Diffractive measurements and analysis at CMS

RDMS/IHEP Diffractive Physics Group

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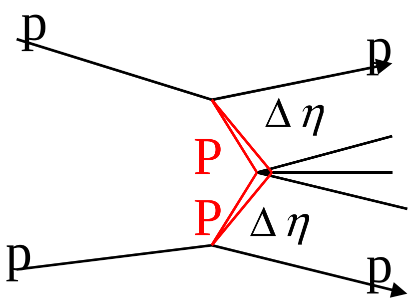
Beam properties at first runs allow to study diffractive physics at unique conditions:
no pile-up

L ~ 10^30 – 10^32 => 0.0027 – 0.27 inelastic events/BX

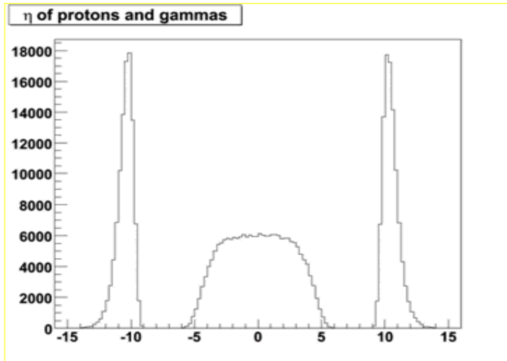
At these conditions we can apply rapidity gap selection of diffractive events



Central diffractive event

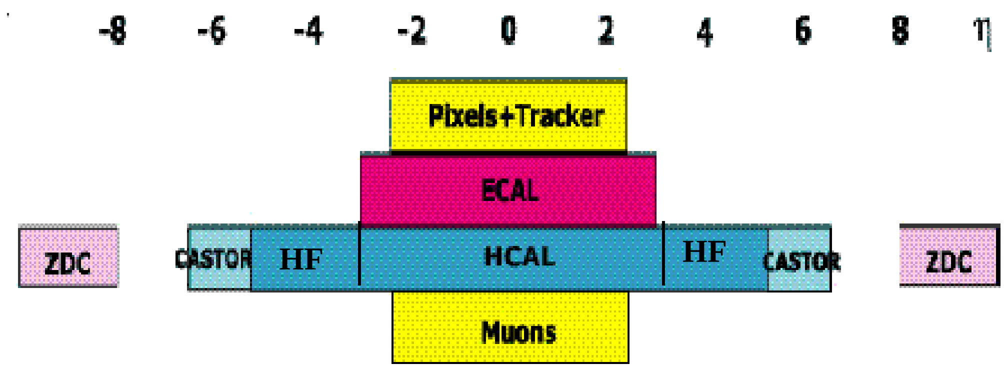
Exchange of color singlets Pomerons:

rapidity gaps $\Delta\eta > 3-4$



Sufficient tools:

ZDC, CASTOR and HF provide good rapgap covering



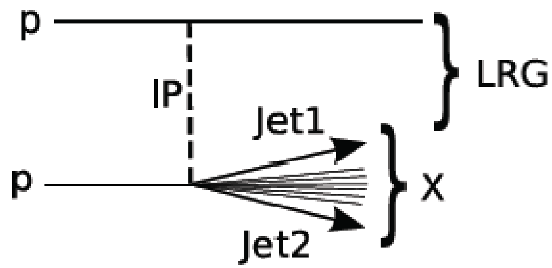
*What we are ready to measure and analyse at 200 pb^-1? **

*** *Results of analysis notes corrected to the integrated luminosity 200 pb^-1***

Observation of single-diffractive production of di-jets at the LHC

Subject:

$$pp \rightarrow p\,j\,jX$$



Physics motivations:

Observation of single diffractive di-jet production is an important ingredient in establishing hard diffraction at the LHC. This reaction is sensitive to the diffractive structure function of the proton, notably its gluon component. It is also sensitive to the rapidity gap survival probability. This process has been studied at the Tevatron, where the ratio of the yields for SD and inclusive di-jet production has been measured to be approximately 1%. Theoretical expectations for LHC are at the level of a fraction of a percent.

