

Looking for exclusive events using the dijet mass fraction at the Tevatron

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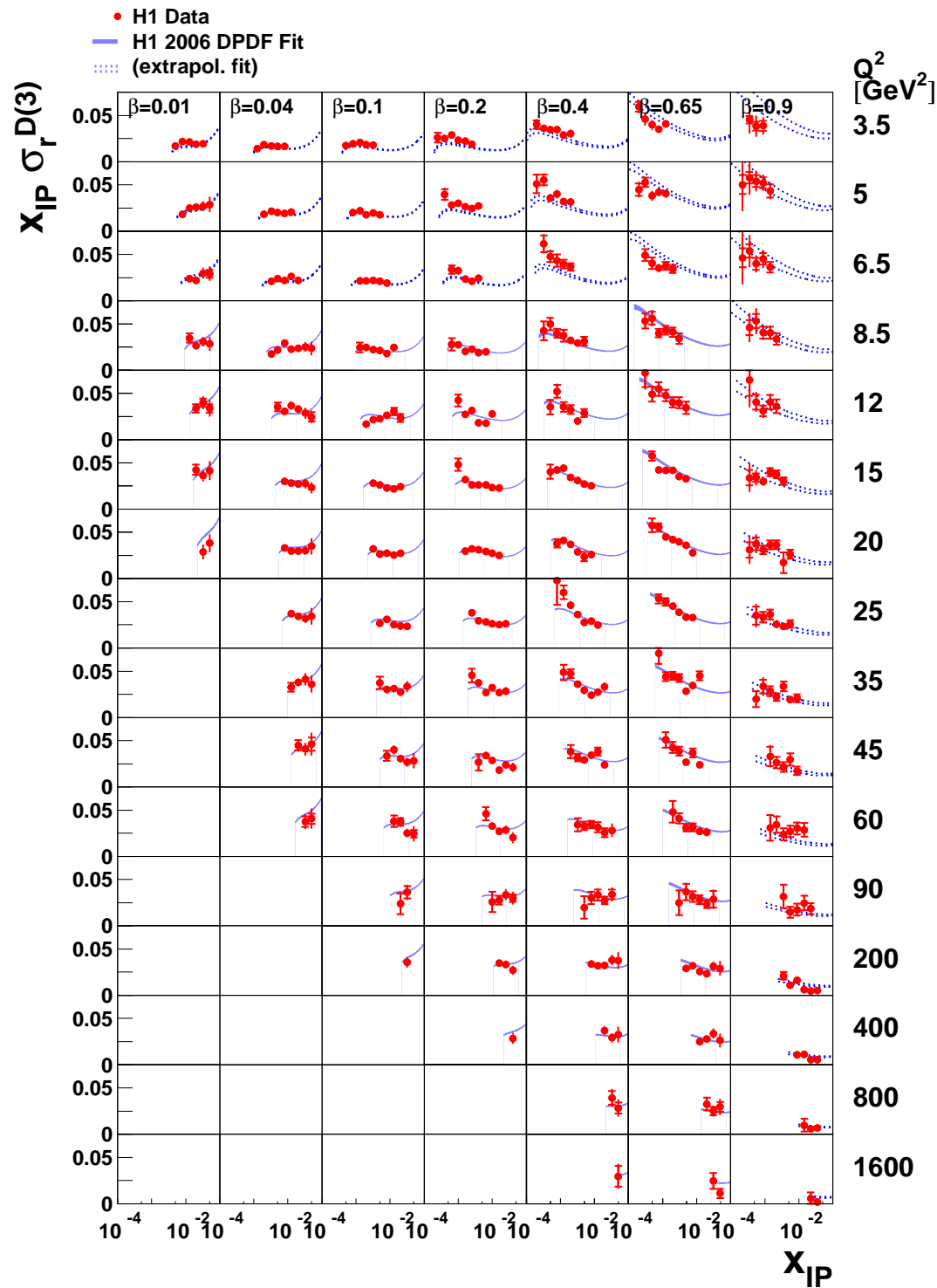
Contents:

- New DGLAP QCD fits to HERA data and extraction of gluon density in Pomeron
- Comparison between CDF measurement of dijet mass fraction and expectations from Pomeron inclusive models
- Exclusive events in dijet channel
- Predictions from Soft Colour Interaction models
- Measurement of exclusive events at the LHC

Work done in collaboration with Oldřich Kepka

Publication to be submitted soon

Measurement of the diffractive structure function F_2^D



QCD fits to F_2^D data

- DGLAP QCD evolution using MRS-like distributions at the starting scale

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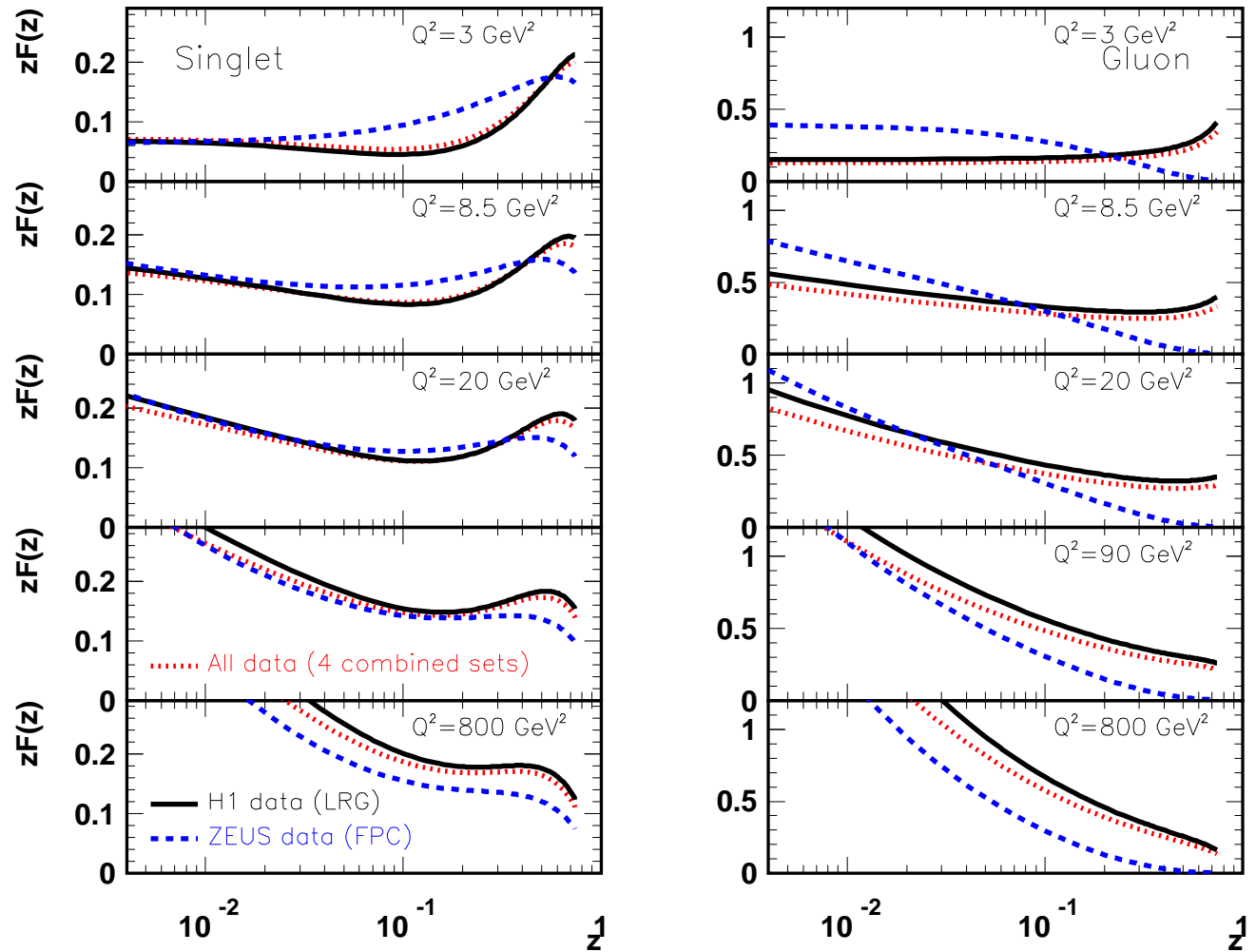
$$zS(z, Q^2 = Q_0^2) = \left[A_S z^{B_S} (1 - z)^{C_S} (1 + D_S z + E_S \sqrt{z}) \right] \cdot e^{\frac{0.01}{z-1}}$$

