Possible improvement in CB reduction and current status

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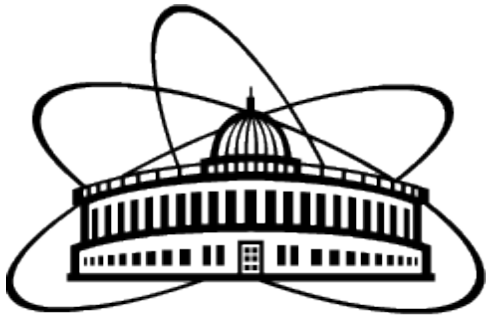
MPD Cross-PWG Meeting

04 October, 2022

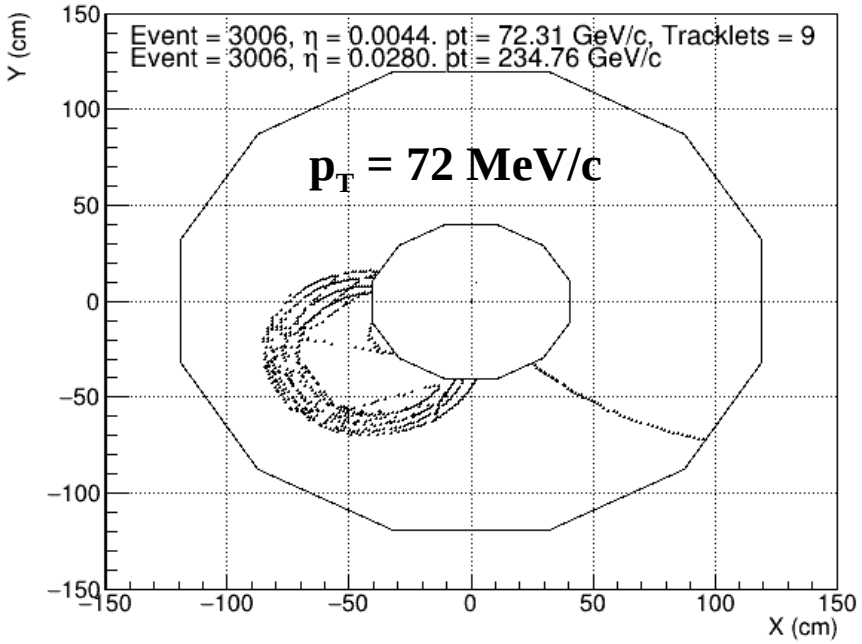


Outline

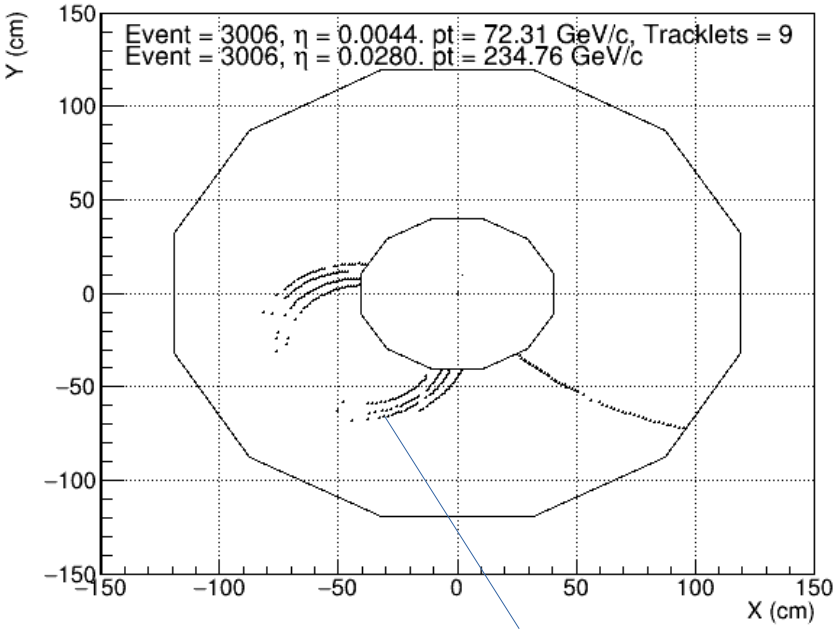
- Reduction in combinatorial background with current reconstruction algorithm: current status.
- Conclusions and outlook.

Recall → Low pt track reconstruction with current algorithm

Reconstructed hits



Reconstructed tracks



Partially reconstructed spiral track

- With current track reconstruction algorithm, low pT tracks are not reconstructed properly even though full hit information is available in the detector for tracks with pT ≳ 30 MeV.

Recall → In the last meeting..

1) Using a close TPC cut with a perfect recognition of the low pt tracks, a significant improvement (about factor 5-8) in the S/B can be obtained.

2) A close TPC cut using the Current tracking algorithm does not bring any significant improvement.

https://indico.jinr.ru/event/2893/contributions/15513/attachments/11976/19930/PWG4_MPD_SR_Feb15_V2.pdf

Recall → Ingredients

1) UrQMD production Min. Bias BiBi@9.2 GeV: Request 11, Events approx. 8.7 M

2) Single event and track selection criteria for creating pools:

1)$|Vz| < 50$ cm

2)Nhits > 39

3)DCA < 3σ

4)-1 < TPC nSigma_e < 2σ

5)|TOF beta| < 2σ

6)TPC-TOF matching 2σ for dφ and dz.

ρ^0 -> e+e- (x20)
ω -> e+e- (x20)
ω -> $л^0$ e+e- (x20)
φ -> e+e- (x20)
φ -> η e+e- (x20)

Mpdroot dev branch: 50110a2507fc3da34d55648c9e7912f319af5455

Recall → Strategy: Pair analysis using UrQMD

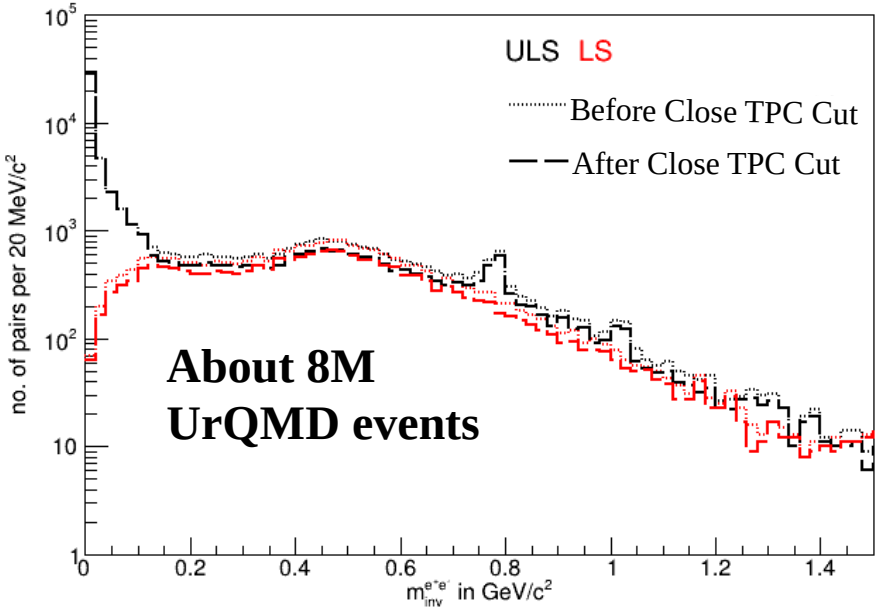
- Three electron pools:
  - Pool-1 for fully reconstructed tracks in fiducial area (|y| < 0.3)
  - Pool-2 for fully reconstructed tracks in veto area (|y| > 0.3 & |y| < 1.0)
  - Pool-3 with TPC only tracks (|y| < 1.0).

- **No further pairing:** Tracks belonging to fully reconstructed π^0 Dalitz are tagged and not used for further pairing.

- **Close TPC cut:** Track from Pool-1 is paired with tracks from Pool-3 and both tracks are removed as a potential Dalitz pair if they have M_{inv} < 120 MeV/c2 and opening angle < 10 degrees.

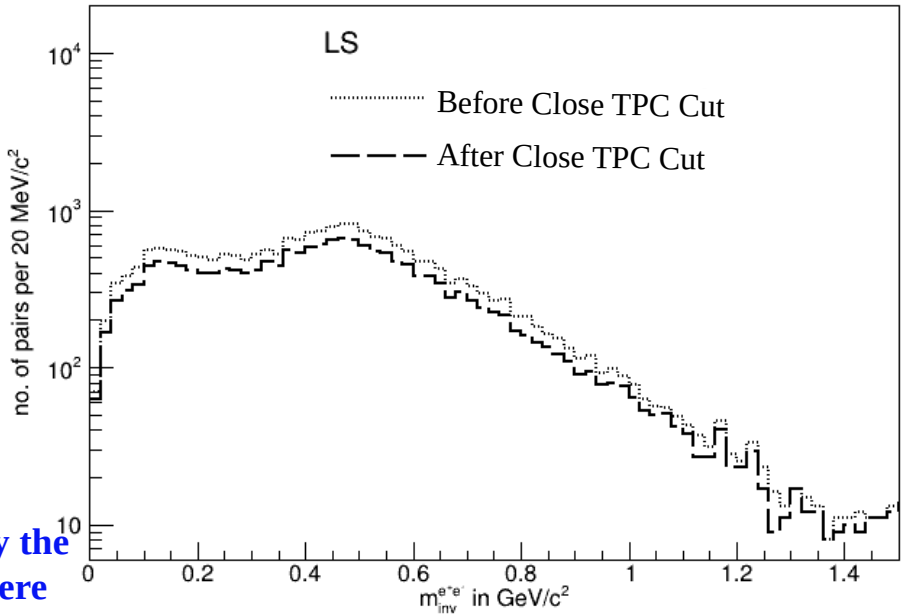
- Rest of the tracks with pt > 200 MeV from Pool-1 are paired among themselves to build ULS and LS pair spectra.

Recall → ULS and LS spectra



- DCA cut < 3 sigma eliminates most of the conversion electrons.
- No further pairing (Before Close TPC cut): fully reconstructed pi0 Dalitz pairs are recognized and not used for pairing.

- **Close TPC cut:** Fully reconstructed track is paired with TPC only track to recognize potential Dalitz track.
- Current tracking algorithm produces a very small reduction of the CB.

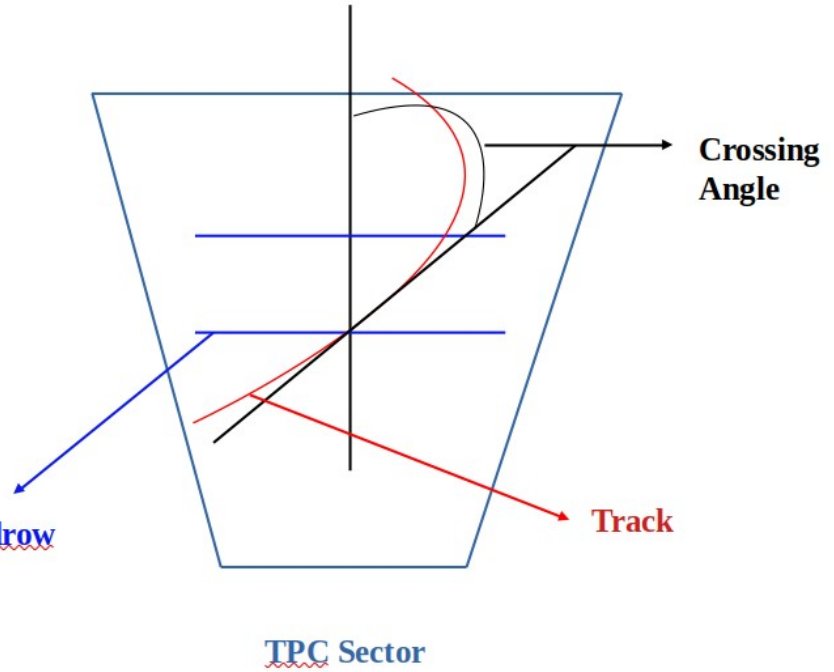


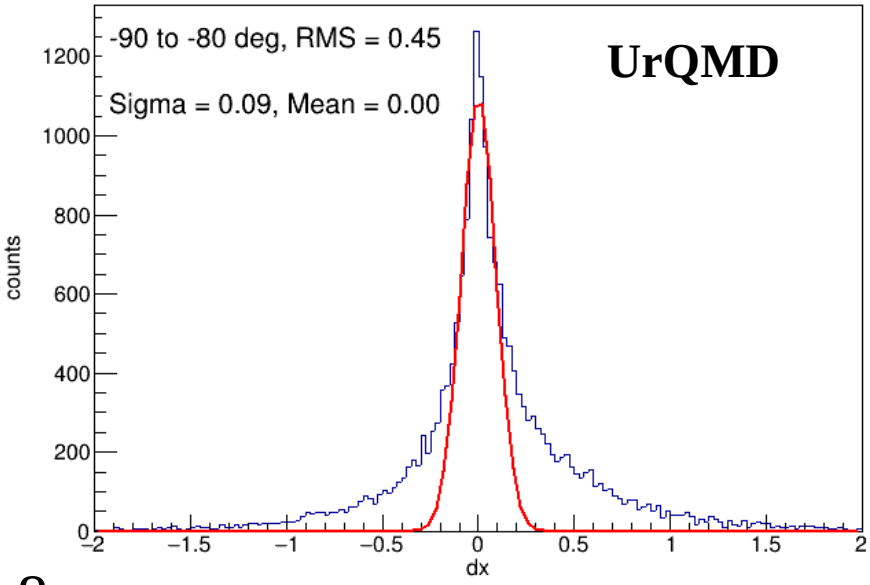
NOTE: Spectra are obtained without scaling down by the factor 20 with which the branching ratios of LVMs were enhanced.

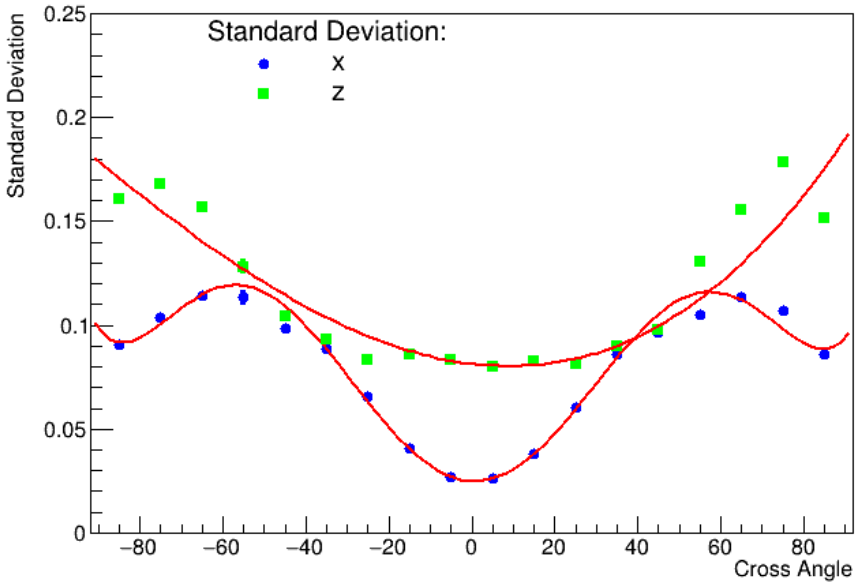
Current status

1) Limitations in Standard algorithm:

- Hit requirement of 39 is too strong for low pT tracks.
- Not able to reach pad rows above apogee (low p_T tracks stop before that).
- In many cases, track stops even before apogee due to high χ^2 value (hence hit is not added to the track) ← this can be improved by performing **crossing angle correction** (more important for low p_T tracks).

