

# Exclusive diffractive Higgs and jet production at the LHC

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in collaboration with

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**DIS 2010**

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- 2 Forward Physics Monte Carlo (FPMC)
- 3 Models of exclusive diffractive production
- 4 Uncertainties
- 5 Predictions for LHC
- 6 Constraining models with early LHC measurements
- 7 Conclusions

# Exclusive production – introduction

- Models

- 1 V.A. Khoze, A.D. Martin, M.G. Ryskin (KMR, Durham model)

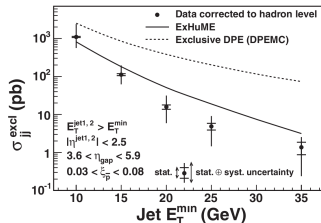
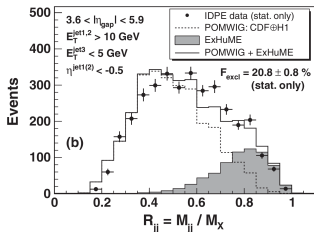
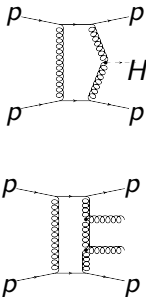
- 2 J.R. Cudell, A. Dechambre, O.F. Hernández, I. P. Ivanov (CHIDe, Liège model)

- 3 A. Szczurek *et al.* (Krakow model)

- 4 A. Bialas, P.V. Landshoff

- 5 M. Boonekamp, R. Peschanski, C. Royon

- CDF measurements (in this analysis only dijets measurement was used)

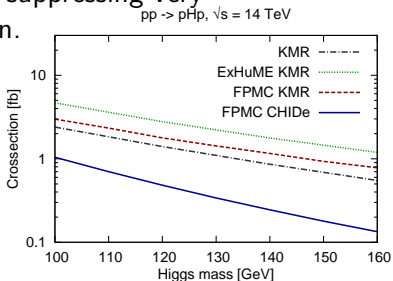
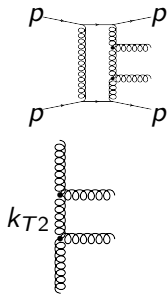


- Projects for forward physics in both ATLAS and CMS
- Proton taggers – on both sides
- Scattered proton fractional momentum loss ( $\xi = \Delta p/p_0$ ) acceptance:  $0.004 < \xi < 0.2$
- Central mass acceptance:  $100 \text{ GeV} < M < 2 \text{ TeV}$
- 220m + 420m from IP
- Pixel detectors for scattered proton position and angle measurement
- GASTOF and QUARTIC – superfast timing detectors ( $\sim 10$  picosecond resolution – for pile-up background rejection)

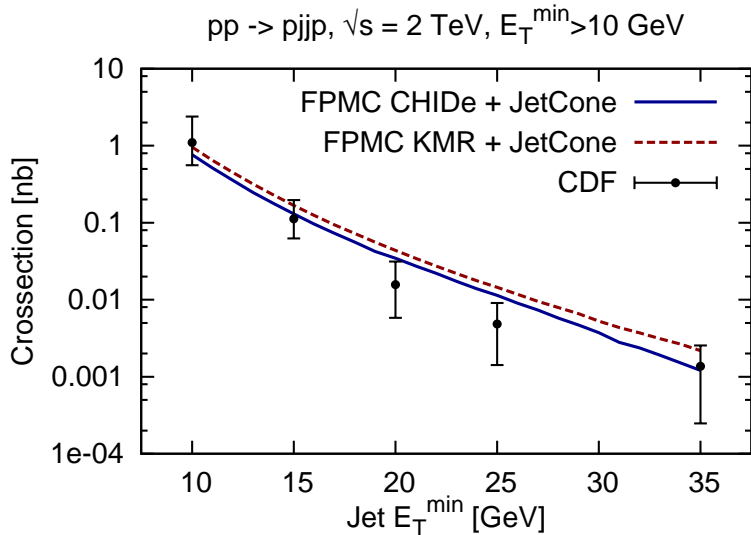
- Inclusive diffraction
- Exclusive diffractive production
  - KMR (Khoze, Martin, Ryskin) – direct implementation (dijets, Higgs)
  - CHIDe (Cudell, Dechambre, Hernández, Ivanov) – the only MC implementation (gluon dijets, Higgs)
  - In preparation
    - diphoton, quark dijets in CHIDe model
    - Krakow model (Szczurek *et al.*)
- Photon-photon physics (including anomalous triple and quartic couplings between  $\gamma$  and  $W/Z$ )
- Hadronisation – Herwig
- Interface to AtI Fast and full ATLAS simulation
- Soon to be published

