

*Testarea in fascicul de particule minim ionizante si in mediu cu rate mari de numarare a prototipului de detector RPC cu electrozi rezistivi din sticla de rezistivitate joasa si electrod de citire a semnalelor cu granularitatea ceruta de zona centrala a subdetectorului TOF al experimentului CBM*

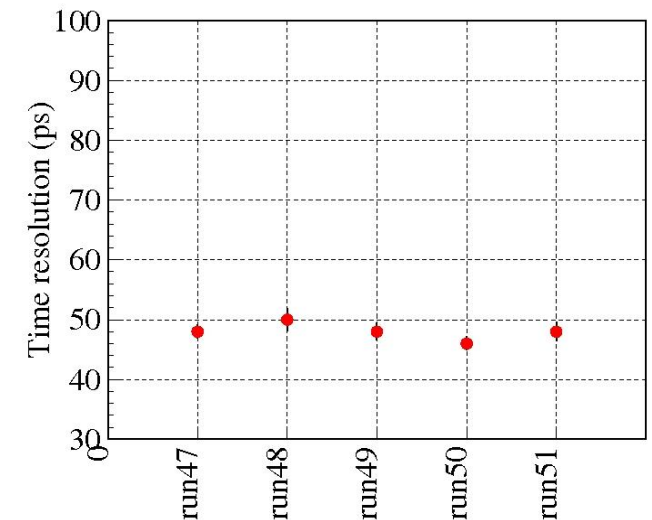
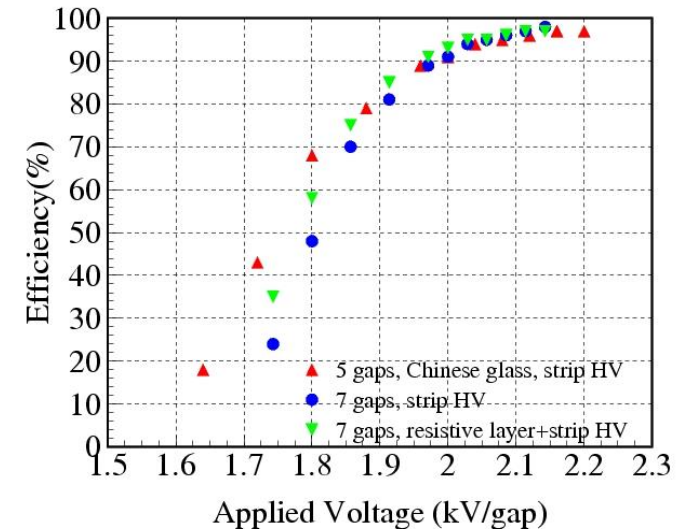
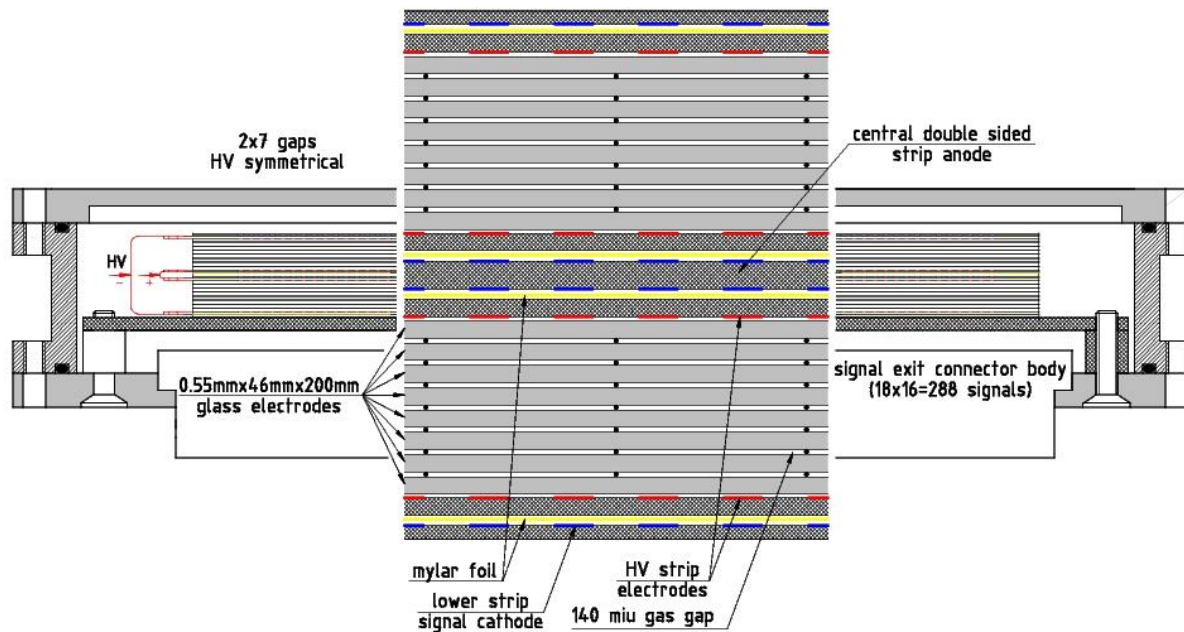
*Proiect Fizica Hadronica3*

*Director Proiect: Prof. Dr. Mihai Petrovici*

# *OUTLINE*

- *Short update of the constructive details of the tested RPCs*
- *COSY experimental setup*
- *Experimental results*
  - *Efficiency and time resolution*
  - *Counting rate performance*
- *Conclusions and Outlook*

# High granularity, differential, strip readout, multi-gap, timing RPC



Symmetric two stack structure, differential readout

Active area: 46 x 180 mm<sup>2</sup>

Gas gap thickness: 140 μm thickness

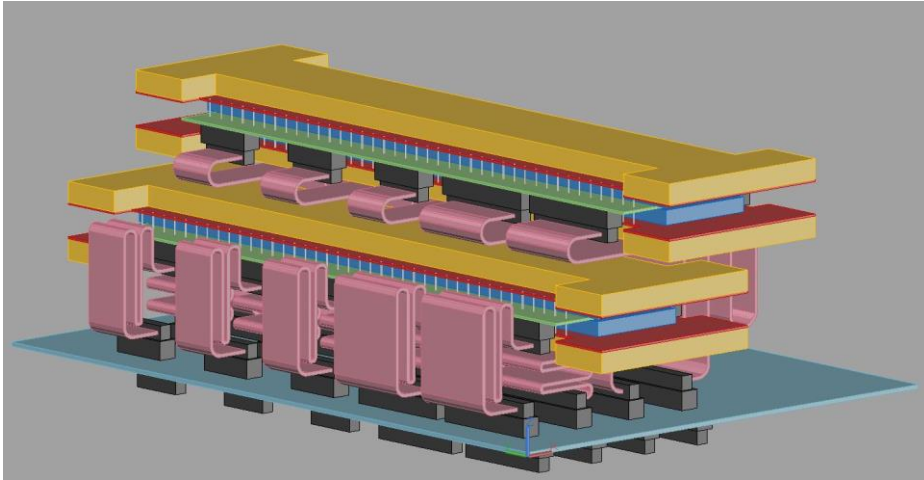
Readout electrodes: 1 double sided anode + 2 single sided cathodes made from pcb with copper strips

2.54 mm strip pitch = 1.1 mm strip width + 1.44 mm gap width

Resistive Electrodes: low resistivity glass: 0.7 mm

*M. Petrovici et al., High counting rate, two-dimensional position sensitive timing RPC, JINST 7 P11003, 2012*

