Very first results of track reconstruction on a small TPC read by SAMPA-SRS

RD51 collaboration
meeting
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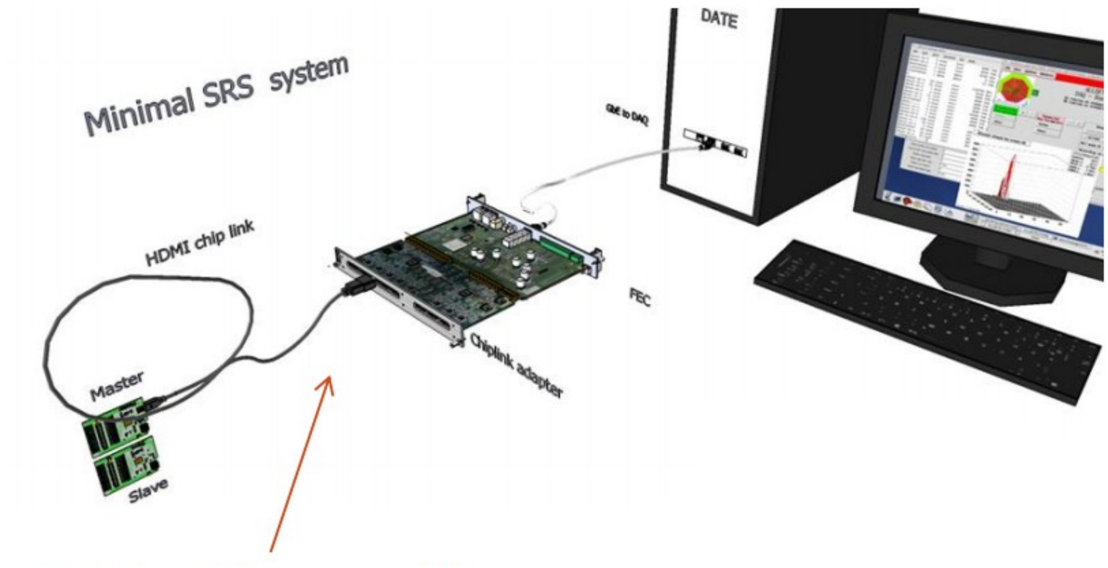
Summary:

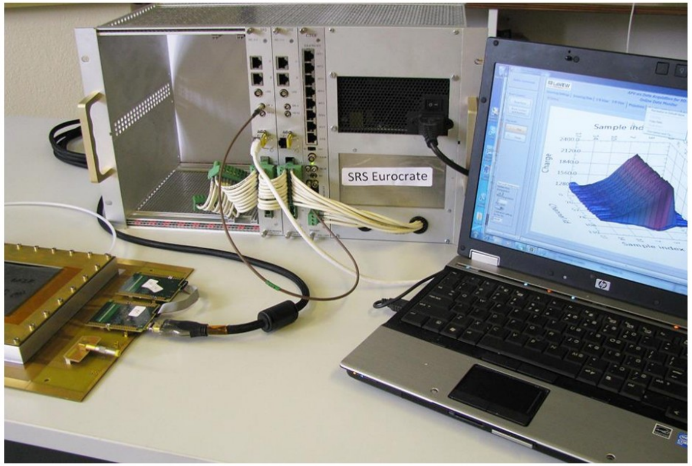
- **The SAMPA chip with the SRS**
- **The tests prototype**
- **Results**

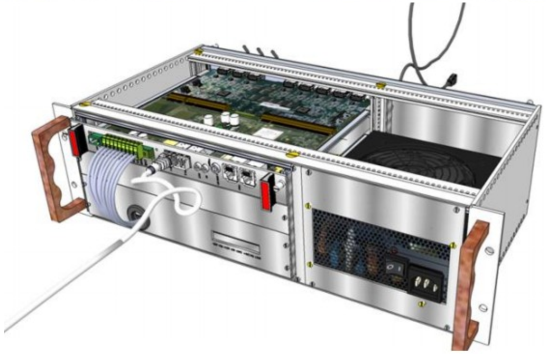
The Scalable Readout System (SRS) – APV25

Scalable → from dozens to thousands of electronic channels



APV25 setup





SRS crate

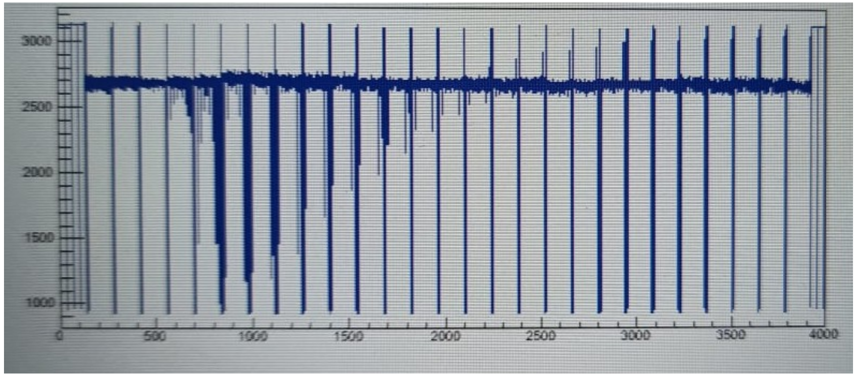
Pictures: Scalable Readout System RD51/GDD LAB 2016 – Hans Muller

Why use SAMPA?

Other ASICs can be limited to a small data frame or just a peak value.

Using the SRS with the APV25 chip for TPCs?

X-ray signal collected by the APV25



30 samples per trigger (1 sample every 25 ns)

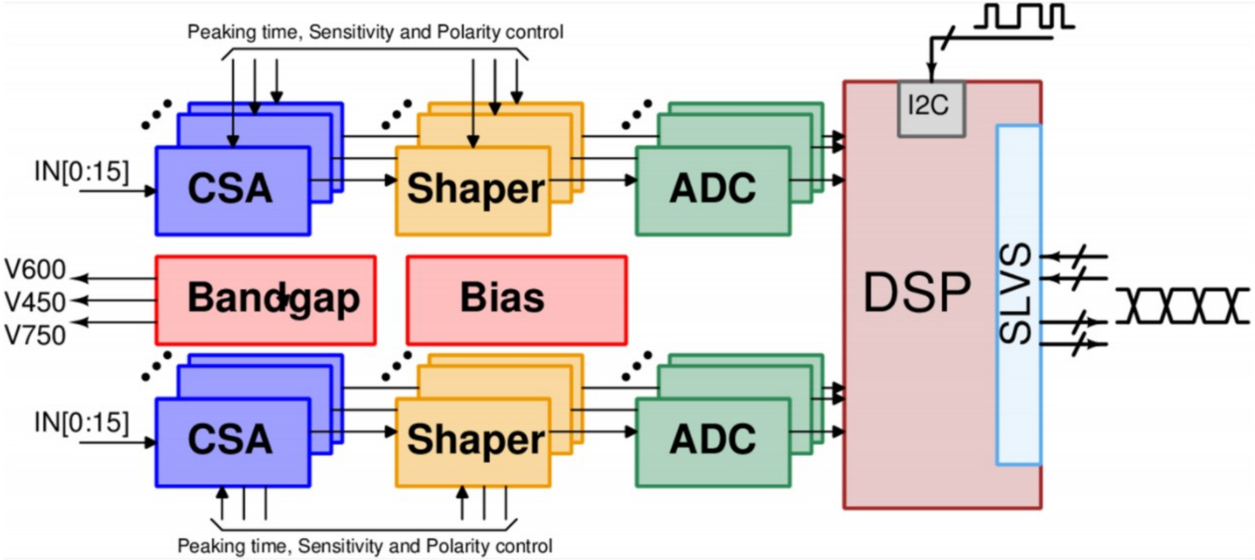
750 ns

Ar/CO_2(70/30)

