Updates of drawing tools and inclusion of PDF uncertainties in the χ^2 evaluation

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Outline

- **LHAPDFErrors** mode
  $\rightarrow$ inclusion of PDF uncertainties in the χ^2 evaluation
  - Usage
  - PDF errors approaches: Symmetric/Asymmetric hessian, Monte Carlo replica
  - Examples
- Drawing tools: **DrawResults** and **DrawPdfs**
  - Experimental, model and parametrization uncertainties
  - PDF sets comparison extended up to 6 sets
  - Data plots including pulls
  - Inclusion of many drawing options

LHAPDFErrors mode - Usage

- Internally use LHAPDF interface to evaluate PDF uncertainties
- Include PDF uncertainties into χ^2 evaluation

Add to the main steering card *steering.txt* the following options

```
*
* (Optional) LHAPDF sttering card
*
&lhapdf
  LHAPDFErrors = true
  LHAPDFSET  = 'cteq66.LHgrid' ! LHAPDF grid file
  ILHAPDFSET = 0               ! Set number withing PdfSet
  SCALE68 = false
&End
```

- LHAPDFErrors = true
  Activate LHAPDFErrors mode
- LHAPDFSET = 'cteq66.LHgrid'
  Select PDF set
- SCALE68 = true/false
  Scale PDF uncertainties from 90% to 68% C.L. applying 1.64 factor

LHAPDFErrors - Errors approaches

- The code distinguishes between 3 possible errors approaches
  - Monte Carlo replica
  - Symmetric hessian
  - Asymmetric hessian
- Info message is printed reporting the error approach

```
NNPDF23_nlo_as_0118.LHgrid has Monte Carlo errors approach
...
abm11_5n_nnlo.LHgrid has symmetric hessian errors approach
...
CT10nnlo.LHgrid has asymmetric hessian errors approach
...
```

→ Current limitation: dataset must be provided with uncertainties as nuisance parameters
(Tool for conversion from covariance matrix to nuisance parameters representation is included)

LHAPDFErrors - Example on ATLAS WZ 2010 data

Plain χ^2 (χ^2 Including PDF uncertainties)

	NNPDF 2.3	ABM11	CT10nnlo
Z partial χ^2/N_{DF}	8.1(5.8)/8	4.9(4.9)/8	4.3(3.3)/15
W^- partial χ^2/N_{DF}	9.4(9.3)/11	11.5(9.6)/11	10.3(9.5)/11
W^+ partial χ^2/N_{DF}	17.3(16.9)/11	15.6(14.8)/11	15.7(15.0)/11
Correlated χ^2	4.0(4.5)	5.4(5.0)	4.3(3.9)
Total χ^2	38.9(36.5)/30	37.4(34.4)/30	34.6(31.7)/30

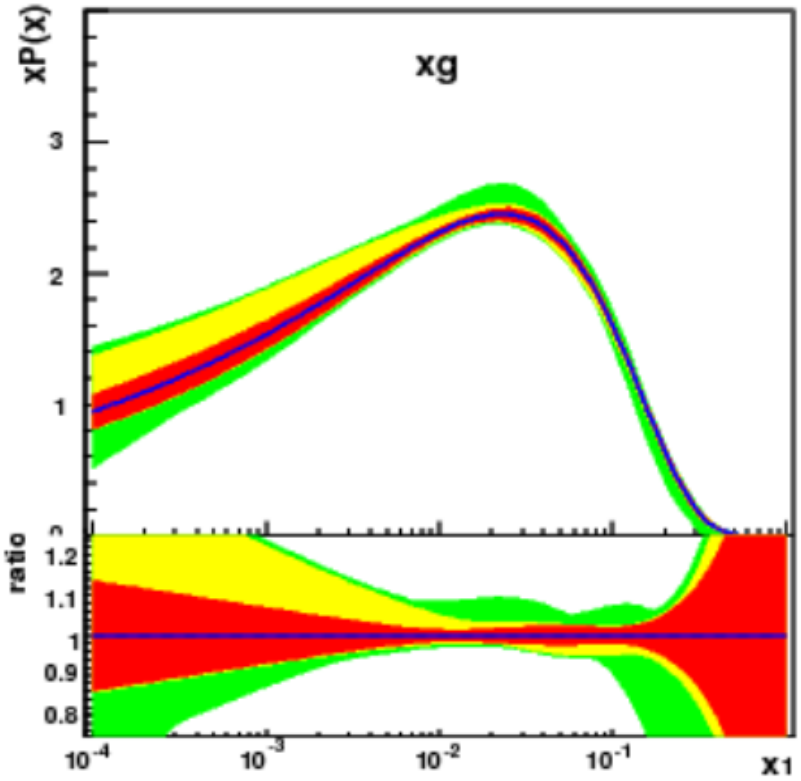
Drawing tools - Experimental, model and parametrization uncertainties

