the multigap rpc and the w-hcal

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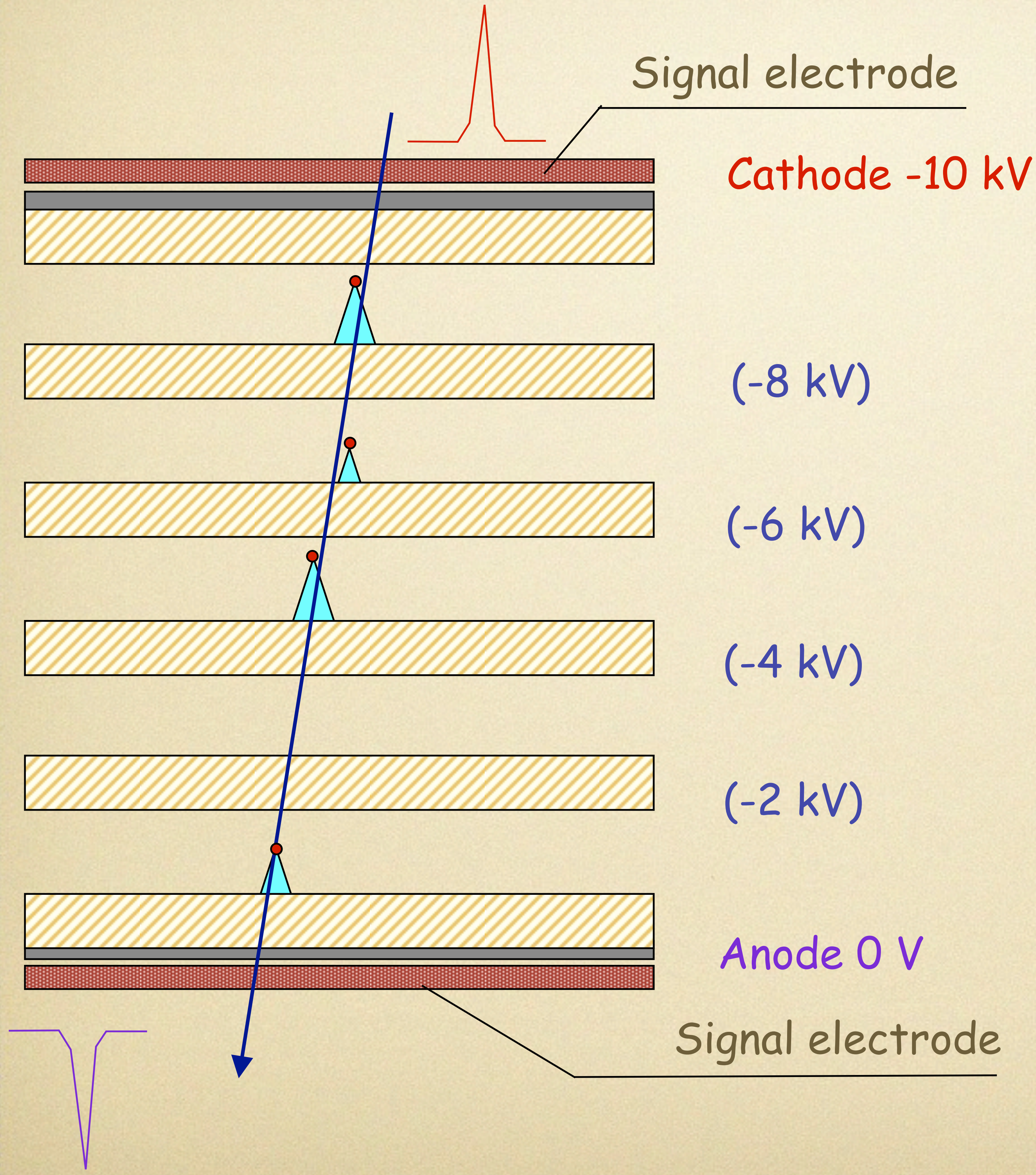
what is the multigap resistive plate chamber?

- Many small gas gaps read out by a common set of pickup electrodes
- intermediate plates electrically floating - ie just stacked up

MULTIGAP RESISTIVE PLATE CHAMBER



Stack of equally-spaced resistive plates with voltage applied to external surfaces (all internal plates electrically floating)

Pickup electrodes on external surfaces - (any movement of charge in any gap induces signal on external pickup strips)

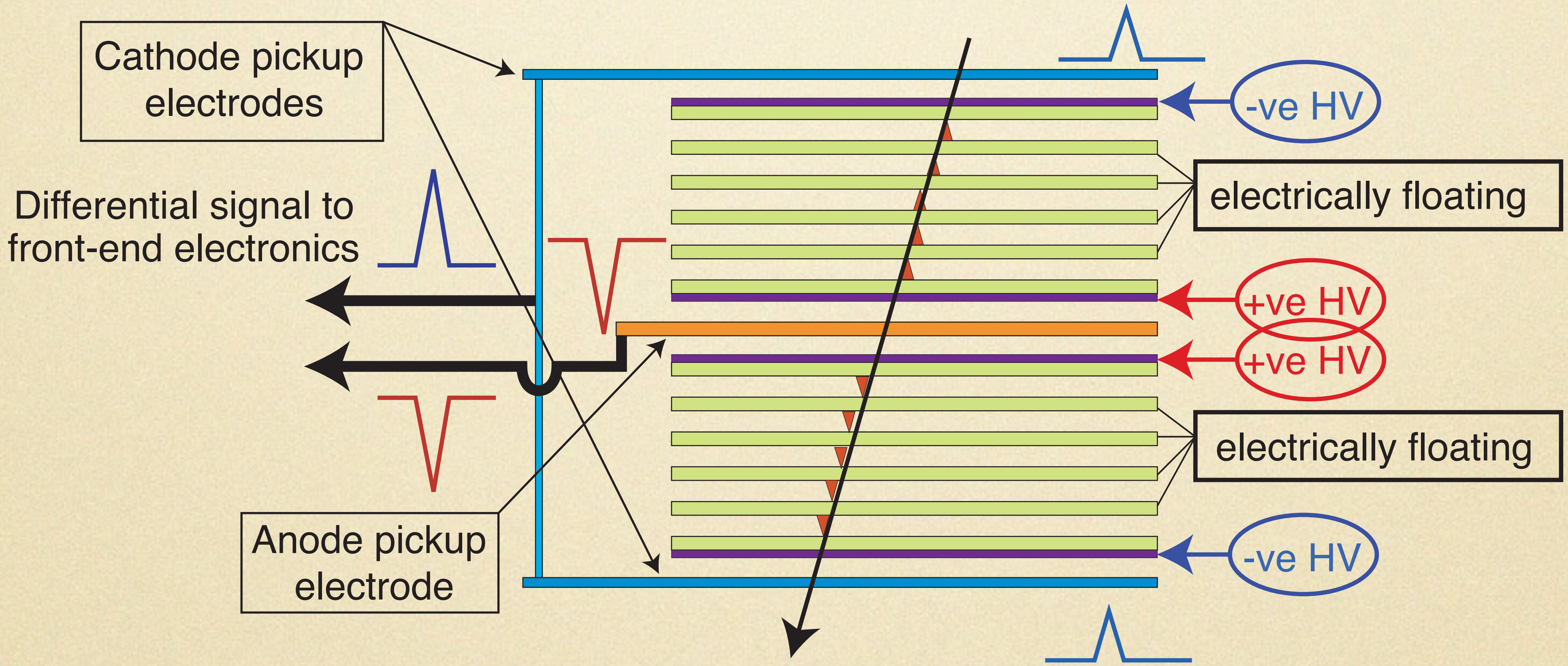
Internal plates take correct voltage - initially due to electrostatics but kept at correct voltage by flow of electrons and positive ions - feedback principle that dictates equal gain in all gas gaps

