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PILE-UP EVENT IDENTIFICATION AND REJECTION IN SNO+: ENHANCING THE SIGNAL TO NOISE RATIO

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Pile-up events

- What are they?
  - When two events happen in the same time window they are reconstructed as a single event
- Why is it important to study these events:
  - Separate events with energy lower than the ROI can be reconstructed as having more than 0.5/0.7 MeV.
  - The original and reconstructed position can be different

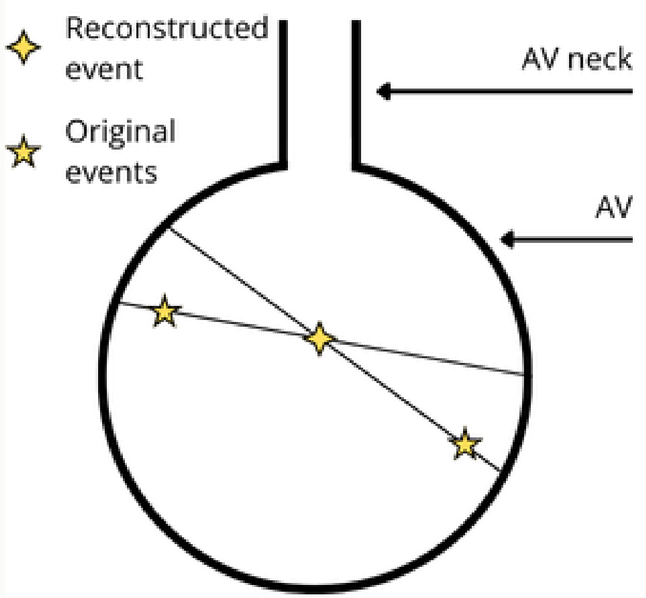


Fig.1 -Schematic of a pile-up event

Pile-up analysis

- First step is to identify a set of variables that help rejecting pile-up events:
  - beta14
  - nearAV
- Then perform an analysis of the effect of these variables on MC and evaluate the survival ratio
- Finally apply the variables to the data an observe their effect

Survival fraction

- To reject pile-up events we applied:
  - beta14 < 0.1
  - nearAV > 0.3
- The effect of these cuts on single events is small

Isotopes	FV3300	FV4500
^{210}Bi	0.999906	0.999407
^{210}Po	1	1
^{234}mPa	0.999974	0.999778
$^{130}Te0\nu2\beta$	1	0.999999

Table.1 -Survival fraction between single events with beta14 < 0.1 and nearAV > 0.3 and the total number of single events, all with energy > 0.7 MeV

Results

- Applied the cuts to the SNO+ scintillator data
  - Removes mainly pile-up events of Bi210 and Po210, as desired
  - Keeps single events

