Paper ID: MOPOJO17

Design & optimization of a 100 kV DC thermionic electron gun and transport channel for a 1.3 GHz High Intensity Compact Superconducting Electron Accelerator (HICSEA)

By

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IIT BOMBAY

LINAC2022 LIVERPOOL

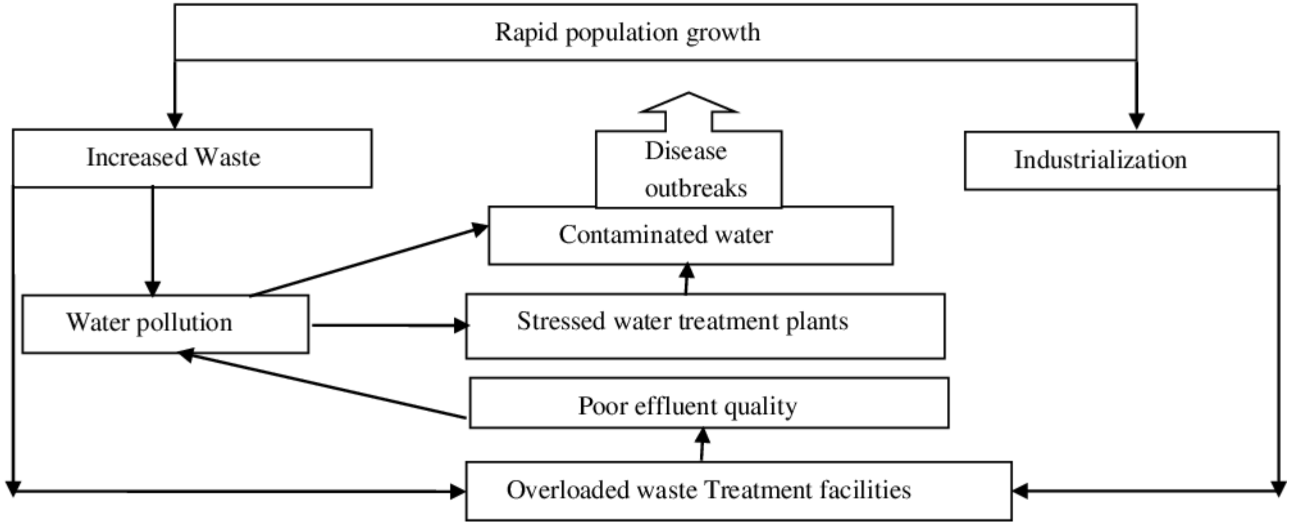
The Cockcroft Institute of Accelerator Science and Technology