Drift velocity≈1 cm/μs maximum height that can be read is 0.75 cm

SAMPA Overview

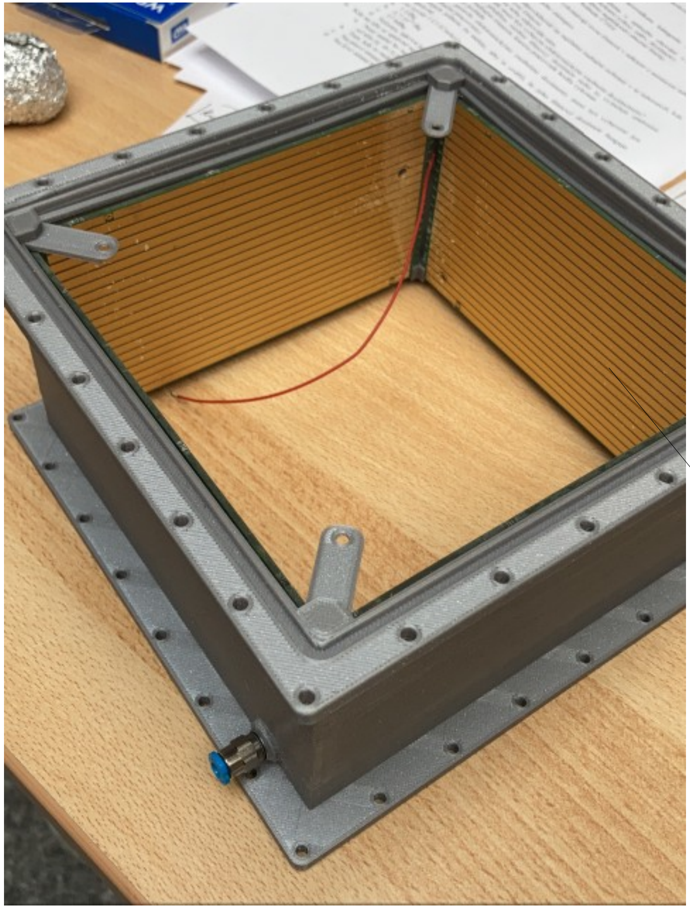
- TSMC CMOS 130nm, 1.25V technology.
- 32 Channels, Front-end + ADC + DSP.
- Positive and negative polarities with 2 analog front-end modes:
  - 20 or 30 mV/fC with 160 ns shaping time.(Sensor Cap: 12 - 25 pF)
  - 4 mV/fC with 300 ns shaping time. (Sensor Cap: 40 - 80 pF)
- ADC: 10-bit resolution, up to 18.5 MSPS.



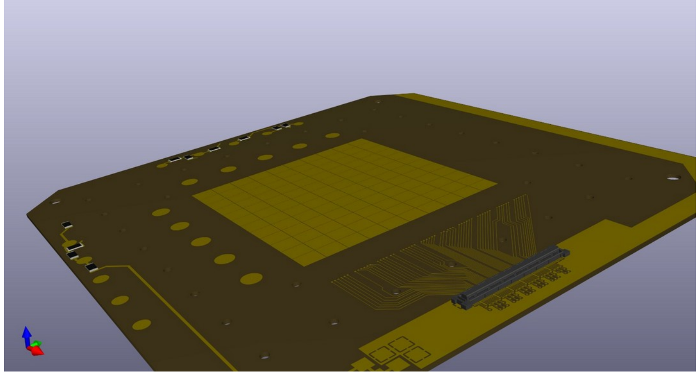
SAMPA Block Diagram

A new SAMPA version with 20/30 mV/fC and 160/80 ns shaping time was later designed, tested on silicon and it is presently available.

The TPC prototype



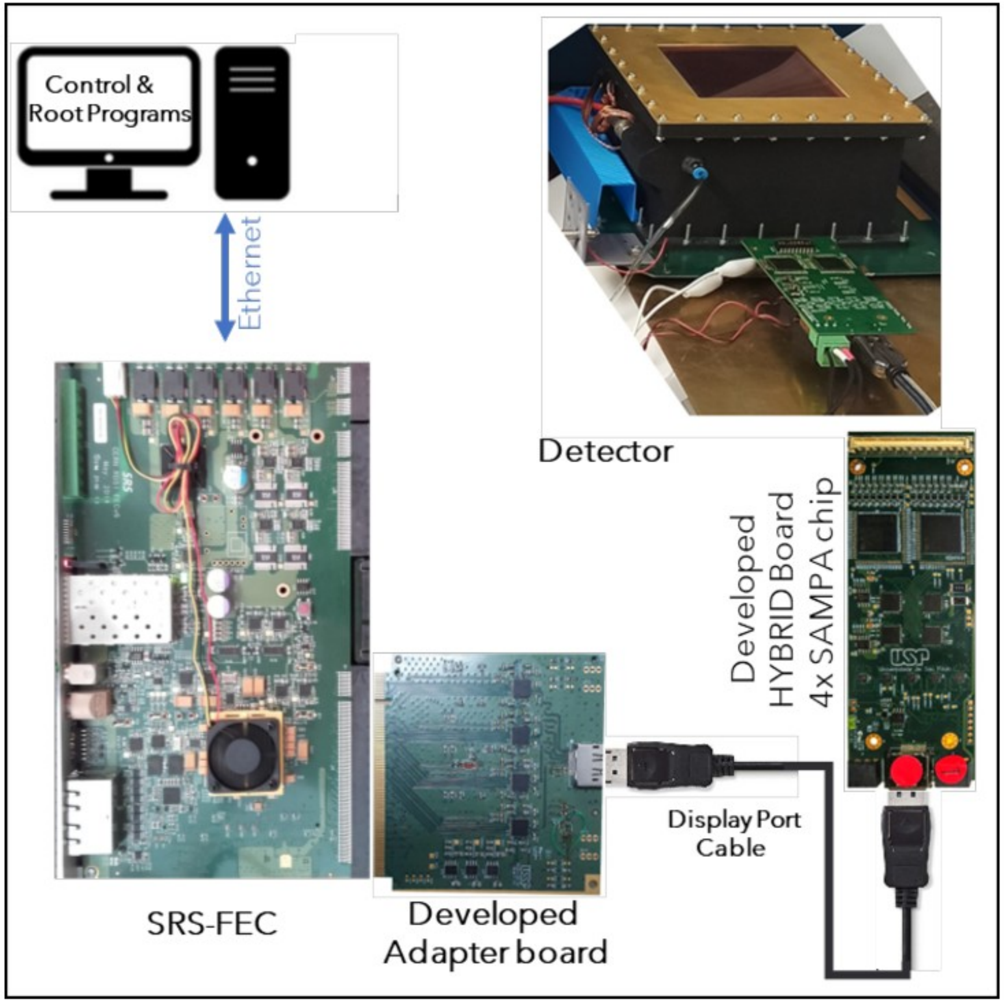
- 80 mm drift region Ar/CO_2(70/30)
- 3D printed frame
- Field cage made of PCB strips and SMD resistors



- Triple-GEM and a pad read-out ($10x10\ cm^2$)

10 x 12 pads

The complete setup



Hybrid board overview:

Each hybrid provides 128 channels

The physical dimensions are compatible with the readout plane (10 cm x 10 cm) developed by the RD51 collaboration

Adapter board overview:

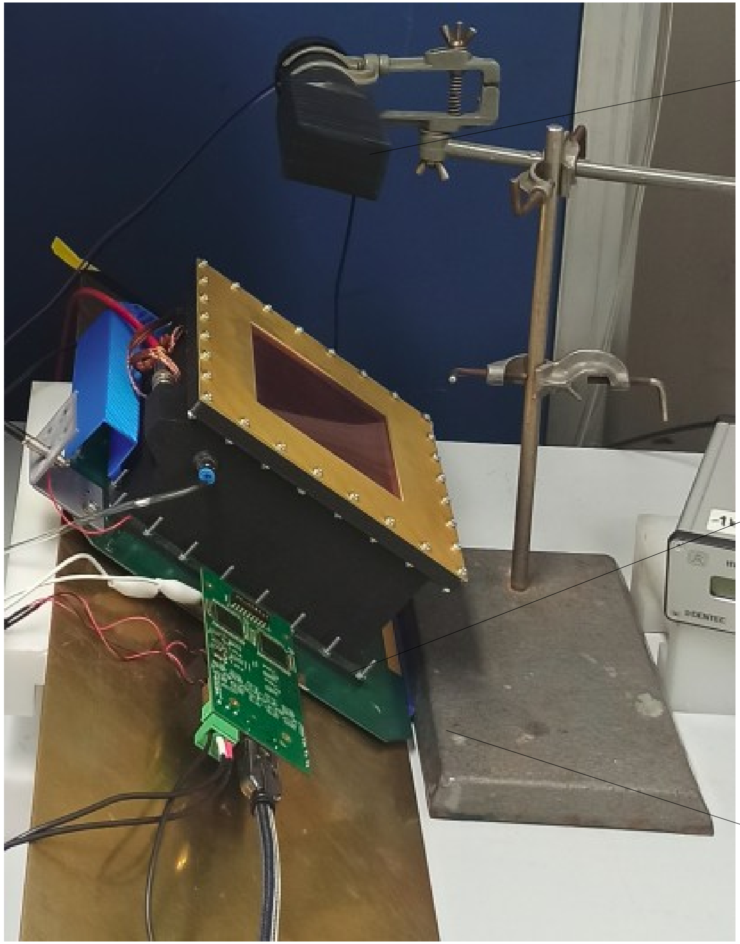
Each SAMPA chip is connected to one high speed serializer

