Innovative Gaseous Detectors

RPC activities

WP-13-2-1

LIP, HZDR,IPNL

WP-13-2-2

IPNL,LPC, GWNU,OMEGa

WP-13-6-1

Bari, Lyon

I.Laktineh

Establishing new resistive materials for high rate RPCs

Global schedule (met so far, except for ageing)

	Year 1	Year 2	Year 3	Year 4
Definition of standards/procedures				
Inventory and procurement of materials				
Exploratory tests electrical/RPC				
Electronics development				
Detailed tests in lab of chambers made out of the best candidate materials				
Address ageing				
Beam test of small but realistic systems				
Conclusion and reporting				

13-2-1

We are here

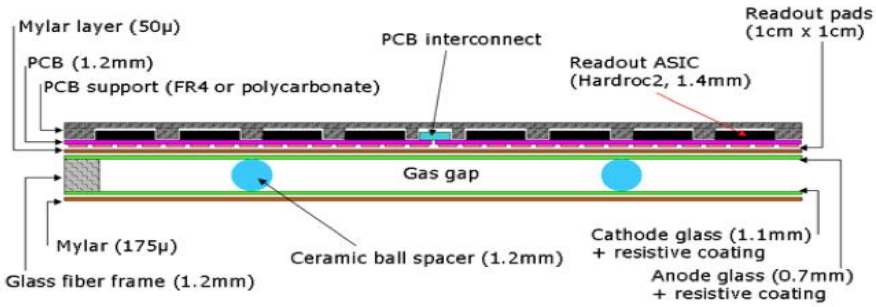
Recent progress in materials

13-2-1

- PVdF+C plate (40x30 cm2) of 2 mm thickness produced by injection ~10e10-11 ohm.cm
- Large KREFINE plate bought, cut and distributed to the participants, ~10e10 ohm.cm
- Pestov glass obtained from GSI, untested so far

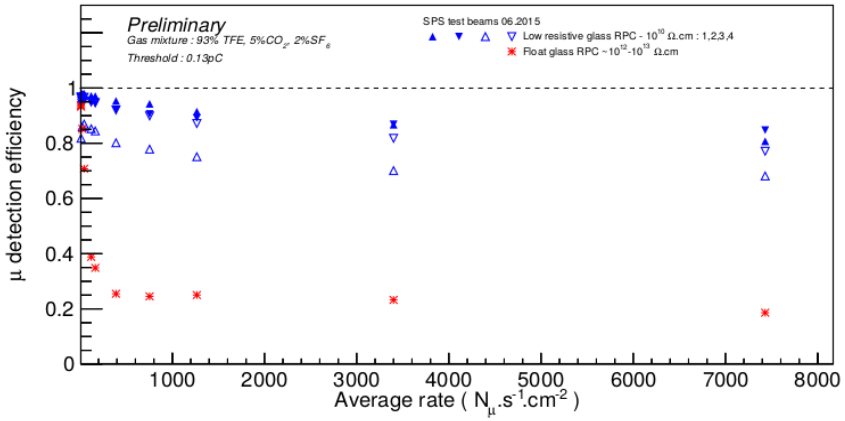
Small tests (in chambers) situation

- High resistivity PVdF+C (Lyon) √
- Ceramics (HZDR) √
- Krefine (LIP) √
- Phosphate glass (Lyon + LIP) √
- Pestov glass (LIP)
- Low resistivity PVdF+C (Lyon)



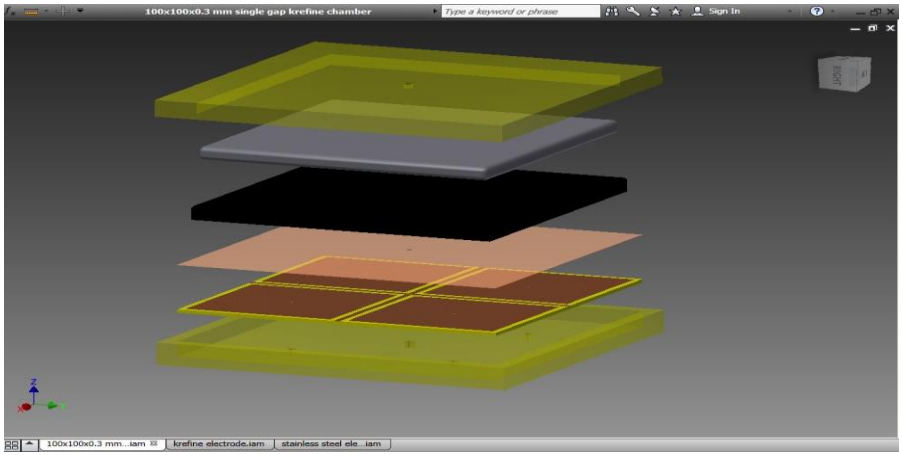
Aging

- Not started. GIF++ AIDA2020 possibilities?



