Status Differential Strip RPC's

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Outline

- ***Motivation***
- ***Pestov Glass RPC Prototypes – short review***
  - ***Construction Details***
  - ***In-Beam tests***
- ***Pestov Glass RPC Prototype – high activity ^{137}Cs source tests***
  - ***Experimental Details***
  - ***Test results***
- ***High granularity differential readout RPC***
  - ***Construction Details***
- ***Conclusions and Outlook***

RPC Counting Rate Performance

- ***"Classical MSMGRPC"***

  keeps the performances up to ~1 kHz/cm^2 (ρ_{glass} ~ 10^{12} Ωcm)

  ⇒ is recommended for a major part of the TOF – CBM subdetector
- ***ToF – CBM at small polar angles ⇒ high counting rate environment***

  (~ 20 kHz/cm^2)
- ***Solutions:***
  - ***Electrodes with lower resistivity***
  - ***Smaller and many gaps, thin glass electrodes***
- ***Our prototypes were built using Pestov glass with ρ ~10^{10} Ωcm.***

Construction details of the standard – readout Pestov glass RPC prototype

Electrode sequence:

- *2 mm aluminum – cathode*
- *0.3 mm nylon fishing line*
- *2 mm glass plate (supporting the spacers)*
- *0.3 mm nylon fishing line*
- *2 mm glass plate*
- *0.5 mm double faced strip readout plate*

symmetry plane

Readout electrode:

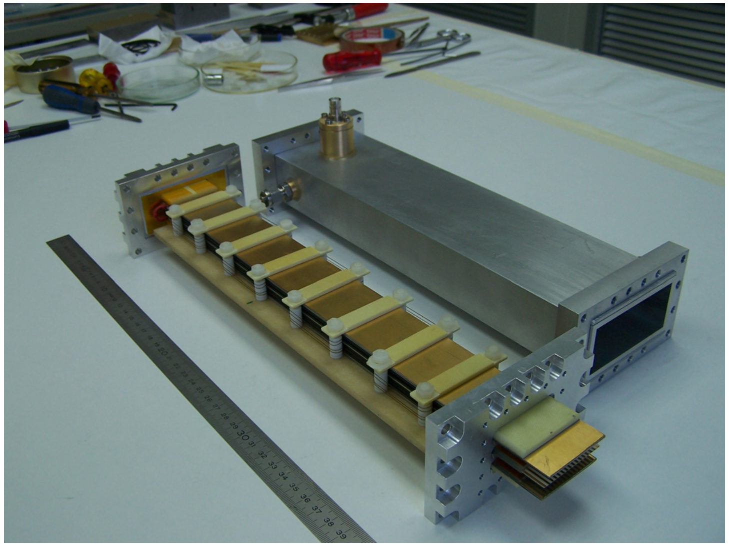
- *support:0.5mm thick pcb plate*
- *14 copper coated strips on each side*
- *pitch: 2.54 mm, 1.10 mm strip width, 1.44 mm gap width*

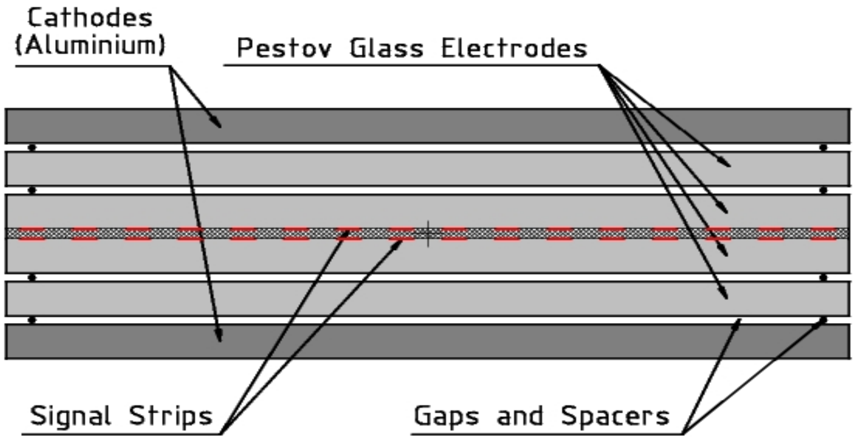
Sizes:

glass electrodes: 40.6 x 300 mm^2

readout plate: 0.5 x 40.6 x 360 mm^3

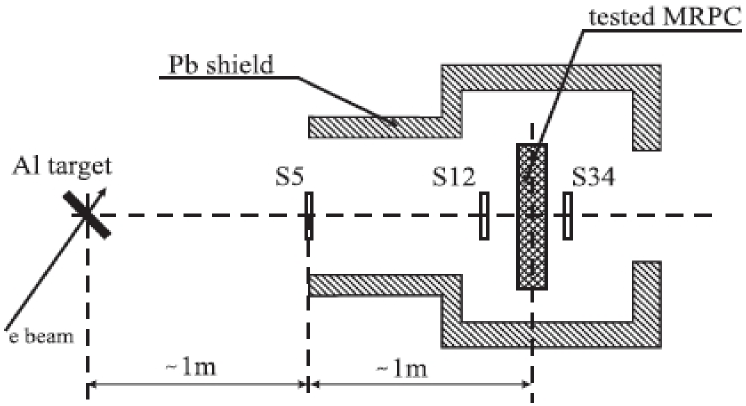
housing: 40 x 80 x 330 mm^3 Al box





In-Beam Tests

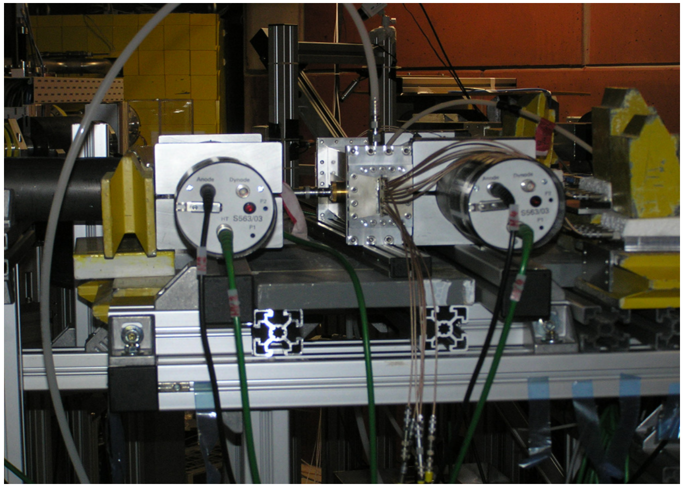
@ ELBE (Electron Linac with high Brilliance and low Emittance)
Forschungszentrum Dresden-Rossendorf

