# FADC:
# overview and performance

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# Outline

- Gaining familiarity with FADC system
  - (growing pains)
- Quality control and utility in data analysis

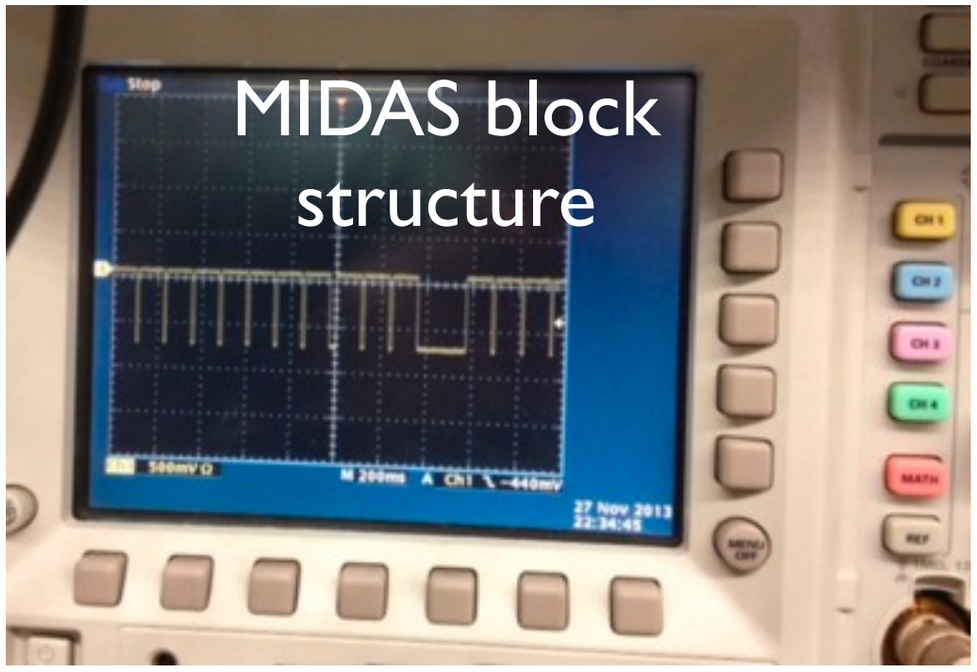
# Early troubles

- Early FADC sanity check: inject pulser signal to two systems
  - MCA. Mostly standalone program with various benefits/drawbacks.
  - FADC. Data collected by MIDAS, analyzed by user modules.

| Run # | FADC analysis | MCA |
|---|---|---|
| 624 | 11069 | 14723 |
| | | |
| 627 | 6467 | 8724 |

- Immediate rate discrepancy (~30% in this case!)

- Obvious difference between two methods: many steps between hardware and results for FADC. Andy, Ben and I spent much time w/ MIDAS blocks and deadtime