ALICE MRPC for TOF

schematic view

ALICE-TOF has 10 gas gaps (two stacks of 5 gas gaps) each gap is 250 micron wide

Built in the form of strips, each with an active area of 120 x 7.2 cm^2, readout by 96 pads



Note : HV only applied to outer surfaces of each stack of glass (internal glass sheets electrically floating) this makes it very easy to build.

Some magical aspects of the MRPC

- Intermediate resistive plates ‘float’ at correct voltage
  - kept at correct voltage by flow of electrons and positive ions, feedback principle equalised the gas gain in each gap
- long streamer-free efficiency plateau
  - space charge* limits growth of avalanche before transition to streamer
- excellent fast signal/total charge ratio
  - space charge* limited avalanche growth
  - recombination : most of negative ions (electronegative gas) recombine with positive ions

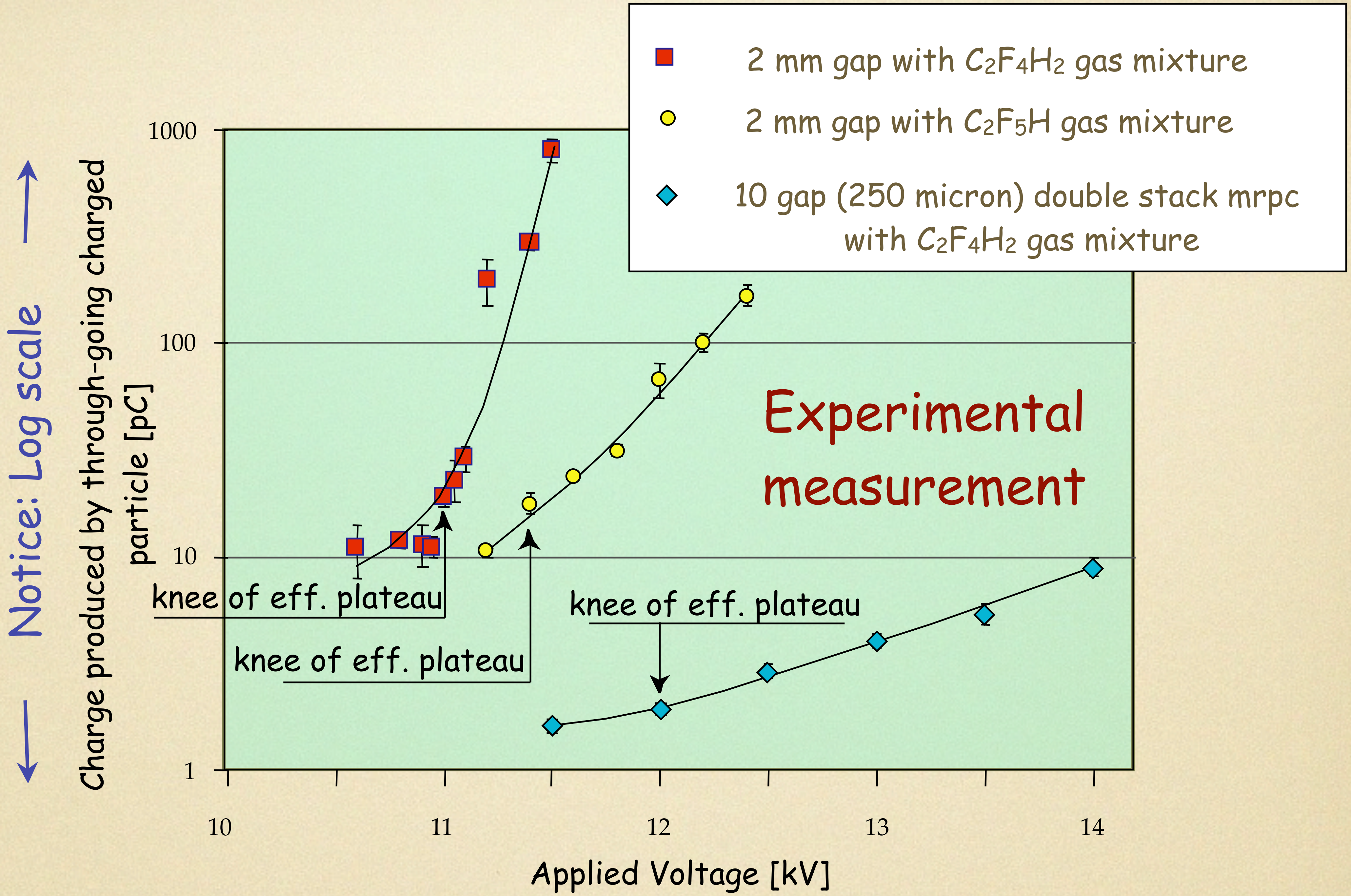
* small gas gaps makes space charge important
small gas gaps is the route to good timing

