

# Summary of Low $x$ and Diffraction WG

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## Contents:

- 10 contributions in our WG
- HERA/RHIC results
- LHC: LHCb, ATLAS, CMS
- Future: EIC
- 2 theory contributions:  $F_2$  fits, Mueller Navelet jets and jet gap jets

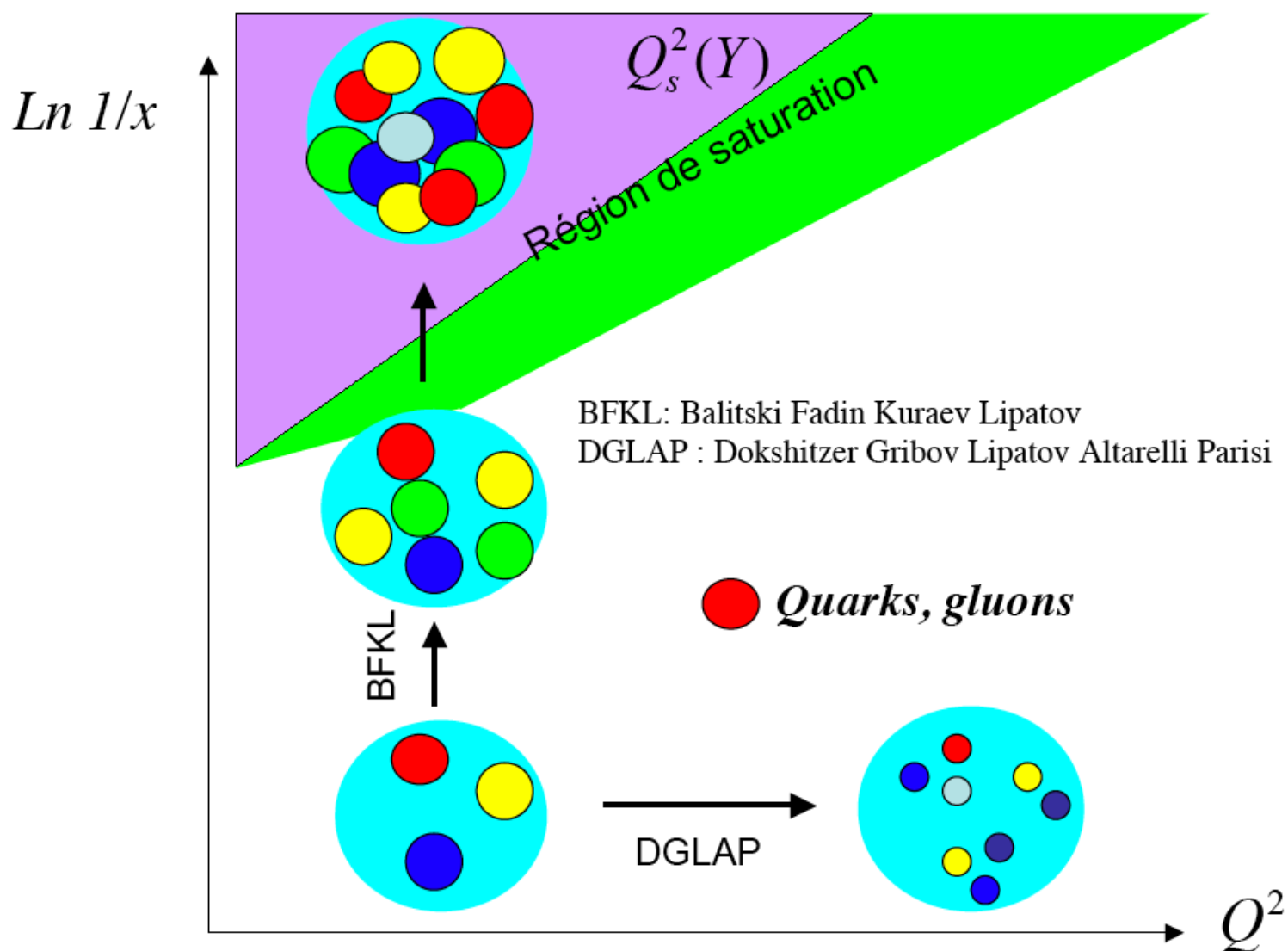
Not a summary, but personal comments following the talks/discussions that we had during the workshop

Thanks to all speakers, participants in our WG!



