Negative pion contamination

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Definition of cuts from Diana

```
TCut neg = "BB.optics.charge[]==-1";
TCut t2 = "(DBB.evtypebits&(1<<2))==(1<<2)";
TCut basic_e = neg && t2;

// Data quality cuts
TCut mag = "BB.optics.vzflag[]==1 && BB.tr.tg_th[]<0.2";
TCut vz = "TMath::Abs(BB.tr.vz[])<0.17";
TCut trps = "TMath::Abs(BB.tr.x[]+0.97*BB.tr.th[]-BB.ts.ps.x-7.8303e-3)<0.2 &&
                Tmath::Abs(BB.tr.y[]+0.97*BB.tr.ph[]-BB.ts.ps.y-0.01)<0.19";
TCut trsh = "TMath::Abs(BB.ts.sh.x-BB.tr.x[]-1.28*BB.tr.th[])<0.1 &&
                TMath::Abs(BB.ts.sh.y-BB.tr.y[]-1.28*BB.tr.ph[])<0.1";
TCut mom = "skim.p[0]>0 && skim.p[0]<10";
TCut chi2 = "BB.tr.chi2[]/BB.tr.ndof[]<5";
TCut beam = "skim.beam_trip==0";
TCut projx = "(BB.optics.bendx + 0.23*BB.tr.ph)>-0.097 &&
                (BB.optics.bendx + 0.23*BB.tr.ph)<0.13";
