PET experiment

BY LEVI KEAY

LAB PARTNER : MARCUS LEE?

UBC DEPARTMENT OF PHYSICS ASTRONOMY

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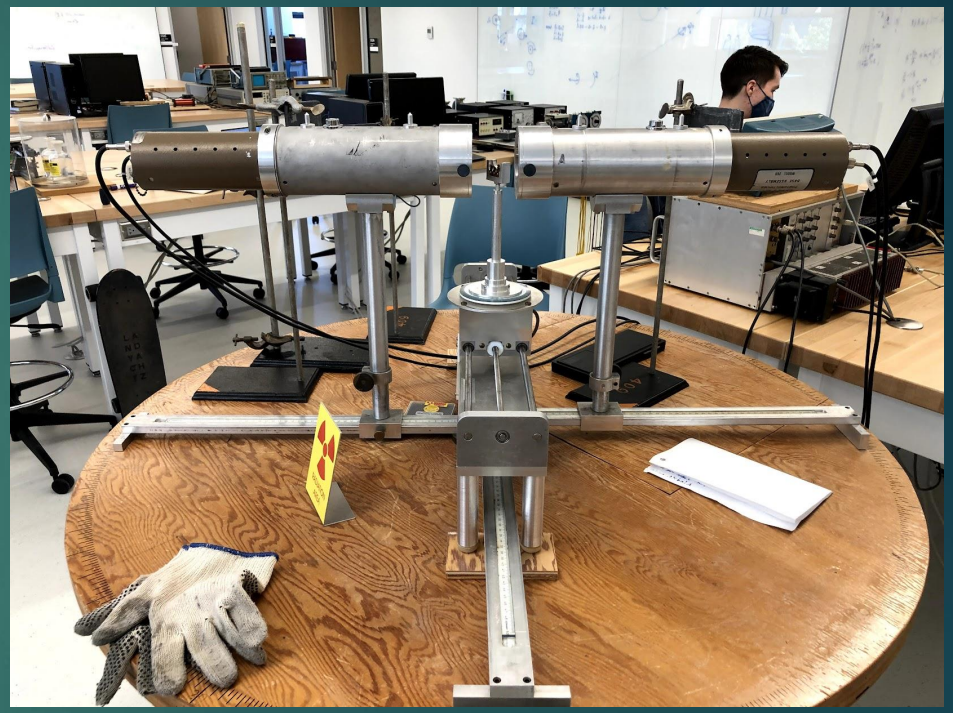

Overview Positron Emission Tomography (PET):

Physical Mechanism :

1) Beta Positive decay -> Positron emission

Detection :

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2) Positron meets electron -> Annihilation

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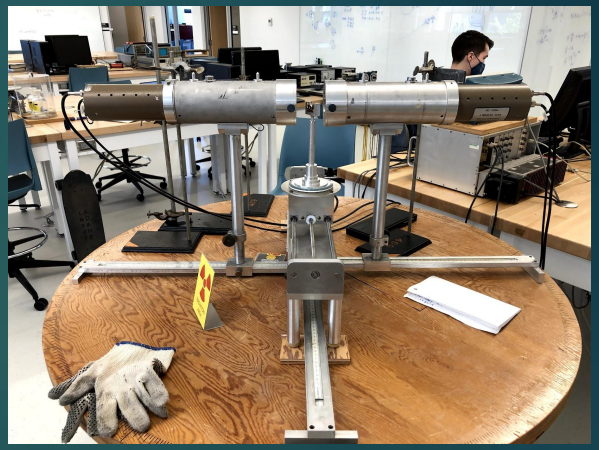
1) Use pair of scintillators + photomultiplier tubes :

   capture gamma photons + amplify/convert to electrical signal



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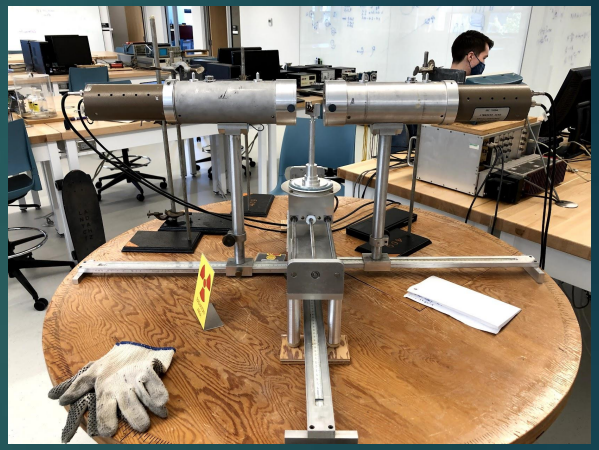


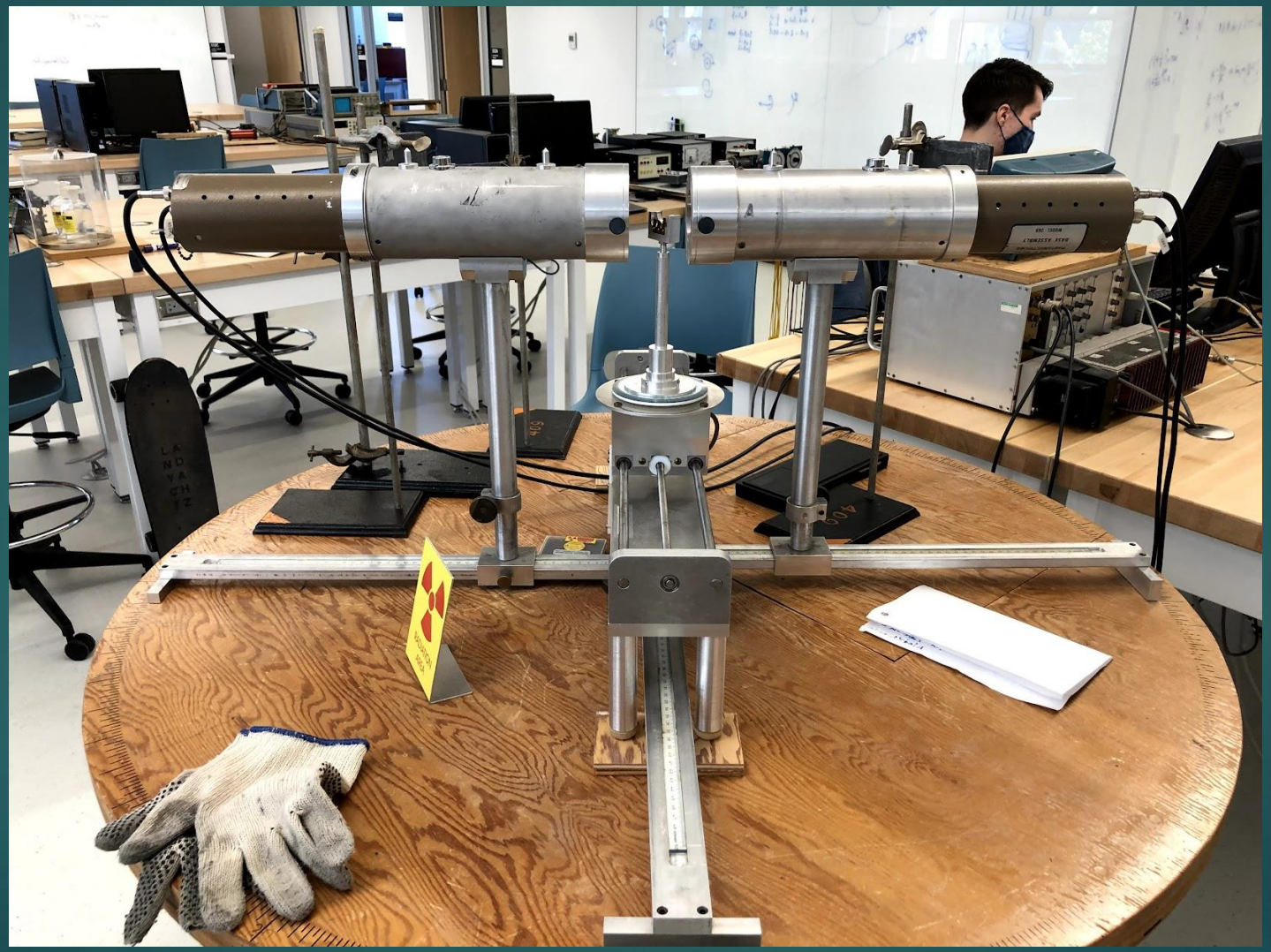
Detection :

1) Use pair of scintillators + photomultiplier tubes :
   capture gamma photons + amplify/convert to electrical signal

2) Use hardware : count number of **coincident*** photon captures

*when **both scintillators activated within time window** (~ns)

Apparatus:



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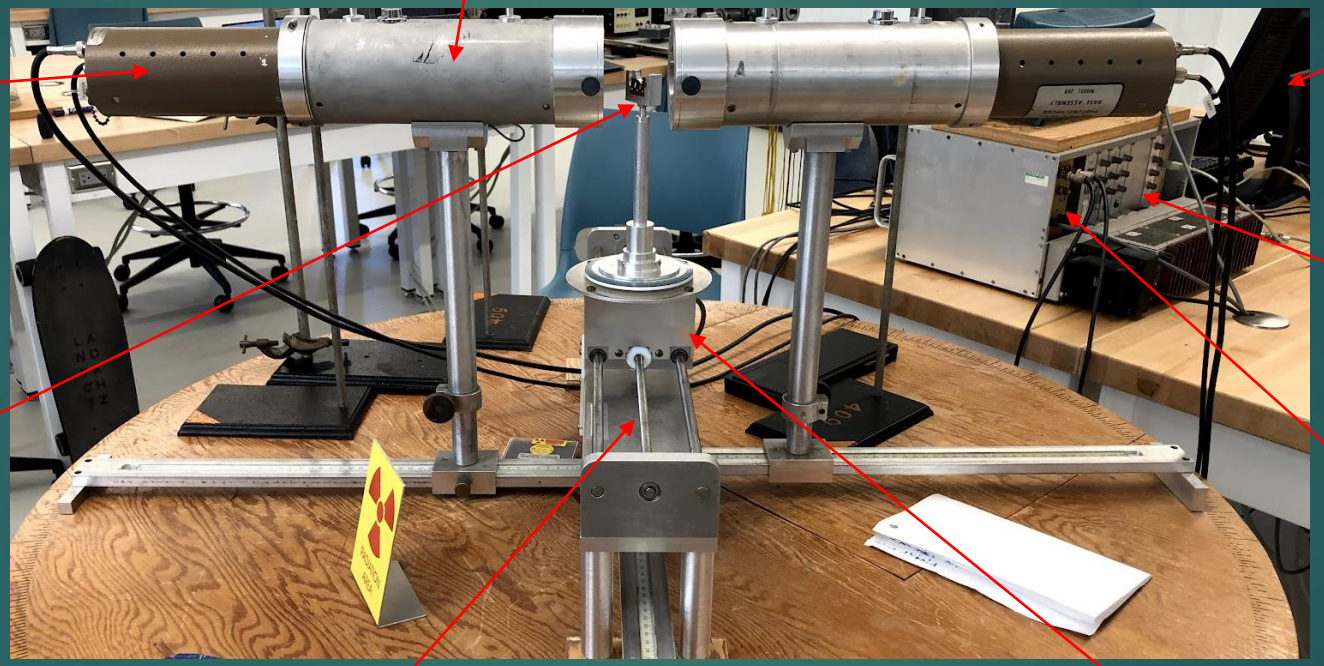
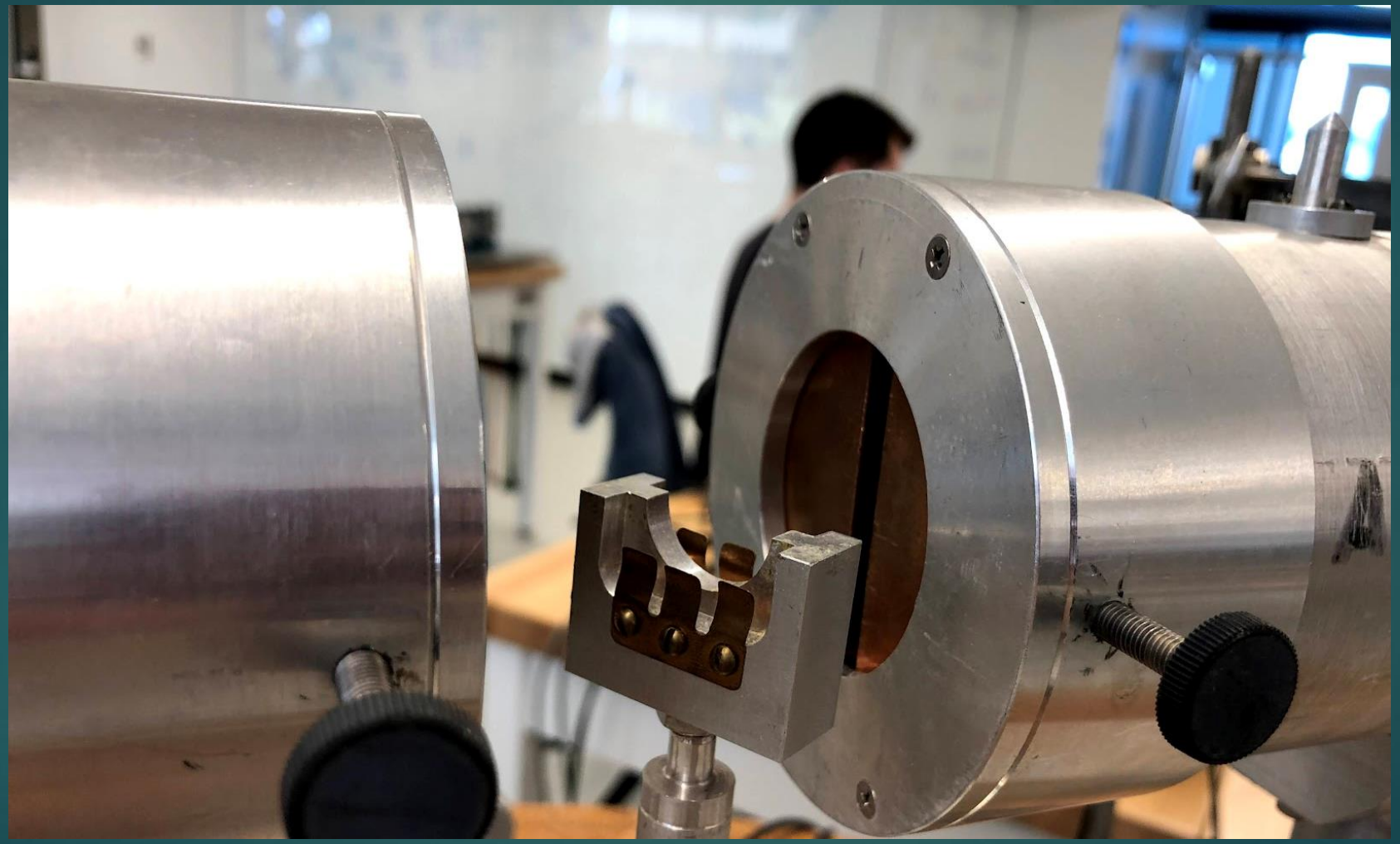

