European LC Workshop
January 8-9 2007, Daresbury Laboratory, UK

Estimated photon backscattering from beam losses in the 2mrad ILC extraction line

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Introduction

In spite of all the attention put into the design of the extraction line, the losses of some :

- disrupted beam particles,
- or synchrotron radiation photons

is unavoidable

⇨ background sources at the IP

(several others sources: beamstrahlung, beam-beam pairs, radiative Bhabhas …)

We would like to quantify the number of such backscattered particles at the IP for the 2mrad crossing angle

We will study the backscattered photons due to:

- SR losses on septum @ 89m
- disrupted beam losses on collimator @ 40m

and those for two different materials

Overview

1. Backscattered photons due to the synchrotron radiations losses on septum
   - On Cupper material
   - On Tungsten material
2. Backscattered photons due to the disrupted beam loss on collimator
   - On Cupper material
   - On Tungsten material
3. Conclusion and prospects

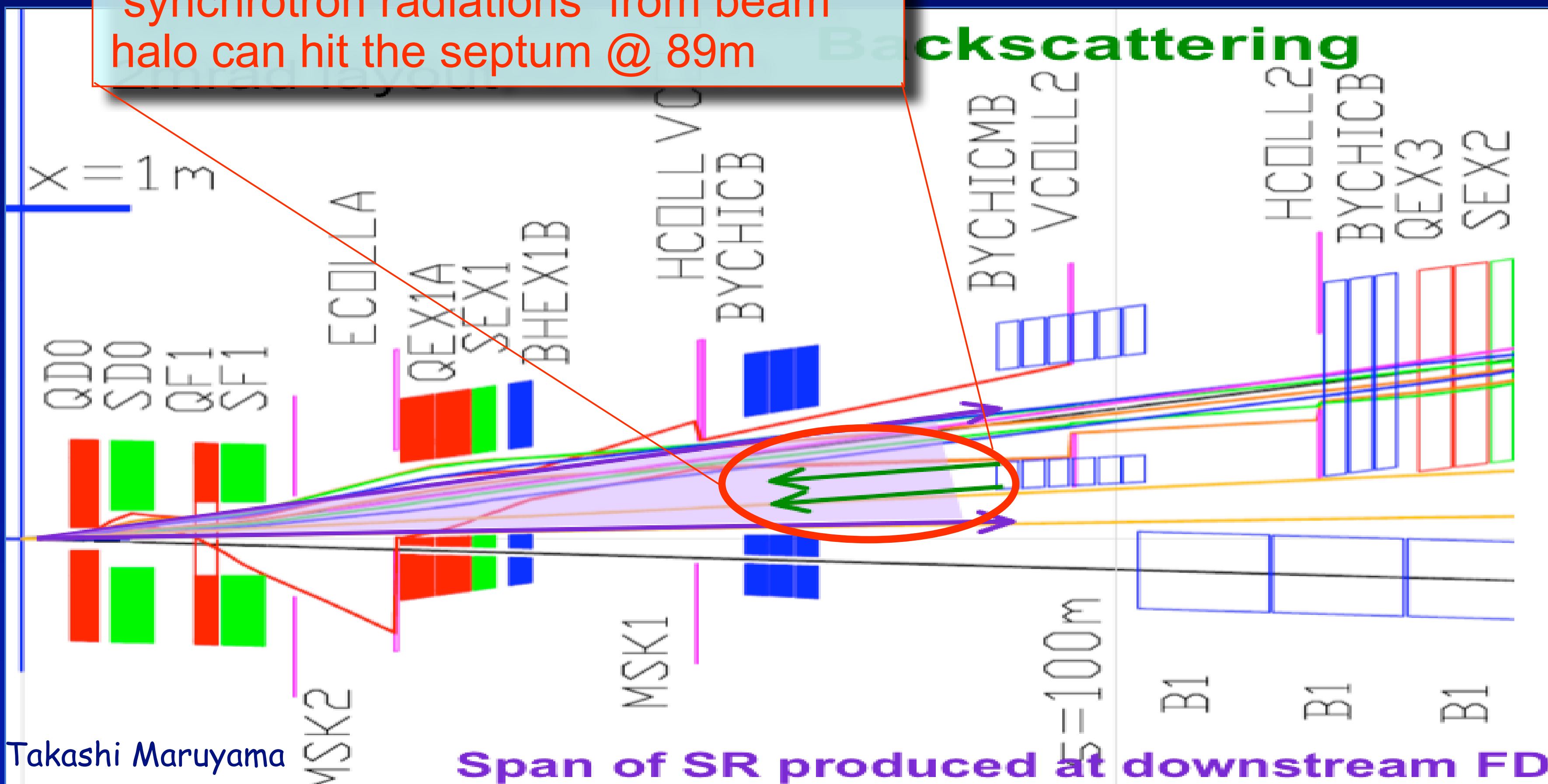
Backscattered photons from synchrotron radiations losses

Synchrotron radiations generations

In the 2mrad scheme, the beam go off axis through the first magnets of the incoming final focus beam

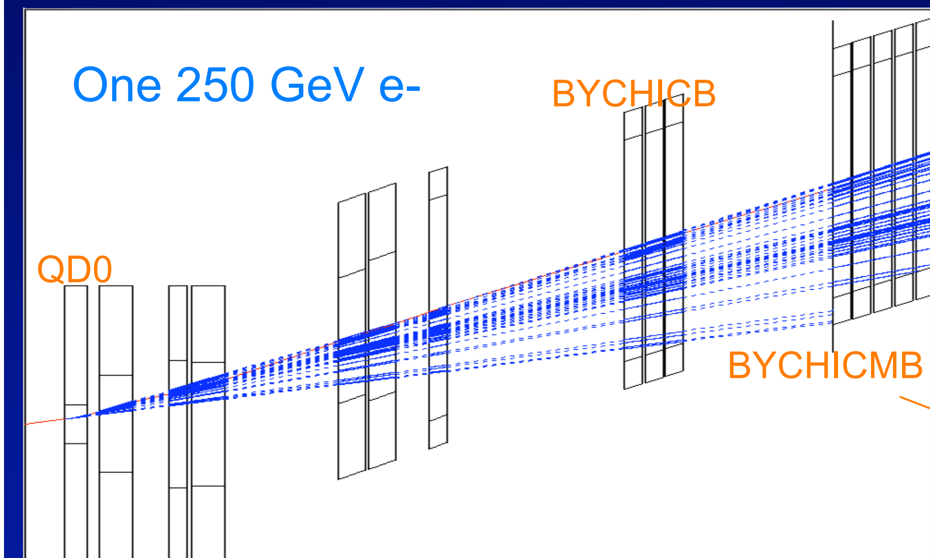
The beam passes off axis at QD0 and see the coil pocket of QF1

