MC event generators and minimum bias events at TEVATRON and LHC energies

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Minimum bias events - definition

Hadron-hadron cross section

- *elastic* – usually rejected by trigger
- *diffractive*
- *non-diffractive*
  - *high-*$p_\perp$ part – described by perturbative QCD
  - *low-*$p_\perp$ part – dominant part in the overall σ

MC event generators

- PYTHIA 6.122 and PYTHIA 5.724
- PHOJET 1.12P
- HERWIG 5.9
- ISAJET 7.32

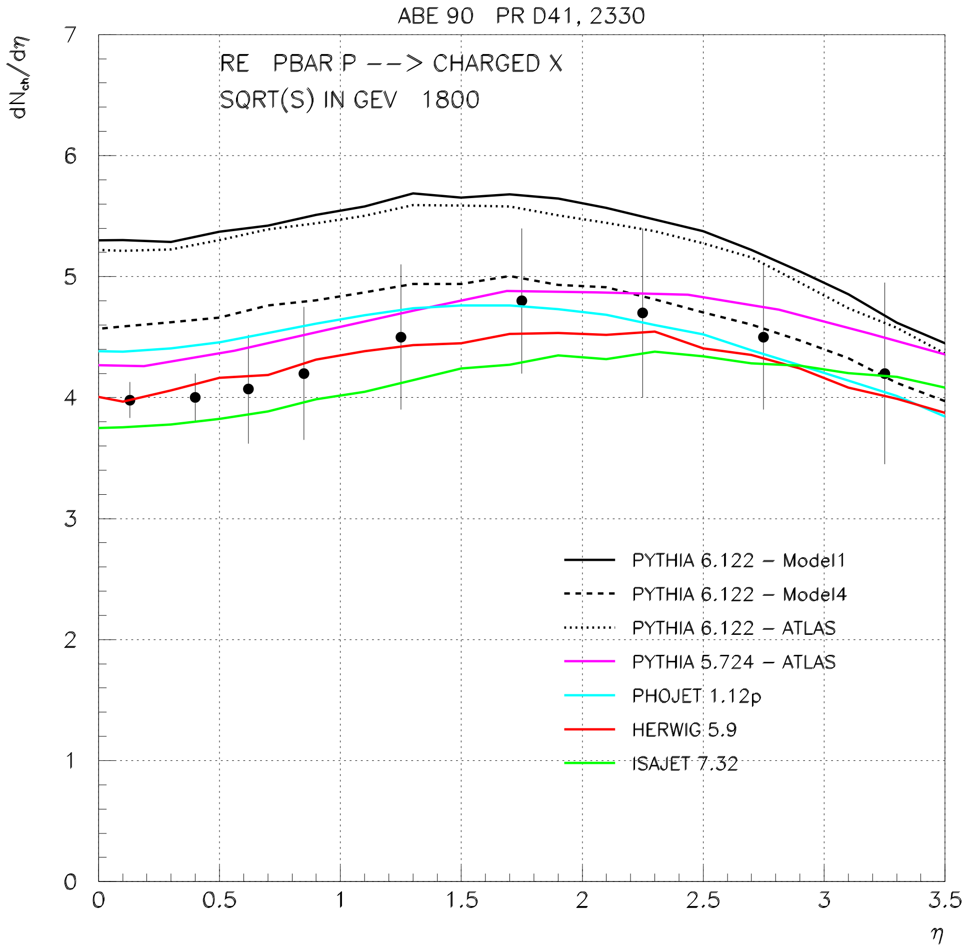
Models of low-$p_\perp$ non-diffractive physics

- PYTHIA
  - language of pQCD (multiple interactions) used for both high-$p_\perp$ and low-$p_\perp$ regions
  - basic processes: $2 \to 2$ with LO matrix elements
  - regulariztion of matrix elemnts at $p_\perp \to 0$
    * abrupt cut $p_{\perp min}$
    * smooth turn off of singularities $p_\perp^2 \to p_\perp^2 + p_{\perp 0}^2$
  - two multiple interaction scenarios (with and without varying impact parameter)
  - **Model 1** - simple scenario with abrupt cut
  - **Model 4** - scenario with an impact parameter and with smooth turn off of matrix elements
  - parameters $p_{\perp min}$ and $p_{\perp 0}$ are energy dependent since version 6.120
- PHOJET 1.12P
  - based on *Dual Parton Model*
  - basic processes: $2 \to n$
  - smooth transition at p_{cut} between soft and hard regions
  - multiple interactions

