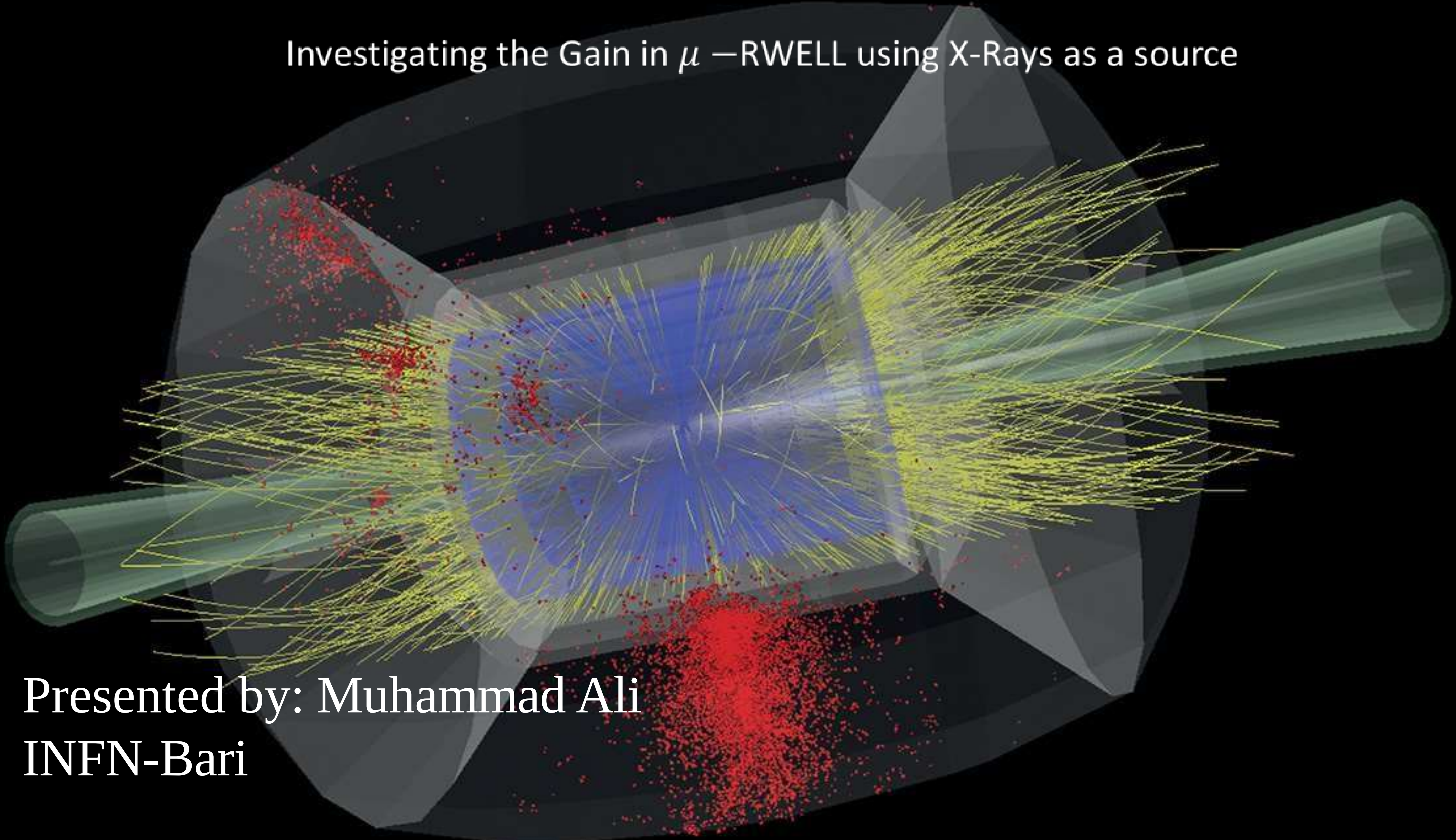
Investigating the Gain in μ −RWELL using X-Rays as a source



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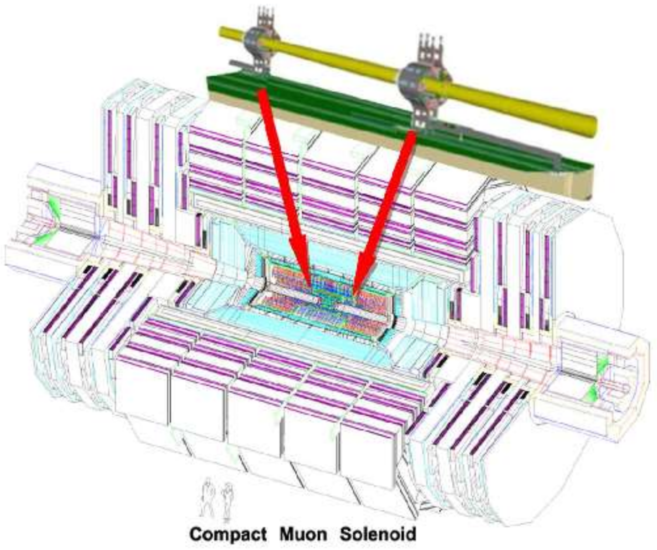
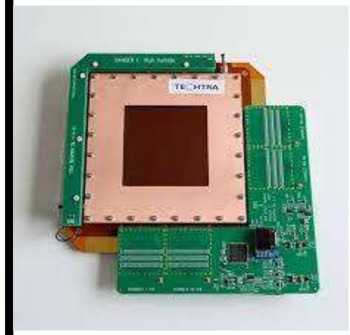
Micro Pattern Gaseous Detectors (MPGDs)

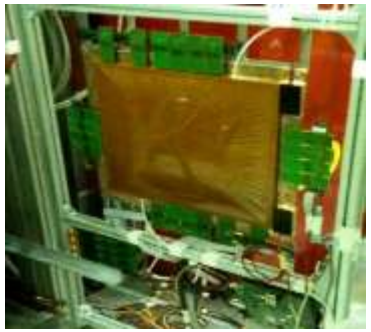
- Allow Stable Operation.
- Environment friendly.
- High efficiency.
- Excellent spatial resolutions.
- High granularity.
- Resistant to Radiations.
- Reasonably priced for large projects.
- The MPGD technologies in the CMS experiment is crucial for achieving precise and efficient particle detection and tracking.



