



Polarized Positron Production and Tracking at the ILC Positron Source

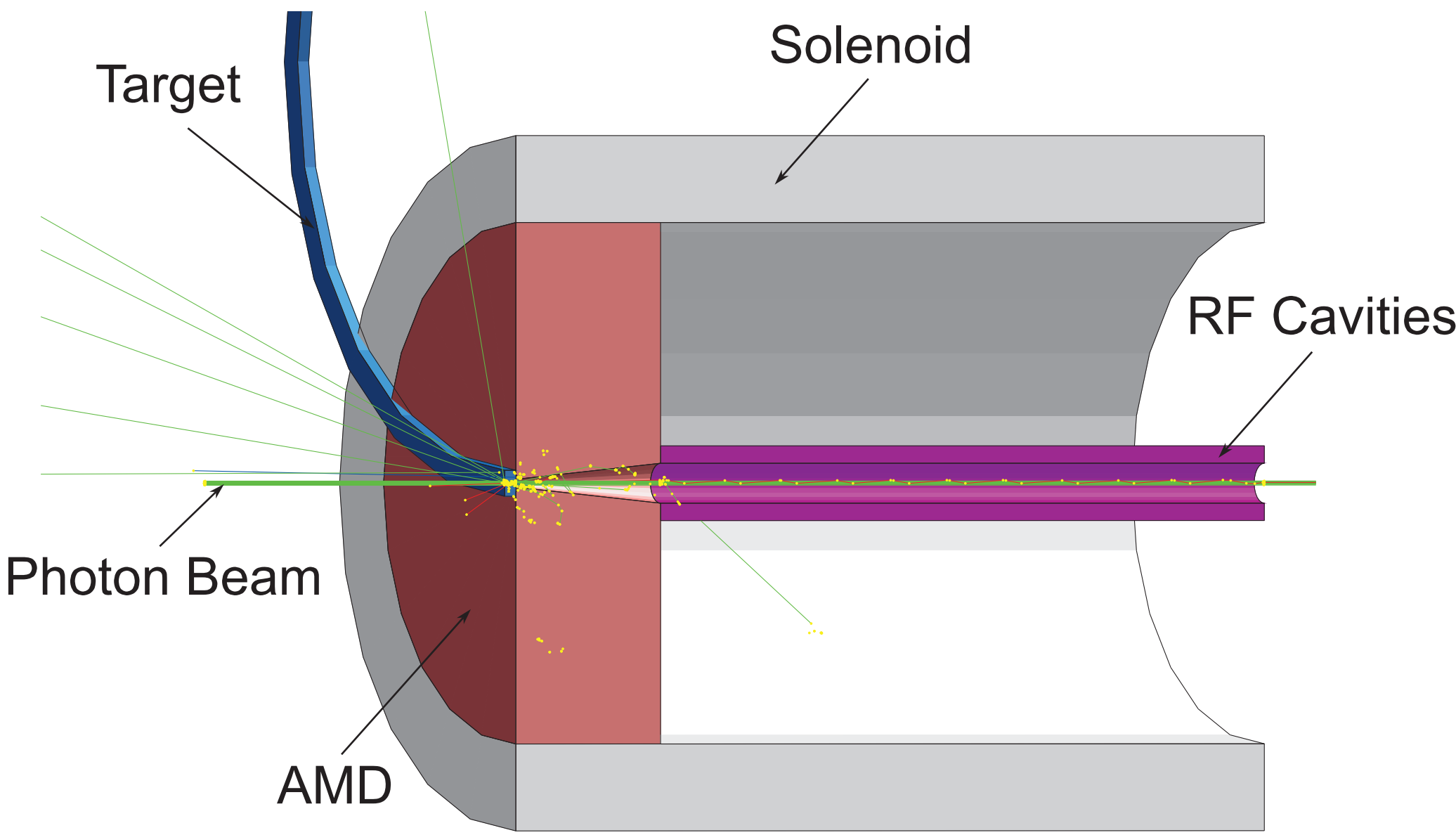


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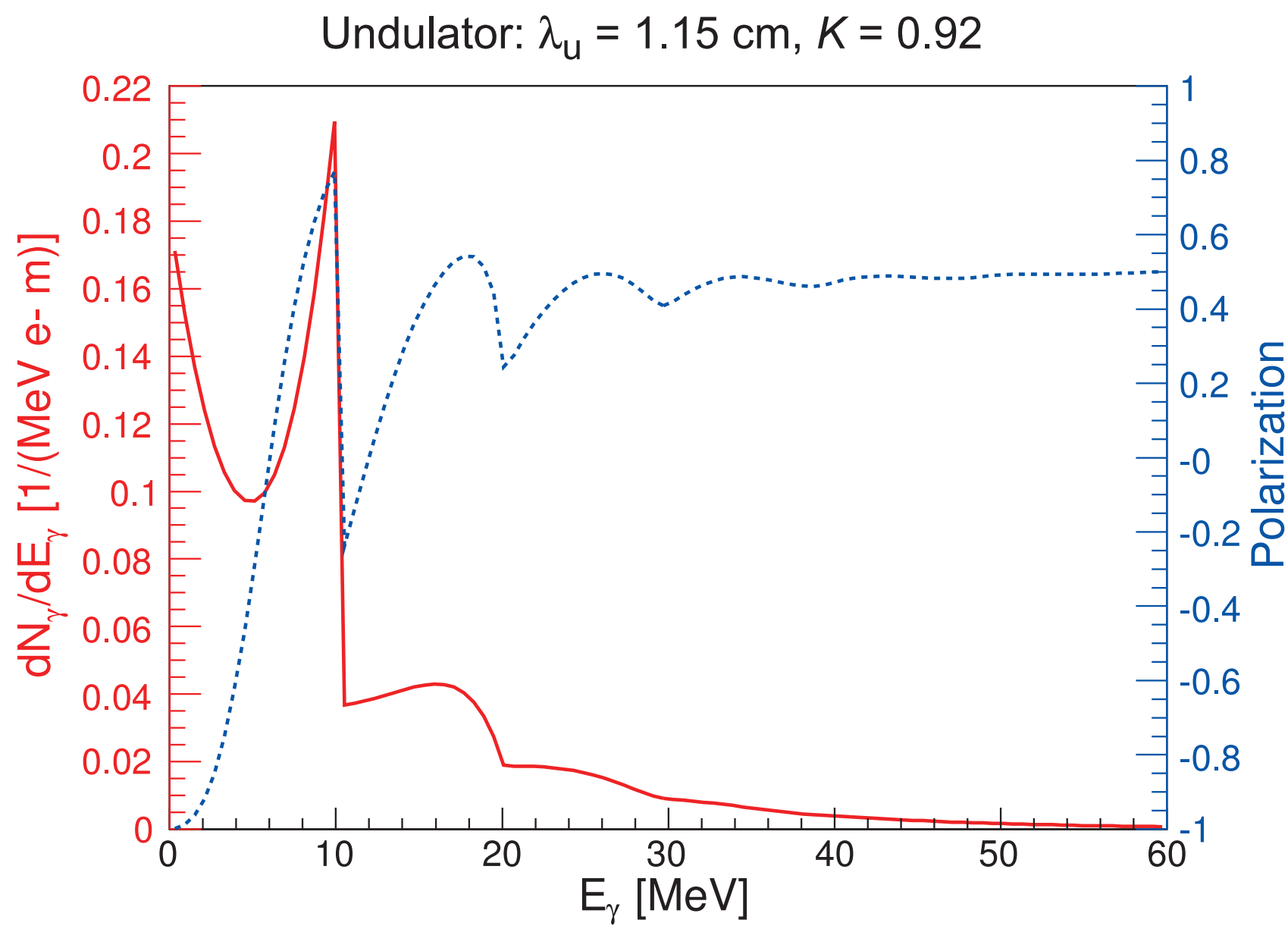
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Abstract

The positron source planned for the future International Linear Collider (ILC) is based on a helical undulator system. Depending on the accelerator design it will be possible to get polarized positrons at the interaction point. A source performance with high positron yield and high polarization is the aim of our design studies. We focus on the optimization of target and capture section by combining the advantages of the simulation codes FLUKA, Geant4 and ASTRA.

