



Misura dell'attività di Underlying Event mediante processo Drell-Yan con il rivelatore CMS a $\sqrt{s} = 13$ TeV

Gloria Rampi

M_{arzo} ^{ultiple} P_{erugia} ^{arton} I_{talia} ^{nteraction}

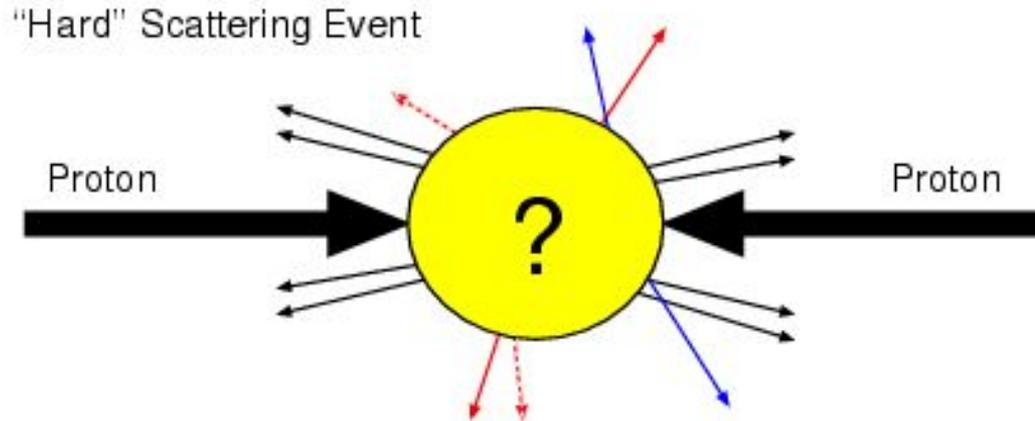
Perugia, 23 Marzo 2016

Outline

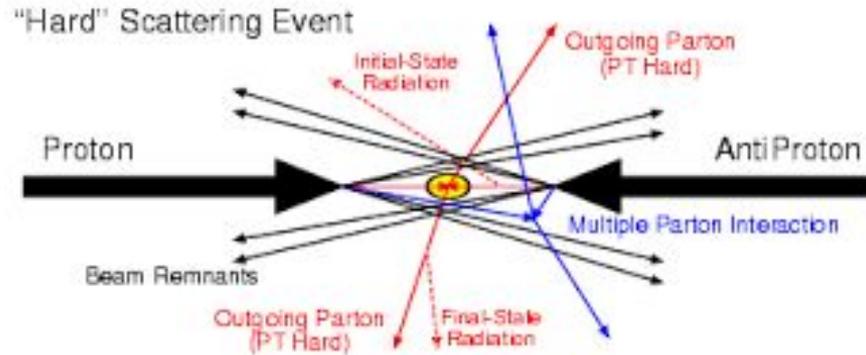
- Underlying Event
- Strategia d'analisi
- Selezione degli eventi
- DY @ 7 TeV vs DY @ 13 TeV
- MinBias @ 13 TeV vs DY @ 13 TeV
- Conclusioni

Underlying Event

Interazioni inelastiche ad LHC:



Underlying Event



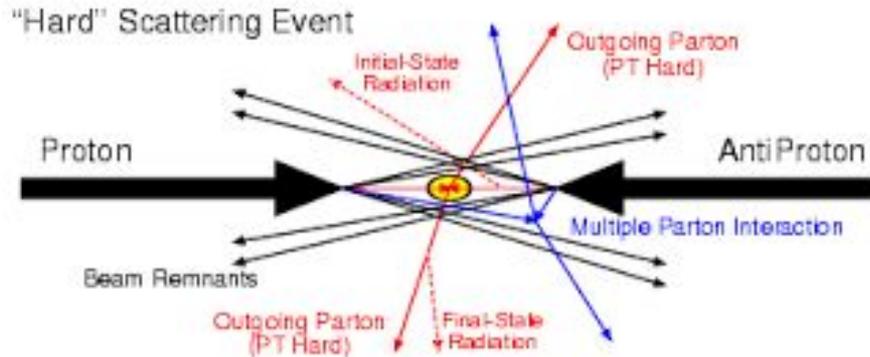
- **Hard scattering:**

è l'interazione di interesse grandi p_T scambiati

- **Underlying Event:**

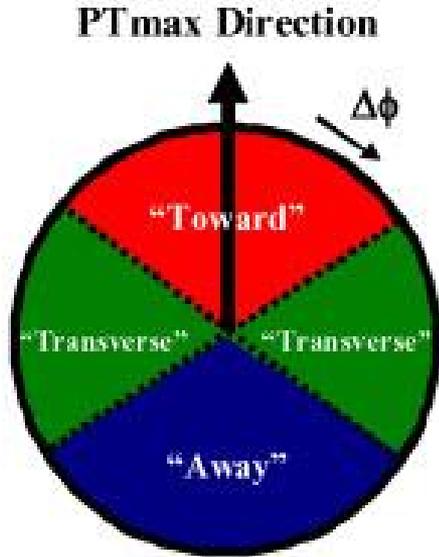
tutta l'attività rimanente dal processo adrone-adrone escluso l'evento di interesse

Underlying Event



- **Underlying Event:**
 - **condivide il vertice primario con l'hard scattering**
 - **Initial State Radiation (ISR)**
 - **Final State Radiation (FSR)**
 - **MPI**
 - **Beam Beam Remnant (BBR)**

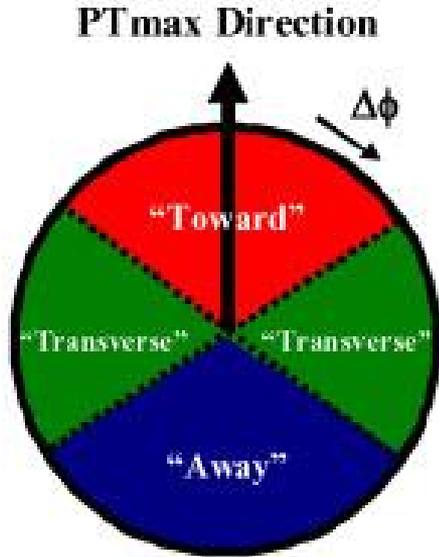
Strategia d'analisi



$$\Delta\phi = |\phi - \phi_{\text{leading}}|$$

- **Towards:** $|\Delta\phi| < 60^\circ$
- **Transverse:** $60^\circ < |\Delta\phi| < 120^\circ$
- **Away:** $|\Delta\phi| > 120^\circ$

