MC studies for CMS two-particle correlation

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Analysis Centre Discussion: The CMS two-particle correlation discovery

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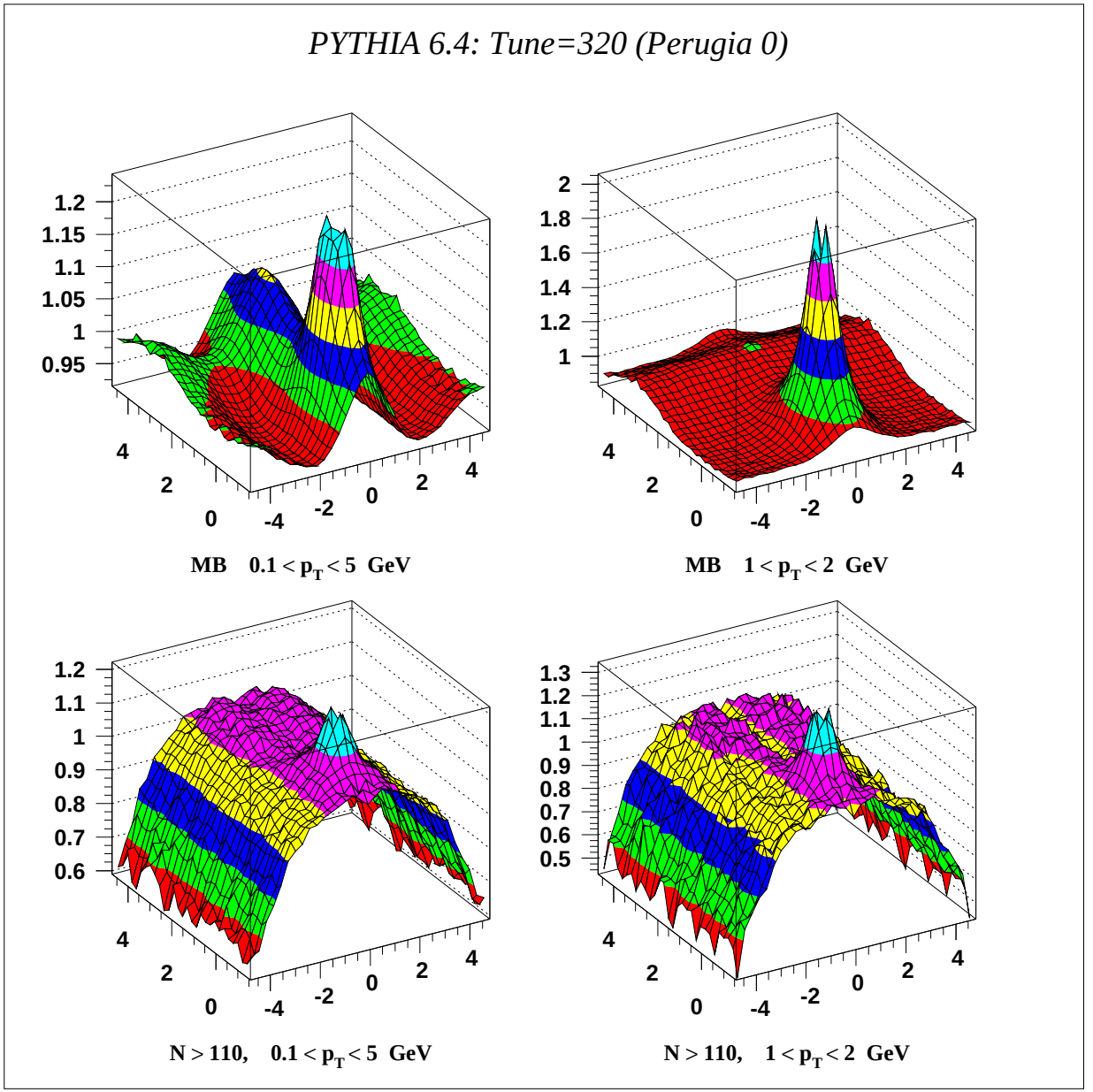
Documentation

