Timing and Charge Measurements for glass RPCs

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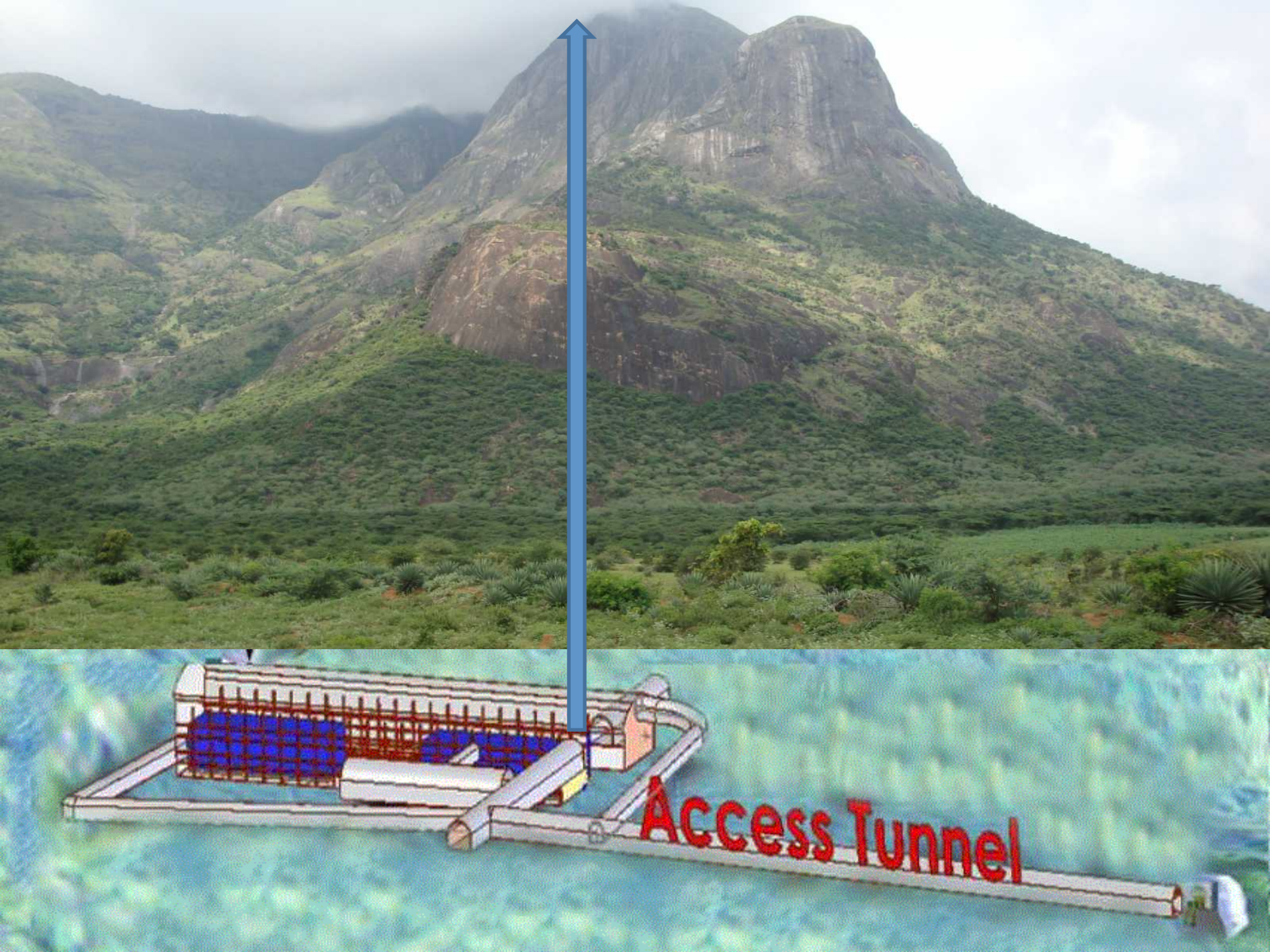

Access Tunnel

The INO Experiment

- About a year ago, we received approval for building the INO facility near Madurai in south India.

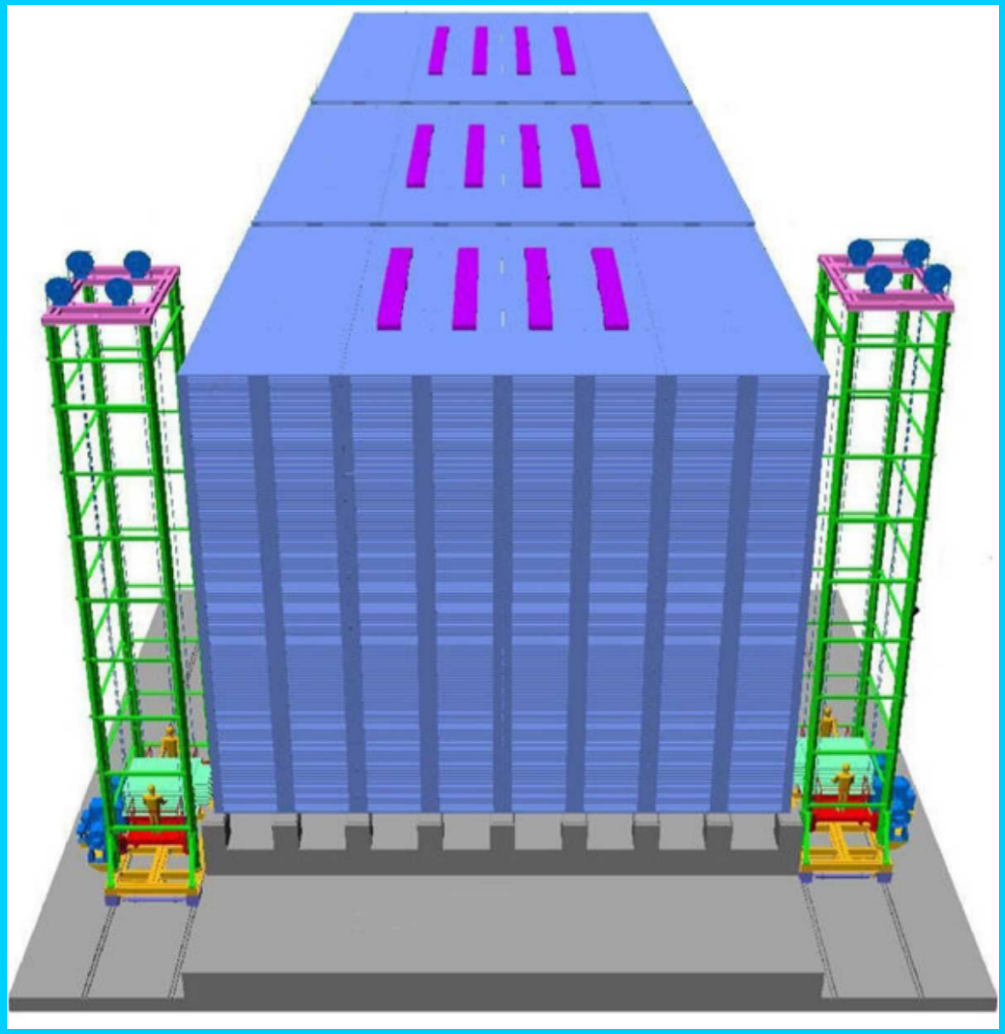
- A cavern of dimensions 132m × 26 m × 32.5m will be constructed at the end of a 1.91 km long tunnel.

- INO will have a 50 kilotons magnetized Iron Calorimeter (ICAL) to detect the atmospheric muonic neutrinos and anti neutrinos interactions.

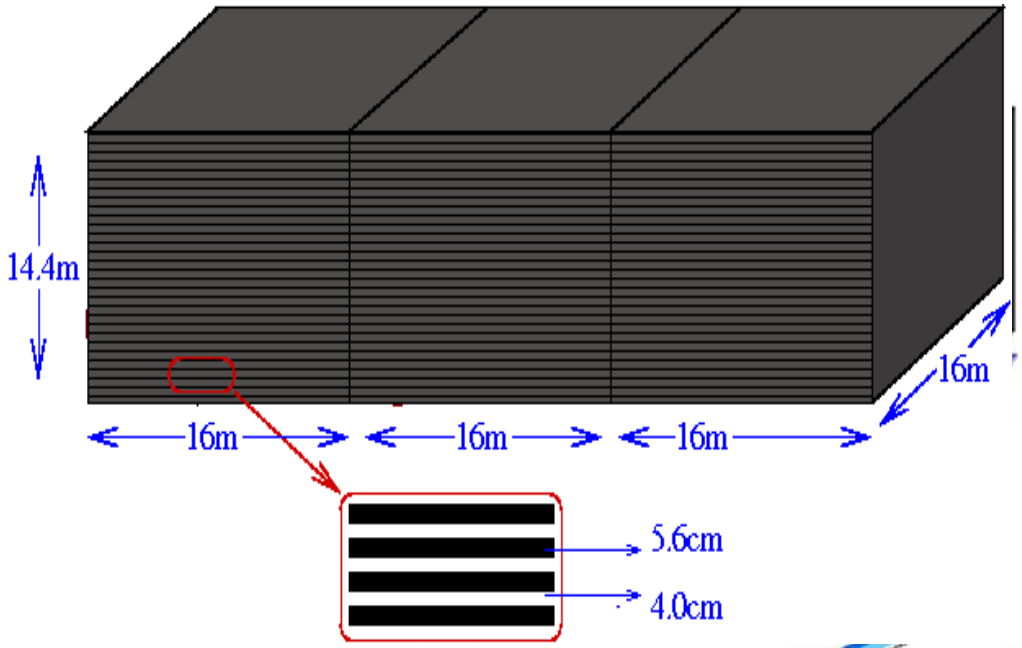
- Uniqueness of this experiment is its capability to differentiate between a positive charged muon and a negatively charged muon and thus between a muon neutrino and a muon anti-neutrino that produces it.

