Instruction for data acquisition and analysis with HIDRA and TROC1-2.

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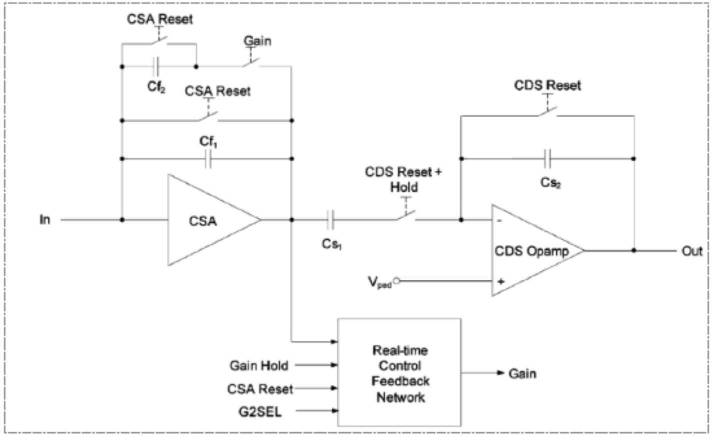
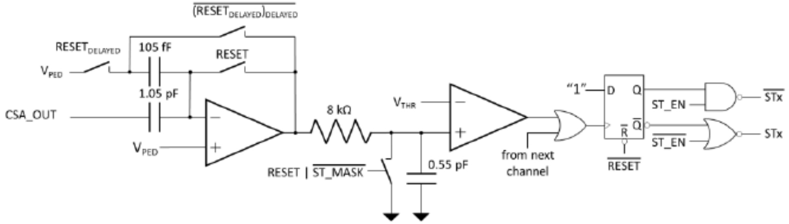
HIDRA chip

- HIDRA 2 chip: 16 channles, designed by INFN Trieste (Walter Bonvicini, Nicola Zampa, Gianluigi Zampa...):
  - Low noise: 2280 e - + 7.5 e - /pF.
  - Low power consumption: 3.75 mW/ch.
  - Double gain 1:20 with automatic gain selection.
  - High dynamic range: from few fC to 52.6 pC.
  - Self-trigger circuit (fixed thresholds).
  - Typical integration window ~ 10 us.

