EGS/Geant4 Benchmark

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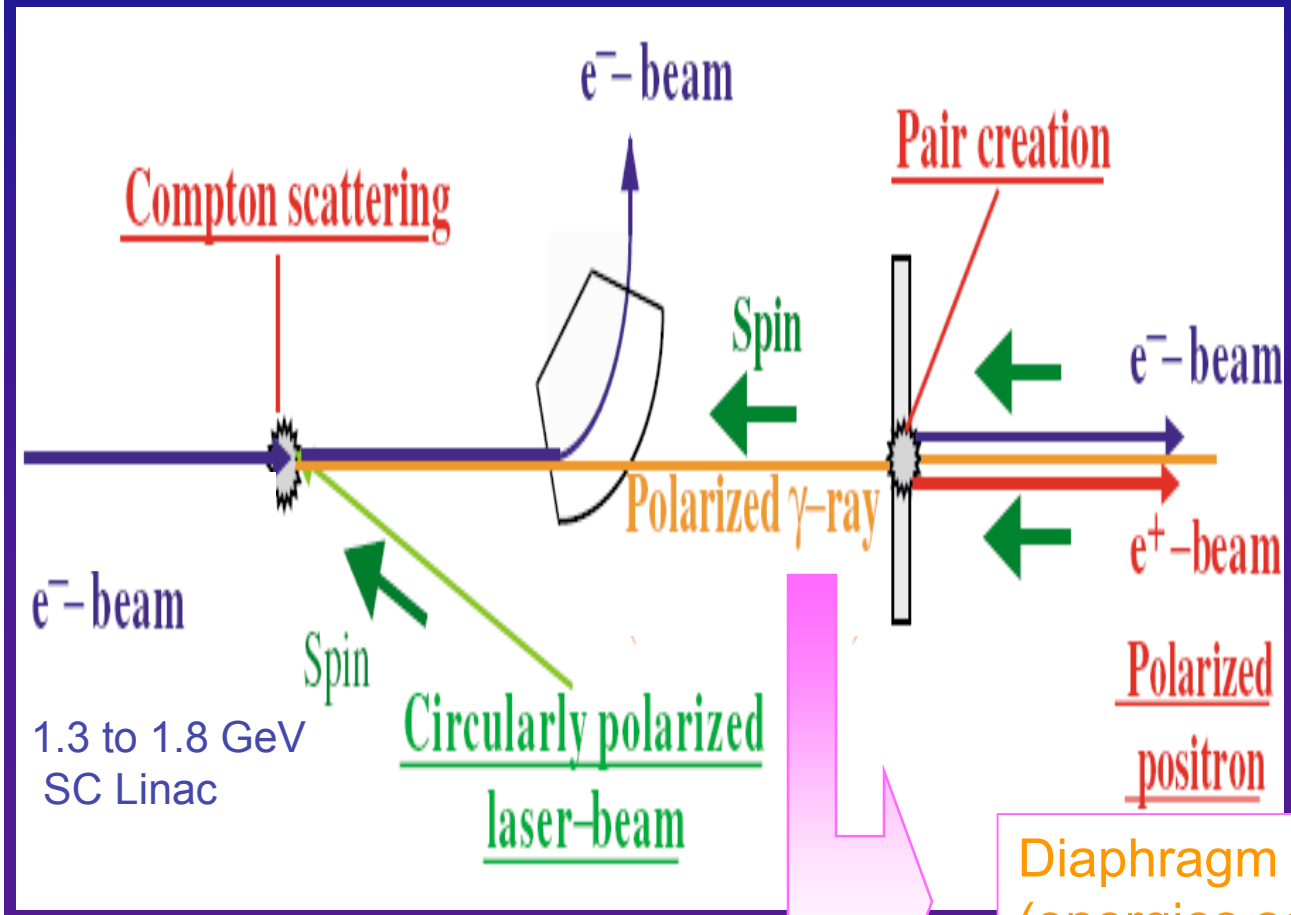
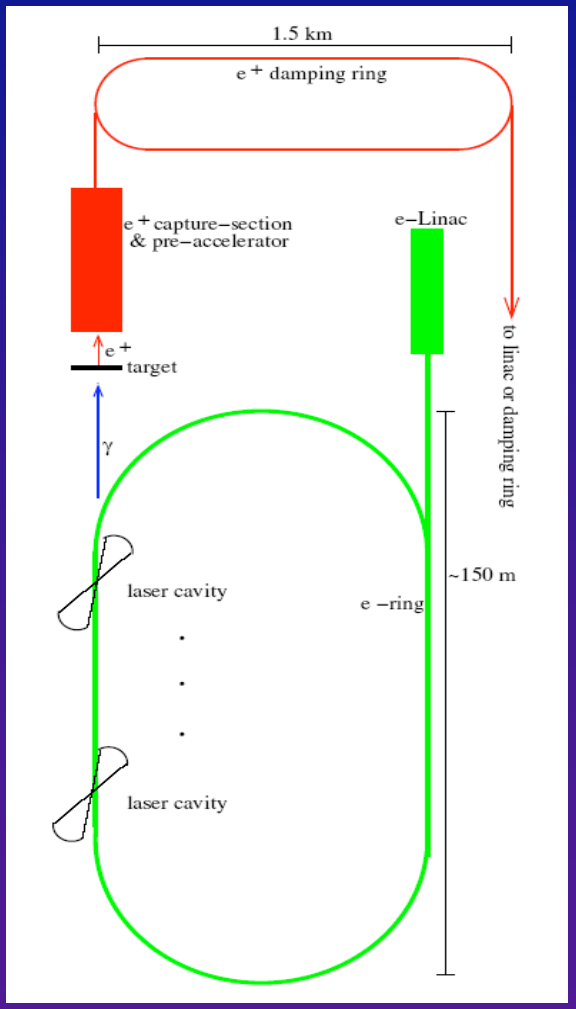
LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

