Already searh trough the run and remove the dummy runs.

```
int Nrun_1 = 40;
int runlist_kin12_list1[] = {2939,2940,2941,2942,2943,2944,2945,2946,2947,2985,
                             2986,2987,2988,2989,2994,2995,2996,2997,2998,2999,
                             3000,3001,3002,3004,3005,3006,3007,3008,3009,3010,
                             3011,3012,3014,3015,3016,3017,3018,3019,3020,3021};
int Nrun_2 = 38;
int runlist_kin12_list2[] = {3022,3025,3026,3027,3028,3029,3031,3033,3034,3035,
                             3036,3037,3038,3039,3040,3043,3044,3045,3046,3047,
                             3048,3049,3050,3051,3053,    3055,3056,3058,3059,
                             3061,3062,3063,3064,3065,    3067,3068,3069,3070};
int Nrun_3 = 37;
int runlist_kin12_list3[] = {3071,3072,3073,3074,3076,3077,3078,3079,3080,3081,
                             3082,3083,3084,3086,3087,3088,3089,3090,3091,3092,
                             3093,3094,3096,3097,3098,3099,3100,    3102,3103,
                                    3107,3108,3109,3110,3111,3113,3114,3115 };
int Nrun_4 = 25;
int runlist_kin12_list4[] = {3116,    3119,3120,3121,3122,3123,3124,3125,3126,
                             3127,3128,3129,3130,3131,3133,3135,3136,3137,
                                    3141,3142,3143,3144,3145,3146,    3149};
///Kin 3
int Nrun_5 = 36;
int runlist_kin3_list5[] = {3188,3189,3190,3191,3192,3193,3194,3196,3197,
                            3198,3199,3200,3201,3202,3203,3204,3206,    3209,
                            3210,3211,3212,3213,3214,3215,3216,3218,    3221,
                            3222,3224,3225,3226,3227,3228,3229,3230,3231,3232};
int Nrun_6 = 25;
int runlist_kin3_list6[] ={3233,3234,3236,3238,3239,3240,3241,3242,3243,3244,
                           3245,3246,3247,    3249,3250,3261,3262,3263,3264,
                           3265,3266,3267,3268,3269,3270 };
                            /*Not replay list: 3271,3272,3273,3274,3277,
                              3278,3279,3280,3281,3282,3283,3284,3285,3287,3288*/
int Nrun_7 = 37;
int runlist_kin3_list7[] = {            3297,3298,3299,3300,3312,3313,3314,
                            3315,3316,3317,3319,3320,3321,3322,3323,3324,3325,
                            3326,3327,3328,3329,3330,3331,3332,3333,3334,3335,
                            3347,3348,3349,3350,3351,3352,3353,3354,3355,3387};
int Nrun_8 = 28;
int runlist_kin3_list8[] = {3388,3389,3390,3391,3392,3393,3394,3395,3396,3397,
                            3398,3399,3400,3401,3402,3403,3404,3405,3406,3407,
                            3408,3409,3410,3411,3412,        3415,3416,3417};
int Nrun_9 = 36;
int runlist_kin3_list9[] = {3418,3419,3420,3421,3422,3423,3424,3425,3426,3427,
                            3428,3429,3430,3431,3433,3434,3435,3436,3437,3438 ,
                            3439,3440,3441,    3443,3444,3445,3446,3447,3448,
                            3449,3450,3451,3452,3453,3454,3454};
```

