Analysis S455

Key Facts:

- Run 273, subrun 10 (~180 s), 10e7 events

- Expected p2p-Events ~ 5/s → 180*5 → 900 events for file

- TWIM calibration file used:

 /u/land/r3broot/202106_testing/R3BRoot_20210726/sofia/macros/s455Up2p/parameters/CalibParam.par

TPats

```
TrloII Scalers (r3b_trloii) begin-of-spill

Input            #               before DT   after DT    after DS   DT [%]
-----------------------------------------------------------------------------
 0:        0 SofStart   # S               0         0          0     -
 1:        0 Fission    # S+F             0         0          0     -
 2:       47 CalifOR    # S+  C&&         0         0          0     -
 3:        0 CalifAND   # S+F+C&&         0         0          0     -
 4:    13043 NeuLAND    # S+  C||         0         0          0     -
 5:        0            # S+F+C||         0         0          0     -
 6:        0            # !S              0         0          0     -
 7:        0            # !S+F            0         0          0     -
 8:        0            # !S+  C&&        0         0          0     -
 9:        0            # !S+F+C&&        0         0          0     -
10:        0            # !S+  C||        0         0          0     -
11:        0            # !S+F+C||        0         0          0     -
12:        0            # CalifOR        47        33         33    29.79
13:        0            # NeuLAND      13043      9425       9425    27.74
14:        0            #                 0         0          0     -
15:        0            # sync           15        12         12    20.00
-----------------------------------------------------------------------------
```
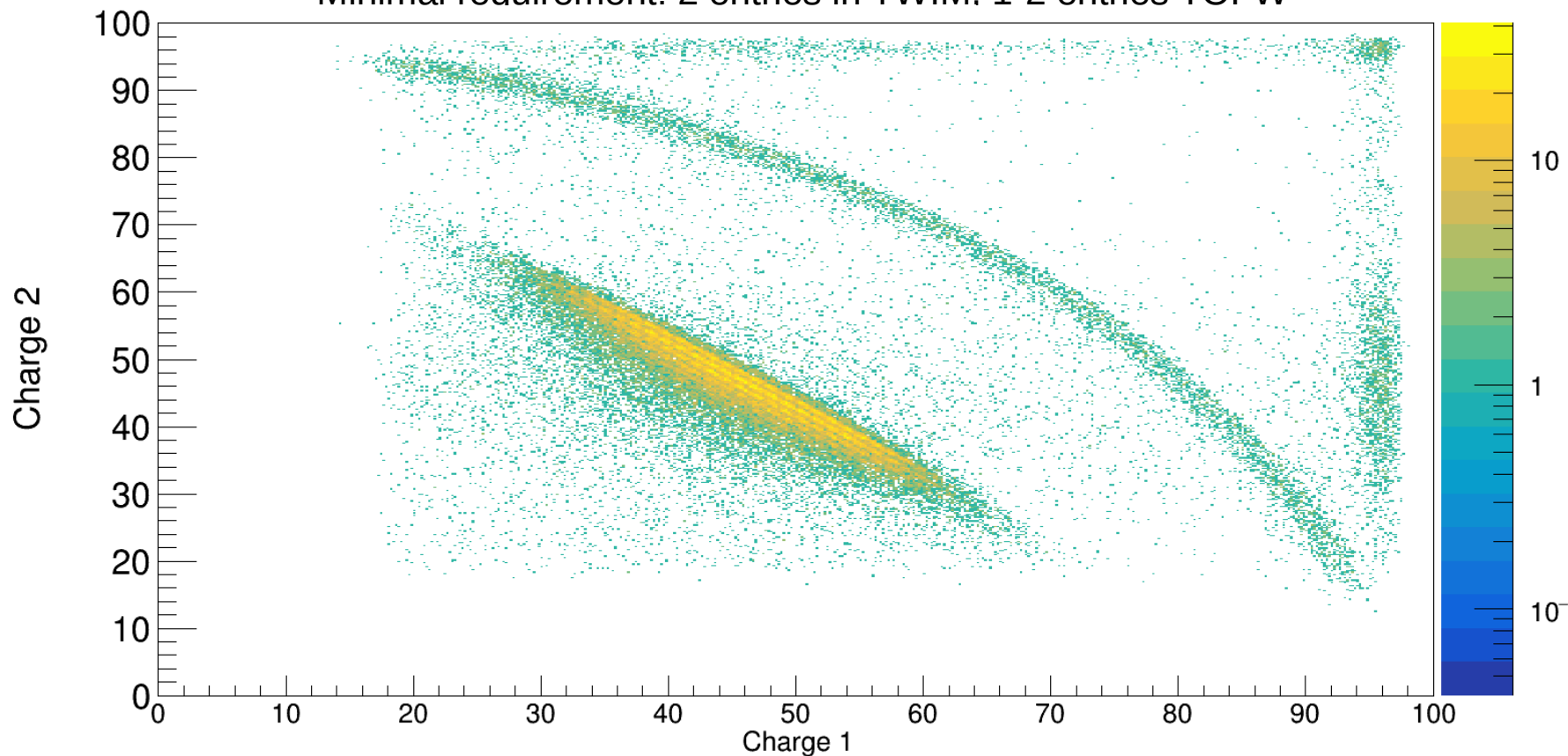
Trigger information: Tpat

h1_trigger	
Entries	352163
Mean	9.172
Std Dev	4.801
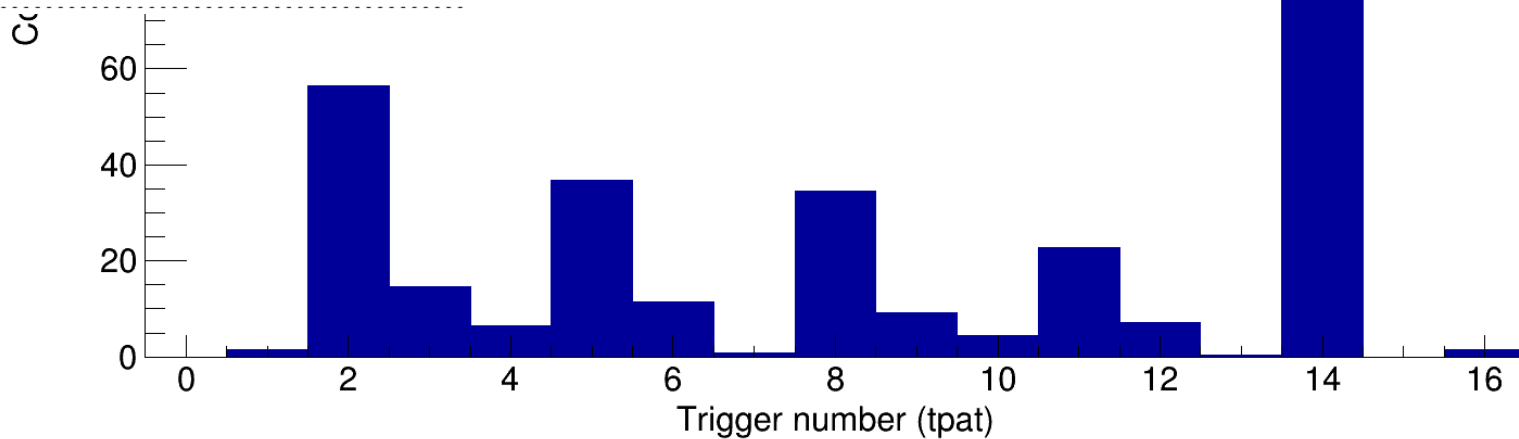
TWIM Charge Distribution

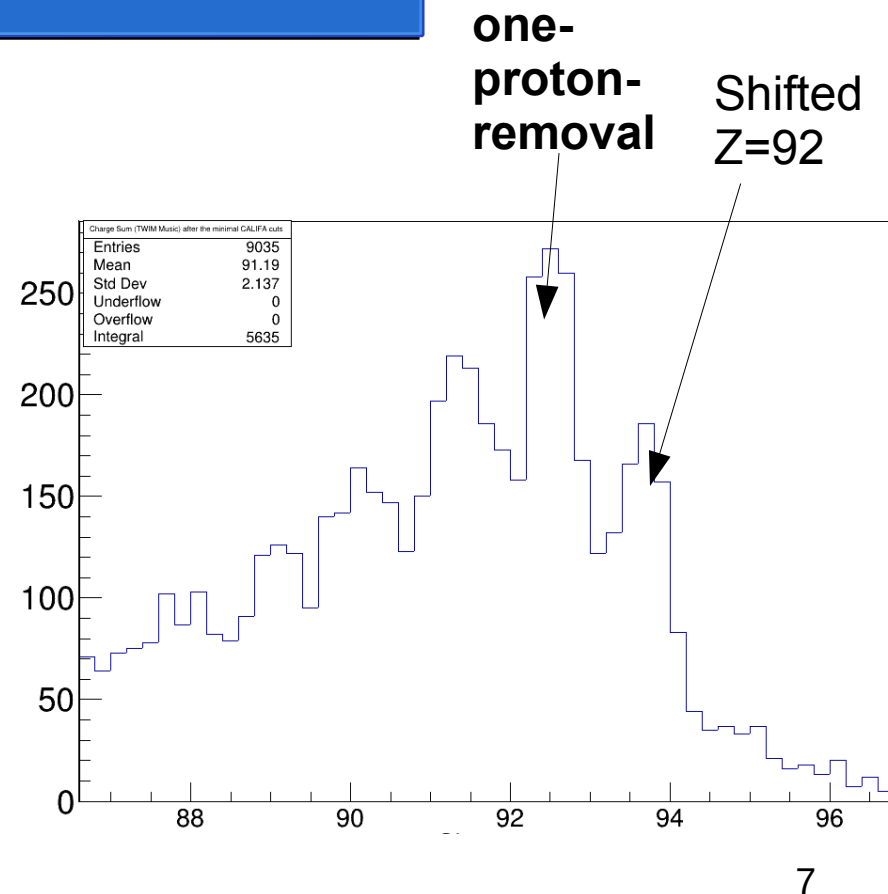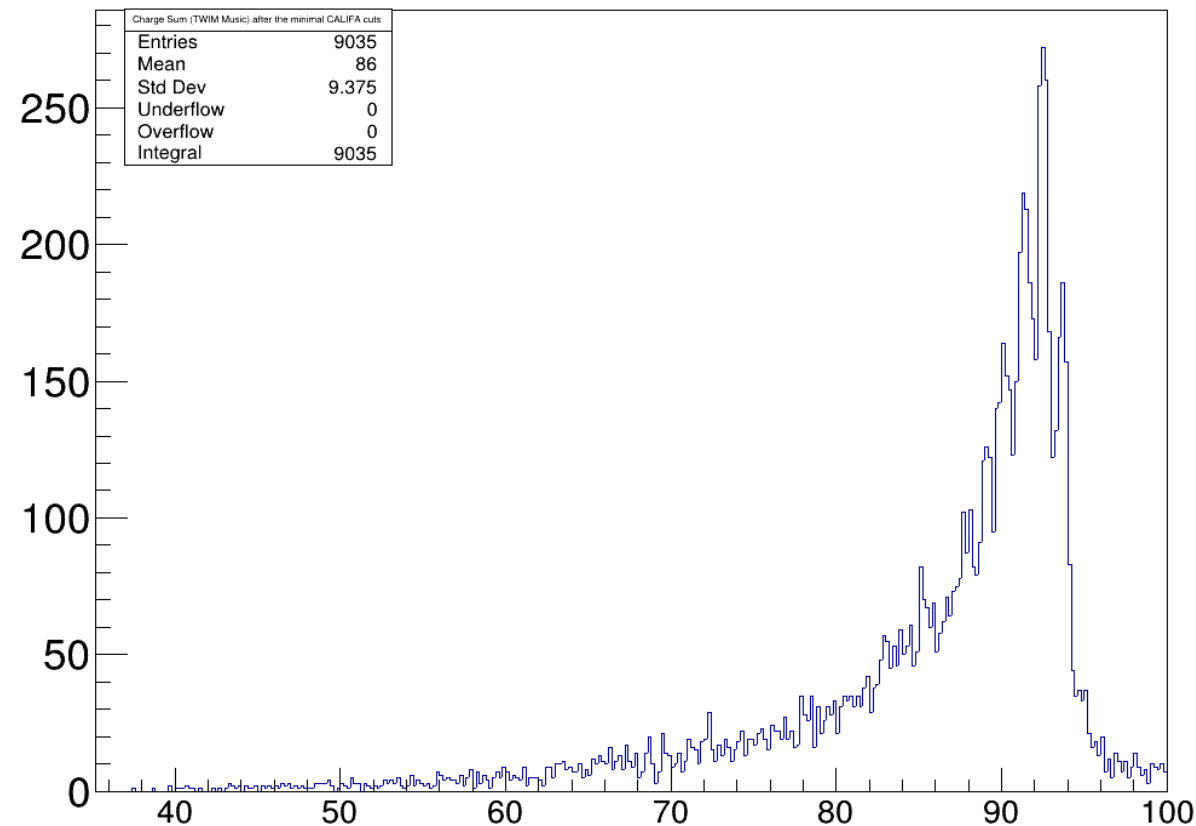Minimal requirement: 2 entries in TWIM. 1-2 entries TOFW

CALIFA p2p-Reconstruction

Minimal Cuts:

- E_1 and $E\_2 > 30$ MeV
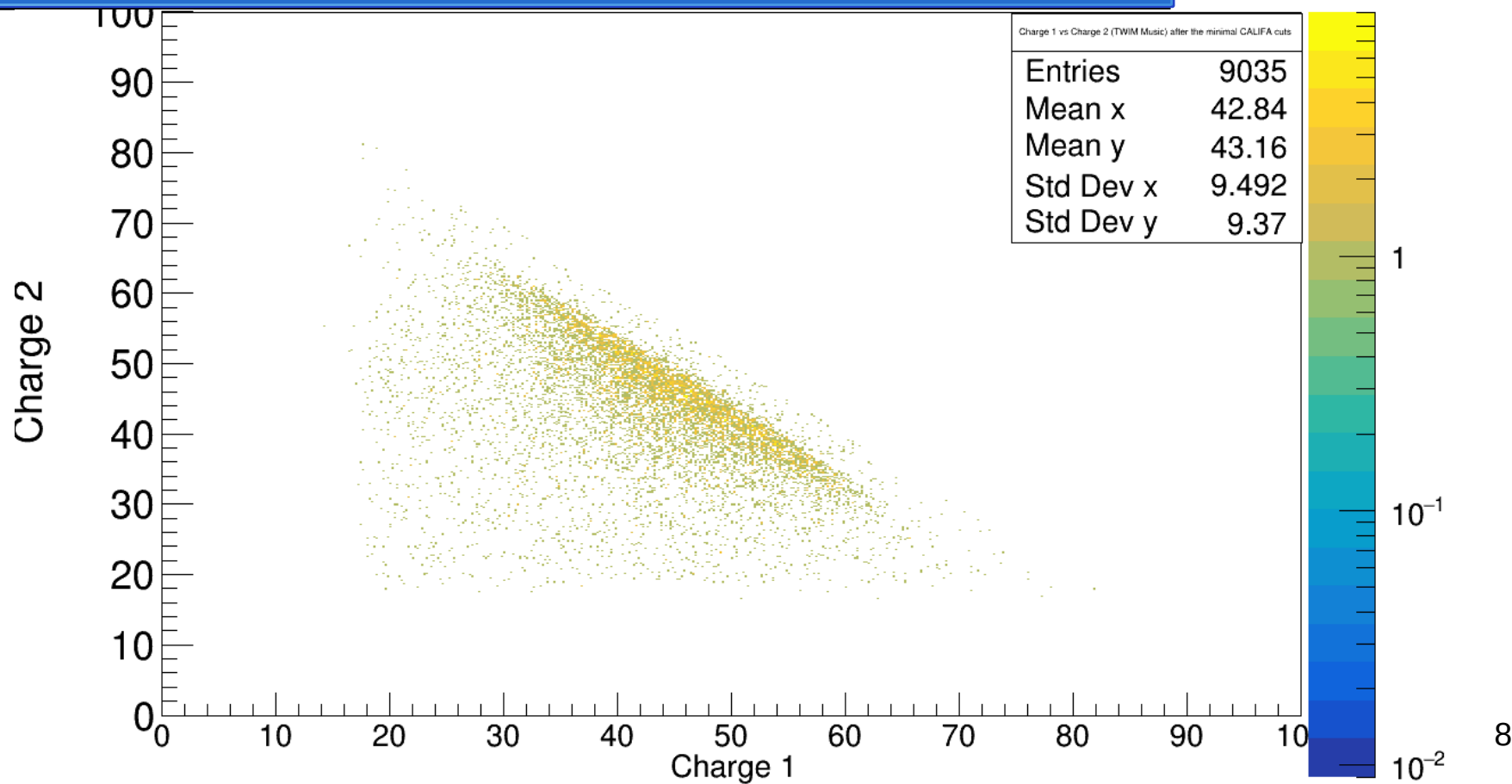- $\Delta\varphi = 180$+-$30°$
- (2 entries in TWIM; $Z\_sum < 100$, 1-2 entries TOFW)

Hit Selection Algorithm

- Sort CALIFA hits according to energy

- Calculate Δφ for the **first two highest** energy hits

- if   Δφ = 180+-30° → **p2p hits**

- Else:

  calculate Δφ for hit with **highest** energy and other hits &

  Δφ for hit with **second highest** energy and other hits

  Select combination with best Δφ (at least 180+-30°)→ **p2p hits**

Z_sum (with minimal CALIFA cuts)

Charge Sum (TWIM Music) after the minimal CALIFA cuts

Entries	9035
Mean	86
Std Dev	9.375
Underflow	0
Overflow	0
Integral	9035

one-proton-removal

Shifted Z=92

Charge Sum (TWIM Music) after the minimal CALIFA cuts

Entries	9035
Mean	91.19
Std Dev	2.137
Underflow	0
Overflow	0
Integral	5635

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Z_1_vs_Z_2 (with minimal CALIFA cuts)