A single DisplayPort cable is used to connect the hybrid and the adapter board

The adapter board has four deserializers and a PCIx16 standard to connect a Front-End Card (FEC).

The TPC prototype – Telescope setup

Detector tilted for longer tracks

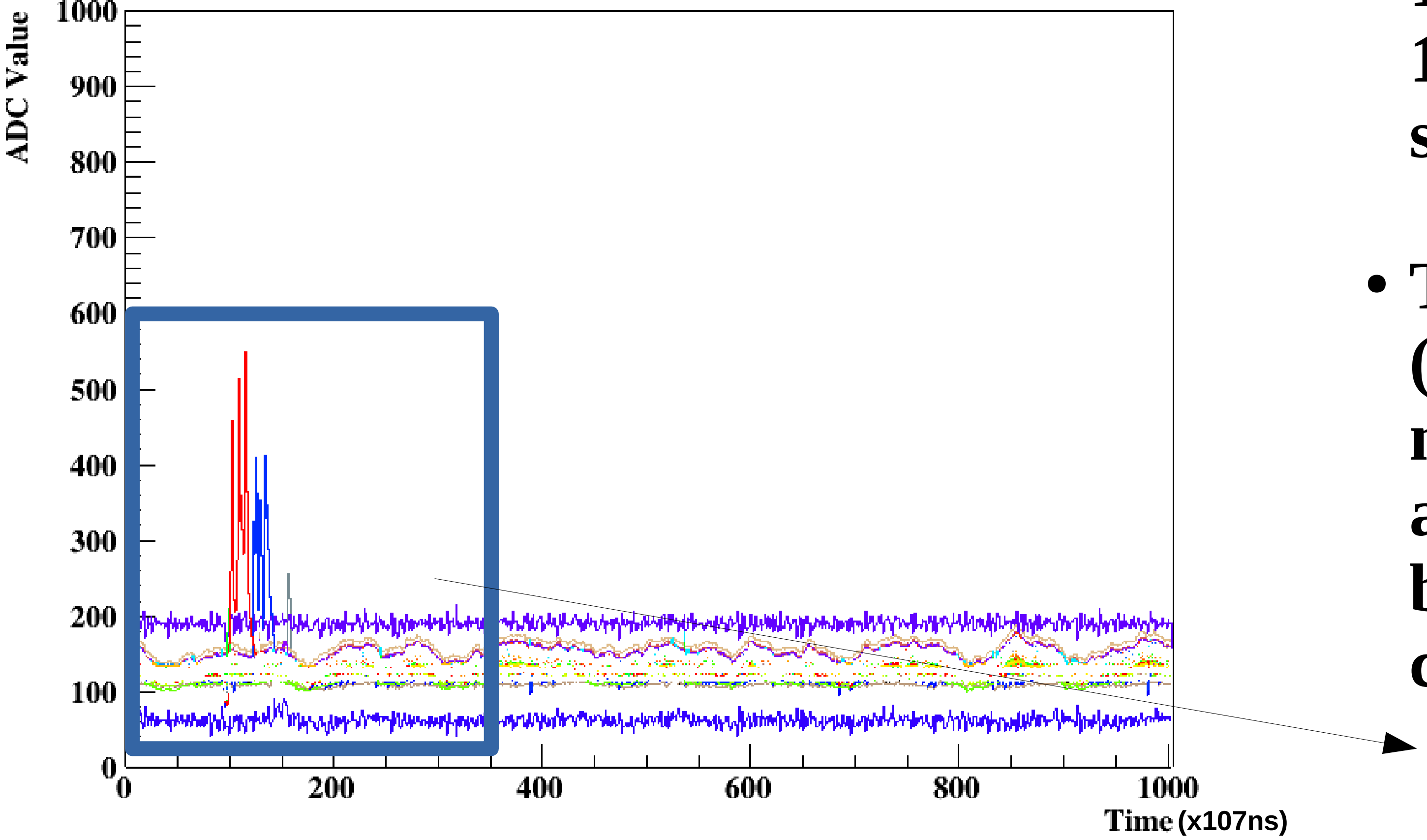


1st plastic scintillator

SAMPA hybrid

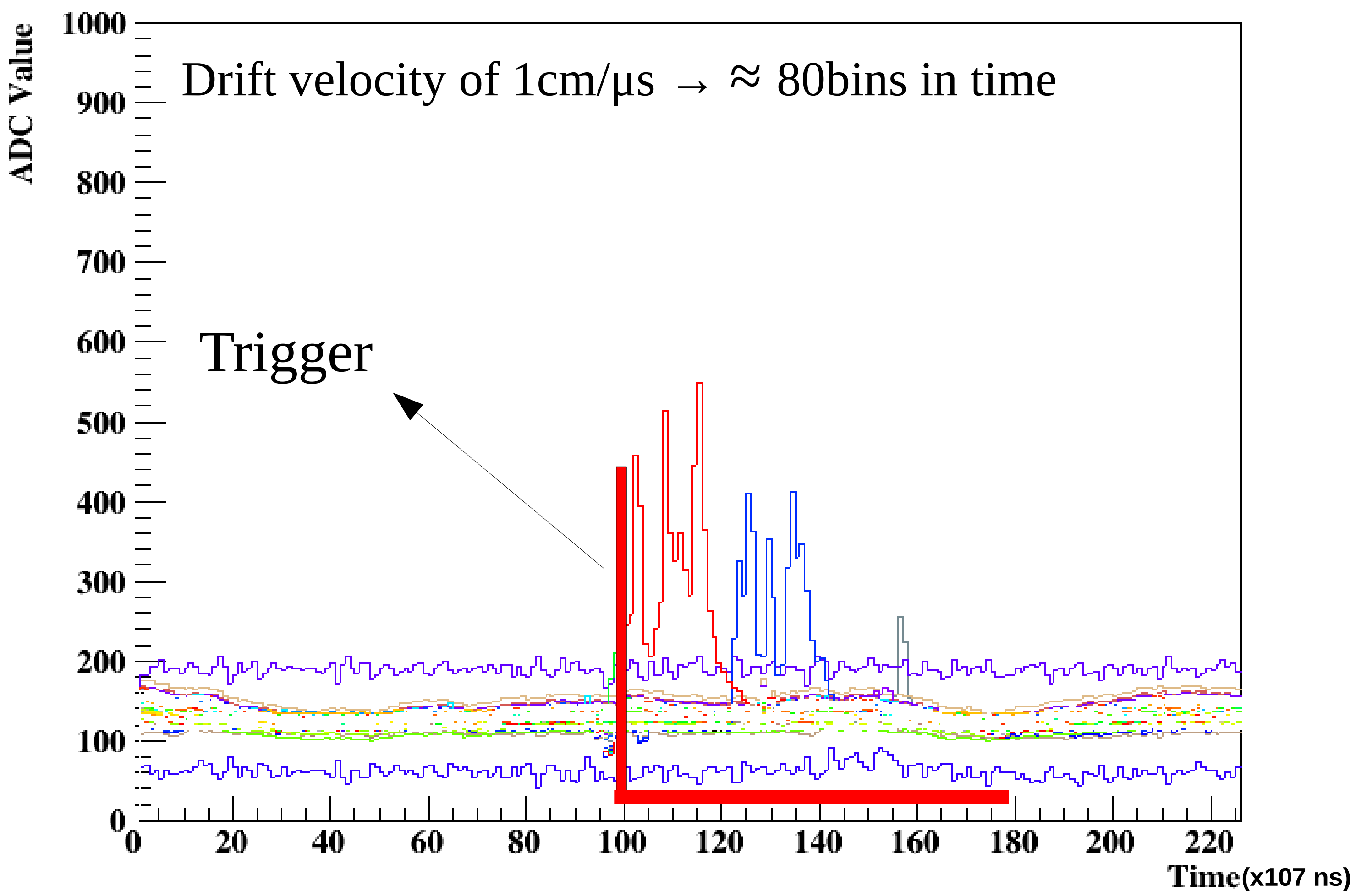