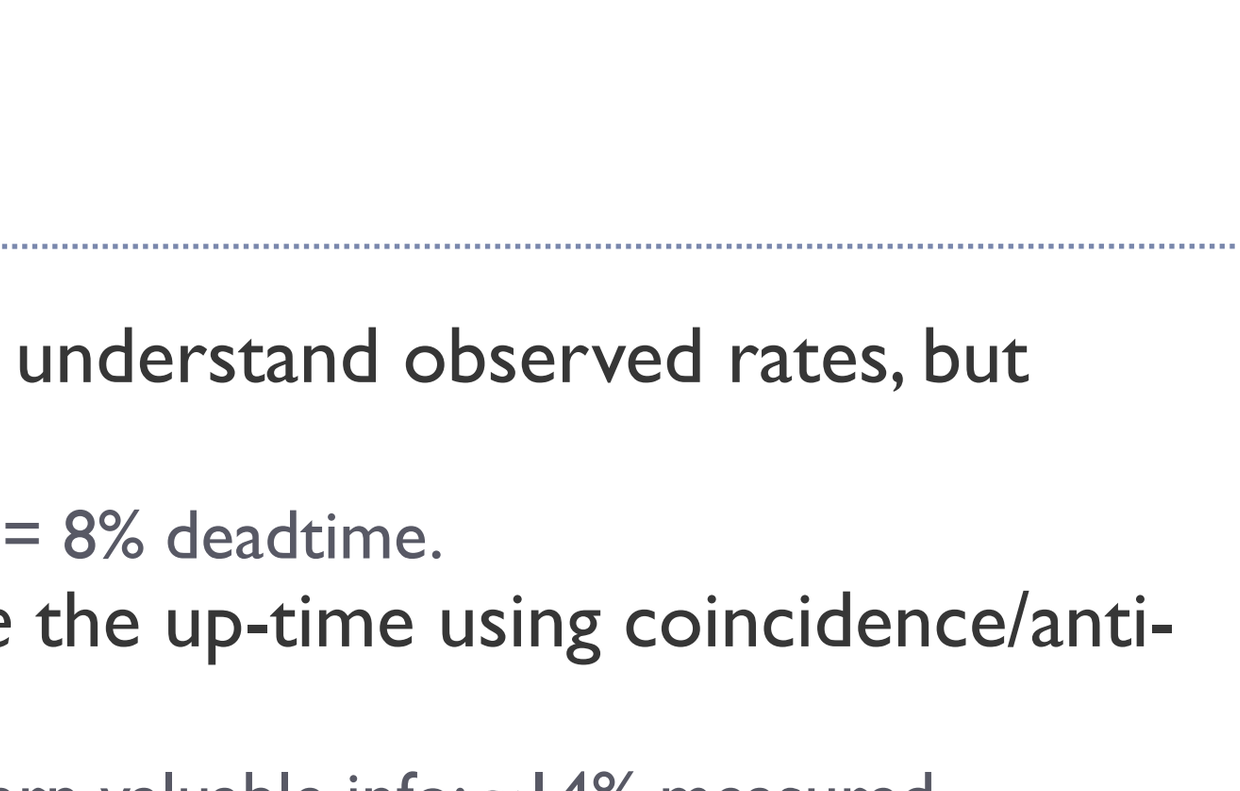


# Early troubles

- Deadtime structure important to understand observed rates, but problem remained.
  - chosen structure: 110ms ↑, 10ms ↓ = 8% deadtime.
- Ben had the great idea to *measure* the up-time using coincidence/anti-coincidence using scaler
  - still didn't do it, but continuing to learn valuable info: ~14% measured deadtime from MIDAS

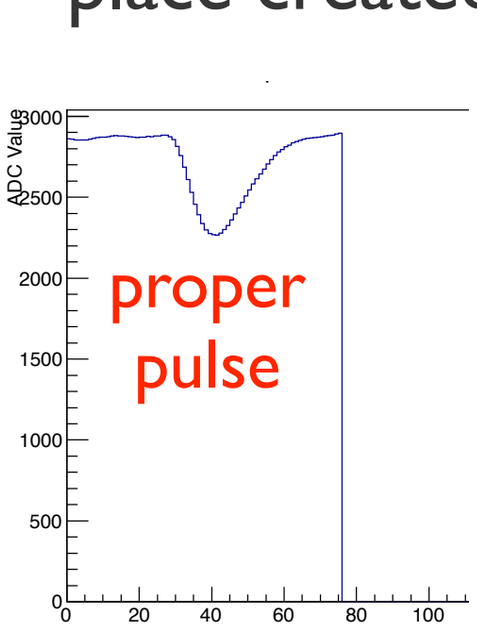
- What about CAEN digitizer?
  - (same DAQ, diff. hardware, analyzer modules)

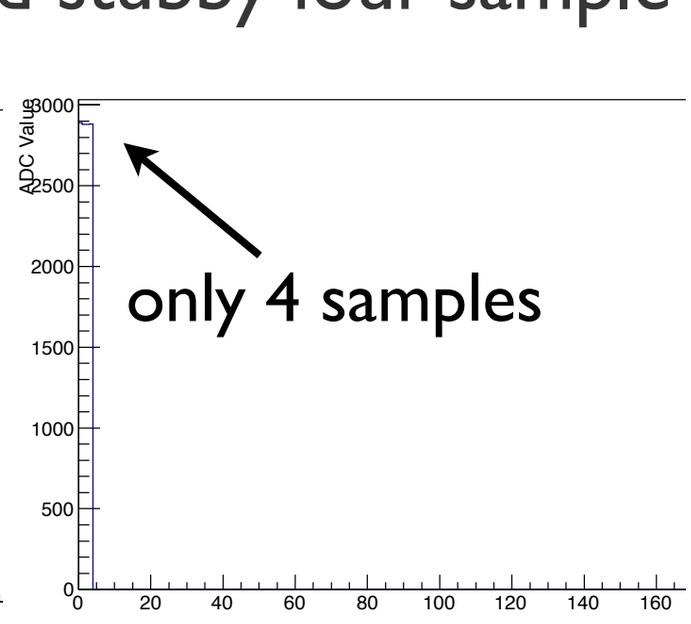
CAEN sees ~14% deadtime, expected number pulses per gate