More plots with minimal CALIFA cuts...
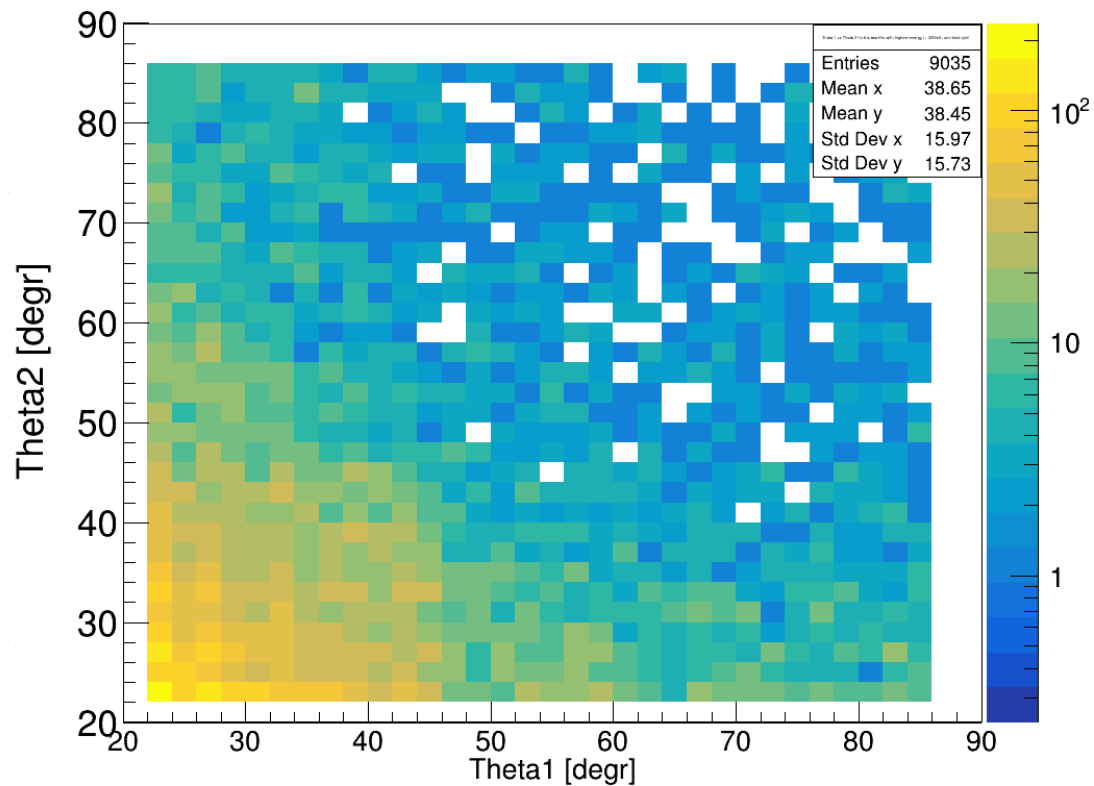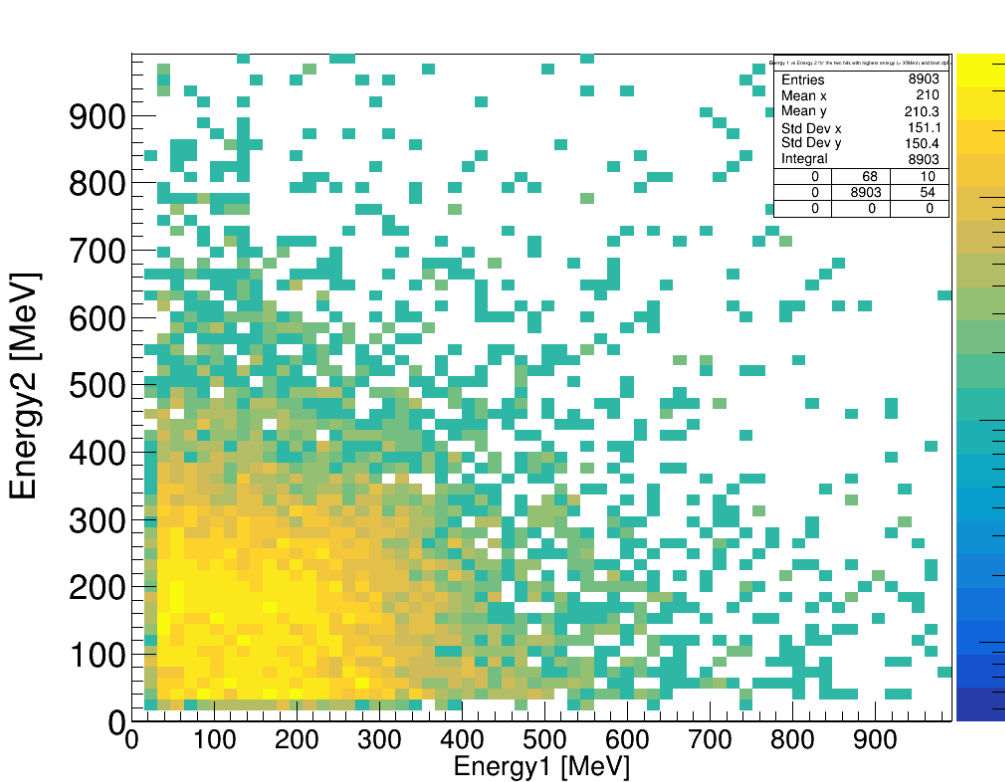
And more...
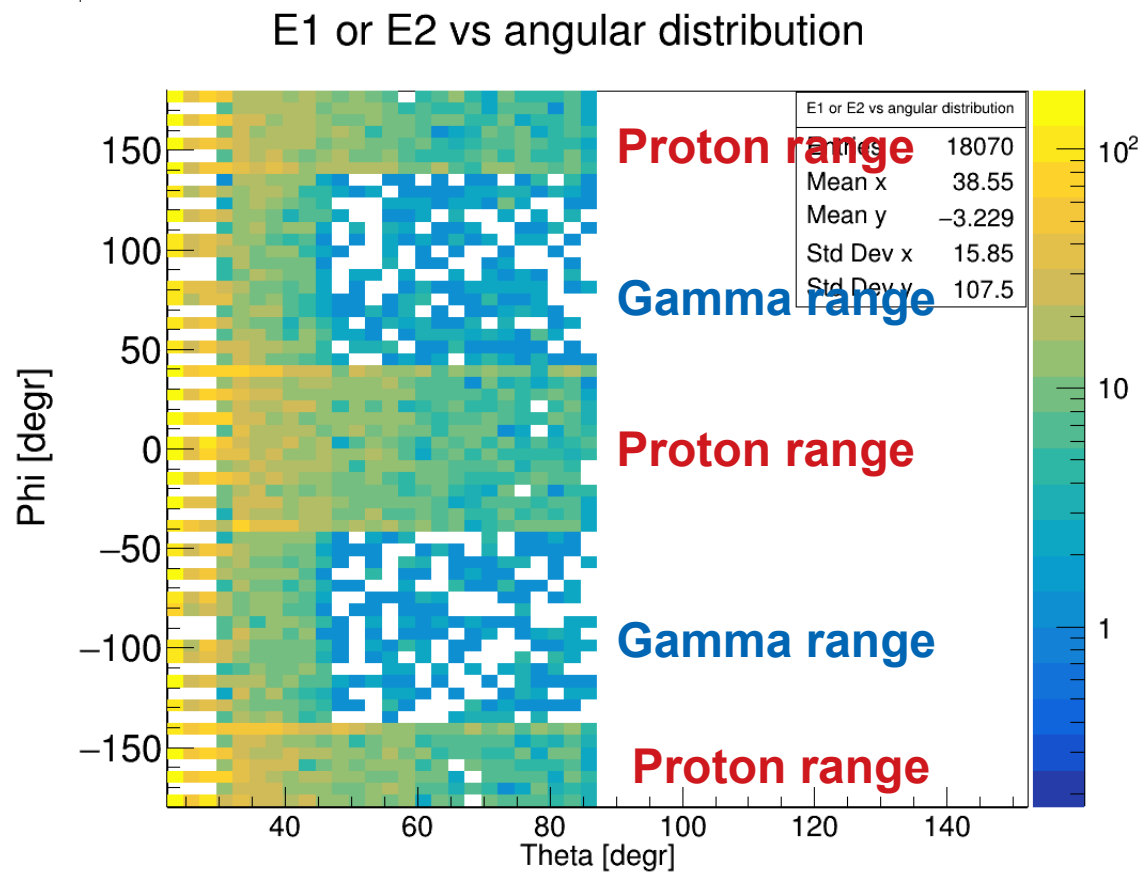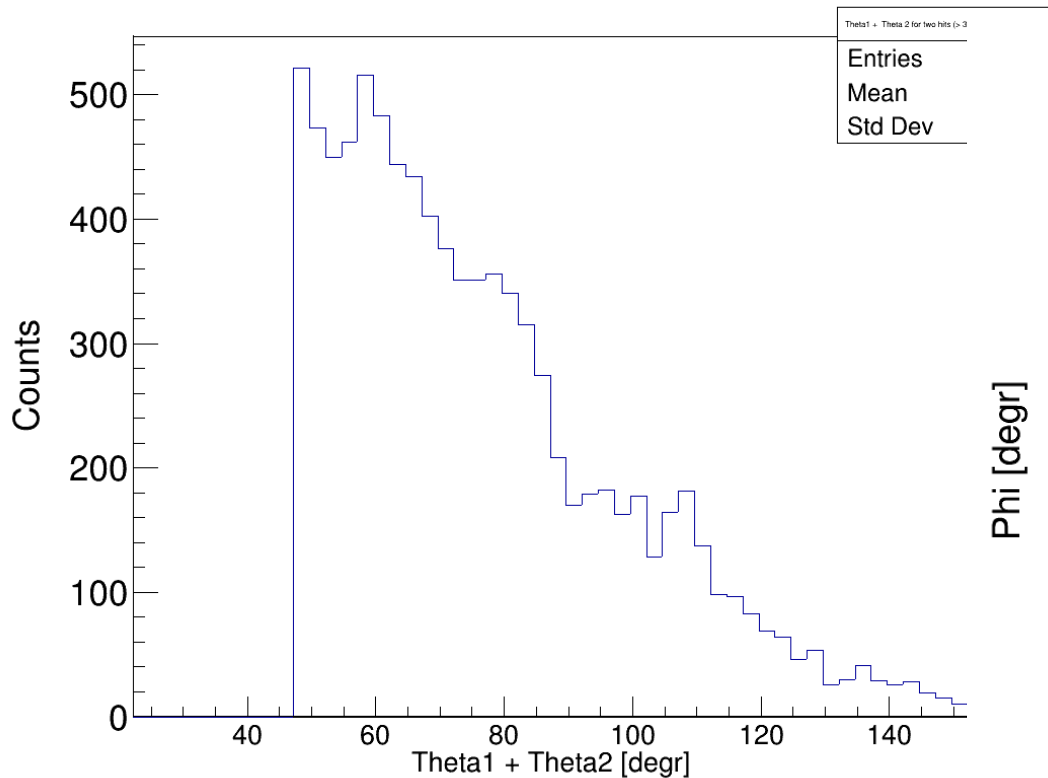
CALIFA cut parameters analysis

Stepwise and independent restriction of parameters $\Delta\varphi$, $\Delta\theta$ (= $\theta_1 + \theta_2$), E_sum (= E_1+E_2)

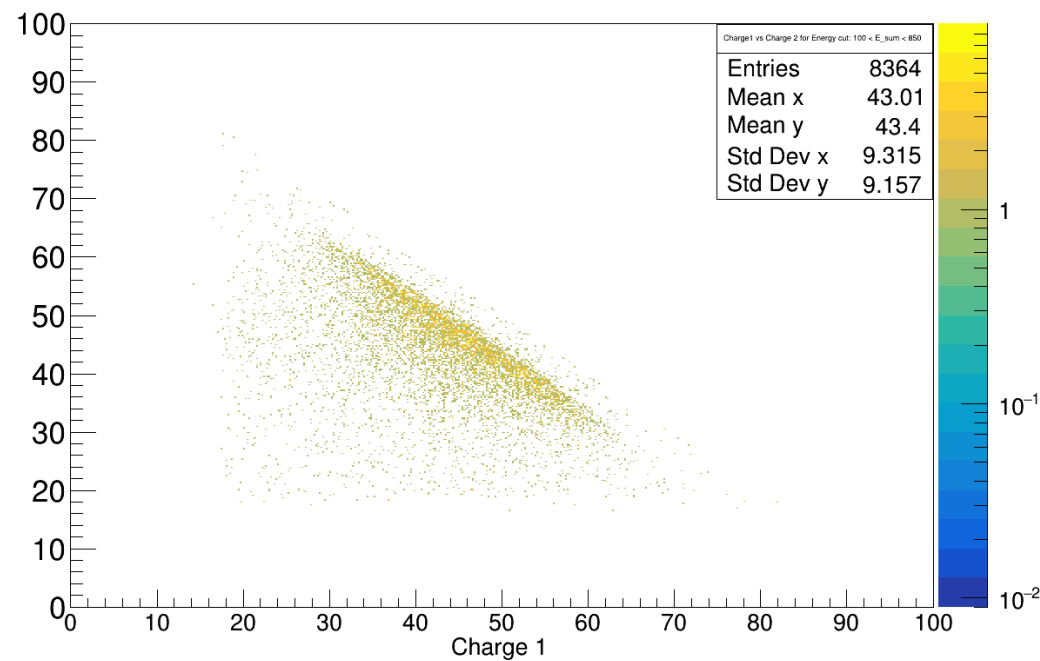- $\Delta\varphi$: from 180+-30° to 180+-5°

- $\Delta\theta$: from 80+-10° to 80+-5°

- E_sum: from 50 < E_sum < 900 to 300 < E_sum < 650 MeV

CALIFA E_sum Cuts 1-3
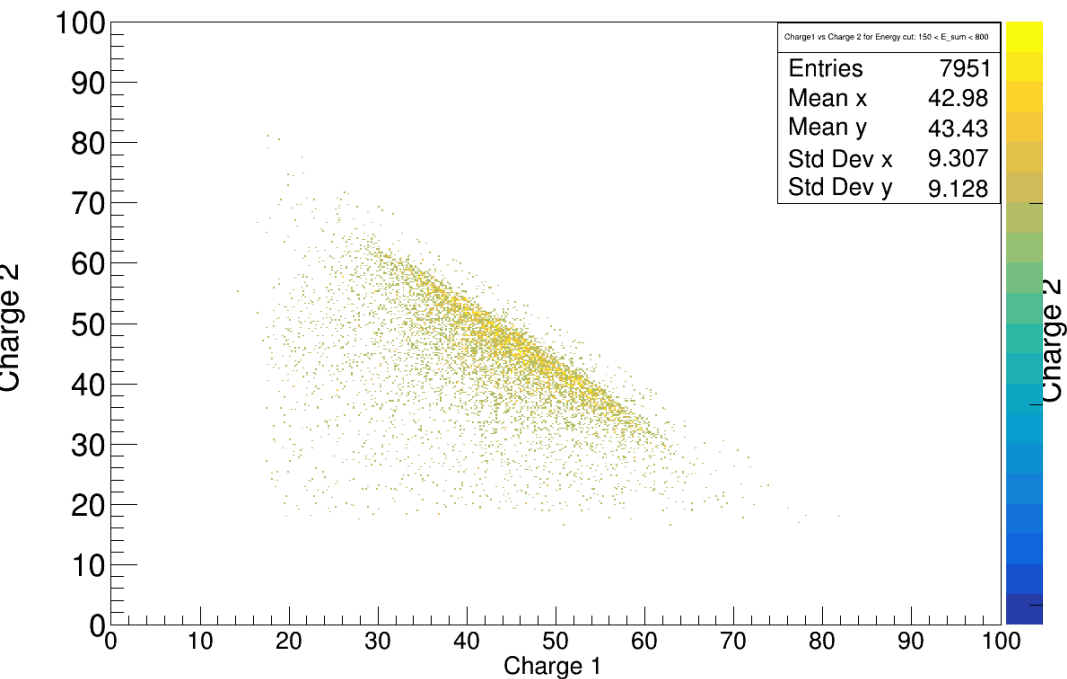

Charge1 vs Charge 2 for Energy cut: 50 < E_sum < 900
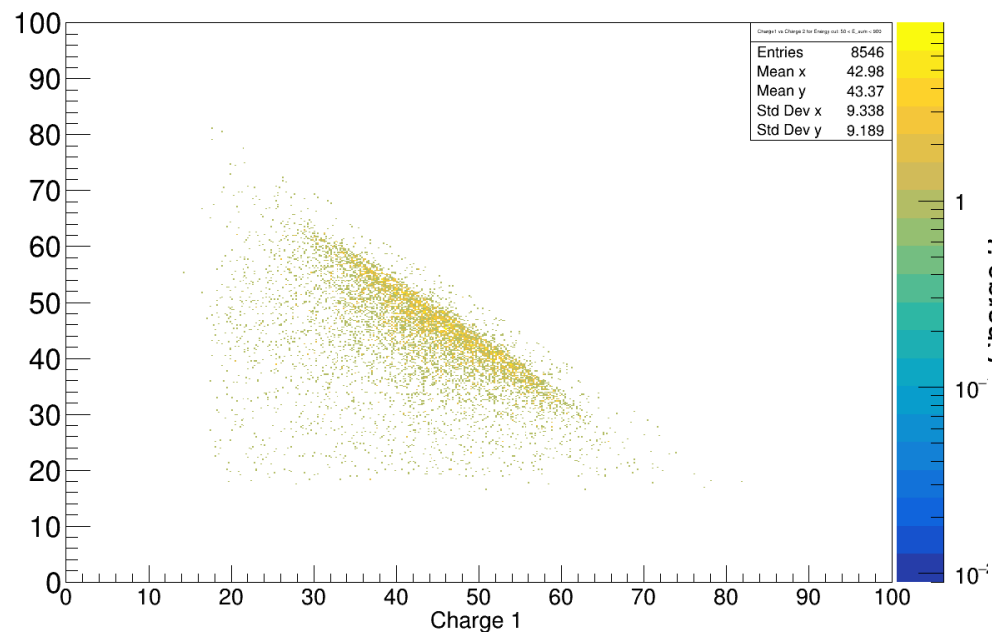
Charge1 vs Charge 2 for Energy cut: 100 < E_sum < 850
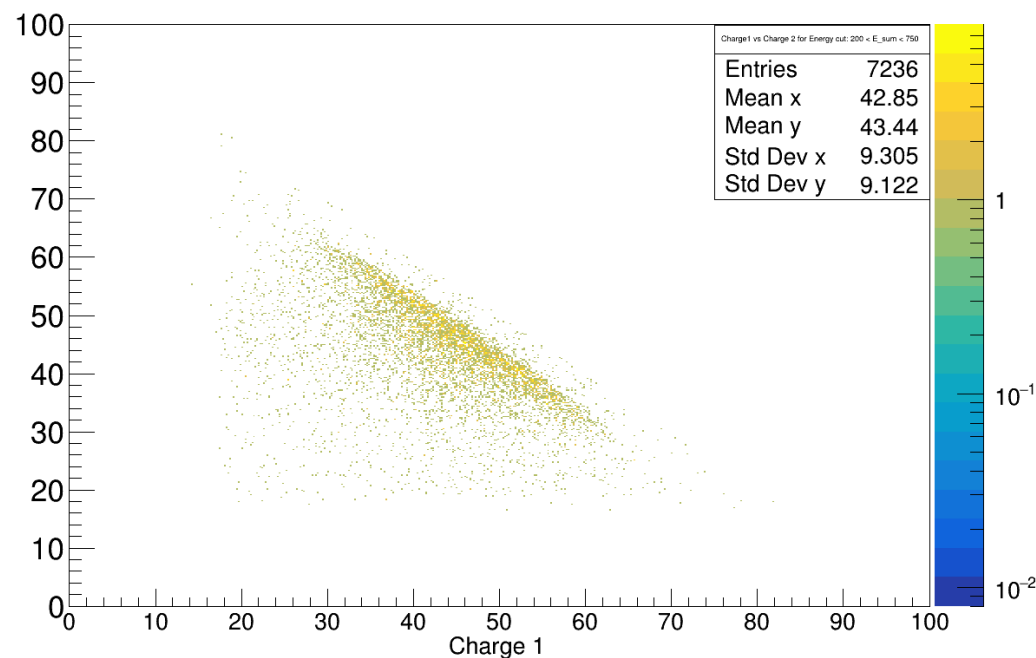
Charge1 vs Charge 2 for Energy cut: 150 < E_sum < 800

Charge1 vs Charge 2 for Energy cut: 150 < E_sum < 800	
Entries	7951
Mean x	42.98
Mean y	43.43
Std Dev x	9.307
Std Dev y	9.128

Charge1 vs Charge 2 for Energy cut: 200 < E_sum < 750

Charge1 vs Charge 2 for Energy cut: 200 < E_sum < 750	
Entries	7236
Mean x	42.85
Mean y	43.44
Std Dev x	9.305
Std Dev y	9.122

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CALIFA E_sum Cuts 3-3

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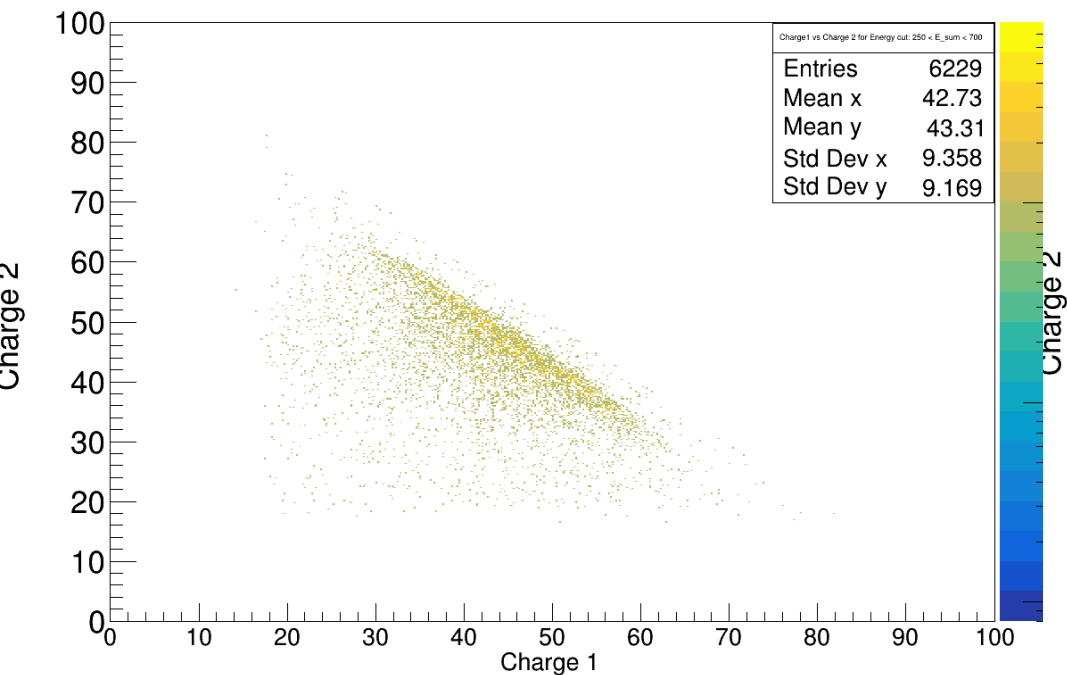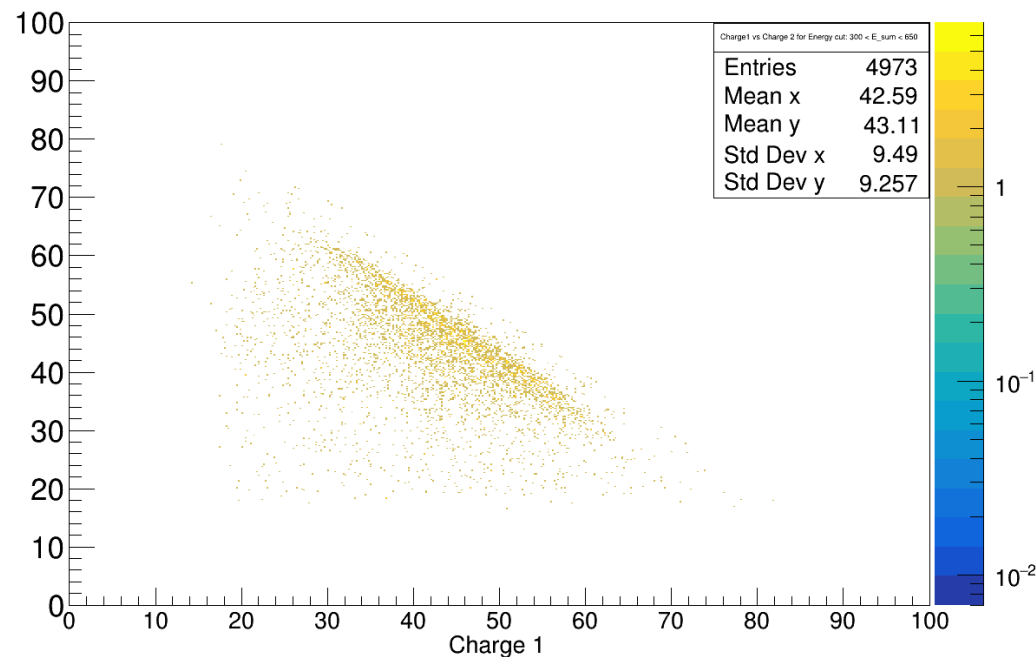
Charge1 vs Charge 2 for theta cut: 70 < Theta1+Theta2 < 90
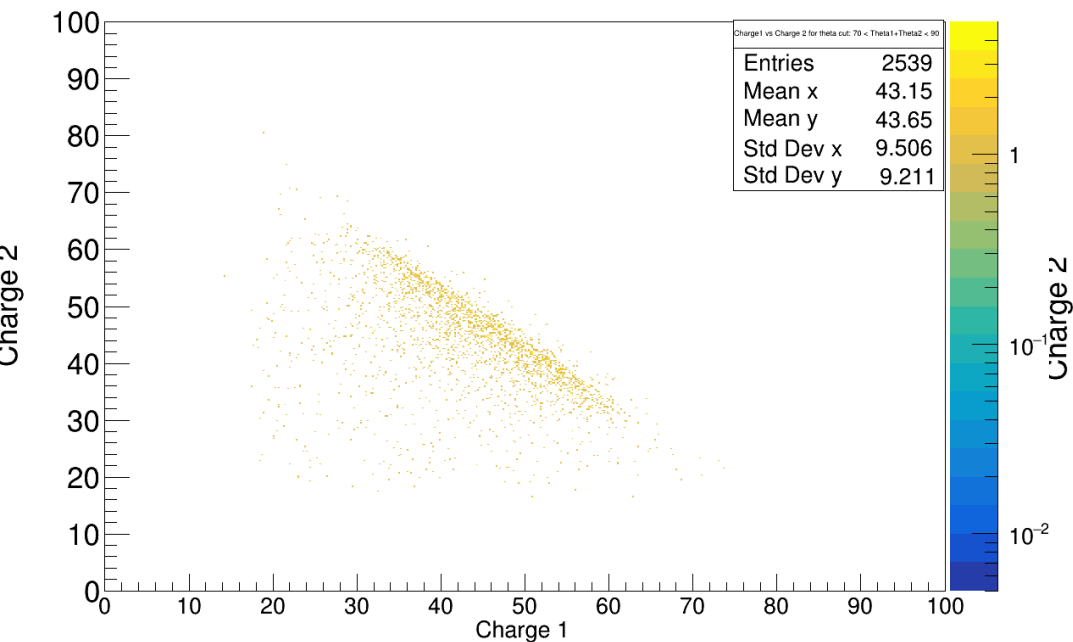
Charge1 vs Charge 2 for theta cut: 71 < Theta1+Theta2 < 89

