The LHAPDF interface – current status and future

Mike Whalley – Durham U. IPPP

The Les Houches Accord PDF interface has been developed byWalter Giele at FNAL as a direct result of the 2001 Les Houches meeting where a desire was expressed by the PDF working group to have an improved and more easily updated replacement to PDFLIB.

It was realised that PDFLIB would never have the latest PDFs, In particular the "error sets"

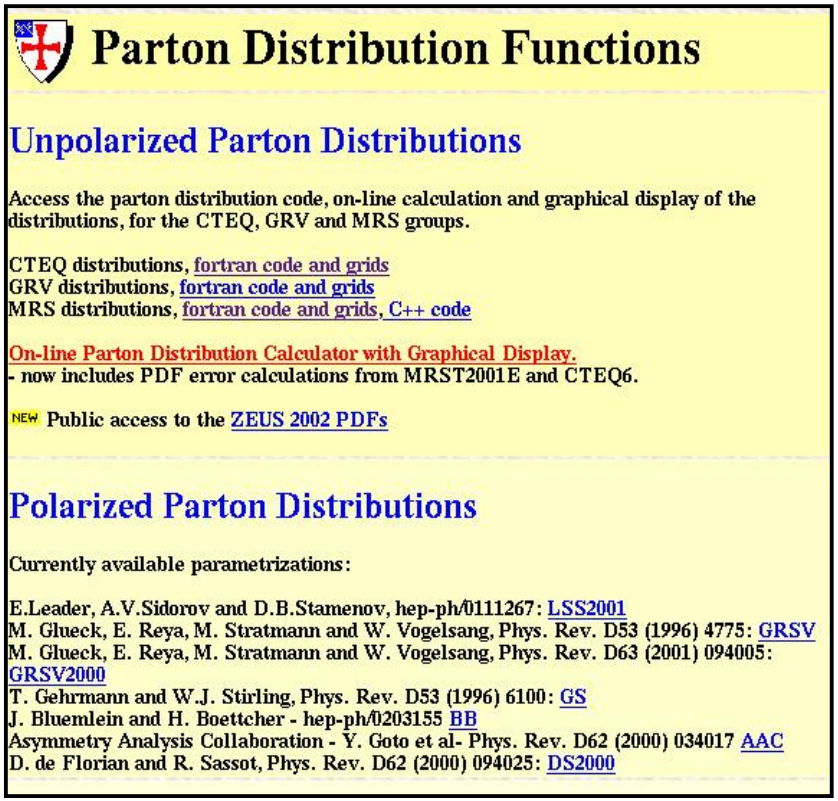
– the so-called Les Houches Accord #2.

The new interface, LHAPDF, was also to be designed to easily and uniformly incorporate these "error PDF sets" so that realistic errors in physical quantities from MCs could be efficiently calculated.

Why am I giving this introductory talk and not Walter?

At the MC meeting in March at the IPPP in Durham – I volunteered to take over from Walter as the official distributer and maintainer of the LHAPDF code from our web server in Durham.

My credentials for doing this are that I already maintain the HEPDATA database server and also the PDF server which has been the official outlet for MRST as well as for other PDFs.



Parton Distribution Functions

Unpolarized Parton Distributions

Access the parton distribution code, on-line calculation and graphical display of the distributions, for the CTEQ, GRV and MRS groups.

CTEQ distributions, fortran code and grids
GRV distributions, fortran code and grids
MRS distributions, fortran code and grids, C++ code

On-line Parton Distribution Calculator with Graphical Display.
- now includes PDF error calculations from MRST2001E and CTEQ6.

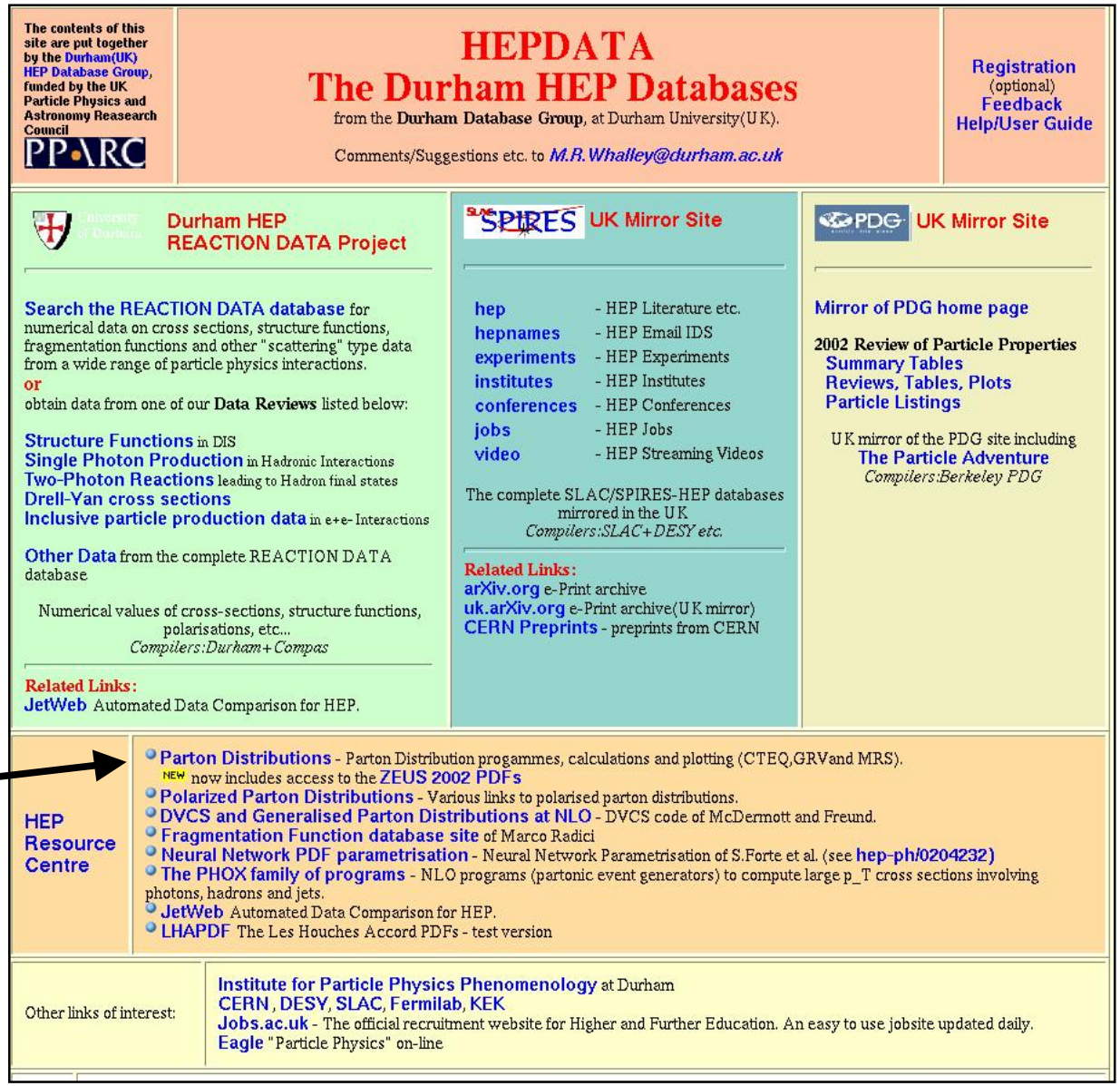
NEW Public access to the ZEUS 2002 PDFs

Polarized Parton Distributions

Currently available parametrizations:

E.Leader, A.V.Sidorov and D.B.Stamenov, hep-ph/0111267: LSS2001
M. Glueck, E. Reya, M. Stratmann and W. Vogelsang, Phys. Rev. D53 (1996) 4775: GRSV
M. Glueck, E. Reya, M. Stratmann and W. Vogelsang, Phys. Rev. D63 (2001) 094005: GRSV2000
T. Gehrmann and W.J. Stirling, Phys. Rev. D53 (1996) 6100: GS
J. Bluemlein and H. Boettcher - hep-ph/0203155 BB
Asymmetry Analysis Collaboration - Y. Goto et al- Phys. Rev. D62 (2000) 034017 AAC
D. de Florian and R. Sassot, Phys. Rev. D62 (2000) 094025: DS2000

The Durham HEPDATA home page



The contents of this site are put together by the Durham(UK) HEP Database Group, funded by the UK Particle Physics and Astronomy Reasearch Council
PPARC

HEPDATA
The Durham HEP Databases
from the **Durham Database Group**, at Durham University(UK).
Comments/Suggestions etc. to *M.R.Whalley@durham.ac.uk*

Registration (optional)
Feedback
Help/User Guide

Durham HEP REACTION DATA Project

Search the REACTION DATA database for numerical data on cross sections, structure functions, fragmentation functions and other "scattering" type data from a wide range of particle physics interactions.
or
obtain data from one of our **Data Reviews** listed below:

Structure Functions in DIS
Single Photon Production in Hadronic Interactions
Two-Photon Reactions leading to Hadron final states
Drell-Yan cross sections
Inclusive particle production data in e+e- Interactions

Other Data from the complete REACTION DATA database

Numerical values of cross-sections, structure functions, polarisations, etc...
Compilers:Durham+Compas

Related Links:
JetWeb Automated Data Comparison for HEP.

SPIRES UK Mirror Site

hep - HEP Literature etc.
hepnames - HEP Email IDS
experiments - HEP Experiments
institutes - HEP Institutes
conferences - HEP Conferences
jobs - HEP Jobs
video - HEP Streaming Videos

The complete SLAC/SPIRES-HEP databases mirrored in the UK
Compilers:SLAC+DESY etc.

Related Links:
arXiv.org e-Print archive
uk.arXiv.org e-Print archive(UK mirror)
CERN Preprints - preprints from CERN

PDG UK Mirror Site

Mirror of PDG home page

2002 Review of Particle Properties
Summary Tables
Reviews, Tables, Plots
Particle Listings

UK mirror of the PDG site including
The Particle Adventure
Compilers:Berkeley PDG

PDFs →

HEP Resource Centre

- **Parton Distributions** - Parton Distribution progammes, calculations and plotting (CTEQ,GRVand MRS).
  NEW now includes access to the **ZEUS 2002 PDFs**
- **Polarized Parton Distributions** - Various links to polarised parton distributions.
- **DVCS and Generalised Parton Distributions at NLO** - DVCS code of McDermott and Freund.
- **Fragmentation Function database site** of Marco Radici
- **Neural Network PDF parametrisation** - Neural Network Parametrisation of S.Forte et al. (see **hep-ph/0204232**)
- **The PHOX family of programs** - NLO programs (partonic event generators) to compute large p_T cross sections involving photons, hadrons and jets.
- **JetWeb** Automated Data Comparison for HEP.
- **LHAPDF** The Les Houches Accord PDFs - test version

Other links of interest:

Institute for Particle Physics Phenomenology at Durham
CERN, **DESY**, **SLAC**, **Fermilab**, **KEK**
Jobs.ac.uk - The official recruitment website for Higher and Further Education. An easy to use jobsite updated daily.
Eagle "Particle Physics" on-line

On-line Plotting and Calculation.

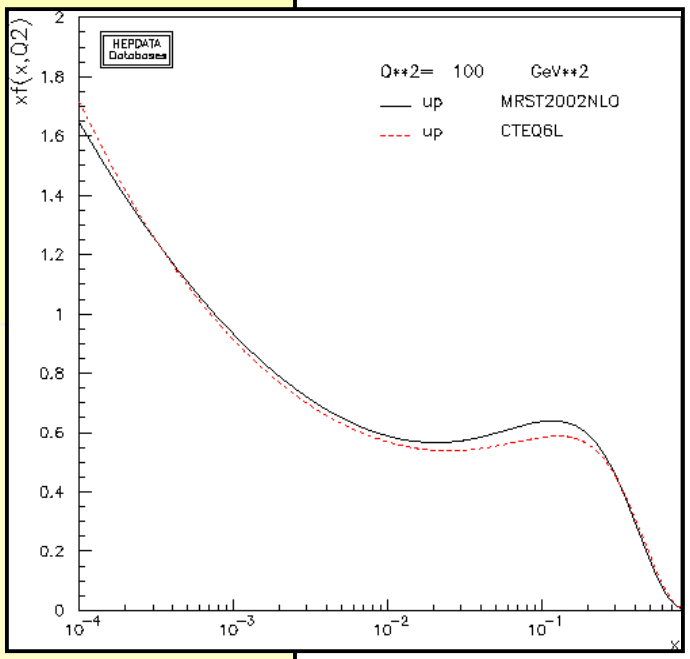
Parton Distributions:

Using the form below you can calculate, in real time, values of xf(x,Q^2) for any of the PDFs from the main groups CTEQ, MRS or GRV. You can also generate and compare plots of xf v x at any Q^2 for up to 4 different parton types or PDFs.

xmin = 0.0001 **xmax** = 0.8 **xinc** = 0.01 **Q**2** = 100 **GeV**2**
select lin x ○ **or log x** ◉
select lin xf ◉ **or log xf** ○ , **xfmin** = 0.0 **and xfmax** = 2.0
select either numbers ○ **or plot** ◉ **or kumac file** ○

1	☑	up	MRST2002NLO	**scale-factor** 1.0
2	☐	up	MRST2002NLO	**scale-factor** 1.0
3	☐	up	MRST2002NLO	**scale-factor** 1.0
4	☐	up	MRST2002NLO	**scale-factor** 1.0