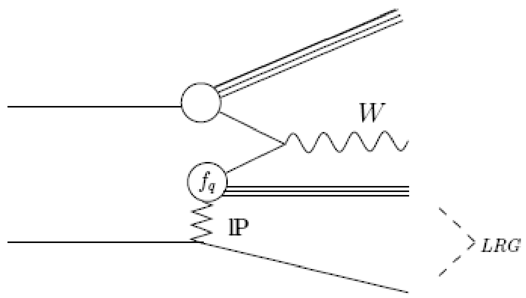
Expected results:

Assuming a rapidity gap survival probability of 0.05, N~6000 reconstructed signal events are expected with a signal-to-background ratio of up to 30 if the CASTOR calorimeter is available. If CASTOR is not available, the HF information alone may be sufficient.

Study of single-diffractive production of W bosons at the LHC

Subject:

$$pp \rightarrow pWX \; (W \rightarrow \mu\nu)$$



Physics motivations:

This reaction is sensitive to the diffractive structure function of the proton, notably its quark component, since W bosons originate from quark fusion. It is also sensitive to the rapidity gap survival probability.
This process has been studied at the Tevatron, where the ratio of the SD W and the inclusive W yields has been measured to be approximately1%. Theoretical expectations for LHC vary from a fraction of a percent to as much as 30% .

Expected results:

Assuming a rapidity gap survival probability of 0.05, approximately 200-400 reconstructed signal events are expected and a signal-to-background ratio of up to 20 if the CASTOR calorimeter is available. If only T2 is used, the signal increases by about a factor two, with a signal-to-background ratio as high as 5. Even if neither CASTOR nor T2 are available, the HF information alone may be suficient.

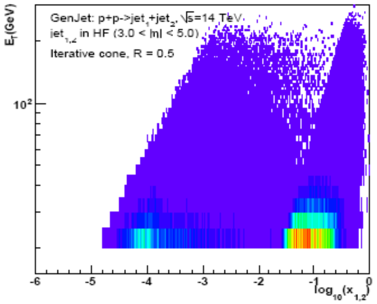
CMS AN-2008/060

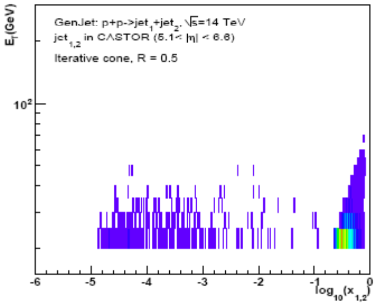
Low-x QCD studies with jets in the CMS Hadron Forward calorimeter in proton-proton collisions at $\sqrt{s}$ = 14 TeV

Subject:

$p\text{-}p \rightarrow jet+X$

$pp \rightarrow jet_1 + jet_2$



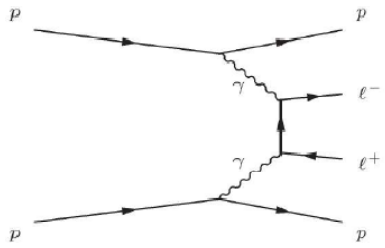


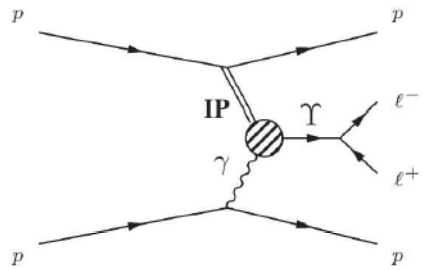
Expected results:

In summary, the HF calorimeter is a well adapted detector to carry out forward jet reconstruction studies in CMS above pT > 35 GeV/c. The single inclusive forward jet pT 658 spectrum may help to constrain the low-x proton PDFs, if the jet energy-scale uncertainty is controlled below the 5% level.