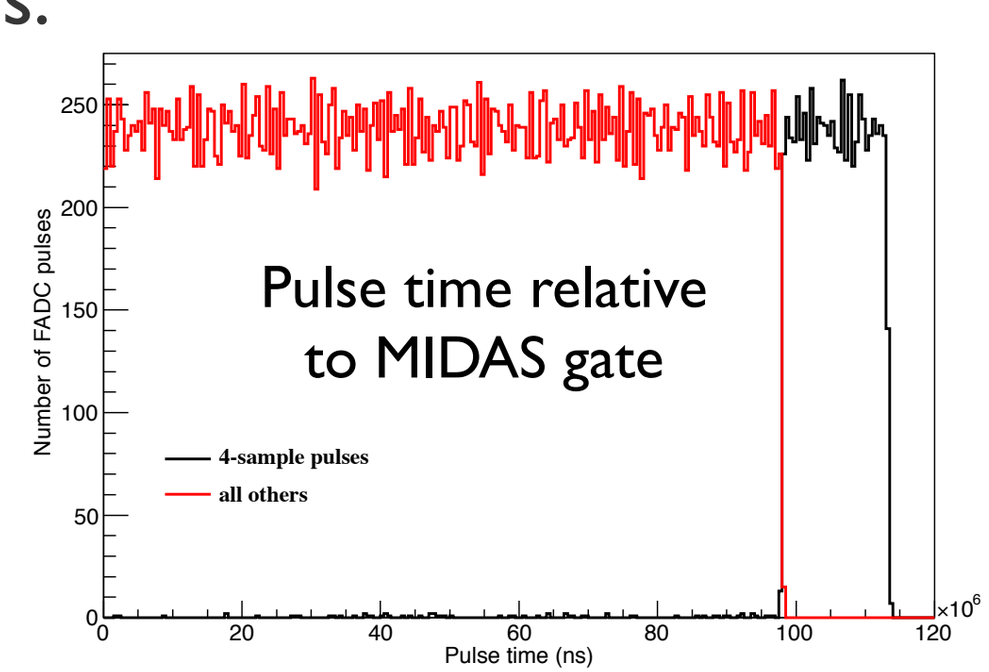


# Early troubles solved

- Have control sample! Looked to correlate pulses observed in CAEN with FADC (when were lost pulses lost?).
  - Andy developed lots of timing analysis modules helpful for later beam/data correlations
- Simple software bug discarded final pulse in each MIDAS block, in its place created stubby four-sample pulses.



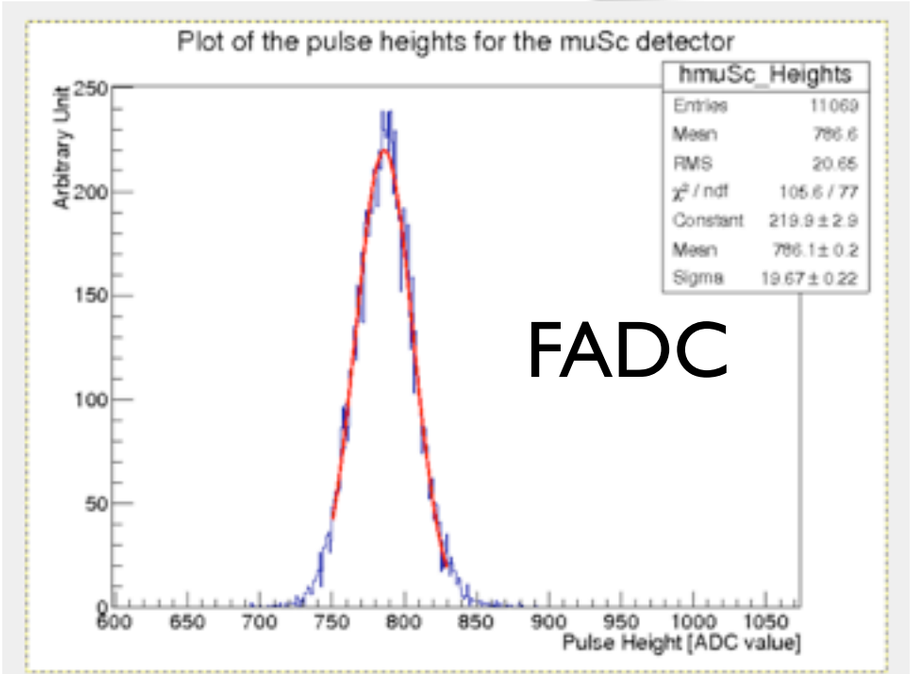

- Fred Gray provided the overseas assist, also provided us with updated FADC firmware (unrelated to these issues)