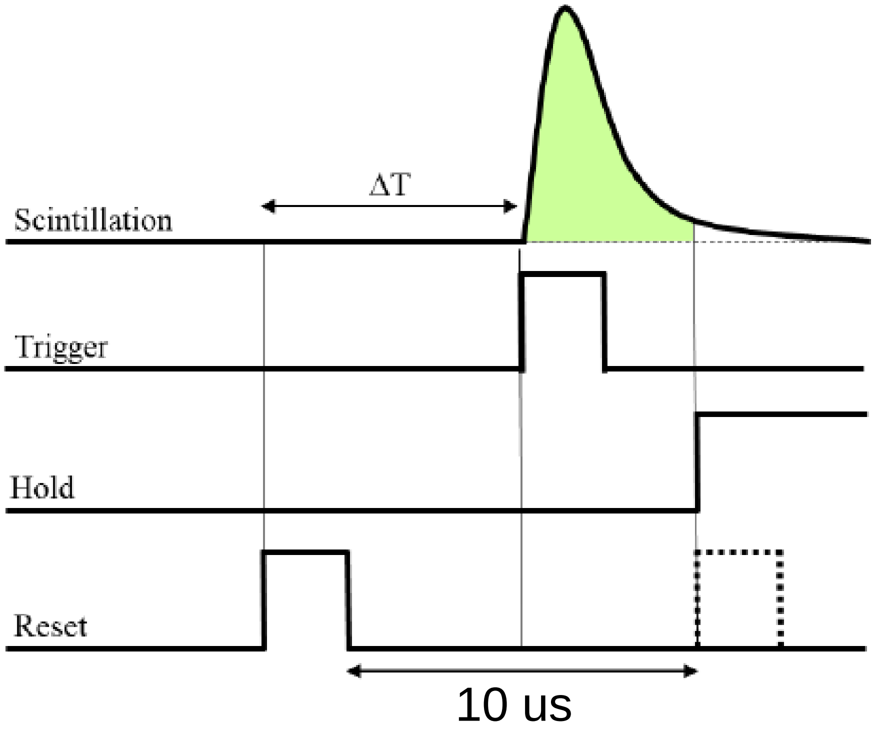


- Charge Sensitive Amplifier with automatic gain selection (CSA)
- Correlated Double Sampling (CDS)
- Self-tirgger circuit



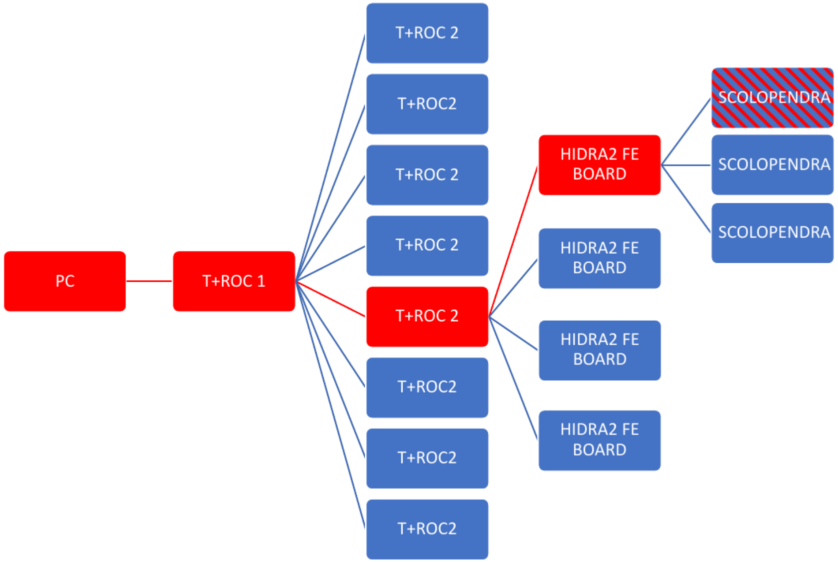
Casis Time and other signals

- HIDRA integrates signal for a fixed amount of time.
- The integration window is between two consecutive resets (10us in this config.)
- The distance between the first reset and the trigger is named casisTime (in clock unit: 16.66666 ns).
- After a trigger the Hold signal goes to 1 at the end of the integration window, it indicates that the events have to be “stored”.
- As soon as all the data are correctly transmitted to the PC, the Holds goes to 0.
- Just after the trigger arrives, the Busy goes to 1 and it returns to 0 when the Hold returns to 0.



TROC1-2 + HIDRA system

General view:



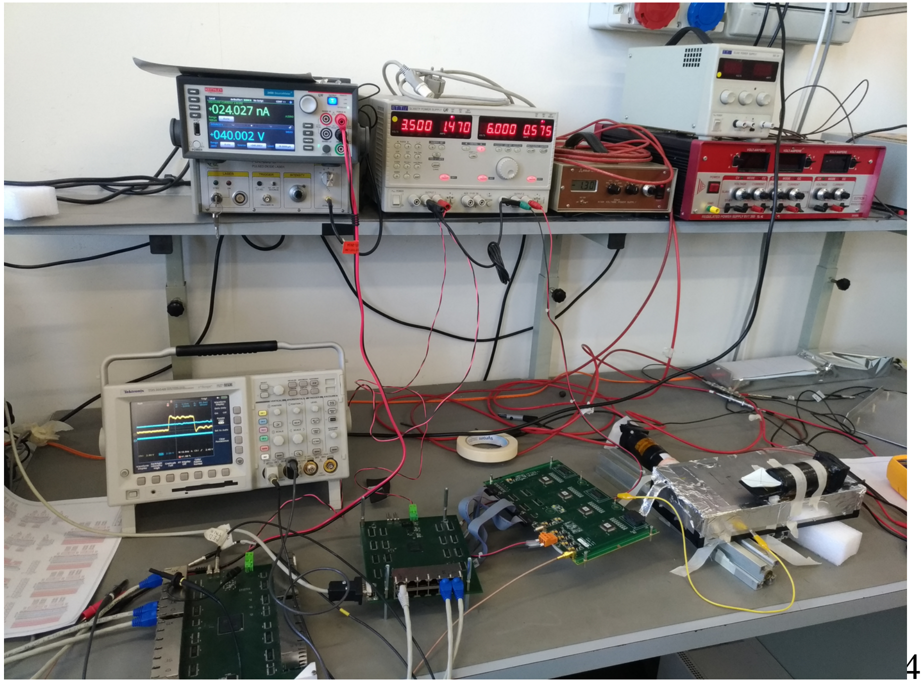
TROC1 accepts 2 independent LVTTL triggers: pedestal and physics.

