LesHouchesAccordPDF
Status Report and Future Plans

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Outline

- Introduction & recap - what is LHAPDF.
- Installation of LHAPDF – changes in download & install
- Using LHAPDF
  - Initialization routines
  - PDF calculating routines
  - PDF sets included in LHAPDF
- Extras:
  - Multiset initialization
  - Adding a User's own PDF set
  - C++ wrapper
  - Short tour of the web site
- Summary – including Future Plans.

Introduction & Recap
the beginning

The story so far….

- 2001 Les Houches meeting – LHAPDF interface was conceived to enable the usage of PDF sets with uncertainties in a uniform manner.
- It was also to be viewed as a successor to PDFLIB.
- 2002 Walter Giele (Fermilab) produced the first LHAPDF version with very elegant (Fortran) code:-
  - Utilised on-the-fly evolution to higher Q scales starting from the parameterized fits at the fitting scale Q0.
  - A PDF sets could contain multiple members (eg error sets)
  - Very compact and easily updated – just add new parameters.
  - Incorporated 2 evolution codes QCDNUM and CTEQ's own.

Introduction & Recap

some problems and their solution

(big) BUT …..

in order to have a usable PDFLIB replacement there were problems.

- The parameterizations were not always available for all sets.
- The specific evolution code used by the authors was not always available.
- It was slow in some circumstances – especially the initialization phase.

so (in 2003*) …..

A hybrid was developed which incorporated:

- using the interpolation grids and codes given by the PDF authors (.LHgrid)
- plus Walter's elegant on-the-fly evolution method. (.LHpdf)

(*This is when I joined and eventually took on the project)

Introduction & Recap
making a complete solution

ALSO …..

In order to have a comprehensive PDFLIB replacement there were other features needed:-

- To enable easy incorporation into existing programs: an (alternative) interface which looked like PDFLIB (ie PDFSET, STRUCTM, etc..)
- Availability of other key PDF sets, eg. photons and pions.
- Availability of some older nucleon PDF sets for comparisons.
- Ability to calculate Nuclear PDFs.
- Ability to add a user's own PDF set.
- Ability to use more than one PDF set in the same programme without having to re-initialize each time.

Over the intervening time all the above have been added in various stages.

Timeline of the development of LHAPDF

2002	V1	original implementation by WG
2003	V2	PDF grid interpolation method + single compilation
2004	V3	PDFLIB-like LHAglue wrapper + numbering scheme
2005	V4	Pion/Photons + changed file structure
	V4.1 V4.2	Moved into hepforge + gnu auto-tools Makefile generation
2006	V5.0 V5.1 V5.2 V5.2.1 V5.2.2 V5.2.3	Multi-PDFset initialization + Bug fixes + libtools library building + New PDF sets + Nuclear PDFs + User PDFs …. etc…
2007	V5.3.0 V5.3.1	
2008	V5.4.0	very soon

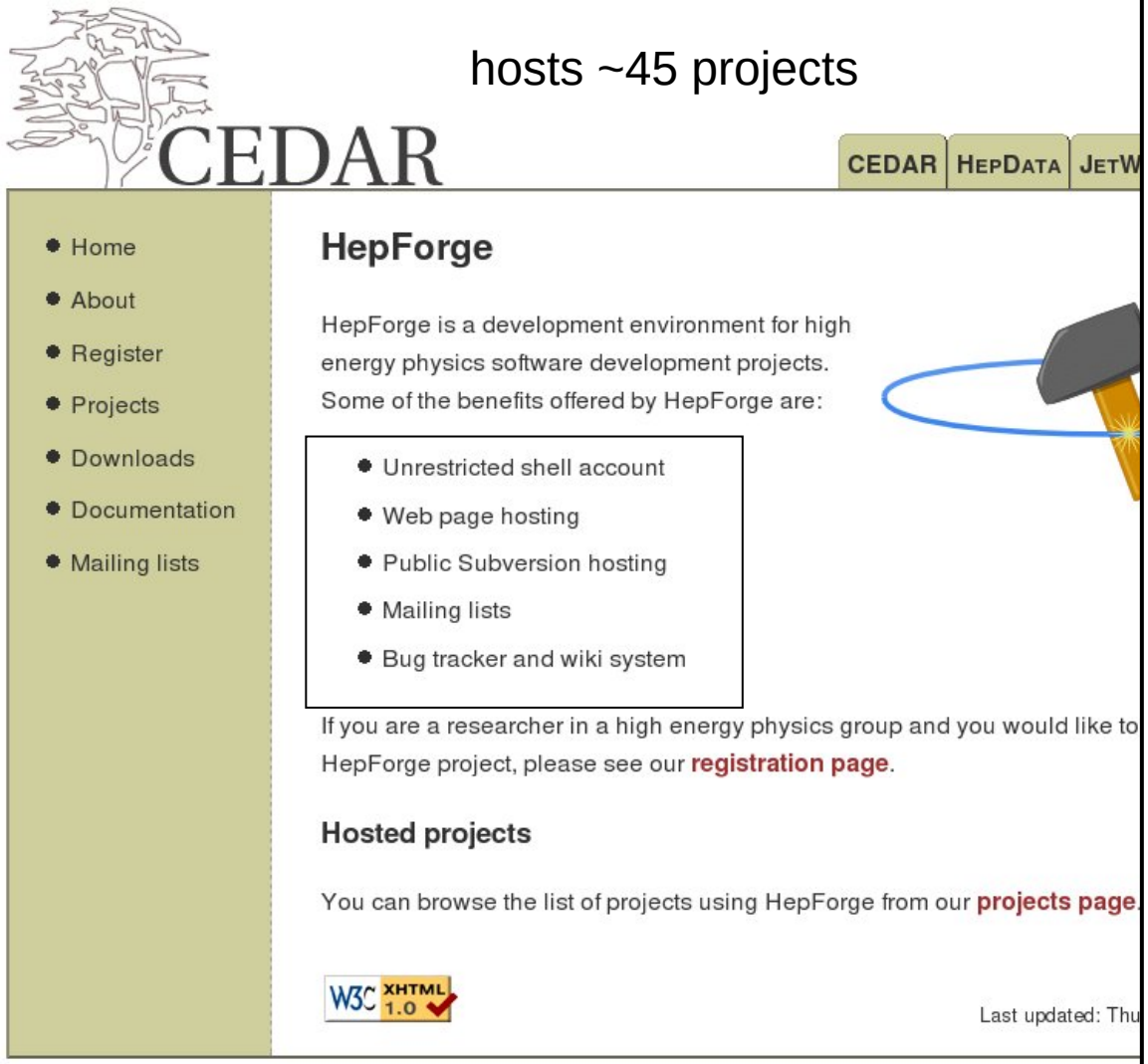
Downloading and Installing LHAPDF

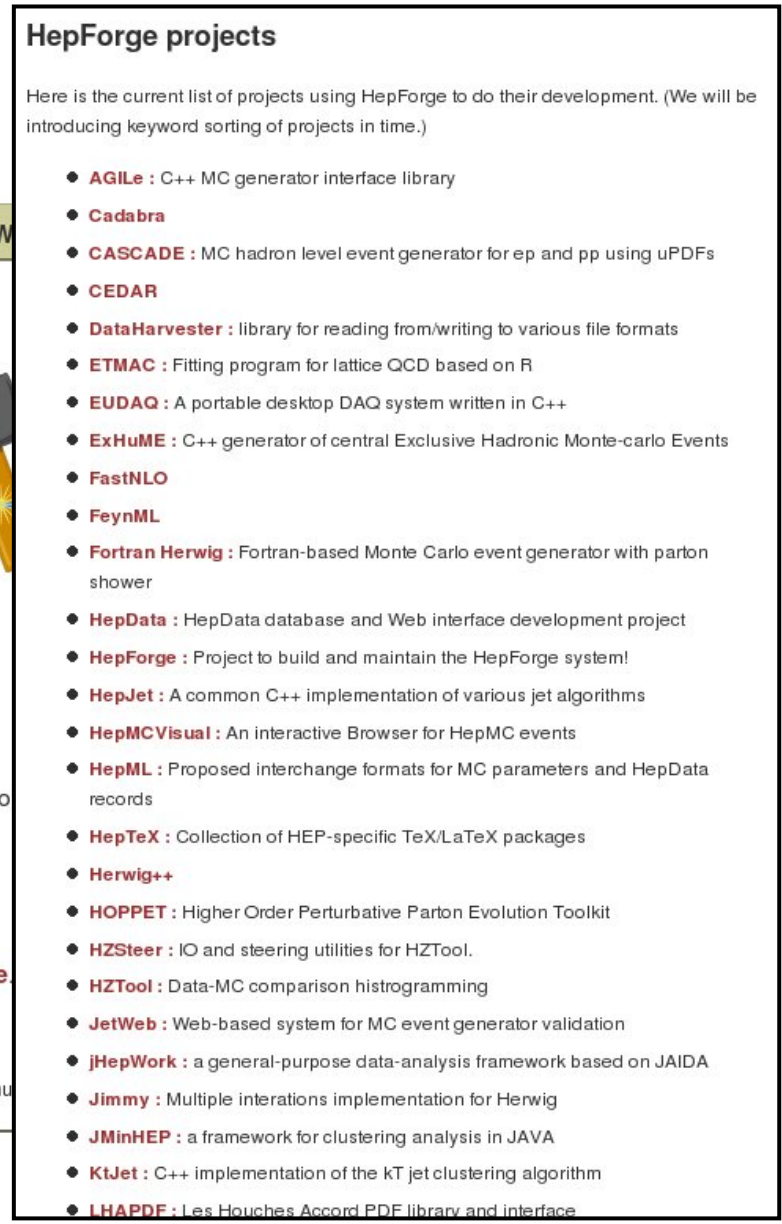
- Since V4.1 LHAPDF has been hosted by hepforge*
- We do not provide precompiled system specific libraries.
- Use the gnu build system, autotools to construct a configure script capable of constructing a Makefile to build LHAPDF on the specific system. Then use gnu libtool to build both the static and dynamic shared libraries libLHAPDF.a and libLHAPDF.so which can be used in linking to a user's programme.
- There is the option of installing either to a standard location /usr/local or to a location of the user's choice (--prefix option).
- Tested on a variety of systems and compilers including:
  f77, g77, gfortran, f95, ifort - SL4, fedora 5, ubuntu, mac OS X, solaris, amd64

* hepforge is a part of the CEDAR project providing a development environment for hep projects (see next slide).

