Discussion Benchmark cross sections

- Motivations
- Programs, People
- definition of the cross sections
- parameters and uncertainties
- first calculations

Motivation

1. **Produce a compilation of the present theoretical knowledge and provide a set of plots/numbers which can be used for comparisons of future results**
2. **compare directly different theoretical approaches in different enviroments (PhP, DIS, pp).**
3. **see if there are regions of the phase space in which different theoretical approaches differ significantly**
4. **(more ambitious) compare different approaches using a common definition of the uncertainty bands**

Models, Programs, Persons

Persons without "?" already kindly agreed to provide the cross sections

- NLO (massive quarks) programs.
  Basic programs, can provide double differential distributions for quarks, hadrons and (with some effort) leptons
  - FMNR (Frixione et. al.), HERA PhP, M. Corradi
  - HVQDIS (Laenen et. al.), HERA DIS, E. Laenen
  - MNR (Mangano et al.), LHC pp, A. Dainese
- NLO programs matched with Fragmentation Functions.
  Provide distributions for heavy hadrons.
  - FONLL (Cacciari et al.) PhP, pp, M. Cacciari ?
  - GM-VFNS (Kniehl et al.) PhP, pp, B. Kniehl
  - MC@NLO (Frixione et al.) pp only ?, ask Frixione ?
- NLO programs with variable flavour-number PDFs.
  Provide inclusive DIS cross-sections, some process at LHC, various schemes exist...
  - VFNS, CTEQ DIS inclusive, semi-inclusive ?, ask S. Kretzer ?
  - VFNS, MRST DIS inclusive ..., ask MRST ...
  - VFNS, Kniehl DIS inclusive, semi-incl. ?, B. Kniehl
  - some LHC cross section ?

Models, Programs, Persons 2

- **Prediction with less standard ingredients**
  - **CASCADE uPDF, (H. Jung) PhP, DIS, pp, H. Jung**
  - **K_T factorization (N. Zotov) pp, N. Zotov**
  - **Nonlinear g(x) (Eskola, Kolhinen etc.) pp, A. Dainese**
  - **saturation at Low-x (BK equation) DIS inclusive, pp, K. Kutak ?**
- **Consider also J/ψ ?**
  - **CS LO PhP, DIS, pp, ask Krämer, Zotov ?**
  - **CS NLO(Krämer et al.) , ask Krämer ?**
  - **CO LO (Krämer et al.) PhP, DIS, pp, ask Krämer ?**
  - **CS K_T-factorization (Zotov, Baranov) PhP, DIS, pp, N. Zotov (+Baranov ?)**
- **Consider also MC ?**

Which cross sections ?

Not too far from experimental observables

Not too complicate

i.e don't repeat exactly experimental cuts (as in JetWeb)

Basic observables such as $d\sigma/dp_T$ in a given y range

Interesting observables to spot particular regions where models may differ (e.g. correlations)

Quark + hadron cross sections (lepton?)

Cross Sections for LHC

$\sqrt{s} = 14$**TeV, differential cross sections** ($d\sigma/dX$, **where X:)**

- p_T **for** $|y| < 2.5$ **(ATLAS/CMS)**

- p_T **for** $2.5 < |y| < 4.5$ **(LHC-B)**

- $p_T(Q + \bar{Q})$ **for** $|y| < 2.5$, $p_T > 2.5GeV$

- $\Delta\phi(Q - \bar{Q})$ **for** $|y| < 2.5$, $p_T > 2.5GeV$

For c, b; Quarks and Hadrons. Same cuts ?

J/ψ **...**

Cross Sections for HERA (γp)

All for $E_p = 920, E_e = 27.5$ **GeV,** $0.2 < y < 0.8$**,** $Q^2 < 1$**GeV**^{2}

New proposal (differs from circulated e-mail):

- p_T **for** $|\eta| < 2.0$
- η **for** $p_T > 3$**GeV**
- $\Delta\phi(Q - \bar{Q})$ **for** $p_T > 3$**GeV,** $|\eta| < 2$

For c, b; Quarks and Hadrons. Same cuts ?

Muon distributions complicated by the decay model, don't do it!

