# CBC 2 offset tuning

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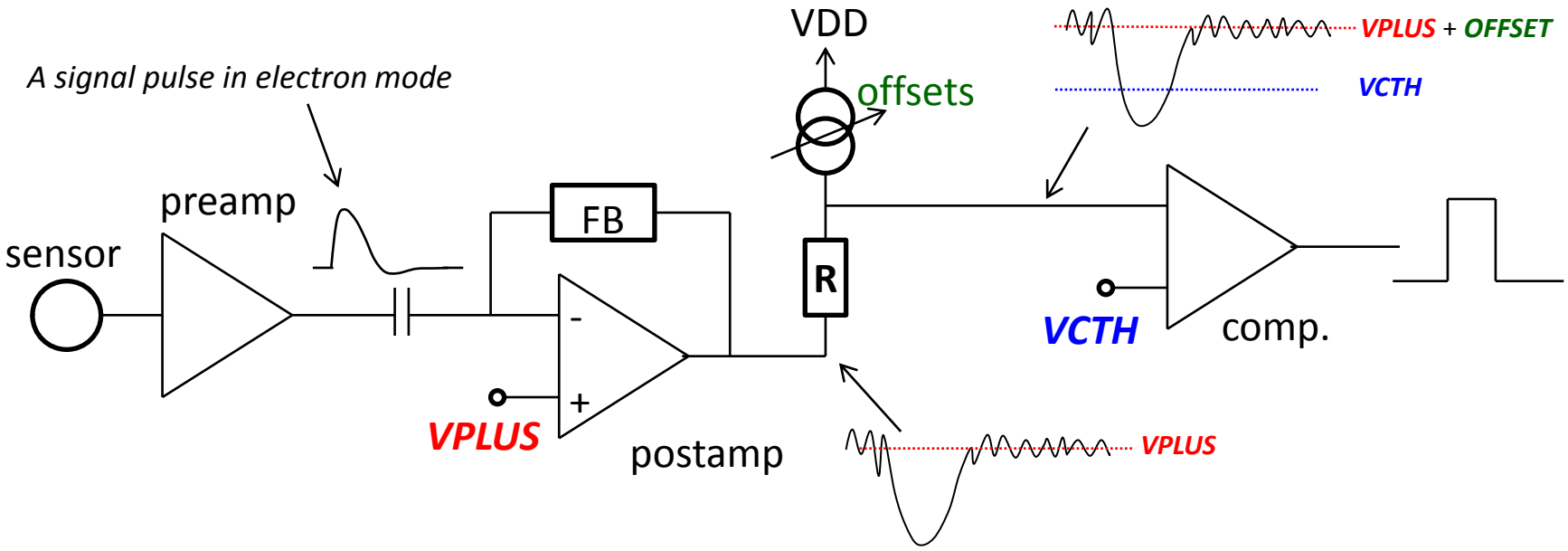
# CBC 2

- Registers for the tuning

  **VPLUS : DC baseline voltage setting at the postamp output for all the channels in the chip**

  **VCTH : The comparator threshold voltage setting for all the channels in the chip**

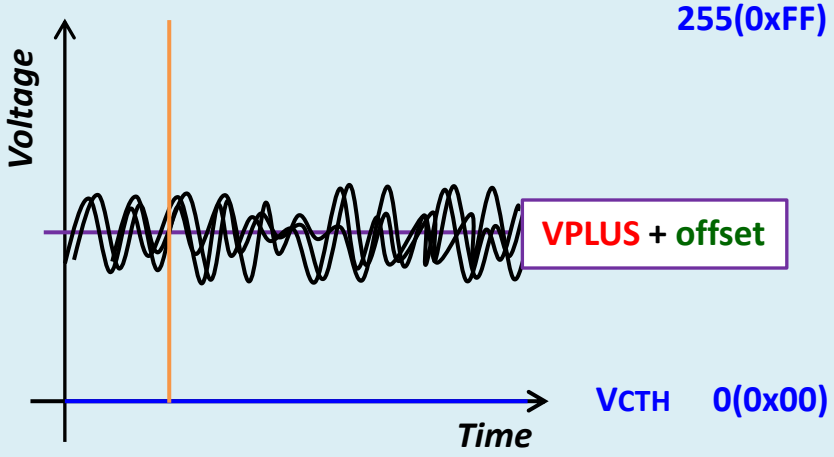
  **OFFSET : Individual fine tuning of the DC voltage for each of 254 channels.**

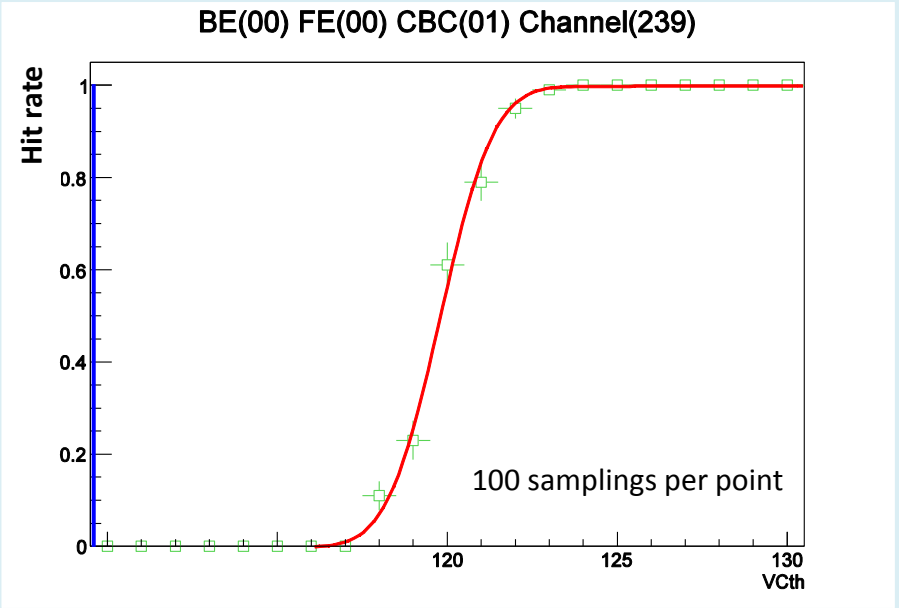


# S-curve for pedestal

- A comparator threshold (VCTH) scan fixing other registers on pedestals
  - **S-curve : hit rate vs. VCTH**