Hepforge ....

hosts ~45 projects





HepForge projects

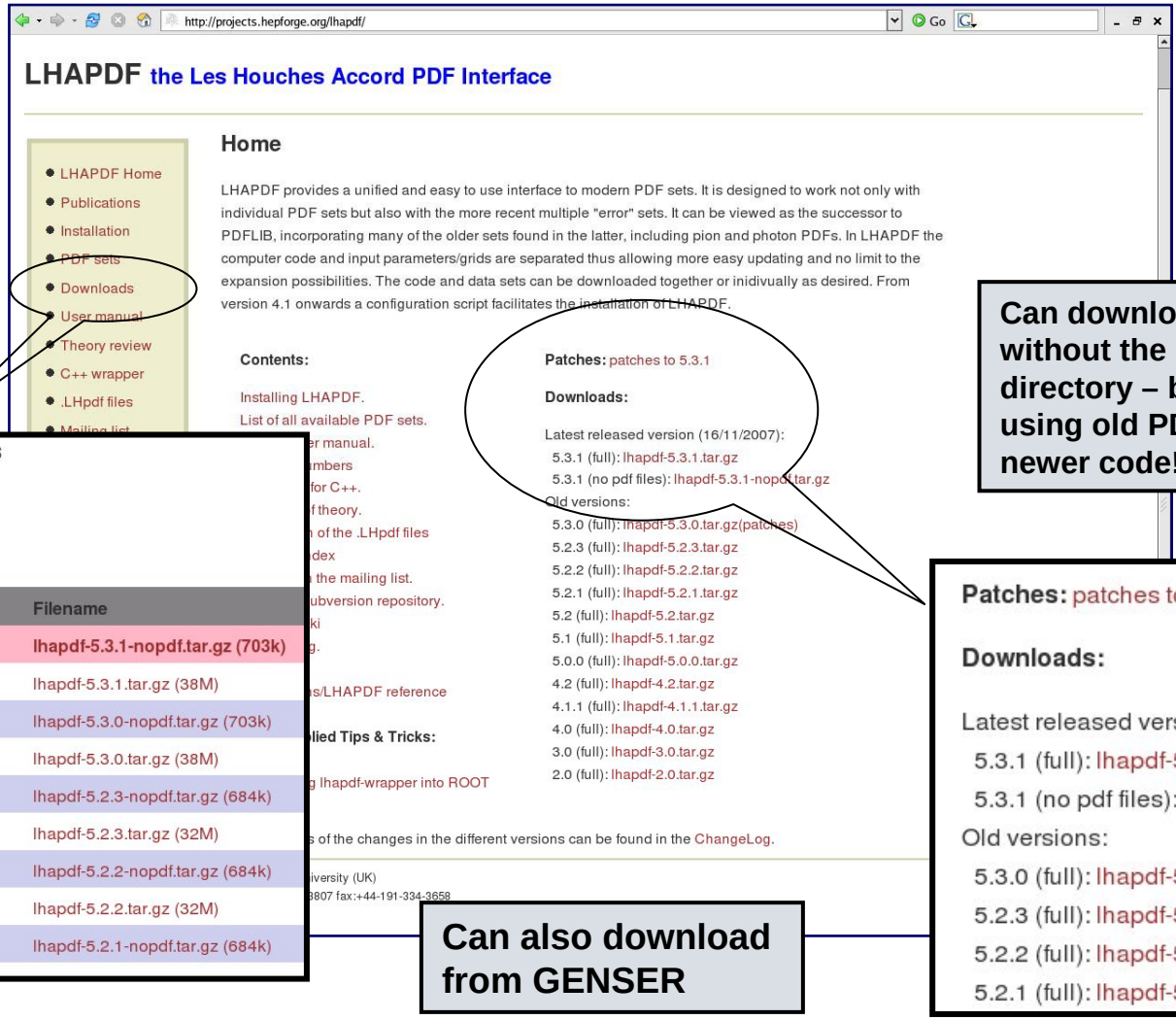
Here is the current list of projects using HepForge to do their development. (We will be introducing keyword sorting of projects in time.)

- **AGILe :** C++ MC generator interface library
- **Cadabra**
- **CASCADE :** MC hadron level event generator for ep and pp using uPDFs
- **CEDAR**
- **DataHarvester :** library for reading from/writing to various file formats
- **ETMAC :** Fitting program for lattice QCD based on R
- **EUDAQ :** A portable desktop DAQ system written in C++
- **ExHuME :** C++ generator of central Exclusive Hadronic Monte-carlo Events
- **FastNLO**
- **FeynML**
- **Fortran Herwig :** Fortran-based Monte Carlo event generator with parton shower
- **HepData :** HepData database and Web interface development project
- **HepForge :** Project to build and maintain the HepForge system!
- **HepJet :** A common C++ implementation of various jet algorithms
- **HepMCVisual :** An interactive Browser for HepMC events
- **HepML :** Proposed interchange formats for MC parameters and HepData records
- **HepTeX :** Collection of HEP-specific TeX/LaTeX packages
- **Herwig++**
- **HOPPET :** Higher Order Perturbative Parton Evolution Toolkit
- **HZSteer :** IO and steering utilities for HZTool.
- **HZTool :** Data-MC comparison histrogramming
- **JetWeb :** Web-based system for MC event generator validation
- **jHepWork :** a general-purpose data-analysis framework based on JAIDA
- **Jimmy :** Multiple interations implementation for Herwig
- **JMinHEP :** a framework for clustering analysis in JAVA
- **KtJet :** C++ implementation of the kT jet clustering algorithm
- **LHAPDF :** Les Houches Accord PDF library and interface

