MAD meeting, October, 2000
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Hadronic $\gamma\gamma$ study : TWOGAM vs PYTHIA

- Introduction
- A bit of hadronic $\gamma\gamma$ physics
- Difference between TWOGAM and PYTHIA
- Description of the SAMPLEs used
- DATA/MC analysis :
  - Squarks searches @ $189 \rightarrow 208$ GeV
  - Chargino searches @ $< 206 >$ GeV
  - 2 Loose selections @ 200 GeV
- Conclusion

Introduction

- Previous study showed that TWOGAM was not giving satisfactory results for loose selection.
- Recently DELPHI processed a PYTHIA 6.143 sample (500k evts).
- A study of this new sample gives promising results.
- A short DELPHI public note has been released :

  DELPHI 2000-163 PHYS 878
- At this present stage cross–checks are really needed :

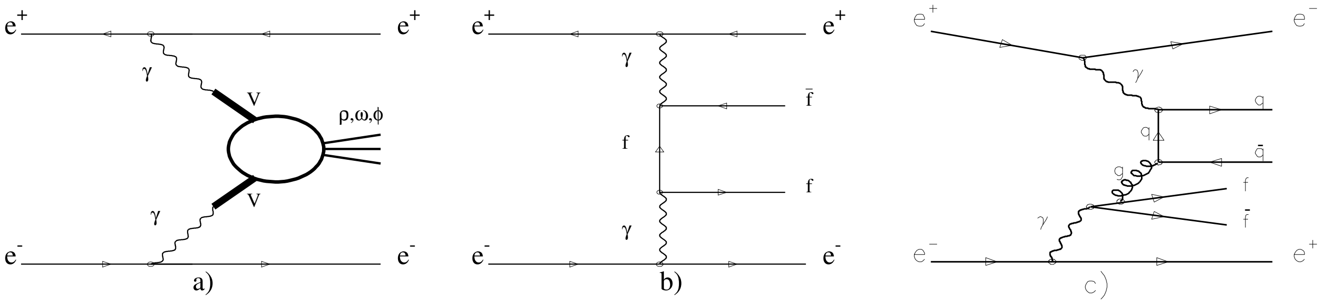
  ALL interested persons are welcome
- New samples (a total of 5 millions evts !!) expected.
- 1.6 millions evts @ 206 GeV available tomorrow !!

A bit of hadronic $\gamma\gamma$ physics

$\gamma\gamma$ events correspond to the interaction of two virtual photons emitted by the colliding electrons and positrons. The interaction gives a final system consisting of leptons or hadrons.

Hadronic $\gamma\gamma$ interactions can be described by a sum of three components:

- A Soft interaction part described by the Vector meson Dominance Model (VDM)
- A perturbative term with a direct quark exchange using the Quark Parton Model (QPM)
- A perturbative hard scattering of the partonic constituents of the photon (QCD)



a) $\gamma\gamma_{VDM}$, b) $\gamma\gamma_{QPM}$ and c) $\gamma\gamma_{QCD}$ (single resolved).

