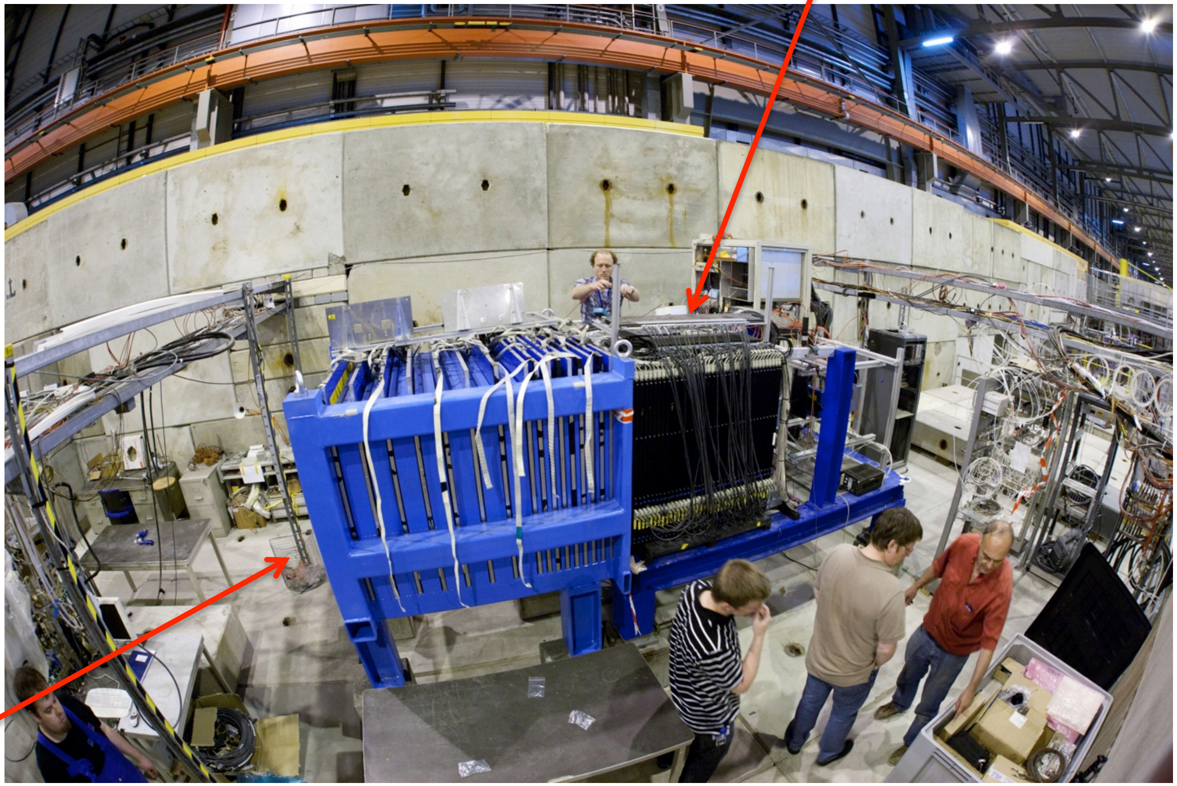
W-HCAL test beams

AHCAL:	PS (2010)		
	3 weeks: $2 \leq E \leq 10$ GeV		+ & – polarity
	SPS (2011)		
	7 days in June:	$E \leq 50$ GeV	+ polarity
	7 days in July:	$E \leq 300$ GeV	– polarity
	6 days in Sep:	$E \leq 180$ GeV	+ polarity
DHCAL:	Plans for 2012 test beams		

Today

W-AHCAL setup

AHCAL setup with 38 W layers.
Including active material ~4.8 λ



TCMT:
Steel/scintillator-strip sandwich calorimeter with 16 layers (~5.5 λ)

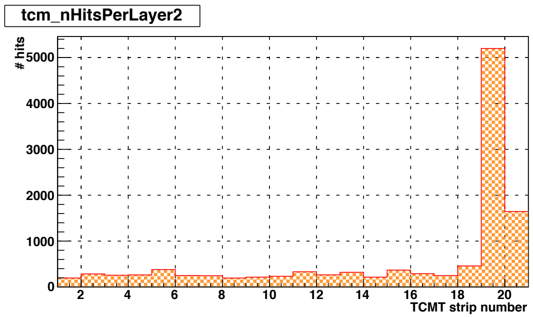
Repairs before the run

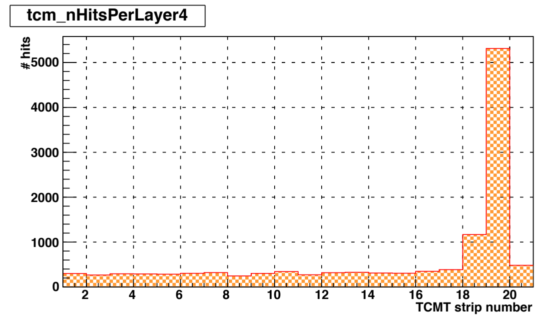
- Week before the run, Ivo Polak came to help tune the Calibration and Monitoring Board #20
  - Six boards however have to be taken out to reach #20.
  - After tuning we retested all → all OK.

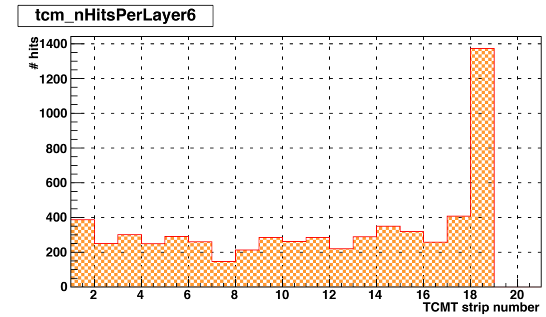
- Weekend before the run, Kurt Francis helped with the tailcatcher
  - MIPs for TCMT strips
  - Mapping problem
  - In the days before & after our beam time, scanned full surface in 9 positions.
    > 200k muons in each position.

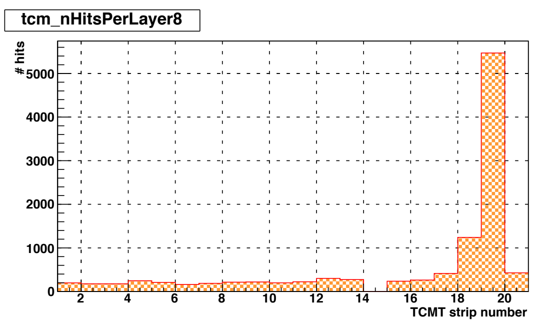
TCMT mapping problem

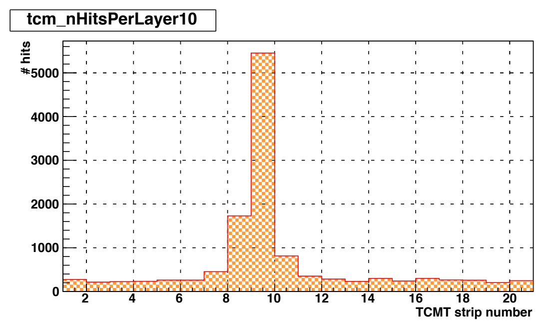
- For the first 4 layers with horizontal strips, the hits indicated a mis-alignment

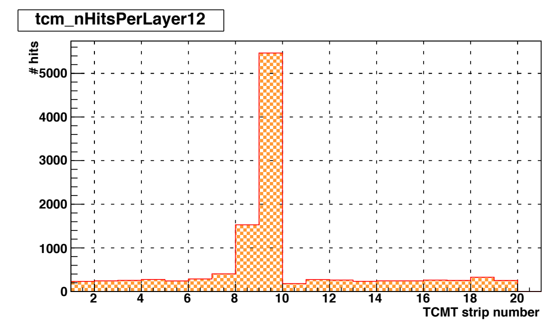


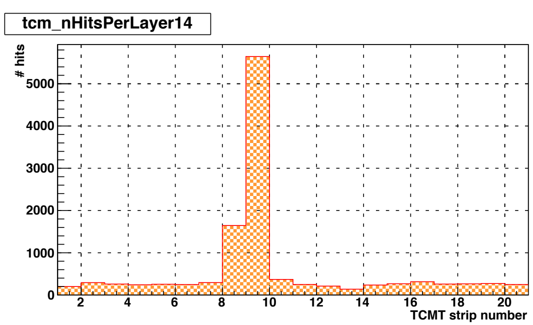


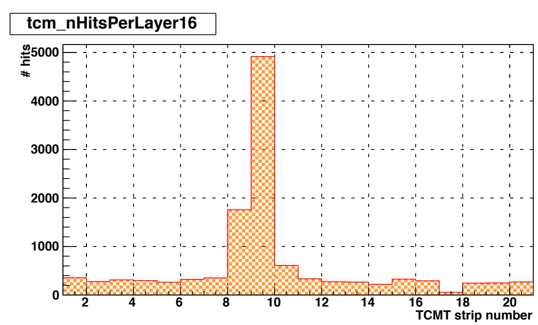












8 layers with horizontal strips

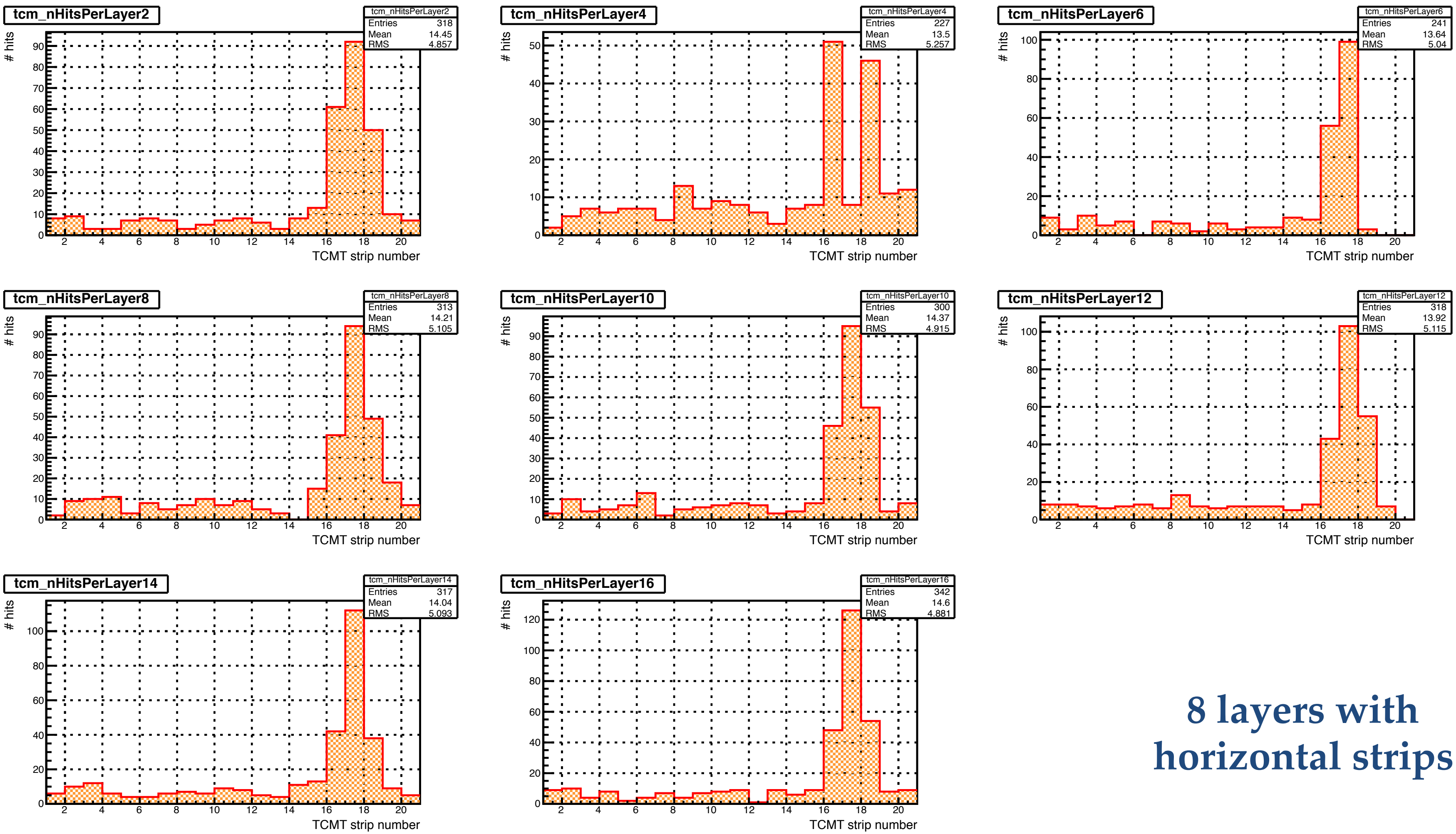
TCMT mapping

- Traced back all cables to FE chips. Assuming the maps of the 3 other boards were correct, board 1B was remapped.

- Best guess why the map is wrong: two different types of boxes for cabling

TCMT mapping - fixed

- After remapping, all strips are aligned.
  (dead strips can be seen in layer 4 & 6)



8 layers with horizontal strips

Problems during run

2 days before end of run, TCMT 1B started drawing high current on SiPM.

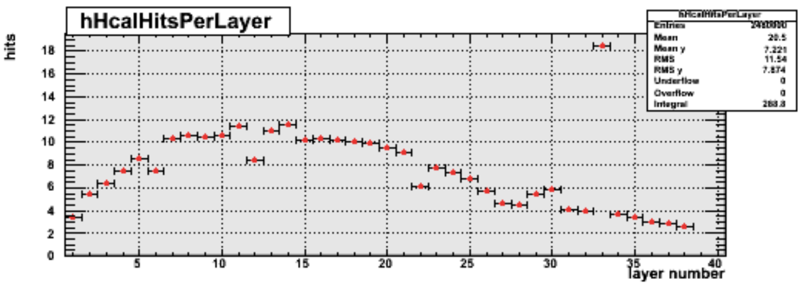
- Replaced total FE board → did not help.
- CRC noise run looked fine → left it as it is.

Considering the wrong mapping: might the high current be caused as the HV settings were sent to the wrong strips..?

➢ Cabling instructions, bias-settings & reconstruction map should be double-checked if TCMT is reused.

For three runs, layer #33 suddenly gave too many hits and too high energy response.

- Do not know why… Restarted these runs.
- Problem did not reappear.



High energy hadron program

Got help from Ilias & Simon on better beam files

200k events with secondary beam at:

- 180, 150, 120, 100 GeV

Higher reconstructed energy probably due to lower T →

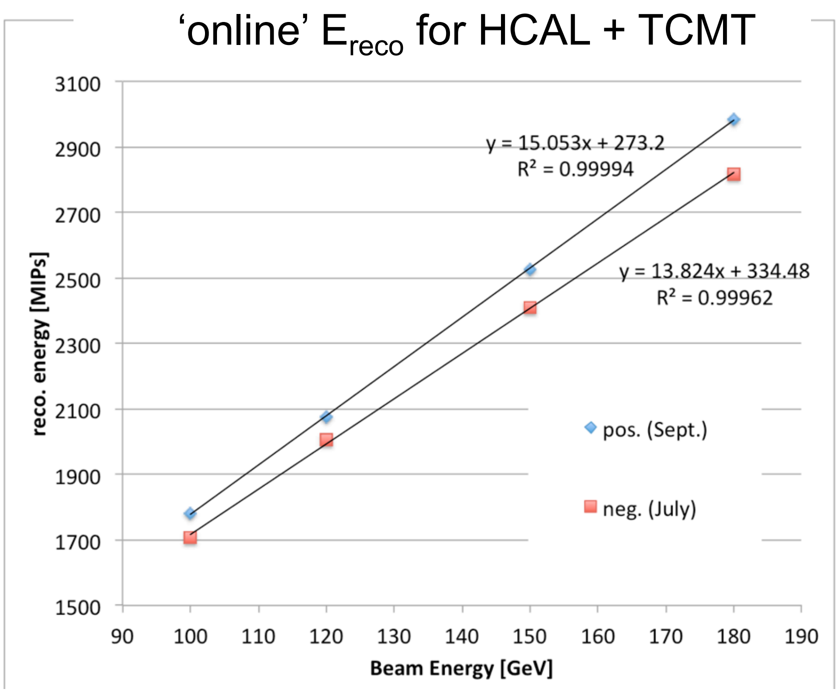
400k events with tertiary beam at:

- 180, 150, 120, 100 GeV

Took 4M events at 60 GeV and 4M at 80 GeV:

→ ~ 100.000 Kaon events at each energy.

Secondary beam runs September vs July

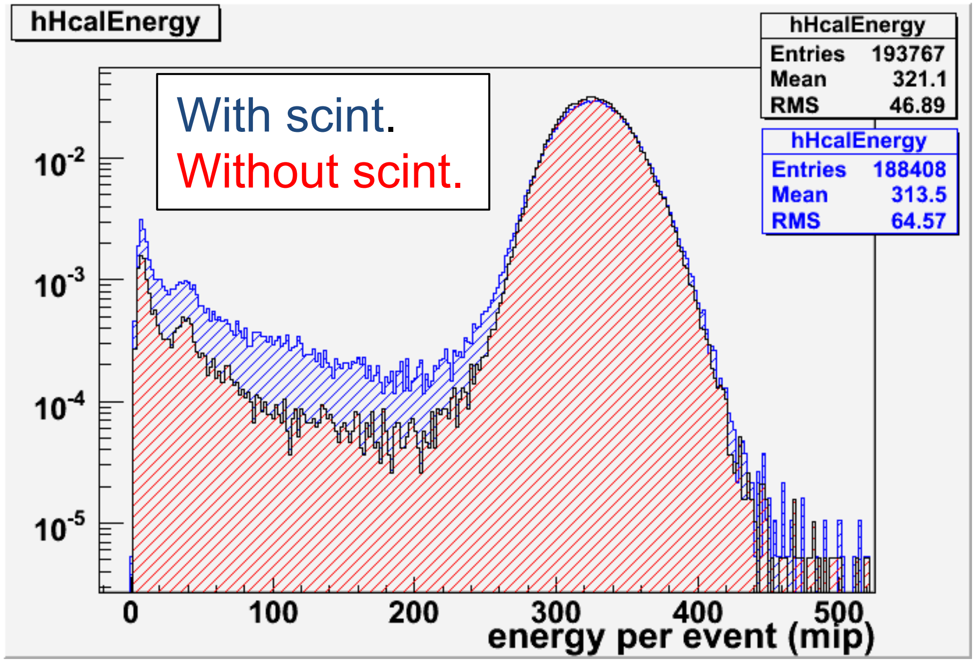


Low energy program

Friday 6 pm - Saturday 8 am: got wobbling set to 50 GeV (with 80 GeV for ATLAS in H6)

- Pion samples (200k each) at 30 & 50 GeV
- Electron samples (200k each) at 15, 20 and 30 GeV

- For the electron runs at 15 & 20 GeV, took sample with and without all H8 beam line scintillators
- ➢ Probably an explanation for the long tails we see in June/July samples.



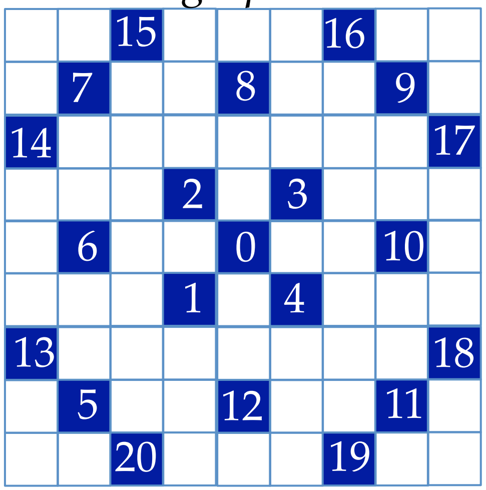
Data taken

		# events	
π^+:	8 energy points in range from 30 to 180 GeV. Including ~400k Kaons at 60 and at 80 GeV.	11.7 M	September
e^+:	at 15, 20, 30 and 40 GeV	1.1 M	
μ:	30x30 triggers, in 9 locations	2.2 M	
π^-:	16 energy points in range from 10 to 300 GeV	11.4 M	June/July
π^+:	5 energy points in range from 10 to 50 GeV	2.7 M	
e^-:	6 energy points in range from 10 to 40 GeV	1.2 M	
μ:	large 80x80 triggers 30x30 triggers, in lower 1/3 of detector area	2.1 M 0.3 M	

T3B: The same events in sync with AHCAL, plus standalone events.