Andy Buckley in Durham is the main author and maintainer of Hepforge

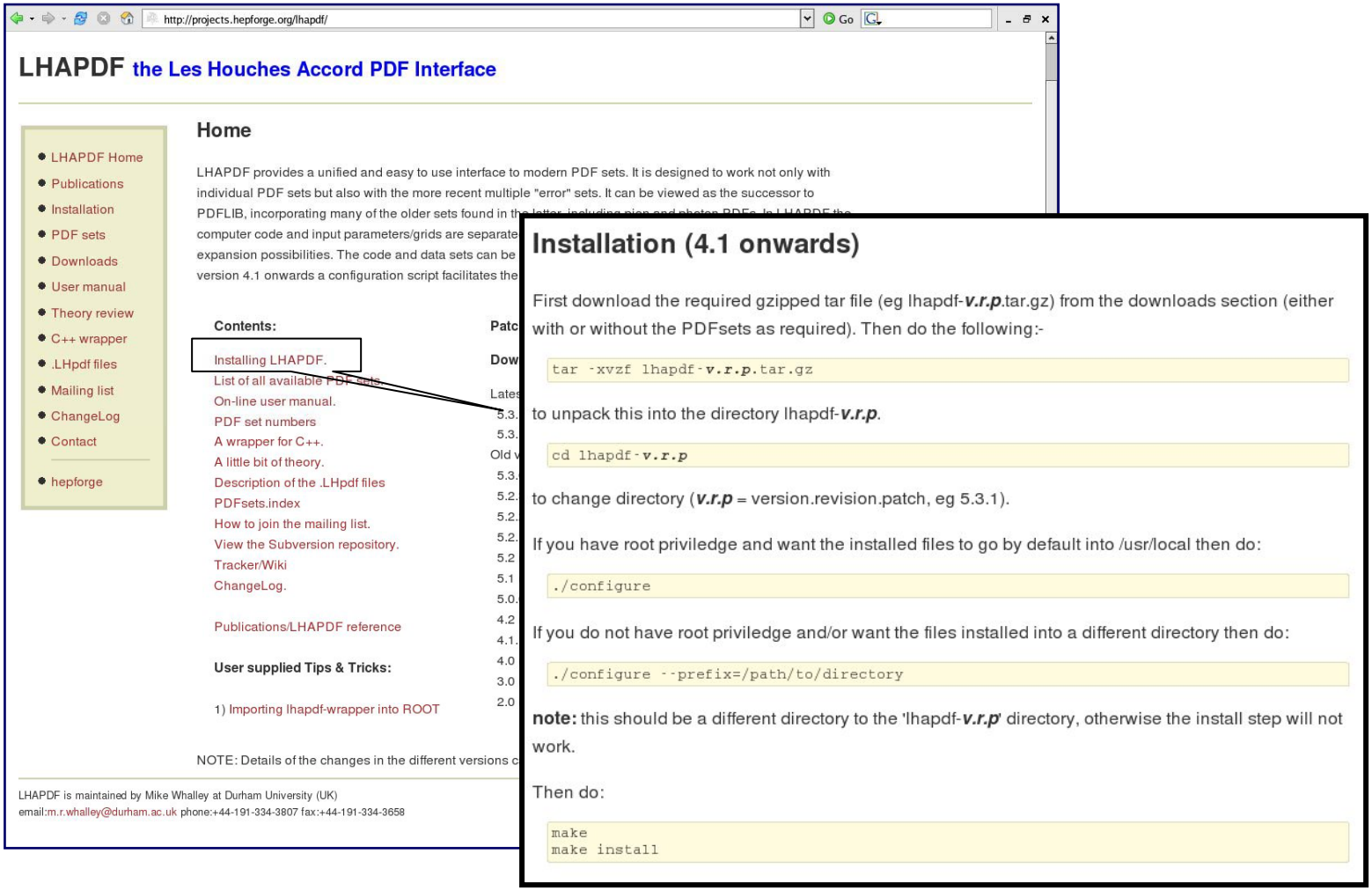
Downloading and Installing LHAPDF

where to find the code



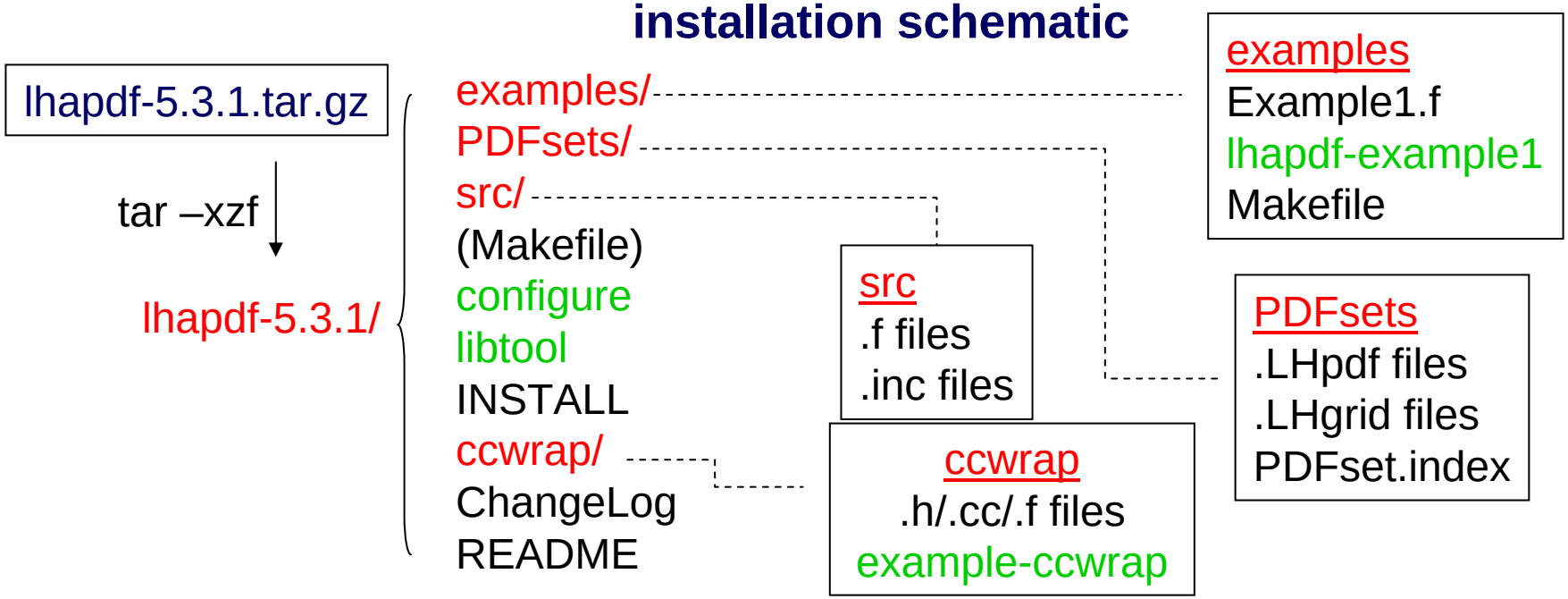
Downloading and Installing LHAPDF

installation instructions are on-line



Downloading and installing LHAPDF

installation schematic



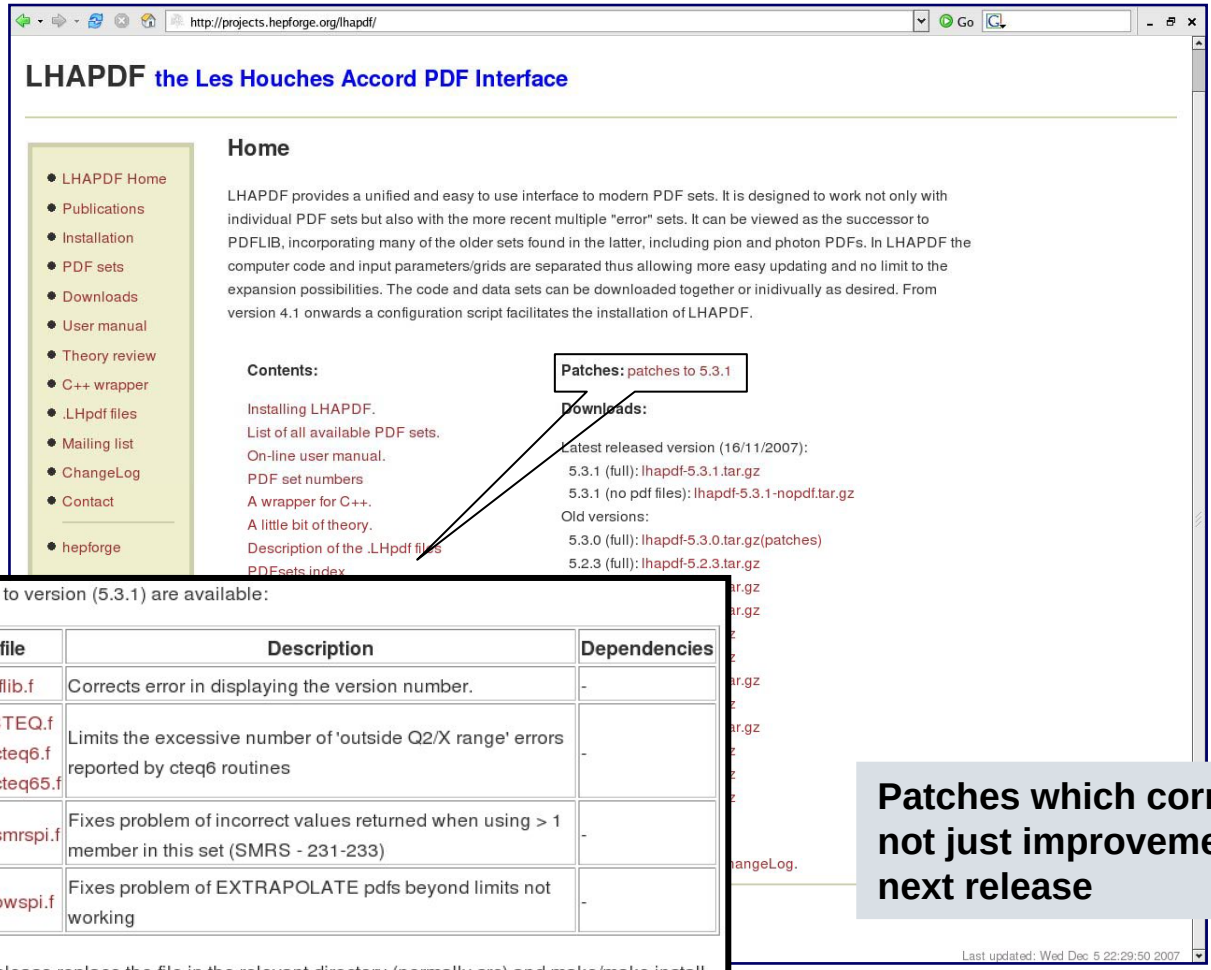
configure –prefix=$home/local/ → make → make install → make clean

Note also:
configure –h
configure –disable-ccwrap --..
configure –disable-lhaglue --.

Do not install in the build directory

$home/local/ bin/ lhapdf-config
lib/ libLHAPDF.a
libLHAPDF.so
libLHAPDFWrap.a
libLHAPDFWrap.so
share/ lhapdf/PDFsets/…..LHpdf
/…..LHgrid
/PDFsets.index

Downloading and Installing LHAPDF
what about patches?



The following patches to version (5.3.1) are available:

Date	New file	Description	Dependencies
19/11/2007	src/LHpdflib.f	Corrects error in displaying the version number.	-
19/11/2007	src/EVLCTEQ.f src/wrapcteq6.f src/wrapcteq65.f	Limits the excessive number of 'outside Q2/X range' errors reported by cteq6 routines	-
13/12/2007	src/wrapsmrspi.f	Fixes problem of incorrect values returned when using > 1 member in this set (SMRS - 231-233)	-
12/12/2007	src/wrapowspi.f	Fixes problem of EXTRAPOLATE pdfs beyond limits not working	-

To apply the patches please replace the file in the relevant directory (normally src) and make/make install again.