UKRI Science and Technology Facilities Council

JAI John Adams Institute for Accelerator Science

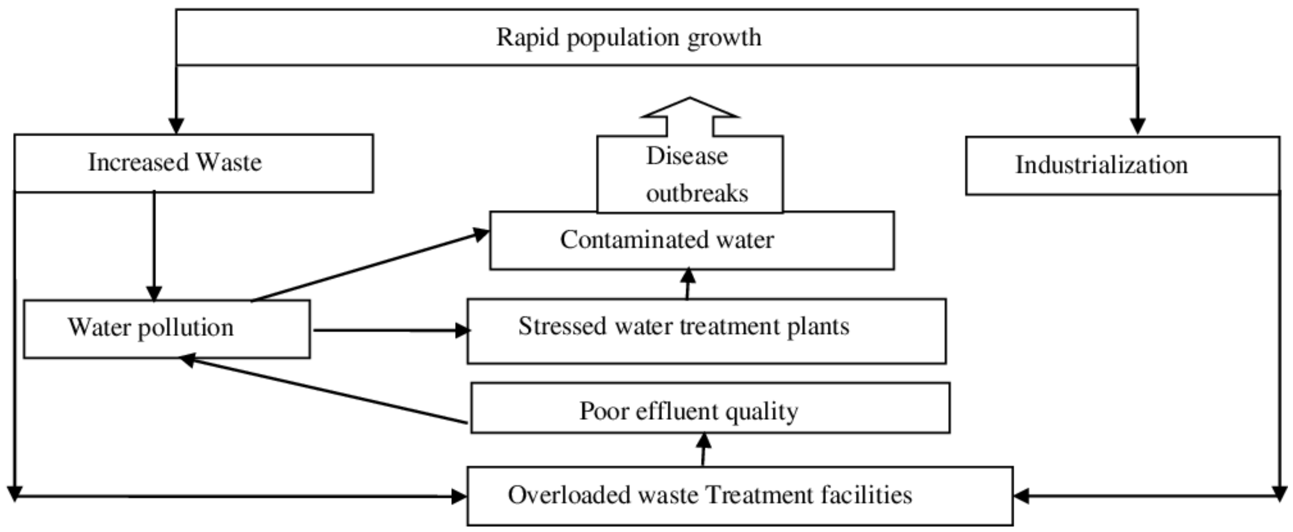
MOTIVATION

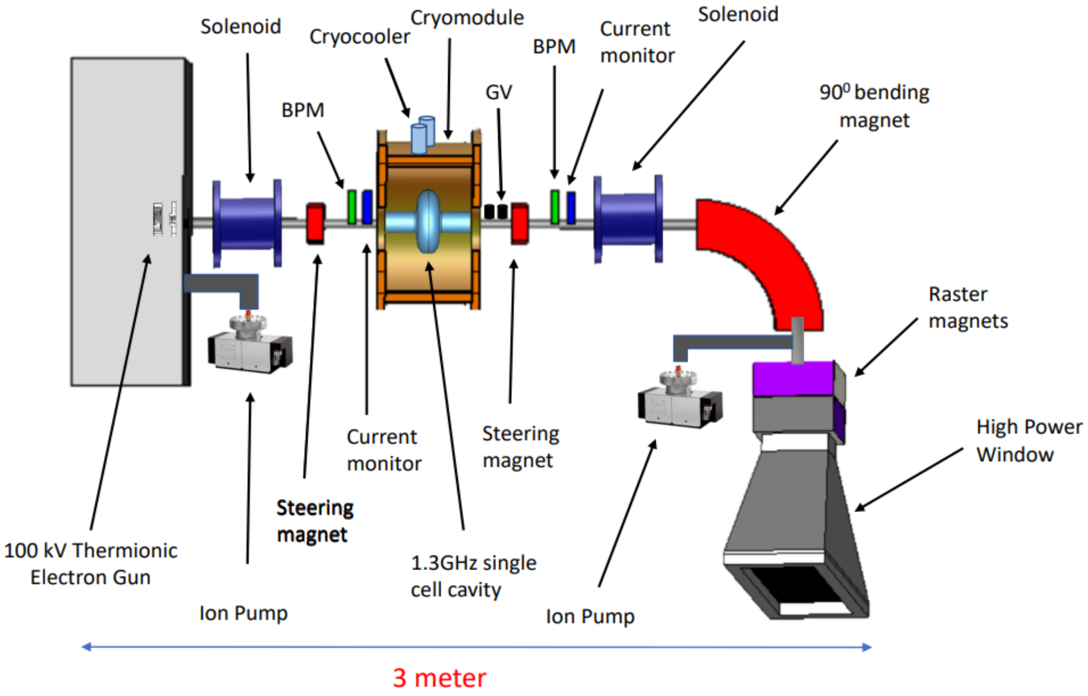
PROBLEM



MOTIVATION

PROBLEM → **SOLUTION**





MOTIVATION

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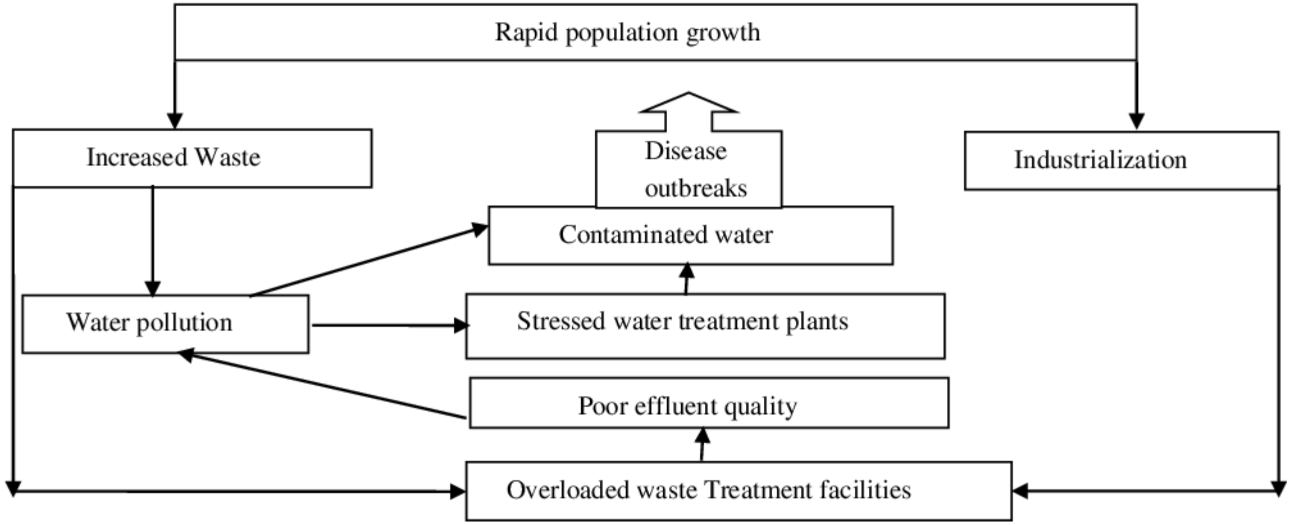
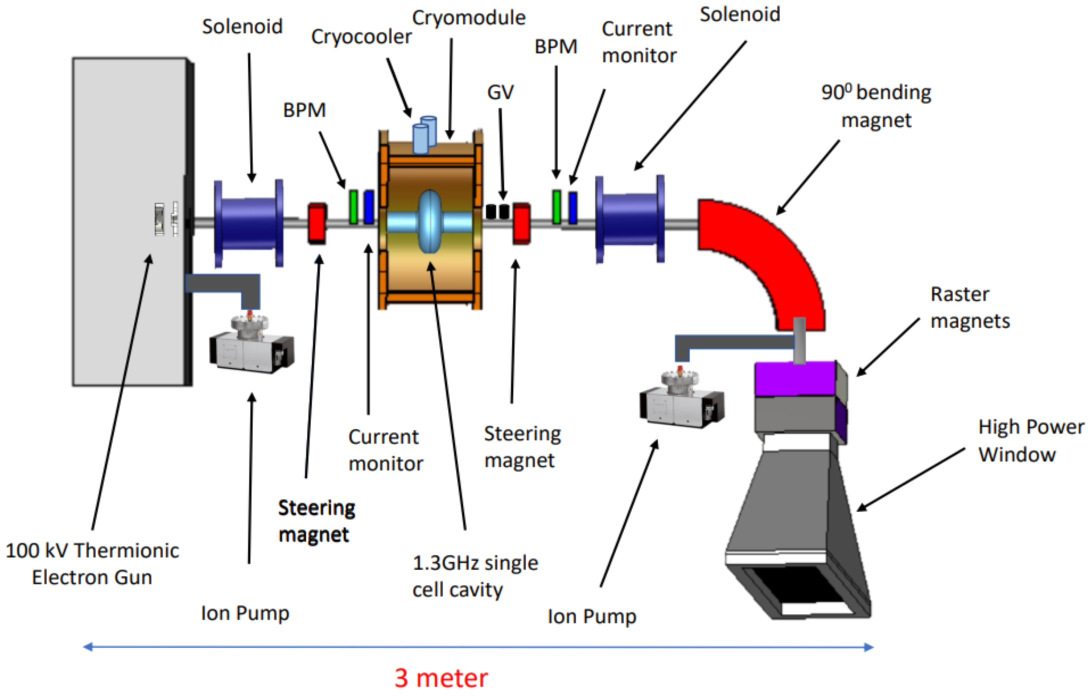


