# Characterising a multi-element laser ablation ion source

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*Supervised by Dr. Thomas Brunner and PhD Candidate Hussain Rasiwala*

Canadian Astroparticle physics Summer Student Talk
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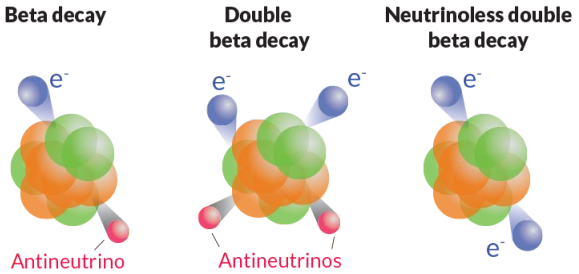
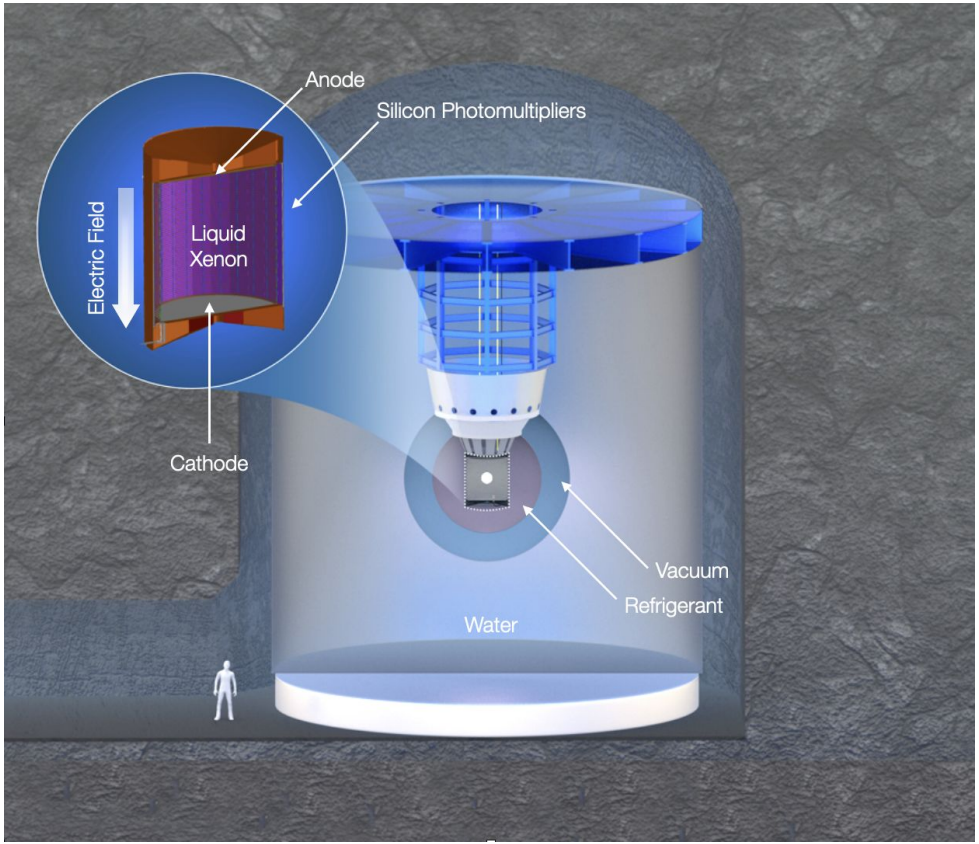
# $0\nu\beta\beta$ and nEXO Experiment

**nEXO** is a proposed experiment that aims to detect neutrinoless double-beta decay ($0\nu\beta\beta$) in 5 tonnes of liquid xenon (**LXe**) enriched to 90% in $^{136}$**Xe**. inside a time projection chamber (**TPC**).

$0\nu\beta\beta$ is a forbidden decay in the Standard Model if observed it would provide insight into:

- the mass of neutrinos,
- lepton number violation and,
- experimental proof of their Majorana nature.




nEXO experiment design. The TPC is proposed to be located 2km underground at SNOLAB.

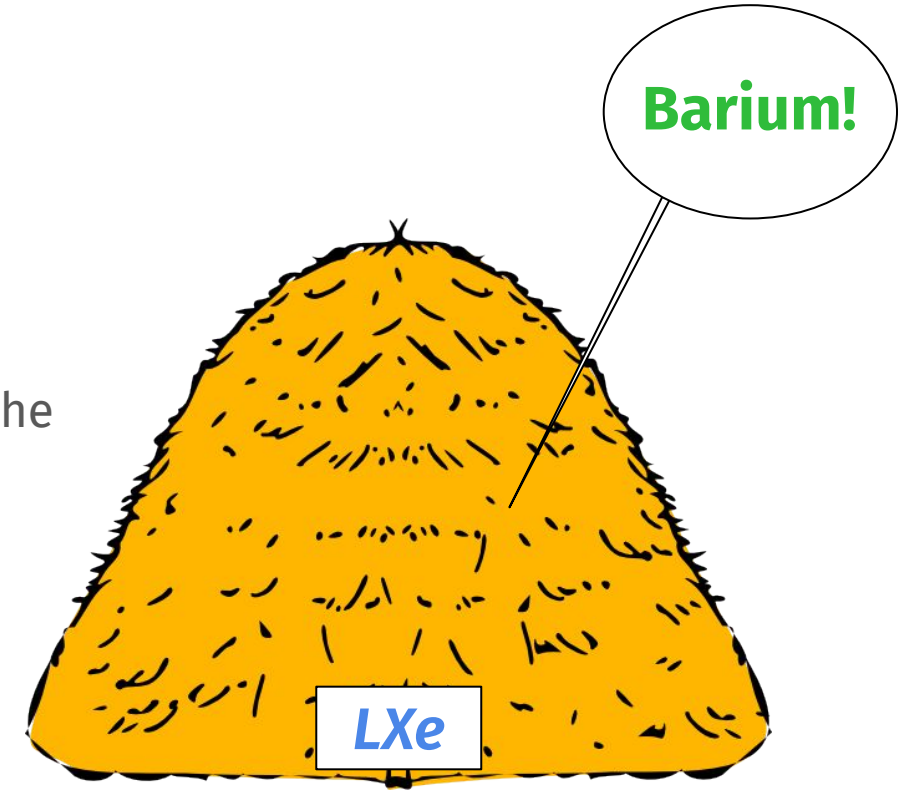
# Searching for a needle in a haystack

From 0νββ:

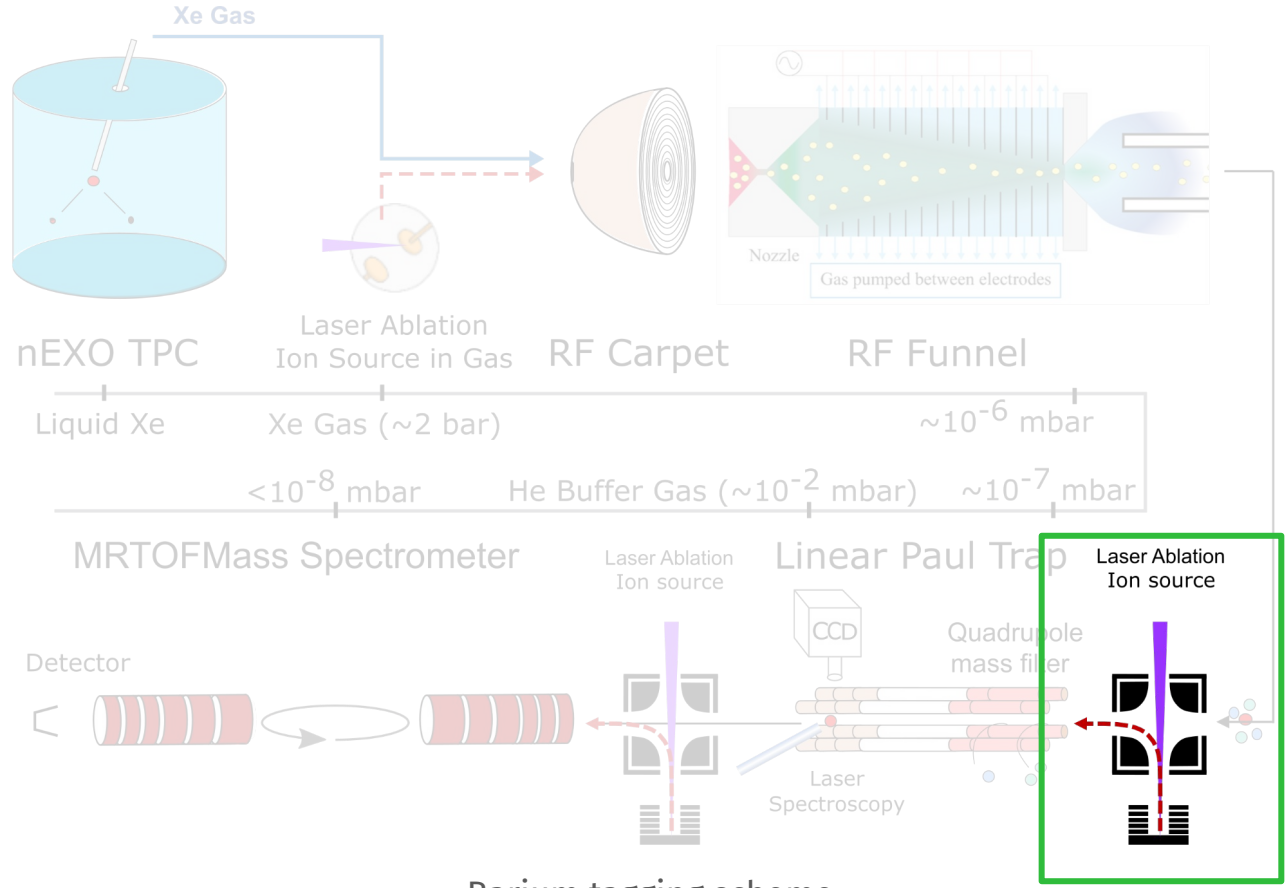
$$^{136}Xe \rightarrow {}^{136}Ba^{2+} + 2e^{-}$$

This technique benefits from **LXe** to potentially extract and identify the decay daughter $^{136}$**Ba** in it providing the ultimate technology in background suppression.

