M.D.I. & Backgrounds (mainly)

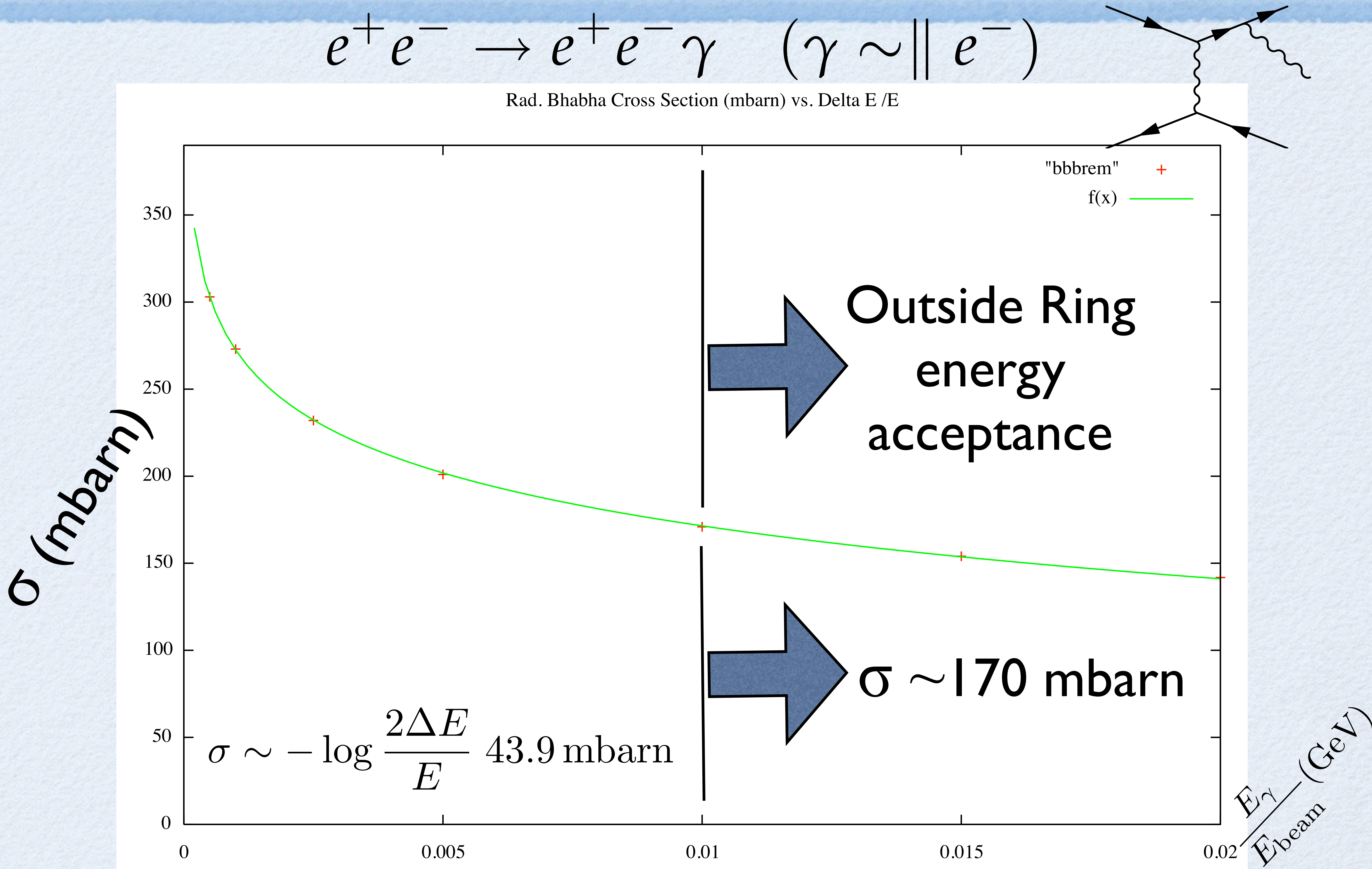
E.P.

Talk outline

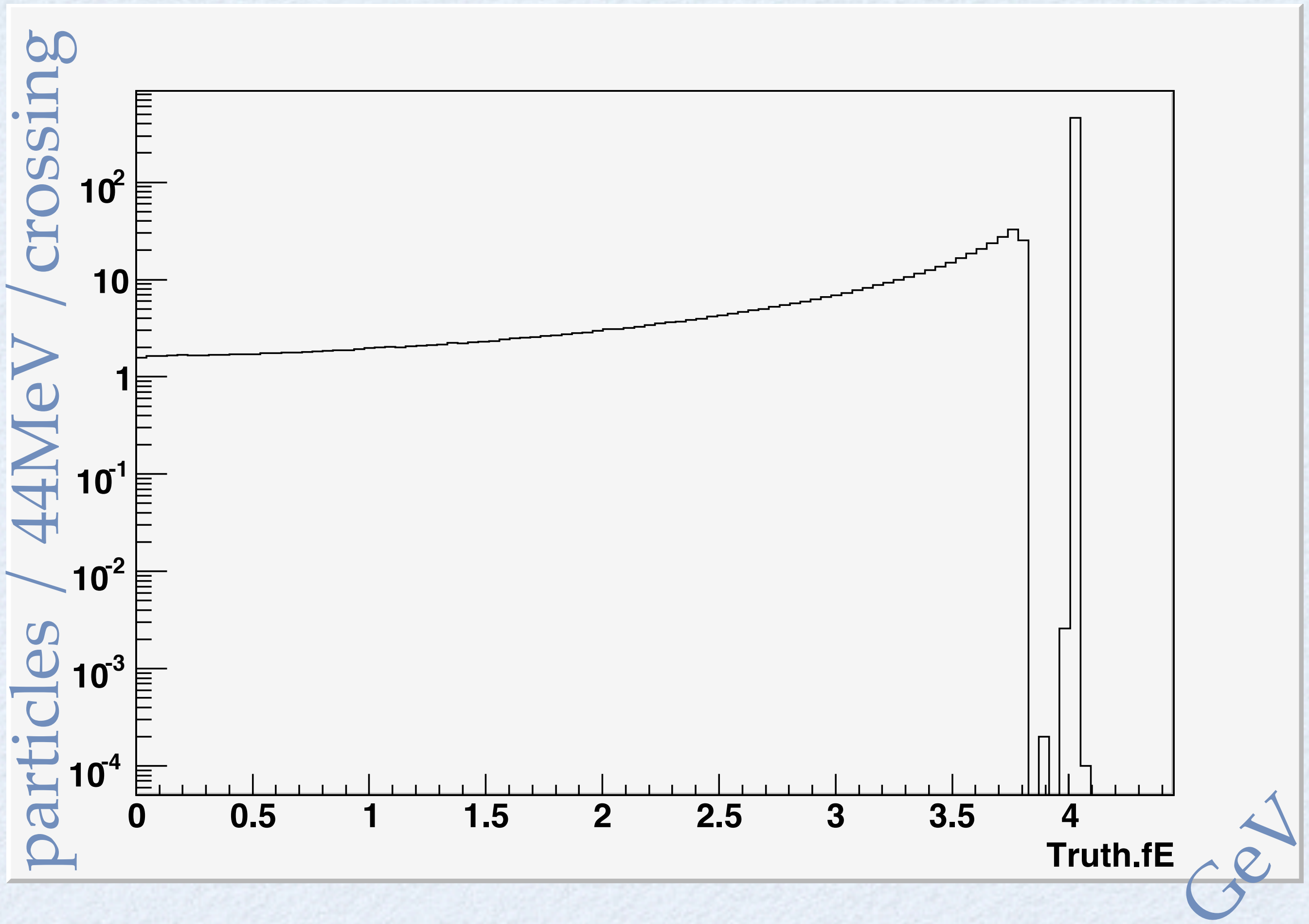
- Big Monte Carlo Production: 0.8 million bunch crossings
    - Two beam line options
        - shielded
        - naked
- Results

