Primary vertexing with beam backgrounds

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Reconstruction of D^0 meson

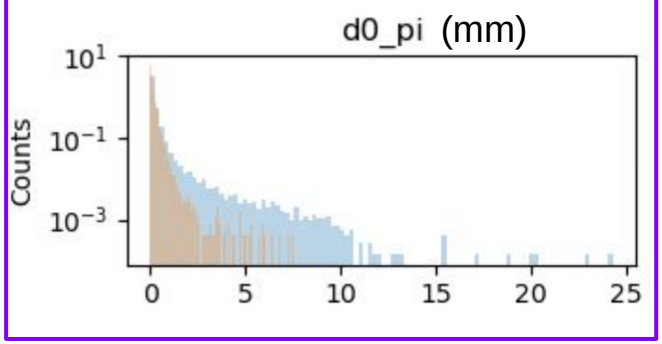
Primary Vertex Reconstruction:

- **CentralTrackVertices**
- Primary vertex: allows access to the DCA of reconstructed tracks

Slides (connie)

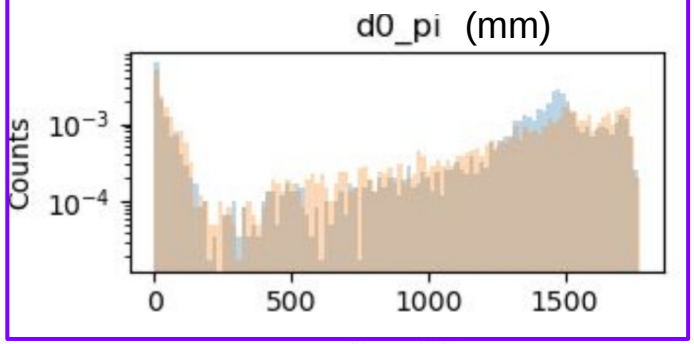
10x100 ep, $Q^2 > 1$

w/o Machine bkg



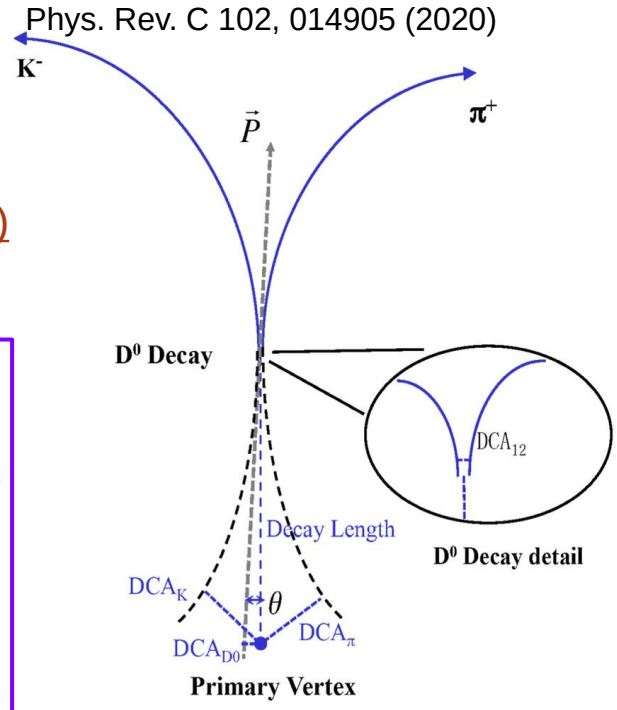
Signal (D^0 sample)

w Machine bkg (nhits>3)



Bkg (DIS Sample)

Phys. Rev. C 102, 014905 (2020)



d0_pi = DCA_π (plot)

Broadening of d0_pi distribution points some issue in the primary vertex position

Initial idea is to do also primary vertexing with nhits>3 to fix the issue (Open Issue#2405)

Primary Vertexing w/o Machine Bkg

10x100 ep, $Q^2 > 1$ (DIS Sample)

Ntracks: CentralTrackVertices.associatedParticles_end-CentralTrackVertices.associatedParticles_begin

