The cleaning, assembling, and testing of a prototype Cylindrical open-ended Penning trap

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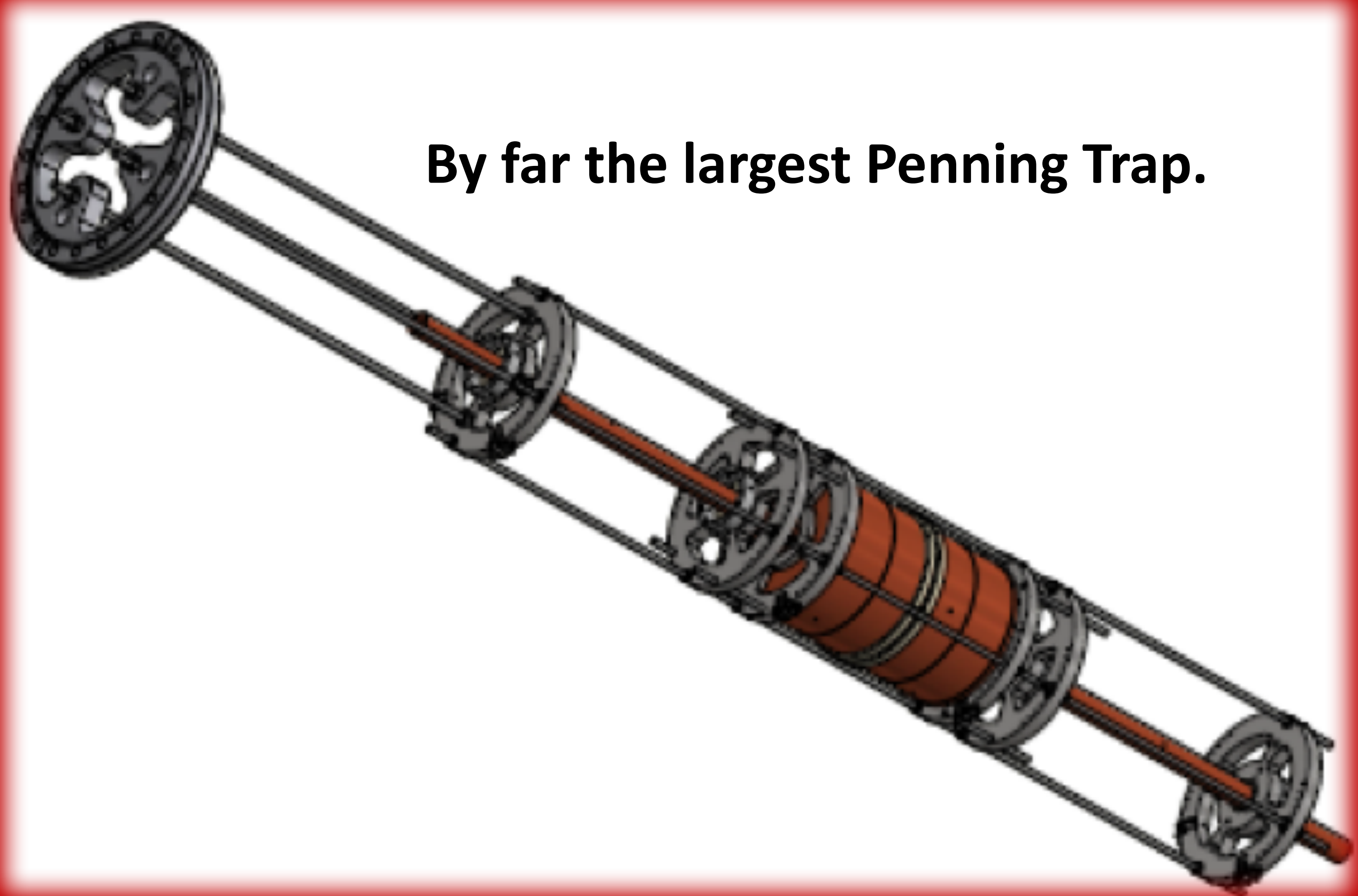
Outline

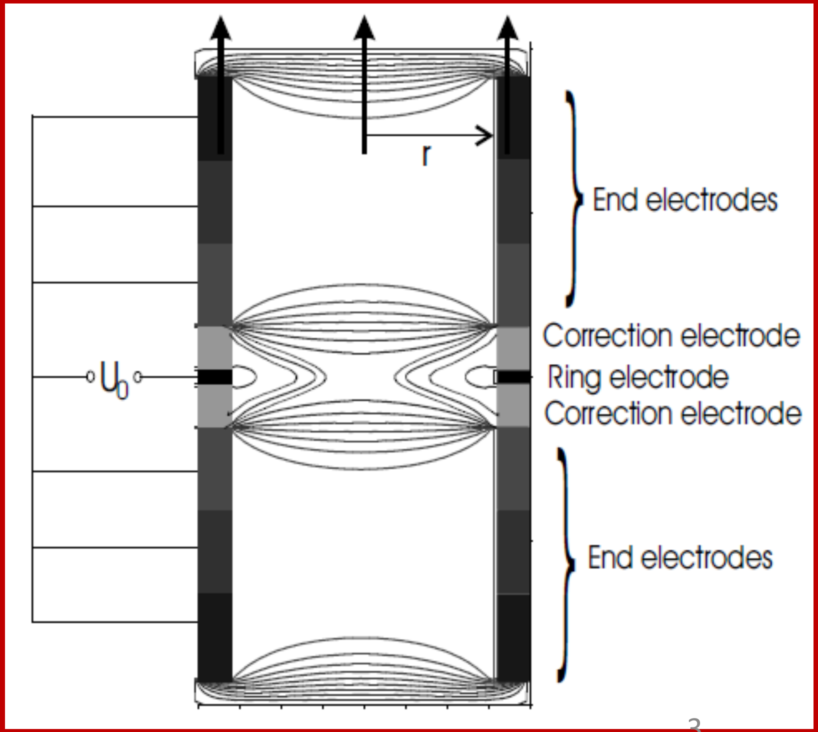
- Background and Motivation
- Cleaning and Assembling the Prototype TAMUTRAP
- Building the Facilities Beamline and Support structure
- Testing the Penning Trap
- Current Status
- Things we have learned along the way.
- Conclusion and Future work
- Acknowledgments