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CALIFA Δθ Cuts 2-3
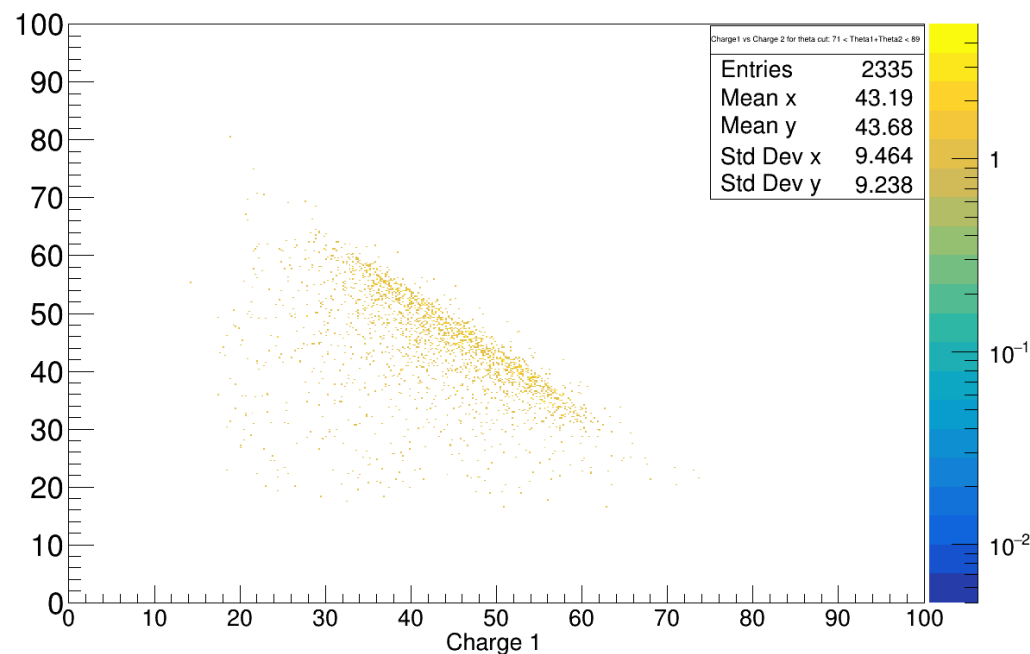
Charge1 vs Charge 2 for theta cut: 72 < Theta1+Theta2 < 88

Entries	2093
Mean x	43.15
Mean y	43.75
Std Dev x	9.431
Std Dev y	9.259
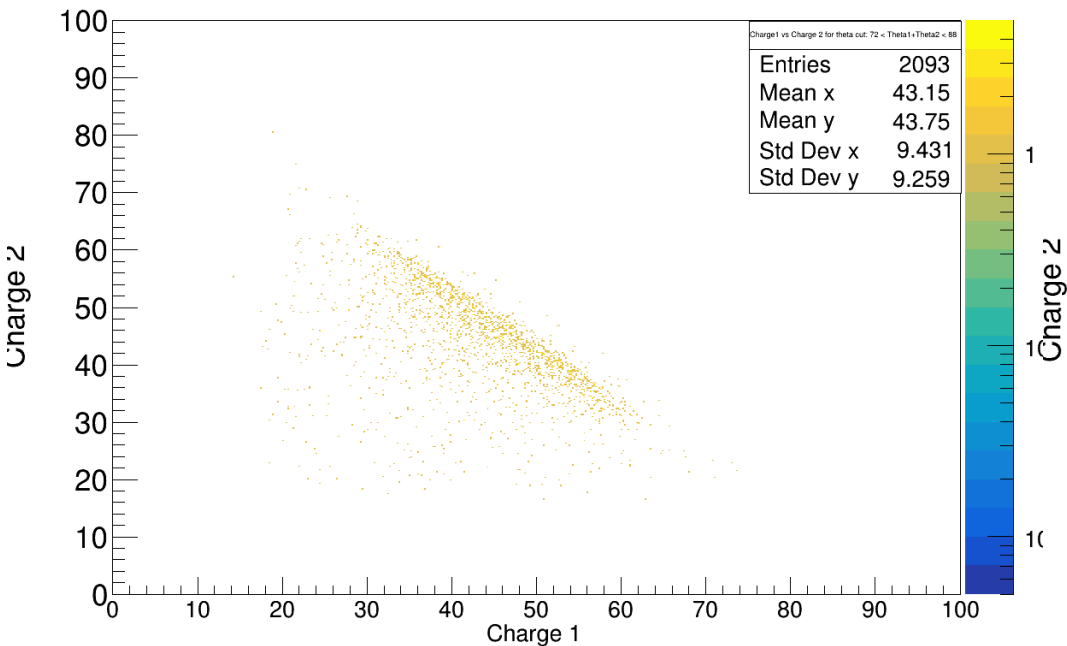
Charge1 vs Charge 2 for theta cut: 73 < Theta1+Theta2 < 87
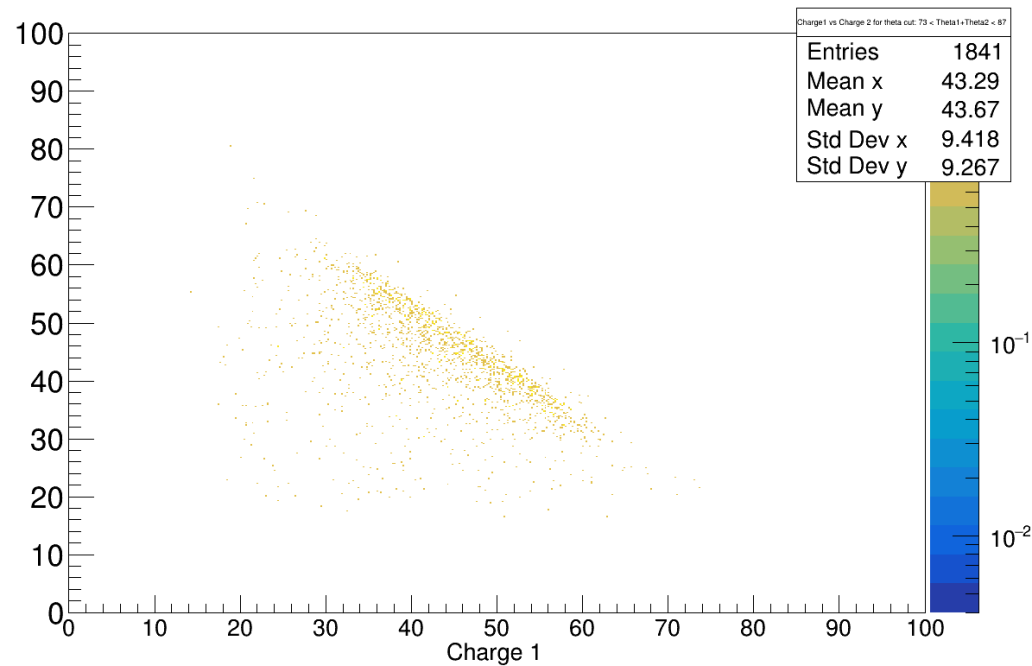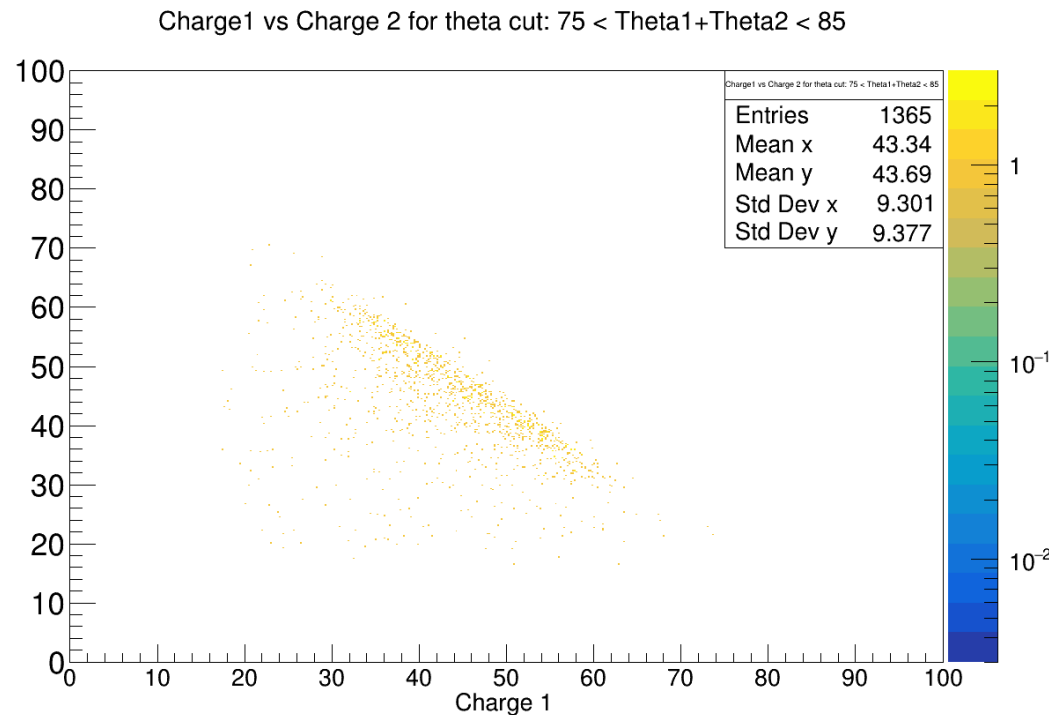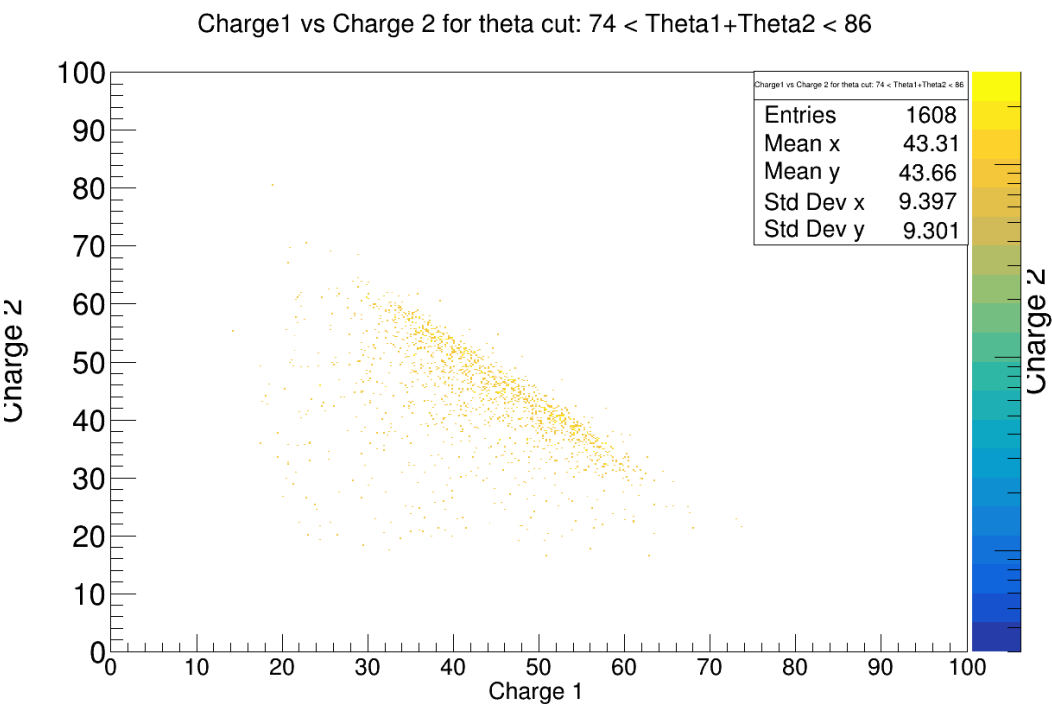
Entries	1841
Mean x	43.29
Mean y	43.67
Std Dev x	9.418
Std Dev y	9.267

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CALIFA Δθ Cuts 3-3

CALIFA Δφ Cuts 1-3

Charge1 vs Charge 2 for phi cut: 150 < delta_phi < 210

	Charge1 vs Charge 2 for phi cut: 150 < delta_phi < 210
Entries	9035
Mean x	42.84
Mean y	43.16
Std Dev x	9.492
Std Dev y	9.37

Charge1 vs Charge 2 for phi cut: 155 < delta_phi < 205

	Charge1 vs Charge 2 for phi cut: 155 < delta_phi < 205
Entries	8425
Mean x	42.78
Mean y	43.07
Std Dev x	9.524
Std Dev y	9.407

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CALIFA Δφ Cuts 2-3
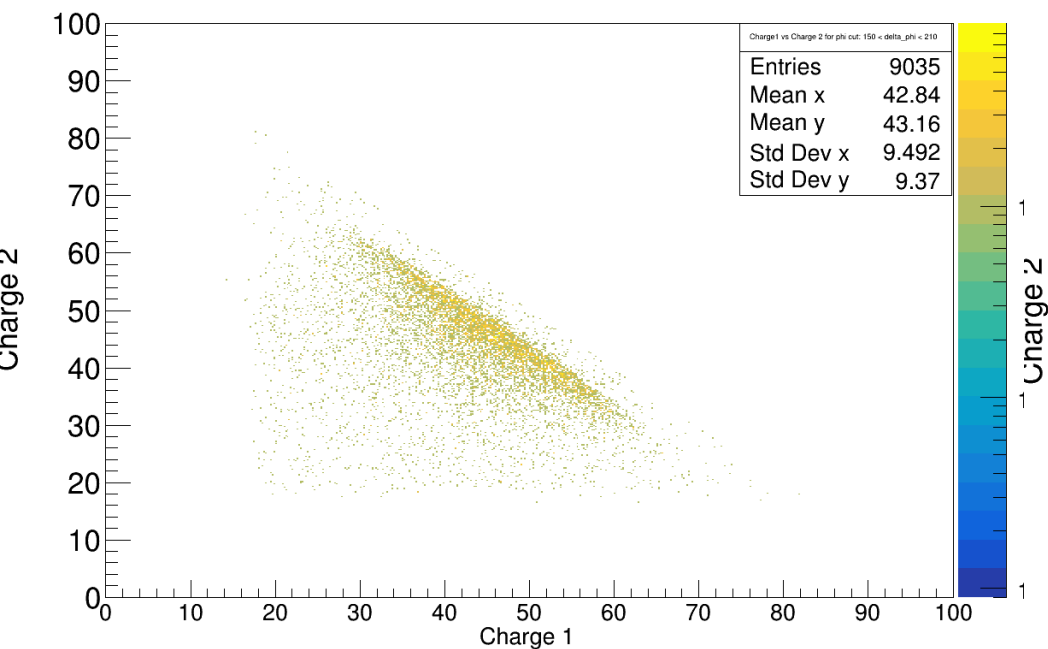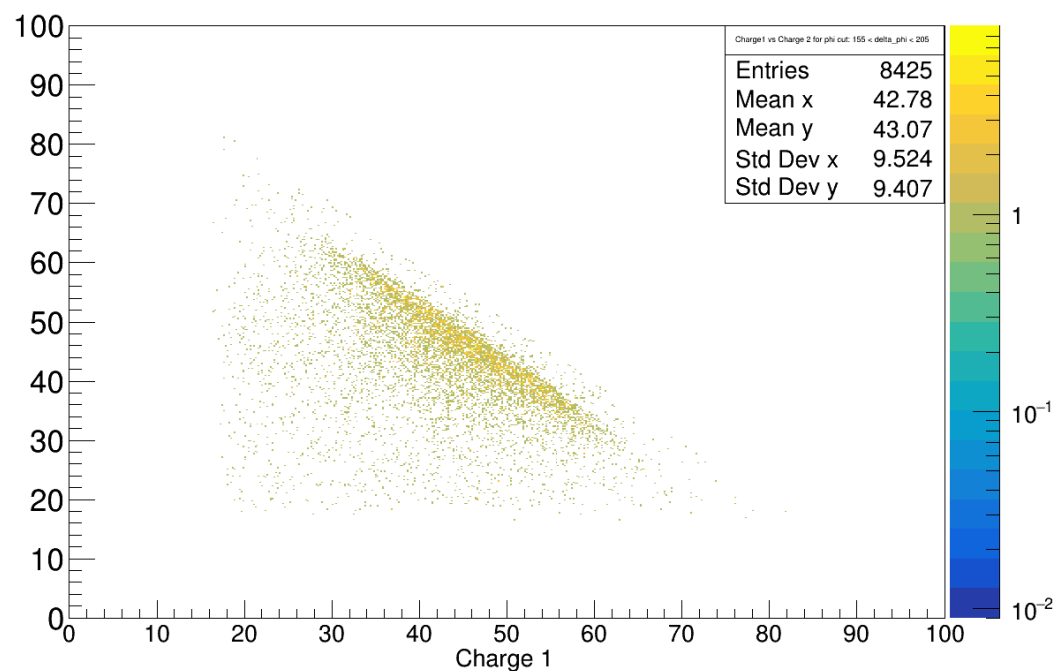
Charge1 vs Charge 2 for phi cut: 160 < delta_phi < 200
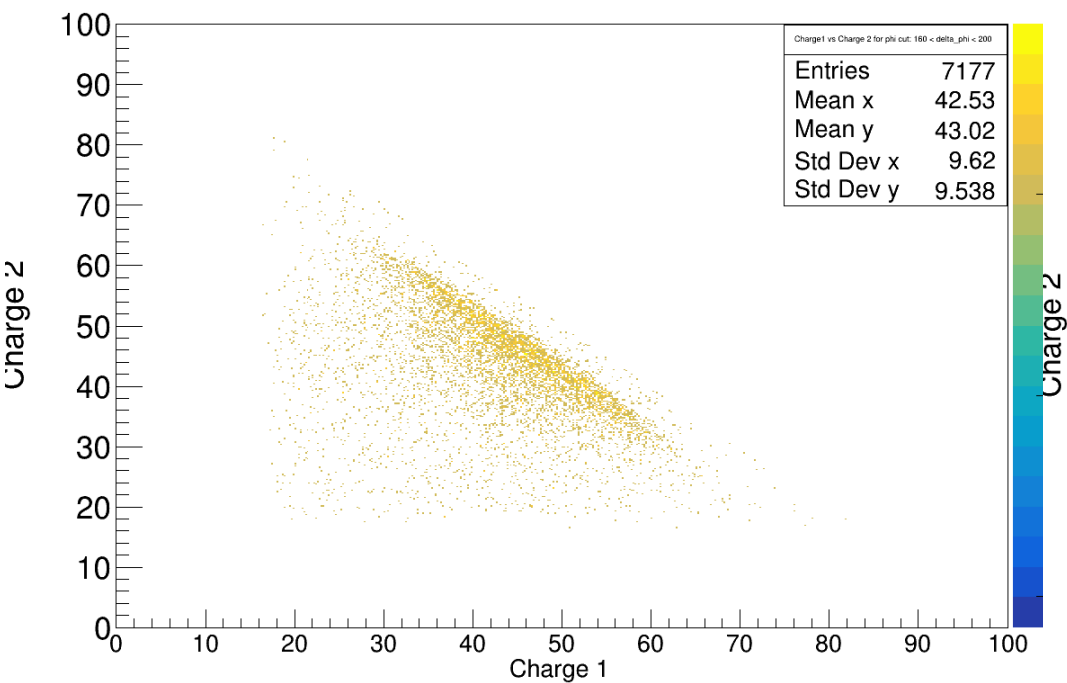
Charge1 vs Charge 2 for phi cut: 165 < delta_phi < 195
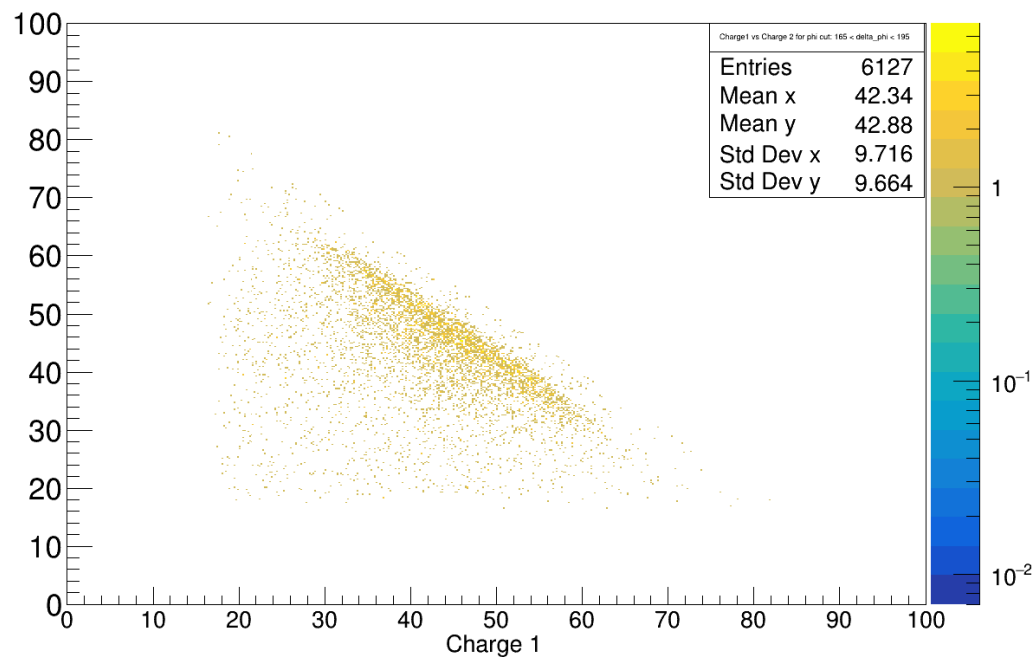
CALIFA Δφ Cuts 3-3