- PYTHIA 6.423 with all available tunes has been run (HZTool package):
  - Tune 100+: Q^2-ordered shower and "old" underlying-event model
  - Tune 300+: p_T^2-ordered shower and interleaved underlying-event model
- The results are presented on **https://www.wiki.terascale.de/index.php/Ridge**
  - Minimum bias events for $0.1 < p_T < 1$ GeV, $1 < p_T < 2$ GeV, $2 < p_T < 3$ GeV and $3 < p_T < 4$ GeV ranges
  - Events with high multiplicity ($N > 110$) for $0.1 < p_T < 1$ GeV, $1 < p_T < 2$ GeV, $2 < p_T < 3$ GeV and $3 < p_T < 4$ GeV ranges

$\longrightarrow$ PYTHIA does not have ridge effect for any of the tunes

$(\Delta\eta, \Delta\varphi)$-correlations; Tune 320 - Perugia 0

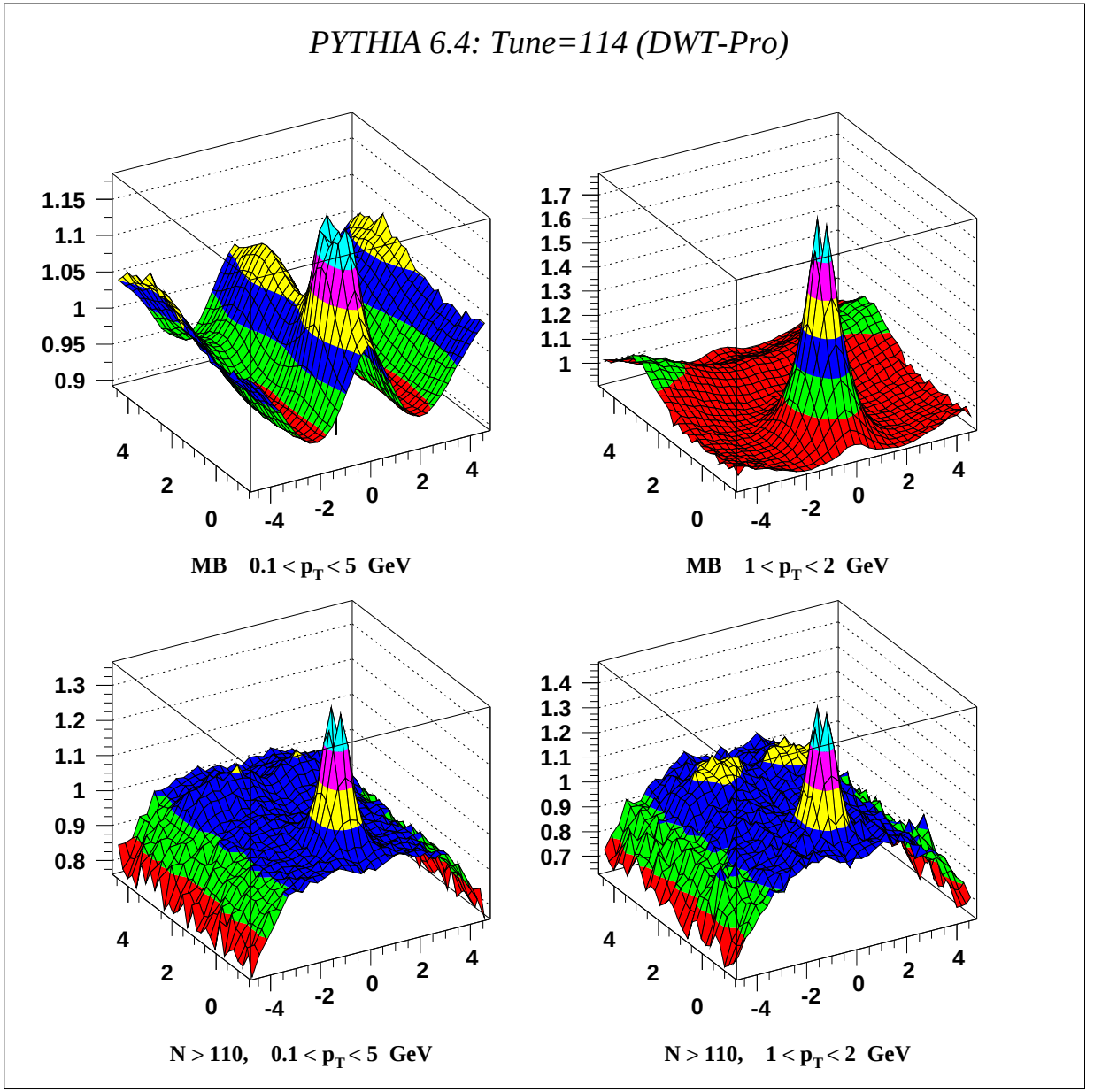


Peguria 0 (tune=320): "Perugia" update of S0-Pro (Feb 2009); Interleaved underlying-event model;

Correlations= $\frac{signal}{background}$

Min Bias and High Multiplicity events for $0.1 < p_T < 5$ GeV and $1 < p_T < 2$ GeV

$(\Delta\eta, \Delta\varphi)$-correlations; Tune 114 - DWT-Pro



DWT-Pro (tune=114): Tune DWT with Professor's LEP parameters; "Old" underlying-event model;