Preparation for beam tests in Fall this year

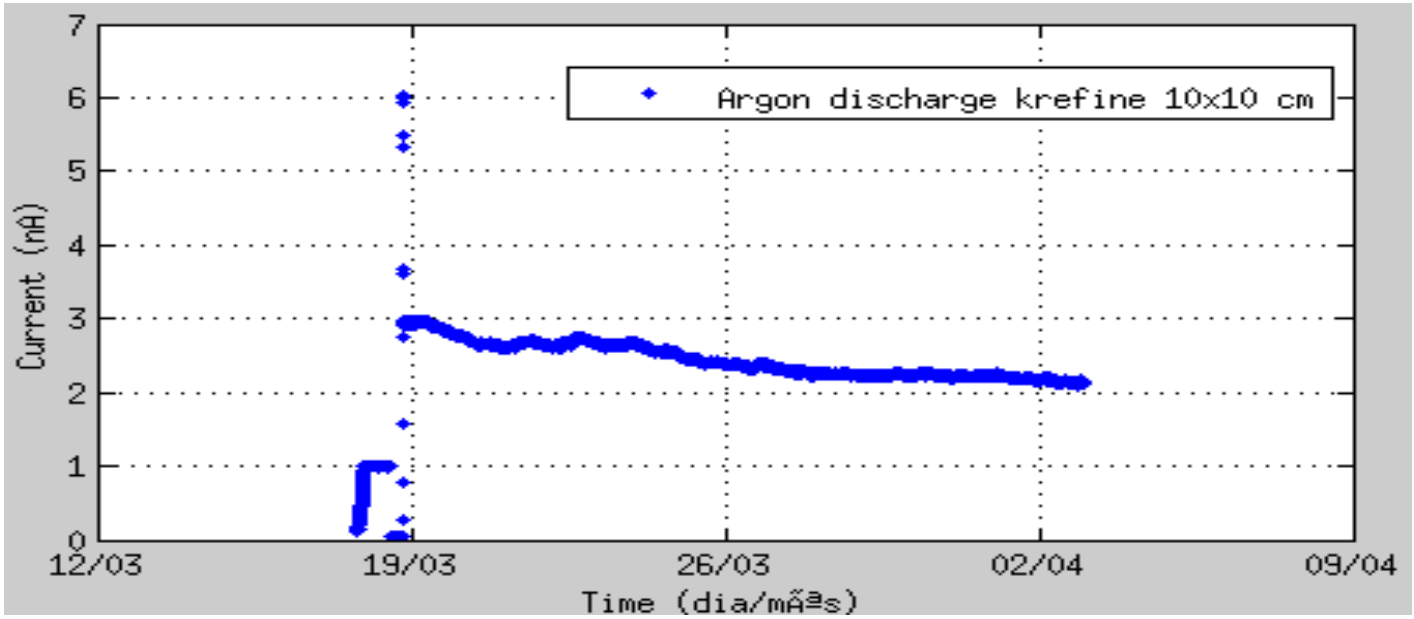
13-2-1



Single gap timing RPC (small pads, narrow gap) with stainless steel cathode and no spacers

(this is to test the material, not the chamber construction technique)

First prototype built and tested in argon discharge with **Krefine** electrode



Preparation for beam tests in Fall this year

13-2-1

Foreseen 2 chambers x 3 materials (doped PVdF, Krefine, “chinese glass”) to be tested next Fall at SPS and maybe GIF++.

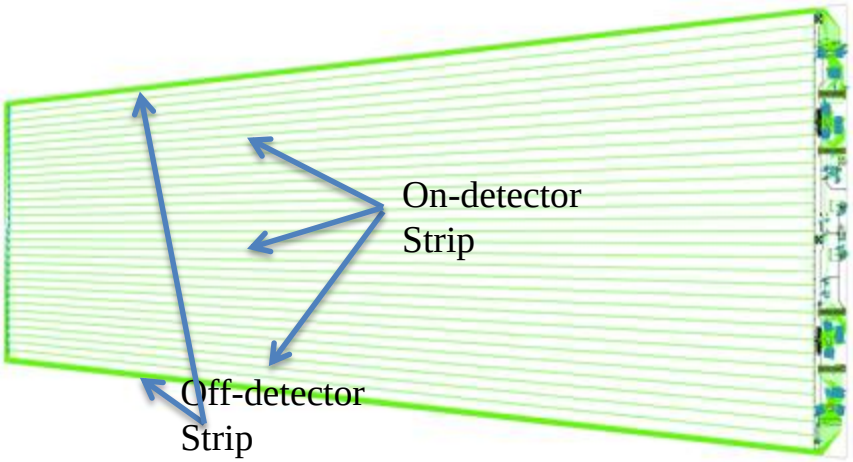
30cm X 30cm RPC made of doped PVdF and doped glass are already built and will be tested using pickup pads read out with HARDROC ASICs developed for the SDHCAL

Development of fast-timing large RPCs

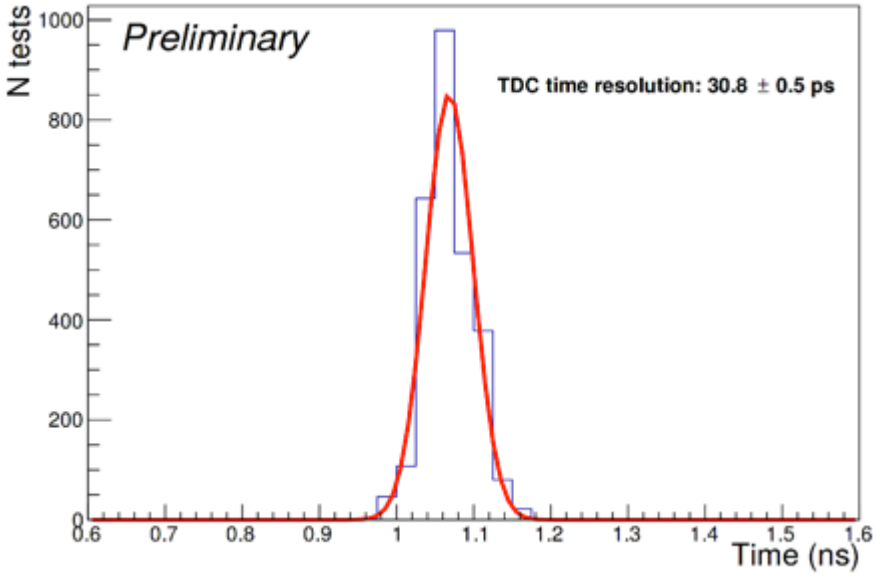
13-2-2

→ Build large RPCs

→ Develop readout electronics able to exploit the fast timing capabilities od RPCs PCB with pickup strips read out by **PETIROC** channels and then **Tsinghua TDC**.

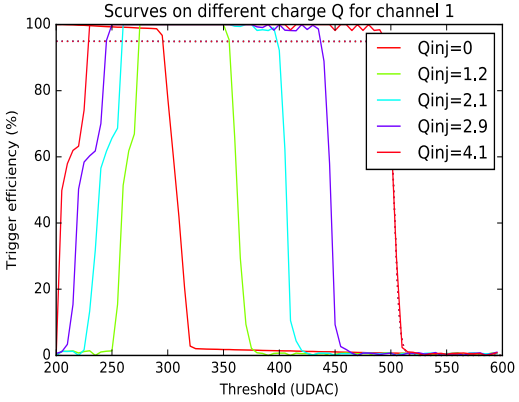


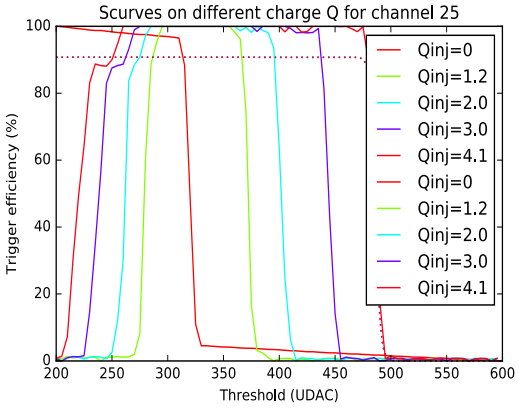
Strip	jitter rms (charges injected = 5pC)
16	0.0347
18	0.03162
20	0.03355
22	0.03445
24	0.03479
26	0.03567
28	0.03467
30	0.03443



