

What is needed for precise diffractive measurement?

- Which measurements do we want to perform ?
- What is needed for that ?

With a lot of input from M. Arneodo, A. Vilela Pereira, A. Proskuryakov

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 - data

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- Which measurements do we want to perform ?
- What is needed for that ?
 - data
 - Monte Carlos

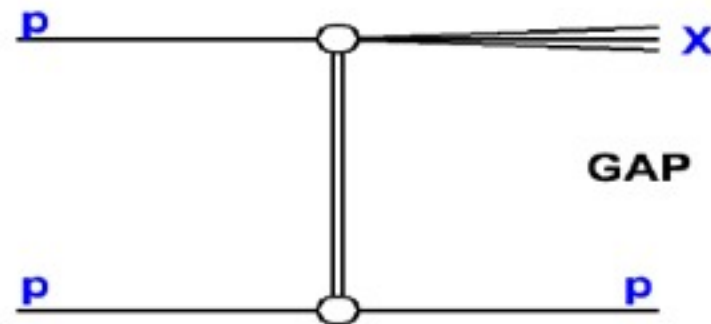
What is needed for precise diffractive measurement?

- Which measurements do we want to perform ?
- What is needed for that ?
 - data
 - Monte Carlos
 - and ?

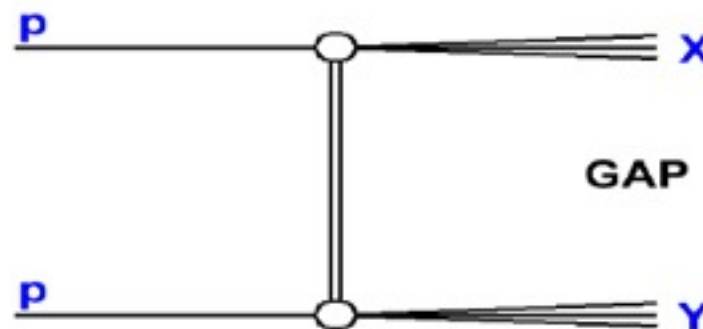
Early measurements: diffraction in minbias

from M. Arebedo

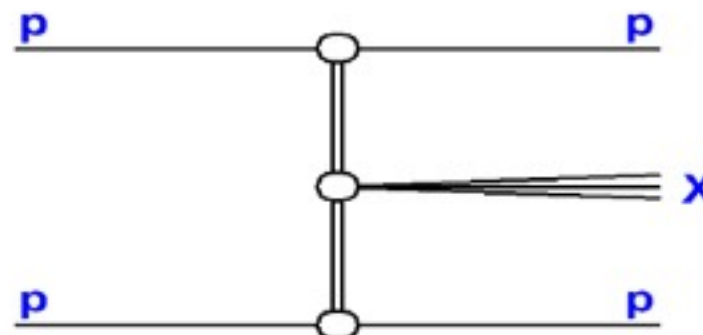
Single diffraction



Double diffraction



Central diffraction

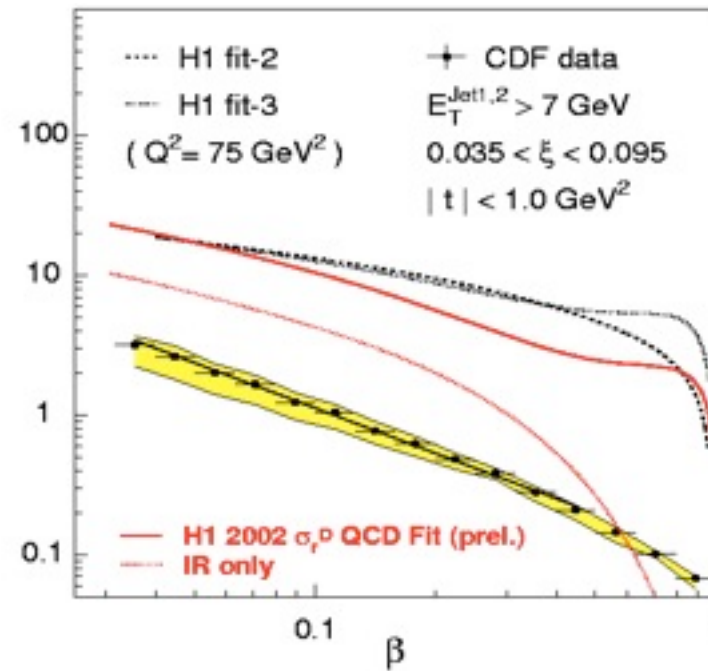
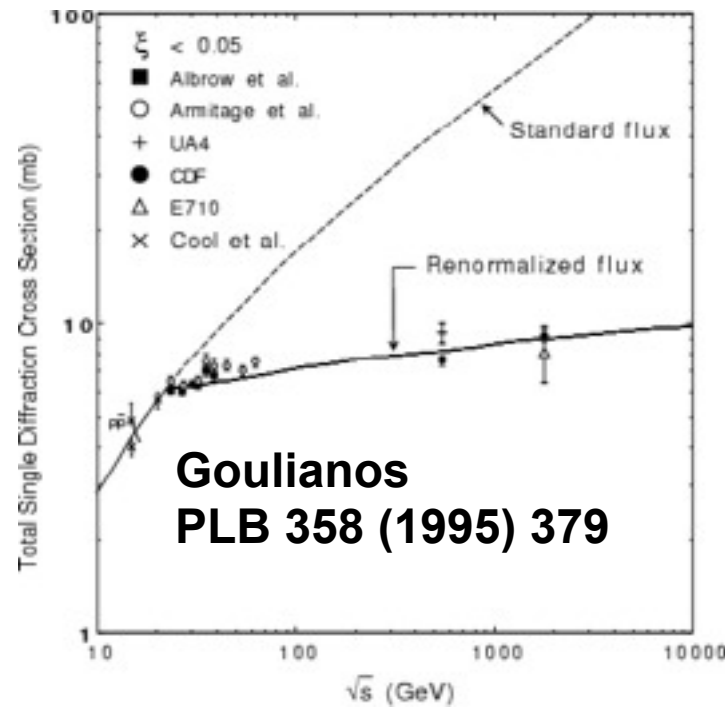


- Measurement of diffractive contribution to total xsection
- important for min-bias
- ingredient for UE simulation
- purely soft process, no hard scale involved

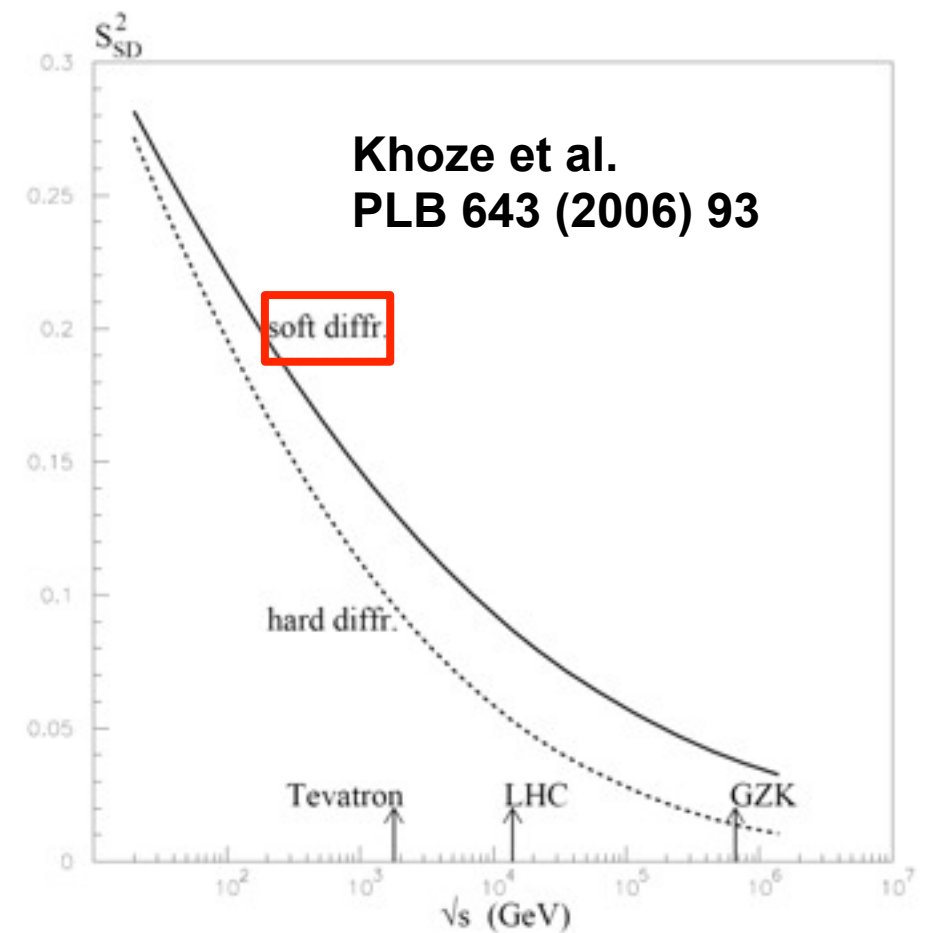
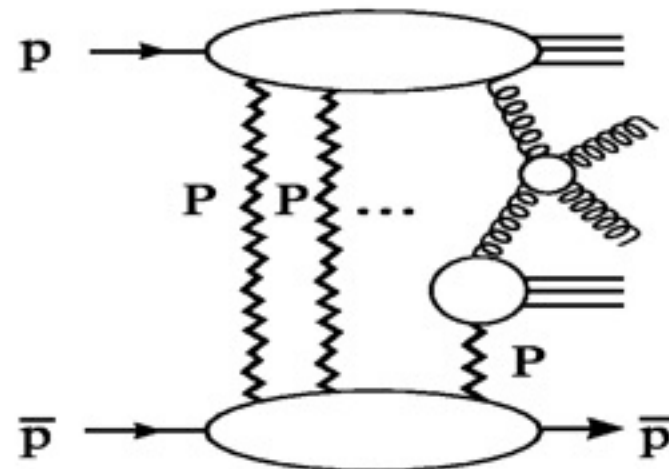
- Beam particles emerge intact or dissociated into low-mass states
- Proton fractional energy loss: ξ -- cross section $\sim 1/\xi$
- Final-state particles separated by large polar angle: **Large Rapidity Gap**

