Mini TPC

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Mini-TPC project

- Recycle existing chamber present at Saclay
- Use recent micromegas (resistive) as TPC pads
  - Relies on existing detector+electronics+DAQ developed for T2K and ILD R&D
  - New TPC end-plate to plug the micromegas device
- Transparent windows to send UV-rays through the chamber
  - UV rays yield photo-electrons at the cathod level
  - Photo-electrons drift toward micromegas
  - Micromegas amplification yields ion back-flow in drift space

- Measure tracking performance with cosmic muons
  - Trigger with 2 scintillators
  - Use 3 micromegas chambers as hodoscope.

Status and to do (presented Sep16)

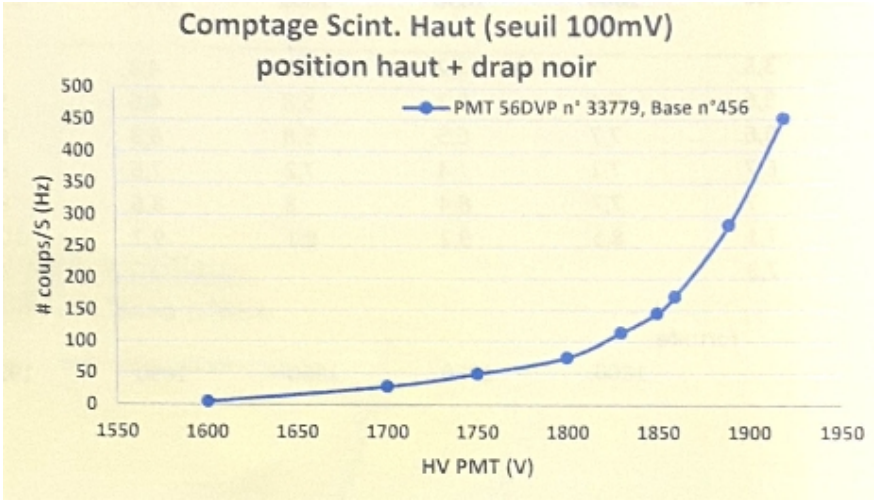
- TPC
  - Endplate/viewports to be commissioned
  - HV (with Fisher plug) ready, Need PCB termination plate
- Micromegas Hodoscopes
  - Chambers to be installed
  - Power supply (with 5 nA resolution) ordered. Expected October 1st
- Alignment: TPC and hodoscope need to be fixed
- Triggering
  - Scintillators + HV OK
  - One PM too noisy. to be fixed
- Gas system
  - Ready (shared with others)
- UV light
  - Need to be commissioned
  - Need to design shutter system to control flux
- DAQ and read-out
  - Use ILC computer
  - May borrow a laptop from SPP
  - Some software development needed to integrate hodoscope+TPC
- Team appointed on Sept. 22 to commission the most of it

Status update

- TPC
  - Endplate/viewports/PCB to be commissioned
  - HV (with Fisher plug) ready, ~~Need PCB termination plate~~ PCB received
- Micromegas Hodoscopes
  - Chambers ~~to be installed,~~ installed, but not final. To be optimized
  - Power supply (with 5 nA resolution) ~~ordered.~~ Powered
- Alignment: TPC and hodoscope need to be fixed
- Triggering
  - Scintillators + HV OK
  - One PM too noisy. ~~to be fixed~~
    Fixed: Gain optimized + black curtain
- Gas system
  - ~~Ready~~ (shared with others). Tested
- UV light
  - Need to be commissioned
  - Need to design shutter system to control flux
- DAQ and read-out
  - Use ILC computer
  - May borrow a laptop from SPP
  - Some software development needed to integrate hodoscope+TPC
    - On going work based on framework developped by Fabrice last year

Cosmic Triggers

- Expected cosmic muon rates per scintillator
  - ~ 100 Hz
- Gain optimized by Roy
- Properly screened with black curtain
  - Output rate of ~ 300 -800 Hz

