MAD meeting, DECEMBER, 2000
T.Alderweireld, P. Verdier

Hadronic $\gamma\gamma$ study : TWOGAM vs PYTHIA

- Introduction
- Difference between TWOGAM and PYTHIA
- Description of the SAMPLEs used
- DATA/MC analysis with very loose selection
- Conclusion

Introduction

- Previous study showed that TWOGAM was not giving satisfactory results for loose selection.
- Recently DELPHI processed a PYTHIA 6.143 sample (5m evts).
- A study of this new sample gave promising results.
- A short DELPHI public note has been released :

  DELPHI 2000-163 PHYS 878

- At this present stage cross–checks are still needed :

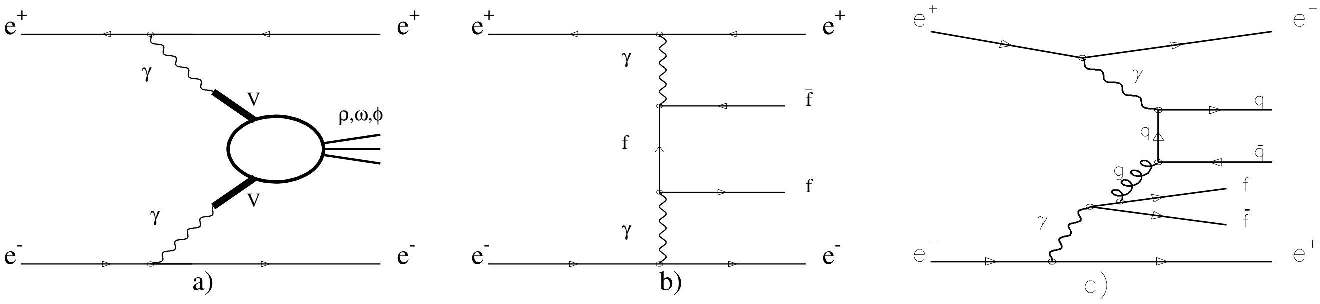
  ALL interested persons are welcome

- The present work is dedicated to a data-MC analysis at a very loose level of selection by taking out the cut on P^t_{max}

