QCD Event-Generator: "GR@PPA2.8" and its Applications

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GRACE-Group

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QuiNhon, Vietnam

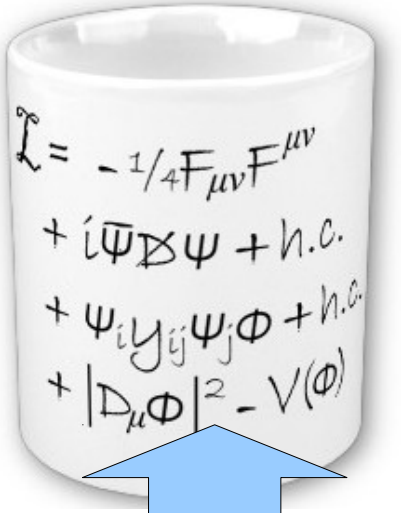
Outline

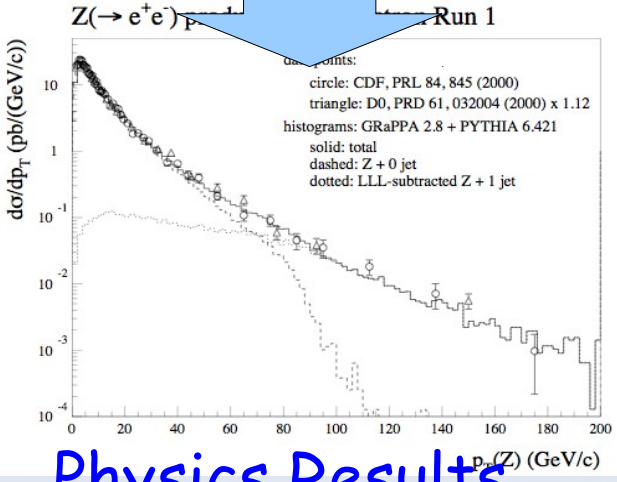
- Introduction
  - Why we need event generators.
  - A structure of event generators.
- GP@PPA Event Generator for TEVATRON/LHC
  - GR@PPA2.7
  - What's New on GR@PPA2.8
- Applications
  - TEVATRON:w+jet
  - LHC:V+jets,VV+jets
- Future
  - GR@PPA3.0 NLO-ME/QCD+QED PS
- Summary

Introduction

Why we need Event Generator?

Theory/Model

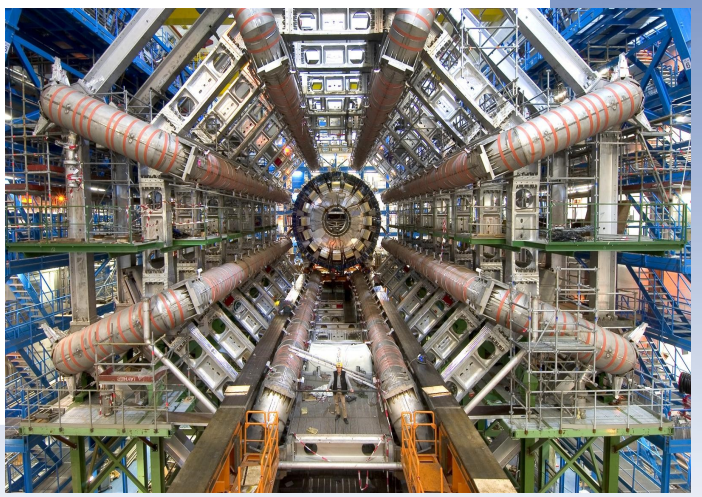




Physics Results

Real data

Detector



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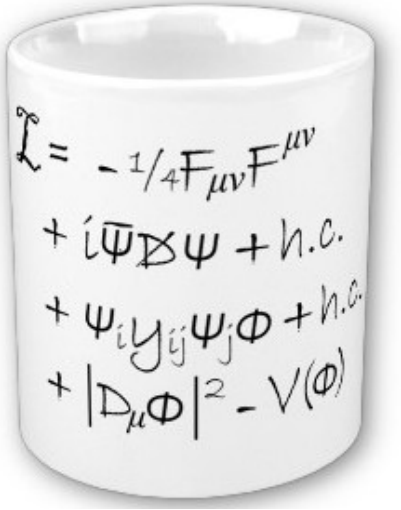
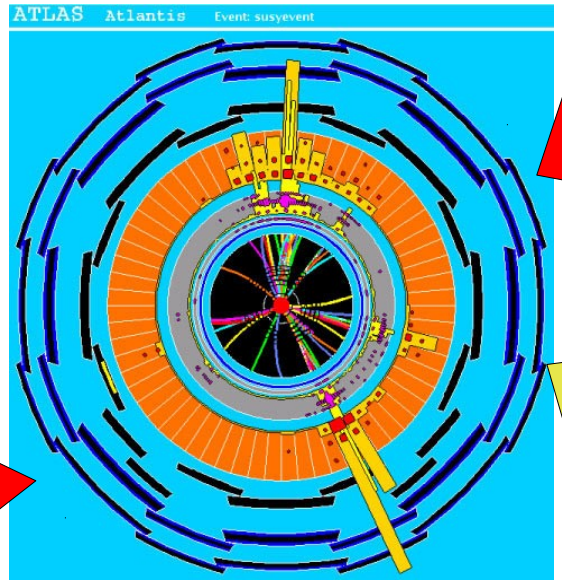
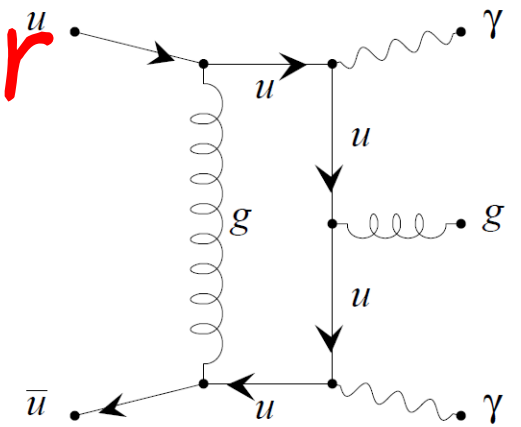
Theory/Model



