Development of GEM for the CBM MUCH Detector

Saikat Biswas[*], D. J. Schmidt, A. Abuhoza, U. Frankenfeld, C. Garabatos, J. Hehner, V. Kleipa, T. Morhardt, C.J. Schmidt, H.R. Schmidt, J. Wiechula

GSI Detector Laboratory, Germany

([*]National Institute of Science Education and Research, India)

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Outline of the talk

- Tests at GSI detector laboratory
- Results
- Summary

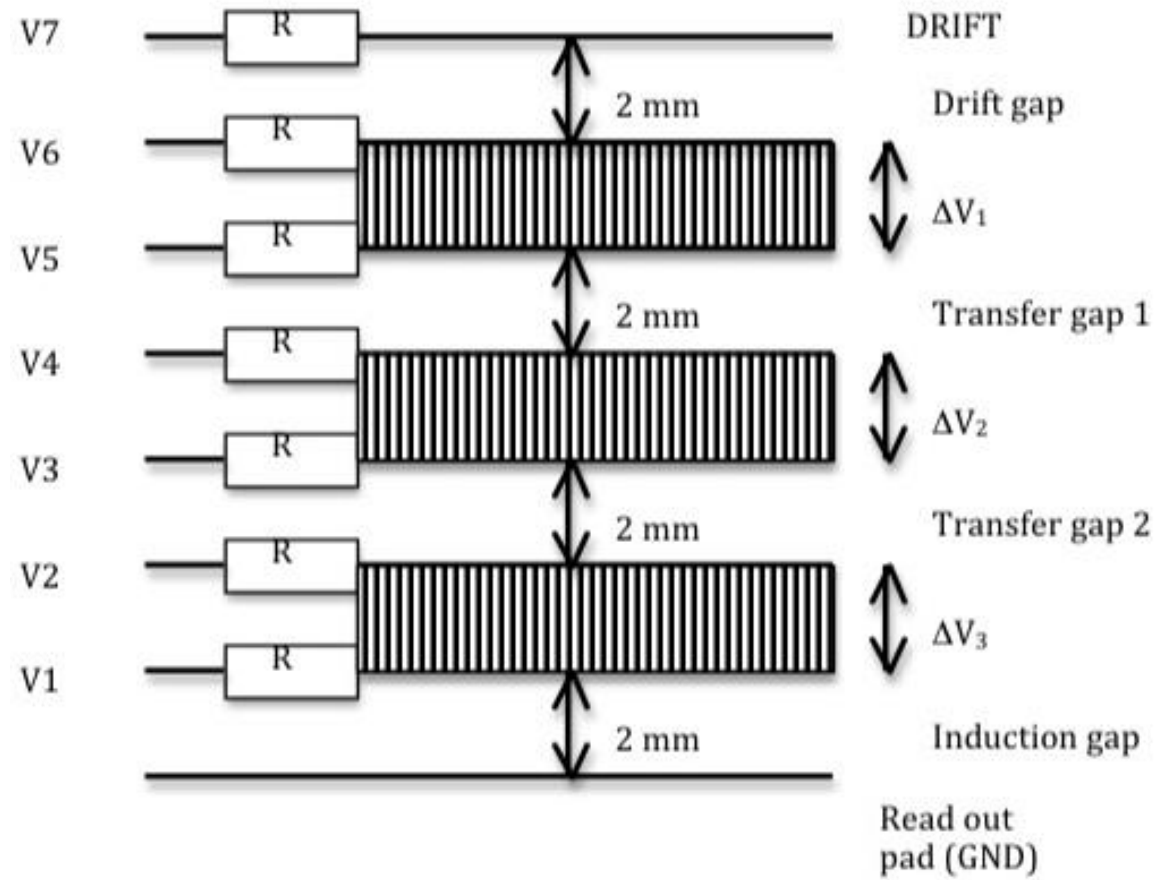
GEM for CBM

- Triple GEM as a precise tracking detector in the Muon Chamber (MUCH) under the extreme conditions of the CBM experiment

Details of the set up

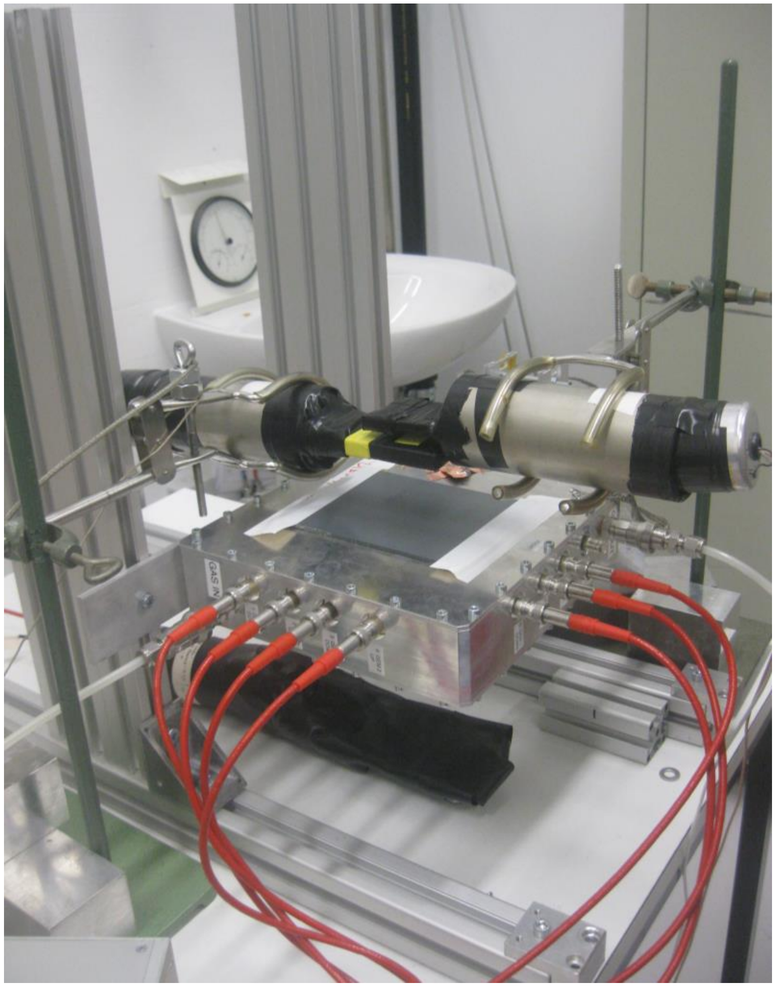
- Double Mask GEM
- Gas mixture: Ar/CO_2: 70/30
- 7 channel HVG210 power supply
- 2 sum-up boards are used for signal (2×128 6×6 mm^2 pads)
- PXI LabView based DAQ is used

