ILC positron production target simulation

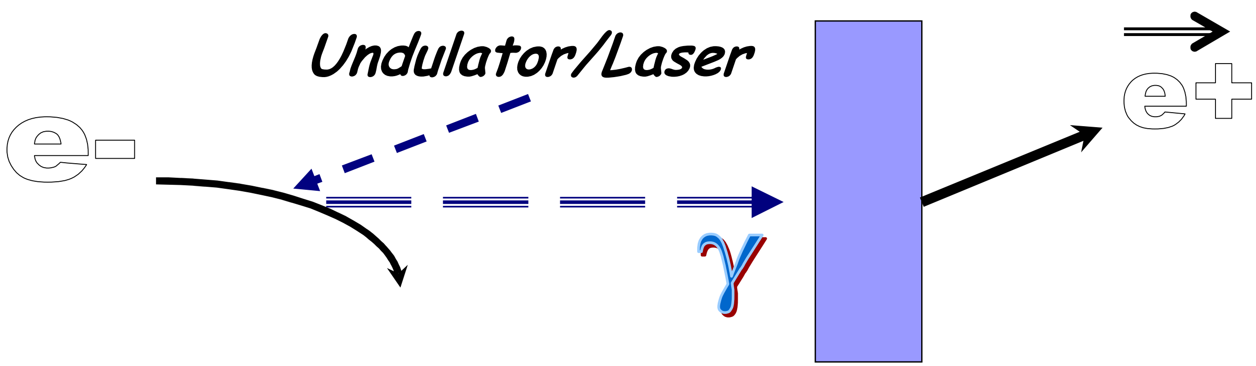
Vahagn.Gharibyan
DESY

01.06.2007

- Positron sources
- Simulation tools
- Considered polarized processes
- Results
- Optimal target
- Summary

Positron sources

Circularly polarized photons
Compton boosted to MeV by accelerated
electrons to produce longitudinally polarized positrons



- *MultiGeV e- hit undulator virtual photons → few MeV e+*
- *GeV e- hit laser real phootons → tens of MeV e+*

Simulation tools to deal with polarisation

How much polarisation gain positrons ?

Which target material and thickness ?

Program	Polarisation incorporated by
EGS	K.Flotmann
Geant4	Zeuthen group

present study is done with polarized Geant3

Polarisation transfer in processes

Pair Creation	$\vec{\gamma} \rightarrow \vec{e+}\ \vec{e-}$
Compton scattering	$\vec{\gamma} + e- \rightarrow \vec{\gamma}\ \vec{e-}$
Photoeffect	$\vec{\gamma} + e- \rightarrow \vec{e-}$
Annihilation	$\vec{e+}\ e- \rightarrow \vec{\gamma}$
Bremsstrahlung	$\vec{e} + N \rightarrow \vec{e} + N + \vec{\gamma}$
Multiple (Coulomb) scattering	$\vec{e} + N \rightarrow \vec{e} + N$
Energy Loss dE/dX	$\vec{e} + Ne \rightarrow \vec{e} + Ne^*$

Closer look to the continuous processes

Multiple scattering

At MeV energies average angles are tens of deg.
Above 1-2MeV polarisation/magnetic moment follows momentum in the Coulomb field.
Is that correct or a crude approximation? For heavy nucleus?
E.g. that's not the case in a uniform field.

Energy loss

Dominant at energies lower than the critical Ec. Direction does not change (is that true?) hence the polarisation.
Continuous/discrete factorization is valid far from the Ec.

