OAK RIDGE National Laboratory

# H2GCROC3 —> ePIROC

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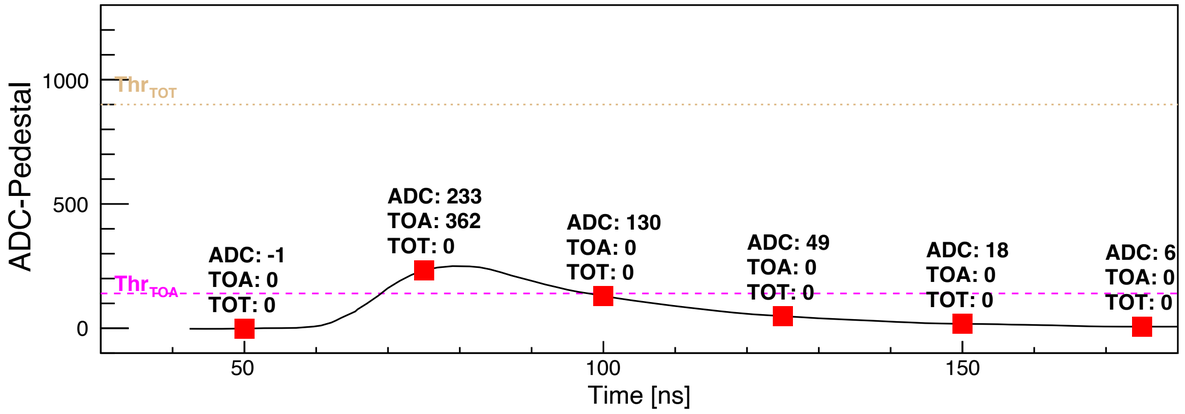
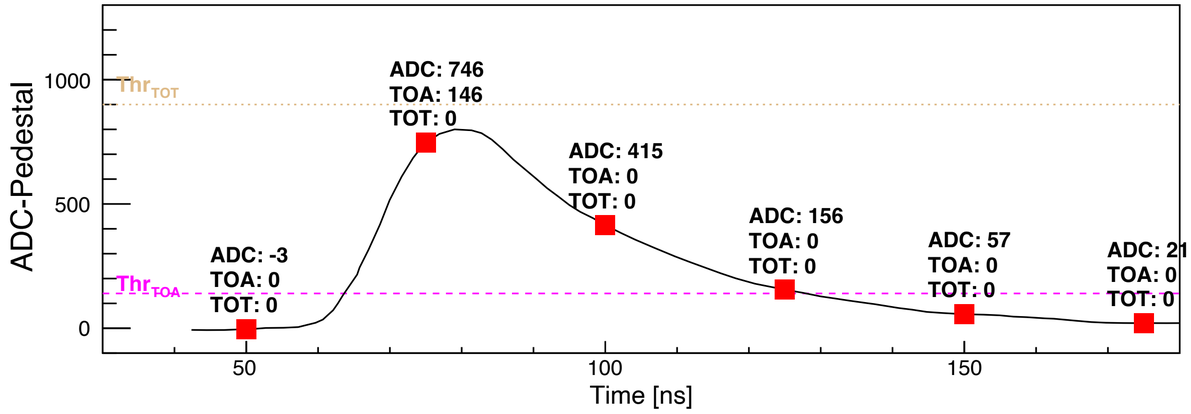
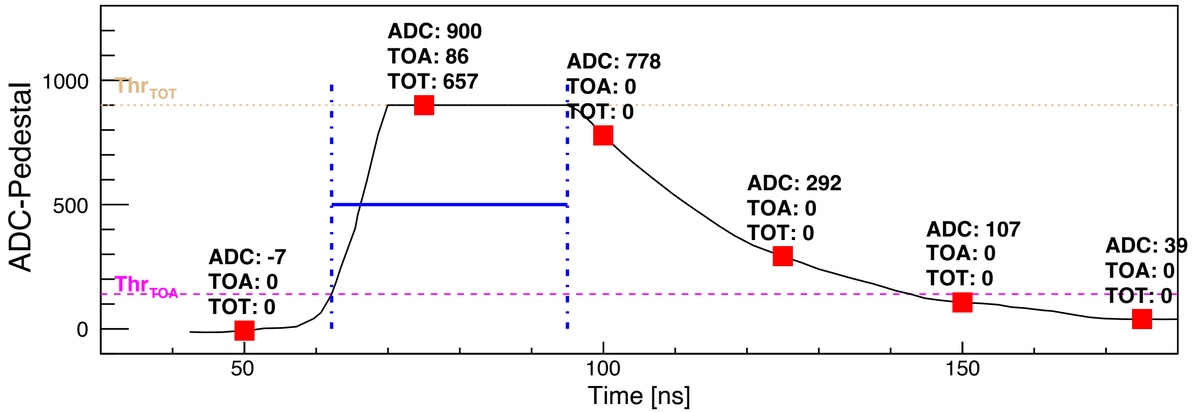
# Explaining the ADC/TOT combination

