

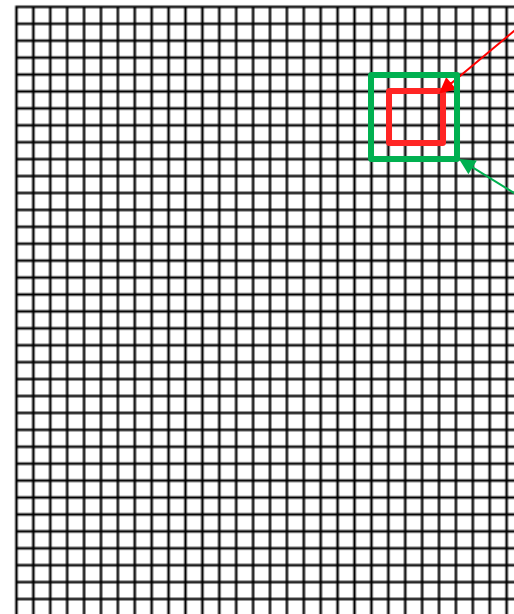
NPS Trigger/DAQ

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Clustered trigger & readout

- 3x3 clustering trigger across full calorimeter: trigger on **clusters \geq threshold**
- 5x5 or 7x7 full waveform readout centered on **clusters \geq readout_threshold**
- cluster pair trigger
- cosmic trigger



All 3x3 views evaluated in parallel – including views across multiple crates (FADC hits on perimeter are shared with optical links)

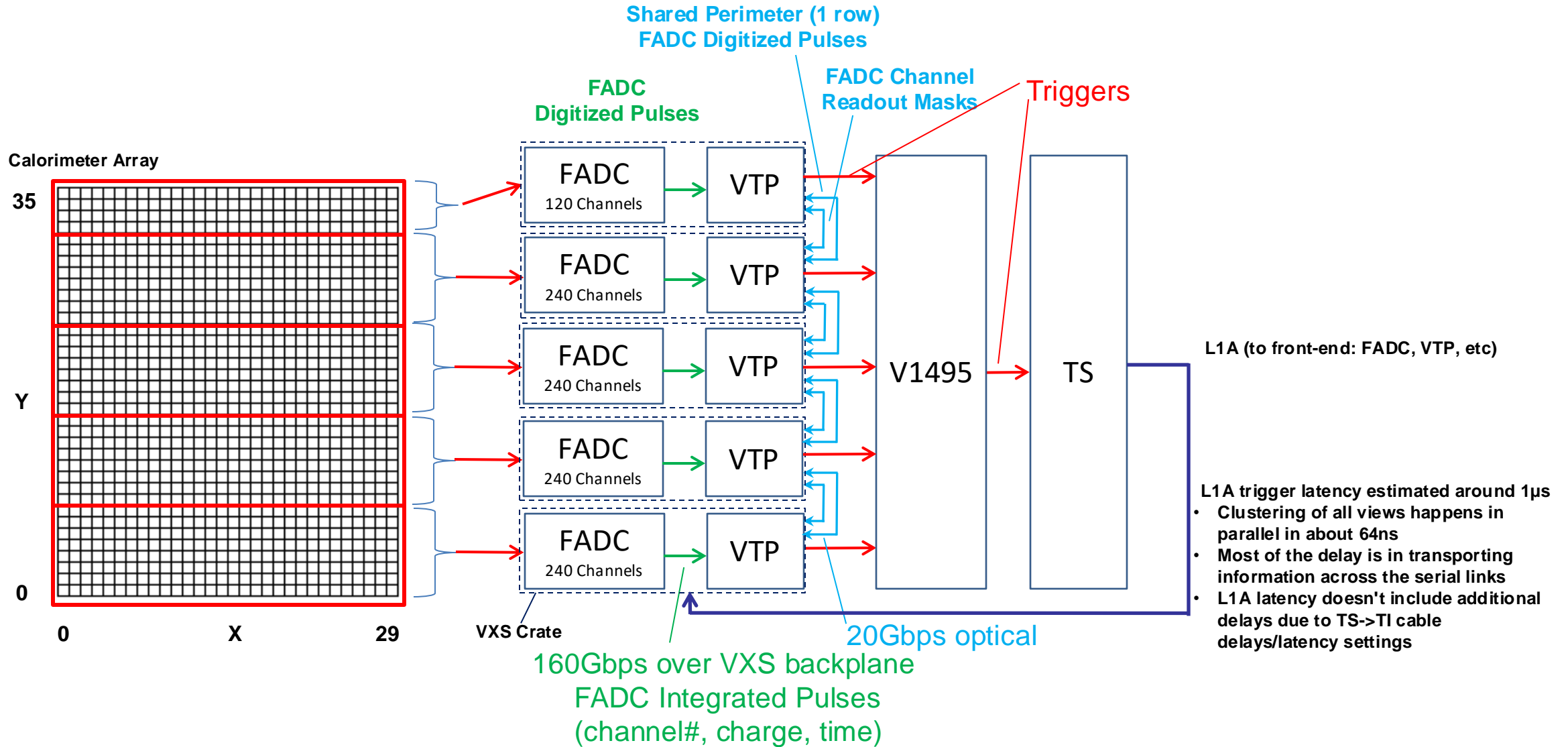
5x5 centered on cluster seed for **clusters \geq threshold** are the FADC channels readout each event