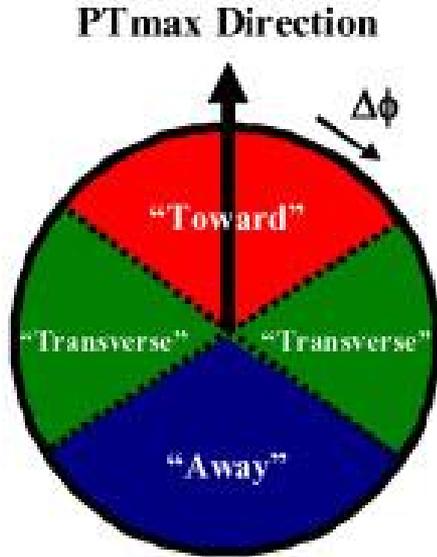
Strategia d'analisi



$$\Delta\phi = |\phi - \phi_{\text{leading}}|$$

- **Towards:** $|\Delta\phi| < 60^\circ$
- **Transverse:** $60^\circ < |\Delta\phi| < 120^\circ$ ➔ **sensibile all' UE**
- **Away:** $|\Delta\phi| > 120^\circ$

Strategia d'analisi

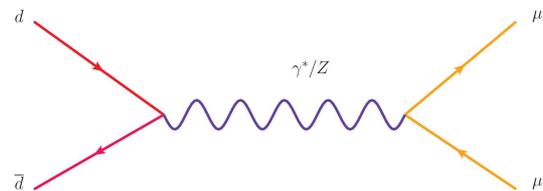


Osservabili cinematiche:

- $dN/d\eta d\phi$: densità di carica
- $d(\Sigma p_T)/d\eta d\phi$: densità di energia

Strategia d'analisi

Perché un processo Drell-Yan $q\bar{q} \rightarrow \mu\mu$?



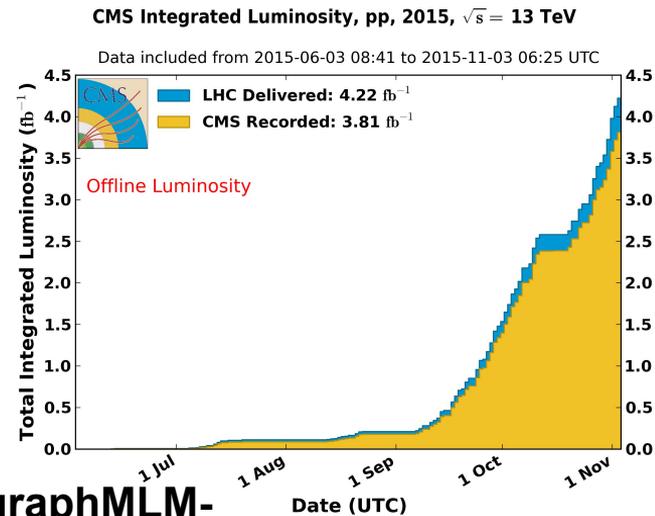
- netta separazione tra componente hard del processo e componente di soft QCD
- processo pulito e teoricamente bene compreso
- assenza di FSR e γ bremsstrahlung

Strategia d'analisi

- Selezione di eventi con $M_{\mu\mu}$ attorno al picco della Z perché meno affetti da background
- Z_{pT} come scala di energia dell'evento
- Osservabili cinematiche delle particelle cariche ad esclusione della coppia $\mu\mu$

Strategia d'analisi

- $L(\text{runD}) \approx 2 \text{ fb}^{-1}$
- Dataset: /DoubleMuon/Run2015D-PromptReco-v4/AOD
- MC: /DYJetsToLL_M-50_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/RunIISpring15FSPremix-MCRUN2_74_V9-v1/AODSIM



Selezione degli eventi

Trigger:

- HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_DZ_v*
- HLT_Mu17_TrkIsoVVL_TkMu8_TrkIsoVVL_DZ_v*

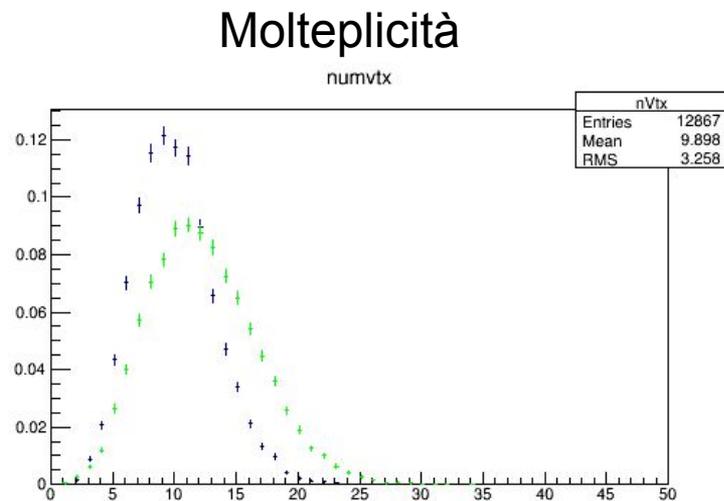
 seleziona eventi con almeno 2 muoni con:

- $\mu_{\text{leading}} (p_T) > 17 \text{ GeV}$
- $\mu_{\text{subleading}} (p_T) > 8 \text{ GeV}$
- isolati

Selezione degli eventi

Vertice :

- n.d.o.f. > 4
- $vtx_z - vtx_BS < 10$ cm
- posizione trasversa < 2 cm



differenze tra Dati e MC dovuti a diversi scenari di PU \longrightarrow reweighting

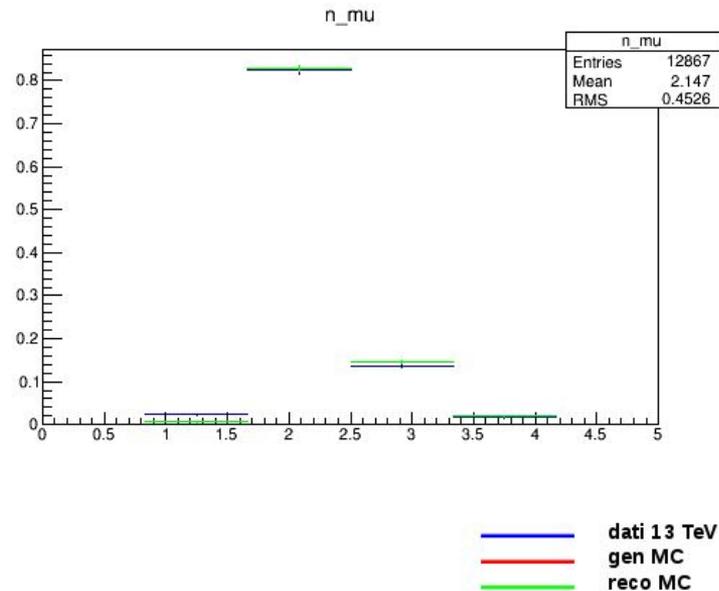
— dati 13 TeV
— gen MC
— reco MC

Selezione degli eventi

Muoni:

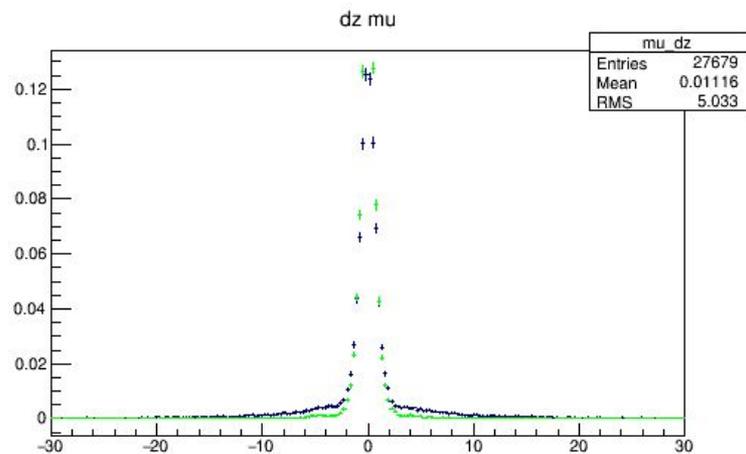
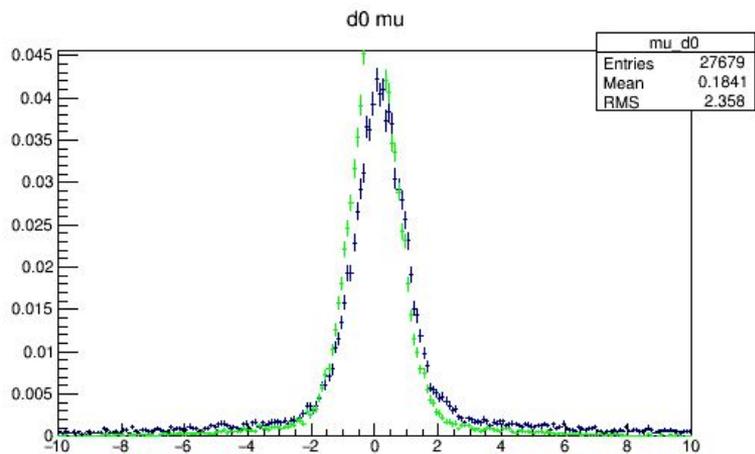
- PAT muons
- $\chi^2 < 10$
- $\text{mu_Iso} < 0.12$
- $\text{sig_d0(PV)} < 3$, $\text{sig_dz(PV)} < 3$
- $p_T \text{ leading}_\mu > 20 \text{ GeV}/c$
- $p_T \text{ subleading}_\mu > 10 \text{ GeV}/c$
- $|\eta| < 2.4$
- $81 < M_{\mu\mu} < 101 \text{ GeV}$