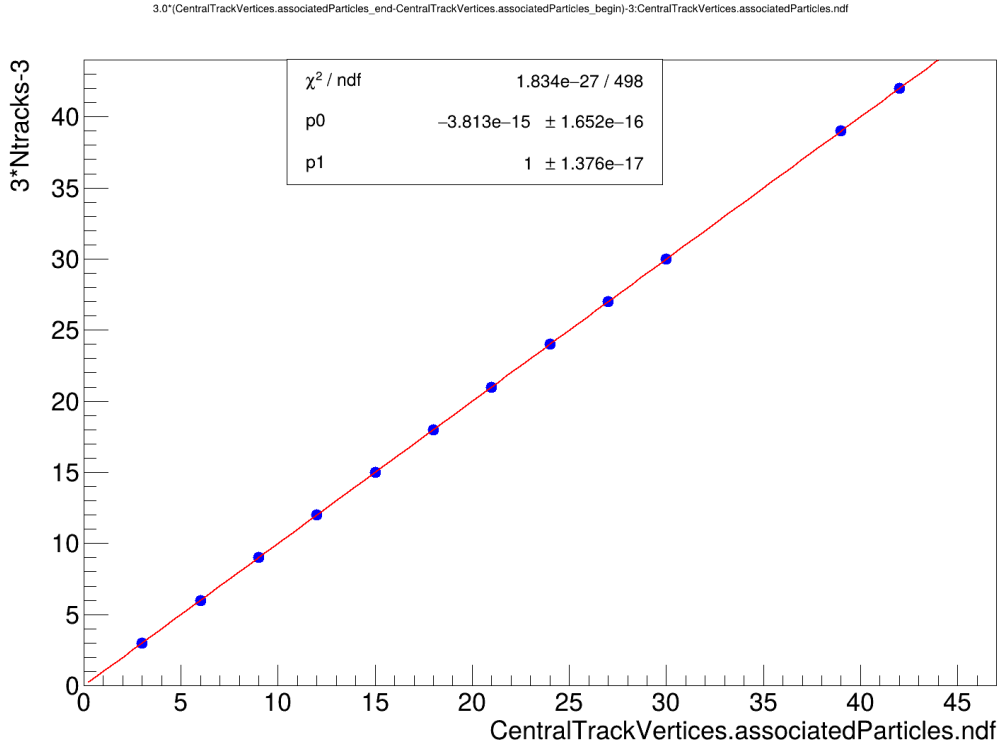
ndf: CentralTrackVertices.associatedParticles.ndf

pythia8NCDIS_10x100_minQ2=1_beamEffects_xAngle=-0.025_hiDiv_1.0028.eicrecon.edm4eic.root (**October Campaign**)

Event	PV Id	Ntracks	ndf
0	0		
1	0	5	12
2	0	4	9
3	0	3	6
4	0	4	9
5	0	2	3
6	0	6	15
7	0	8	21
8	0	6	15
9	0	4	9
10	0		
11	0	3	6
12	0	5	12
13	0	7	18
14	0	3	6
15	0	3	6
16	0	5	12
17	0	5	12
18	0	4	9
19	0	2	3
20	0	5	12
21	0	5	12
22	0		
23	0	3	6
24	0	6	15