Note: there are two thresholds for the 3x3 clusters

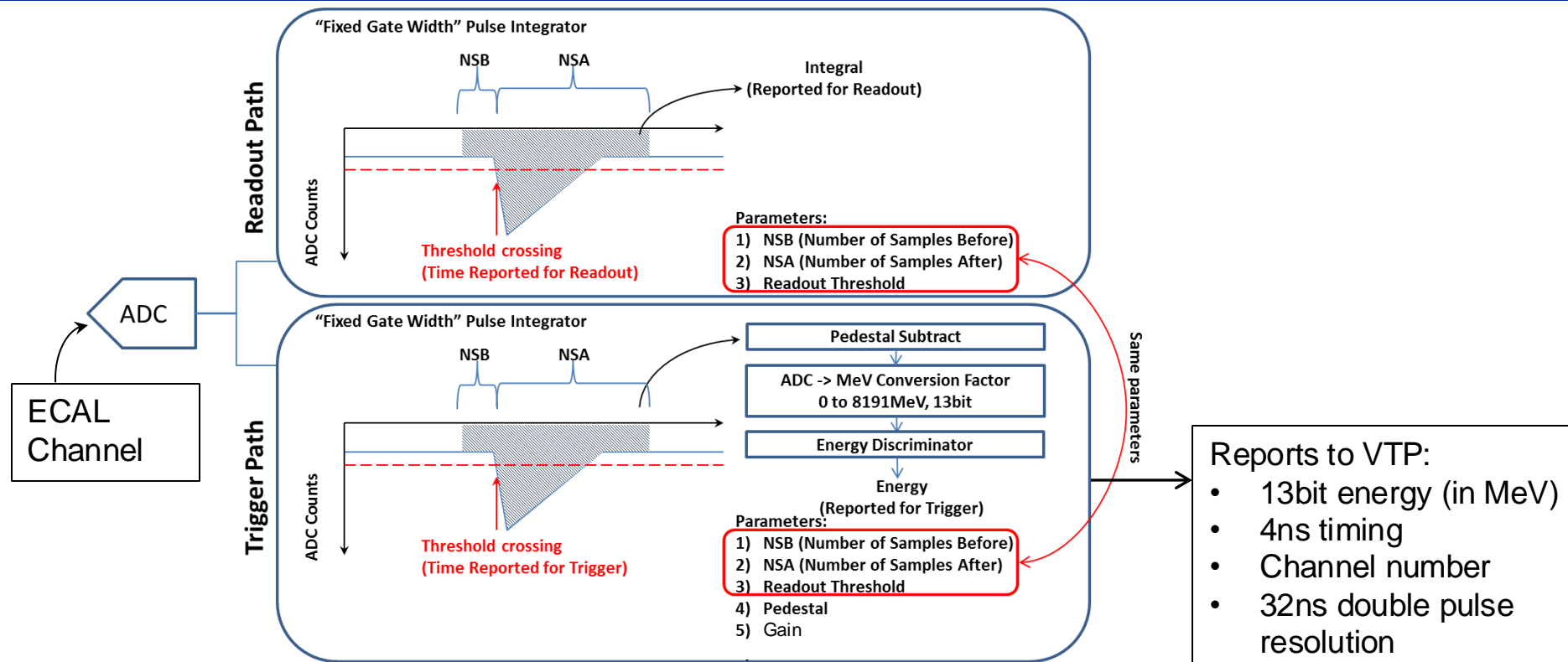
- 1) Is the threshold required to trigger the system
- 2) Is the threshold used to determine which clusters are readout

In this scheme, you can trigger with a high threshold, but readout with a lower threshold to ensure acceptance of multi-cluster events.

