Timing Measurements with RPC for Calorimetry

Pirate Lecture Session 2012

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Max-Planck-Institute for Physics

Young Scientist Workshop – July 25th 2012

Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

Excellence Cluster Universe

Outline

- Is there any alternative to an analog calorimeter based on scintillators?
- What is an RPC and how does it work?
- The FastRPC setup
- Why do we want to repeat the T3B experiment with a different detector?
- Next steps

DHCAL

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And at the same time reduce the data size?

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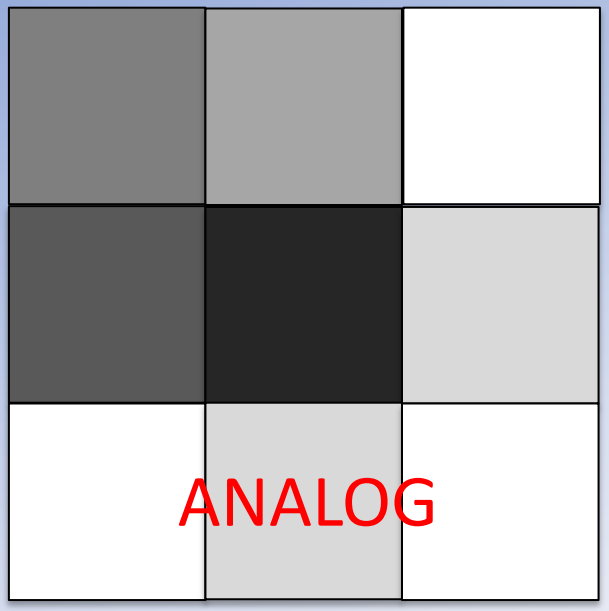

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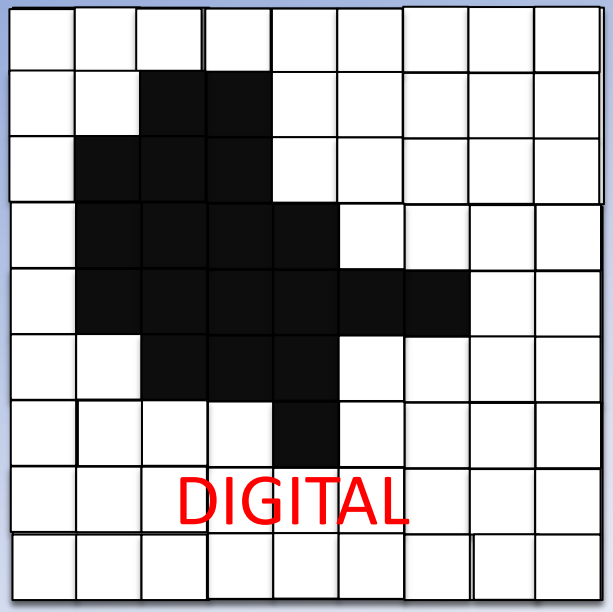

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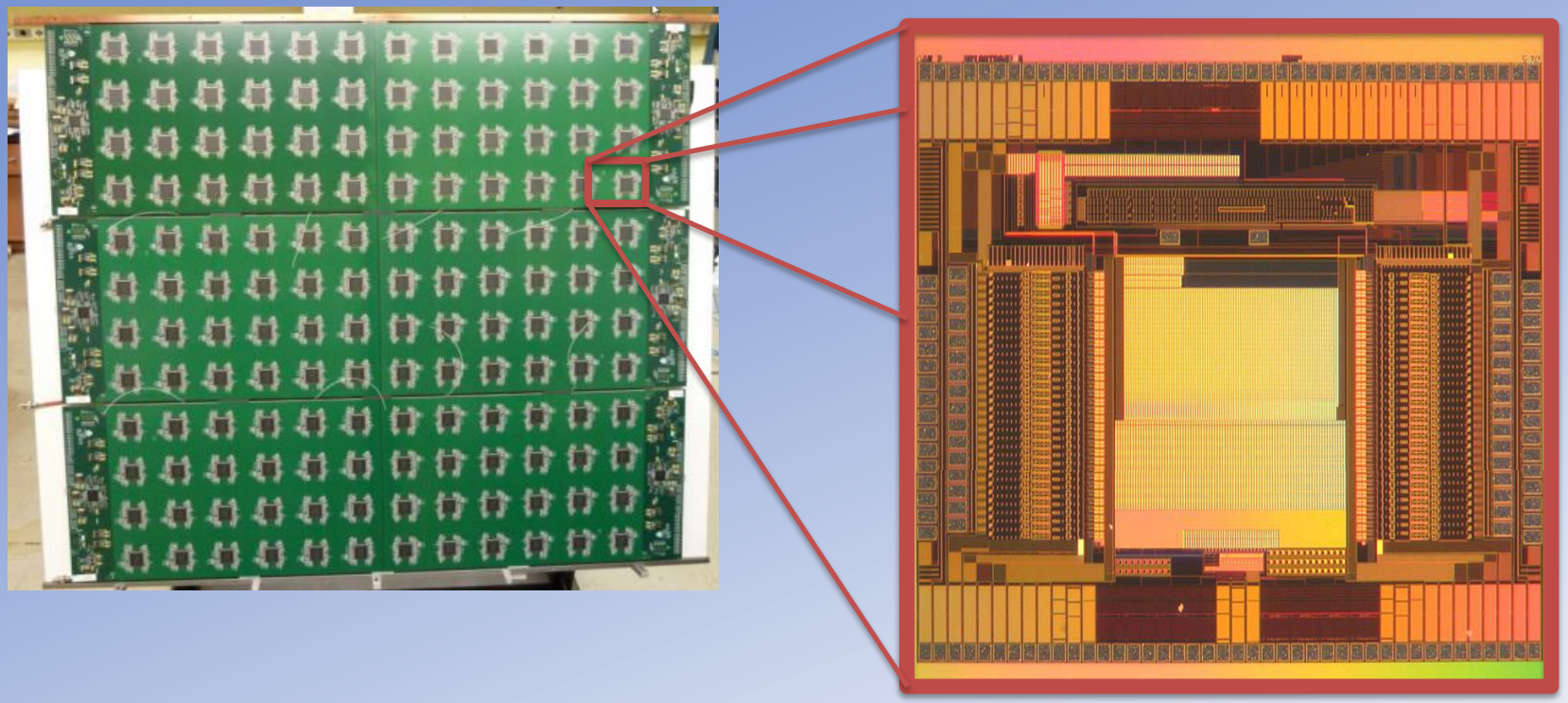


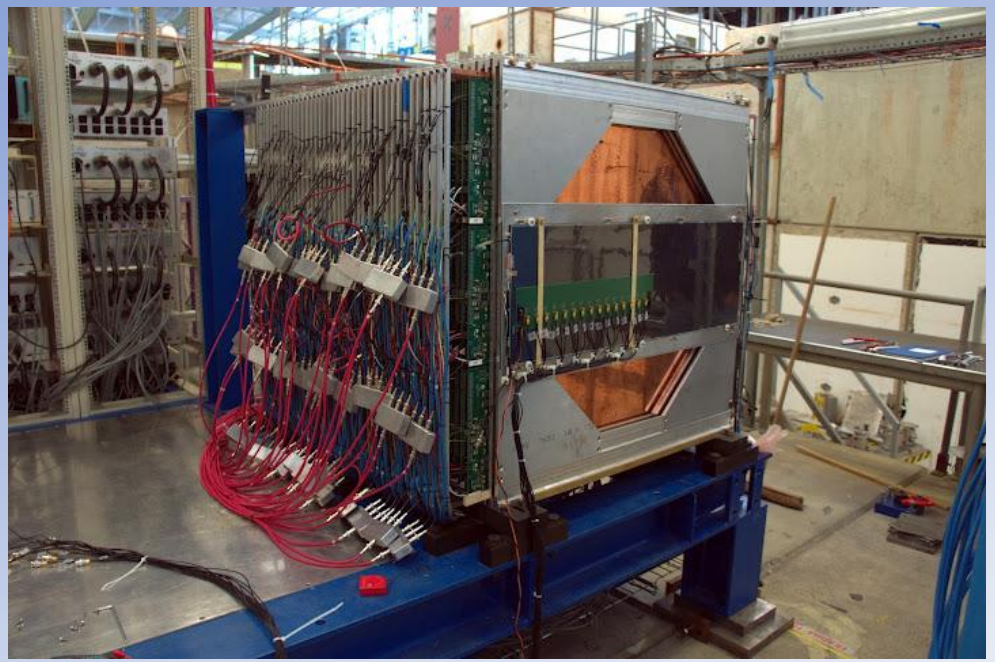
64 channel per ASIC
100 ns timestamps
256 selectable thresholds

DHCAL

DHCAL: 38 layers 100x100 cm^2 with 1x1 cm^2 pads =

400k channels just for the prototype!