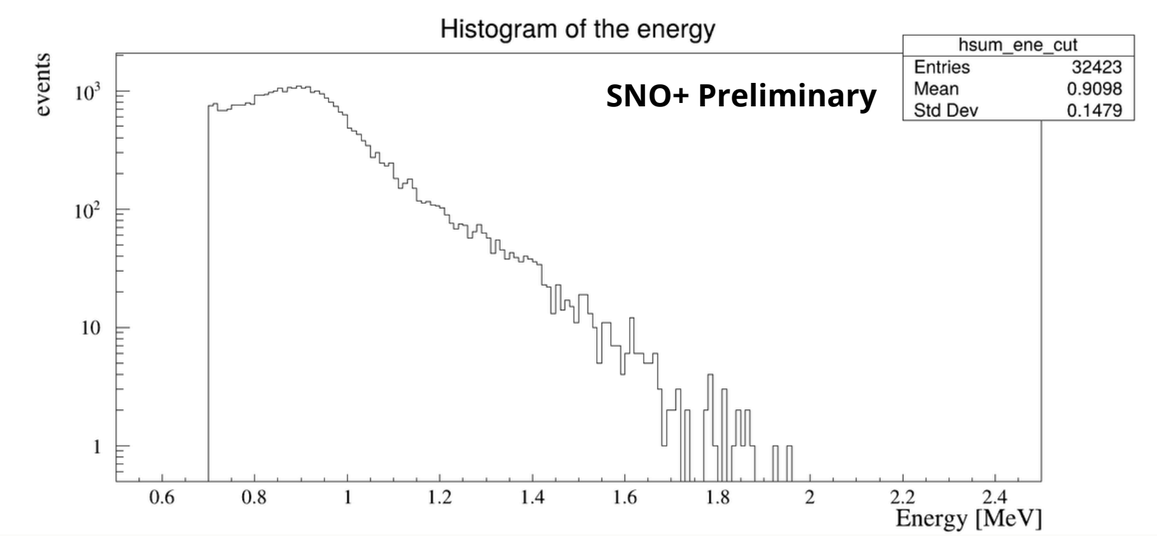


Fig.2 -Histogram of events removed by the pile-up cuts for the FV of 3.3 m

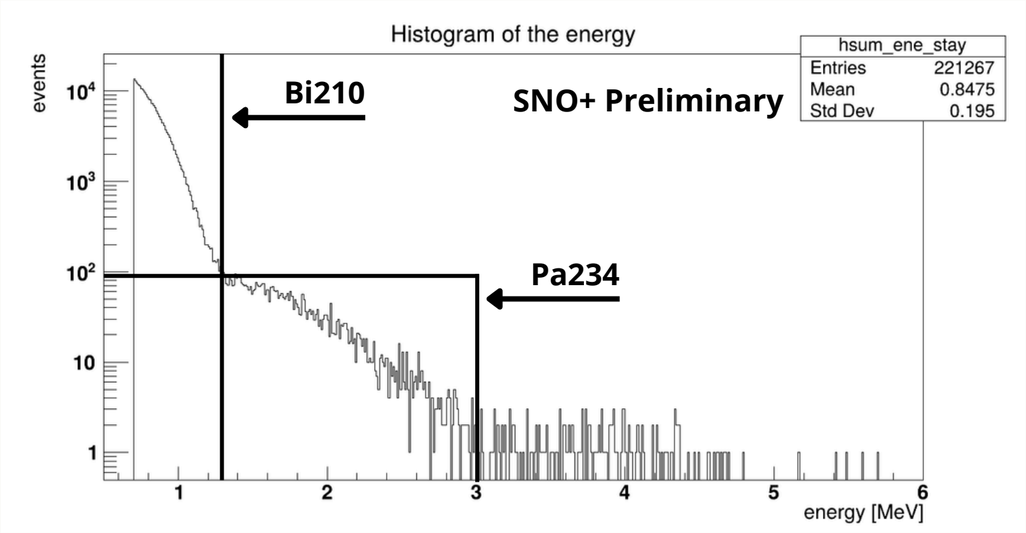


Fig.3 -Histogram of events left after pile-up cuts for the FV of 3.3 m

Conclusion

- The cuts that optimize the rejection by minimizing the sacrifice were: beta14< 0.1 and nearAV> 0.3
- Next steps include a detailed analysis of events identified as pile-up and compare the results to expectation

Thank you!