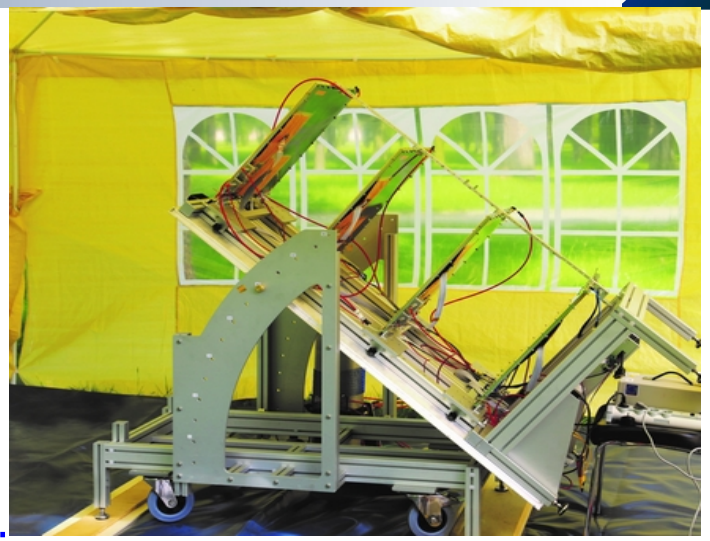


- We have also a 10 cm thick Pb screen

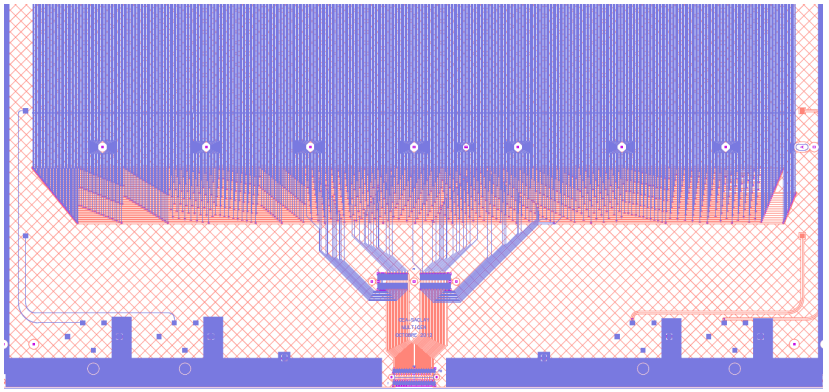
- Scintillators coincidence ~ 1.2 Hz.
  - Consistent with expected muon flux
  - Fortuitous coincidence < 1 – 5 %

- OK

Hodoscope chambers



- Use three micromegas chambers as developed for M-Cube project or Class12 tracker= large area micromegas
- Each chamber:
  - 50 x 50 cm^2 coverage.
  - Resistive strips
  - Two layers of orthogonal read-out strips
  - 1024 strip x 1024 strip → X x Y reconstruction.
  - Pitch: 500 μm. Expect <100 μm resolution ?
- "Genetic multiplexling" (Procureur et al, NIM A 729 (2013) 888)
  - 1024 strip → 61 readout channels
    - ~17 strip connected together.
    - Connections are optimized so that two-three fired channels uniquely defines two-three possible adjacent strips
  - Disadvantage: Very large capacitance → noisy detector

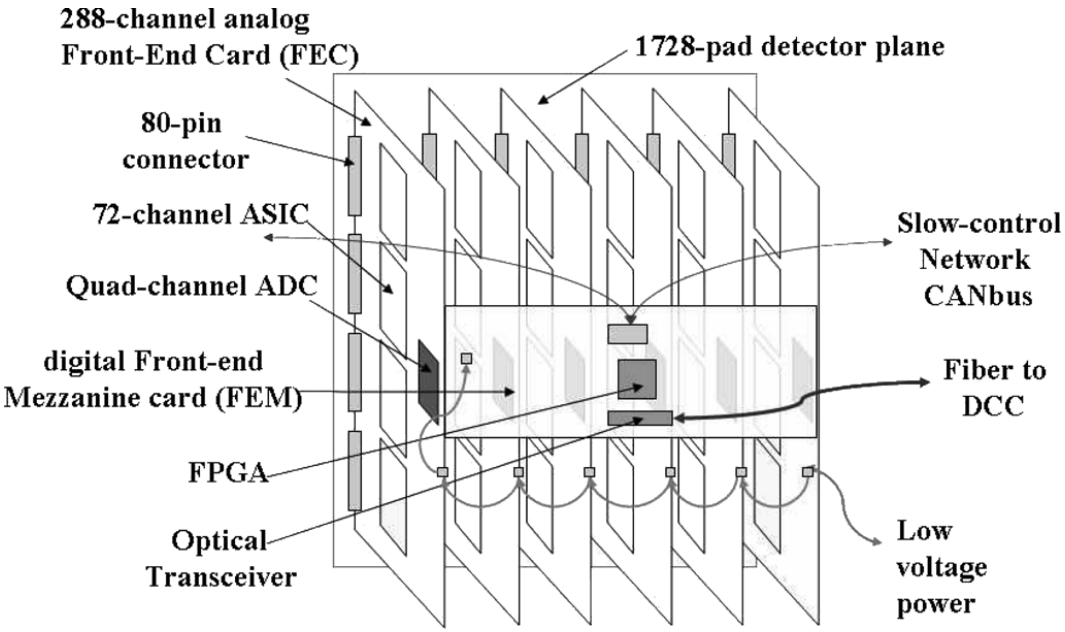


Hodoscope electronics and DAQ

Each layer = 61 readout channels

plugged to one ASIC of T2K electronic → Use T2K DAQ

- Asic 0 X-layer M3 chamber 1
- Asic 1 Y-layer M3 chamber 1
- Asic 2 X-layer M3 chamber 2
- Asic 3 Y-layer M3 chamber 2
- Asic 4 X-layer M3 chamber 3
- Asic 5 Y-layer M3 chamber 3

