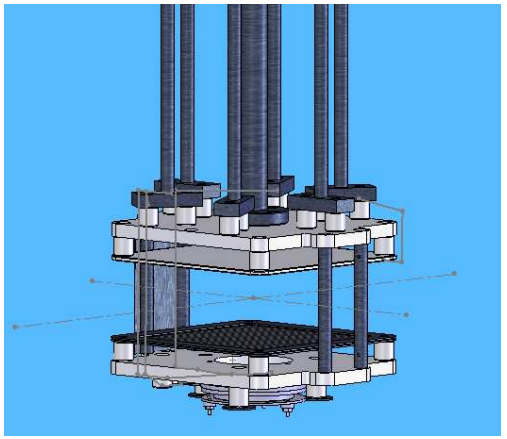
TITAN EBIT MCP Detector Assembly

Cecilia Leung
Undergrad summer student 2007



TRIUMF Summer Student Symposium
Tuesday, July 31 2007

OUTLINE

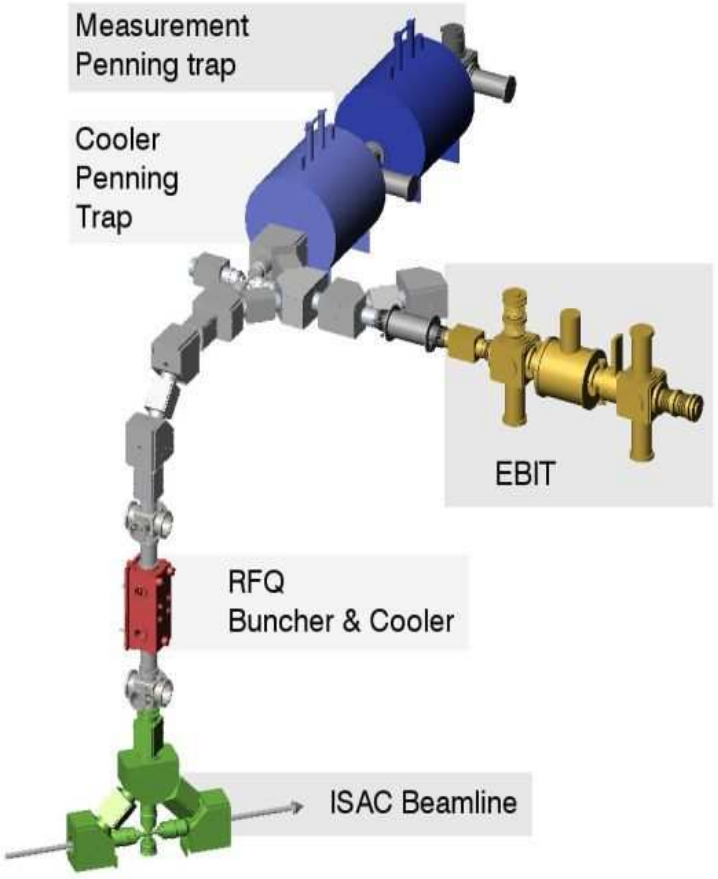
- TITAN Facility at TRIUMF
- EBIT (& its role)
- DETECTOR SYSTEM
  - Requirements
  - Design
  - Working specifications
- CONCLUSION

TITAN Facility at TRIUMF

- TRIUMF's Ion Trap for Atomic & Nuclear physics
- Located in ISAC I

- Binding E = fundamental property of nucleus.
- Performs high-precision atomic mass measurements of short-lived isotopic ions

- 3 main components:
  - RFQ
  - EBIT
  - MPET



Role of the EBIT

- The precision of mass measurements is a function of the ion charge state, *q*.

$$\frac{\delta m}{m} \propto \frac{m}{T_{obs} q B \sqrt{N}}$$

where m = mass of ion
t = observational time
q = ion's charge
B = applied magnetic field
N = # of ions

Mass measurement uncertainty formula developed at ISOLTRAP at CERN
G. Bollen et al. Nucl. Phys. A 693, 3 (2001)

- so…

  For a fixed observation time, accuracy of mass measurements increases with higher charge states