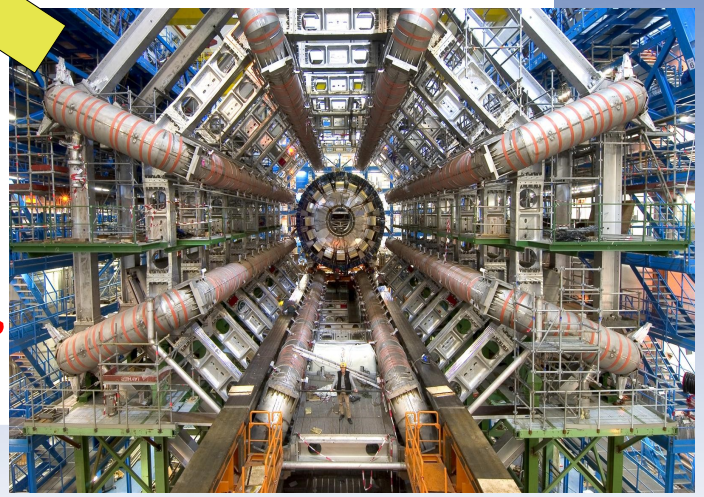
Cross section calculation

Event Generator

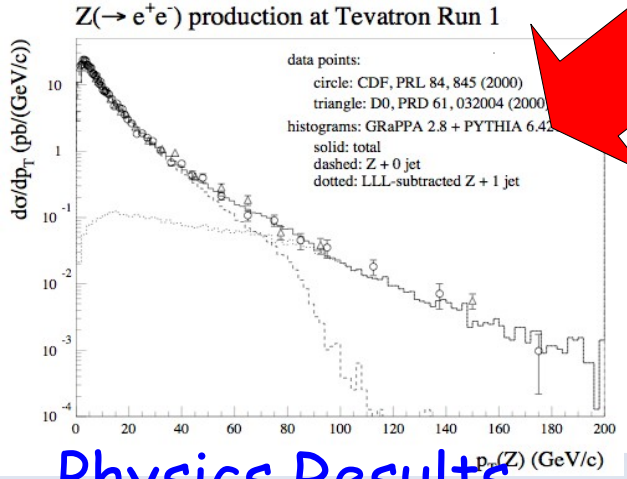




Detector

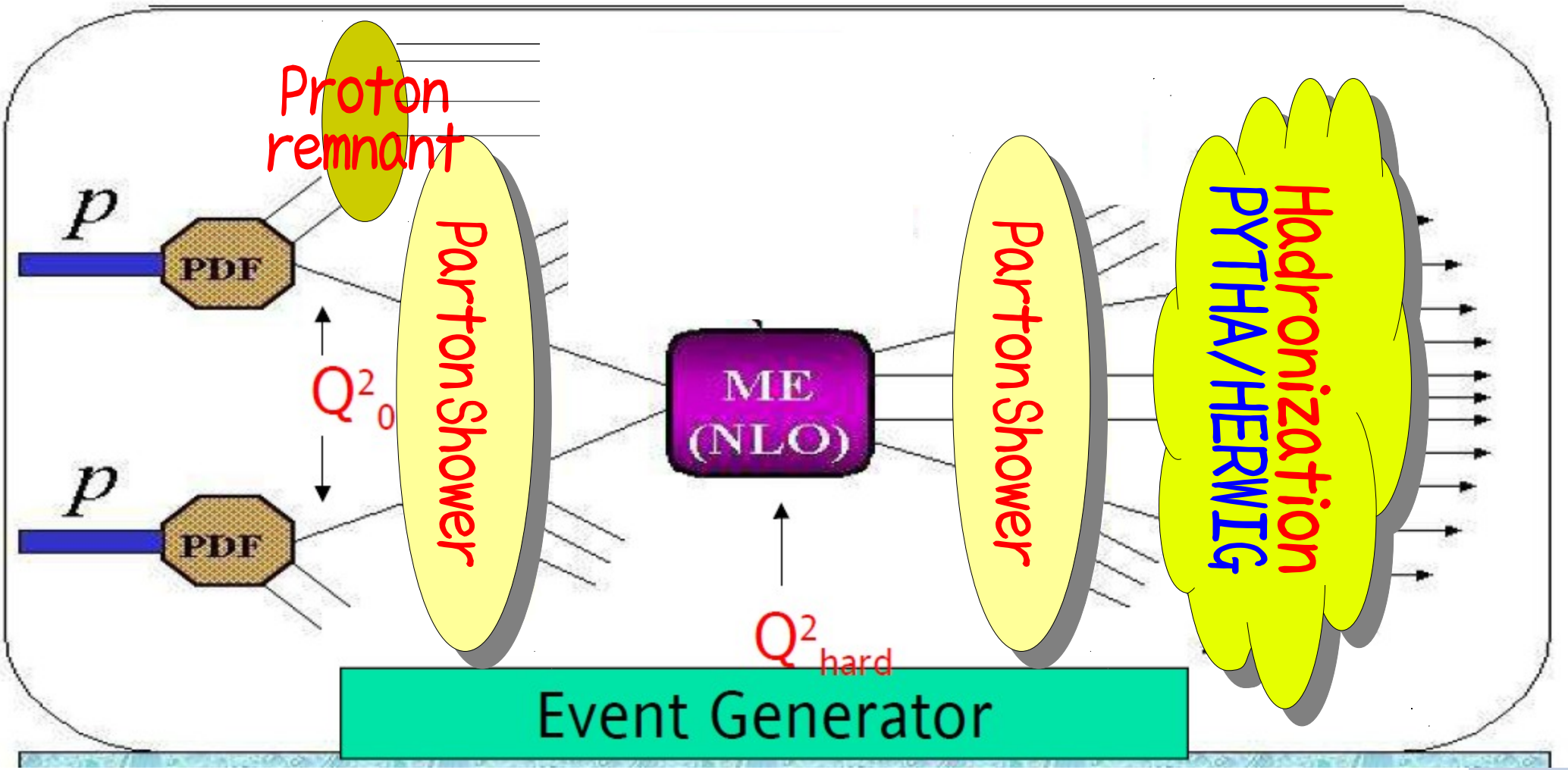


Real data

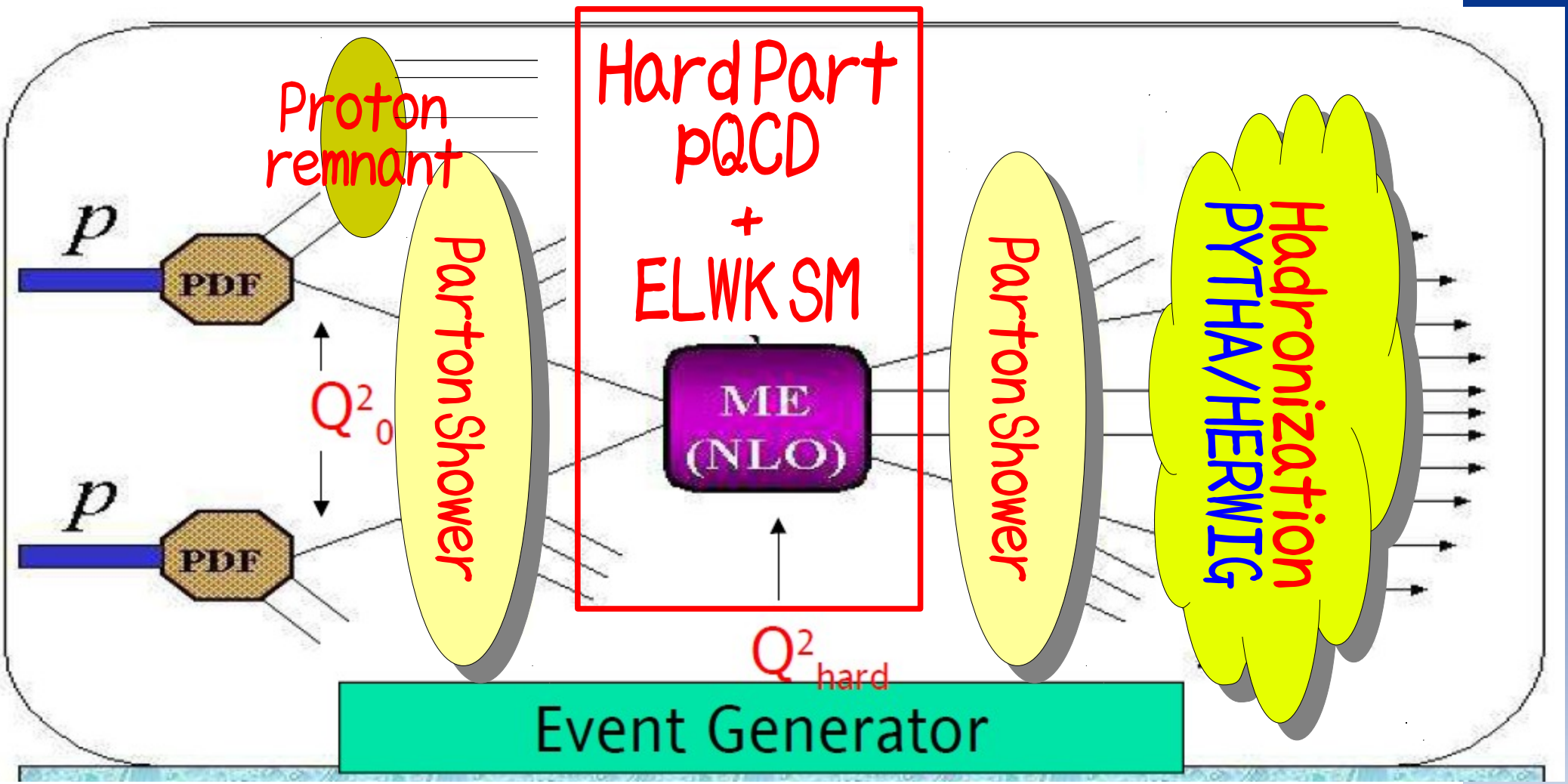


Physics Results

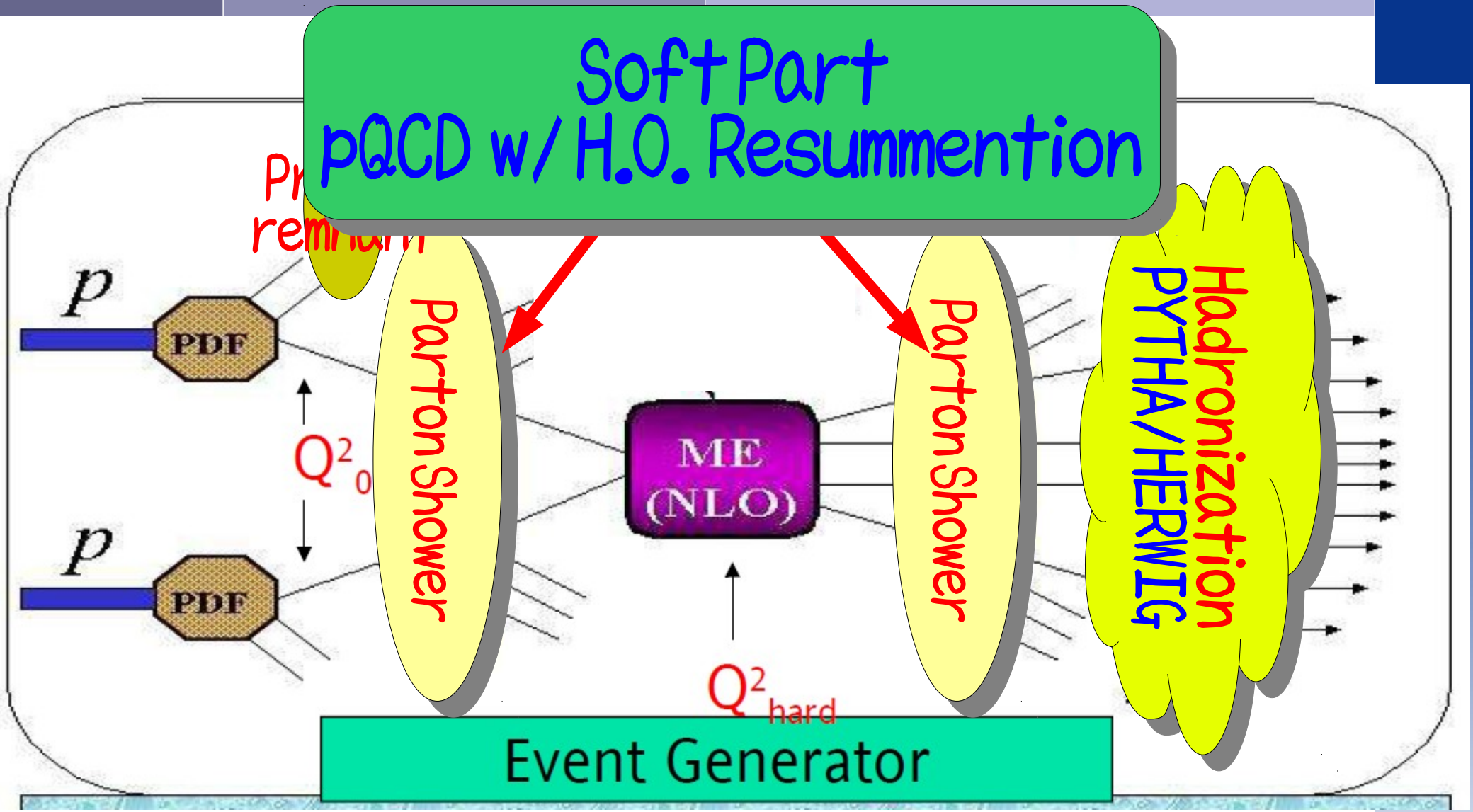
Overview of Event Generator



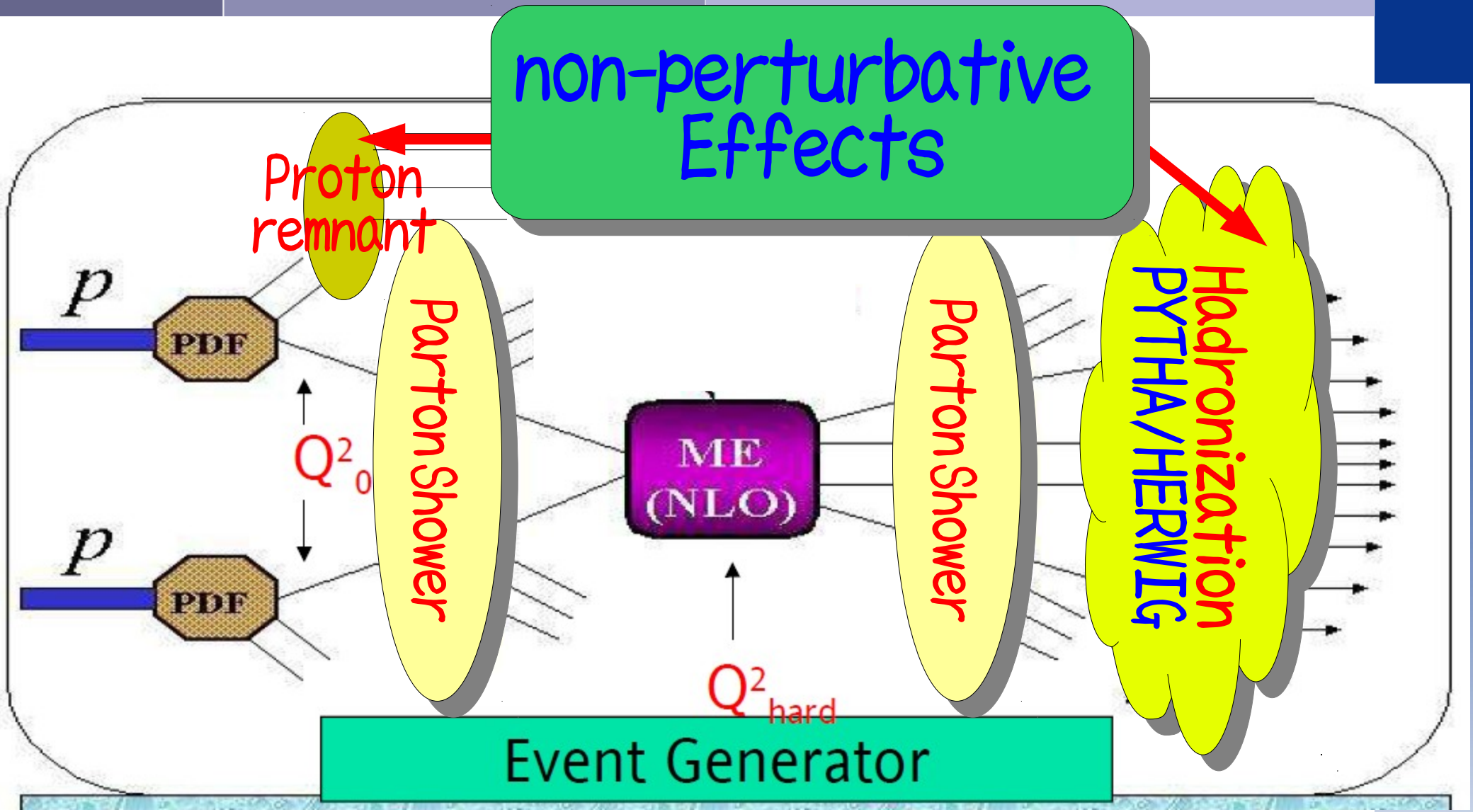
Overview of Event Generator



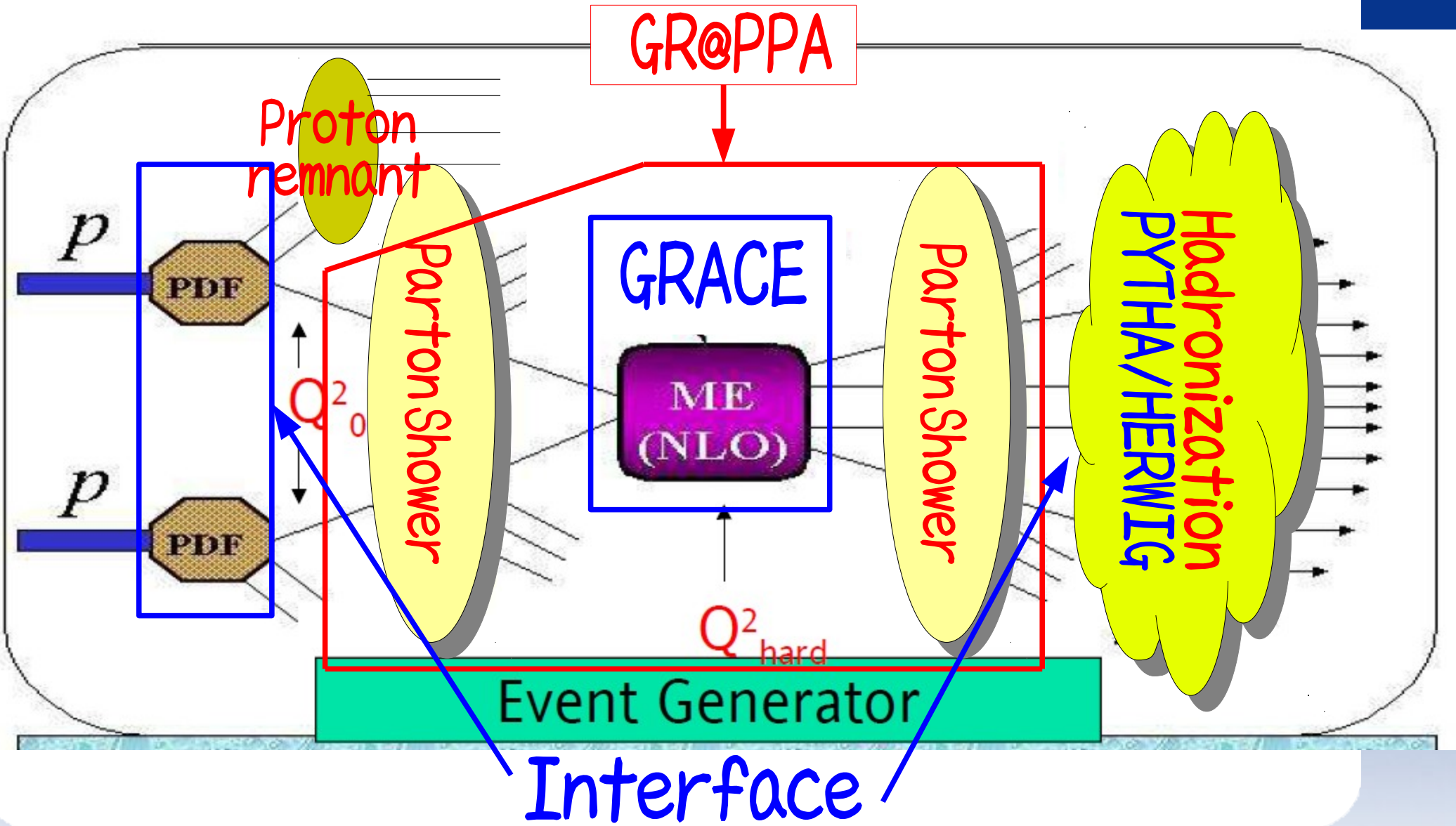
Overview of Event Generator



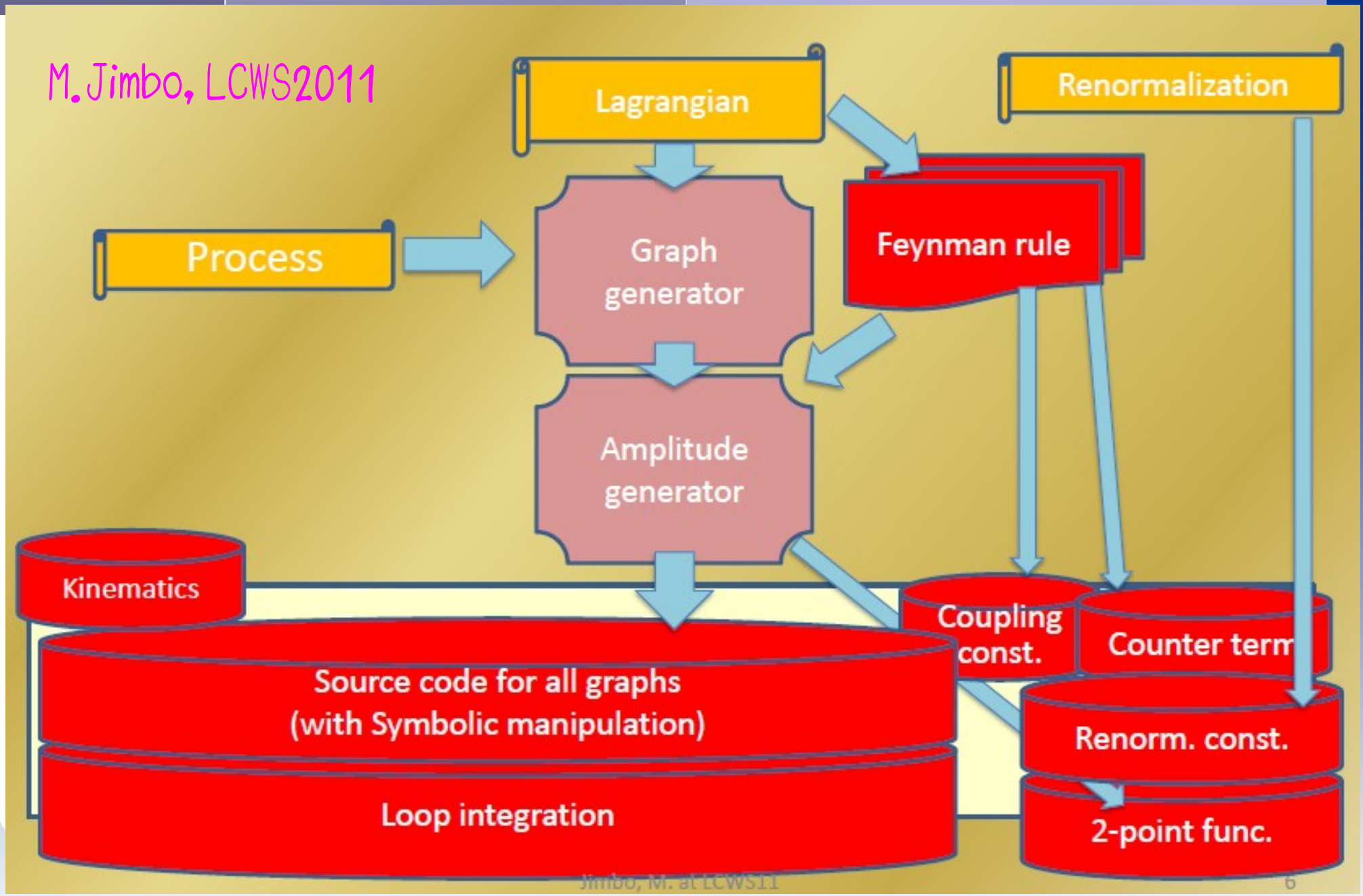
Overview of Event Generator



Overview of Event Generator



What is GRACE? : Structure

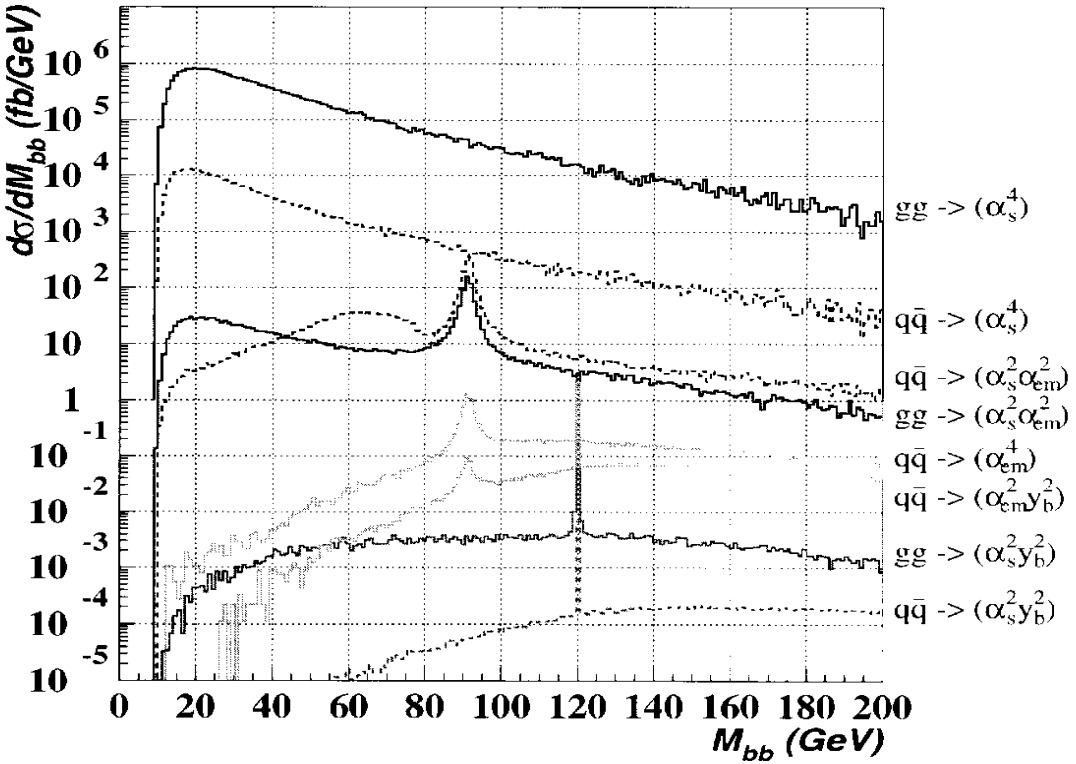


GR@PPA
Event Generator

S. Odaka YK, arXiv:1107.4467
S. Tuno *et al.*, CPC 175(2006)665

GR@PPA 2.7

- W + jets (up to 3 jets) with the subsequent W decay
- Z + jets (up to 2 jets) with the subsequent Z decay
- Four bottom quarks
- top-quark pair with the subsequent decay
- di-boson (WW, WZ and ZZ) with the subsequent W/Z decay



GR@PPA 2.8

New features of GR@PPA 2.8

- ME-PS matching in the generation of W, Z, W^+W^-, ZW, ZZ production processes at hadron collisions
  - LLL subtraction & custom LLPS
  - Forward evolution PS in the initial state (QCDPS)
  - Backward evolution PS (QCDPSb) available as well
  - Final-state PS (QCDPSf) also implemented as well as initial-state radiations.

