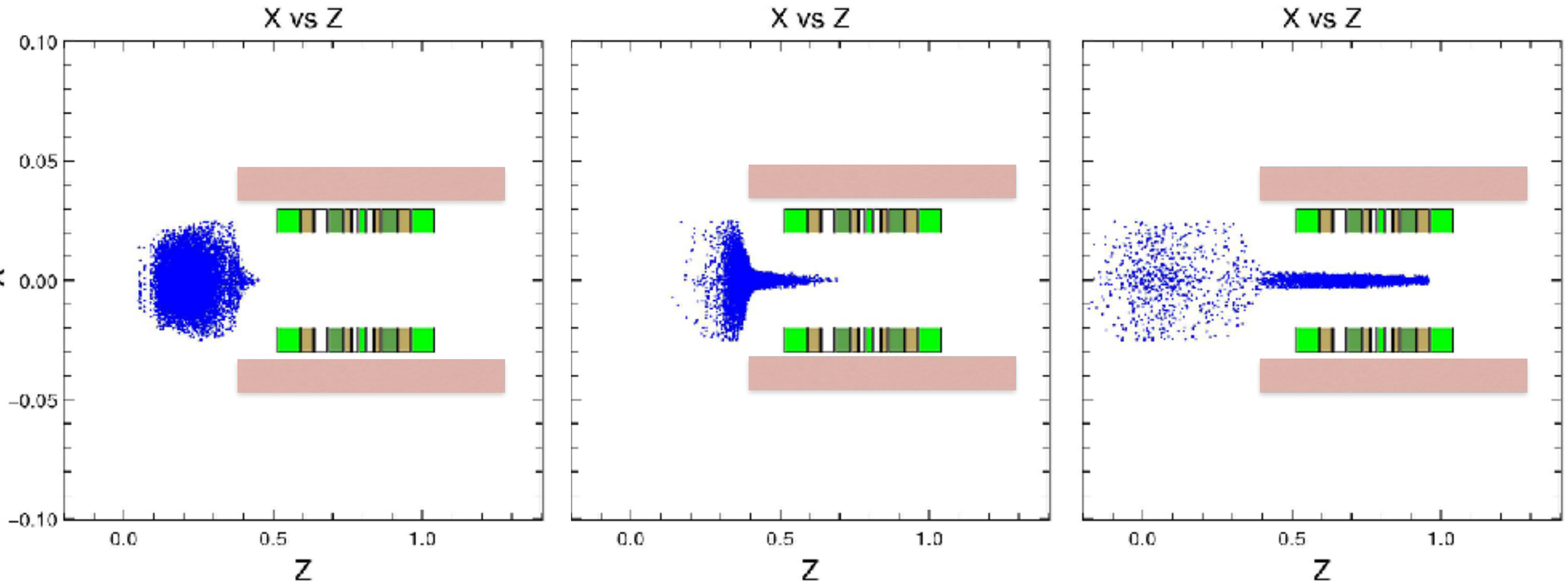
# PIC Simulation for Antiproton Trap

Kyoung-Hun Yoo
Ulsan National Institute of Science and Technology
2017. 02. 10

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

# Injection into Solenoid

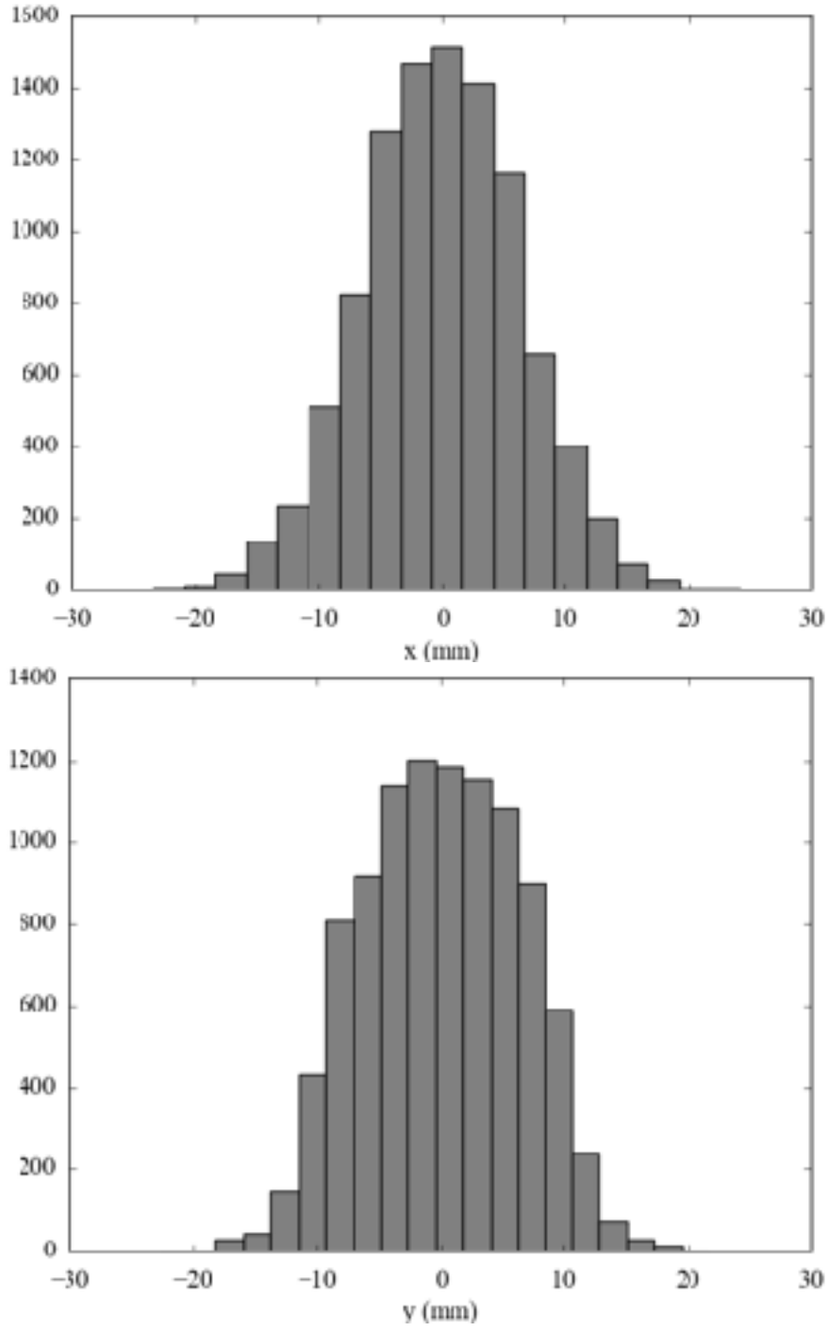
