D-PDFLIB / D-LHAPDF:
Towards a library for diffractive parton distributions

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- Motivation
- Current Status
- Prospects

Motivation: The current situation

- **Diffractive pdf's** used in **Monte Carlos** and **NLO calculations** of diffractive cross sections at HERA, TEVATRON and LHC

- More and more diffractive pdf parameterizations of HERA data available, but **only in terms of standalone code** e.g. downloadable from the www or within MC generators

- pdf's available **only on a fixed (beta,Q2) grid** which may not mach LHC kinematics

- **Implementation** of new pdf into each MC done **by hand and often privately**

- Incomplete list of available diffractive pdf's:

  - H1 fits 2,3
  - H1 2002 (prel.) LO+NLO fits
  - ZEUS (prel.) fit
  - ACTW fits (Alvero, Collins, Terron, Whitmore)
  - Semiclassical model (Buchmueller, Gehrmann, Hebecker)
  - Hautmann, Soper
  - Martin, Ryskin, Watt

Motivation: The Goal

- Collect all diffractive pdf's in common library, analogously to the PDFLIB (or LHAPDF) philosophy
- Common interface for all MC's and NLO programs
- New pdf's to be added only in one place, then usable everywhere immeadiately (just need to relink with latest library)
- HERA-LHC Workshop aim: summary of HERA information to be used for LHC (and Tevatron)
- Additional features possible, such as QCD evolution, structure function calculation, error information, ...

$\Rightarrow$ Provide library of diffractive pdf's!

Current Status

- `DPDFLIB 0.1`: Fortran library, can be linked to Monte Carlos, NLO programs
- Interfaces to some MC generators (e.g. RAPGAP) and NLO programs (e.g. NLOLIB, DISENT, D-HVQDIS, Frixione/Ridolfi) existing

- Initialization call:

```
      subroutine dpdf_init(iset,ifit,ivar)
c     ------------------------------------
c iset: pdf identifier
c ifit: fit within pdf set
c ivar: variation of fit
```

e.g. to initialize 'H1 fit 2 LO':

```
      call dpdf_init(1,5,0)
```

Currently implemented pdf's

```
c set      fit      var   Comment
c ========================================================================
c Set 1: H1 1994 fits
c ------------------------------------------------------------------------
c  1       1        --    H1 fit 1 nlo
c  1       2        --    H1 fit 2 nlo
c  1       3        --    H1 fit 3 nlo
c  1       4        --    H1 fit 1 lo
c  1       5        --    H1 fit 2 lo
c  1       6        --    H1 fit 3 lo
c ------------------------------------------------------------------------
c  Set 2: H1 2002 fits
c  2       1        --    H1 2002 NLO fit
c  2       2        --    H1 2002 LO  fit
c ------------------------------------------------------------------------
c  Set 3: ACTW NLO fits
c  3       1         1    ACTW A
c  3       1         2    ACTW A+
c  3       1         3    ACTW A-
[...]
c  3       5         1    ACTW SG
c  3       5         2    ACTW SG+
c  3       5         3    ACTW SG-
c ------------------------------------------------------------------------
c Set 4: Semi-classical model (Buchmueller, Gehrmann, Hebecker)
c  4       ?         ?    Semi-cl. model
c ------------------------------------------------------------------------
c Set 5: Hautmann-Soper
c  5       ?         ?    Hautmann-Soper
c ------------------------------------------------------------------------
```

- Pomeron/Meson pdf call:

```
      subroutine dpdf_pdf(beta,q2,iopt,xpq)
c     ------------------------------------
c beta:       input  beta value
c q2:         input  q2 value
c iopt:       input  1:Pomeron 2:Meson pdf
c xpq(-6:6): output array of pdf values at (beta,q2)
```

- Pomeron/Meson flux call:

```
      subroutine dpdf_flux(q2,beta,xpom,t2,iopt,int,flux)
c     ---------------------------------------------------
c beta:       input  beta value
c q2:         input  q2 value
c xpom:       input  xpom value
c t2:         input  |t| value
c iopt:       input  1:Pomeron 2:Meson flux
c int:        input  1:yes 0:no t-integral of flux (if 1 then t2 is |t|-max)
c flux:       output flux value
```

- Combined flux*pdf call (also for non-Regge factorizing pdf's):

```
      subroutine dpdf_ppdf(xpom,t2,beta,q2,iopt,int,xpq)
c     --------------------------------------------------
```

Interface to QCDNUM

- **QCDNUM 16.12 (M. Botje)**:
  NLO QCD evolution package used in global fits to inclusive DIS data

- Perform **NLO evolution using grid pdf** taken at arbitrary Q^2 as starting distribution

- **Reproduce orig. evolution** (e.g. to provide structure function coefficients)

  or ..

- **Modified evolution** (different α_s, m_c, HQ treatment)

- Can **evolve to higher Q^2 (for LHC) and/or lower β**

- Calculate **NLO (or LO) structure functions** F_2, $F_{2,c}$, F_L for any pdf

Interface to QCDNUM (cont.)

