Pileup studies in run 8 data

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Aim

- Study frequency and effect of
  - Close pileup (narrow window around mean trigger time)
  - Distant pileup
- Develop a BmnRoot task providing the information about pileup events (time to closest hits in BC, probability of second interaction, etc.)
- Data: Xe+CsI @ 3.8A GeV (production 04.24)

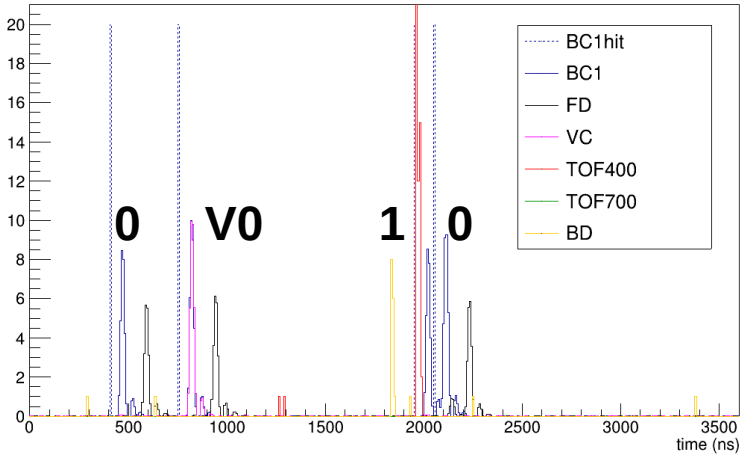
Report on close pileup at CM

Analysis procedure

- Define run-by-run trigger window
- Define run-by-run time windows for peak search in FD and VCS (relative to BC1S hit time)
- Collect run-by-run distributions of FD peaks outside the trigger window (mostly Xe) and single VCS peaks

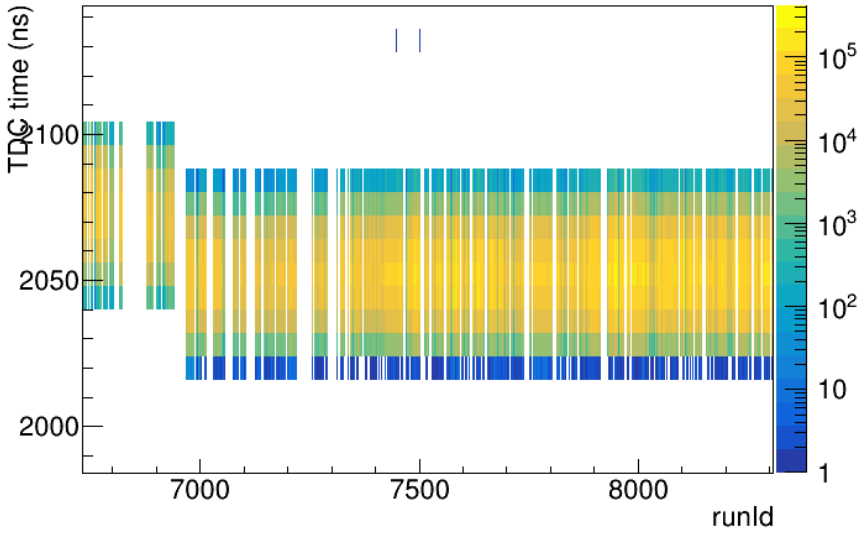
Analysis procedure

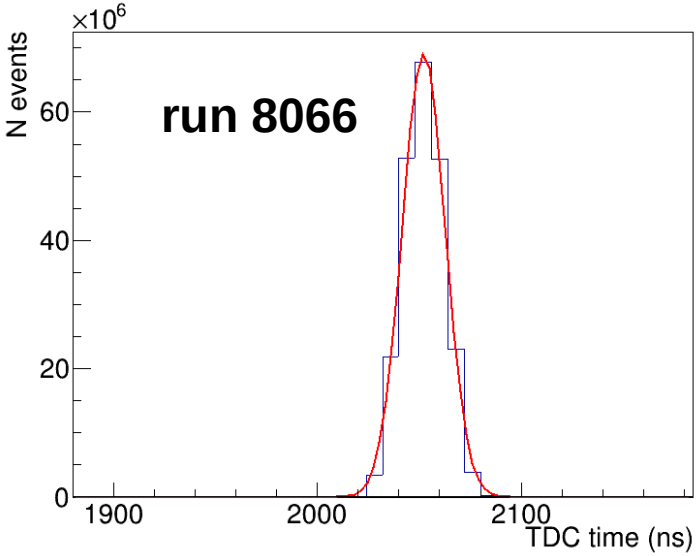
- For every hit in BC1S define the type based on corresponding peaks in FD ans VCS:
  - No interaction (**0**)
  - Interaction (**1**)
  - No interaction + VCS peak (**V0**)
  - Interaction + VCS peak (**V1**)



- Estimate the effect of pileup on digitized and reconstructed data from fast (TOF400, TOF700) and slow (SILICON, GEM) detectors