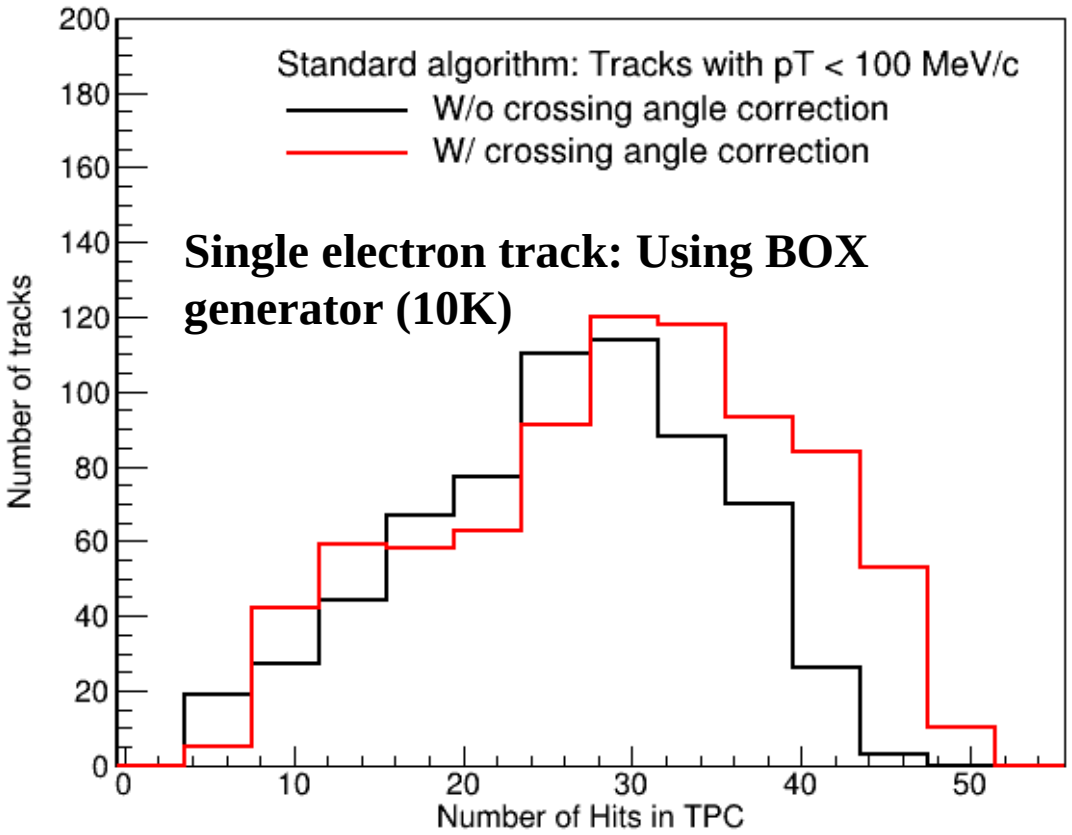






Suggested by Alexander Zinchenko

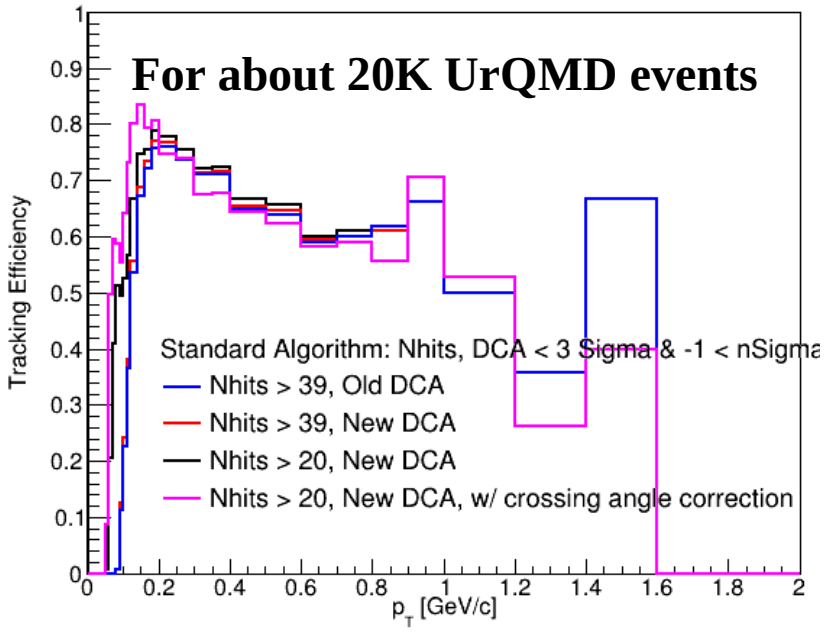
Current status: Improvement due to crossing angle correction

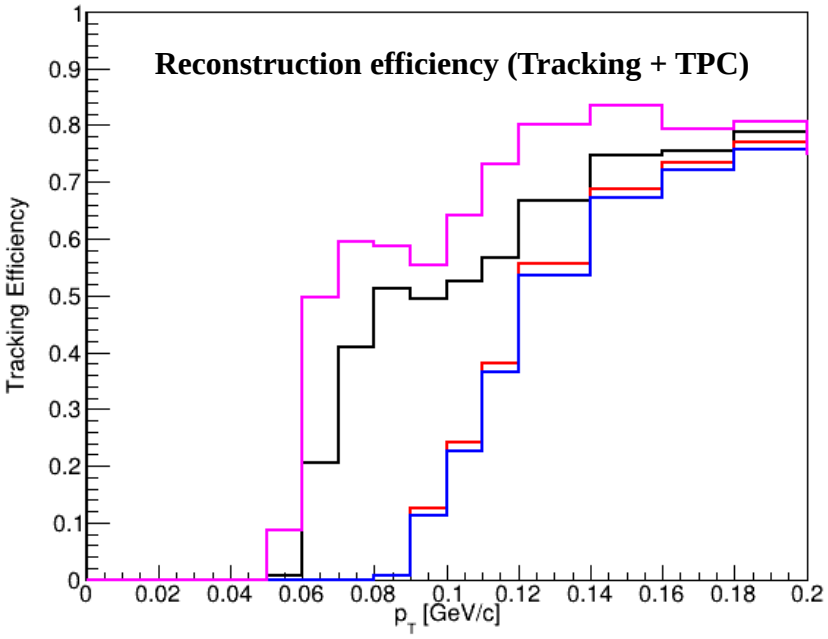


- Many of the reconstructed hits corresponding to a particular track are not found and therefore not added to the track.
- Simulate single electron track using BOX generator for both with and without crossing angle correction to get hit distribution (After DCA selection).
- Crossing angle correction seems to find more hits and therefore, added to the track.

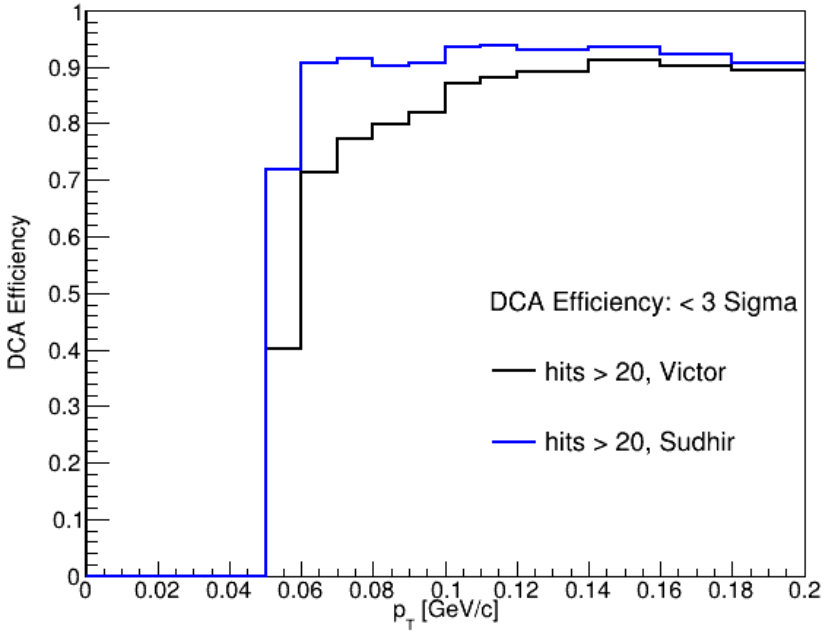
- Apart from crossing angle correction, what can be done?
  - Reduce number of hits on the partner.
  - Improve DCA parametrization at low pT.

Current status: Improvement in tracking + TPC efficiency

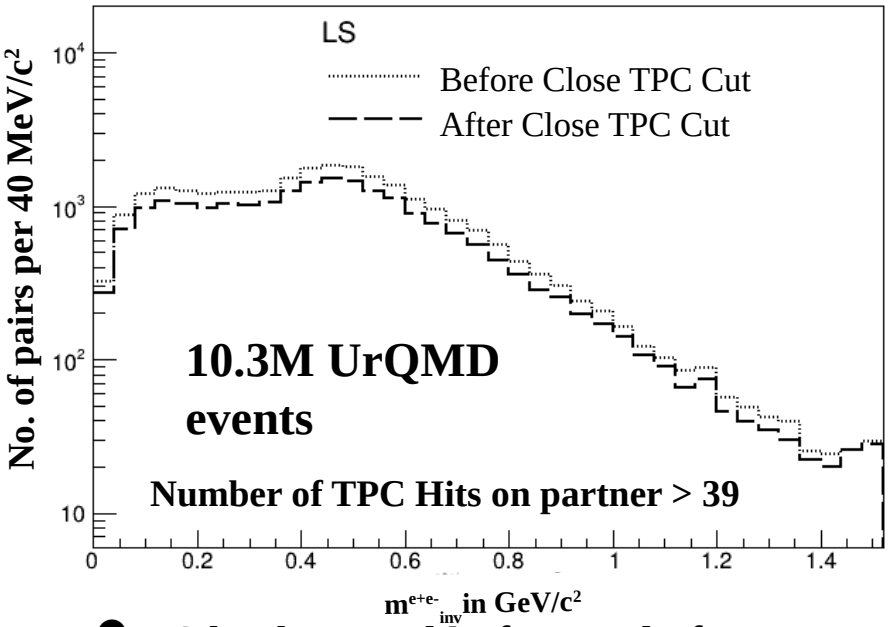


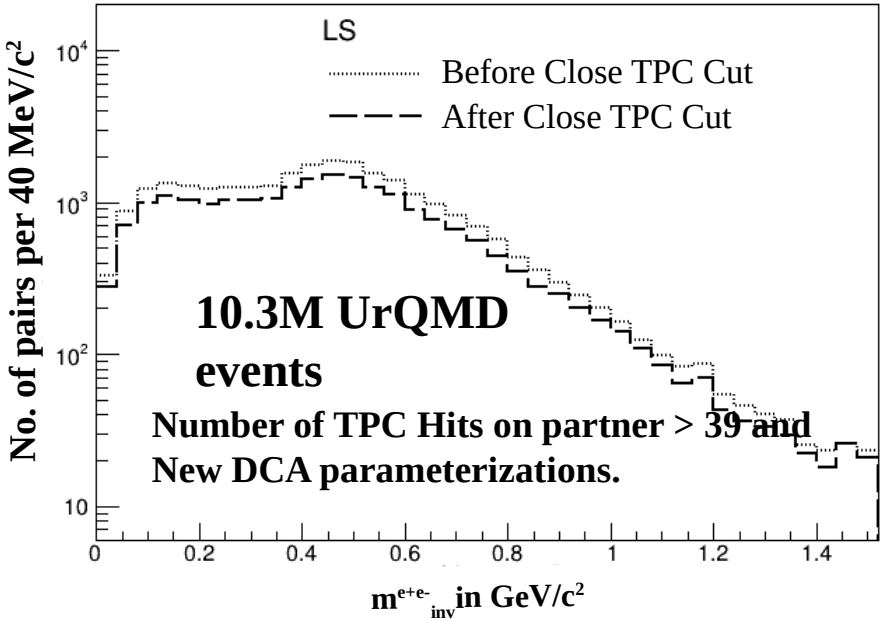


- Cuts: No of Hits, DCA and TPC PID.
- DCA parametrizations are updated at very low pT (enhances efficiency for tracks with Nhits > 20 but slight improvement for tracks with 39 hits → negligible effect on conversion rejection).
- Hits on the partner tracks reduced to 20.
- Effect of crossing angle correction.
- Observed improvement in the efficiency.

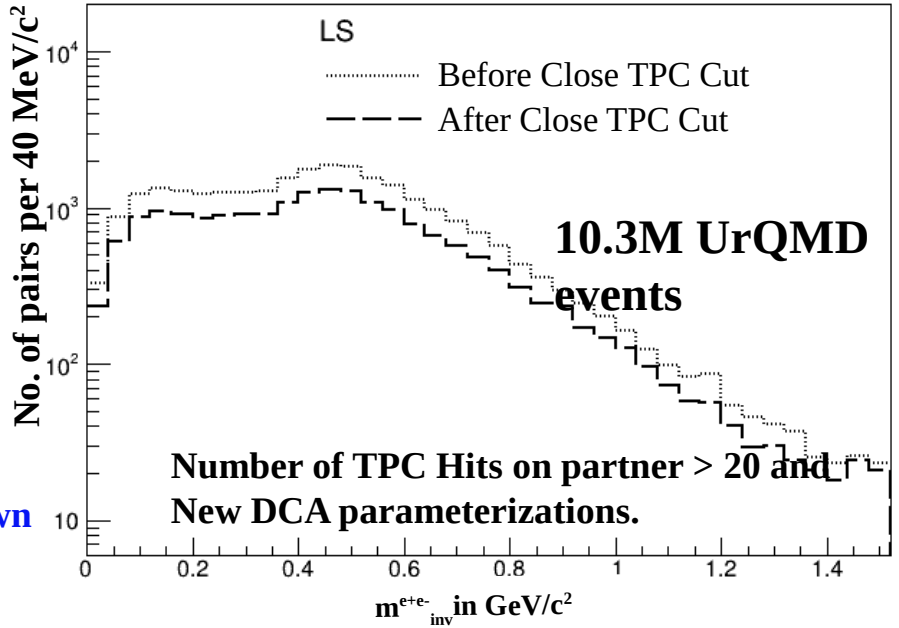


Current status: Reduction in the combinatorial background





- LS background before and after close TPC cut.
- Reduction in combinatorial background is visible.
- Results due to crossing angle correction are not shown → because of unavailability of the production.



NOTE: LS spectra are obtained without scaling down by the factor 20 with which the branching ratios of LVMs were enhanced.

DCA Parameterizations: ULS, LS and Signal ($0.2 < M_{inv} < 0.6$ GeV/c^2)

NOTE: Values are obtained without scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

Nhits > 39 (10.3M)	ULS	LS	Signal
Before Close TPC cut	15290	14730	560 +/- 173
After Close TPC cut	12614	12048	566 +/- 157

Nhits > 39 & New DCA (10.3M)	ULS	LS	Signal
Before Close TPC cut	15496	14940	556 +/- 174
After Close TPC cut	12683	12096	587 +/- 157

- New DCA parametrizations does not change the result much (No significant reduction in the CB).
- From here on, new DCA parametrizations will be used.

ULS, LS and Signal ($0.2 < M_{inv} < 0.6$ GeV/c^2)

NOTE: Values are obtained without scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

Nhits > 39 & New DCA (10.3M)	ULS	LS	Signal
Before Close TPC cut	15496	14940	556 +/- 174
After Close TPC cut	12683	12096	587 +/- 157

Nhits > 20 & New DCA (10.3M)	ULS	LS	Signal
Before Close TPC cut	15496	14938	558 +/- 174
After Close TPC cut	11124	10529	595 +/- 147

- Trend is seen in reduction of CB without killing the signal (30% uncertainty).
- Expect further improvement due to crossing angle correction.
- However, to quantify this, need new production (Outputs after Geant simulation).

Conclusions:

1) We see a trend of improvement in the CB rejection in our study.

2) To attempt more variations as well as to quantify the improvement, we need simulated outputs after Geant transport
→ So reconstruction can be performed for various scenarios.

Outlook:

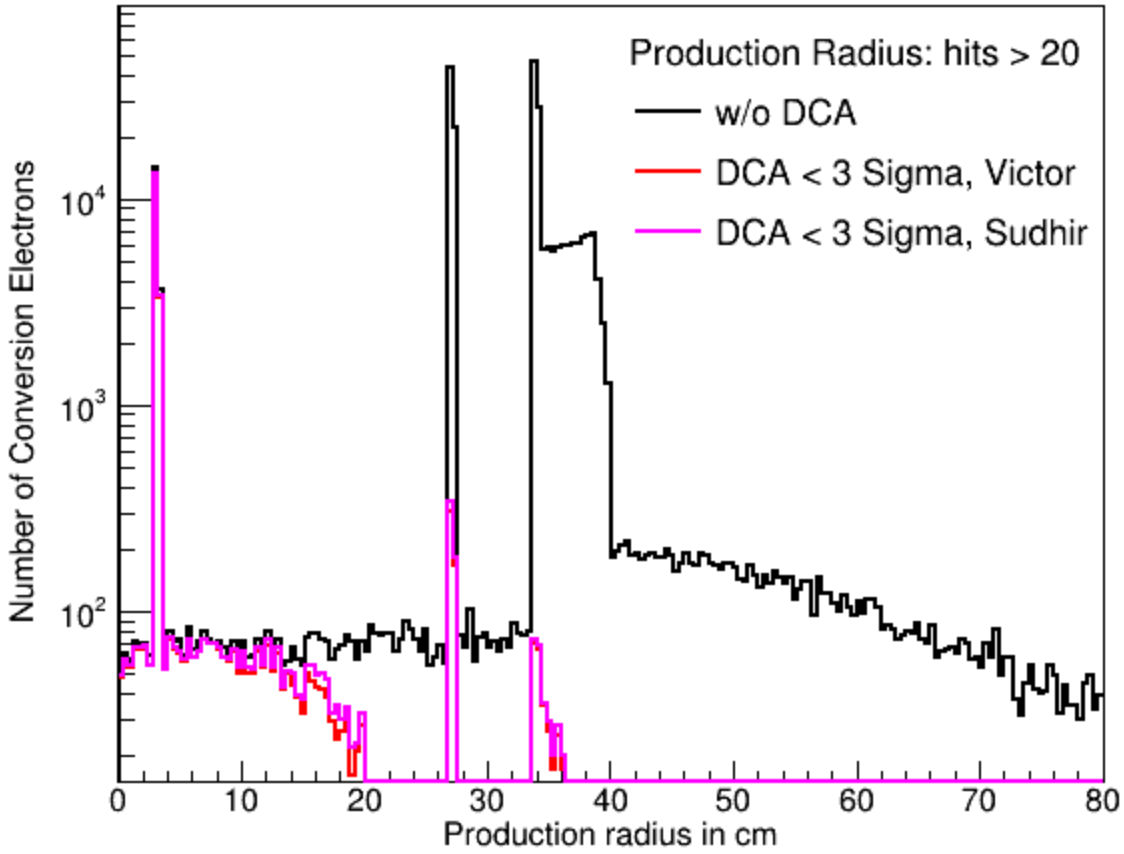
1) Use Request 25 to revisit these results and also for future studies.

2) Quantify the improvement due to crossing angle correction.