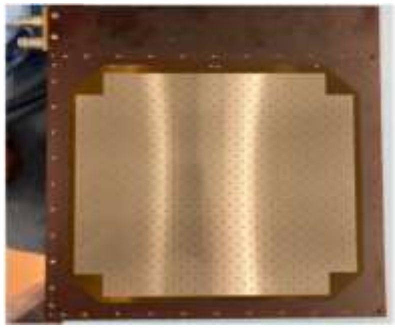
Types of MPGDs



Gas Electron Multiplier (GEM).



MircroMegas Detector

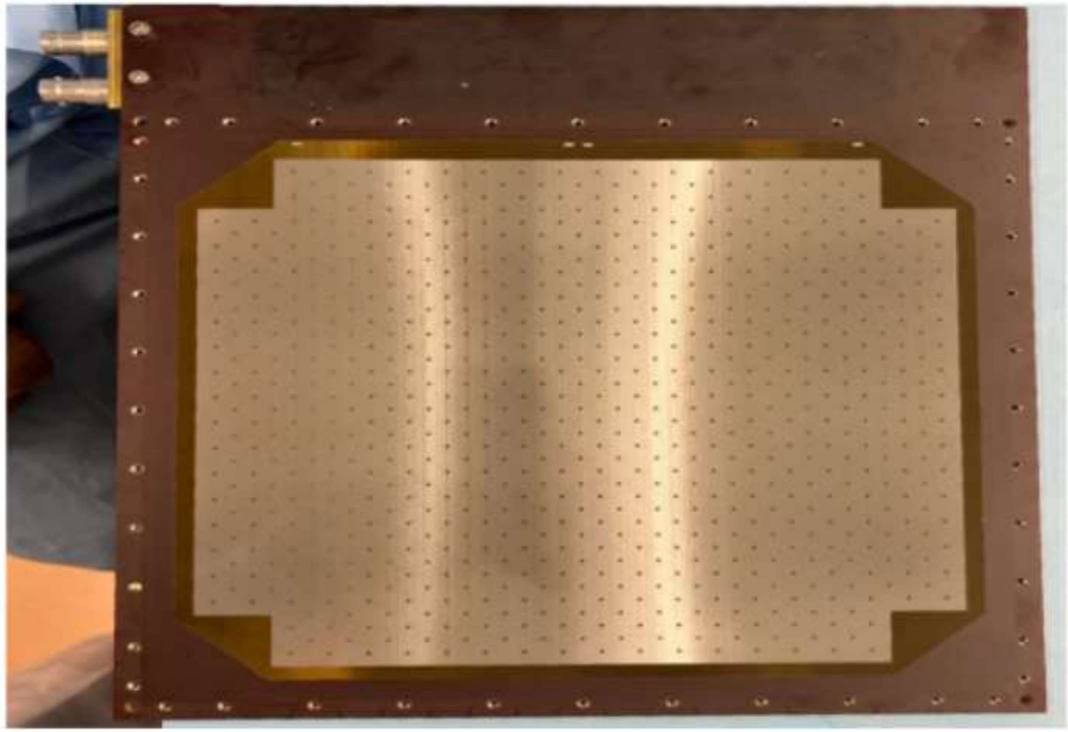


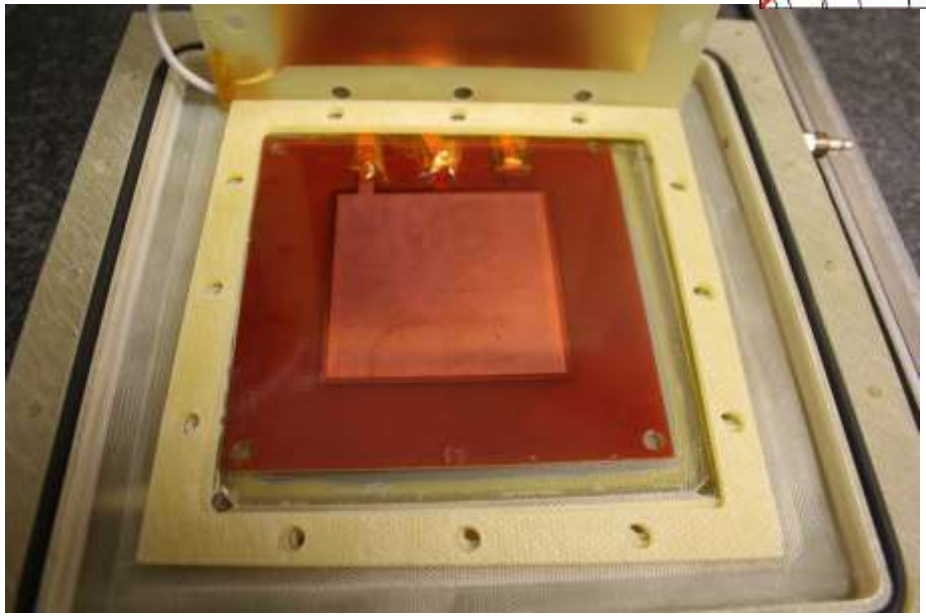
µ-RWELL Detector

We will consider only μ-RWELL in this analysis.

μ-RWELL Detector

- Resistive MPGDs under active development is the μ-RWELL.
- Use Resistive layers for the measurements of gain.

