«Status of background study for Drell-Yan process in e+e- mode»

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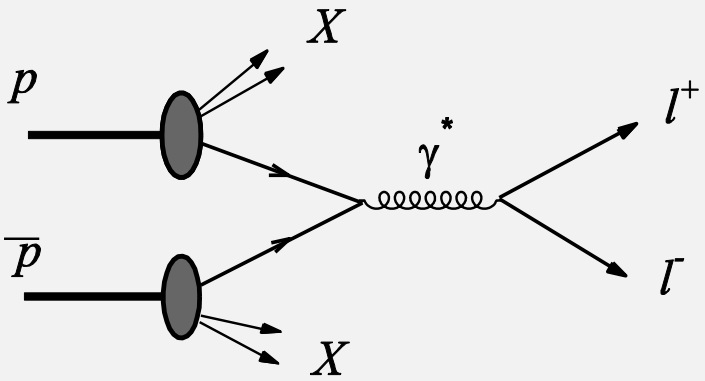
MMT-DY process



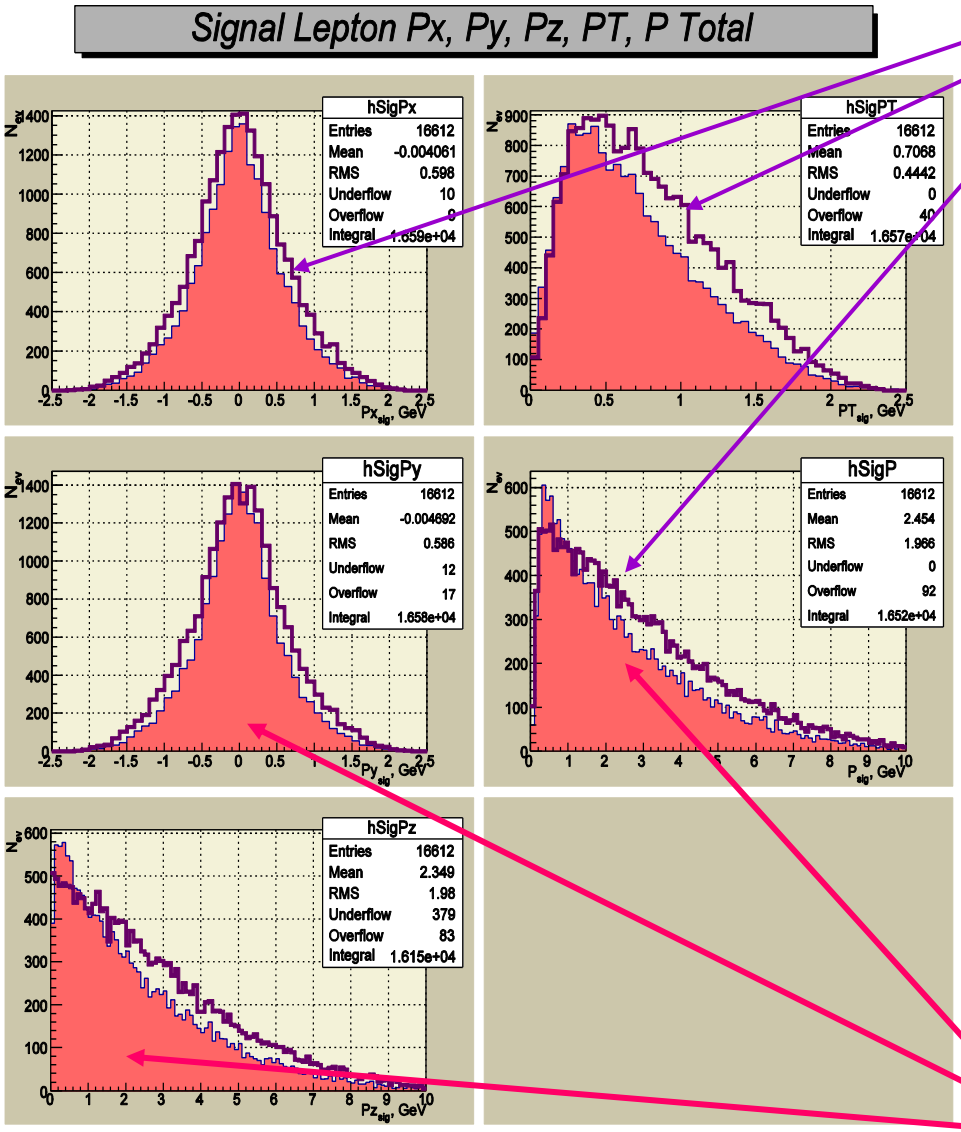
Simulation of electron –positron kinematical characteristics was done for the E_{beam} = 15 GeV (5.474 GeV center-of-mass energy) with use of PandaRoot (oct 14) & Geant 4 (presented by pink histograms) with the set of 100000 signal & 2.000.000 background events generated by Monte-Carlo event generator **PYTHIA6.4.**

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

We can expect to gain a huge sample of about 7×10^6 signal di-lepton events per 1 year (10^7 sec.)

Total Px^e, Py^e, Pz^e, PT^e, P^e of signal ($e^+ + e^-$)