Scintillator
Photo-multiplier tube (PMT)
Source arm
Track
Computer
Hardware
High voltage power supply (for PMTs)
Step motors

Apparatus:



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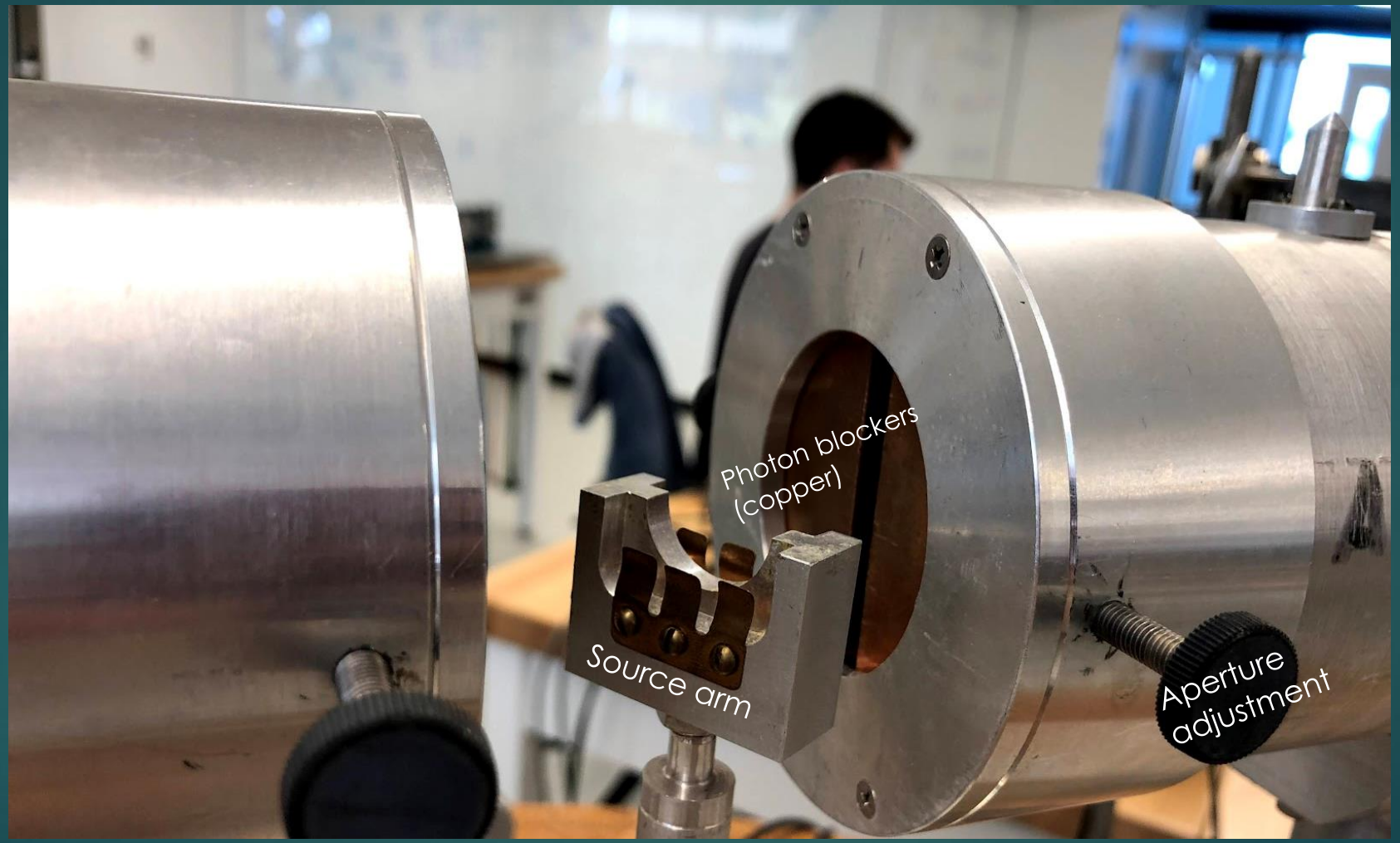
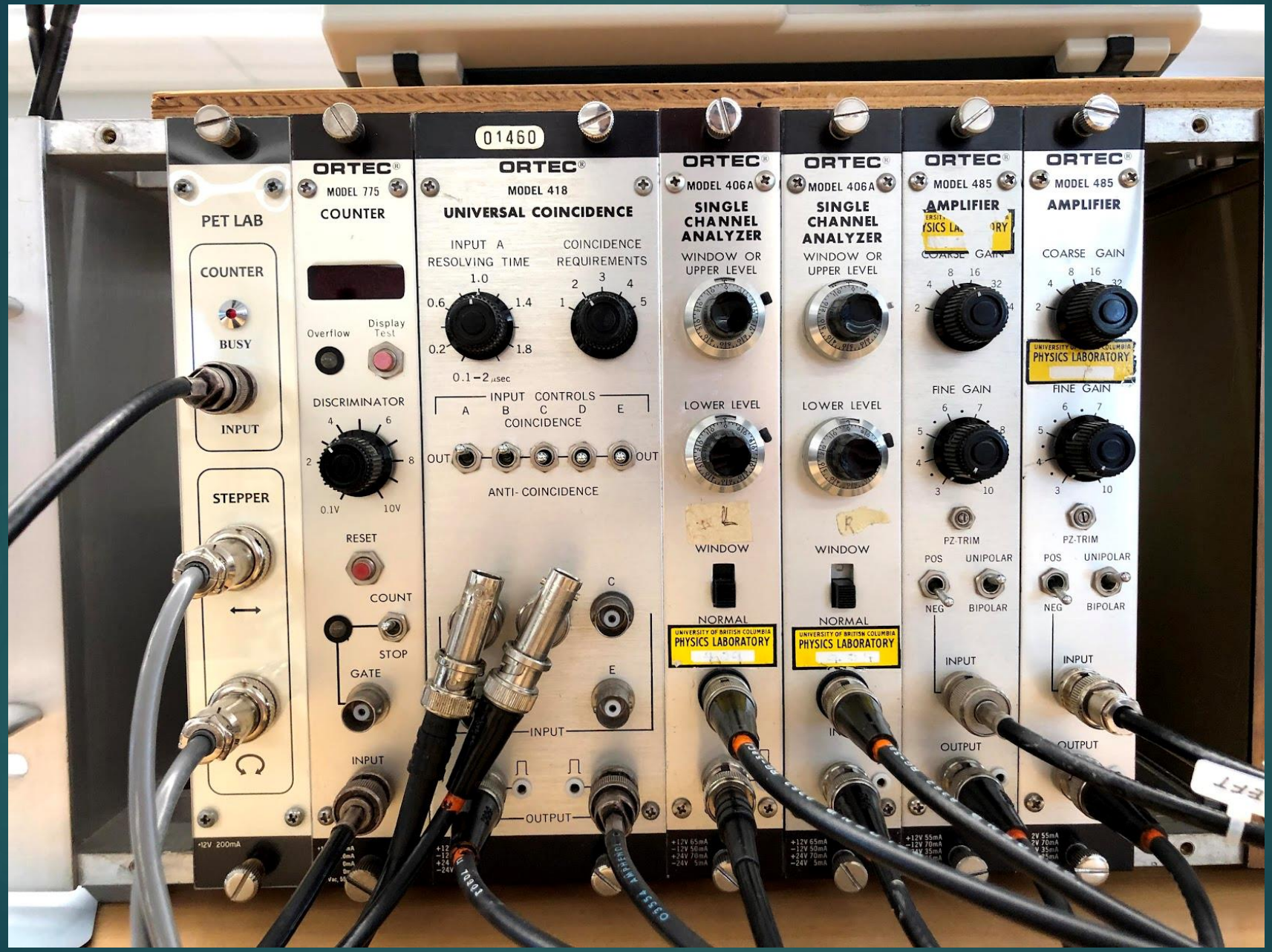



