

Building and Commissioning of a Setup to Study Ageing Phenomena In Gaseous Detectors

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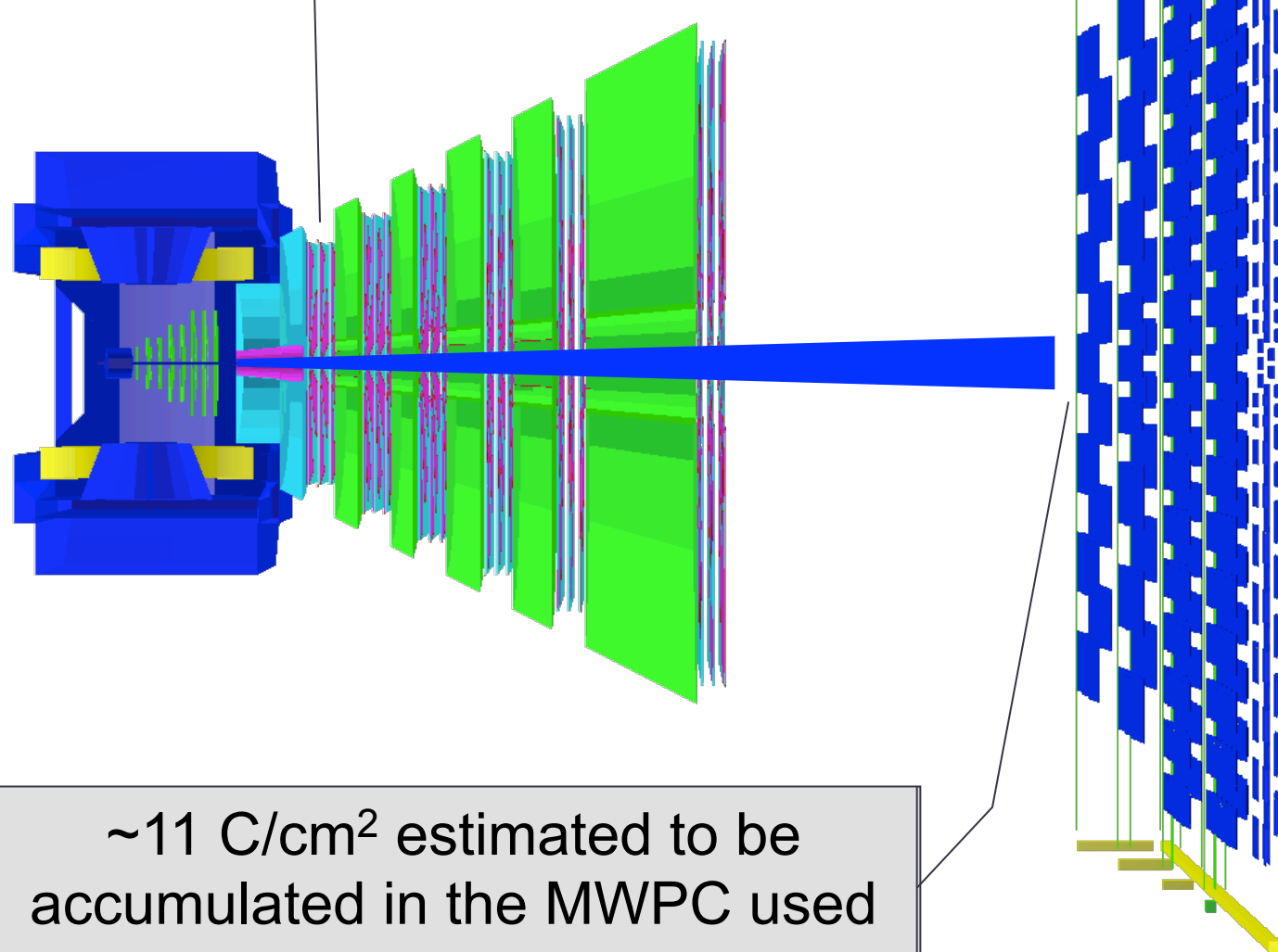


Introduction

The Compressed Baryonic Matter (CBM) experiment is one of the major pillars of the future Facility for Antiproton and Ion Research (FAIR) at Darmstadt, Germany. The fulfillment of the CBM physics goals requires operations at very high collision rates of up to about 10MHz. At these collision rates, fast, rate capable, large area and highly granulate detectors are mandatory. The achievement of the desired qualities in these detectors faces several challenges. One of the most significant challenges is to obtain truly stable performance over the lifetime of the experiment in a high rate radiation environment.