$$zG(z, Q^2 = Q_0^2) = \left[A_G (1 - z)^{C_G} \right] \cdot e^{\frac{0.01}{z-1}}$$

- In the fits: $\alpha_S(M_Z) = 0.118$, $Q_0^2 = 3 \text{ GeV}^2$
- Charm quark contribution computed in the fixed flavour scheme using the photon-gluon fusion prescription
- For H1 data: $\alpha_P = 1.12$, $\chi^2/dof \sim 0.9$

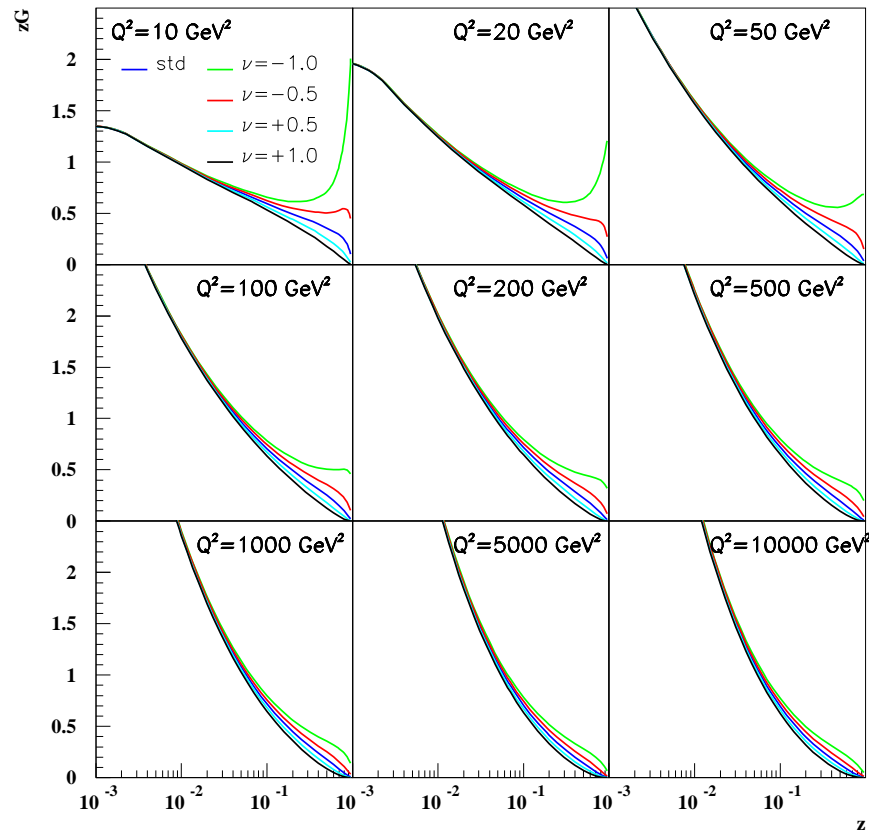
Parton densities in Pomeron

DGLAP fits to most recent H1 and ZEUS data (see: hep-ph/0609291)



Uncertainty on high β gluon

- Important to know the high β gluon since it is a contamination to exclusive events
- Experimentally, quasi-exclusive events indistinguishable from purely exclusive ones
- Uncertainty on gluon density at high β : multiply the gluon density by $(1 - \beta)^\nu$ (fit: $\nu = 0.0 \pm 0.6$)



DPEMC Monte Carlo

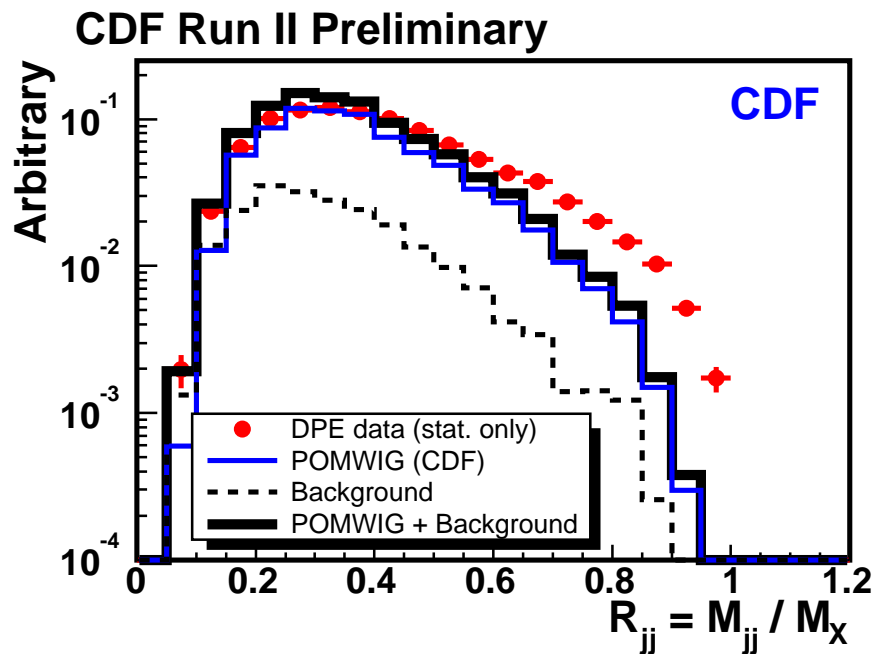
- **DPEMC (Double Pomeron Exchange Monte Carlo):** New generator to produce events with double pomeron exchange (contains POMWIG, Bialas Landshoff model for inclusive diffraction and both “Durham” and “Saclay” models for exclusive diffraction)
<http://boonekam.home.cern.ch/boonekam/dpemc.htm>, paper to be submitted to Comp. Phys. Com.
- **Interface with Herwig:** for hadronisation
- **Exclusive and inclusive processes included:** Higgs, dijets, diphotons, dileptons, SUSY, QED, Z , W ...
- **DPEMC generator interfaced with a fast simulation of LHC detector (as an example CMS, same for ATLAS), and a detailed simulation of roman pot acceptance**
- **Gap survival probability of 0.03 put for the LHC**
- **Another available MC:** “Exhume” for Durham model, POMWIG for inclusive diffraction

