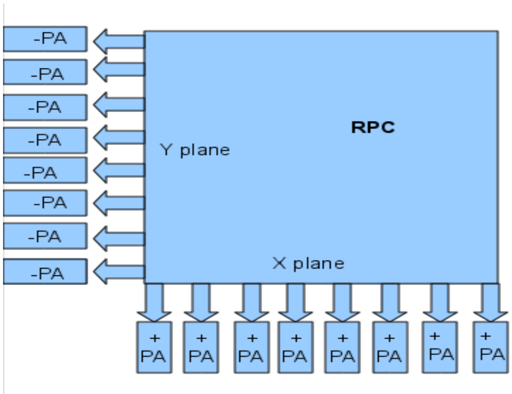
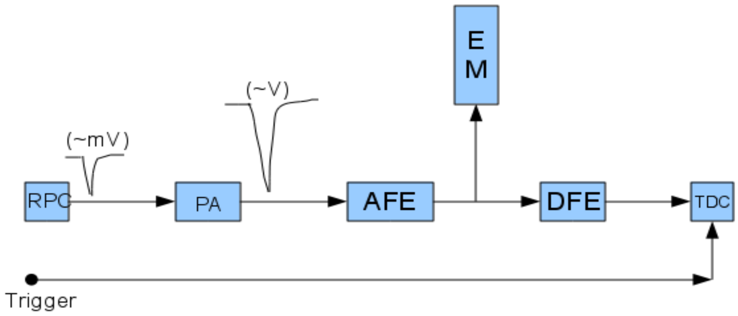
My first job in INO detector lab (C-217) was concerned with off-set measurement of different layers and strips corresponding to each of the layers.To see it,let me first start revising the basic circuit:

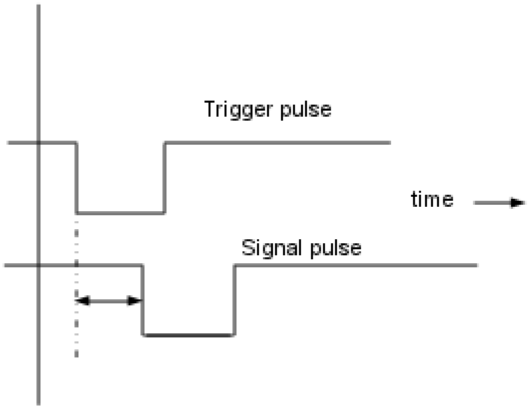
RPC system



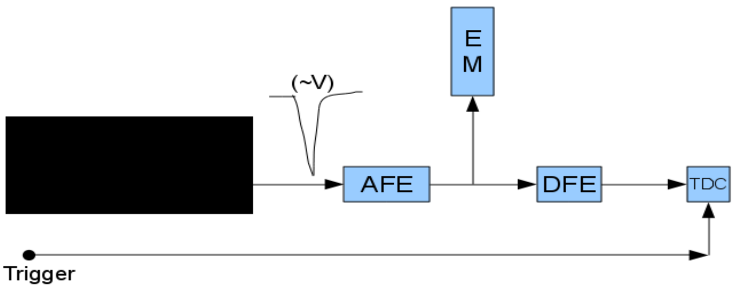
DAQ system: block diagram of the electronnic set-up



Another line of signal (called "trigger") goes to TDC and activates it so as to register the RPC signals.The trigger signal must reach TDC earlier than the signal which is made sure by adjusting the electronics.



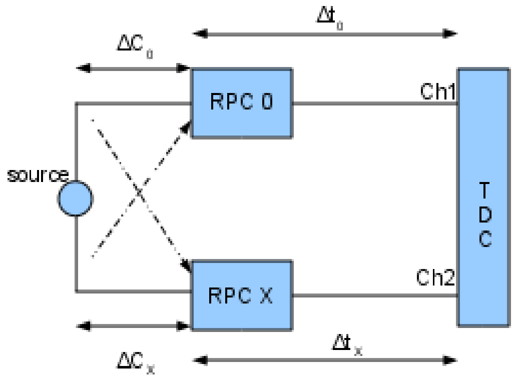
However,our work consists of measurement of the time delay off-set measurement of the cables starting from the output of the pre-amp to the TDC.We made the pre-amp boards unplugged from power supply and thus, RPC and PA were effectively out of our consideration.



The black box is to be replaced by a function generator (frequency can be changed).Two copies of the same signal are connected to two strips of RPC via two cables 1 and 2 coming from the discriminator (output) .Two cases may occur:

Stripwise measurement: Here,we connect one cable to a reference strip,say,31^{st} strip of 0^{th} layer.If

we wish to see stripwise variation of the n^{th} layer,we connect the other cable to m^{th} strip of n^{th} layer.And hence,change the value of m=0,1,2,...,31.
Layerwise Measurement: Here we connect one cable to a reference strip,say,31^{st} strip of 0^{th} layer.Then,we connect the other cable successively to the 31^{st} strip of the n^{th} layer.