# Magnetic Mirroring

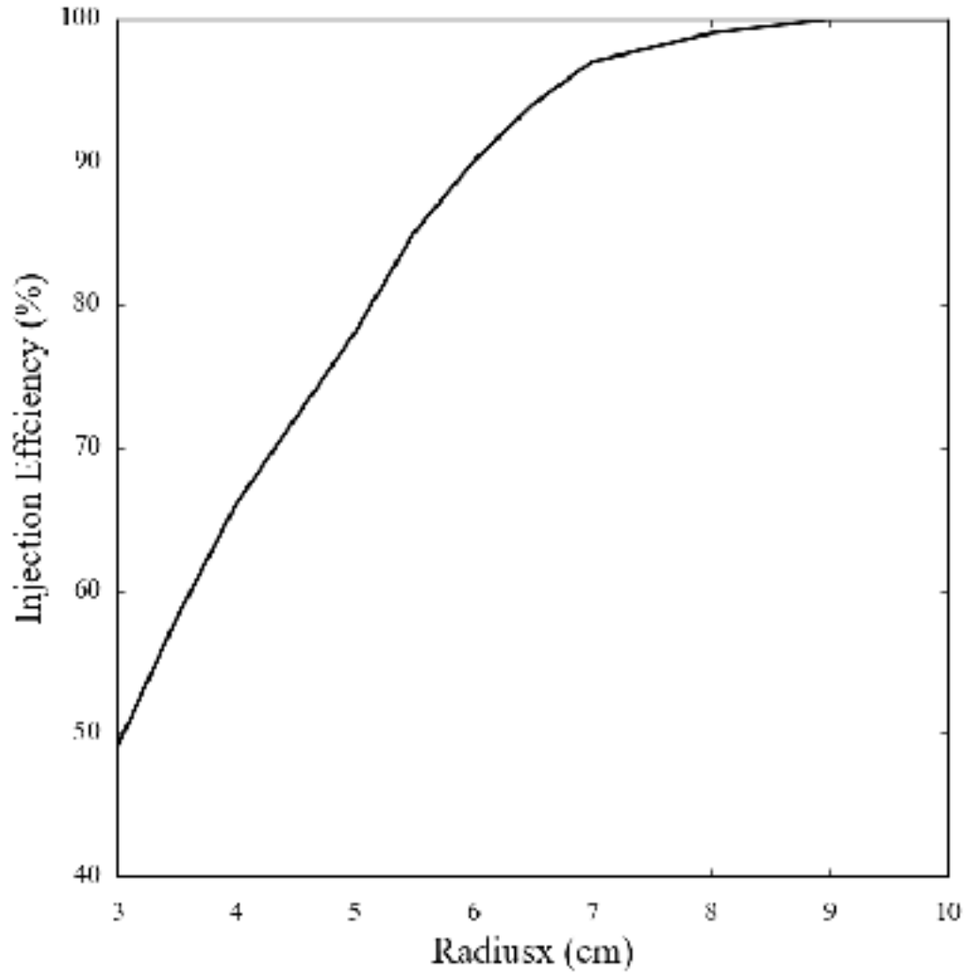



- Inner diameter of solenoid : 30 mm
- Magnetic field along center line : 3T

# Injection Efficiency

Input Beam



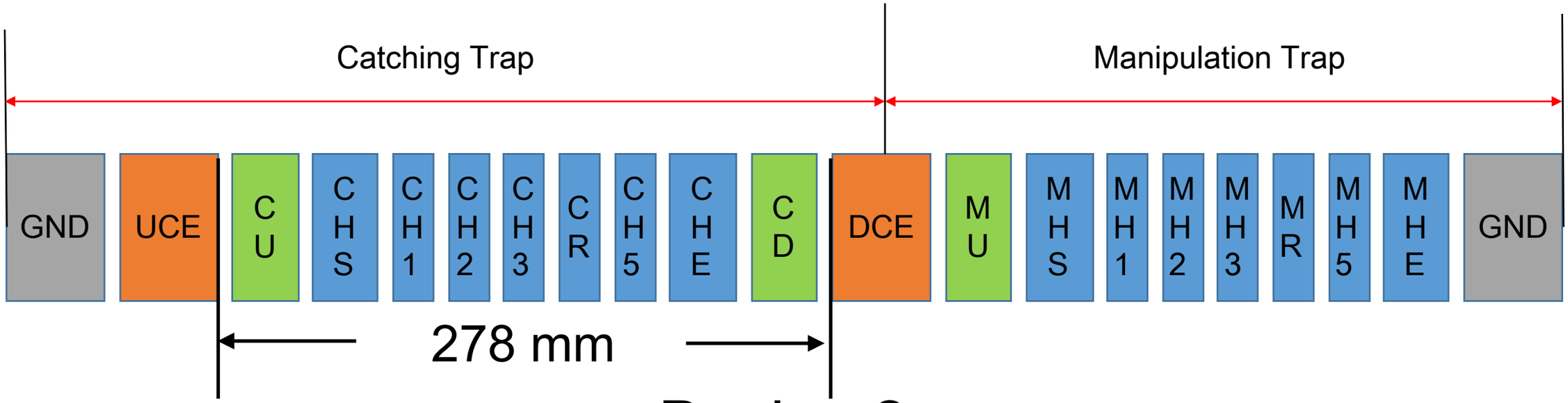




- Affected by fringe field
