



Design of Beam Line for Ion Transport at Low Energies and The Ejection of Specific Ions From Electron Beam

Brice Cannon^{†}**

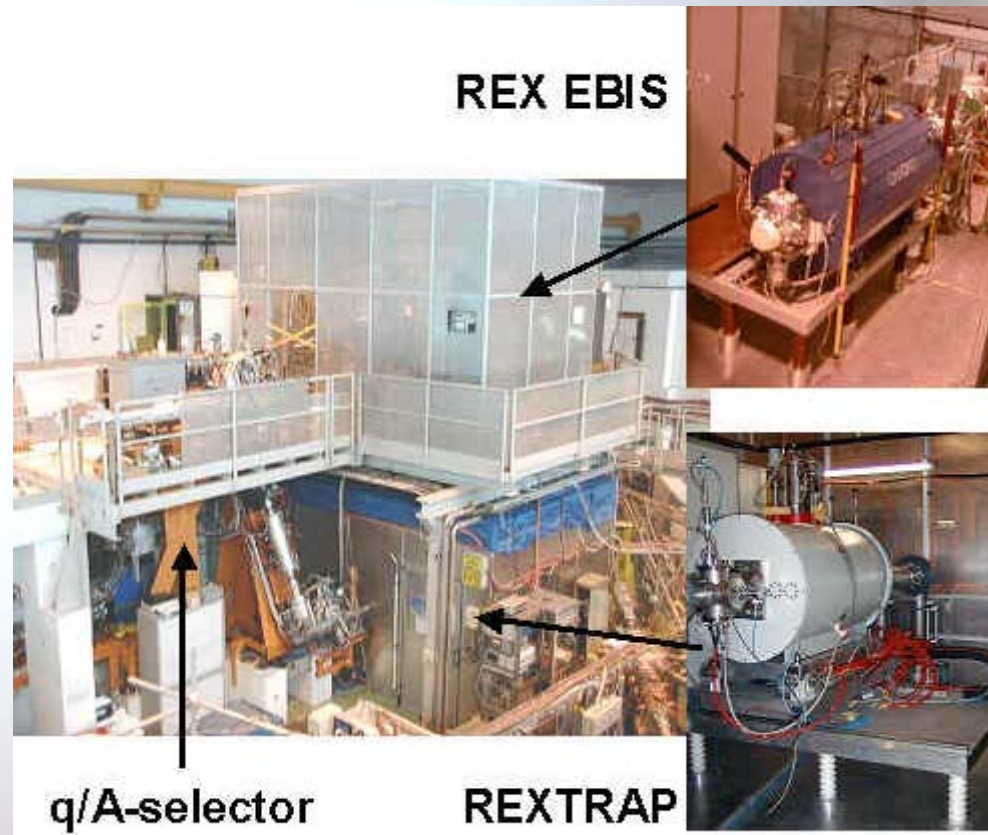
Research Advisor (s): Fredrik Wenander **, Anna Gustafsson**