Charge1 vs Charge 2 for phi cut: 170 < delta_phi < 190

Entries	4029
Mean x	41.92
Mean y	42.62
Std Dev x	9.859
Std Dev y	9.865

Charge1 vs Charge 2 for phi cut: 175 < delta_phi < 185

Entries	2250
Mean x	41.72
Mean y	42.36
Std Dev x	10.02
Std Dev y	10.1

How to quantify

Charge Sum (TWIM Music) after the minimal CALIFA cuts

Entries	9035
Mean	91.19
Std Dev	2.137
Underflow	0
Overflow	0
Integral	5635

Lower region

Higher region

Correlation region (92 < Z_sum <93.2)
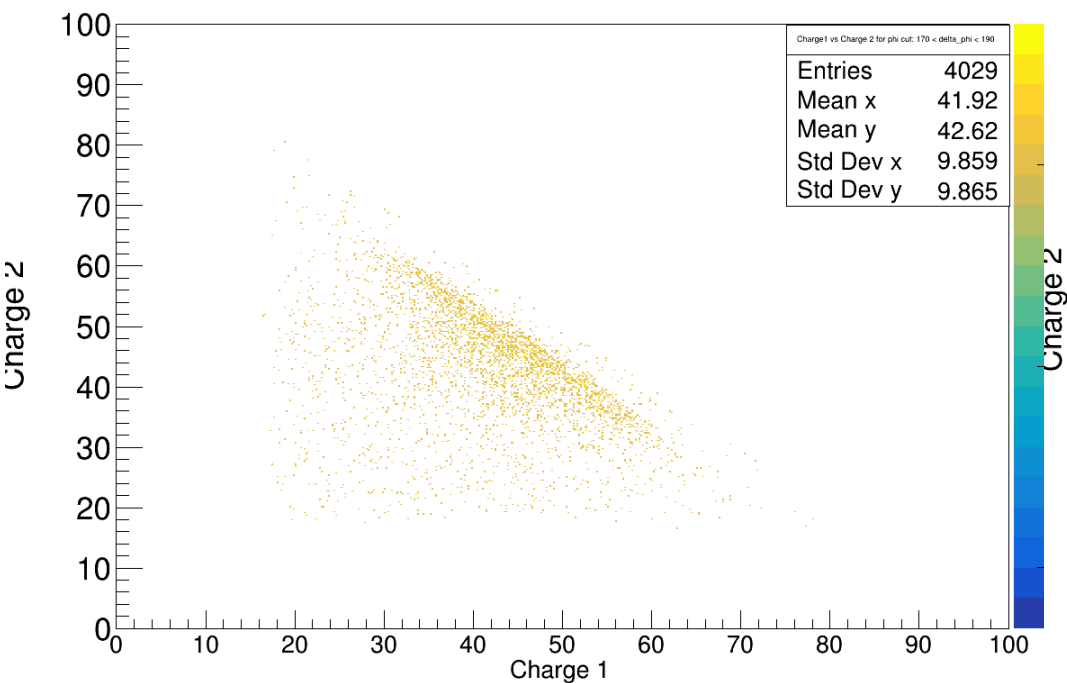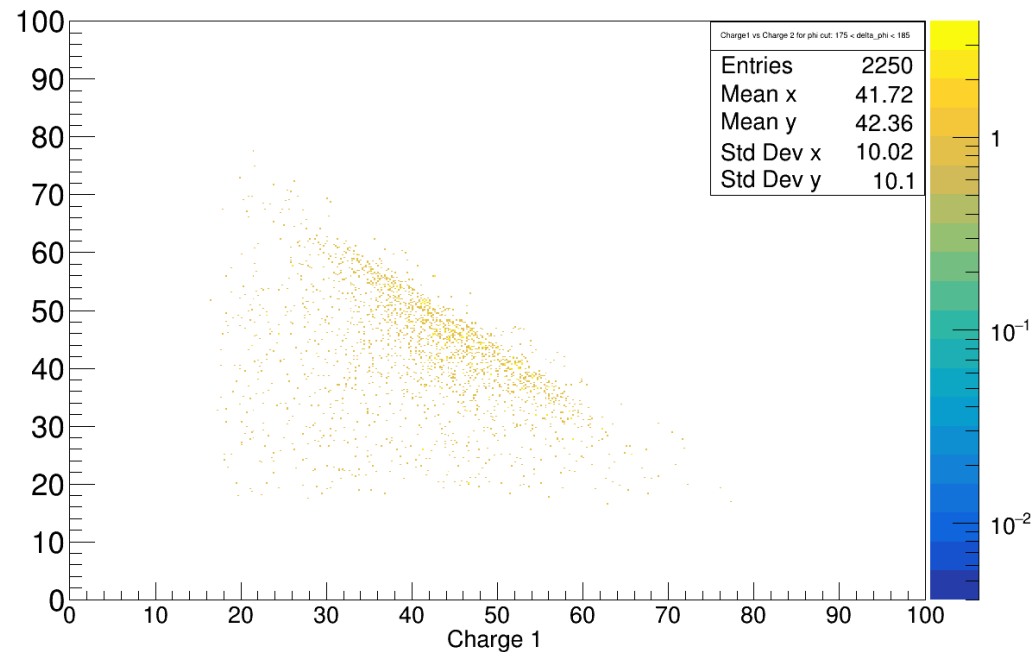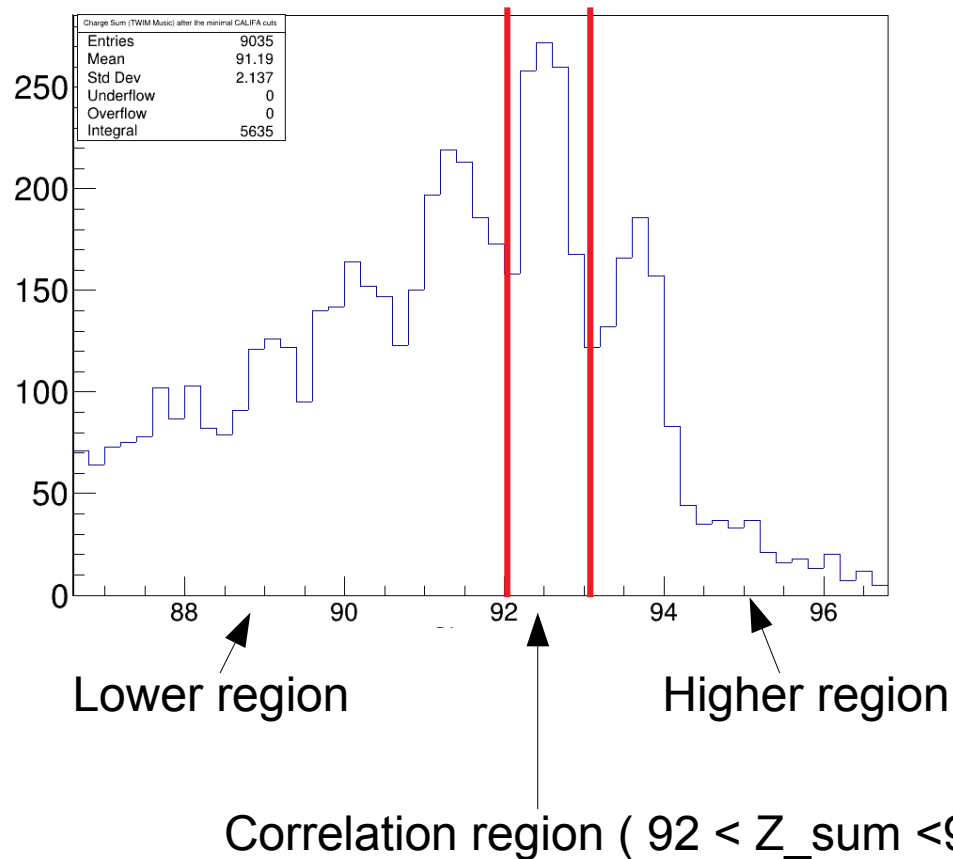
For each cut parameter setting ($\Delta\varphi$, $\Delta\theta$, E_sum) count events in lower-, correlation and higher region.

Some numbers....

```
Values for Energy parameter change: -------------
             low       correlation      high     ▮
50-900:      6250      1203             1093
100-850:     6113      11831            1070
150-800      5832      11234            995
200-750      5355      10130            871
250-700      4675      8533             701
300-650      3797      6603             516
```

```
Values for phi parameter change: -------------
             low       correlation      high
150-210:     6634      1238             1163
155-205:     6251      1119             1055
160-200:     5380      906              891
165-195:     4648      742              737
170-190:     3100      451              478
175-185:     1749      248              253
```
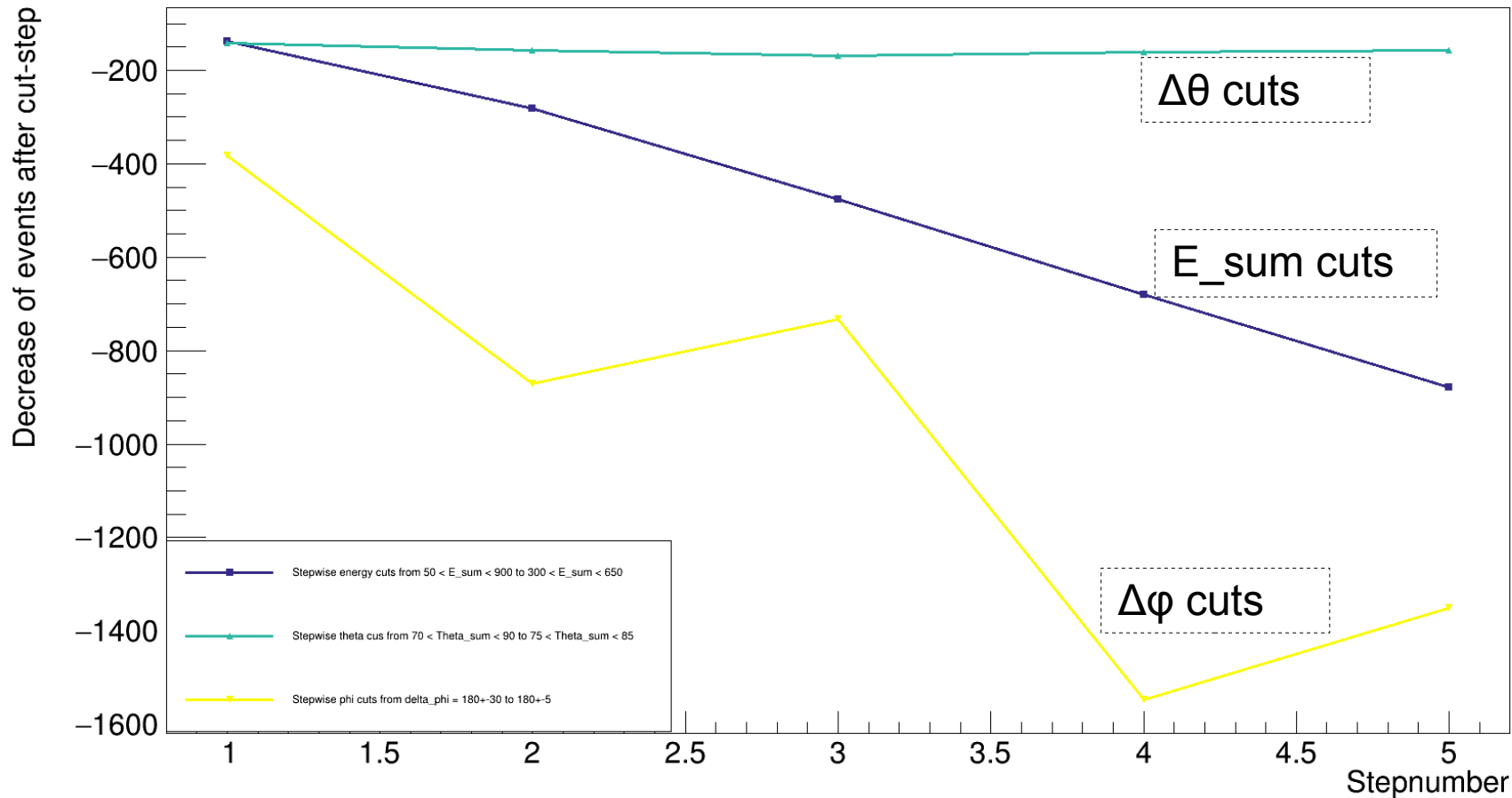
```
Values for theta parameter change: --------------
             low       correlation      high
70-90:       1708      415              416
71-89:       1566      378              391
72-88:       1408      338              347
73-87:       1239      293              309
74-86:       1078      259              271
75-85:       920       216              229
```

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Plotting the decrease of evens from one cut step to next in low region

Δθ cuts

E_sum cuts

Δφ cuts

Decrease of events after cut-step

Stepnumber

Stepwise energy cuts from 50 < E_sum < 900 to 300 < E_sum < 650

Stepwise theta cus from 70 < Theta_sum < 90 to 75 < Theta_sum < 85

Stepwise phi cuts from delta_phi = 180+-30 to 180+-5

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Relative decrease between lower- and correlation line

On y-axis:
(#events_low[step+1]**/**#events_low[step]) **/** (#events_corr[step+1]**/**#events_corr[step])
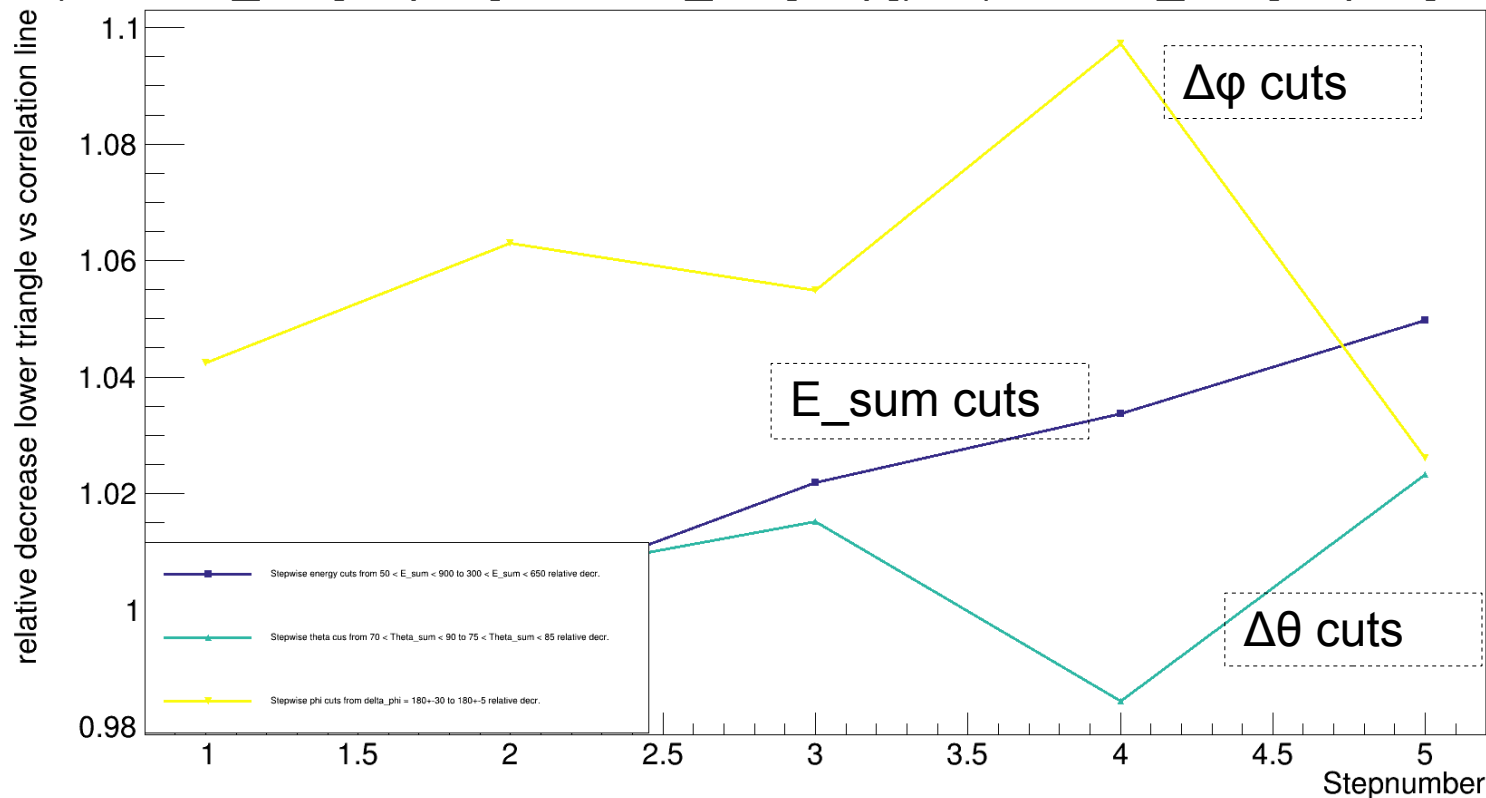
I loose more events in the correlation region than in the low region for all cuts!

2Dos

- Use TWIM calibration file from 202103 (I used the one from:

  /u/land/r3broot/202106_testing/R3BRoot_20210726/sofia/macros/s455Up2p/parameters/CalibParam.par)

Updates

As previous analysis didn't give clear signature for p2p I used two methods to systematically scan for those events:

- Look at the two daughter nuclei and look at different combinations

- Scan over all peaks of Z_sum

Using Minimal Cuts:

- E_1 and E_2 > 30 MeV

- $\Delta\varphi$ = 180+-30°

- (2 entries in TWIM; Z_sum < 100, 1-2 entries TOFW)

Charge Distribution of Daughter Nuclei
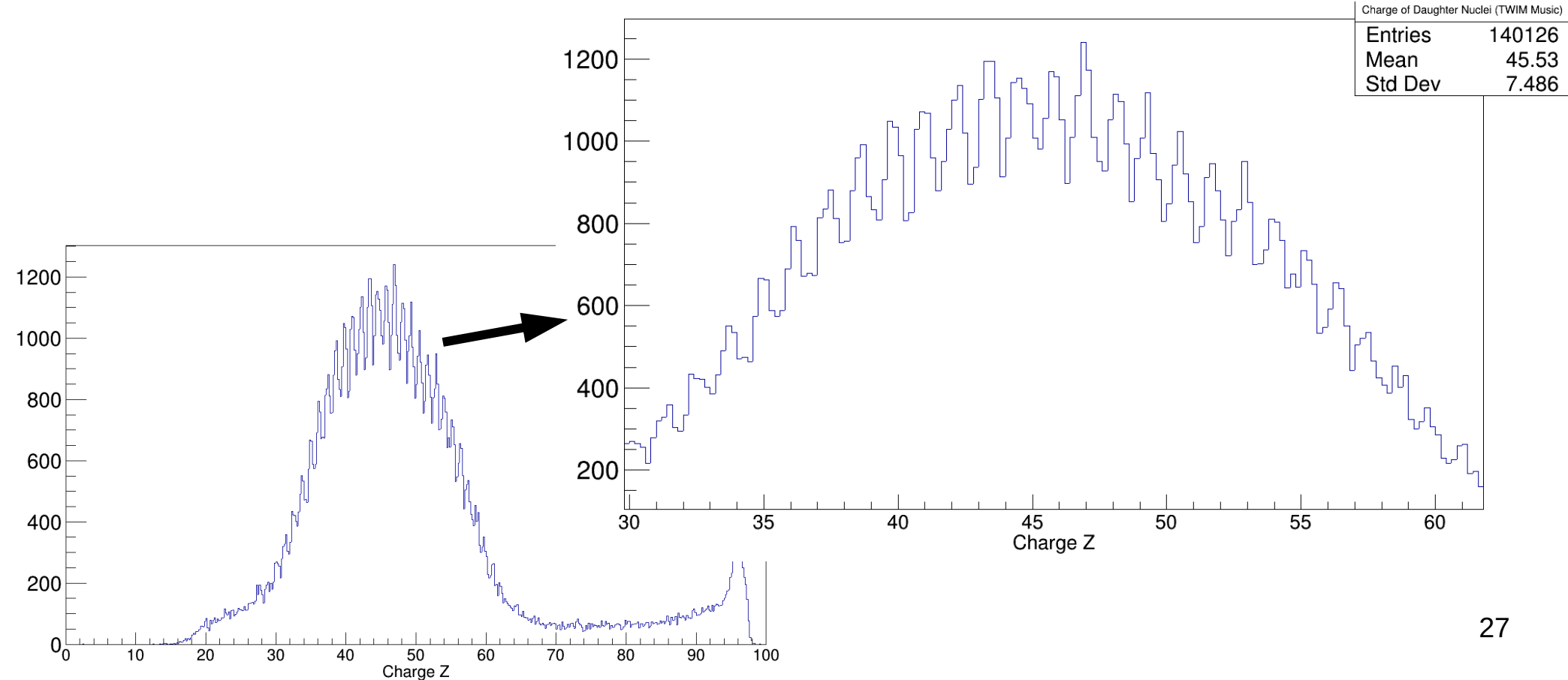
Selection Cuts on Daughter Nuclei