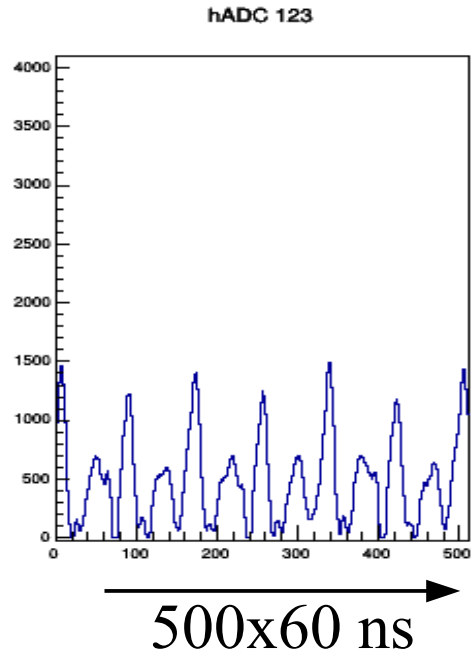


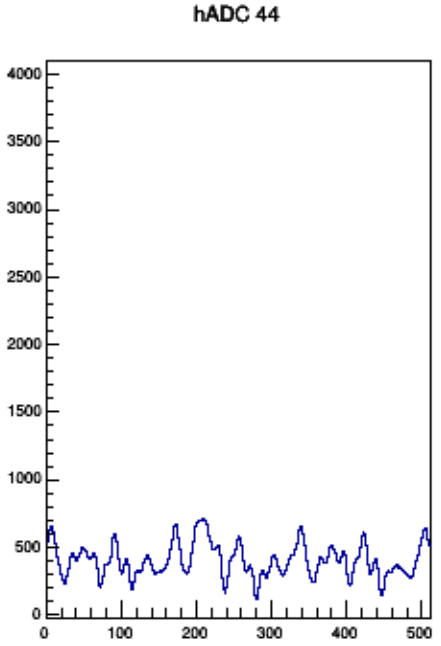
- Note: my X,Y notation is arbitrary however consistent for all detectors.

- Some issues with DAQ.
  - One of the backend (multi-FEM) system was freezing randomly
  - Used a backup backend card (single FEM) (same as for micro TPC)
  - This is a emporary solution
  - we will be running 2 FEMs to for the read-out of hodoscope+TPC

Noise in Hodoscope

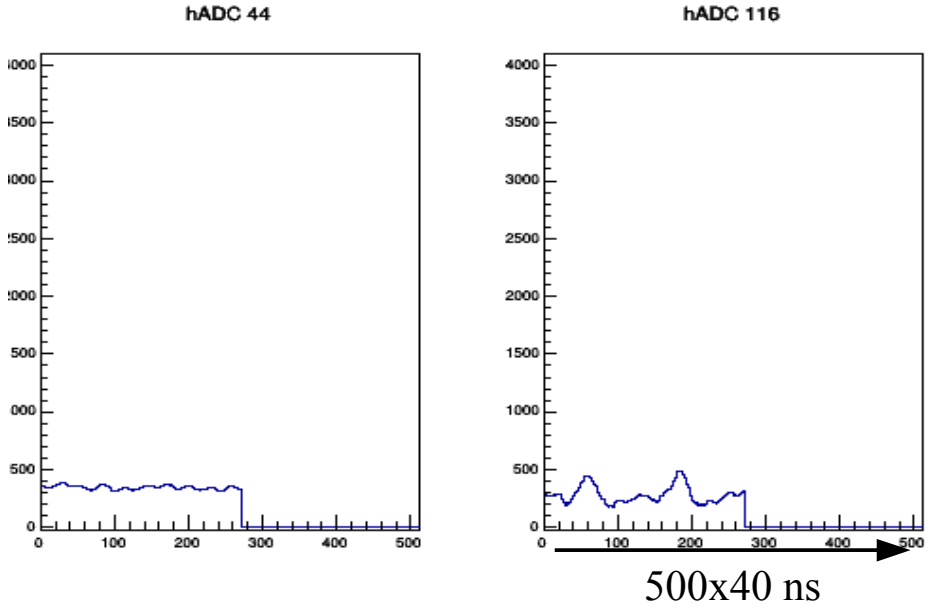
- First attempts with
  - 95% Ar + 5% Isobutane
  - Drift 500 V (~1cm), Micromegas 500V
  - Peaking time : 1000 ns to smooth backgrounds
- Typical output from a given channel
- A few days later
  - Clas12 detectors removed from the nearby room
  - Much quieter electrical environment

