Effect of relative humidity on the long-term operation of a single mask triple GEM chamber

S. Chatterjee*, A. Sen, S. Das, S. K. Ghosh, S. Biswas

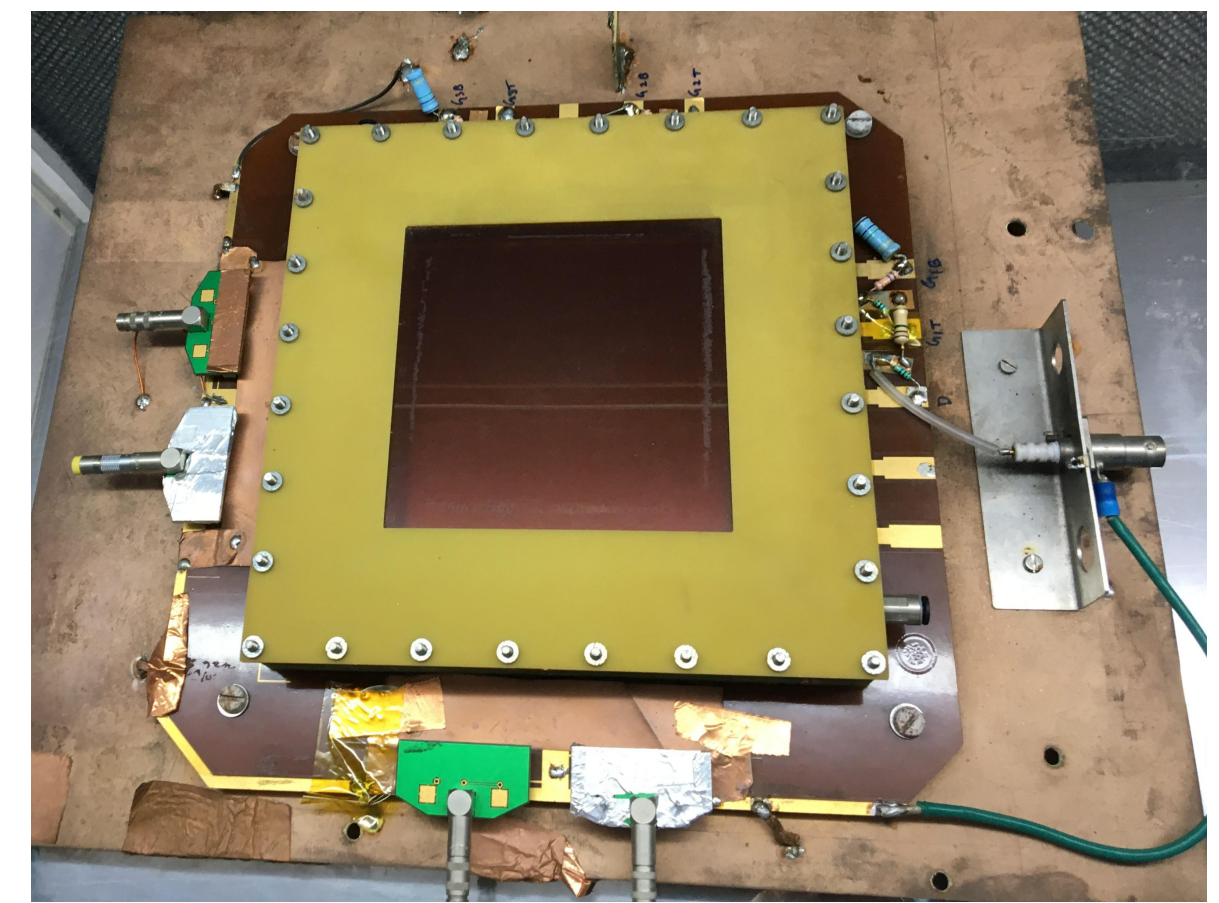Department of Physics, Bose Institute, Kolkata, India