Voltage distribution in GEM



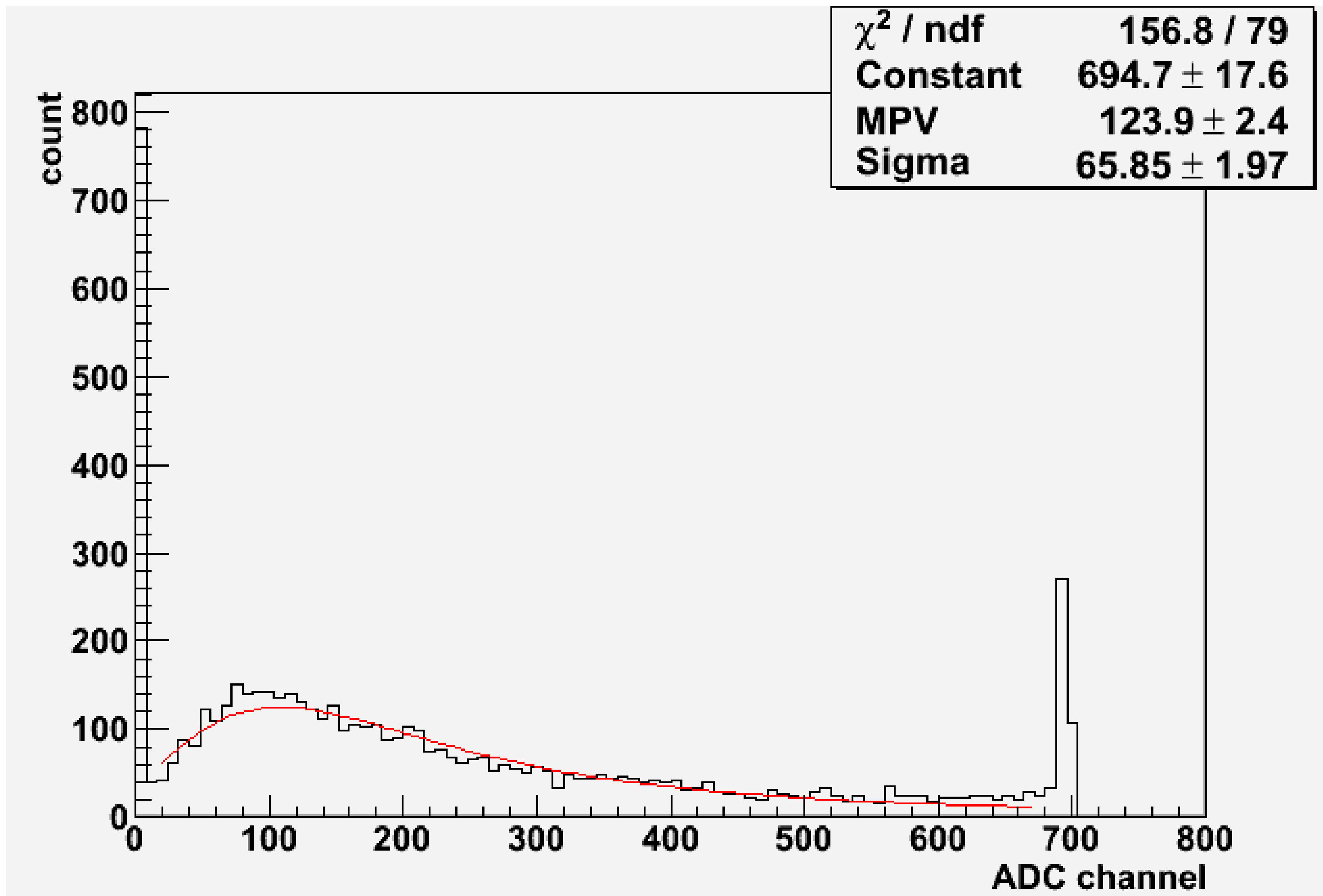
Cosmic ray tests

Cosmic ray test set-up

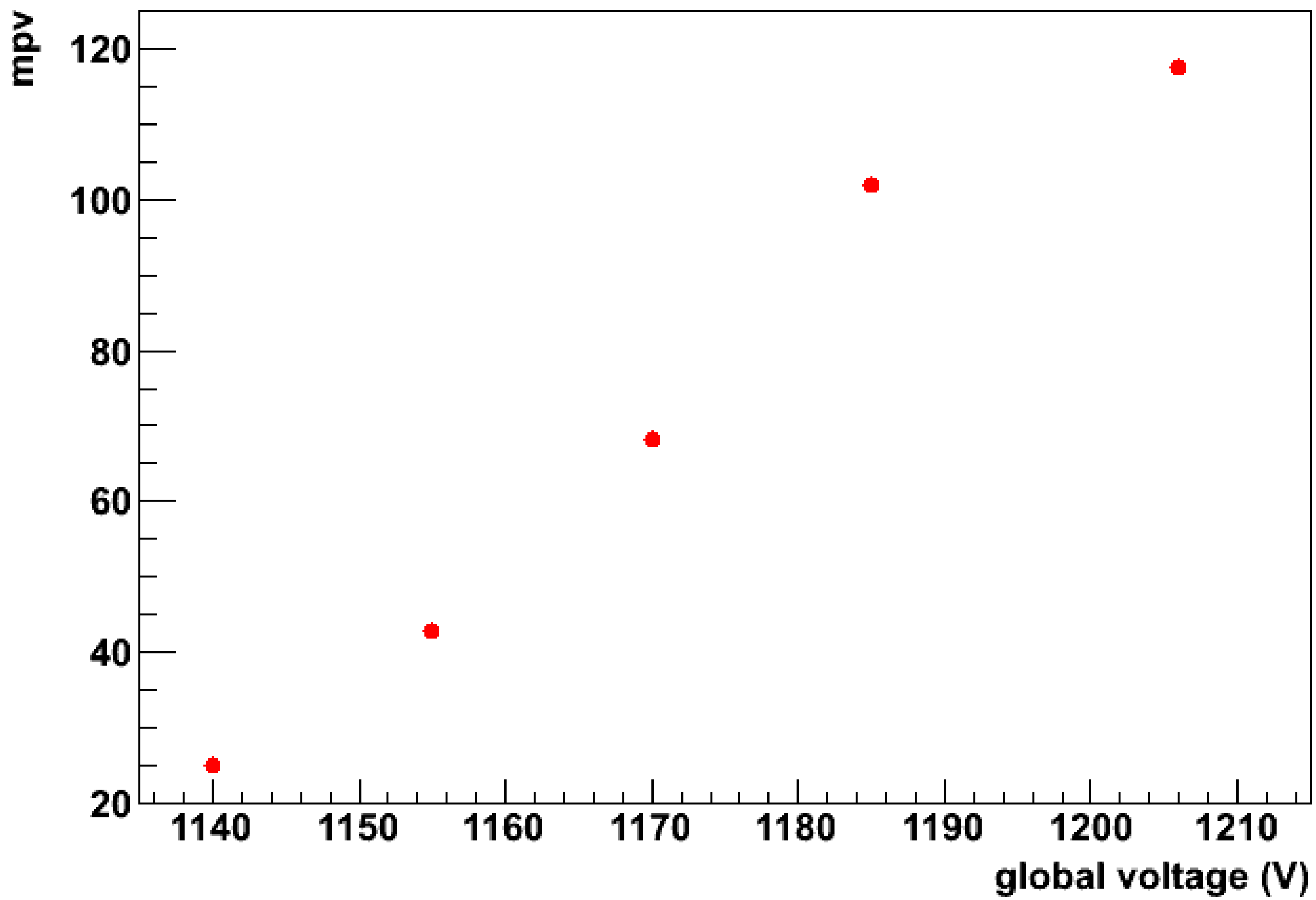


- Trigger: 3 fold Scintillator signal
- Gas: Ar/CO_2 : 70/30

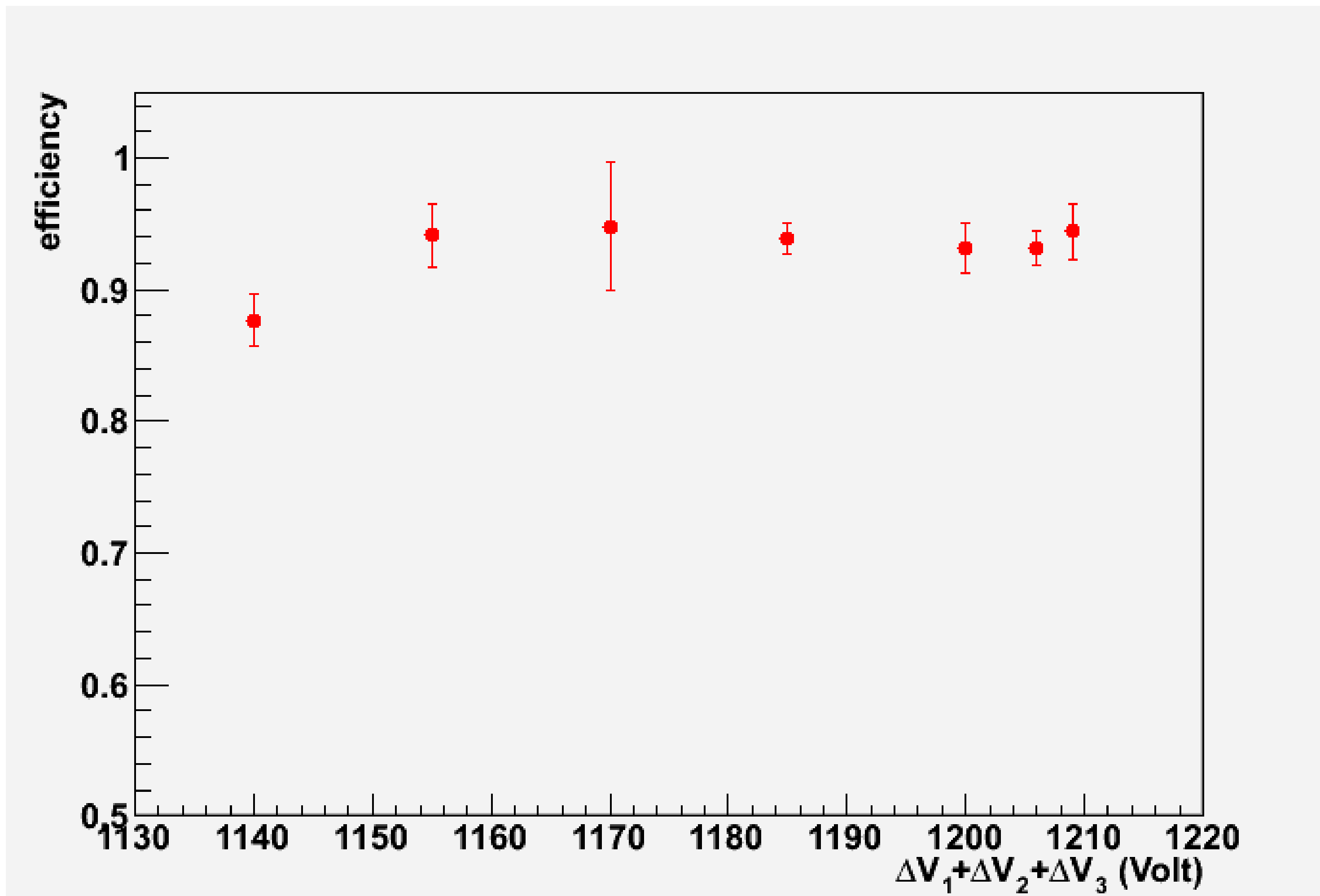
MIP spectrum @ 400-395-390 V



Gain vs. global voltage



Efficiency for cosmic ray

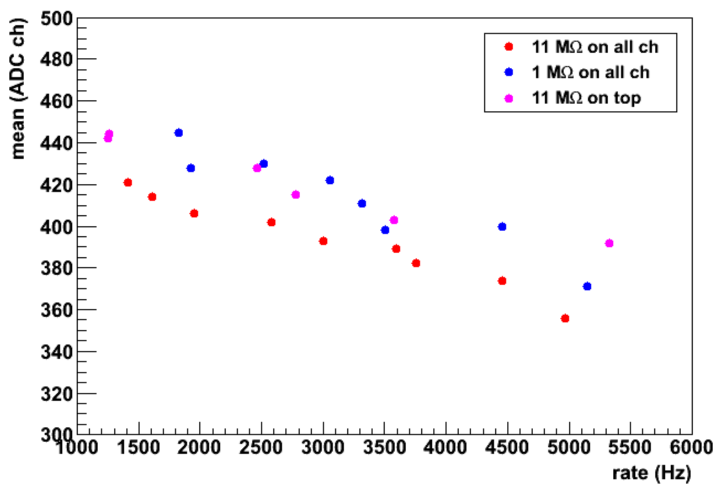


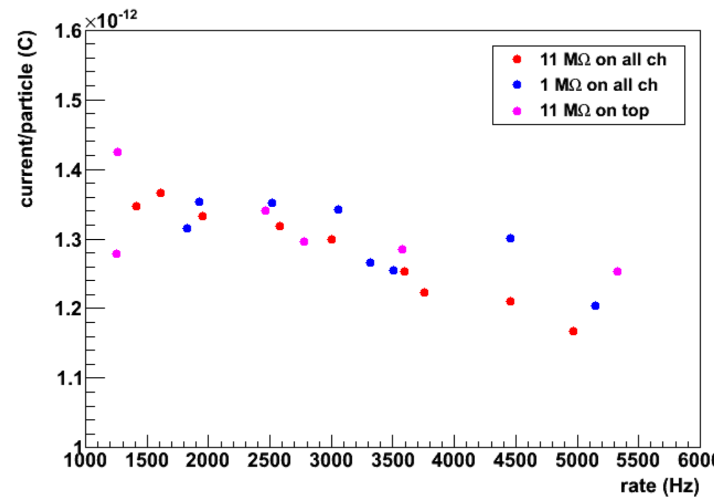
Gain vs. rate

Summary of measurement

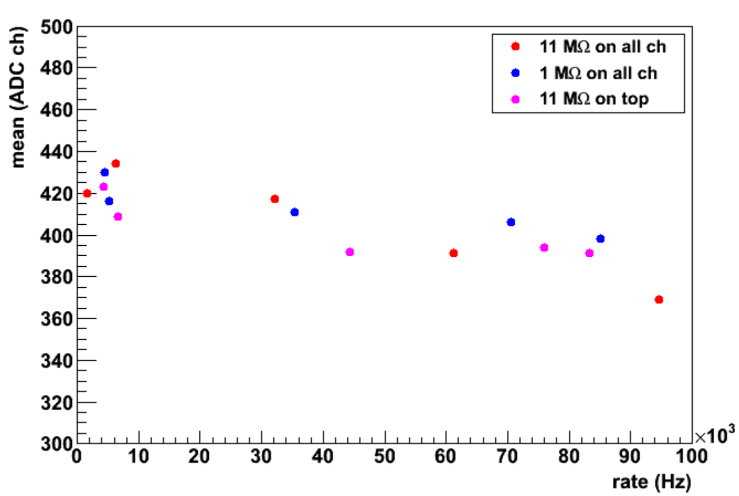
- GEM voltages 400-395-390 V
- E_d =2.5 kV/cm; E_i =2 kV/cm; E_t =3 kV/cm
- Collimator fixed with detector; source position changed
- Varying collimator diameter
- Collimator fixed with source; source position changed
- Using X-ray generator