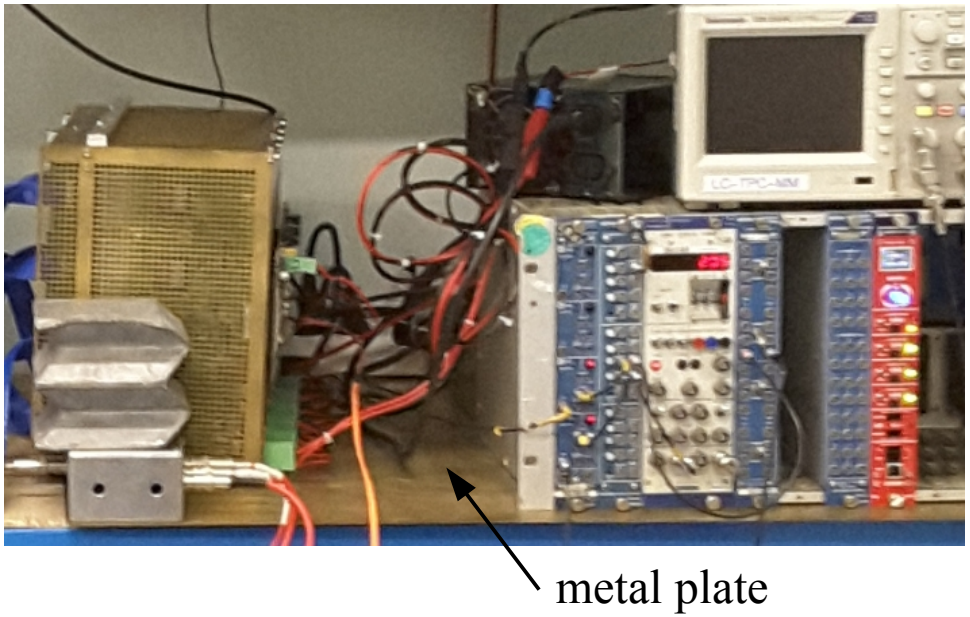




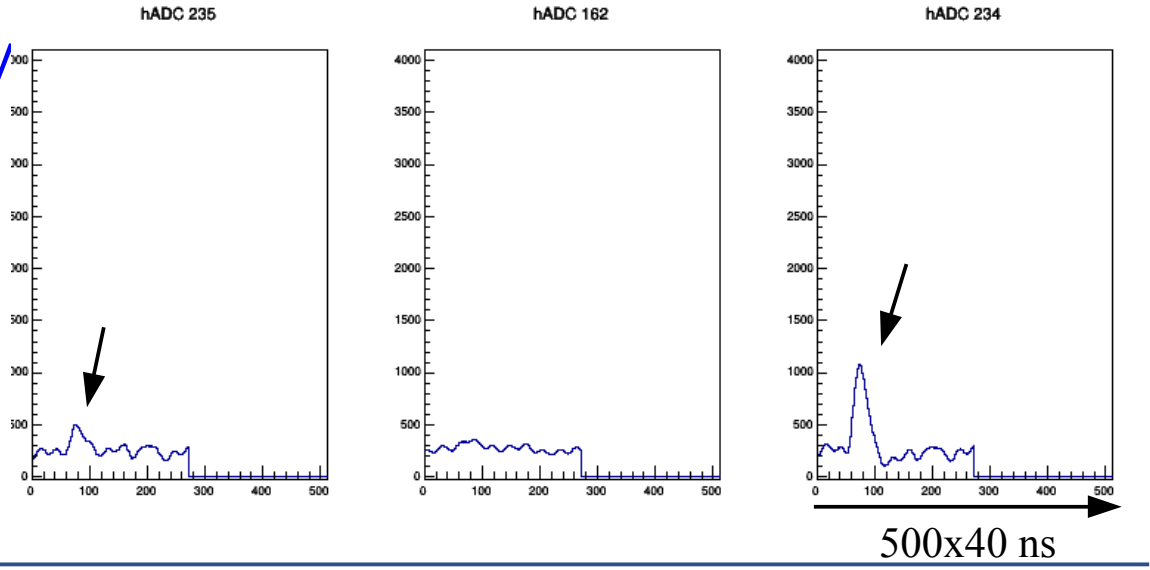
Noise reduction

- Use metal plate to properly ground power supplies, NIM rack, HV drift multiplexing box
  - Much better, but still some noise





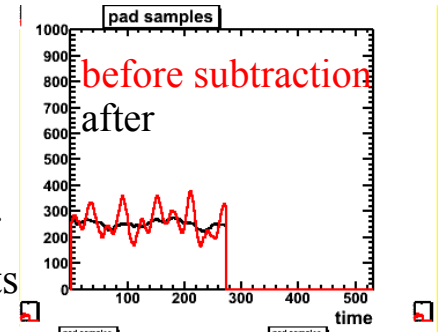
  - With slight increase (+10 V) in HV to increase gain
  - we are able to see muon triggered signal with these settings:



Common noise subtraction

- Need to use technique of “common noise subtraction”
  - For each time sample, remove the median charge seen among all other strips from the same layer.

