Simulation of muon's kinematical distributions from MMT-DY and JPSI decay processes, calculated by PANDARoot at the level of stand alone muon system

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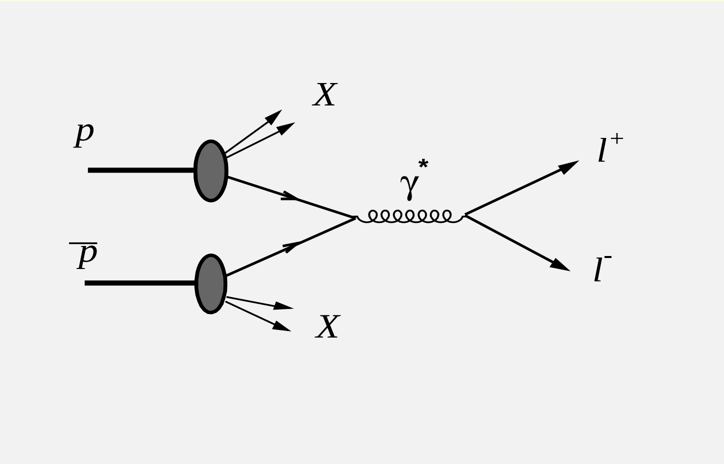
MMT-DY process



Simulation of muon's kinematical characteristics was done with use of PYTHIA6.4, PandaRoot & Geant 3 (presented by pink histograms) at the level of stand alone muon system.

The corresponding histograms done with use of the PYTHIA6.4 alone are superimposed for comparison (blue line).

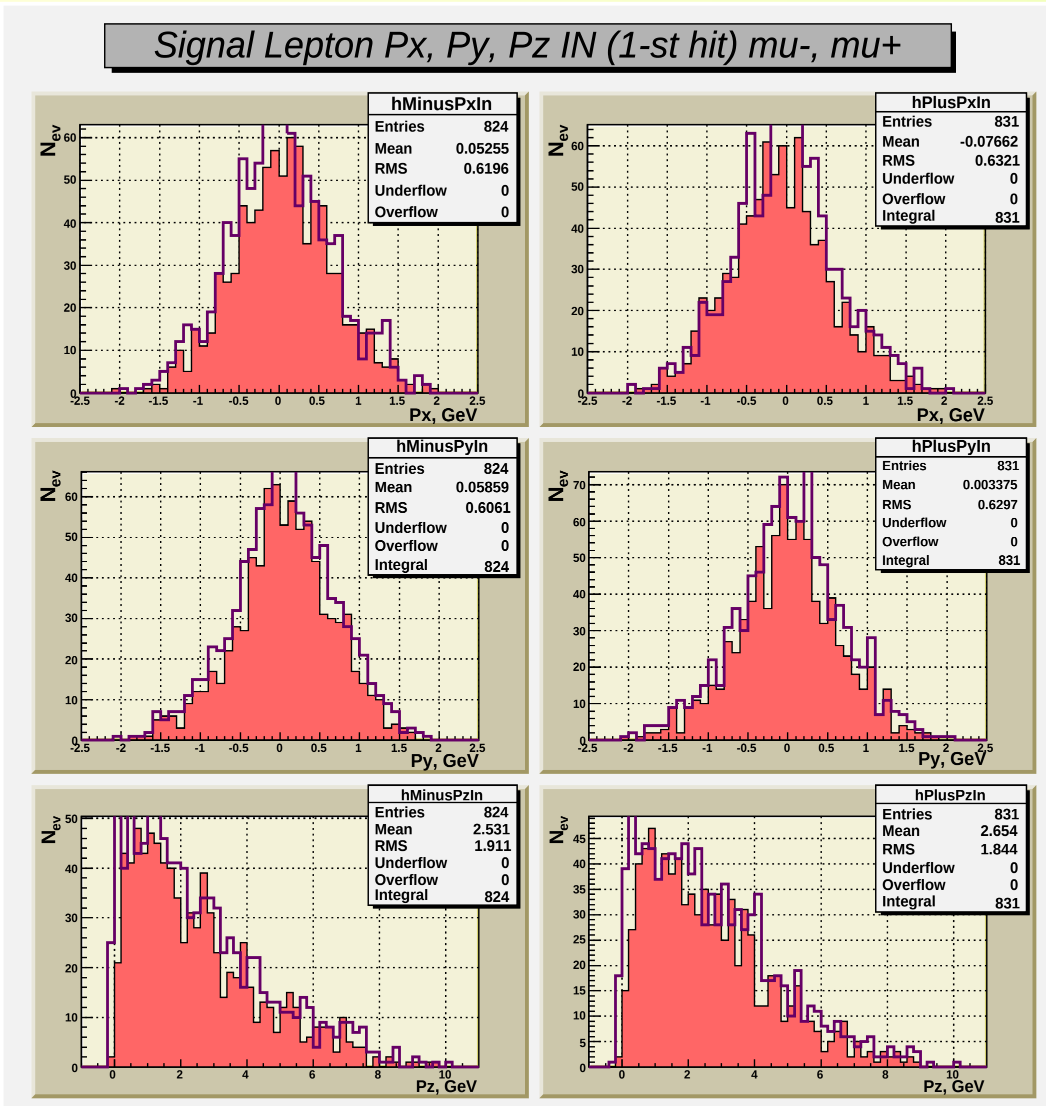
From the statistical numbers (entries) of distributions one can see that the ***total loss of muons in detector*** *is about* ***17.6%*** *for* μ^- *and* ***16.9%*** *for* μ^+*.*

Px^{μ}, Py^{μ}, Pz^{μ} from the 1-st hit in muon system

Px^{μ}

Py^{μ}

Pz^{μ}



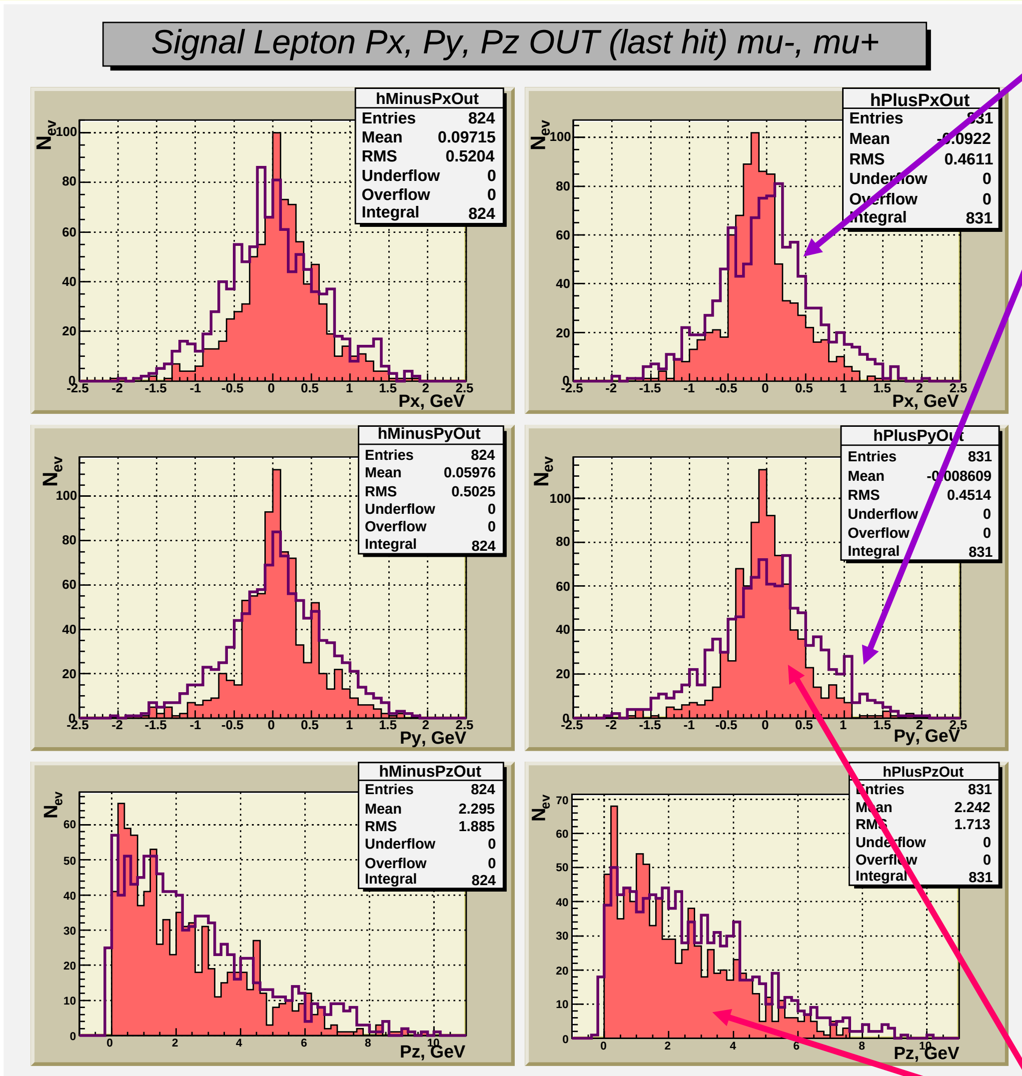
μ^- *μ^+*

Momenta distributions, obtained in the full simulation,

<u>**do not differ**</u> significantly from those, simulated in PYTHIA6.4.

The only distinction is in **the small loss of quantity (~17%)**, especially at very low momenta.

Px^μ, Py^μ, Pz^μ from the last hit in muon system



Px^μ

Py^μ

Pz^μ

μ^- μ^+

PYTHIA6.4

Momenta distributions, obtained in result of full simulation,

in this case is

significantly differ

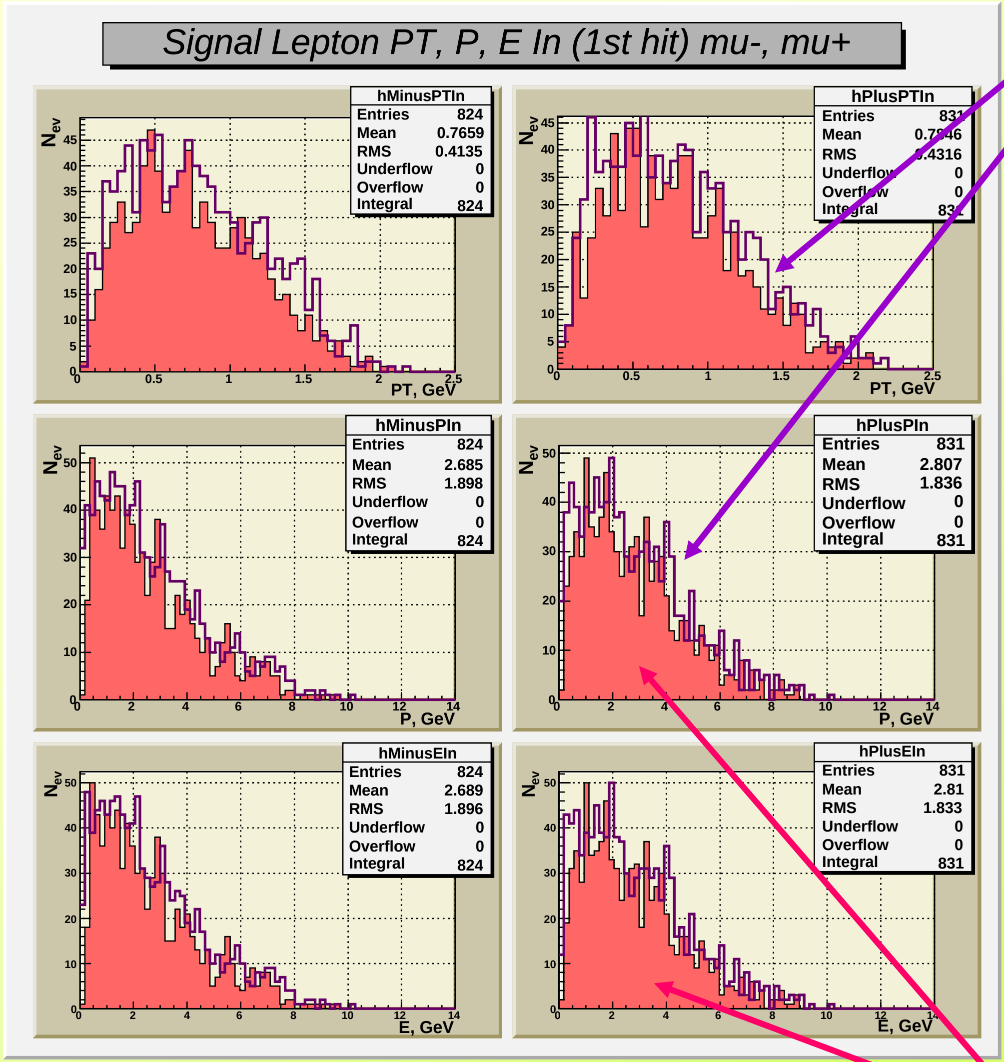
from the ones simulated in PYTHIA6.4, and

show noticeable loss of momentum

(about 0.5-1.5 GeV for each component).