Patches which correct bugs, not just improvements for the next release

Using LHAPDF
PDF set initialization

The location of the PDFsets files have to be specified either:
in the argument of InitPDFset('*fully-qualified-name*')
or, in this order of precedence:

- **call SetPDFPath(*'/path/to/PDFsets'*)**
- Environmental variable **$LHAPATH**
- Determines itself using '**lhapdf-config**' or **binreloc** (5.4.0 onwards)

Selecting which PDFset to use:

call InitPDFset('*fully-qualified-name'*)

call InitPDFsetByName('*name'*)

Which PDFset member to use:

call InitPDF(*member*)

Standard LHAPDF

parm(1)='DEFAULT'
value(1)=*lhaglue number*

parm(1)='PYTHIA'
parm(1)='HERWIG'

Input lhaglue number through specific parameters

call PDFSET(*parm,value*)

LHAglue/PDFLIB-like

Using LHAPDF
routines to evaluate PDFs

call evolvePDF(*x,q,f*)

call evolvePDFp(*x,q,p2,ip2,f*)

call evolvePDFa(*x,q,a,f*)

call evolvePDFphoton(*x,q,f,photon*)
(mrst2004qed set only)

Standard LHAPDF

call STRUCTM(*x,q,upv,dnv,usea,dsea,str,chm,bot,glu*)

call STRUCTP(*x,q2,p2,ip2,upv,dnv*,……)

call STRUCTA(*x,q,a,upv,dnv*,……)

beware the q2 here!

LHAglue/PDFLIB-like

f(-6,6)
0=gluon
(-)1=(anti)down
(-)2=(anti)up
(-)3 =(anti)strange
(-)4=(anti)charm
(-)5=(anti)bottom
(-)6=(anti)top

upv – up valence
dnv – down valence
dsea – up sea
dsea – down sea
etc…

all are x*pdf

Using LHAPDF
other routines

Obtain alphas for current set

alphasPDF(*q*)

Get various parameters

call getLam4(*member,qcdl4*)
call getLam5(*member,qcdl5*)
call getXmin(*member,xmin*)
call getXmax(*member,xmax*)
call getQ2min(*member,q2min*)
call getQ2max(*member,q2max*)

Get number of members in set

call numberPDF(Nmem)

Print out description of set

call getDesc()

Controlling statistics collection

call SetLHAPARM(*'NOSTAT'*)
call SetLHAPARM(*'16'*)
Call PDFSTA()

Controlling what happens at limits

Call SetLHAPARM(*'EXTRAPOLATE'*)
Call SetLHAPARM(*'18')*

Controlling amount of output

Call SetLHAPARM(*'SILENT')*
Call SetLHAPARM(*'LOWKEY'*)
Call SetLHAPARM(*'19'*)

lhaglue numbering scheme

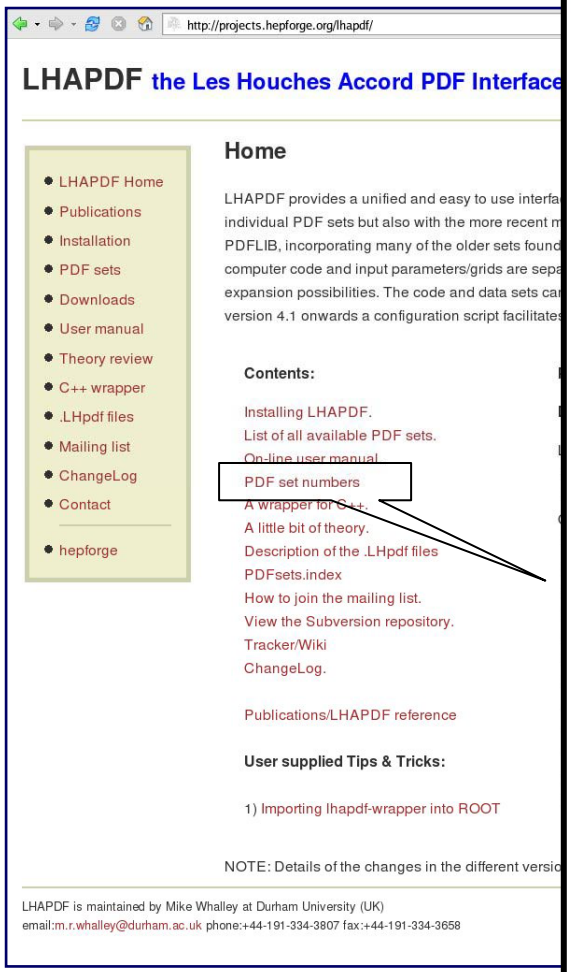
PDFsets included 5.3.1 (5.4.0)

```
10000 -> CTEQ
         (cteq65s), cteq65c, cteq6AB, cteq65 cteq61, cteq6,
         cteq5, cteq4
20000 -> MRST
         mrst2006nnlo, mrst2004qed, mrst2004FF, mrst2004,
         mrst2003c, mrst2002, mrst2001, mrst98
30000 -> Fermi
         Fermi_100/1000
40000 -> Alekhin
         Alekhin_100/1000,  Alekhin2002
50000 -> Botje
         Botje_100/1000
60000 -> ZEUS
         zeus2005, zeus2002
70000 -> H1
         H12000
80000 -> GRV
         GRV98
90000 -> spare
```

xxxx = .LHpdf
xxxx = .LHgrid
xxxx = both

Plus pdfs for
300 - photon
200 - pion
as in PDFLIB

PDFsets numbers for lhaglue



A PDF set numbers and names

Notes:

- **When using the LHAGLUE initialization method:**
  - The columns headed .LHpdf and .LHgrid give the set numbers to use with LHAGLUE
- **When Using the direct LHAPDF initialization routines:**
  - The .LHpdf and .LHgrid columns show the availablity of the respective files
  - The File Name and Member columns give the names to use in the direct LHAPDF initialization routines.
  - .LHpdf or .LHgrid has to be appended to the File Name depending the availability of that file (as indicated in the table) and wishes of the user.