PYTHIA6.4



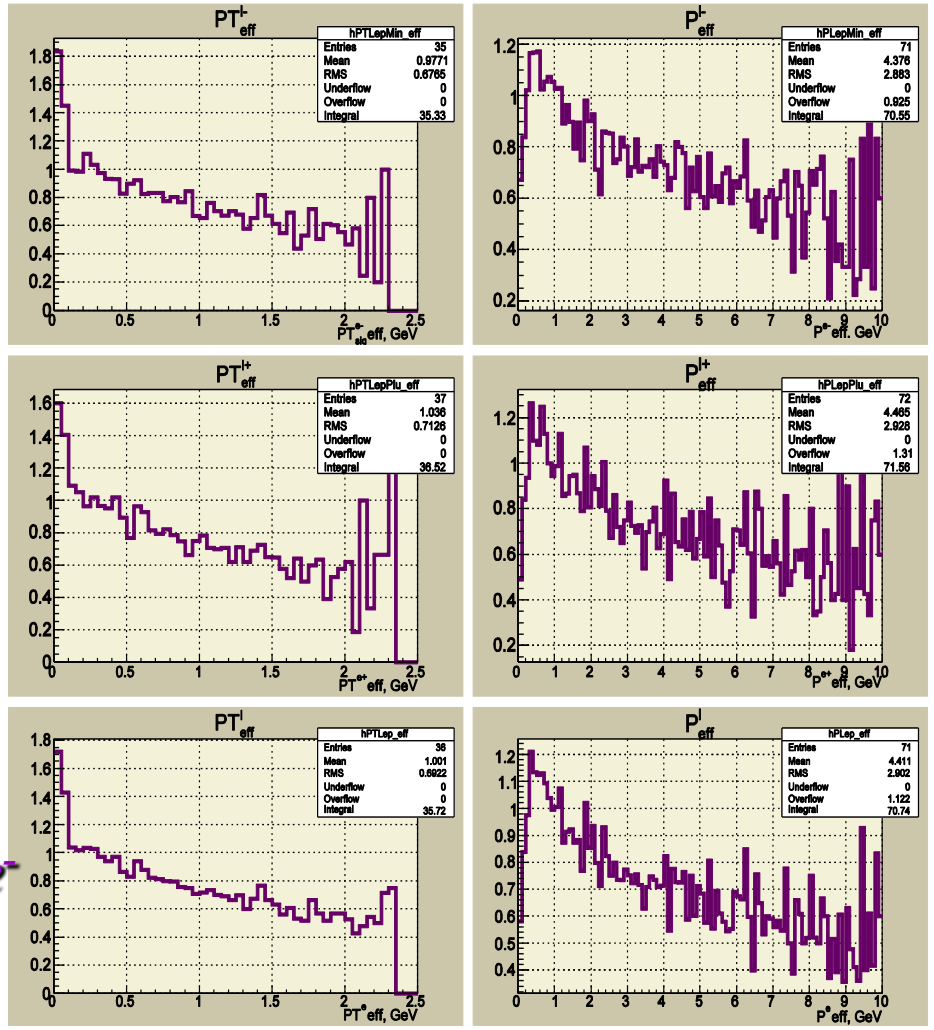
Px^e PT^e Py^e P^e Pz^e

- Like in the case of the e^+/e^-, taken separately:
- Distributions over **Px and Py** are *identical to each other and follow the initial distributions* at PYTHIA level except ***some loss of events***
- Distribution over **PT** shows the **shift** of the spectrum **to the lower values** comparing to PYTHIA one**. At small PT<0.3 GeV** the PandaRoot number of events is **slightly exceed** the initial distributions. At the **higher PT > 0.4 GeV** their number is **reduced significantly**.
- Distributions over the **Pz & P** show the **excess** over PYTHIA results in the region of small **0.2 < Pz,P < 0.8 GeV** and some **reduction** of number of events at the medium values of **1 < Pz,P < 8 GeV**.

PandaRoot & Geant 4

Signal e^+/e^- P & PT registration efficiency

Signal Lepton P & PT registration efficiency



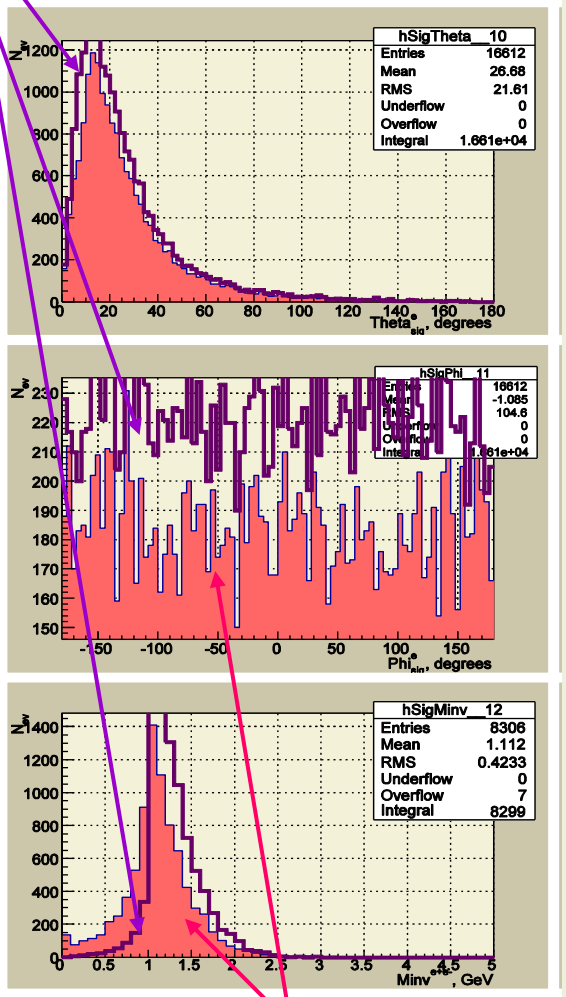
Efficiency of registration *Eff* is calculated as **a ratio of the number of leptons "registered"** in a definite momentum region while modeling *in PandaRoot* **to the ones initially generated** in the same momentum region *in PYTHIA* .

- At the **low values of PT < 0.1 GeV *Eff* >1** may be caused by the production of some additional low energetic e^- in a result of interaction with the detector environment. At the **higher moment values** the registration efficiency *is evenly falls linearly up* to ***Eff* ≈ *0.4-0.6*** and the ***Eff*** spectrum stop at **PT = 2.35 GeV**.
- The values of **e^+/e^- full momentum P *Eff*** *sharply grows* at the values **P < 0.4 GeV** from ***Eff* = *0.6* → *1.2***, that can be explained by the reason described above. Then the distribution curve practically *linearly falls* up to the value of ***Eff* = *0.5***.

Total θ^e, φ^e distributions, $M_{inv}(e^+,e^-)$

PYTHIA6.4

Signal Lepton Theta, Phi, Minv



θ^e

φ^e

M_{inv}

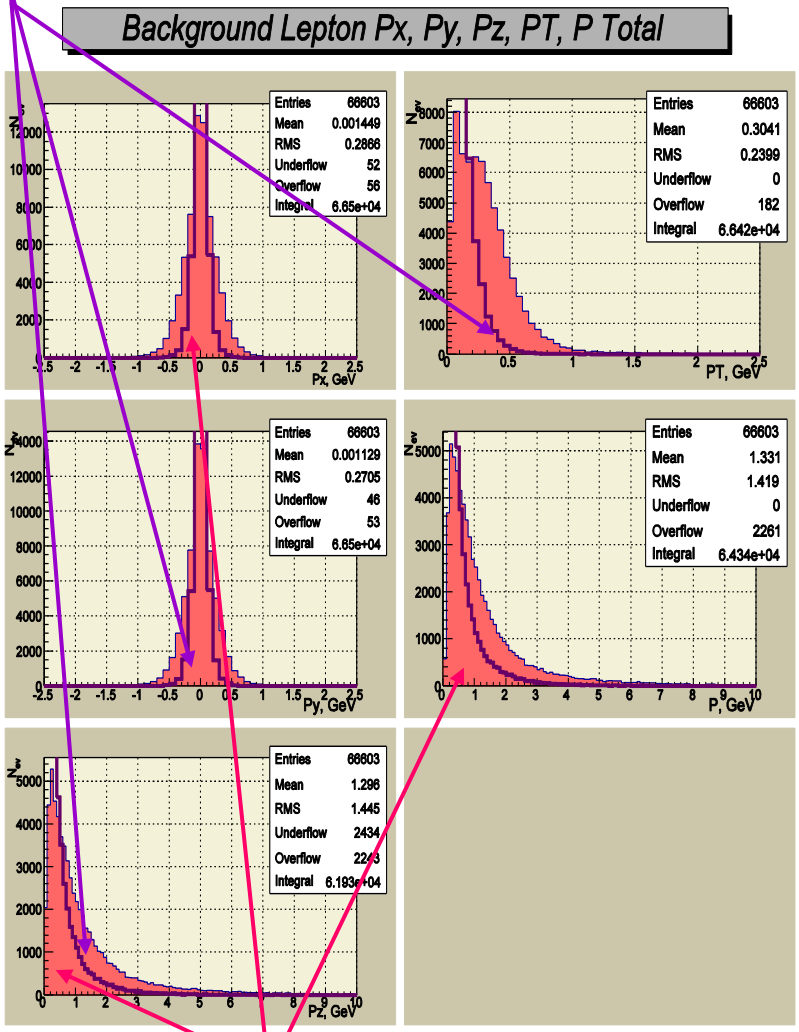
PandaRoot & Geant 4

- ϑ^e - polar angle , φ^e - azimuth angle
- $M_{inv}(e^+,e^-)$ – invariant mass of the e^+,e^- pair
- Both angle distributions repeat the initial distributions obtained in PYTHIA. Distribution over the polar angle θ shows the maximum at the value ≈ 15 °, whereupon sharply falls and goes up to the values ≈120 °. Distribution over the **azimuth angle φ** shows *relatively uniform character*.
- $M_{inv}(e^+,e^-)$ distribution obtained in PandaRoot is shifted to the left for about 0.25 GeV relatively the PYTHIA one. This fact can be explained by some energy loss of electrons in detector environment, that was demonstrated before, as well as by the presence of some small fraction of additional low energetic electrons that are produced in a result of interaction with the medium of detector.

