Prototype of a charged particles tracking device

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Introduction

Realization of charged particles prototype tracker device.

→ Triangular scintillator bars coupled to silicon photomultipliers (SiPM).
Analog readout of the SiPM signal.

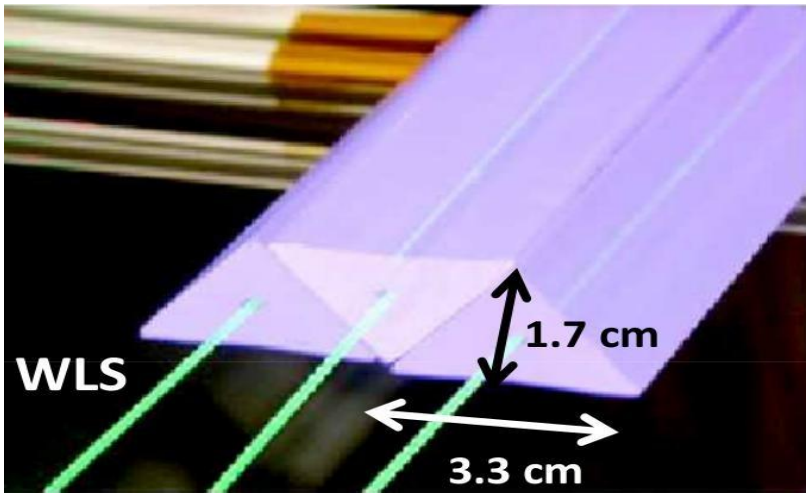
In this thesis :

- Evaluation of the tracker resolution by using MC simulations data
- Evaluation of the tracker resolution by using the data of a test beam

Tracker

Scintillator bars

- Lenght 30 cm
- Triangular cross-section
- Central hole Ø 2.6 mm
- *Wavelength shifting* fiber, WLS
  Ø = **2** mm , Blue to Green Shifter



Light collection

- 3x3 mm^2 SiPM
- Analog readout of the output signal from the SiPM

Triangular cross-section

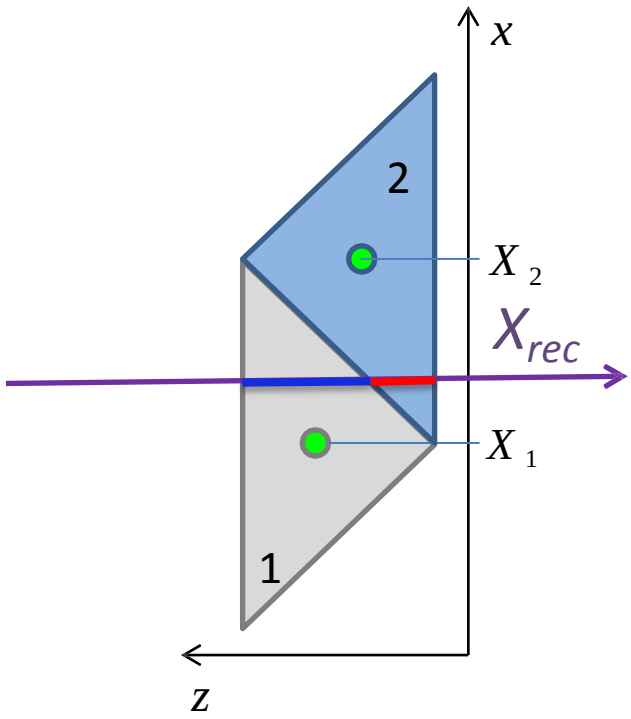
Position reconstruction compairing the deposited energy in adjacent bars

Position reconstruction

For high momentum charged particles the path through the tracker is aproximately straight.

In this case:

- The deposited energy in the detector is proportional to the crossed section leght
- The pulse heigth w_i is proportional to the deposited energy.

