UNIFORMITY STUDY OF INO-ICAL'S RESISTIVE PLATE CHAMBER

Final Report Submitted Under the guidance of

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by

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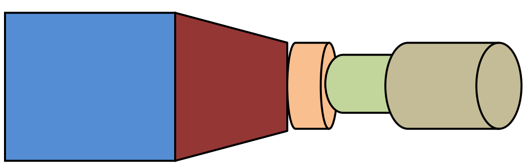
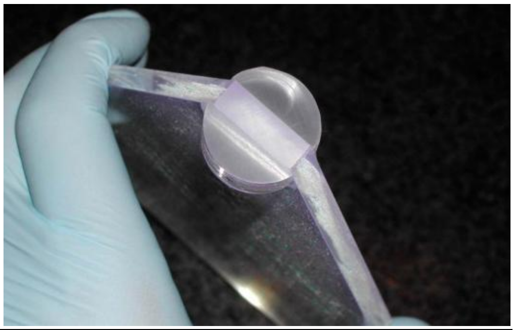
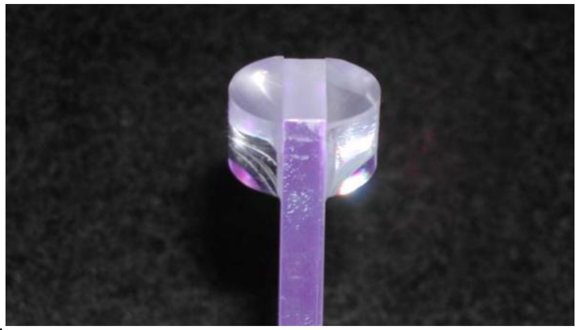
INTRODUCTION

As a part of summer internship ,at tata institute of fundamental research ,my project is to measure the uniformity in effficiency of ino icals's resistive plate chamber. Resistive plate chambers are a type of particle detectors used to detect the high energy particle with high timme resolution and greater efficiency. But there is a chance that all the part of the RPC does not show same efficiency, there can be some variation and my aim is to find the uniformity in the efficiency of the RPC.The variation in the efficiency may be due to several reasons, lack of uniformity in the spreading of the gas, impurities in the gas etc.. This project includes the construction of plastic scintillators, measuring its efficiency and plateauing it. Here we are constructing two plastic scintillators. Then mounting them on the RPC then measuring the efficiency at different zones of RPC by scannig it all along the RPC. The paddle that we are constructing is a 10*10 cm paddle. Using this the whole area of RPC is scanned and efficiency of each zone is measured. This project also includes some programming part that is to to plot the zonal efficiency of RPC at different parts of RPC and also program should b developed to extract data stored in root files.

SCINTILLATORS



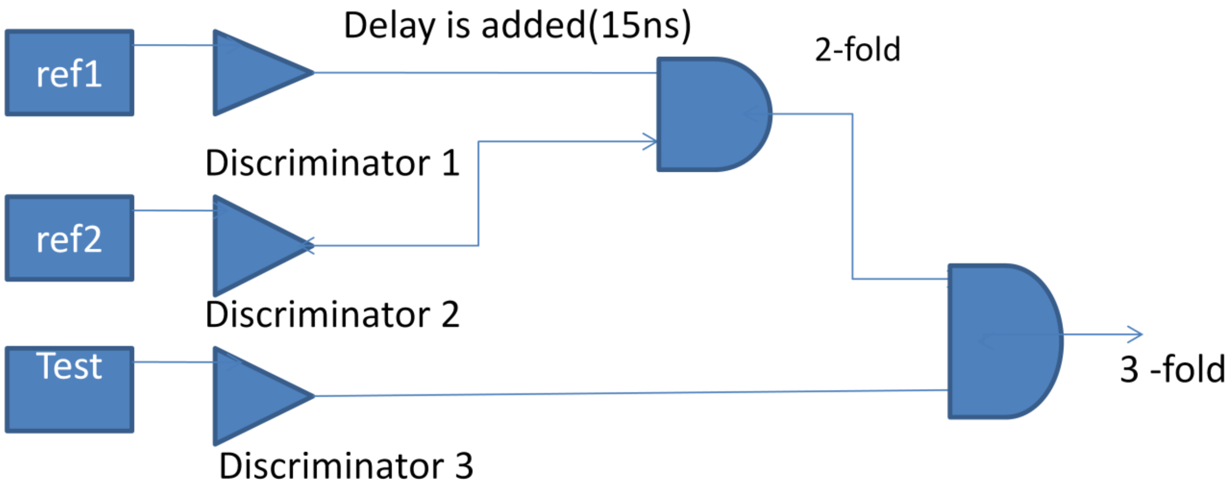
The given above is the schematic diagram of a plastic scintillator telescope. The main reason for using plastic scintillator telescoope in our experiment is due to the ease in manufacturing compared to otherr type of scintillators.First the scintillator material is cut into the desirable shape, for our purpose a 10cm *10cm square peice is sufficient. Then we will attach scintillator to a light guide using optical glue. A cookie is attached to the end of the scintillator (the end that will be joined with the photomultiplier tube) using the same optical glueThey fill in the extra space not taken by the scintillator end on the photomultiplier. Cookies are helpful only as we are planning to glue the scintillator to the photomultiplier; they provide a broader gluing surface.