PandaRoot & Geant 3

PT$^{\mu}$, P$^{\mu}$, E$^{\mu}$ from the 1-st hit in muon system



PT$^{\mu}$

P$^{\mu}$

E$^{\mu}$

μ^- **μ^+**

PYTHIA6.4

Momenta & Energy distributions, obtained in result of full simulation,

do not differ noticeably from the ones, simulated in PYTHIA6.4,

except **some loss of quantity.**

PandaRoot & Geant 3

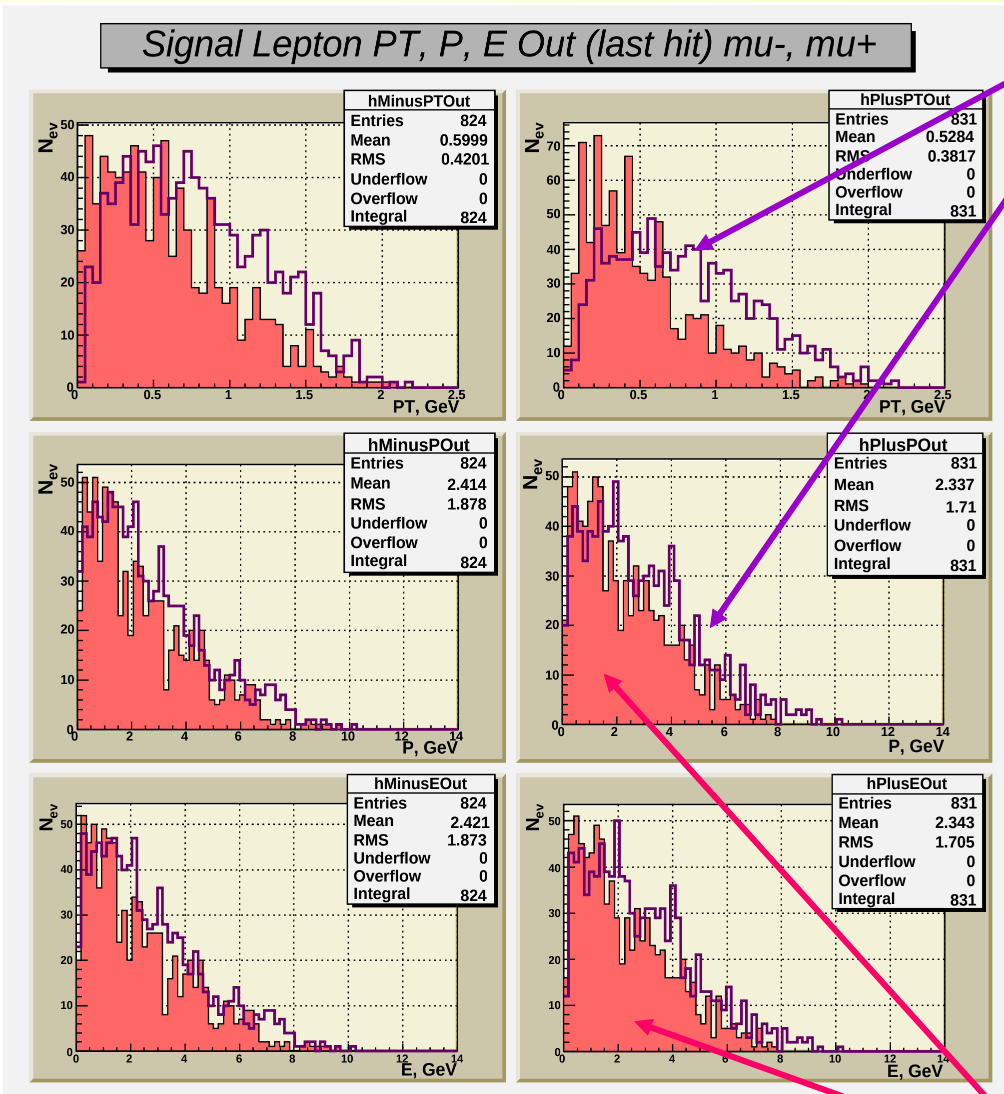
PT^{μ}, P^{μ}, E^{μ} from the last hit in muon system

PYTHIA6.4

PT^{μ}

P^{μ}

E^{μ}



μ^- μ^+

Momenta & Energy distributions, obtained in result of full simulation,

in this case is

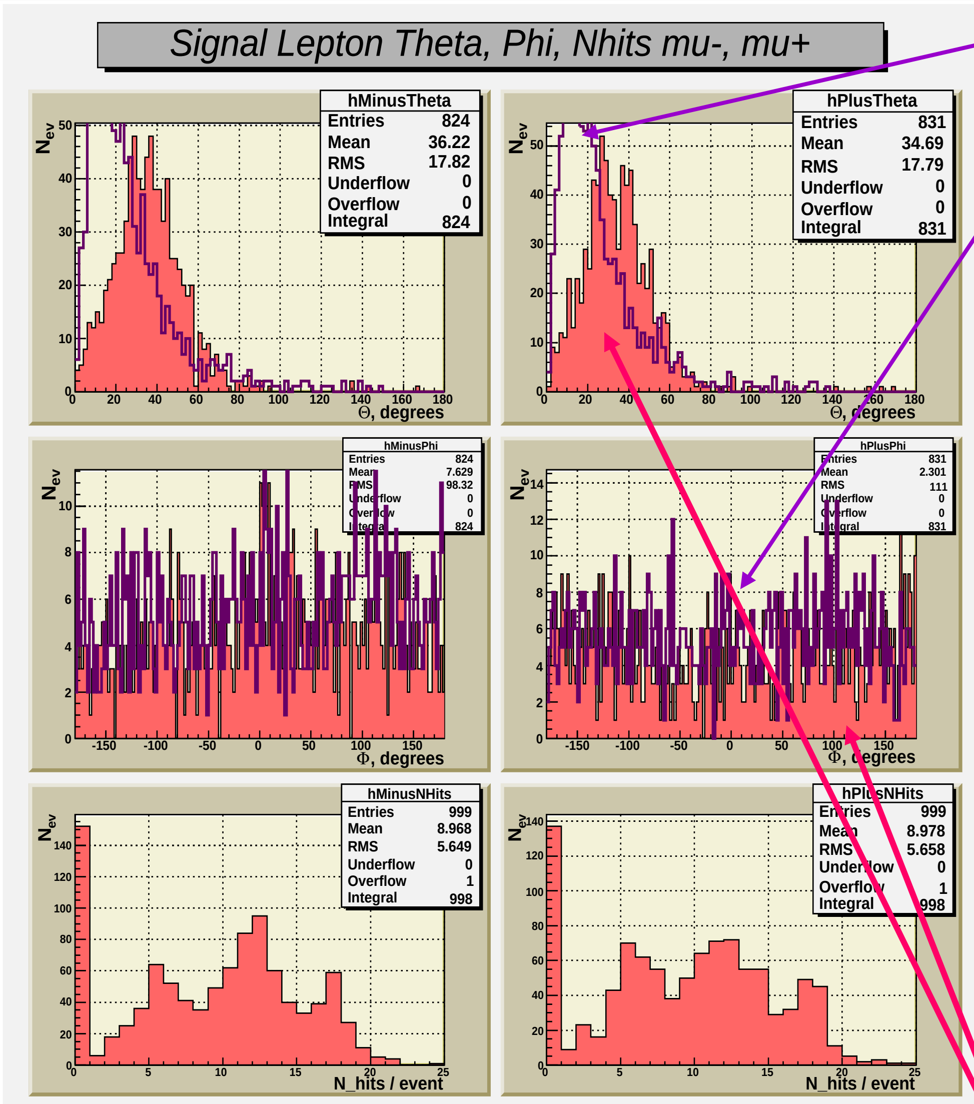
<u>differ significantly</u> from the ones, simulated in PYTHIA6.4, and

show noticeable loss of momentum & energy (about 2 GeV) in result of penetrating through the material of the muon system.

PandaRoot & Geant 3

Angle θ^{μ}, φ^{μ} distributions and N_{hits} in muon system

PYTHIA6.4



θ^{μ}

φ^{μ}

N_{hits}

μ^{-} μ^{+}

- θ^{μ} - polar angle
- φ^{μ} - azimuth angle
- N_{hits} - number of hits, made by muon in muon system per event

- The **significant difference in distributions of polar angle θ^{μ}** can be explaned by deviation in magnetic field.
- Practically no difference in distributions of the azimuth angle φ^{μ}.
- The first column in muon hits distributions shows the number of events, in which the corresponding muons gave no hits in the muon system (lost muons).