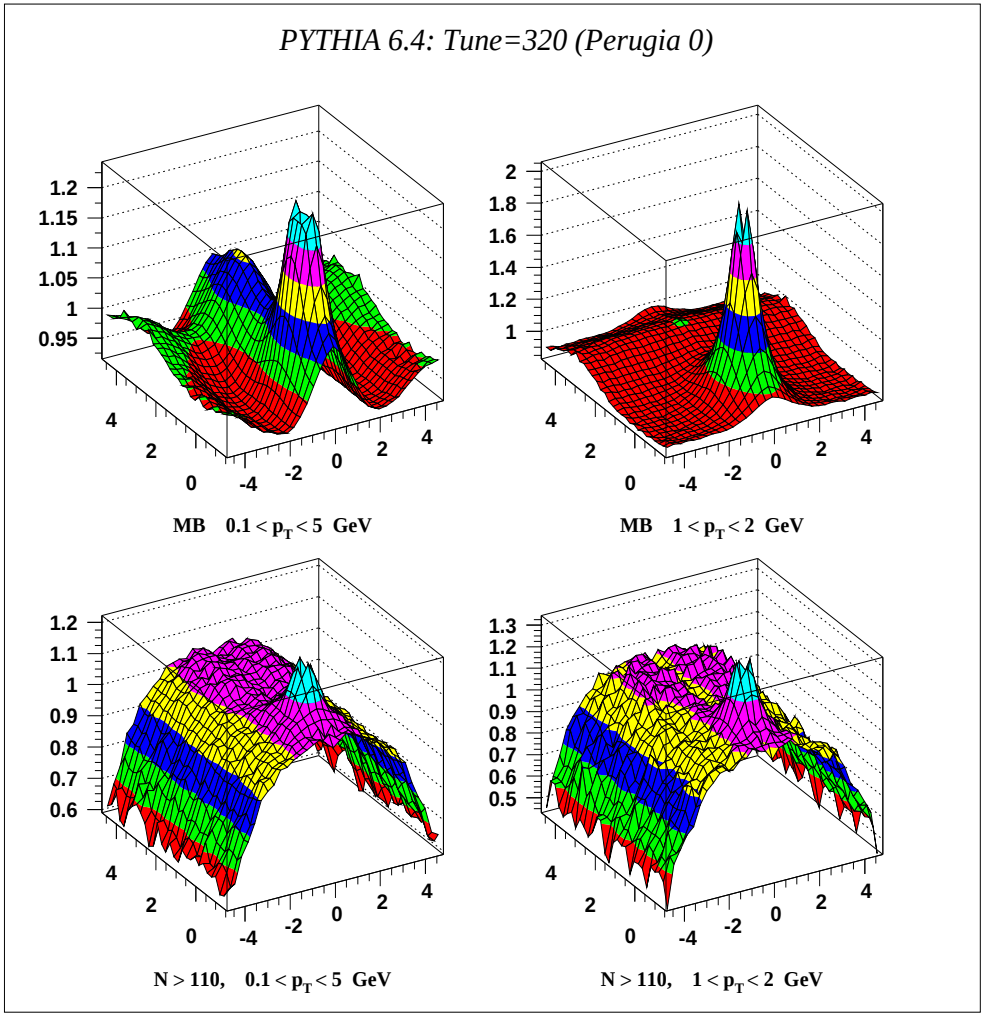
The Rivet Routine

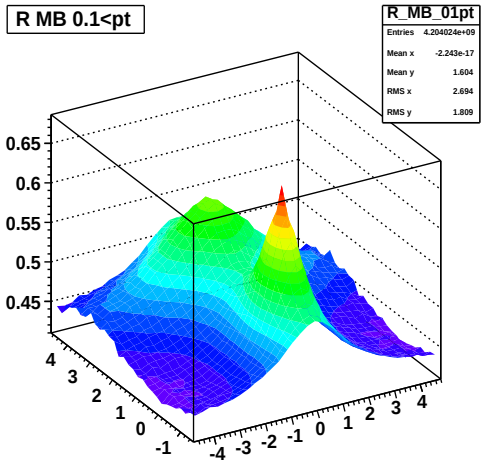
Studies were done by Albert Knutsson

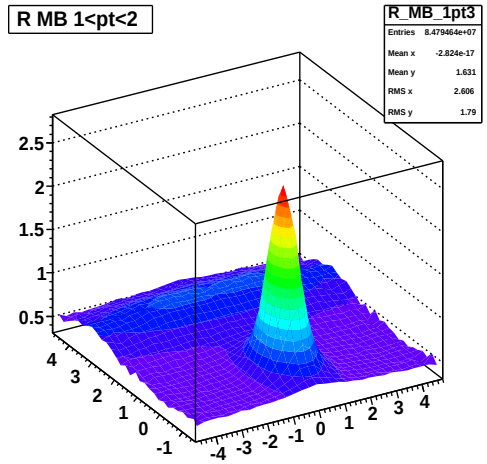
- Available on the DESY MC Group wiki:
  https://www.wiki.terascale.de/index.php/Ridge
- Please feel free to use it. Note: You need to link ROOT when compiling this routine.

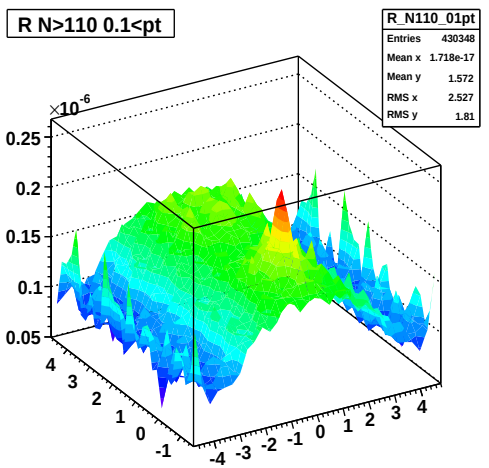
Two-particle correlation using Rivet were produced by Albert $\longrightarrow$ cross check with HZTool results

