CASST 2026

Presented by :
Justine Thebault-Weiser

Supervisor: Dr. Thomas Brunner

Optimizing light ion ablation, transport, and filtering

CINP
ICPN

McGill
UNIVERSITY

Neutrinos

ν_2

$\nu_?$

ν_1

ν_3

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Neutrinos

ν_2

$\nu_?$

WHAT DO WE KNOW?

They exist!
No charge
Flavors
Oscillate
Have mass

ν_1

ν_3

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Neutrinos

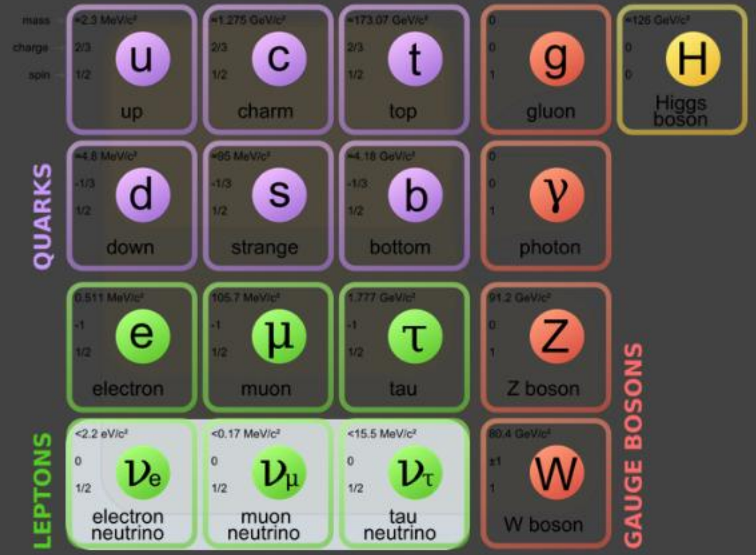
ν_2 $\nu_?$

WHAT DO WE KNOW?

They exist!
No charge
Flavors
Oscillate
Have mass

ν_1

WHAT DON'T WE KNOW (YET)?



Why only 3 flavors?

ν_3

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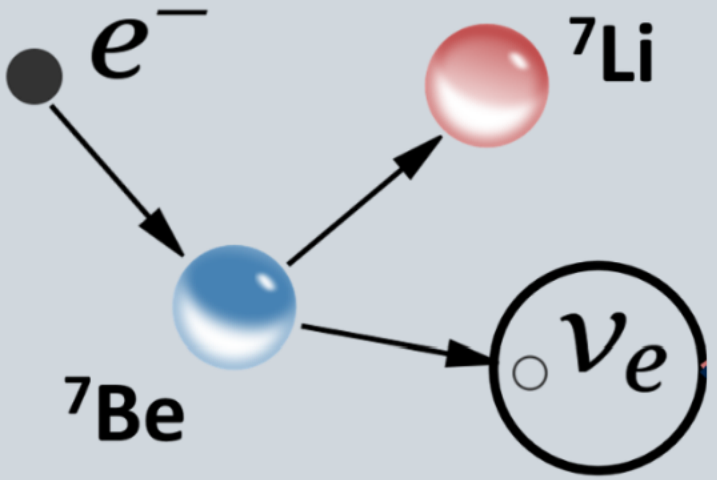
BeEST

Measuring nuclear recoils from electron capture in superconductors to detect sterile neutrinos

BeEST

Measuring nuclear recoils from electron capture in superconductors to detect sterile neutrinos

$$p + e^- \rightarrow n + \nu_e$$



credit: BeEST

BeEST

Measuring nuclear recoils from electron capture in superconductors to detect sterile neutrinos

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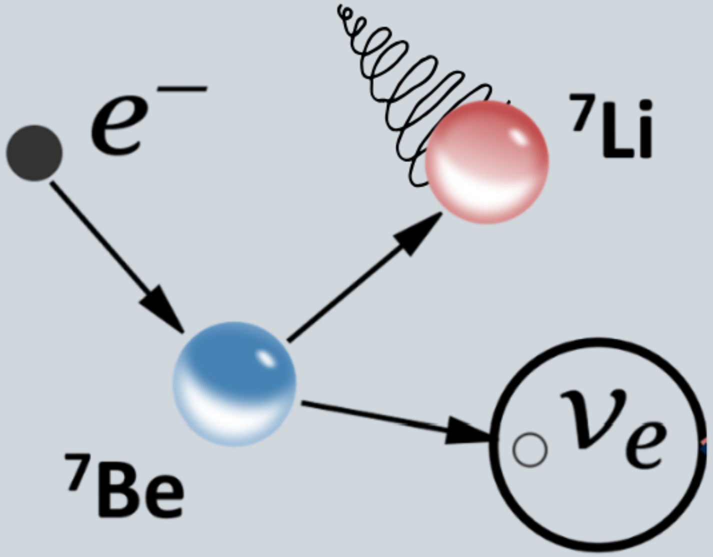

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Measuring nuclear recoils from electron capture in superconductors to detect sterile neutrinos

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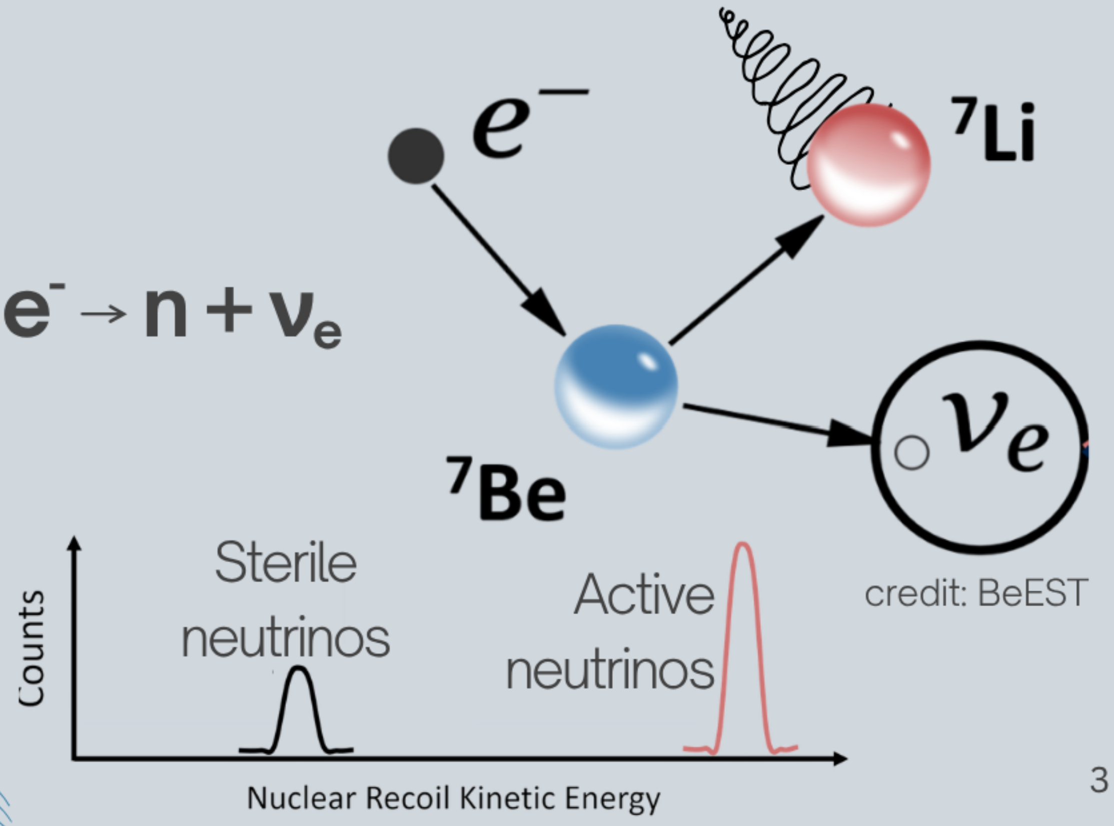


credit: BeEST

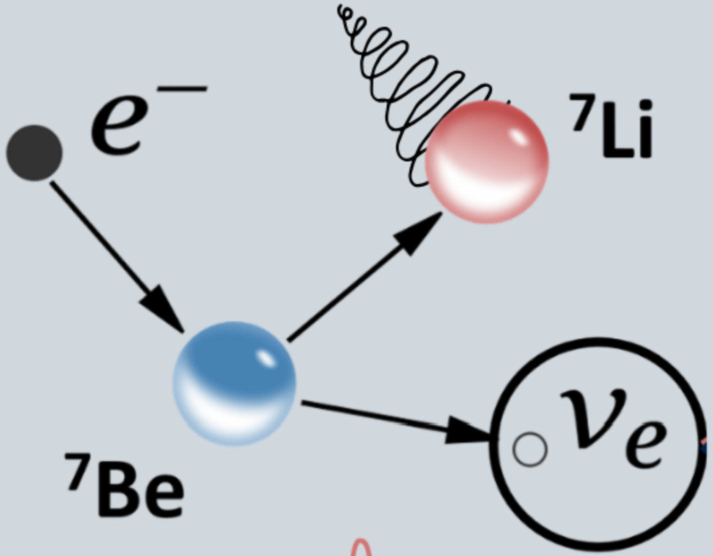
BeEST

Measuring nuclear recoils from electron capture in superconductors to detect sterile neutrinos

Problems:

1. Little control over depth
2. Damaged superconductors

$$p + e^- \rightarrow n + \nu_e$$



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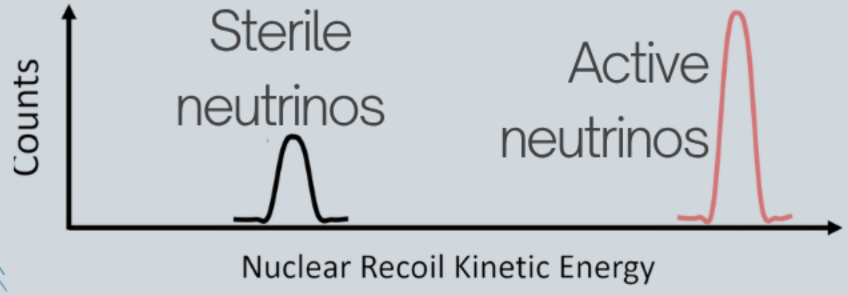
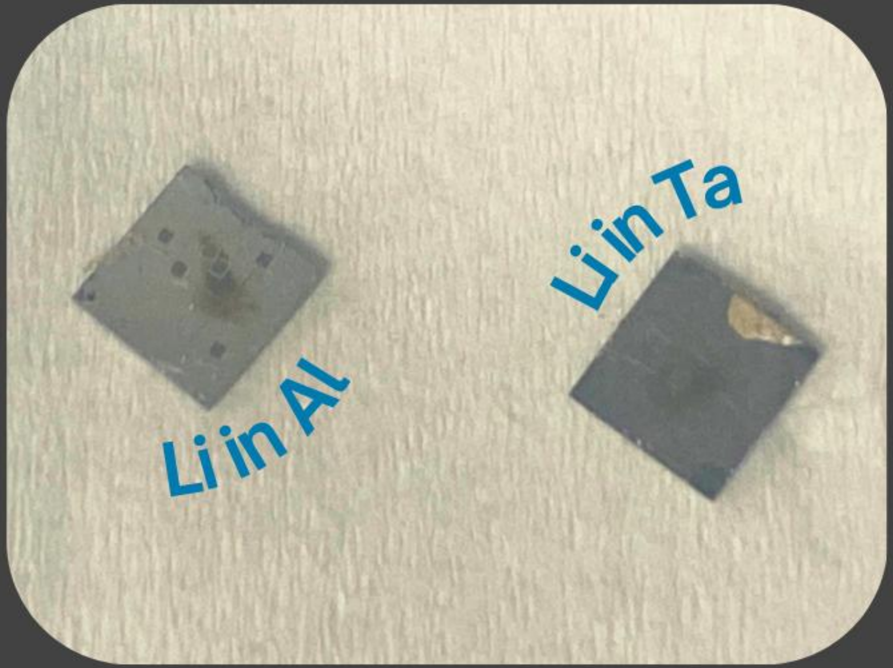
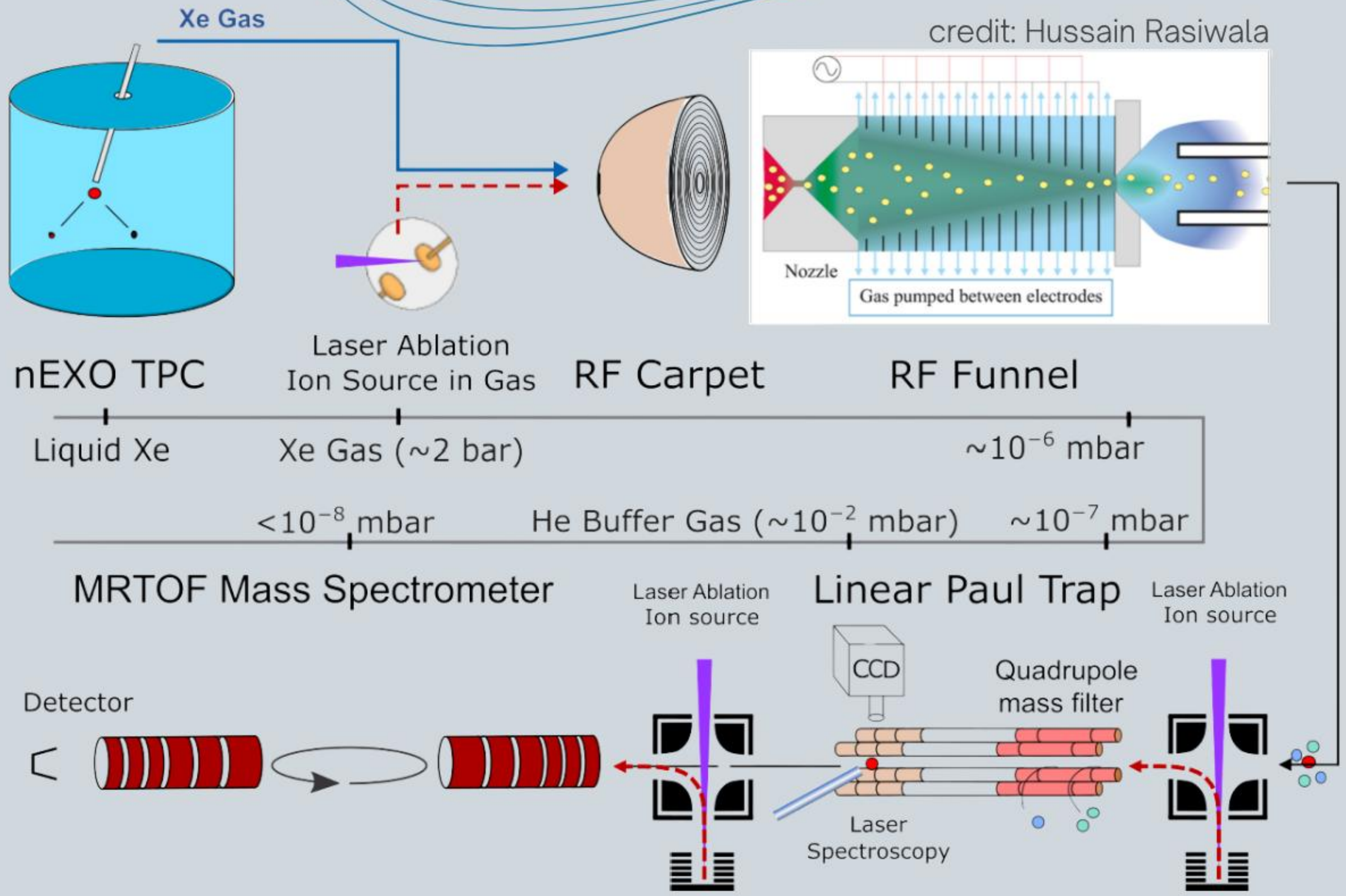