example of noisy events

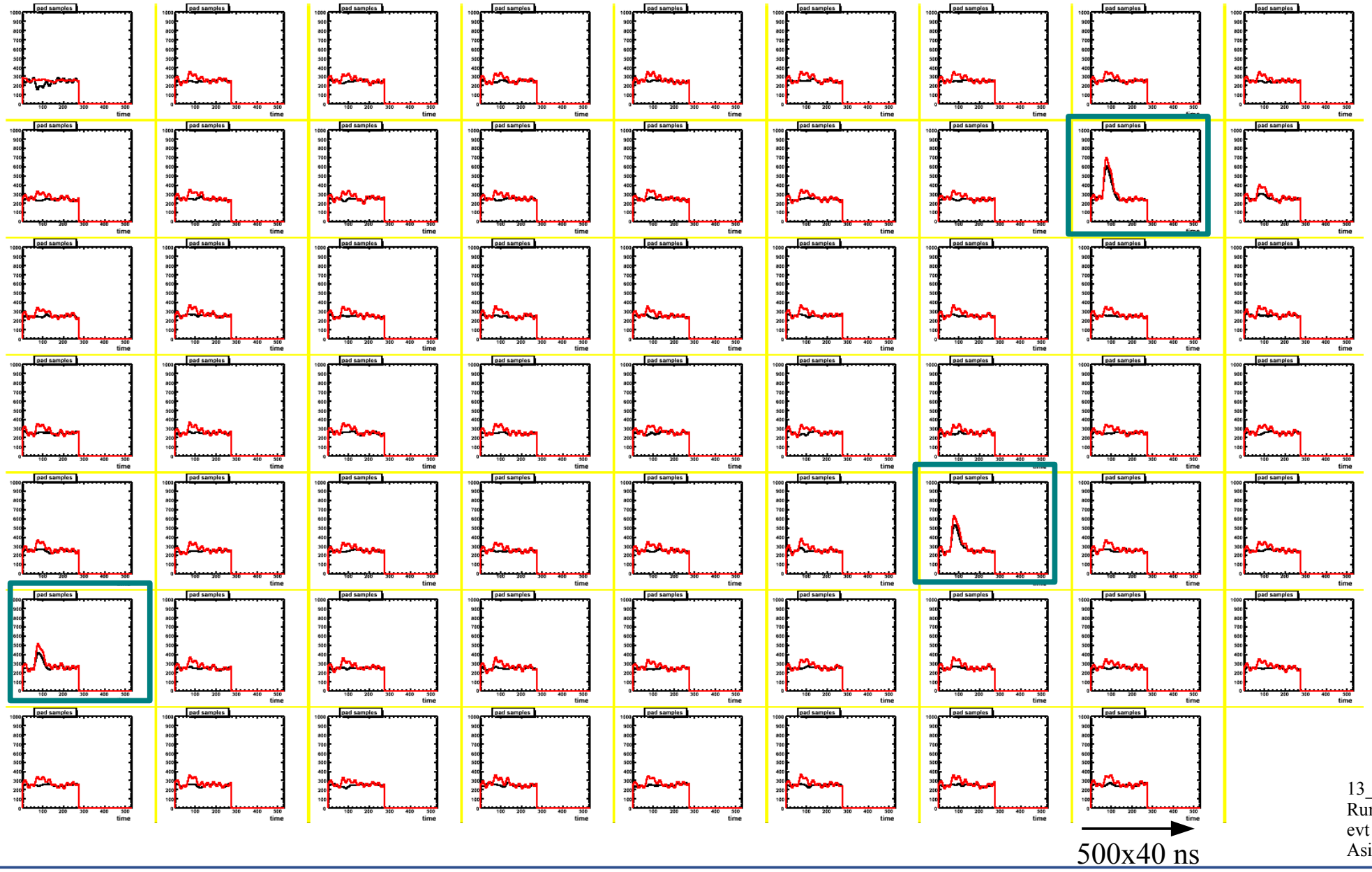


(almost) all strips from a given ASIC are displayed

13_2
Run 5
evt 10,
Asic 3

Noise removal (2)

- Good events: = only 3 strips with a hit.



