Design and performance of the ABCD chip for the binary readout of silicon strip detectors in the ATLAS Semiconductor Tracker

Dengfeng Zhang(Tsinghua University)

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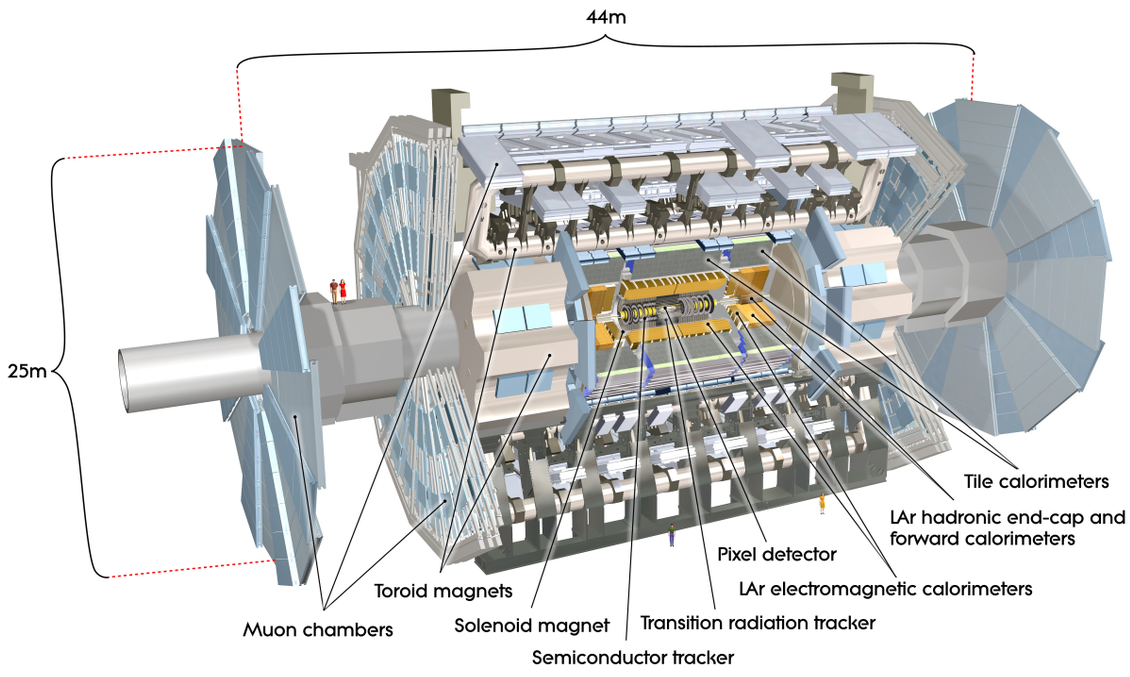
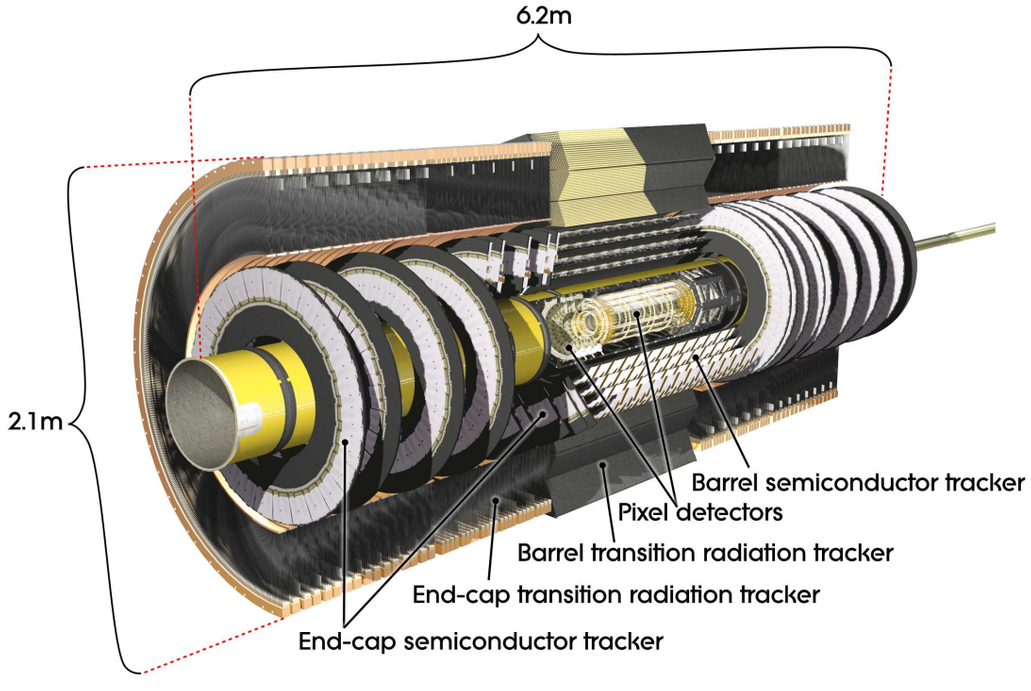
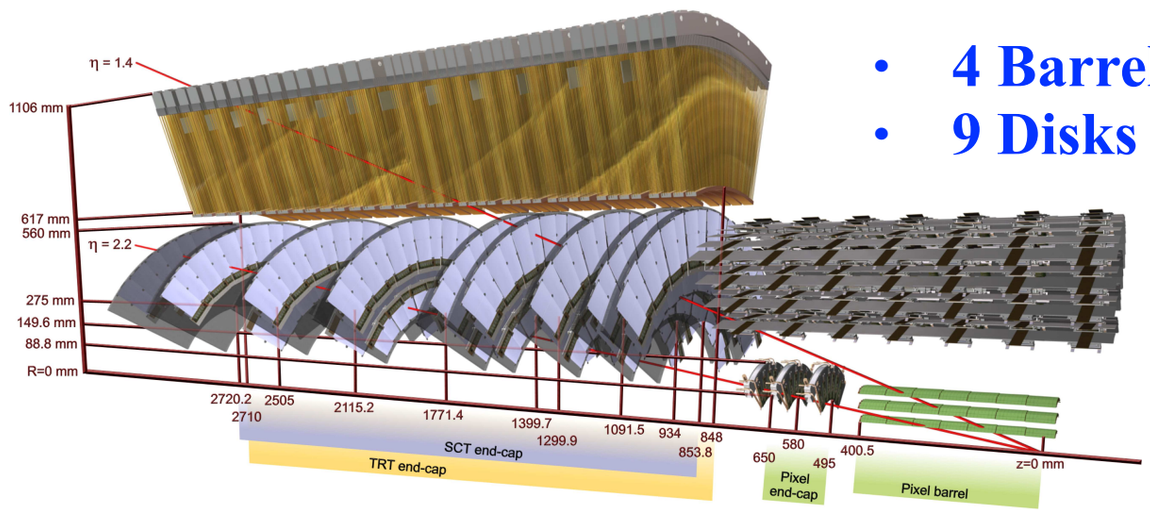
ATLAS Detector and Semiconductor Tracker(SCT)