Why is s dependence of SD interesting ?

from M. Arendo



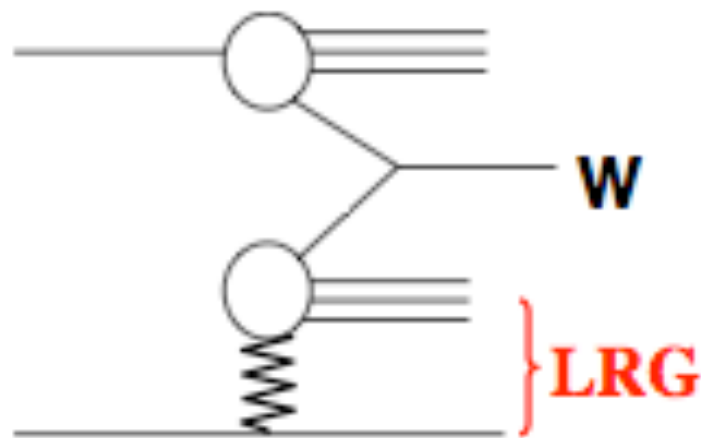
\sqrt{s} dependence of SD related to “shadowing”, “rescattering” corrections, now quantified by “rapidity-gap survival probability” S^2



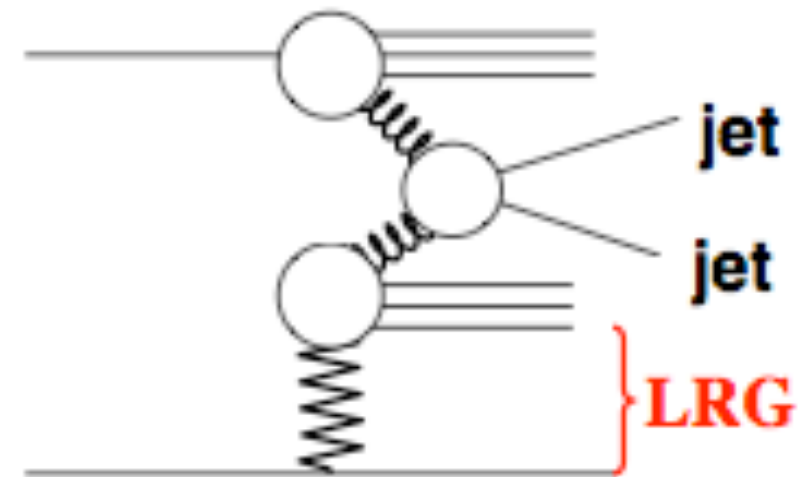
Early measurements: hard diffraction

from M. Arneodo

CMS feasibility studies:



Single diffractive W production
(CMS PAS DIF-07-002)

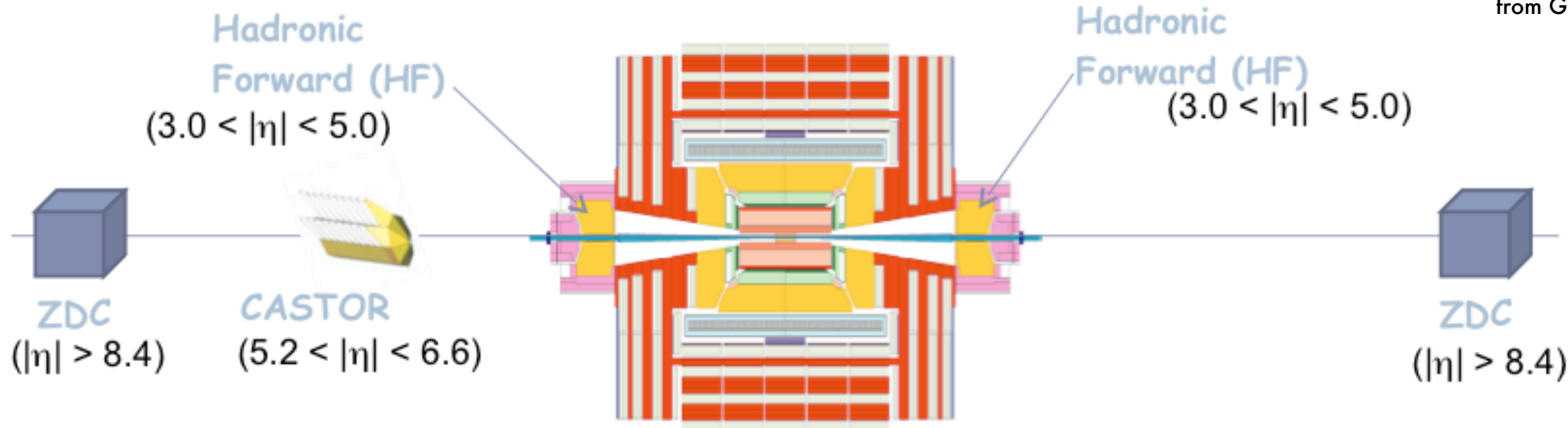


Single diffractive di-jet production
(CMS PAS FWD-08-002)