GR@PPA 2.8

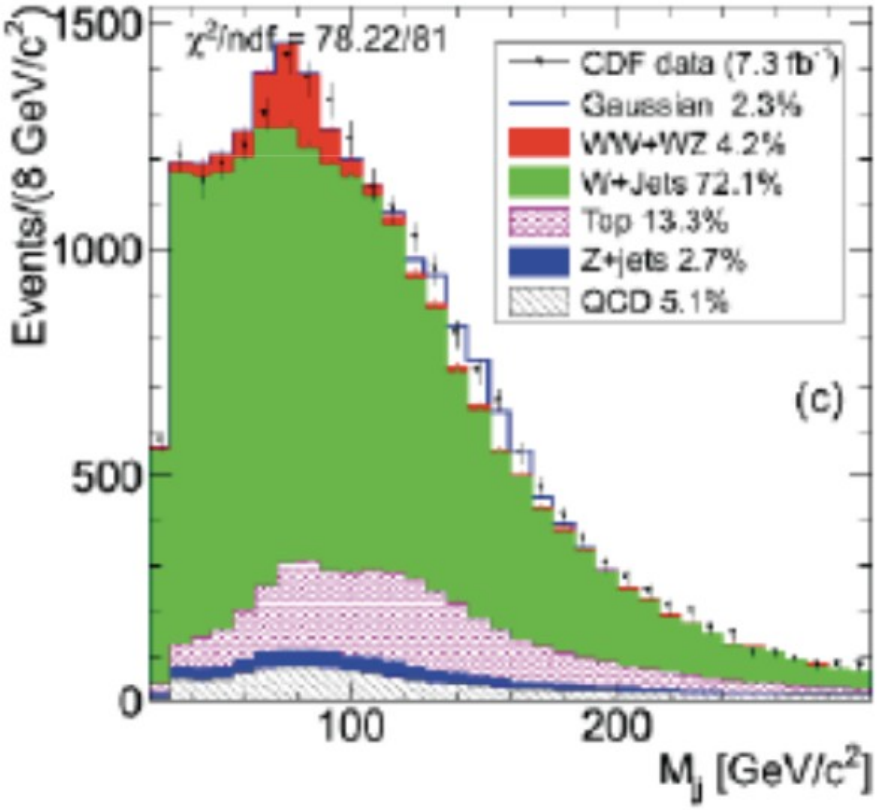
- Additional features
  - W and Z decays in the matrix elements
  - Exact spin, phase-space and off-shell effects at the tree level
  - PDG values for the decay widths and branching ratios of W and Z
  - Generated events can be passed to PYTHIA to proceed the simulation : hadronization and decays
  - Still at LO : Please wait GR@PPA 3.0

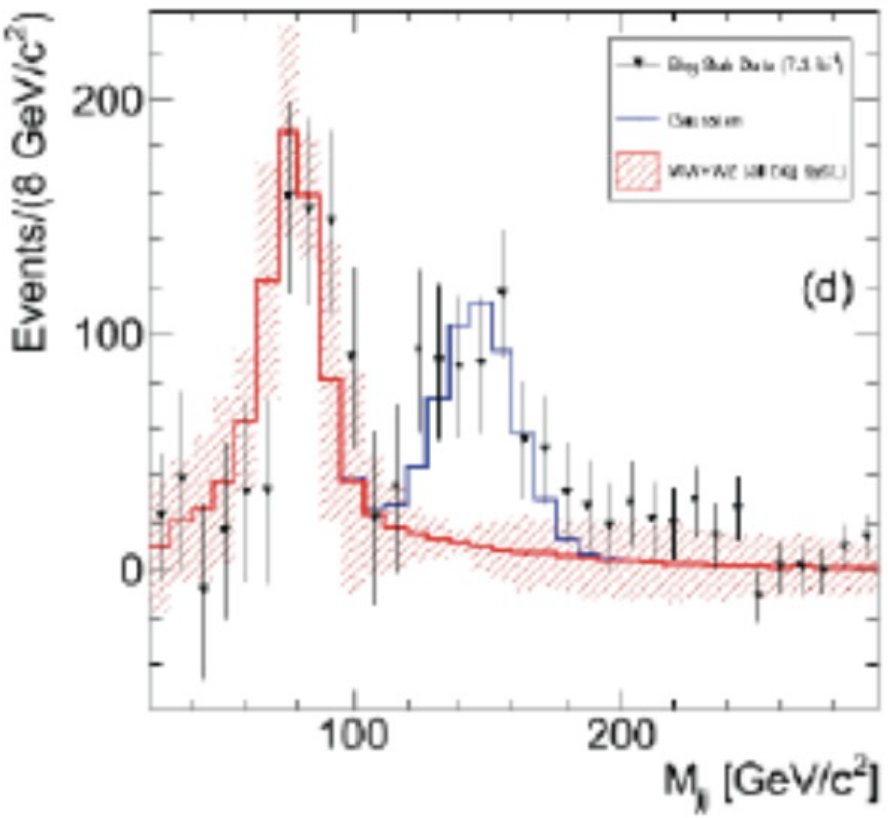
It can be downloaded from:
http://atlas.kek.jp/physics/nlo-wg/grappa.html

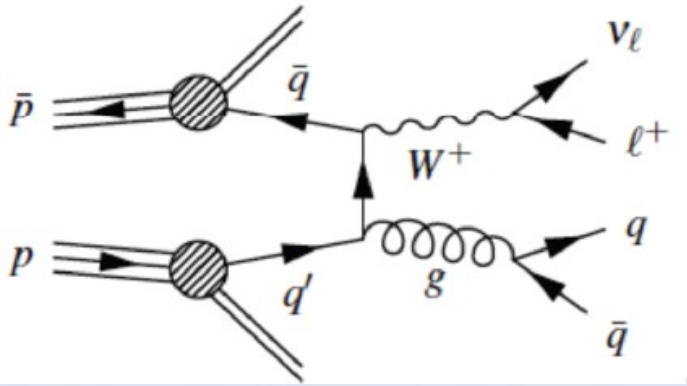
GR@PPA Applications: TEVATRON

H. Kawamura, S. Kumano, YK, Phys Rev D.84.114003

CDF anomaly of 2011





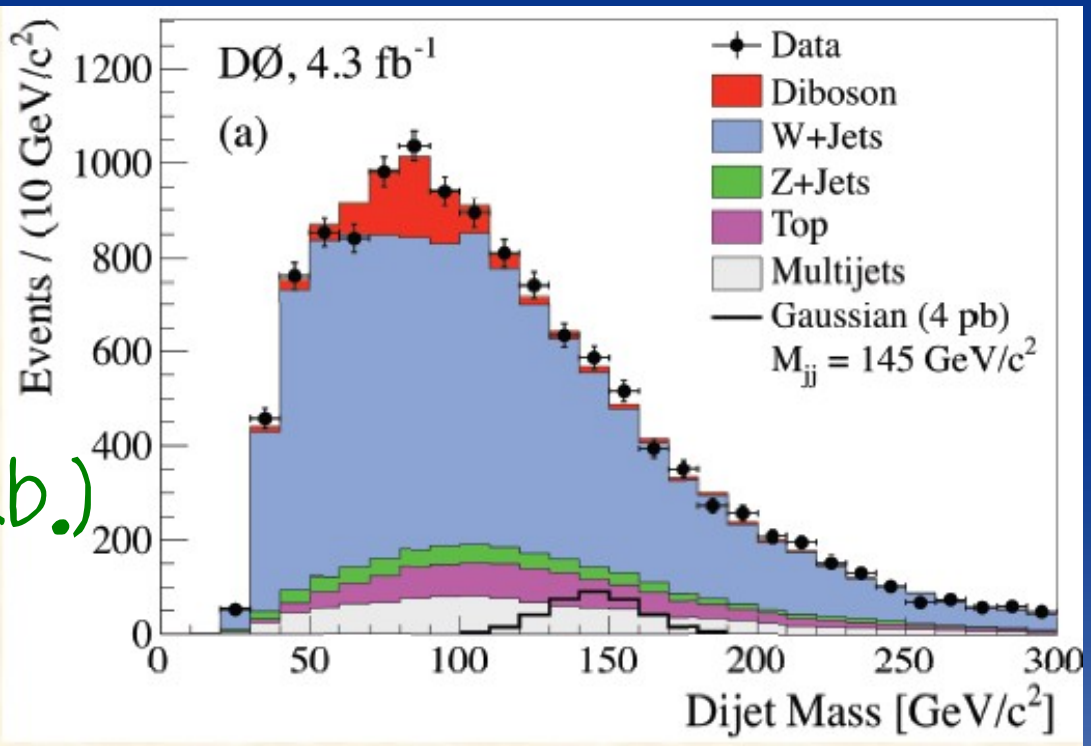


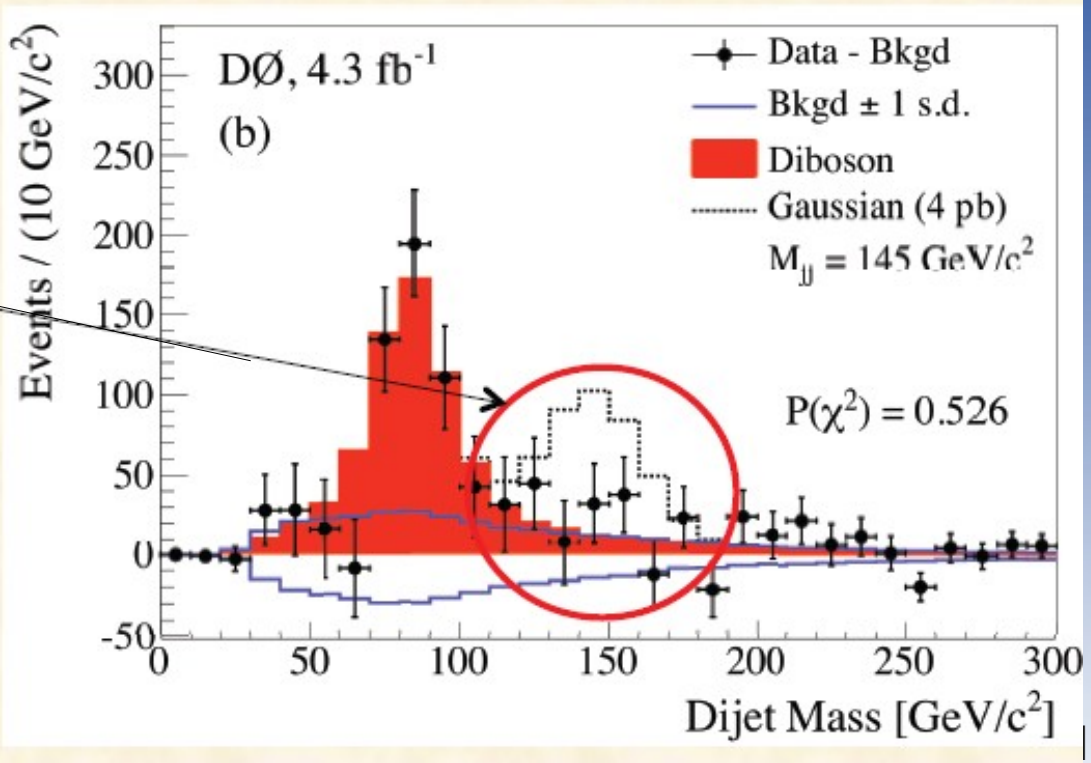
G. Punzi
23rd Rencontres de Blois
May, 2011: 7.3 fb^{-1}

D0 : no anomaly

V.M.Abazov *et al.*(d0-Collab.)
PRL **107** (2011) 011804

No peak!





Event Generation by GR@PPA

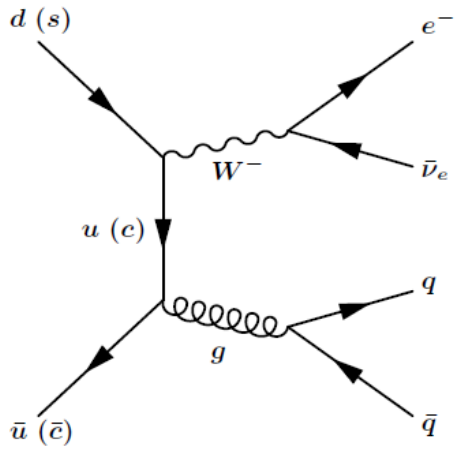


FIG. 1: Typical W+dijet process. The notation q indicates a quark u, d, s, or c.

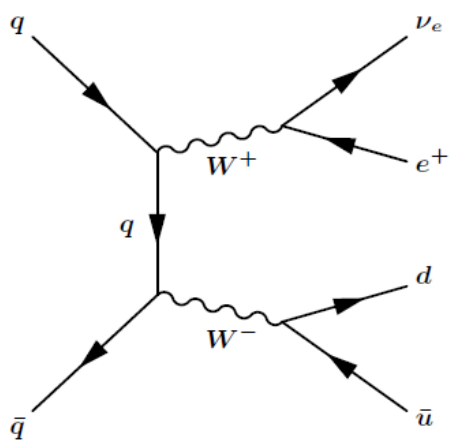


FIG. 4: Typical WW process.

