The Total Cross Section and its Diffractive Components

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ABSTRACT

The total and diffraction dissociation *pp* cross sections at LHC and higher energies are predicted in a model based on a novel, fully unitarized parton-model approach in which diffraction is derived from inclusive proton PDFs and QCD color factors.

Classification of diffractive processes

Basic diffractive processes:

SD **S**ingle **D**issociation (**S**ingle **D**iffraction)

SD$_1$ or **SD**$_2$, depending on which incoming *p* dissociates

DD **D**ouble **D**issociation (**D**ouble **D**iffraction)

CD **C**entral **D**issociation (➔**DPE:** **D**ouble **P**omeron **E**xchange)

Combined diffractive processes:

multigap diffraction with two or more gaps other than **CD**

e.g. **SDD: SD** plus **CD** (predicted & studied at CDF)

SDDS: 4-gap diffraction: fully predicted (can be studied at LHC)

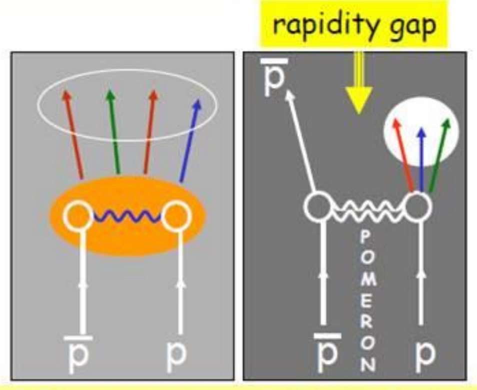
This poster is organized in four columns:

- **Abstract / Introduction** (this column)
- **The *RENORM* model — *RENORmalization Model***
- **Diffraction at CDF:** validation of *RENORM* by data
- **Diffraction at LHC:** predictions and comparisons with data

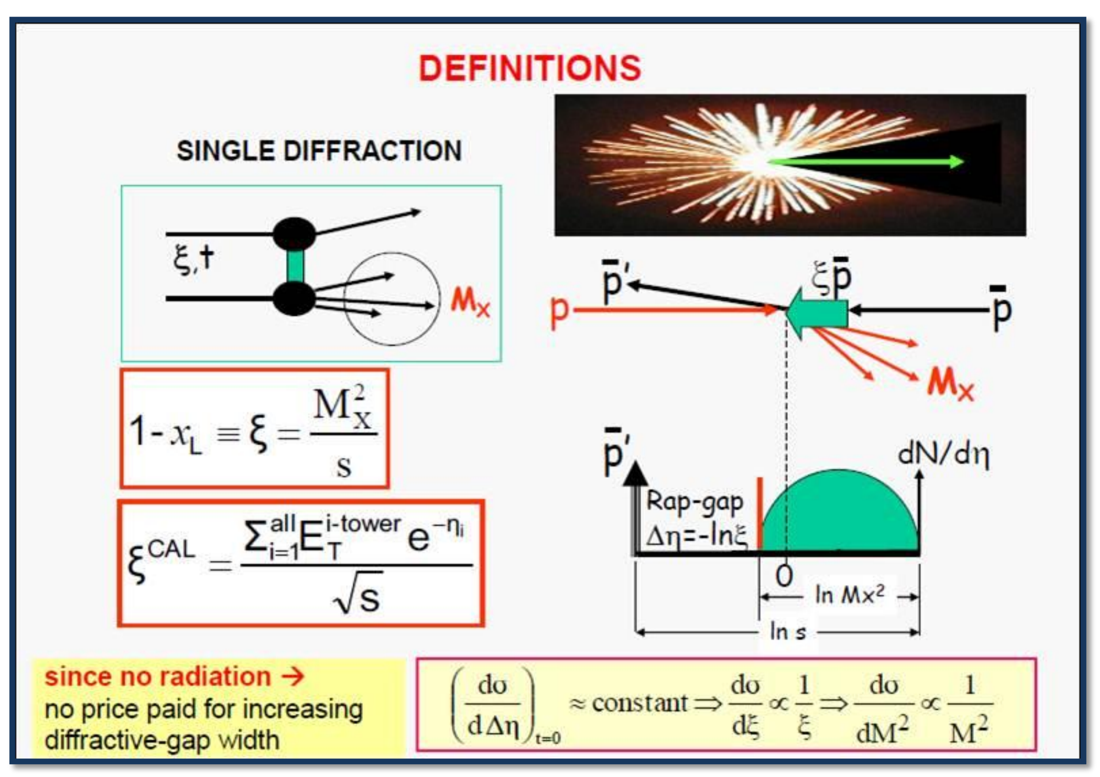
INTRODUCTION

DIFFRACTION IN QCD

Non-diffractive events	Diffractive events
❖ color-exchange ➔ η-gaps exponentially suppressed	❖ Colorless vacuum exchange ➔ η-gaps not exp'ly suppressed