(ATLAS HCAL 10k)



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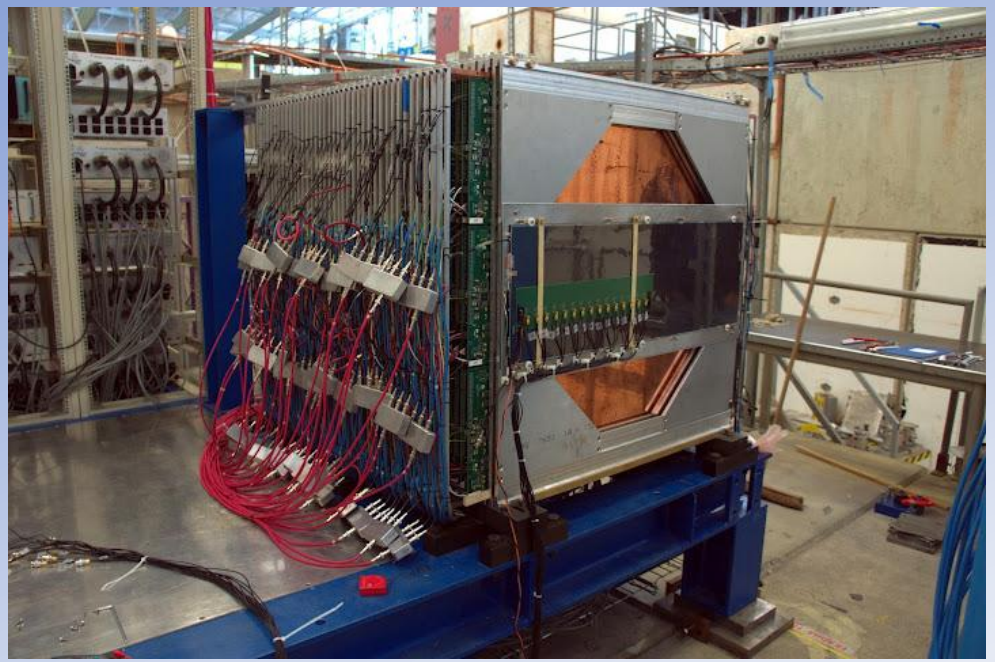
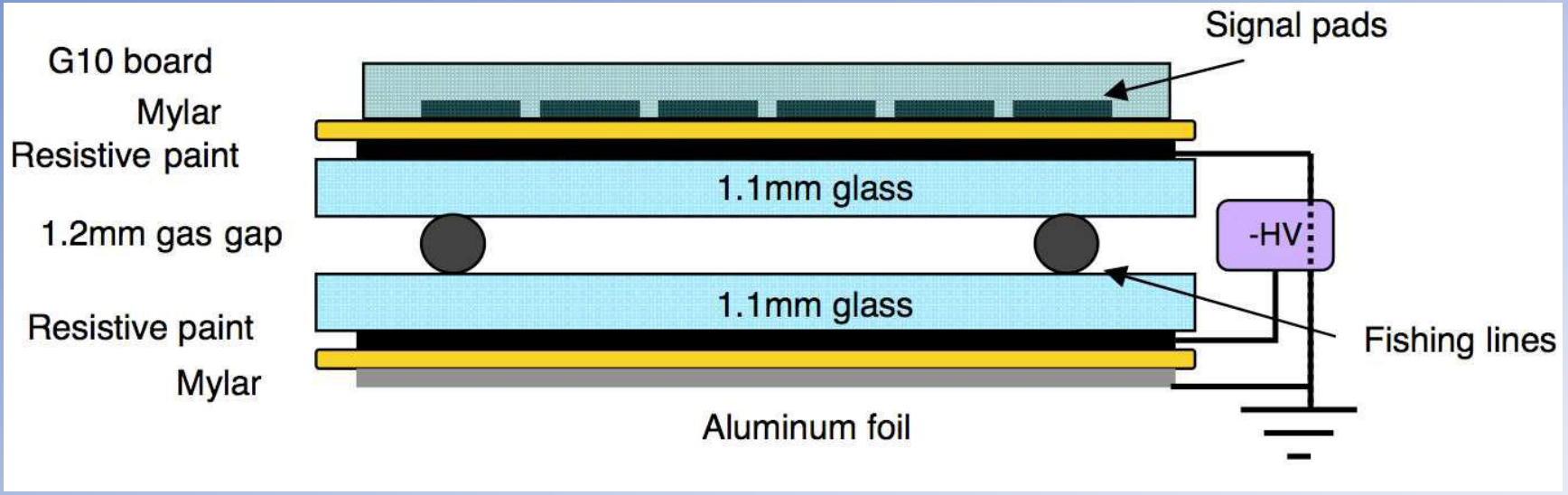


And yet, thanks to dedicated ASICS for serialization and zero suppression the data taken can fit into this:

Arrrr, here be yer new flash drive, landlubber!

Resistive Plane Chambers



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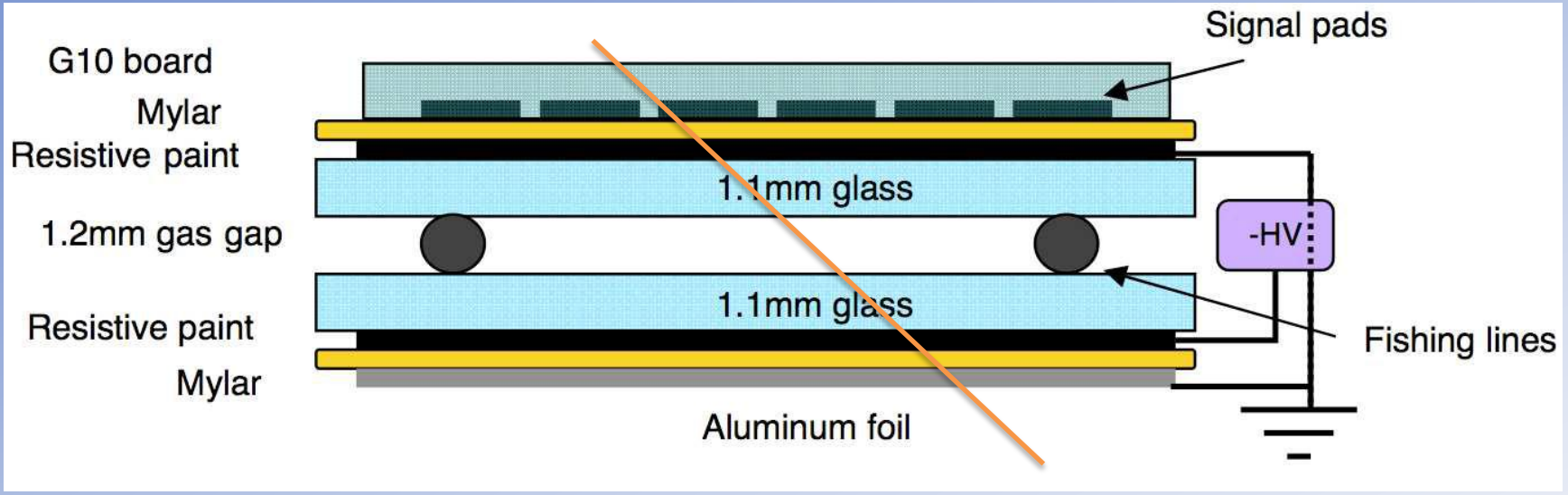

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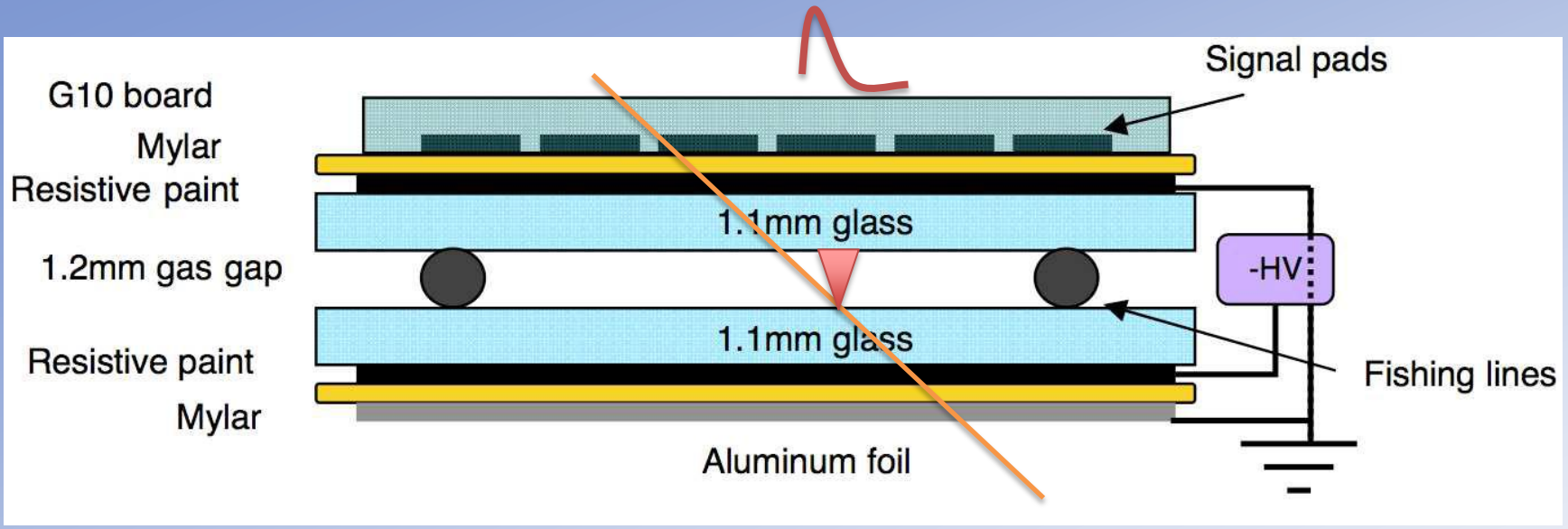