Usage:

```
DrawResults --exp <exp_dir> --model <model_dir> --param <param_dir> <basedir>
```

Scripts to facilitate directory creation are provided:

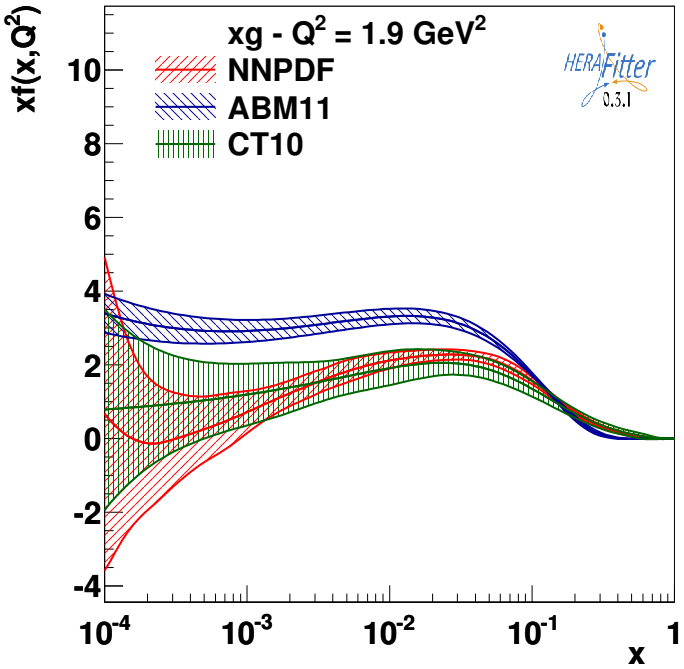
```
tools/DrawResultsPackage/mergeModel.sh
tools/DrawResultsPackage/mergeParam.sh
```