Objective

→ Proof of concept for low energy loading
→ Using Li implanted targets from TRIUMF



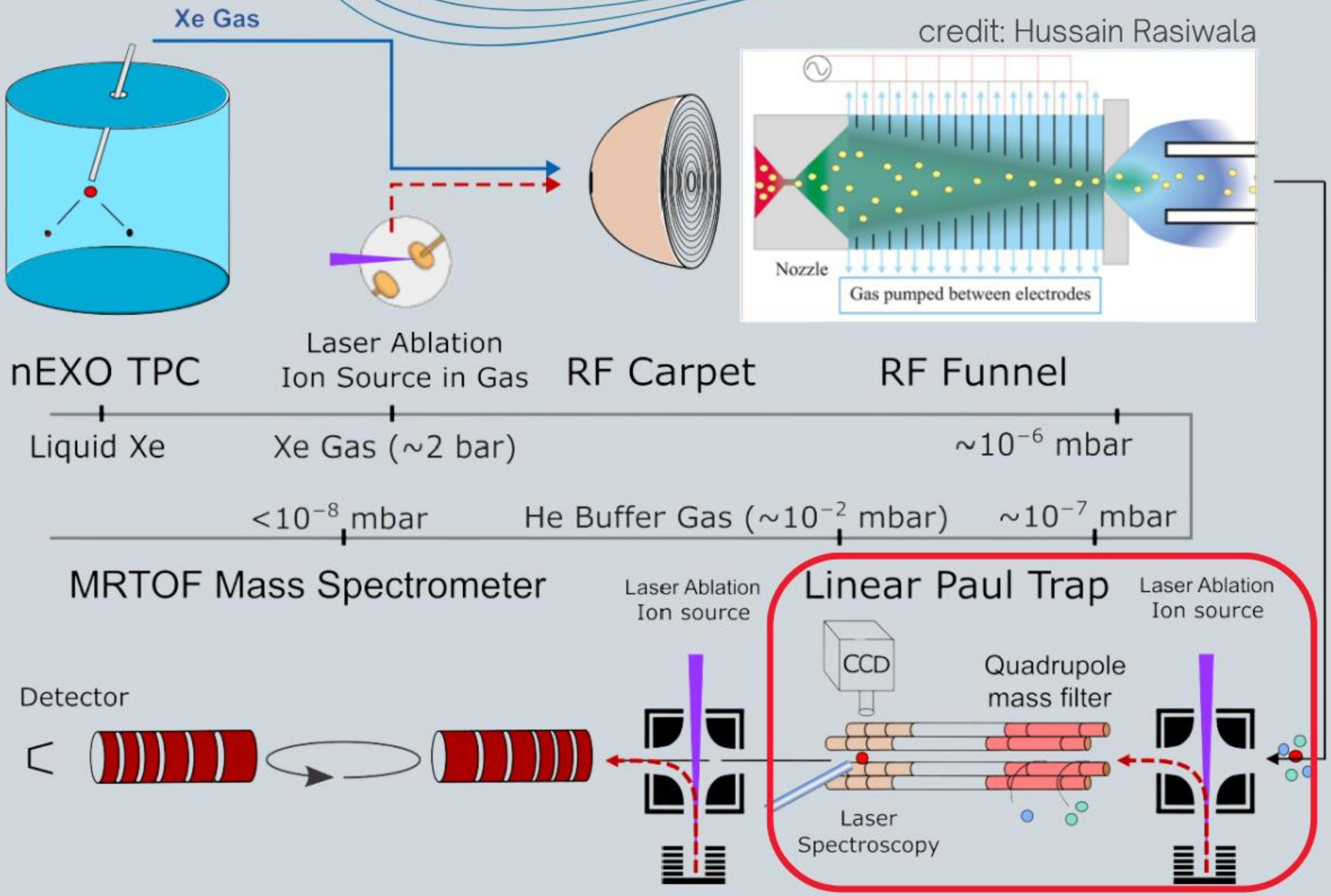


Existing Setup

Ba-Tagging

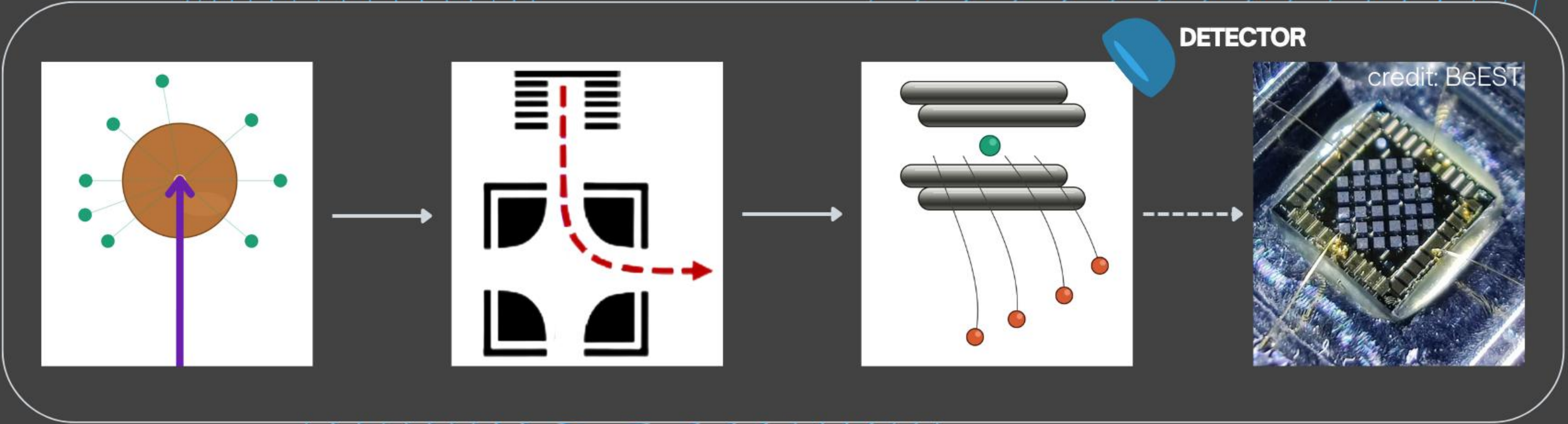
Existing Setup

Ba-Tagging



Ion Trajectory in Setup

ABLATION — BENDING — FILTERING - - - IMPLANTING



Ion Trajectory in Setup

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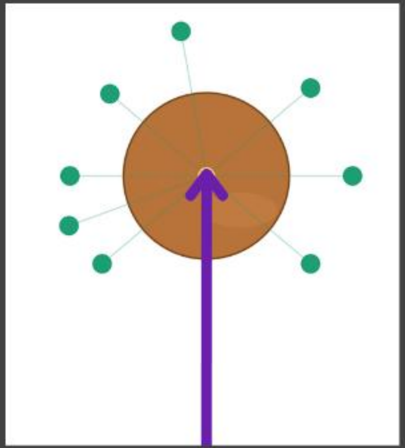
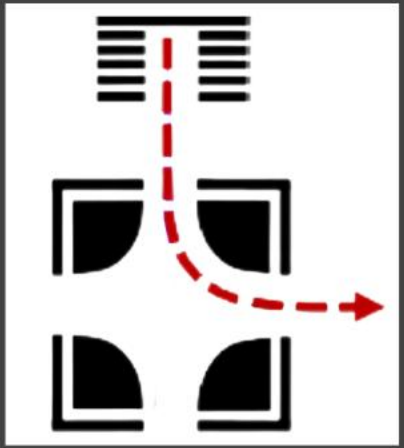
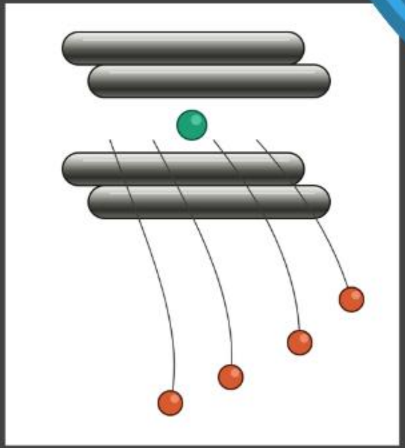
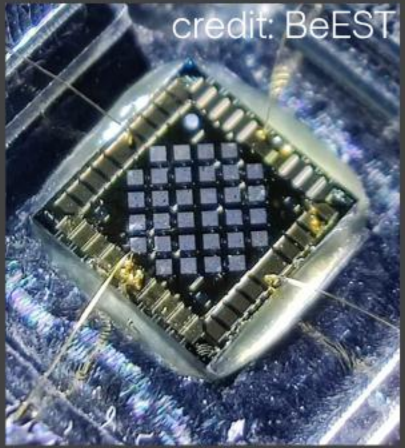


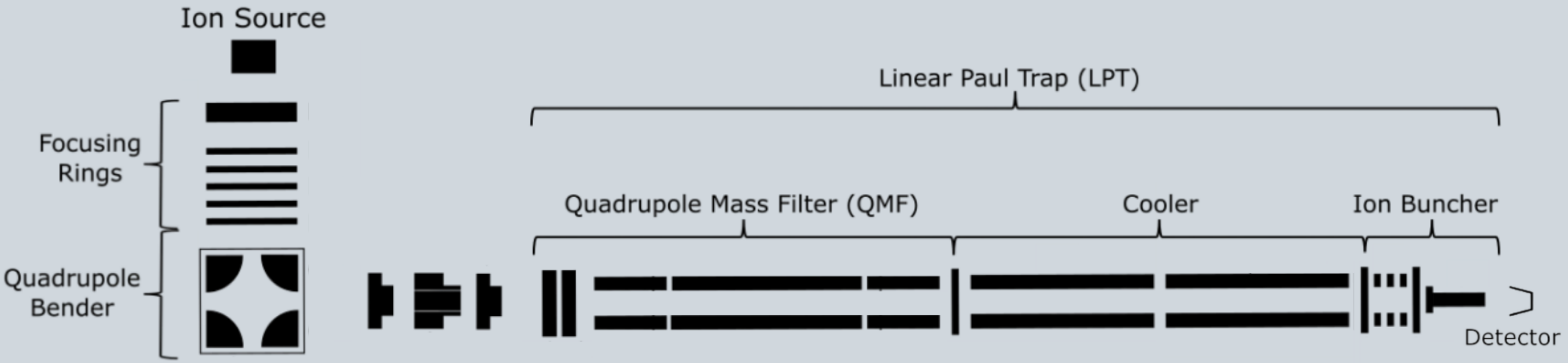




DETECTOR

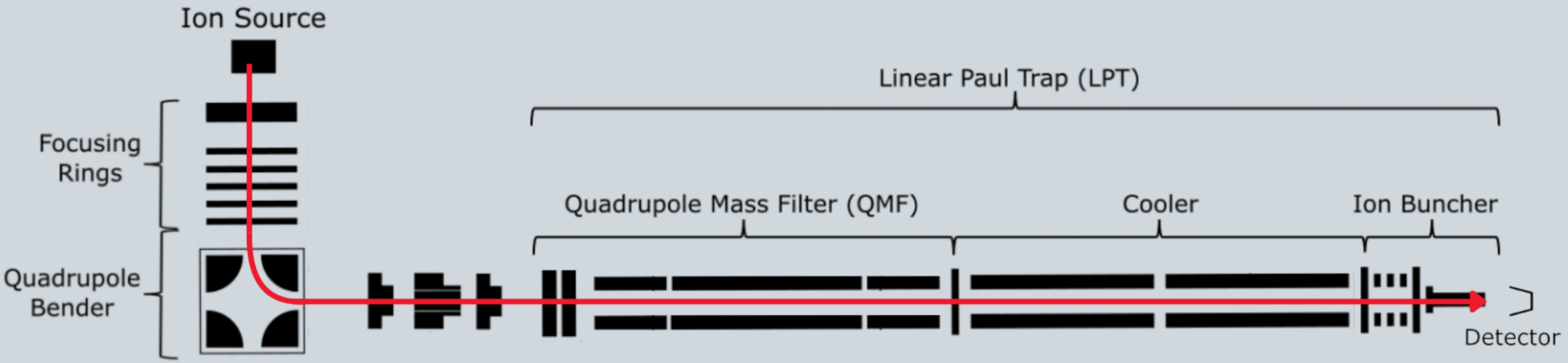


Electrode Configuration



credit: Amelia Remnant

Electrode Configuration



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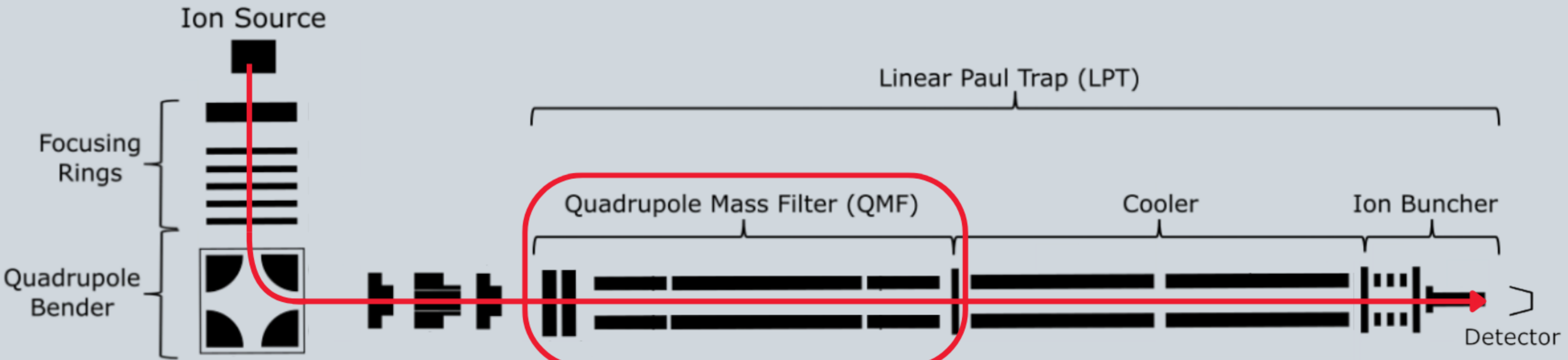


