ILC Positron Source Modeling

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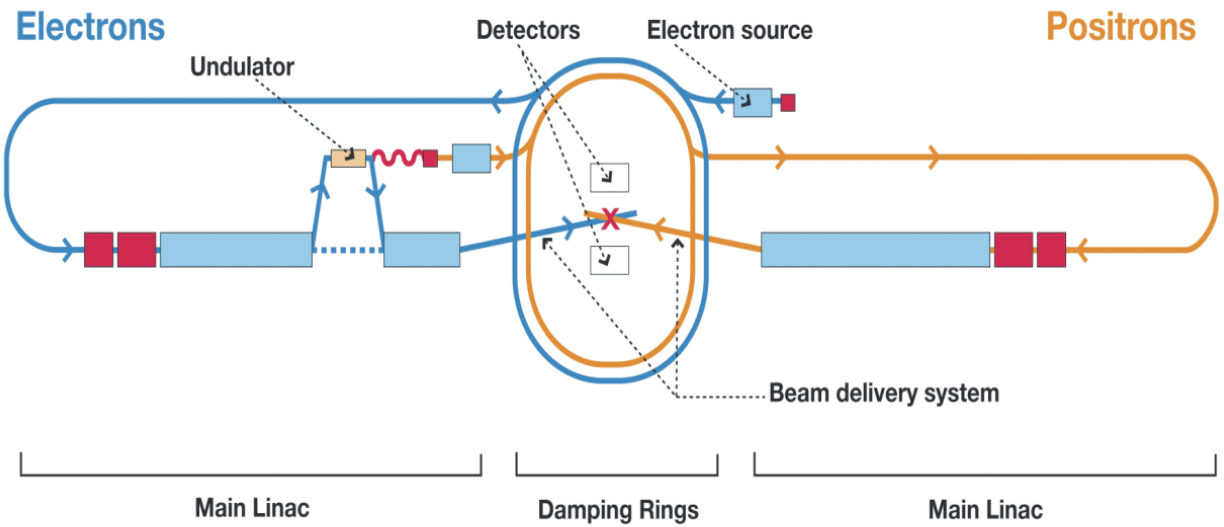
Outline

- Positron source model
- Positron production
- Positron capture
- Radiation aspects
- Outlook

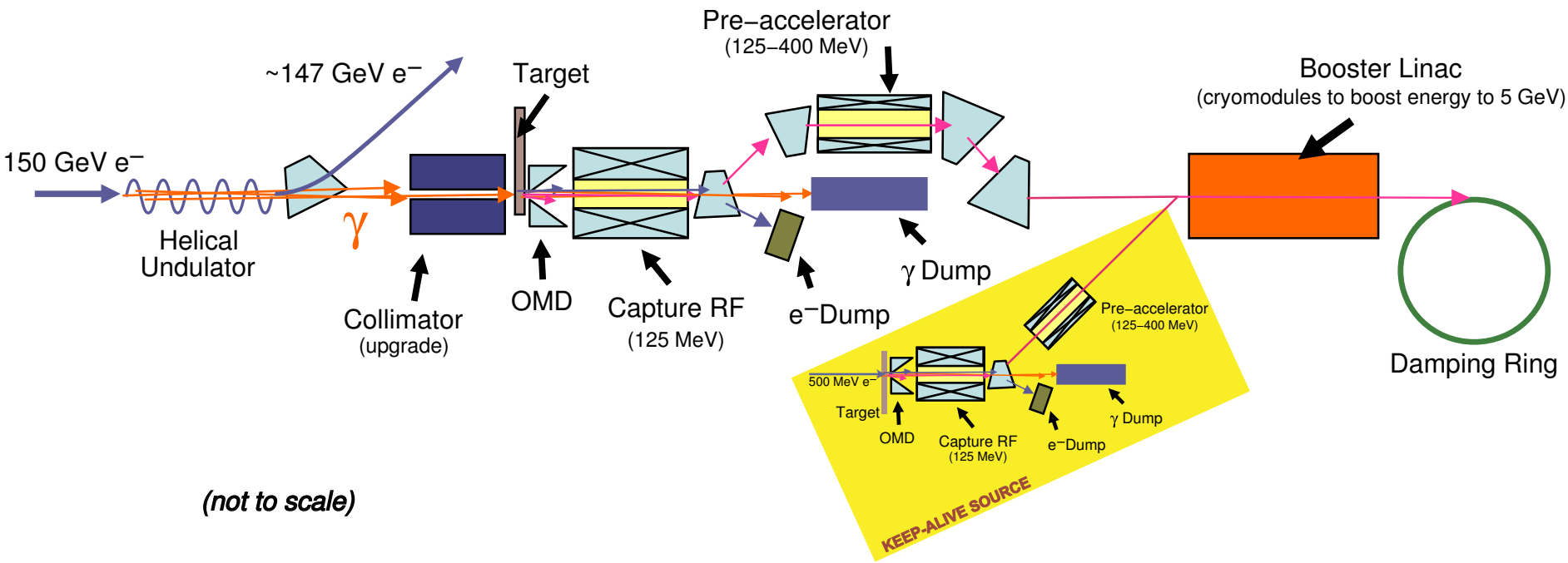
International Linear Collider (ILC) Scheme