Background and Motivation



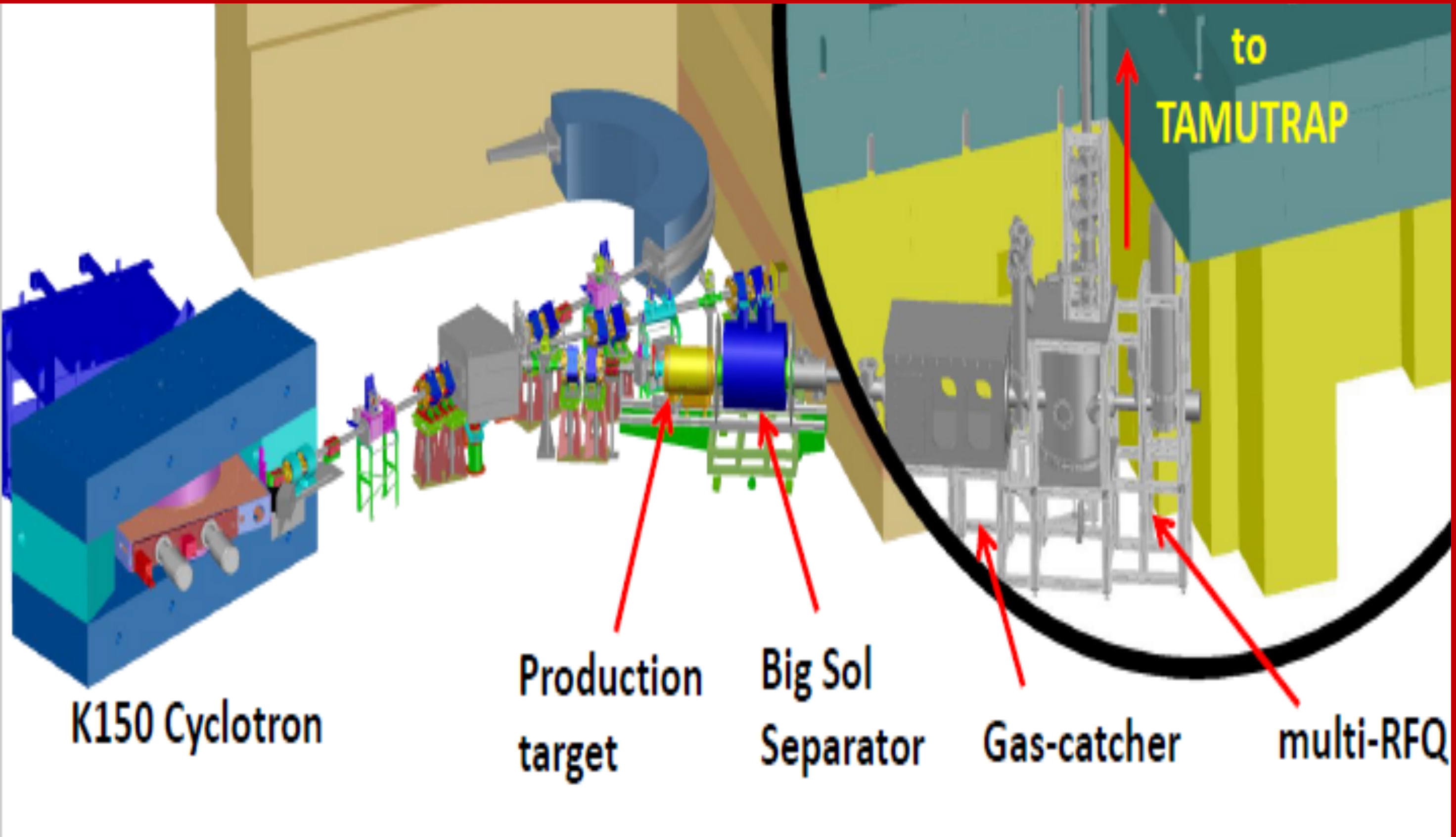
By far the largest Penning Trap.

The TAMUTRAP was designed to observe the angular distribution between β and ν for β-delayed proton emitters. It will also be capable of performing a wide range of other possible experiments such as mass spectroscopy.

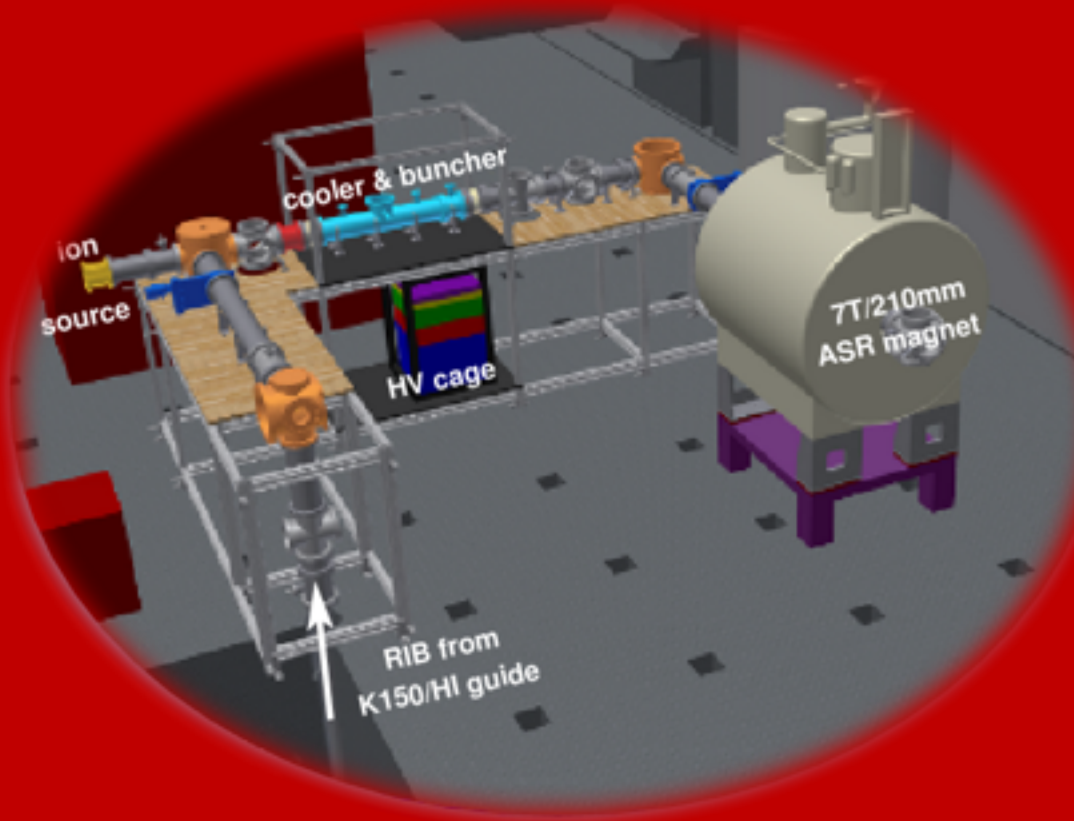


1. These seven electrodes are made of Oxygen free high conductivity copper. They are also gold-plated to avoid oxidation.
2. Insulators are made of aluminum oxide (Al2O3)