Alternative polarized e^+ at ILC

- For ILC e^+ polarized based on ondulator
- Compton as an alternative





Diaphragm
(energies selection
i.e polarization selection)

Positron production: physics processes

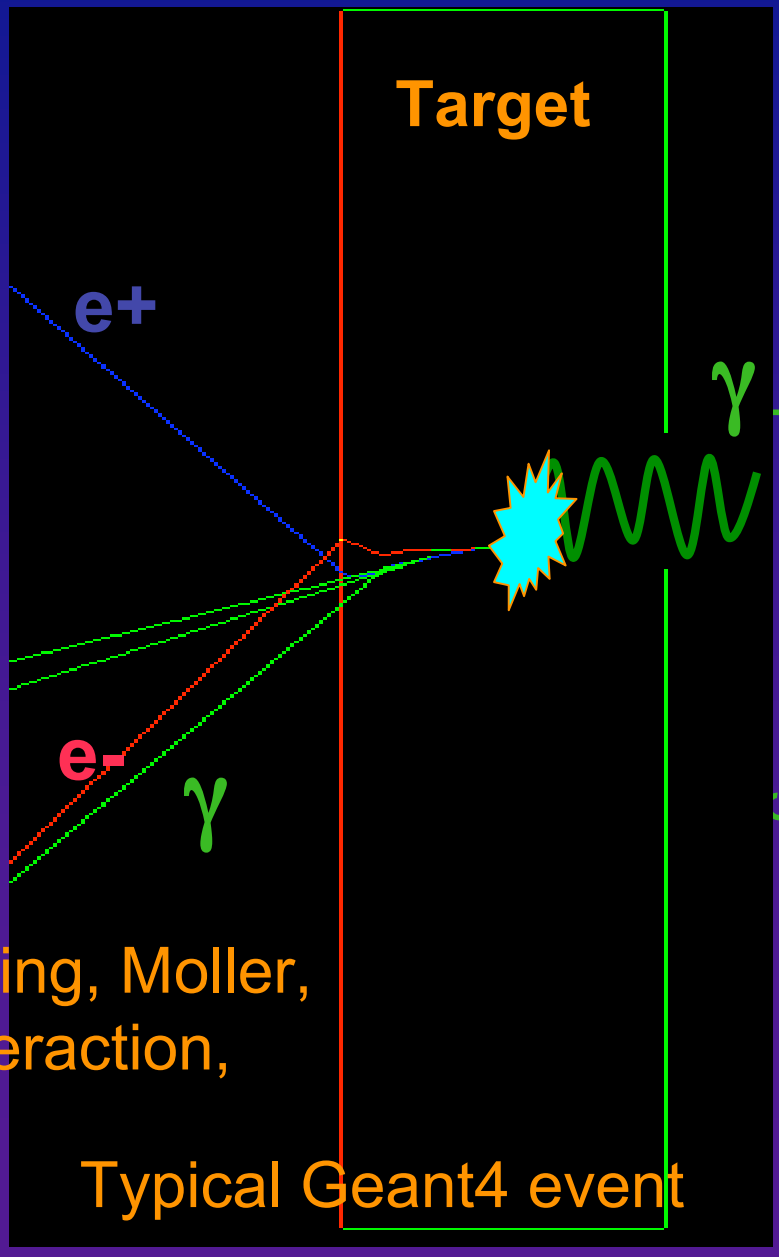
At high energies

- γ: Pair production in the nuclear field (scale with Z^2)
- e^+ e^- : Bremsstrahlung

interaction leads to more γ

cascade of processes: convert high energy particles into large numbers of lower energy particles

(others processes: Compton scattering, Moller, Bhabha scattering, photoelectric interaction, positron annihilation …)