13-2-2

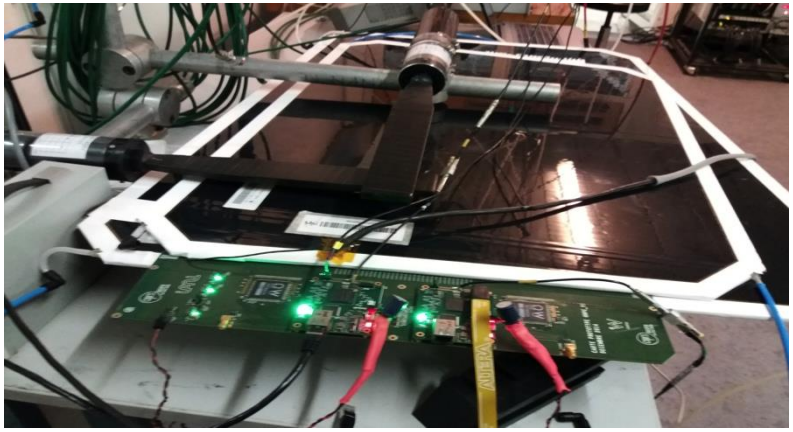
To get the same response of all the 32 channels. Threshold is modified channel by channel to get the Pedestals at almost the same DAC value.

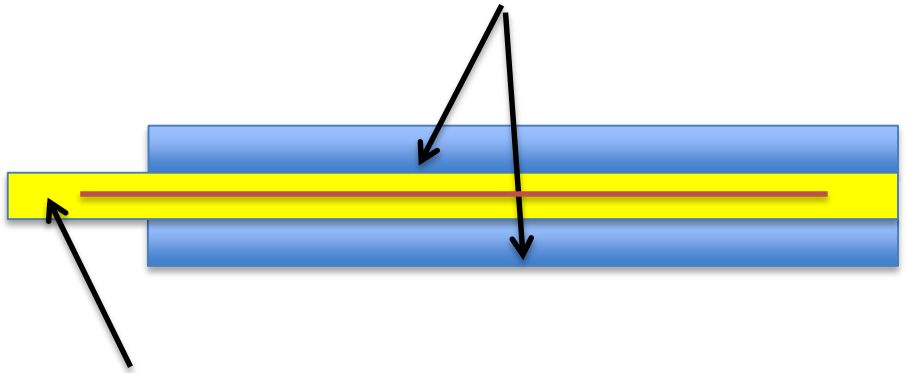




A firmeware was developped to measure the time arrival of the signal with respect to that of an external trigger. The difference of time arrival of the signal in the two channels assoicated to the same strip is then estimated:

The board was inserted in between two large HPL RPC chambers.





Results

13-2-2

Run	HV	Vth	P,T	Efficiency	Noise (Hz/ TDC) (28 channels)	Cluster size	Mean res (ps)
10814	9700	385	?	94.6	780	3.35	235
10815	9500	385	?	92.6	550	2.75	213
10816	9400	385	1000/10.4	88.9	473	2.34	224
10817	9300	385	977/13.3	86.7	297	2.11	226
10818	9300	395	972/13.5	85.7	233	1.97	216
10819	9300	405	984/12.7	75.3	145	1.62	226
10820	9400	405	987/11.9	82.0	190	1.76	232
10821	9500	405	993/10.8	85.5	270	2.02	229

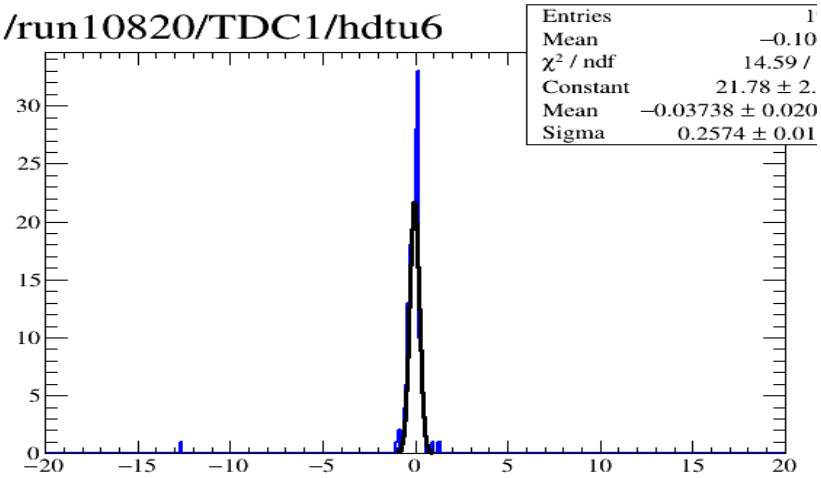
$Y = L/2 - v*(t_2 - t_1)/2 \rightarrow \sigma(Y) = v* \sigma(T_2 - T_1)/2$

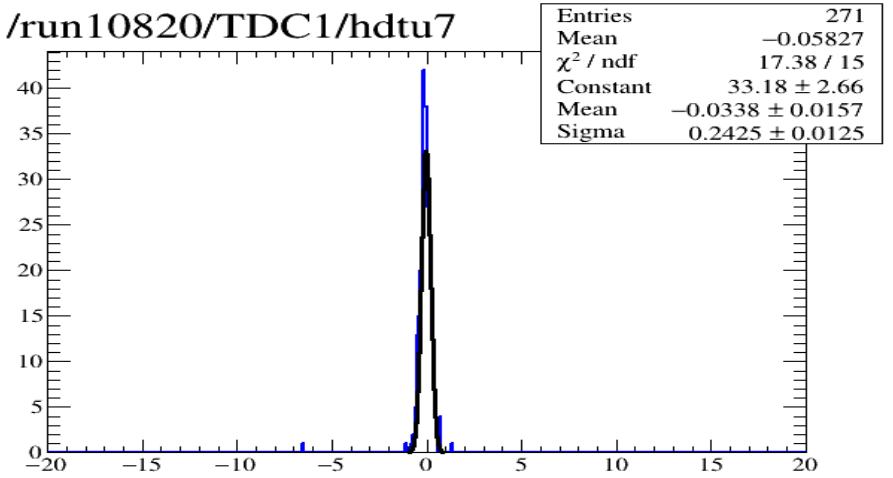
$v = 1/70$ cm/ps $\rightarrow \rightarrow \sigma(Y) < 2$ cm