## *2 MRPC mounted in the same gas tight box in a staggered geometry*



*6 mm strip overlap*

*Symmetric two stack structure: 2 x 5 gas gaps*

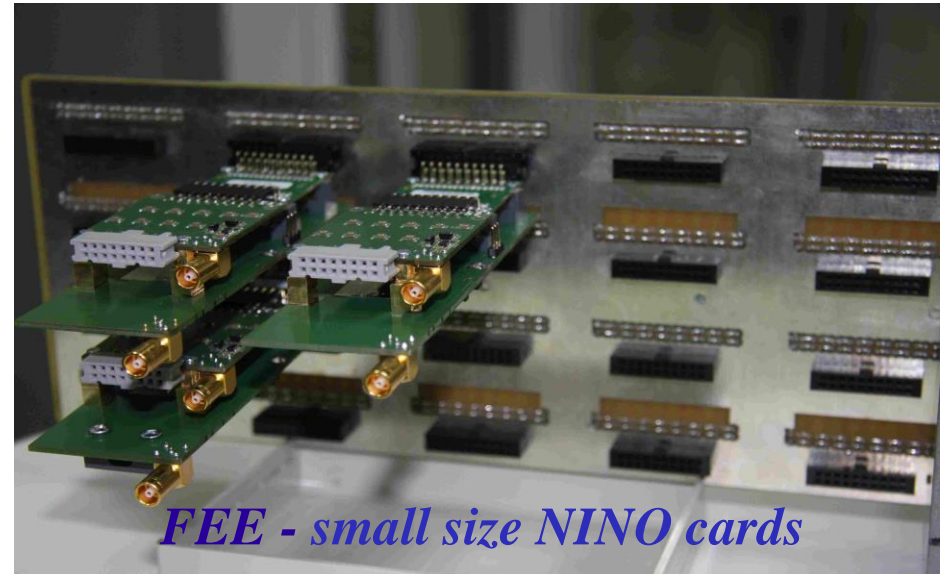
*Differential readout*

*Active area 96 x 300 mm<sup>2</sup>*

*Electrodes: low resistivity glass: 0.7 mm*

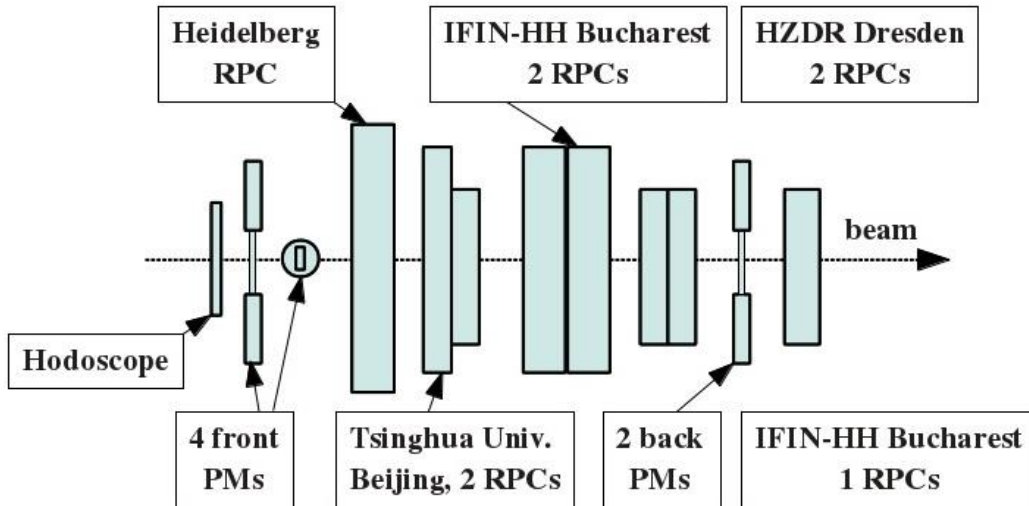
*Gap size: 140 μm thickness*

*Strip pitch = 7.1 mm = 5.6 mm (w) + 1.5 mm (g)*

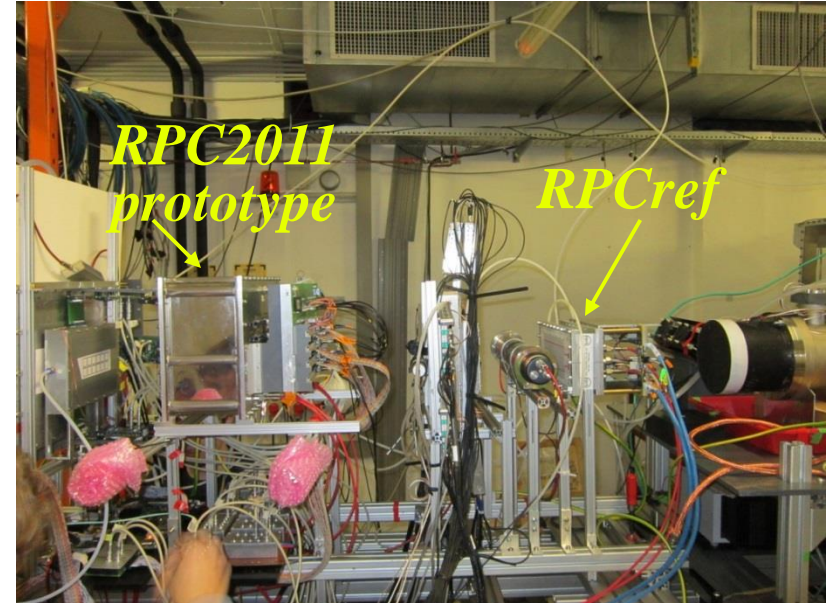


*FEE - small size NINO cards*

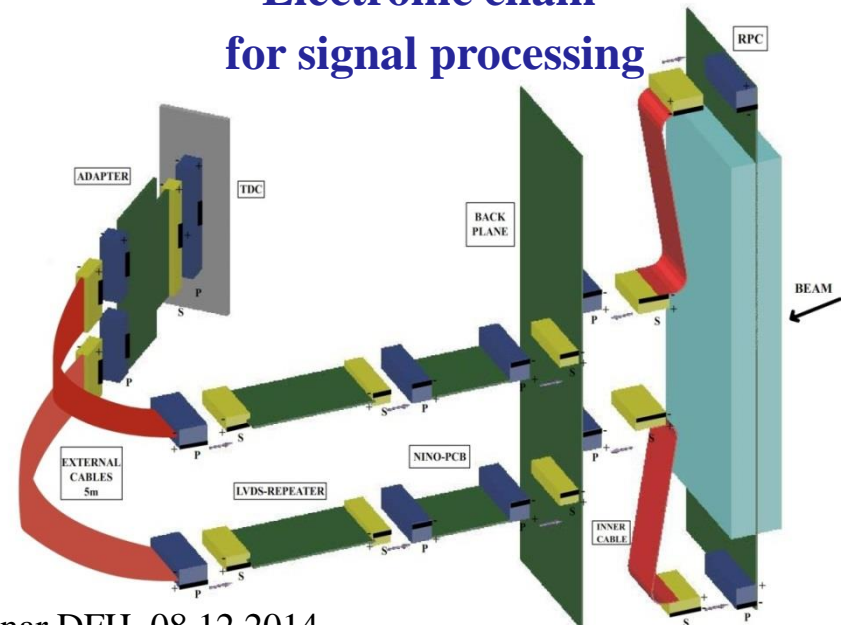
# In-Beam Test @ COSY



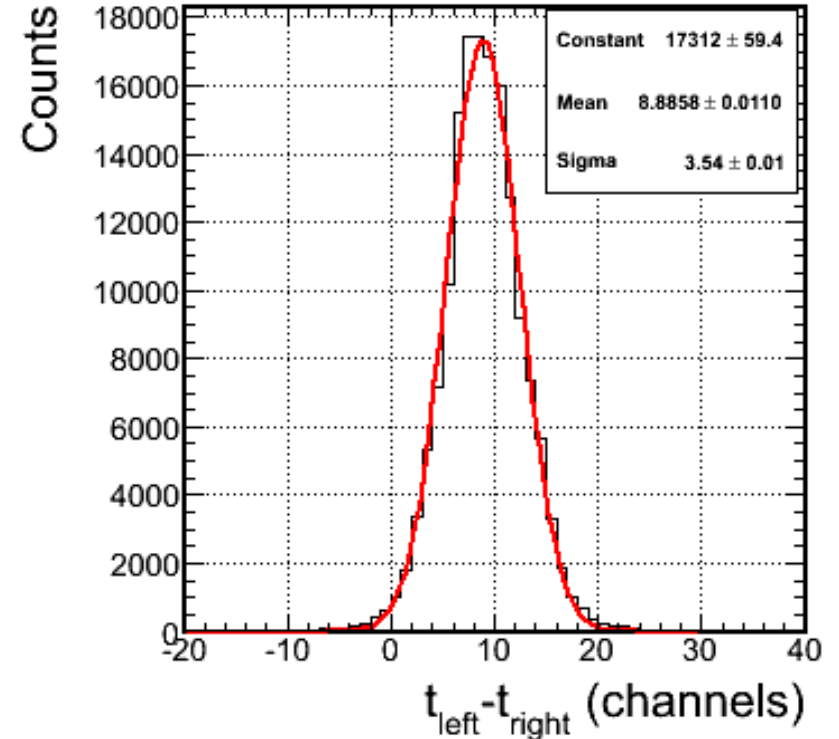
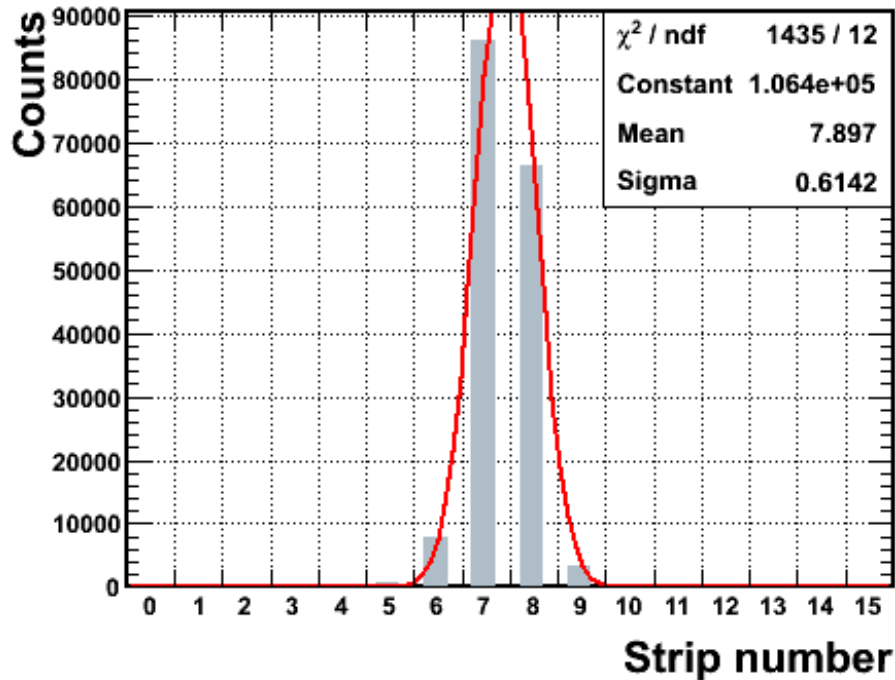
- p beam, 2 GeV/c momentum
- 1 Hodoscope for beam profile
