Week 6 Progress

2022-07-07

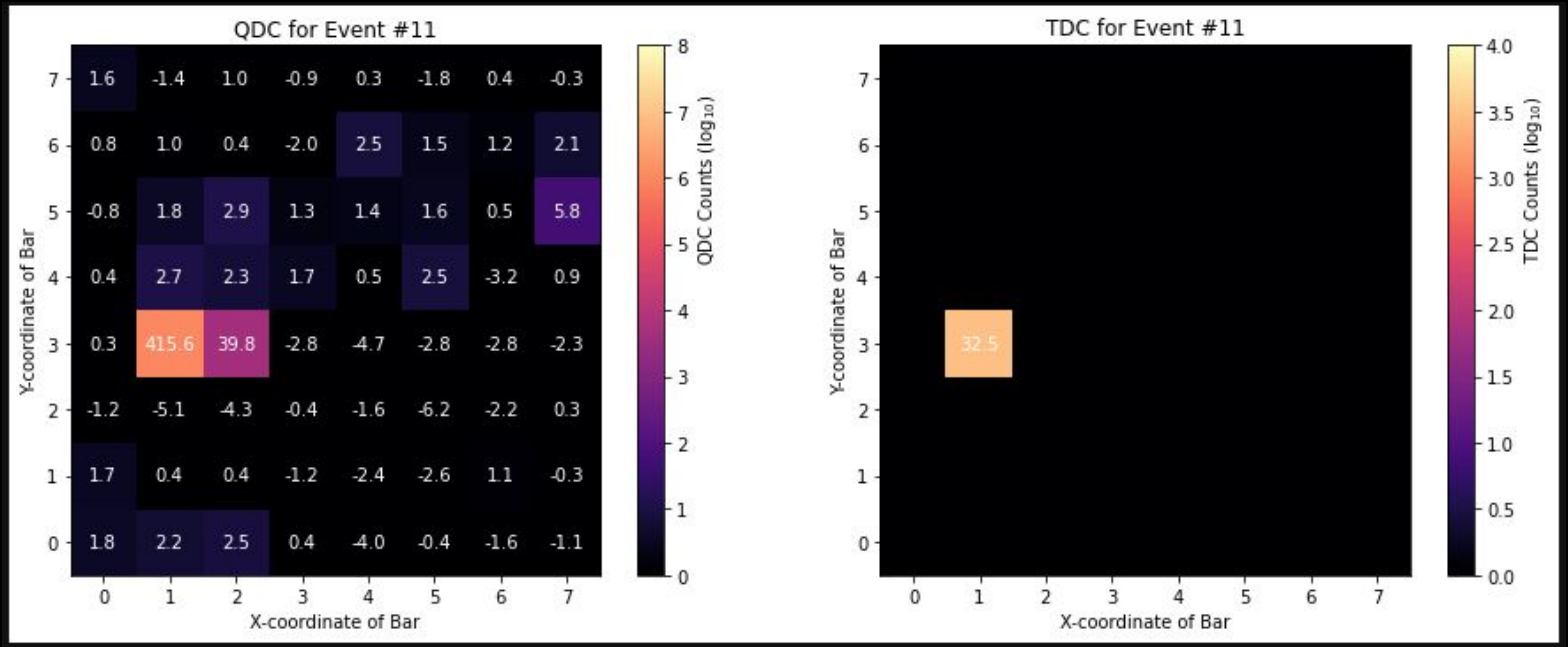
Calorimeter Energy Sums
Generating Calorimeter Images

Outline

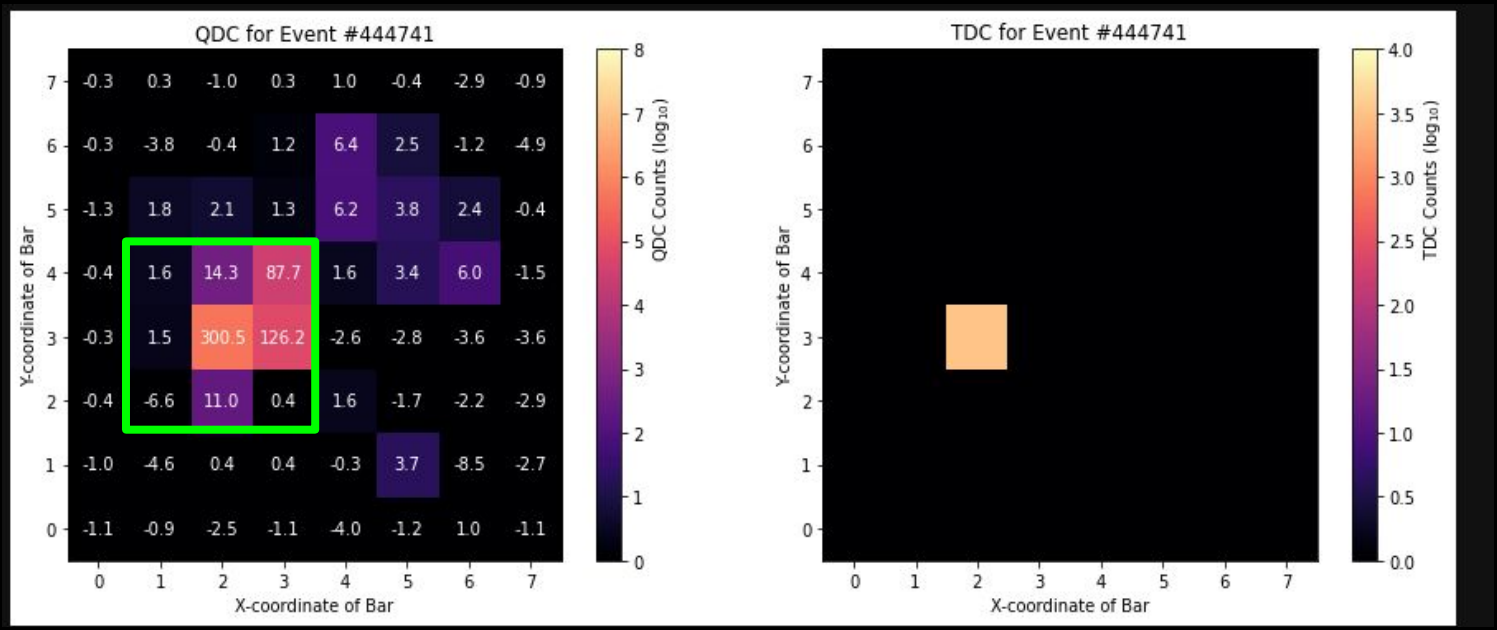
1. Recap
    a. Simple QDC/TDC Event Display
    b. 2 Energy Summing Methods
2. Issue: 2 events in one frame
    a. Different cases
    b. Fixes?
3. Generating calorimeter images