Spectrum Techniques
Oak Ridge, Tennessee USA
Na-22
10 µCi 2.6 Yrs
Radioactive Material
Sept 2016
Spectrum Techniques
USNRC & State License
Exempt Quantity
CAUTION
RADIOACTIVE
MATERIALS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COUNTER
BUSY
INPUT
STEPPER
ORTEC
MODEL 775
COUNTER
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Display Test
DISCRIMINATOR
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10V
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ORTEC
MODEL 418
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INPUT A RESOLVING TIME
COINCIDENCE REQUIREMENTS
0.1–2 μsec
INPUT CONTROLS
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COINCIDENCE
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NORMAL
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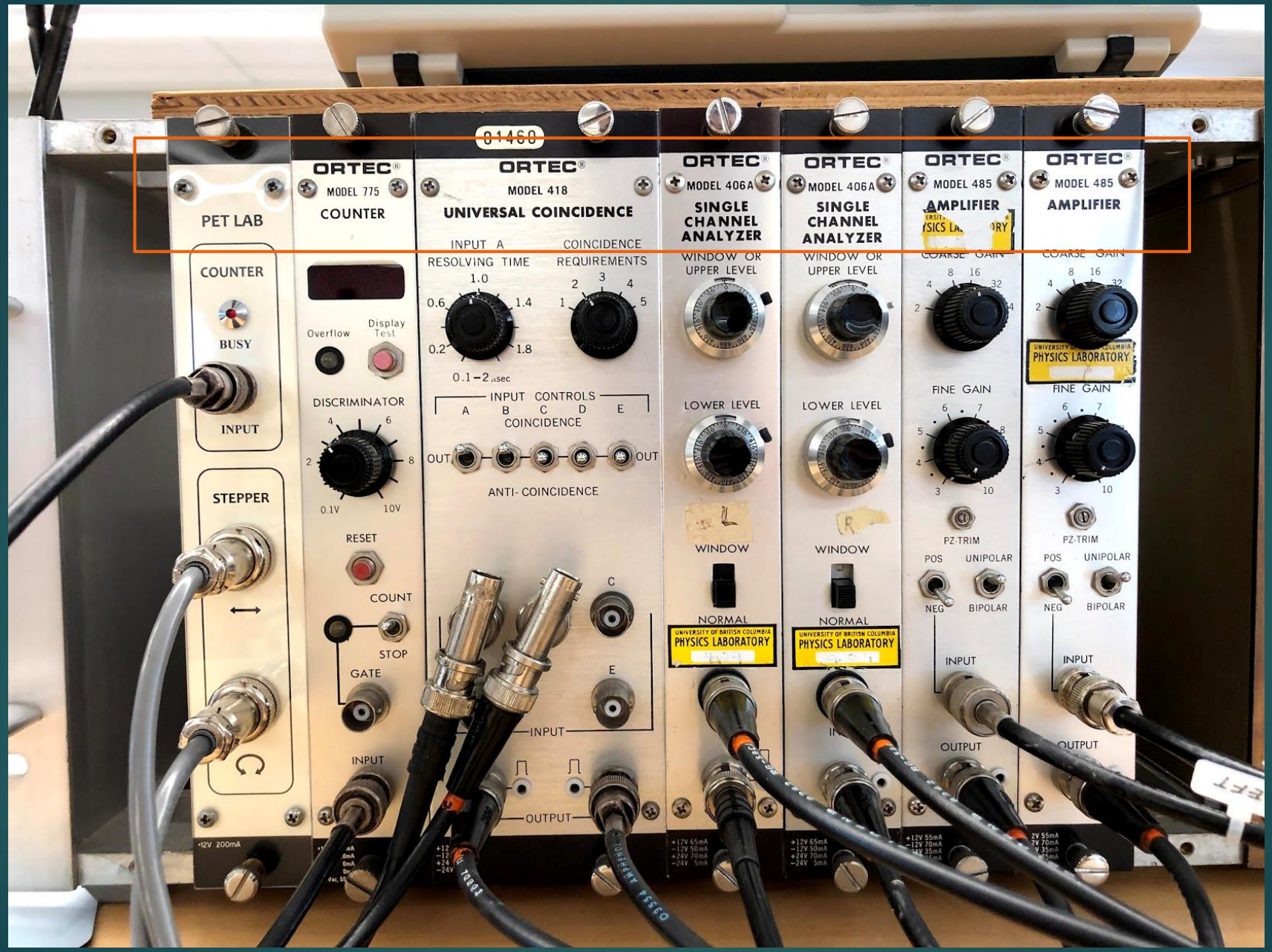
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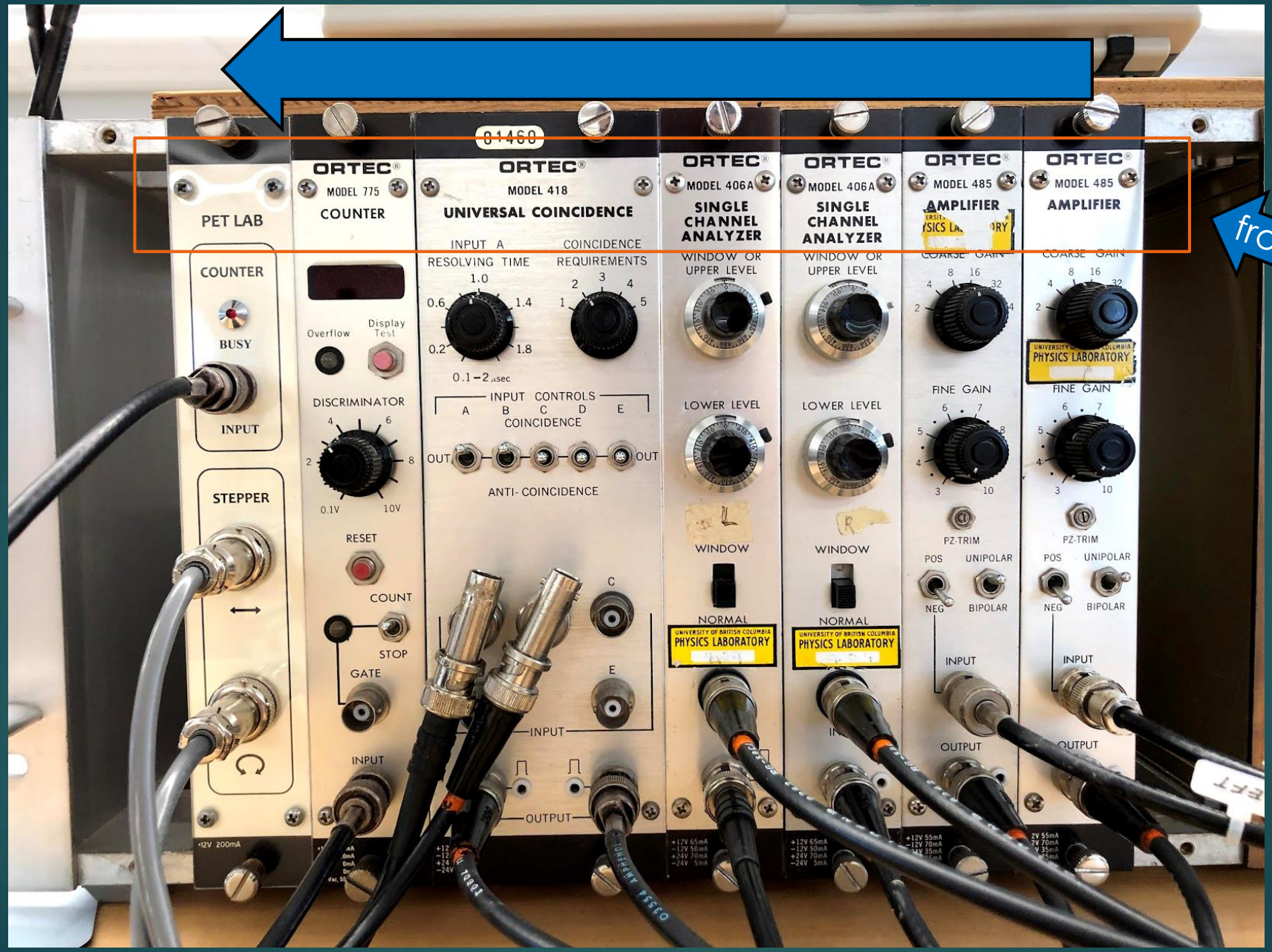
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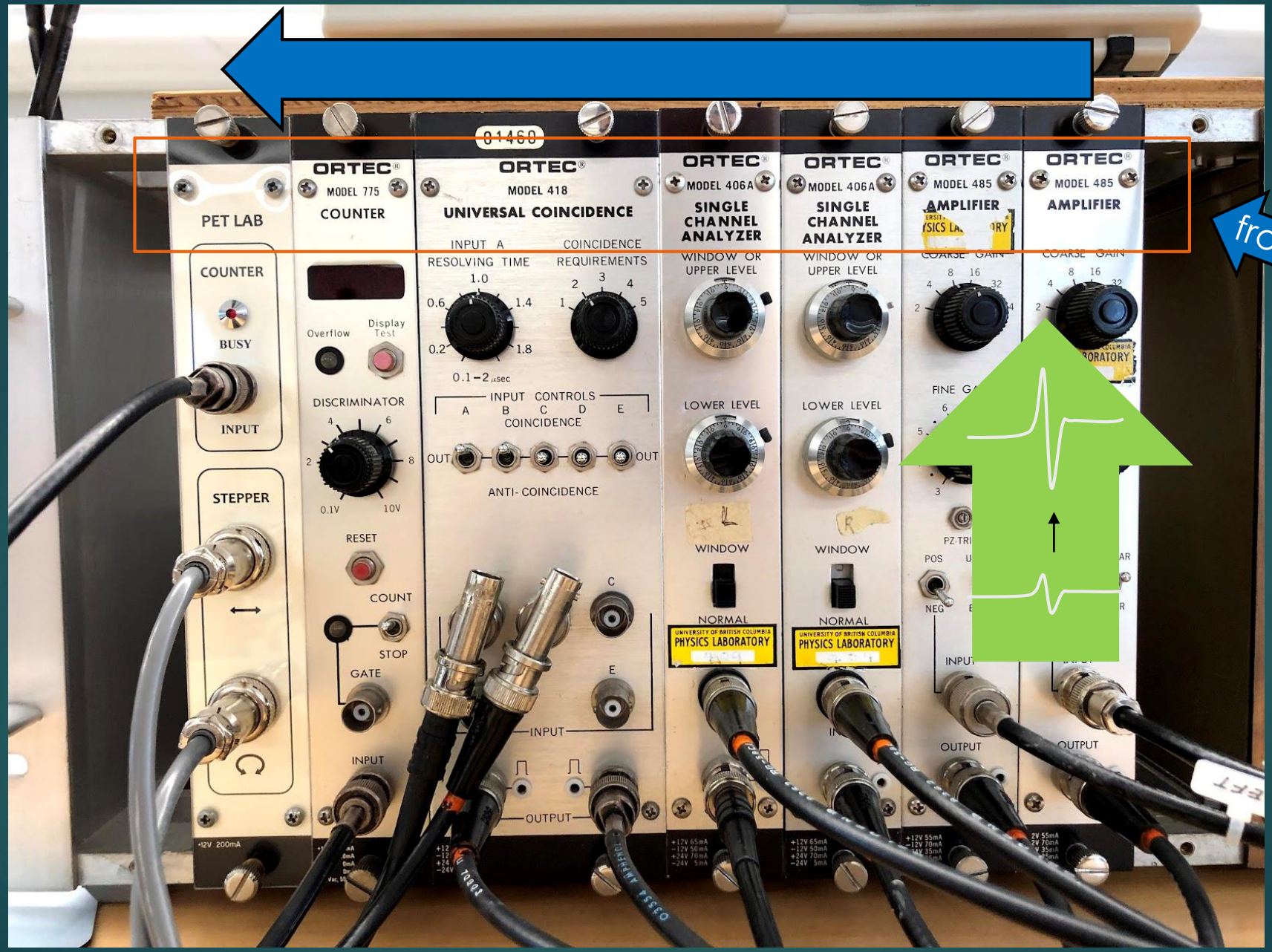
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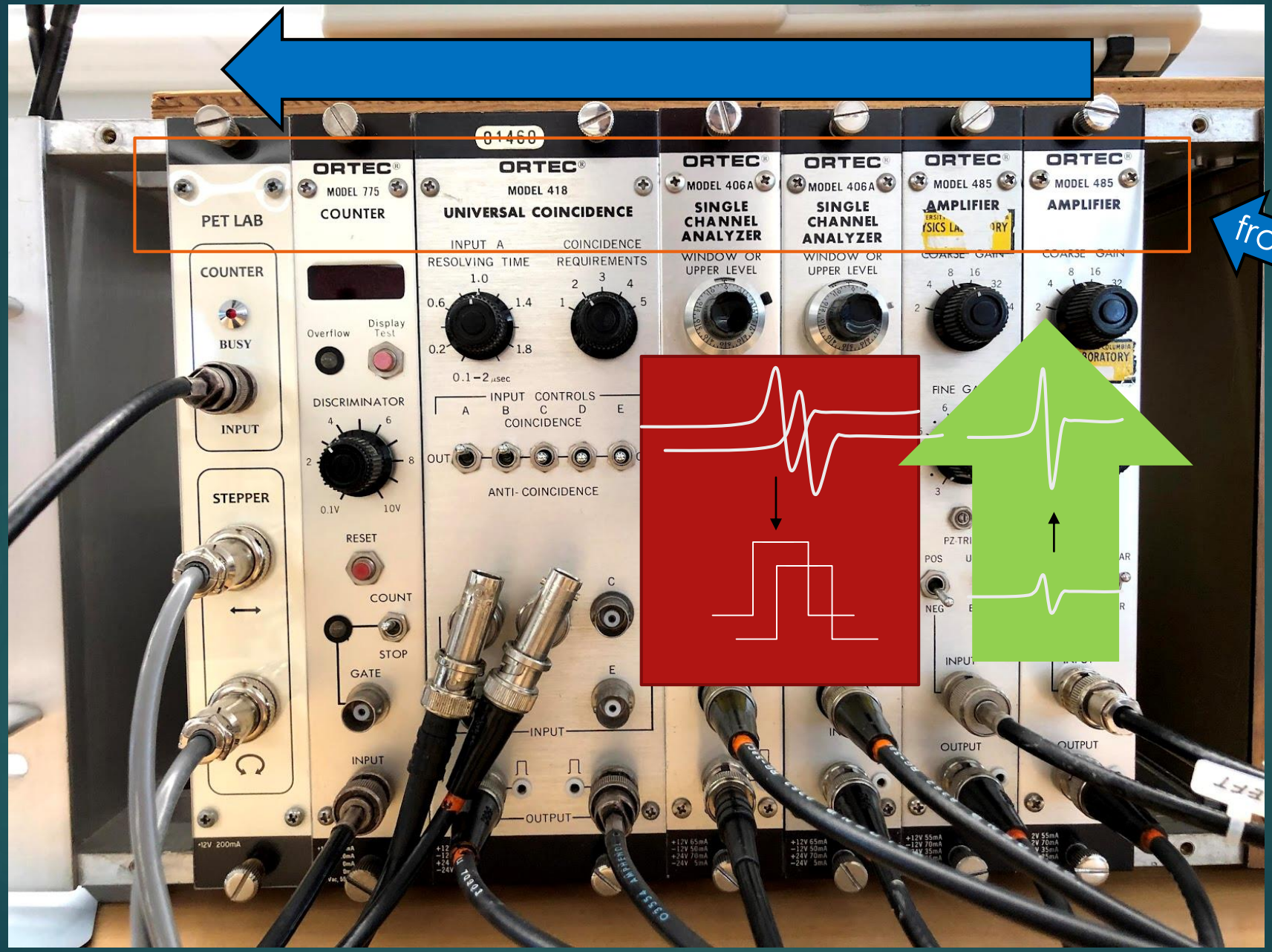
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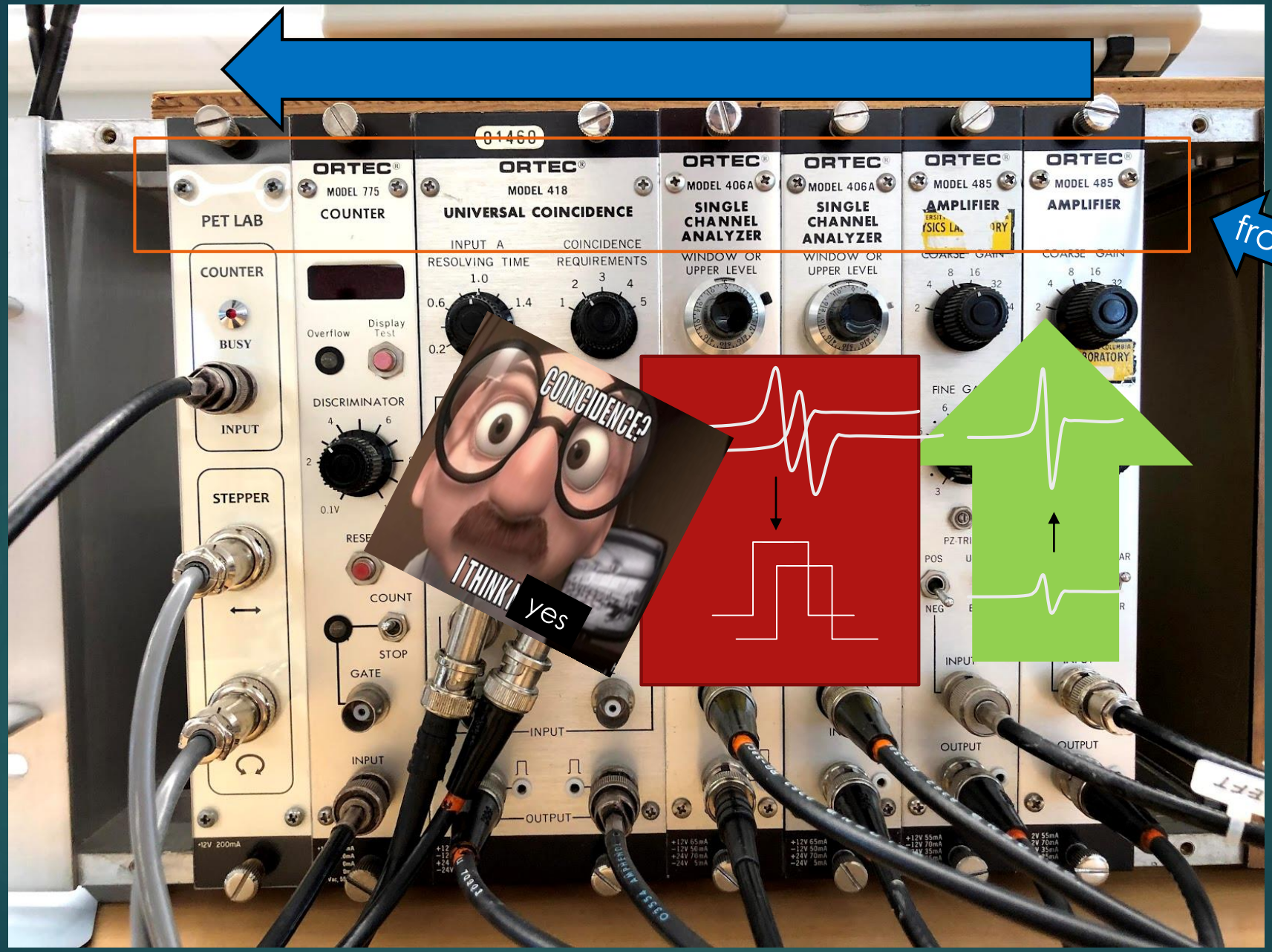
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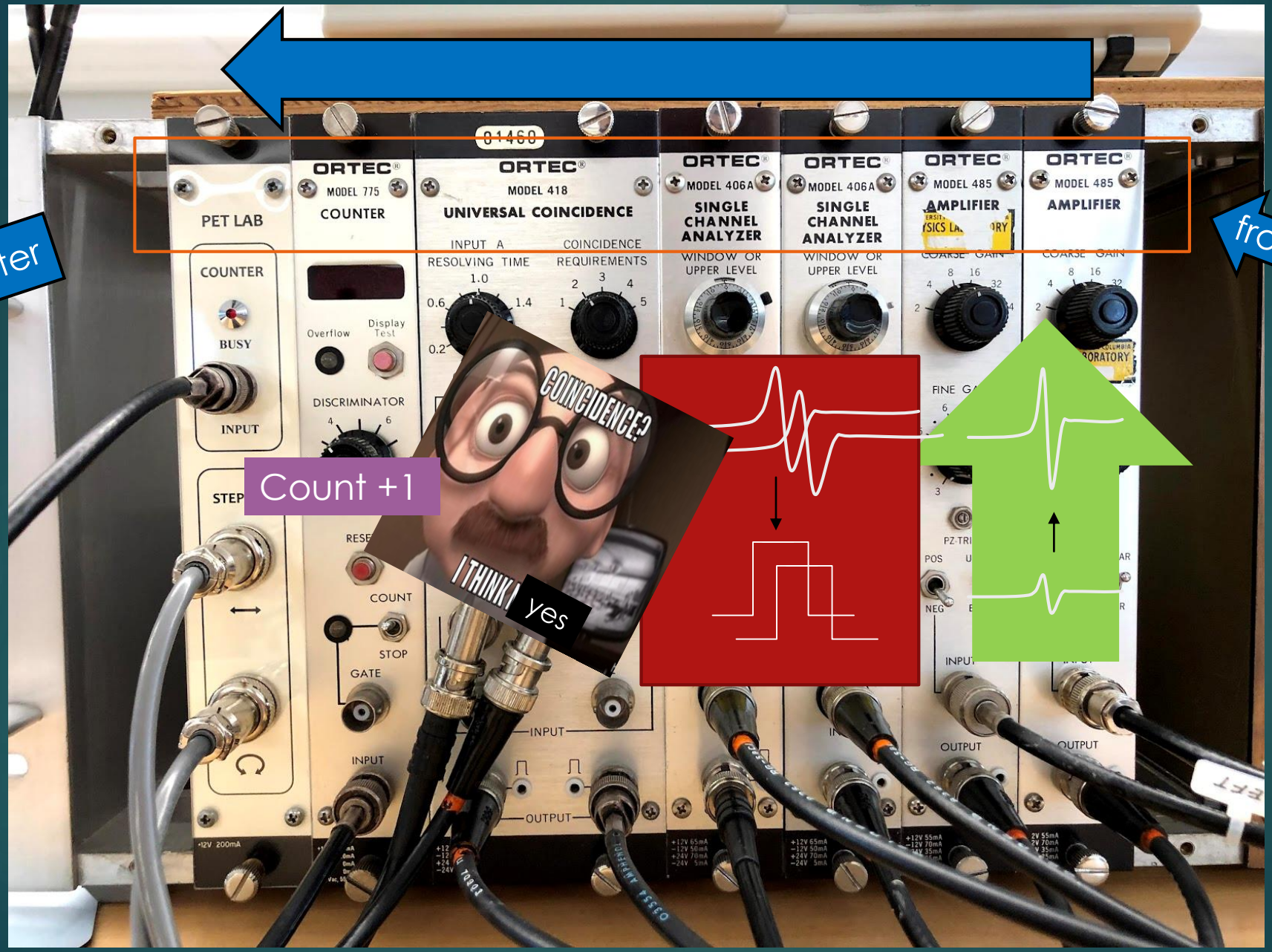
INPUT
OUTPUT
COINCIDENCE?
I THINK
yes
from PMT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ORTEC
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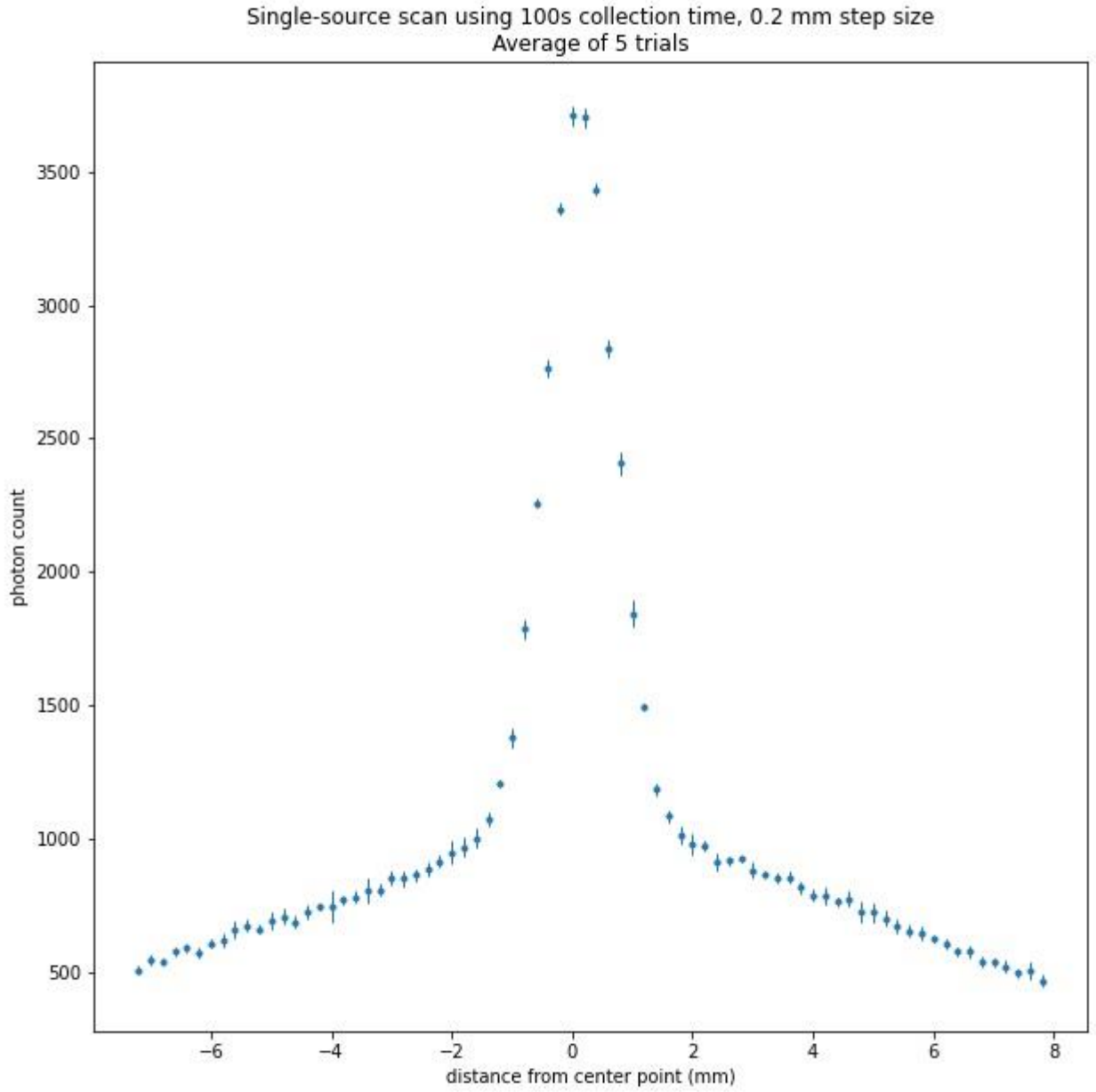
BUSY
INPUT
DISCRIMINATOR
COUNT
STOP
GATE
INPUT
OUTPUT
Count +1
COINCIDENCE?
I THINK
yes