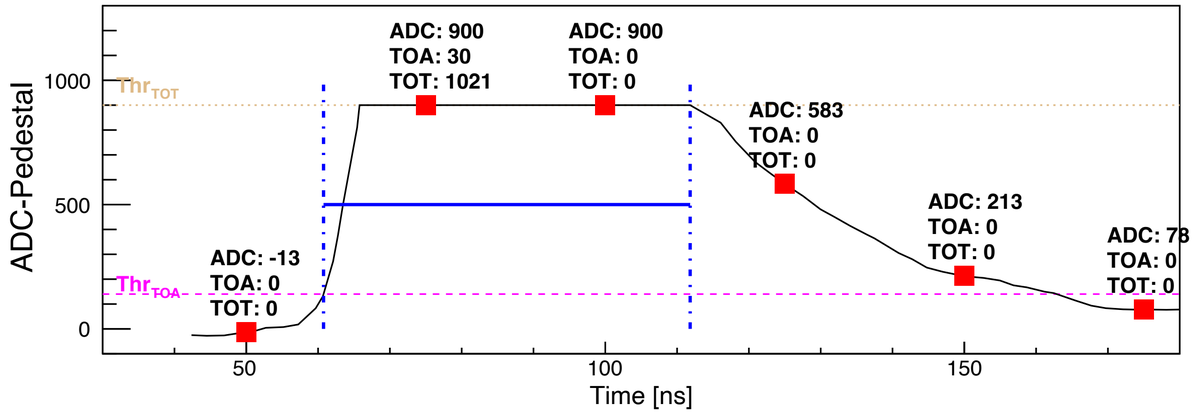
**HGCROC is not a waveform sampling chip:**

- It sends a 32-bit word for each channel each Bunch Crossing (BX) 10-bit ADC, 10-bit TOA, 12-bit TOT:
  - Format explained in the next slide
- eRD109 is looking into the consecutive BX readouts and the shaper configurations