Single BC1S hit time

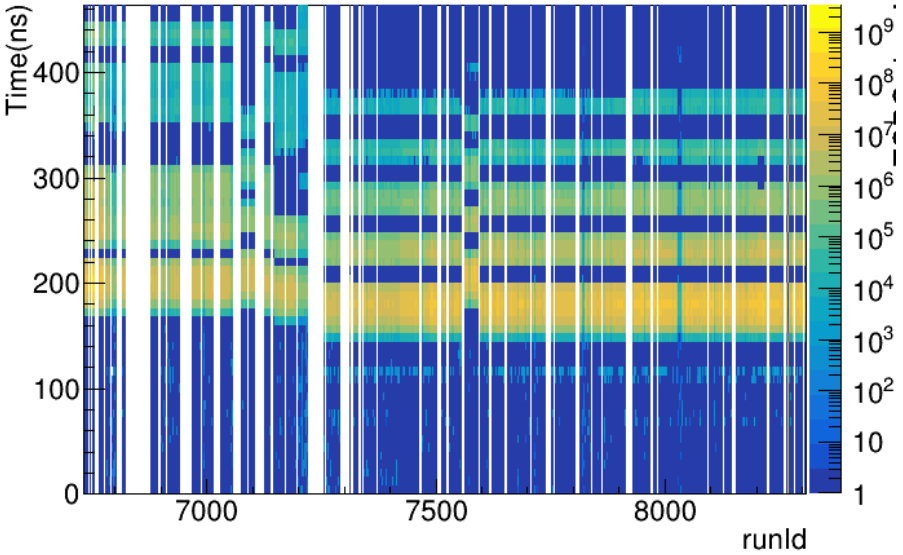


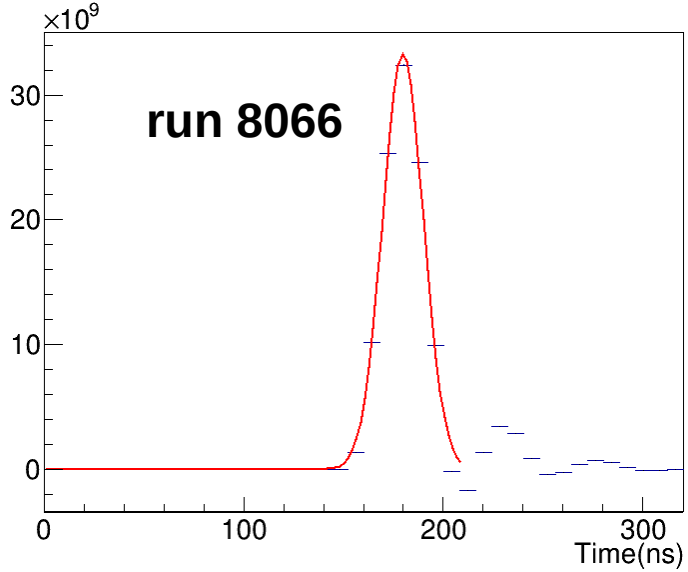


Hit in BC1S closest to mean is considered to be the trigger one

Signal shape relative to single BC1S hit time

FD

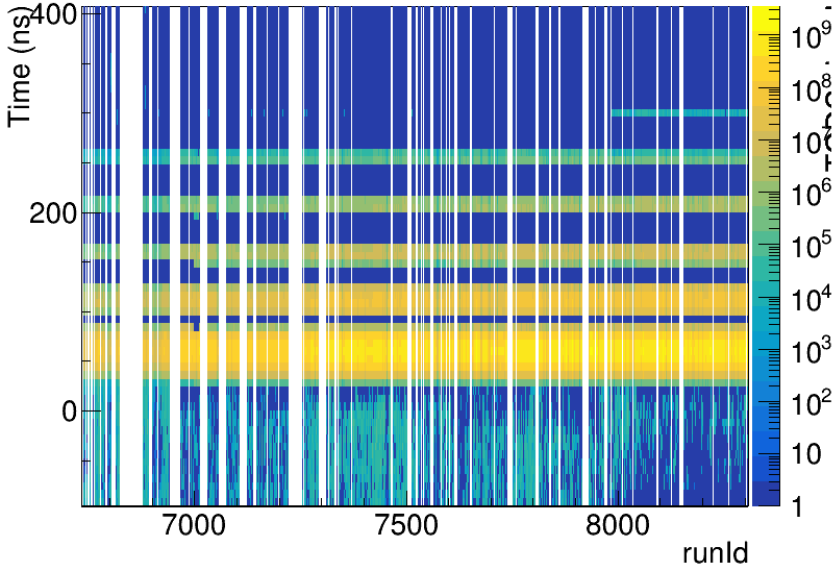


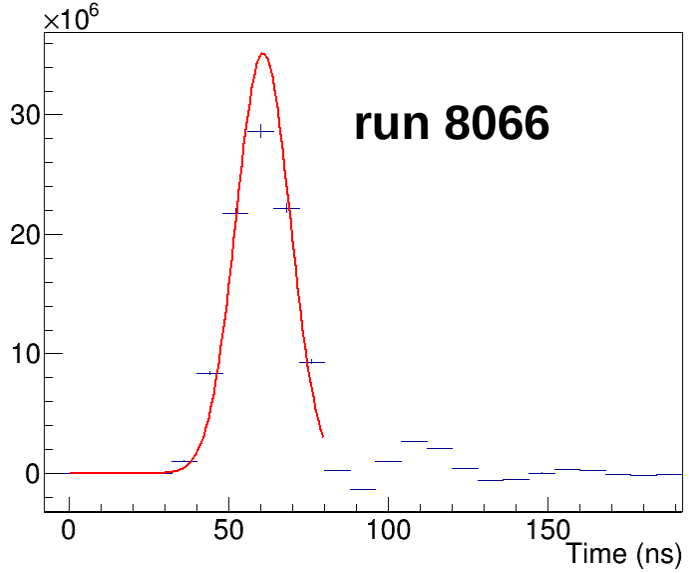


Peak is collected in mean +/- 2 sigma time from BC1S hit time

Signal shape relative to single BC1S hit time

VCS

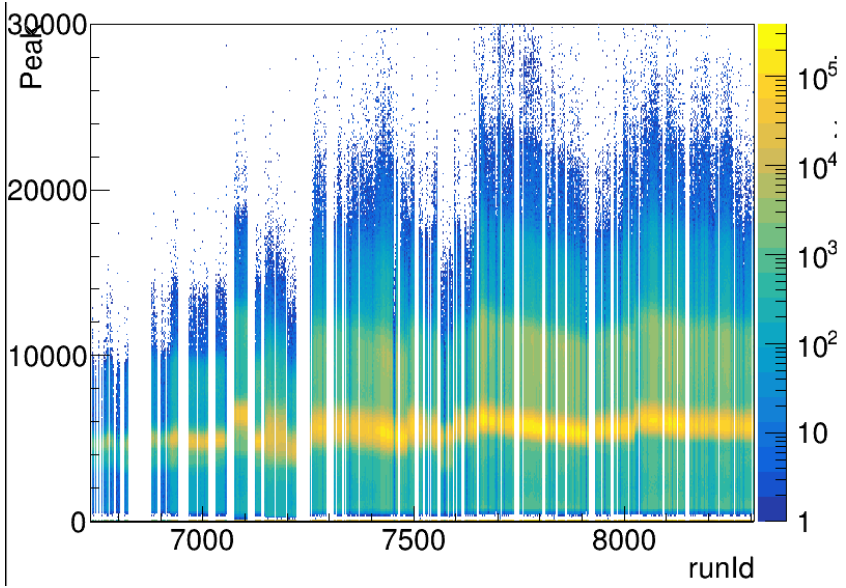


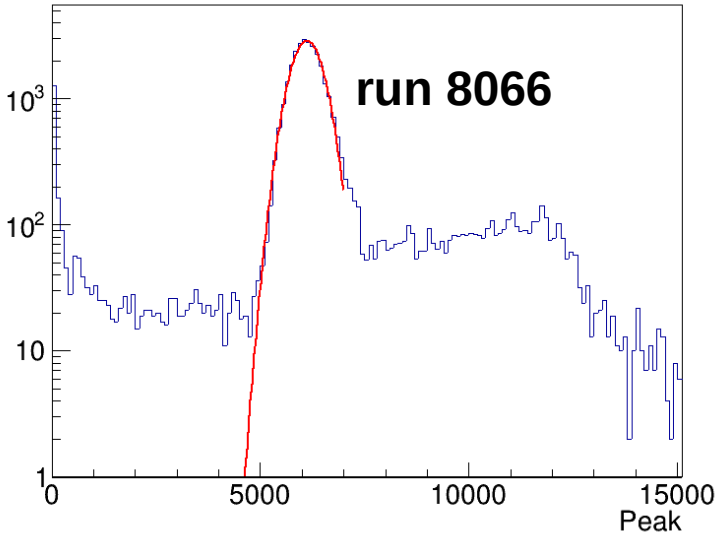


Peak is collected in mean +/- 2 sigma time from BC1S hit time

Peak distributions

FD (non-trigger only)

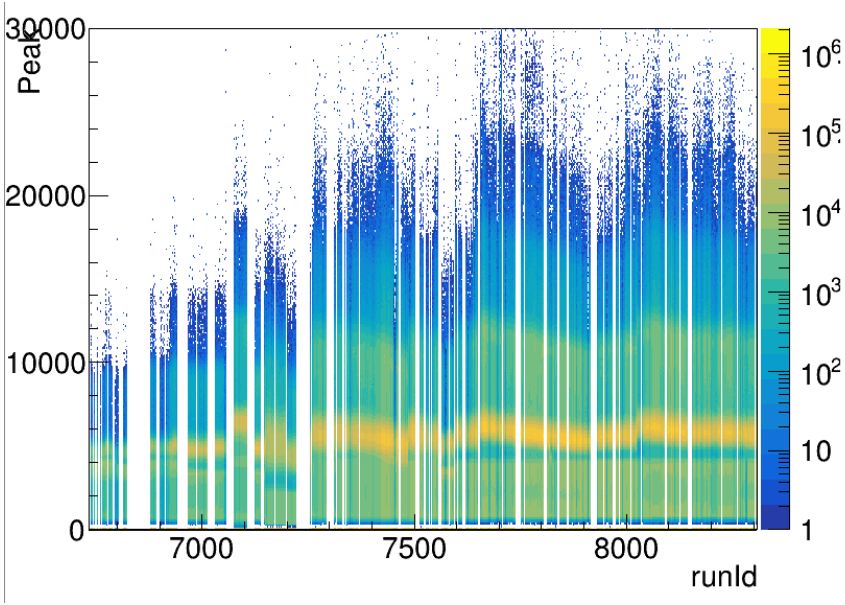


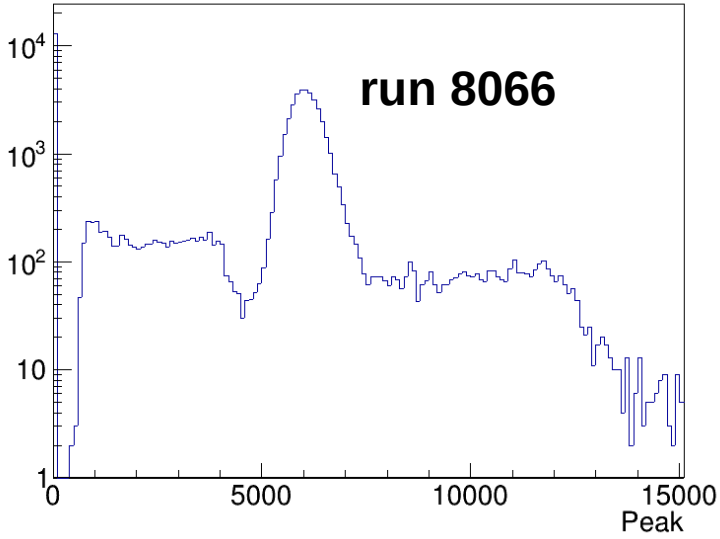


No interaction if peak is inside mean +/- 3 sigma

Peak distributions

FD (all)