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

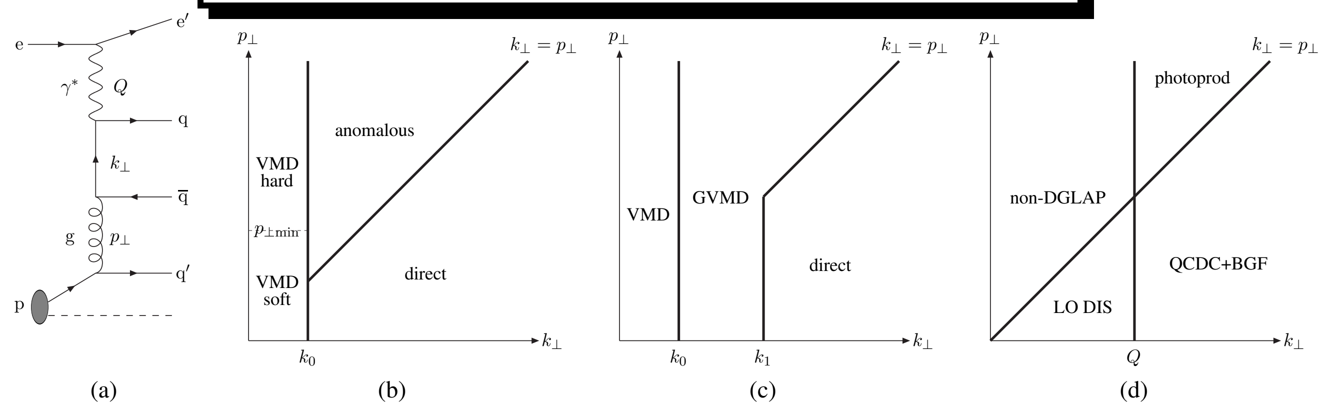


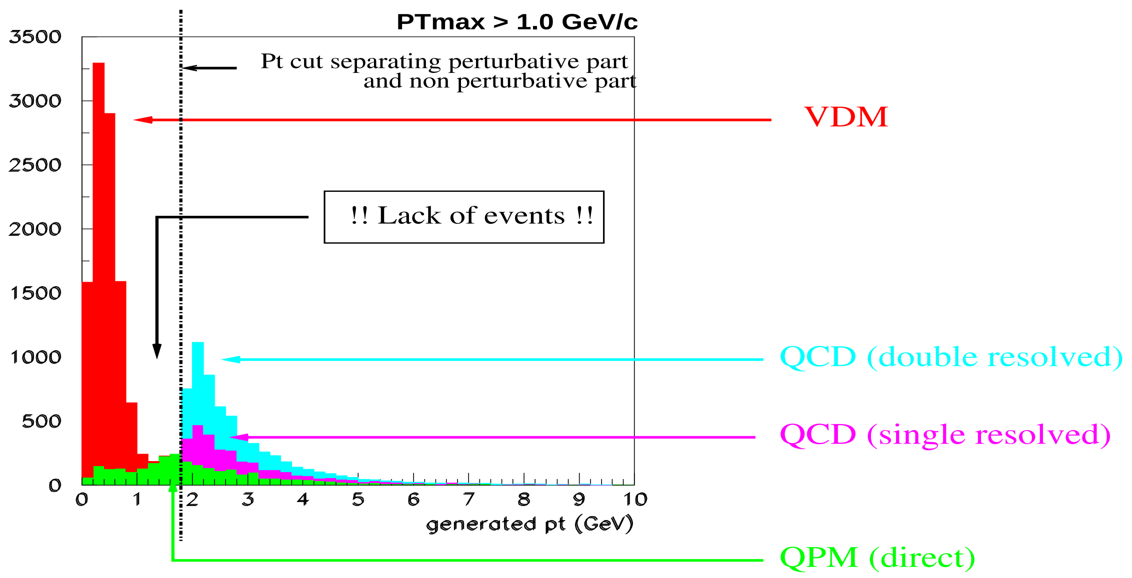
Fig. 1: (a) Schematic graph for a hard γ^*p process, illustrating the concept of three different scales. (b) The allowed phase space for this process when $Q^2 = 0$, with one subdivision into event classes. (c) An alternative classification of the phase space in (b), which better takes into account unitarization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

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

OR

- 1 particle with Energy > 0.4 E_{beam}

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

PYTHIA 6.143

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