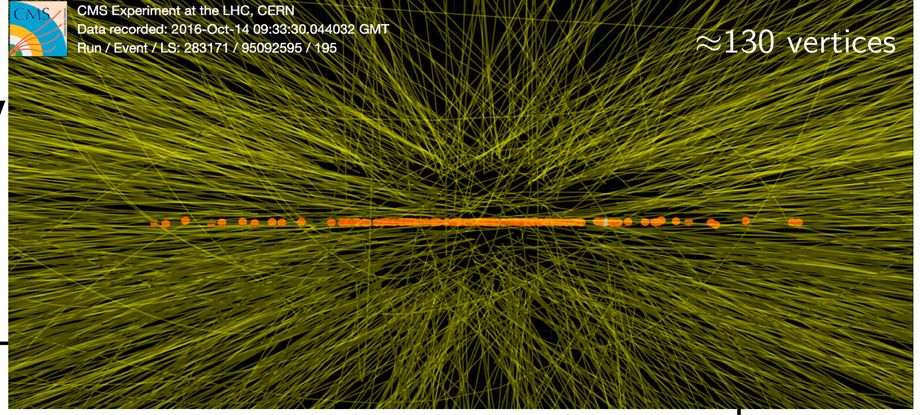


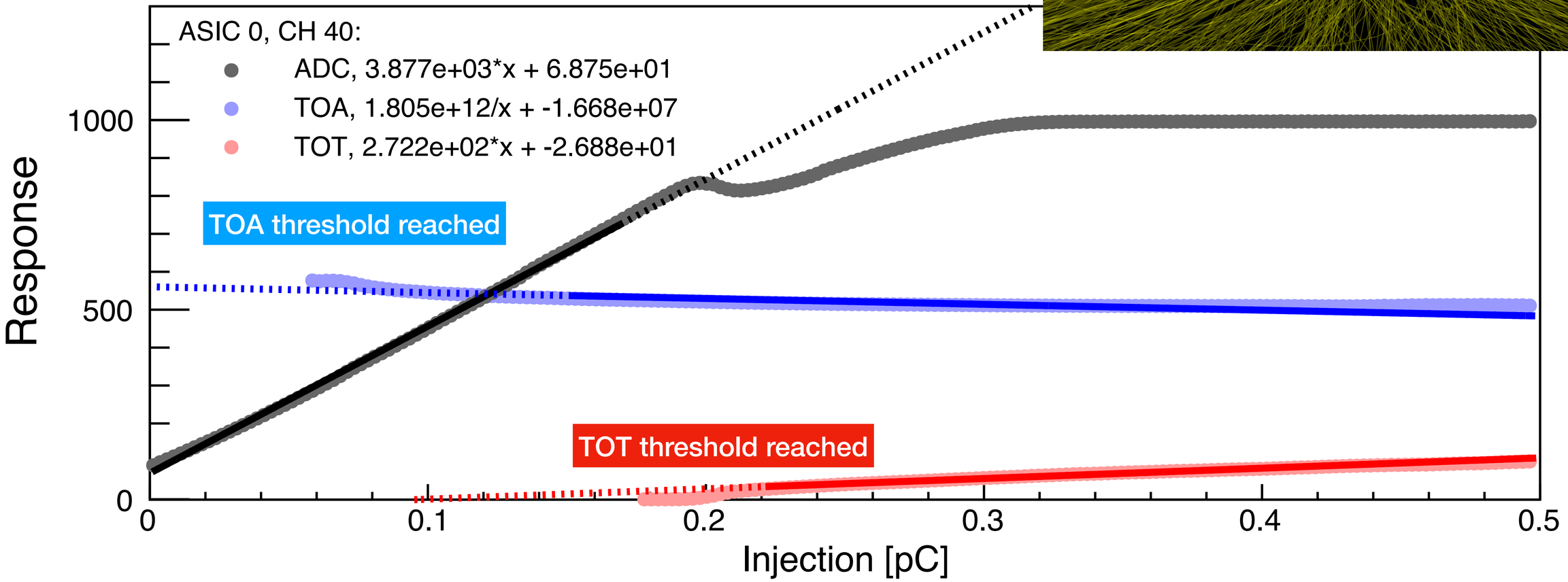



# CMS/LHC strategy is looking into one BX only

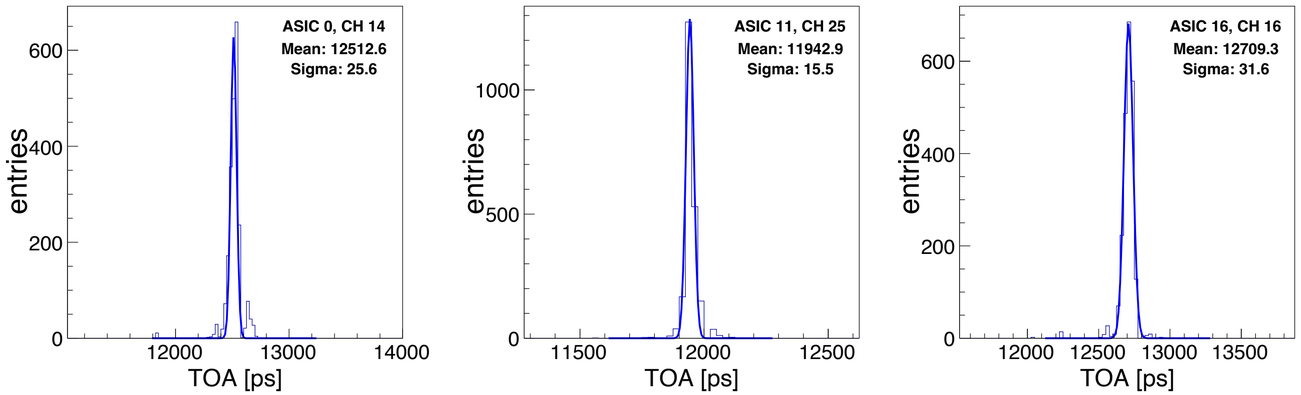



**At CMS they expect up to 200 events each bunch crossing (2800 BX in one ring):**

- Important to distinguish clusters in the pile-up events (timing is 15-35 ps, TOA)
- They focus on 1 single BX readout