Total events = 591

ndf = 3*Ntracks -3



Primary Vertexing w/o Machine Bkg

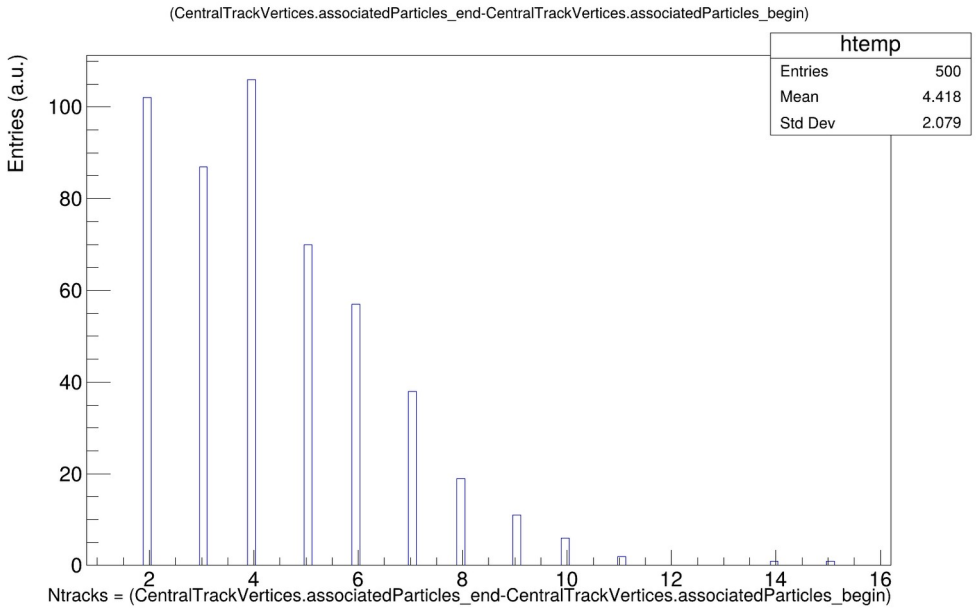
----------MC Vertex Information: Event No = 0----------
(0.22446 0.0057609 24.536)
----------MC Vertex Information: Event No = 1----------
(0.0293175 -0.0203593 73.4263)
----------Reco Vertex Information: Event No = 1----------
3Ntracks-3 ndf chi2ndf Vx Vy Vz
12 12 0.46402 (0.0329644 -0.0242988 73.4962)
----------MC Vertex Information: Event No = 2----------
(0.10376 -0.0211462 -3.96999)
----------Reco Vertex Information: Event No = 2----------
3Ntracks-3 ndf chi2ndf Vx Vy Vz
9 9 0.620851 (0.0701558 -0.06535 -4.32553)
----------MC Vertex Information: Event No = 3----------
(-0.0511386 0.00207766 15.0358)
----------Reco Vertex Information: Event No = 3----------
3Ntracks-3 ndf chi2ndf Vx Vy Vz
6 6 0.0603734 (-0.112971 0.0716674 15.757)
----------MC Vertex Information: Event No = 4----------
(-0.19037 0.00102608 -27.5589)
----------Reco Vertex Information: Event No = 4----------
3Ntracks-3 ndf chi2ndf Vx Vy Vz
9 9 0.74793 (-0.191245 -0.0583328 -26.984)
----------MC Vertex Information: Event No = 5----------
(-0.0807923 0.00214323 34.5827)
----------Reco Vertex Information: Event No = 5----------
3Ntracks-3 ndf chi2ndf Vx Vy Vz
3 3 0.00408565 (-0.0748451 0.00242466 34.4446)
----------MC Vertex Information: Event No = 6----------
(-0.0362494 0.00251776 -2.01529)
----------Reco Vertex Information: Event No = 6----------
3Ntracks-3 ndf chi2ndf Vx Vy Vz
15 15 0.429248 (0.0360853 0.0378036 -1.99735)

Reco vertex is closer to the MC Vertex

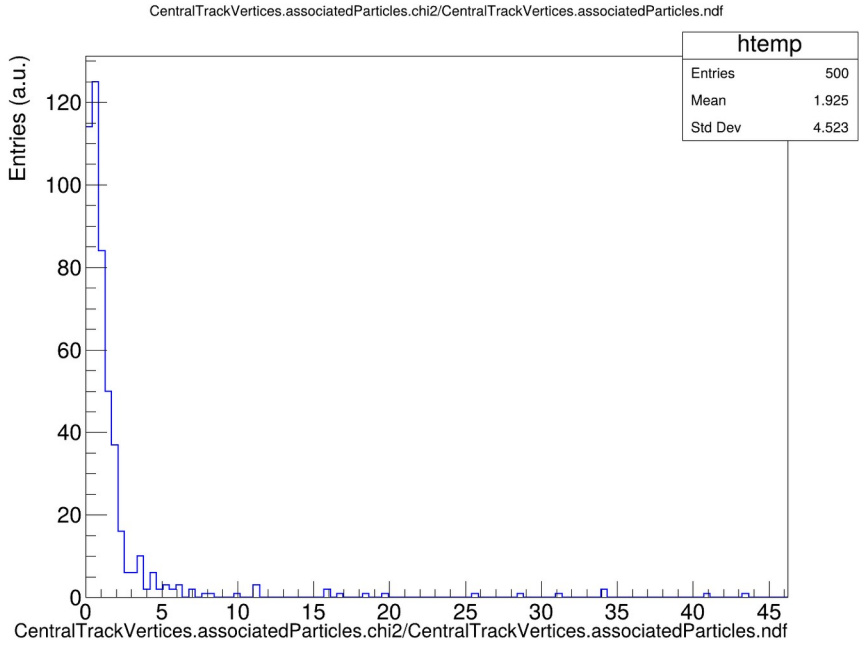
Chi2/ndf is around 1

Primary Vertexing w/o Machine Bkg

Contributors to PV



Chi2/ndf



- Mean contributors for the reconstruction of primary vertex are around 4
- Chi2/ndf is peaks around 1
- Results are inline with expectation in generic NCDIS sample

Primary Vertexing w Machine Bkg

10x100 ep, $Q^2 > 1$ (DIS Sample)

Ntracks: CentralTrackVertices.associatedParticles_end-CentralTrackVertices.associatedParticles_begin