Molteplicità



Selezione degli eventi

Muoni: Parametro d'impatto calcolato rispetto al Vertice Primario

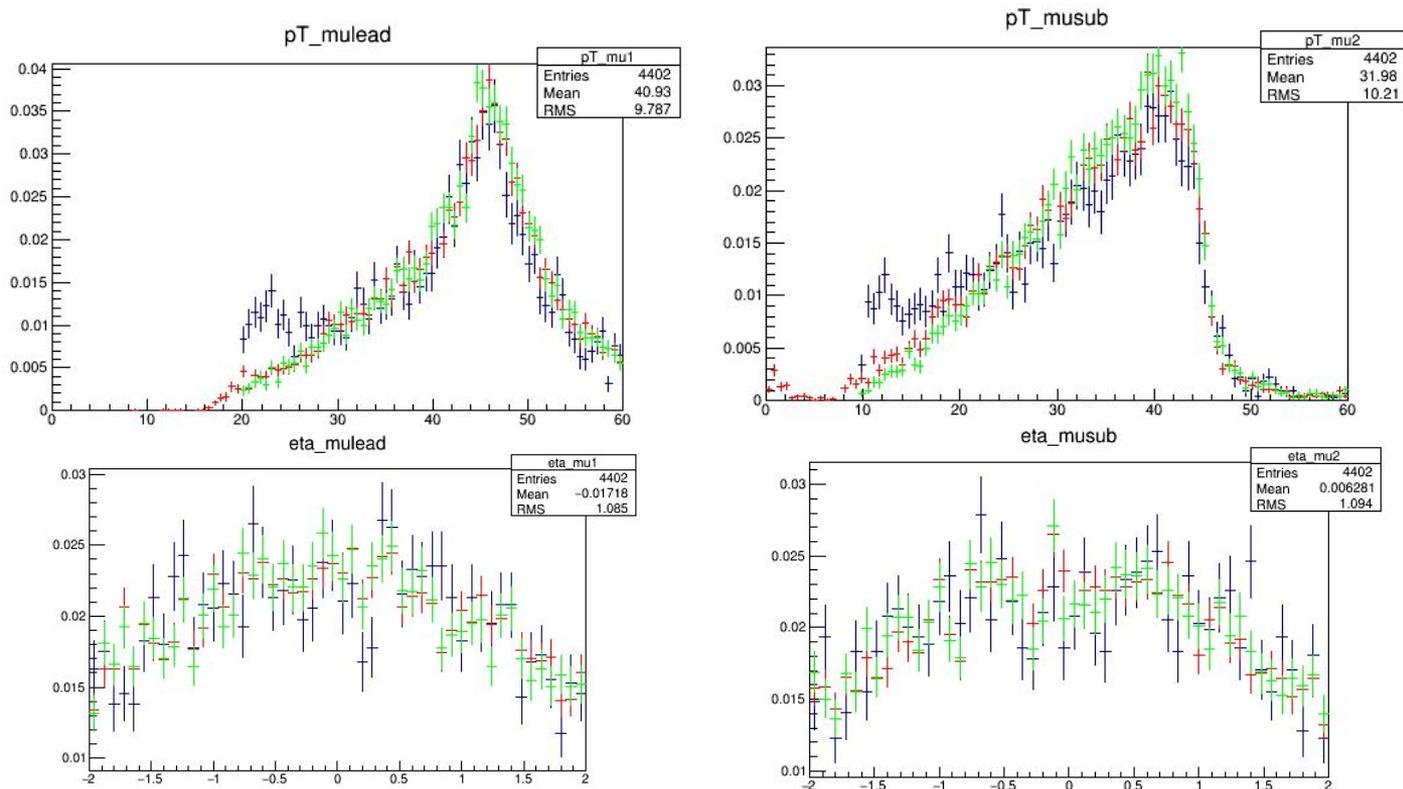


— dati 13 TeV
— gen MC
— reco MC

Selezione degli eventi

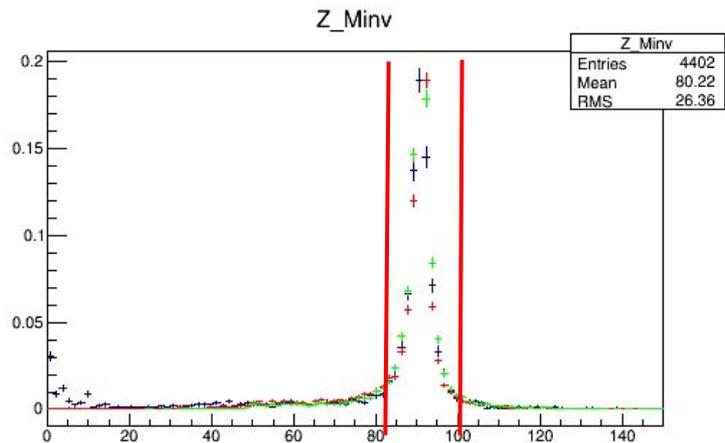
Muoni:

- $pT_{\text{mulead}} > 20 \text{ GeV}$
- $pT_{\text{musub}} > 10 \text{ GeV}$

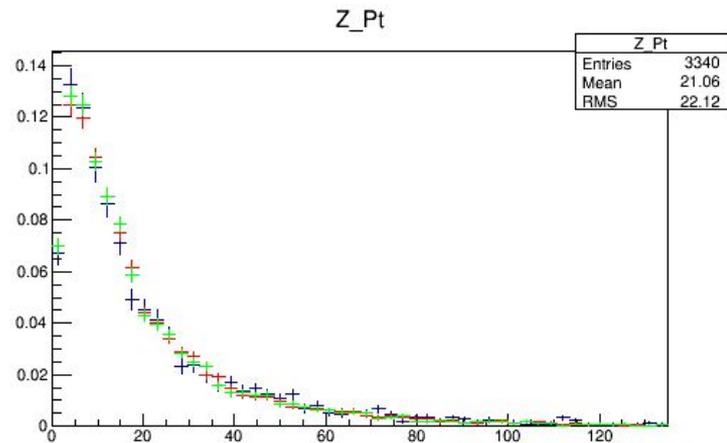


Selezione degli eventi

Muoni:



tagli cinematici: $81 < M_Z < 101$ GeV



Z_{pT} : scala dell'energia

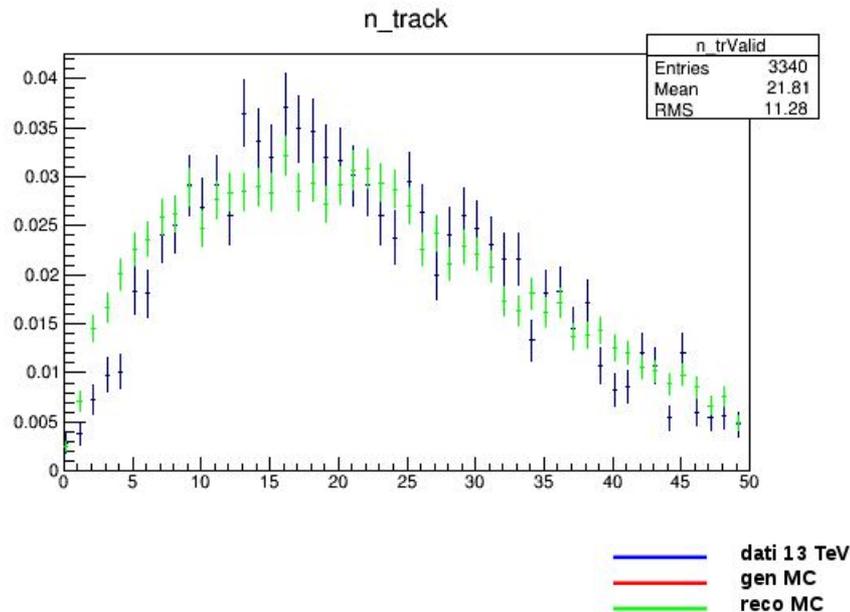
— dati 13 TeV
— gen MC
— reco MC

Selezione degli eventi

Tracce:

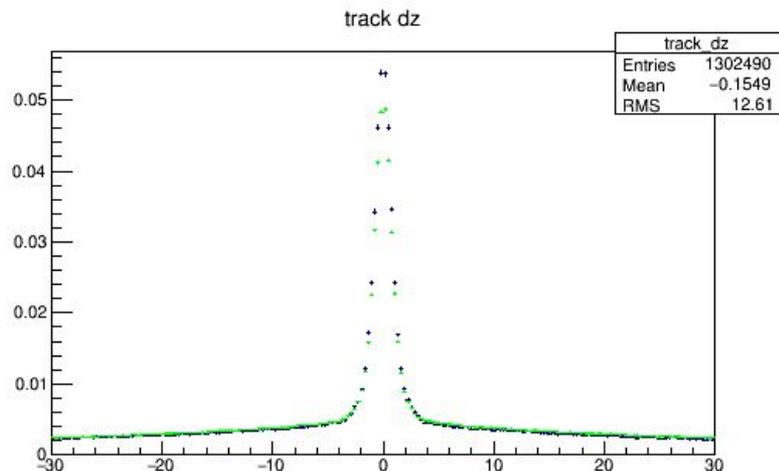
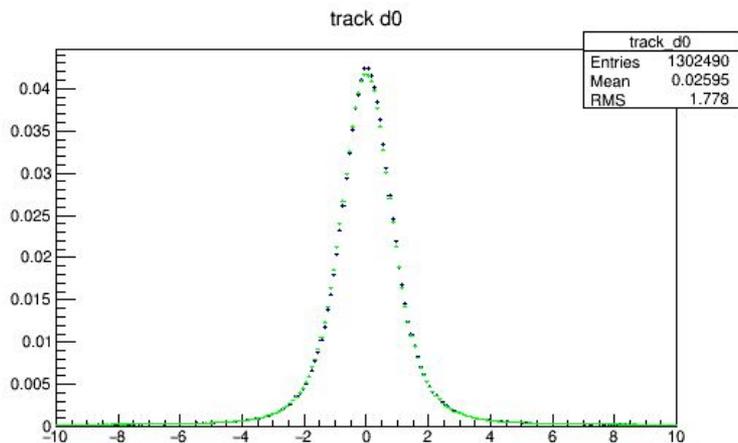
- $p_T > 0.5 \text{ GeV}/c$
- $|\eta| < 2$
- $\text{sig}_{d0}(\text{PV}) < 3$, $\text{sig}_{dz}(\text{PV}) < 3$
- $\sigma_{p_T} / p_T < 0.05$