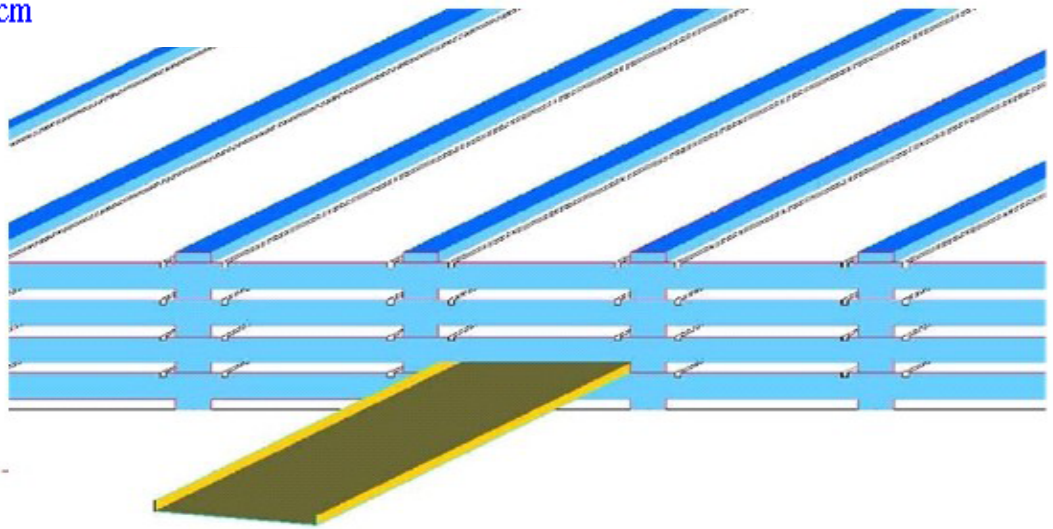
ICAL Detector

- Three modules, each of size 16m×16m×14.4m.
- In each module 151 layers of iron plates and RPC.
- 5.6 cm Thick iron plates are separated by 4.0cm gap for RPC, act as active detector element.
- Total mass of 51kton.
- Magnetic field applied 1~ 1.5T
- The readout of RPC is performed by external orthogonal pick up strips(X and Y strips).

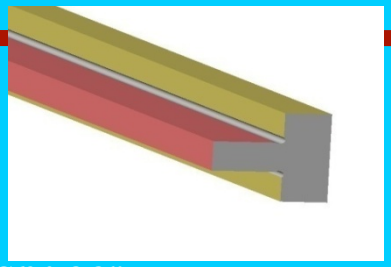


ICAL Detector





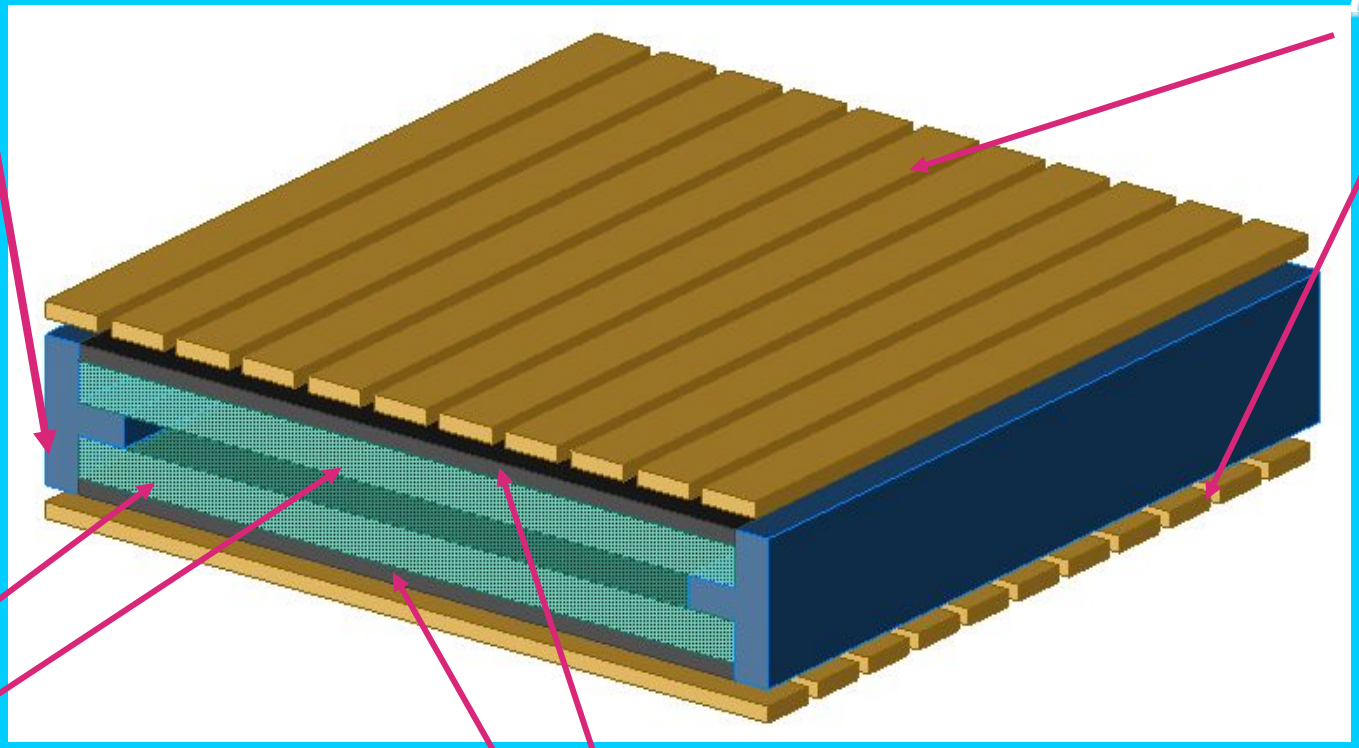
ICAL RPC



2 mm thick spacer

Two 3 mm thick float Glass
Separated by 2 mm spacer

Pickup strips



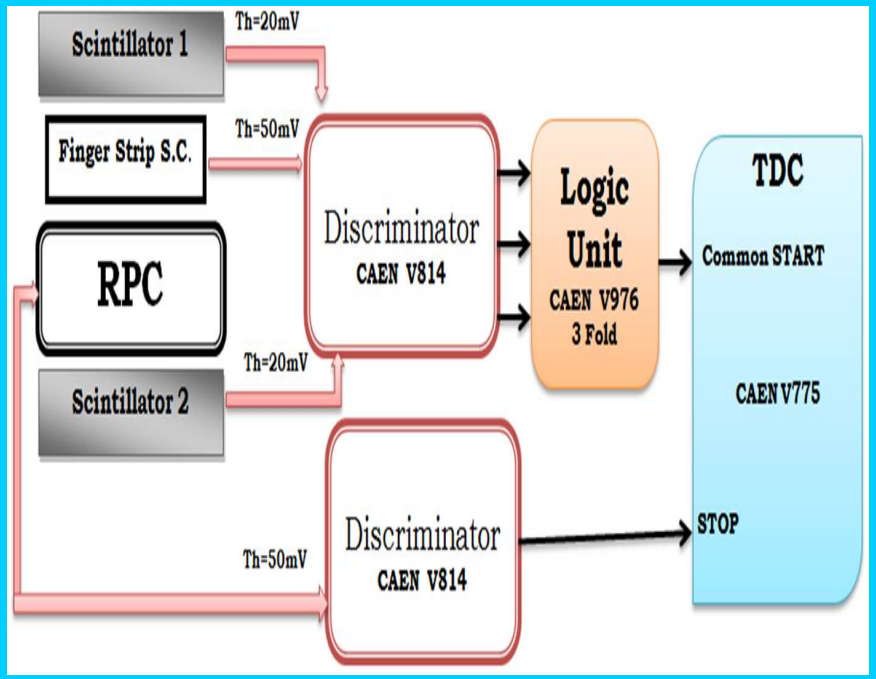
Glass plates

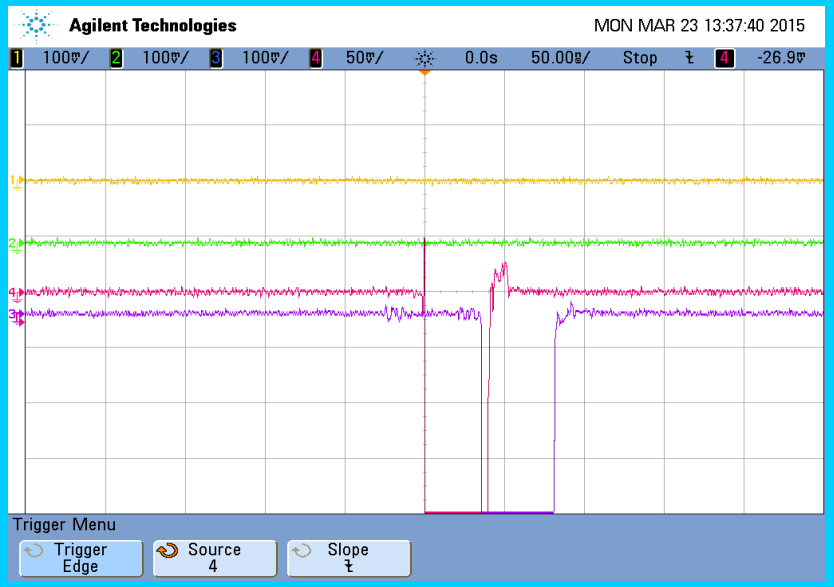
Resistive coating on the outer surfaces of glass