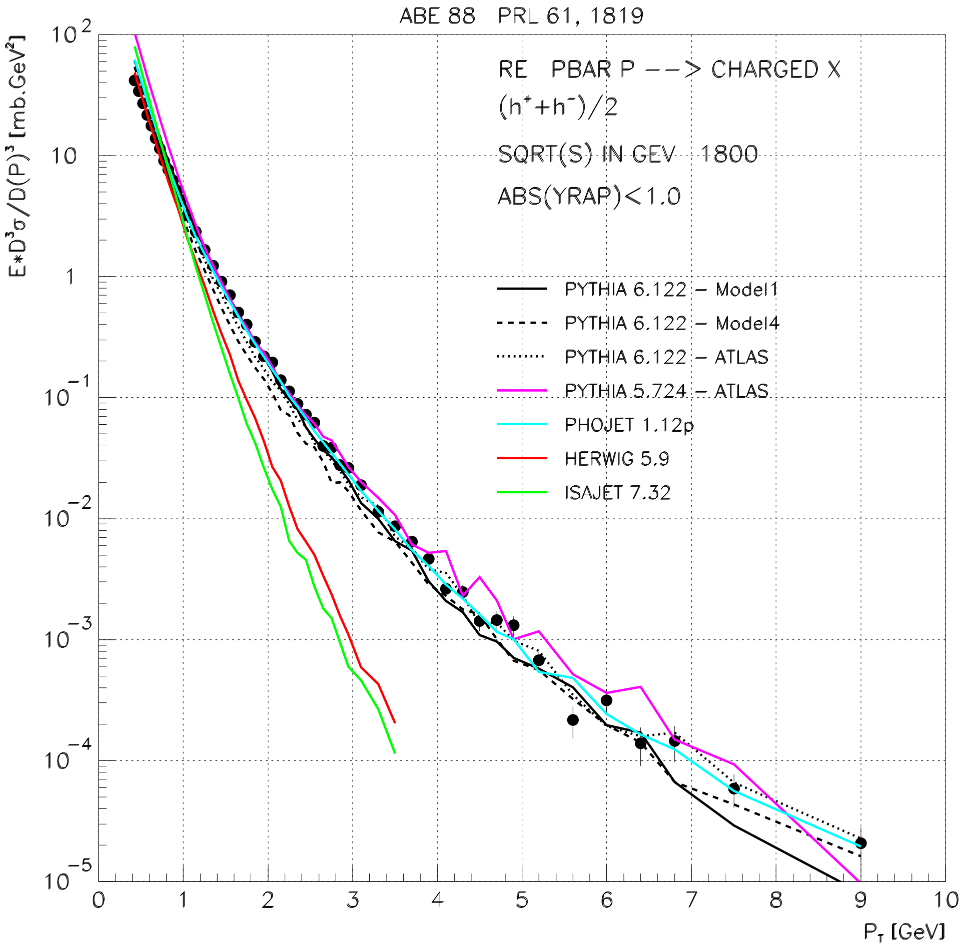
- HERWIG 5.9 and ISAJET 7.32
  - based on phenomenological models
    - HERWIG - UA5 model
    - ISAJET - Abramovskii-Kanchelli-Gribov model
  - no connection between soft and hard regions
  - no energy dependence of model parameters

Summary

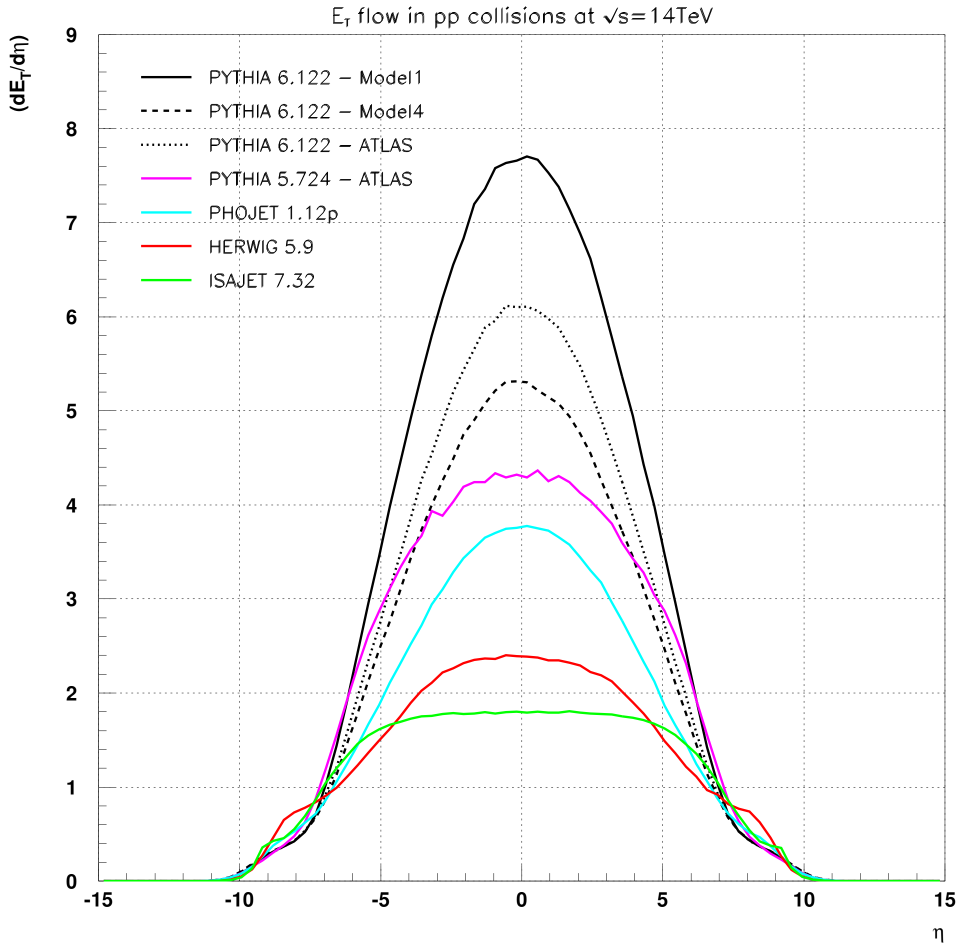
- large differencies between MC generators, espacially at LHC energies
- tuning models to the TEVATRON data at $\sqrt{s} = 1.8\,\mathrm{TeV}$
  - PYTHIA 6.12 – made by LHCB (O. Schneider) for model `MSTP(82)=3`
  - HERWIG – B. Webber works on this problem
  - PHOJET – already tuned
  - ISAJET – unkonwn status
- improtance of running of model parameters with energy
- the best candidates
  - PHOJET 1.12P
  - PYTHIA 6.12 models with varying impact parameter (but not an older versions like 5.7)