1. Extension to higher momentum above 1 GeV.
High Momentum Extension: combine data for all kinematic.

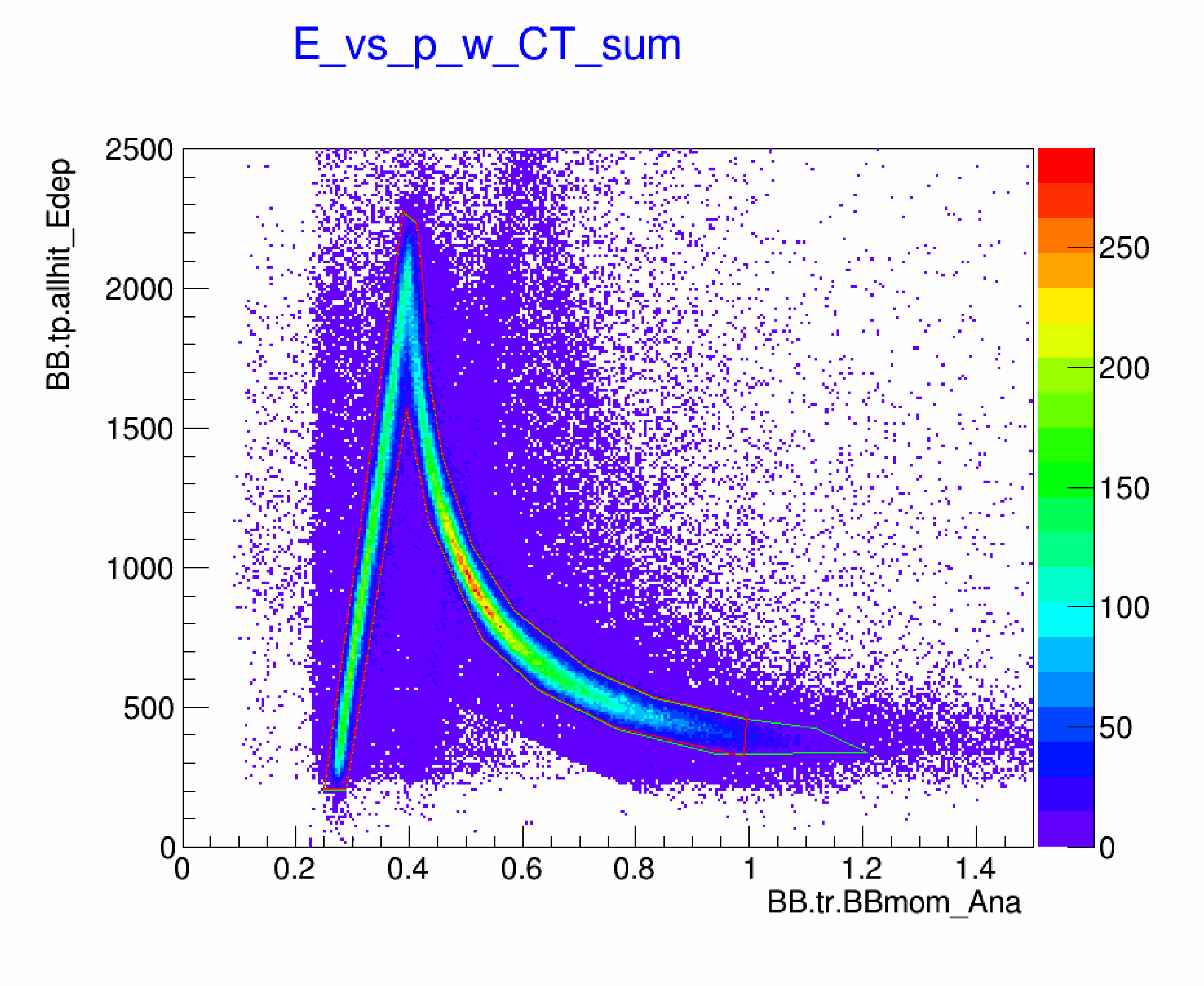

Figure 1: Proton PID: BigBite Energy deposited in E-plane vs Analytical momentum
Red graphical cut: previous cut
green graphical cut: extension cut