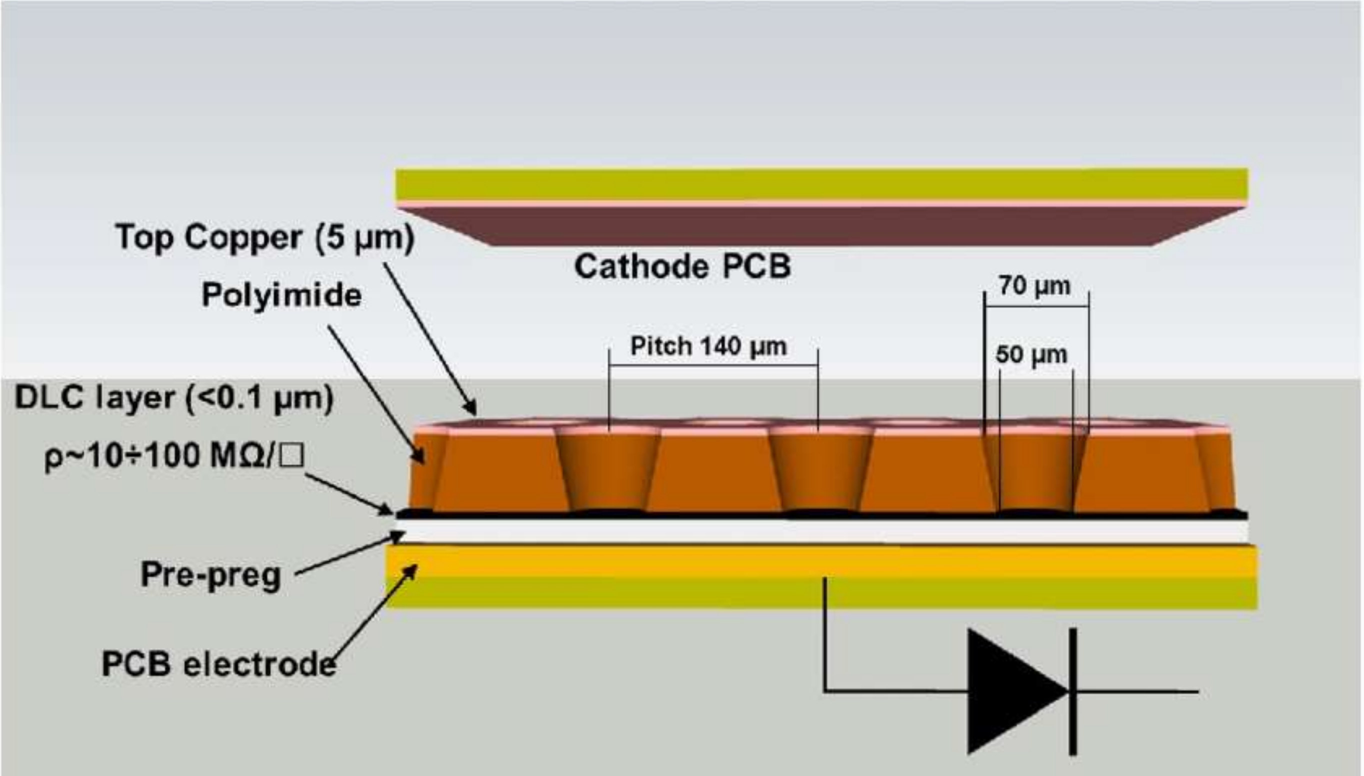




- Single Amplification stage.
- Higher Gains.

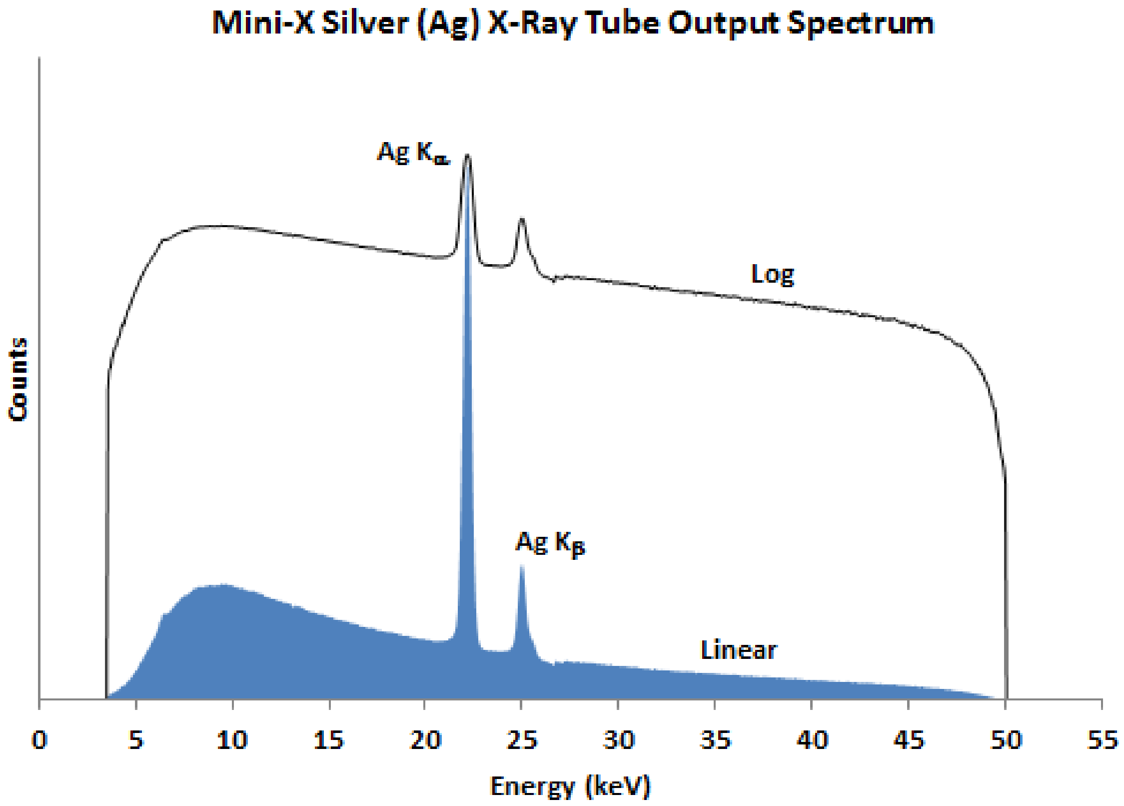
Detector Construction

- Prototype surface of 20x20 cm^2
- Gas Medium (Ar:CO_2 |70:30).
- Core of the detector: Printed Circuit Board (PCB).
- Tiny hole well matrix polyimide foil covered with copper (Cu) on top used for Amplification.
- High Voltage Electric field.
- Resistive DLC layer used for discharge suppression.
- DLC layer: Between μ −RWELL foil and the readout PCB.
- Pads readout: To collect the signal.