Combining the TREX and the TAMUTRAP



TREX

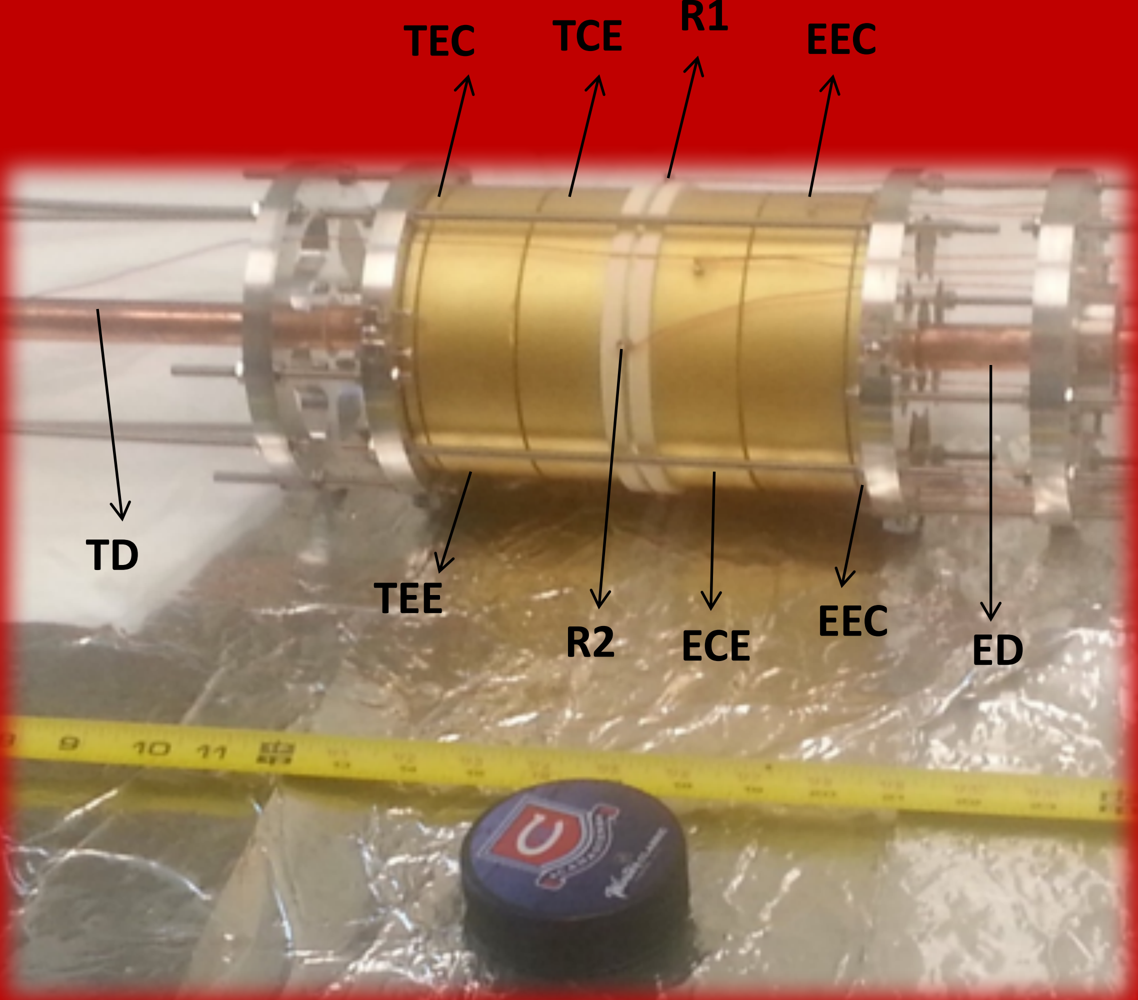


TAMUTRAP

Cleaning and Assembling the TAMUTRAP

Parts to the TAMUTRAP.

1. Pre-Assembly
2. Cleaning with Alcohol, Ultra-Sonic, and Acetone.
3. Assembling the Penning trap and drift tubes.
4. Connecting Capton wires to each electrode