- Using magnetic shield, it will be better

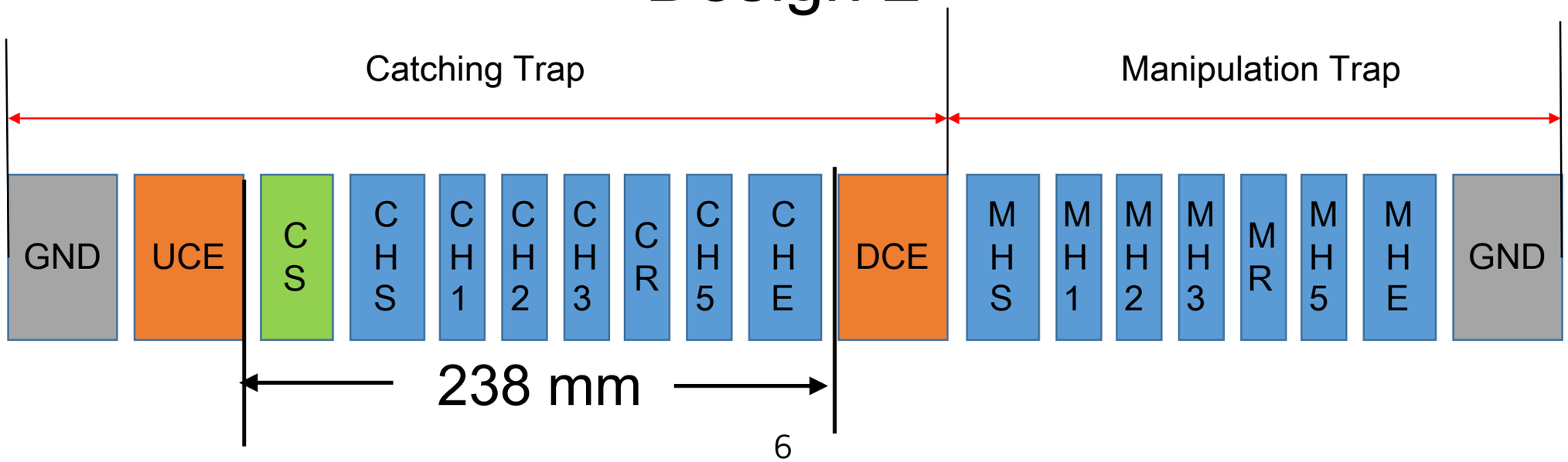
# Trapping Antiproton

# Simulation Setup

< Design 1 >

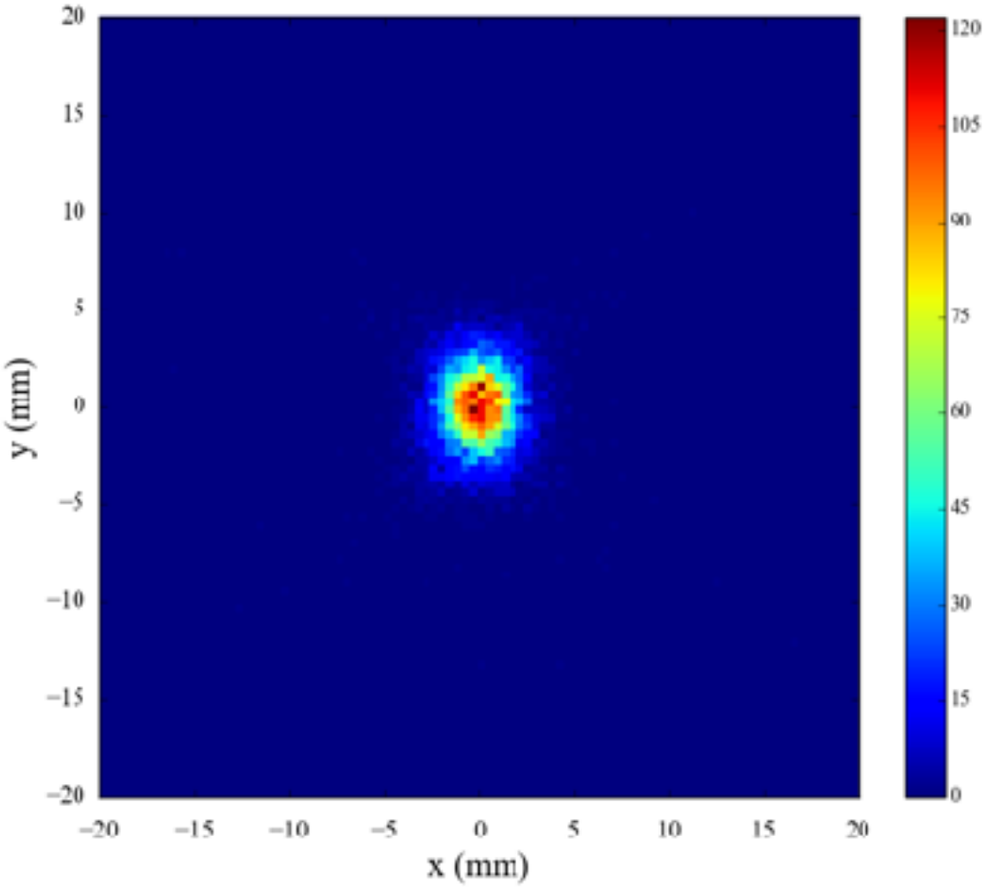



< Design 2 >

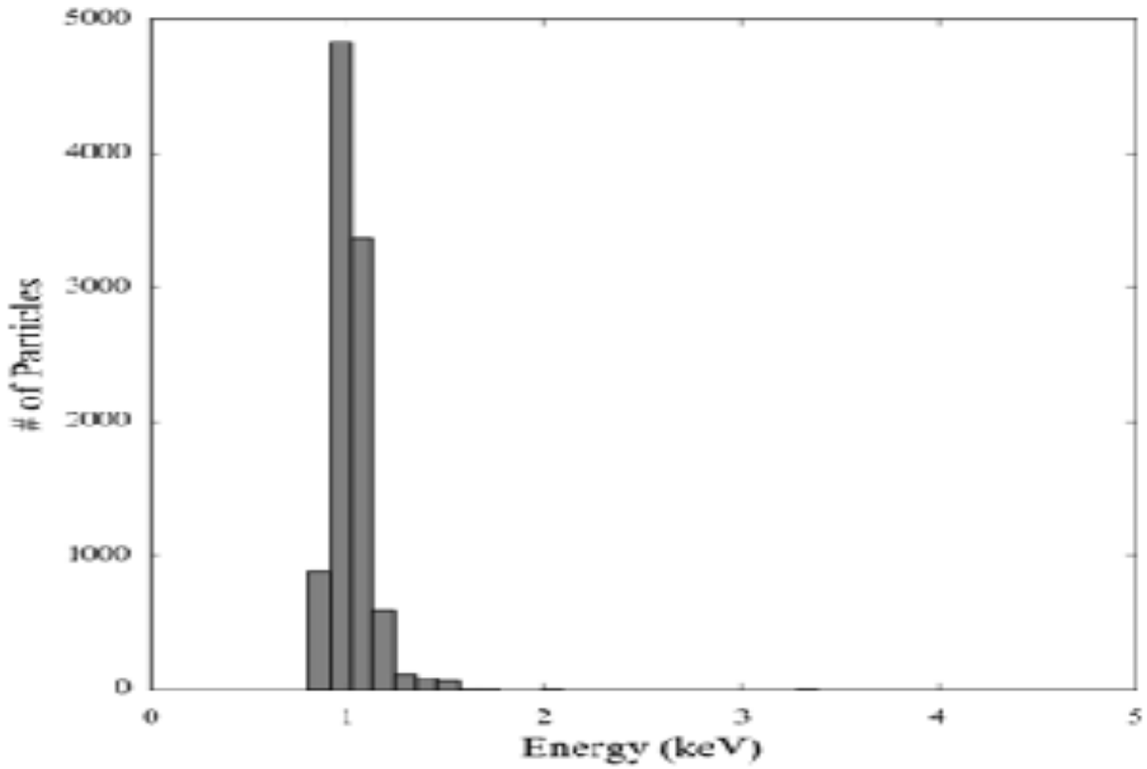


# Simulation Setup

## Input Beam



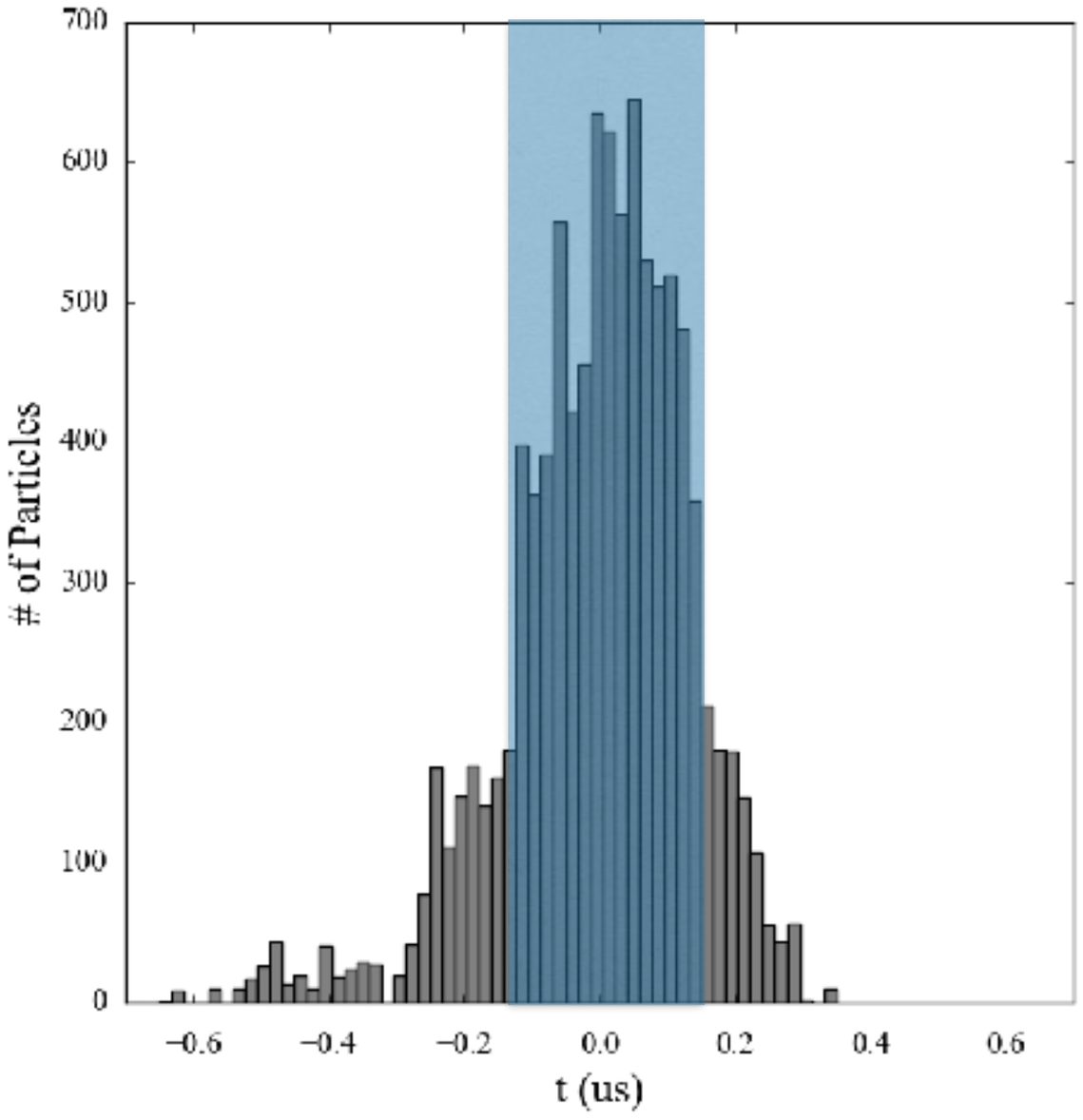