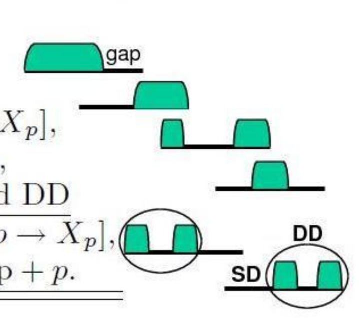


Goal: probe the QCD nature of the diffractive exchange



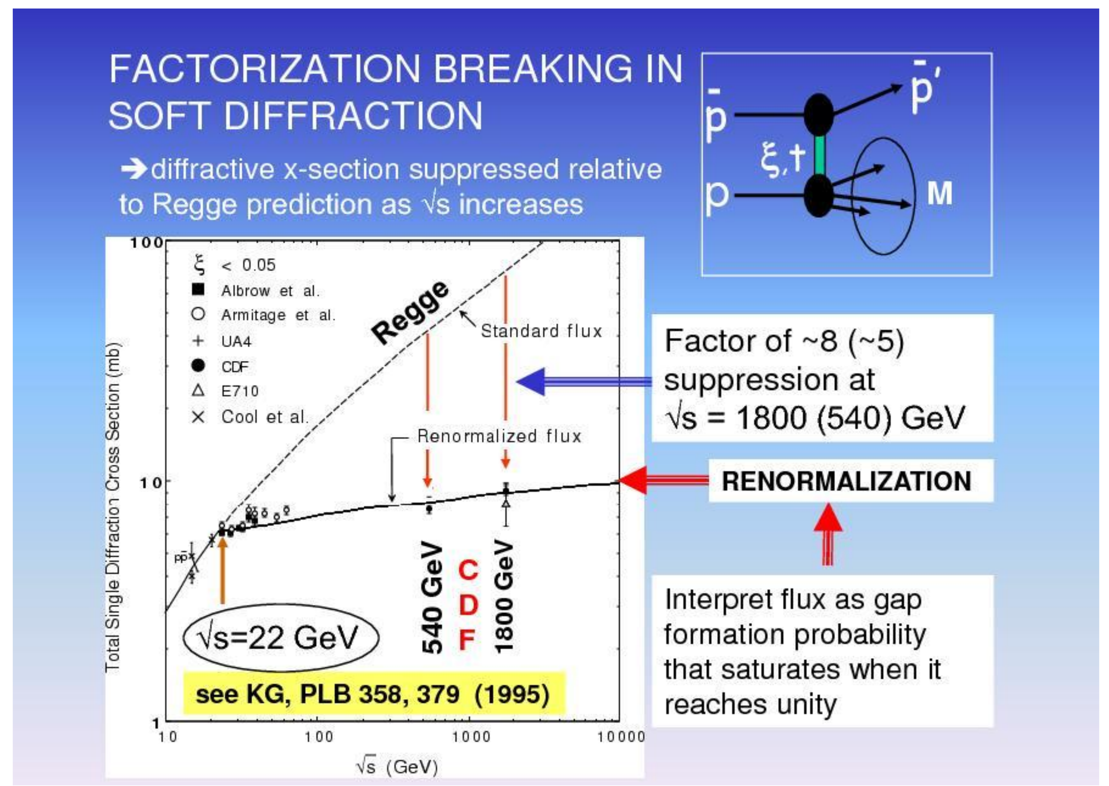
BASIC AND EXAMPLES OF COMBINED DIFFRACTIVE PROCESSES

acronym	basic diffractive processes
$\mathbf{SD}_{\bar p}$	$\bar pp\to\bar p+\text{gap}+[p\to X_p]$,
$\mathbf{SD}_p$	$\bar pp\to[\bar p\to X_{\bar p}]+\text{gap}+p$,
$\mathbf{DD}$	$\bar pp\to[\bar p\to X_{\bar p}]+\text{gap}+[p\to X_p]$,
$\mathbf{DPE}$	$\bar pp\to\bar p+\text{gap}+X_c+\text{gap}+p$,
	2-gap combinations of SD and DD
$\mathbf{SDD}_{\bar p}$	$\bar pp\to\bar p+\text{gap}+X_c+\text{gap}+[p\to X_p]$,
$\mathbf{SDD}_p$	$\bar pp\to[\bar p\to X_{\bar p}]\text{gap}+X_c+\text{gap}+p$.