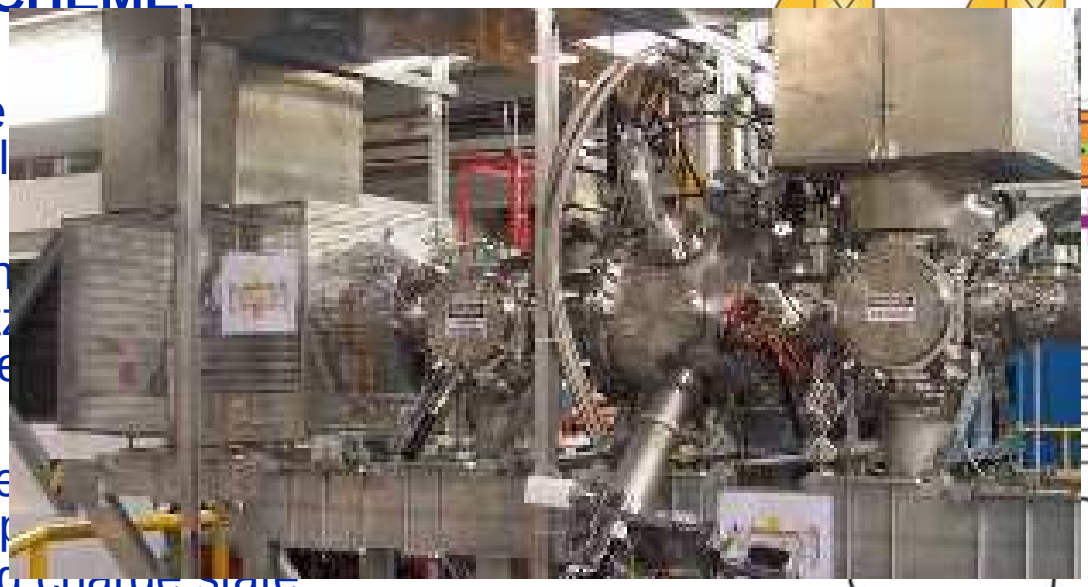
TITAN
ISAC-TRIUMF

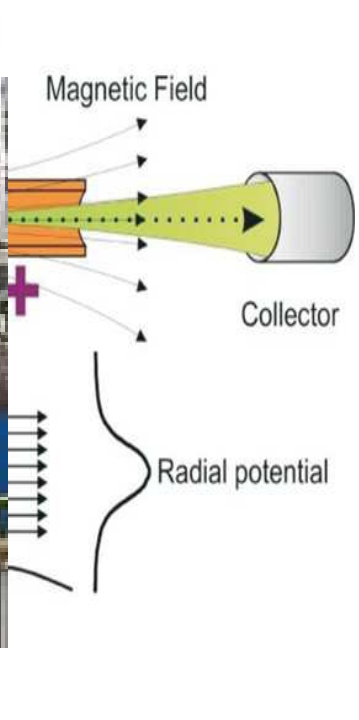
EBIT- Electron Beam Ion Trap

FUNCTION: trap short-lived isotopes from ISAC and breed them into highly charged ions (HCI's)

TRAPPING SCHEME:

- Axial: segme
  potential well
- Radial: magn
  the Helmholtz
  of electron be
- While confine
  collide w/ trap
  to the desired charge state.





Detector System

Need of a diagnostic system:

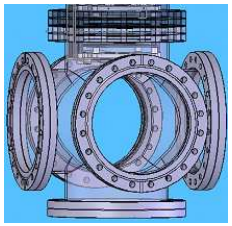
- Provide on-line information
- Image beam
- Alignment

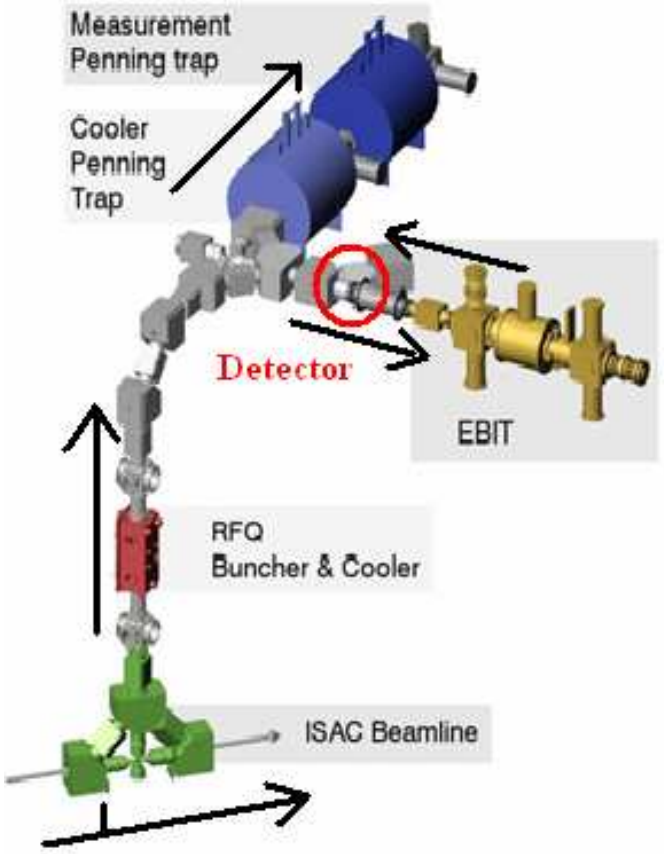
→ Not hard to detect beam. Insert detector in beam path. But we can do a little better.