Proton PDFs

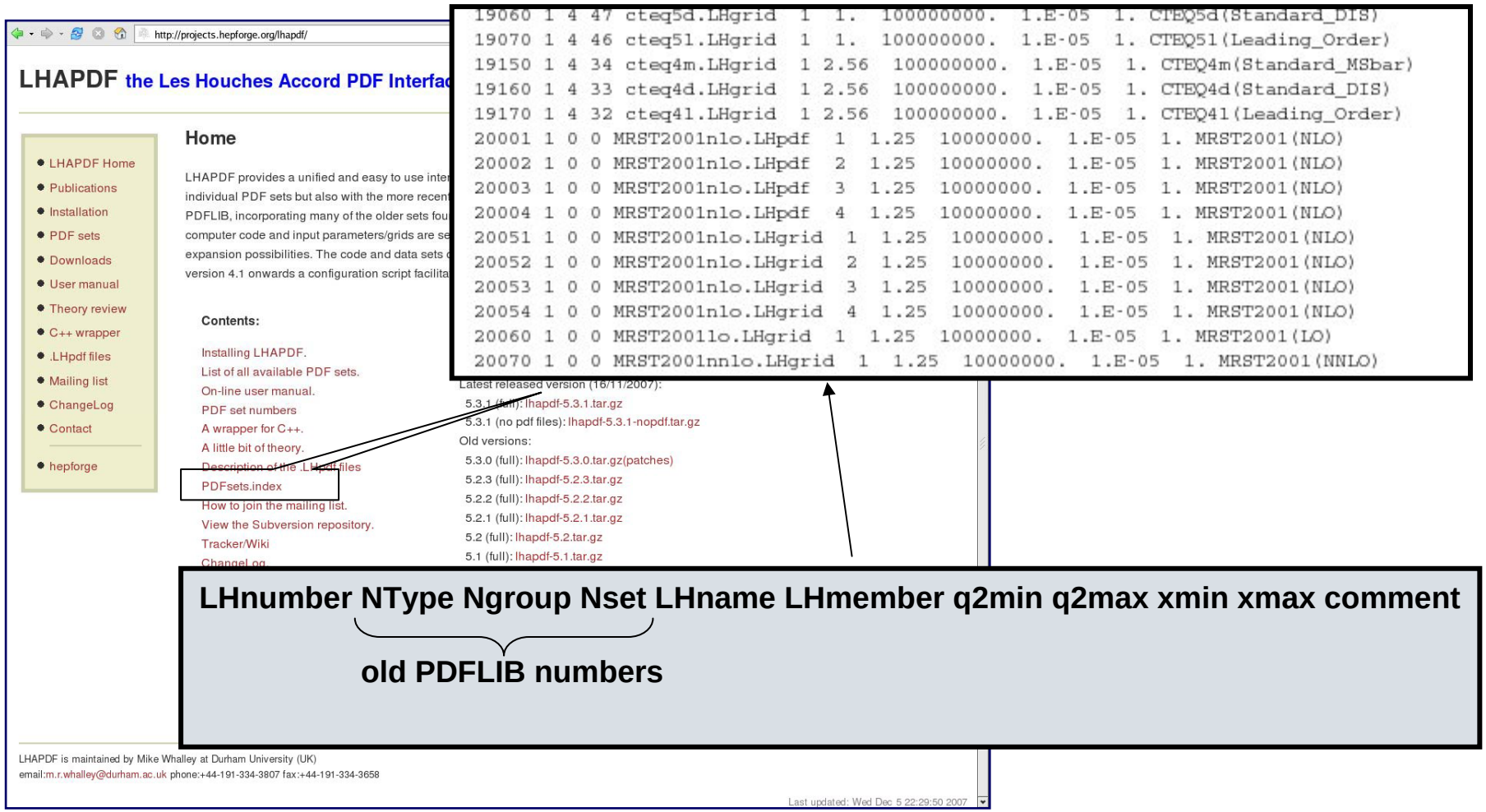
r>

PDF set	.LHpdf	.LHgrid	File Name	Member	Xmin	Xmax	Q2min GeV^2	Q2max GeV^2
CTEQ6m (central value)	10000	10050	cteq6m	0	10^{-6}	1	1.69	10^8
CTEQ6 (40 error sets)	10001-10040	10051-10090	cteq6 | cteq6mE	1-40	10^{-6}	1	1.69	10^8
CTEQ6l (LO fit/NLO alphas)	10041	-	cteq6l	0/1	10^{-6}	1	1.69	10^8
CTEQ6ll (LO fit/LO alphas)	10042	-	cteq6ll	0/1	10^{-6}	1	1.69	10^8
CTEQ61 (central value)	10100	10150	cteq61	0	10^{-6}	1	1.69	10^8
CTEQ61 (40 error sets)	10101-10140	10151-10190	cteq61	1-40	10^{-6}	1	1.69	10^8
CTEQ6AB (20 sets, variable alphas)	-	10250-10269	cteq6AB	0-19	10^{-6}	1	1.69	10^8

ASCII readable flat text file

PDFsets.index file

Installed into the share/lhapdf directory



Multi-PDFset Initialisation introduced from V5

Essential if more than one PDF set is to be used in a single programme (re-initialisation is far too slow). For example a nucleon, a pion, and a photon set in a MC.

V5 onwards allows this to happen.

In the standard LHAPDF there are equivalent routines with the letter 'M' appended to the routine names and an extra first parameter for the set Sequence number , 'nset'

eg. call InitPDFSetByNameM(*nset,'name*')
call evolvePDFM(*nset,x,q,f*)
etc…

In the LHAglue PDFLIB-like wrapper this is all taken care of invisibly to the user. (Will cycle if > the default 3 PDF sets are used)

The maximum number is defined in the include file src/parmsetup.inc (nmxset) with a default of 3.

User's own PDF sets

wrapper routine

Within LHAPDF there is a dummy wrapper routine which a user can use as a basis to construct their own PDF sets and run within the LHAPDF framework.

This is wrapUSER.f and is called from the wrapevolve.f routine.

```
subroutine USERevolve(x,Q,f)
...code to calculate xfx()

entry USERread(nset)
...code to read in and set up grid files

entry USERalfa(alfas,Q)
...code to return alphas

entry USERinit()
...initialization code for whole set

entryUSERpdf()
...initialization code for member

end
```

```
subroutine evolvePDFM(nset,x,Q,f)
.....
If(name(nset).eq.'USER') call USERevolve(x,Q.f)

entry readevolve(nset)
....
If|(name(nset).eq.'USER') call USERread(nset)
....

etc…
```

Recognises the name USER in the 'evolution:' section of the input .LHgrid or .LHpdf file

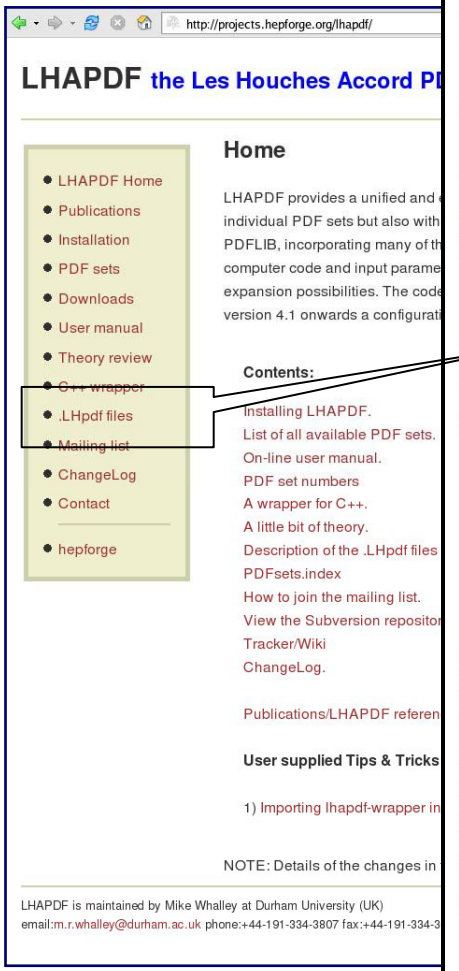
User's own PDF sets
.LHpdf and .Lhgrid files

This must be constructed for the particular circumstance of the PDF depending of the method used and details of the parameters or grid.

Details based on examples are given on the web site, but generally the following sections are present:

'Version' '5.3' <- always the first line
'Description:' <- following lines describe the PDFs
'Alphas:'
'Evolution:' ← Input information about the evolution and for .LHgrid the grid files themselves
'QCDParams:'
'MinMax:'
'Parametrization:' ← For .LHpdf type details of the parameterization
'Parameterlist:'
'End:'

LHAPDF – .LHpdf files



Description of .LHpdf files

All text strings must be enclosed in single quotation marks.

The example shown here is from the MRST2002nlo.LHpdf file

The first line declares the earliest version of LHAPDF with which the files works, in the following way:

```
'Version' '5.0'
```

Next follows a section giving a description of the PDF set. It starts with the line `'Description:'` followed by an arbitrary (max 20) number of lines. This is the text that is printed out with the `call description()` command.

```
'Description:'
'MRST fit: hep-ph/0211080'
'This set has 1 member PDFs. '
' mem=1 --> MRST2002nlo: Best fit (alpha_S=0.119)'
'Note that the best fit (mem=0) has been set equal'
'to MRST2002nlo'
```

Next is a section, starting with the line `'Evolution'`, which defines the evolution method to be used. It is followed by a number of other lines. The first of these lines has three parameters. (1) the order of the evolution, (2) the Q^2 of the PDF fit and (3) the renormalization factor, which for all the sets so far is 1.0. The next line declares the evolution code to be used, in this case `QCDNUM_MRST`. Other options are `QCDNUM`, `QCDNUM_ZEUS_TR`, `QCDNUM_ZEUS_ZM` and `EVLCTEQ`. For the varieties of QCDNUM evolution there is a final line in this section which defines the QCDNUM grid parameters, as file name, number of x bins, xmin, xmax, number of Q2 bins, Q2min and Q2max.

```
'Evolution:'
'nlo',1.0,1.0
'QCDNUM_MRST'
'MRST.large.grid',400,1d-6,1d0,112,1.d0,1d10
```

C++ wrapper (ccwrap)

Initially provided by Stefan Gieseke for V2 and updated through to V5. Recently (V5,4) revamped by Andy Buckley to make more implementation independent.

It consists of:

LHAPDFWrap.cc
LHAPDFWrap.h
LHAPDFfw.f
FortranWrappers.h
test-lhapdf-ccwrap.cc ← test example programme

The standard LHAPDF installation procedure builds the libLHAPDFWrap static (.a) and dynamic libraries (.so), installing them into the standard /lib directory along with the Fortran libraries.

Can be disabled with configure –disable-ccwrap

C++ wrapper (ccwrap)

selecting the pdf set and member

To use, first create instance of LHAPDFWrap using one of:

LHAPDFWrap pdf = LHAPDFWrap*(string name, int member*);
LHAPDFWrap pdf = LHAPDFWrap*(string name*);
LHAPDFWrap pdf = LHAPDFWrap();

plus if needed:

pdf.initPDFSet(string fully-qualified-name);
pdf.initPDFSetByName(string name);
pdf.initPDF(int member);

C++ wrapper (ccwrap)
evaluating the pdfs

(vector) pdf.xfx*(double x, double q*);
(double) pdf.xfx*(double x, double q, int fl*);

(vector) pdf.xfxp*(double x, double q, double p2, int ip2*);
(double) pdf.xfxp*(double x, double q, double p2, int p2, int fl*);

etc… xfxa(…
xfxphoton(…

Plus a complete set with 'M' at the end of the method name and an extra 'int nset' as the first argument for the set number.
eg: pdf.xfxM*(int nset, double x, double q*);

'*int fl*' is the parton flavour (0 =gluon etc..) and these methods return a single double for that flavour, otherwise a vector is returned.