***electron mode pedestal scan (no test pulse)***

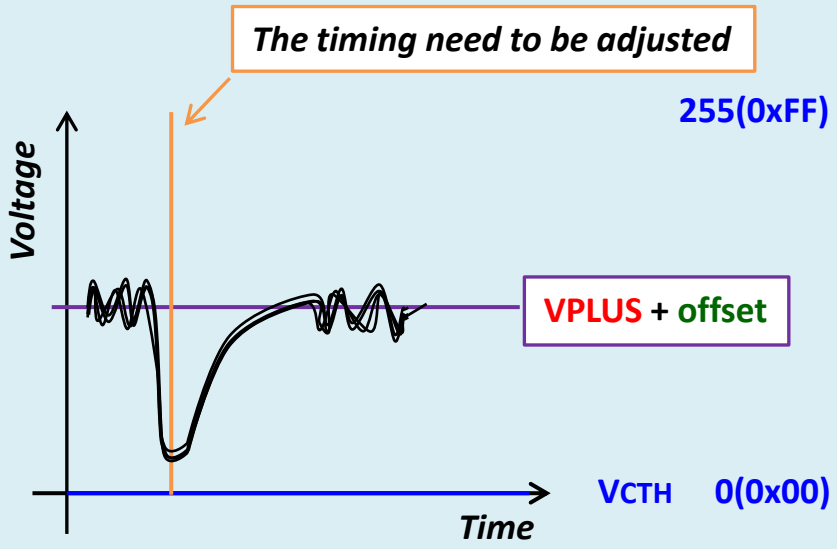


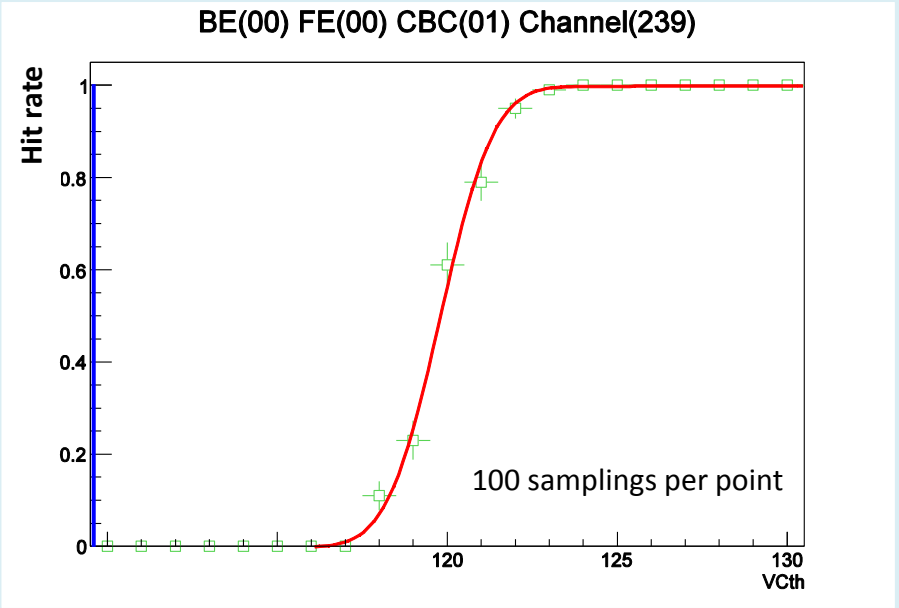



# S-curve for test pulse

- A comparator threshold (VCTH) scan fixing other registers on a certain size of test pulse
  - **S-curve : hit rate vs. VCTH**

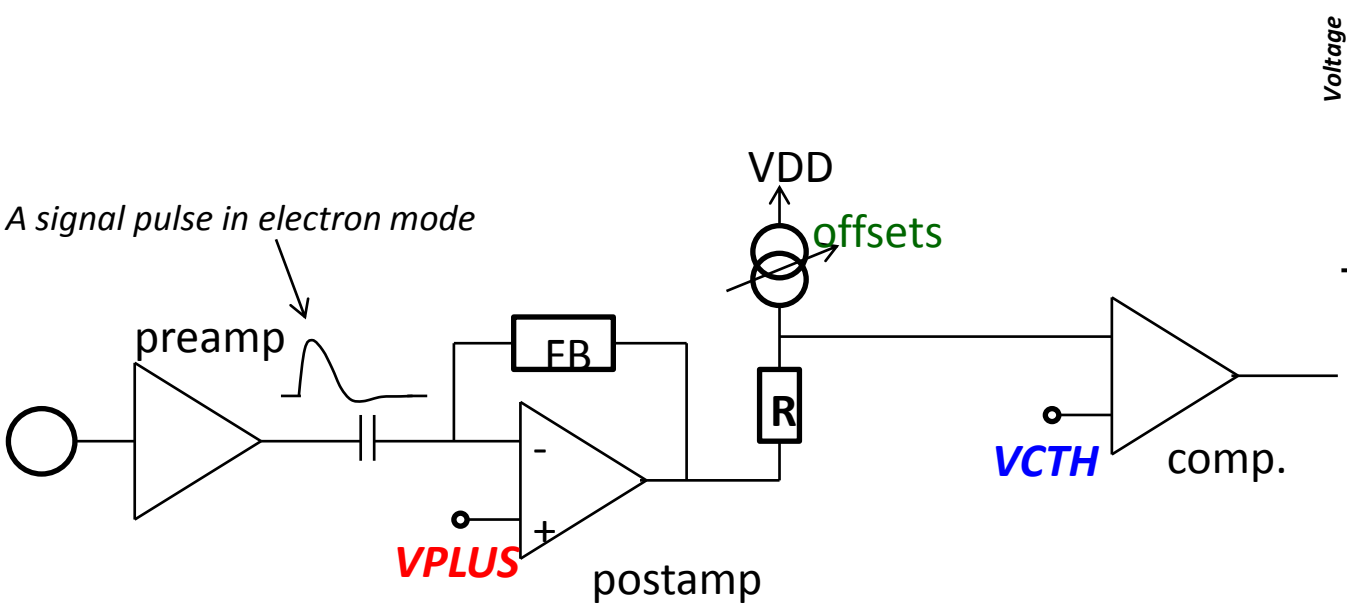
***electron mode with test pulse***

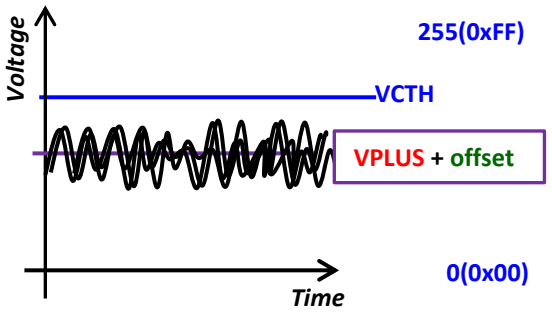


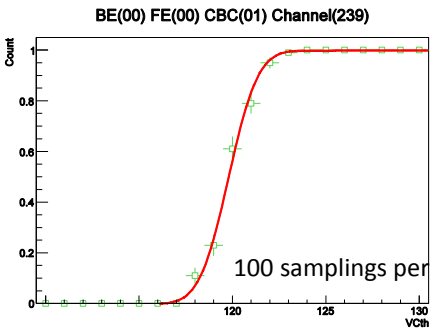



# Offset tuning

- **Objective**
  - Alignment of the pedestals of all the channels at the comparator input in the middle range of power supply.
- **Strategy**
  - Alignment of the s-curve of pedestals for all the channels
    50% hit rate point for a certain **input** corresponds to a certain **VCTH** value (target VCTH s-curve mid-point) for a suitable choice of value for the **OFFSET** register for each channel and **Vplus**.



