R&D for the CBM TOF:
Influence of a MRPC gap construction on a detector rate capability

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Main requirements for the CBM TOF detector:

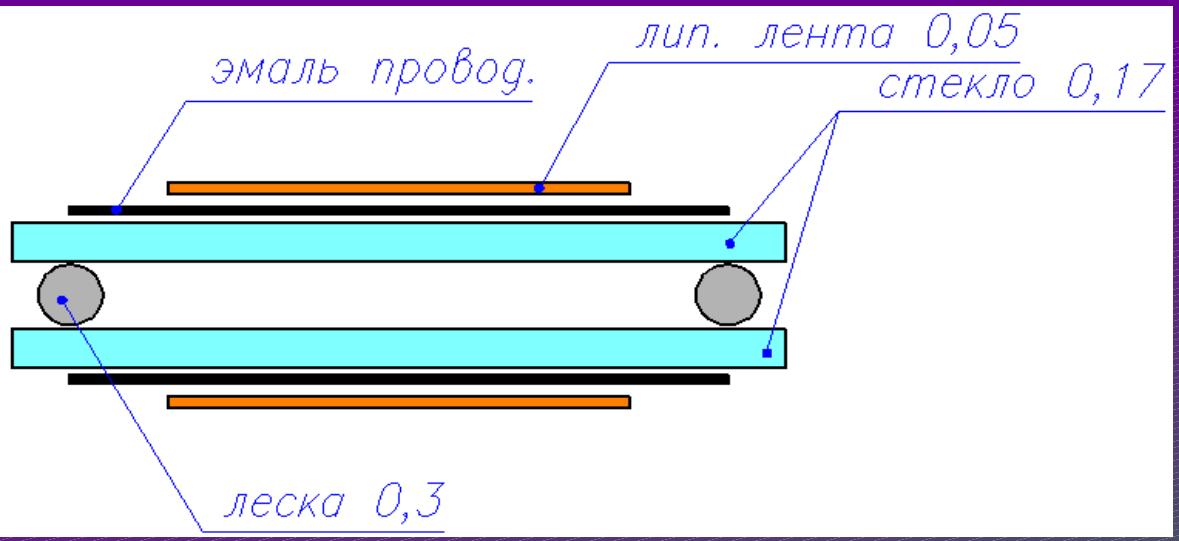
- For the internal detector part a cell size should be 3 ÷ 4 cm^2
- Time resolution should be better than 80 ps.
- Rate capability should be 50 ÷ 20 kHz/cm^2
- Reasonable cost.

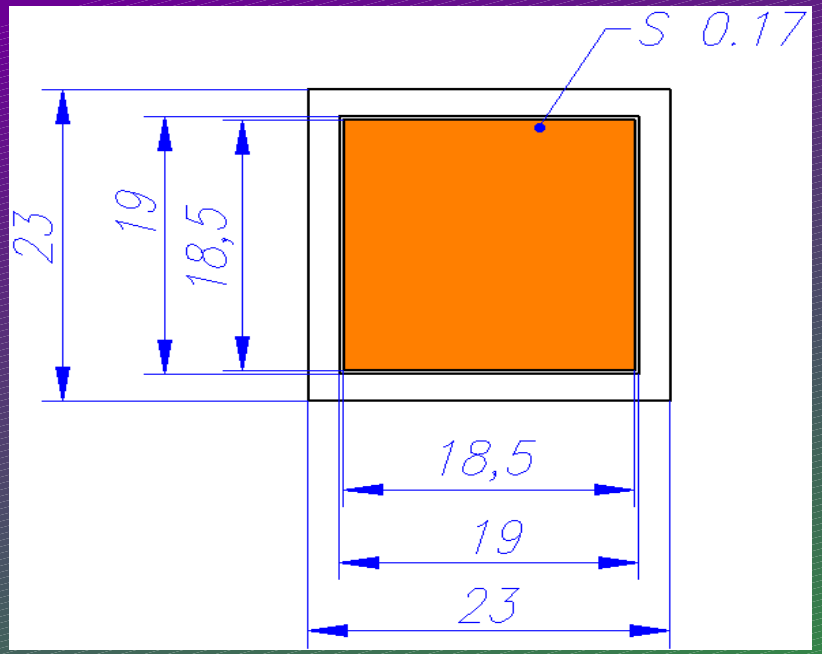
To probe this possibility a number of test were done at U-70 test beam line. A background conditions were simulated by Sr^{90} β-source.