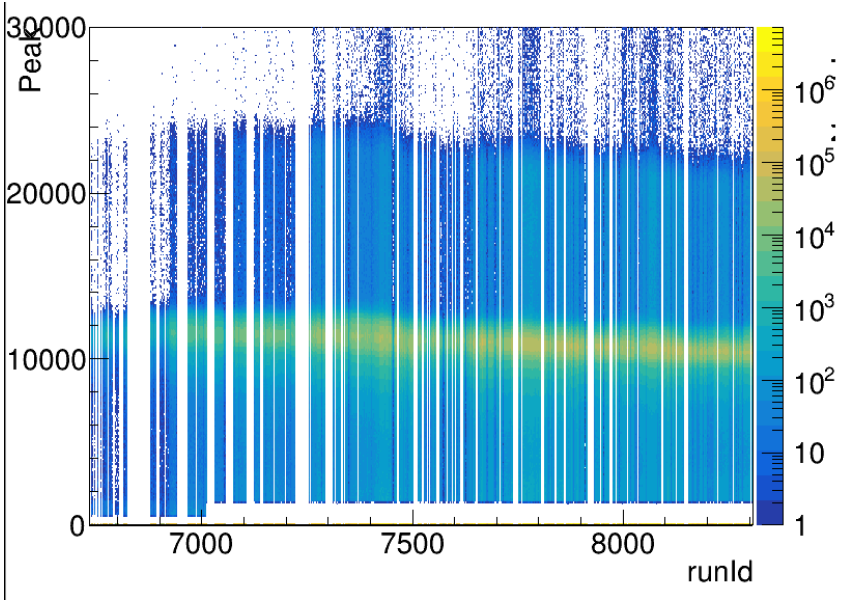


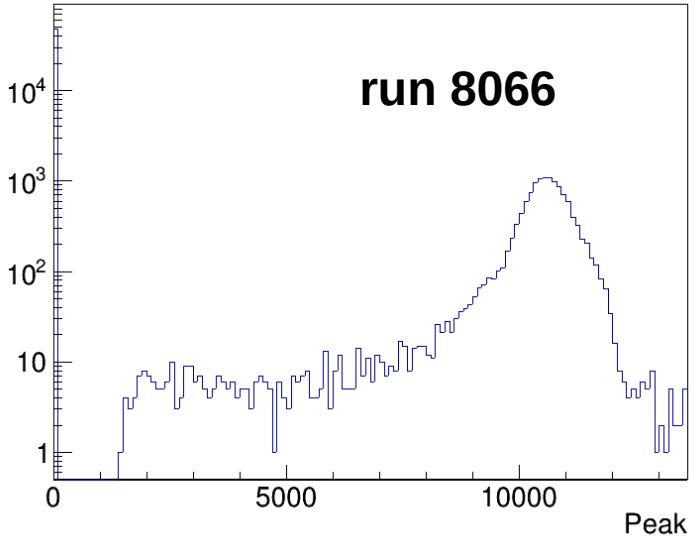


No interaction if peak is inside mean +/- 3 sigma

Peak distributions

VCS





Peak less than 500 is considered as absense of veto signal

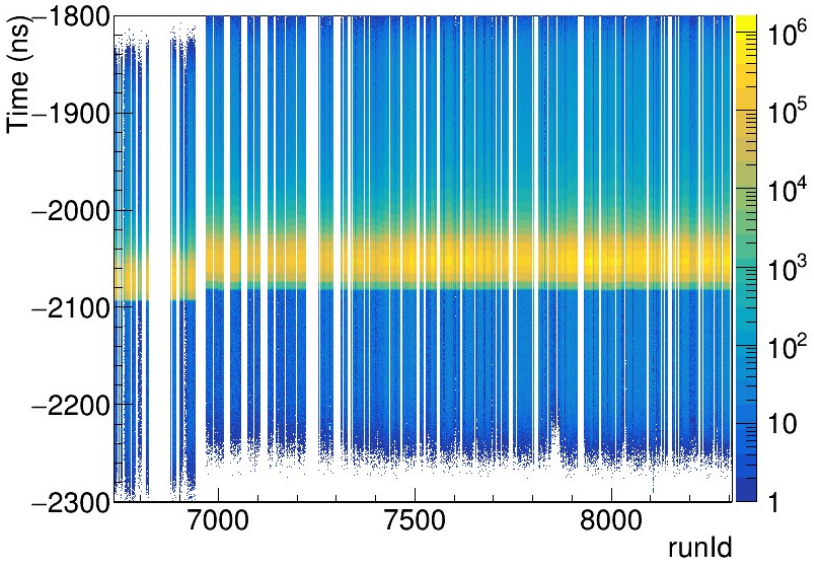
Effect of pileup at digitized data level

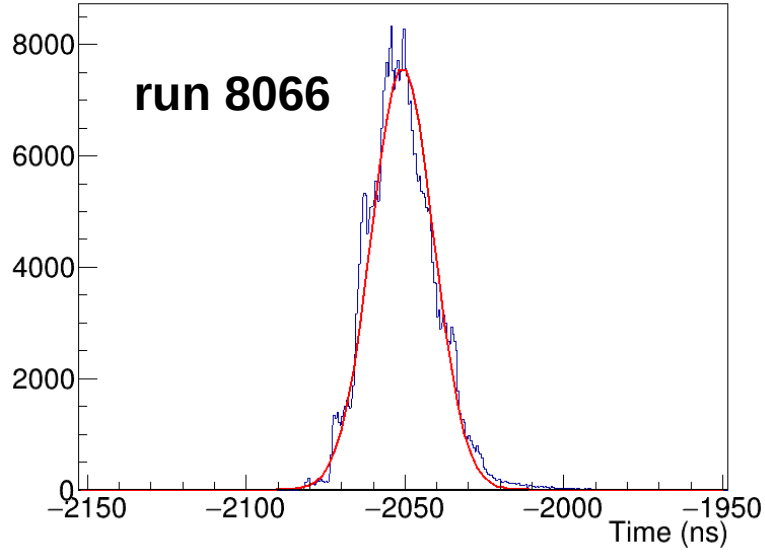
- Choose events with 2 hits in BC1S (runs 7596-8304)
- Define trigger hit as closest to mean time for single BC1S events.
- For different event types plot mean number of digits/hits/tracks as a function of distance from additional to trigger hit for:
  - “Fast” detectors (TOF400, TOF700)*.
  - “Slow” detectors (SILICON, GEM)
- Compare the values with those for events with single hit in BC1S.