2. attempt to remove background from convert the coincidence time to momentum

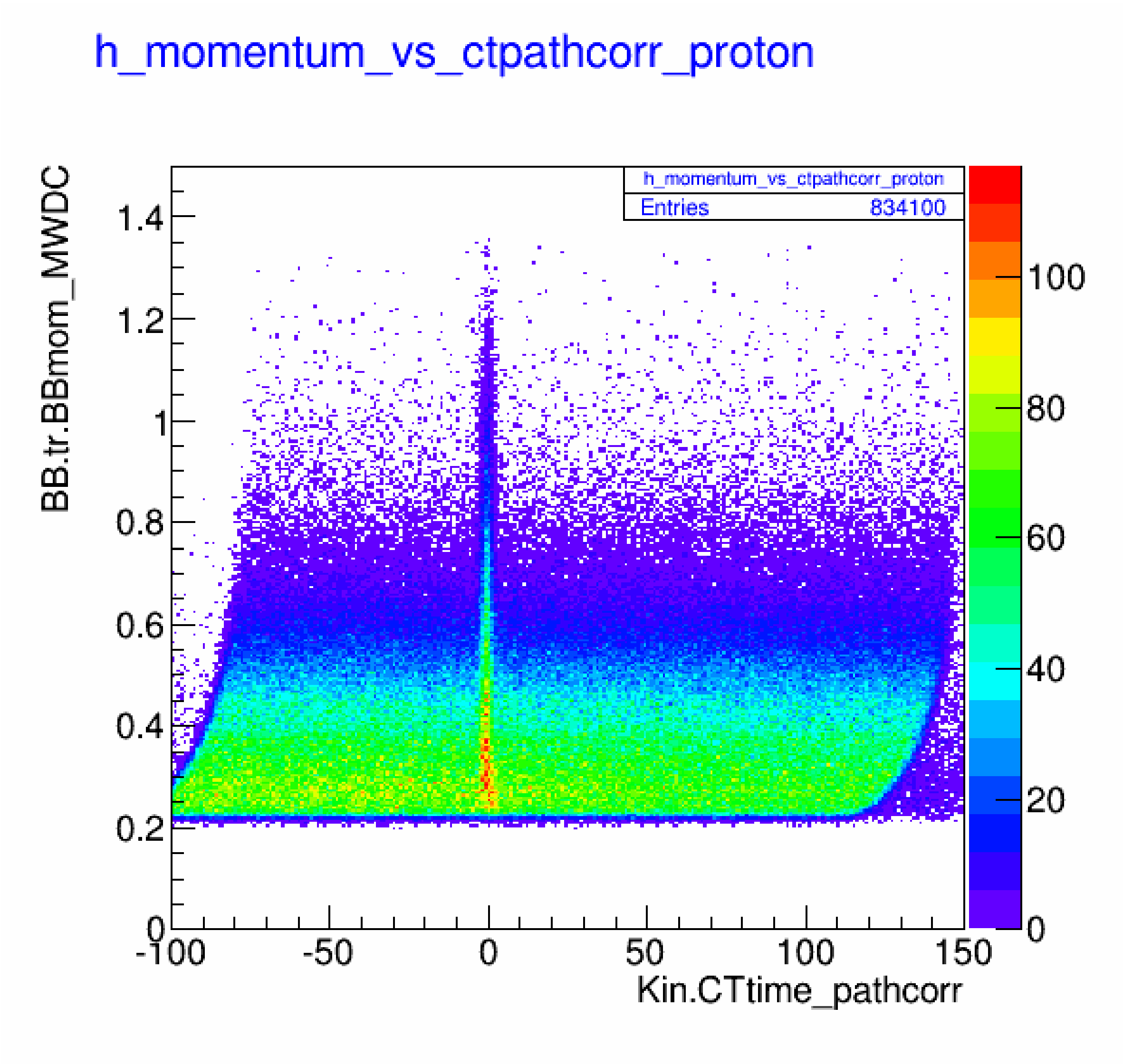

Figure 2.1: CT pathcorr vs momentum (proton PID)

The background is mainly in the low momentum.

With
CT pathcorr = CT with LHRS path-length time correction
and with BigBite path-length time correction
and this value is set to zero.

So for