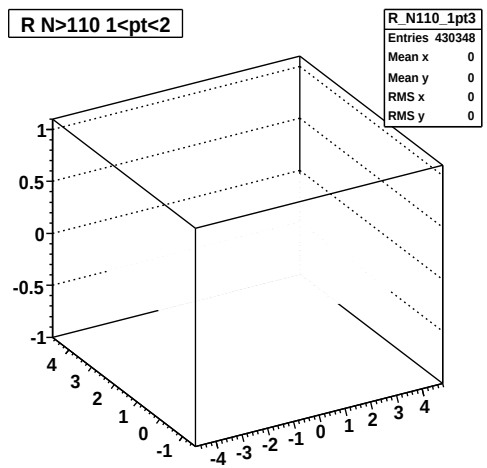
Rivet - HZTool comparison; Tune 320- Perugia 0











⟶ Rivet and HZTool give the similar shape of the correlations

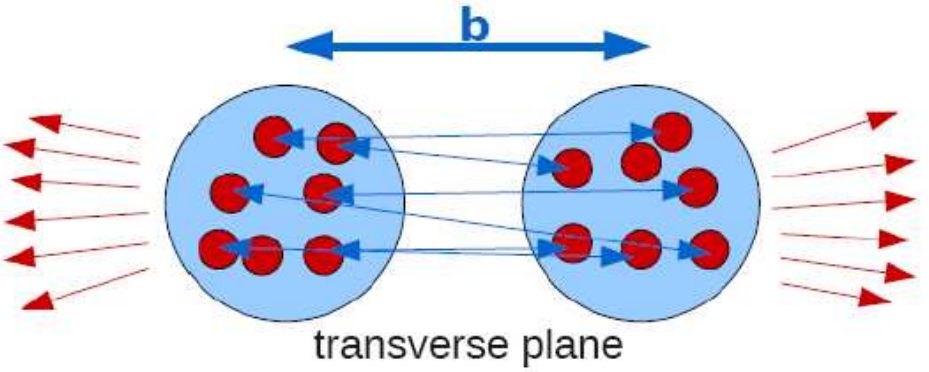
Angular momentum conservation in MPIs with PYTHIA (Pierre Van Mechelen)

Angular momentum conservation in multiple parton interactions

Semi-classical intuition:

Multiple parton inteactions may generate long-range, near side angular correlations

- Protons separated by impact vector ***b***
- All parton collisions will tend to lie in the plane defined by incoming proton momenta ***p*** and impact vector ***b***
  → resulting particles have similar φ
- Initial state partons have different x_{Bj}
  → resulting particles have different η



- Sizeable effect expected for events with many MPI (large multiplicity) and for particles with moderate p_T (because of the $1/p_T^4$ dependence of the partonic cross section)

