中国科学技术大学

University of Science and Technology of China

STCF

# The positron source of STCF in China

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# Contents

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I. The injectors of STCF

II. The positron source of STCF

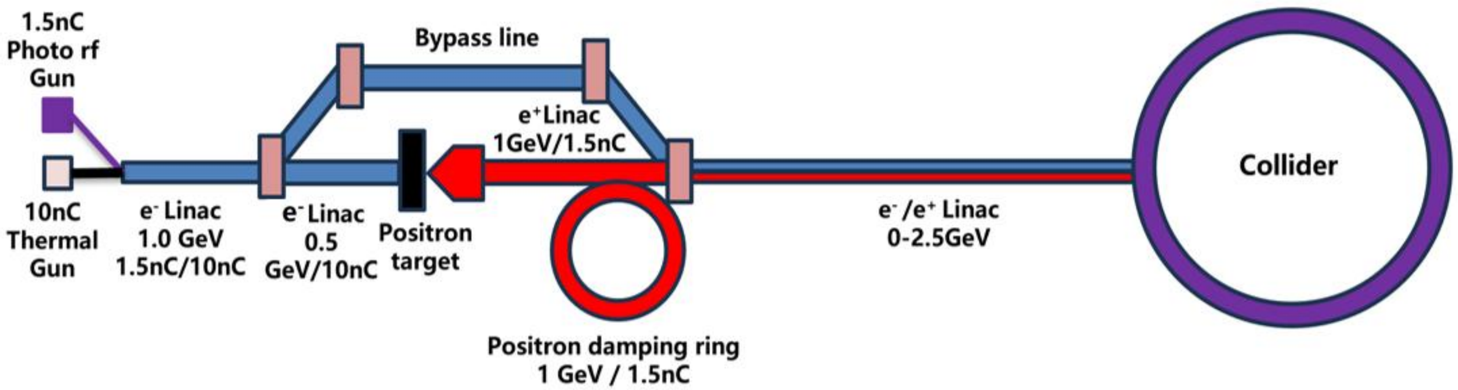
III. Thermal research on target

# The Super Tau-Charm Facility in China

STCF

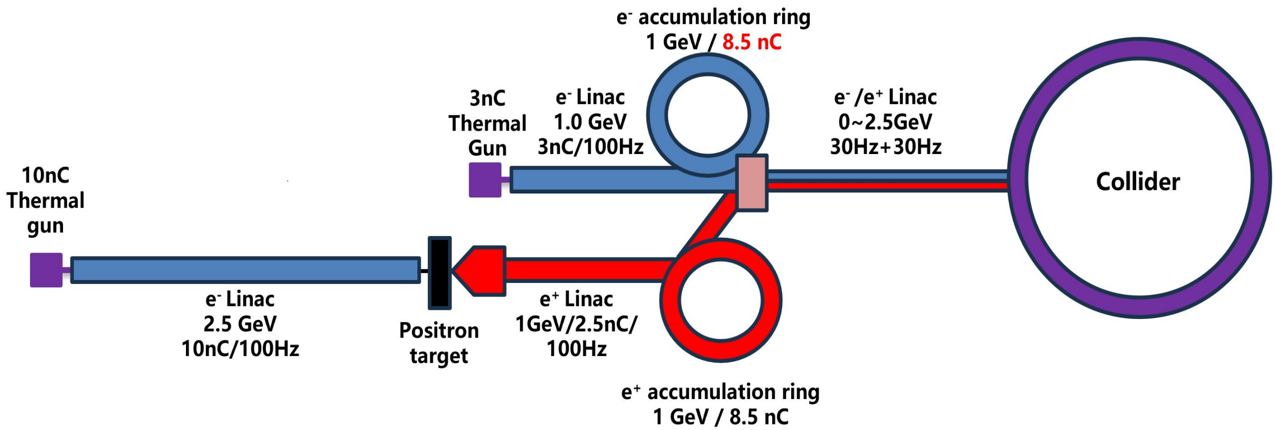
| Parameter | Value |
| --- | --- |
| Perimeter/m | ~800 |
| Optimized beam energy/GeV | 2 |
| Energy/GeV | 1-3.5 |
| Current/A | 1.5 |
| Emittance$(\varepsilon_x/\varepsilon_y)$/nm·rad | 5/0.05 |
| $\beta(\beta_x^*/\beta_y^*)$/mm | 90/0.9 |
| Crossing Angle 2θ/mrad | 60 |
| Frequency shift ξy | 0.06 |
| Luminosity/$\times 10^{35}cm^{-2}s^{-1}$ | ≥0.5 |

# The off-axis injection of STCF




| Parameter | Off-axis injection |
|---|---|
| Bunch charge(e/e$^+$) | 1.5nC/50 Hz |
| Beam energy(e/e$^+$) | 1-3.5GeV |
| Geometric Emittance(@2GeV) | ≤6 nm·rad |
| e beam for e$^+$(energy) | 1.5GeV |
| e beam for e$^+$(charge) | 10 nC/50 Hz |

# The Swap-out injection of STCF




| Parameter | Swap-out injection |
|---|---|
| Bunch charge(e/e$^+$) | 8.5nC/30 Hz |
| Beam energy(e/e$^+$) | 1-3.5GeV |
| Geometric Emittance(@2GeV) | ≤30 nm·rad |
| e beam for e$^+$(energy) | 2.5GeV |
| e beam for e$^+$(charge) | 10 nC/100 Hz |