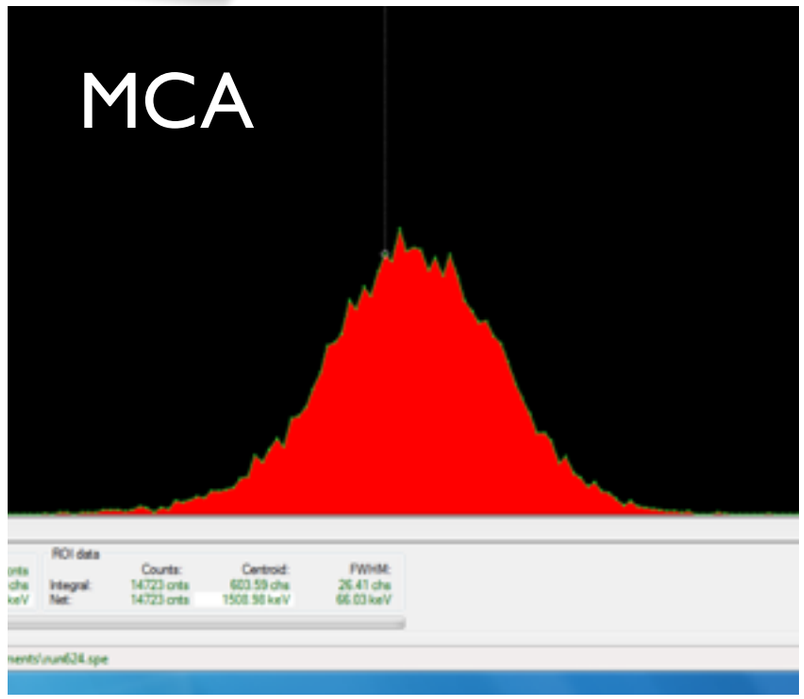
# FADC resolution

- With fixed pulser, discrepancy between FADC and MCA resolution:

**Run 624**

| | Sigma | Mean | Sigma / Mean |
|---|---|---|---|
| MCA | 66.03 keV | 1508.98 keV | 0.044 |
| FADC | 19.67 | 786.1 | 0.025 |

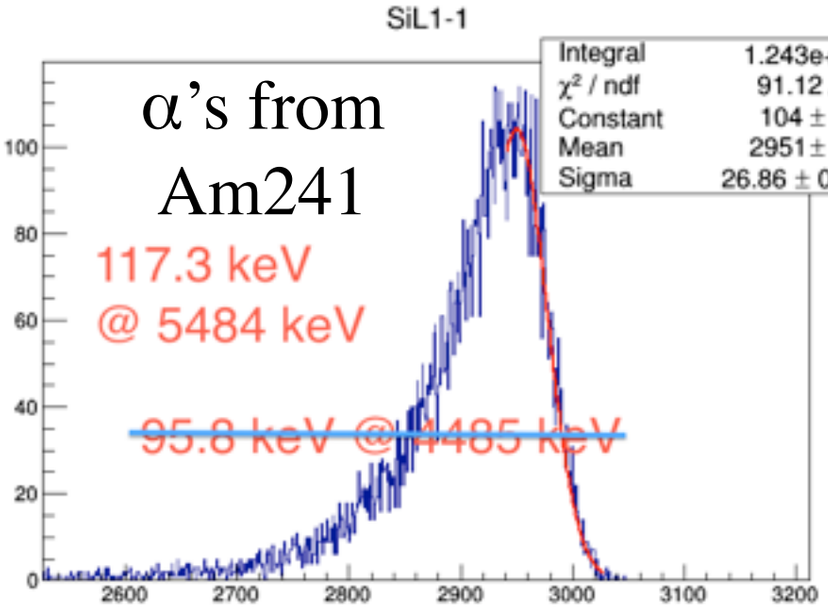


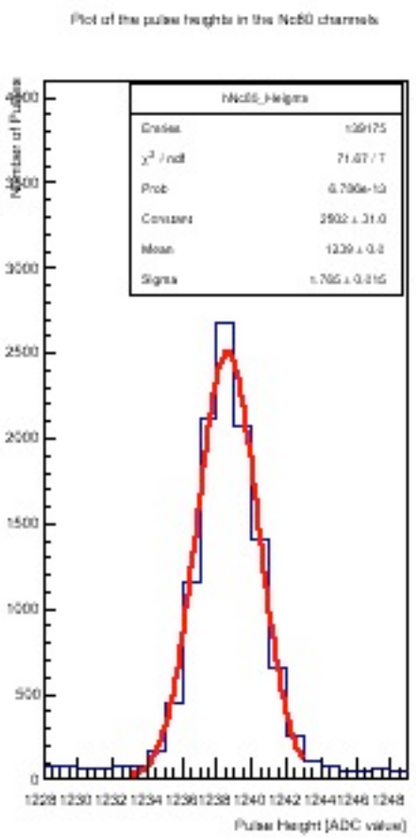

- Ultimately not understood...