- 42.7 < Z1/2 < 43.9 and 46.3 < Z1/2 < 47.6

- 43.9 < Z1/2 < 45.3 and 45.3 < Z1/2 < 46.3

- 42.7 < Z1/2 < 43.9 and 45.3 < Z1/2 < 46.3

- 43.9 < Z1/2 < 45.3 and 46.3 < Z1/2 < 47.6

- 42.7 < Z1/2 < 43.9 and 47.8 < Z1/2 < 48.7

42.7 < Z1/2 < 43.9 and 46.3 < Z1/2 < 47.6 CUT
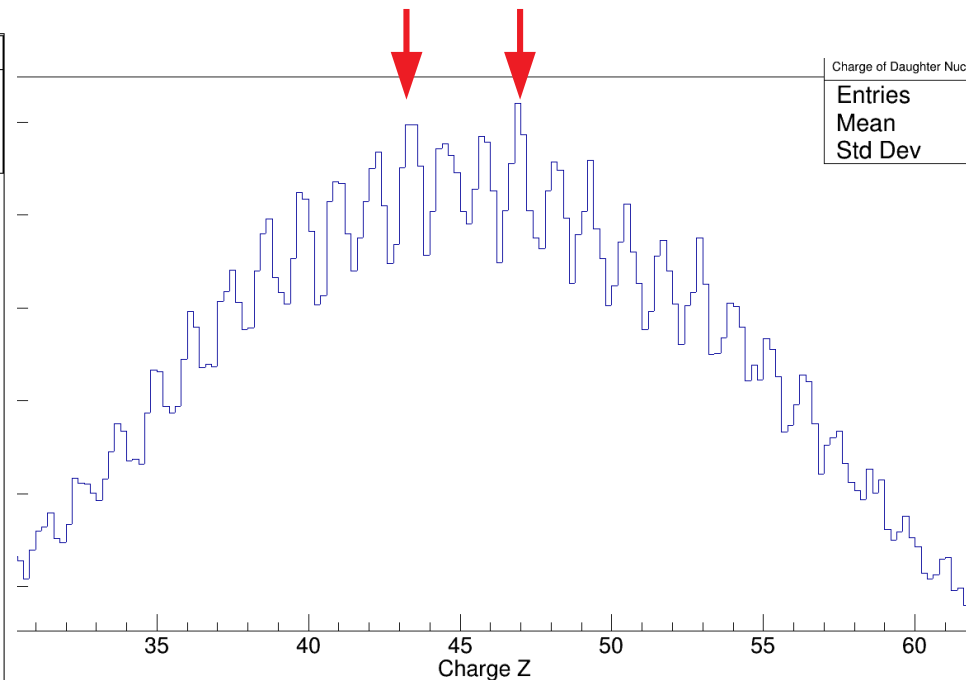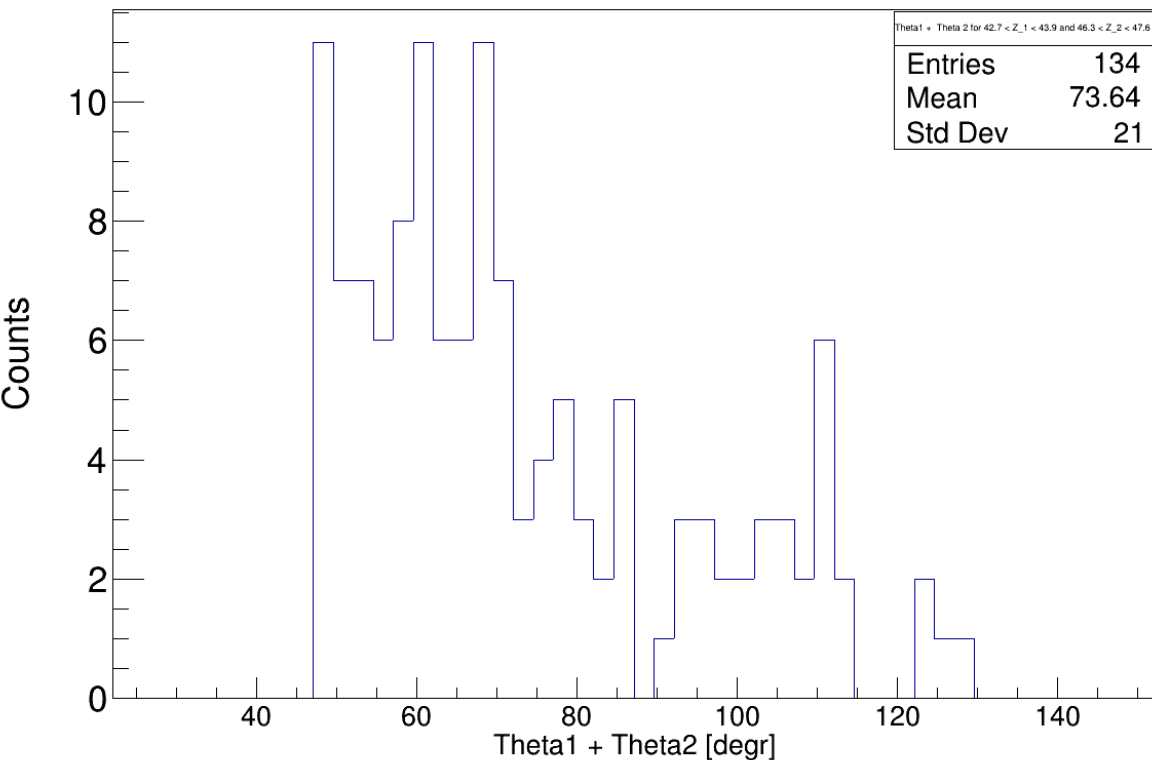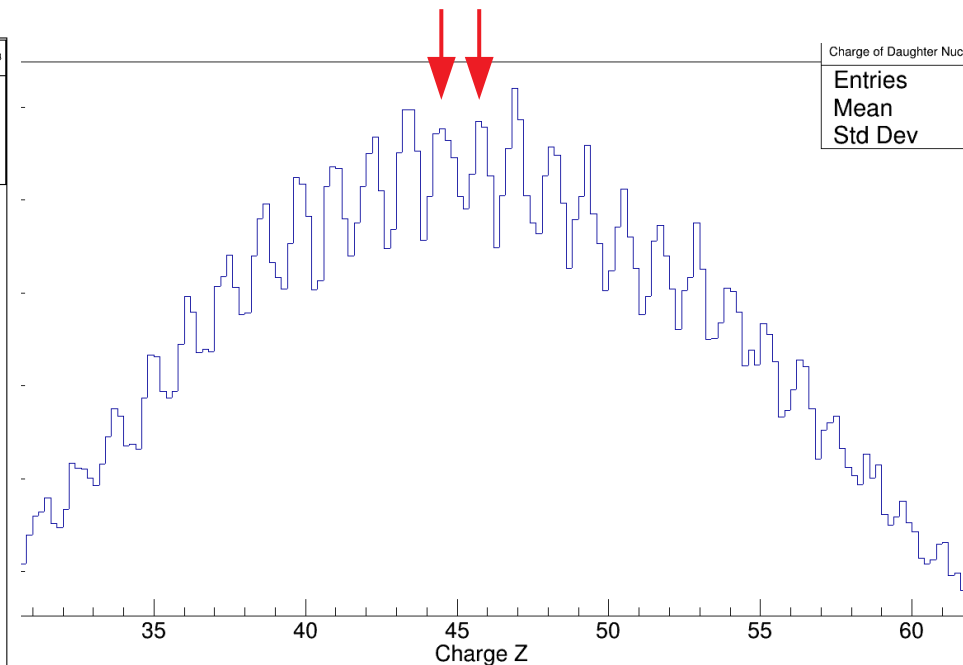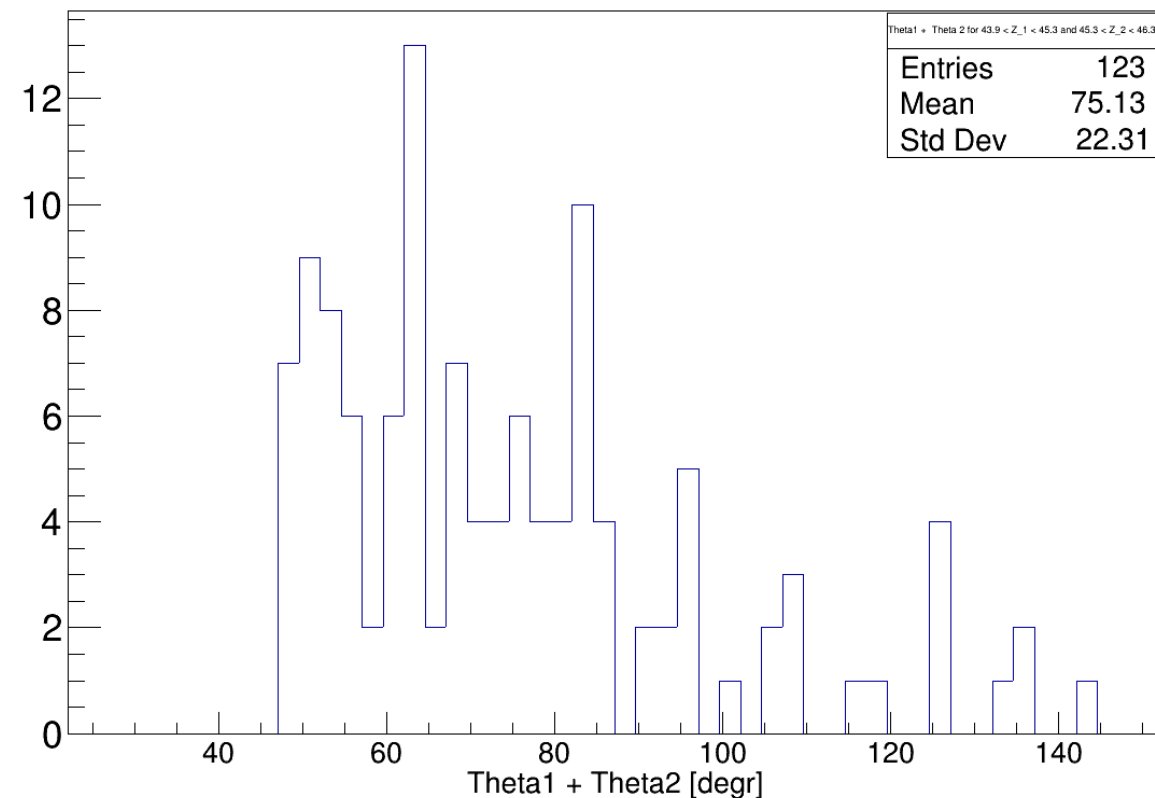
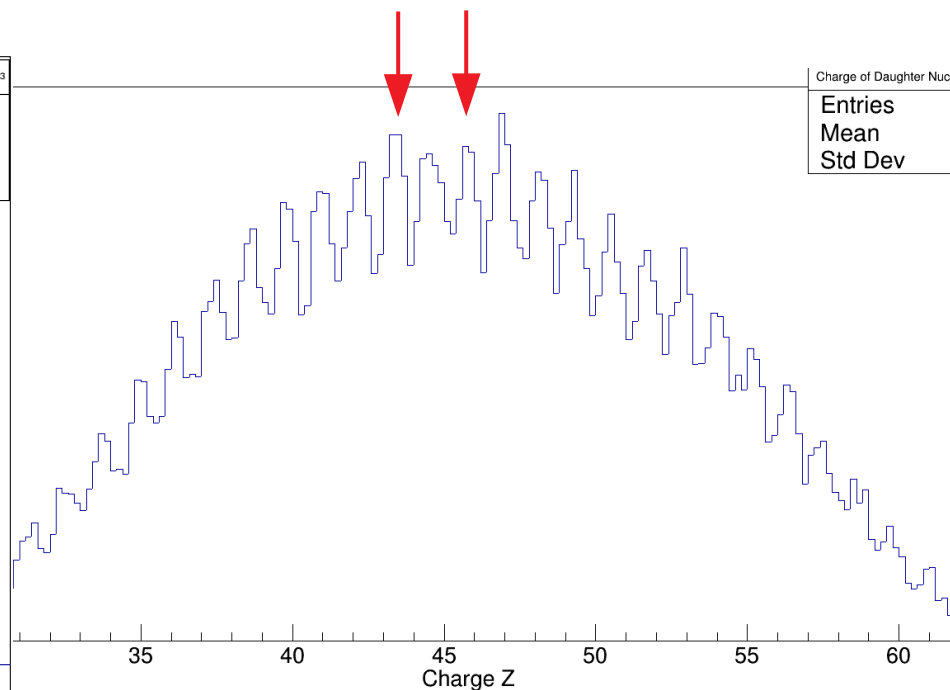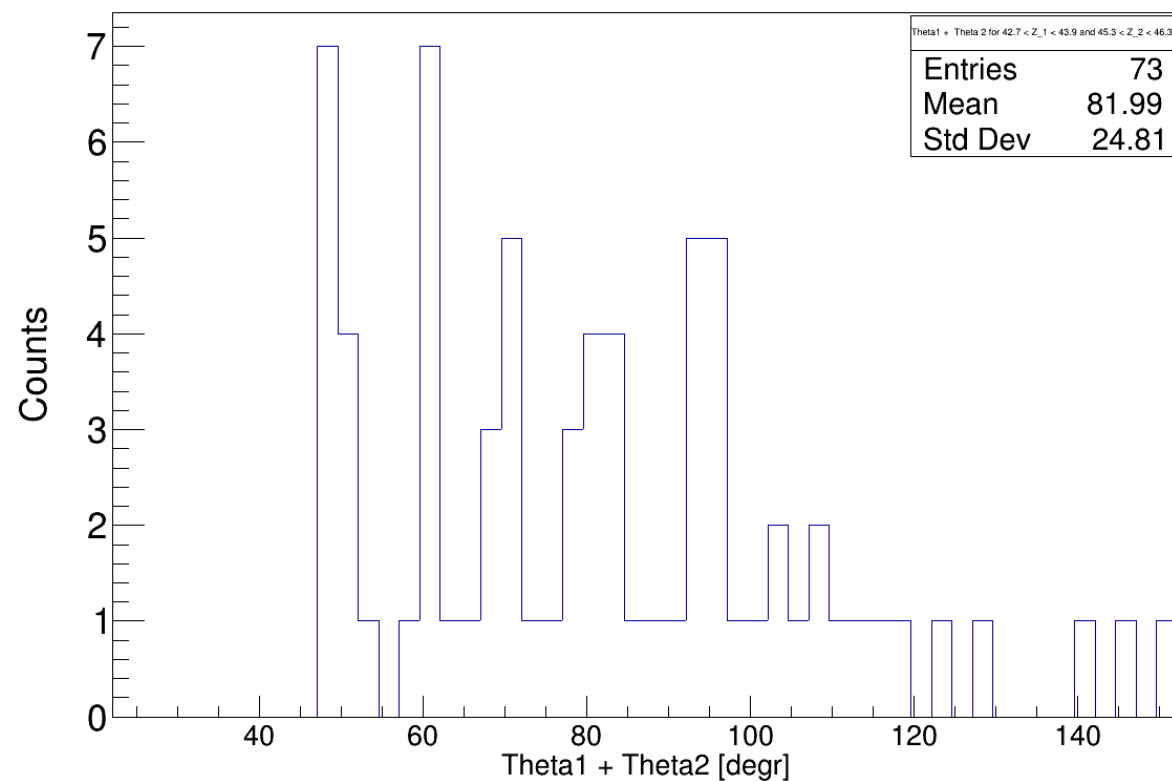# 43.9 < Z1/2 < 45.3 and 45.3 < Z1/2 < 46.3 CUT

Theta1 + Theta 2 for 43.9 < Z_1 < 45.3 and 45.3 < Z_2 < 46.3

Theta1 + Theta 2 for 43.9 < Z_1 < 45.3 < Z_2 < 46.3	
Entries	123
Mean	75.13
Std Dev	22.31

Theta1 + Theta2 [degr]

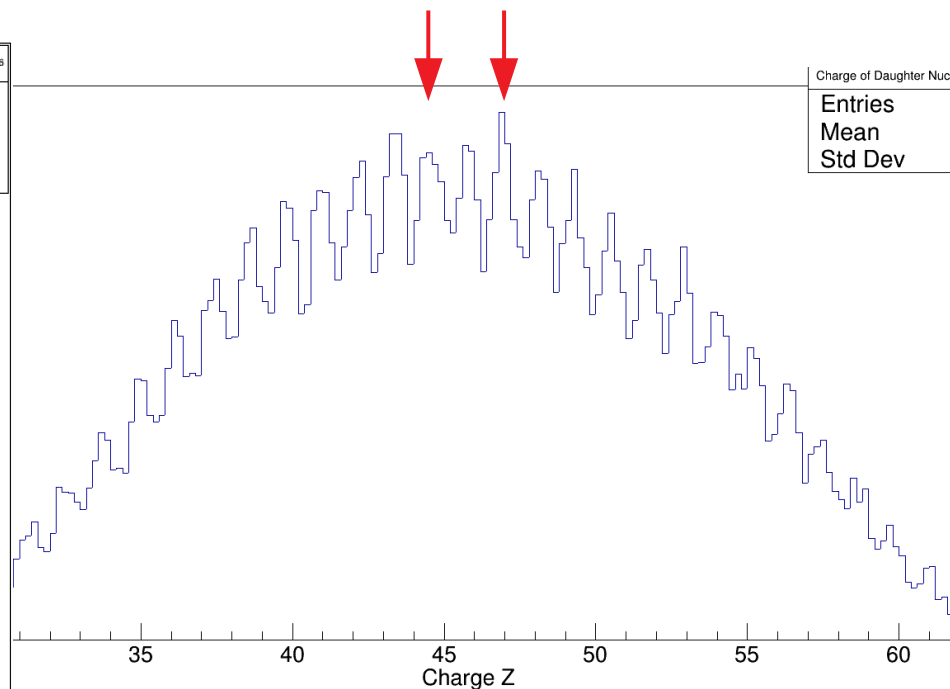| Charge of Daughter Nuc	
Entries	
Mean	
Std Dev	

Charge Z

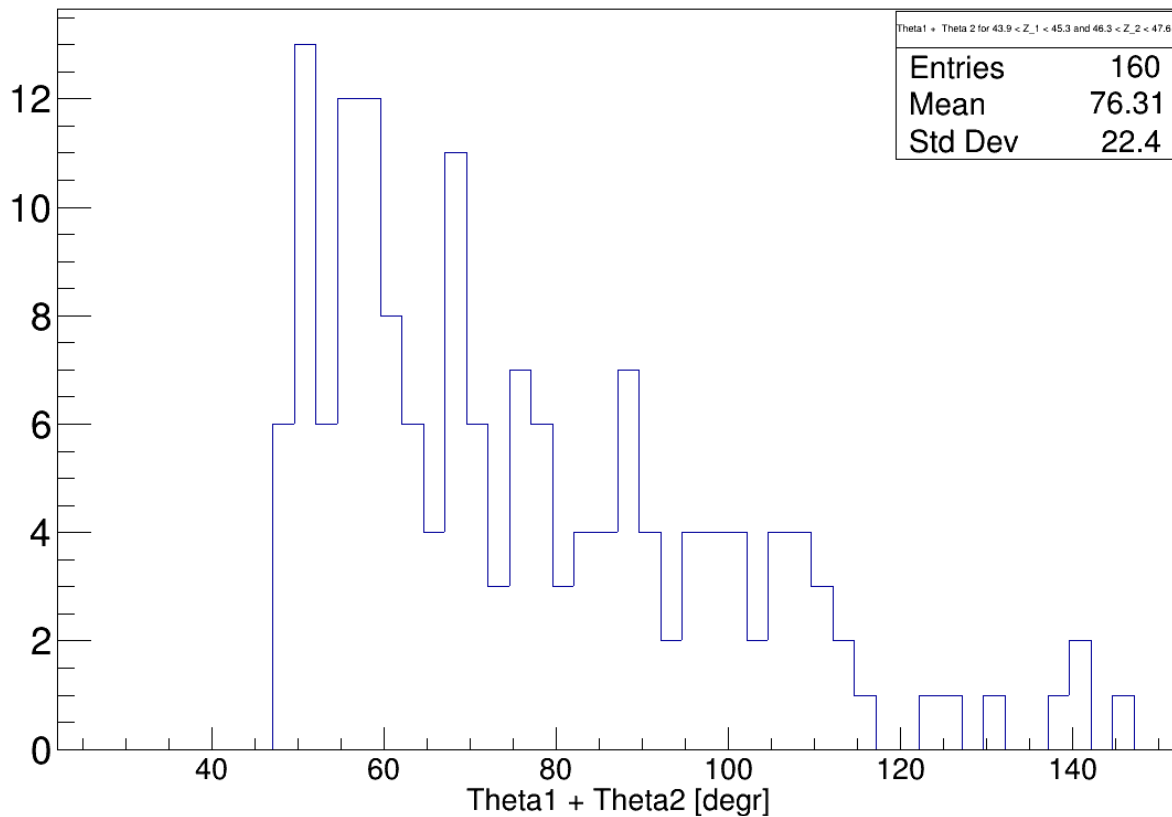# 42.7 < Z1/2 < 43.9 and 45.3 < Z1/2 < 46.3 CUT