In order for the very faint flashes of light from cosmic rays to reach the photomul tiplier tube, the interface between the tube and scintillator end as well as the other edges must be very transparent. For that reason, the scintillator edges , light guide edges and cookie must be polished. Then the scintillator is wrapped with thick black paper along with PMT[1]. Wrapping the scintillator paddle with opaque materials ensures that the photomul tiplier tube detects only the flashes of light produced by cosmic rays. Also, wrapping the scintillator with the photomultiplier provides mechanical support. For wrapping the scintillator is placed in the center of the foil and neatly fold [11]the foil over the surfaces and edges of the scintillator,tightly,with a white paper inside and thick black paper outside. Then the whole set up is again wrapped tightly using a black tape. Instead of light guides we earlier used optical fibres to carry light from the scintillator to the PMT. While measuring the efficiency we found that the efficiency is very low. So we replaced optical fibres with light guides.

<u>Circuit Diagram:</u>

1 PMT(Photo Multipliertube) convets phtons emitted by the paddle into elctric signals using a photo cathode through photo electric effect initially. Then this electric signal is amplified by a series to electrodes called dynodes. After that this it is fed to a voltage divider circuit



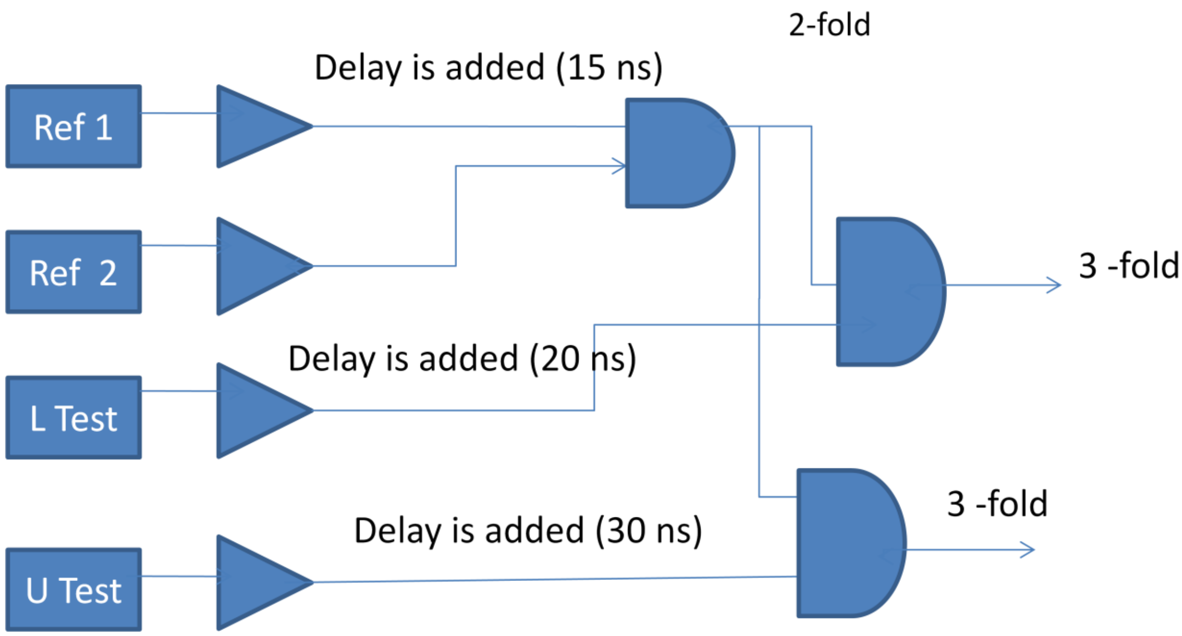
We calculate the efficiency of the paddle that we made by keeping it between two paddles. The two paddles between which the test paddle is kept is generally known as reference paddles. The circuit diagram of the method to calculate efficiency is given above. The analog signal from the reference paddle is passed to a discriminator(sixteen channel,Philips scientific discriminator) and passed to a logic AND gate. This will give us 2 fold. Now we will discriminate the signal from the test paddle and this discriminated signal and the 2 fold signal is again passed to a logic AND gate. This will give us 3 fold. Thus efficiency is given by