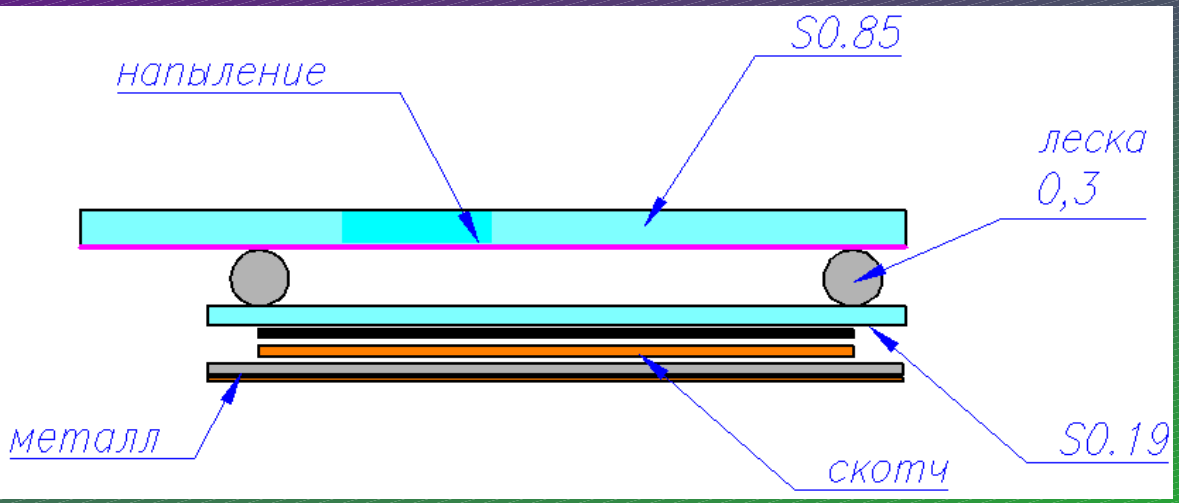
A set of rate measurements which we did at U-70:

- A comparison of single gaps which have different glass electrode thickness – 0.85 mm and ~0.2 mm.
- Rate capability of 0.3 mm and 0.23 mm gas gaps
- Rate capability of RPC gap with one metallic electrode (m. e.)

