Track Study

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Outline

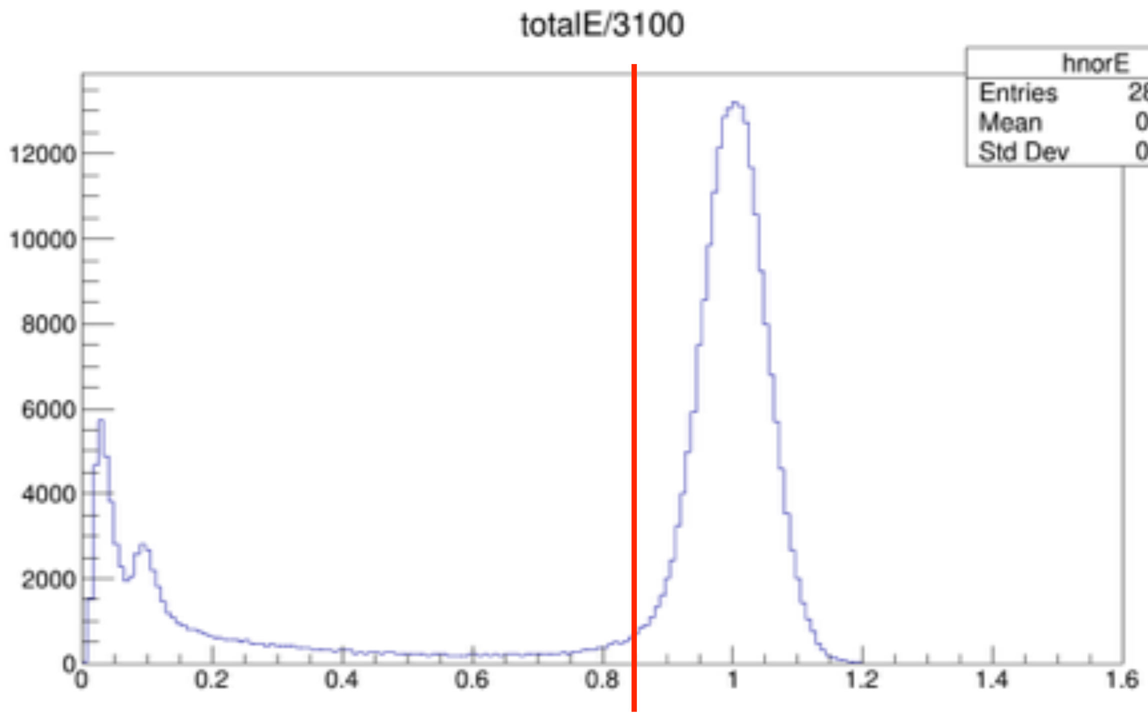
1. Events with no track;
   - Percentage of potential electron events with no track;
   - Reasons for no track;
   - Track efficiency for tritium and He3 targets;

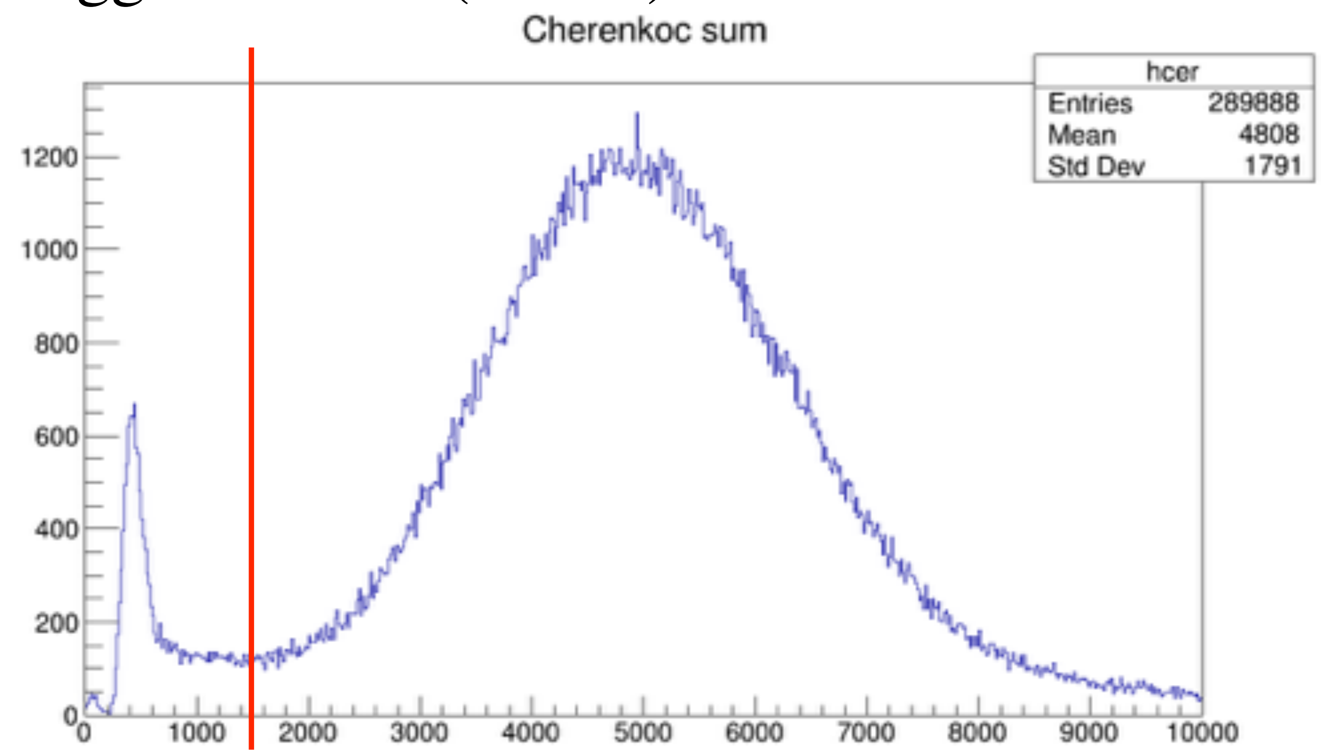
2. Events with multiple tracks;
   - Percentage of good electron events with multiple tracks;
   - Reasons for multiple tracks constructed;
   - How to select the best track among multiple tracks;