C++ wrapper (ccwrap)
other methods

Include:

(int) pdf.numberPDF(); ← returns number of PDF members in set

(void) pdf.getDescription(); ← prints the PDF description

(double) pdf.alphasPDF(*double q*); ← returns alphas for the PDF set

(double) pdf.getLam4();
(double) pdf.getLam5();

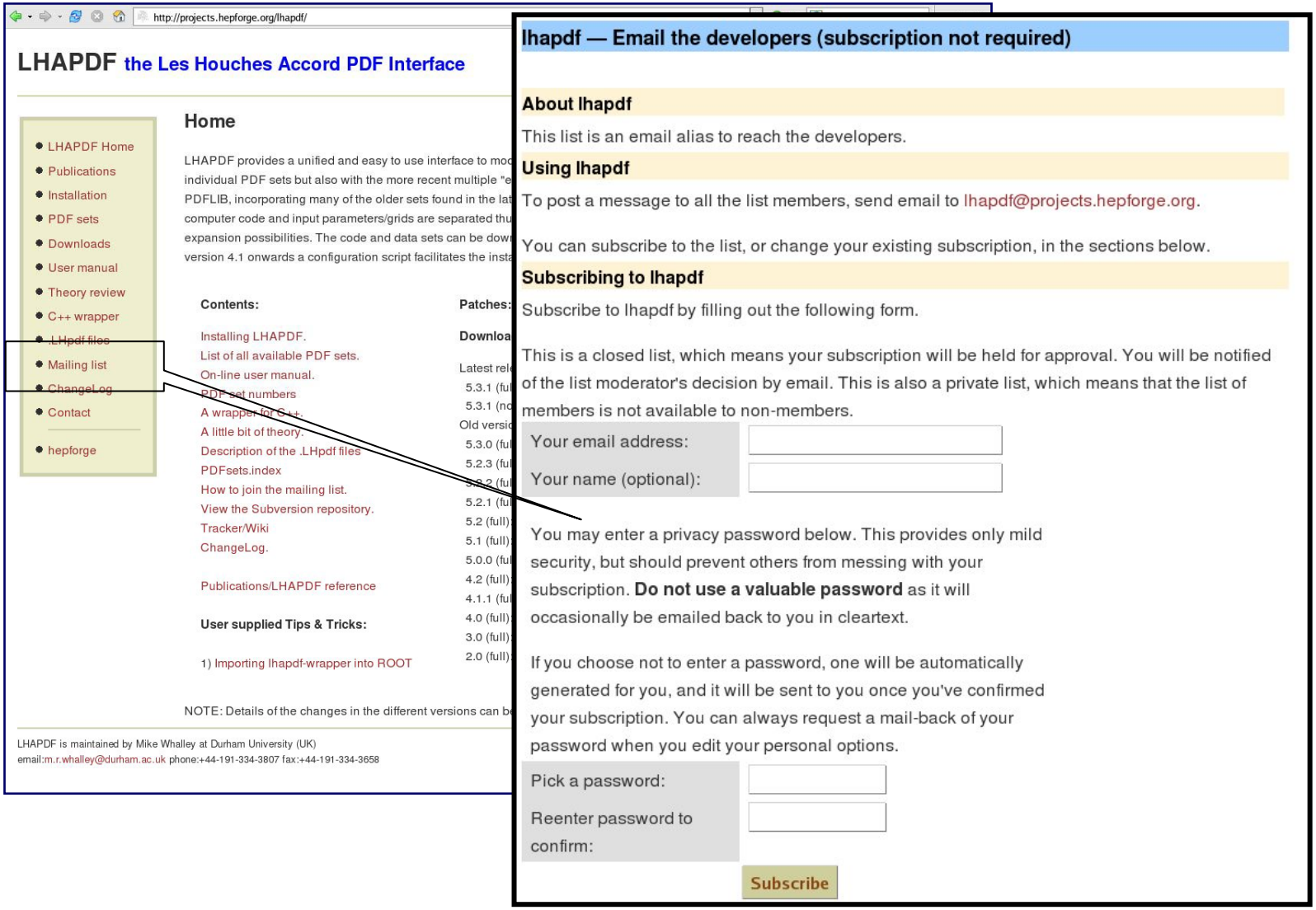
(double) pdf.getXmin(*int member*);
(double) pdf.getXmax(*int member*);
(double) pdf.getQ2min(*int member*);
(double) pdf.getQ2max(*int member*);

} returns the various parameters

Plus the usual set with suffix ‘M’ and extra first argument ‘int nset’ for multiset use.