2nd scintillator under the detector

We were able to retrieve data from all 128 channels



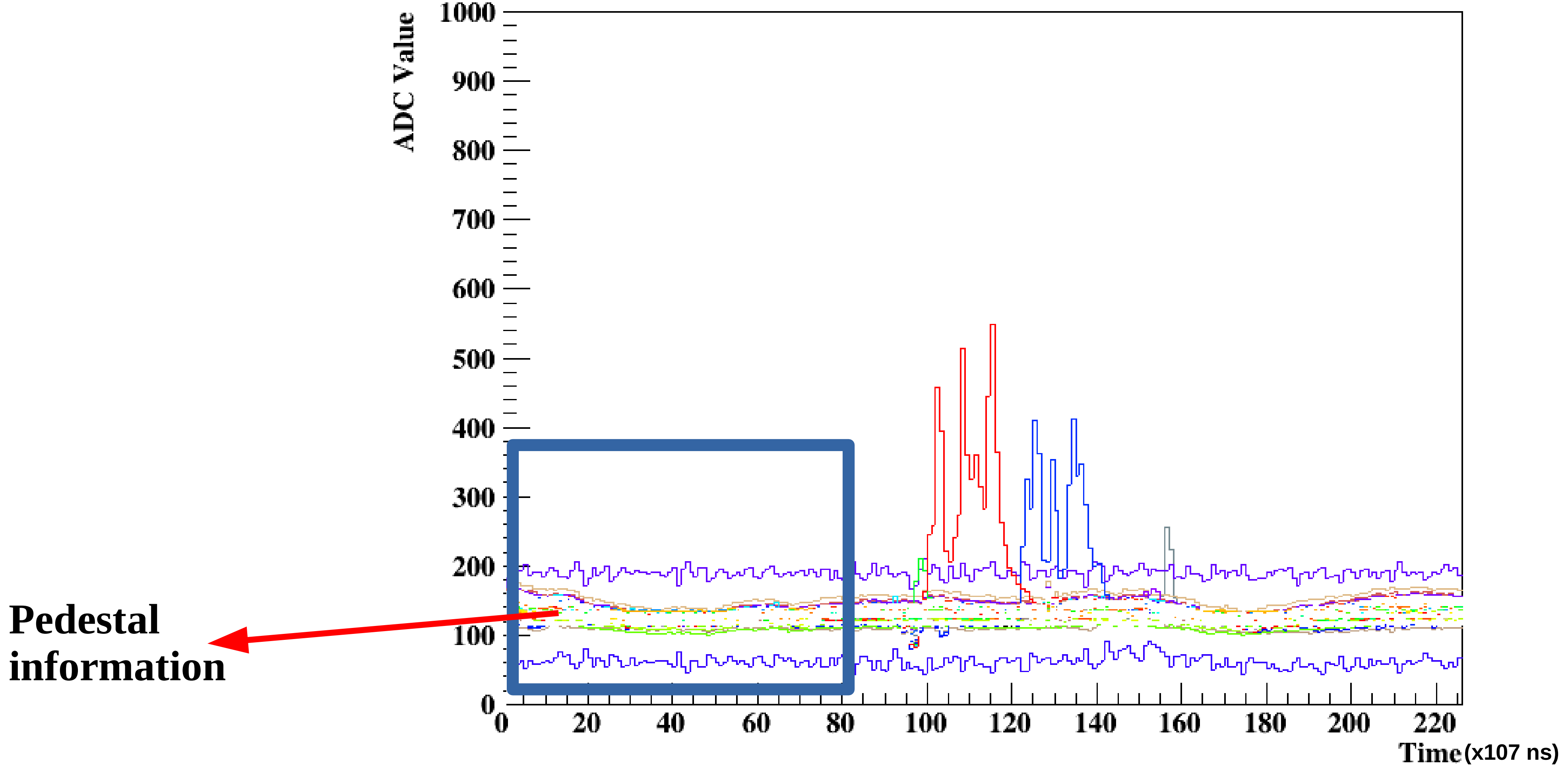
- 1 Sampling each 107 ns, up to ~1000 samples/frame
- Total time window (100 μs) is not necessary for our application. It can be configured and changed

Zooming in

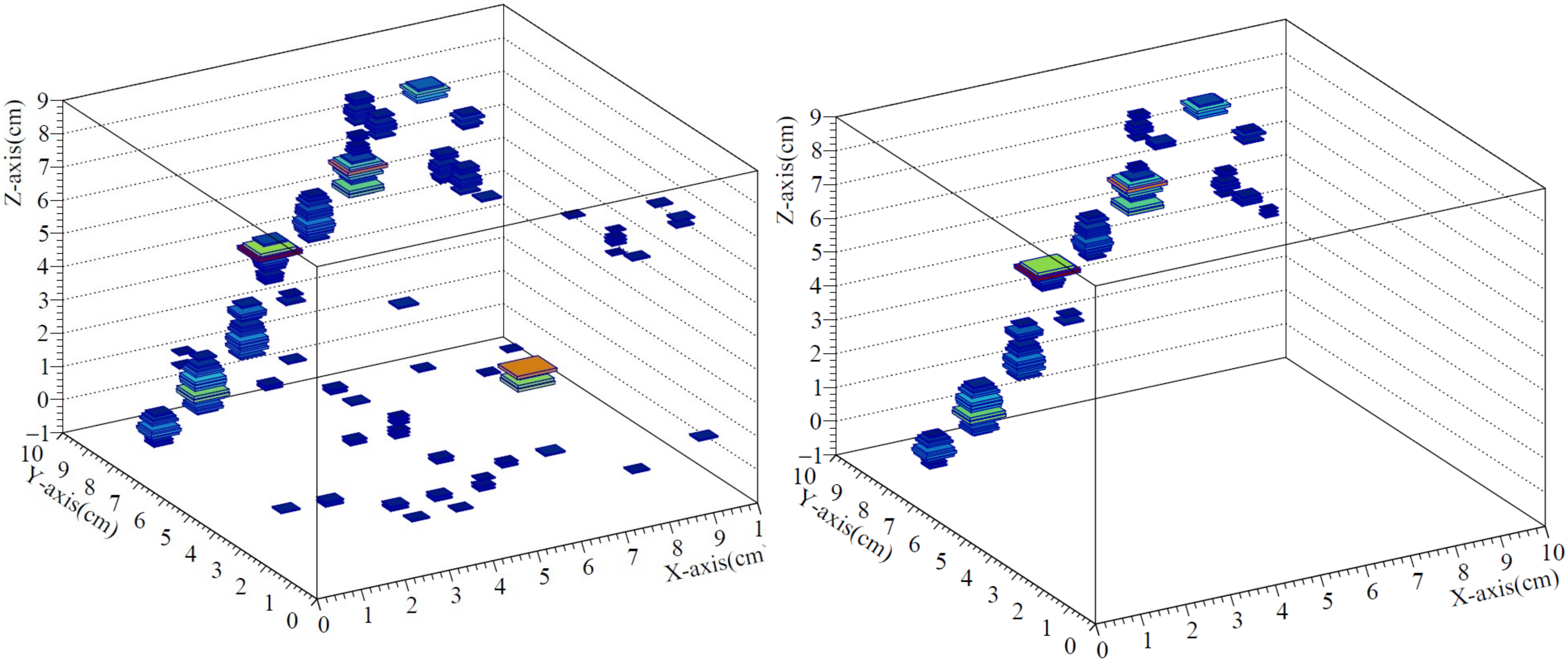


SAMPA amplifies and digitize information every 107 ns.