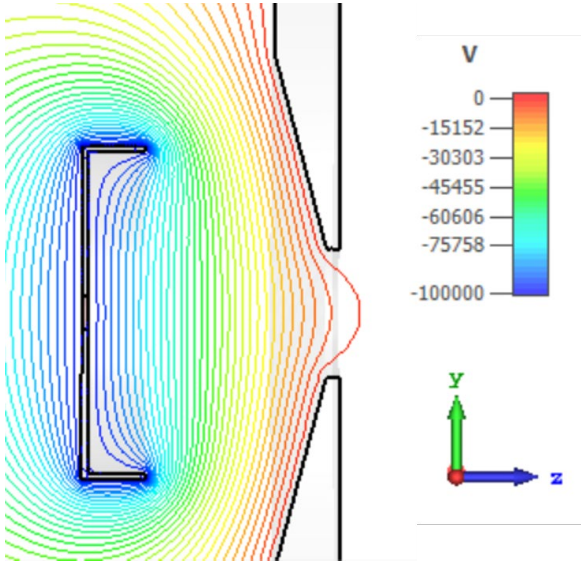


Advantages:

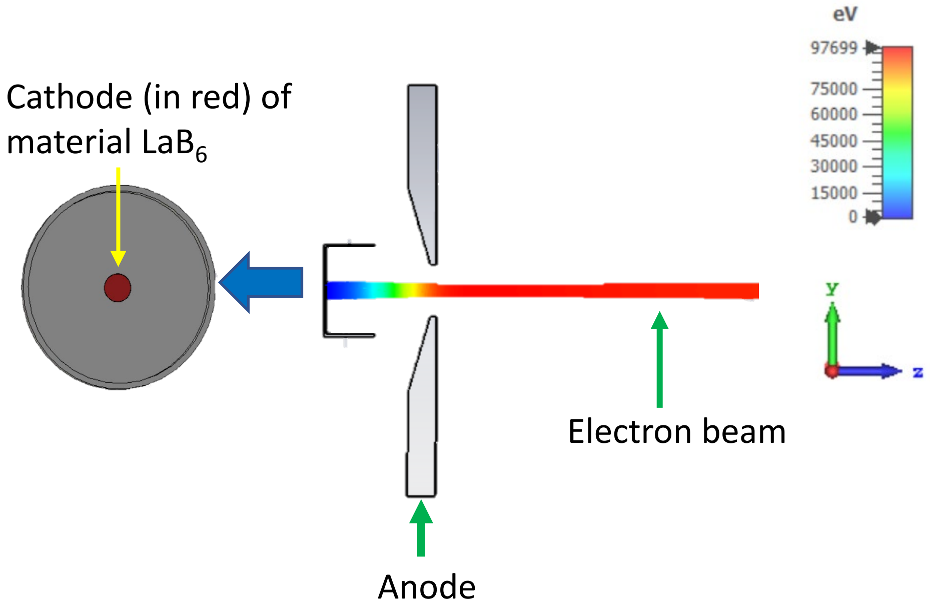
- Eco friendly technology
- Compact, reliable, easy to control
- About 100% disinfection of micro-organisms by destruction of their DNA's