# Offset tuning strategy – input

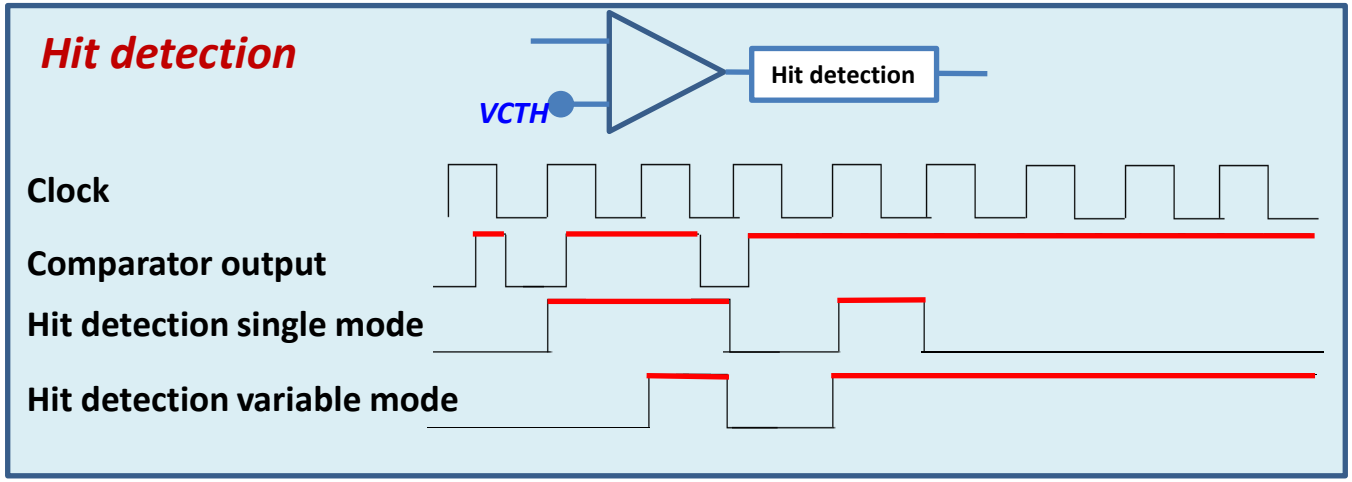
- Up to this proposal, offset tuning has been done with hit detection in single mode (detects an edge and create single clock cycle hit) with small test pulse.
  - Advantage :

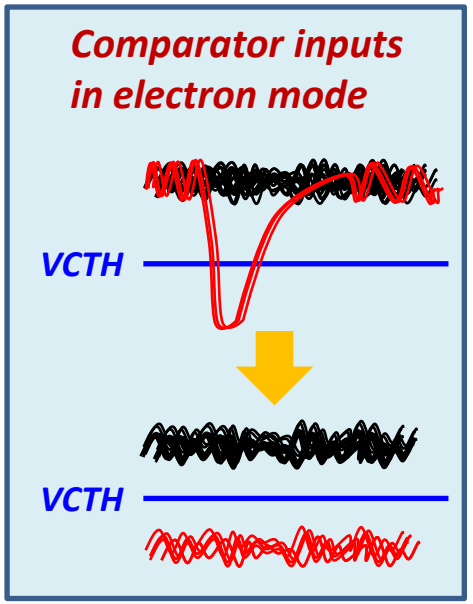
    All channels not firing at once since test pulses are created for 32 channels at once.

    (firing all the channels create oscillations in the circuit)
  - Disadvantage:

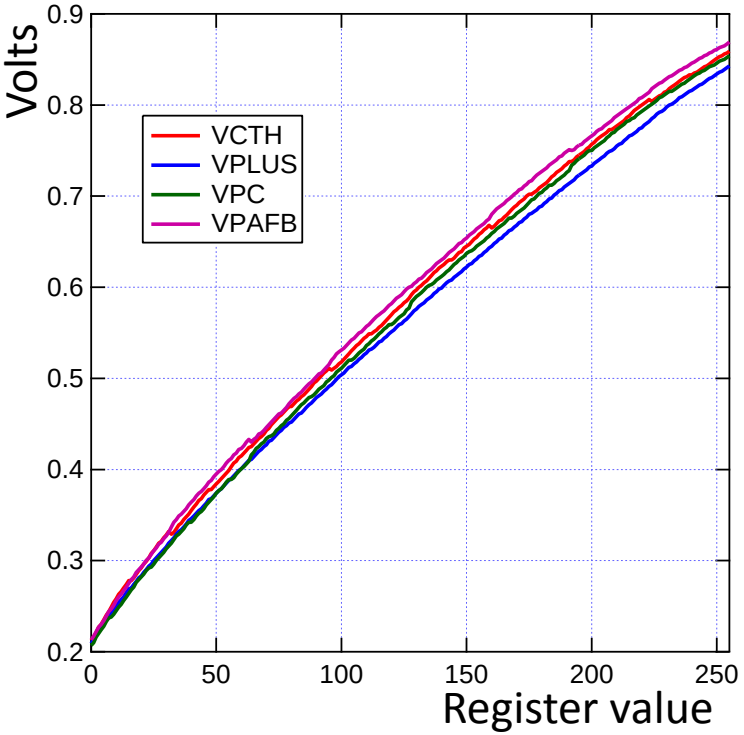
    Resolutions of the timing(?) and size of the test pulse (20%-30%).

- In this proposal, offset tuning is done in hit detection variable mode without test pulse but tuning is done in a group setting other channels offsets to be 0xFF (0x00) for electron (hole) mode.



# Offset tuning strategy – VCTH and VPLUS



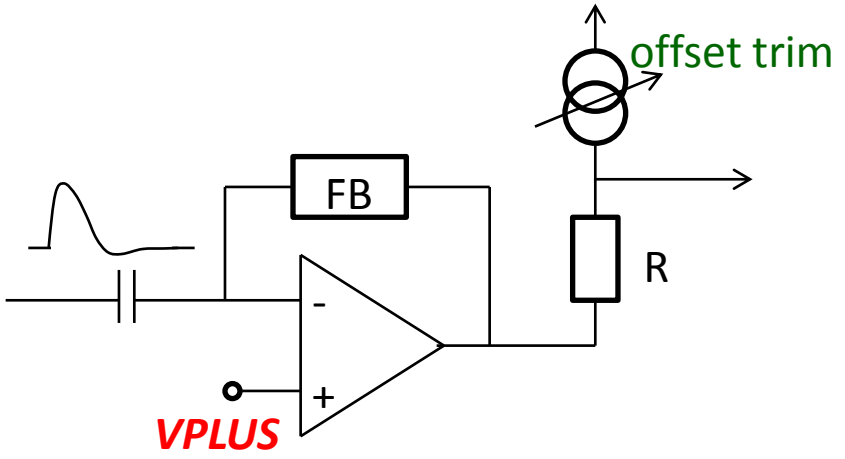

- Generated in the same way.
  The range of the voltages are ~ the same.
  ( some chip-to-chip variation)
- Not perfectly monotonic.
  It might be better for VCTH to be monotonic and to be solved in CBC3
- Resolution : ~ 2.5mV(~300 e)/register unit
  A plan to improved resolution for CBC3

**VCTH non-monotonicity should be considered in offset tuning and threshold .**

*0x80 and 0x7F are to be avoided as the target mid-point in the offset tuning and the threshold setting.*