1.a. Simple QDC/TDC Event Display

- Black = no hit
- Color scale: log 10
- Numerical QDC values: raw

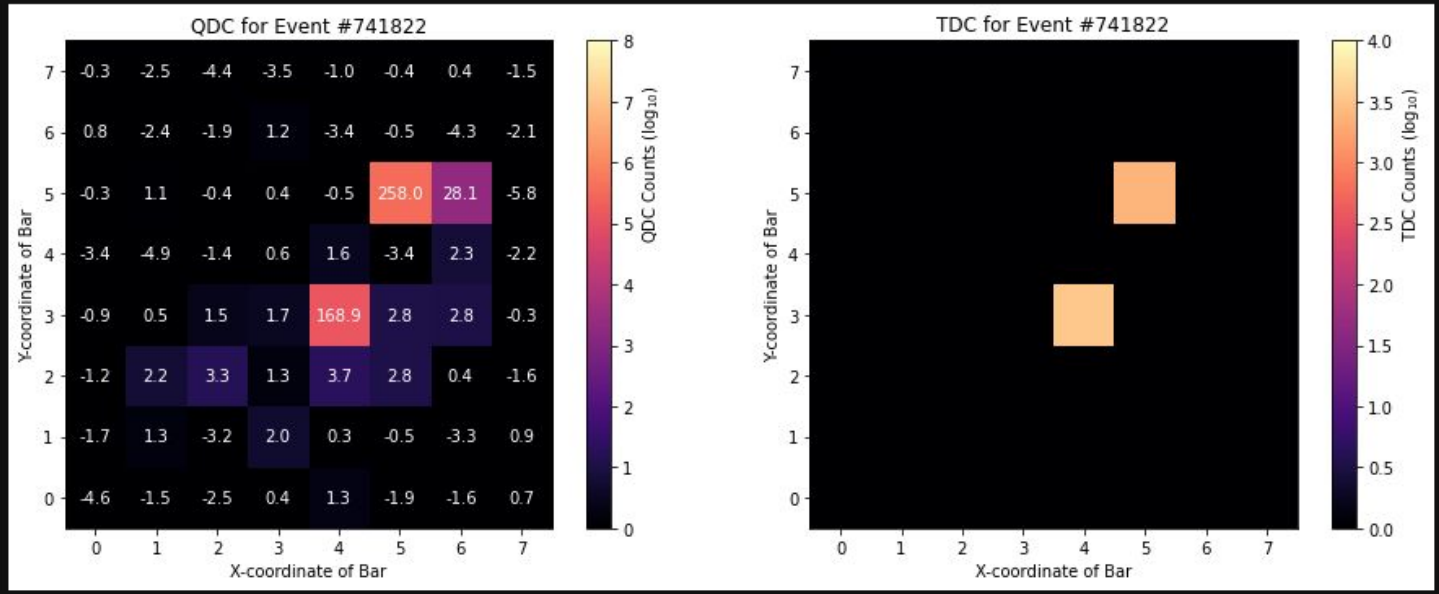


1.b. Old Esum Method



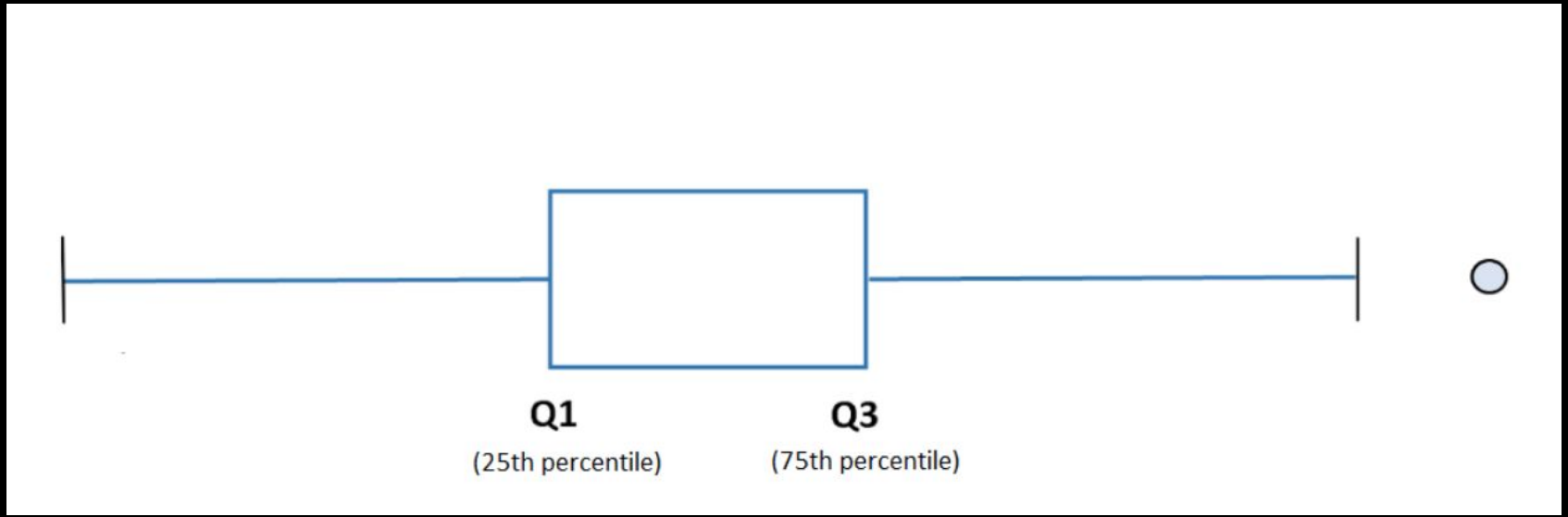
Weakness

inaccurate

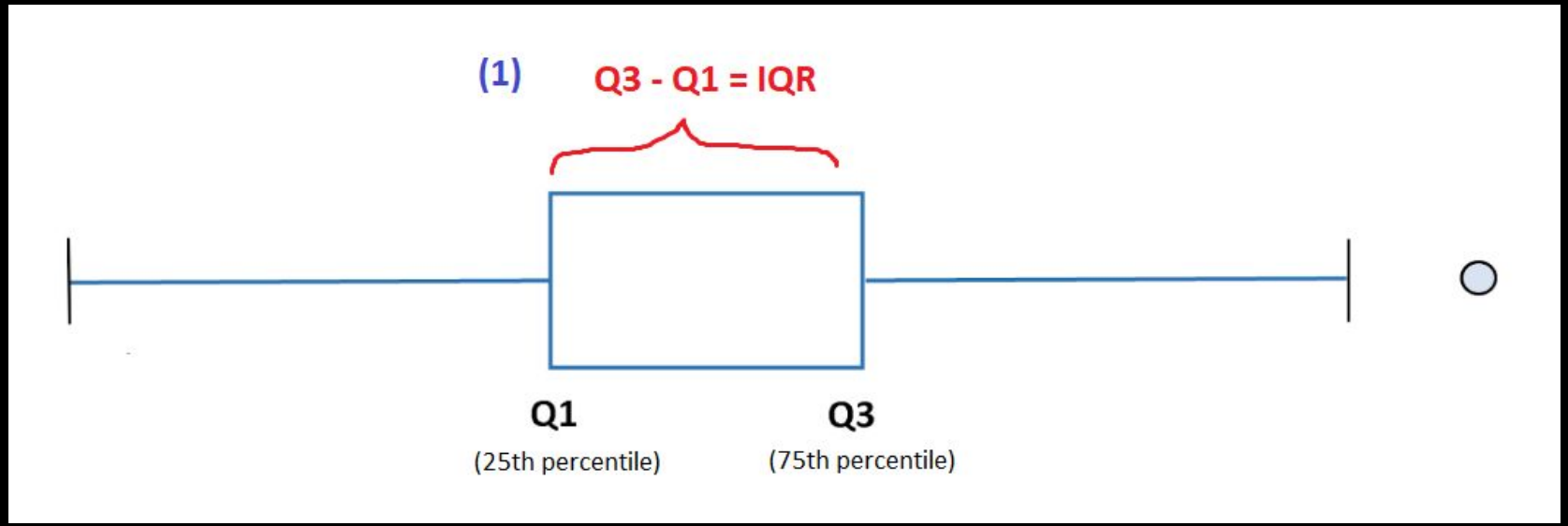



```
290.04            = Sum of nonzero QDC values in 8 bars surrounding max bar.
258.00 @ (5,5)    = Max QDC value and coordinate of bar.

88.95%            = Percent of energy sum deposited into central bar.
98.64%            = Percent of energy sum deposited into central bar + 2nd highest QDC bar.

58.78%            = Percent of total energy captured by energy sum.
```