* digits and hits are counted in a defined (run-by-run) window relative to BC1S hit time

Digit time distributions

TOF700

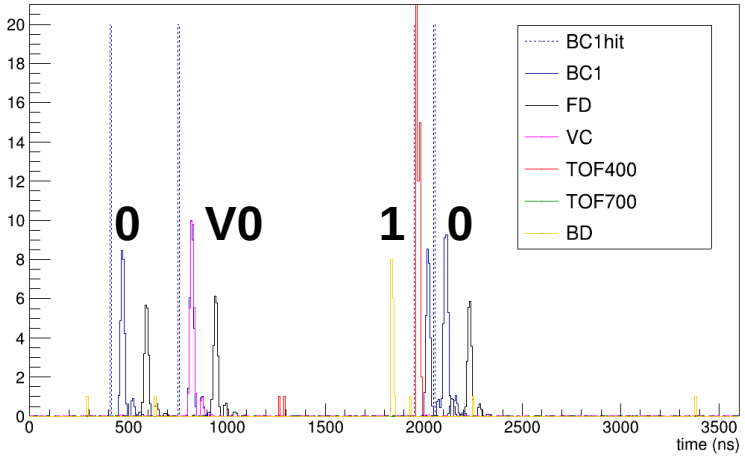




TOF digits and hits are collected in mean +/- 3 sigma time from BC1S hit

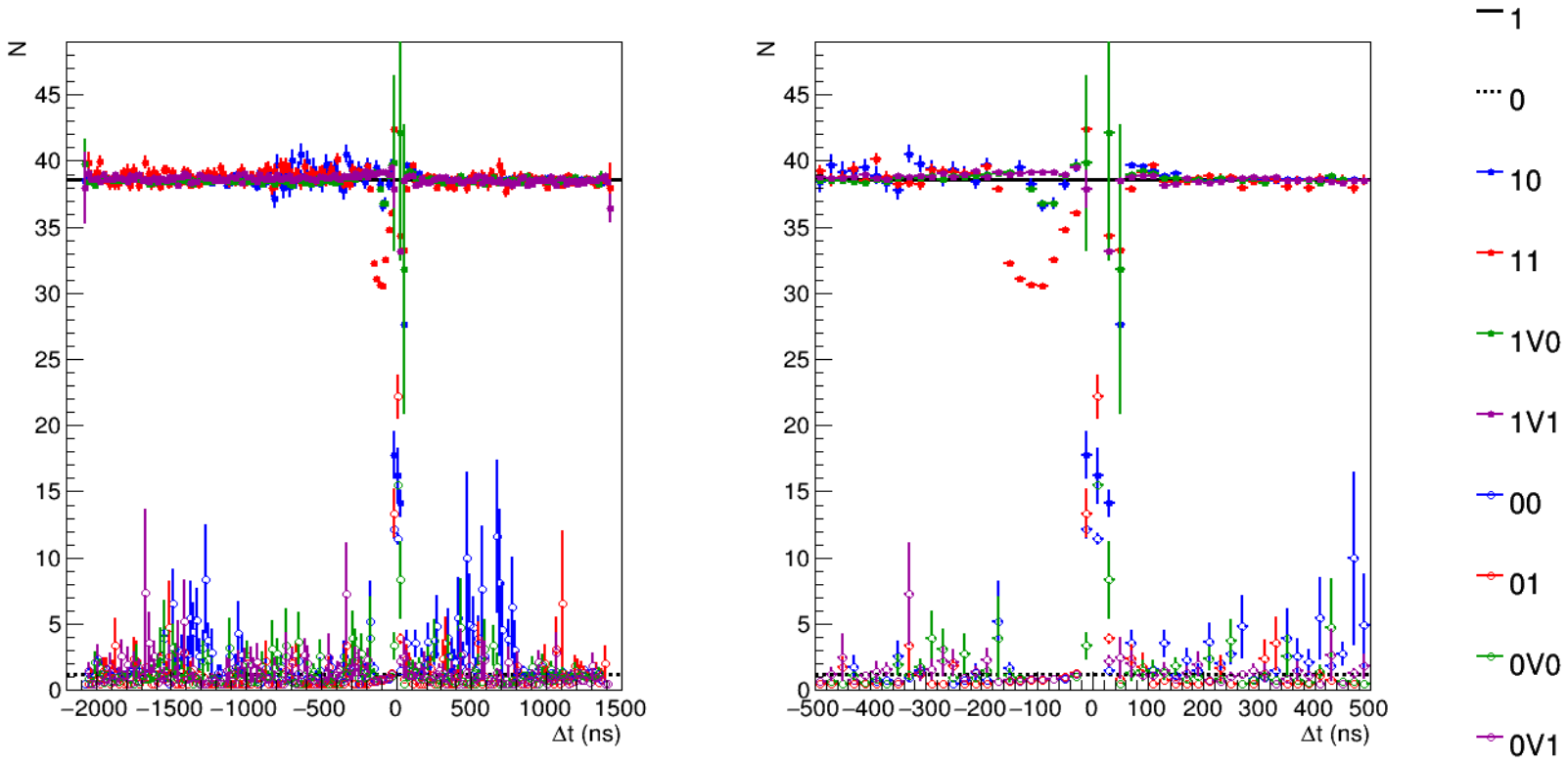
BC1S and event types

- BC1S hit type is defined based on corresponding peaks in FD ans VCS:
  - No interaction (**0**)
  - Interaction (**1**)
  - No interaction + VCS peak (**V0**)
  - Interaction + VCS peak (**V1**)



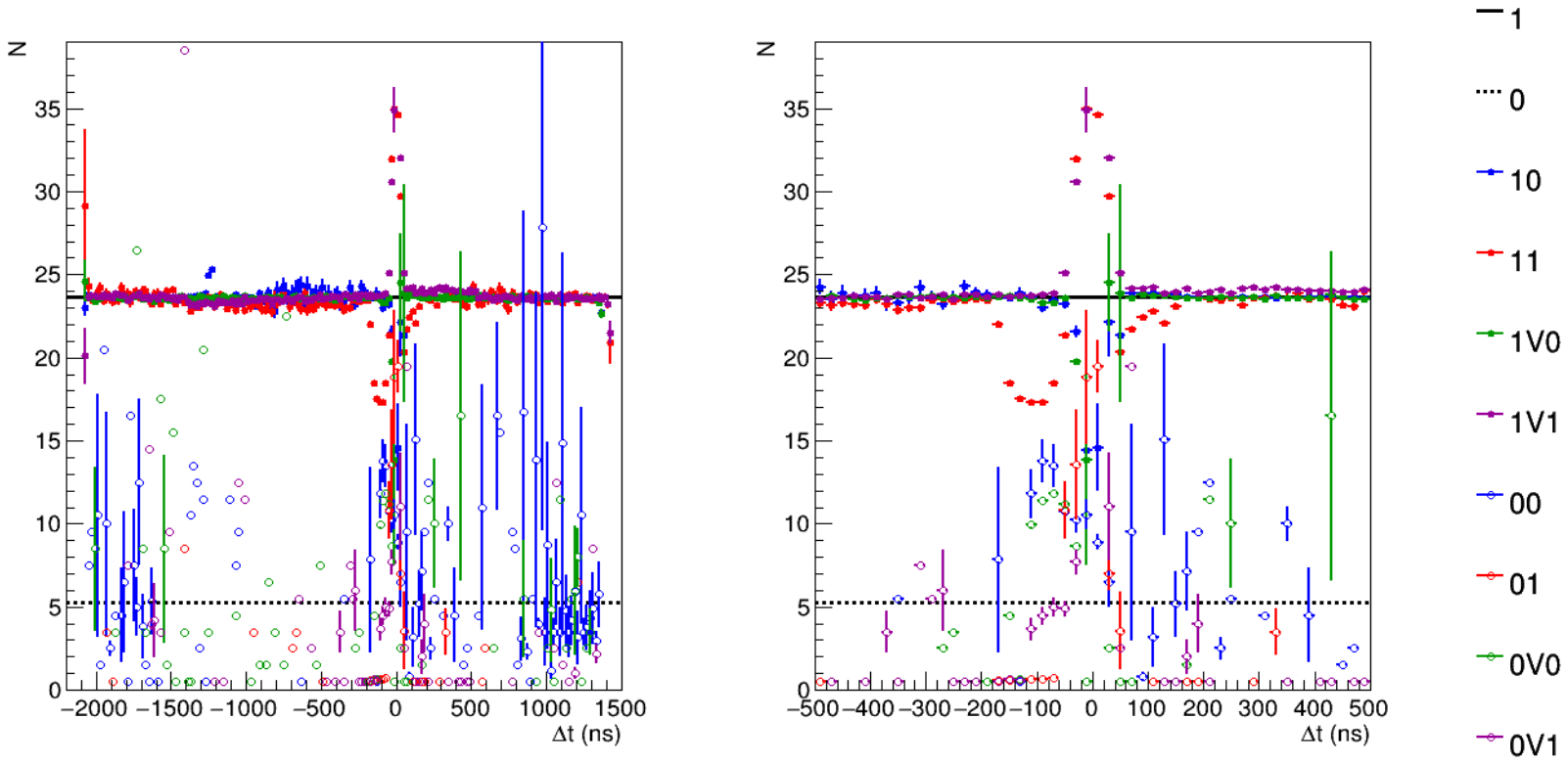
- Events with 1 hit in BC1S are assigned its type
- Events with 2 hits in BC1S are assigned a type based on type of trigger and additional hits (e.g. **1V0**).