CTtime_Lpathcorr = coincidence time with LHRS path-length time correction
= time to travel from vertex to BigBite detector
= BB path-length time correction

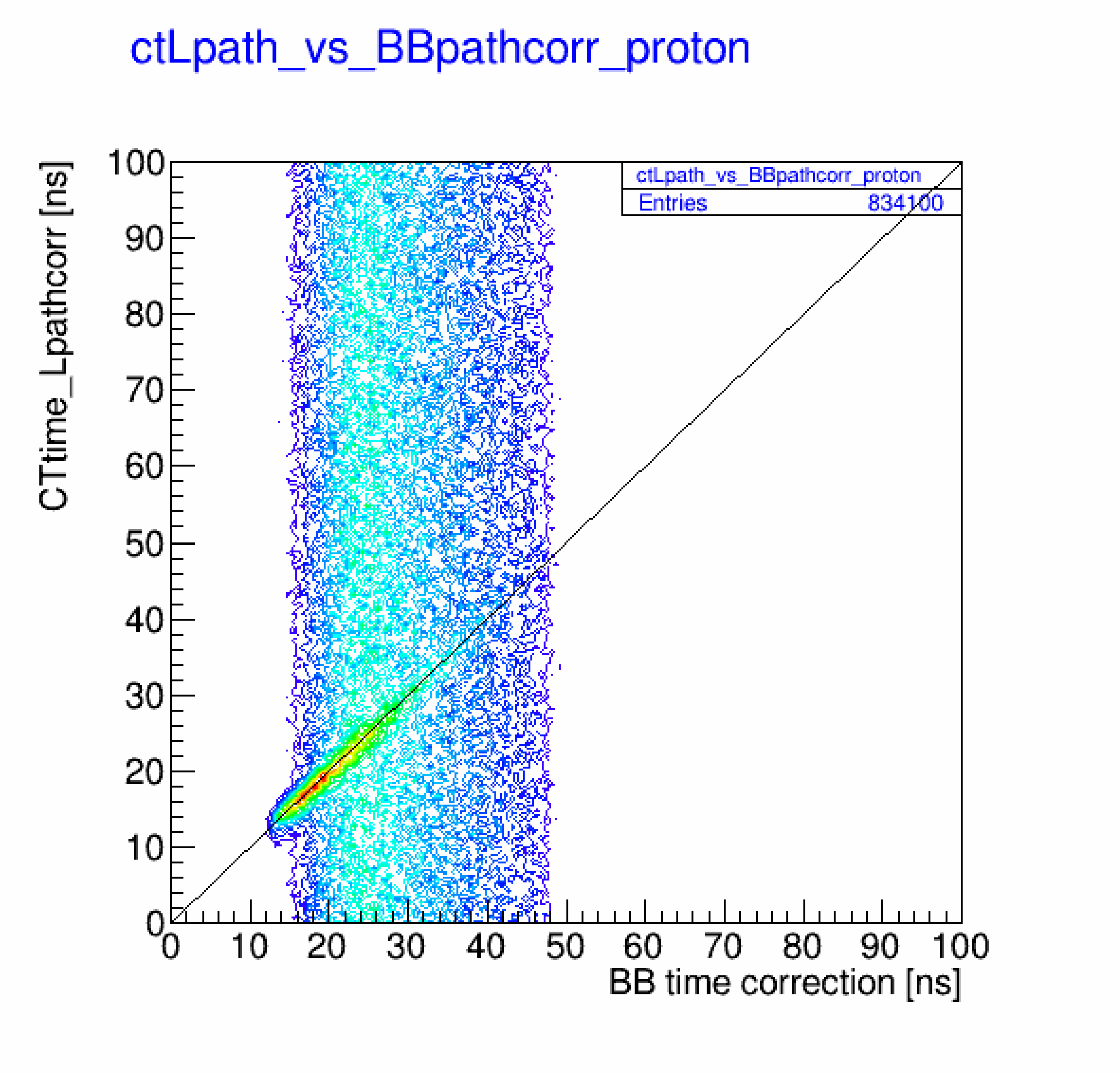

Figure 2.2: CT with Lpathcorr vs BB path-length time correction

Using time from CT_Lpathcorr and convert it to momentum as follow:
(time) = (pathl) E/(pc) = (pathl/c)*sqrt[1+(m_p/p)**2]
so