ILC main parameters

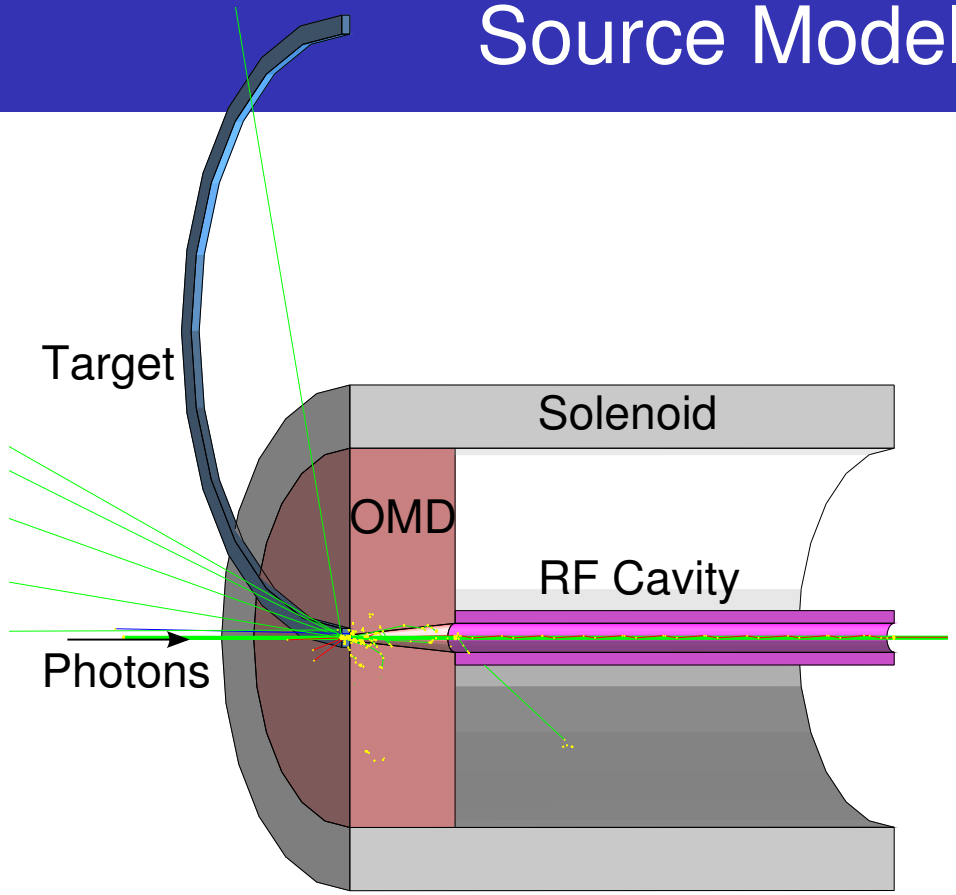
Energy	up to 500 GeV
Luminosity	$2 \cdot 10^{34}$ cm^{-2}s^{-1}
e^- Polarization	$> 80\%$
e^+ Polarization	$\sim 30\%$

Layout of Positron Source



$3 \cdot 10^{10}$ e^+/bunch; 2625 bunch/pulse; 5 Hz

Source Model. Main Issues



Target (Rim)

Thickness	0.4 X_0
Material	**Ti6Al4V**, W25Re, ...