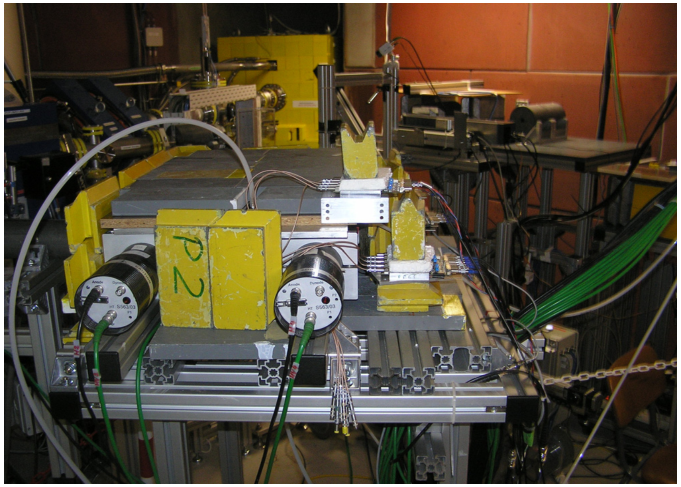


V. Ammosov et al., Nucl. Instr. And Meth. A 576 (2007), 331

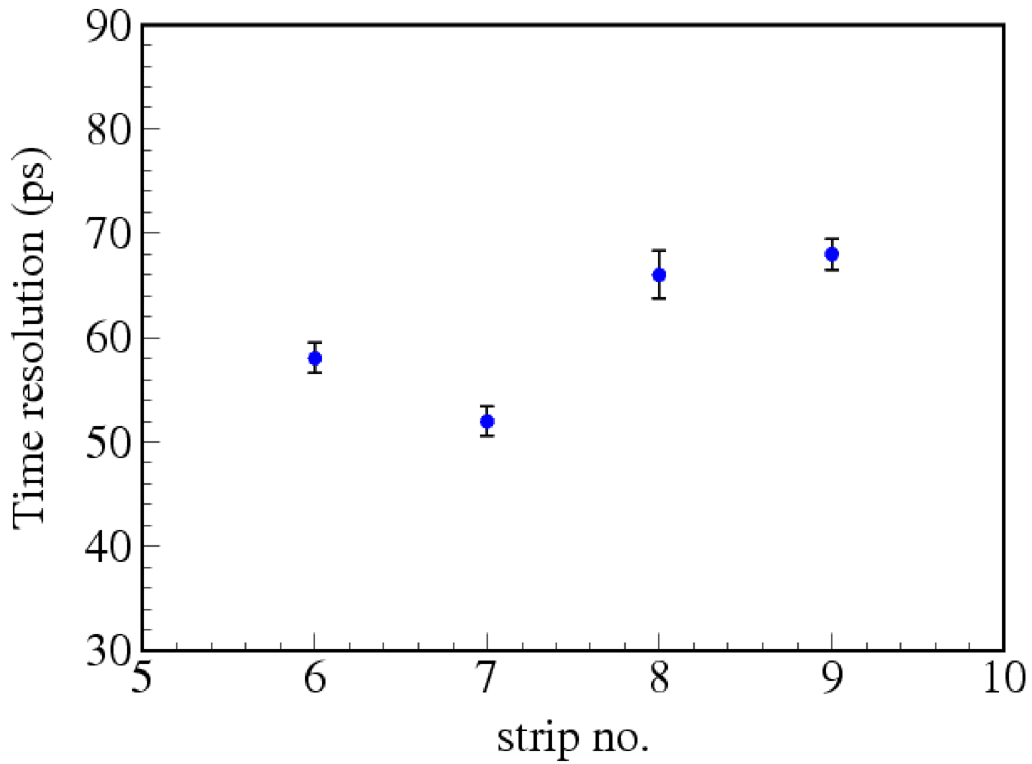
Experimental setup:

- ***electron beam, 30 MeV, scattered @ 45^0 by a 18 μm Al foil;***
- ***plastic scintillators S5(XP2972), S12(XP2020), S34(XP2020), (2 x 2 cm^2) used for active collimation;***
- ***signal amplification: FEE1 developed for FOPI at GSI.***
- ***digital converters: CAEN ADC V965, CAEN TDC V1290N***
- ***DAQ – MBS (Multi-Branch System – GSI – Darmstadt)***
- ***information recorded for 4 central strips***





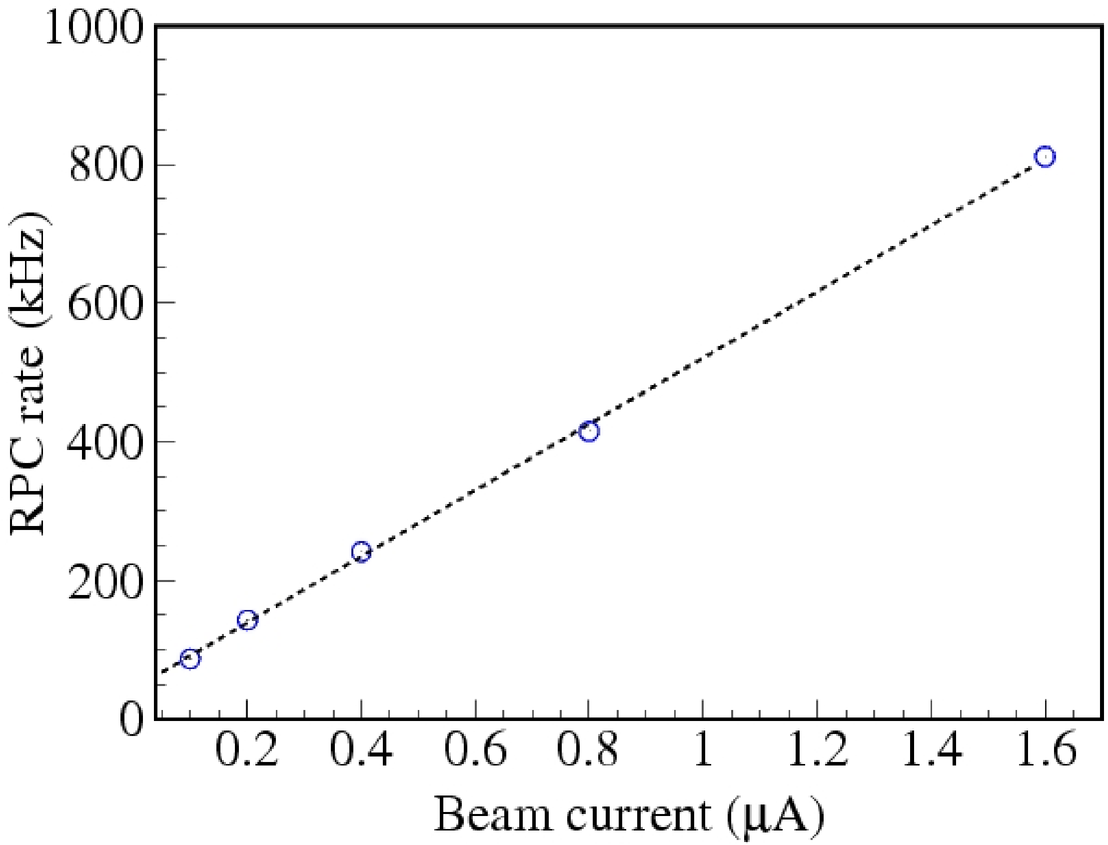
Time resolutions of the 4 measured strips



These results have been obtained with a uniform exposure

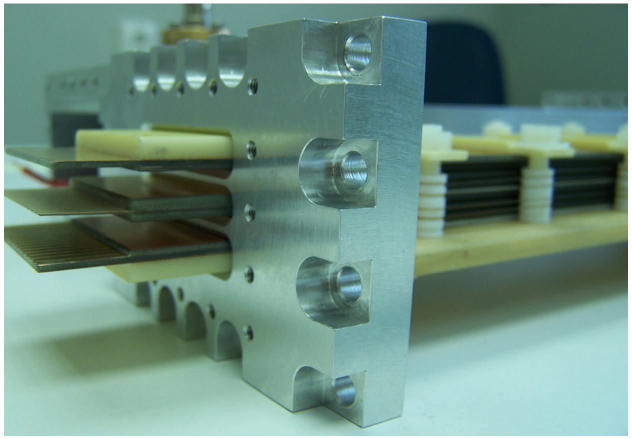
of the counter active area at a particle flux density of ~1kHz/cm2.