Long streamer-free efficiency plateau due to space-charge effects limiting growth of avalanche

Avalanche grows in size to ~ 10^7 electrons then space charge kicks in

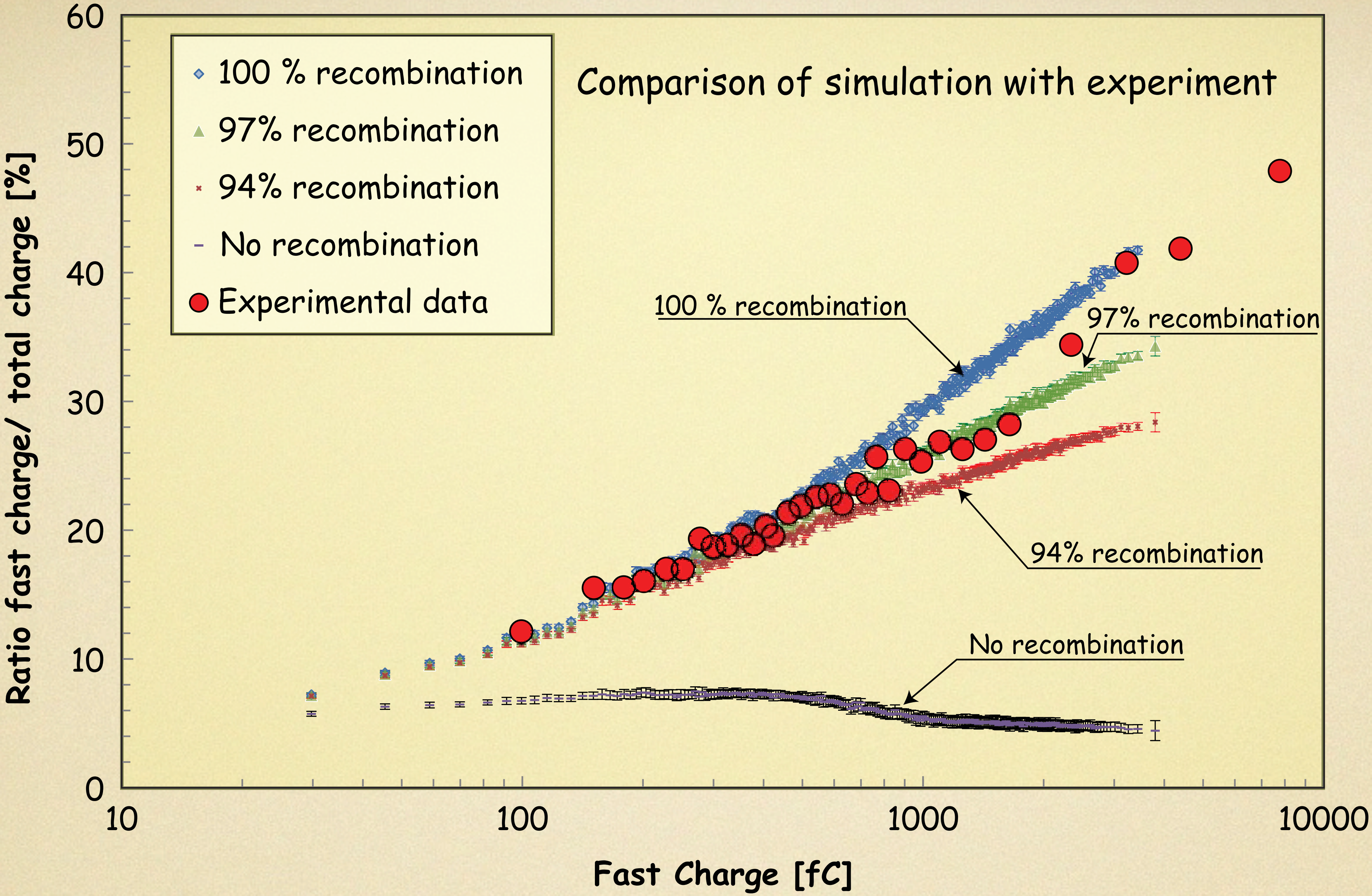
Small gap size essential for this effect to become dominant

Measure TOTAL charge of 2 mm RPC and ALICE-TOF MRPC



(a) observe how slow gain changes with voltage (factor 5 / 2 kV)

(b) MRPC (ALICE TOF) average total charge ~ 2 pC (good rate capability)



Want large fast signal and small total charge (rate capability)

Fast signal/total charge = 1/aD : around 5% for normal 2 mm gap RPC

Recombination very important effect - most negative ions recombine and do not drift to anode