Different models to be studied

- Predictions from inclusive models:
 - “Factorised models” (FM): Use the gluon and quark distributions coming from H1 measurements, apply survival probability of 0,1 for Tevatron, predict cross sections
 - Extension of Bialas Landshoff model: Diffraction is dominated by the exchange of a non-perturbative Pomeron (soft $\alpha_P = 1.08$, natural for hadron-hadron interaction), no survival probability since model scaled to CDF run I DPE cross section measurement
 - Soft colour interaction: Diffraction due to string rearrangement in final state in hadronisation phase
- Predictions from exclusive models:
 - Durham model: Direct 2-gluon coupling to the proton, pure exclusive event production, presence of Sudakov form factor which leads to a strong mass dependence of the cross section
 - Bialas-Landshoff model: Similar to inclusive one, exchange of a non-perturbative soft Pomeron
- Fast simulation of CDF detector used

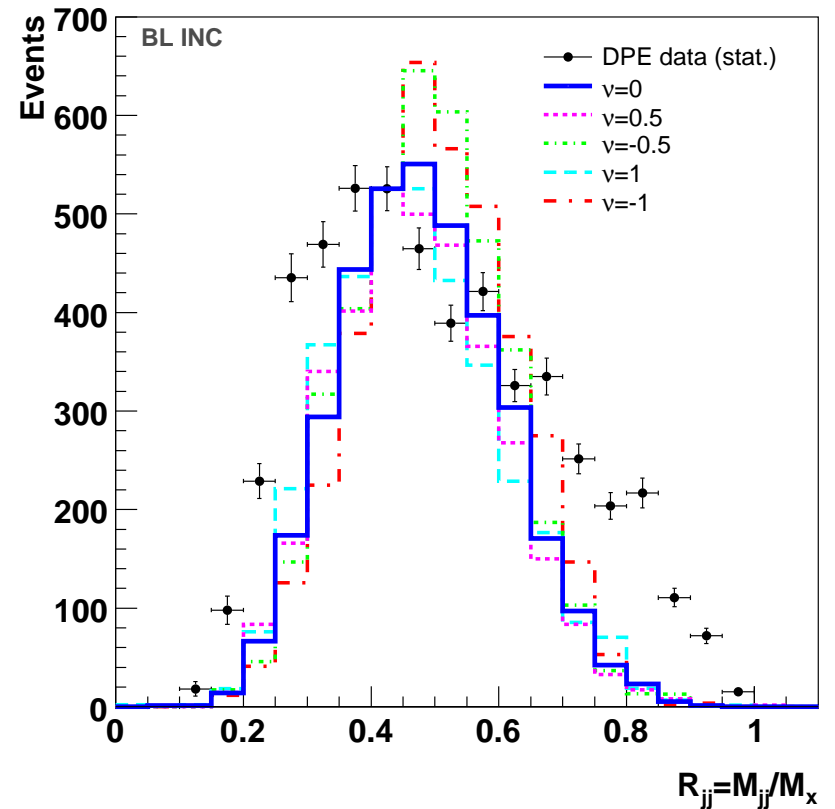
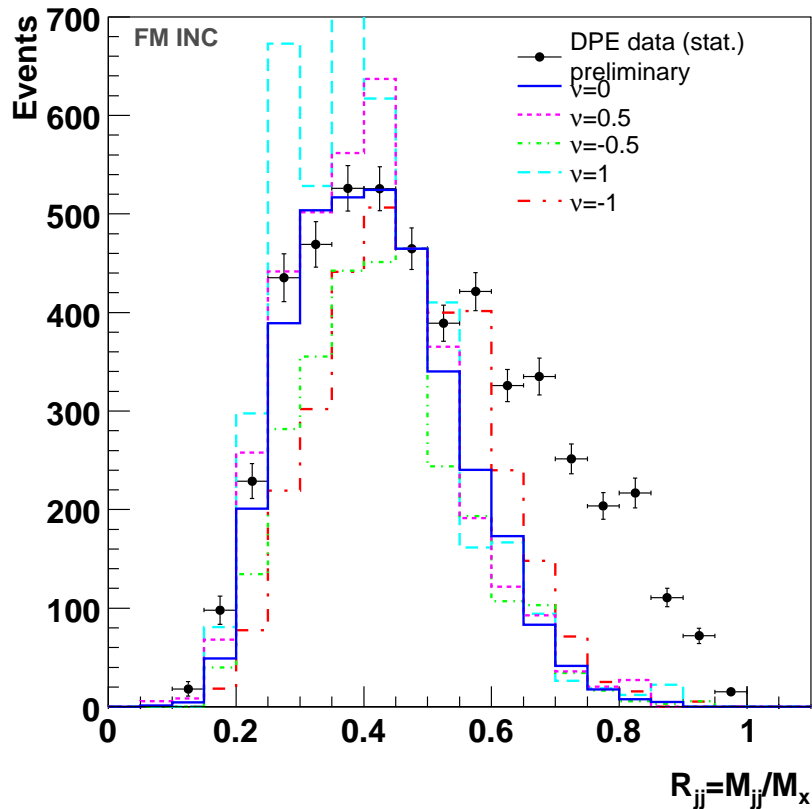
Dijet mass fraction measurement in CDF

- Look for exclusive events (events where there is no pomeron remnants or when the full energy available is used to produce diffractively the high mass object)
- Select events with two jets only, one proton tagged in roman pot detector and a rapidity gap on the other side
- Comparison with POMWIG Monte Carlo using H1 gluon density in pomeron and DPEMC for exclusive signal