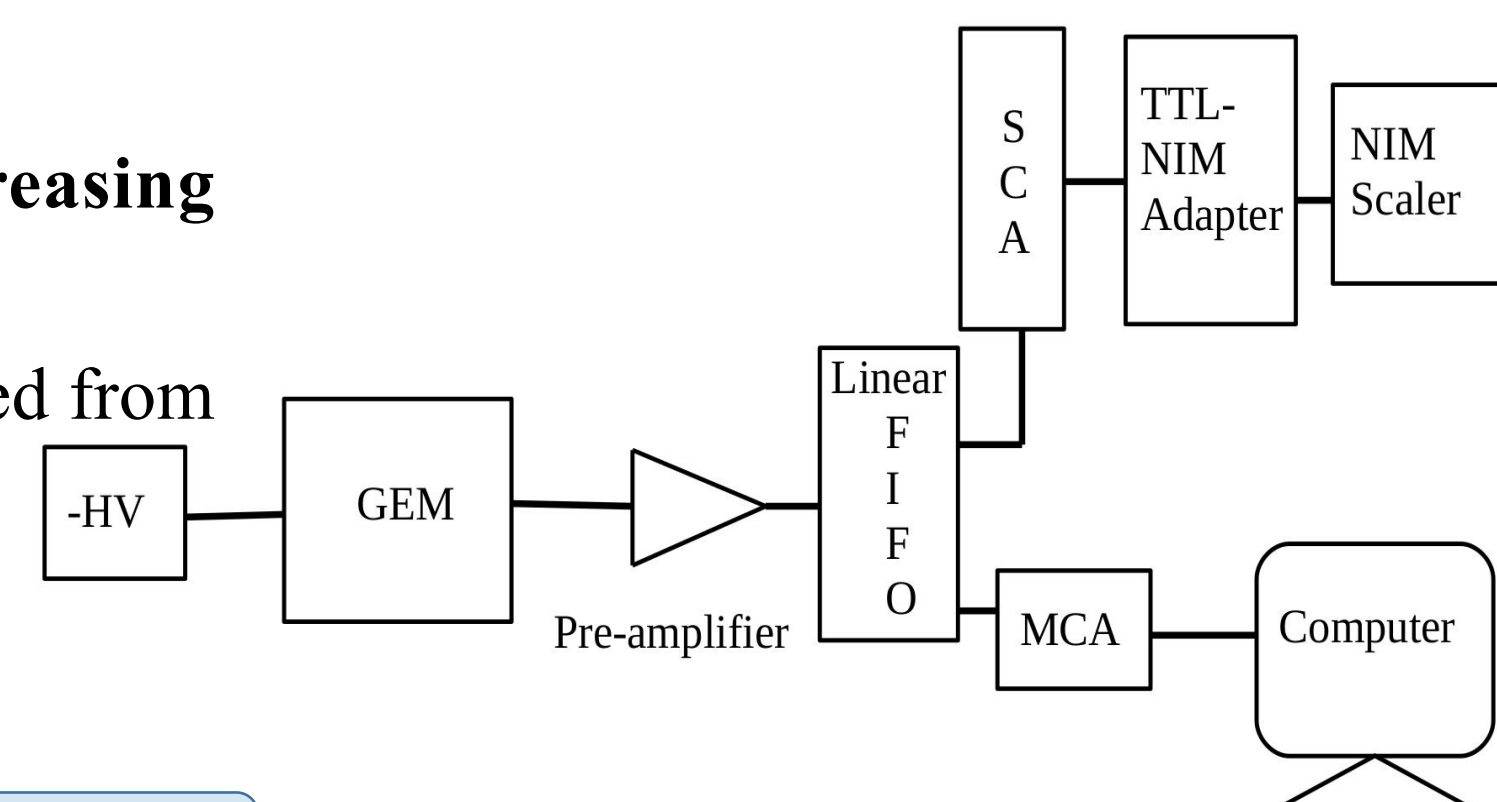15th Pisa Meeting on Advanced Detectors, 22-28 May 2022, La Biodola - Isola d'Elba, Italy

Introduction & Motivation

- **Gas Electron Multiplier (GEM) is used in High Energy Physics (HEP) experiments as a tracking device**

  $\rightarrow$ Good position resolution (~ 30 μm)

  $\rightarrow$ High-rate handling capability (~ 1 MHz/mm^2)

- **Long-term stability is one of the important criteria for any detectors in HEP experiments**

  $\rightarrow$ Long-term stability study is performed with a Single Mask (SM) triple GEM chamber

  $\rightarrow$ Drift gap, transfer gaps and induction gap are kept at 3mm, 2mm and 2mm respectively