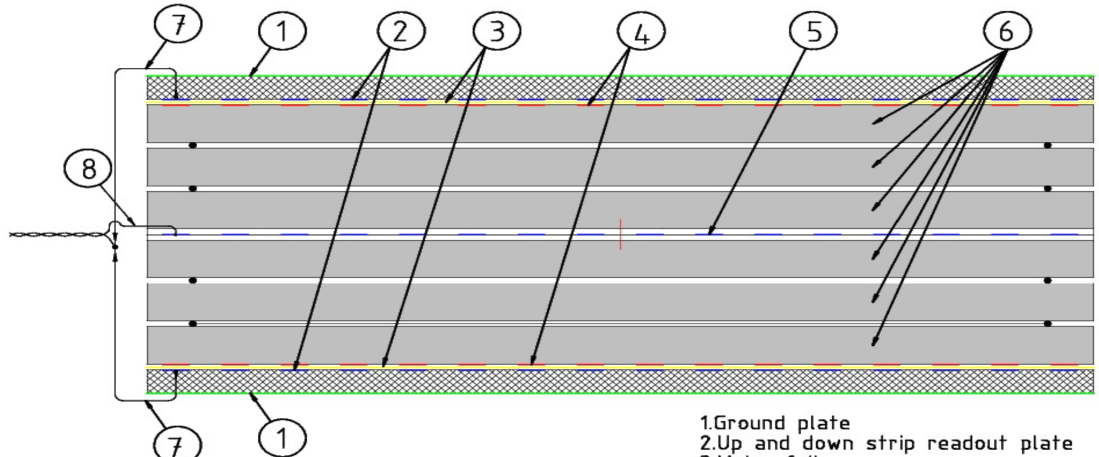
Rate dependence



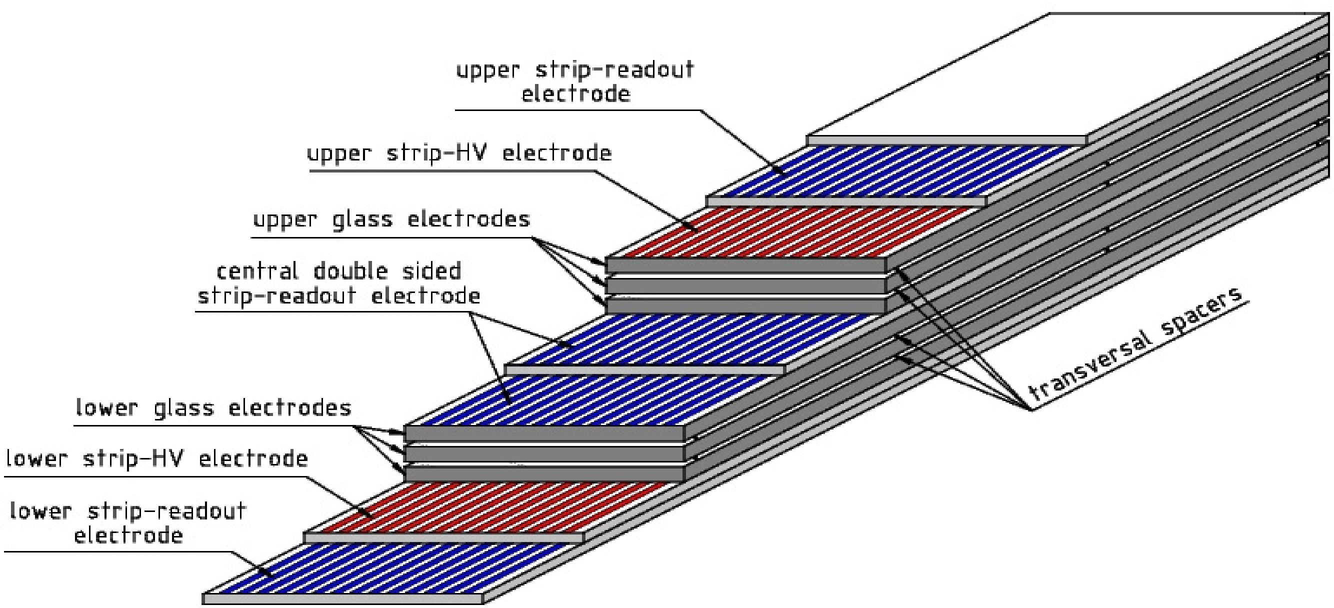
No saturation effect of the number of events recorded by the Pestov glass RPC as a function of counting rate

Differential Strip – Readout Pestov Glass RPC Prototype



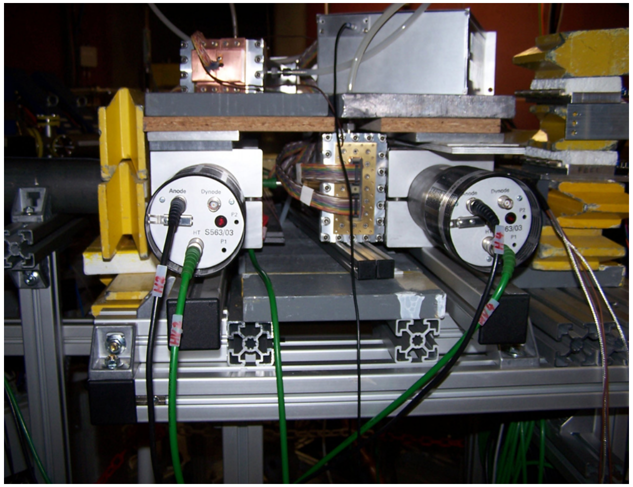


1.Ground plate
2.Up and down strip readout plate
3.Mylar foil
4.Up and down HV plate
5.Central strip readout plate
6.Pestov glass electrodes
7.Up and down strip readout plate signal
8.Central strip readout plate signal



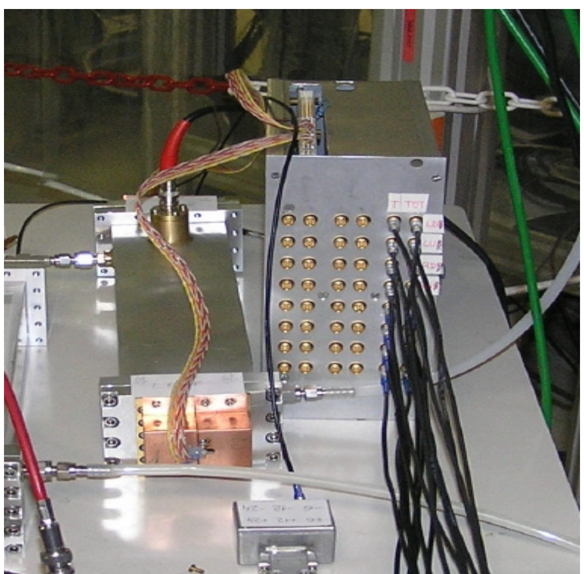
In-Beam Tests

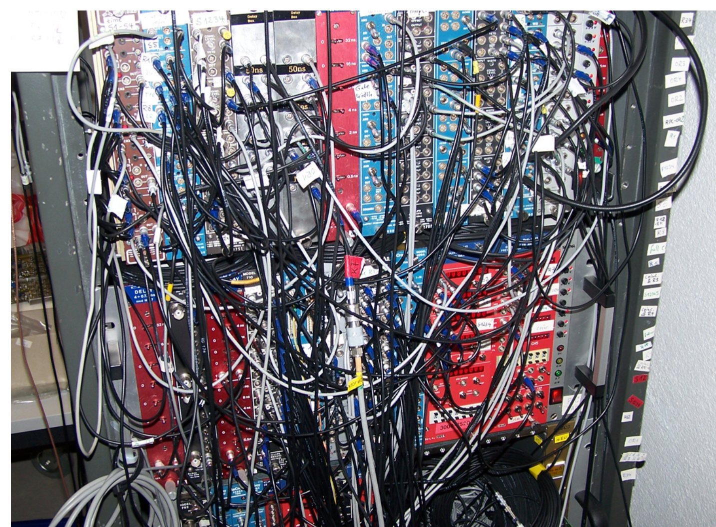
@ ELBE (Electron Linac with high Brilliance and low Emittance) Forschungszentrum Dresden-Rossendorf