Available from <https://twiki.cern.ch/twiki/bin/view/CMS/PhysicsResults>

CMS forward detectors

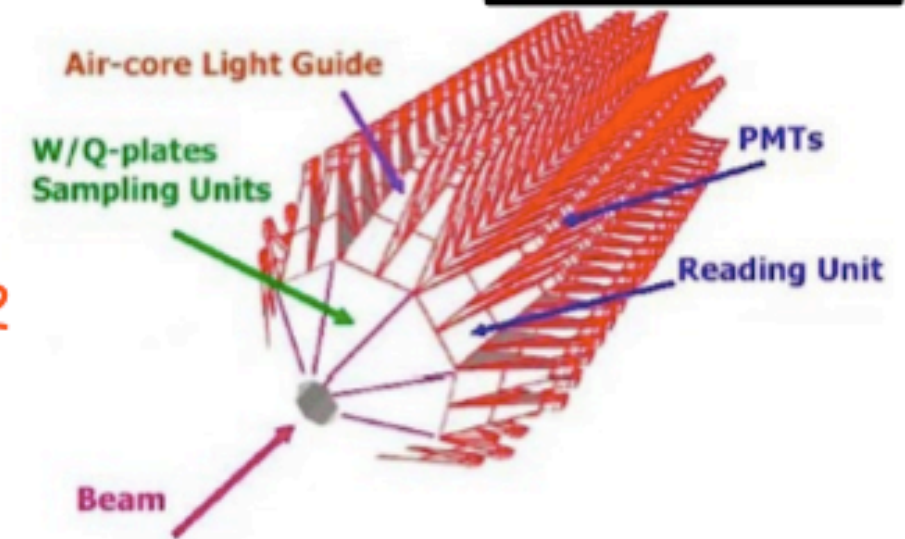
from G. Brona



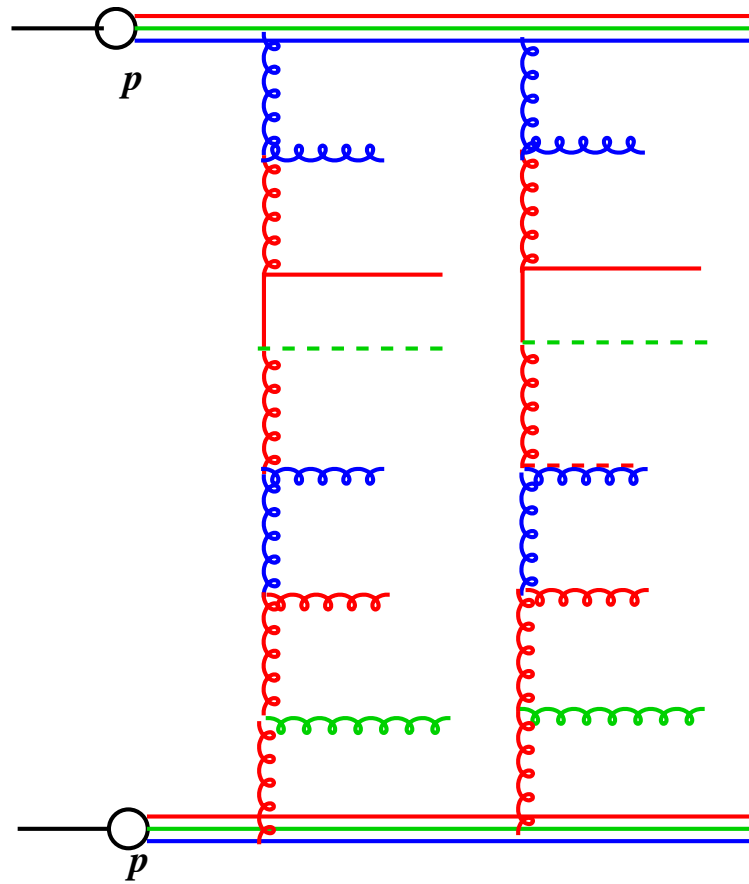
- Located at 11.2 m from IP
- Steel absorbers and embedded radiation-hard quartz fibers for fast collection of Cherenkov light
- Rapidity coverage: $2.9 < |\eta| < 5.2$
- 0.175x0.175 segmentation in η and ϕ



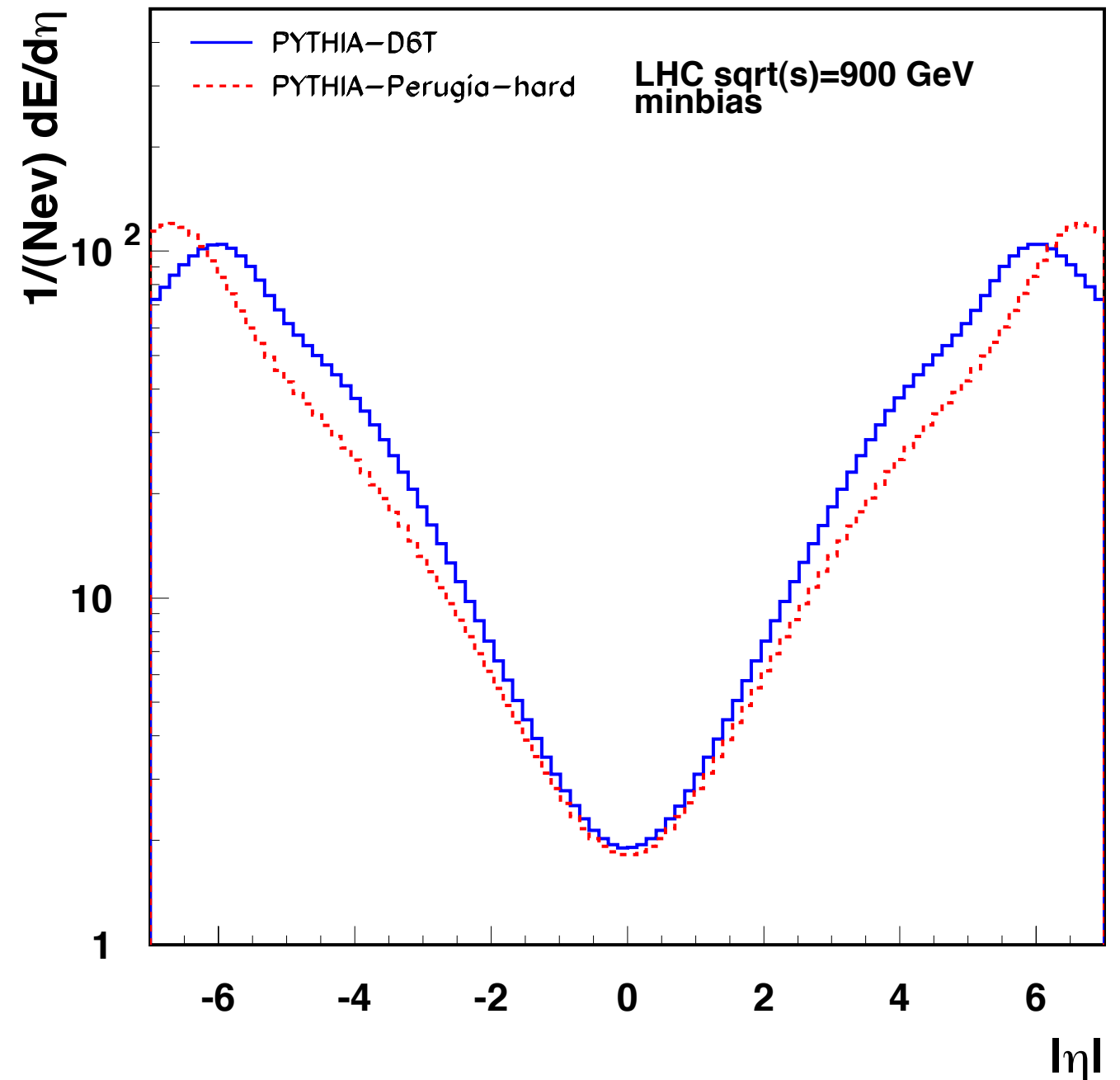
- Located at 14.3 m from IP
- Rapidity coverage: $-6.6 < \eta < -5.2$
- Segmentation in ϕ (16 sectors)
- 14 modules (2EM+12HAD)
- Alternate tungsten absorbers and quartz plates



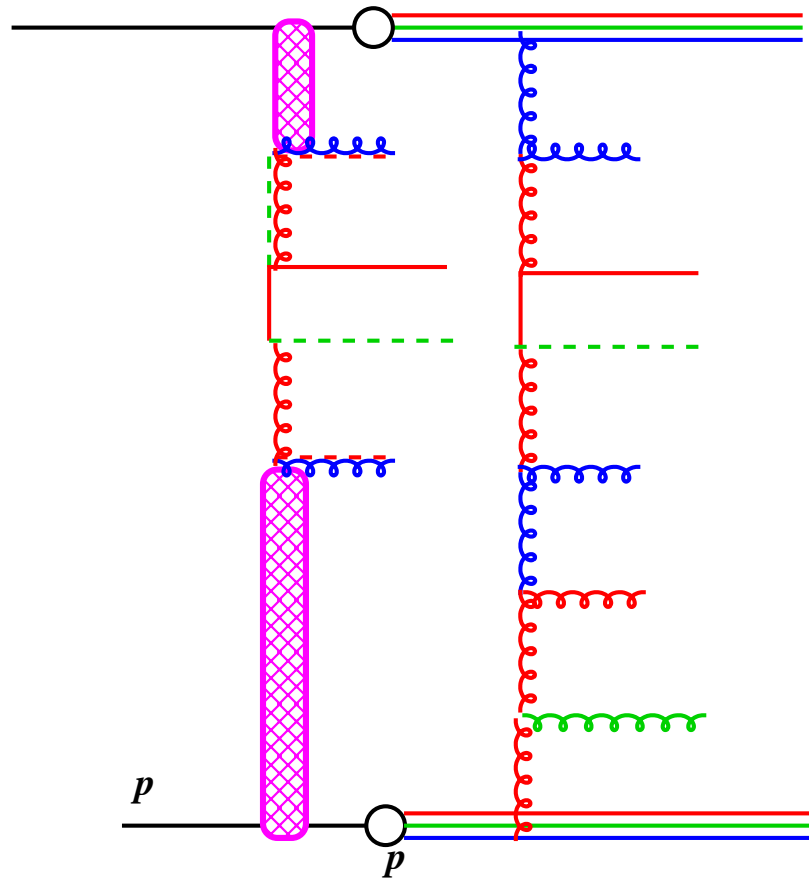
Early measurement: energy flow in min bias