Timing Measurements

- We have choosen Saint Gobain/Asahi and Set up the data acquisition system for the measurement

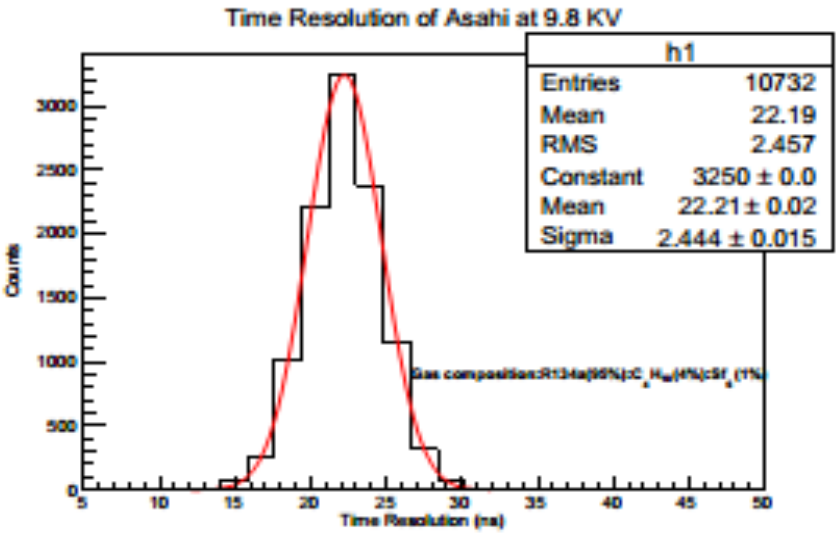
- Three scintillator co incidence pulse used as START & Discriminated RPC pulse used as STOP

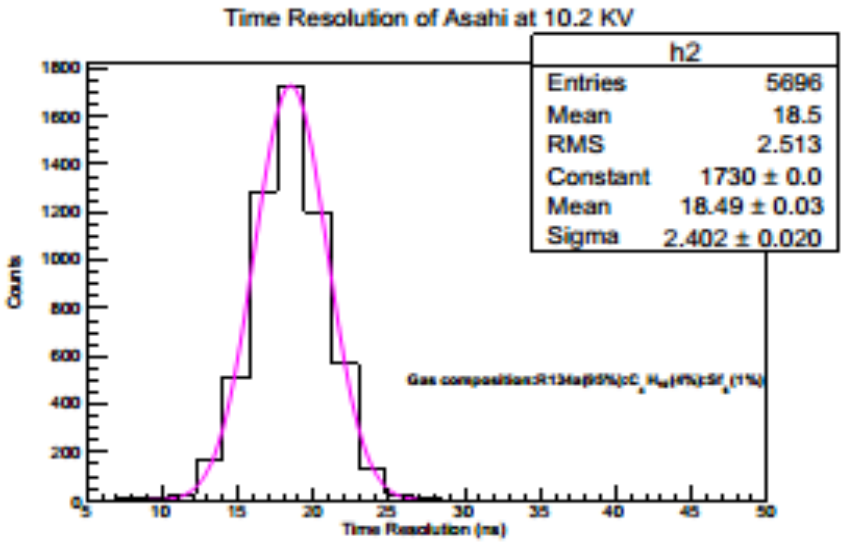


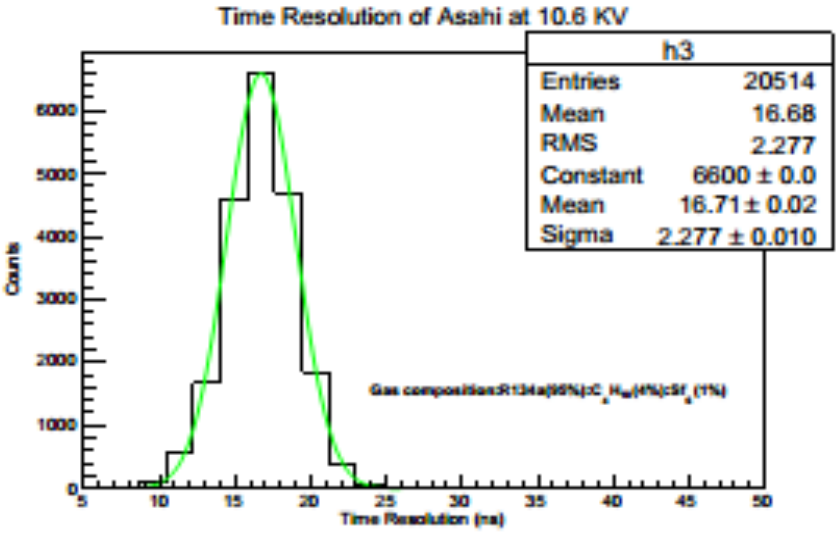


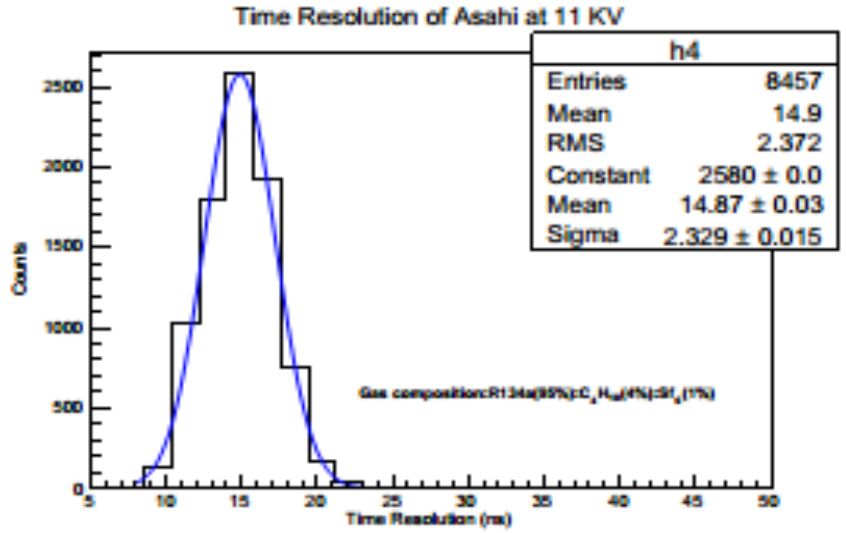
Asahi Glass

Gas composition R134A (95.0%), C4H10 (4.0%), SF6 (1%).



