The reason to quantify diffractive events

Observables such as single-particle inclusive cross sections and multiplicity distributions are traditionally given for non-diffractive events.

These σ's are useful to understand HE strong interactions and to tune Monte Carlos.

How can non-diffractive events be disentangled?
Recall inelastic diffraction is a sizeable part (0.2-0.3) of the cross section. Also the LHC detectors do not have 4π geometry over the whole rapidity interval.

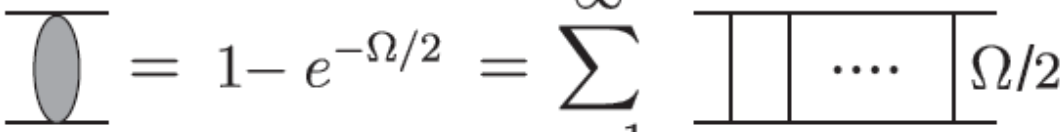
Definition of DIFFRACTION -- not unique

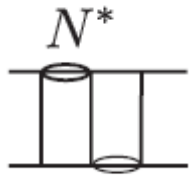
$$2\mathrm{Im}A_{\mathrm{el}} = |A_{\mathrm{el}}|^2 + G_{\mathrm{inel}}$$

Definition 1

Diffraction is “elastic” scatt. caused, via unitarity, by the absorption of compts. of wave fns. of incoming protons

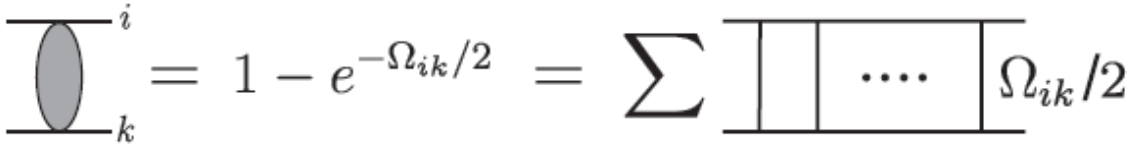
$$\mathrm{Im}\,A_{\mathrm{el}} = \quad = 1 - e^{-\Omega/2} = \sum_{n=1}^{\infty}$$





Inelastic diffraction: diff. compts get absorbed differently. Need to form diffractive (Good-Walker) eigenstates i,k.. which scatter “elastically”

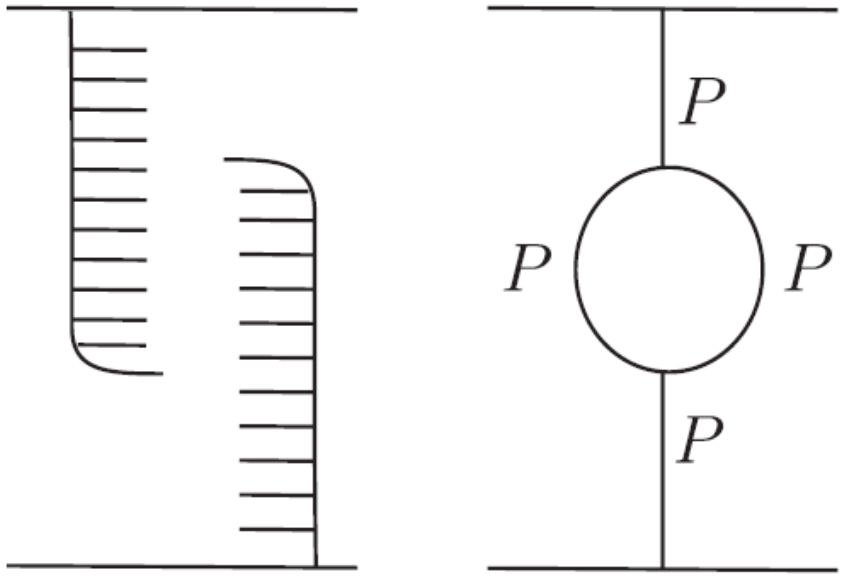
$$\mathrm{Im}\,A_{ik} = \quad = 1 - e^{-\Omega_{ik}/2} = \sum$$



Good definition for quasi-elastic processes, where LRG ~ whole rapidity interval

But is not unique for dissociation into high-mass states

The problem of dissociation into high-mass states



partons from dissociation of colliding protons overlap in central rapidity region !

Definition 2

Diffraction is any process caused by Pomeron exchange.