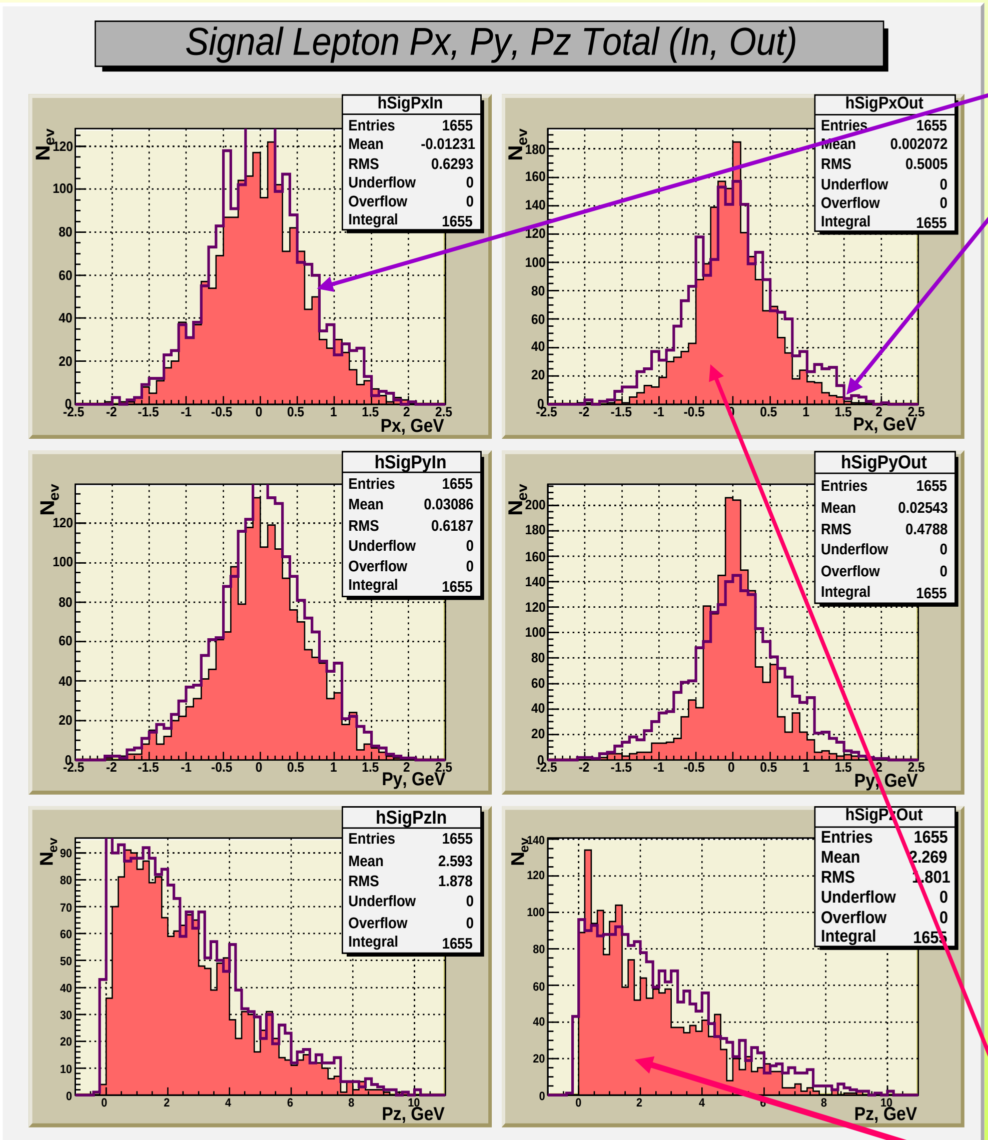
PandaRoot & Geant 3

Px^{μ}, Py^{μ}, Pz^{μ} of $(\mu^{+}+\mu^{-})$ from the 1-st & last hit in muon system

Px^{μ}

Py^{μ}

Pz^{μ}



1-st hit *last hit*

PYTHIA6.4

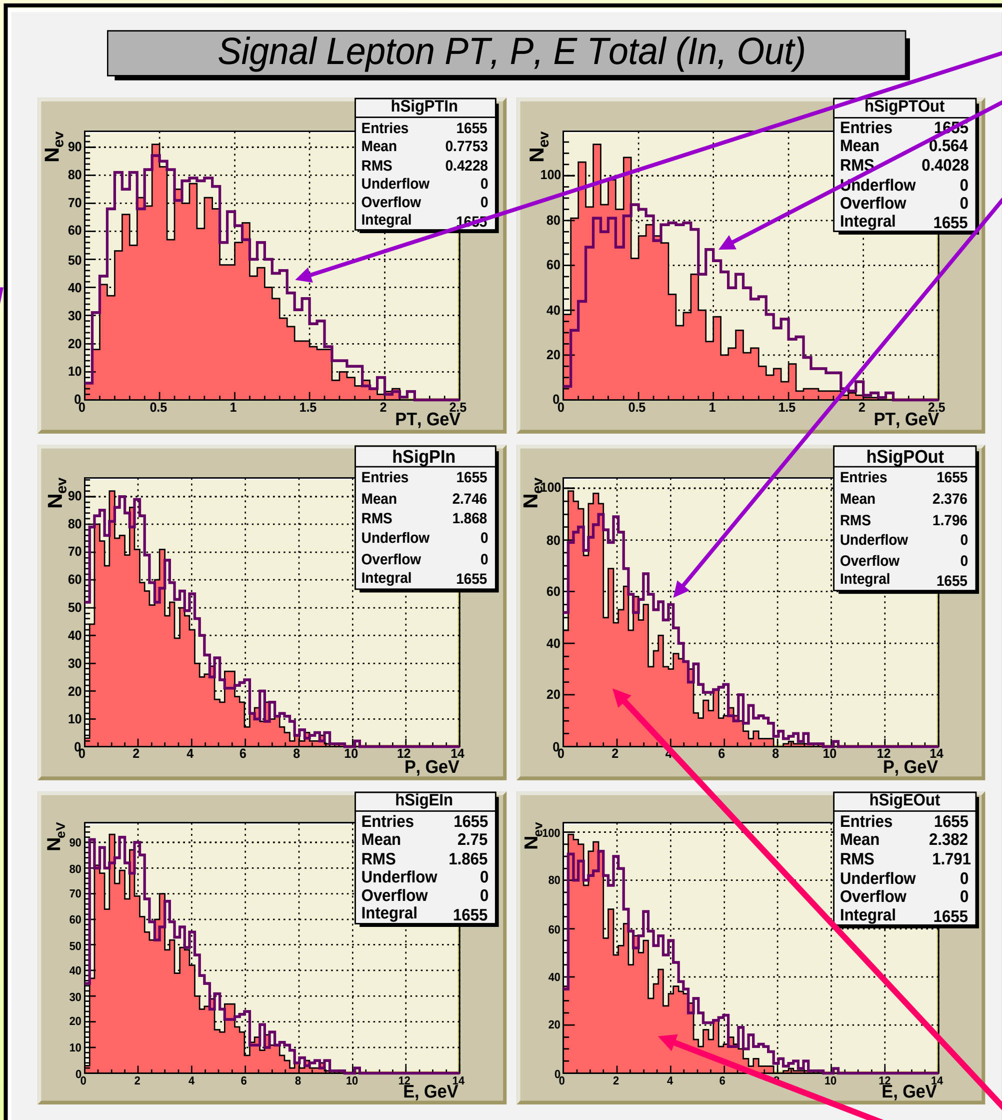
- Like in the case of separate taken muons, the *momenta distributions, obtained in result of full simulation*, **do not much differ** to the ones simulated in PYTHIA6.4 for the **values from the first hit**, exept some loss of quantity, especially at very low momenta,

&

- **noticeably differ** to the ones simulated in PYTHIA6.4 in the **case of the last hit**, and show here the noticeable loss of momentum (about 0.5-1.5 GeV for each components).

PandaRoot & Geant 3

PT^{μ}, P^{μ}, E^{μ} of ($\mu^{+}+\mu^{-}$) from the 1-st & last hit in muon system



PT^{μ}

P^{μ}

E^{μ}

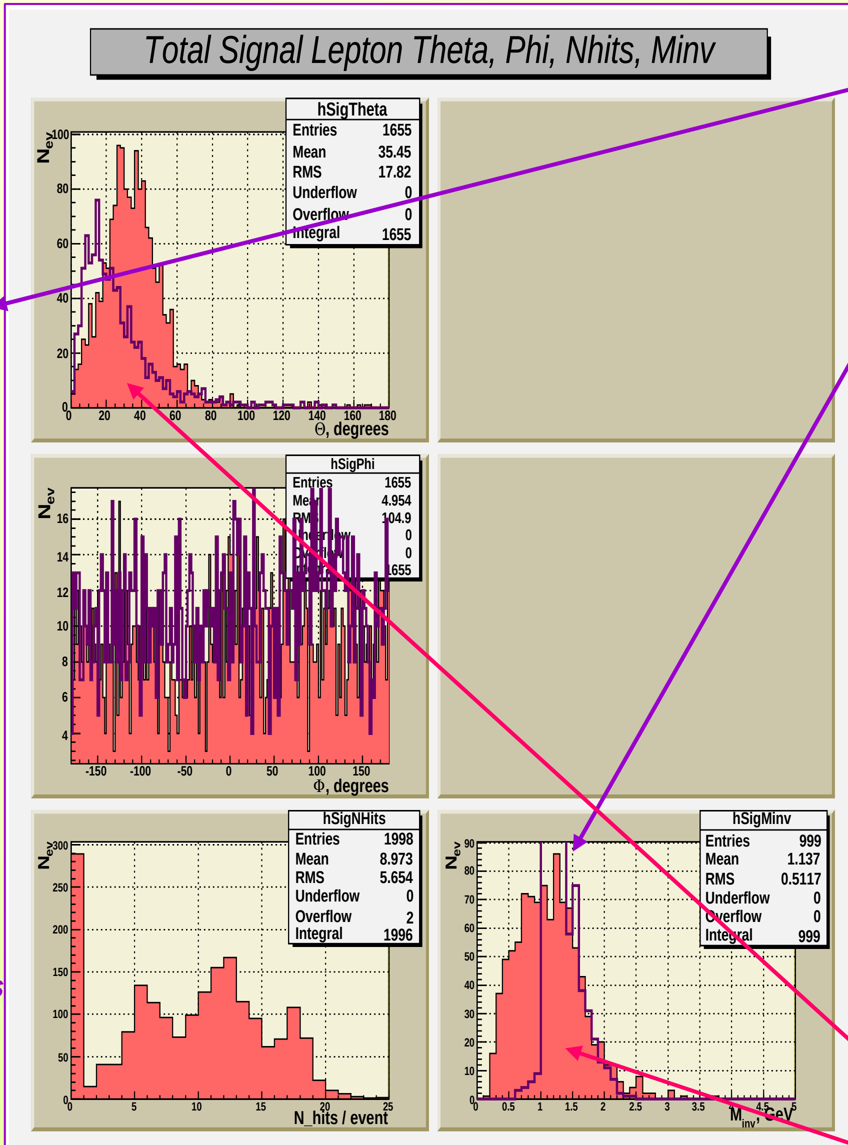
1-st hit ***last hit***

PYTHIA6.4

- Like in the case of the muons, taken separately, the ***momenta and energetical distributions*** of the **first hit**, obtained during a full simulation, **do not differ significantly** from the ones simulated in PYTHIA6.4. The differences is, in general, in a small loss of quantity.
- In the **case of a last hit**, they are **noticeably differ** from the ones, simulated in PYTHIA6.4, and ***show significant loss of momentusm and energy*** (about 2 GeV) as a result of penetrating through the material of the muon system

PandaRoot & Geant 3

Total θ^{μ}, φ^{μ} distributions & N_{hits} in muon system, $M_{inv}(\mu^+,\mu^-)$



θ^{μ}

φ^{μ}

N_{hits}

$M_{inv}(\mu^+,\mu^-)$

PYTHIA6.4

- θ^{μ} - polar angle
- φ^{μ} - azimuth angle
- N_{hits} - number of hits, made by muon in muon system per event

- The **significant difference in distributions of polar angle θ^{μ}** can be explaned by deviation in magnetic field.
- Practically **no difference** in distributions of the azimuth angle φ^{μ}.
- The first column in muon hits distributions shows the number of events, in which the corresponding muons gave no hits in the muon system (lost muons).
- Distribution of invariant mass $M_{inv}(\mu^+,\mu^-)$ also **differ** from the initial one, simulated by PYTHIA.