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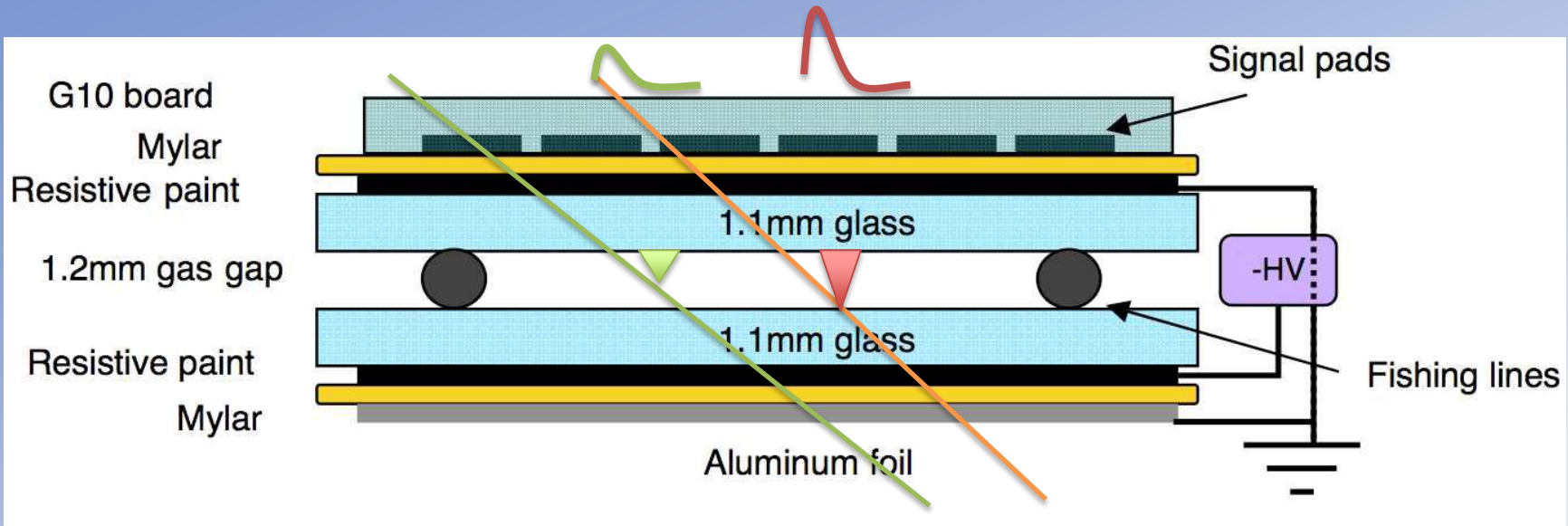

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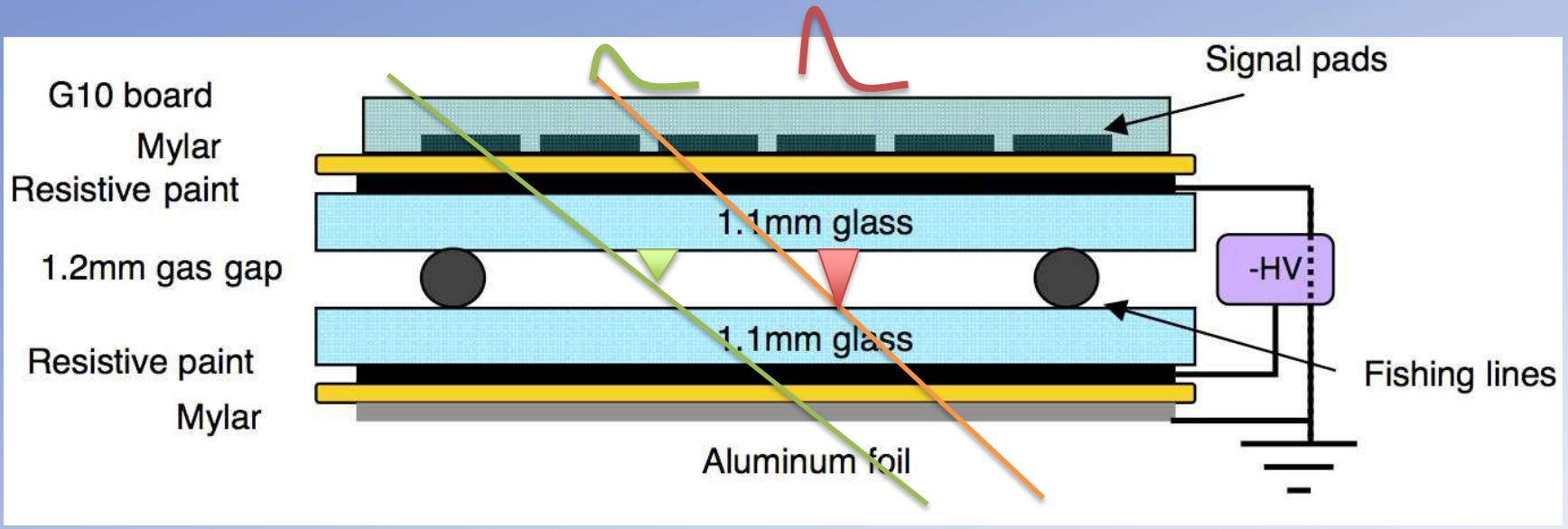

Gas mixture: R134A 94.5%, isobutane 5.0%, SF_6 0.5%

No noble gas, or ye detector will sink like ‘n old hulk in a storm!

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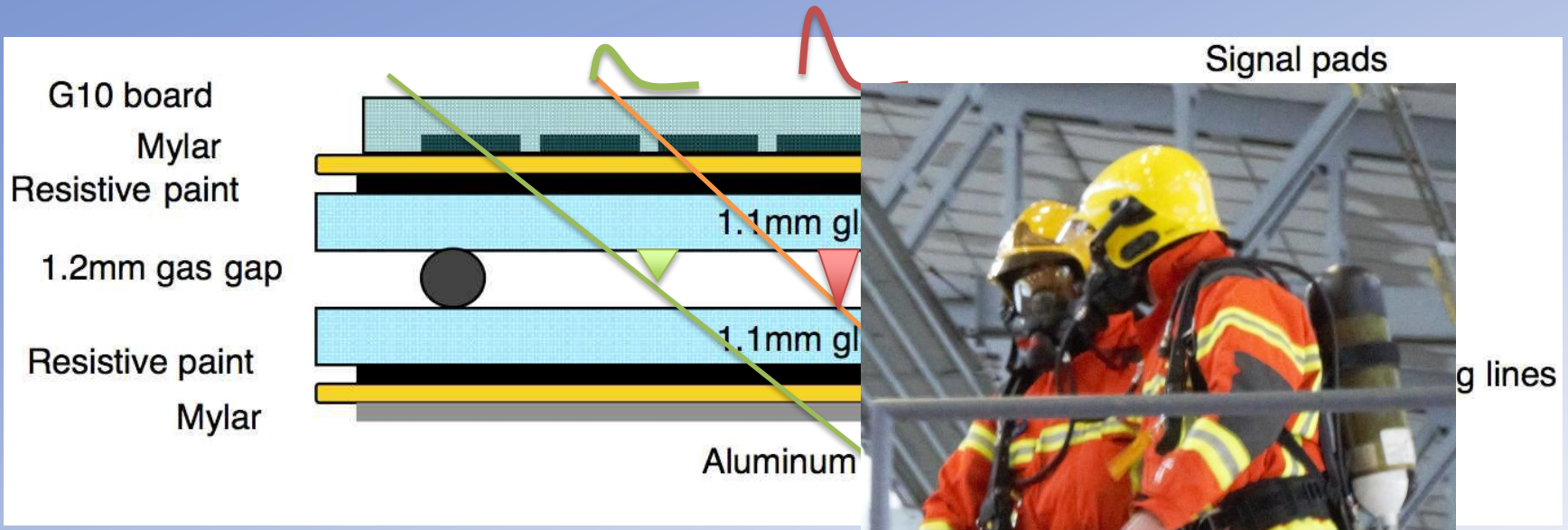

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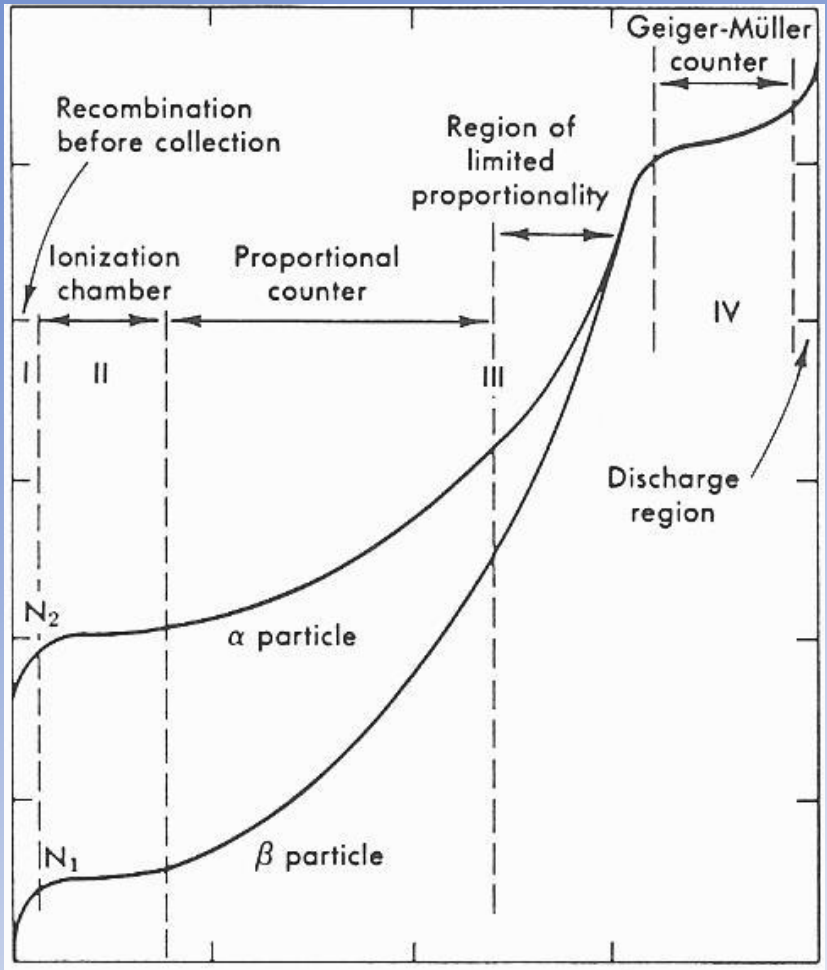
Geiger-Müller
counter
Recombination
before collection
Region of
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Ionization
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Proportional
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IV
I
II
III
Discharge
region
N_2
α particle
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β particle

