

Preliminary data on fragmentation induced by x-rays of gaseous molecules in the chamber for GEM degradation studies

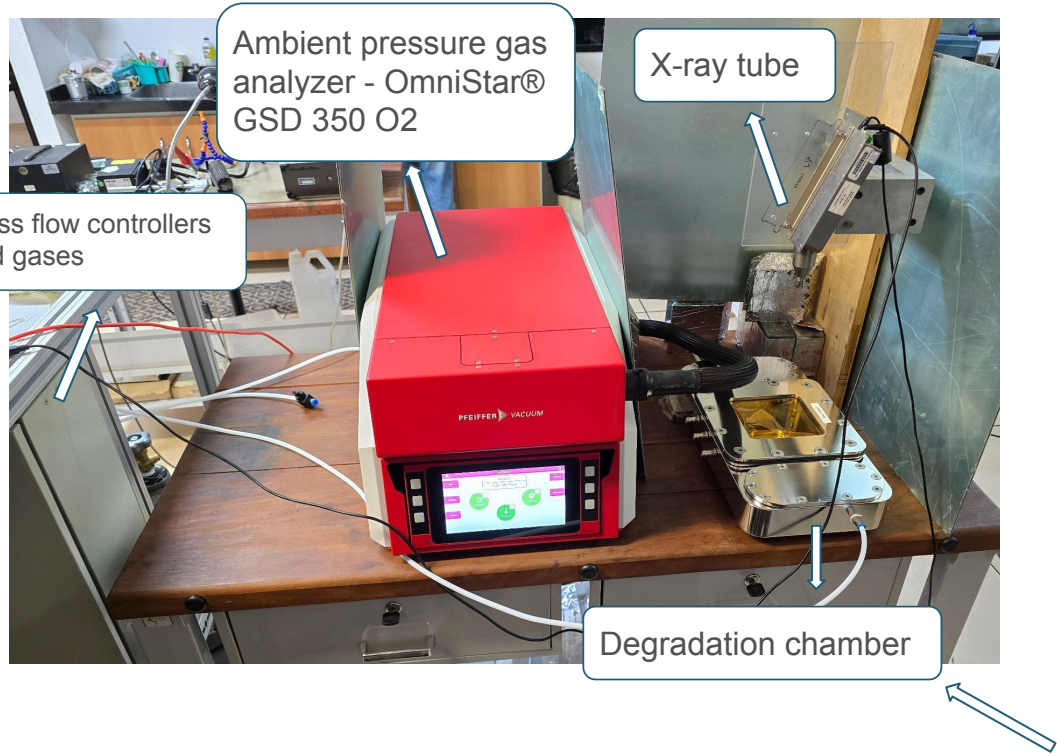
Willian Wallace R.A. da Silva
Universidade de São Paulo, Brasil

Advisor: Tiago Fiorini da Silva
Universidade de São Paulo, Brasil

To perform a characterization of the operating conditions of the degradation chamber with x-ray radiation without a GEM sample. This is important for subsequent degradation experiments with GEM samples.

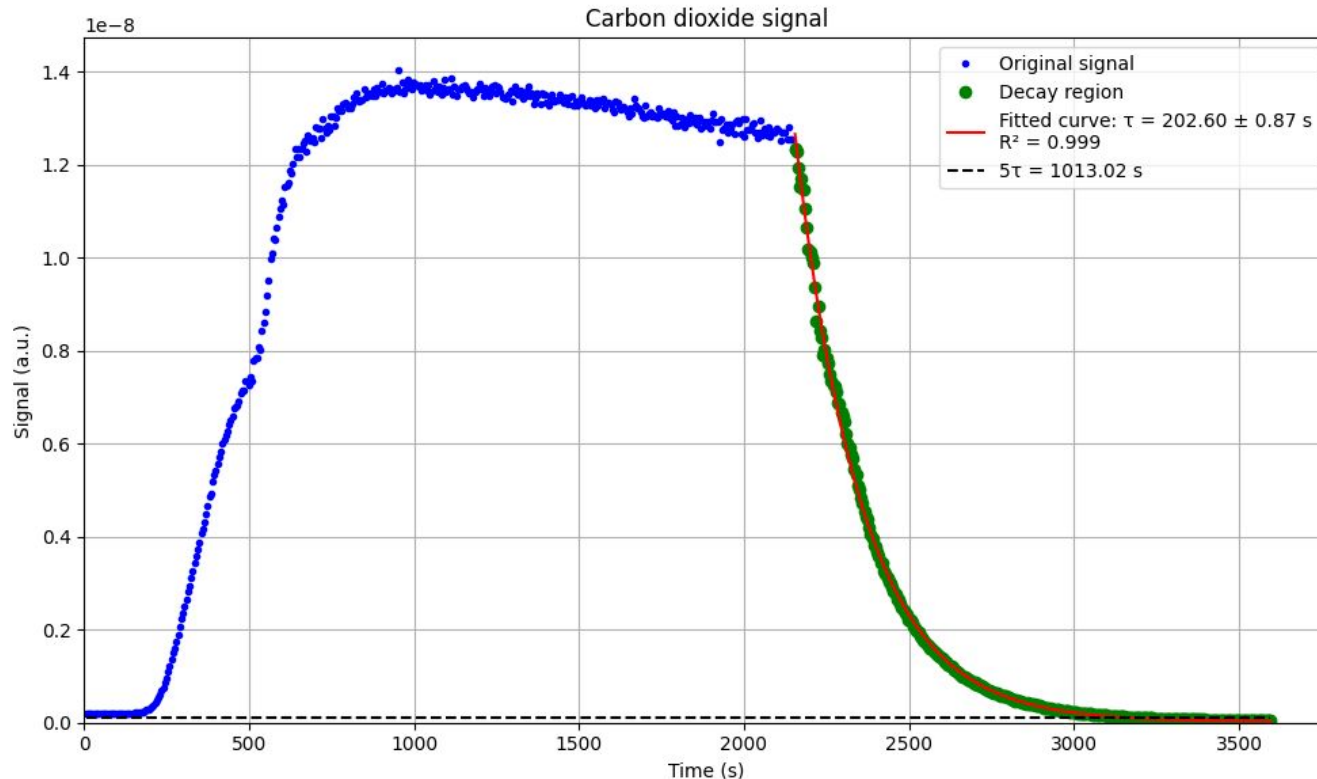
In this preliminary study we are investigating the effect of x-ray radiation in a gaseous mixture of argon and carbon dioxide as well as water contaminants.