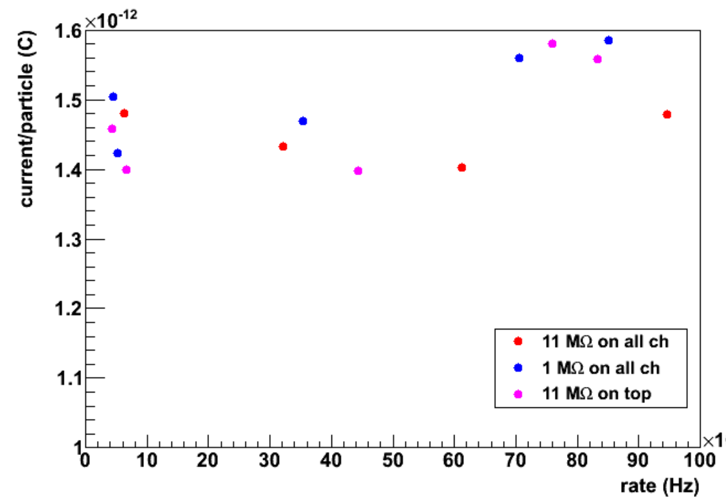
Collimator fixed with detector



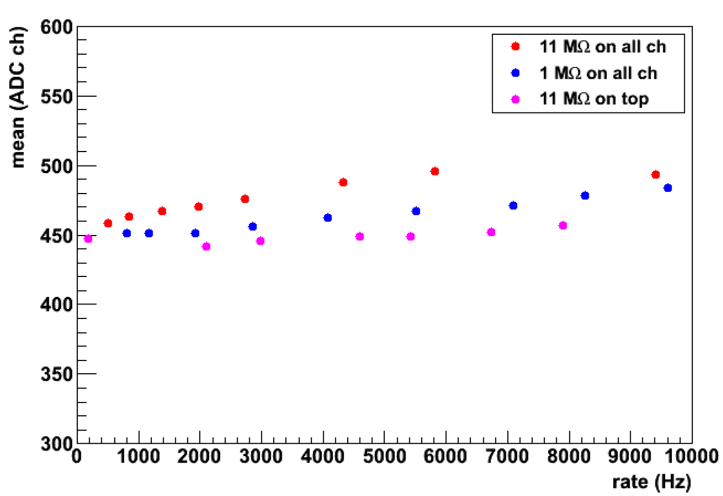


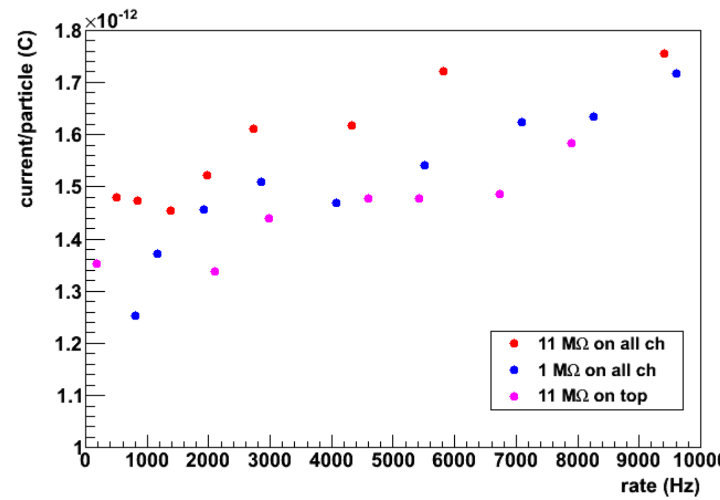
Varying collimator diameter



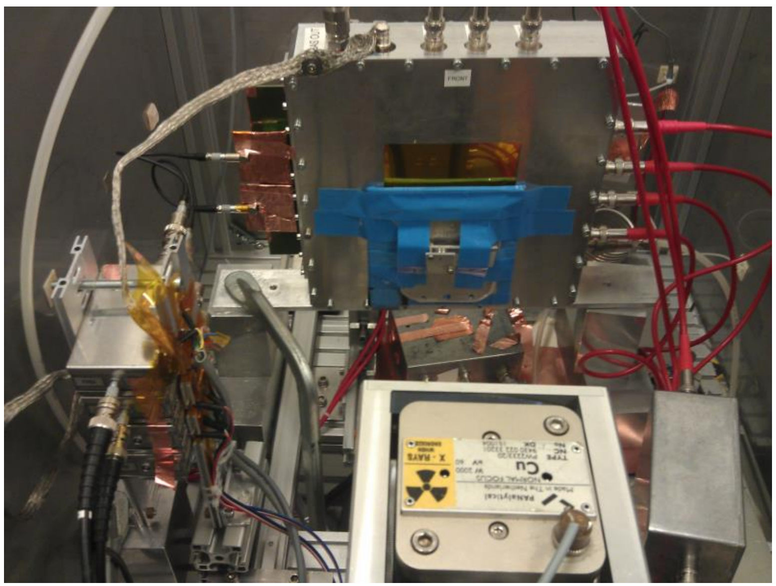


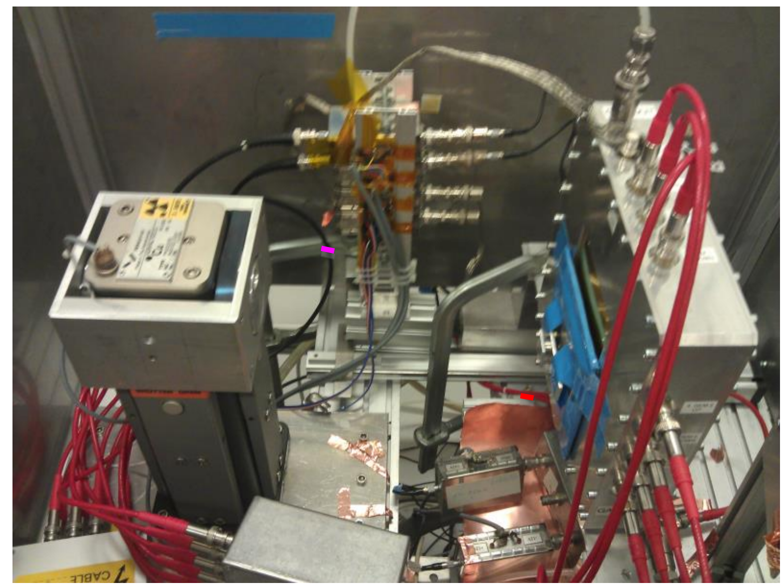
Collimator fixed with source



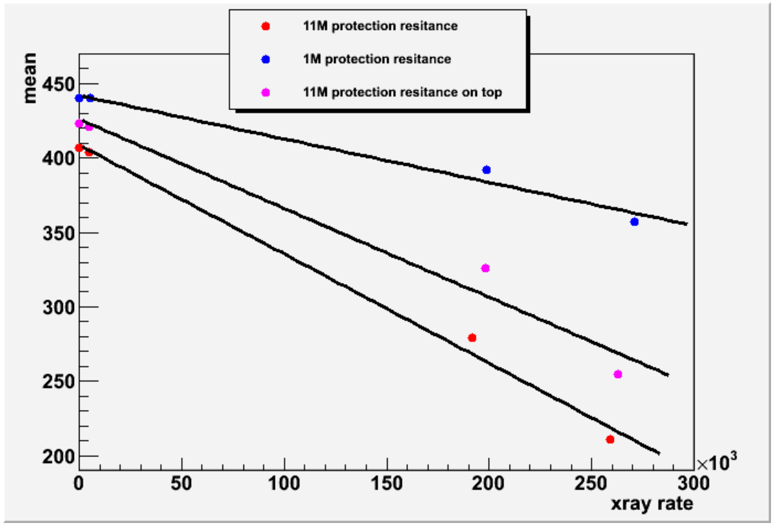


With X-ray generator

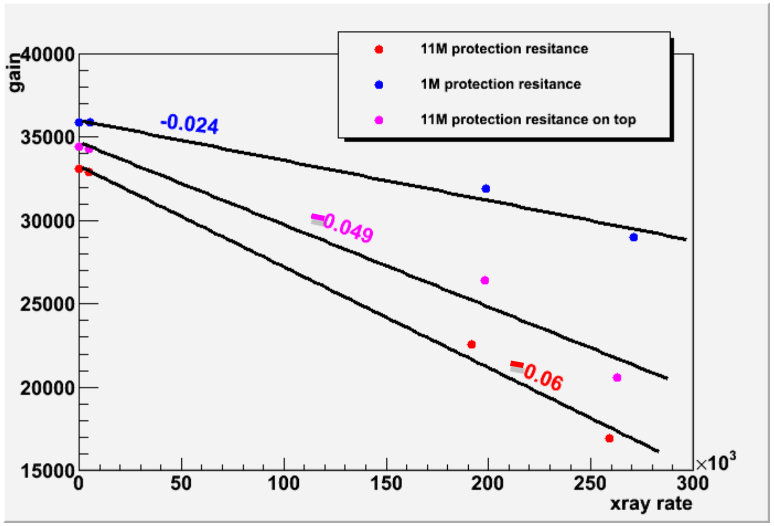




Gain vs. rate



11M protection resitance
1M protection resitance
11M protection resitance on top
mean
450
400
350
300
250
200
0
50
100
150
200
250
300
$\times 10^3$
xray rate

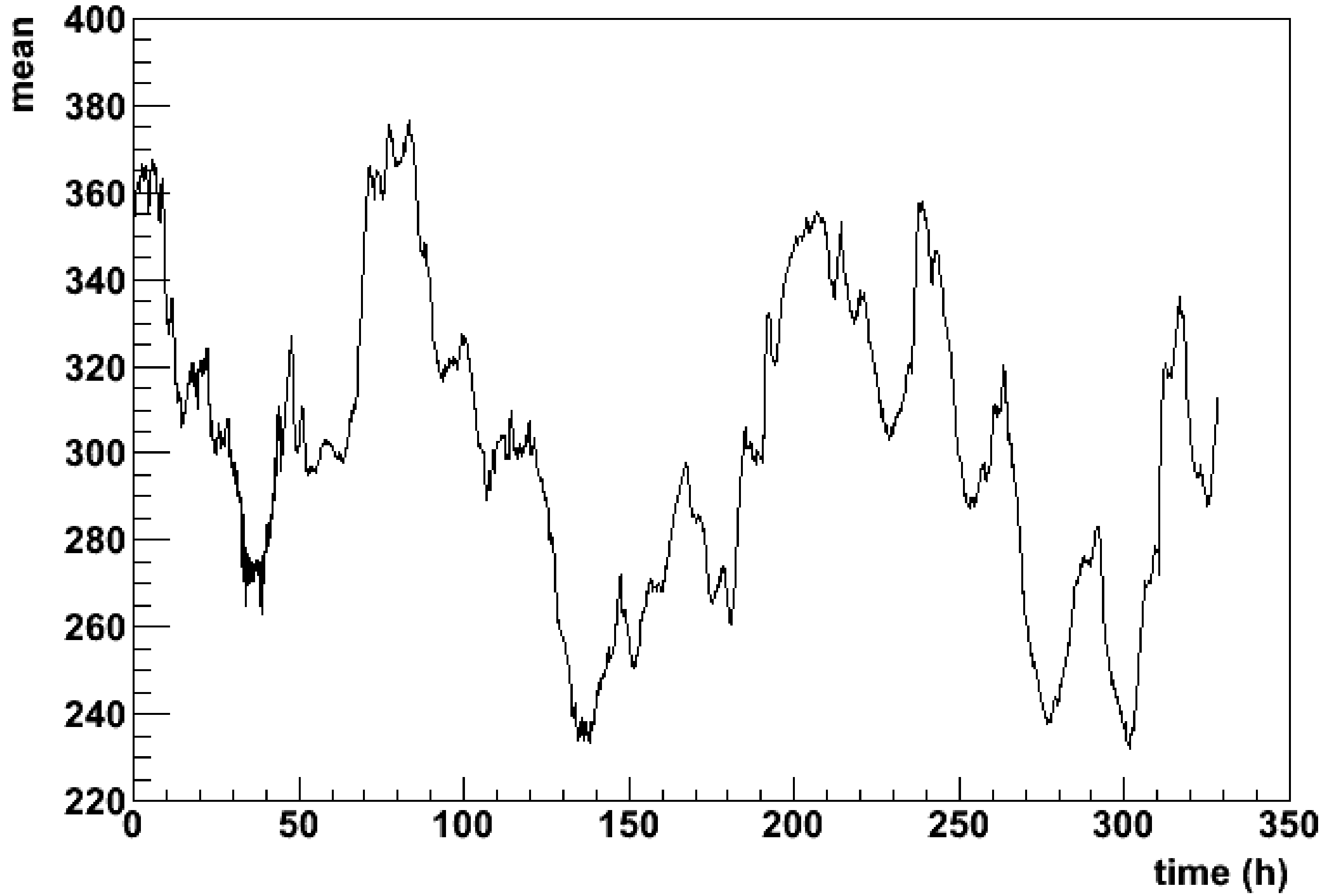


11M protection resitance
1M protection resitance
11M protection resitance on top
gain
40000
35000
30000
25000
20000
15000
-0.024
-0.049
-0.06
0
50
100
150
200
250
300
$\times 10^3$
xray rate