OMD: Flux Concentrator

Length, cm	20
B_0 (z = 0)	6 T
B_0 (z = 20 cm)	0.5 T
$\varnothing$ (z = 0)	1 $\div$ 24 mm
$\varnothing$ (z = 20 cm)	46 mm

SW Structure

Aperture	46 mm
Number of cells	11
Ave. gradient	14.5 MeV/m

Issues:

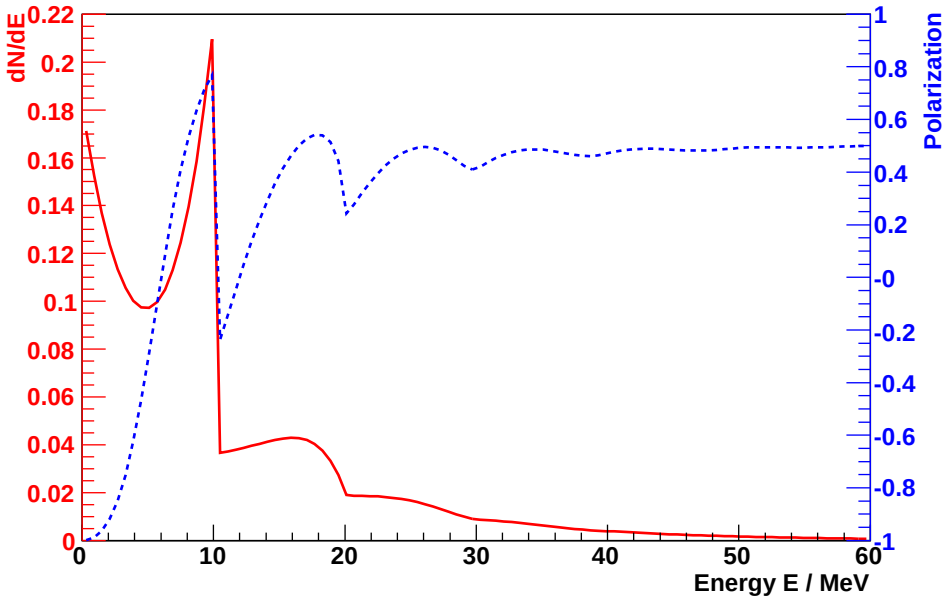
- Positron collection optics downstream the target
- Heat dissipation in the target
- Radiation damage of the target
- Source activation

Photon Production

Undulator Parameters

Undulator K-value	0.92
Undulator period, cm	1.15
Energy of 1^{st} harmonic cutoff, MeV	10.06

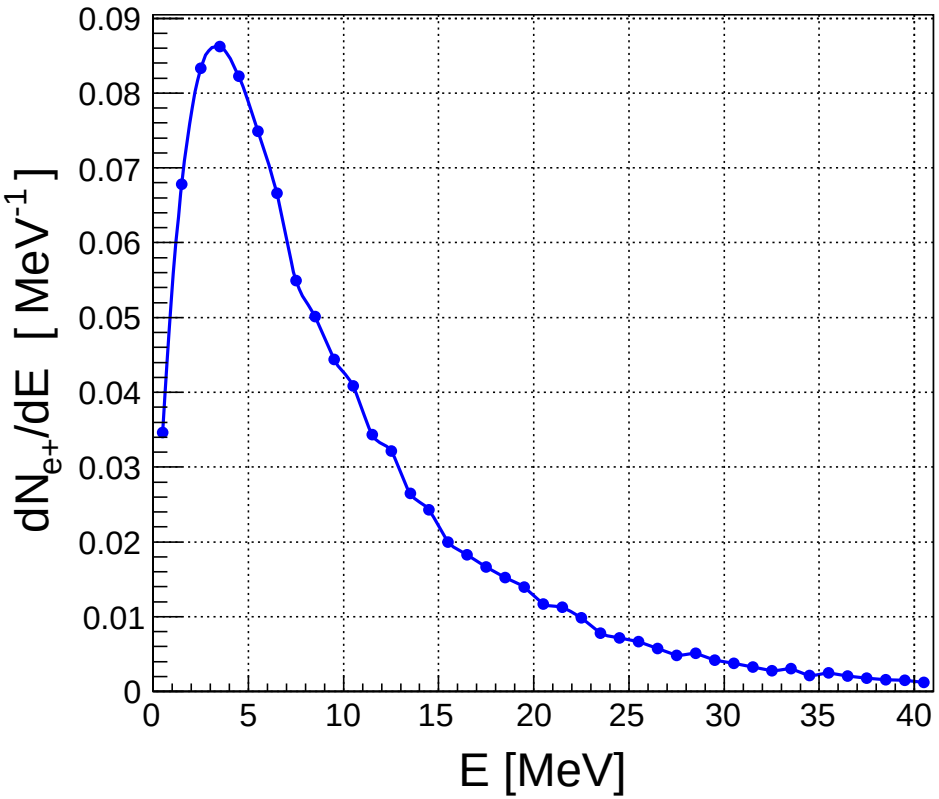
Photon Energy Distribution and Polarization