The SDD cross sections are predicted by the *RENORM* model ➔

THE *RENORM* MODEL



SCALE S_0 ADD PPP COUPLING

Pomeron flux: interpret as gap probability
➔set to unity: determines g_{PPP} and s_o

KG, PLB 358 (1995) 379

$$\frac{d^2\sigma_{SD}}{dt\,d\xi}=f_{IP/p}(t,\xi)\cdot\sigma_{IP-p}(s\xi)$$

s_o^{ε} $\quad s_o^{-\varepsilon/2}\cdot g_{PPP}(t)$

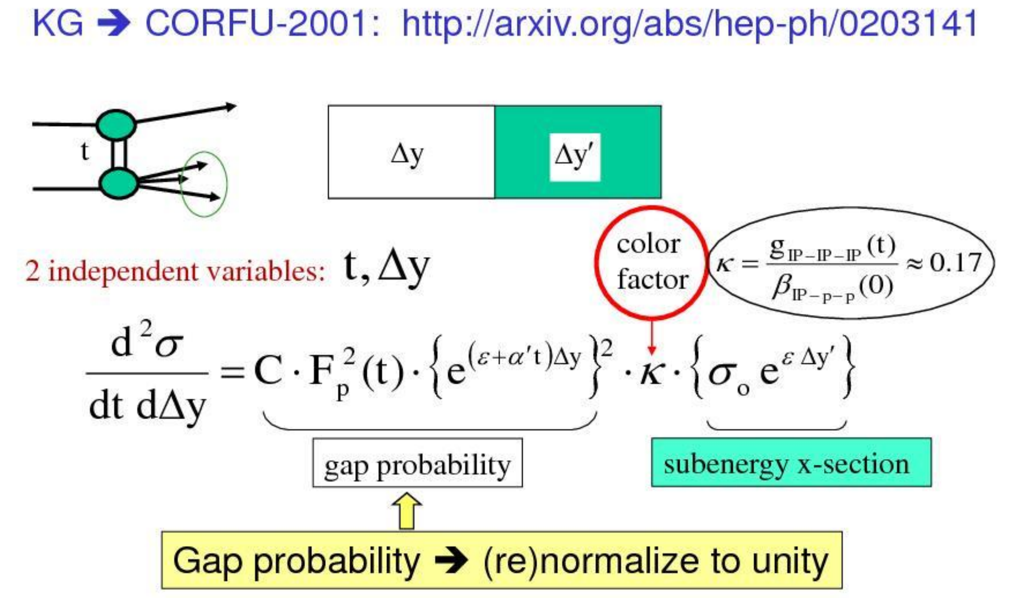
Pomeron-proton x-section

- ❑ Two free parameters: s_o and g_{PPP}
- ❑ Obtain product $g_{PPP}\bullet s_o^{\varepsilon/2}$ from σ_{SD}
- ❑ Renormalized Pomeron flux determines s_o
- ❑ Get unique solution for g_{PPP}