➢ ***0x78 is chosen for the target VCTH s-curve mid-point for the pedestal***

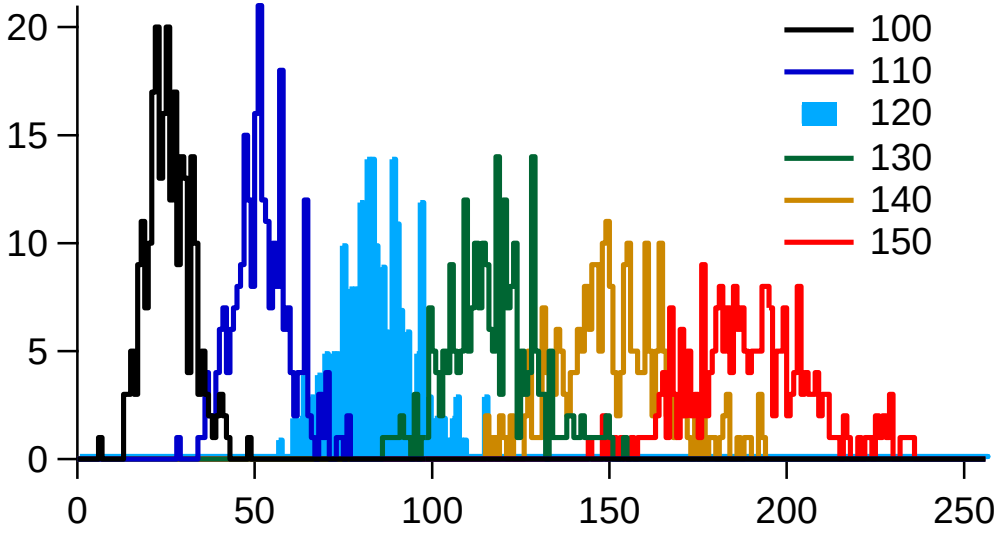
# Offset tuning strategy – OFFSET

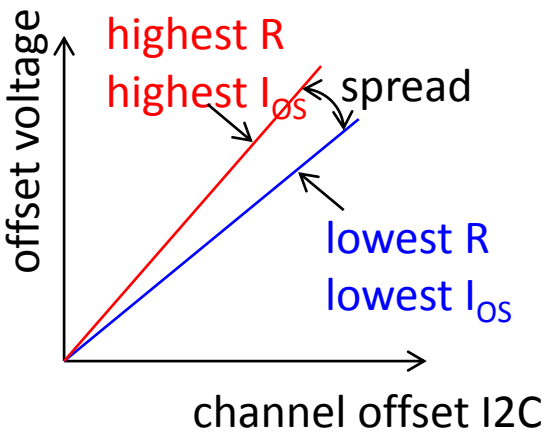



- Offset cannot be 0.
- Study of offset tuning with different target VCTH s-curve mid-point shows increase in the spread with high target value (high offset values).

  Due to spread in current DAC and offset resister values across the chip.

➢ ***Just aim to have the average ~ 80***



# Offset tuning procedure

1. Obtain **VPLUS** value with all OFFSETs at 80(0x50) which gives S-curve VCTH mid-points of pedestals at 120(0x78) in average.

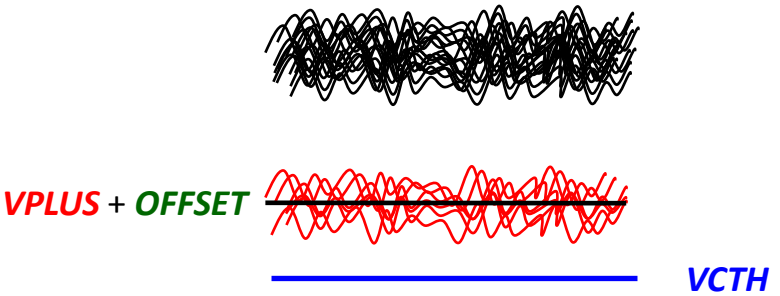
2. Optimise **OFFSET**s with the VPLUS to have S-curve VCTH mid-points of all channels at 120(0x78) for pedestals.

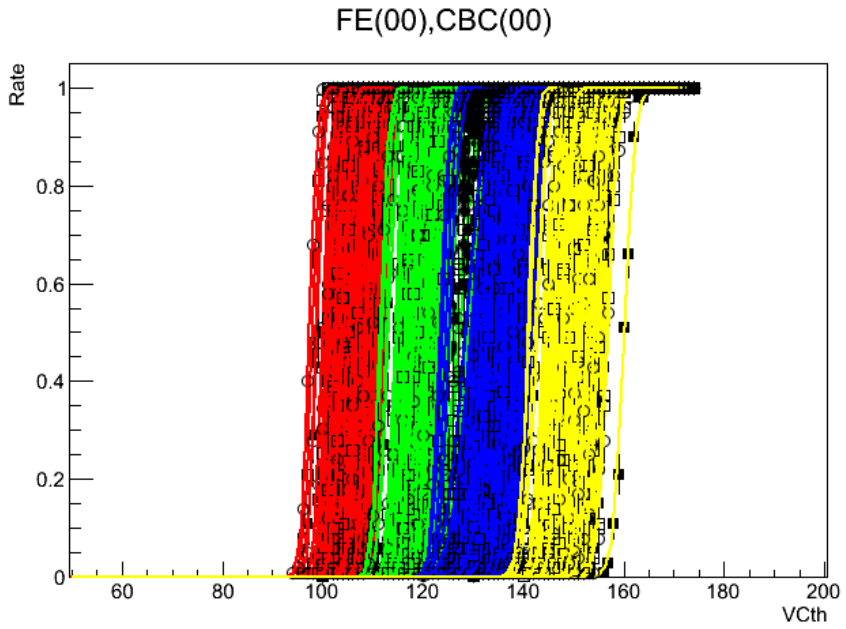
***VCTH scan is done for 32 channels at once.***
***OFFSETs for other channels are always set to 0xFF(0x00) for electron (hole) mode.***