2D temperature profile

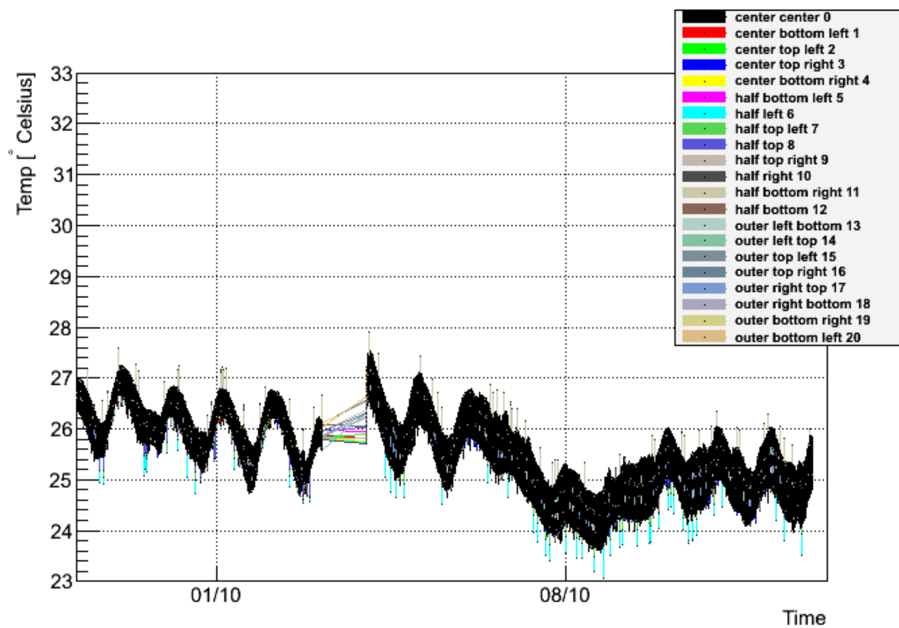
Looking upstream



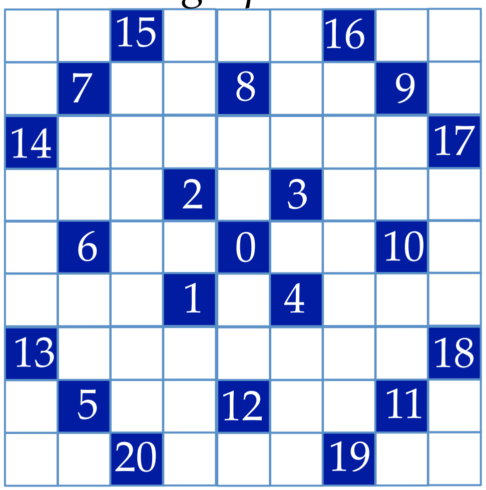
- From T3B team we got a device with 21 Pt_1000 temperature sensors, easily read out via USB.

See also talk by Angela at HCAL main meeting, 13/12/'11

- Placed these on a 1 m^2 aluminium plate → slided in the free slot #39
- After the campaign, in slot #20

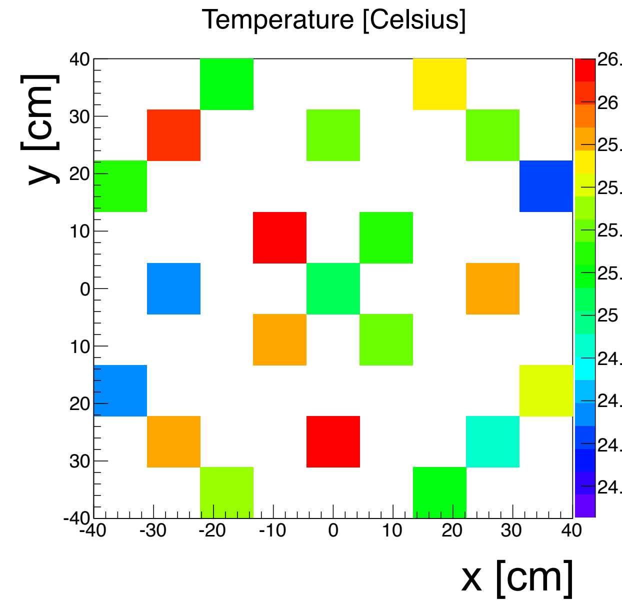


Looking upstream

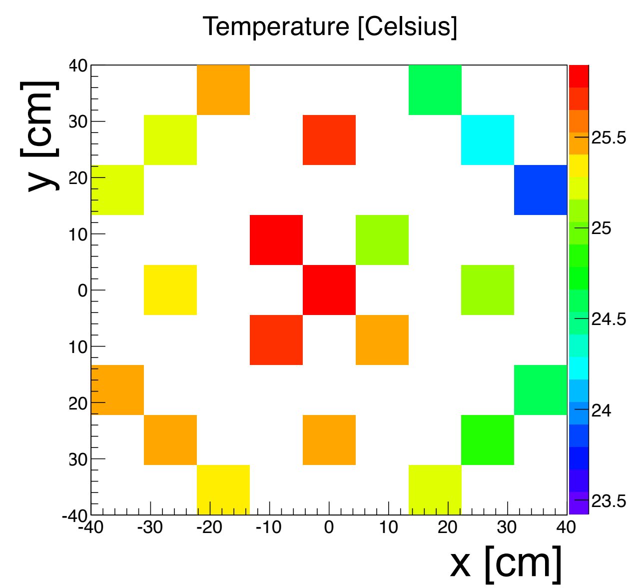


Averaging 4h of data

Layer #39

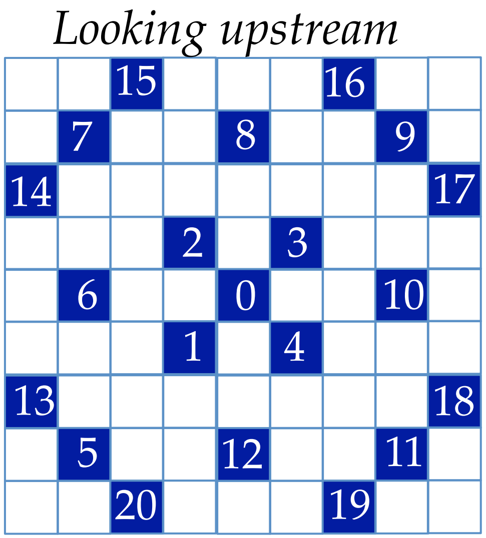


Layer #20

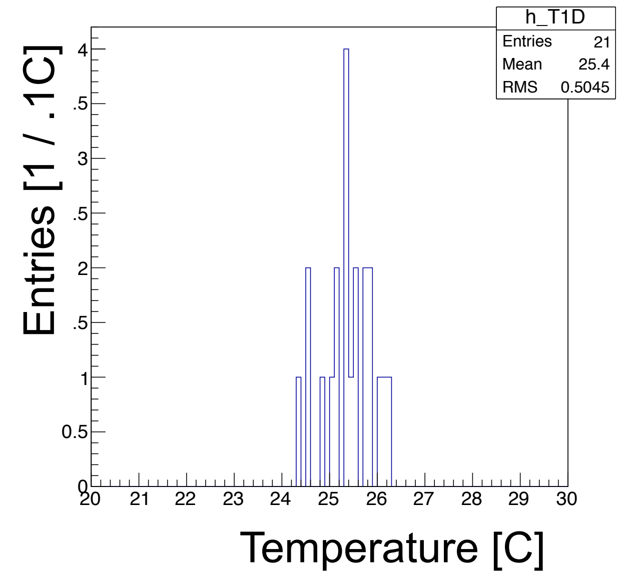


- In #39 mostly center is hotter
- In #20 spread is larger
- In #20 FE-side is hotter

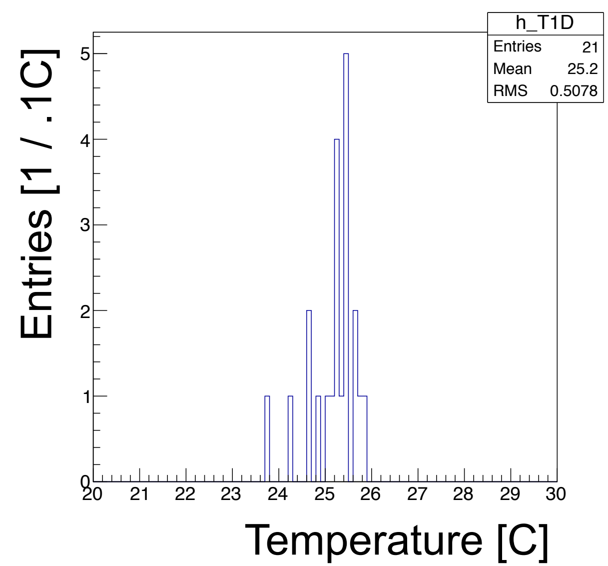
2D temperature profile



Layer #39



Averaging 4h of data



Layer #20

- In #39 mostly center is hotter
- In #20 spread is larger
- In #20 FE-side is hotter

From A to D

- AHCAL program completed & finished
- HCAL active layers & electronics have been shipped back to DESY

- Next: plans for DHCAL 2012 test beams

Preparations for test beam

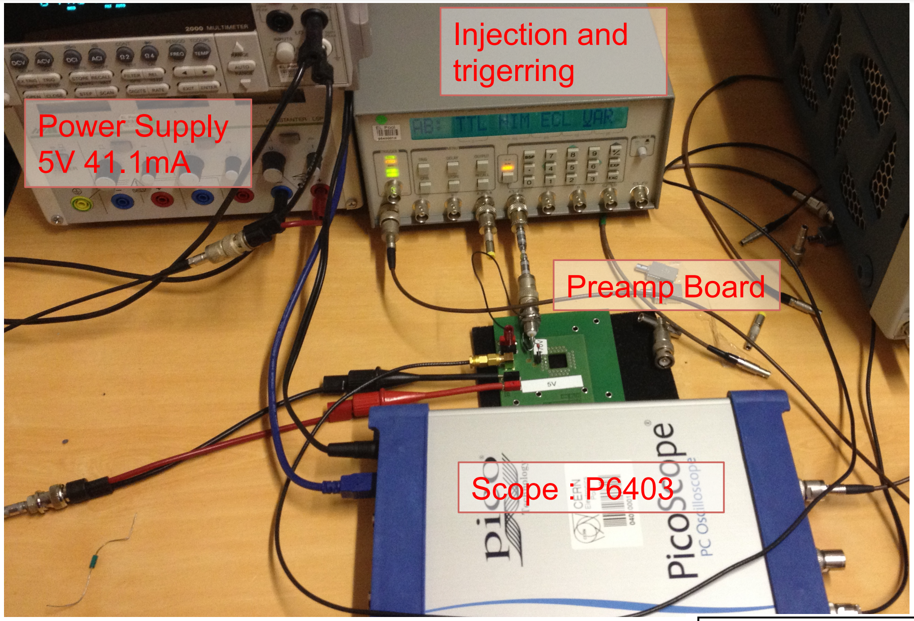
- Support frame
  - Cable basket underneath
  - Extra electronics rack, gas bubbler off platform
- TDC integration in DAQ for wire chambers

- US gas mixing rack
  - not EU-ATEX certified… → CERN might provide a new rack
- Cooling: Discussing with CERN CV

- Transport to CERN
  - 1st tailcatcher might come in fall
- Transportation from PS to SPS
  - Probably with fully equipped detector

T3B preamp for use with RPC

- Very preliminary -

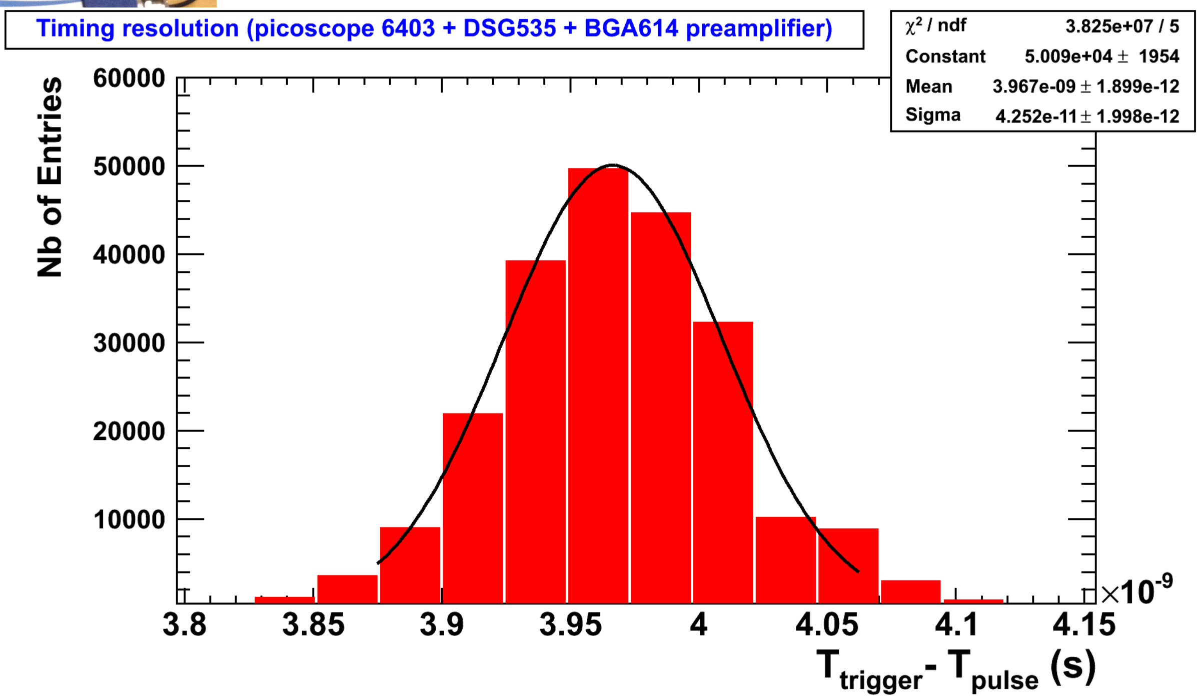


Obtained BGA614 preamplifier board from Frank Simon.

- Studied the preamp in setup with pulse generator
- Created simulation

by Mathieu Benoit

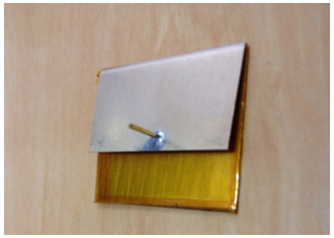
With generated pulse, obtain:

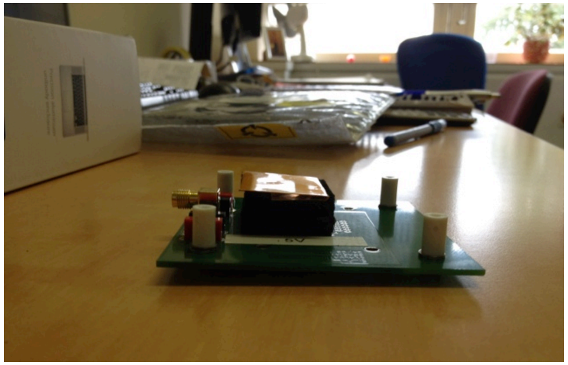


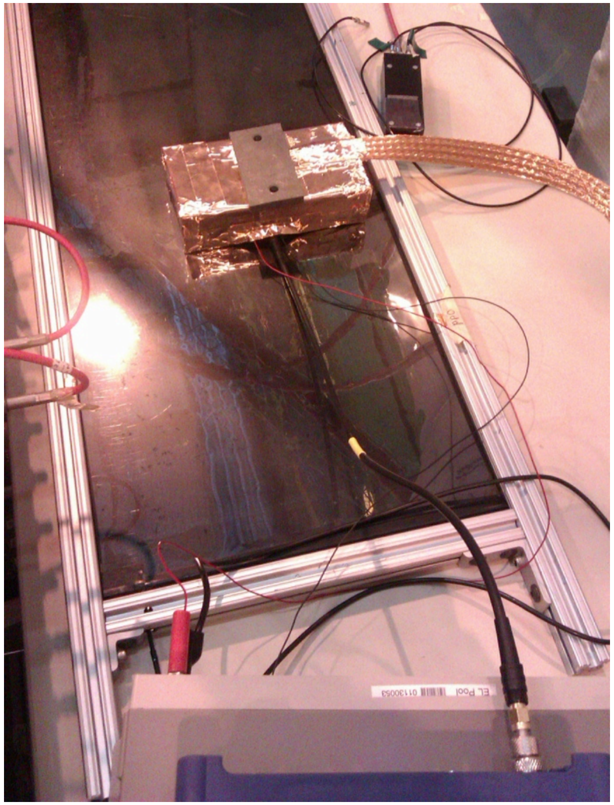
Test on glass RPC at CERN

- Very preliminary -

'pick-up' pad: Copper electrode (3.1 x 2.6 cm^2), covered with 0.07mm thick kapton tape







With a lot of help from Liang Guan (ATLAS):

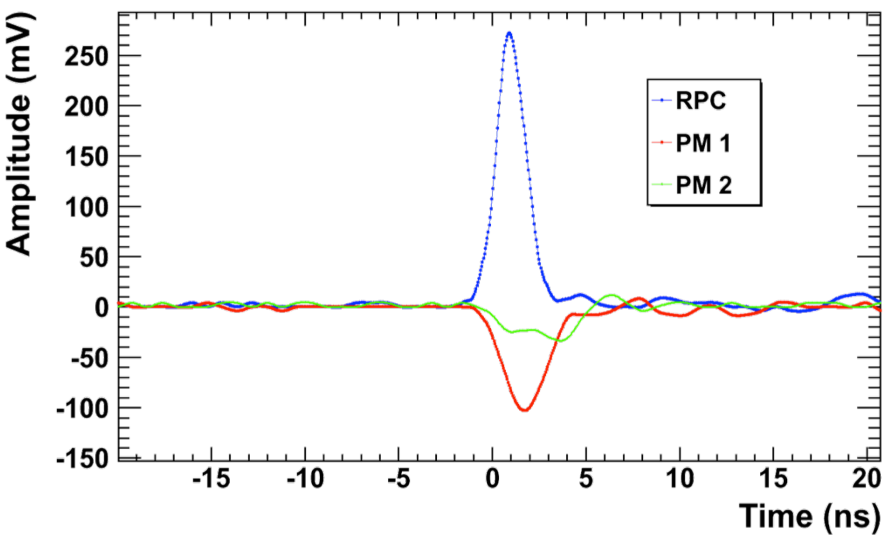
Cosmic tests with:

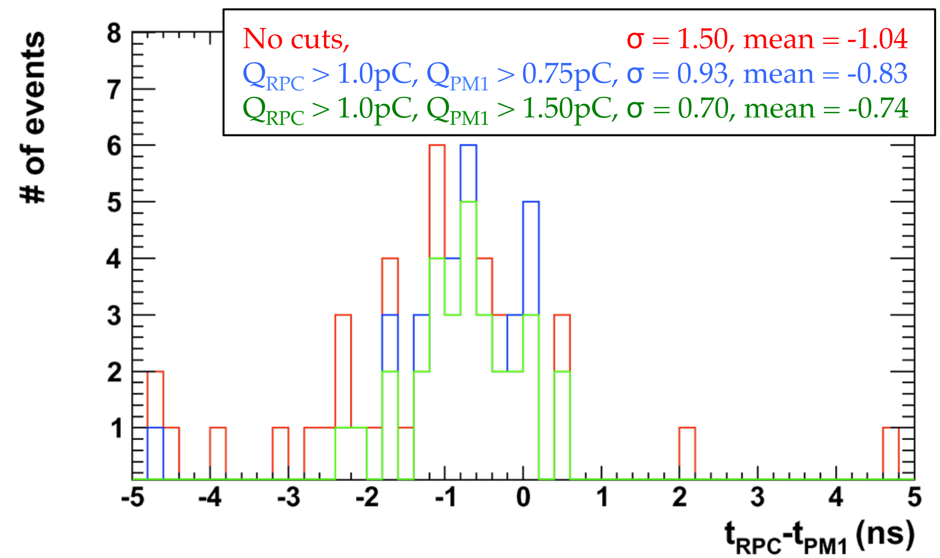
- RPC from Argonne
  - Gas : ATLAS standard mix, 5% isobutane, 0.3% SF6 , 94.7% tetrafluoroethane
  - 7kV bias, leakage current of 80uA
- 2x2cm^2 scintillator

Timing measurement

- Very preliminary -

- With cosmics, measure Δt between thresholds: +50 mV for RPC
  -10 mV for PM





- ➢ Within statistical limit, show a good timing resolution, ≈O(1ns)
  For comparison: SiPM T3B has σ ~ 0.8 ns.
- ➢ RPC works well with BGA614 based amplifier
- ➢ Frank Simon is working at MPI to create a T3B-like board for RPC

Conclusion

W-AHCAL

- Beam operation went well
- Mismapping & some malfunctioning of TCMT 1B
- Completed & finished full 2011 program.