Make the Plot/Calculation | Reset the Form



Parton Distributions with Error Analyses:

xmin = 0.0001 **xmax** = 0.8 **xinc** = 0.01 **Scale(Q**2)** = 100 **GeV**2**
select lin x ○ **or log x** ◉ **and ymax (xf) value** = 2.0
select either plot ◉ **or kumac file** ○

☑ up CTEQ6E / MRST2001E **Range of error for display** 50 **%**

Select below if you wish the comparison of another PDF set with the above (note: this option only works for specific partons - not "all")
☐ up MRST2002NLO

Make the Plot/Calculation | Reset the Form

The CTEQ6 and MRST2001E errors are calculated from the error analyses as decribed in their respective papers hep-ph/0201195 and hep-ph/0211080 by summing over the pdfs given in the 40 (CTEQ) or 30 (MRST) eigenvector grids, in the following way:
sigma(central) +- 1/2 sqrt[sum_i=1,20(15) {sigma(2i-1) - sigma(2i)}^2]

Questions and Comments to m.r.whalley@durham.ac.uk
Updated: Dec 11, 2002

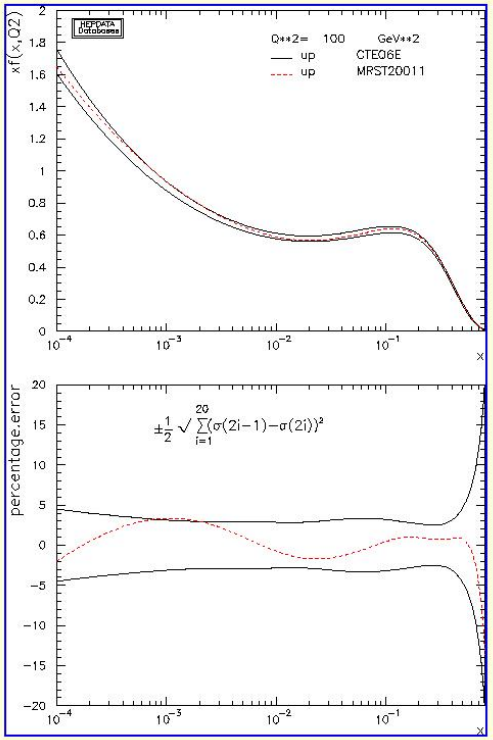
Examples of PDF error plotting in HEPDATA

% difference from central value

CTEQ6E PDF Error Limits

and comparison with MRST20011 PDFs

(click on the plots for postscript version)

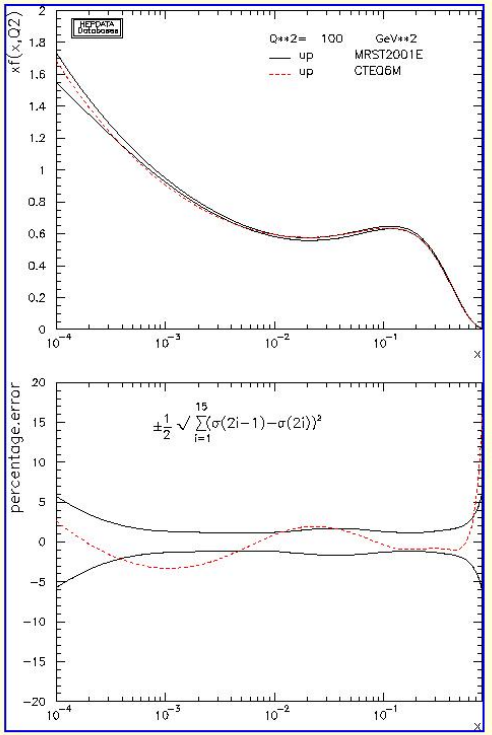


The percentage errors are calculated from the error analyses as decribed in the respective papers hep-ph/0201195(CTEQ) and hep-ph/0211080(MRST) by summing over the pdfs given in the 40 (CTEQ) or 30 (MRST) eigenvector grids, in the following way:

MRST2001E PDF Error Limits

and comparison with CTEQ6M PDFs

(click on the plots for postscript version)