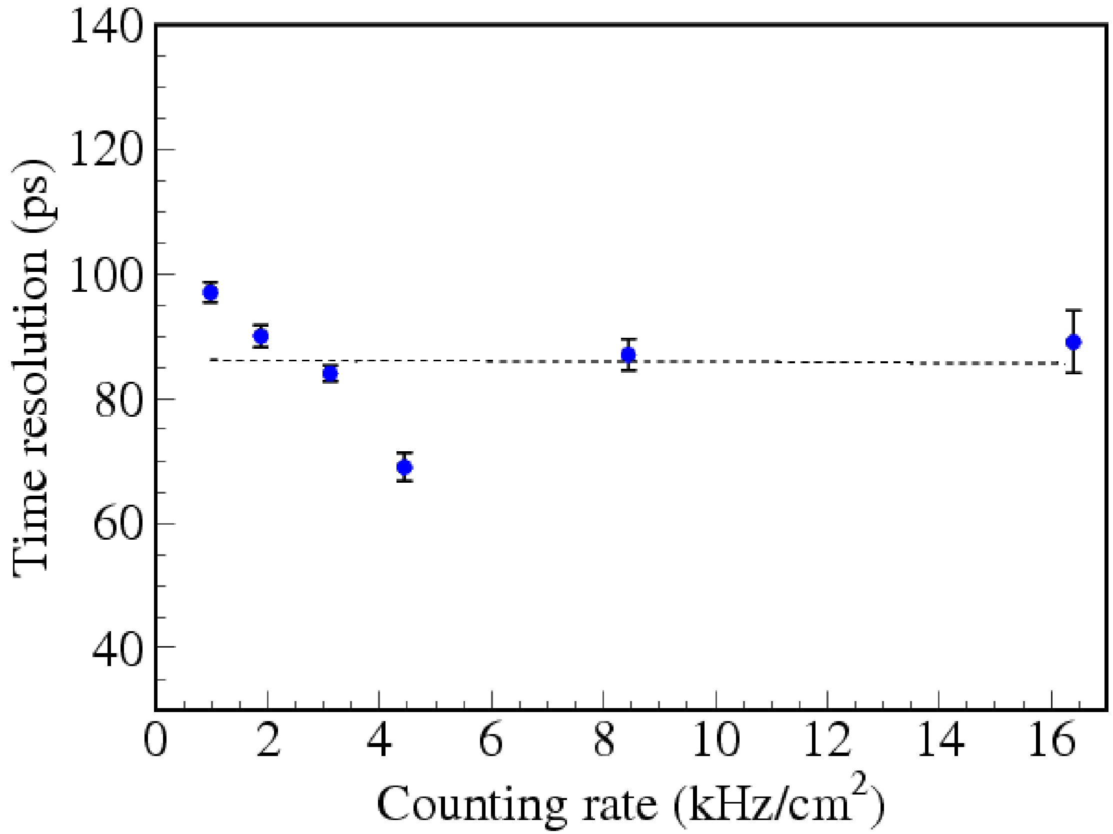
Experimental set-up:

- *electron beam, 28 MeV, scattered @ 45^0 by a 18 µm Al foil;*
- *plastic scintillators S5(XP2972), S12(XP2020), S34(XP2020), (2 x 2 cm^2) used for active collimation;*
- *signal amplification: differential readout based on NINO chip;*
- *digital converters: CAEN TDC V1290N*
- *DAQ – MBS (Multi-Branch System – GSI – Darmstadt)*
- *information recorded for 2 central strips*





Time resolution as a function of counting rate



No deterioration of the time resolution as a function of counting rate up to ~ 16 kHz/cm^2

^{60}Co Source Test

differential architecture – single ended operated

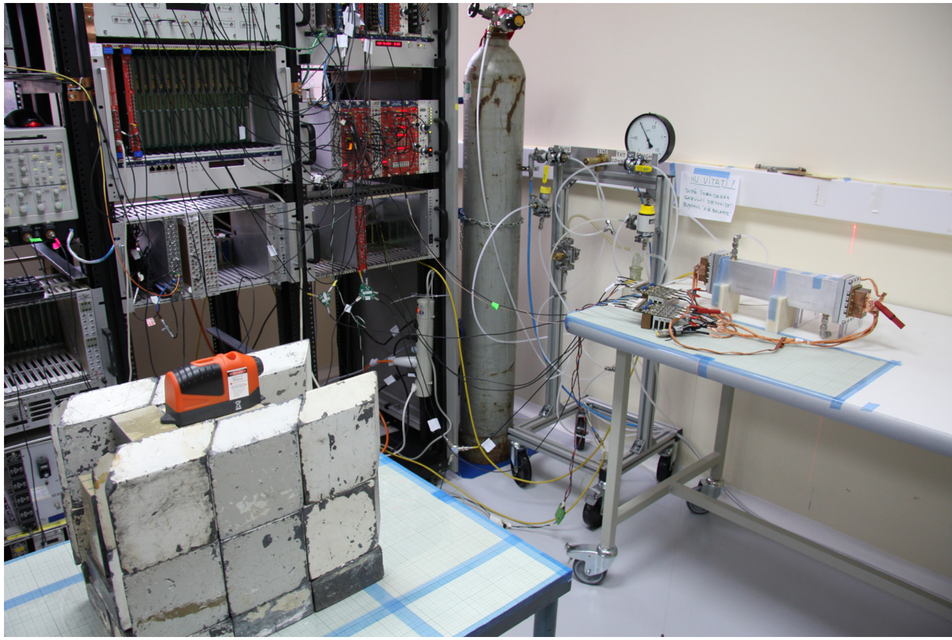
85% $C_2F_4H_2$ +10% SF_6 + 5% izo-C_4H_{10}

Experimental set-up:

- *^{60}Co source;*
- *plastic scintillator NE102 Φ=1 cm; h= 1.5 cm*
- *signal amplification: FEE1 developed for FOPI at GSI.*
- *digital converters: LeCroy 2228A TDC & LeCroy 2249WADC*
- *information recorded for 3 central strips*

Applied High Voltage = 5800 V

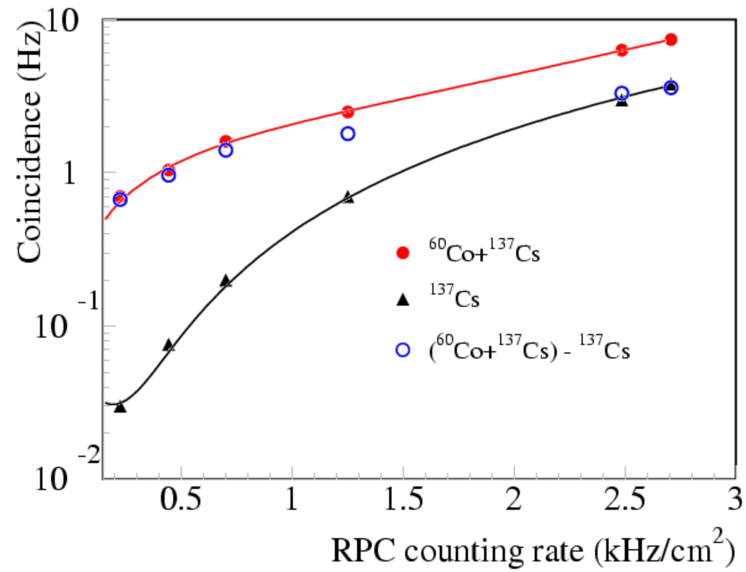
^{60}Co Source Test in a High Counting Rate Environment – ^{137}Cs (800 MBq)