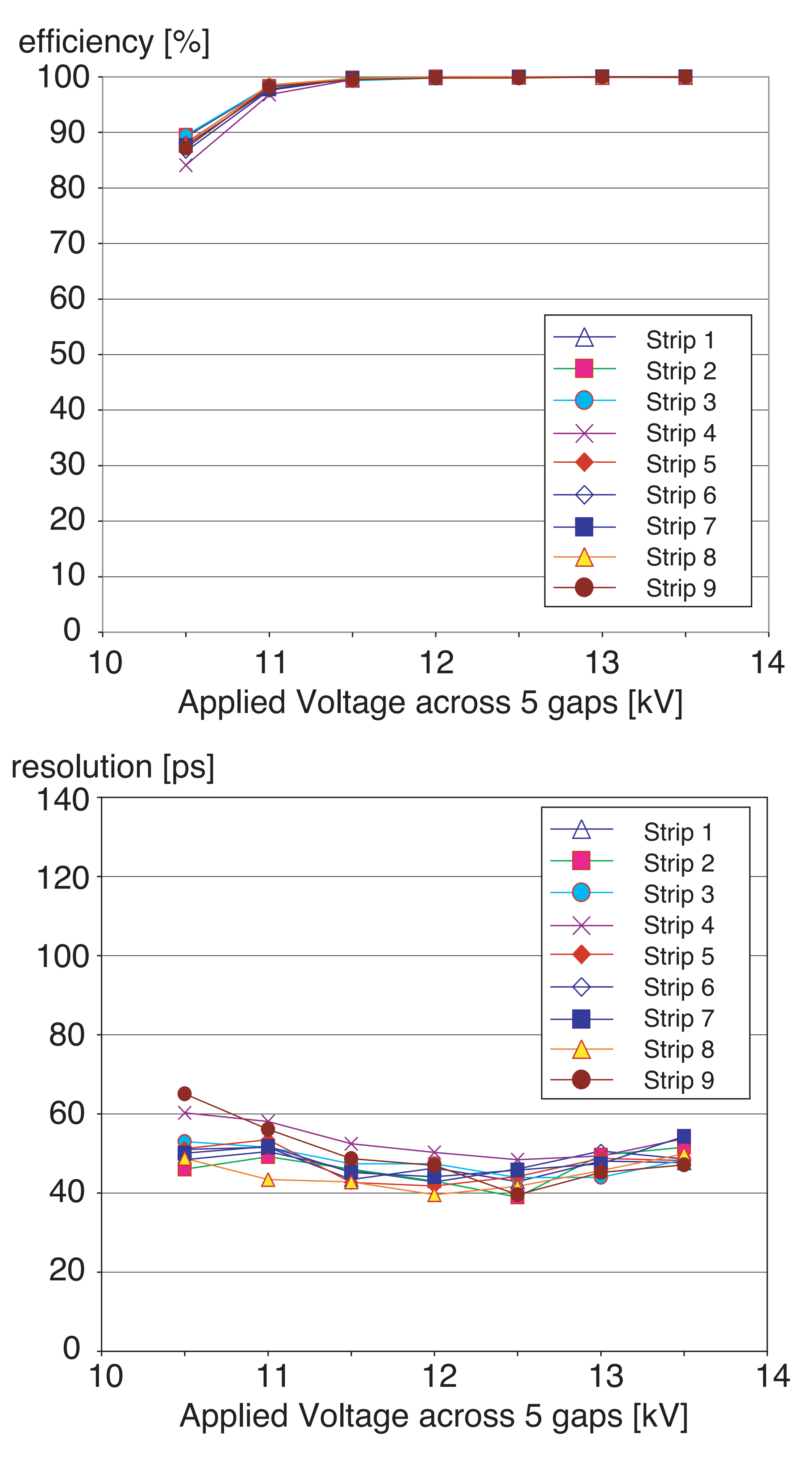
Bottom line : have believable simulation program for the MRPC

Monte Carlo simulation of this process can now be done accurately
(simulation also showed that recombination a very important effect - enhance rate capability)

So now a few words on the ALICE TOF

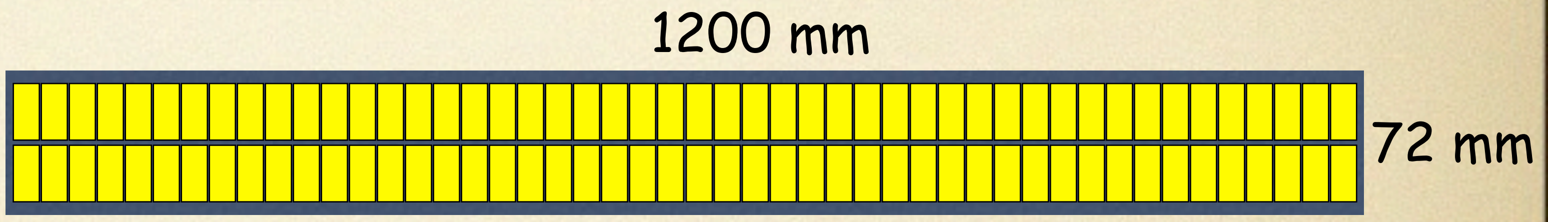
- 160 000 channels of electronics
- 150 m^2 array

Single counting rate ~ 0.2 Hz/cm^2
dark current ~ 10 nA/m^2
whole array at same high voltage
all channels have electronics with same threshold