EGS and new Geant4* simulation of polarized processes

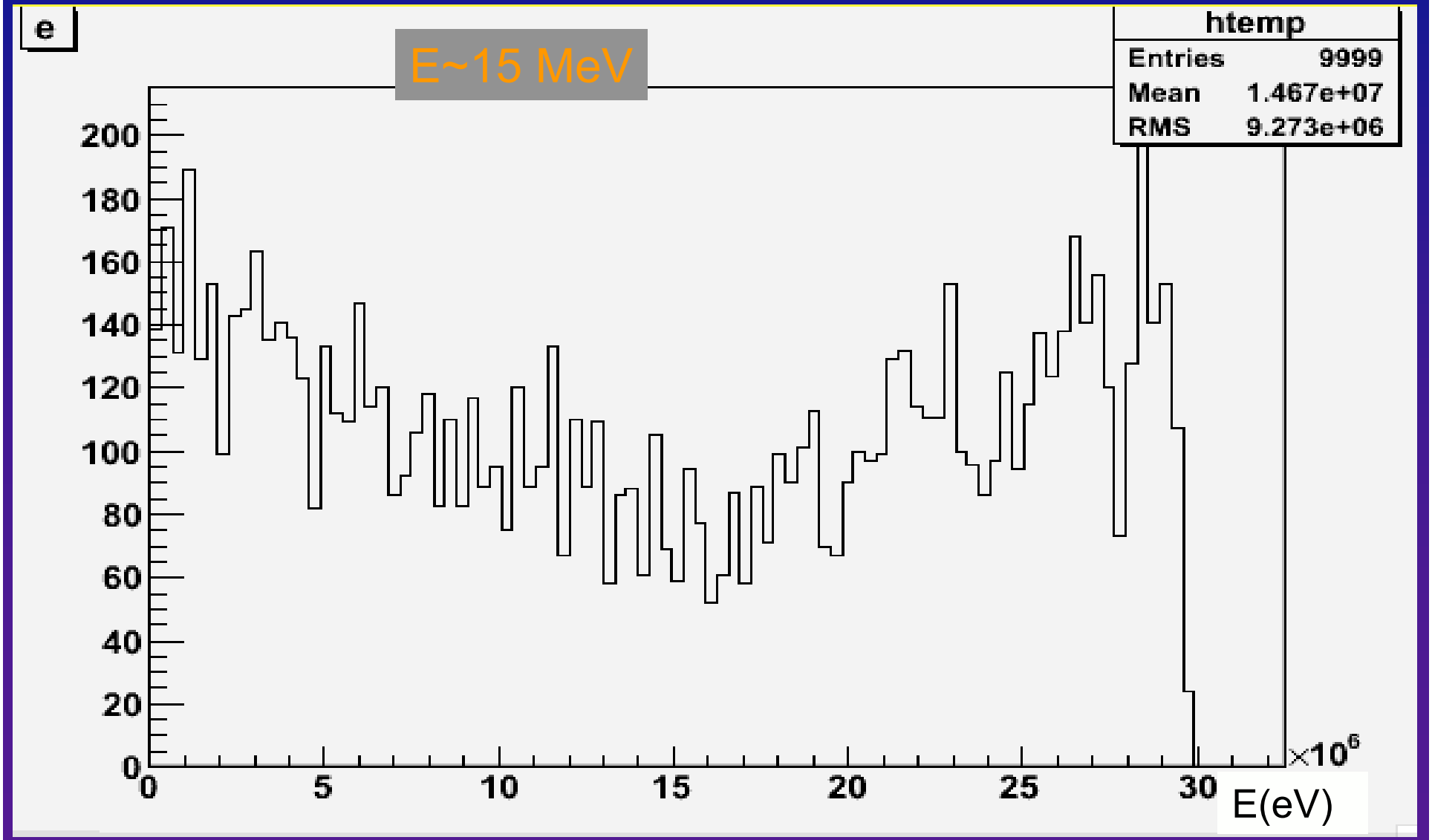
- EGS (Fortran based) : Electron Gamma Shower
  - Treatment of polarized extension has been developed by K. Flöttmannn, based on matrix formalism:
    - Bremsstrahlung, pair production and Compton
    - **Depolarization** in other processes (Bhabha(e^+), Moller(e^-), Rayleigh) **not considered**
- Geant4 (C++)
  - General procedure very similar to similar to EGS K. Flöttmannn polarized extension
  - Depolarization implemented