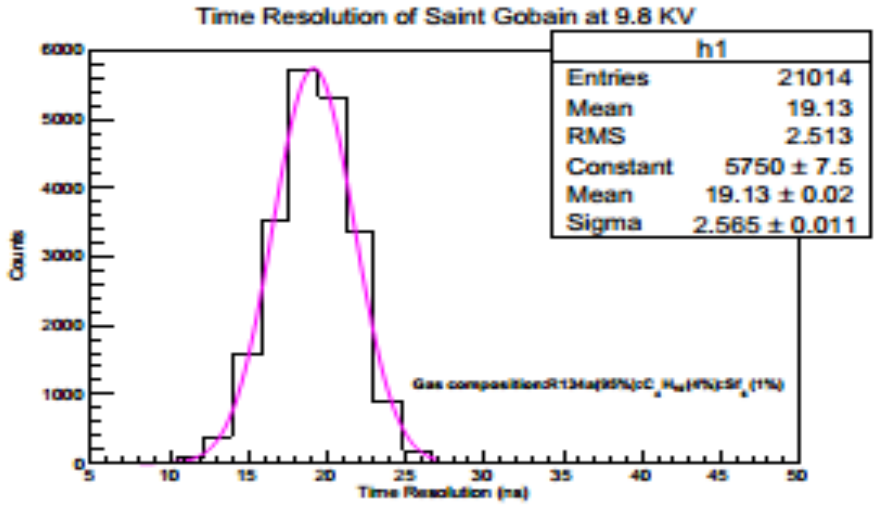


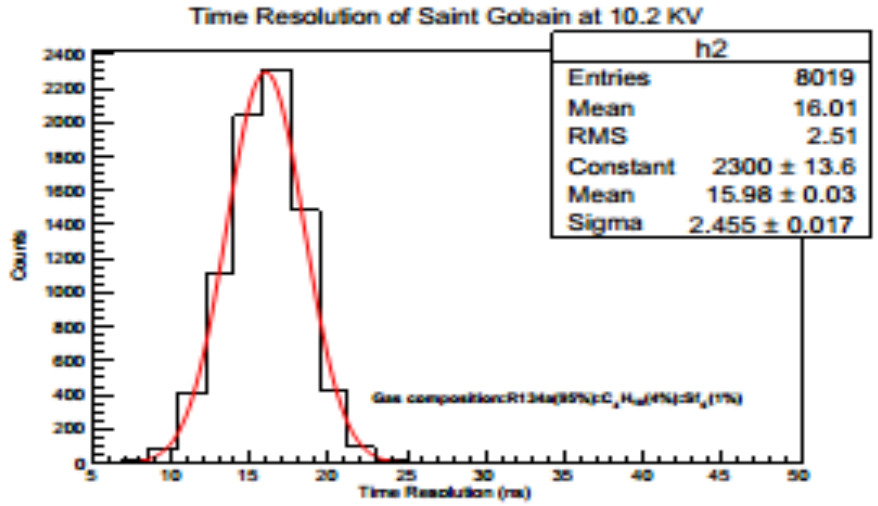


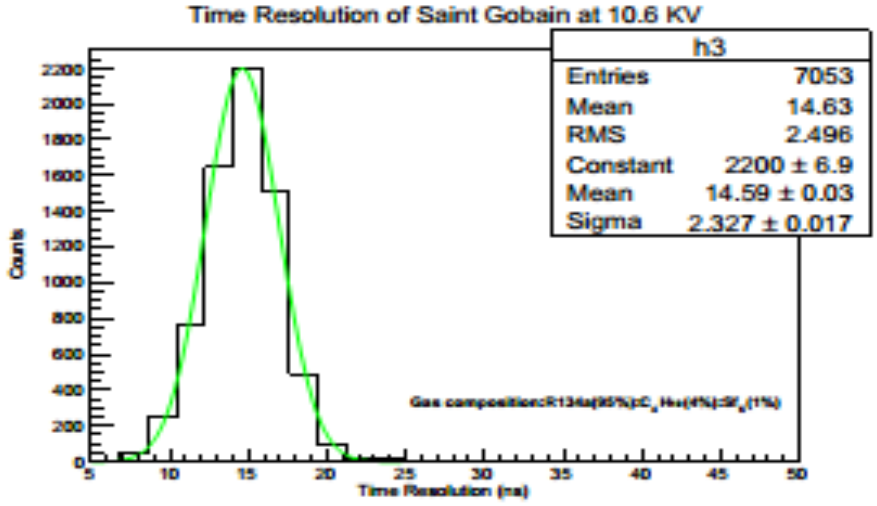


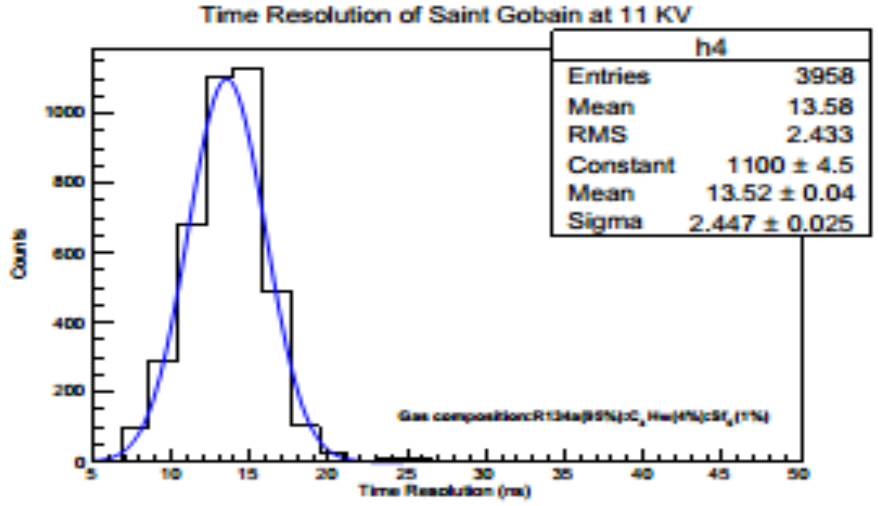
Saint Gobain Glass

Gas composition R134A (95.0%), C4H10 (4.0%), SF6 (1%).