Requirements:

1. Detector sensitive to Radiation damage
2. Accommodate beams from both ends

   (EBIT and RFQ): injection & extraction
3. Image = good representation
4. Fit inside 8” 6-way cross





TITAN
ISAC-TRIUMF

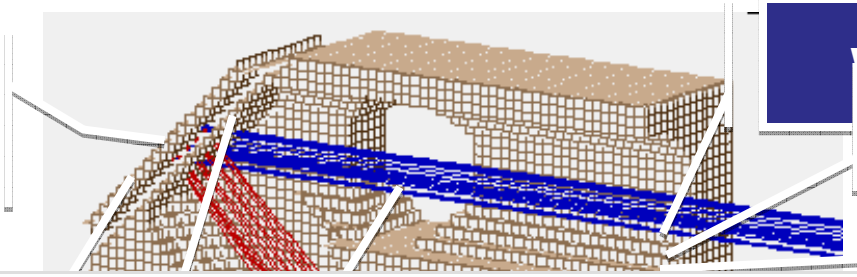
Preliminary Design

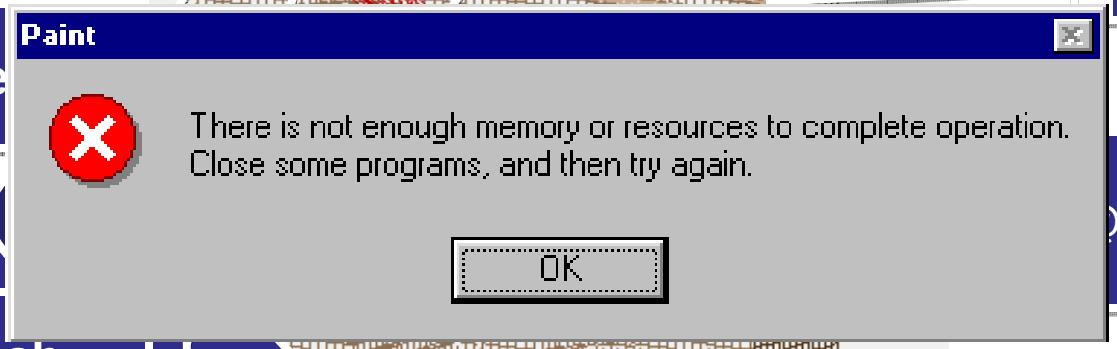
Electrostatic Plate @ 45 °

Wire Mesh

Wire Mesh

Support Plate





Wire Mesh

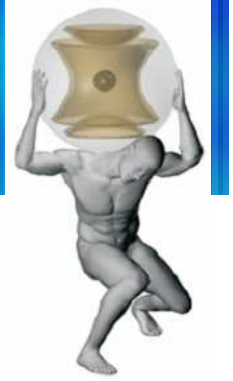
8 Electrical Feedthroughs

Mirror tilted @ 65 deg

CCD Camera

Mirror tilted @ 125 deg

TITAN
ISAC-TRIUMF



Thank goodness Occam's Razor Prevails.

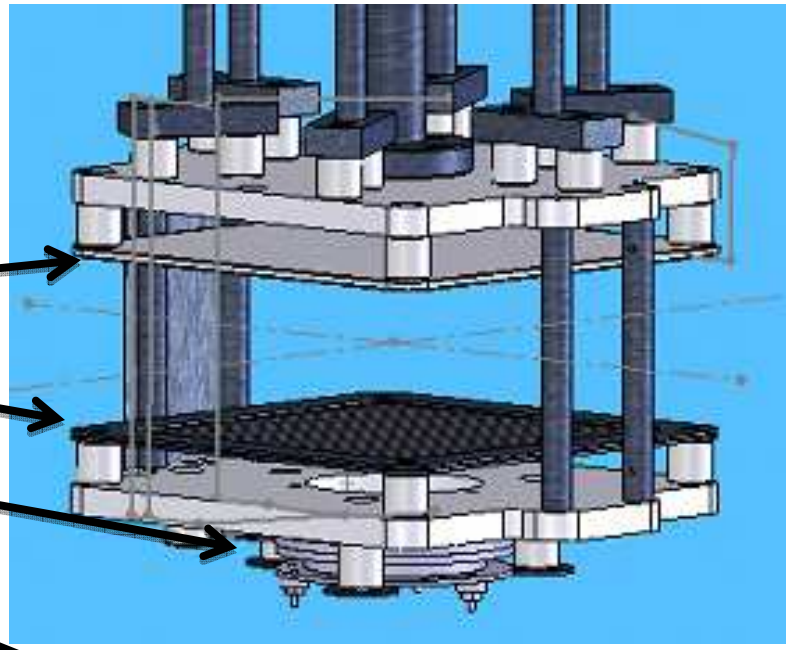
"Entities should not be multiplied beyond necessity."