Estimation of efficiency as a function of counting rate

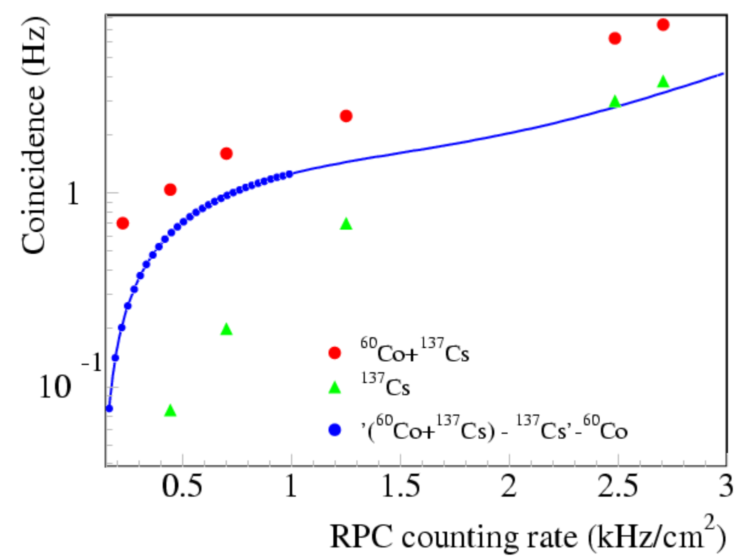
Coincidences:

- *^{60}Co - ^{60} Co*
- *^{60}Co - ^{137}Cs*
- *^{137}Cs - ^{60} Co*
- *^{137}Cs – ^{137} Cs*

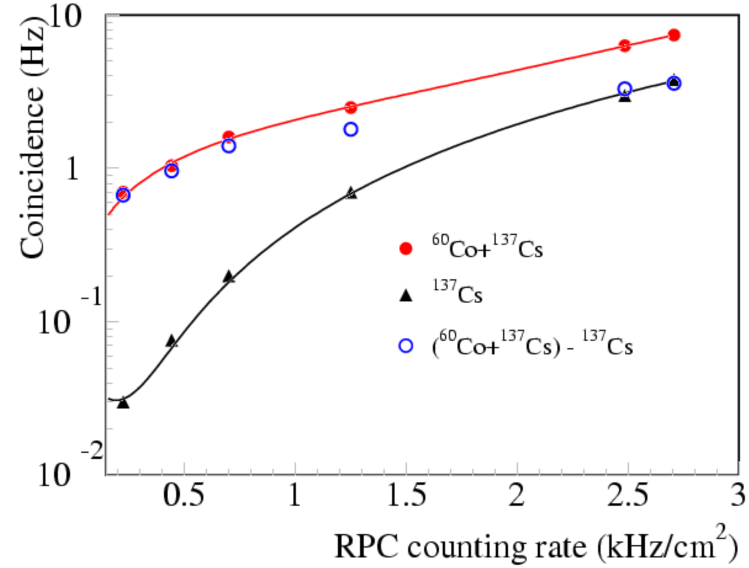


The goal: *^{60}Co - ^{60} Co = f(counting rate)*

The rate of ^{60}Co – ^{60}Co coincidences, measured without ^{137}Cs, is 0.4 Hz



Estimation of efficiency as a function of counting rate

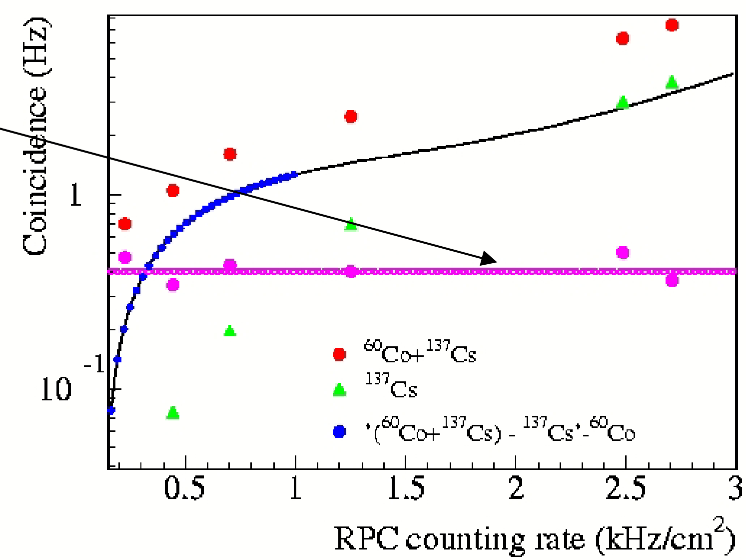


Coincidences:

- *^{60}Co - ^{60} Co*
- *^{60}Co - ^{137}Cs*
- *^{137}Cs - ^{60} Co*
- *^{137}Cs – ^{137} Cs*

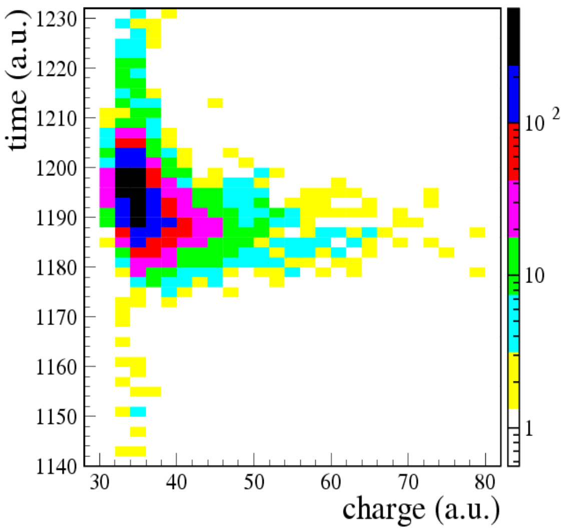
The goal: ***^{60}Co - ^{60} Co = f(counting rate)***

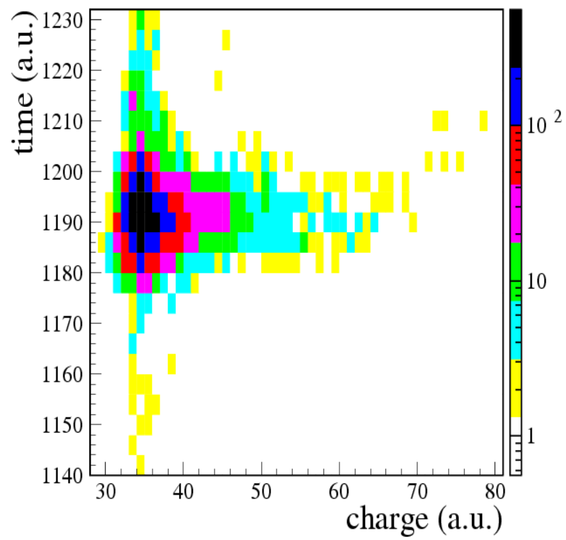
The rate of ^{60}Co – ^{60}Co coincidences is measured without ^{137}Cs 0.4 Hz.