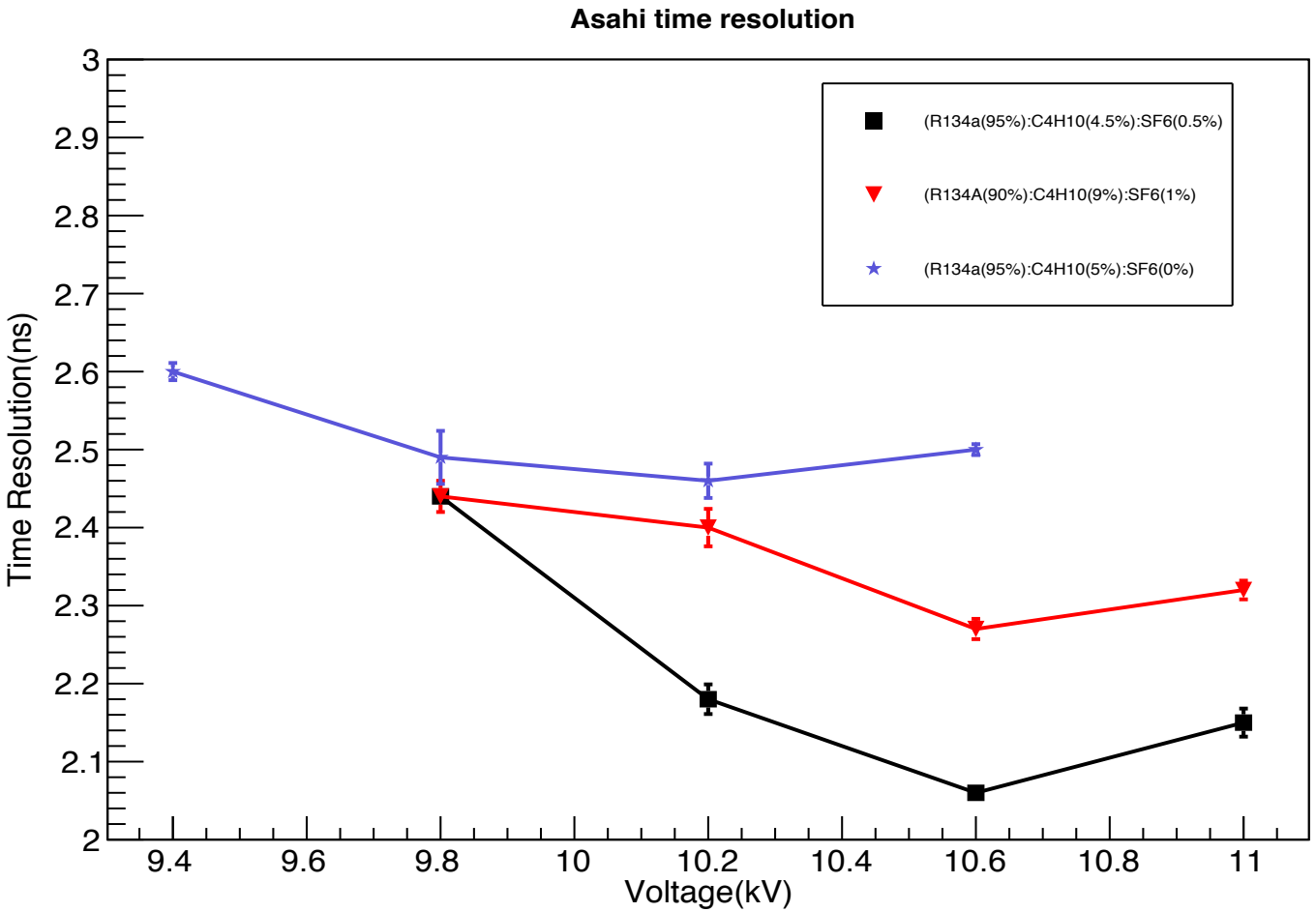






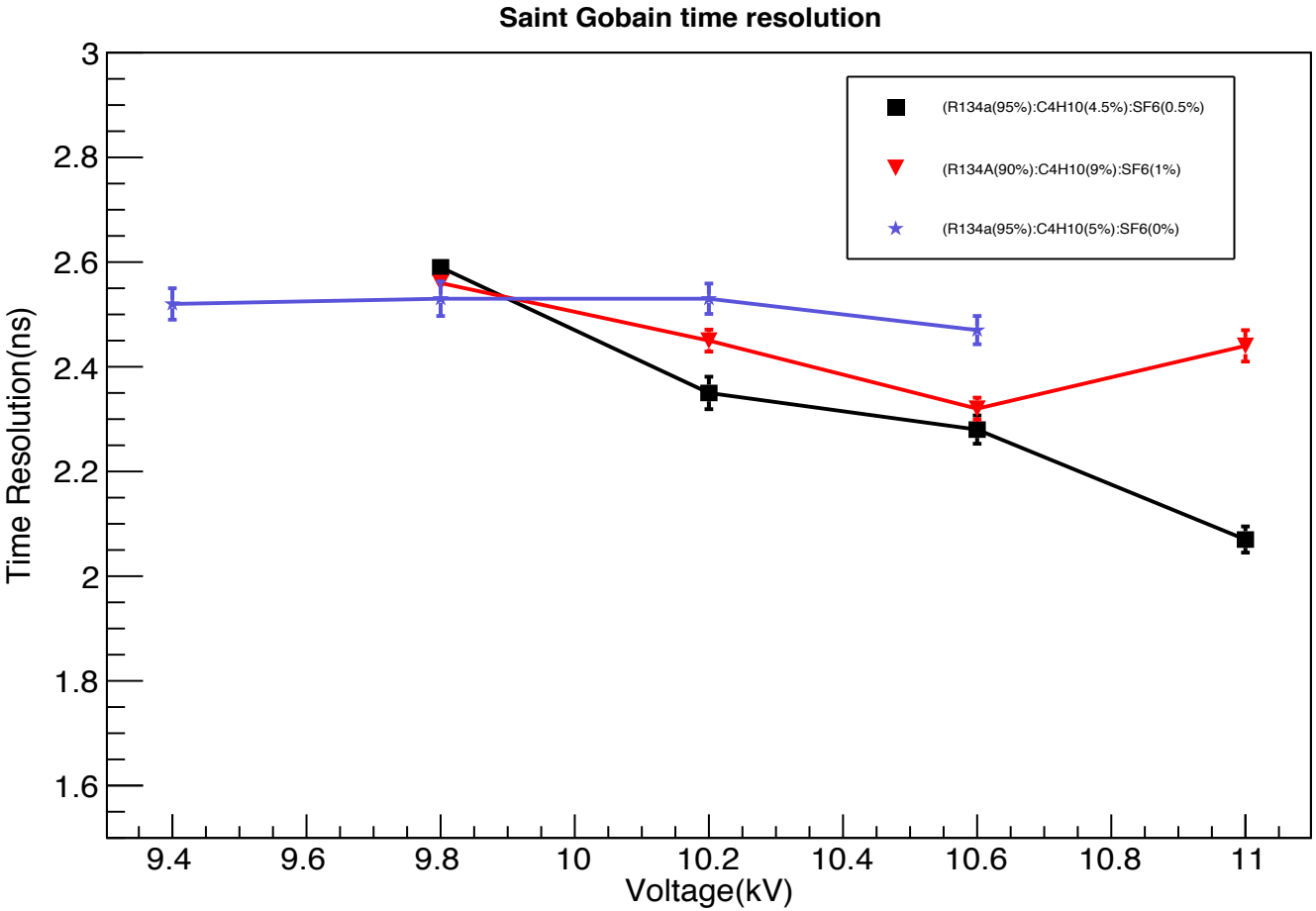


Time Resolution - Asahi



Time resolution around 2.1 ns for the Gas composition R134A (95.0%), C4H10 (4.5%), SF6 (0.5%).

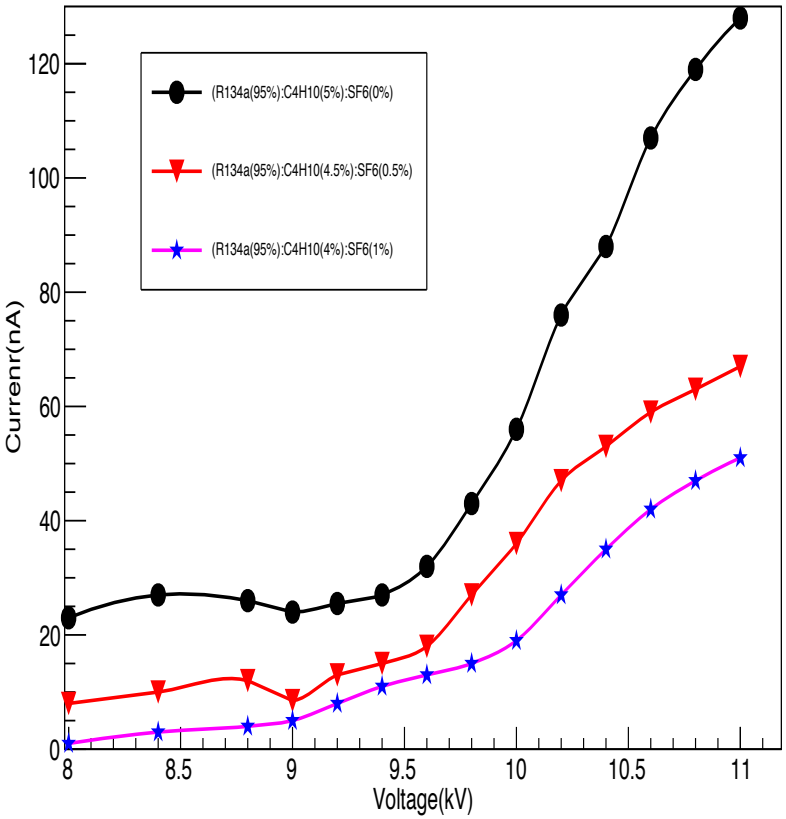
Time Resolution - SG



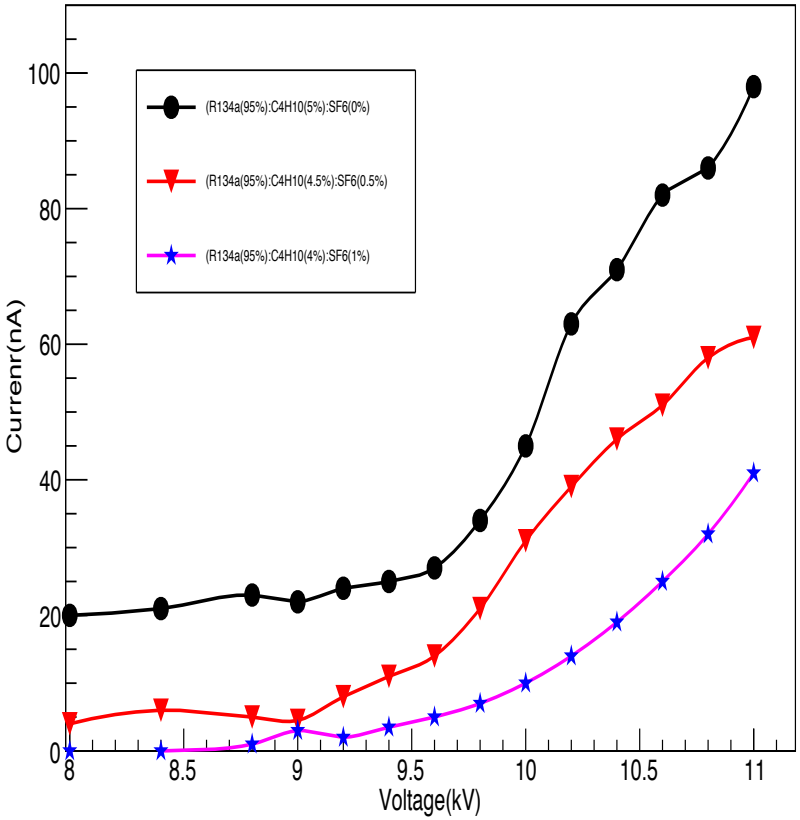
Time resolution around 2.2 ns for the Gas composition R134A (95.0%), C4H10 (4.5%), SF6 (0.5%).

Current

Asahi



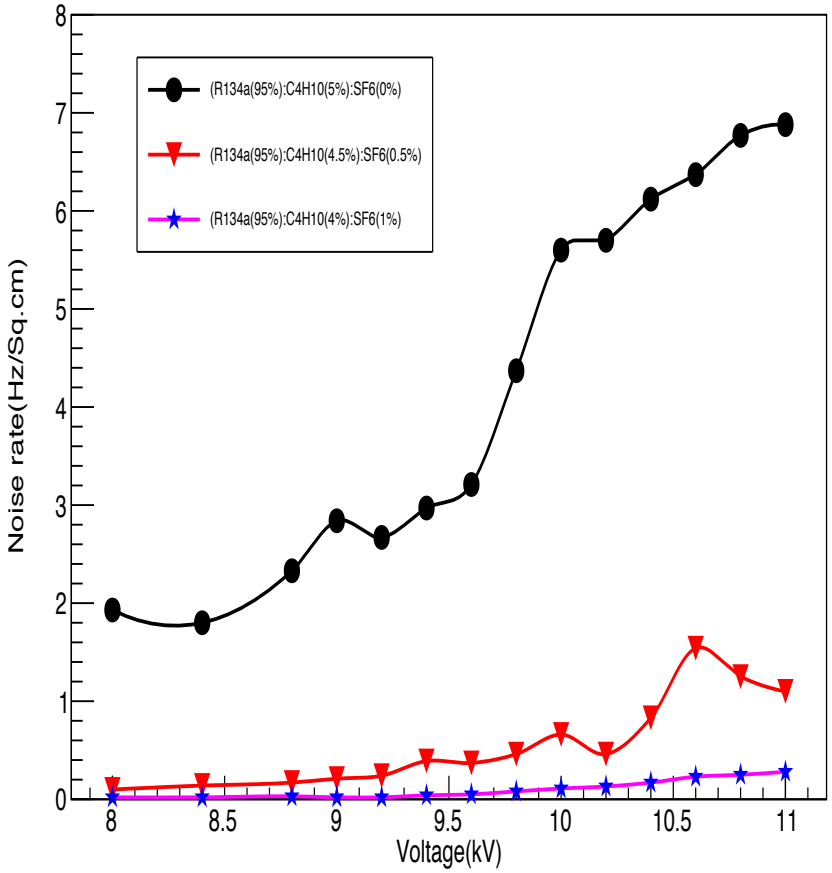
Saint Gobain



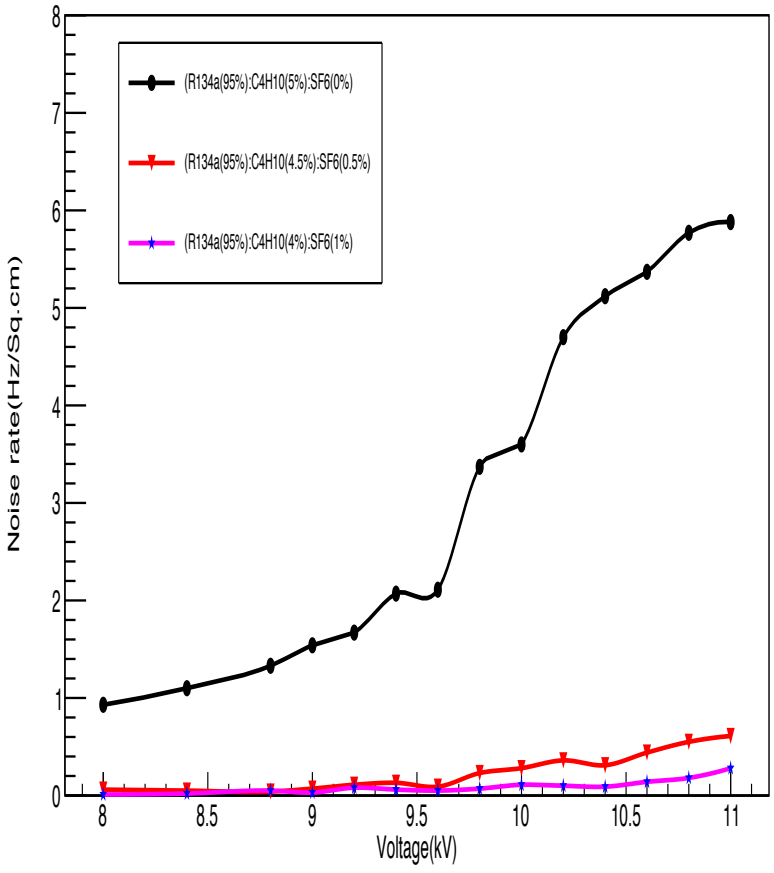
The Temperature around 20^{O}C and relative humidity around 35%.