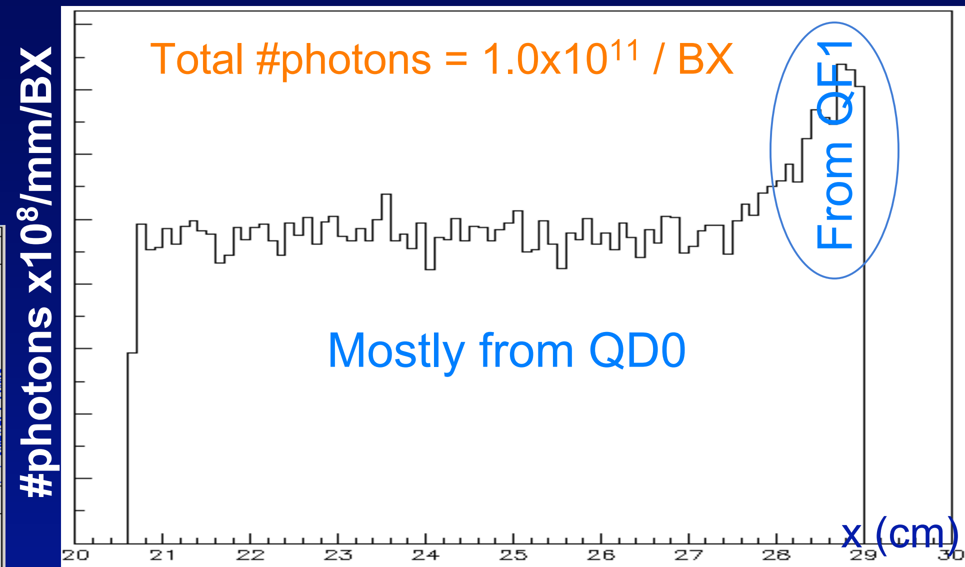
synchrotron radiations from beam halo can hit the septum @ 89m