  $\rightarrow$ Operated with Ar/CO$_2$ gas mixture in 70/30 volume ratio

  $\rightarrow$ Irradiated with Fe^{55} X-ray source (~ 20 mCi) of characteristic energy 5.9 keV

SM triple GEM chamber under testing at HEP detector lab of Bose Institute

- **The gain of any gaseous detector increases with increasing temperature and with decreasing pressure $\rightarrow$ correlated with T/p variation**

  $\rightarrow$ Normalised gain = Measured gain/Aexp(BT/p), where A and B are the parameters obtained from the correlation plot

  $\rightarrow$ Temperature and pressure are monitored using a data logger built in house

- **Energy resolution is anti-correlated with T/p variation**

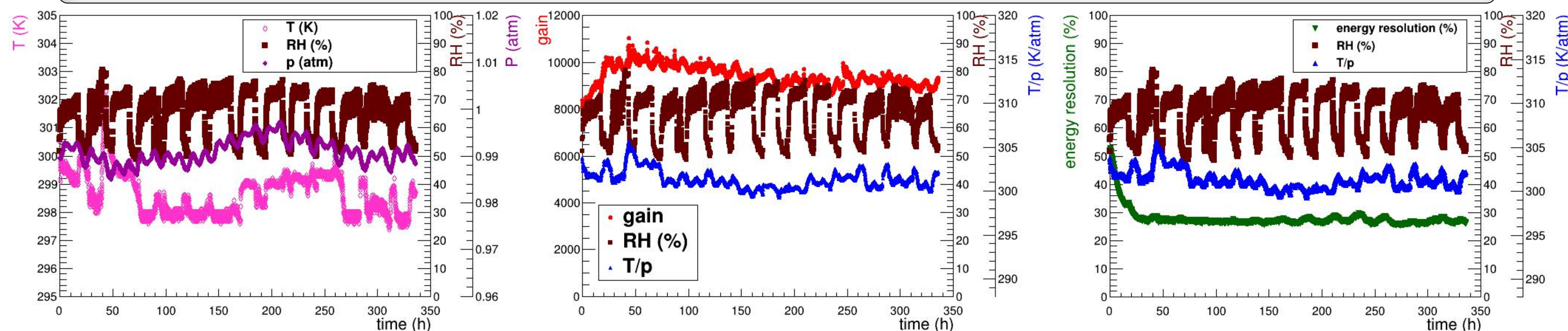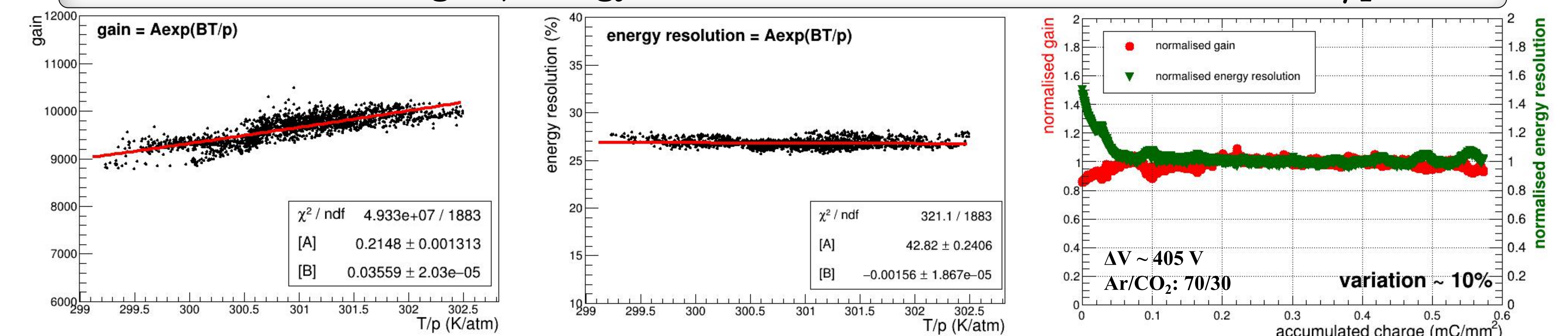- **The effect of relative humidity (RH) on the gain and energy resolution of the chamber is studied**