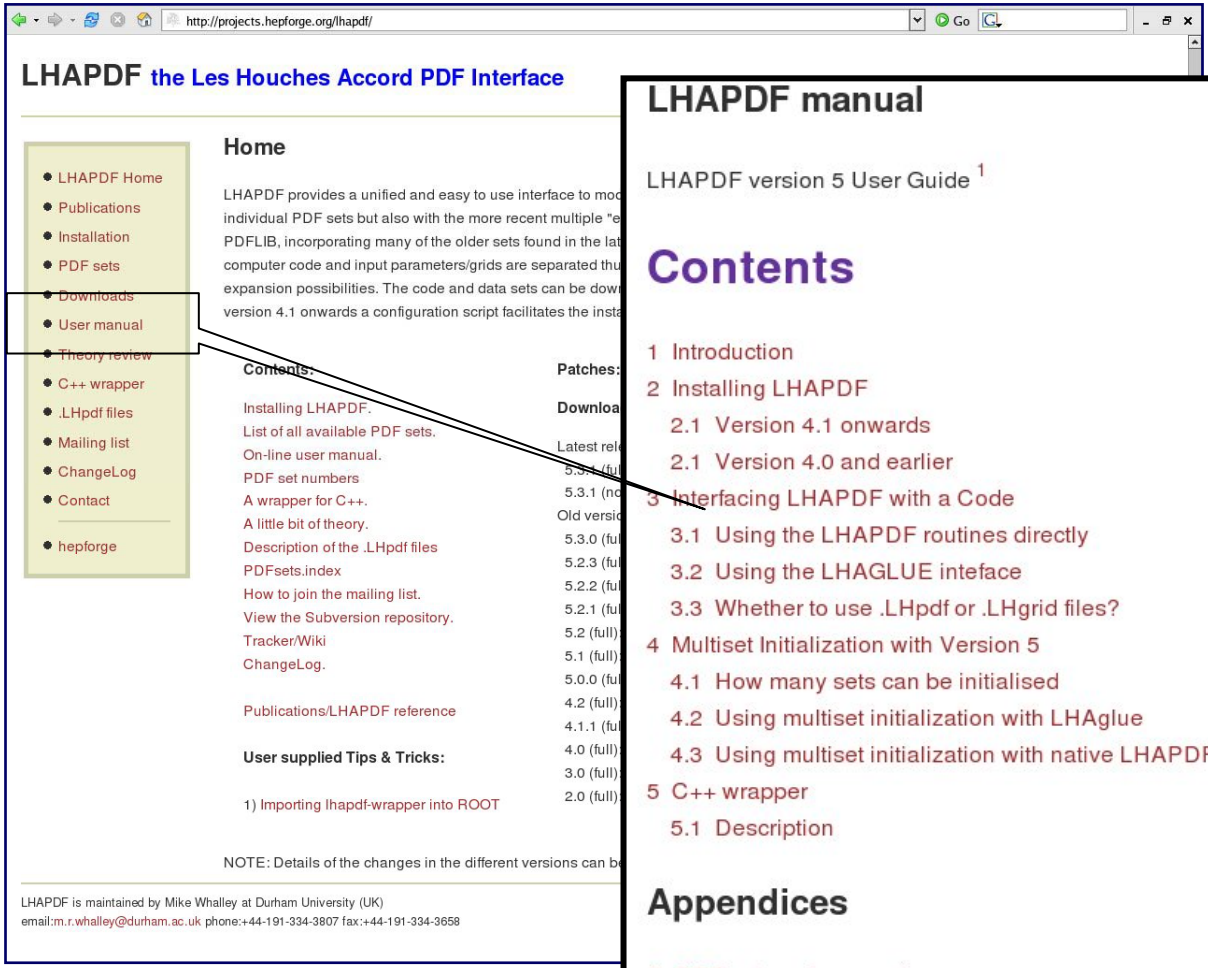
Short tour of the LHAPDF web site

mailing list - subscribing



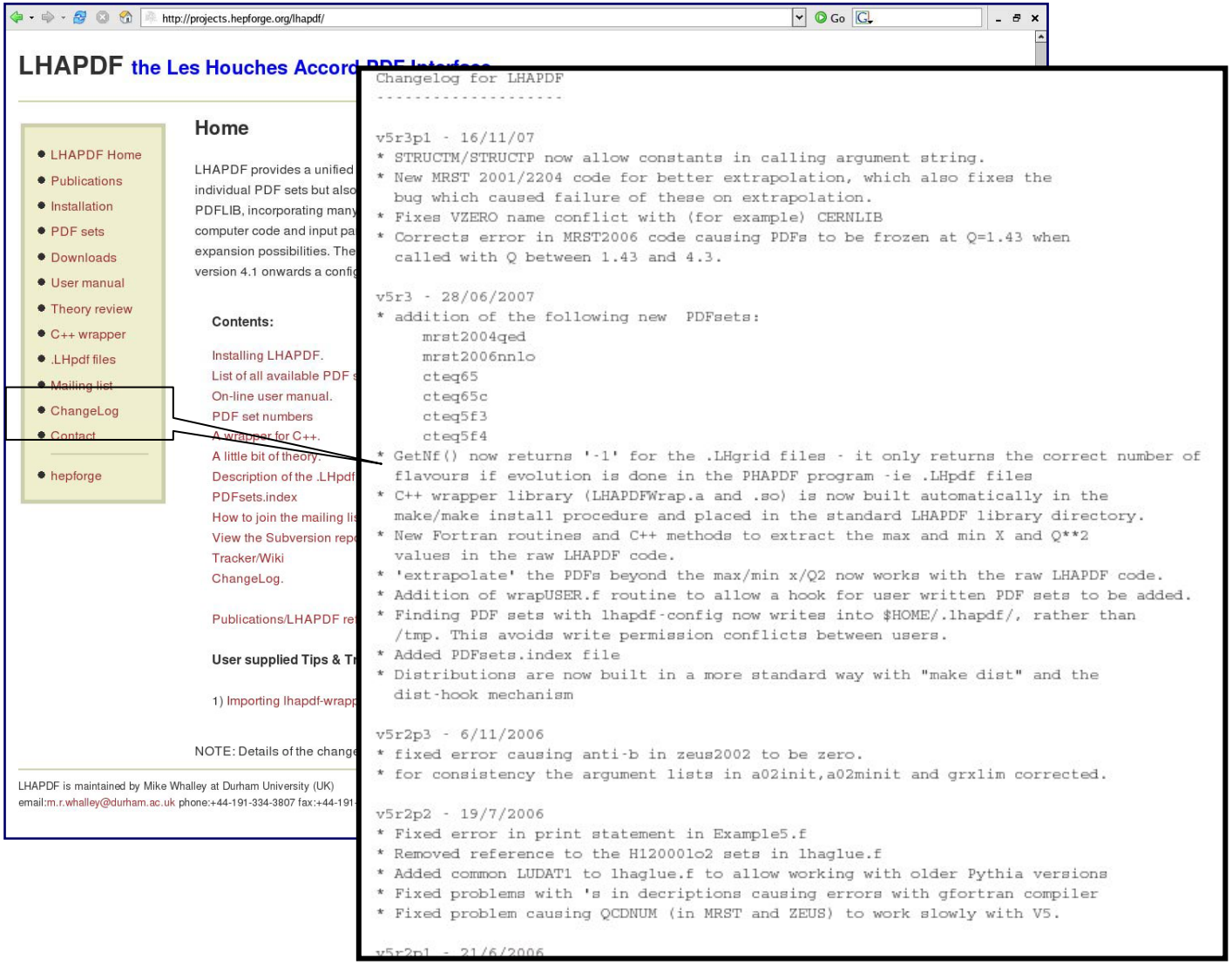
Short tour of the LHAPDF web site

on-line user manual



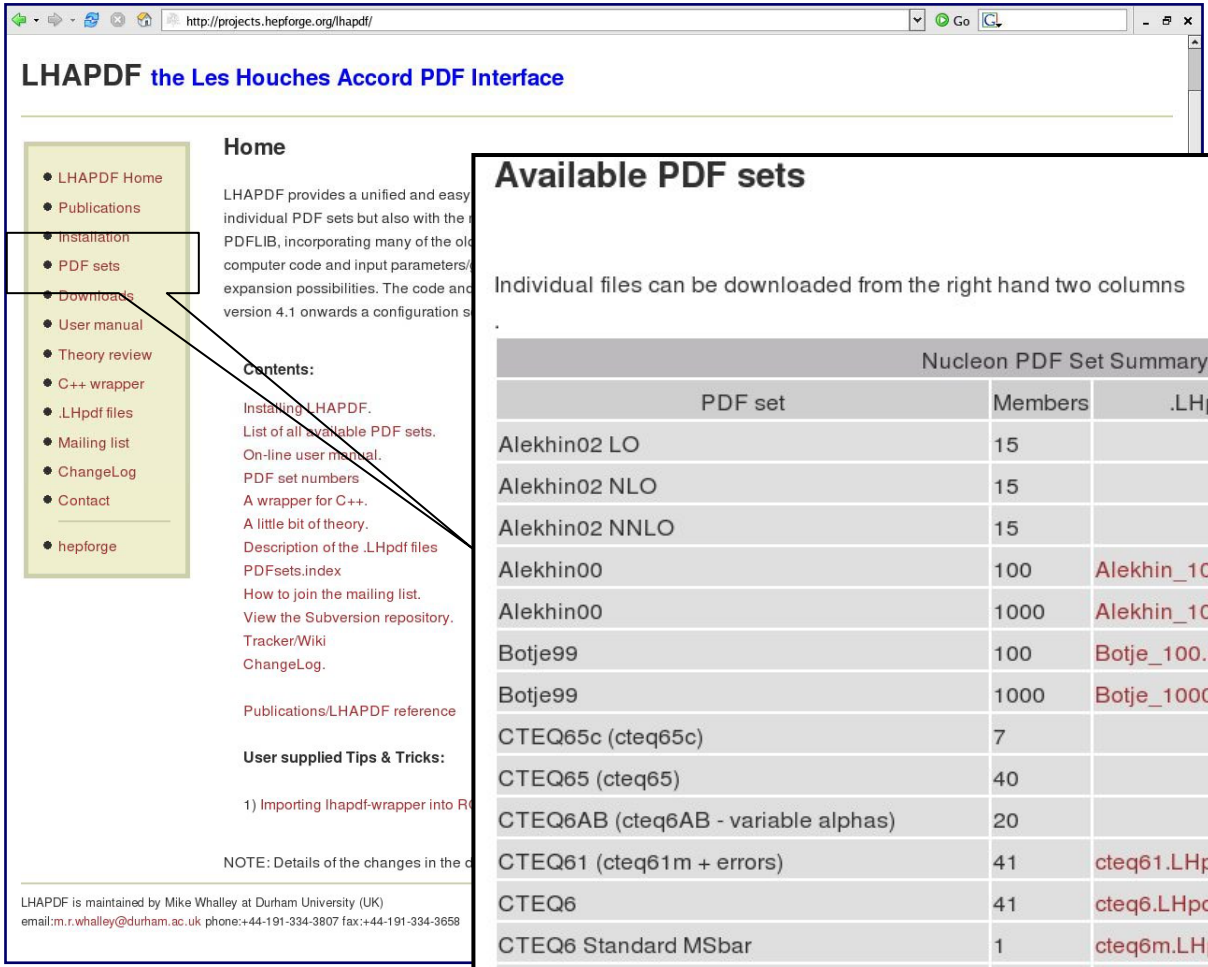
Short tour of the LHAPDF web site

ChangeLog



Short tour of the LHAPDF web site

available PDFsets



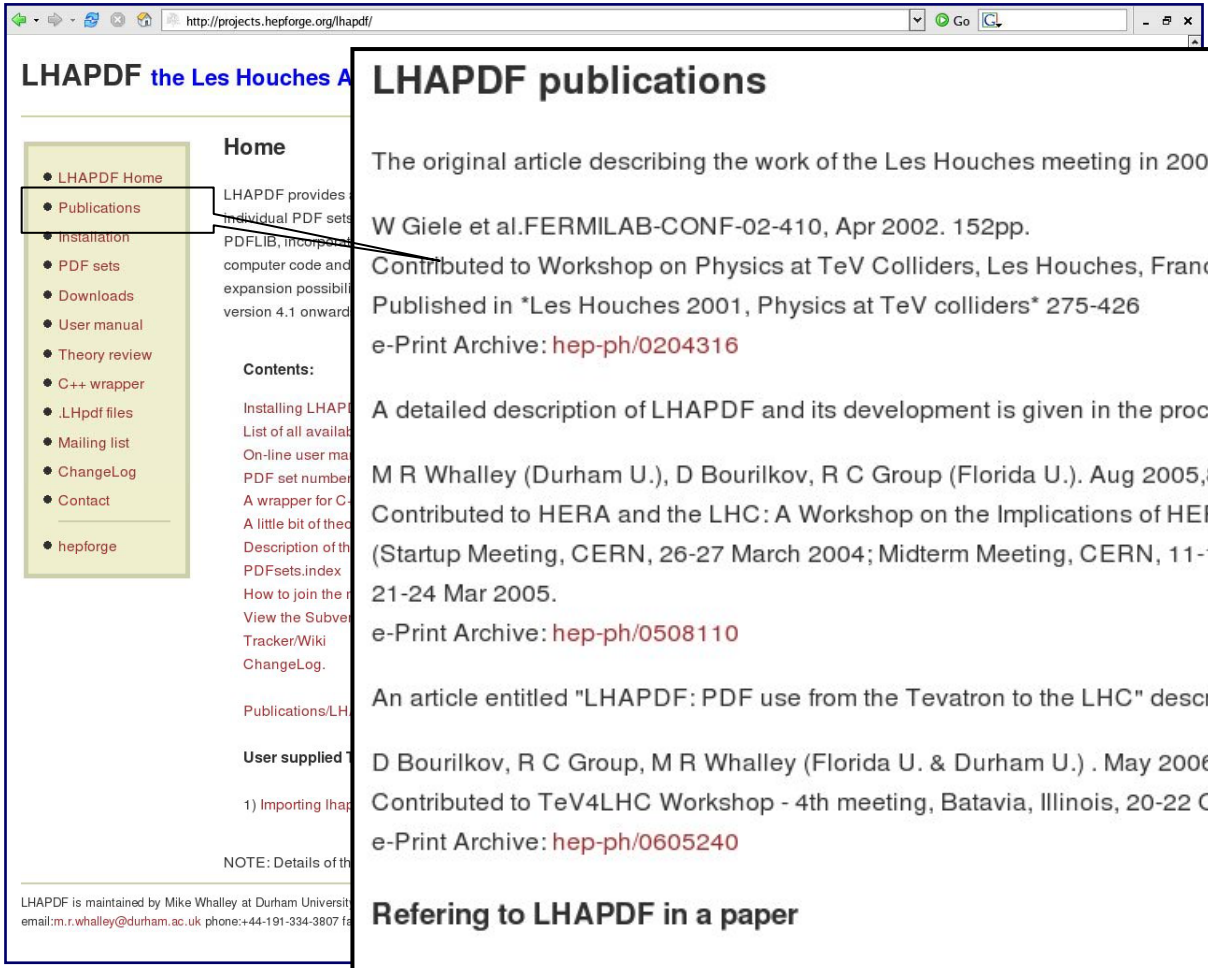
Available PDF sets

Individual files can be downloaded from the right hand two columns

Nucleon PDF Set Summary			
PDF set	Members	.LHpdf File	.LHgrid File
Alekhin02 LO	15	-	a02m_lo.LHgrid
Alekhin02 NLO	15	-	a02m_nlo.LHgrid
Alekhin02 NNLO	15	-	a02m_nnlo.LHgrid
Alekhin00	100	Alekhin_100.LHpdf	-
Alekhin00	1000	Alekhin_1000.LHpdf	-
Botje99	100	Botje_100.LHpdf	-
Botje99	1000	Botje_1000.LHpdf	-
CTEQ65c (cteq65c)	7		cteq65c.LHgrid
CTEQ65 (cteq65)	40		cteq65.LHgrid
CTEQ6AB (cteq6AB - variable alphas)	20		cteq6AB.LHgrid
CTEQ61 (cteq61m + errors)	41	cteq61.LHpdf	cteq61.LHgrid
CTEQ6	41	cteq6.LHpdf	cteq6mE.LHgrid
CTEQ6 Standard MSbar	1	cteq6m.LHpdf	
CTEQ6 LO fit, with NLOrder alpha_S	1	cteq6l.LHpdf	-
CTEQ6 LO fit, with LOrder alpha_S	1	cteq6ll.LHpdf	-
CTEQ5m Standard MSbar	1	-	cteq5m.LHgrid
CTEQ5m1 updated CTEQ5m	1	-	cteq5m1.LHgrid

Can download the individual PDF files from here.
(latest version only)

Short tour of the LHAPDF web site
referencing LHAPDF



LHAPDF publications

The original article describing the work of the Les Houches meeting in 2001 when LHAPDF was first conceived is:

W Giele et al.FERMILAB-CONF-02-410, Apr 2002. 152pp.
Contributed to Workshop on Physics at TeV Colliders, Les Houches, France, 21 May - 1 Jun 2001.
Published in *Les Houches 2001, Physics at TeV colliders* 275-426
e-Print Archive: hep-ph/0204316

A detailed description of LHAPDF and its development is given in the proceedings of the HERA-LHC workshop:

M R Whalley (Durham U.), D Bourilkov, R C Group (Florida U.). Aug 2005,8pp
Contributed to HERA and the LHC: A Workshop on the Implications of HERA and LHC Physics
(Startup Meeting, CERN, 26-27 March 2004; Midterm Meeting, CERN, 11-13 October 2004), Hamburg, Germany,
21-24 Mar 2005.
e-Print Archive: hep-ph/0508110

An article entitled "LHAPDF: PDF use from the Tevatron to the LHC" describes using LHAPDF:

D Bourilkov, R C Group, M R Whalley (Florida U. & Durham U.) . May 2006. 8pp.
Contributed to TeV4LHC Workshop - 4th meeting, Batavia, Illinois, 20-22 Oct 2005.
e-Print Archive: hep-ph/0605240

Refering to LHAPDF in a paper

If you need to refer to LHAPDF we suggest you use either/both the web address (**http://hepforge.cedar.ac.uk/lhapdf/**) or the HERA-LHC article hep-ph/0508110 which gives the most complete description.

Future Plans

- Next release 5.4.0 will be out very soon
- Continue to support the maintenance and developmen of LHAPDF
- Respond to users questions and suggestions for new features and improvements, incorporating them if feasible.
- Add new sets as and when they are made available

Credits

Walter Giele (Fermilab)– original idea and code

Dimitri Bourilkov (Florida) – LHaglue wrapper

Andy Buckley (Durham) – Installation/hepforge/C++ code
David Grellsheid (Durham) – C++ code improvements

Stefan Gieseke(Karlsruhe) original C++ wrapper code

+ MRW

+ those authors who have supplied their PDF sets