Supervisor: Alexander Herlert**

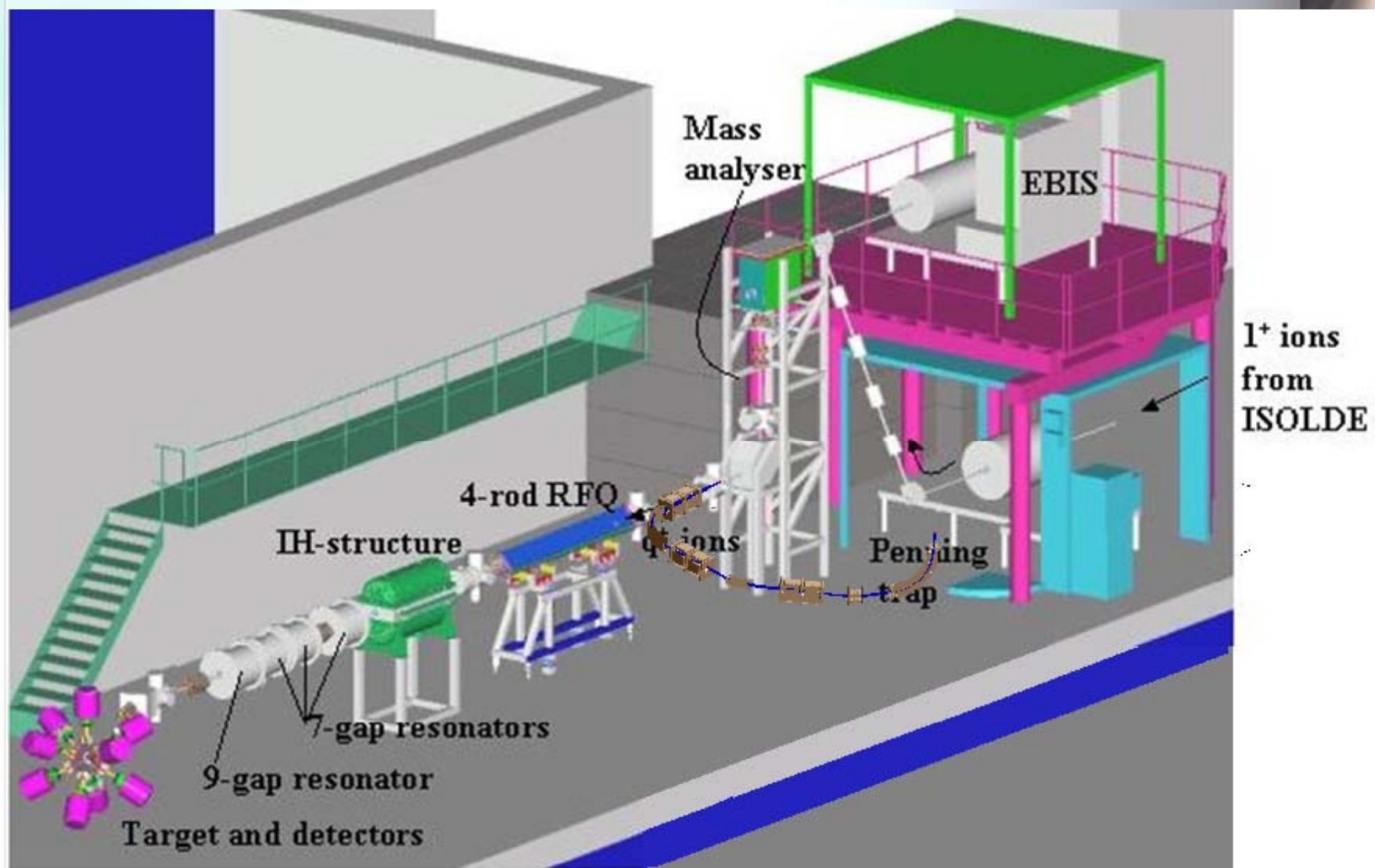
CERN, Norfolk State University[†]**

Introduction

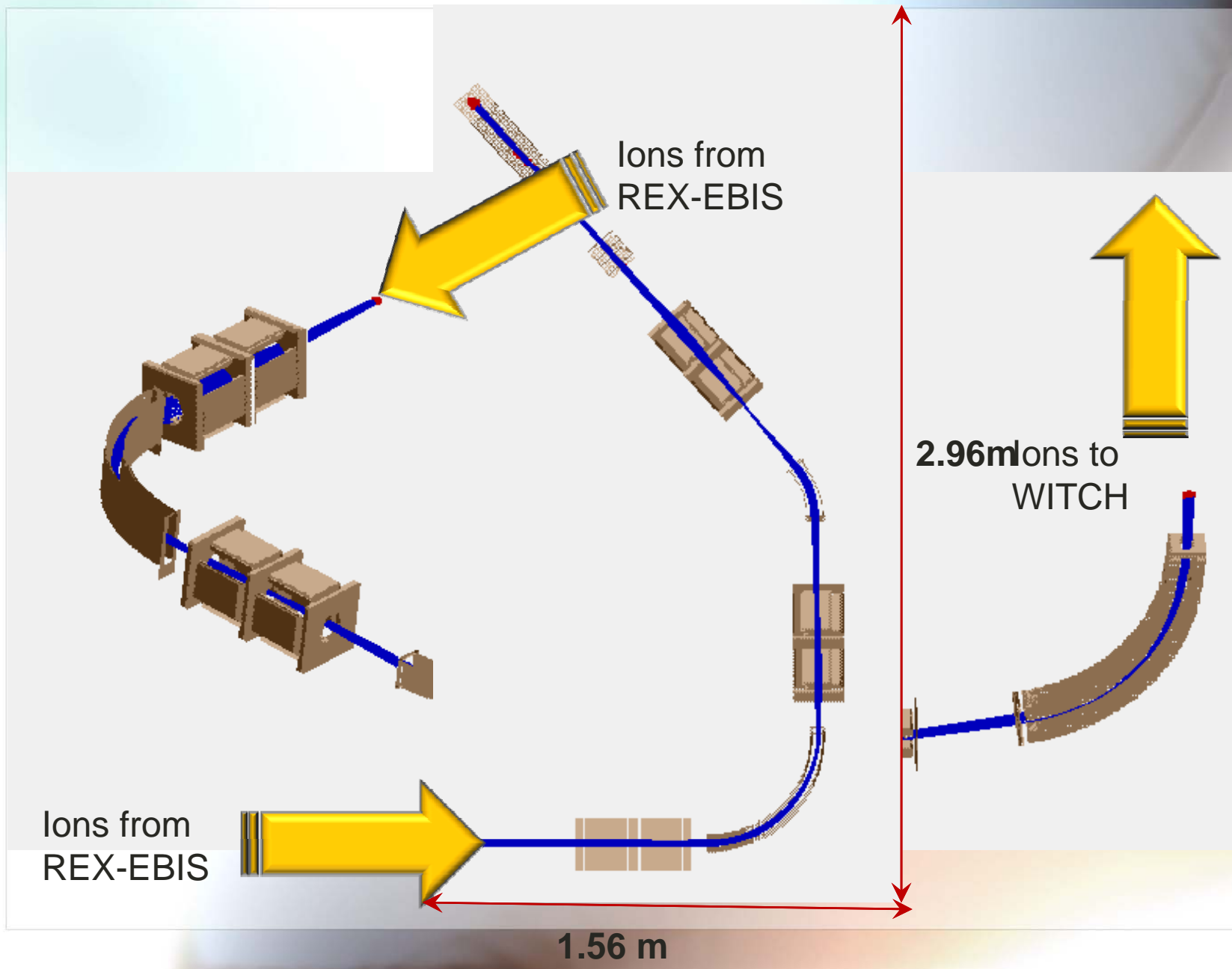
- ISOLDE
- REX-ISOLDE
 - Beam Line
- EBIS
 - RF-Field
- Conclusion
- Experiences