*since geant4.8.2.p01

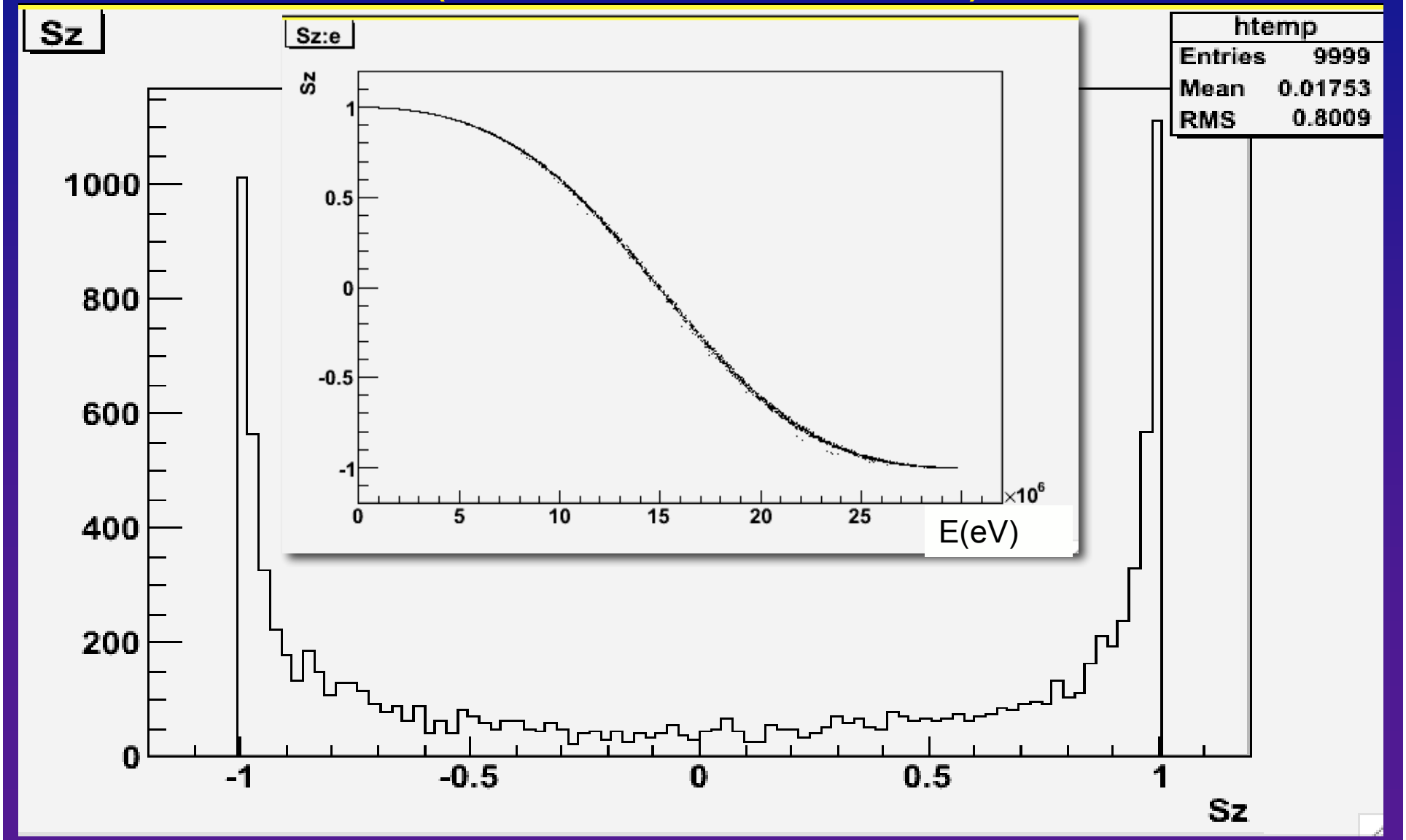
Initial parameters

- Target material W (1.4mm thickness, Z=74)
- In the next all the simulations was done with 10^4 photons as input
- Energy cut
  - e^+ and e^- 1 MeV
  - γ 135 keV
- Sz is:
  - circular polarization for γ
  - linear polarization for e^+ and e^-

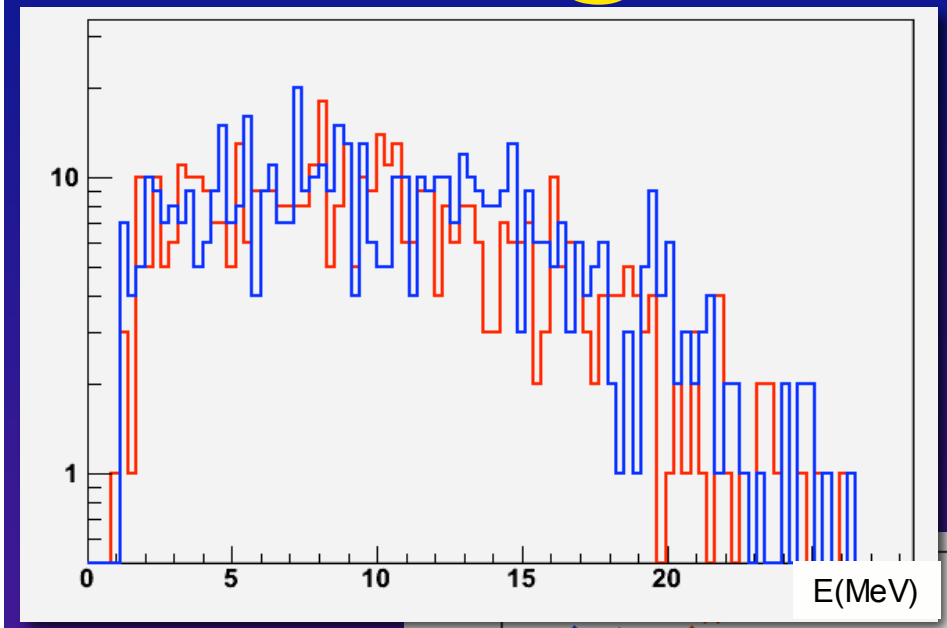
Input photon spectrum, with no diaphragm
(from 1.3GeV e^- beam)