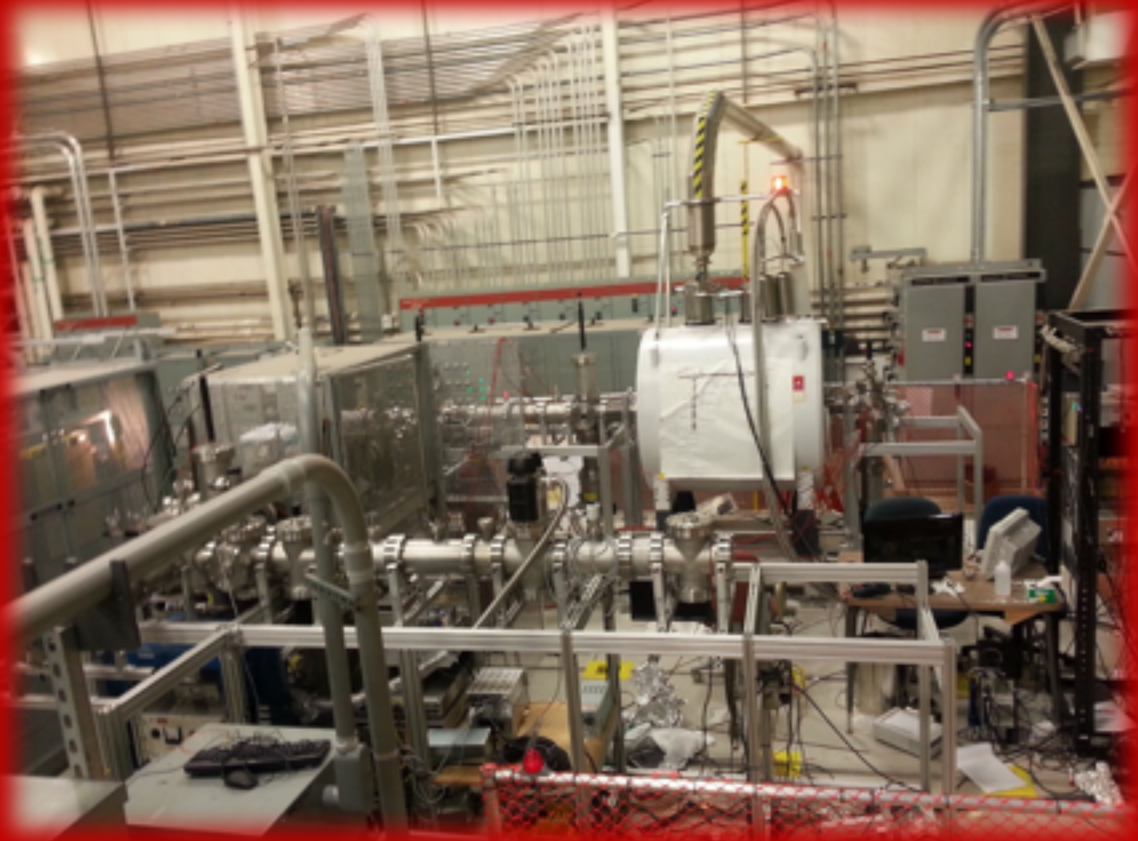


TAMUTRAP in comparison to a hockey puck.

Cleaning and Assembling the TAMUTRAP

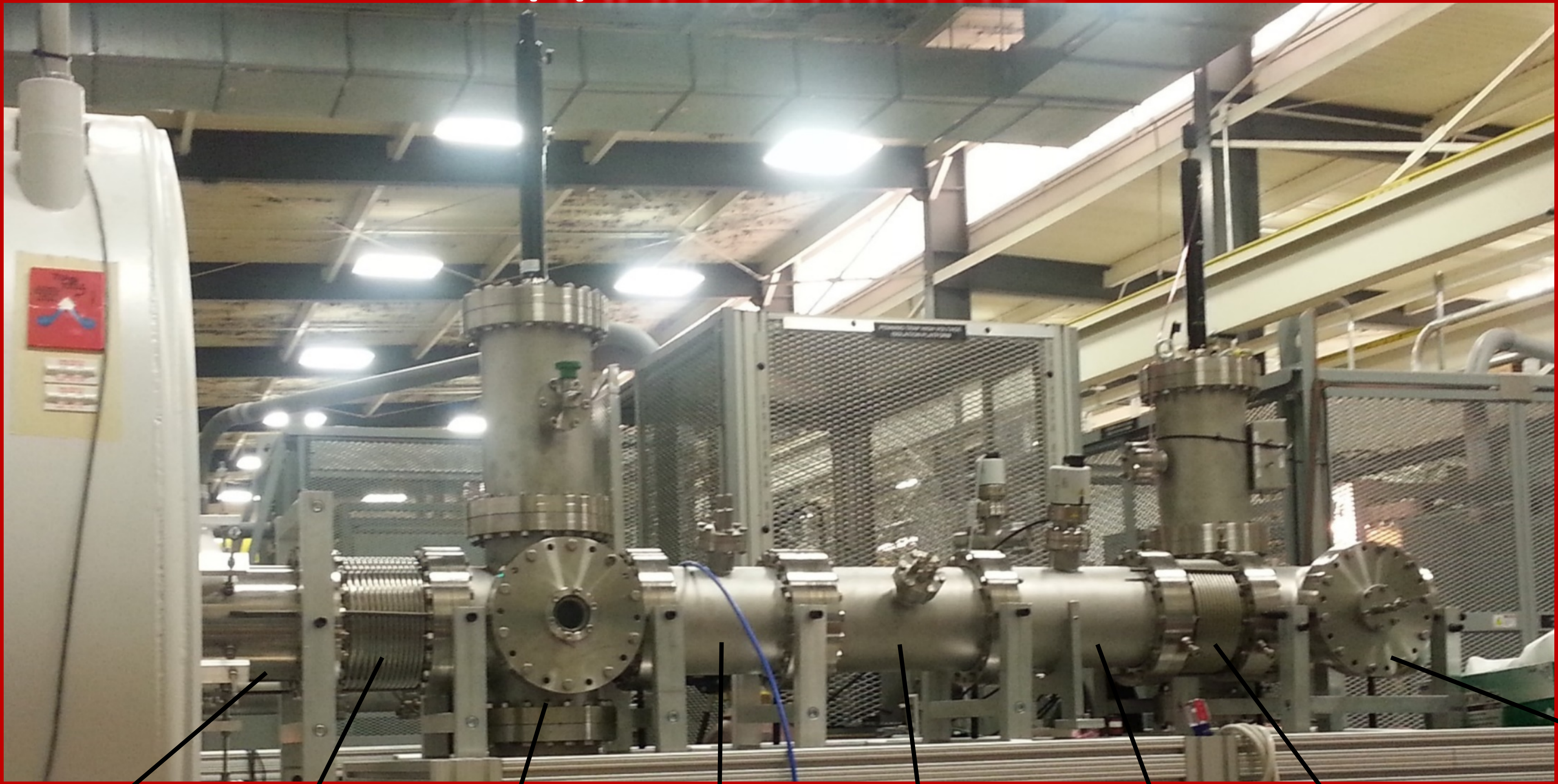
Building the facilities beamline and support structure.

