Analysis of CBM – TOF module response with cosmic rays

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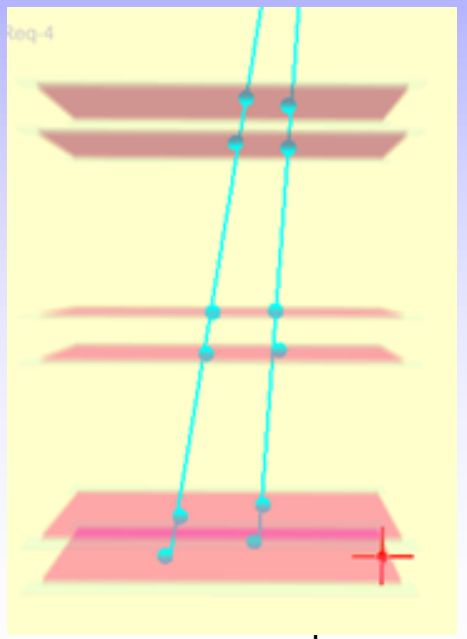
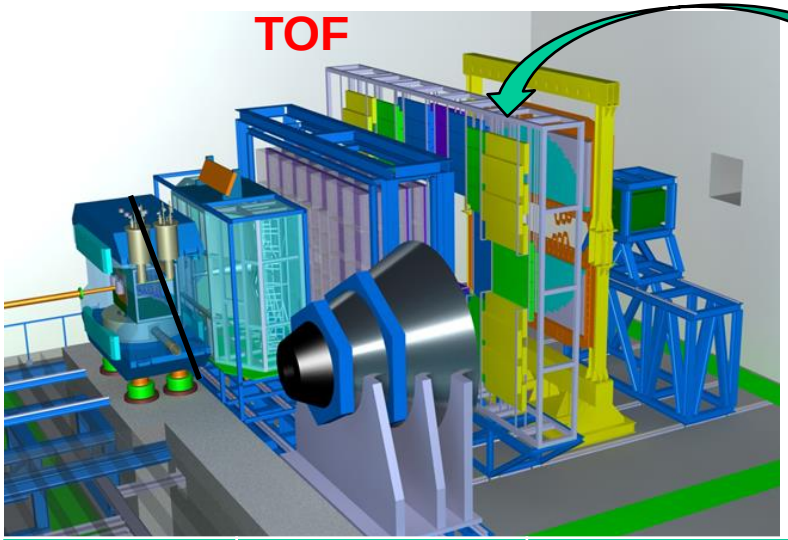
Outline:

- Introduction
- Cosmic test setup
- Analysis procedure
- Results
  - Global response
  - Angle dependences
- Summary

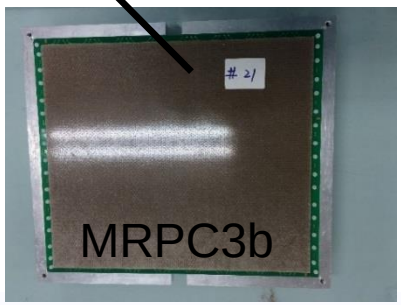


Introduction

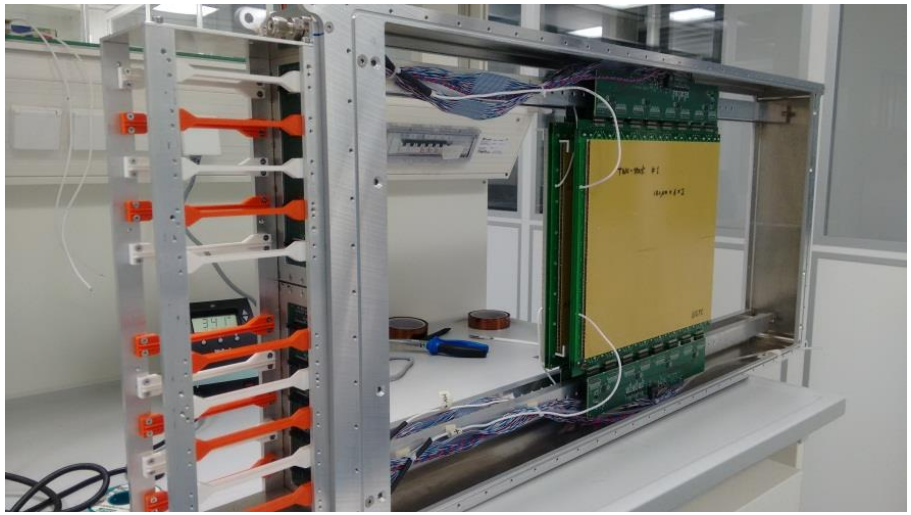
The Compressed Baryonic Matter Experiment



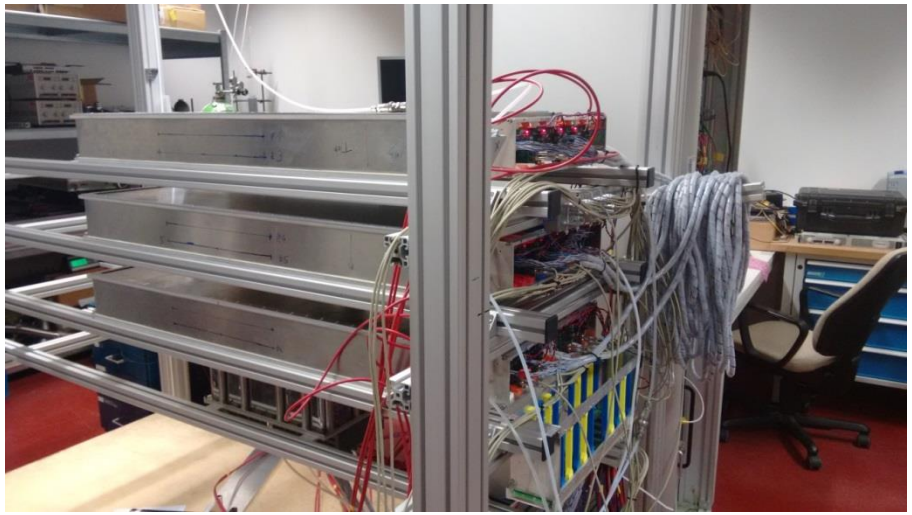
	MRPC3a	MRPC3b
Size	32 x 27 cm^2	32 x 27 cm^2
Nr. of gaps	2 x 4	2 x 5
Gap size	250 µm	230 µm
Glass	700 µm	280 µm
Resistivity	2 x 10^{10} Ωcm	~10^{12} Ωcm