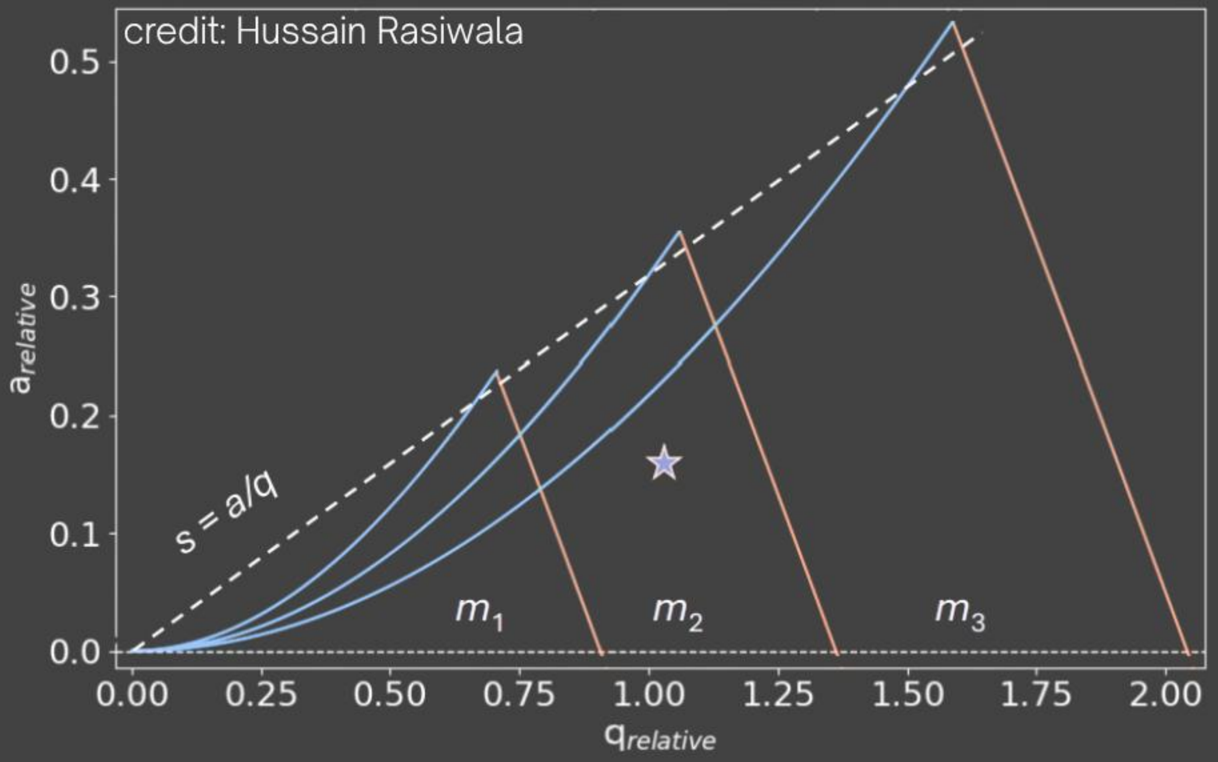
credit: Amelia Remnant

$$a_x = -a_y = -\frac{8QU}{mr_o^2\Omega^2}, \quad q_x = -q_y = \frac{4QV}{mr_o^2\Omega^2}, \quad \epsilon = \frac{\Omega t}{2}$$

Mathieu equations

$$\frac{d^2x}{d\epsilon^2} + (a_x - 2q_x \cos 2\epsilon)x = 0,$$
$$\frac{d^2y}{d\epsilon^2} + (a_y - 2q_y \cos 2\epsilon)y = 0,$$

Stability parameters



Quadrupole Mass Filter

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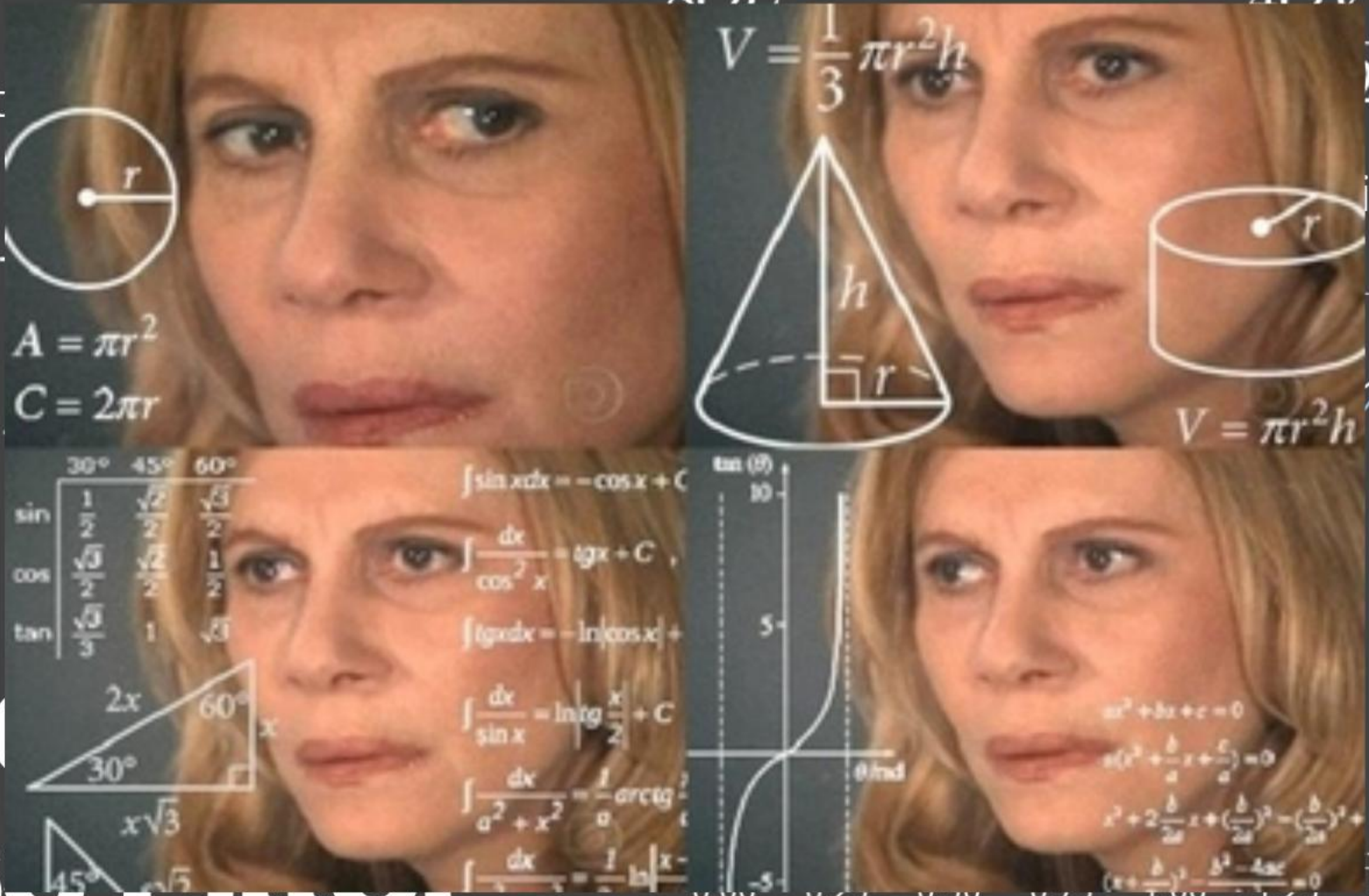
Mathieu equat