Long term test of GEM

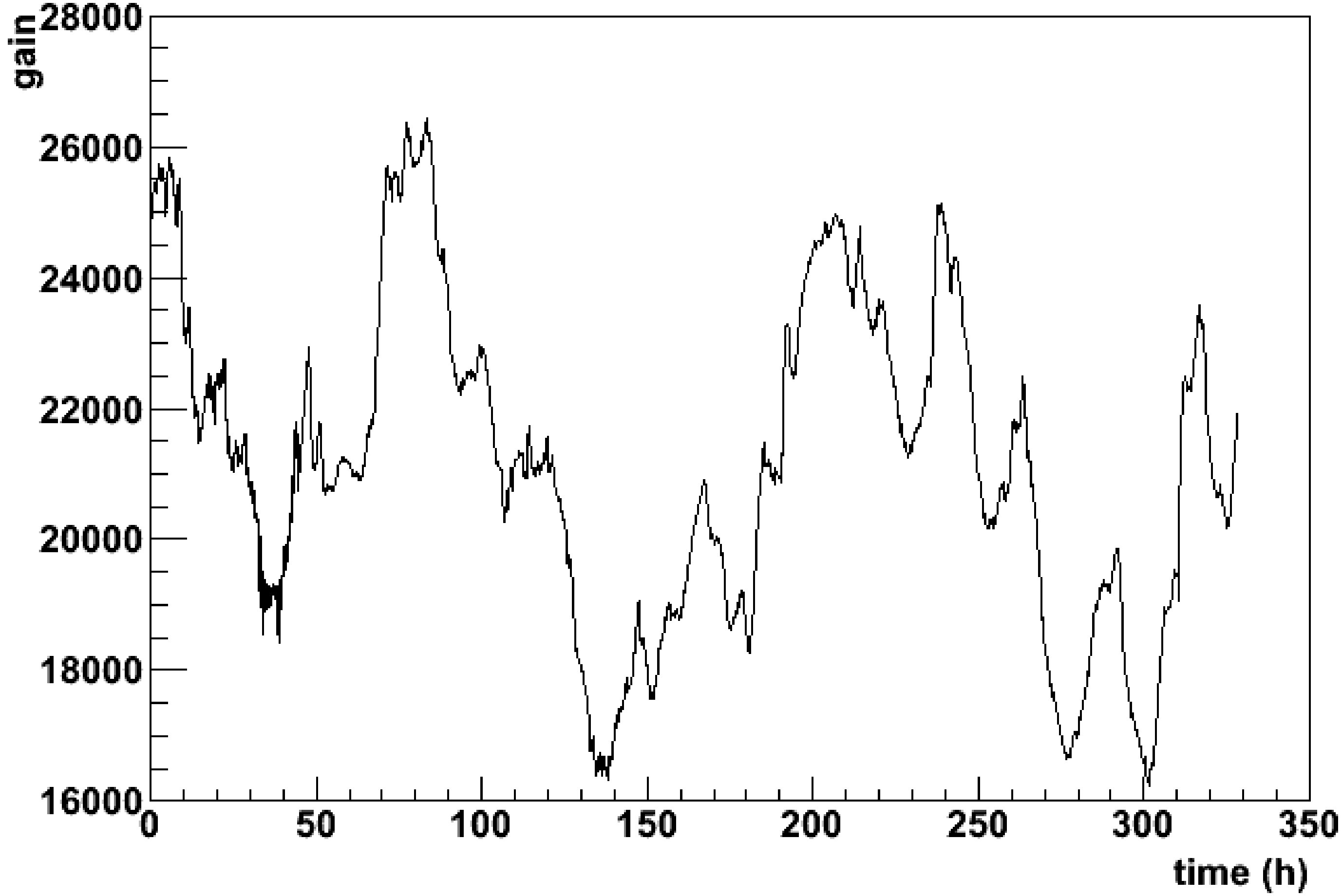
- GEM voltages 400-395-390 V
- E_d =2.5 kV/cm; E_i =2 kV/cm; E_t =3 kV/cm
- Fe^{55} spectra is taken in 10 min interval

Mean vs. time



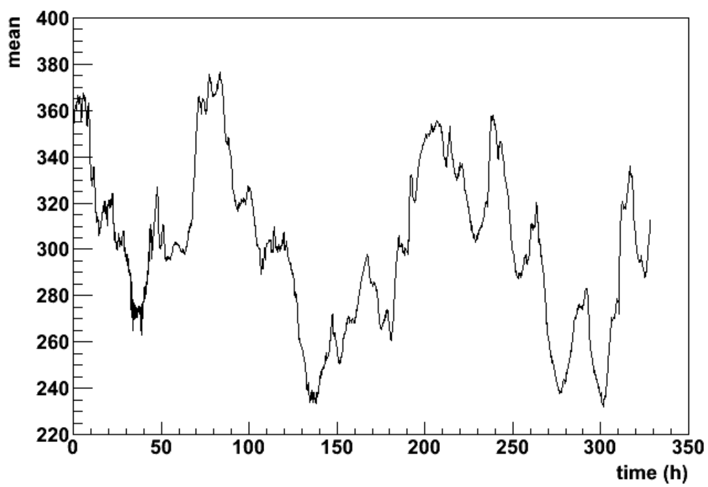
mean
400
380
360
340
320
300
280
260
240
220
0
50
100
150
200
250
300
350
time (h)

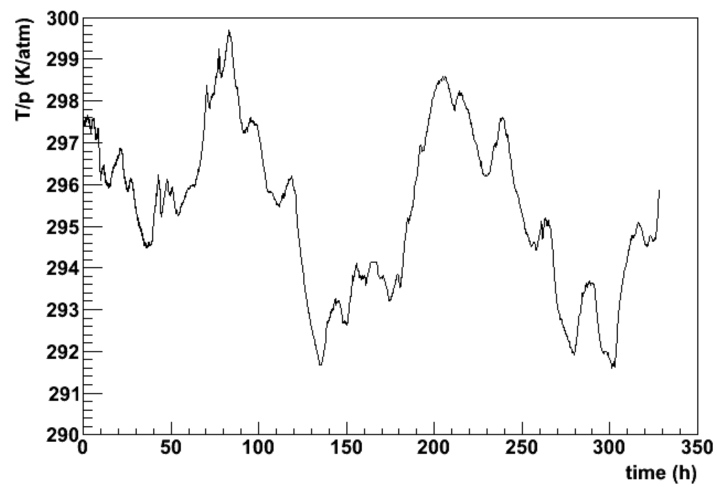
Gain vs. time



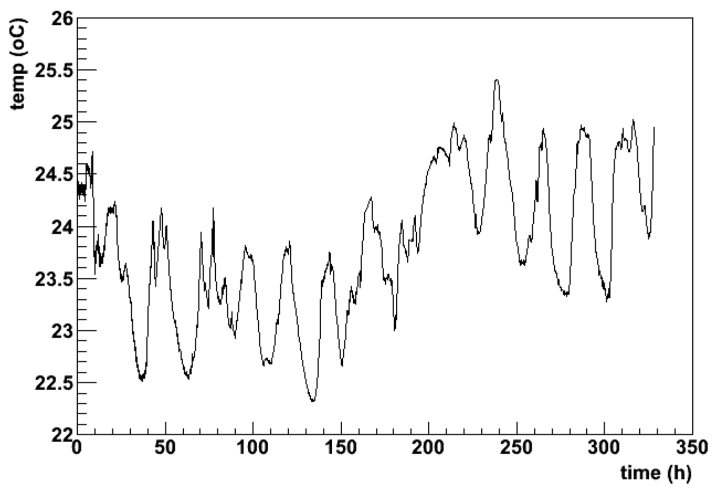
S. Biswas, et al., NIM A 718 (2013) 403-405.

