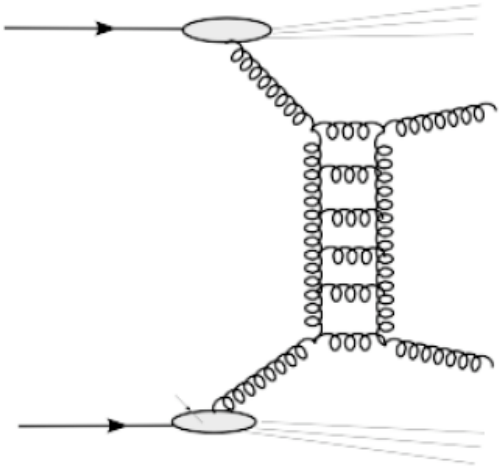
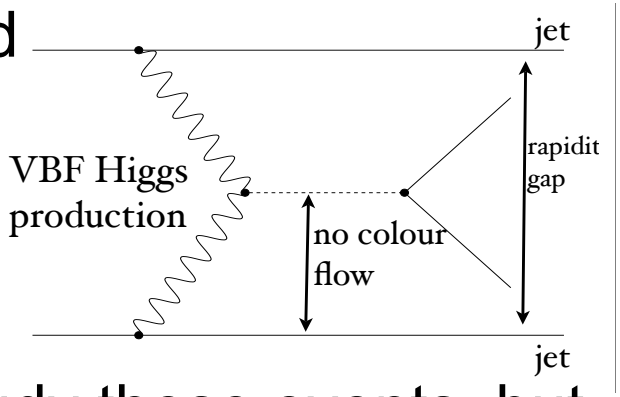
Questions on studying jets and rapidity gaps at the LHC

Mario Campanelli, UCL



Events with jets and rapidity gaps are interesting from the theoretical and experimental point of view.
We are producing them now in fully hadronic final states through colour-singlet gluon ladders, we will have them mediated by electroweak processes for instance in VBF.

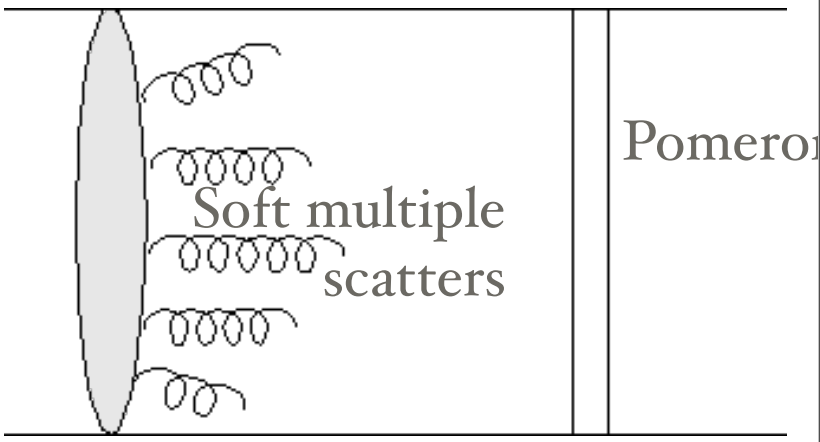


Atlas has a comprehensive program to study these events, but we would like to discuss here some points of theoretical and experimental relevance

Some theoretical points of discussion

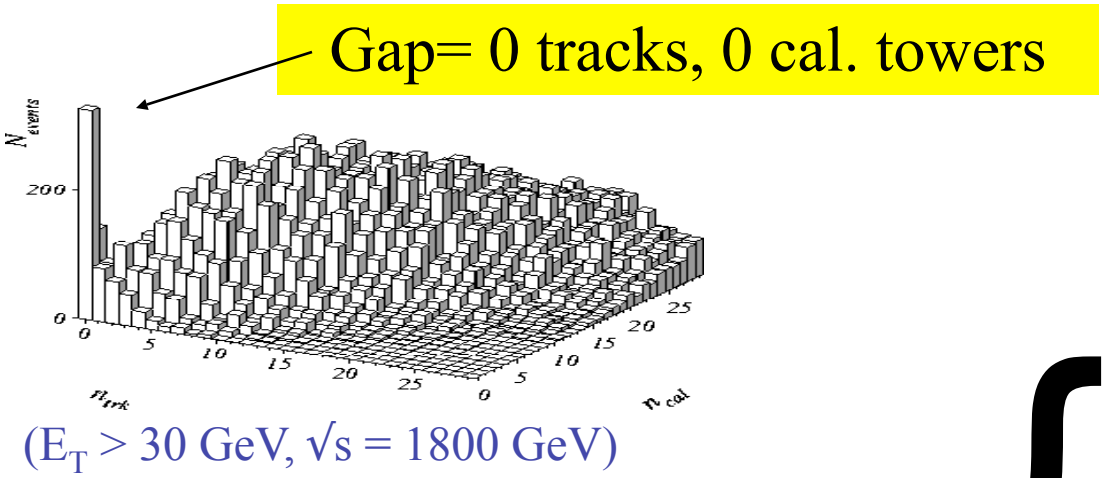
- "Diffractive" final states are referred to as:
    1. interaction mediated by a colour singlet
    2. interaction with a large rapidity gap at hadron level
- The two definitions are not equivalent! (you can have evan large gaps from fluctuations)
- Should we stick to the physics-driven (but model-dependent) definition 1), or the operational one 2) ?
- However also the second definition is not free from ambiguity
- Defining a rapidity gap as an eta region with no radiation at all (or based on multiplicity above a given threshold) is not infrared safe
- Solution proposed by G.Oderda and G.Sterman (Phys. Rev. Lett. 81, 3591 (1998)) is to use the Et sum of kt jets in gap. This is the solution used in Hera from 2002
- It is unlikely we are going to use kt at the LHC, so a possibility would be to use Anti-Kt instead
- This way rapidity gap definition would equate a 'third jet veto' approach