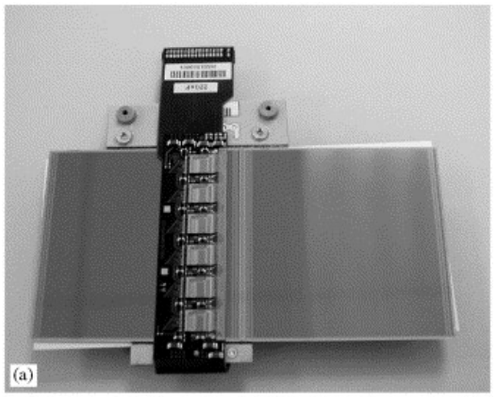
Largest HEP detector ever built

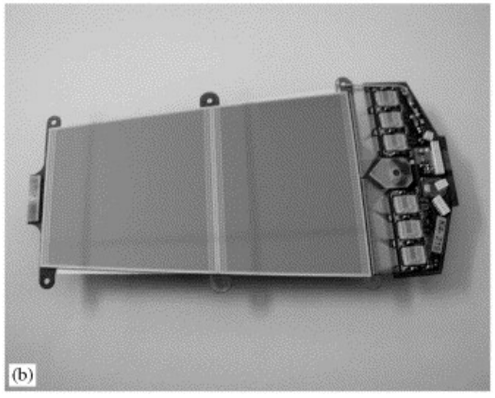
- 4 Barrel Layers
- 9 Disks on each side



SCT

Inner detector





Data Readout Chips on SCT

- ABCD: **A**TLAS **B**inary **C**hip manufactured in the **D**MILL process, a kind of Application Specific Integrated Circuit,