Differences between PYTHIA and TWOGAM

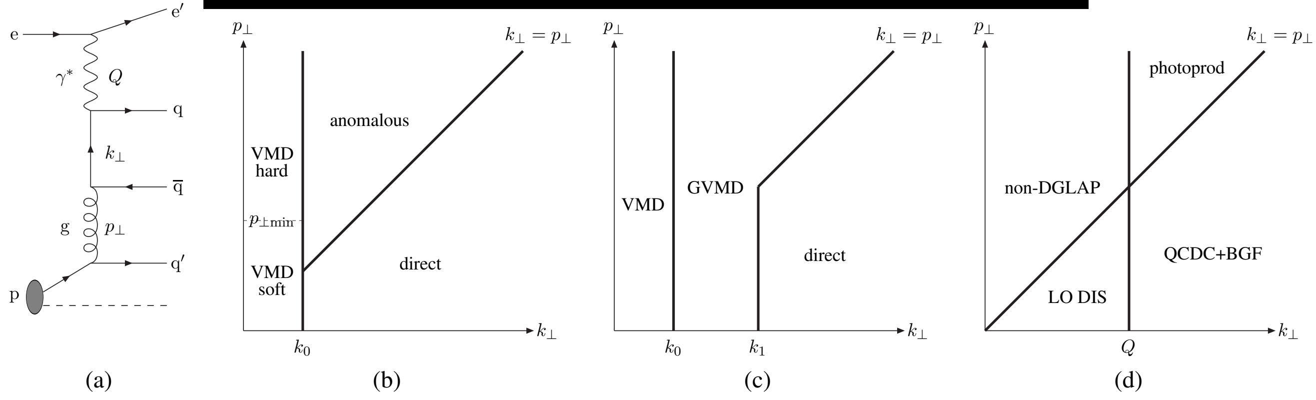


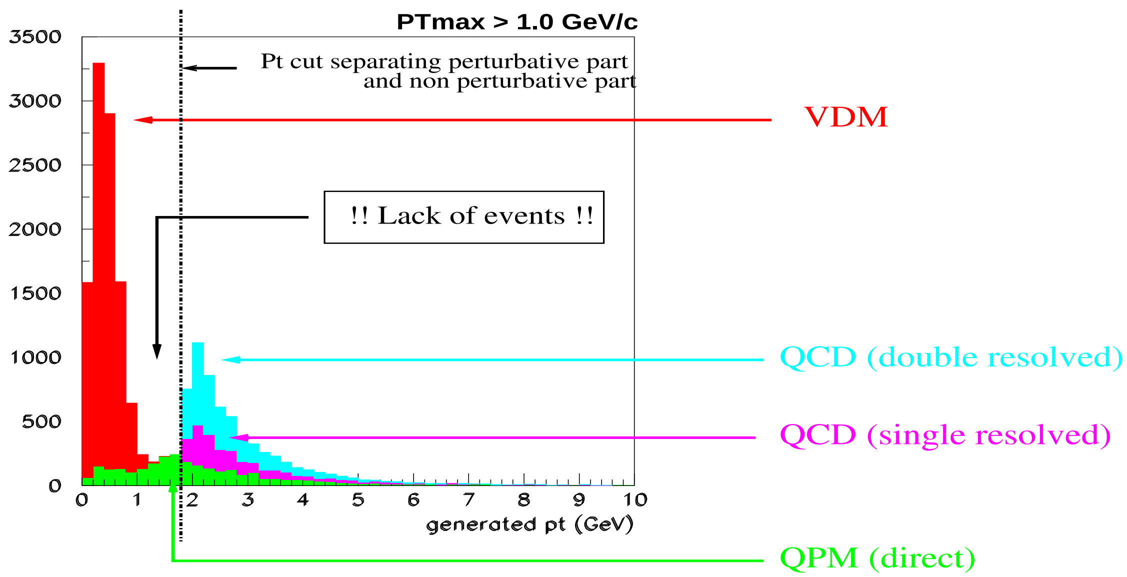
Fig. 1: (a) Schematic graph for a hard γ^*p process, illustrating the concept of three different scales. (b) The allowed phase space for this process when $Q^2 = 0$, with one subdivision into event classes. (c) An alternative classification of the phase space in (b), which better takes into account unitarization effects. (d) Event classification in the large-Q^2 limit.

PYTHIA scheme (here for ep interactions) of separation of different classes of events

Since version 6.137:

- photon flux incorporated
- virtual photon contribution

TWOGAM lacks the sophisticated matching of soft and hard (perturbative) events and underestimates the hadronic activity in soft and underlying interactions



Description of the SAMPLEs

TWOGAM 2.04

- $M_{\gamma\gamma} > 3 \text{ GeV}/c^2$
- $E_{transverse} > 3 \text{ GeV}$

OR

- 1 particle with Energy $> 0.4\ E_{beam}$

User cross-section $=$ 10190$\pm$89 pb @ 200 GeV

PYTHIA 6.143

- $M_{\gamma\gamma} > 3 \text{ GeV}/c^2$
- $E_{transverse} > 3 \text{ GeV}$
- At least 3 charged particles with $p > 0.1$ GeV$/c$

OR

- 1 particle with Energy $> 0.4\ E_{beam}$

User cross-section $=$ 7740$\pm$66 pb @ 200 GeV

Selection cuts

Squark Analysis

SUSANA selection:

- Transverse Energy greater than 4 GeV
- At least 1 charged particles with $P_t > 1.5\ \mathrm{GeV}/c$

Hadronic selection, anti-$\gamma\gamma$:

- At least 4 TPC tracks
- (1) $E_{STIC}/E_{vis} < 0.7$
- $\theta_{thrust} \in]30,150[$
- $P_{TPC}/E_{cha} > 0.55$
- (2) at least 6 charged particles
- Hermiticity cut : IHER(1) from SUSANA
- $E^{max}_{neut.} < 40$ GeV

Pre-selection:

- P_t^{mis} greater than 4 GeV/c
- $\theta_{Pmis} \in]24,156[$
- (3) $E_{20}/E_{vis} < 0.1$
- (4) Visible mass less than 95 GeV/c^2

Chargino Analysis

SUSANA selection:

- Transverse Energy greater than 4 GeV
- At least 1 charged particles with $P_t > 1.5 \text{ GeV}/c$

Hadronic selection :

- At least 3 TPC tracks
- Most energetic neutral not in STIC acceptance.
- $\theta_{thrust} \in]11,169[$
- at least 6 charged particles
- No isolated photon, lepton reconstructed.
- Hermiticity cut : IHER(2) from SUSANA
- P_t^{mis} greater than 4 GeV/c
- $\theta_{Pmis} \in]16,164[$
- % e-m Energy less than 95 %

Loose selections

SUSANA selection:

- Transverse Energy greater than 4 GeV
- At least 1 charged particles with $P_t > 1.5~\mathrm{GeV}/c$

Loose selection A :