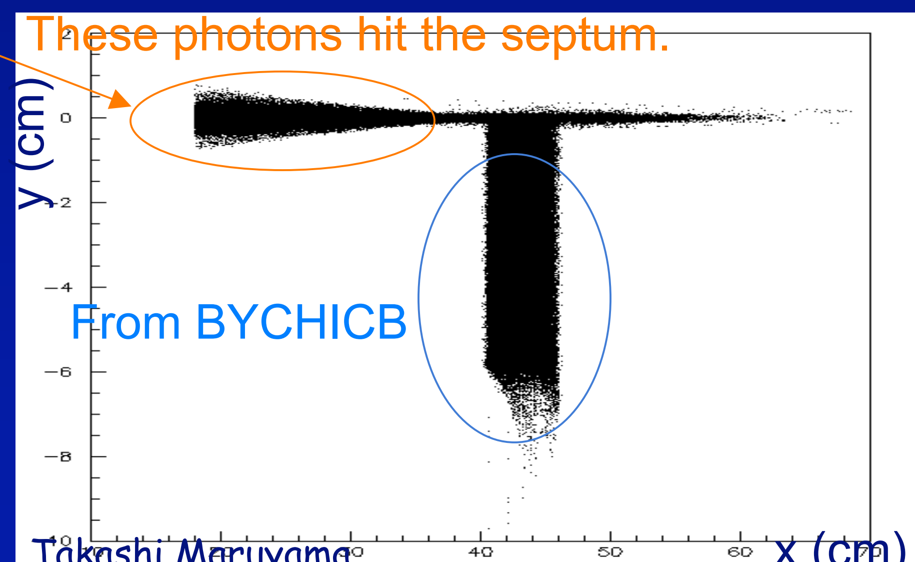


Synchrotron radiations at the septum

The SR hitting the septum is mostly due from QD0





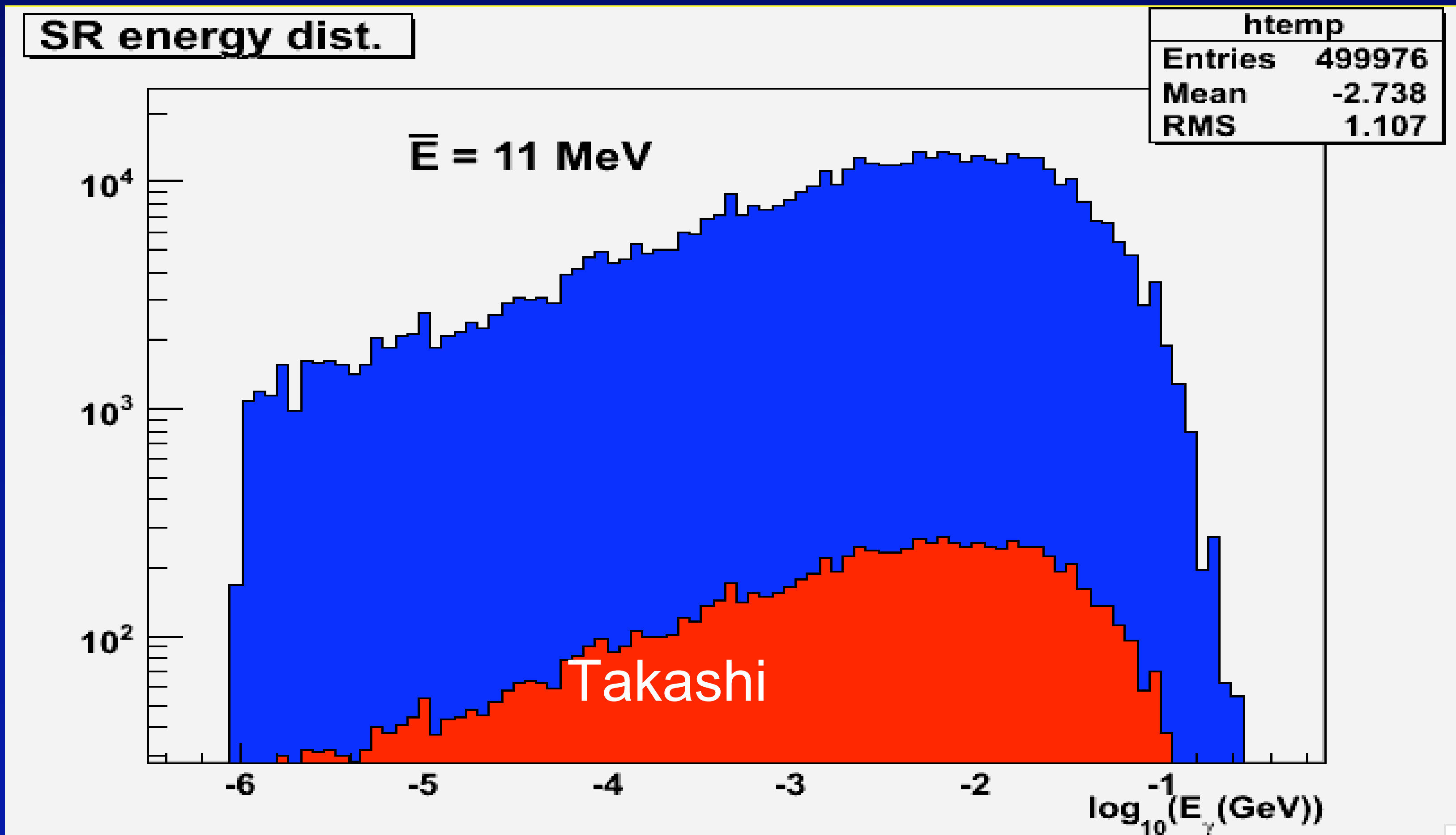


SR from 250 GeV e- :

- <E>=11 MeV
- 10^{11}/BX SR photons
- 2.5 kW deposited power

SR energy distribution

- From Takashi SR distributions, I increased the statistic by a factor of 50 (from 10 K to 500 K photons)
- Take into account only the energy parameters (**X=Xp=0**)



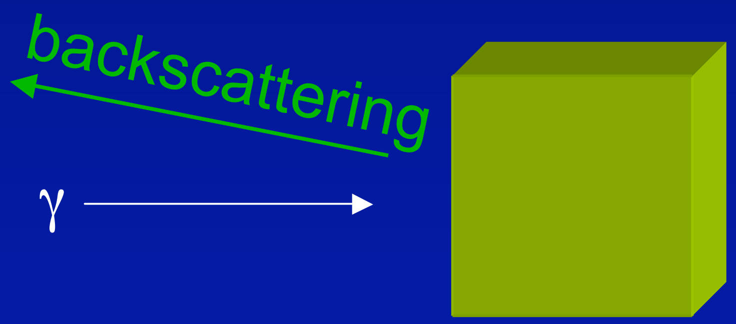
SR backscattering to IP

- Simulations was done using BDSIM simulation, easy SQL geometry description

  (under ilc grid virtual organization)
- Two different materials for the septum:
  - Copper z=29
  - Tungsten z=74
- The septum is modeling like a parallelepiped:

$$1m \times 0.5m \times 0.5m$$

- SR go in the middle of the septum (**X**=**Xp**=**0**)