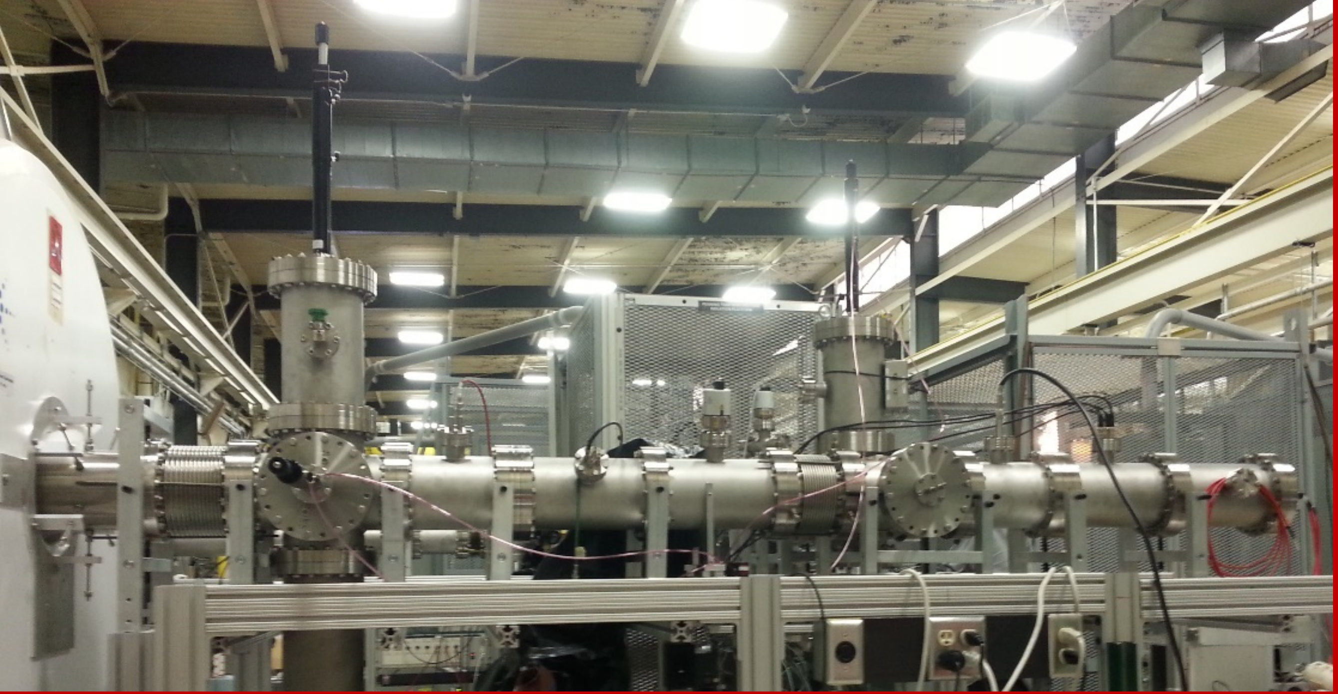
The TAMUTRAP Facility before.



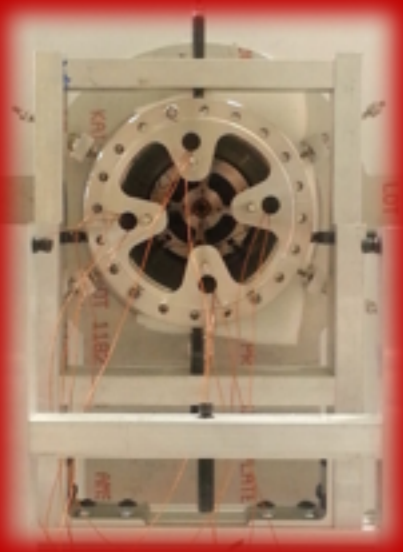
The TAMUTRAP Facility after.

Building the facilities beamline and support structure.





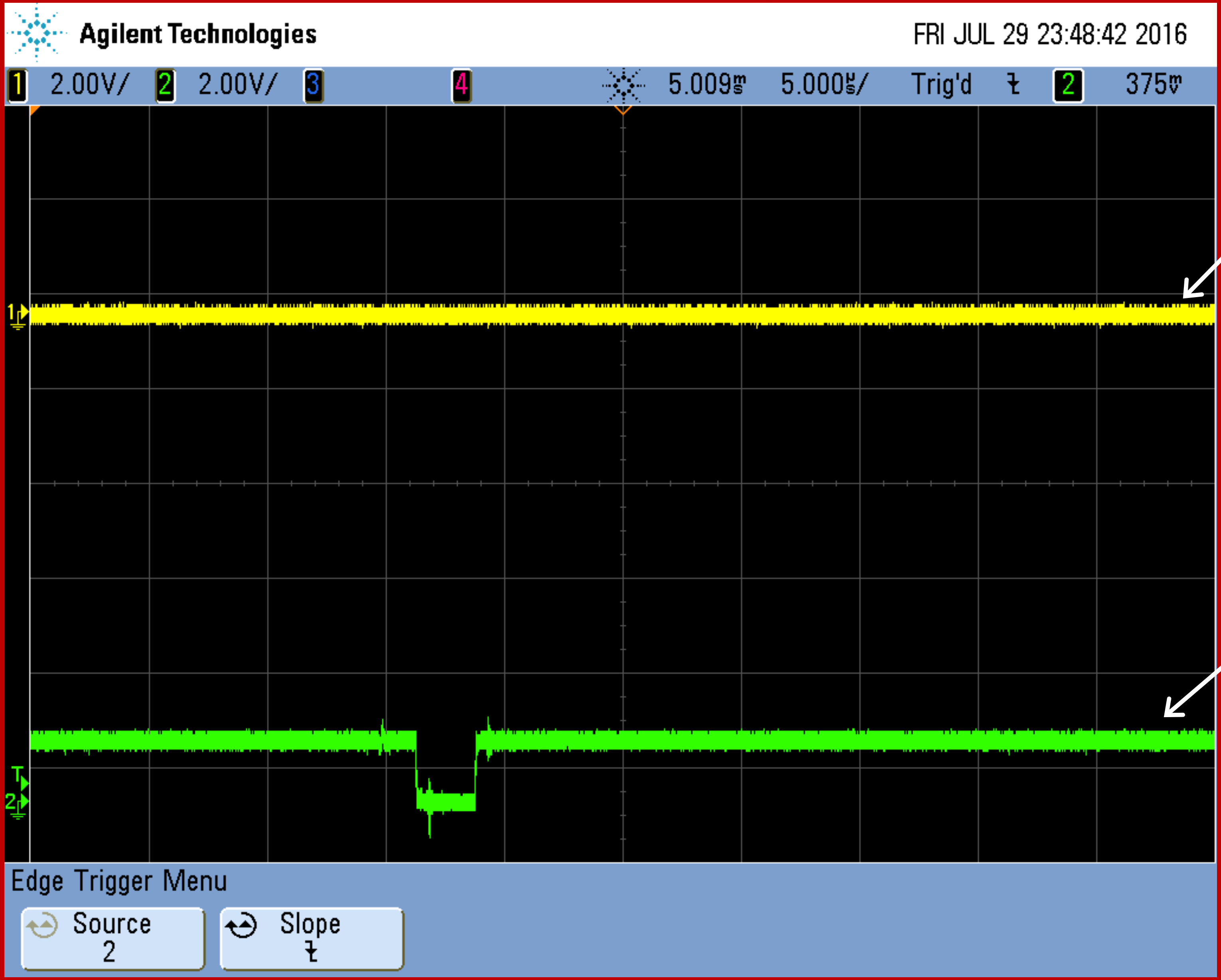
Testing the Trap.