Can we come up with something more elegant??

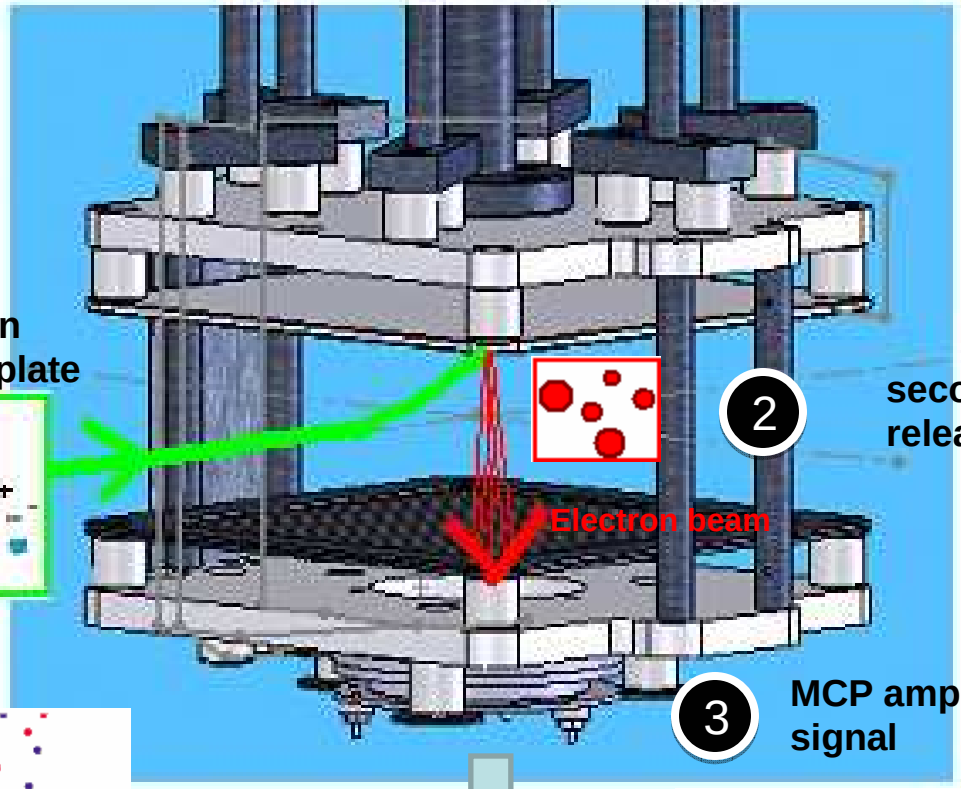
Daly-type detector

Basic Components:

1. Electrostatic plate
2. Wire mesh
3. MCP
4. CCD camera

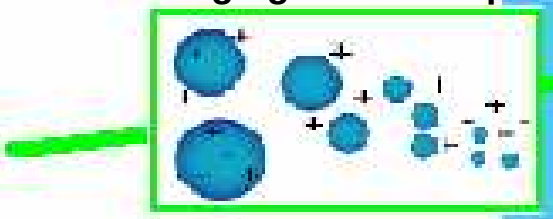


TITAN
ISAC-TRIUMF



1

radioactive ions strike an overhanging aluminum plate



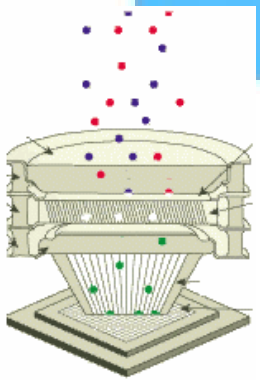
Ion beam

2

secondary electrons released

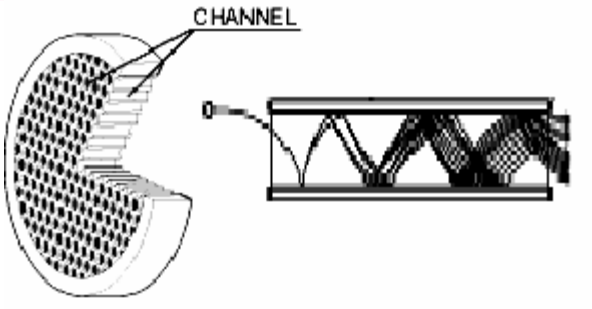
3

MCP amplify signal



4

Signal to CCD Camera

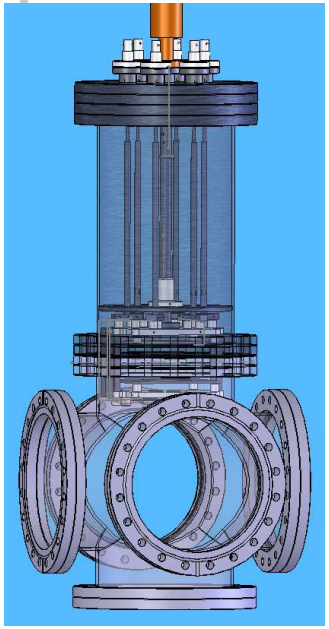


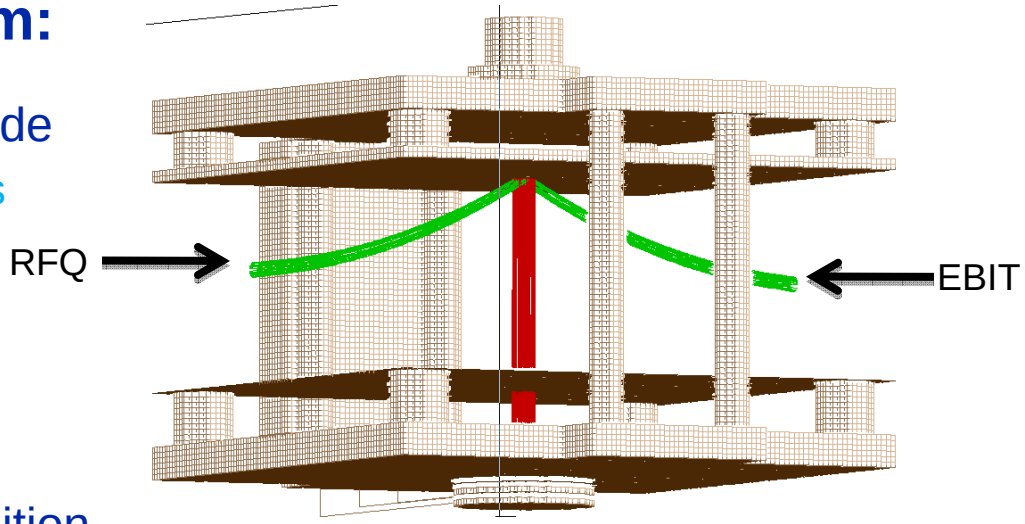
Features

2-way beam imaging system:

a. V-on = detection mode

- beam from both ends



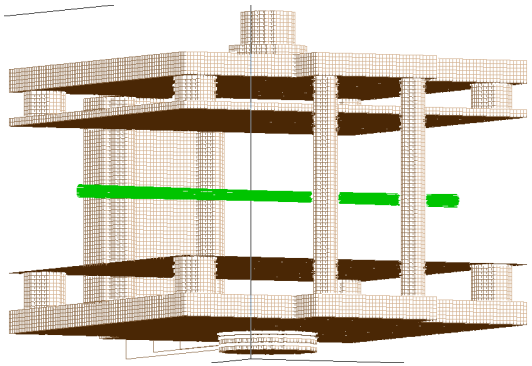


b. V-off = Through position

- No rotation or linear actuation !!!
- Avoid frequent alignment

c. Retractable

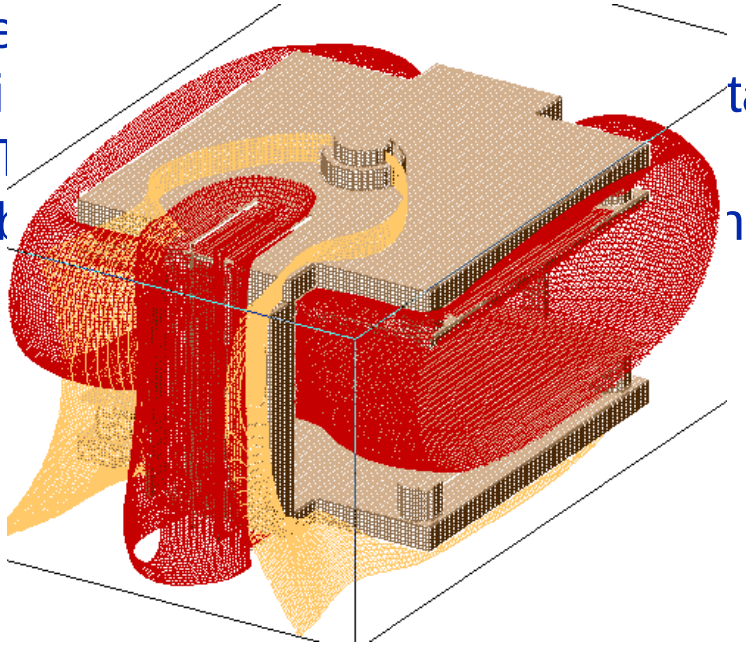
- Insert Faraday cups in tight space.