Backup- beta14 MC simulation

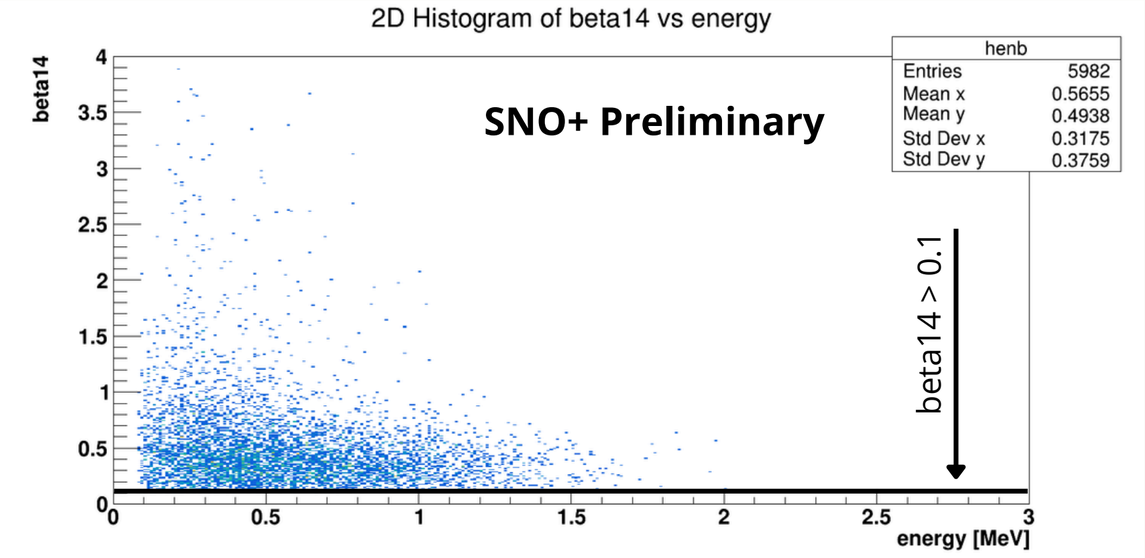


Fig.4 -2D histogram of beta14 vs energy of pile-up between Bi210 on