NPS Calorimeter DAQ/Trigger Setup



FADC – Pulse Processing



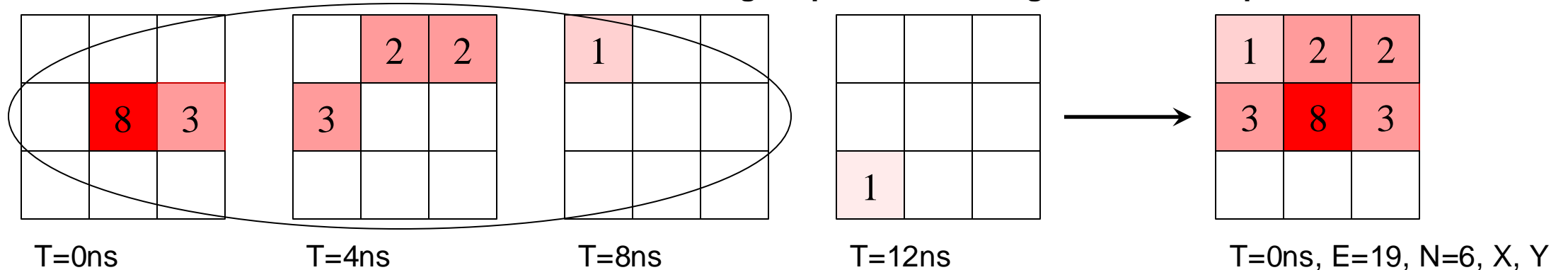
- Trigger pedestal is the same parameter that would be calculated for the readout data.
- Trigger gain parameter normally used to scale ADC -> MeV (makes VTP settings & diagnostics easy to read)
- Both pedestal and gain require calibration to determine parameters.

Cluster Finding

Cluster finding is done by (using 3x3 tower views, all views evaluated in parallel):

- Seed hit (center) must be \geq seed threshold
- Seed hit must also be a local maximum in both space and time
- Cluster is reported with:
 - Timestamp of seed hit (large amplitude hit \Rightarrow lowest jitter)
 - Number of hits in cluster
 - X,Y position of seed hit
 - Energy in MeV units

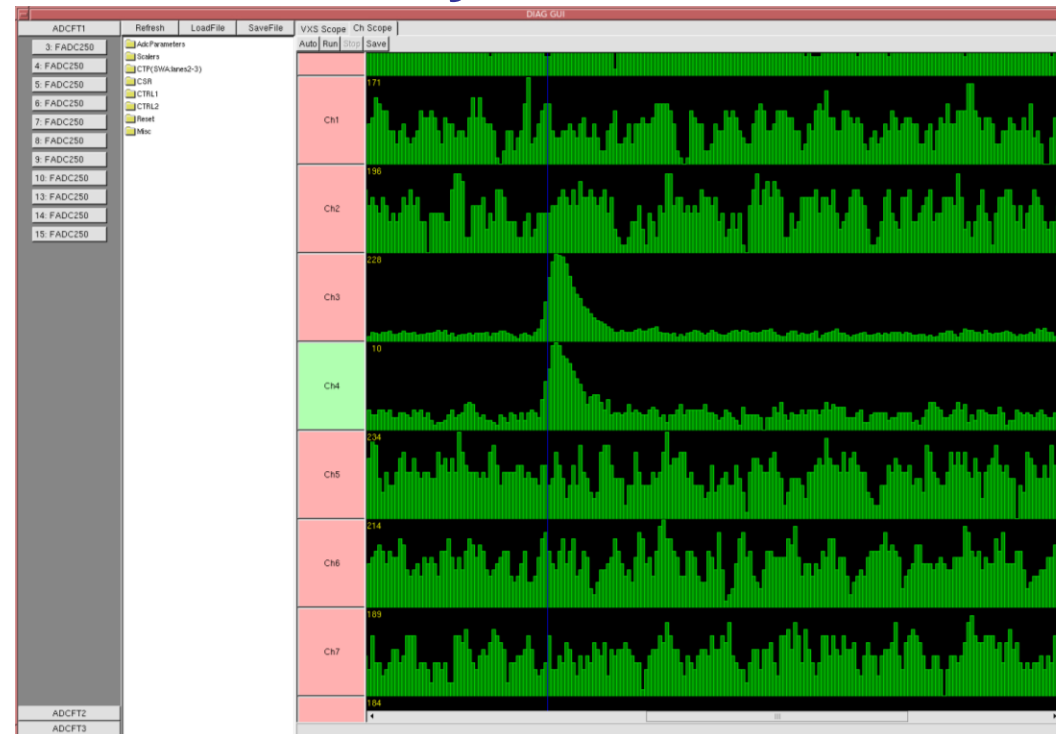
e.g. for seed threshold of 2 and hit $\Delta t = \pm 8\text{ns}$, the following hit pattern evolving in time will report 1 cluster:



DiagGUI – FADC250

DiagGUI is a general purpose tool to gain register access to DAQ modules and display various diagnostics, histograms, scalars, etc...

- Runs parallel to DAQ operations...okay to view, but be careful as it allows changing module parameters on the fly! Really intended for 'expert' only.
- For example, you can look at any FADC250 waveforms and trigger on the channels:



Trigger Configuration Files

All trigger parameters for FADC & VTP used config files

- Documented in VTP manual

<https://coda.jlab.org/drupal/system/files/pdfs/HardwareManual/VTP/VTP-Manual.pdf>

Config files stored in EVIO at the beginning of each run

Config files also uploaded to Hall C Logbook

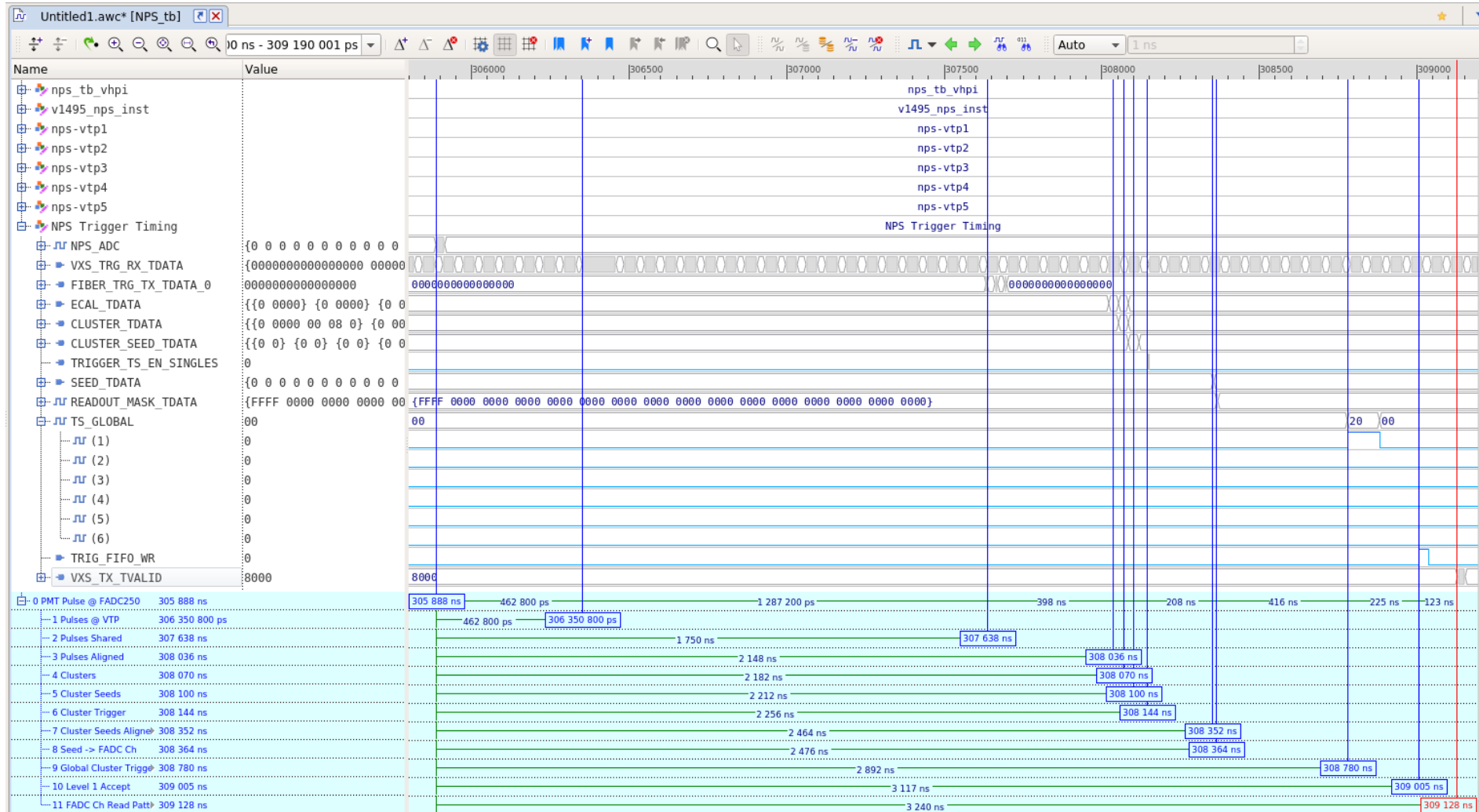
Trigger Data Banks

NPS VTPs also record event data