The hypothesis of this work is that the interaction of X-rays with the gas mixture can induce ionization and molecular fragmentation, leading to measurable variations in the relative intensity of specific mass peaks.



- Experimental conditions:
- Flow rate: 6L/h
 - Mixture: Ar(70)/CO2(30)
 - Distance between the x-ray tube and the degradation chamber: 25cm
 - Kapton window





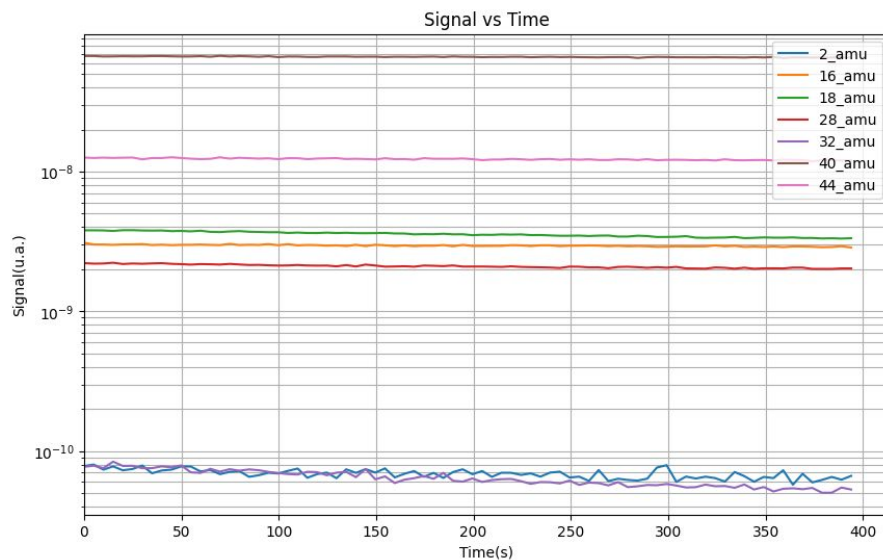
Value obtained for a flow rate of 7 L/h.

The fitted function is an exponential decay, where τ is the average residence time.

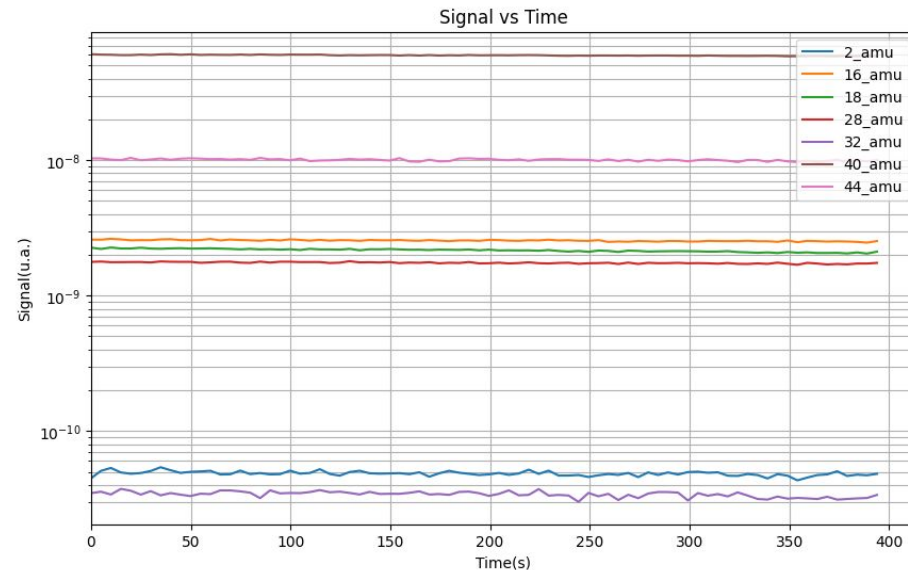
$5\tau \approx 17$ minutes.