1.3 GHz High Intensity Compact Superconducting Electron Accelerator (HICSEA)

GUN DESIGN



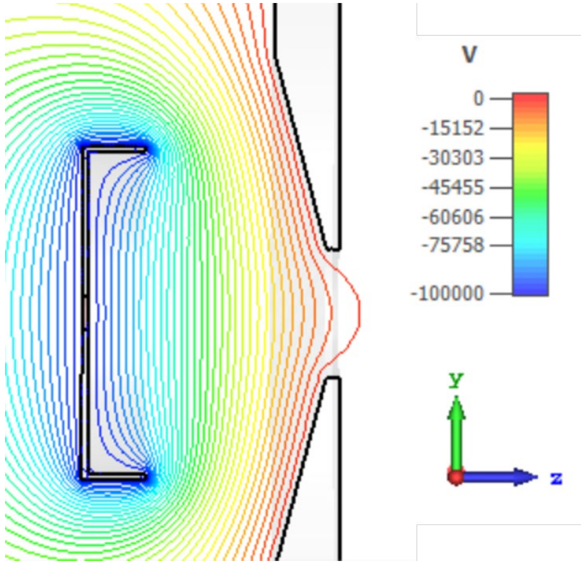
Equipotential lines generated due to the applied potential of -100 kV on cathode



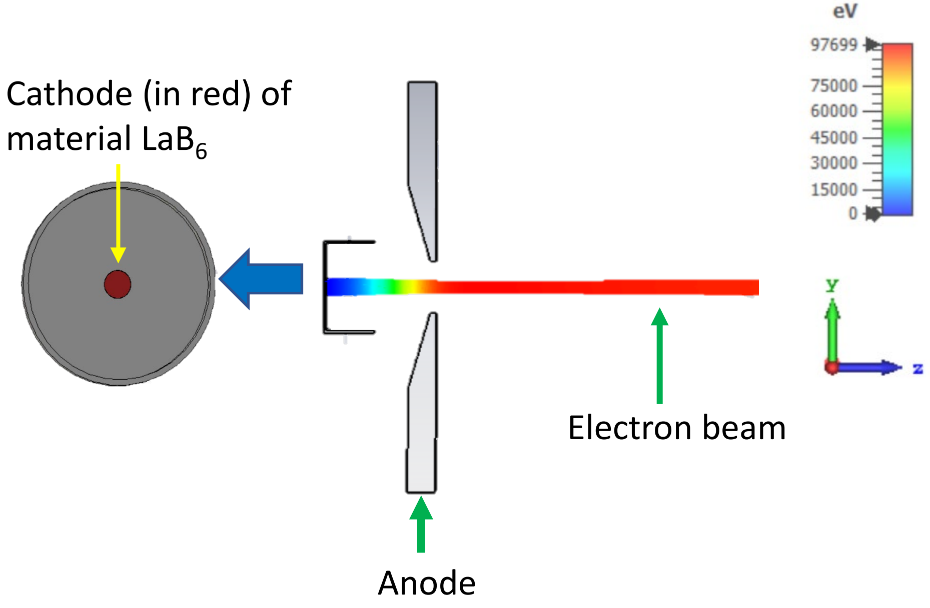
- Cathode and focusing electrode at -100 kV potential, anode at ground
- For 0.5 A current, normalized emittance is minimum for cathode radius of 1.25 mm

Final parameters at the location of the solenoid which is 6 cm away from the cathode

GUN DESIGN



Equipotential lines generated due to the applied potential of -100 kV on cathode

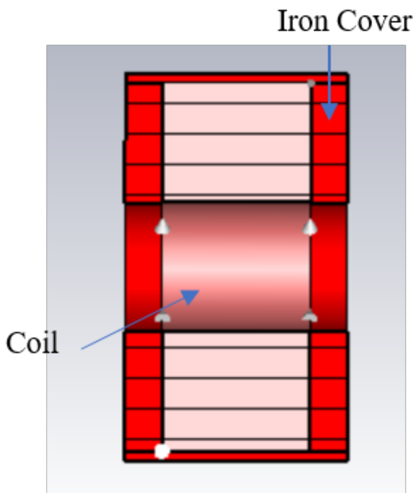


- Cathode and focusing electrode at -100 kV potential, anode at ground
- For 0.5 A current, normalized emittance is minimum for cathode radius of 1.25 mm