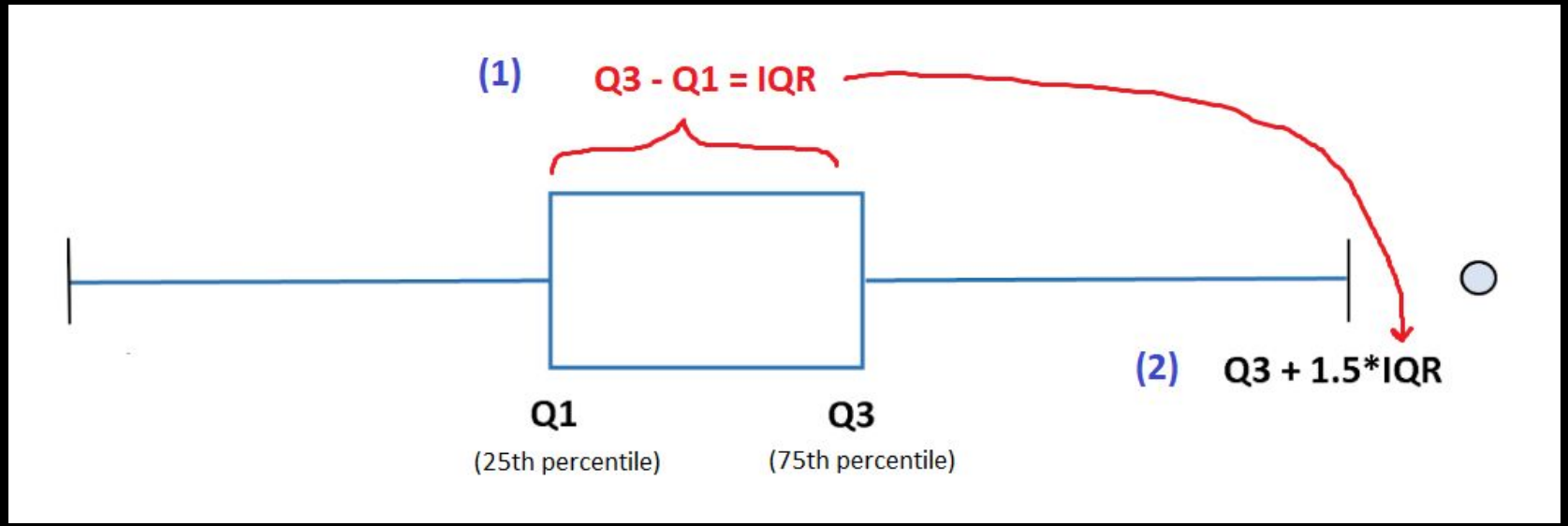
1.b. New Esum Method



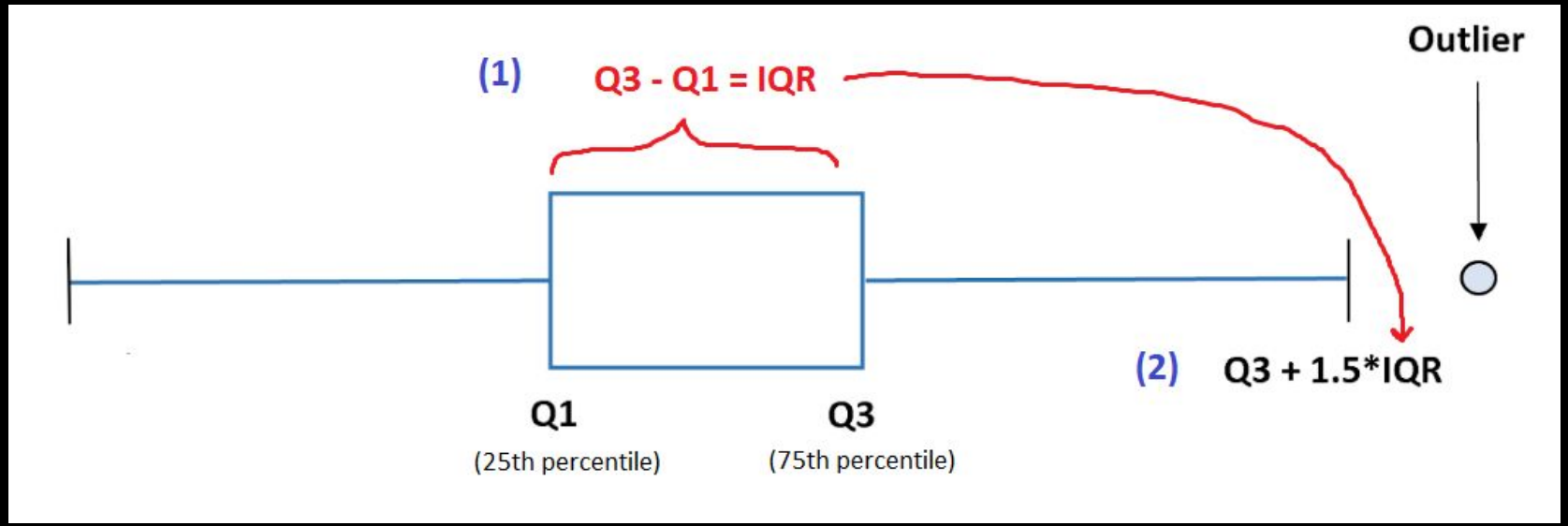
1.b. New Esum Method



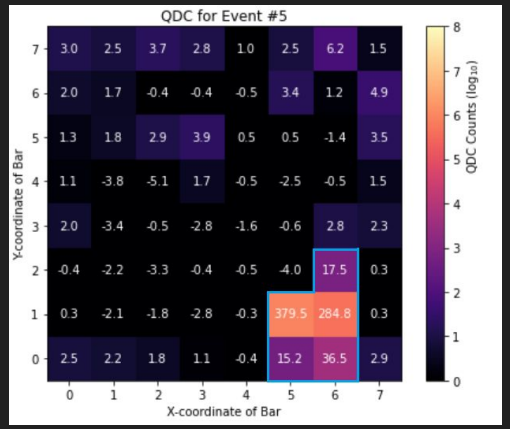
1.b. New Esum Method

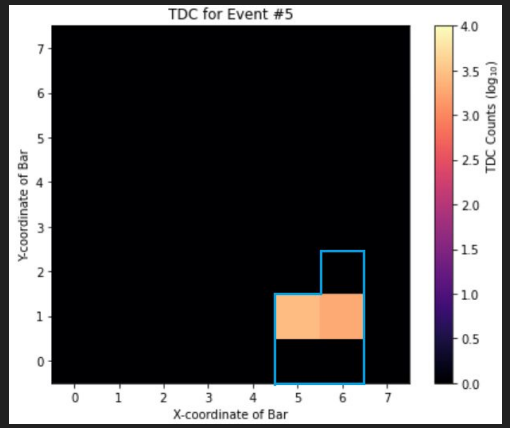


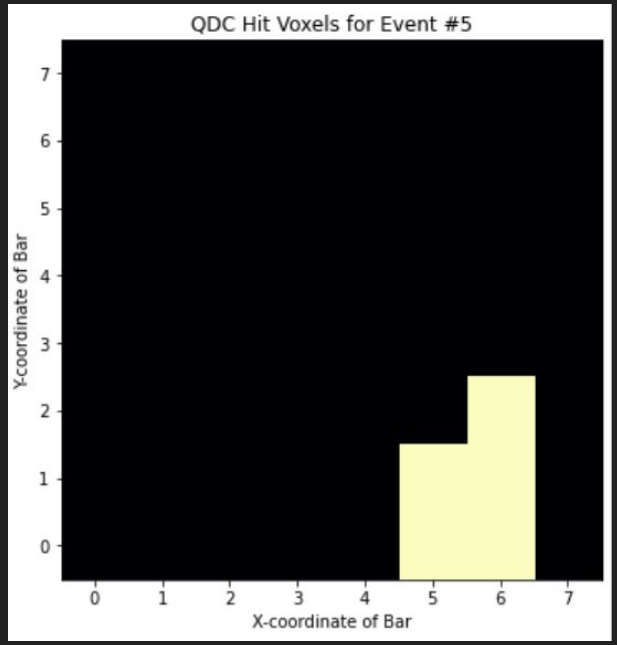
1.b. New Esum Method



III. New Energy Summing Method (Outliers)

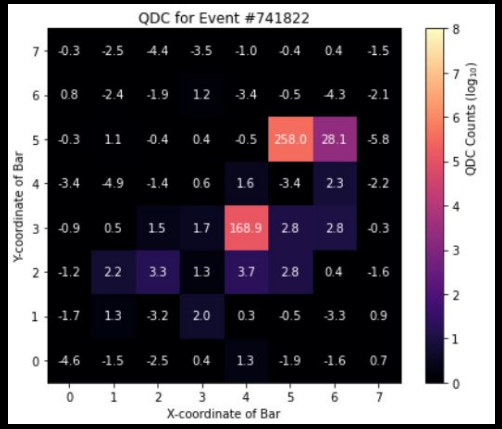


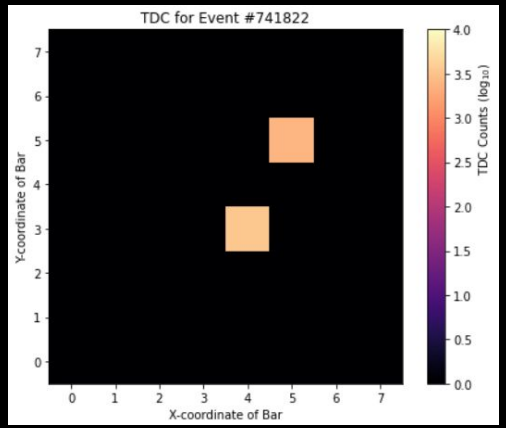


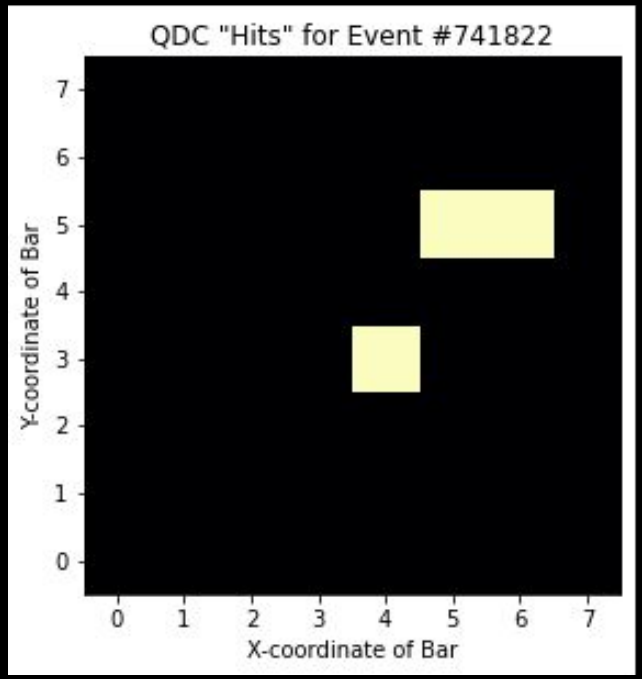