Exclusive $\ell^+\ell^-$ production

Subject: **exclusive** $\gamma\gamma \to \ell^+\ell^-$ **and** $\gamma p \to \Upsilon \to \ell^+\ell^-$

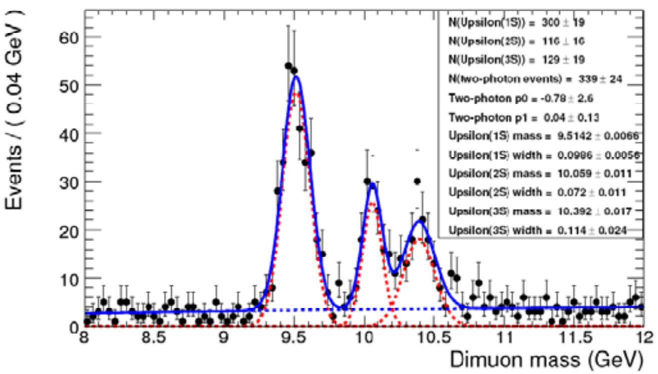




Physics motivations:

Due to the high luminosity of the LHC, a large number of these dilepton events will be produced and reconstructed each year, even in the initial low luminosity phase of running. Such events can be used to monitor the integrated luminosity collected by CMS, and for studies of lepton reconstruction and identication. At higher luminosities, these events will serve as a control sample for studies of supersymmetric leptons and other non-Standard Model physics produced in interactions. Furthermore, if the energy of the dilepton nal state is well measured in CMS, simple kinematics give the true forward proton energy. This process can therefore be used to calibrate forward tracking detectors.

Expected results:



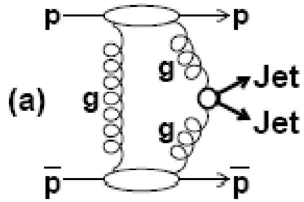
Requiring exclusivity conditions in central detectors and no activity above noise level in CASTOR and ZDC, O(700) μμ events and O(70) ee events can be obtained in 100 pb of data.
We expect a signicant signal for exclusive dimuon production, over a small background from non-exclusive processes, to be visible with early CMS data. With 200pb^{-1} of integrated luminosity, it should be possible to separate the γγ ->ll and γp->Y->ll contributions by performing a fit to the invariant mass spectrum. A signal for exclusive dielectron production should also be visible with 200 pb, although with much lower statistics and no sensitivity to the resonance region.

Under investigations

Exclusive 2 jets production in DPE

$$pp \rightarrow p + jet + jet + p$$

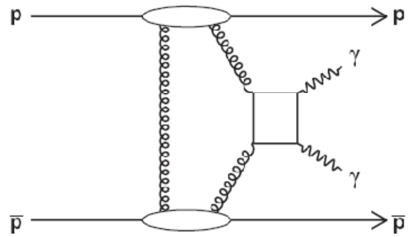
This process has been observed at the Tevatron. Moreover, it can be studied in more detail and, in particular, at larger ET at the LHC.



Exclusive gamma-gamma production in DPE

$$pp \rightarrow p + \gamma\gamma + p$$

This process can be used as a 'standard candle' to check and to monitor the exclusive ggPP luminosity that has been used for the prediction of the Higgs cross section.



Exclusive cc and bb production in DPE

$$pp \rightarrow p + \chi_{c0} + p$$

$$pp \rightarrow p + \chi_{b0} + p$$

and others

CMS-IHEP diffractive physics group interests and contribution

- ***W, Z (2 jets) production in single diffractive dissociation;***

- ***further development of the IHEP MC generator EDDE;***

- ***revision of the machine induced backgrounds for the 1st year LHC conditions;***

- ***2 jets production in central double pomeron exchange;***

- ***2 gamma production in central double pomeron exchange,***

- ***heavy quarkonium (cc, bb) production in double pomeron exchange***