The barium tagging technique is a potential future upgrade for nEXO



# Goal of the Project

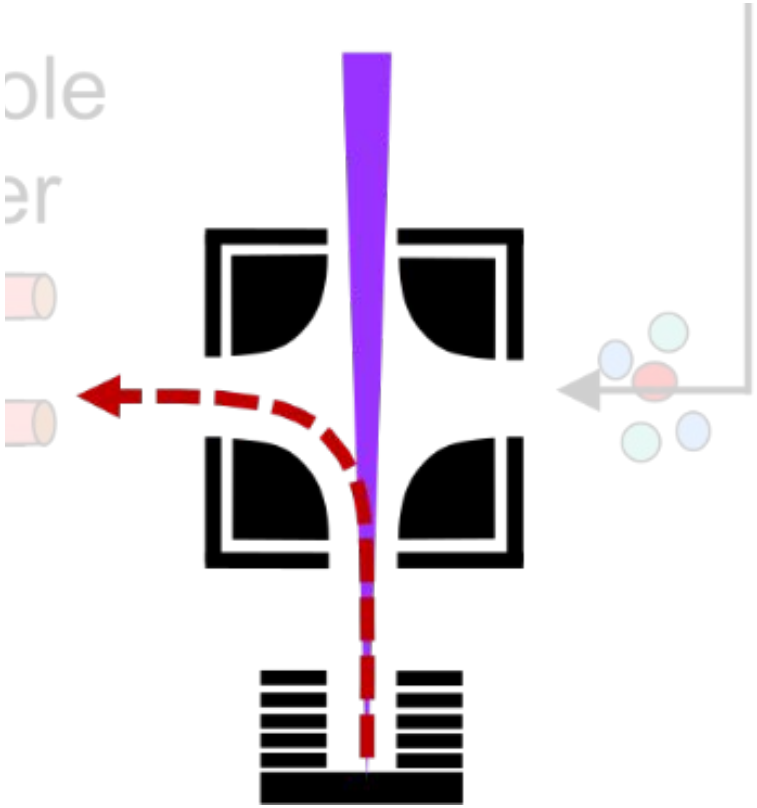



Barium tagging scheme

## Goal

To assemble and characterize a laser ablation ion source