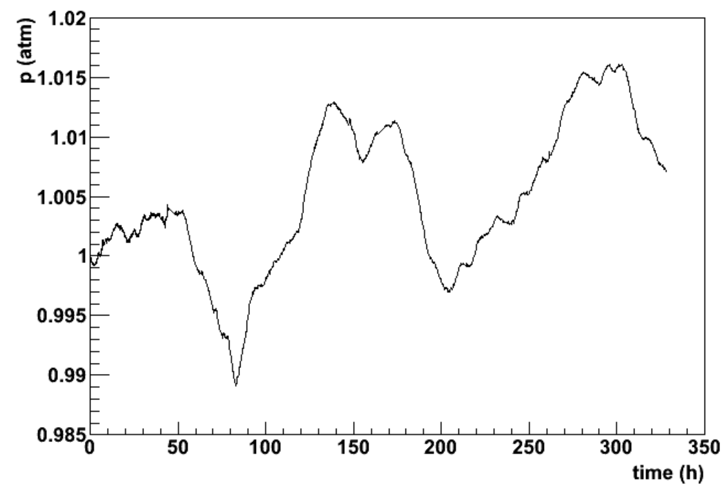
Mean and T/p correlation



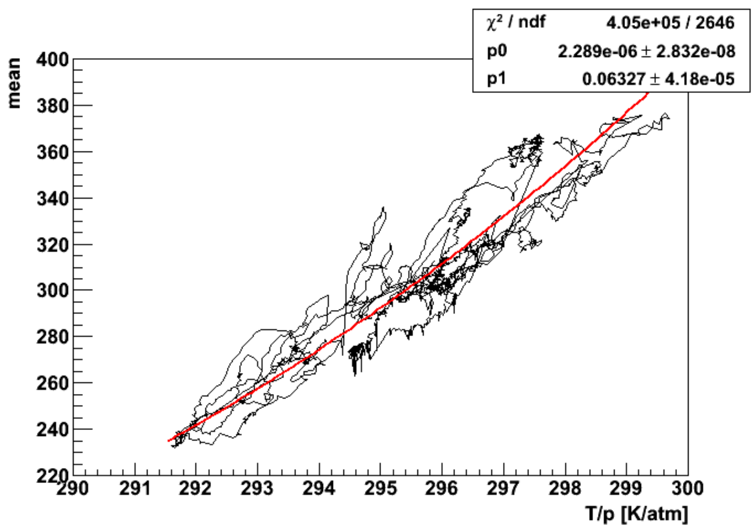


Temp and pressure vs. time





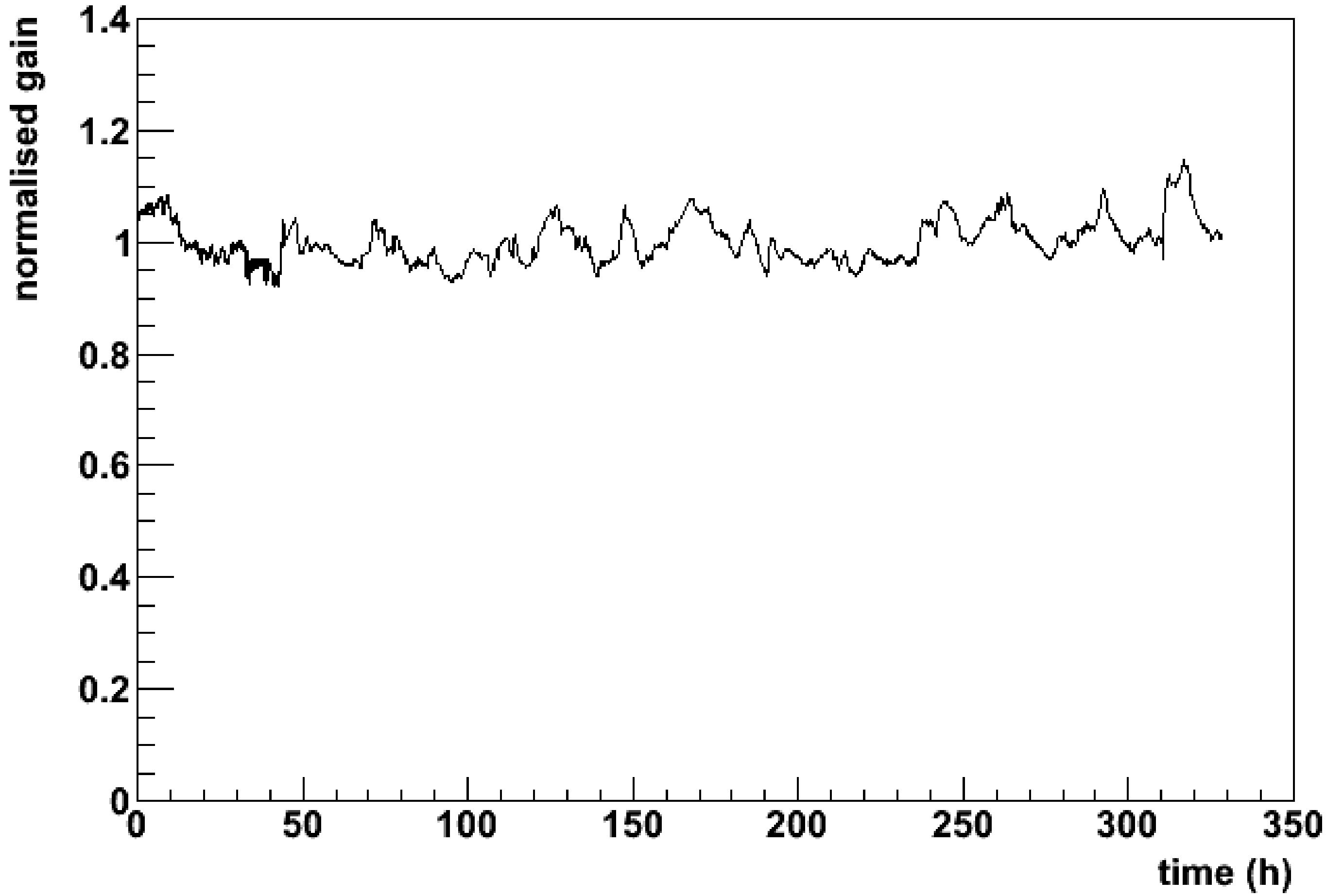
Correlation plot



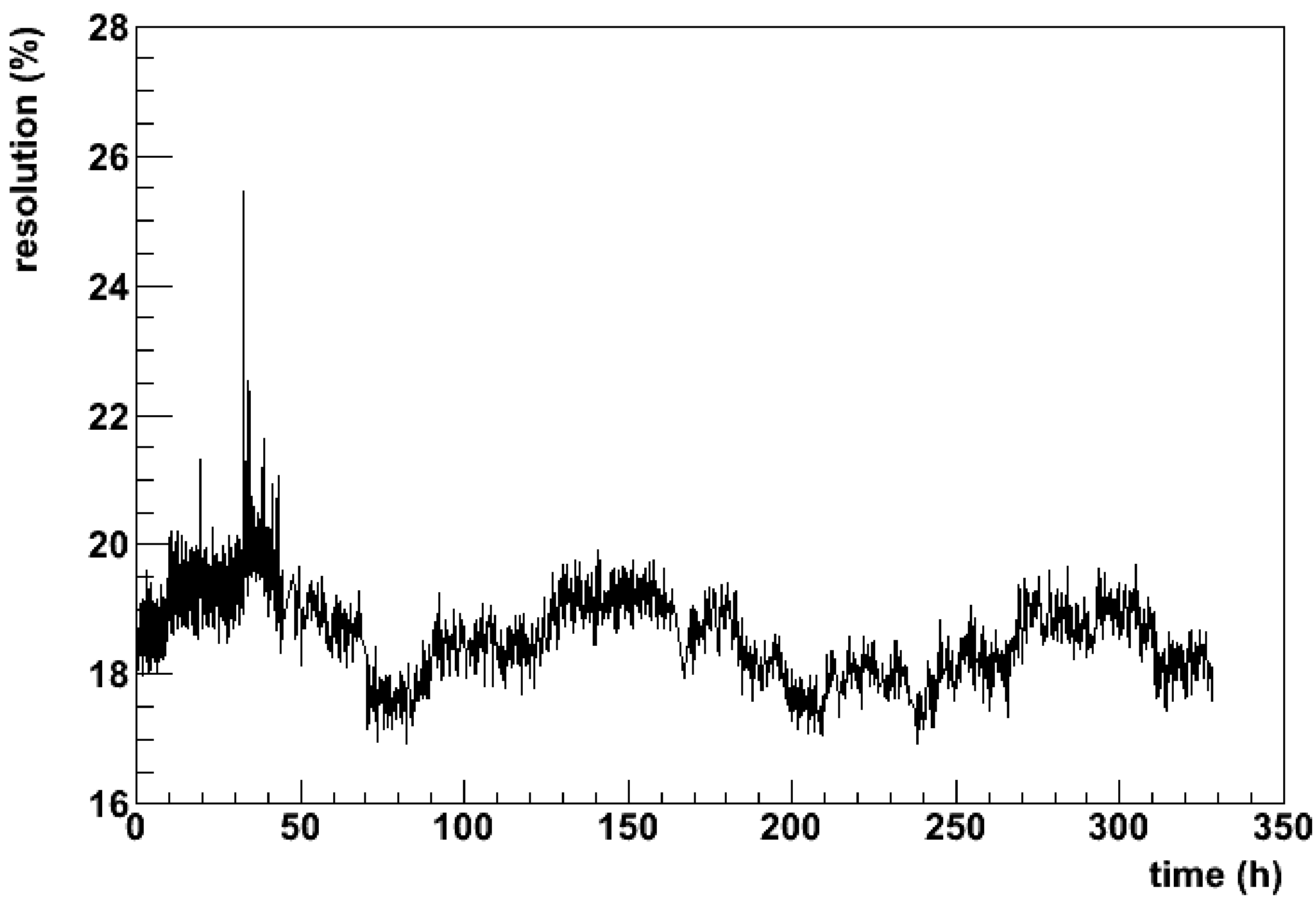
- $g = G/Ae^{BT/p}$
- $G(T/p) = Ae^{BT/p}$
- G = measured gain
- g = normalized gain
- A & B fit parameter
- Townsend coefficient $\alpha \propto 1/\rho \propto T/p$
- ρ= mass density

Ref. M.C. Altunbas et al., NIM A 515 (2003) 249–254.

Normalized gain vs. time

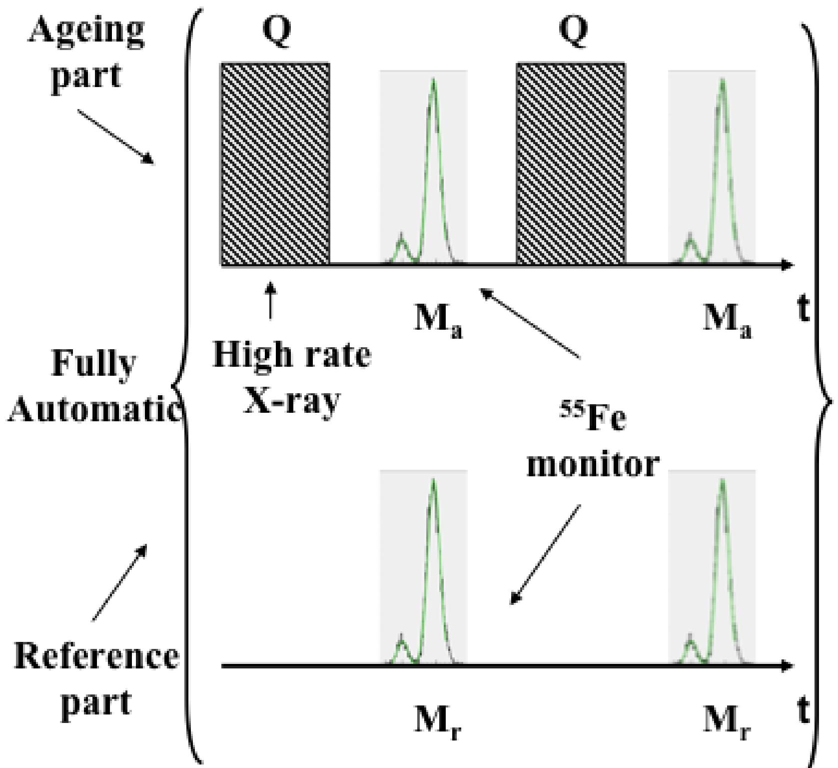


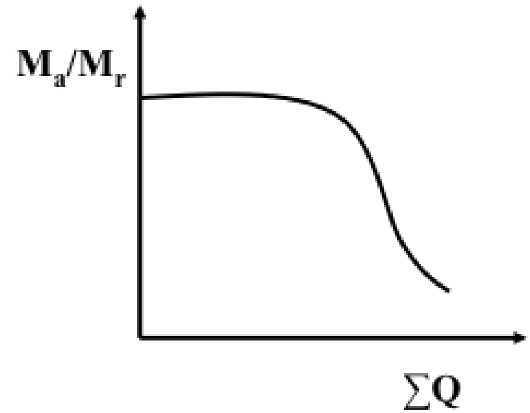
Resolution vs. time



Ageing test of GEM

Work plan



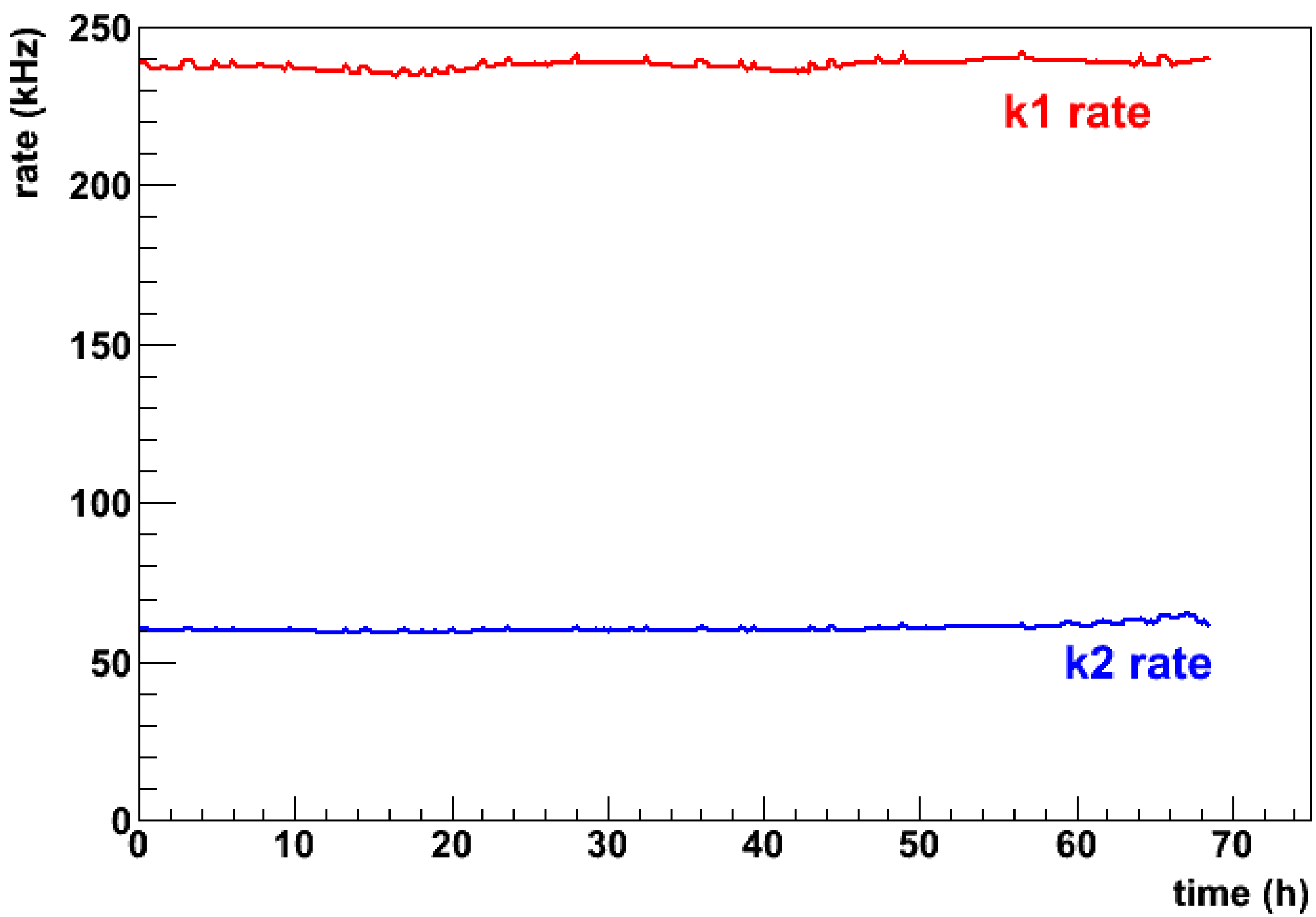


- Correction for Environmental parameters: temperature, pressure, humidity, gas composition
- Precision <1%