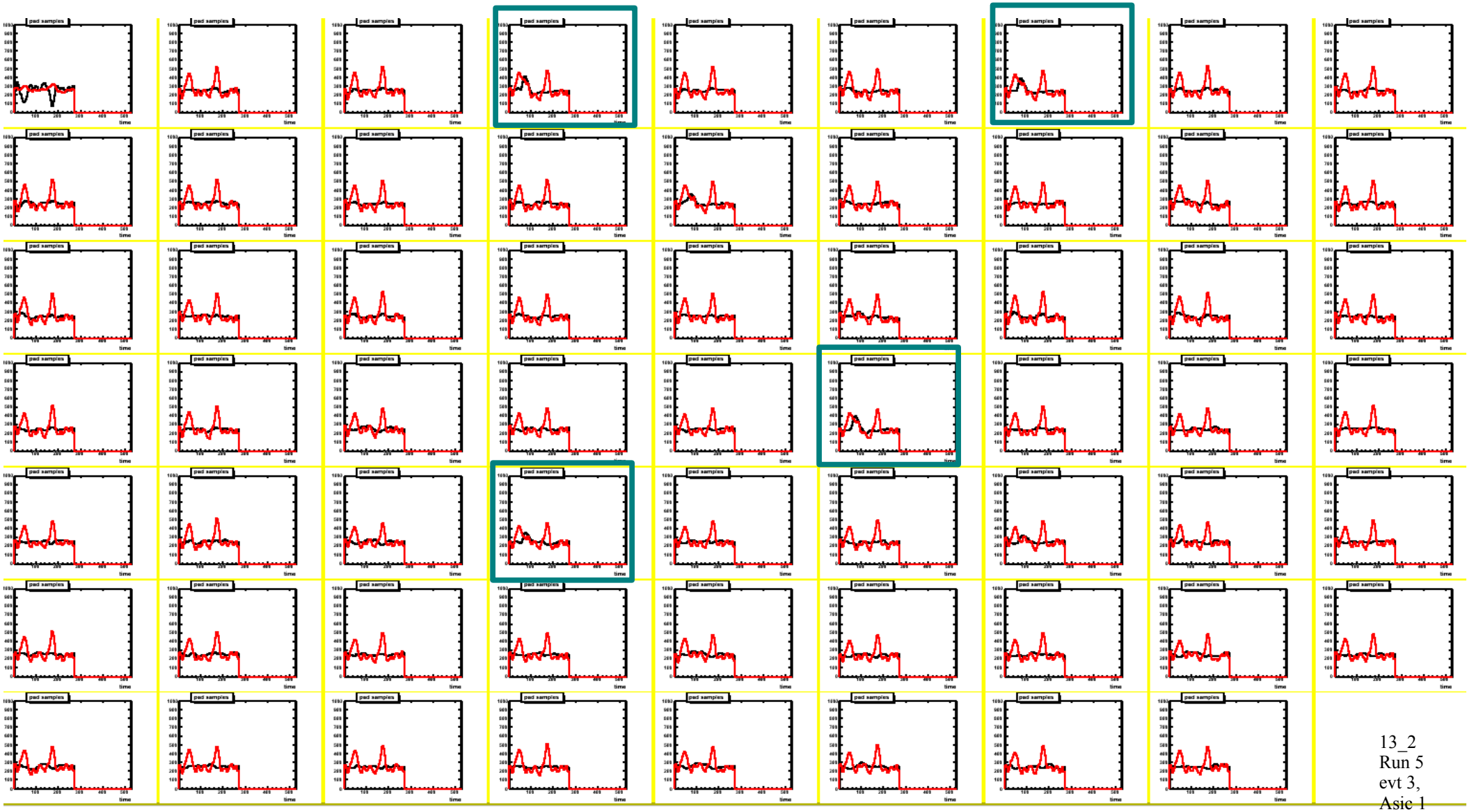
13_2
Run 5
evt 6
Asic 2

subtraction (3)