In lab., single HIDRA board:

Power:

TROC1 and TROC2: 3.5 V

HIDRA: 6V



Configurations

- To install the software: download the code and follow the README:
  - git clone git@git.recas.ba.infn.it:herd/CaloCubeBTsoftware.git
- Update the code (tray to update at least each month): from the code root folder
  - git pull origin master
- Compile the code: from the code root folder
  - make clean; make all
- Configuration of boards:
  - Connect USB cable to TROC1 and PC.
  - Switch ON the boards.
  - From the code root folder launch: bin/acquire_TROC -C

Acquisition

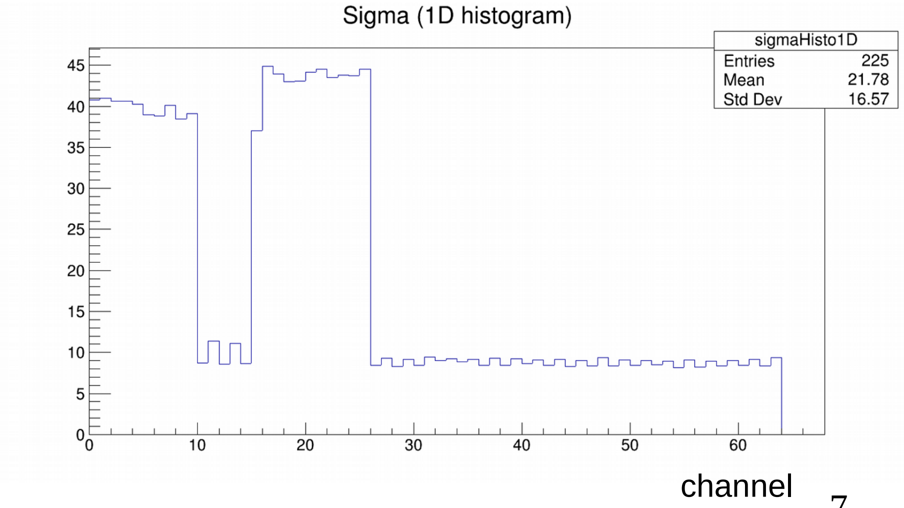
- A typical acquisition, after configuration:
  - From the code root folder launch: "bin/acquire_TROC -n NumberOfEvents -i NumberOfFile -D OutputDir"

-n	number of events to be acquired in each file
-i	number of files to be acquired in sequence
-c	activate chip calibration mode (to be described during next meetings, do not use so far)
-k	calibration scheme (0-Even,1→Odd,2→Both) (do not use so far)
-g	set gain: force gain (low gain)
-d	set gain hold delay coarse (ns): default = 1000 ns
-z	set hold delay coarse (ns): default = 0 ns (do not use so far)
-o	output file, default: %Y%m%d_%H%M%S.dat
-D	output directory, must be specified!
-C	load config files before starting the first acq
-I	inhibit files from config loading ("CAL SEQ HST THR") (do not use so far)
-S	terminal output formatted for python script (do not use so far)
-v	set verbose mode
-h	help