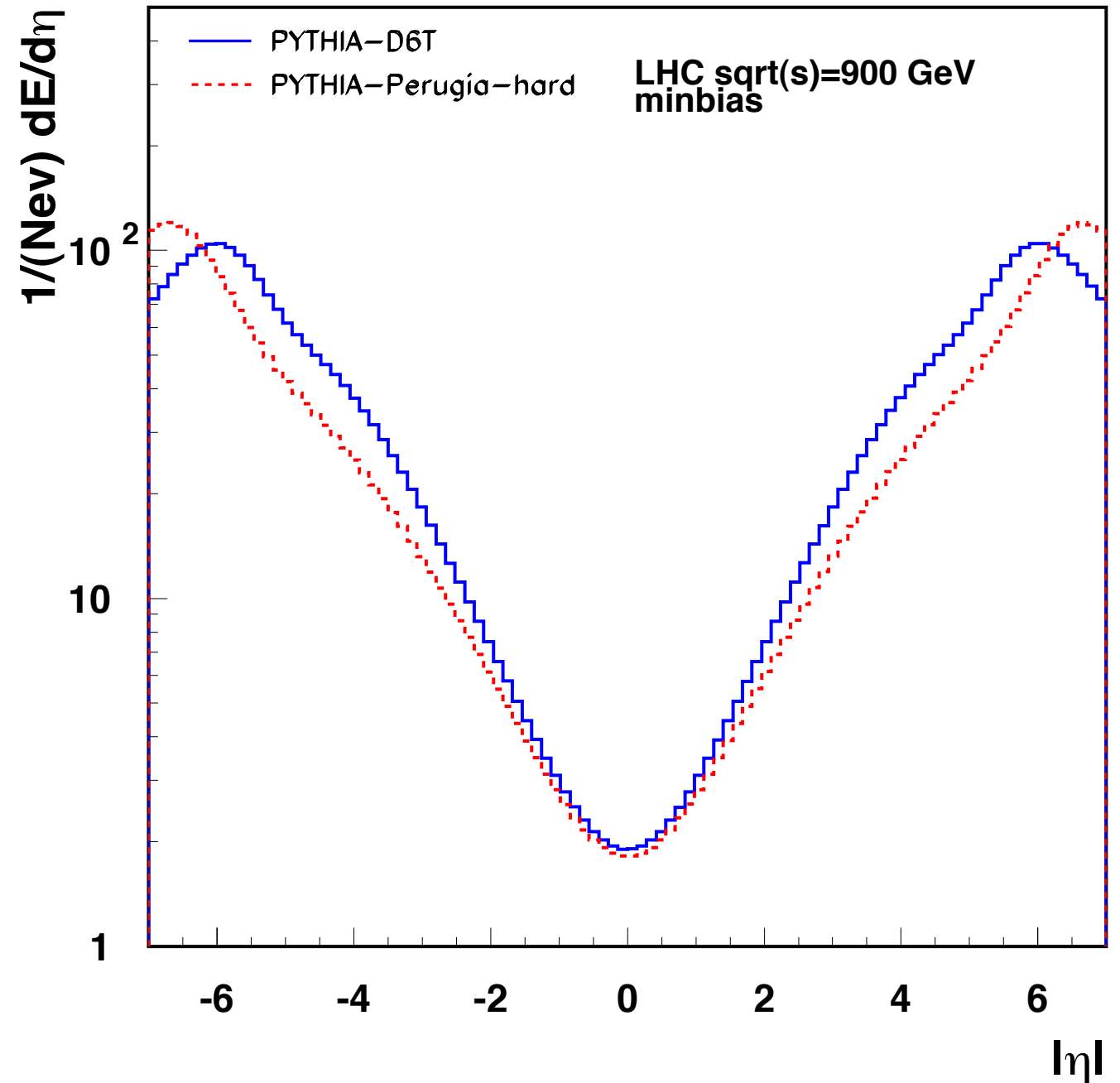
- **But**, what if there is a diffractive process involved?
- can have very different energy flow
- can lead to very different conclusions ...
- is not yet in any MC



Early measurement: energy flow in min bias

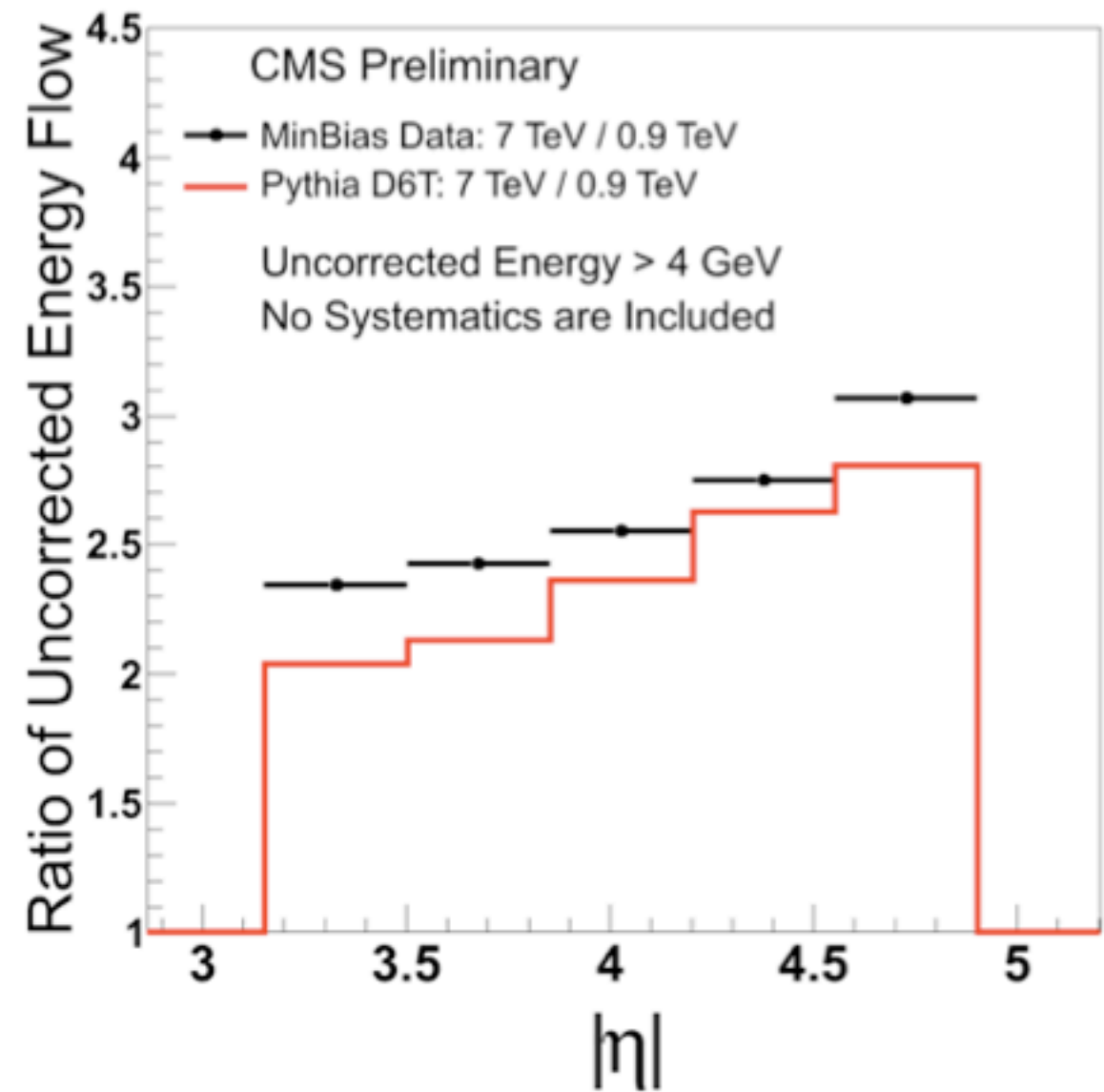
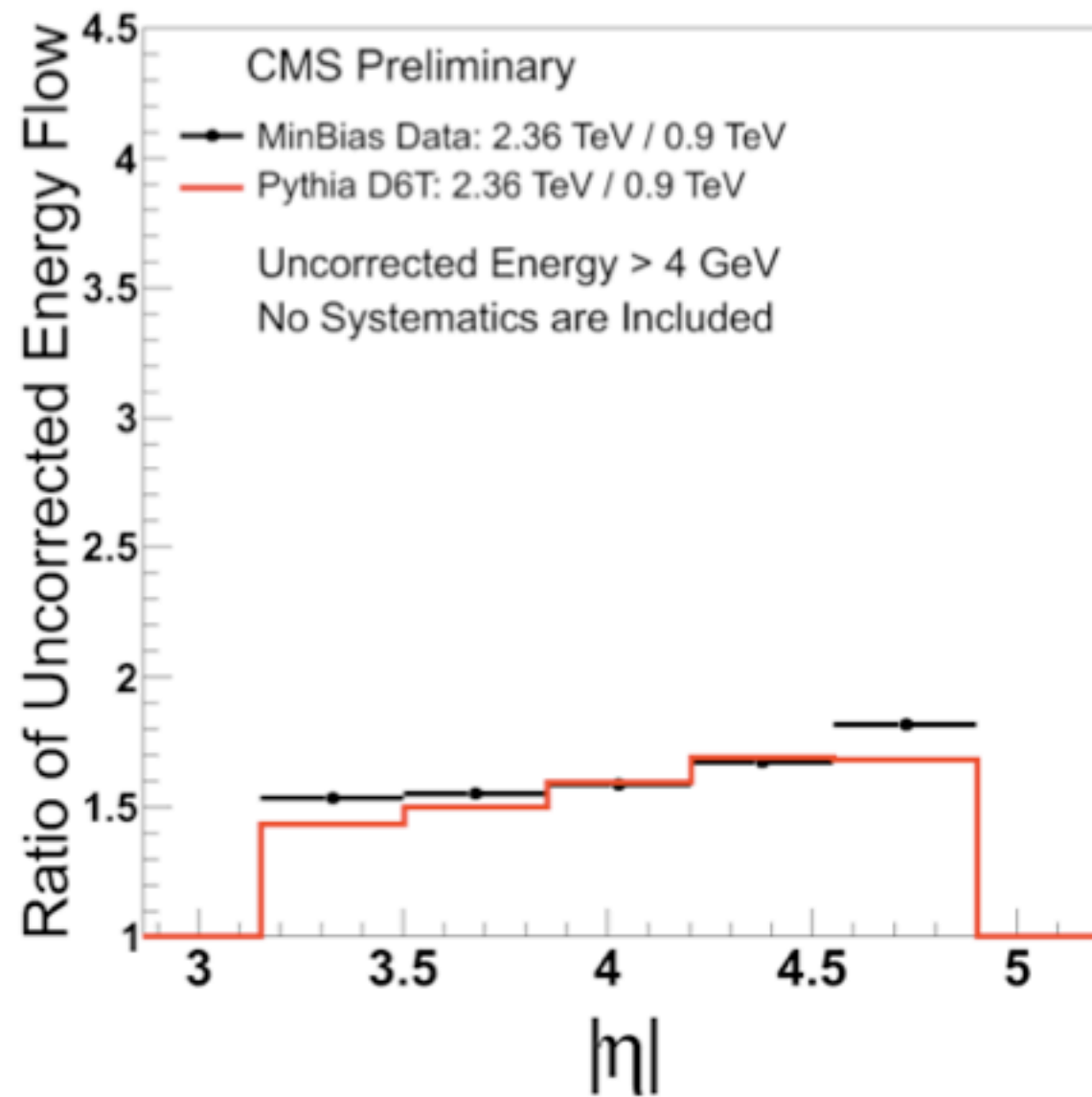