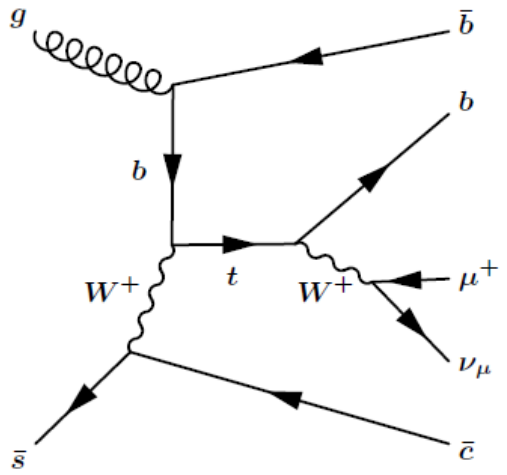


FIG. 3: Typical top-production process.

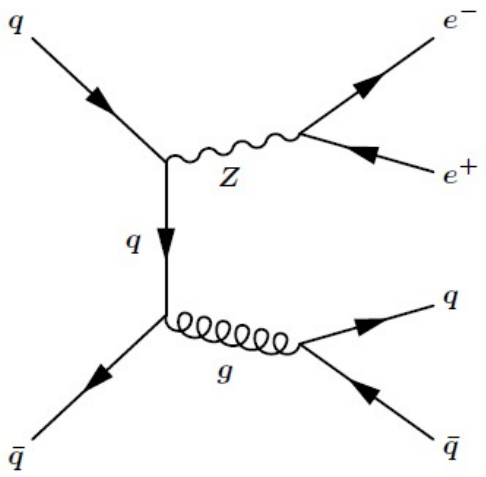


FIG. 2: Typical Z+dijet process.

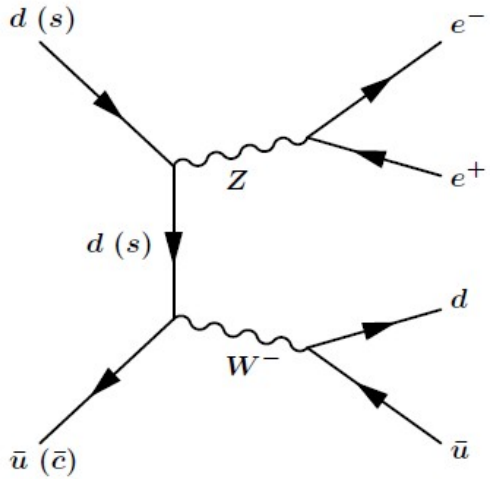
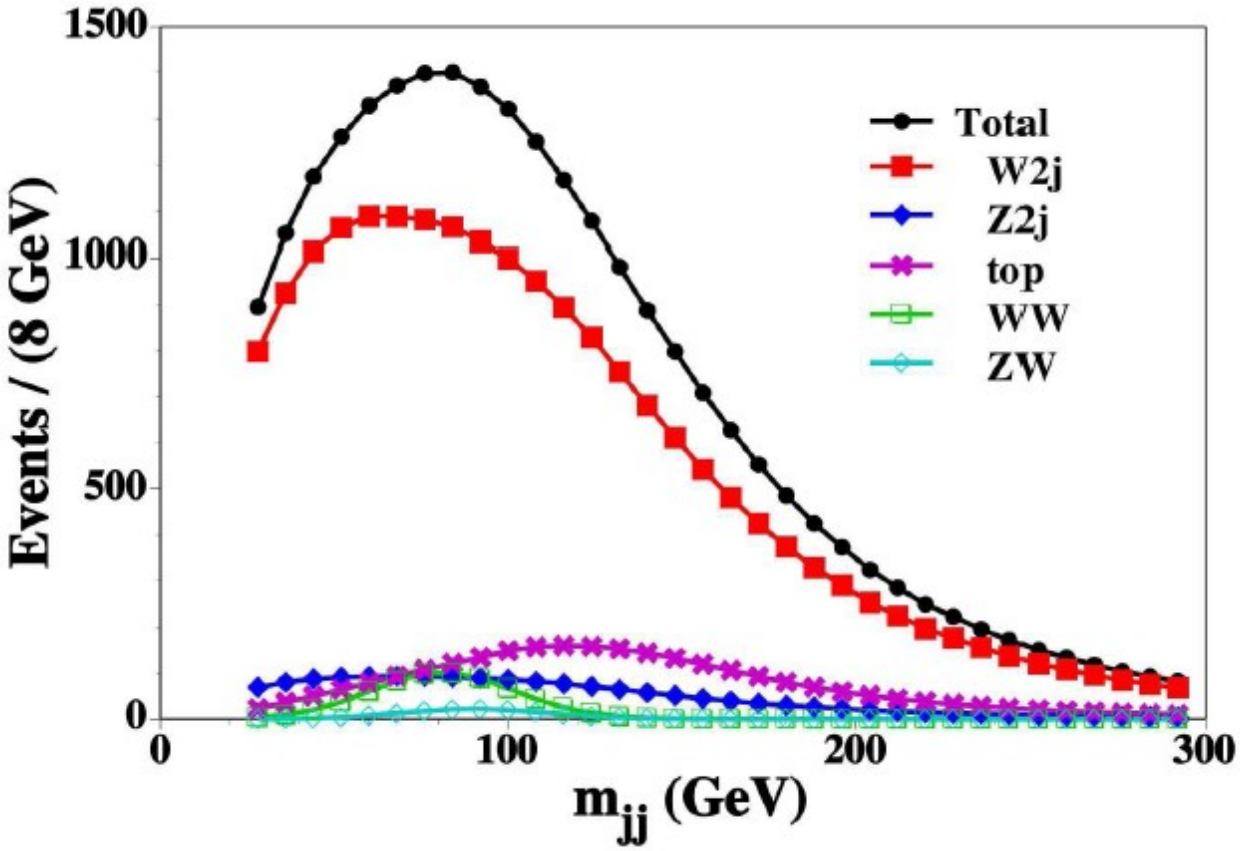
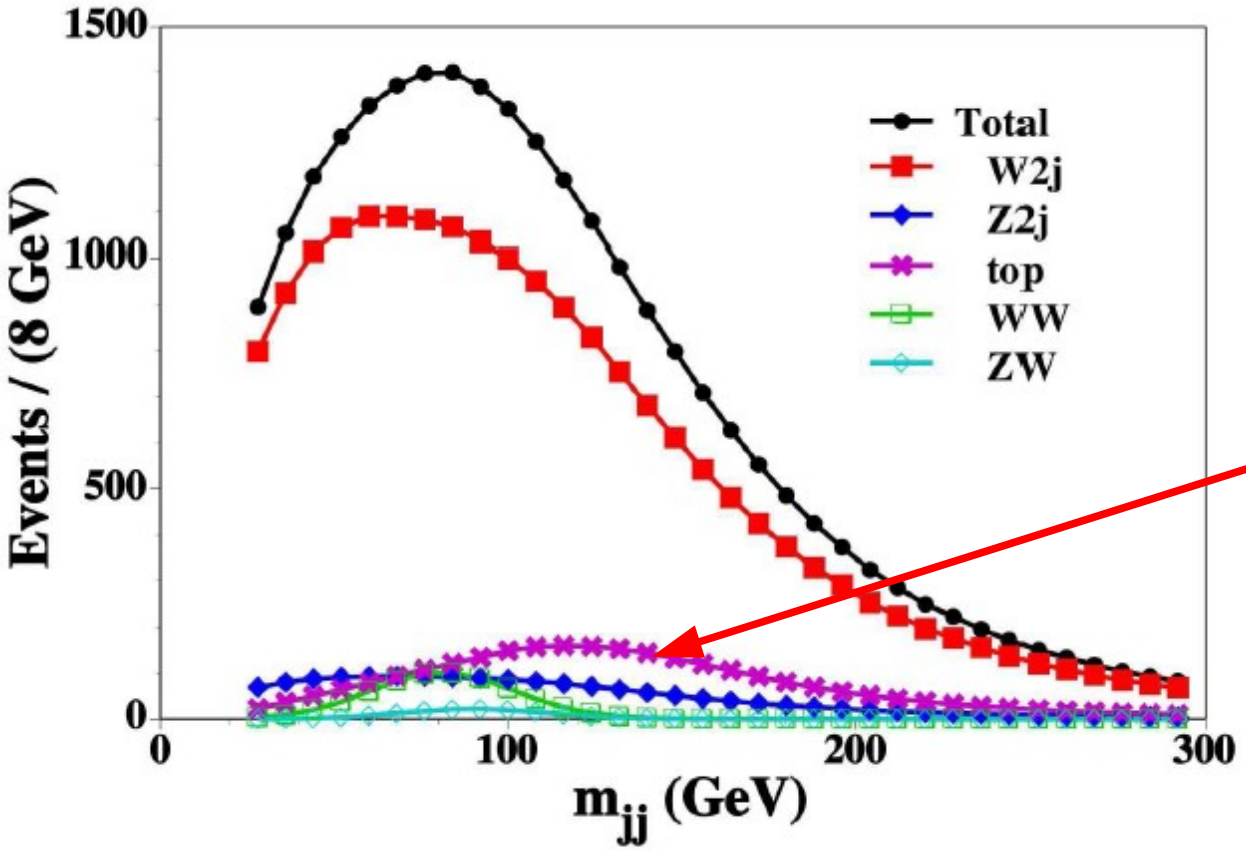


FIG. 5: Typical ZW process.

Event Generation by GR@PPA



Event Generation by GR@PPA



s-quark

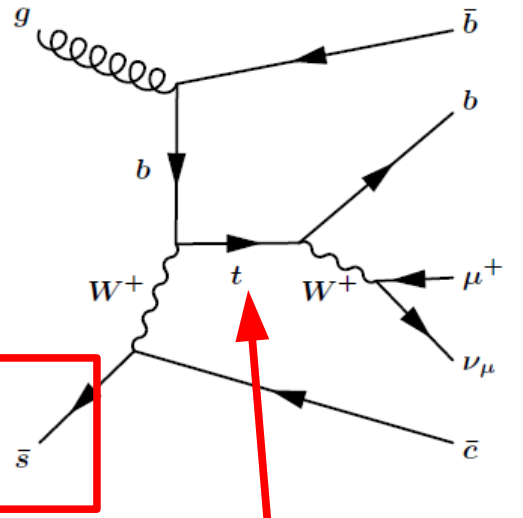
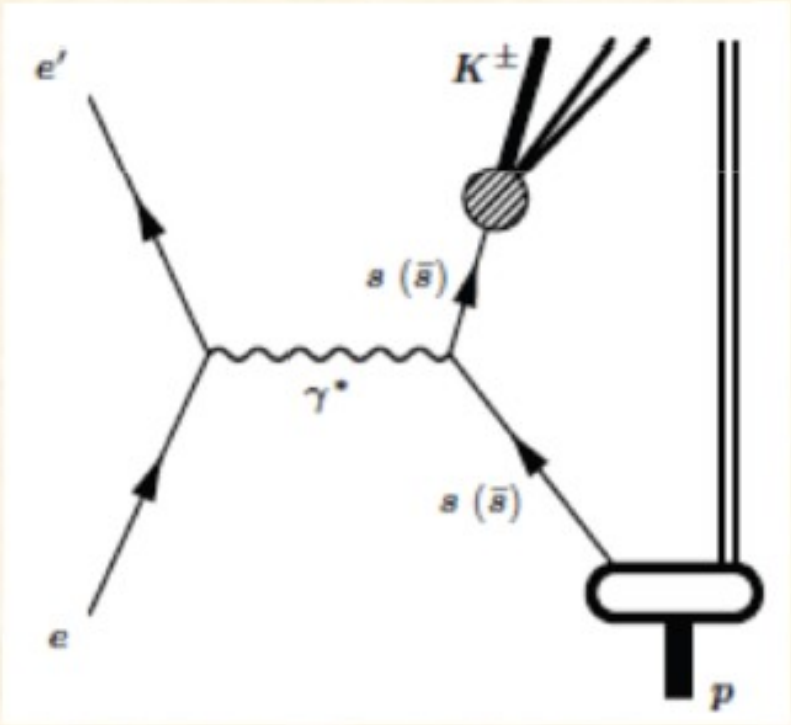