- looks like we can see physical hit with this technique

before subtraction

after



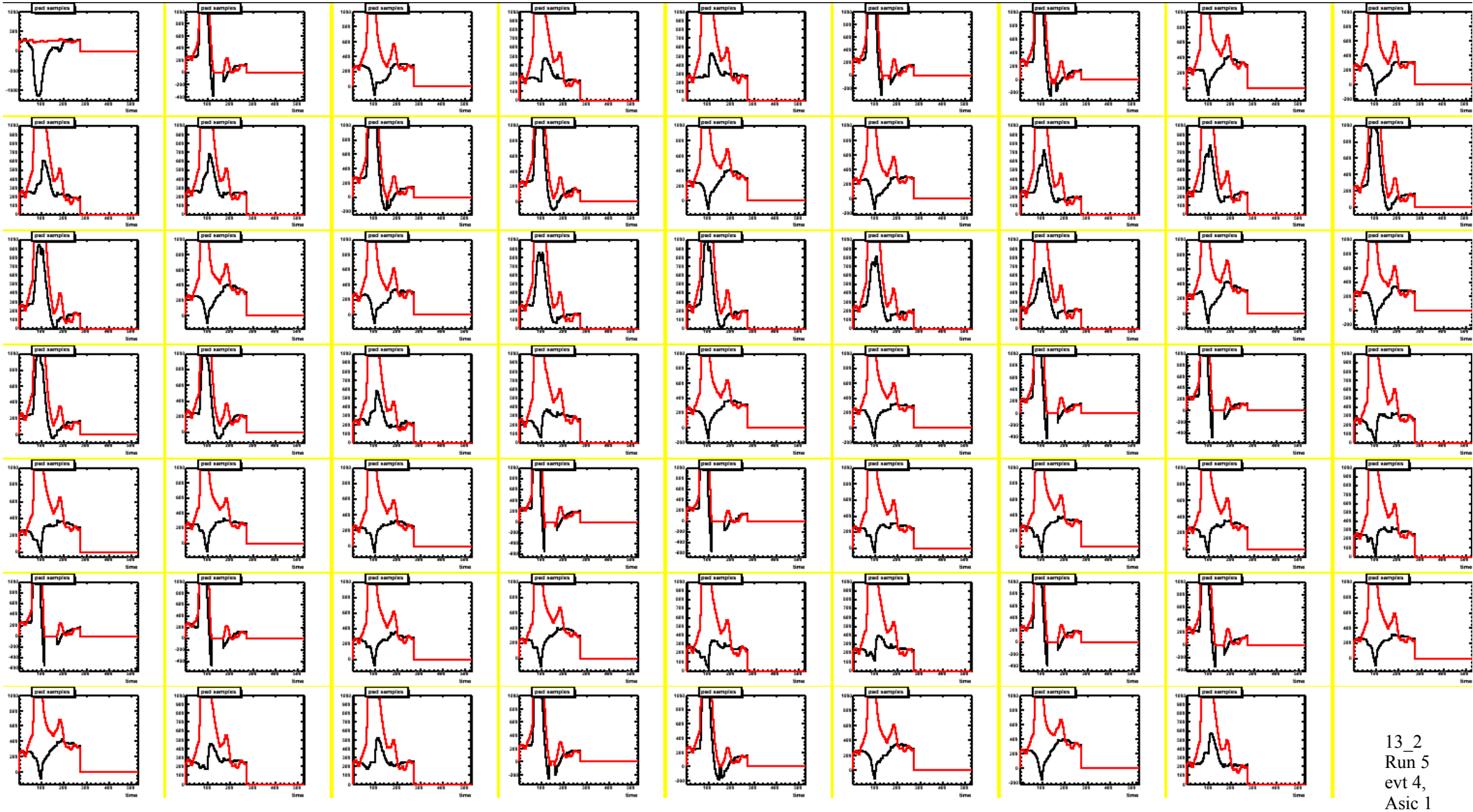
13_2
Run 5
evt 3,
Asic 1

detector is blinking

- looks like we can see physical hit with this technique

before subtraction

after

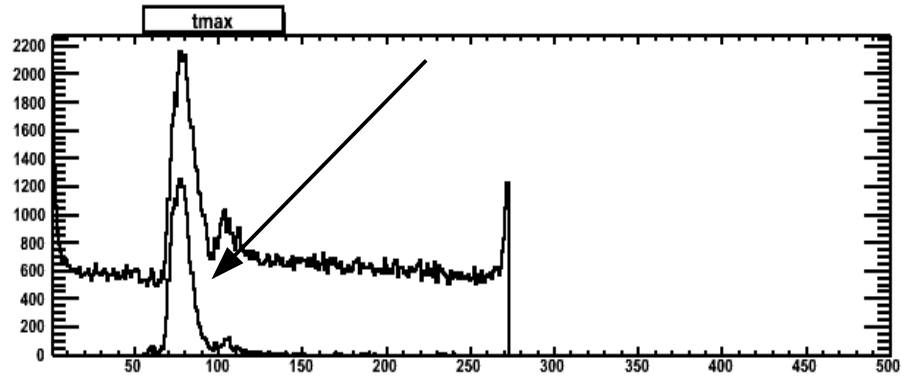


13_2
Run 5
evt 4,
Asic 1

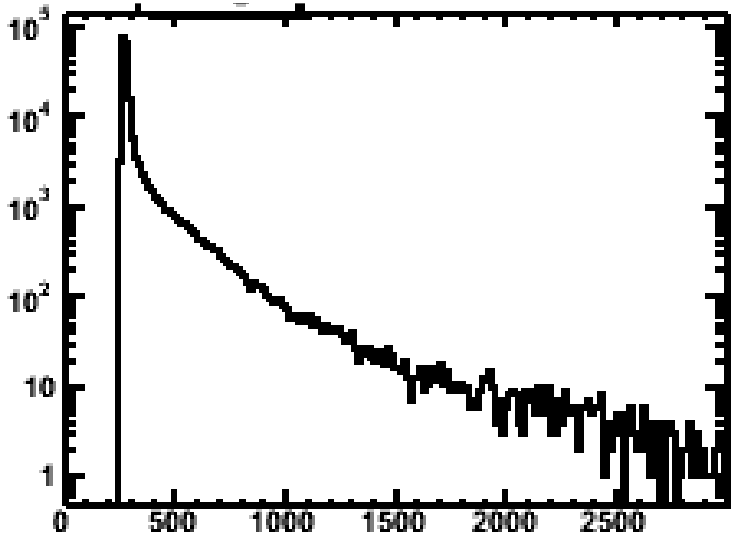
muon hit ?

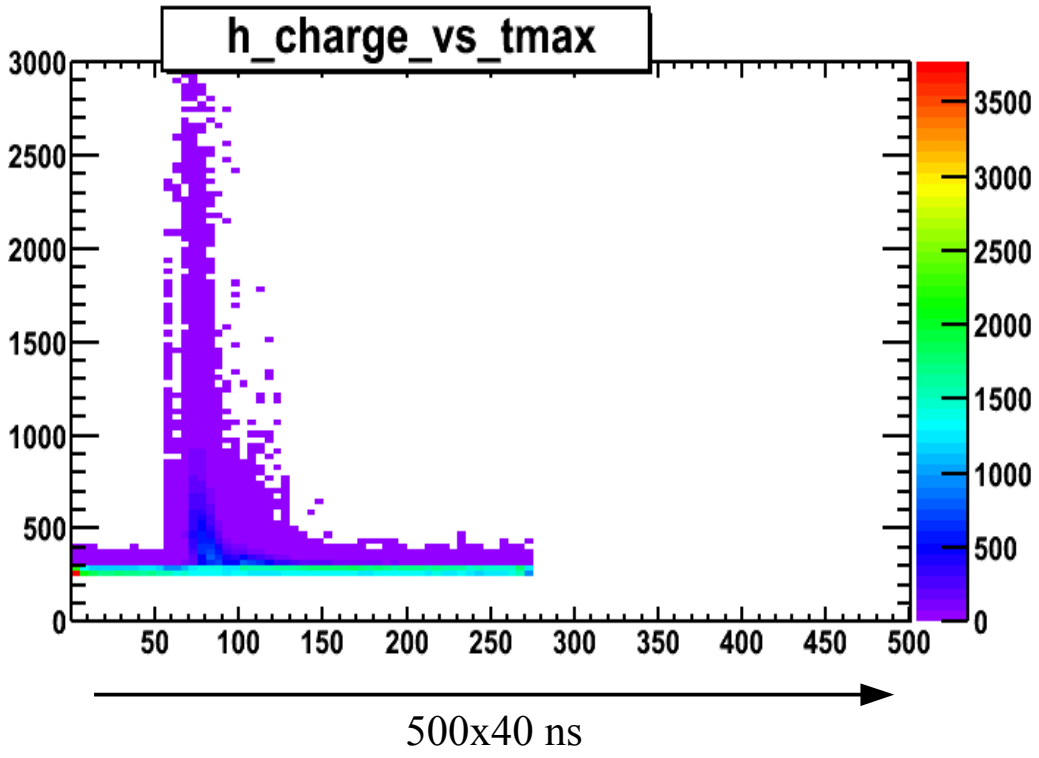
- Do we see real muons.
  - Maximum is always at the same time.
  - So this seems induced by the muons.