- All 3x3 trigger clusters found (meeting cluster seed threshold for central hit): row, col, energy, time, and number of hits in cluster
- Trigger decisions recorded (single cluster, cluster pair, cosmic): trigger bit, and time
- Useful to check if trigger is/was working
 - FADC \leftrightarrow VTP cluster comparison
 - Trigger rate/efficiency studies

NPS Trigger Timing (various stages)

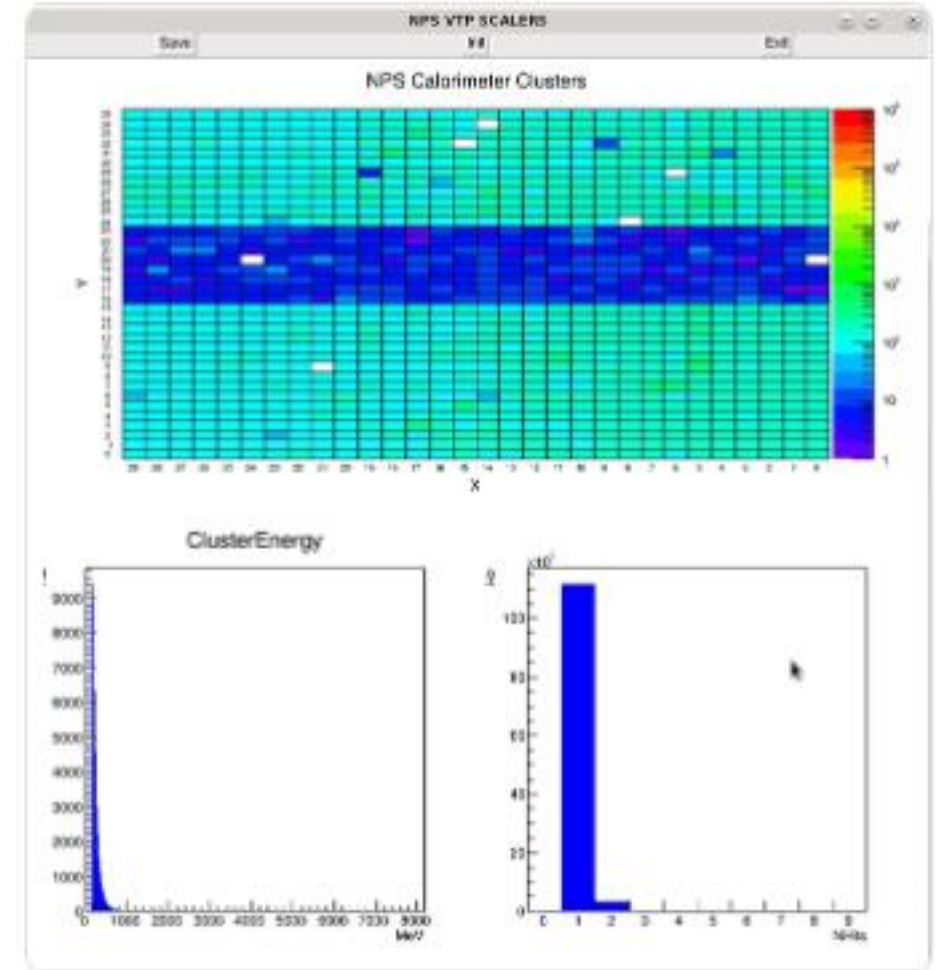
~3.2us min latency, but actual is longer due to long fiber run in Hall C between TS<->TI



VTP Cluster Scaler GUI

Useful to see hardware issues (e.g. a failed FADC slot corrupted this run):

- Real-time display of all VTP clusters found: cluster center position, energy, and number of hits
- In this example, a low occupancy band for nps-vme3 is visible (this is due to a failed FADC that needed to be replaced, but could happen for other reasons)