Effect of pileup on TOF 400 digits



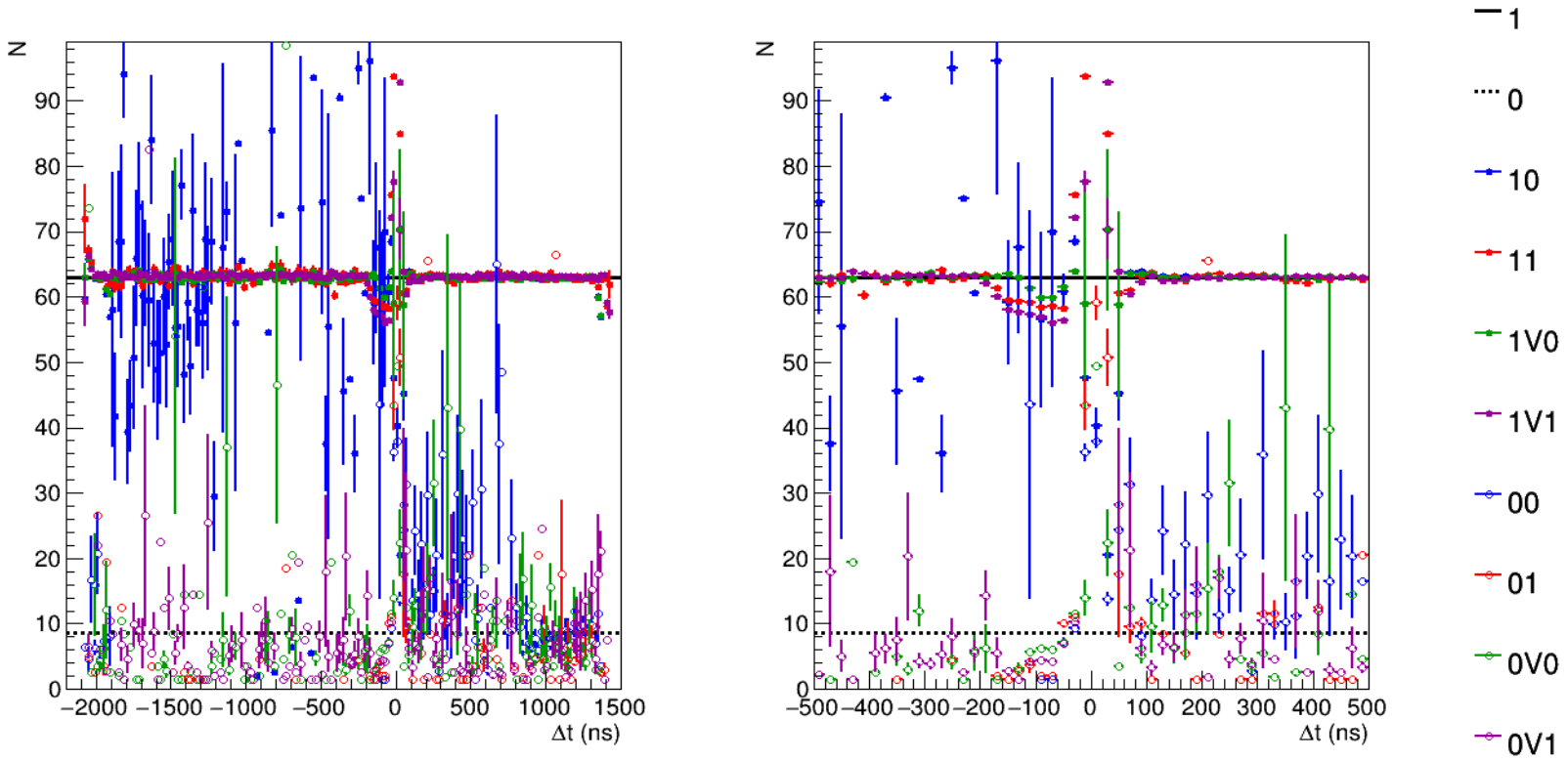
Significant effect at ~200 ns from trigger hit even without additional interaction

Effect of pileup on TOF 400 hits



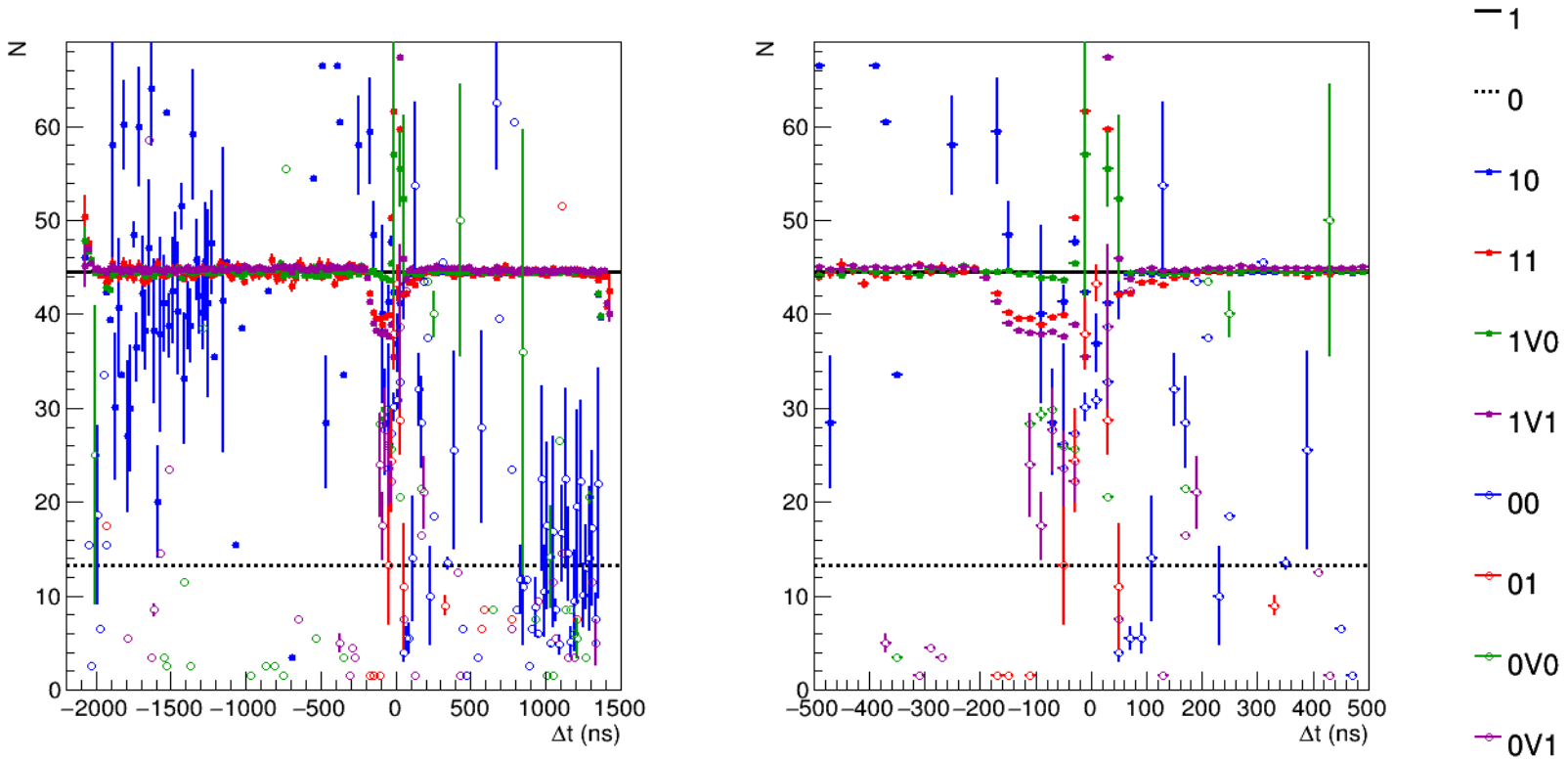
Significant effect at ~200 ns from trigger hit even without additional interaction

