After michael have corrected everything, we can relook at the alignment and to see if we can make the data better.

Ah, looks like we've found a new TDC error condition. The event processor is doing a behind-the-scenes event insertion based on the headers it gets to try and account for missing events, and in this data sample at event ~59,500 TDC3 arbitrarily resets its event counter. I've attached the two TDC reads in question - in the first one, TDC3 is at event number 766 (it loops at 1024), and in the next one it has reset itself to 0. Because of this difference, the software inserts a bunch of empty events to try and account for the offset, and the correct offset moves to +256, beyond the range we actually check. I'll modify the processor to cap the max inserted events at 100 for now, but we should keep an eye out for cases where we lose alignment as more strange TDC errors might pop up. We might also need something more sophisticated to check if the counter has reset, as it might reset and introduce a shift <100 or genuinely need to insert >100 events.

**As Michael rightfully said, the statistics needed to be separated from each other distinctively to make sure it is clear what is what, hence we need to plot the histogram of the metric for 1 offset and 2 offsets.**

**A screenshot of a graph

Description automatically generated**

print(find\_tdc\_alignment\_metric(0,1))

print(find\_tdc\_alignment\_metric(0,2))

print(find\_tdc\_alignment\_metric(1,2))

(1, 2, 0, 1)

(3, 0, 3, 0)

(3, 2, 3, 1)

RPC values

0, 1 far apart, because 0 offset metric is not double counting, and misaligned metric are across three different RPCs, where the average distance is larger

For 0, 2 counting cross chamber, So that average distance of 10 is seen.

For 1, 2, makes sense, since you are looking at cross chamber so that the aligned data is larger than 0, 1.

In both cases, it was clear that they creep into each other…

**A graph of a graph

Description automatically generated with medium confidence**

**A graph of a graph showing a wave

Description automatically generated with medium confidence**

A graph of a graph

Description automatically generated with medium confidence

A graph of a sound wave

Description automatically generated with medium confidence

**A graph of a graph

Description automatically generated with medium confidence**

# Did some fixing of how insertion is made

A graph of a graph

Description automatically generated with medium confidence

A graph of different colored lines

Description automatically generated with medium confidence

The small peaks within the unaligned regime were artifacts from the realignment. When realignment occur, the calculation of metric was done before adjustment, leaving behind a unaligned data.

Setting a global 15 is definitely safe. However dynamically adjusting average metric also works.

# Debugged Plots

A screenshot of a graph

Description automatically generated

A graph of a diagram

Description automatically generated with medium confidence

Misalignment at the end for TDC0 and 1 is very weird. This alignment session was done through using a range of 5

A screenshot of a graph

Description automatically generated

A graph of different colored lines

Description automatically generated

A graph of a tower

Description automatically generated with medium confidence