## Low x physics

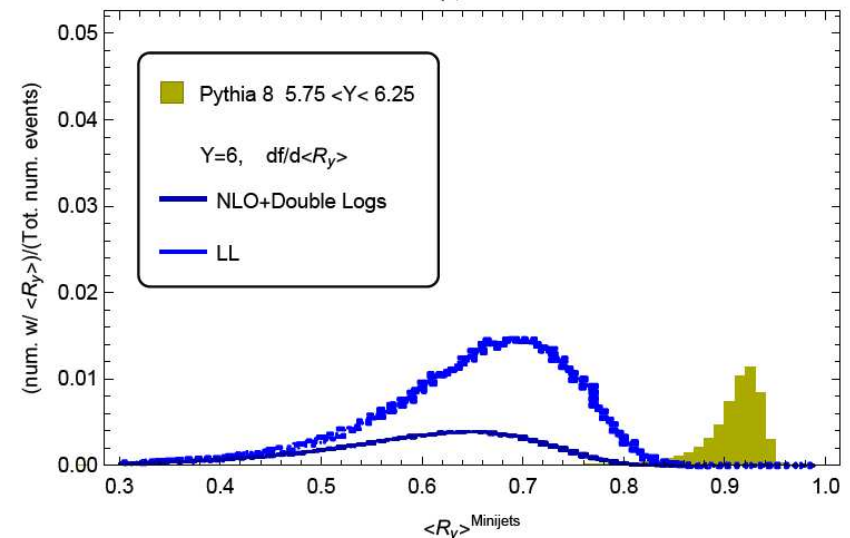
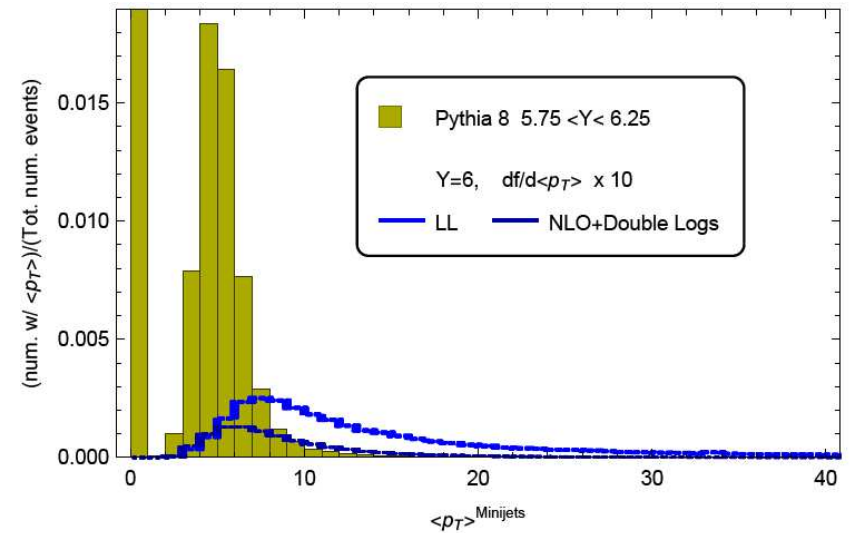
- Low x: high gluon density where BFKL regime is more “natural”: different multiplicities/energy flow than in usual generators
- Identify domains where DGLAP/usual generators might not be the real dynamics
- Other generators? Ariadne, Dipsy, not really BFKL and surely not NLL, BFKLEx but cannot be compared directly with data...