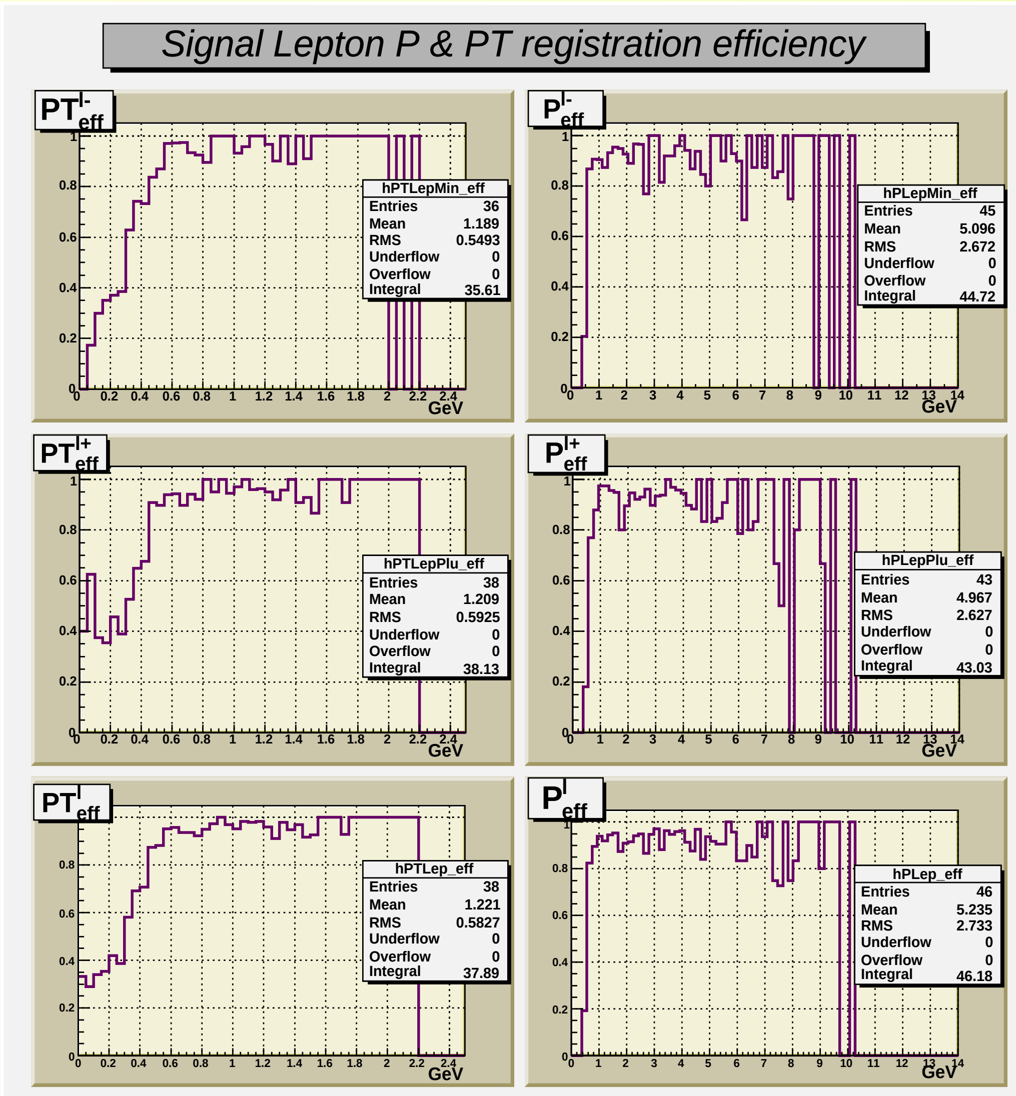
PandaRoot & Geant 3

Signal muon P & PT registration efficiency

μ^-

μ^+

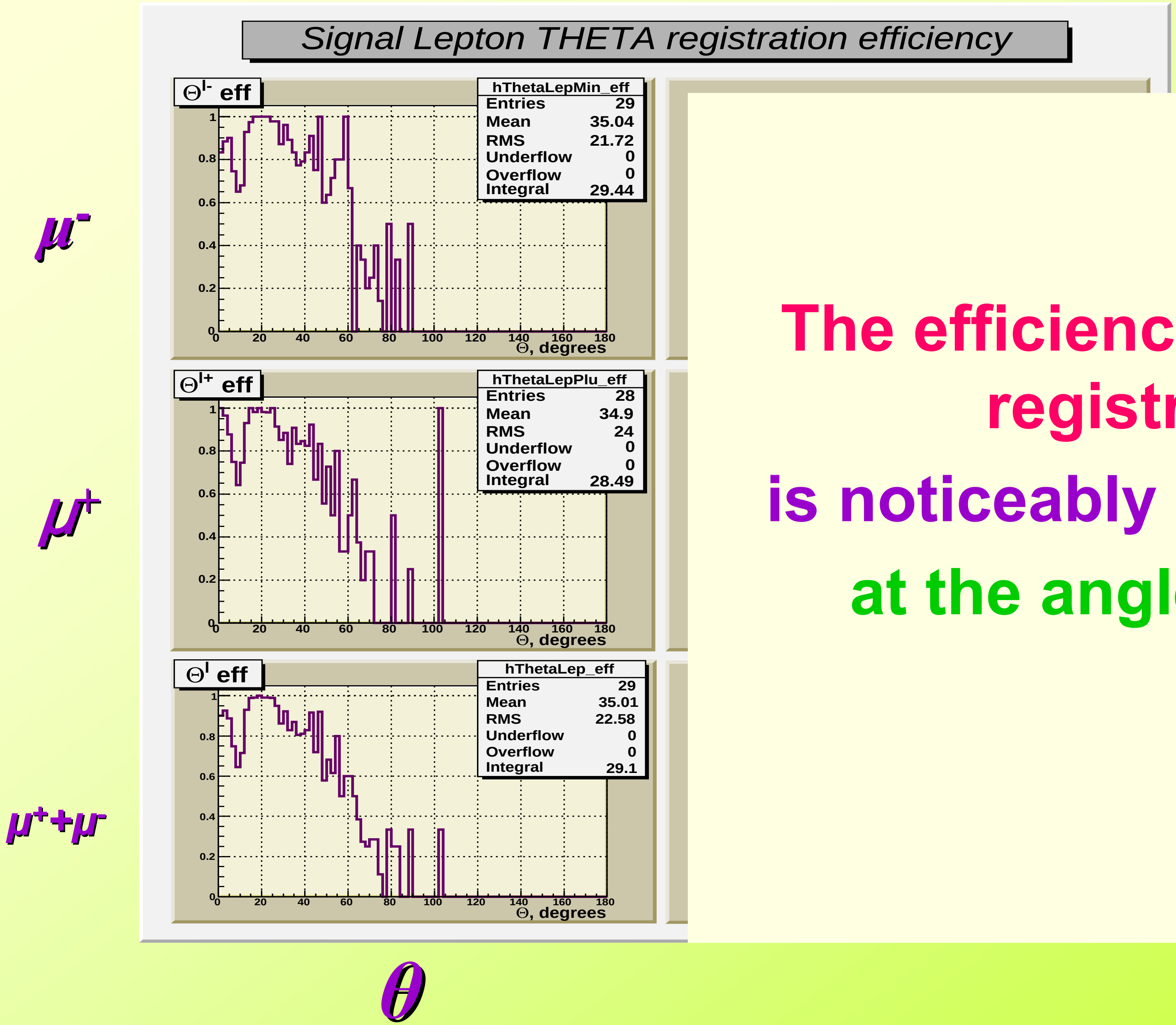
$\mu^+ + \mu^-$



PT **P**

At very low (<0.5 GeV) **initial momentum and transverse momentum, the efficiency of muon registration** is ***noticeably decreasing***.

Signal muon registration efficiency by polar angle θ



The efficiency of muon registration

is noticeably decreasing

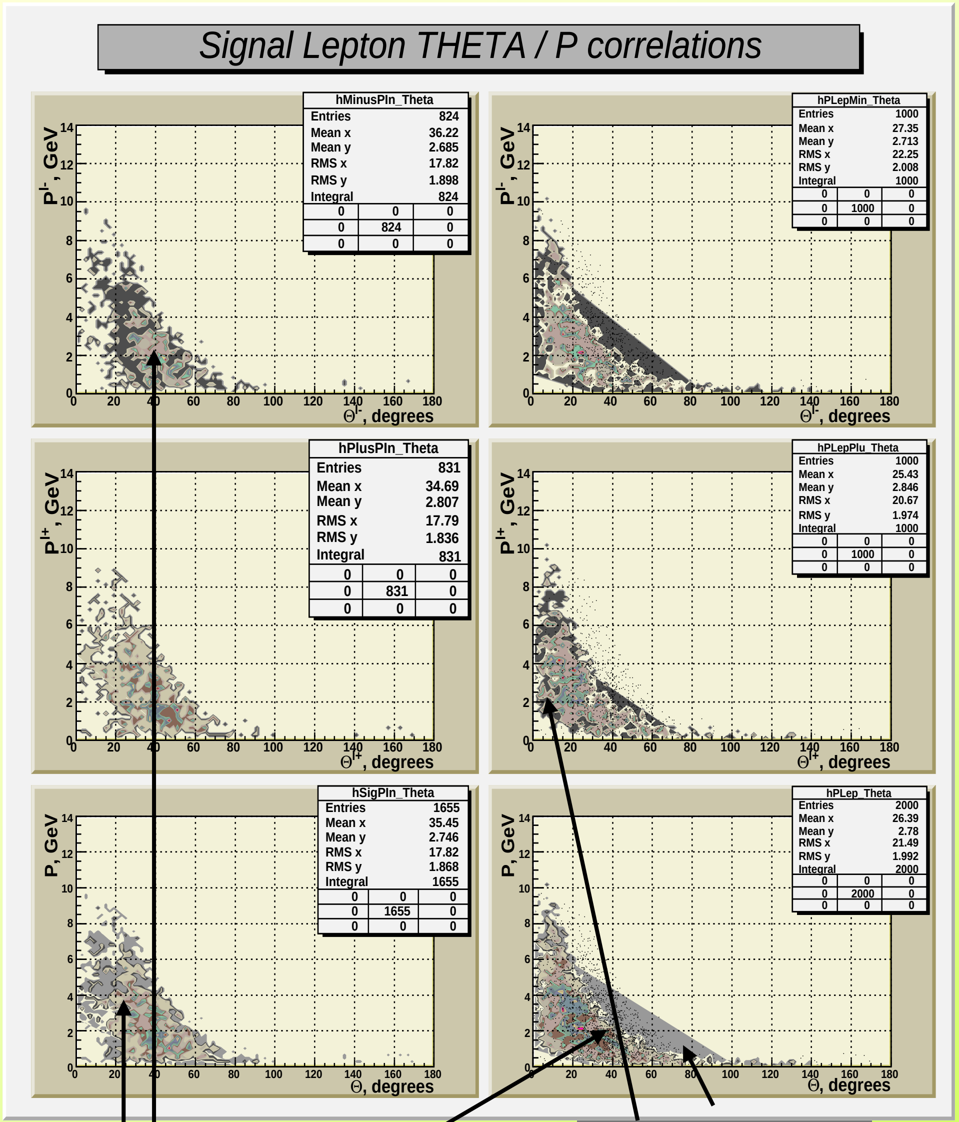
at the angles > 50^0

Correlation distributions of polar angle θ and momentum P

μ^-

μ^+

$\mu^+ + \mu^-$



PandaRoot & Geant 3

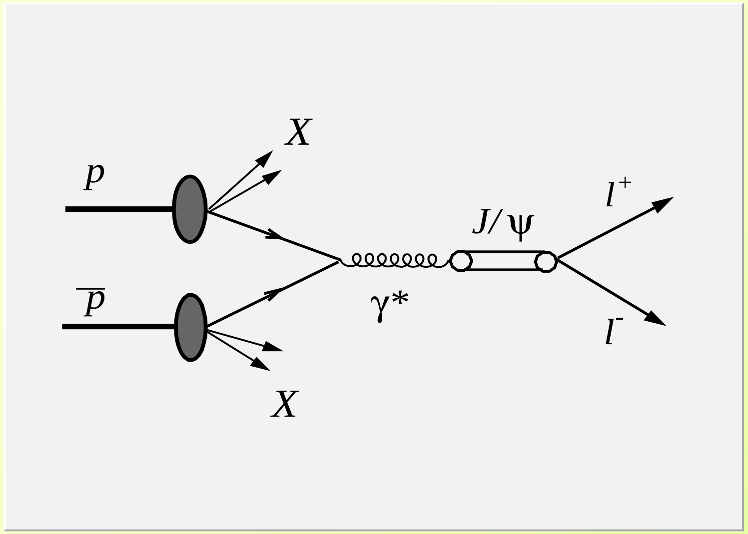
PYTHIA6.4

- *The figures are **projections of 3-D signal muons correlation distributions** of polar angle θ and modulus of momentum P(that correspond to the first hit in the muon system):*
- **Left coloumn** presents the results, obtained by the full simulation (PANDARoot and GEANT3).
- **Right coloumn** - the color area presents the results of PYTHIA simulation. The black dots, which correspond to the results, shown in the left column, are superimposed for comparison.
- **As it was already shown before in 2-D figures,**

  due to the magnetic field influence,

  muons are moving aside to an angle of about 20^0.