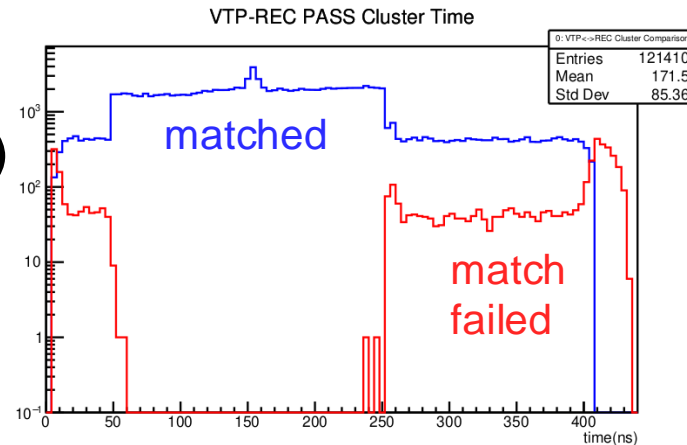
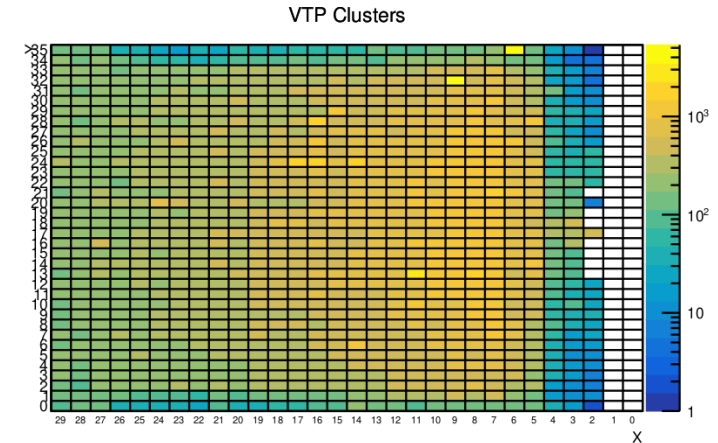
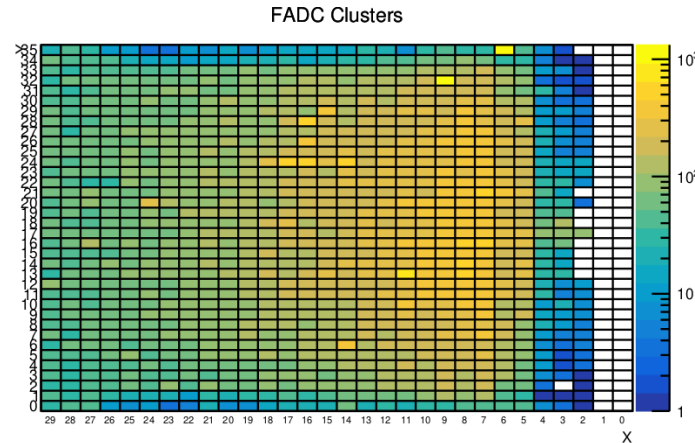
Trigger Emulator

The trigger emulator is a basic ROOT based C++ analyzer

- **Reads trigger banks and also reconstruct trigger banks from FADC waveforms**
- **Compares reconstructed trigger banks to recorded ones reports on discrepancies**
- **Very useful for commissioning DAQ/trigger and debugging various run issues.**