Data is stored in a buffer and after a trigger it is possible to recover the information which was stored (up to approx. 20 µs -latency)

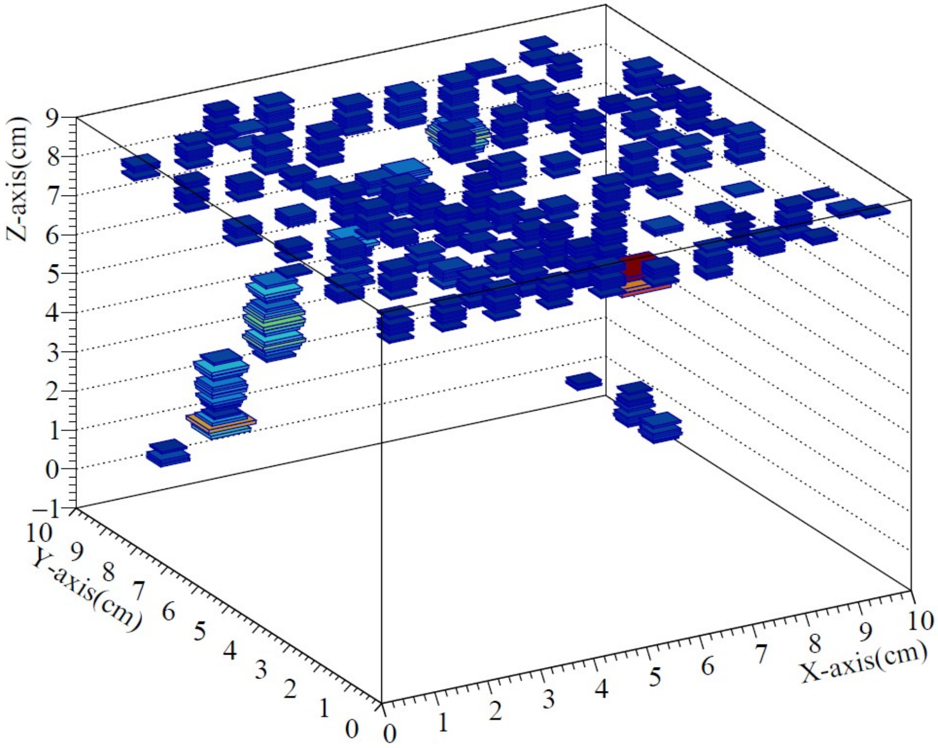

ADC Value
1000
900
800
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
160
180
200
220
Time (x107 ns)
Pedestal
information

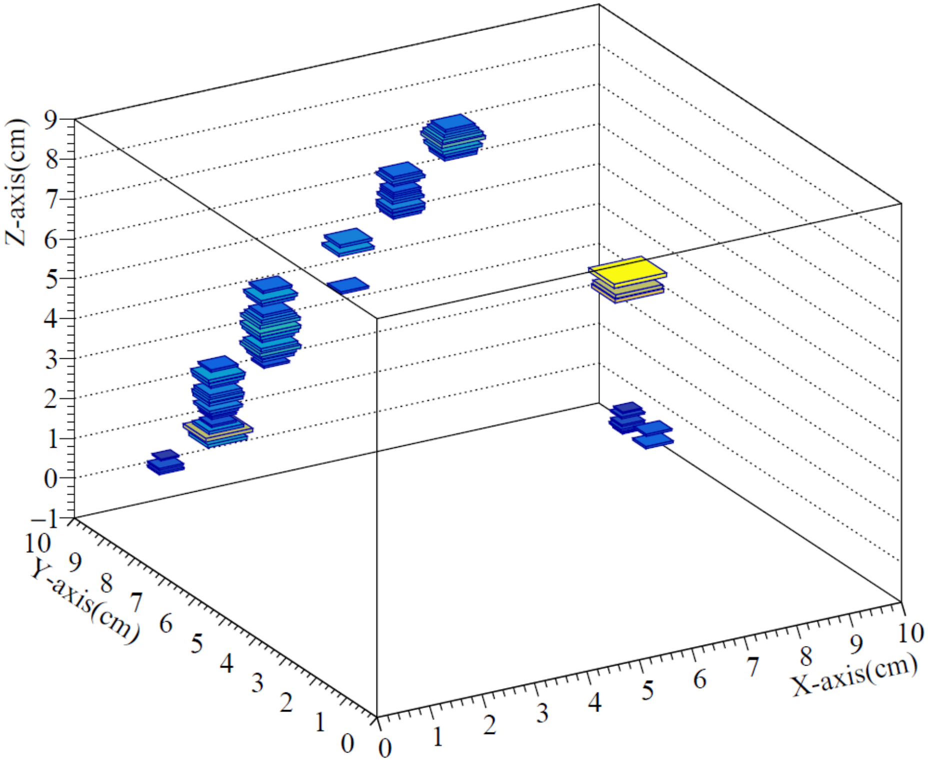
Example 1:



Small amplitude events related to noise, where the baseline occasionally crosses the **5σ threshold** can be removed using a clustering algorithm (remove non-neighboring and events which are short in time).

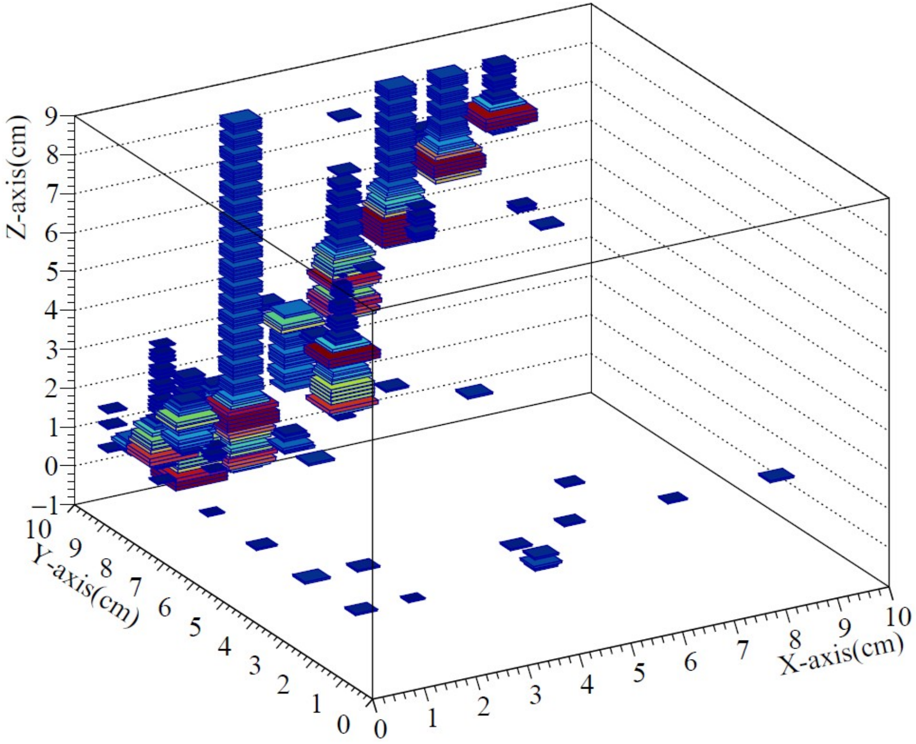
Example 2:

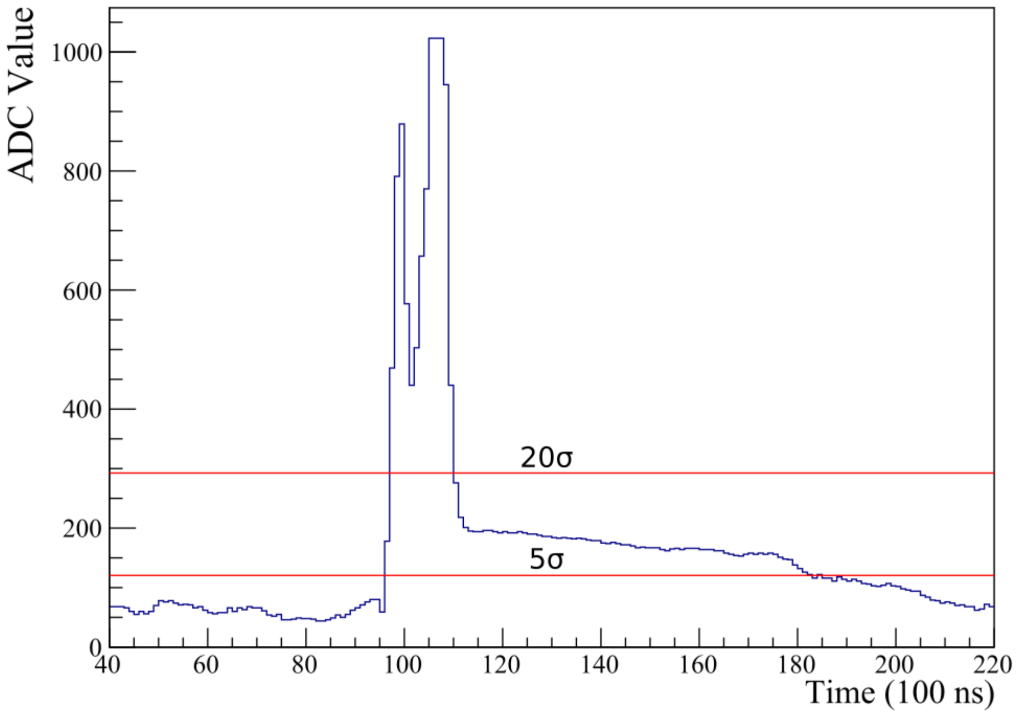




Artifacts yet somewhere unknown in the electronics (maybe a ground/baseline shift?) generated a small amplitude signal that affects many channels at the same time. They can be removed during data processing.

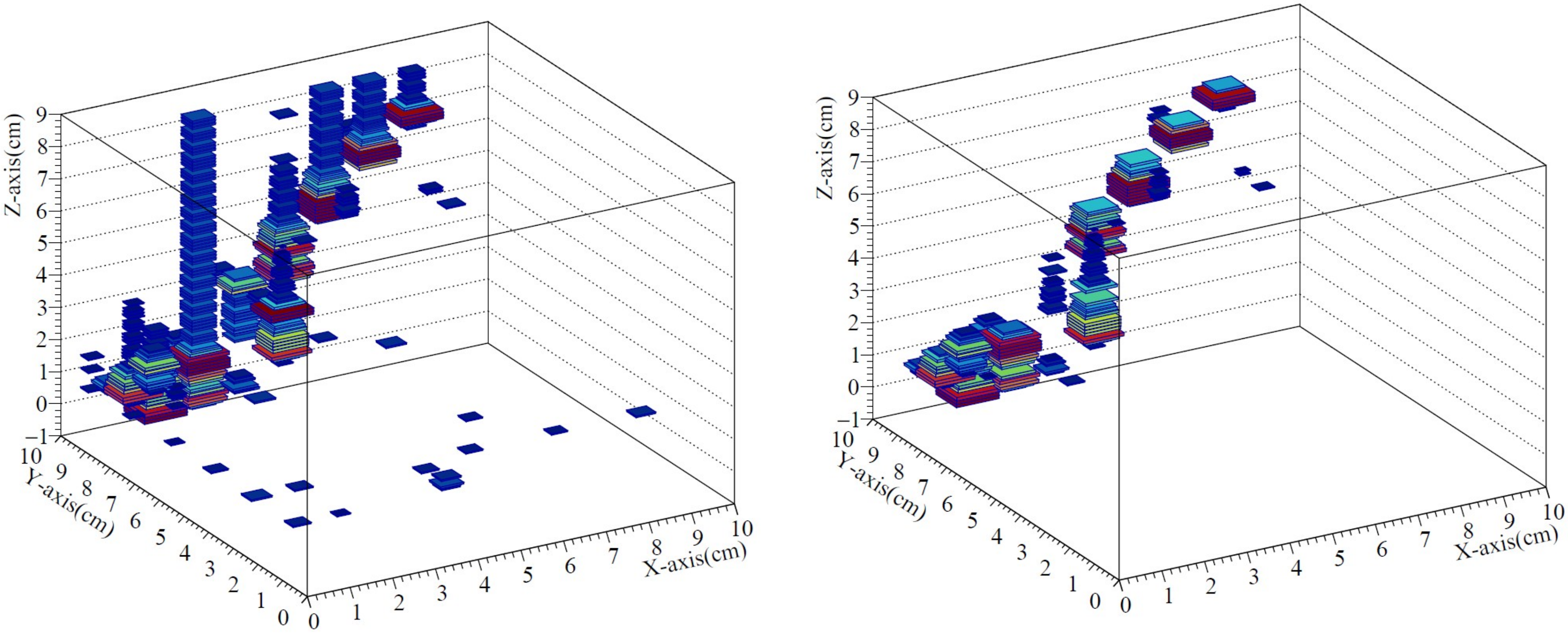
Example 3:





Baseline = The first 80 samples of the data frame. Whenever the charge saturates a channel, the baseline increases its mean. In these cases, the zero suppression cut is changed to 20σ.

Example 3:



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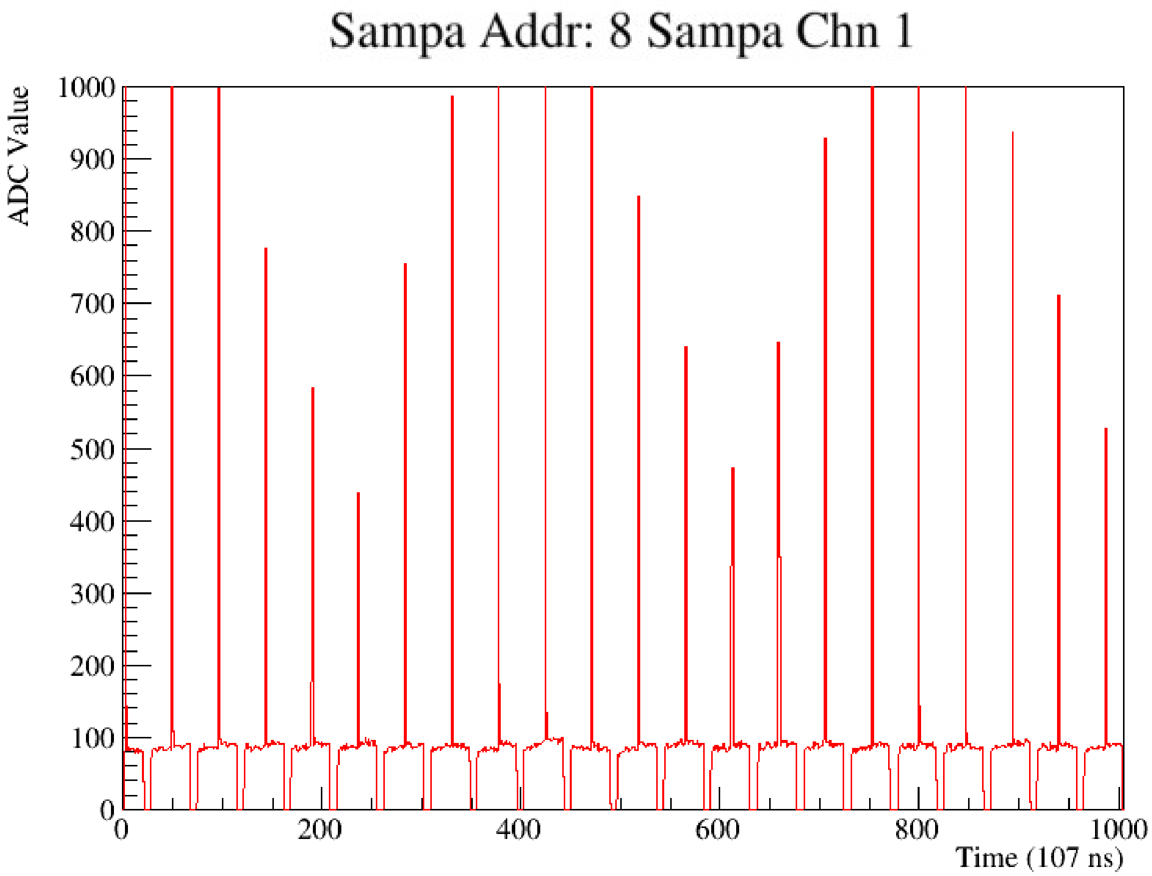
Testing the I2C features of SAMPA with a different setup