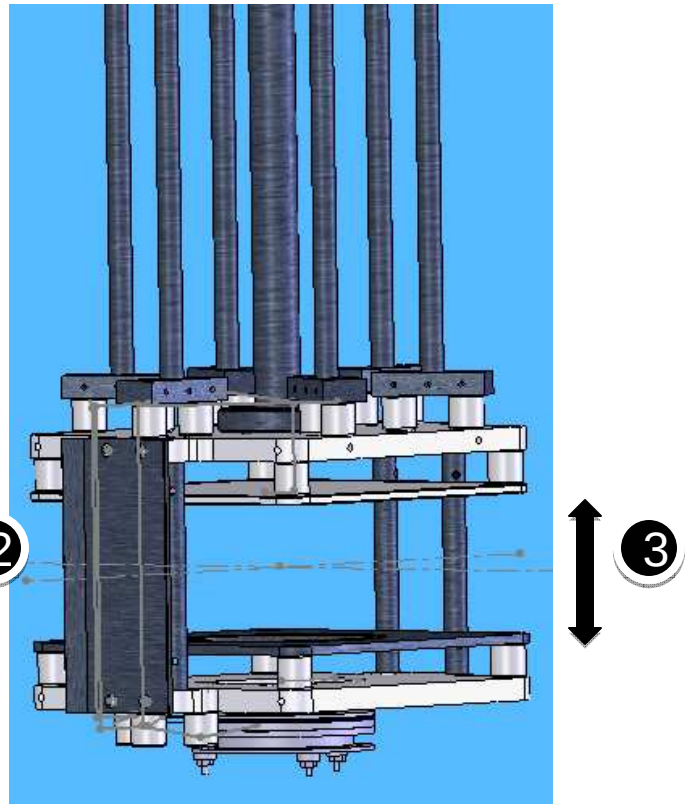


Structural Design

Challenges:

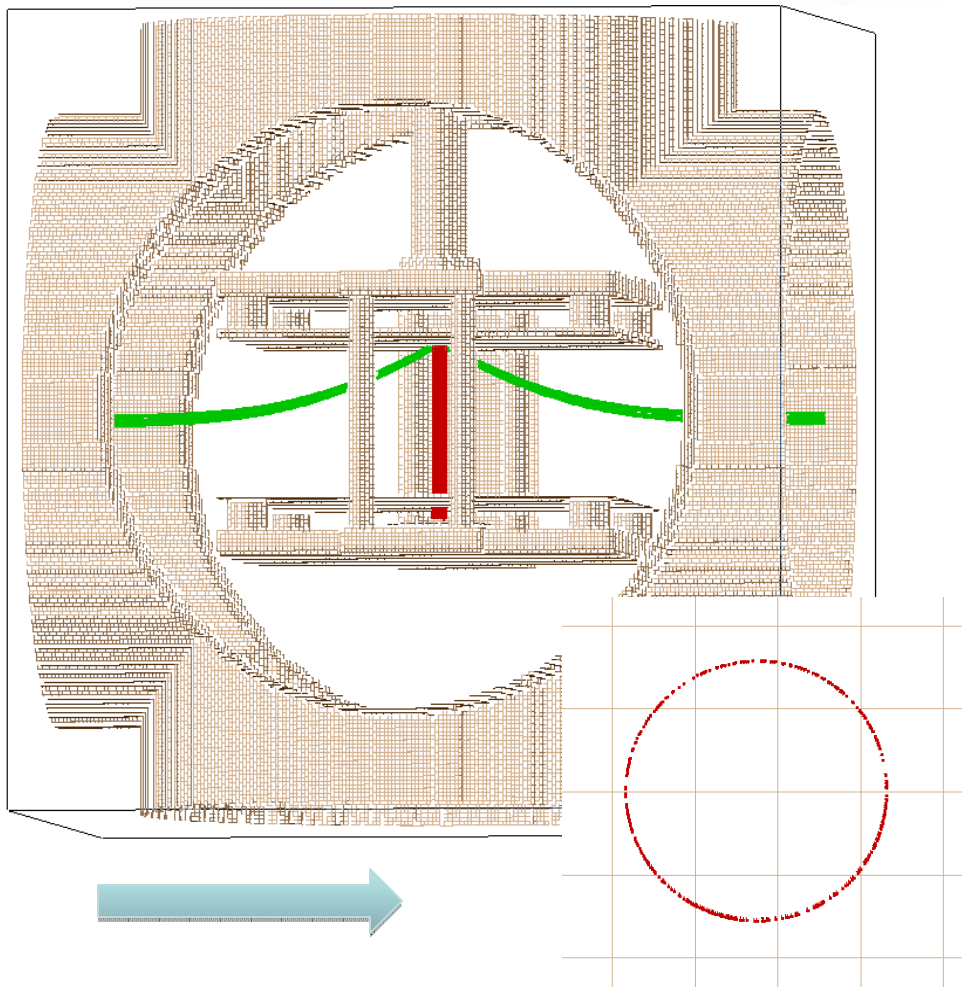
1. Determine support structure that minimize distortion to homogeneous electric field
2. Wire
3. Opti tance
4. EBIT
5. Ion b n