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Early measurement: energy flow in min bias

Collision Data

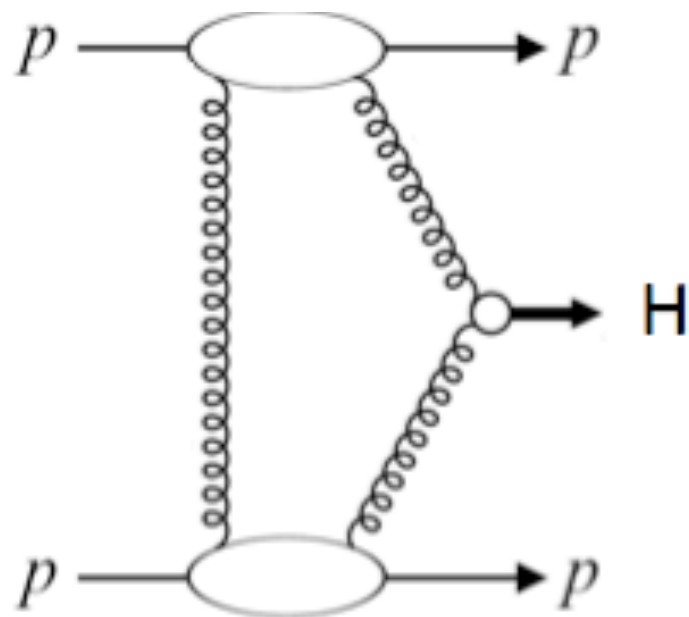


MC prediction in agreement with measured ratio.

No systematic uncertainties are included, no conclusion on the quality of description can be made.

Where is here diffraction ?

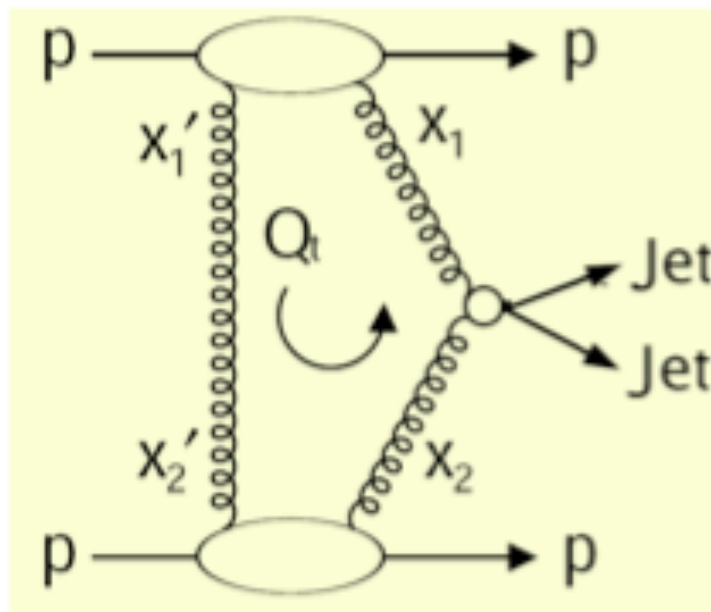
Early measurements: exclusive dijets



- ✓ clean process
- ✓ exclusive $b\bar{b}$ suppressed

Khoze Martin Ryskin: $\sigma_H(\text{LHC}) \sim 3 \text{ fb}$,
signal/bkg ~ 3 (if $\Delta M_{\text{miss}} = 1 \text{ GeV}$)

Attractive Higgs discovery channel at the LHC



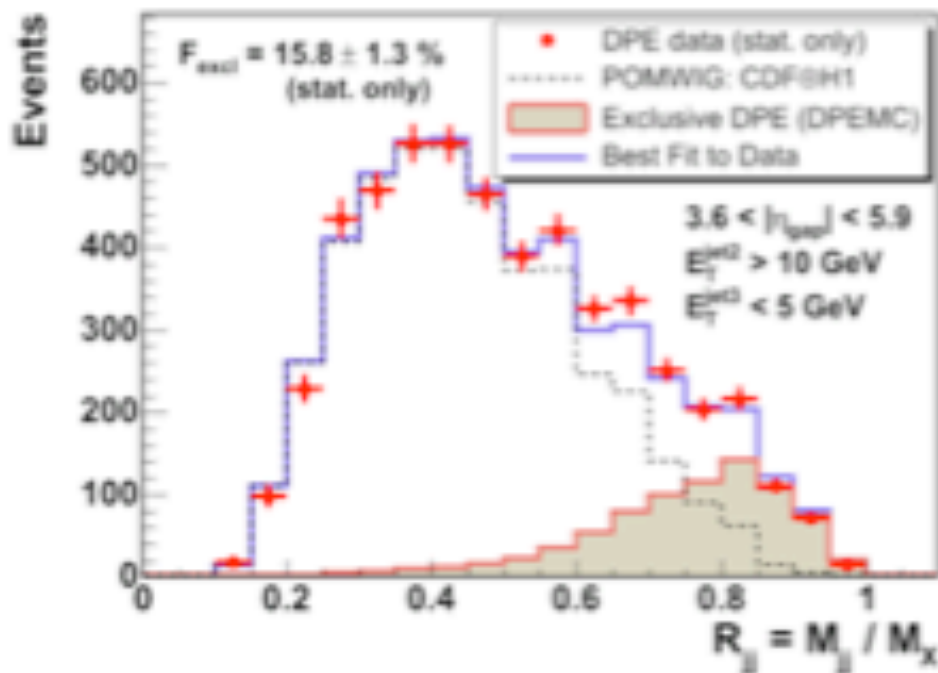
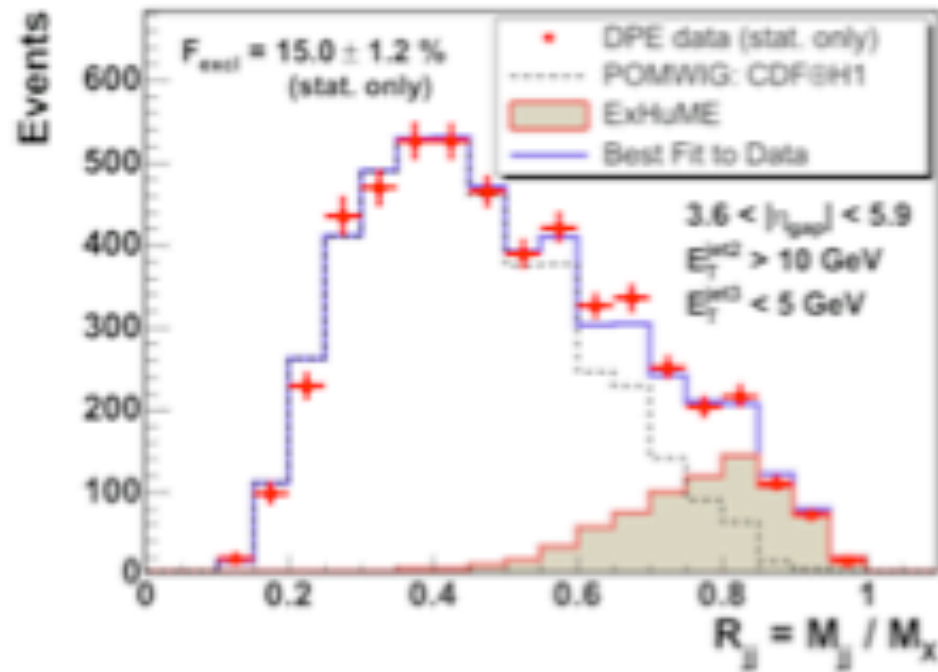
⇒ much larger cross section