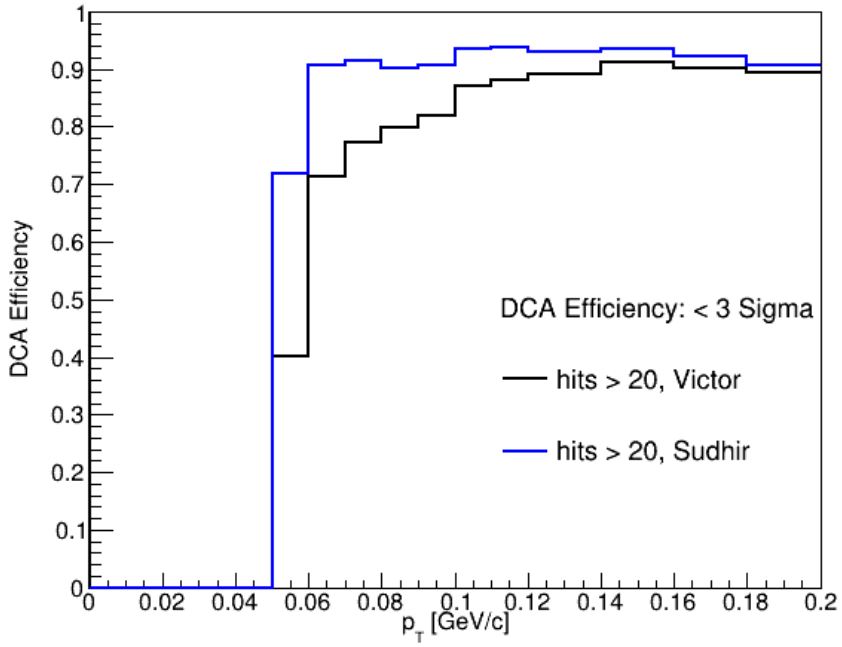
3) Improved reconstruction algorithm for curling tracks is being developed.

BACK-UP

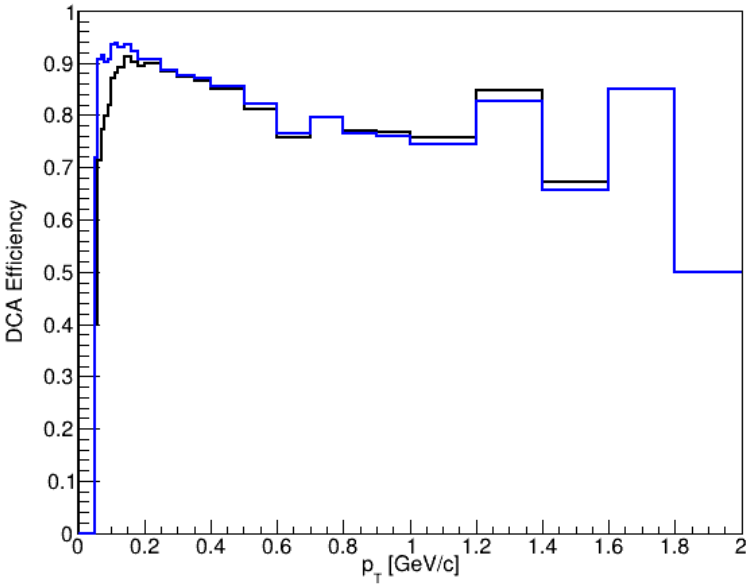
Effect of DCA parametrizations: Conversion electrons



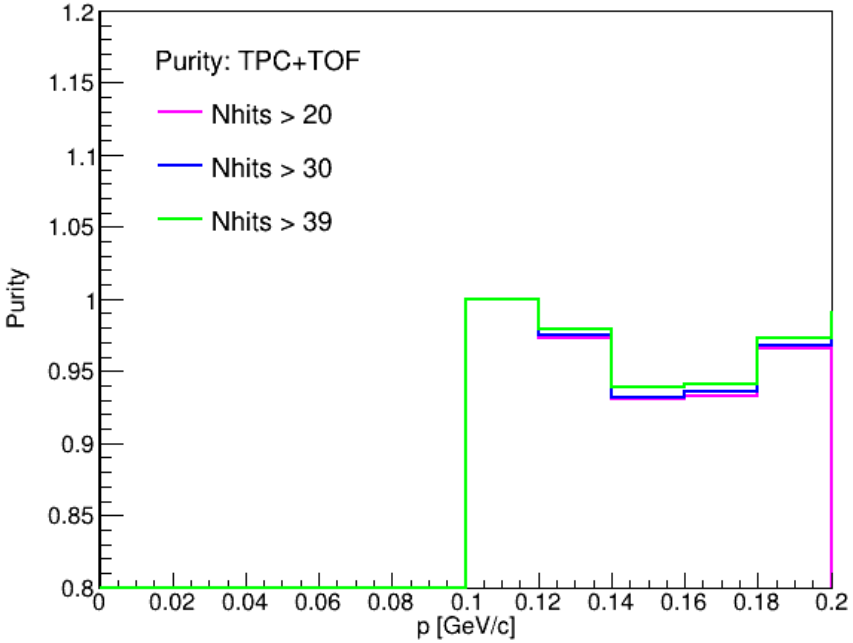
Effect of DCA parametrizations: DCA efficiency

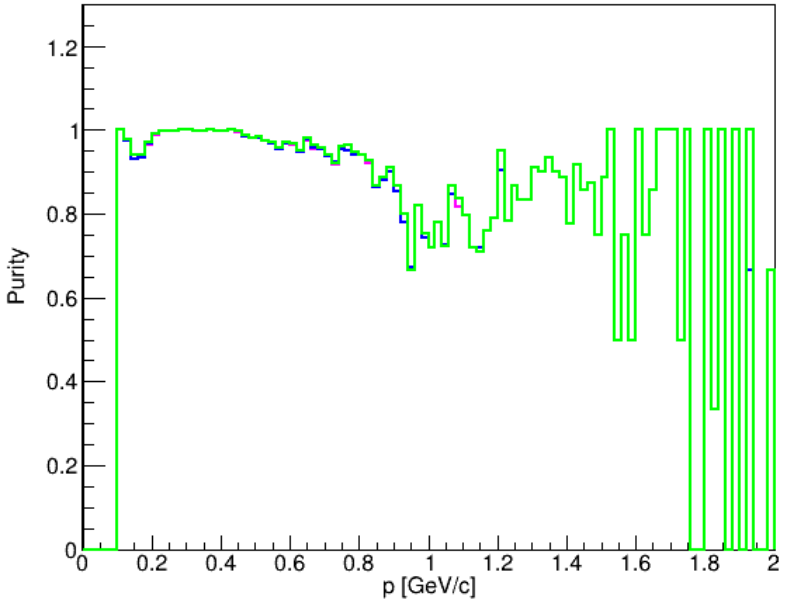


- Denominator: Generated Pt spectra of electron tracks (-1 < eta < 1 and PR < 2 cm) + 20 hits.
- Numerator: + DCA < 3 sigma (Reco pt).

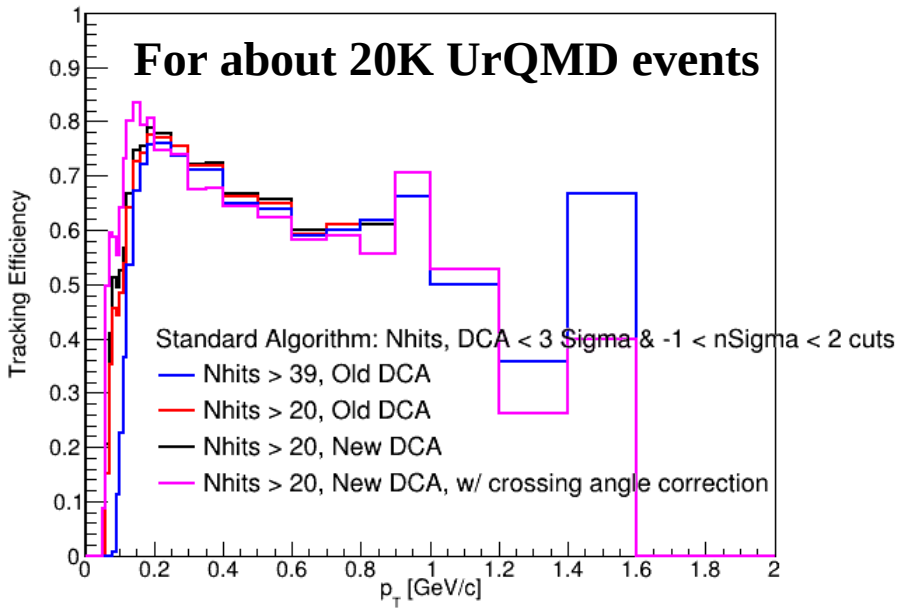


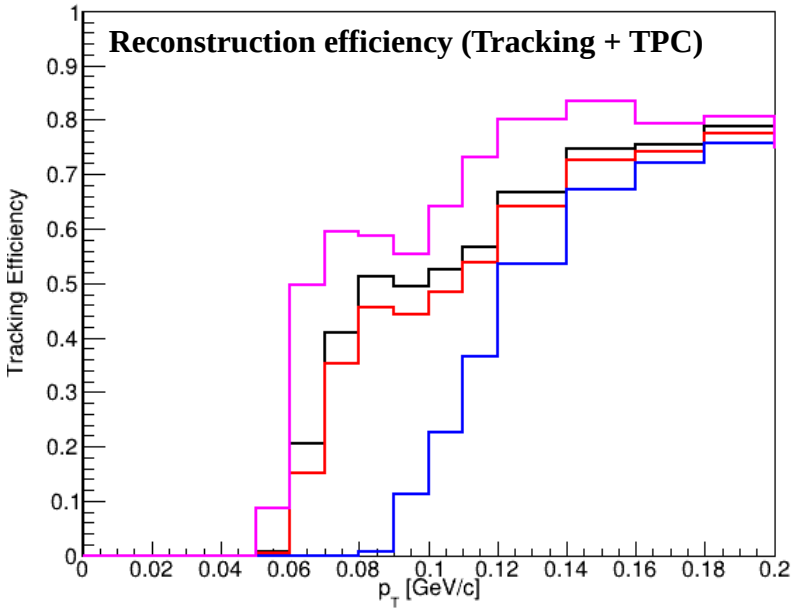
Effect of DCA parametrizations: Purity





Current status: Improvement in tracking + TPC efficiency





- Cuts: No of Hits, DCA and TPC PID.
- Number of hits requirement on the partner tracks is reduced from 39 to 20.
- DCA parametrizations are updated at very low pT (improves efficiency → negligible effect on conversion rejection).
- Effect of crossing angle correction.
- Observe significant improvement in efficiency.

Signal to Background ($0.2 < M_{inv} < 0.6$ GeV/c^2) → (ULS-LS)/LS

Number of TPC Hits on partner > 39.

10.3M events

- S/B: Before Close TPC cut → **0.03802 +/- 0.00044**
- S/B: After Close TPC cut → **0.09698 +/- 0.00060**

Number of TPC Hits on partner > 39 and New DCA parametrizations.

10.3M events

- S/B: Before Close TPC cut → **0.03722 +/- 0.00043**
- S/B: After Close TPC cut → **0.04853 +/- 0.00062**

Number of TPC Hits on partner > 20.

10.3M events

- S/B: Before Close TPC cut → **0.03800 +/- 0.00044**
- S/B: After Close TPC cut → **0.04932 +/- 0.00067**

Number of TPC Hits on partner > 20 and New DCA parametrizations.

10.3M events

- S/B: Before Close TPC cut → **0.03735 +/- 0.00043**
- S/B: After Close TPC cut → **0.05651 +/- 0.00077**

NOTE: Absolute values of S/B are obtained without scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

ULS, LS and Signal values ($0.2 < M_{inv} < 0.6$ GeV/c^2)

NOTE: Values are obtained without scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

Nhits > 39 (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	15290	14730	560	• 10.44
After Close TPC cut	12614	12048	566	• 12.99

Nhits > 39 & New DCA (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	15496	14940	556	• 10.16
After Close TPC cut	12683	12096	587	• 13.91

Nhits > 20 (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	15296	14736	560	• 10.44
After Close TPC cut	11234	10726	528	• 12.68

Nhits > 20 & New DCA (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	15496	14938	558	• 10.23
After Close TPC cut	11124	10529	595	• 16.35

Signal to Background ($0.2 < M_{inv} < 0.6$ GeV/c^2) → (ULS-LS)/LS

Number of TPC Hits on partner > 39. **10.3M events**	● S/B: Before Close TPC cut → **0.00456 +/- 0.00006** ● S/B: After Close TPC cut → **0.00771 +/- 0.00012**
Number of TPC Hits on partner > 39 and New DCA parametrizations. **10.3M events**	● S/B: Before Close TPC cut → **0.00168 +/- 0.00002** ● S/B: After Close TPC cut → **0.00690 +/- 0.00011**
Number of TPC Hits on partner > 20. **10.3M events**	● S/B: Before Close TPC cut → **0.00445 +/- 0.00006** ● S/B: After Close TPC cut → **0.00671 +/- 0.00011**
Number of TPC Hits on partner > 20 and New DCA parametrizations. **10.3M events**	● S/B: Before Close TPC cut → **0.00205 +/- 0.00003** ● S/B: After Close TPC cut → **0.01116 +/- 0.00018**

NOTE: Absolute values of S/B are obtained after scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

ULS, LS and Signal values ($0.2 < M_{inv} < 0.6$ GeV/c^2)

NOTE: Values are obtained after scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

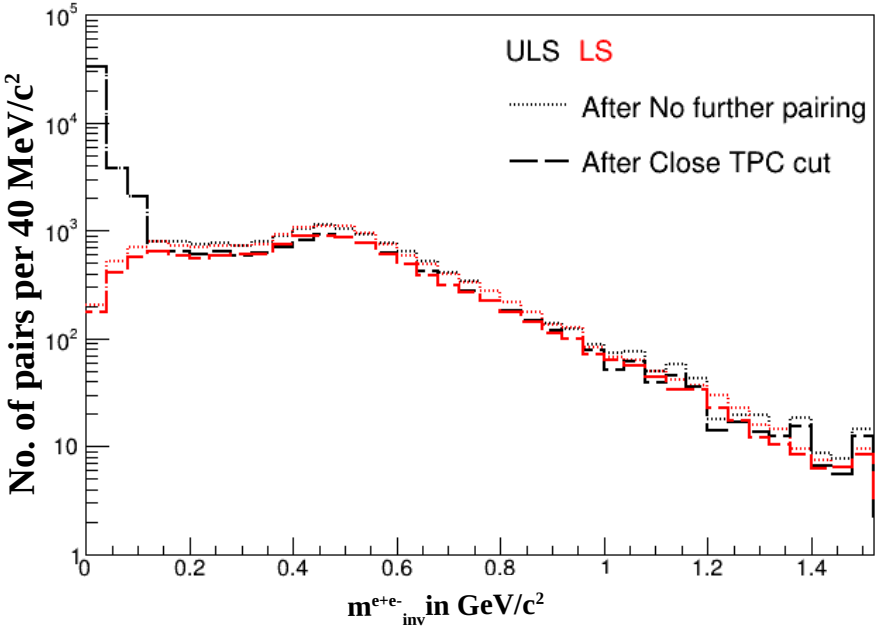
Nhits > 39 (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	10379	10332	47	• 0.11
After Close TPC cut	8432	8368	64	• 0.24

Nhits > 39 & New DCA (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	10527	10509	18	• 0.02
After Close TPC cut	8478	8420	58	• 0.20

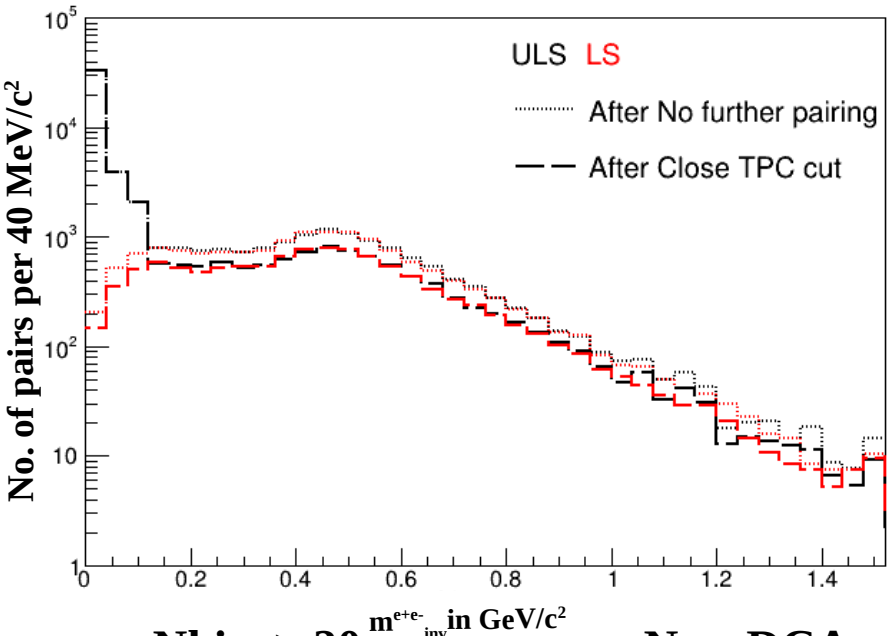
Nhits > 20 (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	10379	10333	46	• 0.10
After Close TPC cut	7391	7343	49	• 0.16

Nhits > 20 & New DCA (10.3M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	10528	10506	22	• 0.02
After Close TPC cut	7302	7222	80	• 0.44