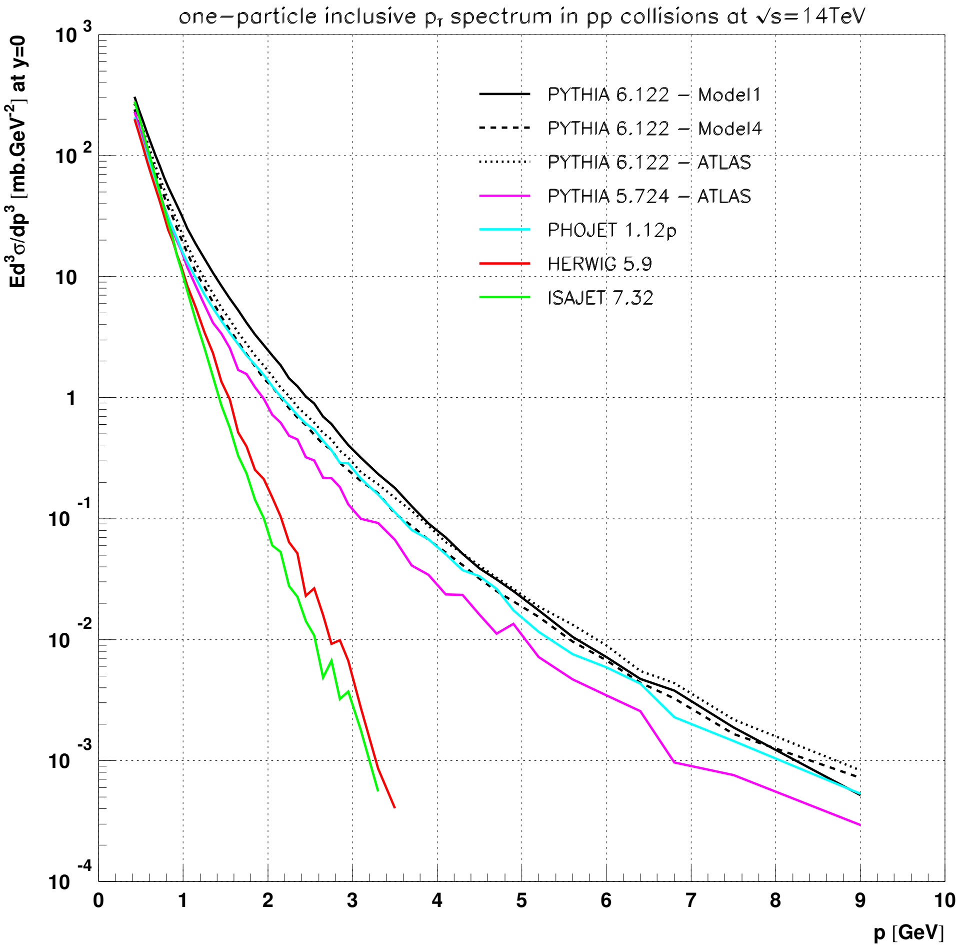
Pseudorapidity distribution. Comparison with CDF data.



One particle inclusive $p_\perp$–spectra. Comparison with CDF data.



E_T flow in pp collisions at $\sqrt{s}$=14TeV
$(dE_T/d\eta)$
PYTHIA 6.122 – Model1
PYTHIA 6.122 – Model4
PYTHIA 6.122 – ATLAS
PYTHIA 5.724 – ATLAS
PHOJET 1.12p
HERWIG 5.9
ISAJET 7.32
0
1
2
3
4
5
6
7
8
9
-15
-10
-5
0
5
10
15
η


one−particle inclusive p_T spectrum in pp collisions at $\sqrt{s}$=14TeV
$Ed^3\sigma/dp^3$ [mb.GeV^{-2}] at y=0
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
1
2
3
4
5
6
7
8
9
10
p [GeV]
PYTHIA 6.122 − Model1
PYTHIA 6.122 − Model4
PYTHIA 6.122 − ATLAS
PYTHIA 5.724 − ATLAS
PHOJET 1.12p
HERWIG 5.9
ISAJET 7.32