Goal:

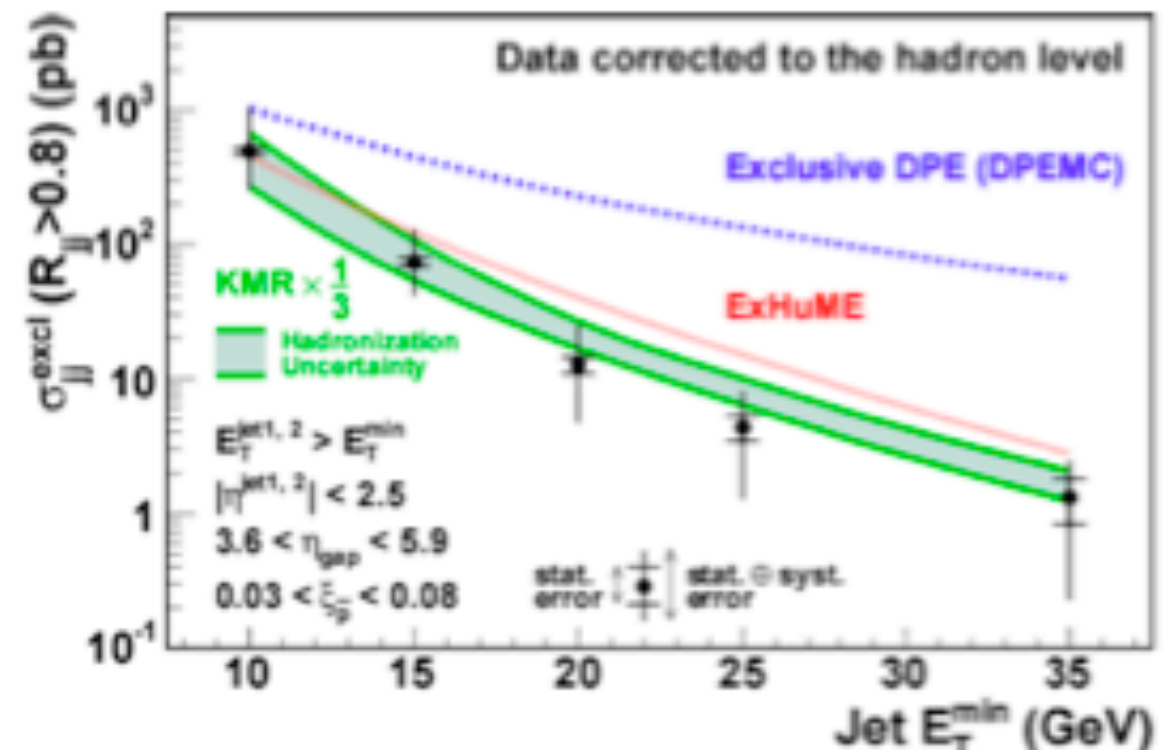
- measure exclusive dijet production (if it exists)
- test/calibrate Higgs predictions at LHC

Exclusive dijet cross section

Phys.Rev.D77:052004,2008



- $R_{||}$ shape described by MC based on two models (ExHuME, DPEMC)
- Cross section agrees with ExHuME
- Data favor KMR model (uncertainty ~factor of 3)

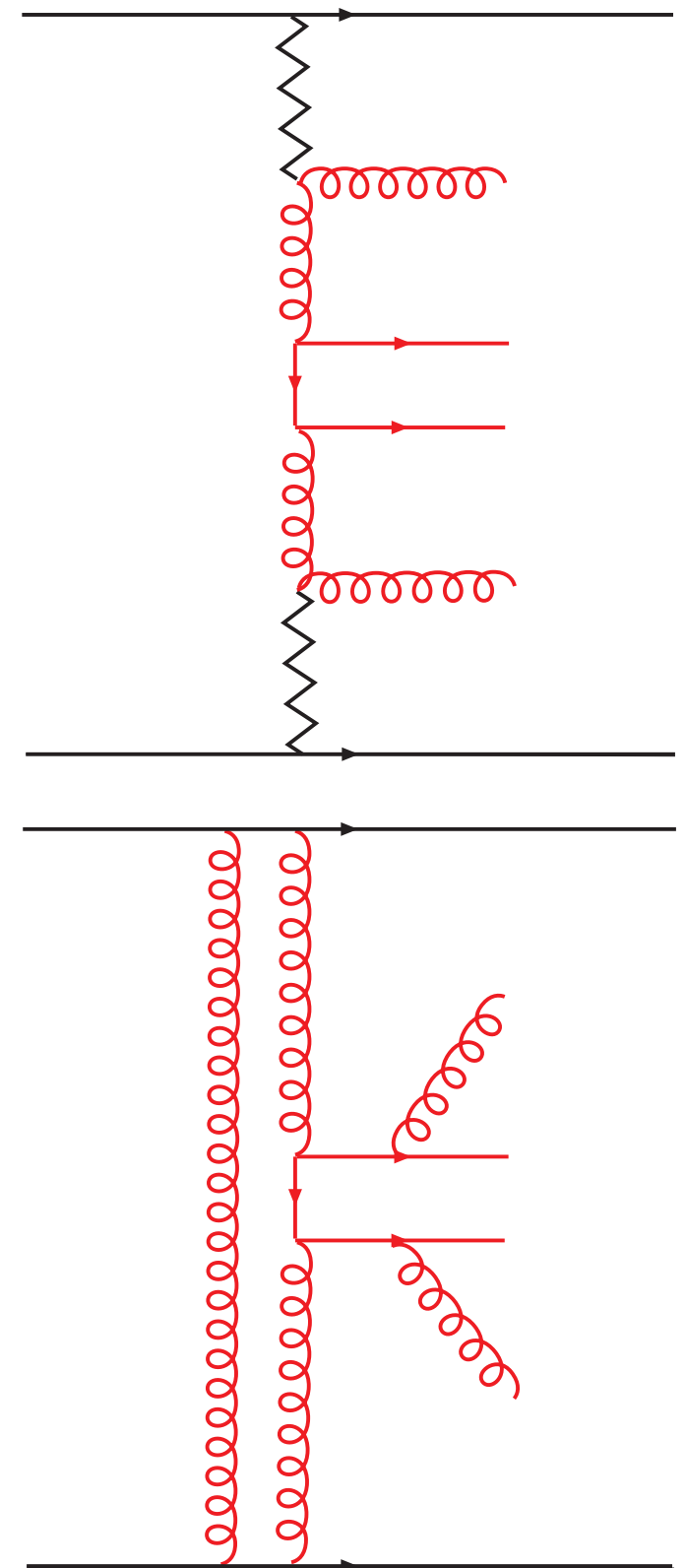


Michele Gallinaro - "CDF experimental results on diffraction" - MPI@LHC'08 - Perugia, Oct. 29, 2008 24

**What are potential systematic effects
in these measurements ?**

Questions on exclusive diffraction

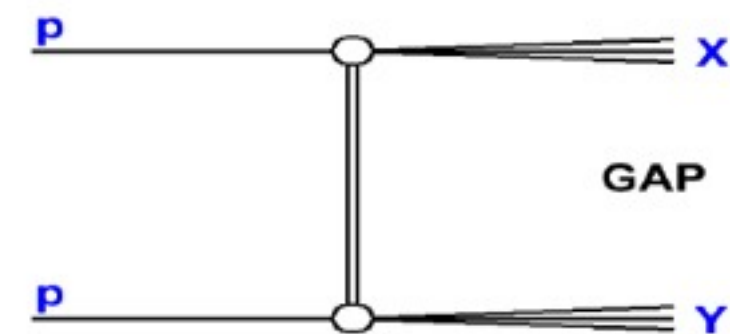
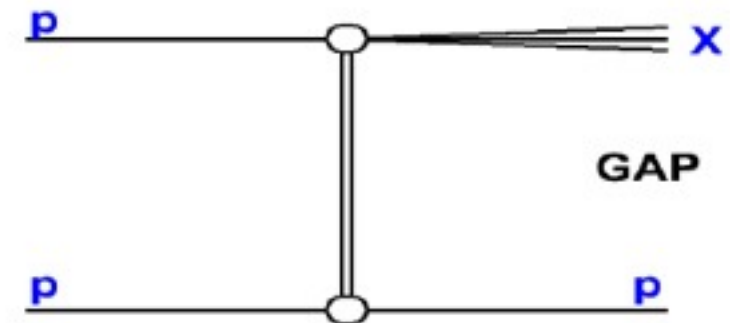
- How sensitive is the M_X spectrum to details of hadronization and parton showering
 - final state parton shower
 - what about different parton showers?
 - how well is hadronisation done ?
 - what about different hadronisation models ?
 - is it exactly like e^+e^-
 - what about qqg states - how are they different from a initial state radiated gluon ?