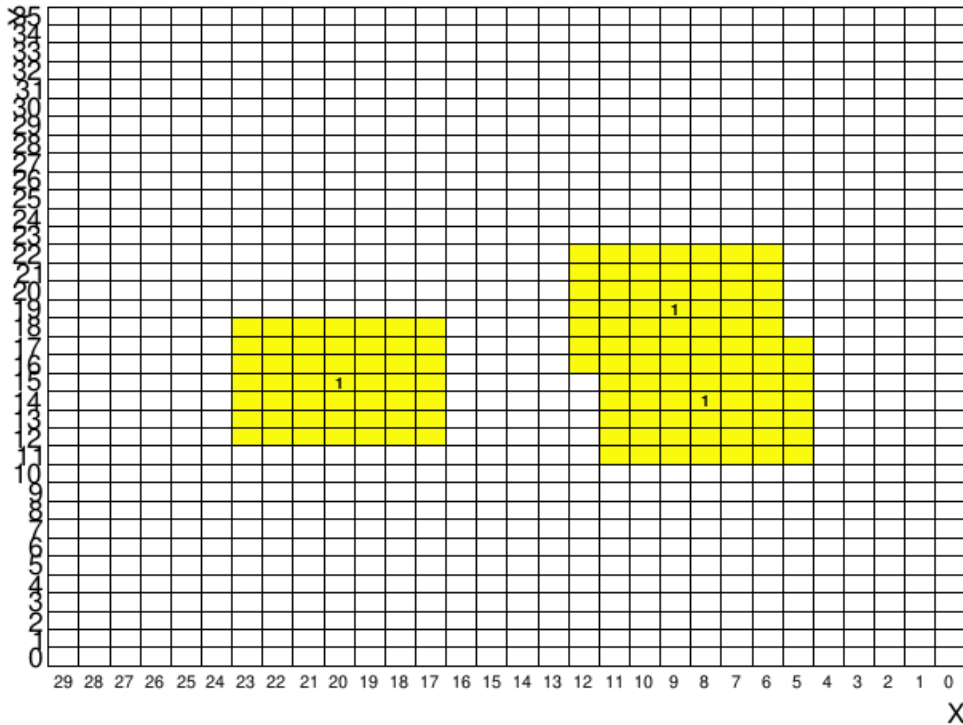
NPS Trigger Report – Cluster Verification

- EVIO file used to compare FADC data vs VTP
- FADC waveform banks used to reconstruct trigger type clusters
- VTP banks record cluster decisions (row, col, energy, time, number of hits) - VTP has a larger time window and no sparsification (so more statistics for same EVIO file vs FADC)
- FADC and VTP clusters compared to check for agreement



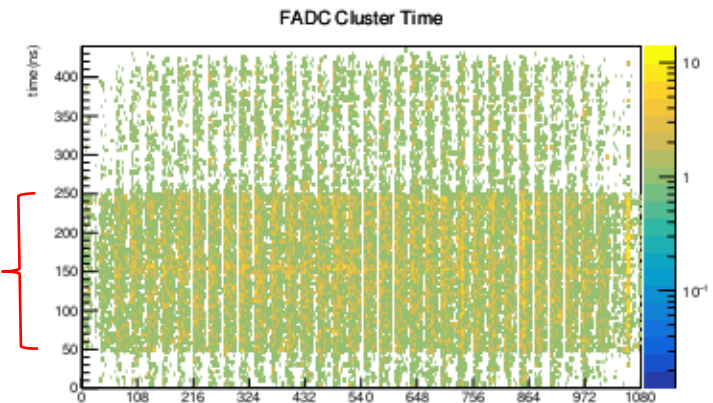
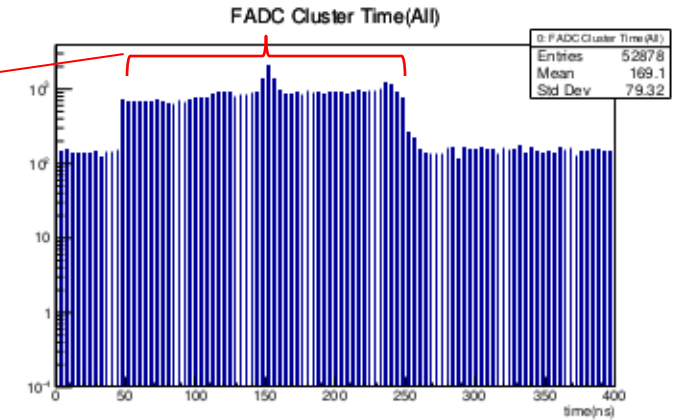
NPS Trigger Report – Sparisification

Analyzer checks that each cluster over threshold has corresponding 5x5 or 7x7 FADC channels readout – all cluster positions were verified to ensure mapping and inter-crate communication on this was working.