Testing the trap:

- ❑ a continuous ion beam was provided using a surface ion source
- ❑ Faraday cups were placed before and after the magnet to ensure that the beam passed through the trap
  - ❑ Einzel lenses and x-y steerers were used to align the beam
  - ❑ Once the beam intensity was determined using the Faraday cups a MCP detector (positioned after the magnet) was used to analyze the signal coming from the beam on an oscilloscope.
  - ❑ Each of the Electrodes were grounded except for the trapping drift tube
    - ❑ To bunch the ion beam the trapping drift tube was pulsed using a filter circuit
      - ❑ The bunched signal was then observed using an oscilloscope

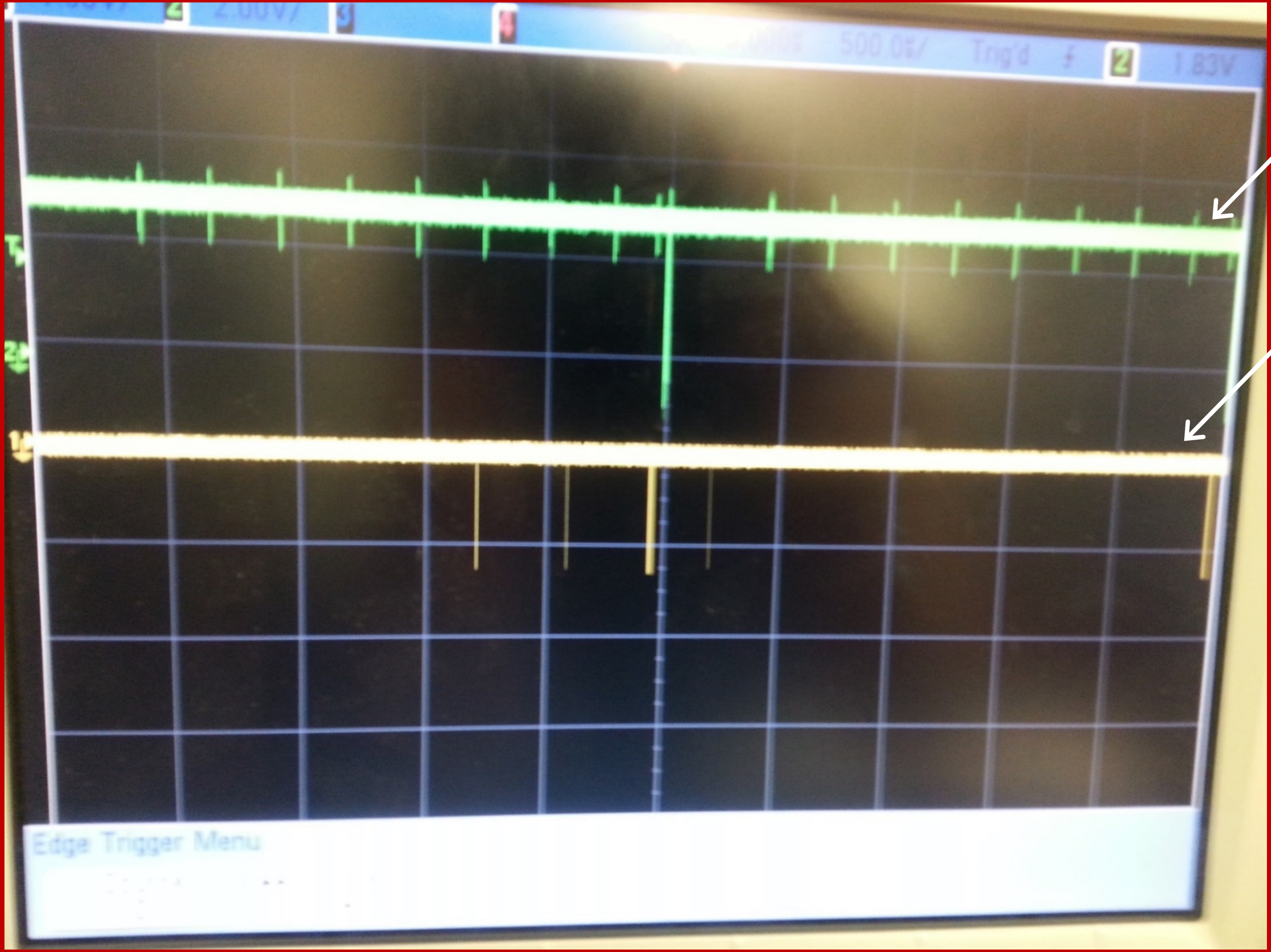
Current Status



The output from the MCP with the ion beam off.

The output from the trapping pulsing drift tube.