TCut basic_qual = mag && vz && trps && trsh && mom && chi2 && beam && projx;
TCut basic_qual_novz = mag && trps && trsh && mom && chi2 && beam && projx;

// PID cuts
TCut psmin = "0.5*BB.ts.ps.e>0";
TCut eoverp = "(0.5*BB.ts.ps.e + BB.ts.sh.e)/(1000*skim.p[]) > 0.833 &&
                (0.5*BB.ts.ps.e + BB.ts.sh.e)/(1000*skim.p[]) < 1.158";
```

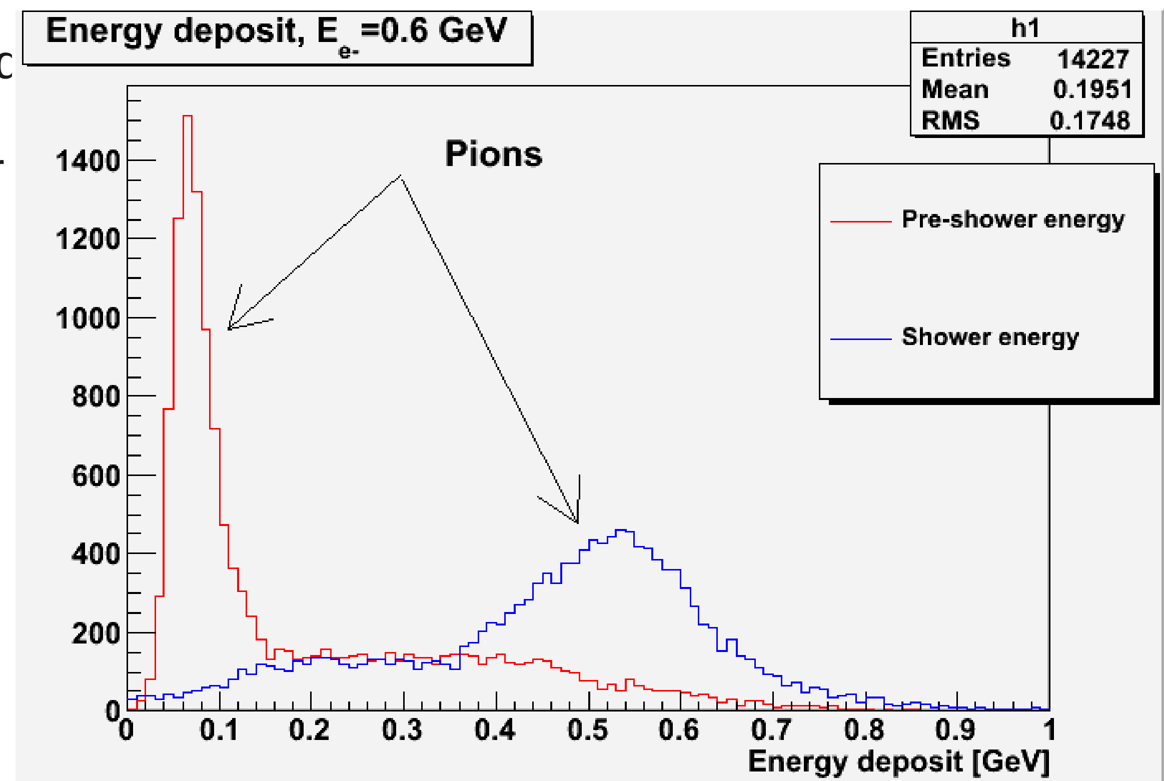
```
//--  The Cerenkov found a matching electron on the beam side!
  TCut   cer_beam ; //-- too long to have it here

// The Cerenkov found a matching electron on the RHRS side!
  TCut   cer_rhrs;     //-- too long to have it here

//-- Total Cerenkov cut
  TCut   cer_tot = cer_beam || cer_rhrs;

//-- Final good electron cut
 TCut good_electron = cer_tot && basic_e && basic_qual && psmin && eoverp;

//-- Good pion
TCut  good_pion = (!cer_tot) && basic_e && basic_qual && psmin && eoverp;
```