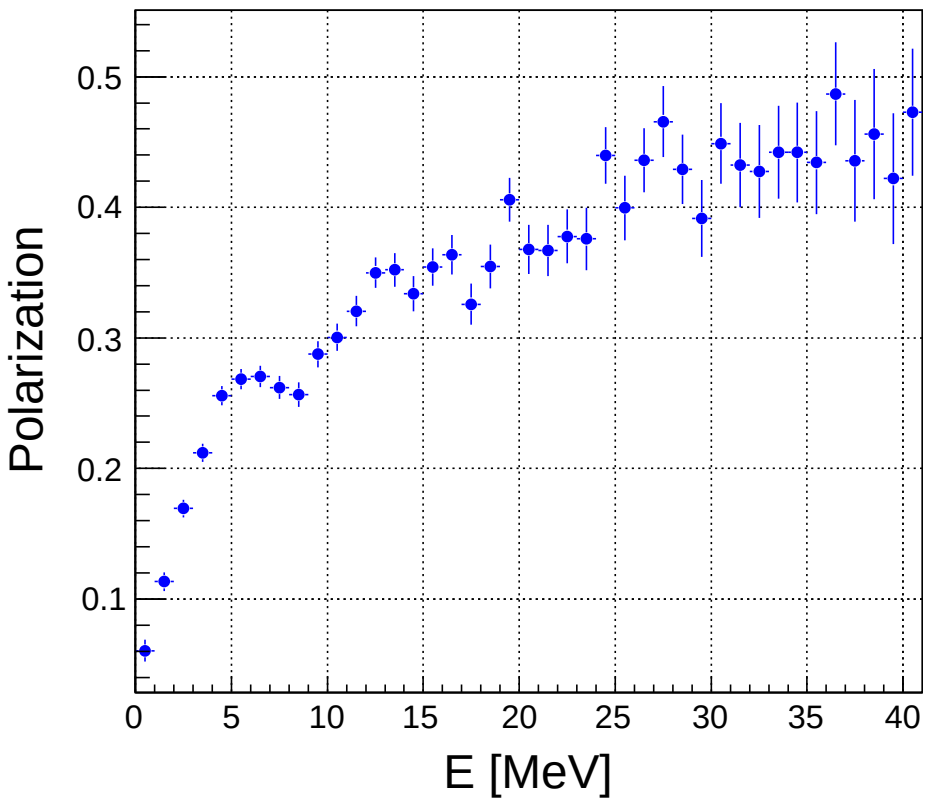
Positron Production

Positron beam after the target

Positron Energy Distribution



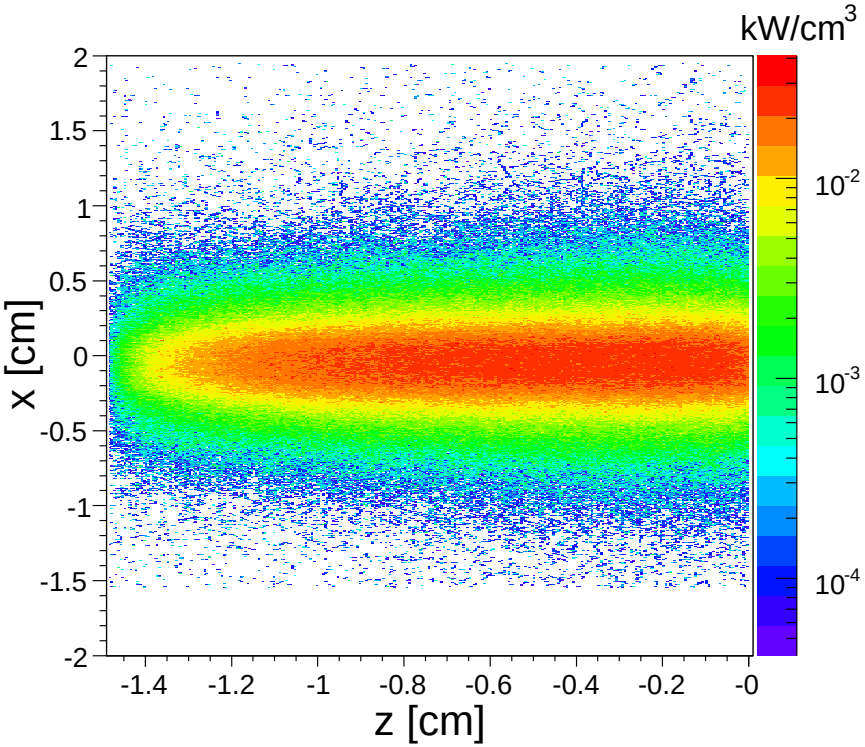
Positron Polarization