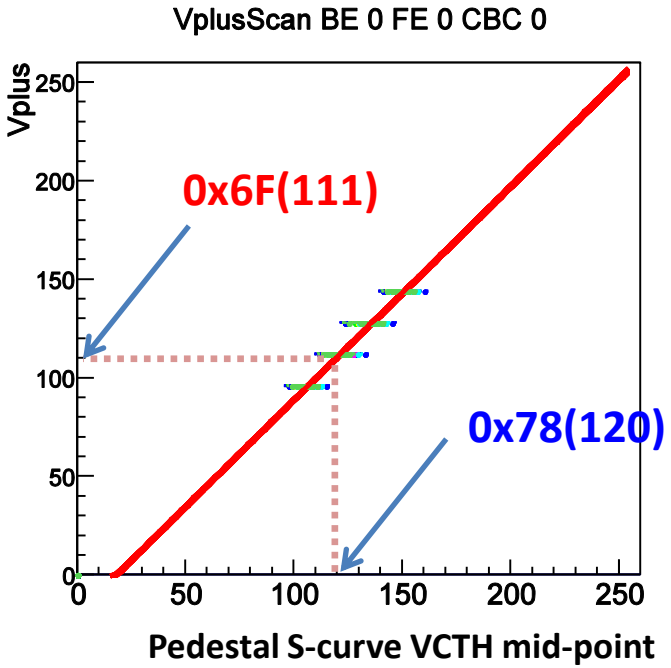
# 1. VPLUS tuning - electron mode

***VCTH scan for couple of VPLUS values with OFFSETs 0x50 (80)***

VPLUS at **0x60**, **0x70**, **0x80**, **0x90**



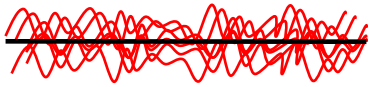



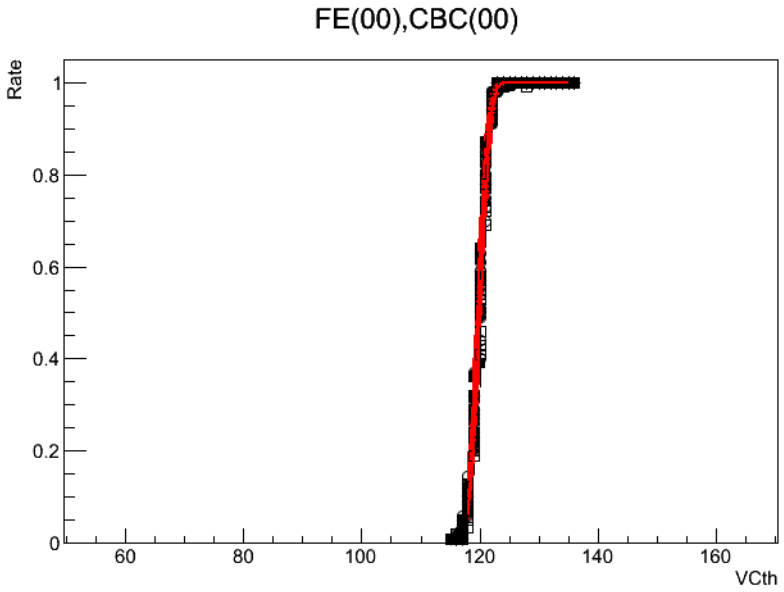
# 2. OFFSET tuning - electron mode

***Tune OFFSETs to have s-curves mid-point to target VCTH 0x78(120) with the VPLUS.***

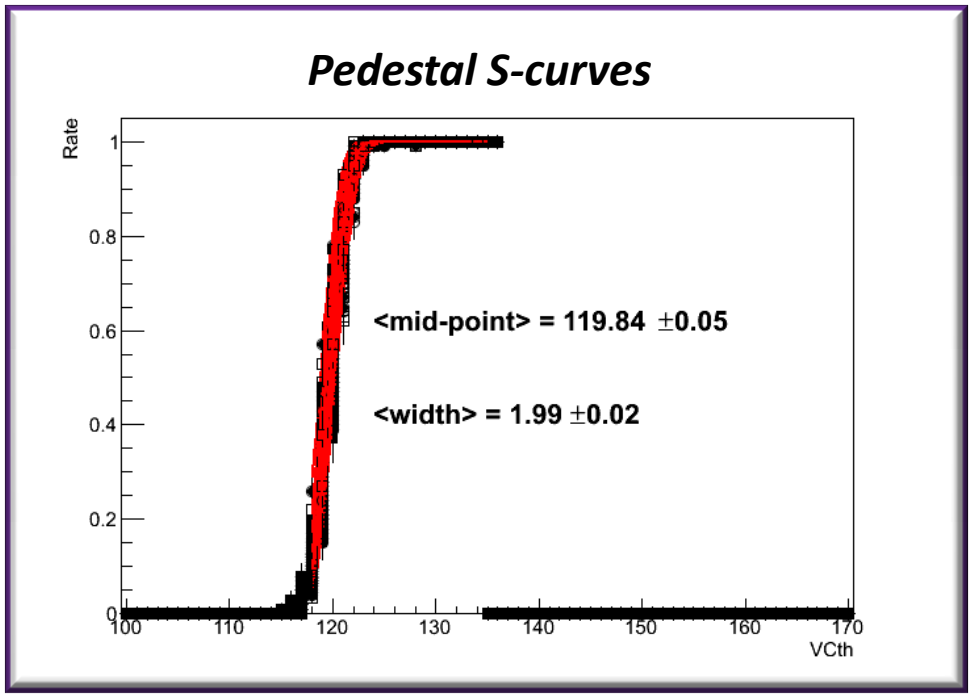
1. **OFFSETs are set to 0**
2. **Set bit[i] to 1 and check VCTH middle points, if it is greater than 120, set bit[i] to 0. Loop over i = 7 to 0.**

***VPLUS*** + ***OFFSET***

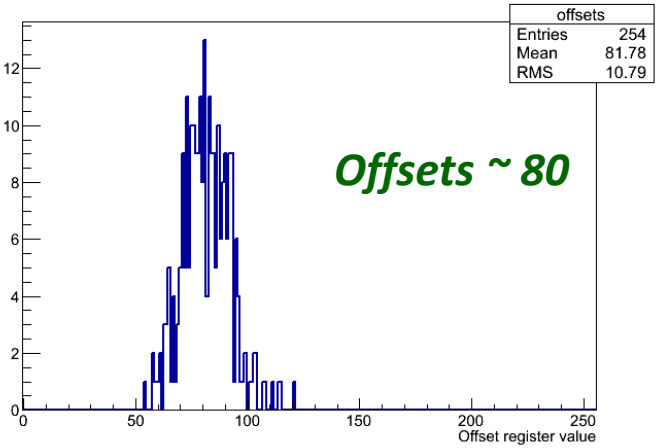


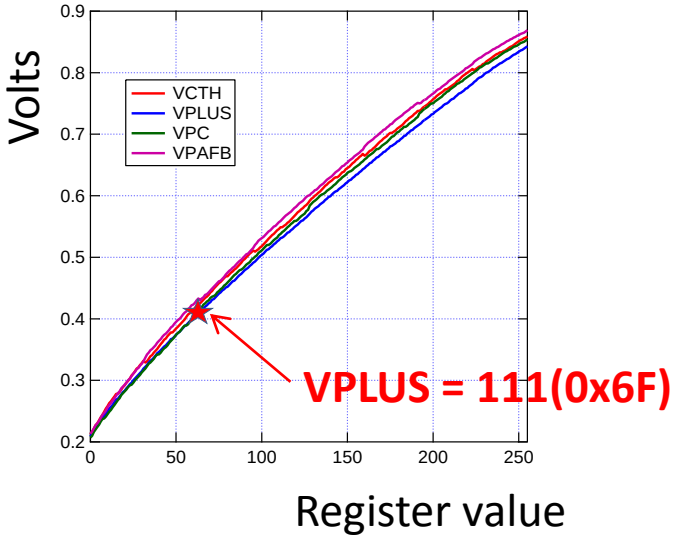


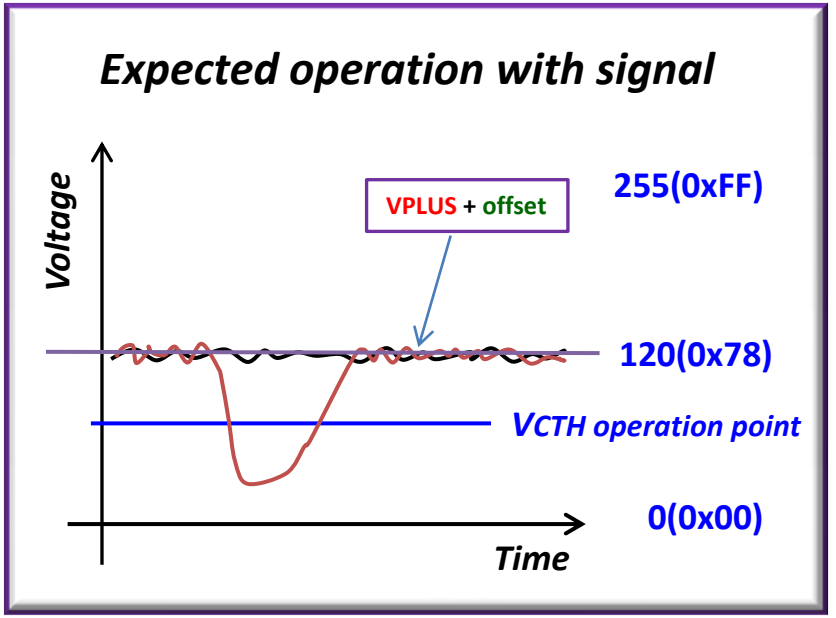
# Offset tuning result (*e* mode, w/o sensors)