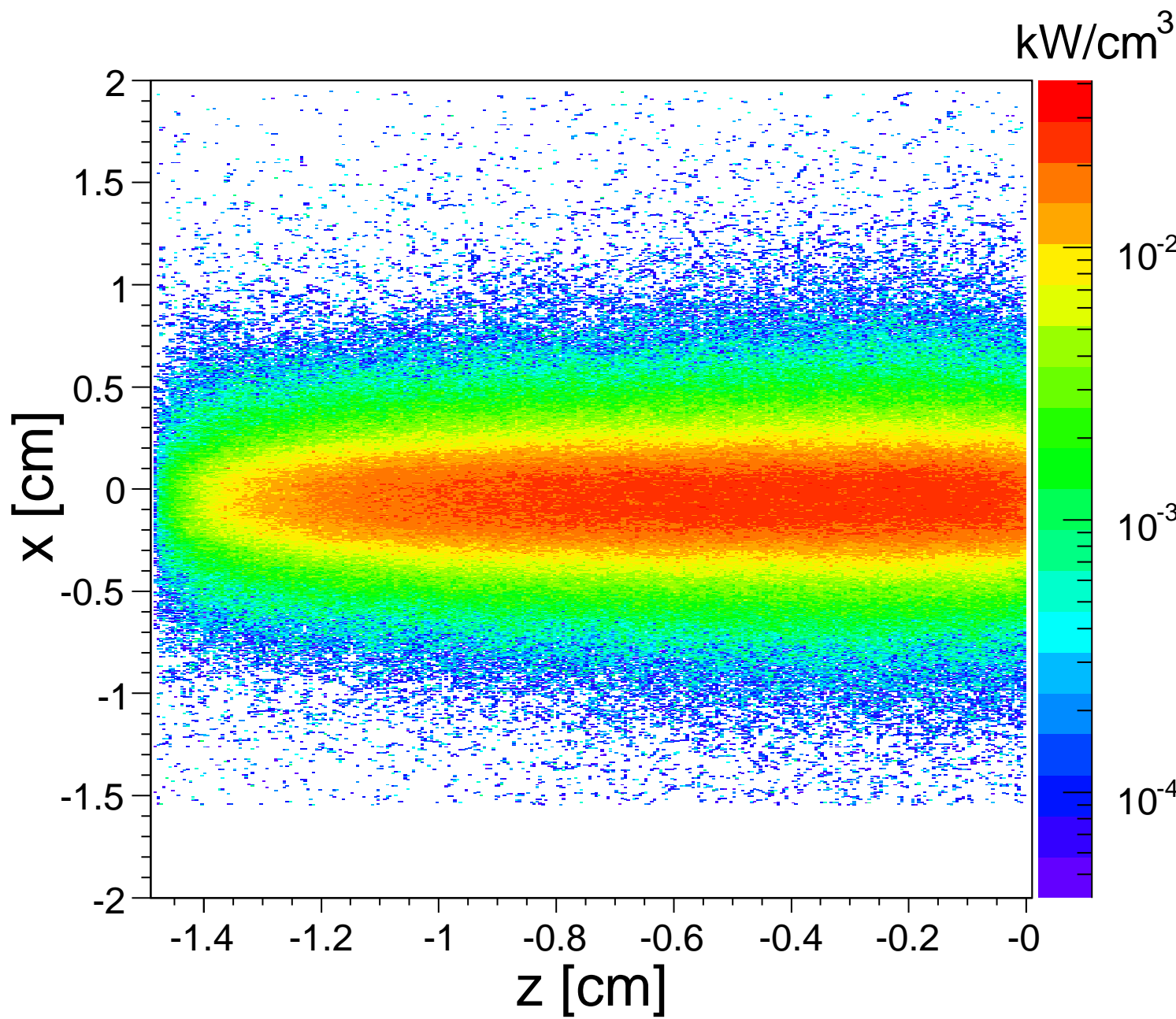


Energy Distribution and Polarization of Photons (produced by an electron passing one meter of undulator)

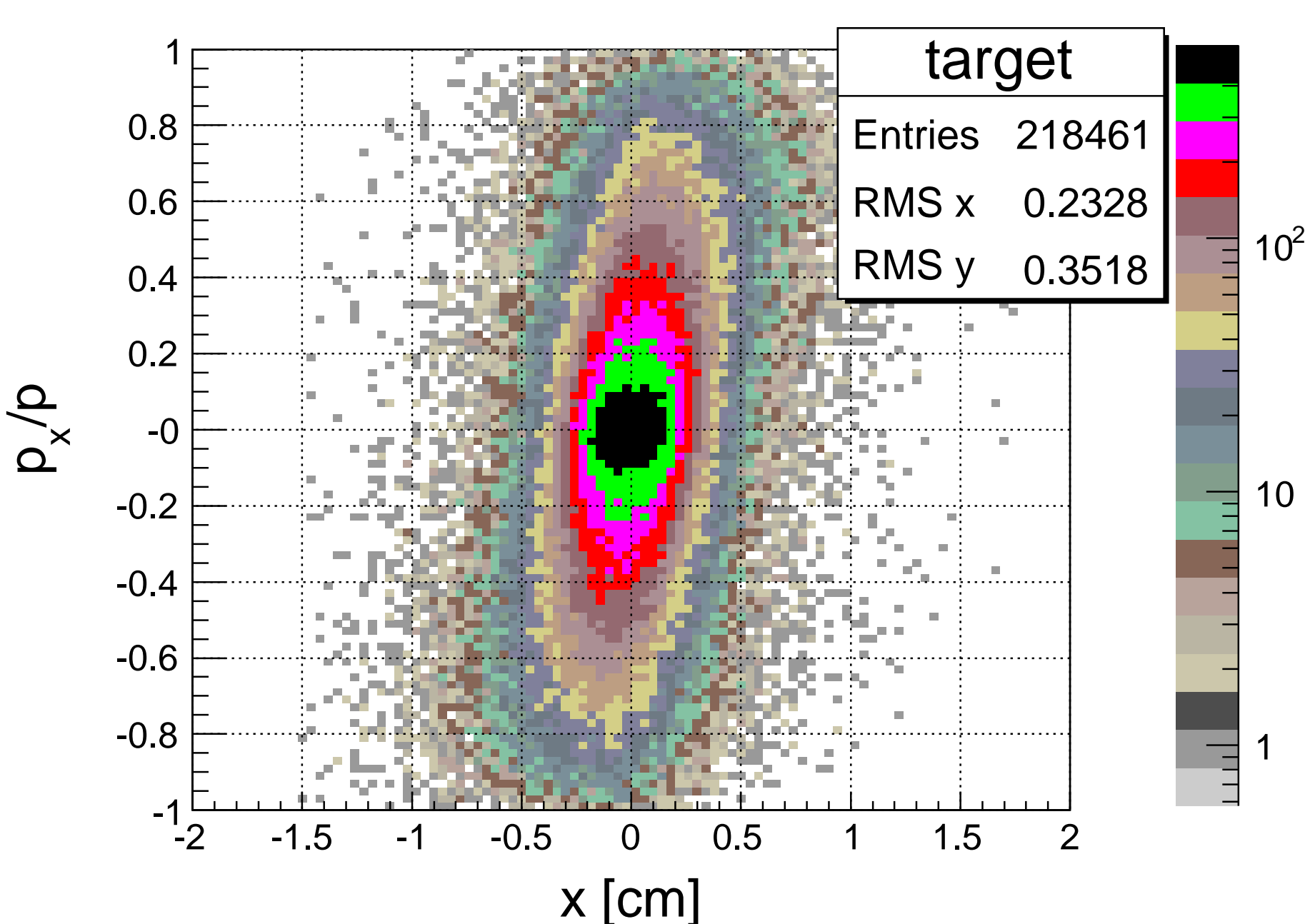


Positron Production: Photons generated by electrons passing an undulator hit a rotating target and create electron-positron pairs. The positrons emerging from the target are collected and accelerated in a capture section. The positron production has been calculated by FLUKA and Geant4.