Good: clusters

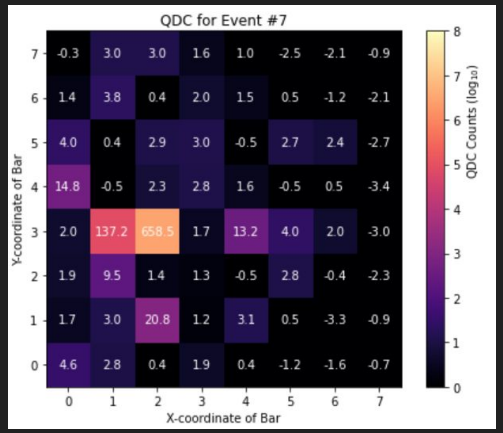
1.b. New Esum Method

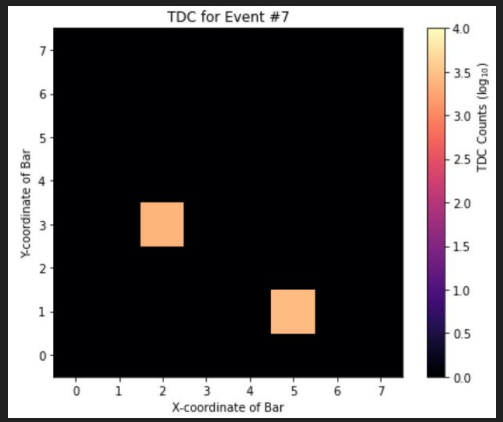


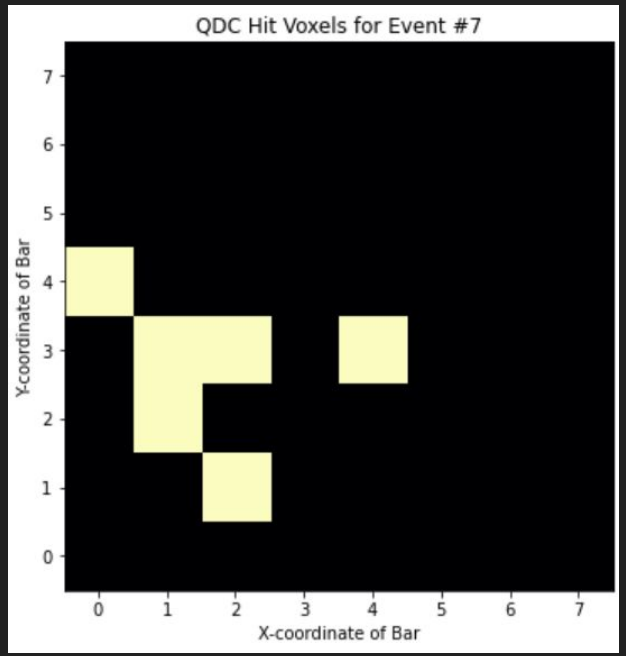




III. New Energy Summing Method (Outliers)

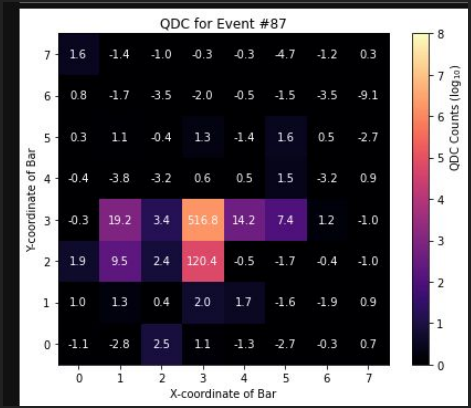


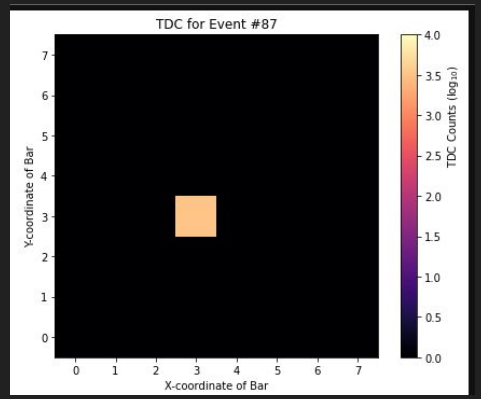


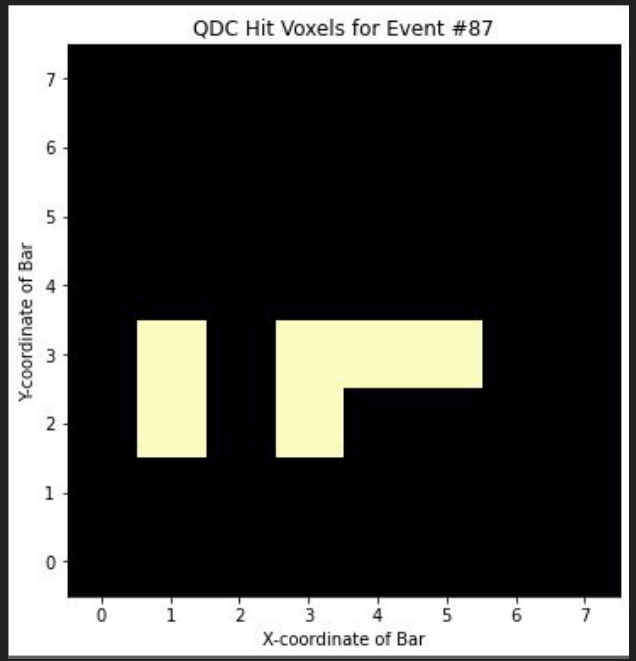


Good: complex shower shapes

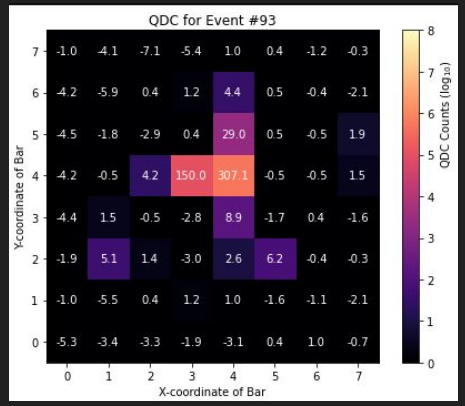
III. New Energy Summing Method (Outliers)

