitter core and theory modules (Hathor, Top++)
- ▶ Access to the theory module through libraries
- ▶ Written in C++
- ▶ Interface template can be easily generated with the python script in the xFitter

xFitter theory module interface

● Interface template generating

Run in xFitter root folder

tools/AddReaction.py Name

Creates class of interface

Name/include/ReactionName.h
Name/src/ReactionName.cc
Name/src/Makefile.am

Class default methods

Constructor, initAtStart,
getReactionName, compute

Updates files

Reactions.txt
configure.ac
Makefile.am

- * Shared library should be created (based on object files from package compiling)
- * Makefile.am should be modified (to point out to the place of shared library)
- * Make shared library available in the run time via setting LD_LIBRARY_PATH

- ▶ Methods of created interface class should be filled with functionality according to package specifications

HATHOR

- **Calculations**

- ▶ Calculate total inclusive **top pair production** cross-section
- ▶ Provide LO, NLO and NNLO calculations
- ▶ Soft gluon resummation at NLL accuracy

- **Update from version 1.5 to 2.0**

- ▶ **Single top-quark** production calculation introduced
- ▶ t -, s -channel and Wt are implemented for single top-quark production
- ▶ Based on the MCFM

- **Main input parameters**

- ▶ ColliderType: PPBAR, PP
- ▶ setSqrtShad: center-of-mass energy
- ▶ Scheme: LO, NLO, NNLO, LOG_ONLY
- ▶ Dataset
- ▶ M_{top}
- ▶ PDF set
- ▶ Precision

arXiv:1007.1327

<https://www-zeuthen.desy.de/~moch/hathor/>

HATHOR interface in xFitter

- xFitter (including 2.0.0 version) has interface to HATHOR 1.5 version
- Interface is built in xFitter (user has it after xFitter installation)
- Main methods:

Hathor initialisation

```
hathorinit_(idataset, qrtS, ppbar, mt, pertubOrder, precisionLevel)
```

↳ Knows about PDFset which comes from xFitter: `Hathor* hathor = new Hathor(*pdf);`
It sets up all main input parameters: `hathor->setScheme(scheme);`
`hathor->setSqrtShad(sqrtS);`

Hathor calculation

```
hathorcalc_(idataset, xsec)
```

↳ Contains few submethods: `getXsection(mtop);` uses `mtop` defined at initialisation step
`getResult(0, xsec, err);`

Returns calculated `xsec` with `error`

Top++

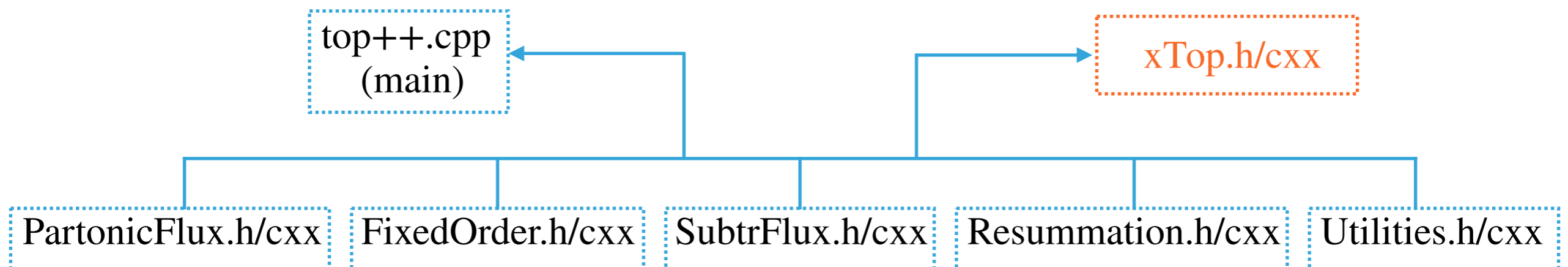
● Calculations

- ▶ Calculate total inclusive **top pair production** cross-section
 - ➔ Pure fixed-order perturbation theory through exact next-to-next-to leading order (NNLO)
 - ➔ Soft-gluon resummation through next-to-next-to-leading logarithmic order (NNLL)

● Main input settings

- ▶ Resummation: Yes/No → include/exclude soft-gluon resummation
- ▶ Precision: defines relative precision of the integration routines → $10^{-precision}$
- ▶ PDFset
- ▶ OrderFO: LO/NLO/NNLO
- ▶ OrderRES: LL/NLL/NNLL
- ▶ Collider: LHC / TeVatron → PP / P \bar{P} collisions available

● Code structure



Top++ interface in xFitter

● Connection using shared library



● Parameters which takes xTop from xFitter

- ▶ Collider: "LHC"
- ▶ orderFO, orderRES
- ▶ ECM
- ▶ Precision
- ▶ WithResummation (yes/no)
- ▶ mtop
- ▶ PDF
- ▶ LO, NLO, NNLO

```
xTop topPP(Collider, PDFset, ECM, mtop, WithResummation, orderFO, orderRES, LO, NLO, NNLO, precision);
```

↳ Create object and initialise all necessary variables (all the rest are defined default)

```
topPP.mt_sqrs_scancalc(mtop, PDF, ECM);
```

↳ Calculate top-pair cross-section

```
double topxseccentr = topPP.gettopcentralres("topxseccentr");
```

↳ Return final result

* PDF came from xFitter using pointer to the function (from xFitter to Top++)

Further steps and plans

● Top++

- ▶ Add auto-tools for building/configuration
- ▶ Add a top++-config command
- ▶ Top++ authors agree to merge our updates into the official version once we are ready

● HATHOR

- ▶ Introduce interface to HATHOR 2.X version
- ▶ Interface is produced in collaboration with HATHOR authors

● HATHOR and Top++

- ▶ Compare results
- ▶ Compare speed of calculations

Backup slides