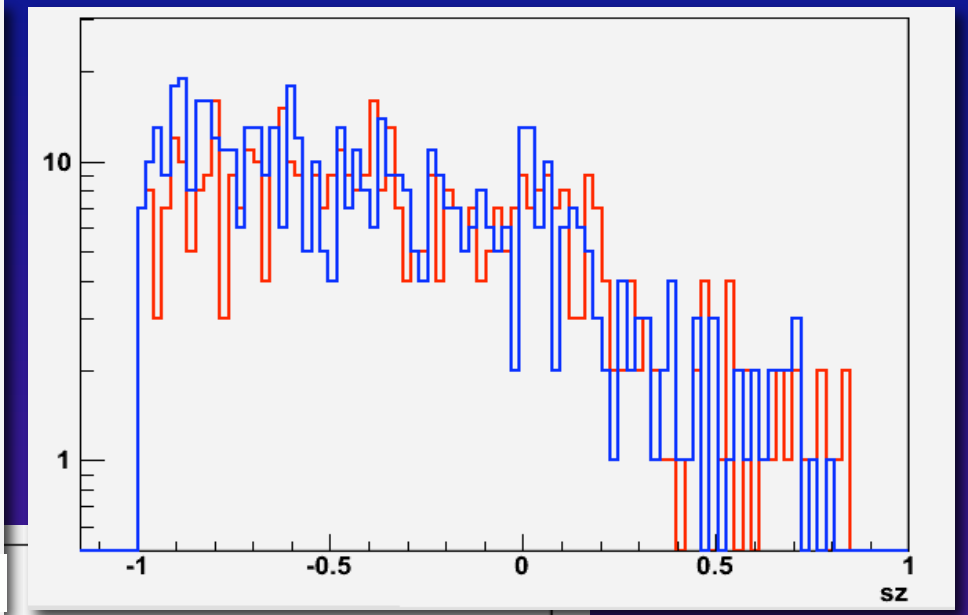


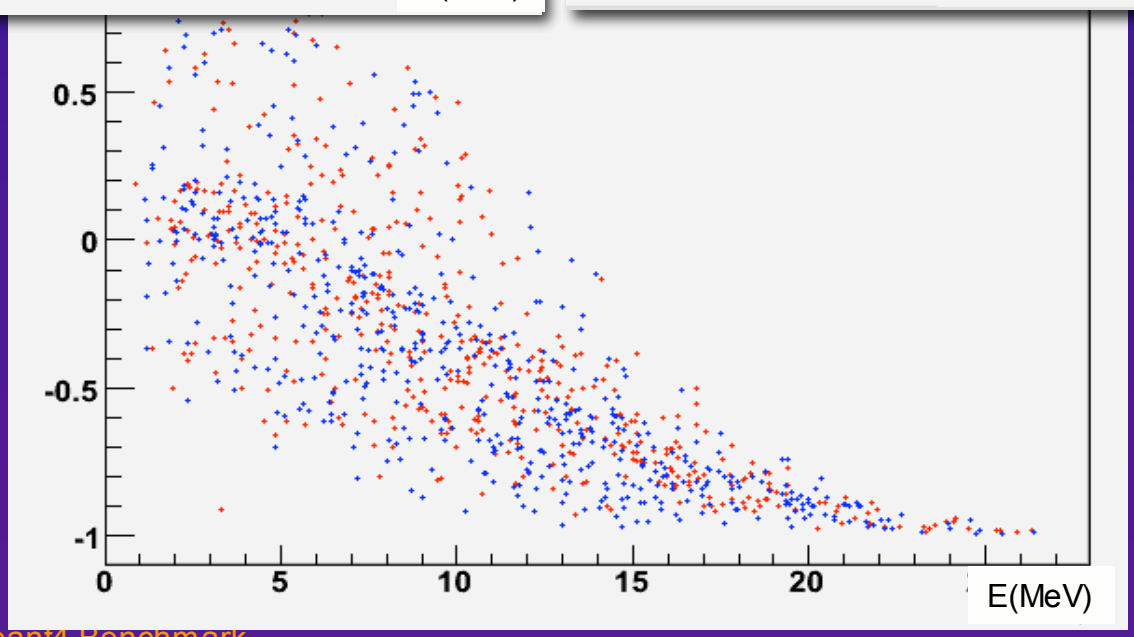
Input photon polarization, with no diaphragm
(from 1.3GeV e^- beam)