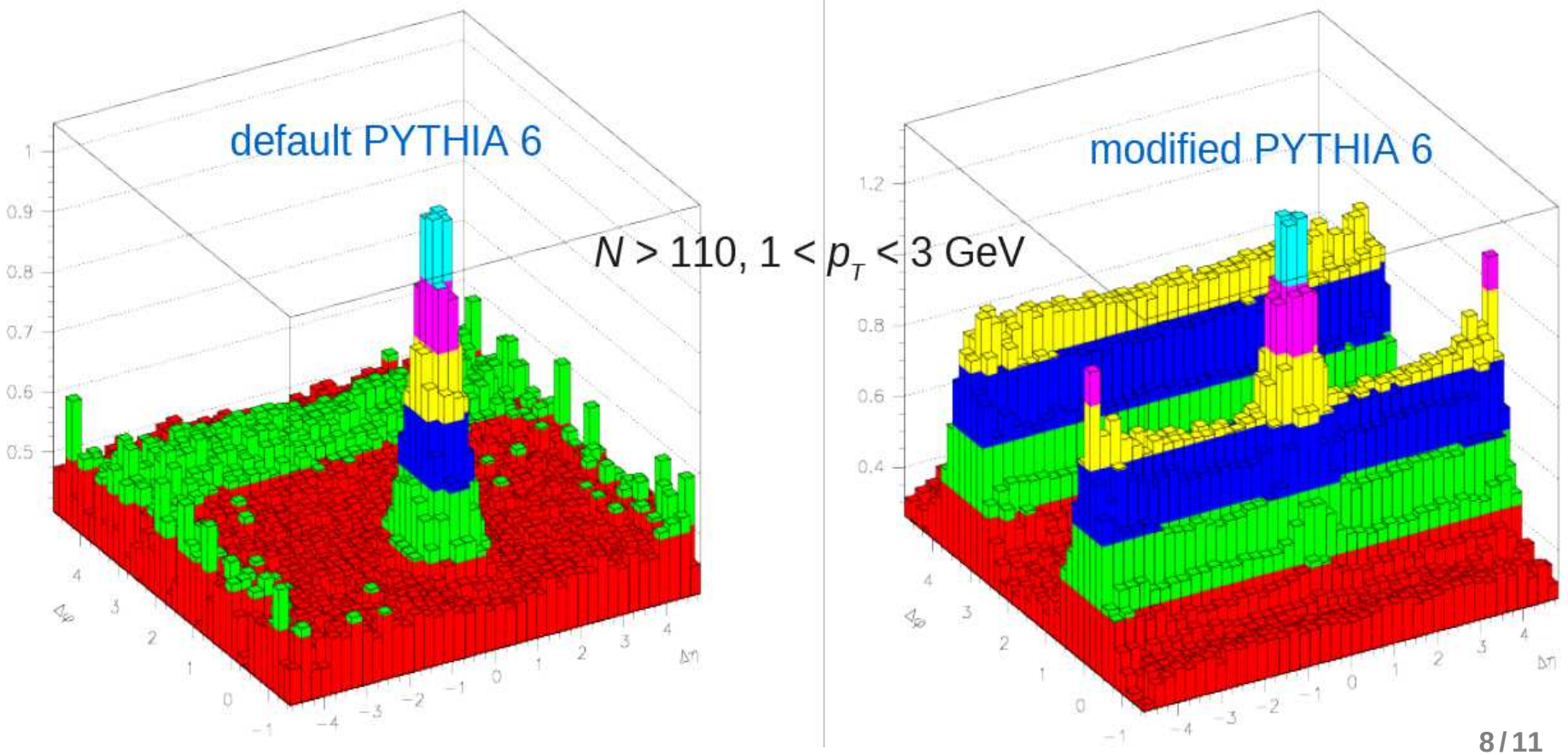
Comments

- Need to consider quantum mechanics of the problem (as e.g. in Kaidalov et al., arXiv:0809.0625)
- Argument does not hold for central collisions, which in principle dominate the high-multiplicity sample
- Azimuthal correlation of MPIs was studied experimentally, e.g. in γ + 3 jet events, but no correlation was found (however the hardness and centre-of-mass energy of the MPIs was quite different)