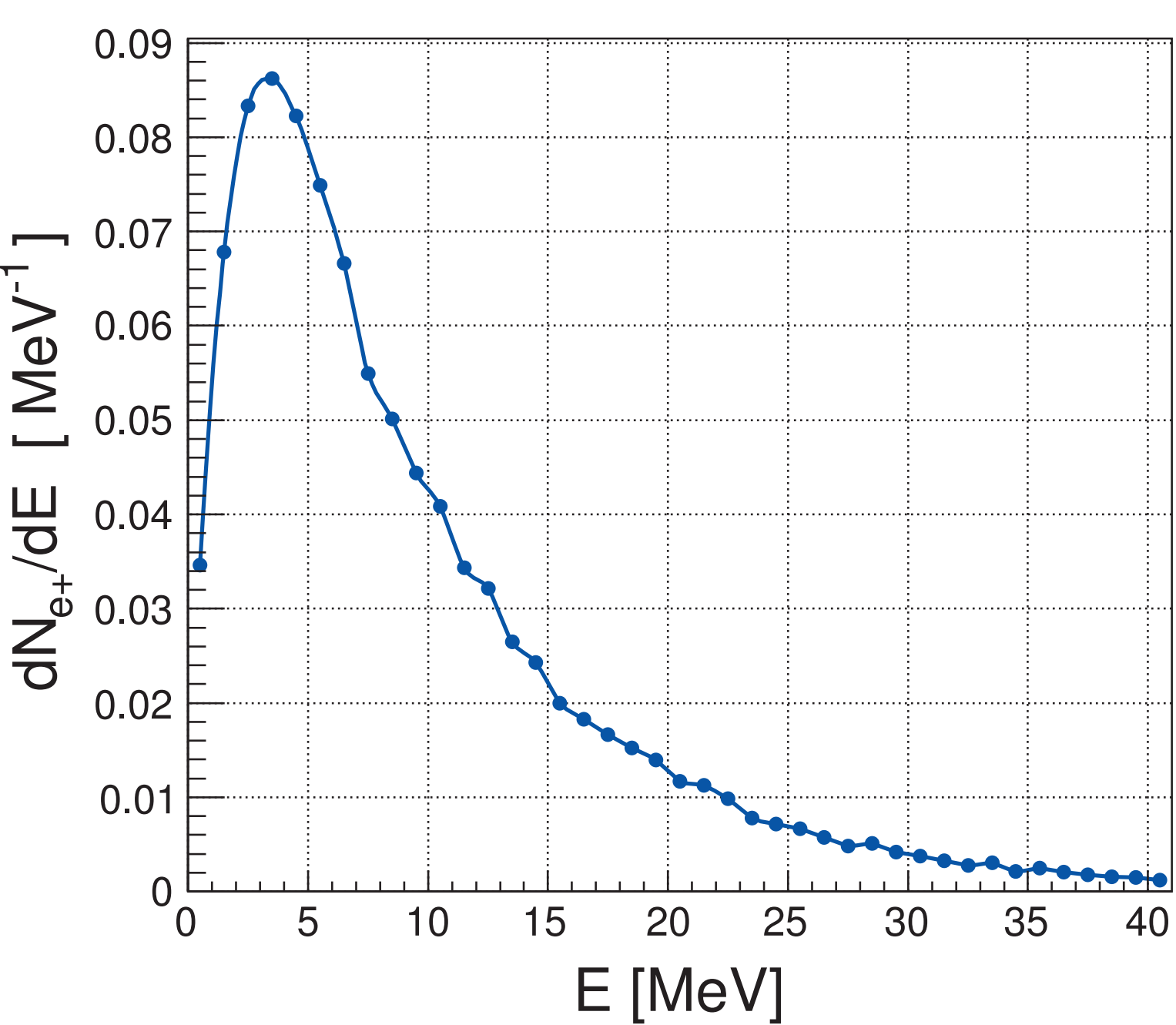
Power Density Deposited in the Target (FLUKA)



Positron xx' Phase Space after the Target (FLUKA)