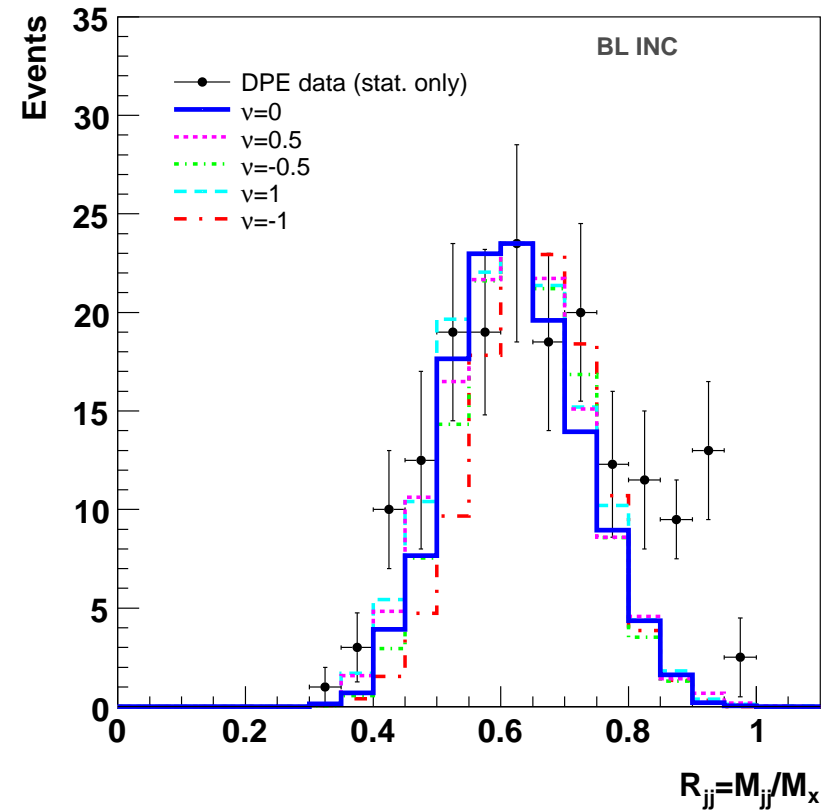
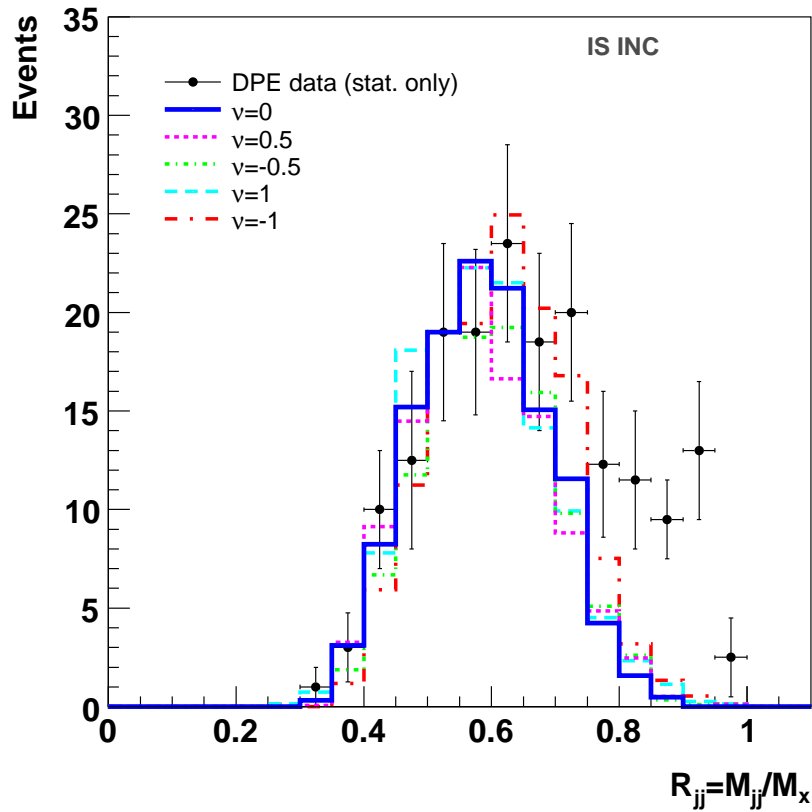
Prediction from inclusive diffraction

- Predictions from the Bialas-Landshoff and “factorised” inclusive diffraction models
- Jet $p_T > 10$ GeV
- Bialas Landshoff inspired approach disfavoured, and both models require additional contribution at large dijet mass fraction



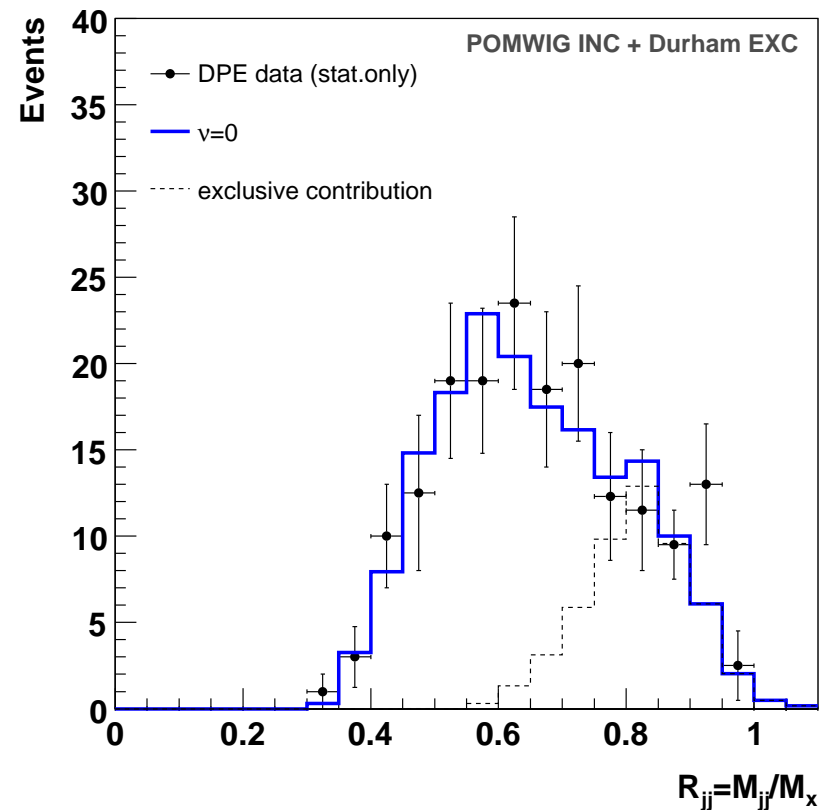
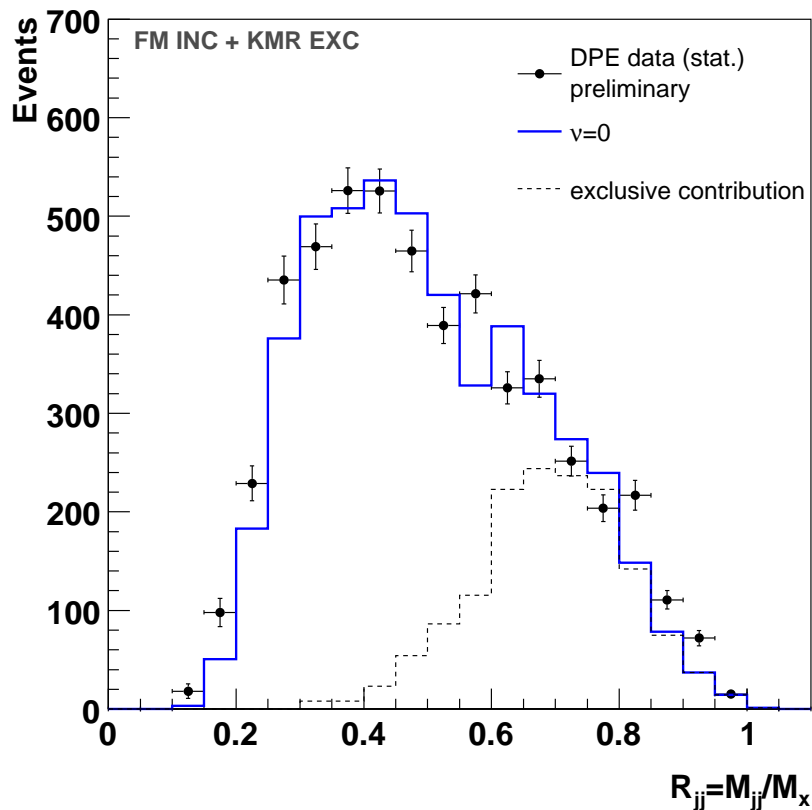
Prediction from inclusive diffraction