# Contents

# The positron production system

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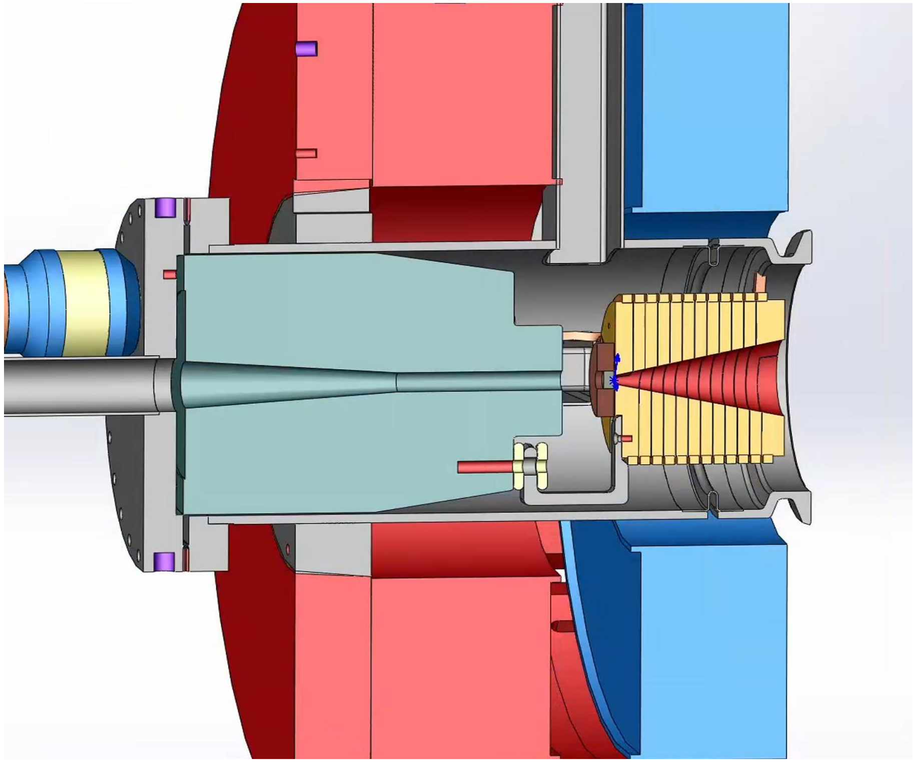


| Parameter | Off-axis | Swap-out |
|---|---|---|
| Electron bunch | 10 nC | 10 nC |
| Electron energy | 1.5 GeV | 2.5 GeV |
| Rep. rate | 50 Hz | 100 Hz |
| Beam size（rms） | 0.5 mm | 0.5 mm |
| Magnetic field | 5↘ 0.5 | 5↘ 0.5 |
| Target thickness | 13 mm | 15 mm |
| Target material | Tungsten | Tungsten |
| e+ yield | 0.15 | 0.25 |
| PEDD | 6.3J/g | 11.5J/g |
| Deposit power(w) | 141w | 495w |
| Peak Deposit power density(kw/cm^3) | 6.09 | 22.34 |

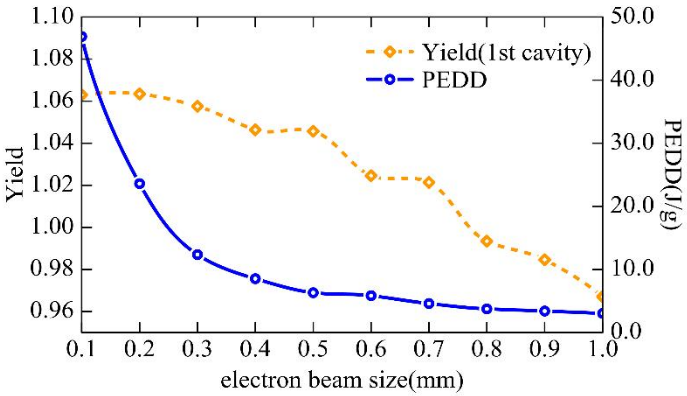
**1.Simulation tools： Geant4、Fluka**

**2. tungsten, with thicknesses of 13mm and 15mm respectively, and PEDD less than 35J/g.**

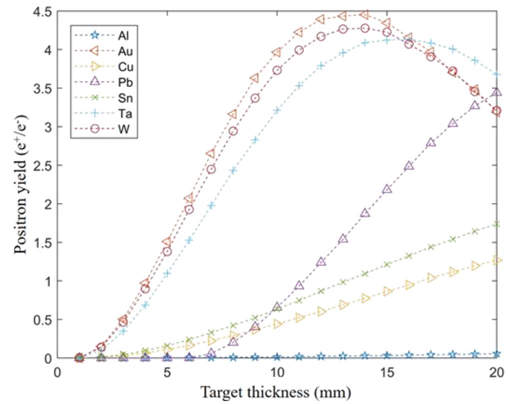
**3.Calculate the peak deposition power, which may cause changes in the lattice state of the material and affect the yield.**