Schematic of the electronic circuit

Variation of environmental parameters, gain and energy resolution with time
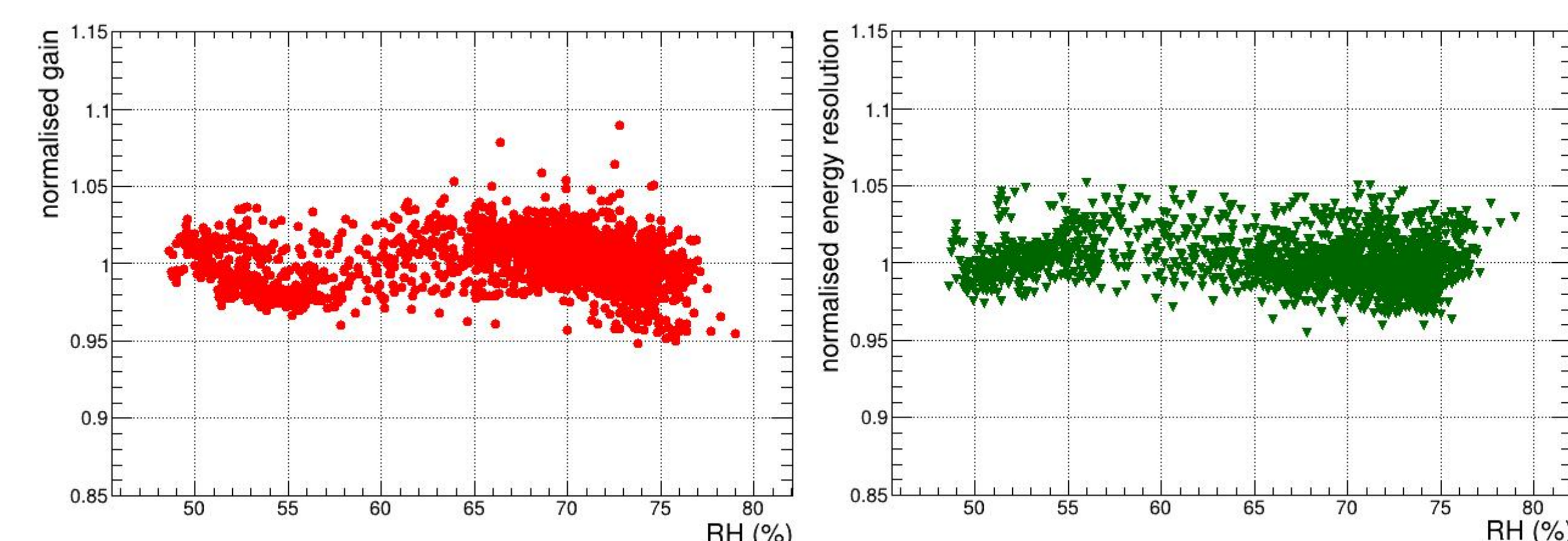

The ΔV across each of the GEM foils are kept at ~ 405 V and the chamber is irradiated continuously with 5.9 keV X-ray flux of ~ 2 kHz/mm^2

Correlation of gain, energy resolution and their normalisation with T/p

χ^2 / ndf	4.933e+07 / 1883
[A]	0.2148 ± 0.001313
[B]	0.03559 ± 2.03e−05

χ^2 / ndf	321.1 / 1883
[A]	42.82 ± 0.2406
[B]	−0.00156 ± 1.867e−05

ΔV $\sim$ 405 V
Ar/CO$_2$: 70/30   variation $\sim$ 10%

Variation of normalised gain and energy resolution with humidity

Summary & Outlook

- **Normalisation of gain and energy resolution is performed to eliminate the effect of temperature (T = t+ 273 in K) and pressure (p in atm) variations.**

- **No significant correlation is obtained with the T/p normalised gain and energy resolution with the relative humidity (RH).**

- **Data taking with longer period of time is ongoing and any possible correlation of detector performance with RH will be investigated.**

Reference

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- D. Nag *et al.*, ADNHEAP 2017 Springer Pros. in Phys. 201, 211
- S. Roy *et al.*, Nucl. Instrum. Methods Phys. Res. A 936 (2019) 485

*Presenter's Email Id: sayakchatterjee@jcbose.ac.in; sayakchatterjee896@gmail.com