$J/\Psi \to \mu^+\mu^-$ process



Simulation of muon's kinematical characteristics was done with use of PYTHIA6.4, PandaRoot & Geant 3 (presented by pink histograms) at the level of stand alone muon system.

The corresponding histograms done with use of the PYTHIA6.4 alone are superimposed for comparison (blue line).

$$q_i \bar{q}_i \rightarrow \gamma^* \rightarrow c\bar{c} \rightarrow J/\Psi \rightarrow l^+ l^- + X$$

$$q\bar{q} \rightarrow c\bar{c}\,[{}^3S_1^{(8)}]\ g \rightarrow l^+ l^- + X$$

$$q\bar{q} \rightarrow c\bar{c}\,[{}^3P_J^{(8)}]\ g \rightarrow l^+ l^- + X$$

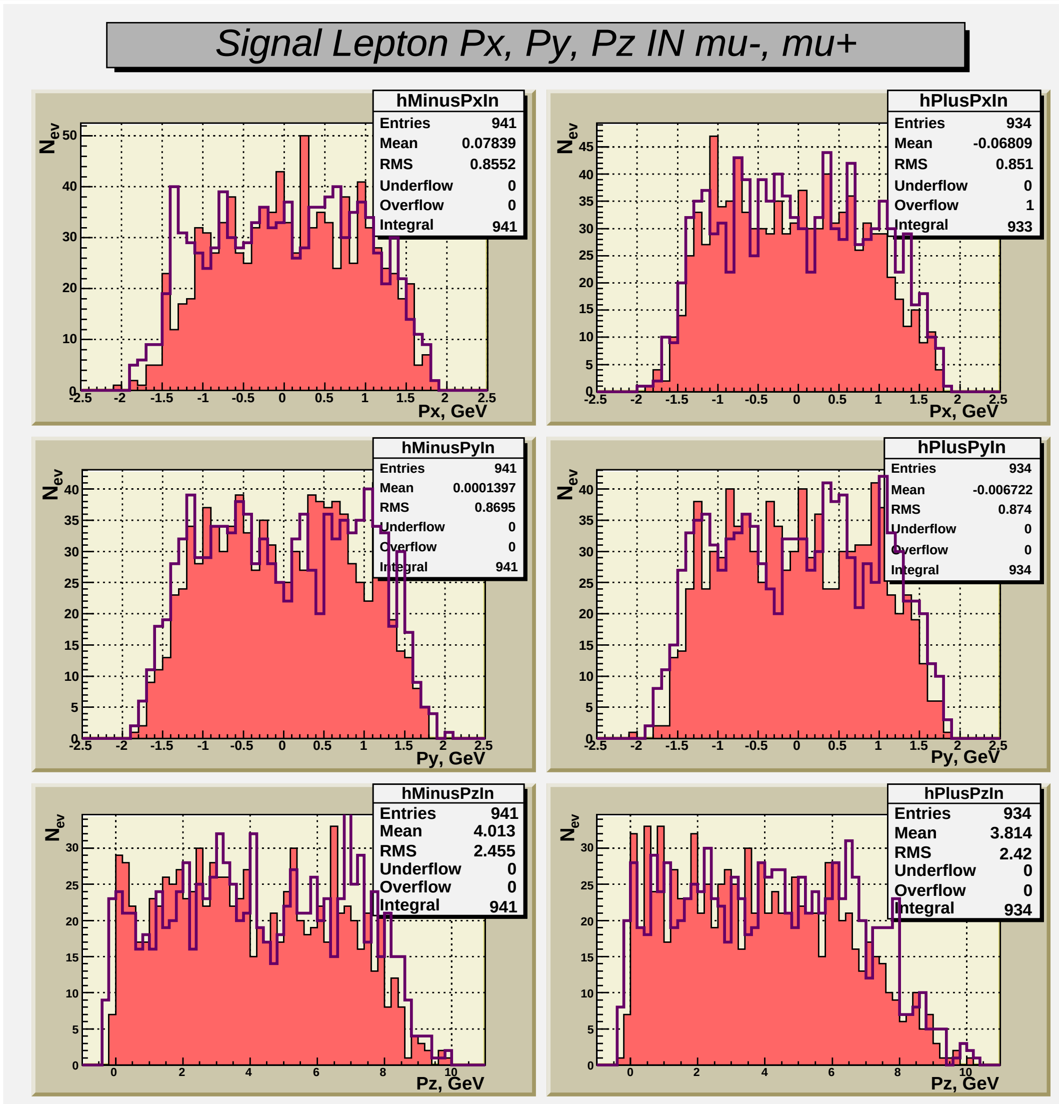
From the statistical numbers (entries) of distributions one can see that the ***total loss of muons in detector*** *is about* ***5.9%*** *for* μ^- *and* ***6.6%*** *for* μ^+.

Px^{μ}, Py^{μ}, Pz^{μ} from the 1-st hit in muon system

Px^{μ}

Py^{μ}

Pz^{μ}



μ^{-} ***μ^{+}***

Momenta distributions, obtained in the full simulation,

<u>do not differ</u> significantly from those, simulated in PYTHIA6.4.

The only distinction is in **the small loss of quantity (~6%)**, especially at large momenta.

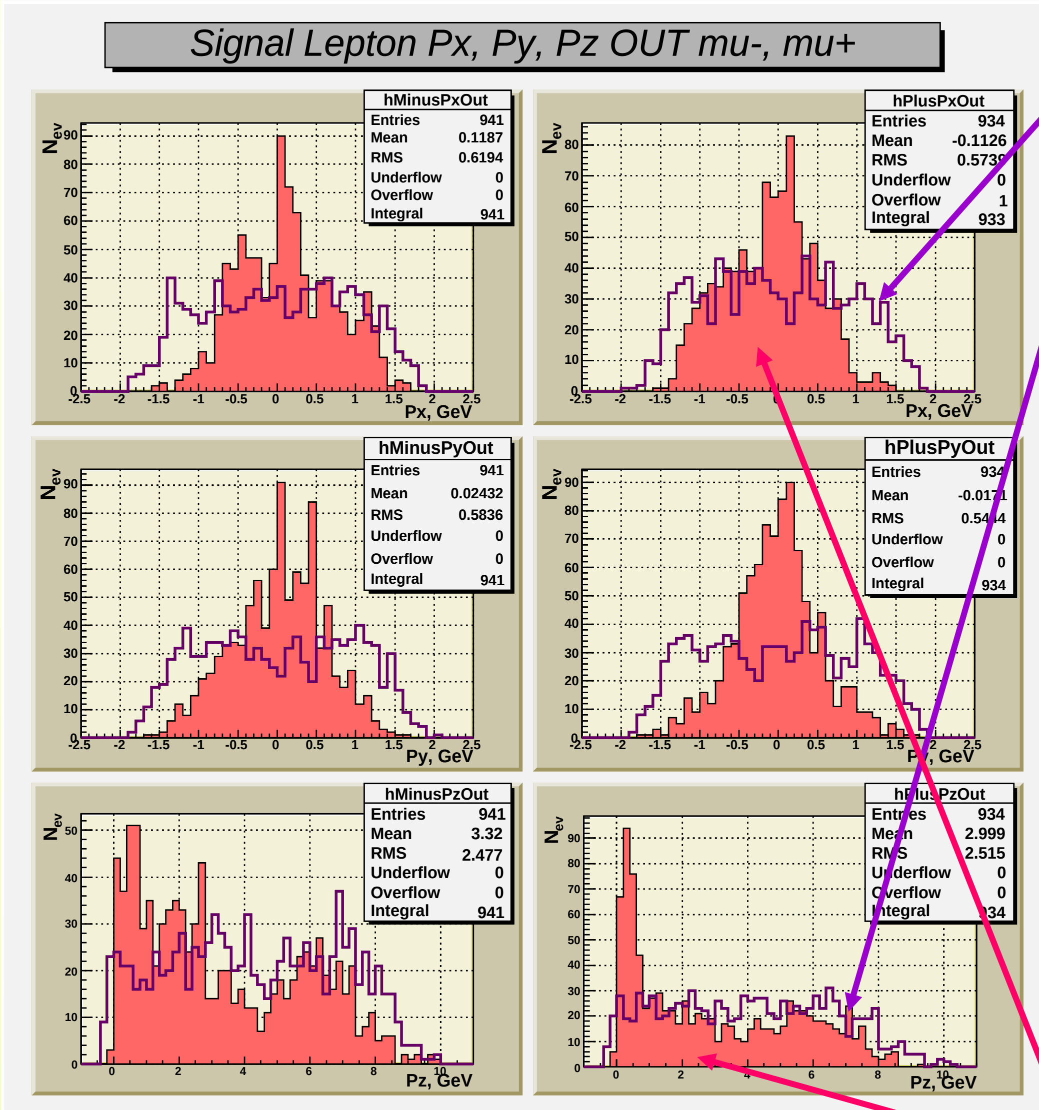
Px^{μ}, Py^{μ}, Pz^{μ} from the last hit in muon system

PYTHIA6.4

Px^{μ}

Py^{μ}

Pz^{μ}



μ^- μ^+

Momenta distributions, obtained in result of full simulation,

in this case is

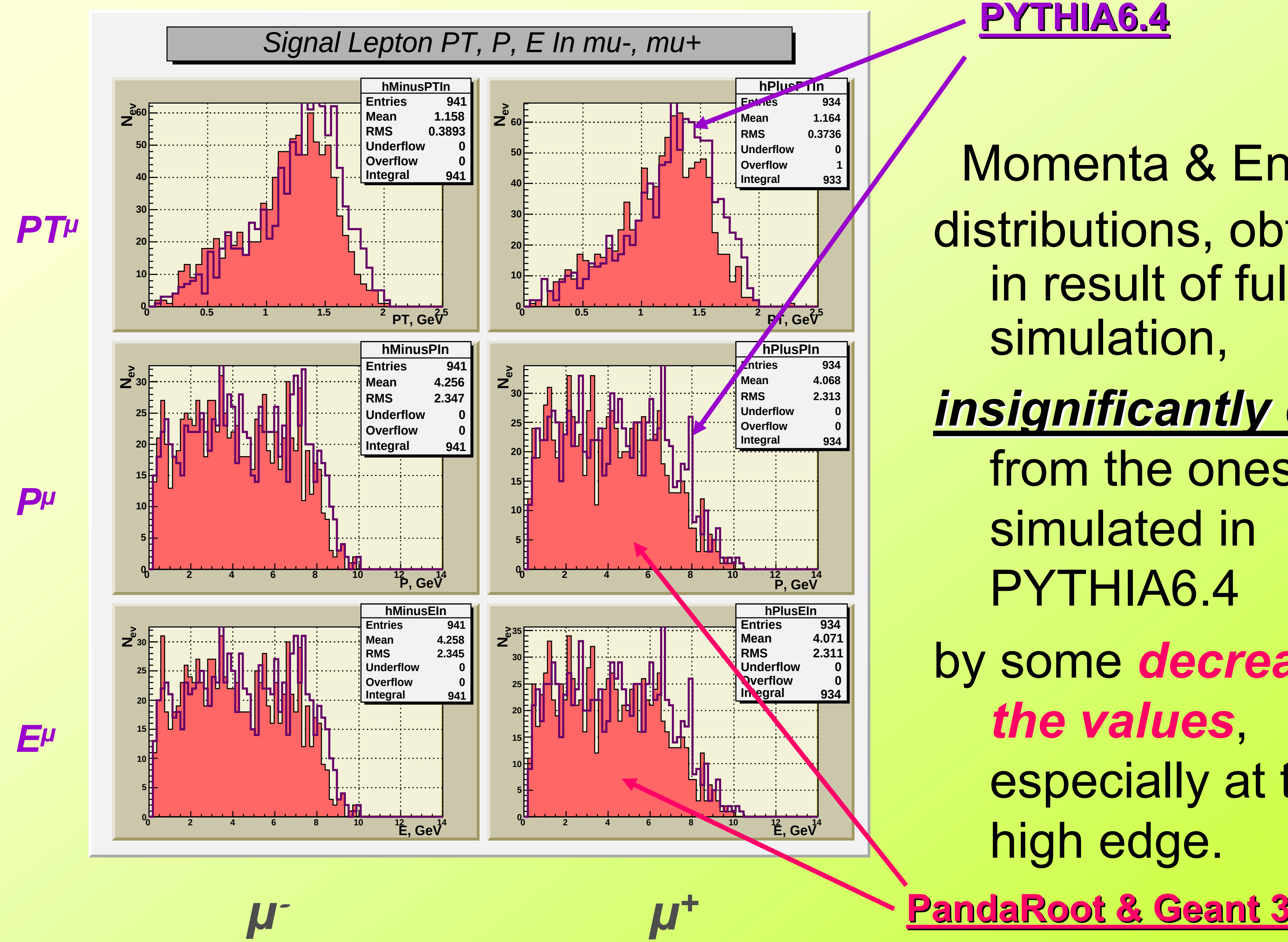
significantly differ in the shape and the values to the ones simulated in PYTHIA6.4, and

show noticeable loss of momentum

(about 0.5-1.5 GeV for each component).