**Width : sigma of the Gaussian which corresponds to the S-curve**



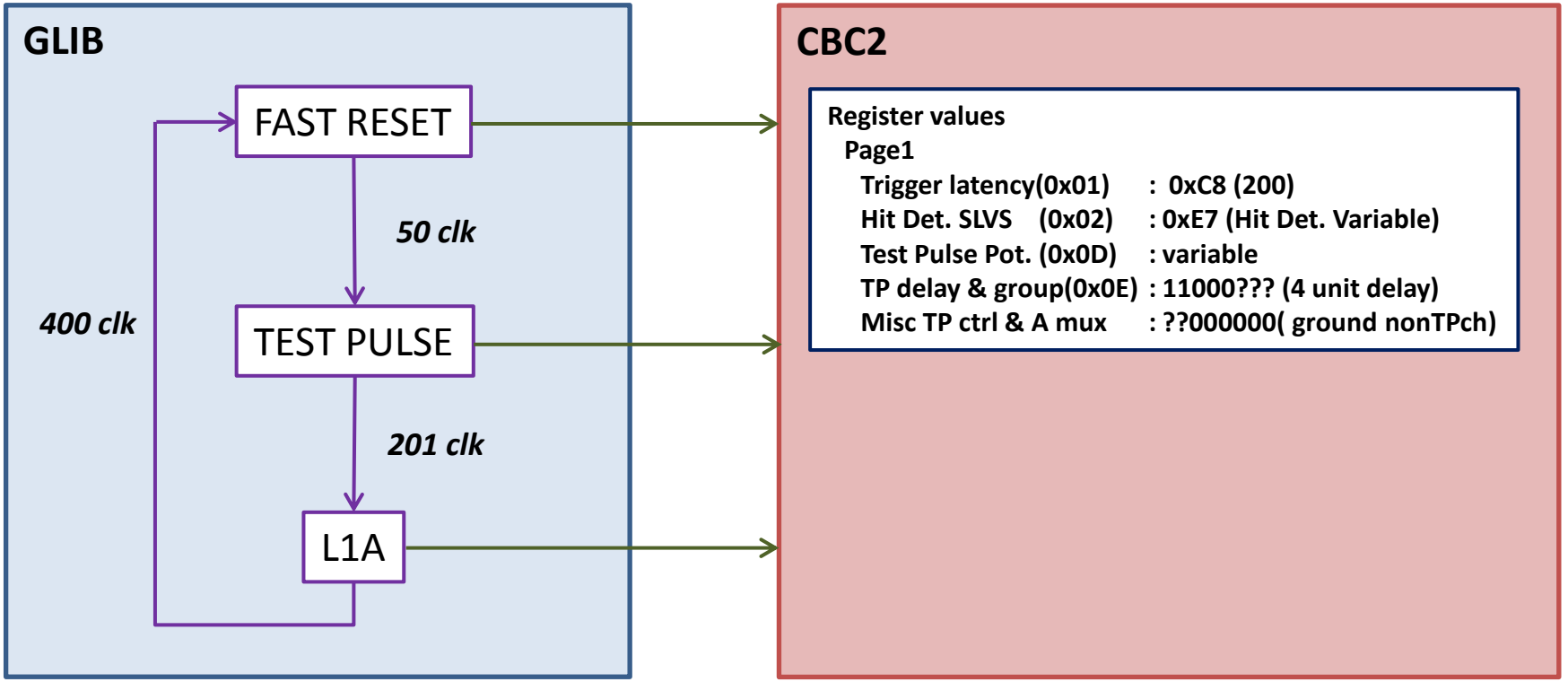
# Summary

- New offset tuning procedure is proposed.
  - The range of VCTH, VPLUS, & OFFSET and monotonicity of VCTH are taken into account.
- The tuning is demonstrated and documentation is prepared.
  - The tuning result shown in this presentation implemented in c++ for single GLIB beamtest setup.
  - It takes ~5 (3) mins for 2CBC (254 x 2 channels) with GUI(w/o GUI)