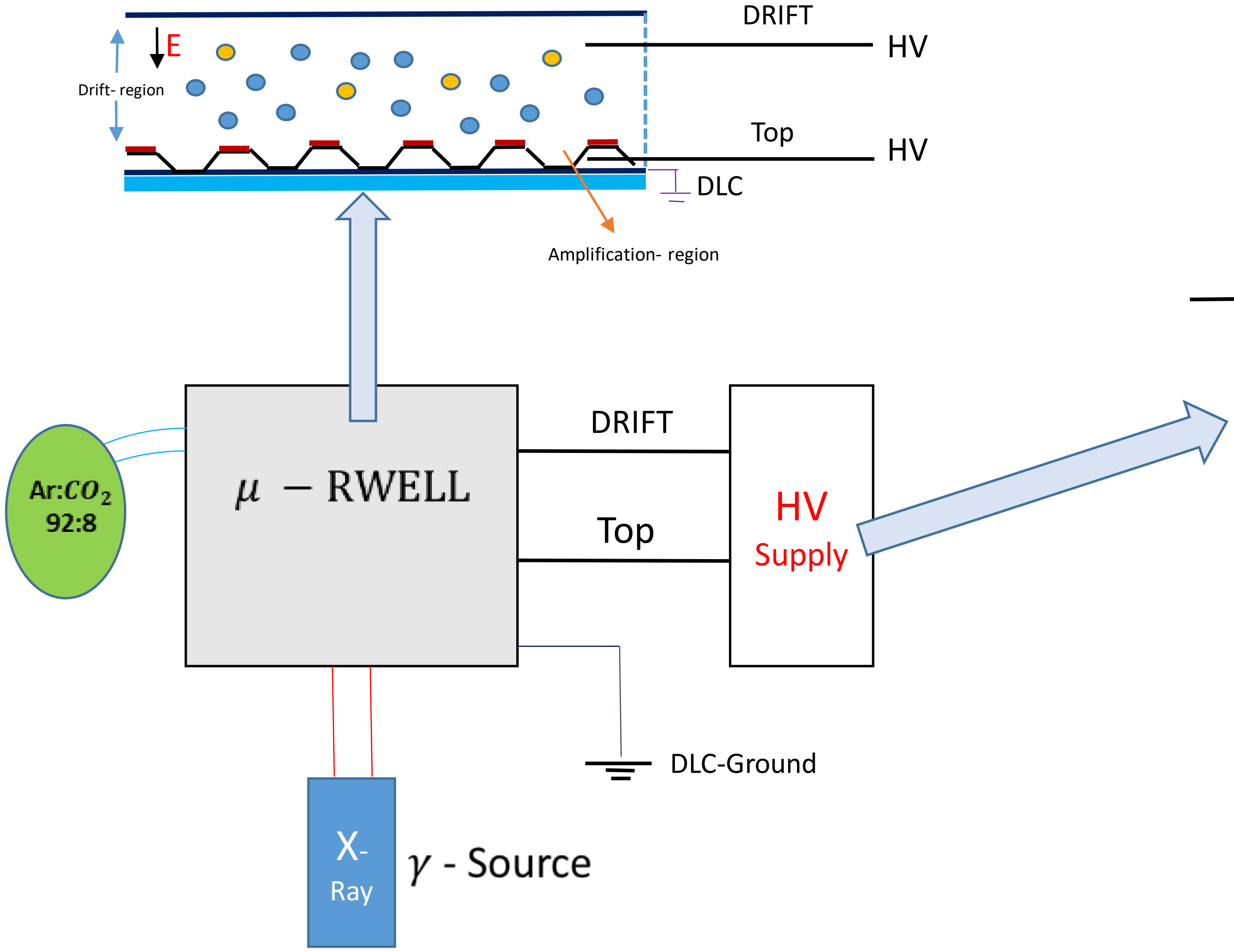


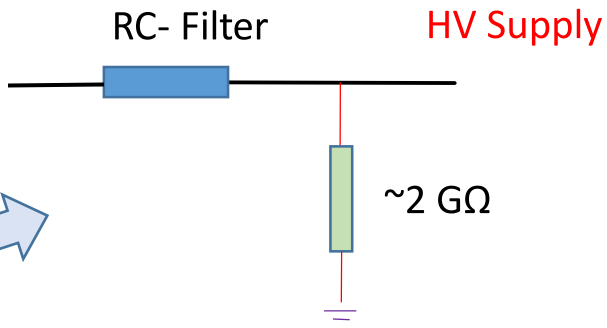
Experimental Setup

- In this analysis, we used X-rays photons for the measurements.
- Calculations are being made setting the source aiming the center of the detector.
- Source voltage 30kV.
- Source current130nA.