- 2 plastics scintillators readout by 4 PMs for time reference & trigger
- 1 RPC Heidelberg University
- 2 RPCs Tsinghua University, Beijing
- RPC2011 IFIN-HH Bucharest
- 2 RPCs HZDR Dresden
- RPCref reference counter (IFIN-HH Bucharest)
- 1 plastic scintillator readout by 2 PMs for trigger



**Electronic chain  
for signal processing**



# Beam profile



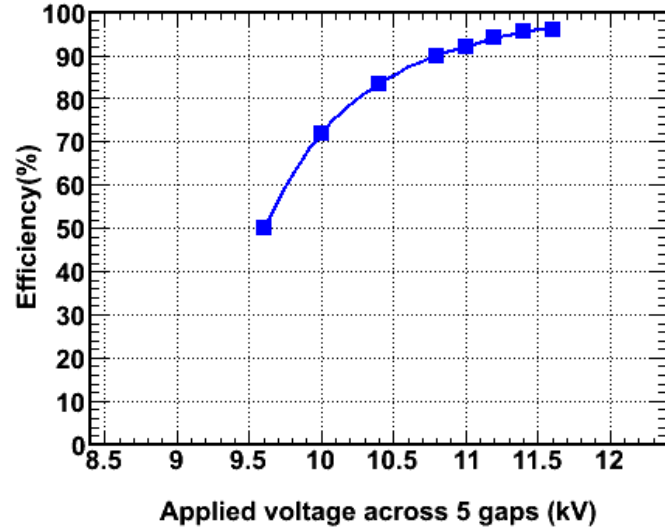
## Rate estimation

$$\text{Beam area} = 3.14 \cdot \sigma_x \cdot \sigma_y = 0.97 \text{ cm}^2$$

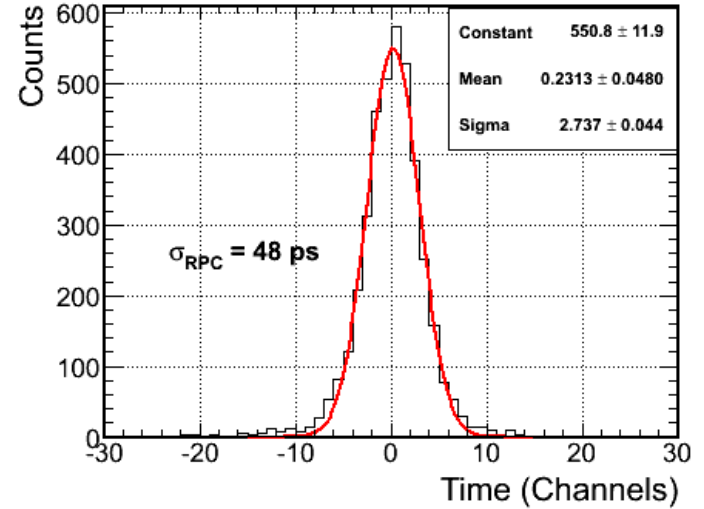
$$\text{Counting rate} = (0.68)^2 (\text{no. of triggers}) / \text{Beam area}$$

# In-Beam Tests @ COSY

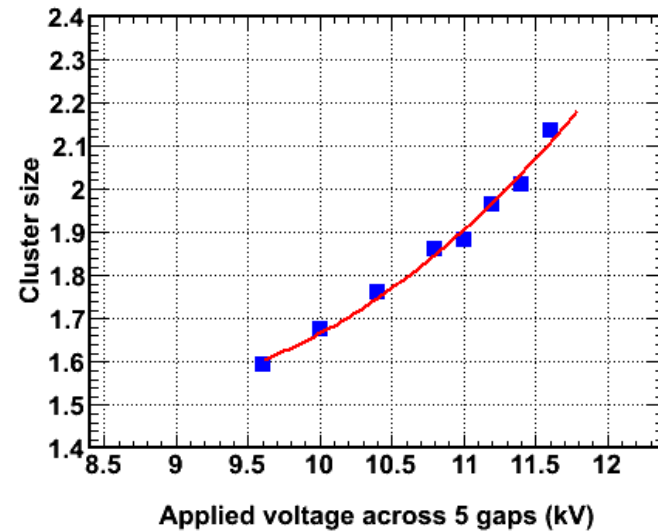
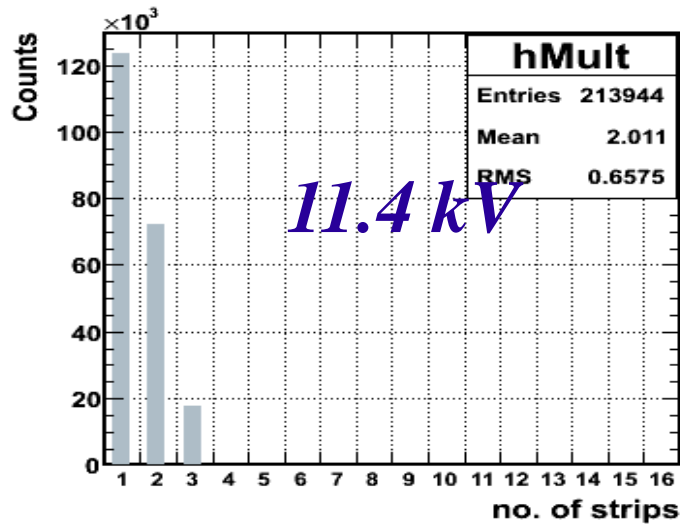
## High voltage scanning