- Predictions from the Bialas-Landshoff and “factorised” inclusive diffraction models
- Jet $p_T > 25$ GeV



Prediction from inclusive and exclusive diffraction

- Add the exclusive contribution from Durham or Bialas-Landshoff model (free relative normalisation between inclusive and exclusive contribution)
- Good agreement between measurement and predictions
- As an example: “Factorisable” models and Durham exclusive
- NB: Bialas Landshoff models leads to a bad description at low dijet mass fraction as before



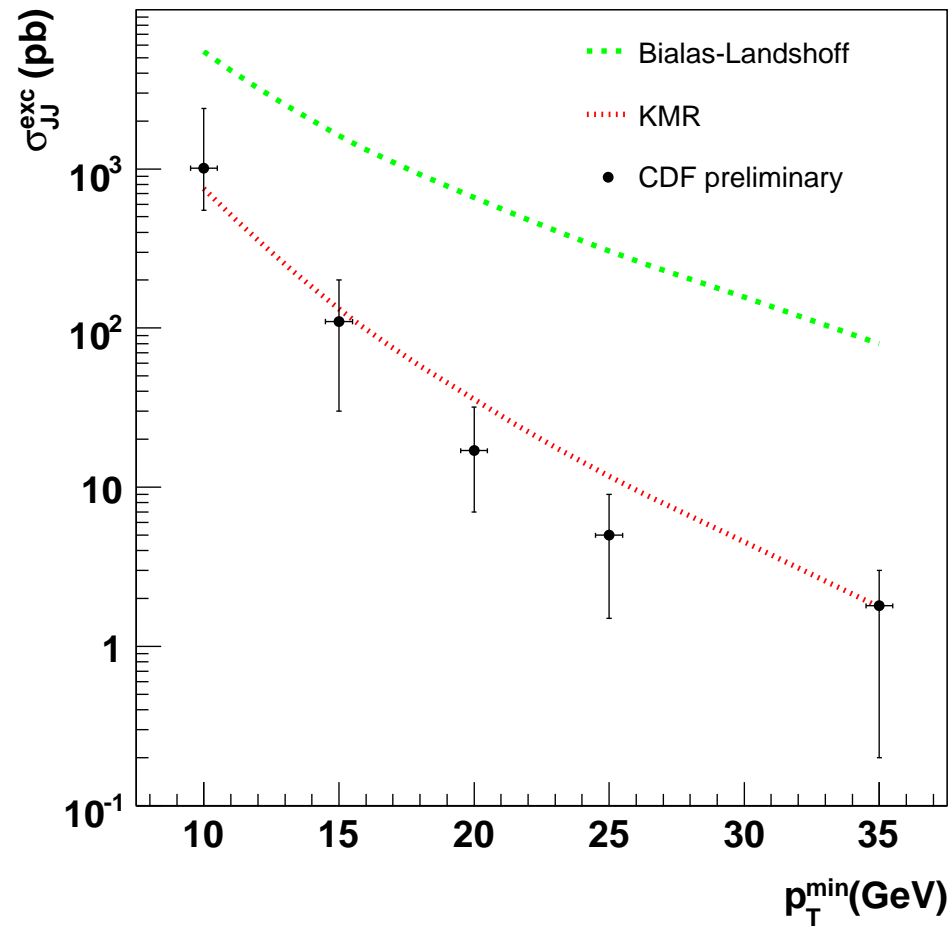
Relative normalisation between inclusive and exclusive

- By default, we take the cross section coming direct from the models as implemented in DPEMC MC
- If model right, expect relative contribution to be of the order 1 both at jet $p_T > 10$ GeV and $p_T > 25$ GeV (modulo imperfection of CDF detector fast simulation)
- Bialas Landshoff approach leads to too low dependence on jet p_T whereas Durham model looks better

Contributions	$r^{\text{EXC/INC}}(10\text{GeV})$	$r^{\text{EXC/INC}}(25\text{GeV})$
FM + KMR	2.6	1.0
FM + BL exc	0.35	0.038
BL inc + BL exc	0.90	0.01