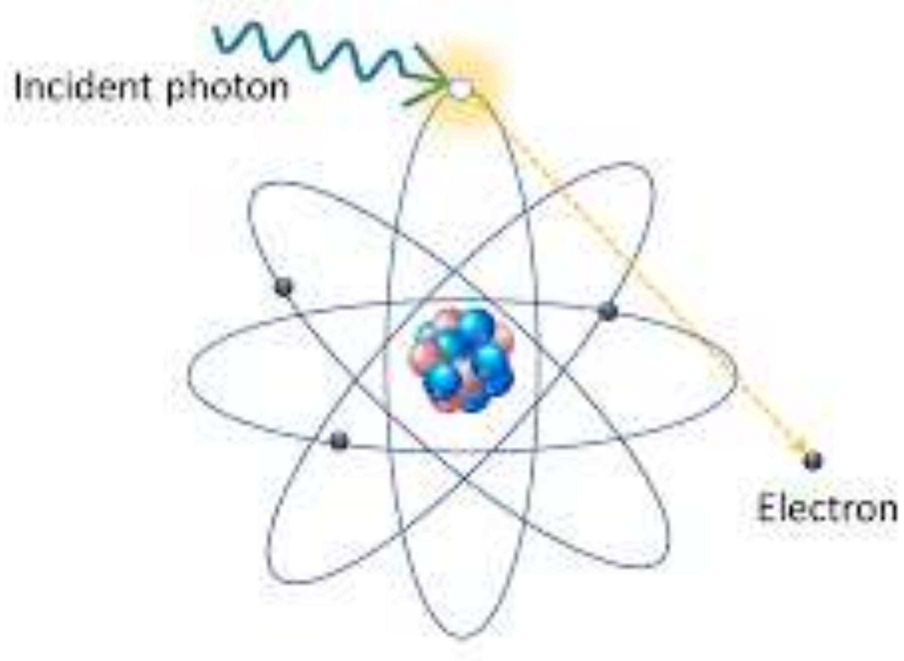
Experimental Setup





- HV Power supply N1471H.
- DLC is connected to GND.
- 2 GΩ used to ground the offset current I.
- For smooth signals RC is being installed.

X-Ray Interactions



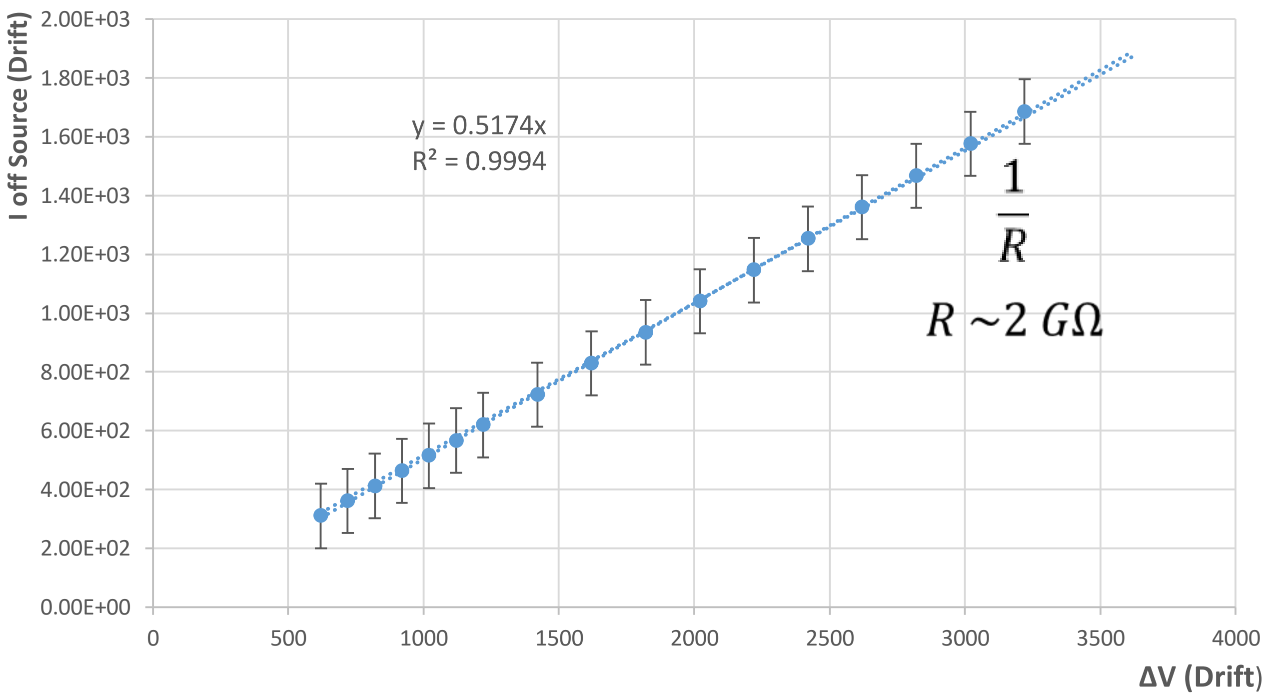
- The dominant interaction process is photoelectric effect.
- Energy loss is constrained to be most equal to the energy of photon.

Working Mechanism

1. Charge particles/photons interaction with gas molecules
2. Ionization.
3. Production of primary electrons.
4. Electrons drift (Electric field).
5. Utilizes etched holes (Electric field).
6. Amplification.
7. Charge spreading on DLC layer.
8. Readout.