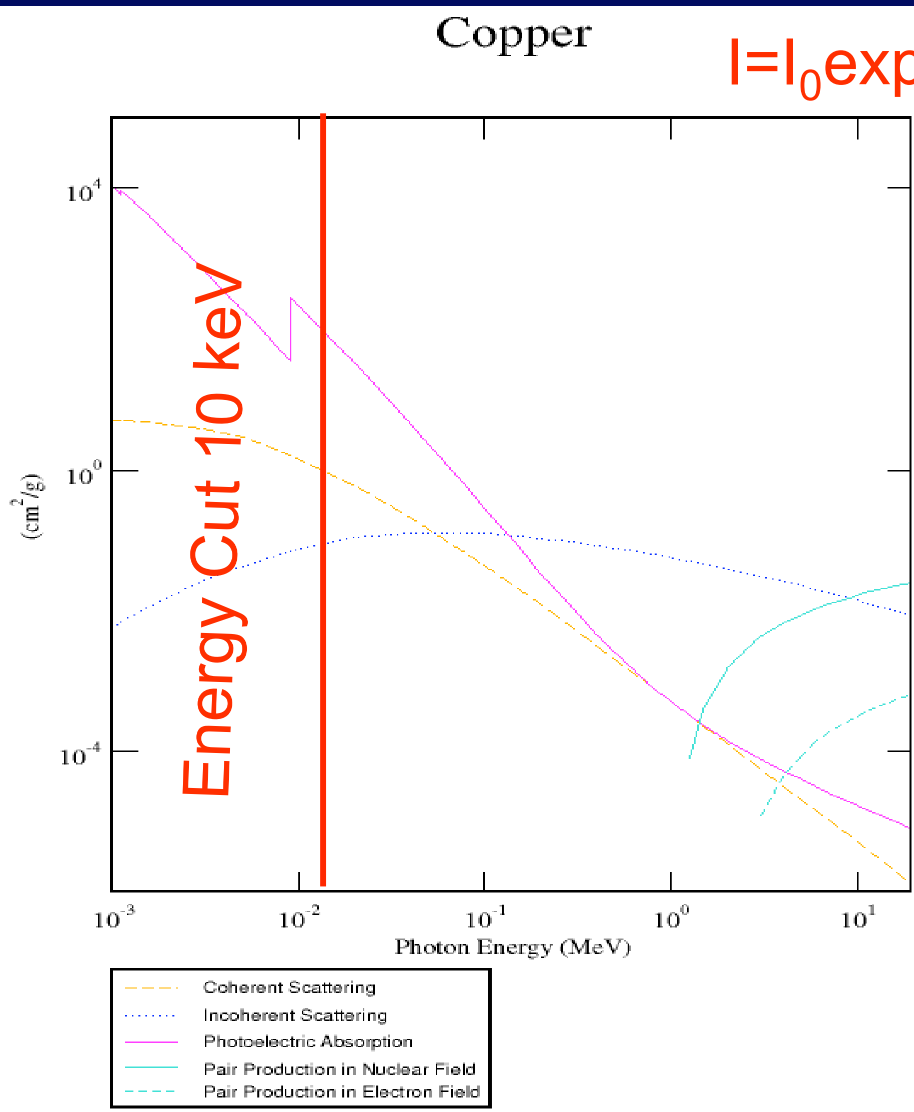


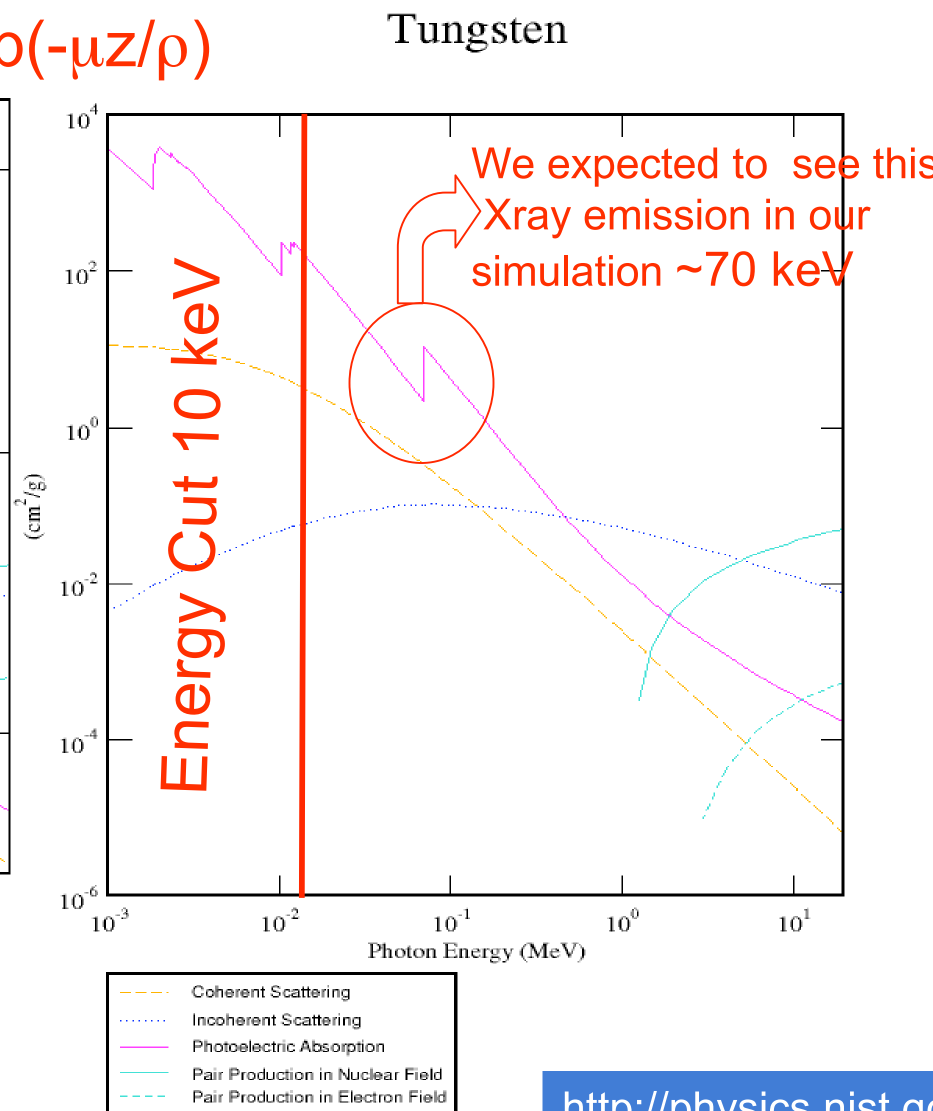
Interactions photons-material
3 majors processes:
- > 1MeV pairs creations
- Compton scattering
- Photo-electric effect