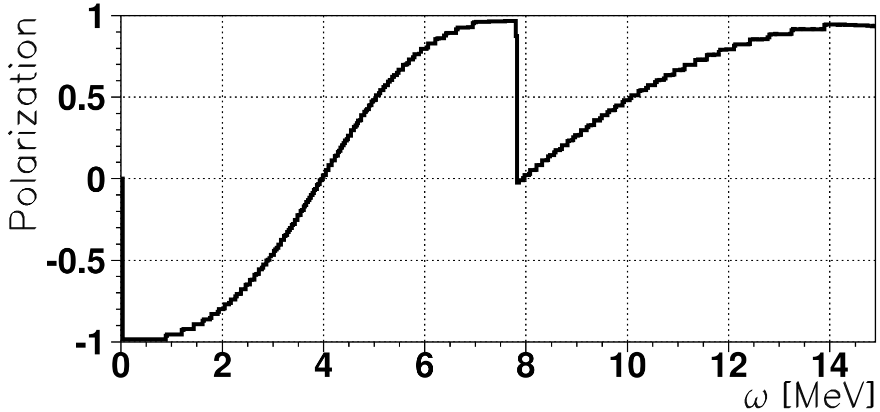
Depolarisation theory/experiment are frozen since 1960s.
Additional investigations/theoretical input are welcome (especially for heavy materials).