# Real measurement of the **timing distribution** in HGCROCv2



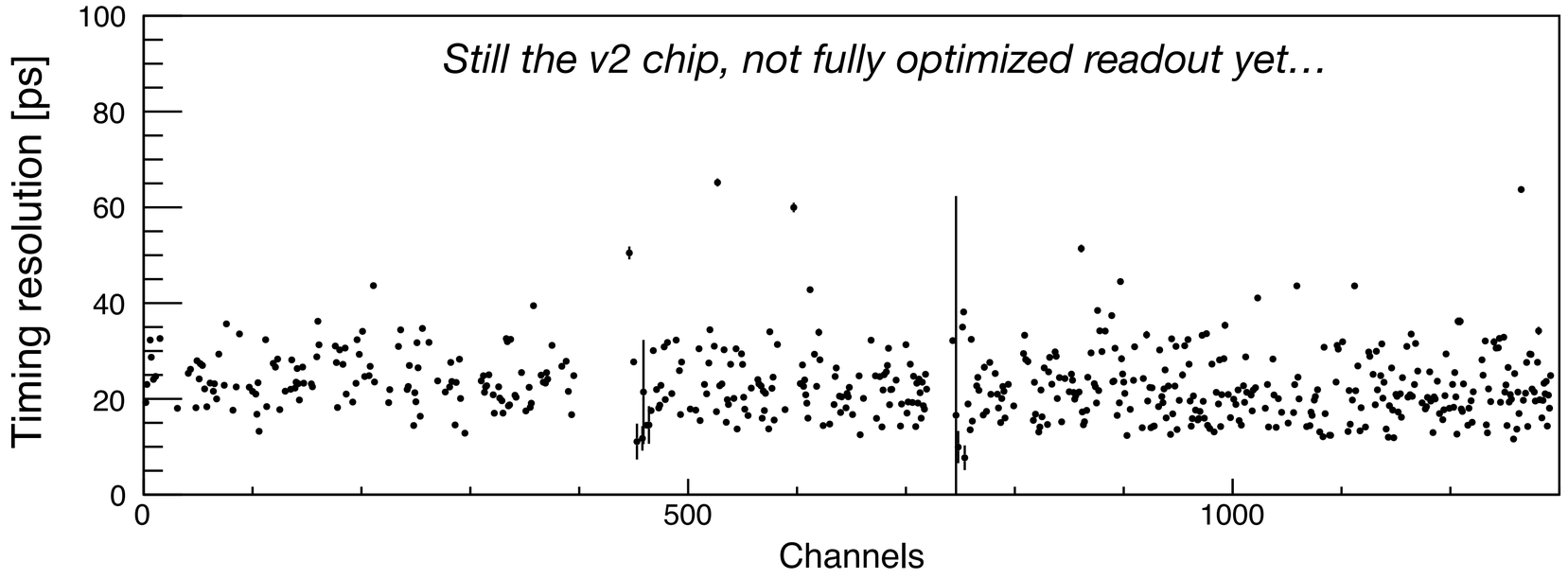

**Some examples of the TOA timing distribution**

**Real data obtained with a prototype used in ALICE-FoCal:**

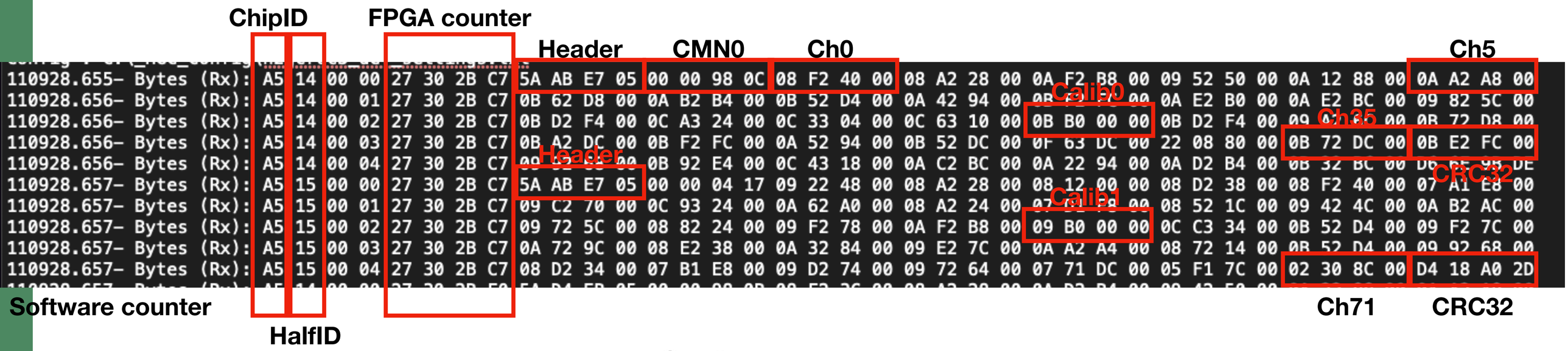
- Older version of the chip
- Realistic resolutions with noise obtained from each channel

**Resolution extracted from 18 ASICs in series:**

- Run by a Xilinx Ultrascale FPGA
- 18 in series (from 30cm to 10cm distance from FPGA-ASIC)
- Extracted the timing resolution where I could: 15-35 ps in general