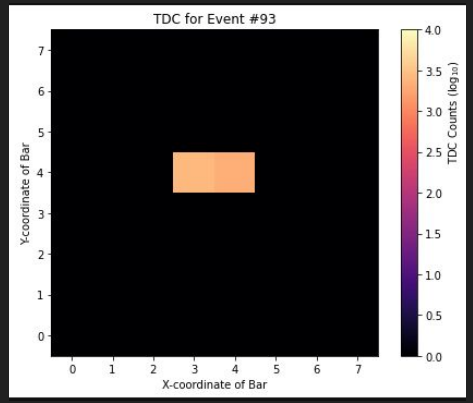


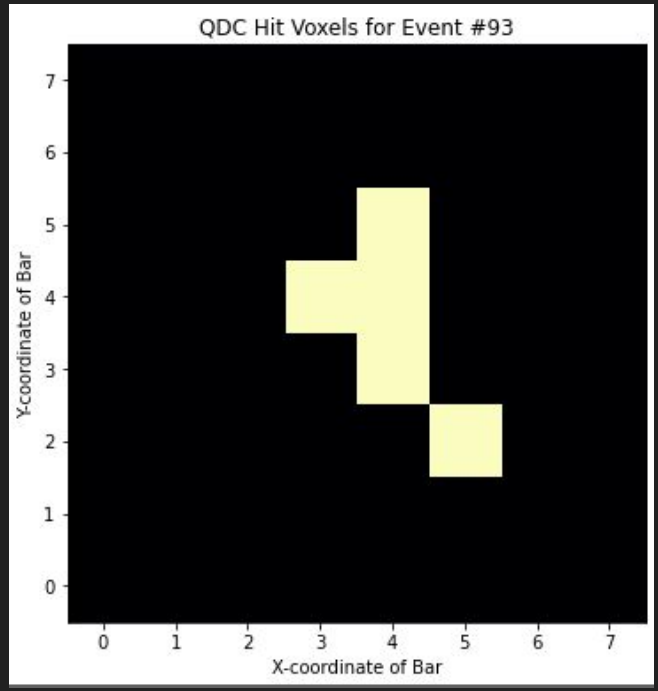




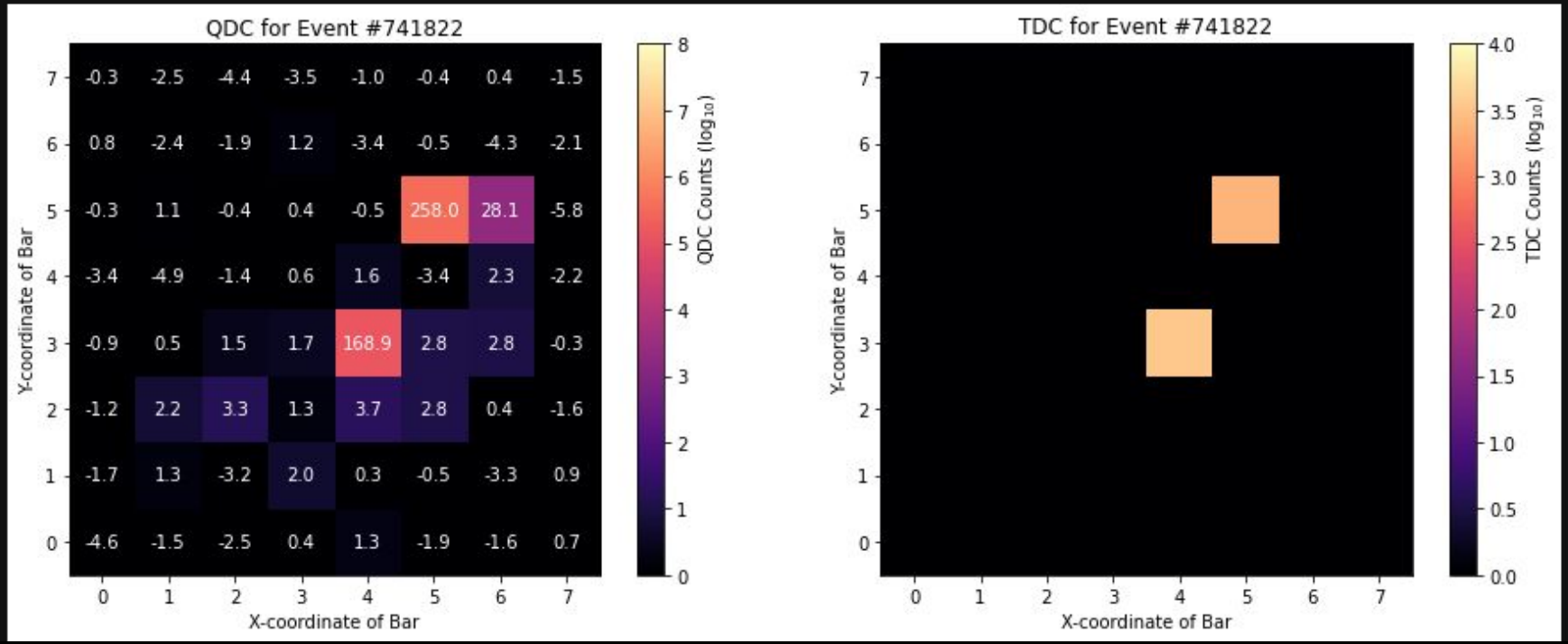
III. New Energy Summing Method (Outliers)

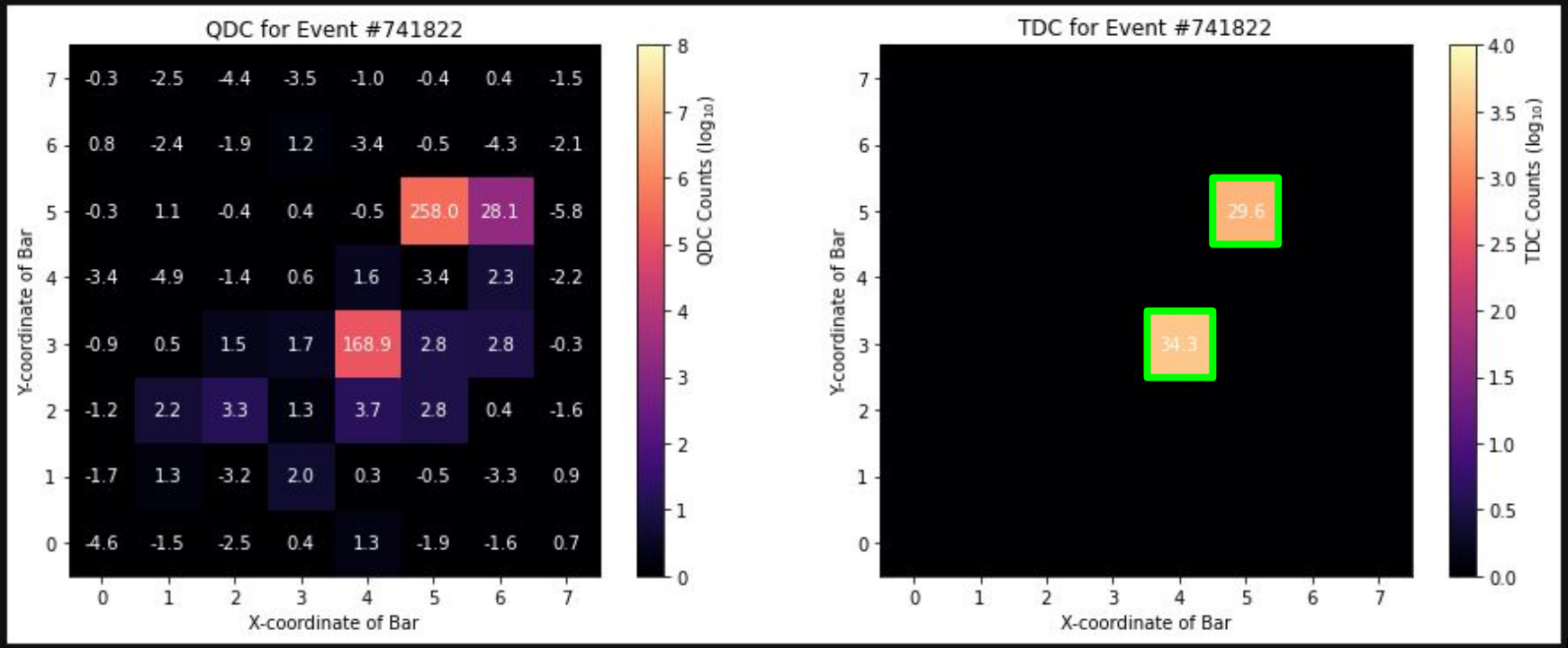






2. Issue: two events in one display

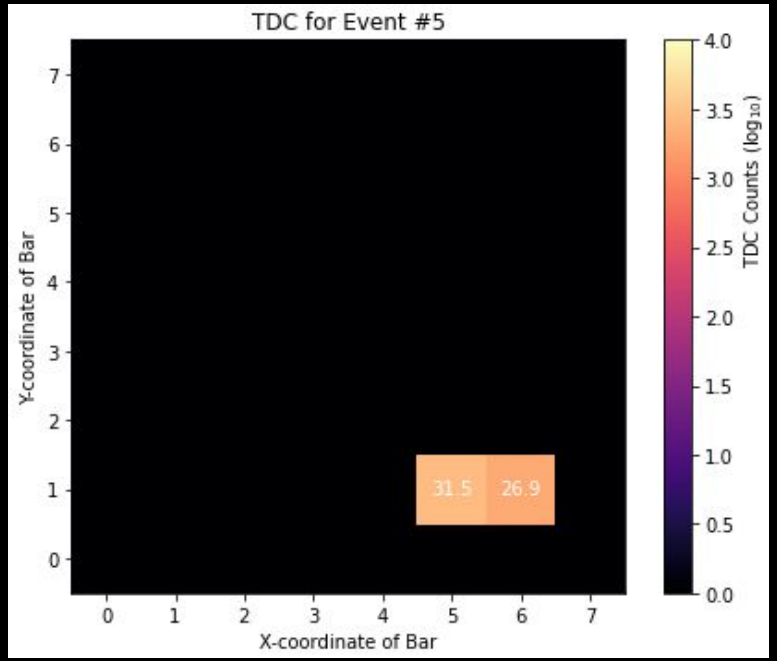

QDC for Event #741822
-0.3 -2.5 -4.4 -3.5 -1.0 -0.4 0.4 -1.5
0.8 -2.4 -1.9 1.2 -3.4 -0.5 -4.3 -2.1
-0.3 1.1 -0.4 0.4 -0.5 258.0 28.1 -5.8
-3.4 -4.9 -1.4 0.6 1.6 -3.4 2.3 -2.2
-0.9 0.5 1.5 1.7 168.9 2.8 2.8 -0.3
-1.2 2.2 3.3 1.3 3.7 2.8 0.4 -1.6
-1.7 1.3 -3.2 2.0 0.3 -0.5 -3.3 0.9
-4.6 -1.5 -2.5 0.4 1.3 -1.9 -1.6 0.7
Y-coordinate of Bar
X-coordinate of Bar
QDC Counts (log10)
TDC for Event #741822
Y-coordinate of Bar
X-coordinate of Bar
TDC Counts (log10)