PandaRoot & Geant 3

PT$^{\mu}$, P$^{\mu}$, E$^{\mu}$ from the 1-st hit in muon system



Momenta & Energy distributions, obtained in result of full simulation,

insignificantly differ

from the ones, simulated in PYTHIA6.4

by some ***decrease of the values***, especially at the high edge.

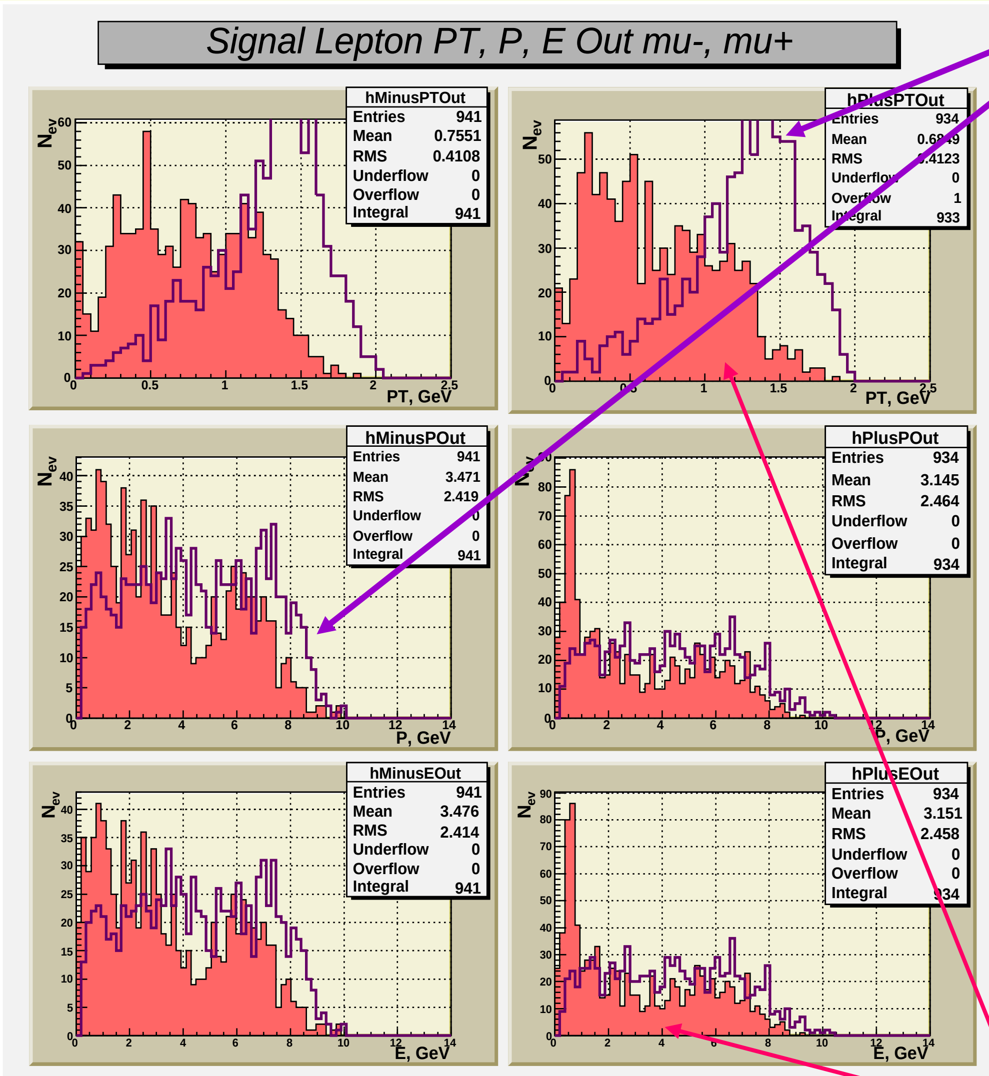
PT$^{\mu}$, P$^{\mu}$, E$^{\mu}$ from the last hit in muon system

PYTHIA6.4

PT$^{\mu}$

P$^{\mu}$

E$^{\mu}$



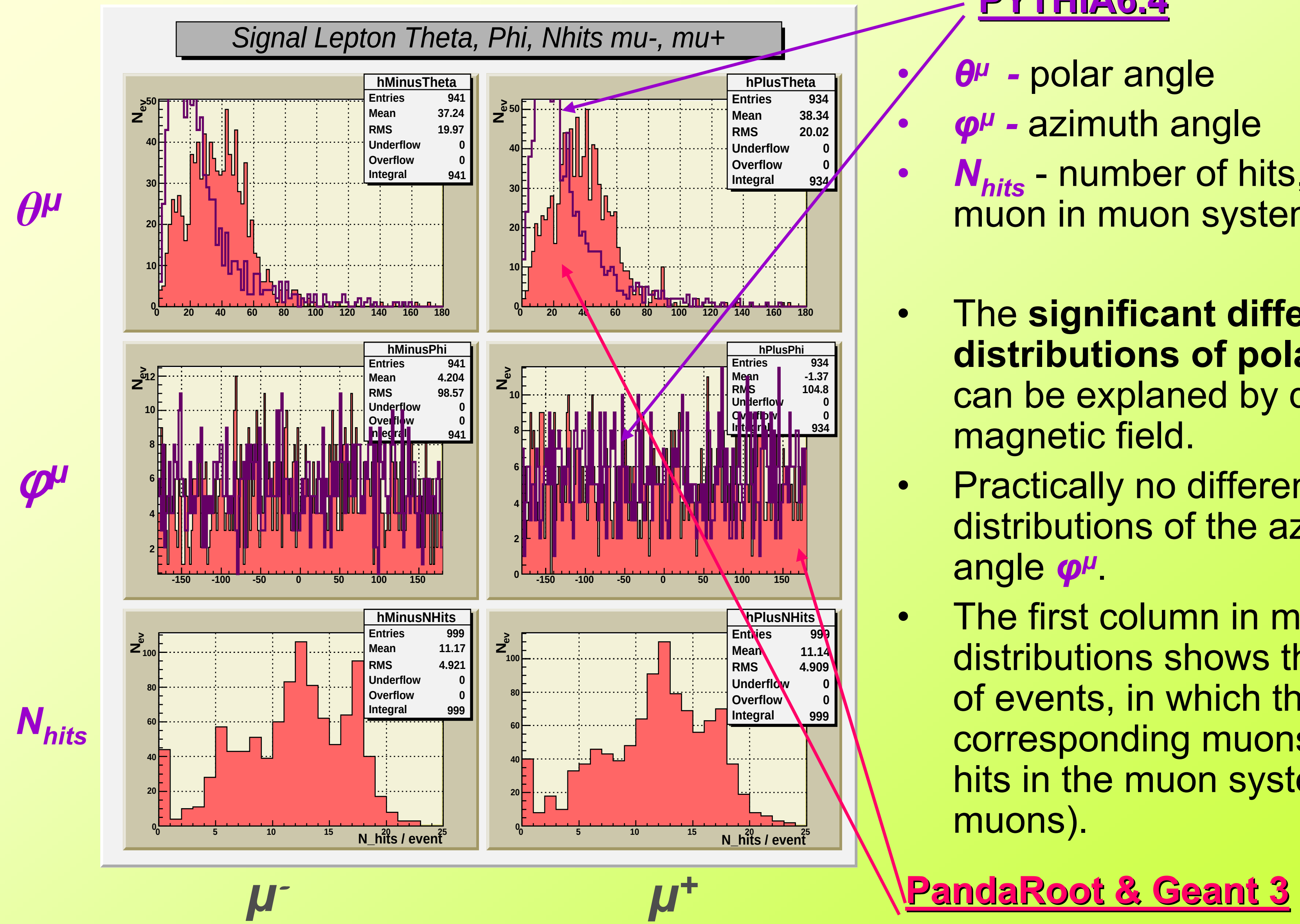
μ^- μ^+

Momenta & Energy distributions, obtained in result of full simulation, in this case is **differ significantly** from the ones, simulated in PYTHIA6.4, and

- **show noticeable loss of momentum & energy** (about 2 GeV) in result of penetrating through the material of the muon system.
- Also, different to PYTHIA, one can see the ***diverse shapes of momentum and energy distributions*** for the cases of positive and negative charges muons.

PandaRoot & Geant 3

Angle θ^{μ}, φ^{μ} distributions and N_{hits} in muon system



- θ^{μ} - polar angle
- φ^{μ} - azimuth angle
- N_{hits} - number of hits, made by muon in muon system per event