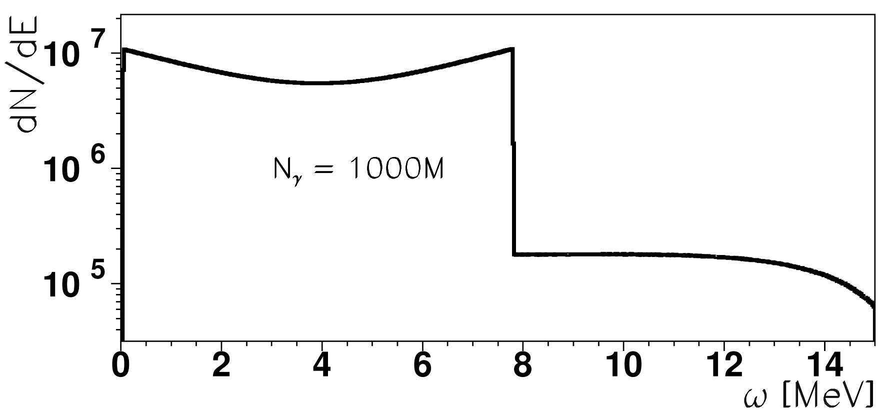
Results

Undulator Case

Initial Photons

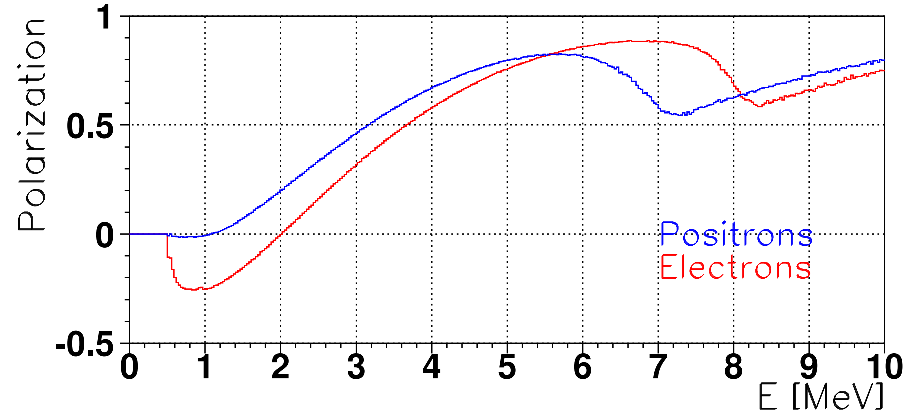
E_0=46.6 GeV   k=0.19

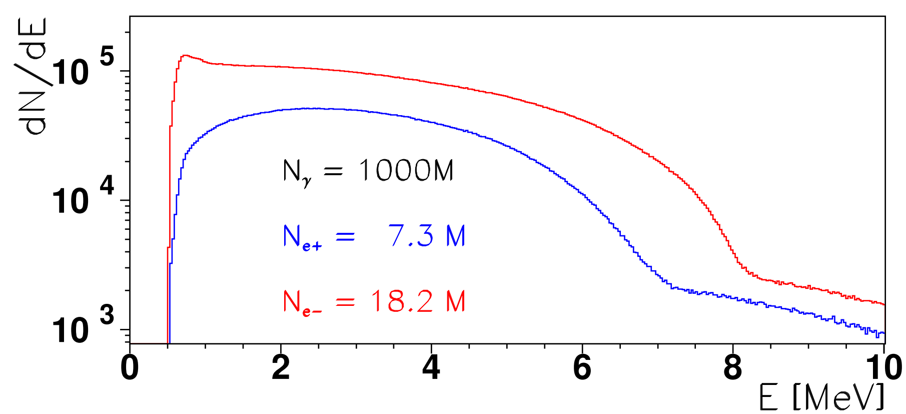