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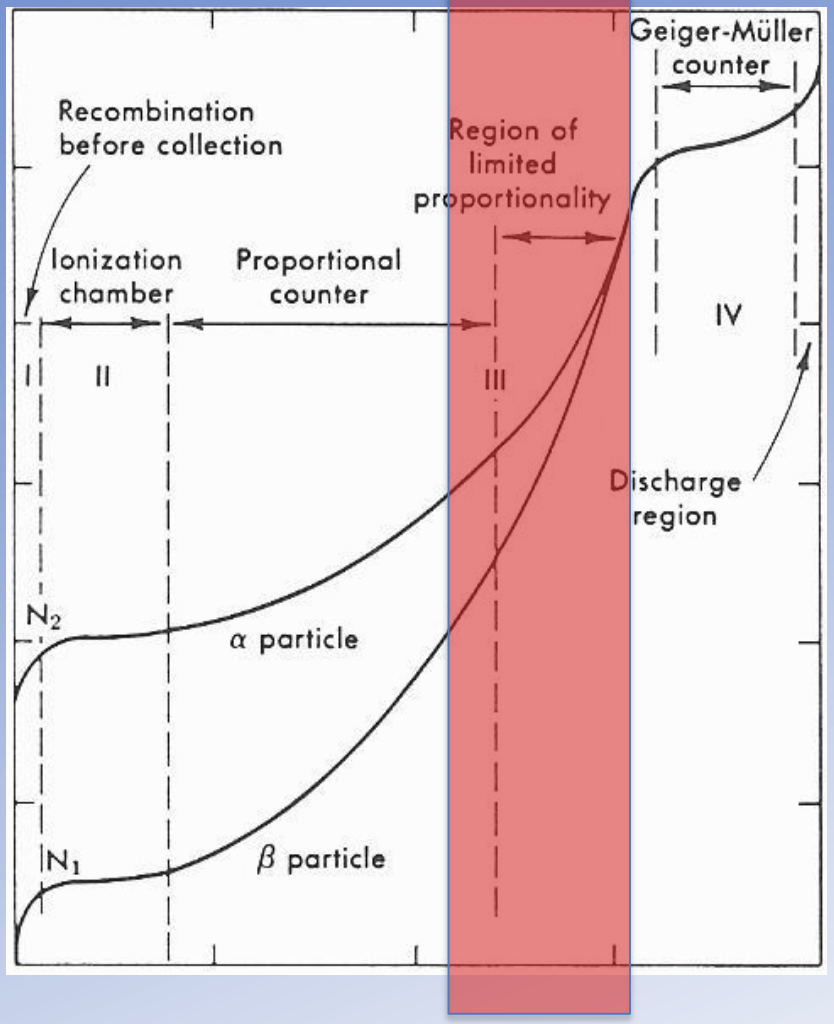
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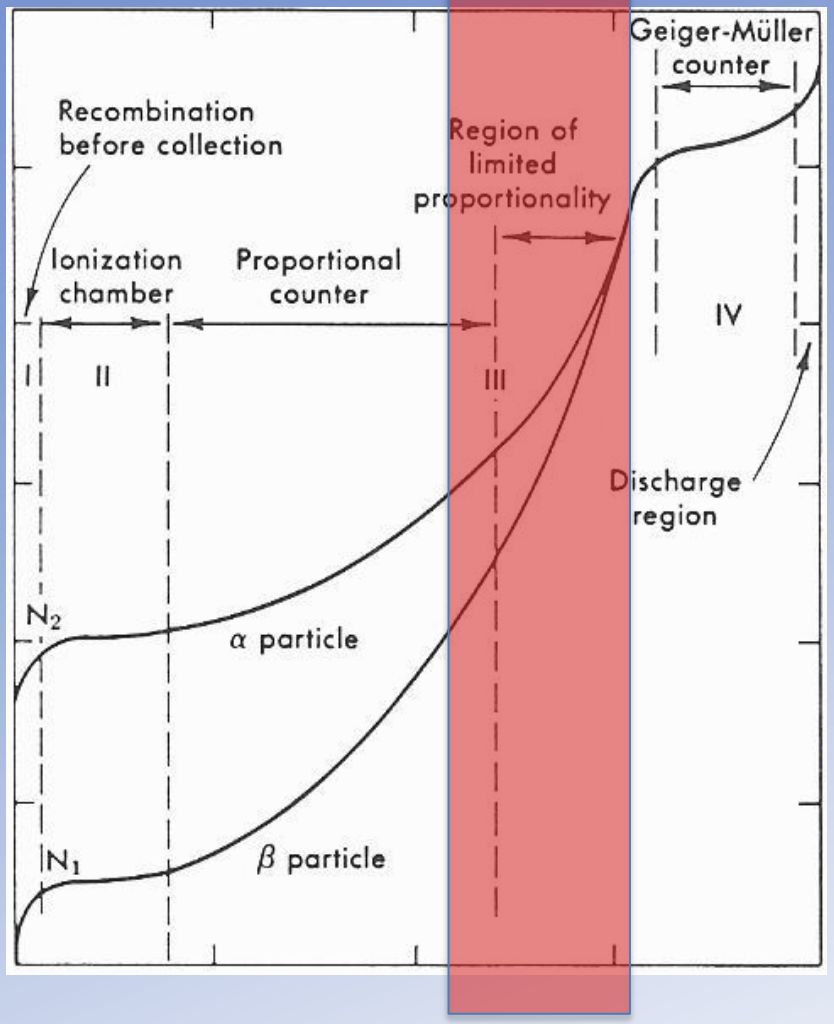
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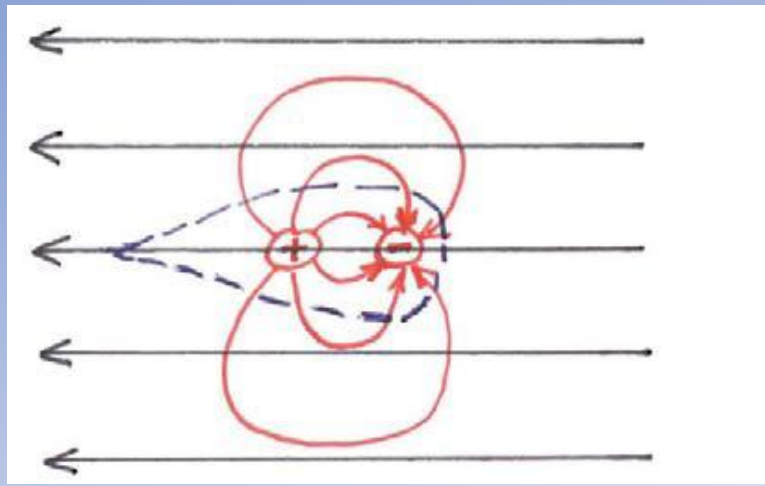

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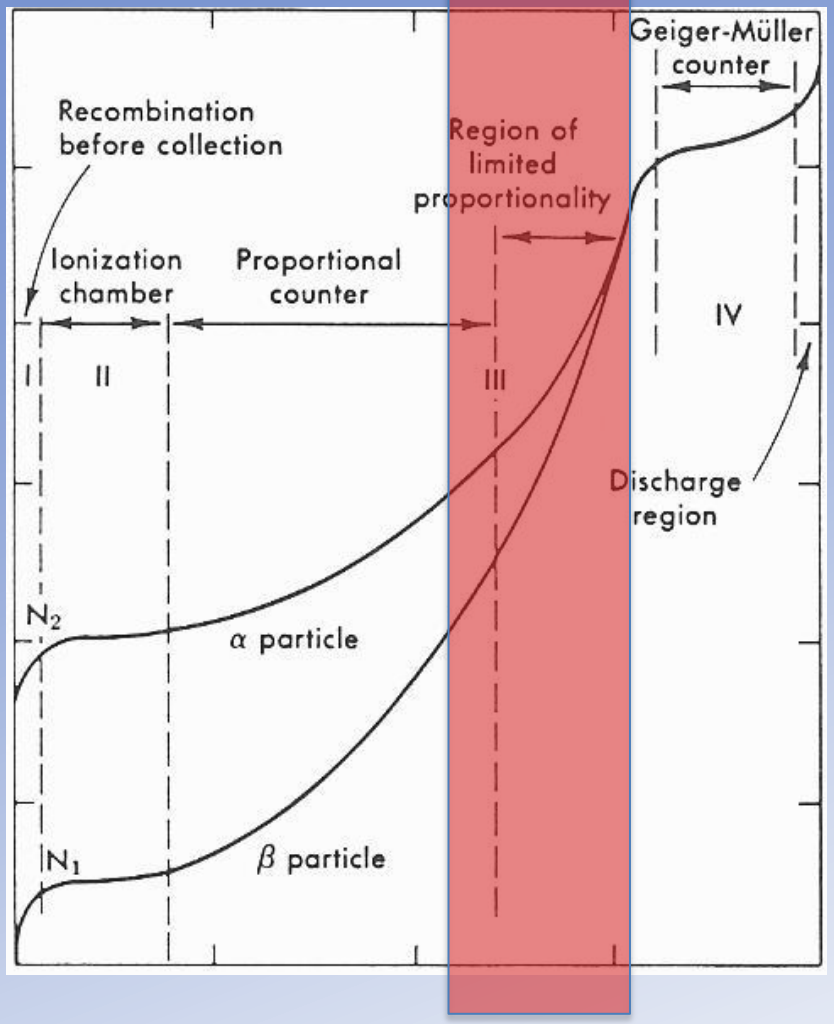
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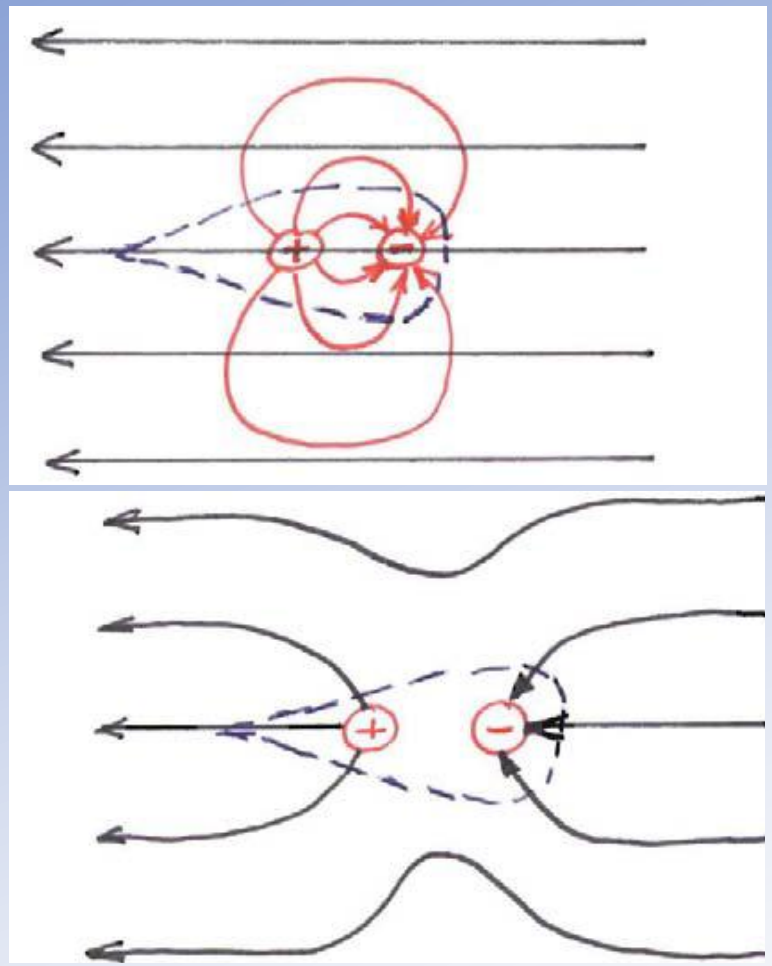
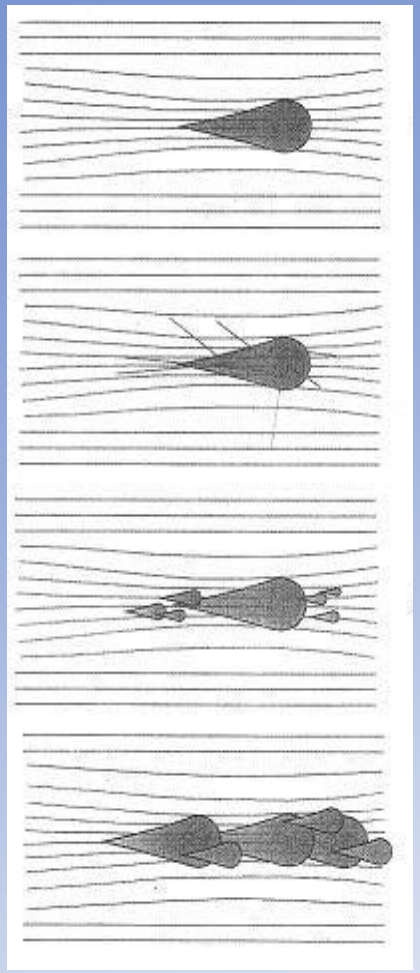