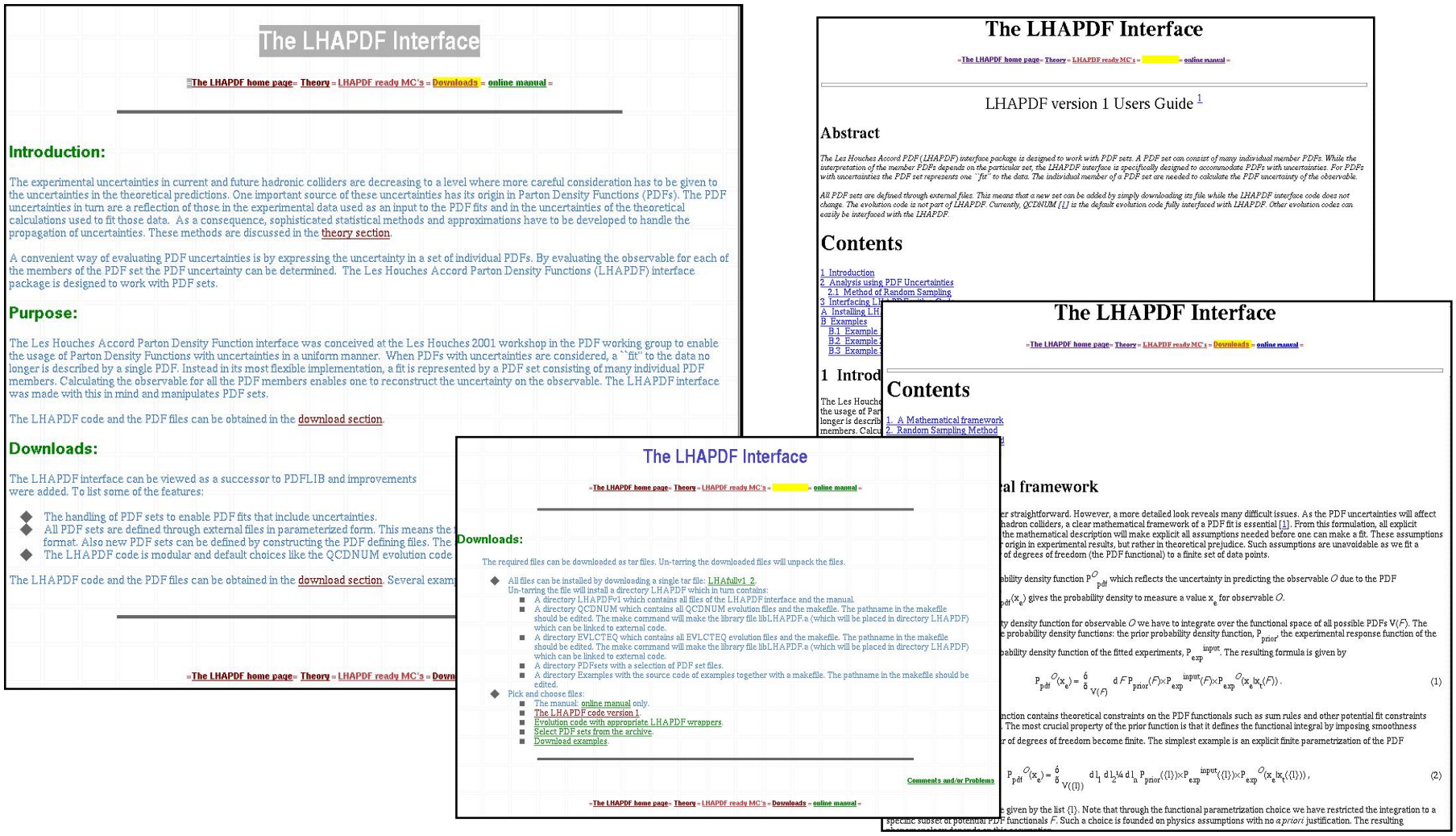


The percentage errors are calculated from the error analyses as decribed in the respective papers hep-ph/0201195(CTEQ) and hep-ph/0211080(MRST) by summing over the pdfs given in the 40 (CTEQ) or 30 (MRST) eigenvector grids, in the following way:

The LHAPDF web site

http://vircol.fnal.gov/index.html

http://durpdg.dur.ac.uk/lhapdf/



The LHAPDF Interface

=The LHAPDF home page= Theory = LHAPDF ready MC's = Downloads = online manual =

Introduction:

The experimental uncertainties in current and future hadronic colliders are decreasing to a level where more careful consideration has to be given to the uncertainties in the theoretical predictions. One important source of these uncertainties has its origin in Parton Density Functions (PDFs). The PDF uncertainties in turn are a reflection of those in the experimental data used as an input to the PDF fits and in the uncertainties of the theoretical calculations used to fit those data. As a consequence, sophisticated statistical methods and approximations have to be developed to handle the propagation of uncertainties. These methods are discussed in the theory section.

A convenient way of evaluating PDF uncertainties is by expressing the uncertainty in a set of individual PDFs. By evaluating the observable for each of the members of the PDF set the PDF uncertainty can be determined. The Les Houches Accord Parton Density Functions (LHAPDF) interface package is designed to work with PDF sets.

Purpose:

The Les Houches Accord Parton Density Function interface was conceived at the Les Houches 2001 workshop in the PDF working group to enable the usage of Parton Density Functions with uncertainties in a uniform manner. When PDFs with uncertainties are considered, a ``fit'' to the data no longer is described by a single PDF. Instead in its most flexible implementation, a fit is represented by a PDF set consisting of many individual PDF members. Calculating the observable for all the PDF members enables one to reconstruct the uncertainty on the observable. The LHAPDF interface was made with this in mind and manipulates PDF sets.

The LHAPDF code and the PDF files can be obtained in the download section.

Downloads:

The LHAPDF interface can be viewed as a successor to PDFLIB and improvements were added. To list some of the features:

- The handling of PDF sets to enable PDF fits that include uncertainties.
- All PDF sets are defined through external files in parameterized form. This means the
- format. Also new PDF sets can be defined by constructing the PDF defining files. The
- The LHAPDF code is modular and default choices like the QCDNUM evolution code

The LHAPDF code and the PDF files can be obtained in the download section. Several exam

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The LHAPDF Interface

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LHAPDF version 1 Users Guide [1]

Abstract

The Les Houches Accord PDF (LHAPDF) interface package is designed to work with PDF sets. A PDF set can consist of many individual member PDFs. While the interpretation of the member PDFs depends on the particular set, the LHAPDF interface is specifically designed to accommodate PDFs with uncertainties. For PDFs with uncertainties the PDF set represents one ``fit'' to the data. The individual member of a PDF set are needed to calculate the PDF uncertainty of the observable.

All PDF sets are defined through external files. This means that a new set can be added by simply downloading its file while the LHAPDF interface code does not change. The evolution code is not part of LHAPDF. Currently, QCDNUM [1] is the default evolution code fully interfaced with LHAPDF. Other evolution codes can easily be interfaced with the LHAPDF.

Contents

1 Introduction
2 Analysis using PDF Uncertainties
2.1 Method of Random Sampling
3 Interfacing LH
A Installing LH
B Examples
B.1 Example
B.2 Example
B.3 Example

1 Introd

The Les Houche
the usage of Par
longer is describ
members. Calcu

The LHAPDF Interface

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Contents

1. A Mathematical framework
2. Random Sampling Method

al framework

er straightforward. However, a more detailed look reveals many difficult issues. As the PDF uncertainties will affect hadron colliders, a clear mathematical framework of a PDF fit is essential [1]. From this formulation, all explicit the mathematical description will make explicit all assumptions needed before one can make a fit. These assumptions r origin in experimental results, but rather in theoretical prejudice. Such assumptions are unavoidable as we fit a of degrees of freedom (the PDF functional) to a finite set of data points.

bability density function P^{O}_{pdf} which reflects the uncertainty in predicting the observable O due to the PDF

$_{pdf}(x_e)$ gives the probability density to measure a value x_e for observable O.

ty density function for observable O we have to integrate over the functional space of all possible PDFs $V(F)$. The e probability density functions: the prior probability density function, P_{prior} the experimental response function of the

obability density function of the fitted experiments, P_{exp}^{input}. The resulting formula is given by

$$P_{pdf}^{O}(x_e) = \int_{V(F)} dF\, P_{prior}(F) \times P_{exp}^{input}(F) \times P_{exp}^{O}(x_e | x_t(F)) . \qquad (1)$$

nction contains theoretical constraints on the PDF functionals such as sum rules and other potential fit constraints . The most crucial property of the prior function is that it defines the functional integral by imposing smoothness

r of degrees of freedom become finite. The simplest example is an explicit finite parametrization of the PDF

$$P_{pdf}^{O}(x_e) = \int_{V(\{l\})} dl_1\, dl_2 \ldots dl_n\, P_{prior}(\{l\}) \times P_{exp}^{input}(\{l\}) \times P_{exp}^{O}(x_e | x_t(\{l\})) , \qquad (2)$$

e given by the list $\{l\}$. Note that through the functional parametrization choice we have restricted the integration to a specific subset of potential PDF functionals F. Such a choice is founded on physics assumptions with no *a priori* justification. The resulting

The LHAPDF Interface

=The LHAPDF home page= Theory = LHAPDF ready MC's = online manual =

Downloads:

The required files can be downloaded as tar files. Un-tarring the downloaded files will unpack the files.