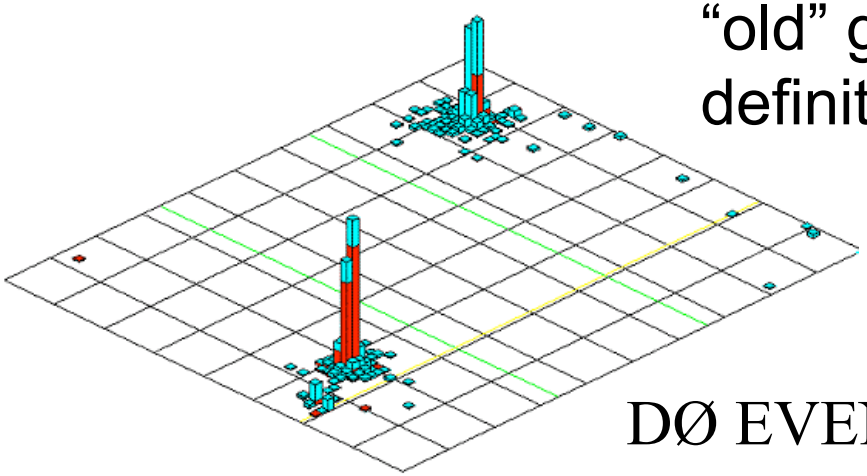
– which would be a safe value to cut on?
– energy deposits close to a jet has a completely different physical meaning than one in the middle of the gap. Treat them equally?
– How well do we trust description of soft radiation?
– Which measurements of radiation in the gap could help modeling of this radiation?
– (examples from M.C. et al. Les Houches'09 tools p.114)
– How to relate QCD measurements to VBF?



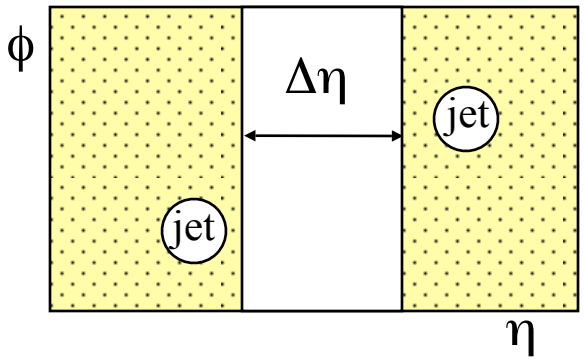
Previous Hard Color-Singlet Mesurements

QCD color-singlet signal observed in ~ 1 % opposite-side events (ppbar)





DØ EVENT



Publications

"old" gap definition!

DØ: PRL 72, 2332(1994)
CDF: PRL 74, 885 (1995)
DØ: PRL 76, 734 (1996)
Zeus: PLB369, 55 (1996)
CDF: PRL 80, 1156 (1998)
DØ: PLB 440, 189 (1998)
CDF: PRL 81, 5278 (1998)

H1: Eur.Phys.J. C24 517 (2002)

Experimental considerations

Additional effects to study on data:

- calorimeter noise
  - can appear anywhere, inside or outside the gap, and can destroy ‘innocent’ gaps
    - perhaps an algorithm could look at the jet shape before killing a gap based on noise?
- pileup
  - can hit us already this summer. Some techniques can associate clusters to non-primary vertexes, but efficiency far from 100%.
  - just raise the threshold for this ‘third jet veto’?
  - raise noise thresholds for clusters?
  - or try to estimate average activity on the event looking at large correlations or jet density?
  - how do we treat forward gaps where pileup will be higher?