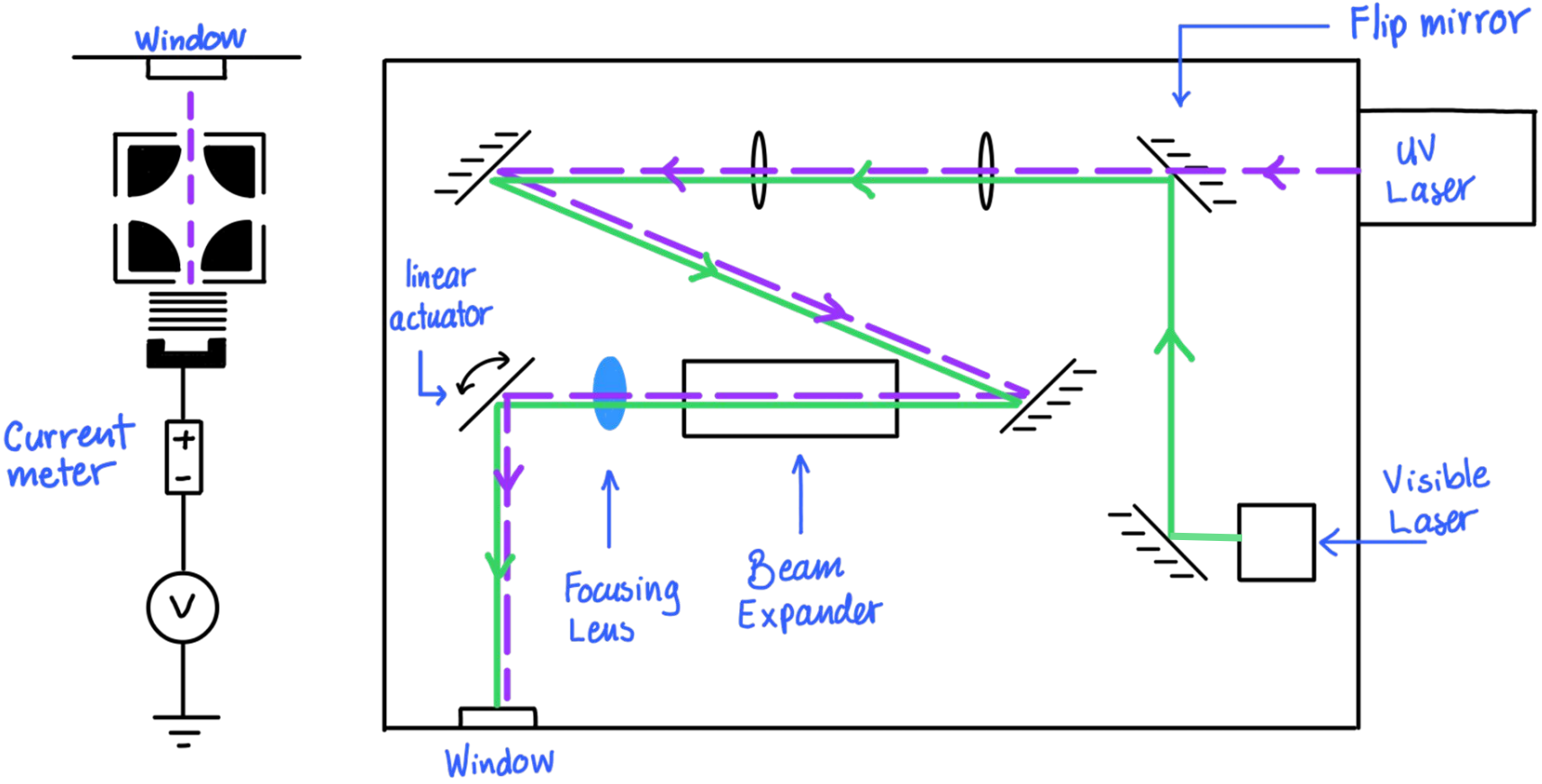
# Goal of the Project



**Goal**

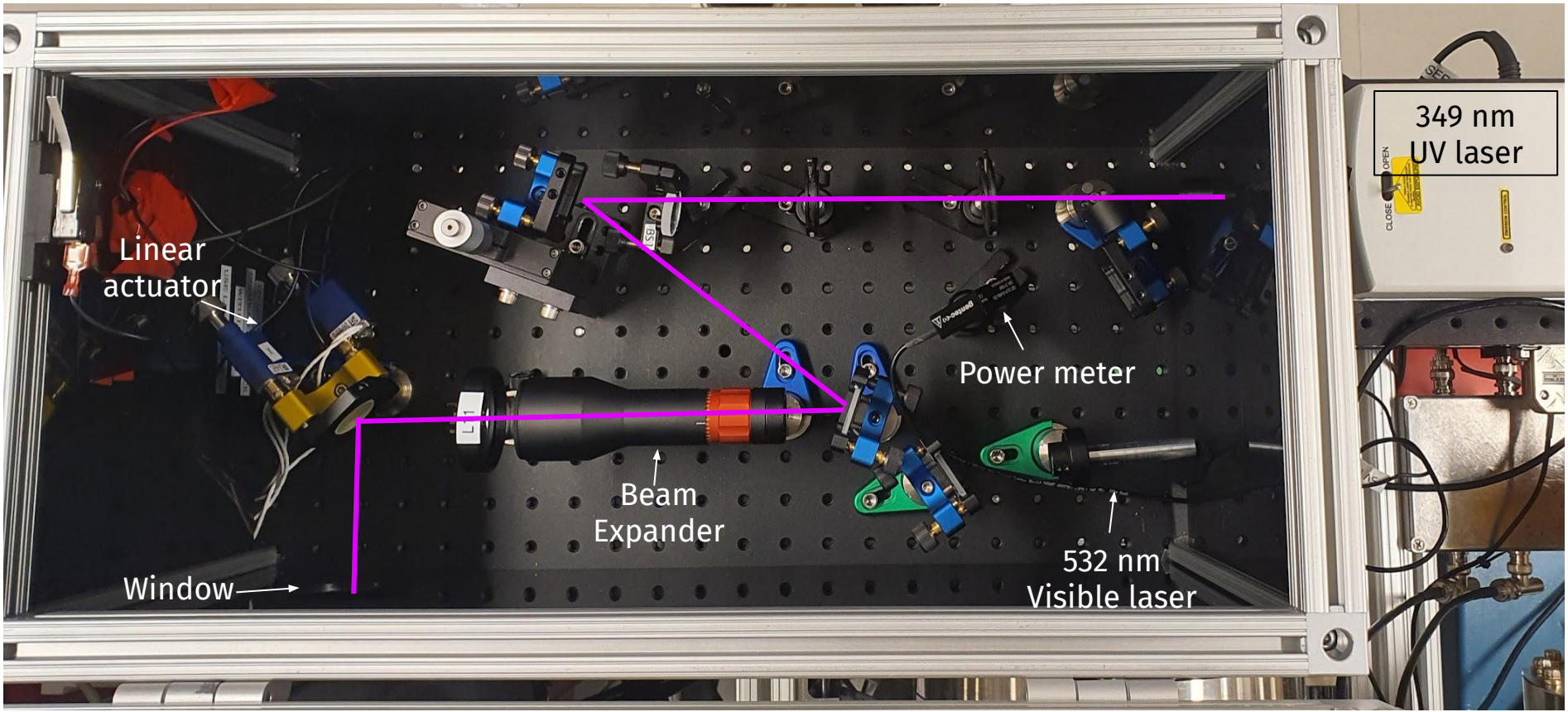
To assemble and characterize a laser ablation ion source