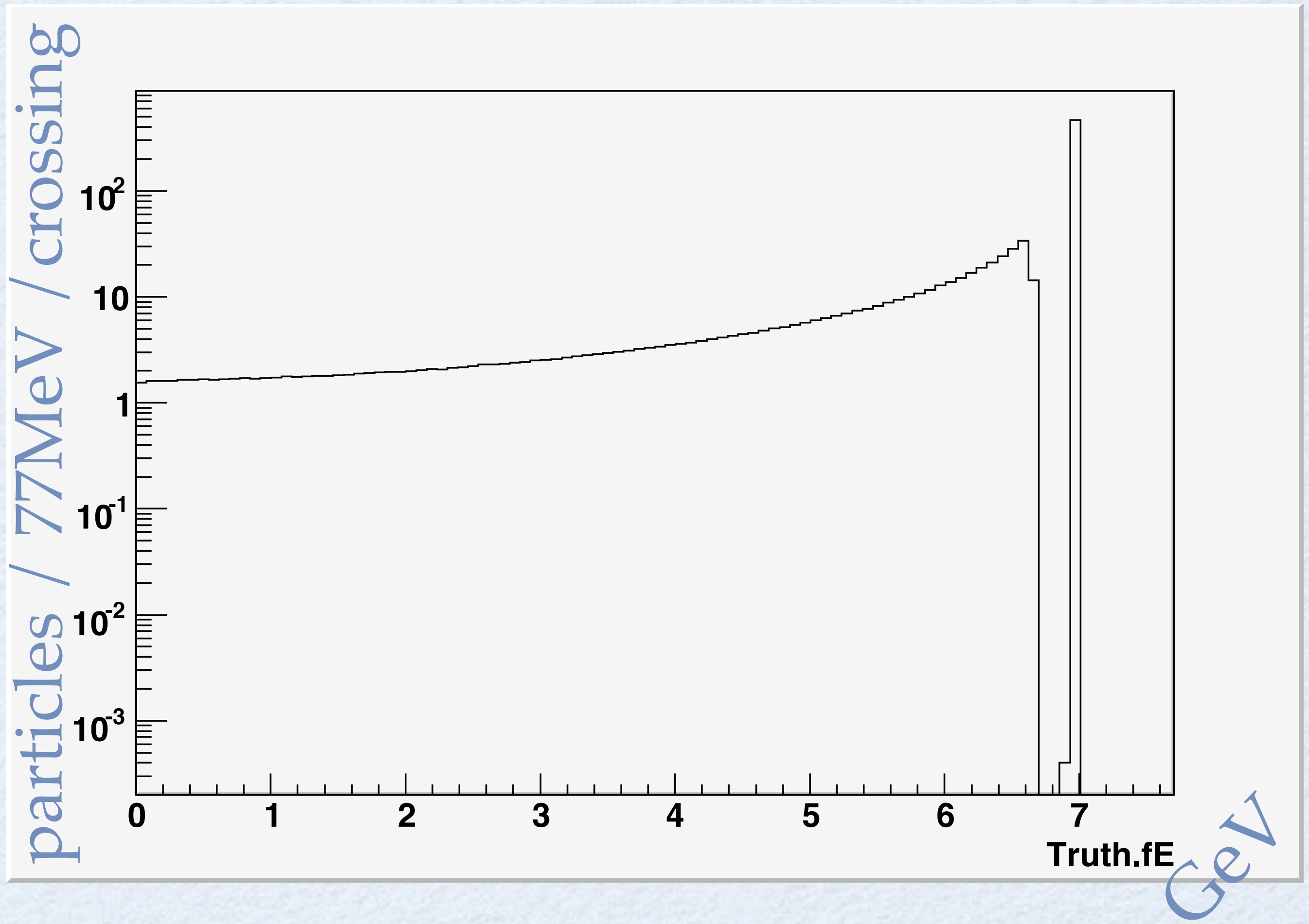
Monte Carlo Production

$$e^+e^- \rightarrow e^+e^-\gamma \quad (\gamma \sim\parallel e^-)$$



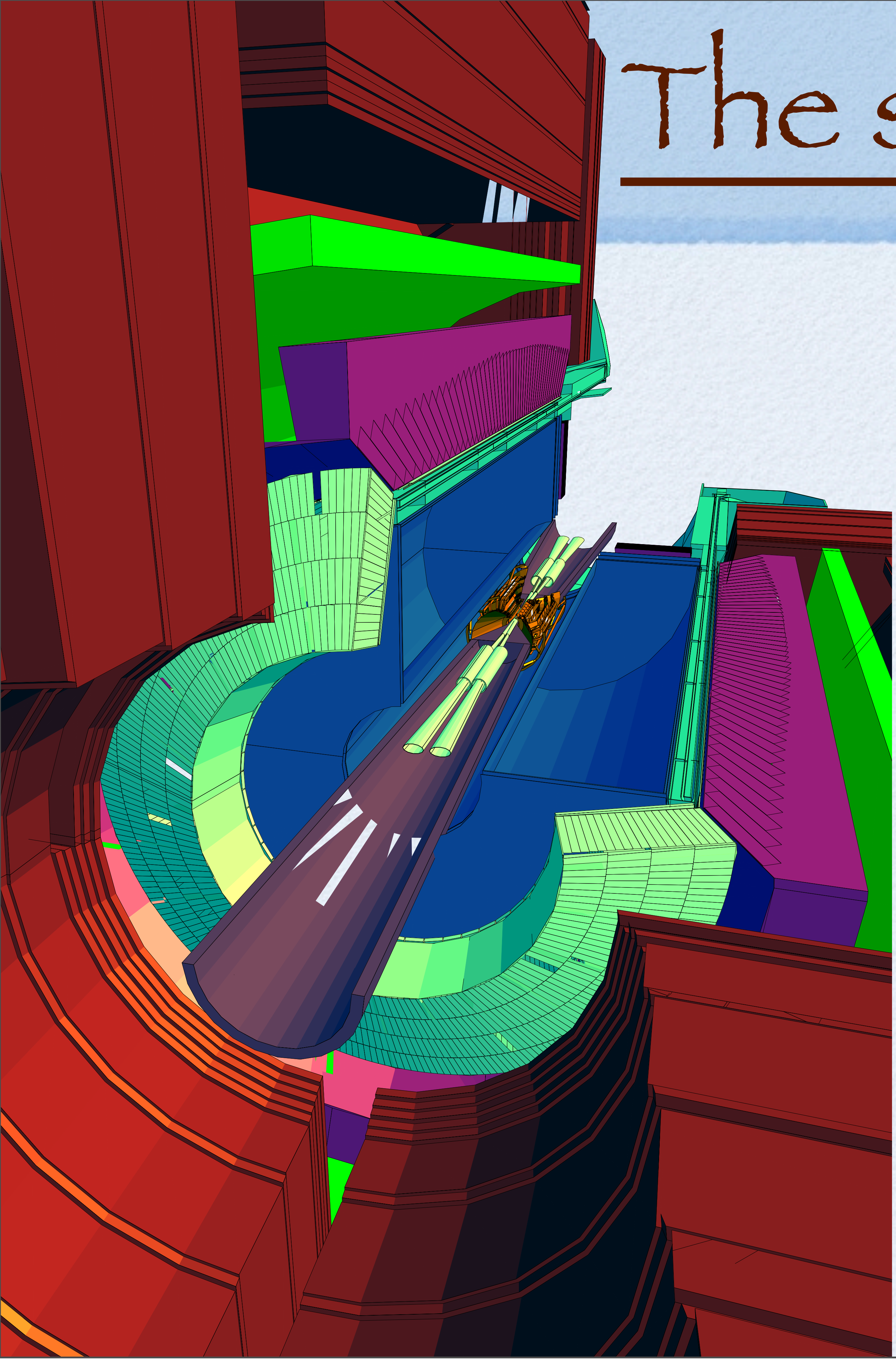
A look at the far tails





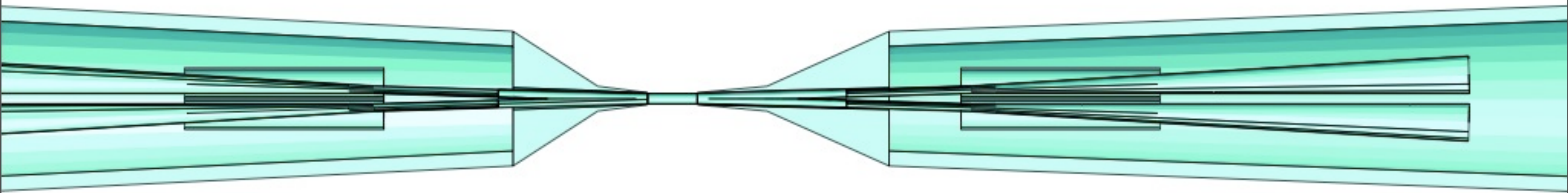