Tested gaps construction and sizes





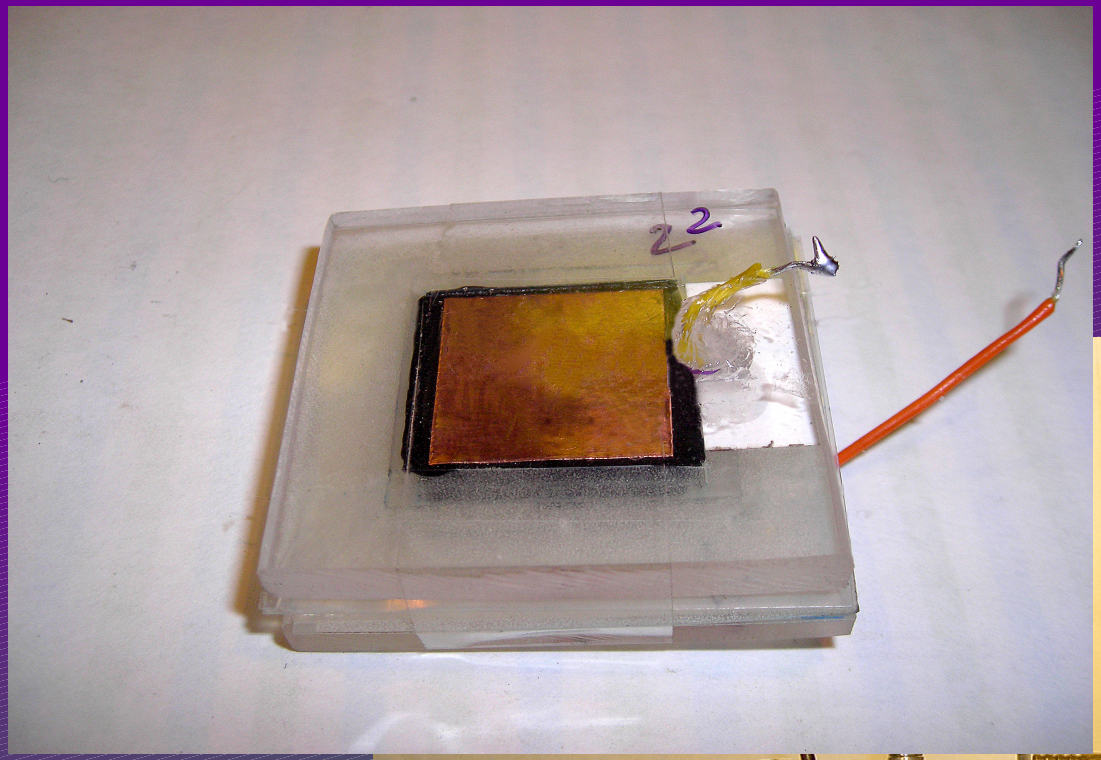


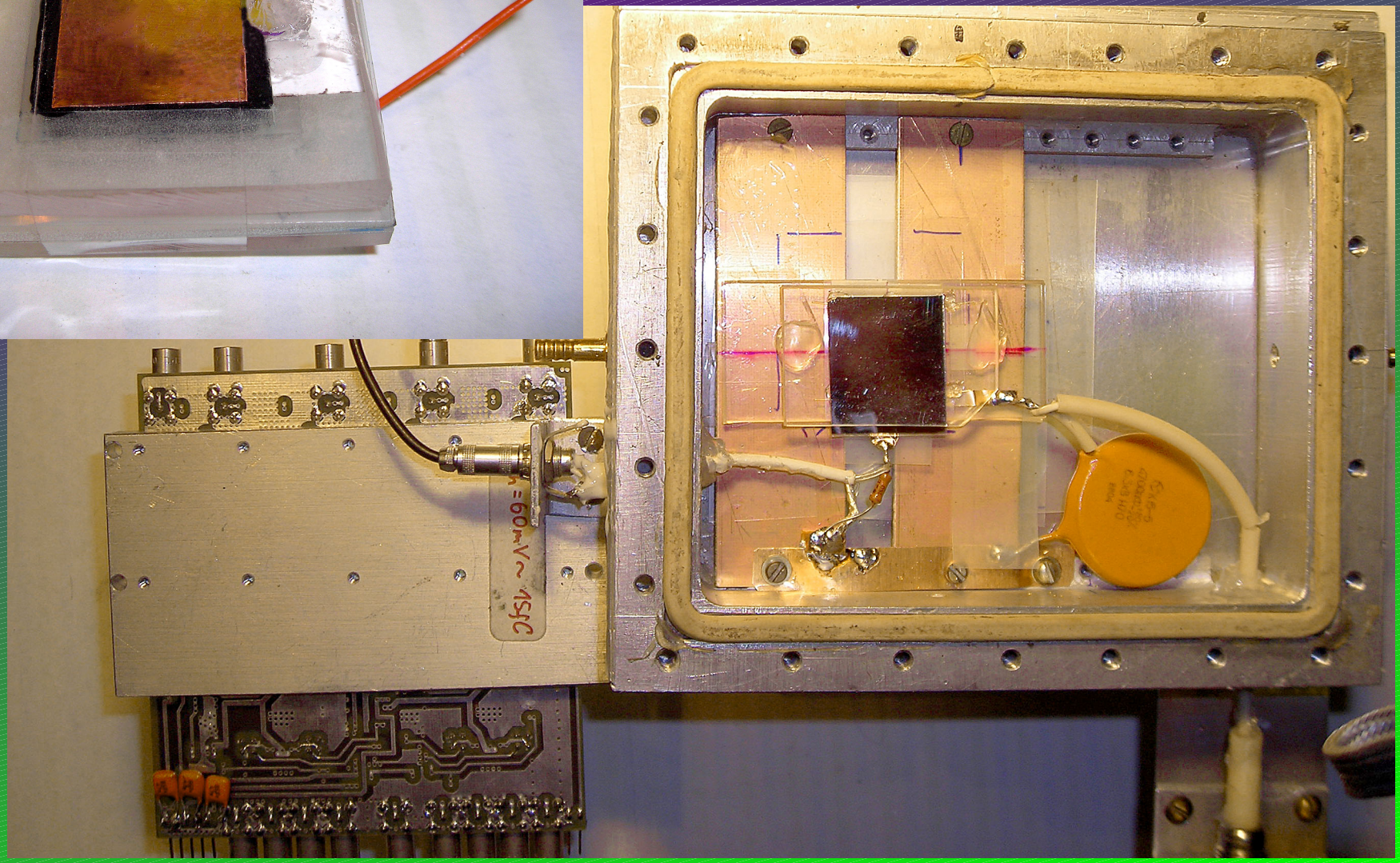
All tests were done with TFE/SF$_6$/i-C$_4$H$_{10}$ = 90/5/5 gas mixture

A signal pad size was 3.24 cm^2.