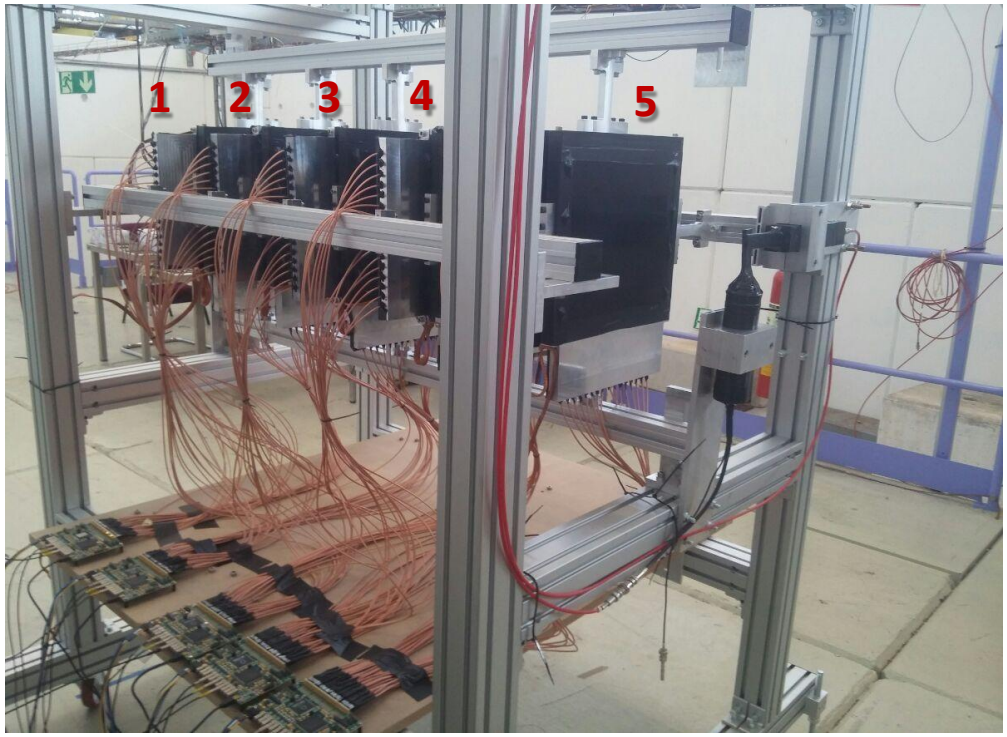


$$X_{\text{rec}} = \frac{(w_1 X_1 + w_2 X_2)}{(w_1 + w_2)}$$

Experimental setup

5 modules at 25 cm from each other made of
2 planes of 16 scintillators bars. 160 Channels.

For the analog reading of the SiPM it has been used a EASIROC chip whose signal is acquired via a chain of NIM and VME modules.



Bars of consecutive planes are perpendicular to each other

X and Y reconstructed position of the particle.

MC Simulations

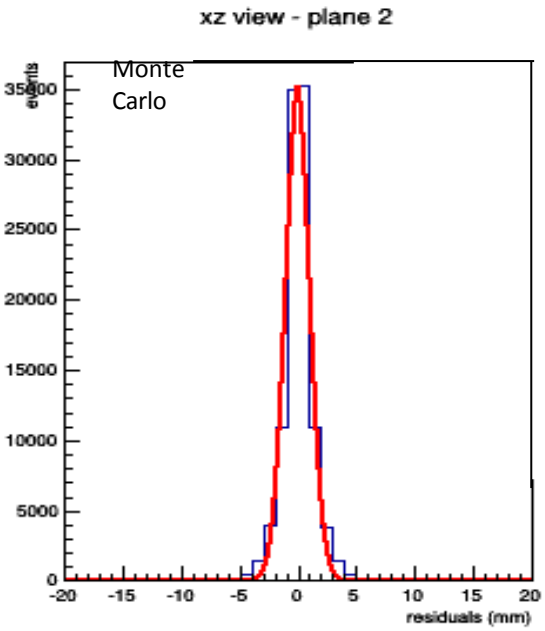
- "Clean" events **selection** : only two fired channels on each plane :
  $\mu^+ \sim 65\%$, $\pi^+ \sim 50\%$