For a gas flow rate of 6 L/h, the measurements were taken over 20 minutes with a 5-minute waiting period.

Reference Measurements

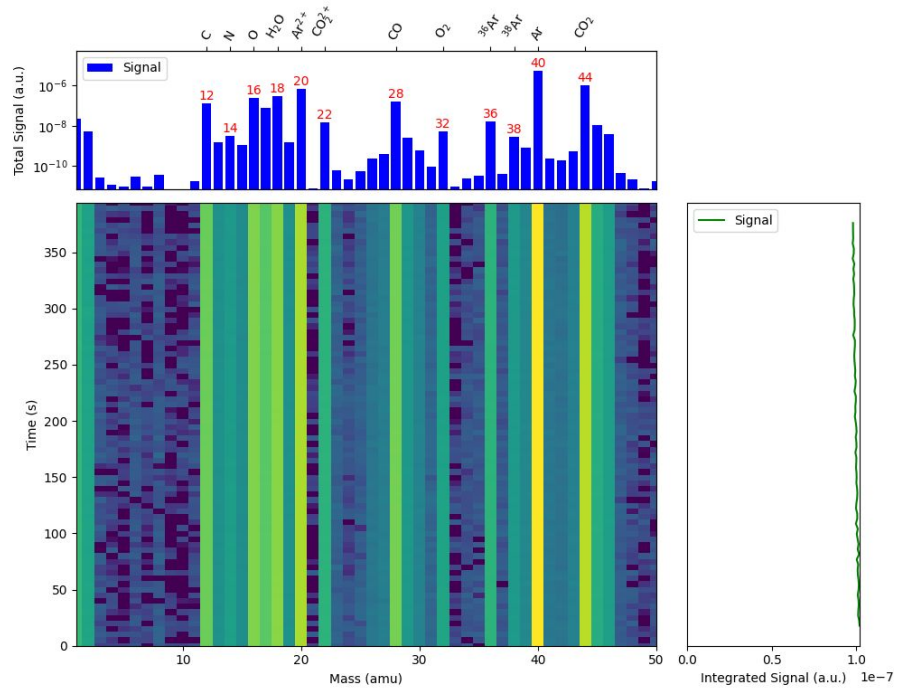


X-Ray radiation - 10 KeV e 50uA

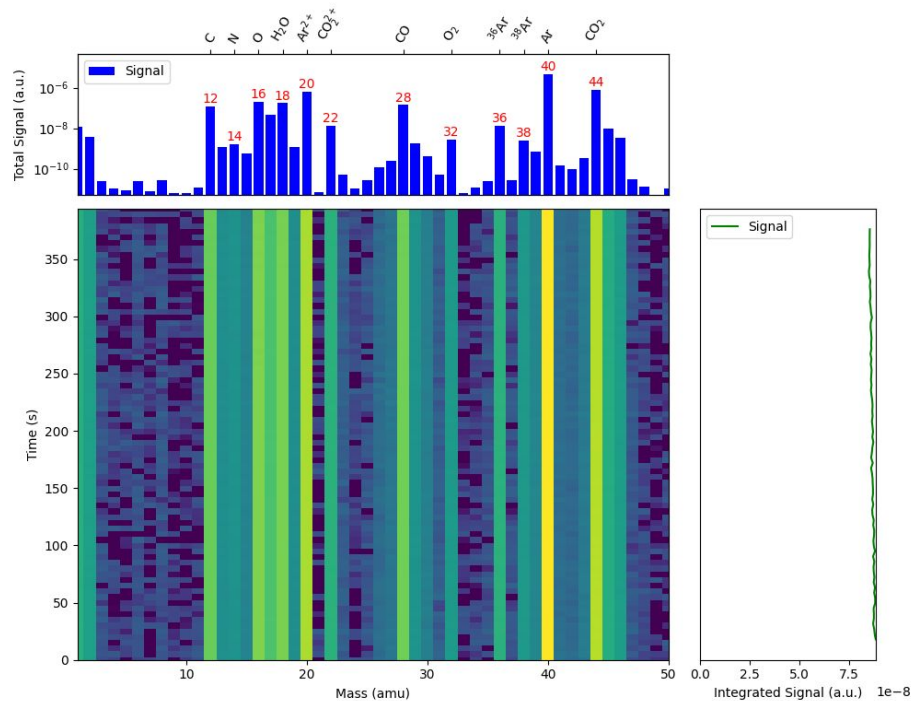


Two examples of the characteristic time evolution of the signals analyzed in this work