Loose selections

SUSANA selection:

Removal of the cut: $P_t^{maxch.} > 1.5\ \mathrm{GeV}/c$

- Transverse Energy greater than 4 GeV
- Transverse charged energy less than 20 GeV
- at least 1 charged particle

Loose selection :

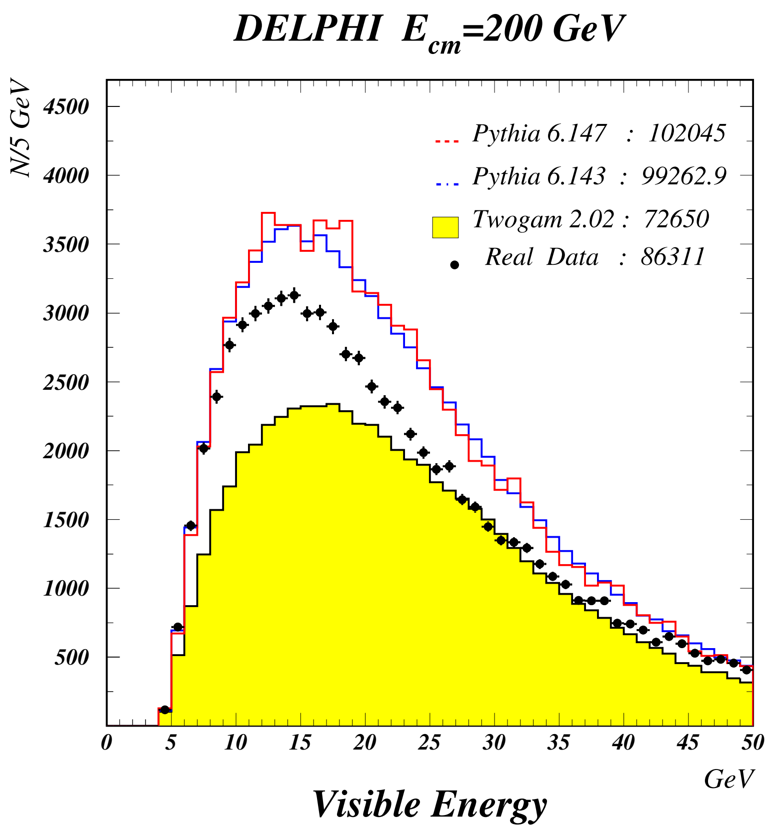
- At least 3 tracks (no TPC requirement)

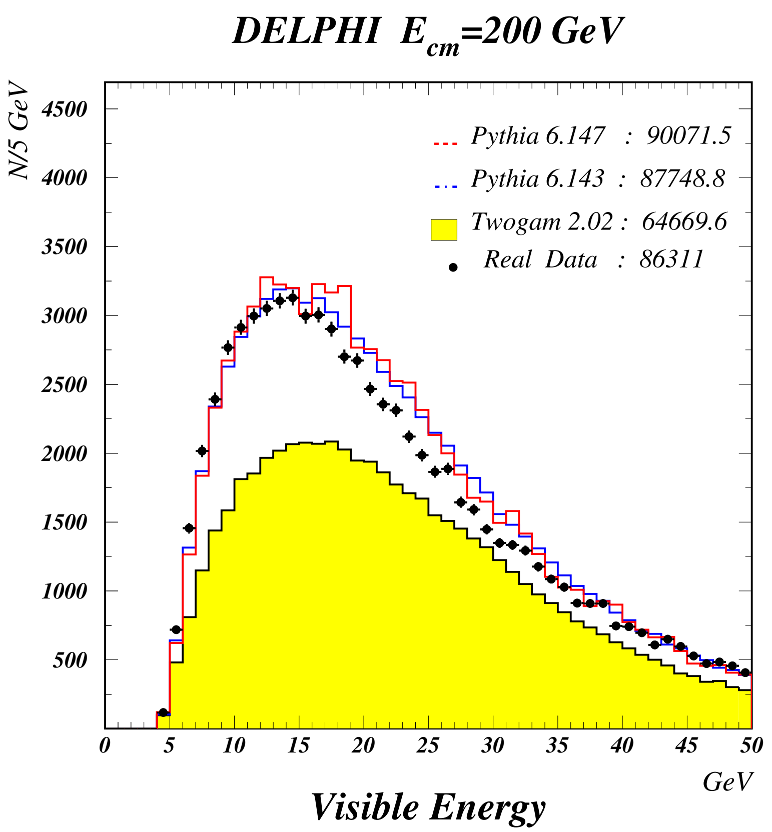
Re-weighting method :
Analysis performed by Andrea Perrotta on last year data showed that the matching between the real DELPHI trigger and the DELANA event filter was not satisfactory in the region where $P_t^{maxch.} < 1.5\ \mathrm{GeV}/c$
$\Rightarrow$ re-weighting of MC events with $P_t^{maxch.} < 1.5\ \mathrm{GeV}/c$

