

# Underlying events and PDF4MC

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- why special PDFs for MCs are needed, necessary and important :

Mini workshop held on 18 - 19 May at DESY on:

## Multiparton Interactions and Underlying events

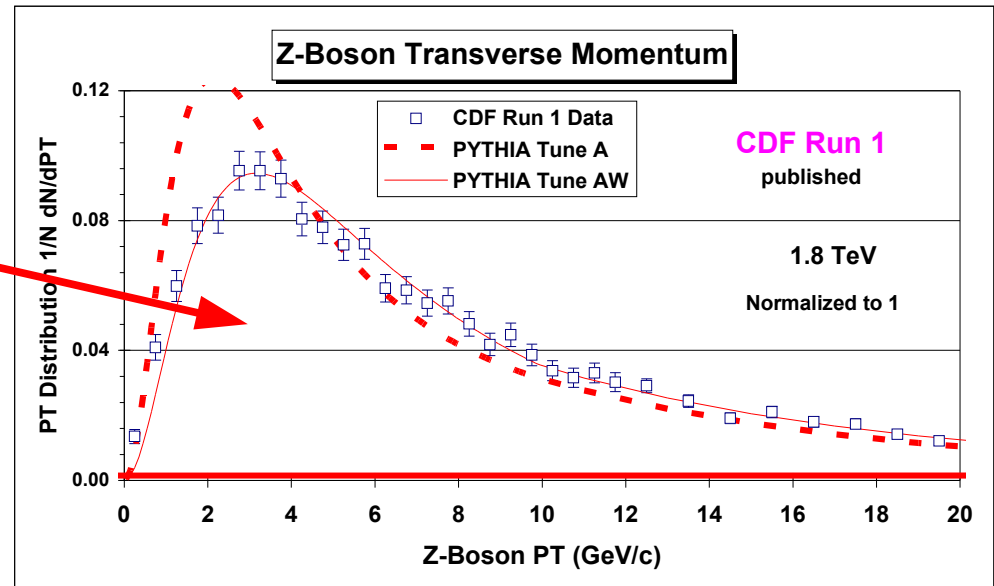
<https://www.desy.de/~jung/multiple-interactions/>

- **Strategy:**  
HOWTO obtain PDF4MC
- **Proof of concept**  
1<sup>st</sup> attempts
- **Conclusions**