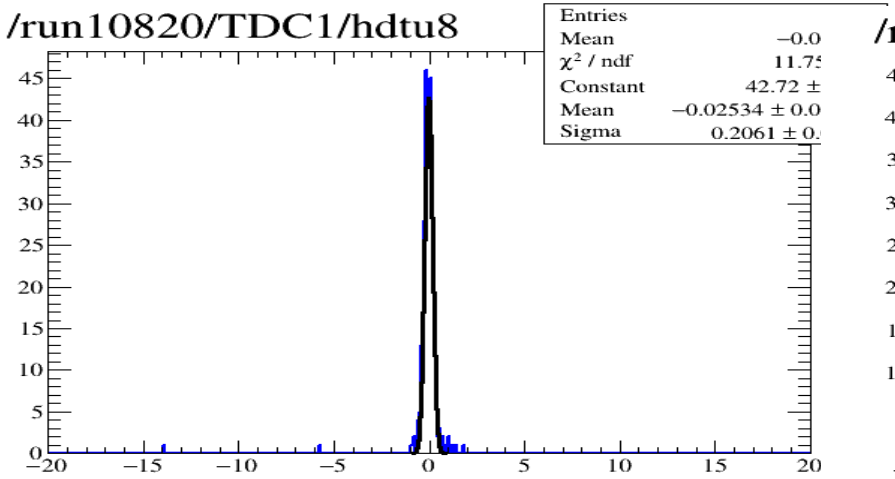
1. Resolution includes ~ 1.1 cm error from the scintillator (~80 ps quadratically)
2. No cluster analysis, it should also improves the resolution (to be divided by sqrt(C))

