

Update on ADC Sticky Code Simulation and Mitigation

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ADC Sticky Code Issue

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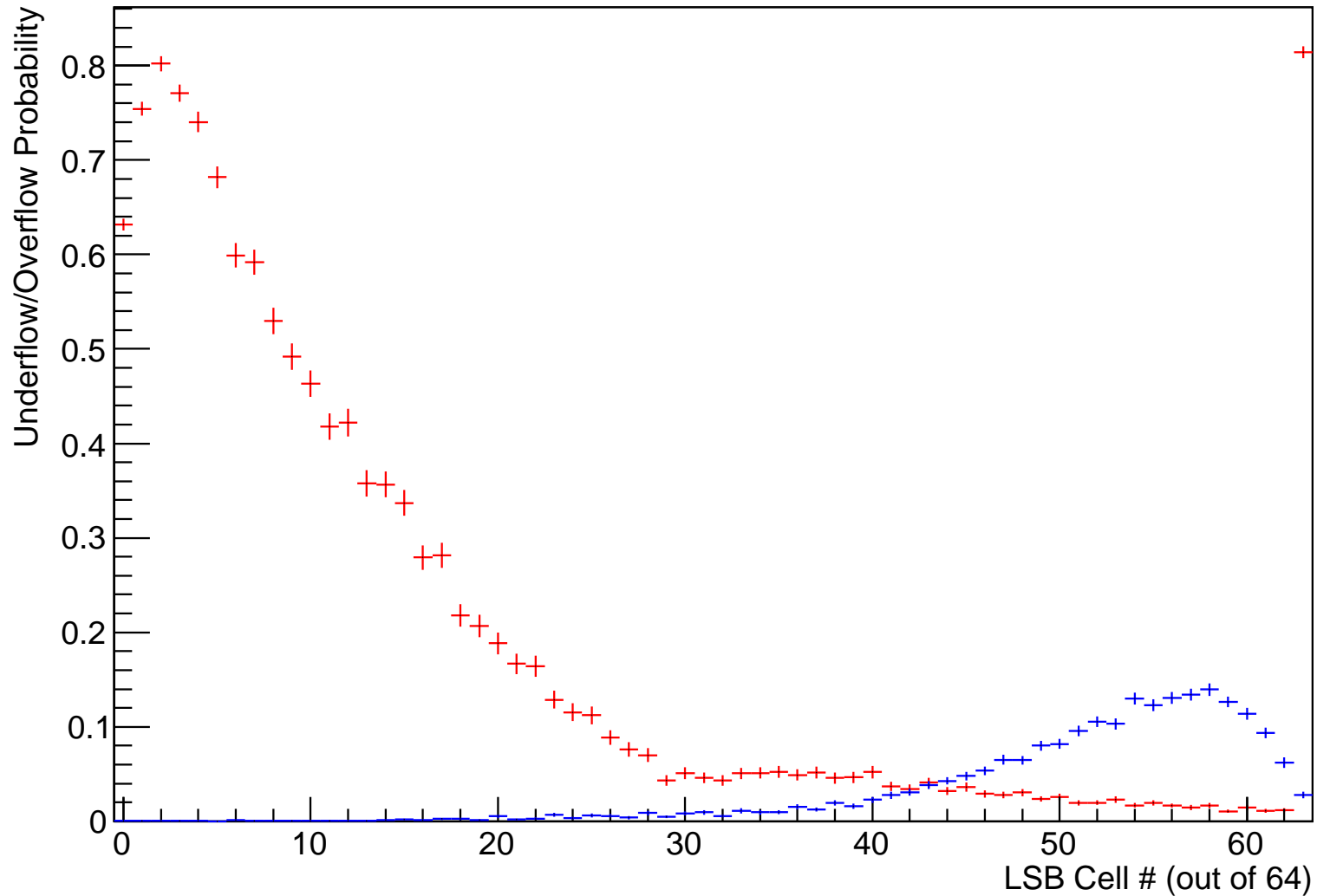
- Linearity study of 35t ADC ASICs found that 6 LSBs frequently “stick” at 000000 (0x00) or 111111 (0x3F)
- Total “stuck ADC code” probability at cryogenic temperatures estimated at average of 22%
- Proper overflow and underflow probabilities are now used by SimWireDUNE35, loaded from dune_pardata
- Software mitigation by linear interpolation over ADC vector waveforms in RawDigits is extremely promising for dealing with sticky ADC codes in 35t results