g_{PPP}=0.69 mb$^{-1/2}$=1.1 GeV^{-1} $\quad S_o$=3.7±1.5 GeV^2

SINGLE DIFFRACTION RENORMALIZED

KG ➔ CORFU-2001: http://arxiv.org/abs/hep-ph/0203141



DIFFRACTIVE AND TOTAL CROSS SECTIONS

arXiv.org > hep-ph > arXiv:1205.1443

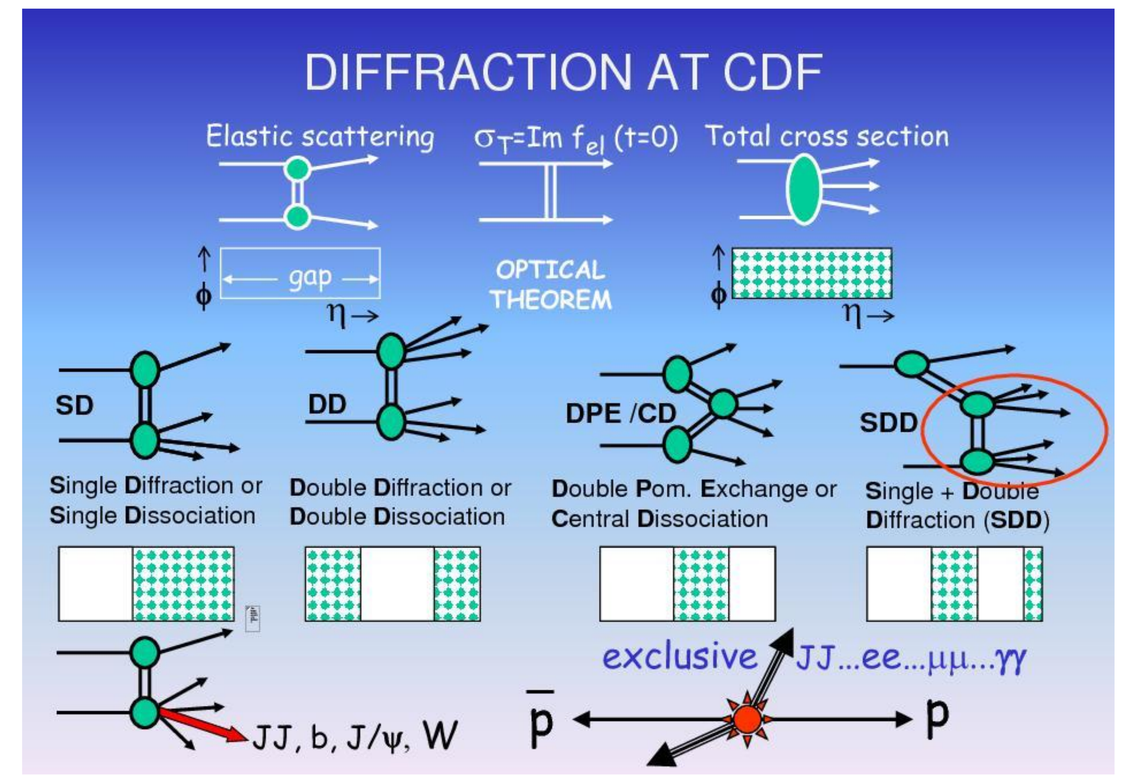
High Energy Physics - Phenomenology

MBR Monte Carlo Simulation in PYTHIA8

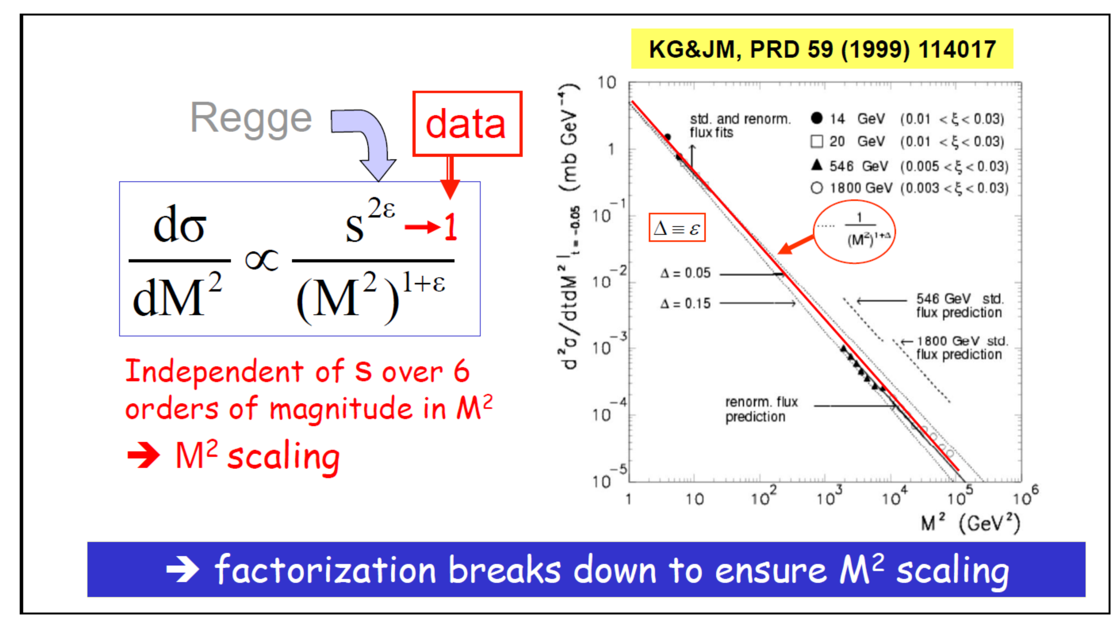
R. Ciesielski, K. Goulianos

Diffractive, elastic, and the total pp cross sections based on the *RENORM* model are now implemented in PYTHIA8.