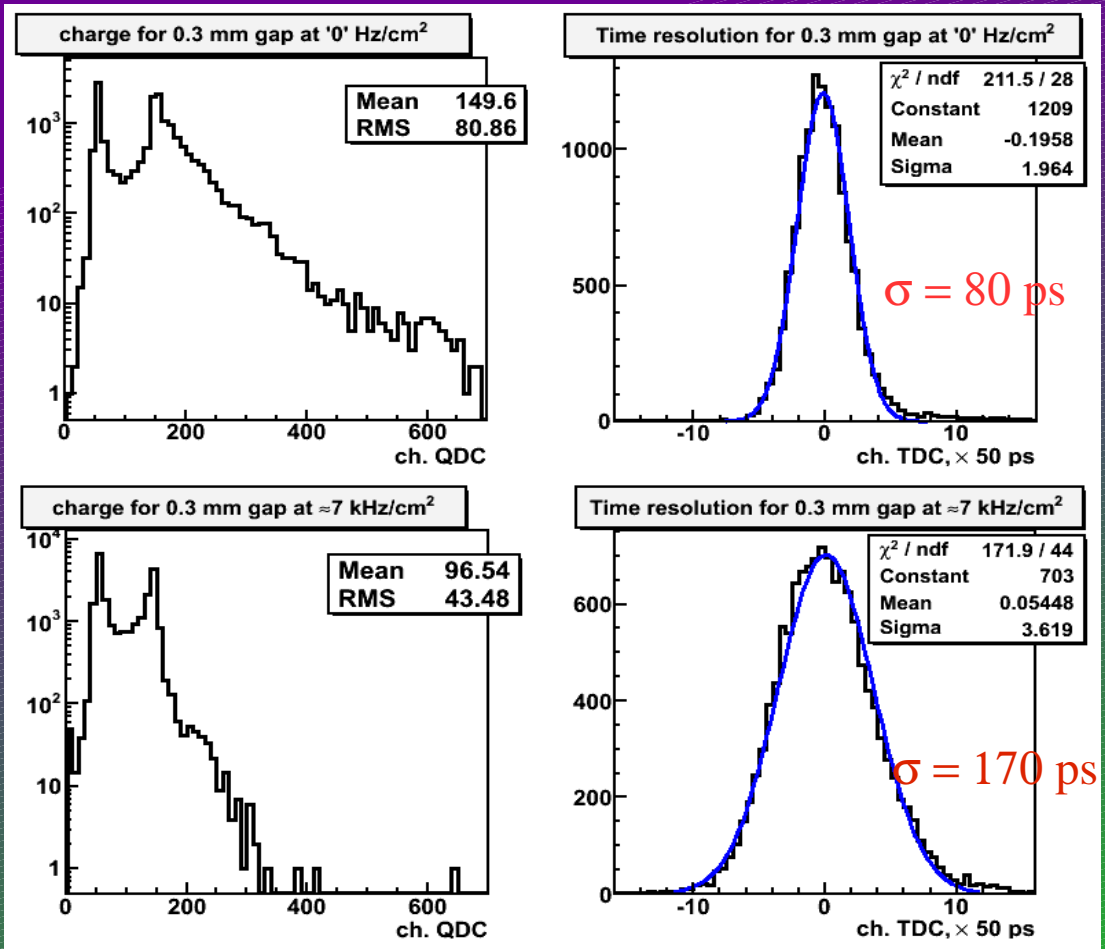
A FOPI 4-channel test card was used as FEE.