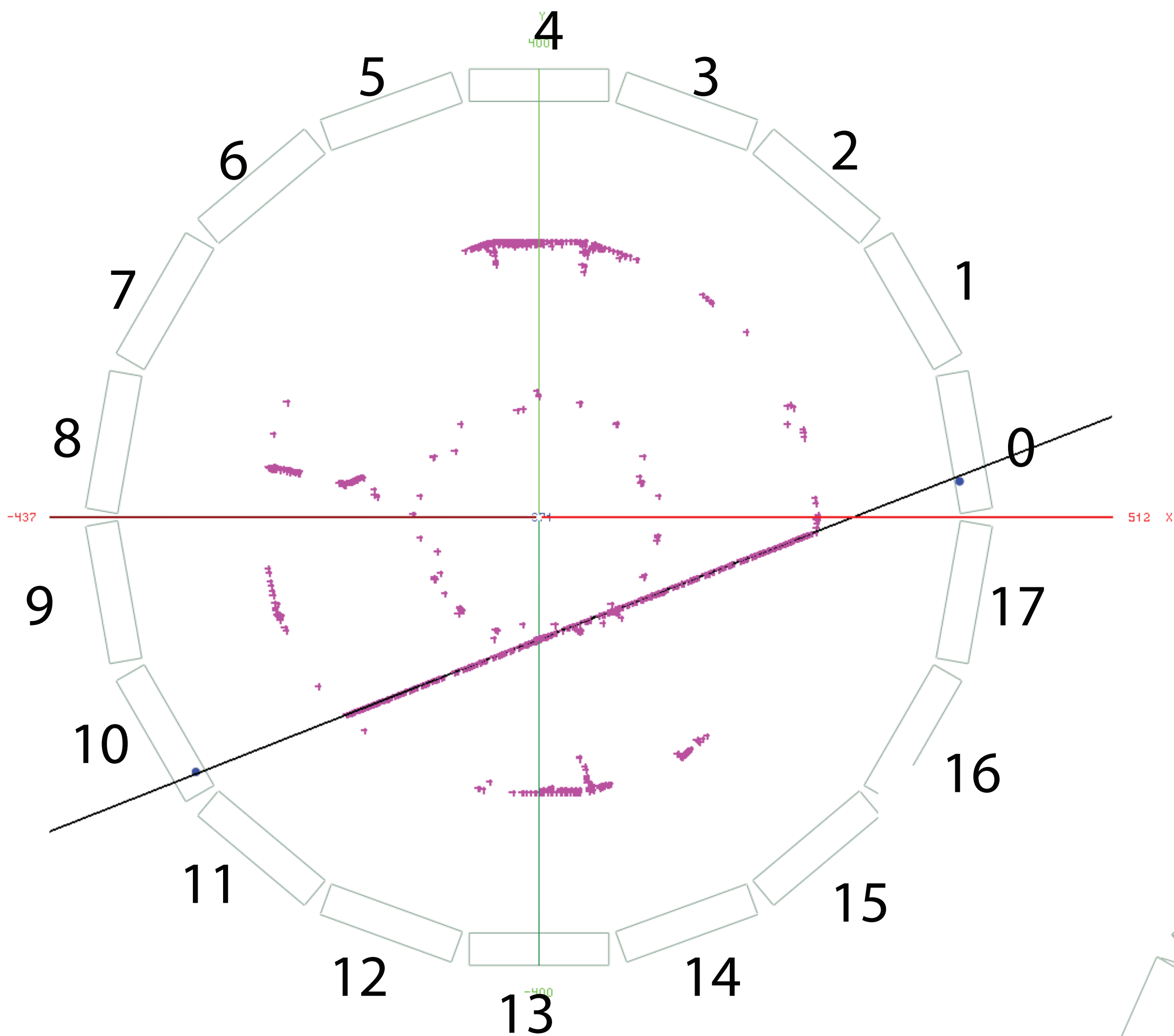
ALICE Time-of-Flight array

ALICE TOF strips



96 pads - each 25 x 36 mm^2

(a) long efficiency plateau
(b) time resolution 40-50 ps (after slewing corrections)



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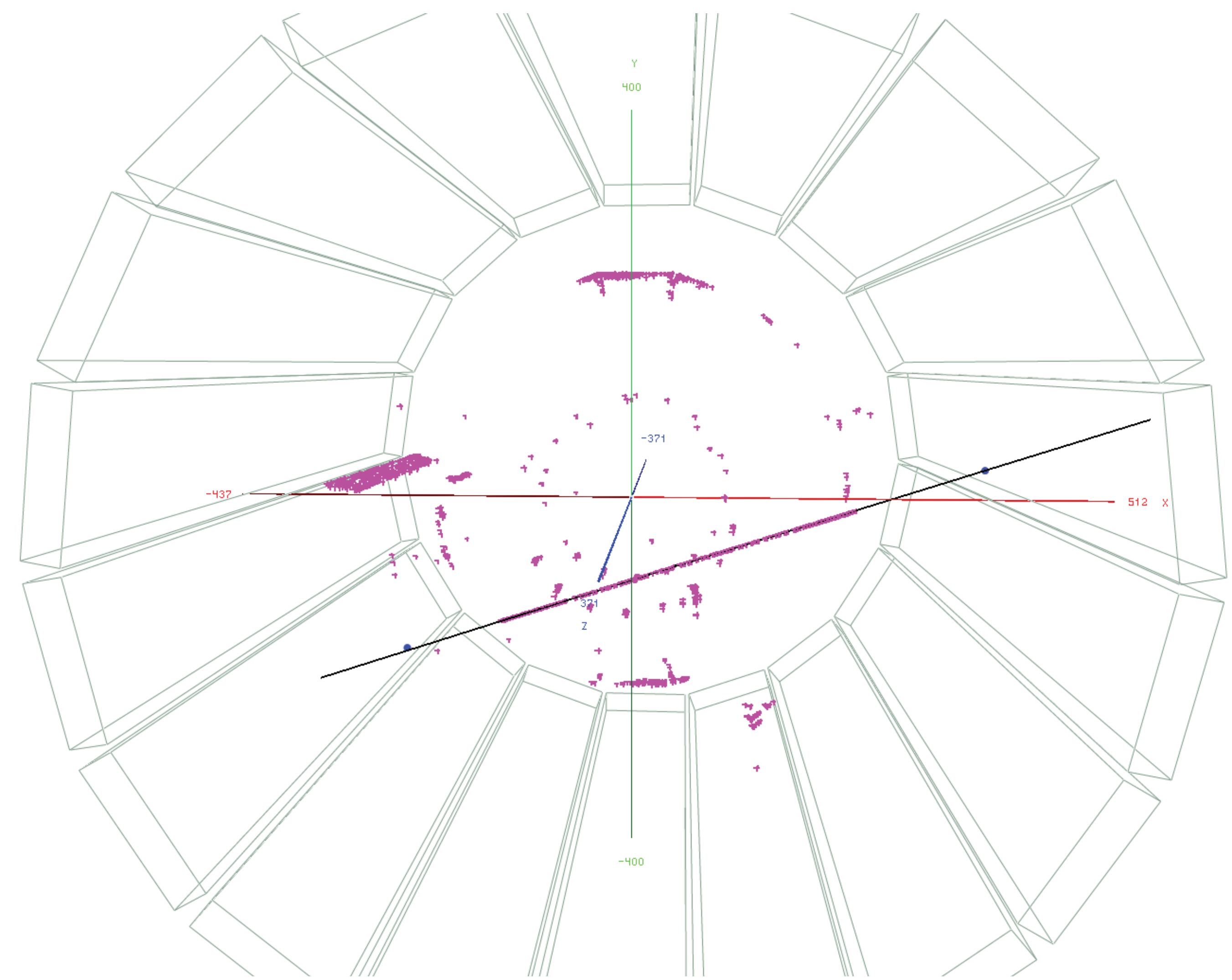
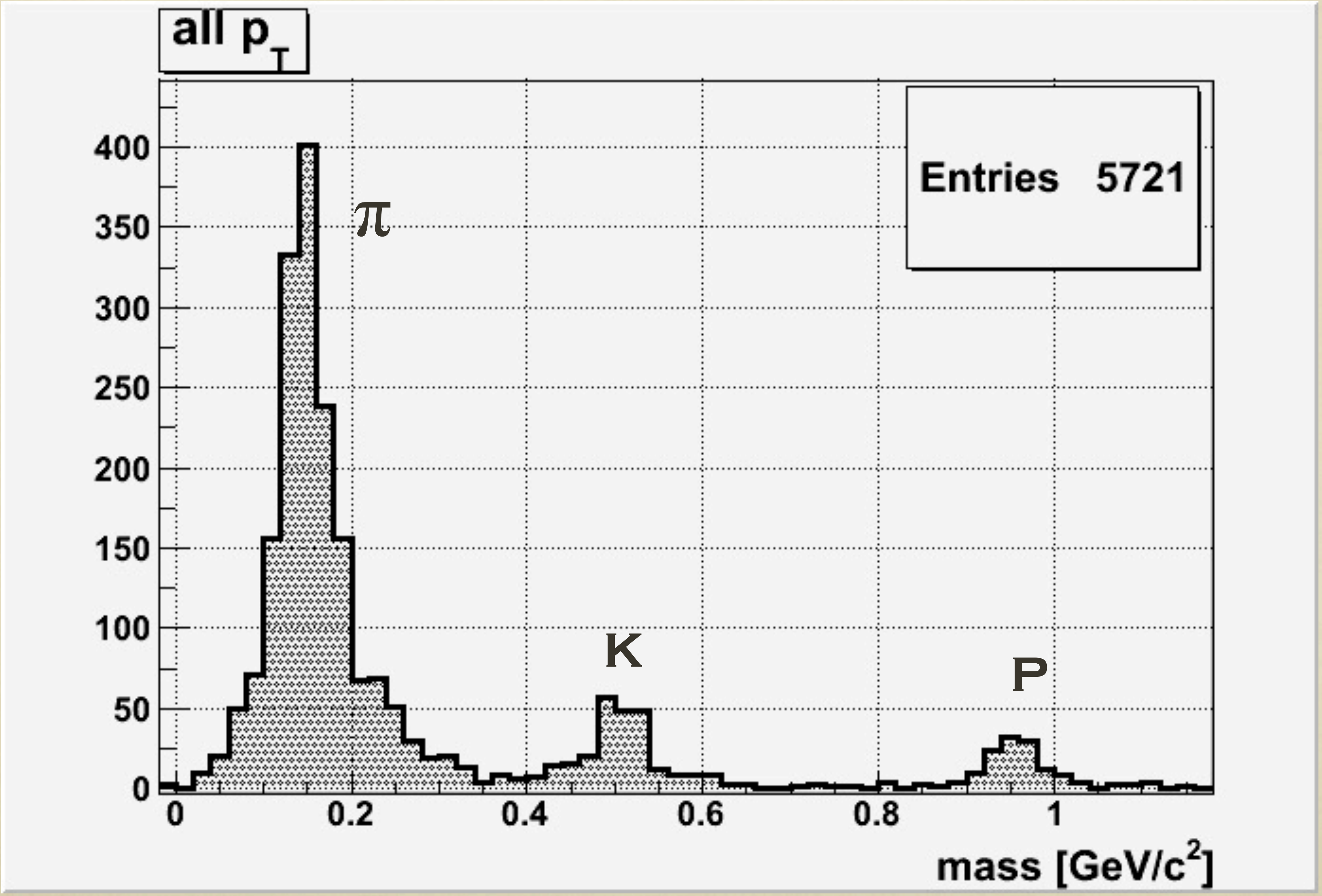