The current plot needs an additional fitting procedure and more detailed study. Nevertheless the peaks of the both distributions (from PandaRoot and PYTHIA) are rather good coincide.

Px^e, Py^e, Pz^e, PT^e, P^e distributions from 10^5 mini-bias BKG events

PYTHIA6.4



PandaRoot & Geant 4

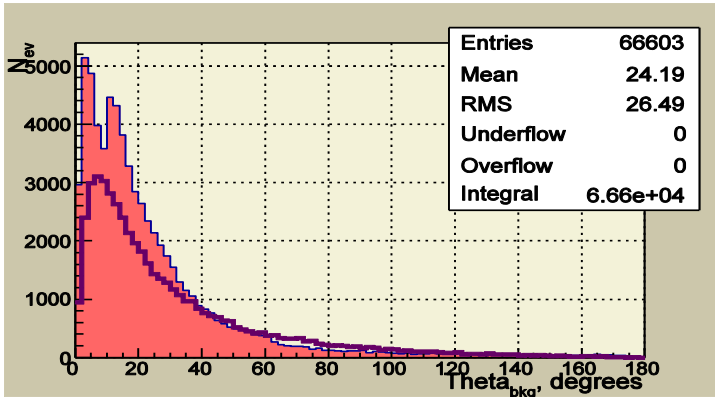
- The final leptons in background processes
  - in PYTHIA come in a result of hadron and meson decays according to Lund fragmentation model,
  - in PandaRoot they are produced from the analogous decays laid in Geant program.

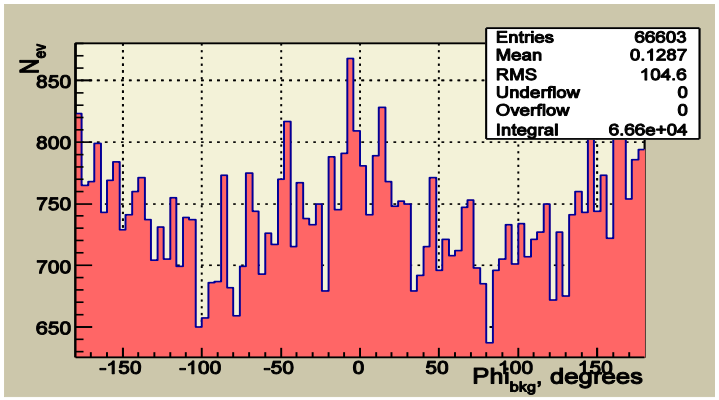
- e^+/e^- produced *from decays* of different particles in detector volume happen to be **more energetic** in comparison with analogous ones simulated in PYTHIA:

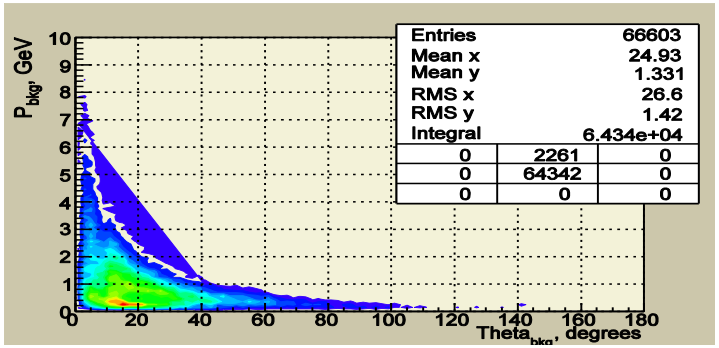
They have ≈ *0.5 GeV higher momentum* in transverse plane (Px, Py and PT),

and ≈ *1 GeV higher momentum in* longitudinal component (Pz and P).

Angle and P^e/ϑ^e BKG distributions







Distributions of the background leptons from PandaRoot over the polar angle θ have the similar shape with electrons/positrons, obtained in PYTHIA simulation, but have some clear excess in direction of 5-35 degrees with the peaks on 3-5 and 9-11 degrees.

Distributions of the background electrons/positrons over the zenith angle ϕ have evidently non uniform character with prevalence in the region of 0 and 180 degrees, as well as with holes close to 80 (-80) and -100 degrees.

Two- dimensional plot of electron/positron distributions over their momentum P and polar angle θ shows the maximum in the region of 0.3 - 0.4 GeV over momentum and 10-21 degrees over the polar angle.

Background suppression criteria

According to predictions of PYTHIA6.4, the total cross section of **e+e- pairs production** process (Drell-Yan) at the energy of antiproton beam E_{beam} = 15 GeV is **4.6 x 10^{-6} mb**. The total cross section for the **background processes (QCD & Minimim-bias, i.e. mainly low-PT and elastic scattering)** is 37.4 mb. Thus the initial ratio of the signal to background is **S/B = 1.23 x 10^{-7}**.

The percentage ratio of events with a certain number of registered electrons (positrons) in event:

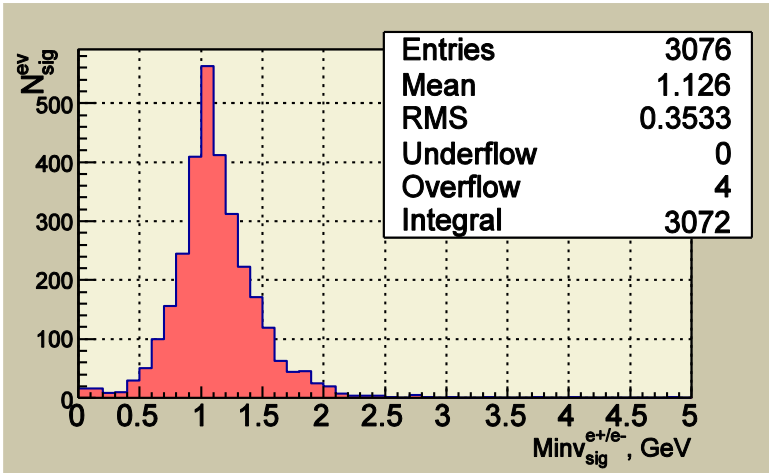
Criterion	Efficiency for background, %	Efficiency for the signal, %	Signal to background ratio S/B
0 electrons	**95.0079**	**27.80**	
1 electron (positron)	**3.58**	**30.33**	
> 1 electrons (positrons)	**0.2462**	**4.34**	
exactly 1 electron + 1 positron	**1.166**	**37.53**	**3.959 x 10^{-6}**
exactly 1 electron & 1 positron with $P^{e+/e-}$ & $PT^{e+/e-}$ > 0.2 GeV	**0.0766**	**30.76**	**4.939 x 10^{-5}**

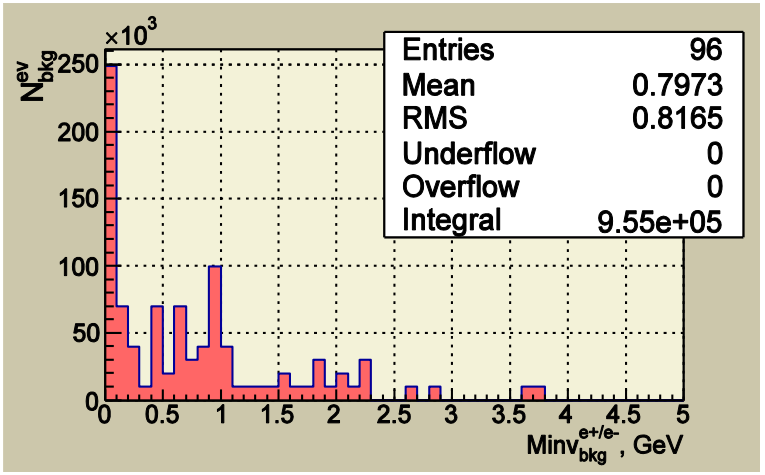
The number of *background events*, including exactly one electron and one positron, is about **1%** of the total number, while in the signal events the **both leptons** are registered in **37% events**, thus initially one signal event corresponds to about 250000 background ones.