the AV surface with another Bi210 (*) for the FV of 3300 mm

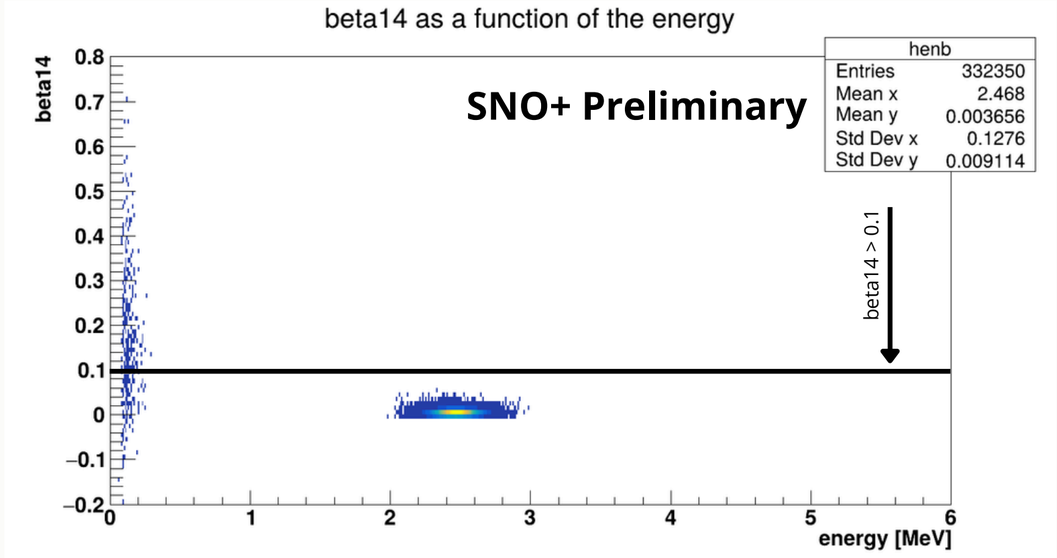
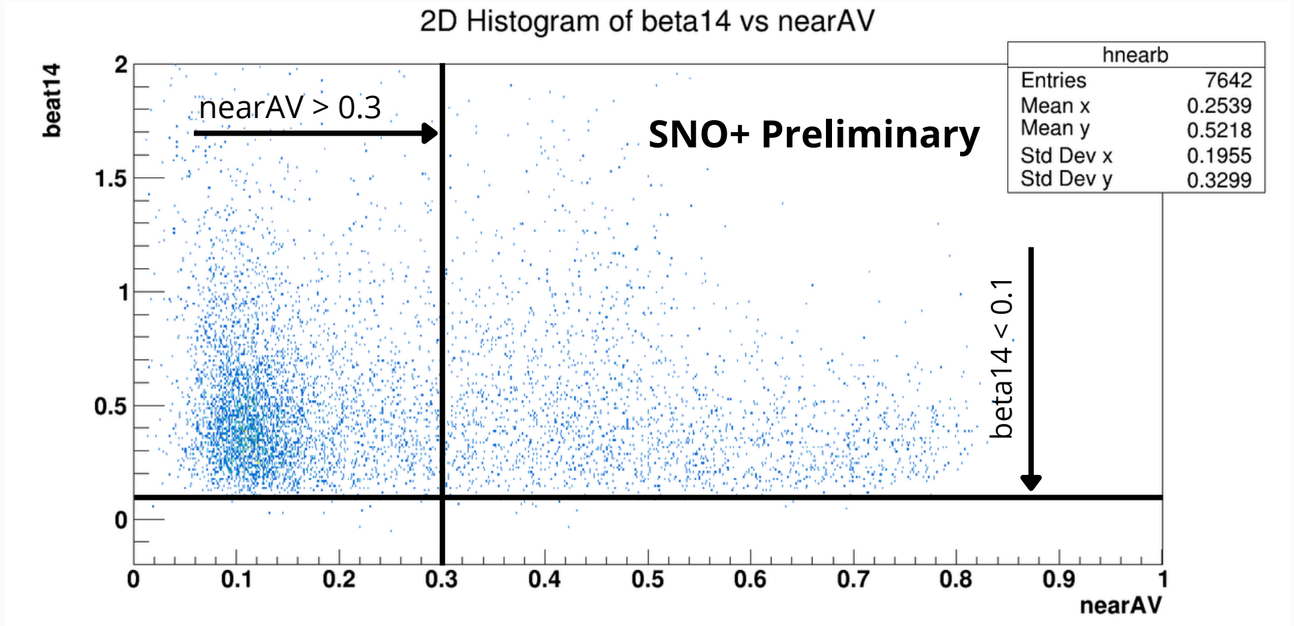