## Time resolution

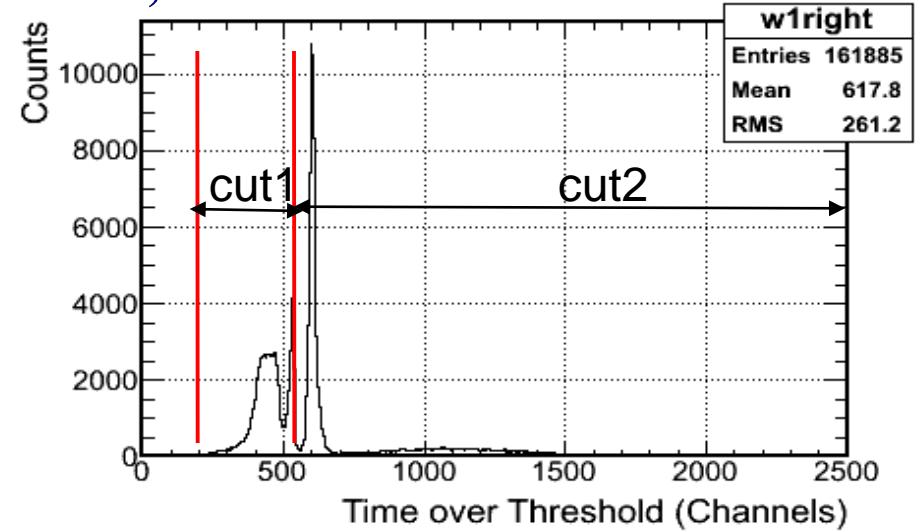
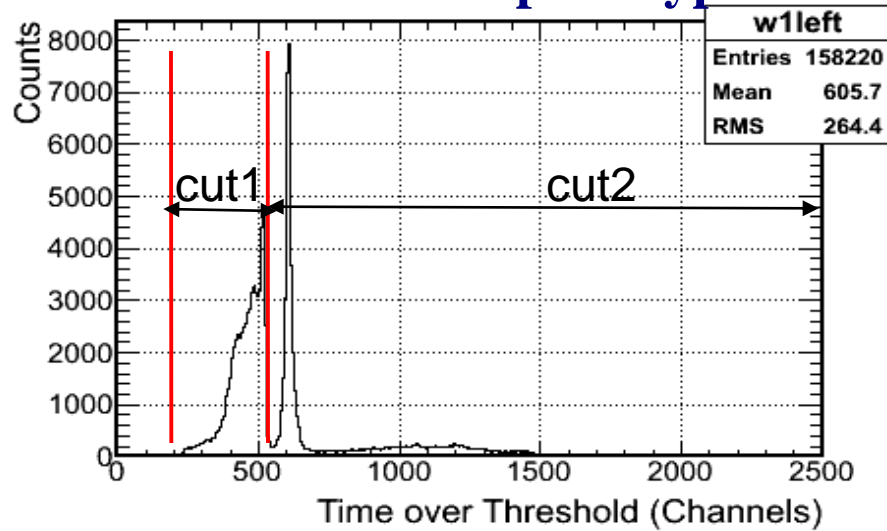


## Cluster size

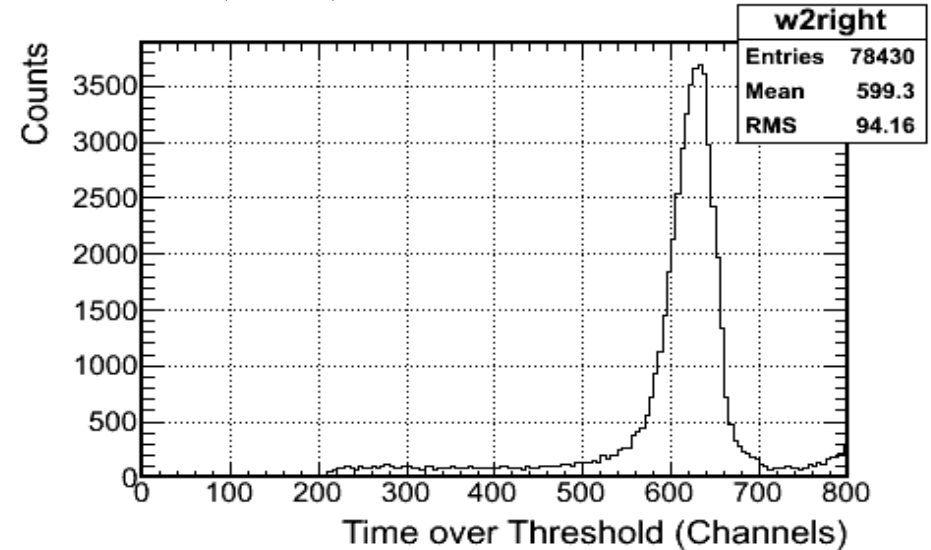
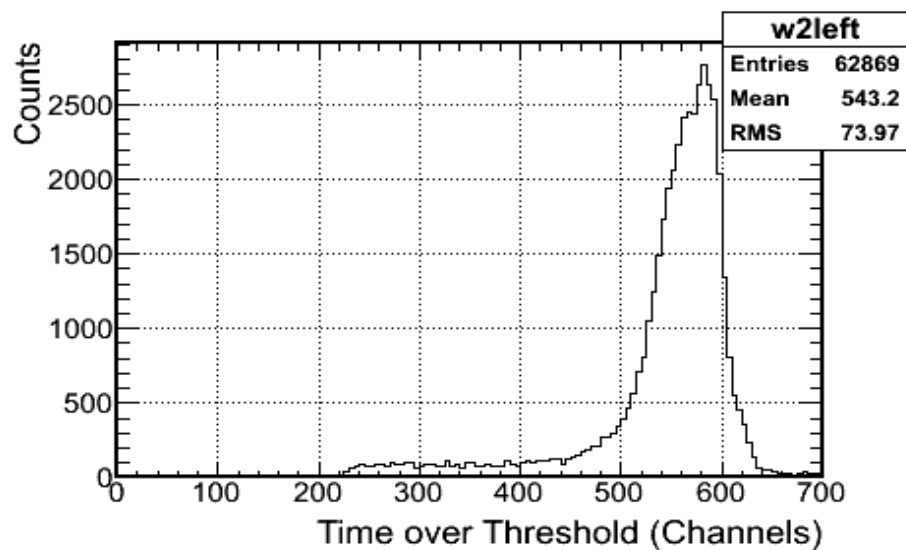


# Time over threshold distributions analysis cuts

New RPC prototype  $200 < \text{cut1} < 550$ ;  $550 < \text{cut2} < 2500$



Reference RPC (cut0)



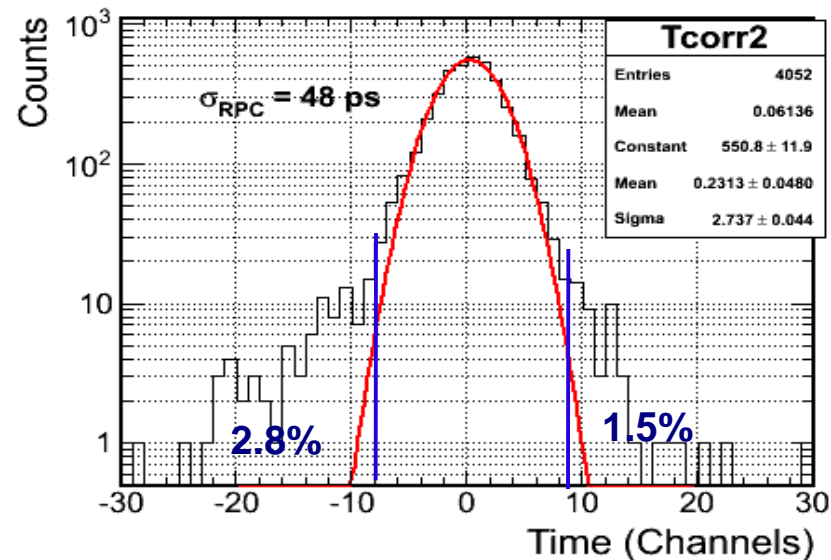
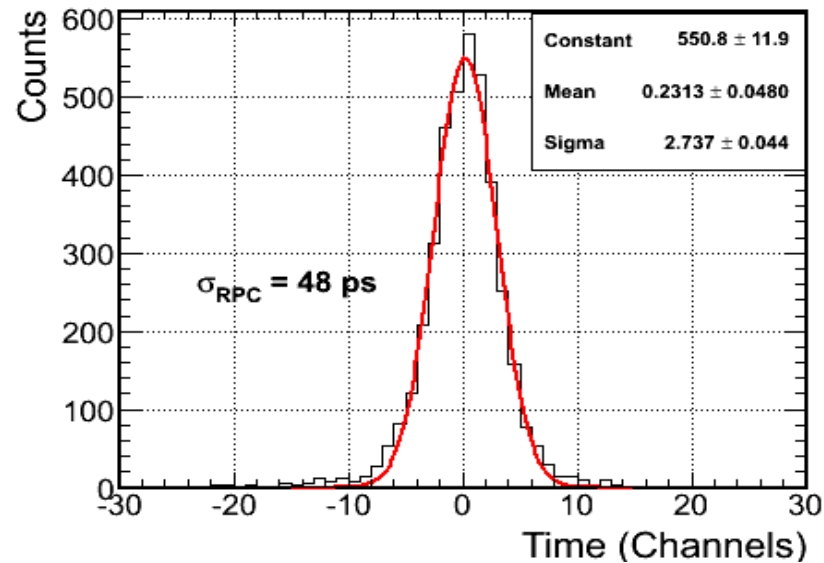