ALICE COSMIC EVENT TRIGGERED BY MRPC (just 2 hits in 150 m^2 TOF array)

Monday December 7, (one day after first collisions) first mass spectrum obtained at LHC already online

All channels have same threshold and same voltage applied to all of the MRPC TOF

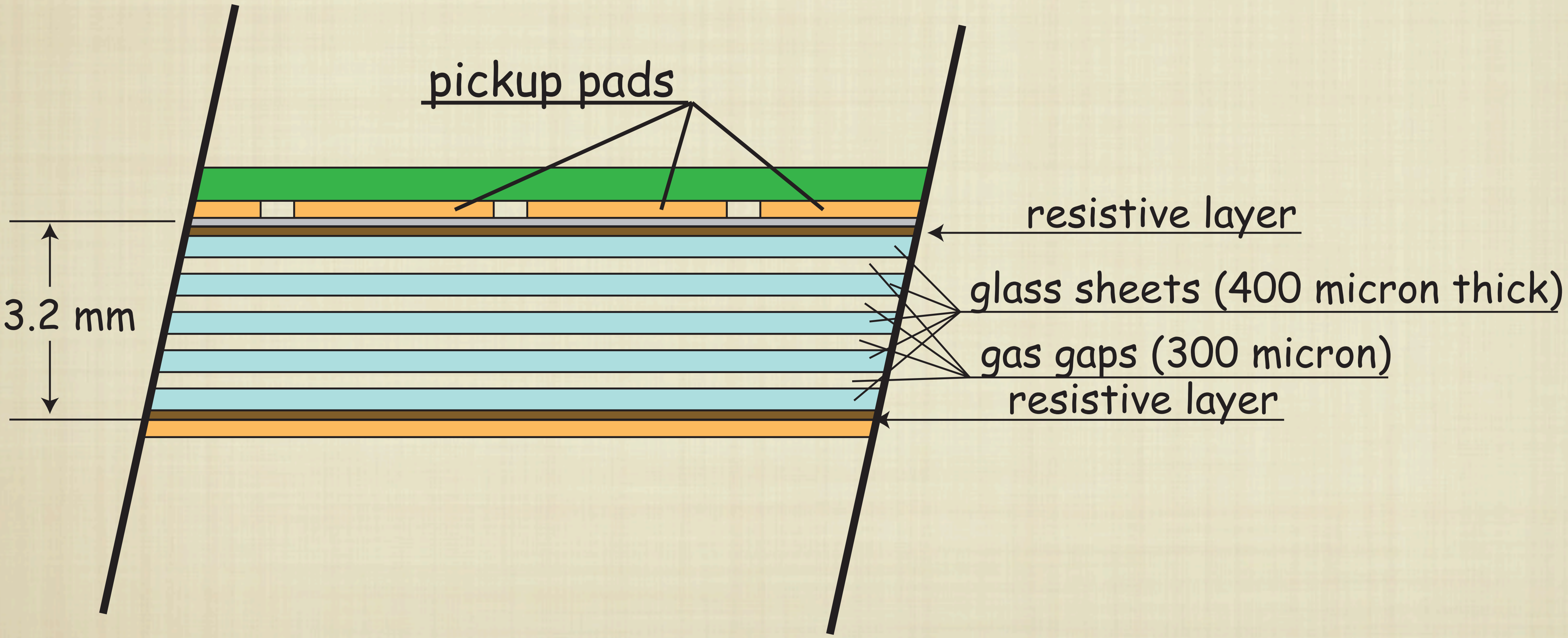


So that is the past ...
And now to the future

the MRPC for the W-HCAL

MRPC for W-HCAL
(4 gas gaps of 300 micron)

Proposed MRPC for W-HCAL
(4 gas gaps of 300 micron)