Selection criterion by the presence of exactly one electron and positron with full and transverse momenta satisfying the condition $P^{e+/e-}$ & $PT^{e+/e-}$ > 0.2 GeV allows to suppress background additionally for more than 1 order of magnitude.

Selection by the leptons invariant mass

Distributions of $M_{inv}^{e+/e-}$ in the signaling events (left) and background events (right), provided that there are exactly $1e^+$ and $1e^-$ with $P^{e+/e-}$& $PT^{e+/e-} > 0.2$ GeV in event.





The numerical calculation of the efficiency (taken as the ratio of the rest from the selection events to their initial number) of application of this criterion is presented in the table below.

The analysis of the Table shows that **the most effective** is the selection of events with the invariant mass **$M_{inv}^{e+/e-} > 0.7$ GeV**, at the condition of the presence in event of exactly 1e- and 1e+ with $P^{e+/e-}$& $PT^{e+/e-} > 0.2$ GeV. At such conditions the achieved signal to background ratio is **S/B = 1.24 x 10^{-4}**. ***The further strengthening of the cut on the invariant mass doesn't lead to improvement of the signal to background ratio, but strongly reduce the number of the signal events.***

Criterion on $M_{inv}^{e+/e-}$	Efficiency for background, %	Efficiency for the signal, %	Signal to background ratio S/B
$M_{inv}^{e+/e-}$ > **0.0 GeV**	0.0766	30.76	**4.939×10^{-5}**
$M_{inv}^{e+/e-}$ > **0.2 GeV**	0.0475	30.44	**7.882×10^{-5}**
$M_{inv}^{e+/e-}$ > **0.3 GeV**	0.0430	30.35	**8.681×10^{-5}**
$M_{inv}^{e+/e-}$ > **0.4 GeV**	0.0385	30.25	**9.664×10^{-5}**
$M_{inv}^{e+/e-}$ > **0.5 GeV**	0.0345	29.96	**1.068×10^{-4}**
$M_{inv}^{e+/e-}$ > **0.6 GeV**	0.0295	29.45	**1.228×10^{-4}**
$M_{inv}^{e+/e-}$ > 0.7 GeV	**0.0282**	**28.45**	**1.241×10^{-4}**
$M_{inv}^{e+/e-}$ > **0.8 GeV**	0.0275	26.89	**1.202×10^{-4}**
$M_{inv}^{e+/e-}$ > **0.9 GeV**	0.0267	24.44	**1.126×10^{-4}**
$M_{inv}^{e+/e-}$ > **1.0 GeV**	0.0237	20.34	**1.055×10^{-4}**
$M_{inv}^{e+/e-}$ > **1.1 GeV**	0.0200	14.71	**9.046×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.2 GeV**	0.0178	10.59	**7.317×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.3 GeV**	0.0158	7.47	**5.815×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.4 GeV**	0.0147	5.24	**4.384×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.5 GeV**	0.0133	3.53	**3.264×10^{-5}**

Criterion on $M_{inv}^{e+/e-}$	Efficiency for background, %	Efficiency for the signal, %	Signal to background ratio S/B
$M_{inv}^{e+/e-}$ > **1.6 GeV**	0.0121	2.34	**2.378×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.7 GeV**	0.0112	1.71	**1.878×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.8 GeV**	0.0103	1.27	**1.516×10^{-5}**
$M_{inv}^{e+/e-}$ > **1.9 GeV**	0.0091	0.81	**1.094×10^{-5}**
$M_{inv}^{e+/e-}$ > **2.0 GeV**	0.0069	0.56	**9.982×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.1 GeV**	0.0062	0.36	**7.142×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.2 GeV**	0.0053	0.28	**6.498×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.3 GeV**	0.0045	0.24	**6.560×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.4 GeV**	0.0042	0.20	**5.857×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.5 GeV**	0.0037	0.16	**5.318×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.6 GeV**	0.0034	0.15	**5.426×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.7 GeV**	0.0032	0.14	**5.381×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.8 GeV**	0.0028	0.11	**4.832×10^{-6}**
$M_{inv}^{e+/e-}$ > **2.9 GeV**	0.0025	0.10	**4.919×10^{-6}**
$M_{inv}^{e+/e-}$ > **3.0 GeV**	0.0023	0.09	**4.813×10^{-6}**

Leptons isolation criterion

- The already considered criteria allow to achieve the background suppression for more than **2 orders of magnitude**, that nevertheless is not enough for the signal separation (and less than it was forecasted before at the level of fast simulation by PYTHIA and full simulation at the earlier version of PandaRoot at lower statistics).

- In the case of e+e- pairs production, the calculations have shown that in the signal *events the leptons are placed in average in the* ***cone R = 0.2 – 0.3*** respect to each other. Thus, the selection criterion by the summarized energy $\mathbf{E_{sum} < 0.25\ GeV}$ of all the charged particles inside the cone of the radius $R = \sqrt{\Delta\eta^2+\Delta\phi^2} > 0.3$ in $\eta - \phi$ space around the momentum direction of the signal leptons, *that works good and widely used in the case of single signal particles production,* **is not applicable here.**

- Also, *the selection of leptons in the cones of the radius* **R = 0.2 – 0.3** *kills the part of the signal events.* The results of an additional selection by the isolation criterion at different values of ***R*** and ***invariant mass*** of the leptons pair, with the calculation of the combined *efficiency of the considered above criteria (taken as the ratio of the rest from the selection events to their initial number)* are presented in the Table below.

Isolation criterion	Criterion	Efficiency for background, %	Efficiency for the signal, %	Signal to background ratio S/B
R = 0.1	$M_{inv}^{e+/e-}$ > **0.7 GeV**	0.02575	28.10	**1.342×10^{-4}**
	$M_{inv}^{e+/e-}$ > 0.8 GeV	**0.02300**	**26.60**	**1.422×10^{-4}**
	$M_{inv}^{e+/e-}$ > **0.9 GeV**	0.02125	24.19	**1.400×10^{-4}**
	$M_{inv}^{e+/e-}$ > **1.0 GeV**	0.01975	20.23	**1.260×10^{-4}**
	$M_{inv}^{e+/e-}$ > **1.1 GeV**	0.01625	14.69	**1.112×10^{-4}**
R = 0.2	$M_{inv}^{e+/e-}$ > **0.7 GeV**	0.01475	13.35	**1.113×10^{-4}**
	$M_{inv}^{e+/e-}$ > **0.8 GeV**	0.01450	12.98	**1.101×10^{-4}**
	$M_{inv}^{e+/e-}$ > **0.9 GeV**	0.01425	12.19	**1.052×10^{-4}**
	$M_{inv}^{e+/e-}$ > **1.0 GeV**	0.01350	10.82	**9.859×10^{-5}**
	$M_{inv}^{e+/e-}$ > **1.1 GeV**	0.01150	8.86	**9.476×10^{-5}**
R = 0.3	$M_{inv}^{e+/e-}$ > **0.7 GeV**	0.00650	2.16	**4.087×10^{-5}**
	$M_{inv}^{e+/e-}$ > **0.8 GeV**	0.00625	2.10	**4.132×10^{-5}**
	$M_{inv}^{e+/e-}$ > **0.9 GeV**	0.00600	2.01	**4.120×10^{-5}**
	$M_{inv}^{e+/e-}$ > **1.0 GeV**	0.00550	1.88	**4.104×10^{-5}**
	$M_{inv}^{e+/e-}$ > **1.1 GeV**	0.00500	1.59	**3.911×10^{-5}**