The expected accumulated charge in GEM and MWPC detectors used in CBM

~50 C/cm² estimated in 10 years at MuCH (GEM)

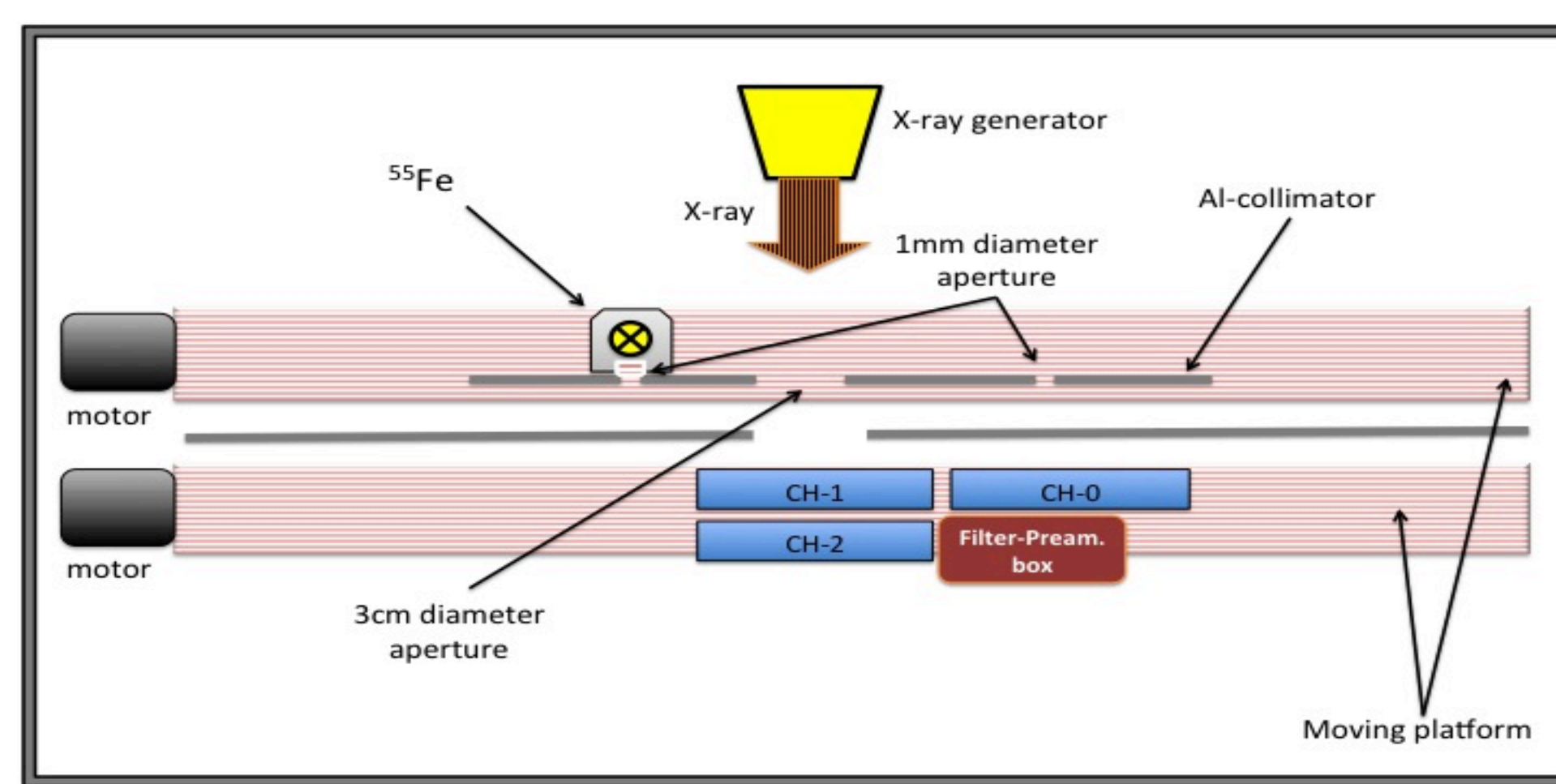


~11 C/cm² estimated to be accumulated in the MWPC used at TRD

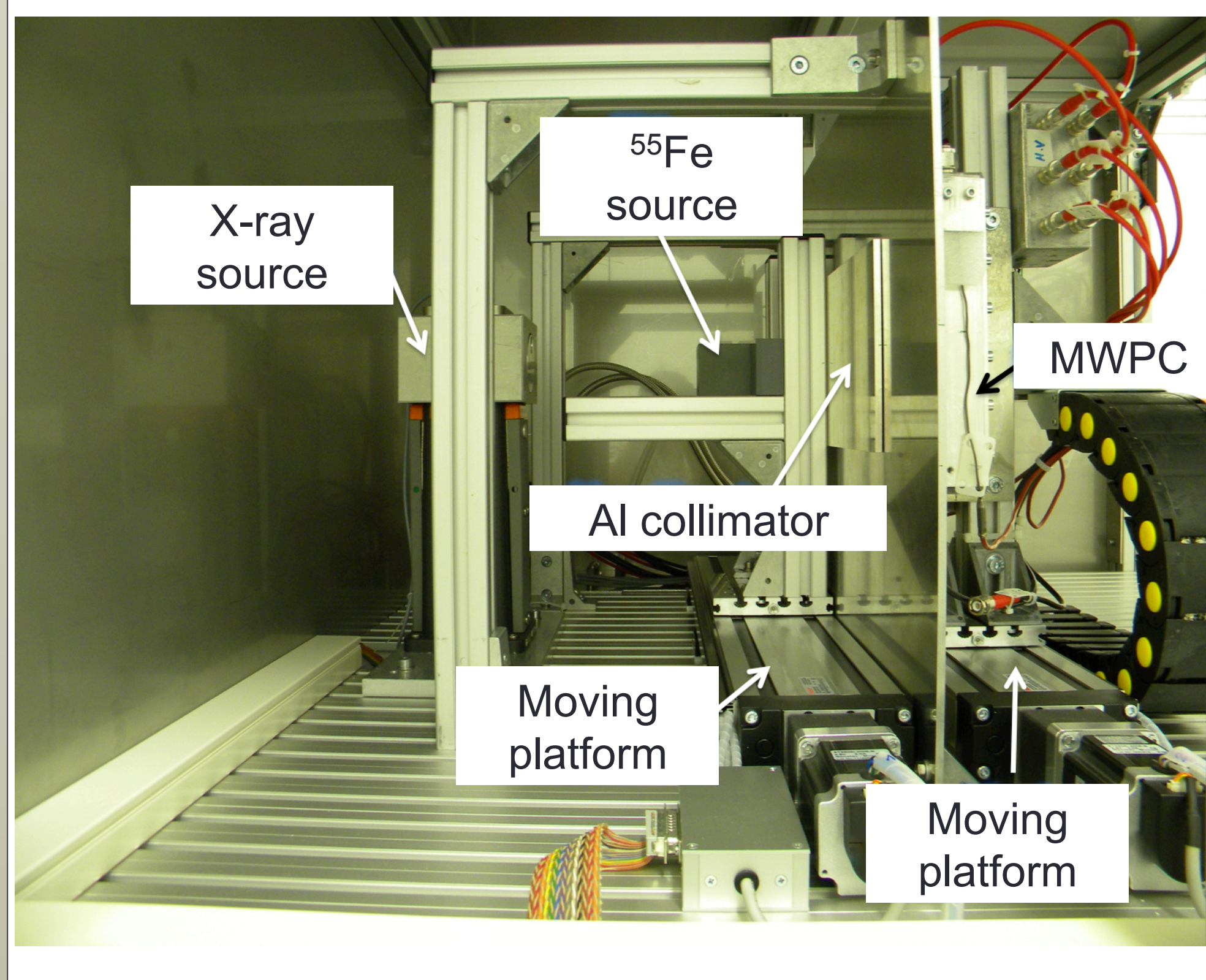
Building and commissioning of the setup

A new setup has been designed and built in the GSI detector laboratory. The setup consisted of three identical Multi Wire Proportional Chambers (MWPCs) mounted onto a moving platform, an X-ray generator and an ⁵⁵Fe source. A second moving platform holds an aluminum collimator plate which has three different apertures, thus allowing to vary the irradiated spot size. The setup has been equipped with a data acquisition and control system enabling fully automated measurement of gain and resolution during long term tests.