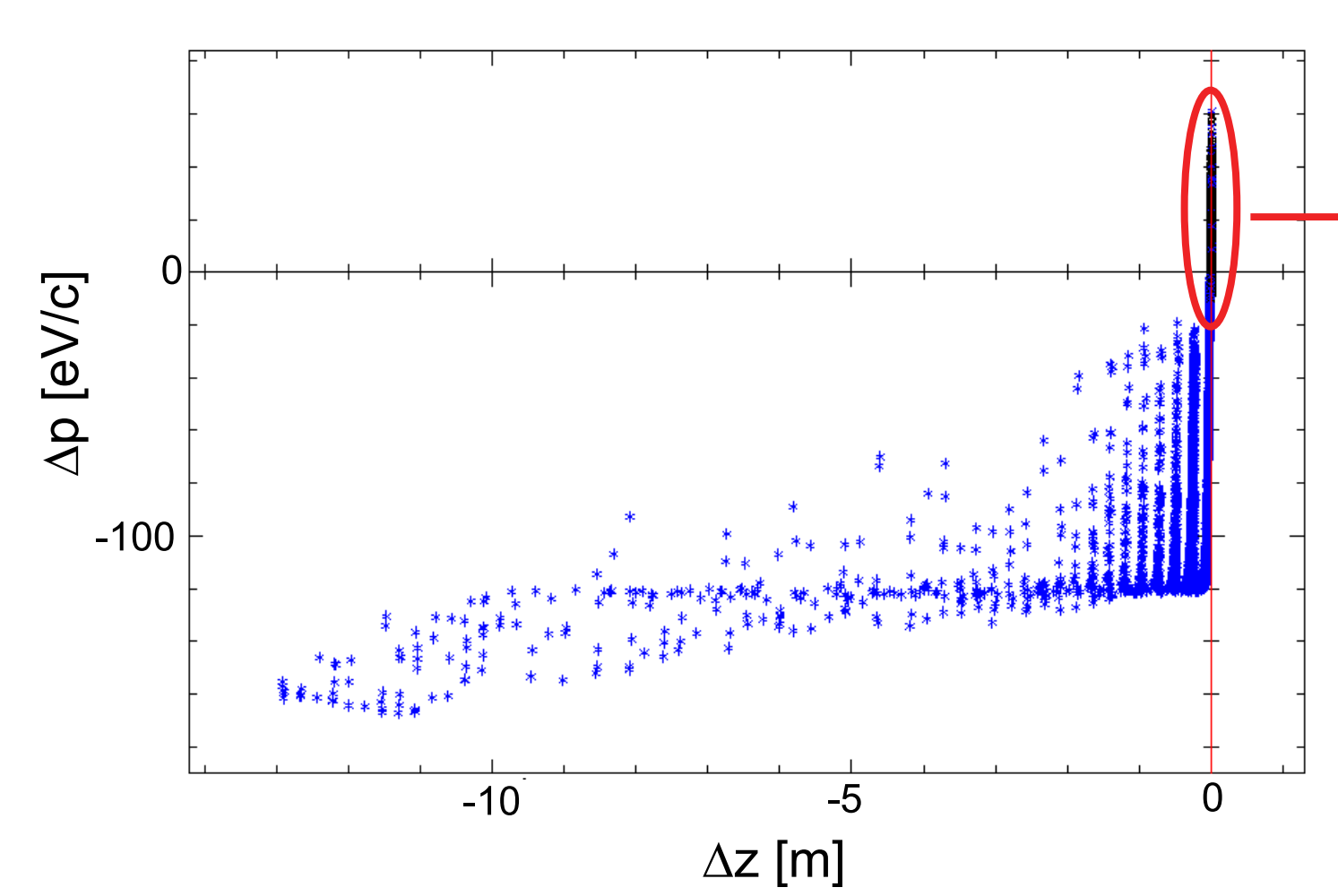


Positron Energy Distribution after the Target (Geant4)

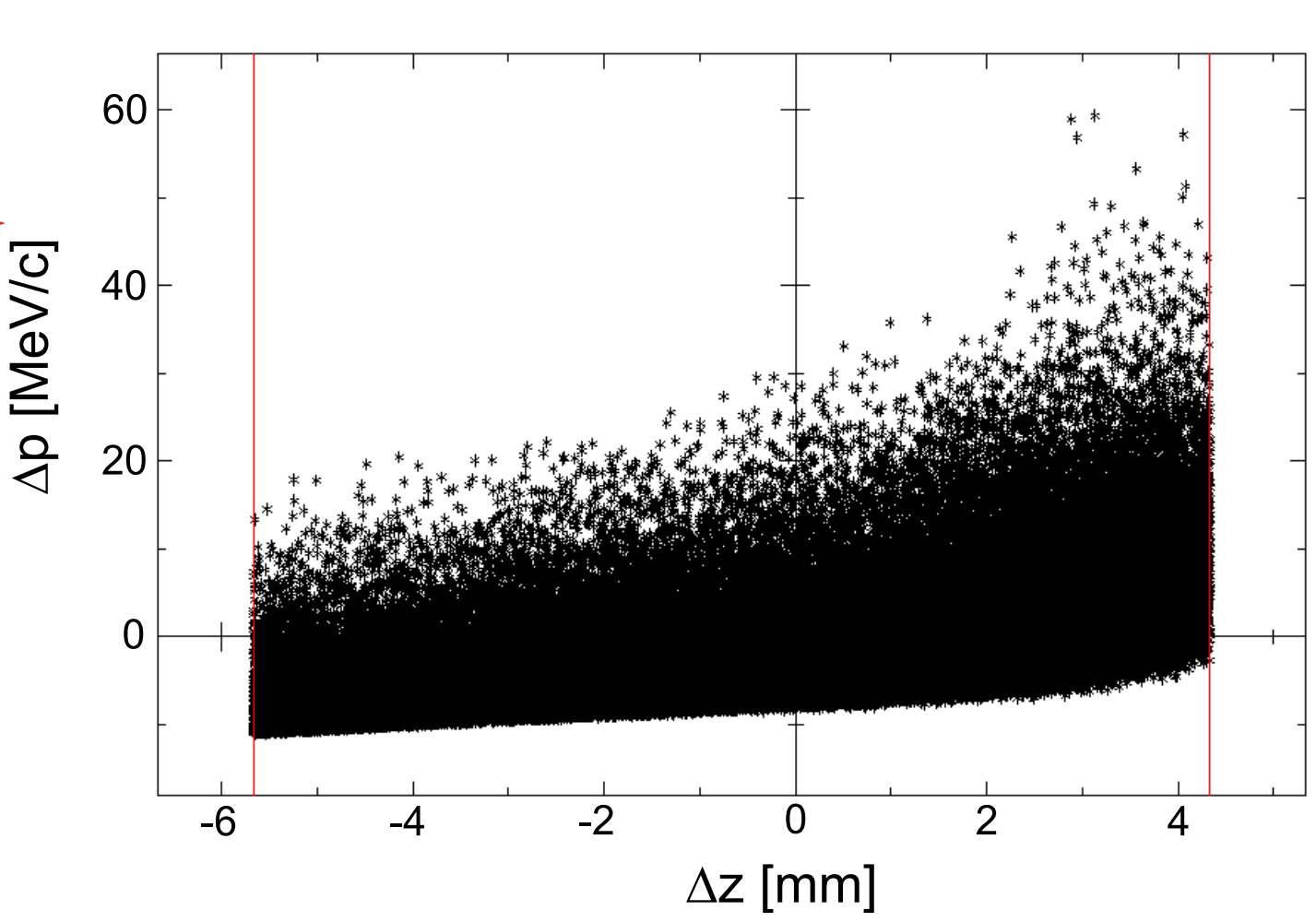


Positron Capture: Positron beam capture and acceleration has been simulated in ASTRA. The captured positron beam must satisfy the dumping ring acceptance requirements. The longitudinal and transverse cuts have been applied at the end of the preaccelerator (at 125 MeV).