ISOLDE & REX-ISOLDE

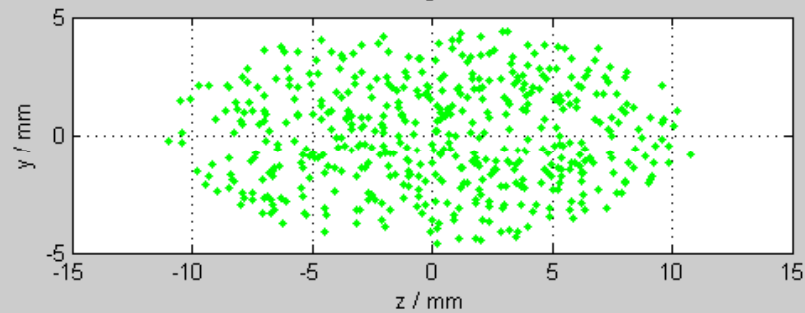
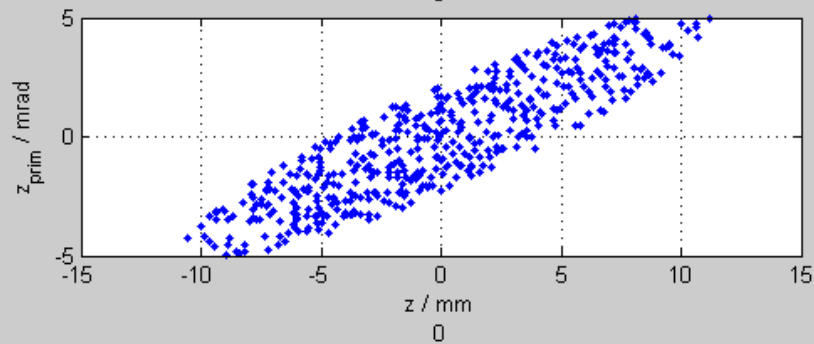
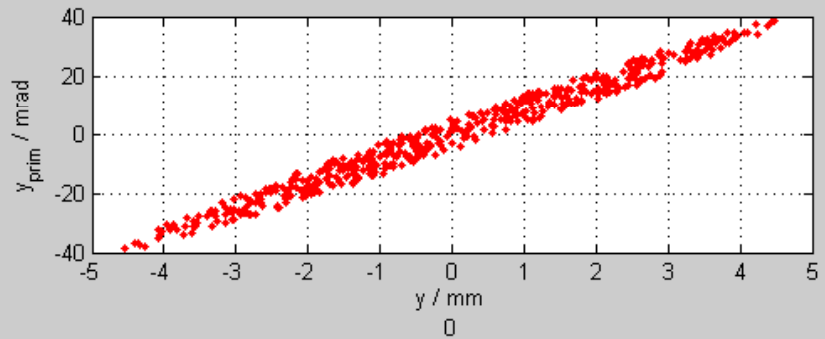


Initial Beam Line



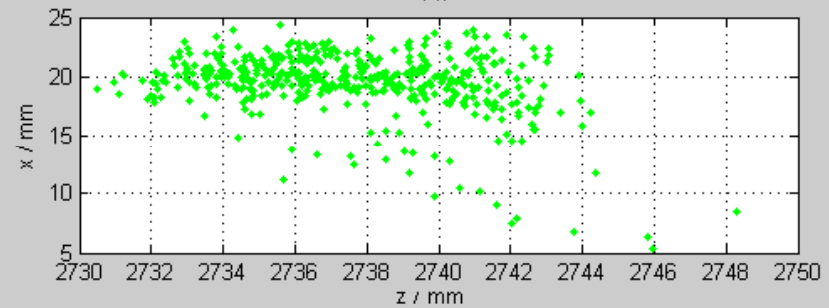
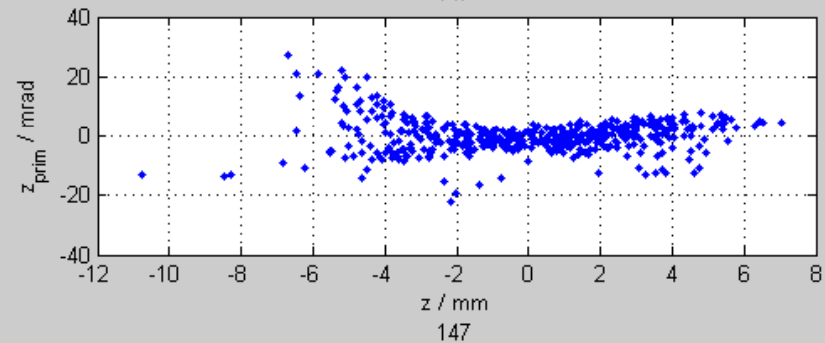
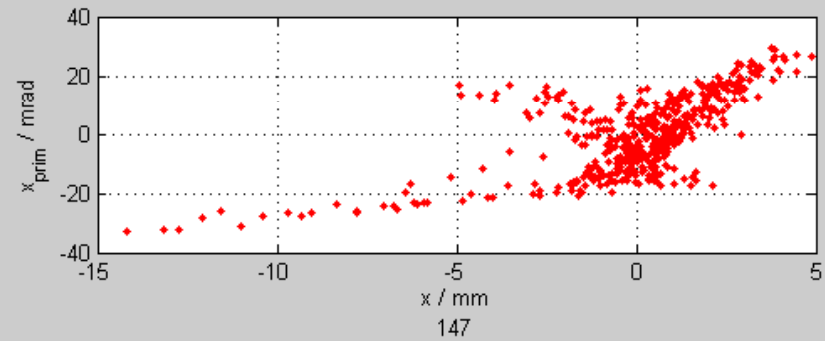
Emittance: Initial Design