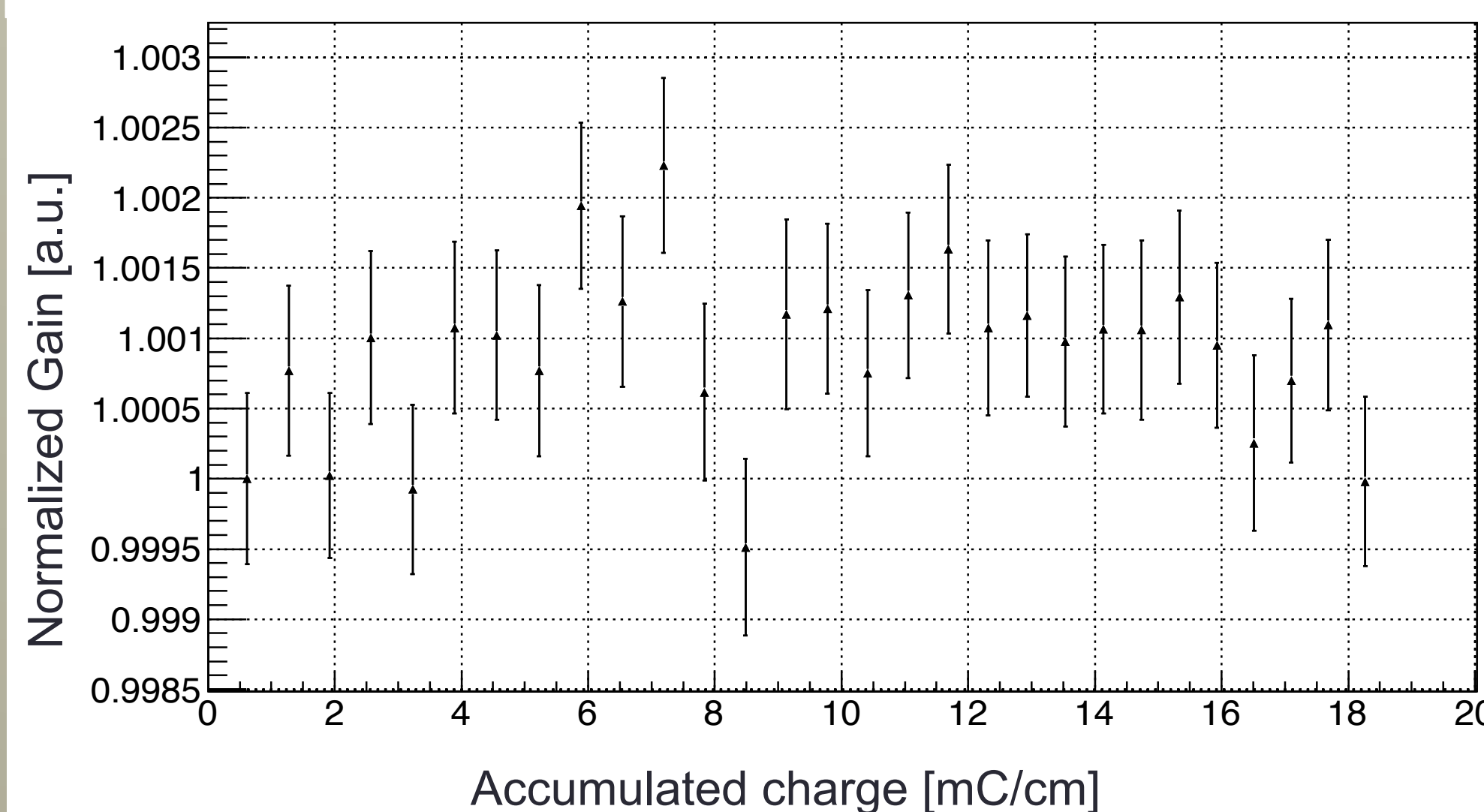
A sketch of the overhead view of the components inside the box.



Close view of the setup components.



During commissioning tests, very stable gain has been achieved after accumulating 18 mC/cm (Gain variation < 0.3%)