- Default evolution of current pdf (as original):

```
      subroutine dpdf_evolve_std(imode,if2calc)
c     ----------------------------------------
c     imode =1: normal mode:  do full calculation
c           =2: save mode:    do calc and dump to disk
c           =3: restore mode: only read from disk
c     if2calc =0: calculate only pdfs
c             =1: calculate structure functions as well
```

  Disk read/write of weight tables for speed up implemented

- Get structure functions at (beta,Q2)

```
      subroutine dpdf_stfun_qcdnum(beta,q2,f2val,flval,f2cval,flcval)
c     ---------------------------------------------------------------
c     beta: beta value (in)
c     q2:   q2 value (in)
c     f2val: F2(D) (out)
c     flval: FL(D) (out)
c     f2cval: F2C(D) (out)
c     flcval: FLC(D) (out)
```

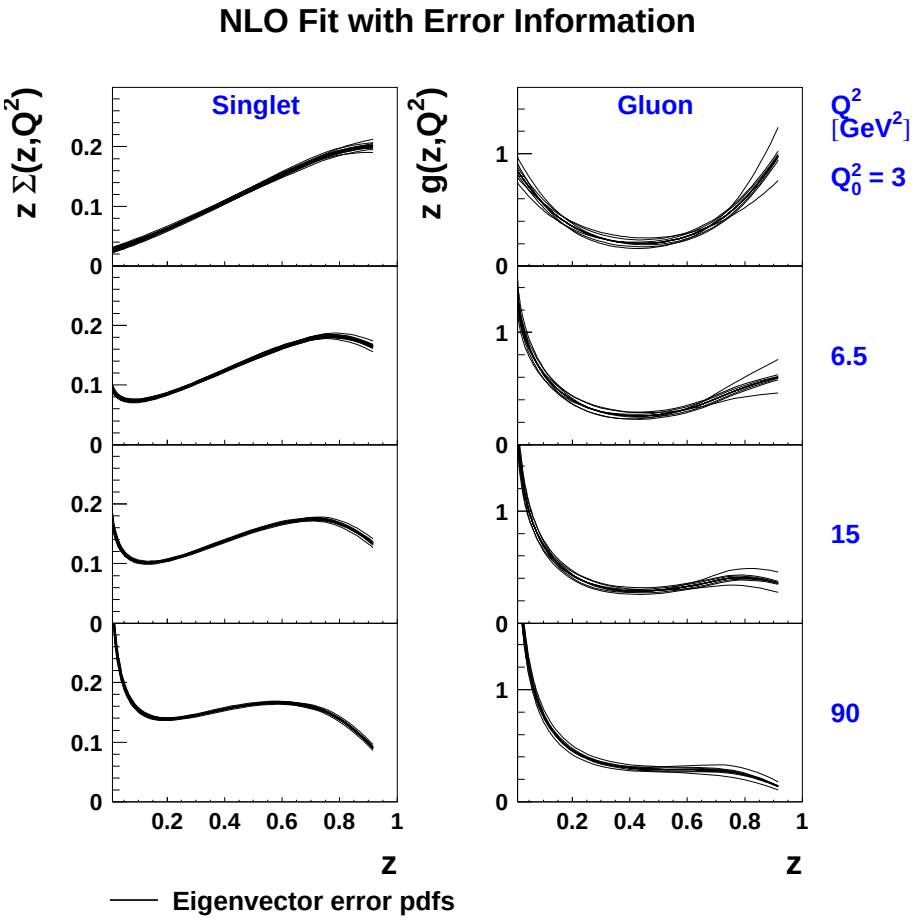
Interface to QCDNUM (cont.)

- Modified QCD evolution of current pdf (as original):

```
      subroutine dpdf_evlqcdnum(iopt,q02,iord,alphas,nfl,nfla,
     &                          xmin,q2max,if2calc,imode)
      ------------------------------------------------------
c iopt: 1: pomeron 2: meson
c q02:  Q0**2 starting scale for evolution
c iord: 1: LO 2: NLO
c alphas: alpha-s(Mz)
c nfl:    Number of flavours for evolution
c nfla:   Number of flavours for alpha-s
c xmin:   x-min of grid
c q2max:  Q2-max of grid
c if2calc: 0:no 1:yes calculate structure functions
c imode 1: normal mode
c       2: calc + dump
c       3: read from disk only
```

PDF's with Error Information

- Modern techniques provide pdf's with error information, e.g. in the form of 'eigenvector displaced' pdf's
- Useful e.g. for propagation of pdf uncertainties on final state cross sections (for example calculations of diffractive processes at the LHC)
- Can be implemented in D-PDFLIB similarly to LHAPDF
- Error pdf's will be available e.g. for final H1 NLO fit



Prospects

Next steps:

- Implement and check **remaining sets of diffractive partons**
- Check **default QCDNUM evolution** for all pdf sets
- Provide **more QCD evolution steering** options (grid etc.)
- Implement framework for **error pdf's**

Two philosophies possible:

- Provide **independent library** for diffraction

- Provide **add-on for LHAPDF**:
  – IP/IR pdfs+errors via LHAPDF,
  – fluxes and all the rest which diffraction specific as add-on library
  However: does only work for Regge-factorizing pdf's ...

$\Rightarrow$ Your input/suggestions are very welcome!