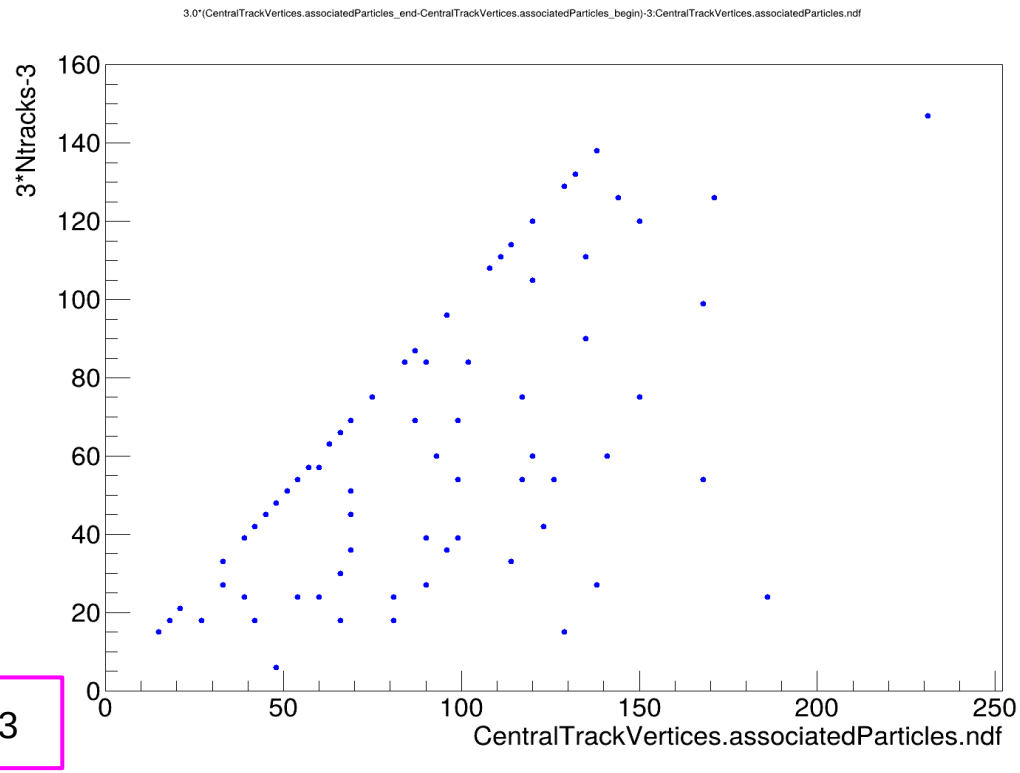
ndf: CentralTrackVertices.associatedParticles.ndf

pythia8NCDIS_10x100_minQ2\=1_beamEffects_xAngle\=-0.025_hiDiv_1.0000.eicrecon.edm4eic.root (**October Campaign**)

Total events = 48

Event	PV Id	Ntracks	ndf	3*Ntracks-3
0	0			
1	0	31	135	90
1	1	23	66	66
2	0			
3	0	39	114	114
4	0			
5	0			
6	0			
7	0	44	129	129
8	0			
9	0	6	129	15
9	1	9	60	24
9	2	18	69	51
9	3	19	54	54
10	0			
11	0	50	231	147
11	1	12	114	33
11	2	9	39	24
11	3	26	75	75
11	4	8	21	21
12	0			
13	0			
14	0	37	108	108
15	0	19	126	54
15	1	33	96	96

ndf = 3*Ntracks -3



Primary Vertexing w Machine Bkg

----------MC Vertex Information: Event No = 1----------
(-0.231462 0.00100639 38.5155)
----------Reco Vertex Information: Event No = 1----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
90	135	539.292	(-0.982007	0.000185017	74.2979)
66	66	292.772	(-0.20596	-1.22411	53.4437)

----------MC Vertex Information: Event No = 2----------
(0.202966 -0.00577033 -58.893)
(0.158751 0.00679257 37.3814)
----------Reco Vertex Information: Event No = 3----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
114	114	584.743	(-0.205433	-0.193026	83.6192)

----------MC Vertex Information: Event No = 4----------
(0.183743 0.003125 7.09439)
(-0.0738131 -0.00324729 -13.3178)
----------MC Vertex Information: Event No = 6----------
(-0.275477 0.00666589 -15.8192)
----------MC Vertex Information: Event No = 7----------
(0.0532232 0.00333409 45.716)
(-0.237821 0.000122148 10.7846)
----------Reco Vertex Information: Event No = 7----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
129	129	481.727	(0.0521538	-0.106361	9.58888)