- 6 ABCDs on each SCT, and each chip contains 128 channels,
- Large discriminator threshold: two versions of the ABCD architecture: **ABCD2T**-employing the TrimDACs and ABCD2NT-enhance matching aspects in the front-end.

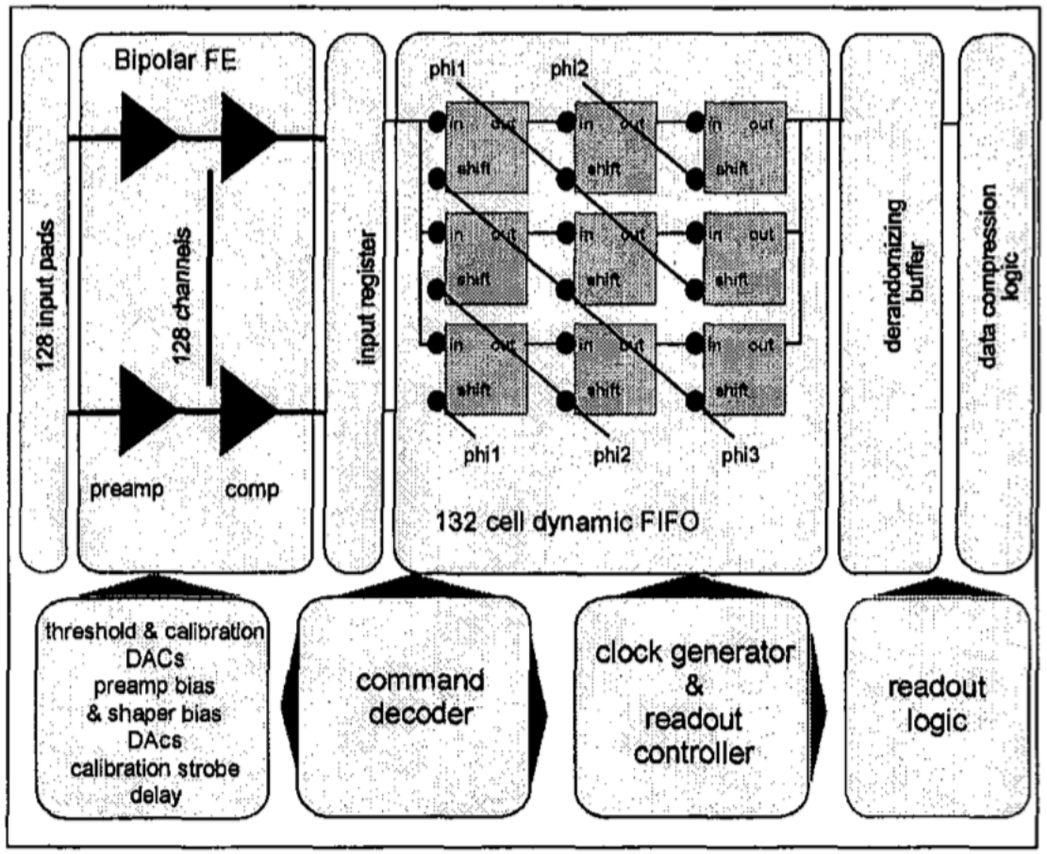
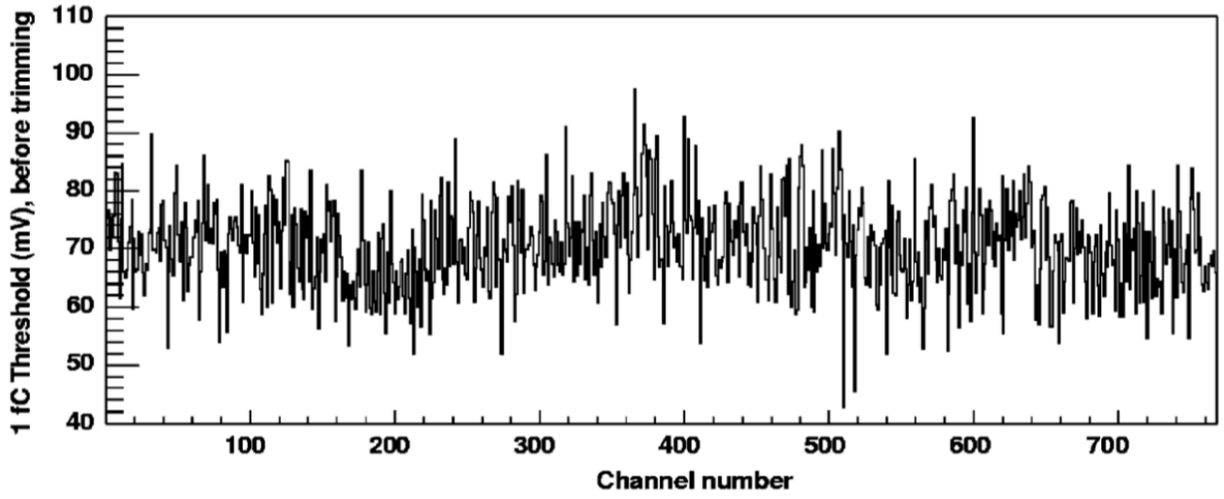