Results and Discussions

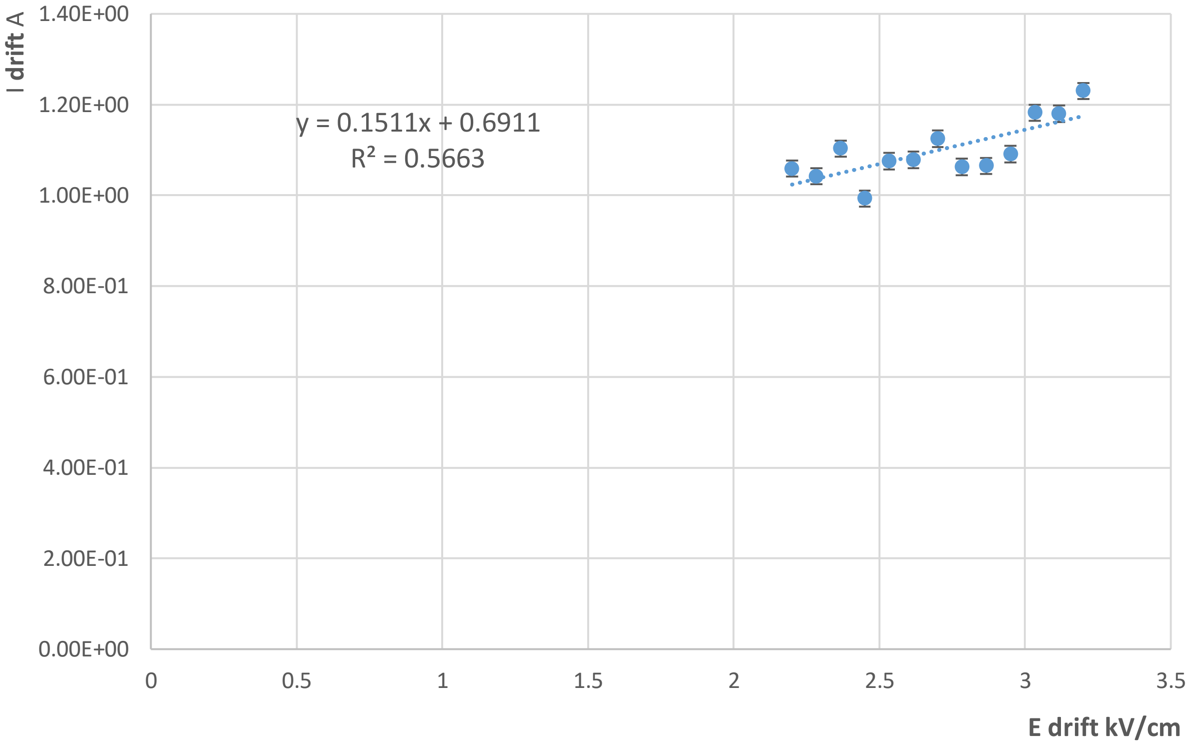
No.	V drift (V)	Ioff(nA)	R GΩ
1	620	3.10E+02	2.00E+00
2	720	3.61E+02	2.00E+00
3	820	4.12E+02	1.99E+00
4	920	4.63E+02	1.99E+00
5	1020	5.15E+02	1.98E+00
6	1120	5.66E+02	1.98E+00
7	1220	6.19E+02	1.97E+00
8	1320	6.71E+02	1.97E+00
9	1420	7.23E+02	1.96E+00
10	1520	7.75E+02	1.96E+00
11	1620	8.29E+02	1.95E+00
12	1820	9.34E+02	1.95E+00
13	2020	1.04E+03	1.94E+00
14	2220	1.15E+03	1.94E+00
15	3020	1.58E+03	1.92E+00



- Measurement of drift Voltage V and drift current I when source is Off.
- Ohmic behavior is being observed.

Results and Discussions

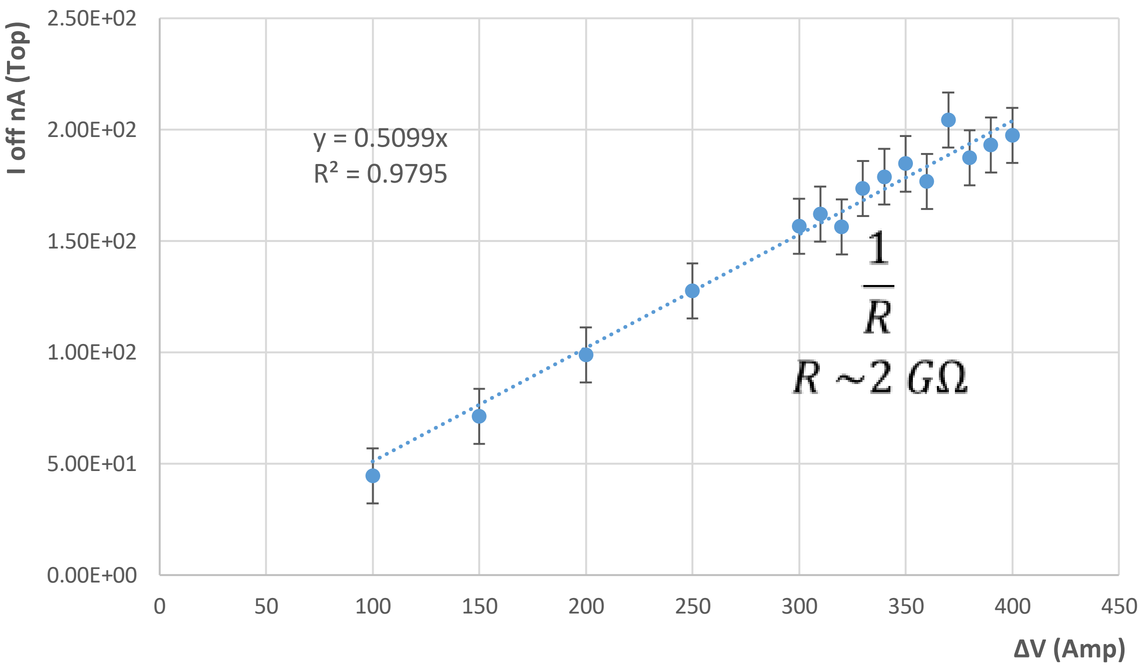
No.	E drift(kV/cm)	I drift (μA)
1	2.2	1.06E+00
2	2.283333	1.04E+00
3	2.366667	1.10E+00
4	2.45	9.93E-01
5	2.533333	1.08E+00
6	2.616667	1.08E+00
7	2.7	1.13E+00
8	2.783333	1.06E+00
9	2.866667	1.07E+00
10	2.95	1.09E+00
11	3.033333	1.18E+00
12	3.116667	1.18E+00
13	3.2	1.23E+00



- It is observed that with the increase in drift field E, the drift current I drift remains constant with little fluctuations indicating the current does not depend on the applied Electric field.