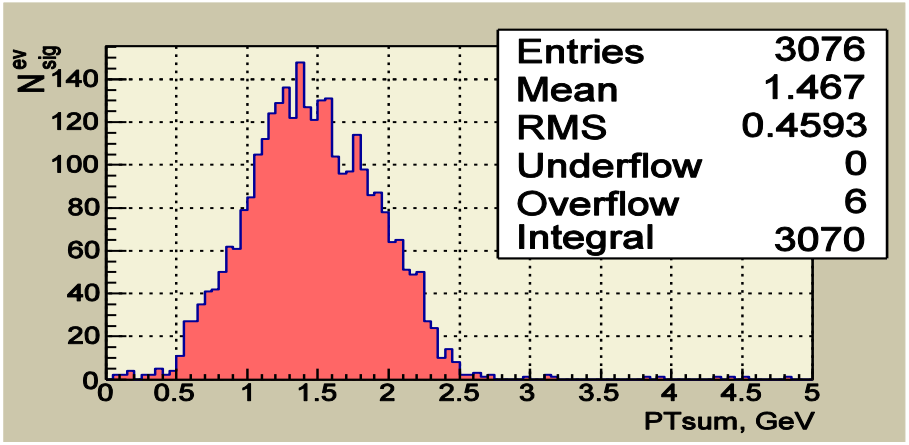
- Analysis of the table indicates that, as it was previously noted, the increase of the values of the invariant mass selection above **$M_{inv}^{e+/e-}$ > 1.0 GeV**, *leads to a significant reduction in the number of signaling events*, which in its turn **reduces the signal to background ratio S/B**.

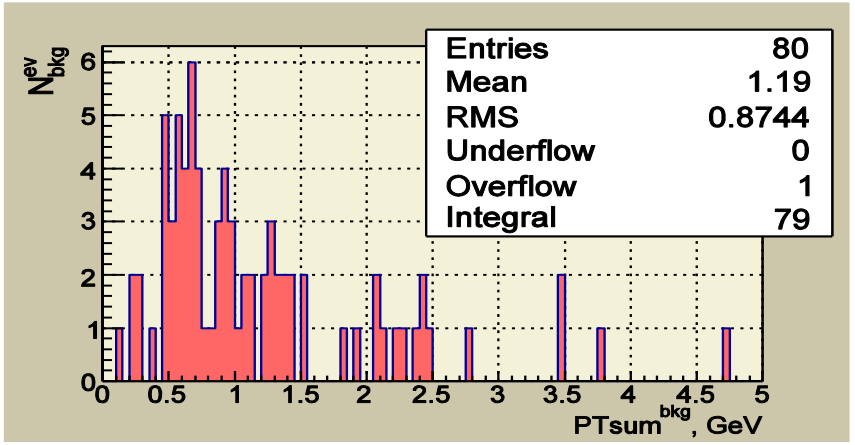
- Similarly, **increasing the radius of the cone** around the electron (positron), where charged particles are summarizing, also, along with a decrease of the background, *leads to much visible decrease in the number of signaling events,* which also **leads to a decrease in the signal to background ratio S/B.**

Thus the most efficient and less affecting the signal events is the criterion of selection by the isolation in the cone of radius R = 0.1 and invariant mass of the lepton pair $M_{inv}^{e+/e-}$ > 0.8 GeV (at the condition of the presence of exactly one electron and one positron with $P^{e+/e-}$ & $PT^{e+/e-}$ > 0.2 GeV in event).

Achieved with use of such the criteria signal to background ratio is **S/B = 1.42×10^{-4}**, which **is also not enough for the signal allocation** and *improve the previous result* only in **1.14 times**.

Separation by $PT_{sum} = PT^{e+} + PT^{e-}$





One can suppose that the separation of signal and background events can be affected by the *criterion on the transverse momentum*, in particular, on the **sum of transverse momentum of the two leptons in the pair** (especially for the values $PT_{sum}^{e+/e-} > 2$ GeV).

Indeed, the visual study of distributions of the sum of transverse momentum of the signal leptons in the pairs (left) and leptons in background pairs (right) after the selection criterion of having exactly 1e- and 1e+ in event with $P^{e+/e-}$& $PT^{e+/e-} > 0.2$ GeV, presented in Figure, shows that for the ***signal leptons*** the summarized transverse momentum for the most part is placed in the range of $0.6 \text{ GeV} < PT_{sum}^{e+/e-} < 2.3$ GeV with a maximum at 1.1-1.6 GeV.

At the same time, for the ***background leptons*** the summarized transverse momentum is mostly placed in the range of $0.5 \text{ GeV} < PT_{sum}^{e+/e-} < 1.5$ GeV with a maximum at 0.5-0.7 GeV.

Therefore, it can be assumed that the restriction on the summarized transverse momentum $PT_{sum}^{e+/e-} >$ 0.7-1.0 GeV may *slightly improve* the signal to background ratio. However, selection for the values $PT_{sum}^{e+/e-} > 2$ GeV *will definitely suppress the most part of the signal.*

Selection by the summarized transverse momentum $PT_{sum}^{e+/e-}$ of lepton pair,
at the condition of a presence in event of exactly 1e- and 1e+ with $P^{e+/e-}$ & $PT^{e+/e-} > 0.2$ GeV
and their invariant mass $M_{inv}^{e+/e-} > 0.7$ GeV

Summarized transverse momentum $PT_{sum}^{e+/e-}$	**Efficiency for background, %**	**Efficiency for the signal, %**	**Signal to background ratio S/B**
$PT_{sum}^{e+/e-} > 0.7$ GeV	0.0280	28.10	1.234×10^{-4}
$PT_{sum}^{e+/e-} > 0.8$ GeV	0.0267	27.56	1.269×10^{-4}
$PT_{sum}^{e+/e-} > 0.9$ GeV	0.0245	26.66	1.338×10^{-4}
$PT_{sum}^{e+/e-} > 1.0$ GeV	0.0225	25.46	1.392×10^{-4}
$PT_{sum}^{e+/e-} > 1.1$ GeV	0.0205	23.76	1.425×10^{-4}
$PT_{sum}^{e+/e-} > 1.2$ GeV	**0.0182**	**21.55**	**1.456×10^{-4}**
$PT_{sum}^{e+/e-} > 1.3$ GeV	0.0170	18.99	1.374×10^{-4}
$PT_{sum}^{e+/e-} > 1.4$ GeV	0.0162	16.38	1.243×10^{-4}
$PT_{sum}^{e+/e-} > 1.5$ GeV	0.0152	13.95	1.129×10^{-4}
$PT_{sum}^{e+/e-} > 1.6$ GeV	0.0140	11.40	1.001×10^{-4}
$PT_{sum}^{e+/e-} > 1.7$ GeV	0.0127	9.43	9.132×10^{-5}
$PT_{sum}^{e+/e-} > 1.8$ GeV	0.0112	7.34	8.060×10^{-5}
$PT_{sum}^{e+/e-} > 1.9$ GeV	0.0105	5.50	6.442×10^{-5}