- All files can be installed by downloading a single tar file: LHAfullv1_2.
  Un-tarring the file will install a directory LHAPDF which in turn contains:
  - A directory LHAPDFv1 which contains all files of the LHAPDF interface and the manual.
  - A directory QCDNUM which contains all QCDNUM evolution files and the makefile. The pathname in the makefile should be edited. The make command will make the library file libLHAPDF.a (which will be placed in directory LHAPDF) which can be linked to external code.
  - A directory EVLCTEQ which contains all EVLCTEQ evolution files and the makefile. The pathname in the makefile should be edited. The make command will make the library file libLHAPDF.a (which will be placed in directory LHAPDF) which can be linked to external code.
  - A directory PDFsets with a selection of PDF set files.
  - A directory Examples with the source code of examples together with a makefile. The pathname in the makefile should be edited.
- Pick and choose files:
  - The manual: online manual only.
  - The LHAPDF code version 1.
  - Evolution code with appropriate LHAPDF wrappers.
  - Select PDF sets from the archive.
  - Download examples.

Comments and/or Problems

=The LHAPDF home page= Theory = LHAPDF ready MC's = Downloads = online manual =

The LHAPDF Interface

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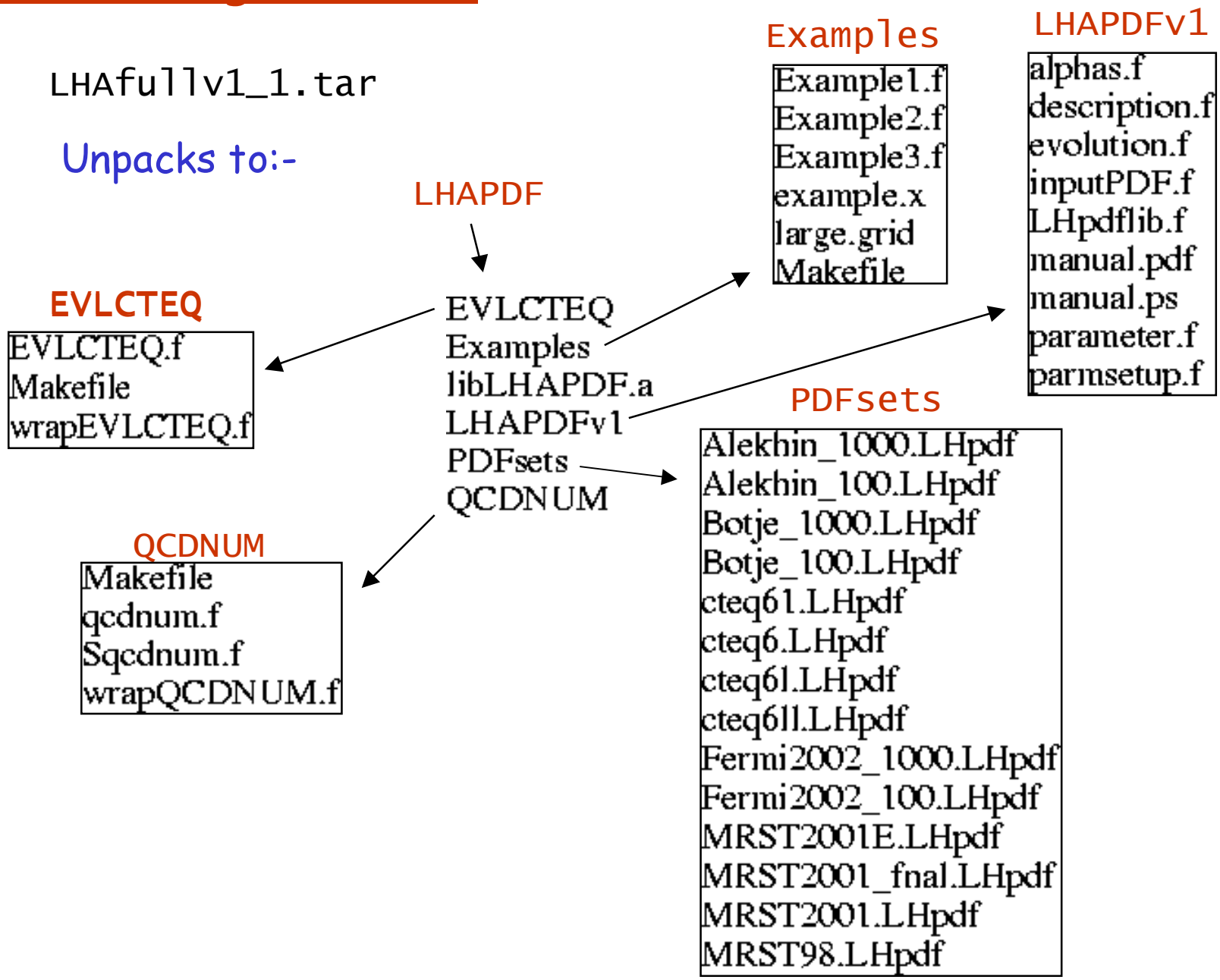
  - A directory EVLCTEQ which contains all EVLCTEQ evolution files and the makefile. The pathname in the makefile should be edited. The make command will make the library file libLHAPDF.a (which will be placed in directory LHAPDF) which can be linked to external code.
  - A directory PDFsets with a selection of PDF set files.
  - A directory Examples with the source code of examples together with a makefile. The pathname in the makefile should be edited.
- Pick and choose files:
  - The manual: online manual only.
  - The LHAPDF code version 1.
  - Evolution code with appropriate LHAPDF wrappers.
  - Select PDF sets from the archive.
  - Download examples.

Comments and/or Problems

Downloading the code

LHAfullv1_1.tar

Unpacks to:-



PDF sets available in LHAPDF

Alekhin sets – Alekhin_1000.LHpdf, Alekhin_100.LHpdf

Botje sets – Botje_1000.LHpdf, Botje_100.LHpdf

Fermilab sets – Fermi2002_1000.LHpdf, Fermi2002_100.LHpdf

CTEQ6 sets – cteq6.LHpdf, cteq6l.LHpdf, cteq6ll.LHpdf
cteq6m.LHpdf

CTEQ61 sets – cteq61.LHpdf

MRST98 sets – MRST98.LHpdf

MRST2001 sets – MRST2001.LHpdf*, MRST2001E.LHpdf

Those shown in RED are only on the Durham site at present
MRST2001* parameters at FNAL not most accurate

Using LHAPDF in a FORTRAN programme

Basic routines

`call InitPDFset(`*name*`)`

called only once at the beginning: *name* is the file name of the external defining PDF file

`call InitPDF(`*mem*`)`

called to initialise (use) a specific *mem*ber of the PDF set selected. *mem* is a number

`call evolvePDF(`*x,Q,f*`)`

Returns the PDF momentum densities *f* (ie x*f) at momentum fraction *x* and scale *Q* (GeV).

f(-6:6) is a double precision array where the partons are defined in the standard way: 0 = gluon; 1(-1) = up(bar); 2(-2) = down(bar)
3(-3) = strange(bar); 4(-4) =charm(bar)
5(-5) = bottom(bar); 6(-6) = top(bar.