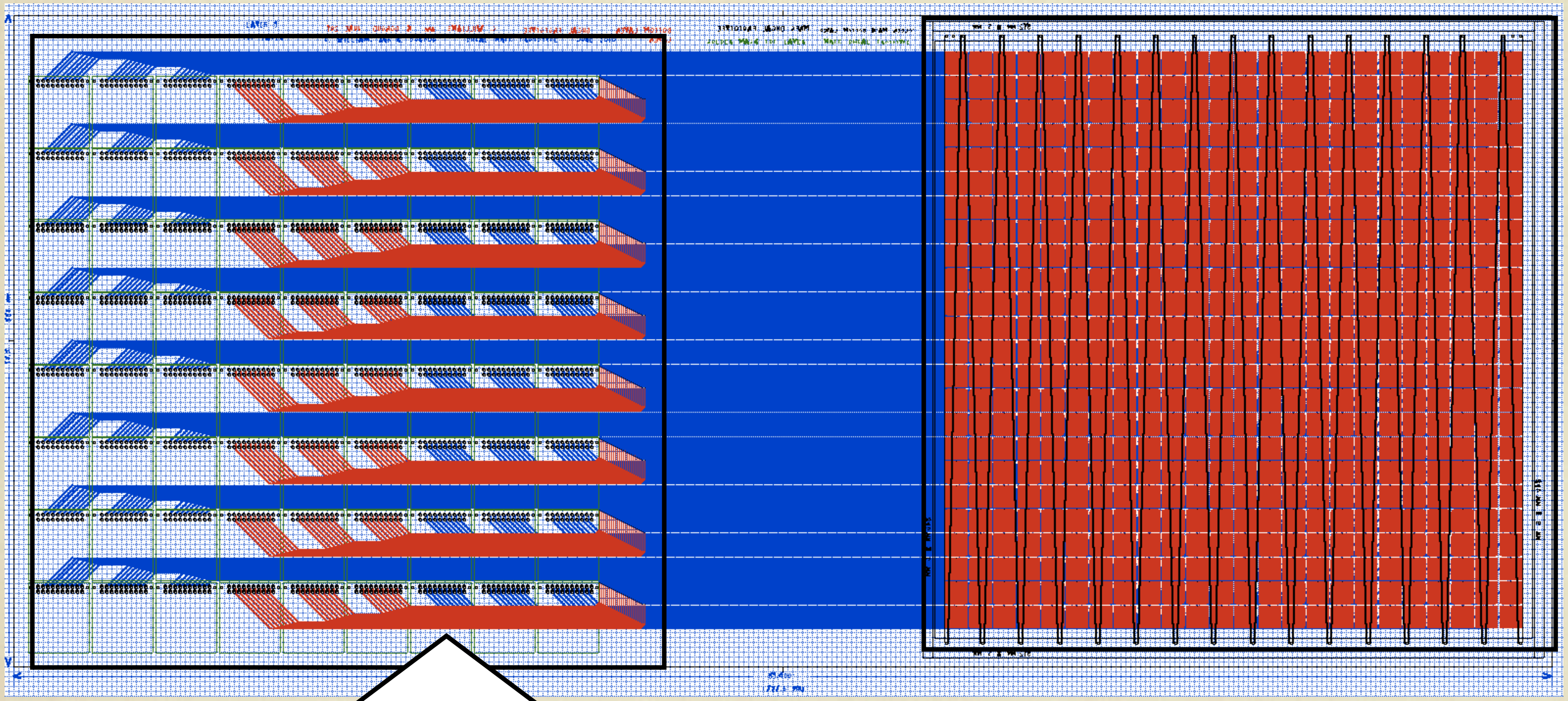


Last year built a 1m x 1m prototype for Imad Laktineh

Now we want to build a prototype chamber using our front-end electronics with each channel coupled to a TDC*