- Cross sections predicted by BBBrem very slowly decreasing with energy loss

The simulated model



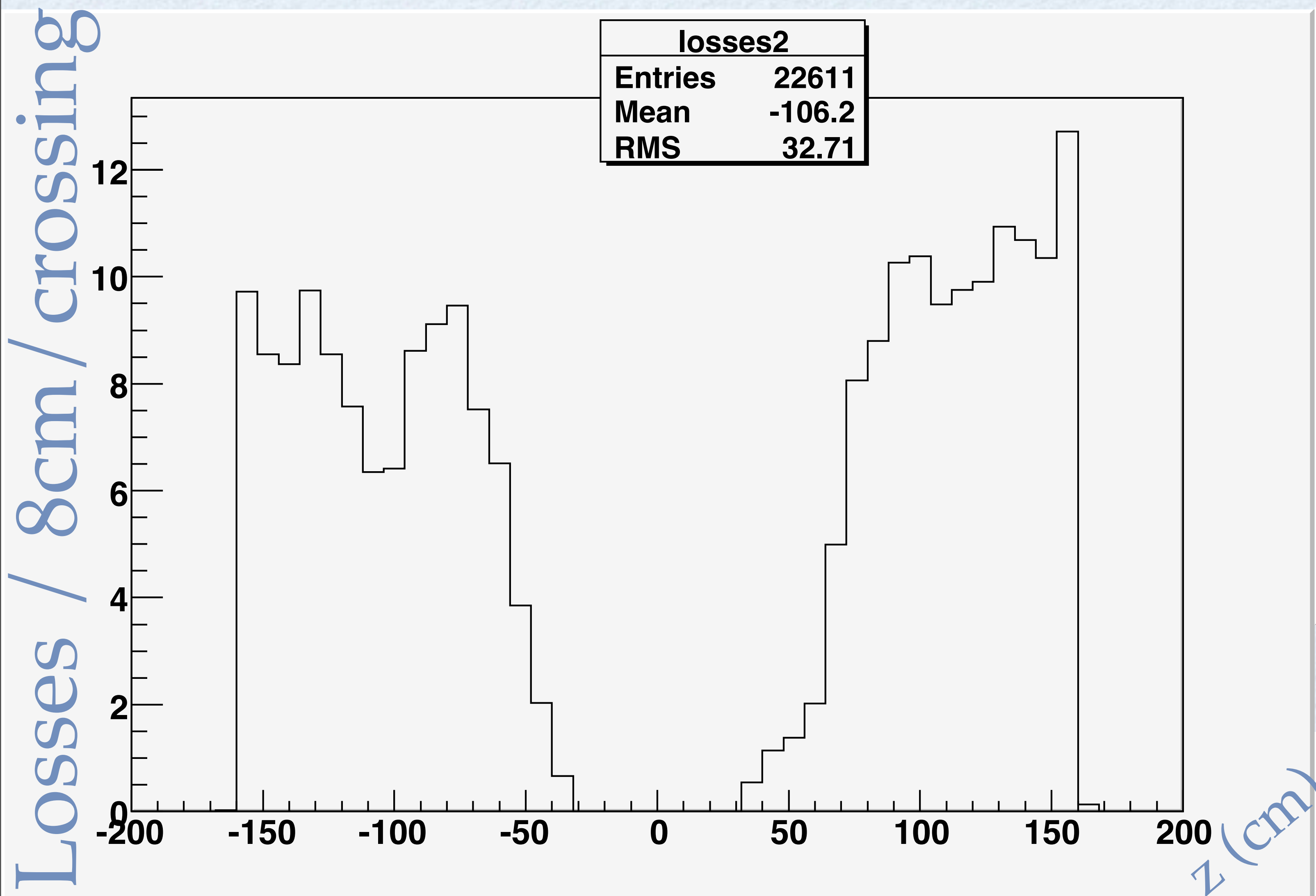
- P3 IR design
- Shields / naked beam line
- Wolfram shields 3cm thick