Results and Discussions

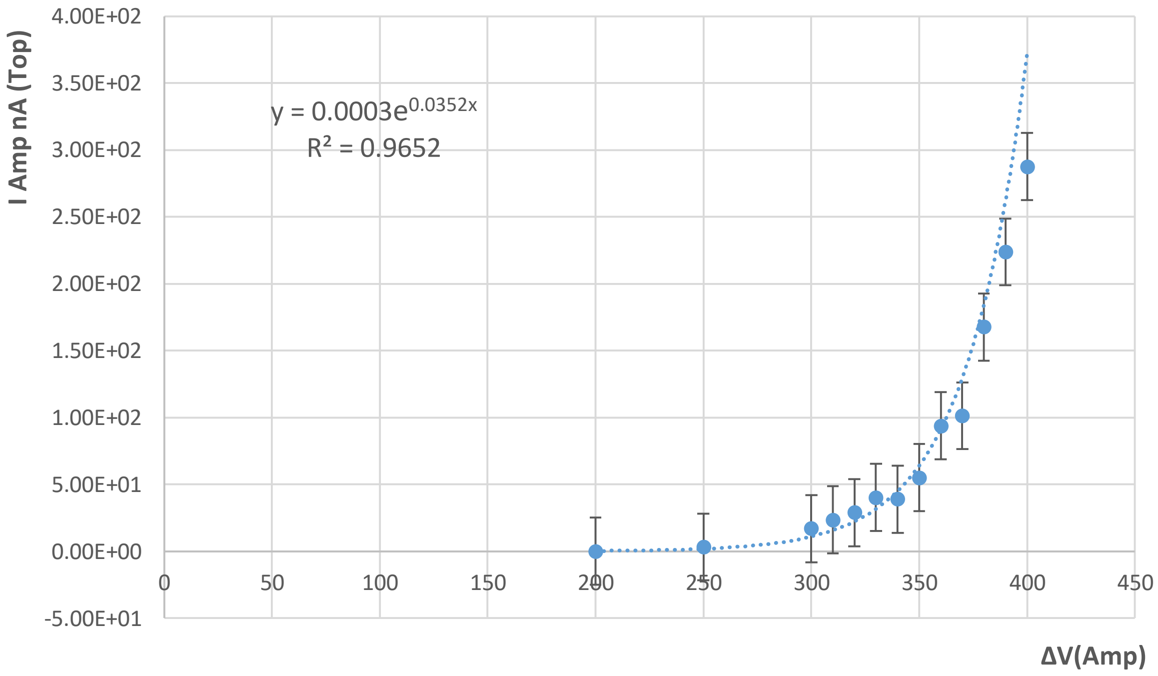
No.	V amp(V)	I off (nA)	R GΩ
1	100	4.45E+01	2.25E+00
2	150	7.12E+01	2.11E+00
3	200	9.89E+01	2.02E+00
4	250	1.28E+02	1.96E+00
5	300	1.57E+02	1.92E+00
6	350	1.85E+02	1.90E+00
7	400	1.98E+02	2.03E+00
8	310	1.62E+02	1.91E+00
9	320	1.56E+02	2.05E+00
10	330	1.74E+02	1.90E+00
11	340	1.79E+02	1.90E+00
12	360	1.77E+02	2.04E+00
13	370	2.04E+02	1.81E+00
14	380	1.87E+02	2.03E+00
15	390	1.93E+02	2.02E+00



- It is observed that offset current Ioff in circuit is increasing with the amplification voltage ΔV.

Results and Discussions

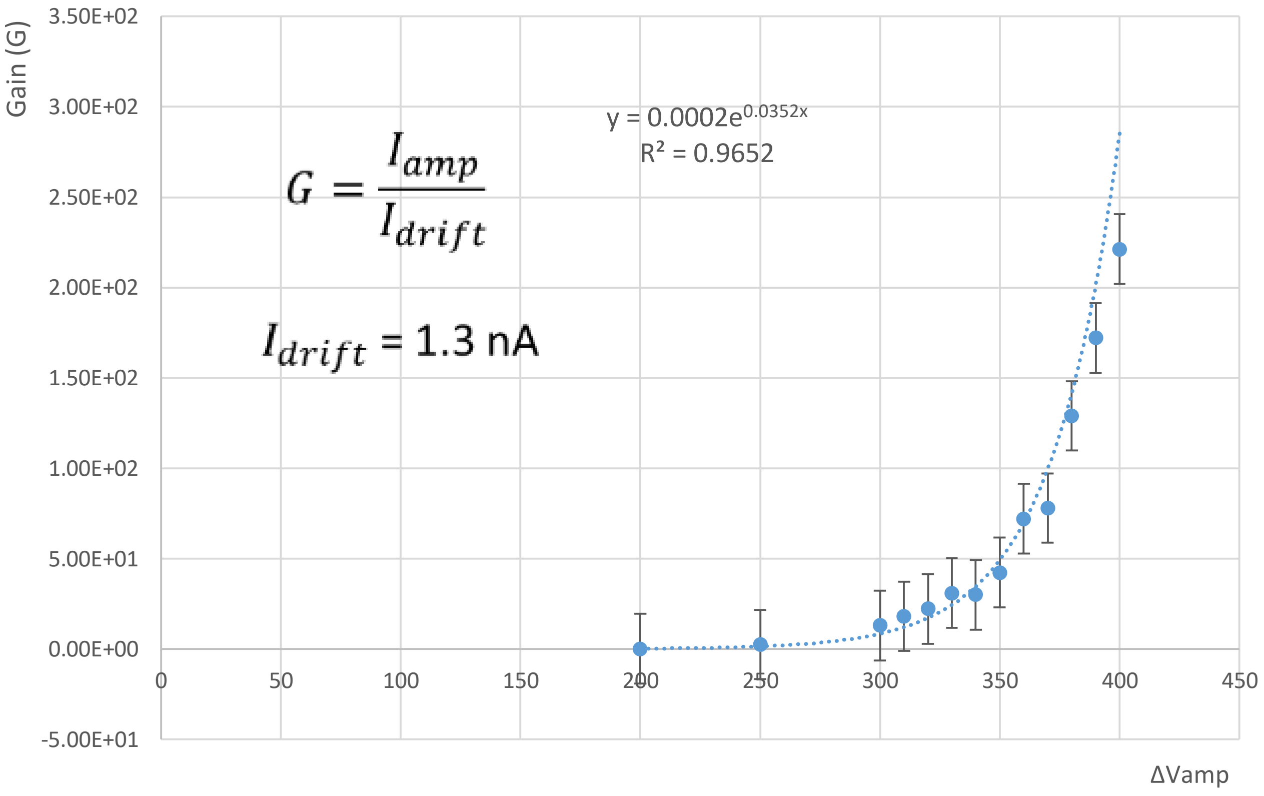
No.	Vamp (V)	Iamp(nA)
1	200	1.38E-01
2	250	3.28E+00
3	300	1.70E+01
4	350	5.50E+01
5	400	2.88E+02
6	310	2.35E+01
7	320	2.89E+01
8	330	4.03E+01
9	340	3.91E+01
10	360	9.38E+01
11	370	1.01E+02
12	380	1.68E+02
13	390	2.24E+02