Behind the conversion target

E_0=46.6 GeV   k=0.19 $0.2X_0$ W



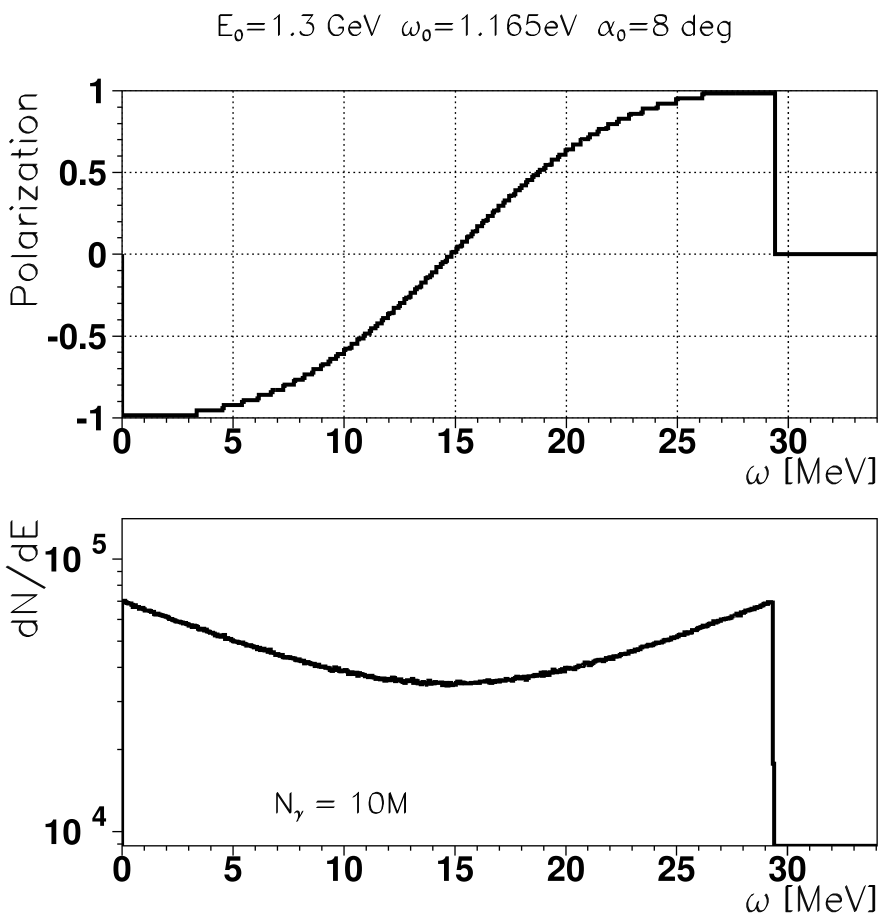


ILC/ LCWS POLarisation 01-06-2007

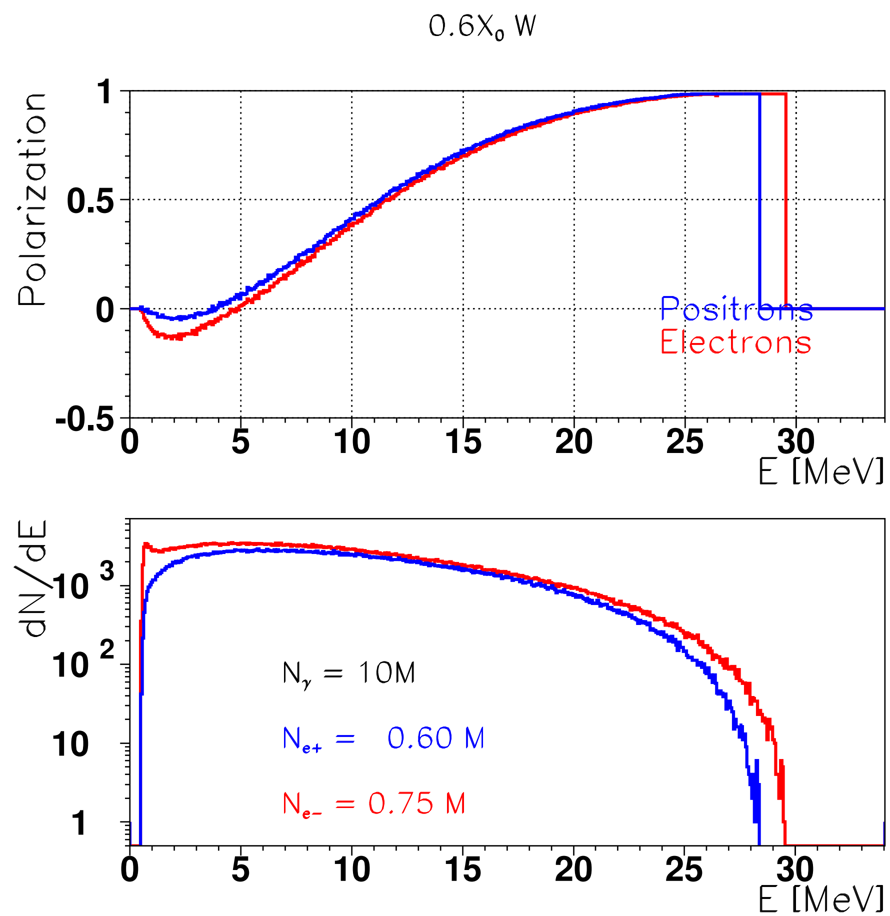