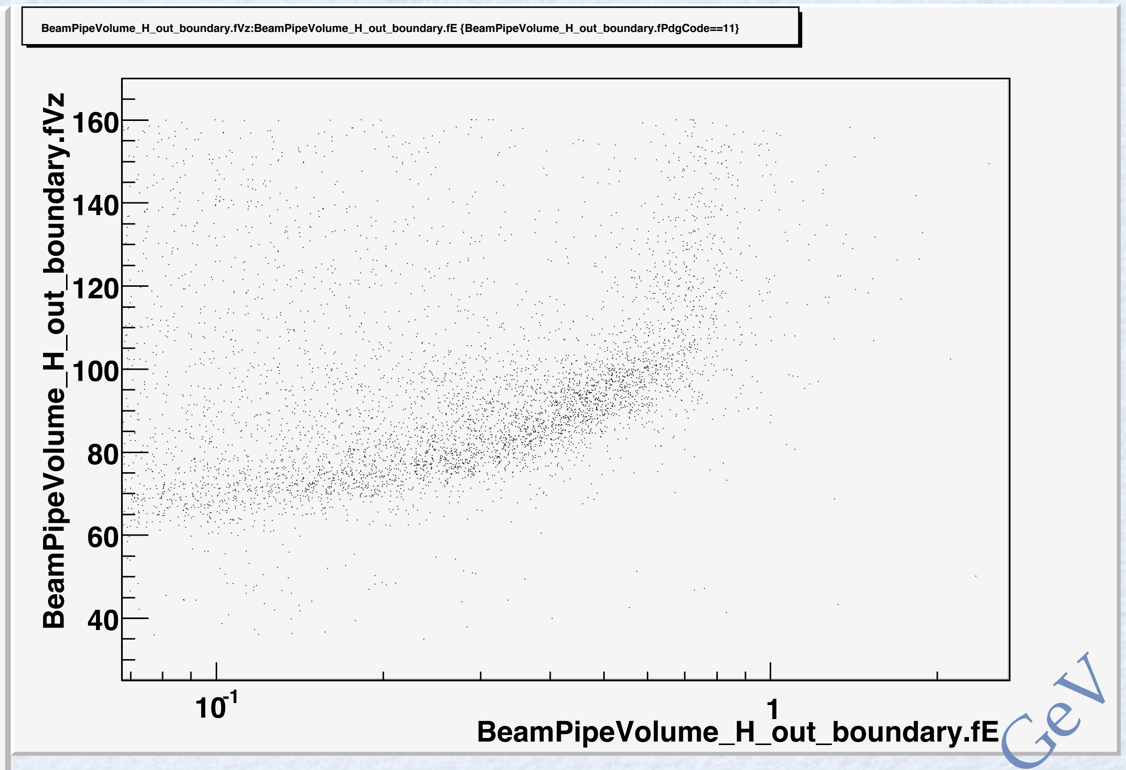
Beam line model

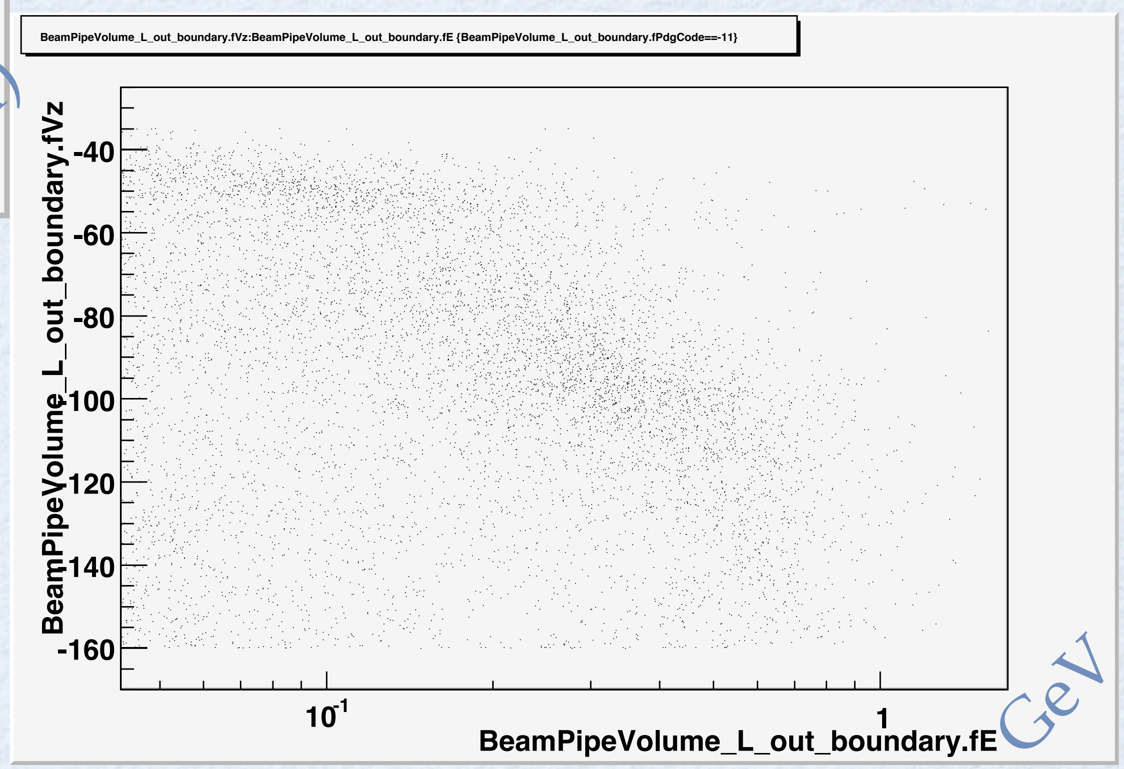


- Mike P4 model. Her @ 7 GeV, s @ 10.58 GeV
- Magnetic model: PMs, QD0, QF1
- Material model: shields (3cm thick), 1mm thick stainless steel beam pipe, QD0 coils
- Solenoid compensation not modeled (no detector solenoidal field in the machine volume)
- If is not written here, it is not simulated.

Rad Bhabha losses @ IP







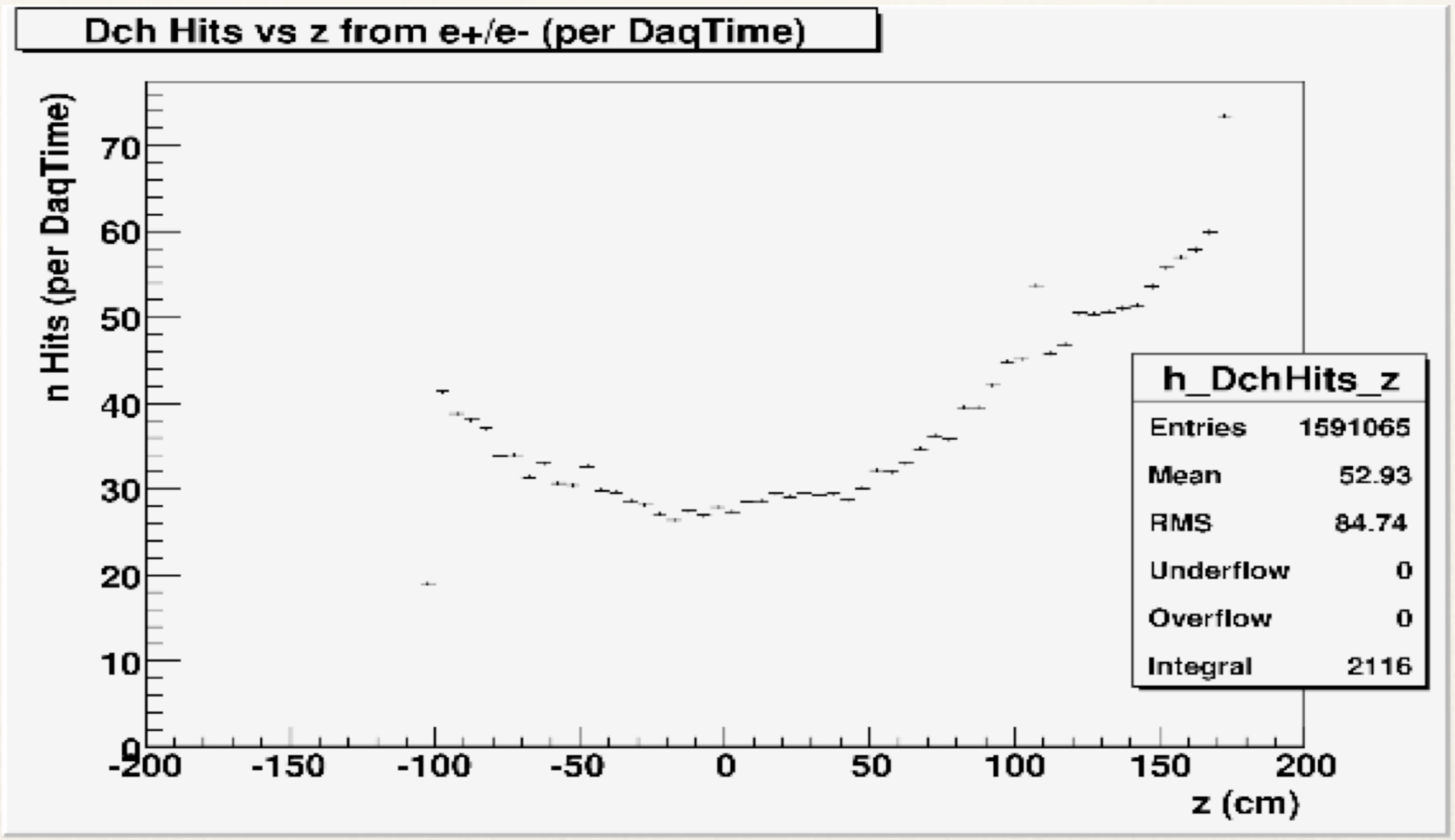
- Particles lost (e^+ e^-) downstream the IP