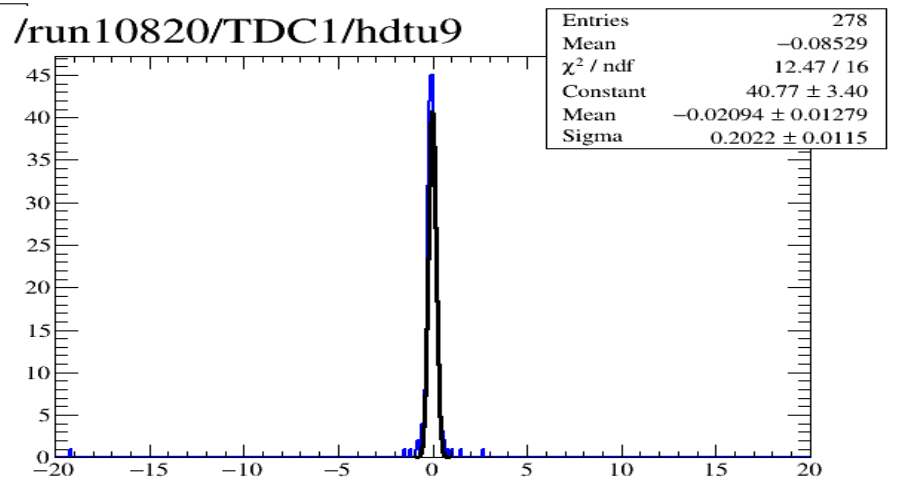
Run 10820

13-2-2



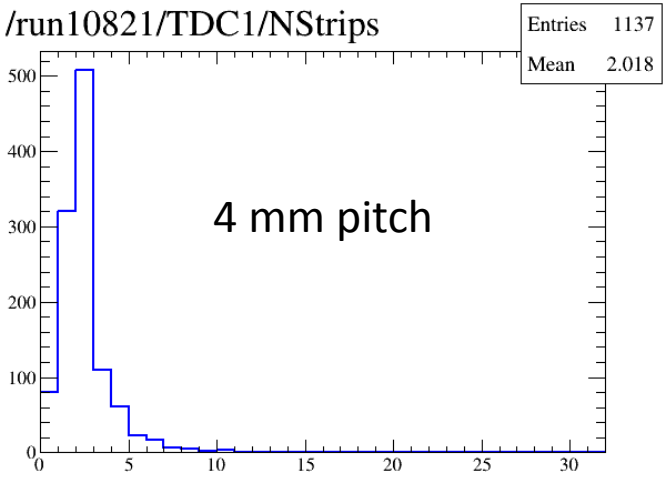


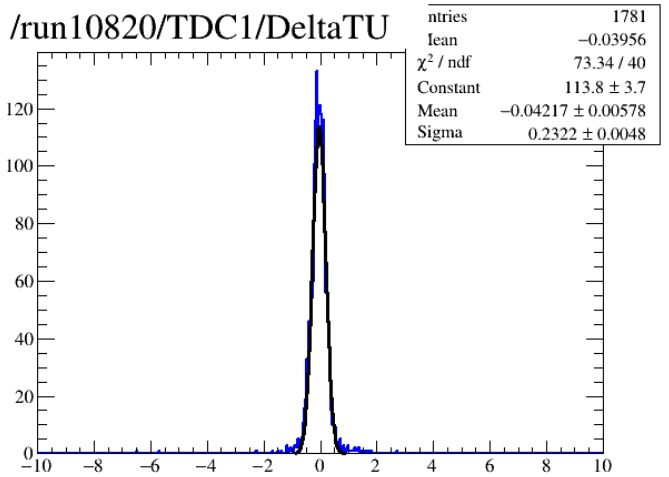


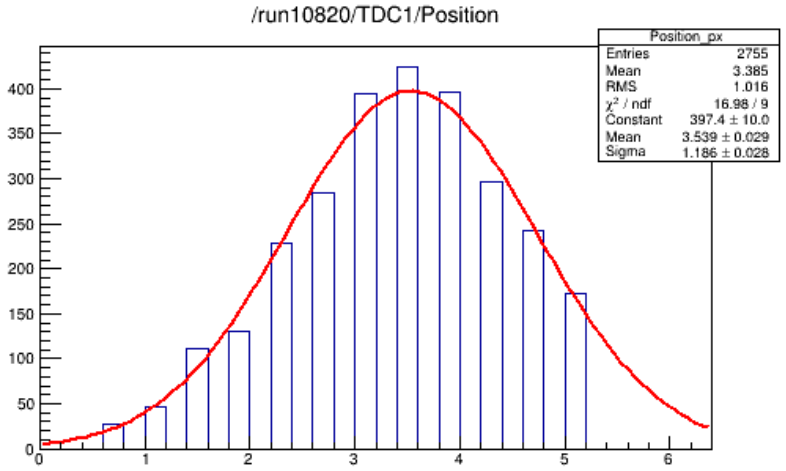


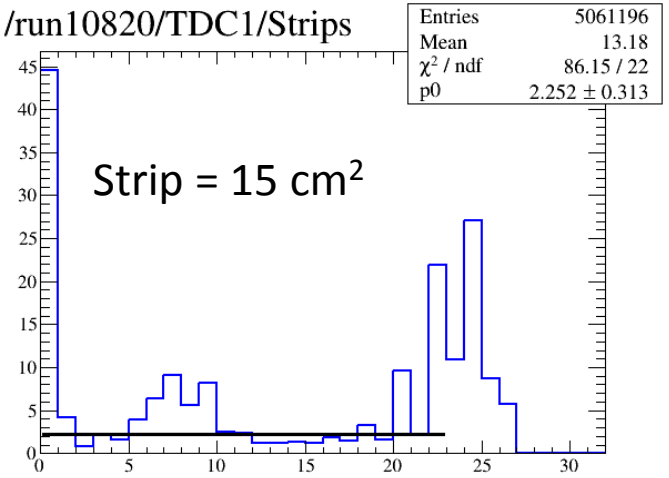
13-2-2

Run 10820



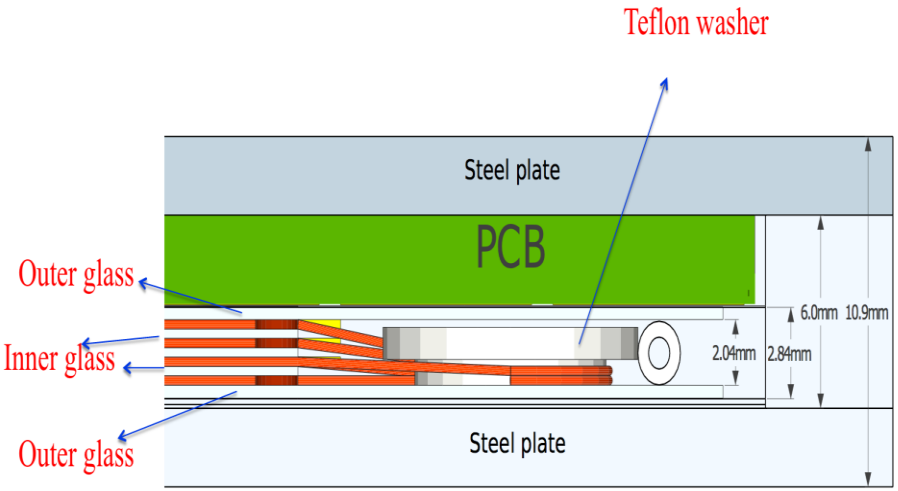


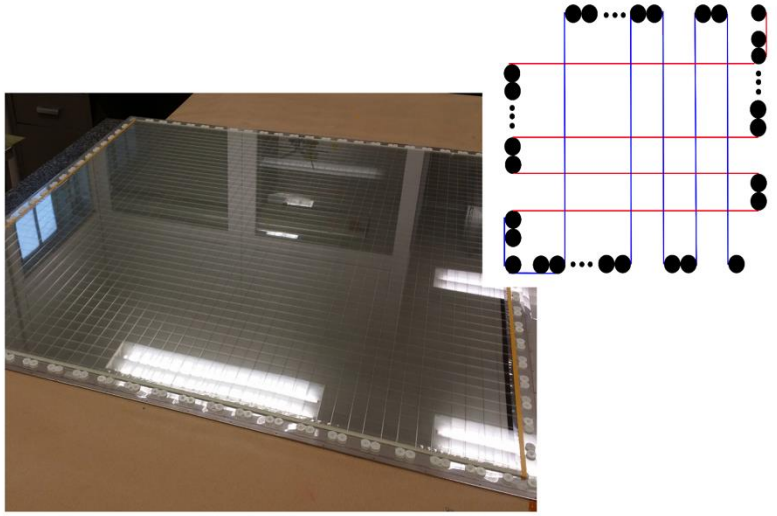


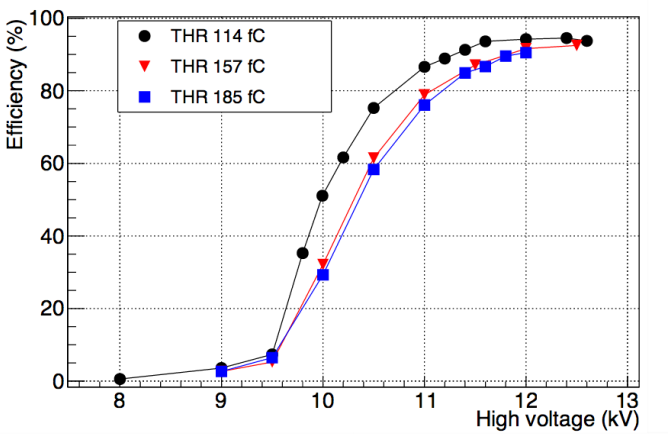


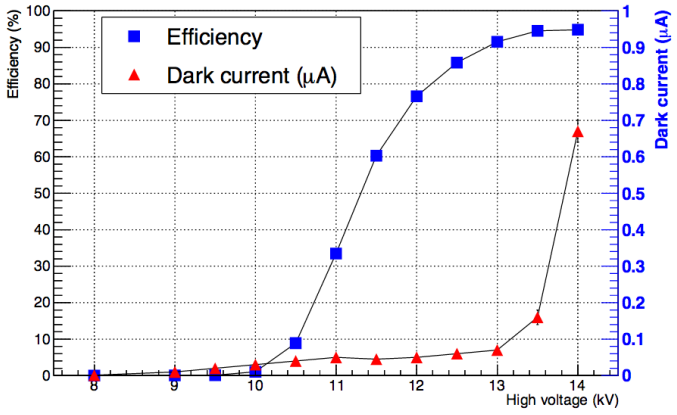
13-2-2

Several Multi-gap detectors were designed and built . Excellent efficiency when tested with HARDROC ASICs





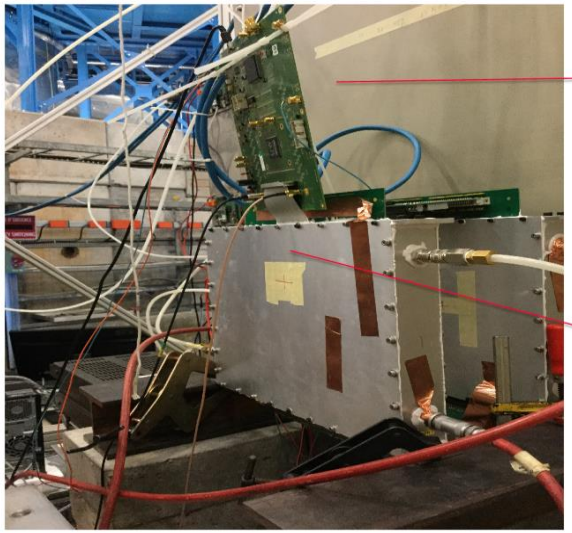




Threshold sets at 114 fC

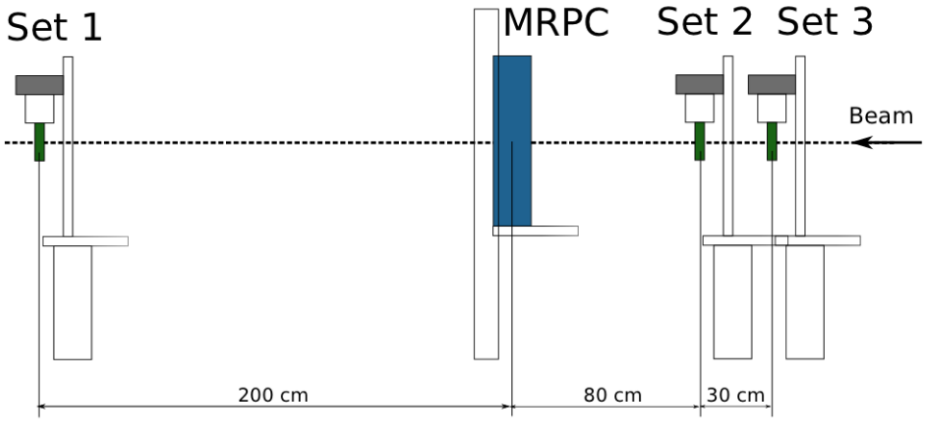
A new PCB with pickup pads read out with PETIROC was developed and used to test timing of small MRPC