Sign of negative pion contamination

To see the effect of pion contamination a run with many pions is selected. For that purpose run 1530 was selected since pre-shower sum was not included in the trigger allowing many pions to be collected. The cut used to make the plot shown below is:

TCut = cer_cut = basic_e&&cer_tot&&"abs(BB.tr.p-0.6)<0.1";

The cut |BB.tr.p-0.6|<0.1 to be around 0.6 GeV the blue peak corresponds to pions that have a sharp red peak in pre-shower to give total energy around 0.6 GeV. As you can see if one removes the pion peak from shower energy distribution the remaining spectrum in shower looks symmetric and in pre-shower too. Also it can be seen that the blue pion peak is centered at around 0.5 GeV and looking at https://hallaweb.jlab.org/wiki/images/e/e0/Bbsimulation_new.pdf page 2 left blue spectrum one can see that there is similar peak in around 0.5 GeV. The peak in page 2 is not as visible as in run 1530 because pre-shower sum was included in the trigger and momentum cut abs(BB.tr.p-0.6)<0.1 takes only pions that deposit more than 0.1 GeV energy in pre-shower.

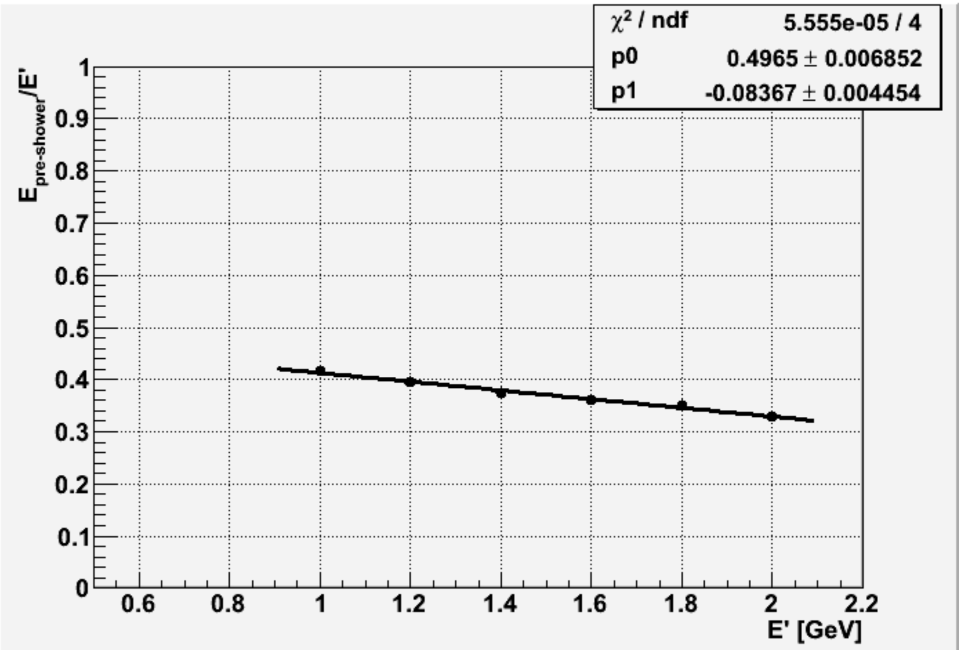


Estimation of pion contamination

To estimate pion contamination at a given initial electron momentum three distributions are needed:

Normalized means energy deposit divided by electron momentum found from drift chambers.

1) Normalized pre-shower energy spectrum for both pions and electrons. This is the spectrum that is left after the final cut good_electron, which intends to selects only electrons.
2) Normalized pre-shower energy spectrum for pion events good_pion (no Cerenkov signal).
3) Normalized pre-shower energy spectrum for electrons. This spectrum is found by plotting pre-shower energy at higher electron momentum since there are no pions left at that energy. In this analysis I used |BB.tr.p-1.16|<0.05 to make sure that no pion is left. I also adjusted the center of the pre-shower energy spectrum to take account the fact that more of the shower energy is deposited at lower electron energy. This was estimated by plotting how the normalized pre-shower energy mean changes versus electron momentum. From the plot in this page, center of normalized distribution is at 0.46. Since the pre-shower energy fluctuations are much larger than the energy resolution of pre-shower, using normalized pre-shower energy at 1.16 GeV for 0.6 GeV electron spectrum does not make noticeable difference.