Analysis software: main feature

- Now it is configured to read-out only one TROC-2 and one HDRA board, 4 HIDRA chips.
- Convert from binary to ROOT data, TTree name: data, raw ADC channels are saved in raw[chip][chan].
- Subtract the pedestal mean and compute the noise: ADC pedestal subtracted are saved in adc_cn[chip][chan]
- Compute the common noise (se later) and compute the CN subtracted value: adc[chip][chan].
- Fill several histograms which contain the noise and the mean pedestal for each channels:
  - Channel ID = chip_number*16 + channel_number

KEY: TH1F	pedHisto1DRaw;1	Pedestals (1D histogram) raw
KEY: TH1F	sigmaHisto1DRaw;1	Sigma (1D histogram) raw
KEY: TH1F	pedHisto1D;1	Pedestals (1D histogram)
KEY: TH1F	sigmaHisto1D;1	Sigma (1D histogram)
KEY: TH1F	pedHisto1DTrue;1	Pedestals (1D histogram) true
KEY: TH1F	sigmaHisto1DTrue;1	Sigma (1D histogram) true
KEY: TH1F	sigmaHisto1DCube;1	Sigma (1D histogram) instrumented
KEY: TH2F	alphaHisto2D;1	Alpha (2D histogram)



Run analysis

- Run analysis with pedestal trigger only, or where pedestal and physics triggers are stored inside the same binary file:
  - bin/analyze_alone -T input_file.dat output_file.root or
  - bin/analyze_alone -T -O Path_to_acquired_files/file.dat (the output file will be created as: Path_to_acquired_files/../analysed_files/file.root)
- Run analysis with physics trigger only, using pedestal form a different root file (produced by analyze_alone)
  - bin/analyze_alone -T -c pedestal_file.root input_file.dat output_file.root or
  - bin/analyze_alone -T -c pedestal_file.root -O Path_to_acquired_files/file.dat

The options: -c <file.root> Read pedestals and sigma from file.root

-n <iters> Set the number of iterations (default: 3)