# Calibrations

- Constrain FADC response with known radioactivity




Ge calib.
4 keV @
1.17 MeV

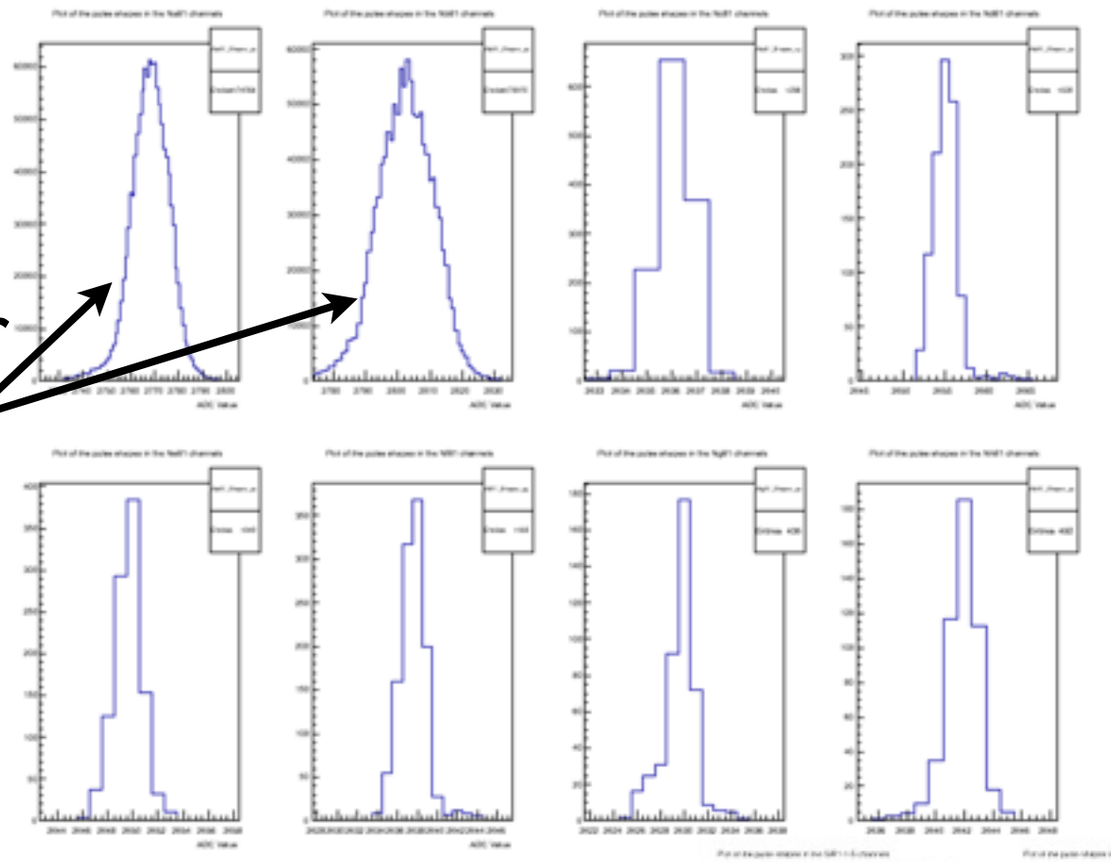



| Bank | Pedestal [ADC] | Mean [ADC] | Height [ADC] | Sigma [ADC] | Resolution [keV] |
|---|---|---|---|---|---|
| Ne82 | 2631 | 590.9 | 2040.1 | 16.21 | 102 |
| Nf82 | 2642 | 630.8 | 2011.2 | 21.62 | 138 |
| Ng82 | 2631 | 588.2 | 2042.8 | 19.87 | 125 |
| Nh82 | 2631 | 716.4 | 1915.6 | 18.79 | 126 |