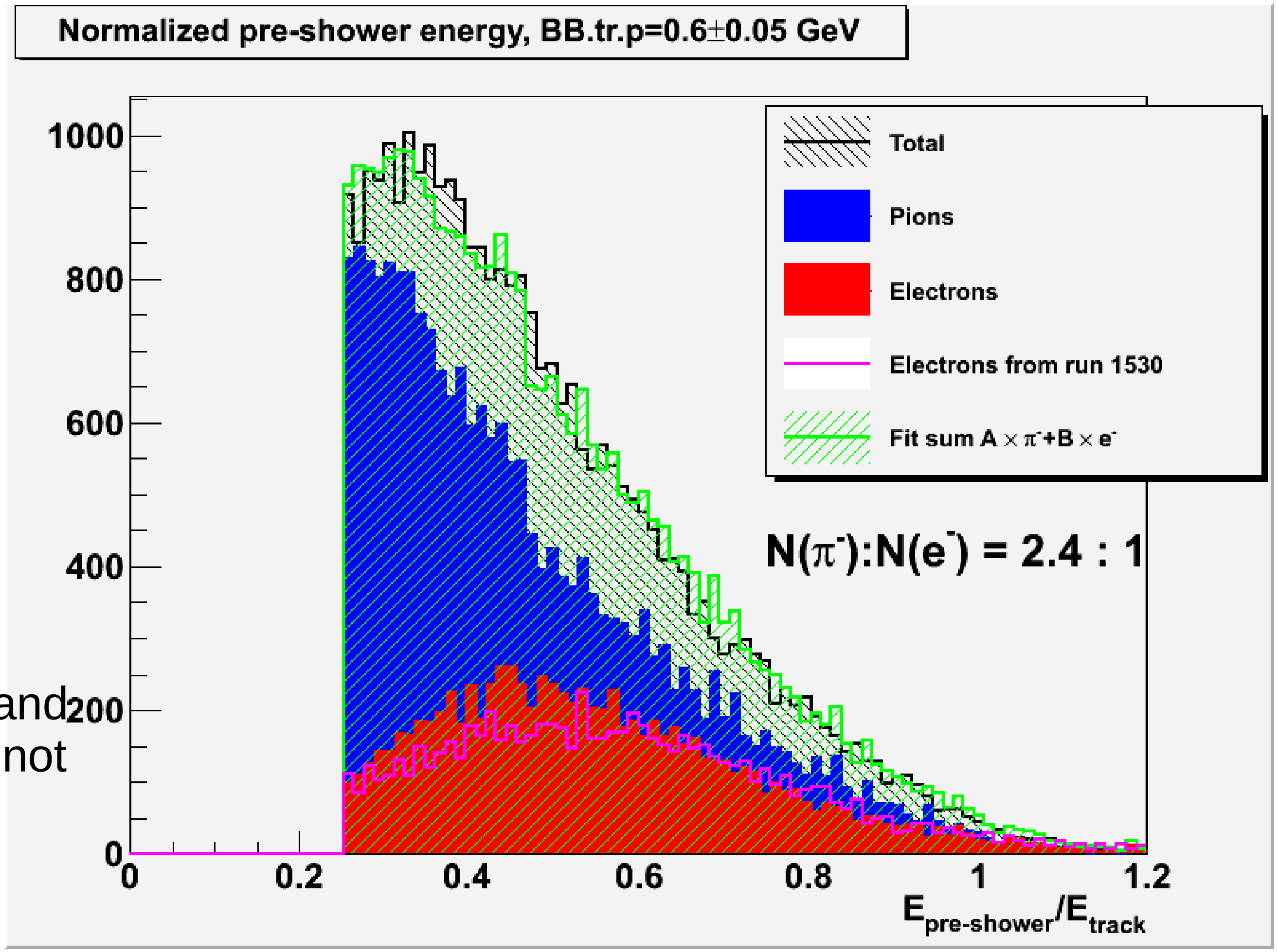
The blue spectrum is normalized energy spectrum in pre-shower obtained with good_pion cut. The red spectrum is normalized electron energy spectrum in pre-shower obtained with good_electron&&"abs(BB.tr.p-1.16)<0.05" cut and shifted in positive direction by 0.045 to compensate for higher pre-shower energy deposition at lower energy (0.6 GeV). To take account pre-shower resolution effects the electron distribution (red) is smeared to take account the energy dependence of pre-shower resolution. The black spectrum is pre-shower energy distribution with good_electron&&"abs(BB.tr.p-0.6)<0.05" cut. The green spectrum is obtained by summing pion and electron spectrum with corresponding coefficients, which are found by minimizing the following:

CHI2 = [TOTAL – (A * PIONS + B * ELECTRONS)] ^ 2
GREEN = A * PIONS + B * ELECTRONS

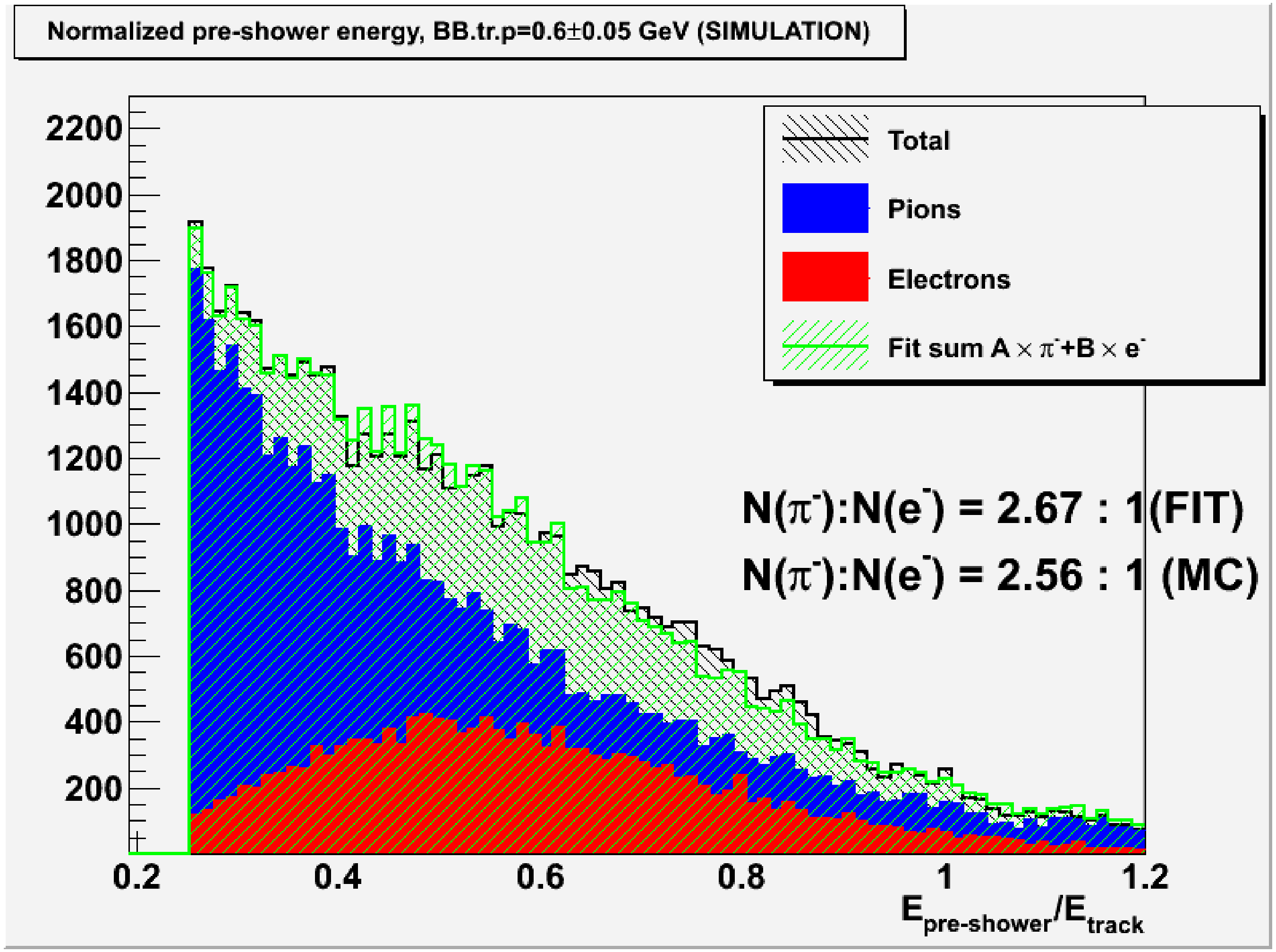
N(π-) = ∫ A * PIONS

N(e-) = ∫ B * ELECTRONS

The magenta spectrum is from runs 1530,1533,1534. Pion contamination is rejected using good_electron&& BB.s.MaxADCHit>500.0 &&"abs(BB.tr.p-0.6)<0.05" cut. There is some difference in red and magenta which can be explained by not enough smearing of electron energy distribution obtained with |BB.tr.p-1.16|<0.05 cut.



The procedure described in the previous slide is done on MC.