Results

Laser Case

Initial Photons



Behind the conversion target



Optimizing target thickness

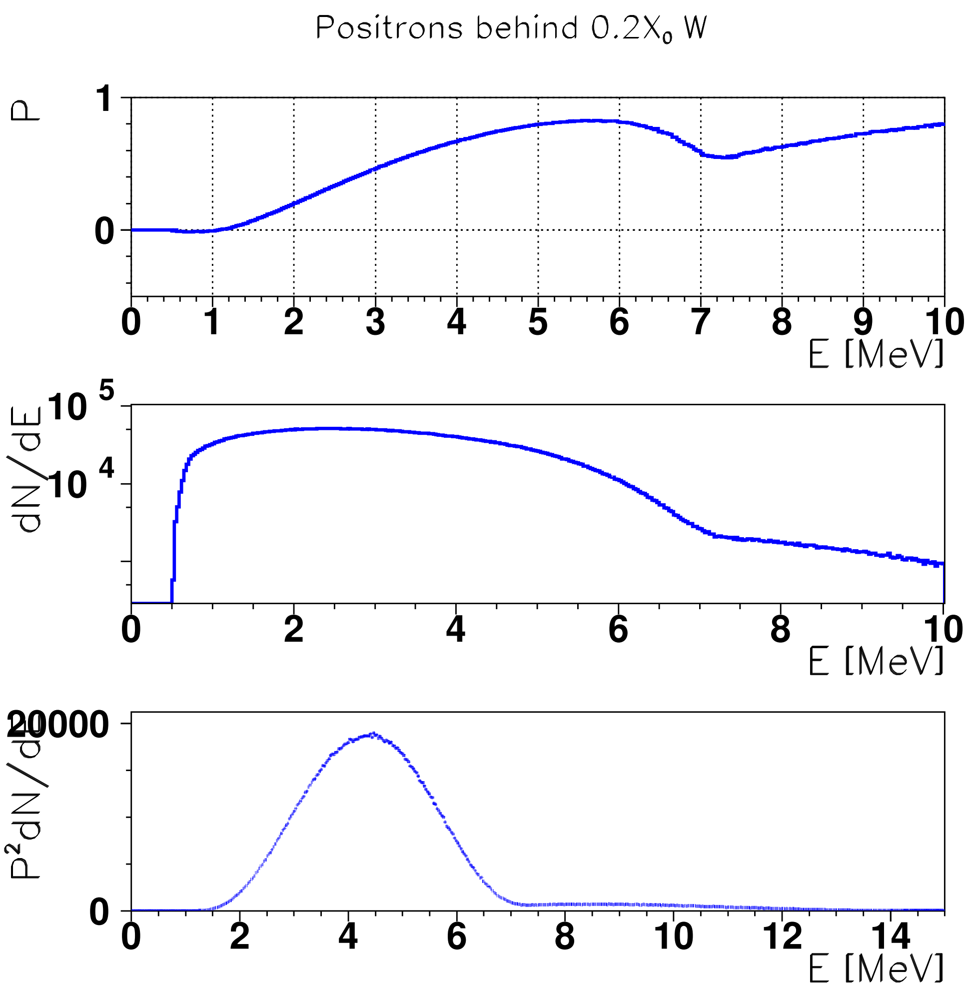
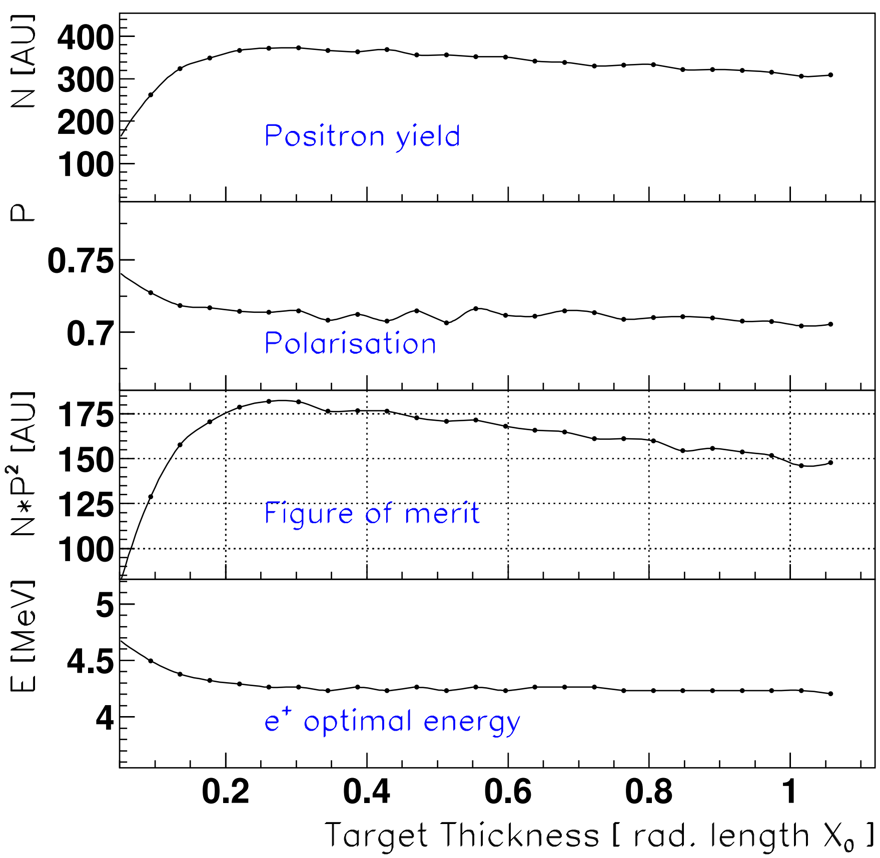