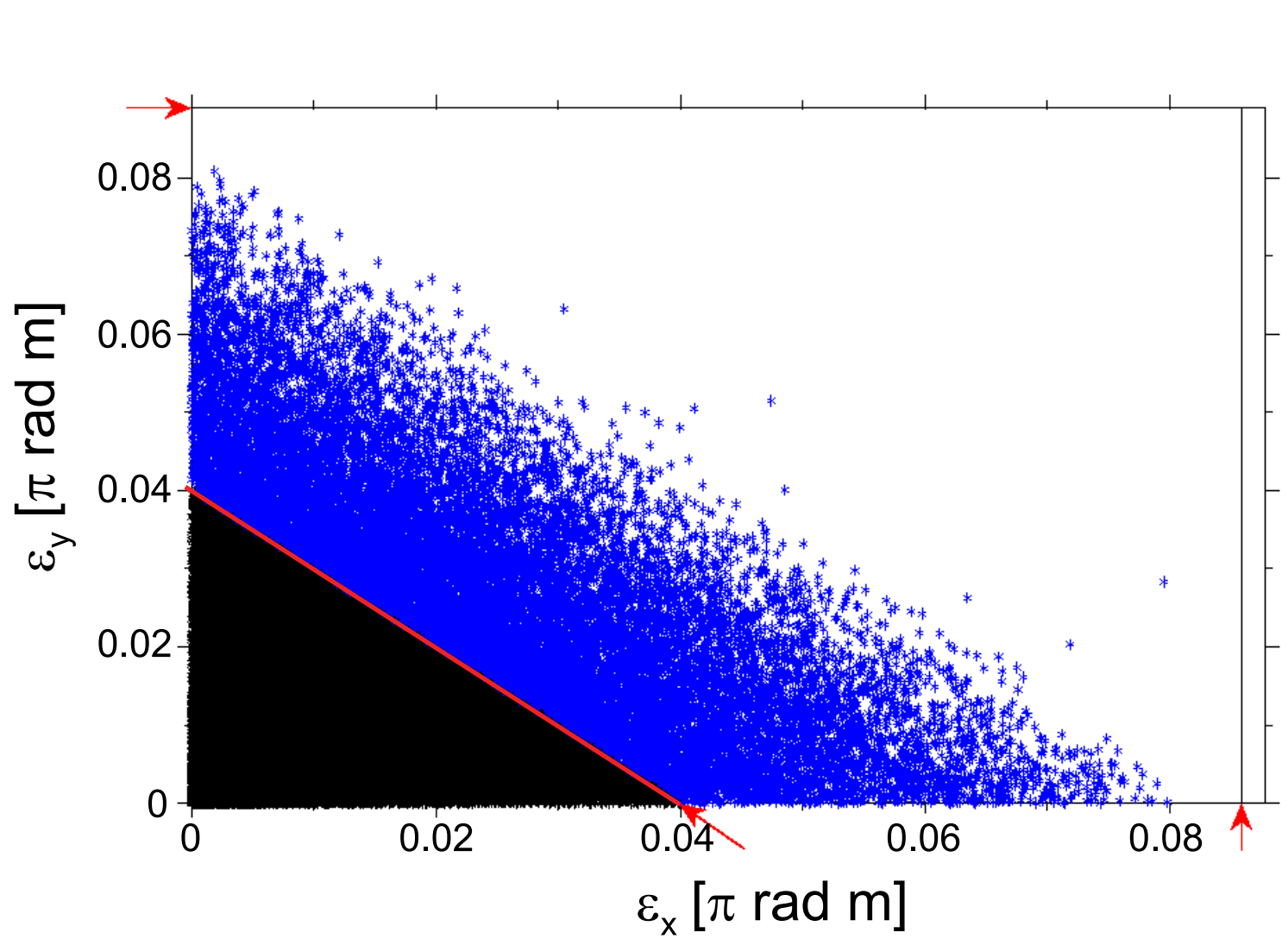
Longitudinal Distribution of Positron Momentum