- Measurement between ΔVamp and Iamp is being recorded:
- Exponential production of electrons in amplification region are observed at higher voltages.

Results and Discussions

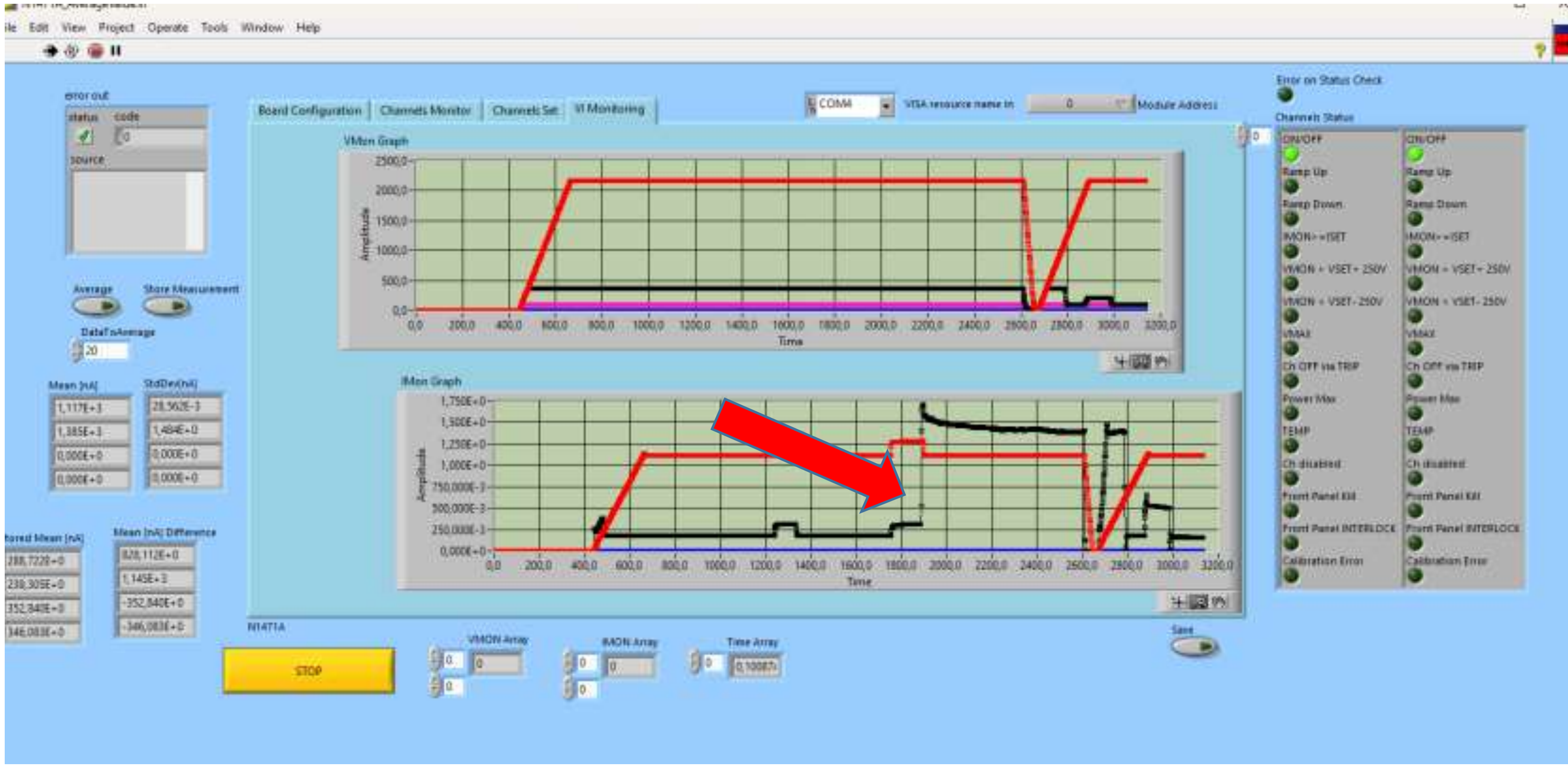
No.	Vamp (V)	Gain
1	200	1.06E-01
2	250	2.52E+00
3	300	1.31E+01
4	350	4.23E+01
5	400	2.21E+02
6	310	1.81E+01
7	320	2.23E+01
8	330	3.10E+01
9	340	3.01E+01
10	360	7.21E+01
11	370	7.80E+01
12	380	1.29E+02
13	390	1.72E+02



- Gain is measured as a function of the amplification voltage, which is the difference of potential establishing across the top electrode and the DLC.
- Exponential production of the secondary electrons in amplification region results into Avalanche of electrons.

Results and Discussions

- We attempted to measure the Gain (G) by setting the X-ray Source on right center of the detector.
- But sudden increase and fluctuations in the current indicated about some disturbance inside of the detector.
- So, we stopped taking further measurements of the Gain (G).



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3. The micro-Resistive WELL detector: a compact spark-protected single amplification-stage MPGD. G. Bencivenni, R. De Oliveira, G. Morelloa and M. Poli Lener. https://arxiv.org/abs/1411.2466v1.
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