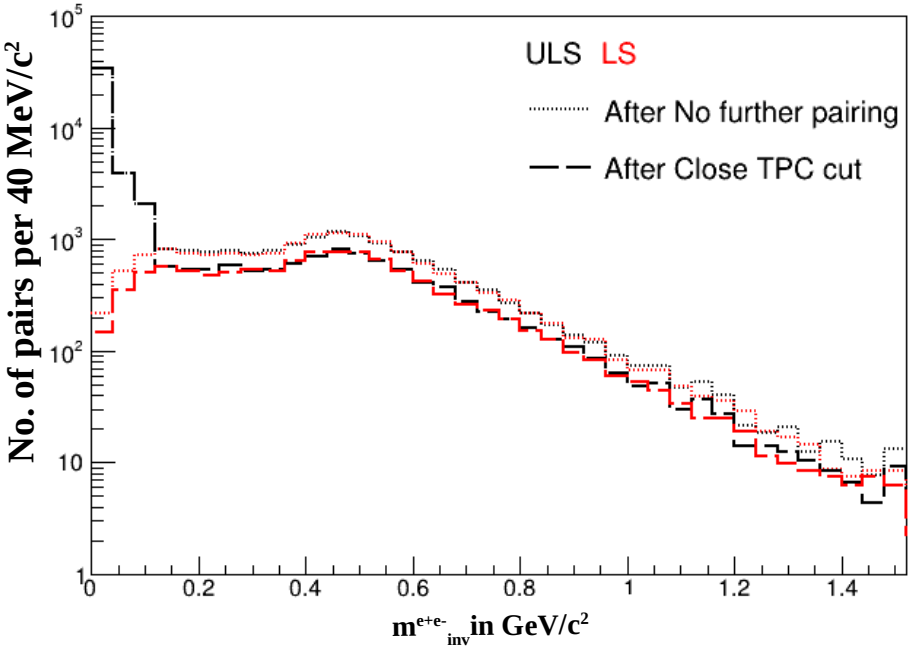
Default



Nhits > 20 on partner

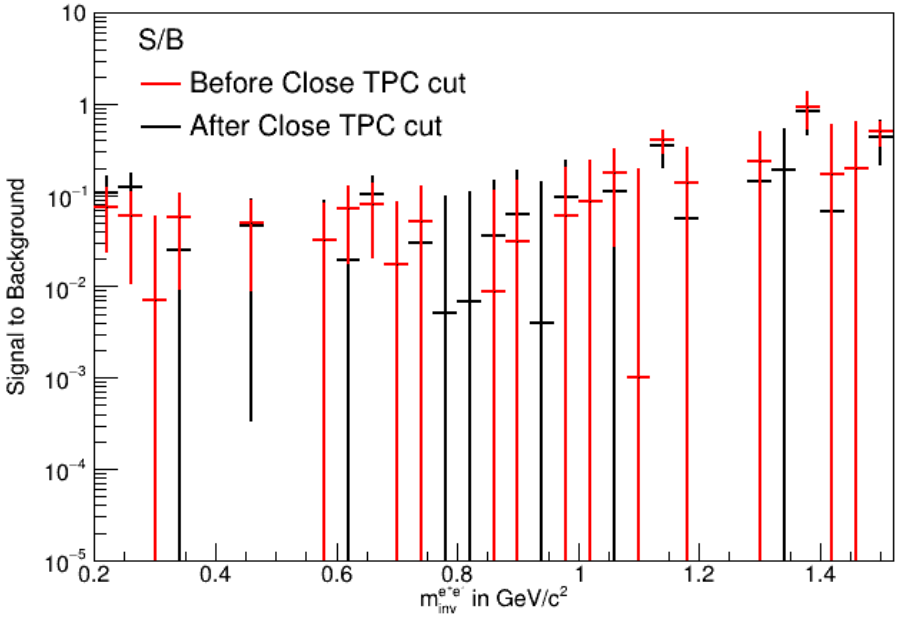


Nhits > 20 on partner + New DCA

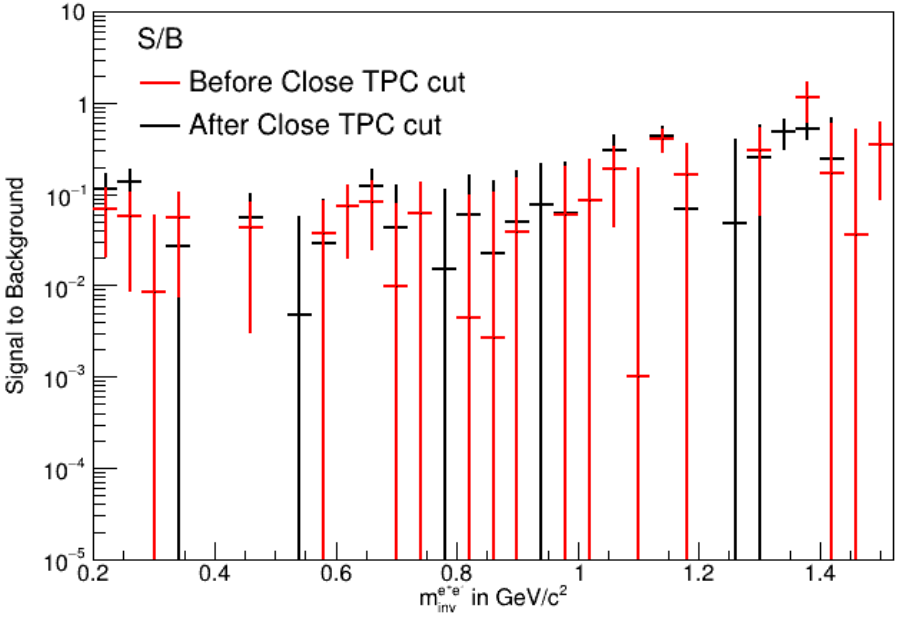


ULS and LS w/ scaling down

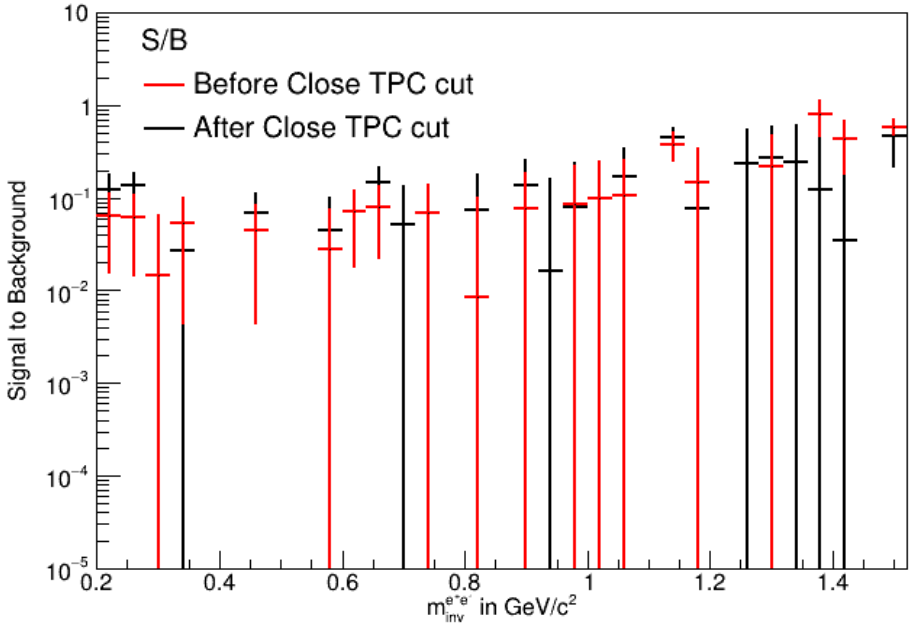
Default



Nhits > 20 on partner

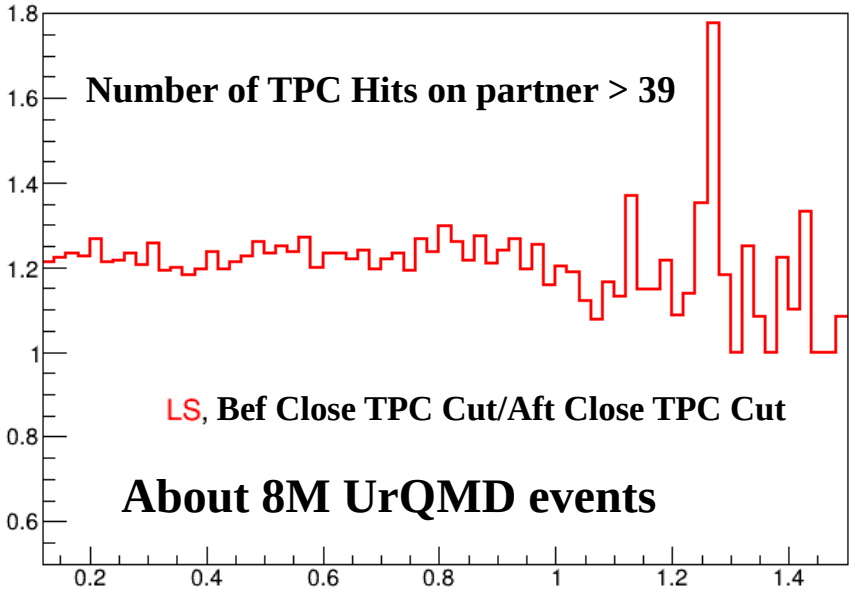


Nhits > 20 on partner + New DCA



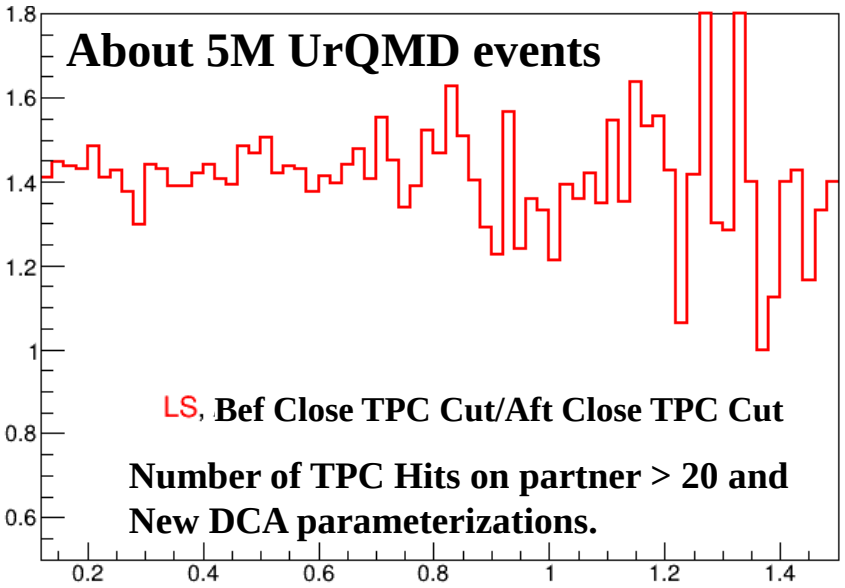
Signal to Background → (ULS-LS)/LS → w/ scaling down

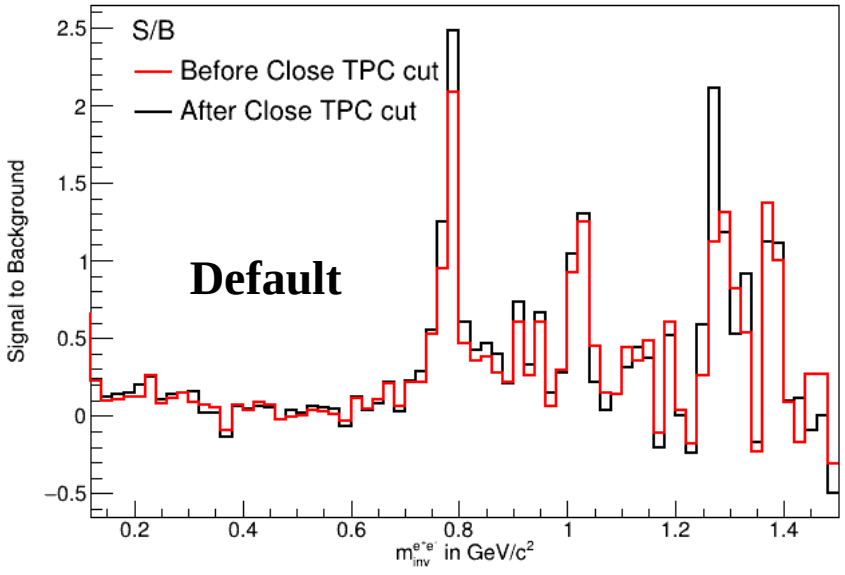
Current status: Reduction in the combinatorial background

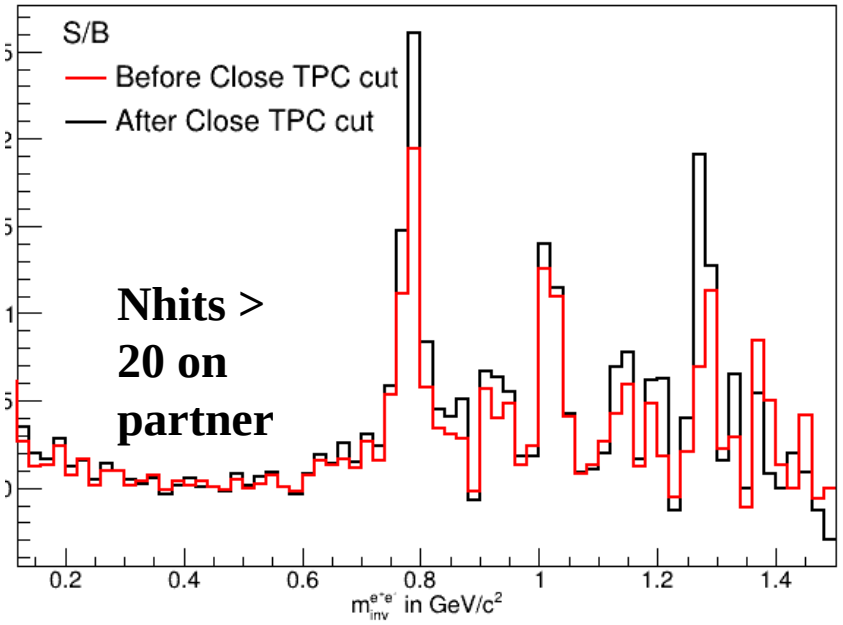


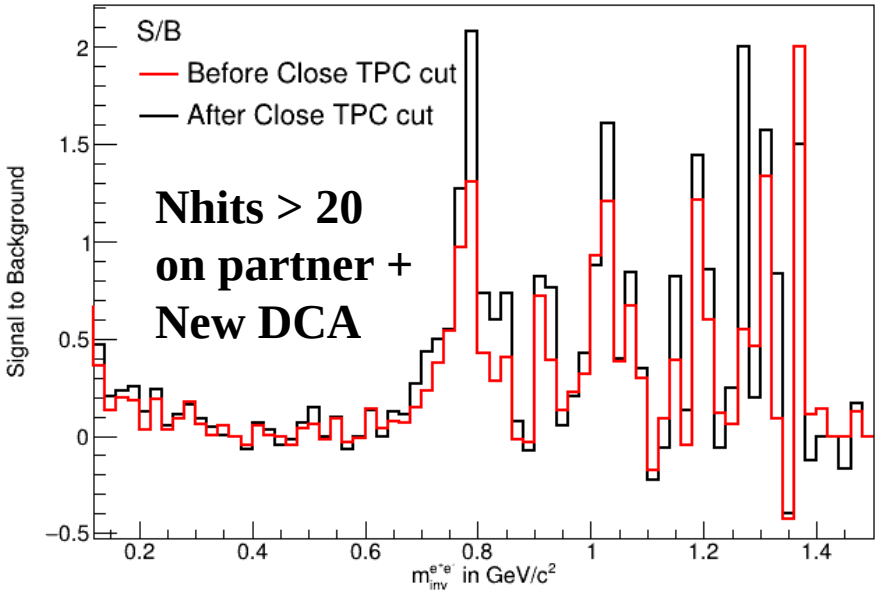
- Ratio of LS background before to after close TPC cut.
- Reduction in combinatorial background up to 20% → S/B (Aft Close TPC Cut/Bef Close TPC cut): (ULS-LS/LS): 1.11 (~10% improvement)

- Reduction in combinatorial background up to 40% → S/B (Aft Close TPC Cut/Bef Close TPC cut): (ULS-LS/LS): 1.40 (~40% improvement)




S/B
Before Close TPC cut
After Close TPC cut
Default
Signal to Background
$m_{inv}^{e^+e^-}$ in GeV/c²


S/B
Before Close TPC cut
After Close TPC cut
Nhits > 20 on partner
$m_{inv}^{e^+e^-}$ in GeV/c²


S/B
Before Close TPC cut
After Close TPC cut
Nhits > 20 on partner + New DCA
Signal to Background
$m_{inv}^{e^+e^-}$ in GeV/c²

Signal to Background ($0.2 < M_{inv} < 0.6$ GeV/c^2) → (ULS-LS)/LS

Number of TPC Hits on partner > 39.

5.60M events

- S/B: Before Close TPC cut →
- **0.0250 +/- 0.0006**
- S/B: After Close TPC cut →
- **0.0320 +/- 0.0009**

Number of TPC Hits on partner > 20.

5.63M events

- S/B: Before Close TPC cut →
- **0.0231 +/- 0.0005**
- S/B: After Close TPC cut →
- **0.0357 +/- 0.0011**

Number of TPC Hits on partner > 20 and New DCA parametrizations.

5.62M events

- S/B: Before Close TPC cut →
- **0.0230 +/- 0.0005**
- S/B: After Close TPC cut →
- **0.0350 +/- 0.0011**

NOTE: Absolute values of S/B are obtained without scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

ULS, LS and Signal values ($0.2 < M_{inv} < 0.6$ GeV/c^2)

NOTE: Values are obtained w/o scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

Nhits > 39 (events: 5.60M)	ULS	LS	Signal	• S/(1+2B/S)
Before Close TPC cut	8317	8111	206	• 2.58
After Close TPC cut	6873	6662	211	• 3.29

Nhits > 20 (events: 5.63M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	8336	8148	188	• 2.14
After Close TPC cut	6127	5916	211	• 3.70

Nhits > 20 & New DCA (5.62M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	8440	8252	188	• 2.12
After Close TPC cut	6035	5833	202	• 3.44

Signal to Background ($0.2 < M_{inv} < 0.6$ GeV/c^2) → (ULS-LS)/LS

Number of TPC Hits on partner > 39.

8.72M events

- S/B: Before Close TPC cut →
- **0.0086 +/- 0.0002**
- S/B: After Close TPC cut →
- **0.0090 +/- 0.0002**

Number of TPC Hits on partner > 20.