Start



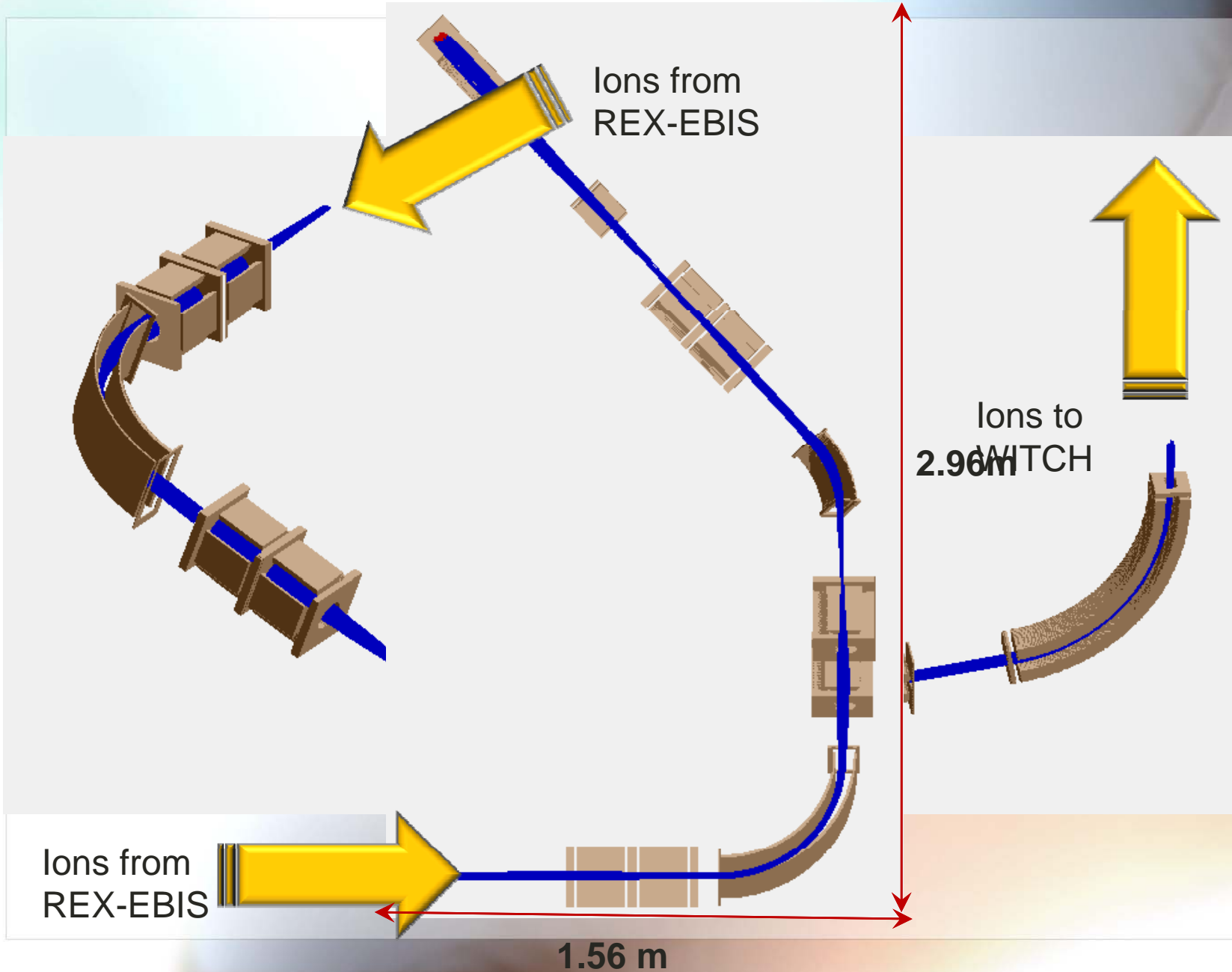
$y = 23$ mm-mrad
 $z = 23$ mm-mrad

End



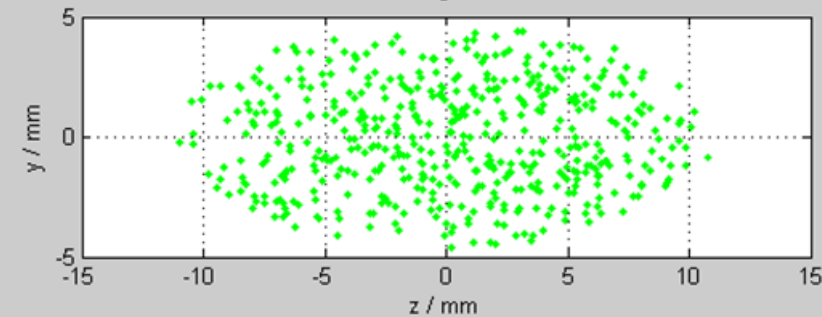
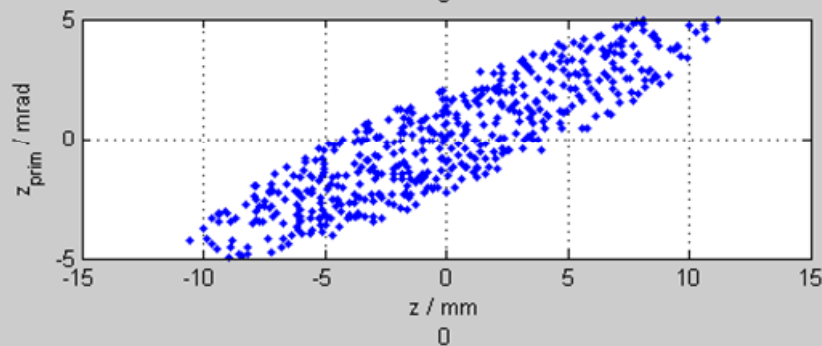
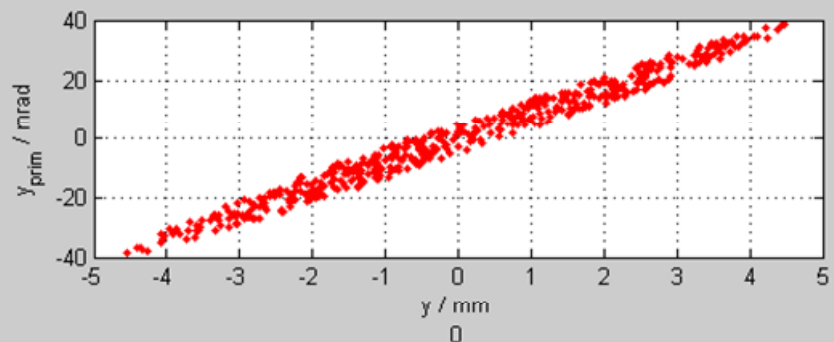
$x = 104$ mm-mrad
 $z = 71$ mm-mrad