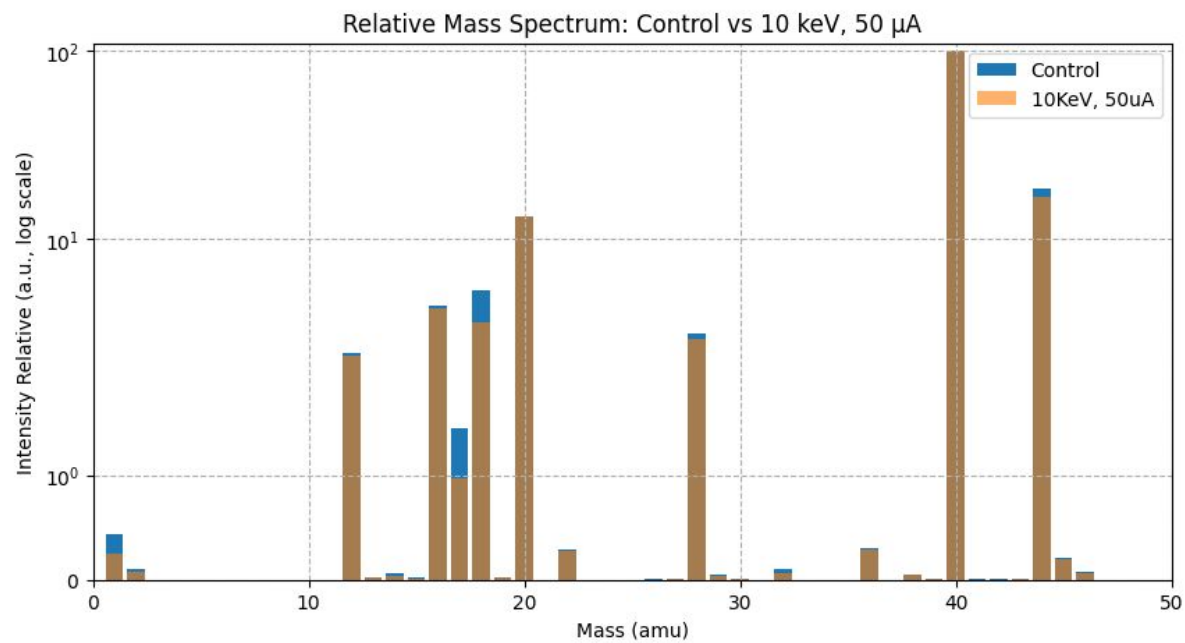
Reference Heatmap



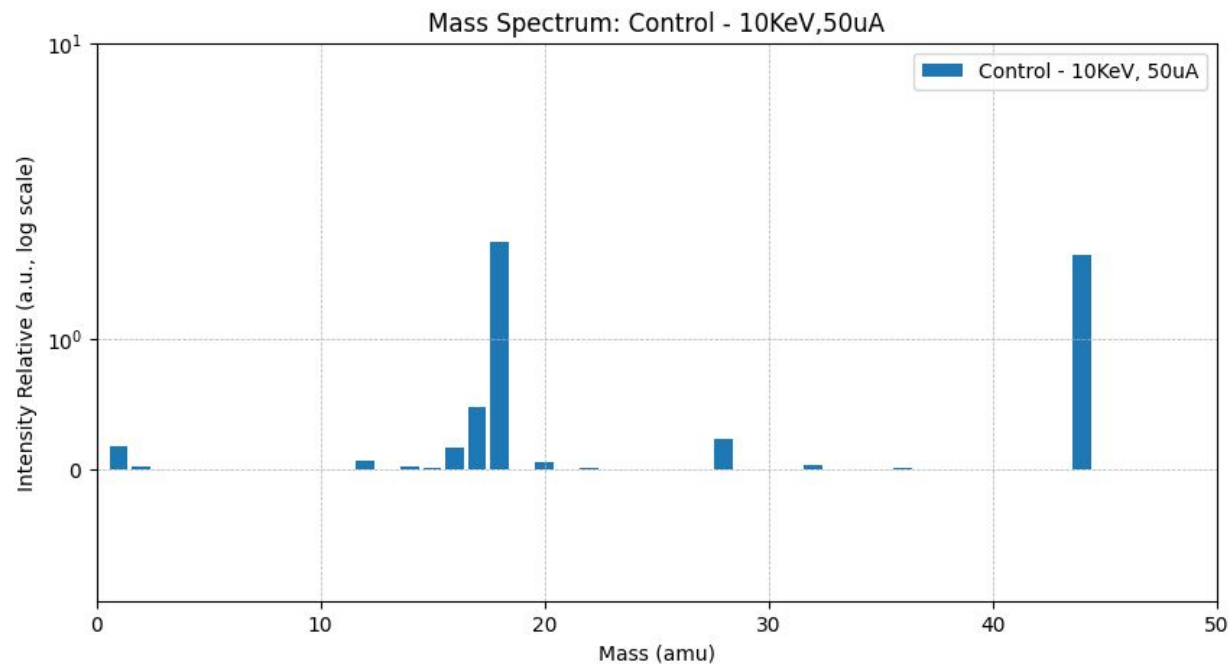
X-Ray radiation Heatmap - 10 KeV e 50uA



