Baseline fluctuation studies for the sPHENIX TPC readout

Luke Legnosky (Stony Brook University),

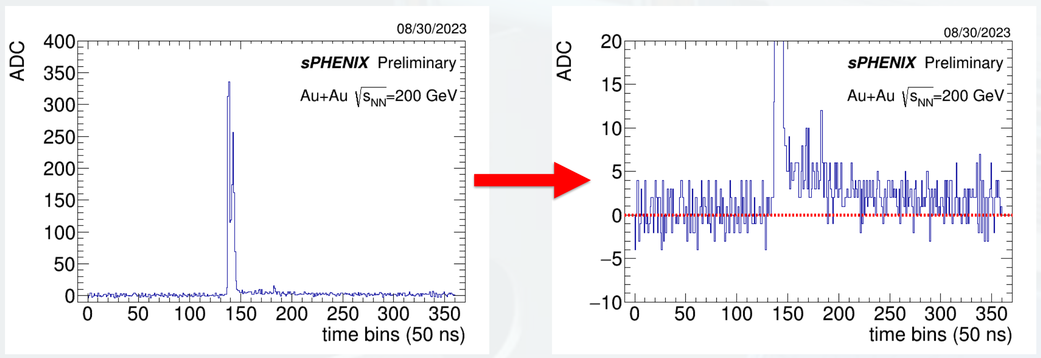
For the sPHENIX Collaboration

Abstract

The sPHENIX TPC readout will use an array of quadruple-stacked gas electron multiplier (GEM) modules to amplify signals from the chamber in order to perform precise tracking measurements. The performance of the system may be affected by a shift in the readout baseline due to event-by-event fluctuations. These fluctuations are a result of the common-mode noise generated in the induction gap of the readout as well as the ion tails on the signals caused by capacitive coupling between the bottom GEM and pad plane of each module. It is important for this baseline shift to be well understood and accounted for to avoid degradation in the tracking performance of the TPC. We will present studies done to investigate the baseline shift of the sPHENIX TPC readout along with the methods used to correct for it.

Motivation

- Ion tails cause lingering shift in pedestal baseline
- High frequency of hits + baseline shift could hinder tracking performance



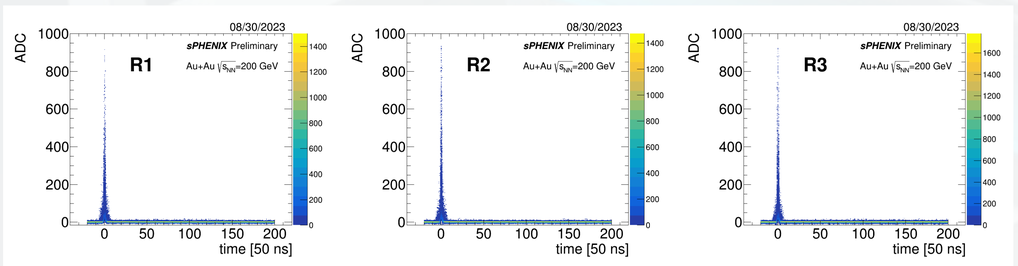
- Ion tails shapes can be used to correct baseline shift at software level
- Easiest to investigate single hit waveforms

Single Hit Waveform Selection

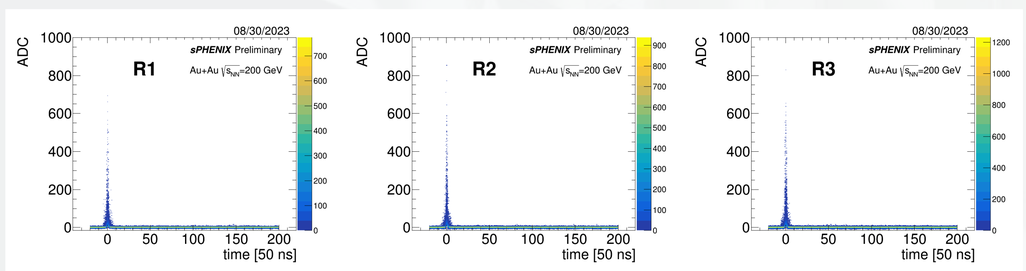
- Hit from single electron cloud will be split between multiple pads (charge sharing)
  - Useful to inspect waveform shape of both max and neighboring pads