- 10 keV threshold for charged particles and photons

Mass Attenuation Coefficients

$I=I_0 exp(-\mu z/\rho)$

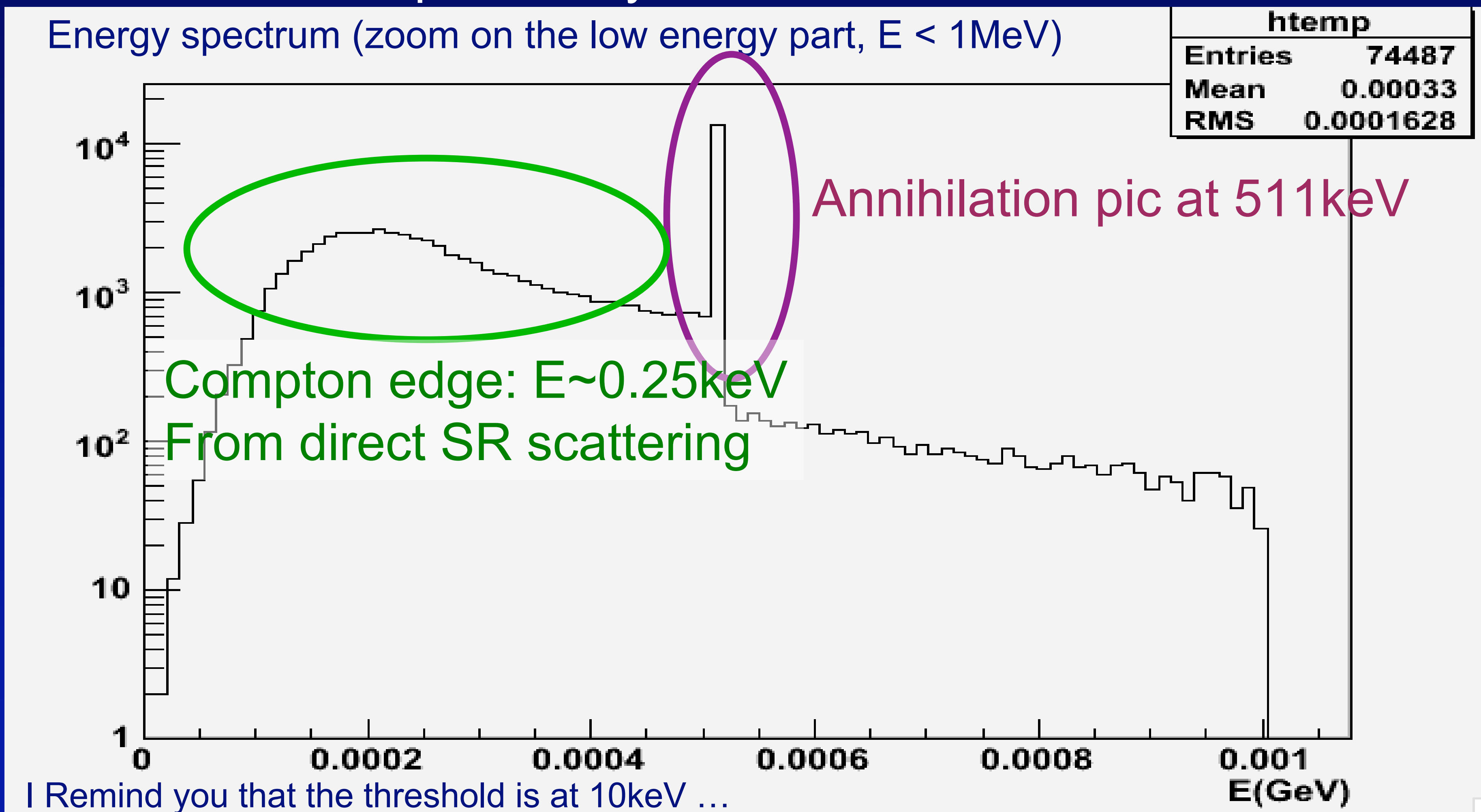




http://physics.nist.gov

Cu material: backscattered photons energy from SR

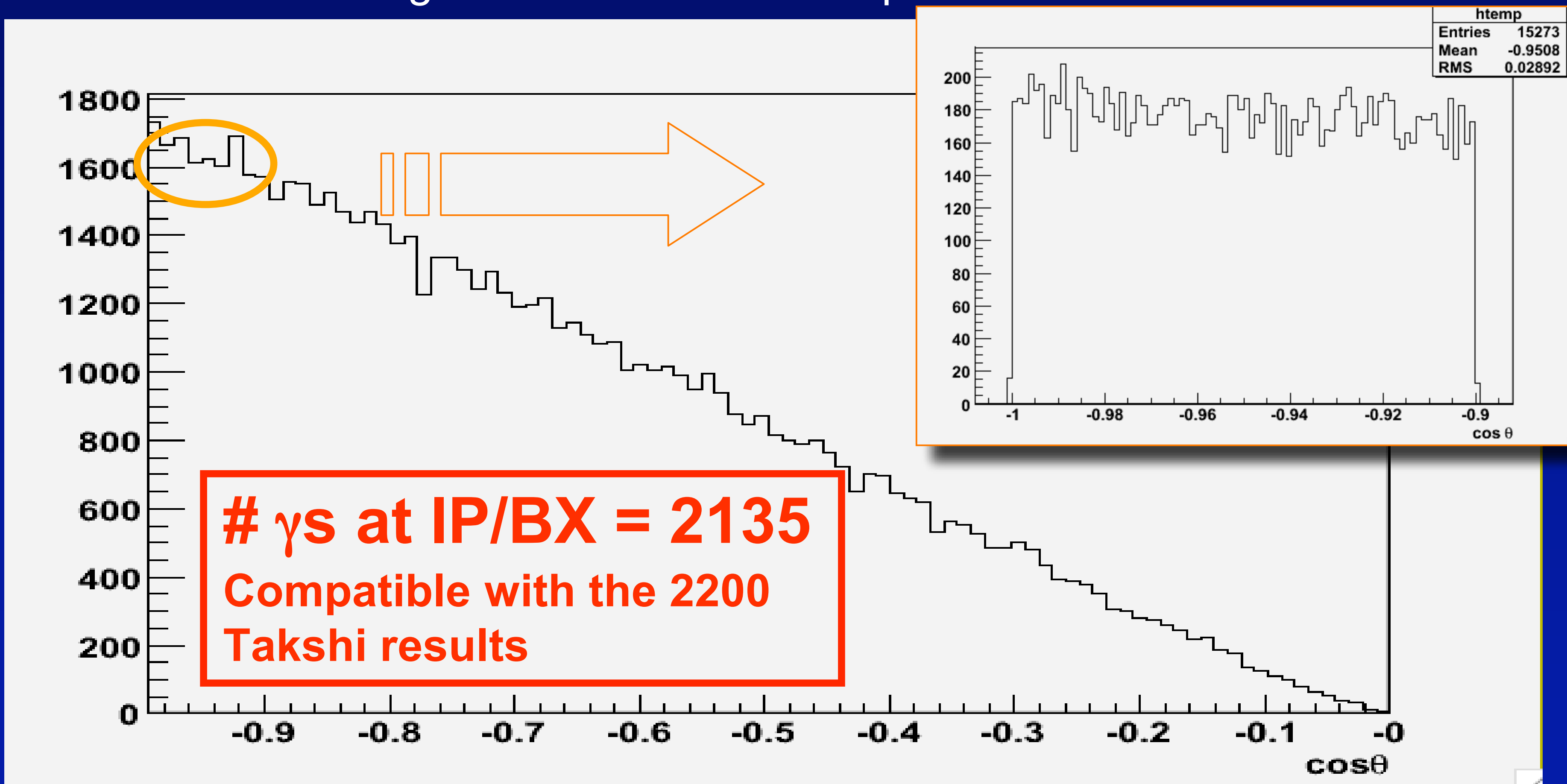
- 3.62×10^5 SR incoming photons simulated
- Backscattered probability 21.7%