Questions on systematics

A. Proskuryakov

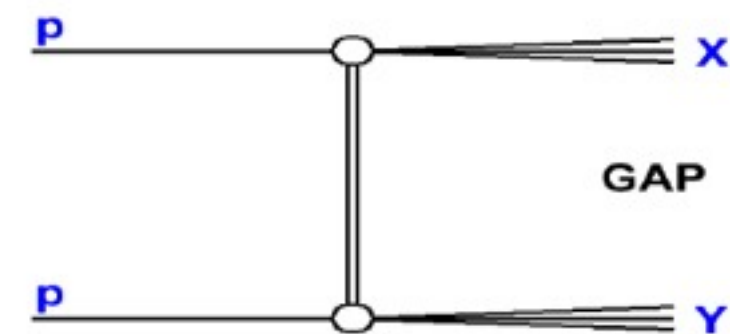
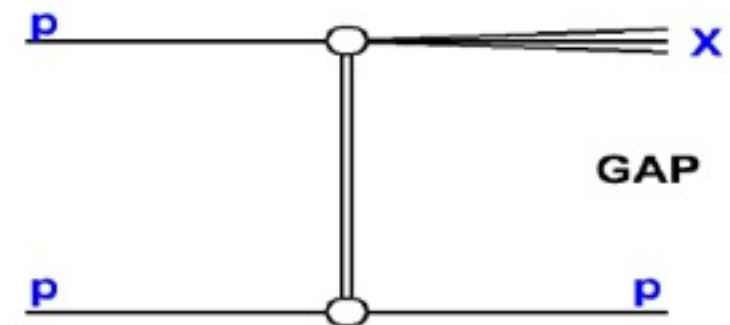
- **Single Dissociation**
 - contribution from soft Pomeron exchange
 - contribution from secondary trajectories and Reggeon (at HERA this was important ($\xi \leq 0.1$))
 - what about interference effects of Pomeron-Reggeon
- **Single - Double Dissociation**
 - low - high mass dissociative systems
 - treatment of low mass system can influence rapidity gap x-section
 - pt distribution of partons in low and high mass system ?



Questions on systematics

A. Proskuryakov

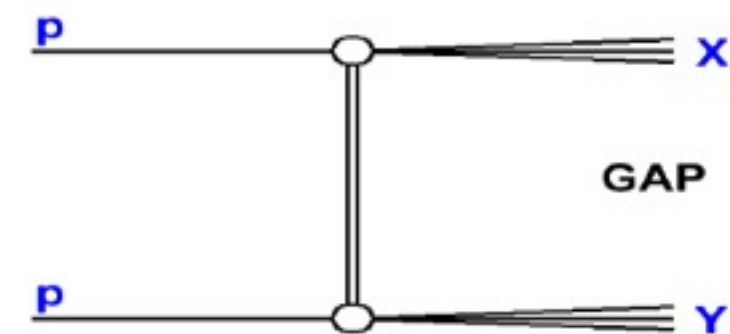
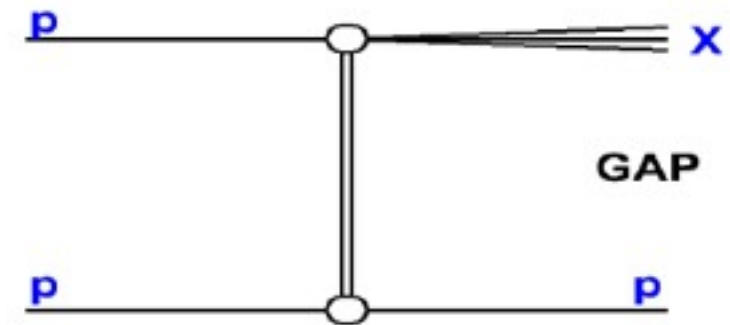
- **proton dissociation:**
 - what are the details of the M_x and M_y system ?
 - **low mass diffraction:** simple hadronization but even for that it was tricky at HERA (differences between H1 and ZEUS)
 - **high mass diffraction:** should contain all the pQCD effects (jets, heavy quarks etc) as discussed before
 - how is that included in the simulation of MB and total x_{sec} ?



Questions on systematics

A. Proskuryakov

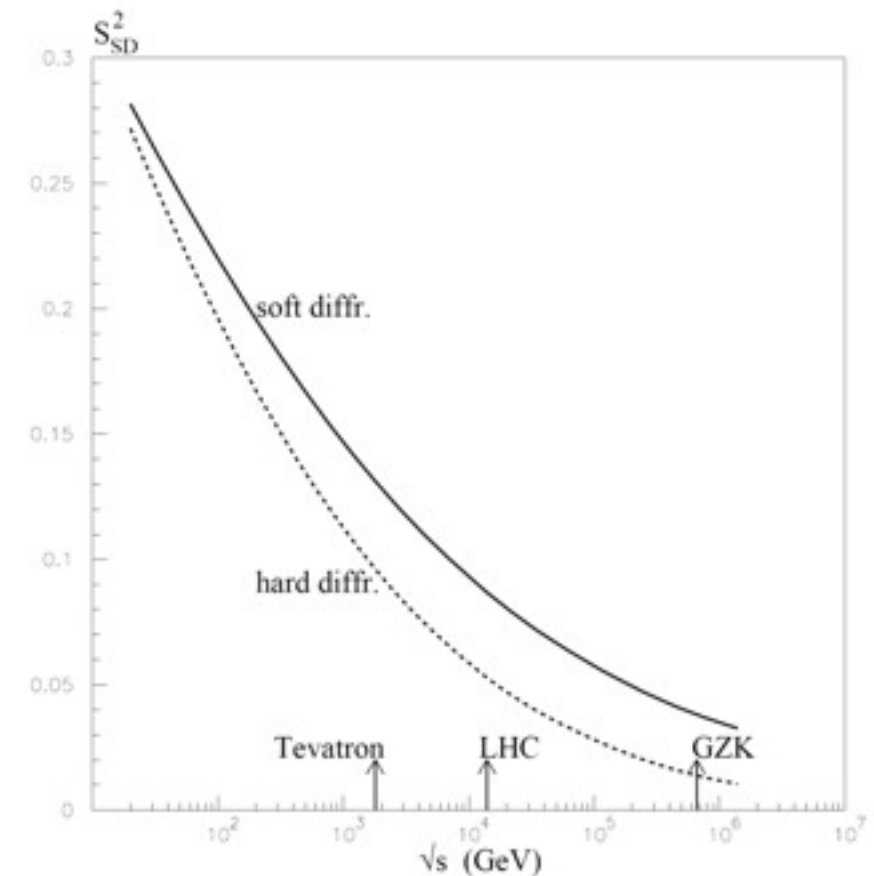
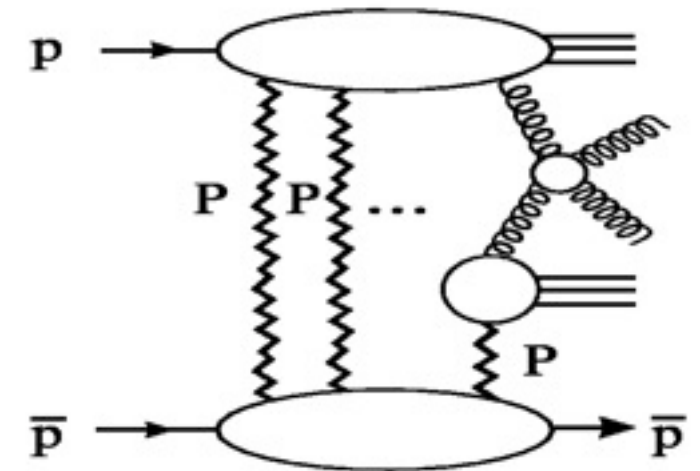
- **Measurement of soft Single Dissociation:**
 - experimentally observe only part of dissociative system (without low mass piece).
 - measure above $M_x > 30$ GeV or so
 - how can this be used to constrain modelling of low mass dissociation ?
- **Measurement of hard Single Dissociation:**
 - due to requirement of jets/W low mass plays little role... **but** what about contribution from DD with small M_y ?