Noise

Asahi



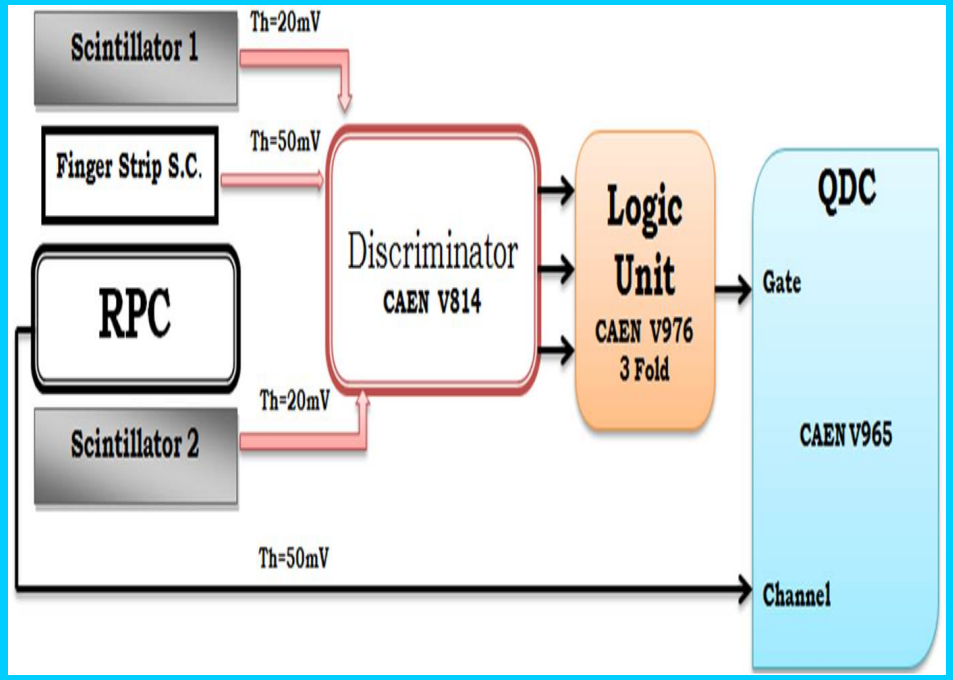
Saint Gobain



The Temperature around 20^{O}C and relative humidity around 35%.

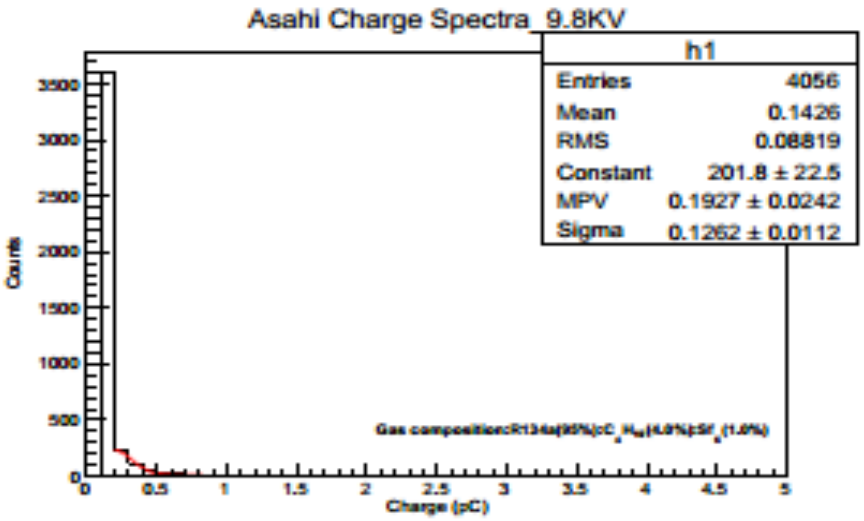
Charge Measurements

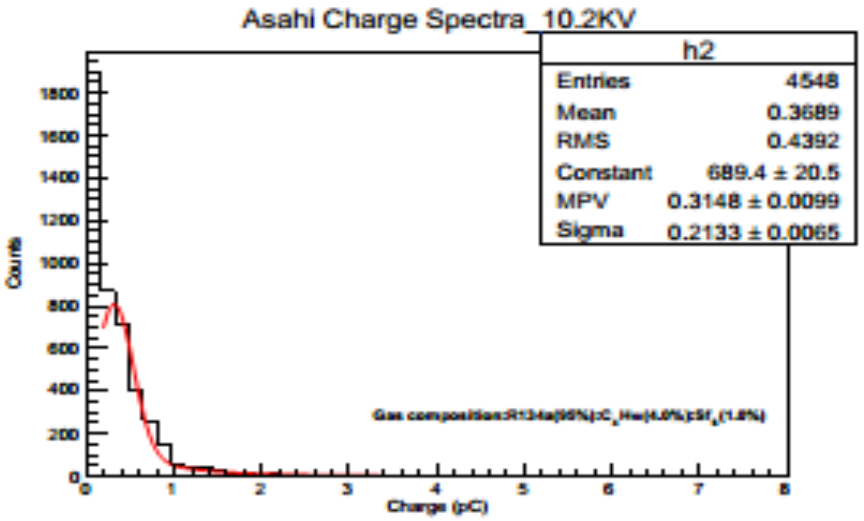
- Charge spectra for Asahi and Saint Gobain have been measured.
- QDC is used to study induced charge as a function of bias voltage.
- Coincidence pulse of three Scintillator is used as Gate for QDC.

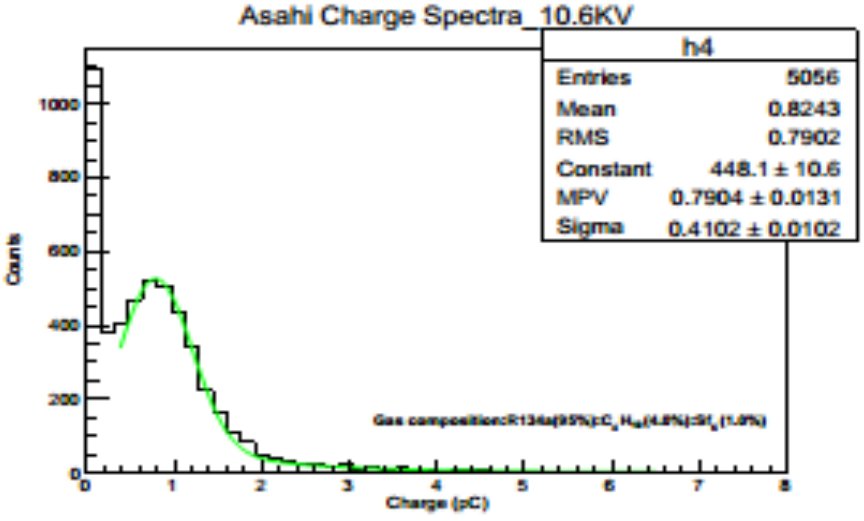


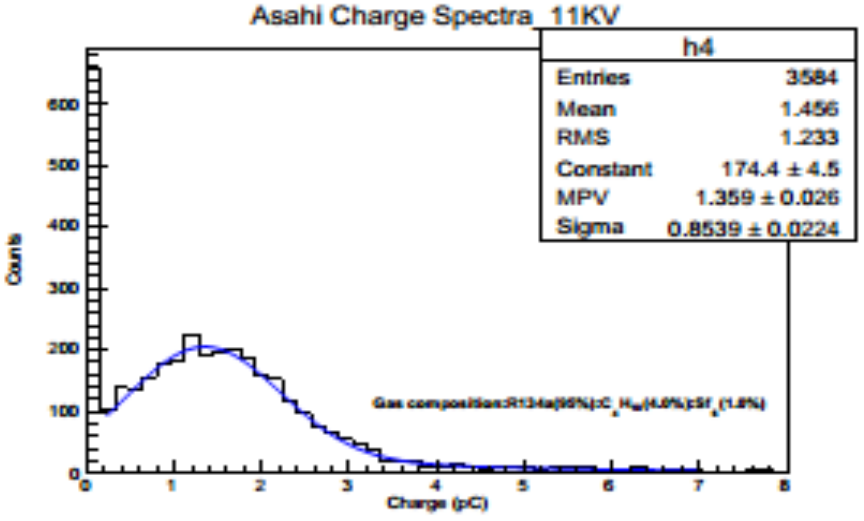
Asahi Glass

Gas composition(95.0%), C4H10 (4.0%), SF6 (1%).