RPC

KPC



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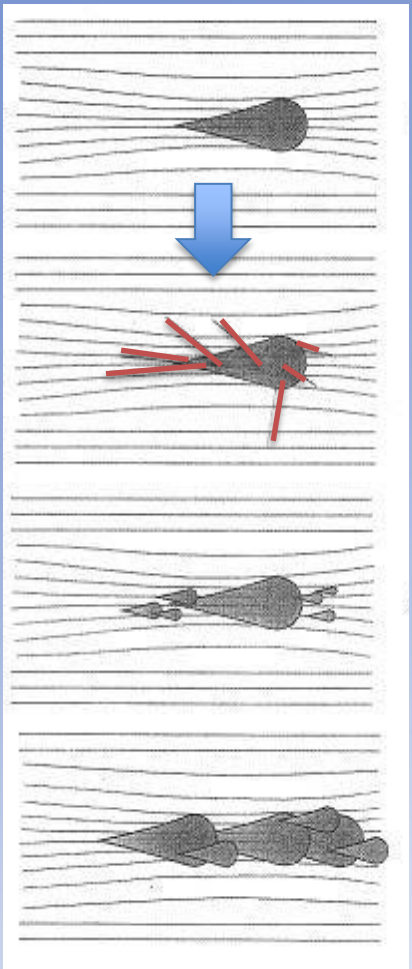

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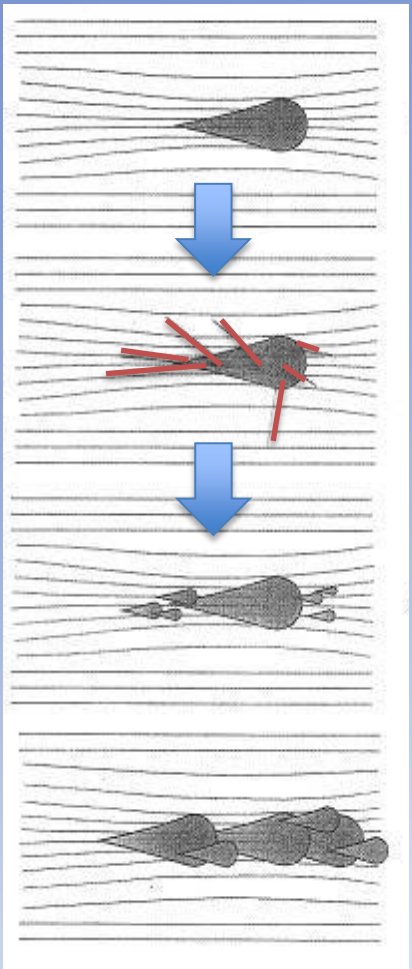

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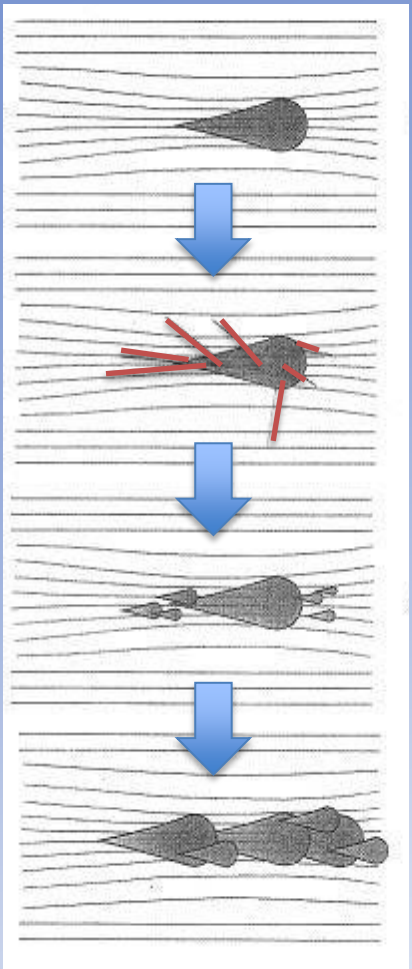

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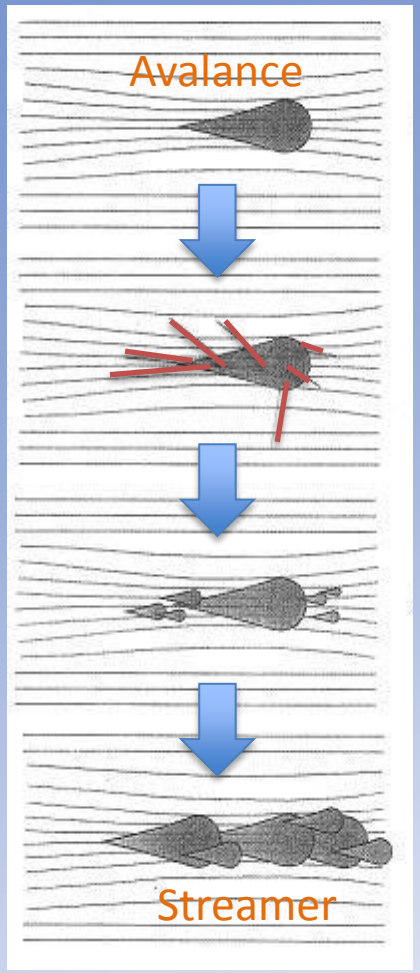

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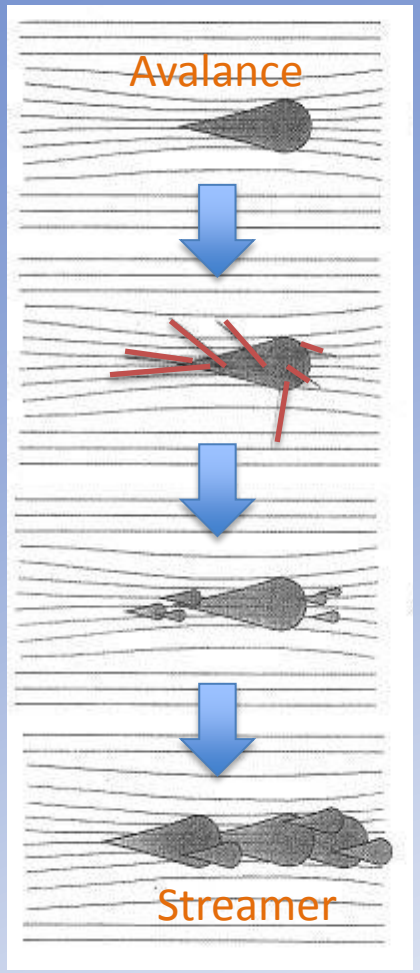

Prevent secondary photons to develop to streamers, therefore: photon absorption

=> **quencher gases**!