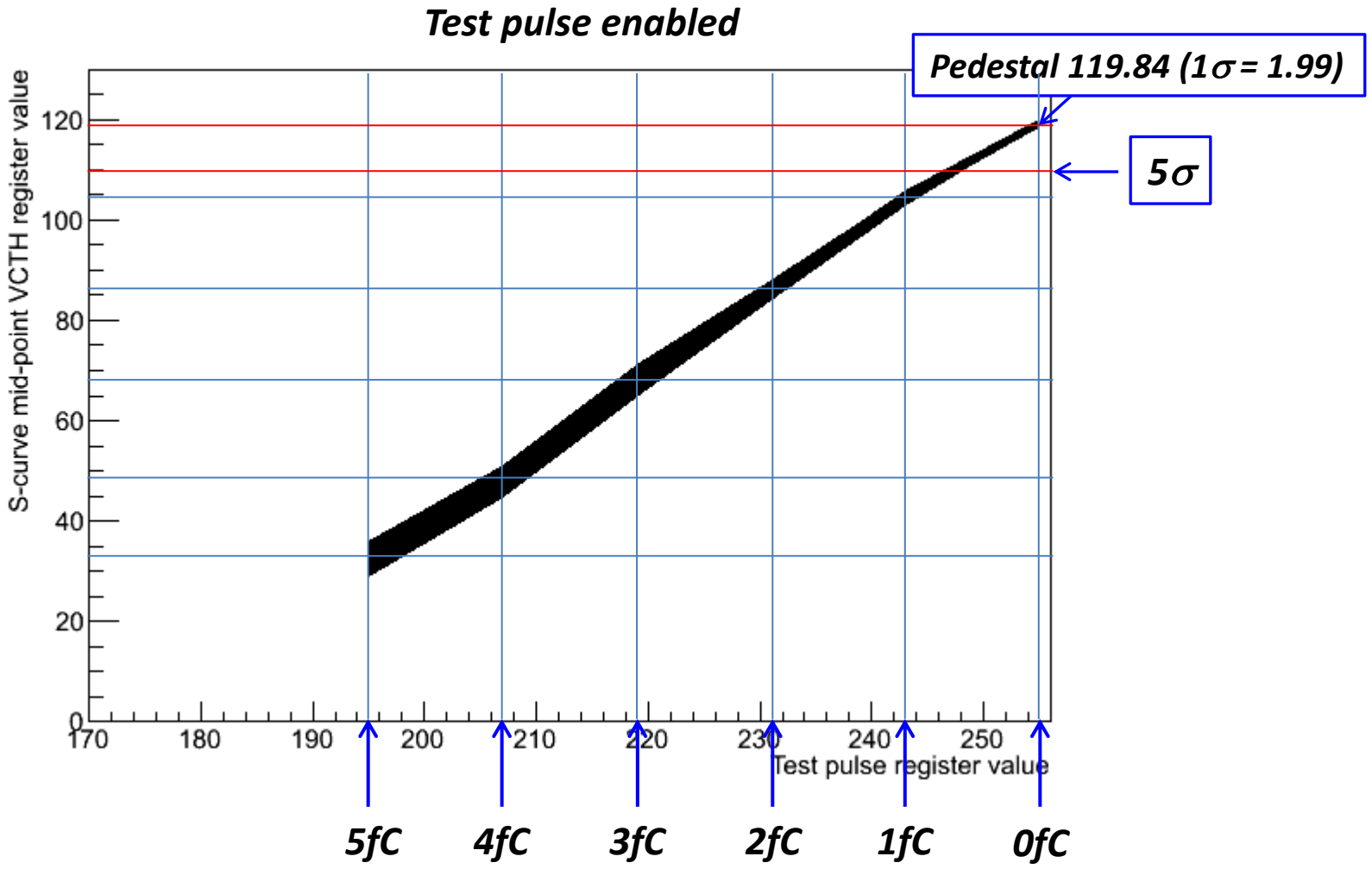
backup

# DAQ commissioning mode

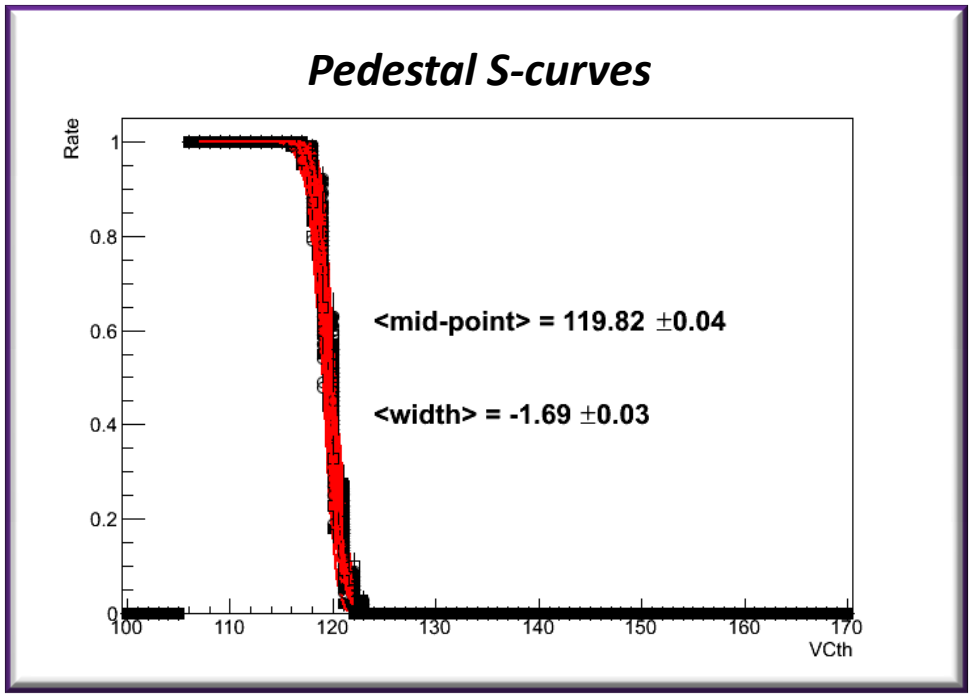
- Trigger is generated at FPGA on GLIB periodically.



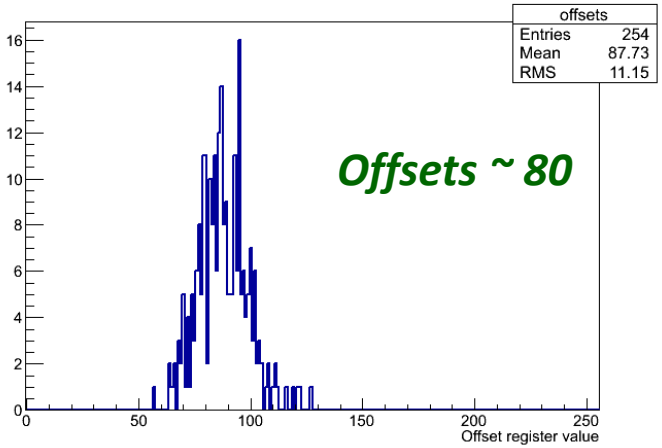
# Gain in *e* mode, w/o sensor

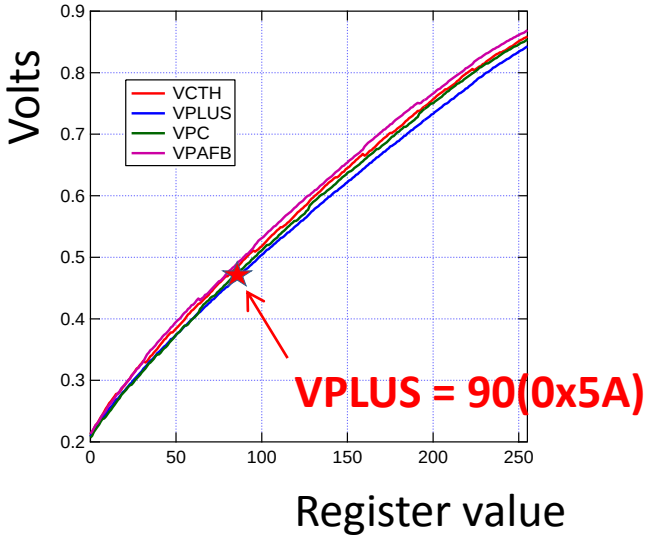


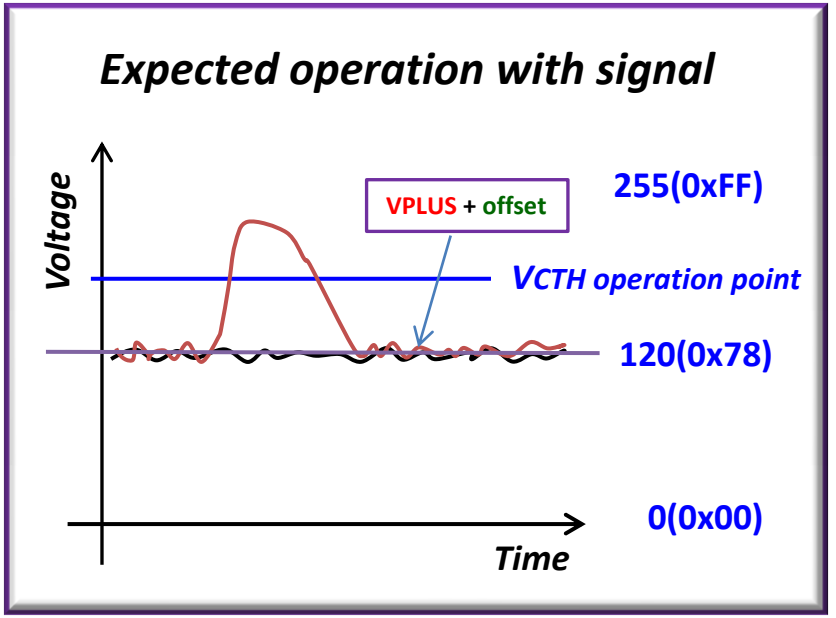
# Offset tuning result (*hole* mode, w/o sensors)