Theta1 + Theta 2 for 42.7 < Z_1 < 43.9 and 45.3 < Z_2 < 46.3

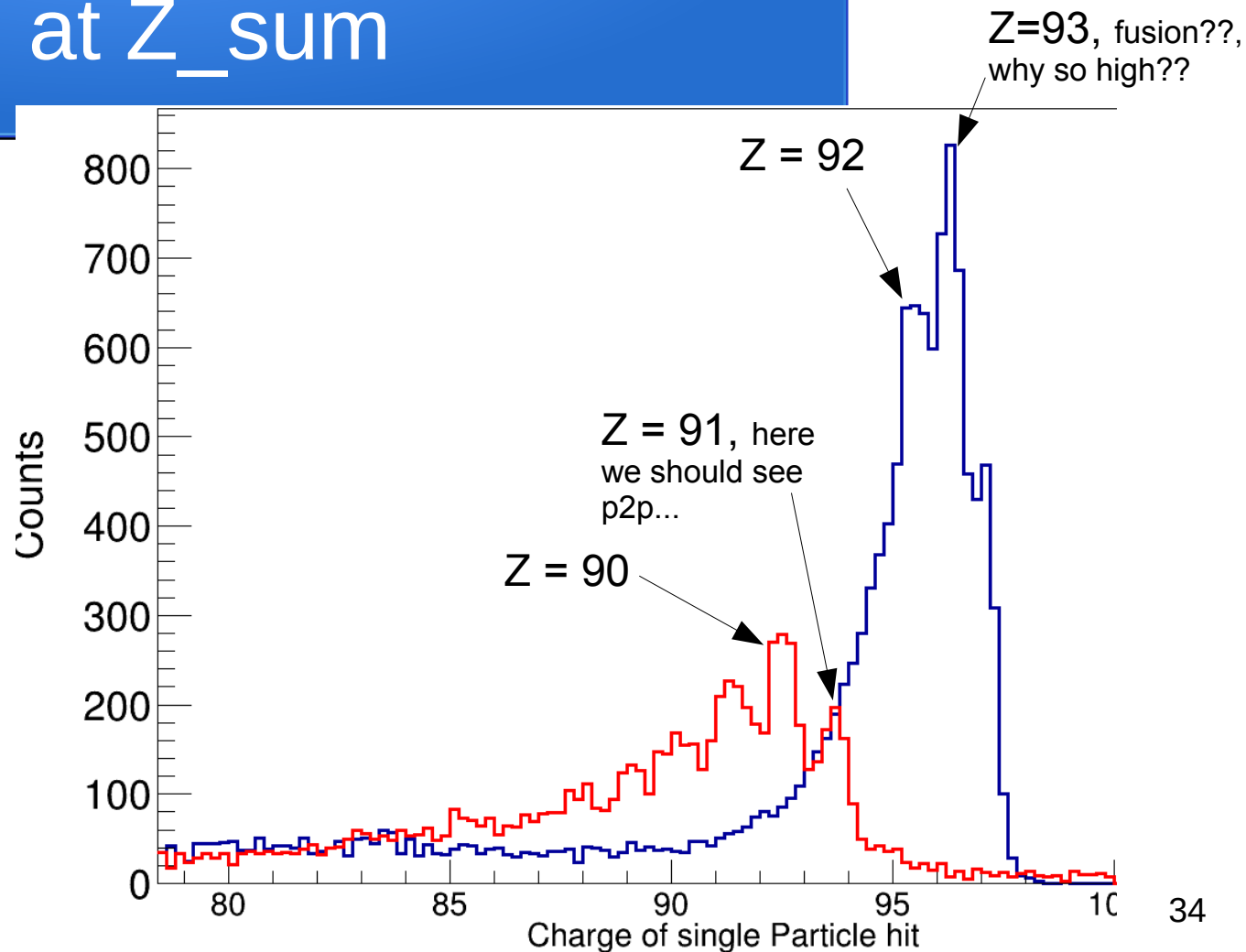| Theta1 + Theta 2 for 42.7 < Z_1 < 43.9 and 45.3 < Z_2 < 46.3	
Entries	73
Mean	81.99
Std Dev	24.81

Charge of Daughter Nuc	
Entries	
Mean	
Std Dev	

Theta1 + Theta 2 for 43.9 < Z_1 < 45.3 and 46.3 < Z_2 < 47.6

Theta1 + Theta 2 for 43.9 < Z_1 < 45.3 and 46.3 < Z_2 < 47.6	
Entries	160
Mean	76.31
Std Dev	22.4

Theta1 + Theta2 [degr]

Charge of Daughter Nuc	
Entries	
Mean	
Std Dev	

Charge Z

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42.7 < Z1/2 < 43.9 and 47.8 < Z1/2 < 48.7 CUT

Theta1 + Theta 2 for 42.7 < Z_1 < 43.9 and 47.8 < Z_2 < 48.7

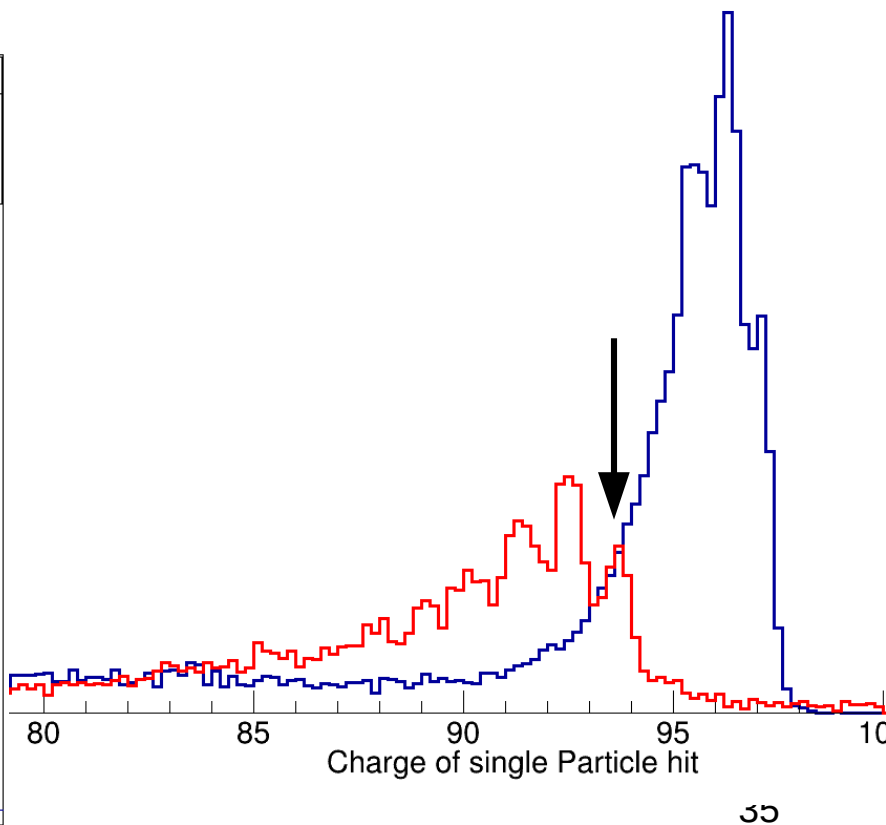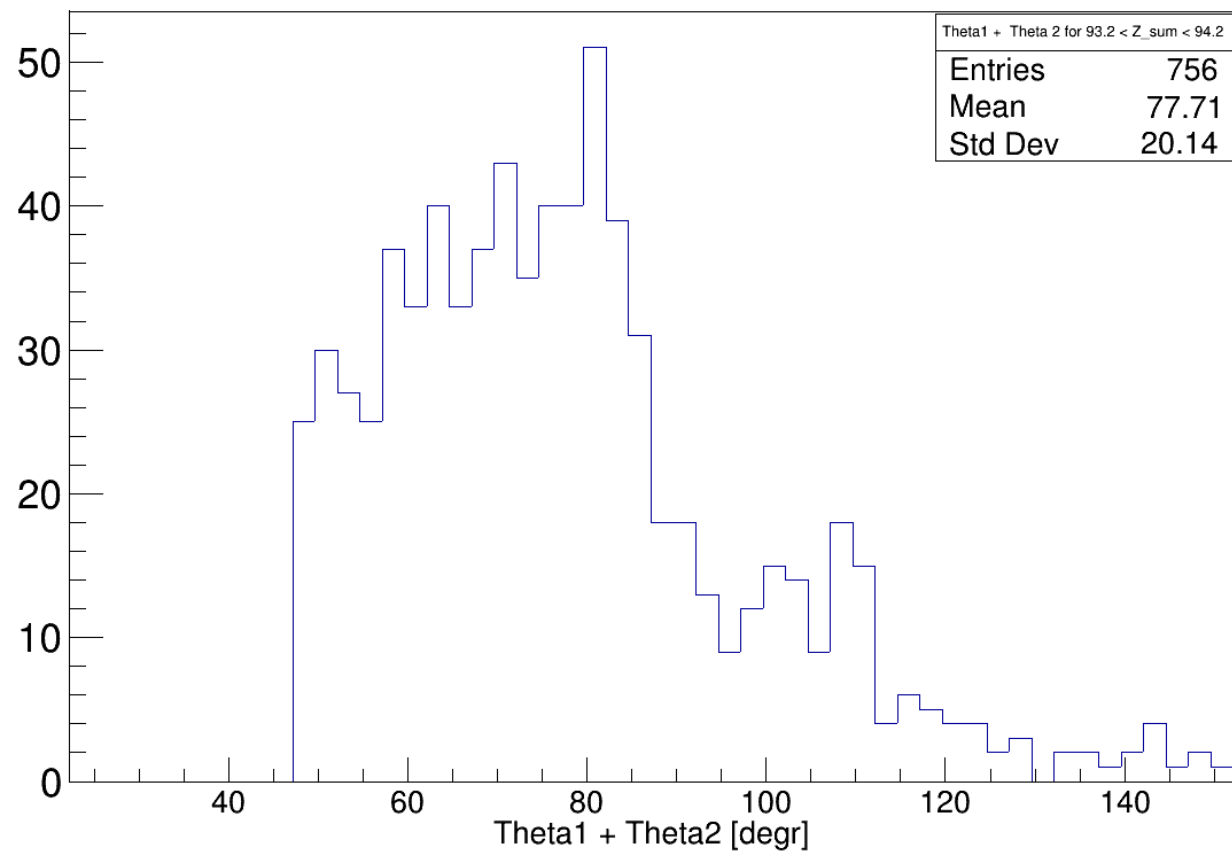|	
Entries	104
Mean	78.06
Std Dev	25.64

Theta1 + Theta2 [degr]

Charge Z
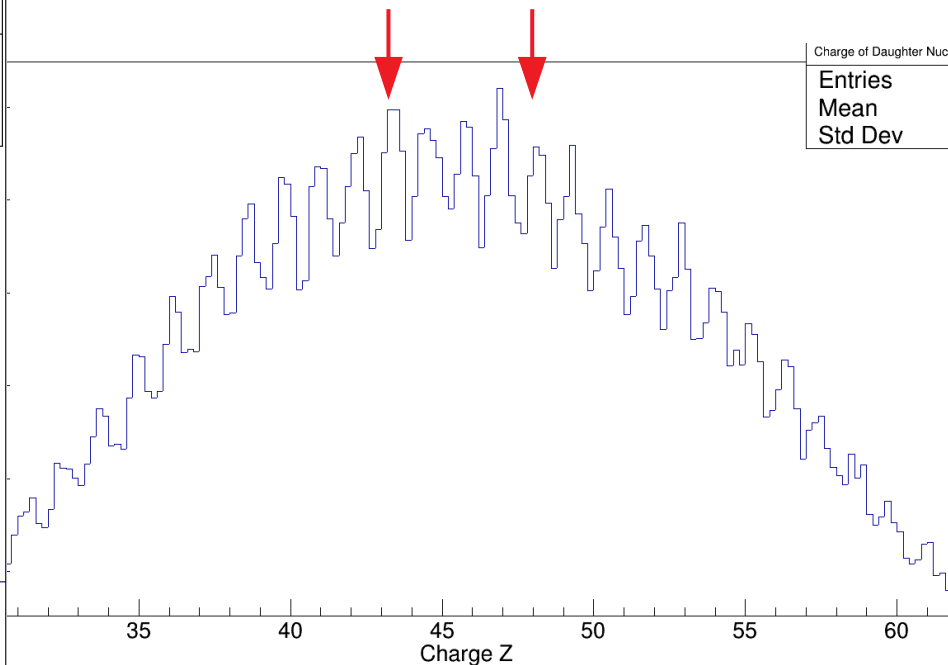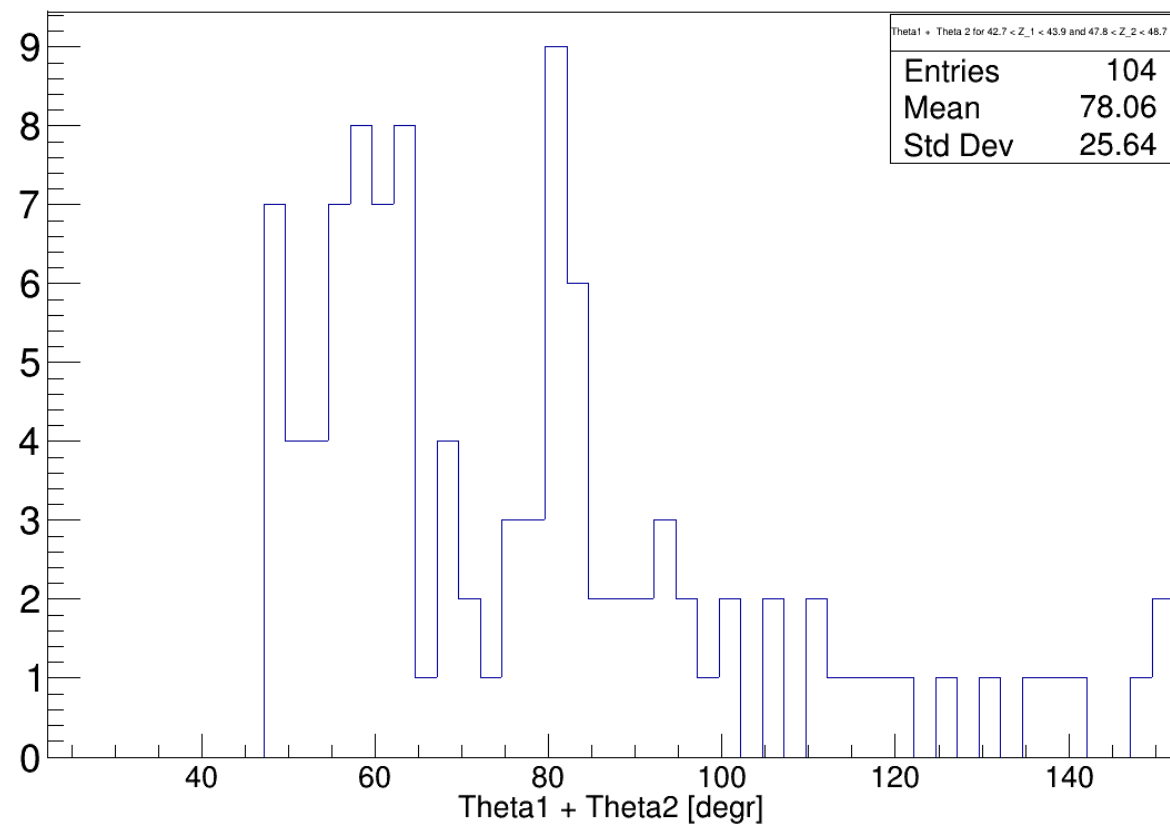
Looking again at Z_sum

Blue: one hit in TWIM
Red: two hits in TWIM

Theta1 +Theta2 for 93.2 < Z_sum < 94.2

Theta1 + Theta 2 for 93.2 < Z_sum < 94.2
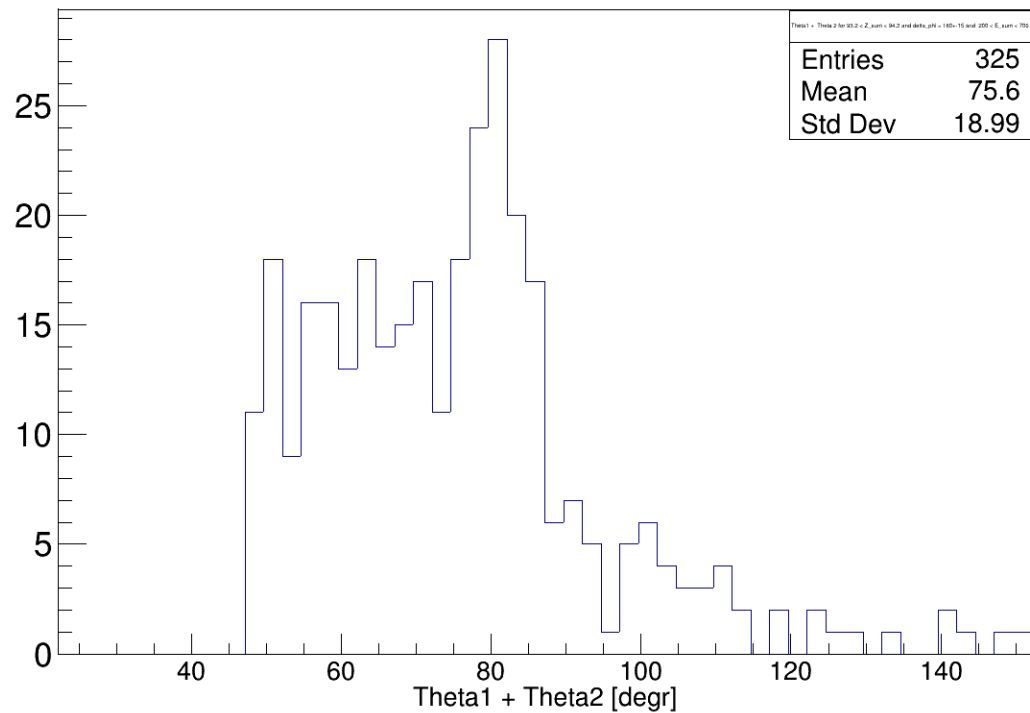
Theta1 + Theta 2 for 93.2 < Z_sum < 94.2	
Entries	756
Mean	77.71
Std Dev	20.14

Theta1 + Theta2 [degr]

Charge of single Particle hit

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Theta1 +Theta2 for 93.2 < Z_sum < 94.2 CUTS

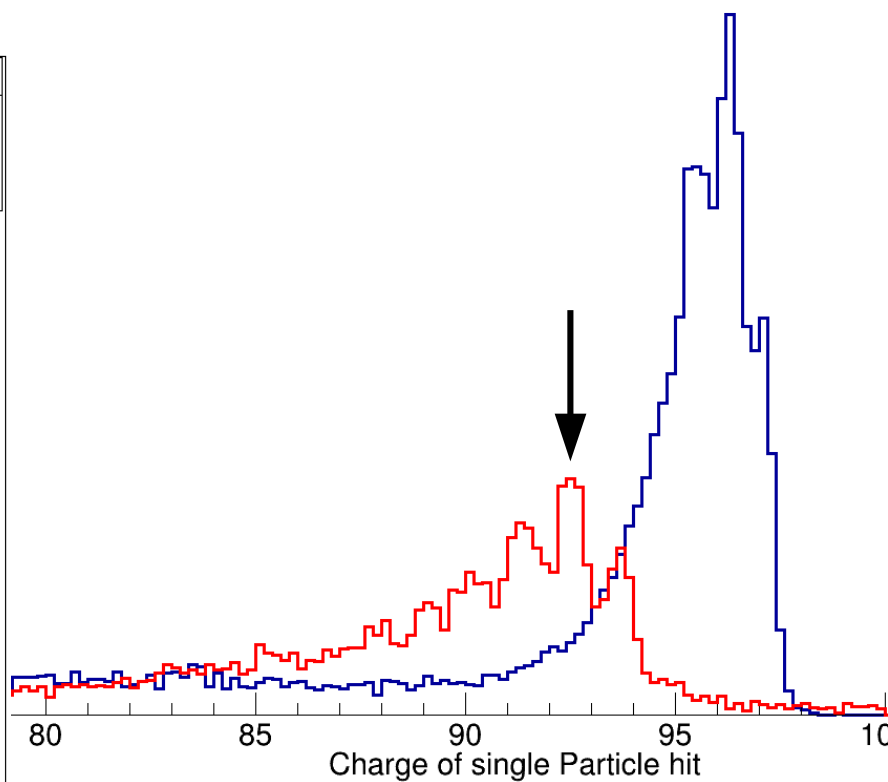Theta1 + Theta 2 for 93.2 < Z_sum < 94.2 and delta_phi = 180+-15
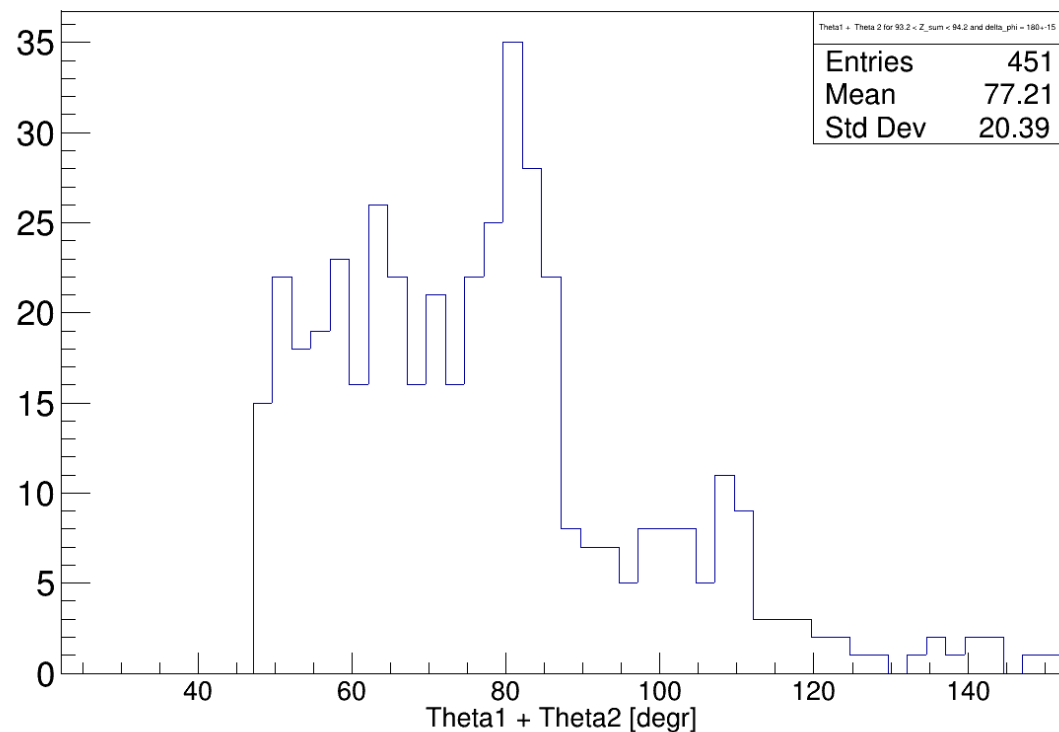
	Entries	451
	Mean	77.21
	Std Dev	20.39