----------MC Vertex Information: Event No = 8----------
(0.275048 0.00679094 -12.0624)
(-0.287426 -0.00715041 -15.4685)
----------MC Vertex Information: Event No = 9----------
(0.137061 -0.00632873 -61.8435)
----------Reco Vertex Information: Event No = 9----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
15	129	577.552	(0.555058	-0.000395048	69.1452)
24	60	620.273	(-0.120499	1.49236	66.9512)
51	69	565.713	(2.61076	1.91363	84.2191)
54	54	629.041	(0.461923	-0.976131	66.1694)

----------MC Vertex Information: Event No = 10----------
(0.00958197 -0.0106679 18.6299)
----------MC Vertex Information: Event No = 10----------
(0.00958197 -0.0106679 18.6299)
----------Reco Vertex Information: Event No = 11----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
147	231	448.038	(-0.0800432	0.298621	147.571)
33	114	480.897	(0.528023	0.446084	135.613)
24	39	152.542	(-0.625209	0.214257	138.567)
75	75	512.248	(-0.158184	-0.155488	117.331)
21	21	58.6147	(-0.234956	0.226591	141.855)

----------MC Vertex Information: Event No = 12----------
(-0.0428635 0.00553318 40.799)
----------Reco Vertex Information: Event No = 14----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
108	108	607.39	(-0.14313	0.0803161	40.0763)

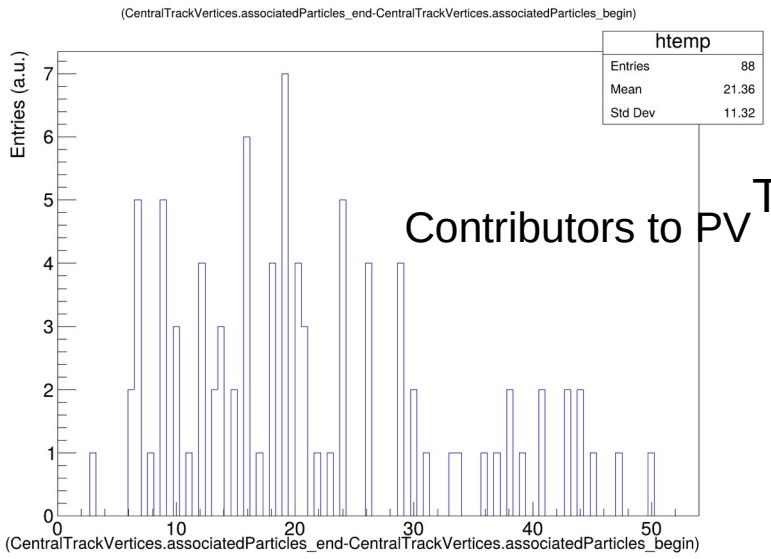
----------Reco Vertex Information: Event No = 15----------

3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
54	126	682.862	(-0.517397	-0.0936542	102.186)
96	96	672.357	(-1.12386	-2.15272	96.8841)

----------MC Vertex Information: Event No = 17----------
(-0.0348569 -0.00194254 8.92103)
(0.0849519 -0.00769813 92.0899)
(-0.0704257 -0.00695555 23.6963)
----------Reco Vertex Information: Event No = 18----------

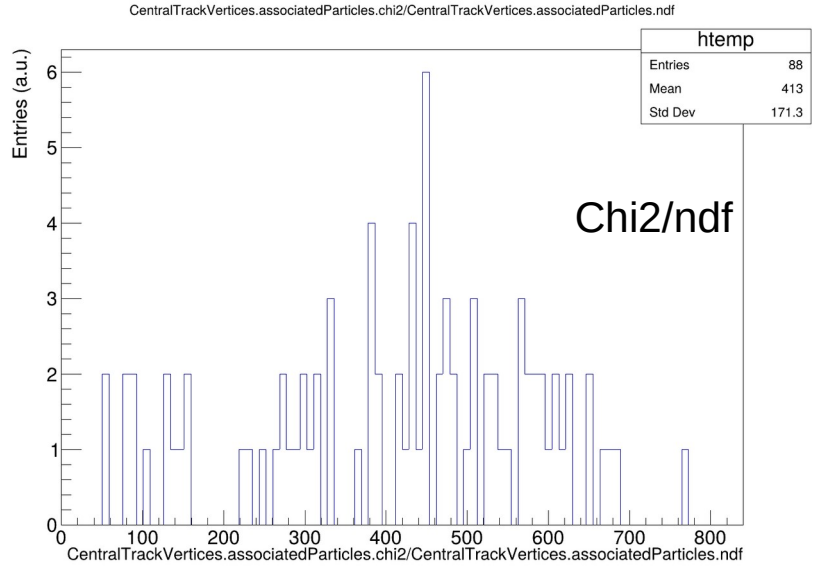
3Ntracks-3	ndf	chi2ndf	Vx	Vy	Vz
24	81	379.364	(-0.348915	0.421615	74.4291)
27	33	392.97	(-0.0494302	0.469802	63.6181)
60	141	274.244	(0.242418	-0.543177	113.241)
18	42	453.122	(0.263138	0.141284	24.3681)
18	27	330.76	(0.0202363	0.479298	24.2588)
51	51	275.124	(0.127823	-0.0339718	-13.4445)
87	87	265.18	(0.475516	-0.437681	125.855)
18	18	53.2311	(0.227272	-0.280079	79.2558)
15	15	135.979	(-0.0893718	-0.276172	4.12428)

