Positron transport system in MACE experiment

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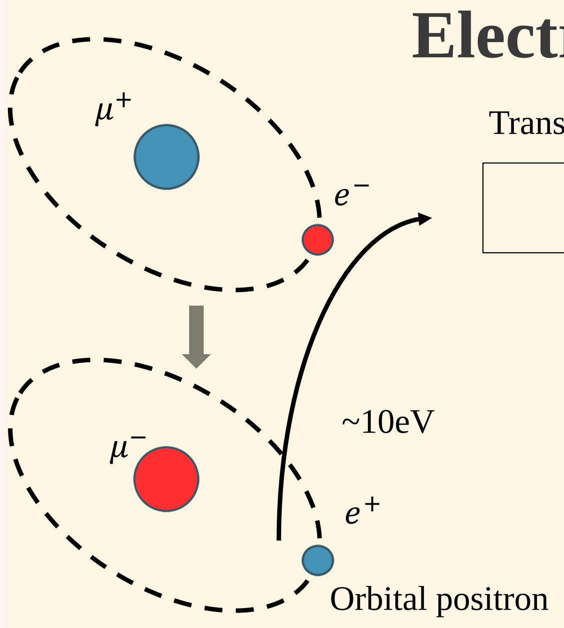
Electrostatic accelerator