(Old convention was any event with LRG of size $\delta\eta$>3, since Pomeron exchange gives the major contribution)

However LRG in the distribution of secondaries can also arise from

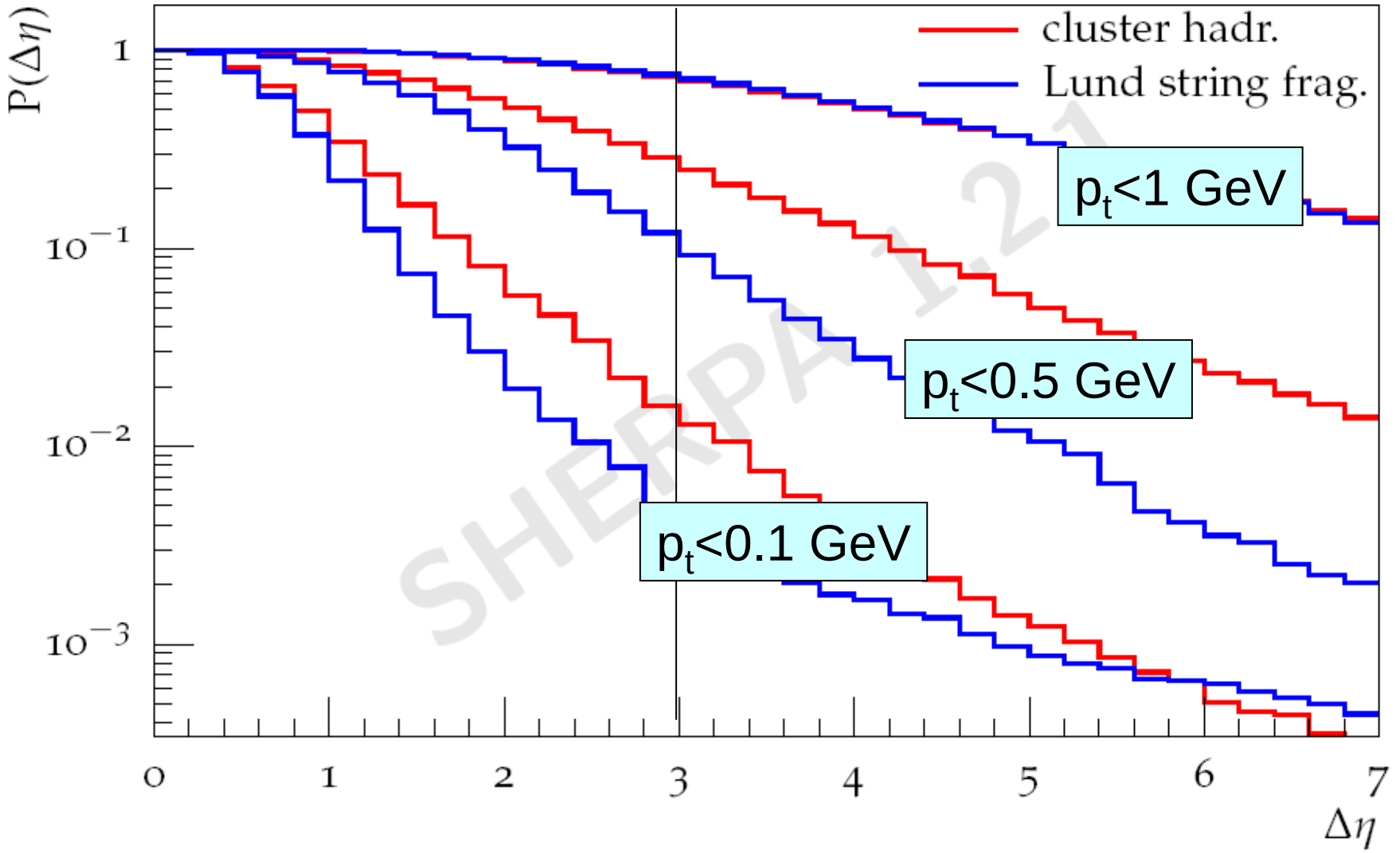
(a) Reggeon exchange

(b) fluctuations during the hadronization process

Indeed, at LHC energies LRG of size $\delta\eta$>3 do not unambiguously select diffractive events.

Prob. of finding gap larger than $\Delta\eta$ in inclusive event at 7 TeV due to fluctuations in hadronization

gap anywhere in -5 <η <5, different threshold p_t



So to study pure Pomeron exchange we have

either to select much larger gaps

or to study the $\delta\eta$ dependence of the data, fitting so as to subtract the part caused by Reggeon and/or fluctuations.

Conclusions of paper by Khoze, Krauss, Martin, Ryskin, Zapp

Any process due to Pomeron exch. may be called diffractive.

Such processes lead to LRG in the distrib. of secondaries.

With the present rapidity acceptances and p_t cuts at the LHC, MC studies show that up to ~0.5 mb of diffractive σ can be mimicked by fluctuations. Not a problem if σ(diffractive)>10 mb, but is serious for Double-Pomeron-Exch events where σ~10 μb

For processes driven by multi-Pomeron exchange, the same diagram describes LRG events and also events with an enlarged multiplicity of secondaries. Thus, comparing long-range correlations between multiplicities it is possible to confirm that the effect is due to Pomeron exchange (and not to fluctuations).