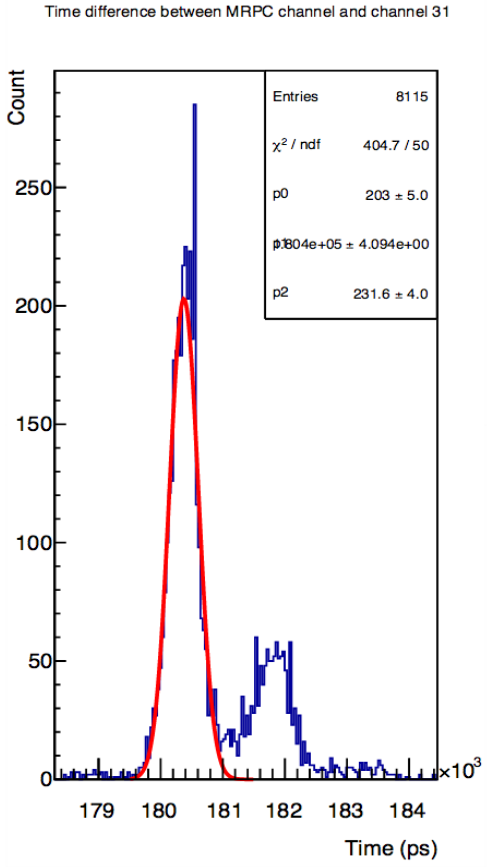
13-2-2



Petiroc2 testboard

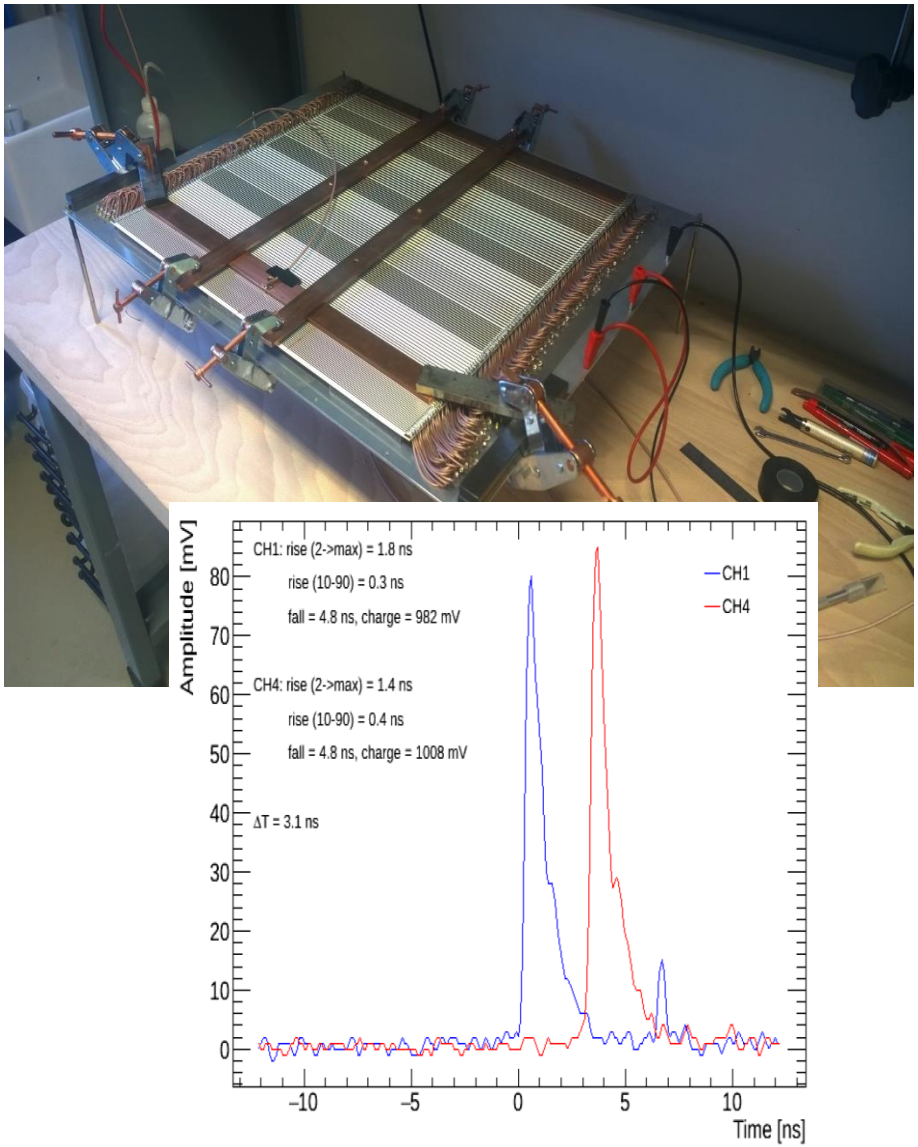
MRPC with 32 1 cm x1 cm pads.