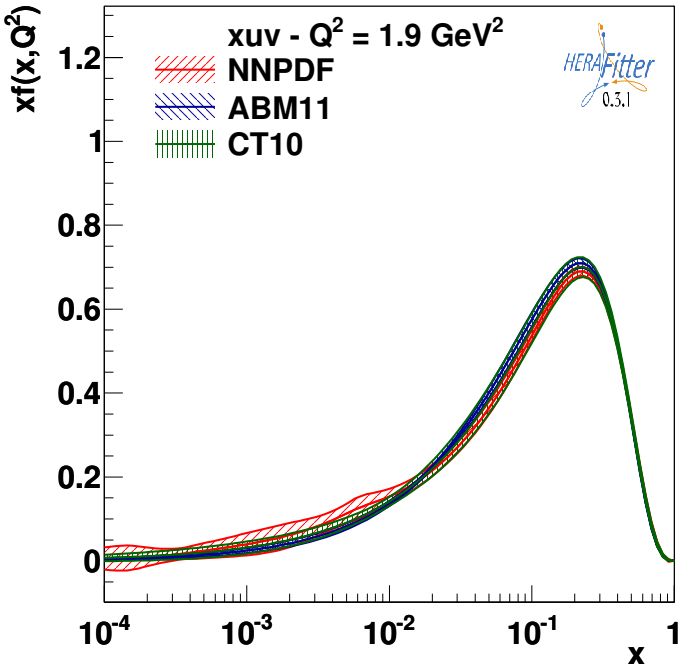


Drawing tools - Multiple PDF sets

Usage:

```
DrawPdfs [options] dir1[:label1] [dir2:[label2]] [...]
```





Drawing tools - Multiple PDF sets

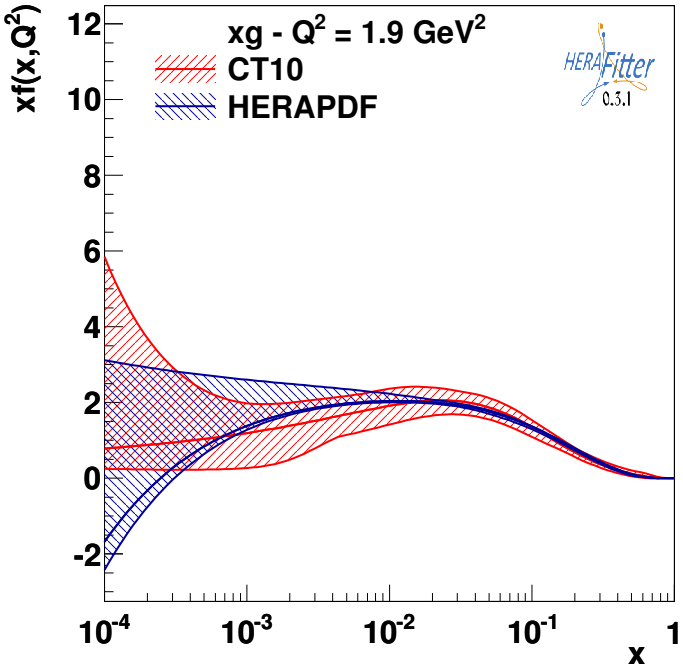
Options:

```
--bands
  Draw PDF uncertainty band
--asymbands
  PDF bands are not symmetrised
--outdir <output directory>
  Specify output directory
--splitplots
  Produce also additional eps files for each plot
--filledbands
  Filled uncertainty bands, usefull for sensitivity studies
--ratiorange min:max
  Specify y axis range in PDF ratio plots
--xrange min:max
  Specify x axis range in PDF plots: minimum x is 0.0001, maximum x is 1
--no-logx
  Linear x scale in PDF plots
```

Drawing tools - Multiple PDF sets options

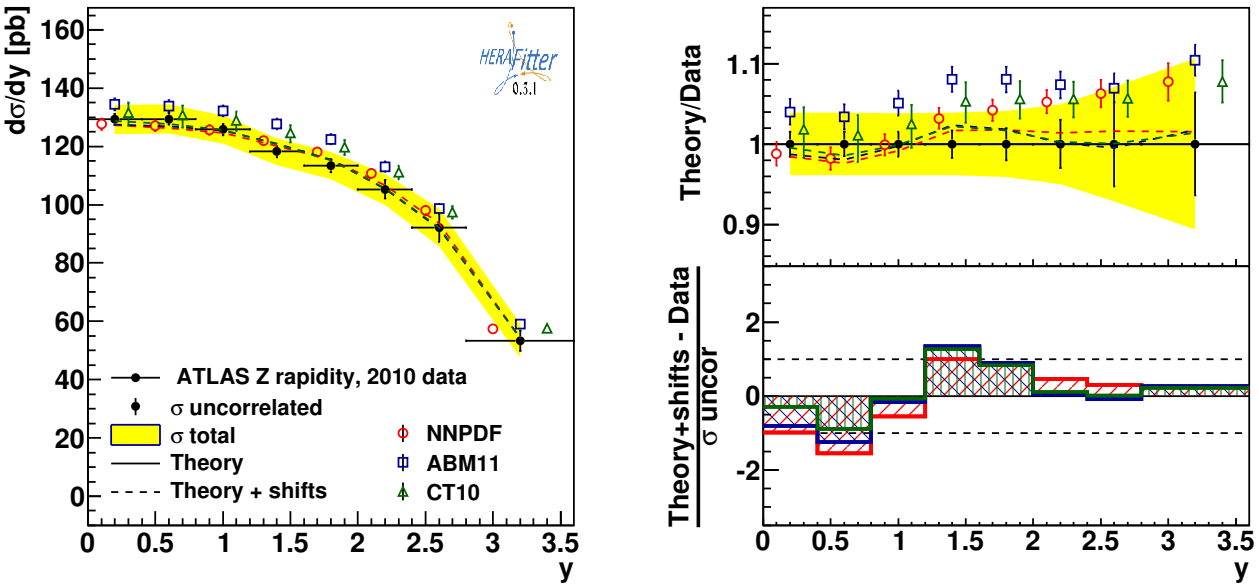
Option

`--asymbands`



Drawing tools - Data pulls plot

```
DrawPdfs [options] dir1[:label1] [dir2:[label2]] [...]
```



Works on datasets including bin edges information

Summary

- Inclusion of PDF uncertainties in the χ^2 evaluation
- Available for all PDF errors approaches:
  Symmetric/Asymmetric hessian, Monte Carlo replica
- Functionality for plotting experimental, model and parametrization uncertainties
- New drawing tools for PDF sets comparison
- New drawing tools for plotting data including pulls information

Available in the forecoming stable release