p_timeconverted = m_p/ sqrt[(time*c/pathl)**2-1]

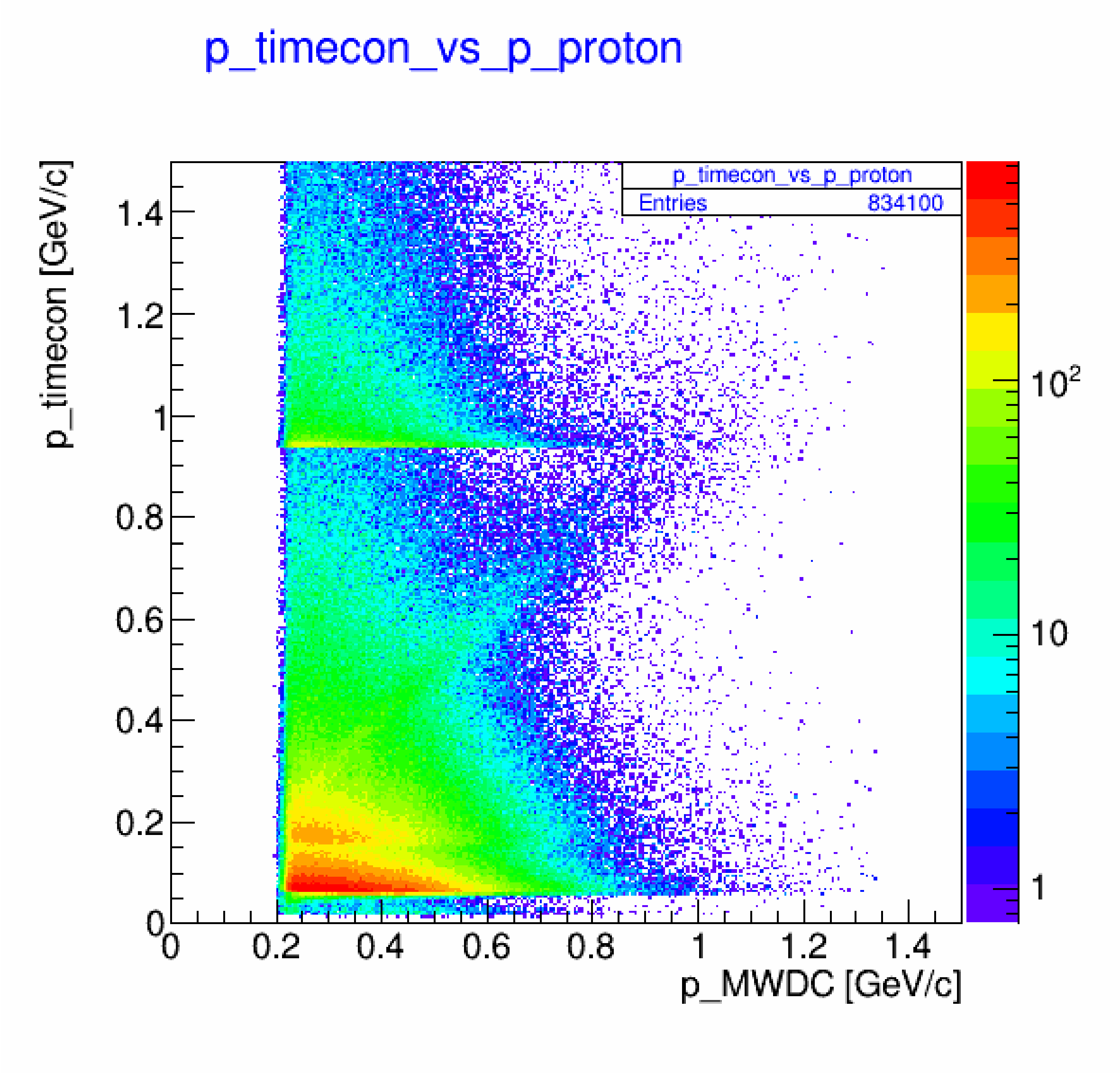

Figure 2.3: momentum from time conversion vs momentum at MWDC : after proton PID

The data that should be interested us should be along the line of p_time_converted == p_MWDC. But before making the CT pathcorr cut, it is harder to even see the line above other things.