DCH

- Unshielded (more a test than a real option)
  - Occupancy up to 31.4±1.4%, really not feasible

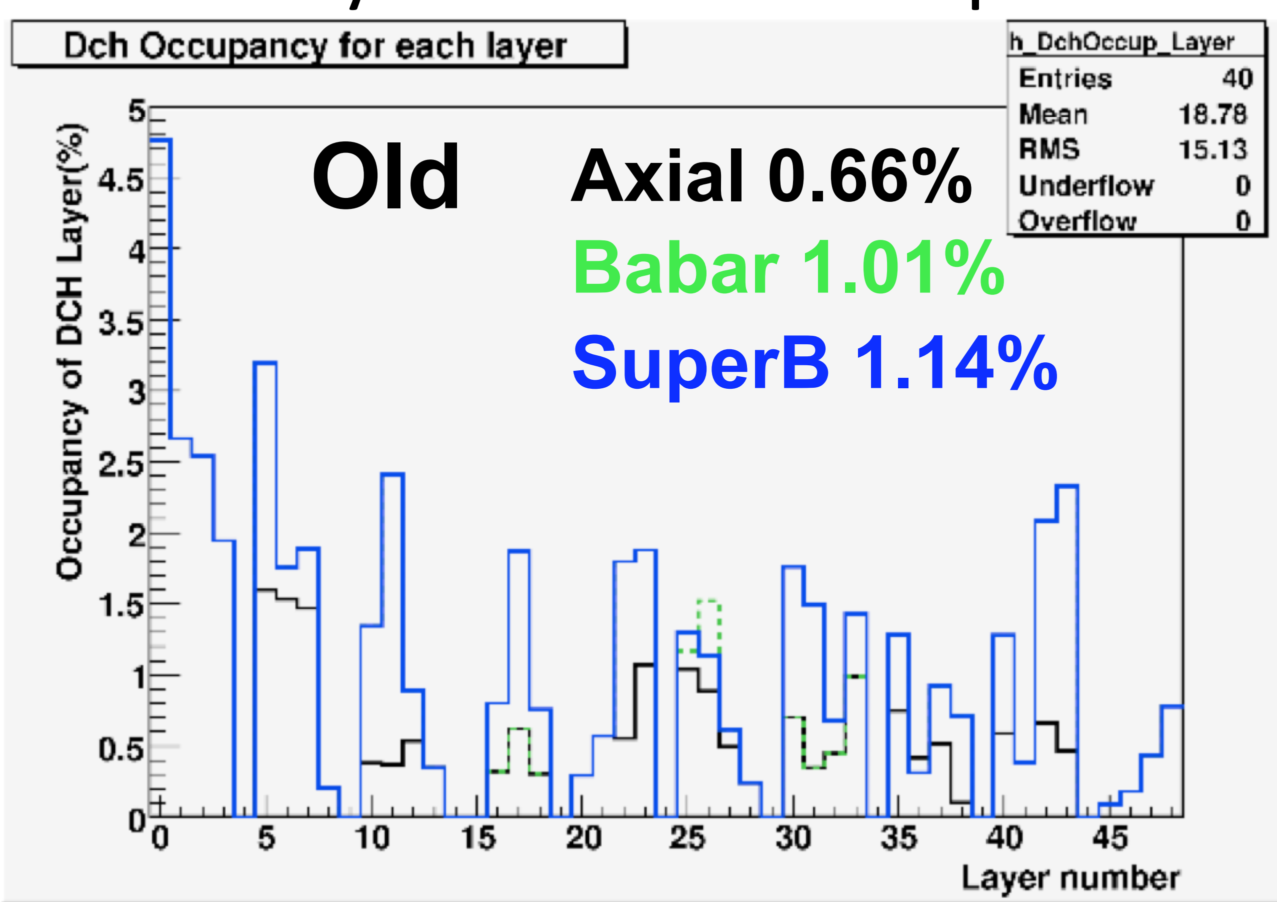
Hits distribution (z coordinate)

- Note: those are Geant4 hits
- Z distribution confirms that most part of the hits is coming from the endplates