# Time resolution using both RPCs (cut1)

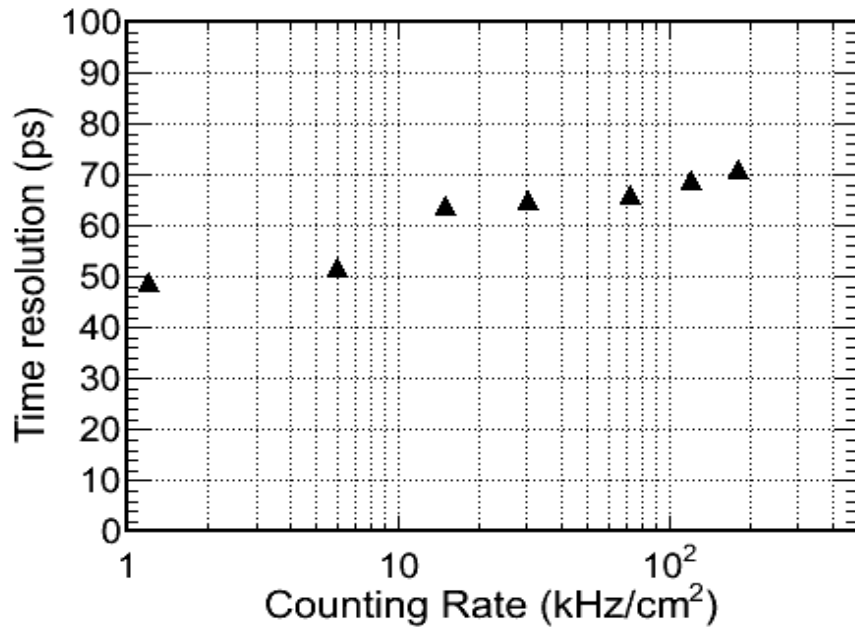
*The time resolution was obtained for the 6 mm overlap of the strips of the two counters*



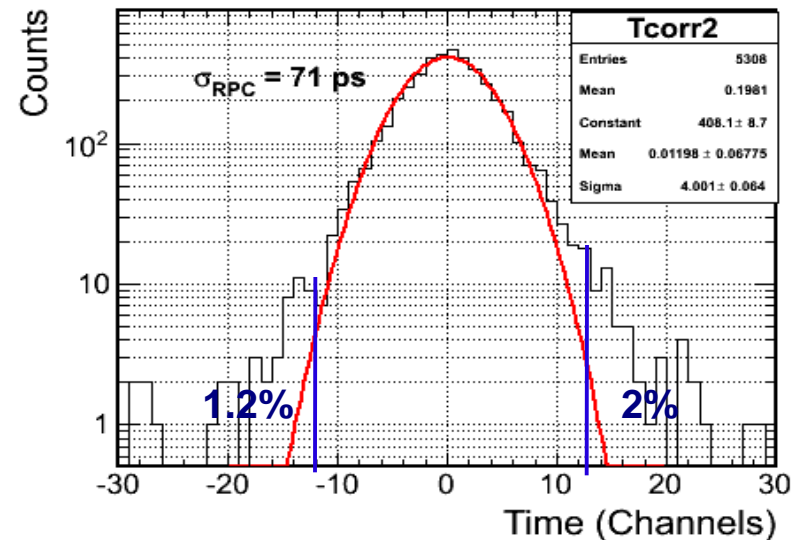
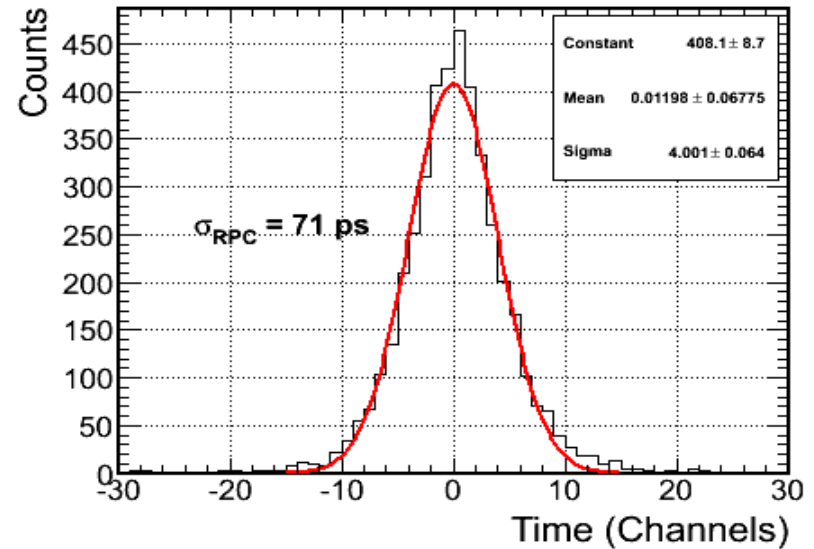
Counting rate = 700 Hz/cm<sup>2</sup>



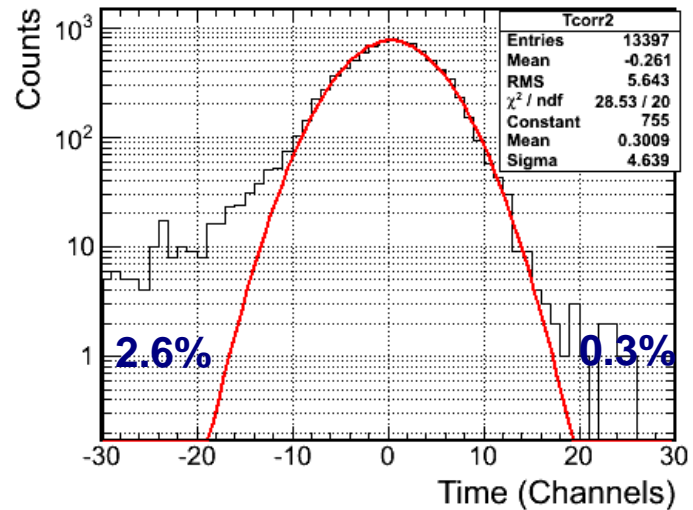
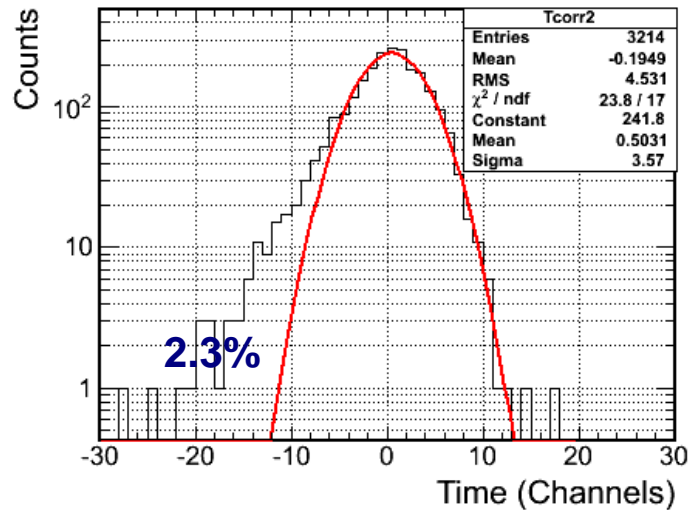
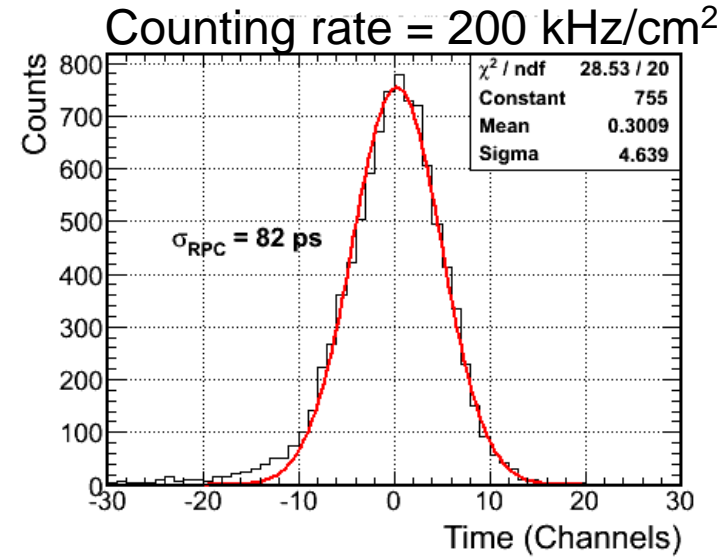
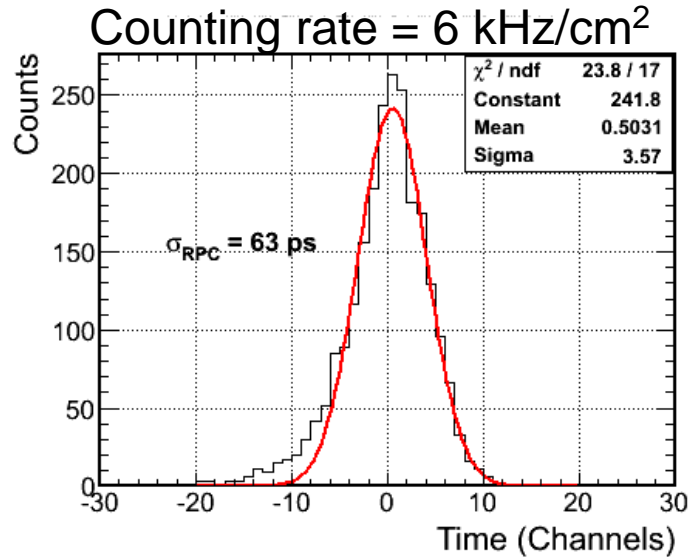
# Time resolution using both wide strip RPCs as a function of counting rate (cut1)