α's from
Am241

# Noise

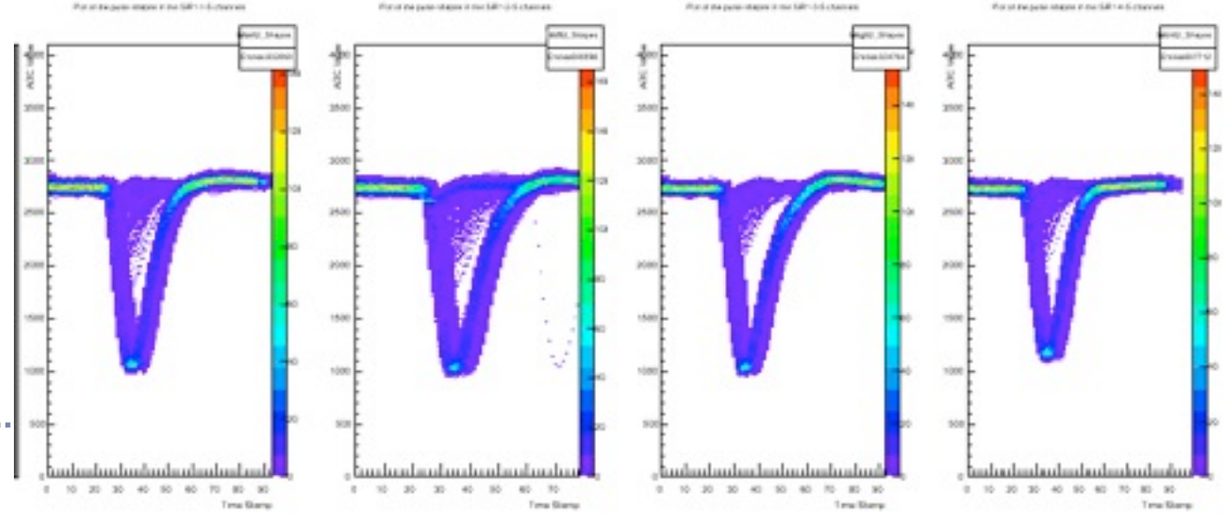
- FADC's very noisy early on



Self-trigger ~30 ct noise

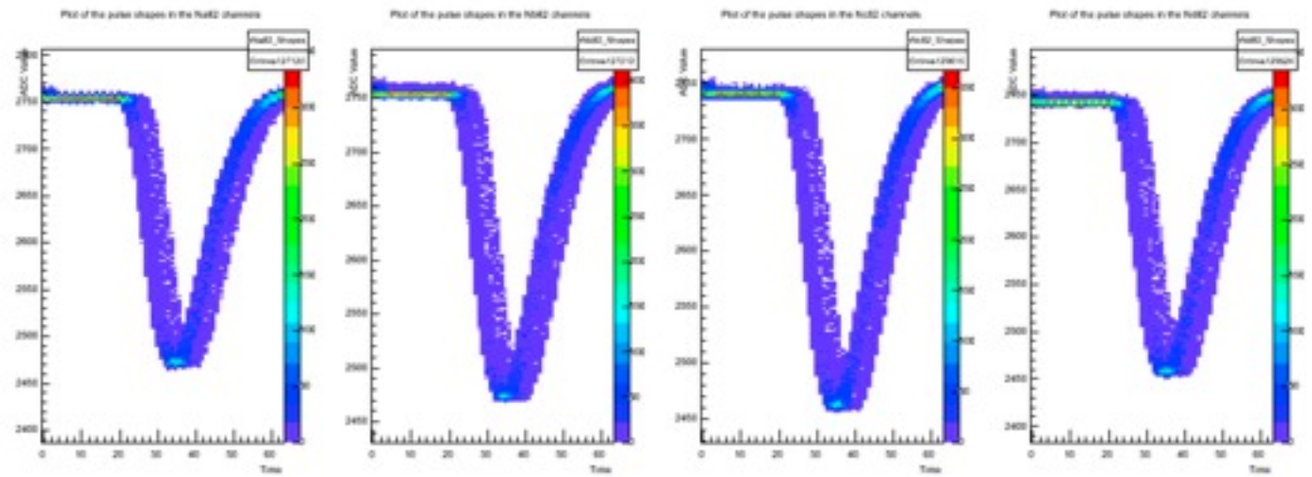
Other ch: plugged in Si but not turned on ~4 ct noise

- Also, funny pulse shape from pulser:



# Noise

- Suspected bad power supply swapped before serious beam runs. Changed to 120A MuSun power supply.
- Updated pulse shapes:



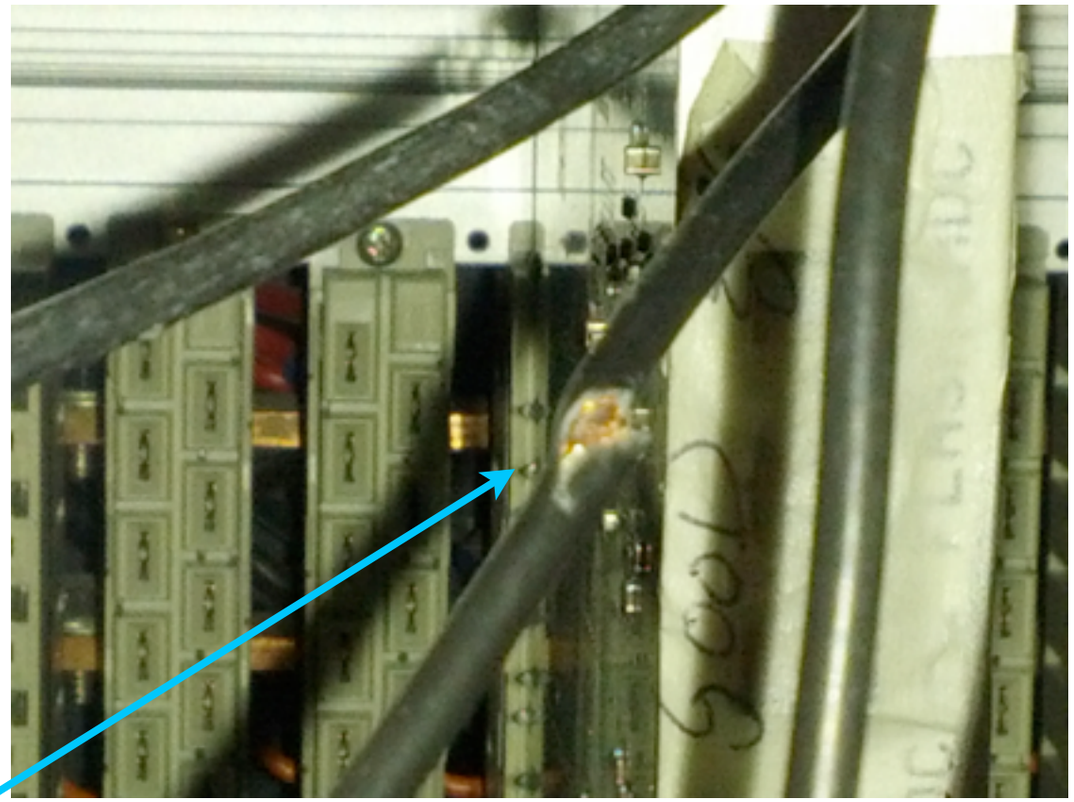
| | | No detector | | | Detector connected | |
|---|---|---|---|---|---|---|
| **Board** | **channel** | **mean (ch)** | **sigma (ch)** | **FWHM (keV)** | **sigma (ch)** | **FWHM (keV)** |
| x80 | SiL-2 | 132.9 | 1.45 | 25.75 | 4.2 | 74.58 |
| x80 | SiR-2 | 151.0 | 1.91 | 29.87 | 2.6 | 40.64 |
| x82 | SiL-1-1 | 281.3 | 1.68 | 14.09 | 6.60 | 55.37 |
| x82 | SiL-1-2 | 278.9 | 1.56 | 13.20 | 11.3 | 95.62 |
| x82 | SiL-1-3 | 289.2 | 1.62 | 13.22 | 11.6 | 94.66 |
| x82 | SiL-1-4 | 295.0 | 1.66 | 13.28 | 29 | 232.00 |