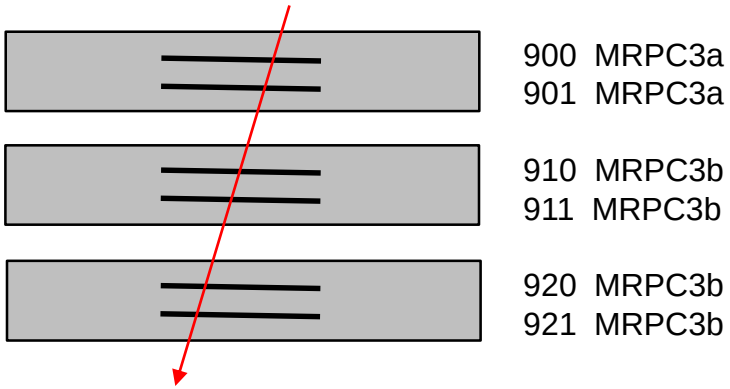
Introduction – test setup



Test module with 2 MRPCs



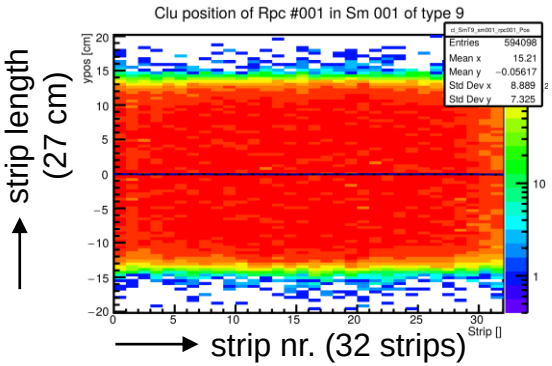
Cosmic test setup in Heidelberg



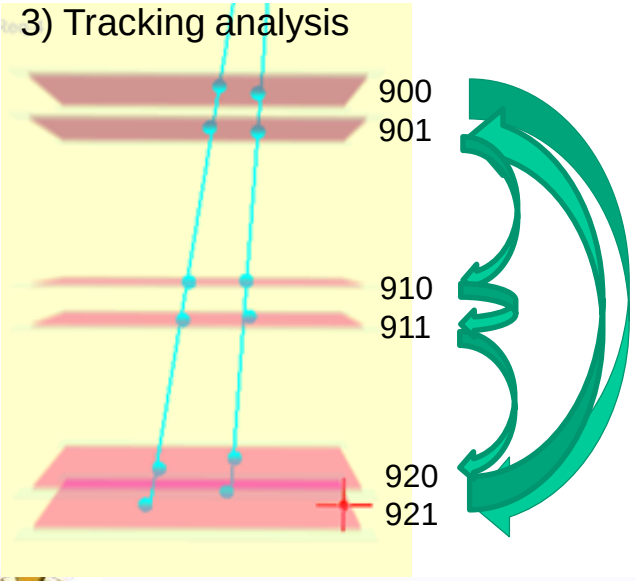
- Gas mixture:
  90% R134a, 5% Isobutane, 5% SF_6
- Free seeming data acquisition
- About 100000 good tracks per day

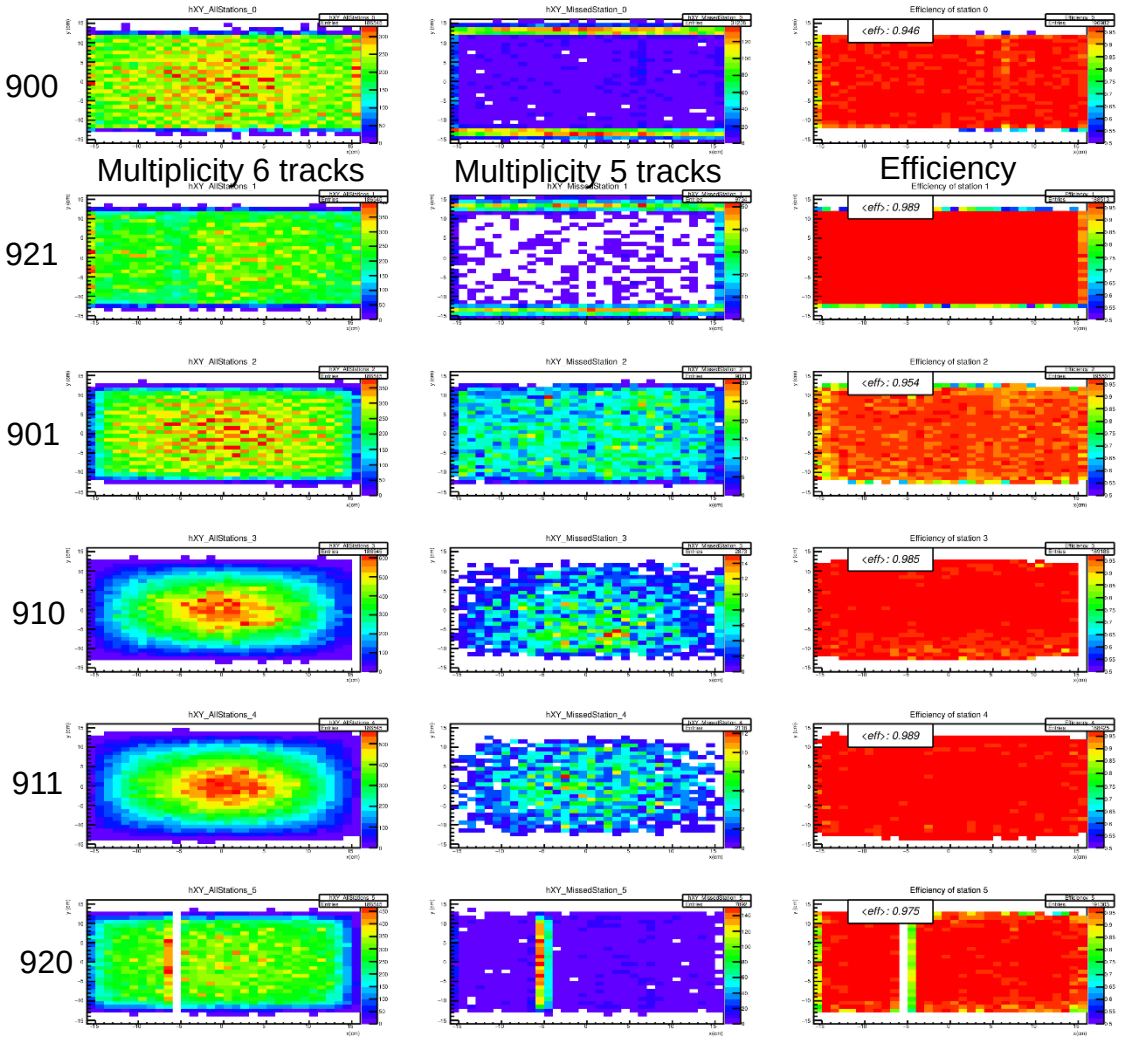
Analysis procedure

1) Unpacking
2) Calibration (position/time offsets and walk)