Final Beam line



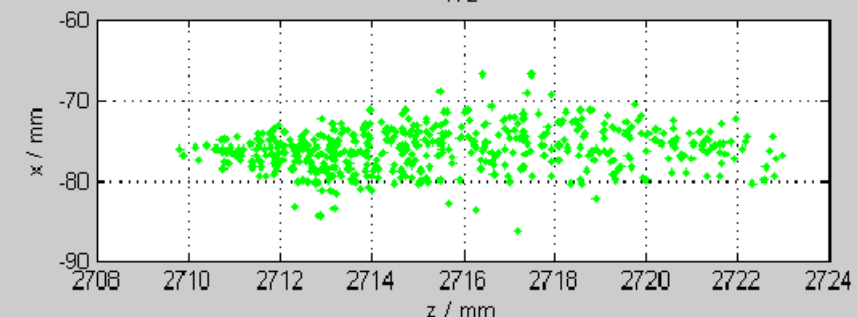
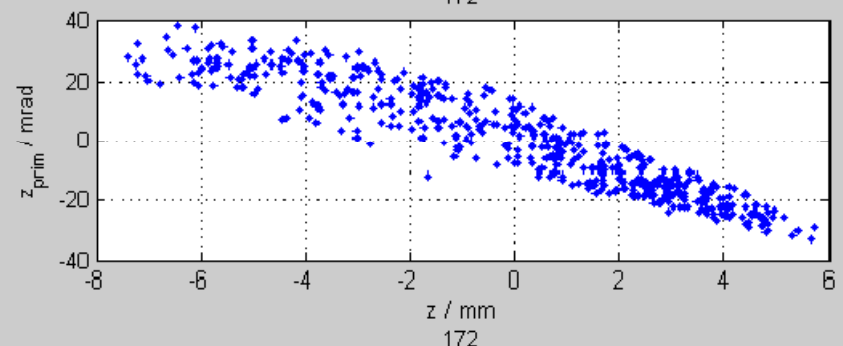
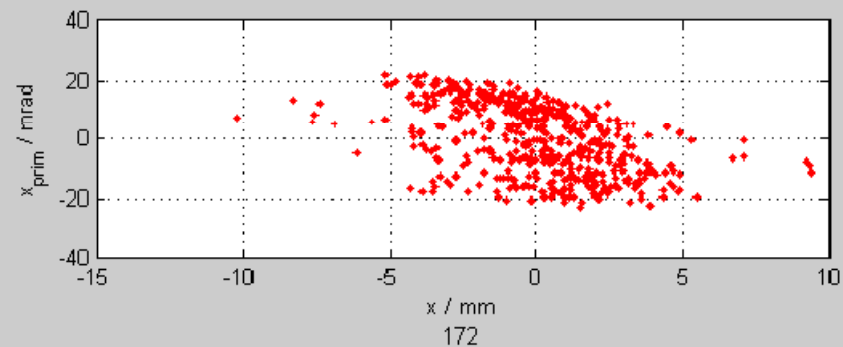
Emittance: Final Design