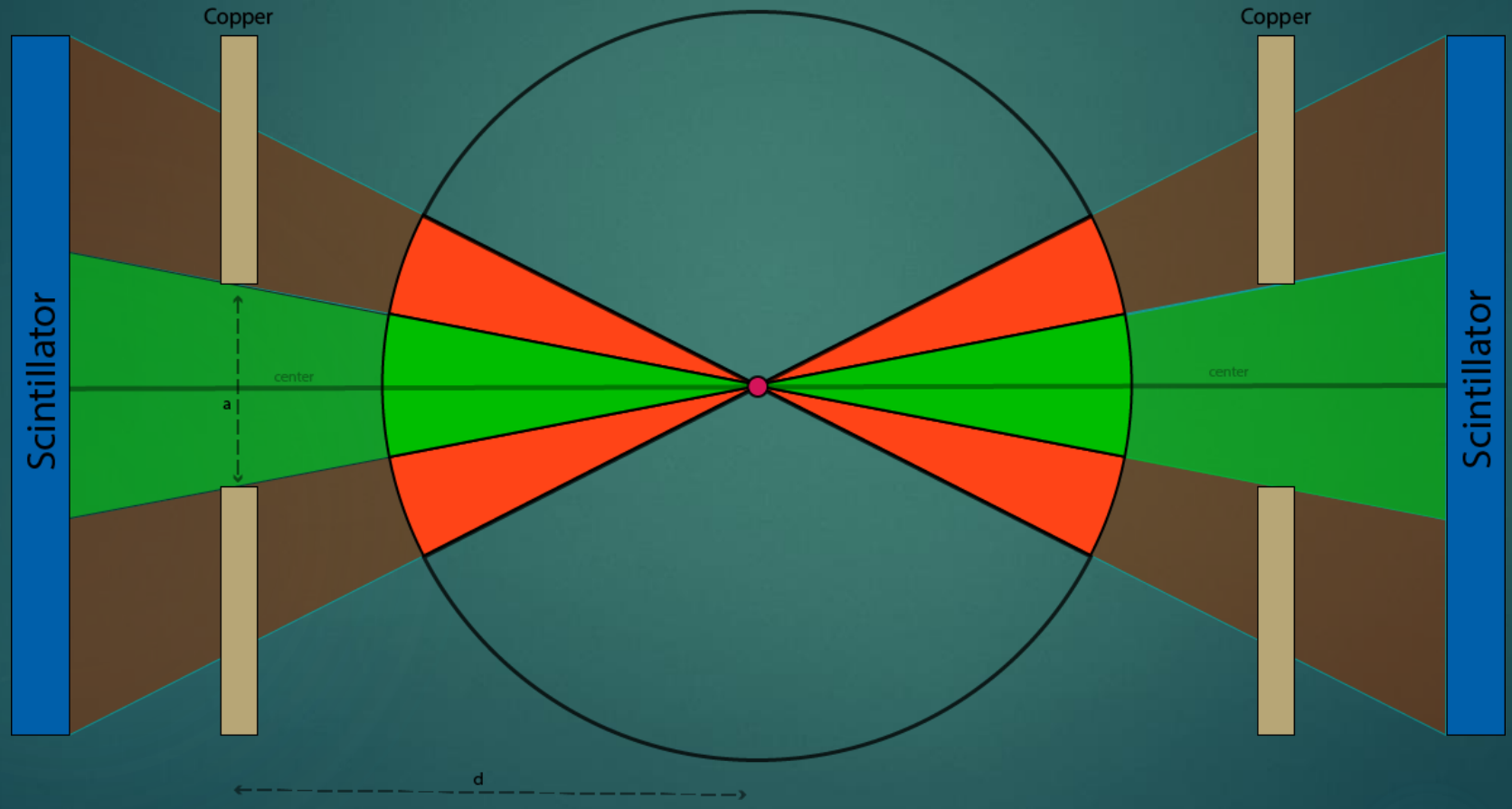
Data collected from a scan of a single radioactive source looks like this:

The aperture is set to 3mm.

Why does it not go to zero outside of the aperture?



Limitations of resolution: SNR and aperture



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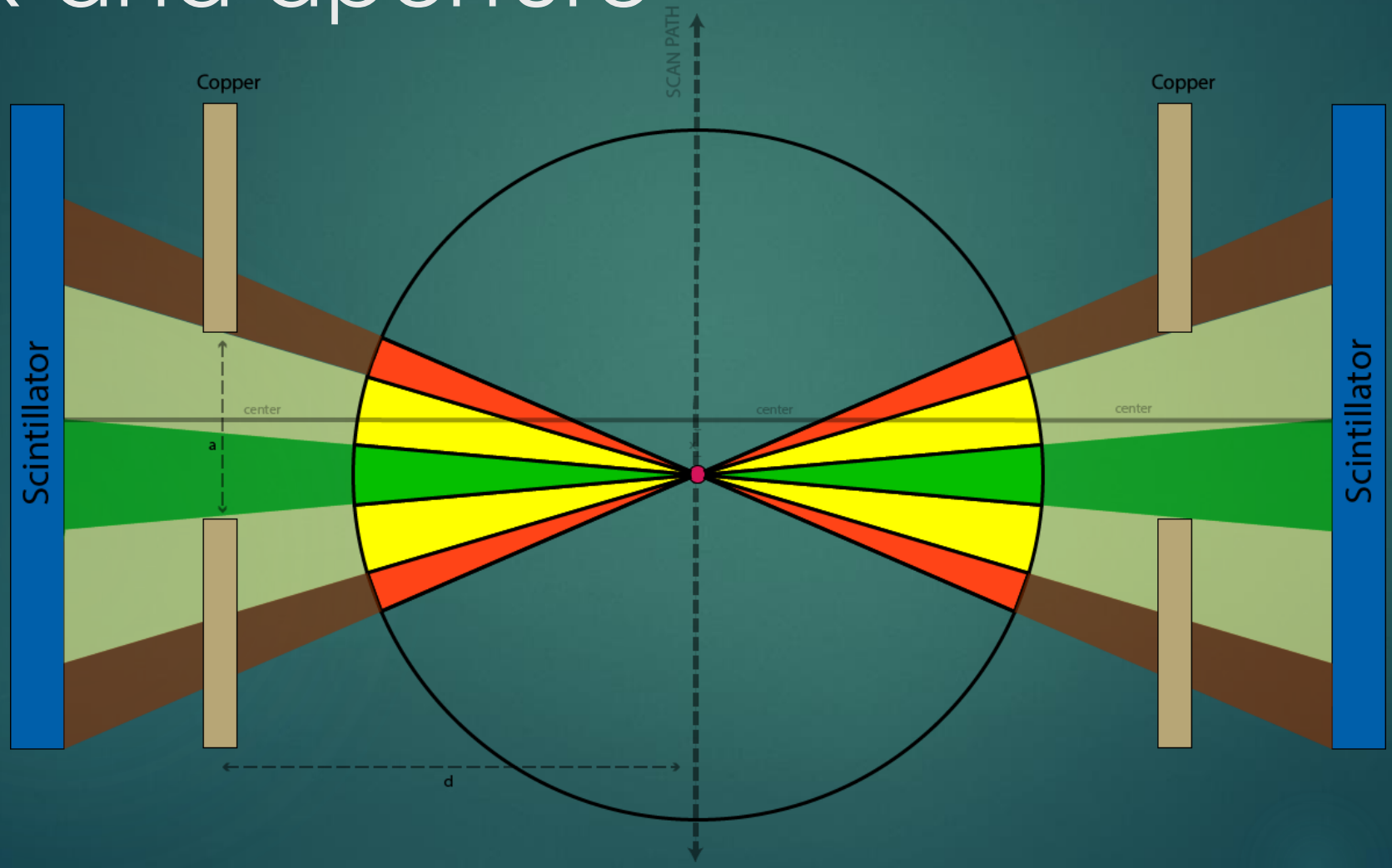
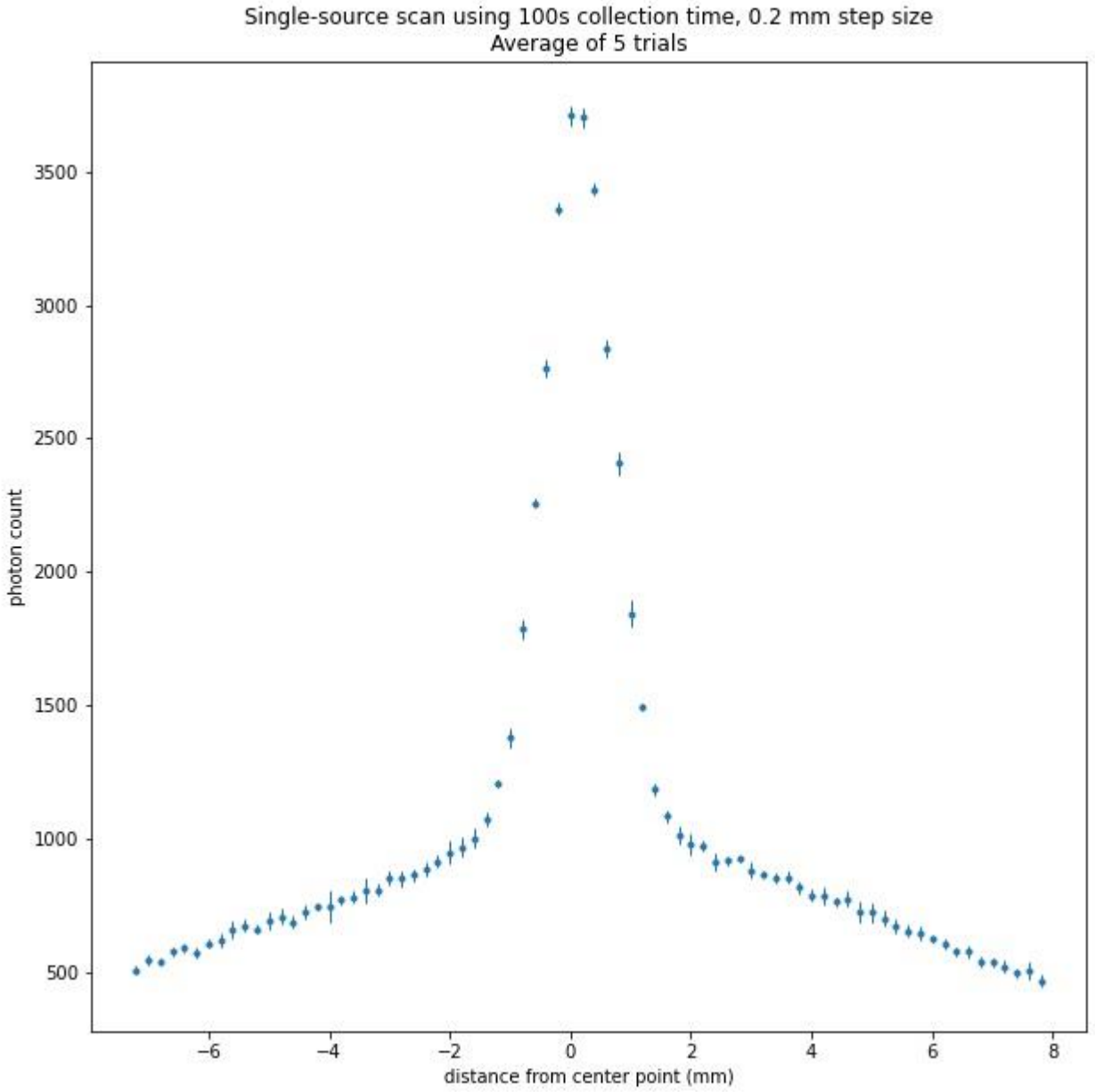
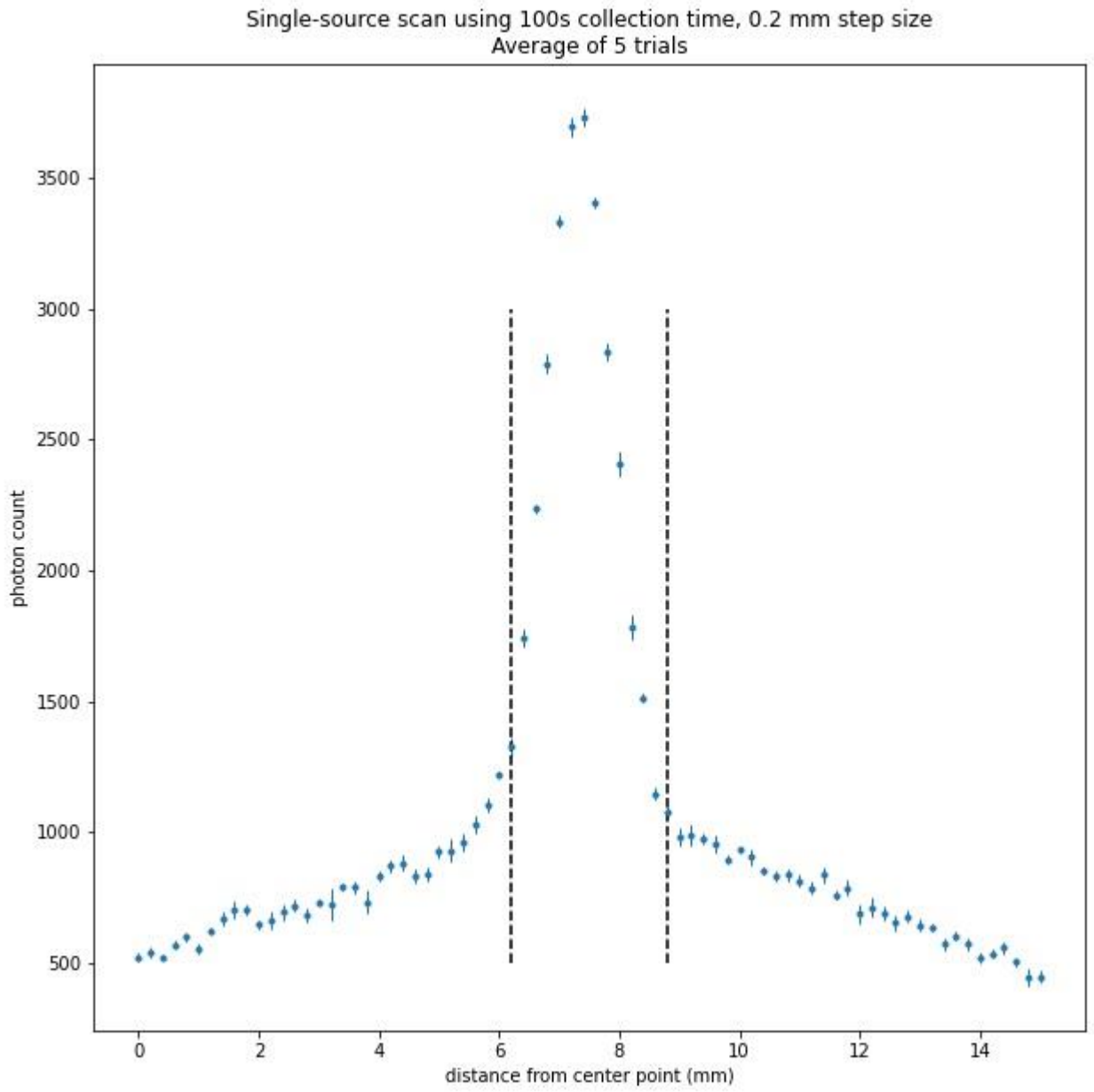