Current Status

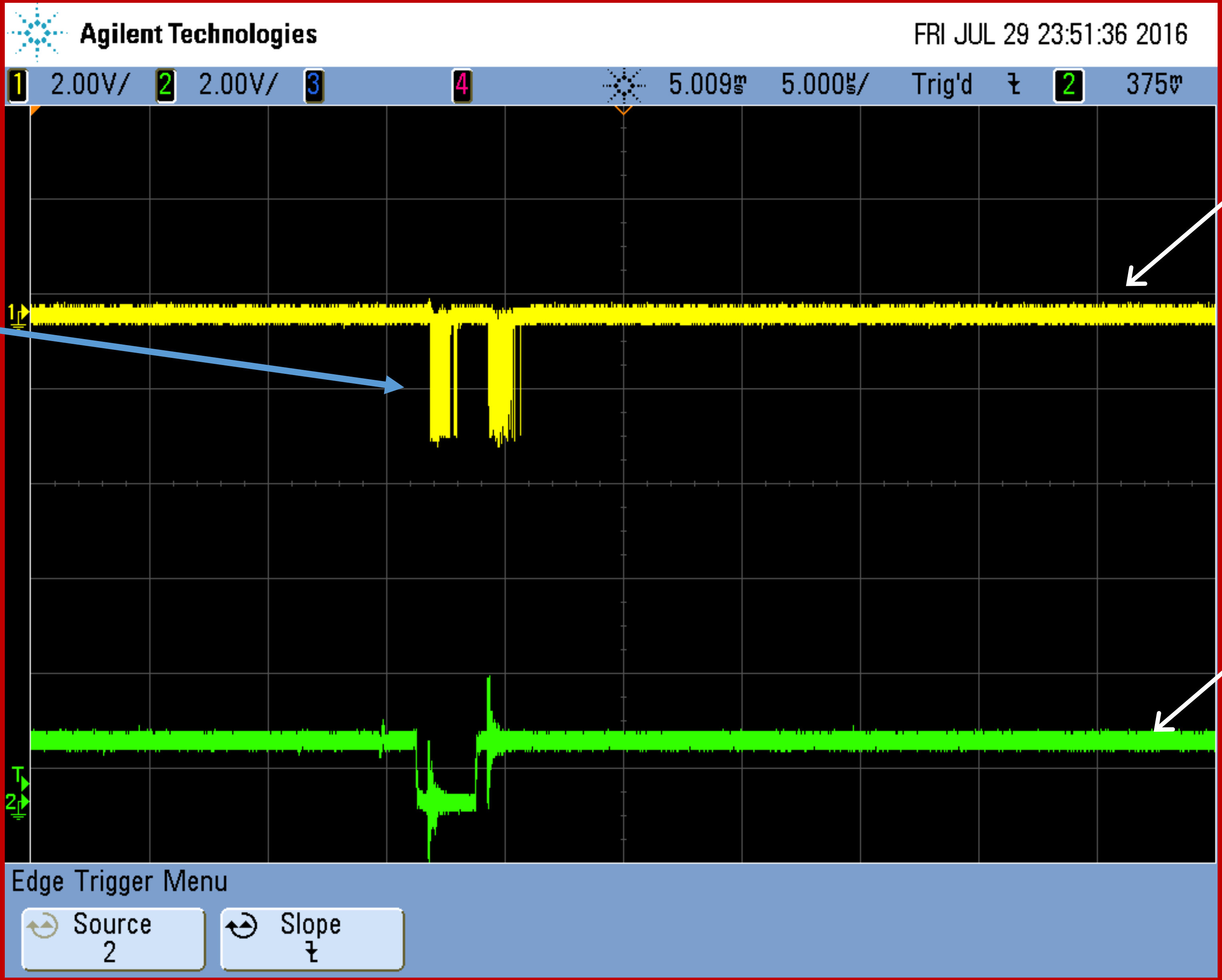


The output from the trapping pulsing drift tube.

The output from the MCP with the ion beam on, but not pulsing.

Current Status

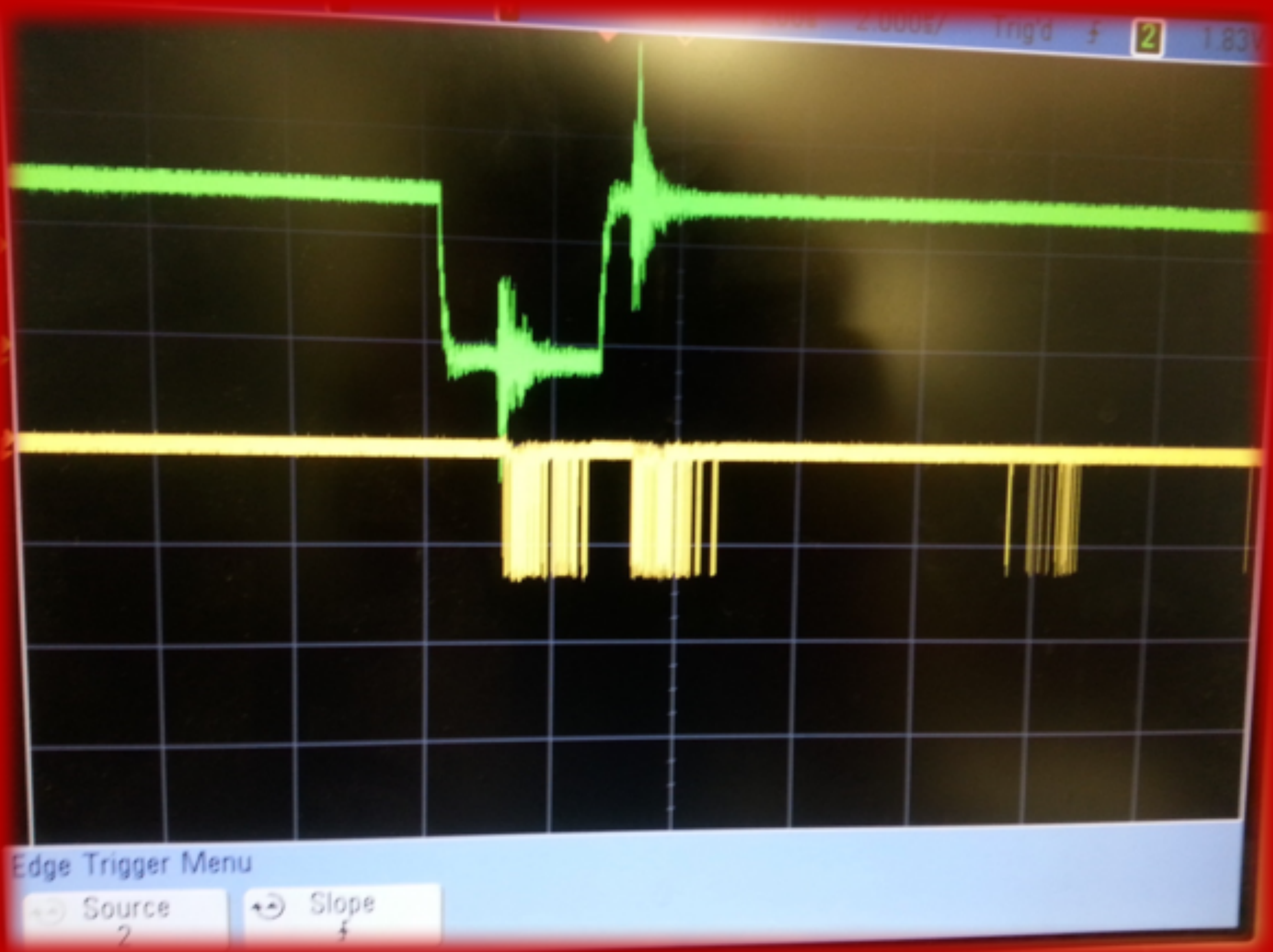
Noise from pulsing the drift tube.