Molteplicità



Selezione degli eventi

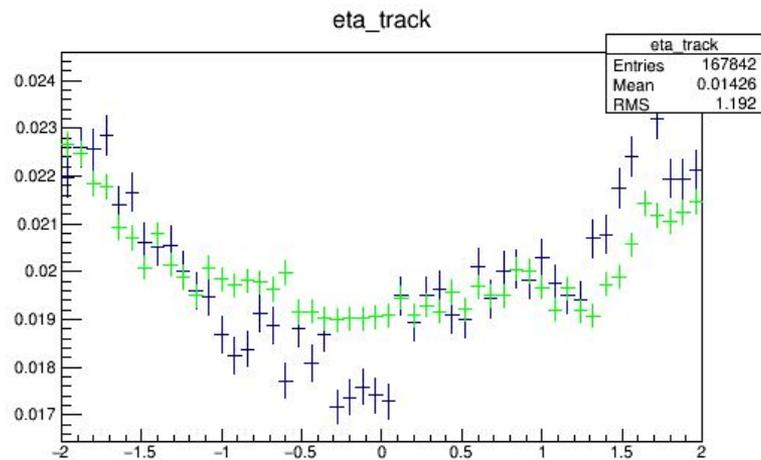
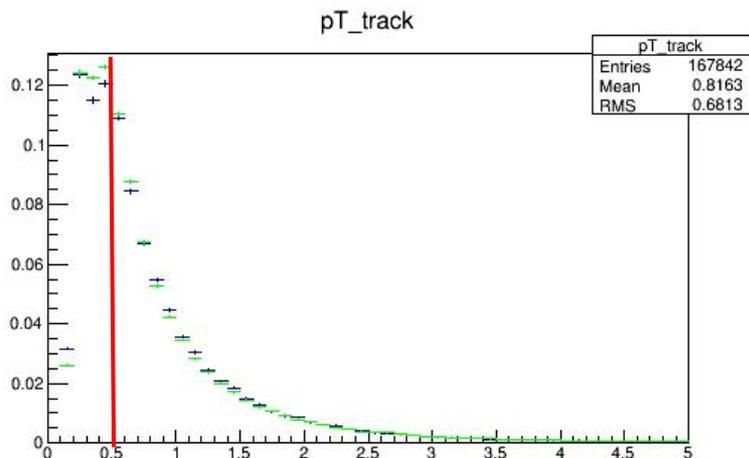
Tracce: Parametro d'impatto calcolato rispetto al Vertice Primario



— dati 13 TeV
— gen MC
— reco MC

Selezione degli eventi

Tracce:

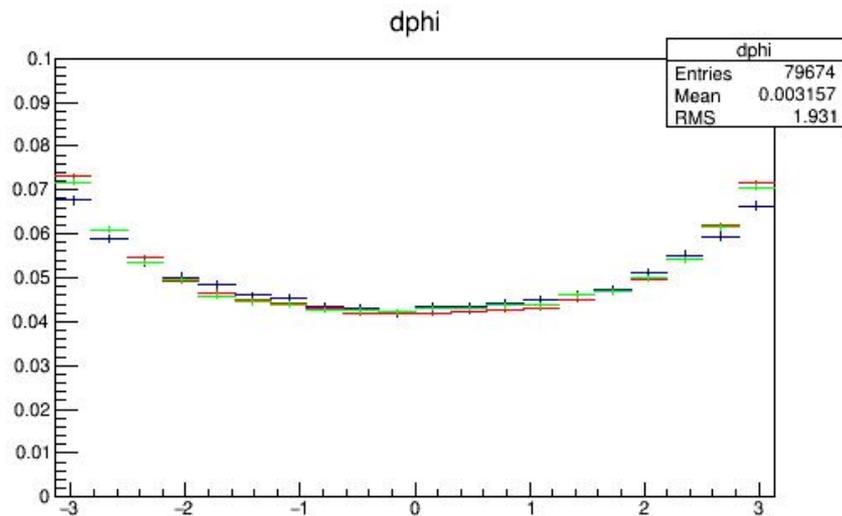


— dati 13 TeV
— gen MC
— reco MC

Definizione degli osservabili

Tracce:

- $d\phi = \phi_{\text{track}} - \phi_Z$
- $p_T > 0.5 \text{ GeV}$
- $|\eta| < 2$