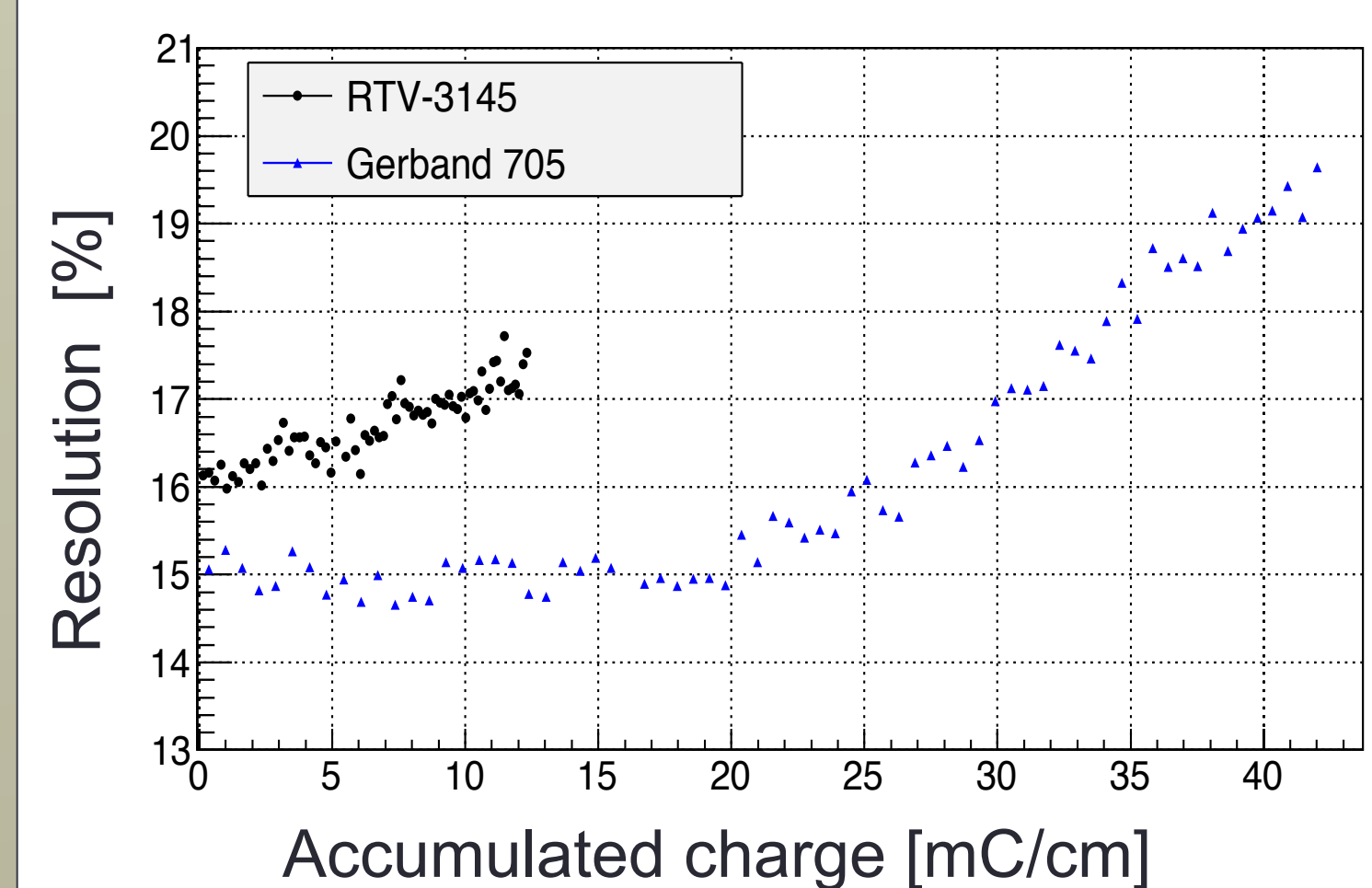
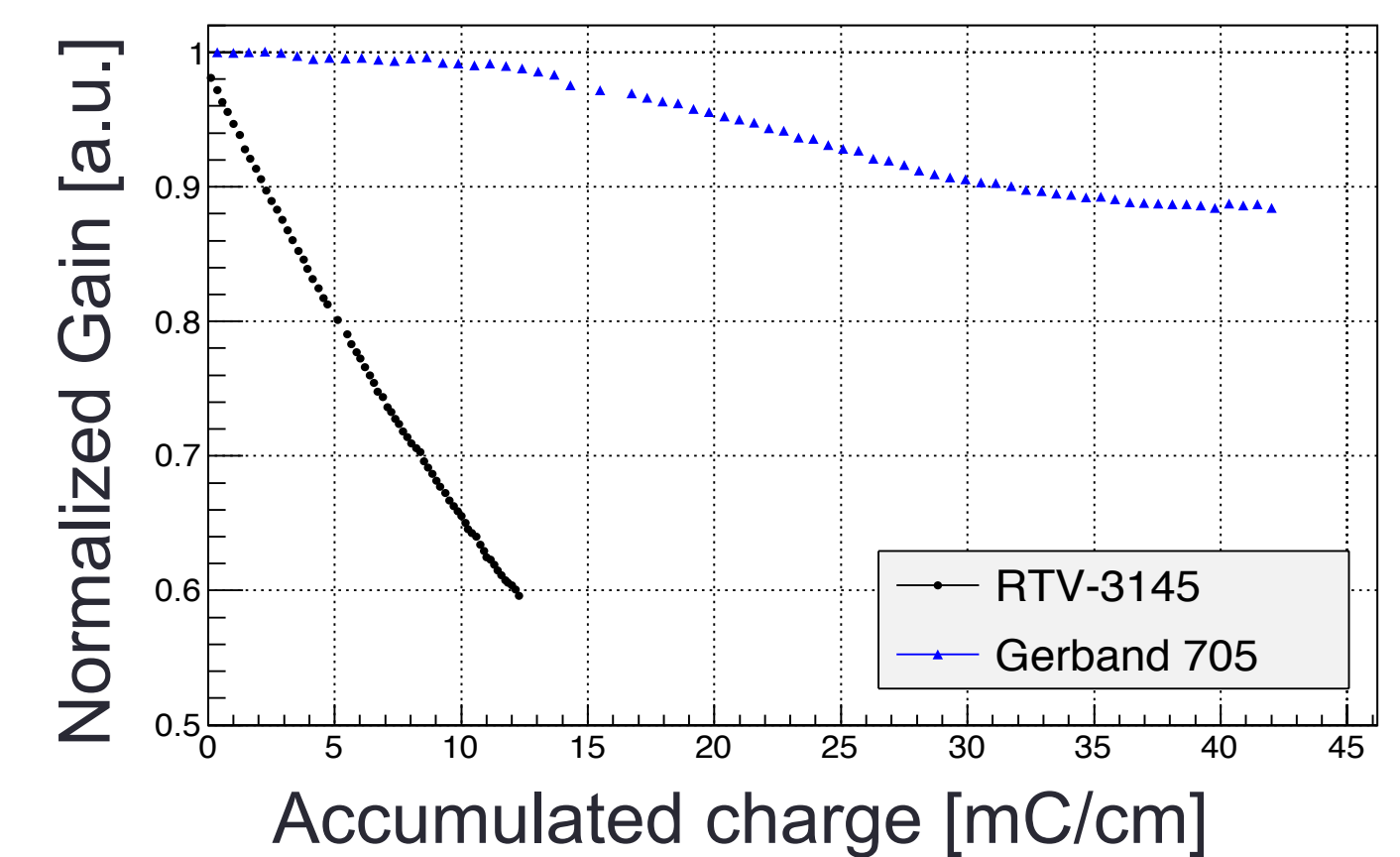