# How did I get to do it?

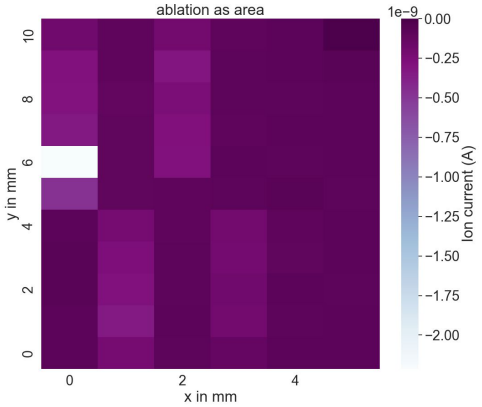


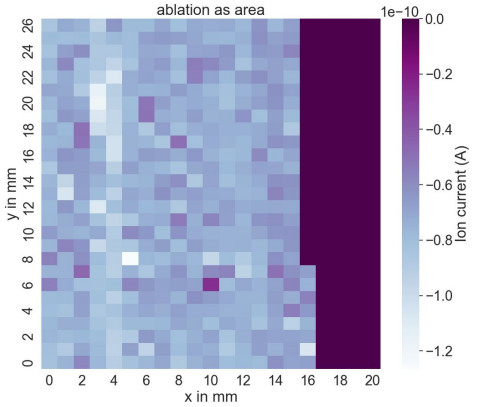

Final laser setup diagram for the ion detector

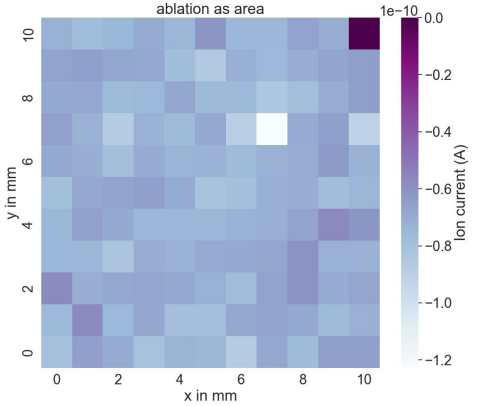
# Final laser optics setup

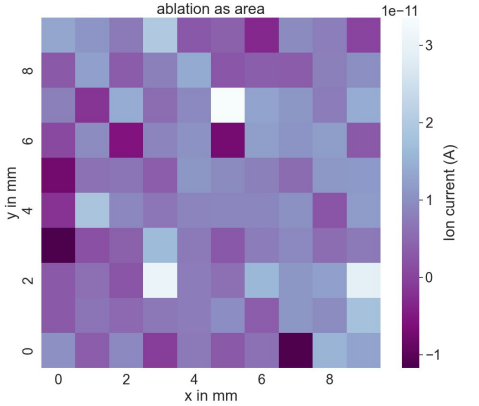


# Ablations so far



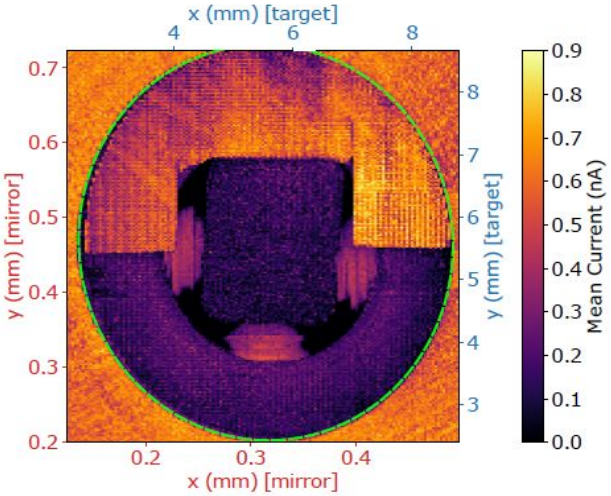




Ablation from scans of ion current reads

# What’s next?

- Perform detailed scans of the target
- Optimize electric potentials to maximize ion transmission efficiency
- Inject ions from laser ablation source into the quadrupole mass filter




Different ablated target at the lab. similar detailed scans are expected

# Thank you for your attention!

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# *Appendix. 0νββ & 2νββ*, lepton number violation

If dirac particles;

$$^{136}Xe \rightarrow {}^{136}Ba^{2+} + 2e^{-} + 2\bar{\nu}_{e^-}$$

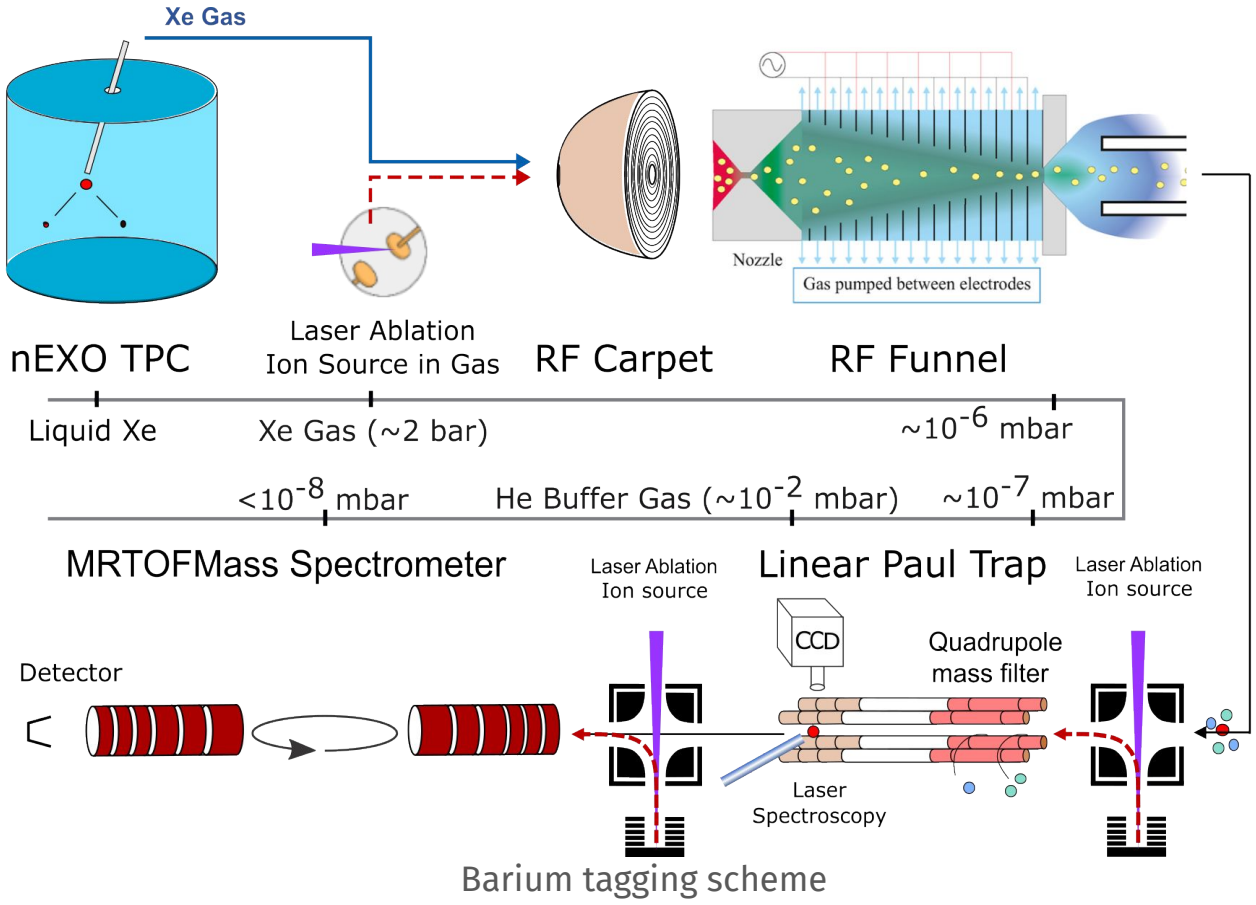
$$0 = 0 + 2 - 2$$

If majorana particles;