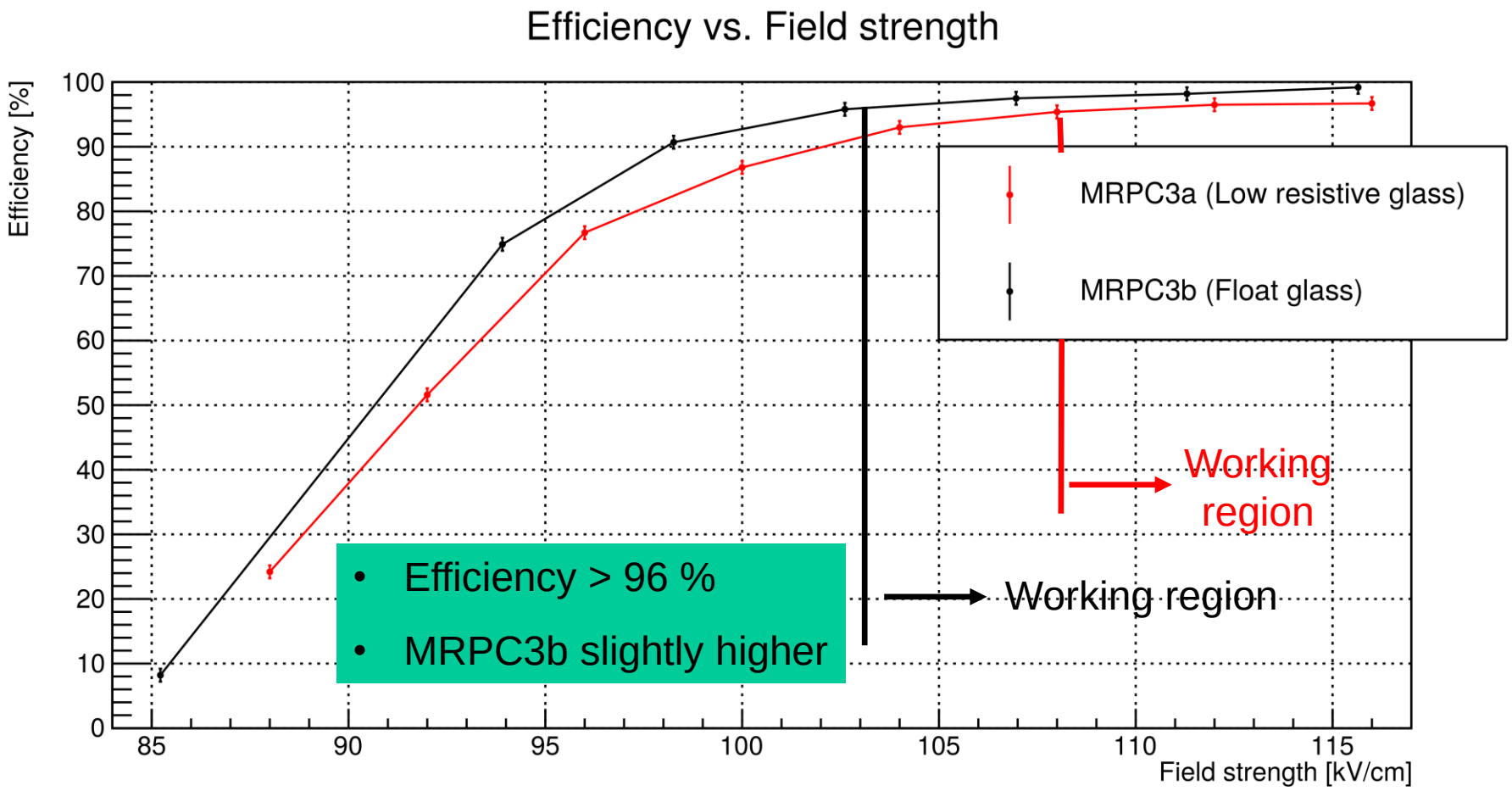


3) Tracking analysis

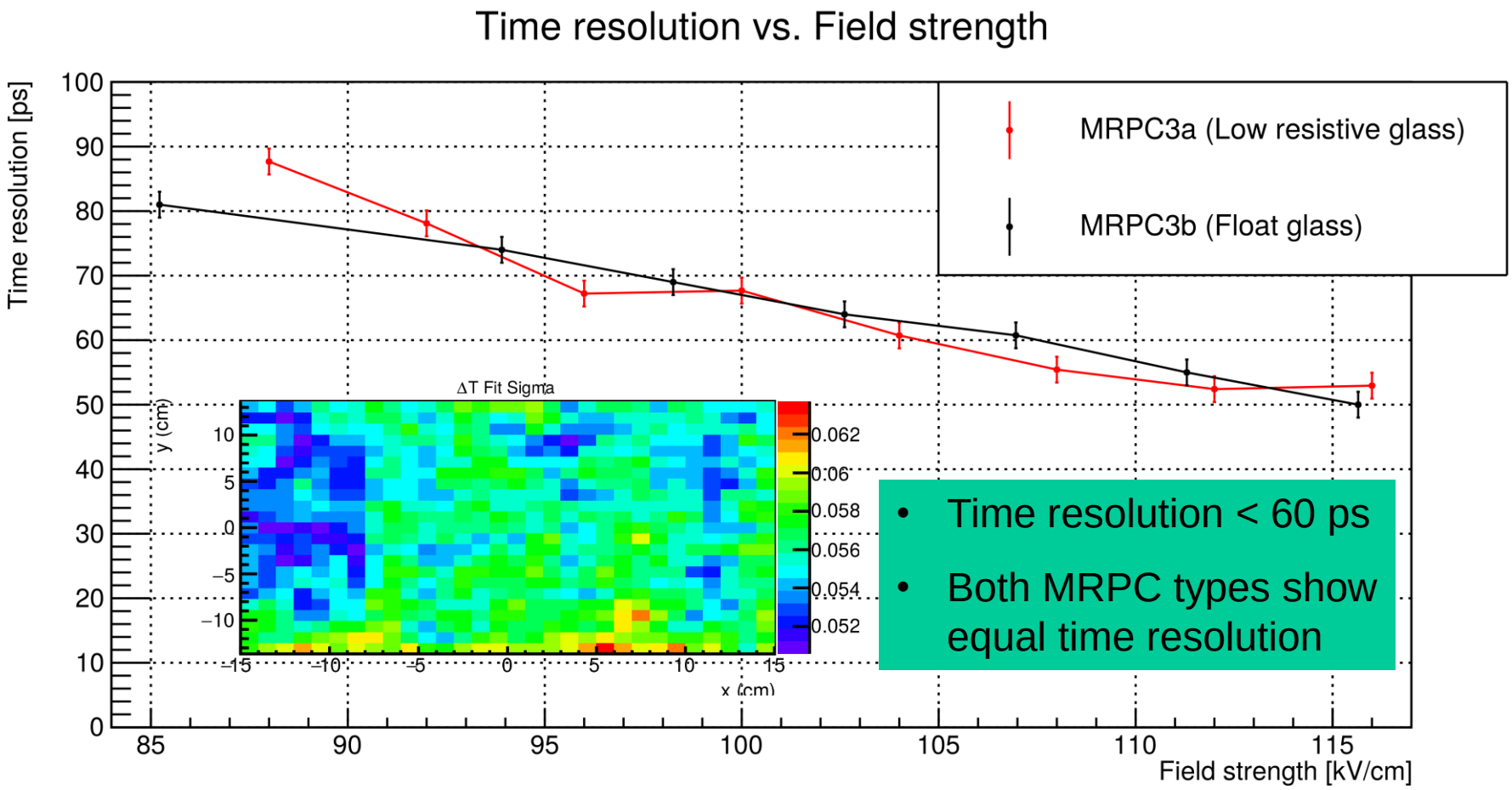




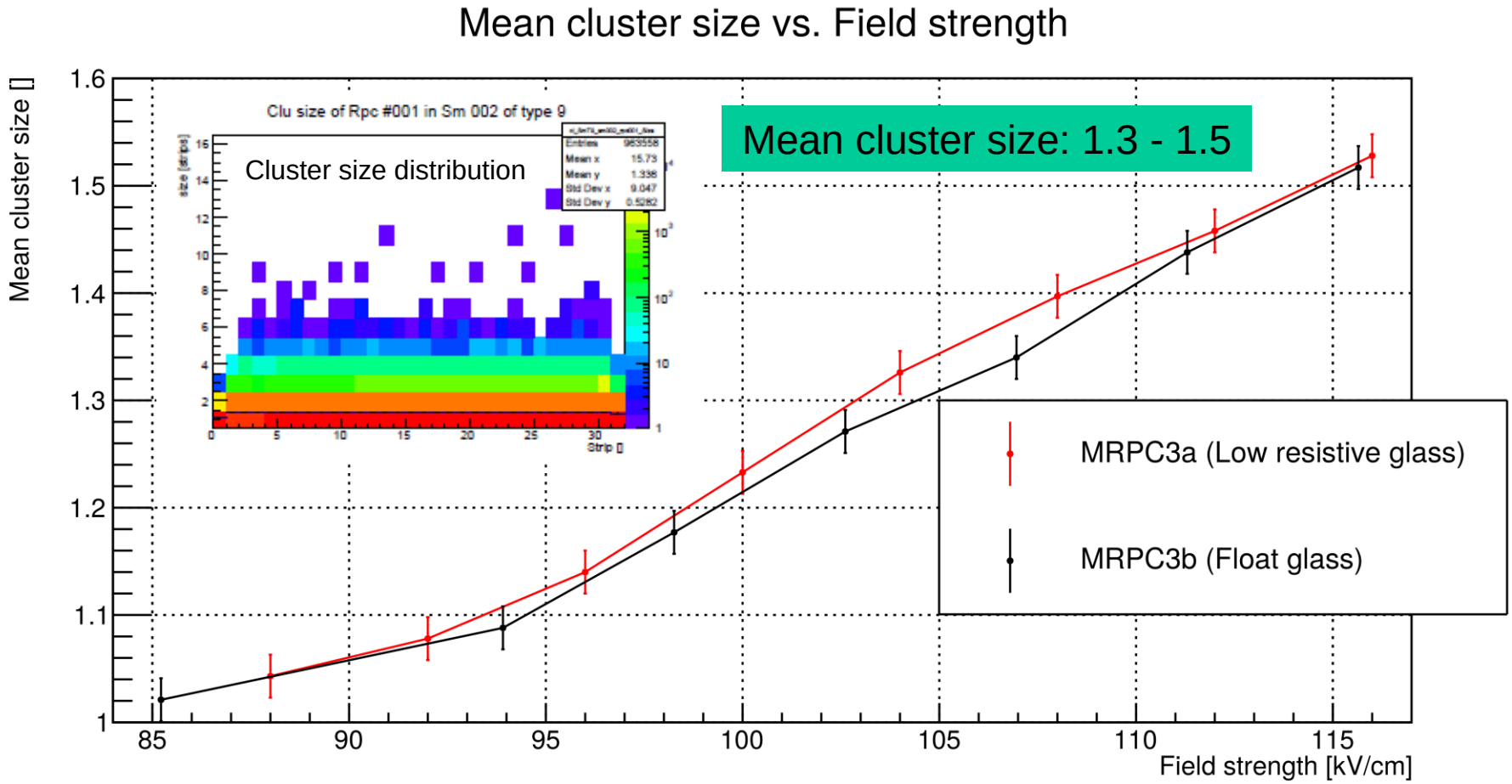
Efficiency


Efficiency vs. Field strength
Efficiency [%]
100
90
80
70
60
50
40
30
20
10
0
85
90
95
100
105
110
115
Field strength [kV/cm]
MRPC3a (Low resistive glass)
MRPC3b (Float glass)
Working region
Working region
• Efficiency > 96 %
• MRPC3b slightly higher