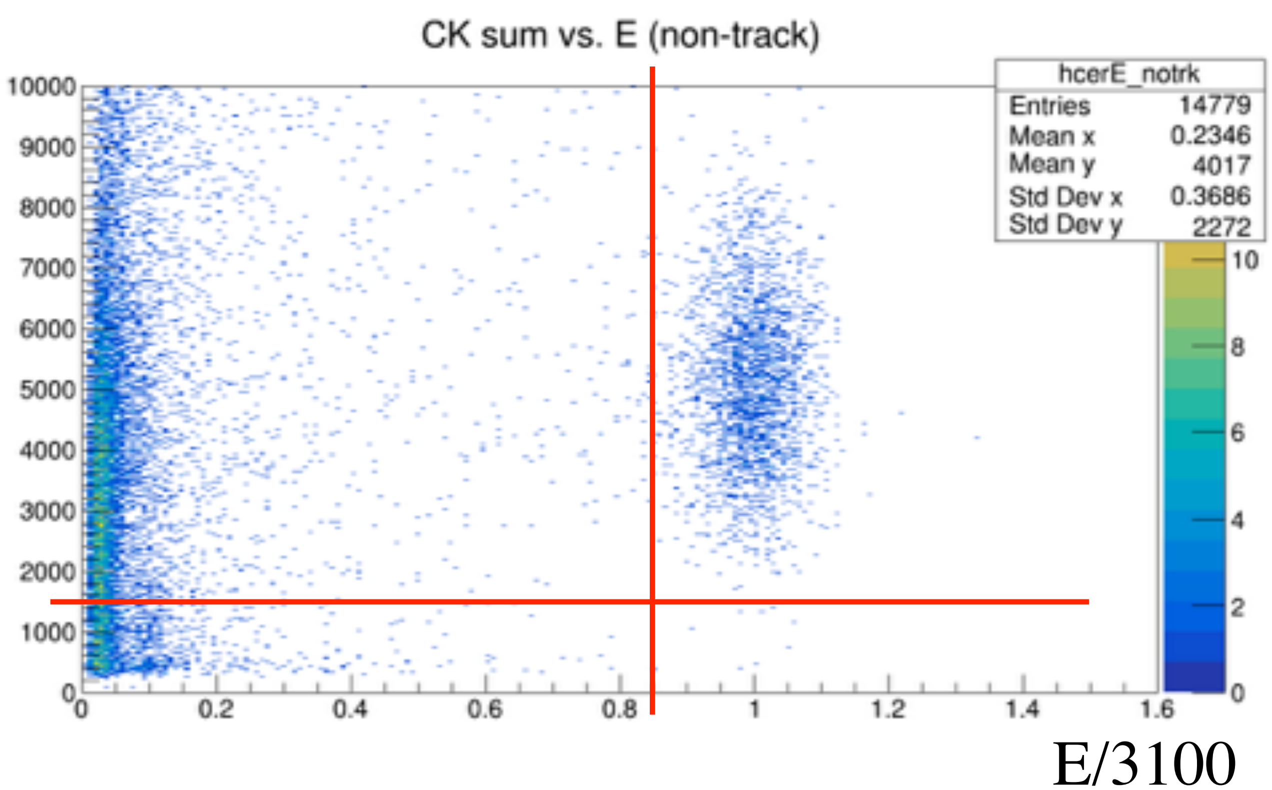
Percentage of non-track events

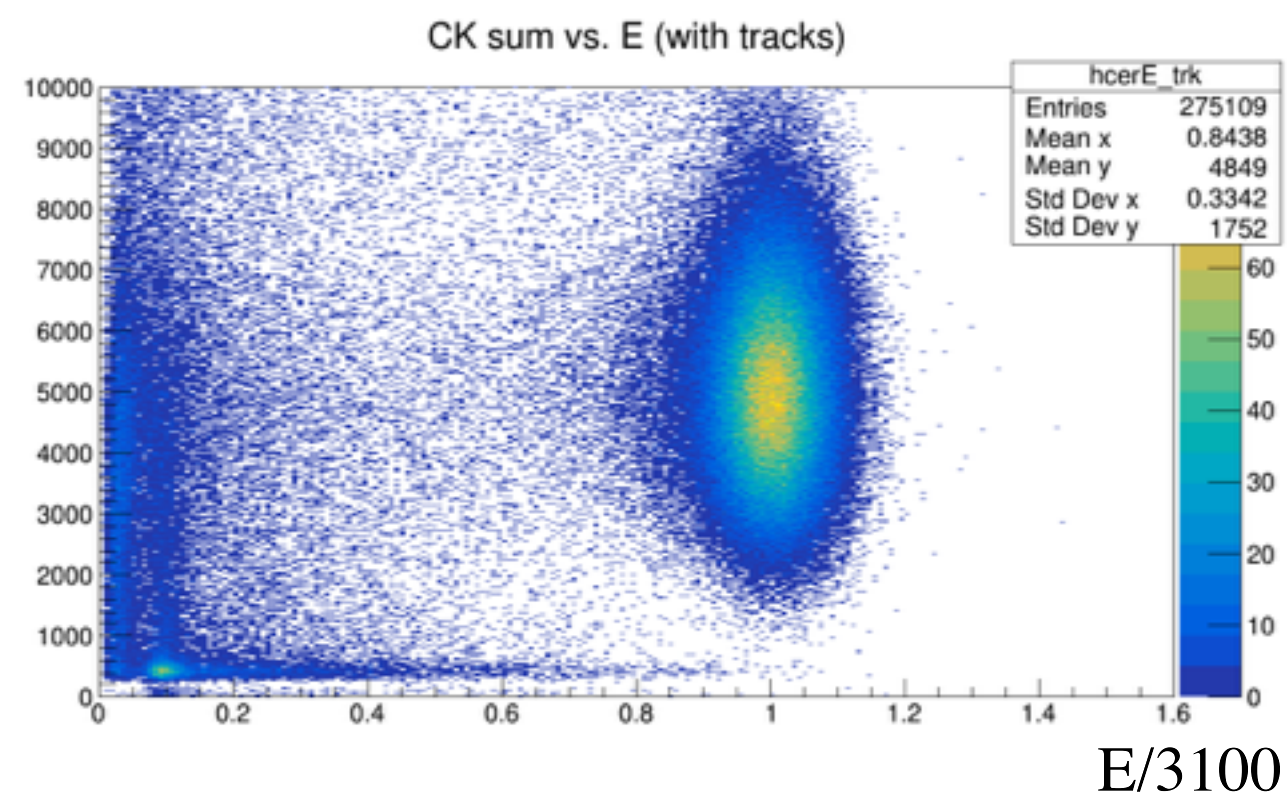
1. Potential electron events:

Total energy and Cherenkov sum plots for trigger2 events (LHRS):