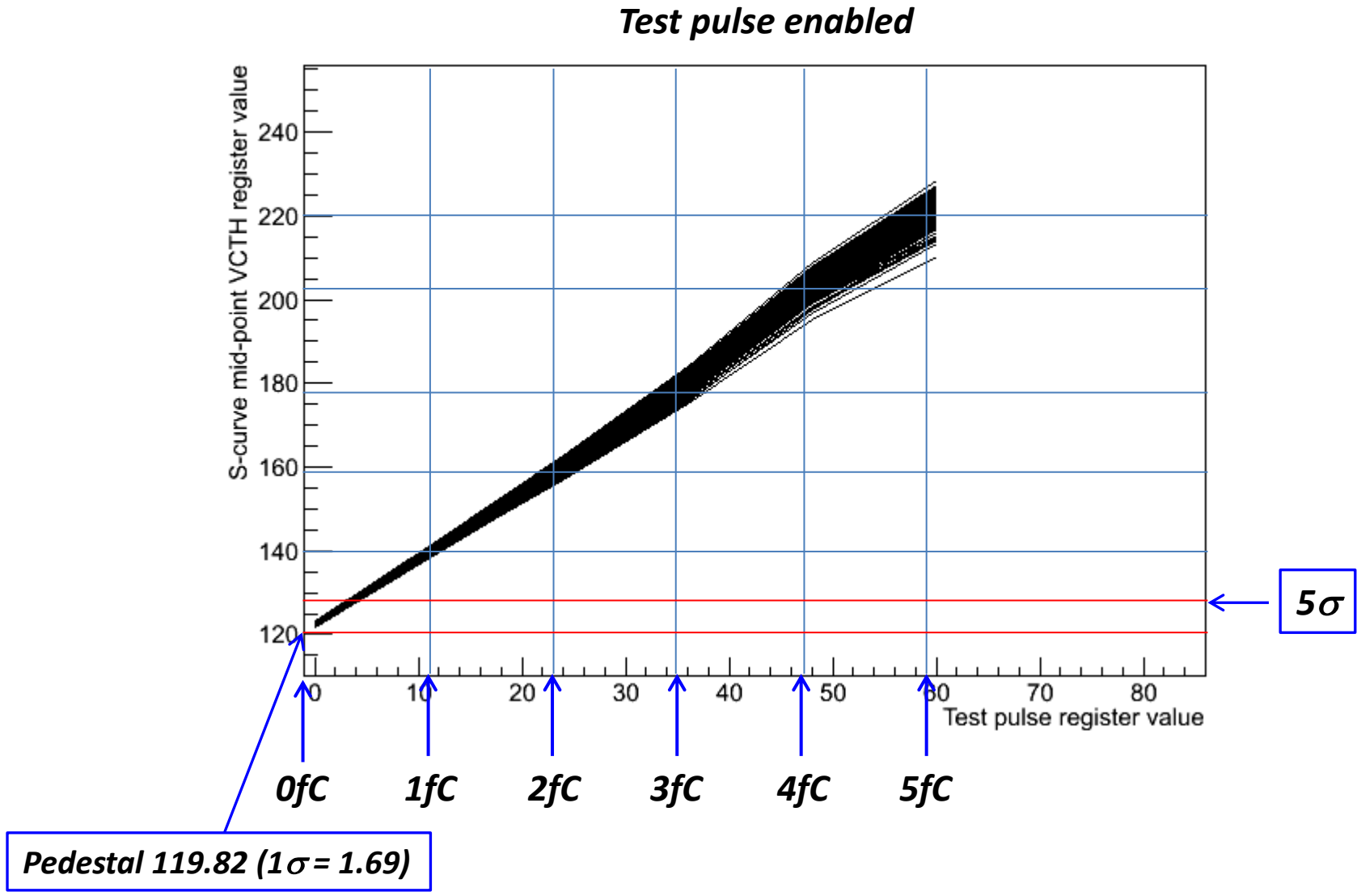

**Width : sigma of the Gaussian which corresponds to the S-curve**



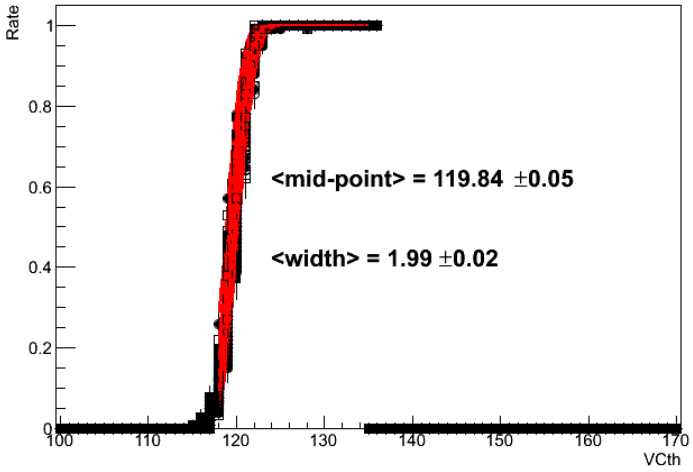
# Gain *in hole* mode, w/o sensor



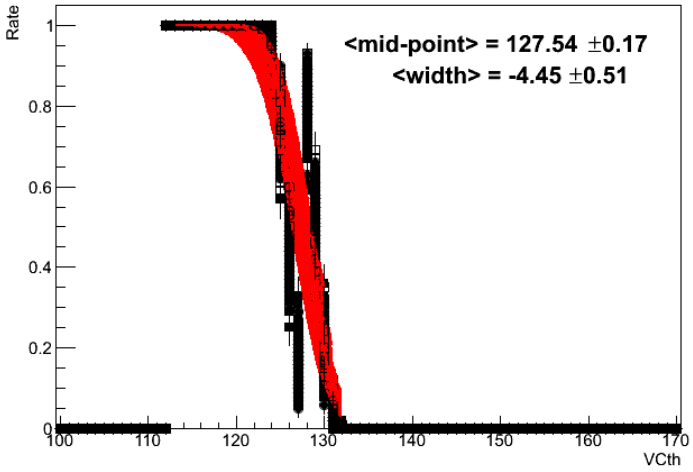
# S-curves at the binary transitions

***Pedestal S-curves***

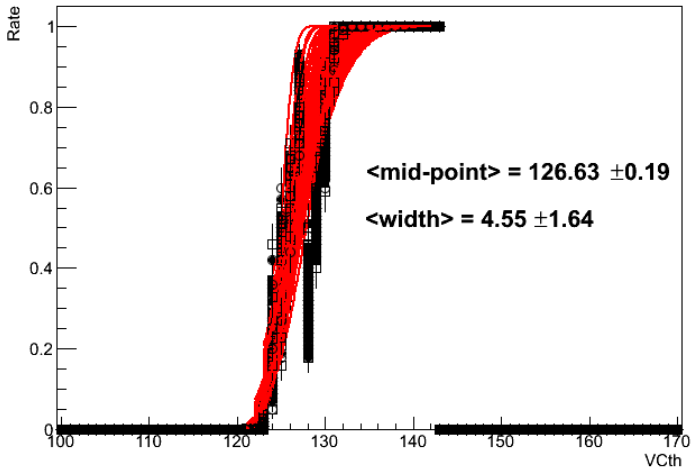
***Target mid-pint VCTH : 0x78(01111000)***



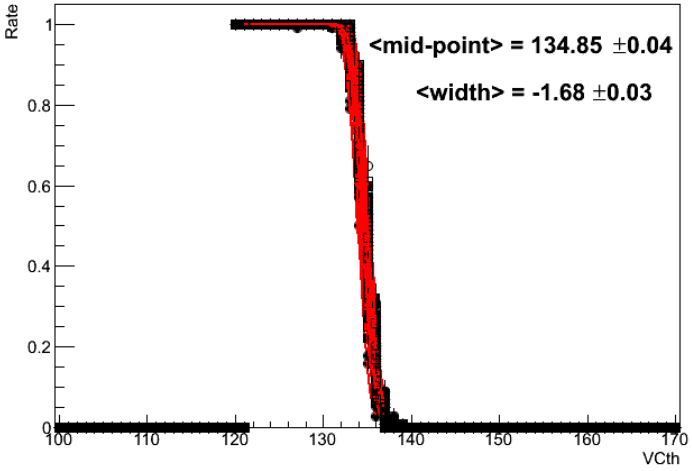

***Target mid-pint VCTH : 0x80(10000000)***




***Target mid-pint VCTH : 0x7F(01111111)***




***Target mid-pint VCTH : 0x87(10000111)***



# Gain *in hole* mode, w/o sensor