Simulations

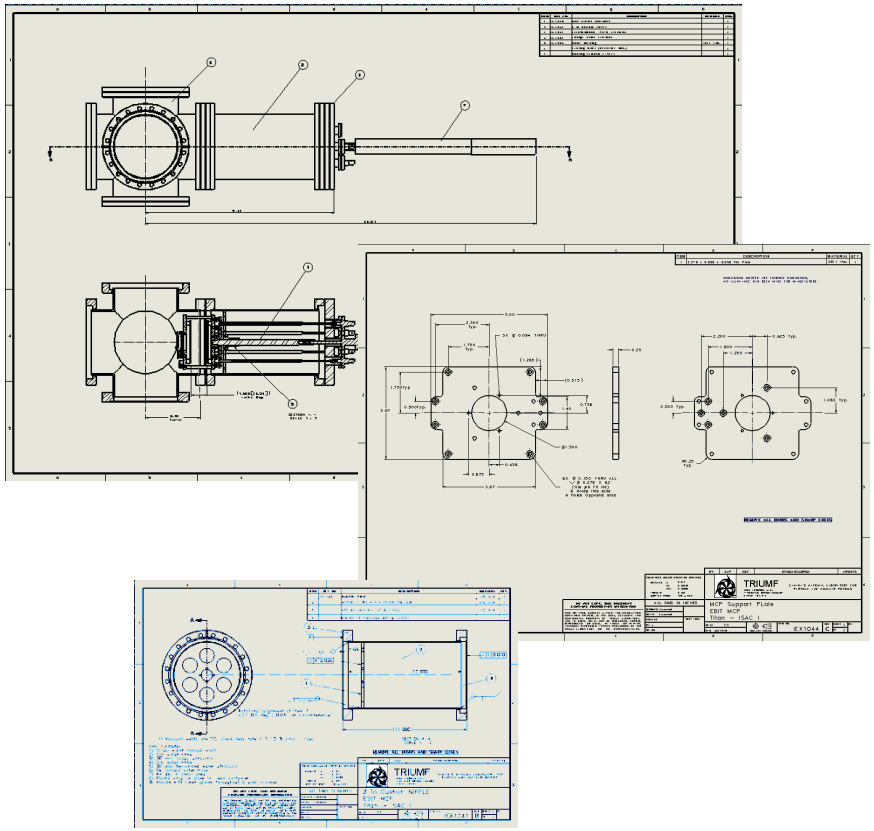
- Usage of SIMION
- Simulate surrounding environment
- Start out by defining green ion beam with reasonable beam emittance.