Figure of merit

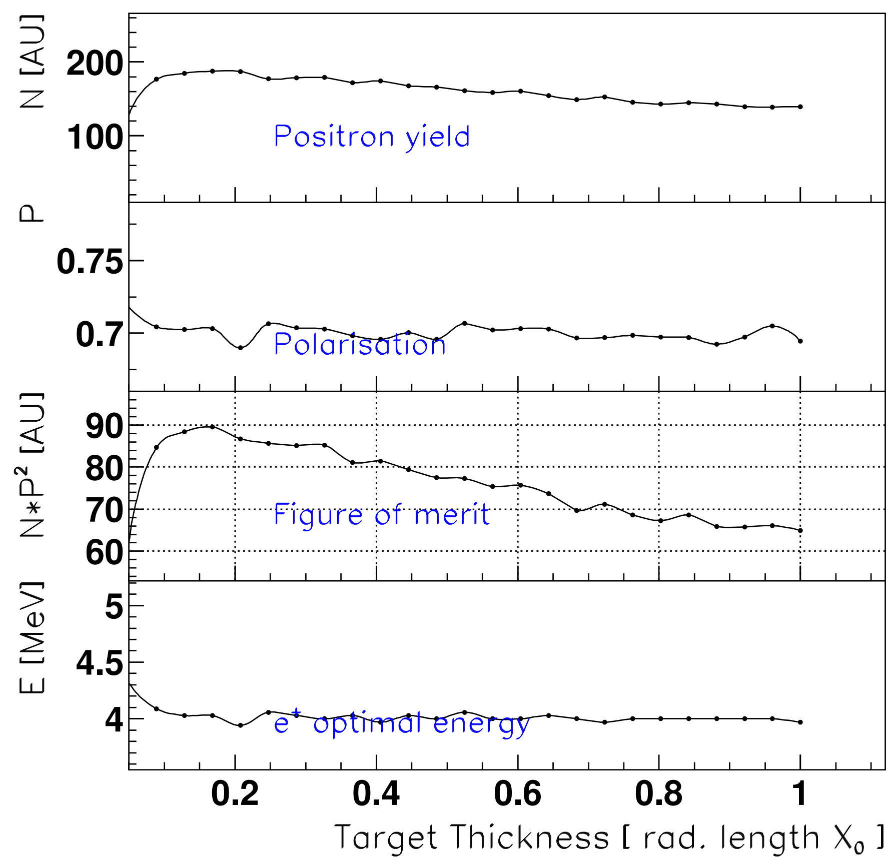
Optimal target thickness

Undulator case

Tungsten



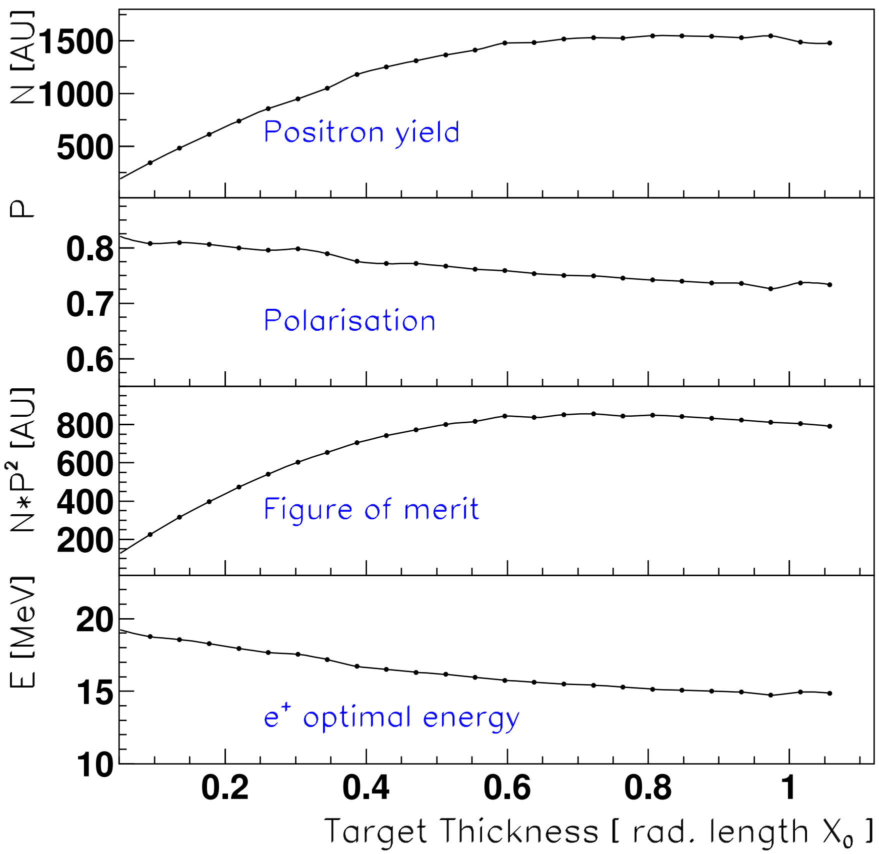
Titanium



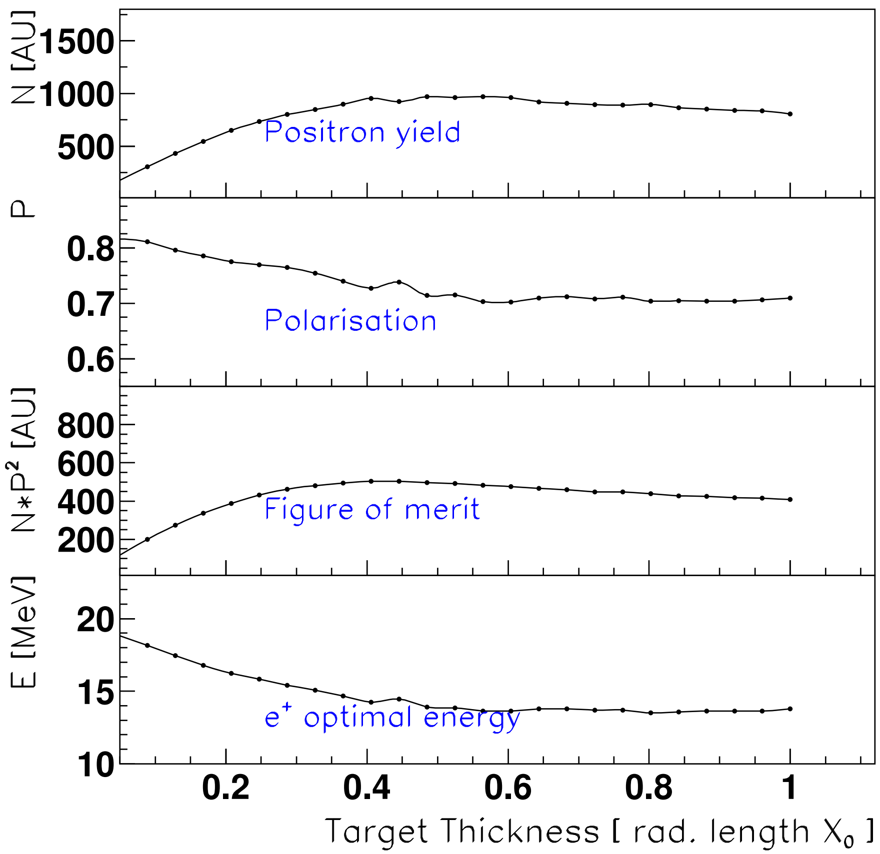
Optimal target thickness

Laser case

Tungsten



Titanium



Summary

In addition to existing MC programs Geant3 is modified
To count the polarisation.
For low energies calculation errors could be large,
Special simulation tools are necessary.

For the target choice polarized calculations could almost be escaped, its sufficient to maximize the positron yield.

Preferred are heavier target materials (ignoring theoretical uncertainties).