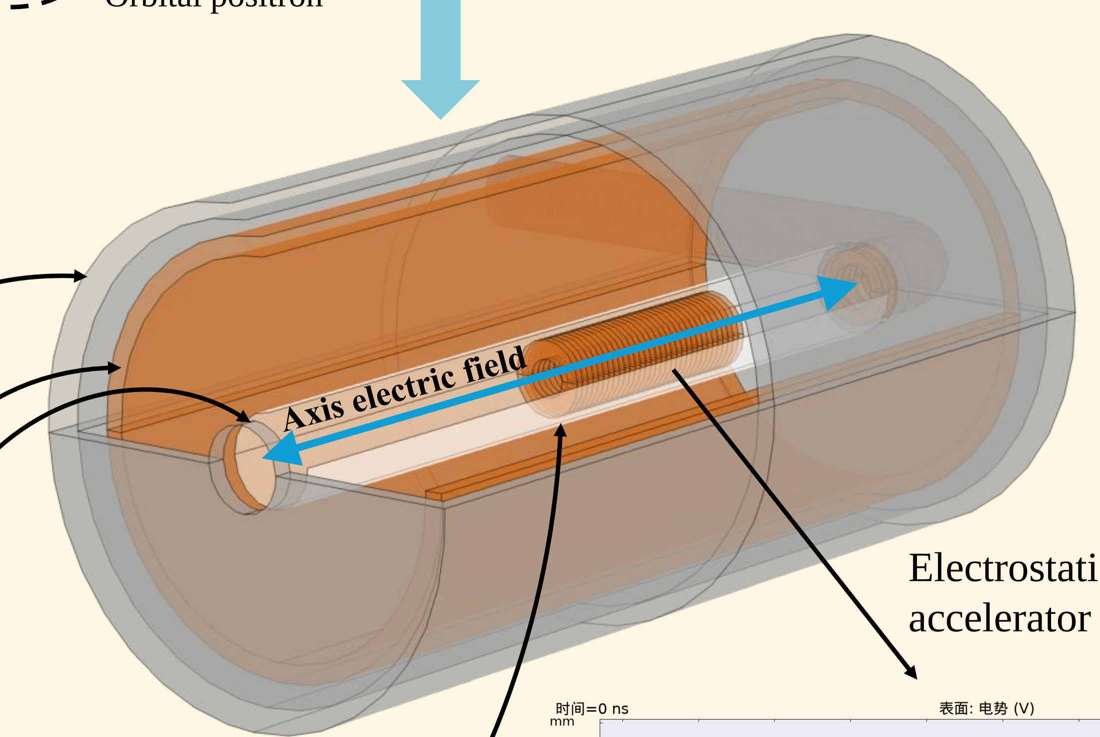
Transported particles

Positron → Low energy → Electrostatic accelerator

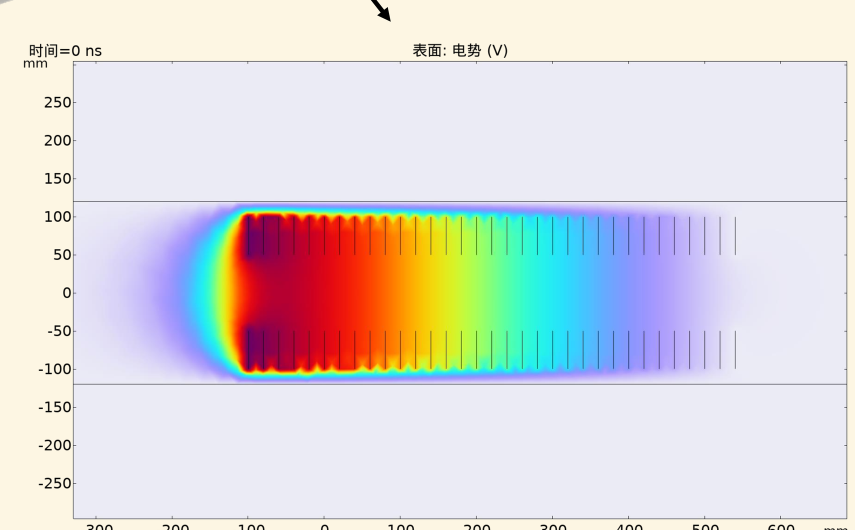
- Voltage
- Acceleration time
- Field strength
- Transmission efficiency

