# MANTRA BES III

Chandrasekhar Akondi
P.I.Dr.Garzia

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Università degli Studi di Ferrara

# Outline

1. $\bar{n}$ particle gun MC simulation
2. TOF: Debugging Issues
3. $e^+e^- \rightarrow n\bar{n}$

# $\bar{n}$ particle gun MC simulation

Charged tracks are rejected if

| variable | Value |
|---|---|
| $R_{vxy}$ | $\geq 1.0$ mm |
| $R_{vz0}$ | $\geq 10.0$ mm |
| $\lvert\cos\theta_{\mathrm{mdctrack}}\rvert$ | $\geq 0.93$ |

Table: Track selection criteria.

EMC tracks are selected if they satisfy at least one.

| **Barrel Region** | |
|---|---|
| $\cos\theta$ EMC track | $\leq 0.80$ |
| Energy EMC track | $\geq 0.04$ GeV |
| **Endcap Region** | |
| $\cos\theta$ EMC track | [0.86 , 0.92] |
| Energy EMC track | $\geq 0.04$ GeV |
| Number of showers | Between 1 and 9 |

Table: EMC track selection criteria.

Charged tracks and showers selection

| Charged Tracks | EMC Showers |
|---|---|
| All are considered | Between 1 and 9 |

Table: Track and shower selection criteria.

# $\bar{n}$ particle gun MC simulation (cont)

```
*****************
Initial no cut  15000
100 %    no cut
100 %    RvzRxy cut
100 %    ChTrk2 cut
100 %    barrel region selection
92.84 %          showers 1 and 10 cut
92.84 %          min one shower cut
charge events %          2.98 ←
zero shower %    7.15333 ←
single shower %          24.78
double shower %          26.16
*****************
Initial no cut  15000
100 %    no cut
100 %    RvzRxy cut
100 %    ChTrk2 cut
100 %    barrel region selection
86.66 %          showers 1 and 10 cut
86.5733 %        min one shower cut
charge events %          1.44667←
zero shower %    13.3267 ←
single shower %          33.44
double shower %          22.9933
Survived 100%  after Ncut_charge
Survived 86.66%  after Ncut_shower
Survived 86.5733%  after Ncut_mostengyshower
Survived 30.3667%  after Ncut_tof_mostengyshower
```

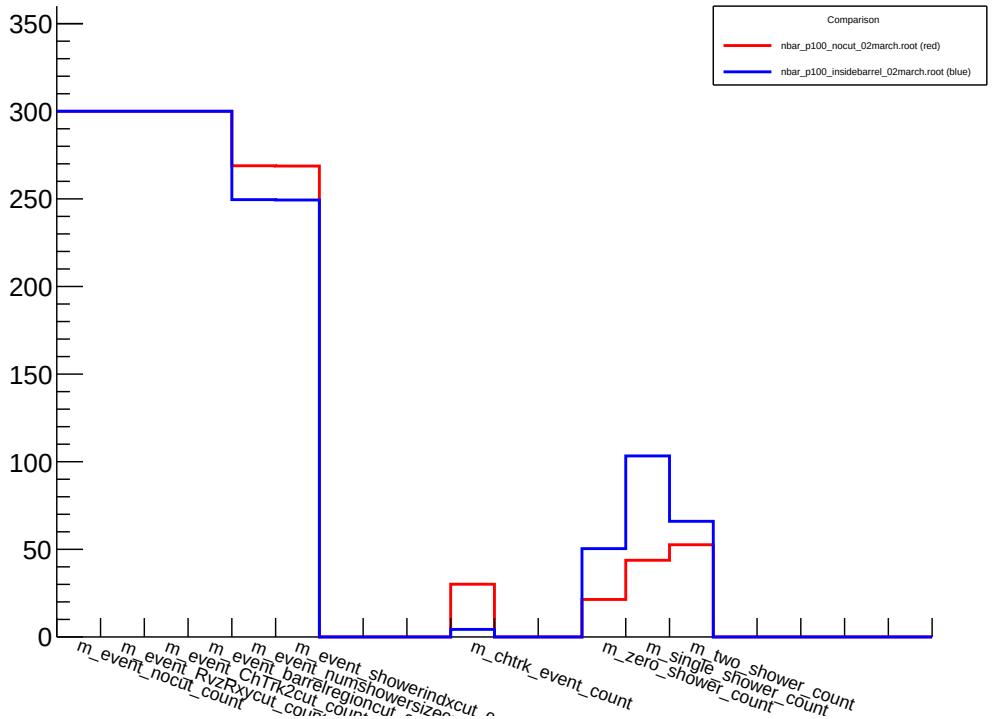
```
*****************
Initial no cut  15000
100 %    no cut
100 %    RvzRxy cut
100 %    ChTrk2 cut
100 %    barrel region selection
90.5467 %        showers 1 and 10 cut
90.5467 %        min one shower cut
charge events %          2.02667←
zero shower %    9.45333 ←
single shower %          30.82
double shower %          25.9067
Survived 100%  after Ncut_charge
*****************
Initial no cut  15000
100 %    no cut
100 %    RvzRxy cut
100 %    ChTrk2 cut
100 %    barrel region selection
84.86 %          showers 1 and 10 cut
84.56 %          min one shower cut
charge events %          1.44 ←
zero shower %    15.1133 ←
single shower %          29.8467
double shower %          21.7667
Survived 100%  after Ncut_charge
Survived 84.86%  after Ncut_shower
Survived 84.56%  after Ncut_mostengyshower
Survived 30.54%  after Ncut_tof_mostengyshower
```

Charged track and Zero Shower % for $\bar{n}$ at $p$ 0.25, 0.5, 1.0, and $1.5 GeV/c$.