W-DHCAL

- Preparations are ongoing
- 14 – 28 May in PS
  - SPS times not defined yet.
- Good chance of having fast RPC readout system before first run.

Backup

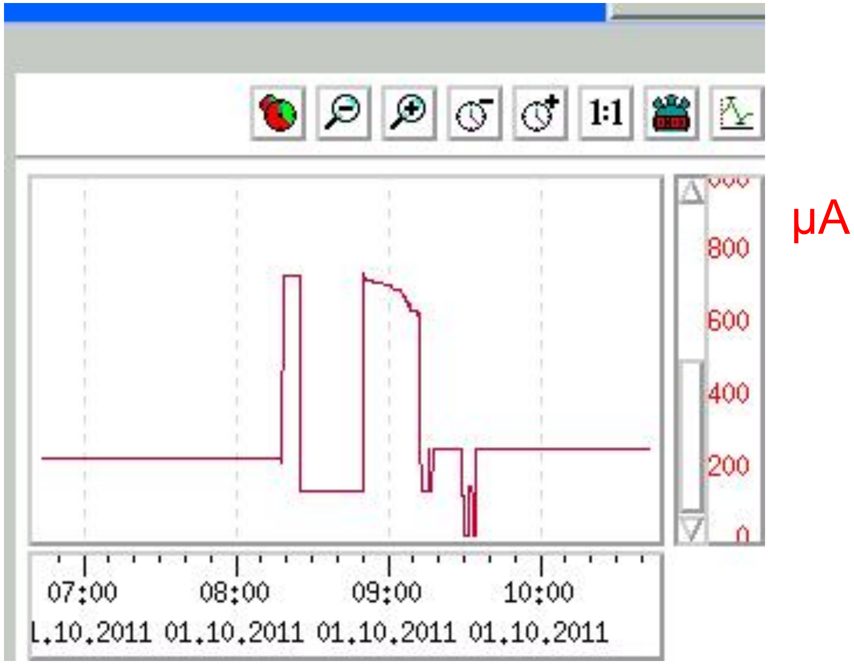
TCMT Front End board 39B

Saturday morning TCMT 1B started drawing high current on the SiPM.

- Unplugged all cables
- Replaced several FE chips

Nothing worked. After this, could also not configure chips anymore.

→ Replaced total FE board

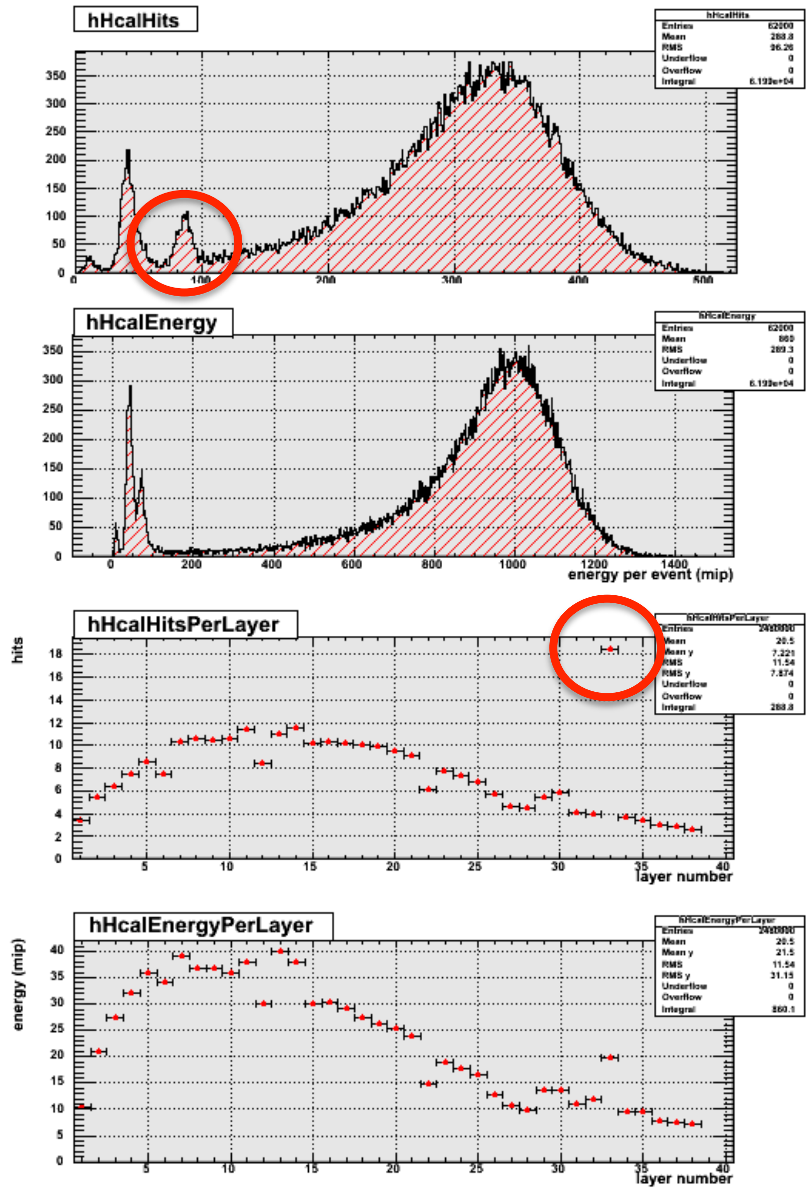


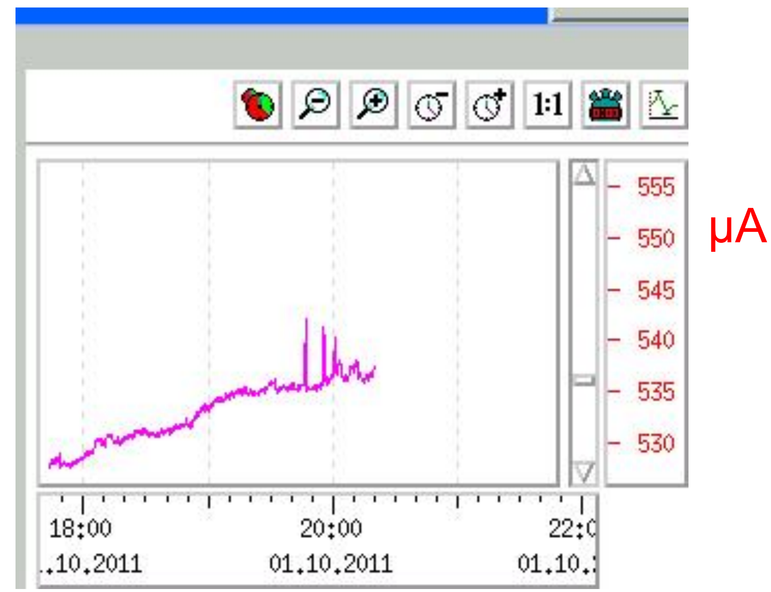
- Could reconfigure again, high current remains.
- All other monitoring tools looked fine.
  → did not touch it anymore.

Unfortunately forgot to reset LEDs for AHCAL!

- The 4 gain runs from this point on are empty… (2 days)

HCAL layer #33





For three runs layer #33 suddenly gave too many hits and too high energy response.

- Do not know why… Restarted these runs.
- Not related to LEDs being off, it also happened a day before TCMT problem.

CMB #20 fine tuning

- Week before the run, Ivo Polak came to help tune the Calibration and Monitoring Board #20
  - Via LEDs a CMB sends light to the tiles for calibration.
  - #20 never functioned properly since installation at CERN
  - Each of the 11 LEDs has a potentiometer to be tuned.
    → LED #8 could not be tuned, light intensity fluctuated

- Six boards however have to be taken out to reach #20.
- After tuning we retested all six
  - #20 now finally sees light: for ~70% of channels the gain can be extracted
  - No significant effect on other 5 modules.

TCMT MIP peaks

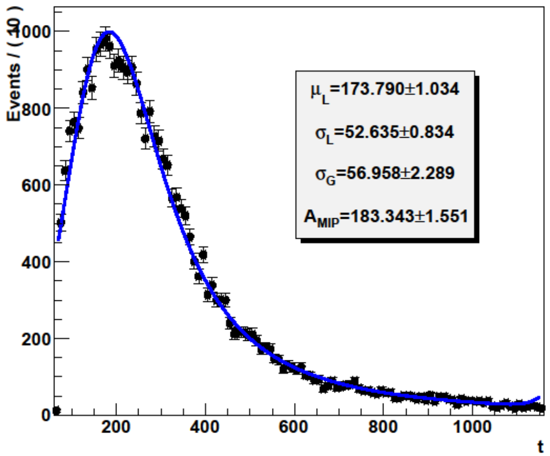
The weekend before the run, Kurt Francis visited CERN and helped with the tailcatcher.

- Extended AngleTrackFinder to find mips in TCMT
  - extrapolate track to TCMT and allow +- 1 strip
- Additional quality cuts
  - Consider only hits which form a tower of at least 5 in the TCMT alone

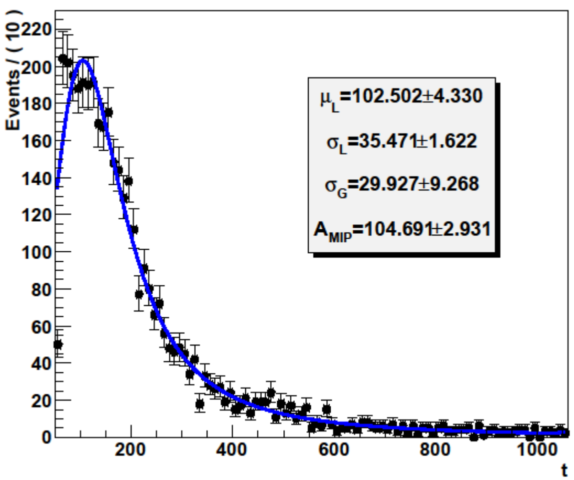
➢ Some channels give nice results, however still have the MIP peak very close to the pedestal

TCMT MIP peaks

- Some channels give nice peak



- Many channels have peak very close to pedestal
  - results in bad fits



Setting up a beam in SPS-H8

SPS aims 400 GeV primary beam at a target.

- Both H6 and H8 beam start after this target. These two secondary beams are linked in energy by the wobbling magnet settings.
- Most of the time we ran with wobbling of +180, -180 or -300 GeV.

In the beam line we can produce a tertiary beam at lower energy by inserting secondary target:

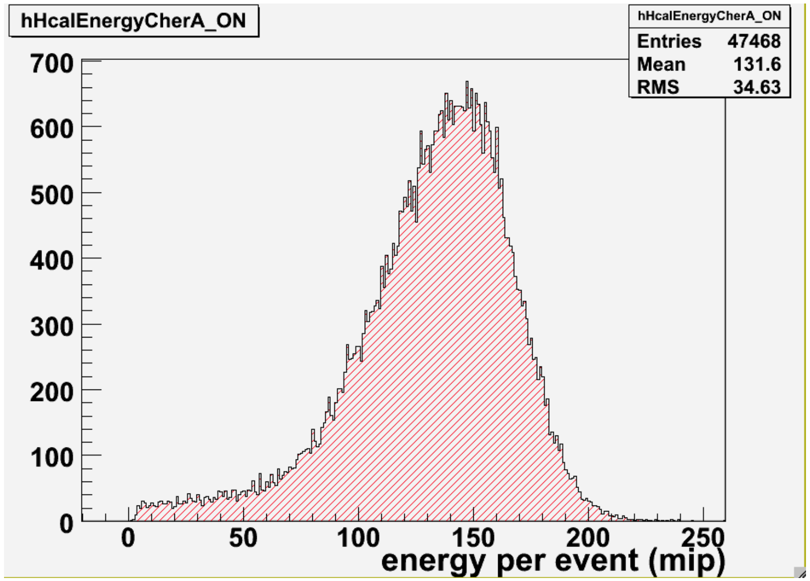
- 400 mm Cu target for hadron production
- 6 mm Pb target for e+- production.

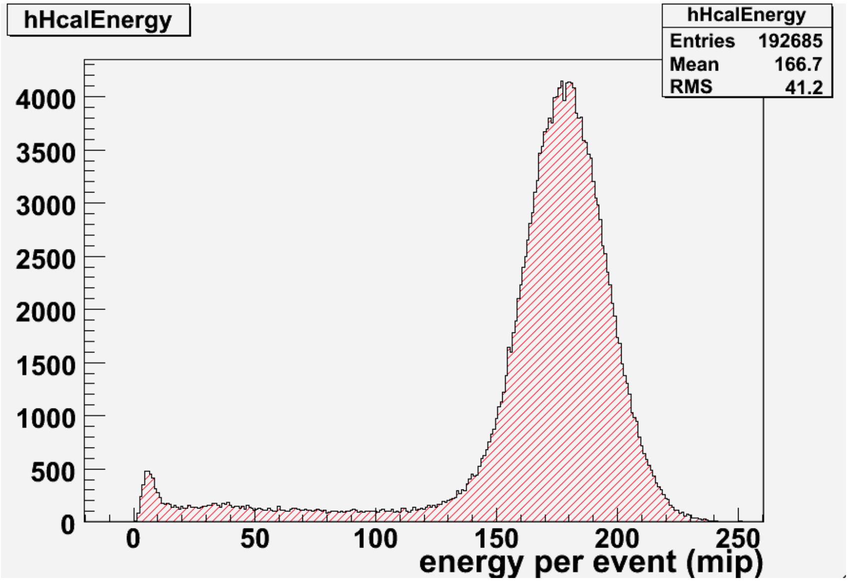
The "hadron" beam is actually a mixed beam consisting of e+, mu+, pi+, p+

- Can be stripped of the e+ with an absorber of 4 mm, 8 mm or 18 mm thick Pb.

Material and air along the beam

Electrons are very sensitive to material in the beam





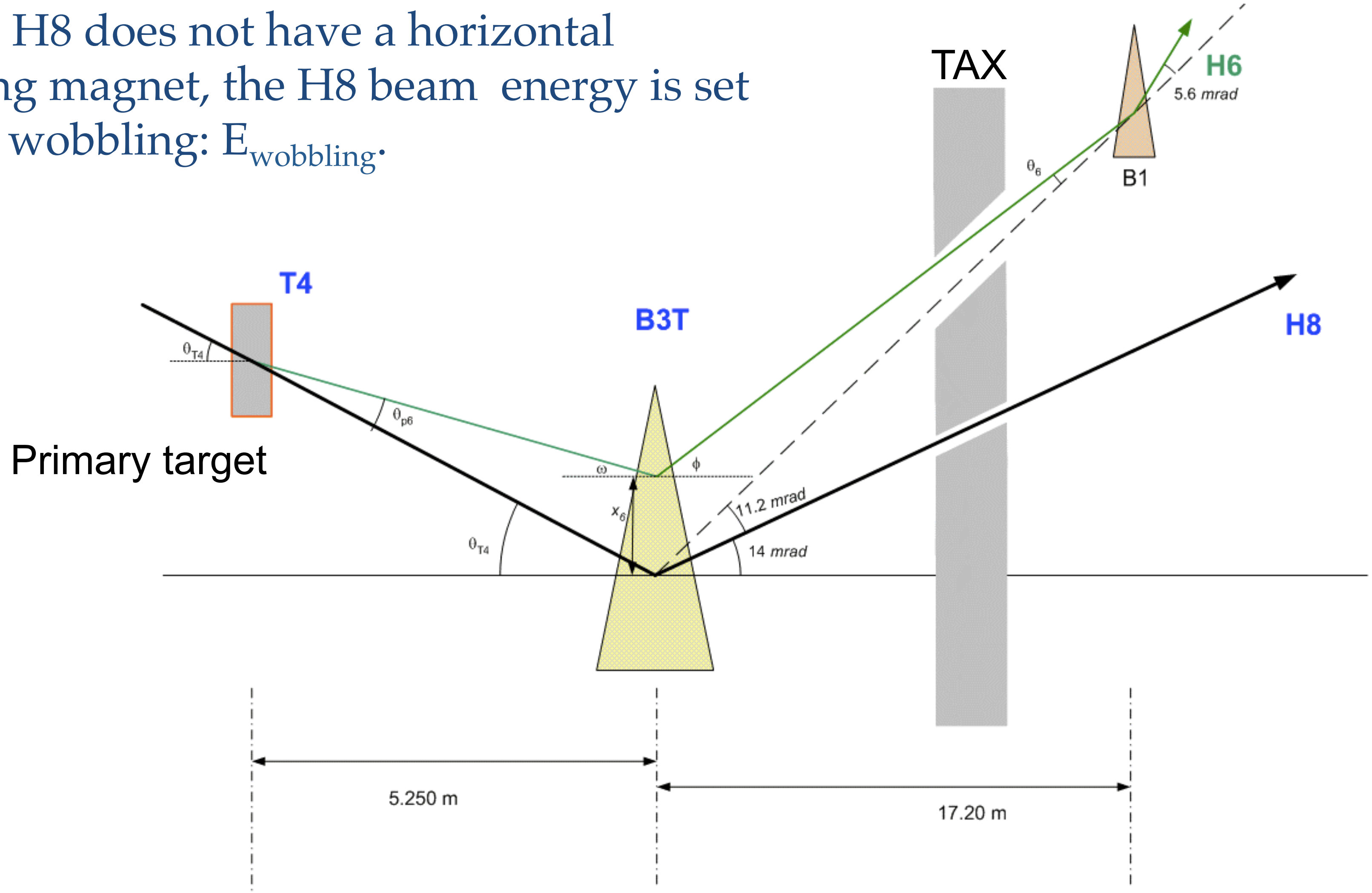
10 GeV e^- signal from June run,
With 80m air and some material in beam

10 GeV e^- signal from July run.
Material in the beam minimized
Vacuum beam pipe installed

Wobbling

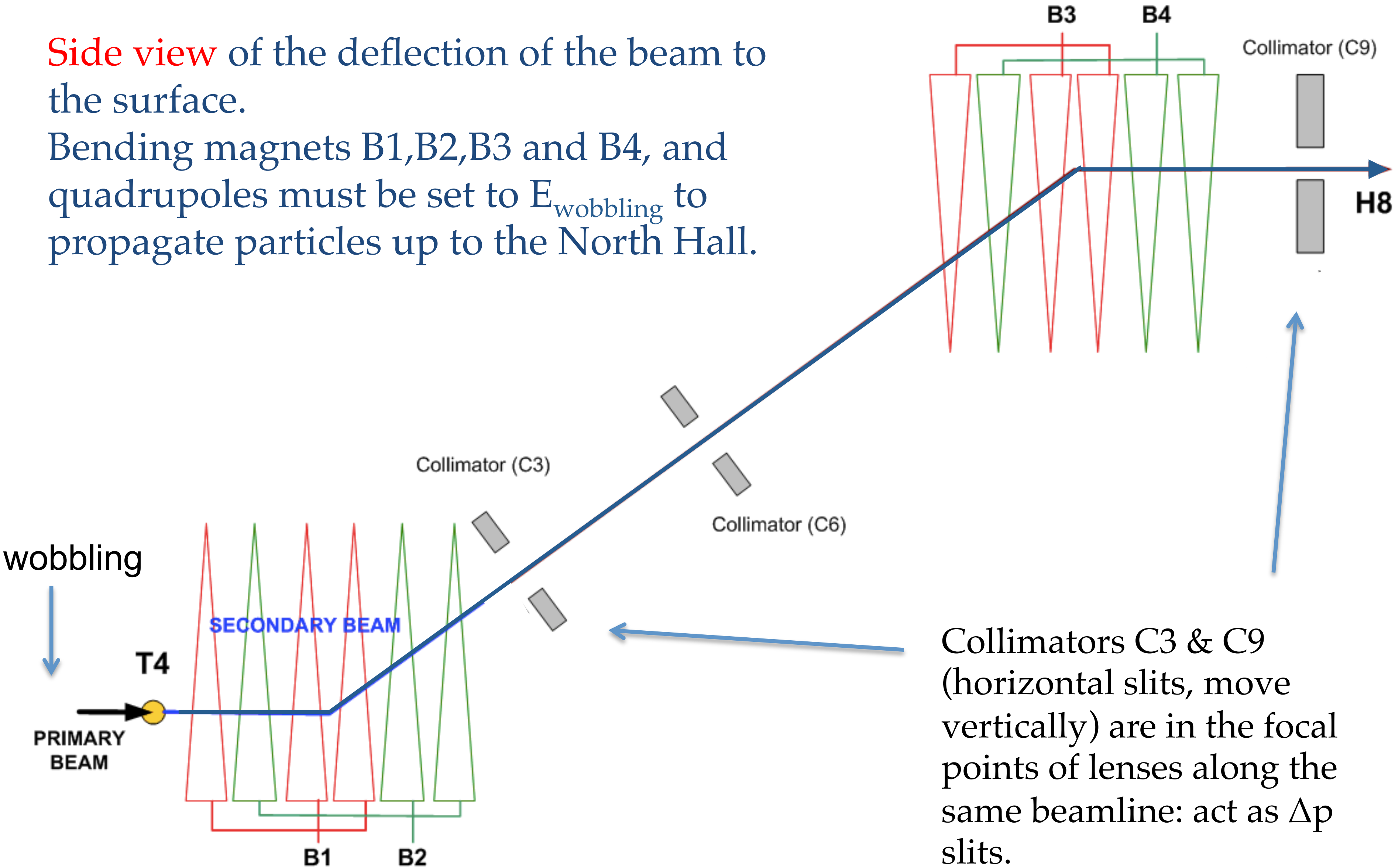
Top view of the end deflection of the beam in the wobbling

- As the H8 does not have a horizontal bending magnet, the H8 beam energy is set by the wobbling: $E_{wobbling}$.