# The positron production system

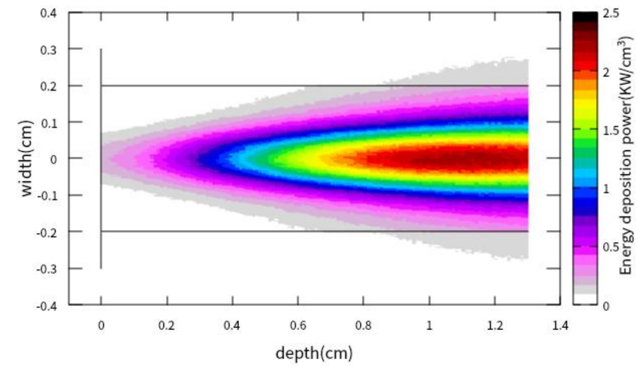
STCF



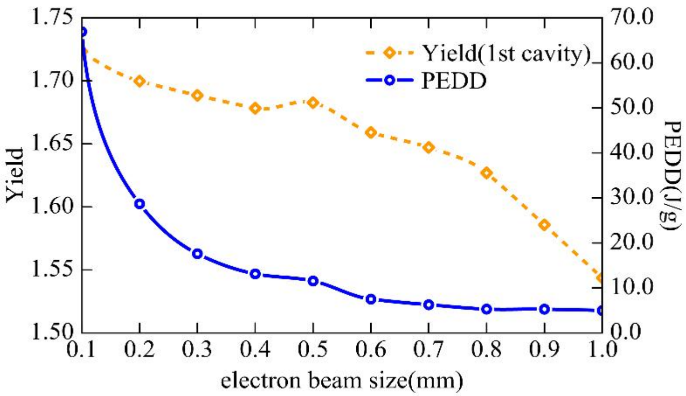

Positron yield and PEDD of different electron size(1.5Gev)



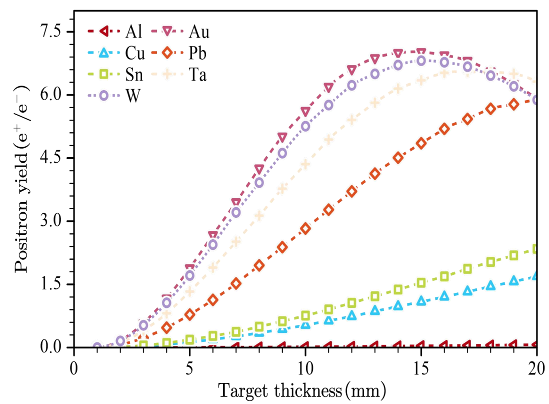

Positron yield under 1.5 GeV electron



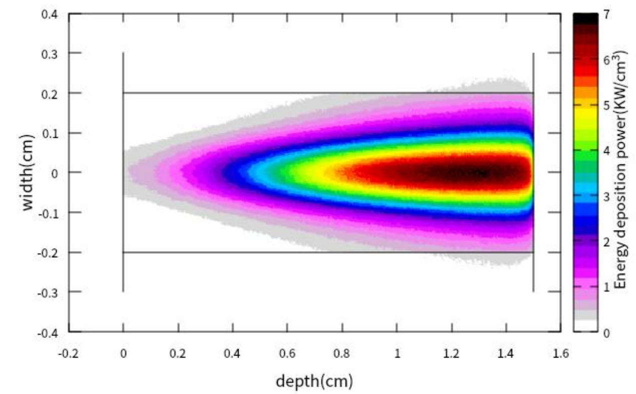

Energy deposition of a 1.5 GeV electron beam in a 13 mm thick tungsten




Positron yield and PEDD of different electron size(2.5Gev)