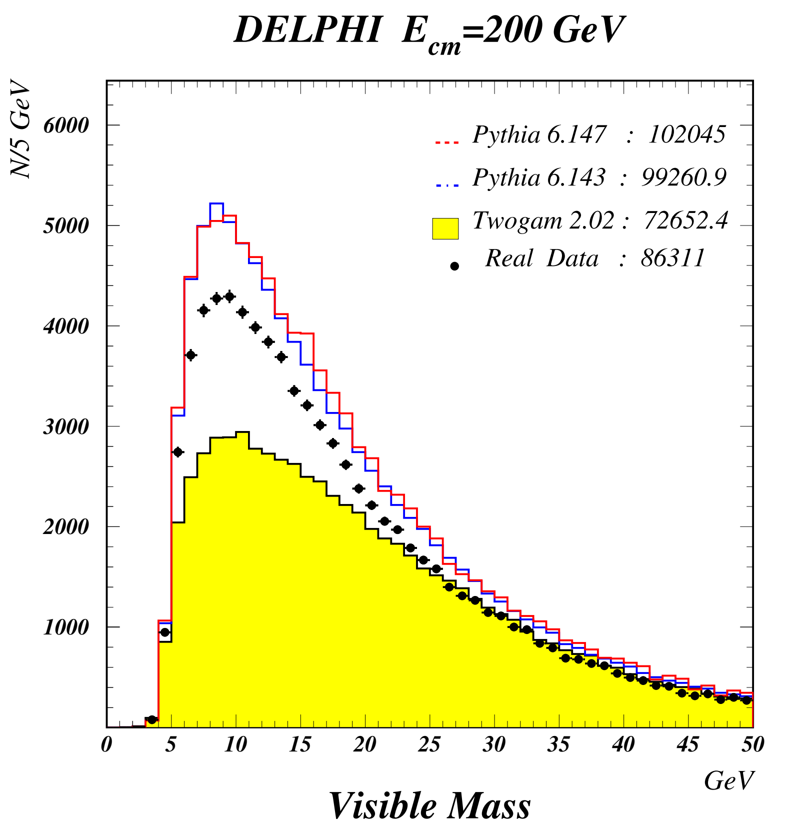
Weighting function provided by A. Perrotta
Corrections implemented blindly in this analysis

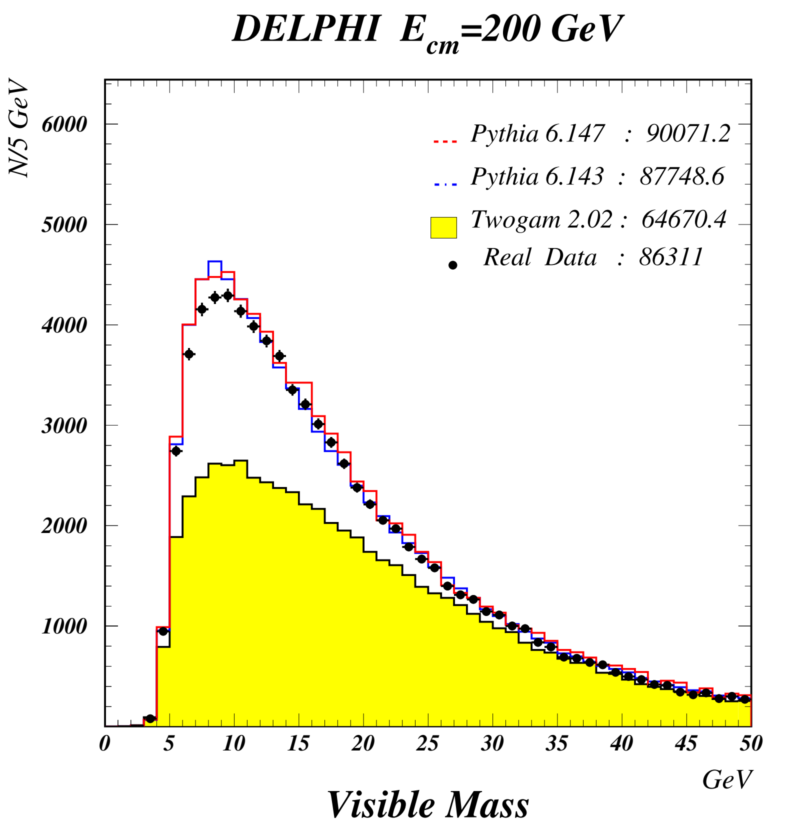
$Weigth = 0.959 - 0.878 * \exp\left(-(P_t^{maxch.}/0.743) * *2\right)$