Using LHAPDF in a FORTRAN programme

Some other routines

`call alphasPDF(`*Q*`)`

Returns the value of alpha_s at the scale *Q*

`call numberPDF(`*Nmem*`)`

The integer *Nmem* will contain the number of PDF members, excluding the best fit member (0)

`call getDesc()`

Prints out the PDF description given at the beginning of the PDF file

+ others (see the user guide)

Differences approaches of LHAPDF and PDFLIB

PDFLIB – uses grids supplied by the authors of the PDF sets and basically does interpolation to the required x and Q values

LHAPDF – uses the parameter values, supplied by the authors of the PDF sets, which define the fits at the starting points and does the evolution to x and Q itself.

The LHAPDF approach has the advantage that it is easily updated to the next generation PDF set by simply supplying the new set of parameters in the small ".LHpdf" file.

The LHAPDF code itself does not have to be rebuilt.

cf. PDFLIB where a new pdflib library had to be produced and added to CERNLIB.

```
Version 1.0
Description:
'MRST fit: hep-ph/0110215'
'This set has 4 member PDF's. However, the publication on
'parametric information of 2 members.'
'    mem=1 --> MRST2001nlo: Best fit (alpha_S=0.119)'
'    mem=2 --> MRST2001J: Jet data fit (alpha_S=0.212)'
'Note that the best fit (mem=0) has been set equal'
'to MRST2001'
Evolution:
nlo,1.0,1.0
QCDNUM
'large.grid',400,1d-6,1d0,112,1d0,1d10
Alphas:
Variable,nlo,Internal
1,91.71,1.43,4.30,180.0
Parametrization:
MRST,-1,6
uv,x-taylor
2.0,5
2,3,4,5,6
dv,x-taylor
2.0,5
7,8,9,10,11
g1,x-taylor
2.0,5
12,13,14,15,16
g2,x-taylor
1.0,3
17,18,19
S,x-taylor
2.0,5
20,21,22,23,24
Delta,x-taylor
1.0,5
25,26,27,28,29
```

$$xu_V = 0.158x^{0.25}(1-x)^{3.33}(1+5.61x^{0.5}+55.49x)$$

$$xd_V = 0.040x^{0.27}(1-x)^{3.88}(1+52.73x^{0.5}+30.65x)$$

$$xS = 0.222x^{-0.26}(1-x)^{7.10}(1+3.42x^{0.5}+10.30x)$$

$$xg = 1.90x^{0.09}(1-x)^{3.70}(1+1.26x^{0.5}-1.43x) - 0.21x^{-0.33}(1-x)^{10}.$$

$$x\Delta = x(\bar{d}-\bar{u}) = 1.195x^{1.24}(1-x)^{9.10}(1+14.05x-45.52x^2)$$

```
Compose:
tbar,none
bbar,treshold
4.3
cbar,treshold
1.43
sbar,composite
0.0,0.0,0.0,0.0,0.1,0.0
ubar,composite
0.0,0.0,0.0,0.0,0.2,-0.5
dbar,composite
0.0,0.0,0.0,0.0,0.2,0.5
g,composite
0.0,0.0,1.0,-1.0,0.0,0.0
d,composite
0.0,1.0,0.0,0.0,0.2,0.5
u,composite
1.0,0.0,0.0,0.0,0.2,-0.5
s,composite
0.0,0.0,0.0,0.0,0.1,0.0
c,treshold
1.43
b,treshold
4.3
tbar,none
```

$$2\bar{u}, 2\bar{d}, 2\bar{s} \;=\; 0.4S - \Delta, \quad 0.4S + \Delta, \quad 0.2S$$

```
Parameterlist:
list,2,29
  0.119015,  0.156678,  0.247800,  3.331000,  5.608000, 55.490002,  0.040503,  0.271400,  3.8827
00, 52.730000, 30.650000,  1.904081,  0.093430,  3.704000,  1.264000, -1.425000,  0.211000, -0.3
28600, 10.000000,  0.222100, -0.258900,  7.104000,  3.420000, 10.300000,  1.201163,  1.242000,
9.104000, 14.050000,-45.520000
  0.119015,  0.156678,  0.247800,  3.331000,  5.608000, 55.490002,  0.040503,  0.271400,  3.8827
00, 52.730000, 30.650000,  1.904081,  0.093430,  3.704000,  1.264000, -1.425000,  0.211000, -0.3
28600, 10.000000,  0.222100, -0.258900,  7.104000,  3.420000, 10.300000,  1.201163,  1.242000,
9.104000, 14.050000,-45.520000
0.121,0.158,0.25,3.33,5.61,55.49,0.040,0.27,3.88,52.73,30.65,123.5,1.16,4.69,-3.57,3.41,0.038,-0
.5,10.0,0.222,-0.26,7.10,3.42,10.30,1.195,1.24,9.10,14.05,-45.52
End:
```

Evolution Codes used by LHAPDF

QCDNUM version 16.12 – used in all cases except CTEQ.
Fast evolution code written by M.Botje and
freely available at www.nikhef.nl/~h24/qcdnum.