Start



$y = 23 \text{ mm-mrad}$
 $z = 23 \text{ mm-mrad}$

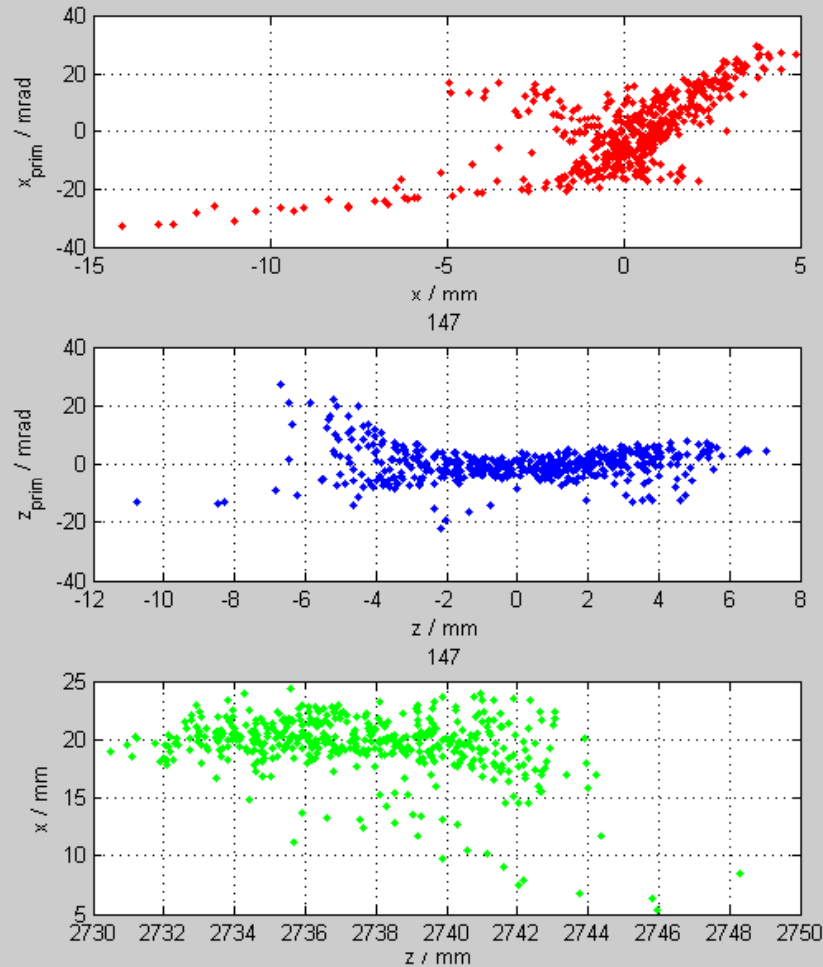
End



$x = 108 \text{ mm-mrad}$
 $z = 79 \text{ mm-mrad}$

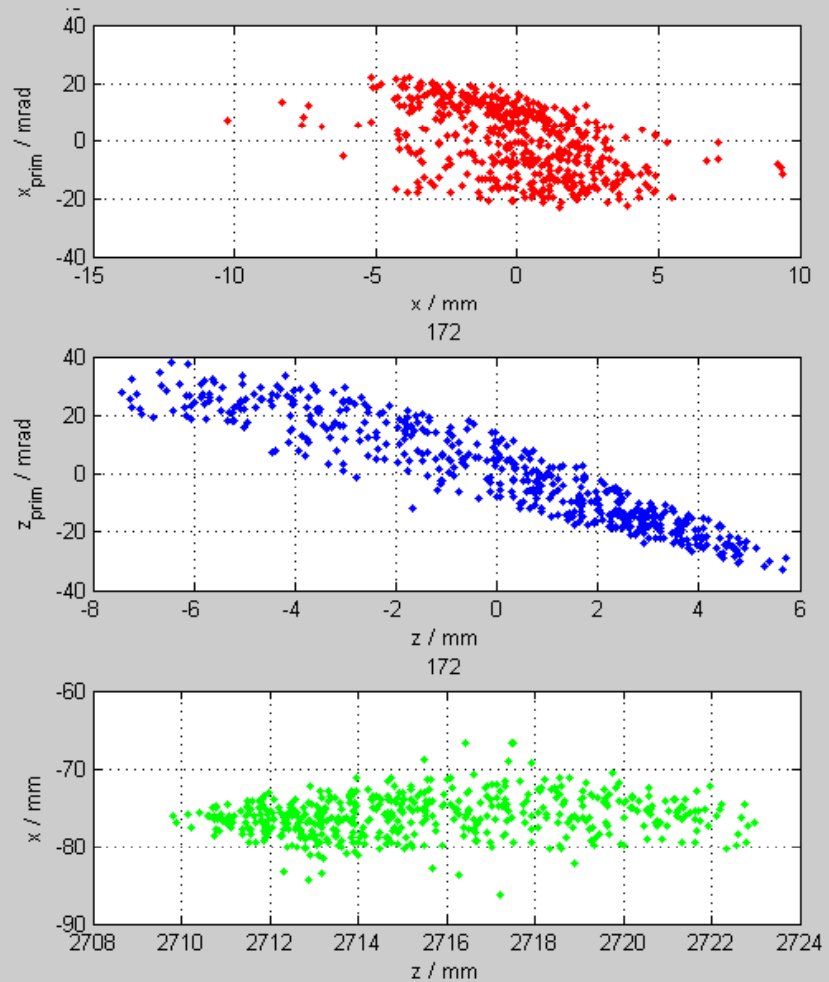
Original vs. Final Design

End Original



$x = 104 \text{ mm-mrad}$
 $z = 71 \text{ mm-mrad}$

End Final



$x = 108 \text{ mm-mrad}$
 $z = 79 \text{ mm-mrad}$



*Design of Beam Line for Ion
Transport at Low Energies
and*

*The Ejection of Specific Ions
From Electron Beam*

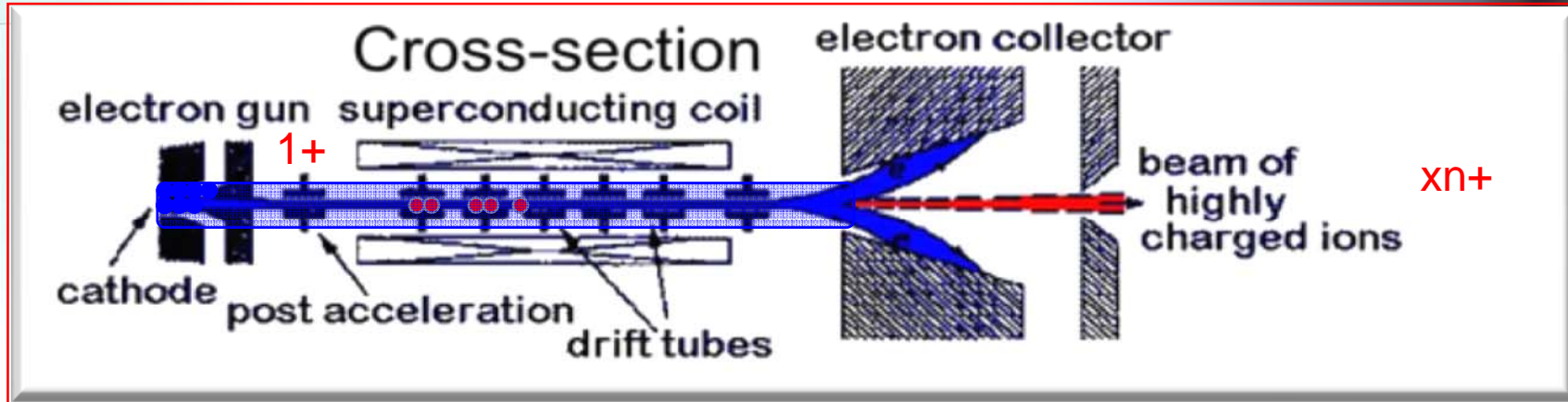