<u>Selection Algorithm</u>

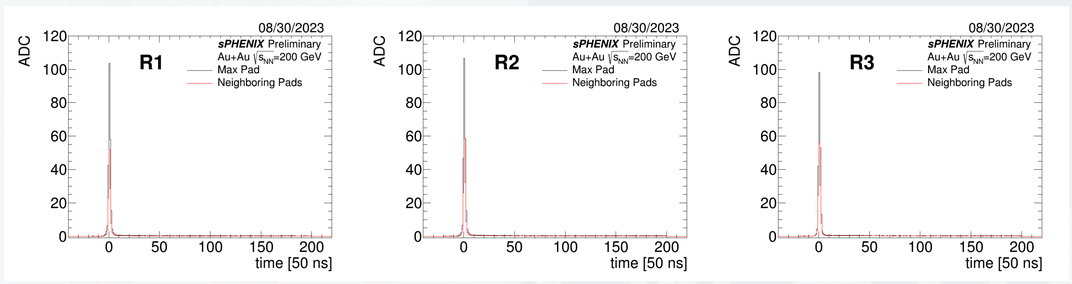
1. Keep waveform if max ADC $\geq 5\sigma$ times the pedestal mean
2. Scan to the left and right of max ADC sample to look for additional peaks
3. Reject if peak count > 1 or max peak width > 20



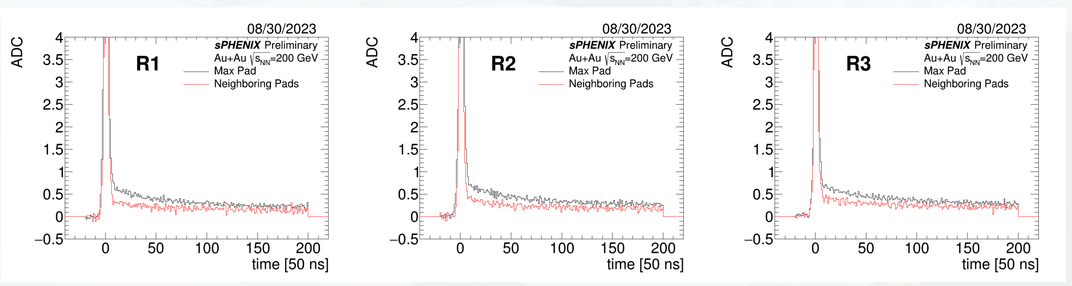
- Max pad (top) and neighboring pad (bottom) waveform distributions (All peaks centered around zero & pedestal subtracted from each sample)



Ion Tail Shape



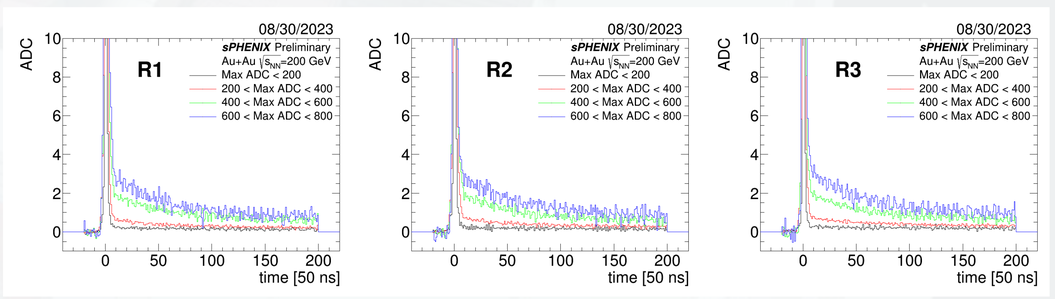
- Averaged waveforms of max and neighboring pads (ADC values averaged at each time bin of 2D histograms)



- Profiles of max and neighboring pad zoomed in on ion tails region
- Ion tails of max and neighboring pads may have similar shapes
  - ➢ Results still inconclusive

Dependency on Max ADC

- Investigated effects of max ADC on ion tail shape
- Selection algorithm was kept the same except waveforms were parsed into different max ADC ranges



- Averaged max pad waveforms divided by max ADC (ADC values averaged at each time bin)
  - ➢ Ion tail decay time appears to grow with max ADC of waveform
  - ➢ Functional forms of each ion tail under investigation

Summary and Outlook

- Ion tails of single hit waveforms may have similar functional forms for max and neighboring pads
- Decay time of the ion tails may vary as a function of max ADC
- Studies ongoing to further develop these results
- Also investigating baseline shift effects in multi-hit waveforms and next-to-nearest neighbors of max pads

U.S. DEPARTMENT OF ENERGY | Office of Science
Stony Brook University
Brookhaven National Laboratory