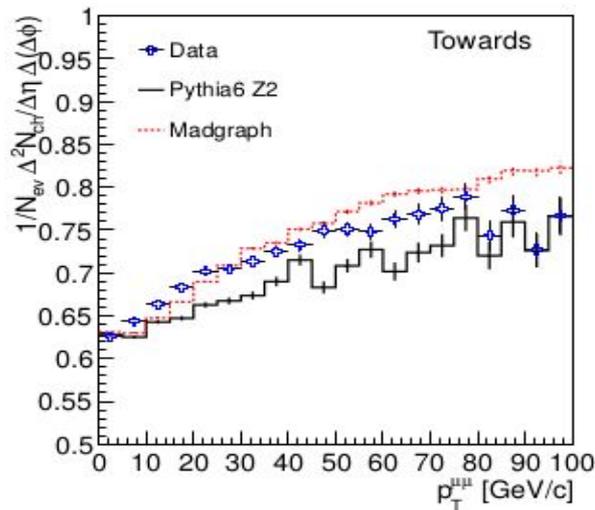


— dati 13 TeV
— gen MC
— reco MC

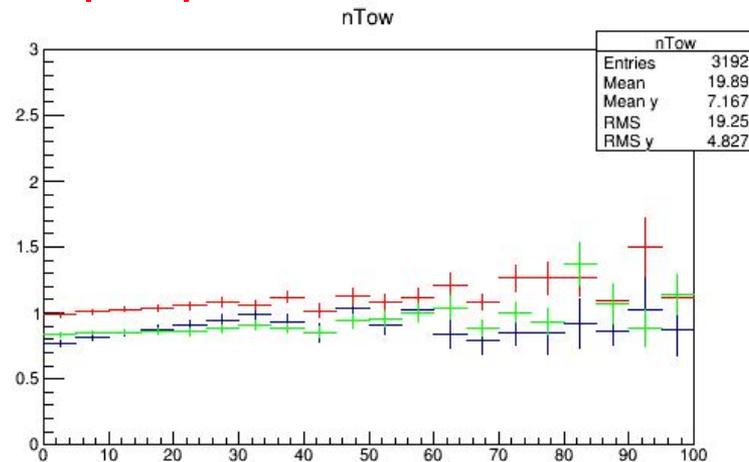
DY @ 7 TeV vs DY @ 13 TeV

$dN/d\eta d\phi$

Towards: $|\Delta\phi| < 60^\circ$



— dati 7 TeV
— MC

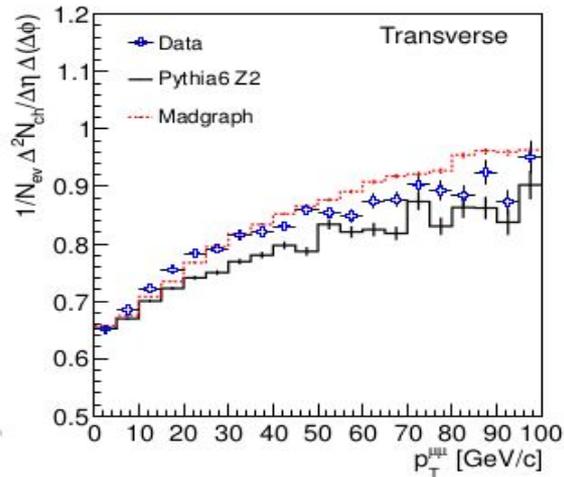


— dati 13 TeV
— gen MC
— reco MC

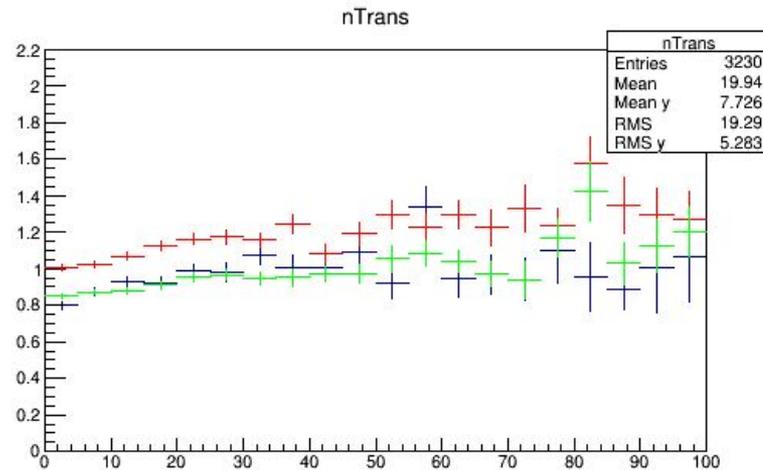
DY @ 7 TeV vs DY @ 13 TeV

$dN/d\eta d\phi$

Transverse : $60^\circ < |\Delta\phi| < 120^\circ$



— dati 7 TeV
— MC

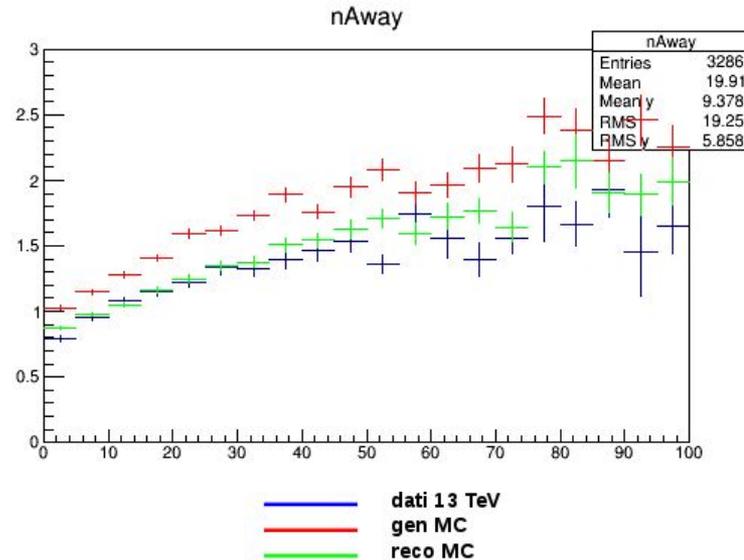
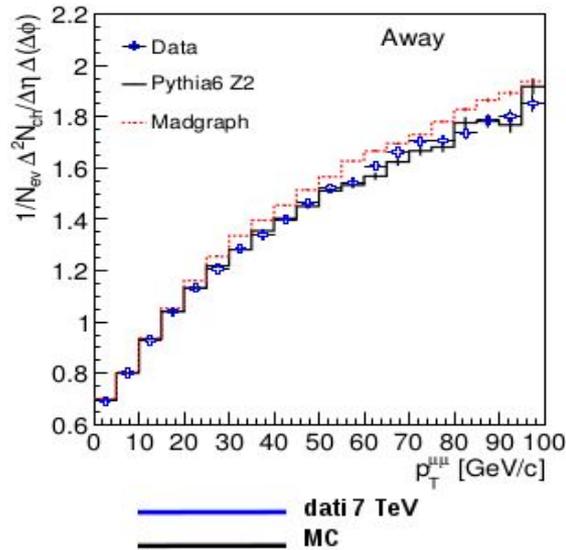