Fig.5 -2D histogram of beta14 vs energy for the single events of Te130 for the FV of 3300 mm

*Despite expecting no events to be present in the FV of 3.3 m, we can see that those events exist

Backup- nearAV MC simulation

- For smaller FV: an additional cut on nearAV barely improves pile-up rejection



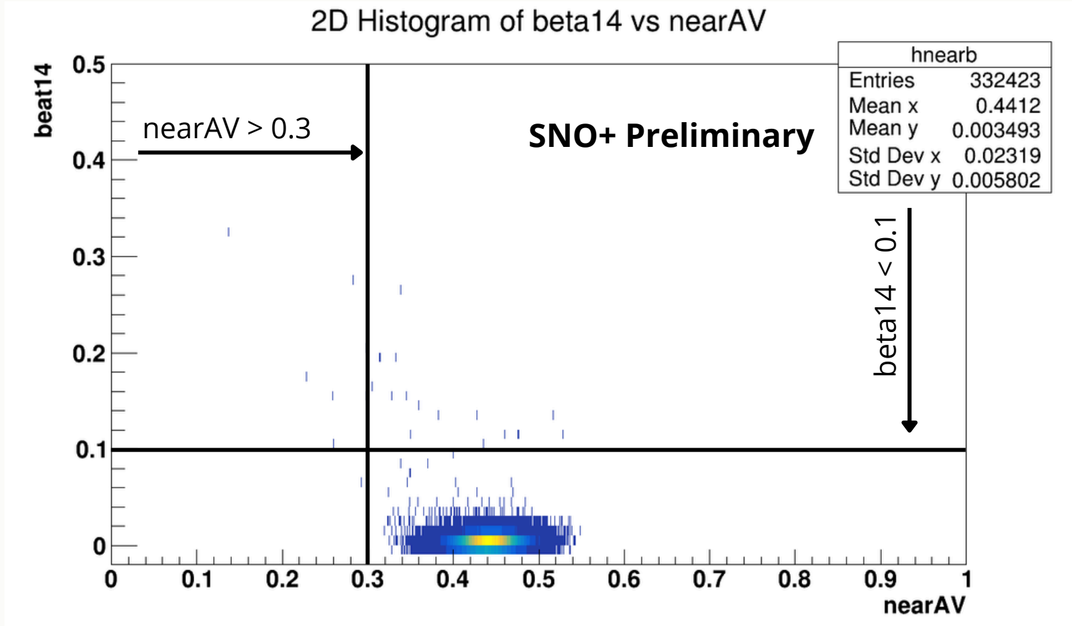
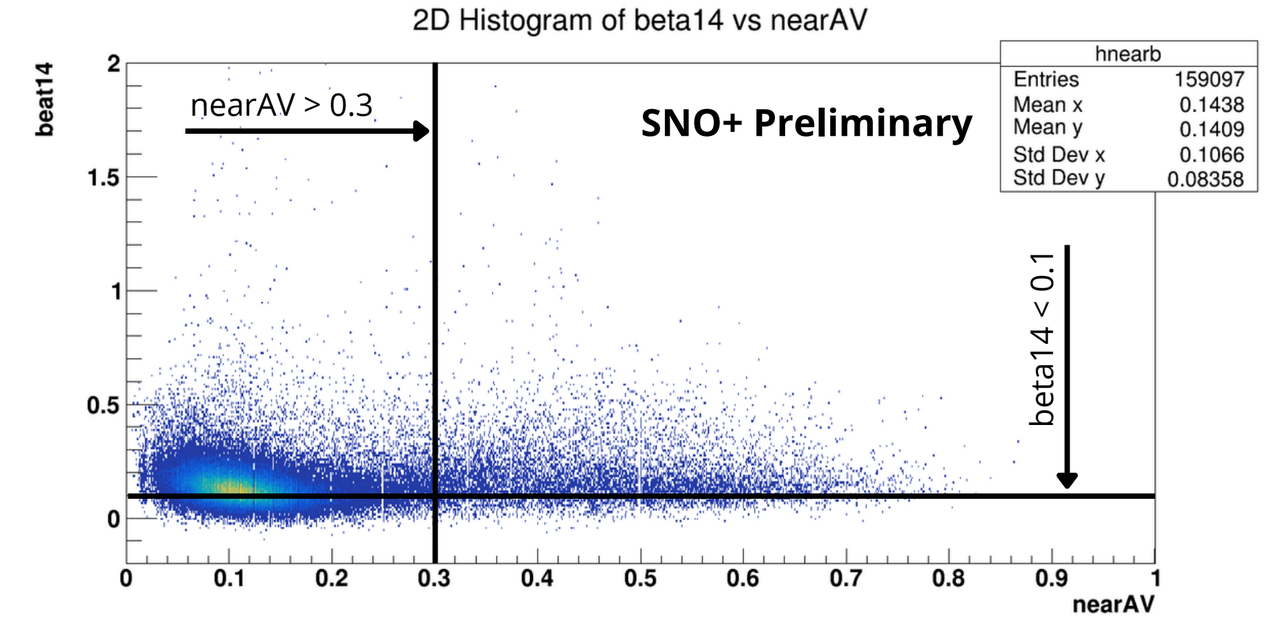


Fig.6 -2D histograms of beta14 vs nearAV for the pile-up between Bi210 on the Av surface and Bi210 from the AV surface (left) and Te 130 (right) for the FV of 3.3 m

backup- nearAV MC simulation

- For larger FV: an additional cut on nearAV significantly improves pile-up rejection