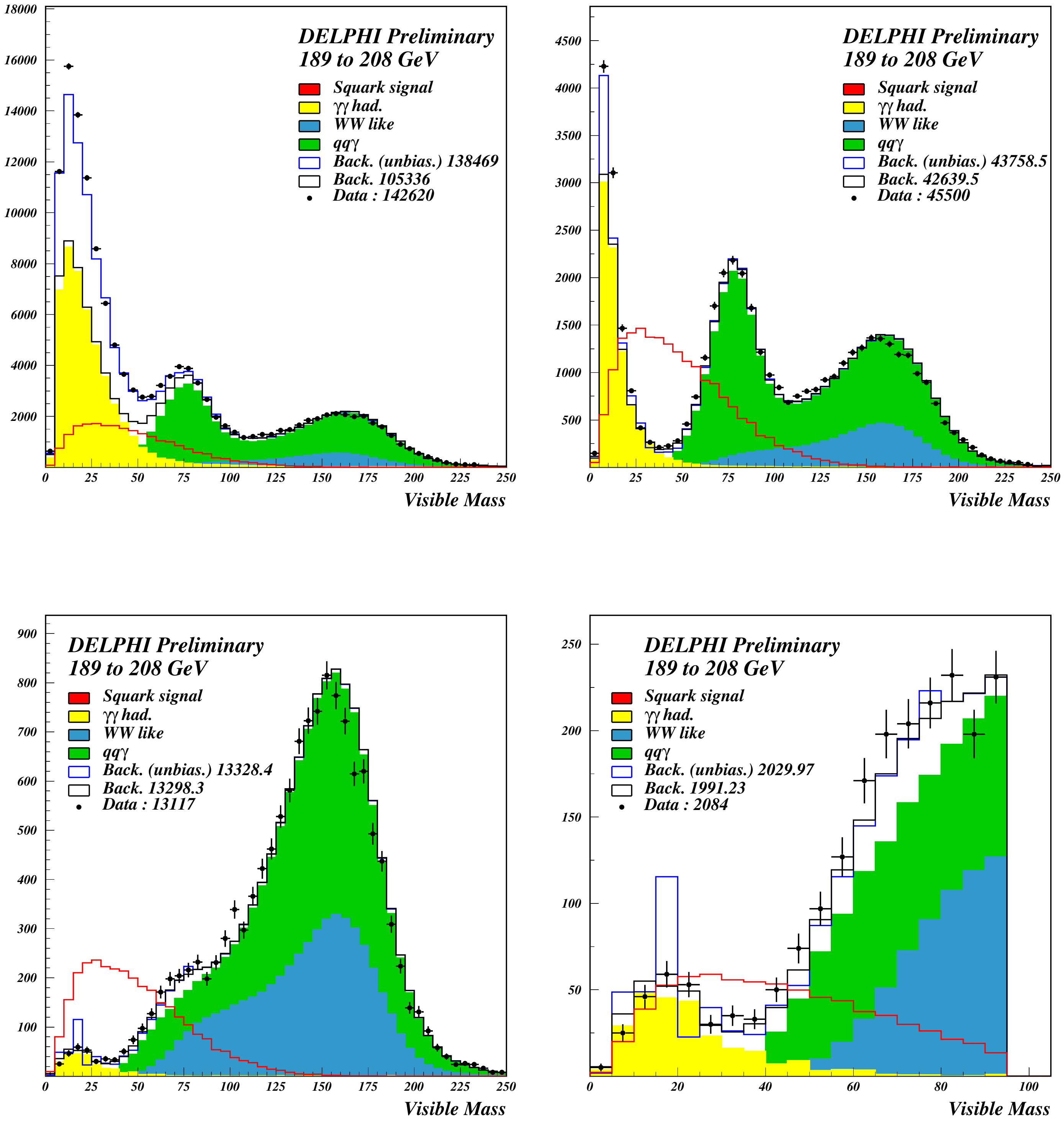
- At least 3 TPC tracks
- $E_{STIC}/E_{vis} < 0.7$

Loose selection B :

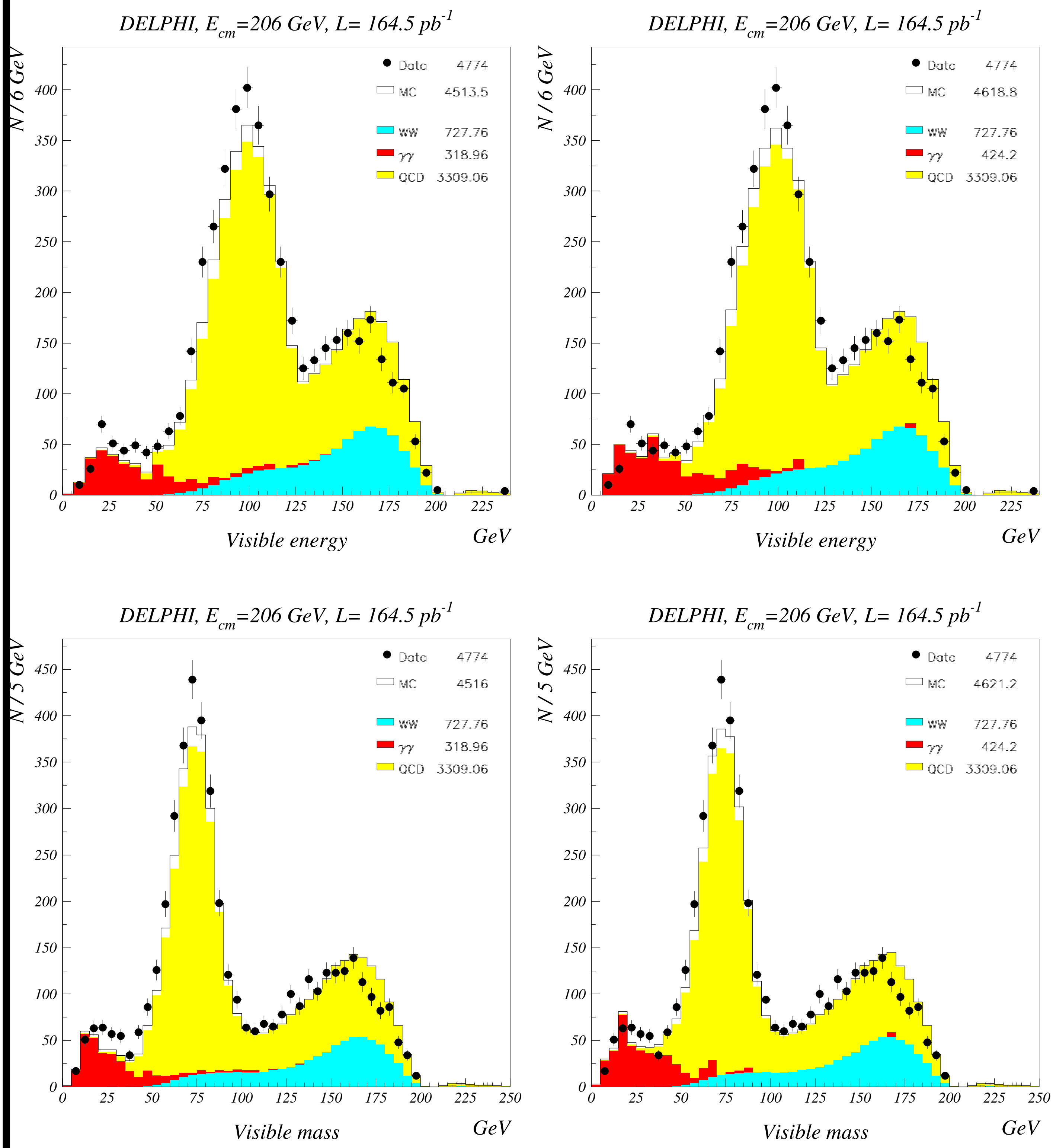
- At least 3 TPC tracks
- Transverse charged energy $< 20~\mathrm{GeV}$