-t Random and Physics Trigger are inverted

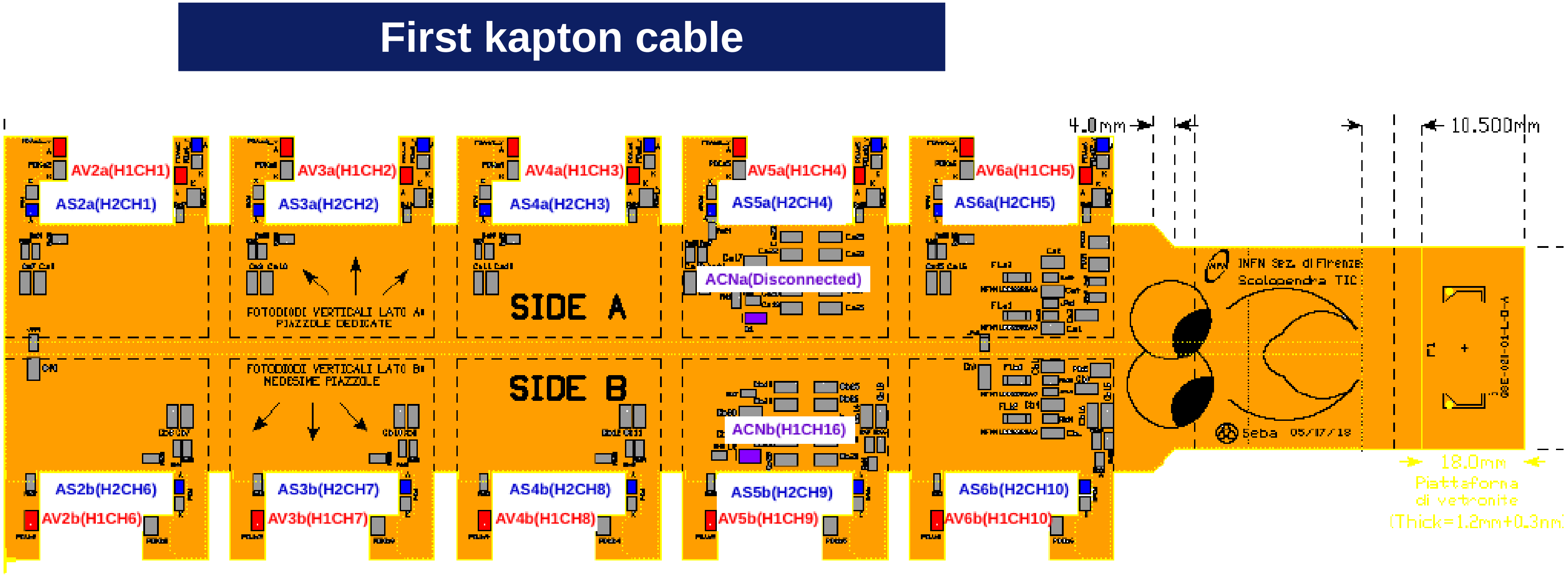
-v Be verbose

-O Save a file with the same name (.root) inside the following folder: datFileFolder/../analysed_files

-T TROC data format (mandatory)

Channel connections

- The current kapton cable (beam test version will be available in July)



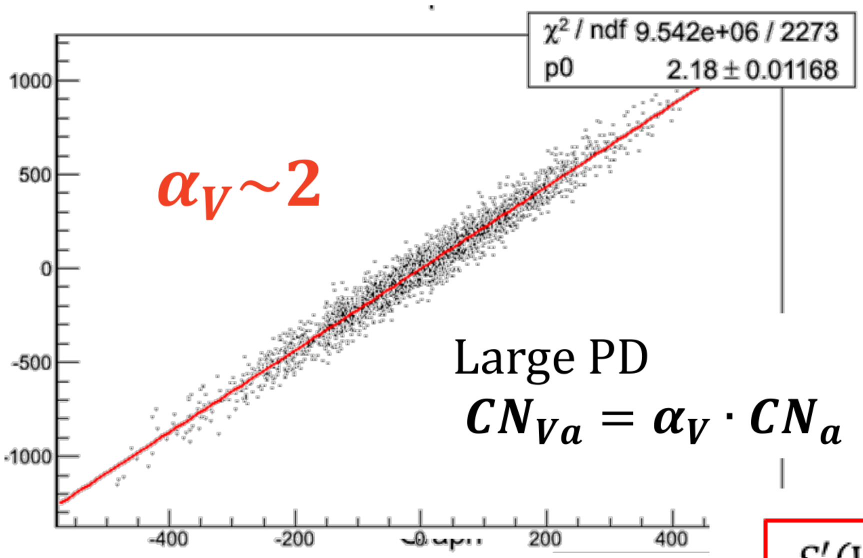
See the attached document for the description of all the cables