A. Abuhoza, et al., NIM A 718 (2013) 400-402.
A. Abuhoza, et al., Physics Procedia 37 (2012) 442-447.

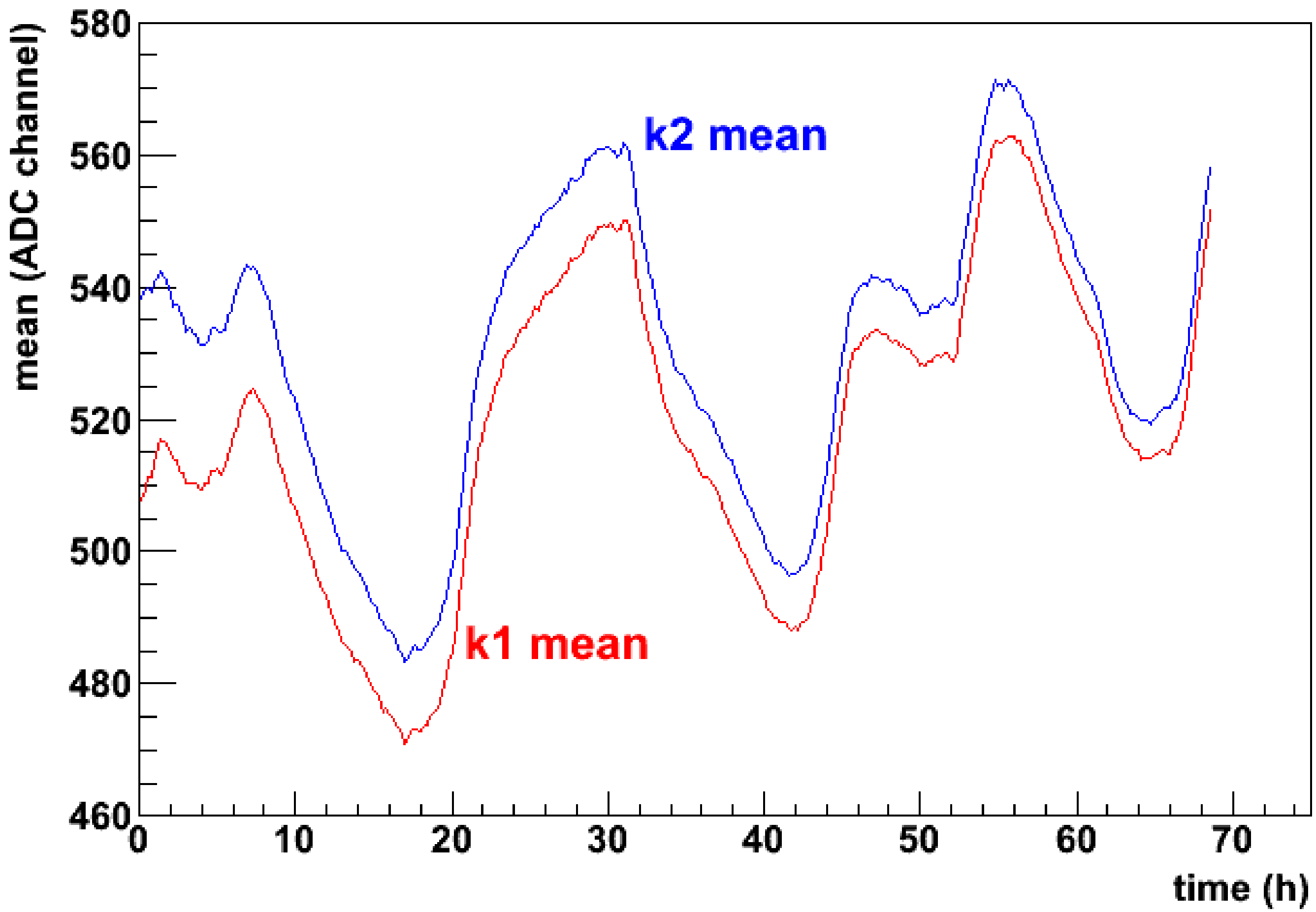
- GEM voltages 395-390-385 V
- E_d =2.5 kV/cm; E_i =2 kV/cm; E_t =3 kV/cm
- During this long term test the upper side of the GEM was exposed to x-rays and Fe^{55} spectra are taken from both part
- Fe^{55} spectra is taken in 10 min interval

Rate vs. time



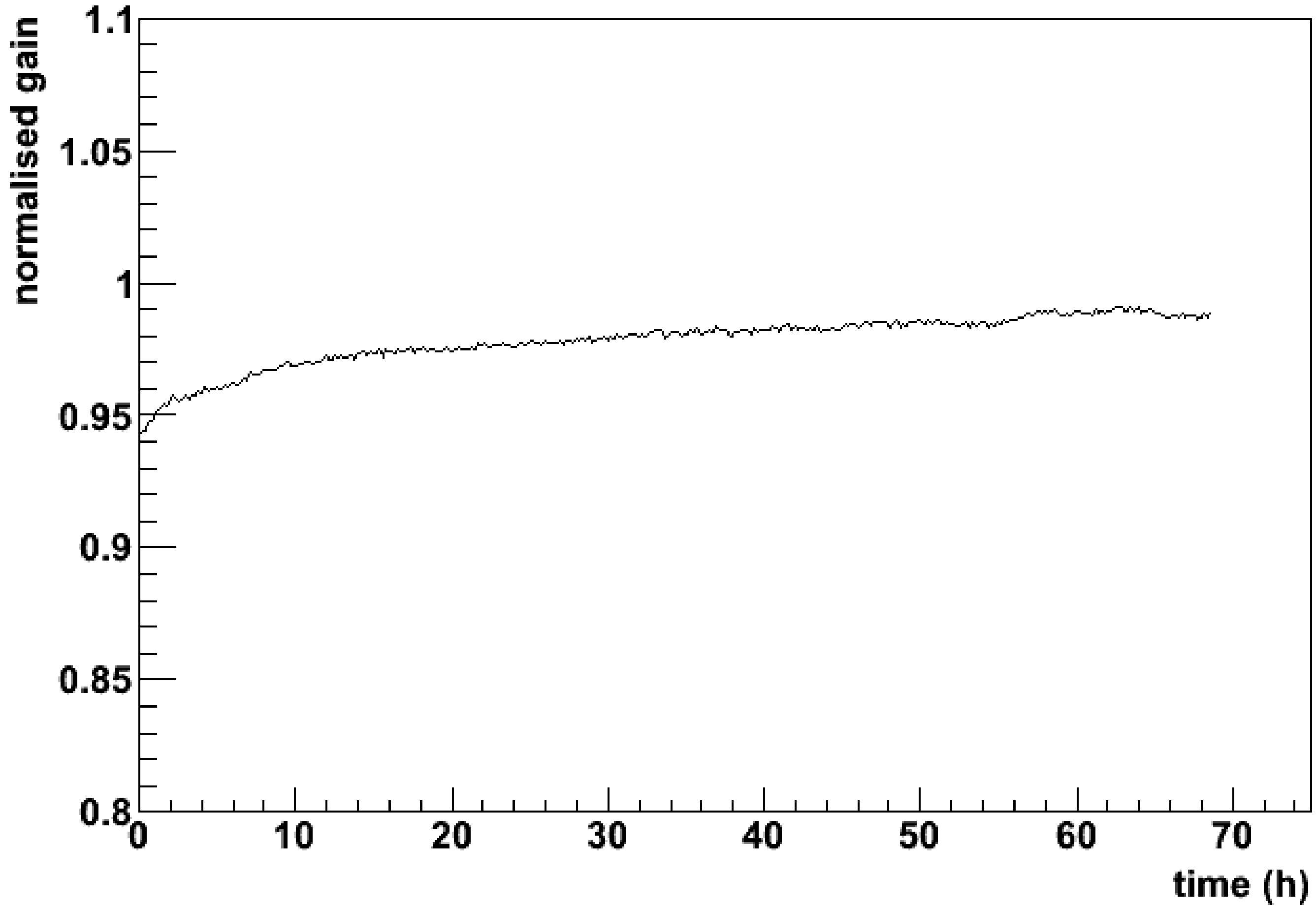
rate (kHz)
250
200
150
100
50
0
k1 rate
k2 rate
0
10
20
30
40
50
60
70
time (h)

Mean vs. time

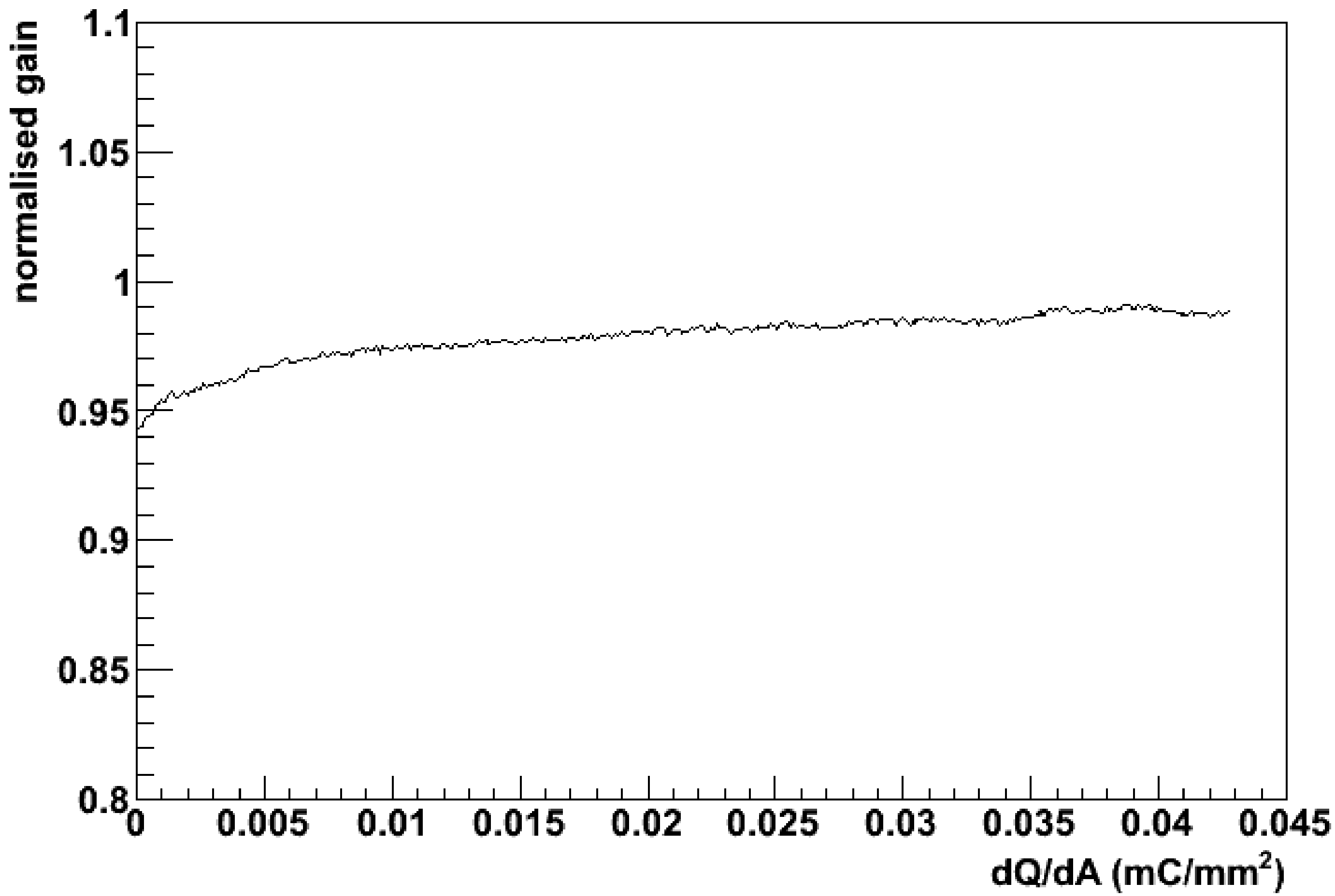


k2 mean
k1 mean
mean (ADC channel)
580
560
540
520
500
480
460
0
10
20
30
40
50
60
70
time (h)