Cu material: backscattered photons

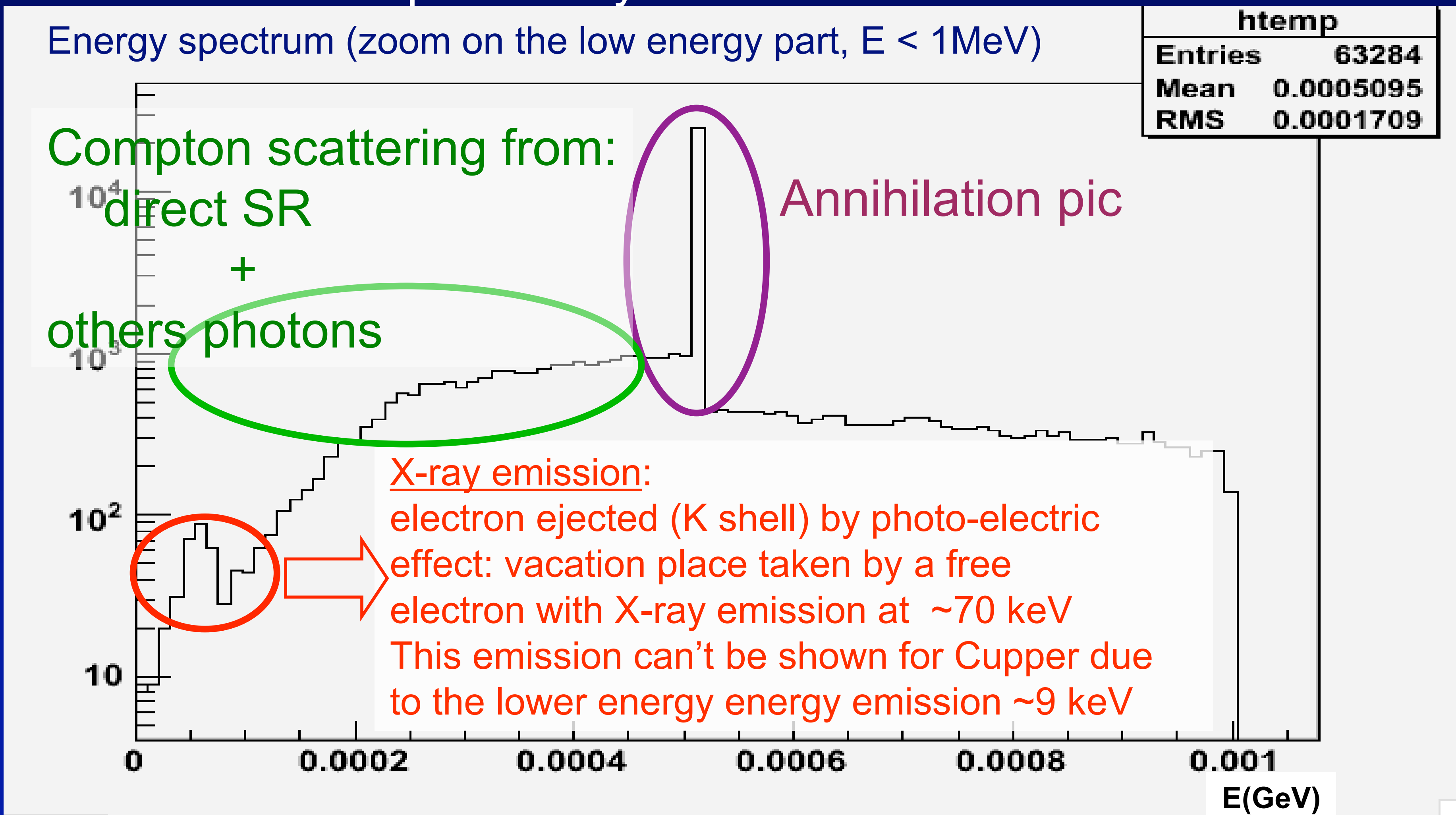
To estimate the photon flux within 2 cm BeamCal aperture.

- Find the backscattering rate in $-1 < \cos\theta < -0.9$, almost flat region
- Use the solid angle of the 2 cm radius aperture from z= 89m



W material: backscattered photons energy from SR

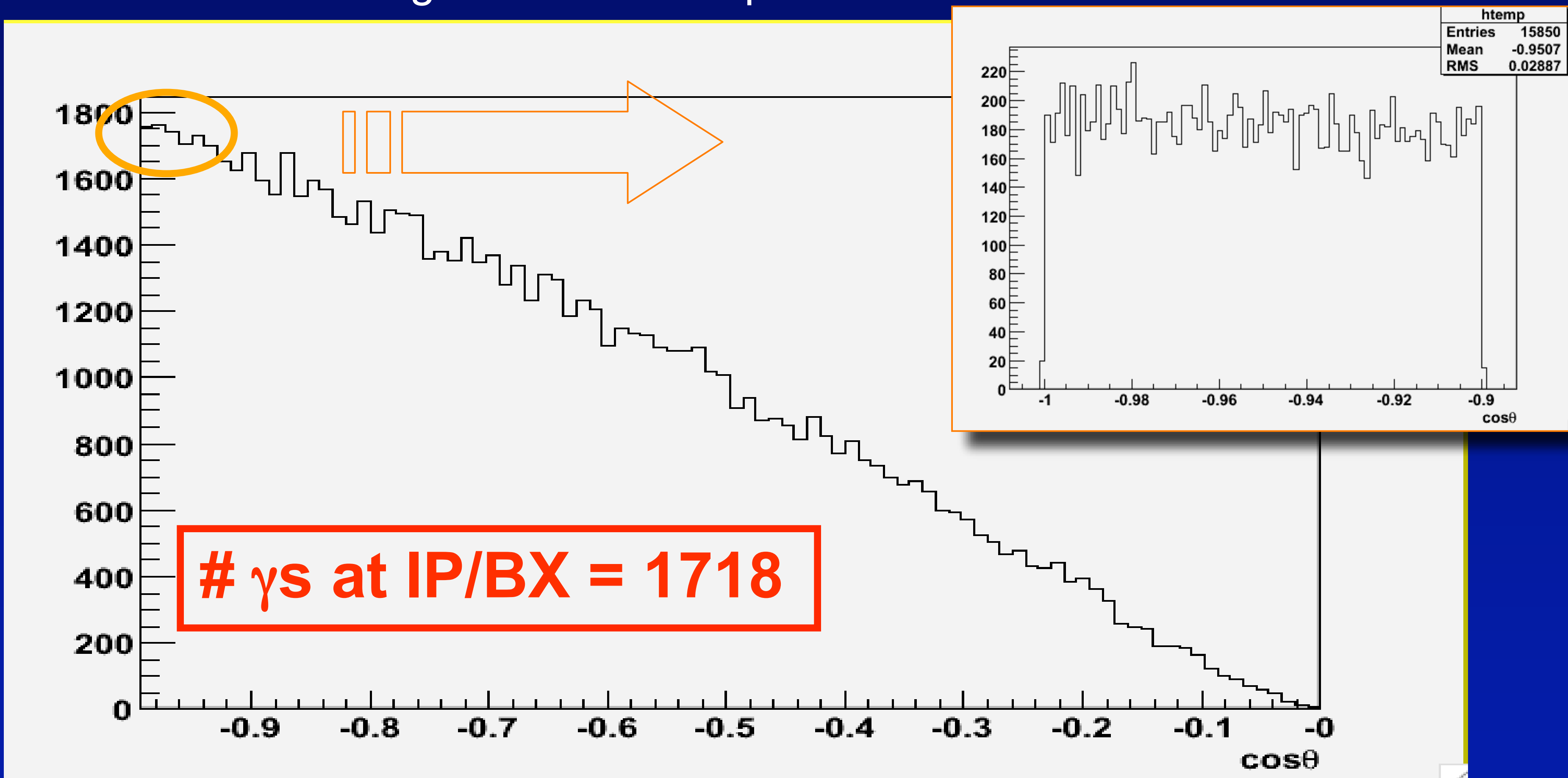
- 4.65×10^5 SR incoming photons simulated
- Backscattered probability 18.1%



W material: backscattered photons

To estimate the photon flux within 2 cm BeamCal aperture

- Find the backscattering rate in -1 < cosθ < -0.9, almost flat region
- Use the solid angle of the 2 cm aperture from z= 89m