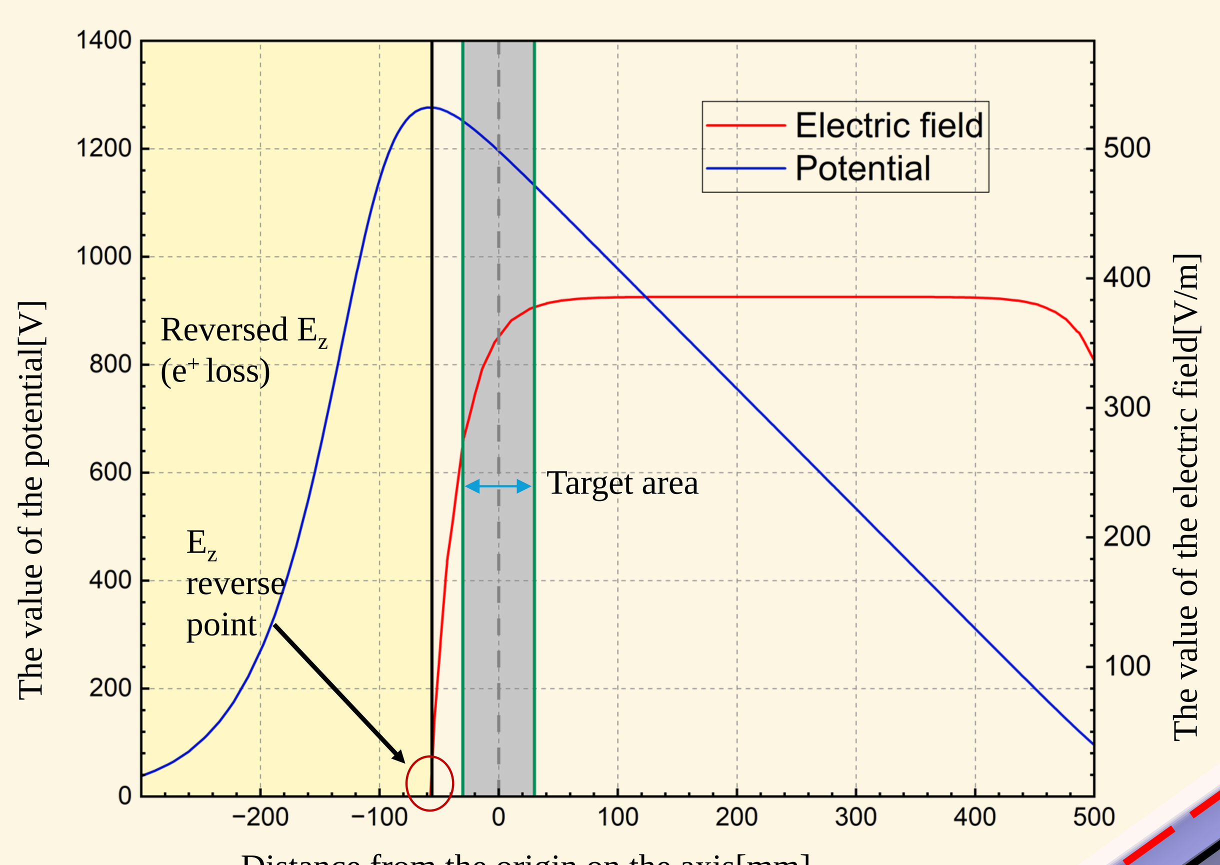
Aim of design

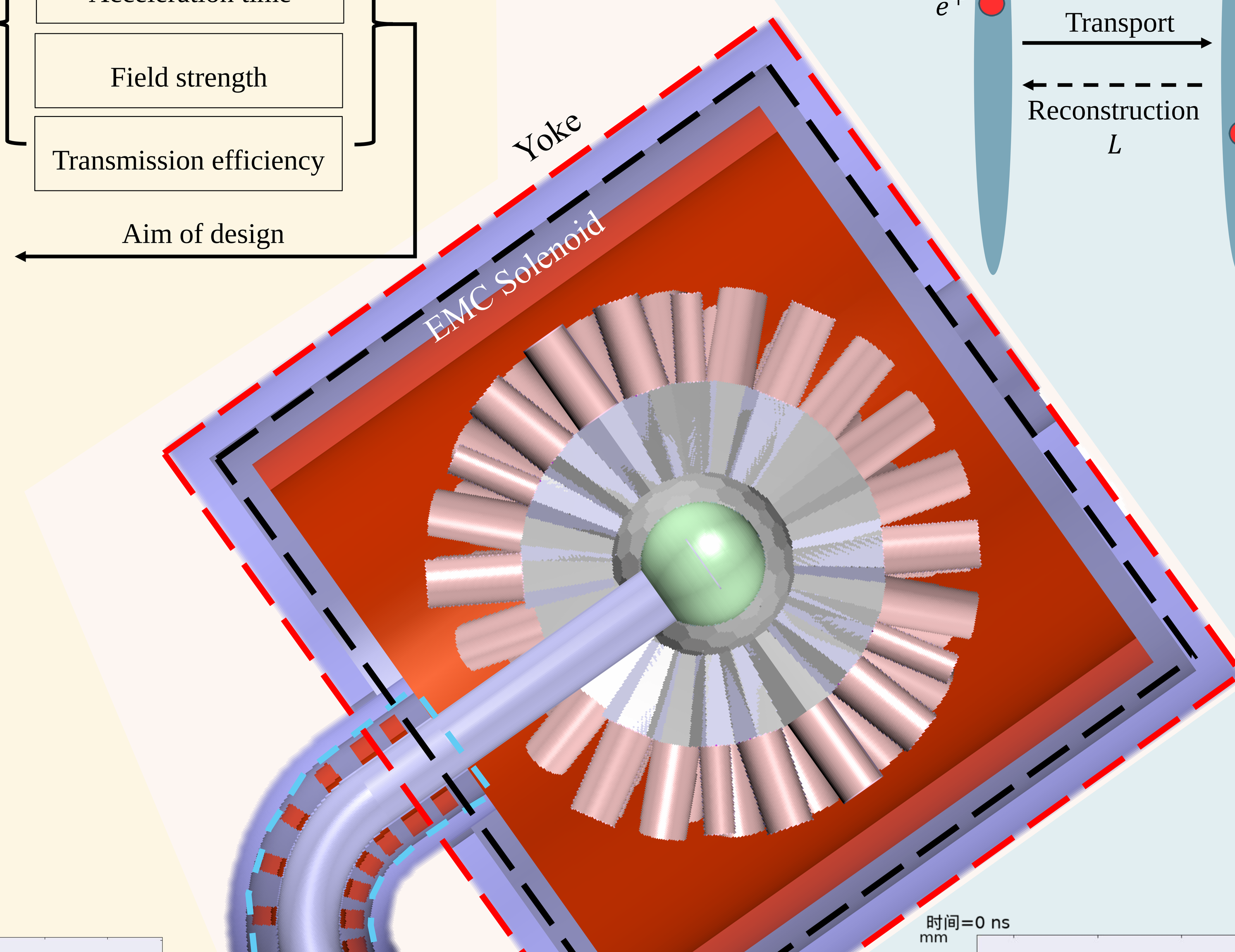
- High transmission efficiency
- Accelerate and transport positrons
- Filter out other particles