# $\bar{n}$ particle gun MC simulation (cont)

45k events are generated at p=1.0$GeV/c$

Red: No cuts
Blue: only inside barrel region



# TOF: Issues

Tof:EMC matching,some issues are surfaced.

```
/////// TOF testing

cout<<red<<"*****************TOF Testing **********************"<<reset<<endl;
cout<<green<<"largest index = "<<largestindx<<"\t"<<"showesize="<<showersize<<reset<<endl;
double temptrkmom;
temptrkmom = 1.0; ///// particle gun monetum fed in MC, need to change for each p value of MC
      for(int t=0;t<showersize;t++)
       {/////tof shower loop
        if(t!=largestindx) continue;
       cout<<green<<"check n bar only : tof index  = "<<t<<"\t"<<"largeindx ="<<largestindx<<reset<<endl;
        int trkid =-1,tofid=-1;
        double tof =-1, ph=-1, path =-1, zrhit =-1, beta =-1, t0 =-1;
        double texp=-1;
    EvtRecTrackIterator itTrk=evtRecTrkCol->begin()+ishower[t];
    if(!(*itTrk)->isEmcShowerValid()) continue;
    if(!(*itTrk)->isTofTrackValid()) continue;
    cout<<"validating the TOF track"<<endl;
    SmartRefVector<RecTofTrack> tofTrkCol = (*itTrk)->tofTrack();
    SmartRefVector<RecTofTrack>::iterator iter_tof = tofTrkCol.begin();
          for(;iter_tof != tofTrkCol.end();iter_tof++)
              {////tof iteration
             TofHitStatus *status =  new TofHitStatus;
             status->setStatus((*iter_tof)->status());
            cout<<"ph before status check = "<<(*iter_tof)->ph()<<endl;
            cout<<"t0 before status check  = "<<(*iter_tof)->t0()<<endl;
            cout<<"status = "<<(*iter_tof)->status()<<endl;
  cout<<"Raw : "<<status->is_raw() <<",Cluster: "<<status->is_cluster() <<endl;
 if(status->is_raw()) continue; //// skip if noisy or unprocessed data
         //    if(!(status->is_cluster())) continue;//// only cluster hits are allowed
        //   cout<<"testing"<<endl;
            trkid = (*iter_tof)->trackID();
            tofid = (*iter_tof)->tofID();
            tof = (*iter_tof)->tof();
            ph = (*iter_tof)->ph();
            path = (*iter_tof)->path();
            zrhit = (*iter_tof)->zrhit();
            beta = (*iter_tof)->beta();
            t0 = (*iter_tof)->t0();
            double gammabeta = temptrkmom/0.93956;
            double beta2 = gammabeta/sqrt(1+gammabeta*gammabeta);
            texp = 10*path/beta2/velc;
            Ncut_tof_mostengyshower++;
           cout<<"inside tof iteration Ncut_tof_mostengyshower= "<<Ncut_tof_mostengyshower<<endl;
           cout<<"*ph* after status->is_raw()  = "<<(*iter_tof)->ph()<<endl;
           cout<<"*t0* after status->is_raw()  = "<<(*iter_tof)->t0()<<endl;
              }////tof iteration
      }////tof shower  loop
```

```
neutral trk shower size after barrel endcap and [1,9] cut = 1
shower number =0        eraw= 0.287141
*****************TOF Testing **********************
largest index = 0       showesize=1
check n bar only : tof index  = 0       largeindx =0
validating the TOF track
ph before status check = 9999
t0 before status check  = 0
status = 0
Raw : 0,Cluster: 0
inside tof iteration Ncut_tof_mostengyshower= 4763
*ph* after status->is_raw()  = 9999
*t0* after status->is_raw()  = 0
```

```
neutral trk shower size after barrel endcap and [1,9] cut = 4
shower number =0        eraw= 0.833762
shower number =1        eraw= 0.20184
shower number =2        eraw= 0.144952
shower number =3        eraw= 0.0895908
*****************TOF Testing **********************
largest index = 0       showesize=4
check n bar only : tof index  = 0       largeindx =0
validating the TOF track
ph before status check = 9999
t0 before status check  = 0
status = 0
Raw : 0,Cluster: 0
inside tof iteration Ncut_tof_mostengyshower= 4757
*ph* after status->is_raw()  = 9999
*t0* after status->is_raw()  = 0
Ncut_tof_mostengyshower   =  4757
```