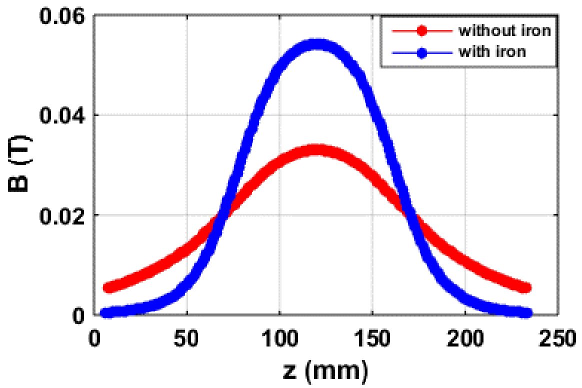
Final parameters at the location of the solenoid which is 6 cm away from the cathode

Parameter	Value
Operating temperature	1940 K
Potential	100 kV
Current	500 mA
Distance b/w anode-cathode	20 mm
Cathode radius	1.25 mm
Height of focusing electrode	5 mm
Radius of focusing electrode	13 mm
Beam diameter	5 mm
Normalized RMS transverse emittance	0.3 mm.mrad

SOLENOID DESIGN

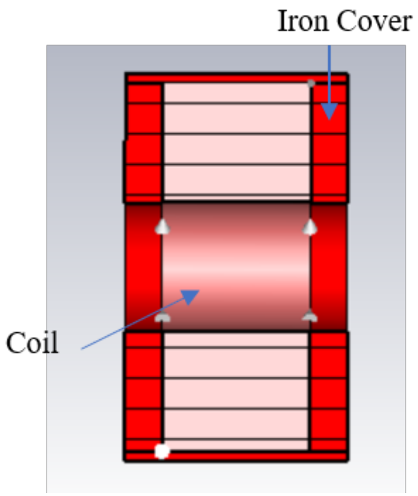


Effect of Iron shielding



Beam dynamics results

SOLENOID DESIGN



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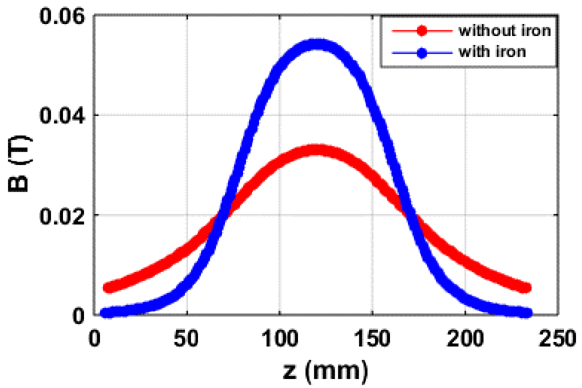
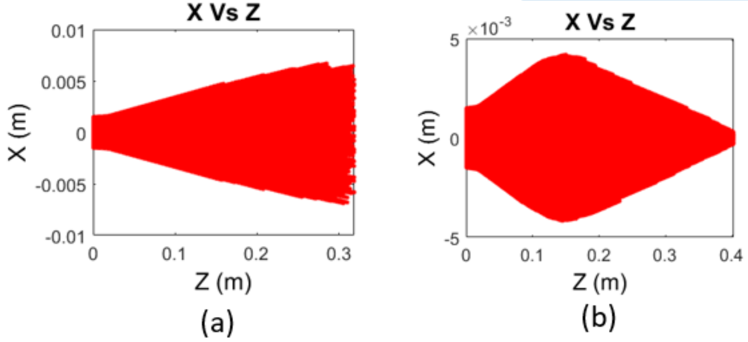


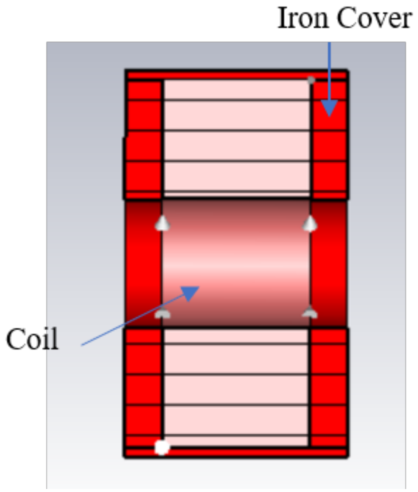
Beam dynamics results



Without solenoid

With solenoid

SOLENOID DESIGN



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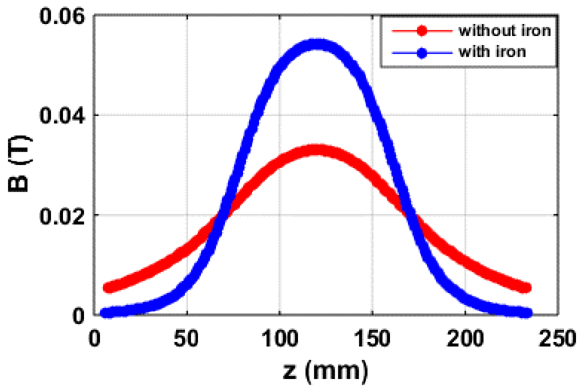