H8 secondary beam

Side view of the deflection of the beam to the surface.
Bending magnets B1,B2,B3 and B4, and quadrupoles must be set to $E_{wobbling}$ to propagate particles up to the North Hall.

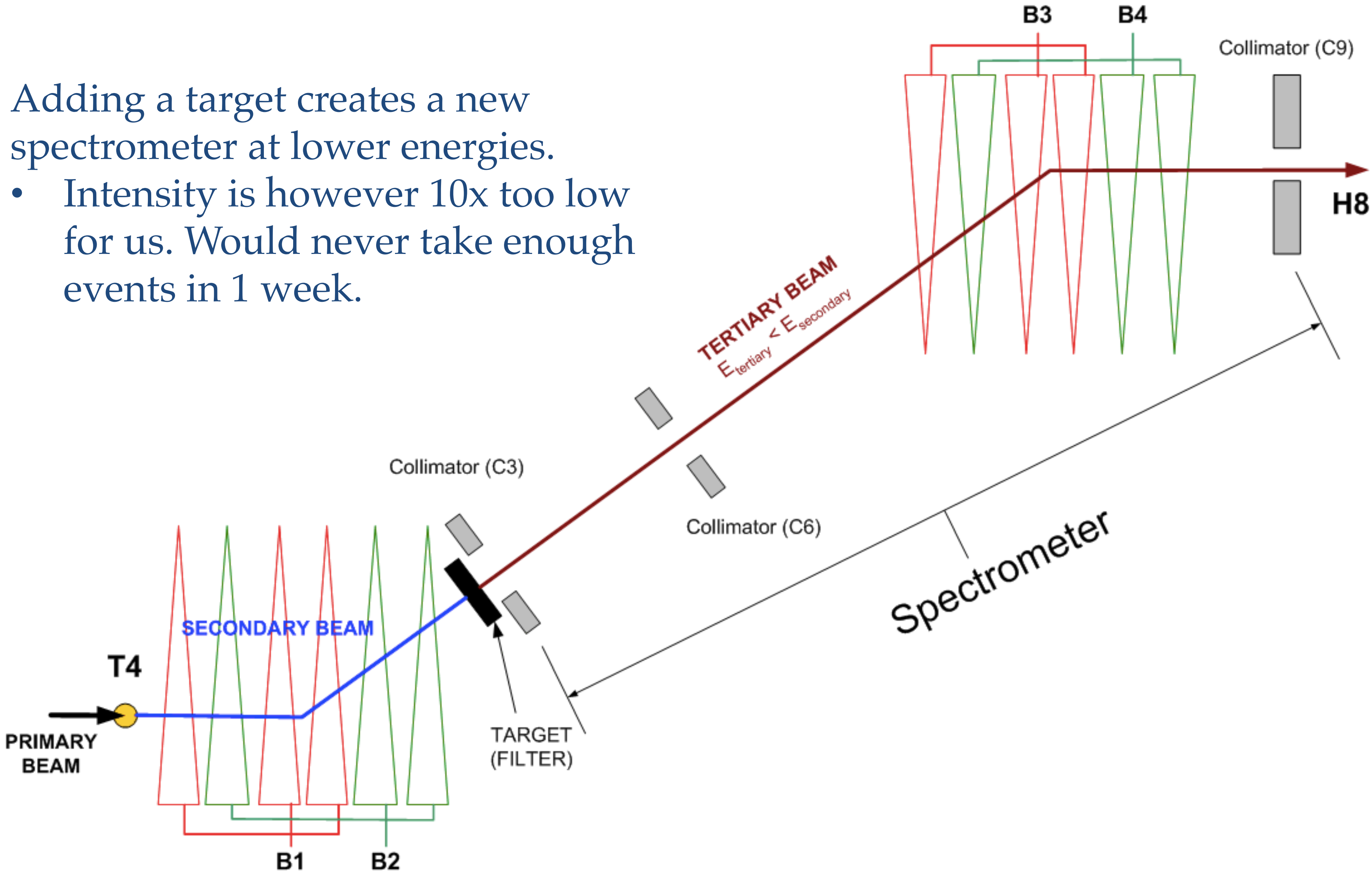


Collimators C3 & C9 (horizontal slits, move vertically) are in the focal points of lenses along the same beamline: act as Δp slits.

H8 tertiary beam

Adding a target creates a new spectrometer at lower energies.

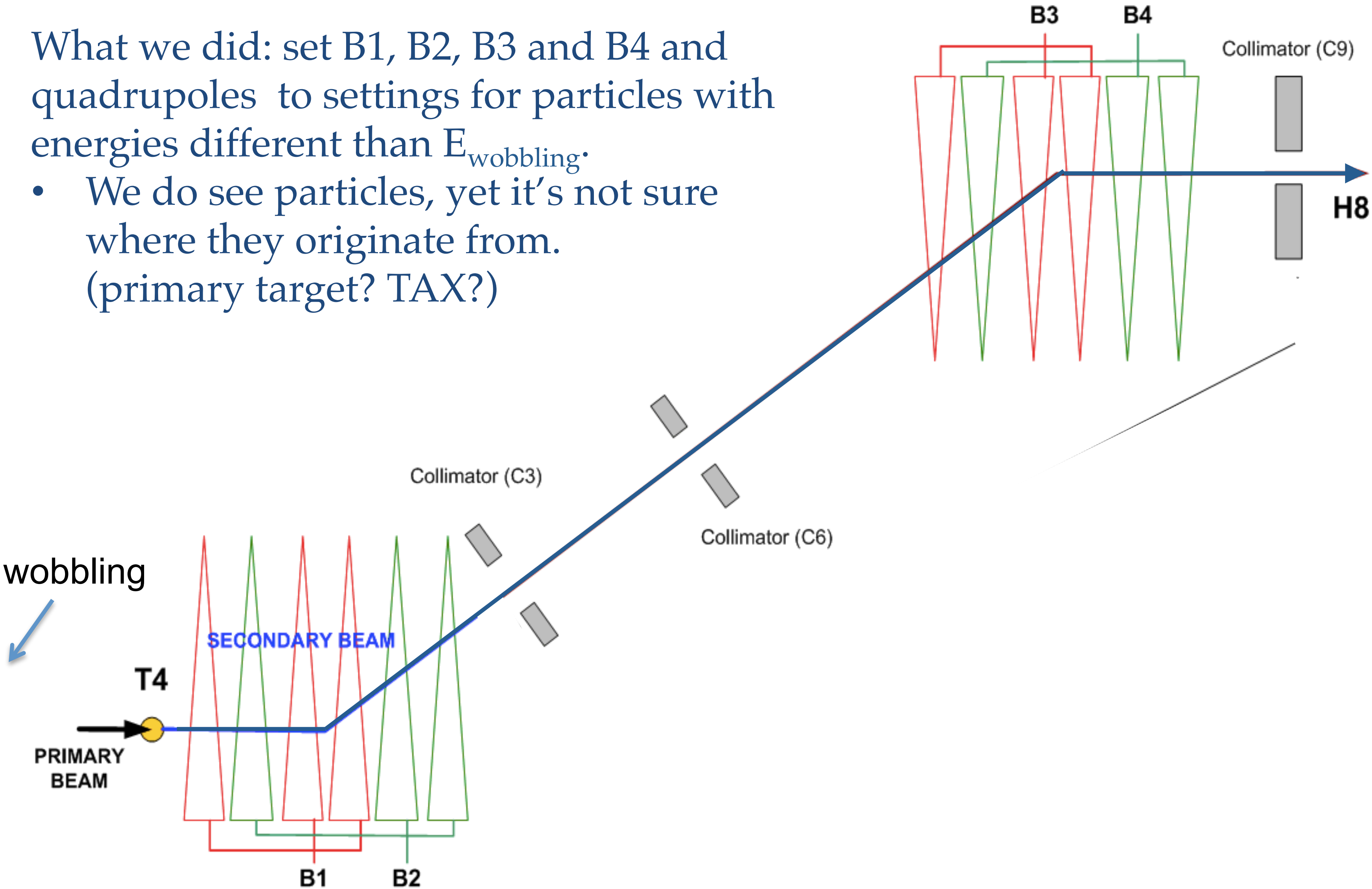
- Intensity is however 10x too low for us. Would never take enough events in 1 week.



H8 spectrometer

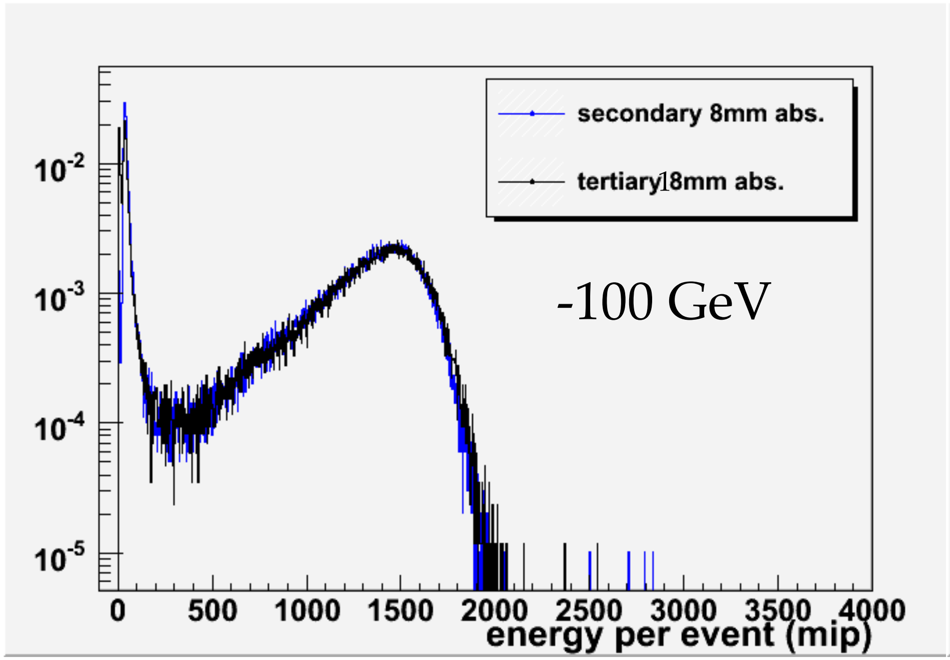
What we did: set B1, B2, B3 and B4 and quadrupoles to settings for particles with energies different than $E_{wobbling}$.

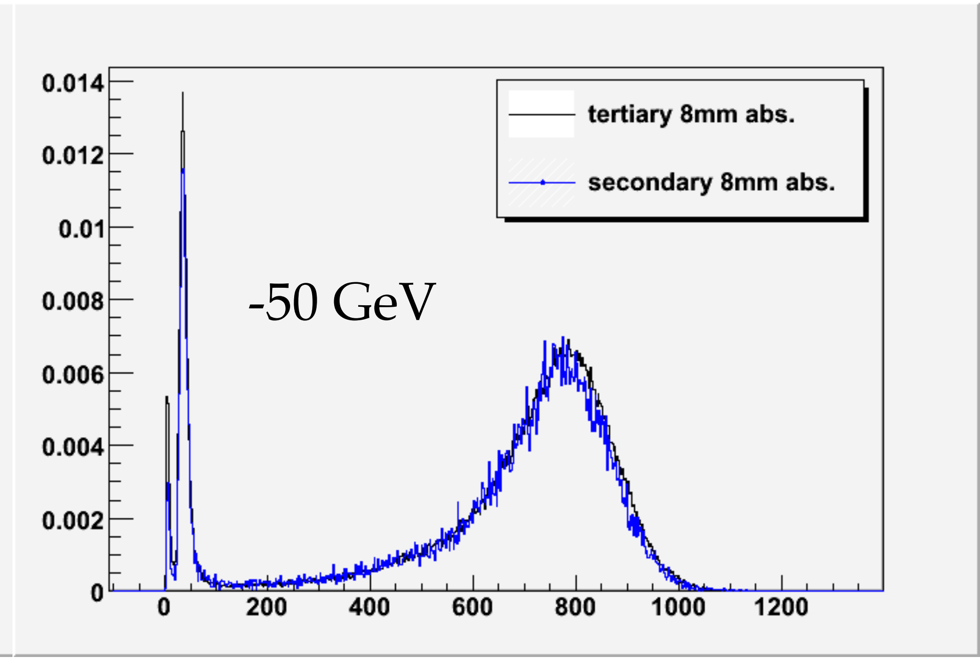
- We do see particles, yet it's not sure where they originate from. (primary target? TAX?)



Tertiary vs secondary beam

Check of secondary beam quality: energy





Two energy points crosschecked between tertiary and secondary beam

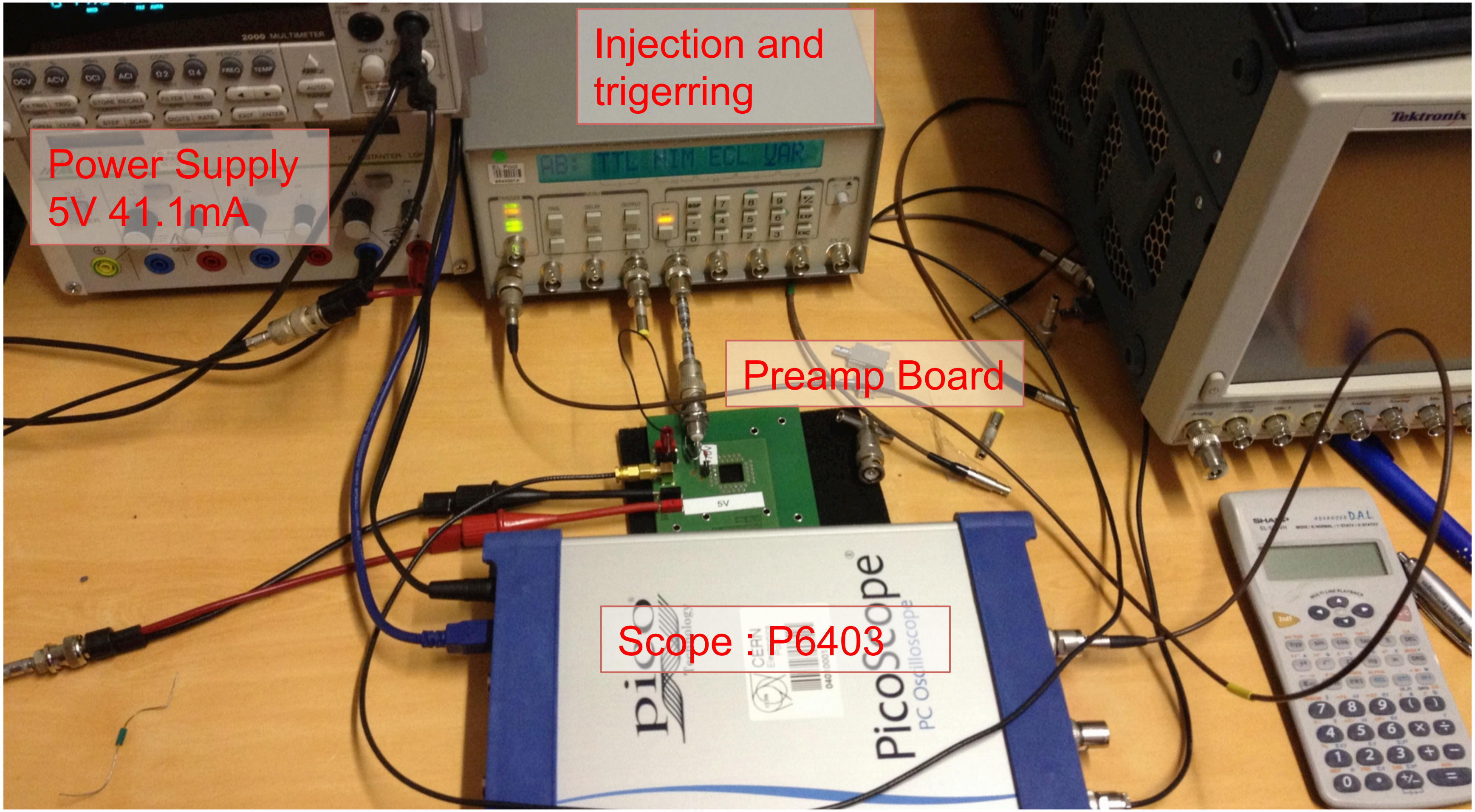
- Same energy distribution

➢ Even though it is unclear where exactly the particles are created, the particles have the correct energy.