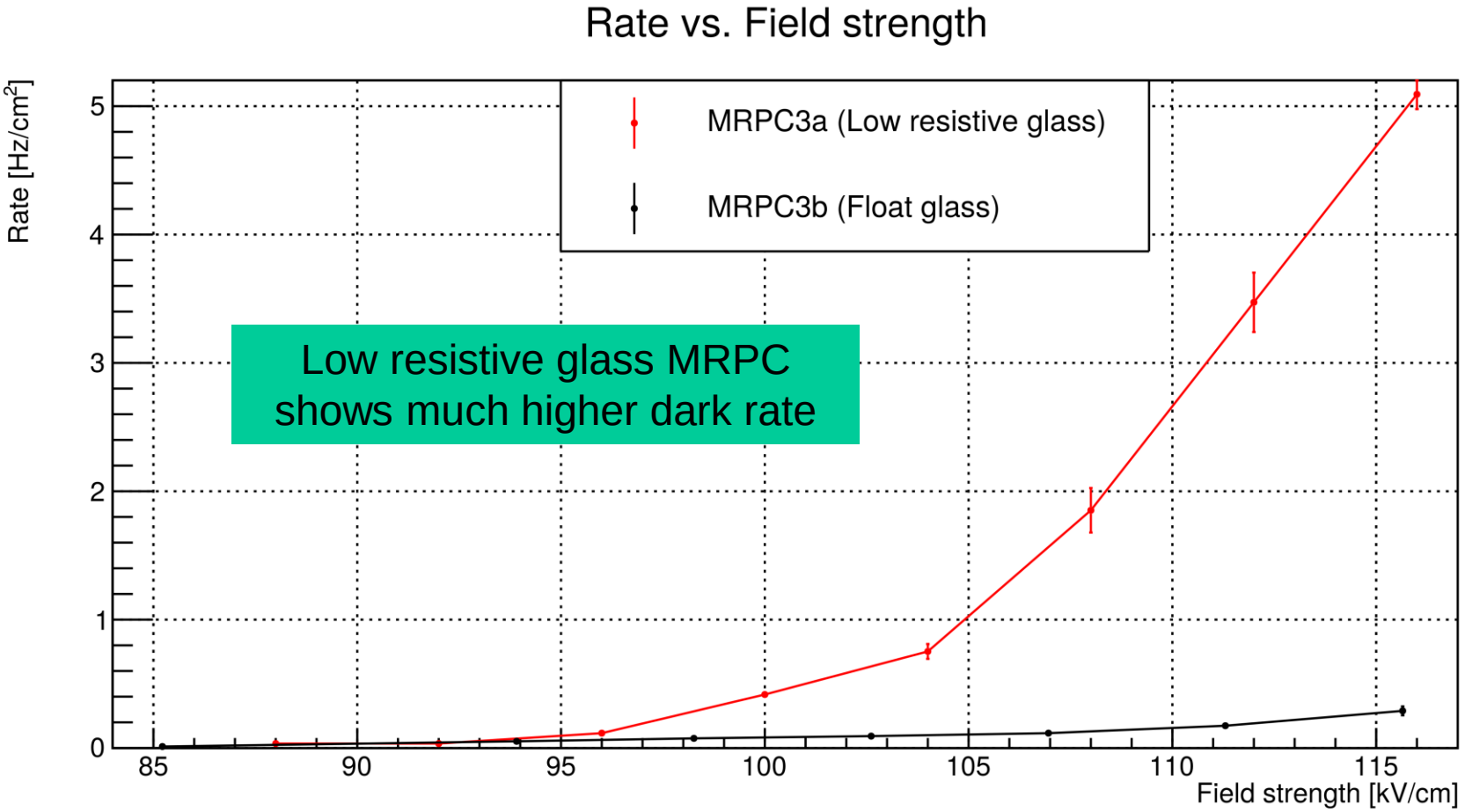
Time resolution



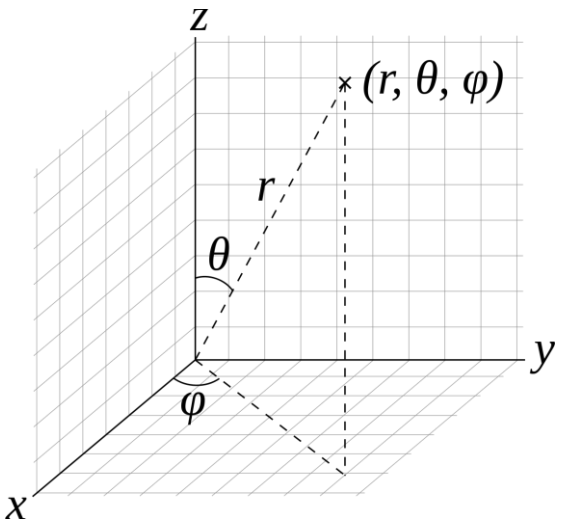
Mean cluster size



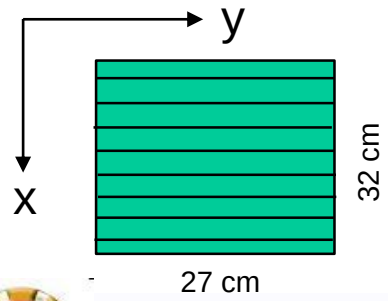
Dark rate


Rate vs. Field strength
Rate [Hz/cm^2]
MRPC3a (Low resistive glass)
MRPC3b (Float glass)
Low resistive glass MRPC
shows much higher dark rate
0
1
2
3
4
5
85
90
95
100
105
110
115
Field strength [kV/cm]

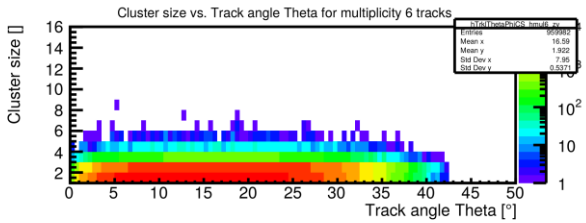
Angle dependence of the mean cluster size