Transverse Distribution




Energy Distribution

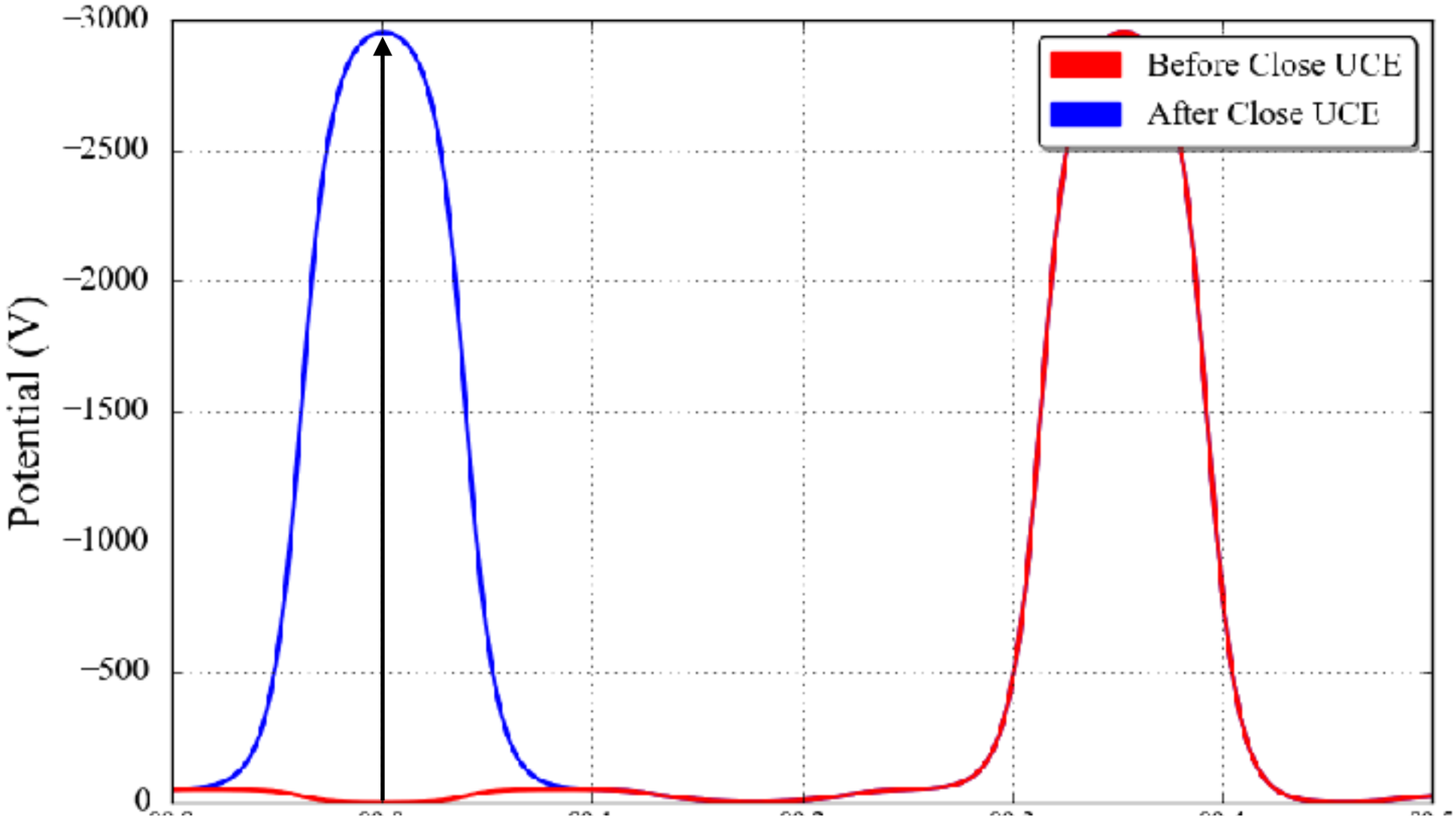
# Simulation Setup

Input Beam



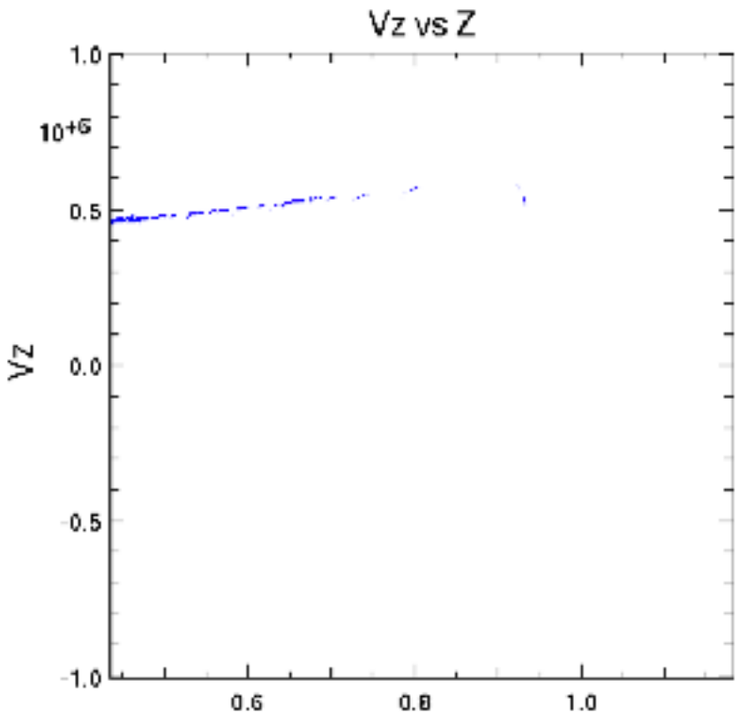

- Diameter : 1 cm
- Energy : 1 keV
- Bunch Length (- 1 sigma ~ 1 sigma) : ~ 300 ns

