



News from QCDNUM

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xFitter users meeting

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Recent QCDNUM release history

- QCDNUM-17-01-10 released 27 Oct 2015
 - Can build library with `autotools`
 - Small bug fix in `PDFEXT` routine
- QCDNUM-17-01-11 released 13 Nov 2015
 - Can specify the number of perturbative terms in `EVDGLAP` (2/3/4 at LO/NLO/NNLO in QCD-QED)
- QCDNUM-17-01-12 released 26 Feb 2016
 - Bug fix in NLO time-like singlet evolution
 - Put NLO matching conditions in time-like evolution
 - Also update release 17-00-06 → 17-00-07

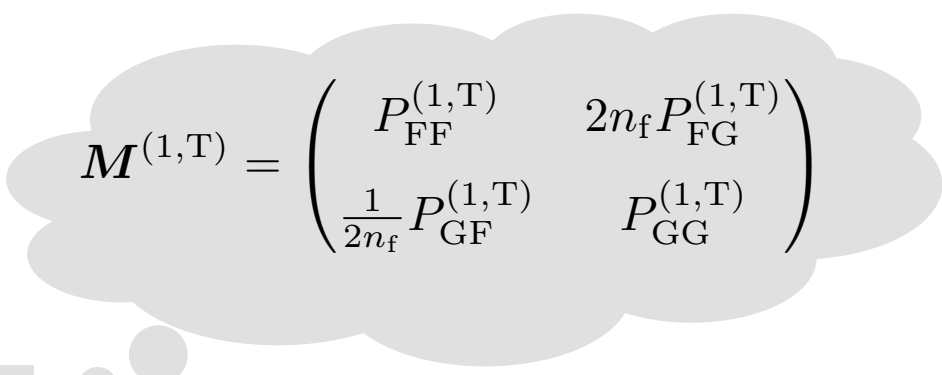
Splitting function matrices for singlet evolution

- The matrices for space-like evolution were OK

$$M^{(0,S)} = \begin{pmatrix} P_{FF}^{(0)} & P_{GF}^{(0)} \\ P_{FG}^{(0)} & P_{GG}^{(0)} \end{pmatrix} \quad M^{(1,S)} = \begin{pmatrix} P_{FF}^{(1,S)} & P_{GF}^{(1,S)} \\ P_{FG}^{(1,S)} & P_{GG}^{(1,S)} \end{pmatrix}$$

- Those for the time-like evolution should be transposed

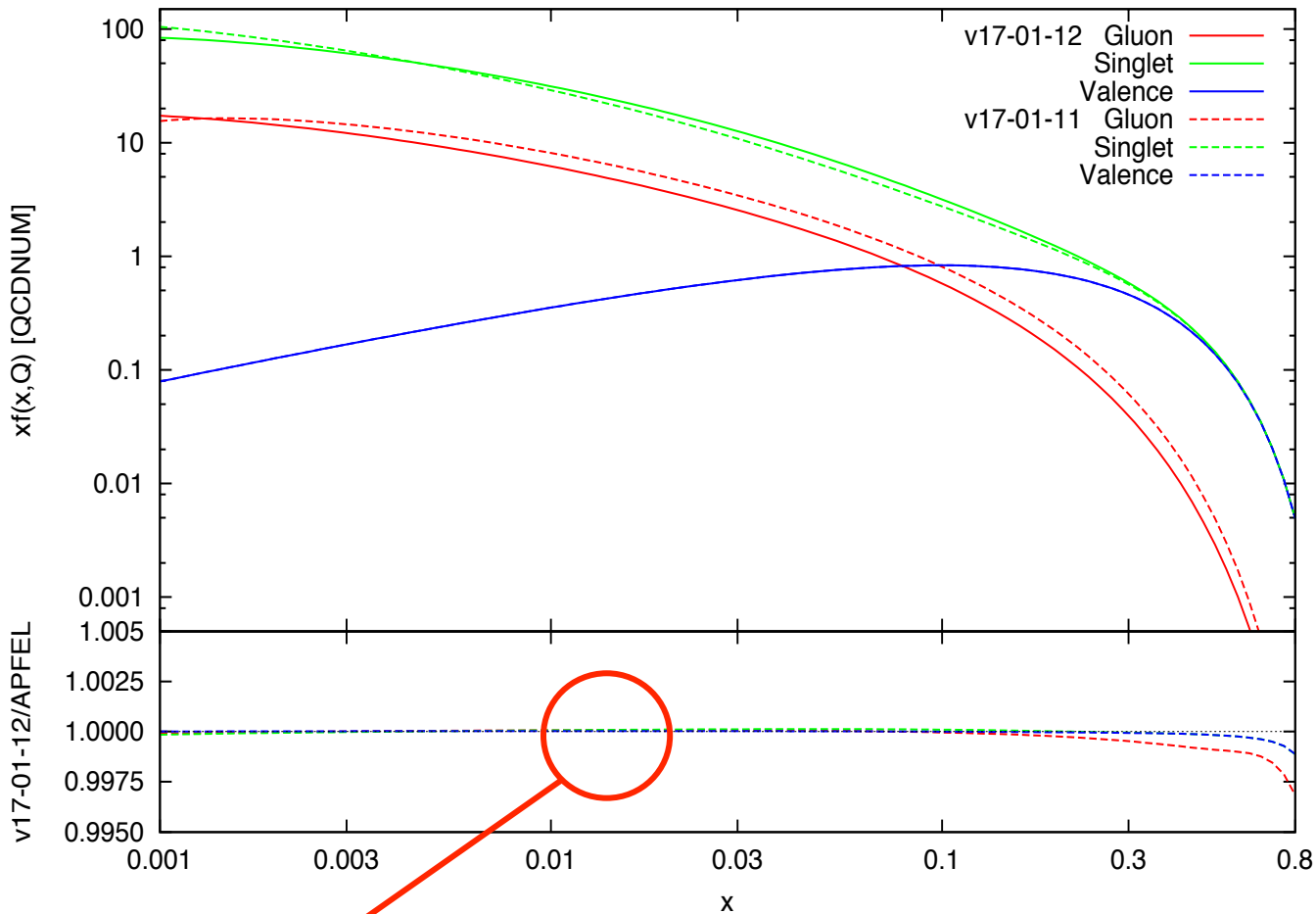
$$M^{(0,T)} = \begin{pmatrix} P_{FF}^{(0)} & 2n_f P_{FG}^{(0)} \\ \frac{1}{2n_f} P_{GF}^{(0)} & P_{GG}^{(0)} \end{pmatrix}$$