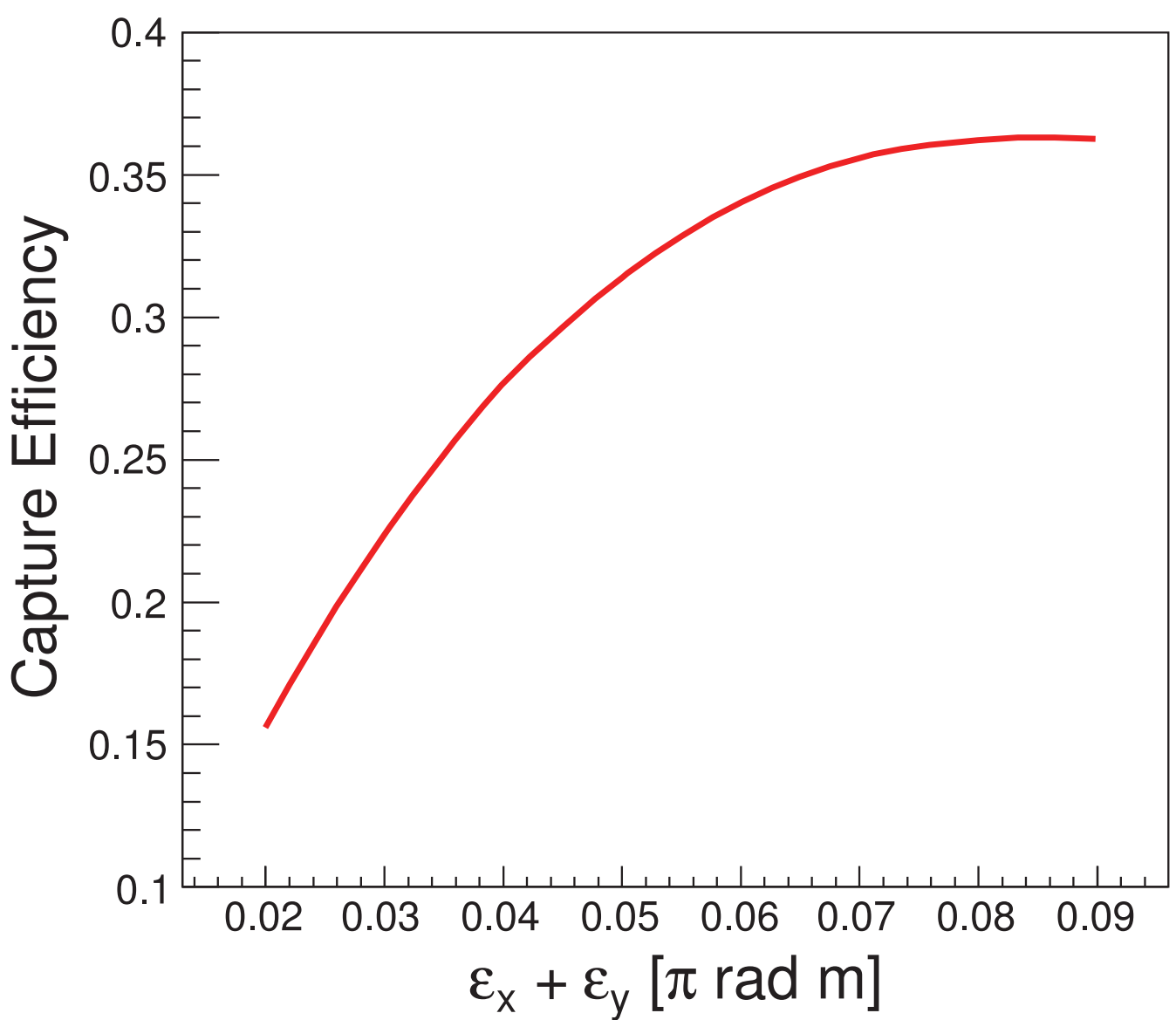
10 mm Bunch Length Cut



Transverse Emittance (Diagonal) Cut

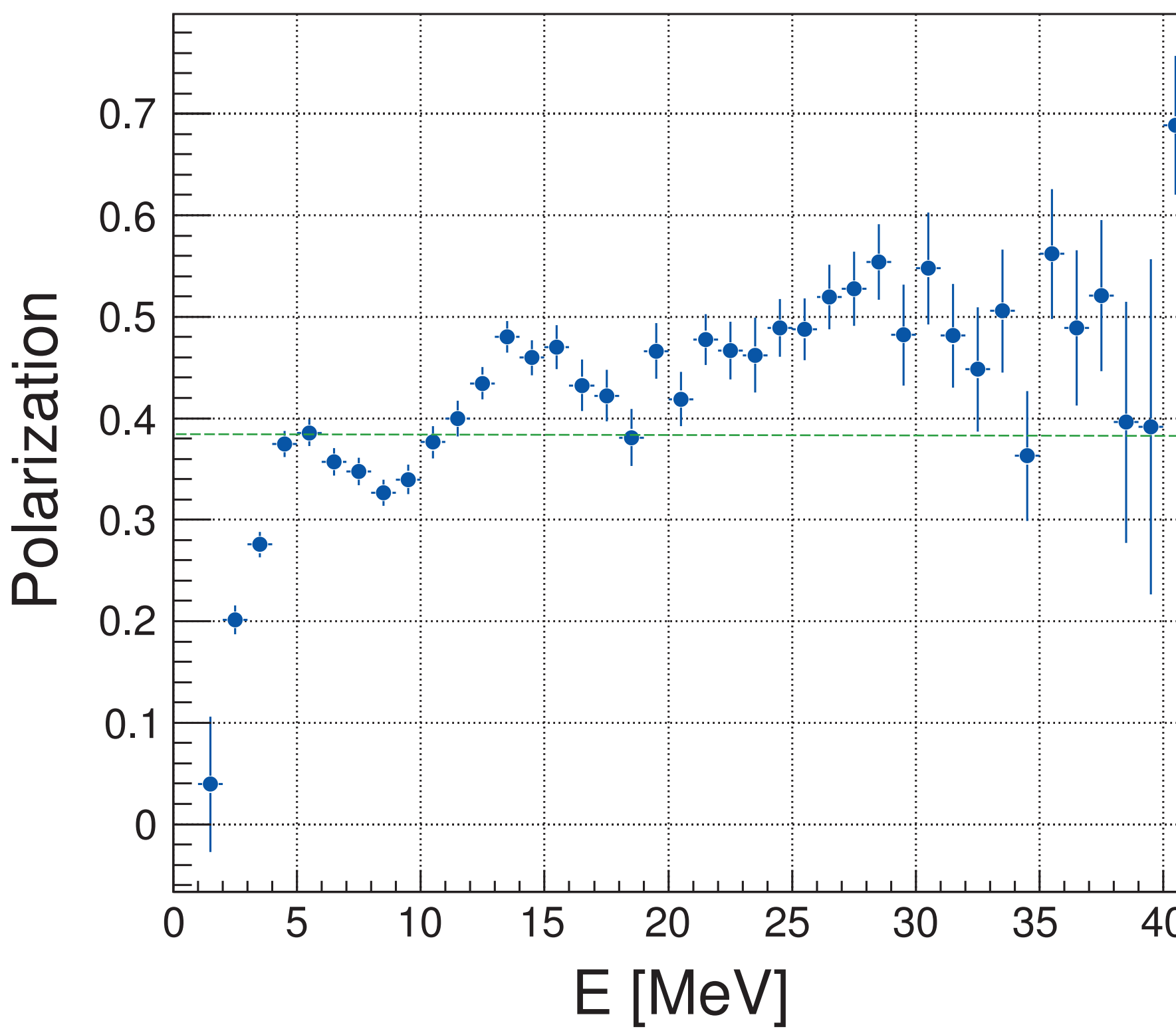


Capture Efficiency vs Transverse Emittance (Diagonal) Cut



Positron Polarization after the Target

(taking into account a 10 mm longitudinal bunch length cut and 0.04 pi rad m transverse emittance cut)