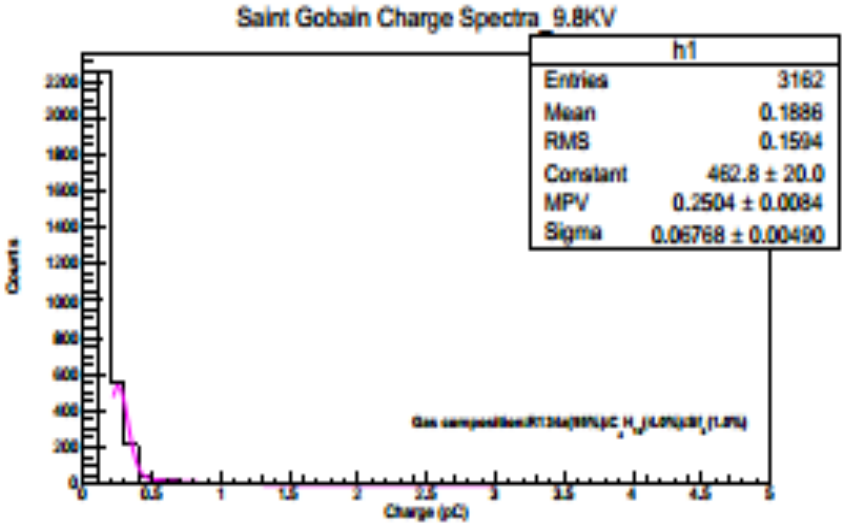


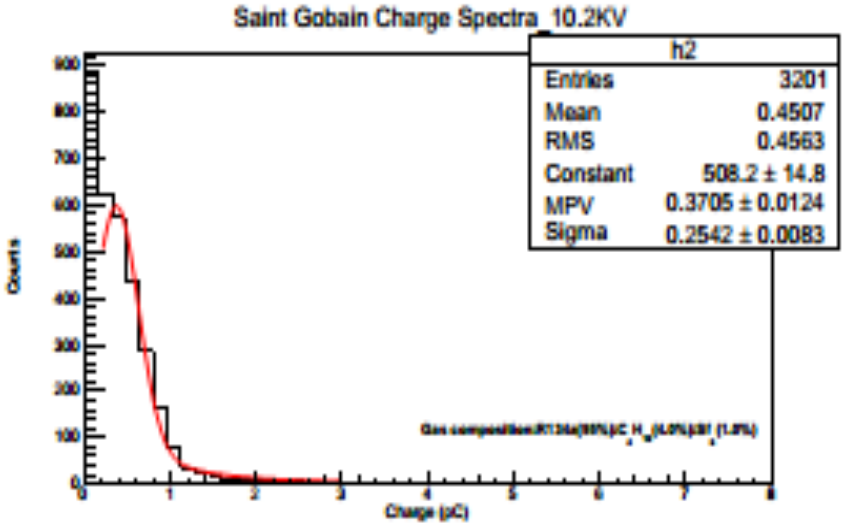


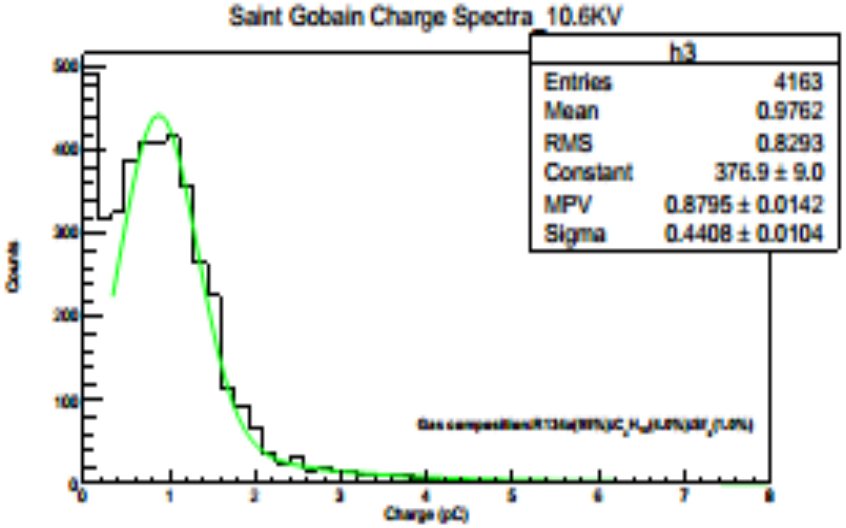


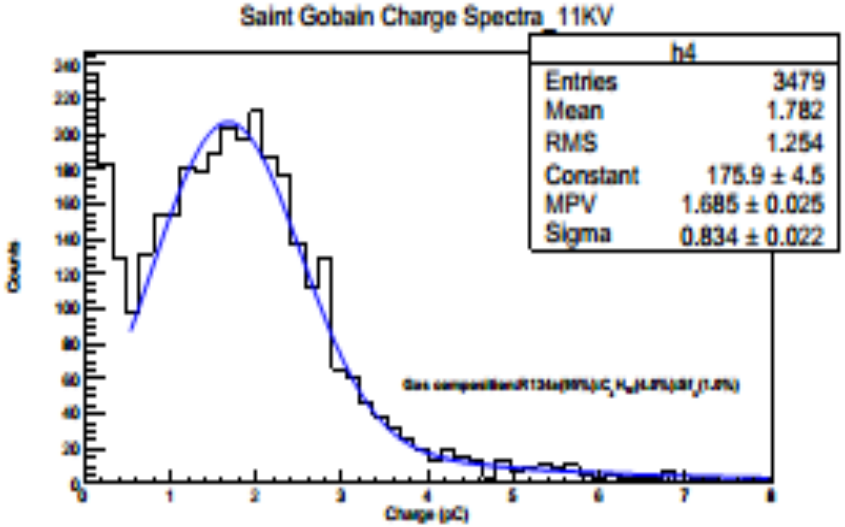
Saint Gobain Glass

Gas composition(95.0%), C4H10 (4.0%), SF6 (1%).