Samples of used RPC



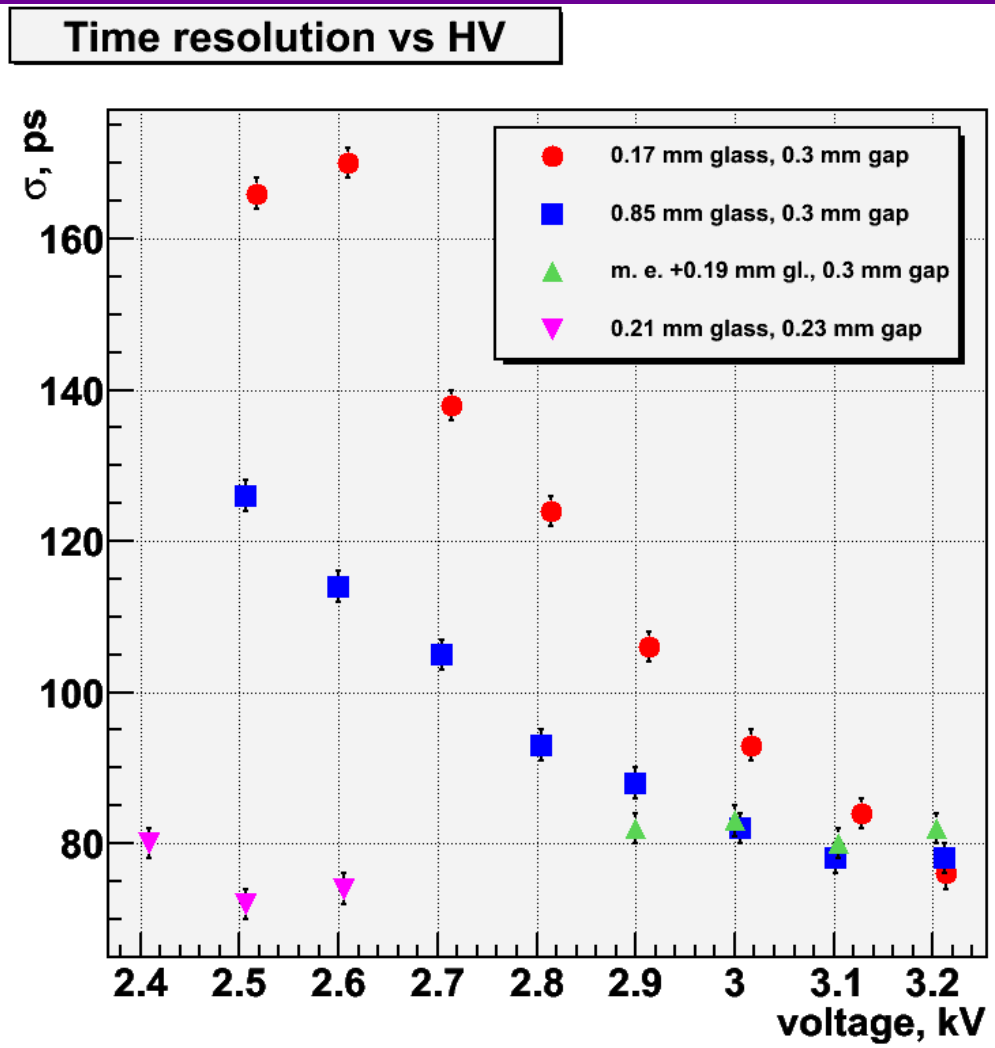


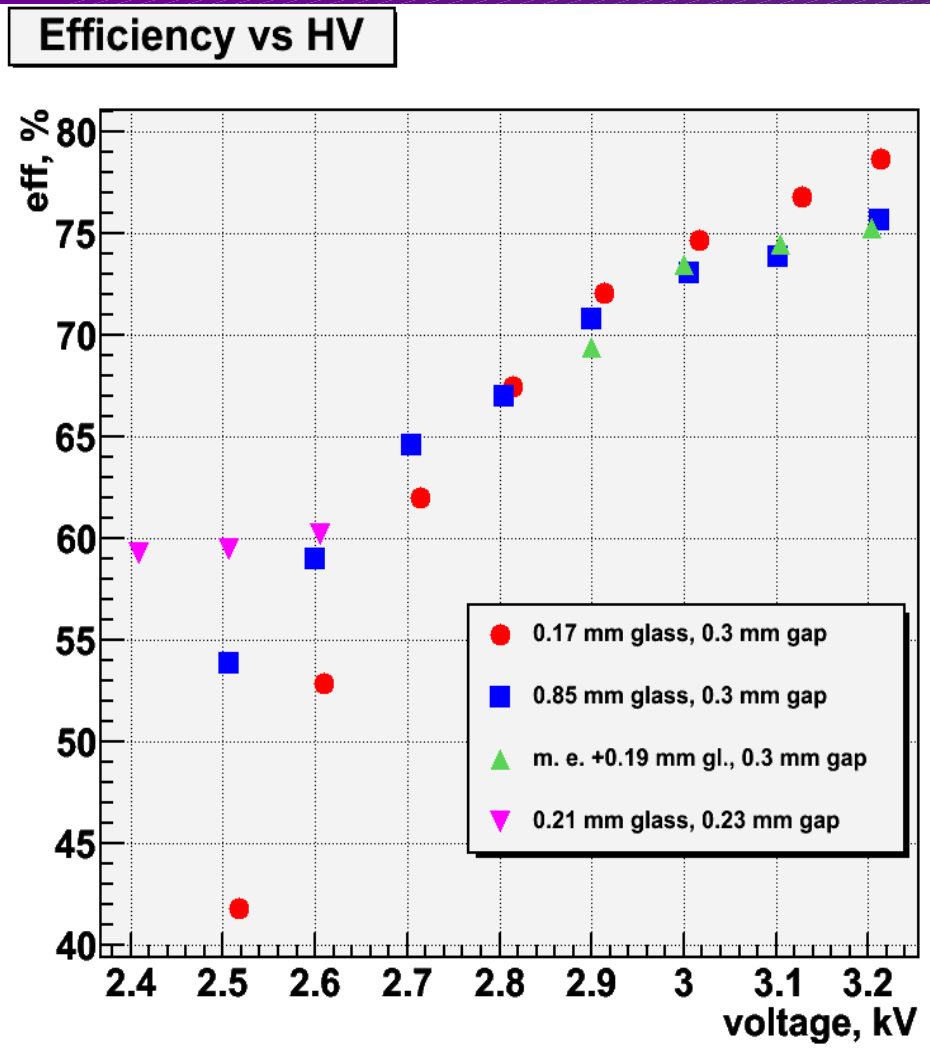
R&D mainstream



- The observed charge distribution is clear indicator that the internal electric field fall down with increase external load.
- The limitation of RPC rate capability it is a voltage drop across resistive electrodes.
- Instead of use low resistive glass we can use very thin usual glass.
- A thin glass to metal junction (if it is in construction) can produce undesired fall down of the chamber efficiency.