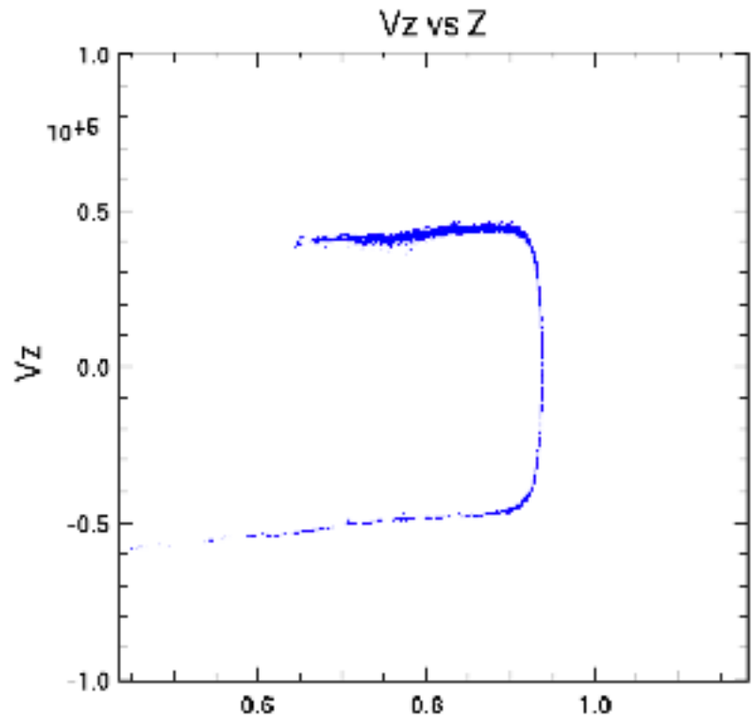
# Simulation Setup

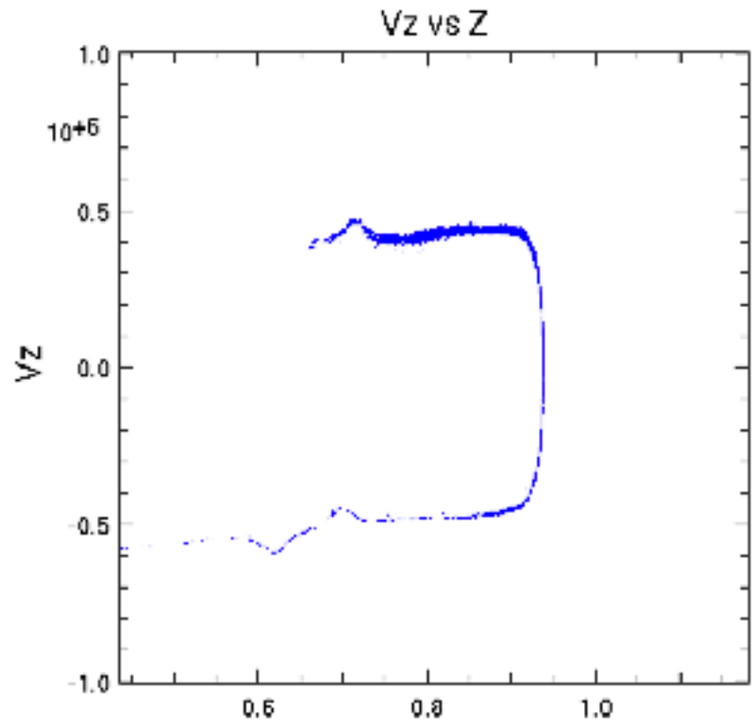


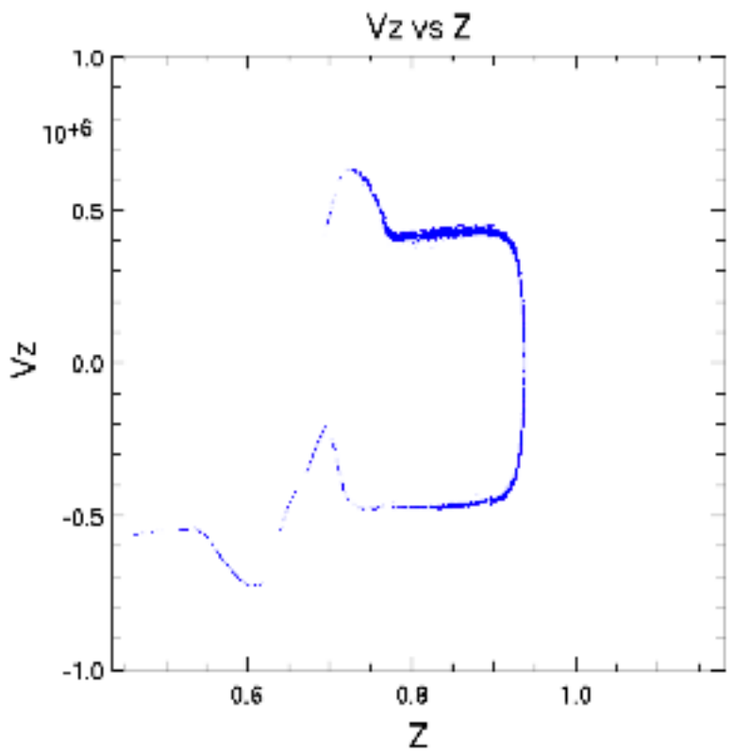

Rise Time : 300 ns

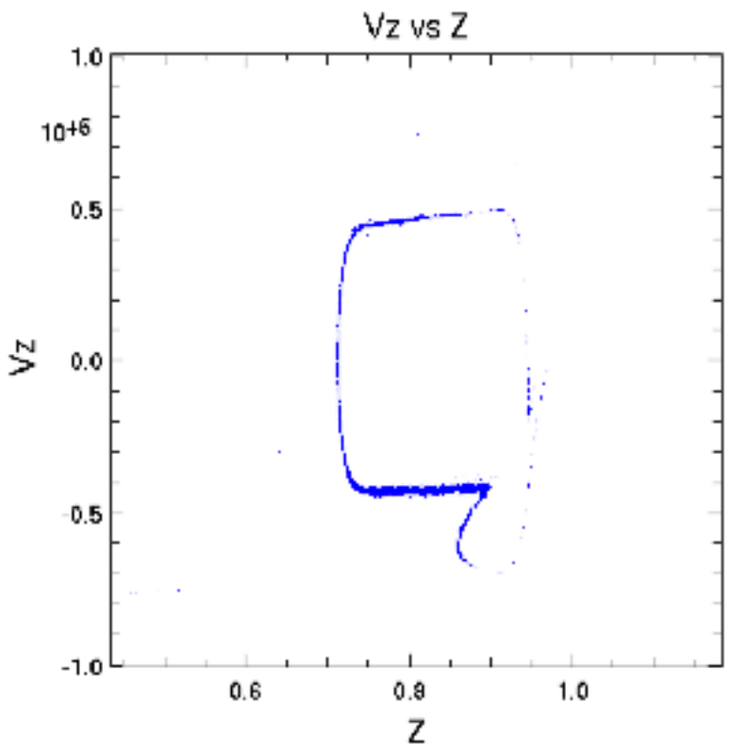