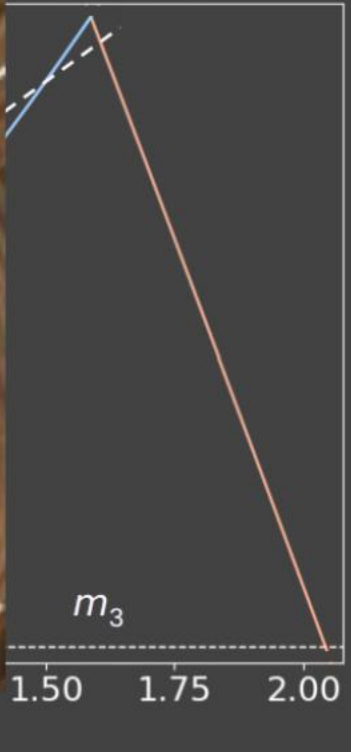
$$\epsilon = \frac{\Omega t}{2}$$

ity parameters

$$\frac{d^2x}{d\epsilon^2} + (a_x$$

$$\frac{d^2y}{d\epsilon^2} + (a_y$$



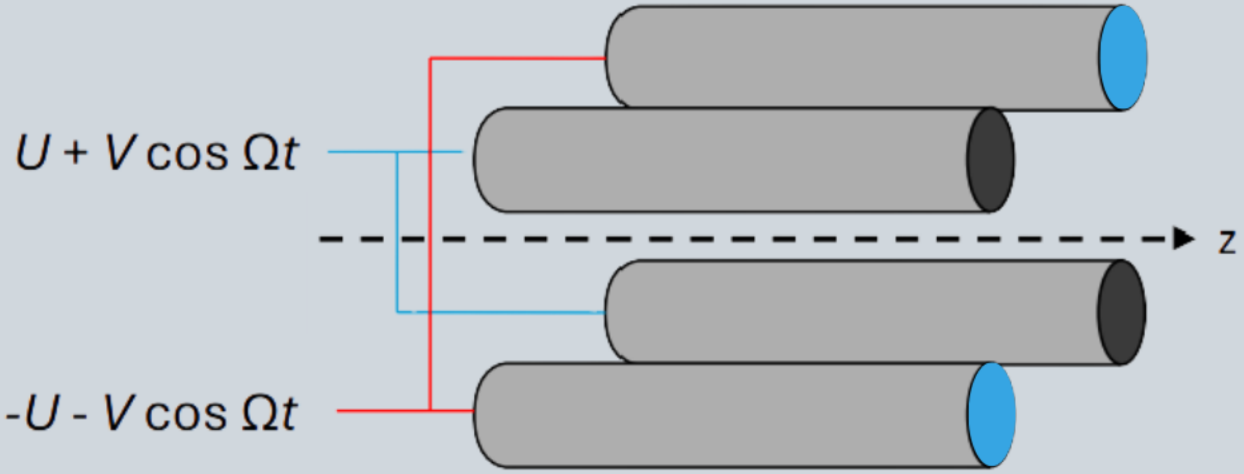


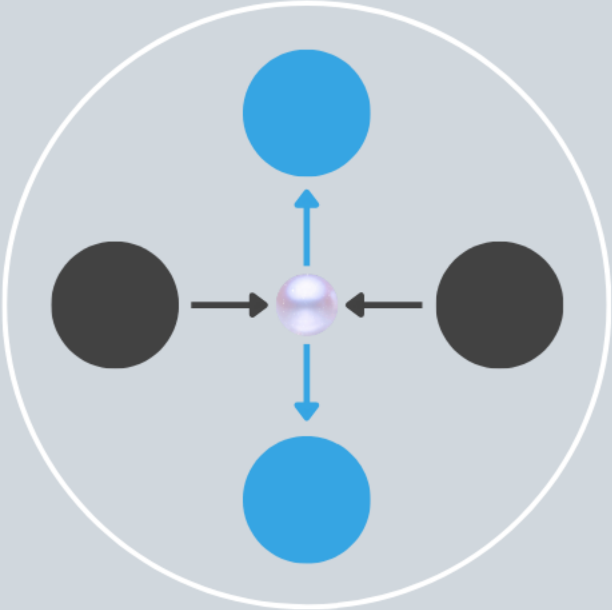
Quad… Mass Fitter

Quadrupole Mass Filter

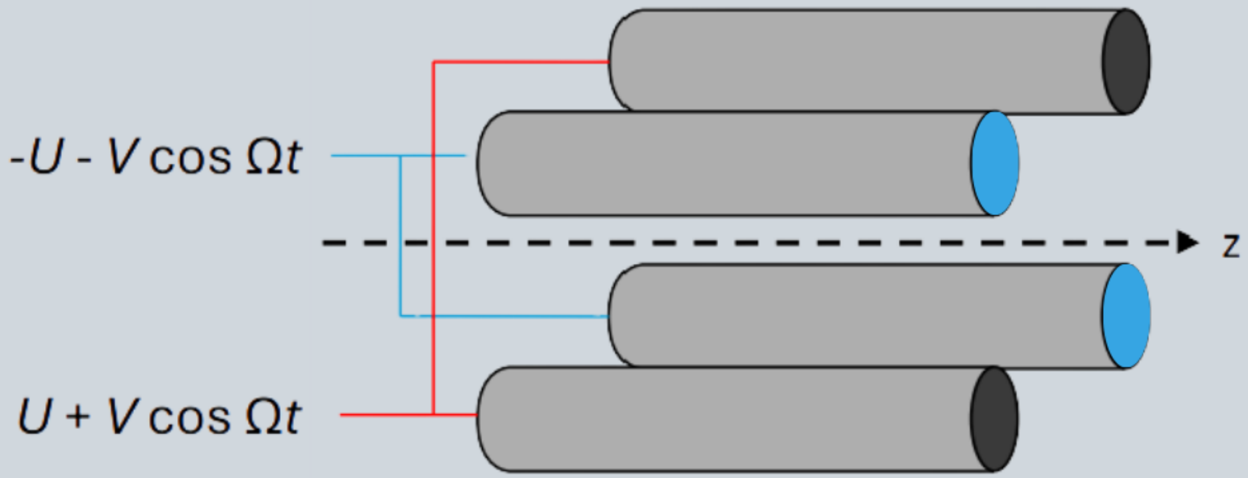
Intuitive Explanation™

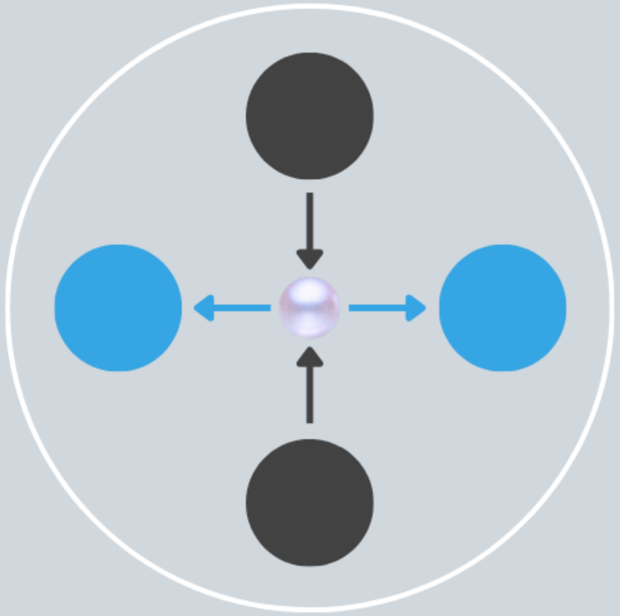
Quadrupole Mass Filter



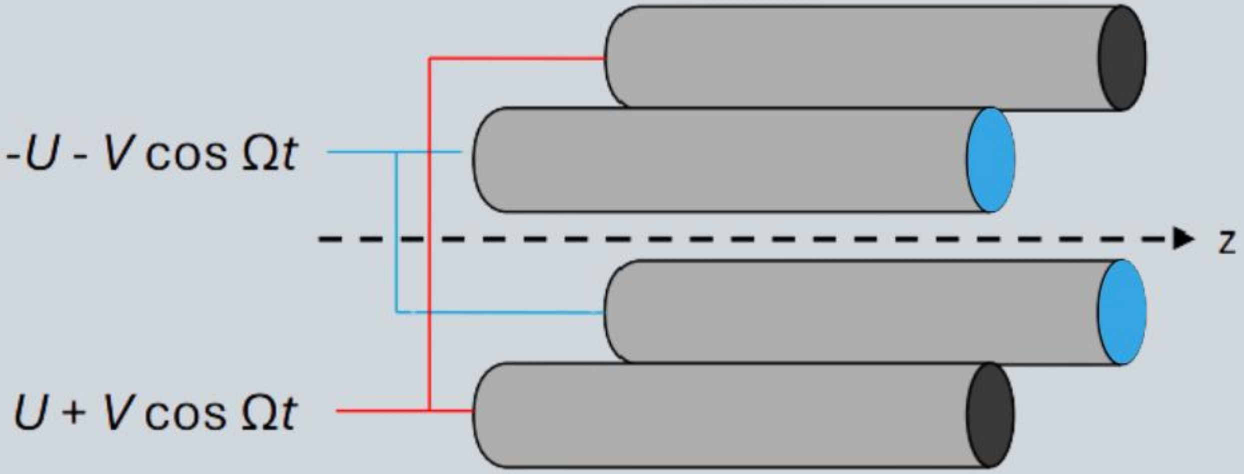


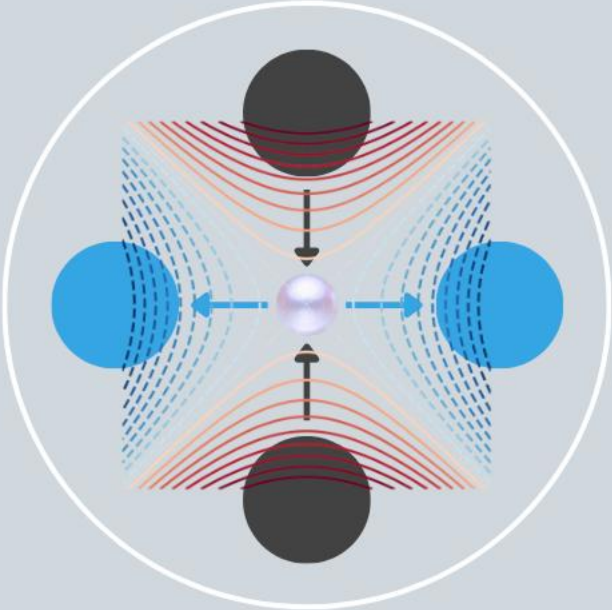
Quadrupole Mass Filter



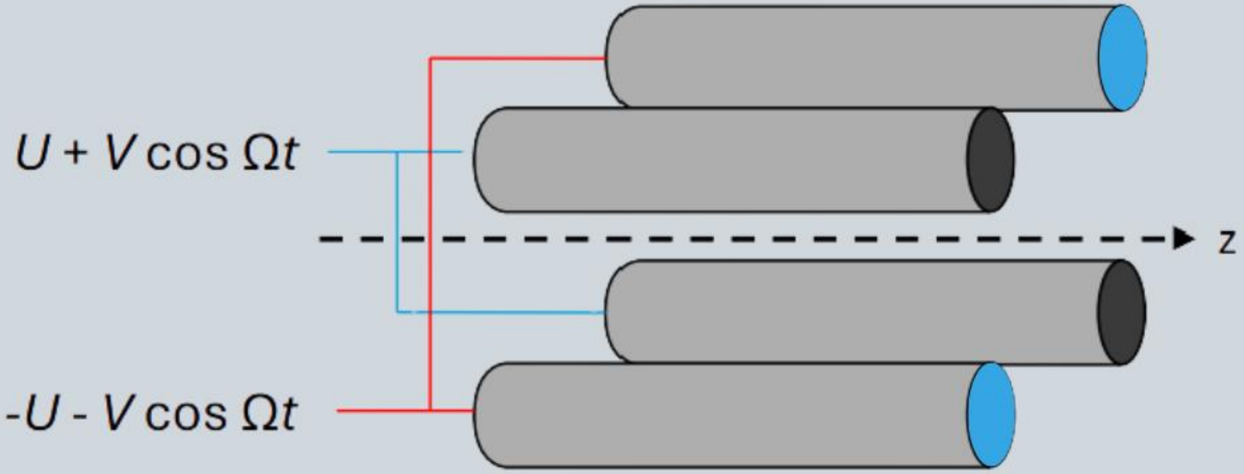


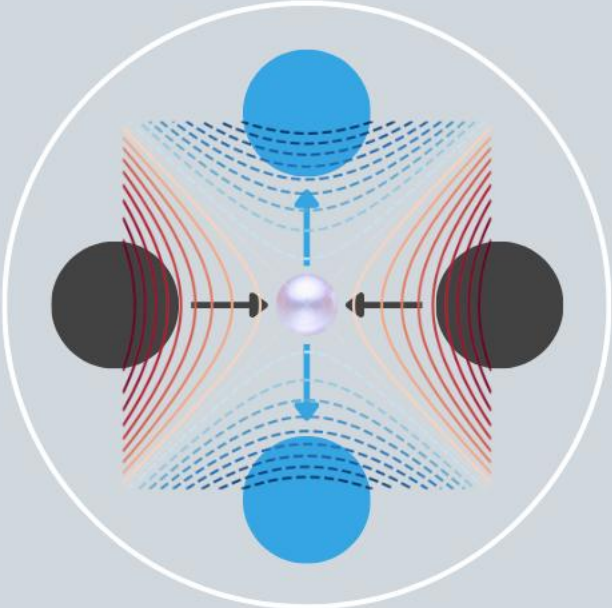
Quadrupole Mass Filter





Quadrupole Mass Filter





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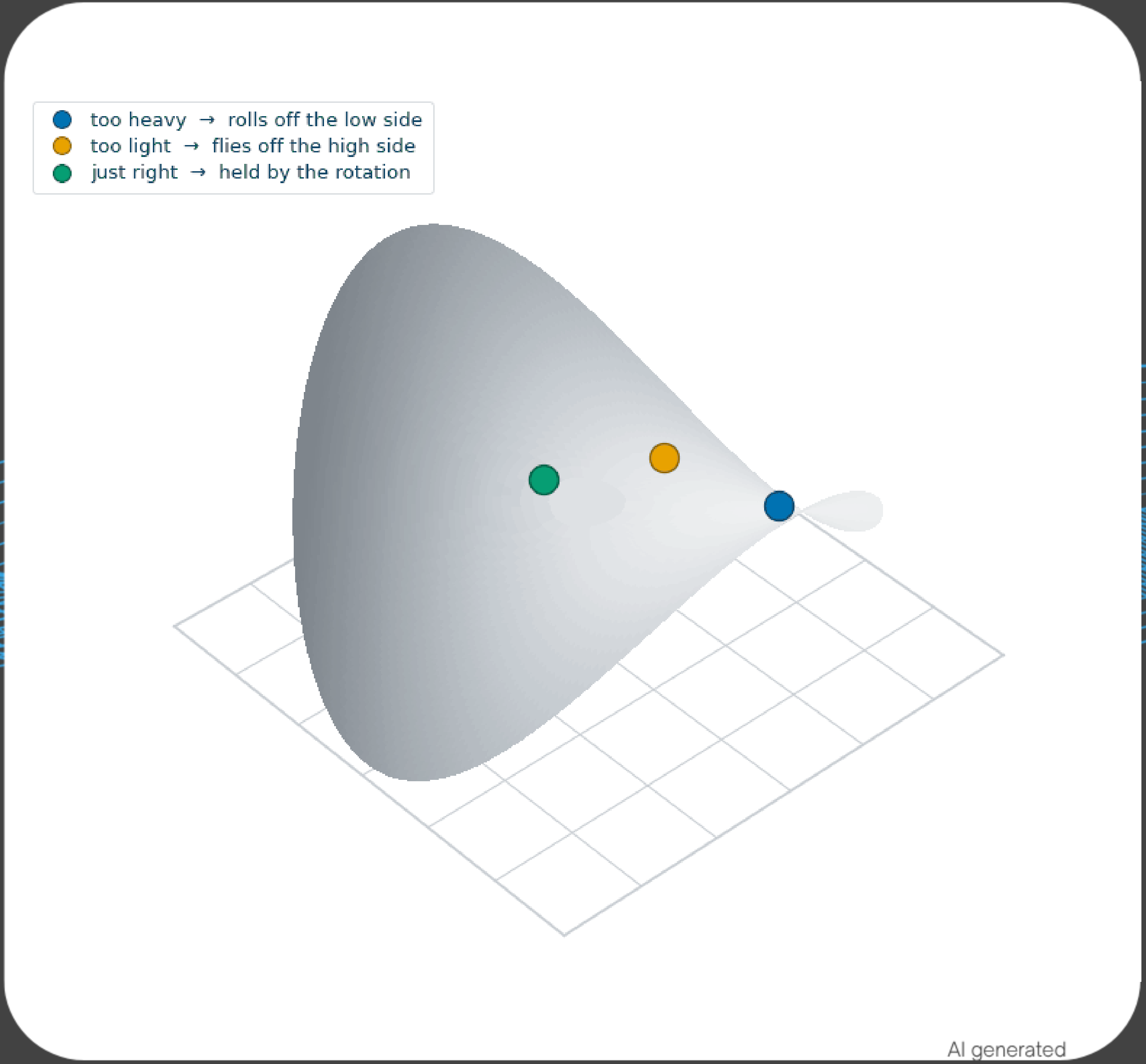
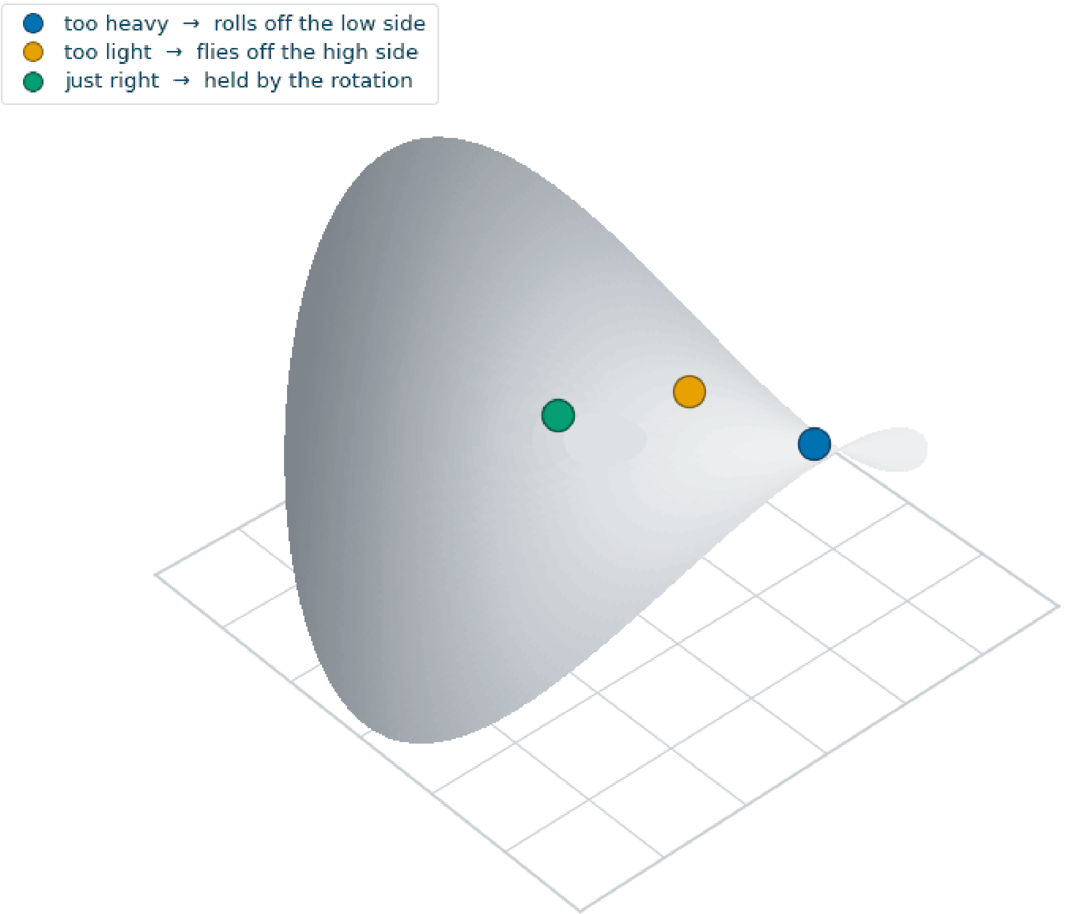


What settings does Li need?