$$^{136}Xe \rightarrow {}^{136}Ba^{2+} + 2e^{-}$$

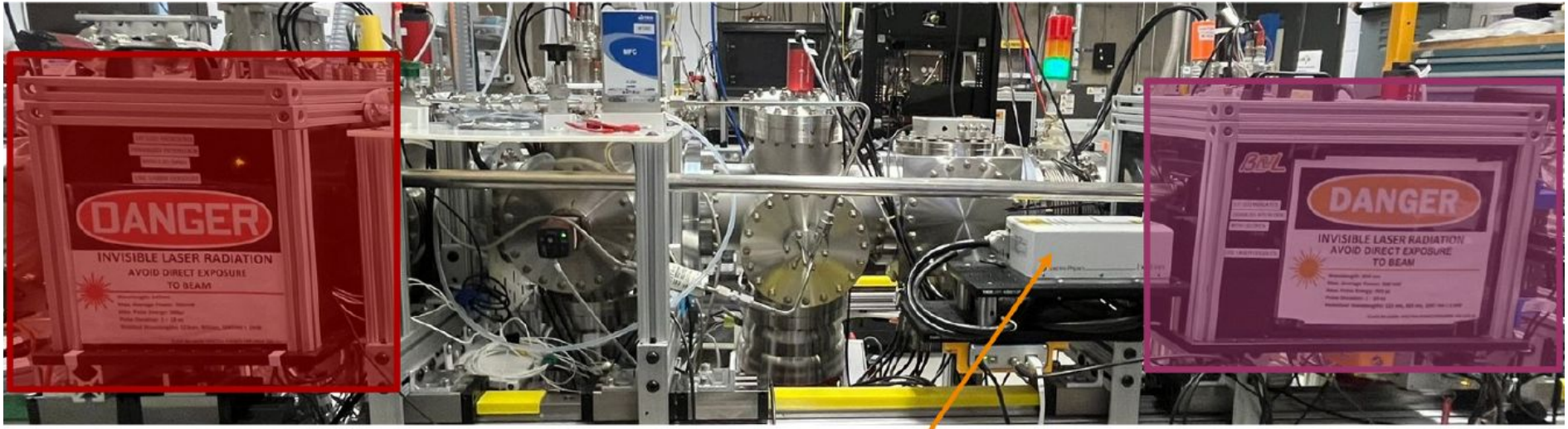
$$0 \neq 0 + 2$$

# *Appendix.* Barium tagging



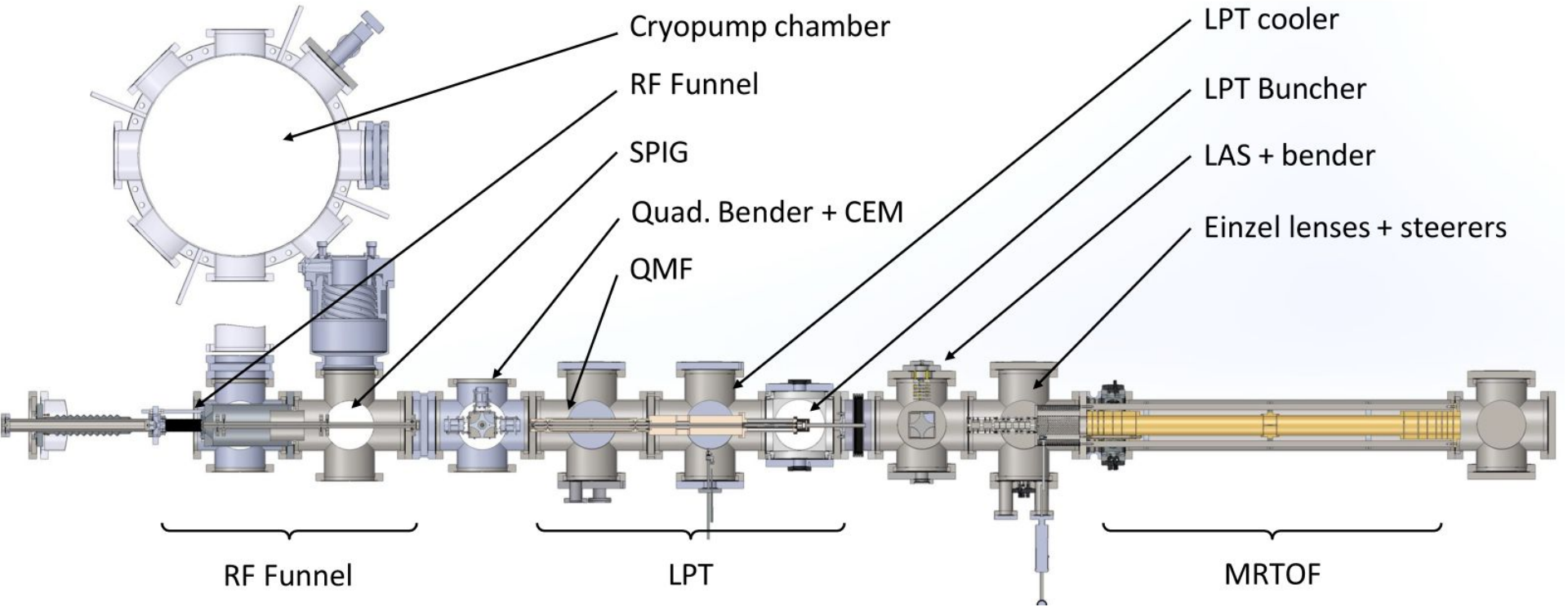

Barium tagging scheme

# *Appendix.* Previous setups



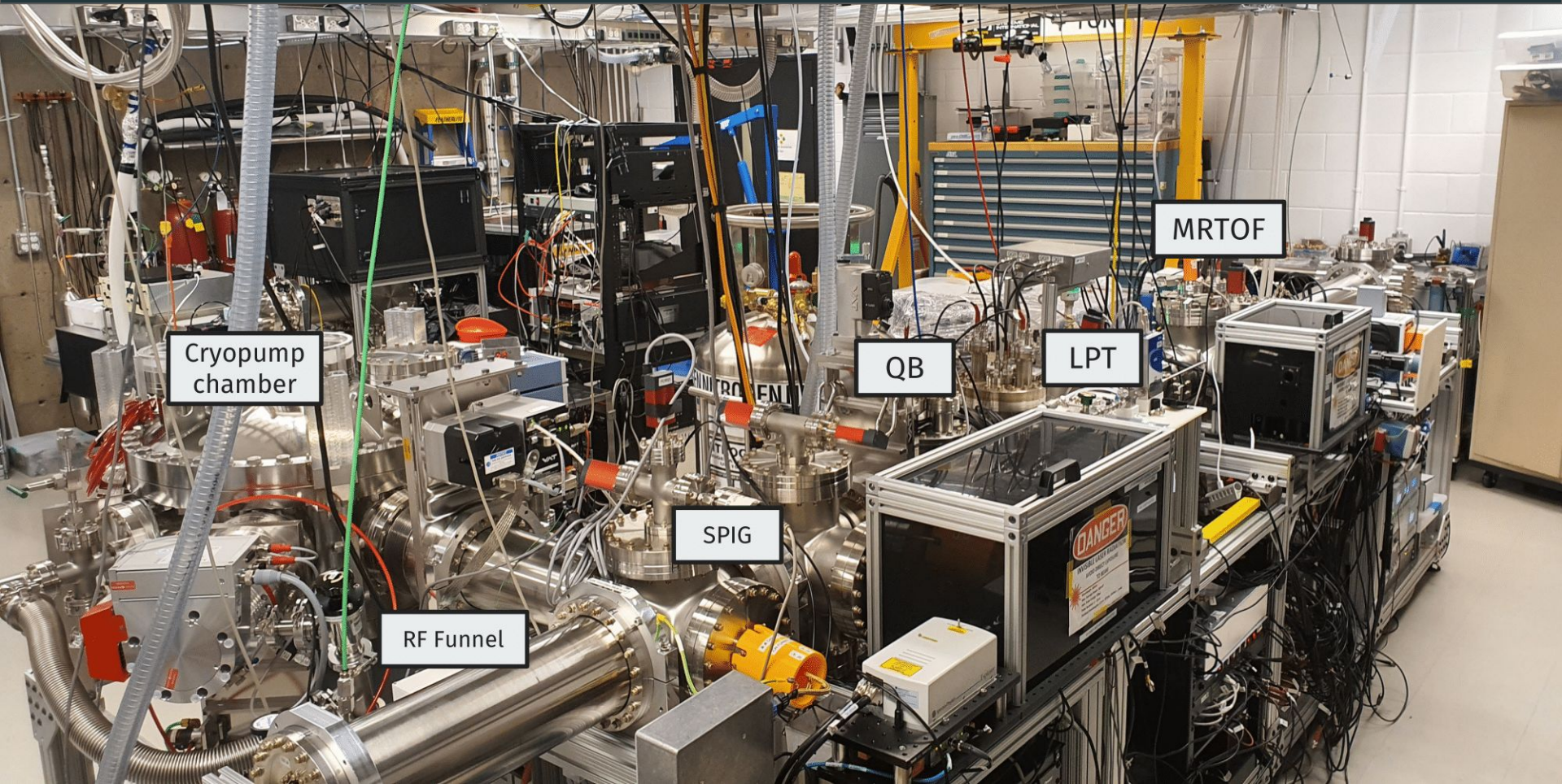