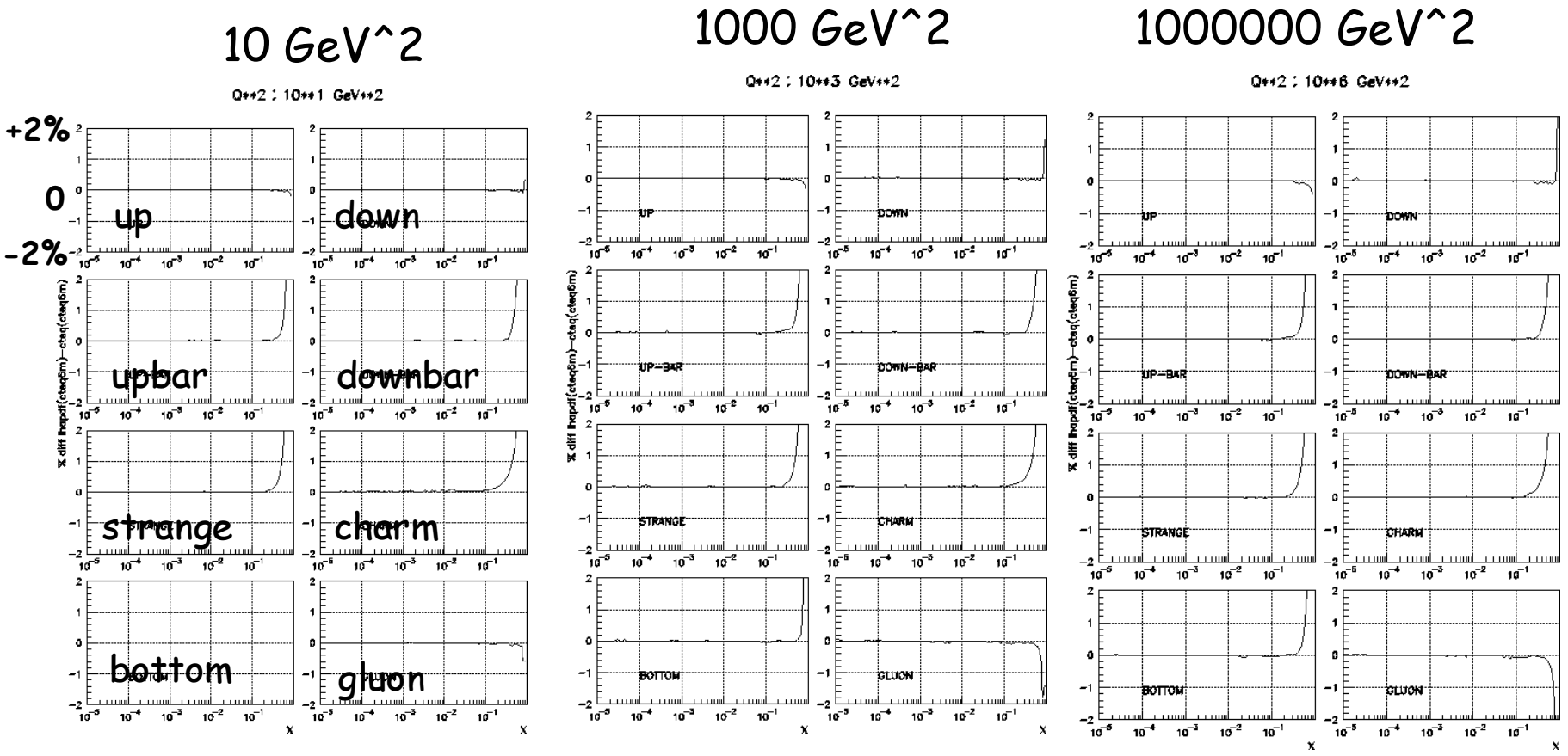
EVLCTEQ – used in all the CTEQ PDF sets. Specific
evolution code written by CTEQ

WARNING !! – at present the user needs to recompile
the code in changing between CTEQ and any
other PDF sets.

ALSO ! – MRST do not use QCDNUM in their fitting
procedures, so there is the issue as to the
effects of using QCDNUM here.

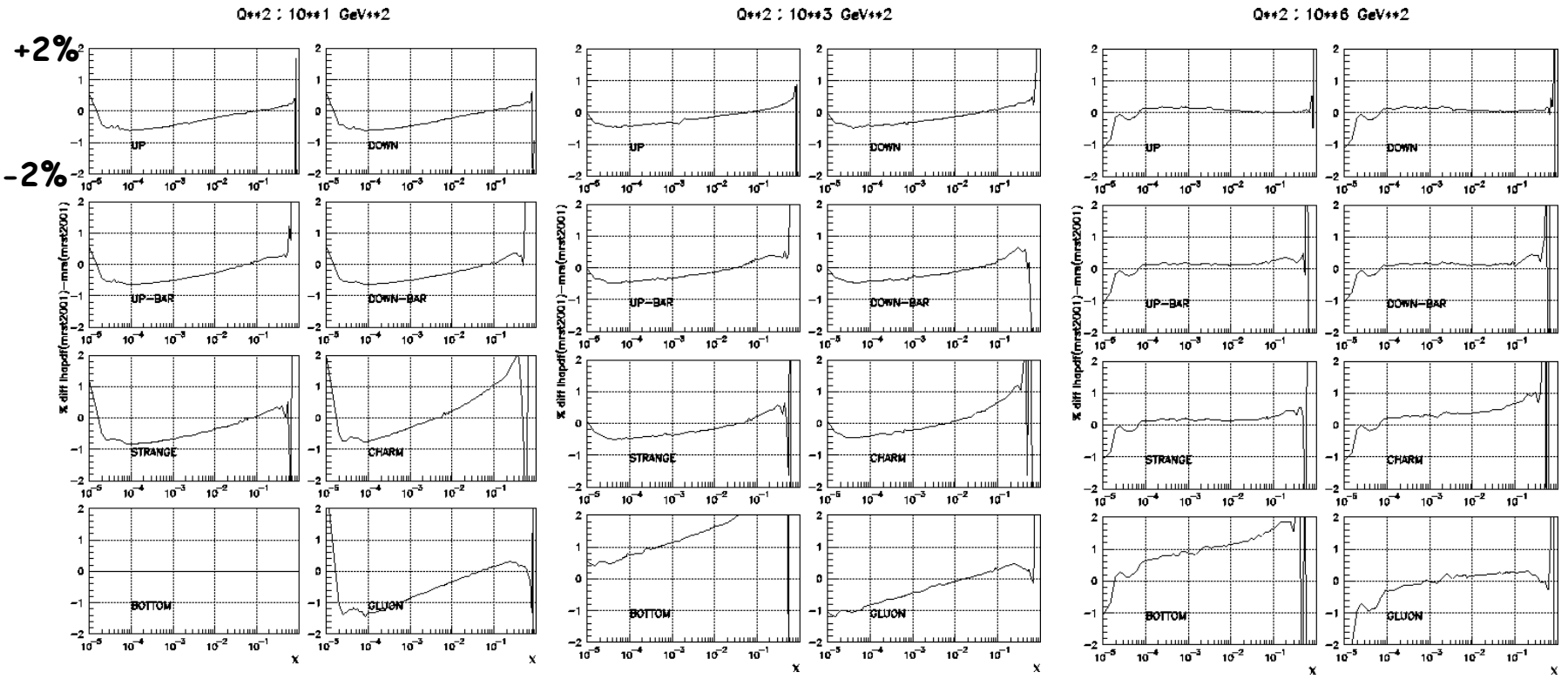
Comparison of PDFs obtained with CTEQ6 from LHAPDF and CTEQ6 code directly