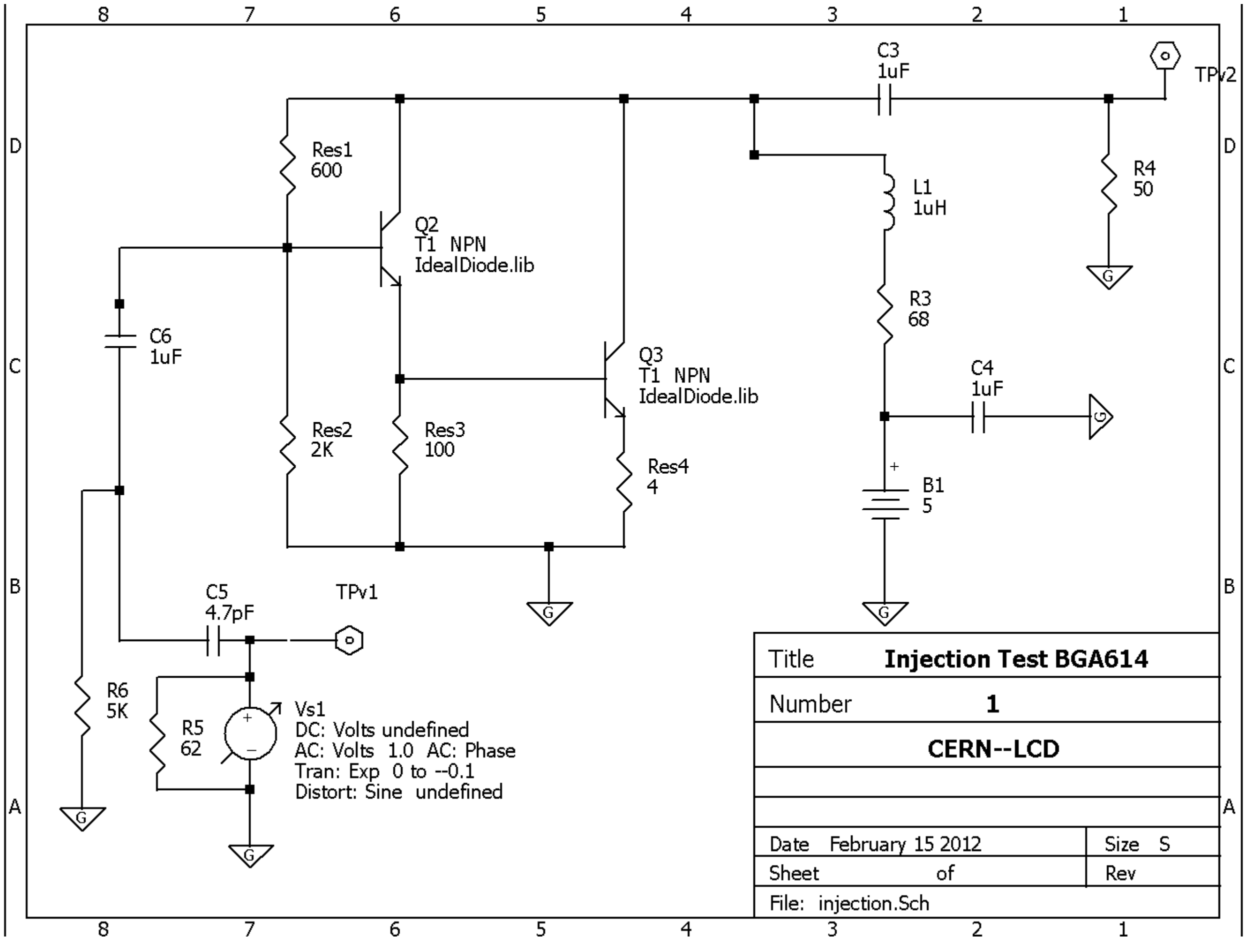
Preliminary study of T3B BGA614 preamplifier for use with RPC

Mathieu Benoit

The setup

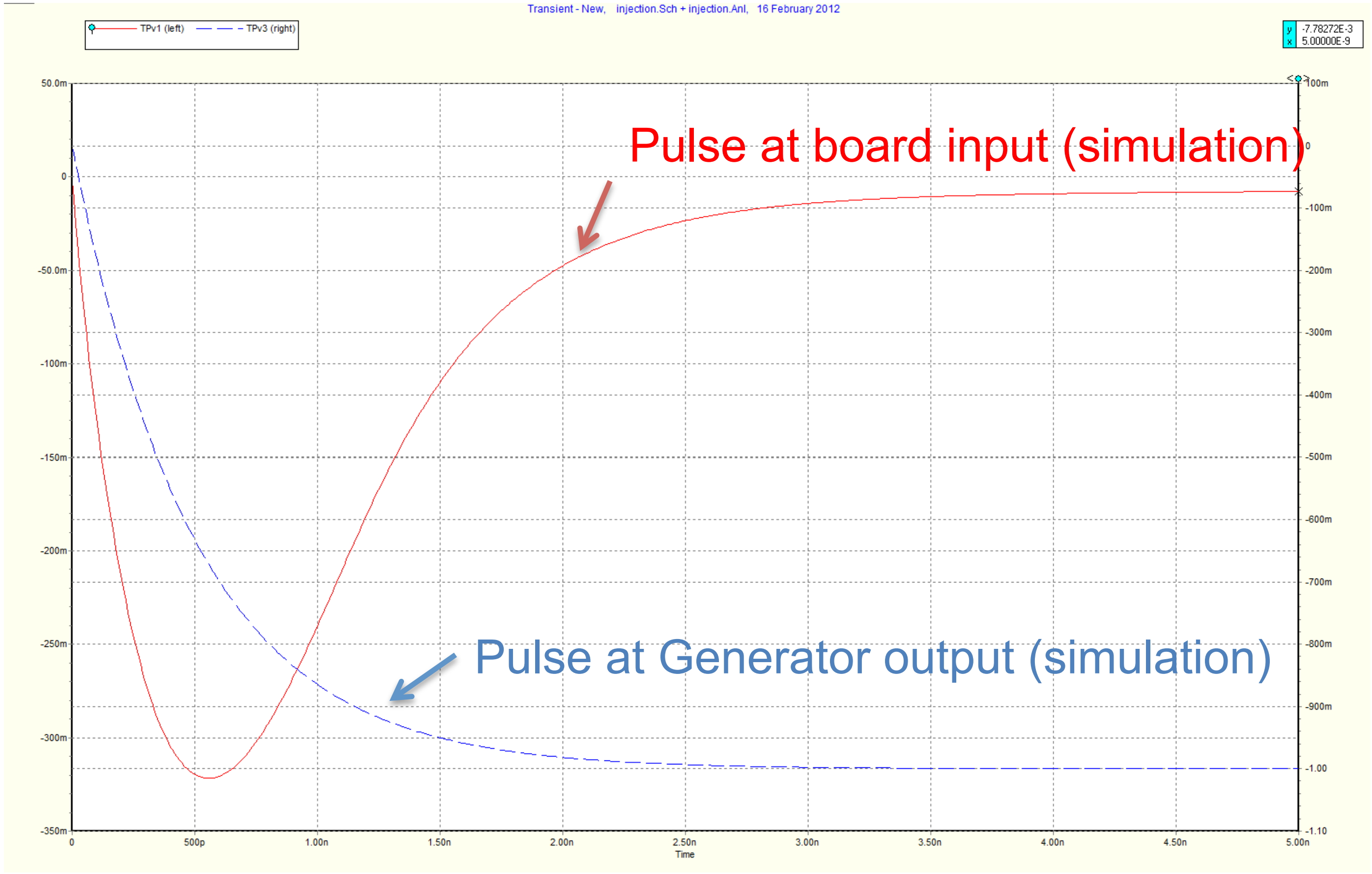


Injection and trigerring
Power Supply 5V 41.1mA
Preamp Board
Scope : P6403

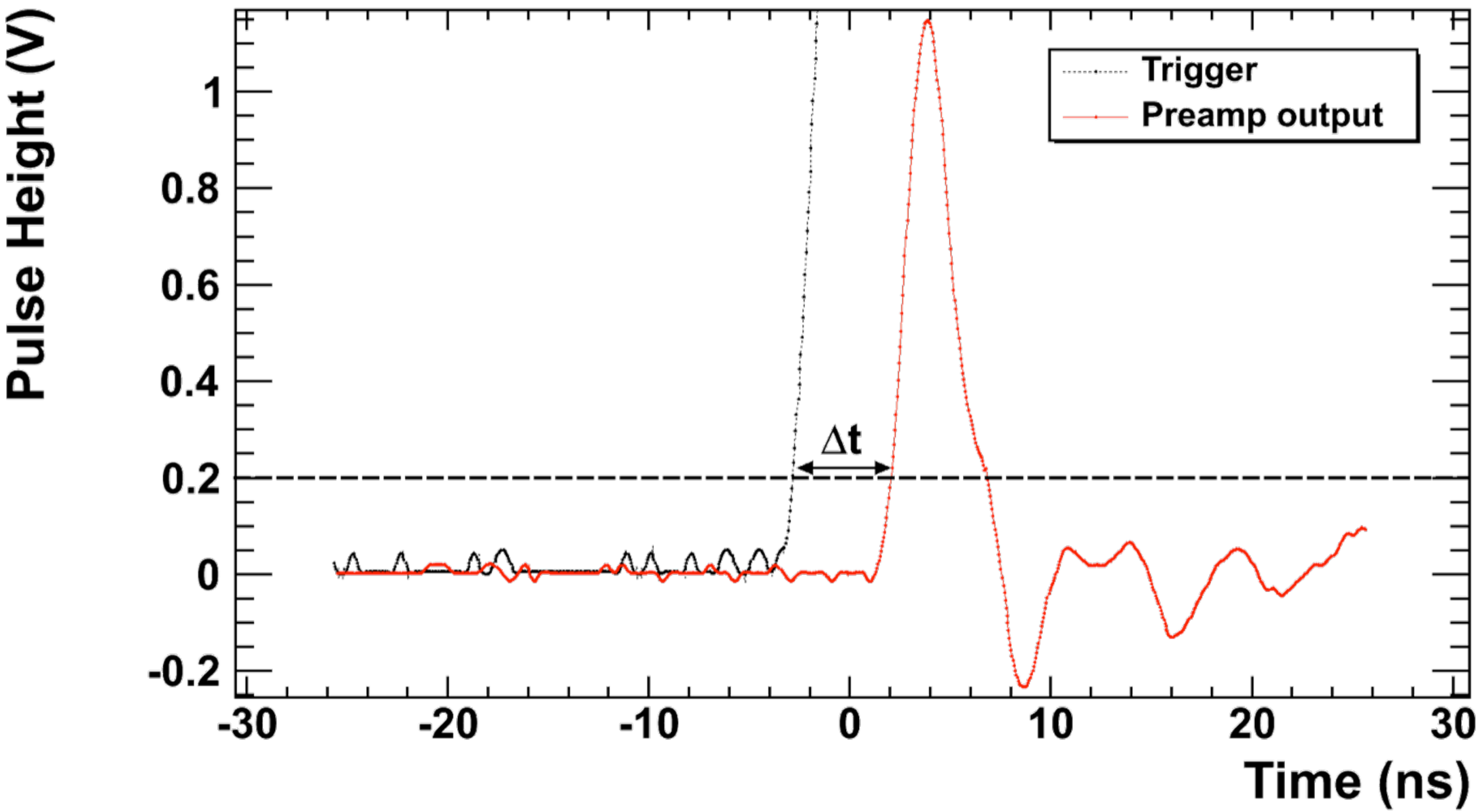

C3
1uF
TPv2
Res1
600
R4
50
L1
1uH
Q2
T1 NPN
IdealDiode.lib
R3
68
C6
1uF
Q3
T1 NPN
IdealDiode.lib
C4
1uF
Res2
2K
Res3
100
Res4
4
B1
5
C5
4.7pF
TPv1
R6
5K
R5
62
Vs1
DC: Volts undefined
AC: Volts 1.0 AC: Phase
Tran: Exp 0 to --0.1
Distort: Sine undefined
Title Injection Test BGA614
Number 1
CERN--LCD
Date February 15 2012
Size S
Sheet of
Rev
File: injection.Sch

Injection pulse

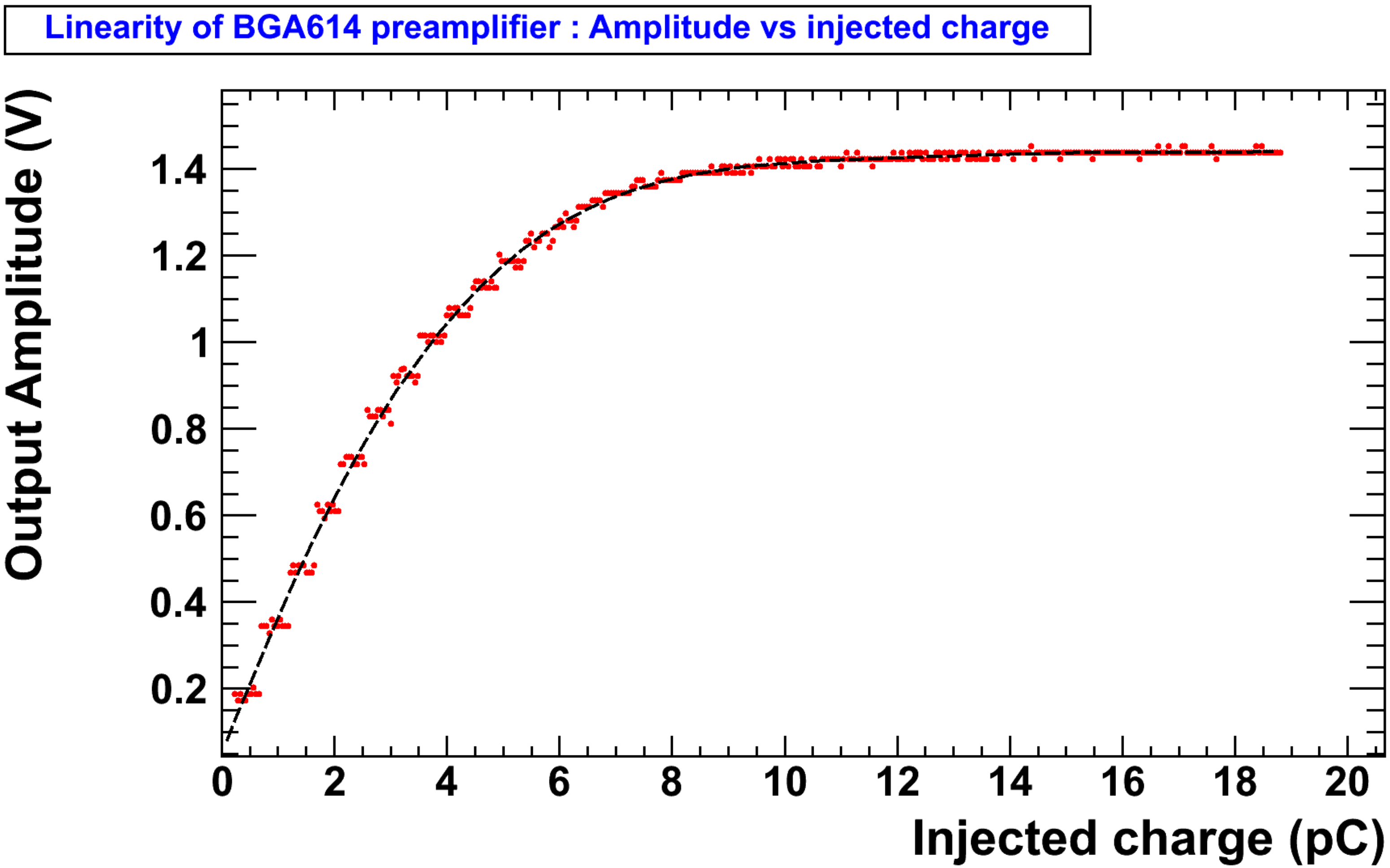
- 4.7pF +62 Ohm + Step (~2ns risetime)



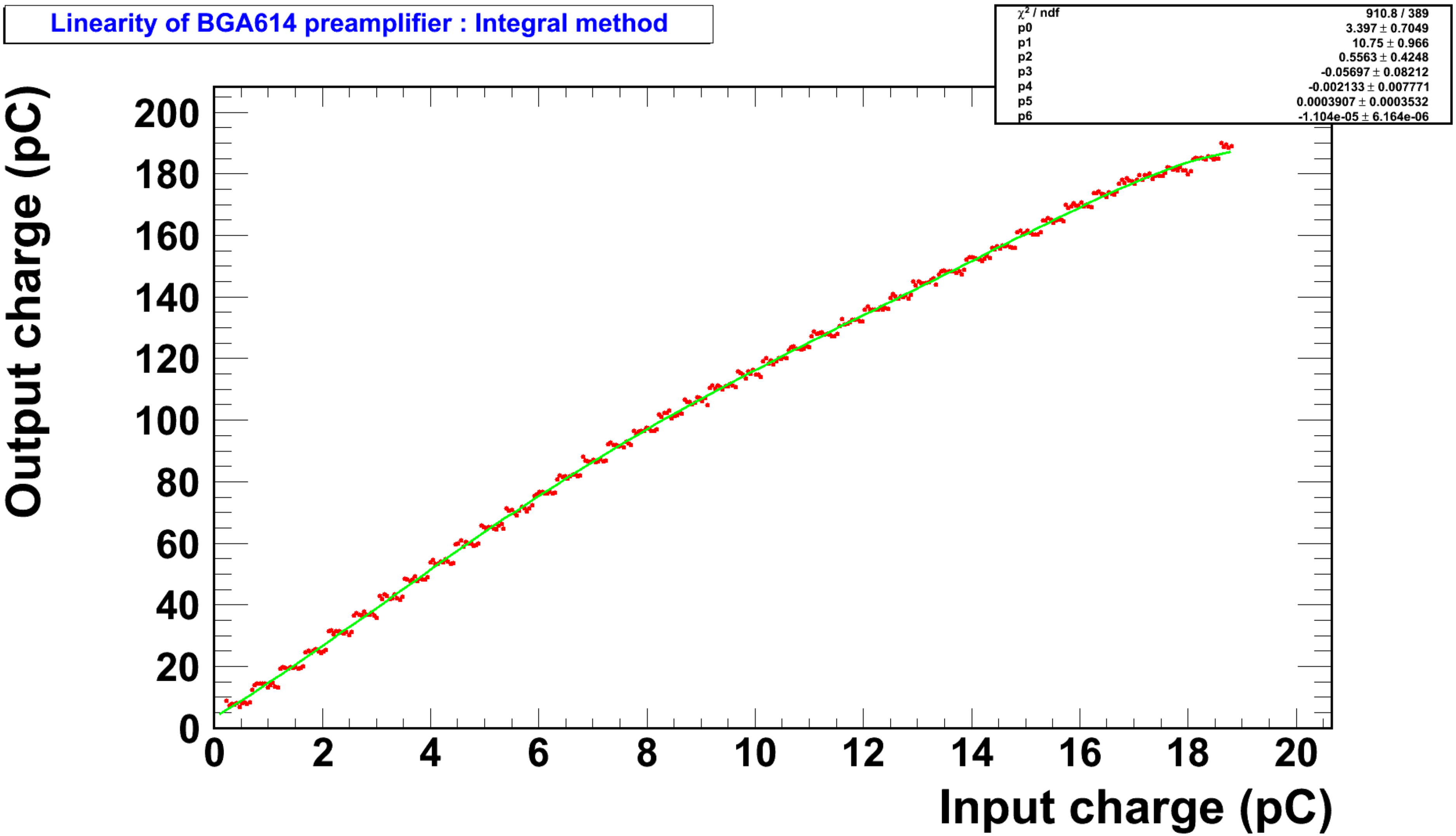
Typical pulse



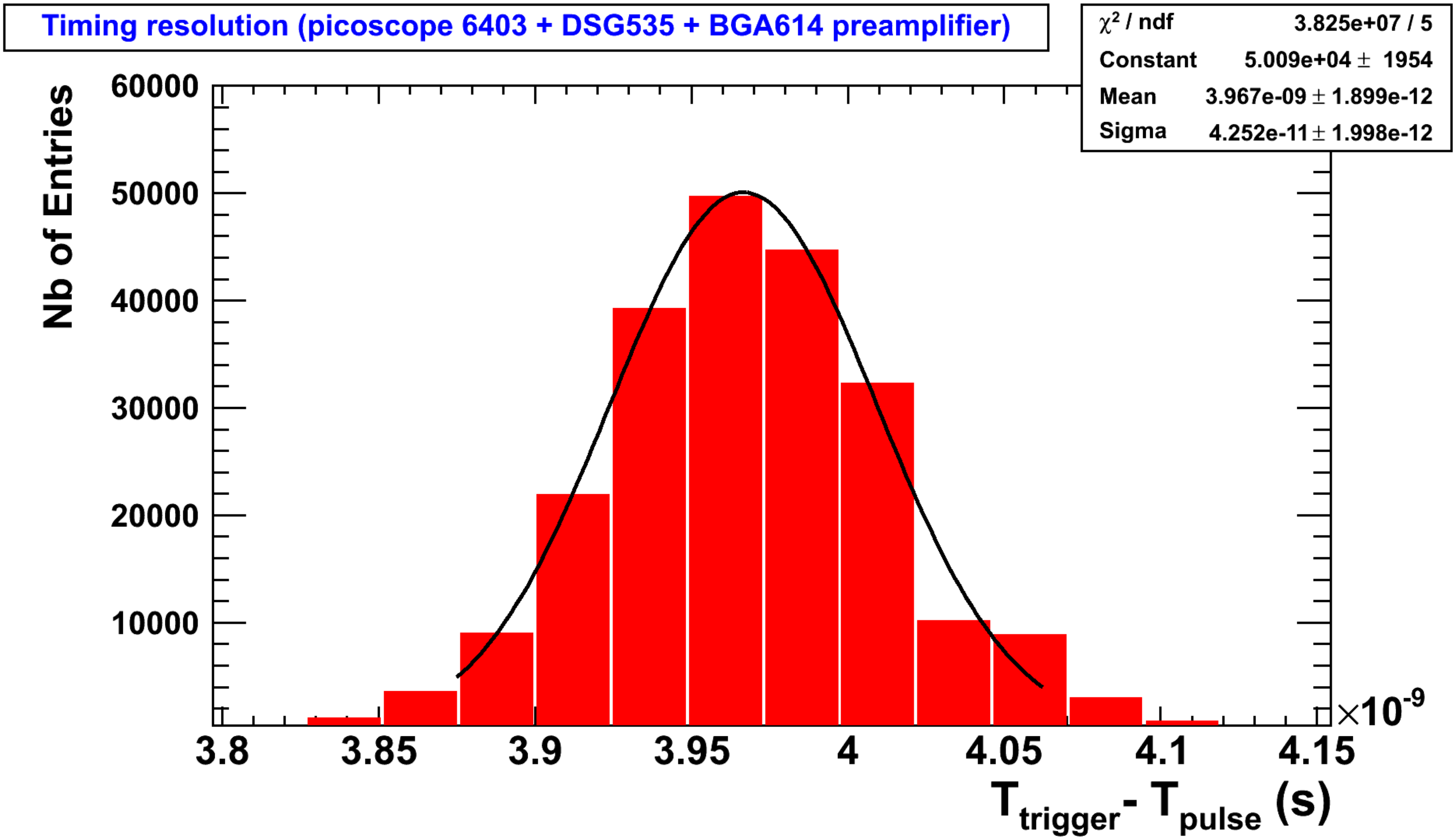
Linearity test : Amplitude vs injection charge