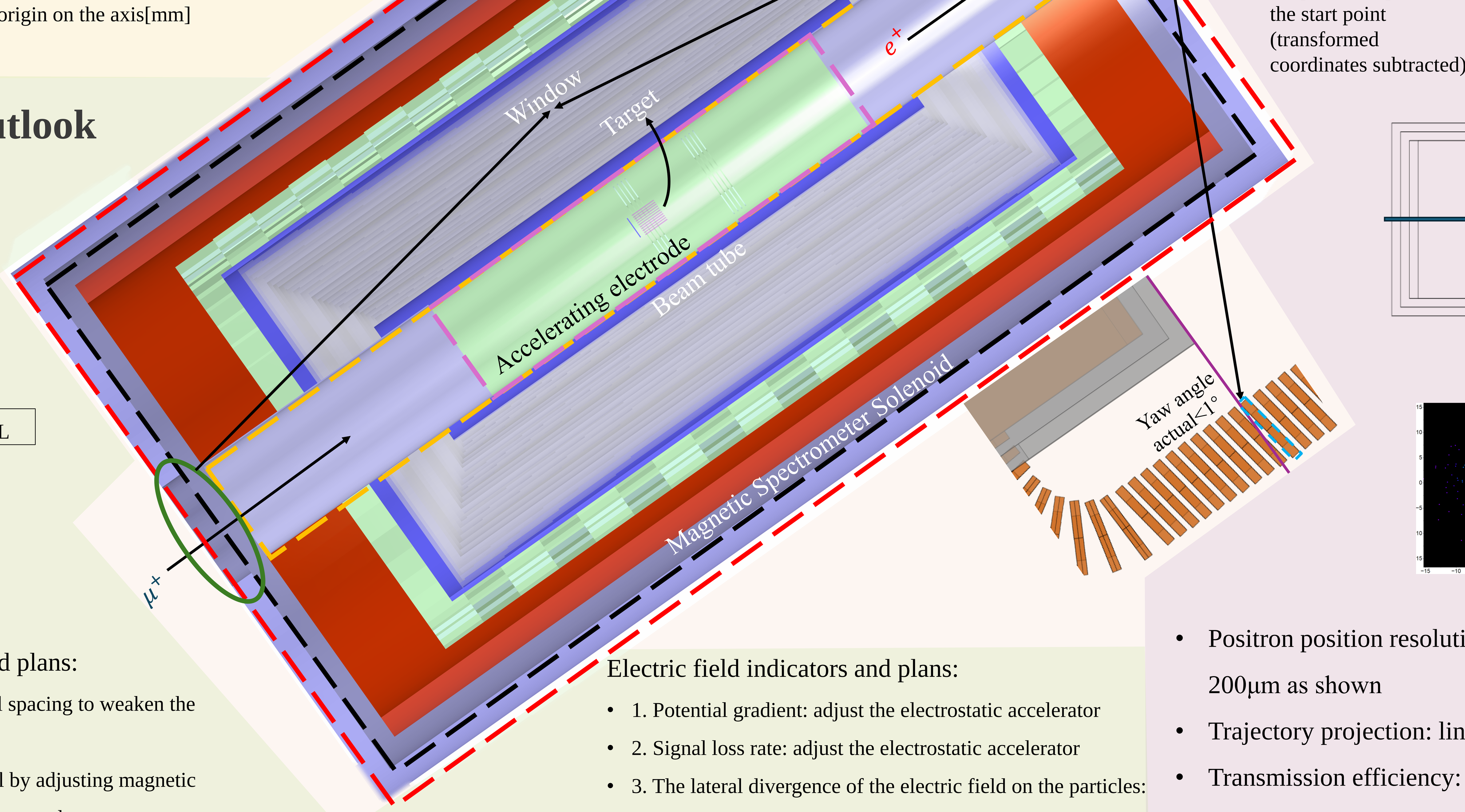


- Beryllium tube :Beam tube
- Spectrometer magnet
- Yoke: Magnetic Shield
- Electrostatic accelerator