# CHIDE model vs KMR model

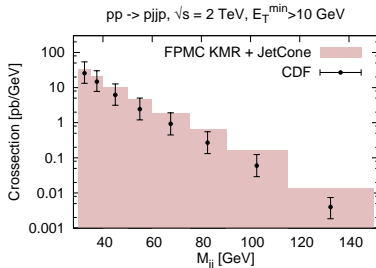
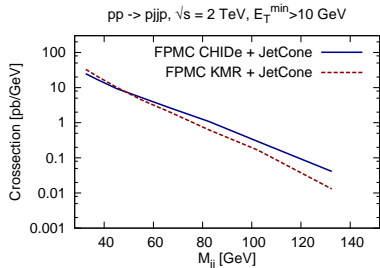
- 1 Models are similar – basically the same ingredients, differences in details
- 2 Different upper limit in Sudakov factor (for jets)
  - 1 KMR:  $s_{gg}$  – gluon-gluon invariant mass
  - 2 CHIDE:  $k_{T2}$
- 3 Exact kinematics in CHIDE (collinear for KMR)
- 4 Proton wavefunction included in CHIDE – in addition to Sudakov factor there is an impact factor, regulating divergence by suppressing very soft gluon emissions from proton.



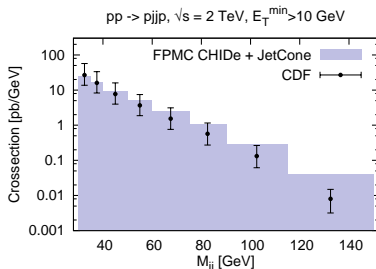
# CDF measurement of exclusive dijets



# Dijet mass distributions



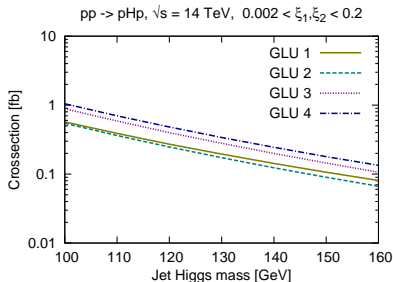
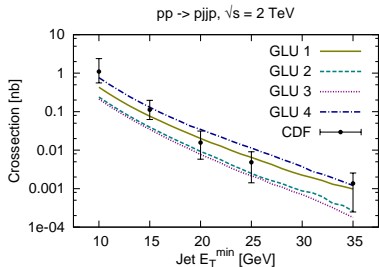
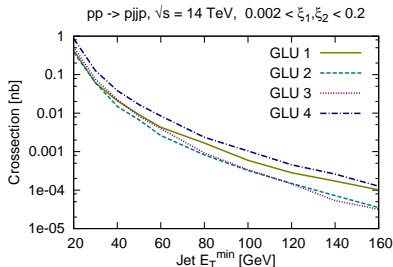
CDF prescription for extracting  $M_{JJ}$  distribution:  
Reweight every MC event using the measured  $E_T^{\min}$  distribution.





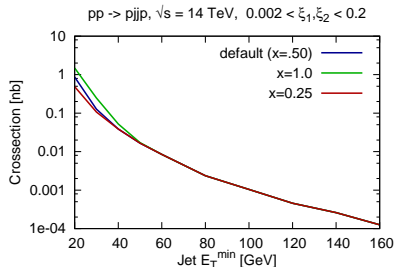
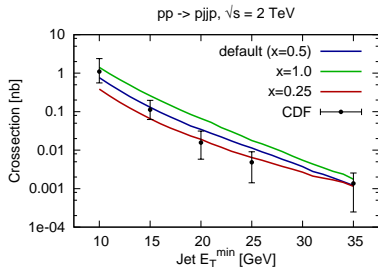
# Model uncertainties – gluon distribution

- 1  $G = G^{\text{hard}} + G^{\text{soft}}$
- 2  $G^{\text{hard}}$  – based on MRST98
- 3 different soft contribution
- 4 different fitting



# Model uncertainties – Sudakov factor upper limit ( $x$ )

$$T(Q_T, \mu) = \exp \left\{ - \int_{Q_T^2/x'}^{\mu^2/x} \frac{\alpha_S(k_T^2)}{2\pi} \frac{dk_T^2}{k_T^2} \right. \\ \left. \int_0^{1-\Delta} dz \left( zP_{gg}(z) + \sum_q P_{qg}(z) \right) \right\}$$