# MI workshop: experimental issues

Rick Field – Florida/CDF/CMS

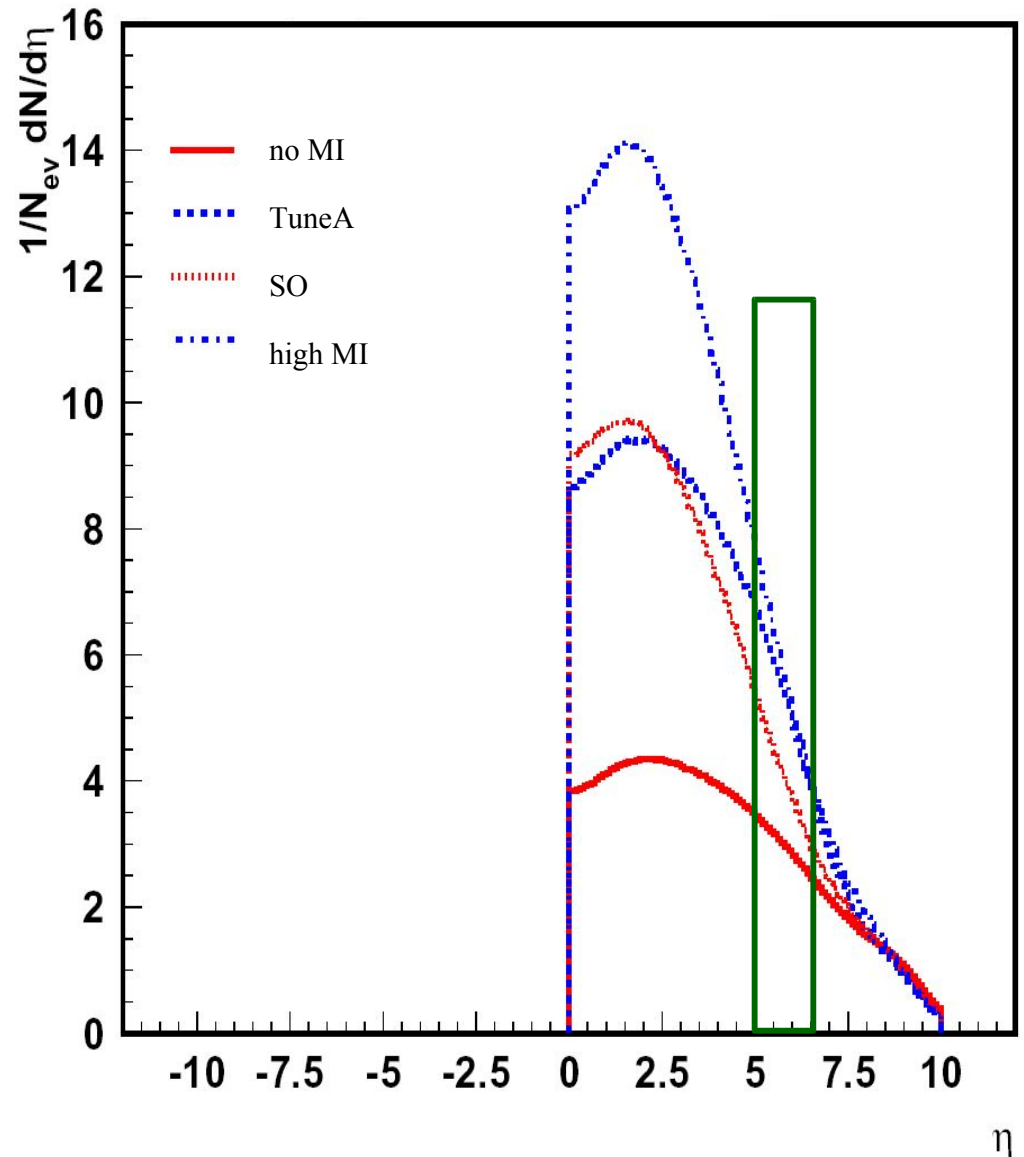
- Experimental provocateur: R.Field
- what do we know about soft underlying events and hard multiple interactions ?
- what is needed for LHC predictions ?
- which measurements are needed ?
- Pt spectrum of W/Z depends on
  - UE event parameters
  - PDFs
  - ISR parameters, cutoffs, ordering etc
  - intrinsic kt
- Using NLO or LO pdfs ? it is much more than just MC tuning ...



→ Shows the Run 1 Z-boson  $p_T$  distribution ( $\langle p_T(Z) \rangle \approx 11.5 \text{ GeV/c}$ ) compared with **PYTHIA Tune A** ( $\langle p_T(Z) \rangle = 9.7 \text{ GeV/c}$ ), and **PYTHIA Tune AW** ( $\langle p_T(Z) \rangle = 11.7 \text{ GeV/c}$ ).