Injecting pulse 200kHz – T = 5μs



Testing the I2C features of SAMPA with a different setup

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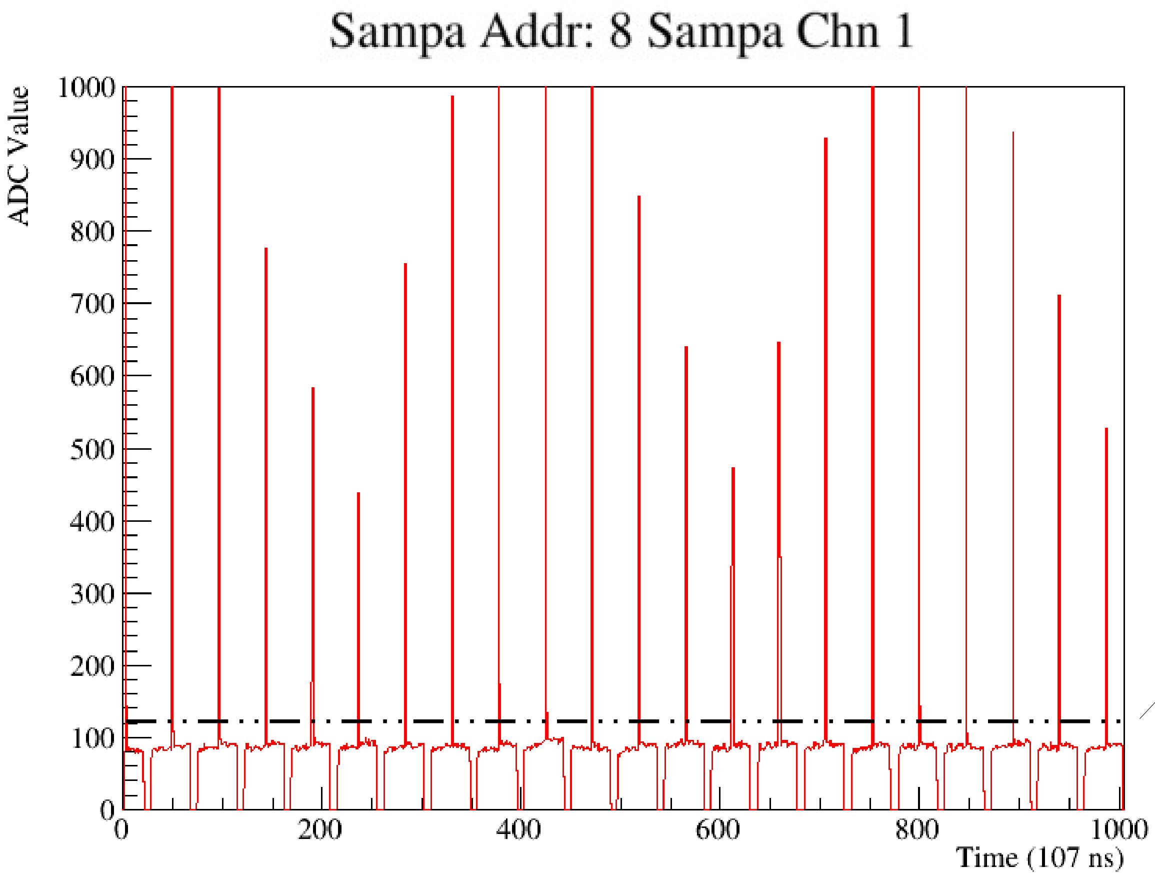
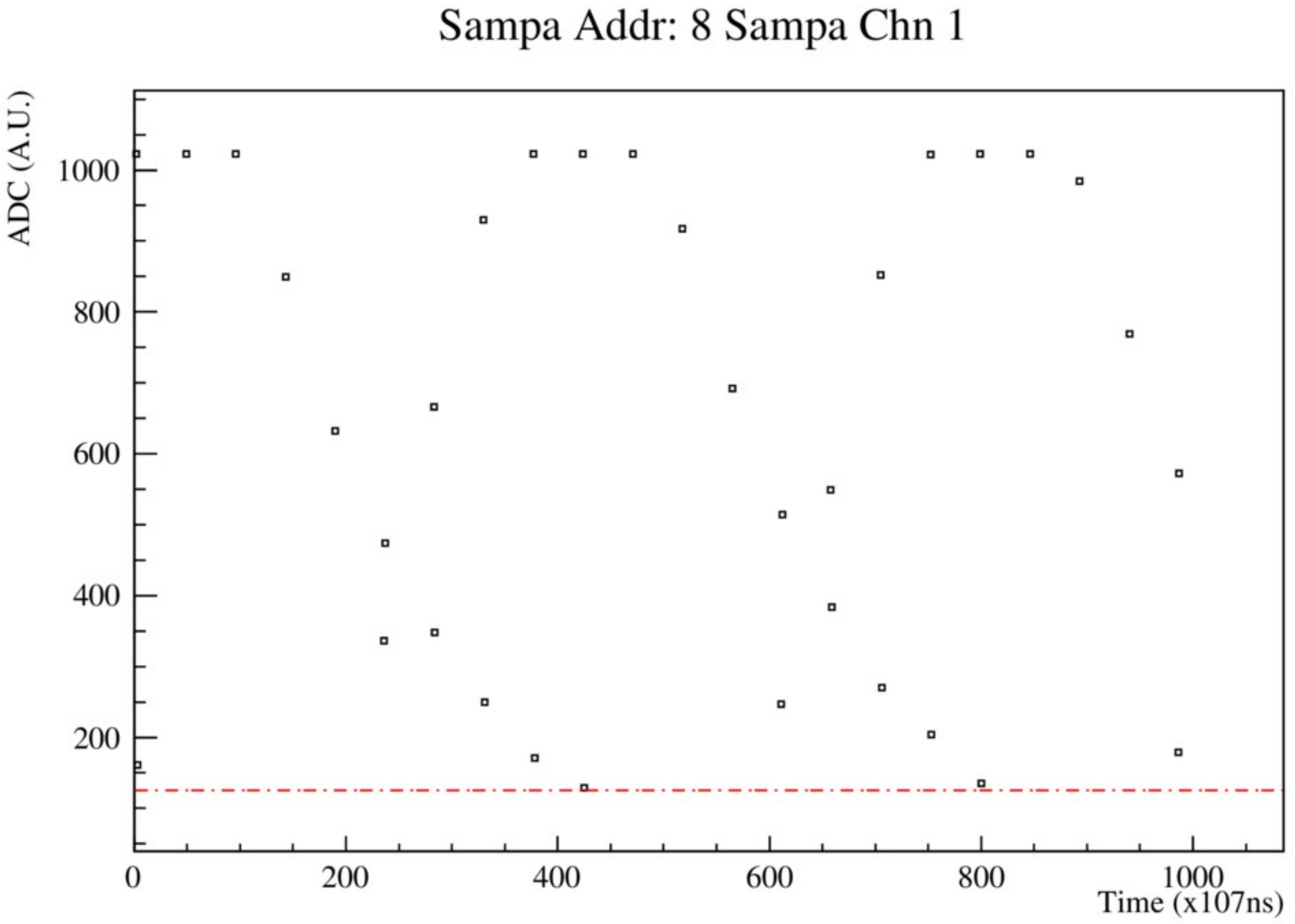


Zero suppression at 125 A.U.