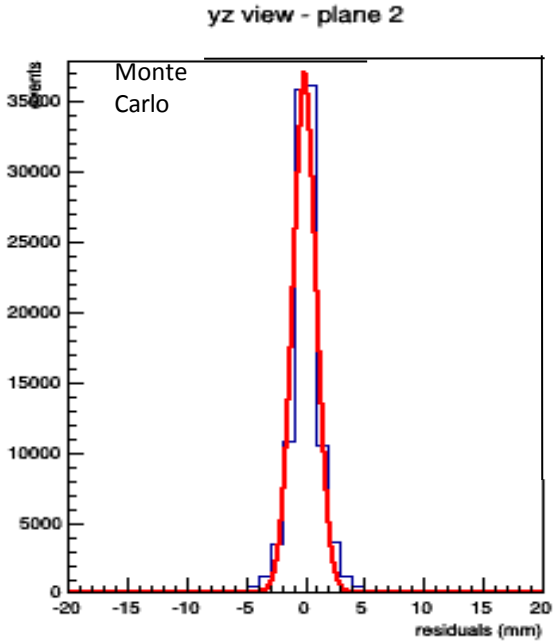
- **Reconstruction** of particle position on each plane

- **Linear fit** on both the YZ and XZ projections by using the reconstructed positions on each plane

Results from MC simulations

From the residual distribution between the recontructed position and the fitted one it's possible to evaluate the tracker resolution

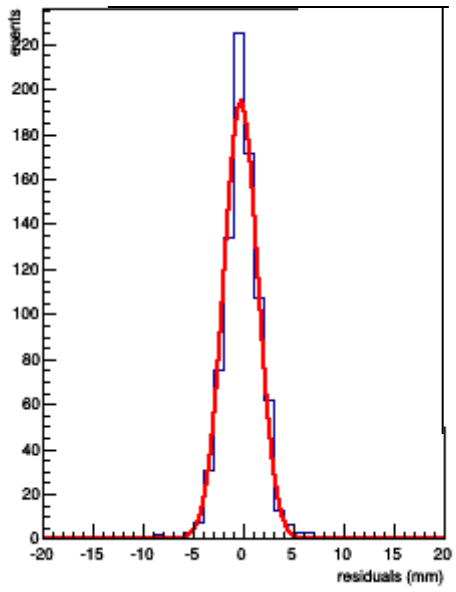


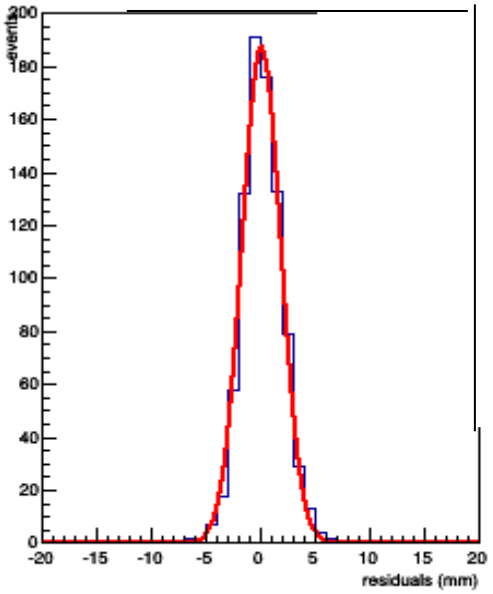


For 5 GeV π^+ events the resolution ~ 1.5 mm.