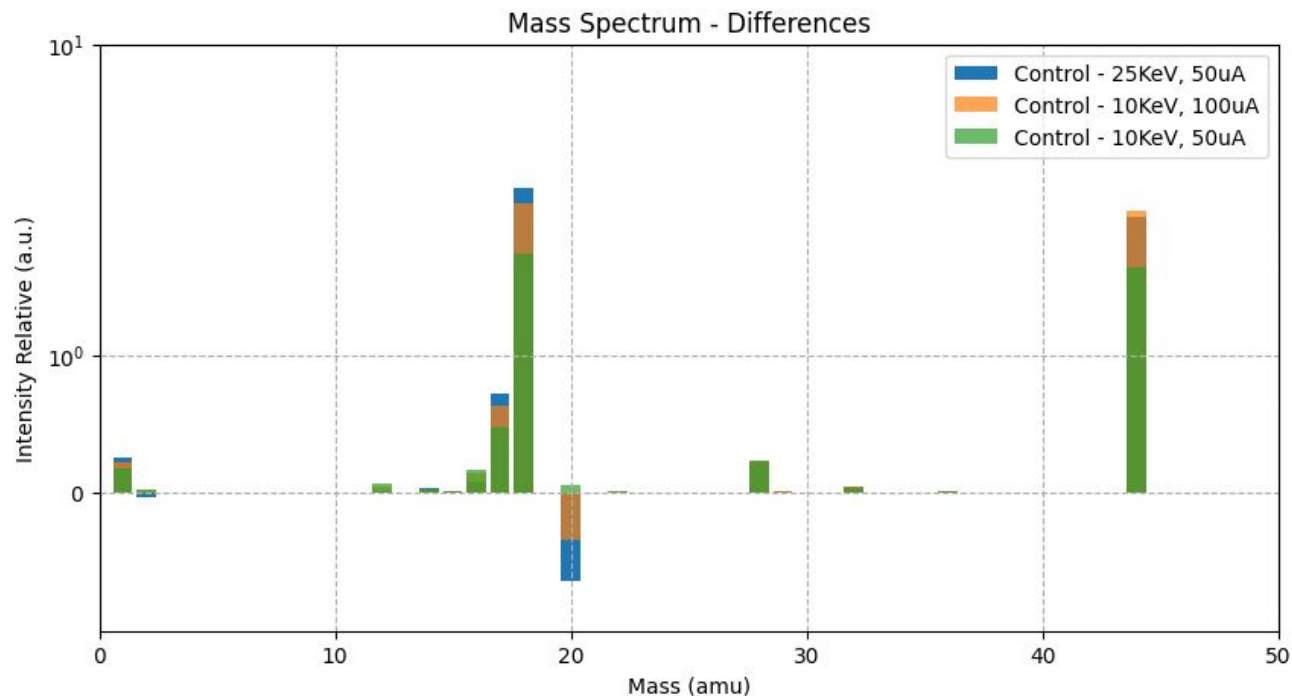
Comparison of Relative Mass Spectra: Control and 10 keV, 50 μ A Irradiation