Theta1 + Theta2 [degr]

Theta1 + Theta 2 for 93.2 < Z_sum < 94.2 and delta_phi = 180+-15 and 200 < E_sum < 700

	Entries	325
	Mean	75.6
	Std Dev	18.99

Theta1 + Theta2 [degr]

Theta1 +Theta2 for 92.1 < Z_sum < 93

Theta1 + Theta 2 for 92.1 < Z_sum < 93

Theta1 + Theta 2 for 92.1 < Z_sum < 93	
Entries	1085
Mean	74.33
Std Dev	20.08

Theta1 + Theta2 [degr]

Charge of single Particle hit
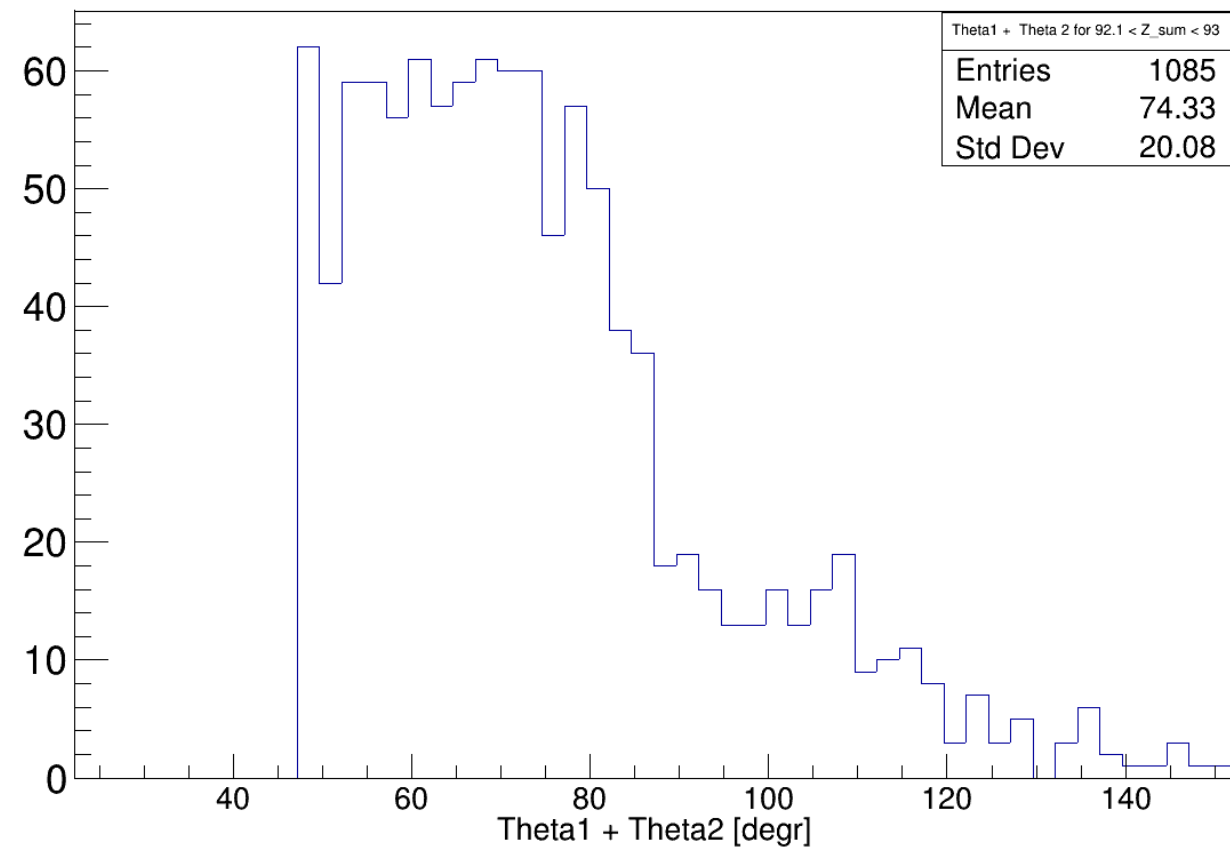
Theta1 +Theta2 for 92.1 < Z_sum < 93 CUTS

Theta1 + Theta 2 for 92.1 < Z_sum < 93 and delta_phi = 180+-15
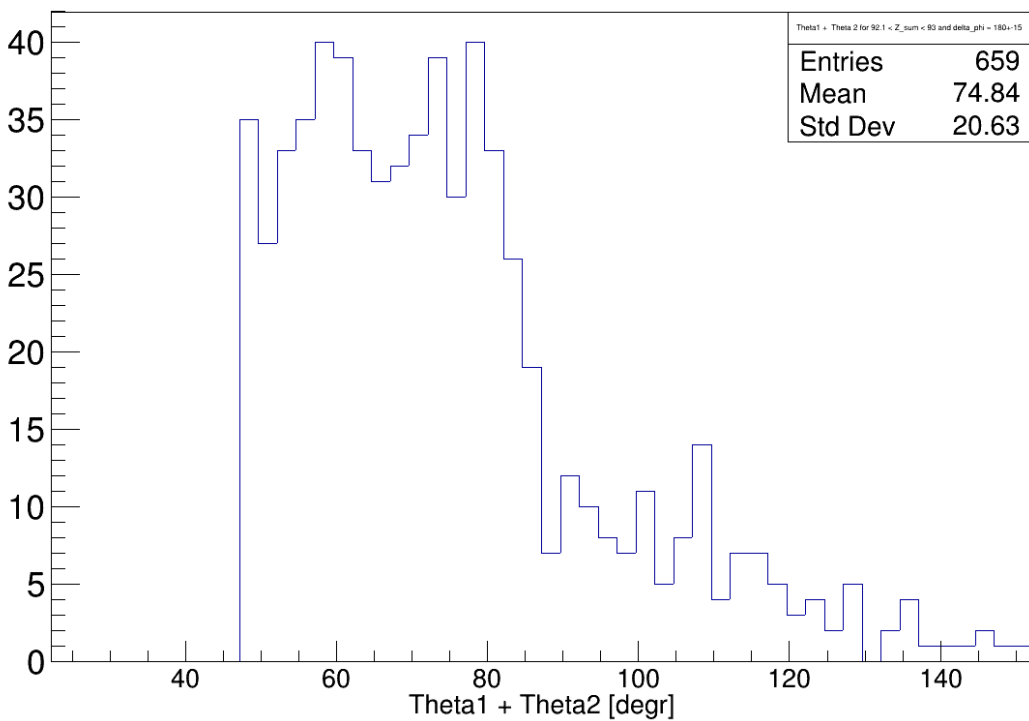
Theta1 + Theta 2 for 92.1 < Z_sum < 93 and delta_phi = 180+-15 and 200 < E_sum < 700

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Theta1 +Theta2 for 90.7 < Z_sum < 92

Theta1 + Theta 2 for 90.7 < Z_sum < 92

Theta1 + Theta 2 for 90.7 < Z_sum < 92	
Entries	1252
Mean	75.78
Std Dev	22.4

Theta1 + Theta2 [degr]

Charge of single Particle hit

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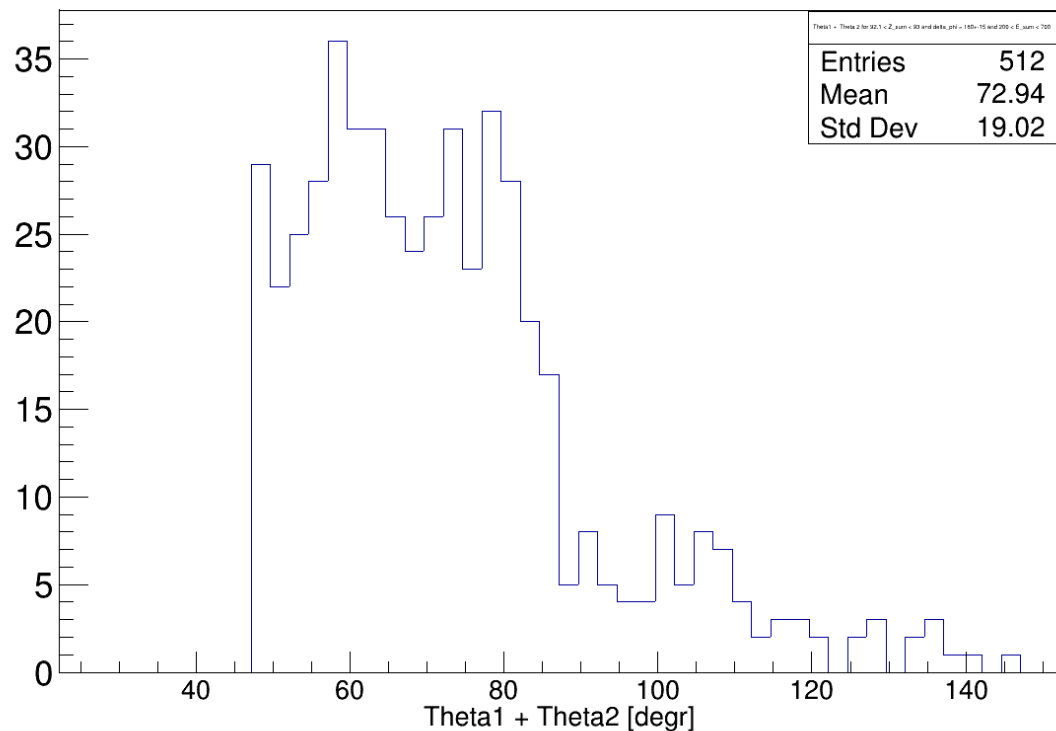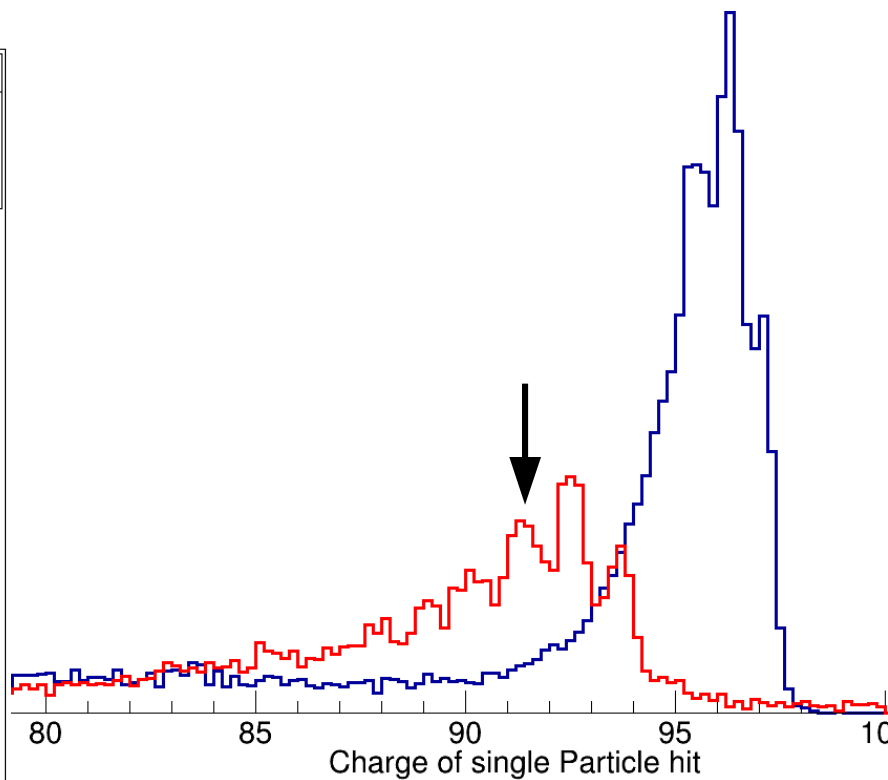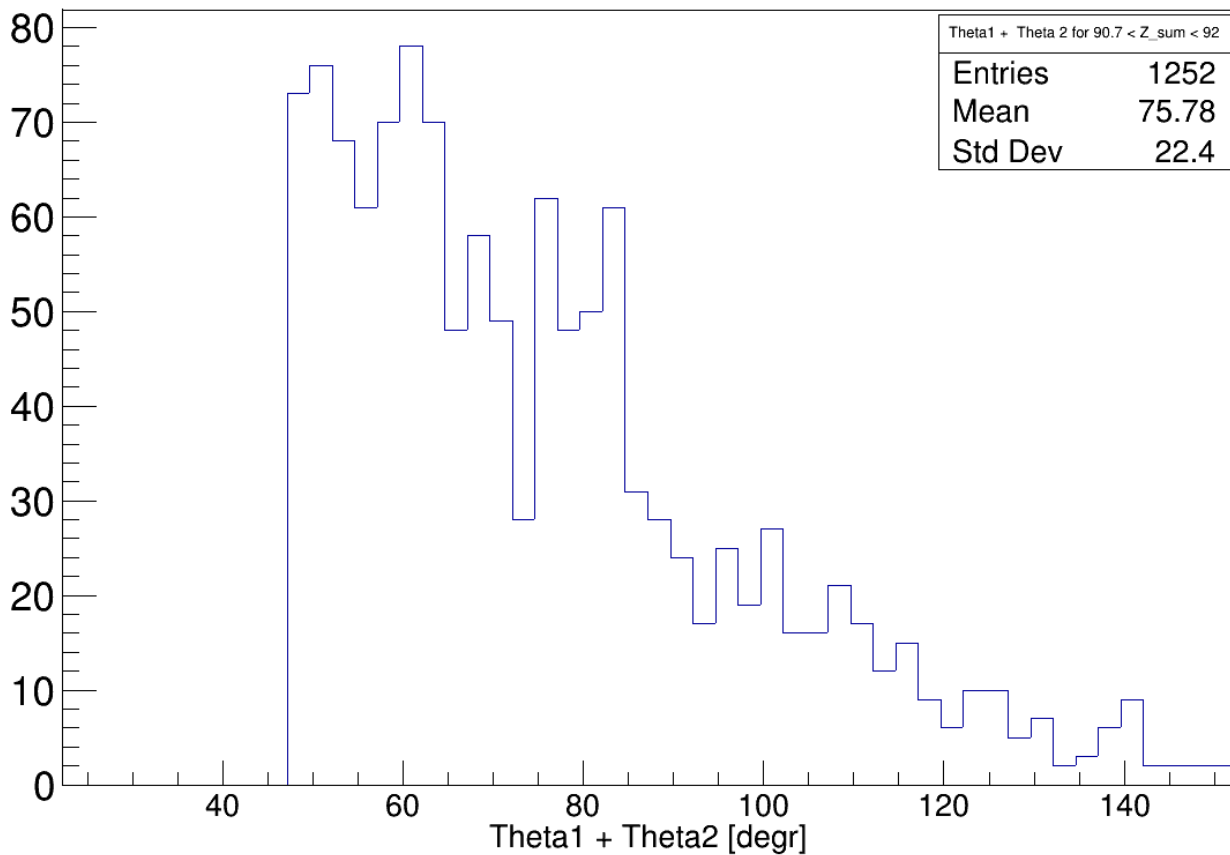
Theta1 +Theta2 for 90.7 < Z_sum < 92 CUTS

Theta1 + Theta 2 for 90.7 < Z_sum < 92 and delta_phi = 180+-15
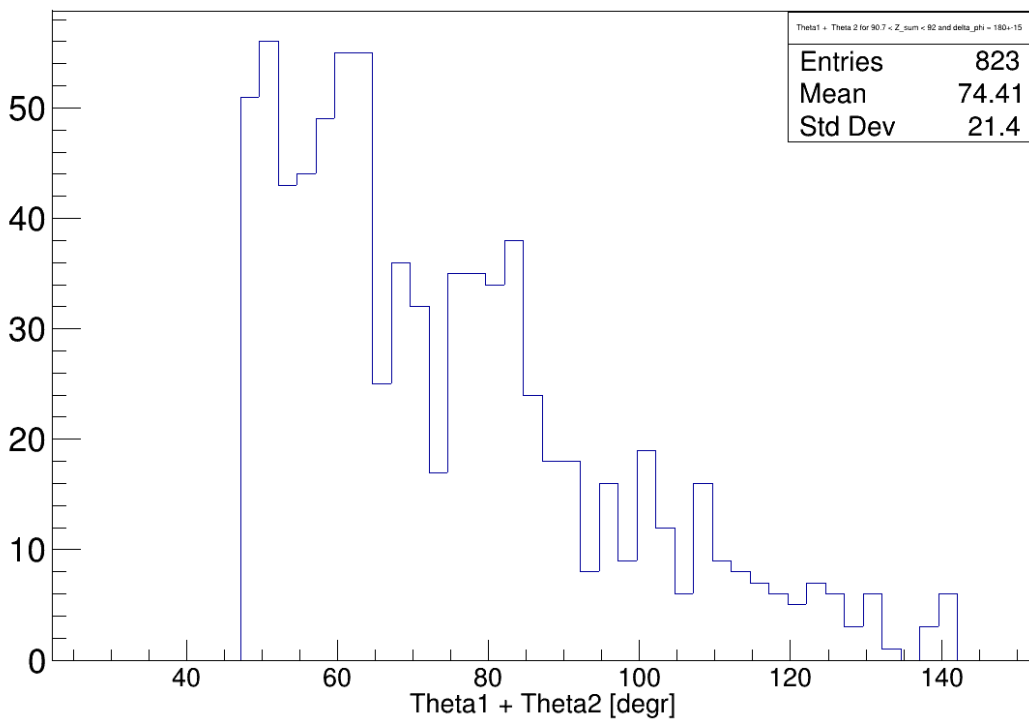
Theta1 + Theta 2 for 90.7 < Z_sum < 92 and delta_phi = 180+-15 and 200 < E_sum < 700

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Theta1 +Theta2 for 89.5 < Z_sum < 90.6

Theta1 + Theta 2 for 89.5 < Z_sum < 90.6

Theta1 + Theta 2 for 89.5 < Z_sum < 90.6	
Entries	820
Mean	75.45
Std Dev	22.12

Theta1 + Theta2 [degr]