Effect of pileup on TOF 700 digits



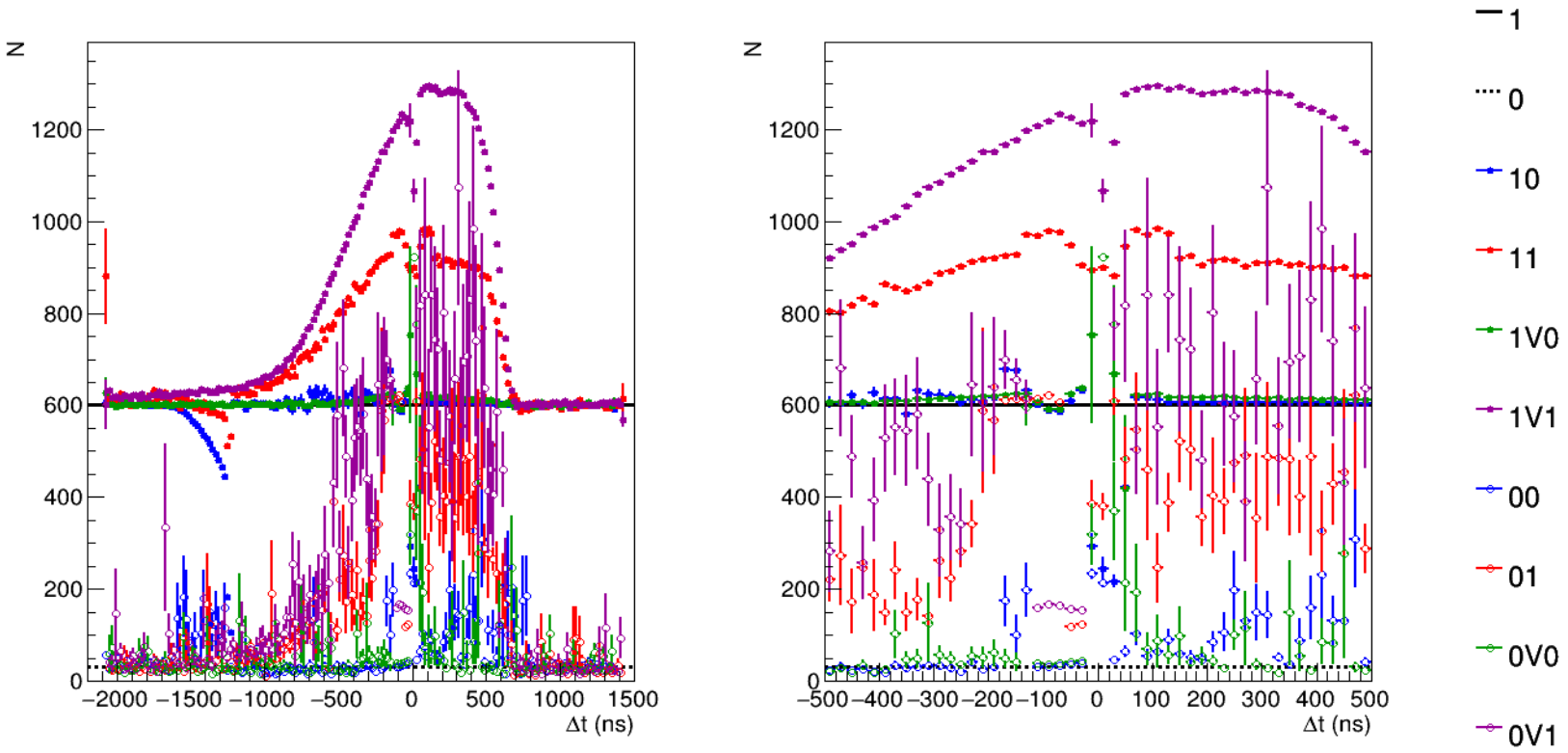
- Significant effect at ~200 ns from trigger hit even without additional interaction
- Hope for improvement in 10 class with the new data production

Effect of pileup on TOF 700 digits



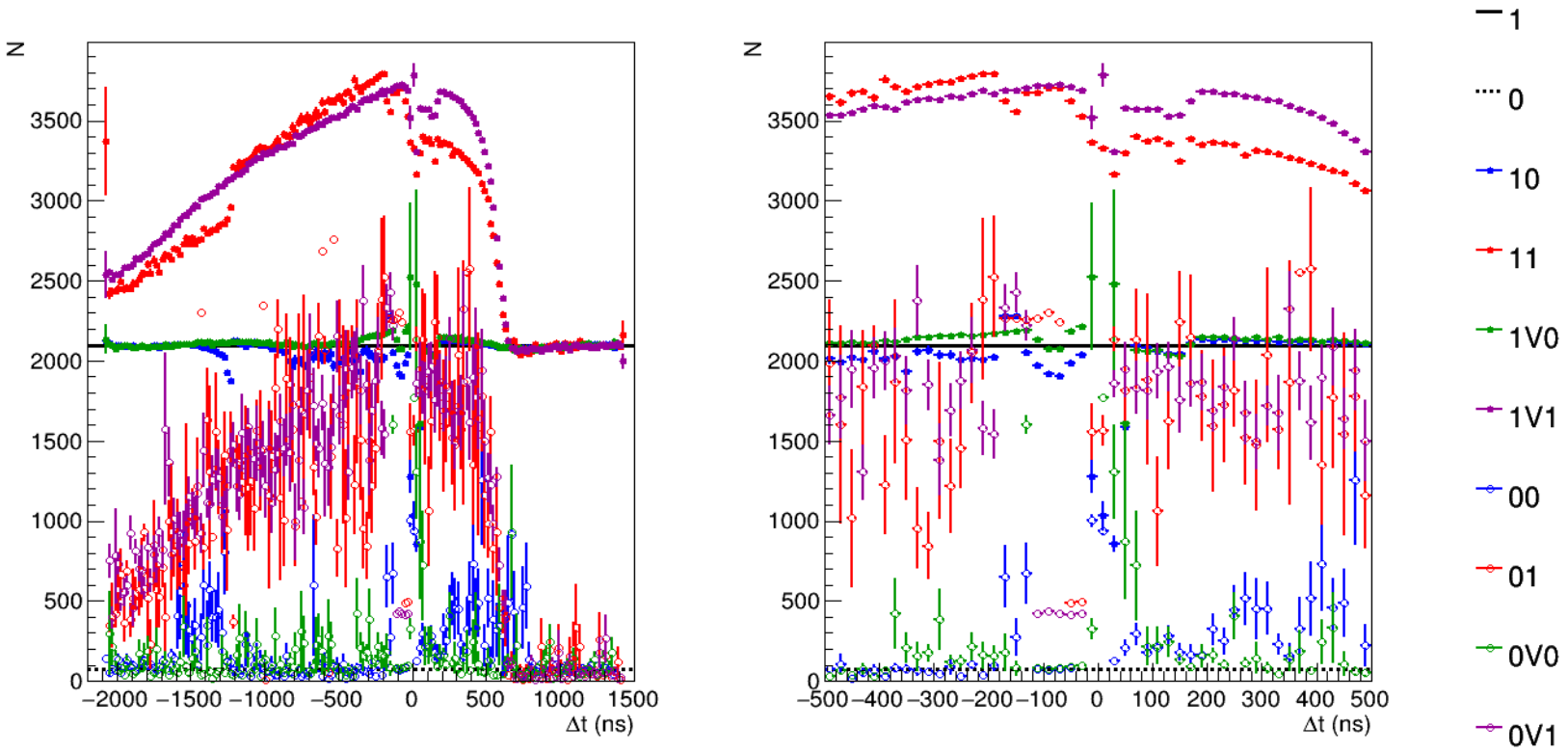
- Significant effect at ~200 ns from trigger hit even without additional interaction
- Hope for improvement in 10 class with the new data production