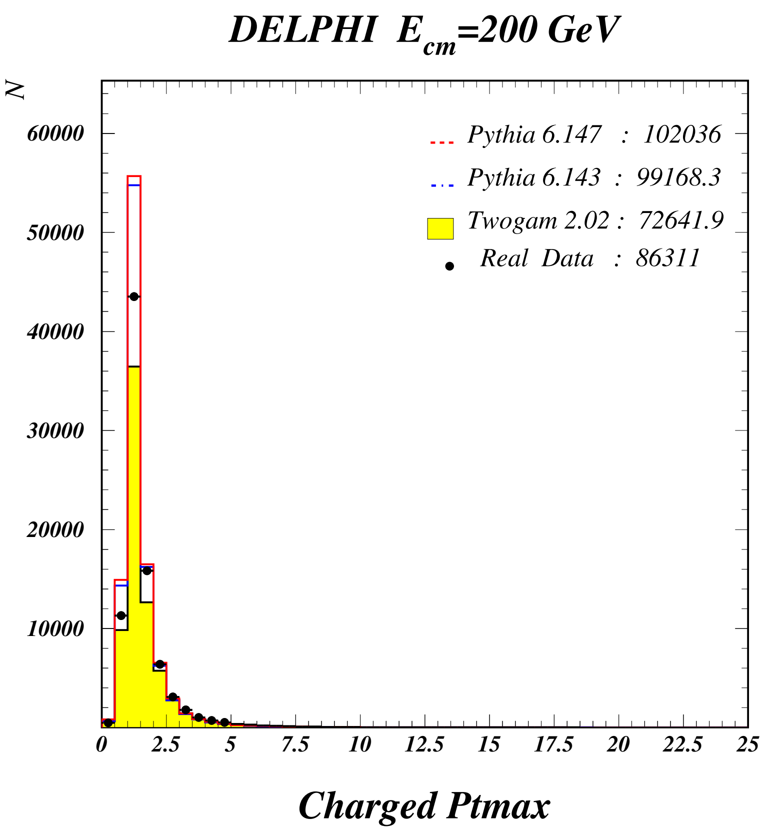
DATA-MC comparison






DELPHI E_{cm}=200 GeV
N/5 GeV
6000
5000
4000
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
50
GeV
Pythia 6.147 : 102045
Pythia 6.143 : 99260.9
Twogam 2.02 : 72652.4
Real Data : 86311
Visible Mass