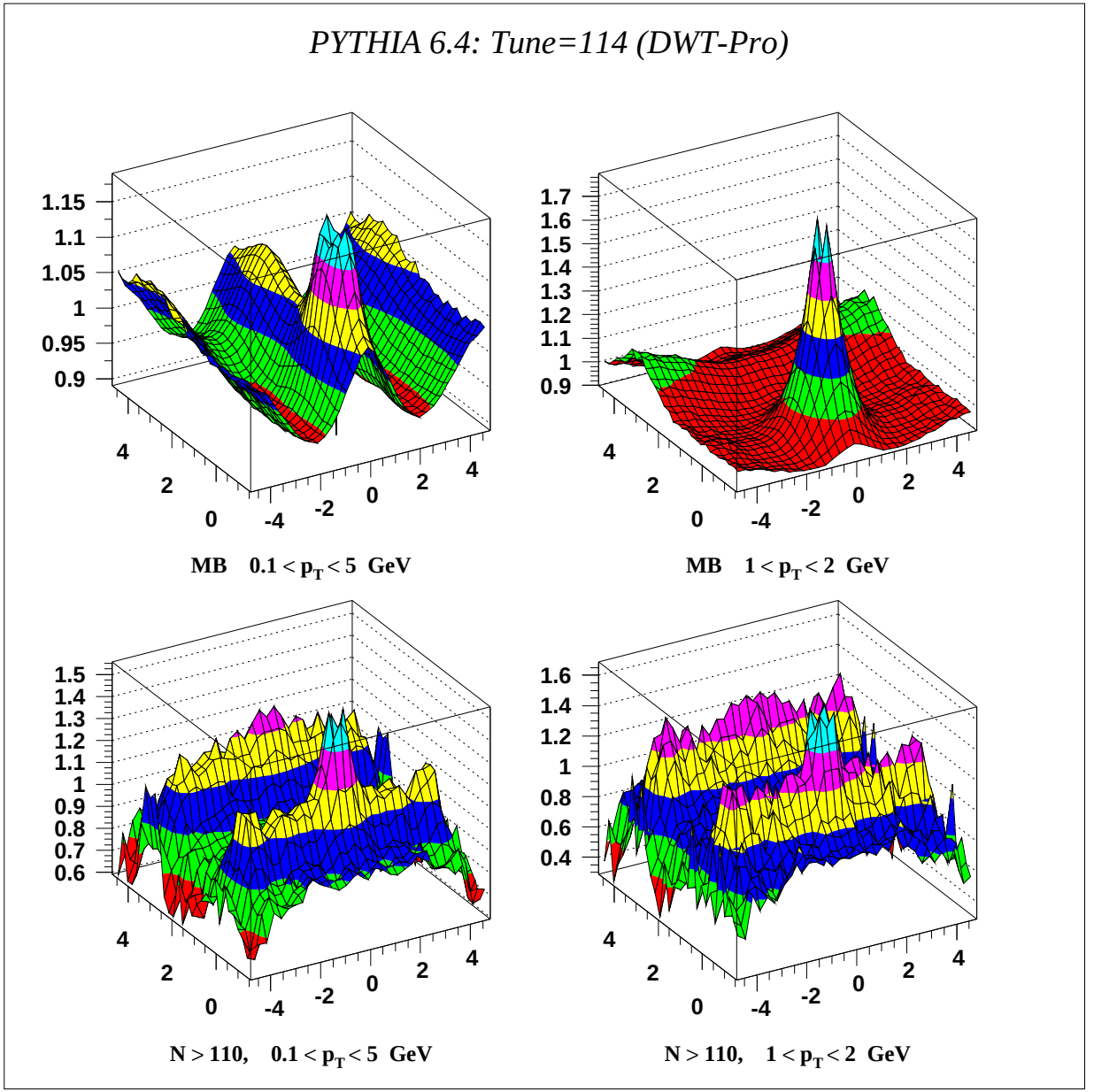
Angular momentum conservation in MPIs with PYTHIA (Pierre Van Mechelen)

PYTHIA does not take into account angular momentum conservation in MPI.
Pierre's modification of PYTHIA aligns MPI to scattering plane of hardest interaction, but with a impact-parameter dependent smearing:

$$\varphi i = \varphi hardest + Gauss(\mu{=}0,\sigma{=}1)\,\arctan(b_{avg}/b)$$



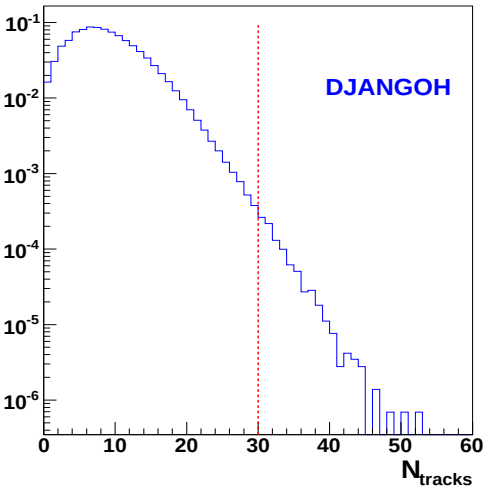
$(\Delta\eta, \Delta\varphi)$-correlations; Tune 114 - DWT-Pro