Positron Yield, e^+/γ	**0.022**
Polarization, %	**27**

Heat Load and Radiation Damage of Stationary Target

Power deposited in target

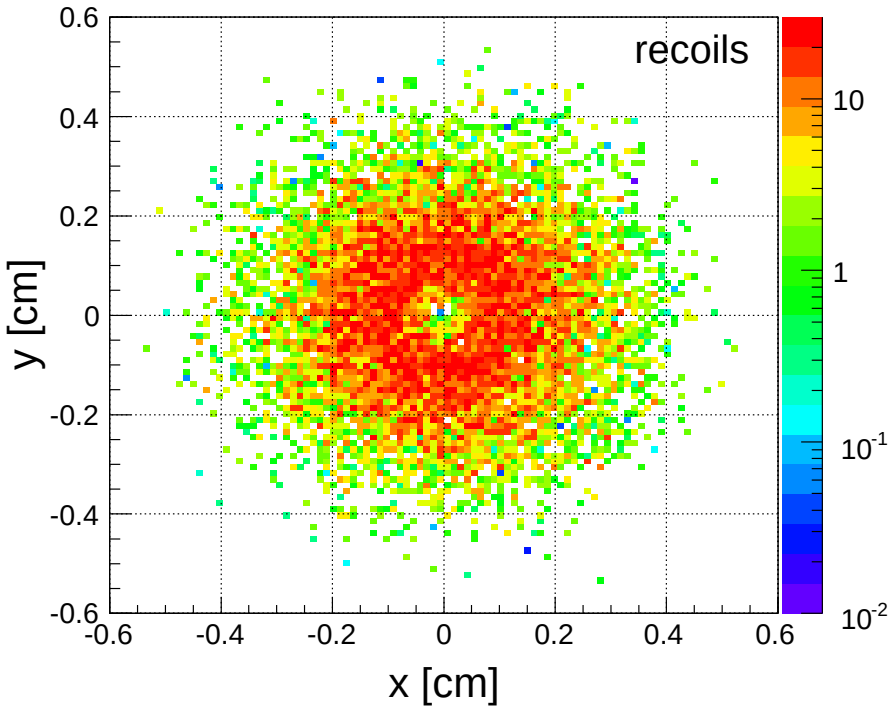


Undulator length: 128 m (1.5 e^+/e^-)