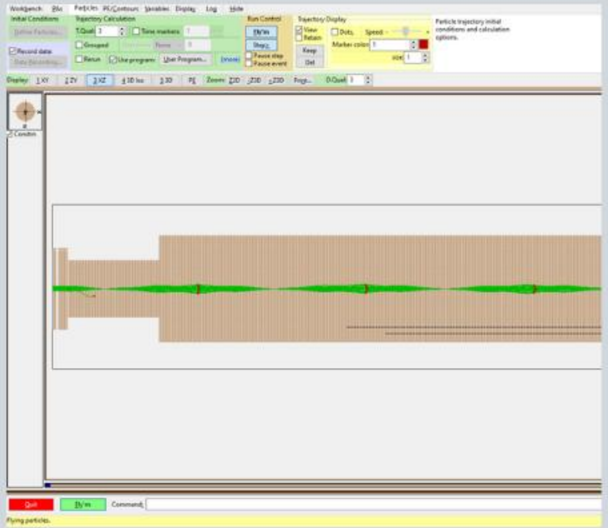


AI generated

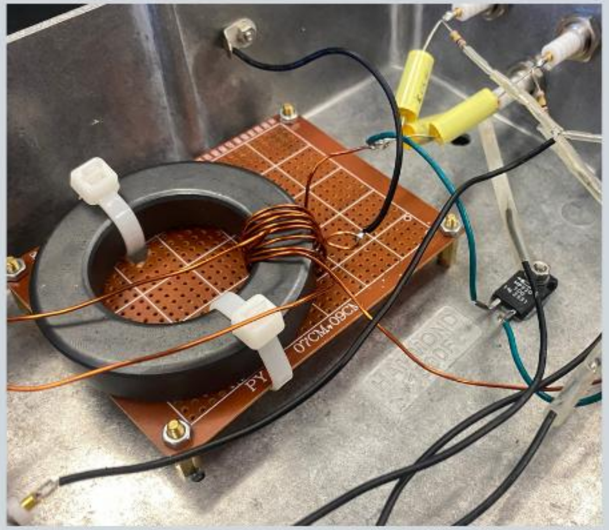
Quadrupole Mass Filter

Method

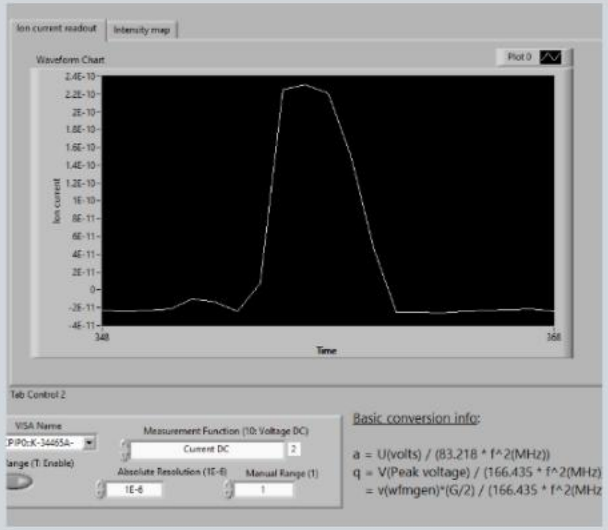
SIMULATIONS



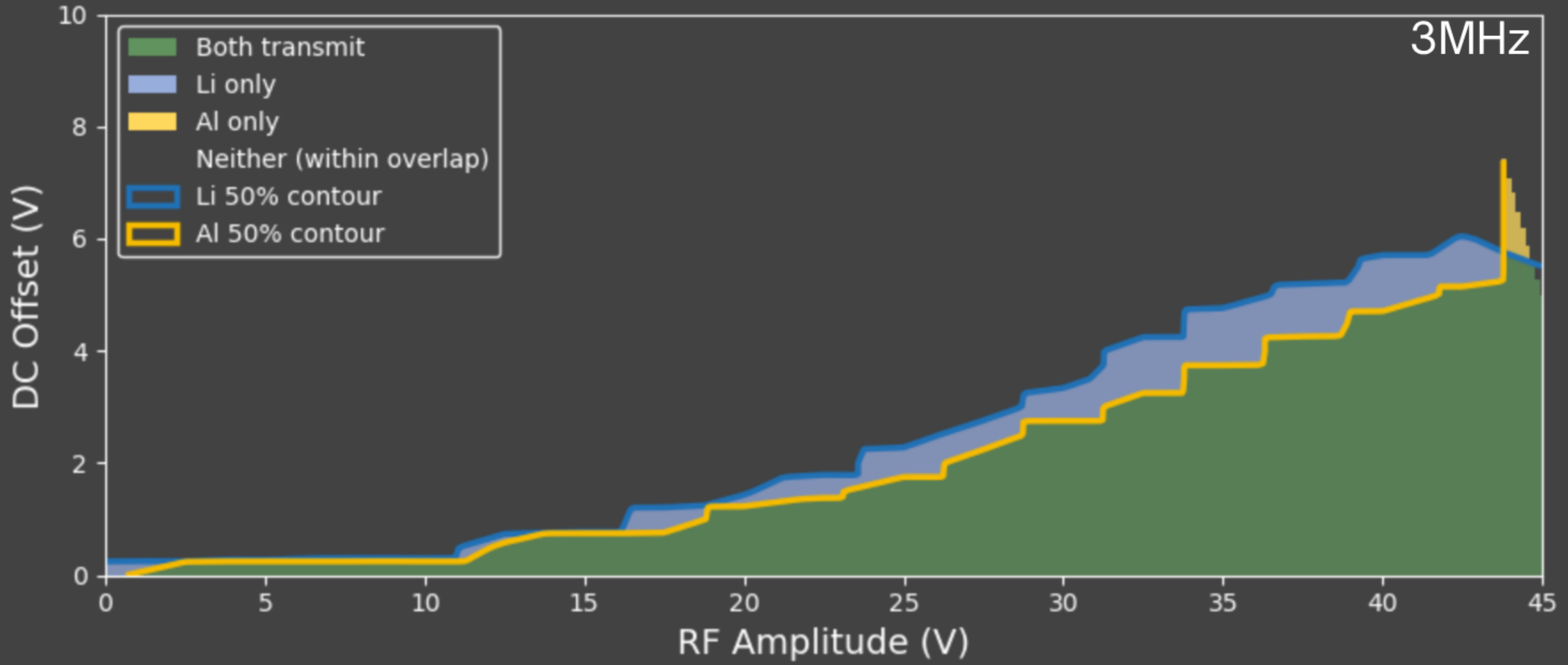
ELECTRONICS



TESTING



Simulations



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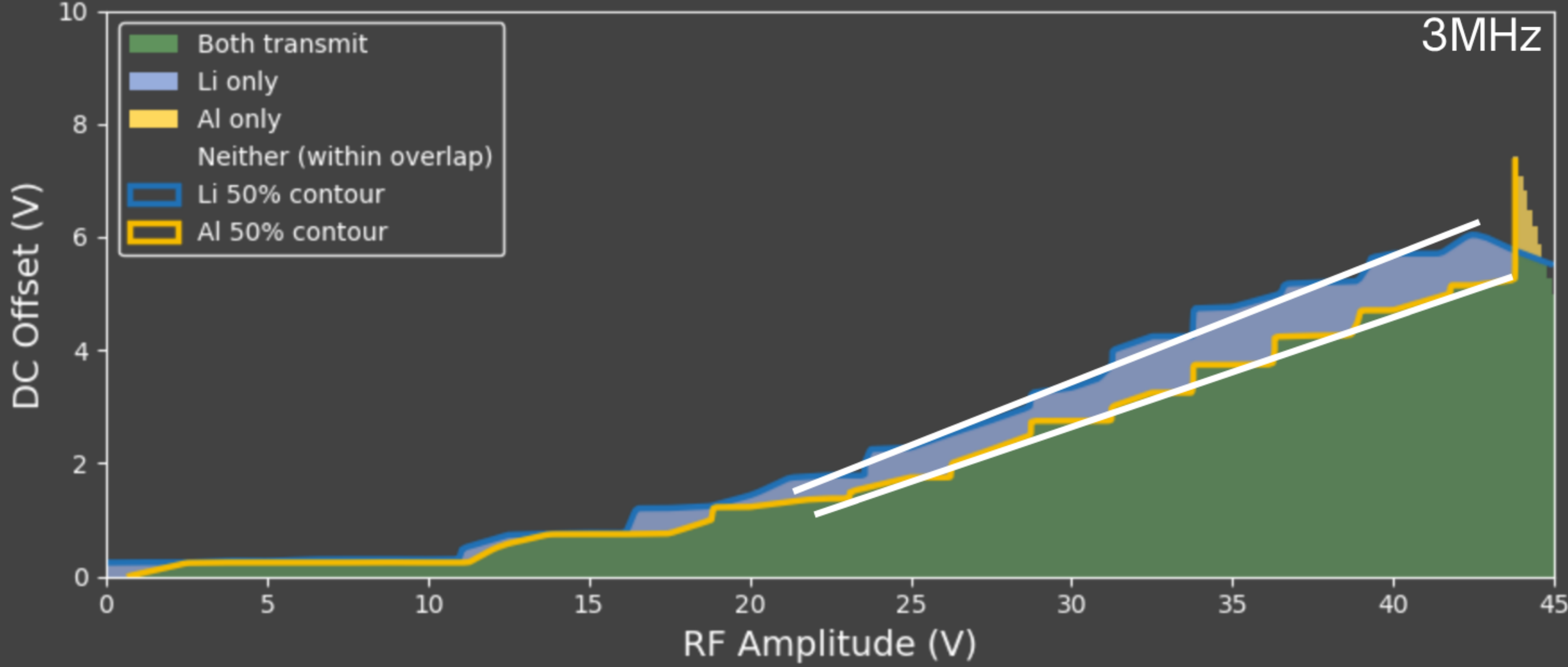

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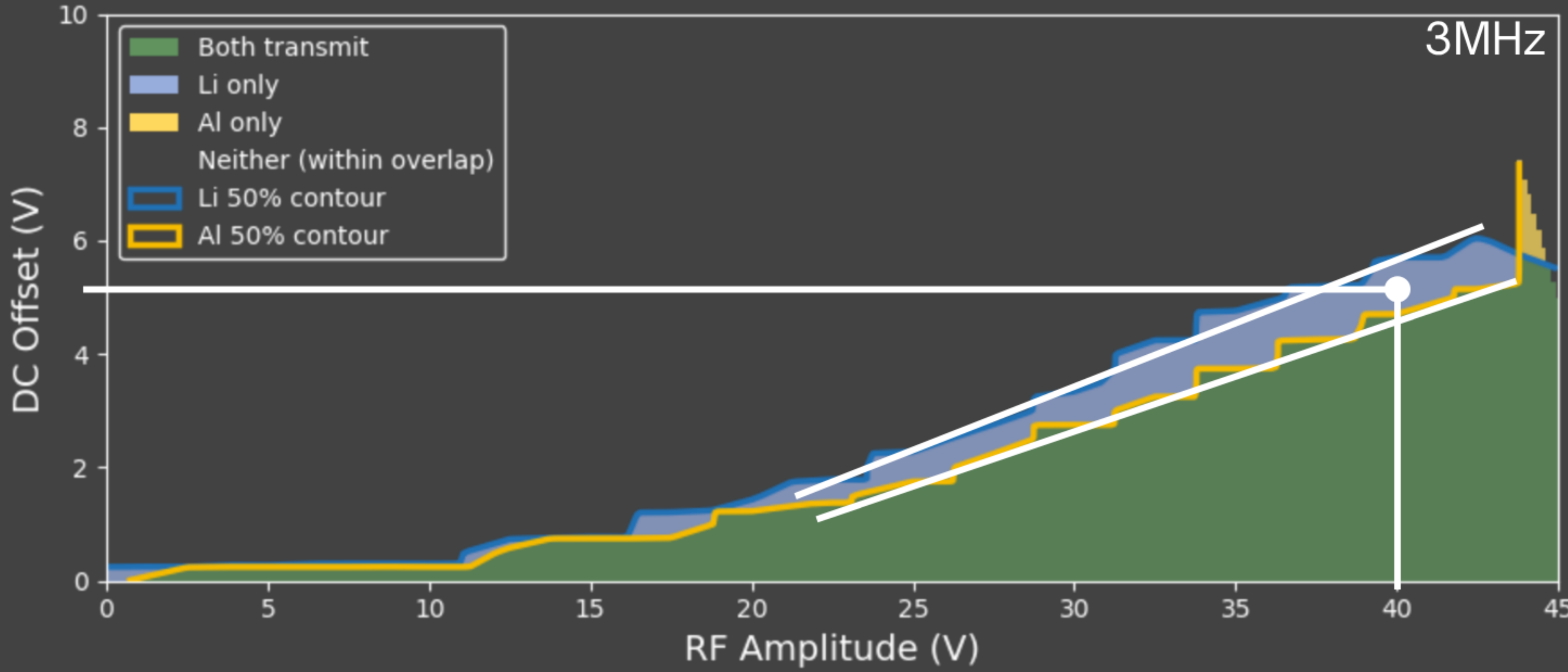
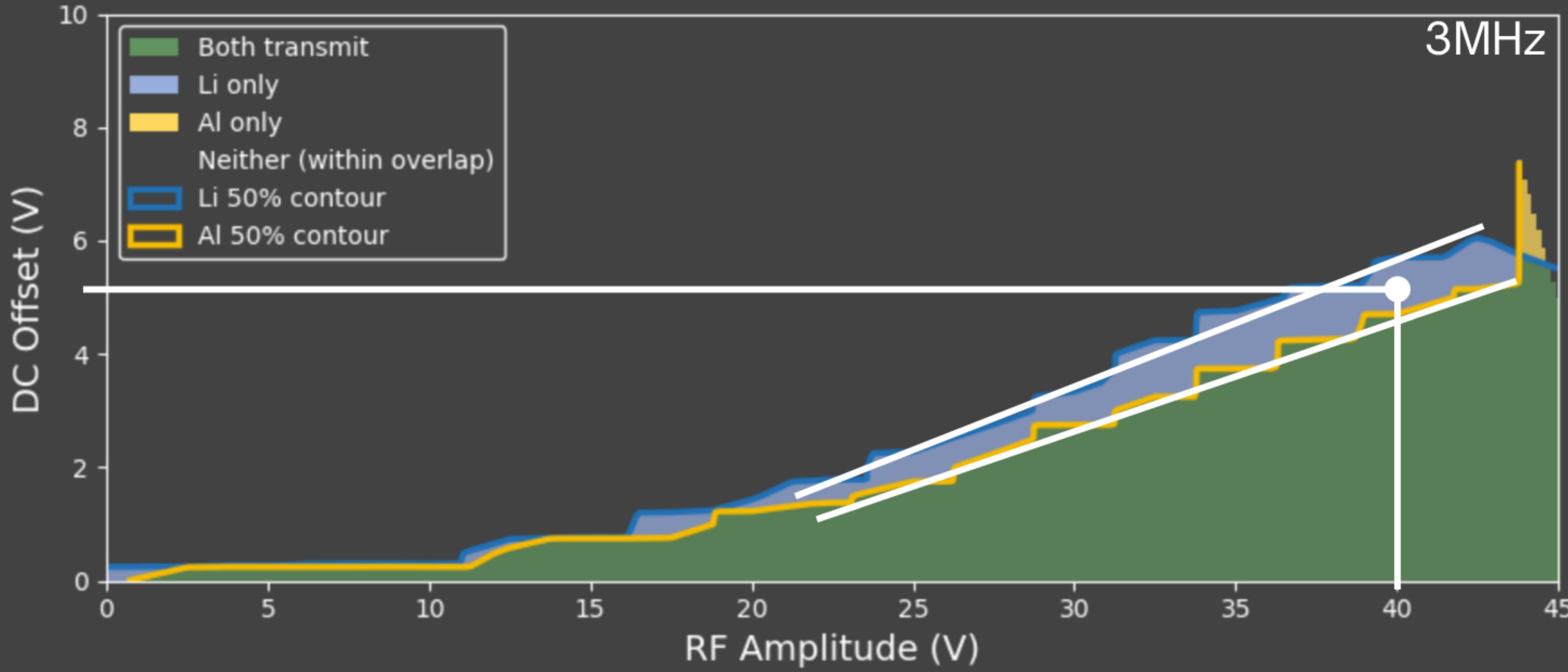
Simulations