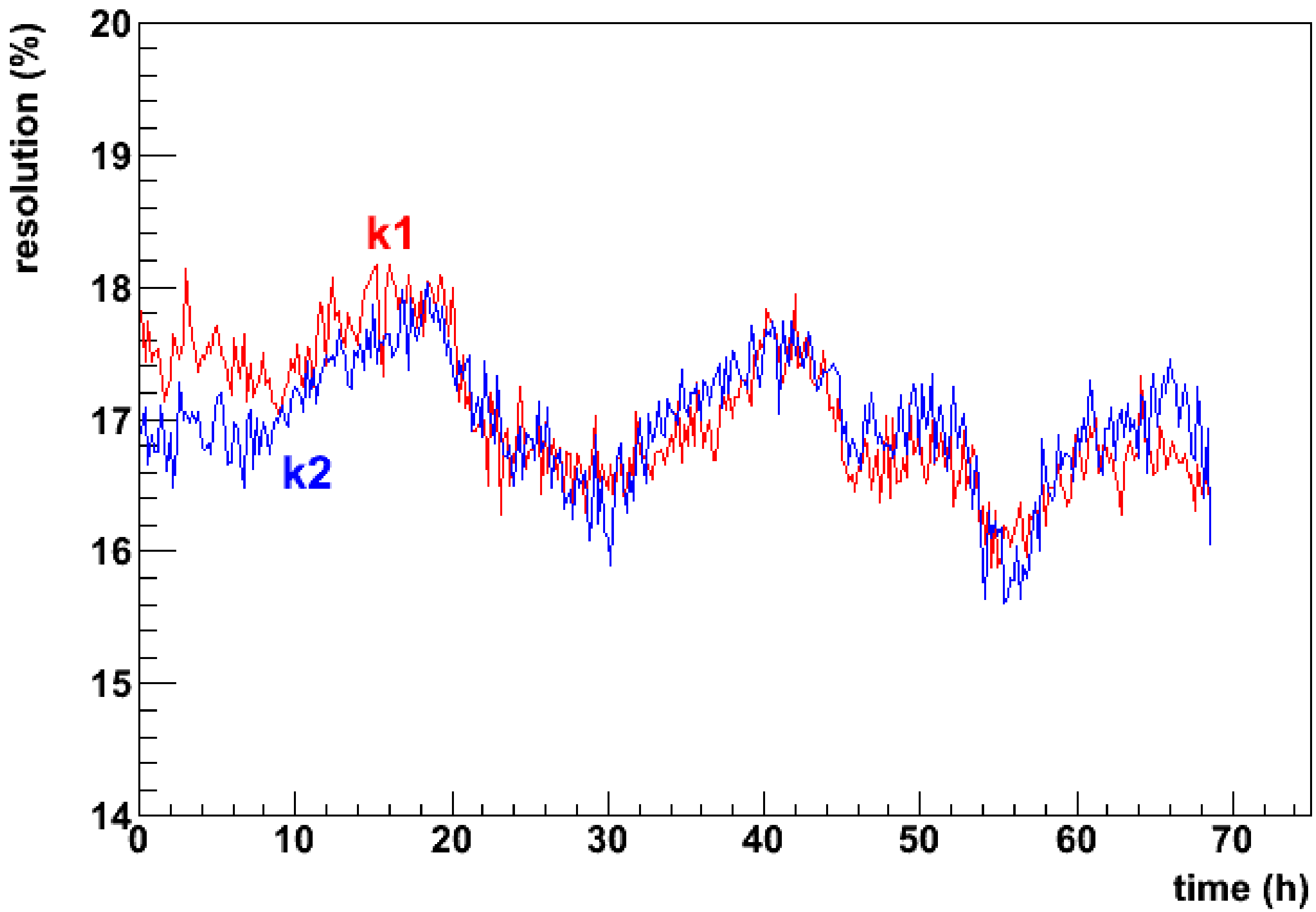
Normalized gain vs. time



Normalized gain vs. accumulated charge



Resolution vs. time



Summary

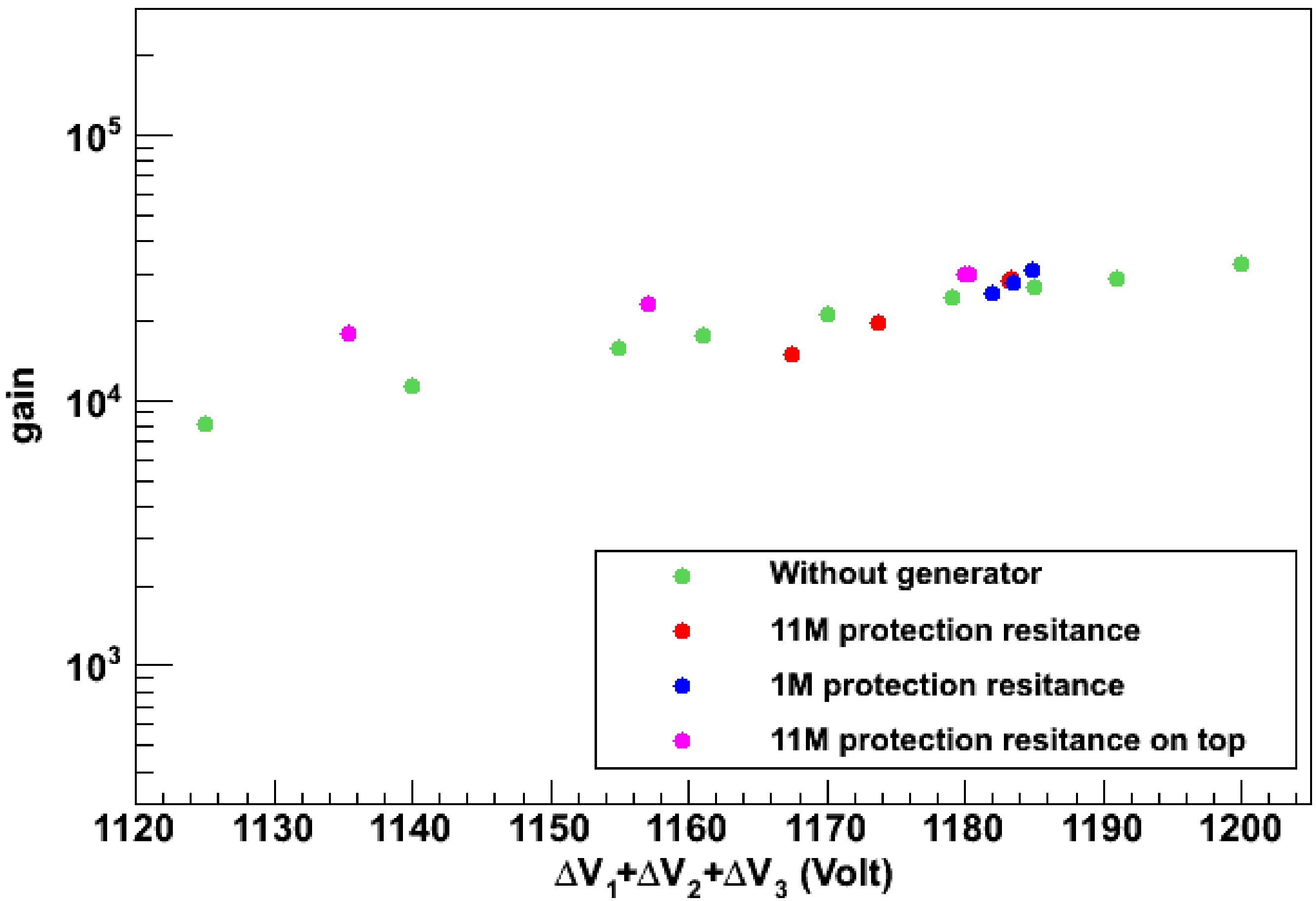
- MIP spectrum obtained and efficiency is measured for cosmic ray
- ~95% efficiency is obtained for cosmic rays

- Variation of Gain with rate is measured using X-ray
- Gain is decreasing with rate (reason to be understood)
- Long term study and ageing study of GEM is performed by X-ray
- No ageing is observed after accumulation of charge >0.04 mC/mm^2

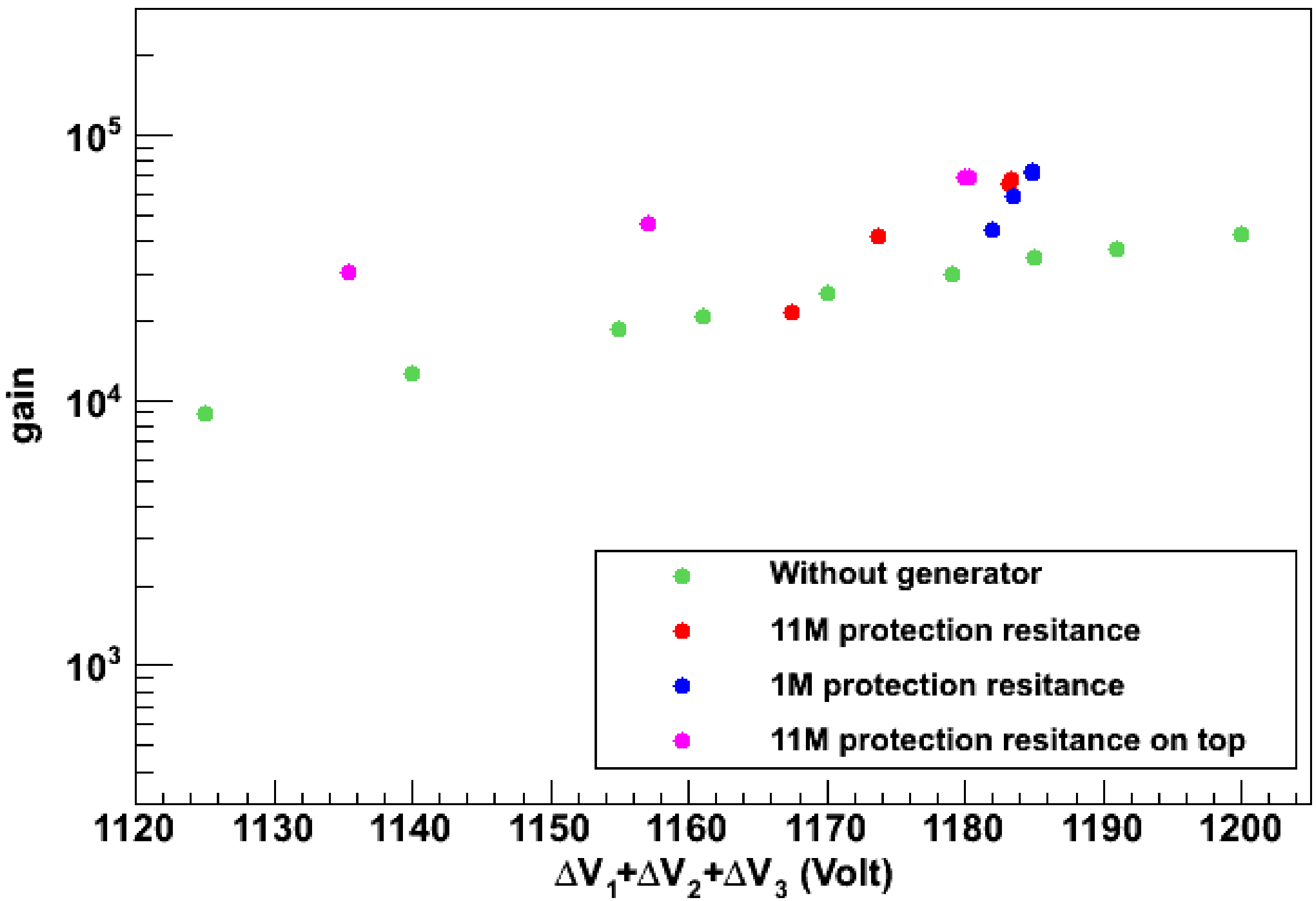
Thank you for your kind attention !