DELPHI E_{cm}=200 GeV
N/5 GeV
6000
5000
4000
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
50
GeV
Pythia 6.147 : 90071.2
Pythia 6.143 : 87748.6
Twogam 2.02 : 64670.4
Real Data : 86311
Visible Mass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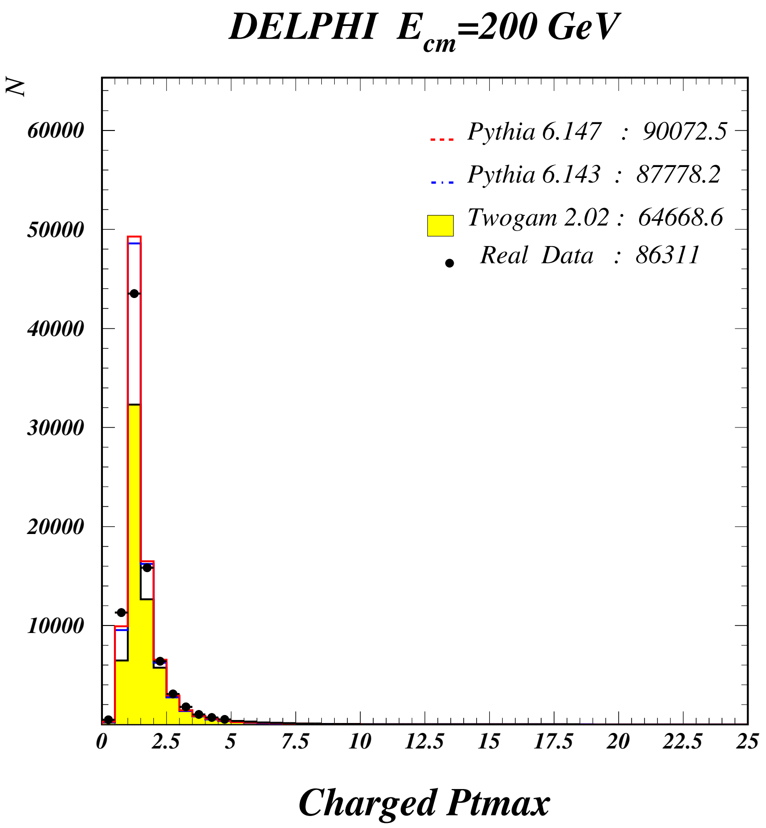
60000
50000
40000
30000
20000
10000
Pythia 6.147 : 102036
Pythia 6.143 : 99168.3
Twogam 2.02 : 72641.9
Real Data : 86311
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Charged Ptmax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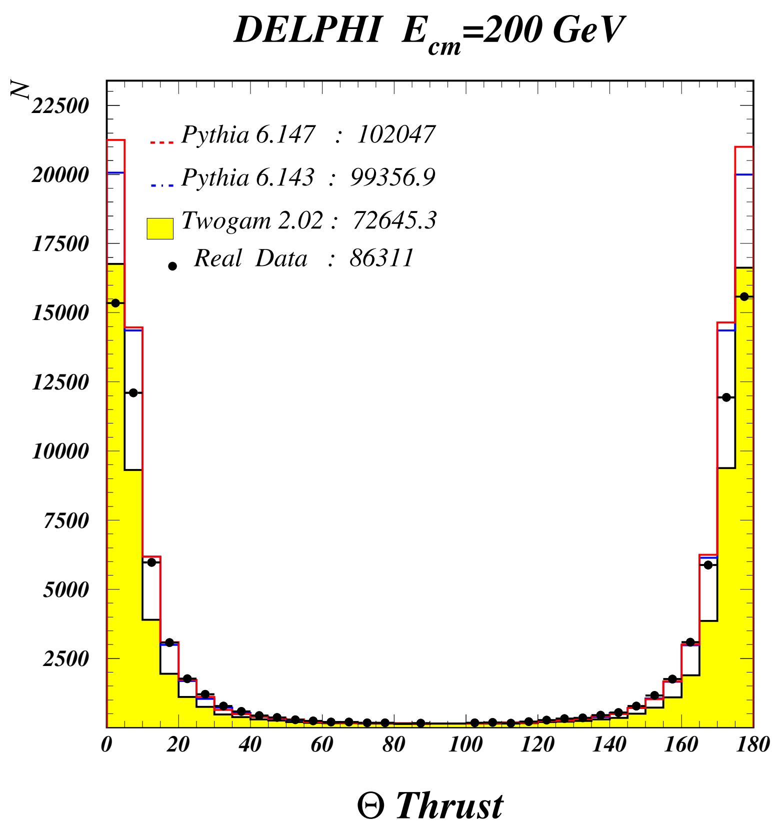
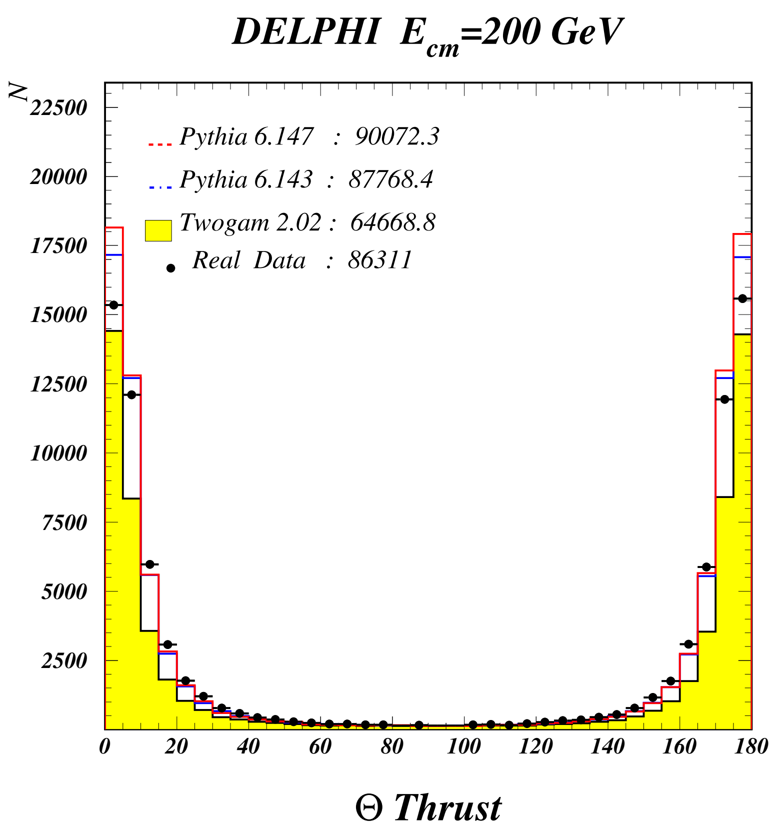
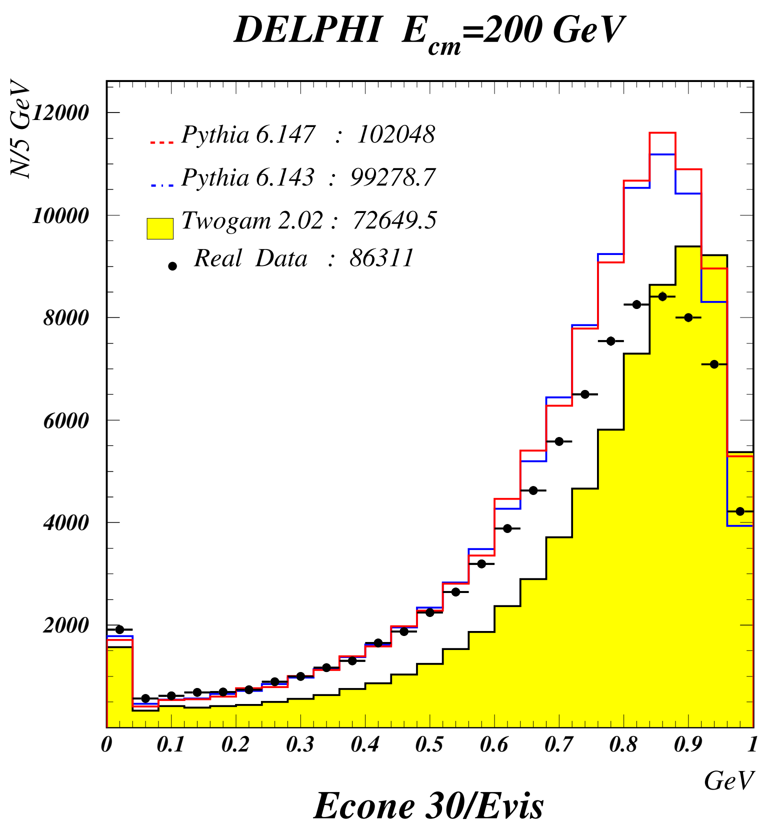
N
60000
50000
40000
30000
20000
10000
Pythia 6.147 : 90072.5
Pythia 6.143 : 87778.2
Twogam 2.02 : 64668.6
Real Data : 86311
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Charged Ptmax