Efficiency= (3fold/2fold)*100

Actually when we used optical fibres to carry light from scintillator to PMT the efficiency was too low then we replaced optical fibre with light guides then we got a very good efficiency.

Plateauing of a scintillator

Circuit Diagram:



Threshold for all the paddles were set as -25 mV

The procedure of finding the operating point of two test paddles is almost same as that of calculating efficiency. Here we will find the efficiency of both the paddles and find out the region where the efficiency of two paddles are not very much sensitive to the change in voltage. The values that we got are

Lower test paddle

Voltage	Time(s)	1 fold	2 fold	3 fold	efficiency
1	3600	17	432	5	1.15
1.1	9000	493	1160	29	2.5
1.2	9000	6367	1198	428	35.72
1.3	9000	27109	1151	1020	88.6
1.4	9000	58966	1158	1039	89.72
1.5	9000	100671	1171	1041	88.89
1.6	9000	159443	1131	1010	89.3
1.7	9000	245646	1189	1067	89.7
1.8	9000	369498	1100	994	90.36
1.9	5400	906574	699	632	90.41

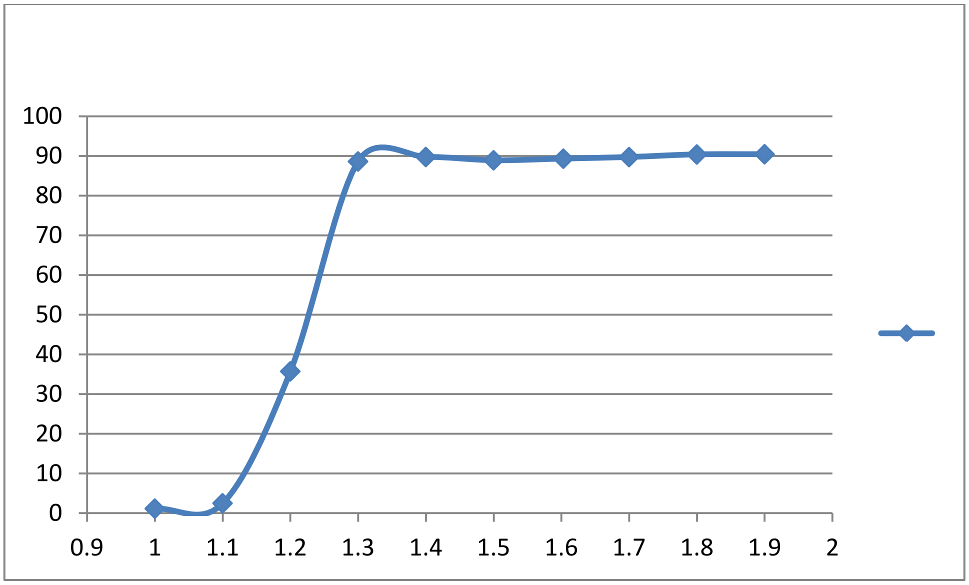


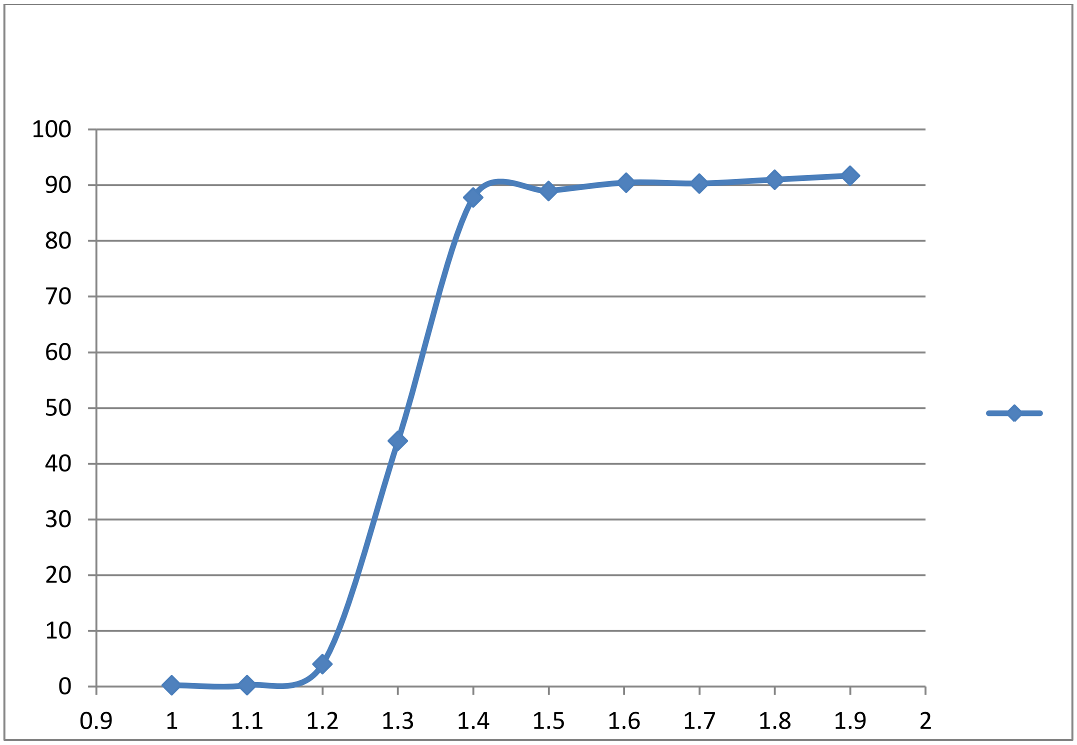
Figure 1 Efficiency V/s Voltage Plot

X-axis- voltage(kV)

Y-axis- efficiency(%)

Upper test paddle:

Voltage	Time(s)	1 fold	2 fold	3 fold	efficiency
1	3600	124	432	1	0.23
1.1	9000	74	1160	3	0.25
1.2	9000	873	1195	55	4.02
1.3	9000	8291	1151	508	44.1
1.4	9000	27482	1155	1021	87.8
1.5	9000	56274	1170	1041	88.97
1.6	9000	94717	1131	1023	90.45
1.7	9000	142735	1189	1074	90.3
1.8	9000	218032	1099	1000	90.99
1.9	5400	216232	699	641	91.7



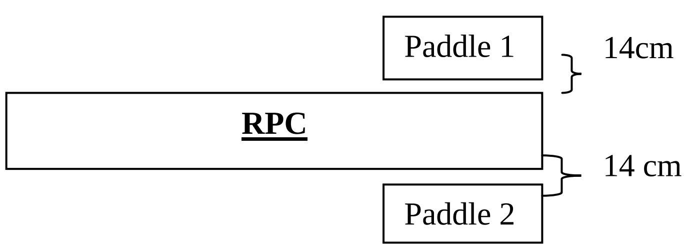
X-axis- voltage(kV)

Y-axis- efficiency(%)

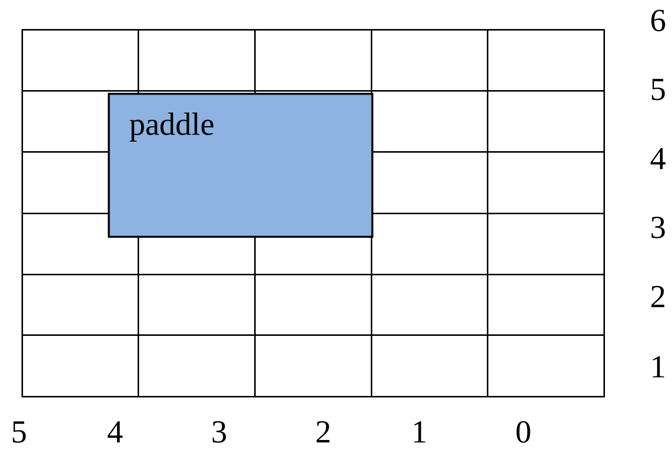
As we can see that the efficiency scintillator is less sensitive to the change in voltage from 1.5kV to 1.9kV, we choose the operating point of scintillator to be 1.7kV.