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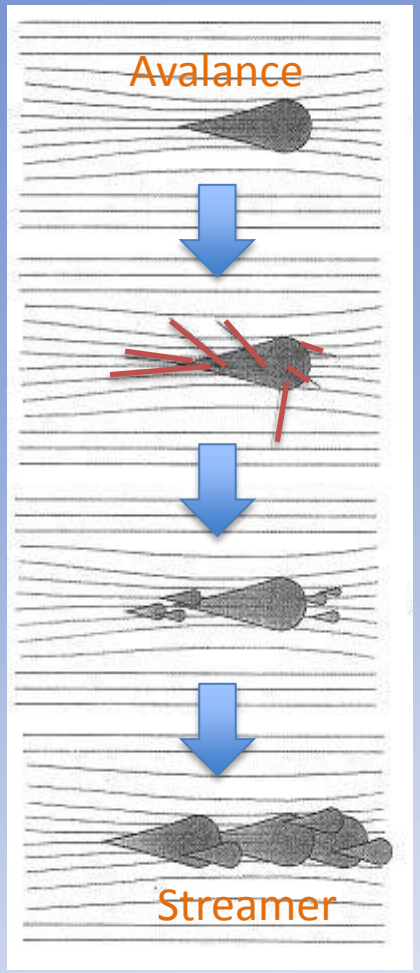

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=> **quencher gases**!

Ye better collect all ye photons before they scuttle ye detector

Comparison

RPC

- Pressure sensitive
- Temperature sensitive
- Gas Mixture sensitive
- Longer recovery time
- **Faster Signal**
- **Lower Cost**

SCINTILLATORS with SIPM

- Temperature sensitive
- Afterpulses
- High dark noise
- **Easier to operate (no HV, gas mixtures…)**
- **Easier to simulate**

DHCAL

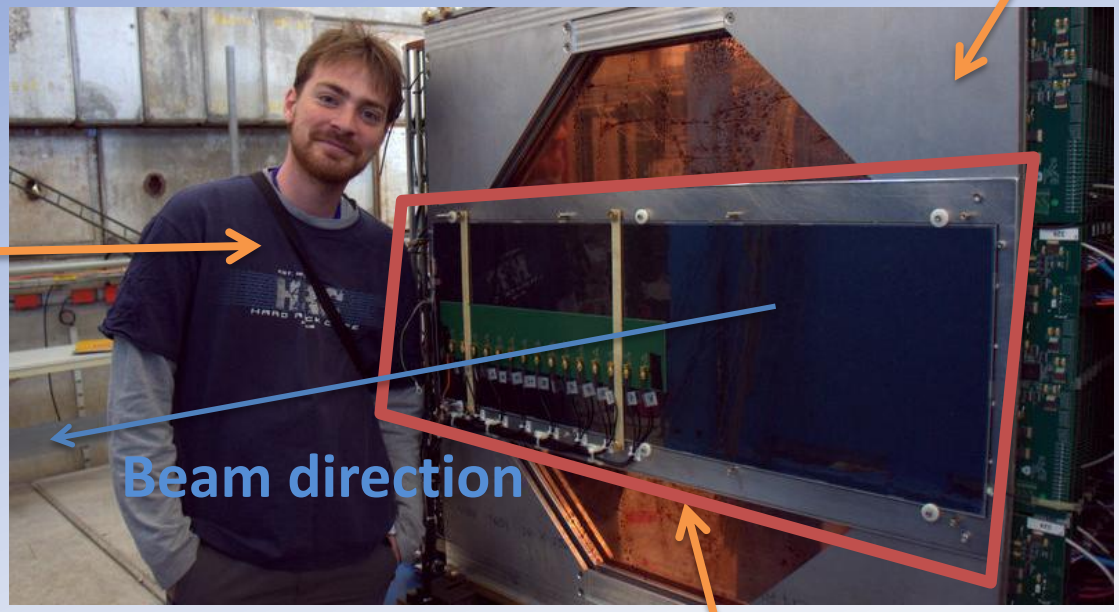
- **Easier calibration**
- **Smaller data size**

AHCAL

- **More Information**
- **Little to no dead time**

FastRPC

- 15 3x3 cm^2 tiles, same geometry as T3B
- Same analog readout with ps6000 picoscope
- Same RPC as the DHCAL



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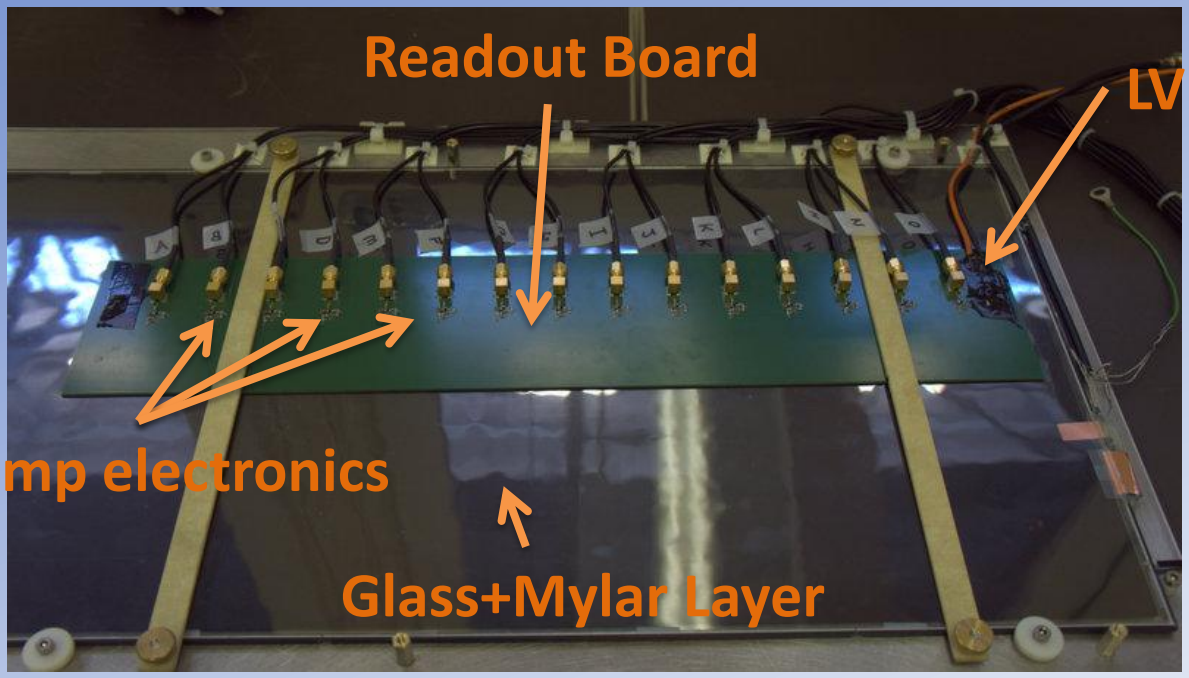
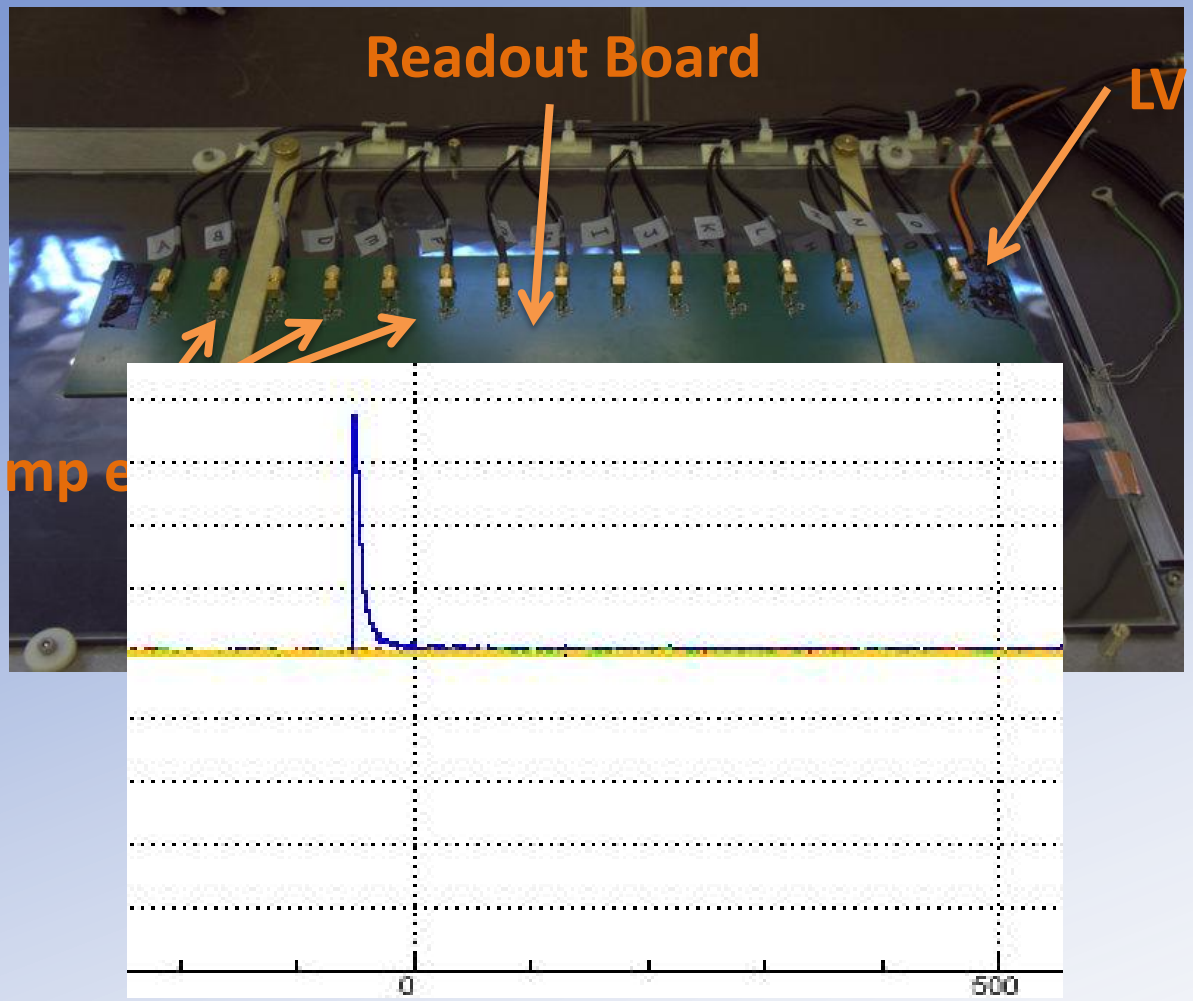

Readout Board
LV for preamps
Preamp electronics
Glass+Mylar Layer

FastRPC



FastRPC

- External trigger using 2 10x10 cm^2 scintillator in front of the DHCAL
- 1.25GHz 8bit Picoscope readout (15 tiles plus check on the scintillator coincidence)

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- External trigger using 2 10x10 cm^2 scintillator in front of the DHCAL
- 1.25GHz 8bit Picoscope readout (15 tiles plus check on the scintillator coincidence)

Ye landlubber, can ye go below 1ns with ye trigger?