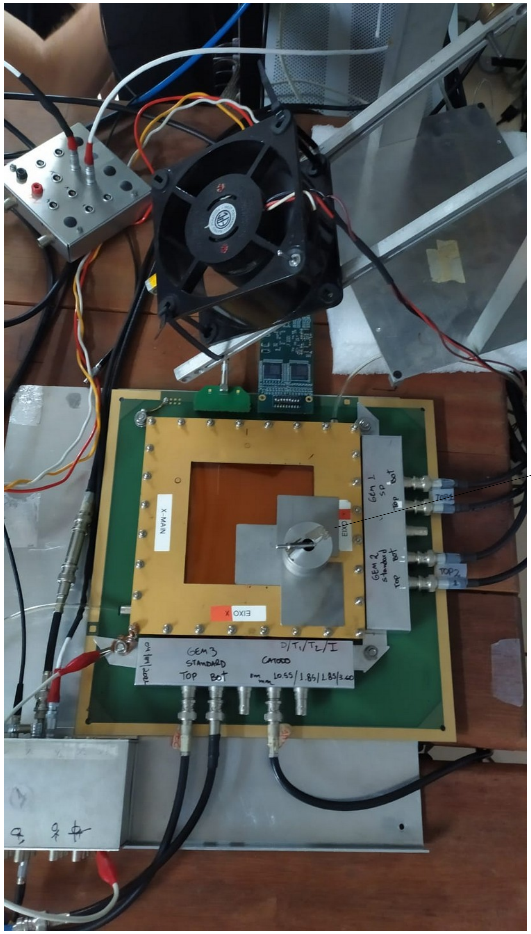
Testing the I2C features of SAMPA with a different setup

Online zero suppression – Injected pulse 200kHz



Zero suppression at 125 A.U.

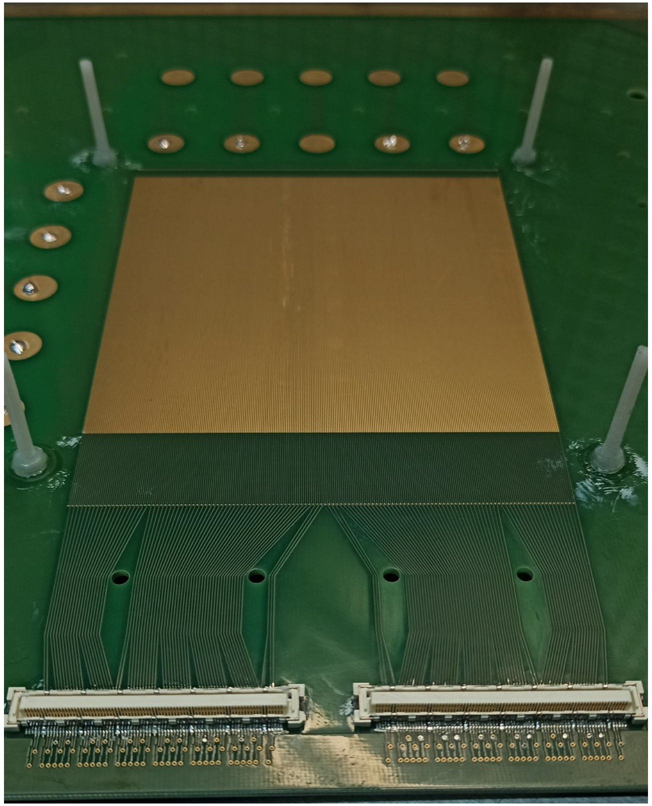
We have set another detector to test the system



Triple-GEM

$Ar/CO_2(70/30)$

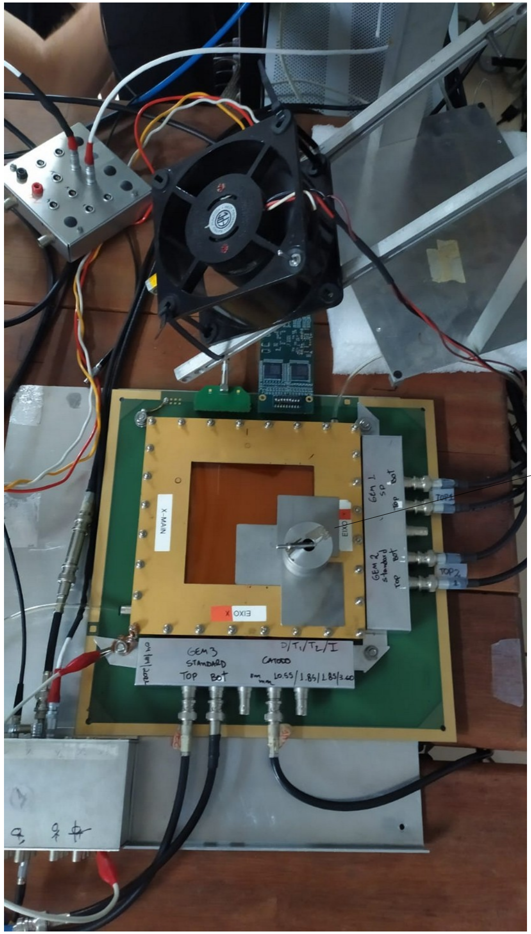
^{55}Fe Source



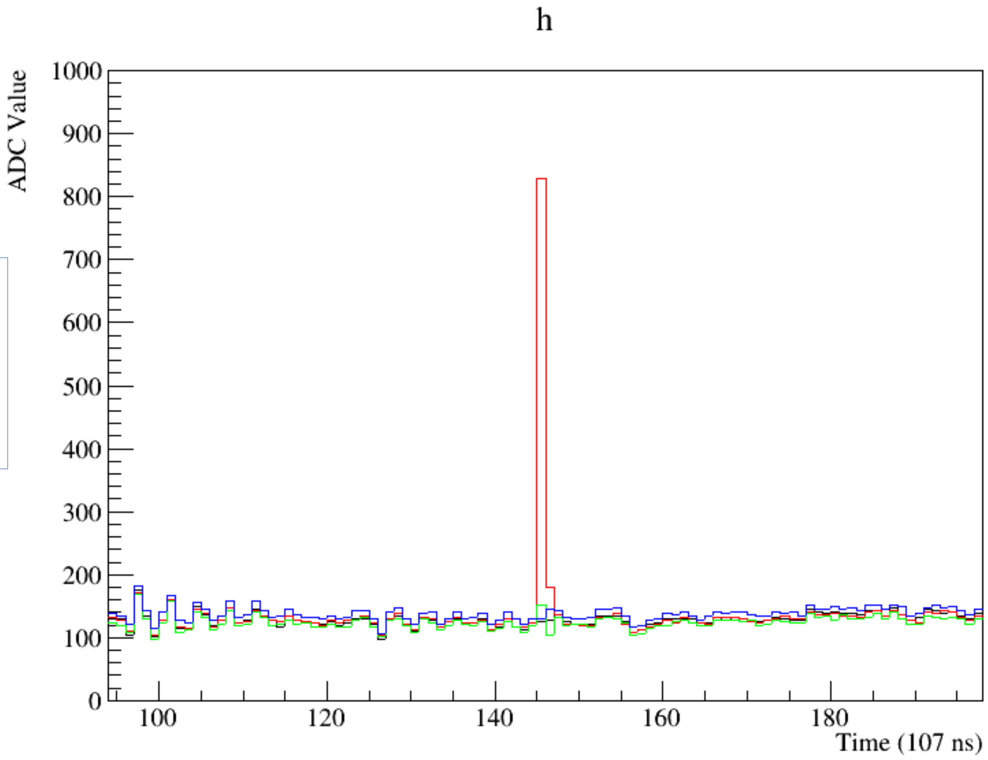
Designed by T. Abelha HEPIC@IFUSP

1D strip read-out (0.39 mm pitch)

We have set another detector to test the system



^{55}Fe Source



Conclusions:

- **SAMPA data was successfully retrieved using the SRS**
- **We have mounted a prototype TPC that is acquiring cosmic rays (we still have work to do in track reconstruction)**
- **I2C features seems to be working fine (ex:frame length, online zero suppression)**

Future work:

- **Develop a framework to process ZS data**

- **Use all I2C controlled features to perform acquisitions with the 1D strip read-out detector**

- **Use Amore and Date to acquire data with SAMPA**

- **Work with more than one hybrid**

Thank you!

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