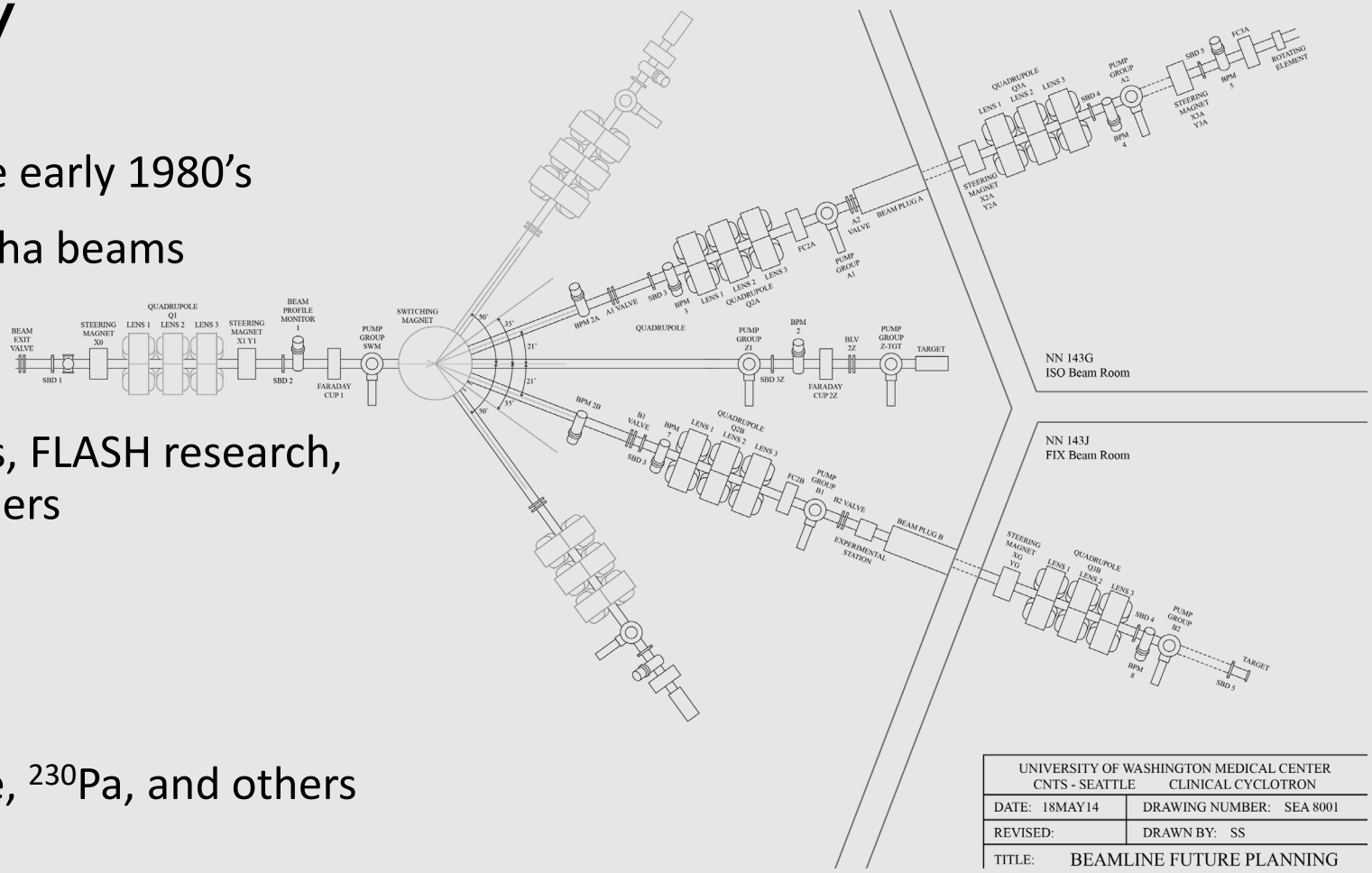
D-Pace UniBEaM Beam Profiler Integration and High Beam Power Scan Data at the University of Washington Medical Cyclotron Facility

Marissa Kranz, Eric Dorman, Robert Emery – University of Washington Medical Cyclotron Facility
Morgan Dehnel – D-Pace