Cross Sections for HERA (DIS)

All for $E_p = 920, E_e = 27.52$ **GeV**

Many variables (x, Q^2 **and** y, p_t, ϕ **of the HQ)**
Possible choices:
a) plot y**,** p_T **for bins of** x**,** Q^2
b) plot double-differential in x**,** Q^2 **for fixed range in** y**,** p_T

Option b) is probably better:

- σ **vs** $\log(x)$ **for** $Q^2 = 1, 10, 100, 1000, 10000$ **GeV**^{2}
- σ **vs** $\log(x)$ **for** $Q^2 = 1, 10, 100, 1000, 10000$ **GeV**^{2} **and hadrons with** $P_T > 3$**GeV,** $\eta < 2$

Nominal parameters and uncertainties.

Evaluate an uncertainty band or produce curves for various sets of the parameters ?

Both:
different curves for different parameters (gives more info) AND
an uncertainty band by summing in quadrature single variations (better for comparison among different theories)

Proposed parameters and systematics (at least for FO programs)

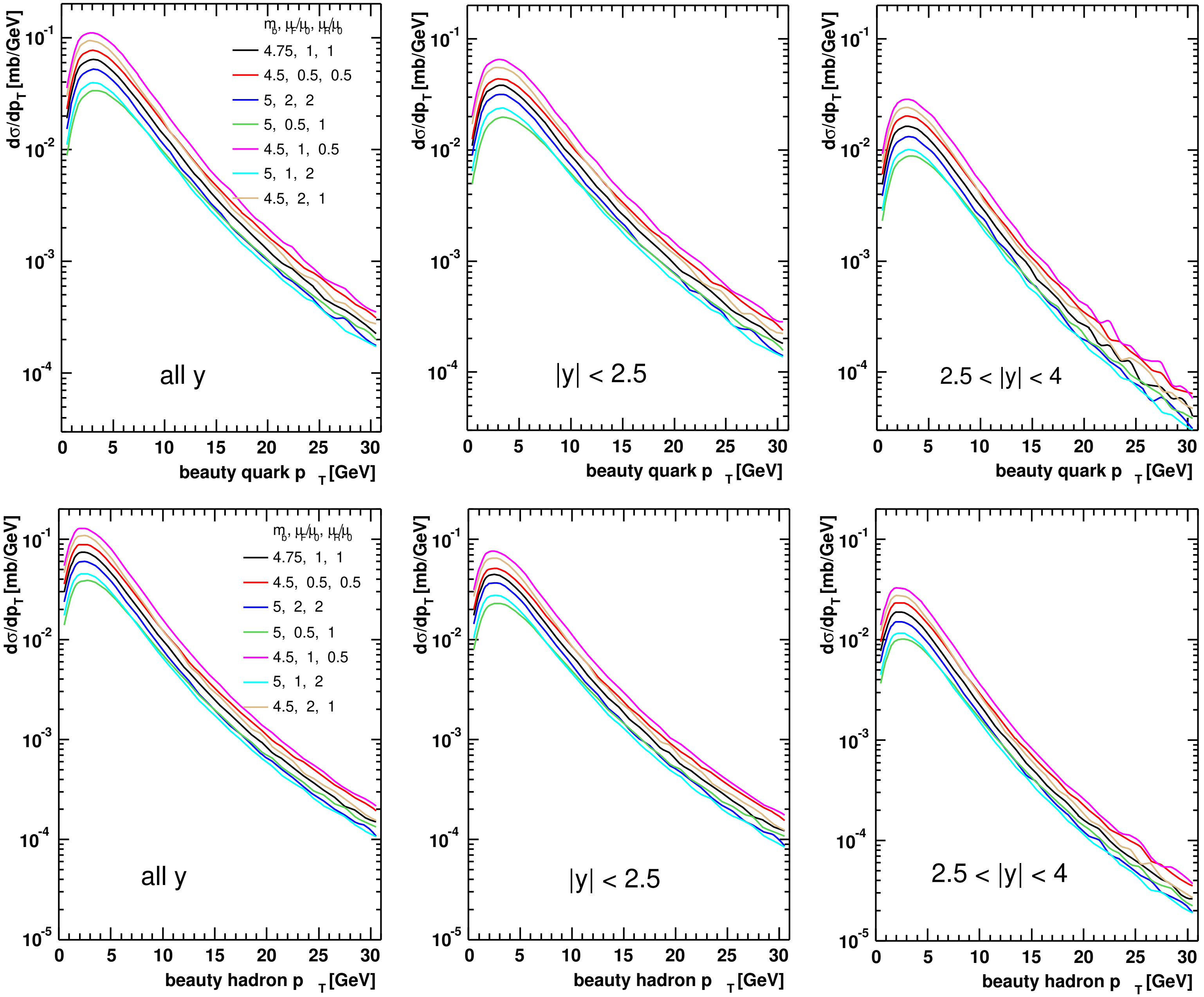
Parameter	nominal	variation
PDF	**CTEQ6.1**	**do "error analysis" or use Alekin/MRST ?**
α_S	$\alpha_S(M_Z) = 0.1182$ $(\Lambda_5^{MS} = 0.226)$	± 0.0020
μ_R μ_F	$\sqrt{m_T^2 + Q^2}$ $\sqrt{m_T^2 + Q^2}$	$\times 2, \times 1/2$ $\times 2, \times 1/2$
m_c m_b	**1.5 GeV** **4.75 GeV**	**1.3 - 1.7 GeV** **4.5 -5.0 GeV**
ϵ_c ϵ_b	**0.04** **0.0035**	**0.02 - 0.06** **0.002 - 0.005 , use Kartelishvili ?**