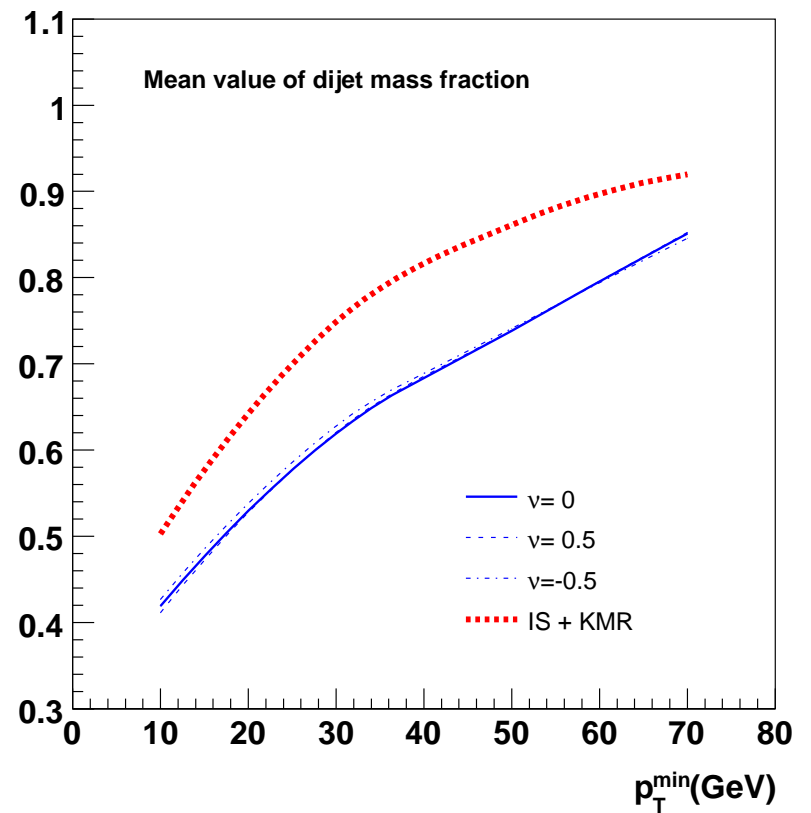
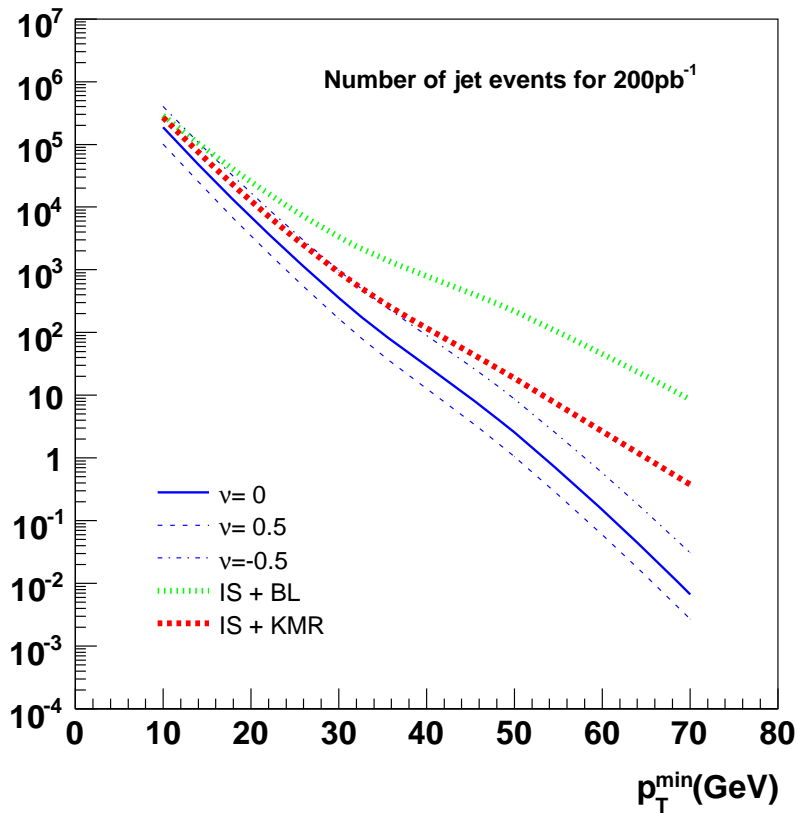
Measurement of exclusive cross section (CDF)

Bias-Landshoff approach leads to too slow p_T dependence
and too large exclusive contribution



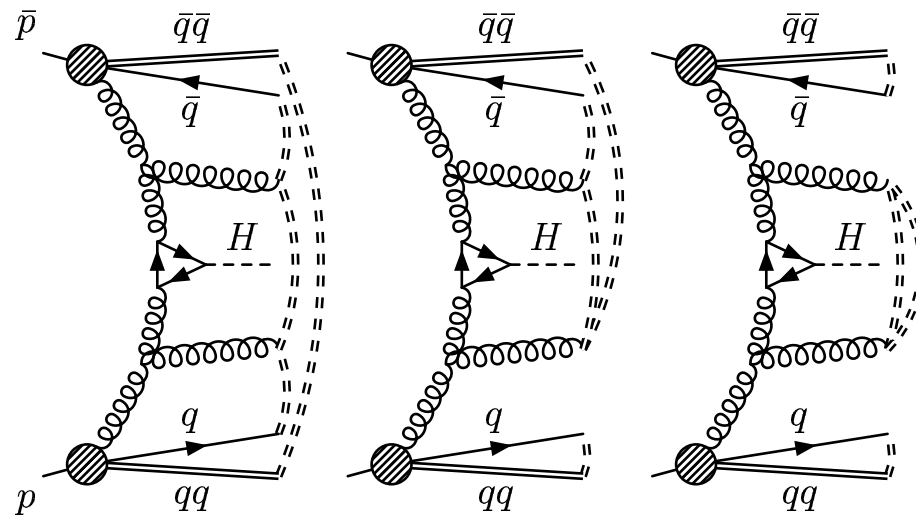
A better way to look for exclusive events?

Exclusive contribution more visible at jet p_T of 30-40 GeV



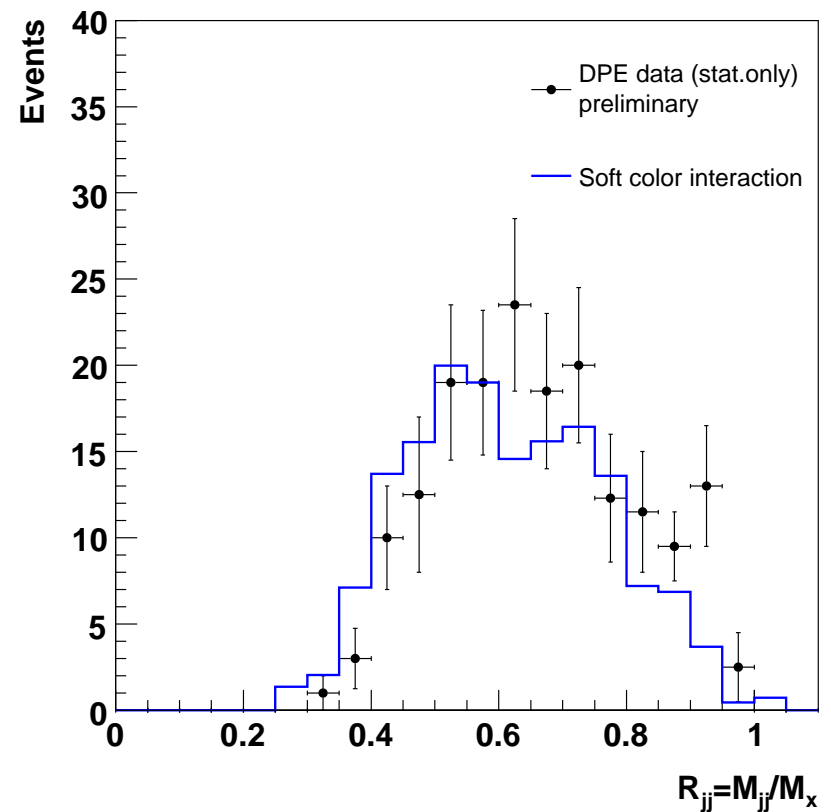
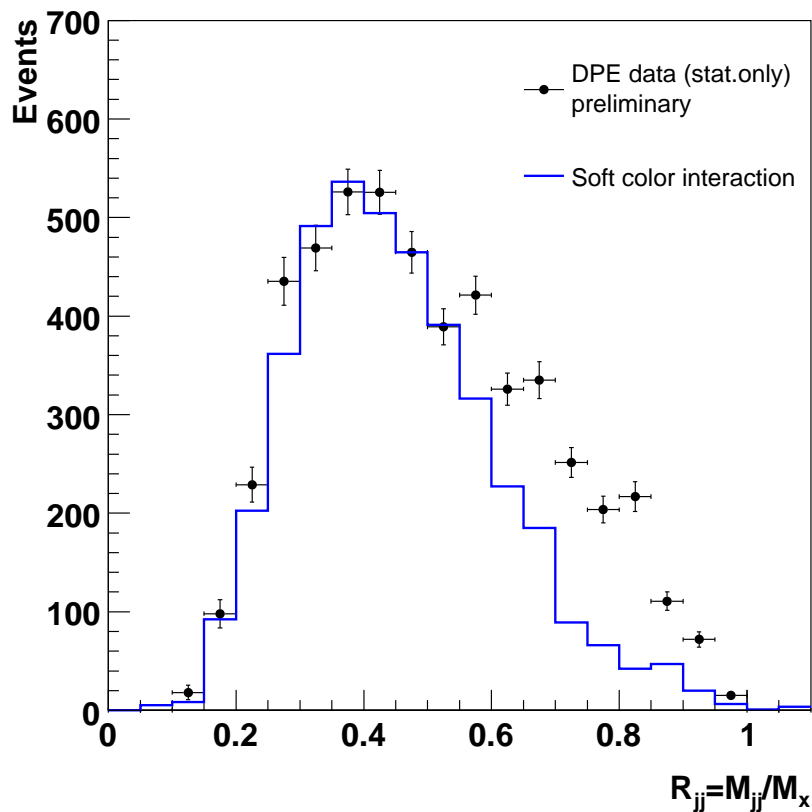
Soft Colour Interaction models