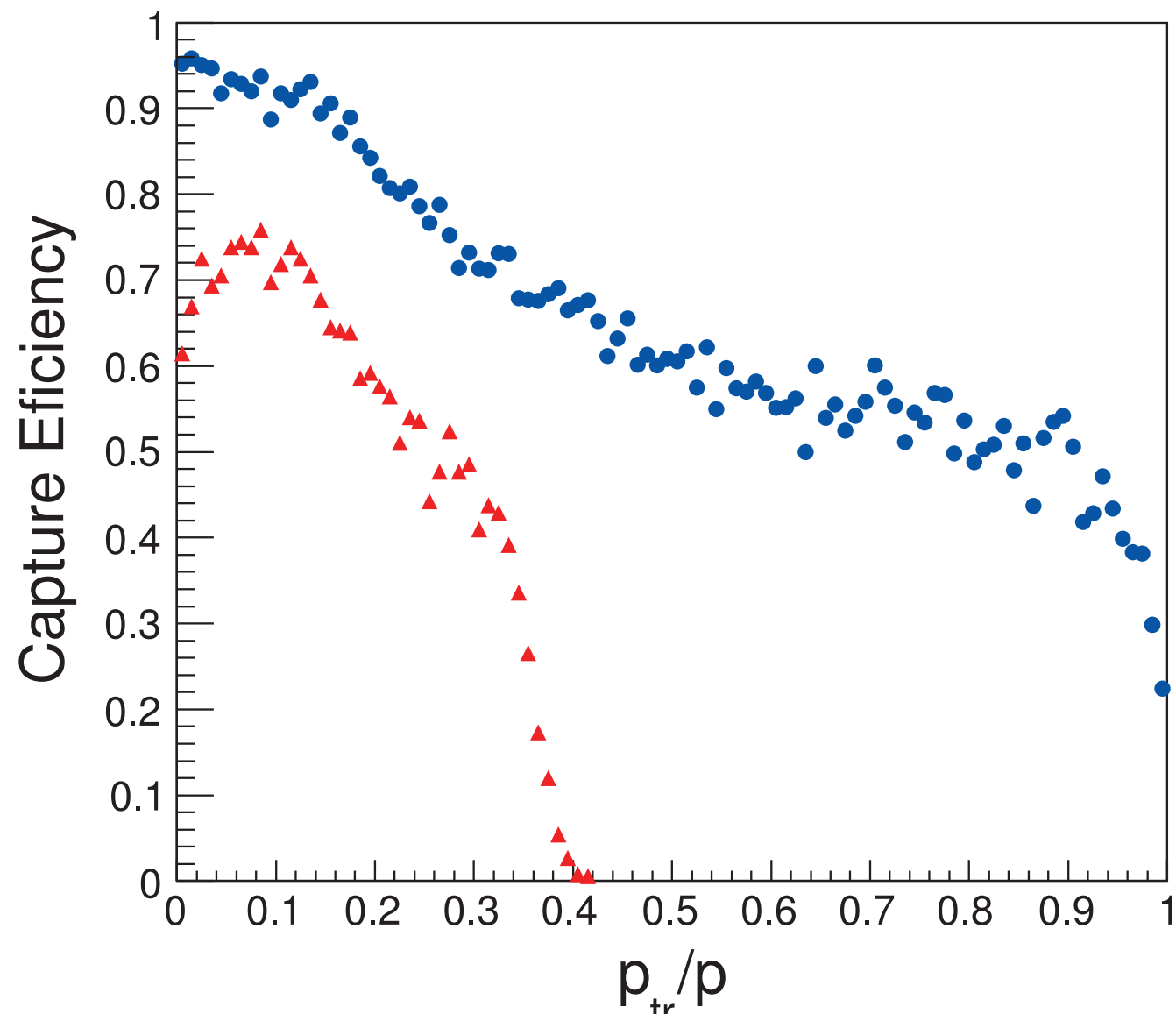


Summary

- The simulations of polarized positron production and capture have been performed.
- The simulations have been done using FLUKA, Geant4 and ASTRA to cover positron yield and polarization, power dissipation, capture efficiency, particle tracking in the optical matching device and accelerator structures.
- The positron yields calculated by FLUKA and Geant4 are in good agreement.
- The positron capture efficiency is 27% for Ti6Al4V target if an AMD is used as positron beam focusing device.
- The positron polarization for a Ti6Al4V target is 39%.
- The positron polarization for a W25Re target is only 25%.
- Plans: Detailed simulations of different positron capture devices using Geant4 including the particle and spin tracking.

Results

Capture Efficiency vs Transverse Momentum (ASTRA)



Comparison of Target Materials

Target Material	Ti6Al4V	W25Re
e ⁺ Yield, e ⁺ /gamma	2.19 · 10 ⁻²	3.34 · 10 ⁻²
E _{deposited} , keV/gamma	854	455
Capture Efficiency, %	26.7	23.0
e ⁺ Polarization, %	38.6	25.1