Effect of pileup on SILICON



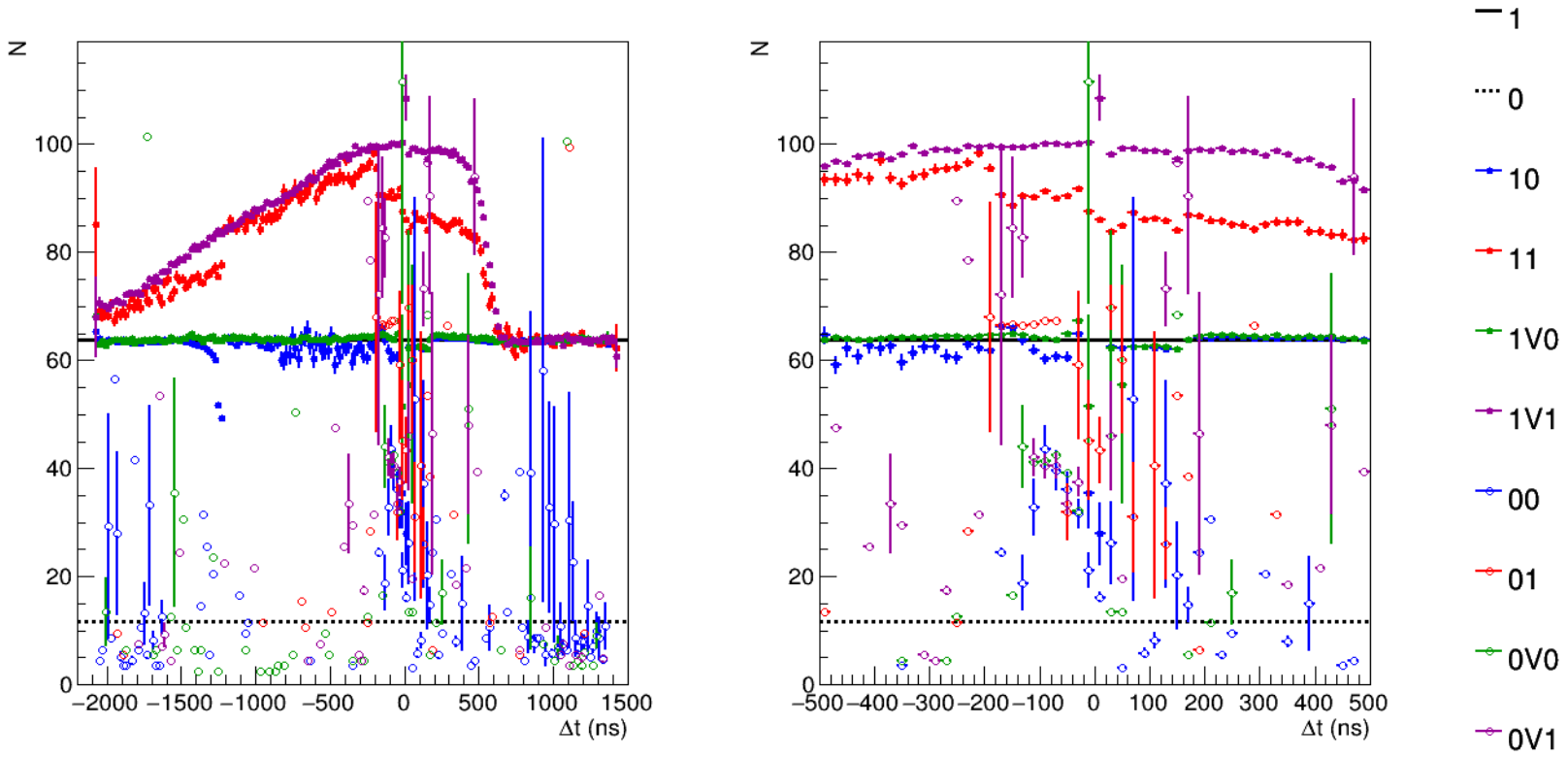
- Significant effect at ~100 ns from trigger hit even without additional interaction
- Significant long-range effect in case of additional interaction

Effect of pileup on GEM



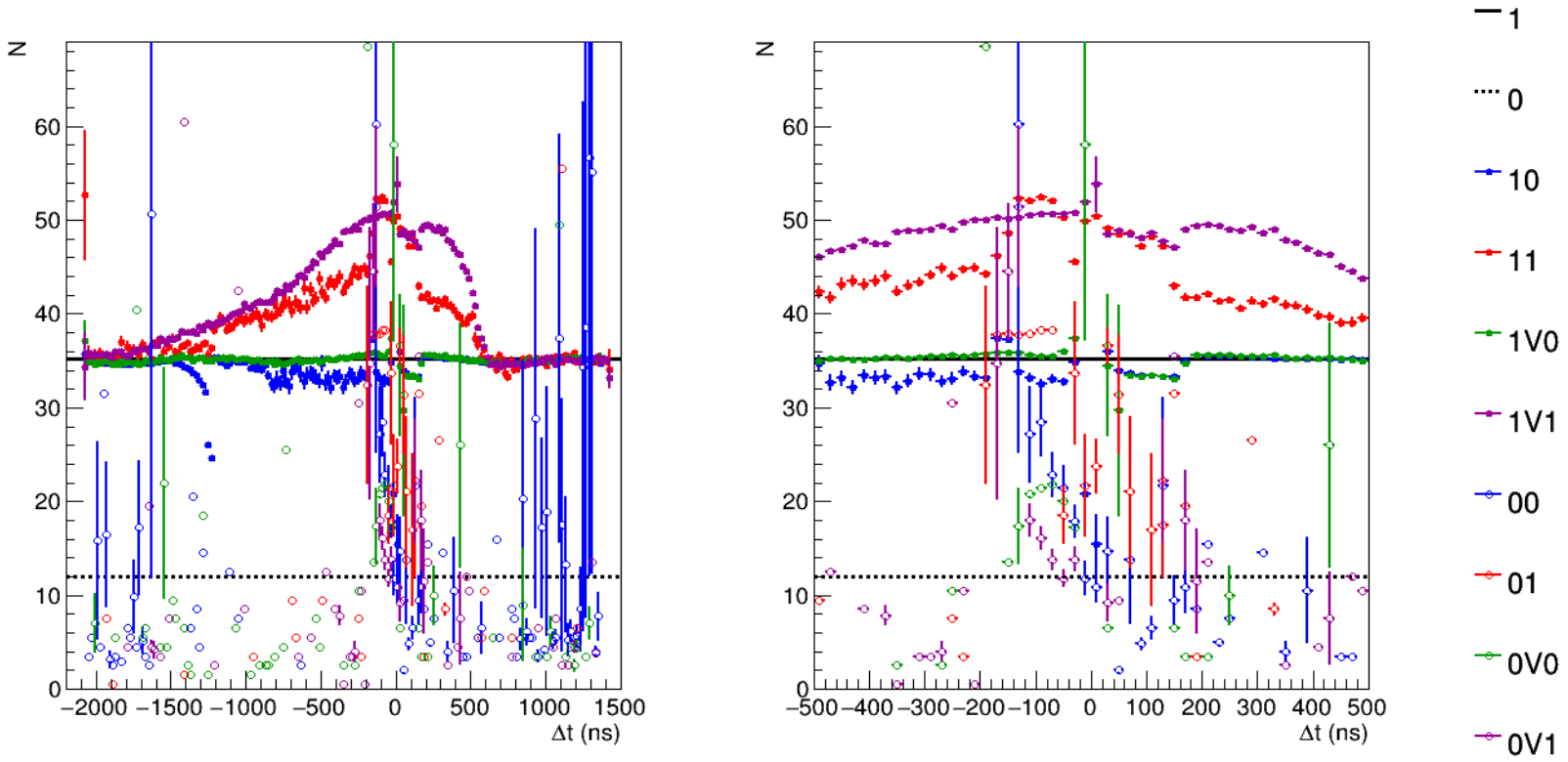
- Significant effect at ~200 ns from trigger hit even without additional interaction
- Significant long-range effect in case of additional interaction