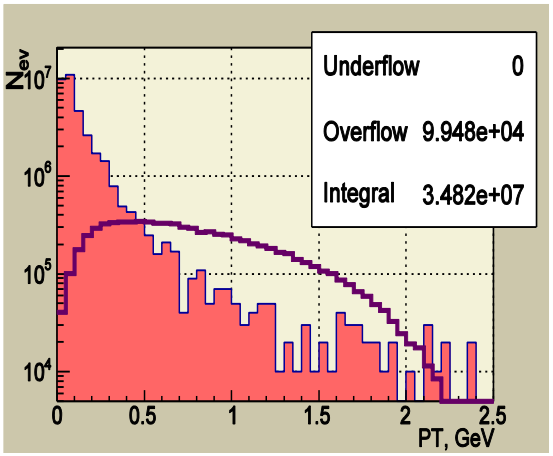
Summarized transverse momentum $PT_{sum}^{e+/e-}$	Efficiency for background, %	Efficiency for the signal, %	Signal to background ratio S/B
$PT_{sum}^{e+/e-} > 2.0$ GeV	0.0100	3.86	4.747×10^{-5}
$PT_{sum}^{e+/e-} > 2.1$ GeV	0.0080	2.57	3.951×10^{-5}
$PT_{sum}^{e+/e-} > 2.2$ GeV	0.0075	1.57	2.575×10^{-5}
$PT_{sum}^{e+/e-} > 2.3$ GeV	0.0070	0.80	1.405×10^{-5}
$PT_{sum}^{e+/e-} > 2.4$ GeV	0.0065	0.46	8.704×10^{-6}
$PT_{sum}^{e+/e-} > 2.5$ GeV	0.0060	0.20	4.099×10^{-6}

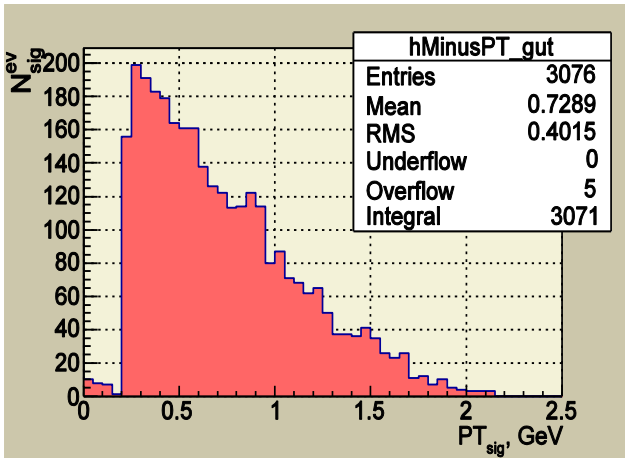
The analysis of the Table shows that the **maximum ratio of signal to background** **S/B = 1.45×10^{-4}** is achieved by the limit **$PT_{sum}^{e+/e-} > 1.2$ GeV**, which is ***only slightly more than the one achieved using the criterion of isolation***.

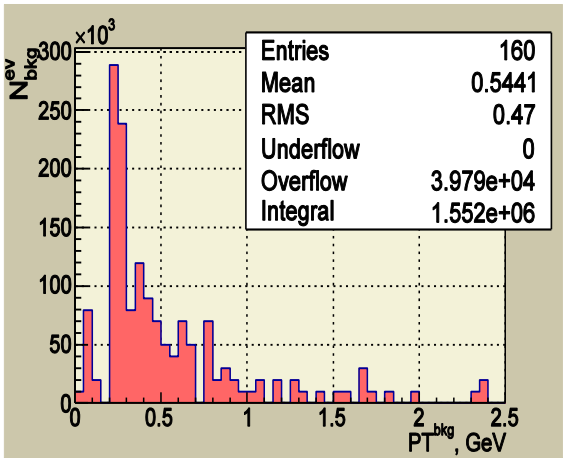
The table also clearly shows that the *further strengthening* of the criterion on summarized transverse momentum does not lead to an improvement of the signal to background ratio, but leads to increased suppression of the signal.

Limitations on the transverse momenta of the both leptons

Comparative initial distribution of signal (purple) and **background (pink)** leptons over their transverse momentum $PT^{e+/e-}$ **(left).** $PT^{e+/e-}$ distributions of individual leptons in **signaling events (center)** and **background events (right),** at the condition of a presence in event of exactly **1e-and 1e+** with $P^{e+/e-}$**&** $PT^{e+/e-}$ **> 0.2 GeV** and their invariant mass $M_{inv}^{e+/e-}$ **> 0.7 GeV**







At the value $PT^{e+/e-}$ **< 0.5 GeV**, the *contribution of background leptons significantly (by more than an order of magnitude) exceeds the signal ones*. After the point of 0.5 GeV occurs the fracture, and the *amount of background leptons is reducing compare the signal ones* at the same values of PT, although the background leptons even overlap the area in PT, covered by signal leptons.

A similar picture can be seen on the distribution of the signal leptons (on the middle histogram)and **background ones on the histogram (on the right)** with account of the cross sections, and after the application of restrictions on the invariant mass $M_{inv}^{e+/e-} > 0.7$ *GeV and* $P^{e+/e-}$*&* $PT^{e+/e-} > 0.2$ *GeV*.

We can see that the restriction on the transverse momentum of leptons $PT^{e+/e-}$ > 0.5 GeV could improve the ratio S/B of signal to background. Analysis of the effectiveness of restrictions on the transverse momentum imposed simultaneously on both leptons are given in Table.

Selection by the PT^{e+} & PT^{e-} of leptons in a pair (at the condition of the presence in event exactly 1e- and 1e+ with $P^{e+/e-}$ & $PT^{e+/e-}$ > 0.2 GeV and their invariant mass $M_{inv}^{e+/e-}$ > 0.7 GeV)

Transverse momenta PT^{e+} & PT^{e-}	Efficiency for background, %	Efficiency for the signal, %	Signal to background ratio S/B
PT^{e+} & PT^{e-} > 0.3 GeV	0.0215	23.17	1.325×10^{-4}
PT^{e+} & PT^{e-} > 0.4 GeV	0.0150	16.79	1.377×10^{-4}
PT^{e+} & PT^{e-} > 0.5 GeV	0.0097	11.16	1.415×10^{-4}
PT^{e+} & PT^{e-} > 0.6 GeV	**0.0060**	**7.01**	**1.437×10^{-4}**
PT^{e+} & PT^{e-} > 0.7 GeV	0.0052	3.95	9.343×10^{-5}
PT^{e+} & PT^{e-} > 0.8 GeV	0.0027	2.18	9.931×10^{-5}
PT^{e+} & PT^{e-} > 0.9 GeV	0.0025	0.99	4.870×10^{-5}
PT^{e+} & PT^{e-} > 1.0 GeV	0.0022	0.39	2.180×10^{-5}
PT^{e+} & PT^{e-} > 1.1 GeV	0.0020	0.12	7.379×10^{-6}
PT^{e+} & PT^{e-} > 1.2 GeV	0.0019	0.04	2.589×10^{-7}
PT^{e+} & PT^{e-} > 1.3 GeV	0.0017	0.03	2.170×10^{-7}
PT^{e+} & PT^{e-} > 1.4 GeV	0.0015	0.02	1.639×10^{-7}

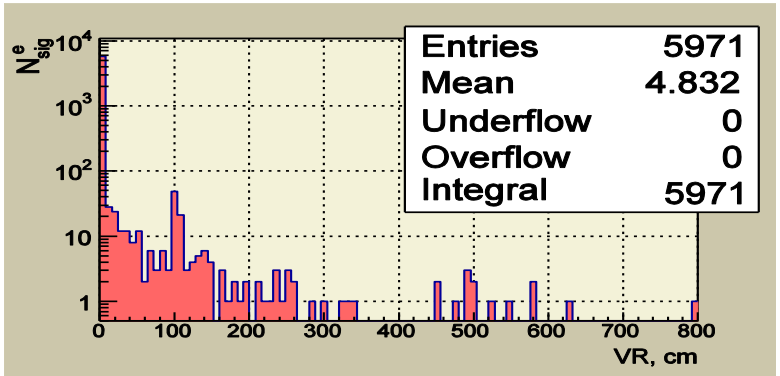
Analysis of this Table shows that the **maximum result of the signal-to-background ratio S/B = 1.44×10^{-4} is comparable with results obtained earlier via the isolation criterion and selection criteria by the summarized transverse momentum of the lepton pair.** ***However, in the latter case it is achieved by significant suppression of the signal and, correspondingly, such a selection does not look appropriate.***