Charge of single Particle hit

41
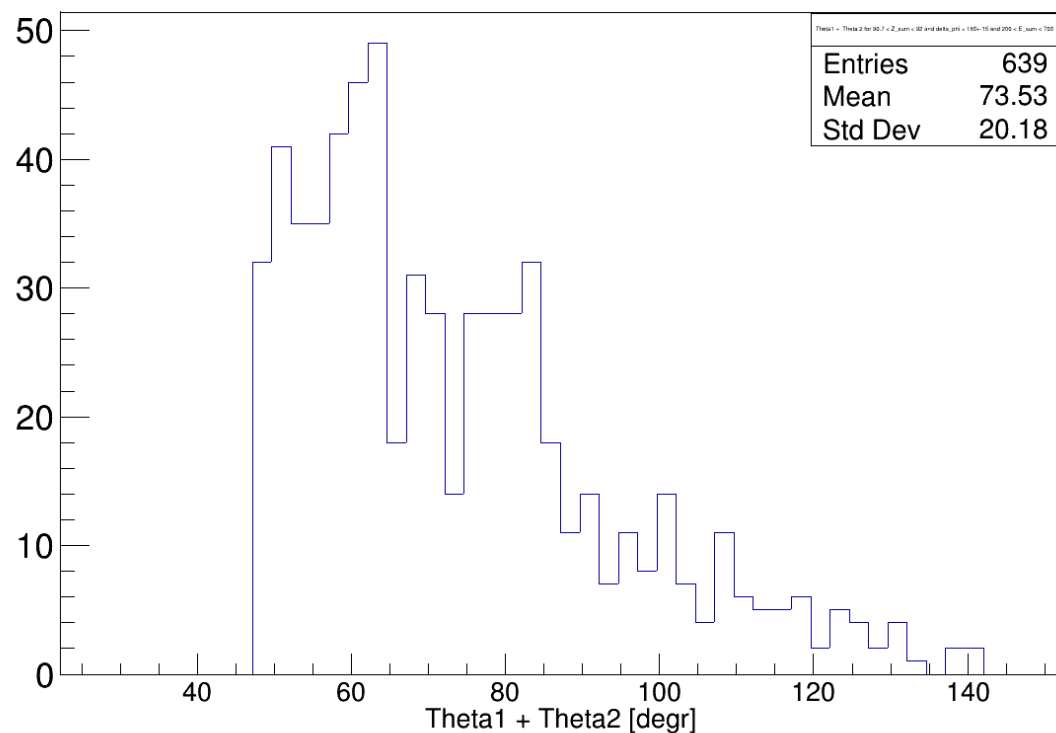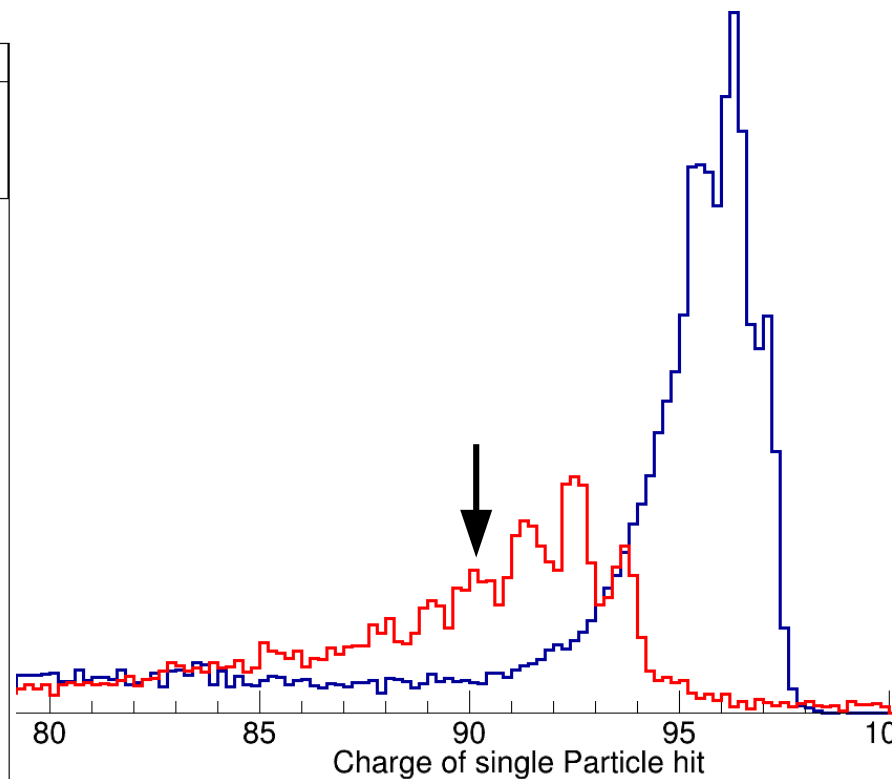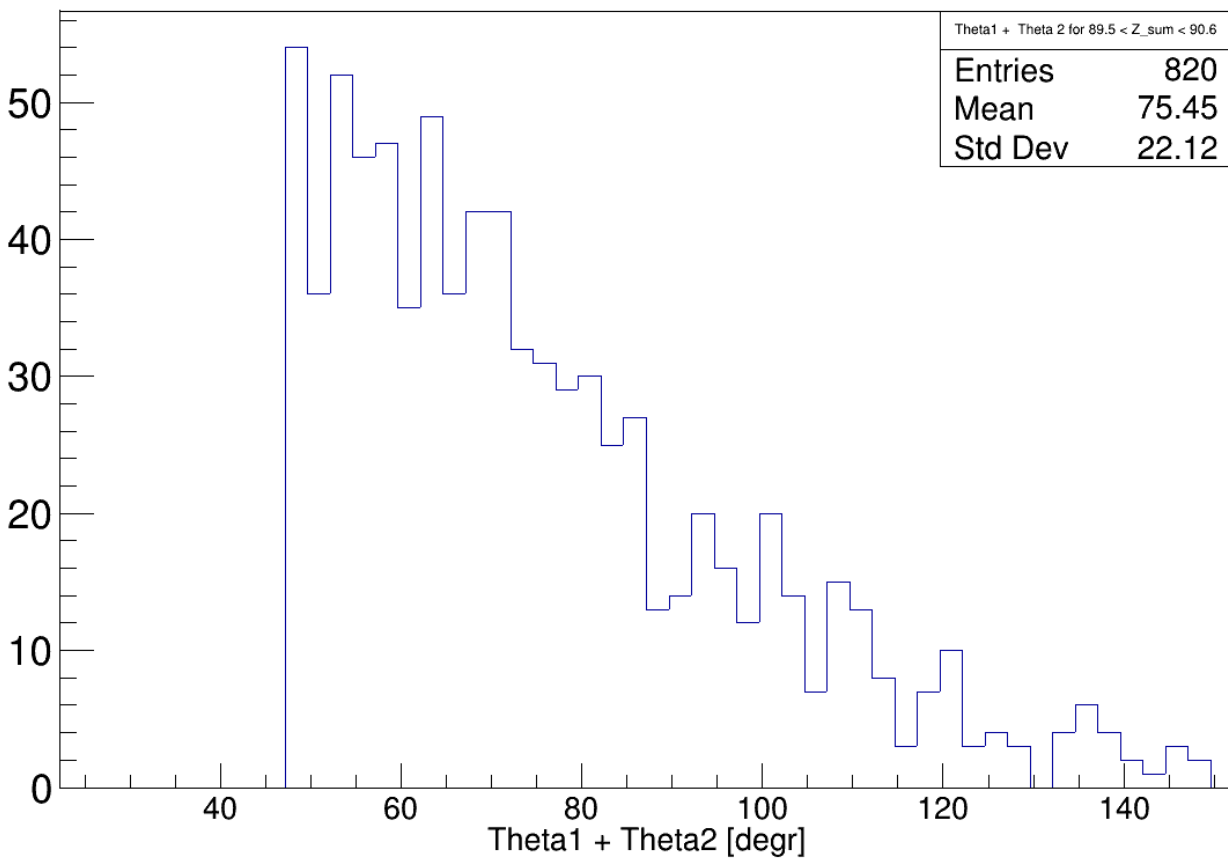
Theta1 +Theta2 for 89.5 < Z_sum < 90.6 CUTS

Theta1 + Theta 2 for 89.5 < Z_sum < 90.6 and delta_phi = 180+-15

Theta1 + Theta 2 for 89.5 < Z_sum < 90.6 and delta_phi = 180+-15	
Entries	549
Mean	75.07
Std Dev	21.76

Theta1 + Theta 2 for 89.5 < Z_sum < 90.6 and delta_phi = 180+-15 and 200 < E_sum < 700

Theta1 + Theta 2 for 89.5 < Z_sum < 90.6 and delta_phi = 180+-15 and 200 < E_sum < 700	
Entries	430
Mean	74.82
Std Dev	21.18
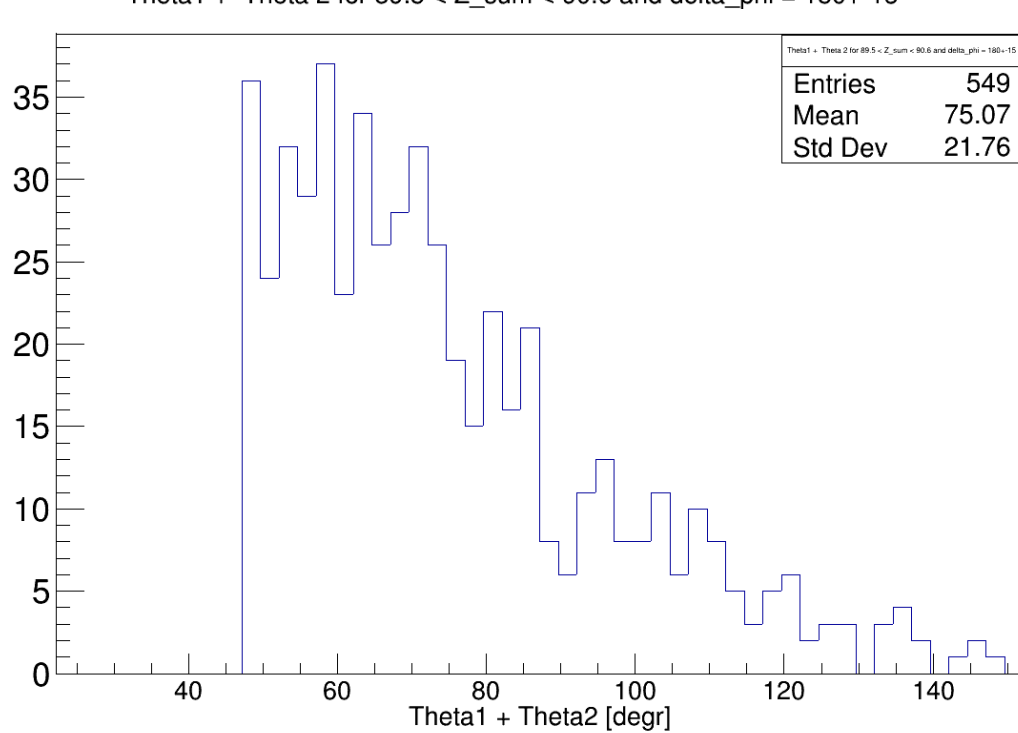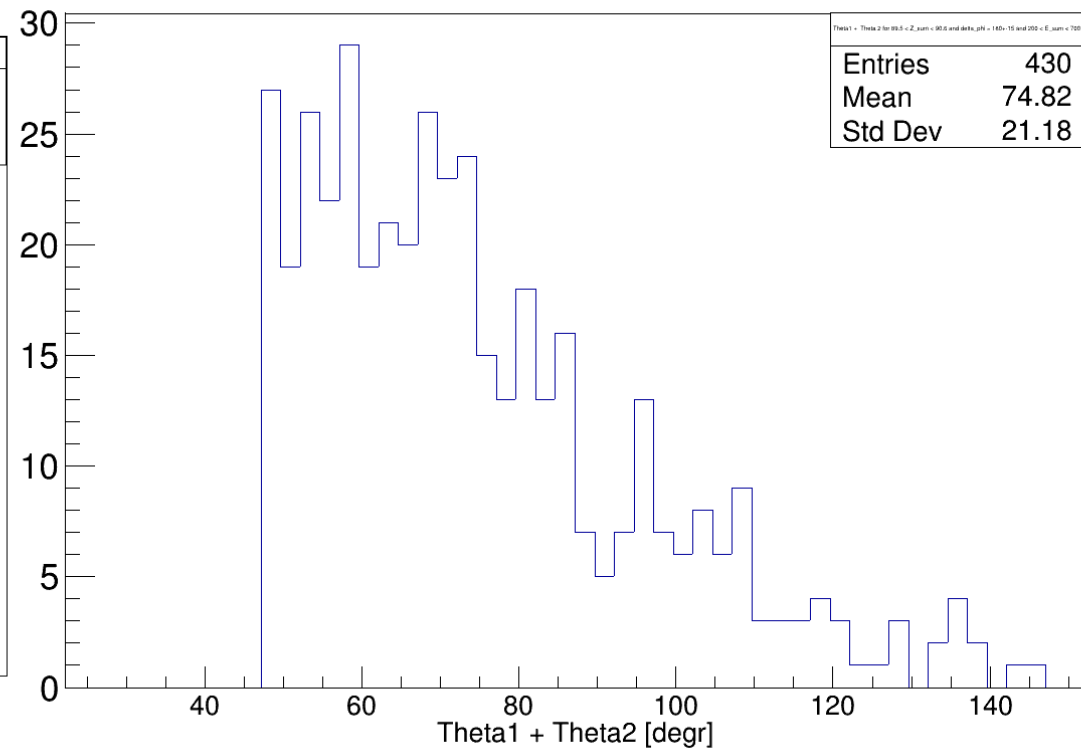
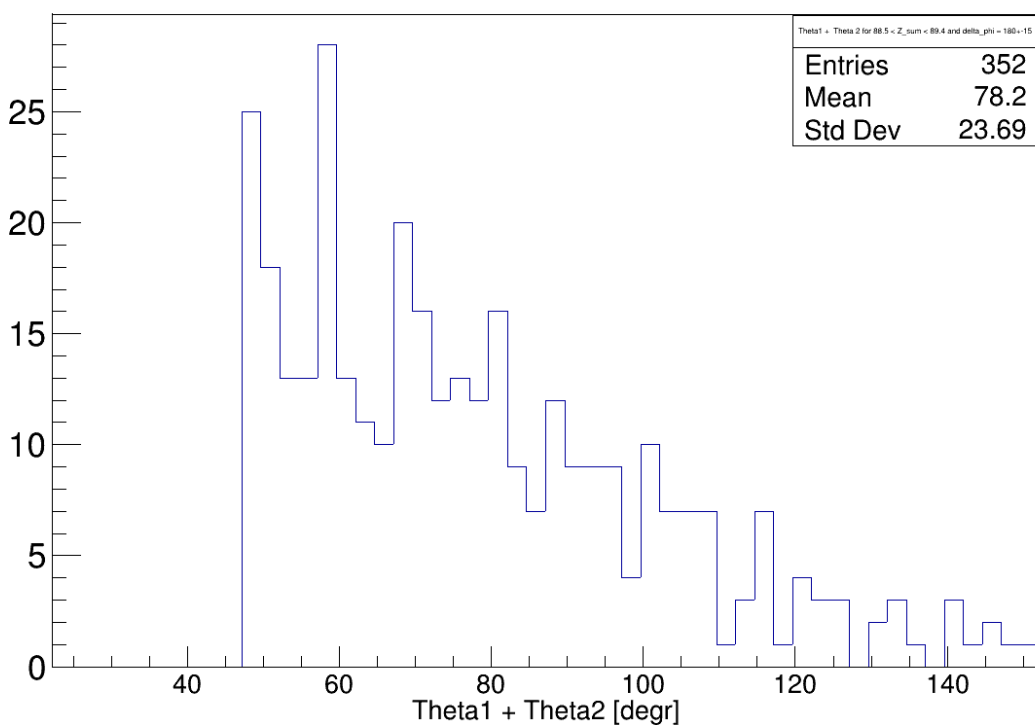# Theta1 +Theta2 for 88.5 < Z_sum < 89.4
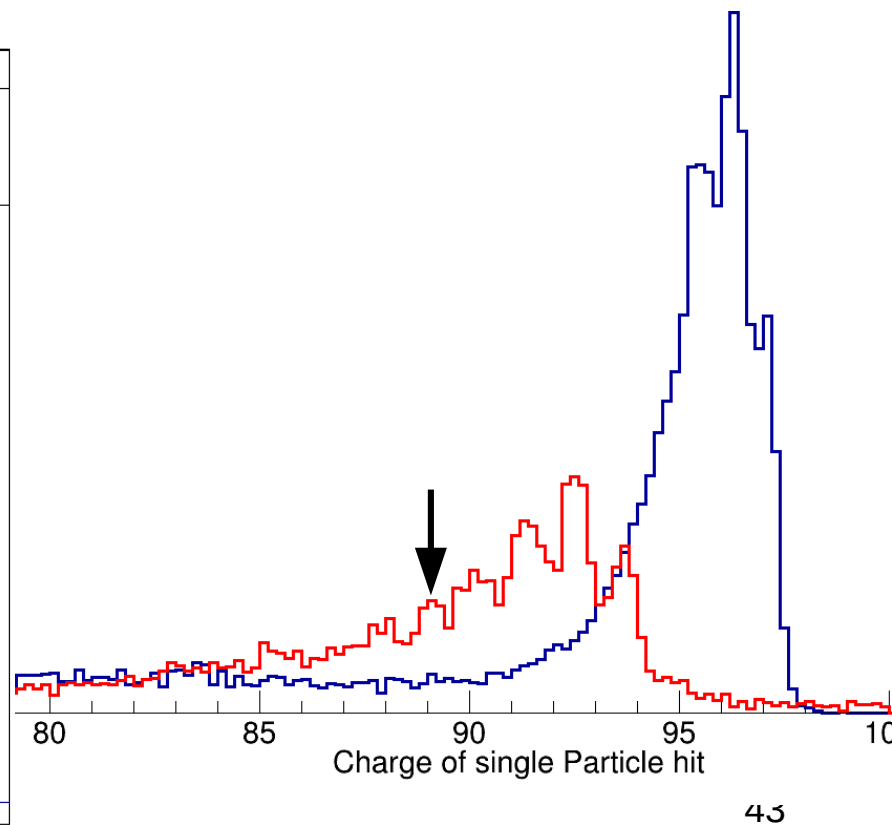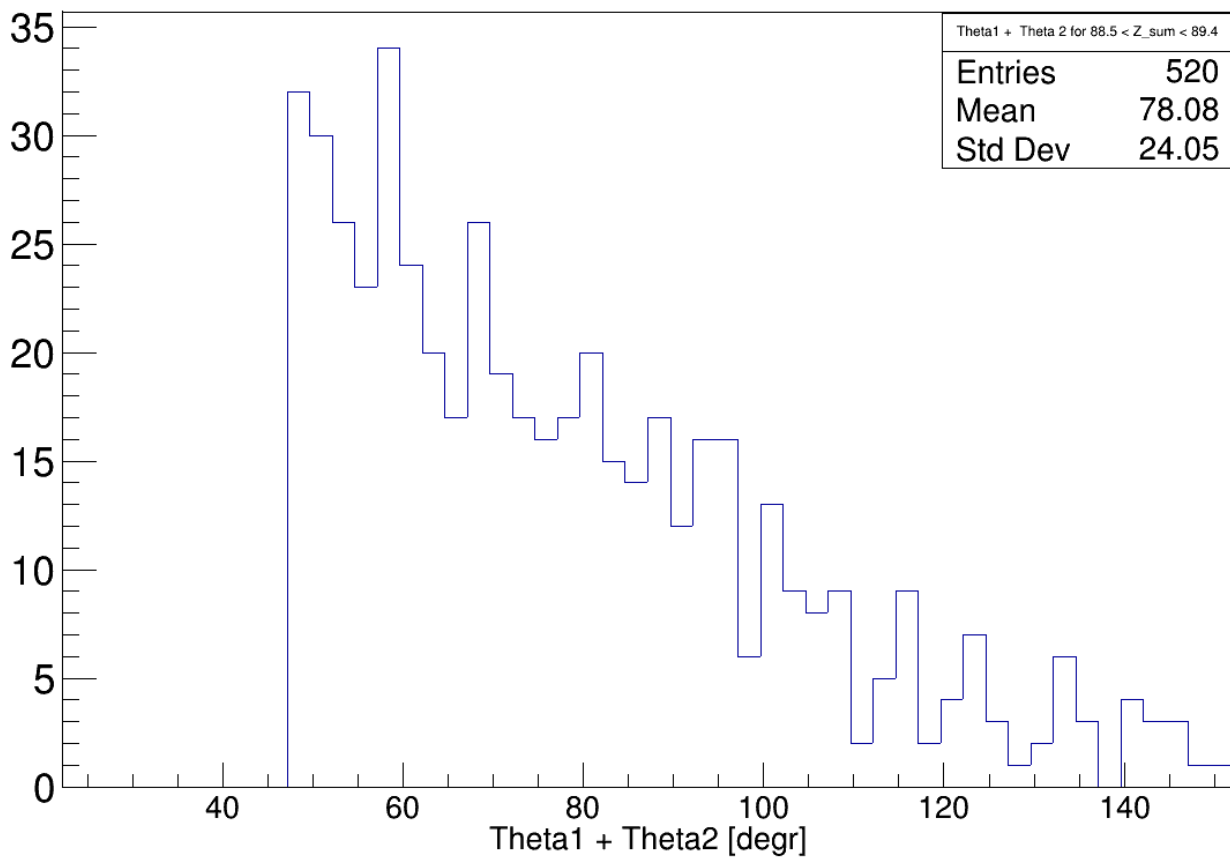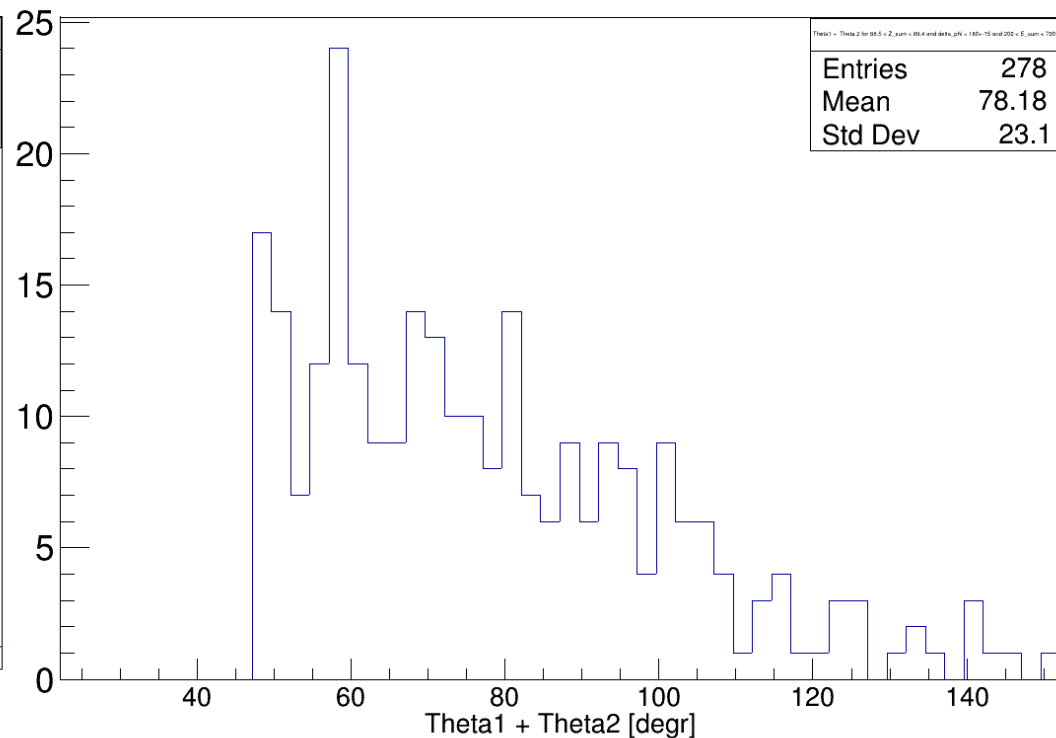
Theta1 +Theta2 for 88.5 < Z_sum < 89.4 CUTS

Theta1 + Theta 2 for 88.5 < Z_sum < 89.4 and delta_phi = 180+-15

Theta1 + Theta 2 for 88.5 < Z_sum < 89.4 and delta_phi = 180+-15	
Entries	352
Mean	78.2
Std Dev	23.69

Theta1 + Theta2 [degr]

Theta1 + Theta 2 for 88.5 < Z_sum < 89.4 and delta_phi = 180+-15 and 200 < E_sum < 700

Theta1 + Theta 2 for 88.5 < Z_sum < 89.4 and delta_phi = 180+-15 and 200 < E_sum < 700	
Entries	278
Mean	78.18
Std Dev	23.1

Theta1 + Theta2 [degr]

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Summary

- 93.2 < Z_sum < 94.2 seems to be the right channel

- 42.7 < Z1/2 < 43.9 and 47.8 < Z1/2 < 48.7

  → also a peak at ~ 80°

- Why do we have so many Z=93 events ?

Theta1 + Theta 2 for 93.2 < Z_sum < 94.2 and delta_phi = 180+-15 and 200 < E_sum < 700

Entries	325
Mean	75.6
Std Dev	18.99

Theta1 + Theta 2 for 42.7 < Z_1 < 43.9 and 47.8 < Z_2 < 48.7

Entries	104
Mean	78.06
Std Dev	25.64