Measuring the primary signal:



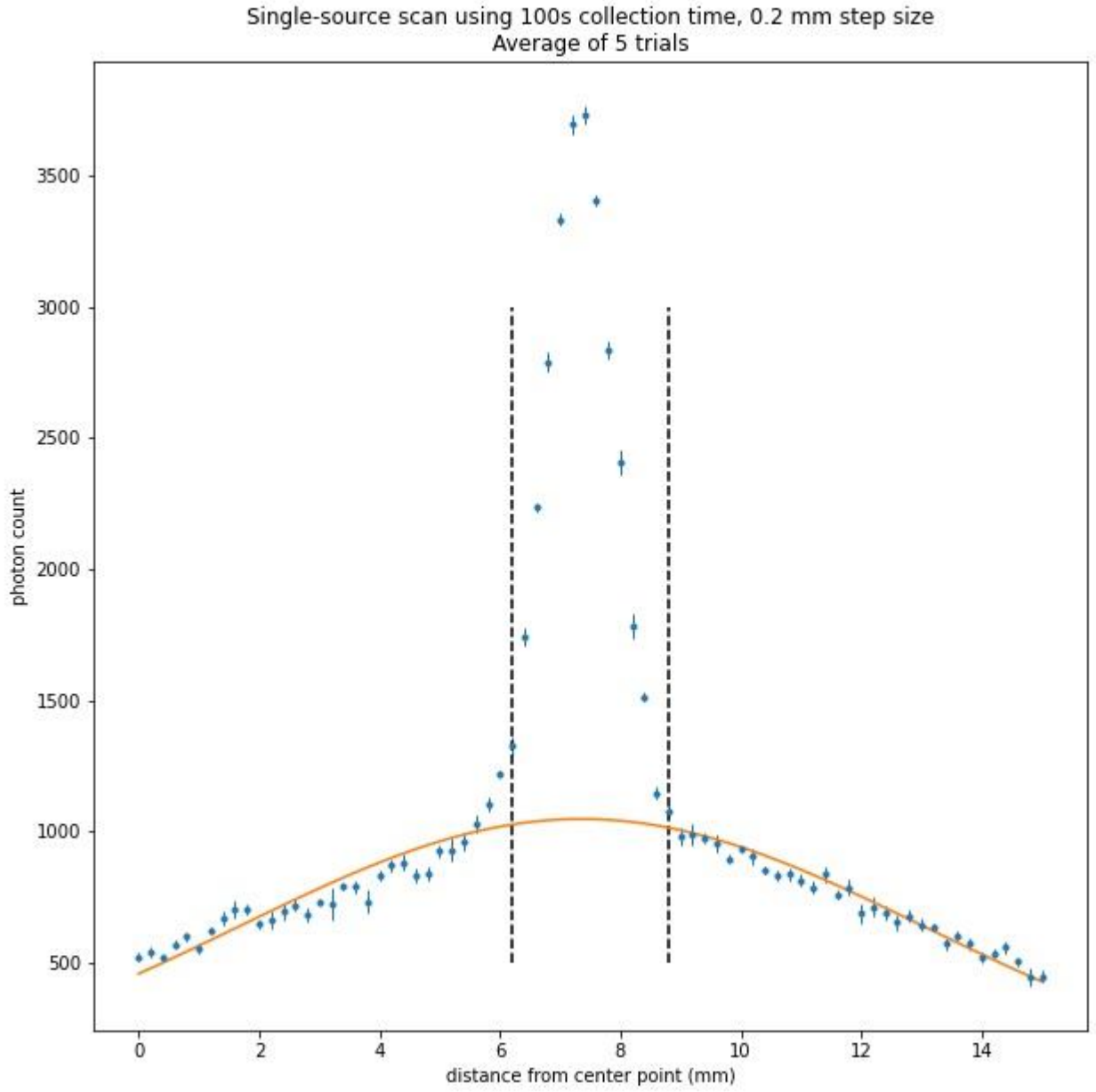
Measuring the primary signal:

1. Segment using first spatial derivative



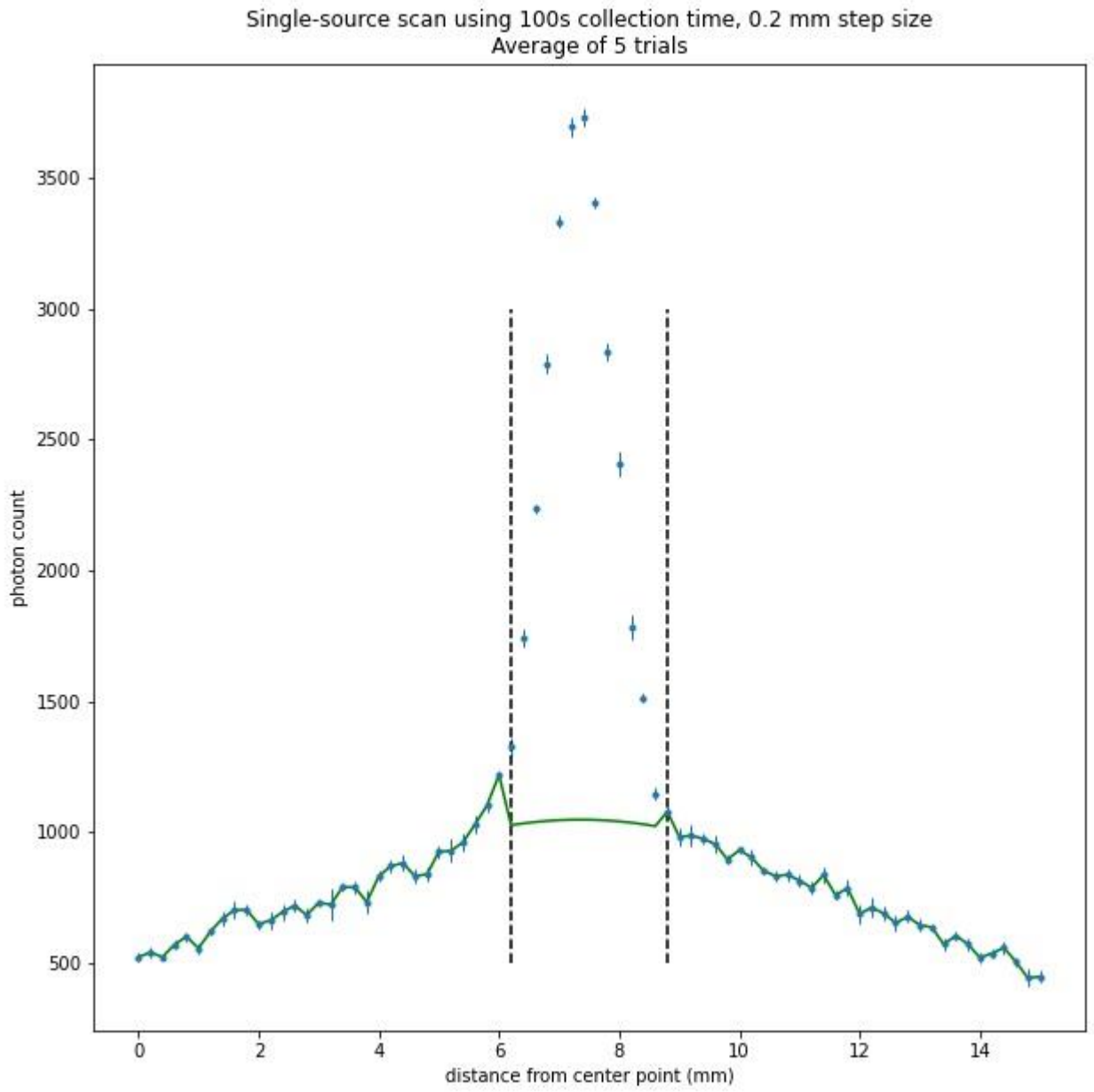
Measuring the primary signal:

1. Segment using first spatial derivative
2. Fit gaussian to the tails



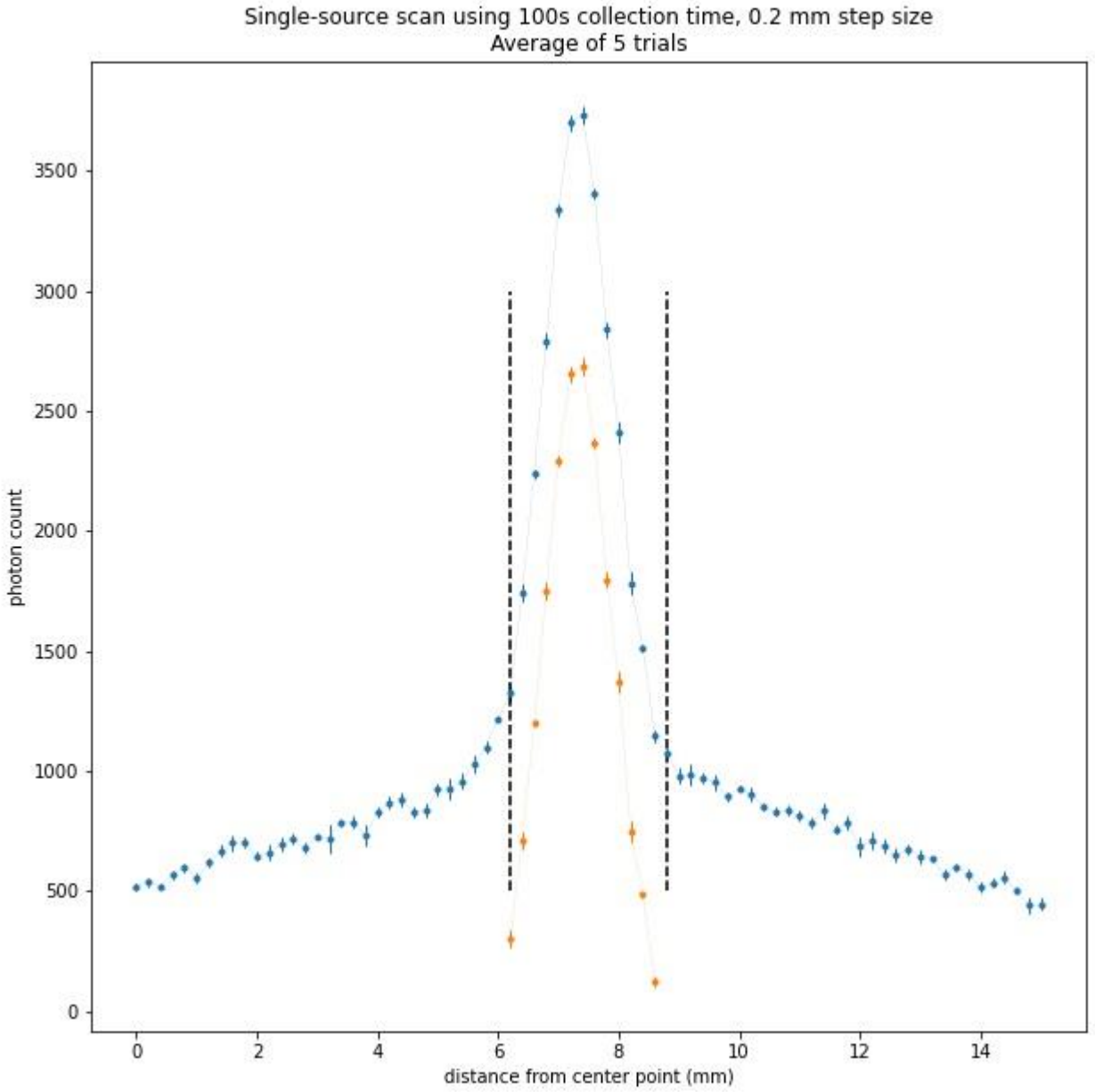
Measuring the primary signal:

1. Segment using first spatial derivative
2. Fit gaussian to the tails
3. Generate corrective signal



Measuring the primary signal:

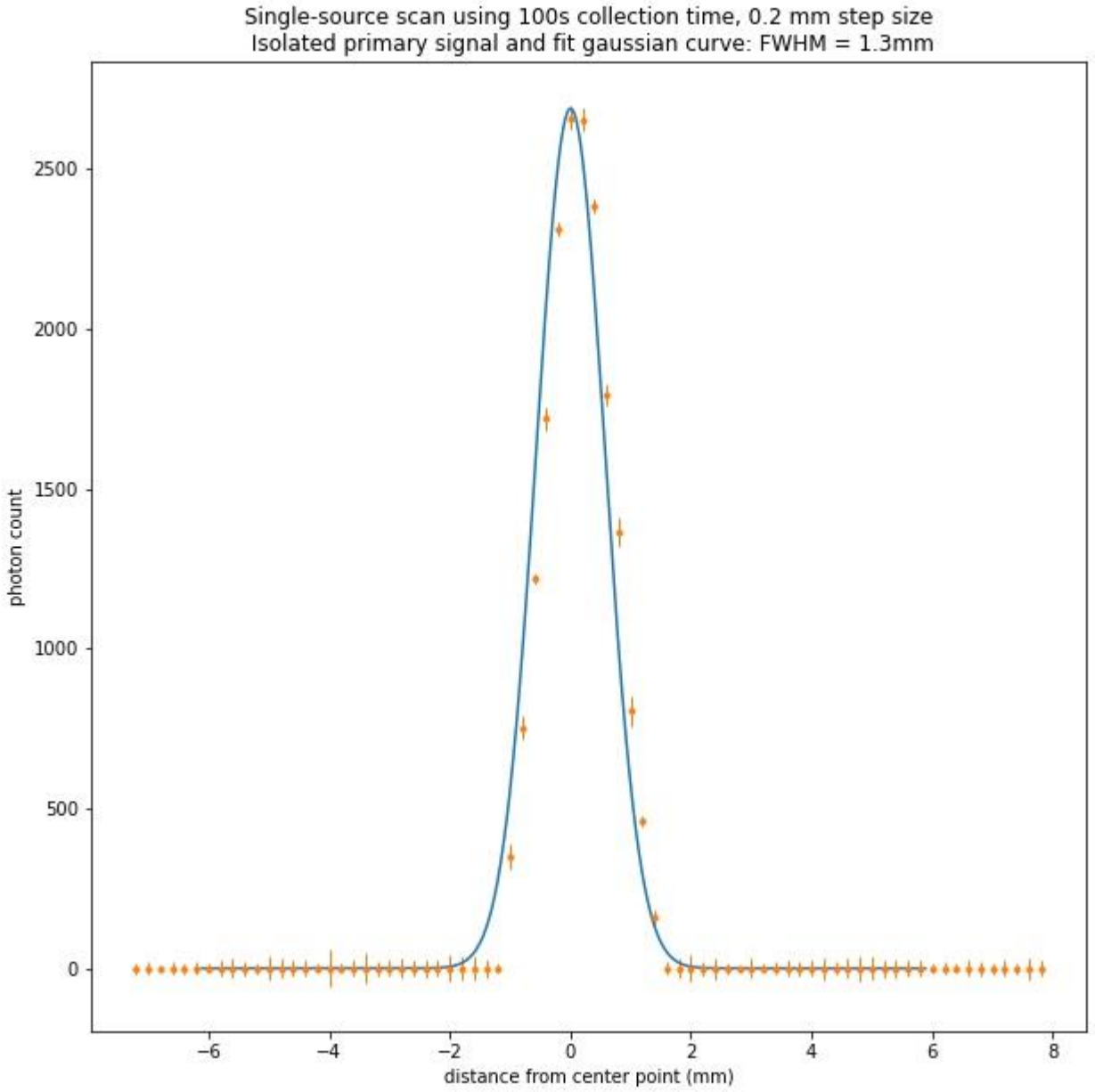
1. Segment using first spatial derivative
2. Fit gaussian to the tails
3. Generate corrective signal
4. Isolate the primary signal by subtracting the corrective signal



Measuring the primary signal:

1. Segment using first spatial derivative
2. Fit gaussian to the tails
3. Generate corrective signal
4. Isolate the primary signal by subtracting the corrective signal
5. Fit gaussian to the primary signal,

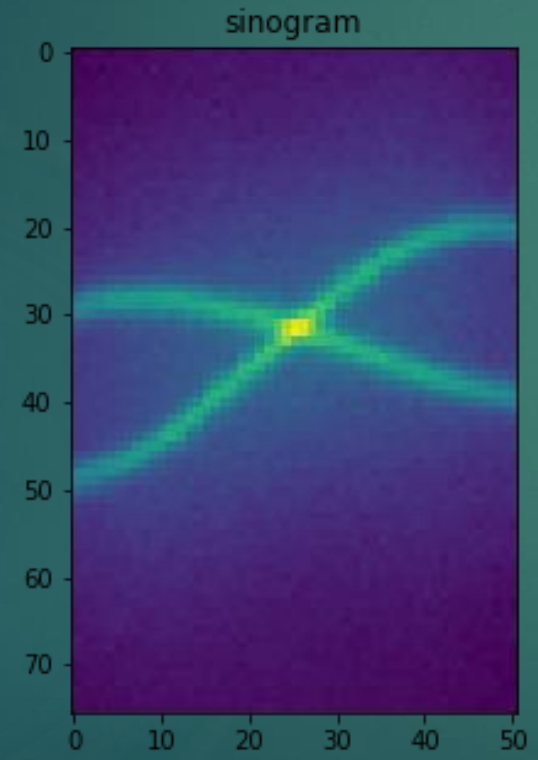
   measure full width @ half maximum (FWHM)

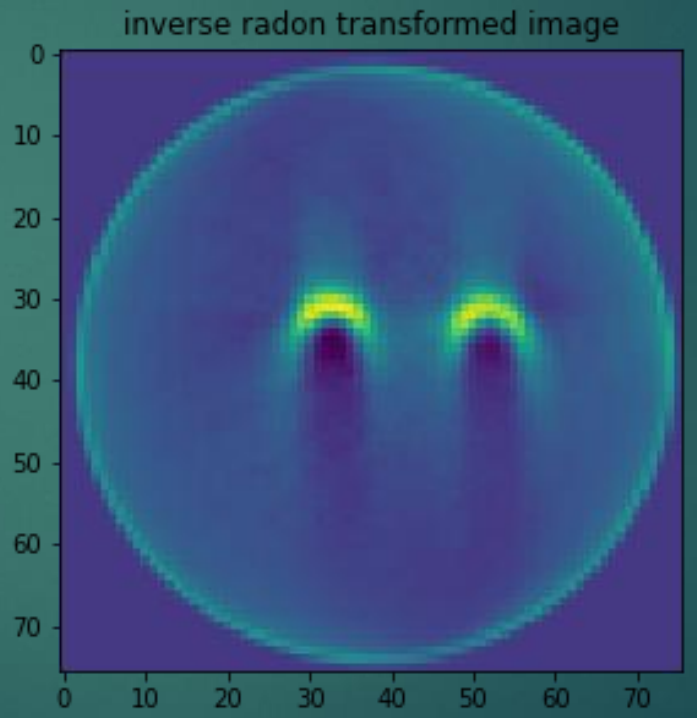


- Considering two sources figure
- Rotation progression

- Why is SNR important in this context?
- Medical application : looking for a tumour
  - Smaller signal
  - Important to get right