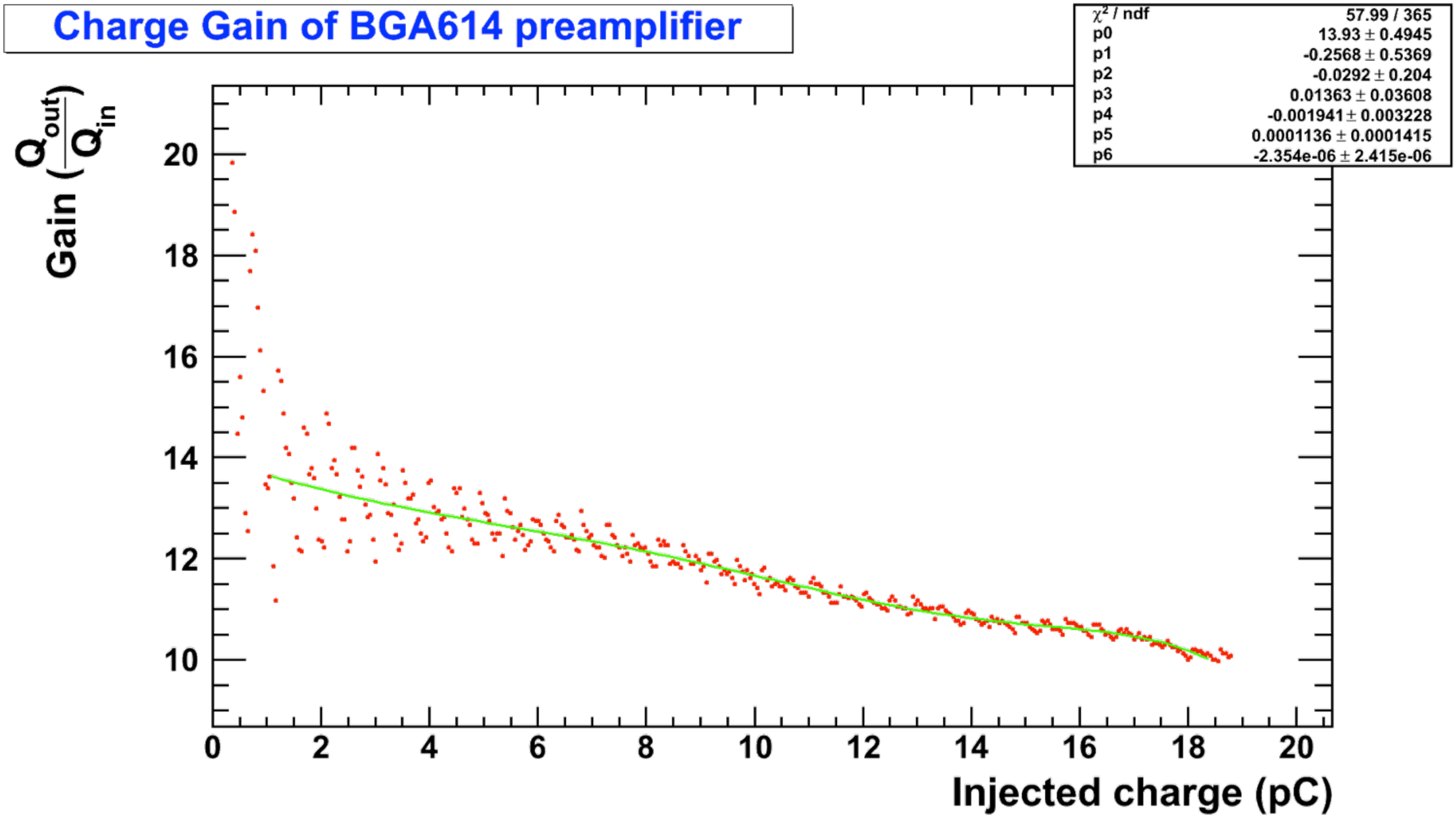
Linearity test : Output charge vs injection charge



Timing measurement



Gain



Charge Gain of BGA614 preamplifier
χ^2 / ndf 57.99 / 365
p0 13.93 ± 0.4945
p1 -0.2568 ± 0.5369
p2 -0.0292 ± 0.204
p3 0.01363 ± 0.03608
p4 -0.001941 ± 0.003228
p5 0.0001136 ± 0.0001415
p6 -2.354e-06 ± 2.415e-06
Gain ($\frac{Q_{out}}{Q_{in}}$)
20
18
16
14
12
10
0
2
4
6
8
10
12
14
16
18
20
Injected charge (pC)

Timing measurement with RPC readout test structure (BGA614-based amplifier)

Mathieu Benoit, Dominik Dannheim, Erik Van Der Kraaij

With the help of Liang Guan

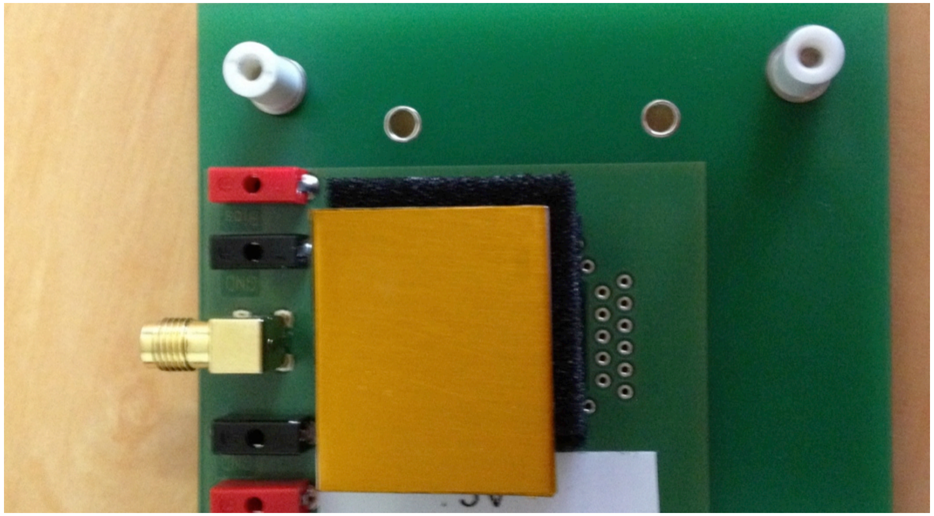
Introduction

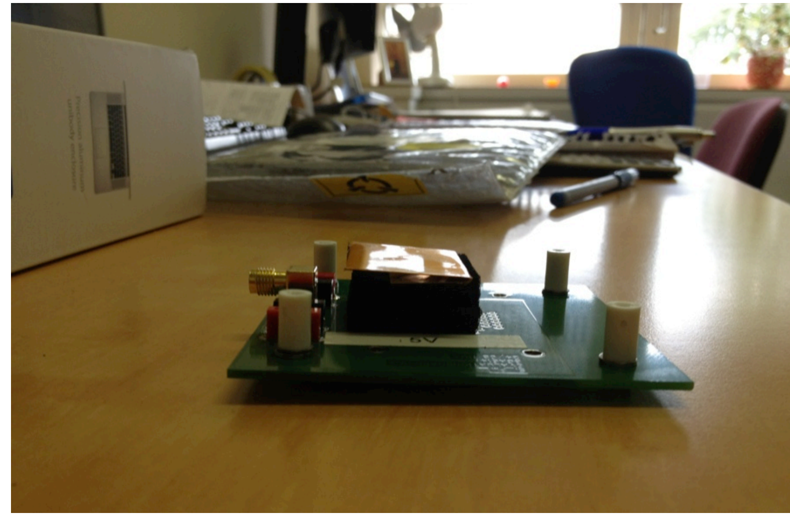
- Following promising results obtained in-lab with Munich T3B readout card, it was decided to do a test using a Glass RPC available at CERN
  - A pickup electrode and faraday cage were produced to perform the measurement on the bare RPC surface
  - 124 events collected in Coincidence with a scintillator trigger during the short test period

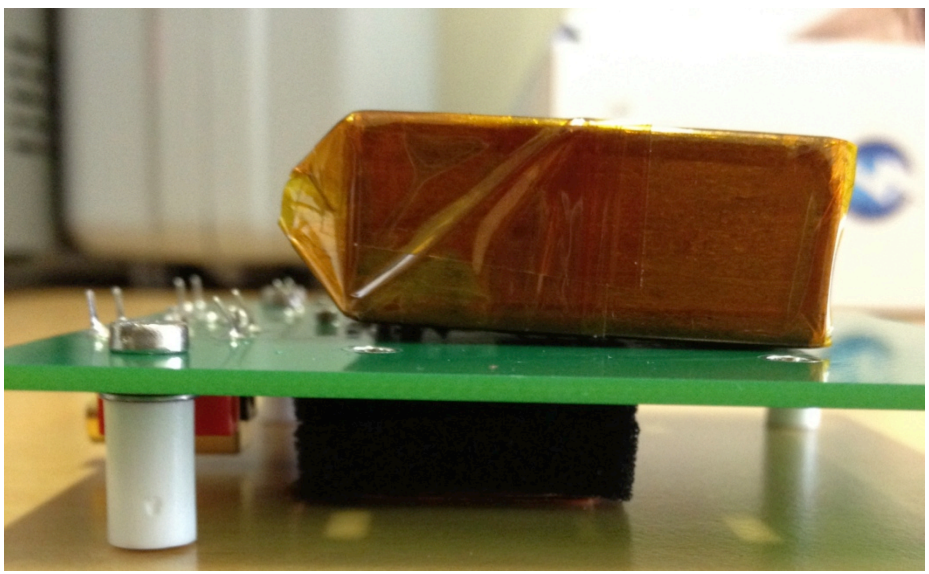
Pickup system prototype

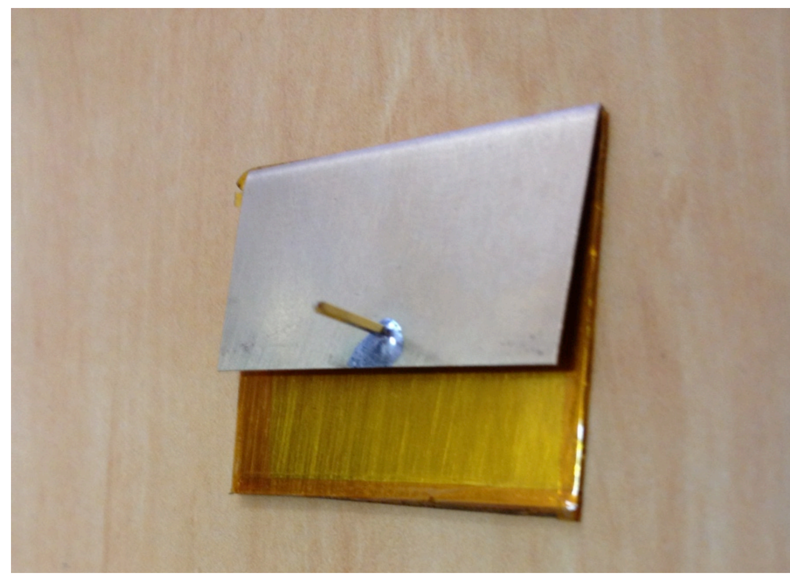
- Copper electrode (3.1 x 2.6 cm^2). Covered with 0.07mm thick kapton tape
- Nylon PCB holder
- ~164g stainless kapton covered weight to ensure electrode flatness on RPC surface
- Copper faraday cage to cover the system (not needed during tests !)

Pickup system prototype





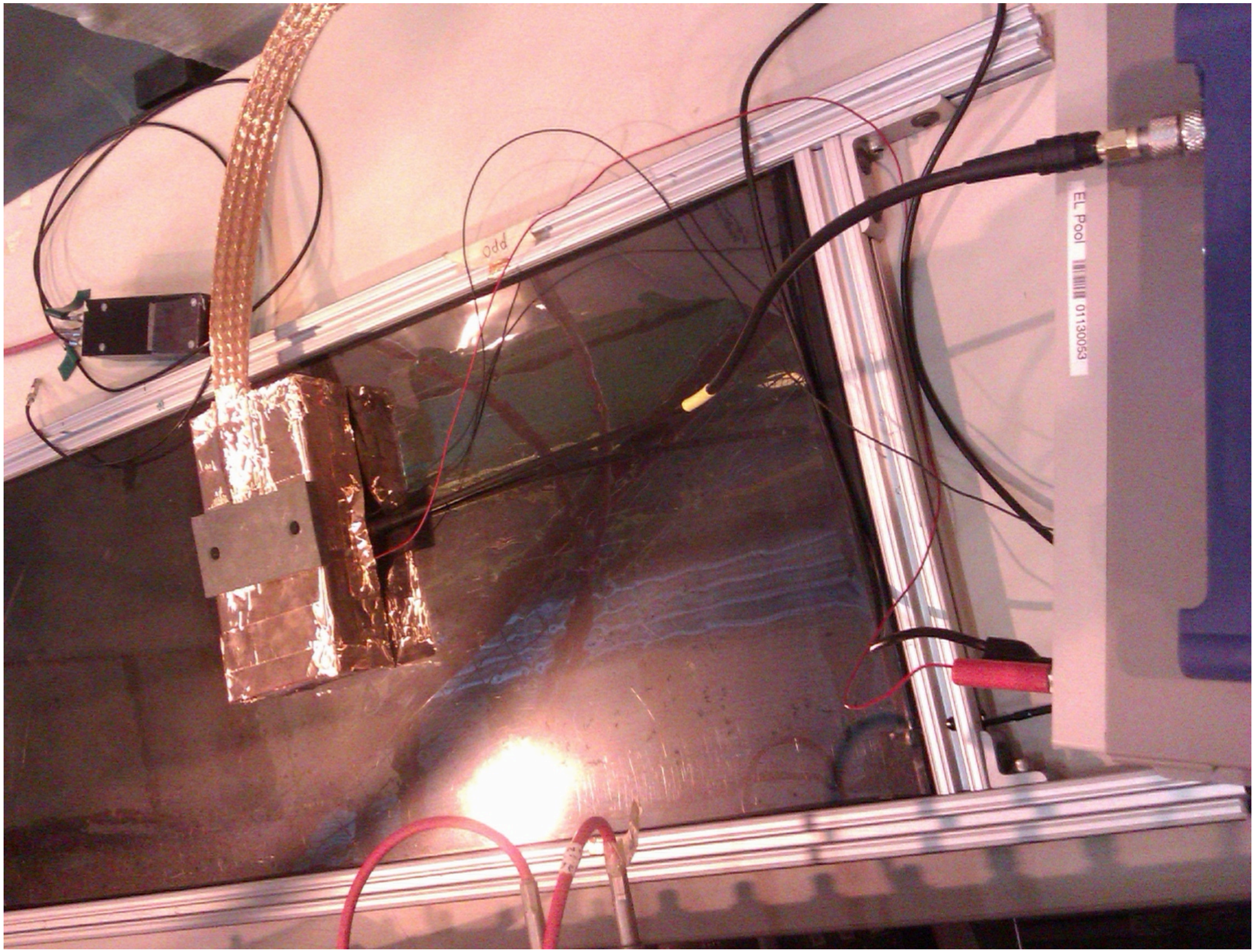




Test Conditions

- RPC from Argonne
  - Gas : 5% isobutane, 0.3% SF_6 , 94.7% tetrafluoroethane, ATLAS standard mixture
  - 7kV bias, leakage current of 80uA
- 2 2x2cm^2 plastic(?) scintillators + PM (850V)
  - PM2+scint was unreliable according to Liang, also seen during data taking (Noisy, less efficient ?)
  - Used only PM1 for analysis
- Cosmic beam (should $\approx$ 8.1 muon/min, E>1GeV)

Test in GIF facility on glass RPC



Preliminary observations

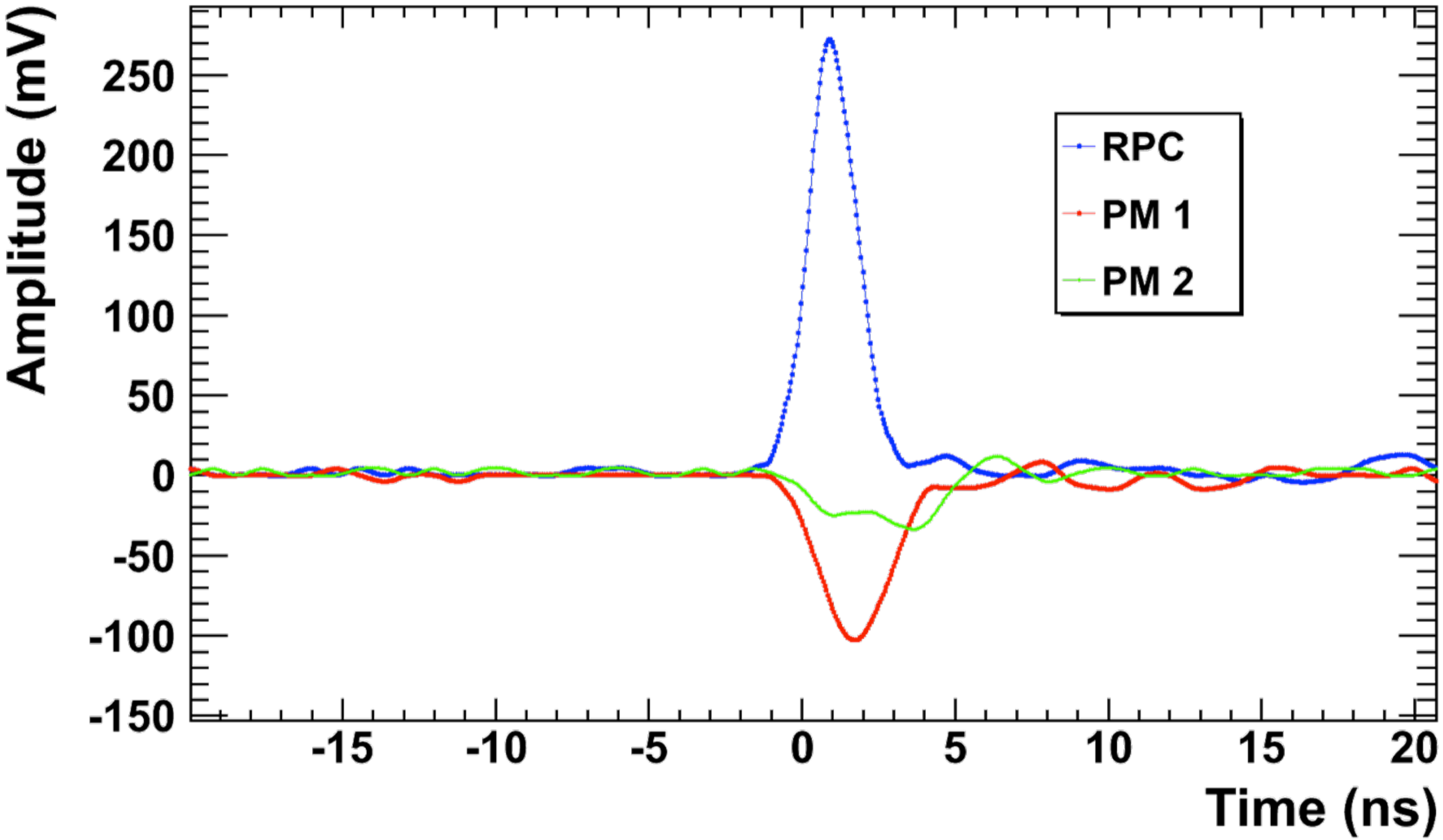
- As we ramp up bias voltage, we clearly see a onset point where pulses start showing up on the scope (~6kV)
- Rate is ≈ 1Hz
- We clearly see pulse coming from RPC, but are they cosmics ?
- Do we pick-up pulse from outside the pick-up electrode ?
- Time to perform test was very limited, our « source » very weak