Ageing tests

Al-tape (Gerband 705) and RTV-3145 glue have been tested in parallel. They reveals dangerous effect in terms of ageing on a MWPC during exposure to X-ray. Particle rate density, accumulated charge, ageing rate and resolution loss are detailed in the table below.

Chamber	Radiation type	Particle rate density (KHz/cm)	Accumulated charge (mC/cm)	Ageing rate (%/mC/cm)	Resolution loss (%)
Gerband 705	X-ray	22	42	0.3	4
RTV-3145	X-ray	15	12	3	1.5

Gain and resolution of test chambers as a function of accumulated charge during the ageing tests



Objectives and requirements of ageing test setup

The objectives of building this setup are:

- ❑ Investigation of material influences on gaseous detector performance
- ❑ Ageing studies with moderate rates under realistic conditions
- ❑ Long-term stability tests of gaseous detector
- ❑ Study of ageing phenomena in gaseous detectors

To achieve these objectives, many requirements had to be considered during designing and building such as:

- ❑ Precise measurements using parameters of gain and resolution of chambers under test
- ❑ Many tests in parallel using many chambers and moving platforms
- ❑ A fully automated setup

Summary

- ❑ A fully automated system for gaseous detector ageing studies has been constructed and commissioned.
- ❑ This system is able to observe the onset of ageing in MWPC.
- ❑ Gain variation in the order of 0.3% peak-to-peak.
- ❑ Two ageing measurements can be carried out in parallel.
- ❑ Ageing studies have been carried out for different materials.
- ❑ This setup is ready to do ageing studies for construction materials of gaseous detectors employed in FAIR experiments.