Better no intrinsic K_T or transverse fragmentation in FO calculations...

Results for LHC with MNR, A. Dainese

BEAUTY QUARK

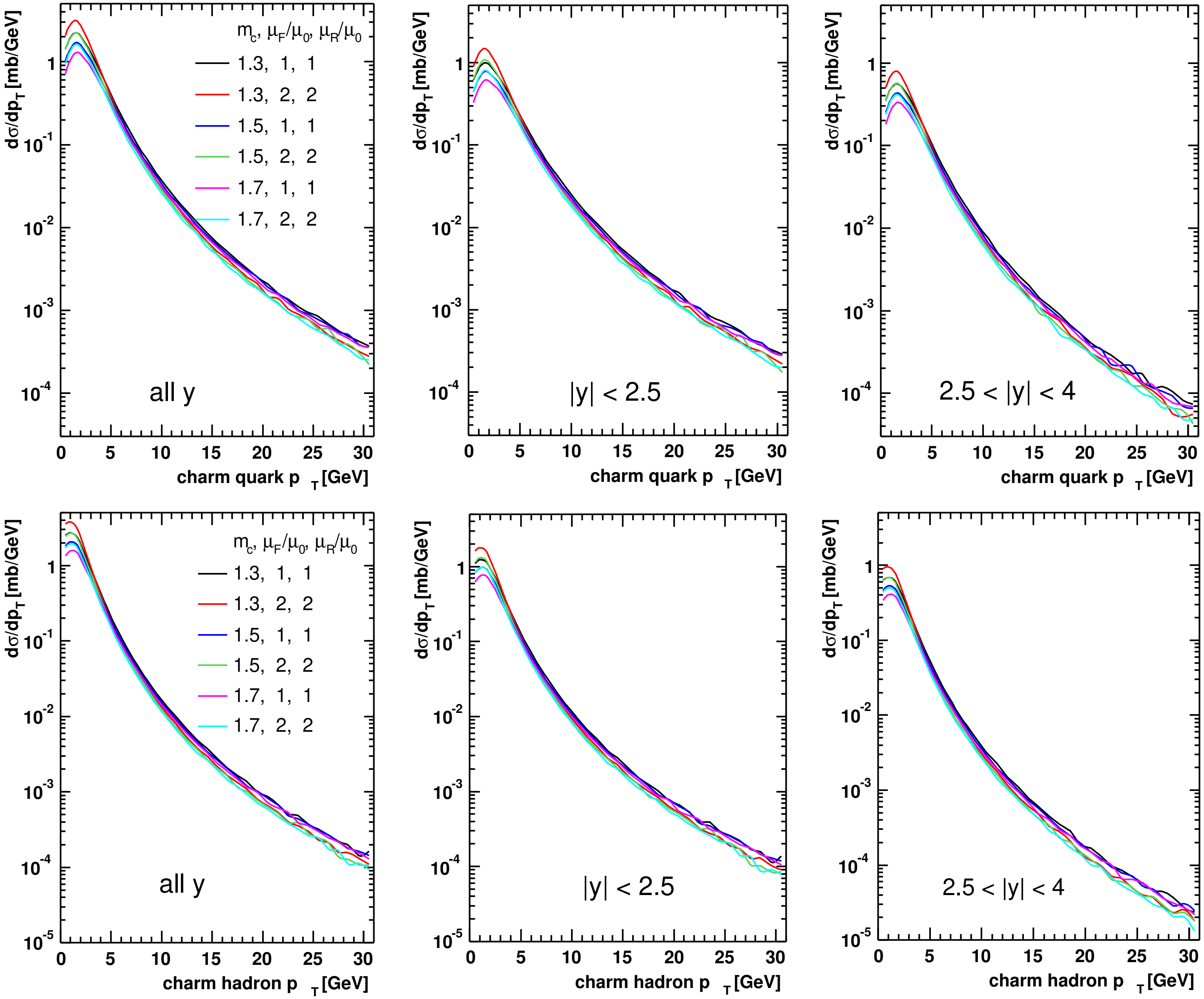