Positron yield under 2.5 GeV electron

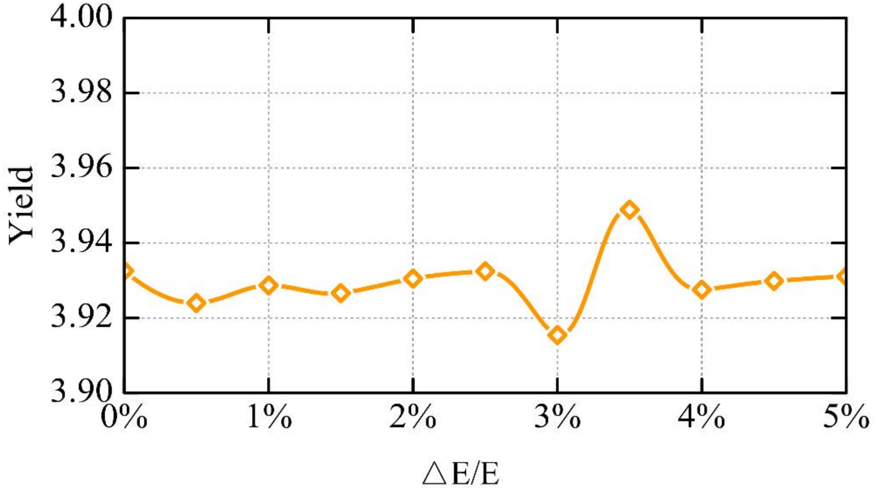



Energy deposition of a 2.5 GeV electron beam in a 15 mm thick tungsten

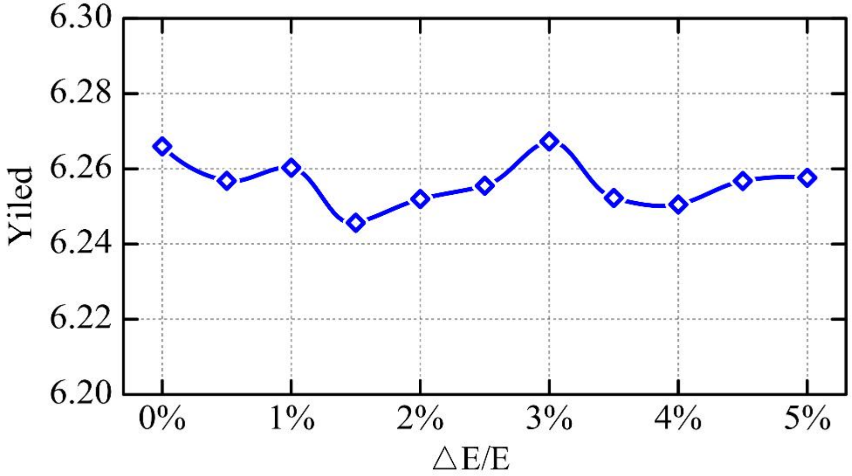
**1.Beam size(0.5mm):Make the beam spot size as large as possible without affecting the yield, thereby reducing PEDD**

**2.The average deposition power of the two injection methods is 141w and 495w, respectively**

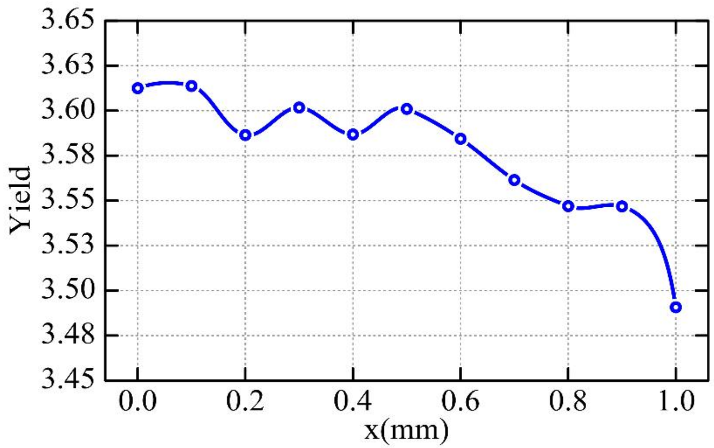
# The positron production system



Positron yield of different electron energy spread(1.5Gev)



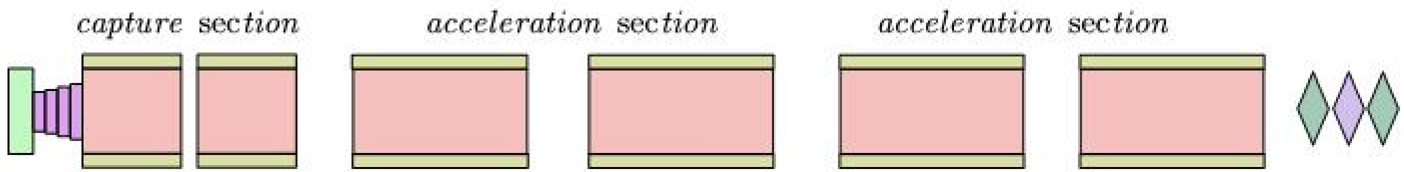
Positron yield of different electron energy spread(2.5Gev)