Average photon beam power: 117 kW

Power deposited in target: **~10 kW**

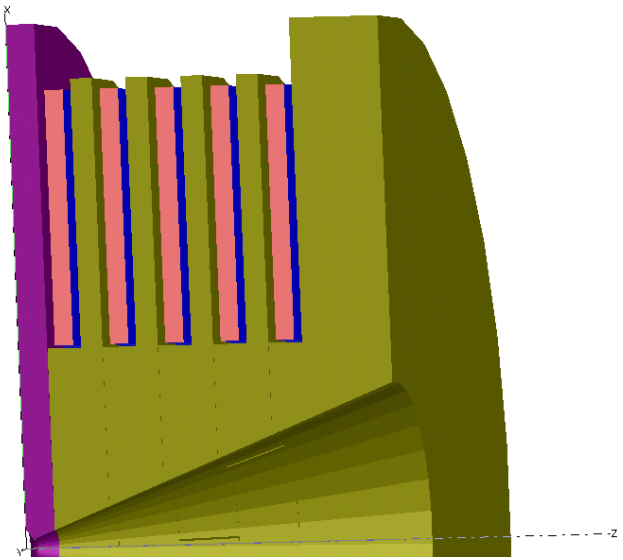
Damage by recoil atoms



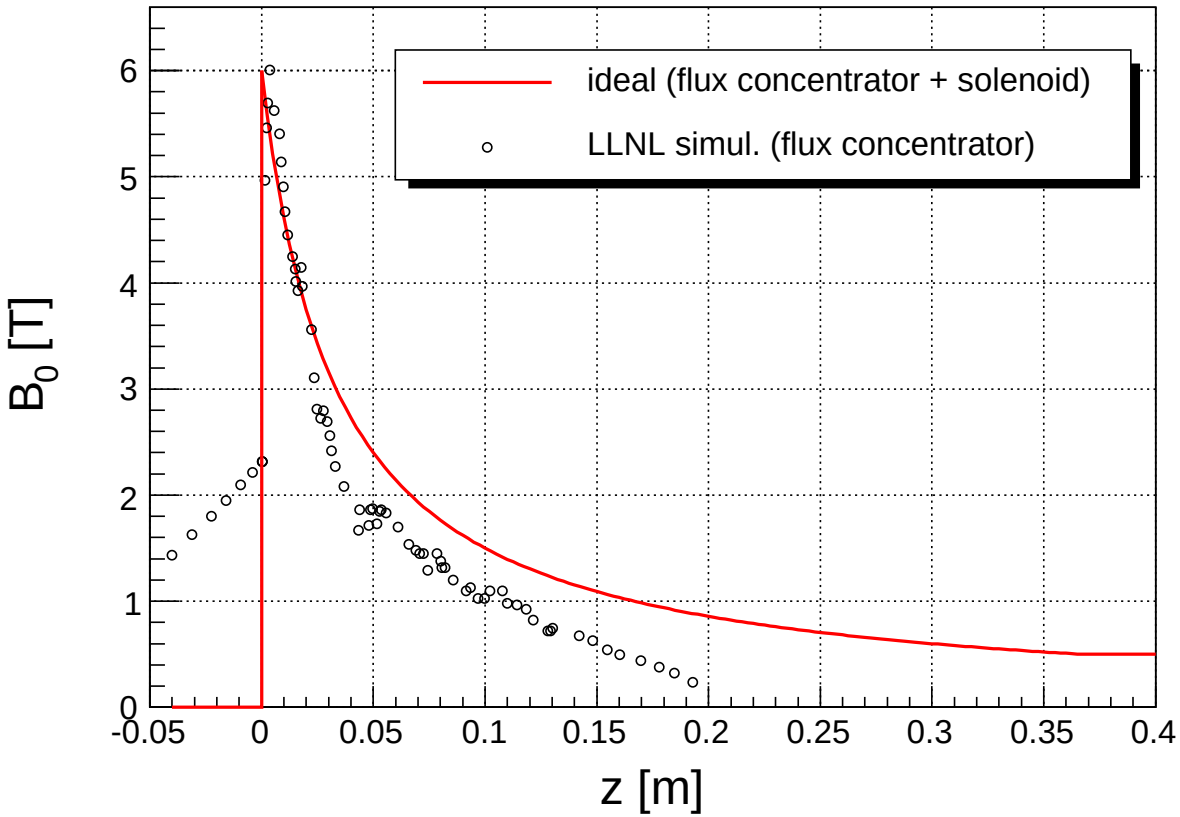
Damage of Ti6Al4V target after 5k hours:
~ **7 dpa** (12.5% by neutrons)