BEAUTY HADRON



Results for LHC with MNR, A. Dainese

CHARM QUARK

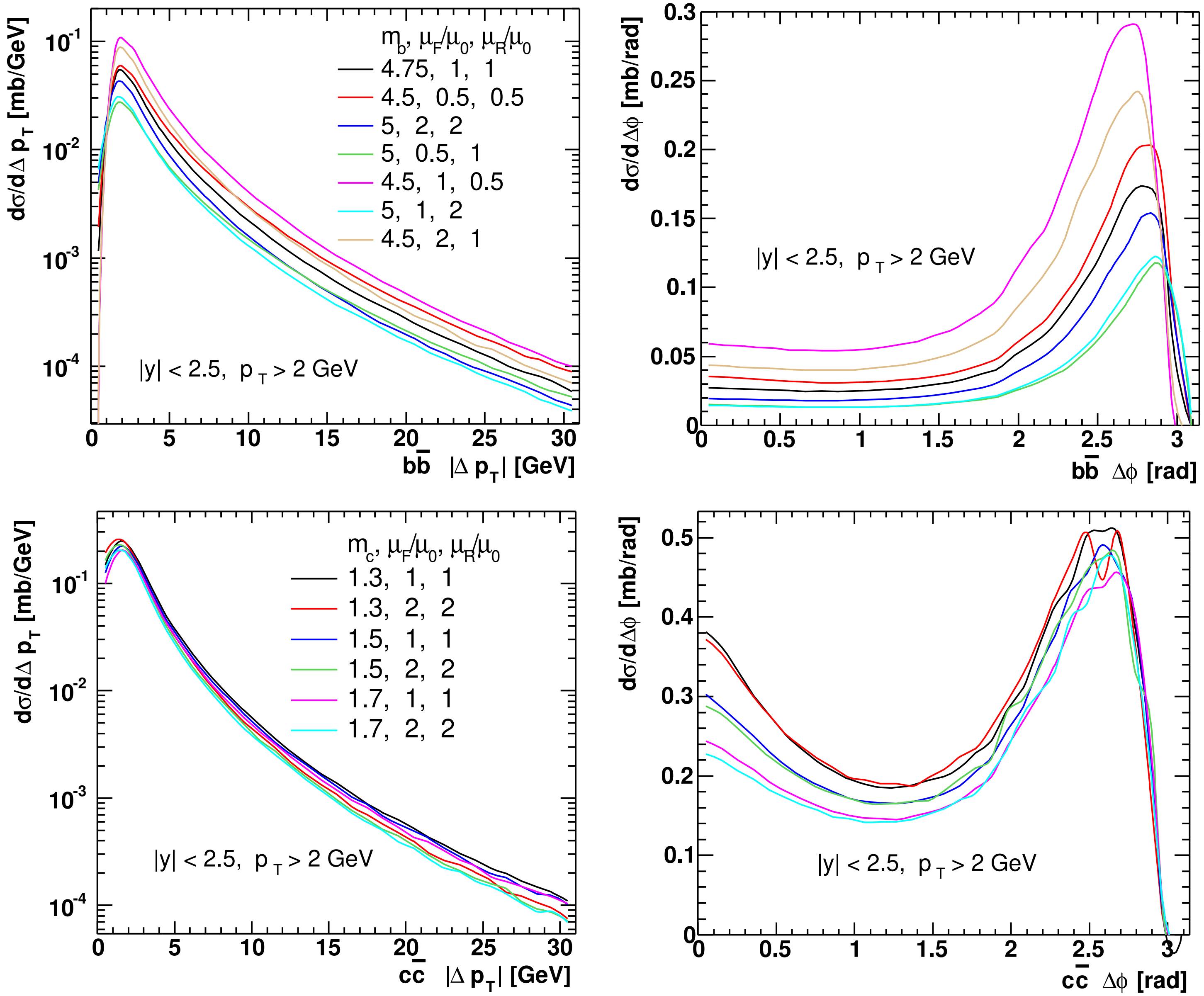
CHARM HADRON