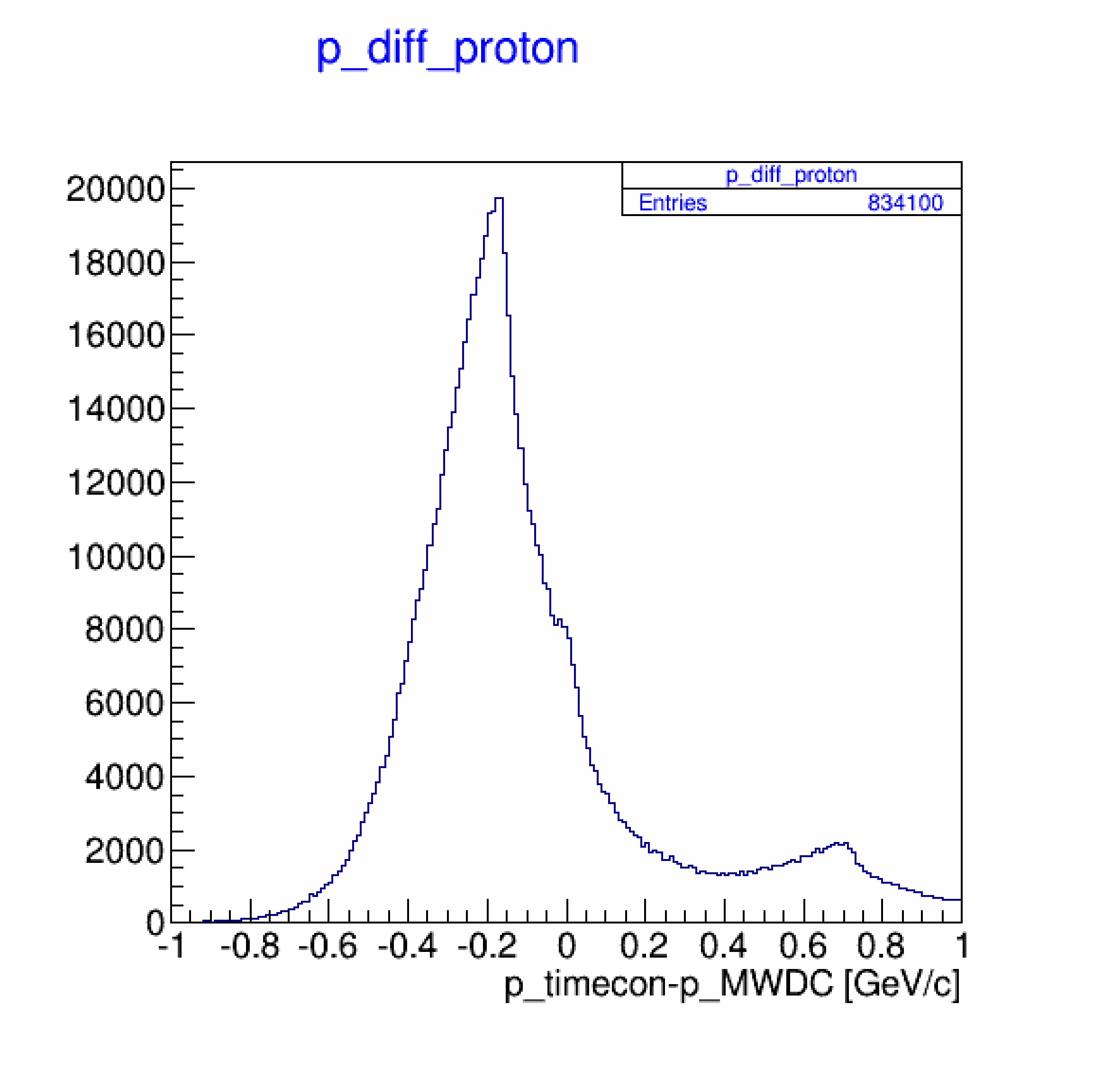

Figure 2.4: momentum from time conversion - momentum at MWDC : after proton PID

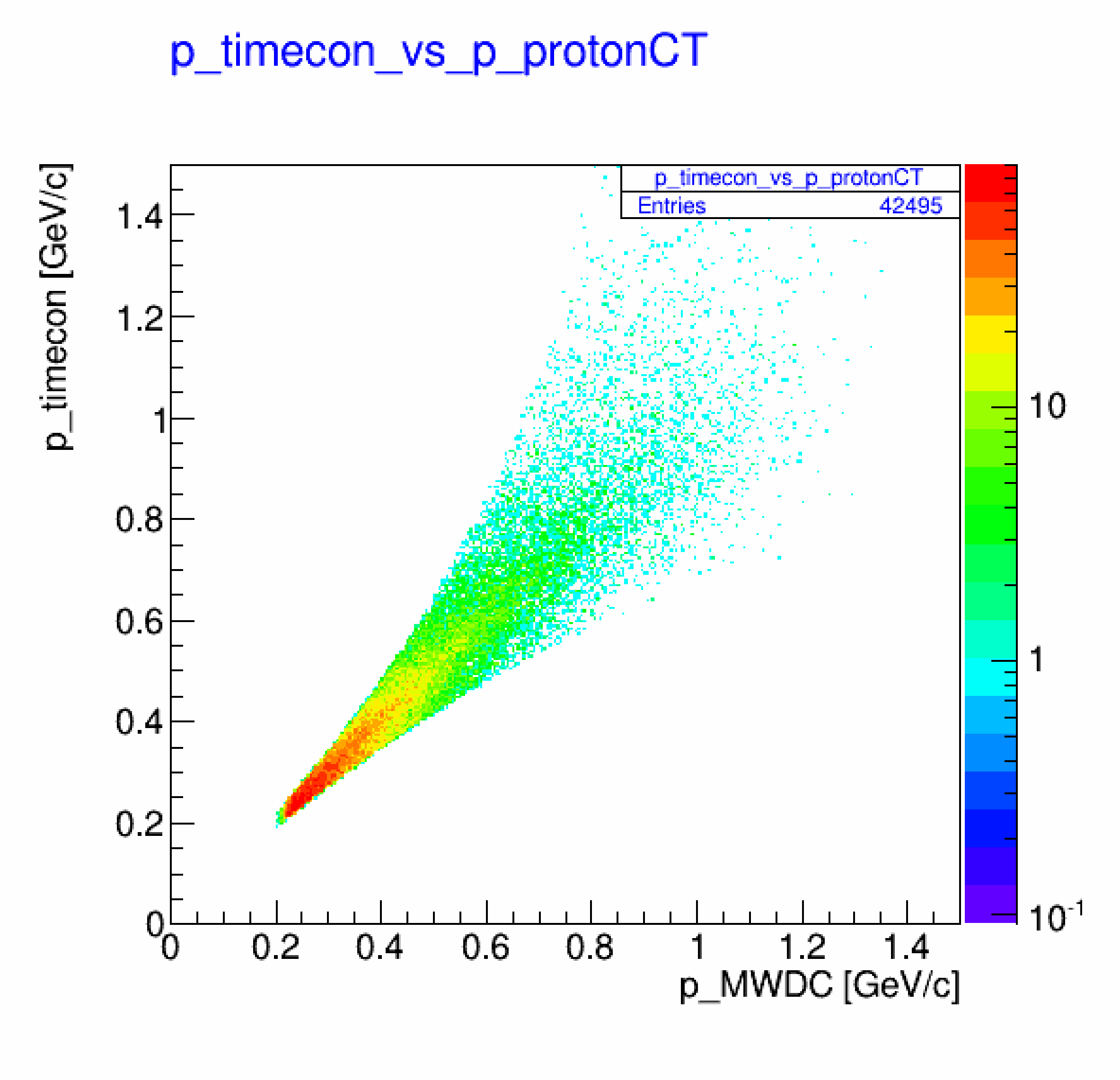

Figure 2.5: momentum from time conversion vs momentum at MWDC : after proton PID and CT pathcorr cut at 3sigma.