## BFKL dynamics: looking for less inclusive variables

$$\langle p_T \rangle = \frac{1}{N} \sum_{i=1}^N |p_{Ti}|$$

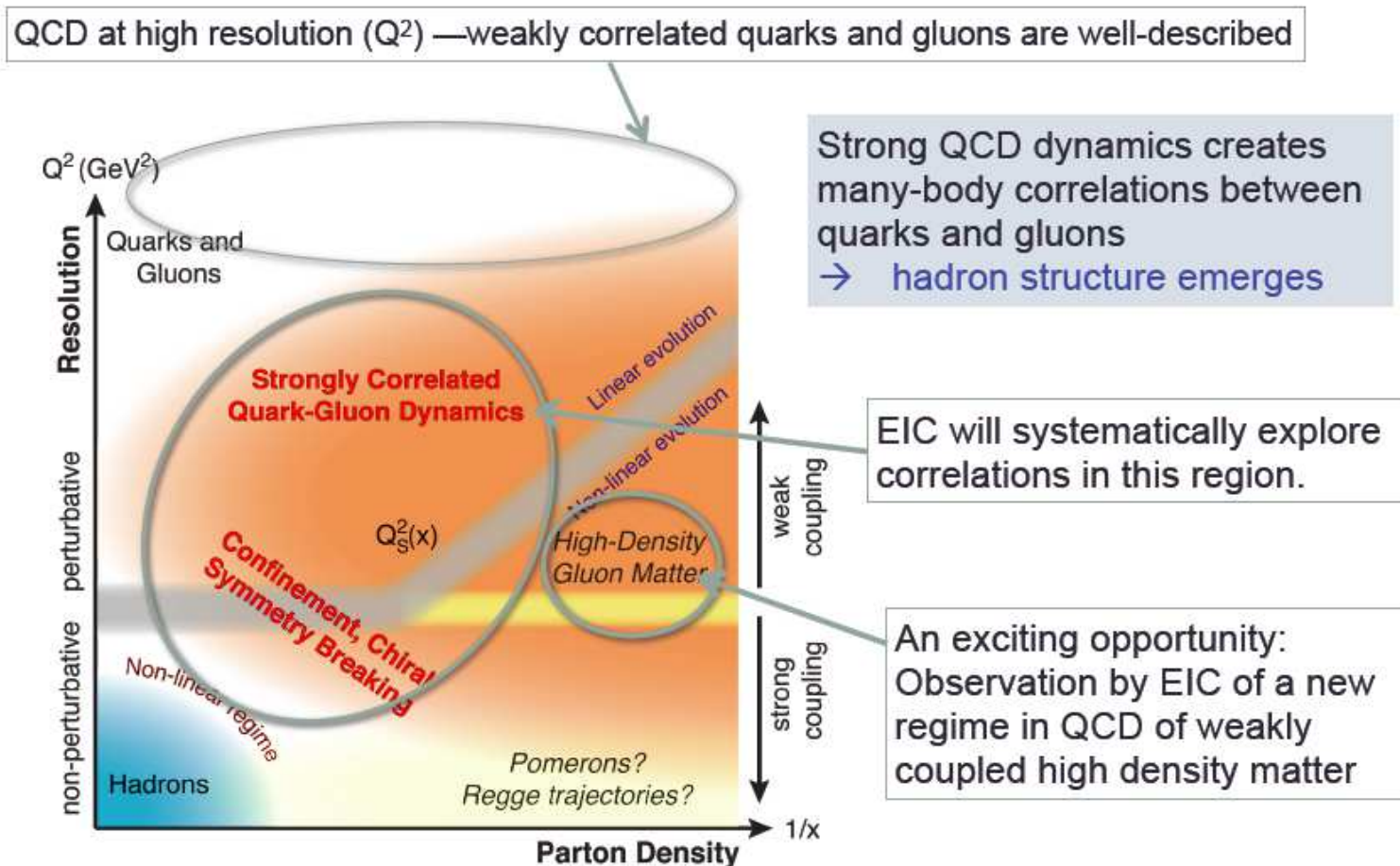
$$\langle R_y \rangle = \frac{1}{N+1} \sum_{i=1}^{N+1} \frac{y_i}{y_{i-1}}$$



- Looking for multiple gluon emission along ladder characteristic of BFKL: number,  $p_T$ , rapidity distributions of “minijets”
- Comparison between BFKL-ex MC and pythia/herwig to find best variables: collaboration with A. Sabio Vera, D. Gordo, G. Chachamis, F. Deganutti, T. Raben

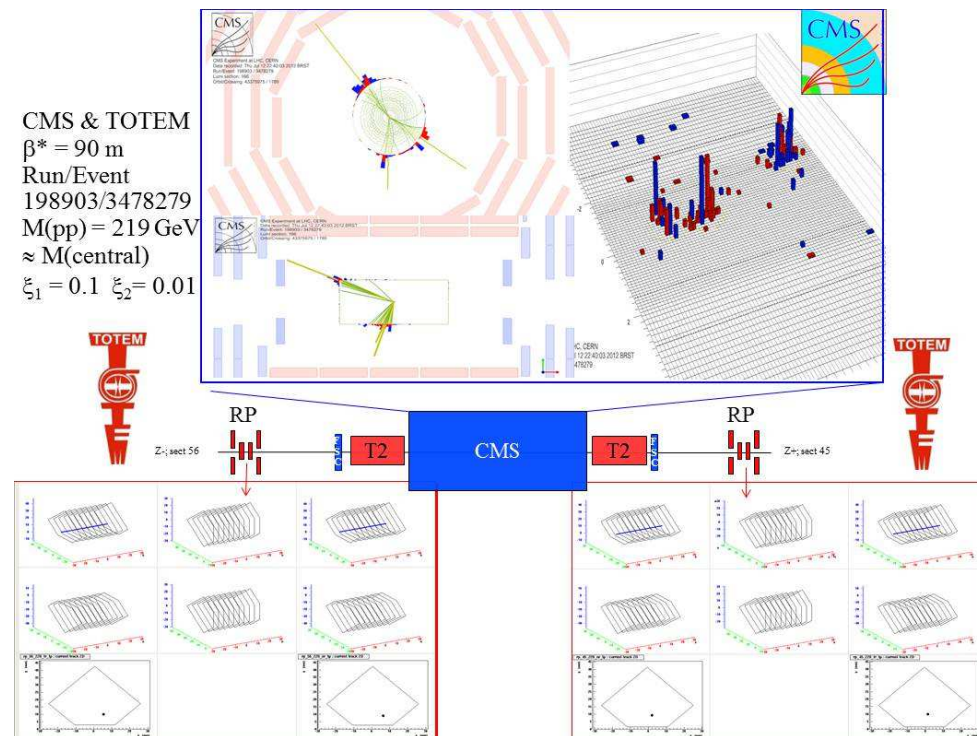
## Looking for saturation

- Again a new regime not present in generators
- Fundamental for RHIC, heavy ion LHC and the future EIC project
- As an example: precise measurements of  $F_L$  and  $F_2$  at the EIC, and of course jet disappearance effects...
- How to include these effects in MC? Useful if one wants to make less inclusive measurements and compare with predictions with/without saturation