- A completely different model to explain diffractive events: Soft Colour Interaction (R.Enberg, G.Ingelman, N.Timneanu, hep-ph/0106246)
- Principle: Variation of colour string topologies, giving a unified description of final states for diffractive and non-diffractive events
- No survival probability for SCI models



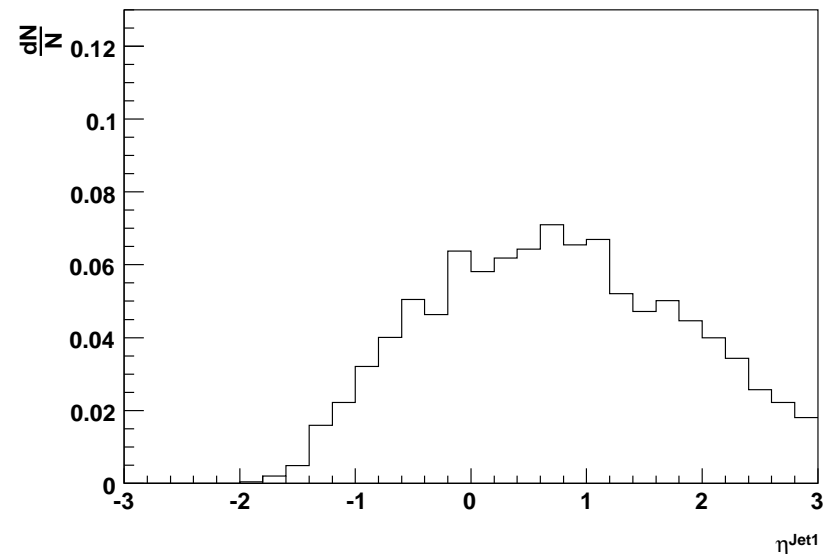
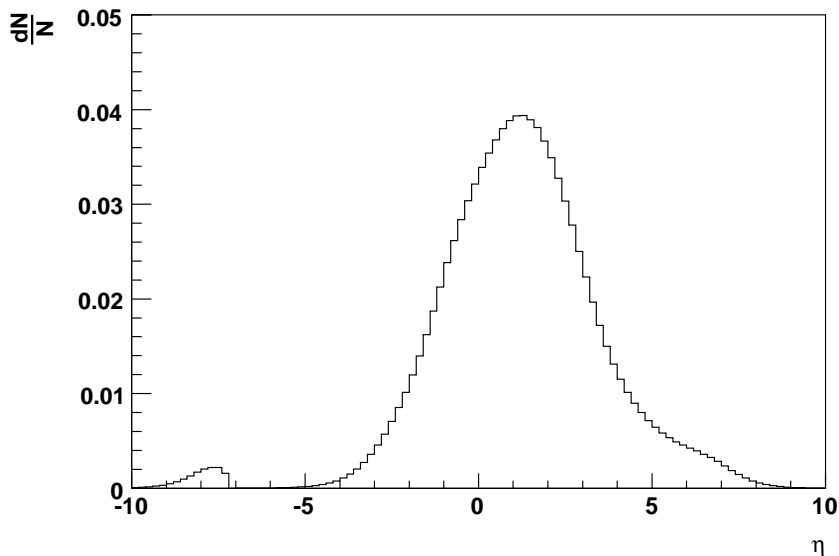
What about SCI?

- SCI models give correct normalisation for single diffraction at Tevatron and diffraction at HERA without any additional parameter
- **Exclusive events and SCI:** Contribution of exclusive events needed much lower compared to Pomeron-like models, even vanishes for jet $p_T > 25$ GeV...



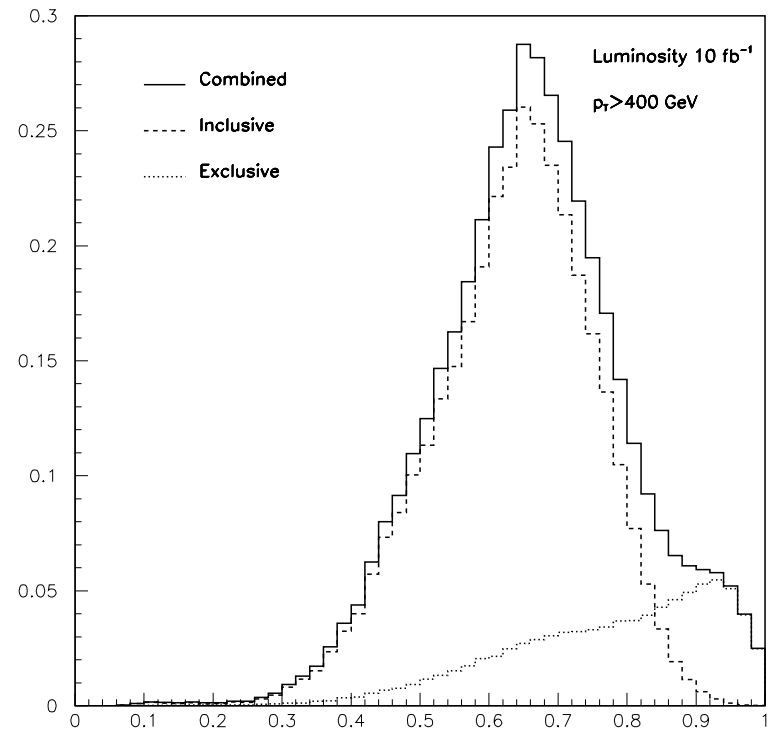
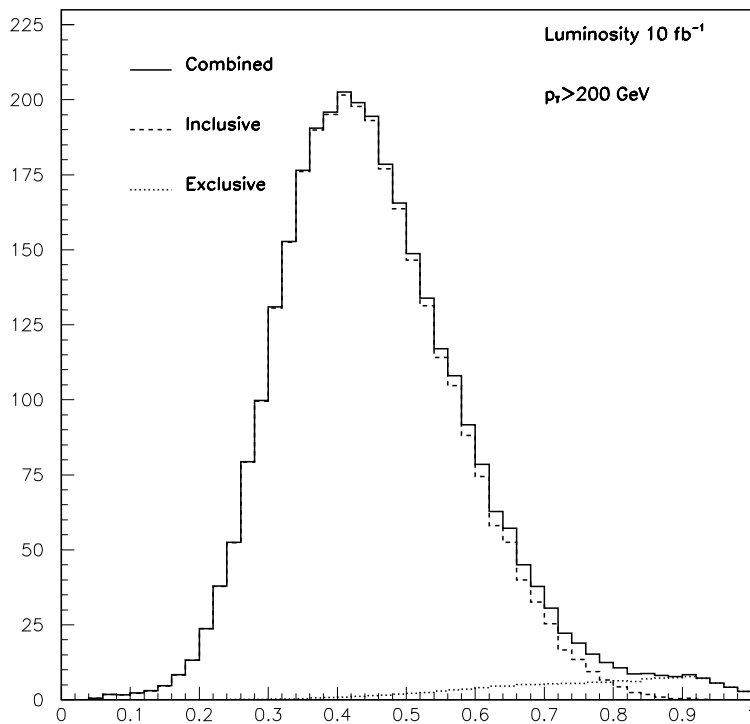
Comments about SCI