channels with peak above 400



distribution of maxADC

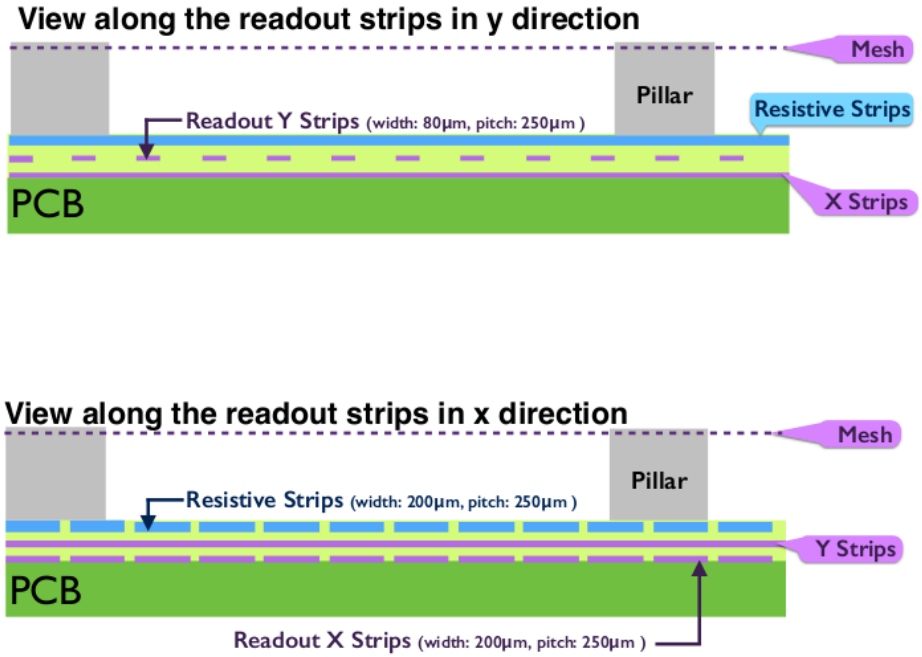


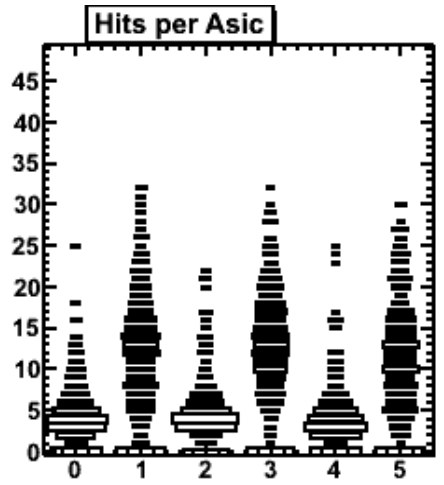


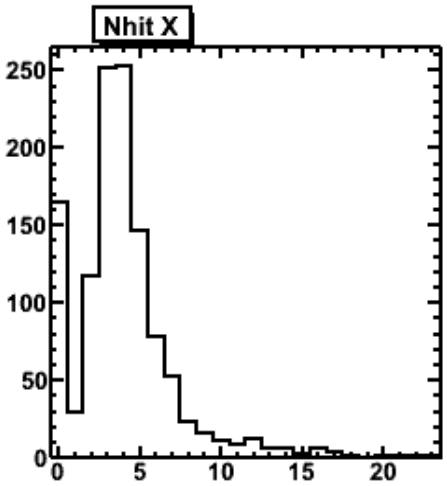
- No clear separation between signal and background !

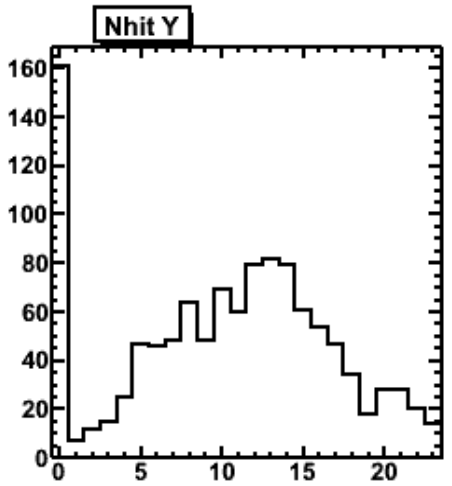
Premature to define hit in noisy environement ?

- Define hit as 60<t<115, ADC > 400
- Not same number of hits for X vs Y strips
  - too many hits to reconstruct something in Y layer
- Actually the two layers are physically different
  - Pitch is 500 µm
  - Different width of strips X,Y
  - Different position relative to resistive layer:
    - Smaller capacitive signal for the strip far away from the resistive layer









example from Atlas (Mamma) R&D

Conclusion Hodoscope

- Detector is running.
- Looks like we see muon hits
- Not sure we achieve good separation between signal and background..

- Still need some work to understand and tune the detector
- Then reconstruction of hit clusters... and tracks

Quick summary

- TPC chamber
  - Endplate/viewports/PCB termination plate to be commissioned
  - HV (with Fisher plug) ready,
- Micromegas Hodoscopes
  - Chambers running. Some work to understand detector and reconstruct muon track
- Alignment: TPC and hodoscope need to be fixed
- Gas system
  - ok. May be need to optimize gaz composition
- Muon Triggering
  - Scintillators + HV OK
- UV light
  - Need to be commissioned
  - Need to design shutter system to control flux
- DAQ and read-out
  - Use ILC computer
  - Software development ongoing to integrate hodoscope+TPC
  - Need to solve issue with backend electronics