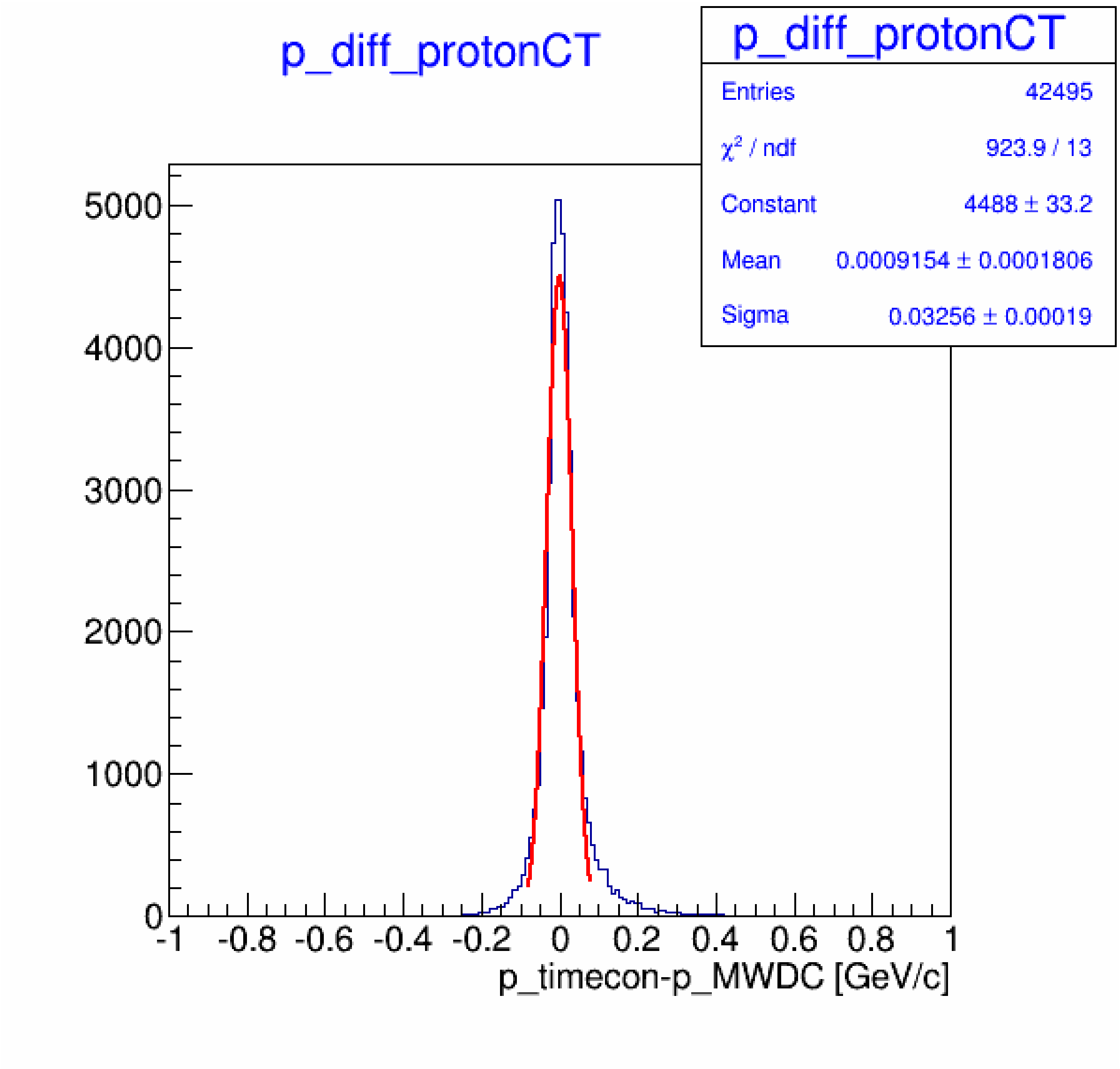

Figure 2.6: momentum from time conversion - momentum at MWDC : after proton PID and CT pathcorr cut at 3sigma.

We can try with making the cut between the momentum from time conversion - momentum at MWDC. But the background is mainly in the low momentum (refer to figure 2.1). The spread in the difference is in the high momentum section.

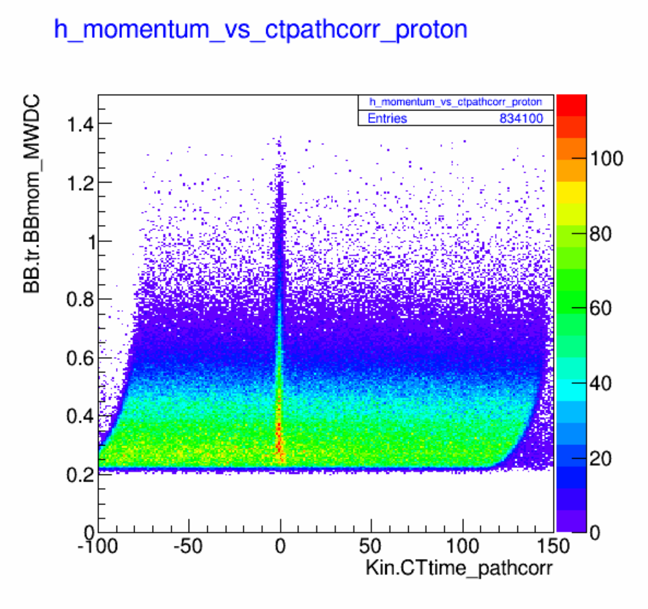

Figure 2.1 Ctpathcorr vs p_MWDC proton

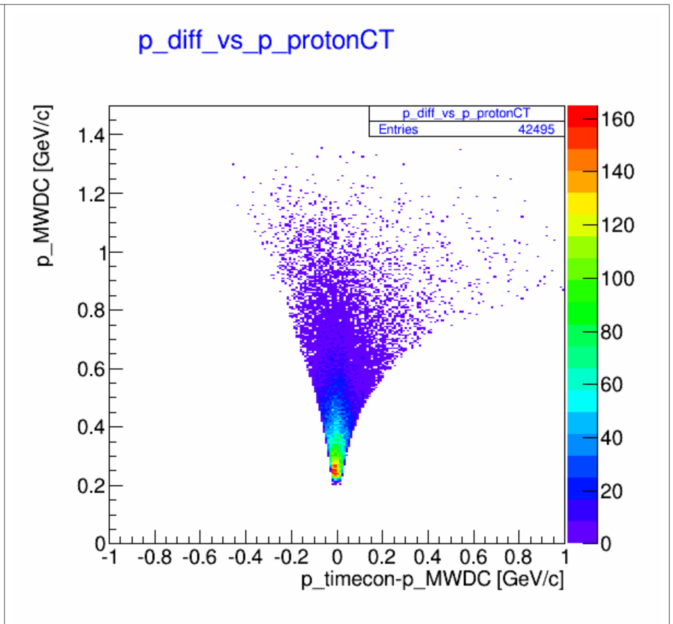

Figure 2.7 diff_p vs p_MWDC protonCT

So in this case I think the cut will NOT remove the background but the high momentum section where the time-converted momentum is not exactly equal to p_MWDC.

3. **How much Boiling Effect at 4 uA?**

Our production target is a 20-cm target which is at the bottom of the two can loops.
The He4 target is at
T = 19.91 K and
p = 204.52 psiA,

Using temperature and pressure we can obtain the ideal case (no beam) density of the He4 target (from the density of He4 is

rho = 33.834 kg/m^3 = 33.834 * 10^-3 g/cm^3.