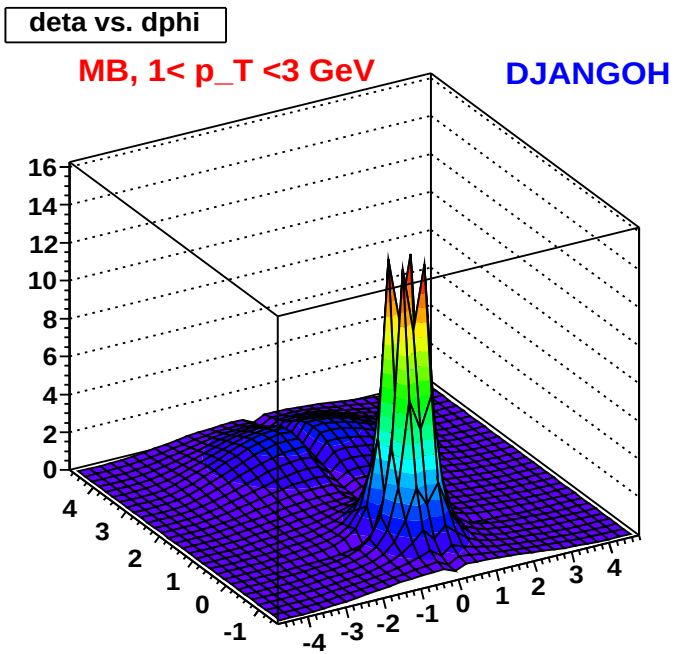


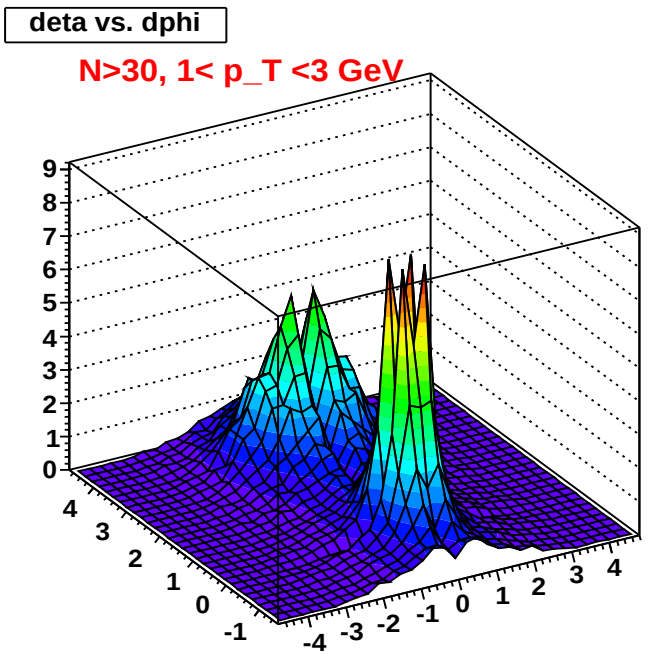
DWT-Pro (tune=114): Tune DWT with Professor's LEP parameters; "Old" underlying-event model;

Two-particle correlation in DIS

Two-particle correlation in DIS:
Events with number of particles large than 30 where compared with MB events. ⟶ DJANGOH does not have ridge effect







Summary

Summary

- PYTHIA does not have ridge effect for any of the tunes
- Rivet Routine were prepared to study ridge effect
  - Rivet Routine and HZTool reproduce the similar results
- DJANGOH does not predict ridge in DIS