- Contribution of exclusive events much smaller for SCI
- “DPE” exchange in SCI models dominated by the following configuration for CDF events: 1 antiproton tagged in the final state, a bunch of particles going through the beam pipe on the other side (dominated by pions), no proton in the final state, due to the fact that only a rapidity gap is requested
- Jet rapidity boosted towards high rapidity: SCI model worth to be studied in more detail, but needs further improvement



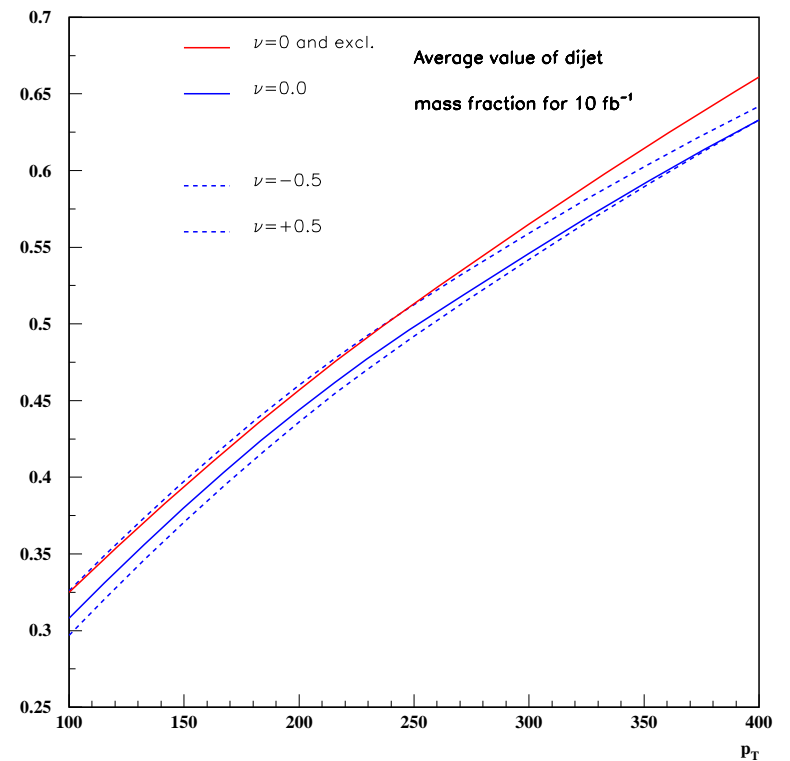
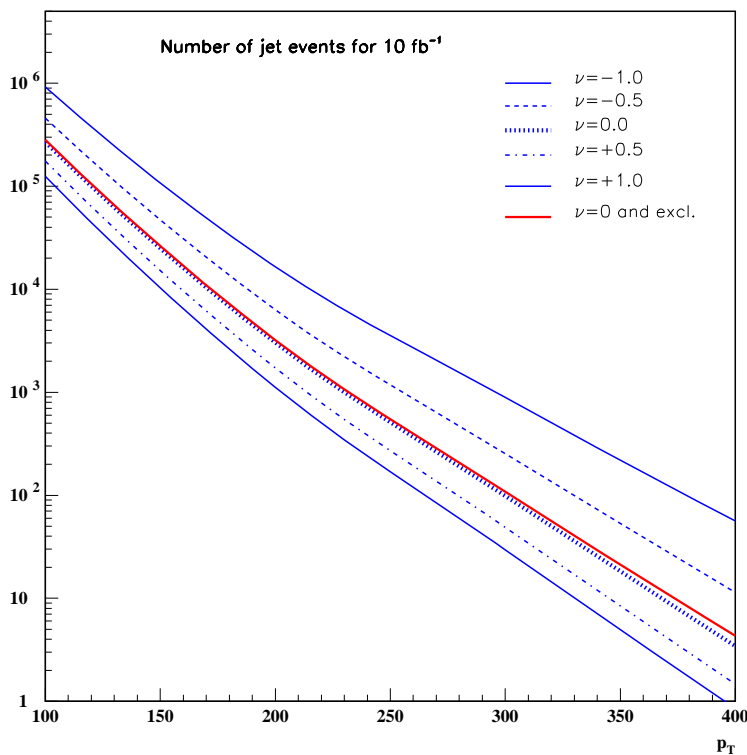
LHC: Exclusive and inclusive events

- Study of exclusive and inclusive production to be made at the LHC: study cross section of both components as a function of jet p_T and perform DGLAP QCD fits
- Important to understand background and signal for exclusive production of rare events: Higgs, SUSY...



LHC: Exclusive and inclusive events

- Number of dijet events as a function of jet p_T :
dominated by uncertainty on gluon density
- Dijet mass fraction (average value as an example):
sensitive to exclusive production, quite easy to measure



Conclusion

- Inclusive Diffractive model cannot describe properly dijet mass fraction measurement at high values
- Inclusive and Exclusive models together lead to a good description of dijet mass fraction: Durham model together with “factorised” models are favoured (Bialas-Landshoff inspired models are disfavoured)
- Ideally look at jets with $p_T > 30 - 40$ GeV at Tevatron to obtain the best separation between inclusive and exclusive events
- At the LHC: Full cross section analysis of exclusive and inclusive production needed to obtain good prediction for Higgs, SUSY...
- Other observables at the Tevatron: R_J , use of the k_T algorithm for jets, use of double tagged events in DØ which has roman pots on both sides
- SCI models: worth to study in more detail since they show a completely different model of diffraction and lead to a sensibly different dijet mass fraction