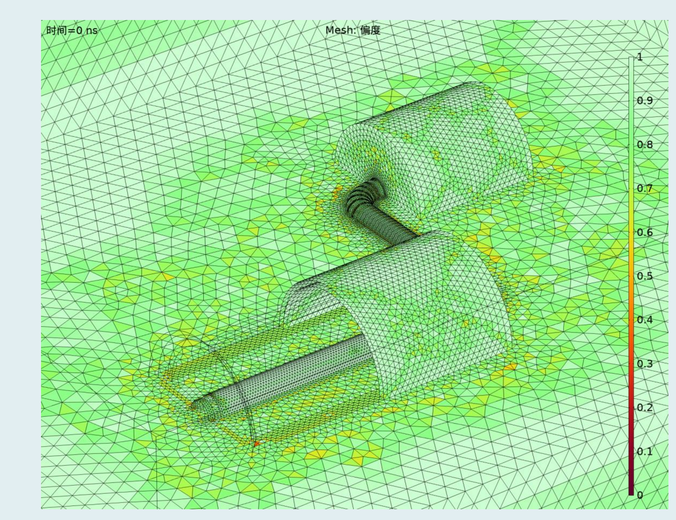
Transport solenoid

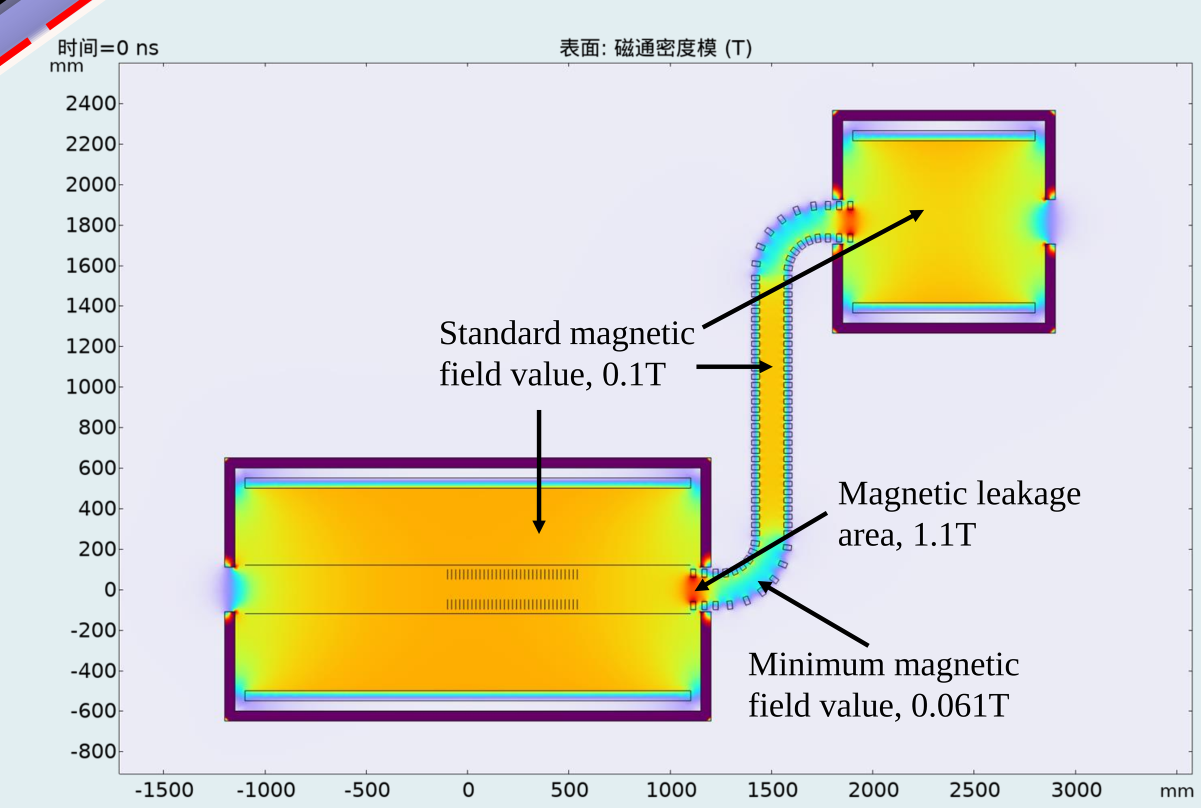
e^+ $r=(x,y,z)$ Transport → $r'=(x',y',z')$ e^+