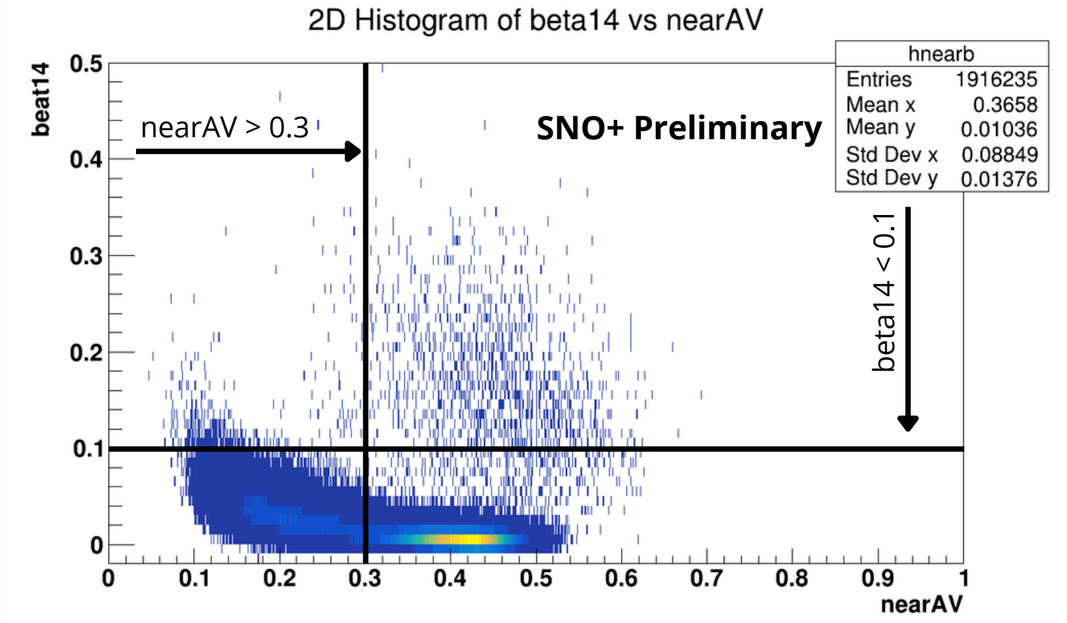


Fig.7 -2D histograms of beta14 vs nearAV for the pile-up between Bi210 on the AV surface and Bi210 from the AV surface (left) and Te 130 (right) for the Shell of 6m - 5.5 m

Backup- beta14

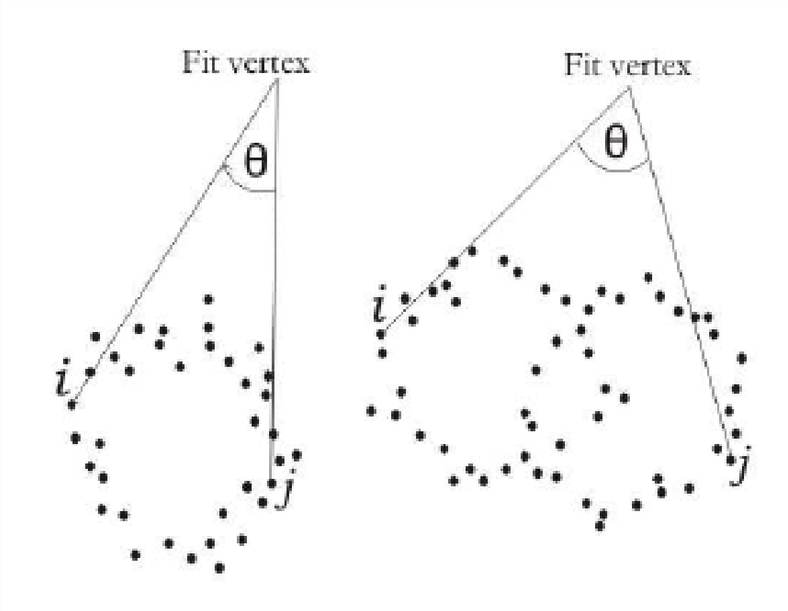


Fig.8 - beta14 variable. Example of the relative angle to the event vertex