DELPHI E_{cm}=200 GeV
N
22500
20000
17500
15000
12500
10000
7500
5000
2500
Pythia 6.147 : 102047
Pythia 6.143 : 99356.9
Twogam 2.02 : 72645.3
Real Data : 86311
0
20
40
60
80
100
120
140
160
180
Θ Thrust



DELPHI E_{cm}=200 GeV
N
22500
20000
17500
15000
12500
10000
7500
5000
2500
Pythia 6.147 : 90072.3
Pythia 6.143 : 87768.4
Twogam 2.02 : 64668.8
Real Data : 86311
0
20
40
60
80
100
120
140
160
180
Θ Thrust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N/5 GeV
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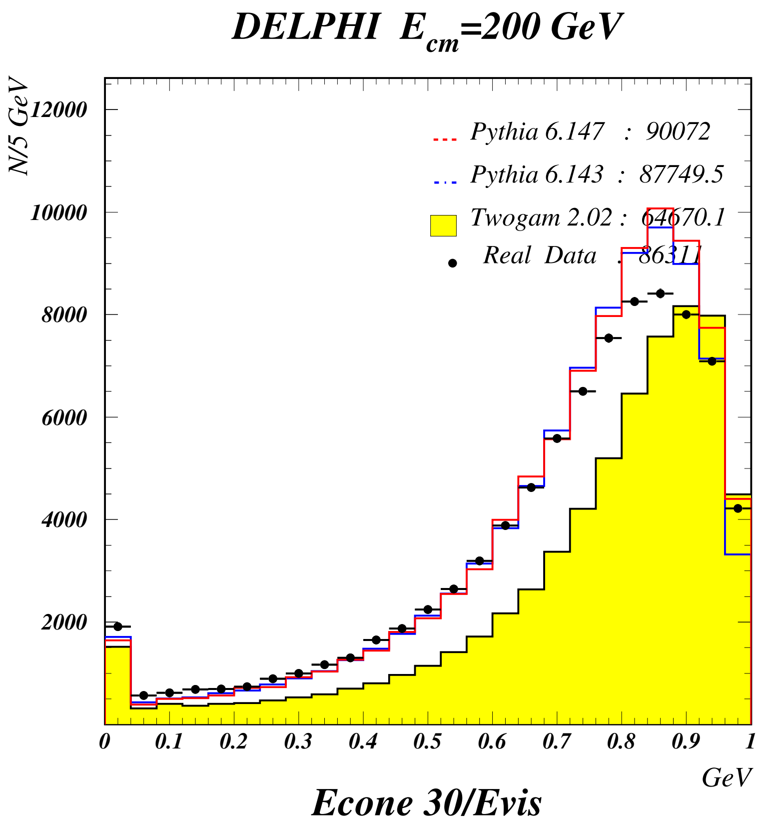
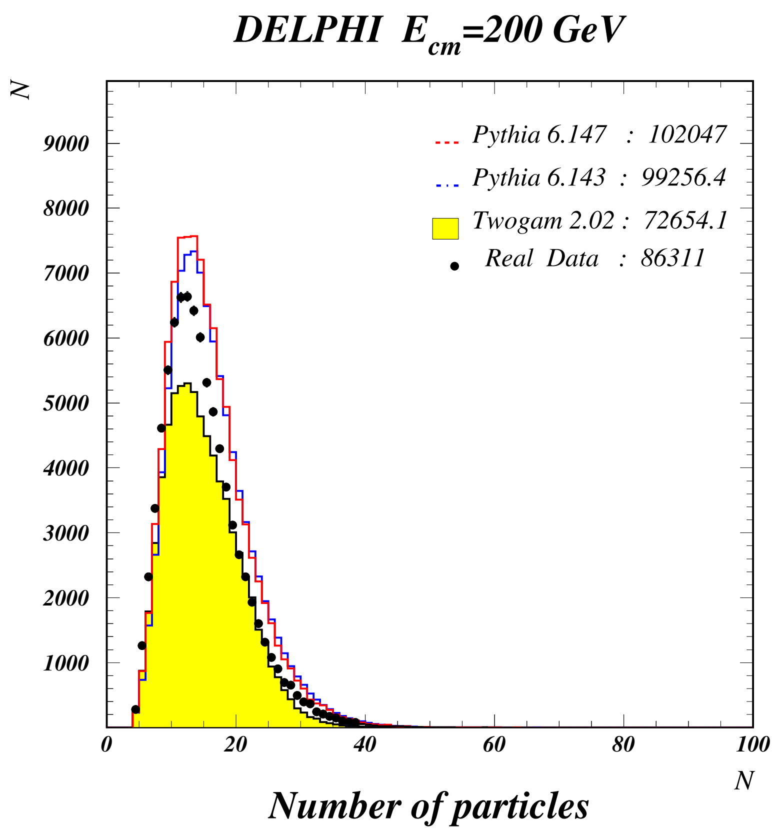
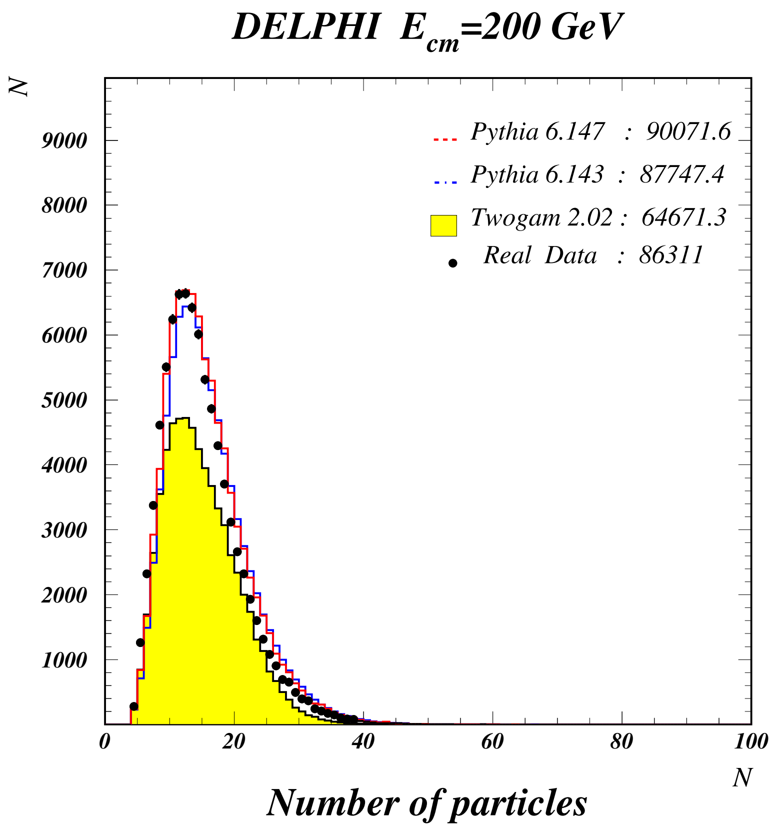
Pythia 6.143 : 99278.7
Twogam 2.02 : 72649.5
Real Data : 86311
GeV
Econe 30/Evis