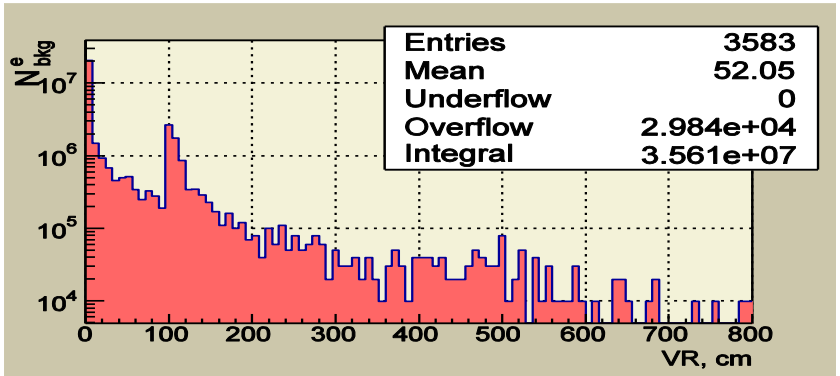
Events selection by coordinates of the lepton production vertex

Obviously, the leptons whose production vertex is different from the point of interaction of the proton and antiproton, *cannot be considered as a signal*. As a soft selection criterion was considered the selection of leptons by the production vertex within a radius of $VR = \sqrt{(Vx^2+Vy^2+Vz^2)} = 15$ mm from the interaction point.

Histograms show the distributions of the distance from the interaction point to the production vertex of the lepton (left - for signaling events, to the right - for the background). On the vertical axis in a logarithmic scale is shown the number of particles supposed to be produced in a year. It is seen that in the case of signal events, *number of leptons produced near zero (at the interaction point) by more than 3 orders of magnitude greater than the number of leptons produced in different parts of the detector*. The last ones in the signal events are produced by decay of mesons and hadrons existing in the same signal events as a hadron accompaniment.

For the background events, *the number of leptons produced in different parts of the detector volume is significantly larger, and smaller than the number of leptons produced in the interaction point by only of 2 orders of magnitude*. **However, the latter still make up a very large part of the background and the most difficult to separate.**





Conclusion

The numerical analysis of the **criterion of signal and background selection by the leptons production vertex** has shown that such a criterion has the efficiency of the signal events selection up to the level of **19.63%** *(together with the criteria of isolation, and invariant mass* $M_{inv}^{e+/e-} > 0.9$ *GeV and the condition of the presence of exactly 1e- and 1e+ with* $P^{e+/e-}$ *&* $PT^{e+/e-} > 0.2$ *GeV in event).* Minor suppression of the signal events can be explained by the presence in such events of the additional leptons, produced by decays of the mesons and hadrons in the same event, which can fake the signal leptons.

At the same time **all, except the one**, of the considered **2×10^6 background events** were eliminated. Thus we can claim that **such a criterion allows to eliminate the larger part of background and to reach the signal to background ration at least up to the level of** $\mathbf{S/B = 4.8 \times 10^{-2}}$

So, for the present moment, the prospects for lepton pairs signal extraction in electron-positron fashion (Drell-Yan process) already does not look as promising as they were at the stage of fast simulation.

Publications

- **Monte-Carlo simulation of lepton pair production in "p pbar → $\ell^+\ell^-$ + X" events at E_{beam} = 14 GeV**
  A.N.Skachkova, N.B.Skachkov, G.D.Alexeev
  arXiv: hep-ph/0506139v2, 2011 PANDA-NOTE PHY-003

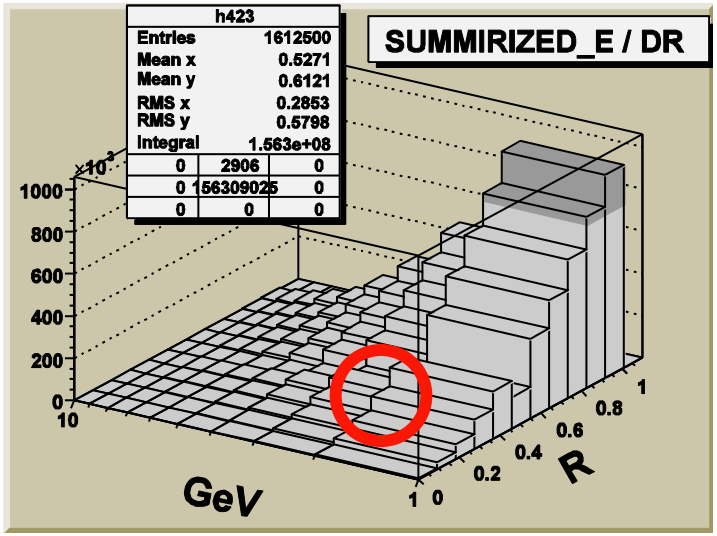
- **On Lepton Pair Production in Proton-Antiproton Collisions at Intermediate Energies**
  A.N.Skachkova, N.B.Skachkov
  PepanLetters: JINR, V.6 №:4 (153) – 2009. - Pp. 504-518

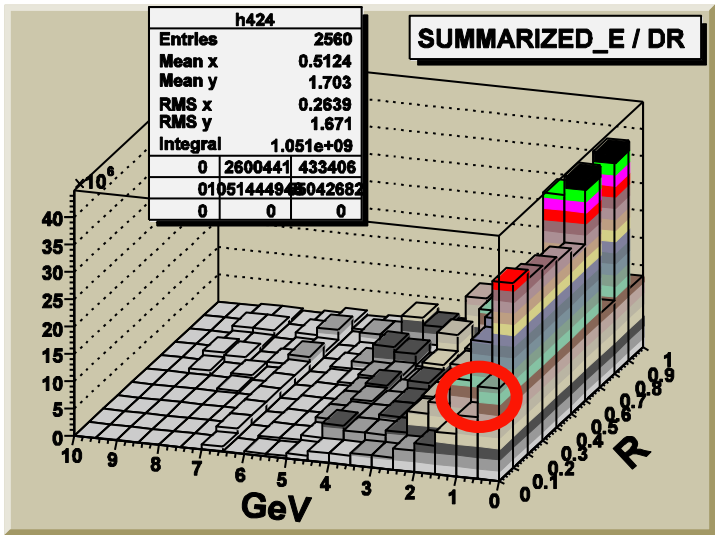
- ***Monte-Carlo simulation of lepton pairs production in "pp ¯ →mu + mu – +X" events at E (beam) = 5 GeV***
  A.N. Skachkova
  J.Phys.Conf.Ser. 426 (2013) 012031, 5 pp

- **Monte-Carlo simulation of lepton pairs production in "p pbar -- > e+ e- + X" events at PANDA experiment**
  A.N.Skachkova,
  Journal of Physics: Conference Series, 503 (2014) 012016

OUT-BACK slides

Lepton (e) isolation criteria





The plots show the distributions over ***summarized energy*** of the final state particles in the cones of radius

$R_{isolation} = \sqrt{\eta^2+\phi^2}$ respect to the

(η – *pseudorapidity*)

upper plot → **signal events**

bottom plot → **background events**

Isolation criteria ($R_{isolation} = 0.2$)