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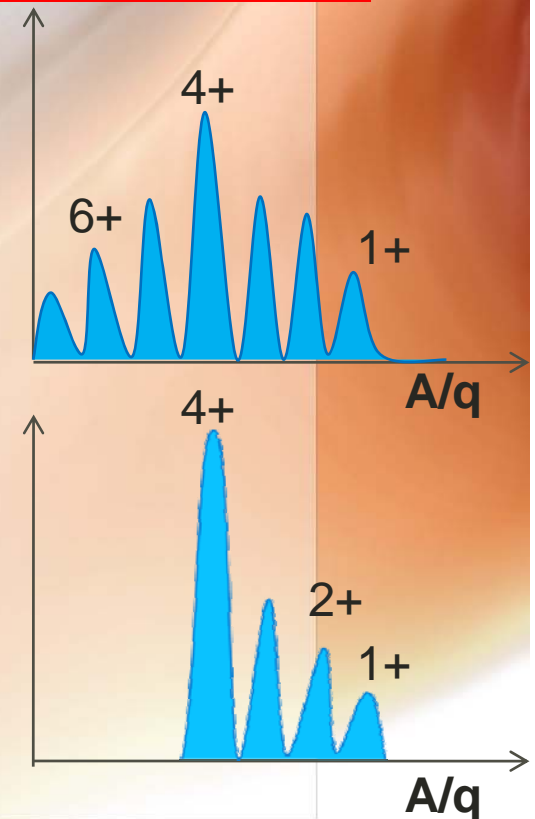
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Electron Beam Ion Source



- Maximum efficiency is $\sim 25\%$
 - Charge state distribution
- Eject ions from electron beam
 - Orbit around beam
- Higher efficiency



Electron Beam Potential

$$r > r_{\text{ebeam}}$$

$$E(r) = \frac{\rho_L}{2\pi\epsilon_0 r}$$

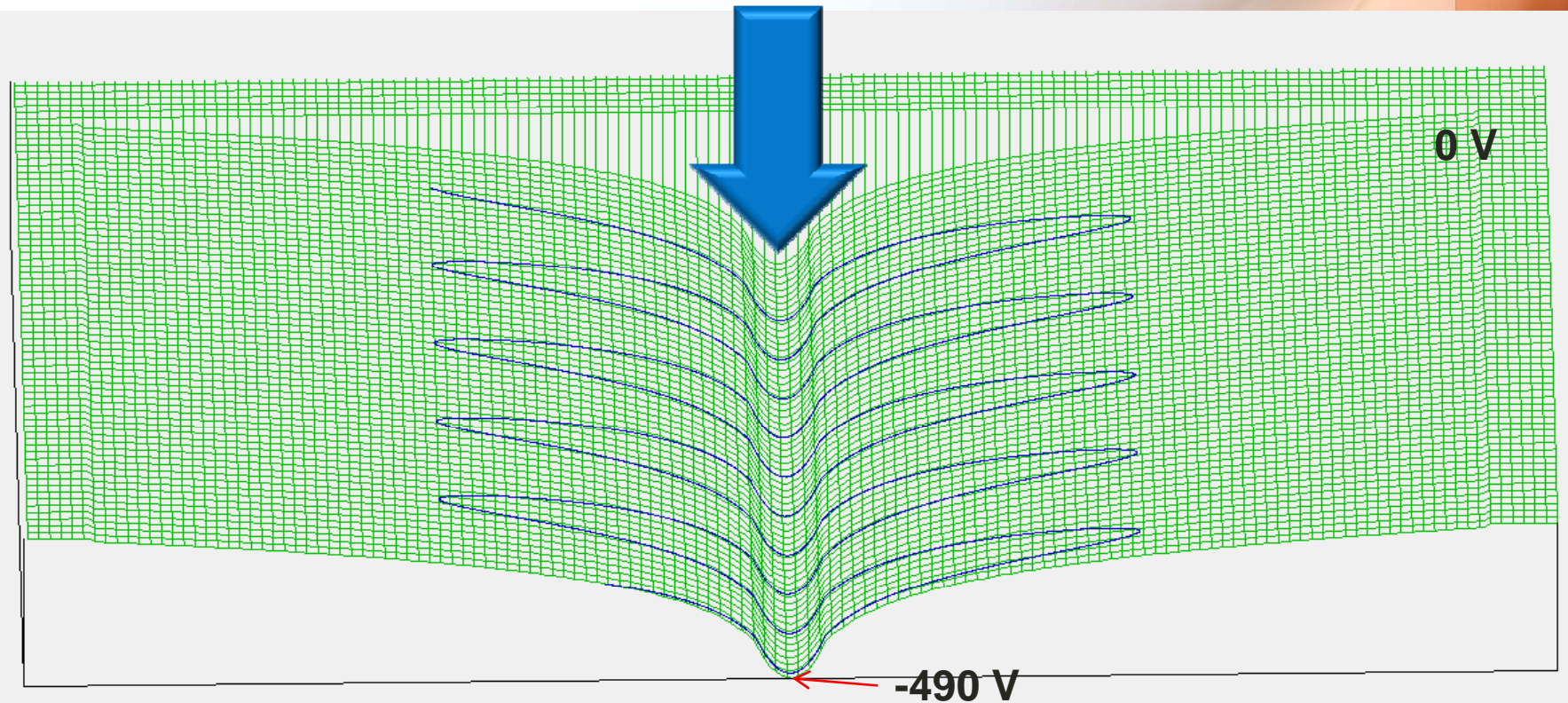
$$V(r) = -\frac{\rho_L \ln|r|}{2\pi\epsilon_0} + C$$

