#### news from CASCADE

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- forward jets for first LHC data
- Higgs production in kt-factorization with finite top mass
- $pp \to Z(W) + Q + \bar{Q} + X$
- pp 
  ightarrow Z(W) + X (next months)
- $pp 
  ightarrow j_1 + j_2 + X$  (next months)

## **CASCADE** basic idea

 $\times x_{q1}\mathcal{A}(x_{q1}, k_{t1}, \bar{q}) x_{q2}\mathcal{A}(x_{q2}, k_{t2}, \bar{q})$ 

CASCADE elements are: Matrix Elements: → on shell/off shell PDFs unintegrated PDFs Parton Shower angular ordering (CCFM) Proton remnant and hadronization 0 handled by standard hadronization program, e.g. PYTHIA  $\sigma(pp \to q\bar{q} + X) = \int \frac{dx_{g1}}{x_{g1}} \frac{dx_{g2}}{x_{g2}} \int d^2k_{t1} d^2k_{t2} \hat{\sigma}(\hat{s}, k_t, \bar{q})$ 

H. Jung, CASCADE & PDF4MC, MC network meeting, Karlsruhe, 3. Dec 2009

# forward jets in CASCADE

**Forward Jet Production at the Large Hadron Collider.** M. Deak, F. Hautmann, H. Jung, K. Kutak JHEP 0909:121,2009.

- look at jets under small angles
- involves very small x parton
- observe BFKL effects ?



## forward jets in CASCADE II



- In forward region, large differences in pt spectrum predicted
- Applicable to very first LHC data

# **RAPGAP** for pp

- historically first version for hard diffraction in ep
   Rapidity Gap events
- developed into a full MC generator for ep (including non-diffraction) with initial/final state parton showers a la DGLAP (PYTHIA) and hadronization
- extensively used and tested in ep by H1 and ZEUS for all QCD physics
- NOW also for pp
  - hard diffraction and proton dissociation (no diff Higgs/W yet)
  - leading neutron production
  - standard QCD processes
  - no underlying event/MPI
- in GENSER soon

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- first results
- refit using latest HERA F<sub>2</sub> data (next months)
- release for LHC usage(next months)

## PDF4MC

- fully consistent approach would require doubly uPDFs and appropriate factorization theorem, which will include collinear factorization and ktfactorization as asymptotic limits...
- branch 1: use uPDFs and k<sub>t</sub>-factorization as done with CCFM and CASCADE
- branch 2: use standard MCEG like PYTHIA/HERWIG/RAPGAP and obtain PDFs from fits to F<sub>2</sub> and TeVatron data, as done in global analyses
  - neither LO or NLO is appropriate
  - define MC-PDFs, depend on generator, parton showers etc
    - MC-factorization scheme.... instead of MS bar
  - include proper treatment of parton showers in initial and final state
  - include all kinematics from full simulation, no approximations

# PDF4MC strategy

- 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<sub>2</sub>, F<sub>2</sub><sup>c</sup>, 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 extendable for other MC generators and also NLO programs
  - BUT it is slow !!!
  - Improvements for fits (in progress: A. Knutsson, K.Kutak (DESY))
    - calculation in grid points
      - → parametrization
      - → fit to data (including uncertainties)

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# PDF4MC: first results

- perform fits to F<sub>2</sub> using a Monte Carlo event generator which includes parton showers and intrinsic k<sub>1</sub>
- the resulting PDFs agree with standard LO ones if PS and intrinsic k<sub>t</sub> is applied.
- the final PDFs are differer because of kinematic effects coming from transverse momenta of PS and intrinsic k<sub>t</sub>

Determination of parton density functions using Monte Carlo event generators (Diploma 2009) Federico C. A. von Samson-Himmelstjerna



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