UNIFORMITY MEASUREMENT OF RPC

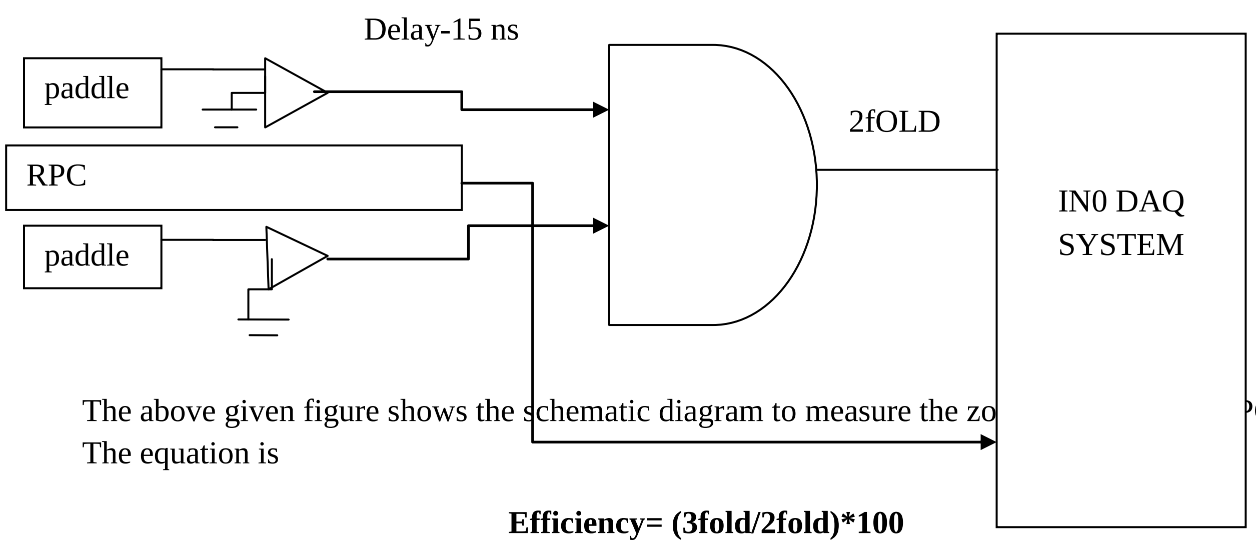
Here we are placing the RPC between two scintillators and will find the efficiency. As our paddles have the area 10cm*10cm we will get the efficiency of a specific zone only.



The above figure is the geometric arrangement of the method to measure the zonal efficiency.