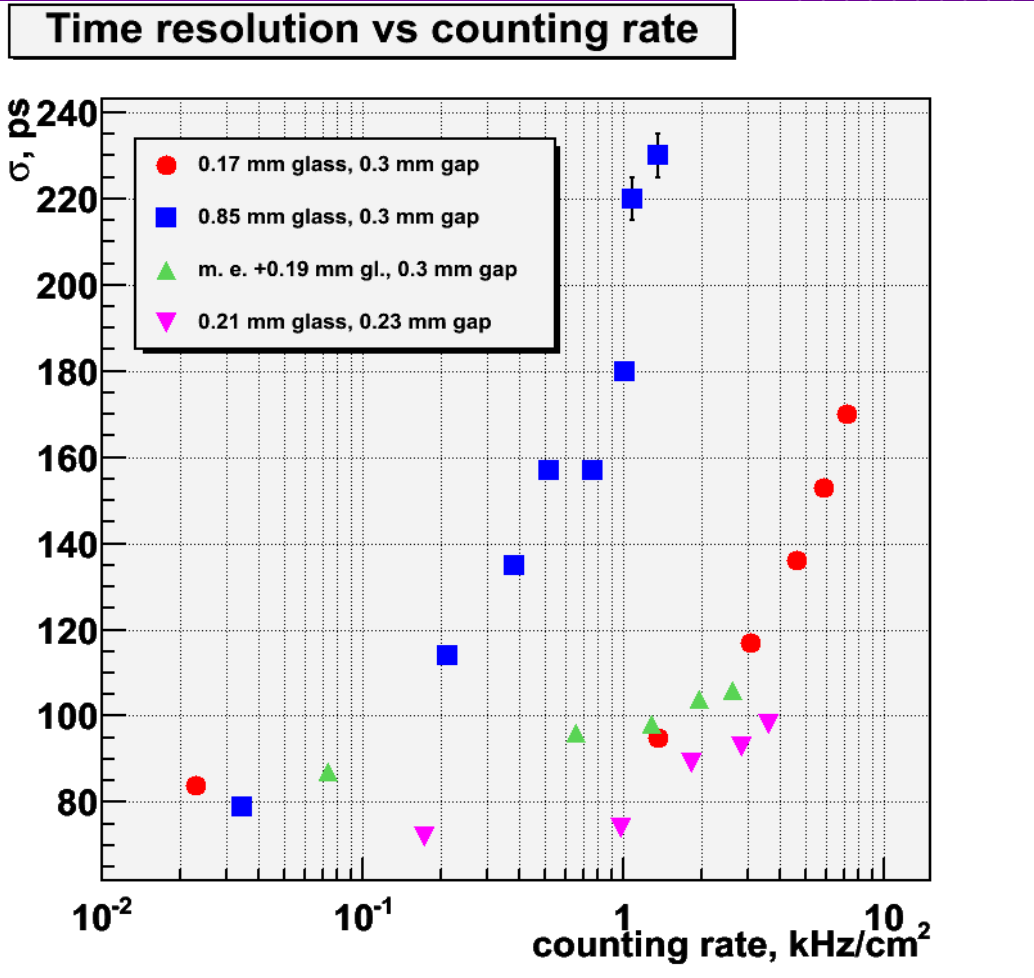
Main properties overview at “quiet environment”





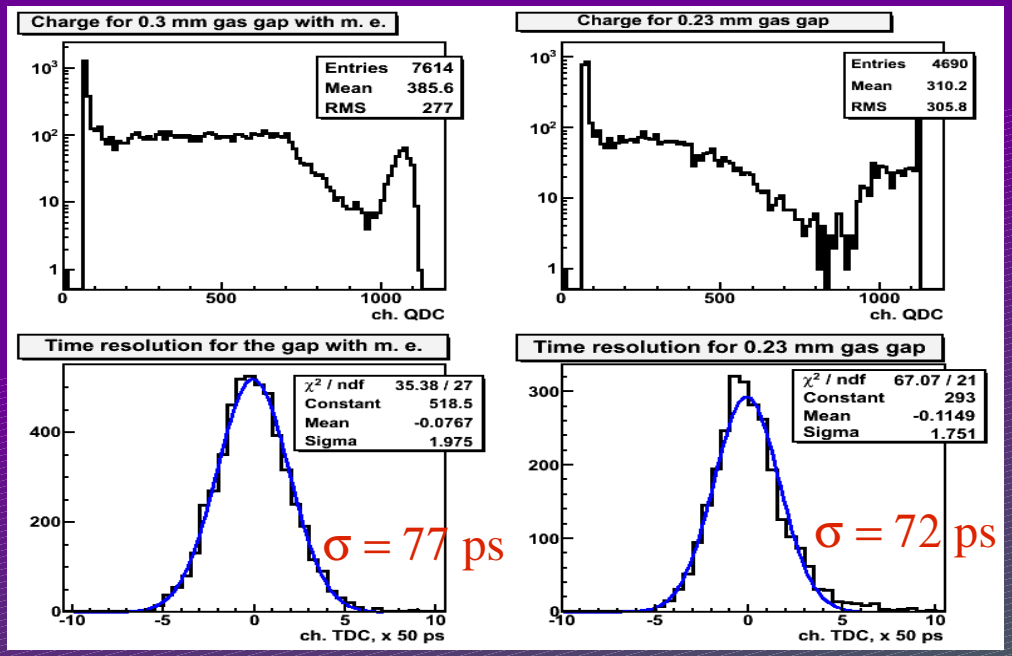
The best time resolution of all tested gaps is at level 80 ps.
The efficiency behaviour do not show any oddity.
The time resolution of the start counters was 50 ps.