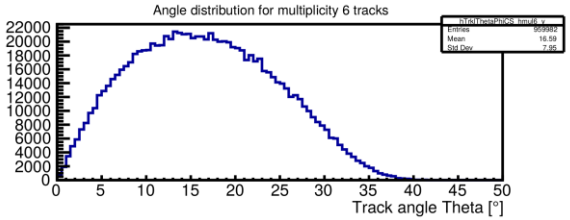


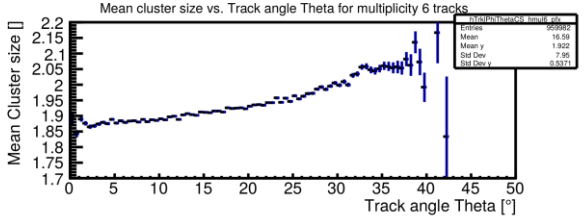
MRPC strips run in y-direction

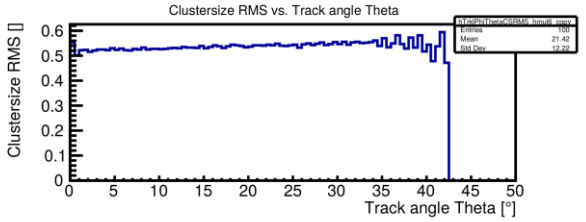


θ - dependence

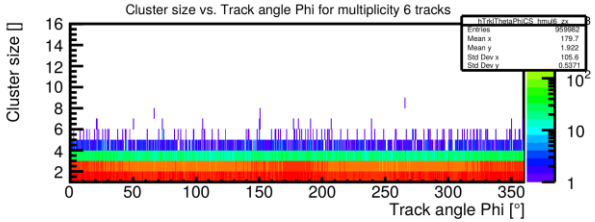


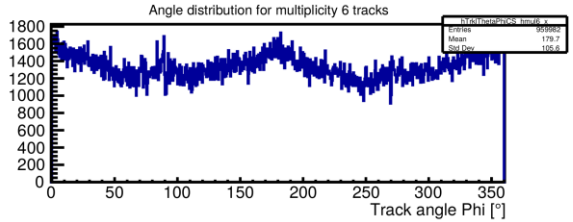


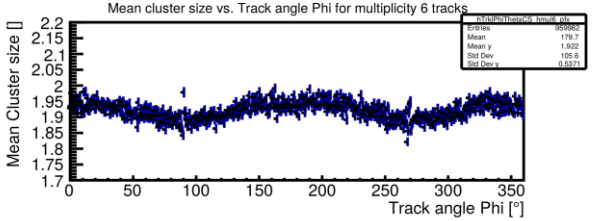


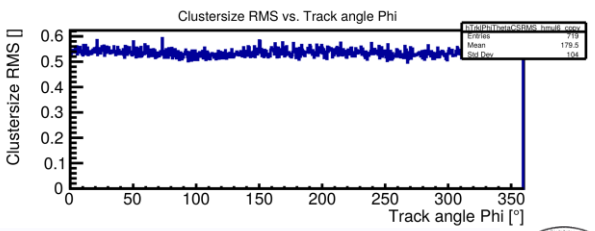


φ - dependence







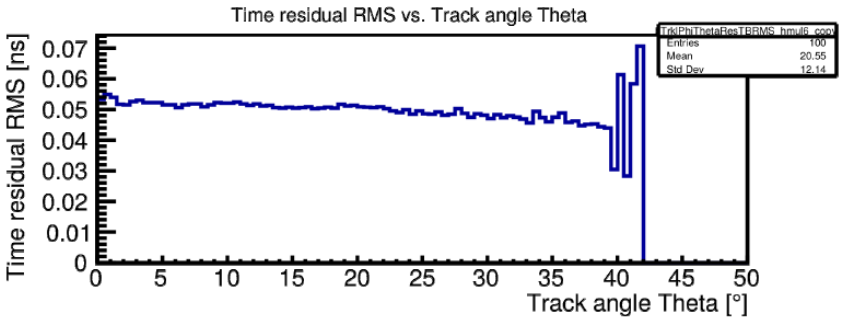


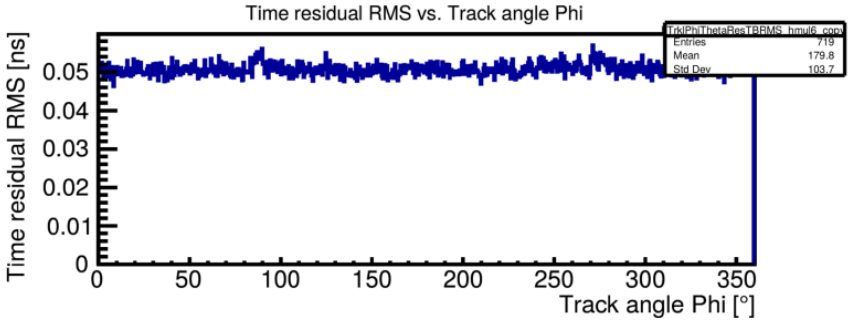
Angle dependence of the residuals in t, x, y

θ - dependence

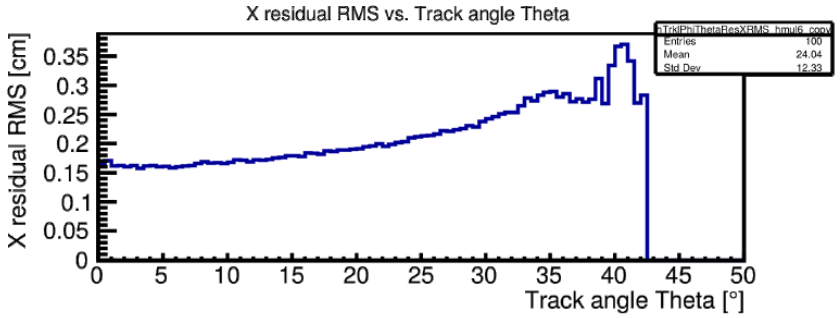
φ - dependence

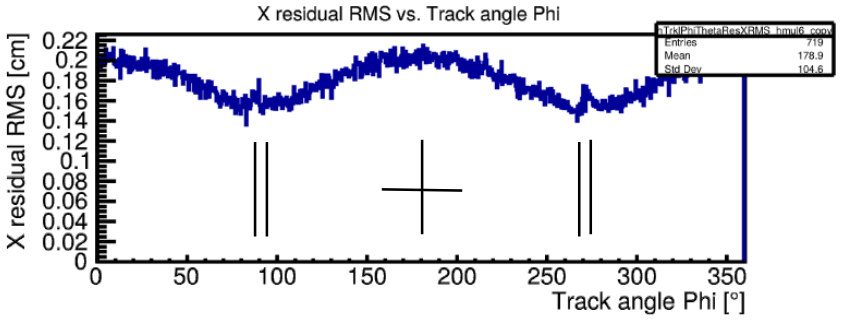
t



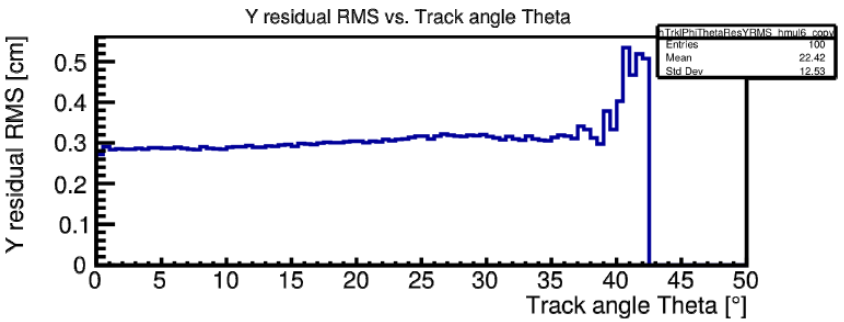


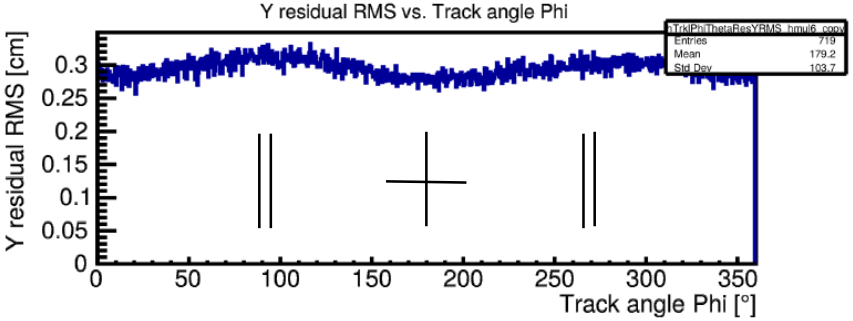
x





y





Summary

- Intensive cosmic ray measurement for MRPC3a/b counter were performed
- Counters are fulfilling the specs
- Dependencies on the incident angle are minor
- Preproduction of MRPC3a/b counter for FAIR phase 0 finished
- R&D for MRPC3a/b counter ongoing
- Ultra high rate test still pending $\Rightarrow$ miniCBM