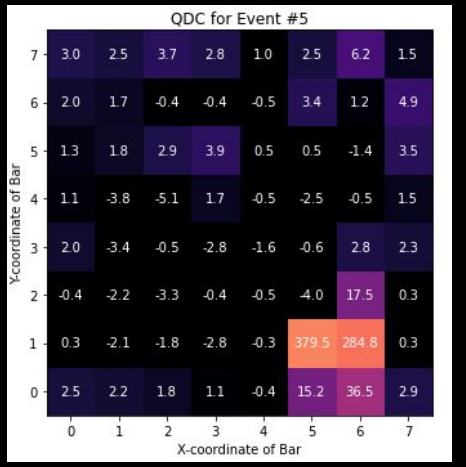

QDC for Event #741822
-0.3 -2.5 -4.4 -3.5 -1.0 -0.4 0.4 -1.5
0.8 -2.4 -1.9 1.2 -3.4 -0.5 -4.3 -2.1
-0.3 1.1 -0.4 0.4 -0.5 258.0 28.1 -5.8
-3.4 -4.9 -1.4 0.6 1.6 -3.4 2.3 -2.2
-0.9 0.5 1.5 1.7 168.9 2.8 2.8 -0.3
-1.2 2.2 3.3 1.3 3.7 2.8 0.4 -1.6
-1.7 1.3 -3.2 2.0 0.3 -0.5 -3.3 0.9
-4.6 -1.5 -2.5 0.4 1.3 -1.9 -1.6 0.7
Y-coordinate of Bar
X-coordinate of Bar
QDC Counts (log10)
TDC for Event #741822
29.6
34.3
Y-coordinate of Bar
X-coordinate of Bar
TDC Counts (log10)

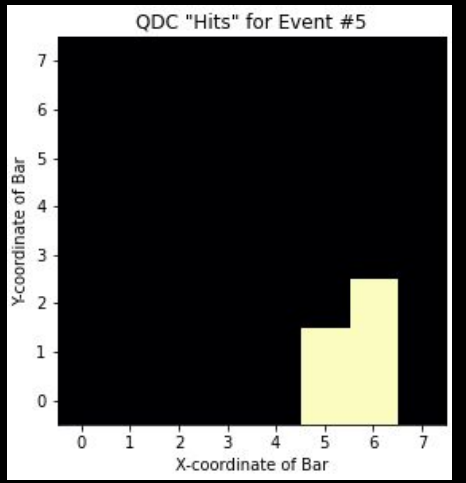
Cases:

1. Two events, far apart
2. Two events, close together
3. One event, far apart
4. One event, close together
5. ???

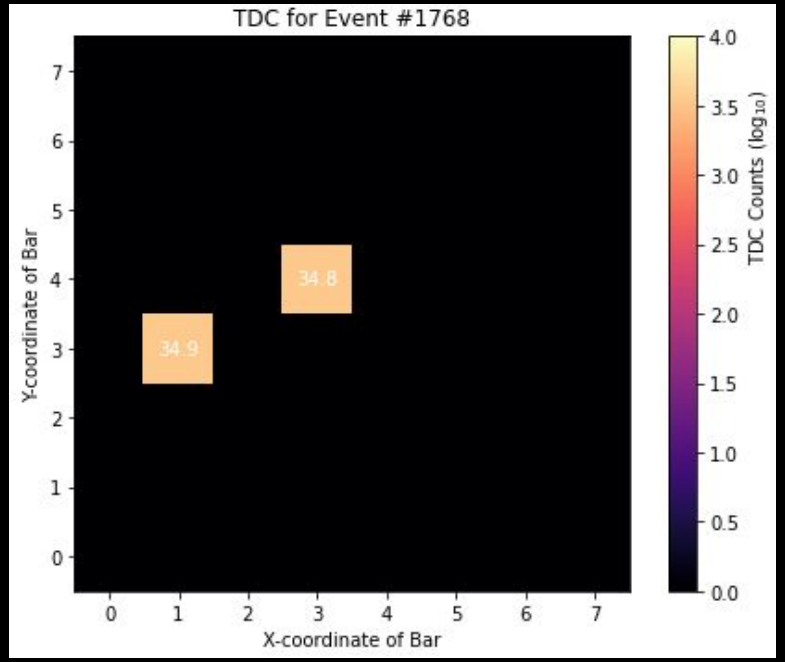
Case 2:
Two events, close together

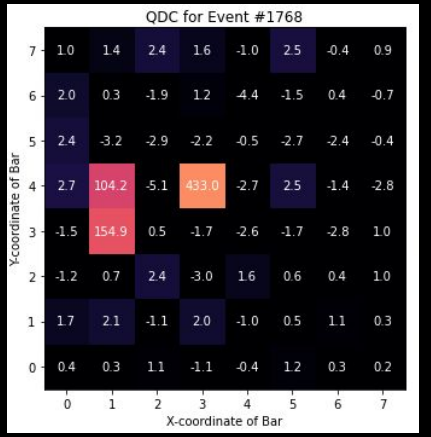


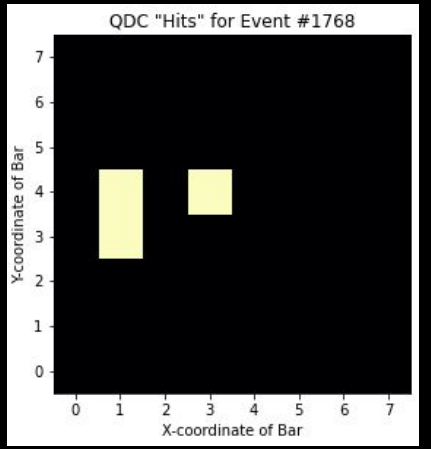




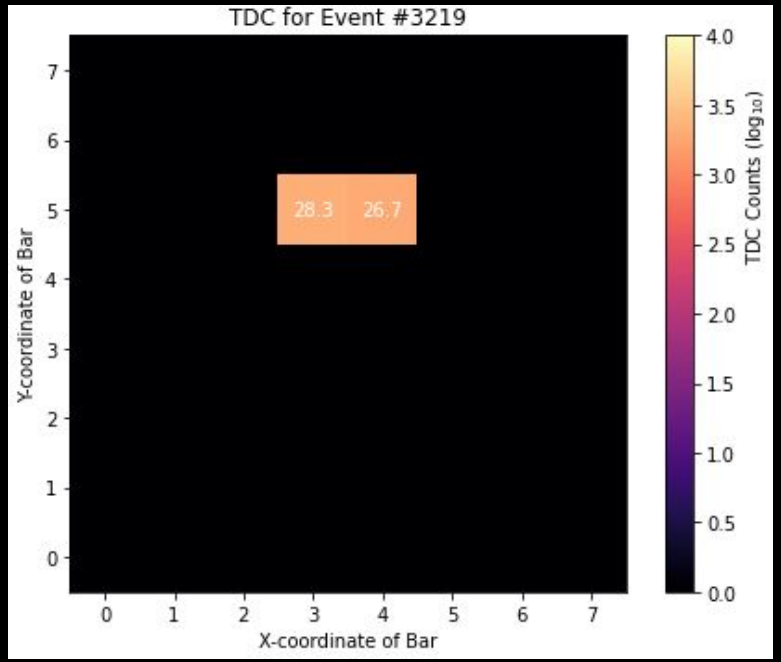
Case 3:
One event, far apart

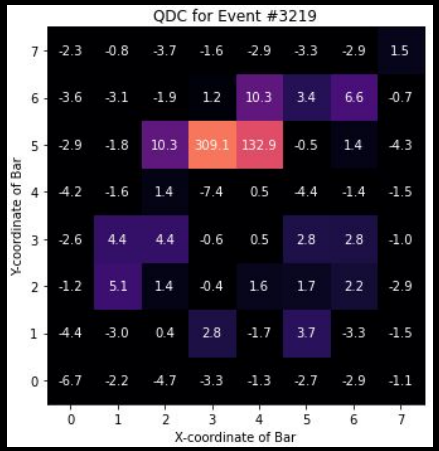


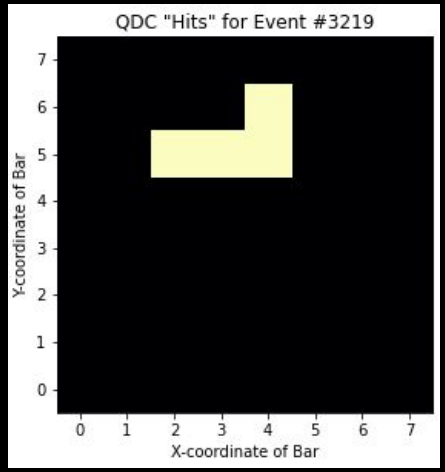




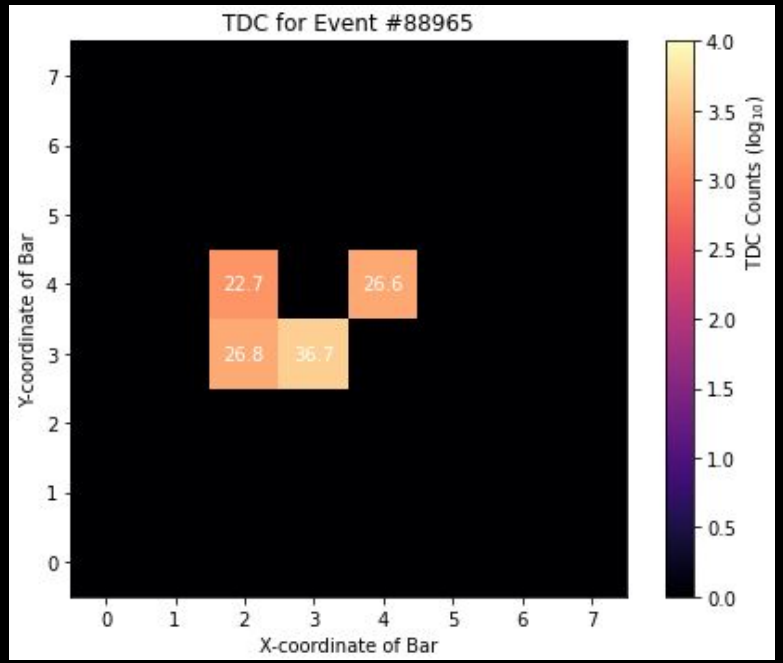
Case 4:
One event, close together

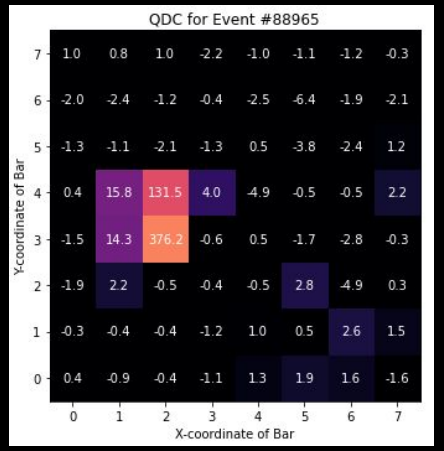


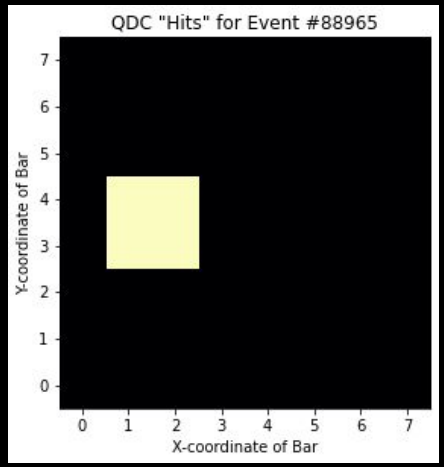




Case 5:
???


TDC for Event #88965
Y-coordinate of Bar
X-coordinate of Bar
TDC Counts (log10)
22.7
26.6
26.8
36.7


QDC for Event #88965
Y-coordinate of Bar
X-coordinate of Bar
1.0 0.8 1.0 -2.2 -1.0 -1.1 -1.2 -0.3
-2.0 -2.4 -1.2 -0.4 -2.5 -6.4 -1.9 -2.1
-1.3 -1.1 -2.1 -1.3 0.5 -3.8 -2.4 1.2
0.4 15.8 131.5 4.0 -4.9 -0.5 -0.5 2.2
-1.5 14.3 376.2 -0.6 0.5 -1.7 -2.8 -0.3
-1.9 2.2 -0.5 -0.4 -0.5 2.8 -4.9 0.3
-0.3 -0.4 -0.4 -1.2 1.0 0.5 2.6 1.5
0.4 -0.9 -0.4 -1.1 1.3 1.9 1.6 -1.6


QDC "Hits" for Event #88965
Y-coordinate of Bar
X-coordinate of Bar

Solutions?

1. Ignore “double” events?

Max TDC diff = 5

```
[68]: print(num_double_events)
      print(total_num_events)
      print(num_double_events / total_num_events)

      15771
      674056
      0.023397165814116334
```

Max TDC diff = 4

```
[78]: print(num_double_events)
      print(total_num_events)
      print(num_double_events / total_num_events)

      34951
      674056
      0.05185177492671232
```

2. If far apart, add separately

3. Generating Calorimeter Images

- Hopefully next week:
  - Step 1: Trying to make a GAN
  - Step 2: Trying to implement normalizing flows
- Got access to Amarel cluster for GPU access

- Question: do different types of events have unique TDC signatures?
  - (If so, this would make the normalizing flow method more robust)
  - Do we have GEANT4 calorimeter images?