Data Acquisition

- Trigger :
  - 50mV for RPC
  - -10mV for PM1 + scintillator
- « Run 0» : trigger on RPC 100mV, Auto mode, 1034 pulses
- « Run 1» : 11AM to 1:15PM : AND between PM1 and RPC , 64 pulses
- « Run 2» : ~1:15PM to 1:25PM, trigger only on PM1, 795 pulses
- « Run 3» : 1:30PM to 1:38PM, trigger only on RPC, 1090 pulses

- Run 2 and 3 contain together another 60 events with PM1 and RPC in coincidence

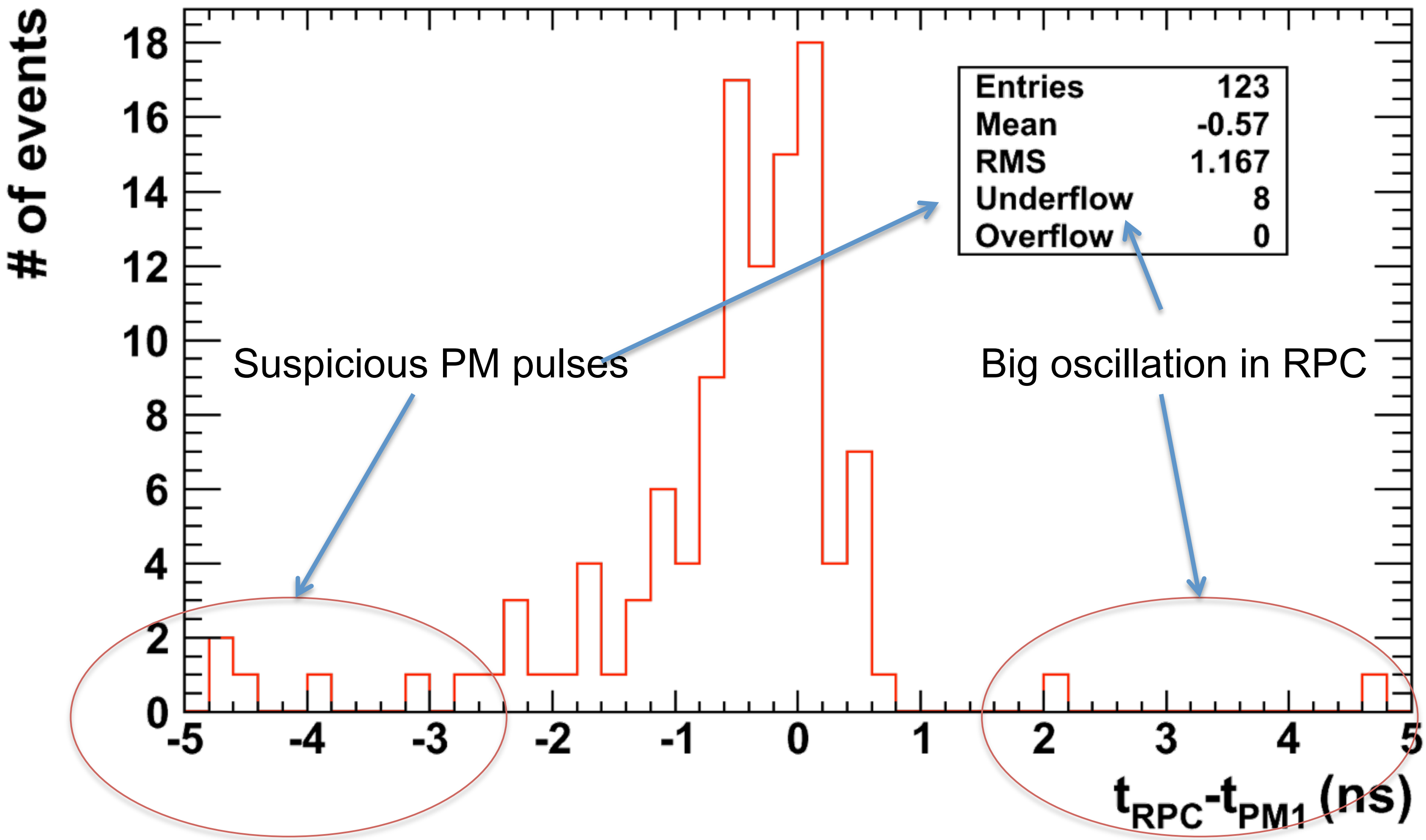
Typical « AND » pulse



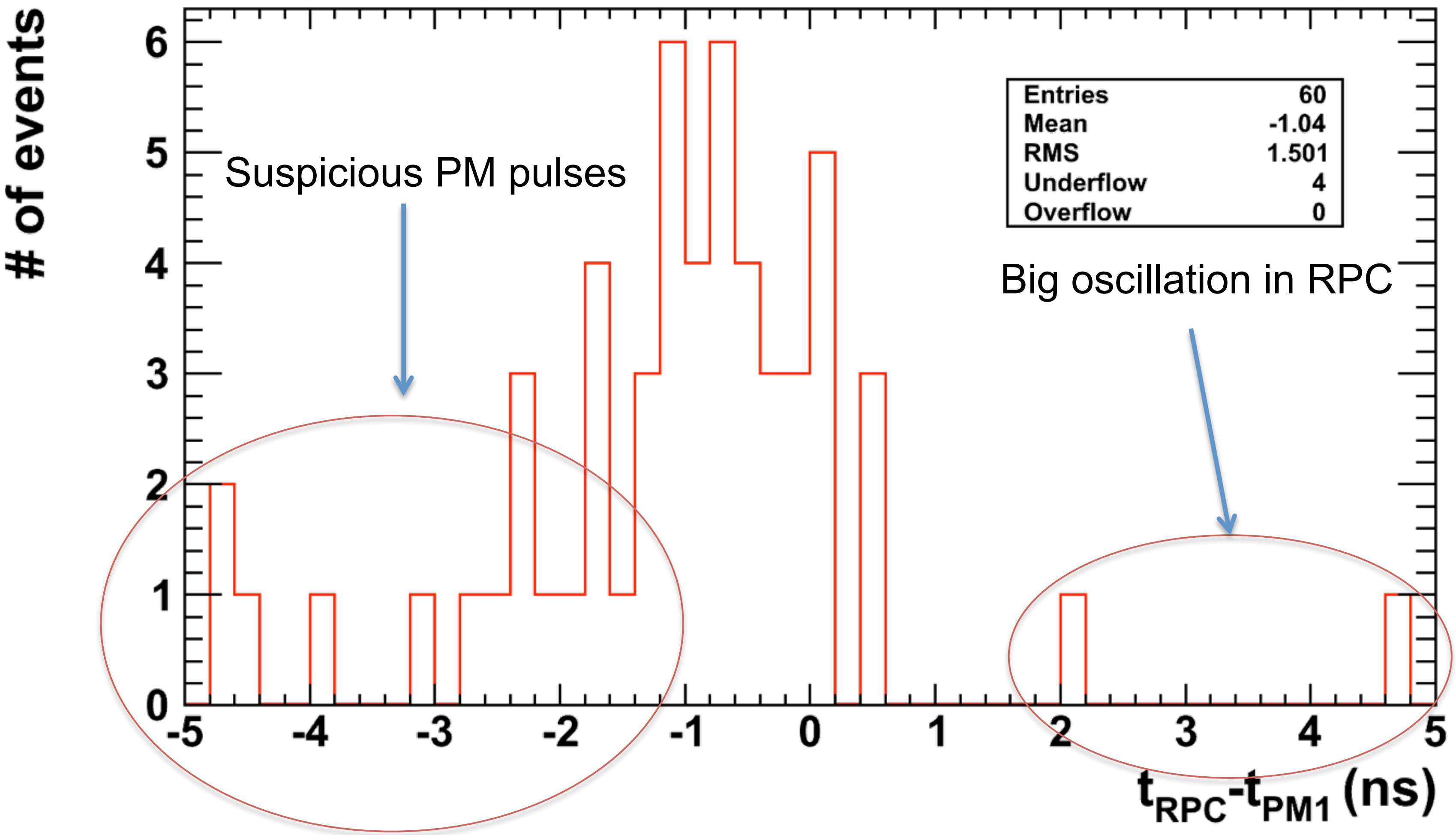
Timing measurement

- Timing measurement was done with all pulses where both PM1 and RPC cross the threshold
- An interpolation method was used to determine t_0 for each pulse
  1. find first i where V[i] over threshold
  2. Take V[i-10:i+10], fit a 4th order polynome ($a+bx+cx^2+dx^3+ex^4$)
  3. Find roots of $a+bx+cx^2+dx^3+ex^4$=Threshold (see formulas in backup)
     1. Discard imaginary roots
     2. keep the closest to Time[i]

Timing measurement (all pulses in coincidence)

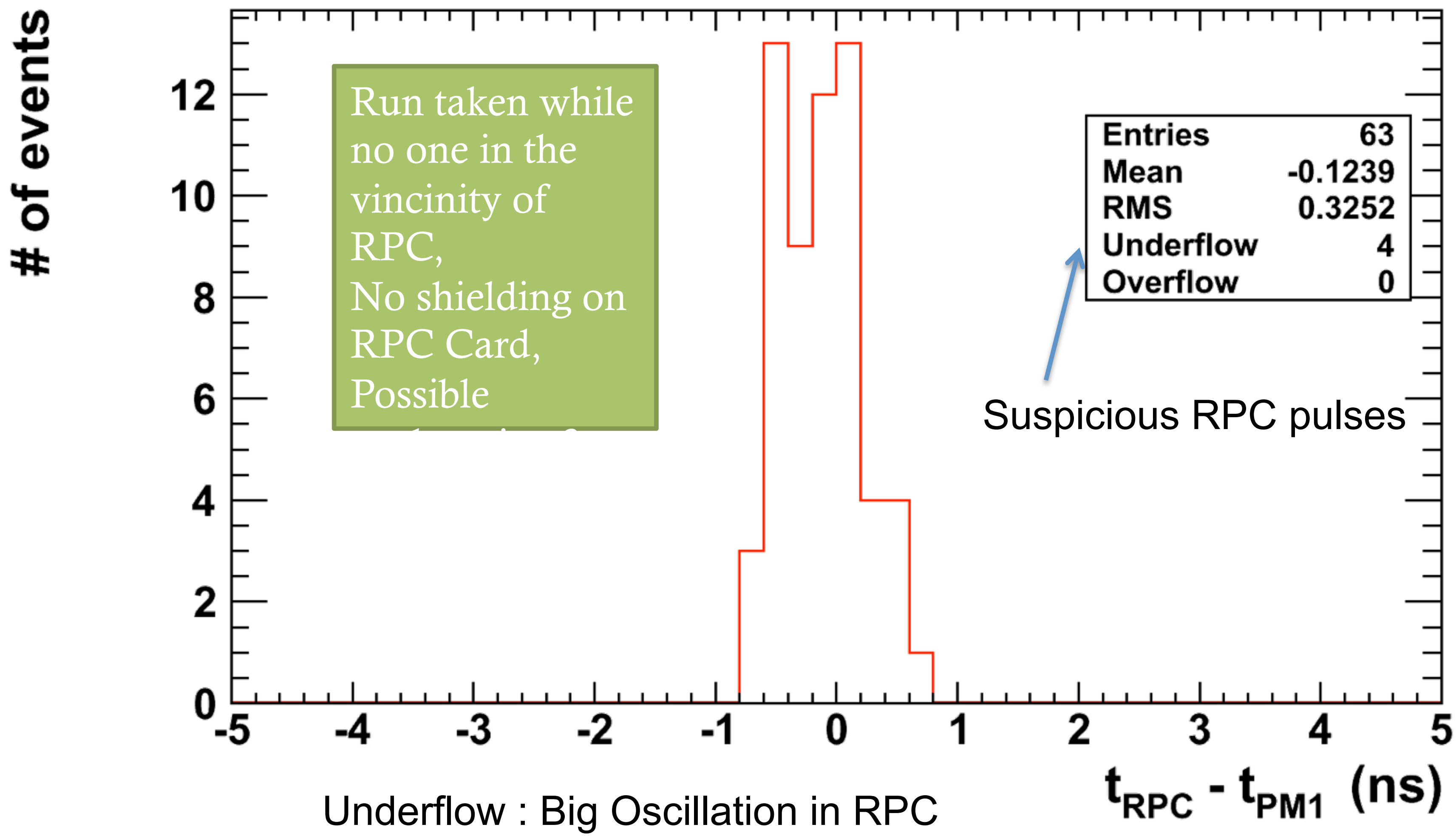


Timing measurement (run 0,2,3)

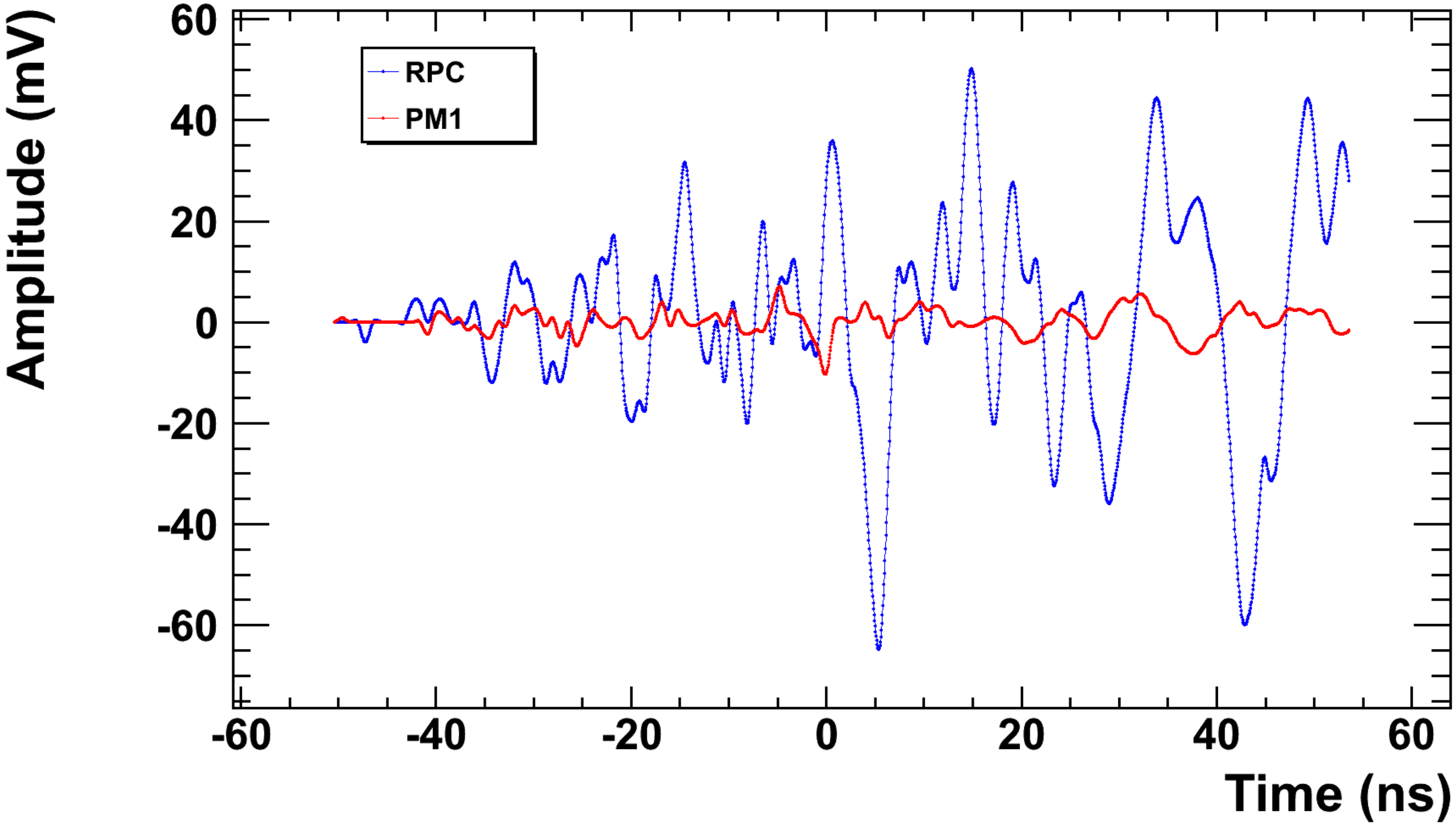


Underflow : 3PM and 1 RPC suspicious pulses

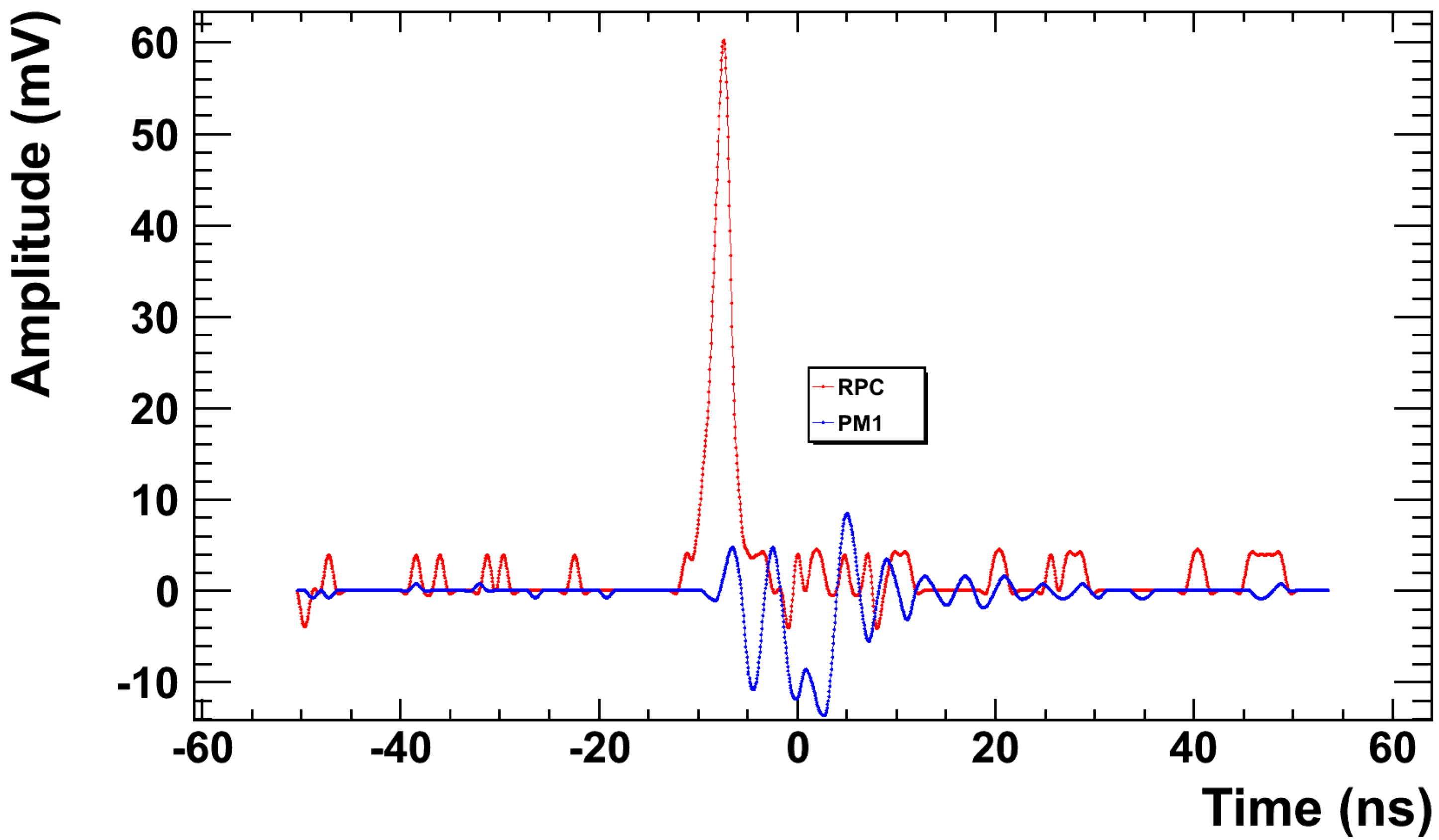
Timing measurement (run 1)