Counting rate = 180 kHz/cm<sup>2</sup>



# Time resolution vs. Counting rate using as reference narrow strip RPC4 (cut1+cut0)

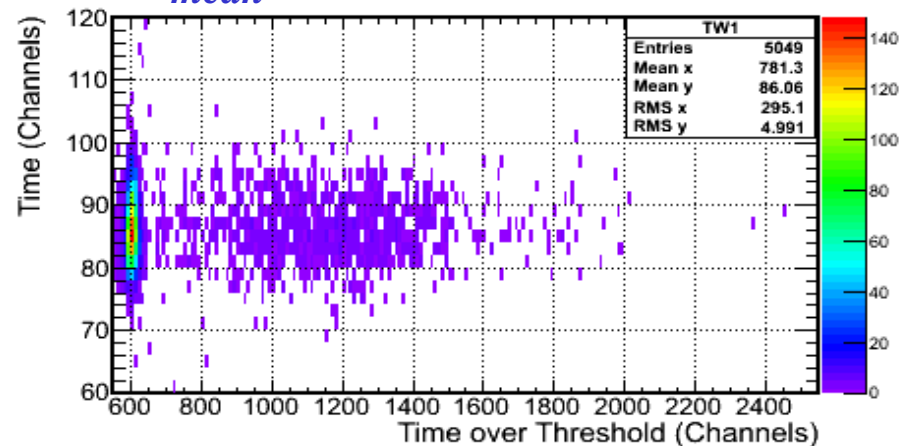
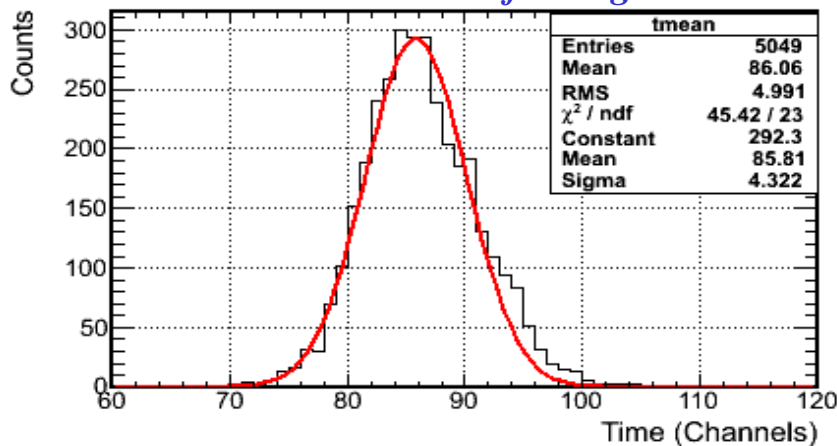


# Time resolution vs. Counting rate using as reference narrow strip RPC4 (cut2+cut0)

Counting rate = 6 kHz/cm<sup>2</sup>

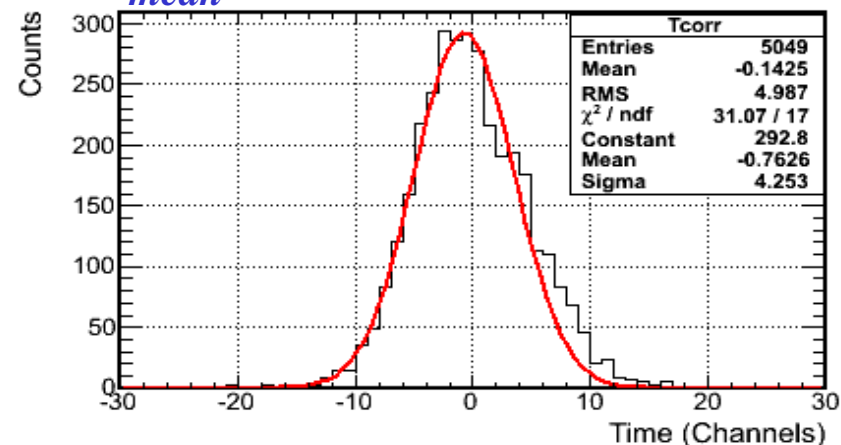
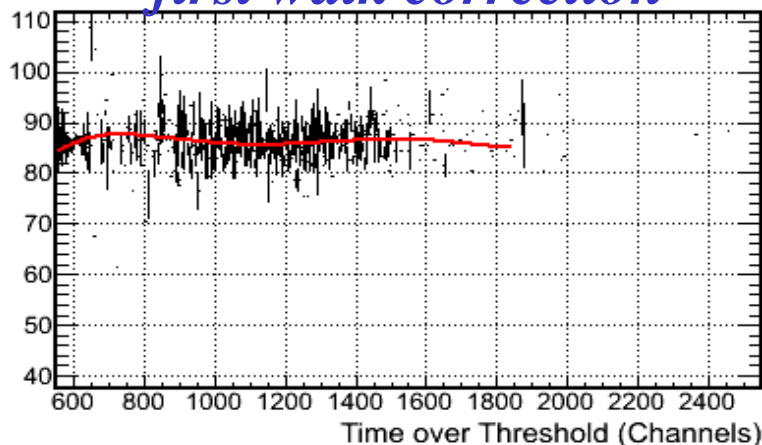
$$t_{mean} = 1/2(t_{left} + t_{right})$$