Primary Vertexing w Machine Bkg

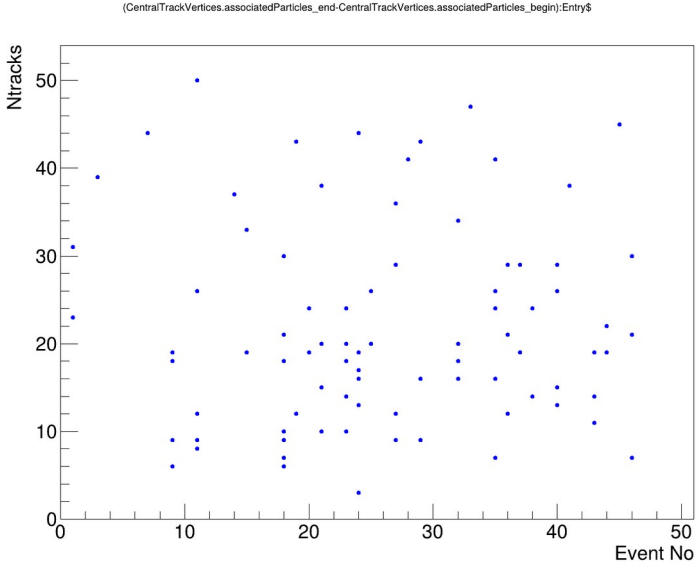


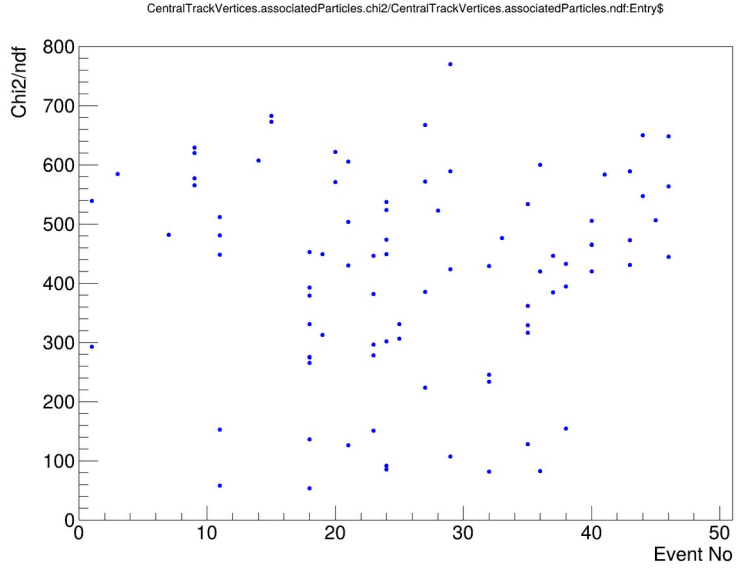
Contributors to PV

Total events = 48



Chi2/ndf

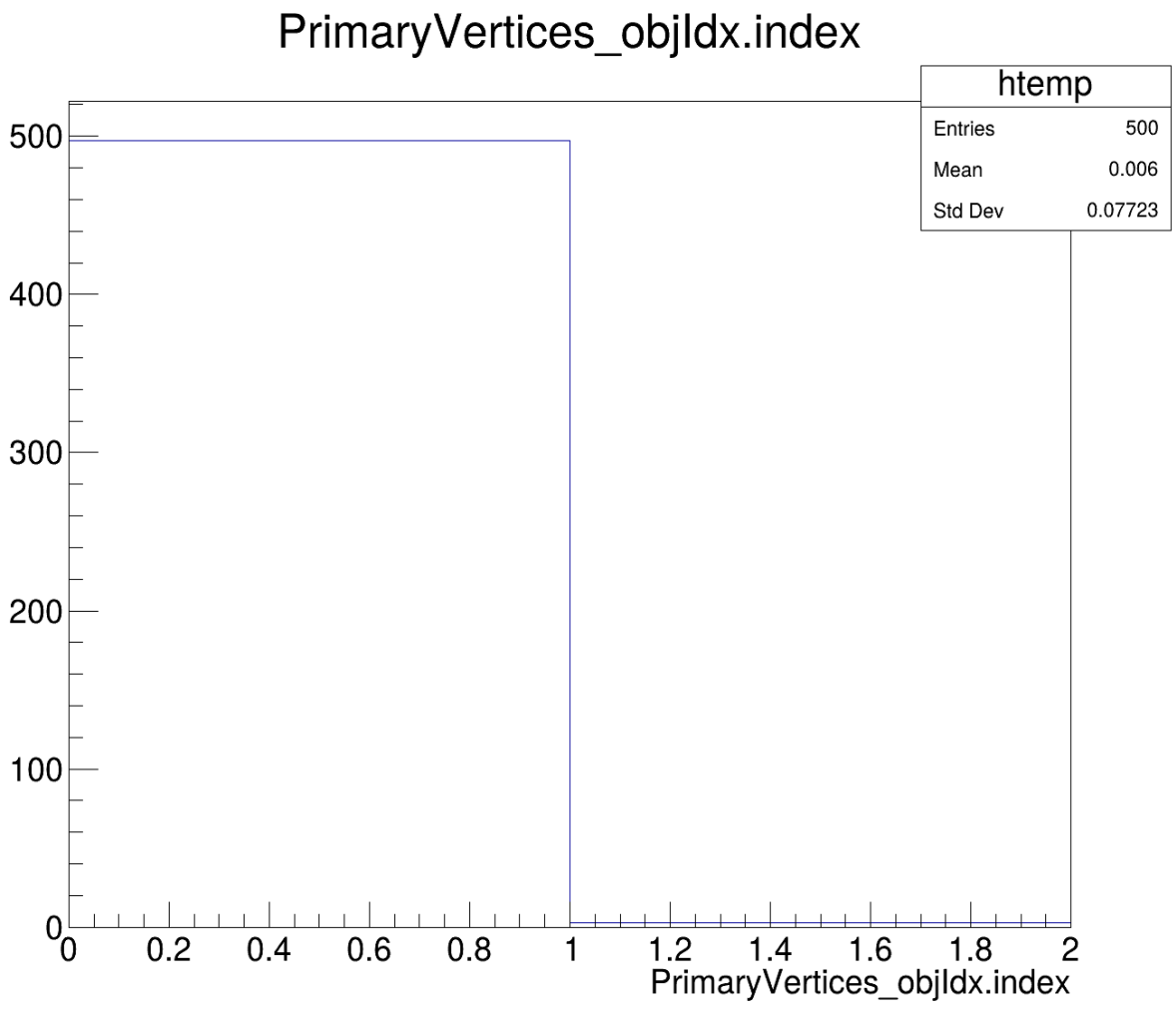




Accessing Primary Vertex (w/o Machine Bkg)

```
TTreeReaderArray<int> prim_vtx_index = {treereader, "PrimaryVertices_objIdx.index"};
int rc_vtx_index = prim_vtx_index[0];
```