# Phase-space on z

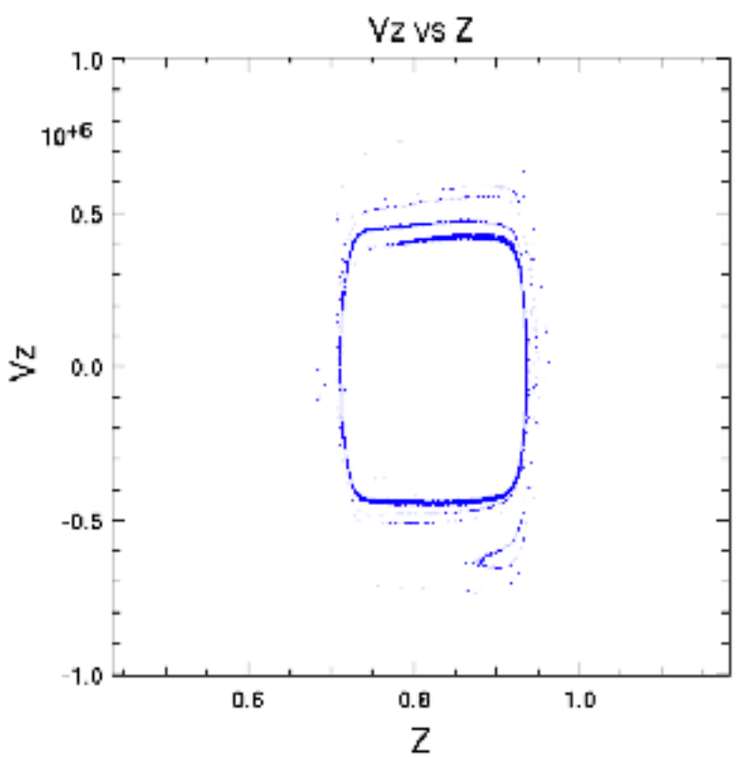


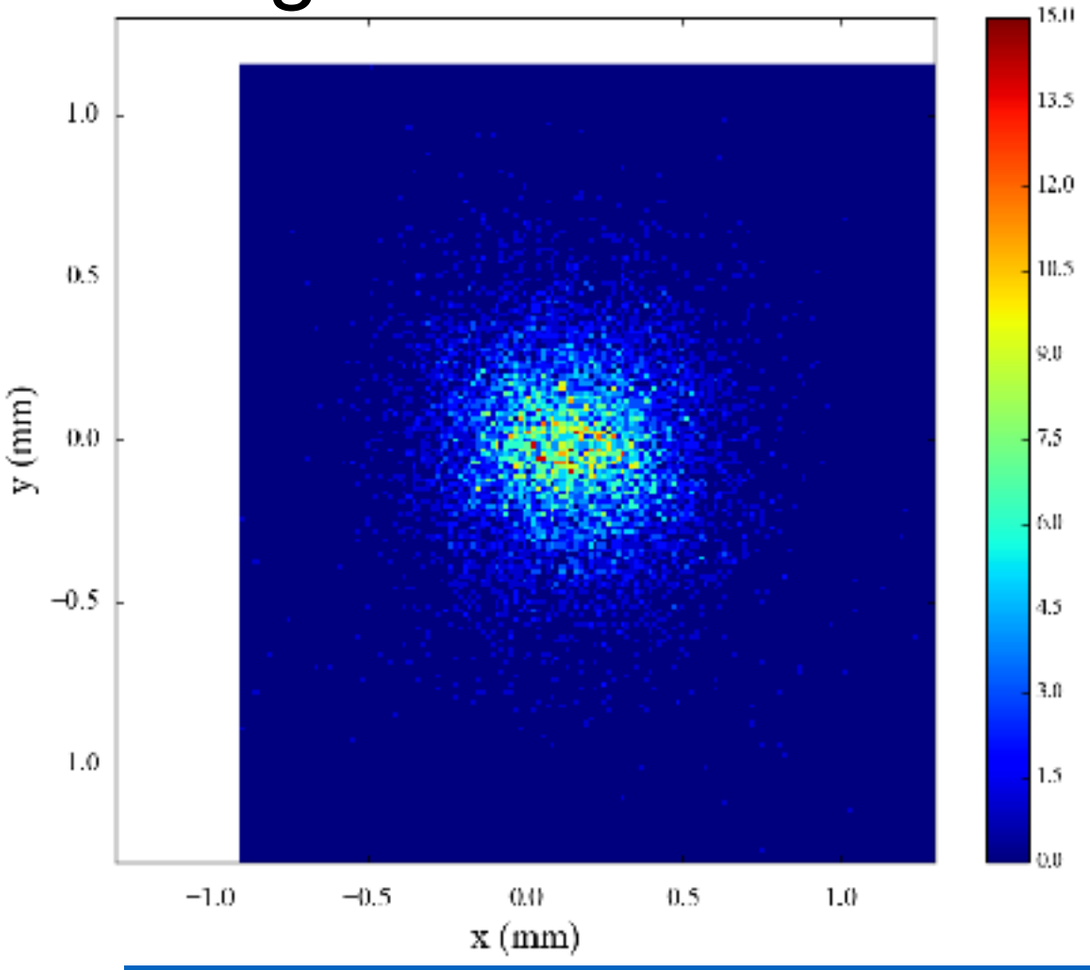



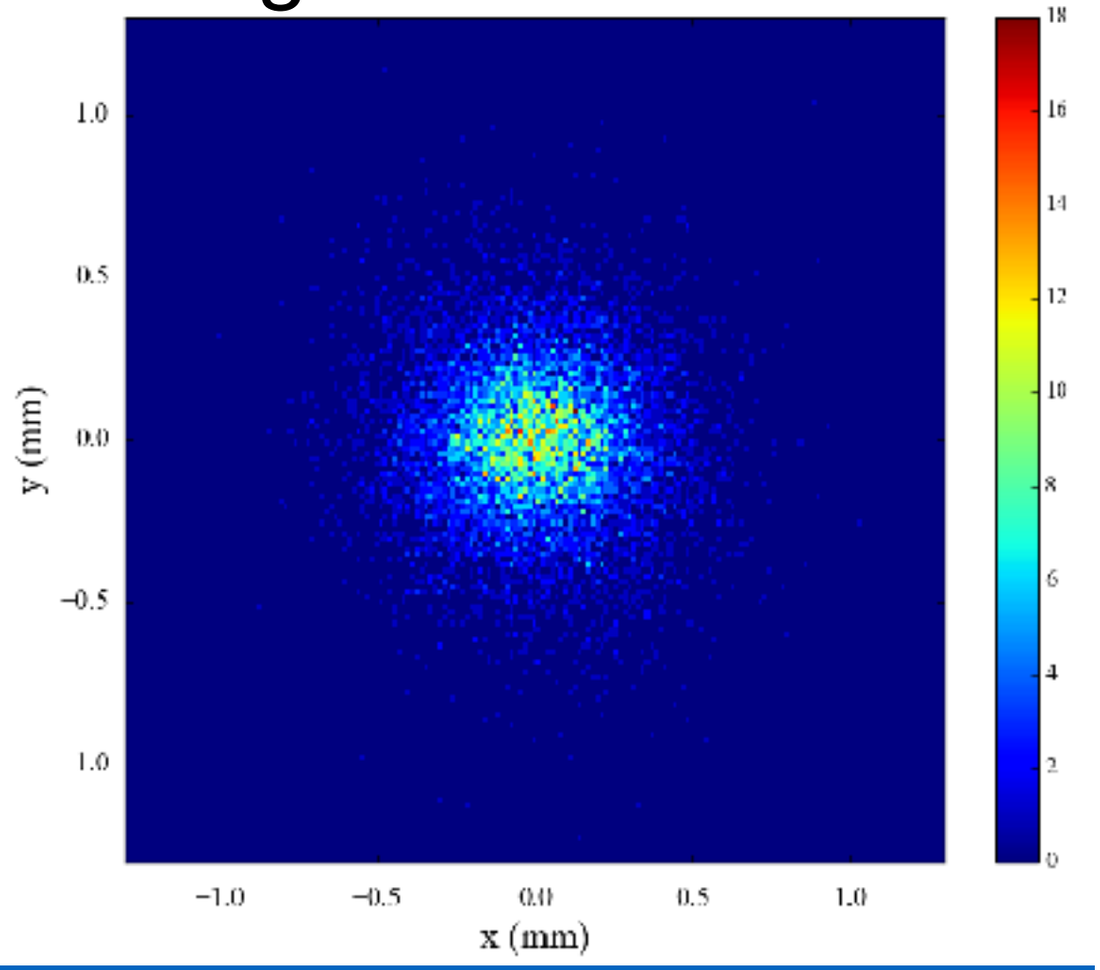