— dati 13 TeV
— gen MC
— reco MC

DY @ 7 TeV vs DY @ 13 TeV

$dN/d\eta d\phi$

Away: $|\Delta\phi| > 120^\circ$



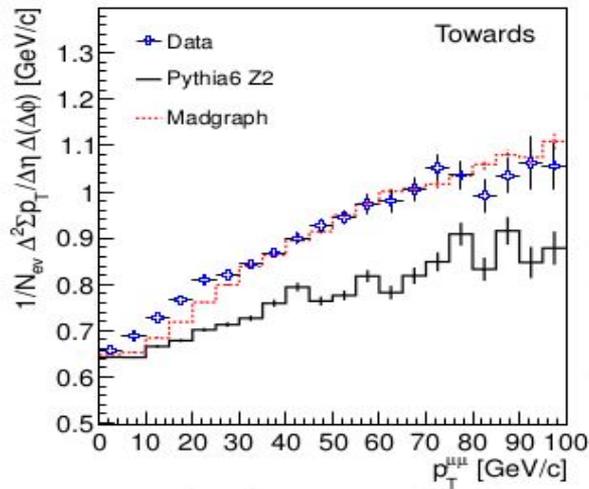
Conclusioni parziali

1. DATI e MC_RECO consistenti
2. MC_GEN più alto (ragionevole per le inefficienze)

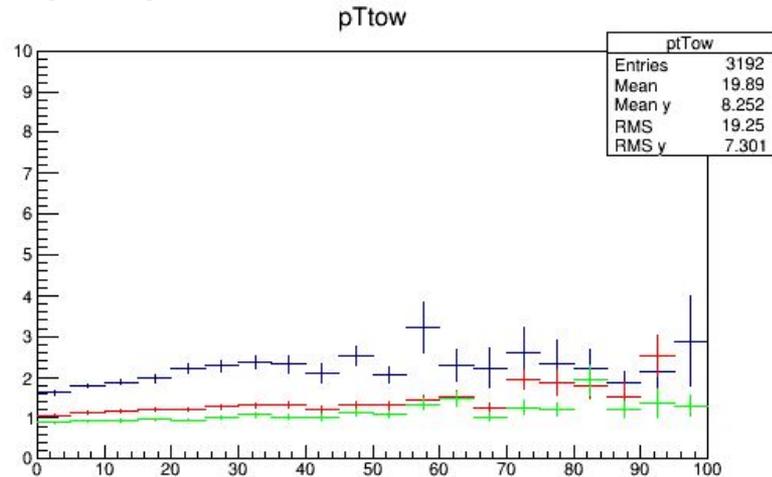
DY @ 7 TeV vs DY @ 13 TeV

$$d(\Sigma p_T)/d\eta d\phi$$

Towards: $|\Delta\phi| < 60^\circ$



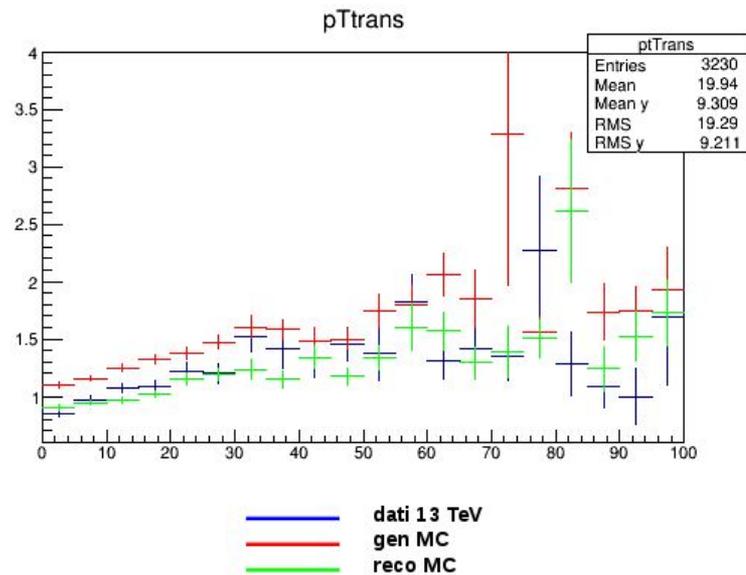
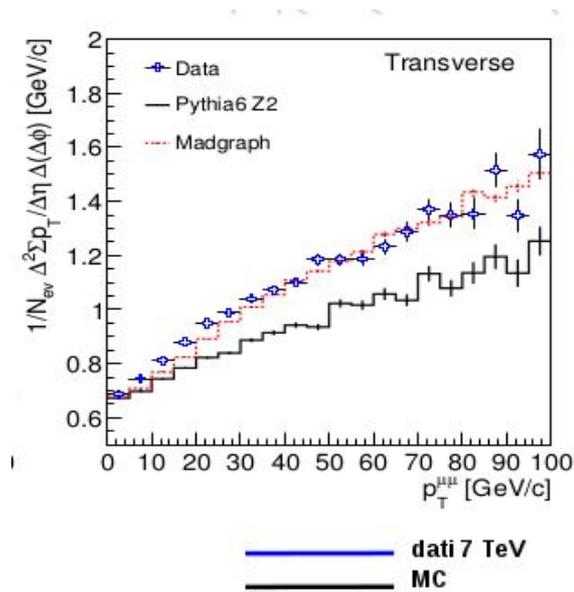
— dati 7 TeV
— MC



DY @ 7 TeV vs DY @ 13 TeV

$$d(\Sigma p_T)/d\eta d\phi$$

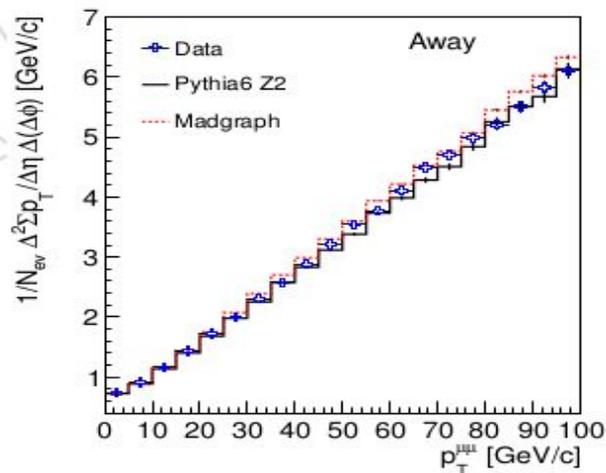
Transverse : $60^\circ < |\Delta\phi| < 120^\circ$