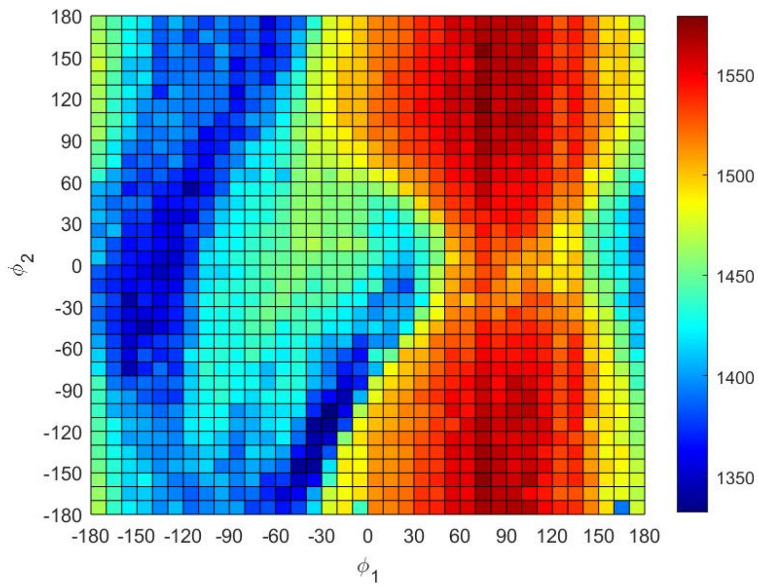


The effect of electron beam target displacement on positron yield

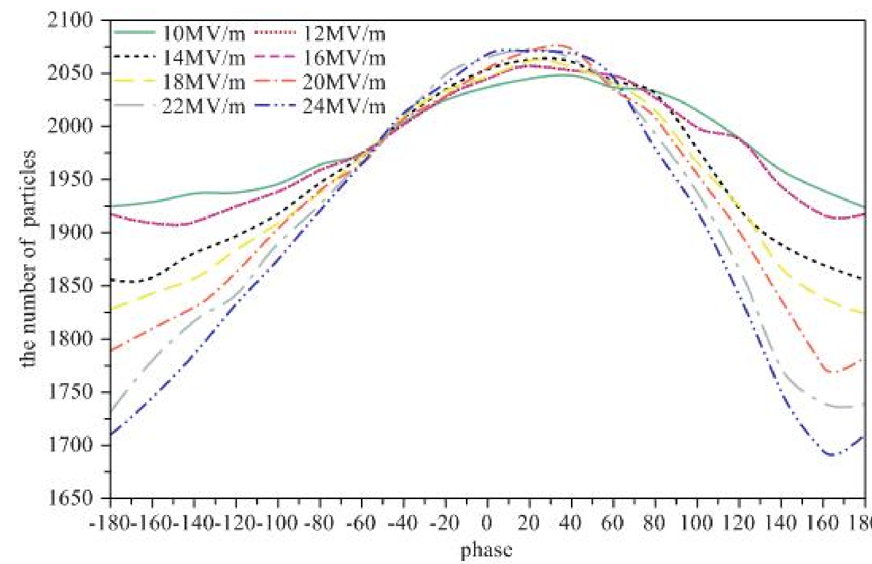
1. **The energy spread of the electron beam has a relatively small impact on the positron yield .**
2. **Offset of electron beam targeting needs to be within 0.6 mm**

# Positron pre-accelerating section




Phase optimization of Capture Section



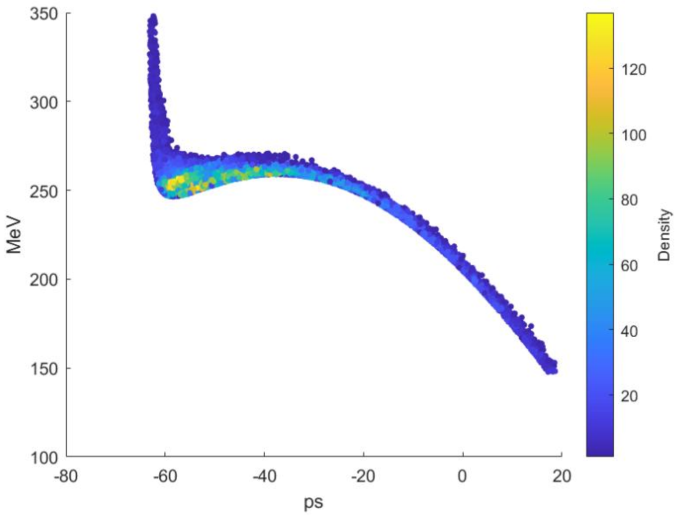

Acceleration gradient of Capture Section

**1.The capture section consists of two 1m acceleration cavities, and the acceleration section consists of four 3m acceleration cavities. The aperture of the acceleration tube is 30mm.**

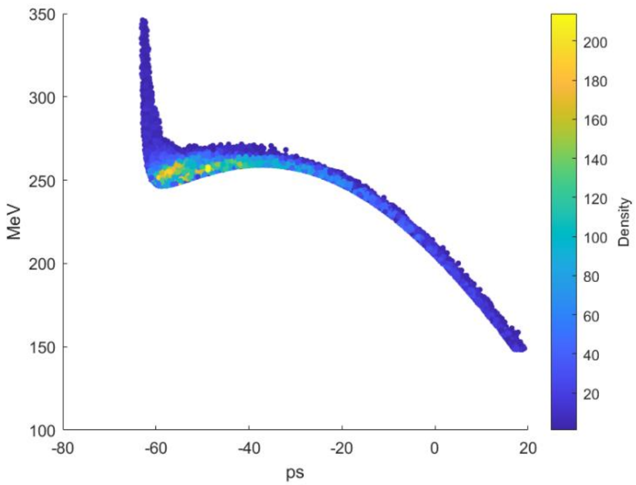
**2. The peak magnetic field of Flux Concentrator is 5T, and the magnetic field of the solenoid is 0.5T**

**3. Acceleration gradient : 20MV/m**

# Positron pre-accelerating section




longitudinal phase space distribution of
the end of pre-accelerating section(Off-axis)




longitudinal phase space distribution of
the end of pre-accelerating section(Swap-out)

| Parameter | Off-axis | Swap-out |
|---|---|---|
| yield | 0.570 | 0.883 |
| Energy spread | 8.21% | 8.06% |
| Bunch length | 5.66mm | 5.63mm |
| Beam size | 4.63mm | 4.63mm |
| $\varepsilon_n/mm{\cdot}mrad$ | ~3200 | ~3200 |

1. **There is not much difference between the two injection methods except for production at the end of the pre acceleration stage**
2. **The energy divergence is relatively large, accounting for 8.21% and 8.06% respectively**