Optical Matching Device

Pulsed Flux Concentrator



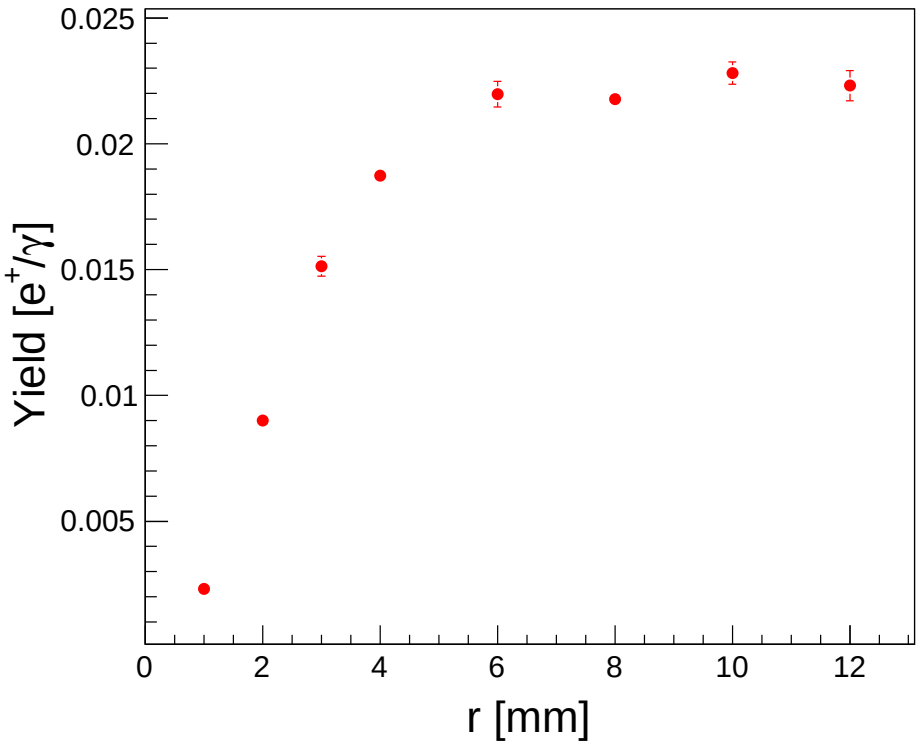
B-field along beam axis



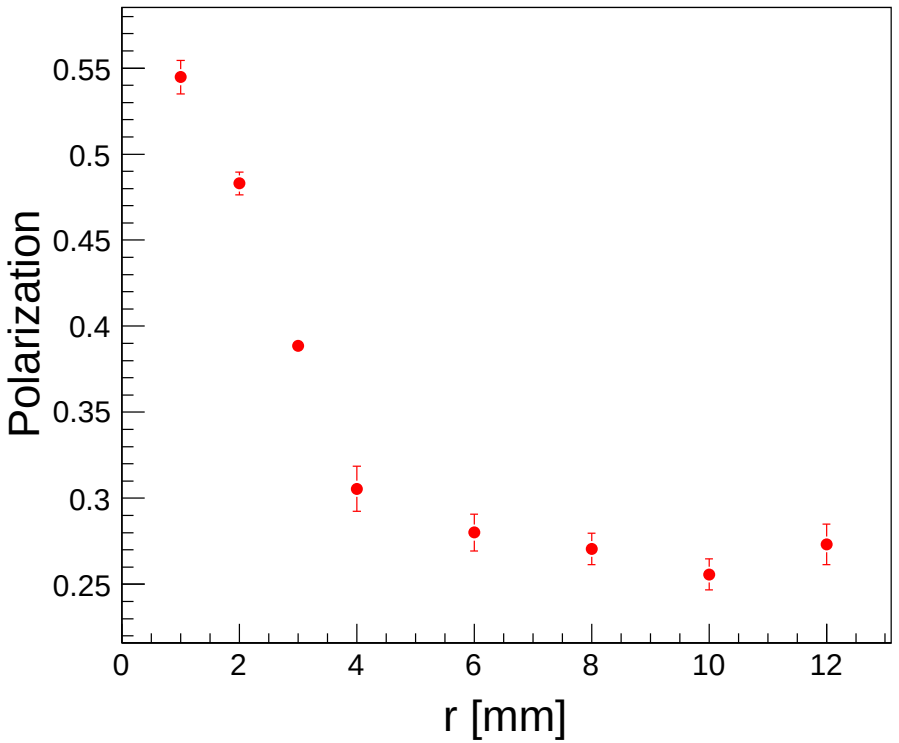
OMD Optimization. Positron Beam after the Target

Impact of OMD Aperture

Positron Yield vs Size of OMD Aperture



Positron Polarization vs Size of OMD Aperture



Positron Capture and Polarization (Geant4 & ASTRA)

e^+ beam after first RF structure

	ASTRA	Geant4
Capture Efficiency, %	70.7	70.1 ± 1.0
Polarization, %	28.7*	27.6 ± 1.2**

* Spin precession is not implemented in ASTRA

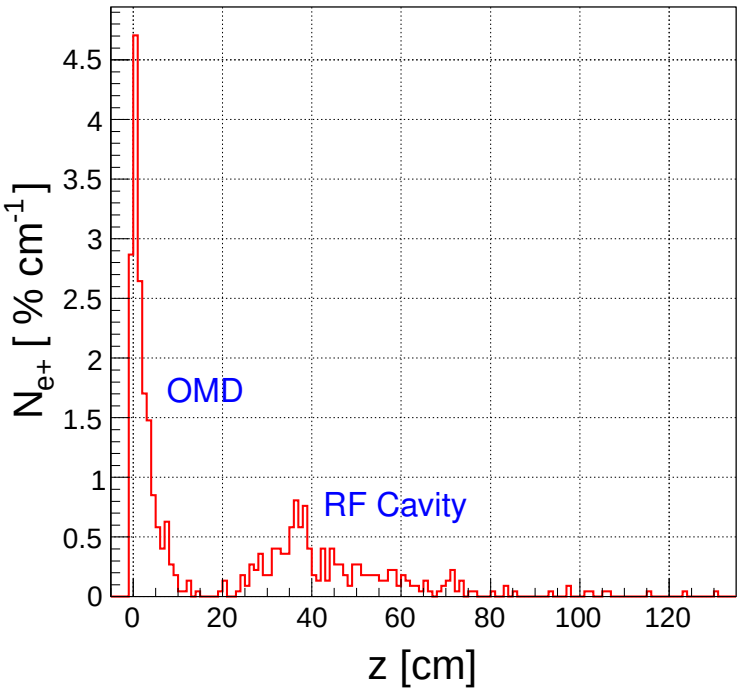
** Spin precession in magnetic field has been taken into account