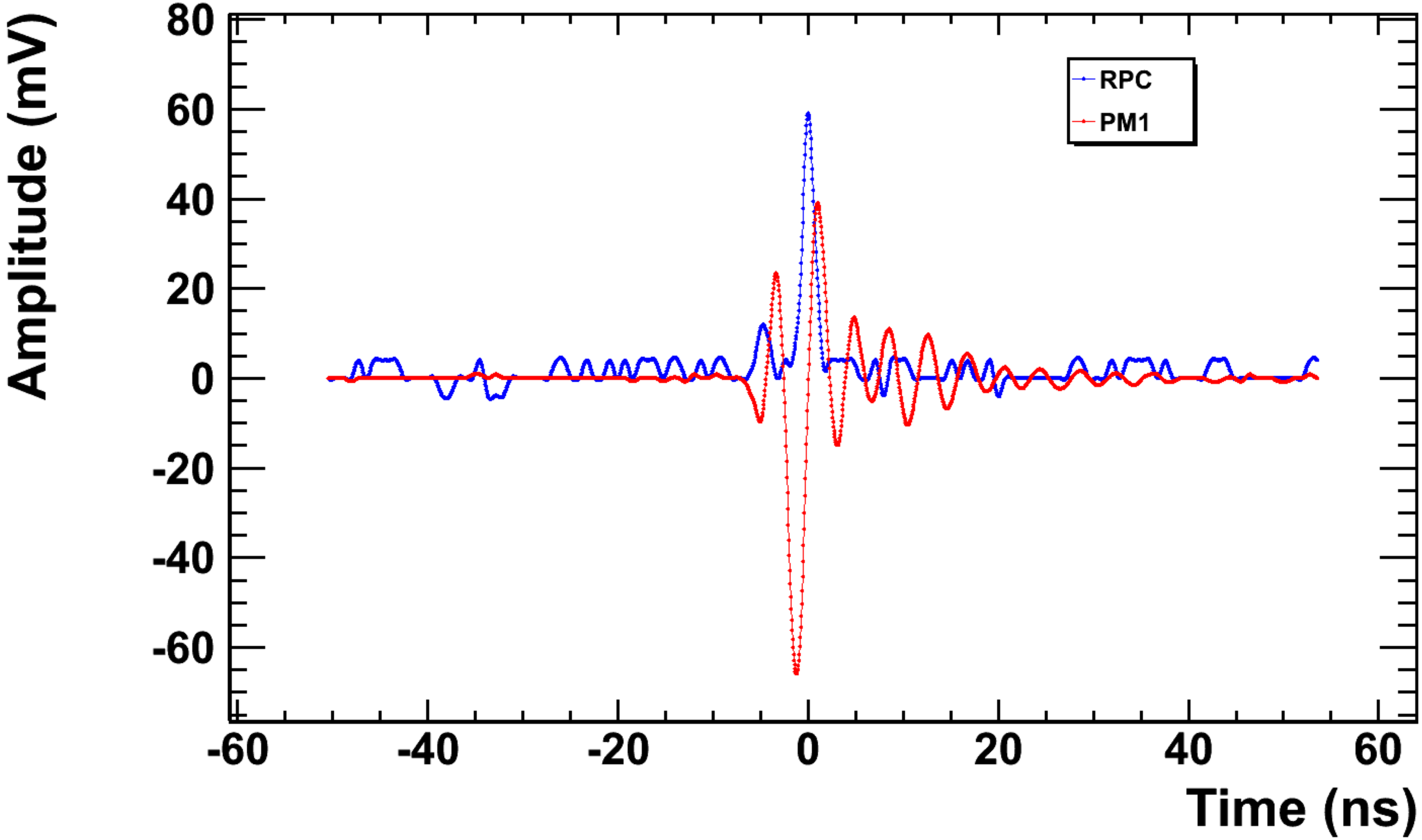
Suspicious pulses (RPC)



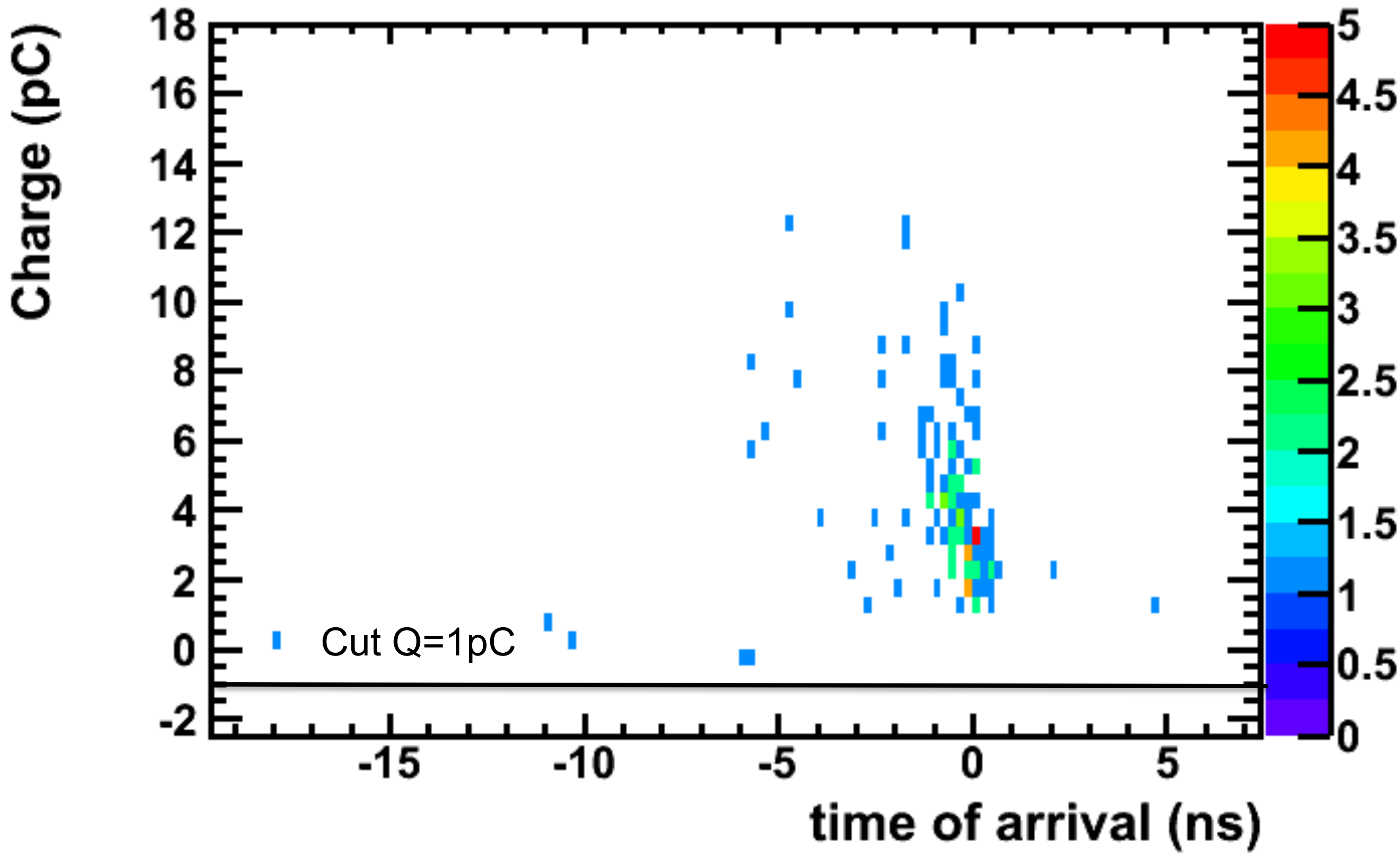
Suspicious pulses (PM1)



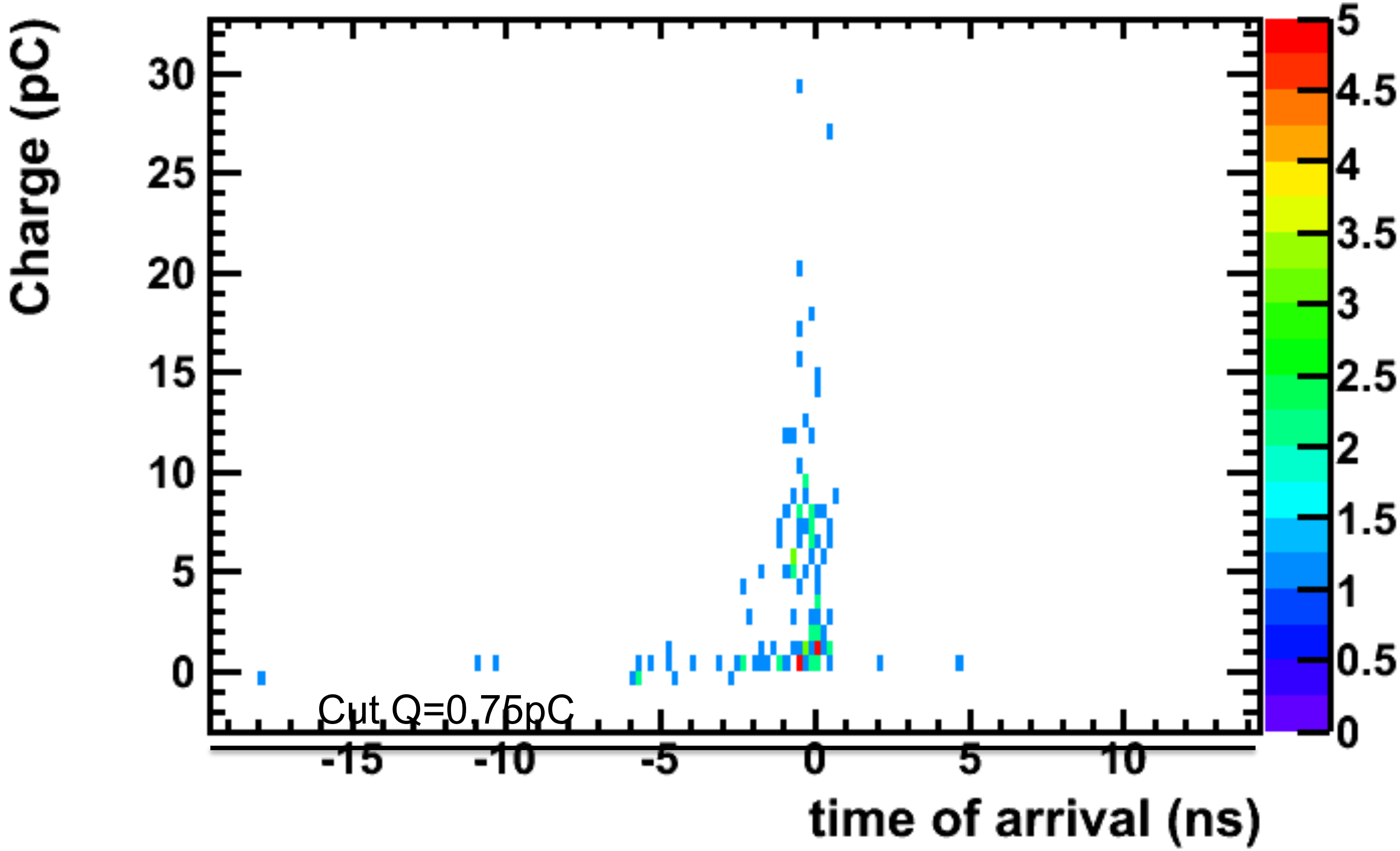
Suspicious pulses (PM1)



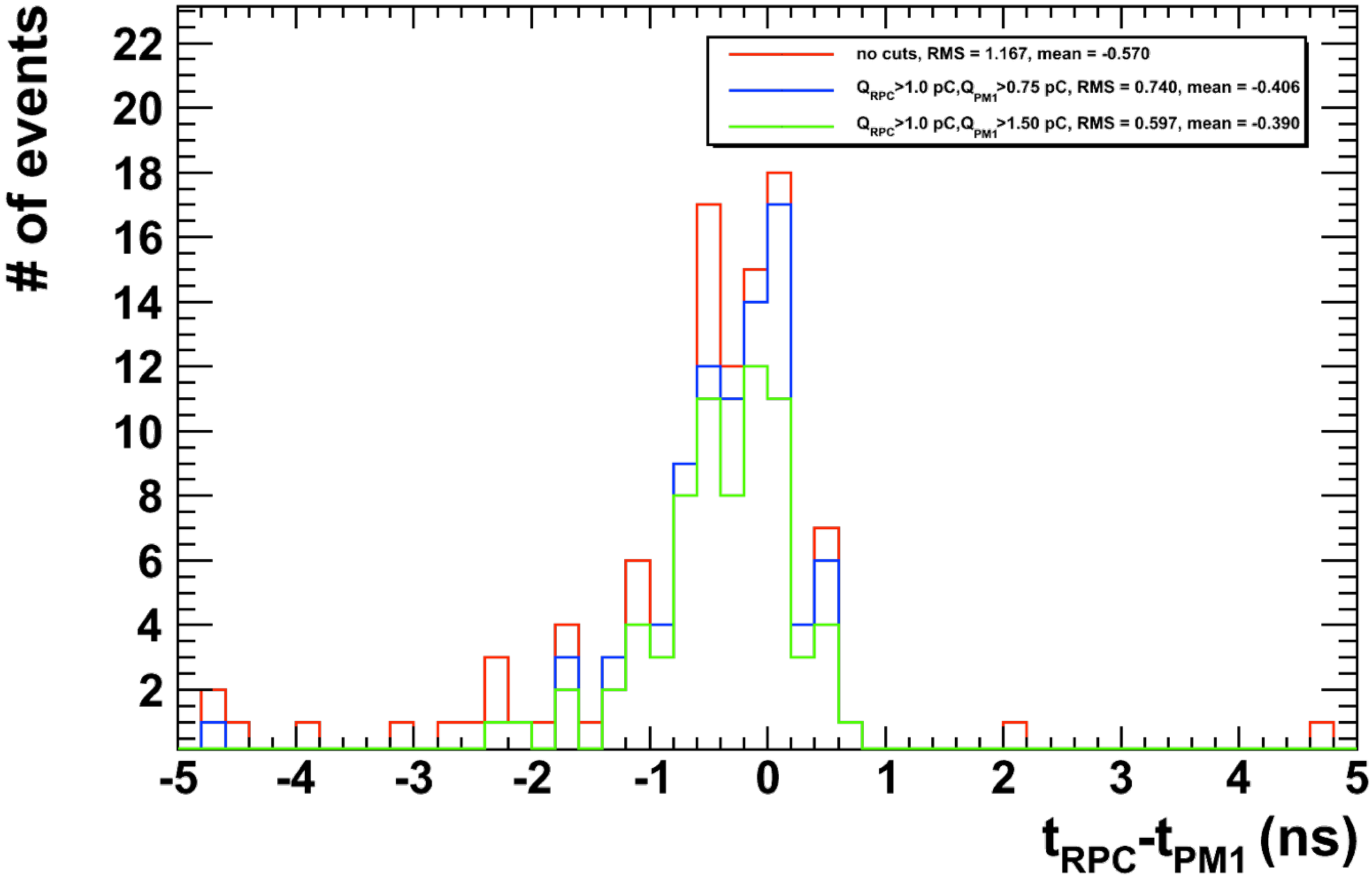
Charge versus delay (RPC)

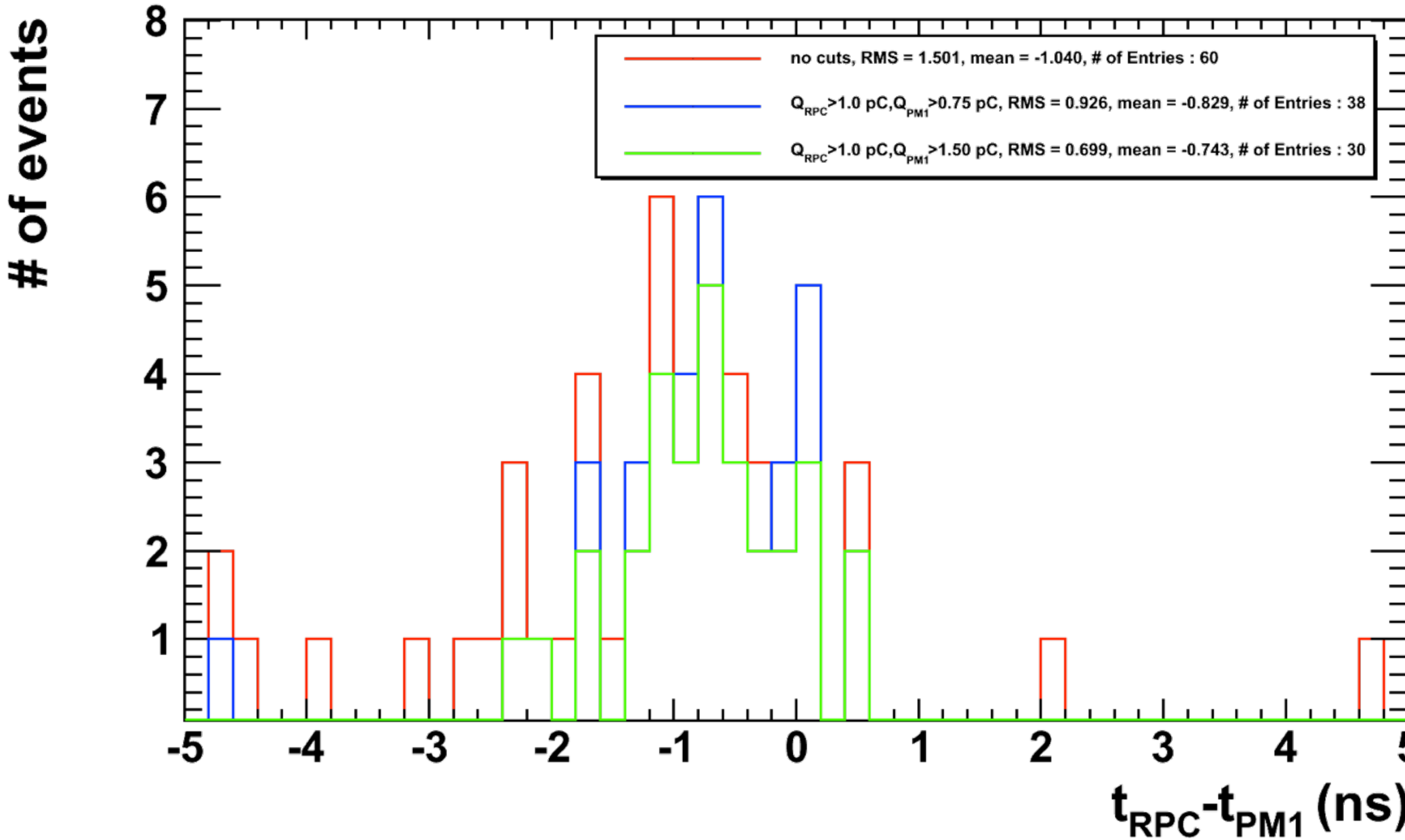


Charge versus delay (PM1)



Timing histogram, after cuts, all pulses in Coincidence





# of events
8
7
6
5
4
3
2
1
-5
-4
-3
-2
-1
0
1
2
3
4
5
t_{RPC}-t_{PM1} (ns)
no cuts, RMS = 1.501, mean = -1.040, # of Entries : 60
Q_{RPC}>1.0 pC,Q_{PM1}>0.75 pC, RMS = 0.926, mean = -0.829, # of Entries : 38
Q_{RPC}>1.0 pC,Q_{PM1}>1.50 pC, RMS = 0.699, mean = -0.743, # of Entries : 30

Conclusion

- RPC works well with BGA614 based amplifier
- Within statistical limit, we show a good timing resolution using the RPC , ≈O(1ns)
- Larger statistic, more well known scintillator and PM would be great to identify possible problem with the method
- Data and analysis available at : /afs/cern.ch/eng/clic/work/mbenoit/RPC_Timing_Analysis_2012