Facility Overview

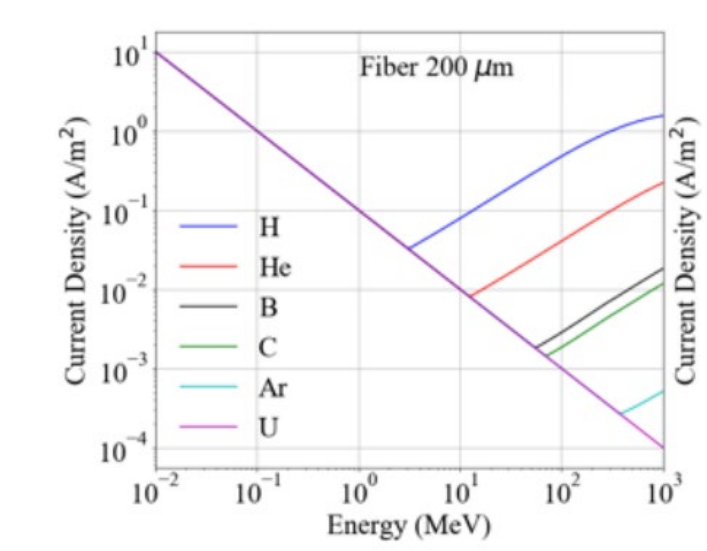
- Scanditronix MC-50 cyclotron built in the early 1980's
- Variable energy Proton, Deuteron, & Alpha beams
- 4 soon to be 5 beamlines
  - Clinical Neutron Therapy System
  - Proton Research Room: SEU analysis, FLASH research, SARRP comparative studies, and others
  - Isotope research station
  - Isotope production station
- Production Isotopes: ^{211}At, ^{117m}Sn
- Research Isotopes: ^{72}Se/^{72}As, ^{155}Tb, ^{186}Re, ^{230}Pa, and others
- EPICs based control system

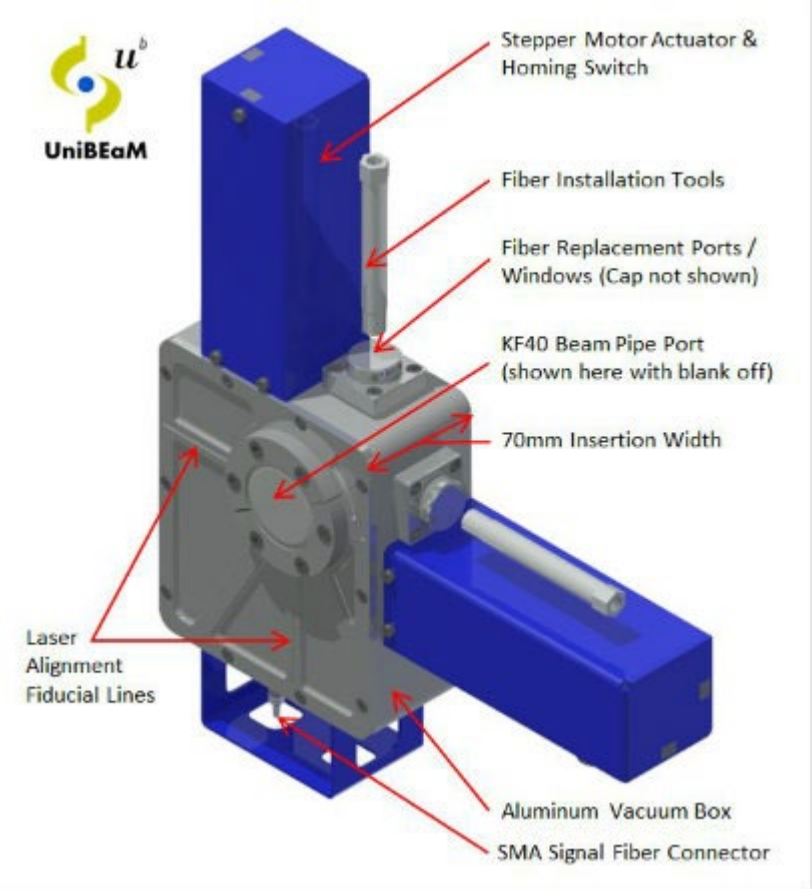


UniBEaM Scanner

- Optical fiber scanner that generates a line integral of beam current intensity along the x and y axes
- Withstands currents of alpha and deuteron beam that burned prior wire loop profile monitor
- Supports integration into EPICs control systems

- Current density limit for scanner governed by plot
- Going above these recommended limits results in saturated plots or melted/broken/burned fibers (something we learned many times)