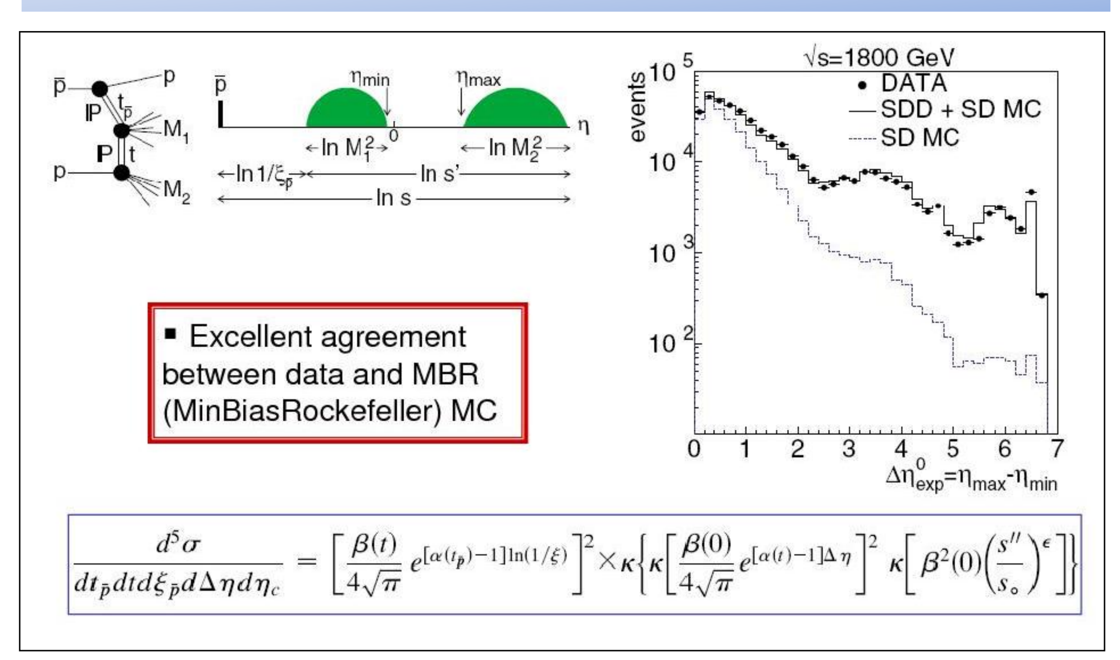
DIFFRACTION AT CDF



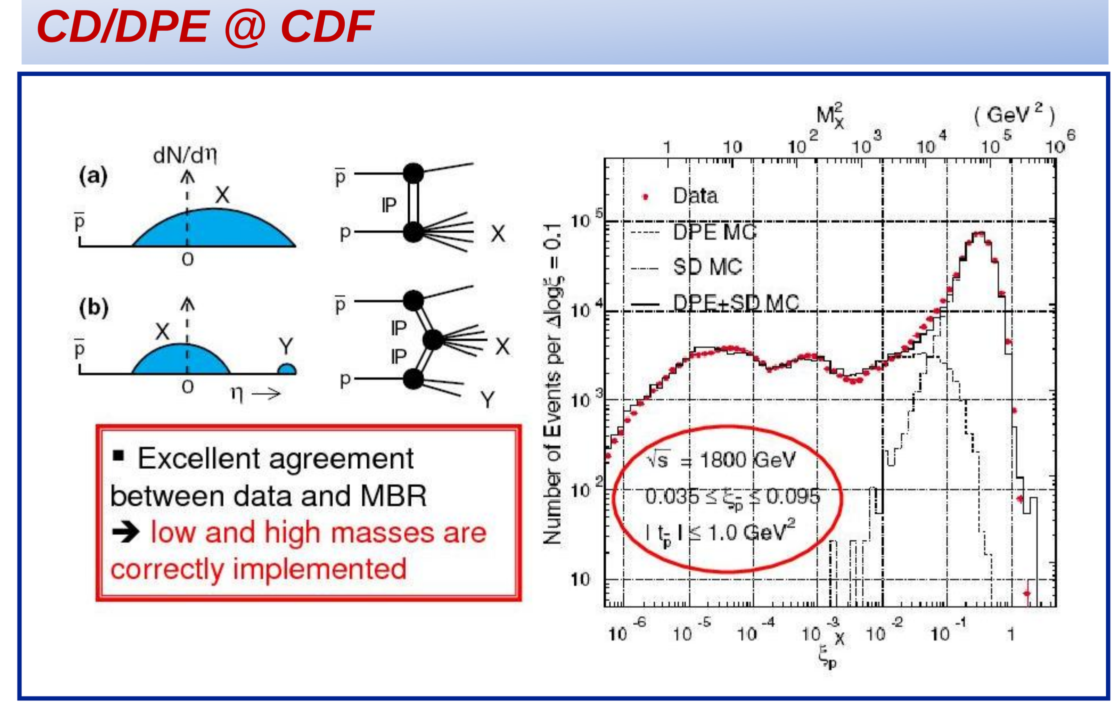
SINGLE DIFFRACTION $d\sigma/dM^2$ vs M^2 AND s