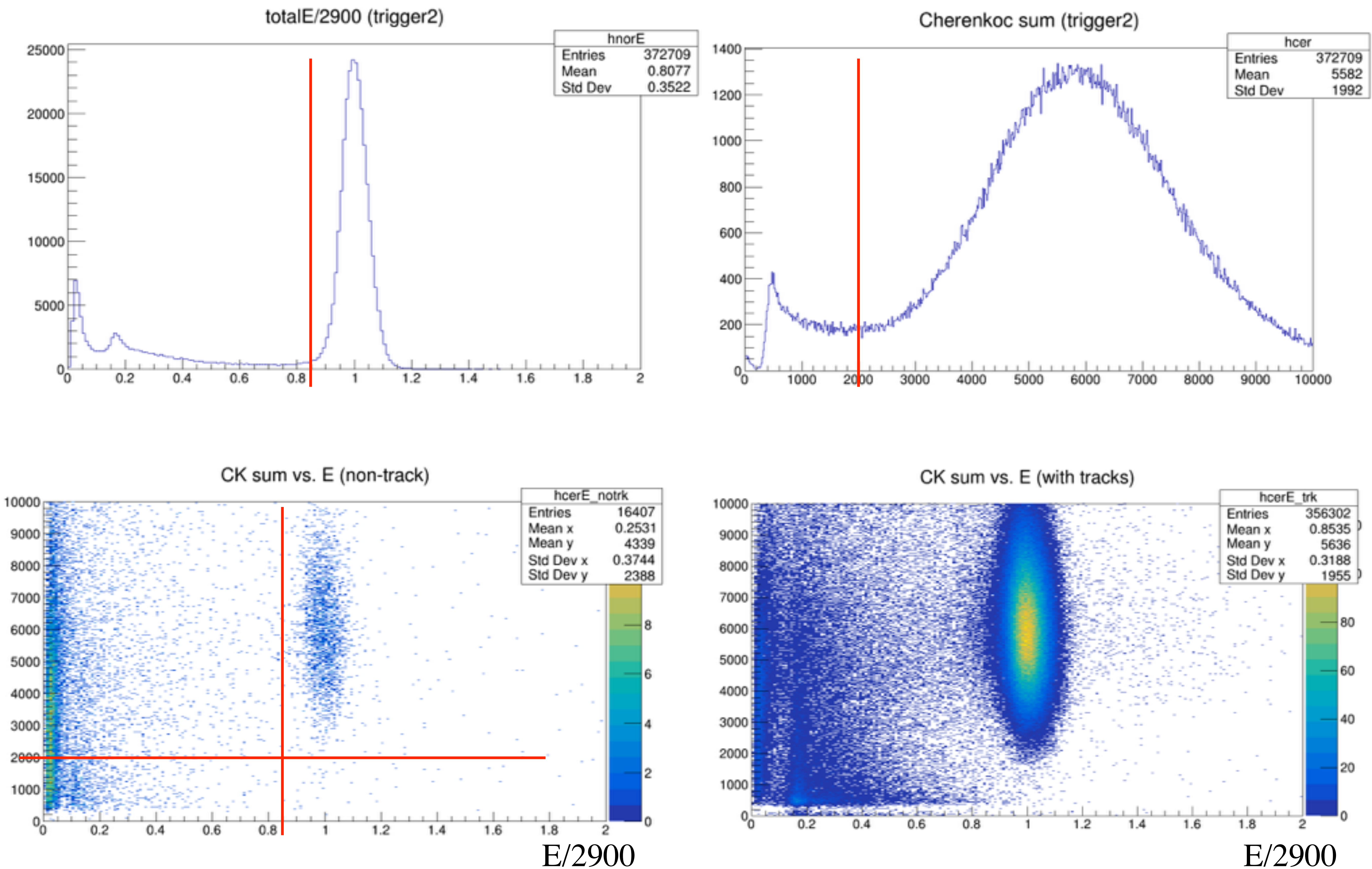








Total energy and Cherenkov sum plots for trigger2 events (RHRS):



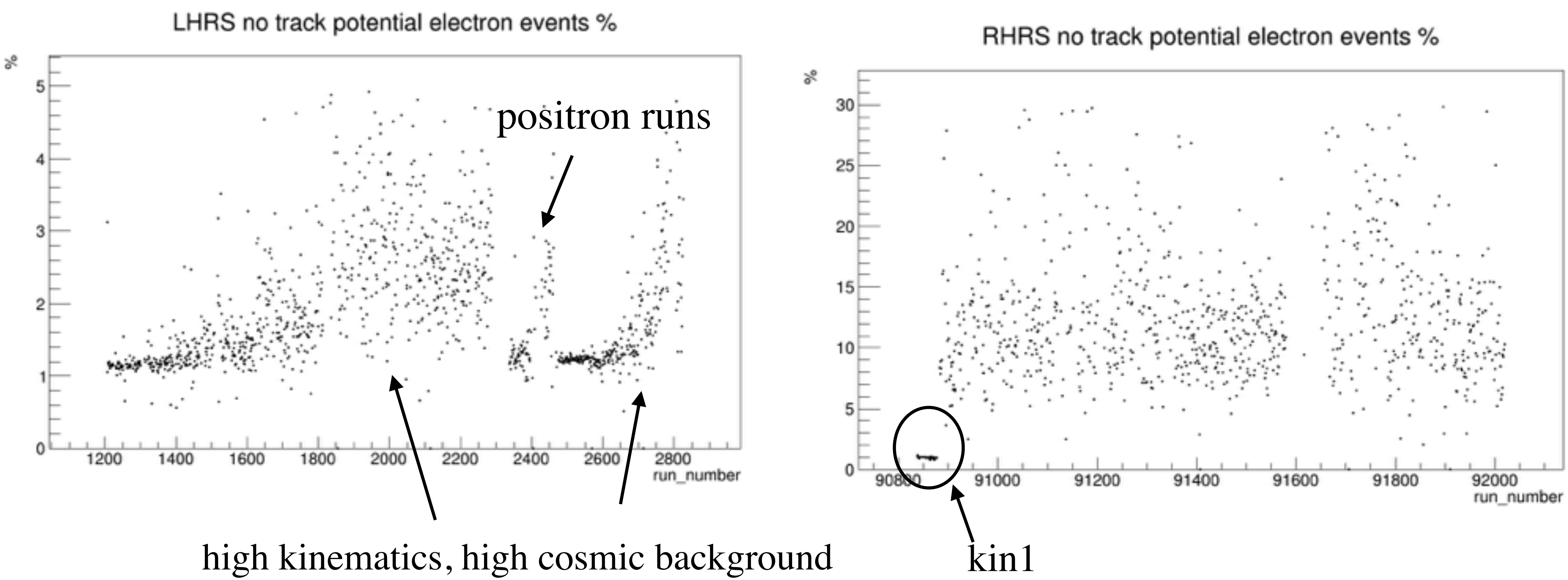
1. Potential electron events:

- events pass cuts: T2+CK+totalE:

LHRS	RHRS
T2 = (DL.evtypebits>>2)&1;	T2 = (DR.evtypebits>>5)&1;
CK = L.cer.asum_c>1500;	CK = R.cer.asum_c>2000;
totalE = (L.prl1.e+L.prl2.e)/3100.0>0.85;	totalE = (R.ps.e+R.sh.e)/2900.0>0.85;

2. Percentage of potential electron event with no track:

$$p = \frac{\text{potential electron events with no track}}{\text{potential electron events}}$$



Reasons for no track

1. 0 cluster is found in some VDC planes (>99.8%)

(1). Analyzer requires at least one cluster found in each VDC plane to construct a track;

(2). Reasons couldn't find a cluster:

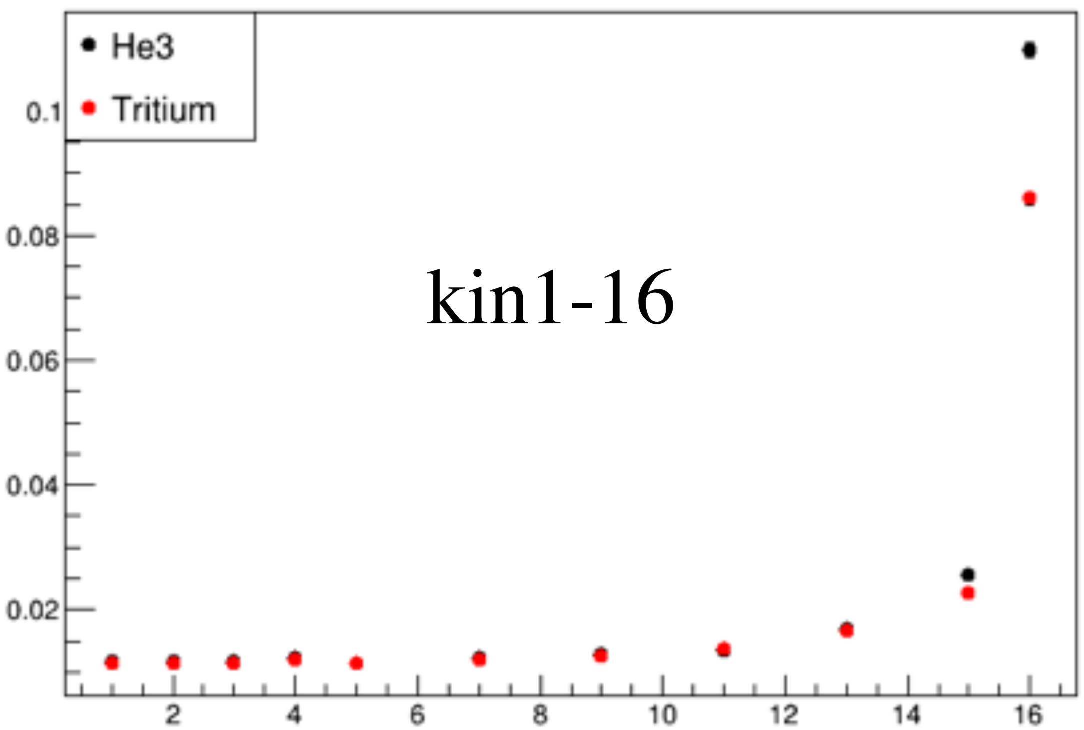
- hits couldn't pass the rawtime cut (defined in DB);
- the time difference between two consequent hits couldn't pass the tdiff cut (defined in DB);
- the time changes for consequent hits aren't "V" shape;

2. Each VDC plane has a cluster but no track is constructed (<0.2%)

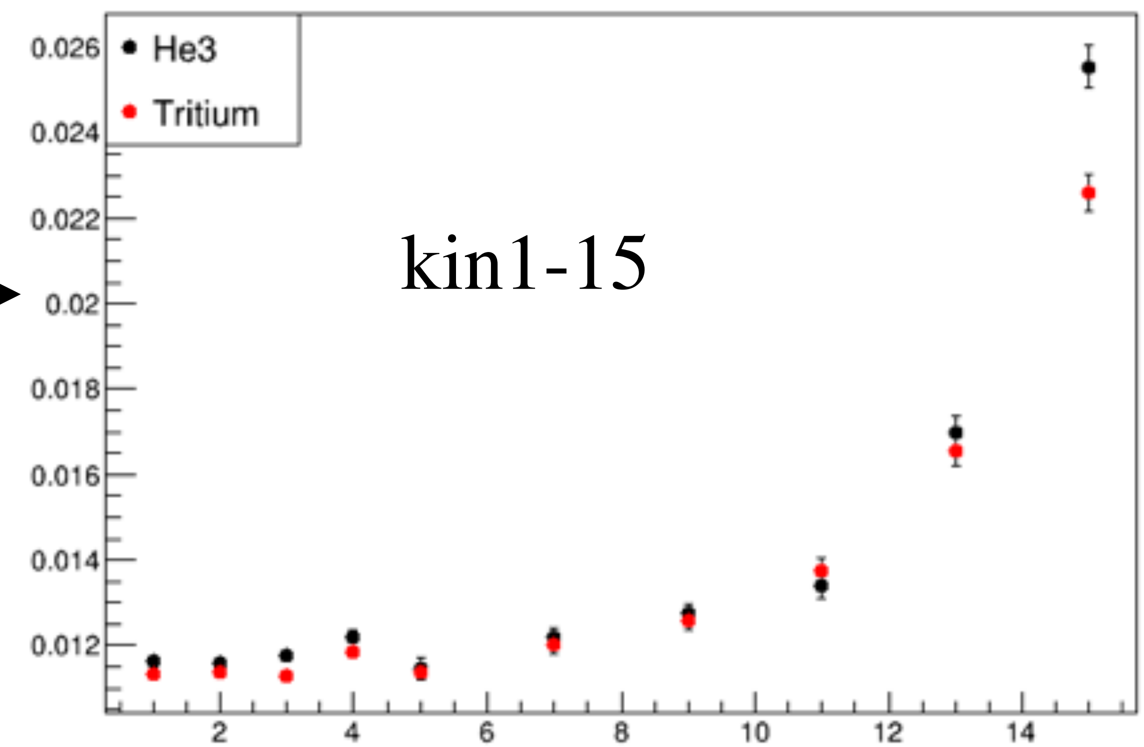
- the x, y position calculated from U,V clusters are out of the VDC active area;