Correlations at LHC, A. Dainese

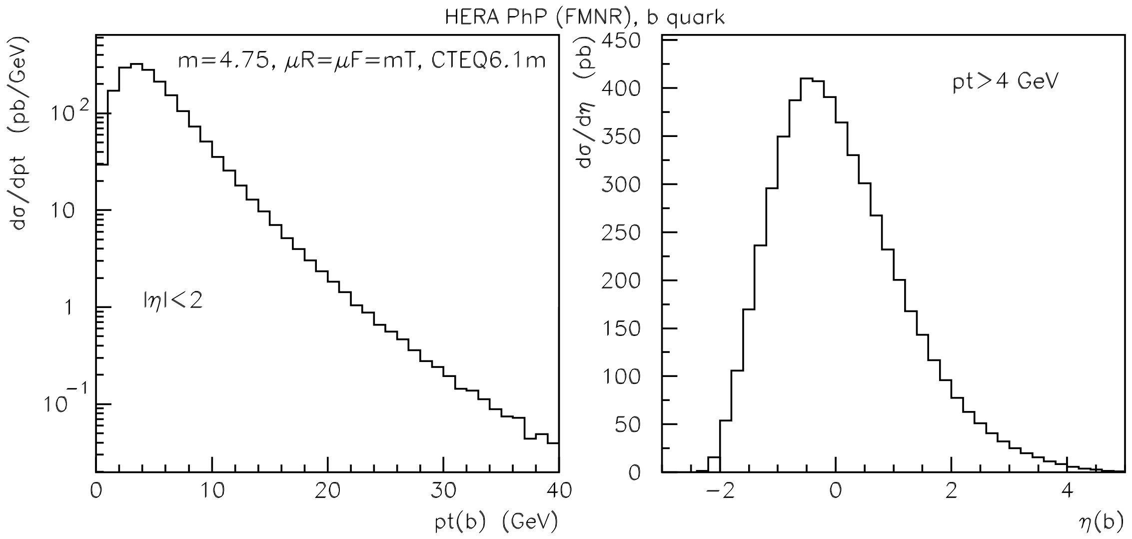
BEAUTY

CHARM

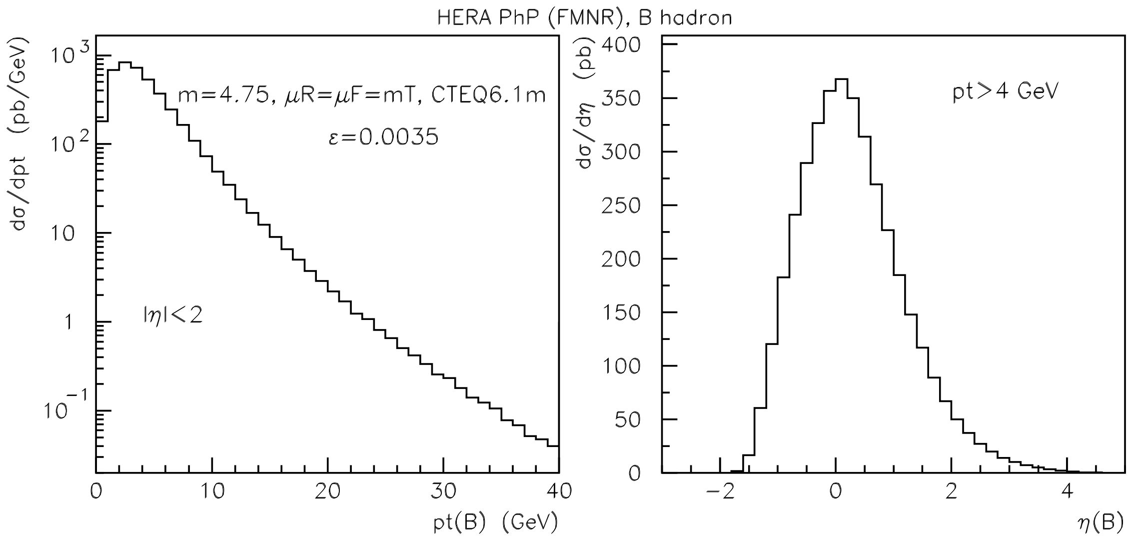


Beauty PhP at HERA with FMNR, M.C.