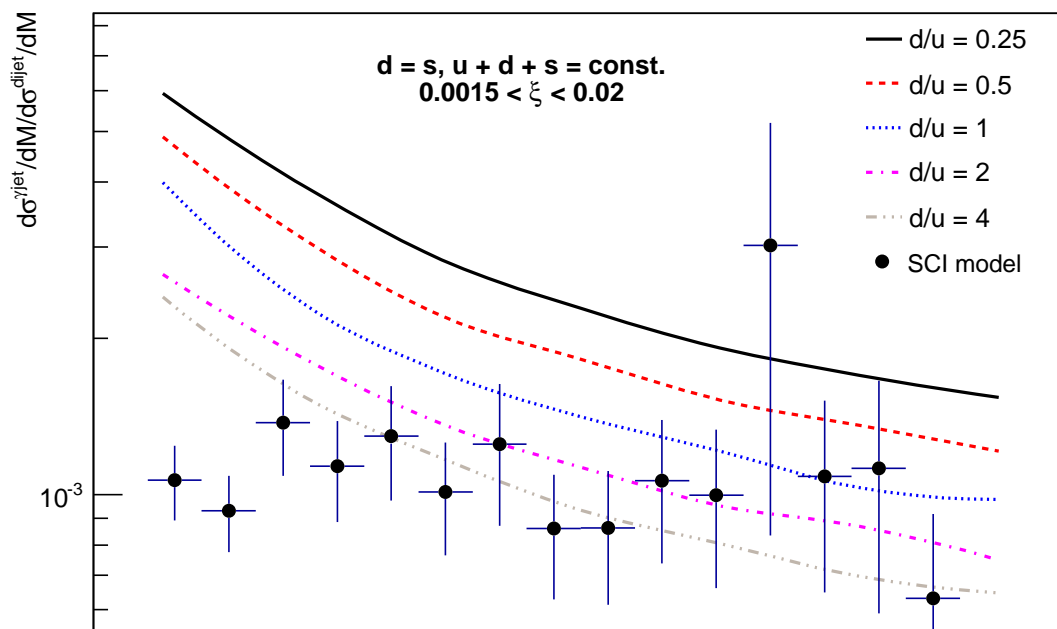
## A few general remarks about Forward Physics

- Forward Physics addresses QCD dynamics at the interface between hard and soft physics
  - Example I: Total  $pp$  cross section probes long transverse distances
  - Example II: BFKL (Balitsky Fadin Kuraev Lipatov) Pomeron is valid at short distances
  - Transition: hard diffraction, structure of Pomeron
- Allows in addition searching for physics beyond the standard model
- Important for understanding underlying events, soft QCD: MC tuning, almost all MC designed for hard processes and new physics have difficulties with incorporating diffraction, and need improvement. Measurements of diffraction (rapidity gaps) are vital for testing MC



## Diffraction

- MC tuning for diffraction: which best variables to be used? Also, sometimes some tuning might include some diffractive events, should they be removed?
- Rapidity gap versus proton tag: Complementarity between experiments at the LHC, description of proton dissociation and MC tuning
- Survival probability and relation with MPI: Difficult to compute, soft models (Durham/Tel Aviv/Penn State...), needs to be measured experimentally, and to be put in MC (Superchic is one example)
- Total cross section /  $\rho$  parameter: odderon exchange? saturation effects?
- Dynamics for diffraction? Pomeron exchange (hard diffraction) or soft effects (gluon/quark recombination at a much longer timescale such as soft color interactions like models, or both)



## Additional topics

- Discrepancy between TOTEM and ATLAS/ALFA for the total cross section at 8 TeV: What about 13 TeV?
- Incompatibility between recent measurement of  $\rho$  and total cross section at 13 TeV: cannot be described by COMPETE fits without additional effects (odderon?)
- BFKL NLL and saturation: Common framework?
- Understanding of exclusive diffraction: low mass (pions,  $\chi_C$ ...), high mass (anomalous couplings)
- Input from our MC friends: Which measurements would be useful to compare with existing MC for low  $x$ /diffraction? Comparison between diffractive and non-diffractive events?
- MPI and survival probability?
- Tuning vs not perfect understanding of physics: not so well known pomeron structure, diffraction vs MC tuning