Target Dependence

The percentage of non-track events for each kinematics
(with beam trip cut: BeamUpTime>3s)



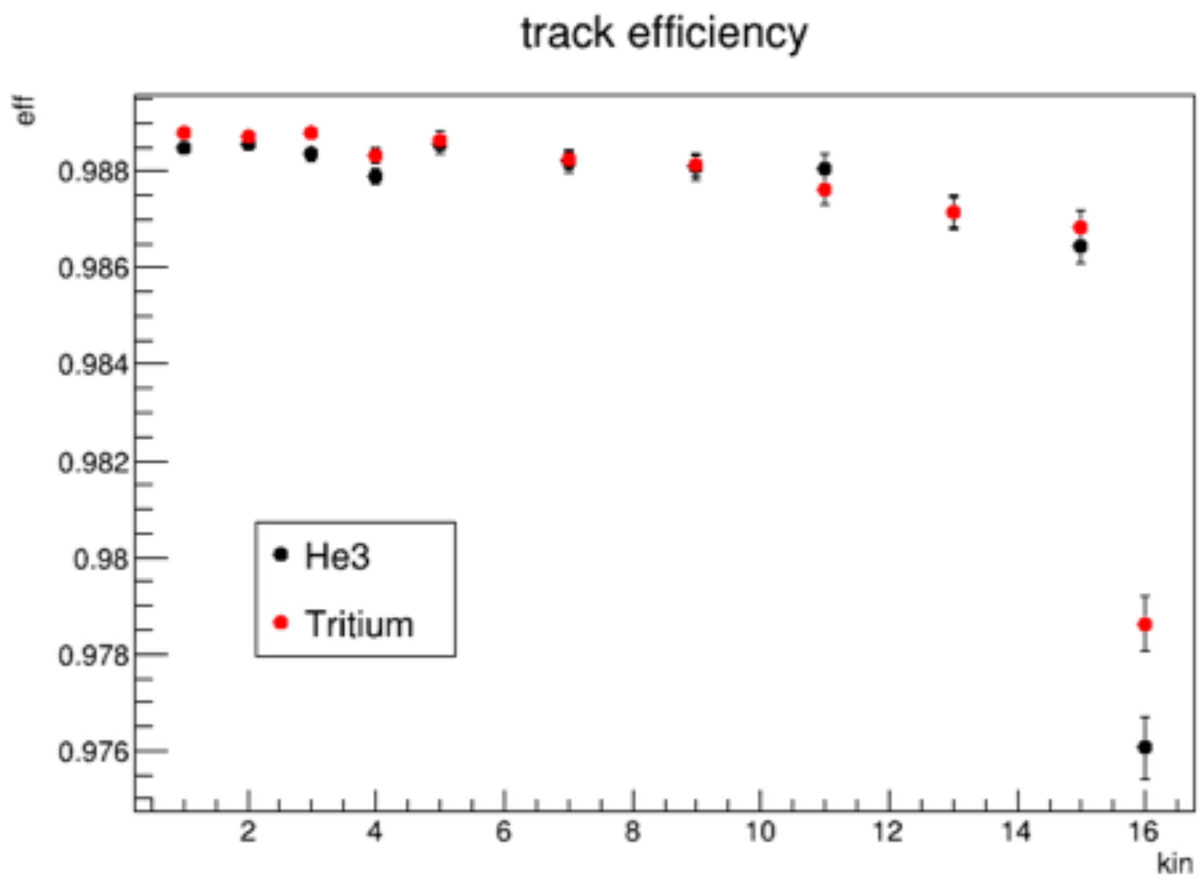
zoom

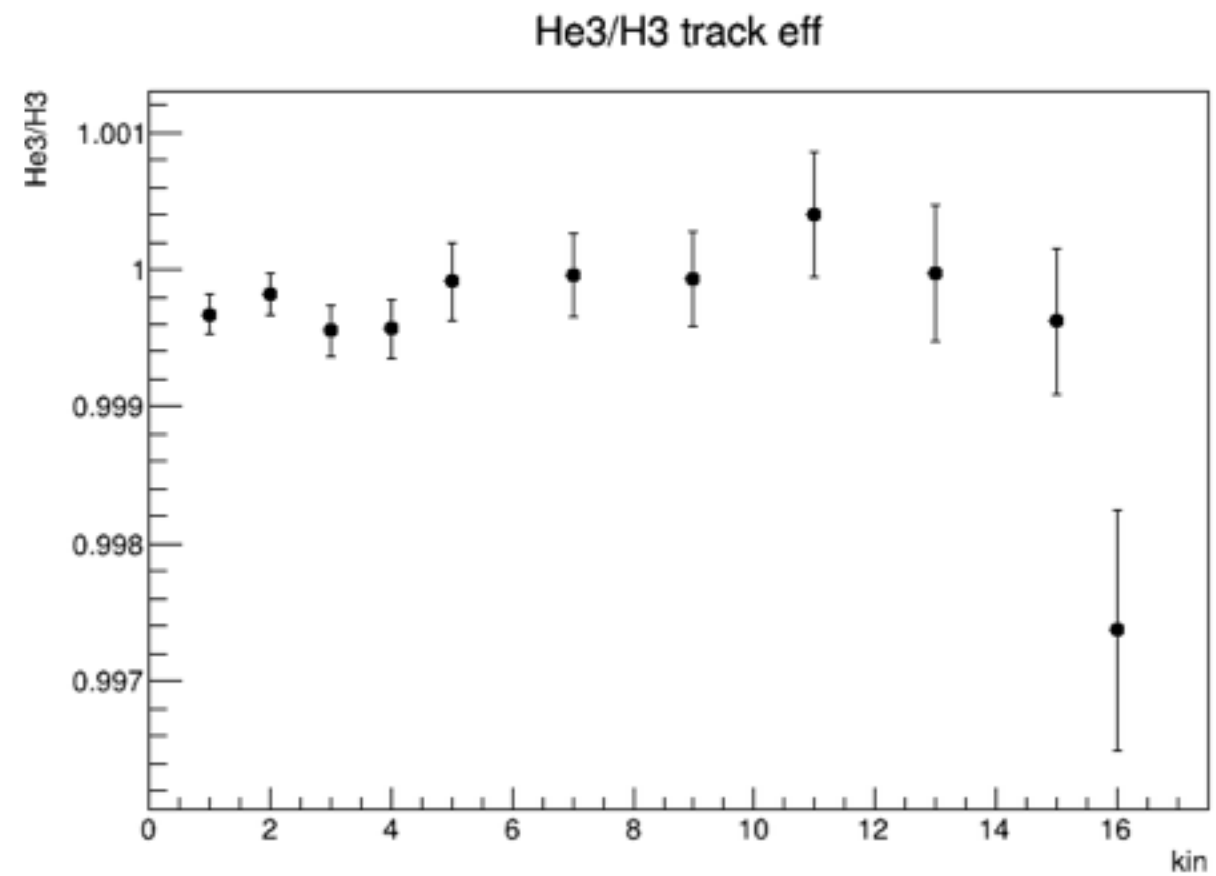


1. At low x points, where the event rates are high, the track efficiency is almost the same for Tritium and He3 target;
2. The efficiency difference at high x is probably due to cosmic and different end cup contamination, since the event rate at high x is same order as cosmic rate;