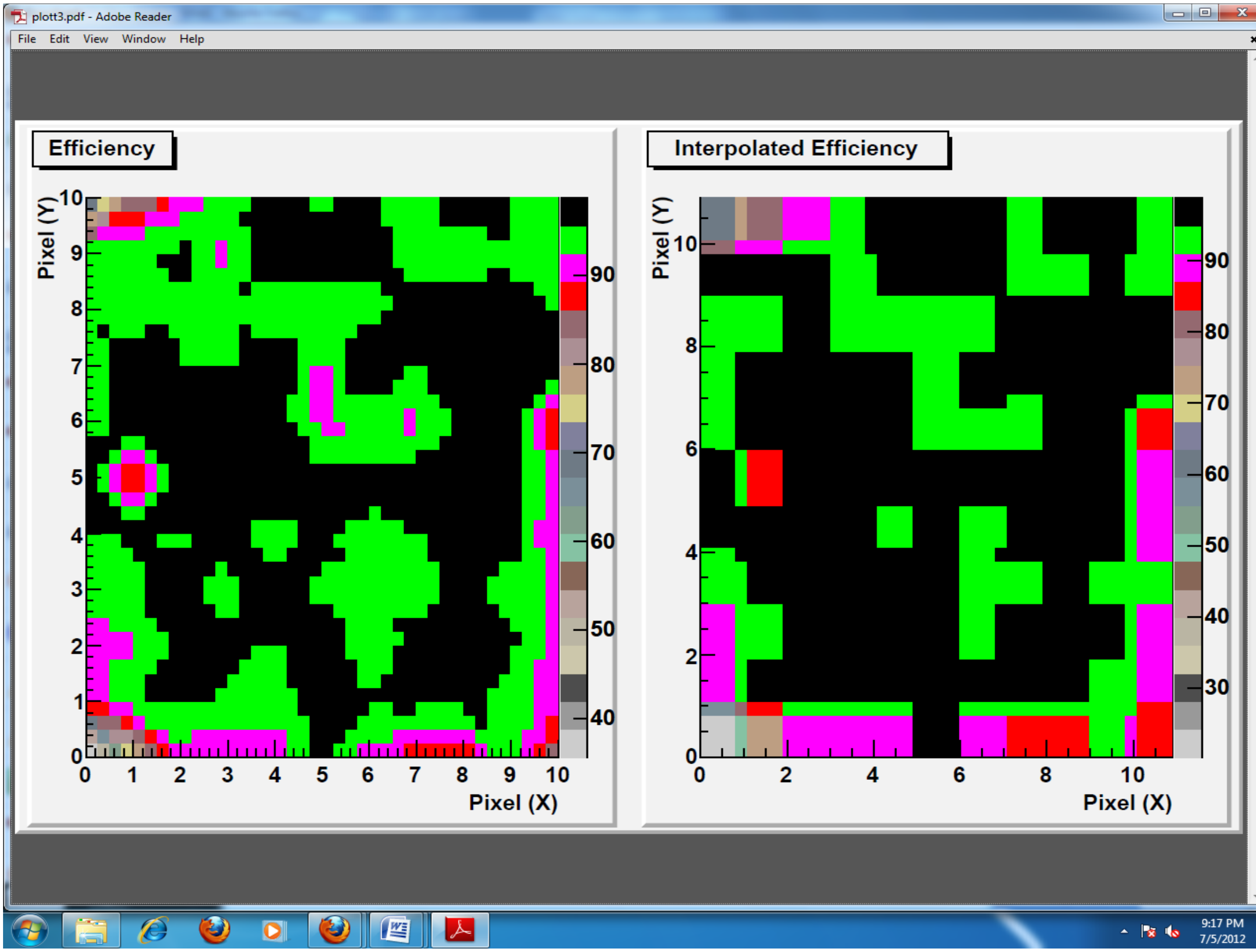
As shown in the figure above, in order to calculate the efficiency, we consider the hits in x strips-1 2 3 4 5 and y strips-2 3 4 5 6. The equation is same as that in the case of scintillator. The schematic diagram to calculate the efficiency is



The above given figure shows the schematic diagram to measure the zo PC. The equation is

Efficiency= (3fold/2fold)*100

INO-DAQ is an indigenously developed system to collect and analyse the data from the RPC. In this case our 2 fold is taken as trigger. The data of DAQ system is stored as root files. Then a code was developed to access data from the root file and measured the efficiency of the RPC. Also the efficiency was plooteed as lego plot and other type of plot



CONCLUSION

The uniformity study of efficiency of RPC is being done. From the plots and the data that I have obtained we could see that the efficiency is much low in the gas outlet system of the Resistive Plate Chamber (RPC). We got the efficiency around 95% except at the edges. At the edges we especially at gas outlet portions 20.24% and 63.36%. Also from this project I could gain experience in the simulation part and in the construction of scintillator and understanding the physics behind that. We encountered many problems during the project mainly, when we used optical fibre to carry light from scintillator paddle to the PMT. The efficiency that we got was around 0.5%. We realised that its due that attenuation of the signal when it passed through the optical fibre. Then that problem was solved by replacing the optical fibre with the light guide.

REFERENCES

1. B Satyanarayana, Design and Characterisation Studies of Resistive Plate Chambers.
2. Personal Website of Satyanarayana Bheesete: http://www.hecr.tifr.res.in/~bsn/ino.html.

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