Resolution using real data

- From the residual distribution between the lineat fit and the recontructed position it's possible to evaluate the tracker prototype spatial resolution



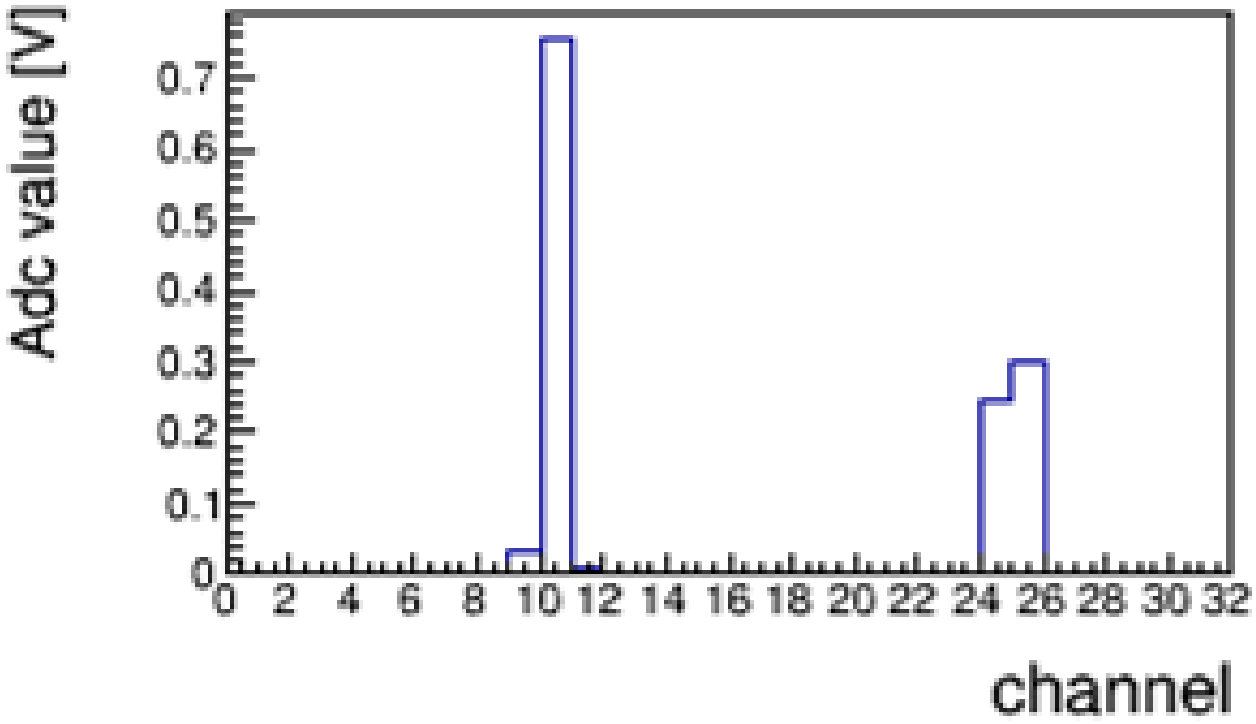


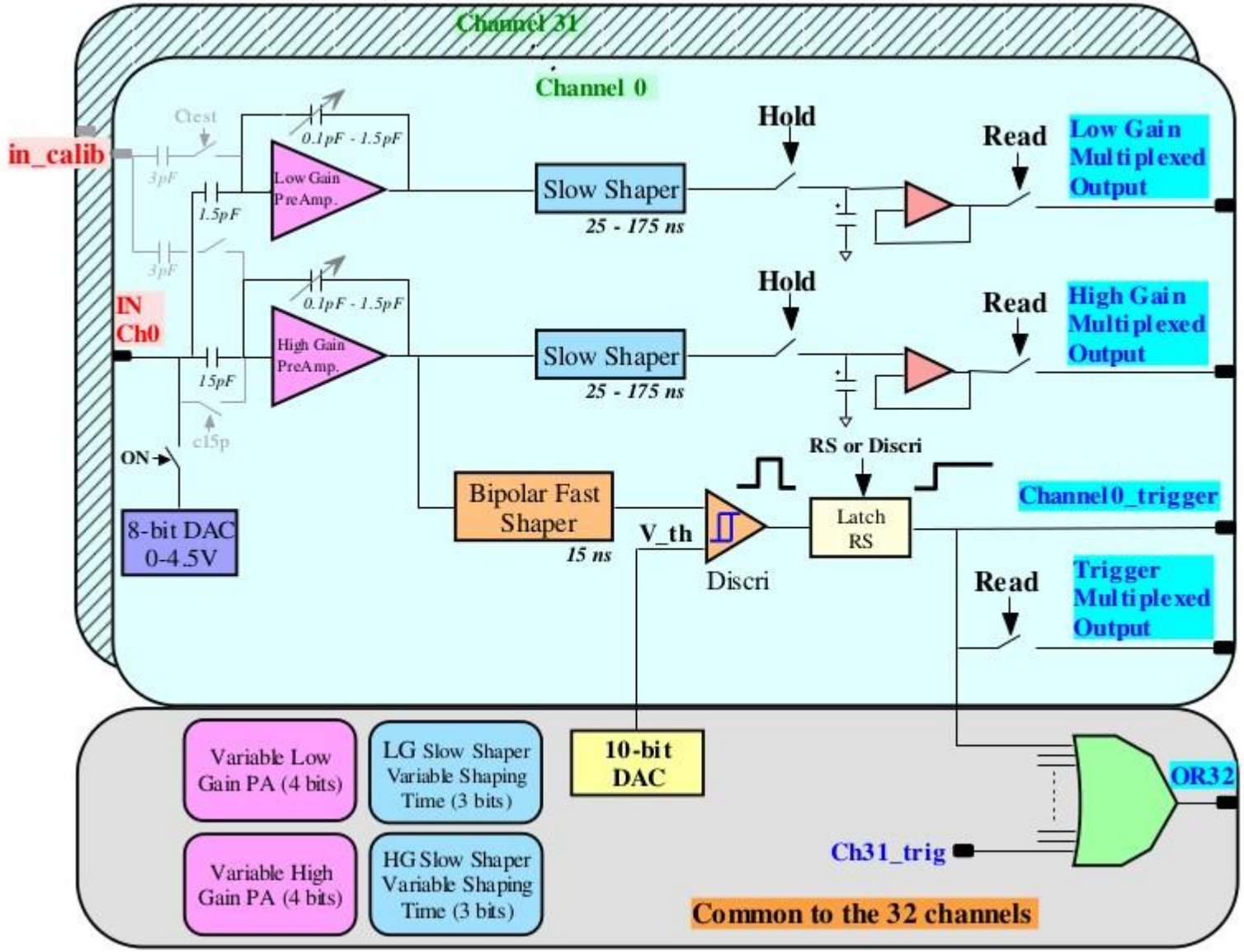
Spatial resolution
~ 2 mm (preliminary)