* HPTDC - 100 ps bins time of leading and trailing edge recorded

30 cm x 30 cm MRPC matrix of 24 x 24 pads



NINO readout asics plug in here

PCB on order - ready in October

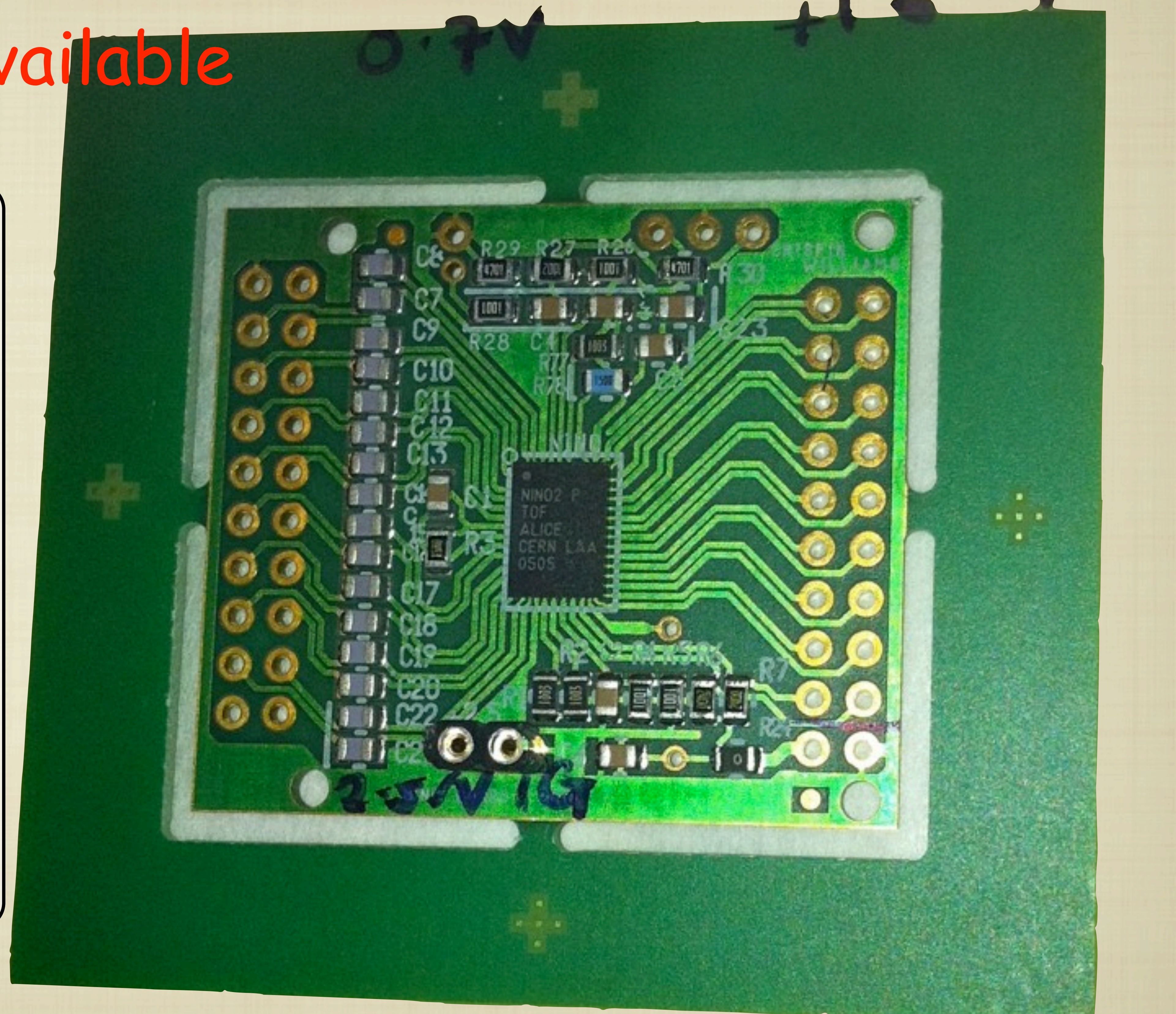
8 channel NINO plugin

100 plugins available

LVDS output

input charge encoded into pulse width

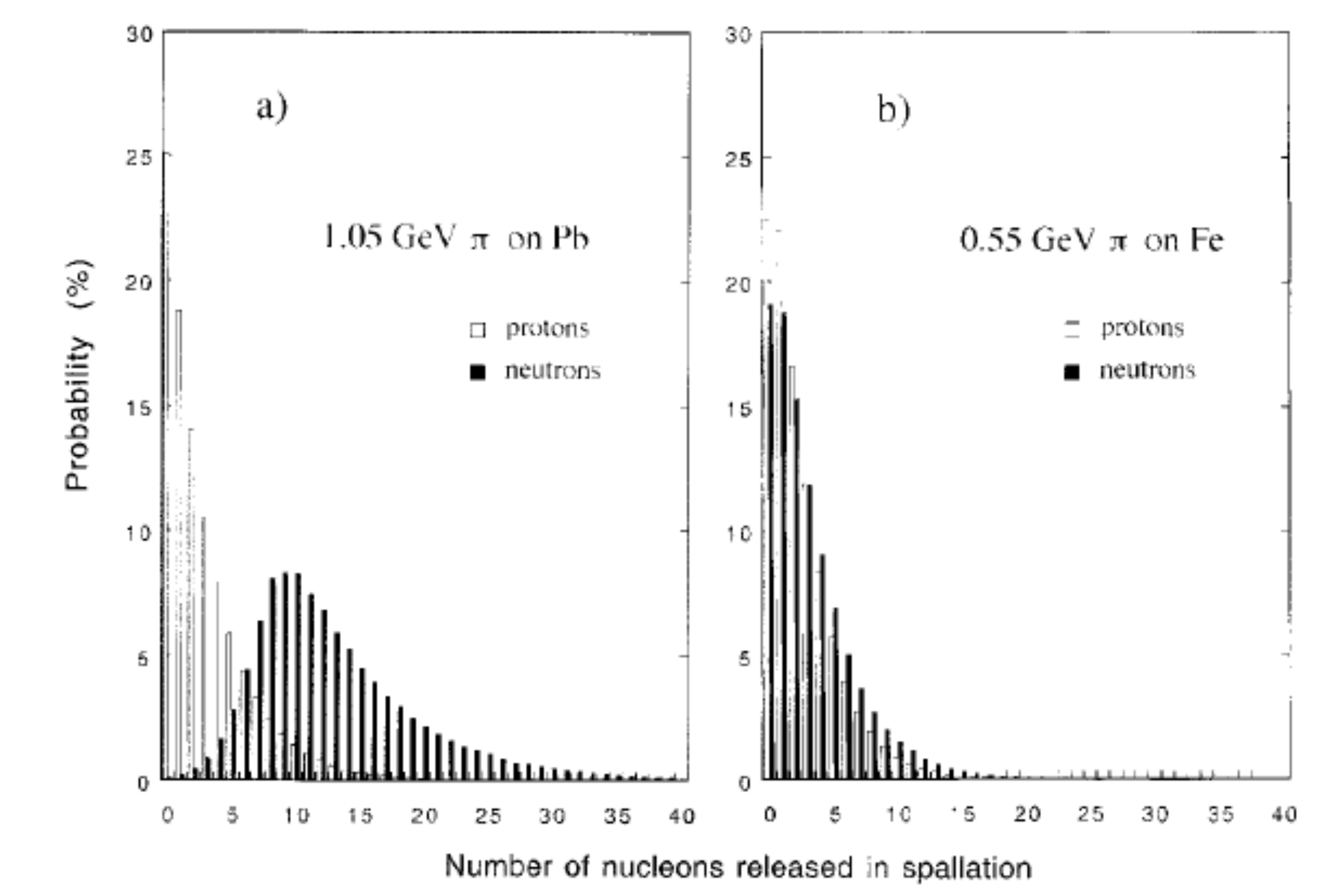
HPTDC will be used for readout



What do we want to learn?

Reminder from talk by Wolfgang Klempt
(17 June 2009)

- Tungsten is high Z - high number of spallation neutrons



- A sizeable fraction of energy will be carried by the neutrons
- These neutrons will give a delayed signal in the detector
- By measuring the neutron signal we may improve the energy resolution
- We want to check the Monte Carlo for hadronic showers
- We can fill MRPC with different gases (ie C_4H_{10} or $C_2F_4H_2$) to pin down the number of neutrons
- Insert MRPC in various positions in stack - check for neutron signal

Summary

- MRPC should not be confused with a single-gap RPC
  - the MRPC has high efficiency - a long streamer-free plateau - excellent timing - easy to build - works with a wide range of gases - easy to operate
- Understanding the importance of neutrons is needed
  - MRPC can be used to examine the time structure of the signals within the hadronic shower