$t_{mean}$  vs. ToT for new RPC



first walk correction

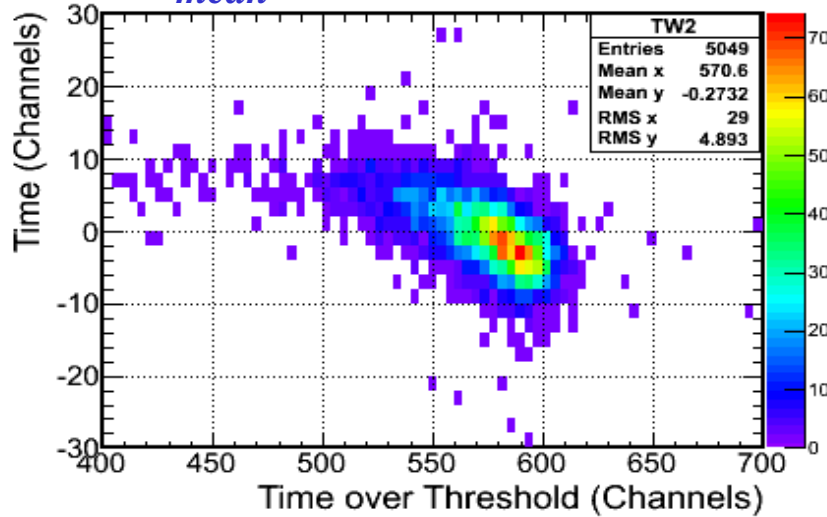
$t_{mean}$  after first walk correction



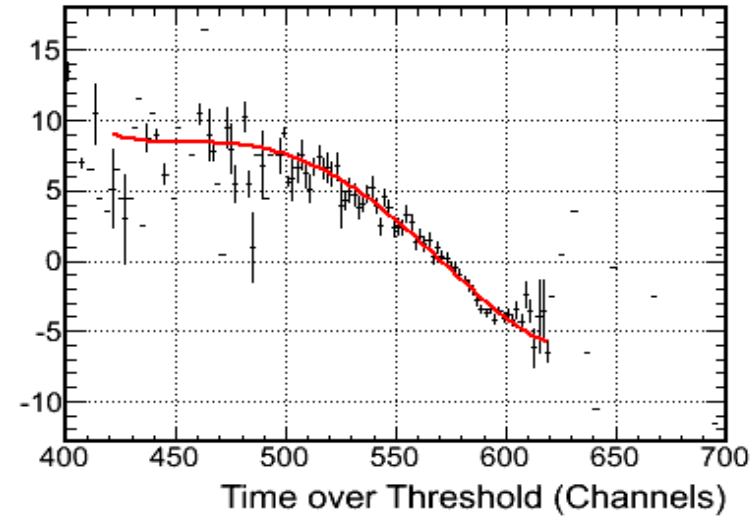
# Time resolution vs. Counting rate using as reference narrow strip RPC4 (cut2+cut0)

Counting rate = 6 kHz/cm<sup>2</sup>

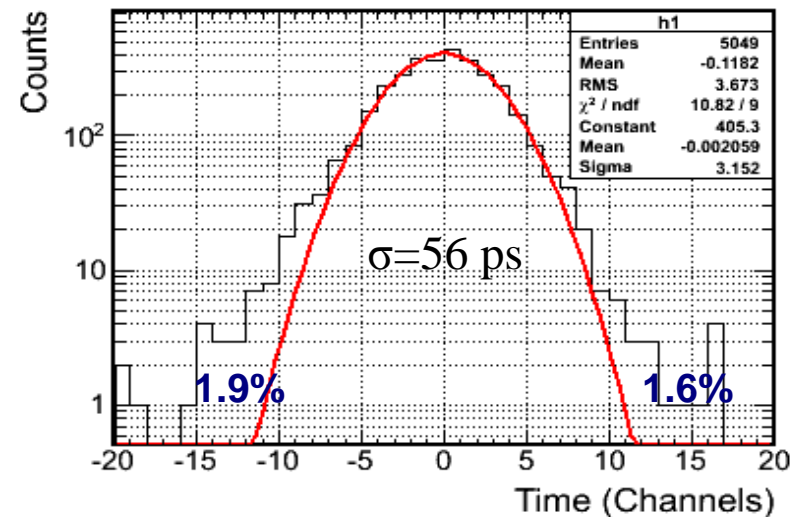
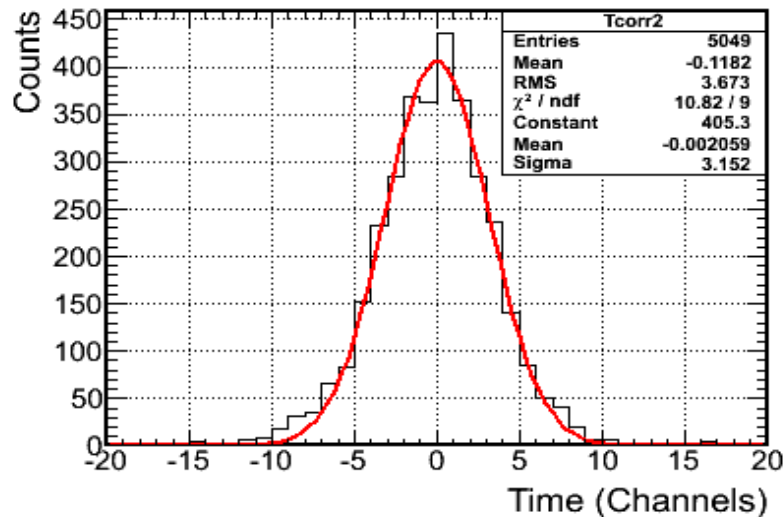
$t_{mean}$  vs. ToT for RPC4



second walk correction

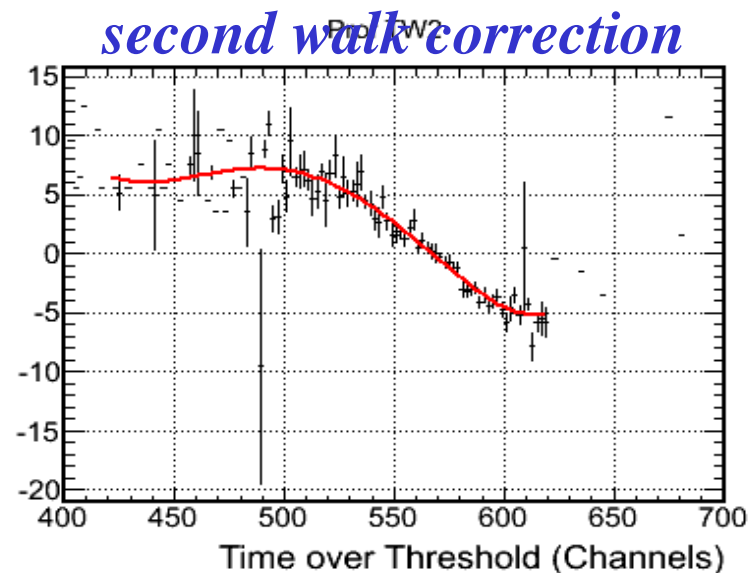
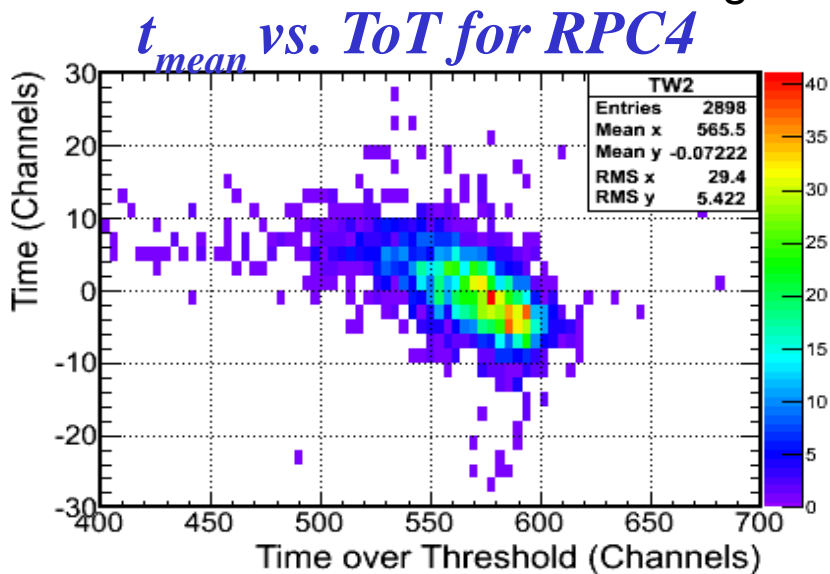