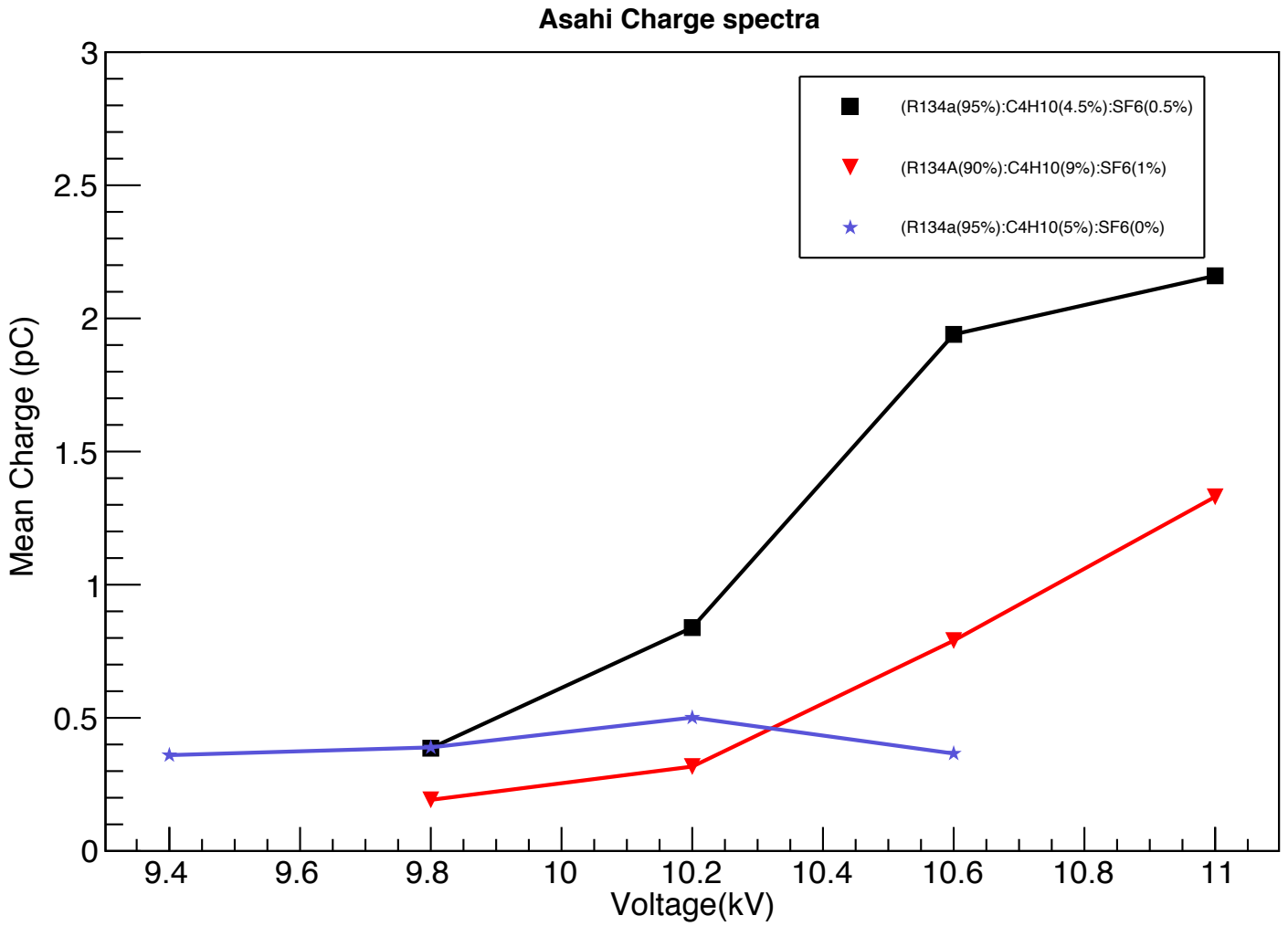




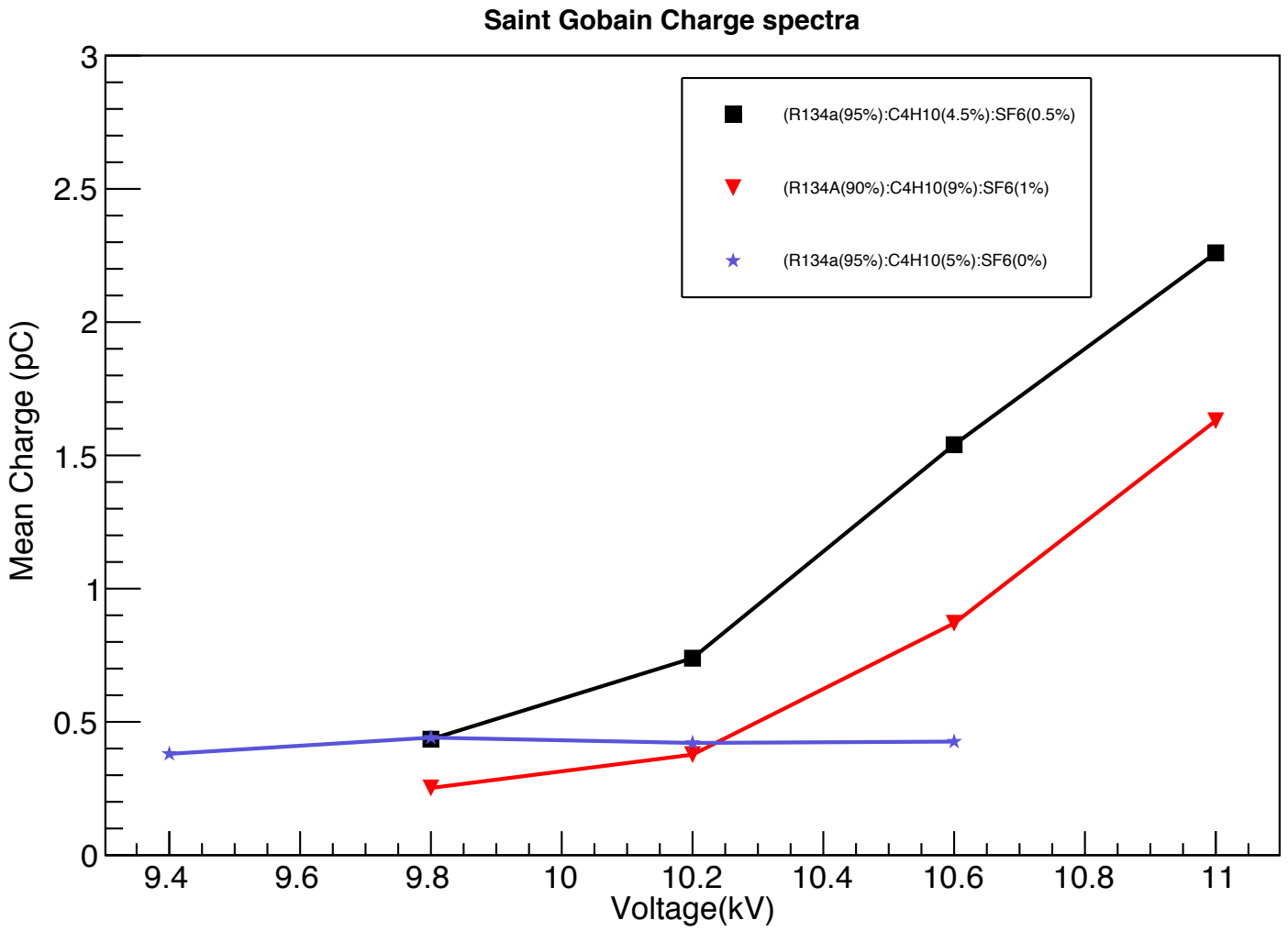




Charge Spectra - Asahi



Charge Spectra - SG



Conclusions

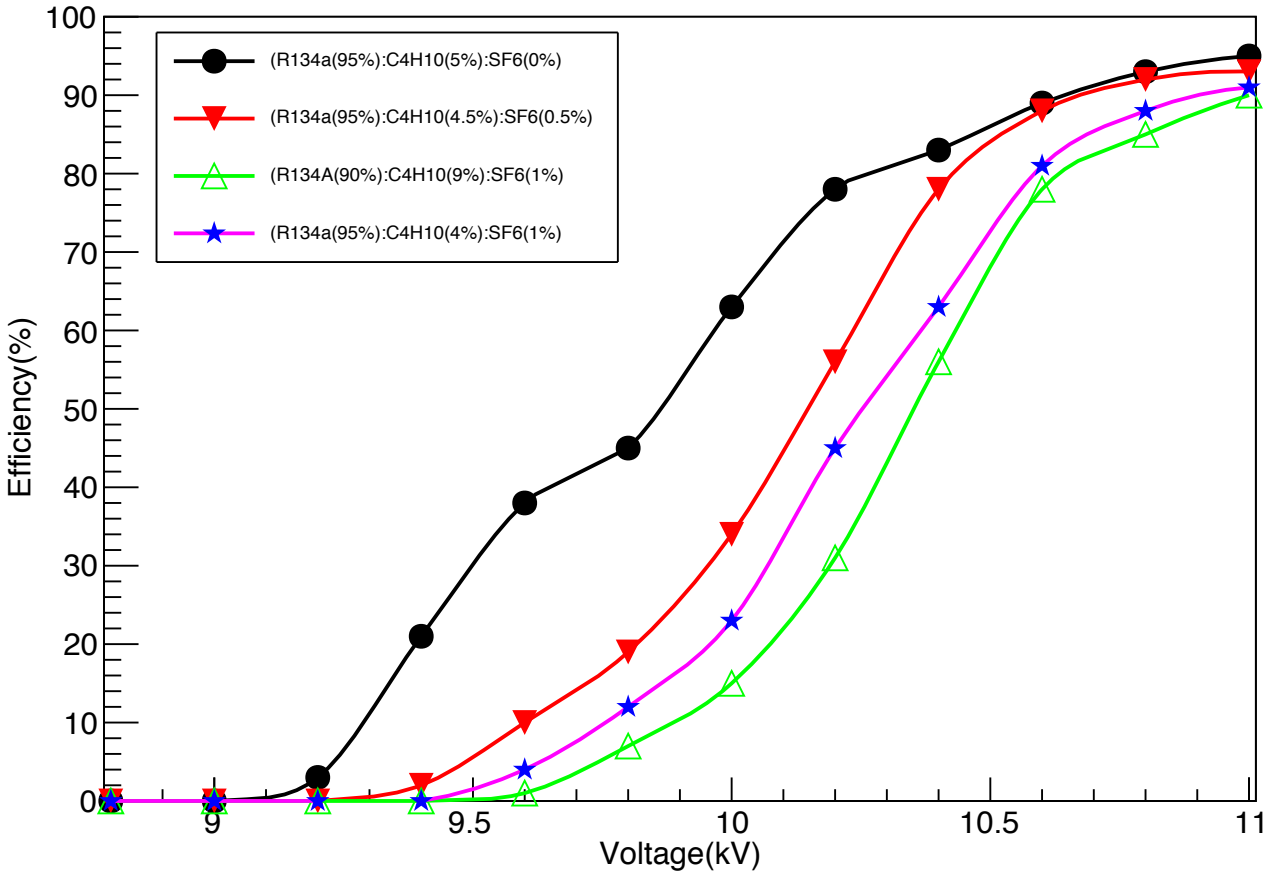
- The RPC efficiency is found to be more than 95% over a long period of operation.
- The gas composition of R134A/Isobutane(4.5)/ SF6 mixture in (95/4.5/0.5)% gives the best timing resolution and charge measurement.
- Asahi timing resolution is around 2.1 ns and Saint Gobain around 2.2 ns.
- Asahi and Saint Gobain both appears to be giving similar performance.

THANK YOU!

ICAL Design Parameters

No of modules	*3*
Module dimension	*16 m X 16 m X 14.4m*
Detector dimension	*48.4 m X 16 m X 14.4m*
No of layers	*150*
Iron plate thickness	*5.6cm*
Gap for RPC trays	*4 cm*
Magnetic field	*1.4 Tesla*
RPC unit dimension	*195 cm x 184 cm x 2.4 cm*
Readout strip width	*3 cm*
No. of RPCs/Road/Layer	*8*
No. of Roads/Layer/Module	*8*
No. of RPC units/Layer	*192*
Total no of RPC units	*28800*
No of Electronic channels	*3.7X 10^6*

Efficiency


(R134a(95%):C4H10(5%):SF6(0%)
(R134a(95%):C4H10(4.5%):SF6(0.5%)
(R134A(90%):C4H10(9%):SF6(1%)
(R134a(95%):C4H10(4%):SF6(1%)
Efficiency(%)
Voltage(kV)
100
90
80
70
60
50
40
30
20
10
0
9
9.5
10
10.5
11