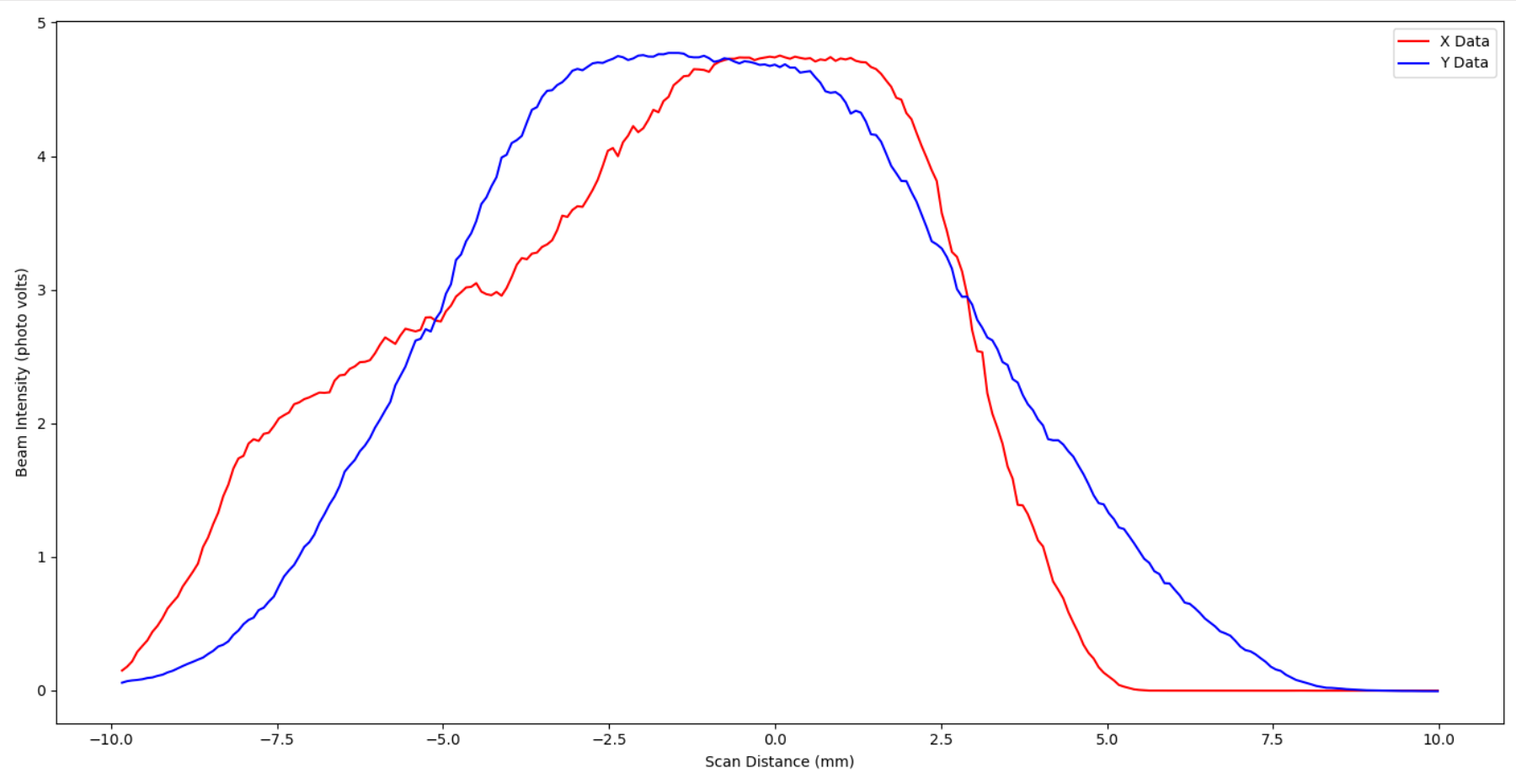


Images courtesy of D-Pace

Technology licensed from AEC-LHEP University of Bern


FARADAY CUP
CAUTION
HIGH RADIATION AREA
SCANDITRONIX

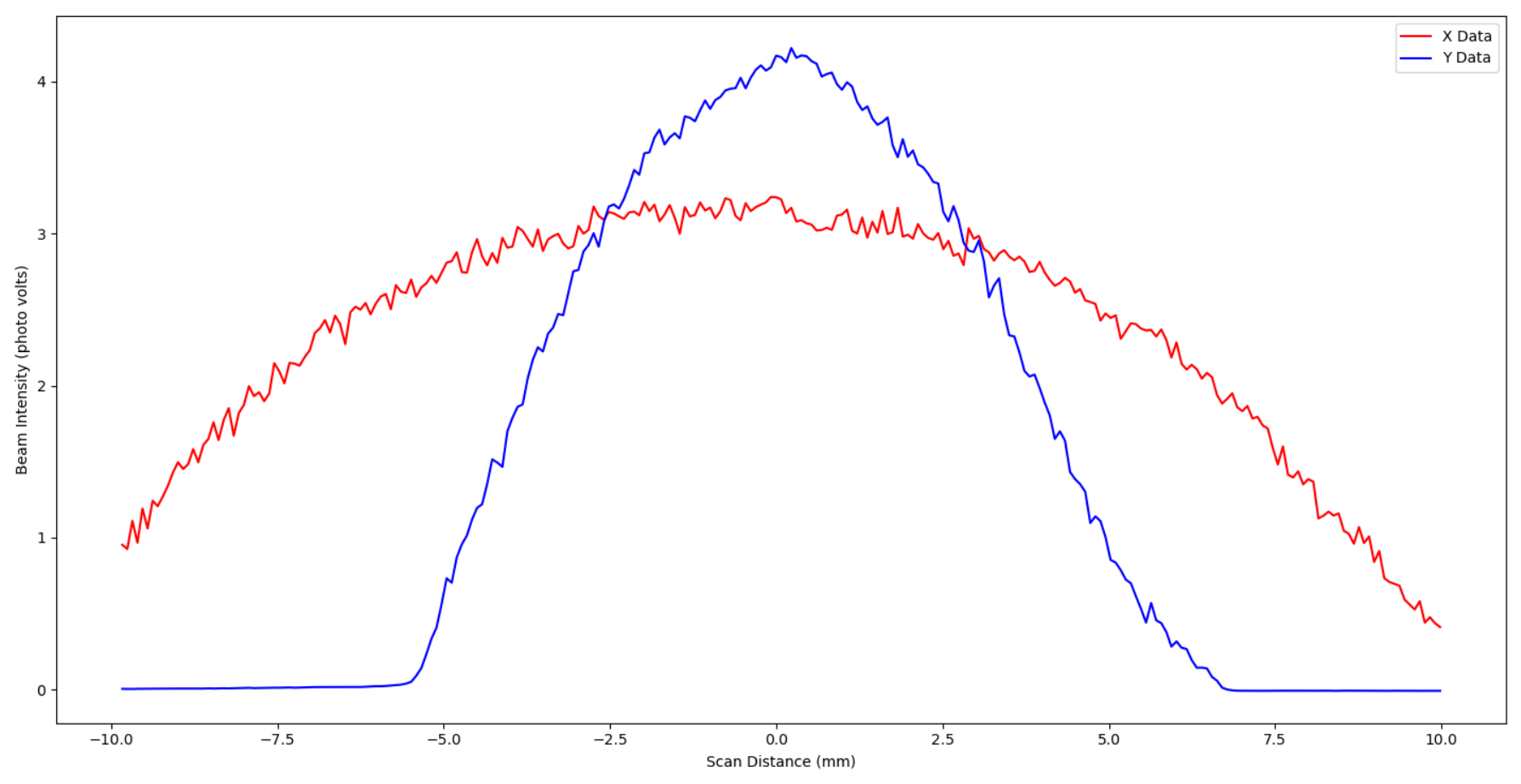
Beam Scans: 35MeV Protons



Beam Current: 0.5 uA

Estimated Beam Current Density: 0.0028 A/m^2

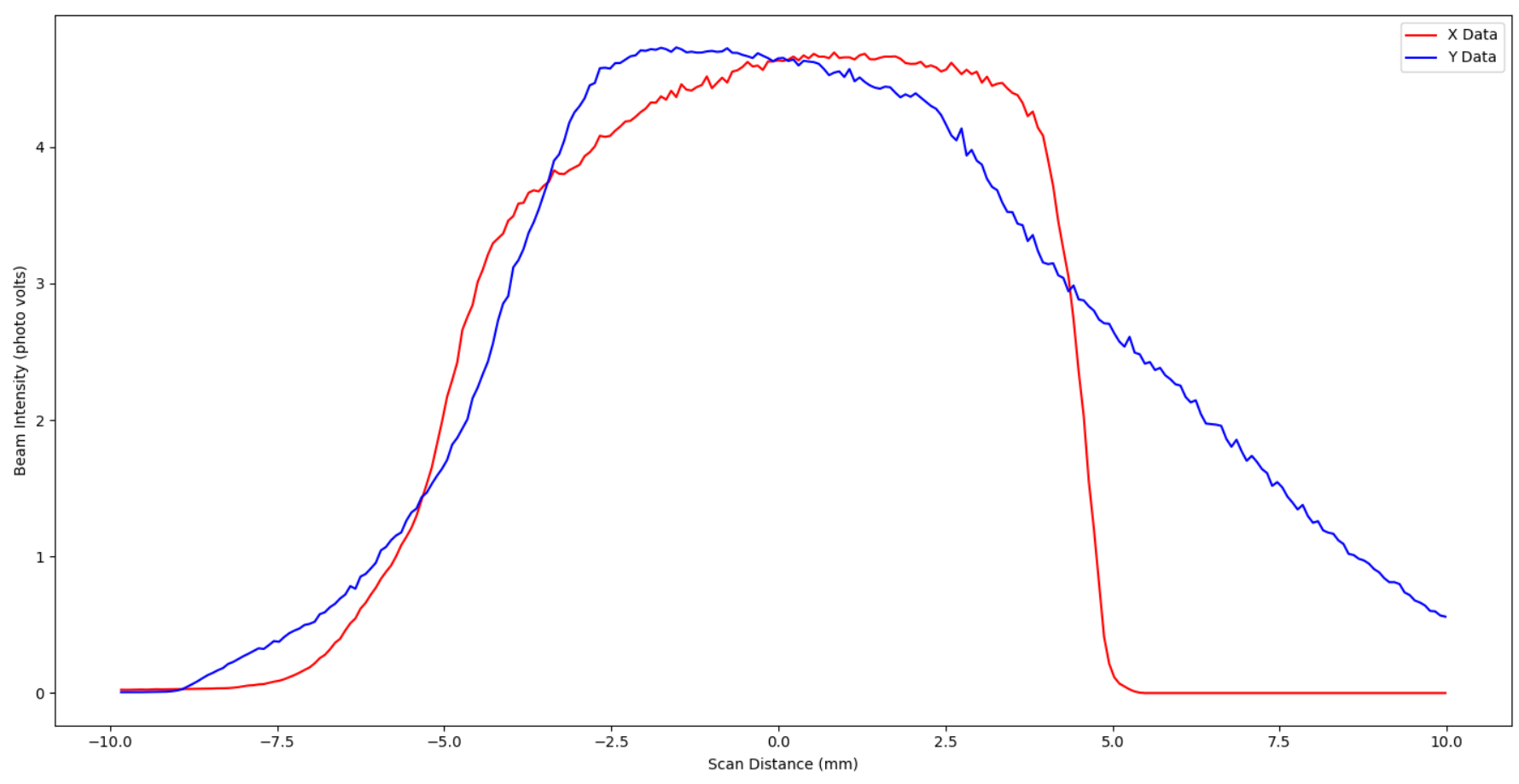
Beam Scans: 22MeV Deuterons



Beam Current: 0.4 uA

Estimated Beam Current Density: 0.00255 A/m^2