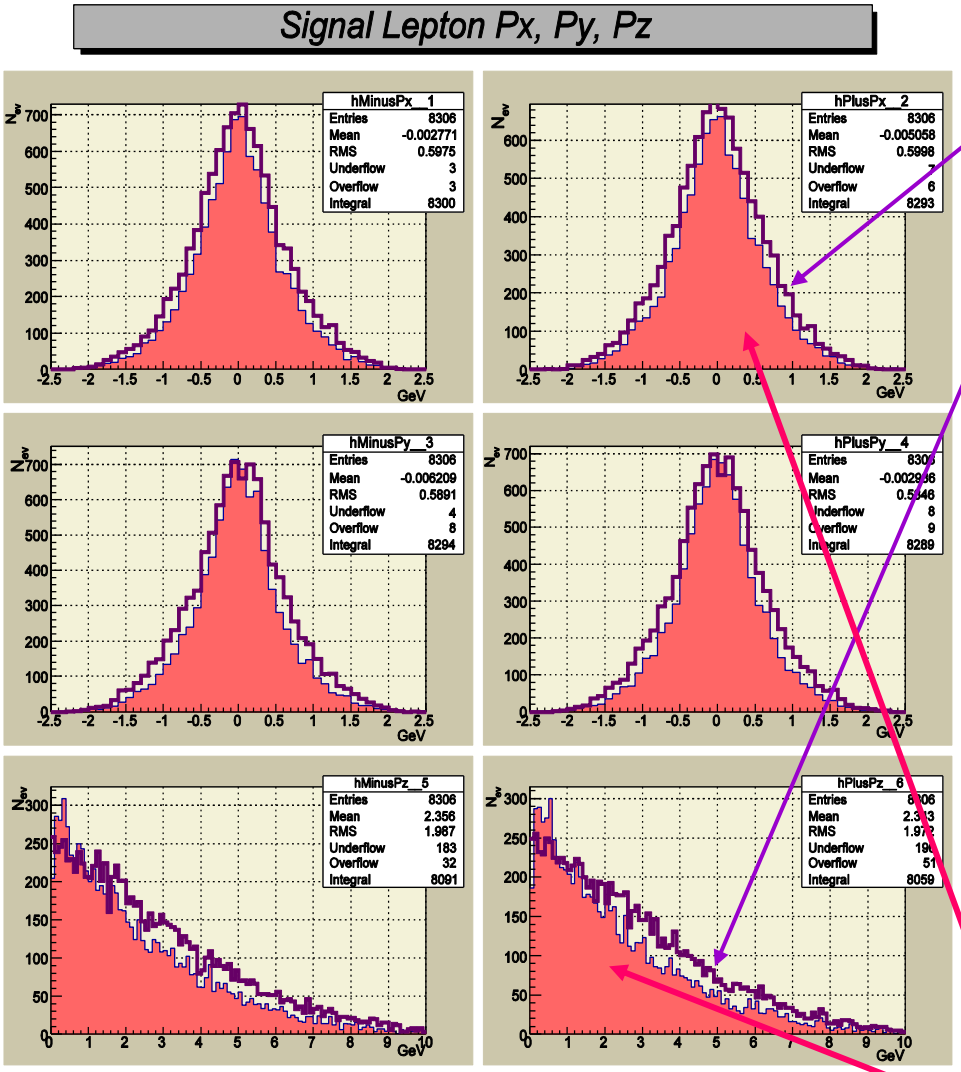
$E^{(of\ particles)} = 0.5$ GeV

allows to separate **100%** of QCD leptons with loss of **8%** of signal events

Final ***S/B ratio = 3.8!*** $M_{inv}(l+,l-) > 0.9$

S/B ratio = 9! For $M_{inv}(l+,l-) > 1.0$

Px^e, Py^e, Pz^e of e^+ & e^-



PYTHIA6.4

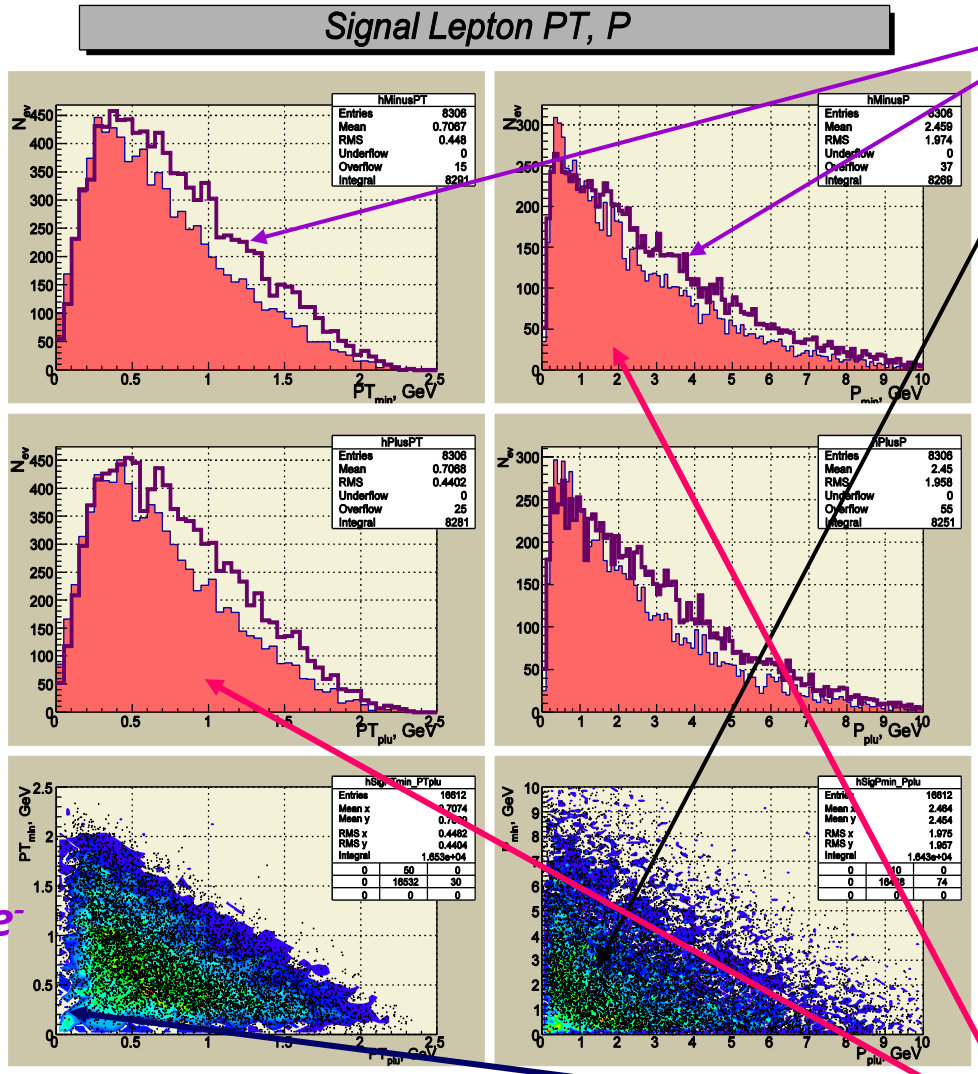
- Distributions of *transverse components* of momentum in PandarRoot follow the ones obtained in PYTHIA except some reduction of number of events.

- Distributions of *longitudinal component* show the **excess** over PYTHIA results in the region of small Pz 0.2 – 0.6 GeV and **some reduction** of number of events at the medium values of Pz 2 – 6 GeV

PandaRoot & Geant 4

PT^{e}, P^{e}, PT^{e+}/PT^{e-}, P^{e+}/P^{e-} of e^{+} & e^{-}

PYTHIA6.4 (black dots)



- The distributions for e^{+} and e^{-} are practically identical.
- PandaRoot spectra *shift to the* ***region of lower momenta P and PT*** comparing to the PYTHIA ones.
- In the region of **small 0< PT <0.3 GeV** the number of events obtained in PandaRoot **slightly exceed** the initial distributions. At the **higher PT > 0.4 GeV** their **number is reduced** significantly.
- At the region of **smaller values 0.3 < P < 0.8 GeV** one can see the **excess** of PandaRoot events over initial ones simulated in PYTHIA, whereas at the **larger values of P > 2 GeV** their **number is reducing**.

PandaRoot & Geant 4 (blue dots)