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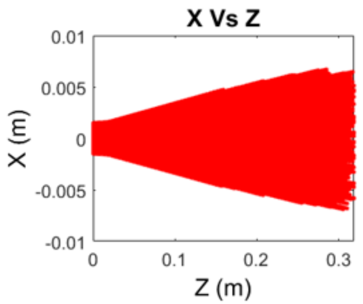
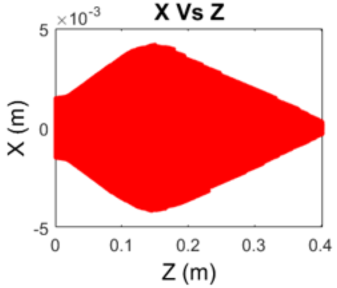


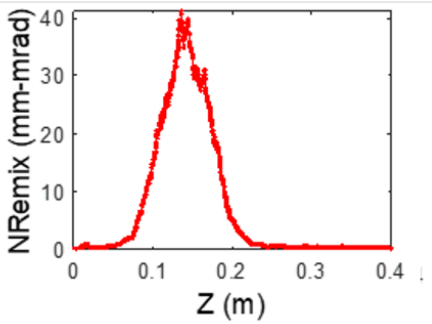
(a)

Without solenoid

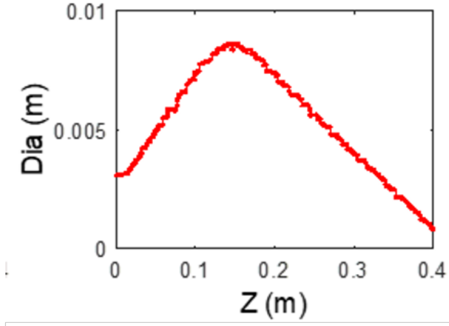


(b)

With solenoid



Normalized RMS emittance

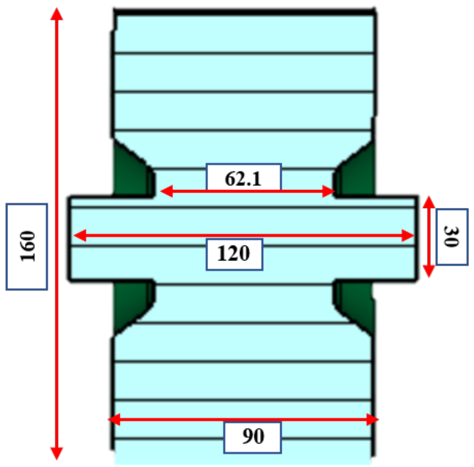


Beam Diameter

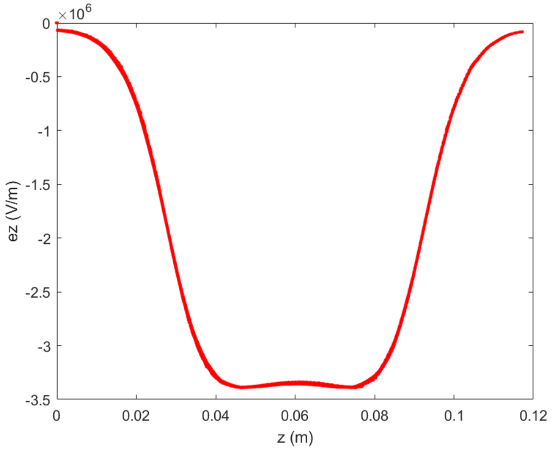
Final parameters at the location of the buncher cavity

Parameter	Value
length	8 cm
Coil current	1 A
Number of turns	2000
Inner radius of solenoid	35 mm
Outer radius of solenoid	100 mm
Thickness of iron cover	1 mm
Magnetic field	0.027 T
Beam diameter	3 mm
Normalized RMS transverse emittance	0.4 mm.mrad