$$M^{(1,T)} = \begin{pmatrix} P_{FF}^{(1,T)} & 2n_f P_{FG}^{(1,T)} \\ \frac{1}{2n_f} P_{GF}^{(1,T)} & P_{GG}^{(1,T)} \end{pmatrix}$$

**QCDNUM did not
transpose this matrix**

V. Bertone et al, JHEP 1503 ,046 (2015)
M. Botje, arXiv:1602.08383 (2016)

QCDNUM vs. APFEL, time-like evolution at NLO in the VFNS, Q = 100 GeV



Comparison
of NLO
time-like
evolution

Excellent agreement between QCDNUM and APFEL after the bug fix

My thanks to Valerio Bertone for help in sorting this out

Next release QCDNUM-17-01-13 (1)

- QCDNUM can have pdf sets with different evolution parameters in memory
- In version 13 you can only access sets evolved with the current parameters

```
call SETORD(3)
..
pdf = FVALXQ(iset, id, x, q, ichk)
```

Error if *iset*
was not evolved
at NNLO

- Cure is to (temporarily) activate the evolution parameters of *iset*
- This was done automatically before 17-01-13 but should now be done by hand

```
call PUSHCP           !store current parameters
call USEPAR(iset)     !activate parameters of iset
pdf = FVALXQ(iset,...) !this will now work
call PULLCP           !restore current parameters
```

- Looks clumsy but protects against using incompatible pdfs in a calculation
- It also much simplifies the QCDNUM internal error checking machinery

Next release QCDNUM-17-01-13 (2)

- Much faster access to the pdfs in memory, because
 - Improved polynomial interpolation algorithm
 - Improved addressing of pdf tables
 - Improved error checking mechanism
- New speed-up goody: switch off error checking in body of loop

```
pdf(1) = FVALXQ( iset, id, x(1), q(1), 1 )  
do i = 2,n  
  pdf(i) = FVALXQ( iset, id, x(i), q(i), -1 )  
enddo
```

Check arguments

Do not check arguments

- NB: the QCDNUM table boundary check is never switched off

Performance QCDNUM-17-01-13

PDF accessed	Old Name	New Name	CPU (arb units)	Speed gain wrt 01-12
One basis pdf	FSNSIJ	BVALIJ	10	6
One flavour pdf	FVALIJ	FVALIJ	16	8
Sum of flavour pdfs	FSUMIJ	FSUMIJ	33	14
All flavour pdfs	FPDFIJ	ALLFIJ	31	6
One basis pdf	FSNSXQ	BVALXQ	58	2
One flavour pdf	FVALXQ	FVALXQ	112	4
Sum of flavour pdfs	FSUMXQ	FSUMXQ	389	5
All flavour pdfs	FPDFXQ	ALLFXQ	383	2

Naming convention: B = basis pdfs
F = flavour pdfs

Fast interpolation in QCDNUM-17-01-13

- The QCDNUM interpolation algorithm is split in two parts
 - Set-up interpolation meshes and weights for a list of interpolation points
 - Interpolate by computing a weighted sum of data on each mesh
- QCDNUM-17-01-13 will provide a user interface to this mechanism
 - `LSTINI` enter a list of interpolation points to set-up the interpolation
 - `LSTFUN` interpolate a user-defined function for all points on the list
- Tables are faster to process than lists so we have also
 - `TABINI` and `TABFUN`
- Very flexible since you provide the function to be interpolated
- Efficient when several functions are interpolated for one list of points
- Efficient when meshes overlap (reduced number of function evaluations)

All this exists already (toolbox fast convolution engine)
but we will provide a user interface outside the toolbox

QCDNUM joblist beyond 17-01-13

- Cleanup code to have one evolution routine (now there are two)
- Upgrade polarised and time-like evolution to NNLO
- VFNS evolution starting above charm threshold (intrinsic charm)
- C++ interface
- Re-enable cuts
- Toolbox improvements
- ...

You are welcome to add to this list or
make suggestions to prioritise it