Simulations ✅



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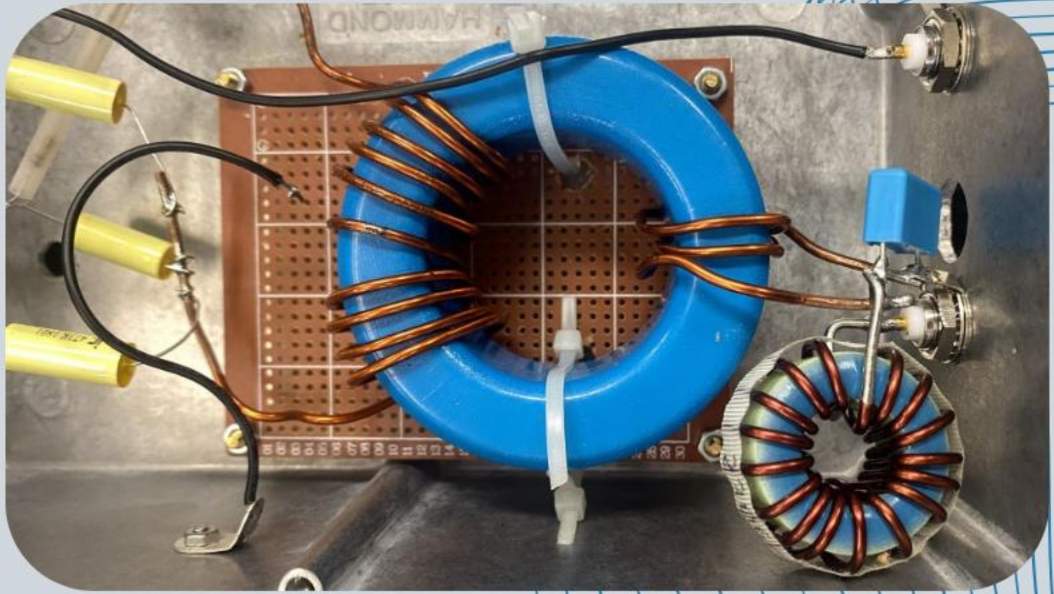
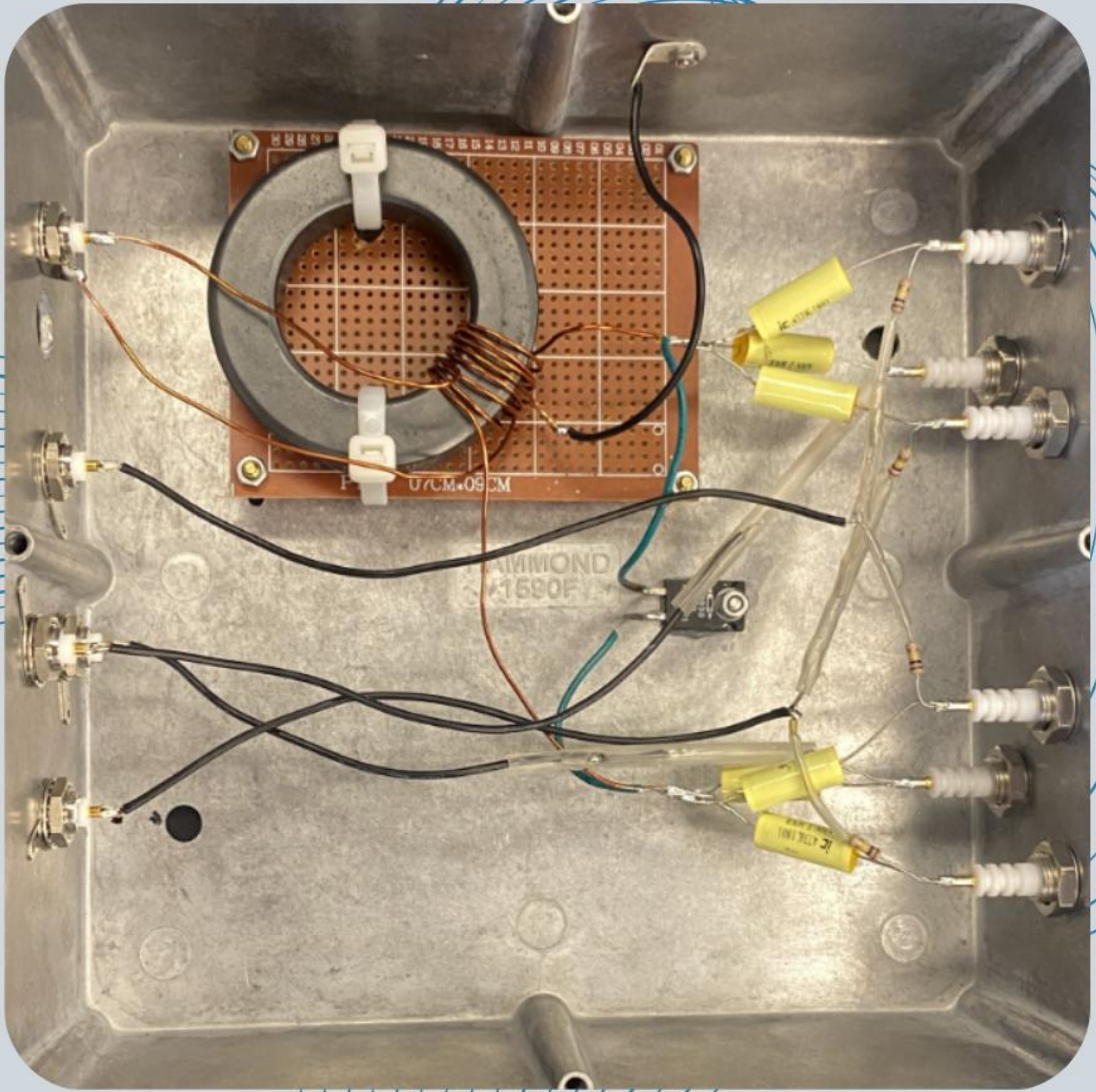
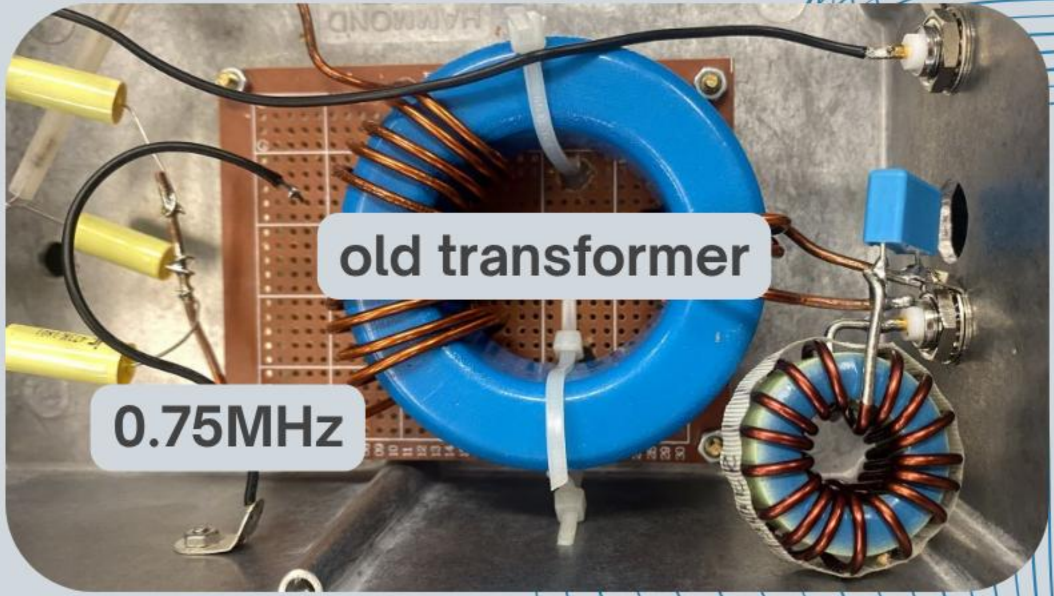
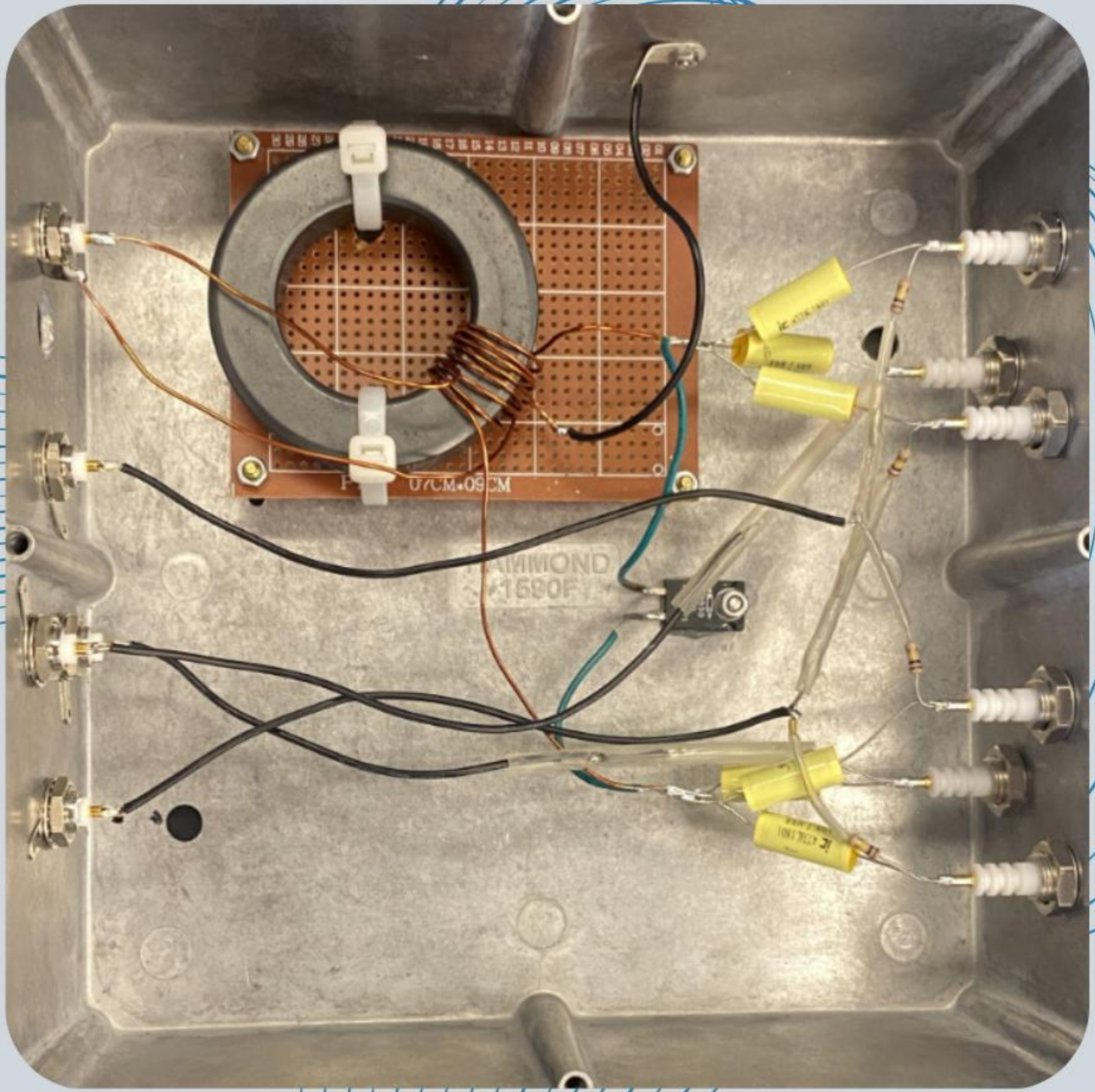
Electronics Upgrade





Electronics Upgrade





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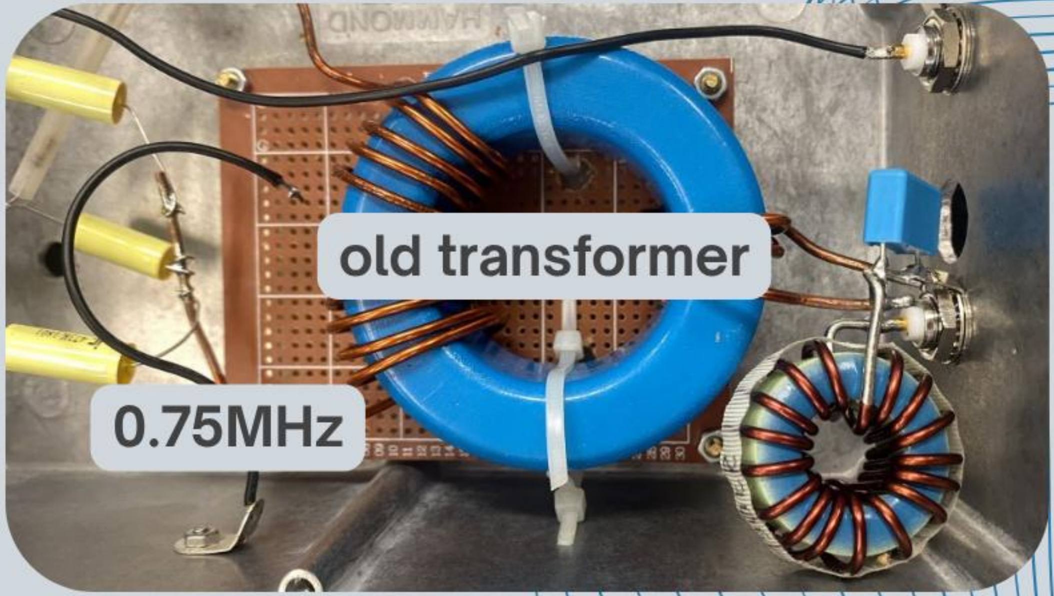