BUNCHER DESIGN

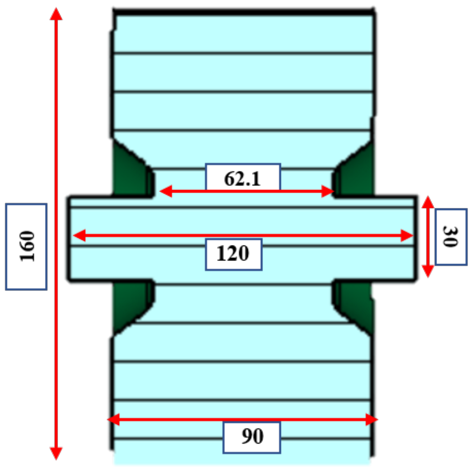


Buncher cavity

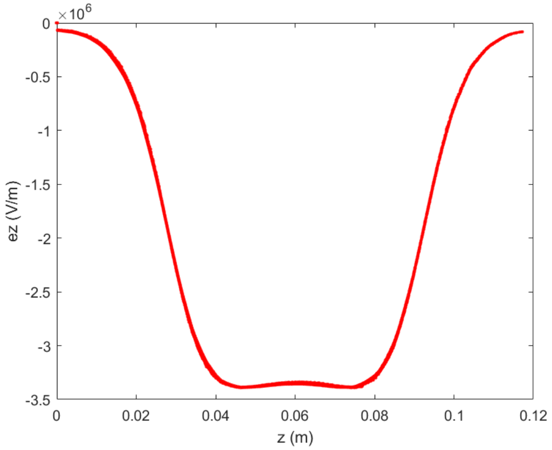


Electric field

BUNCHER DESIGN

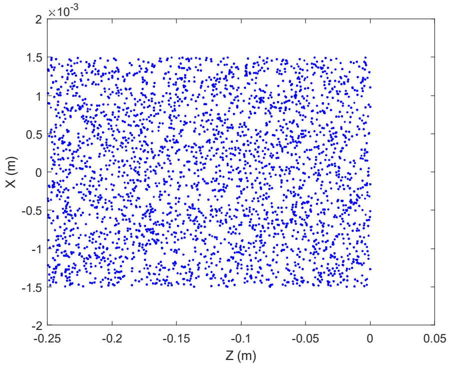


Buncher cavity

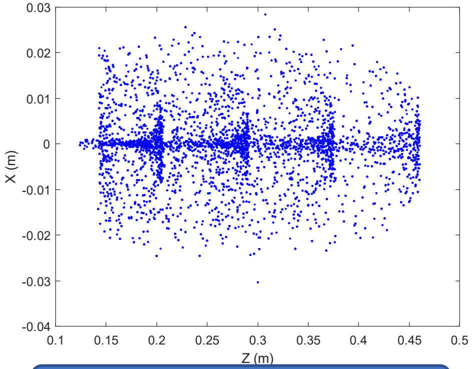


Electric field

Beam dynamics results

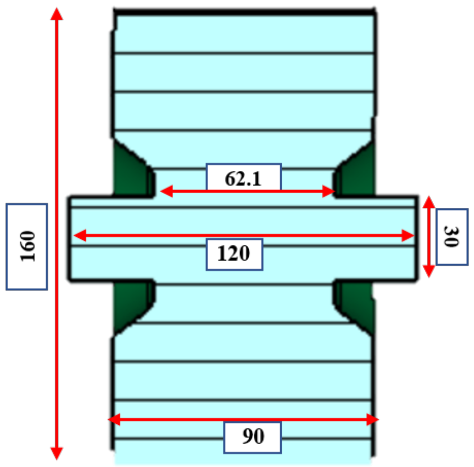


Before buncher

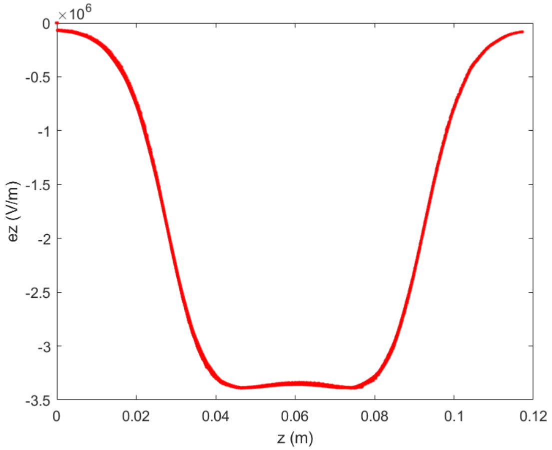


After buncher

BUNCHER DESIGN

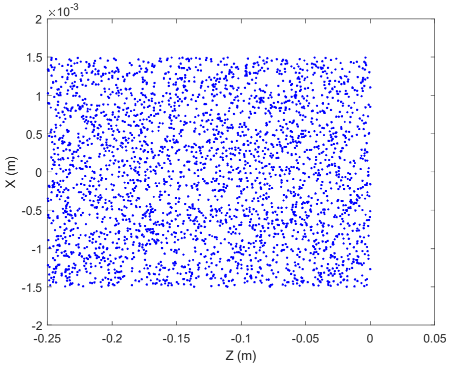


Buncher cavity

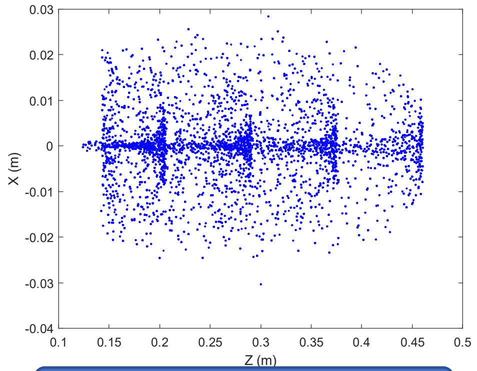


Electric field

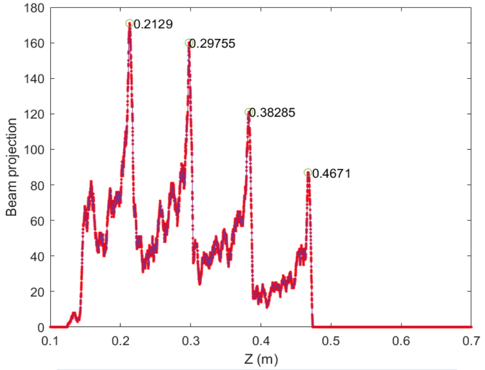
Beam dynamics results



Before buncher

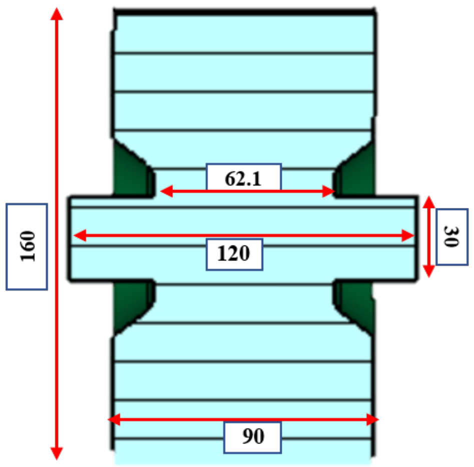


After buncher

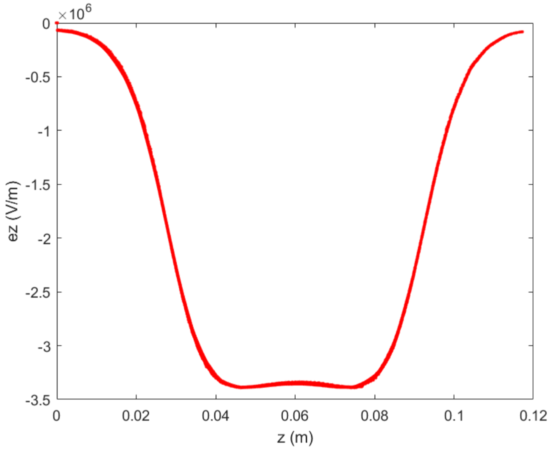


Beam projection

BUNCHER DESIGN



Buncher cavity

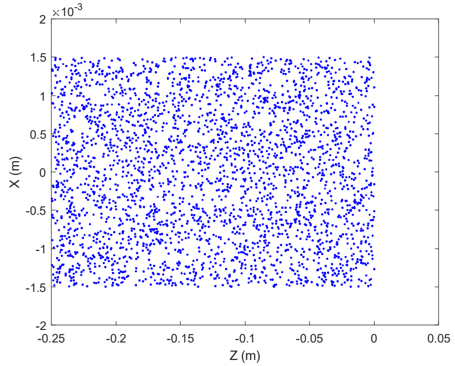


Electric field

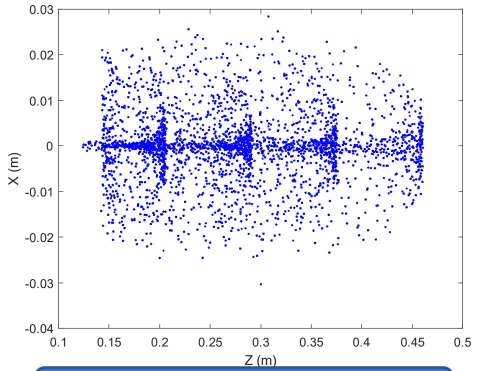
Parameter	Value