8.78M events

- S/B: Before Close TPC cut →
- **0.0080 +/- 0.0002**
- S/B: After Close TPC cut →
- **0.0122 +/- 0.0004**

Number of TPC Hits on partner > 20 and New DCA parametrizations.

8.75M events

- S/B: Before Close TPC cut →
- **0.0070 +/- 0.0001**
- S/B: After Close TPC cut →
- **0.0156 +/- 0.0005**

NOTE: Absolute values of S/B are obtained after scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

ULS, LS and Signal values ($0.2 < M_{inv} < 0.6$ GeV/c^2)

NOTE: Values are obtained after scaling down the factor 20 by which the branching ratios of LVMs were enhanced.

Nhits > 39 (events: 8.72M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	8823	8748	75	• 0.32
After Close TPC cut	7177	7113	64	• 0.29

Nhits > 20 (events: 8.78M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	8889	8821	68	• 0.26
After Close TPC cut	6348	6271	77	• 0.47

Nhits > 20 & New DCA (8.75M)	ULS	LS	Signal	S/(1+2B/S)
Before Close TPC cut	8967	8910	57	• 0.18
After Close TPC cut	6227	6131	96	• 0.75

Motivation and Pre-requisite

- Major source of combinatorial background: pi0 Dalitz decays (and conversions in beam pipe) where only one track is reconstructed whereas its partner is not.

- Partial information available on the partner. Important to study maximum possible benefit in the CB reduction.

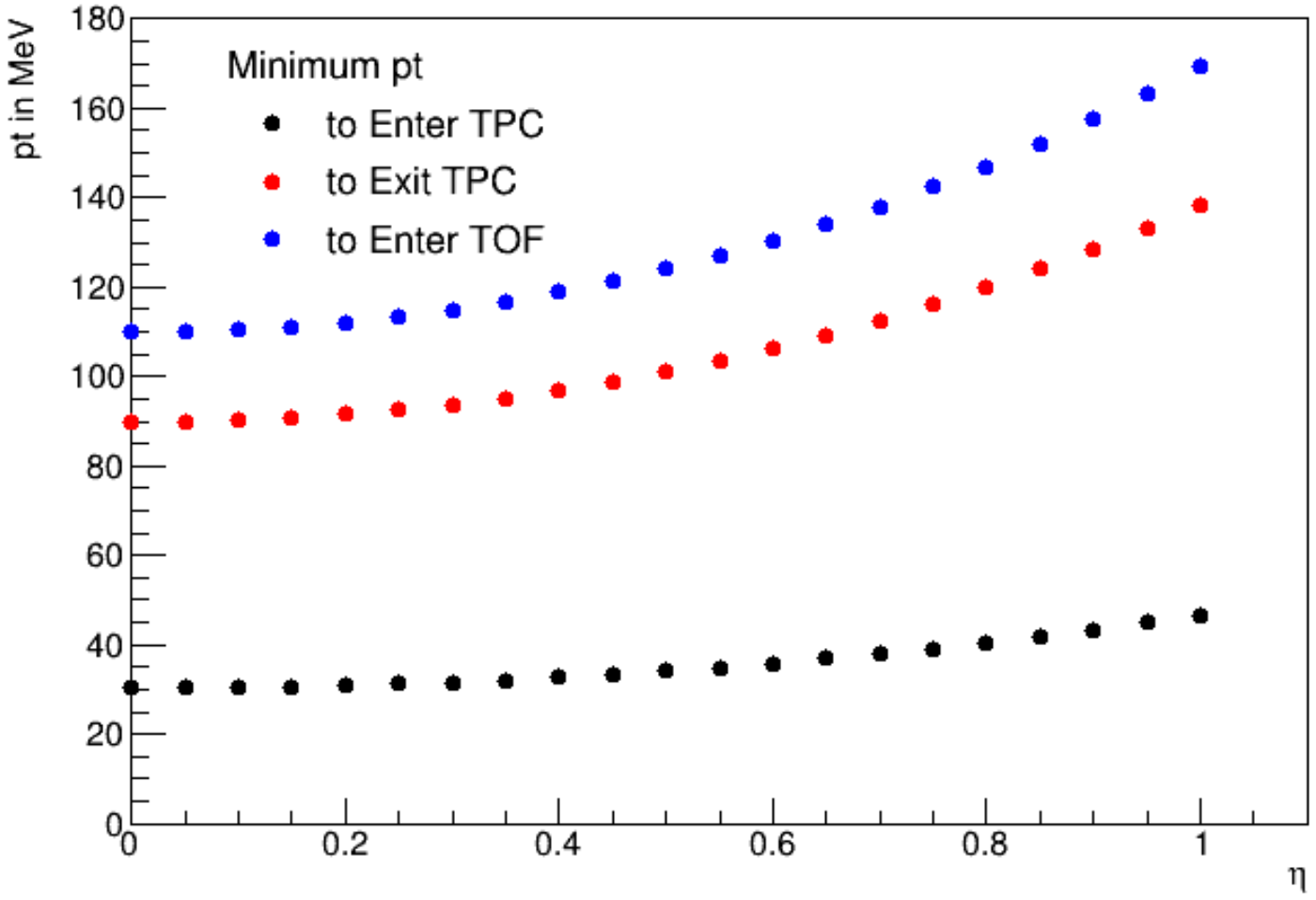
- In this study use :
  - Pluto: single pi0 Dalitz decay
  - UrQMD: Min. Bias BiBi at 9.2 GeV

ρ^0 -> e+e- (x20)
ω -> e+e- (x20)
ω -> $л^0$ e+e- (x20)
φ -> e+e- (x20)
φ -> η e+e- (x20)

- Divide the acceptance into the fiducial and veto area.

  - In this study, we use a very conservative fiducial region, $|y| < 0.3$ and veto is $0.3 < |y| < 1.0$.

Minimum pt required to enter or exit TPC and TOF



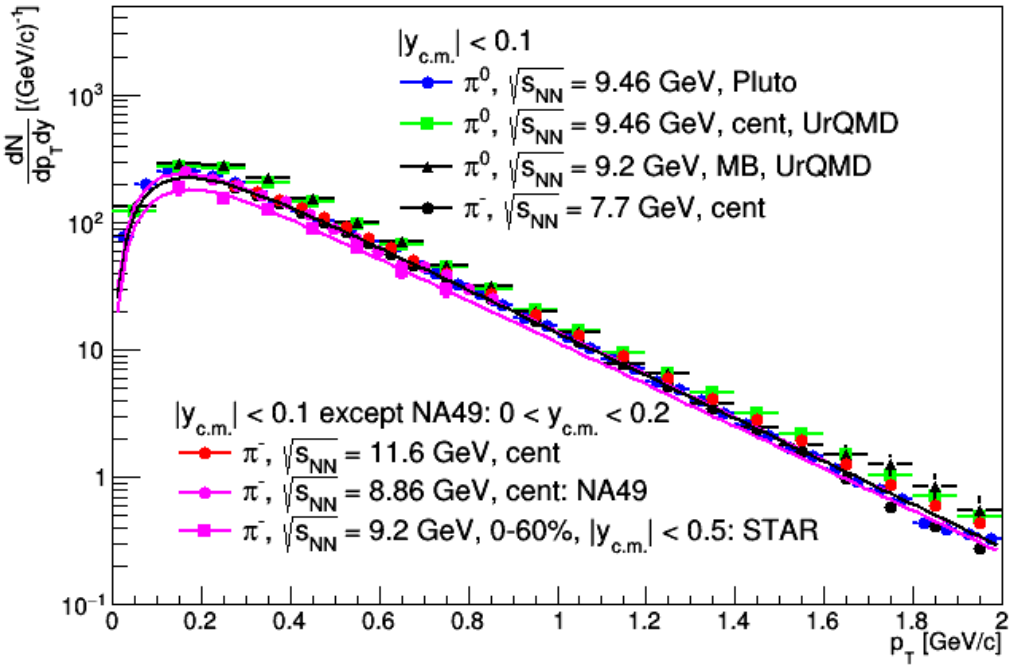
Assuming the TPC Inner radius to be 40.3 cm and outer radius to be 119.5 cm as well as TOF inner radius is 146.5 cm which is taken from its TDR.

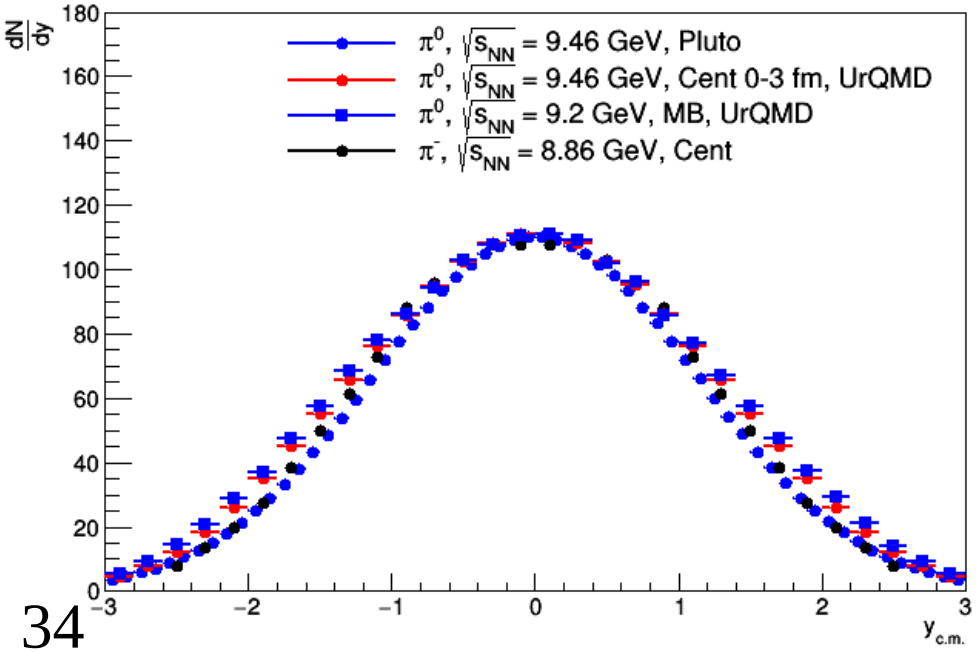
Comparison with data

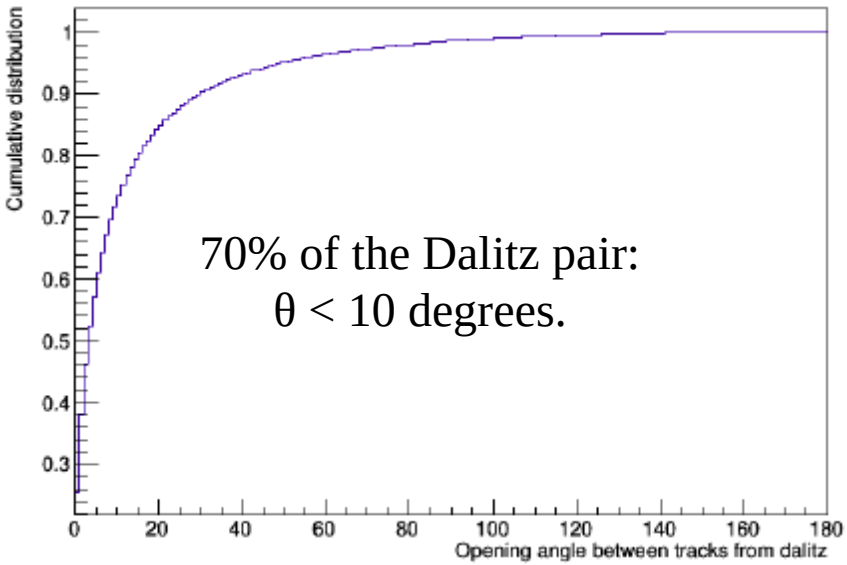
1) Analysis maybe sensitive to the shape of the pT and rapidity spectra.

2) pT spectra of pions in Pluto is rescaled to match with the data.

3) Rapidity spectra is reasonably reproduced without rescaling.







70% of the Dalitz pair:
$\theta < 10$ degrees.

1. Strategy: Ideal case with no detector effect

1) Assume that electron is fully reconstructed if it has a pt > 110 MeV and it is reconstructed in TPC only if it has a 30 < pt < 110 MeV.

2) Assume signal (N_s) is proportional to the number Dalitz pairs with both legs p_T > 200 MeV and within |y| < 0.3

3) Assume background (N_b) is proportional to square of single tracks originating from Dalitz decay where one leg is pT > 200 MeV in |y| < 0.3 and other leg is not fully reconstructed (TPC only track or Spiral track that is not reconstructed at all), can be anywhere in fiducial or veto area.

4) **Absolute values of S/B in these slides have no meaning, however, the relative difference between the two values is meaningful.**

5) Close TPC cut: Electrons with 30 < pt < 110 MeV and within an opening angle of 10 degrees.

Possible improvement in S/B

S = N_s = No of Dalitz pair in |y| < 0.3 with both legs pt > 200 MeV

B = $(N_b)^2$ = (No of single tracks from Dalitz in |y| < 0.3 with pt > 200 MeV with partner anywhere in fid. or veto

Pluto

Acc. |y| < 0.3 S/B = = 323 **(For representation only)**

Maximum gain in S/B (assuming partner with pT > 30 MeV and opening angle <10 deg is fully recognized)**:**
|y| < 0.3 S/B = 1259 ← **factor 4 improvement**

UrQMD

Acc. |y| < 0.3 S/B = 142 **(For representation only)**

Maximum gain in S/B (assuming partner with pT > 30 MeV and opening angle <10 deg is fully recognized):
|y| < 0.3 S/B = 692 ← **factor 5 improvement**

2. Strategy: Realistic case with detector

1) Now with more realistic case, with detector effect.
2) UrQMD: Request 11 production: Min. Bias BiBi at 9.2 GeV
3) Pluto using MPD ROOT used for request 11: pi0 Dalitz decay.
4) Applied track selection and PID cuts.
    1) |Vz| < 50 cm
    2) Nhits > 39
    3) DCA < 3σ
    4) -1 < TPC nSigma_e < 2σ
    5) |TOF beta| < 2σ
    6) TPC-TOF matching 2σ for dφ and dz.

5) Close TPC cut: Electron pool without TOF (TPC only tracks) and opening angle < 10 degrees.

Mpdroot dev branch: 50110a2507fc3da34d55648c9e7912f319af5455

Possible improvement in S/B

S = N_s = No of Dalitz pair in |y| < 0.3 with both legs pt > 200 MeV

B = $(N_b)^2$ = (No of single tracks from Dalitz in |y| < 0.3 with pt > 200 MeV with partner anywhere in fid. or veto

Pluto

Acc. |y| < 0.3 S/B = = 229 **(For representation only)**

Maximum gain in S/B (assuming partner with pT > 30 MeV and opening angle <10 deg is fully recognized)**:**
|y| < 0.3 S/B = 1080 ← **factor 5 improvement**

Gain in S/B (i.e. using TPC current reconstruction software and requiring Nhits > 39 and opening angle < 10 deg.)**:**
|y| < 0.3 S/B = 326 ← **factor 1.42 improvement**

UrQMD

Acc. |y| < 0.3 S/B = 101 **(For representation only)**

Maximum gain in S/B (assuming partner with pT > 30 MeV and opening angle <10 deg is fully recognized)**:**
|y| < 0.3 S/B = 8308 ← **factor 8 improvement**

Gain in S/B (i.e. using TPC current reconstruction software and requiring Nhits > 39 and opening angle < 10 deg.)**:**
|y| < 0.3 S/B = 128 ← **factor 1.26 improvement**

3. Improvement in CB rejection: Current Status

1) UrQMD production Min. Bias BiBi@9.2 GeV: Request 11, Events approx. 8.7 M

2) Single event and track selection criteria for creating pools:

   1) $|Vz| < 50$ cm

   2) Nhits > 39

   3) DCA < 3σ

   4) -1 < TPC nSigma_e < 2σ

   5) |TOF beta| < 2σ

   6) TPC-TOF matching 2σ for dφ and dz.