Short conclusion to SR backscattered

- Backscattering photons depends on materials, but the difference it is not so huge
- #γs at IP/BX @ 250 GeV :

  2135 IP/BX for Cupper

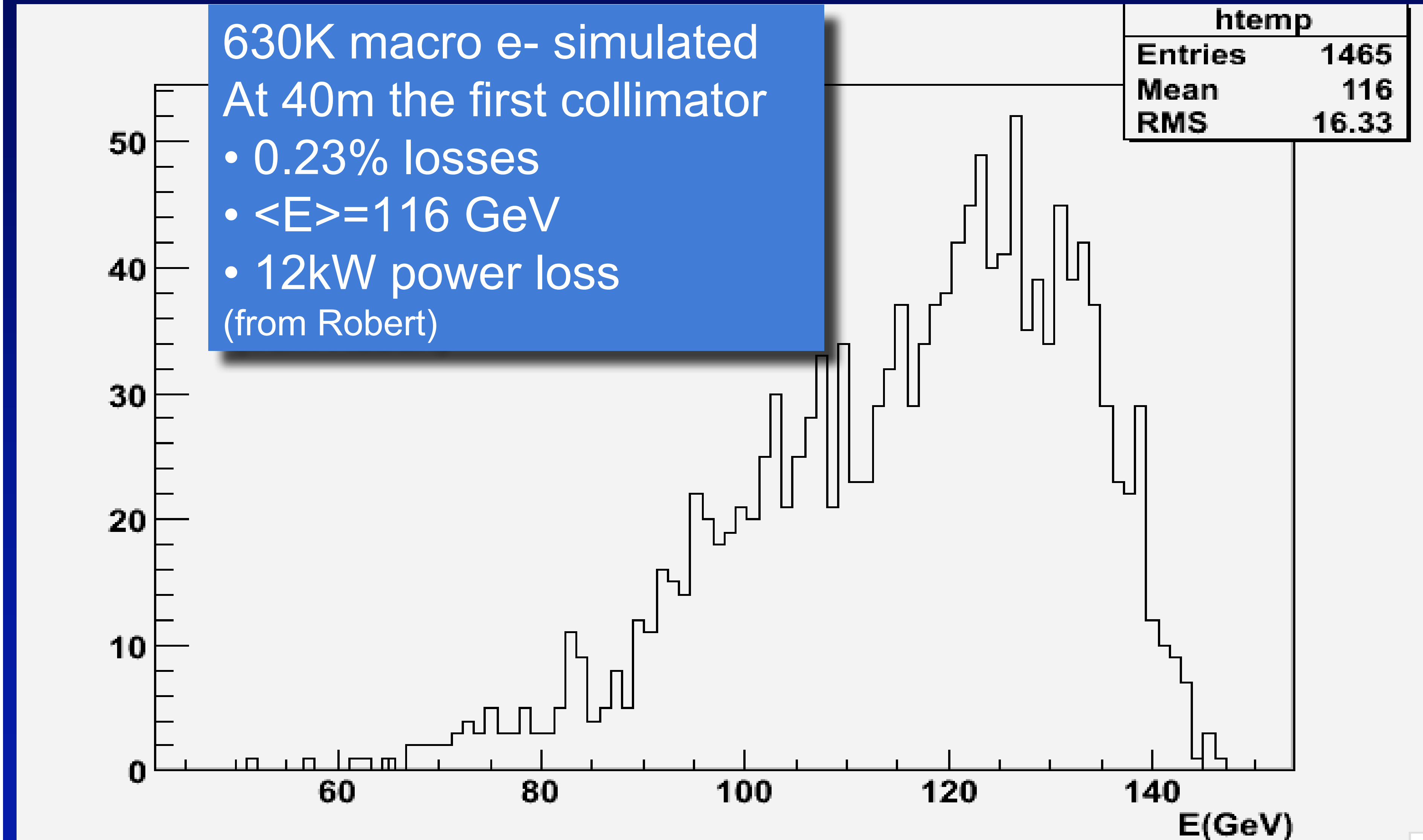
  1718 IP/BX for Tungsten
- Those must be compare to 700 γs from pairs in Si Tracker
- All the simulation was relatively fast due to the low energies of the SR
  (50 Jobs with 10K photons for each simulation took ~1/2 day on Grid)
- We expected a lot of CPU time calculation for the disrupted beam losses (~100 GeV energy)
- Fortunately the statistic is not problematic due the cosθ distribution analysis

Backscattered photons from disrupted beam loss

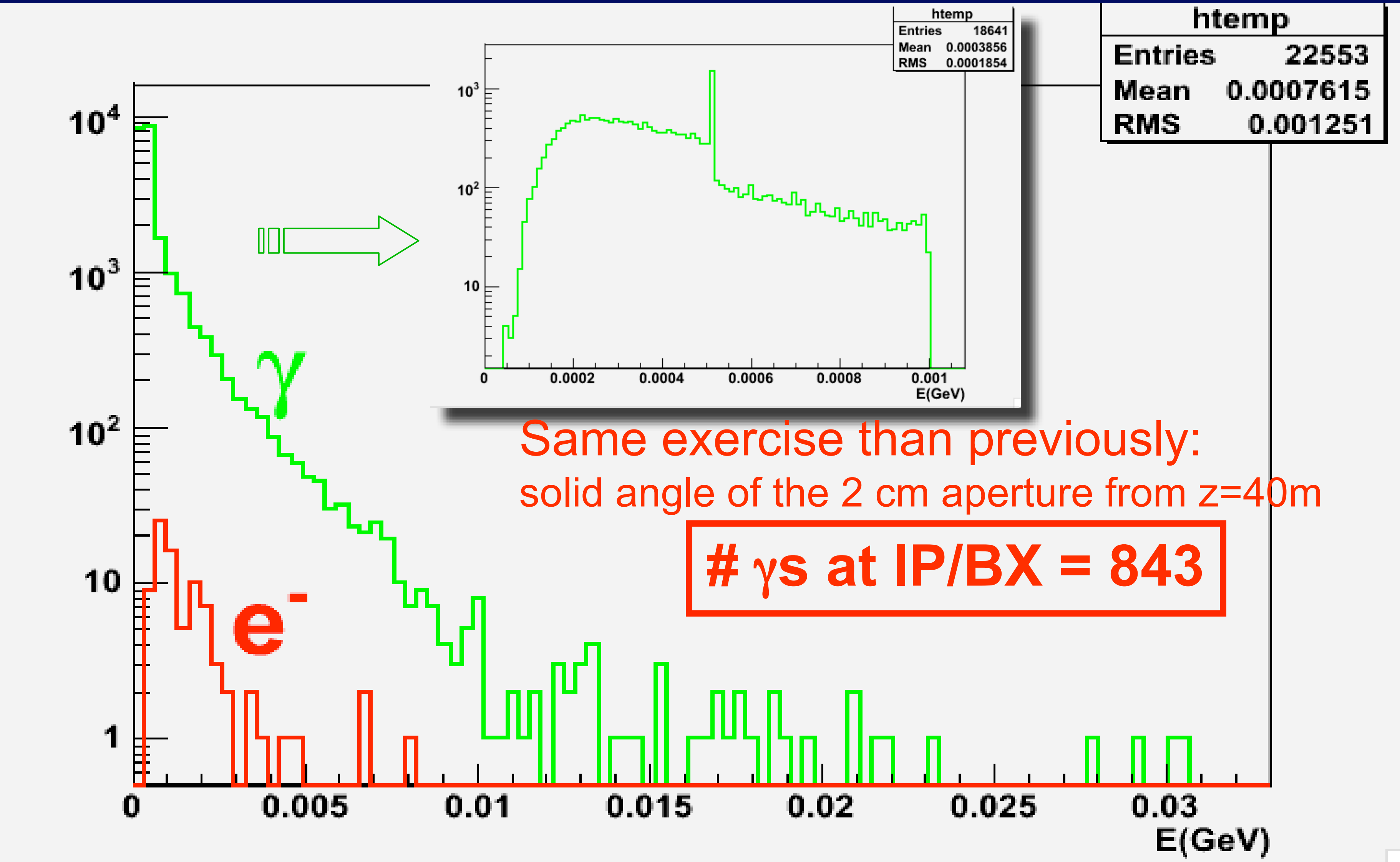
Energy distribution of the 2mrad disrupted beam losses at the first collimator