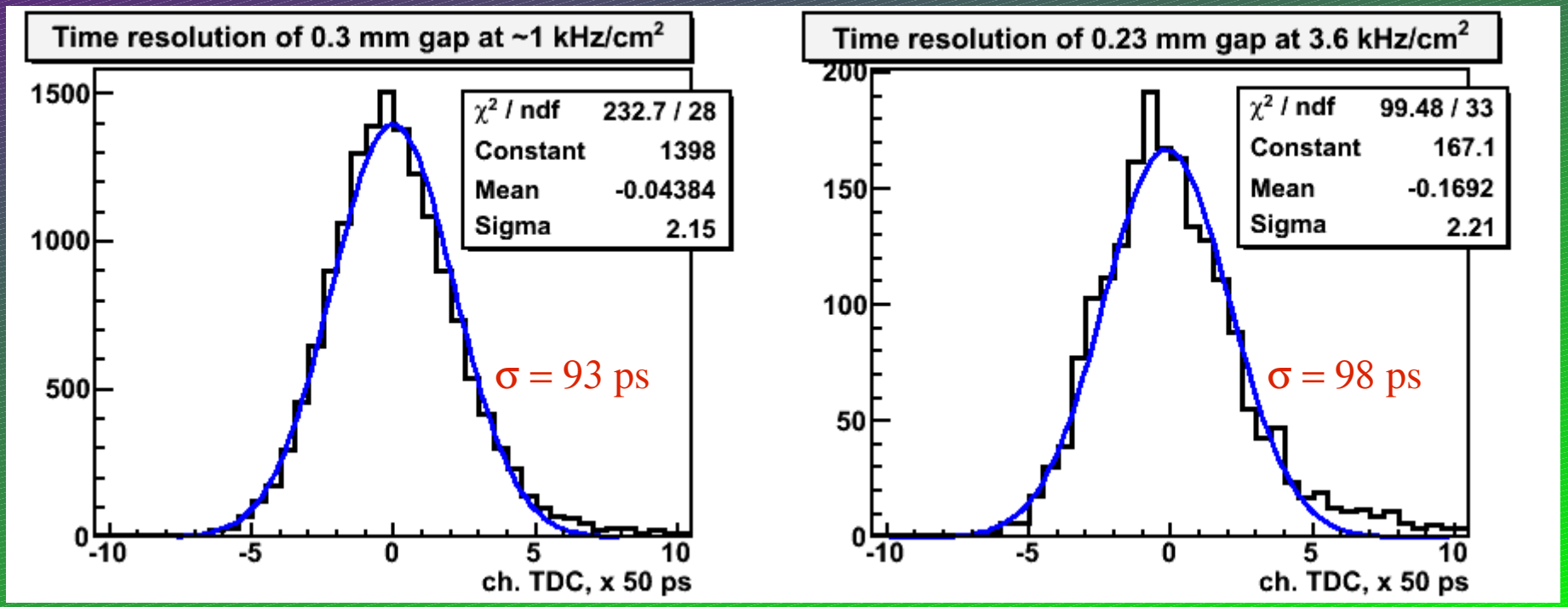
Rate capability of different RPC gaps



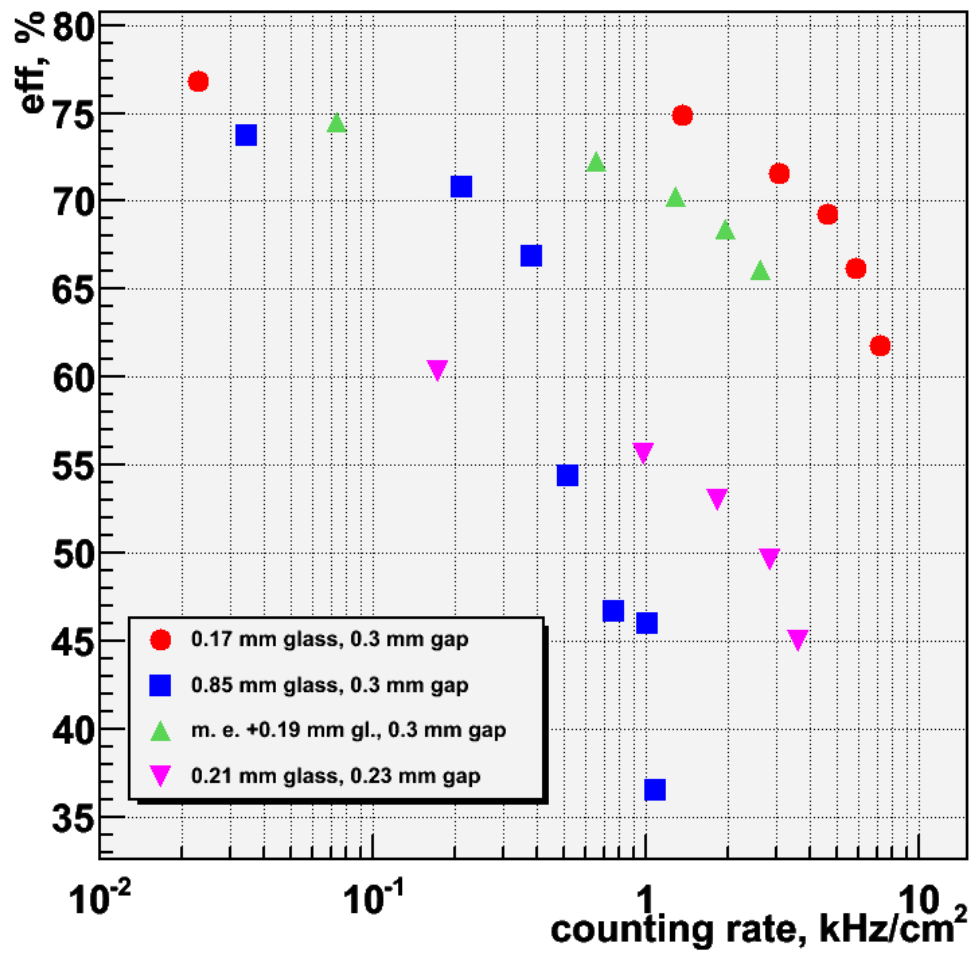
- At the same gas gap width more thick glass electrodes strongly reduce maximum operation rate
- At thickness ratio 0.85/0.17 = 5 a rate capability differ ~ 10 times!
- Gas gap shrinking from 0.3 mm to 0.23 mm gives more than 3 times improvement in external load.
- Replacing one of glass electrodes to the metallic electrode lead to increase avalanche charge and probably will not considerable change the situation.