Mpdroot dev branch: 50110a2507fc3da34d55648c9e7912f319af5455

Improvement in S/B

S = (ULS -LS) in $0.2 < M_{inv} < 0.6$ GeV/c^2

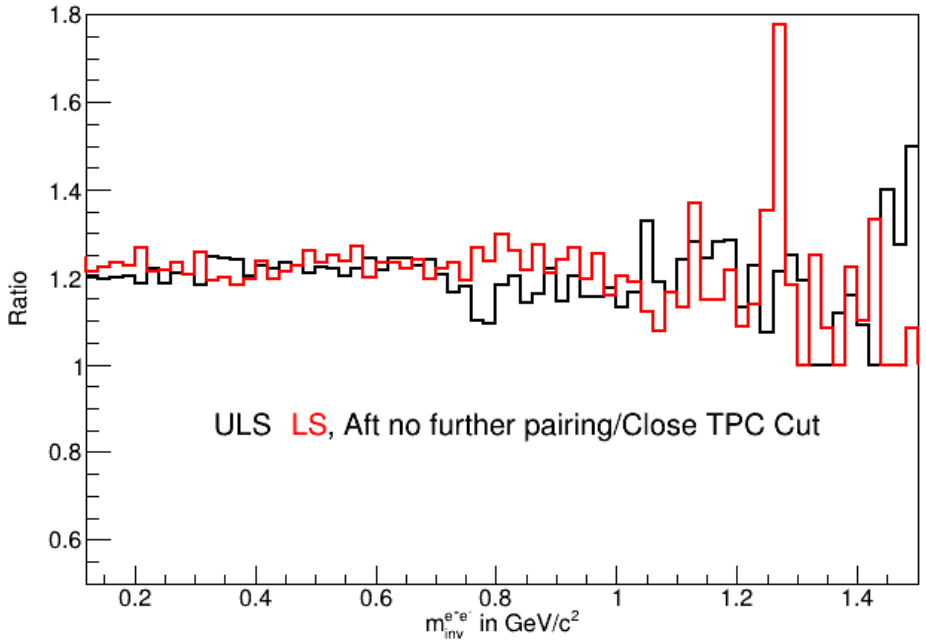
B = LS in $0.2 < M_{inv} < 0.6$ GeV/c^2

UrQMD

Acc. |y| < 0.3 S/B = 0.049 **(for representation only)**

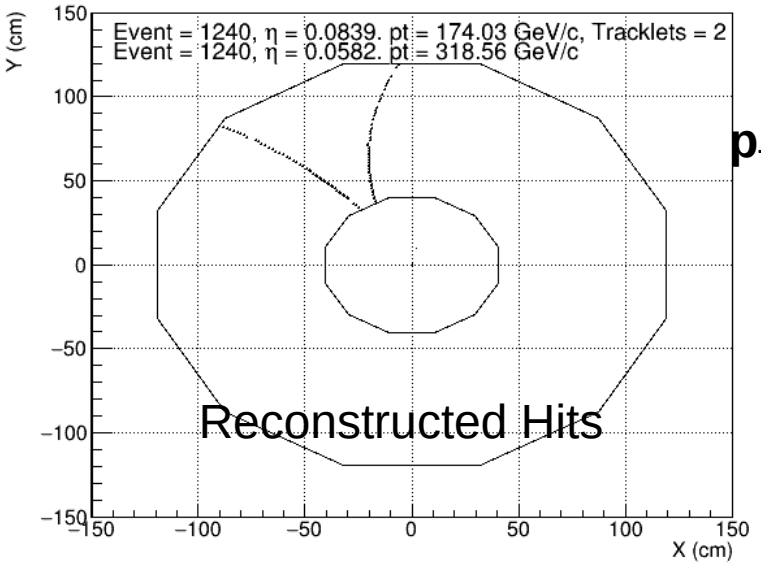
Gain in S/B (i.e. With current reconstruction algorithm)**:**

|y| < 0.3 S/B = 0.055 ← **factor 1.12 improvement**

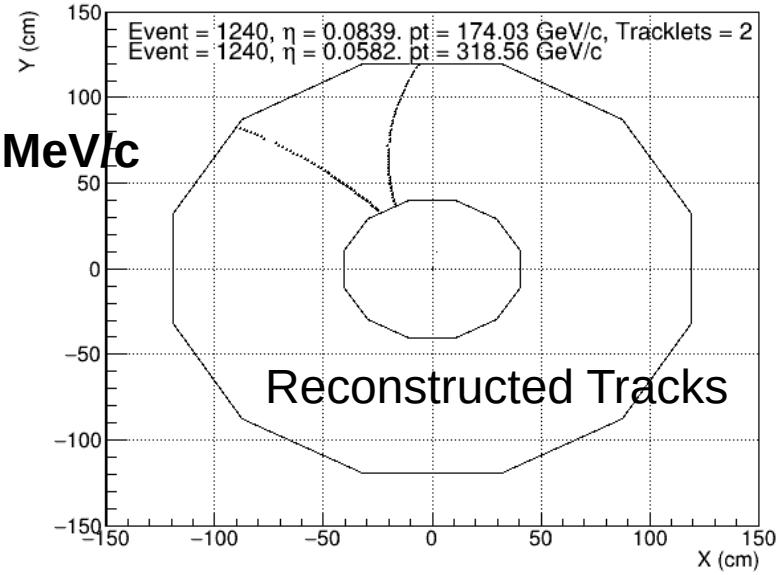


- About 20% reduction in combinatorial background.

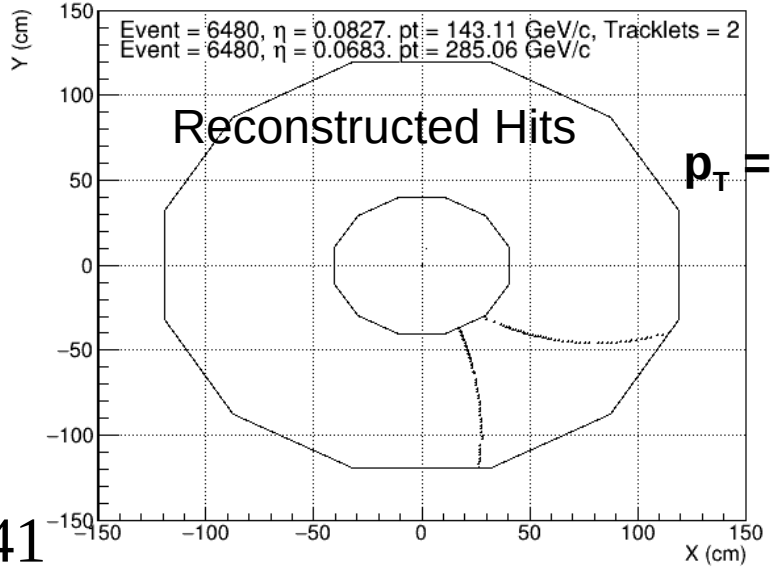
Low pt track reconstruction with current algorithm



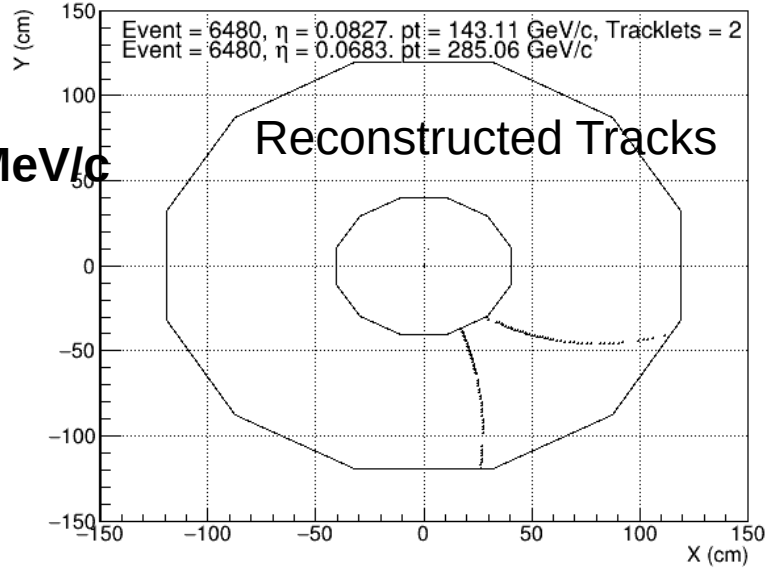
p_T = 174 MeV/c



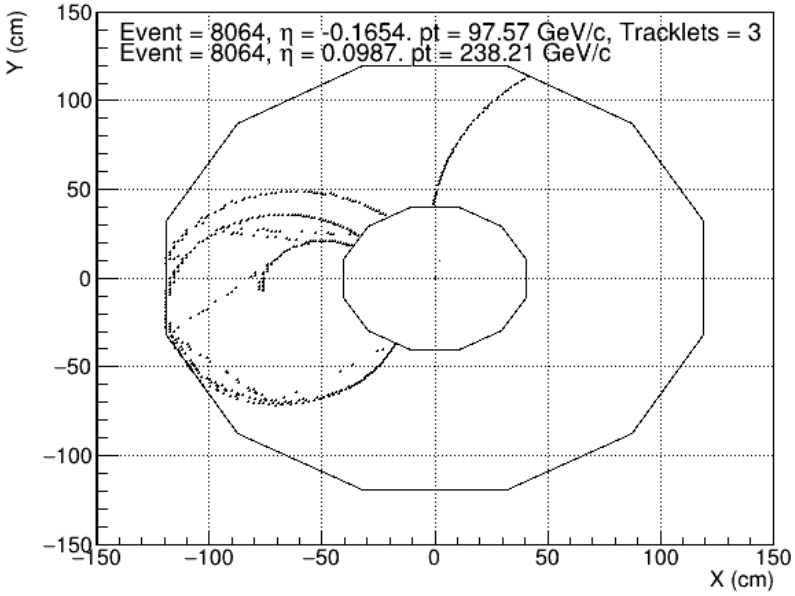
In all the plots one leg has p_T > 200 MeV and 0 < η < 0.1