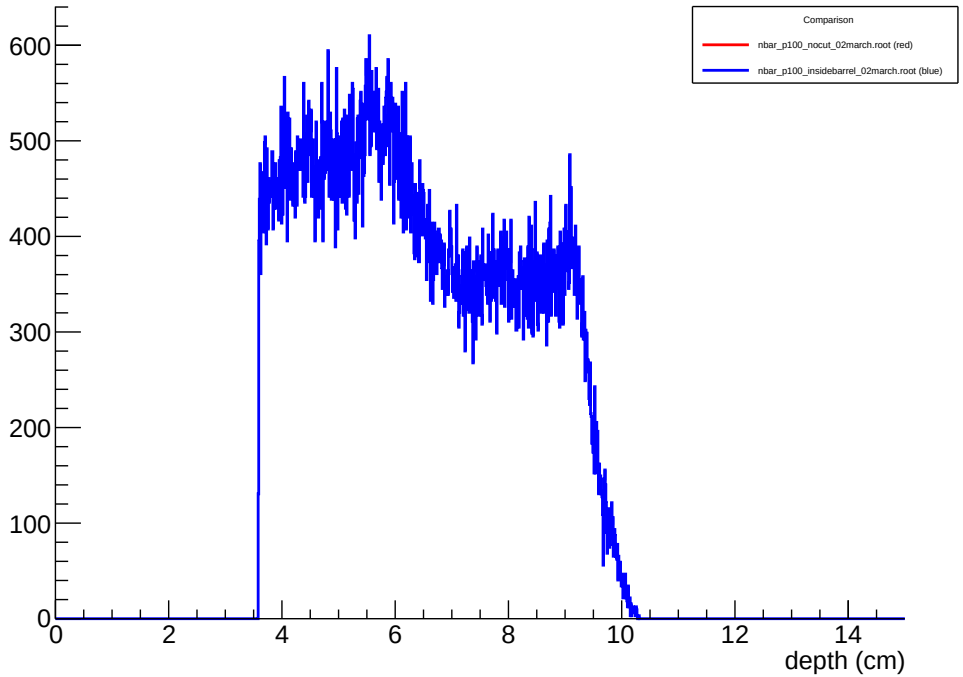
# TOF: Issues (cont)

ph = 9999, t0 = 0, status = 0 for all showers
pulse height =9999 : default pulse height?
is_raw() = 0, is_cluster() = 0,no TOF hits or clusters are formed.

Looked into the depth of the shower in EMC

$$\text{Depth} = X_0 \cdot \ln\left(\frac{E_{recon}}{E_c} + 1\right)$$

$X_0 = 1.85$ cm, $E_c = 8.4$ MeV





**References:**
Nuclear Instruments and Methods in Physics Research A **614** (2010) 345–399.
Bruno Rossi, *High Energy Particles*, Prentice-Hall, 1952.
P. K. Das, *Electromagnetic Shower Theory*, World Scientific, 1993.
William R. Leo, *Techniques for Nuclear and Particle Physics Experiments*, Springer, 1994.

# $e^+e^- \rightarrow n\bar{n}$

Produce the same $\bar{n}$plots for TOF and EMC as shown in $n\bar{n}$ publication and as well as in the MEMO
Time line: a week to 10 days for the $n\bar{n}$ plots.

# backup

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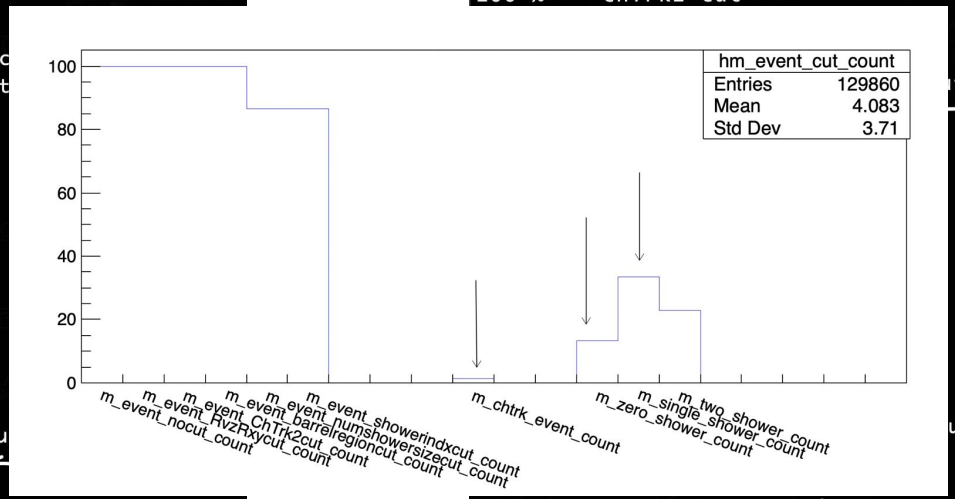


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Charged track and Zero Shower % for $\bar{n}$ at $p$ 0.25, 0.5, 1.0, 1.5, and 2.0 $GeV/c$.