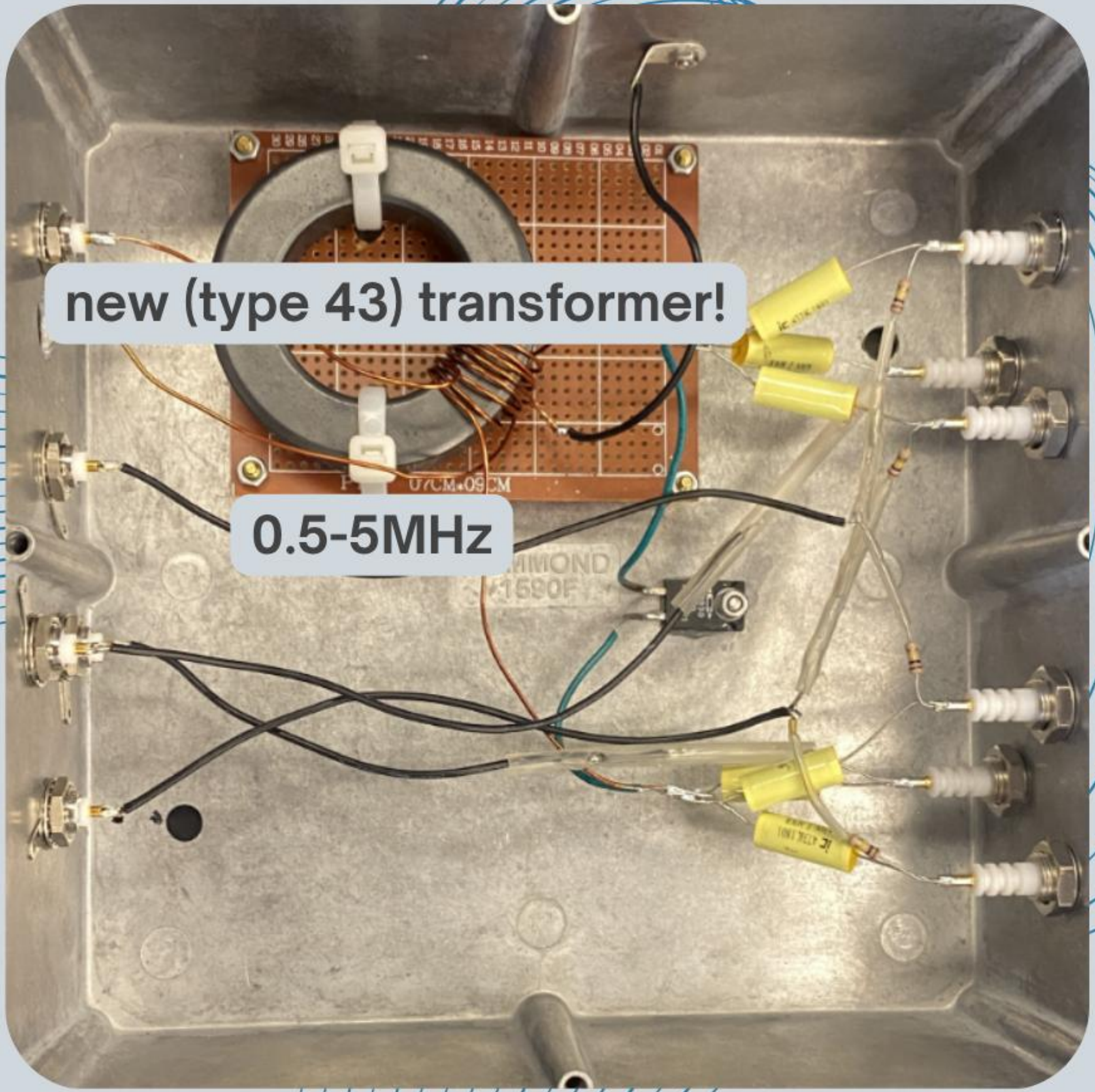

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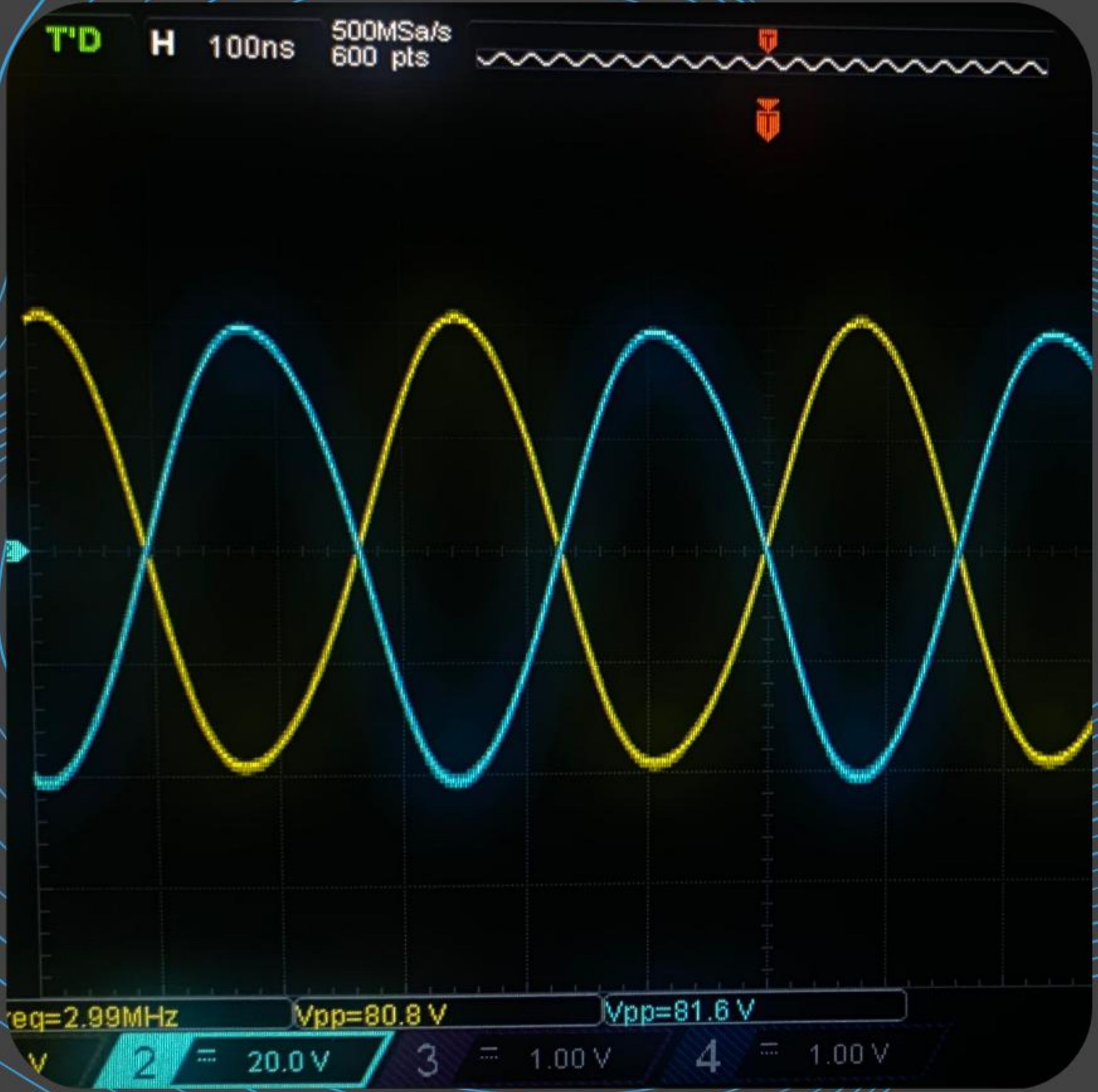
Electronics Upgrade



→ Balanced
→ In phase
→ No distortion

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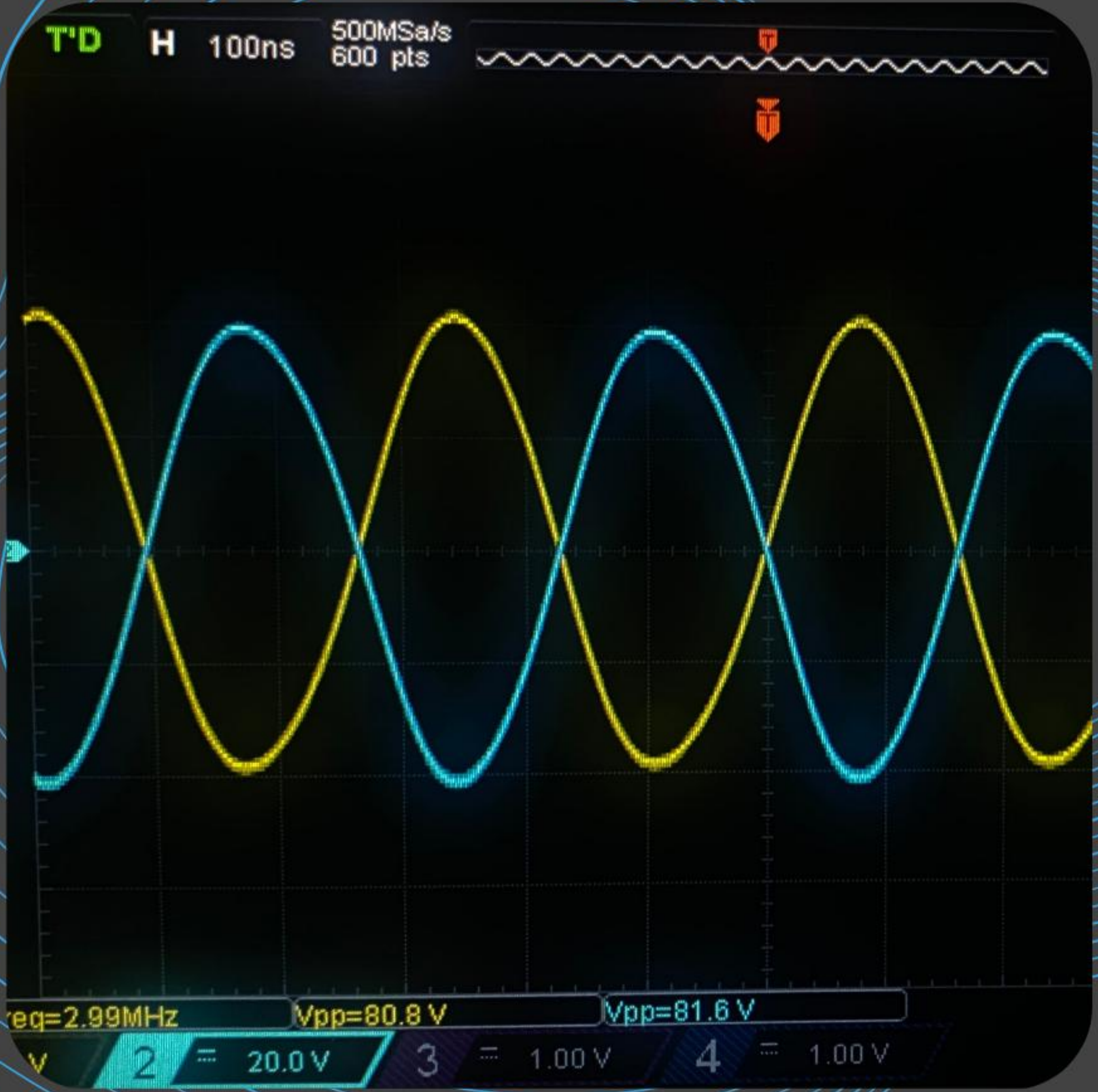
Electronics Upgrade ✅



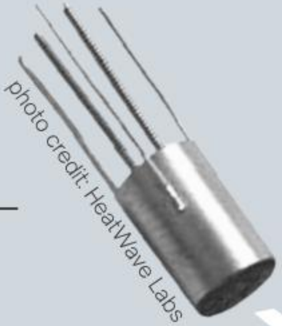
→ Balanced
→ In phase
→ No distortion

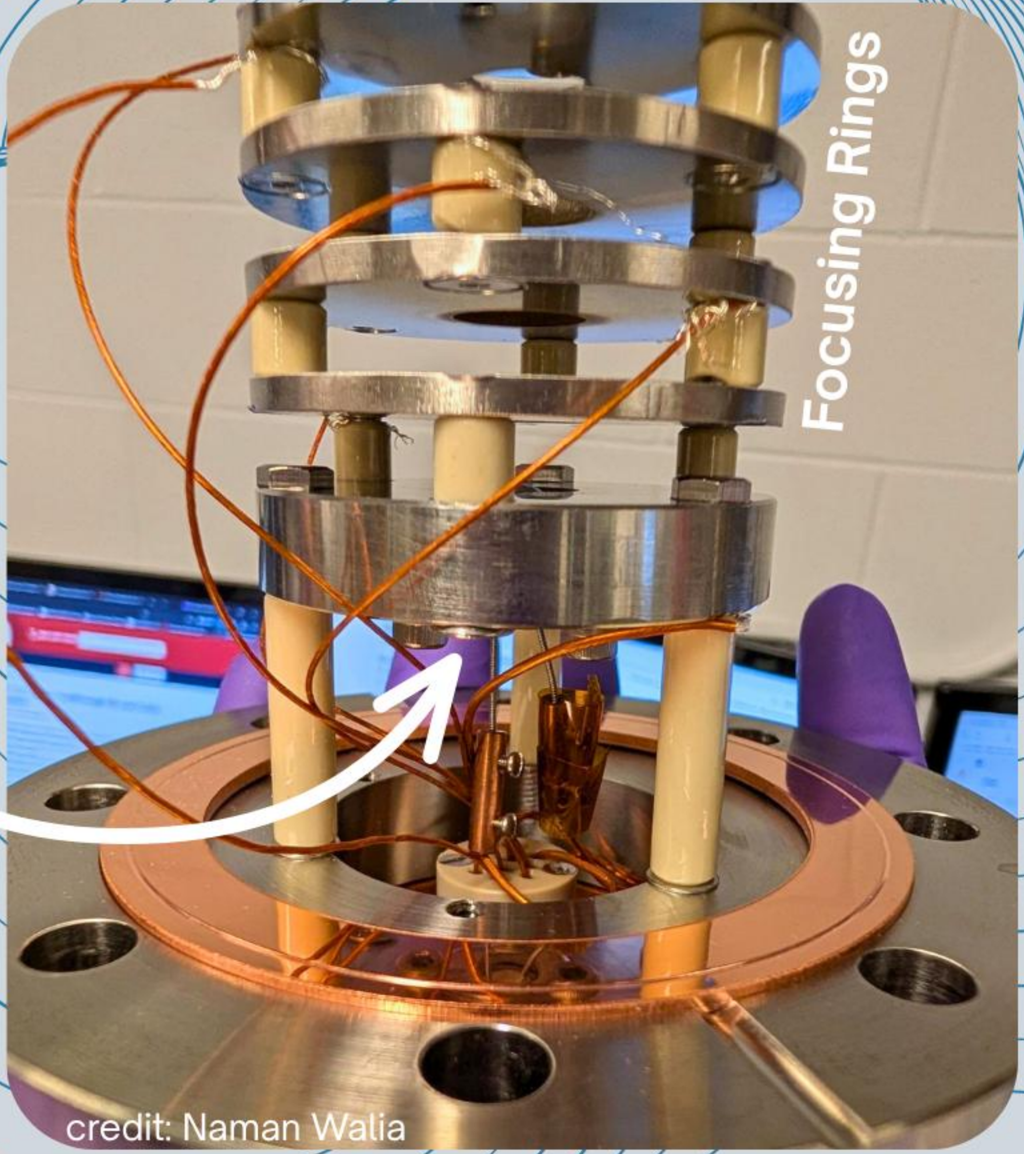
Testing

New Source
→ Mixed Alkali Thermal Source

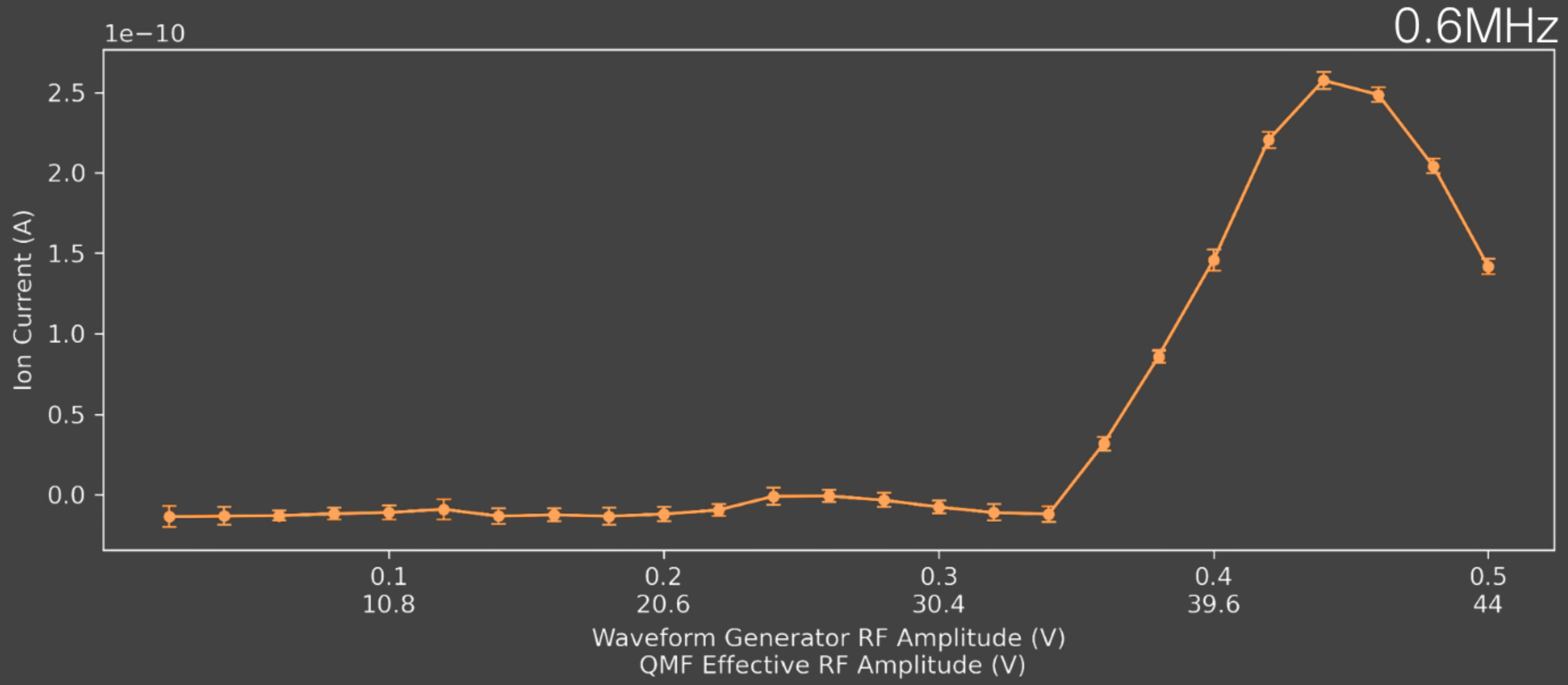
Tuning the Bender
→ 70% of source ions reach QMF