# Readout formatting (as of now)




## Ch0

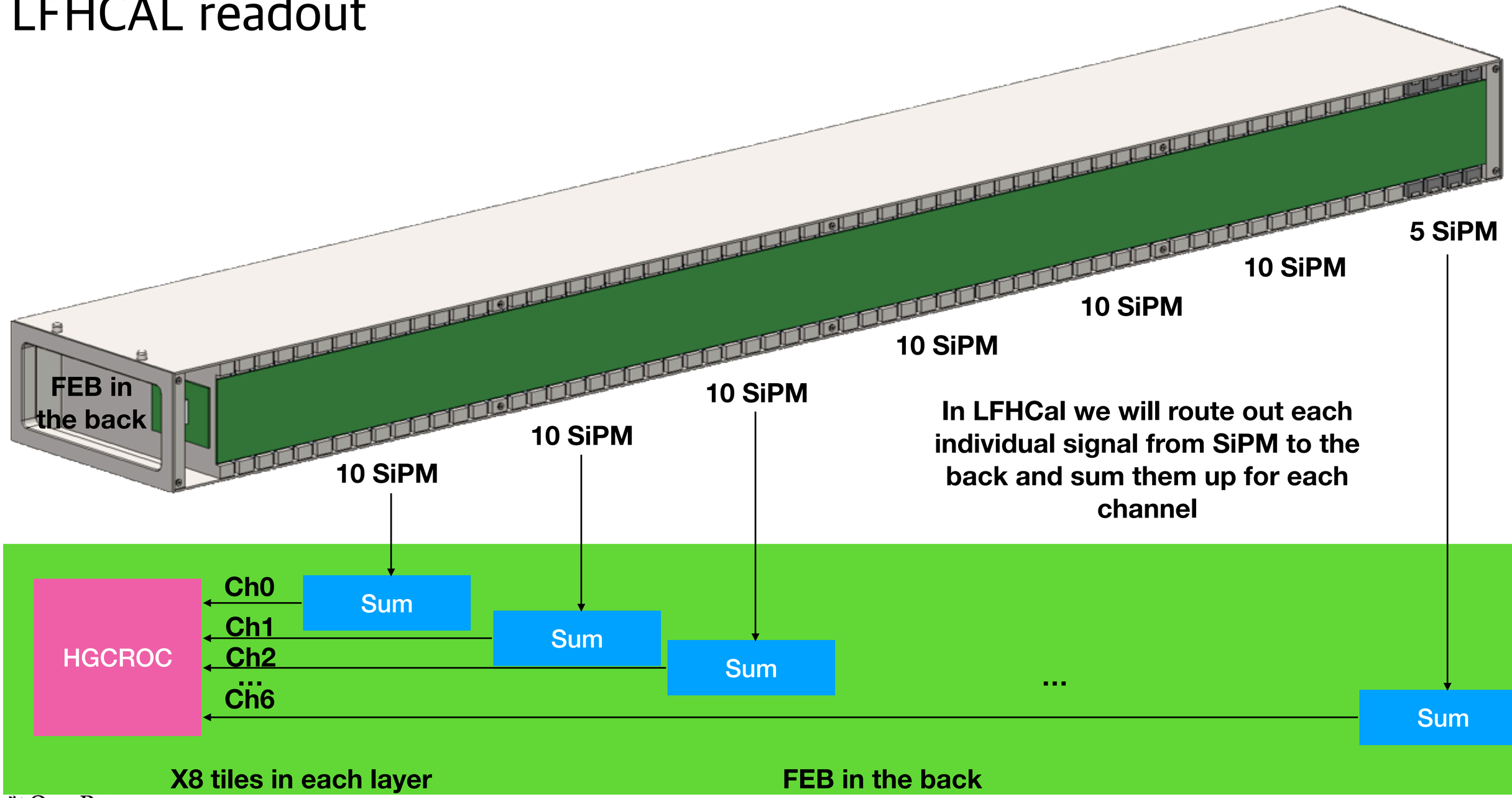

**0 0 0010001111 0010010000 0000000000**

Tc Tp ADC(BX-1) ADC(BX) TOA(BX)