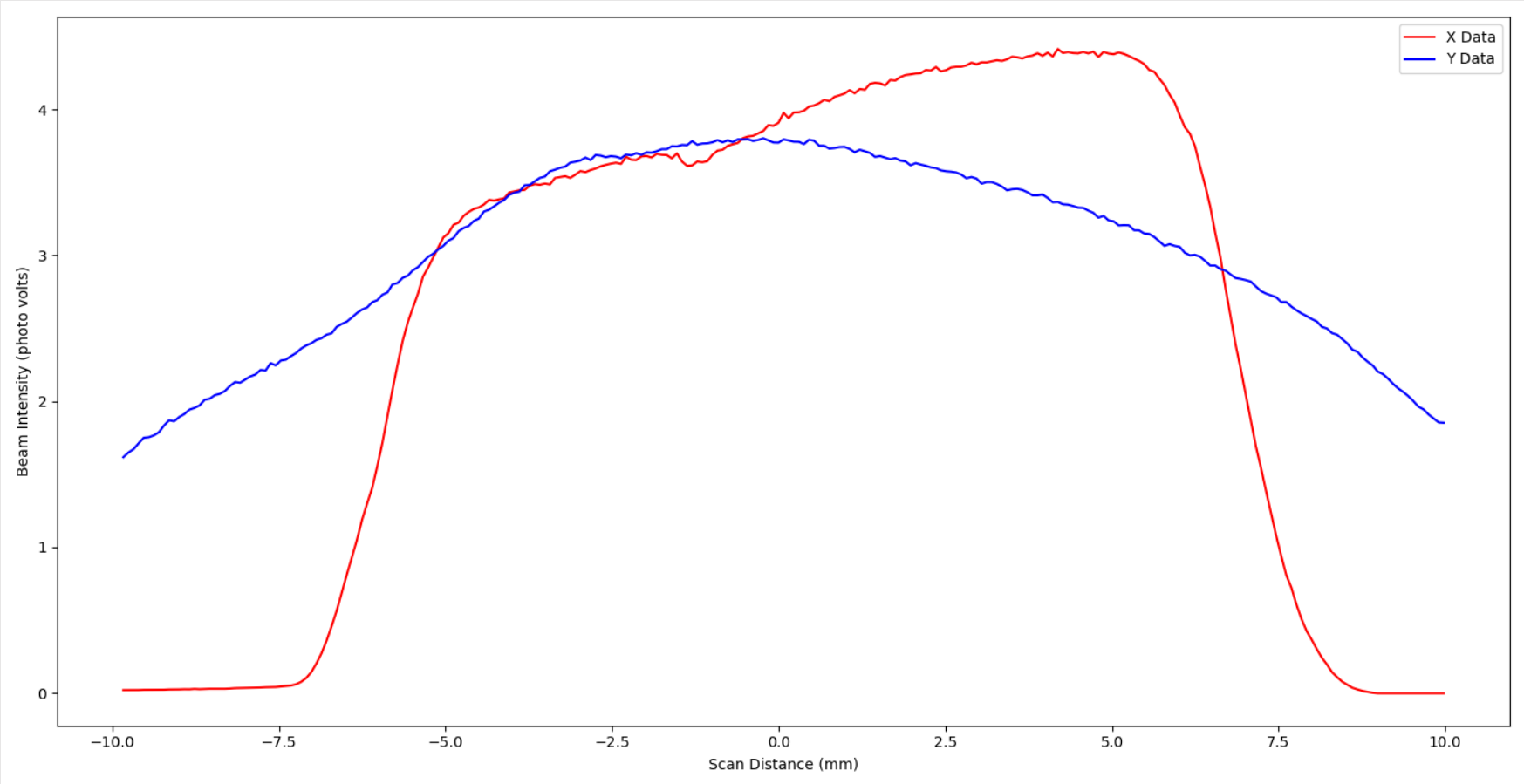
Beam Scans: 29MeV Alphas



Beam Current: 0.4 uA

Estimated Beam Current Density: 0.00233 A/m^2

Beam Scans: 47MeV Alphas



Beam Current: 0.5 uA

Estimated Beam Current Density: 0.0021 A/m^2

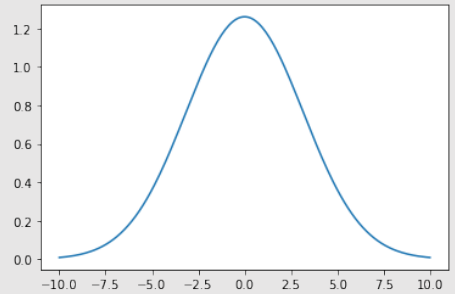
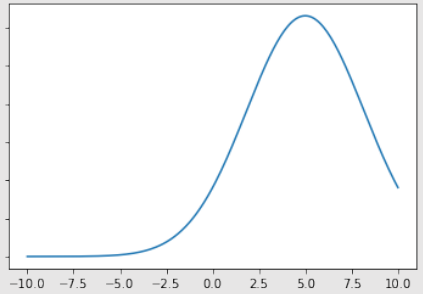
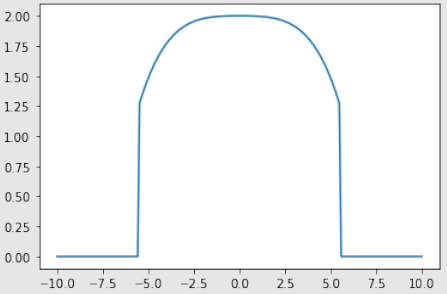
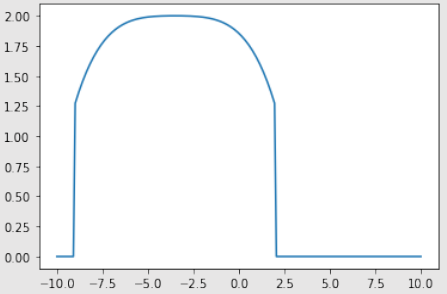
Saturation for both alpha beam energies started at about 0.8uA