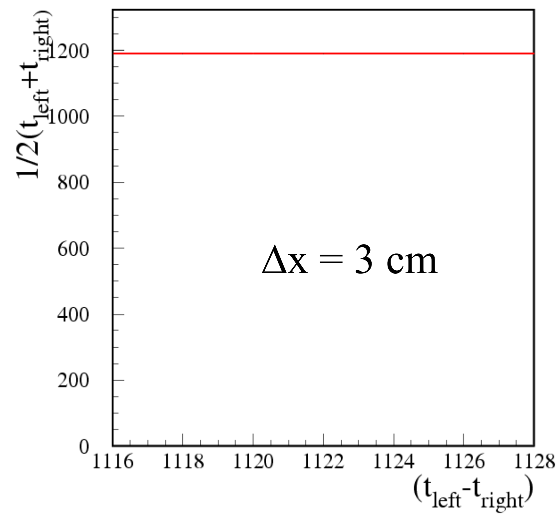


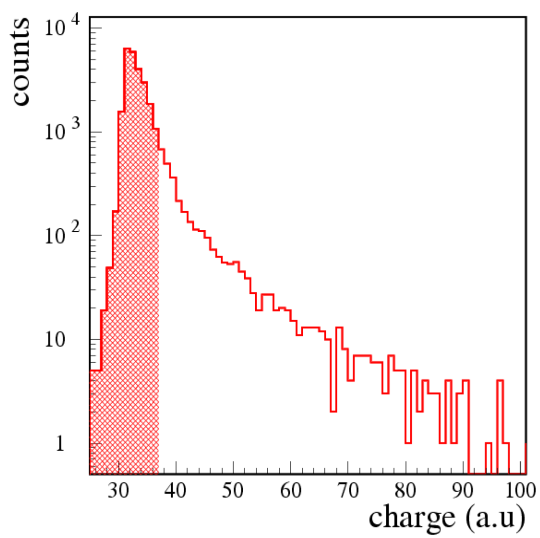
Time resolution

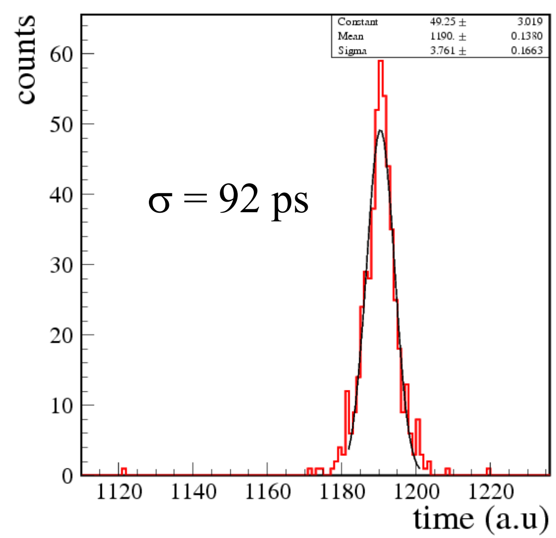
160 Hz/cm²



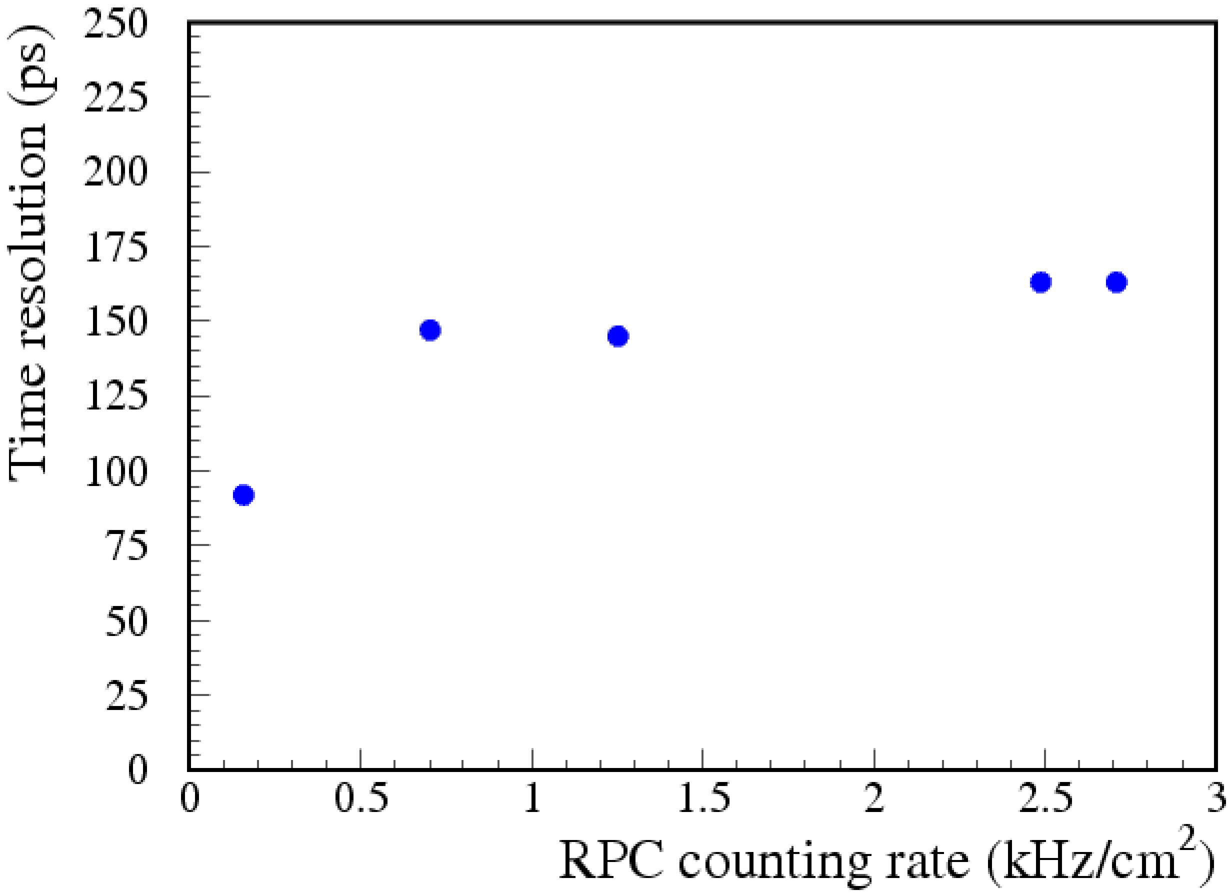




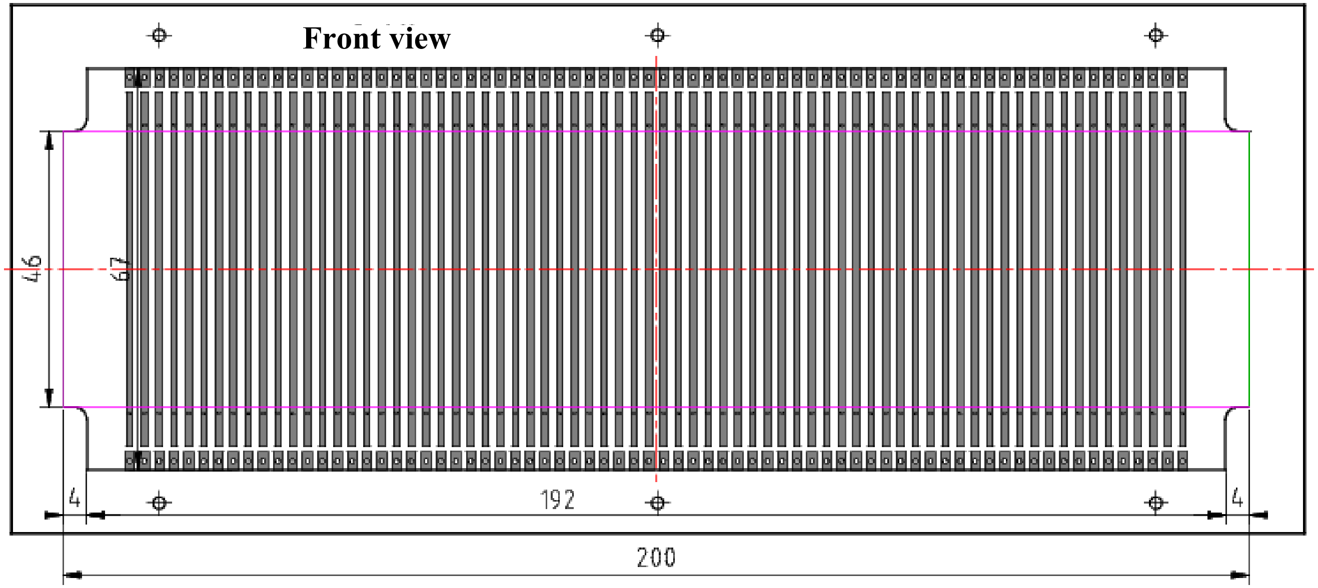


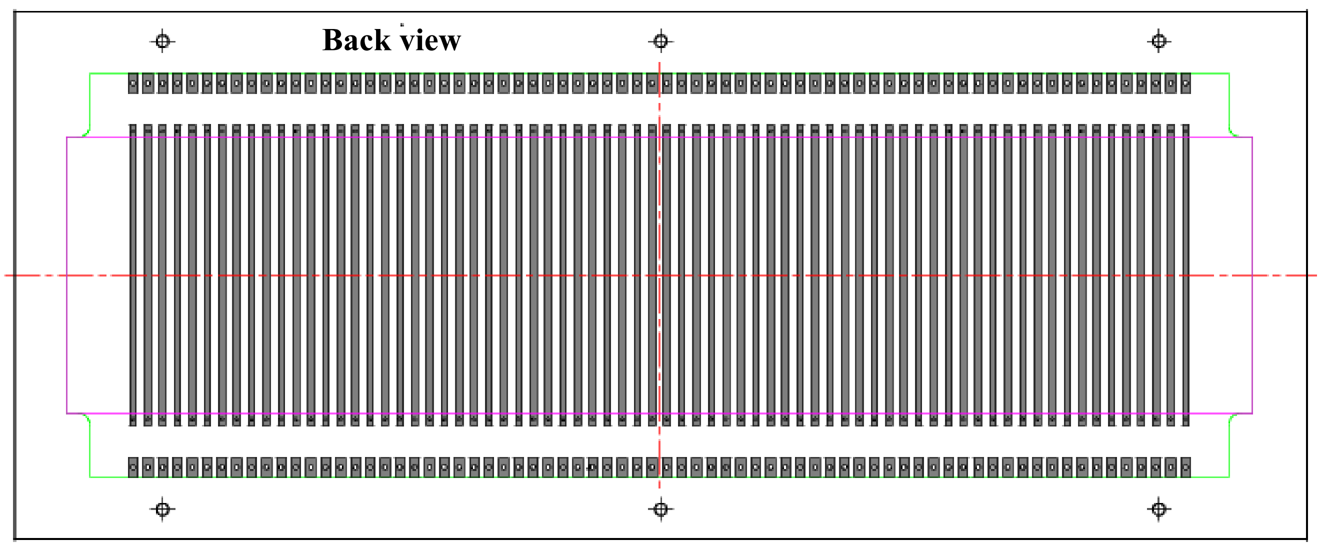


Time resolution as a function of counting rate

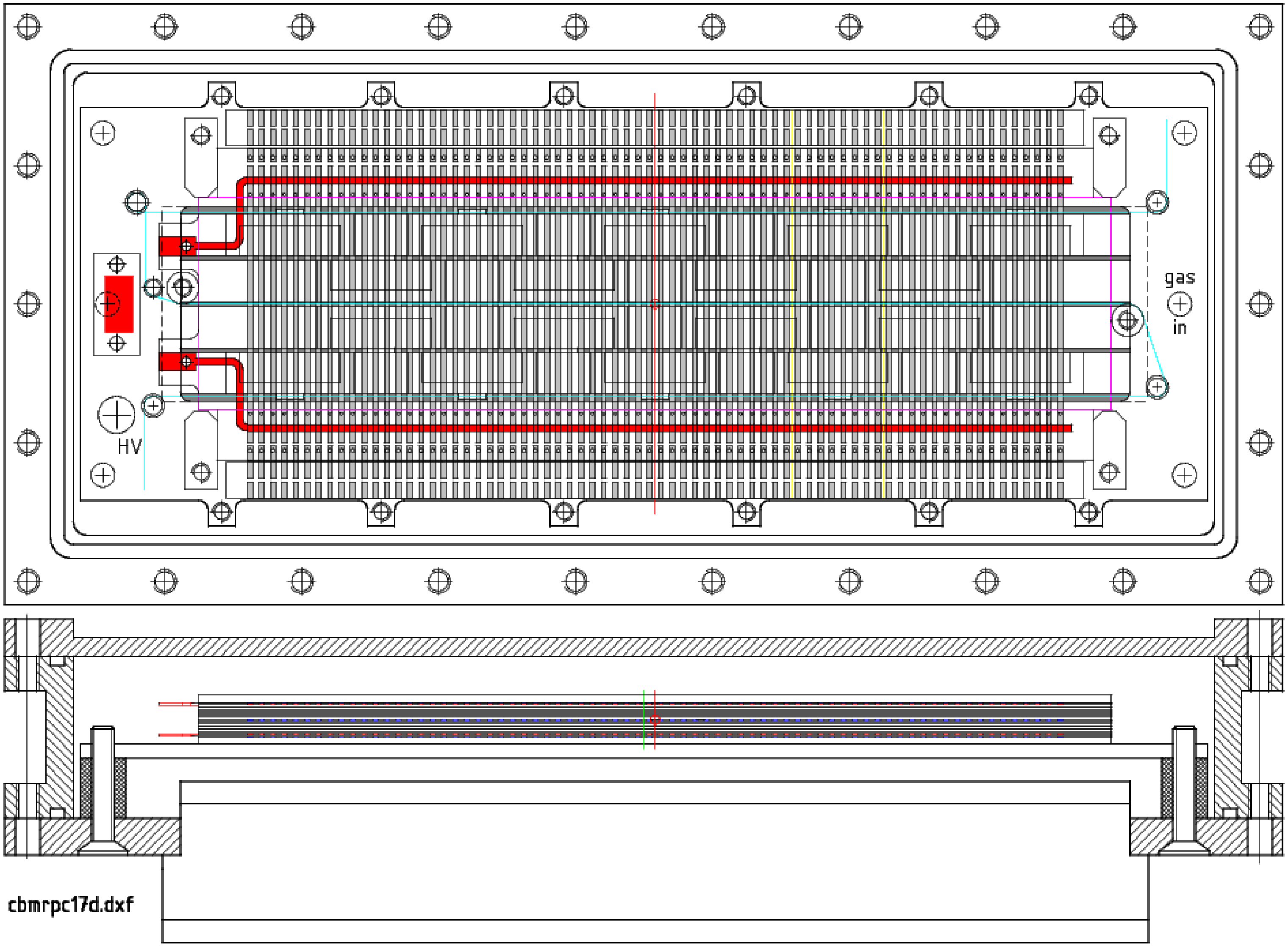


High granularity HCRRPC



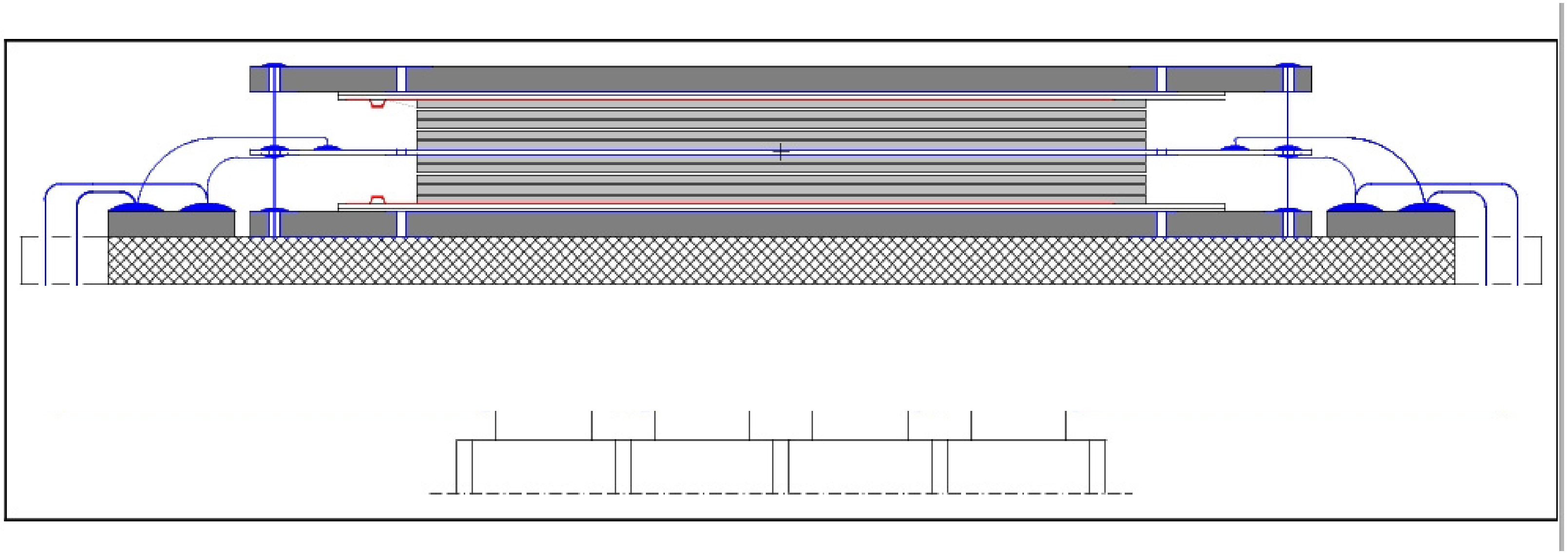


High granularity HCRRPC

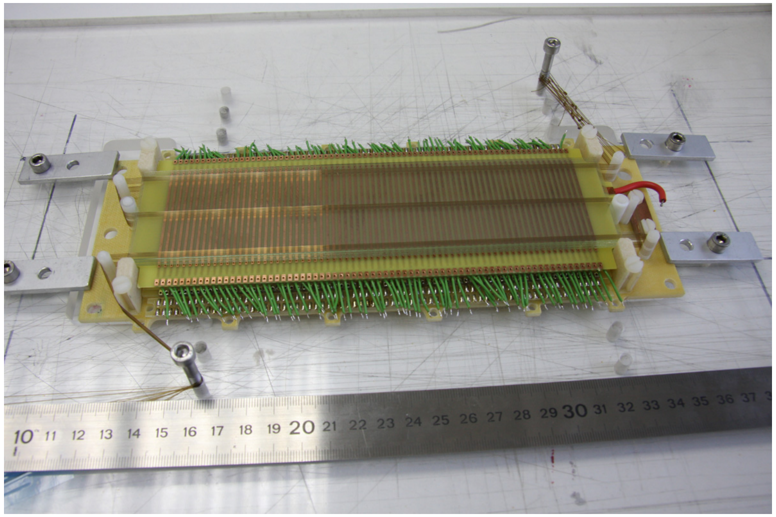


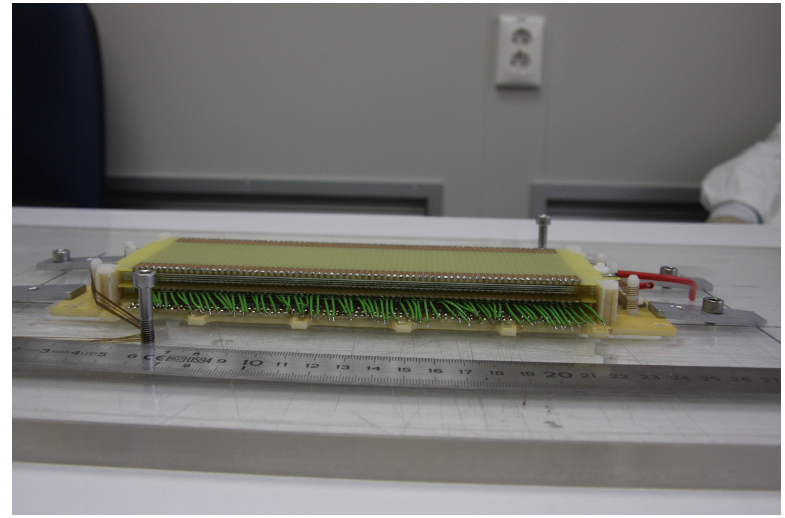
High granularity HCRRPC

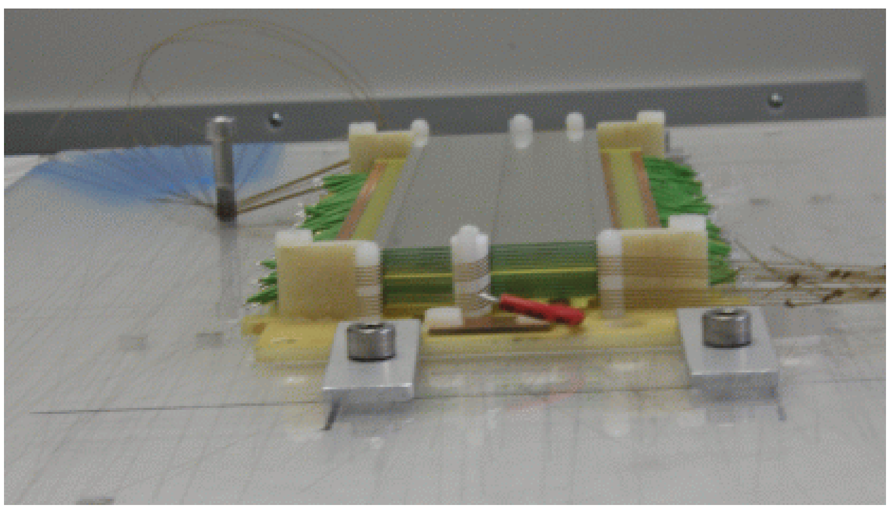
- thin glasses – 0.5 mm
- 10 gaps
- differential readout