Strip readout PCB – signal propagation study

13-2-2



PCB with readout strips, several configurations of pitch and width, SMA connectors

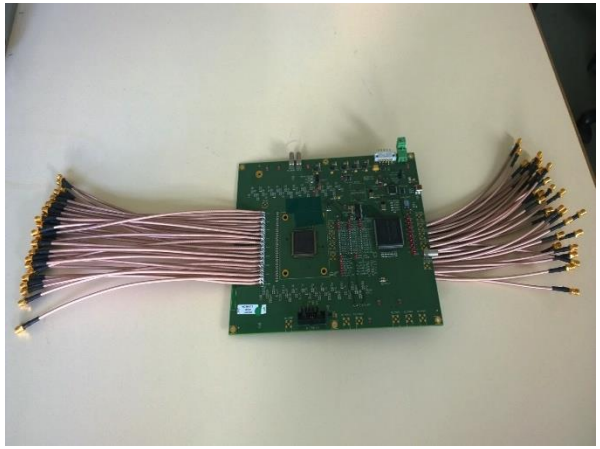
Signal propagation integrity, impedance matching

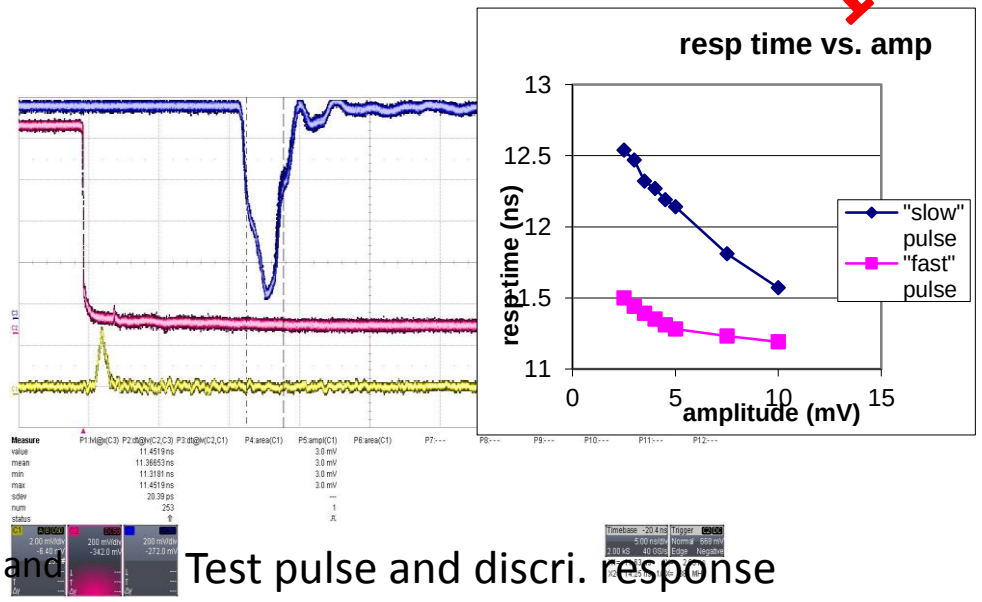
proof of concept of reconstruction using fast pulser and scope (~1.4 ps rms)

Used for study of prototype chambers

Evaluation of PETIROC ASIC for RPC readout

13-2-2





Test pulse and discri. response

Tests with fast waveform generator and oscilloscope

- Test pulse = triangle 500 ps fwhm

Minimal amplitude for « clean » discrimination

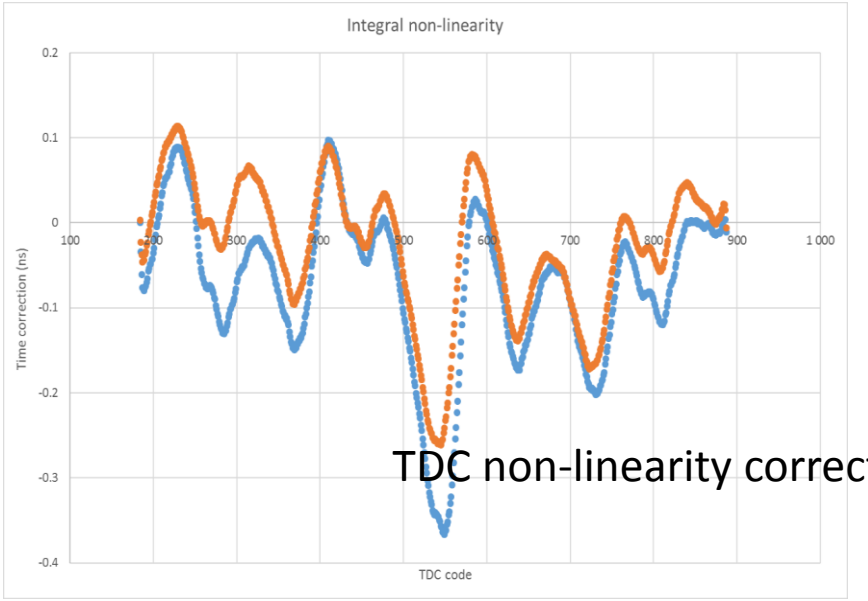
- Clock off : <2 mV (24 fC in present conditions)
- Clock on : ~10 mV (120 fC)

Jitter (discriminator output) :

- Clock off ~20 ps
- Clock on ~50 ps

Internal TDC test

- 150 ps rms (time difference / 2 channels)
- after correction of non-linearity : 60 ps rms (idem)