Now,the length of cable1 and cable 2 are the same.Again,lengths of the cables from pre-amp o/p terminal to TDC is also the same~170 cm.Since,we are applying two copies of the signal at the same point (pre-amp o/p terminal) to TDC,it is expected that the signals (guided by the same trigger coming out from FAN OUT module)will reach the TDC at the same time instant.However,there are relative delays from strip to strip, and from layer to layer involved in the process.

Our off-set measurement is a means of calibration of these errors.This calibration help us to know the “zero errors of the system” and amend the results of the real experiments with proper additions and subtractions.

Our basic motivation is to determine the value of $\beta=(v/c)$.From the definition of velocity $v=dx/dt$, we can determine speed if distance is divided by the time elapsed to traverse the distance.In our case,we know the distace between the RPCs,say s meter.Clearly,the magnitude of the velocity is given as $v= s \cos\theta/\Delta t$. Since, time appears in the denominator,slight error in the measurement of time will result in large error in the value of β.Hence,we must be extremely careful in the time-response of the RPCs and the associated electronics.

Again,the timing information is also necessary to find out the direction from which the muon is coming;it is coming from upward or downward.All these considerations led us to find out the off-set characteristics of different RPC-cables.

Time at channel of TDC,Ch-1=Tdc[0]=getting time information from layer '0'.If we define,
$\Delta t=Tdc[0]-Tdc[1]=(\Delta C_0+\Delta t_0)-(\Delta C_X+\Delta t_X)=(\Delta C_0-\Delta C_X)+(\Delta t_0-\Delta t_X)$

$\Delta t_{swap}=Tdc[0]-Tdc[1]=(\Delta C_X+\Delta t_0)-(\Delta C_0+\Delta t_X)=(\Delta C_X-\Delta C_0)+(\Delta t_0-\Delta t_X)$

Then,$(\Delta t_0-\Delta t_X)=1/2*[\Delta t+\Delta t_{swap}]$

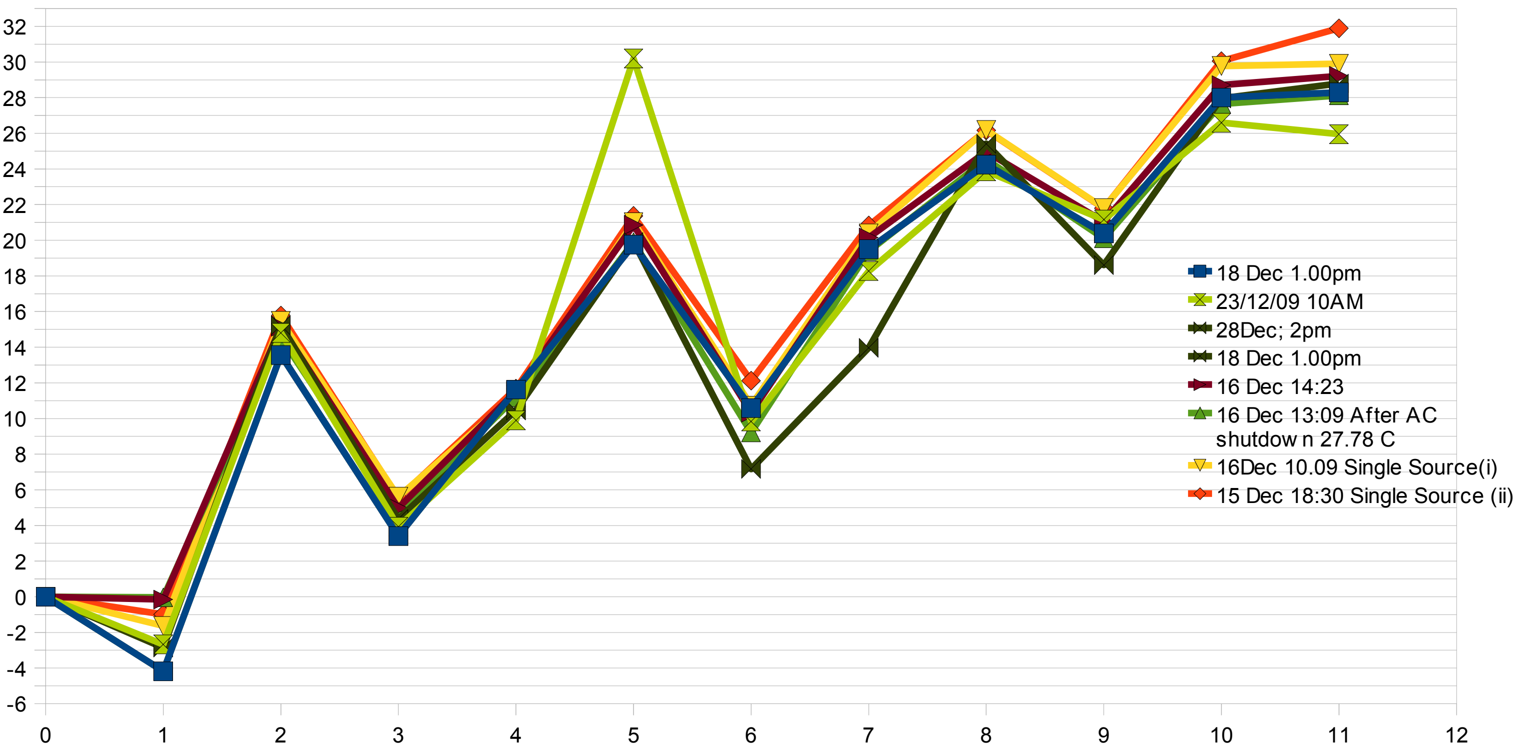
Pulse Generator information:

- frequency 1kHz;
- width 400 ns

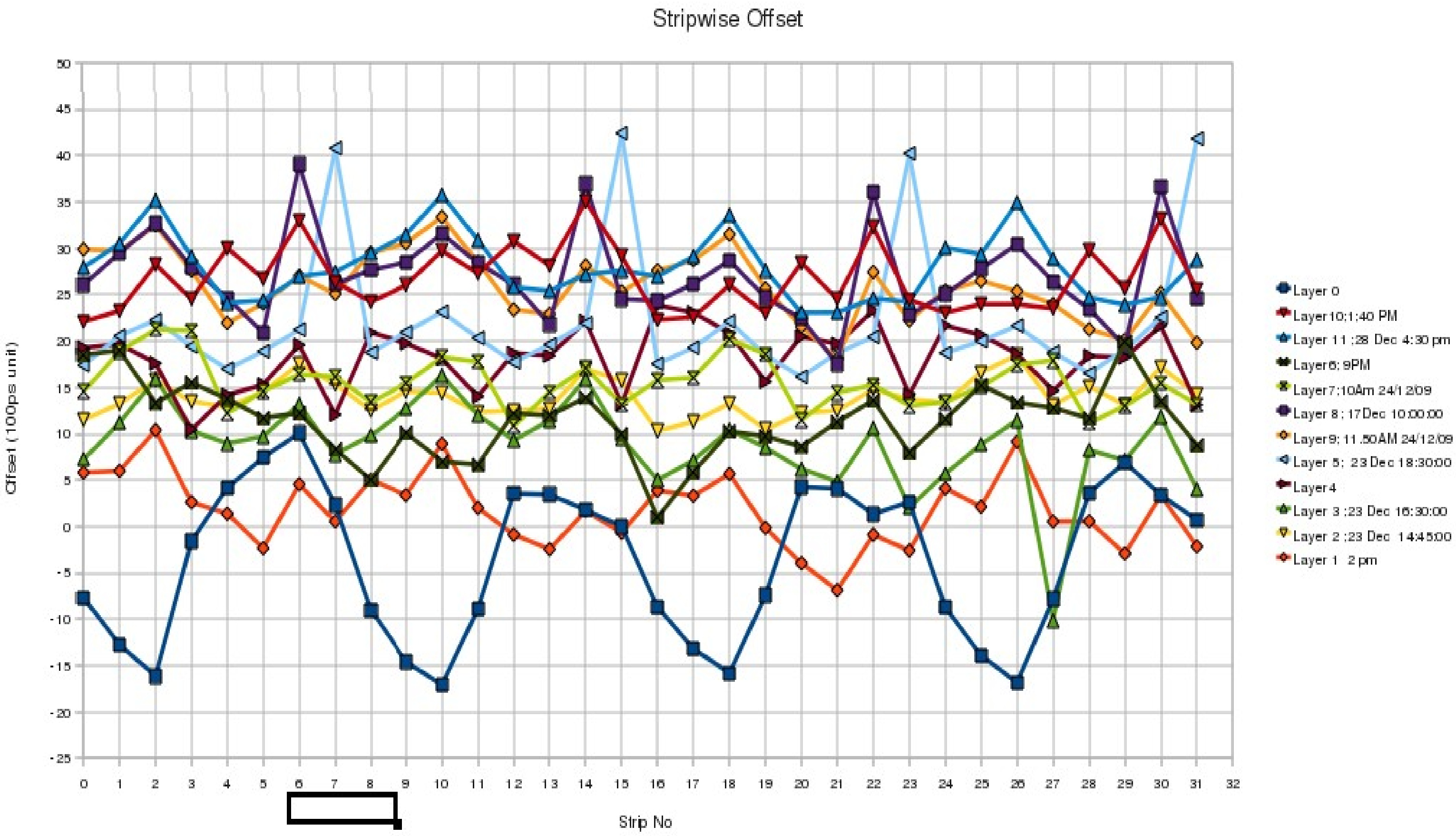
Cable Attachment Information:

- Cable A3=cable 1,fixed at 1^{st} layer 31^{st} strip.This is the signal to be compared with.
- Cable A6=cable 2,varying across the strips of 0^{th} layer.

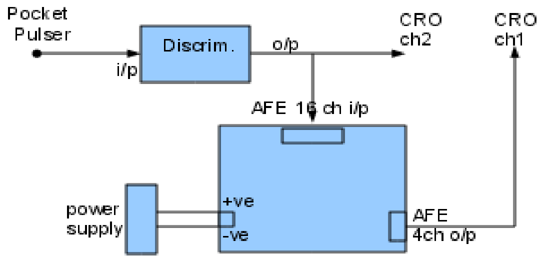
<u>Result of layer-wise off-set measurement:</u>



<u>Result of strip-wise off-set measurement:</u>



Then,we tested the AFE board according as the circuit below: (17,22).



17/12/2009

Input	t_1(ps)	t_2(ns)	Δt(ns)	Average(ns)
1	-152	15.63	15.78	
2	-152	15.63	15.78	15.84
3	-152	15.76	15.91	
4	-152	15.73	15.91	

Input	t_1(ps)	t_2(ns)	Δt(ns)	Average(ns)
1	-152	15.48	15.63	
2	-152	15.44	15.59	15.65
3	-152	15.55	15.7	
4	-152	15.52	15.68	

Input	t_1(ps)	t_2(ns)	Δt(ns)	Average(ns)
1	-152	15.04	15.19	
2	-152	15.11	15.26	15.26
3	-152	15.19	15.34	
4	-152	15.13	15.28	

Input	t_1(ps)	t_2(ns)	Δt(ns)	Average(ns)
1	-152	15.12	15.28	
2	-152	15.15	15.31	15.39
3	-152	15.39	15.54	
4	-152	15.29	15.44	

22/12/2009

AFE board 056 (8^{th} layer); t_1 & t_2 refers to ch.1 ch.2 respecively.

Input	t_2(ns)	t_1(ns)	Δt(ns)	Average(ns)
1	1.12	16	-14.88	
2	1.12	16	-14.88	-14.88
3	1.12	16	-14.88	
4	1.12	16	-14.88	

Input	t_2(ns)	t_1(ns)	Δt(ns)	Average(ns)
1	1.12	16.48	-15.36	
2	1.12	16.56	-15.44	-15.38
3	1.12	16.48	-15.36	
4	1.12	16.48	-15.36	

Input	t_2(ns)	t_1(ns)	Δt(ns)	Average(ns)
1	1.12	17.36	-16.24	
2	1.12	17.36	-16.24	-16.24
3	1.12	17.36	-16.24	
4	1.12	17.36	-16.24	

Input	t_2(ns)	t_1(ns)	Δt(ns)	Average(ns)
1	1.12	11.6	-10.48	
2	1.12	11.6	-10.48	-10.48
3	1.12	11.6	-10.48	
4	1.12	11.6	-10.48	

AFE 054 (8^{th} layer)

Input	t_1(ns)	t_2(ps)	Δt(ns)	Average(ns)
1	16	480	-15.52	
2	16	480	-15.52	-15.52
3	16	480	-15.52	
4	16	480	-15.52	

Input	t_1(ns)	t_2(ps)	Δt(ns)	Average(ns)
1	15.68	480	-15.2	
2	15.68	480	-15.2	-15.2
3	15.68	480	-15.2	
4	15.68	480	-15.2	

Input	t_1(ns)	t_2(ps)	Δt(ns)	Average(ns)
1	15.52	480	-15.04	
2	15.6	480	-15.12	-15.12
3	15.6	480	-15.12	
4	15.68	480	-15.2	

Input	t_1(ns)	t_2(ps)	Δt(ns)	Average(ns)
1	14.08	480	-13.6	
2	14.08	480	-13.6	-15.56
3	14	480	-13.52	
4	14	480	-13.52	