Energy of electrons	96 keV
Beta	0.54
Beam current	0.5 A
Resonant frequency	1.3 GHz
Maximum accelerating gradient	1 MV/m
Peak surface electric field	3.3 MV
Bunch length	45 ps
Bunch current	0.548 A

Final parameters at the exit of buncher cavity

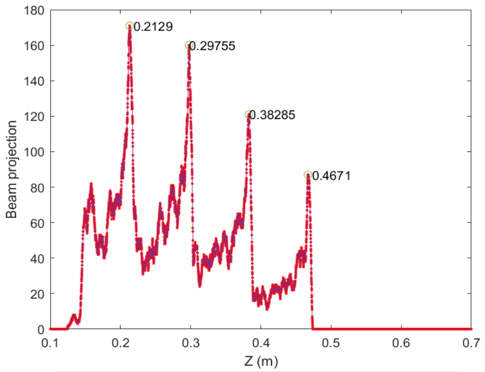
Beam dynamics results



Before buncher



After buncher



Beam projection

CONCLUSION

- A DC thermionic gun, and transport channel consisting of solenoid and buncher cavity is designed and optimized for the proposed system.
- Currently, Beam dynamic study is going on for the designed system.

Acknowledgement

- I would like to acknowledge Dr. Abhishek Pathak for the guidance and motivation for the study.
- Thankful to my labmates Anjali, Pankaj and Manisha for support and discussions
- I am grateful to LINAC 2022 organizing team for giving me the opportunity and financial support.

THANK YOU