Relative Mass Spectra:
Control subtracted by the 10 keV, 50 μ A Irradiation

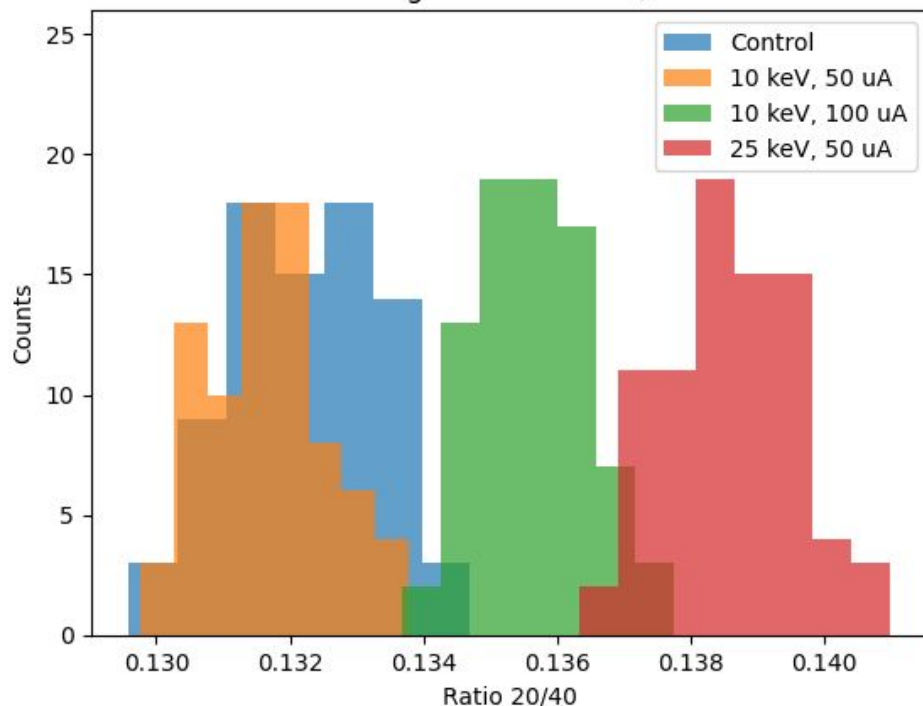


Comparing the residual for different irradiation conditions in relation to control data



Studying the ratio 20/40:

Histogram of Ratio 20/40



Control -> Mean: 0.1322 | Std: 0.0011

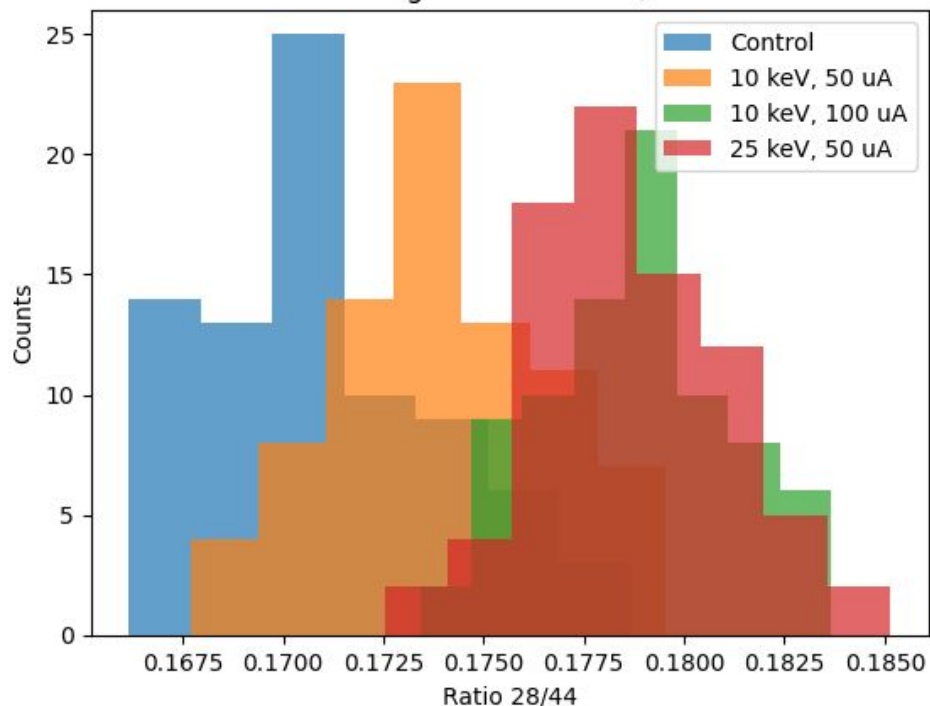
10 keV, 50 uA -> Mean: 0.1317 | Std: 0.0009

10 keV, 100 uA -> Mean: 0.1356 | Std: 0.0009

25 keV, 50 uA -> Mean: 0.1386 | Std: 0.0010

Studying the ratio 28/44:

Histogram of Ratio 28/44



Control -> Mean: 0.1710 | Std: 0.0030

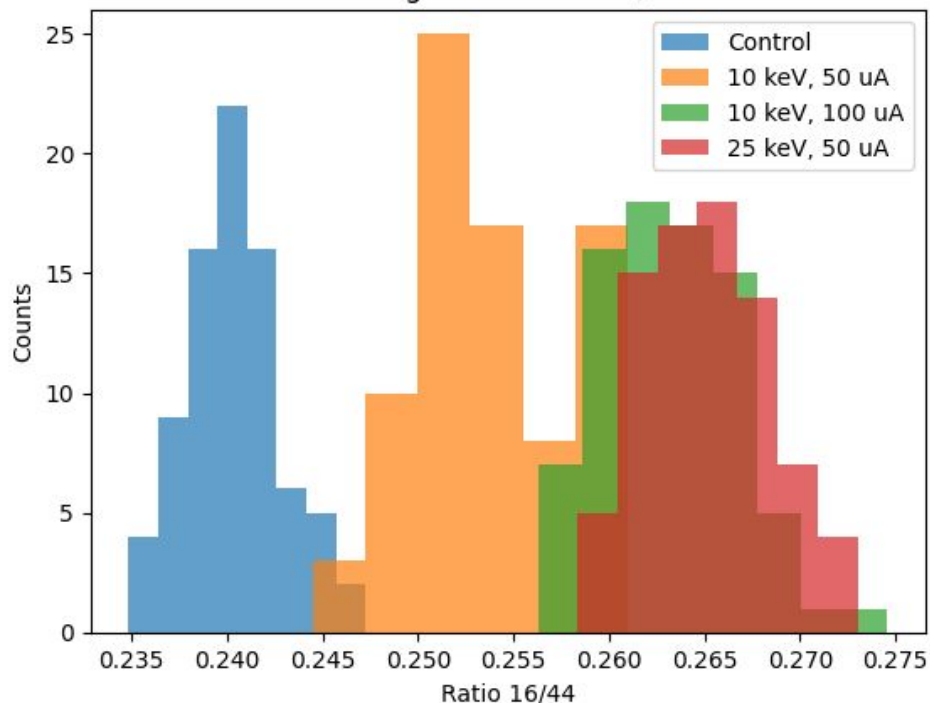
10 keV, 50 uA -> Mean: 0.1739 | Std: 0.0027

10 keV, 100 uA -> Mean: 0.1788 | Std: 0.0024

25 keV, 50 uA -> Mean: 0.1786 | Std: 0.0024

Studying the ratio 16/44:

Histogram of Ratio 16/44



Control -> Mean: 0.2404 | Std: 0.0025

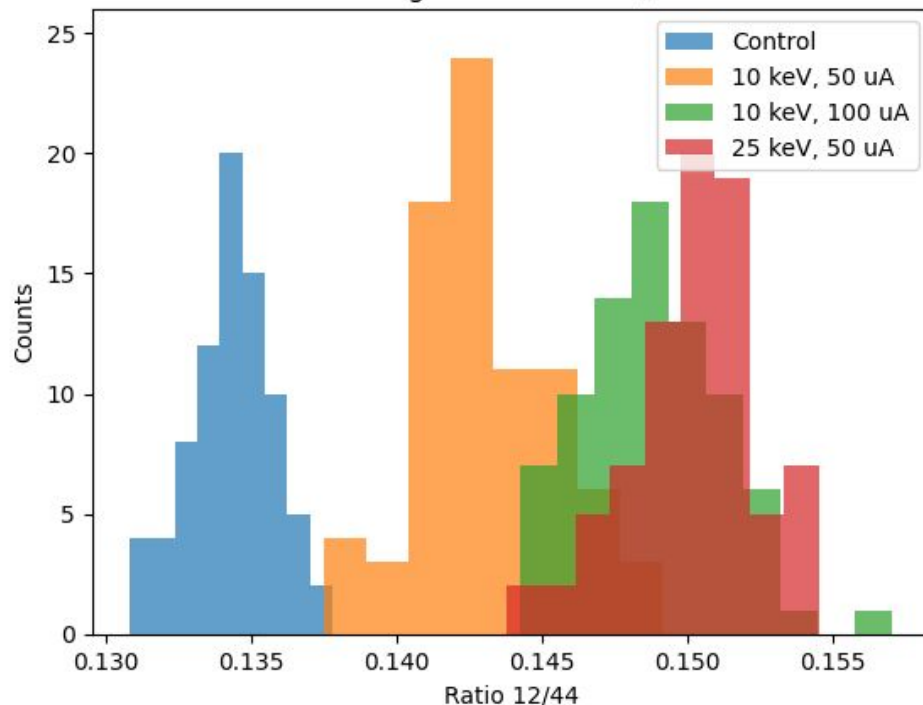
10 keV, 50 uA -> Mean: 0.2538 | Std: 0.0042

10 keV, 100 uA -> Mean: 0.2632 | Std: 0.0035

25 keV, 50 uA -> Mean: 0.2650 | Std: 0.0034

Studying the ratio 12/44:

Histogram of Ratio 12/44



Control -> Mean: 0.1343 | Std: 0.0015

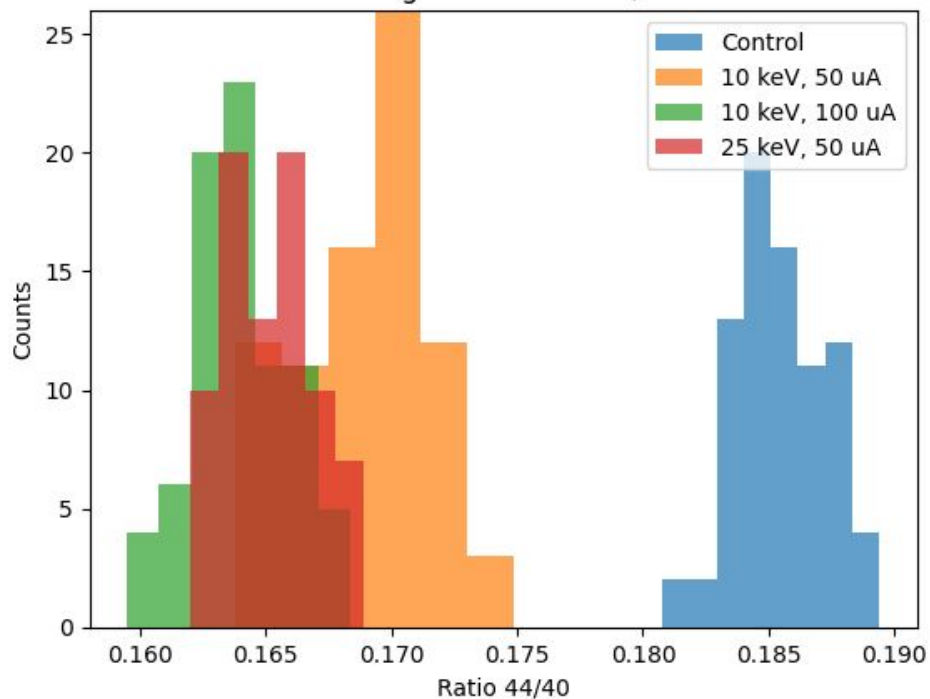
10 keV, 50 uA -> Mean: 0.1431 | Std: 0.0024

10 keV, 100 uA -> Mean: 0.1488 | Std: 0.0024

25 keV, 50 uA -> Mean: 0.1502 | Std: 0.0022

Studying the ratio 44/40:

Histogram of Ratio 44/40



Control -> Mean: 0.1854 | Std: 0.0018

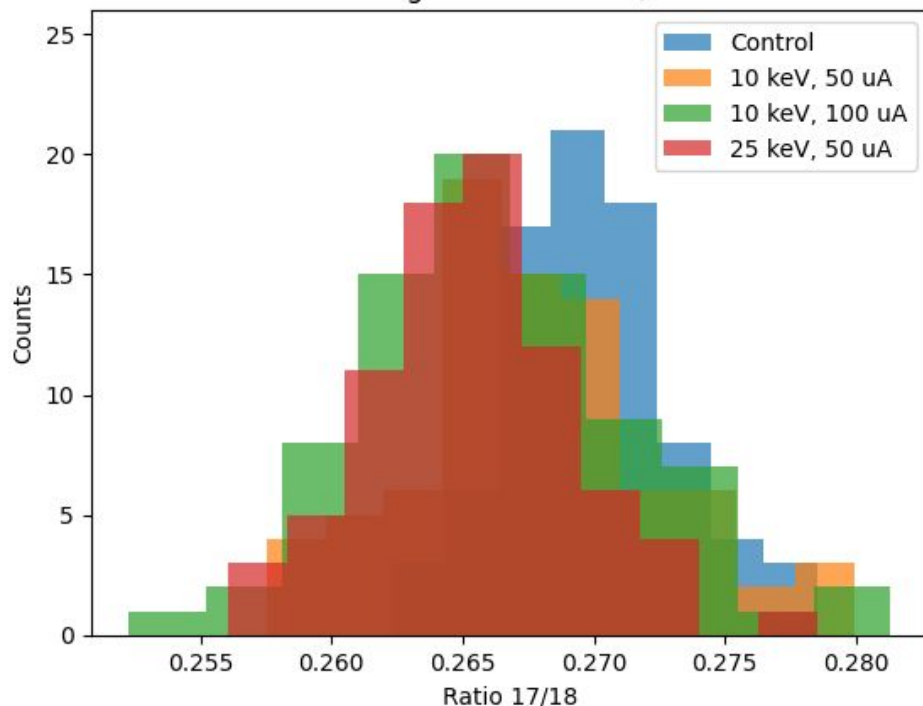
10 keV, 50 uA -> Mean: 0.1690 | Std: 0.0026

10 keV, 100 uA -> Mean: 0.1640 | Std: 0.0019

25 keV, 50 uA -> Mean: 0.1652 | Std: 0.0017

Studying the ratio 17/18:

Histogram of Ratio 17/18



Control -> Mean: 0.2698 | Std: 0.0033

10 keV, 50 uA -> Mean: 0.2677 | Std: 0.0048

10 keV, 100 uA -> Mean: 0.2663 | Std: 0.0051

25 keV, 50 uA -> Mean: 0.2655 | Std: 0.0039

- The results are consistent with the initial hypothesis since we could observe variations in the ratios studied that indicated an increase in double ionization and molecular fragmentation as well as decrease in 44/40 ratio.
- However, the results for 17/18 ratio were inconclusive indicating that we still need a deeper understanding about the fragmentation patterns.

- Improve the analysis to obtain quantitative information.
- Implement fragmentation patterns into the analysis script to automatically identify contributions related to molecular fragmentation due to X-ray radiation.
- Repeat the experiment for other gaseous mixtures.

Thanks!