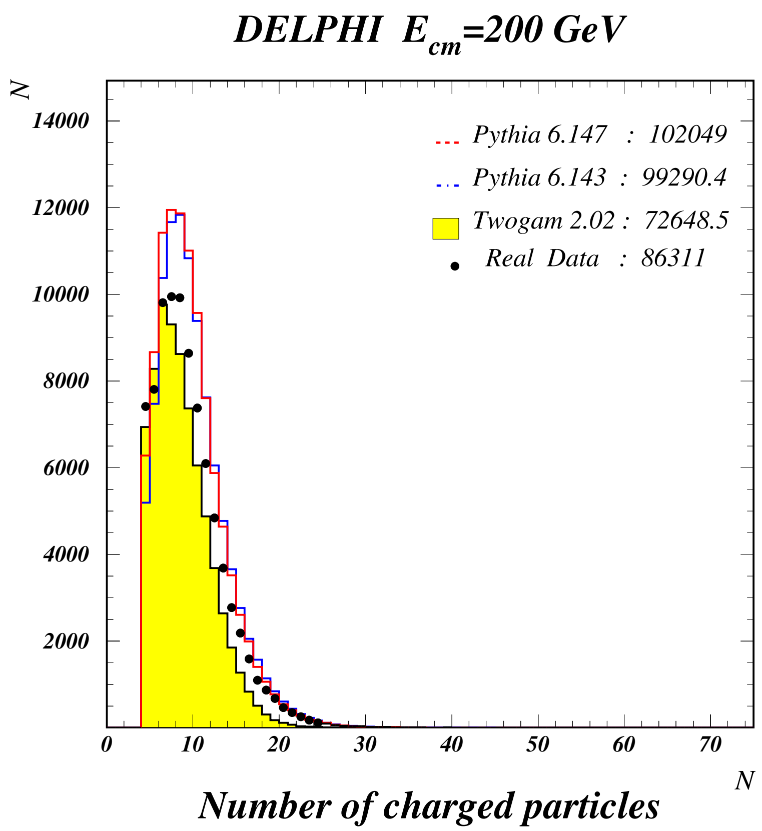

DELPHI E_{cm}=200 GeV
N/5 GeV
Pythia 6.147 : 90072
Pythia 6.143 : 87749.5
Twogam 2.02 : 64670.1
Real Data : 86311
GeV
Econe 30/Evis



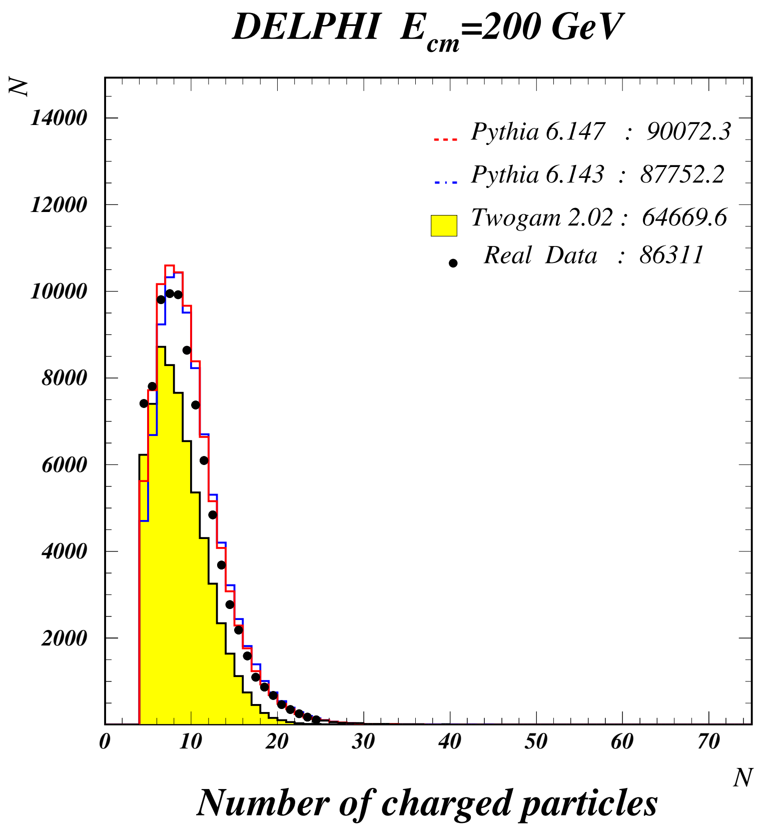
DELPHI E_{cm}=200 GeV
N
9000
8000
7000
6000
5000
4000
3000
2000
1000
Pythia 6.147 : 102047
Pythia 6.143 : 99256.4
Twogam 2.02 : 72654.1
Real Data : 86311
0
20
40
60
80
100
N
Number of particles



DELPHI E_{cm}=200 GeV
N
9000
8000
7000
6000
5000
4000
3000
2000
1000
Pythia 6.147 : 90071.6
Pythia 6.143 : 87747.4
Twogam 2.02 : 64671.3
Real Data : 86311
0
20
40
60
80
100
N
Number of particles



DELPHI E_{cm}=200 GeV
N
14000
12000
10000
8000
6000
4000
2000
0
10
20
30
40
50
60
70
Pythia 6.147 : 102049
Pythia 6.143 : 99290.4
Twogam 2.02 : 72648.5
Real Data : 86311
N
Number of charged particles



DELPHI E_{cm}=200 GeV
N
14000
12000
10000
8000
6000
4000
2000
0
10
20
30
40
50
60
70
Pythia 6.147 : 90072.3
Pythia 6.143 : 87752.2
Twogam 2.02 : 64669.6
Real Data : 86311
N
Number of charged particles

Conclusion

- It has been shown in the SUSY meeting that PYTHIA gives good results in the no-tag region
- SUSY analysis need to go below $P_t^{maxch.} = 1.5\ \mathrm{GeV}/c$
- An excess of MC events is observed in the $P_t^{maxch.} < 1.5\ \mathrm{GeV}/c$ region with PYTHIA
  - this excess could be due to trigger effect
  - the use of a re-weighting function improves sligthly the data-MC comparison
- the use of the re-weighting function :
  - needs to be study carefully
  - would improves SUSY search in degenerate region (chargino, squark ...)
- what need to be understand:
  - A. Perrotta started to check the two samples (PYTHIA vs TWOGAM)
    In some regions, TWOGAM has a higher rate than PYTHIA
    But before giving any conclusions, it has to be compared to the data