# Positron pre-accelerating section

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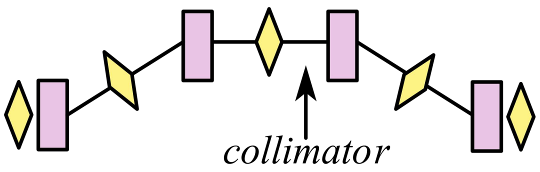


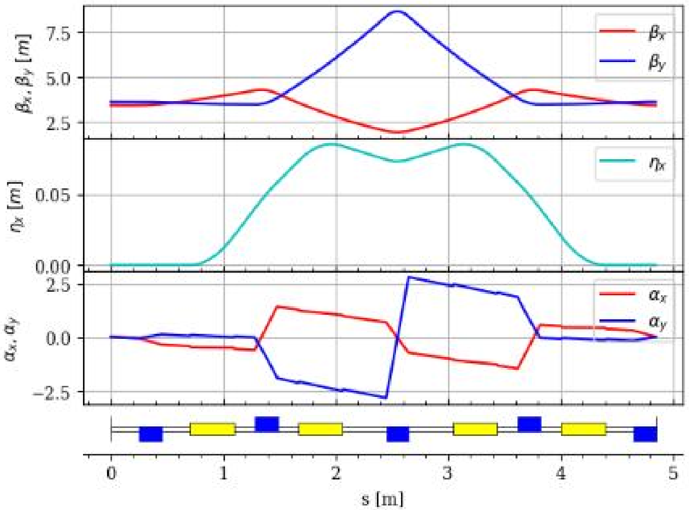


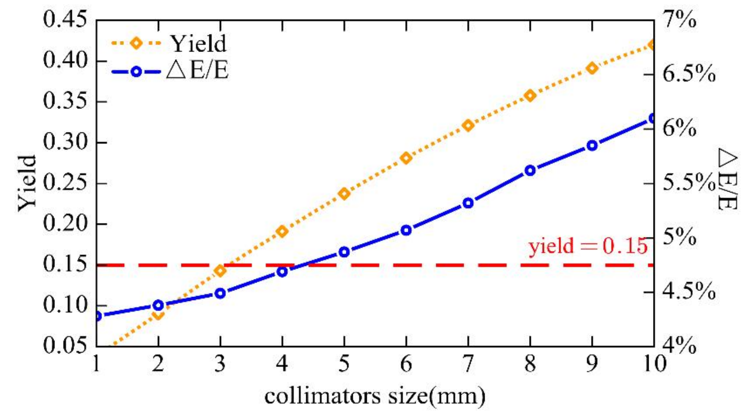


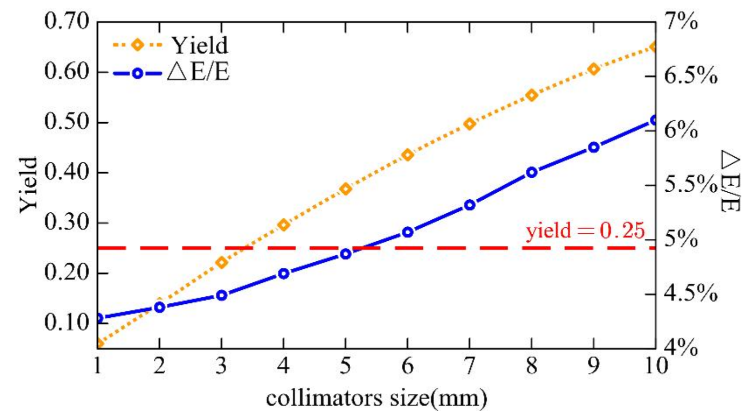


**1.Add a collimator after the second group of Bend Magnet in the Chicane structure to reduce energy spread**

**2. The collimator radius :5mm, balance positron yield and energy spread.**

# Design of 1 GeV positron beam-line

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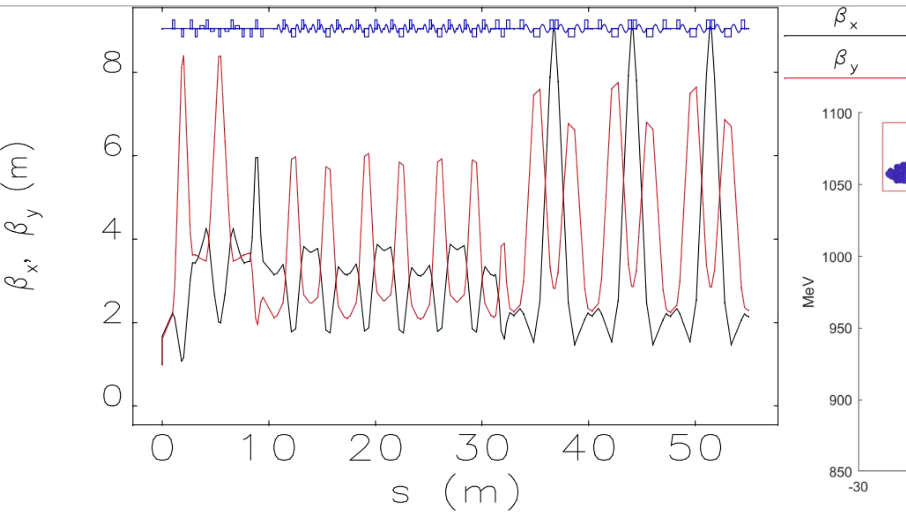
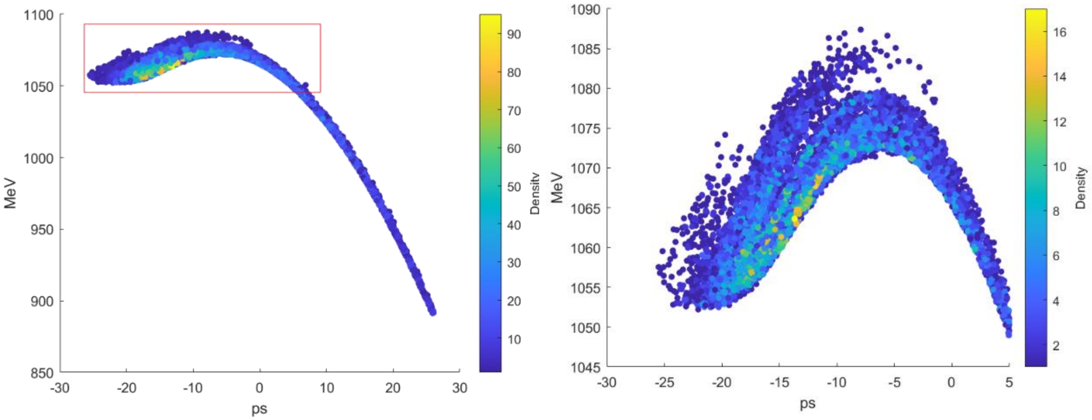