630K macro e- simulated
At 40m the first collimator
- 0.23% losses
- <E>=116 GeV
- 12kW power loss

(from Robert)



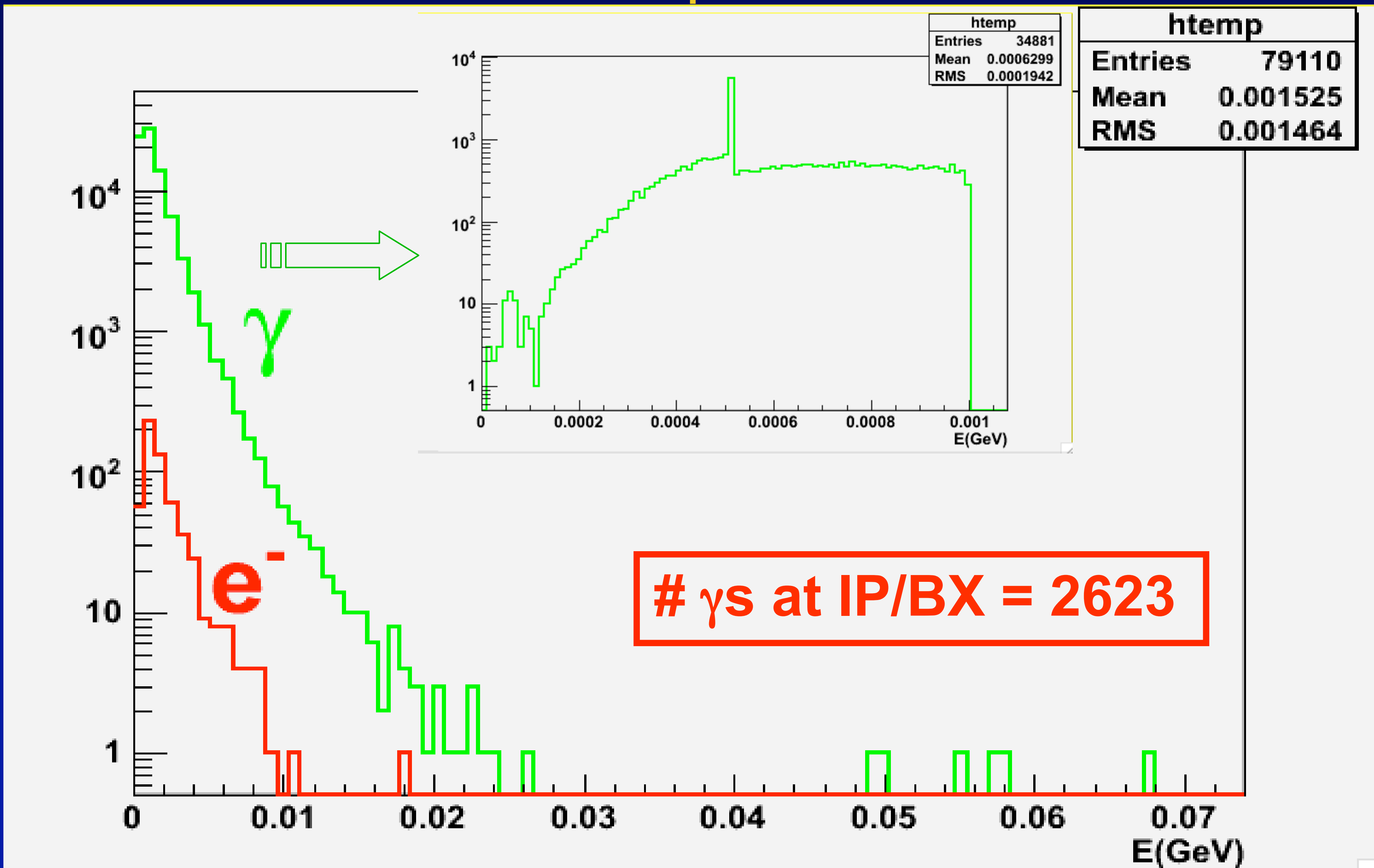
Cu material: backscattered photons energy from disrupted beam



Same exercise than previously:
solid angle of the 2 cm aperture from z=40m

 # γs at IP/BX = 843

W material: backscattered photons energy from disrupted beam



Conclusion & prospects

- The studies off SR losses show use that difference #γs at IP/BX for Tungsten and Cupper is not so important contrary to the disrupted beam loss

  For SR
  - the Compton scattering is independent of Z
  - in Tungsten more pairs creations but photoelectric effect is important, equilibrium between both effect

Future:

- Give the BDSIM output to Mokka simulation to have a really the number of hits those photons generates
- Study the backscattered photons from the dump