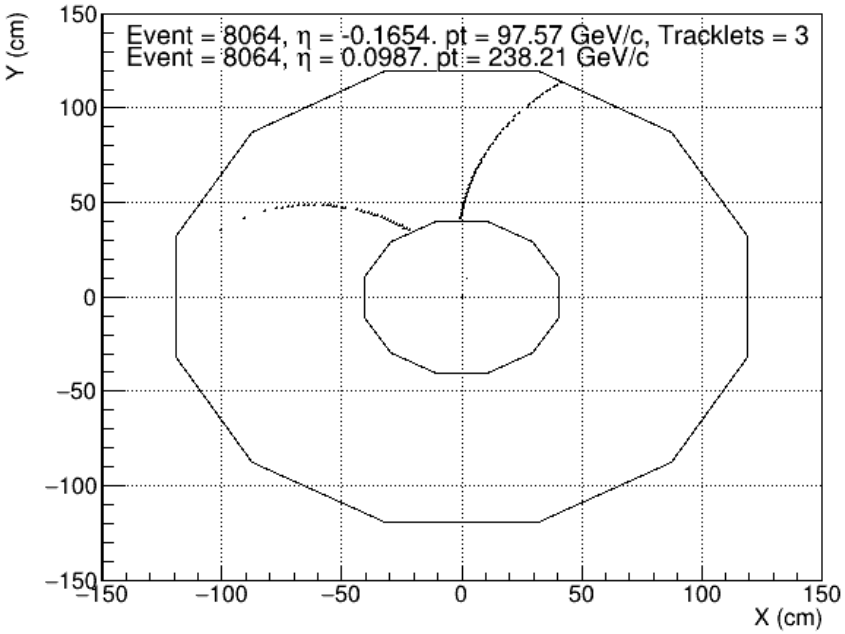


p_T = 143 MeV/c

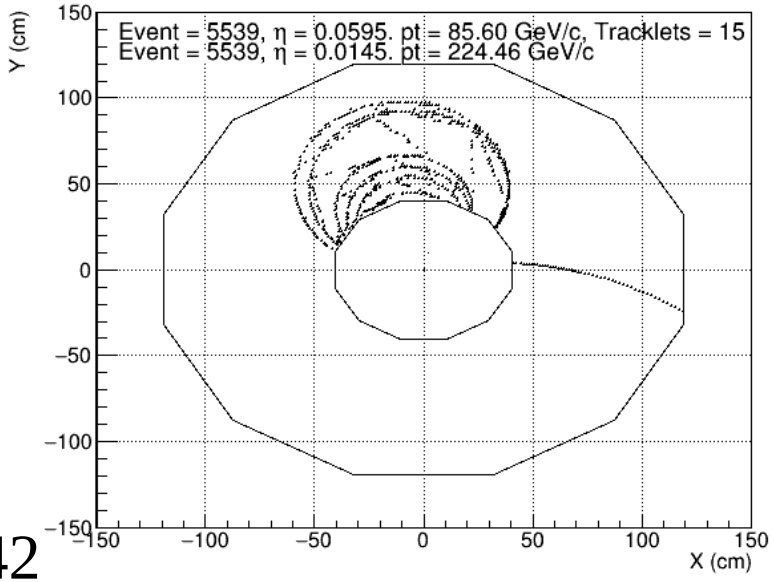


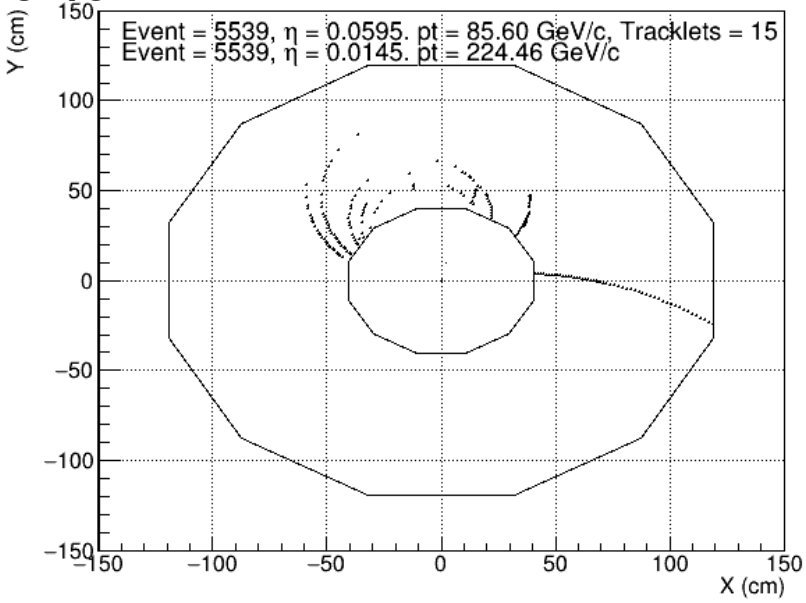
p_T = 98 MeV/c



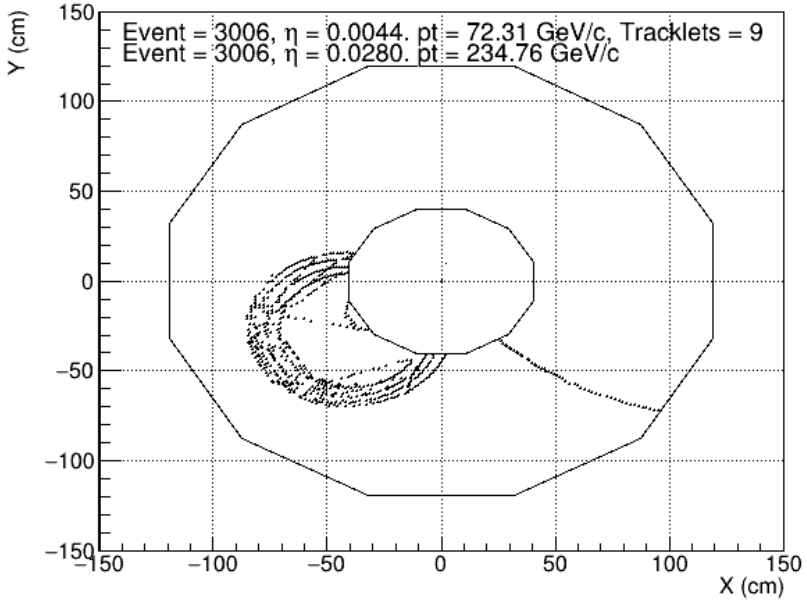


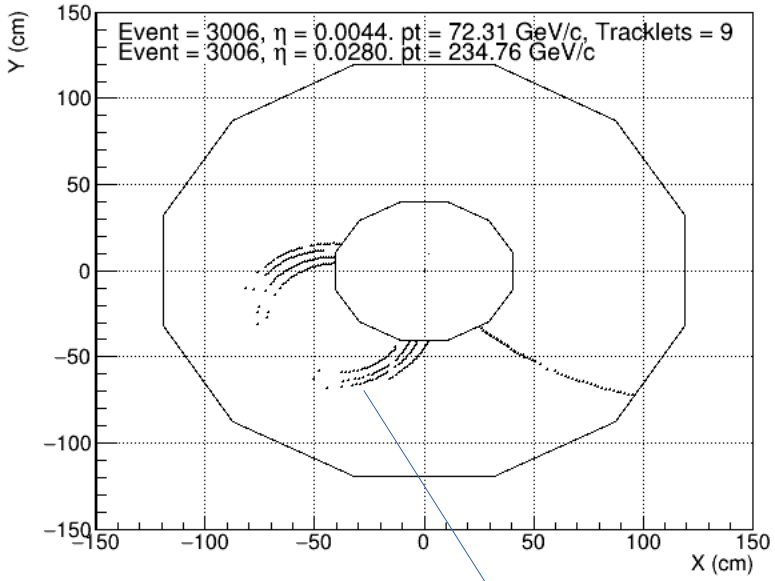
p_T = 86 MeV/c





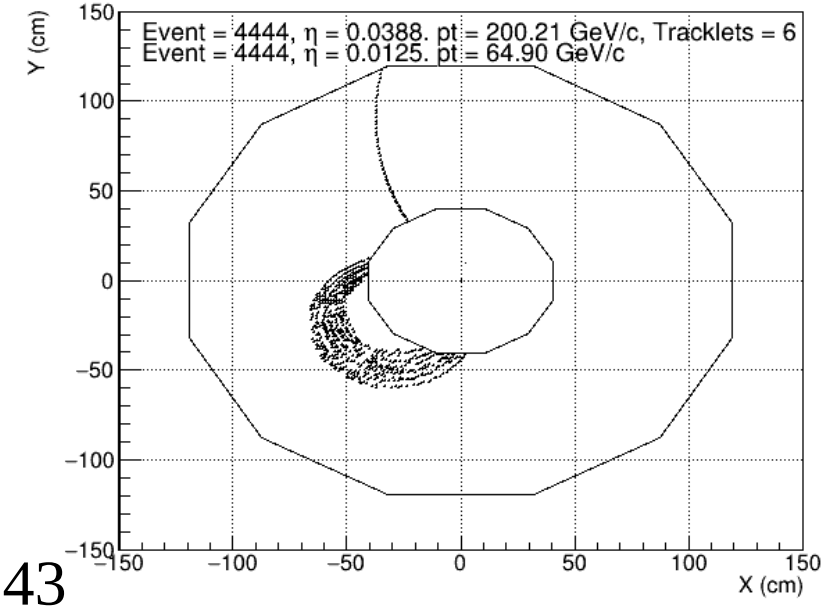
p_T = 72 MeV/c

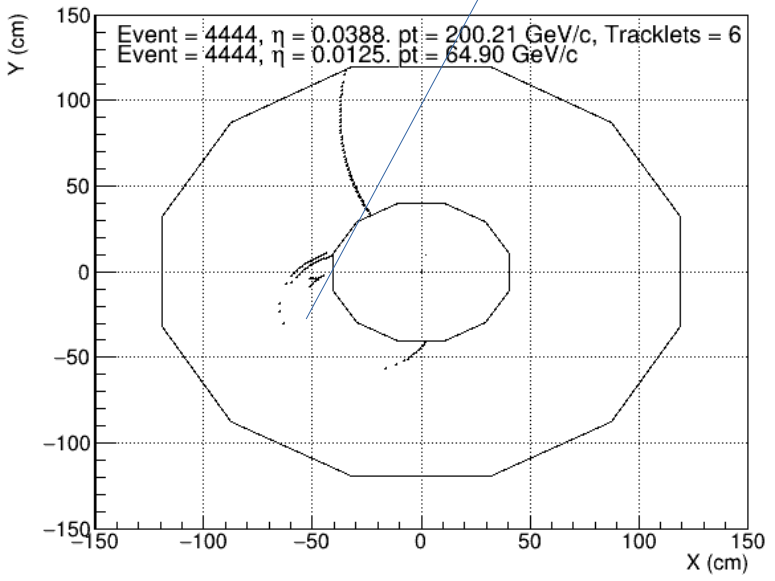




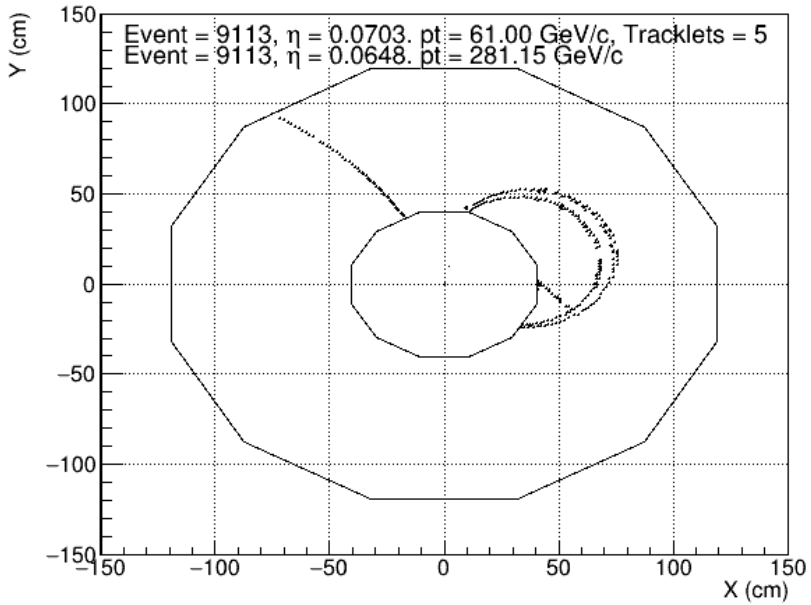
p_T = 65 MeV/c

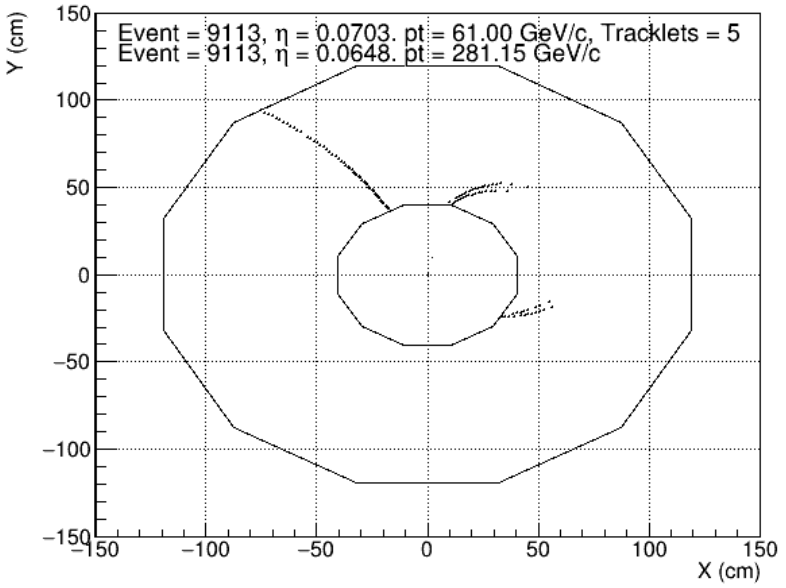
Partially reconstructed spiral track



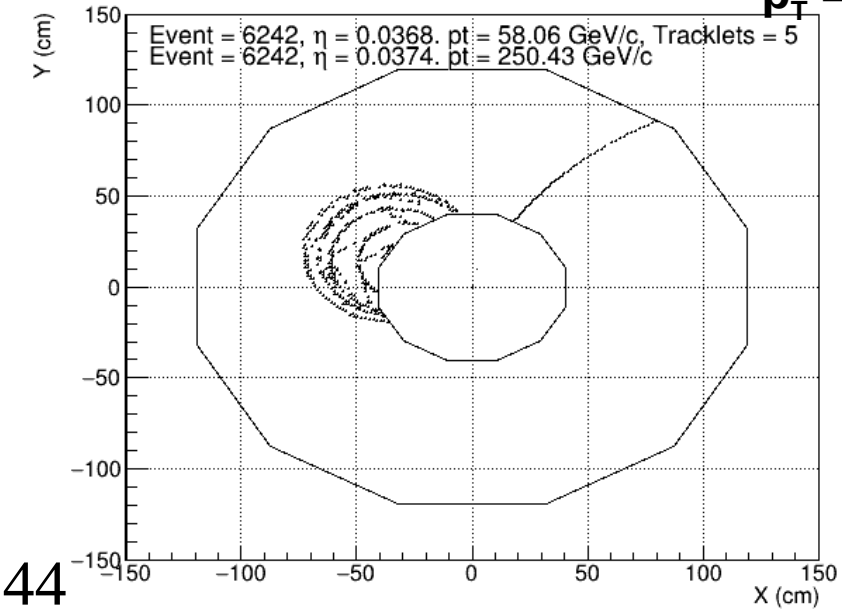


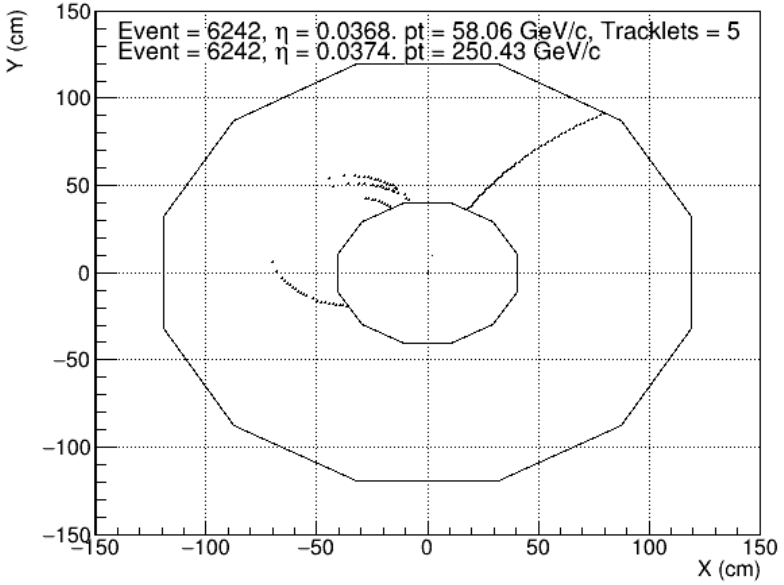
p_T = 61 MeV/c



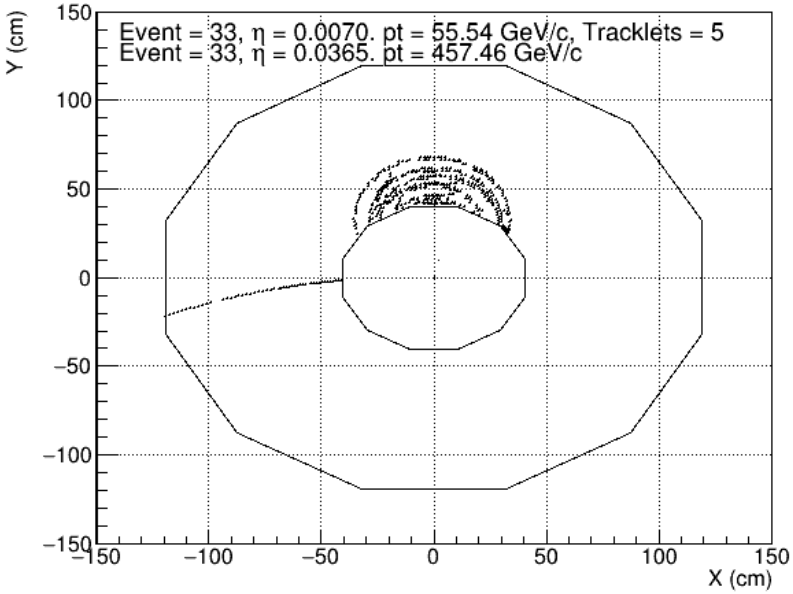


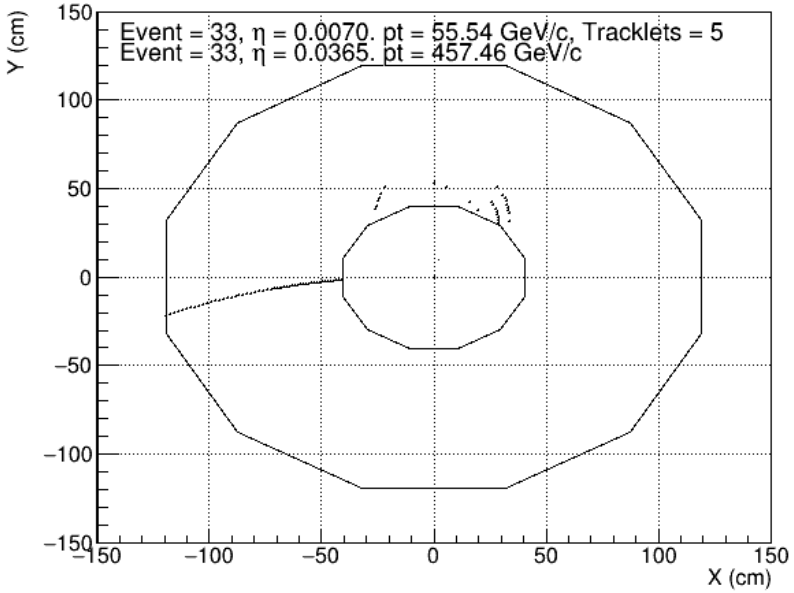
p_T = 58 MeV/c



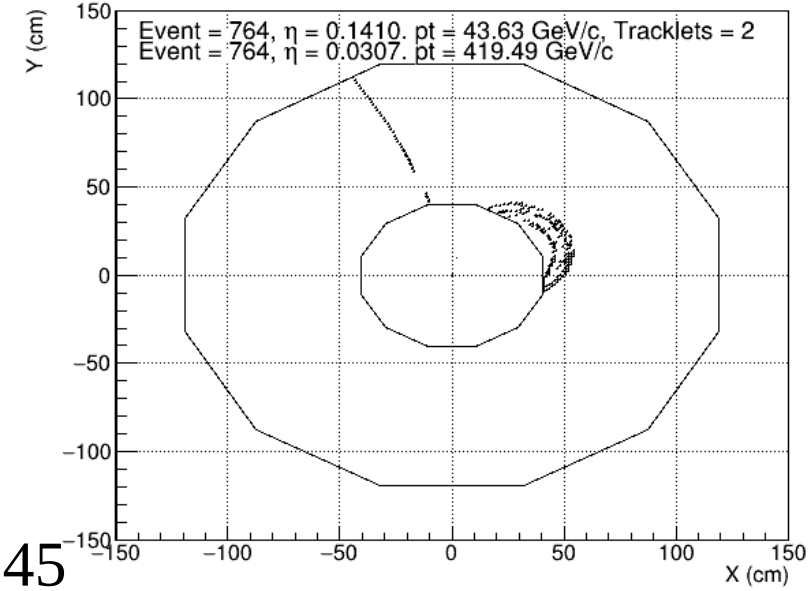


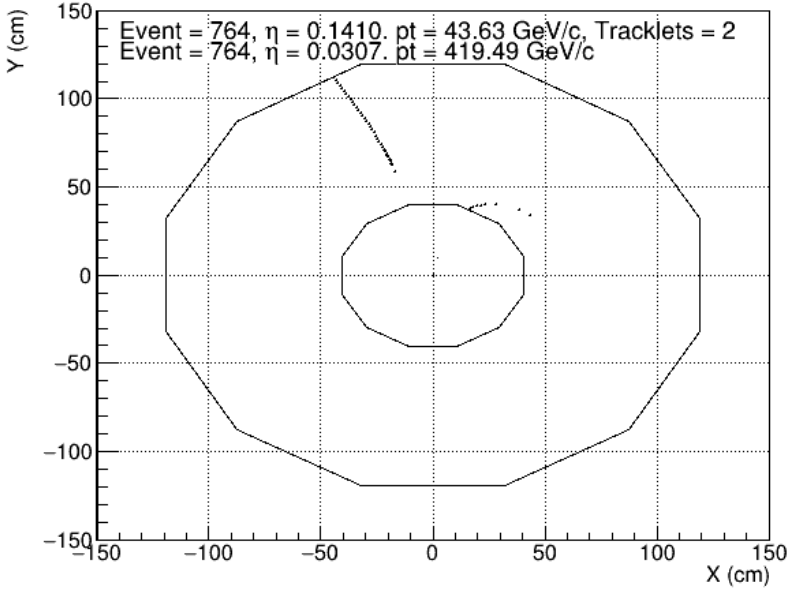
p_T = 56 MeV/c



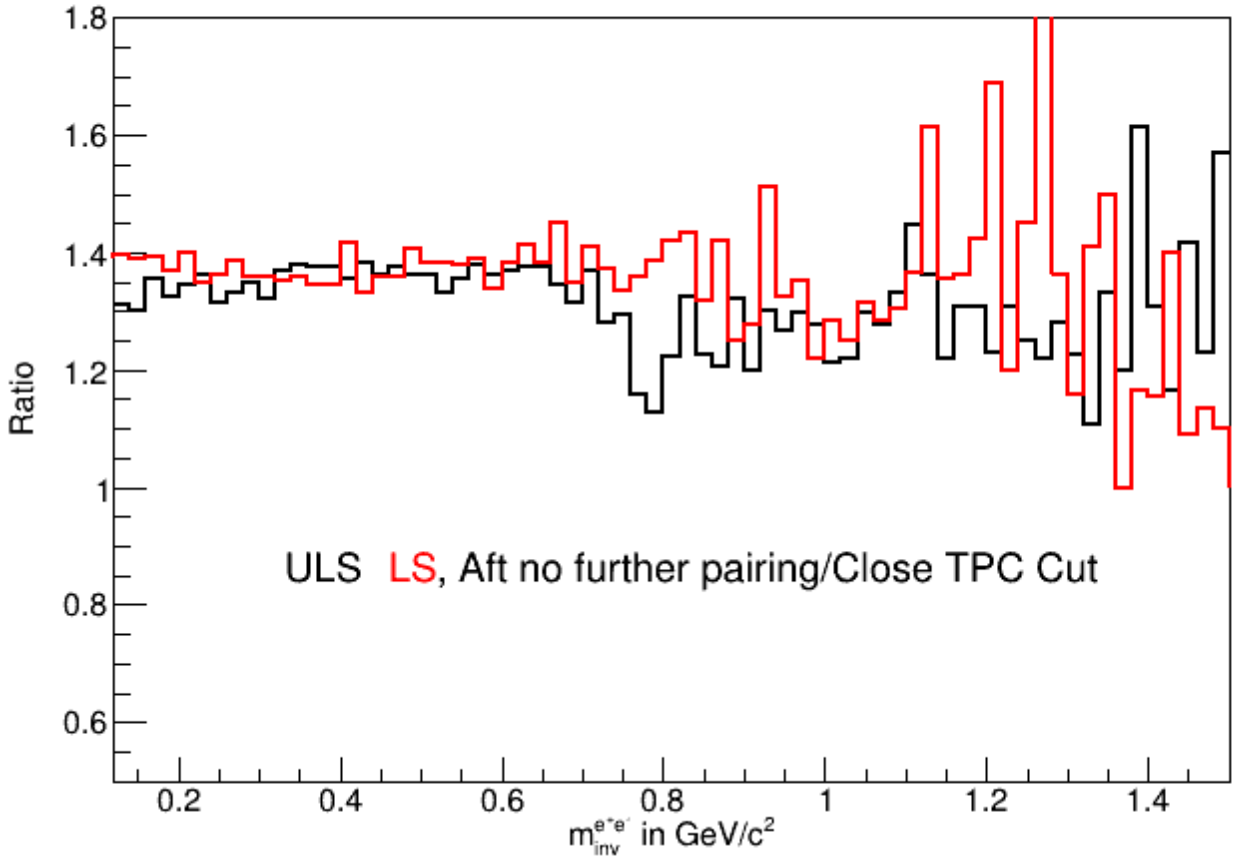


p_T = 44 MeV/c





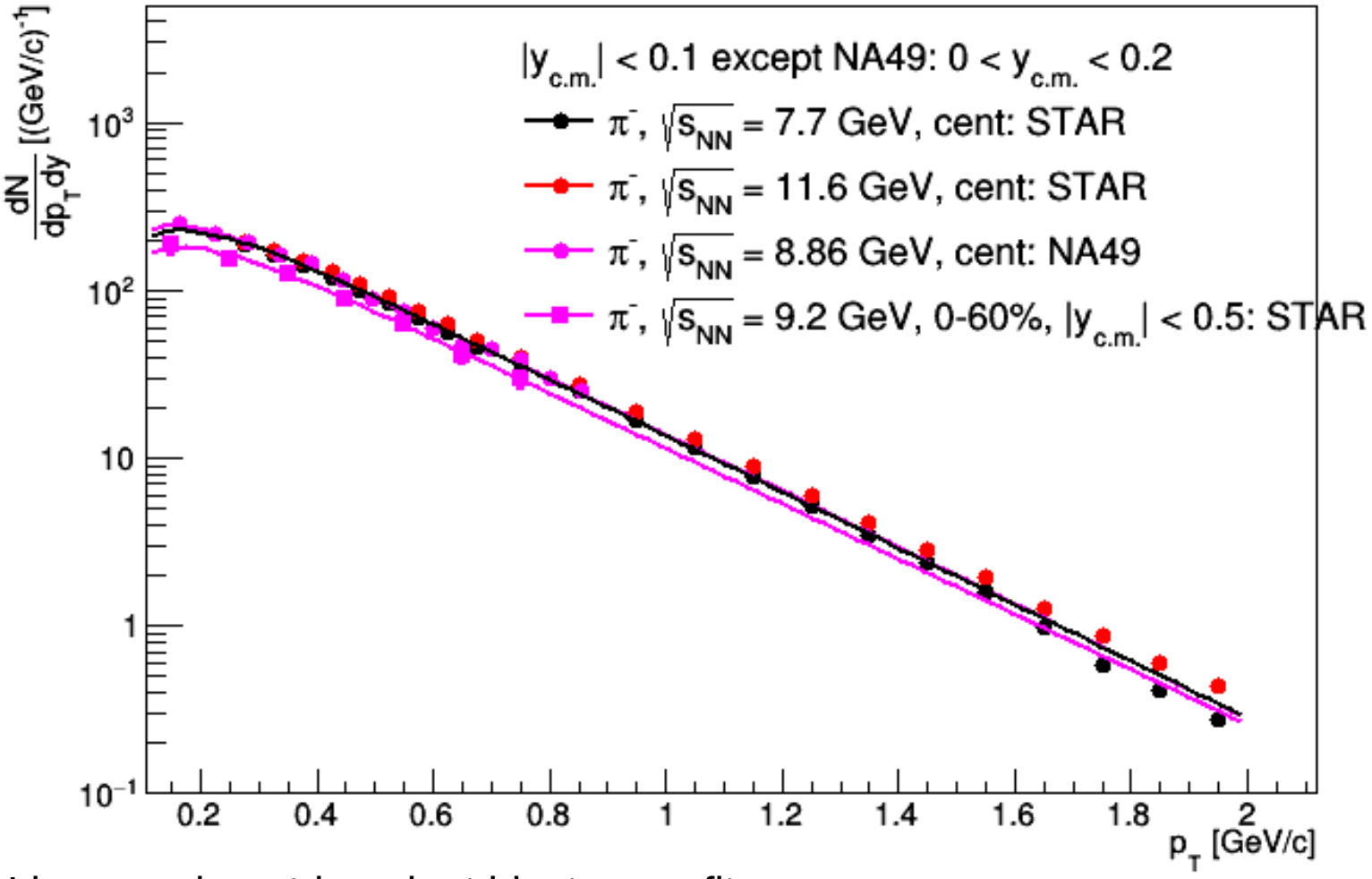
Number of TPC Hits on partner > 20



S/B (Aft Close TPC Cut/No further pairing):(ULS-LS/LS): 1.21

ρ^0 -> e+e- (x20)
ω -> e+e- (x20)
ω -> π^0 e+e- (x20)
ϕ -> e+e- (x20)
ϕ -> η e+e- (x20)

Y-axis is scaled with an arbitary factor

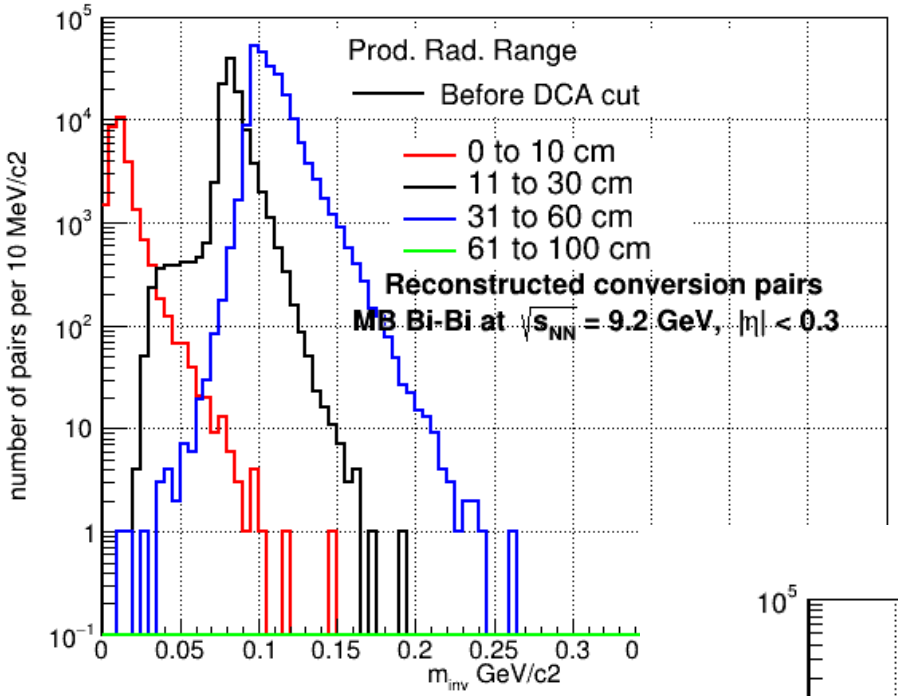


Lines are boost-invariant blast wave fits.

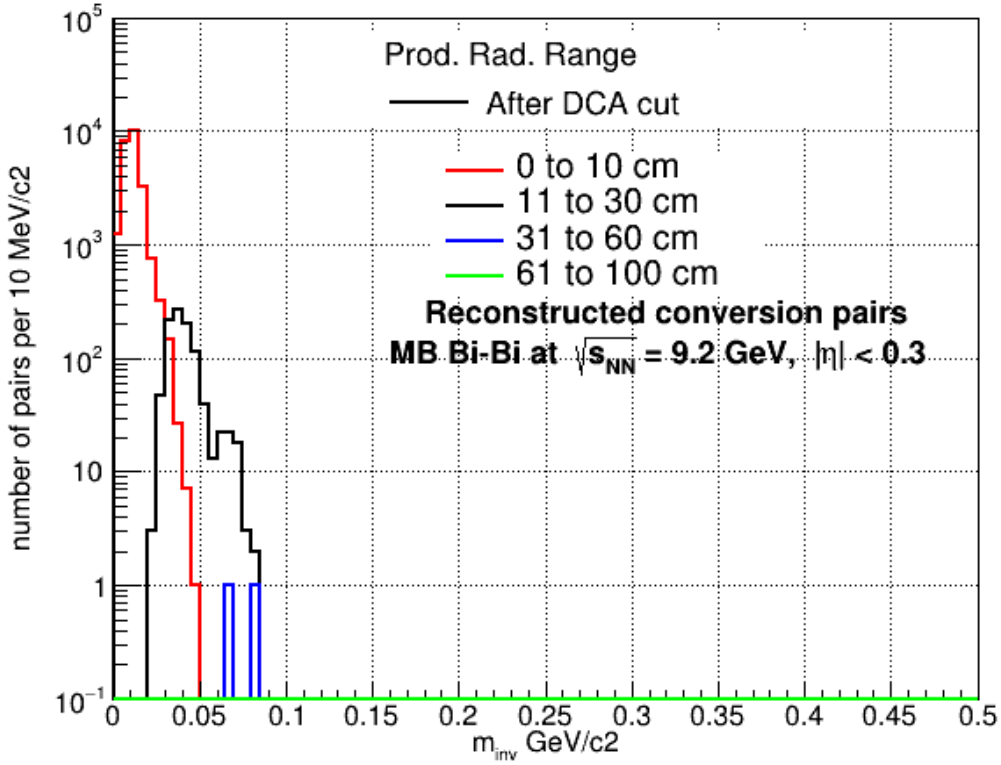
Minimum pt (in MeV) to enter TPC and TOF and exit TPC in various eta regions

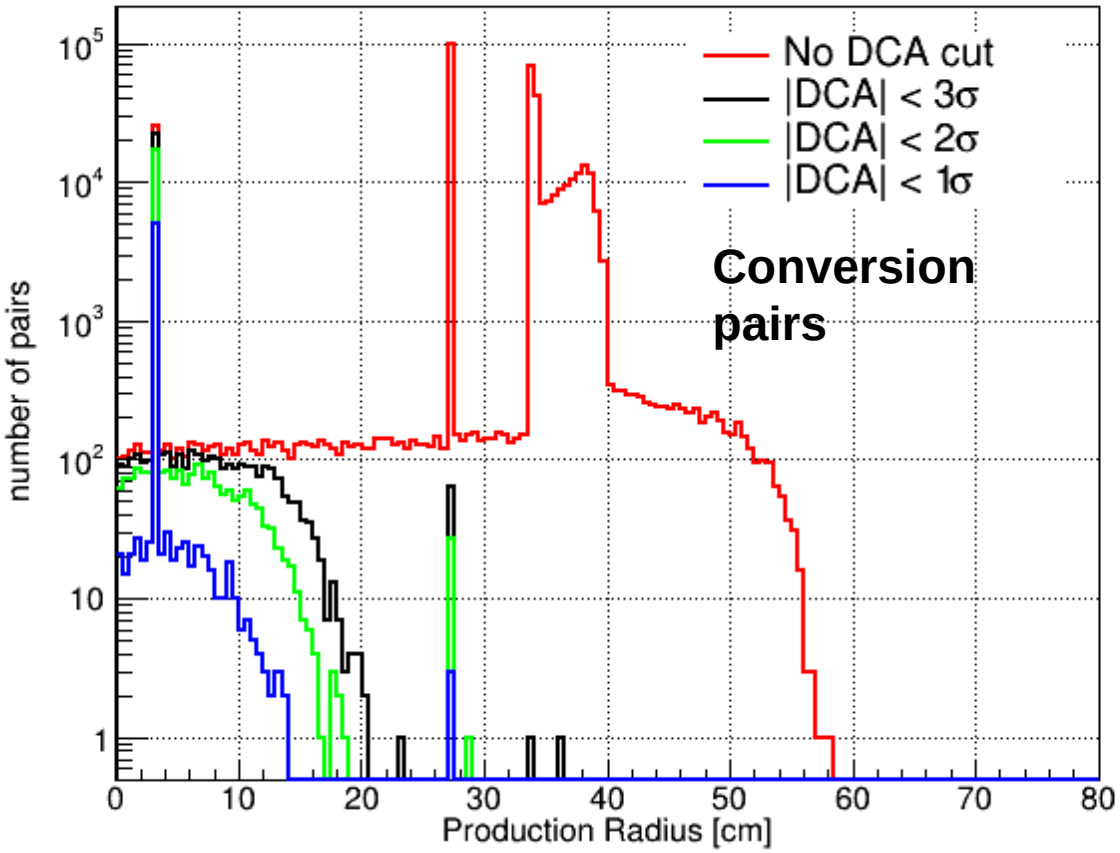
Eta	theta	Min. Rad. of curv at TPC entrance	Min. pt to enter TPC	Min. Rad. of curv. at TPC exit	Min. pt to exit TPC	Min. Rad. at TOF entrance	Min. pt to enter TOF
0.000	90.00	20.15	30.22	59.75	89.62	73.25	109.88
0.050	87.14	20.18	30.26	59.82	89.74	73.34	110.01