2D Representation of the Beam Current

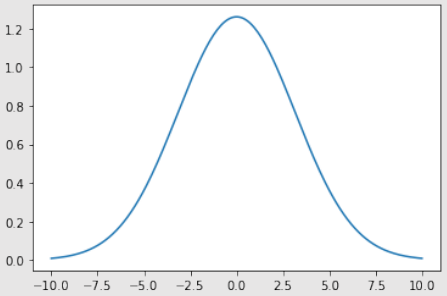
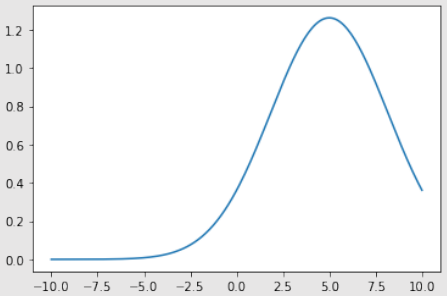
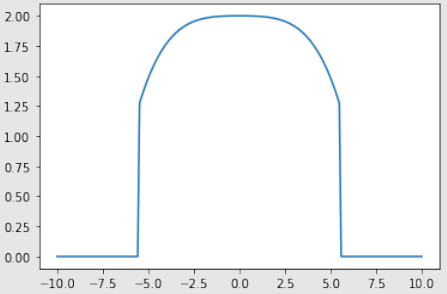
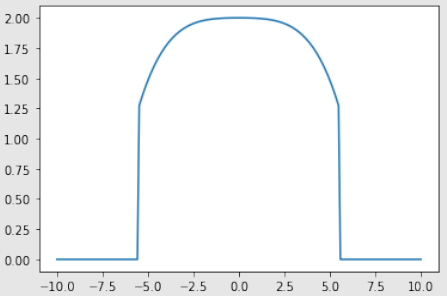
- A UniBEaM scan produces one array for the X-Axis intensity data and a similar array for the Y-Axis intensity data. The resolution for each axis scan is the same.
- Algorithm:
  - Transpose the Y-Axis array