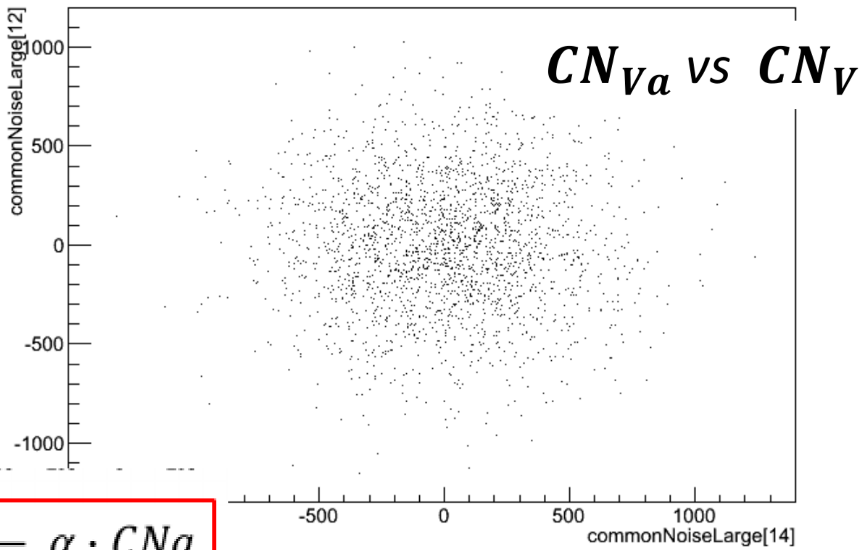
- Small PD
- Large PD
- CN Diode

AV1a, AS1a, AV1b, AS1b - Disconnected

Common noise

- CN subtraction procedure, using blind diode connected to chan. 16 (starting from 1).
- Linear fit of each PDs vs the blind diode.
- Using the fit parameters to compute the corrected signal.

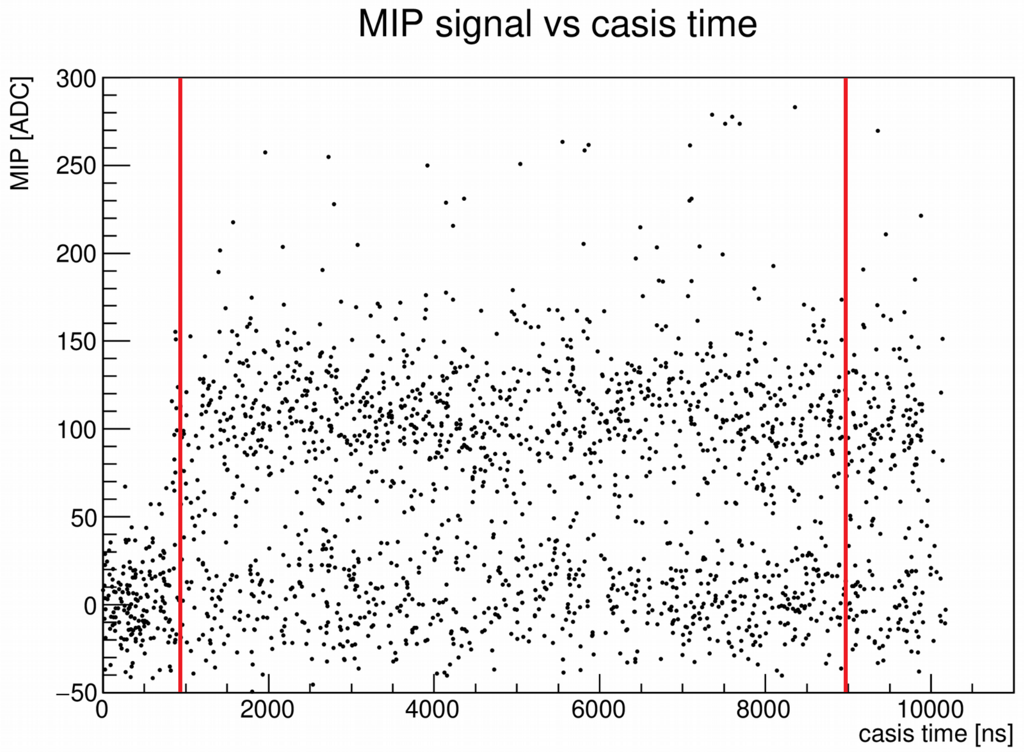




$$S'(V4a) = S(V4a) - \alpha \cdot CNa$$

MIP signals vs the casisTime

- MIP acquired with LPD+LYSO cube.
- Trigger done with 2 scintillators which are larger than the cube.
- Triggers nearby the reset and hold signal should be rejected.
- Events with true MIP signal are around 100 ADC, other events nearby 0 are particles outside the cube