Figure 1: Block diagram of the ABCD chip.

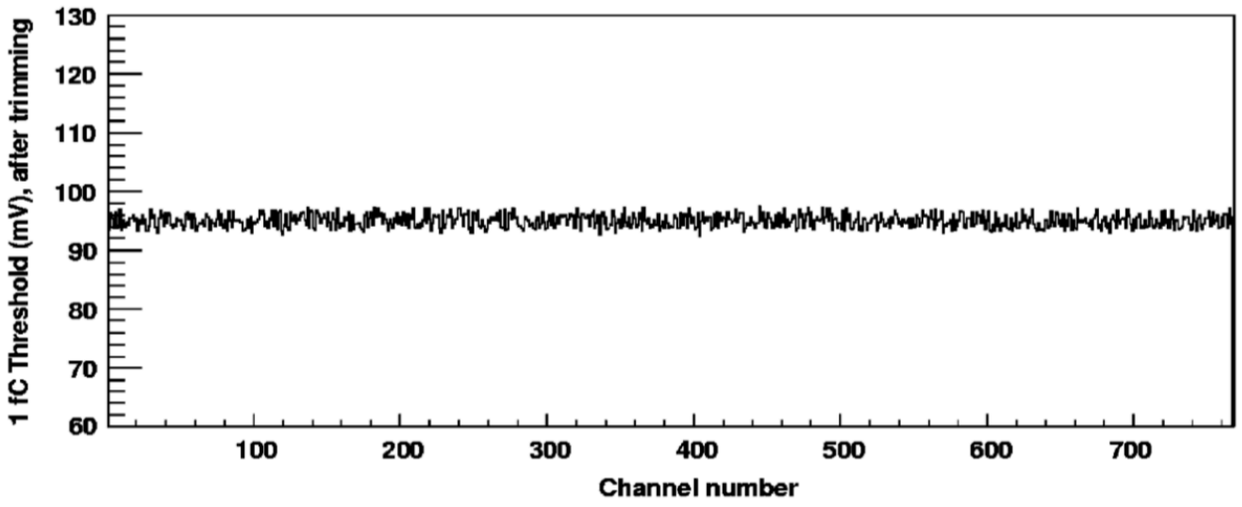
- preamplifier-shaper,
- discriminators,
- binary pipeline,
- de-randomizing buffer,
- data compression logic and the readout control logic.