  - Multiply the X-Axis and Y-Axis array to generate a matrix where each cell represents an (x,y) coordinate of the scanner window
  - Plot the matrix using imshow function of matplotlib python library that generates a color plot using the values in the matrix and a user specified color gradient

A Few Validation Examples

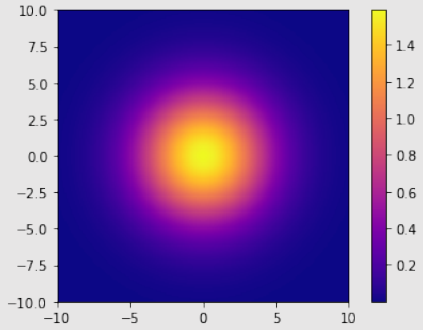
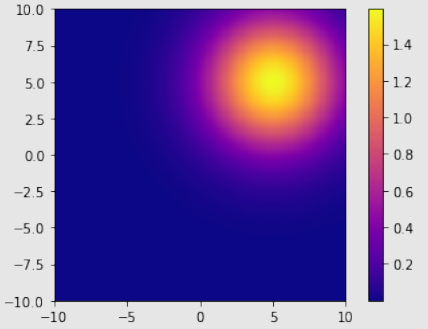
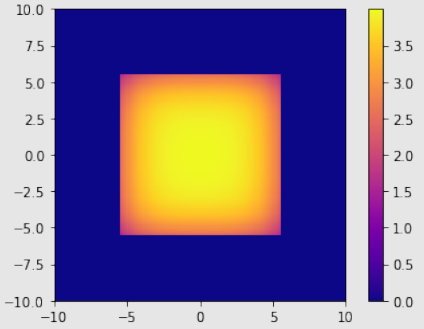
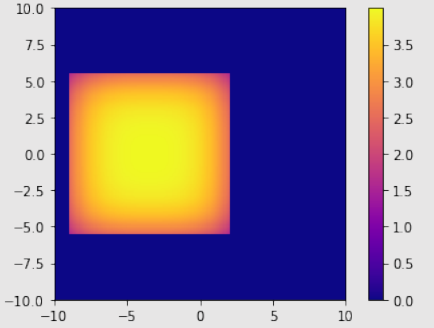
X-Axis