Previous laser setup before modifying dark box 2

# *Appendix.* Barium tagging comissionings 1

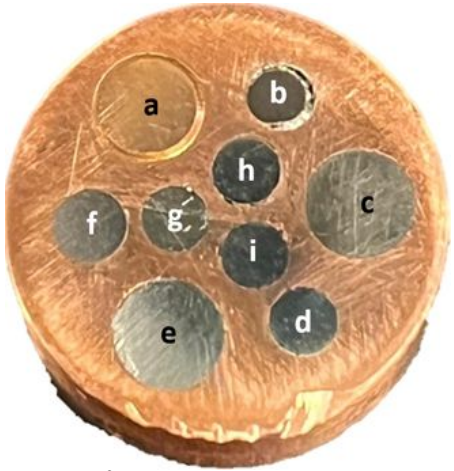



Barium tagging commissioning at McGill University

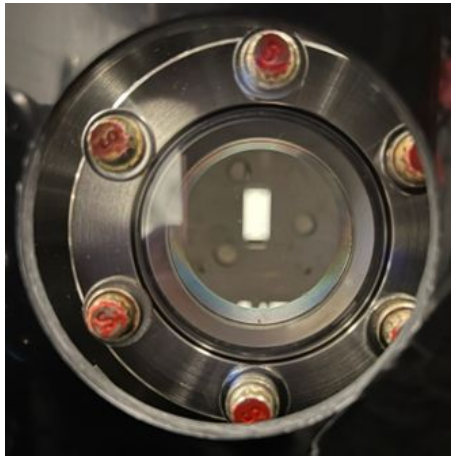
# *Appendix.* Barium tagging comissionings