Effect of pileup on tracks



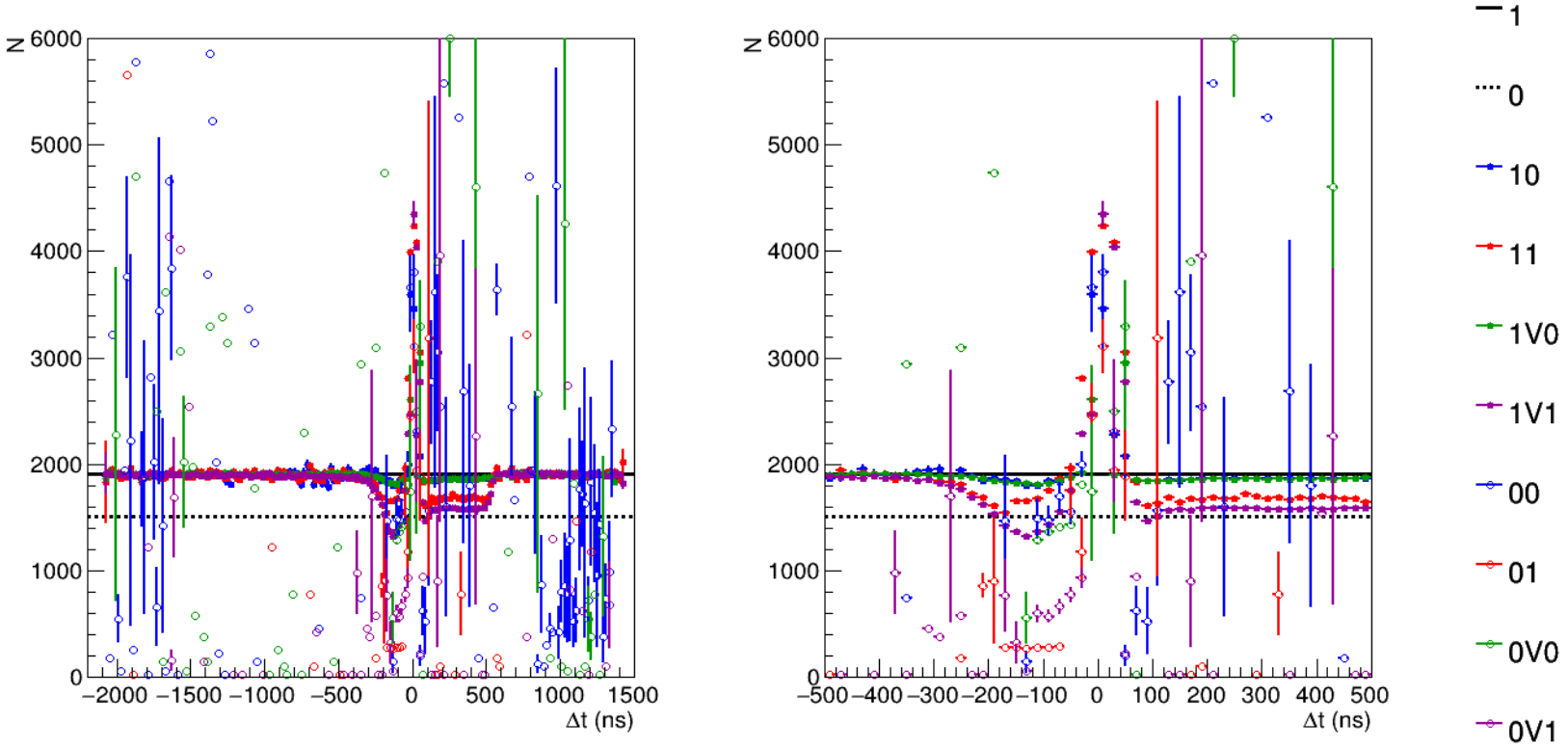
- Significant effect at ~200 ns from trigger hit even without additional interaction
- Significant long-range effect in case of additional interaction

Effect of pileup on selected tracks



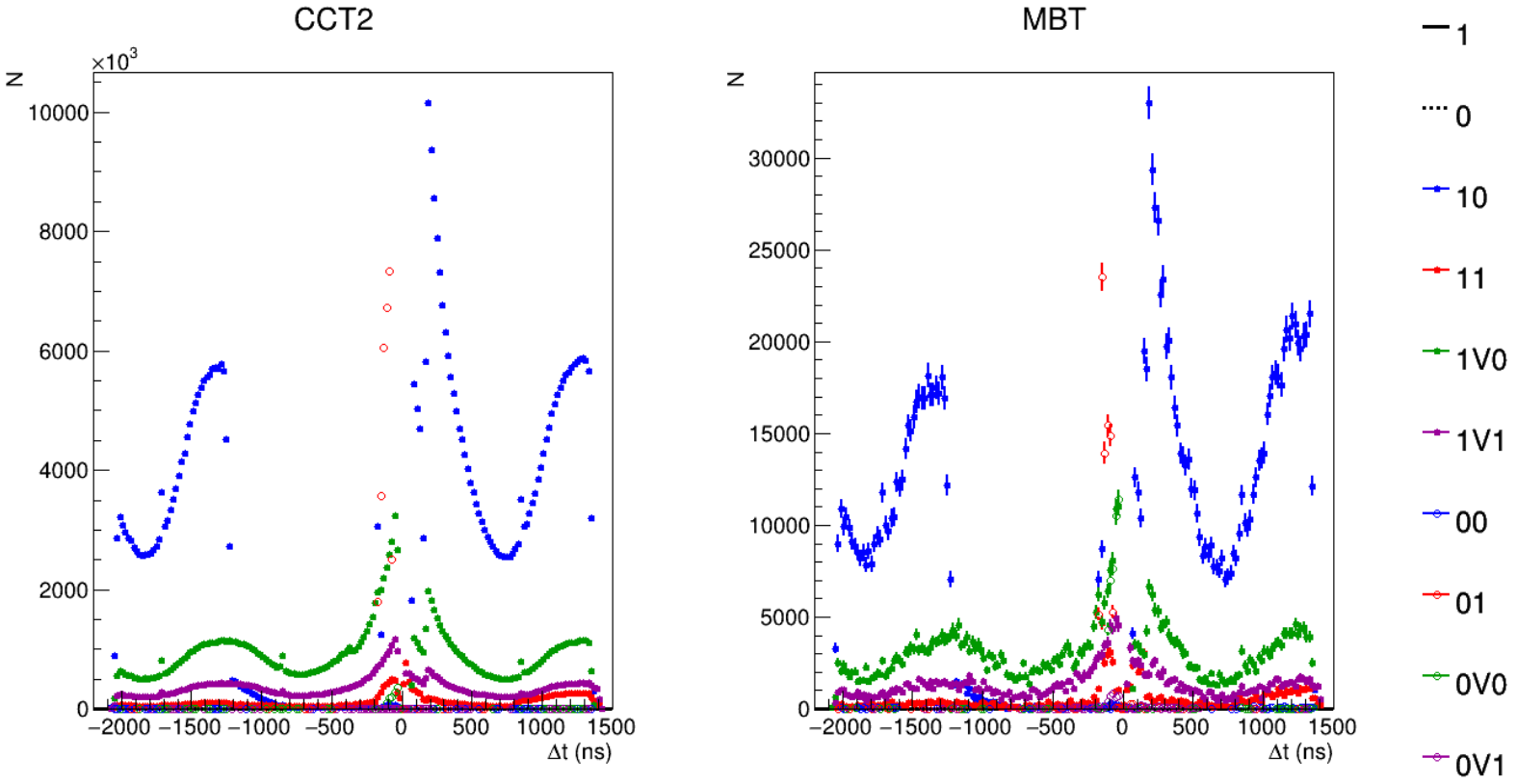
- Significant effect at ~200 ns from trigger hit even without additional interaction
- Long-range effect is smaller but still significant

Effect of pileup on FHCal (24 central modules)



- Significant effect at ~200 ns from trigger hit even without additional interaction
- Long-range effect up to ~600 ns

Number of double-hit events



BmnRoot task for event classification

- Collects run-by-run distributions to obtain needed constants
- Based on run-by-run constants calculates peaks and defines classes of BC1S hits in event
- Provides time distances (positive and negative) from trigger to the closest hits of selected class
- Creates additional branch with variables:
  - Index of trigger hit in BC1S
  - For every hit in BC1S
    - Hit class
    - Time distance to trigger hit
    - Corresponding FD and VCS peak values
    - Number and amplitude sum of BD digits
    - Number of TOF400 and TOF700 digits

Summary

- BmnRoot task for classification of pileup events has been created and tested. Suggestions for improvement are welcome. Consider adding to production chain?
- Significant effect on digitized and reconstructed data of additional hit in BC1S without interaction at ~200 ns from trigger
- Short-range effect on “fast” detectors in case of additional interaction
- Long-range effect on “slow” detectors in case of additional interaction. Still part of muli-hit events may be used.