DATA-MC COMPARISON
preselection level

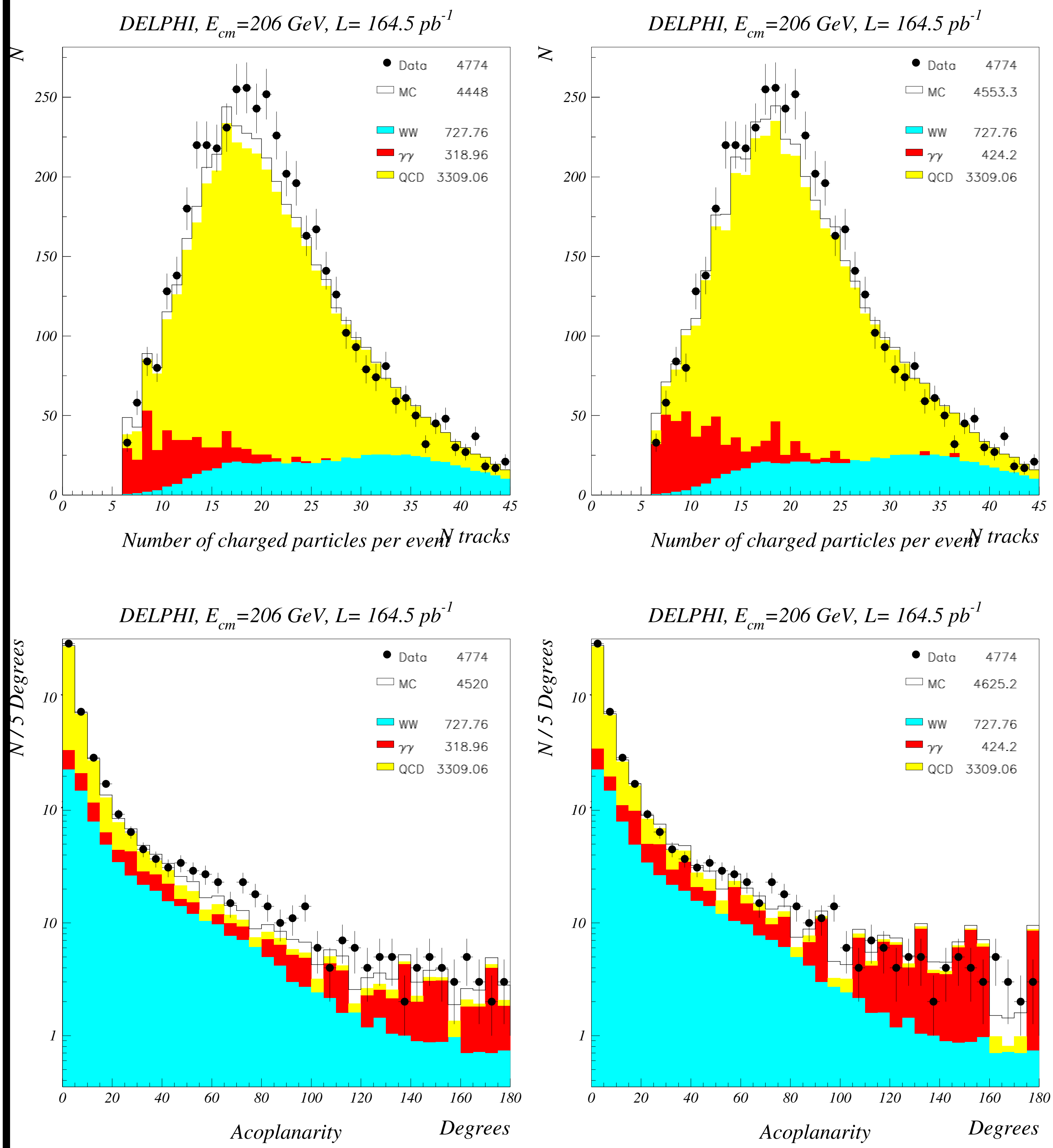
Squark Analysis



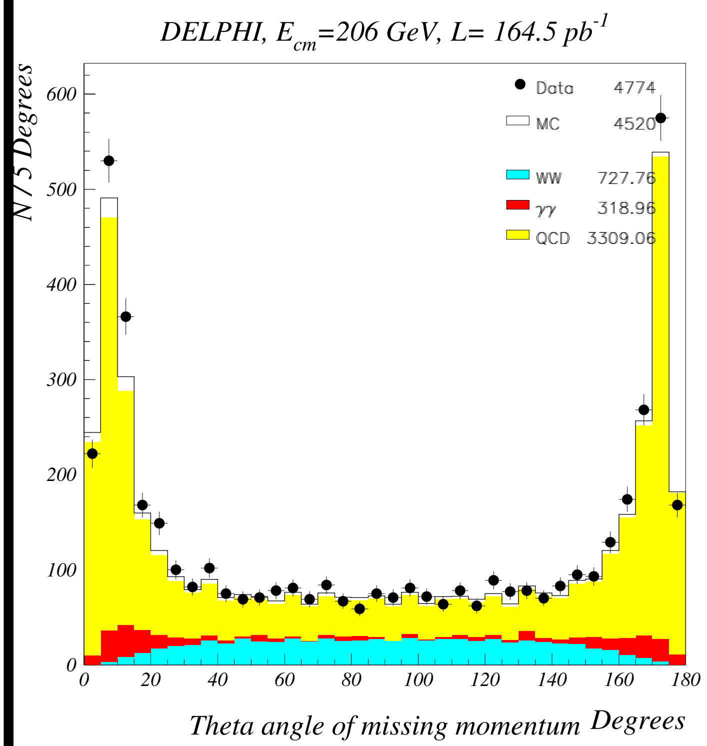
Chargino Analysis

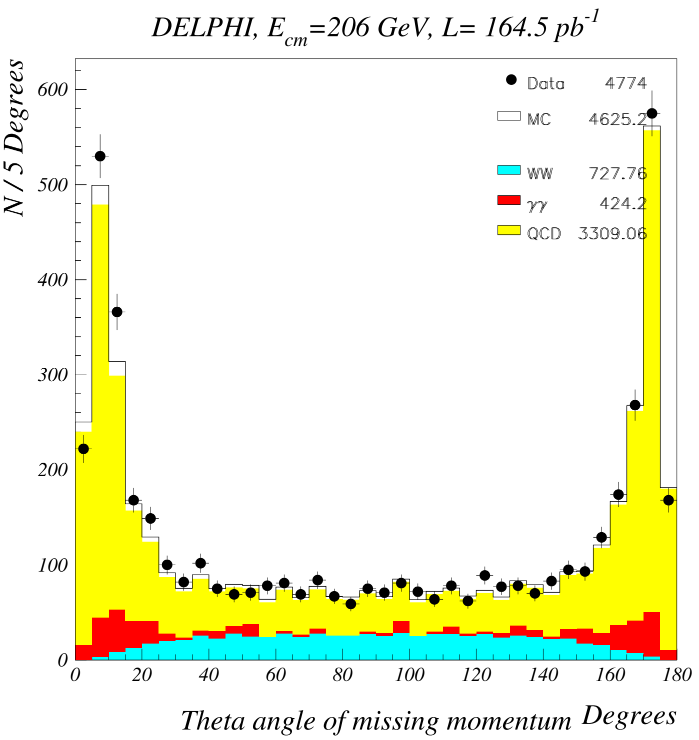


Chargino Analysis

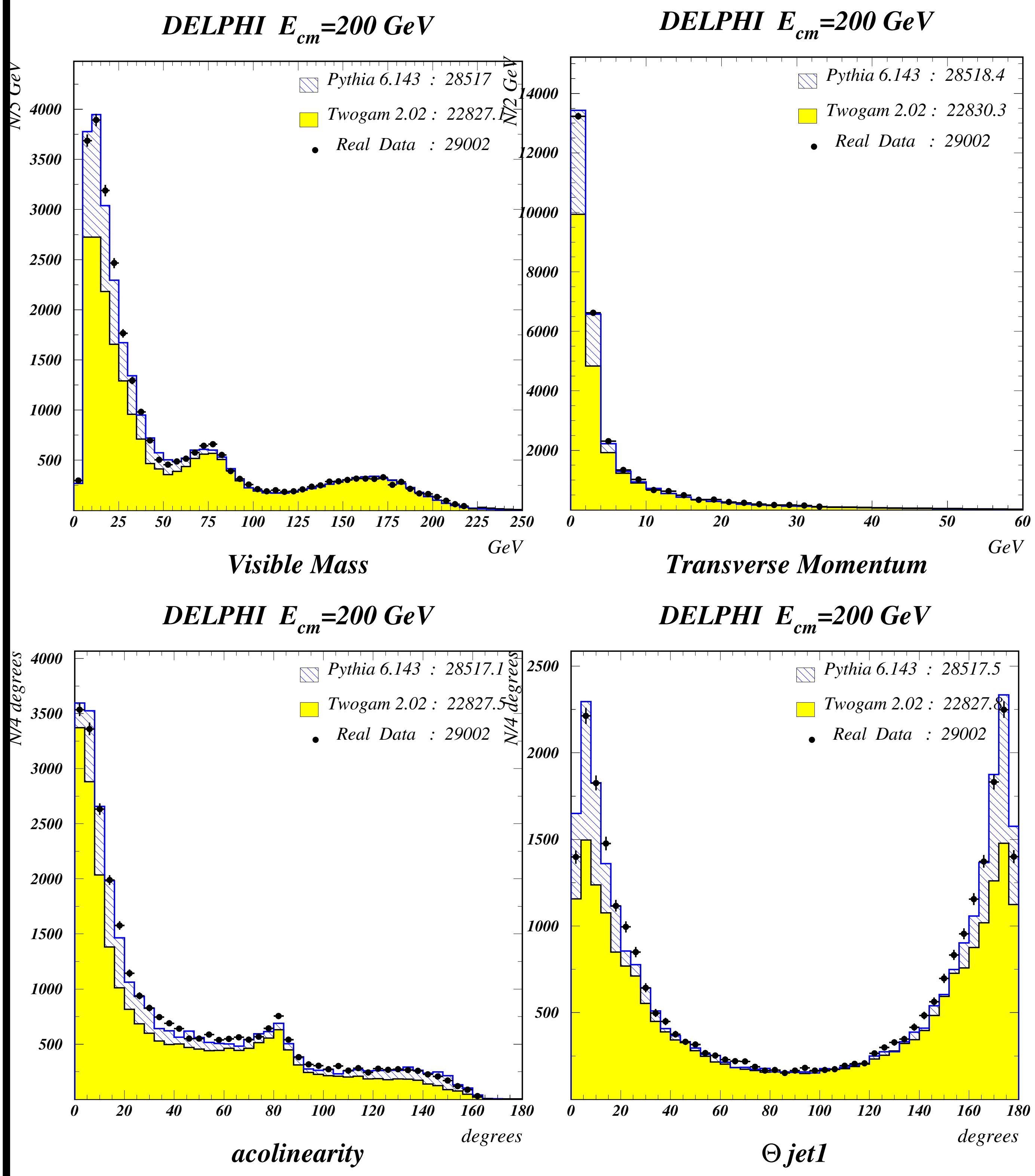


Chargino Analysis

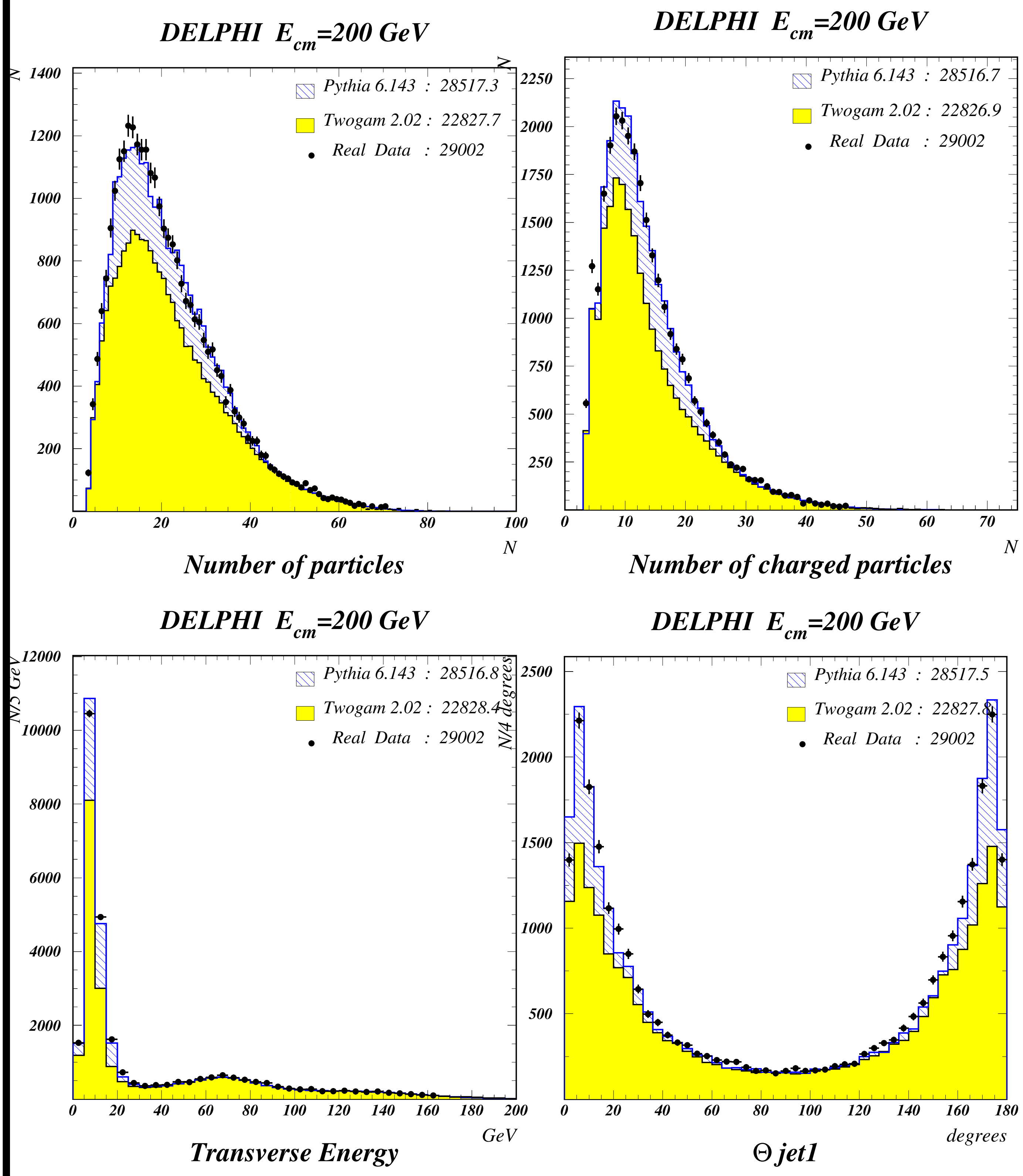