Result: reconstructed image final image





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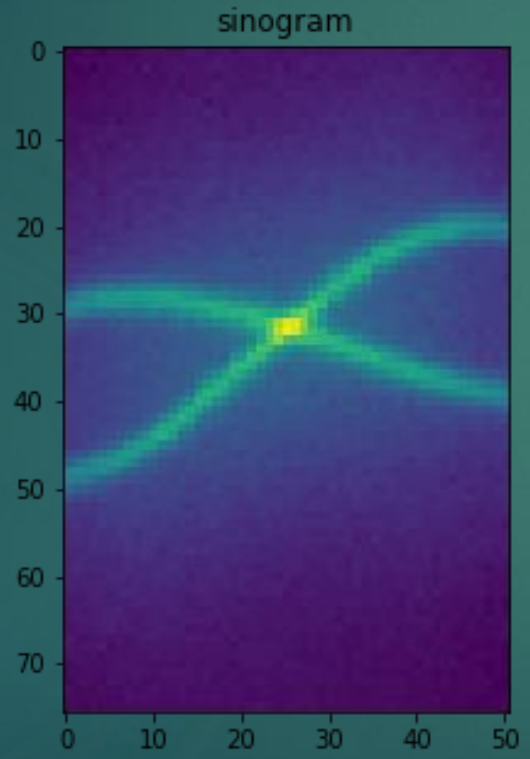
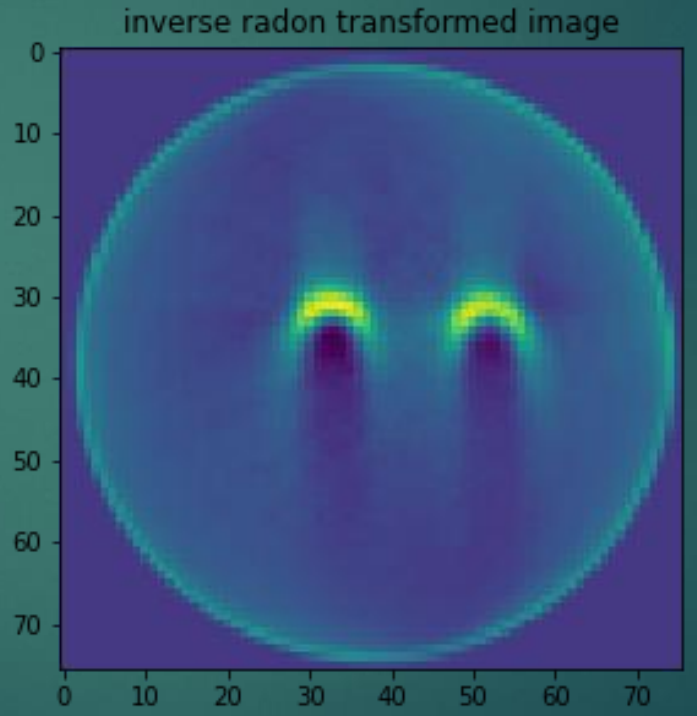
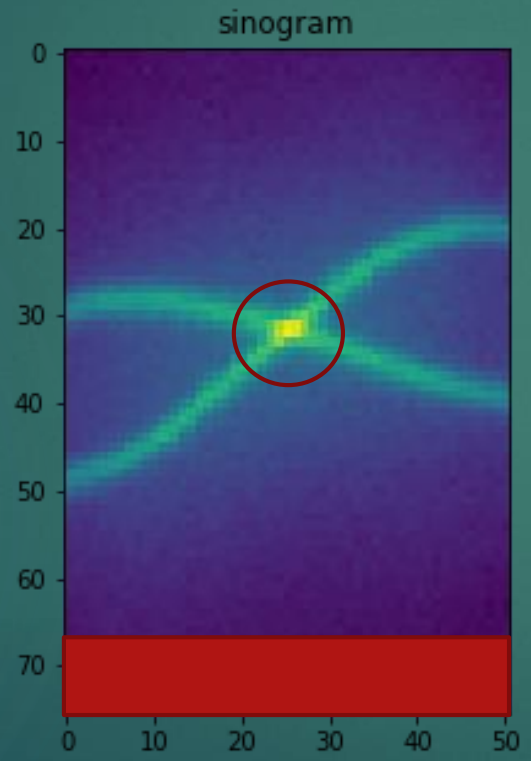


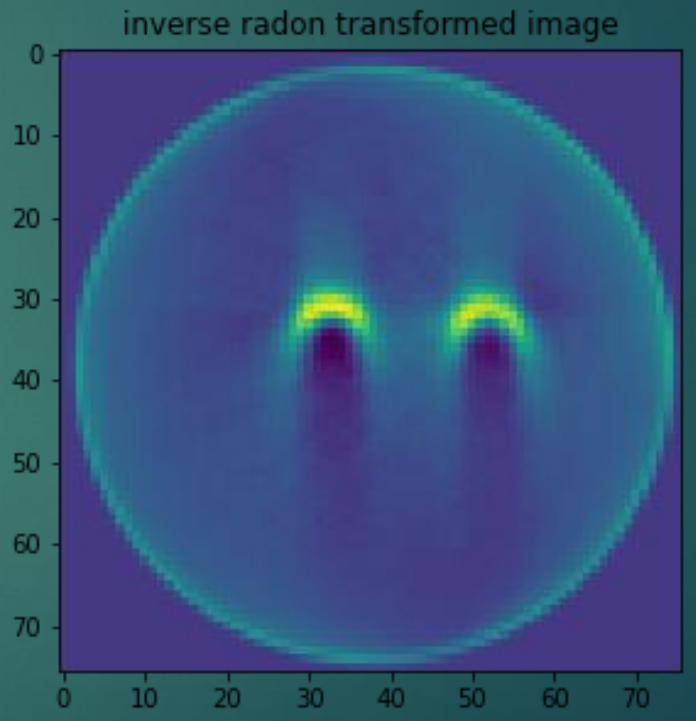


Sensative to scanner alignment!

Result: reconstructed image final image

Attempt to center this point on the spatial (vertical) axis by removing rows at the bottom:





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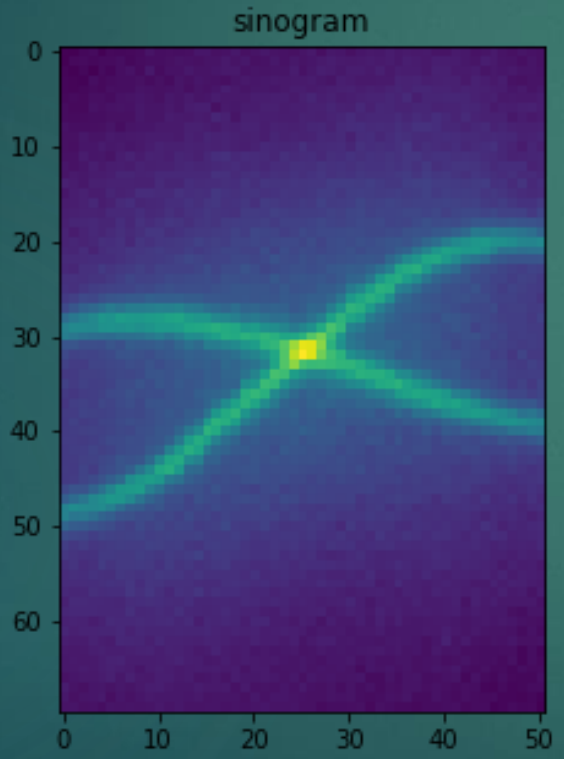
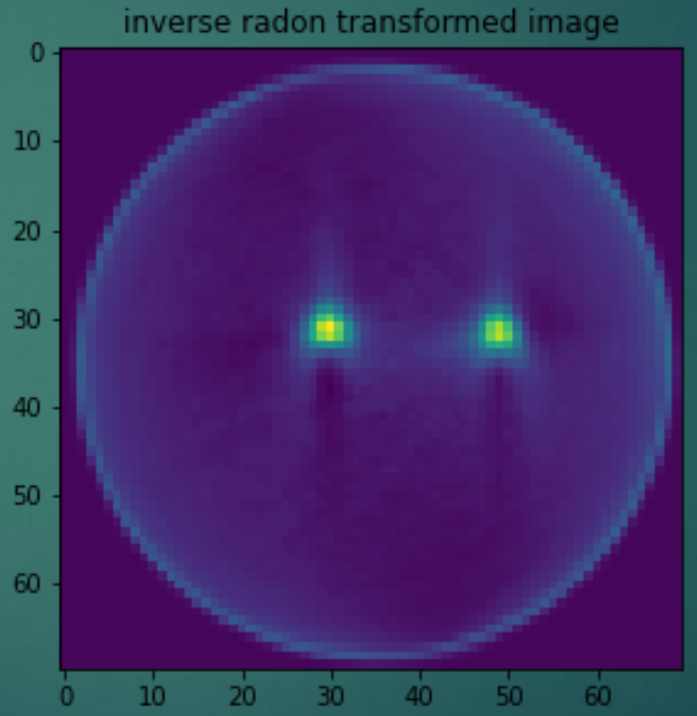
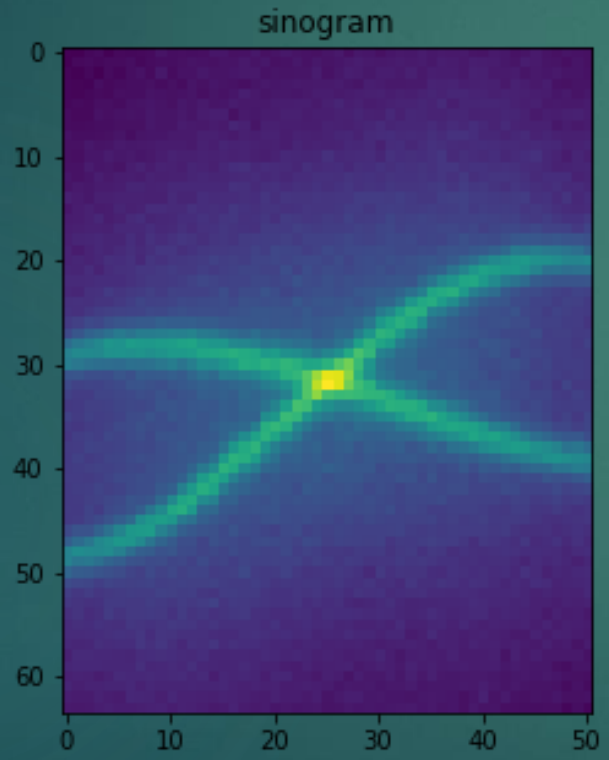




That's better!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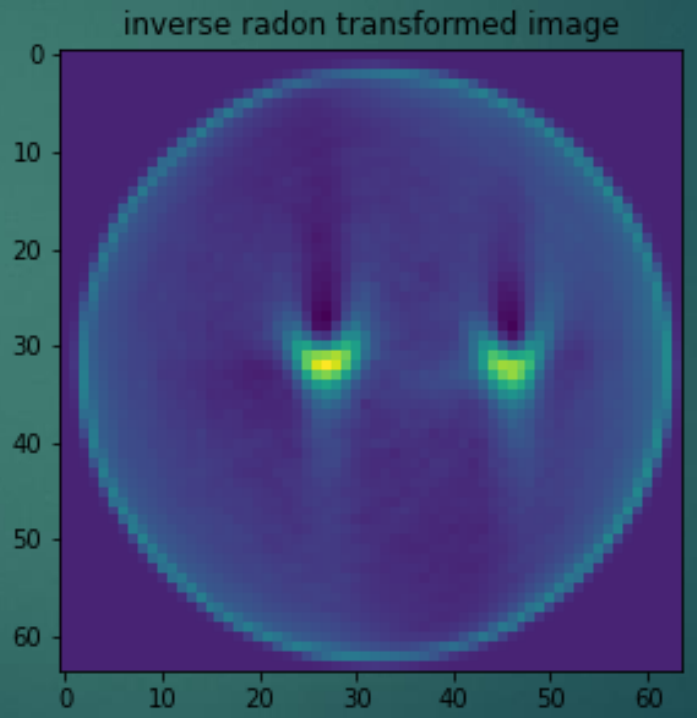
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