Illustration to the previous slide

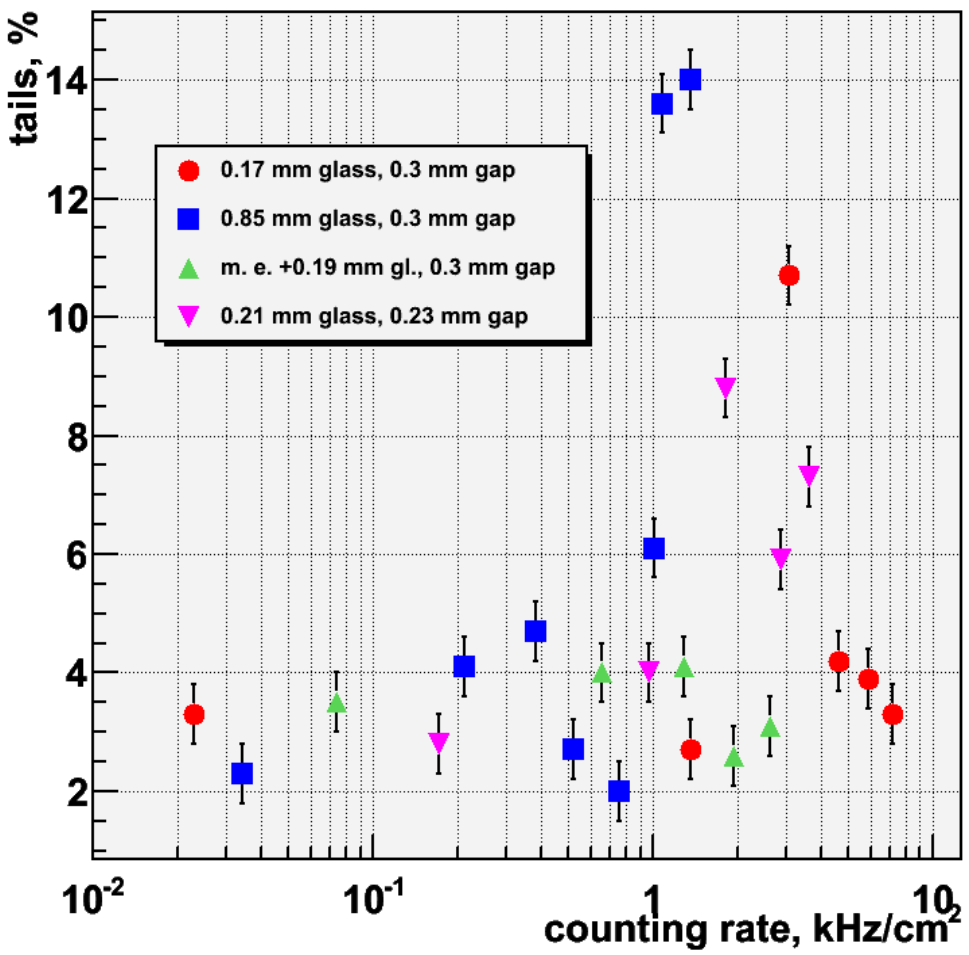




Efficiency vs counting rate



Tails vs counting rate



The efficiency demonstrate a good behaviour. Even at 45% efficiency for the one gap for a 6 gaps chamber the total efficiency drop will be only ~1%.

Tails was defined as difference between the gaussian fit and the histogram area. Probably due to systematics it is hard to see any dependence .

Conclusion

- A comparison of RPC gaps with different electrode thickness and gas gap width was done.
- The best rate capability was obtained for 0.23 mm gas gap and 0.2 mm electrode thickness. At ~4 kHz/cm^2 counting rate the time resolution was ~100 ps.
- To achieve a desirable rate capability of a few kHz/cm^2 we have to minimise the thickness of used glass down to 50 mkm. But this is only assumption!