# *Appendix.* Backup slides



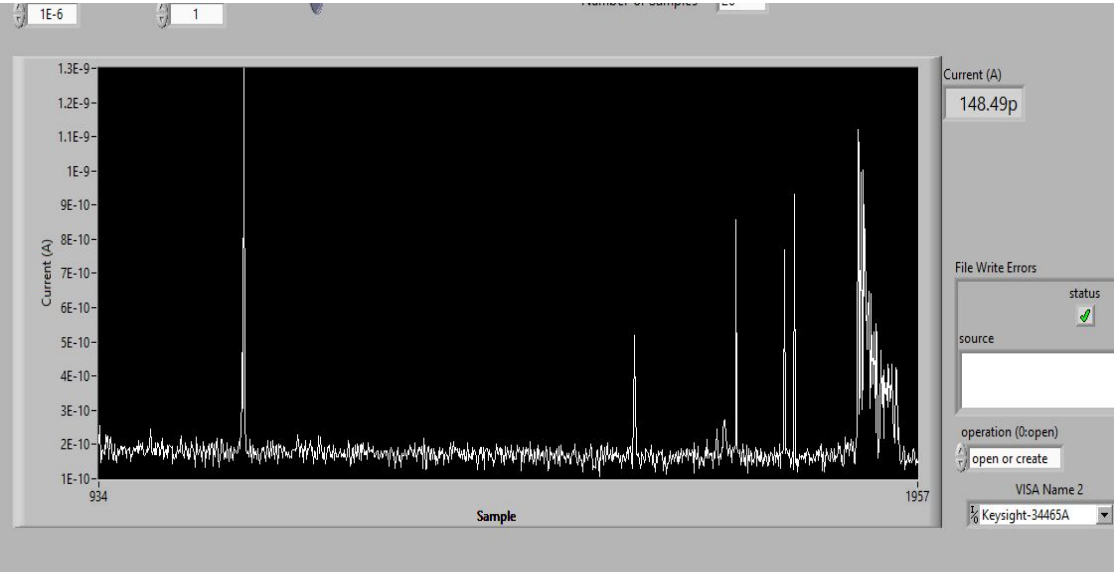

Multi-element target source :
a) Bronze , b)Carbon fiber, c) Titanium
d) Tool steel, e) Molybdenum , f) Tantalum,
g) Nickel , h) Tungsten, i) Stainless Steel.
The holder of these elements is made of copper.

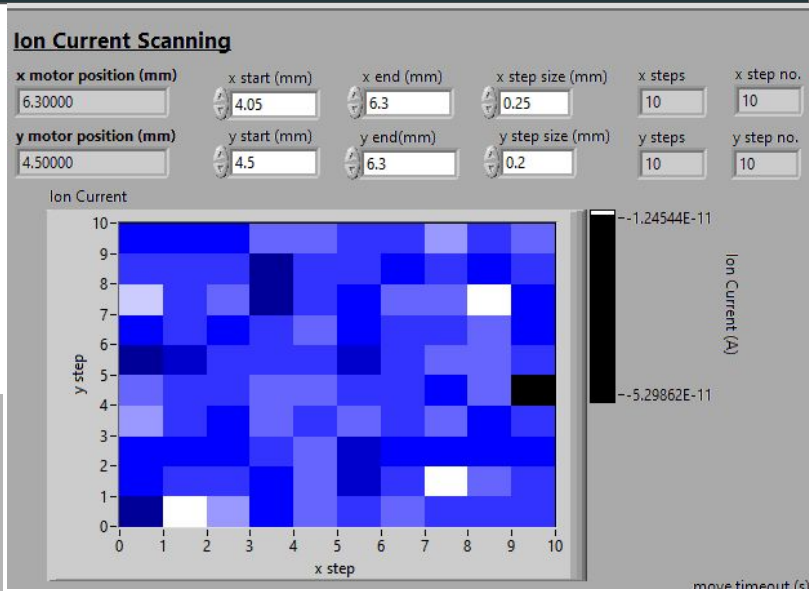


Slit range-target seen from external window

# *Appendix.* Backup slides

Current reading for ablation

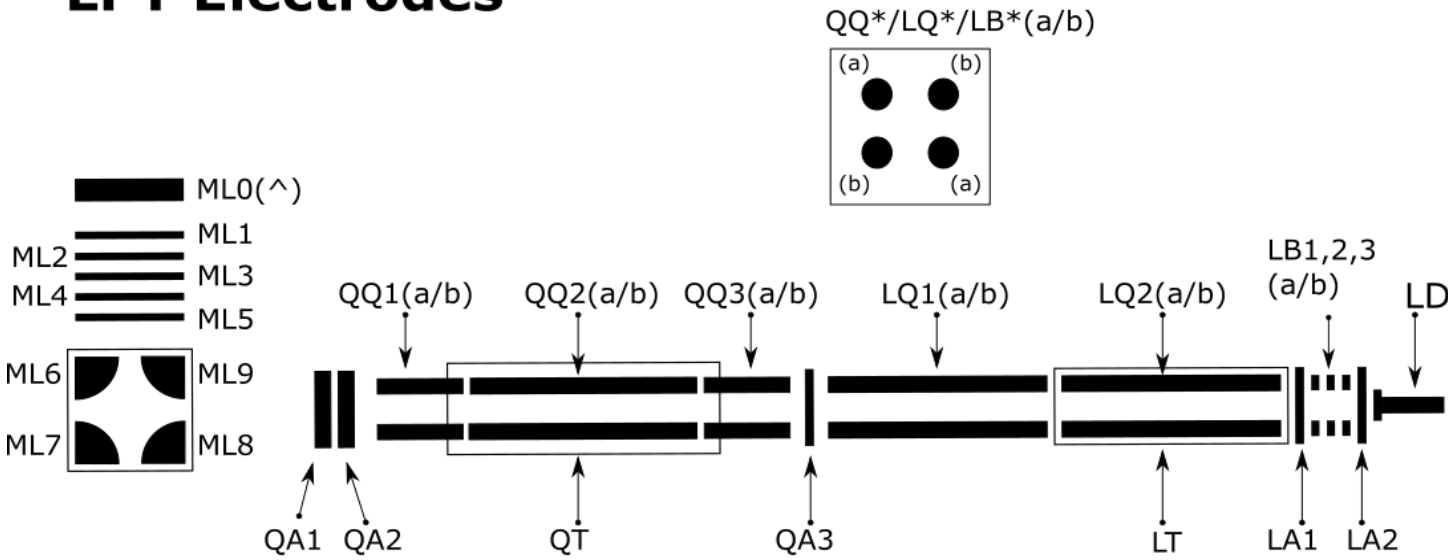



labview ss from how we control the linear actuator

# *Appendix.* Backup slides

## LPT Electrodes




^ : Two separate connections present for running current in the source

* : Quad/buncher number 1,2 or 3

# *Appendix.* Backup slides