Thank you for your attention

Contributing institutions:

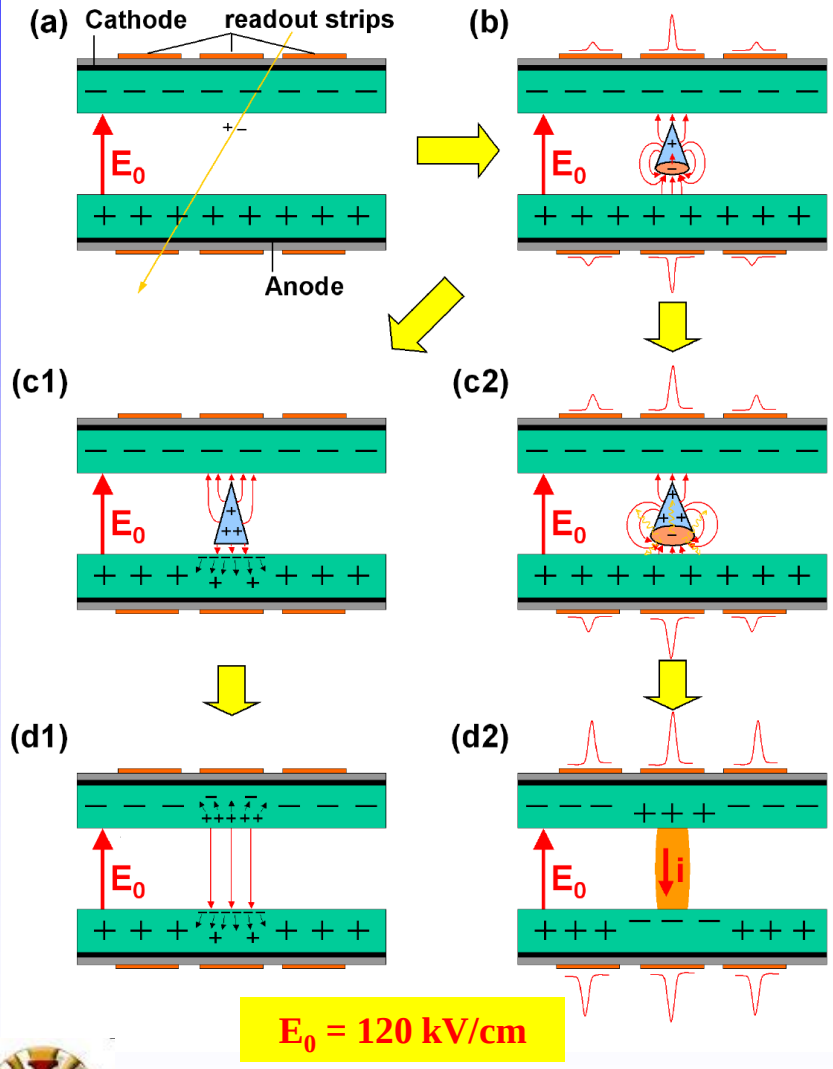
Tsinghua Beijing,
GSI Darmstadt,
USTC Hefei,
PI Heidelberg,
CCNU Wuhan,

Special thanks go to:

Norbert Herrmann

Backup Slides

Working principle of an RPC



E_0 = 120 kV/cm

First Multi-gap RPC 1996

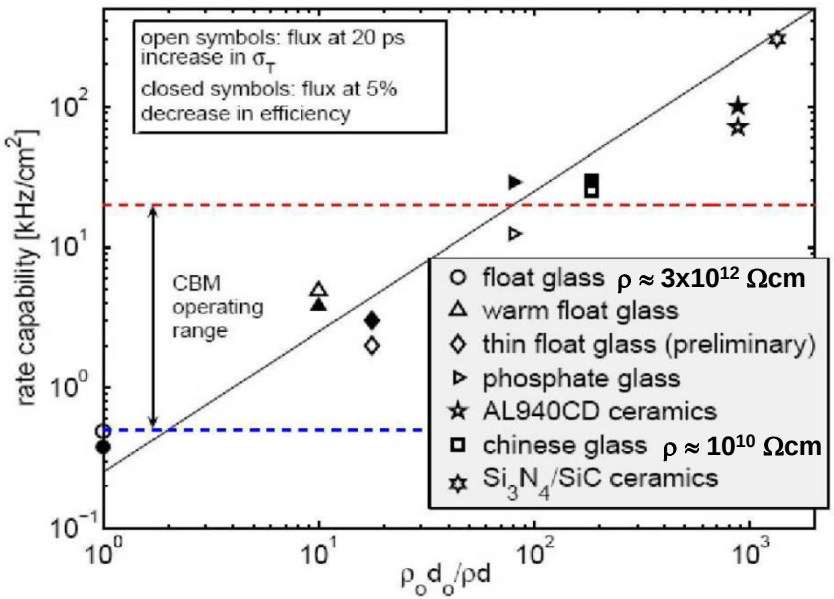
E. Cerron Zeballos et al., **Nucl.Instrum.Meth. A374 (1996) 132-13**

Time resolution: $\sigma_T = \sigma_0 + K_T \bar{q} \phi \rho d$

Efficiency: $\epsilon = \epsilon_0 - K_\epsilon \bar{q} \phi \rho d$

ϕ: incident ch. particle flux, ρ: electrode bulk resistivity, d: electrode thickness

How to increase the rate capability?