FastRPC

- DHCAL can't resolve more than 10 MHz
- Still lot of issues with RPC montecarlo simulations

  800ps analog readout solves those problems!

  But for this, 15 tiles produces more data than the 400k channel DHCAL prototype!

Why T3B again?

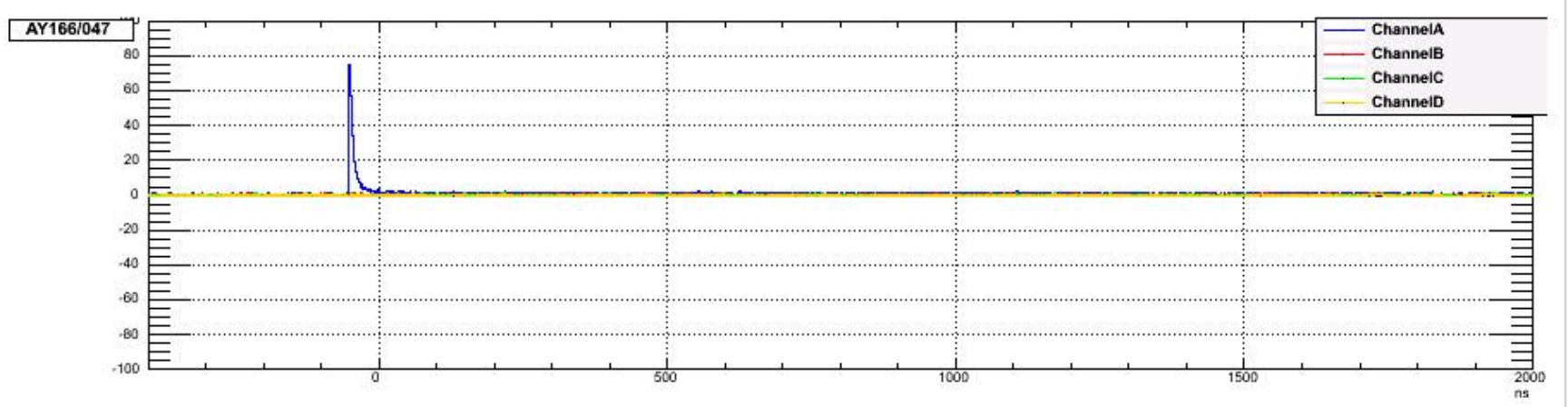
- Crosscheck is always good
- Proof of principle that hadronic shower timing measurements can be achieved with RPC
- Neutron contribution much smaller than scintillator devices

PS and SPS

	PS	SPS
Muons	>1.5Mio	3Mio
Hadrons	16Mio	7Mio

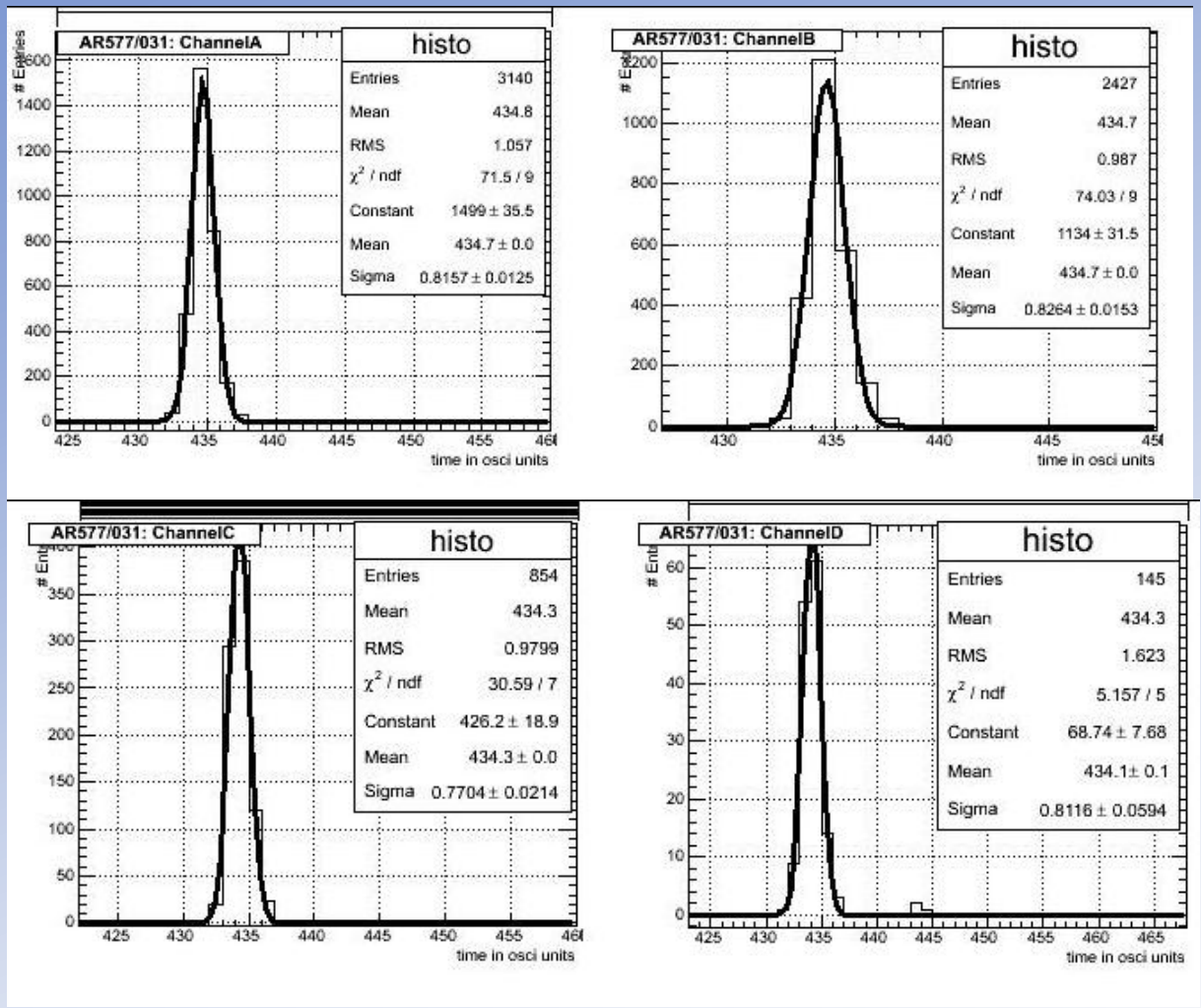
- Very good commissioning run at PS (0-10GeV)
- Tricky run at SPS (20-180 GeV)
- Smaller statistic at high energy because the rate for the DHCAL could not exceed ~100Hz

Time Of First Hit



- Sample millions of trigger events
- Cleaning the data: apply filtering on the data sample (coincidences and FFT)
- Find rising edge with threshold (eventually with 3^{rd} or 4^{th} order interpolation over few bins)
- Fill an histogram with the time distribution

Muon Run Example



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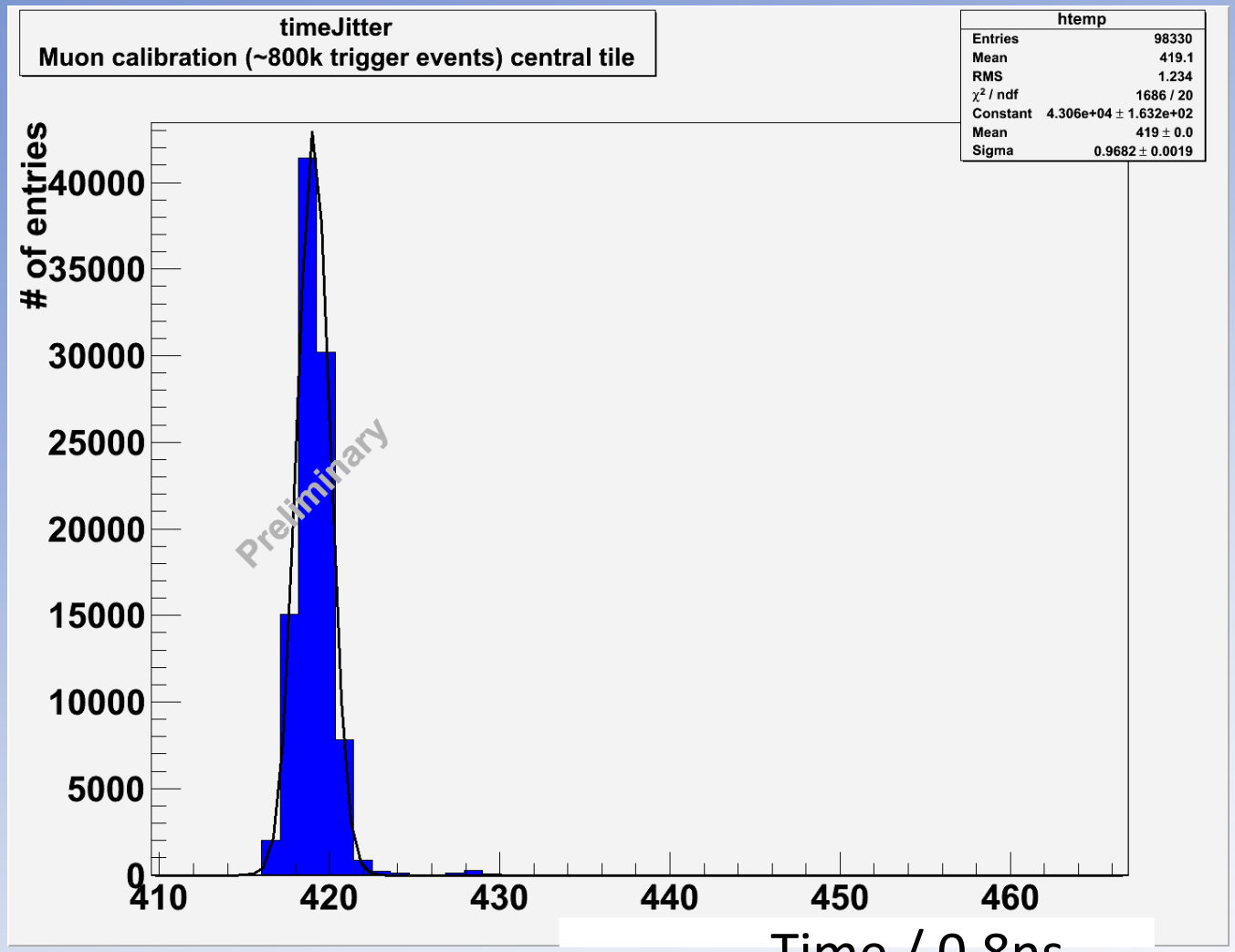