0.100	84.28	20.25	30.38	60.05	90.07	73.62	110.42
0.150	81.44	20.38	30.57	60.42	90.64	74.08	111.11
0.200	78.62	20.55	30.83	60.95	91.42	74.72	112.08
0.250	75.82	20.78	31.17	61.63	92.44	75.55	113.33
0.300	73.06	21.06	31.60	62.46	93.69	76.57	114.86
0.350	70.34	21.40	32.10	63.45	95.17	77.78	116.67
0.400	67.67	21.78	32.68	64.59	96.89	79.19	118.78
0.450	65.05	22.22	33.34	65.90	98.85	80.79	121.19
0.500	62.48	22.72	34.08	67.38	101.06	82.60	123.90
0.550	59.97	23.28	34.91	69.02	103.53	84.61	126.92
0.600	57.52	23.89	35.83	70.83	106.25	86.84	130.25
0.650	55.13	24.56	36.84	72.82	109.23	89.28	133.91
0.700	52.82	25.29	37.94	75.00	112.49	91.94	137.91
0.750	50.57	26.09	39.13	77.36	116.04	94.84	142.25
0.800	48.39	26.95	40.42	79.91	119.87	97.97	146.95
0.850	46.29	27.88	41.82	82.67	124.00	101.34	152.02
0.900	44.25	28.88	43.32	85.63	128.44	104.97	157.46
0.950	42.29	29.95	44.92	88.80	133.20	108.87	163.30
1.000	40.40	31.09	46.64	92.20	138.30	113.03	169.55
1.050	38.57	32.32	48.47	95.83	143.74	117.48	176.22
1.100	36.82	33.62	50.43	99.69	149.54	122.22	183.33
1.150	35.14	35.01	52.51	103.8	155.72	127.27	190.90
1.200	33.52	36.48	54.73	108.2	162.28	132.63	198.95

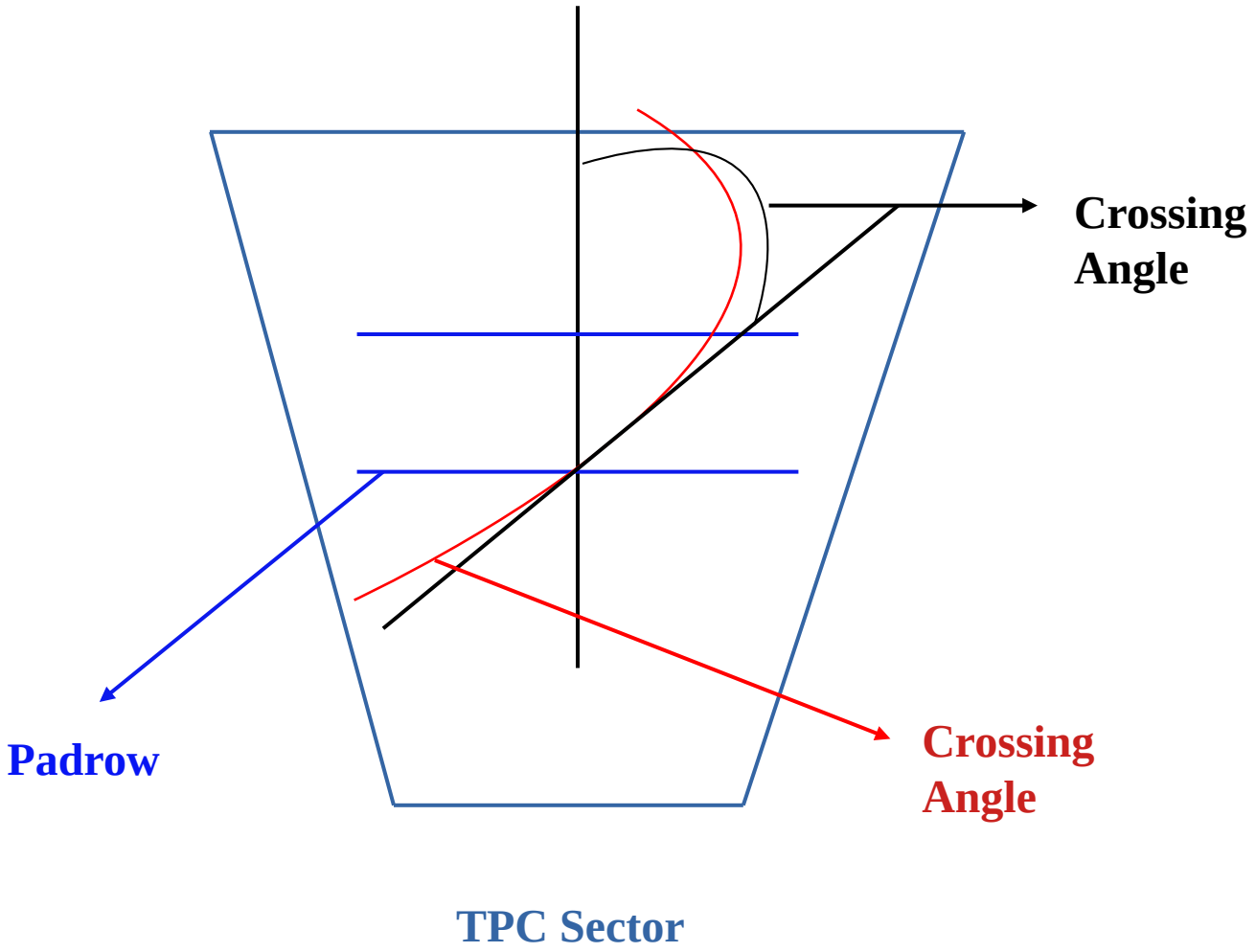
NOTE: TPC Inner (40.3 cm) and outer radius (119.5 cm) values are taken from the analysis code and TOF inner radius (146.5 cm) value is taken from its TDR.



Invariant mass spectra of reconstructed conversion pairs in different production radius regions, before and after applying DCA selection.




No DCA cut
|DCA| < 3σ
|DCA| < 2σ
|DCA| < 1σ
Conversion pairs
number of pairs
Production Radius [cm]
10^5
10^4
10^3
10^2
10
1
0
10
20
30
40
50
60
70
80


Crossing
Angle
Padrow
Crossing
Angle
TPC Sector