+ many others …

Finally….

to check output numbers

Durham University **On-line Plotting and Calculation.**

Parton Distributions:

Using the form below you can calculate, in real time, values of xf(x,Q^2)
from the groups CTEQ, MRS, GRV, Alekhin, ZEUS and H1. You can
compare plots of xf v x at any Q^2 for up to 4 different parton types or P

xmin = 0.095 xmax = 0.95 xinc = 0.05 Q**2 = 1000

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	all	CTEQ6.5M	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, xf(x), from CTEQ6.5M

X	Q**2	up	down	upbar	downbar	strange	charm	bottom	gluon
CTEQ6.5M 									
9.500E-02	1.000E+03	6.221E-01	3.865E-01	9.312E-02	1.259E-01	7.130E-02	3.306E-02	1.582E-02	1.029E+00
1.450E-01	1.000E+03	5.896E-01	3.236E-01	4.989E-02	7.412E-02	3.905E-02	1.610E-02	7.515E-03	5.494E-01
1.950E-01	1.000E+03	5.369E-01	2.614E-01	2.962E-02	4.179E-02	2.230E-02	8.903E-03	4.048E-03	3.239E-01
2.450E-01	1.000E+03	4.702E-01	2.042E-01	1.892E-02	2.182E-02	1.285E-02	5.331E-03	2.347E-03	2.024E-01
2.950E-01	1.000E+03	3.965E-01	1.546E-01	1.234E-02	1.046E-02	7.384E-03	3.367E-03	1.428E-03	1.313E-01
3.450E-01	1.000E+03	3.221E-01	1.136E-01	7.802E-03	4.688E-03	4.223E-03	2.200E-03	8.957E-04	8.741E-02
3.950E-01	1.000E+03	2.521E-01	8.079E-02	4.585E-03	2.137E-03	2.412E-03	1.463E-03	5.707E-04	5.921E-02
4.450E-01	1.000E+03	1.900E-01	5.531E-02	2.477E-03	1.111E-03	1.384E-03	9.751E-04	3.644E-04	4.050E-02
4.950E-01	1.000E+03	1.376E-01	3.616E-02	1.259E-03	6.606E-04	8.002E-04	6.405E-04	2.298E-04	2.777E-02
5.450E-01	1.000E+03	9.545E-02	2.240E-02	6.251E-04	4.093E-04	4.621E-04	4.071E-04	1.408E-04	1.889E-02
5.950E-01	1.000E+03	6.298E-02	1.301E-02	3.098E-04	2.449E-04	2.610E-04	2.447E-04	8.212E-05	1.258E-02
6.450E-01	1.000E+03	3.917E-02	7.000E-03	1.510E-04	1.351E-04	1.391E-04	1.351E-04	4.447E-05	8.054E-03
6.950E-01	1.000E+03	2.266E-02	3.423E-03	6.844E-05	6.543E-05	6.618E-05	6.543E-05	2.156E-05	4.823E-03
7.450E-01	1.000E+03	1.193E-02	1.478E-03	2.618E-05	2.578E-05	2.588E-05	2.578E-05	8.914E-06	2.595E-03
7.950E-01	1.000E+03	5.522E-03	5.373E-04	7.105E-06	7.071E-06	7.080E-06	7.071E-06	2.911E-06	1.174E-03
8.450E-01	1.000E+03	2.104E-03	1.505E-04	9.140E-07	9.127E-07	9.130E-07	9.127E-07	6.831E-07	3.968E-04
8.950E-01	1.000E+03	5.721E-04	2.692E-05	1.205E-07	1.205E-07	1.205E-07	1.205E-07	1.202E-07	7.800E-05
9.450E-01	1.000E+03	7.363E-05	1					08	4.728E-06
9.950E-01	1.000E+03	1.260E-06	5					00	1.894E-07

HEPDATA

The Durham HEP Databases

rom the **Durham Database Group**, at Durham University(UK).

Comments/Suggestions etc. to *M.R.Whalley@durham.ac.uk*

Registration (optional)
Feedback
Help/User Guide

HEP
DataBase

ss sections, structure and
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iews listed below.

, Journal of Physics G -
ons of the reviews can be

Durham University **Parton Distribution Function Server**

Access the latest parton distribution codes plus on-line calculation and graphical display of the distributions, for the CTEQ, GRV, MRST and Alekhin PDF sets. Includes also polarized parton distributions , and also the code for the ZEUS 2002 , ZEUS 2005 jet fit and H1 PDF 2000 pdfs.

See also LHAPDF-5.0.0 The Les Houches Accord PDFs (now hosted by CEDAR-hepforge)

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