Reconstruction L

The designed magnetic field satisfies $L(r')=r$

- Collimation
- Uniformity





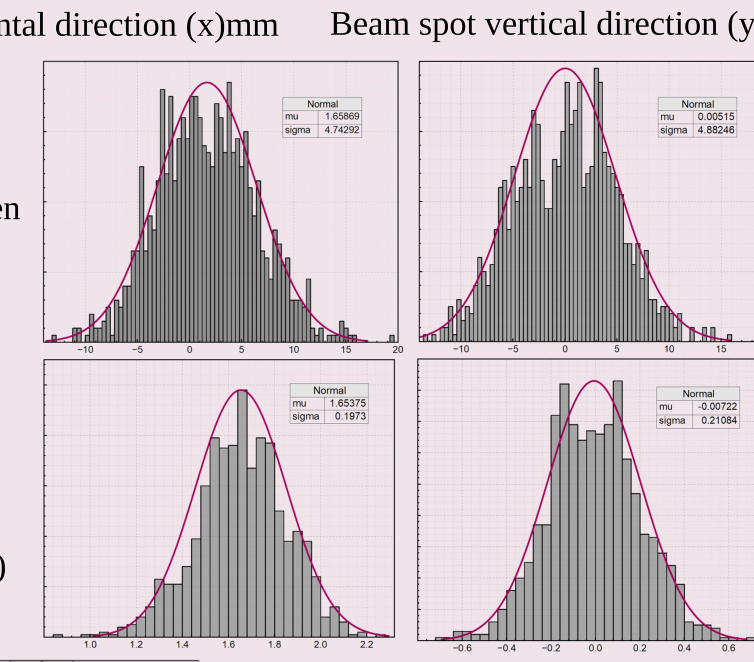
Transport simulation results

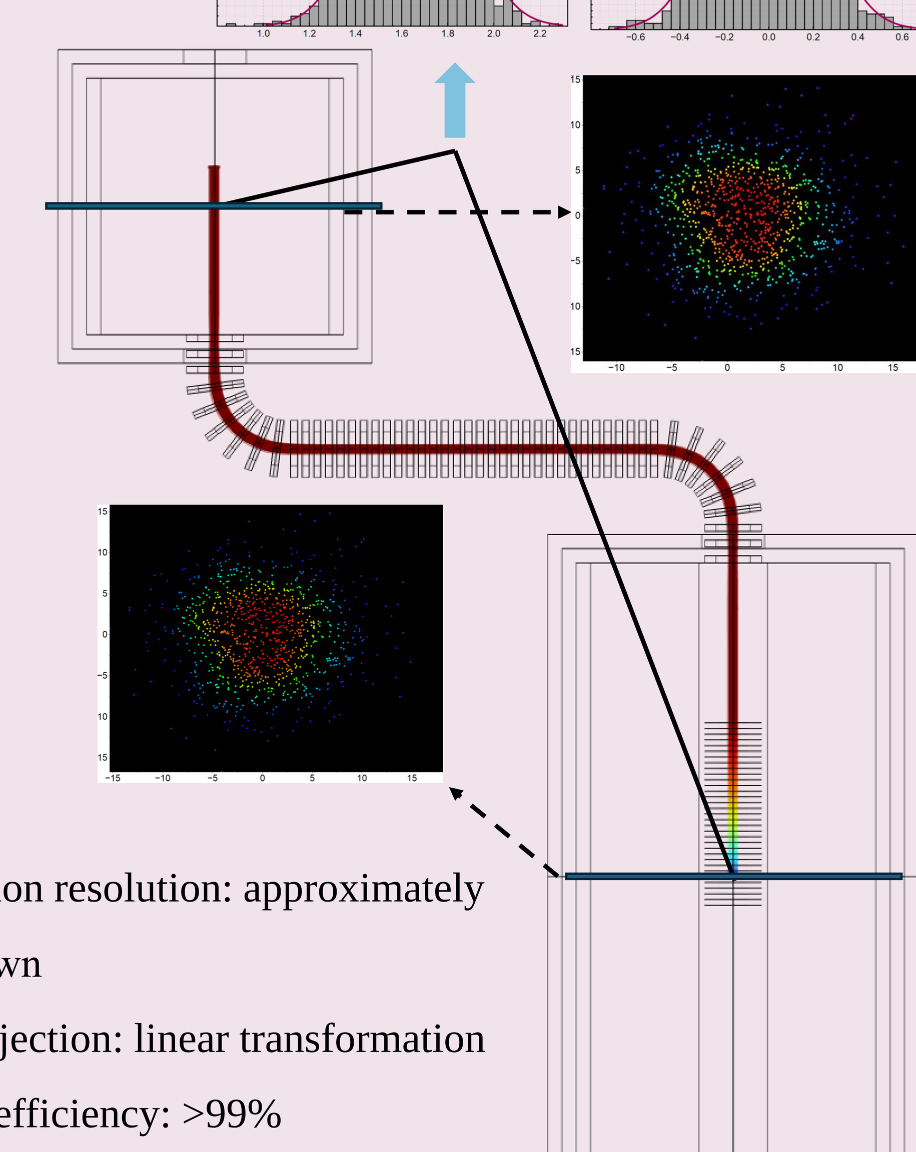
Beam spot horizontal direction (x)mm

Beam spot vertical direction (y)mm

Endpoint (coordinate transformation has been performed)

The drift of the endpoint compared to the start point (transformed coordinates subtracted)





- Positron position resolution: approximately 200μm as shown
- Trajectory projection: linear transformation
- Transmission efficiency: >99%
- Time of flight spreading (500eV): 0.03ns

Summary and outlook

Research process:

Electromagnetic field design

Simulate electromagnetic field distribution

COMSOL

Import

MACE offline software

Magnetic field indicators and plans:

- 1. Uniformity: optimize the coil spacing to weaken the magnetic lens phenomenon.
- 2. Collimation: achieve the goal by adjusting magnetic shielding, magnetic compensation, and geometry

Electric field indicators and plans:

- 1. Potential gradient: adjust the electrostatic accelerator
- 2. Signal loss rate: adjust the electrostatic accelerator
- 3. The lateral divergence of the electric field on the particles: maintain the current effect

References

[1]Bai, A.-Y., & others. (2022, March). Snowmass2021 Whitepaper: Muonium to antimuonium conversion. *Snowmass 2021*.

[2]T. J. Roberts and D. M. Kaplan, "G4beamline simulation program for matter-dominated beamlines," *2007 IEEE Particle Accelerator Conference (PAC)*, Albuquerque, NM, USA, 2007, pp. 3468-3470, doi: 10.1109/PAC.2007.4440461.