Beam distribution of 1 GeV positron beam

| Parameter | Off-axis | Swap-out |
|---|---|---|
| yield | 0.16>0.15 | 0.252>0.25 |
| Energy spread | 0.068% | 0.068% |
| Bunch length | 1.92mm | 1.95mm |
| Beam size | 1.2mm | 1.2mm |
| $\varepsilon x/nm{\cdot}rad$ | 795 | 769 |
| $\varepsilon y/nm{\cdot}rad$ | 1168 | 1185 |

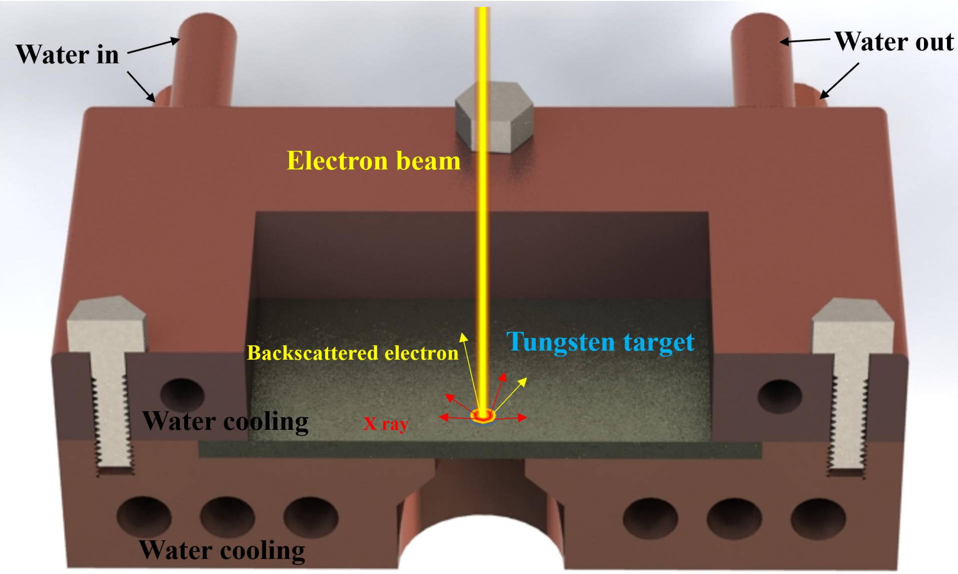
**1. The beam Emittance has met the requirements**

**2. Energy spread and beam length still need to be optimized**

**2. Gradient:22Mv/m , LAC for 600MeV**

# Contents

# Recrystallization of tungsten target

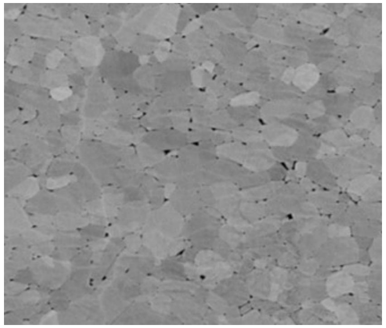



Melting point of tungsten 3410℃.