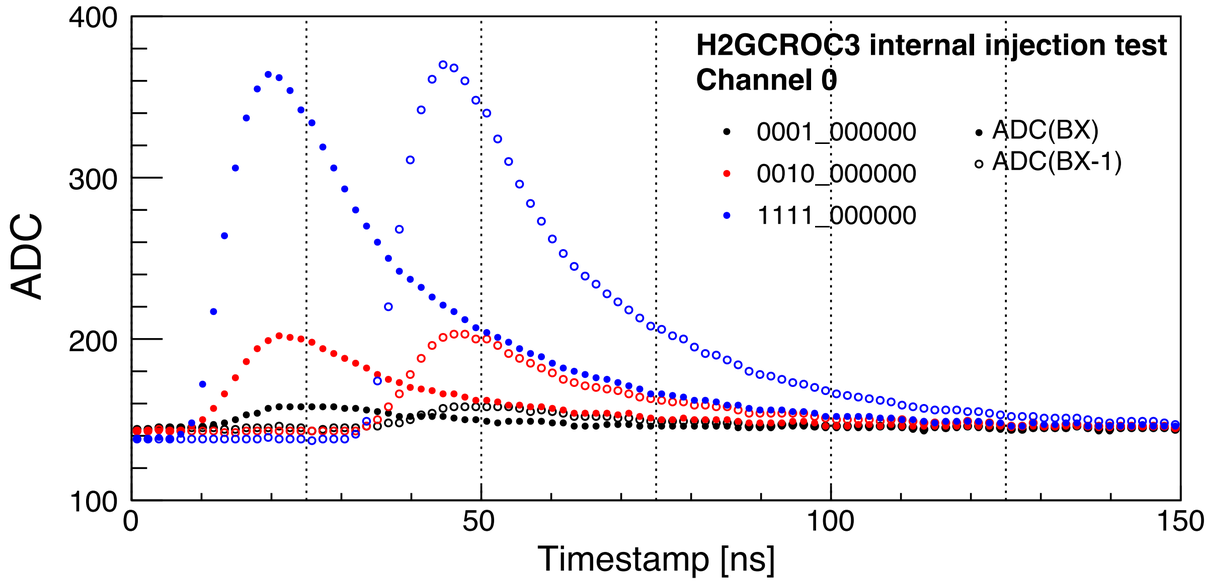
### Decoding from the documentation

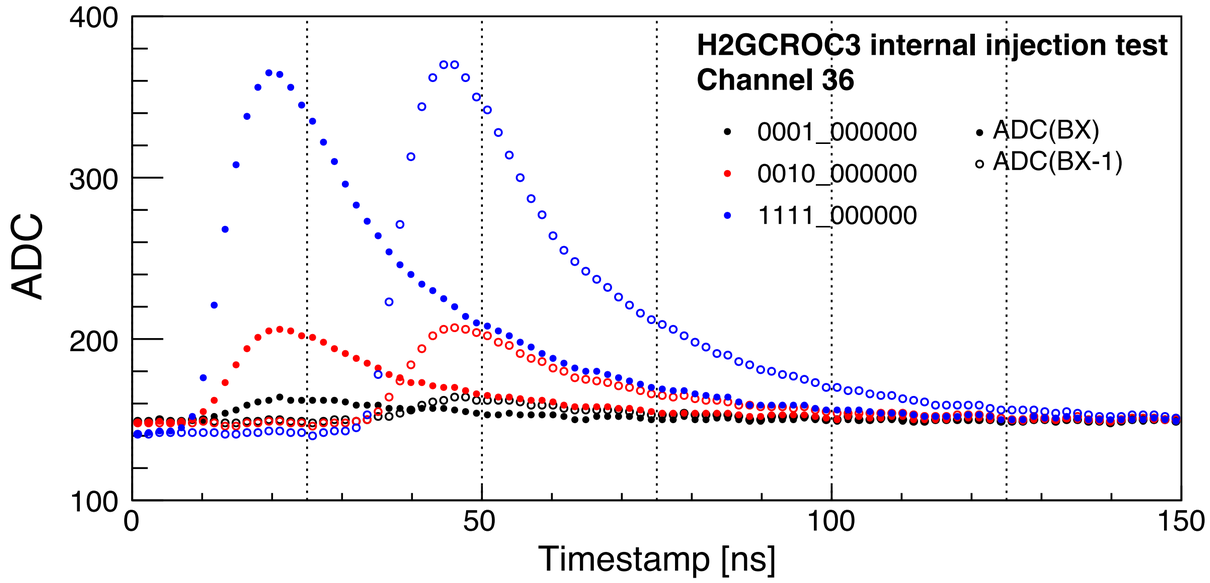
| | ADC (BX-1) | ADC (BX) | TOT (BX) | TOA (BX) | Charge collection | Data type |
|---|---|---|---|---|---|---|
| 1 | x | x | | x (=0) | Q < TOA_thr AN | Normal |
| 2 | x | x | | x | Q < TOT_thr AN | Normal |
| 3 | x | | x | x | Q > TOT_thr AN | Normal |
| 4 | | x | x | x | | “Characterization” |