The output from the MCP pulsing with the ion beam off.

The output from the trapping pulsing drift tube.

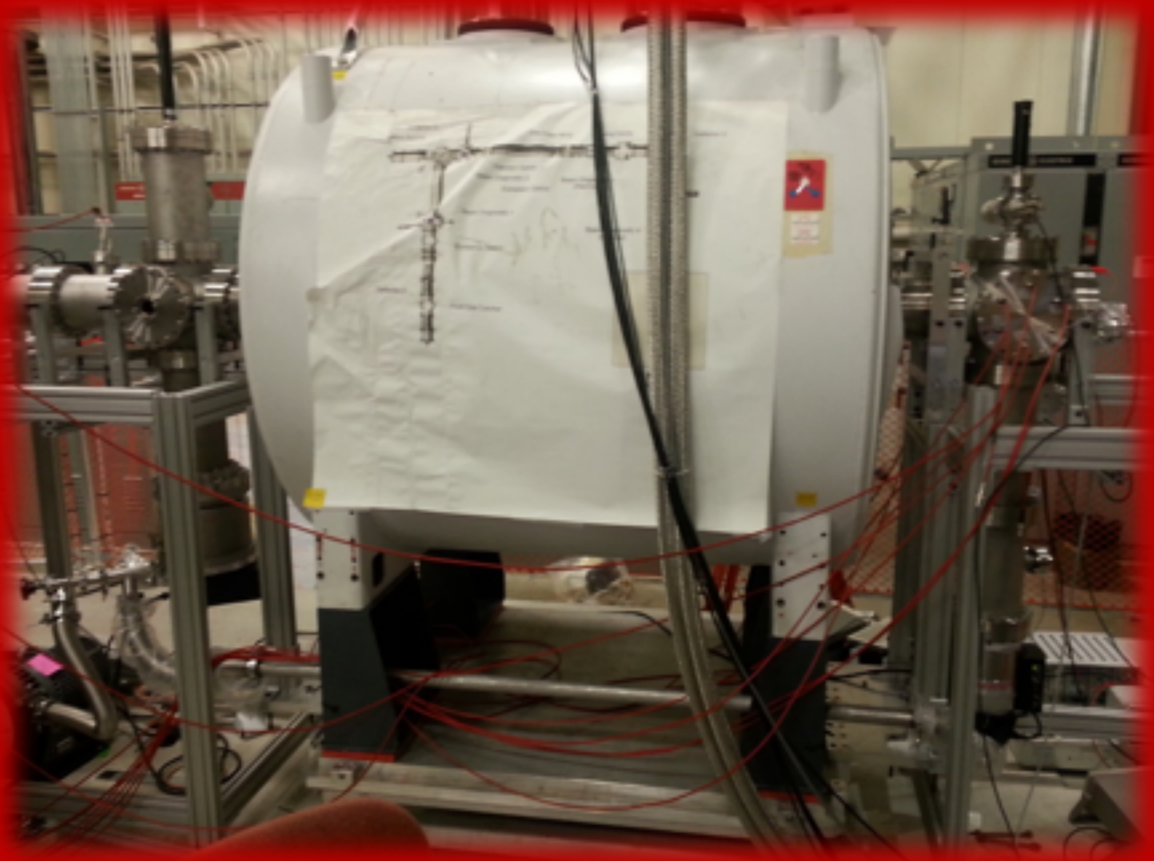
Current Status



The output from the trapping pulsing drift tube.

The output from the MCP with the drift tube pulsed and the ion source on.

Things we have learned.



- ✓ There were three separate incidents where magnetic objects were pulled into the magnet.
- ✓ Sealing: Star Pattern Vs. Circular the war begins.
- ✓ There is no such thing as a leak. Only opportunities to fix leaks.
- ✓ Turbo pumps can not handle a magnetic field > 50 Gauss.
- ✓ Always use zip ties
- ✓ Bellows…

Conclusion and Future work

In conclusion:

- ✓ The prototype trap was cleaned and assembled
- ✓ A beamline was constructed and aligned using a optical transit.
- ✓ The intensity of the beam was optimized.
- ✓ The ion beam was successfully bunched using the pulsing drift tube.

What is next?

- ❑ Finish testing the prototype penning trap.
- ❑ Mass Spectroscopy will be used to determine the performance of the prototype trap.
- ❑ Adjustments to the design of the final penning trap will be made based upon performance testing results.
- ❑ Assembly and testing of the final TAMUTRAP.
- ❑ Final TAMUTRAP will be connected to the K150 cyclotron.

Acknowledgements

My advisor: Dr. Dan Melconian

Dr. Praveen Shidling – for giving me guidance every step of the way with my project

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M. S. Rahaman, Ph.D. thesis, University of Heidelberg, 2005.

(Extra) Possible Questions and there answers

Q1. What needs to be taken into account for Real Traps:

1. Inhomogeneous magnetic field
    - Finite extent of solenoidal windings
    - Magnetic susceptibility of the material forming the electrodes and vacuum tube
        - Prevented by making the electrodes out of copper.
2. Misalignment with magnet
3. Space charge effects

Q2. Would the geometry of the trap matter if containment was the only requirement for the trap:

- No it wouldn’t.

Q3. Why are you using an MCP detector and not any other type of detector?

- For its applications in mass spectroscopy. TOF-MS detectors need a high-speed response and high efficiency and beam energy is very low around 2 keV..

Q4. What is the pumping speed of your turbo pumps?

- 1000 L/s

Q5. What is the width of your beam?

- While we did not measure the width of the beam it is going through the inner diameter of the traps drift tube (0.5”). Around 2 to 3 mm

Q6. How does the mean free path of the particle compare to the length of the trap?

- It is greater than the length of the trap.

Q. Why must the trapping geometry be orthogonalised?

- So that the axial oscillation frequency is independent to the changes to the voltage across the compensation electrodes. It should be tunable and orthogonized so that you form a quadrupole field and it is very important for mass measurement.