e^+ beam after pre-accelerator matched DR requirements:

- DR energy acceptance $< 0.5\%$
- DR transverse acceptance < 0.09 rad m

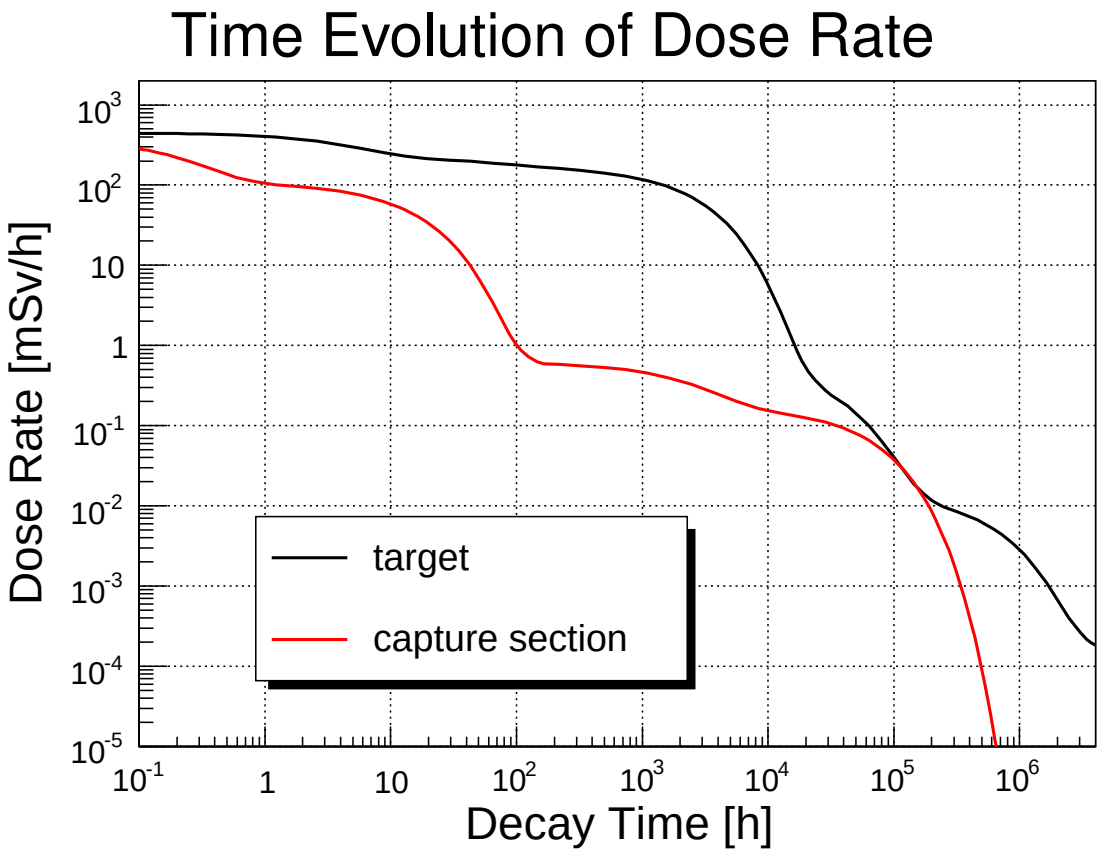
Capture Efficiency, %	**25.4**
Polarization, %	**40.3**

Positron losses



Source Activation: Equivalent Dose Rate

after 5000 hours of source operation at 1 m from the source



Ti6Al4V target

Summary and Outlook

- Positron yield, capture efficiency and polarization have been calculated for source with pulsed flux concentrator.
- Heat load, target radiation damage and activation have been estimated.

Future plans

- Full implementation of spin tracking in Geant4
- Further optimization of positron source