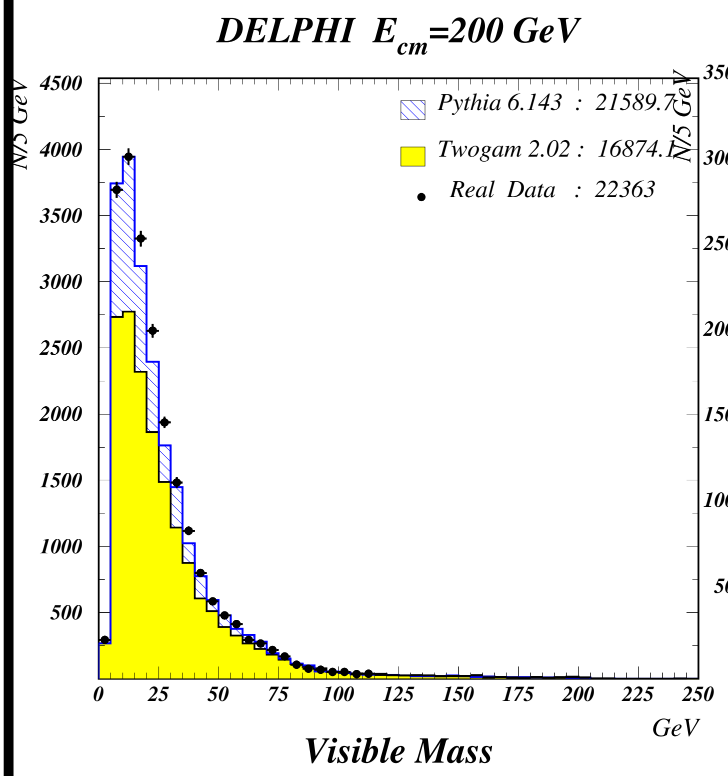
Loose selection A

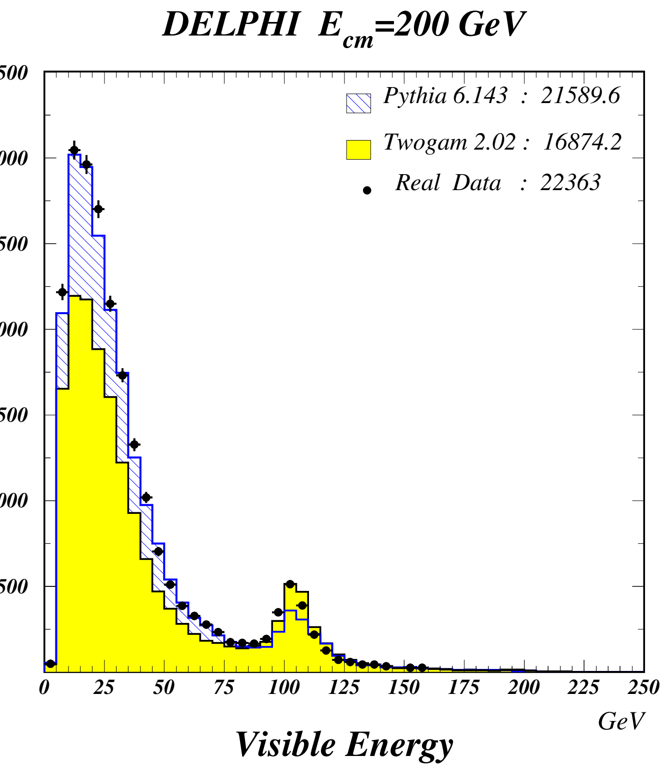


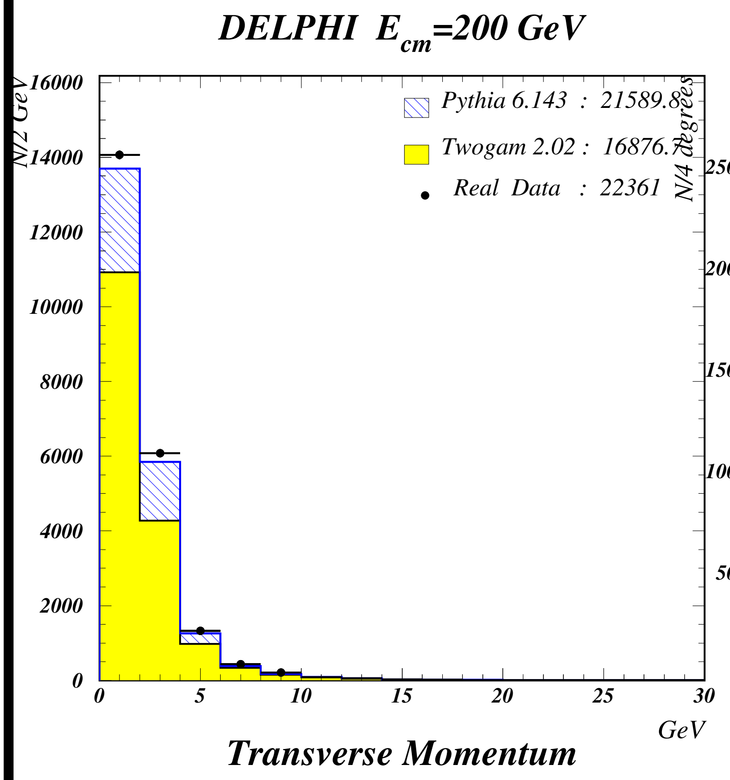
Loose selection A

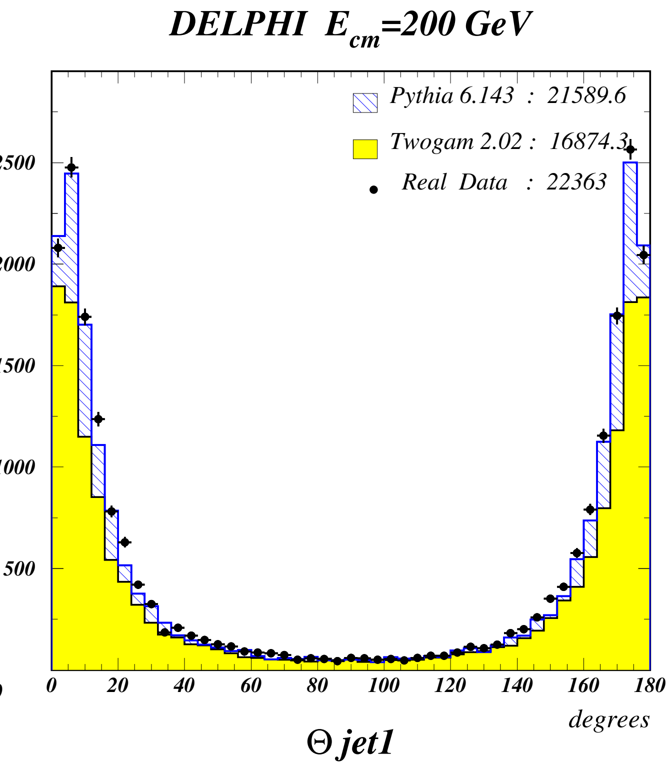


Loose selection B

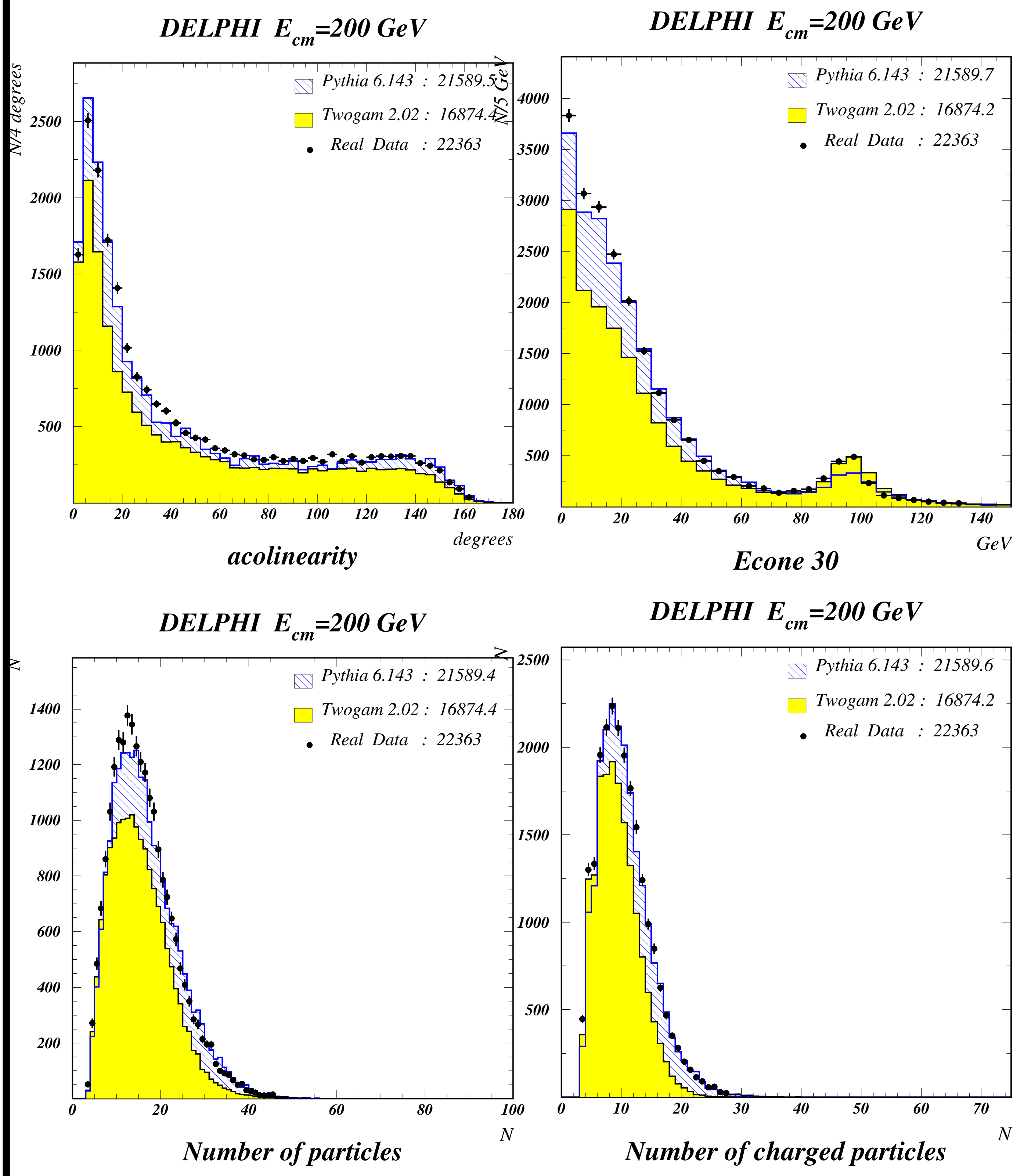








Loose selection B



Conclusion

- Our simulation of hadronic $\gamma\gamma$ processes has evolved :
  - PYTHIA has almost restored the agreement in the no tag region at a loose selection level
  - TWOGAM is still better in the one tag region

    $\longrightarrow$ this has to be understood $\longleftarrow$
  - @ the final SUSY searches event selection hard to compare the two generators due to the low statistic in the PYTHIA sample
- Soon with the new samples the following analysis will be performed :
  - Analysis with the release of the PTMAX cut which affects dramaticaly the degenerate SUSY searches.

    $\longrightarrow$ already under way: Patrice and Thomas $\longleftarrow$
  - Understanding of the disagreement of PYTHIA in the one tag region

    $\longrightarrow$ Sharka and Igor $\longleftarrow$
  - Comparison @ the final SUSY searches event selection

    $\longrightarrow$ we hope everybody will participate $\longleftarrow$