Questions on systematics

A. Proskuryakov

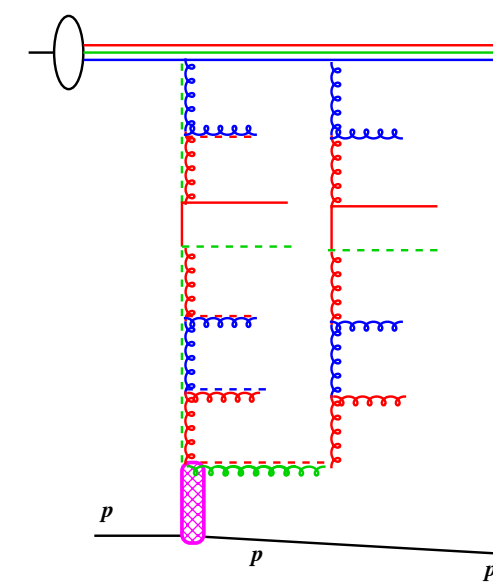
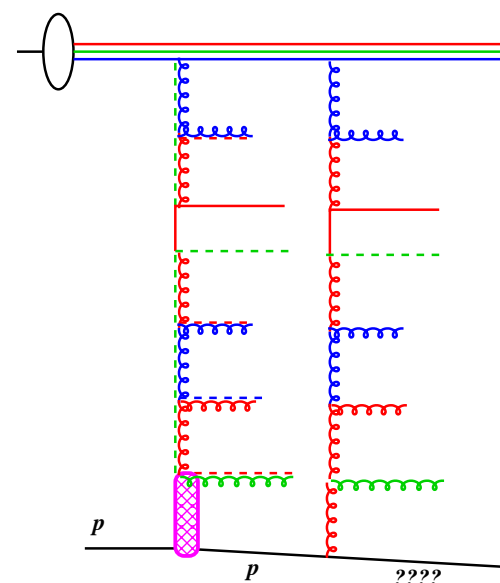
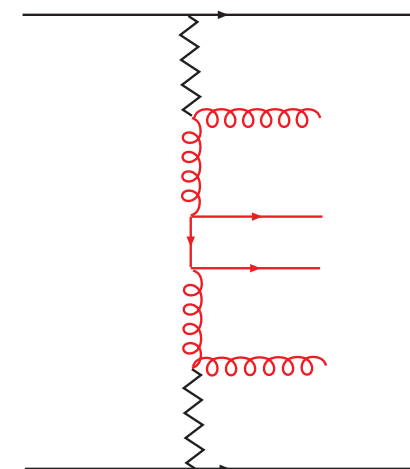
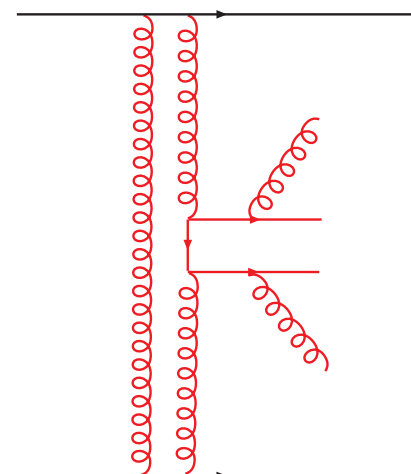
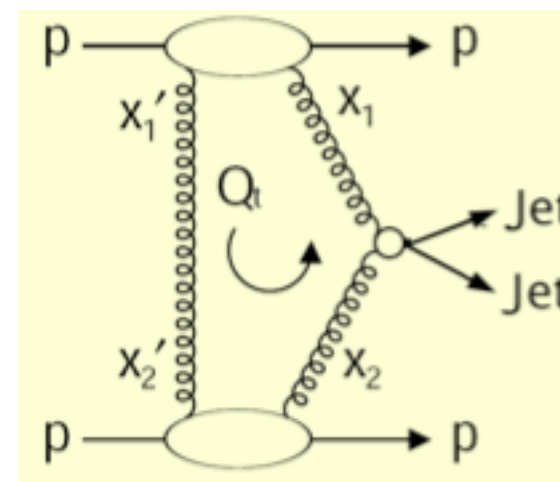
- **Hard diffraction:**
 - contribution from Reggeon exchange to hard diffractive x-section ?
 - how to merge non-diffraction and hard diffraction without double counting ?
 - does the same mechanism as at HERA apply ?
 - gap survival probability
 - if $S^2 \sim 0.05$, where are the remaining 95 % of diffractive events ?
 - how is/can this be included into underlying event - multiparton interactions ?
 - what is the effect not only in diffraction but also in non-diffraction ?
 - what is the final state of those ?



Questions on systematics

A. Vilela Pereira

- **Selection of exclusive dijets relies on**
 - non-diffractive component
 - single & double dissociation
 - simulation of exclusive jet fragmentation and parton showering:
 - charged track multiplicity
 - energy deposition
- **Simulation of hard Processes in diffraction**
 - including MPI between remnants
 - including MPI between dissociative systems
 - including MPI between elastic p and remnant



Questions on systematics

A. Vilela Pereira

- selection of **rapidity gap events** depends much on the simulation of non-diffractive events: different tunes of MPI give large uncertainties...
- **need reliable MPI simulation** for the forward regions (where the rapidity gaps are ...)

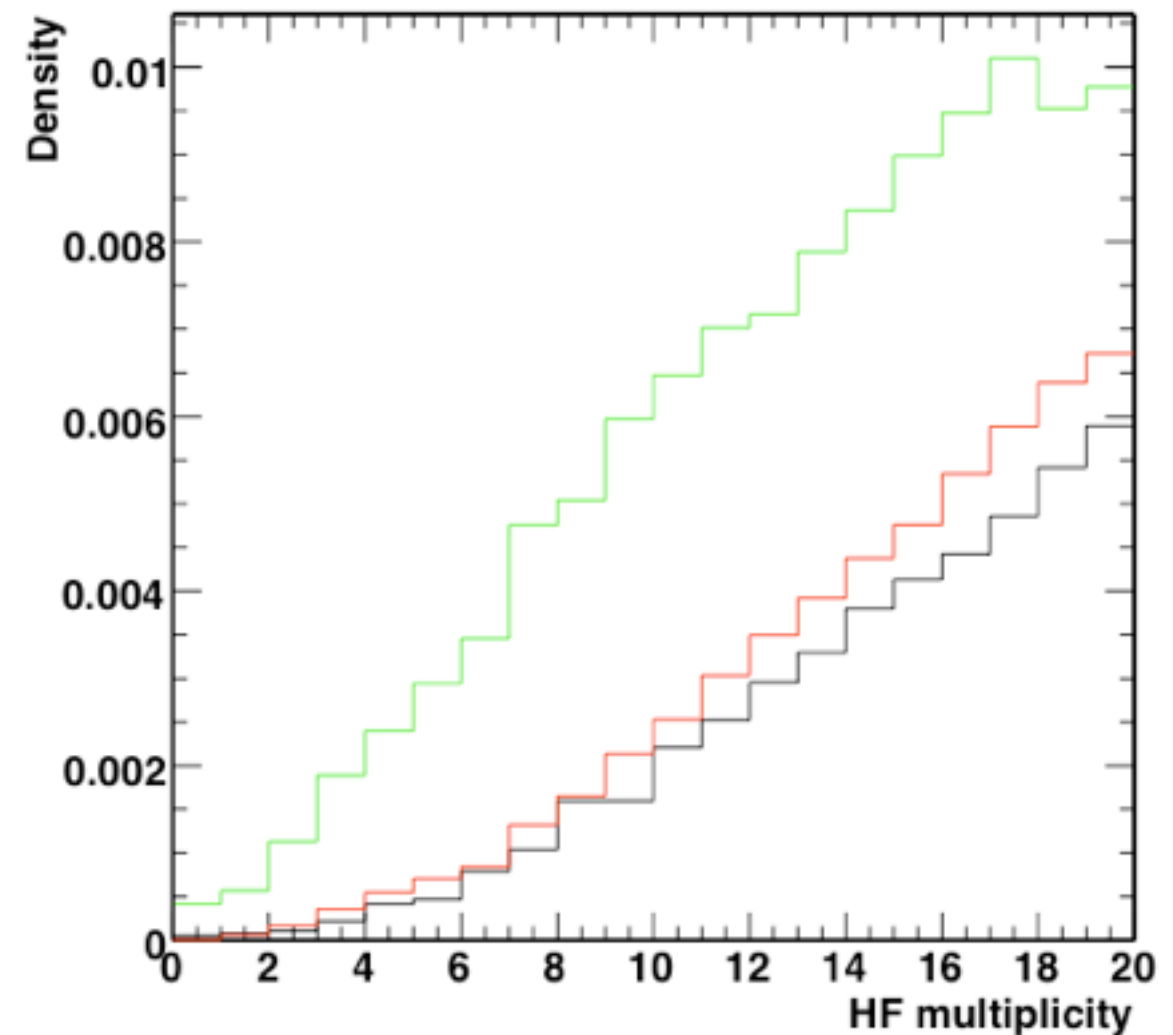


Figure 43: Comparison of the generator-level HF tower multiplicity for events generated with PYTHIA default tune DWT (black histogram), tune S6T (red histogram) and tune S0 (green histogram). No cut on N_{track} was

Planned measurements

- measurement of single dissociation in min bias events in a limited M_x range
- measurement of diffractive dijet production
- measurement of diffractive Drell Yan and W/Z
- measurement of transverse energy flow in forward region

Conclusions

- first measurements are coming very soon
- **NEED** combined HERA dPDFs (like for the proton)
- **NEED** of combined Tevatron results
- **NEED** support from theory, phenomenology **AND** **MC** groups
 - how well is diffractive final state understood
 - soft/hard: parton showering and hadronization
 - how well is edge of rapidity gap simulated
 - soft or hard Pom remnant ?
 - how well is non-diffractive “background” simulated
 - how reliable can diffractive PDFs from HERA transported to LHC

Support from theory, phenomenology and **MC** is very welcome and needed (not on the exotic pieces...) and will help to reduce the model uncertainties for diffraction **BUT ALSO** for

NON -DIFFRACTIVE MEASUREMENTS