# Trapped Beam Data

## Design 1




## Design 2

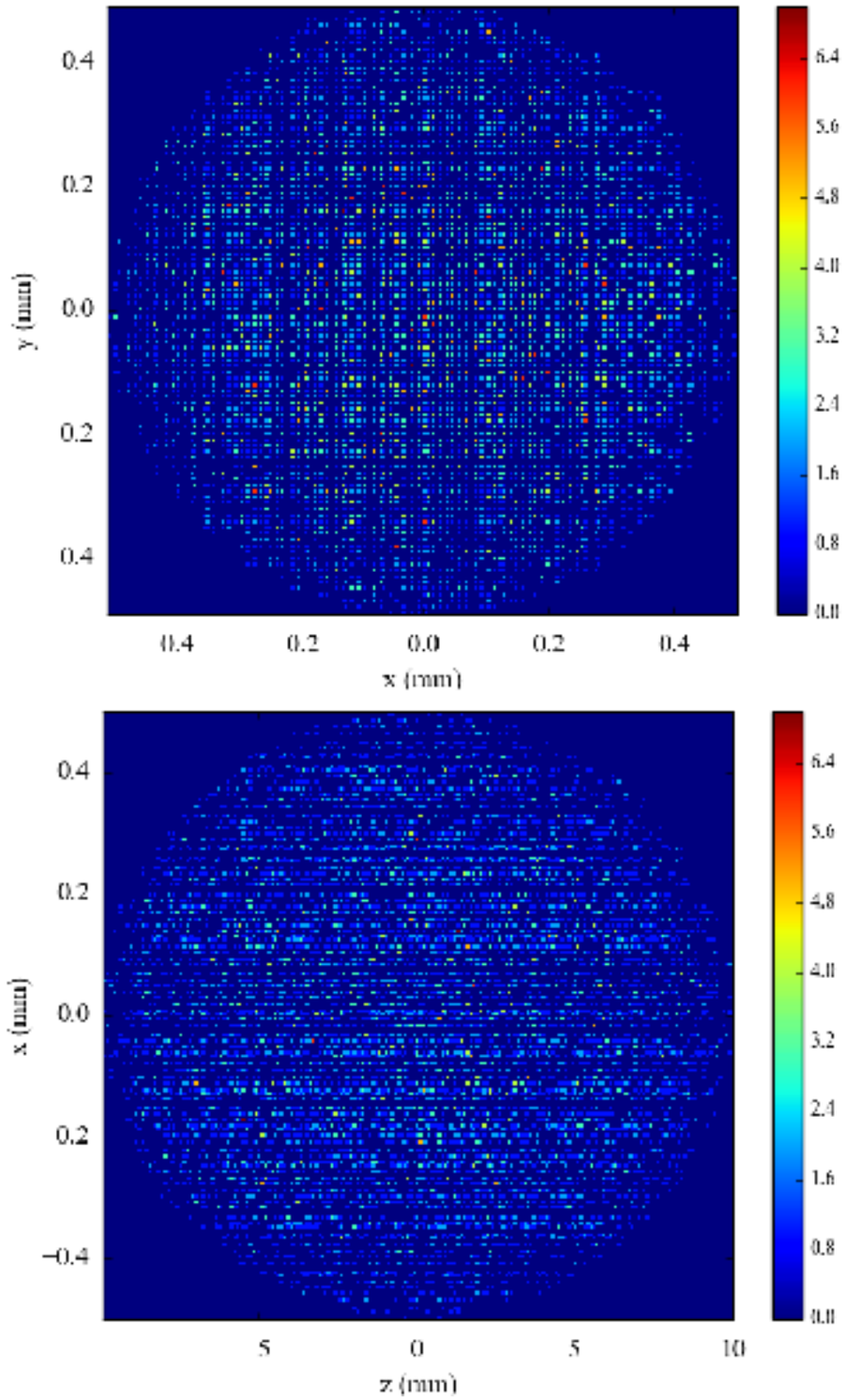



| | Trap Length (mm) | Efficiency (%) |
|---|---|---|
| Design 1 | 278 | 98.44 |
| Design 2 | 238 | 97.76 |