walk corrected time spectrum

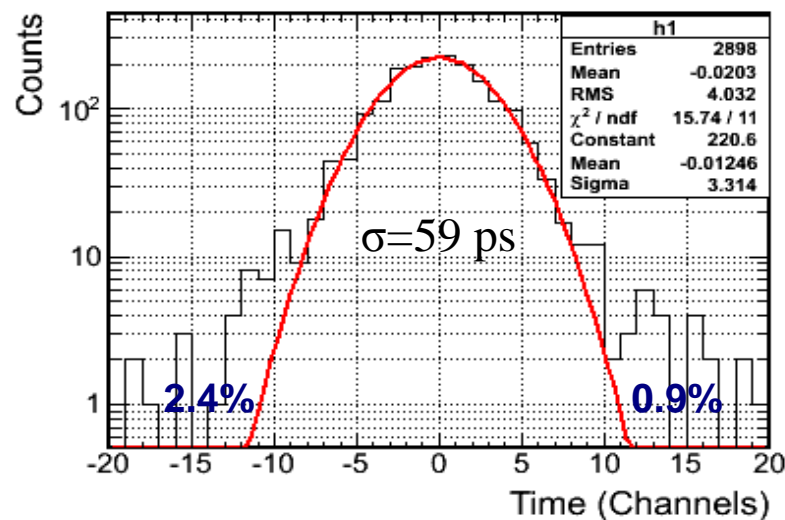
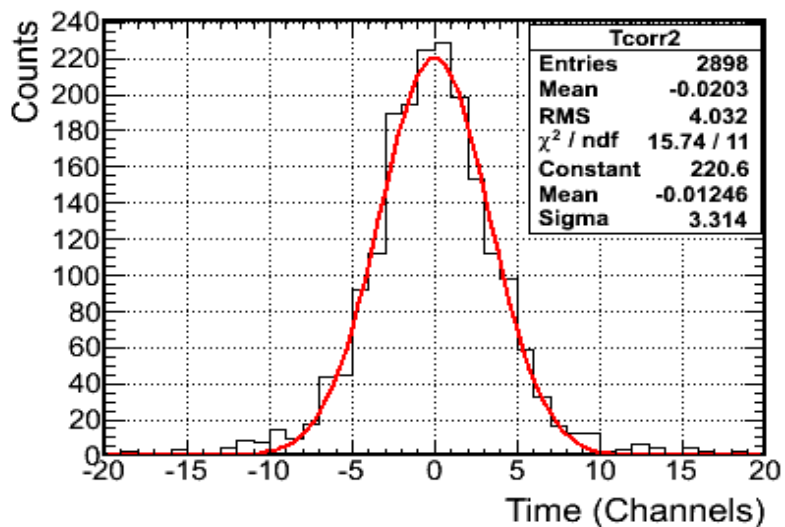


# Time resolution vs. Counting rate using as reference narrow strip RPC4 (cut2+cut0)

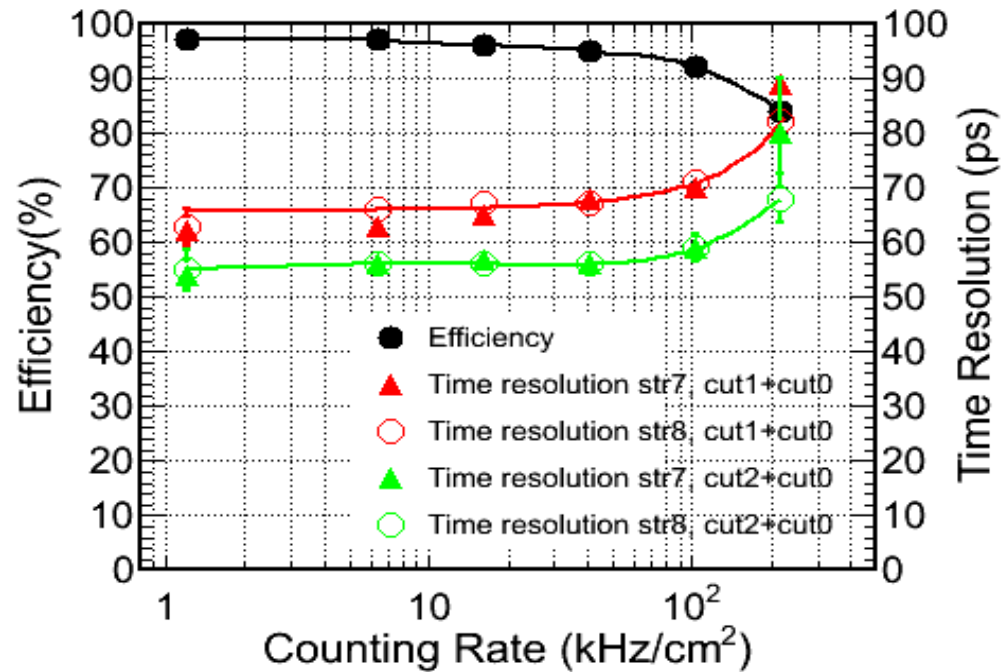
Counting rate = 100 kHz/cm<sup>2</sup>



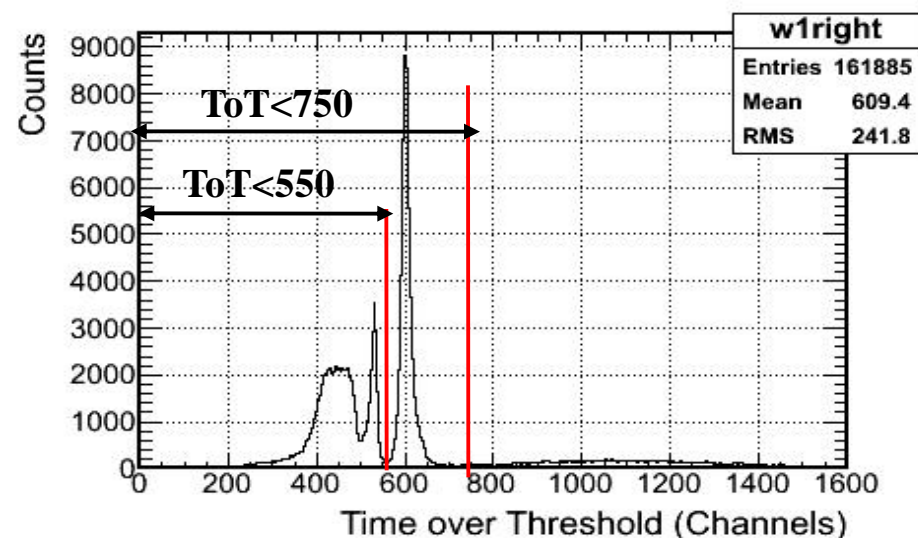
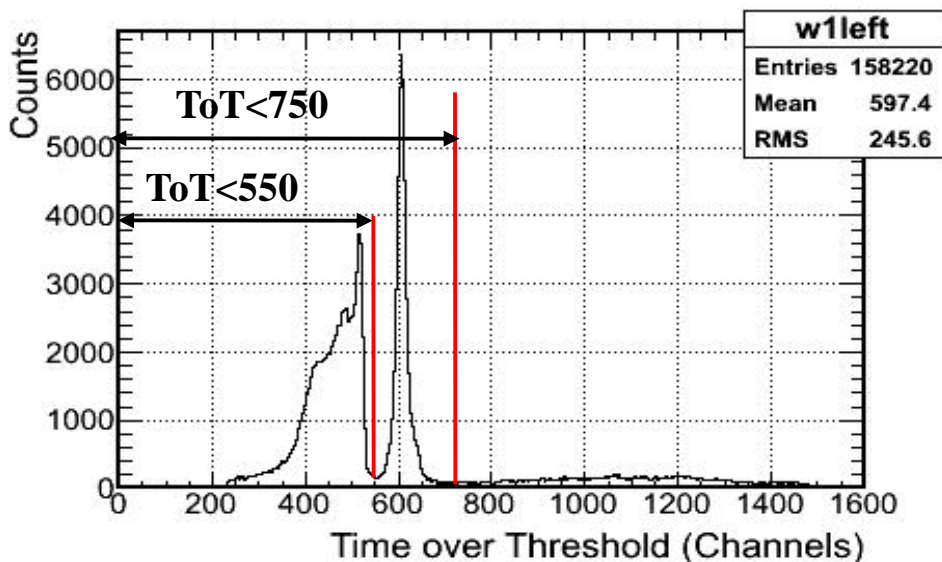
## walk corrected time spectrum



# *Efficiency, and Time resolution vs. Counting rate*



# Efficiency vs. Counting rate



run	Rate (kHz/cm <sup>2</sup> )	Efficiency (%)		
		ToT < 550	ToT < 750	ToT < 1550
53	1.2	65%	89%	96%
54	6.4	66%	90%	96%
55	16	69%	92%	96%
56	41	72%	92%	94%
57	104	74%	91%	92%
58	218	73%	83%	83%



# Conclusions & Outlook

- *The COSY November 2011 in-beam test results showed:*
  - *detection efficiency plateau @ 96%*
  - *average cluster size of 2 strips*
  - *time resolution ~ 50 ps*
- *COSY November 2011 high counting rate test showed: at 100 KHz/cm<sup>2</sup> the time resolution is around 70 ps, the efficiency is better than 90%*
- *Based on the obtained results, a new prototype with a basic architecture of a CBM-TOF module (staggered arrangement on two direction), was designed, constructed and tested.*
- *Reported results are published in:*
  - *M. Petris , M. Petrovici, “Multi-strip RPC for high counting rate experiment”, Vol. 533 of Journal of Physics: Conference Series, 012009, 2014, (Proceedings of the 2013 International Varna School on Nuclear Physics – invited talk)*
  - *CBM Collaboration, CBM-TOF TDR*