(LHAPDF-CTEQ6)/CTEQ6 in %



Comparison of PDFs obtained with MRST2001 From LHAPDF and MRST2001 code directly

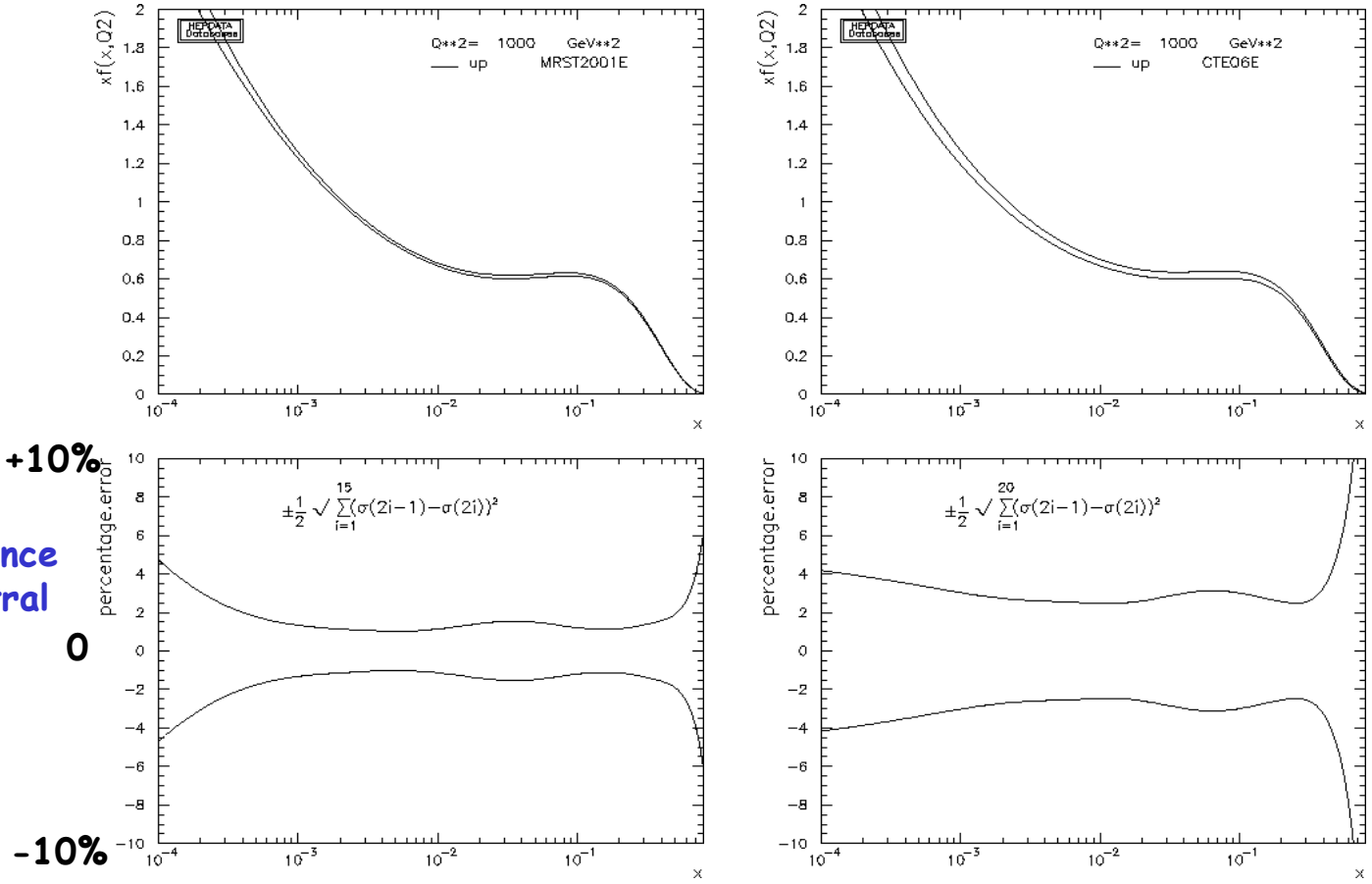
(LHAPDF-MRST2001)/MRST2001 in %



Upper and lower limits of the up parton distributions from the "error PDFs" obtained from the HEPDATA PDF web server

MRST2001E

CTEQ6E



Increasing use of LHAPDF by the community

No specific information in detail but a quick scan of the literature etc… shows evidence of use in…

ATLAS
CMS
&
Tevatron experiments

PYTHIA
HERWIG
GRACE
GENIE
MCFM
+
others

This is not surprising since PDFLIB does not have the latest PDFs (CTEQ6 and MRST2001….) and in particular the error sets

Current Problems and Future

1) Evolution Codes

- Need to recompile when using different evolution codes could lead to mistakes, and is time consuming.

  It would be good if all PDF sets used the same evolution code – but this will not happen!

  Therefore – rewrite code to incorporate both QCDNUM and EVLCTEQ – (I noted one paper where the author said he had done this – DANGER if people start to play around with the code and attribute the results to LHAPDF).

- MRST with QCDNUM is not quite correct. Discussions with M, R, S and T about this.

  (R has supplied me with MRST evolution code but as yet this has not been implemented in LHAPDF)

Current Problems and Future

2) Initialisation of multiple PDF members from a set

```
Call InitPDF(nmem)
```

At present only one PDF member from a given PDF set can be initialised at one time.

This is can make things slow especially if the error PDF sets are to be used in a meaningful way.

For example to calculate the errors on a quantity on an event by event basis where all the PDFs are used for each generated event.

Current Problems and Future

3) Other PDF sets

Need to get the parameters for the MRST2002(E) sets and make sure that any future new sets are added as quickly as possible.

Older (legacy PDF sets)?

How easy is it to get the necessary parameters to sufficient accuracy? – impossible and probably unnecessary!

Interface with PDFLIB – see next slide

Current Problems and Future

4) Interface with PDFLIB

Needed (possibly) because of:

- Access to older PDF sets for verification with previous results.
- To allow existing programs to use the LHAPDF PDFs with the minimum of change.

The latter is more contentious as it may be better to encourage the authors of MC/ME programs to incorporate a dual scheme, for PDFLIB and LHAPDF, with a switch in the code.

Otherwise LHAPDF will forever be tied to PDFLIB.

However, Steve Mrenna at FNAL has developed an interface for LHAPDF using PDFLIB –
http://cepa.fnal.gov/personal/mrenna/pdfnew.tgz

Current Problems and Future

5) Better/more efficient usage of "error PDFs" in ME/MC

At the 2003 Les Houches meeting suggestions were made to improve the use of the "error PDF" sets in ME/MC programs.

Instead of re-running the progams with all the different error sets then averaging, the program could run once using the central PDF and at the same time store some pdf*pdf weights from the other error PDF sets.

To do this most efficiently, this would involve initialising multiple PDFs as referred to on an earlier slide.

The exact form of the pdf*pdf weights needs to be defined.

Current Problems and Future

6) Odds and Ends (from suggestions at Les Houches 2003)

- Mapping PDF set names onto an integer (as in PDFLIB but with no overlap)

- Adding routines to return:
  - Lambda_qcd(4)
  - Lambda_qcd(5)
  - Parton threshold masses (already in)
  - x_min and Q_min

- A descriptive routine returning a table of all included PDFs and a description of each

Summary

1. **Mirror copy of LHAPDF web site at Durham installed.**

2. **Several new PDF sets added (notably CTEQ61 and MRST2001E)**

3. **Possible problems/improvements identified:**

   Unified library for all evolution codes needed.

   Possible improvement in MRST evolution code.

   Need to allow multiple initialisation of PDF sets for MCs

   Interface with/from PDFLIB for older PDF sets