$$r < r_{\text{ebeam}}$$

$$E(r) = \frac{\rho_L r}{2\pi\epsilon_0 r_{\text{ebeam}}^2}$$

$$V(r) = -\frac{\rho_L r^2}{2\pi\epsilon_0 r_{\text{ebeam}}^2} + C$$

Direction of Electron Beam

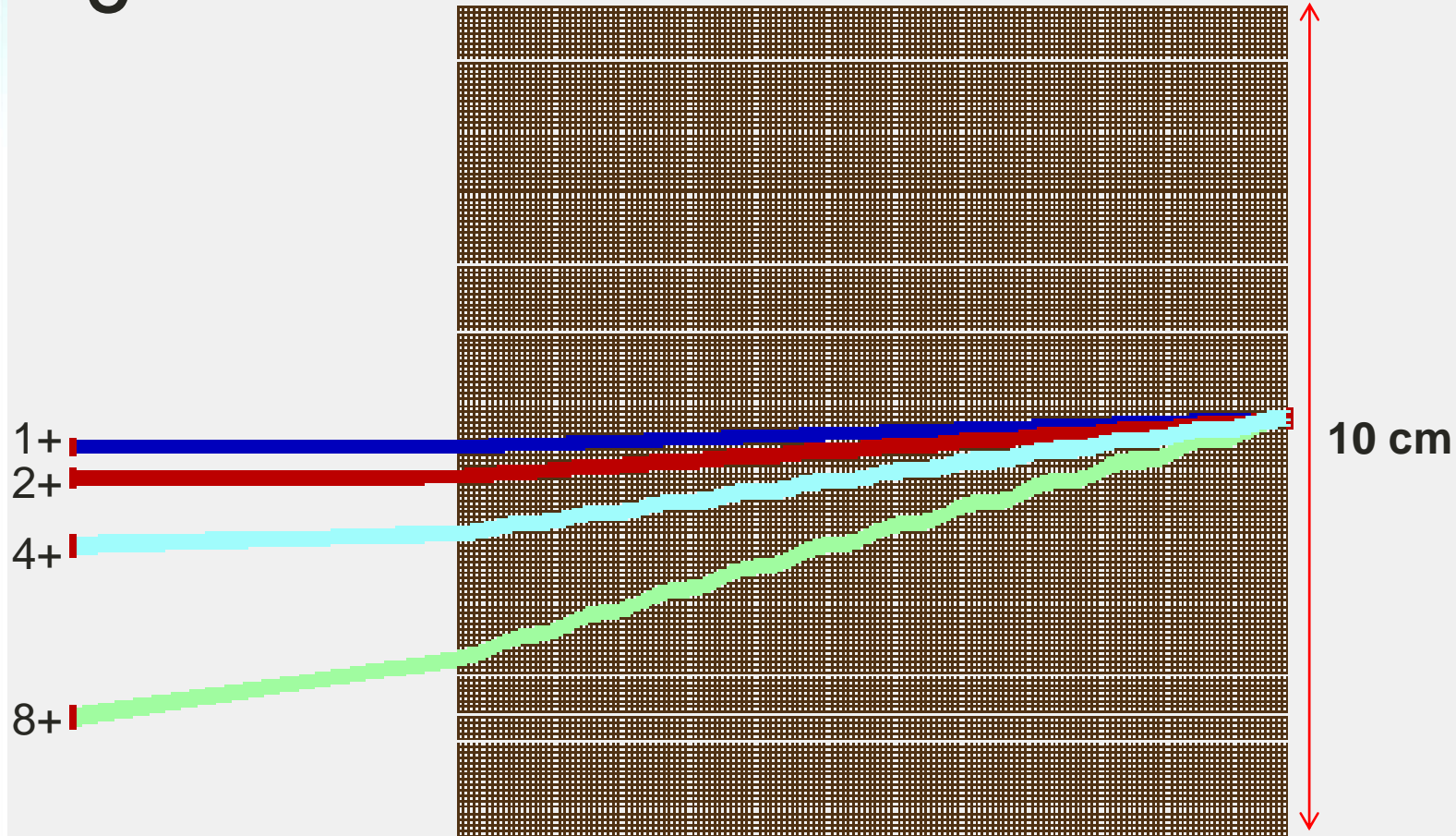


Results of EBIS RF-Field

Angular velocity of 15 rad/ μ sec

RF voltage of 250 V

^{16}O



Conclusion

- **100% transmission for beam line to WITCH experiment**
 - Further development of the beam line and construction
- **All components of the EBIS simulation with RF-field are complete individually**
 - Implement the EBIS with RF-field into different program and test

Expo



Questions?