Simulating Sticky Codes

- Each ADC vector entry has some probability of sticking at 0x00 or 0x3f, dependent on input voltage
- SimStuckBits Boolean fcl parameter added to detsimmodules_dune.fcl
- Flip 6 LSBs with bitwise operators:
 - 0x00: set ADC value $\text{adcvec_a}[i] = \text{adcvec_a}[i] \& 0\text{xffc}0$
 - 0x3f: set ADC value $\text{adcvec_a}[i] = \text{adcvec_a}[i] | 0\text{x}003\text{f}$
- Use random number (in range 0 to 1) to determine if it sticks to either 0x00 or 0x3f:
 - If random number is smaller than underflow probability, set 6 LSBs to 0x3f
 - If random number is larger than underflow probability and smaller than underflow + overflow probabilities, set 6 LSBs to 0x00
 - If random number is larger than underflow + overflow probabilities, ADC value is left alone

ADC Sticky Code Simulation

Mean Cryogenic Probability vs. LSB Cell

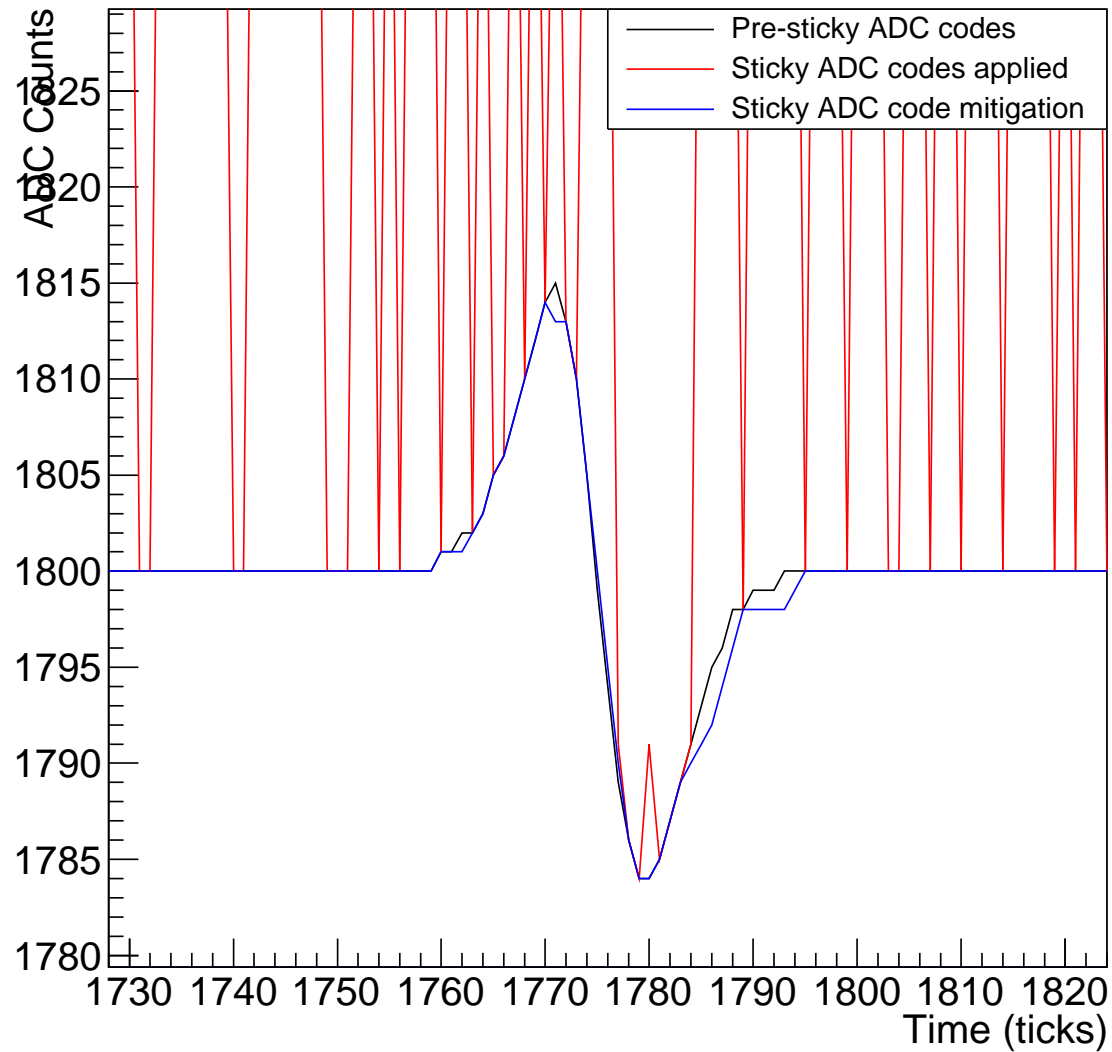


ADC Sticky Code Mitigation

- New module “UnstickADCcodes” created to read in RawDigit collections and output mitigated RawDigit ADC vectors as first step in reconstruction
- Each ADC vector is scanned over for entries ending in 000000 or 111111
- If first ADC value has LSB of 0x00 or 0x3f, default to pedestal
- If 6 LSBs of code are found to be 0x00 or 0x3f, we scan ahead to find next entry without stuck 6 LSBs
 - If over some number (default 5) of following ADC codes appear to be sticking, we give up and default to pedestal
- Mitigated value is computed from linear extrapolation between previous entry and next unsticking entry

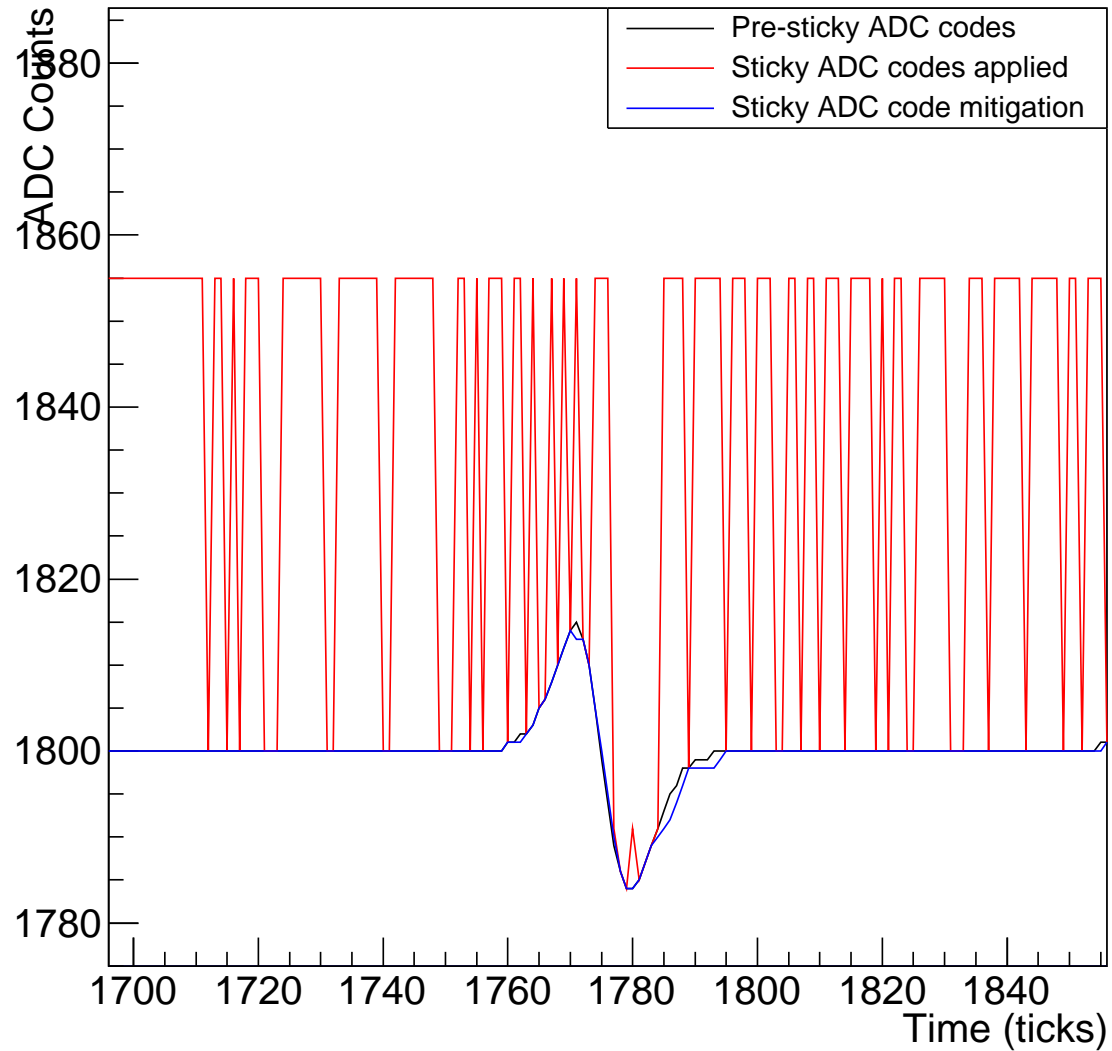
ADC Sticky Code Simulation and Mitigation