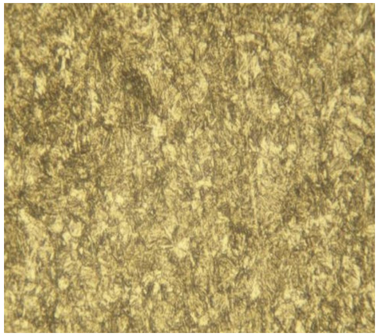
Recrystallization of tungsten 900 ℃

Single crystal tungsten

900 ℃

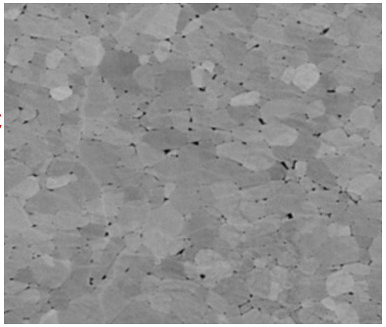


Polycrystalline tungsten



Amorphous tungsten

900 ℃



Polycrystalline tungsten

Recrystallization of tungsten target

# Design of oscillating moving targets

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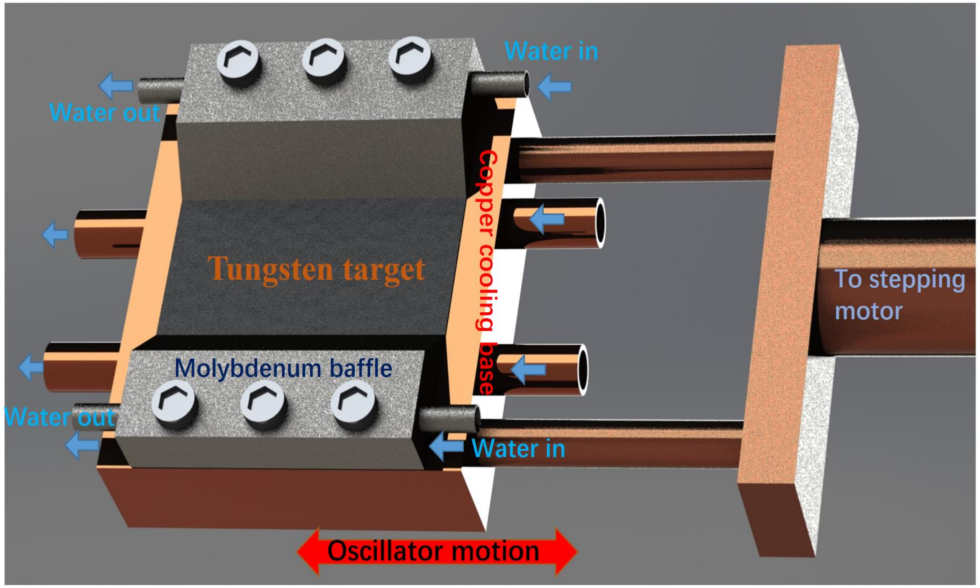


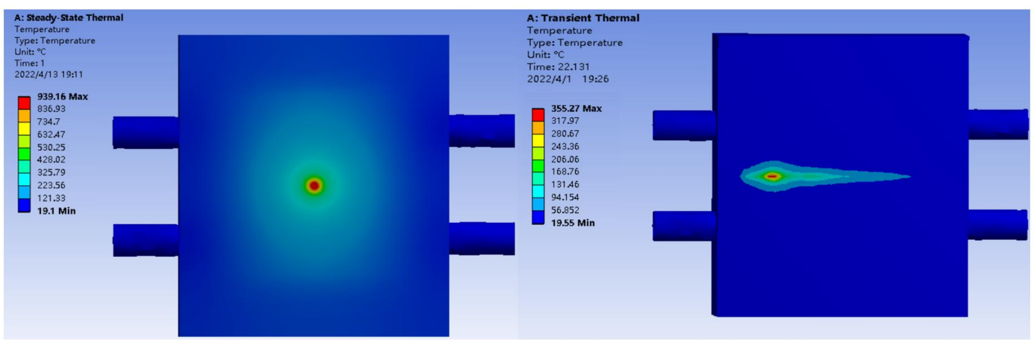


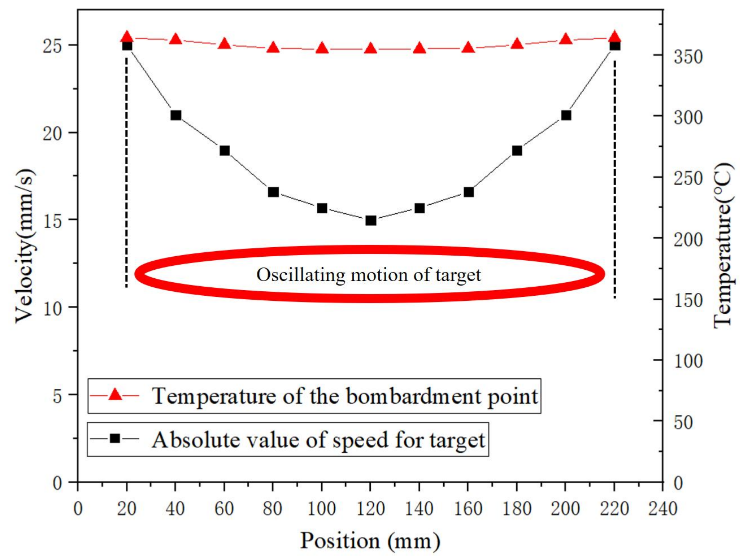


2.5 GeV/100Hz/10nC

# Conclusion

**1.Two positrons were designed for off-axis injection and swap out injection, respectively.**

**2. Completed the design of the positron beam line in front of the damping ring.**

**3.The recrystallization phenomenon of tungsten positron conversion targets has been studied, and oscillating motion water-cooled targets have been designed.**

# Thanks for your attention!