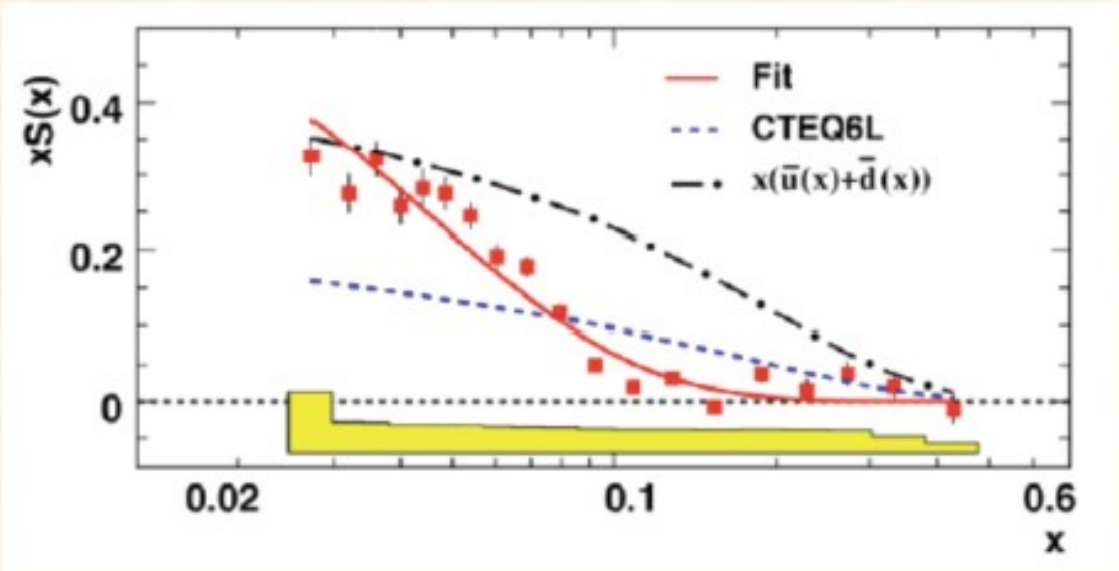
FIG. 3: Typical top-production process.

single-top prod.

PDF ambiguity for s-quark

HERMES semi-inclusive measurement

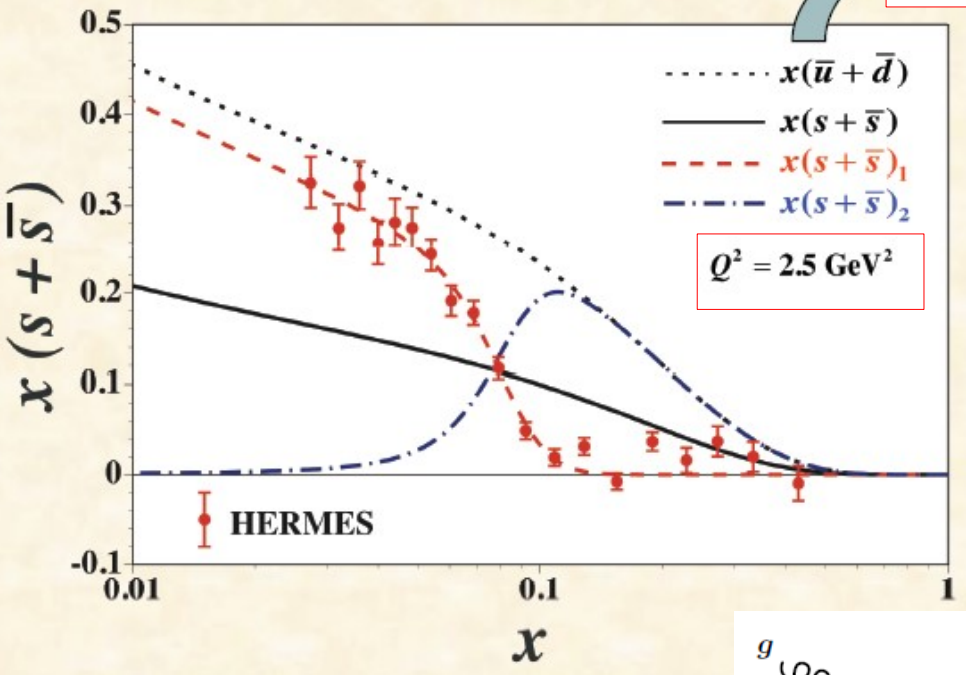


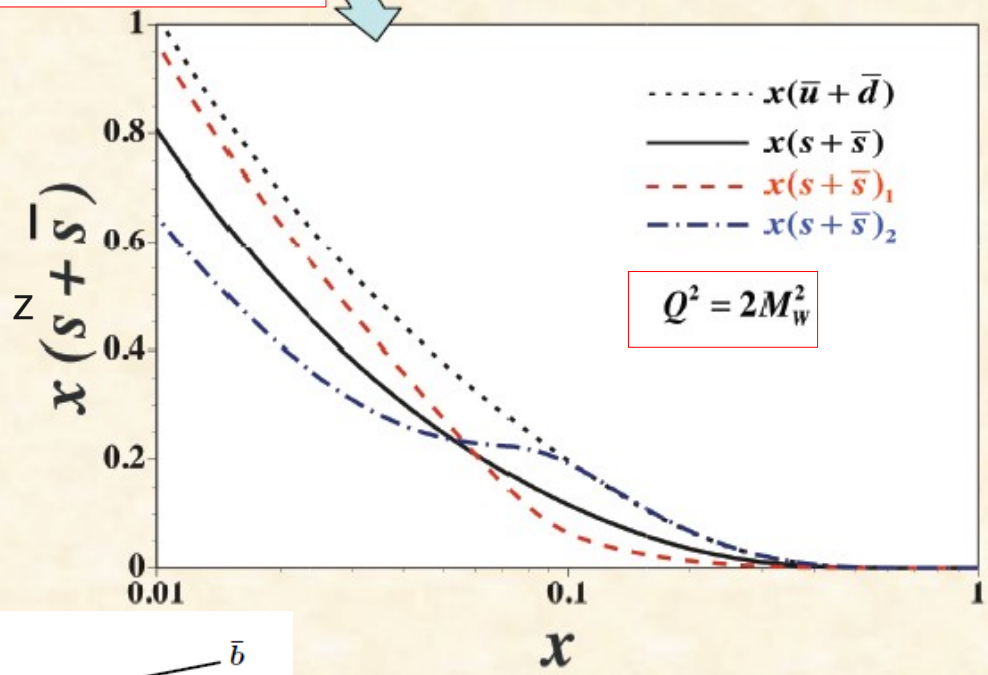


Issue: fragmentation functions

Play with s-quark PDF

Q^2 evolution





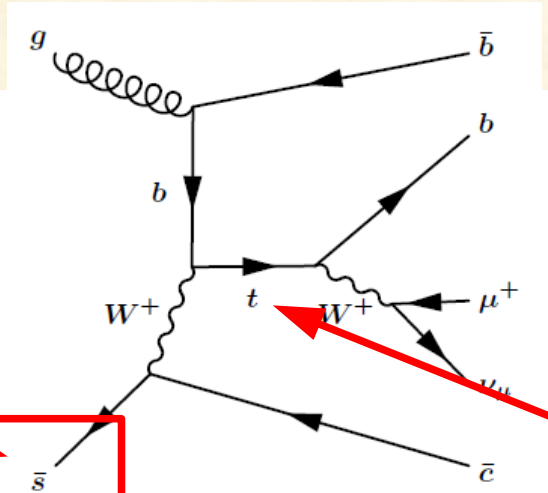
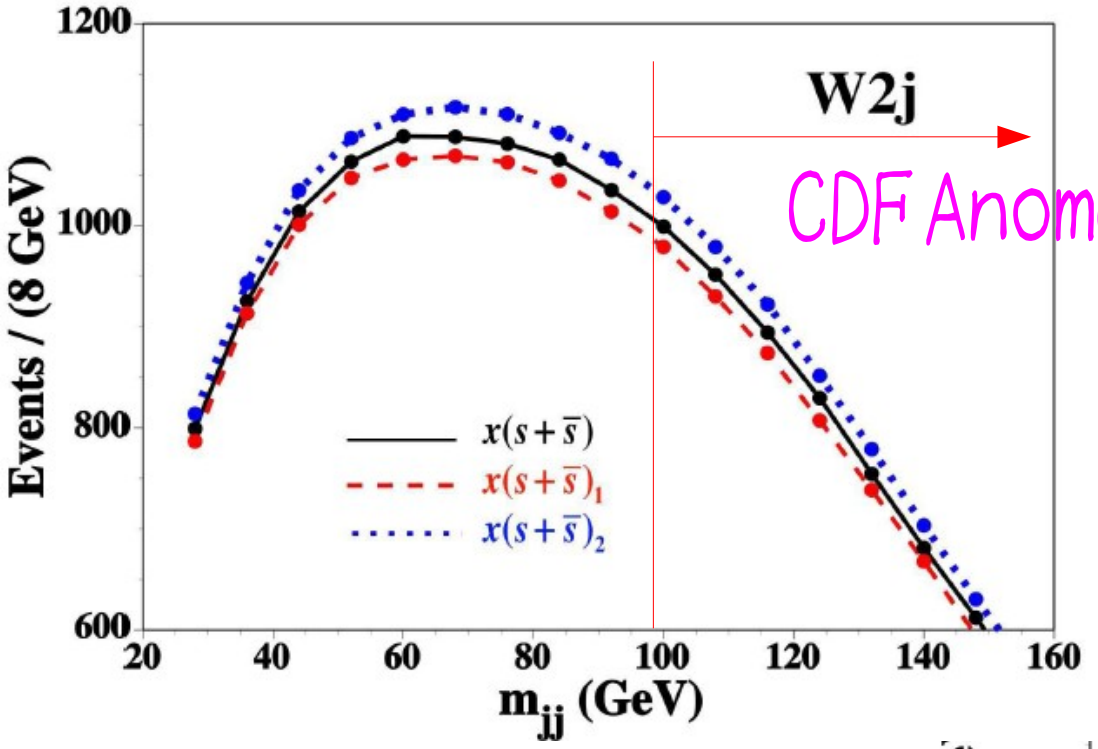


FIG. 3: Typical top-production process.

s-quark

single-top prod.