- symmetrical structure

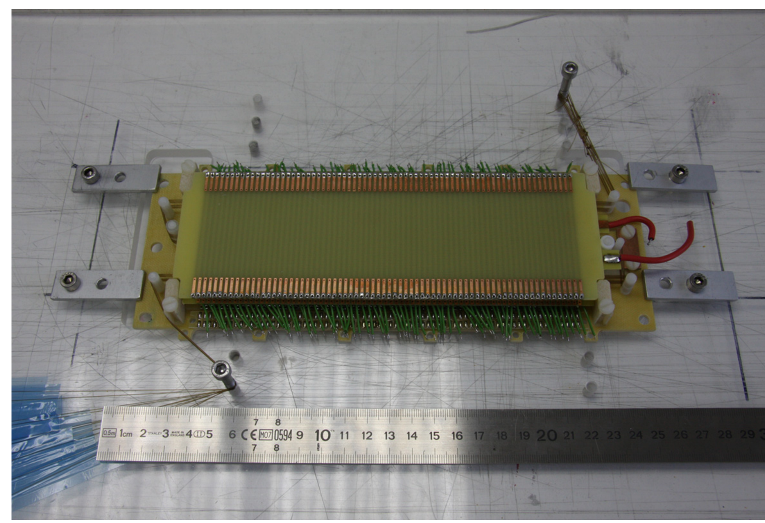


High granularity HCRRPC









Conclusions and Outlook

•The RPC prototypes based on PESTOV glass with a resistivity of ~10^{10} Ωcm were tested in-beam in March 2008 @ the ELBE facility at Forschungszentrum Dresden-Rossendorf

• Standard readout Pestov glass RPC prototype.

•Its performance in terms of time resolution, ~60 psec, fulfil the requirement for the CBM- TOF subdetector. This time resolution was obtained in condition of a uniform exposure of the counter active area at a particle flux density of ~1kHz/cm^2

• Differential strip readout RPC prototype.

•The in-beam test showed the good performance of the counter with a differential readout based on NINO chip in terms of time resolution ~85 ps.

• No significant deterioration of the time resolution as a function of counting rate was observed up to ~ 16 kHz/cm^2

• The ^{60}Co tests in a high counting rate environment -^{137}Cs (800MBq) - show that the counter keeps its performance – time resolution and efficiency - up to 3 kHz/cm^2

• We designed and built a new configuration of a high granularity high counting rate RPC using thinner glasses, for small polar angles.

• In-beam tests using MIPs & uniform high counting rate on the whole detector are mandatory !

Participants

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