e+ @ the exit of the target





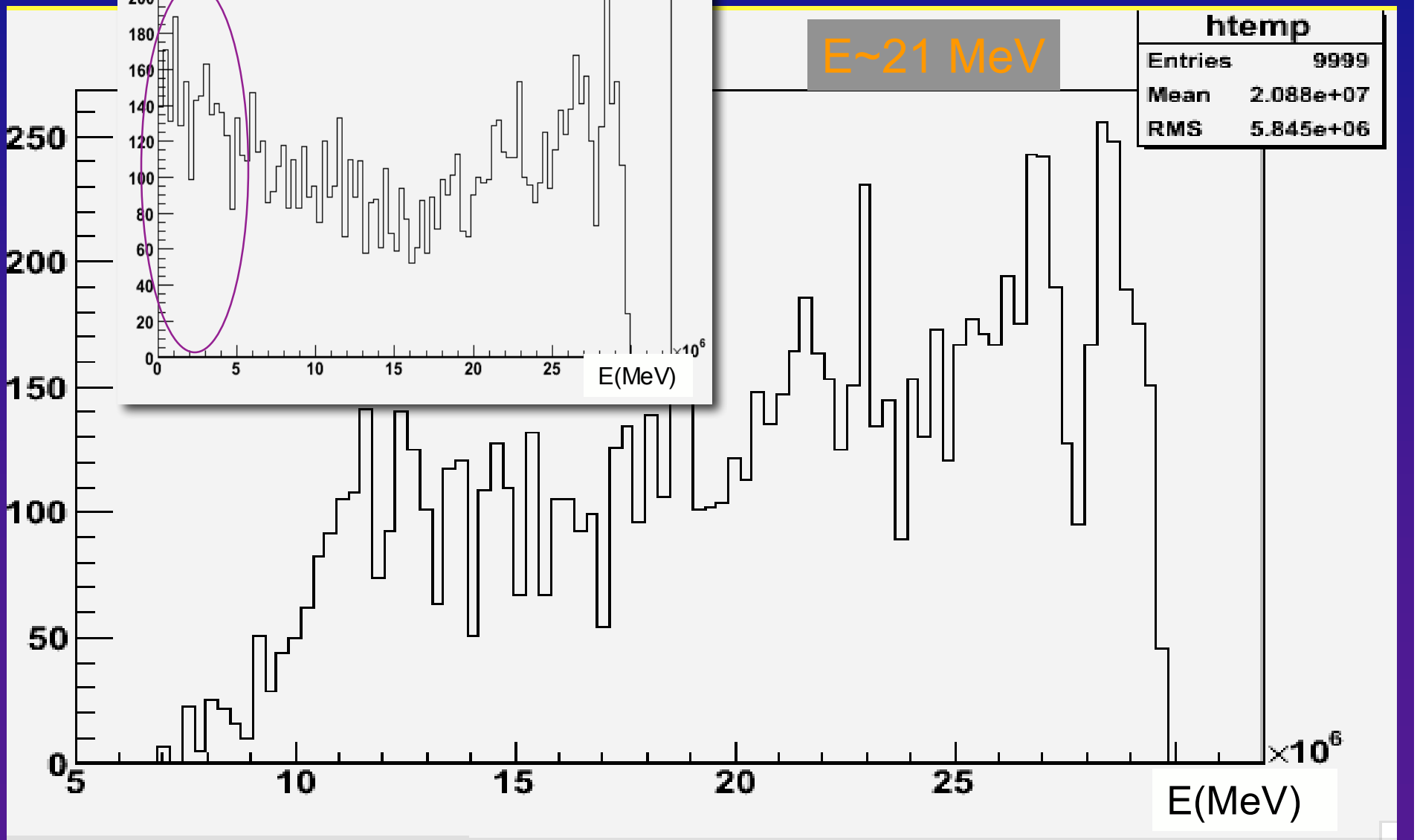


Geant4/EGS results

		Geant4	EGS
γ	<E(MeV)>(RMS)	13.02 (9.65)	11.40 (9.80)
	Sz (RMS)	-0.05 (0.70)	0.01 (0.70)
e^-	<E(MeV)>(RMS)	10.00 (6.02)	9.51 (5.74)
	Sz (RMS)	-0.30 (0.47)	-0.23 (0.43)
e^+	<E(MeV)>(RMS)	10.16(5.53)	10.5 (5.60)
	Sz (RMS)	-0.34 (0.42)	-0.40 (0.42)