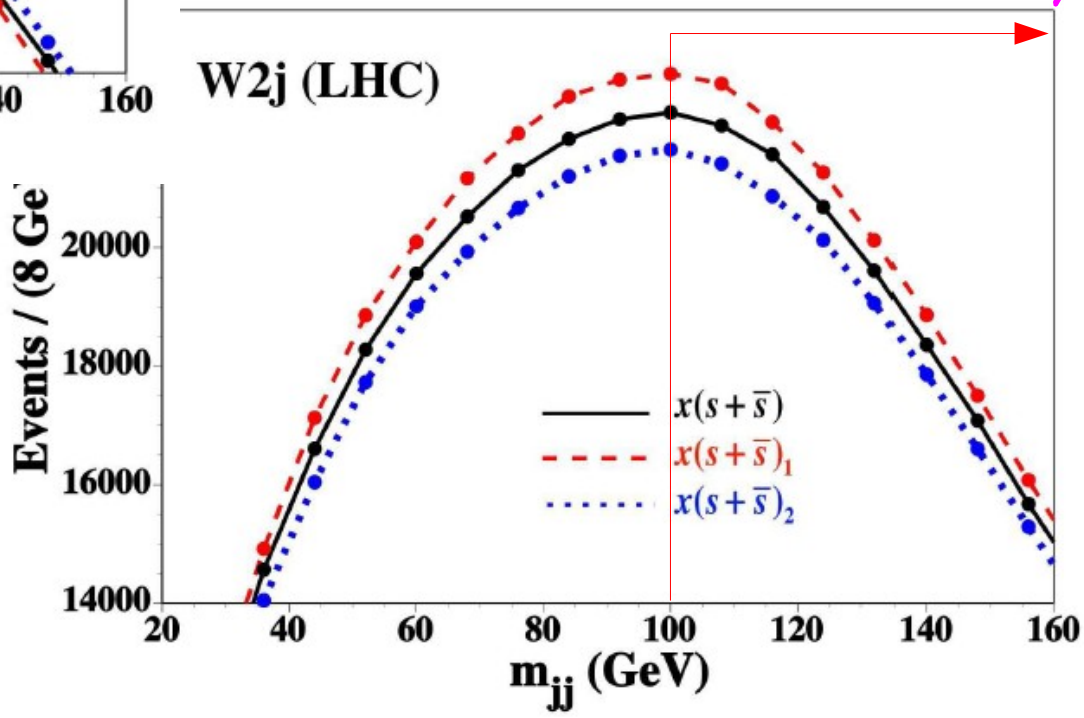
Possible Impact



TEVATRON

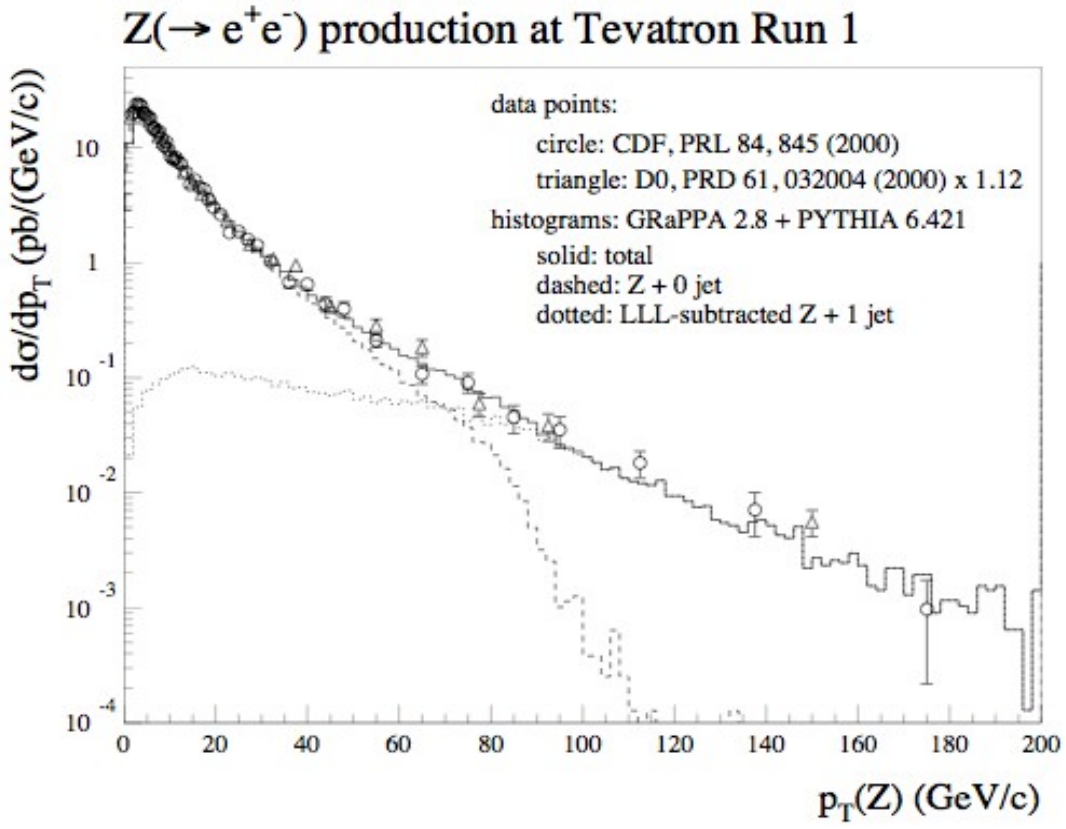
LHC

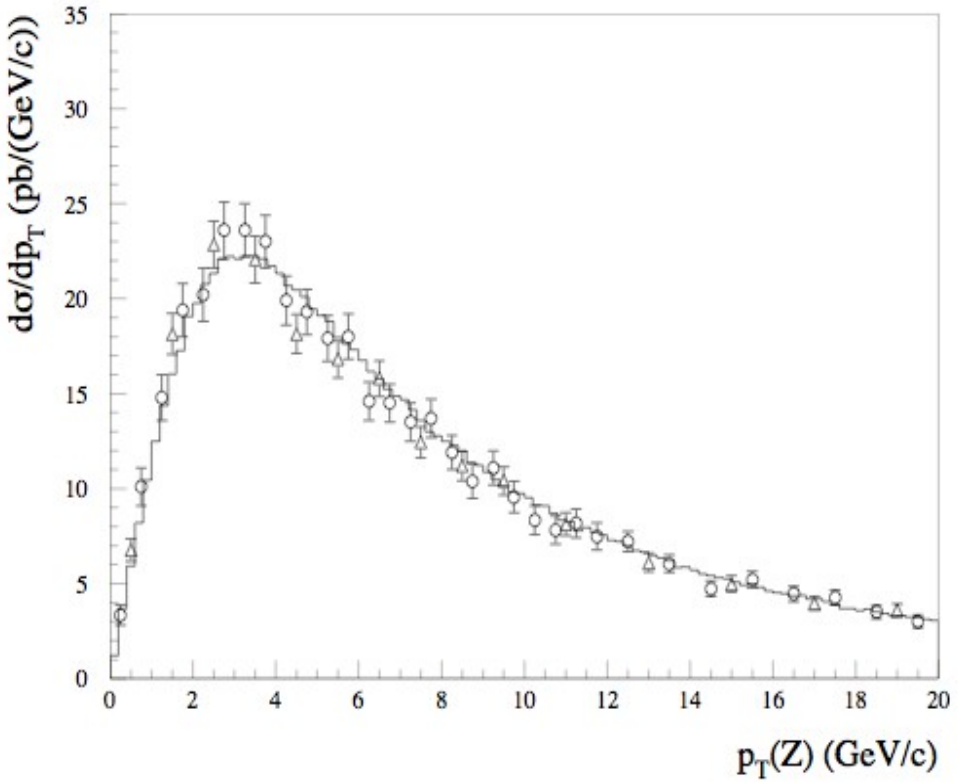
CDF Anomaly



GRACE for TEVATRON: Z→ee

Z-boson production





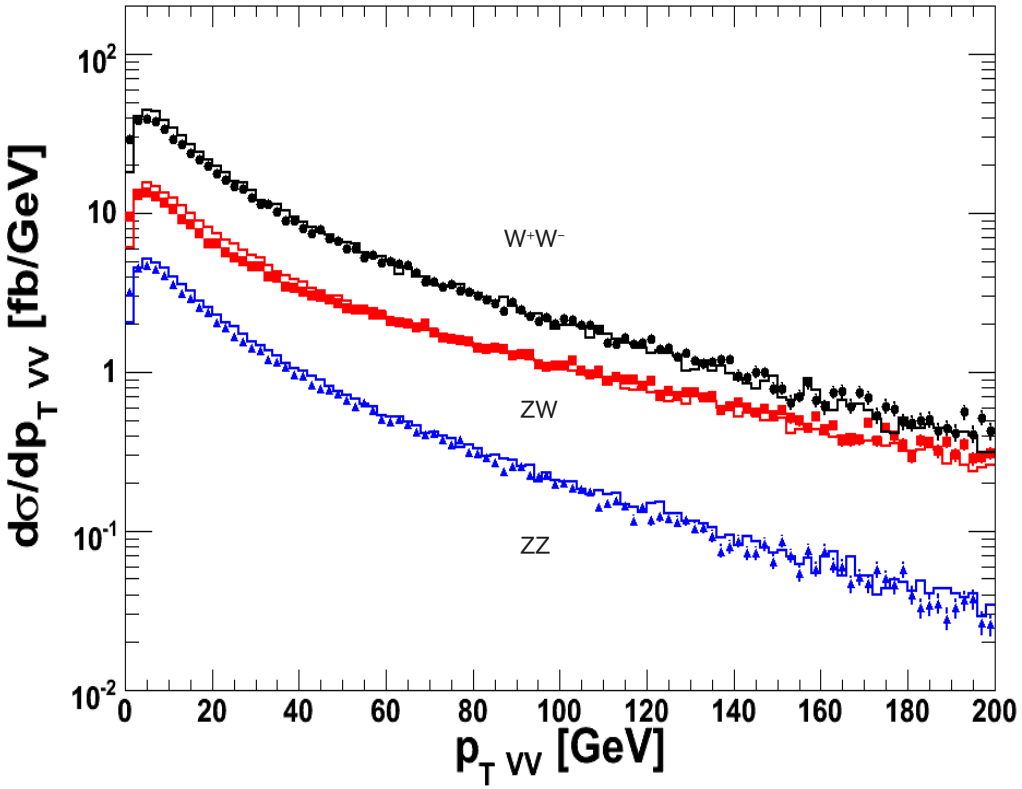
The D0 data and the simulation are normalized to the CDF cross section.