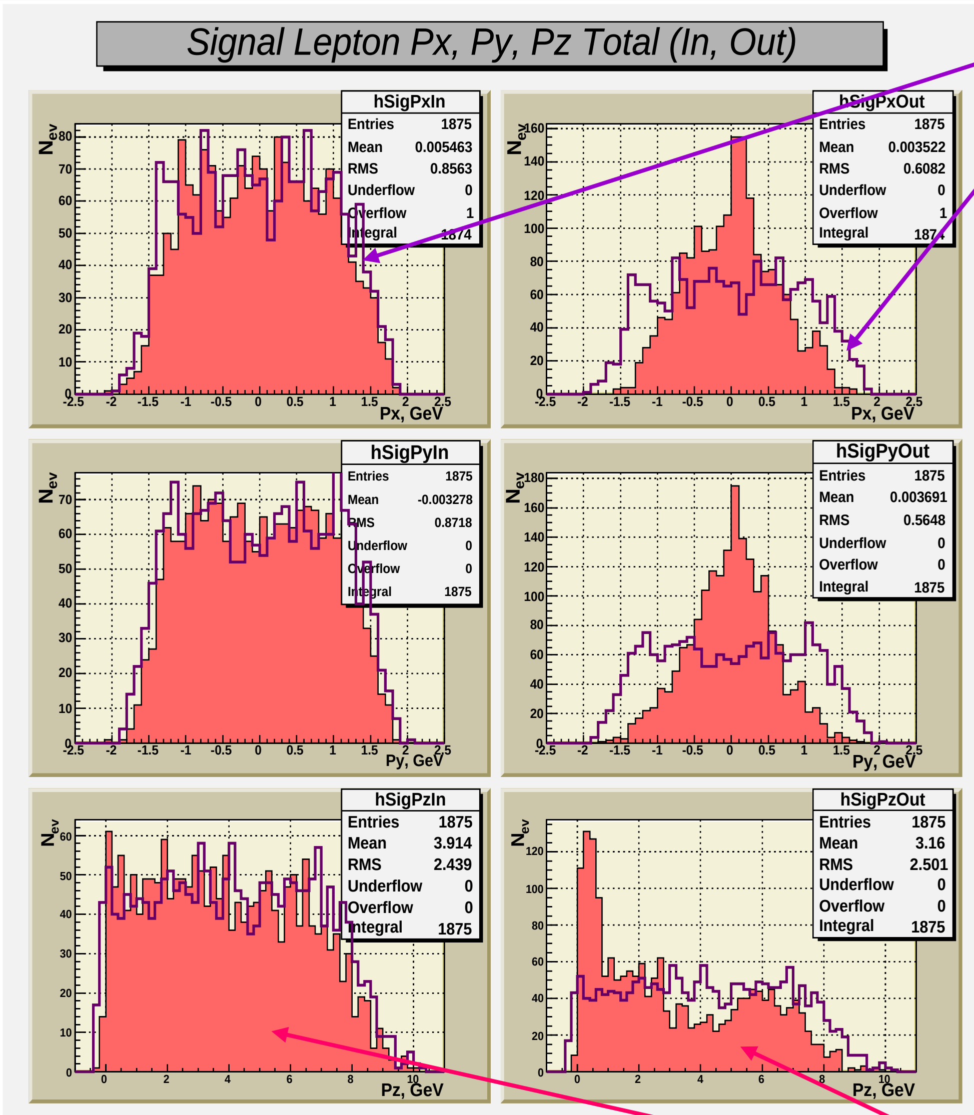
- The **significant difference in distributions of polar angle θ^{μ}** can be explaned by deviation in magnetic field.
- Practically no difference in distributions of the azimuth angle φ^{μ}.
- The first column in muon hits distributions shows the number of events, in which the corresponding muons gave no hits in the muon system (lost muons).

Px^{μ}, Py^{μ}, Pz^{μ} of $(\mu^{+}+\mu^{-})$ from the 1-st & last hit in muon system

Px^{μ}

Py^{μ}

Pz^{μ}



1-st hit *last hit*

PYTHIA6.4

- Like in the case of separate taken muons, the *momenta distributions, obtained in result of full simulation*, **do not much differ** to the ones simulated in PYTHIA6.4 for the **values from the first hit**, exept some loss of quantity, especially at high momenta,

&

- **noticeably differ** to the ones simulated in PYTHIA6.4 in the **case of the last hit**, and show here the noticeable loss of momentum (about 0.5-1.5 GeV for each components).

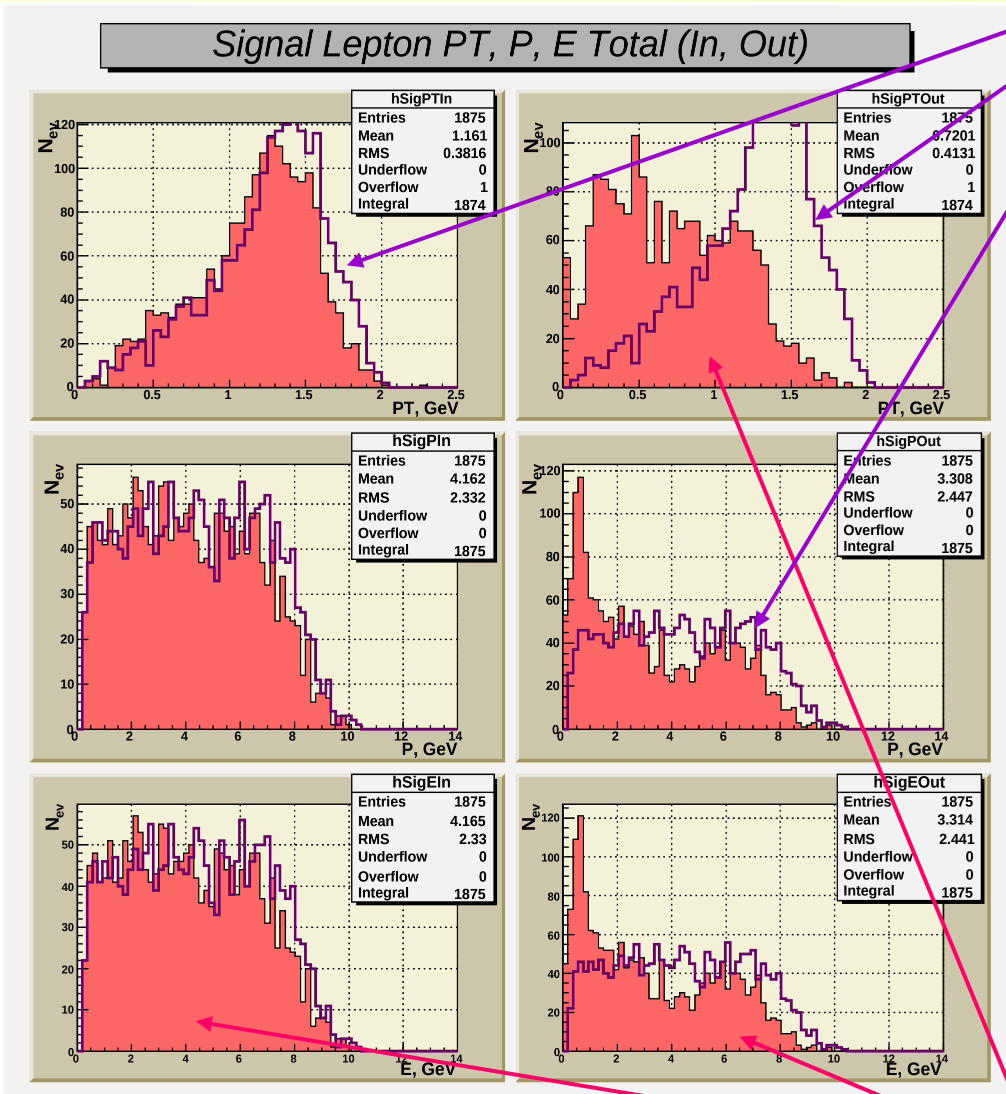
PandaRoot & Geant 3

PT$^{\mu}$, P$^{\mu}$, E$^{\mu}$ of (μ^{+}+μ^{-}) from the 1-st & last hit in muon system

PT$^{\mu}$

P$^{\mu}$

E$^{\mu}$



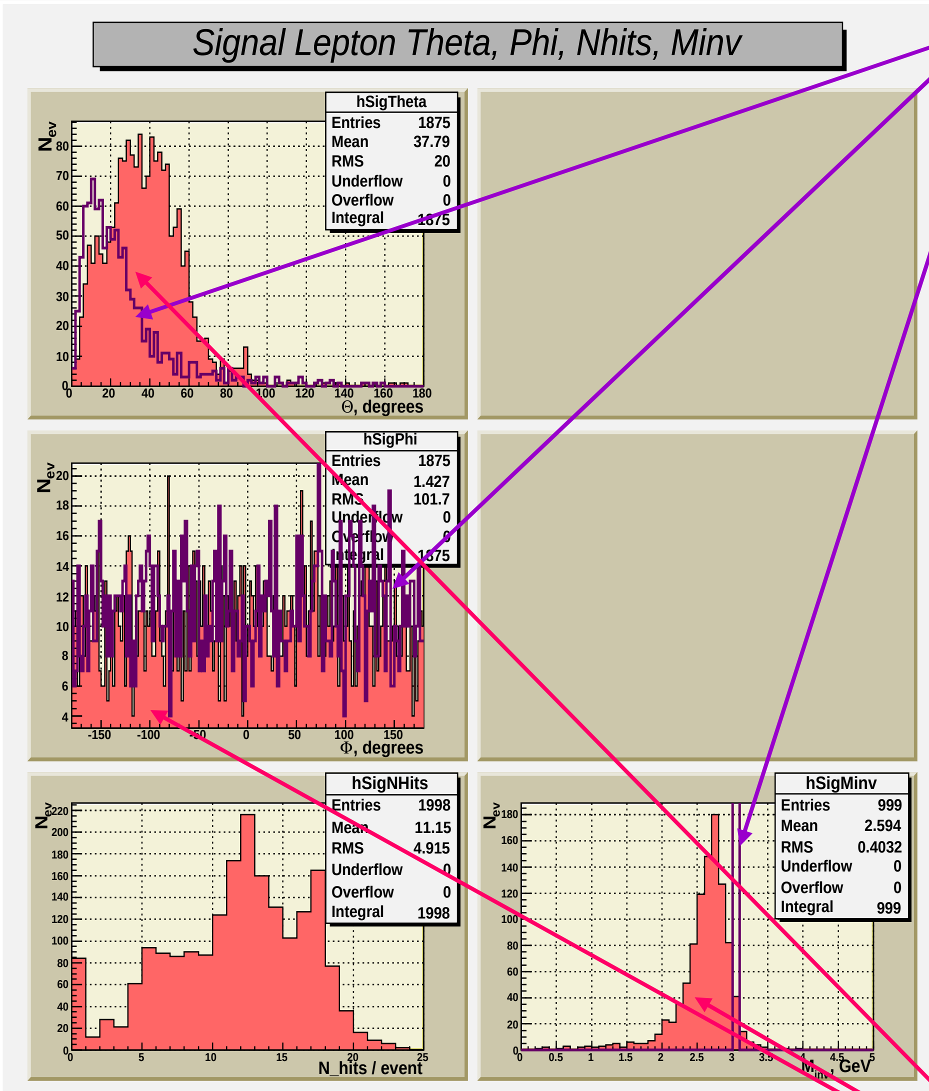
1-st hit *last hit*

PYTHIA6.4

- Like in the case of the muons, taken separately, the ***momenta and energetical distributions*** of the **first hit**, obtained during a full simulation, **do not differ significantly** from the ones simulated in PYTHIA6.4. The differences are, in general, in a small loss of quantity at higher values.
- In the **case of a last hit**, they are **noticeably differ** from the ones, simulated in PYTHIA6.4, and ***show significant loss of momentusm and energy*** (about 2 GeV) as a result of penetrating through the material of the muon system

PandaRoot & Geant 3

Total θ^{μ}, φ^{μ} distributions & N_{hits} in muon system, $M_{inv}(\mu^+,\mu^-)$



θ^{μ}

φ^{μ}

N_{hits}

$M_{inv}(\mu^+,\mu^-)$

PYTHIA6.4

θ^{μ} - polar angle

φ^{μ} - azimuth angle

N_{hits} - number of hits, made by muon in muon system per event

The **significant difference in distributions of polar angle θ^{μ}** can be explaned by deviation in magnetic field.

Practically **no difference** in distributions of the azimuth angle φ^{μ}.

The first column in muon hits distributions shows the number of events, in which the corresponding muons gave no hits in the muon system (lost muons).

Distribution of invariant mass $M_{inv}(\mu^+,\mu^-)$ also **differ** from the initial one, simulated by PYTHIA.