Beauty quarks

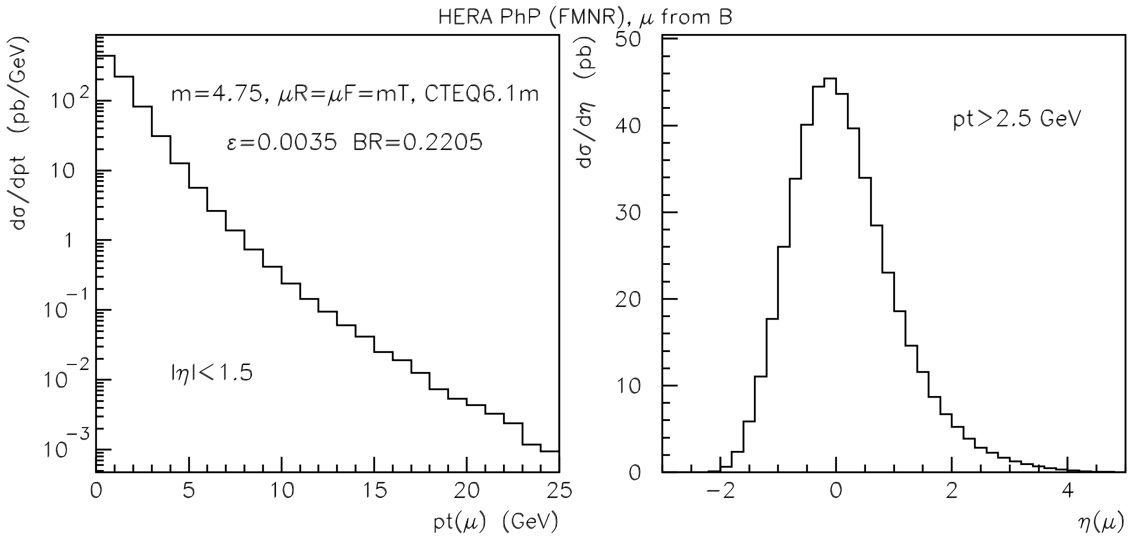


Beauty Hadrons

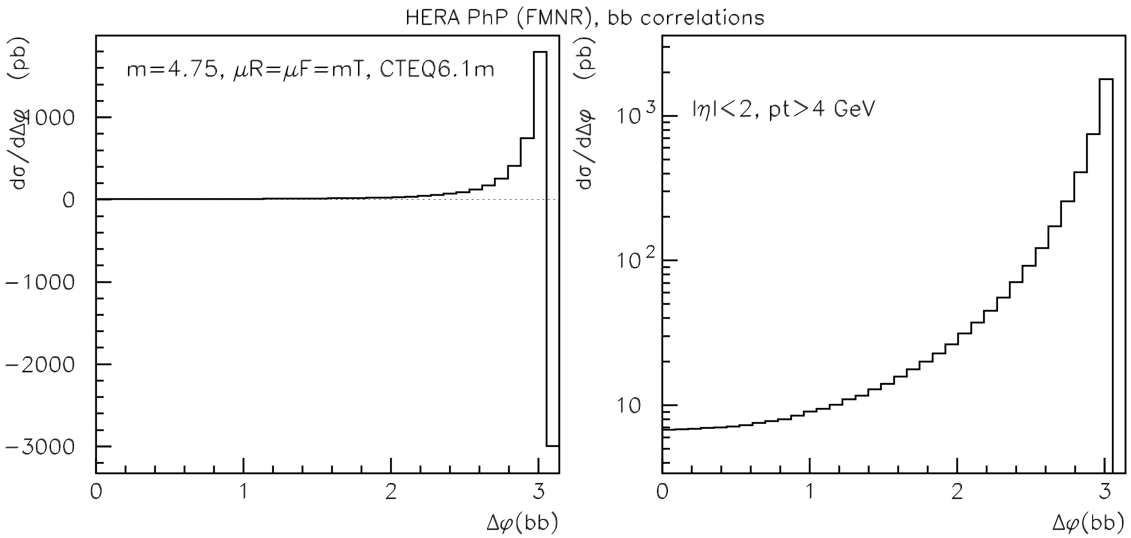


Beauty PhP at HERA with FMNR, M.C.

Beauty muons



Beauty Quark correlations



Format of the ASCII files

```
#
# comments (author, parameters)
#
# descrtiption of each column
#
#          nominal diff.                                systematic variations
# variable  cross-section  upper-band  lower-band  variation1 variation2 ...
    x1        y1              y1+          y1-         y1a        y1b      ...
    x2        y2              y2+          y1-         y2a        y2b      ...
    ...       ...             ...
    ...       ...
    ...
```