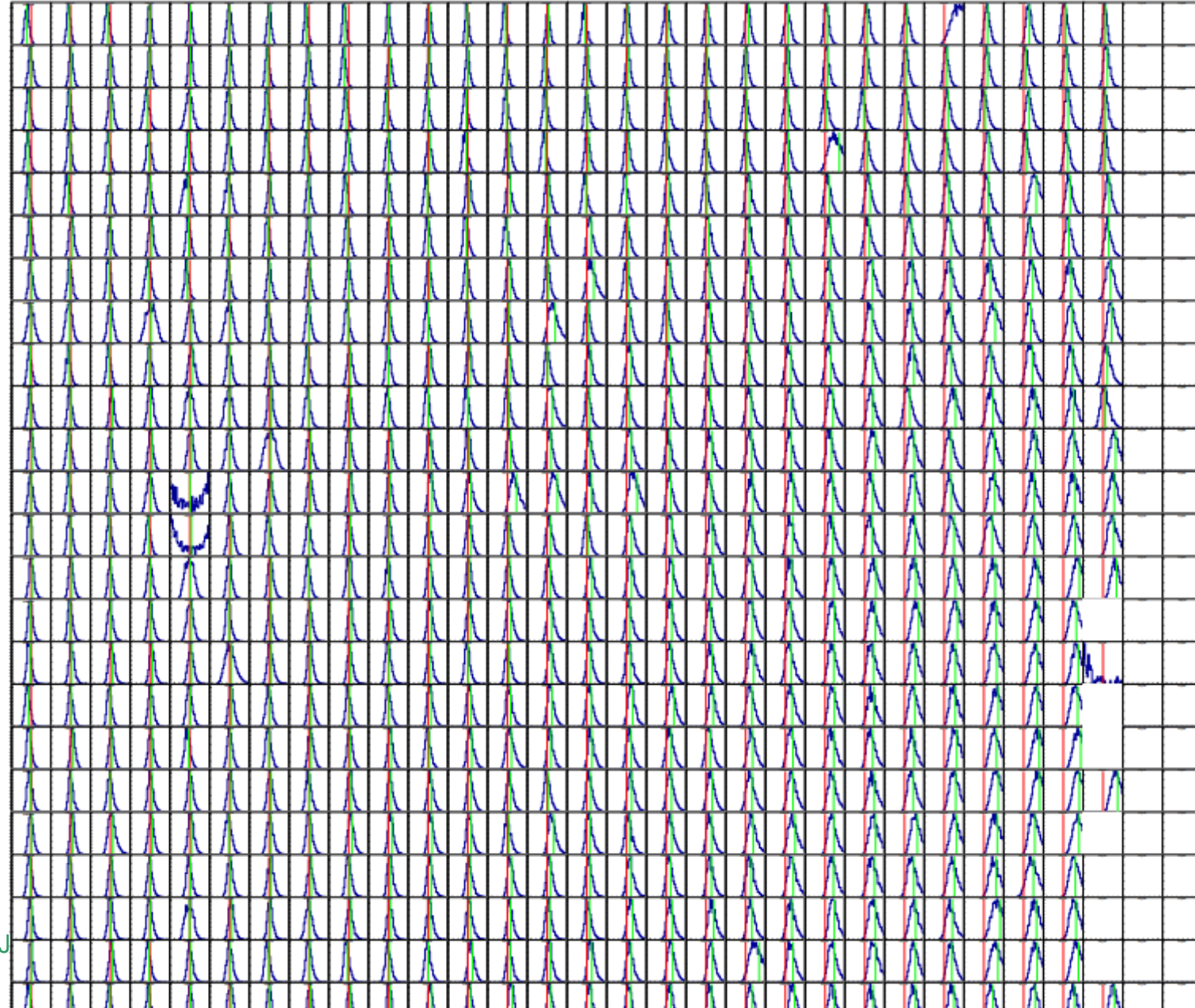
Clusters in this time region have FADC channels readout (5x5 or 7x7)

Yellow channels are readout. Numbers are how many clusters centered on the channel. 7x7 readout shown.



NPS Trigger Report - Pedestal Drifts

- **ADC Sample histogram per channel**
- **Green line: used pedestal in run**
- **Red line: calculated pedestal from data**
- **Quick analysis tool that quickly can show if pedestals are set right and also shows noisy channels.**



Future Changes

Firmware Improvement Plans

- **More robust trigger link synchronization startup & check to eliminate occasional failures where a crate appears to not be timed in (the unresolved problem always seemed to be the same crate, so may be a hardware problem – need better diagnostics)**
- **Auto-pedestal adjustment mode (optional to use). Planning to test a simple pedestal measurement firmware module that would eliminate the need to compute offline pedestals for each channel. This would allow pedestals to dynamically adjust due to drifting issues and provide more stable thresholds and pulse integrals.**
- **Anything other suggestions?**

Summary

- **Small changes/improvements to NPS trigger are proposed/planned**
- **New/additional requests for firmware changes: give a few months notice at least – hopefully small or none needed (outside already planned mentioned)**