Y-Axis

2D

What does this give us?

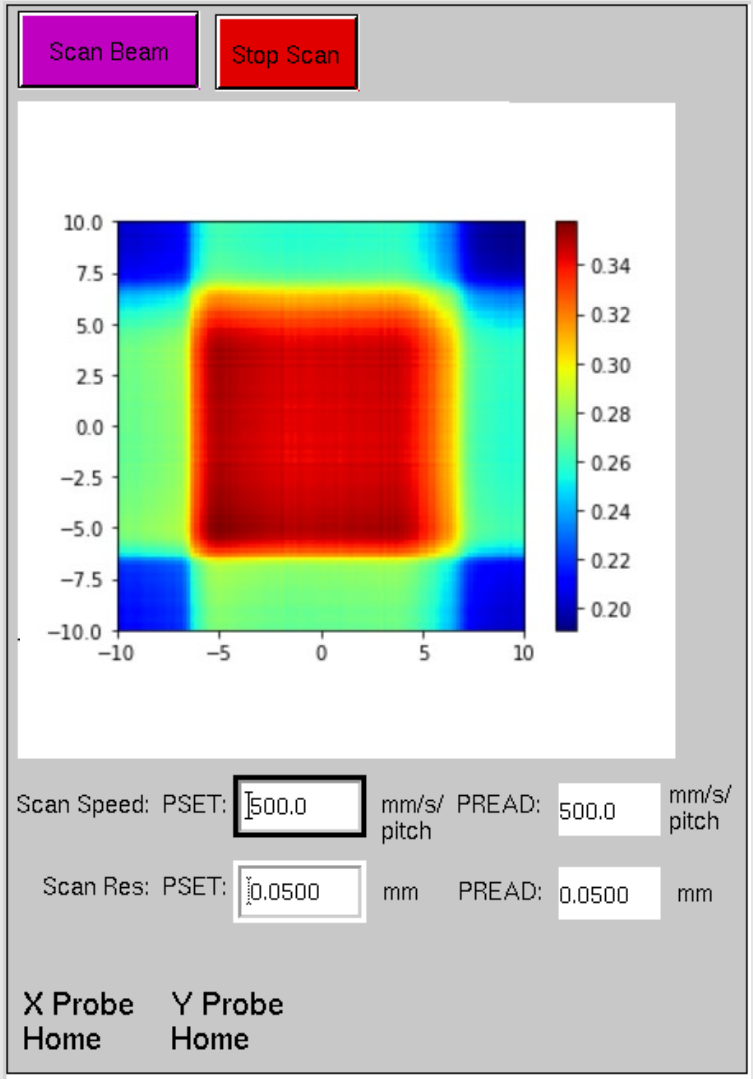
- A representation of the beam that is easier to interpret than line plots
- An exaggerated visual indication for each (x,y) point in the beam cross section that there is 'probably beam' or 'definitely no beam'
  - 'Probably beam': multiplication step in algorithm blurs areas of low beam intensity – problematic with double peaked beams or other non-standard shapes
  - 'definitely no beam': for any (x,y) location, a corresponding zero in either array means no beam

What does this not give us?

- Information on beam energy or current density
- A definitive beam spot shape

EPICs Integration

- UniBEaM Controller ethernet capable and had existing command library for integration into our EPICs control system
  - StreamDevice – device communication
  - PyEPICs – data processing and some EPICs processing
  - EDM – graphics display with 2D plot, control buttons, and some parameter input
- GUI on a touchscreen display in the cyclotron control console for operator use