# LFHCAL readout



# First results in ORNL



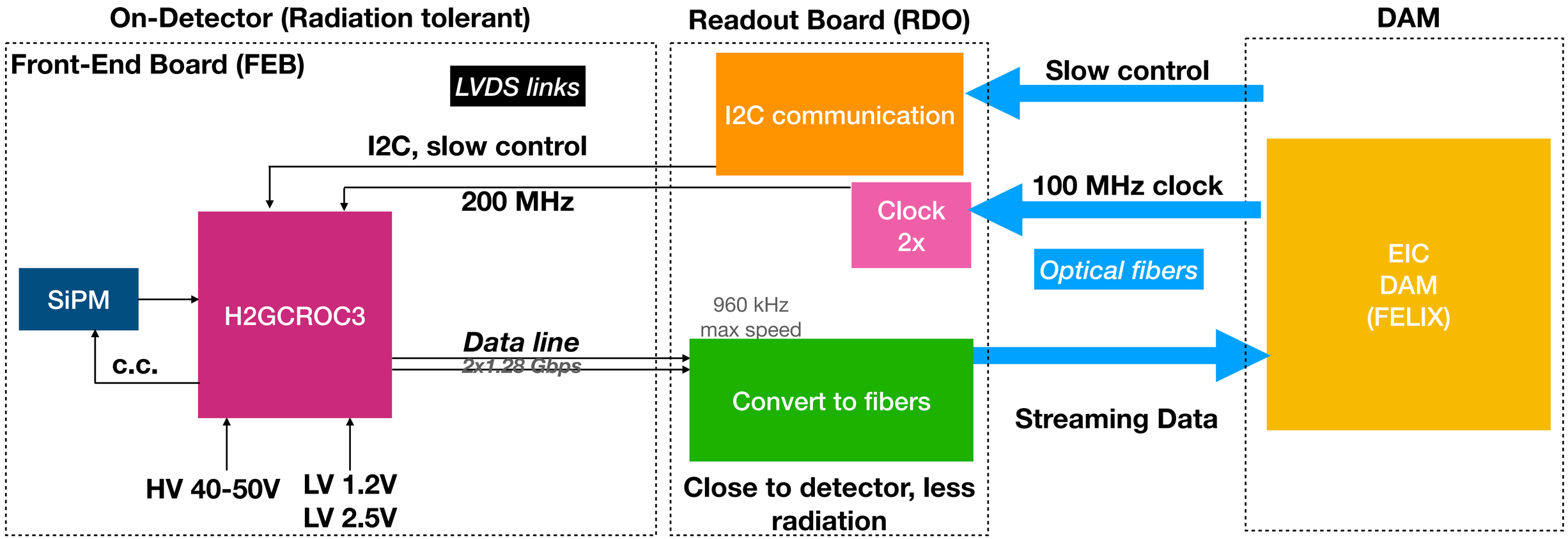

**Very first results on the internal injections on 2 channels in H2GCROC3:**

- Still need the full scan of different gains
- High/Low range injection, plus 2.5V injection (low injection was done only)
- Working on the algorithms for full calibration of the chip
- Collecting a bunch of questions/feedback to Omega

In parallel:

- By end of July (hopefully) first PCB layout of the 2xH2GCROC3 prototype will be submitted
  - Input will be compatible with CAEN A5253 board

# LFHCal readout hierarchy (after the upgrade)




**Data propagation from the detector to the EPIC DAQ system:**

- The H2GCROC3 requires the L1 trigger for readout, with the maximum speed of 960 kHz
- The expected hit rate in **one channel of LFHCal** is up to 50 kHz:
  - With possible 4 sample readout we would reach a maximum of 200 kHz
  - Streaming readout towards the EPIC DAQ system

# Plans and thoughts

PARIS-Omega:

- 200 MHz clock input (or better 98.5x2) for EIC and it would convert it inside to 1/5$^{th}$
- Self-triggering like HKROC
- TOT nonlinearity fix at threshold
- I2C fixes:
  - We had some troubles with the stability of the I2C module
- Number of data lines:
  - if there is a lot of hit multiplicity and we would need faster readout (deeper RAM2)

**https://indico.bnl.gov/event/19653/sessions/6335/attachments/47872/81221/FD_230606_ROC4EIC_introduction.pdf**

ORNL:

- Initial (first) prototype to be available in September this year:
  - Input will be compatible with the A5253 from CAEN (then we can always hook up a CAEN commonly used by different groups now)
  - 2 HGCROCs (144 channels in total)
  - KCU105 for readout electronics (firmware is ready from the testboard)
- Test the Samtec cables for data transmission, while using it also for LV/bias, 200 MHz clock and I2C communication
- Sum-up module for the FEB to sum up multiple SiPM outputs:
  - This depends on each calorimeter (some use up to 16 SiPM in one channel)
  - Different capacitance of the inputs has to be checked (or passive component to fix it)
- Implement the readout for each calorimeters.
  - LFHCal as baseline for Sept/Oct testbeam already
  - Implement readout to barrel HCal (from sPHENIX prototype) and backward HCal prototypes.
  - Backward HCal prototype?
  - BarrelECal: existing prototype from GlueX
  - Backward and Forward ECals can be tested also