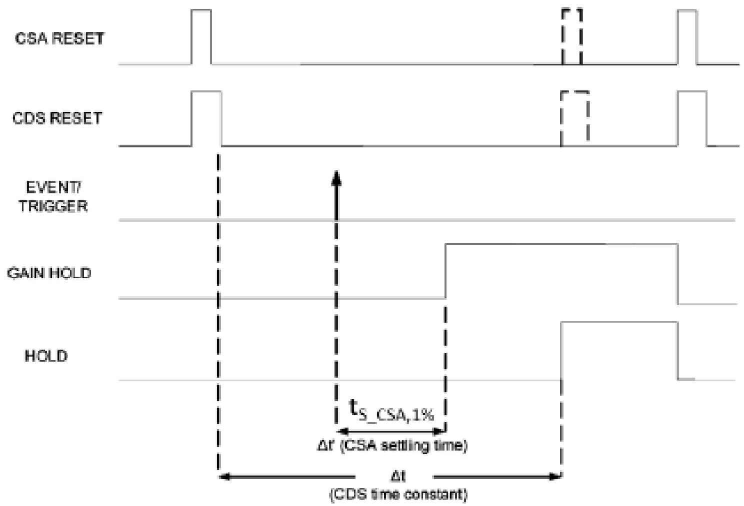
Casis time ranges to be rejected:

Casis time < 1000 ns (~60 clock cycles

Casis time > 9000 ns (~ 540 clock cycles)

Gain and self trigger.

- HIDRA has 2 gains, automatic gain selection.
  - gain[][] contains a bool = 1 if low gain, 0 if high gain
- HIDRA can provide information about the self-trigger: each channel is connected to a threshold discriminator, and a single trigger is computed as the OR of two consecutive discriminated signals.
  - selfTrigger[][] contains a bool which is 1 if the trigger is hit, 0 if it is not
  - Example: selfTrigger[0][5]=1 means that the channel 10 OR 11 is above the selected threshold.
- Gain hold signal: it is asserted after a fixed time (default = 1us) with respect to the trigger: it disables the self-switching gain, it is very important when the signal is very close to the low gain threshold.



Main TTree (data) variables.

eventInfo : trigger/I	0x20 for physics trigger, 0x40 for pedestal trigger
casisTime :casisTime/I	casis time measured in clock cycles (16.6666ns)
gainBranch : gain[16][16]/S	1 if low gain, 0 is high gain
rawBranch : raw[16][16]/F	ADC raw signals (negative if it is in low gain)
signalBranch : adc[16][16]/F	ADC signal, pedestal subtracted, gain corrected, CN corrected.
signalCNBranch : adc_cn[16][16]/F	ADC signal, pedestal subtracted, gain corrected.
selfTrigger : selfTrigger[16][8]/O	self trigger information, which merges two nearby channels.
timeTag : timeTag/I	acquisition time of each events (us).
LADC.nHits : nHits/I	Number of hits for cube read-out by LPD
LADC.hitRow : hitRow[LADC.nHits]/I	The raw of each hit (LPD)
LADC.hitCol : hitCol[LADC.nHits]/I	The col of each hit (LPD)
LADC.hitLayer : hitLayer[LADC.nHits]/I	The layer of each hit (LPD)
LADC.hitGain : hitGain[LADC.nHits]/I	Gain of each hit (LPD)
LADC.hitSignal : hitSignal[LADC.nHits]/F	Signal, ADC, of each hit (LPD)
LADC.hitChip : hitChip[LADC.nHits]/I	Chip of each hit (LPD)
LADC.hitChan : hitChan[LADC.nHits]/I	Chan of each hit (LPD)

(SADC $\rightarrow$ small PD, WADC $\rightarrow$ WLS fibers+SiPM)

The hit definition must be updated.