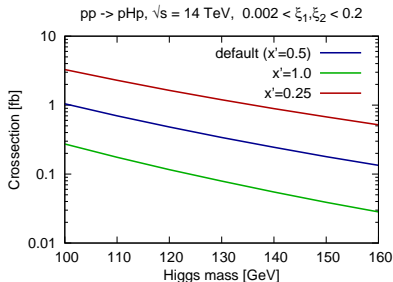
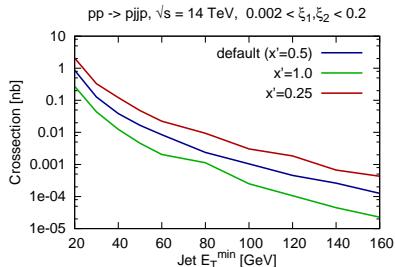
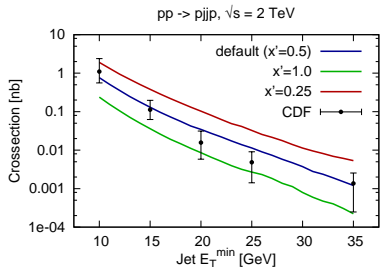


No upper limit ambiguity for Higgs ( $\mu = M_H$ )

# Model uncertainties – Sudakov factor lower limit ( $x'$ )

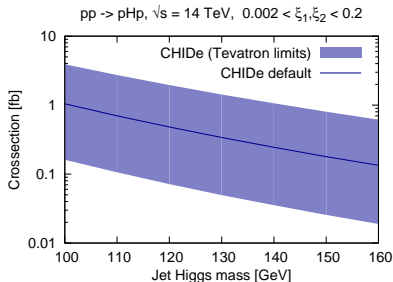
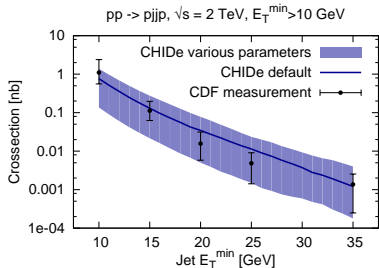
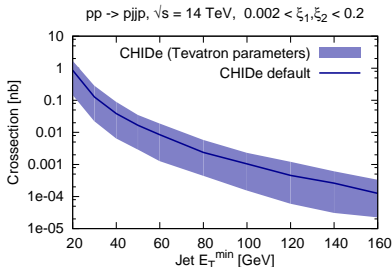
$$T(Q_T, \mu) = \exp \left\{ - \int_{Q_T^2/x'}^{\mu^2/x} \frac{\alpha_S(k_T^2)}{2\pi} \frac{dk_T^2}{k_T^2} \right.$$

$$\left. \int_0^{1-\Delta} dz \left( zP_{gg}(z) + \sum_q P_{qg}(z) \right) \right\}$$



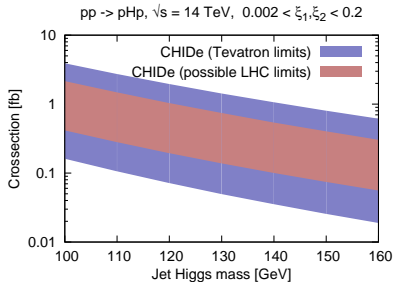
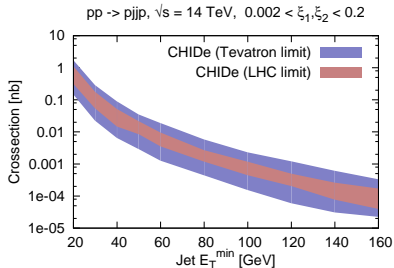
# Model constraining from CDF measurements

- For each gluon distribution choose a range of lower Sudakov limit ( $x'_{min}$  and  $x'_{max}$ ) which agrees with CDF measurement
- For each gluon distribution use the same  $x'$  range to calculate uncertainty on LHC dijets and Higgs



# Model constraining from LHC measurements

- Assume LHC measurement of exclusive dijets
  - **For each gluon distribution** choose a range of lower Sudakov limit which agrees with CDF
  - **For each gluon distribution** use the same range to calculate uncertainty on LHC dijets and Higgs
- ↓
- Dijets measurement – constraining uncertainties for exclusive Higgs
  - Dijets and Higgs measurement – constraining both gluon and  $x'$



- 1 FPMC is developing rapidly – quark jets, di-photons in CHIDe model and Krakow model this year
- 2 CHIDe & KMR – fine description of CDF dijet measurement
- 3 Uncertainties for Higgs production can be constrained by LHC measurements of exclusive dijets
- 4 Need for studies of other exclusive processes to constrain better the Higgs prediction