SDD @ CDF



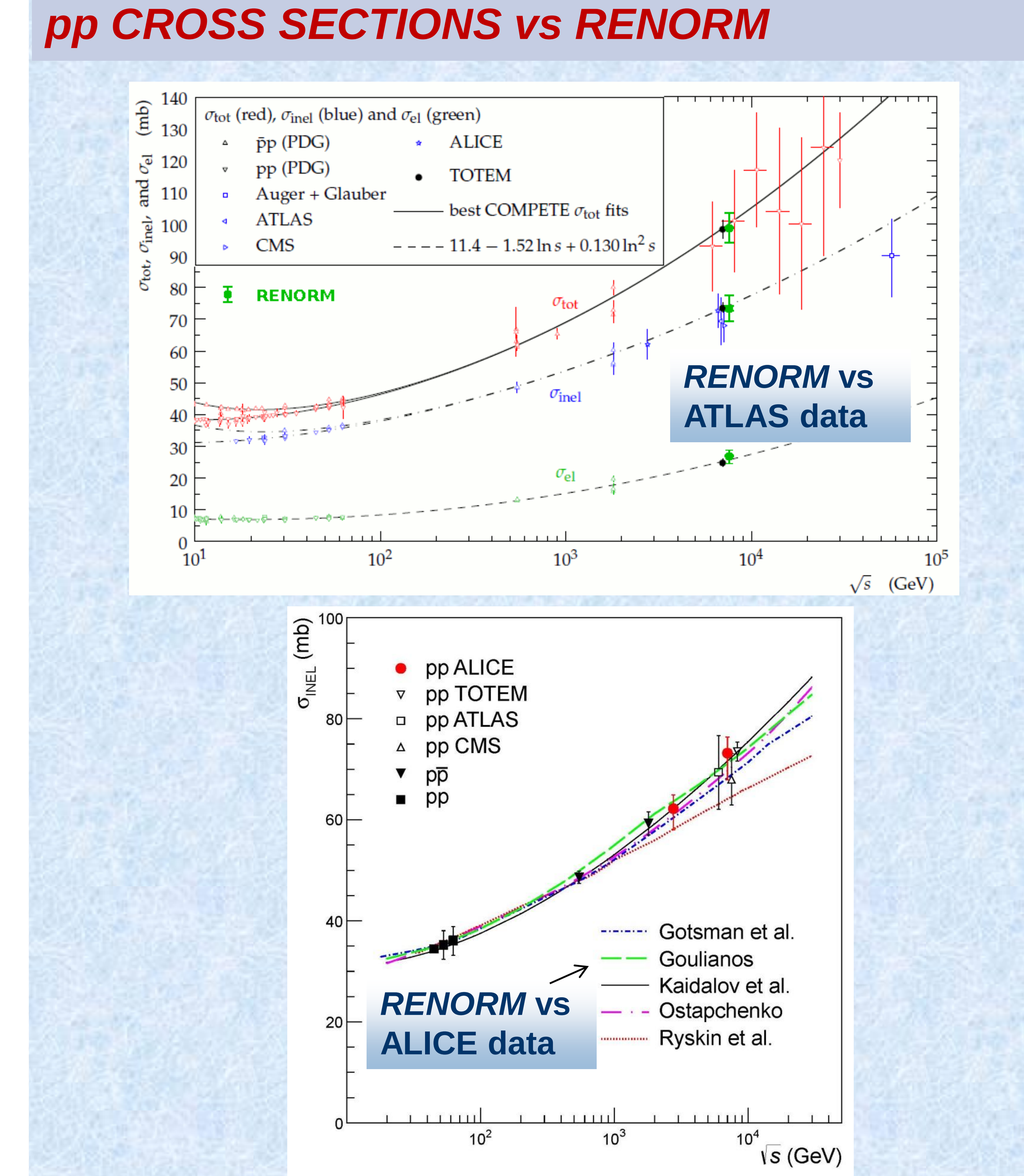
CD/DPE @ CDF



In all the above cases there is excellent agreement between *RENORM*-based MBR and data.

DIFFRACTION AT LHC

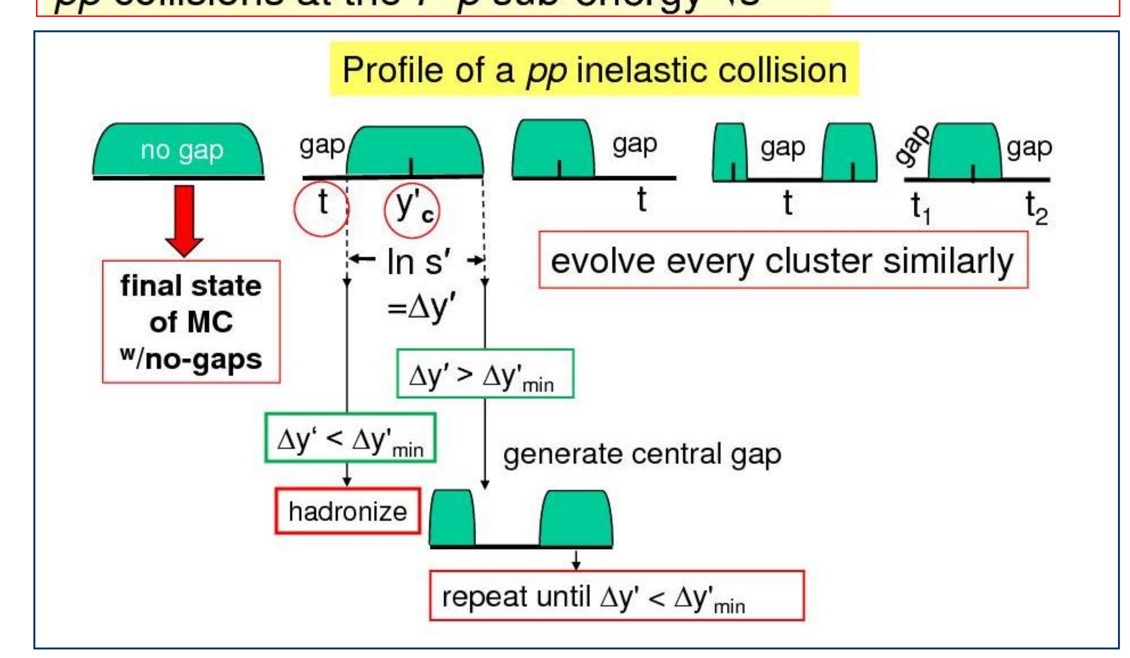
pp CROSS SECTIONS vs *RENORM*



MONTE CARLO STRATEGY

- ❑ σ_{tot} ➔ from SUPERBALL model
- ❑ optical theorem ➔ Im f_{el}(t=0)
- ❑ dispersion relations ➔ Re f_{el}(t=0)
- ❑ σ_{el} ← using global fit
- ❑ σ_{inel}= σ_{tot} - σ_{el}
- ❑ differential σ_{SD} ➔ from RENORM
- ❑ use *nesting* of final states for *pp* collisions at the *P-p* sub-energy √s'

σ_T ↕ optical theorem; Im f_{el}(t=0) ↕ dispersion relations; Re f_{el}(t=0)



REFERENCES:

***RENORM* has been implemented in PYTHIA8 in collaboration with Robert Ciesielski from The Rockefeller University.**