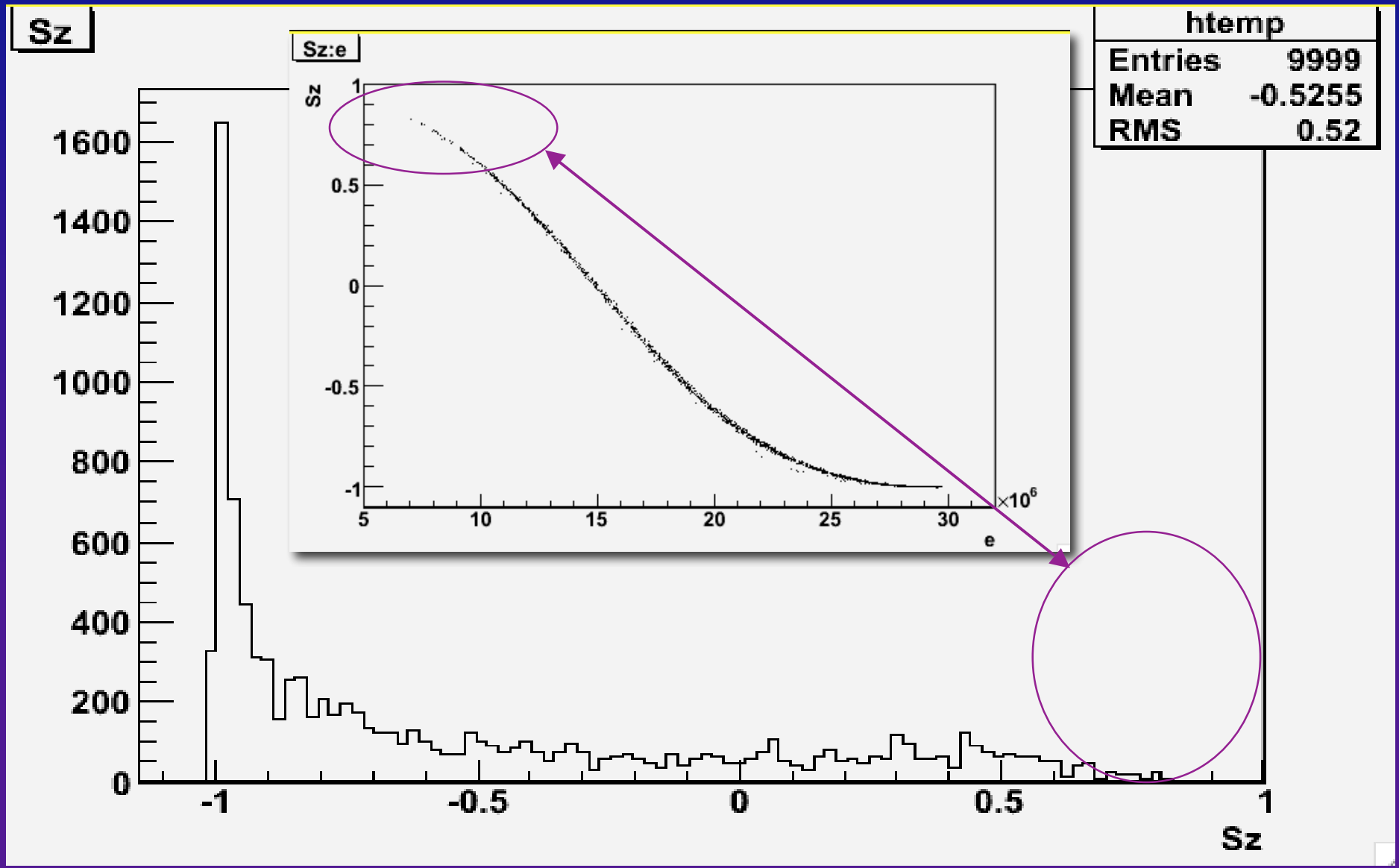
Sz comparison is not so good (20%)

Input photon with diaphragm
(from 1.3GeV e^- beam)



Input photon with diaphragm

(from 1.3GeV e^- beam)