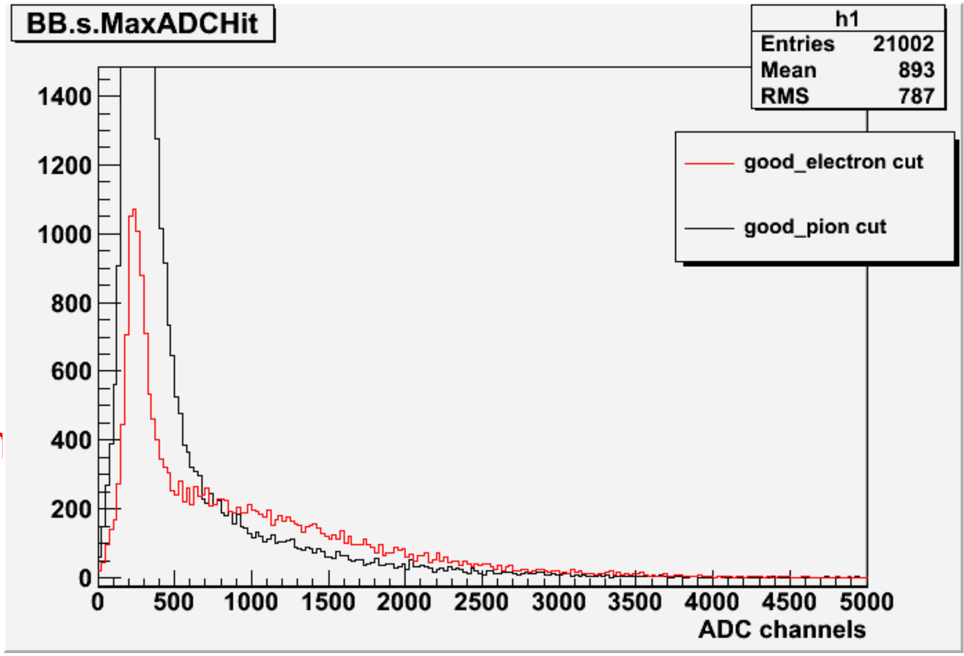
Using Scintillator to Reject Pions

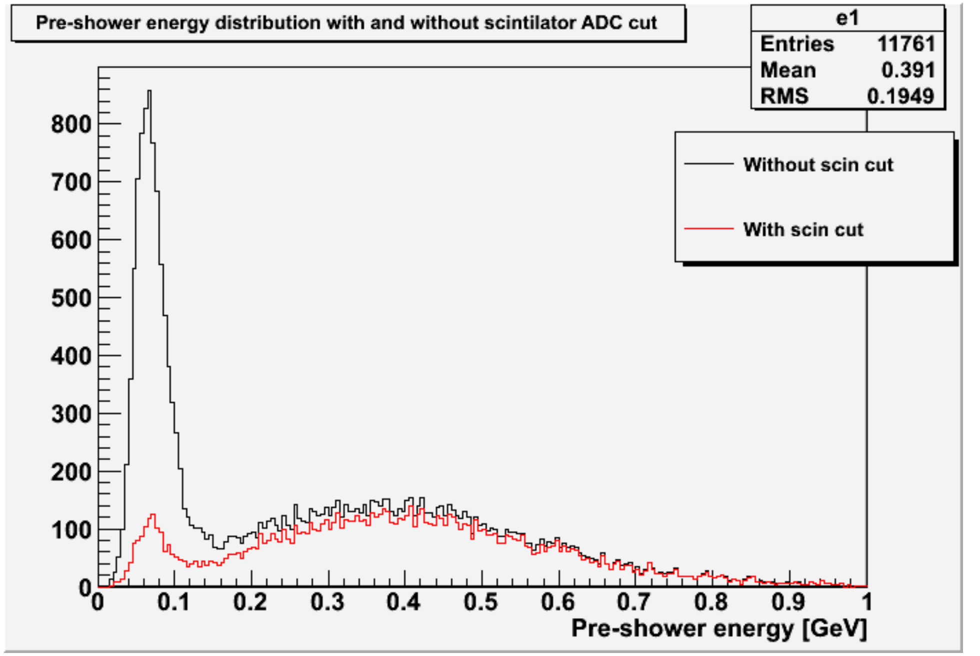
First plot is ADC distribution of scintillator paddle that gave the biggest signal (?). Black histogram corresponds to good_pion cut, the red one to good_electron cut. Since electrons lose more energy than pions in the scintillator a cut on ADC can be used to reject pions.

Second plot shows pre-shower energy distribution with good_electron cut (black) and with good_electron and scintillator ADC > 500 cut. The cut mostly removes pions.

These plots are made using root file e06014_1530_cal_1.root (from Matthew).

BB.s.MaxADCHit variable is not included in the root files Diana gave me.





Conclusion

Using normalized pion energy spectrum in pre-shower it is possible to estimate pion to electron ratio.

In this note it is found that at BigBite track energy 0.6+-0.05 GeV pion to electron ratio is 2.4 : 1.