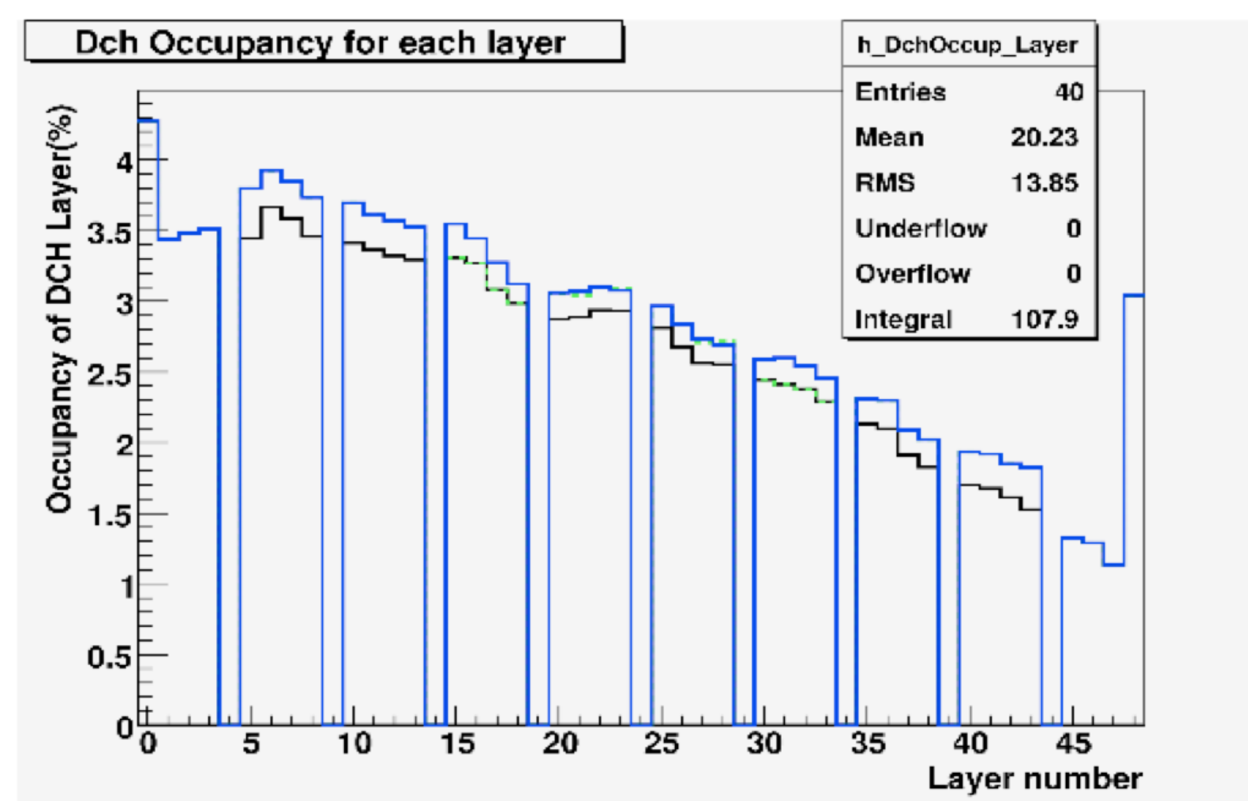


Occupancy

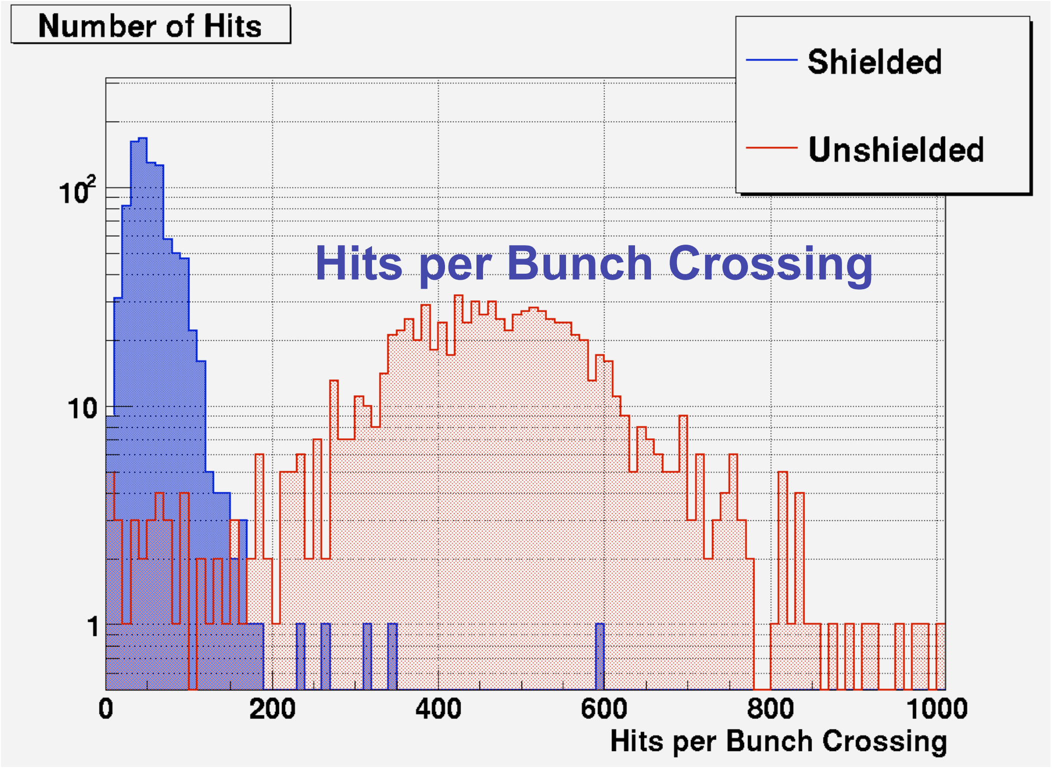
- Higher stat, total occupancy: **2.5%** with RMS ~0.6%
- New results not exactly compatible with old ones
- Again stereo layers does not make so much difference for bkg, less than 0.5%
  - Maybe related to step size issue