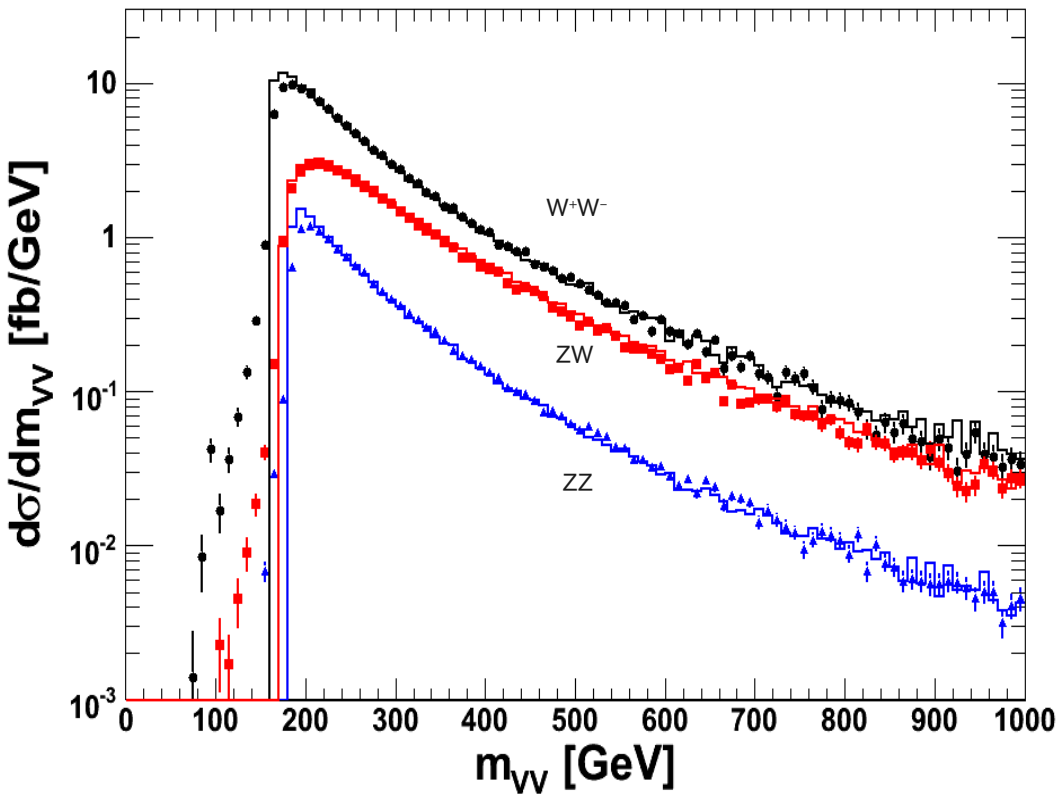
GR@PPA Applications: LHC

S. Odaka YK, arXiv:1107.4467

GRACE for LHC : GR@PPA 2.8

Di-boson production@LHC : GR@PPA v.s. MC@NLO





Plots: GR@PPA 2.8 + PYTHIA 6.419

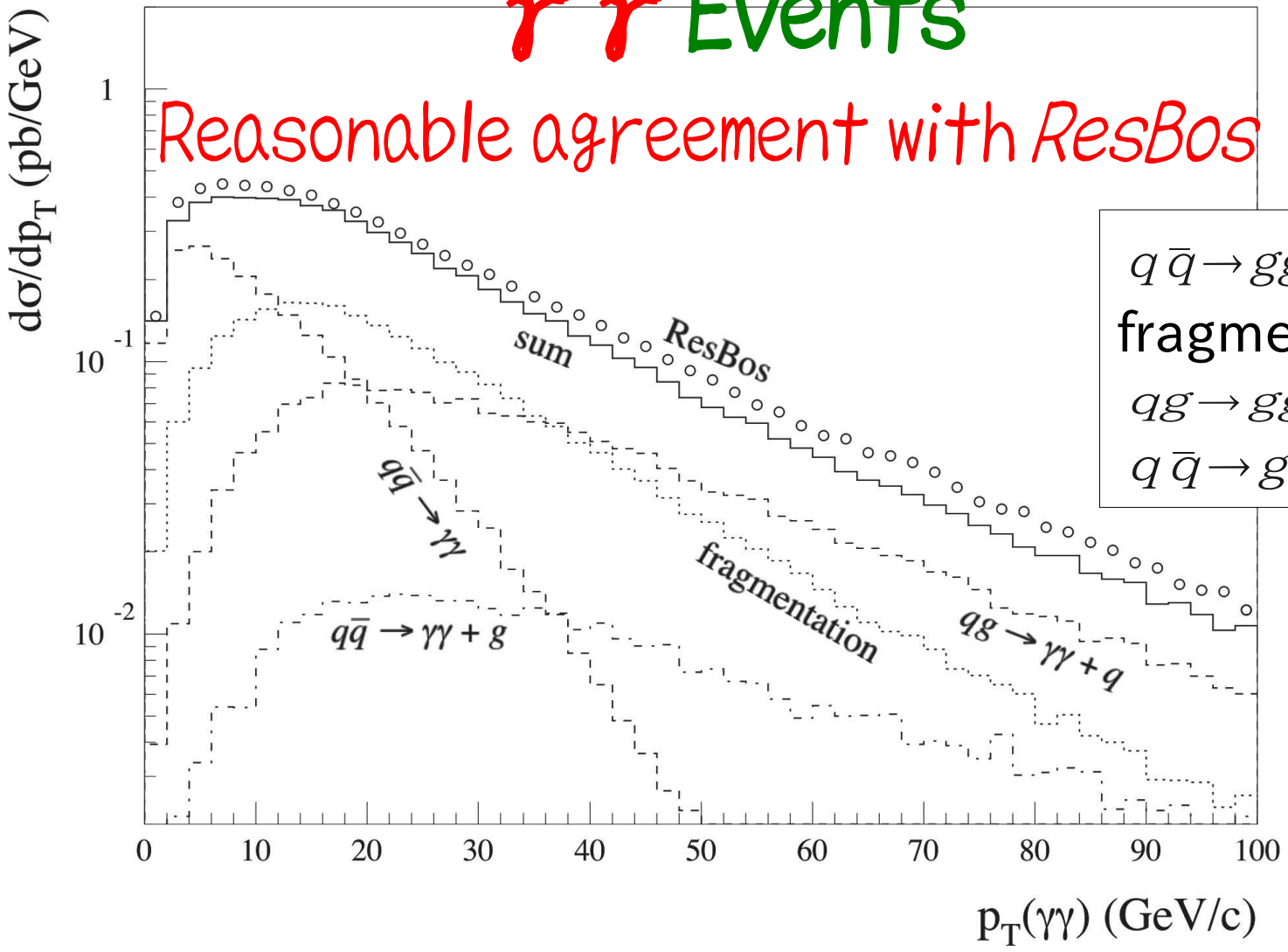
Solid lines : MC@NLO3.31+Herwig6.510.3+Jimmy4.31.3

Total sum: p_T distribution of the $\gamma\gamma$ system

$\gamma\gamma$ Events

Reasonable agreement with *ResBos*

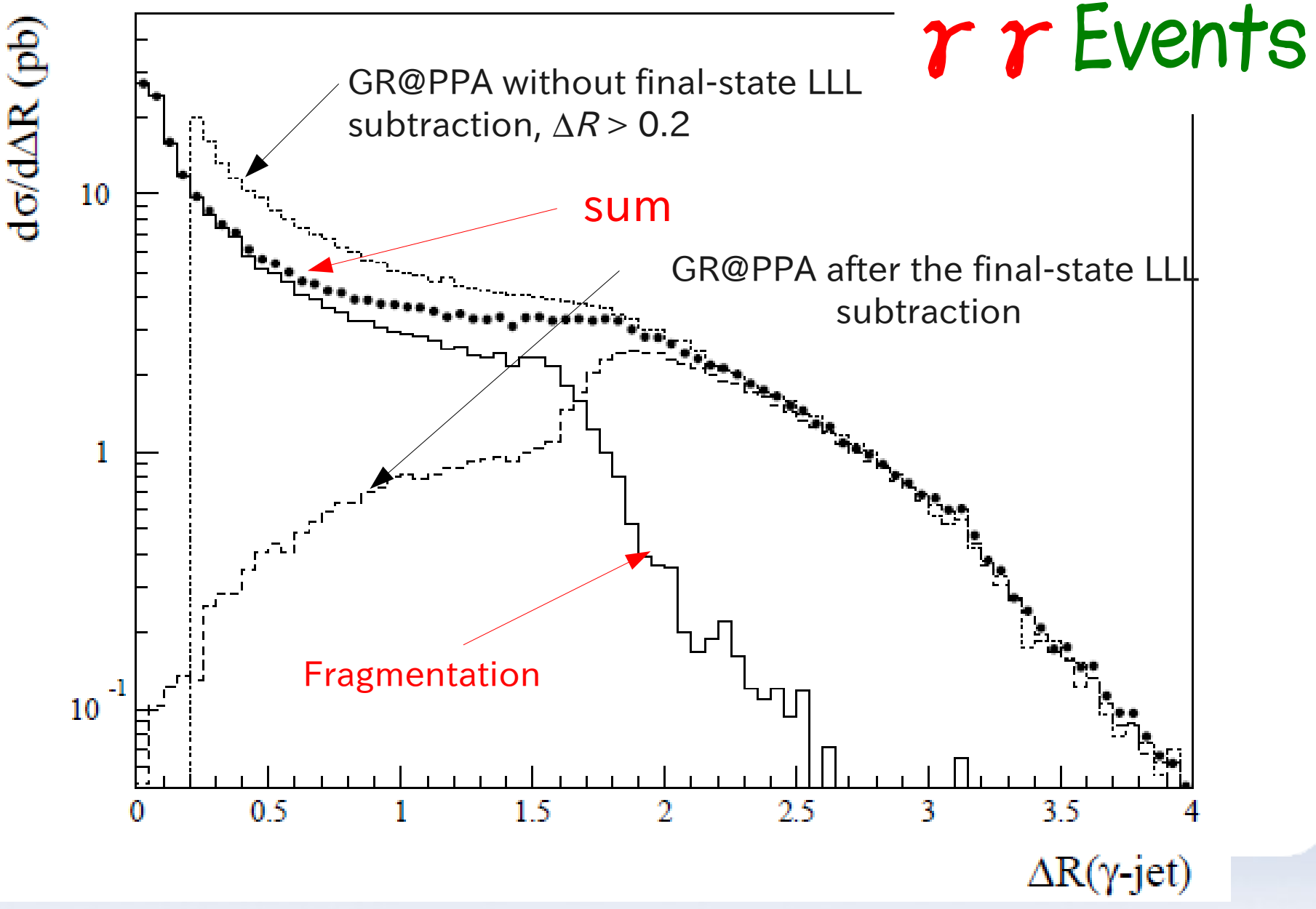
ResBos : 15.5 pb
GR@PPA : 13.7 pb



$q\bar{q} \to gg$	: 4.1 pb	(30%)
fragmentation	: 5.1 pb	(37%)
$qg \to gg + q$	: 3.7 pb	(27%)
$q\bar{q} \to gg + g$	: 0.8 pb	(11%)

$q\bar{q} \to \gamma\gamma$ less than 1/3 of the sum.

Sum of the LLL-subtracted $qg \to \gamma\gamma + q$ and the fragmentation



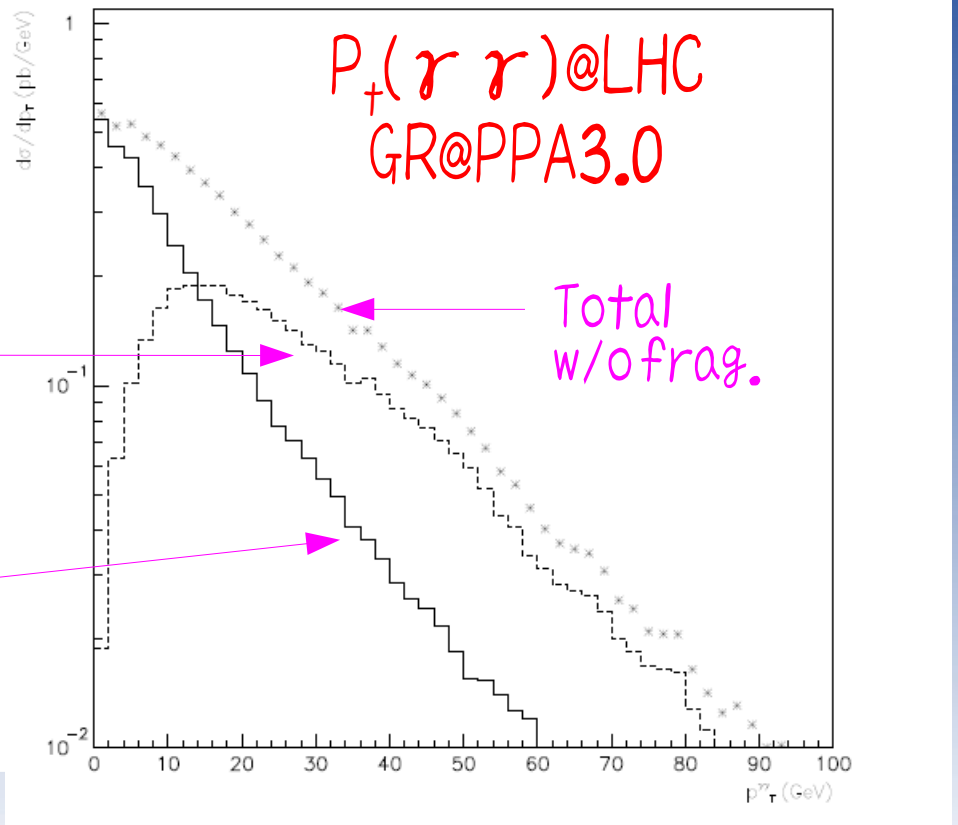
GR@PPA: Near Future

GR@PPA2.8 (3.0 will be open soon)

- $\gamma\gamma$ +X, γ +X in GR@PPA
  - ME
    - LO (GR@PPA2.8), NLO (GR@PPA3.0)
  - PS
    - LL initial/final PS
  - ME/PS matching
    - QCD/QED LLL-Subtraction
  - Fragmentation
    - QED/QCD mixed PS (GR@PPA3.0)

$q\bar{q} \to \gamma\gamma j$ (LLL-Sub.)

$q\bar{q} \to \gamma\gamma$ (NLO)



Summary

Summary

- GRACE is a Automatic Generator of Generators
- GR@PPA 2.8
  - Full Exclusive unweighted Hadron Event Generator w/ ME⇔PS Matching @ Tree Level
  - 2.8→3.0: NLO+QECD PS Full Exclusive unweighted Event Generator
- Applications
  - TEVATRON: CDF W+jets anomaly
  - LHC: W/Z+jets, $\gamma\gamma$+jets