Tuning the QMF
→ Identifying distinct ion masses

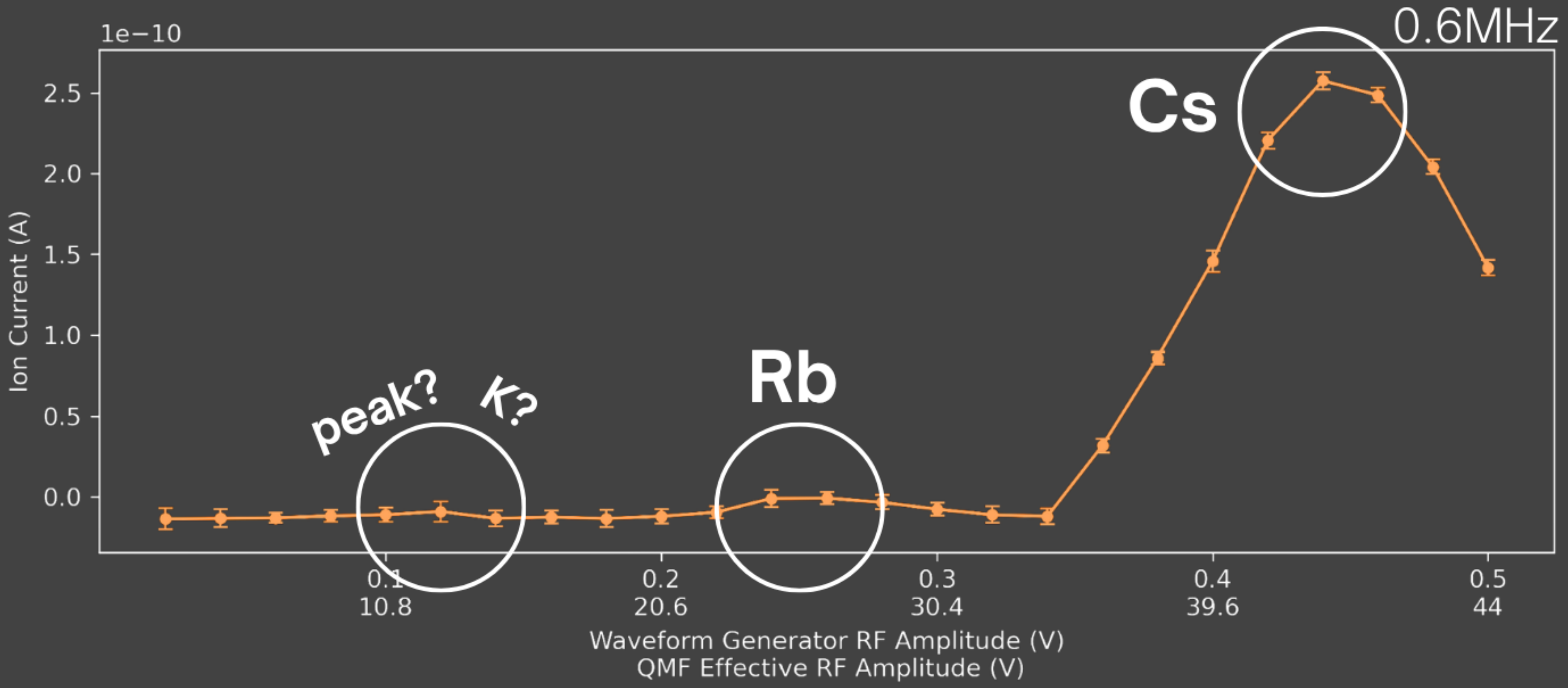




QMF Results


0.6MHz
1e−10
2.5
2.0
1.5
1.0
0.5
0.0
Ion Current (A)
0.1
10.8
0.2
20.6
0.3
30.4
0.4
39.6
0.5
44
Waveform Generator RF Amplitude (V)
QMF Effective RF Amplitude (V)

QMF Results



0.6MHz
1e−10
Ion Current (A)
2.5
2.0
1.5
1.0
0.5
0.0
Cs
Rb
peak?
K?
0.1
10.8
0.2
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Waveform Generator RF Amplitude (V)
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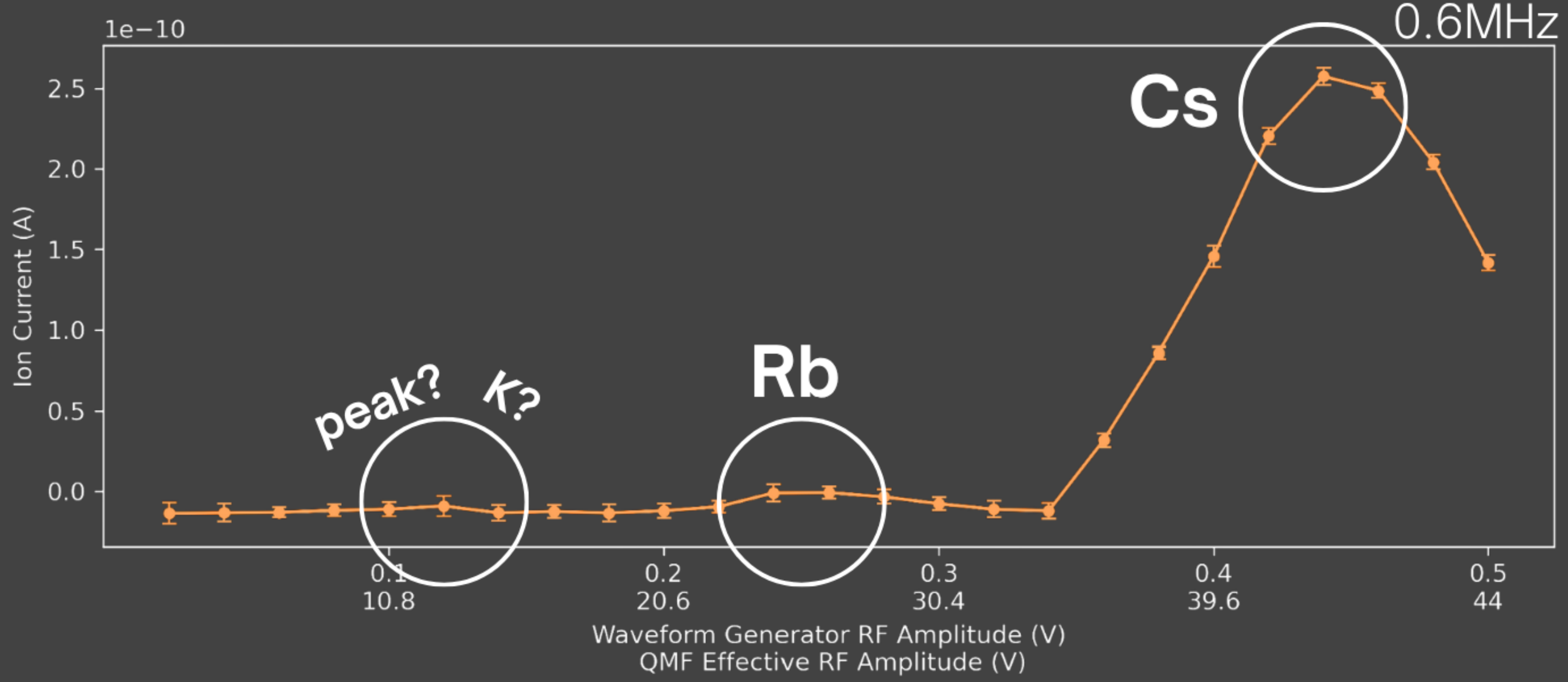
QMF Results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Waveform Generator RF Amplitude (V)
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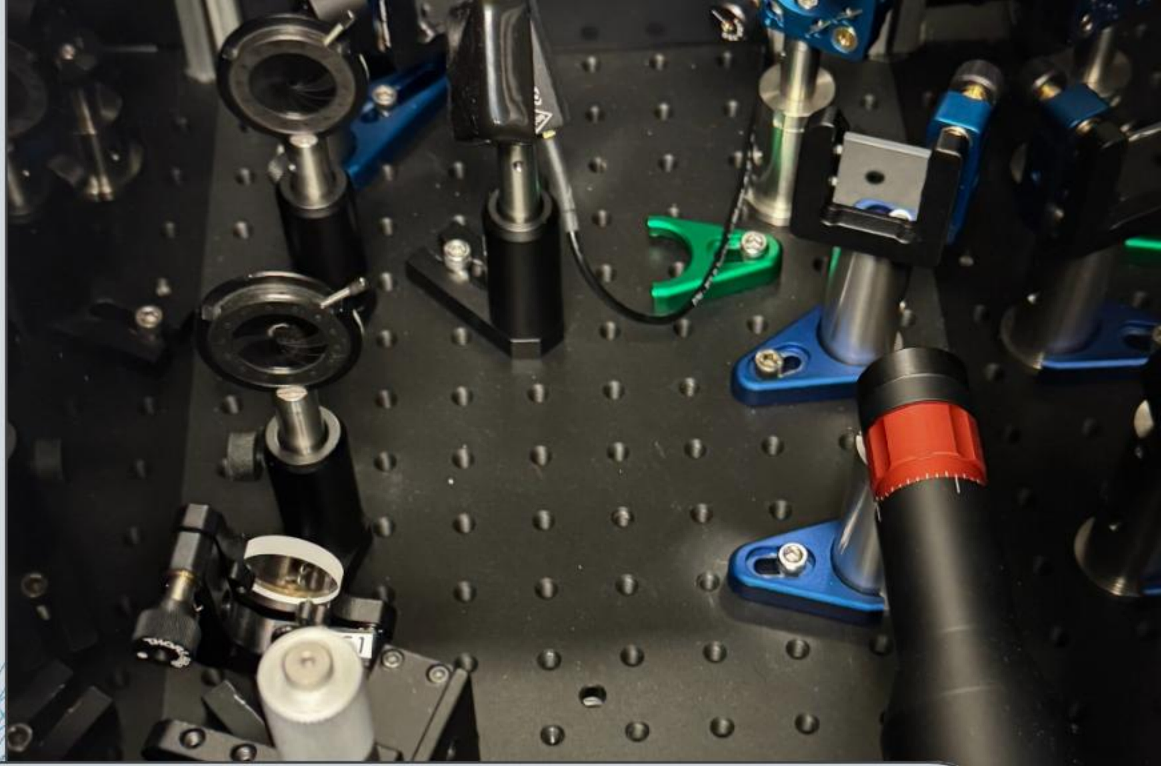
Conclusion

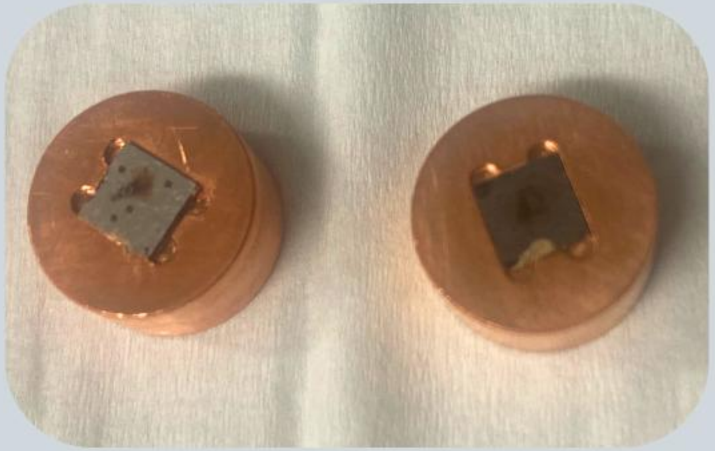


Summary

✓ Transmission simulations
✓ RF electronics
! (some) Mass resolving power

Next Steps

→ Further tuning
→ Recondition
laser ablation



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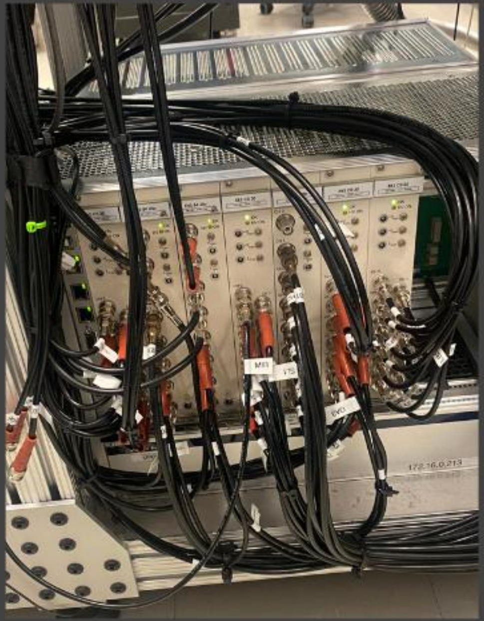
Presented by :
Justine Thebault-Weiser

Thank You

justine.thebault-weiser@mail.mcgill.ca



Thomas Brunner · Hussain Rasiwala · Eamon Egan · Naman Walia · Iskender Isikbay · Frederic Girard · Ethan Coulthard
CINP & the BvL group