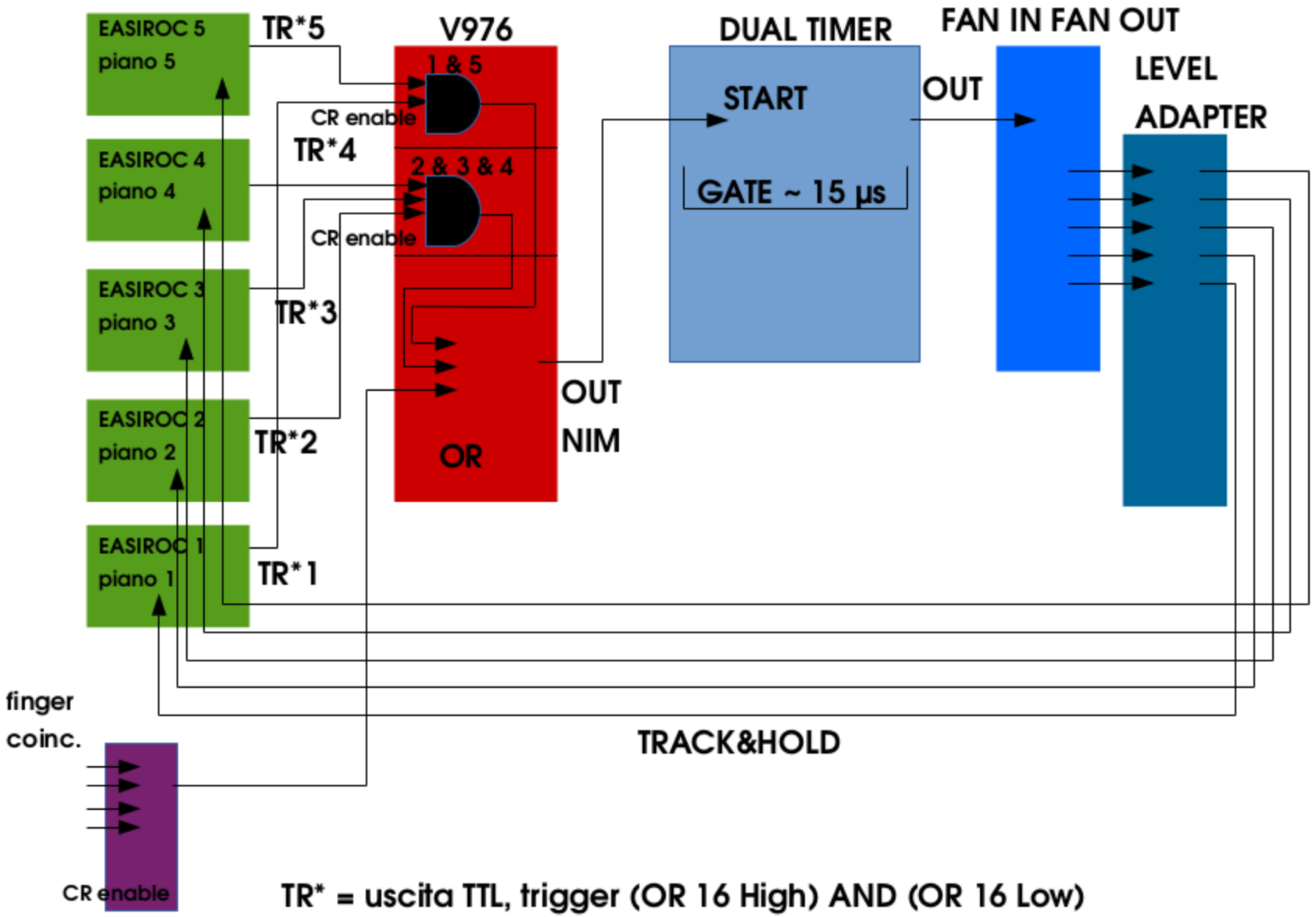
Conclusions

It’s possible to improve this resolution introducing some corrections like the recalibration of the individual channel signals and then analysing all the data.

Thank you


Adc value [V]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
channel


Channel 31
Channel 0
in_calib
Ctest
3pF
1.5pF
0.1pF - 1.5pF
Low Gain PreAmp.
Slow Shaper
25 - 175 ns
Hold
Read
Low Gain Multiplexed Output
IN Ch0
3pF
15pF
c15p
ON
0.1pF - 1.5pF
High Gain PreAmp.
Slow Shaper
25 - 175 ns
Hold
Read
High Gain Multiplexed Output
8-bit DAC 0-4.5V
Bipolar Fast Shaper
15 ns
V_th
Discri
RS or Discri
Latch RS
Channel0_trigger
Read
Trigger Multiplexed Output
Variable Low Gain PA (4 bits)
LG Slow Shaper Variable Shaping Time (3 bits)
10-bit DAC
Variable High Gain PA (4 bits)
HG Slow Shaper Variable Shaping Time (3 bits)
OR32
Ch31_trig
Common to the 32 channels


EASIROC 5
piano 5
EASIROC 4
piano 4
EASIROC 3
piano 3
EASIROC 2
piano 2
EASIROC 1
piano 1
TR*5
TR*4
TR*3
TR*2
TR*1
V976
1 & 5
2 & 3 & 4
CR enable
CR enable
OR
OUT
NIM
DUAL TIMER
START
GATE ~ 15 µs
OUT
FAN IN FAN OUT
LEVEL
ADAPTER
TRACK&HOLD
finger
coinc.
CR enable
TR* = uscita TTL, trigger (OR 16 High) AND (OR 16 Low)