TrimDAC Performance

- A common threshold DAC to all channels of each chip, bad channel-to-channel uniformity

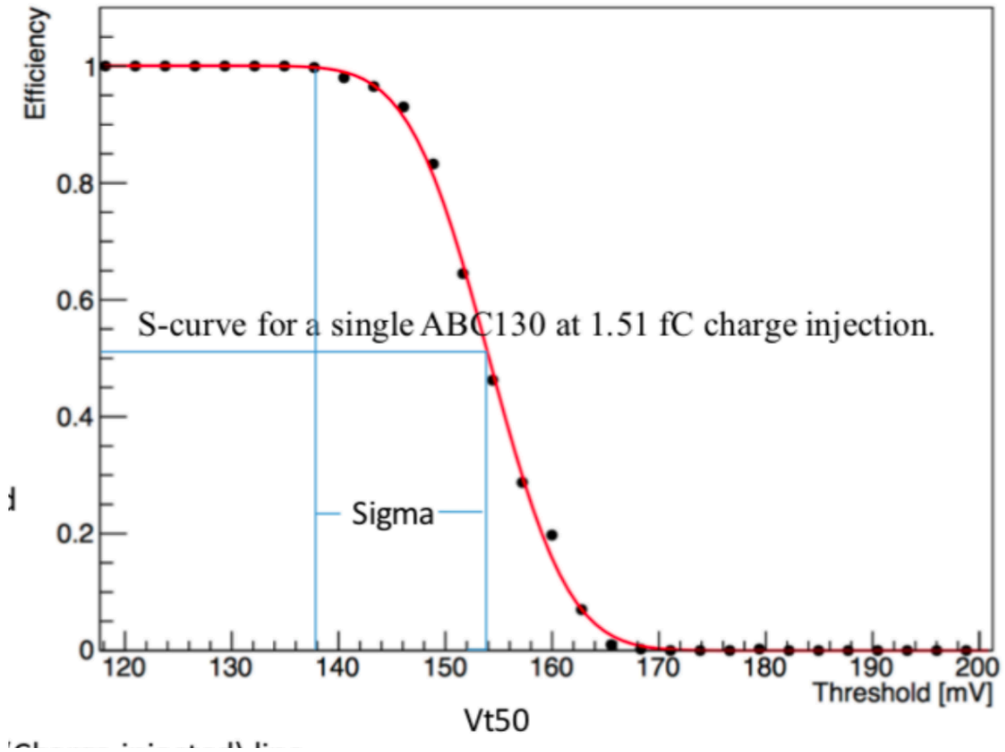


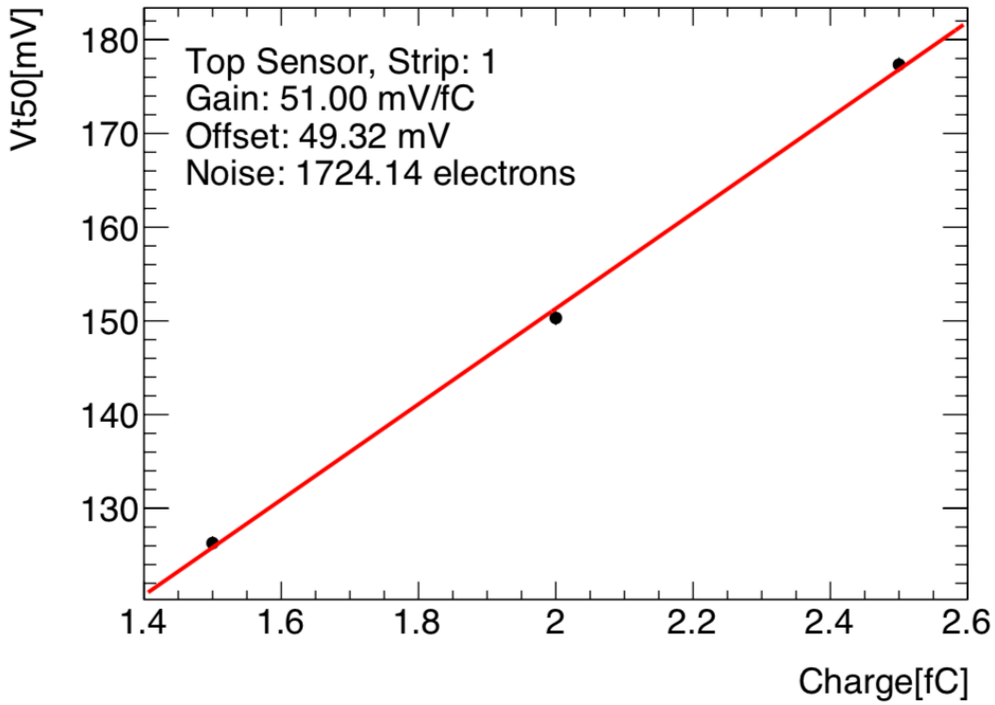
- Add TrimDAC to each channel, good uniformity