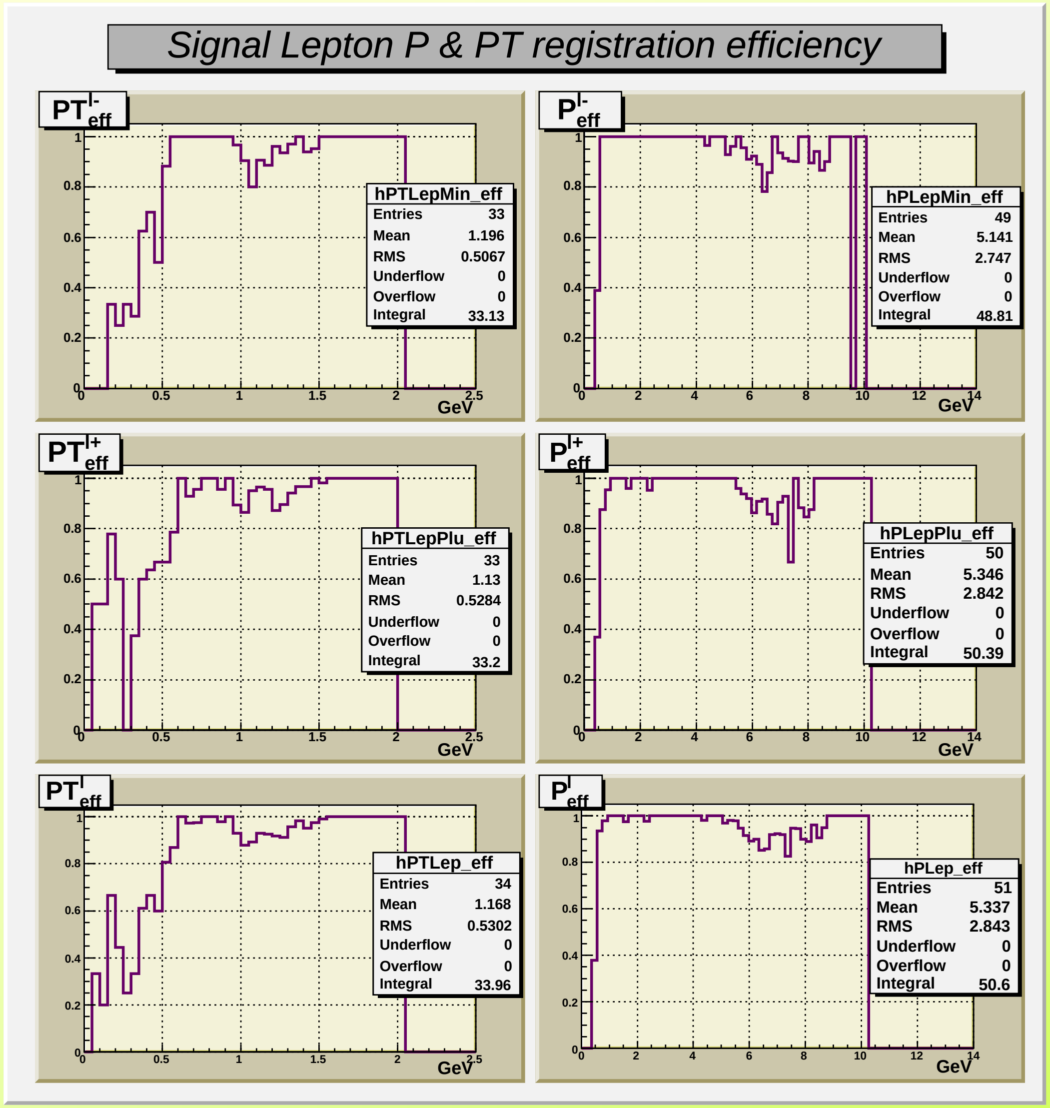
PandaRoot & Geant 3

Signal muon P & PT registration efficiency

μ^-

μ^+

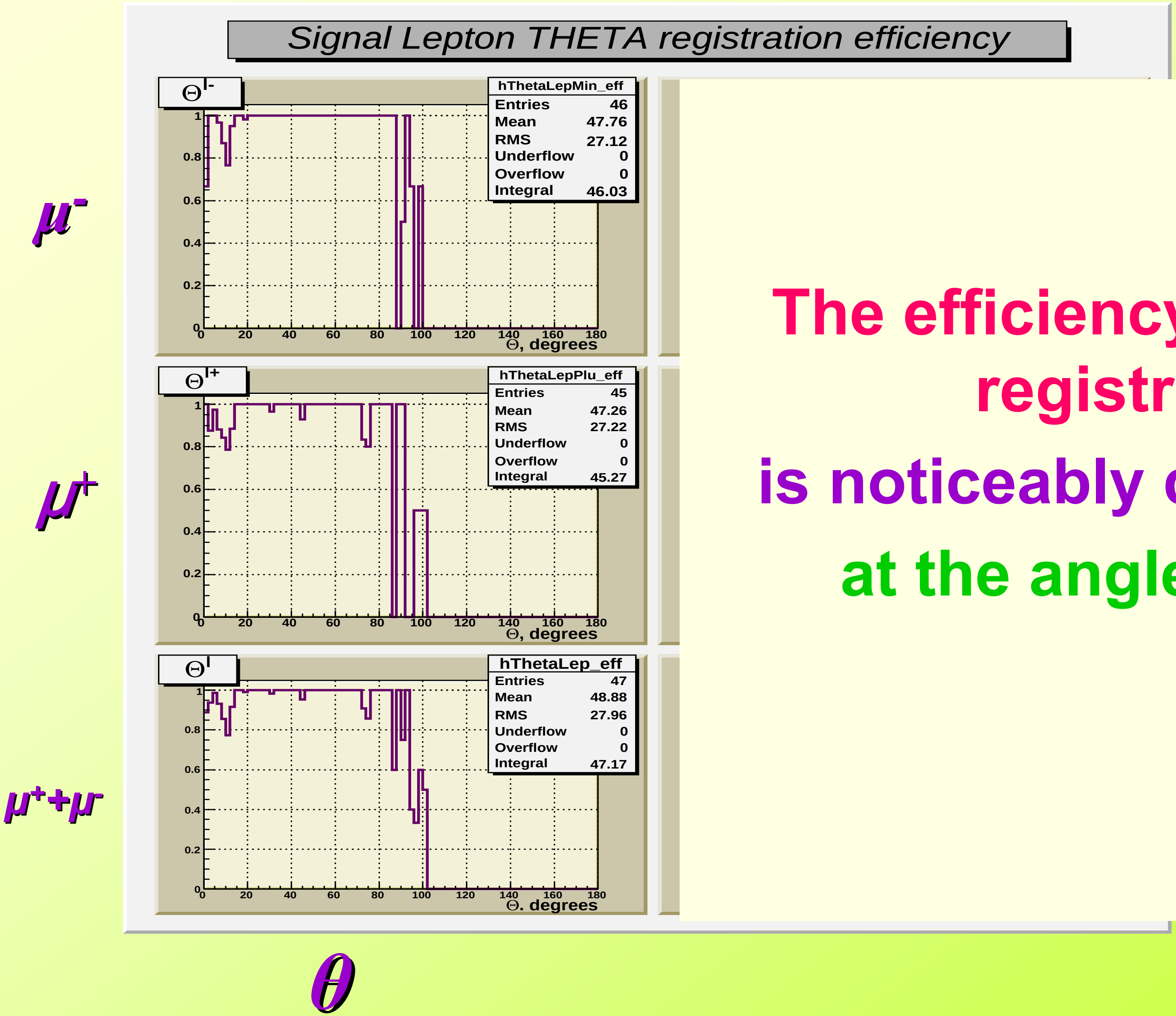
$\mu^+ + \mu^-$



PT ***P***

At very low (<0.5 GeV) **initial momentum and transverse momentum, the efficiency of muon registration** is ***noticeably decreasing***.

Signal muon registration efficiency by polar angle θ

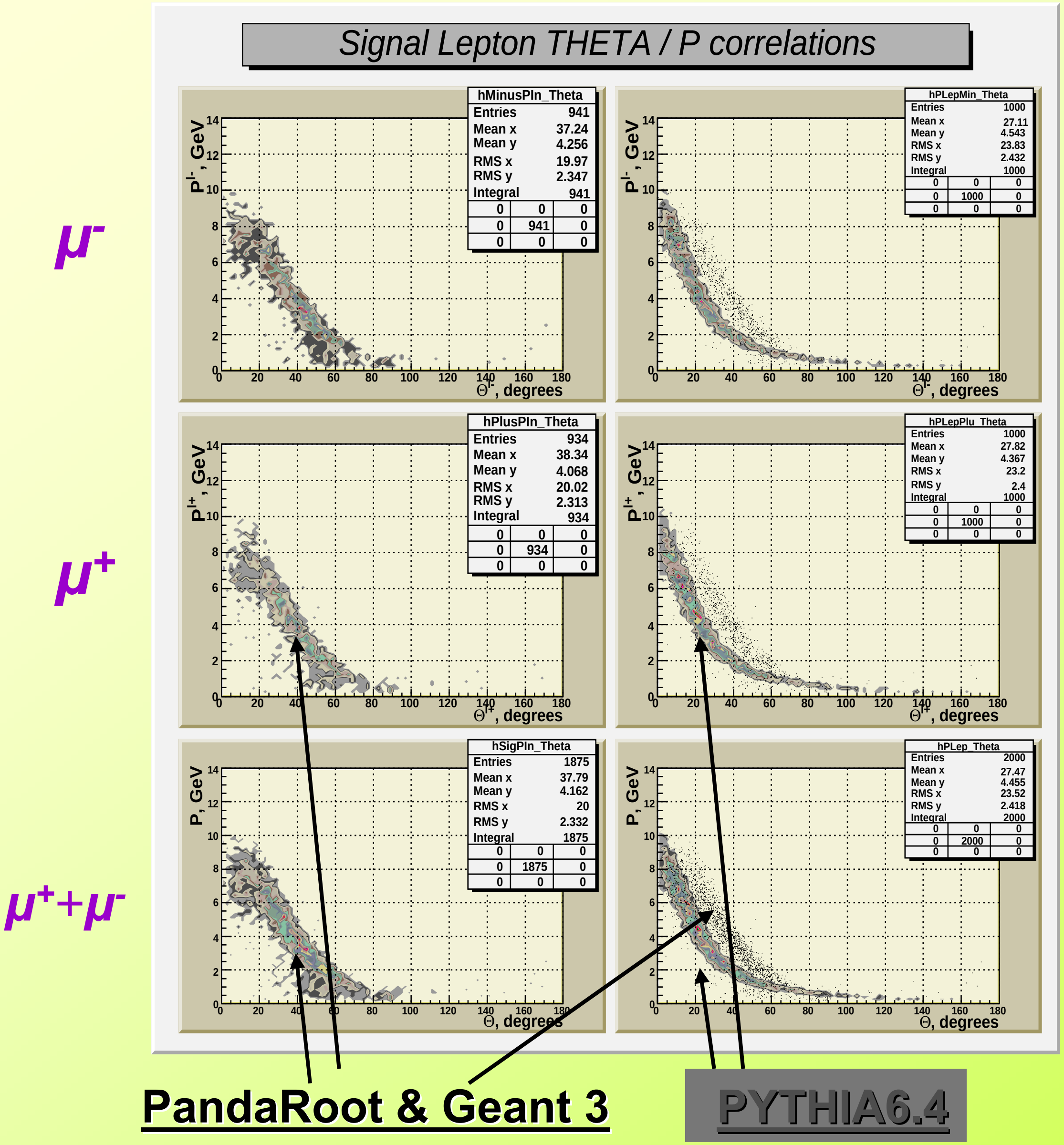


The efficiency of muon registration

is noticeably decreasing

at the angles > 90⁰

Correlation distributions of polar angle θ and momentum P



- *The figures are the* ***projections of 3-D signal muons correlation distributions of*** *polar angle* ***θ and*** *modulus of momentum* ***P*** *(that correspond to the first hit in the muon system):*
- **Left coloumn** presents the results, obtained by the full simulation (PANDARoot and GEANT3).
- **Right coloumn** - the color area presents the results of PYTHIA simulation. The black dots, which correspond to the results, shown in the left column, are superimposed for comparison.
- **As it was already shown before in 2-D figures, due to the magnetic field influence, muons are moving aside to an angle of about 20^0.**
- Also, ***in the case of the muons from J/Ψ decay, one can observe the clear correlation and the tendency of momentum decrease with increase of a polar angle.***