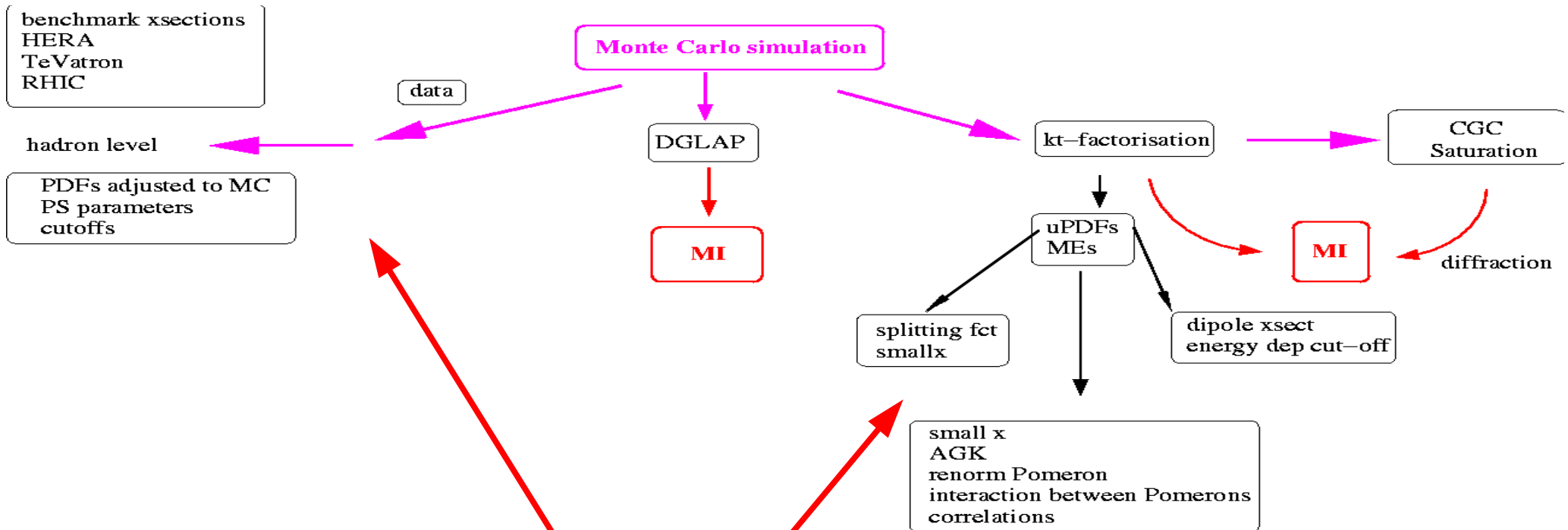
# Soft underlying events

- Models tuned to TeVatron data
- give **HUGE** differences at LHC ...
- the tunings depend on PDFs, parton showers, matrix-elements and all that influence on nearly all observables ...
- **better understand multiple interactions ...**
- **better tunings...**