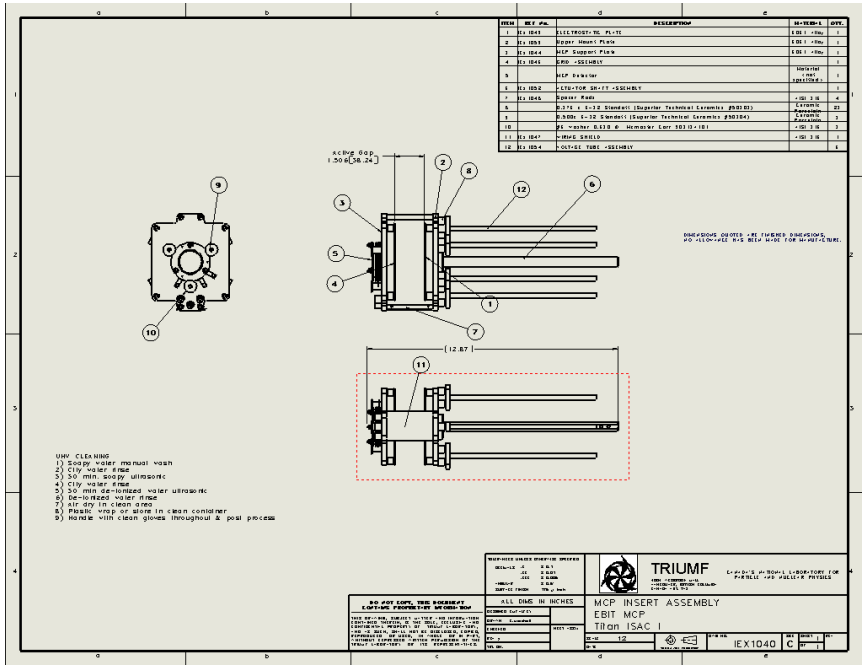


Computer program convert ion ‘splat’ location into e- starting origin

Red electrons impinging on MCP surface= circular: a good representation of beam

Technical Drawings to Machine Shop



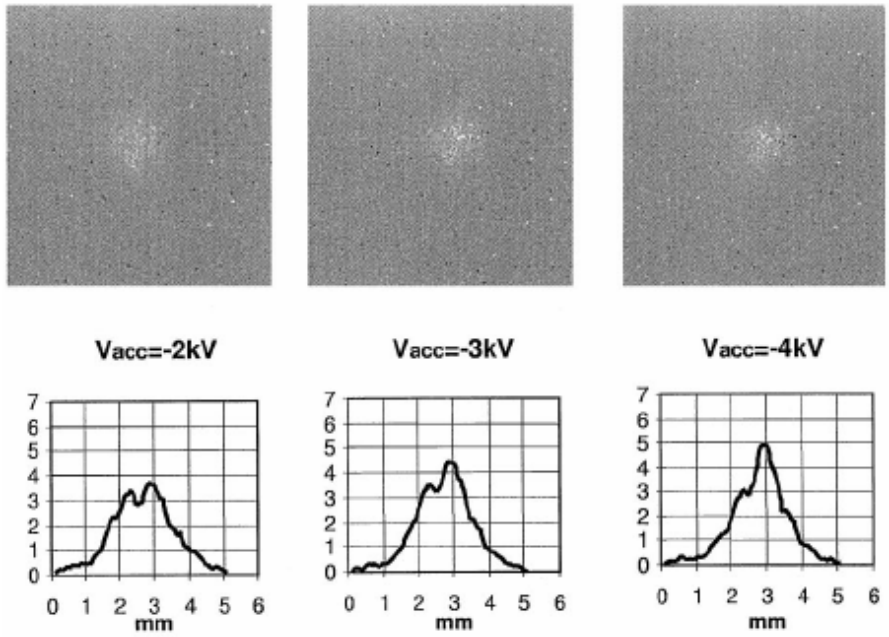


SolidWorks Machine Drawings prepared by Cam Marshall

Next Steps

Once machining completes….

- Compare actual beam shape to Simion simulations
- Test spatial resolution of detection system.
- Test intensity distribution of these ion beams.



Beam profile tests at the REX-ISOLDE facility

Summary

- Beam diagnostic essential part of beamline
- TITAN EBIT beamline requires a 2-way detection system that avoids radiation damage to MCP
- Chosen Daly-type design
- Test for beam profiling capabilities

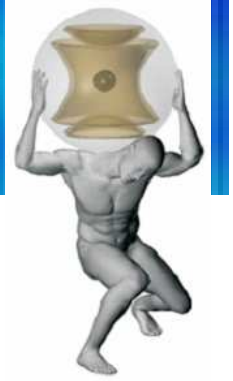
References

- Google
- Wikipedia

References

- Kruglov K., Weissman L. ‘ A beam diagnostic system for low-intensity radioactive beams’, Sept 1999
- Lapierre, Alain & the TITAN collaboration. ‘The TITAN EBIT: Status & Research Plans’ July 2007
- Lapierre, Alain. ‘The TITAN-EBIT: An Electron Beam Ion Trap as a Charge Breeder of Short-Lived Isotopic Highly Charged Ions’
- http://www.onafarawayday.com/Radiogenic/Ch2/Ch23.htm
- O’Sullivan, Erin ‘Low Energy Beam Emittance Detection for the TITAN Project’, Sept. 2006
- Odland, O.H. ‘A Fast position sensitive MCP detector for ray-tracing’, Jan 2006
- Van den Bergh, et al. ‘The Rex-Isolde Beam Diagnostic System’, CP376 American Institute of Physics, 2001

TITAN
ISAC-TRIUMF



Any Questions??