3 Point Gain and Noise

- Perform threshold scan with 3 charges





- Noise=Sigma/Gain

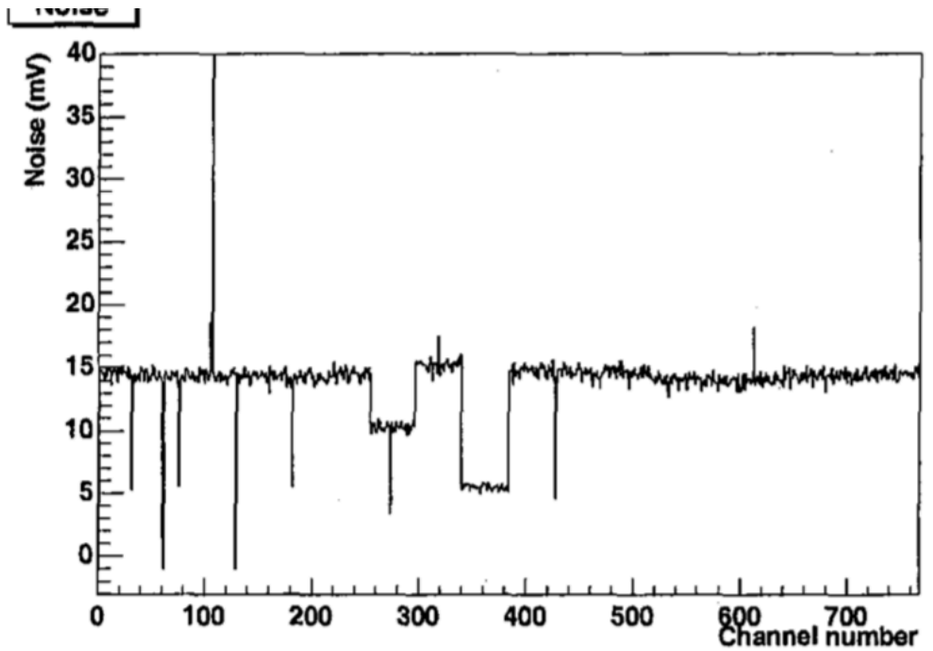
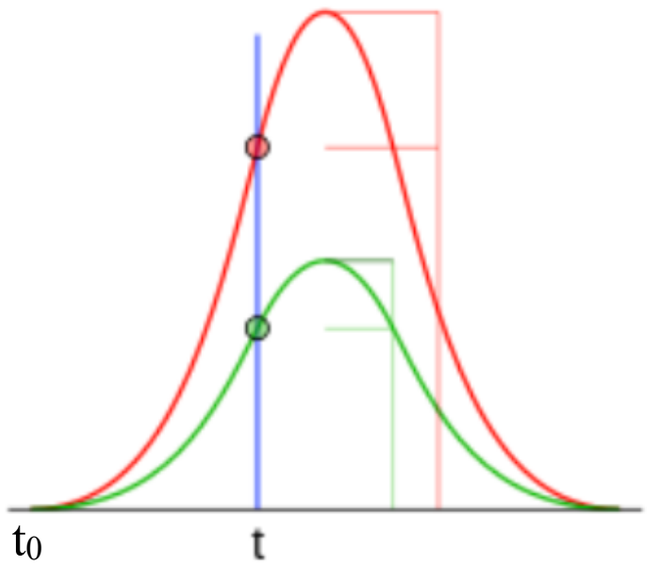
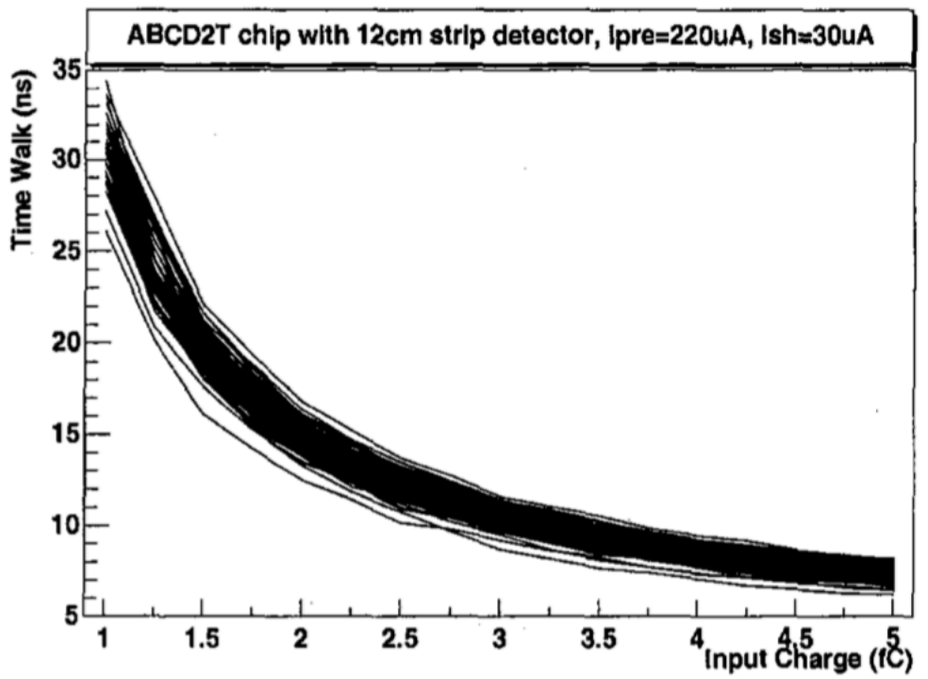


Figure 5: Noise distribution across the module.

Timewalk

- The maximum time variation in the output signal of the comparator over an input signal range of 1.25–10fC.
- Variation = $t-t_0$
- Requirement: <15/16 ns
- MIP can introduce signals of several fC





Questions

1. What does it mean for “data sparsification” in the front-end electronics? (from Xin SHI)

Usually, the channel occupancy is less than 1%, for ABCD, only the channels with signal more than threshold will be read out. Here I think “data sparsification” means only useful informations will be transferred.

2. Does this chip equip the common model cancellation?(from Ryuta)

I don’t know.

3. on figure 2. the low TrimDAC settings can be noticed a significant non-linearity effect(the S curves separated by different values). could you try to explain the reason cause this?(from Kai)

I don’t know the exact reason. This version is quite old, I didn’t see they mention this non-linearity in later version of ABCD.

4. What is the full name of ABCD chip?(from Amit)

ATLAS **B**inary **C**hip manufactured in the **D**MILL process