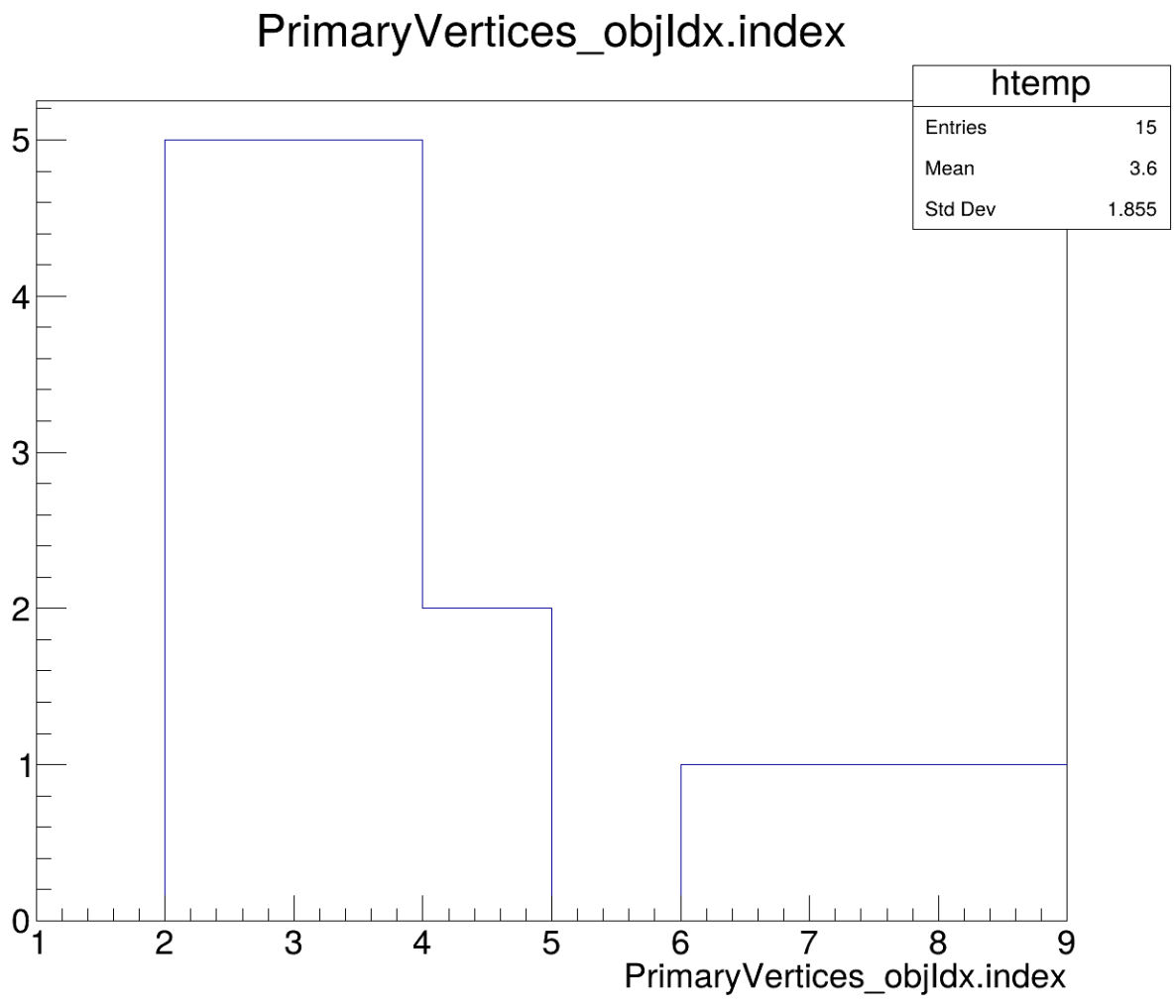
```
**********************************
*    Row   * Instance * PrimaryVertices_objIdx
**********************************
*        0 *        0 *         *
*        1 *        0 *         0 *
*        2 *        0 *         0 *
*        3 *        0 *         0 *
*        4 *        0 *         0 *
*        5 *        0 *         0 *
*        6 *        0 *         0 *
*        7 *        0 *         0 *
*        8 *        0 *         0 *
*        9 *        0 *         0 *
*       10 *        0 *         *
*       11 *        0 *         0 *
*       12 *        0 *         0 *
*       13 *        0 *         0 *
*       14 *        0 *         0 *
*       15 *        0 *         0 *
*       16 *        0 *         0 *
*       17 *        0 *         0 *
*       18 *        0 *         0 *
*       19 *        0 *         0 *
*       20 *        0 *         0 *
*       21 *        0 *         0 *
*       22 *        0 *         *
*       23 *        0 *         0 *
*       24 *        0 *         0 *
```



Accessing Primary Vertex (w Machine Bkg)

```
TTreeReaderArray<int> prim_vtx_index = {treereader, "PrimaryVertices_objIdx.index"};
int rc_vtx_index = prim_vtx_index[0];
```

```
**********************************
*    Row   * Instance * PrimaryVertices_obj
**********************************
*        0 *        0 *         *
*        1 *        0 *         *
*        2 *        0 *         *
*        3 *        0 *         *
*        4 *        0 *         *
*        5 *        0 *         *
*        6 *        0 *         *
*        7 *        0 *         *
*        8 *        0 *         *
*        9 *        0 *         *
*       10 *        0 *         *
*       11 *        0 *         2 *
*       11 *        1 *         4 *
*       12 *        0 *         *
*       13 *        0 *         *
*       14 *        0 *         *
*       15 *        0 *         *
*       16 *        0 *         *
*       17 *        0 *         *
*       18 *        0 *         4 *
*       18 *        1 *         7 *
*       18 *        2 *         8 *
*       19 *        0 *         *
*       20 *        0 *         *
*       21 *        0 *         3 *
```



Summary and Future Plan

- There are more than one reconstructed primary vertices in an event
- Primary vertex has a large chi2/ndf with respect to w/o background
- Need to redo the primary vertexing with nhits>3

Thank you for your attention!