# Misc issues encountered

- Many, many MIDAS crashes and errors mysteriously solved by reloading .odb file from most recent successful run + much patience (power cycling)

- More serious FADC frontend crashes req'd DAQ reboots

- Cable woes
  - wiggling caused dramatic changes in signal/noise
  - damage prevented any signal transmission
  - ethernet connection to DAQ not secure



- Gaining familiarity with FADC system
  - (growing pains)

- Quality control and utility in data analysis

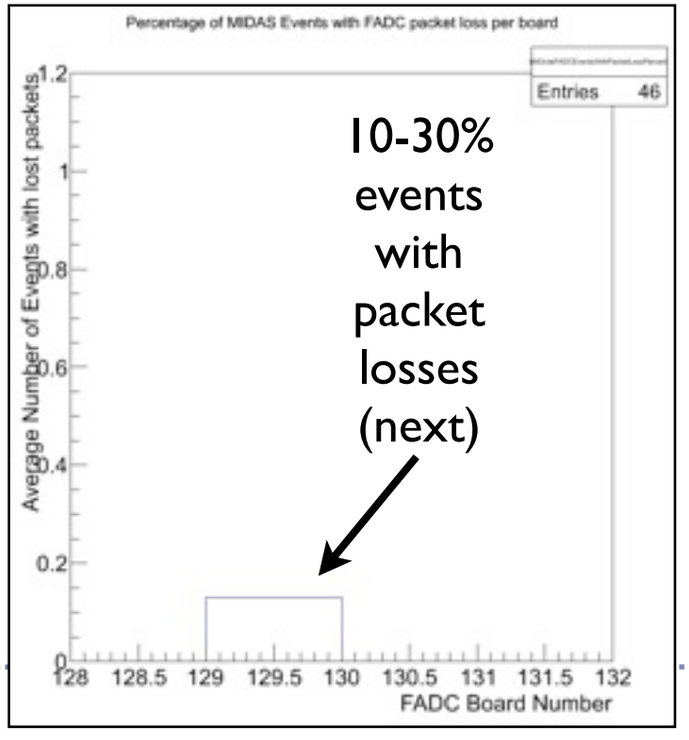
# FADC package losses

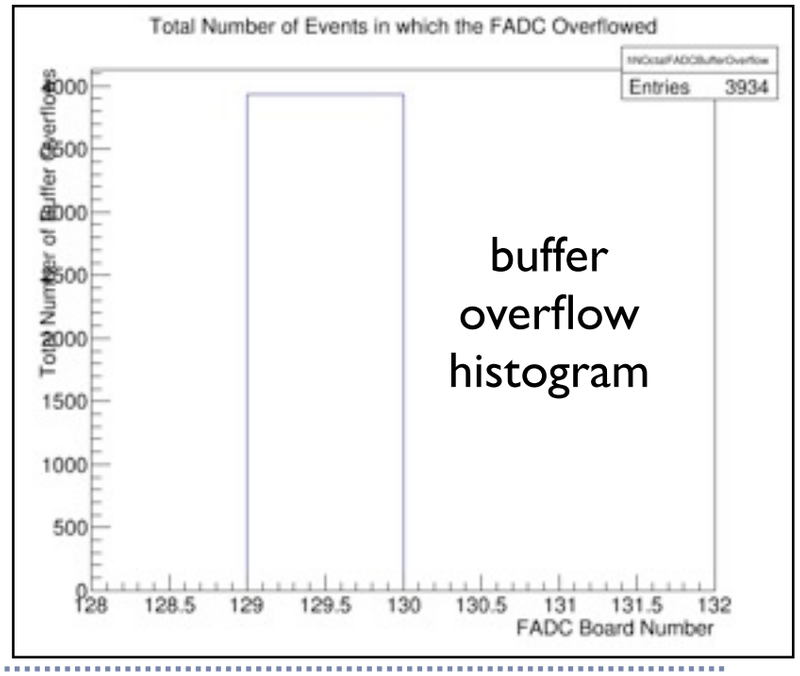
- Fred's updated firmware reports when internal FPGA buffer is full (and so data may be missed), very useful tool for real-time diagnostics