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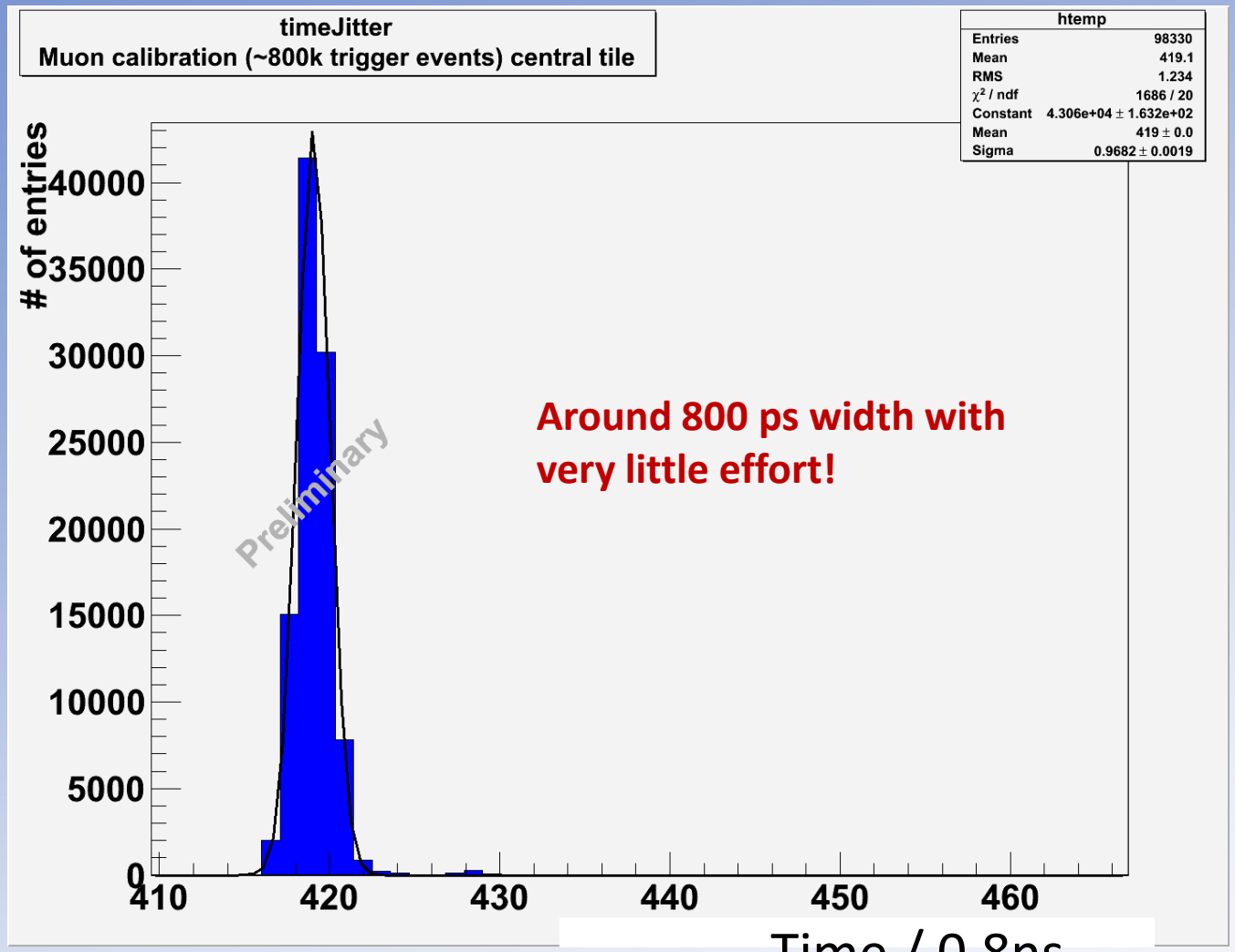
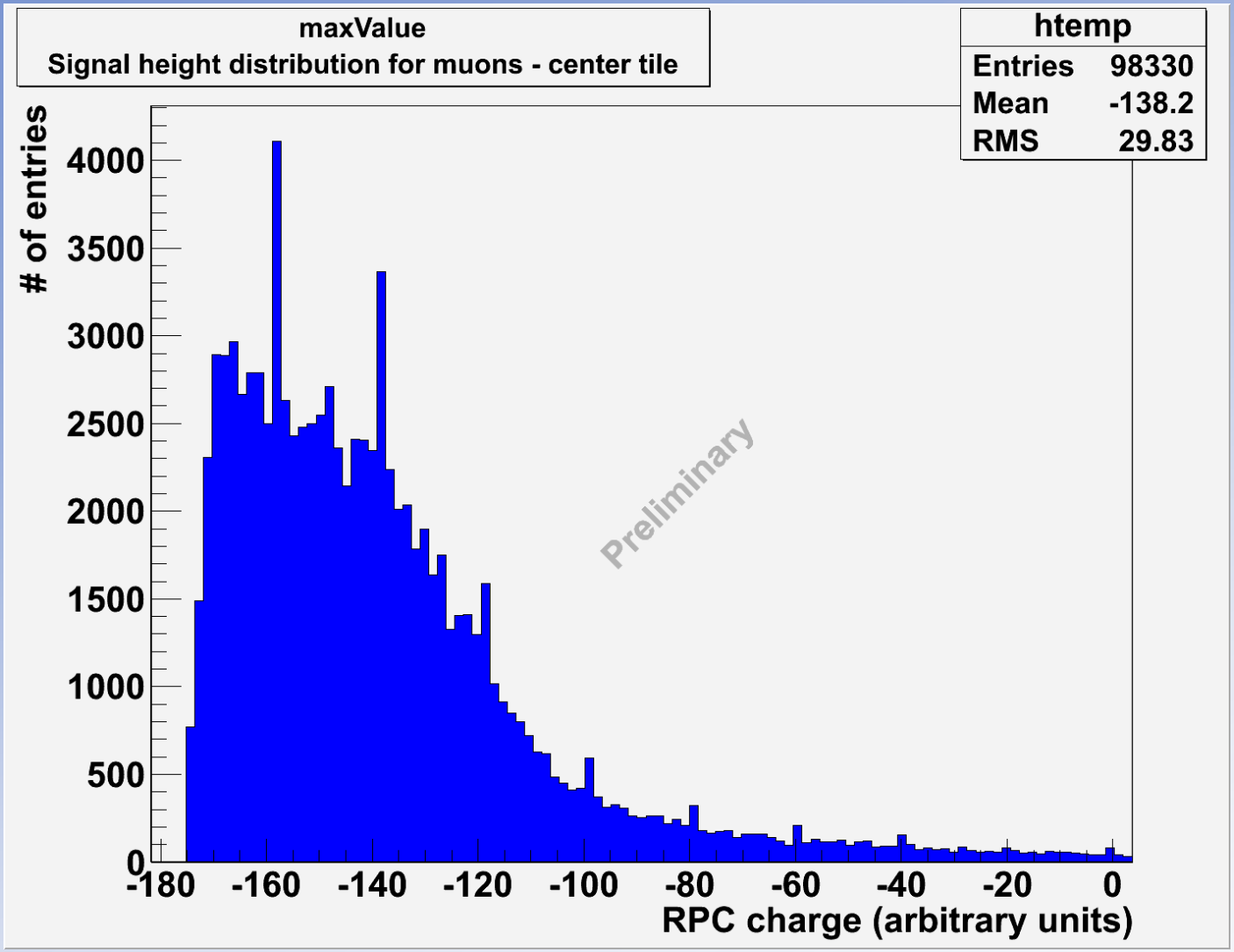


Peak Heigth


maxValue
Signal height distribution for muons - center tile
htemp
Entries 98330
Mean -138.2
RMS 29.83
# of entries
4000
3500
3000
2500
2000
1500
1000
500
0
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
RPC charge (arbitrary units)
Preliminary

Next Steps

- Filter out all the noise events
- Time of first hit analysis: create histograms with the time distribution of the rising edge of all signals
- Calibrate: use the muon data to understand statistical and sistematic uncertanties
- Simulate: Compare the results with montecarlo and T3B results
- Synchronize with DHCAL events to gain position and topology of the shower informations