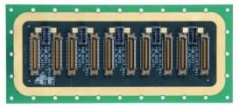


Electronic readout chain

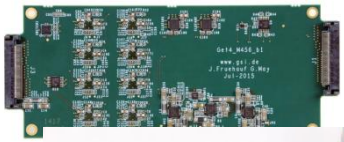
Readout chain

- PADI: Preamplifier board 32 ch

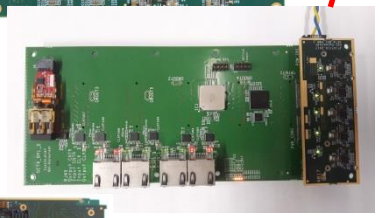
- Feed through PCB



- GET4: TDC board 32 ch

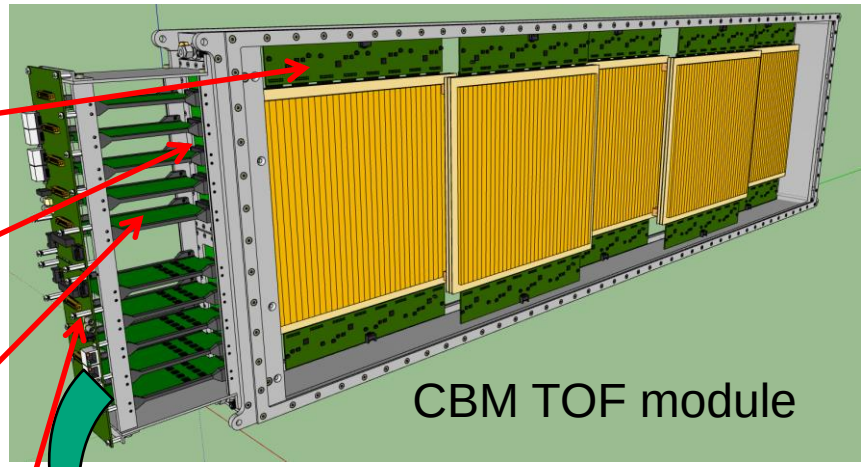


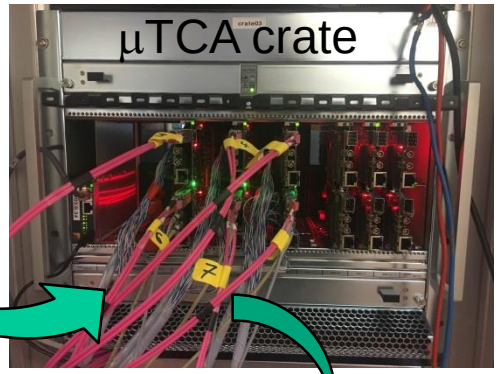
- Backplane with GBTx chip



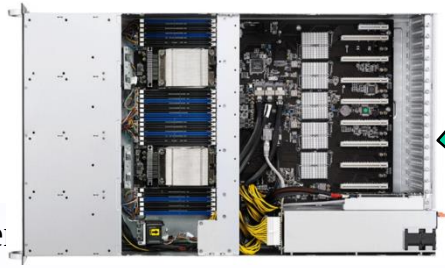
- AFCK: FPGA board

- FLIB: FPGA PCI express card

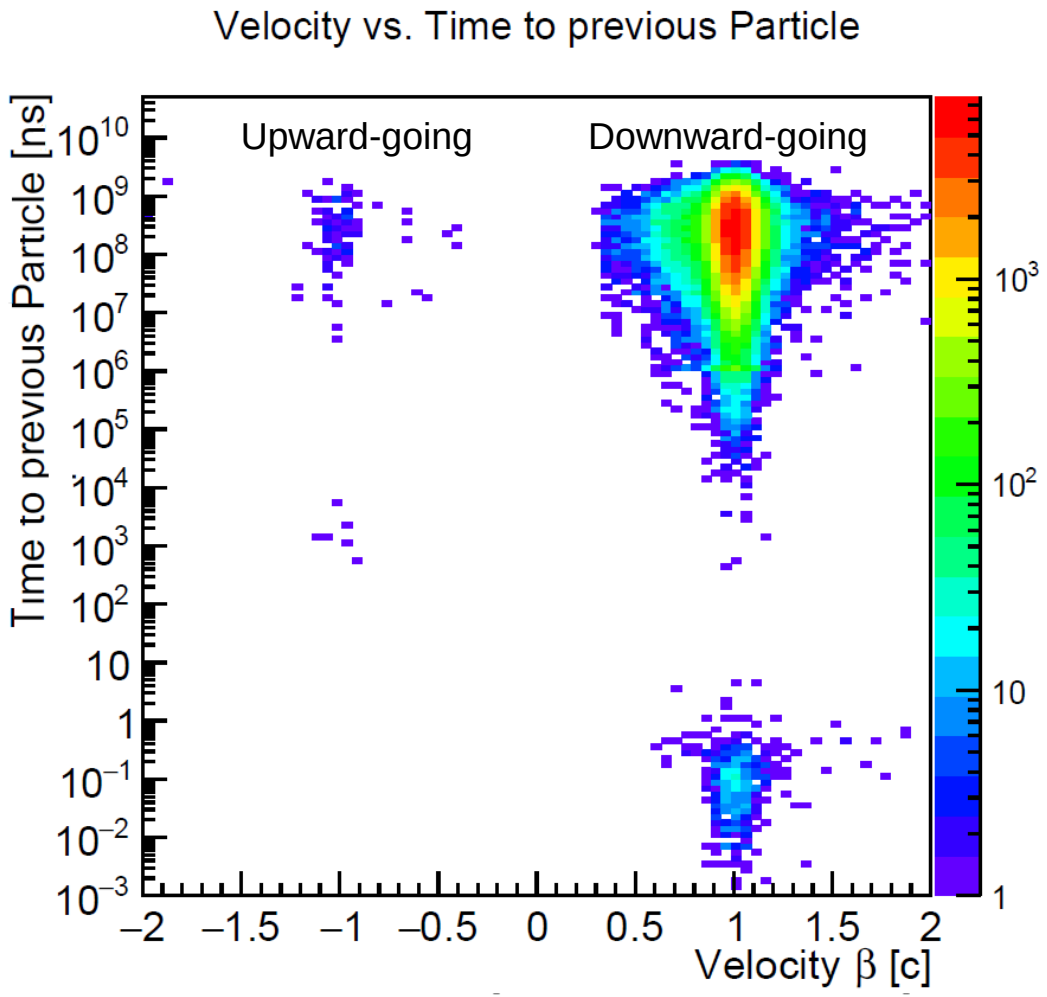


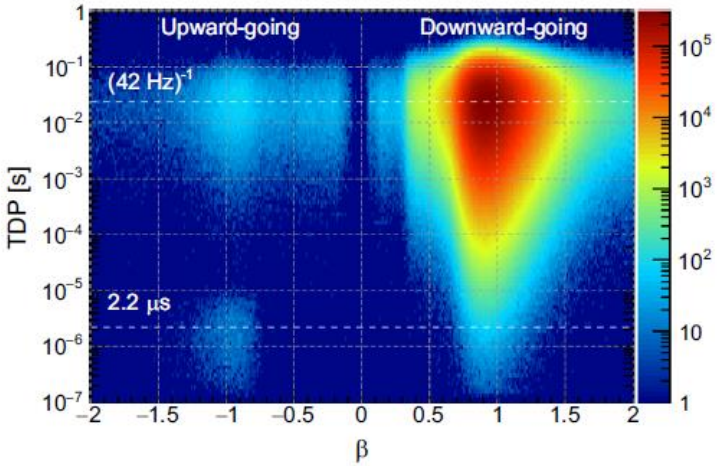


HP-PC



Upward-going particles





Abbrescia at al. Nucl.Instrum.Meth. A816 (2016) 142-148