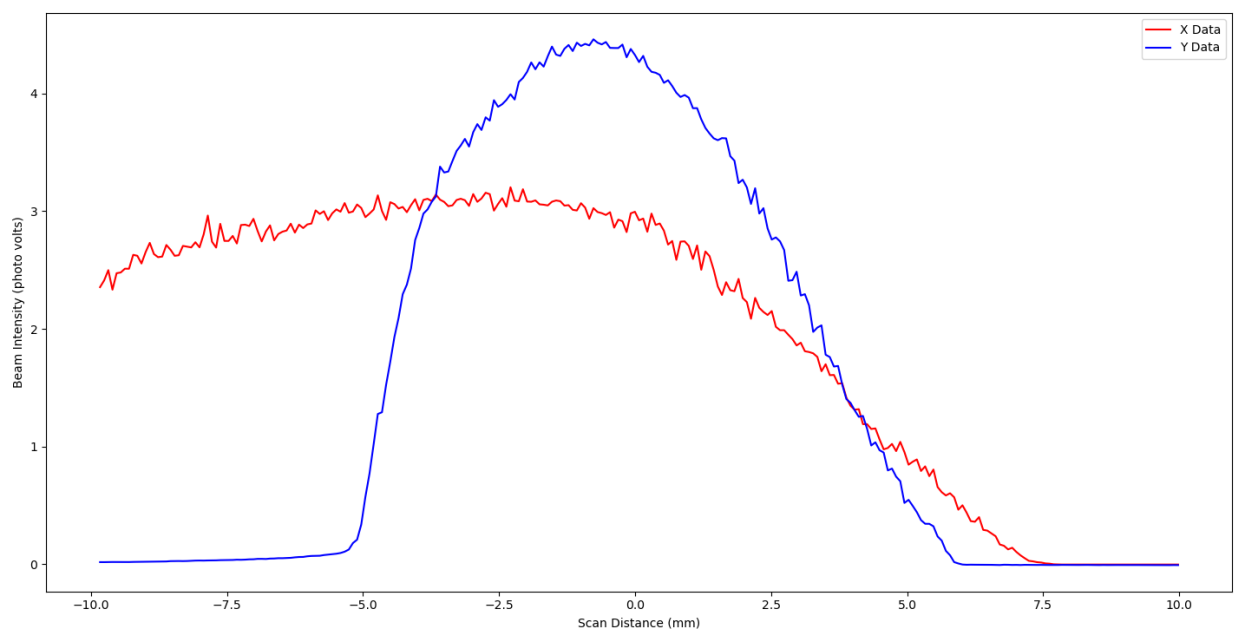
Acknowledgements

- D-Pace UniBEaM team: Kurt Dehnel, Dave Potkins, Jeff Martin, Andrew Richards
- Stefani Banerian

Support for conference attendance provided by D-Pace.

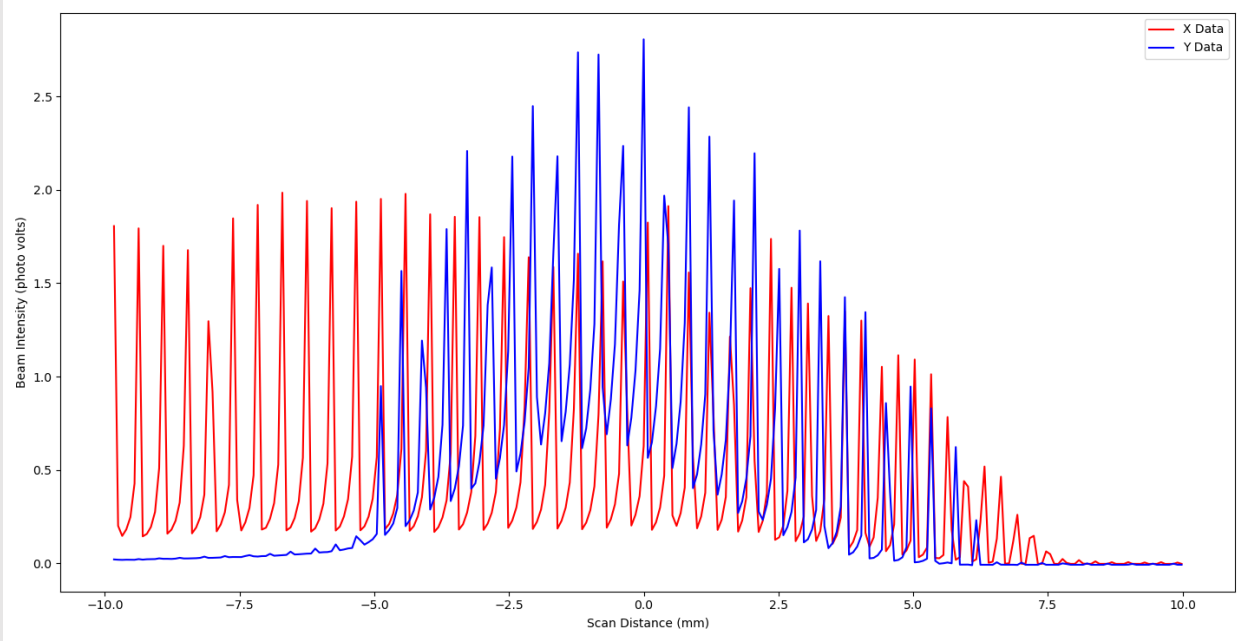
Questions?

Unexpected Benefit: Deuteron Impedance



Beam with standard deuteron source configuration:

- 2KΩ resistors



Scan with altered deuteron source configuration:

- 20KΩ resistors

Result of improper impedance matching of ion source power supply and deuteron plasma