- PeterW added monitoring capabilities to FADC frontend:
  - as well as a FADC timeout message, indicating not all packages collected were sent

```
new_fadc_read
Board 0x81: start 16070 (+) - stop 16124 (+) - buffer full (+)
Board 0x82: start 16072 (+) - stop 16125 (+) - buffer full (+)
```

- Both these are stored in MIDAS banks, we choose how to handle at the analysis stage
  - (have we decided?)

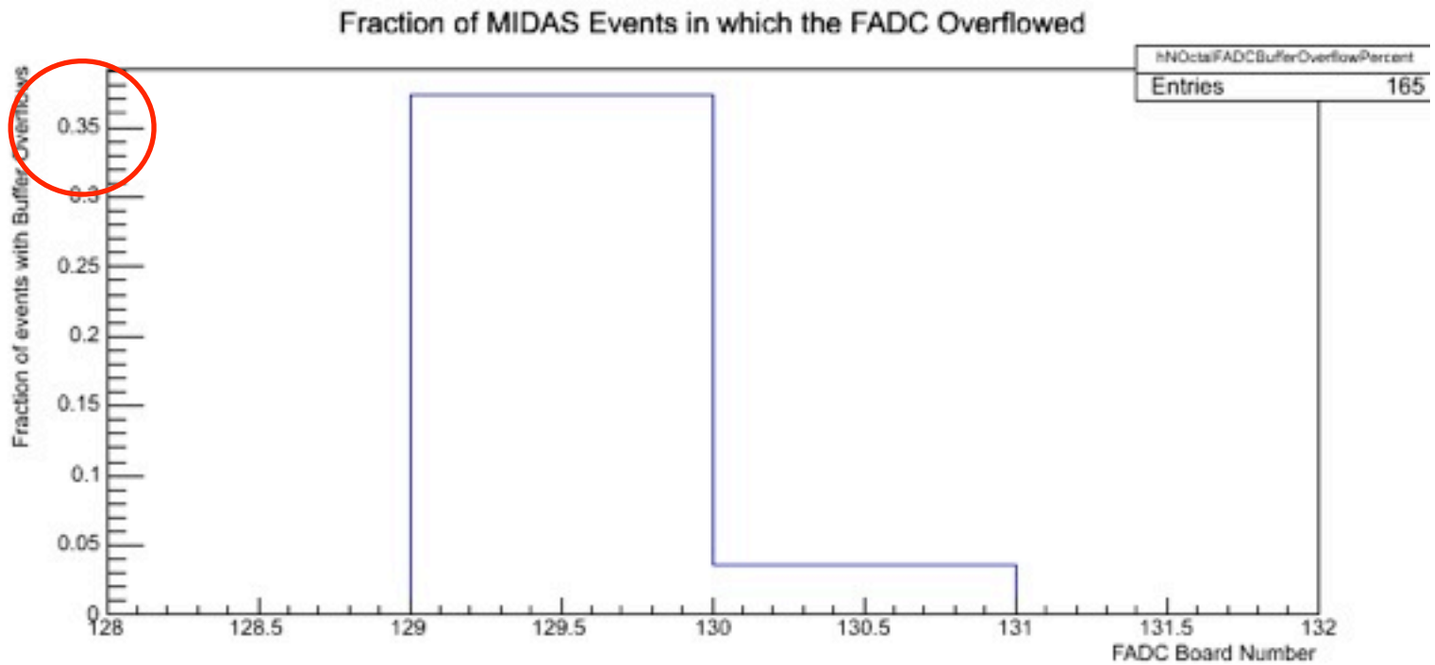


# FADC package losses

- Early on, bug in online monitoring root scripts prevented proper package loss monitoring

- When fixed, realized rates were (and presumably had been) too high (~30%)
  - unacceptable losses, combatted with increased thresholds, shortened def'n of pulse island.




- I see quantification of these rates with run numbers as a next step for myself (would this duplicate any efforts?)

# Summary, next steps

- FADC system proved particularly sensitive and temperamental early on, smooth running reached when it counted
  - software bug
  - noise (power supply)
  - some troublesome cabling

- Track FADC packet losses/buffer health through physics runs to begin quantifying data/analysis confidence