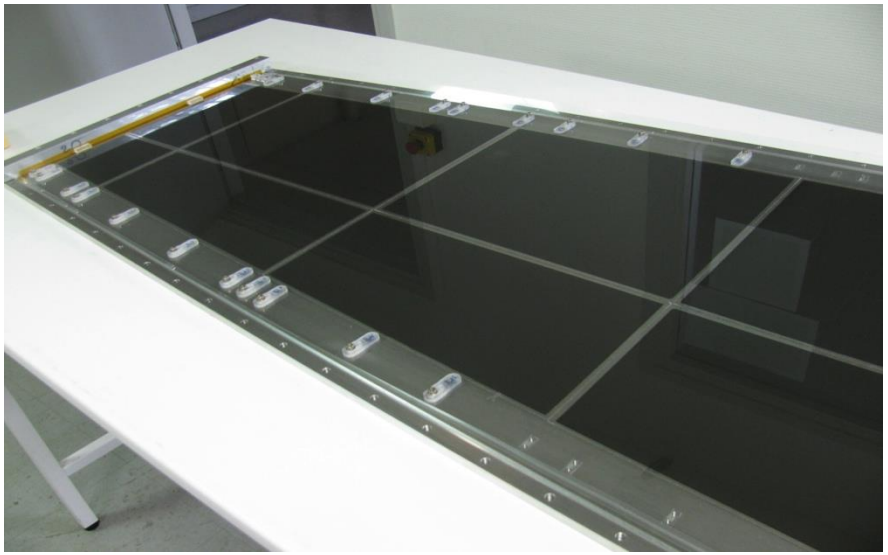


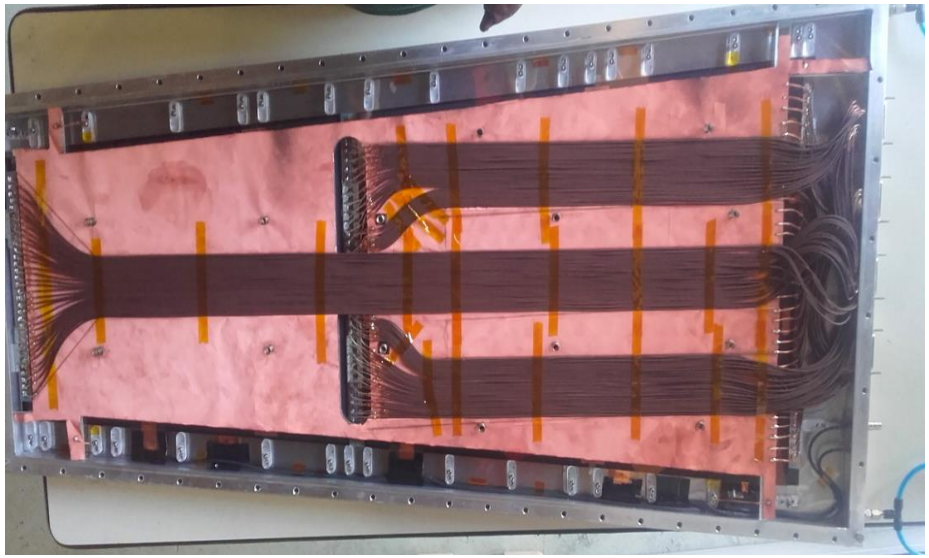
TDC non-linearity correction

13-4-6

Large Chamber Realization

Large HPL realization is ok. For other materials such as the doped glass produced in small pieces. Several designs tried and robust ones are selected





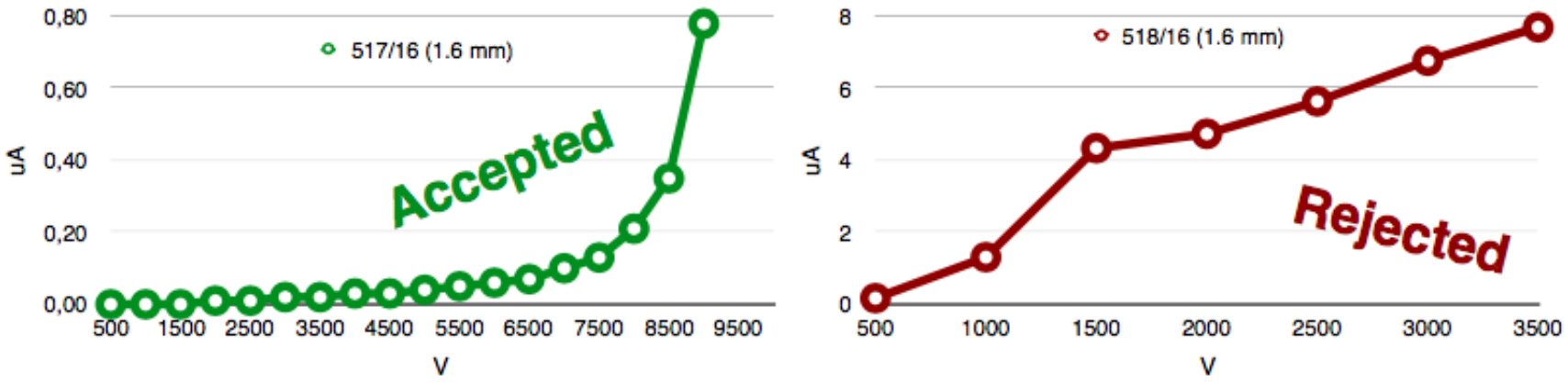
The construction of a large RPC (about 1 m^2) using small pieces of doped glass (30 x 30 cm2) by mechanical fixation with gas-tight cassette successfully done.

Chamber Certification

13-4-6

To guarantee high quality of the production, quality controls and assurance have been defined during all production steps:

1. **Electrode resistivity measured.**
2. **Control of gap production.** Protocols for leak, HV tests have been defined and criteria selection applied in order to accept or reject the gaps.

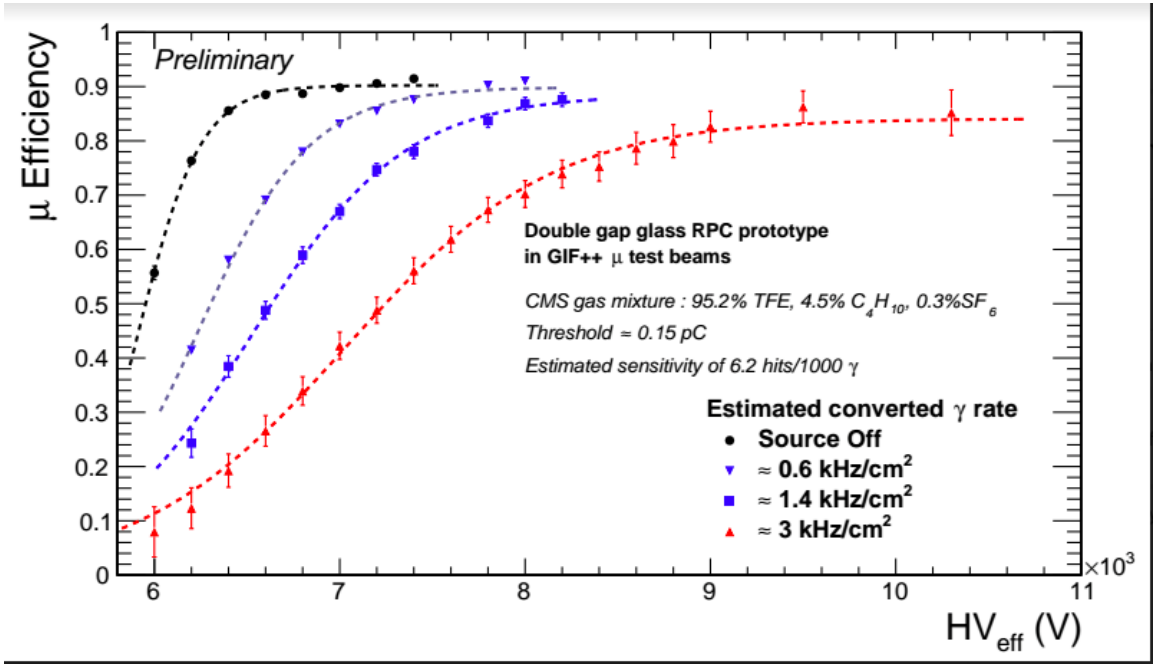


Example of I vs. HV for one accepted and one rejected RPC

Chamber Certification

13-4-6

RPC prototypes have been certified first with cosmic muons, then at the CERN Gamma Irradiation facility with muon beam in different background conditions.



Conclusion

New resistive materials are being developed, tested and detectors built using these materials are conceived to ensure high rate capabilities.

Fast timing RPC with adequate electronics are being built and some are successfully tested. Several applications : muons, calorimetry and volcanoes tomography

Large detectors techniques and certification protocols are in an advanced stage. Main goal is the preparation of HL-LHC upgrade muon projects