(NIST: webbook.nist.gov) with the standard deviation from the fits of the temperature and pressure < **1% relative.**

The density loss (d_loss) (%) = - slope/Yield(0) *I_run *100.

The E08-014 target density boiling study cover the average current (I_ave) from 15 to 84 uA. Unfortunately it did not include our low current beam (I = 4 uA). But we can extrapolate the possible of the boiling effect.

Yield(0) = 20.57+/-0.03

Yield(0) = yield extrapolated to zero current:
from the look of the plot yield vs current with a straight line fitting through multiple detected-current points
For He4 slope = -0.0620 +/- 0.0004 (LHRS)
= -0.0649 +/- 0.0004 (RHRS)

d_loss (%) at 95 uA = 28.6%

d_loss (%) at 4 uA = 1.2%

compare to the extraction from the T,P, the density lost at 4 uA is at the same level.

Target length effect.
The other component that effect the density is the fluctuation along the target length. But from the smooth curve for the vertex, do we need to investigate?

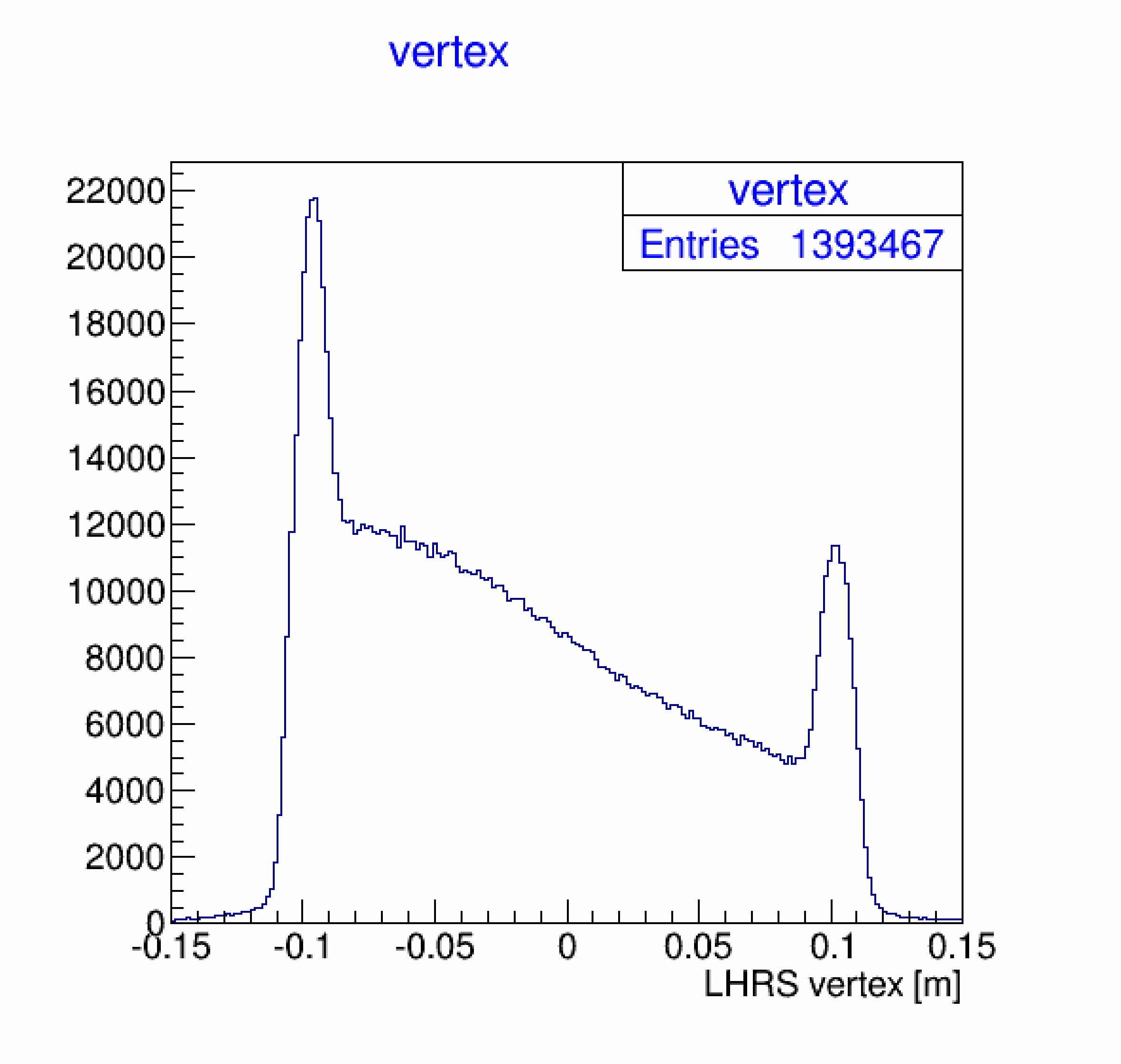

Figure 3.1: vertex distribution

Would it be within say 2% density loss if the average is 1.2%?