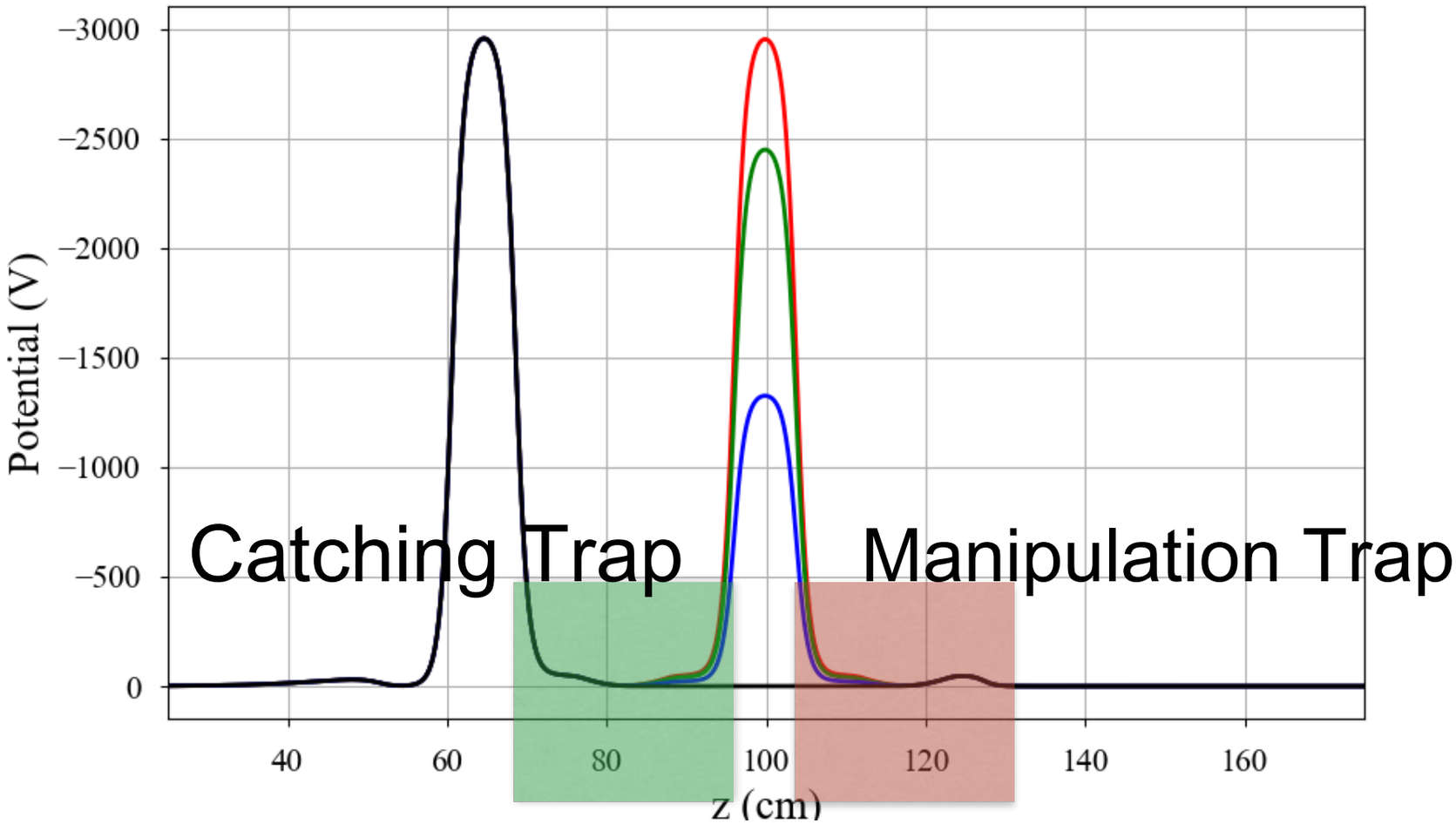
# From Catching Trap to Manipulation Trap

# Simulation Setup

- Input Beam Shape : Spheroid
- Diameter : 1 mm
- Uniform Distribution
- Energy : Maxwell Distribution



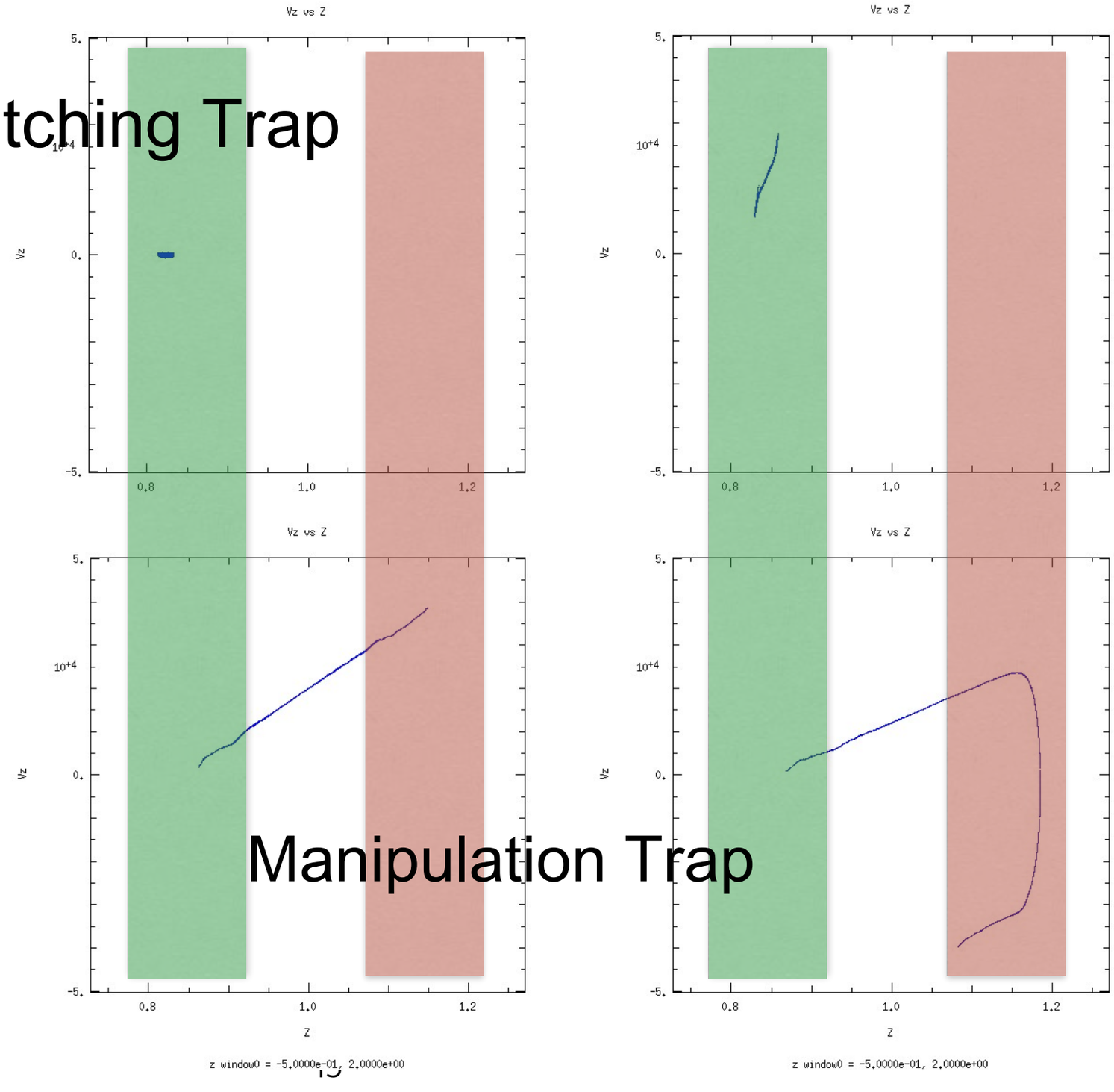
# Simulation Setup




With Falling Time : 300 ns

# Transported Beam

Phase-space on z



# Conclusion

- As smaller diameter of magnet, the loss of particles increase due to fringe field. So, with magnetic shield, magnet bore size can be reduced.

- In current design, most of antiproton is well trapped with efficiency above 90 %. But, considering floating, the result might be some different, so, additional simulation is needed.

- The diameter of antiprotons injected in trap is about 1 mm, so, the diameter of electrode can be reduced, and the length can be also reduced.

- The parameters of cooled beam need to be modified. And after that, additional simulation will be done.