Back up

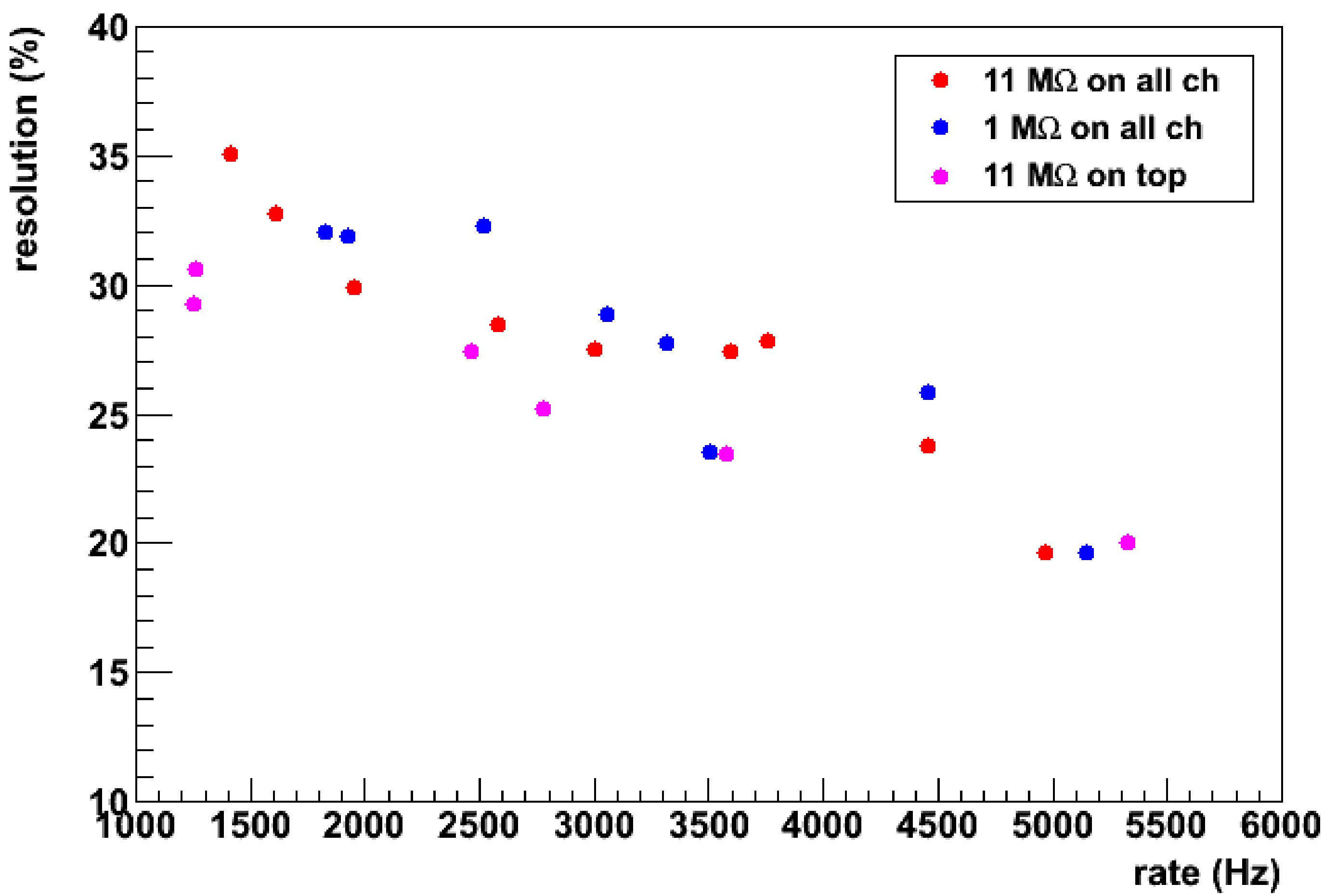
Gain from mean of Fe^{55} spectrum



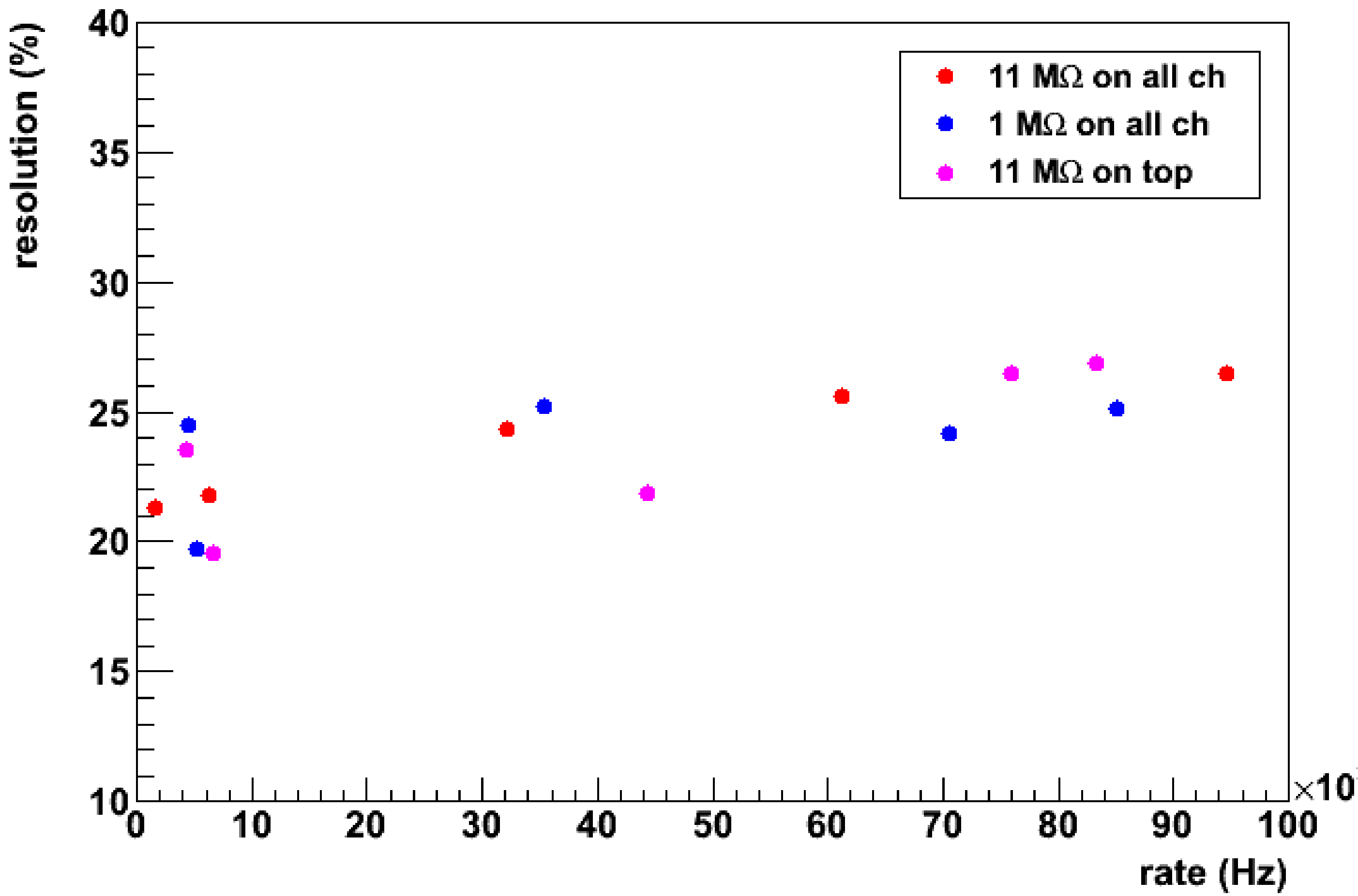
Gain from anode current



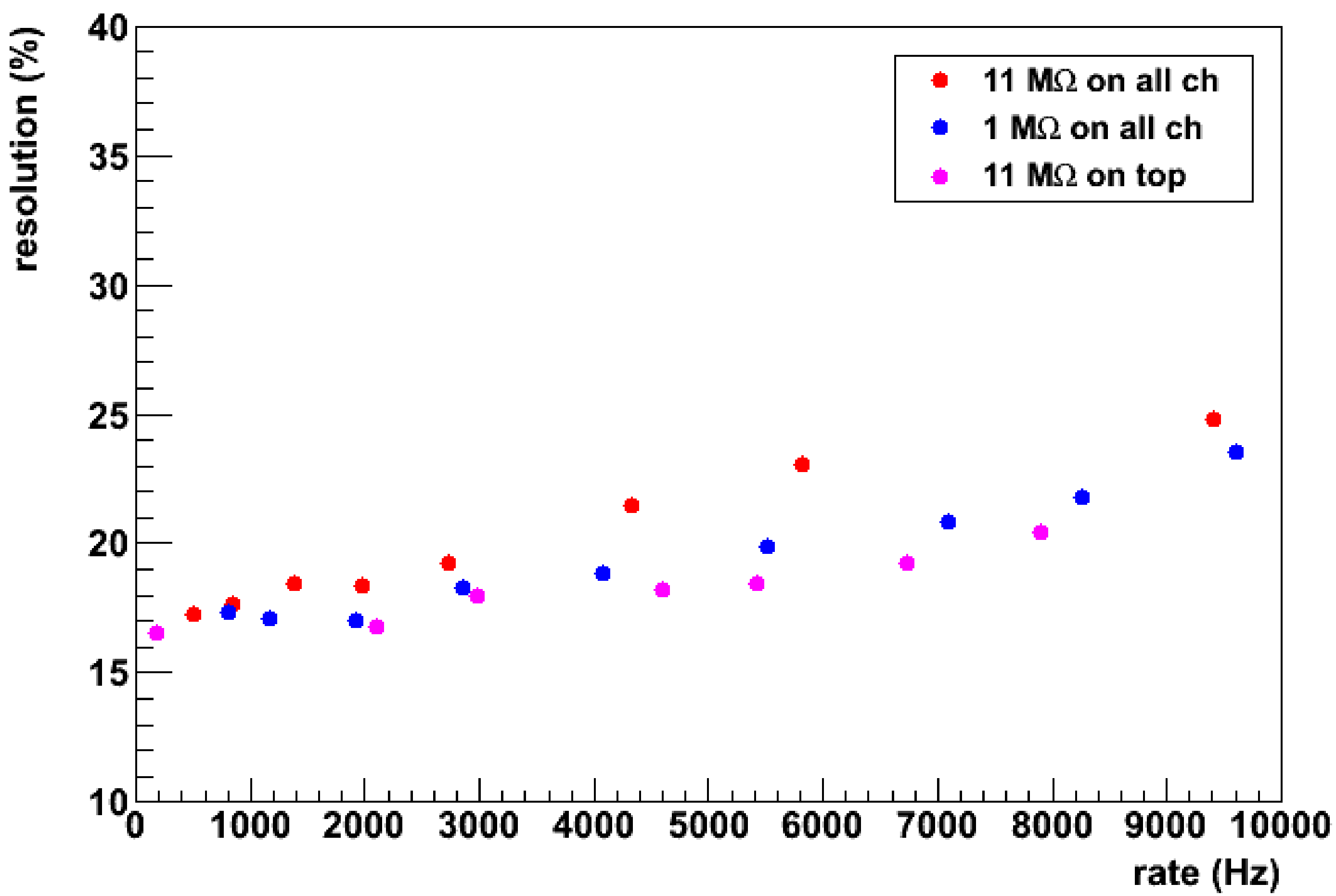
Resolution: Collimator fixed with detector



Resolution: Varying collimator diameter



Resolution: Collimator fixed with source



Resolution: With X-ray generator