Add Cosmic cuts:

1. S2.time - S0.time>0;
2. Hit the middle of S2: 2< S2.t_pads <14;





1. The remaining difference which comes from cosmic and end up contamination could be removed by ACC and VZ cut;
2. It’s safe to make the conclusion that the track efficiency doesn’t have target dependence;
3. The track efficiency is around 98.8%;

Multiple tracks

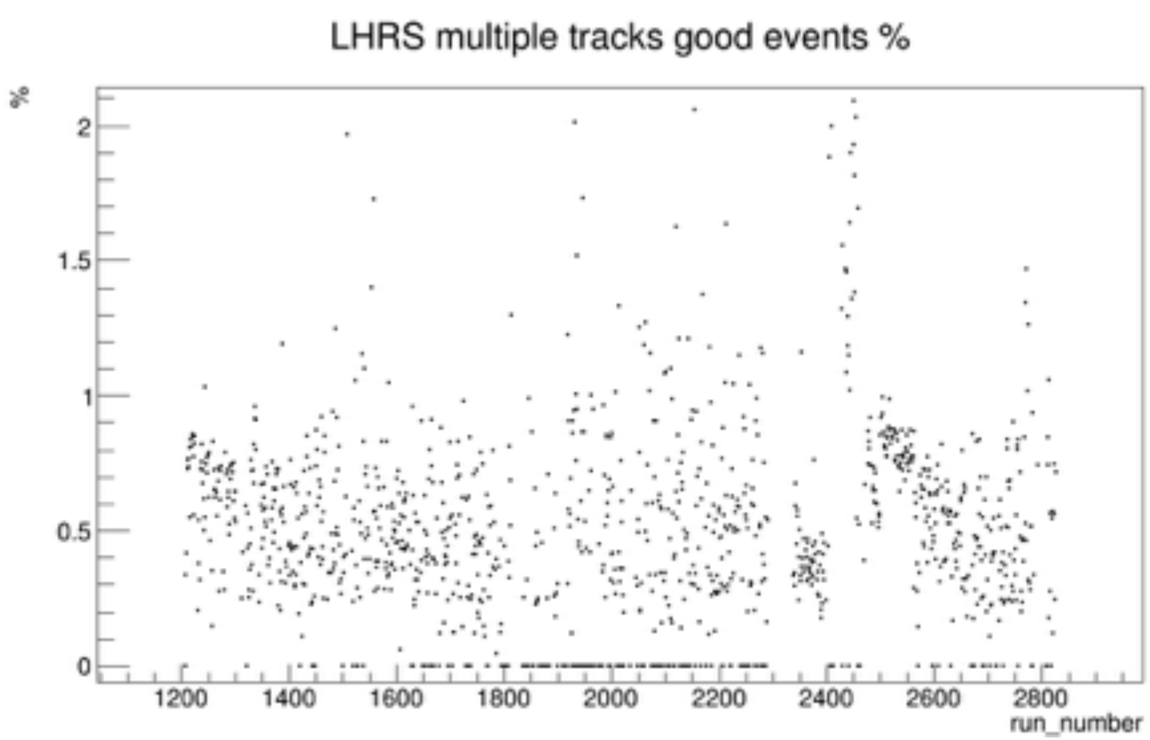
1. percentage of good events with multiple tracks

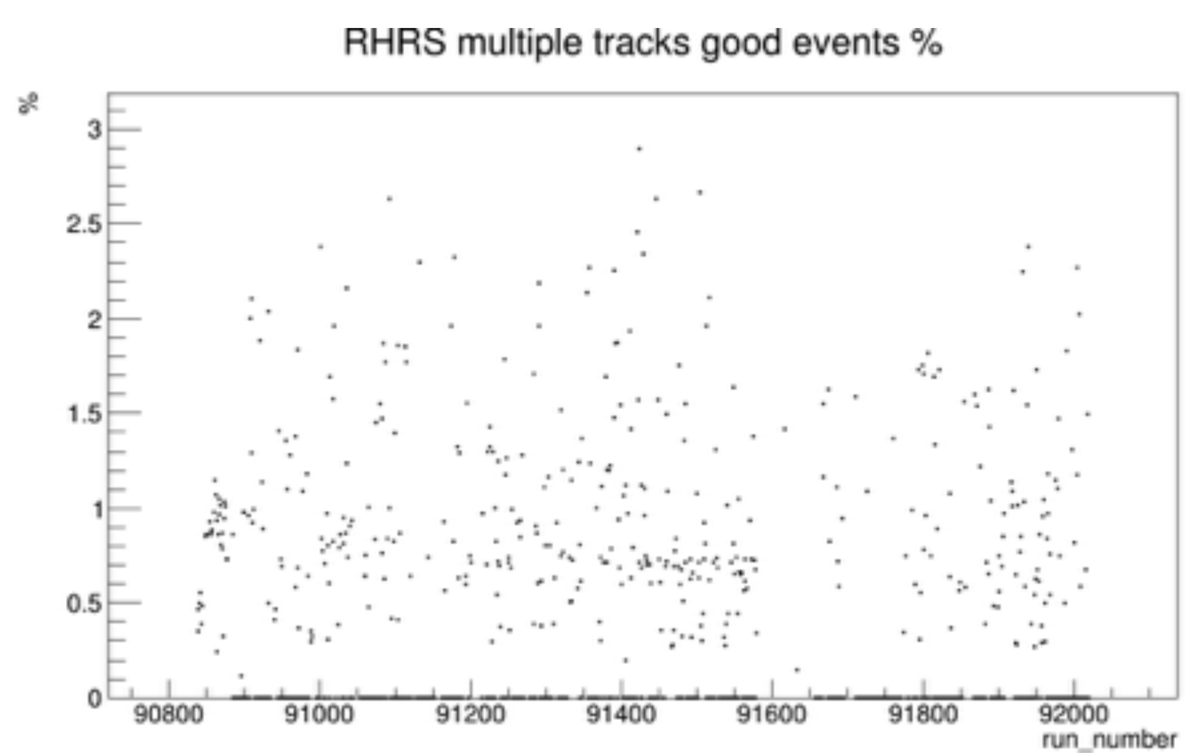
(1). Good electron events:

- Events pass cut: trigger2+ACC+VZ+CK+Ep+beta (any track pass ACC, VZ, beta)
  - trigger2: (DL.evtypebits>>2)&1;
  - ACC: abs(L.tr.tg_th)<0.06 && abs(L.tr.tg_ph)<0.03 && abs(L.tr.tg_dp)<0.045;
  - VZ: abs(L.tr.vz)<0.1;
  - CK: L.cer.asum_c>1500;
  - Ep: (L.prl1.e+L.prl2.e)/(1000*L.gold.p)>0.75;
  - beta: L.tr.beta>0;

(2). percentage of good events with multiple tracks:

$$p = \frac{\text{good electron events with "L.tr.n>1"}}{\text{good electron events}}$$





Reasons for multiple track

1. **Multiple clusters are found at each VDC plane**

- How many tracks constructed corresponds to how many clusters are found at each VDC plane, that is, two tracks means there are at least two clusters found at each plane;
- "Analyzer" sort the tracks by ascending orders of chi2/ndof;

Select the best track from multiple tracks

Step 1:

By using S2:

1. S2 hitted paddle

- S2 hitted paddles: both PMTs TDC values of that paddle are bigger than 0;

2. A good track should have corresponding hit in S2 plane

- L.s2.trdx: the distance between the track projection in S2 dispersive plane and the middle of the closest hitted paddle;
- s2.trdx should be smaller than half paddle width (~0.07m);

3. Apply "abs(L.s2.trdx[n]<0.075)" cut to multiple tracks events

(using two tracks events as an example; run 1213 is used)

- 99.2% one track good events pass this cut;
- For two tracks events:
  - ~39.3% events have only one track pass the cut; → one track is selected
  - ~59% events both tracks have corresponding hits; → go to step2

Step 2:

(using two tracks events as an example; run 1213 is used)

By using Calorimeter:

1. A good track should have a related shower cluster

- For a good electron track, it should be close to the cluster in shower;
- Analyzer only gives the position of the largest cluster, while there could be a second cluster;

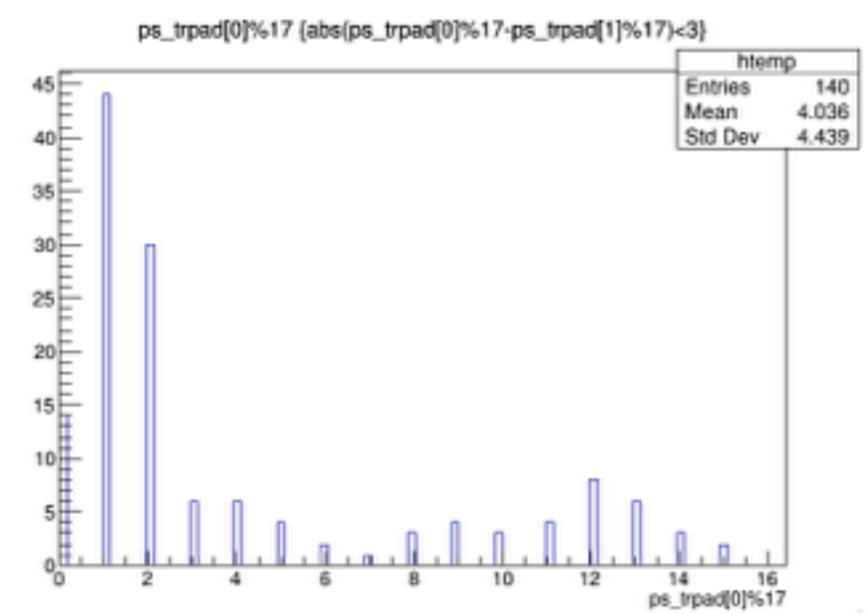
2. Find the closest cluster:

- Find all the blocks that corrected ADC values are bigger than 100;
- Find the closest block (with >100 ADC) to the track projection; **ps_trpad, sh_trpad**
- Calculate the distance between the track projection and the block center; **ps_dx, sh_dx**

3. Select the better track:

- abs(ps_trpad[0]%17-ps_trpad[1]%17)>=3
  - 10.8% events have two clusters; —> the electron goes with another particles and the good track is the one close to the latest cluster; → one track is selected
- abs(ps_trpad[0]%17-ps_trpad[1]%17)<3
  - 89.2% events both tracks are close to same cluster;
  - most tracks are at edge of spectrometer, so the multiple tracks could be the result of edge scattering

→ go to step3



Step 3:

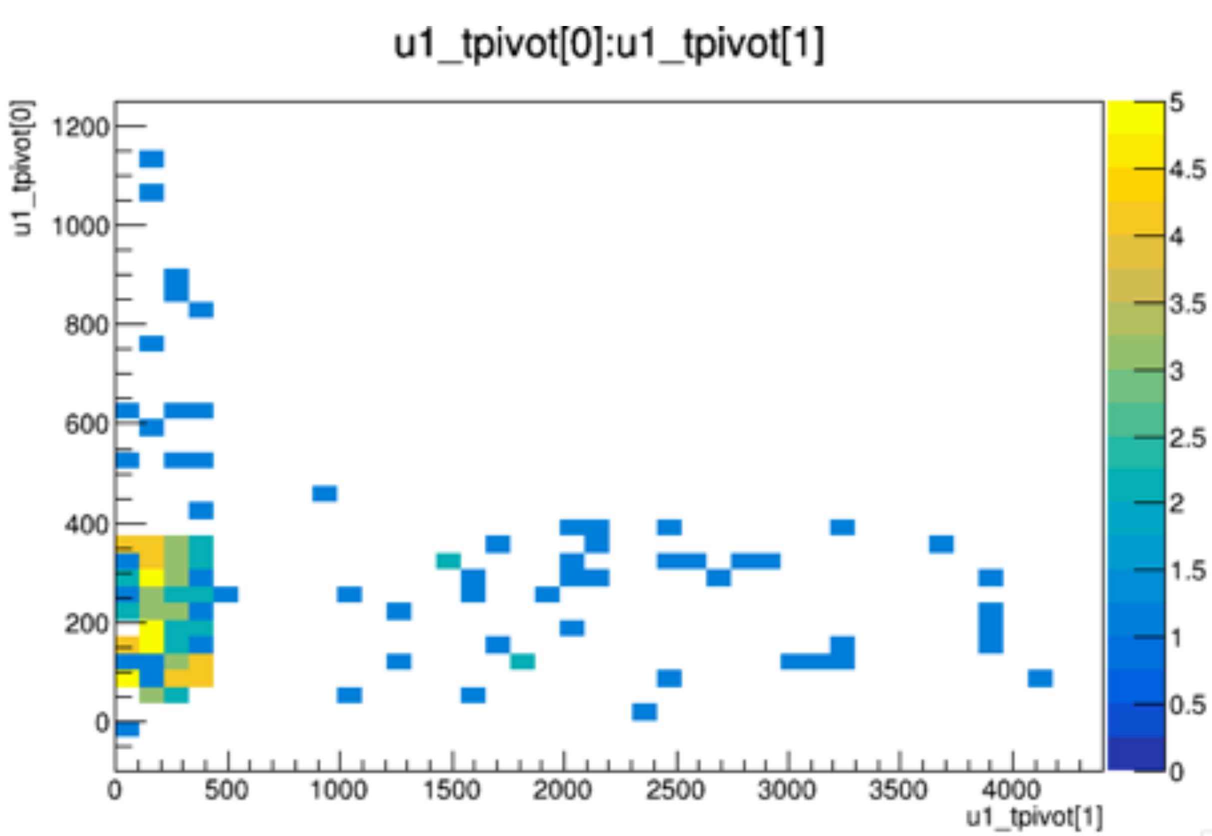
Track VDC pivot wire timing:

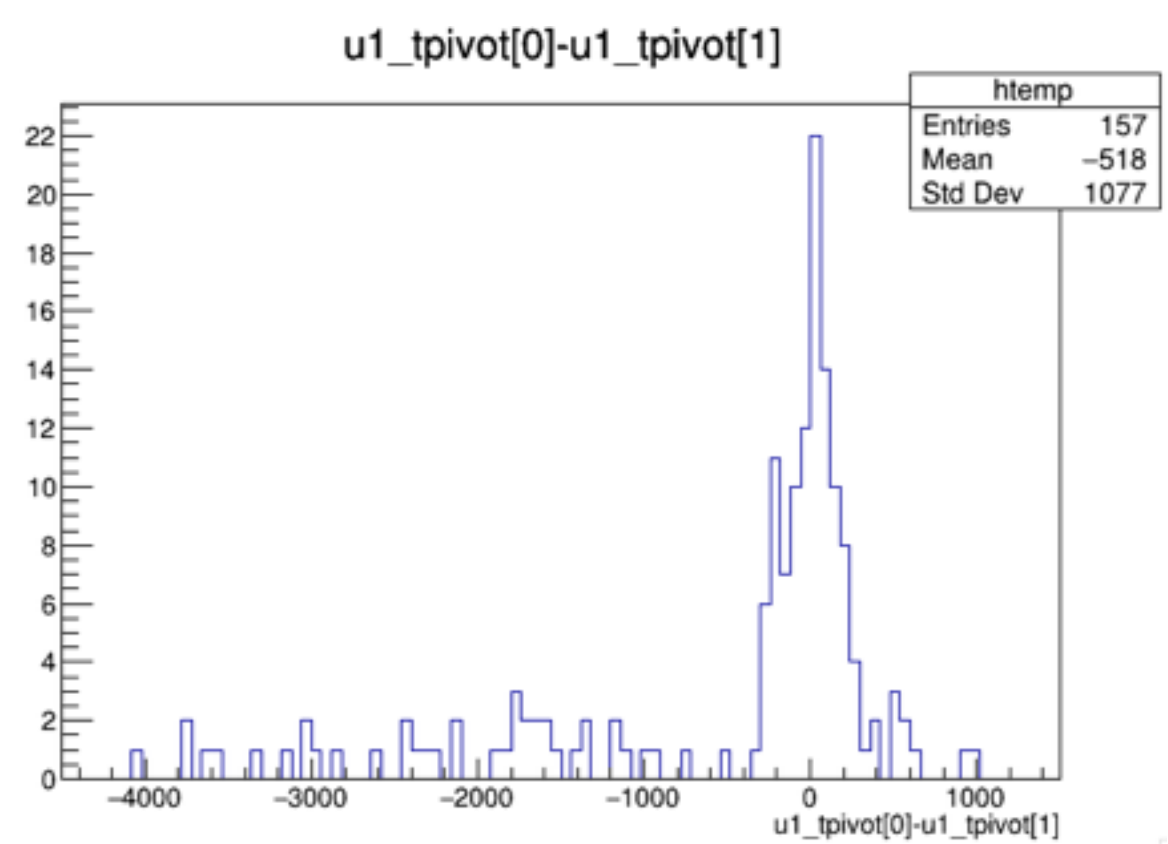
- loop all VDC hits, for hit[ii]:

  if "vdc.u1.trknum[ii]==1(or 2) && vdc.u1.wire[ii]==vdc.u1.clpivot[vdc.u1.clsnum[ii]]",

  —> u1_tpivot=vdc.u1.time[ii]*10^9 (ns);

- The better track has smaller timing?
- Multiple tracks are constructed due to some background;





Conclusions:

1. 1.2% potential electron events don't have a track constructed;

2. About 1% good electron events have multiple tracks;

3. By looking at the related clusters in shower, the multiple tracks could be:
   - One electron going with another particles;
   - One electron from target and some backgrounds;

4. More than 99% one-track good events pass the "S2.trdx" cuts, which means, the cut efficiency is about 99%. While our multiple tracks events are about 1%, I feel keeping multiple tracks doesn't improve the statistics a lot.

p_m : measured non-track percentage;

R_c : cosmic rate;

R_e : physics electron rate;

P_{real} : real non-track percentage;

R_{cn} : non-track cosmic rate;

R_{en} : non-track physics electron rate;

$$p_m = \frac{R_{cn} \cdot t + R_{en} \cdot t}{R_c \cdot t + R_e \cdot t} = \frac{R_{cn} + R_{en}}{R_c + R_e}$$

$$P_{real} = \frac{R_{en}}{R_e}$$

$$p_m - p_{real} = \frac{R_{cn} + R_{en}}{R_c + R_e} - \frac{R_{en}}{R_e}$$

$$= \frac{R_e R_{cn} - R_{en} R_c}{R_e (R_e + R_c)}$$

$$= \frac{R_{cn} - R_c \cdot \frac{R_{en}}{R_e}}{R_c + R_e}$$

R_c, R_{cn}, $\frac{R_{en}}{R_e}$ should be constant. When R_e decrease, p_m increase.

In experiment, at high x point, He3 physics electron rate is smaller than tritium rate. Thus, the measured non-track percentage will be higher.