# Where are we and where to go ?

we are here  
with simulations



we need to consider  
also these areas

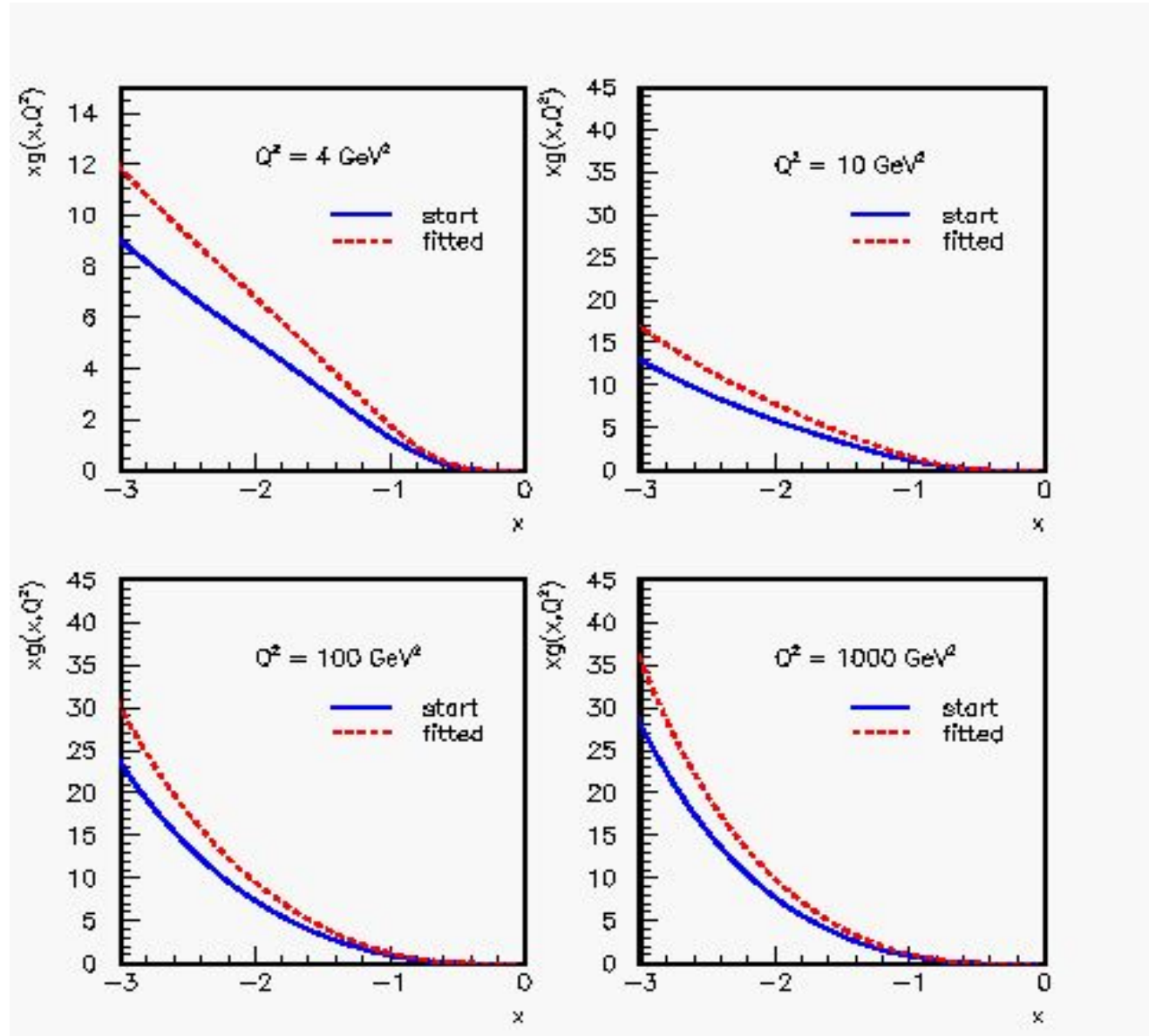
# 1<sup>st</sup> steps for PDF4MC

- use LHAPDF library for parton evolution and alphas
  - use any distribution and evolution code
  - evolve for every call (fast enough, can be improved if necessary...)
  - massive/massless treatment
  - LO/NLO etc
- use HZTool/RIVET for comparison of MC prediction with measurements
  - HERA H1/ZEUS:  $F_2$ ,  $F_2^c$ , jets etc....
  - TeVatron CDF/D0: jets, W/Z x section as fct of pt
    - (CTEQ also wants to do this.....)
- use general fit program (as used for CASCADE uPDF fits)
  - easily to extent for other MC generators and also NLO programs
  - BUT it is slow !!!
  - Improvements for fits (see talk by K.Kutak)
    - calculation in grid points
      - parametrization
      - fit to data (including uncertainties)



# The gluon after fitting ....

- Use LO fit....
- Fit  $F_2$  by varying
$$xg(x, \mu) = A_0 x^{A_1} \dots$$
and  $\alpha_s(\mu)$
- Fit changes normalization and slope of gluon ... as seen in the scan....
- $\chi^2/ndf$  improves...., but can still be better....
- Not yet the final answer...



# Conclusions

- use PDF4MC helps to improve description of data by MCs
  - tuned to include also underlying events
  - use it for better detector simulation
  - will improve model dependence of data correction to hadron level
  - smaller systematic uncertainty
- use of PDF4MC improves our physics understanding:
  - includes kinematic effects
  - allows to use all order resummed predictions (from PS MCs)
  - allows to analyze data which cannot be compared to parton level NLO calculations ...
- PDF4MC can be directly used at LHC with much improved predictive power
  - consistent treatment of  $\alpha_s(\mu)$
  - consistent treatment of parton showers
  - consistent treatment of  $p_t$  cutoffs and other parameters



# Plans

- perform 1<sup>st</sup> fits to  $F_2$  and TeVatron during summer
  - include TeVatron with W/Z and Jets
  - include all HERA data
    - summerstudent
  - end of summer: 1<sup>st</sup> HERA PDF4MC
- use tuned MC for UE studies (A. Knutsson)
  - in central region (with F. Bechtel): multiplicities
  - extend to tag with energy deposit in CASTOR