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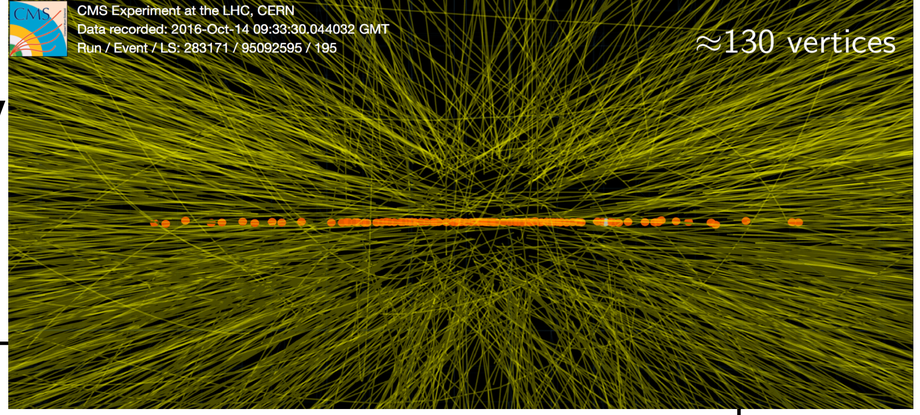


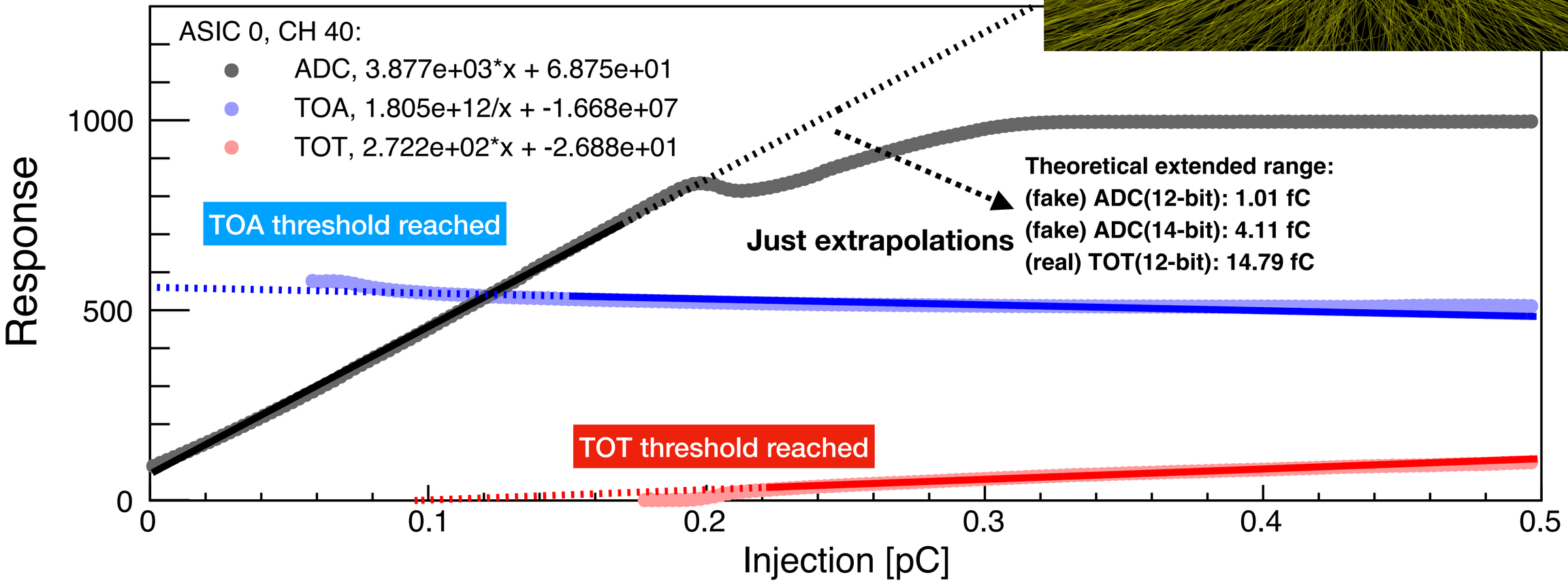


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