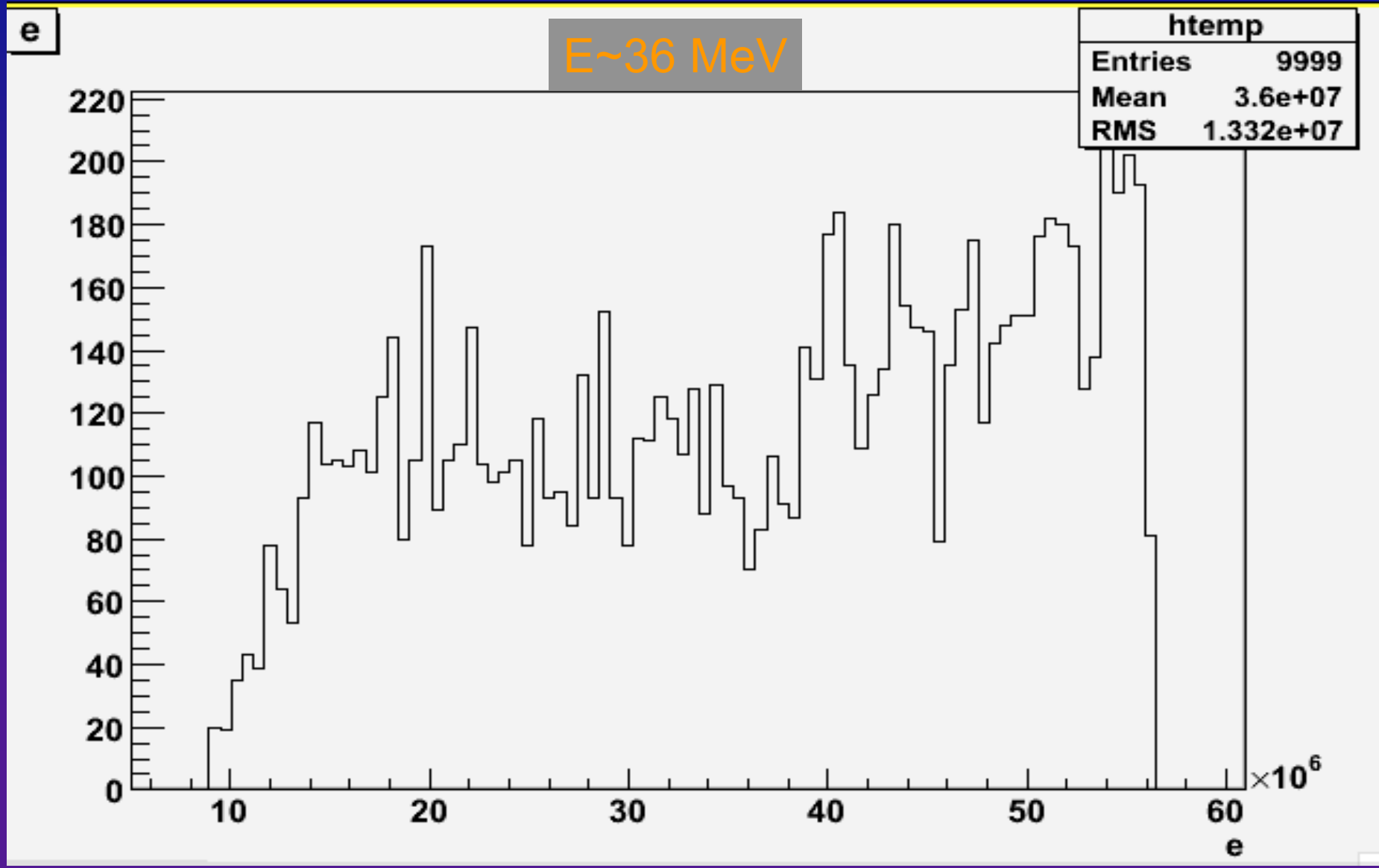
Geant4/EGS results

		Geant4	EGS
γ	<E(MeV)>(RMS)	16.50(9.60)	14.45 (10.25)
	Sz (RMS)	-0.41 (0.50)	-0.36 (0.48)
e^-	<E(MeV)>(RMS)	10.82 (6.31)	10.35 (5.96)
	Sz (RMS)	-0.38(0.39)	-0.33 (0.39)0
e^+	<E(MeV)>(RMS)	10.72 (5.67)	10.41 (5.55)
	Sz (RMS)	-0.40 (0.37)	-0.41 (0.38)

Sz for e^+ is better, why ?

Input photon with diaphragm

(from 1.8GeV e^- beam)



Geant4/EGS results using higher energy of incoming photon

(from 1.8GeV e^- beam, with diaphragm)

<15 MeV
Energy selection
for all particles

		Geant4	EGS
γ	<E(MeV)>(RMS)	3.55(4.56)	3.20 (4.18)
	Sz (RMS)	0.10 (0.32)	0.07 (0.28)
e^-	<E(MeV)>(RMS)	7.76 (4.13)	8.05 (3.93)
	Sz (RMS)	-0.03(0.31)	0.06 (0.26)
e^+	<E(MeV)>(RMS)	8.45 (3.63)	8.50 (3.68)
	Sz (RMS)	0.04 (0.28)	0.06 (0.30)

For all the polarization: EGS > Geant4

Geant4/EGS results using higher energy of incoming photon

(from 1.8GeV e^- beam, with diaphragm)

		Geant4	EGS
γ	<E(MeV)>(RMS)	37.10(12.33)	37.08 (12.40)
	Sz (RMS)	-0.40 (0.60)	-0.40 (0.60)
e^-	<E(MeV)>(RMS)	26.32 (8.48)	26.79 (8.55)
	Sz (RMS)	-0.50(0.37)	-0.45 (0.37) ?
e^+	<E(MeV)>(RMS)	26.62 (8.73)	26.21 (8.30)
	Sz (RMS)	-0.54 (0.32)	-0.53 (0.32)

>15 MeV
Energy selection
For all particles

For γ e^+ Sz: EGS = Geant4

EGS/Geant4 short conclusion

- For higher energies the results between EGS/Geant4 is better
  - Rayleigh cross section: negligible (polarization of this process not implemented in EGS)
  - Bhabha cross section: negligible (polarization of this process not implemented in EGS)
  - Moller still present due to the very huge tail
    - But we expected at higher energies both code give same results

Conclusion and prospects

- Need to make the simulation using a huge statistic
  - Larger energies of incoming photon (>50 MeV where Rayleigh , Bhabha and Moller will be negligible)
  - Use different material and different thickness
- Geant4 tasks
  - Implement the magnetic in the target
  - Implement the polarization in BDSIM simulation
- Thanks:
  Andreas Schaelicke for very useful mails exchanges