ADC Vectors with and without Stuck 6 LSBs



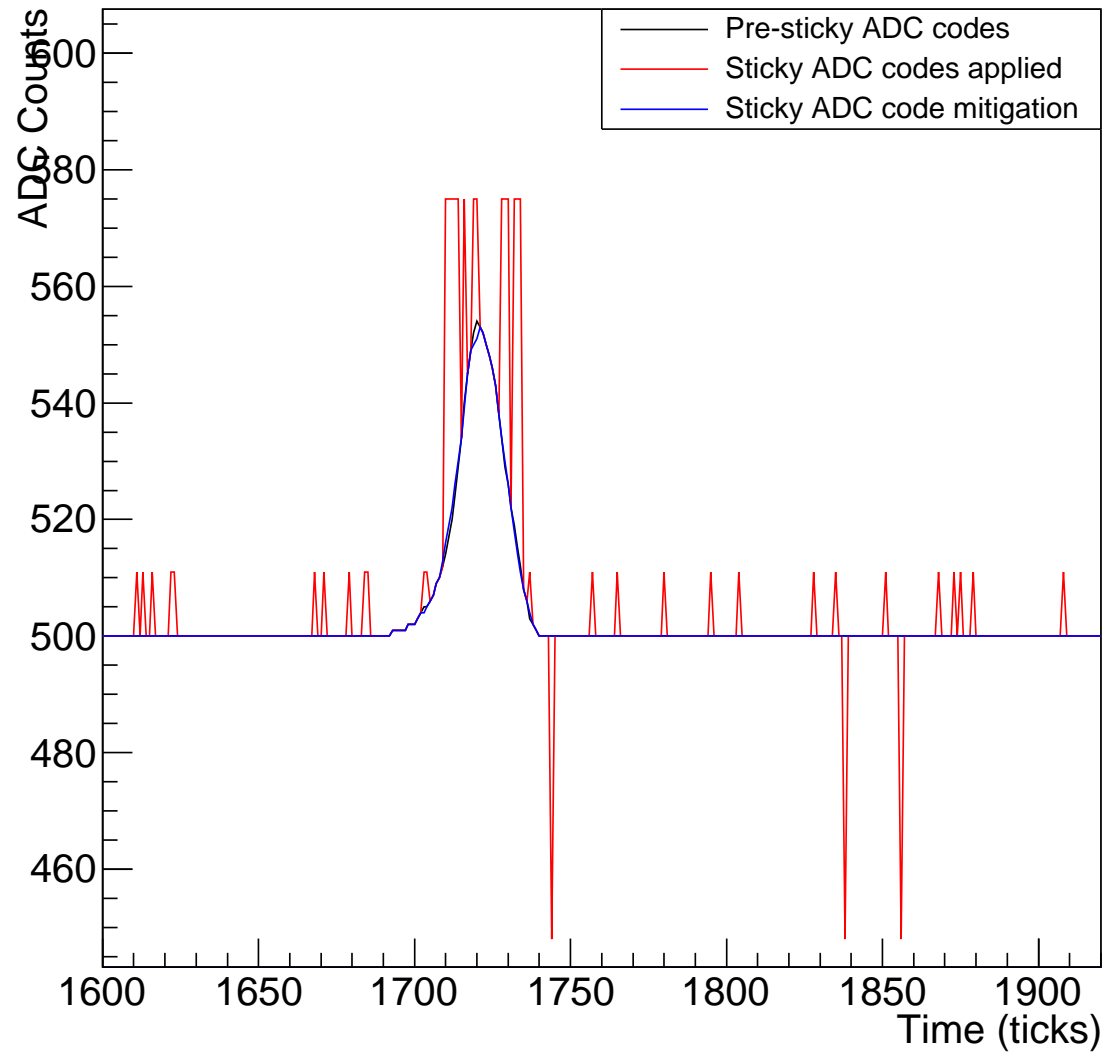
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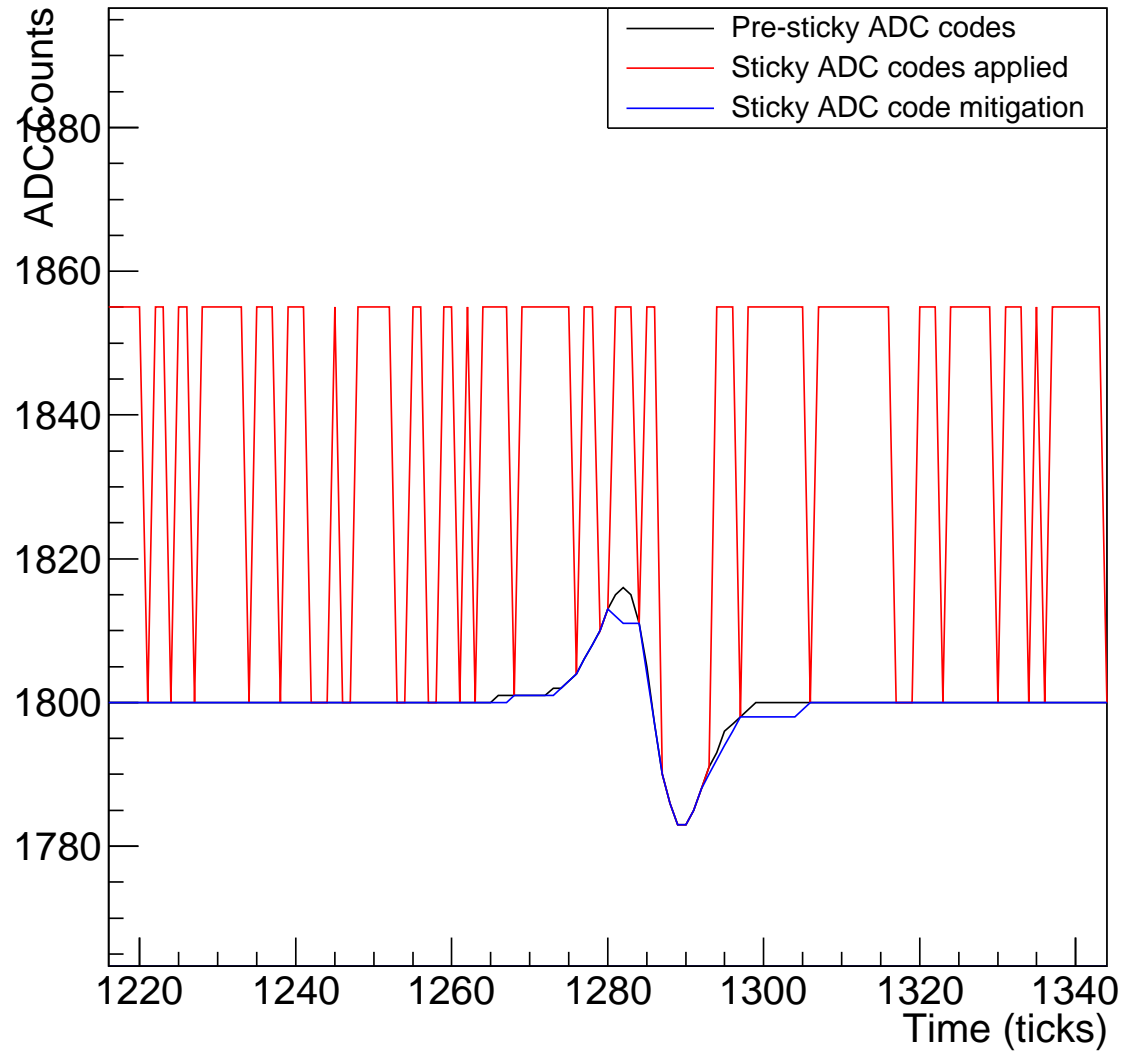
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Next Steps

- Evaluate effect of sticky ADC codes on energy resolution
- Update 35t zero suppression to handle nonzero pedestal values, sticky codes
- External calibration pulser will be used to directly check effect of sticky ADC codes on small signals during commissioning of 35t
- Implement overflow and underflow probabilities for each channel in offline database