

(Hard) diffraction at LHC

Challenge to tag the LRG at the LHC

- The rapidity gap(s) maybe **very forward and outside CMS-ATLAS acceptance**
- **Pileup** events destroy the gap(s) **ALICE and LHCb** in a favorable situation!
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→ **LRG not always/really usable** → **proton tracking (and timing) detectors**

- Already installed
 - TOTEM Roman Pot (RP) stations
N.B.: joint TOTEM-CMS data taking!
 - ATLAS/ALFA RP stations
- > 2016
 - CT-PPS (CMS-TOTEM)
 - AFP (ATLAS)

Hard diffraction with CMS/ATLAS run I data

- A few measurements with **Run I** data based on LRG tagging
 - Dijet cross section measured by CMS and ATLAS. Comparing to MC predictions based on dDPDFs from HERA, an estimate of the gap survival probability was obtained [PRD 87 (2013) 012006], [arXiv:151100502]
 - W/Z events with a pseudorapidity gap observed by CMS. For most of them the charged leptons from W/Z decays were found in the hemisphere opposite to the gap, consistent with diffractive W/Z production [EPJ C72 (2012) 1839]
 - Jet-gap-jet analyses
 - ATLAS [EPJ C72 (2012) 1926, EPJ C74 (2014) 3117]
 - **New:** CMS [CMS PAS FSQ-12-001]
- CMS-TOTEM common 2012 data with proton tag under analysis

The operation/installation of forward detectors will lead to unprecedented possibility in the understanding of forward physics

Plenty of ideas for diffractive measurements!

The Yellow Report: hard diffraction (chapter IV)

□ Topics

- Single diffractive jet production (ATLAS AFP/ALFA)
- Single diffractive W, Z production (CMS-TOTEM and ATLAS AFP/ALFA)
- Single diffractive J/psi production (CMS-TOTEM)
- Double Pomeron Exchange jet production (ATLAS AFP/ALFA)
- Double Pomeron Exchange photon+jet production (ATLAS AFP/ALFA)
- Double Pomeron Exchange jet-gap-jet production (ATLAS AFP/ALFA)
- Single diffractive Drell-Yan production (theory)
- Ultra-Peripheral Collisions (theory)

□ Different running conditions investigated ($\beta^* = 0.55$ m and $\beta^* = 90$ m)

□ Physics and beam background treatment addressed

□ Monte Carlo studies extrapolated to 13/14 TeV in all cases

Mandatory issues (personal view)

Measurement of the **gap survival probability**

Never-ending **discussion on diffractive dijet production at HERA**...is it photon issue or rather survival probability issue? If the latter, is there something which we can do at the LHC to clarify the issue?

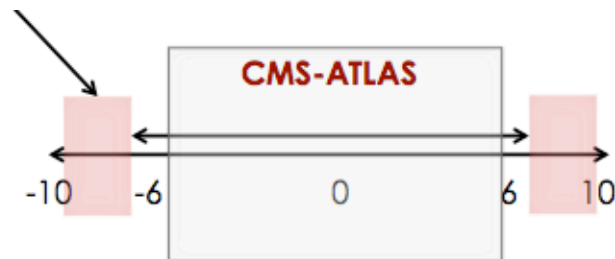
Common **dPDF fit** to LHC + HERA data, what is needed from LHC?

Where is the rapidity gap at LHC ?

- Total room for particle production @LHC: $\Delta\eta \approx \ln(s/m_p^2)$
- Rapidity range effectively populated by particles: $\Delta\eta \approx \ln(m_x^2/m_p^2)$

Depends on M_x , e.g. with $M_x = 500 \text{ GeV}$: $\Delta\eta \approx 12$

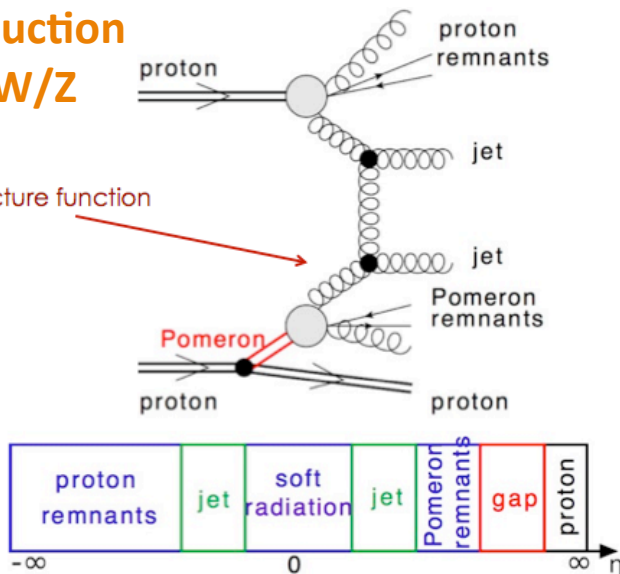
- The resulting gap size depends on the process, e.g. in central diffraction, assuming two symmetric gaps, each will have a size of $\Delta\eta \approx \frac{1}{2}(20-12) \approx 4$ i.e. **very forward, often outside CMS-ATLAS acceptance**



Topologies of gap events in hard diffraction

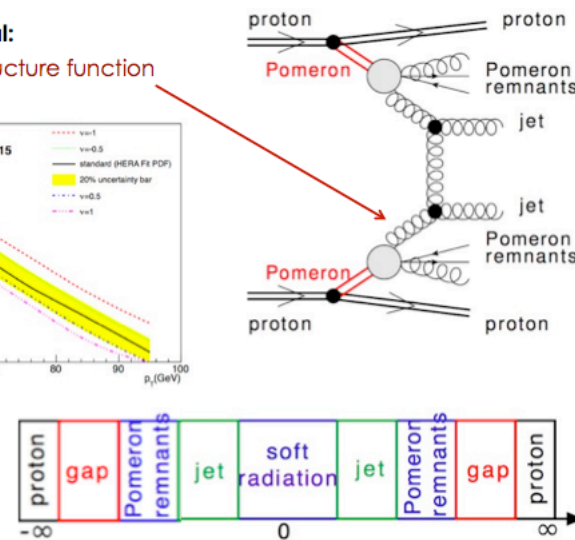
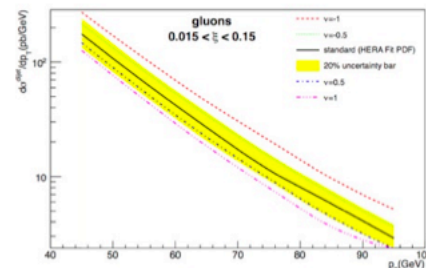
SD production of jets, W/Z

Main Goal:
Gluon structure function

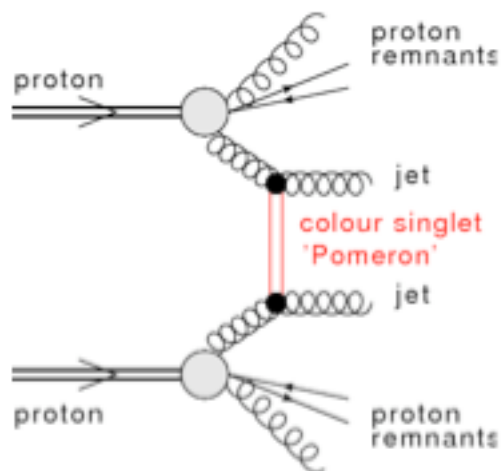


DPE

Main Goal:
Gluon structure function



jet-gap-jet



DPE with jet-gap-jet

Main Goal: BFKL evolution between the hard scale set by the two jets