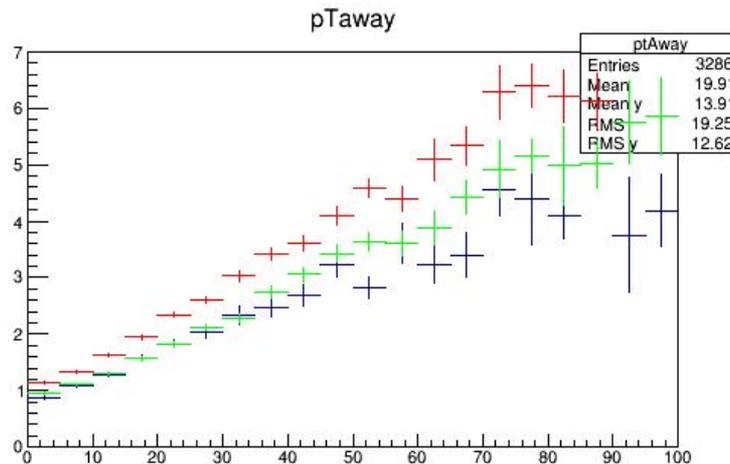
DY @ 7 TeV vs DY @ 13 TeV

$$d(\Sigma p_T)/d\eta d\phi$$

Away: $|\Delta\phi| > 120^\circ$



dati 7 TeV
MC



dati 13 TeV
gen MC
reco MC

Conclusioni parziali

1. Consistenza tra DATI e MC_RECO
2. Attività Tow da investigare

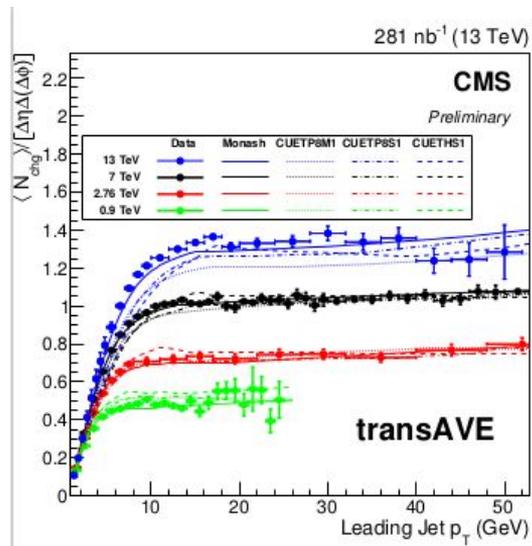
MinBias @ 13 TeV vs DY @ 13 TeV

Universalità:

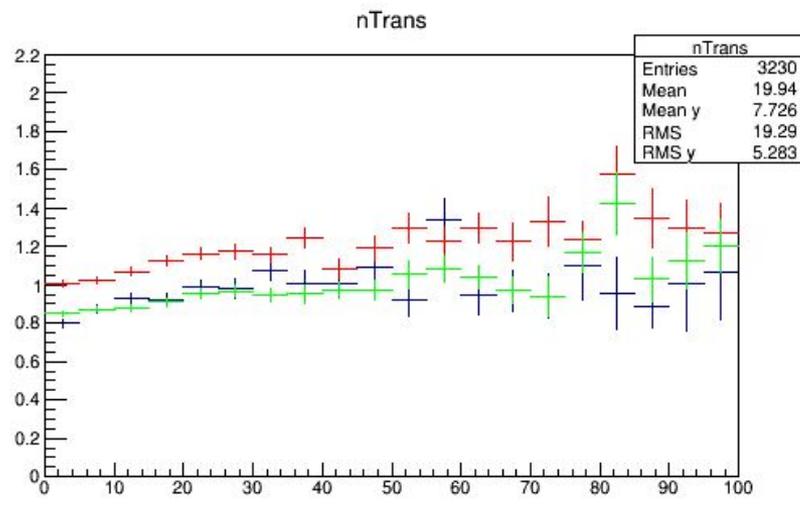
$dN/d\eta d\phi$

Transverse : $60^\circ < |\Delta\phi| < 120^\circ$

Minimum Bias



Drell-Yan



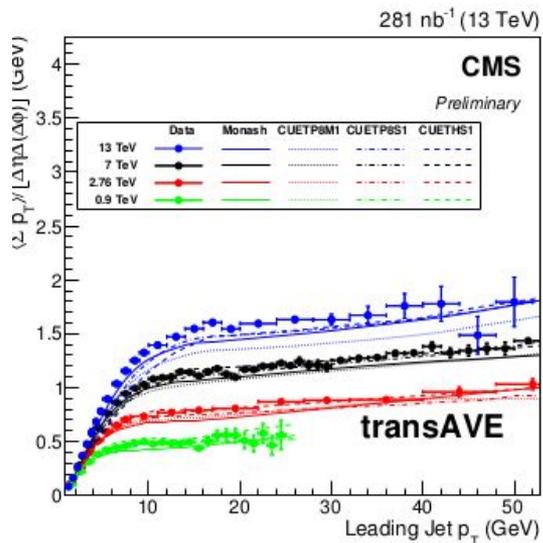
MinBias @ 13 TeV vs DY @ 13 TeV

Universalità:

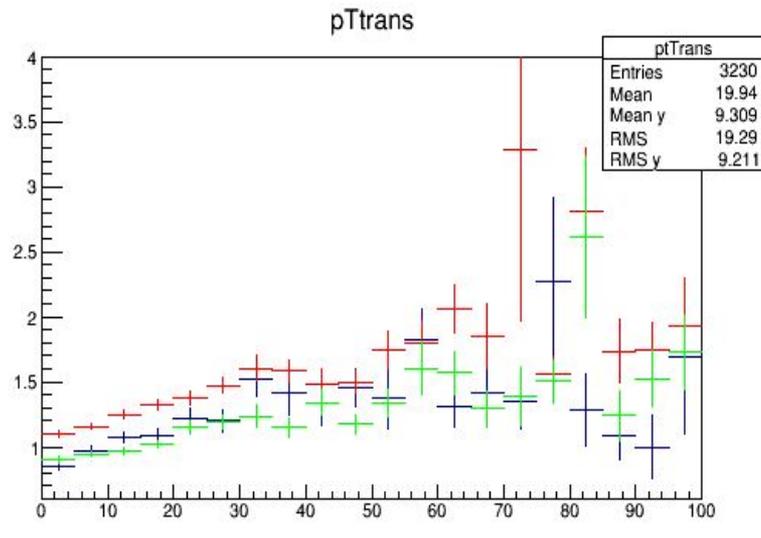
$d(\Sigma p_T)/d\eta d\phi$

Transverse : $60^\circ < |\Delta\phi| < 120^\circ$

Minimum Bias



Drell-Yan



Conclusioni

1. To do: Correggere Σp_T (Tow), Unfolding
2. Consistenza tra DATI e MC, discrepanze residue dovute a:
 - effetti di background (tt jets, W+ jets, softQCD)
 - pile up
3. Attività di UE indipendente per $M_{\mu\mu} > 40 \text{ GeV}/c^2 \longrightarrow$ saturazione delle MPI
4. Aumento dell'attività nel passaggio da 7 TeV a 13 TeV
5. Universalità dell'UE in differenti processi
6. Lenta crescita dell'attività nelle regioni Trans e Tow \longrightarrow presenza di ISR