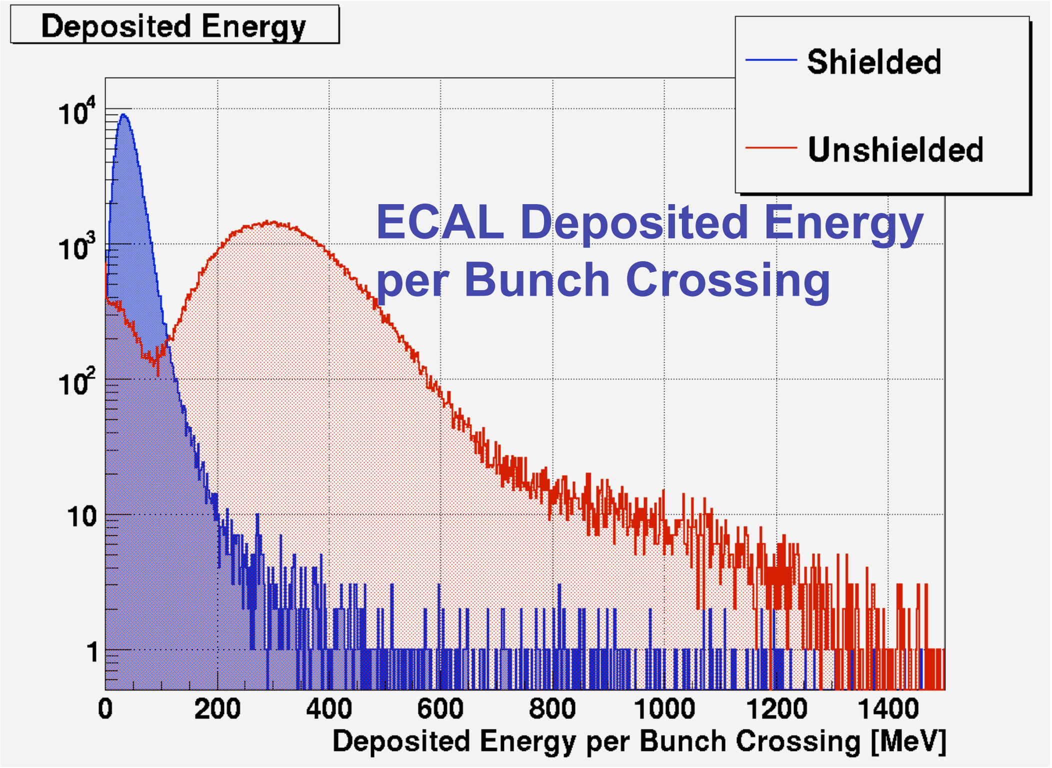


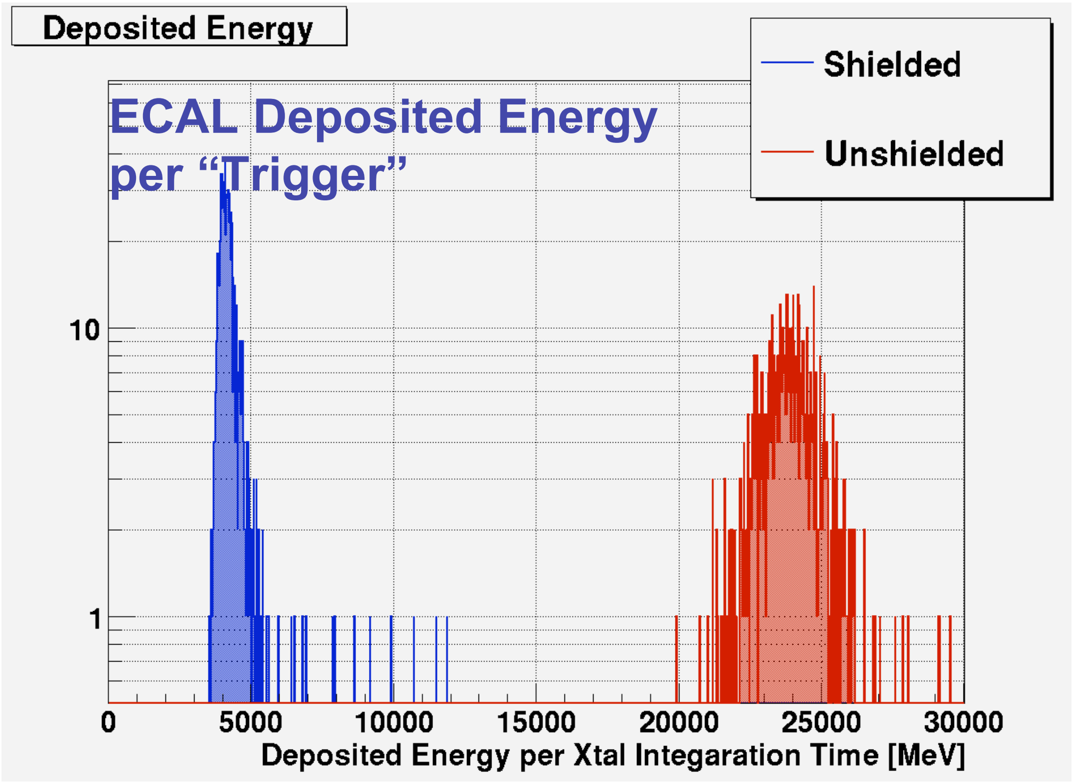
Axial 2.48%
Babar 2.60%
SuperB 2.64%

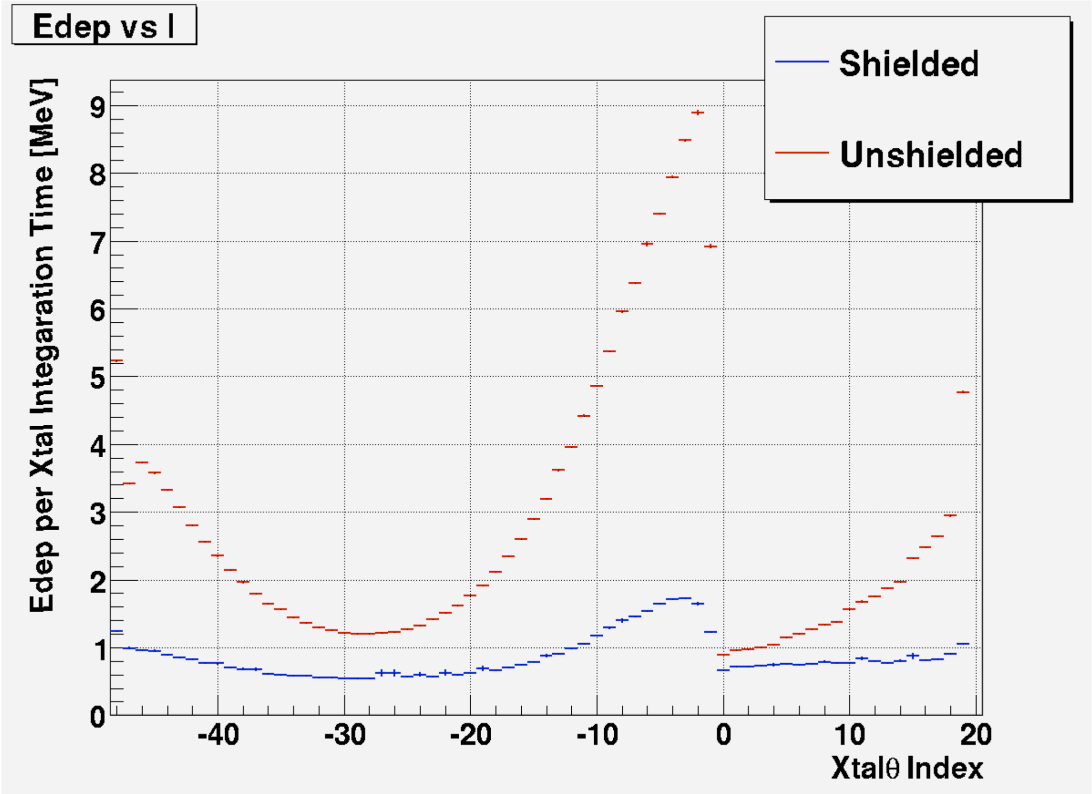


Shielded - Unshielded

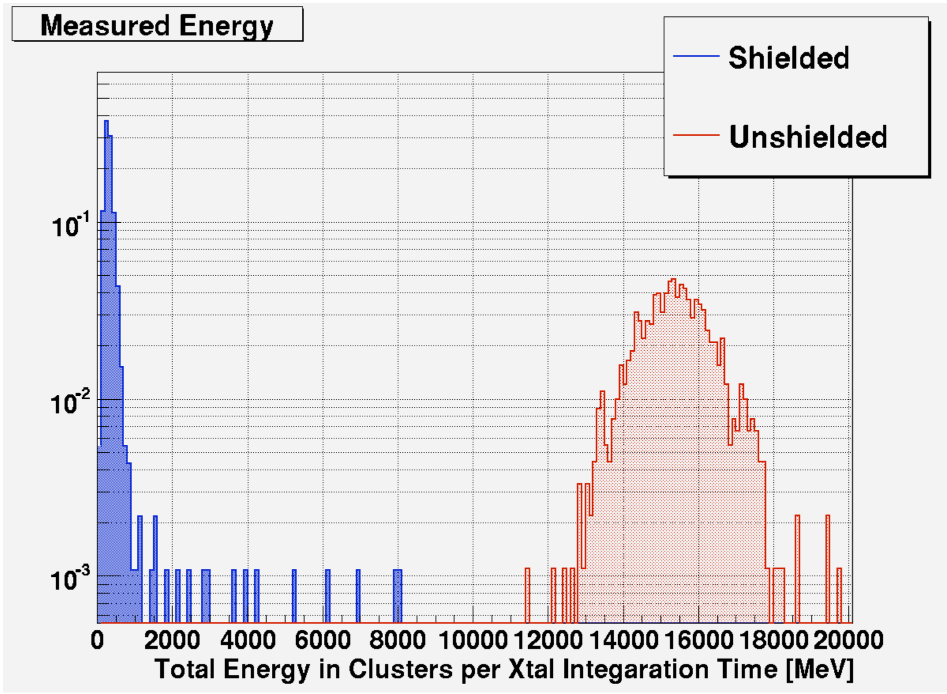


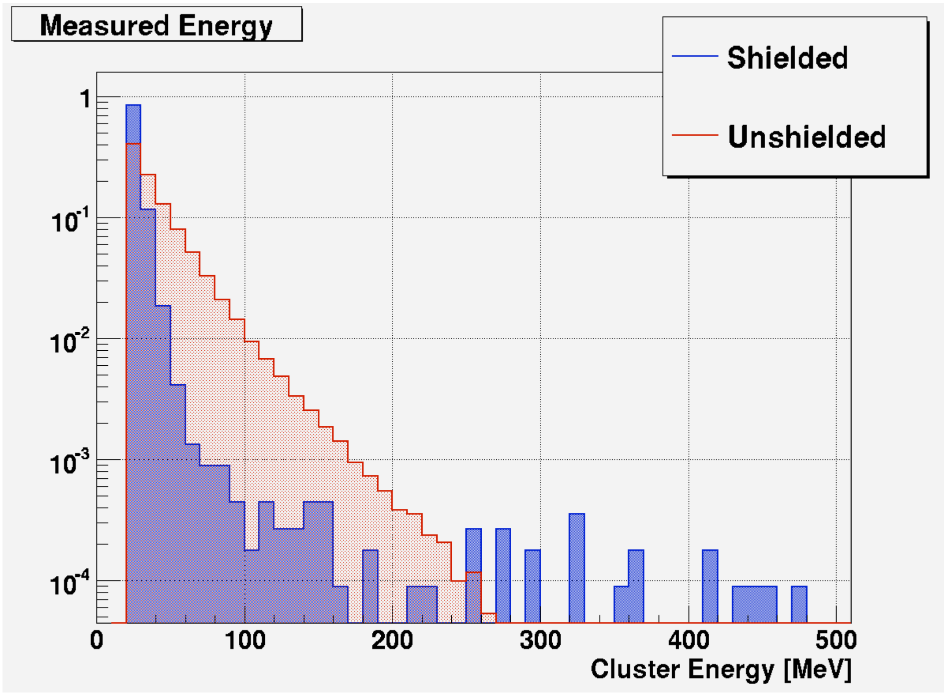


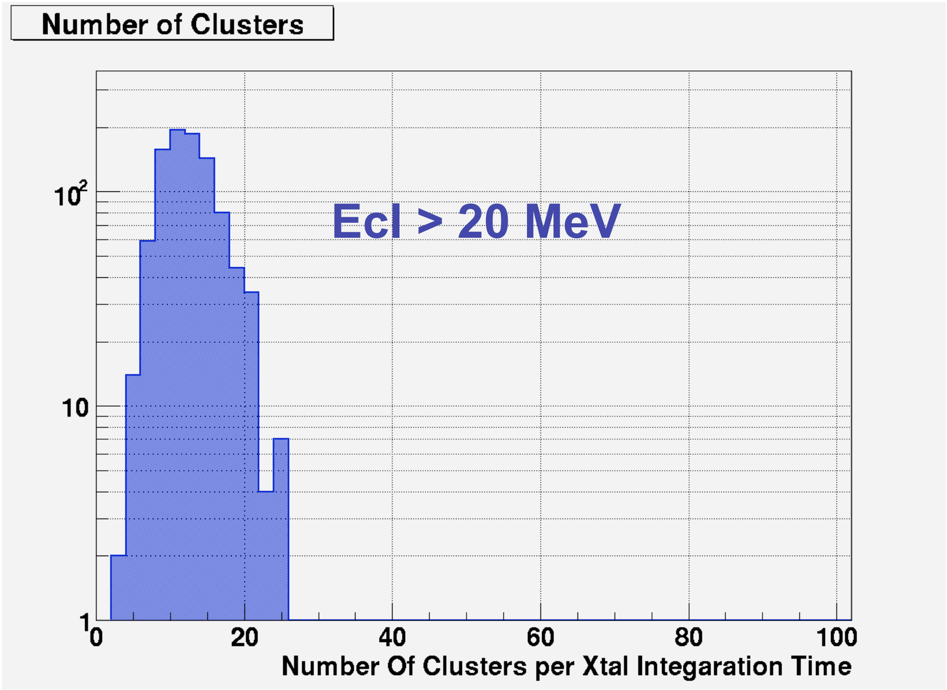


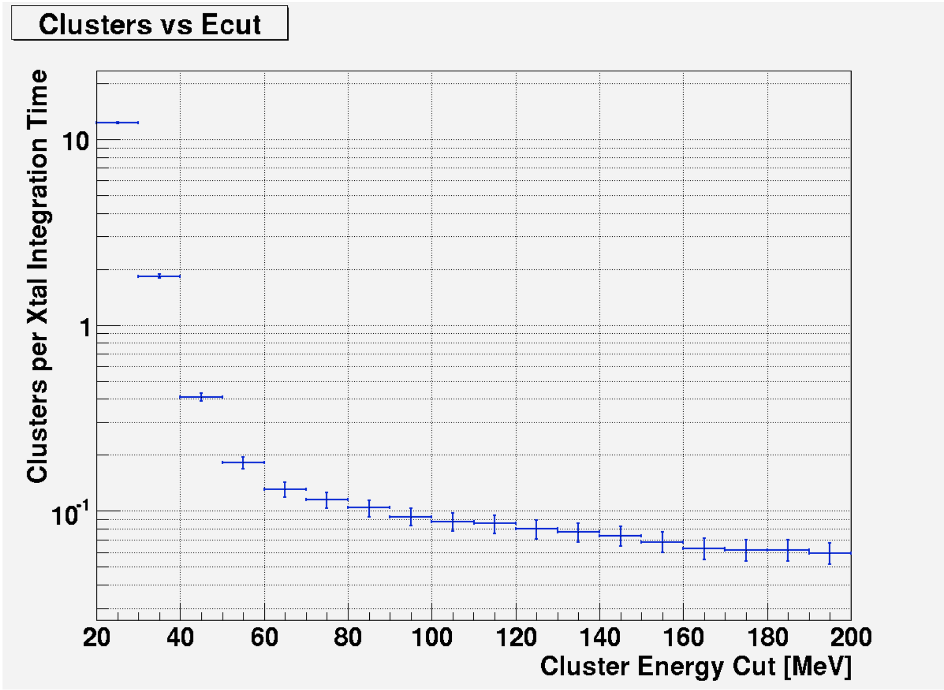


Clusters


Measured Energy
Shielded
Unshielded
Total Energy in Clusters per Xtal Integaration Time [MeV]


Measured Energy
Shielded
Unshielded
Cluster Energy [MeV]


Number of Clusters
Ecl > 20 MeV
Number Of Clusters per Xtal Integaration Time


Clusters vs Ecut
Clusters per Xtal Integration Time
Cluster Energy Cut [MeV]

Neutron damage on silicon devices

The silicon damage function has a strong dependance on the energy spectrum therefore to obtain useful rate estimation we need to scale the doses to 1MeV equivalent accordingly to ASTM E 722 - 93.

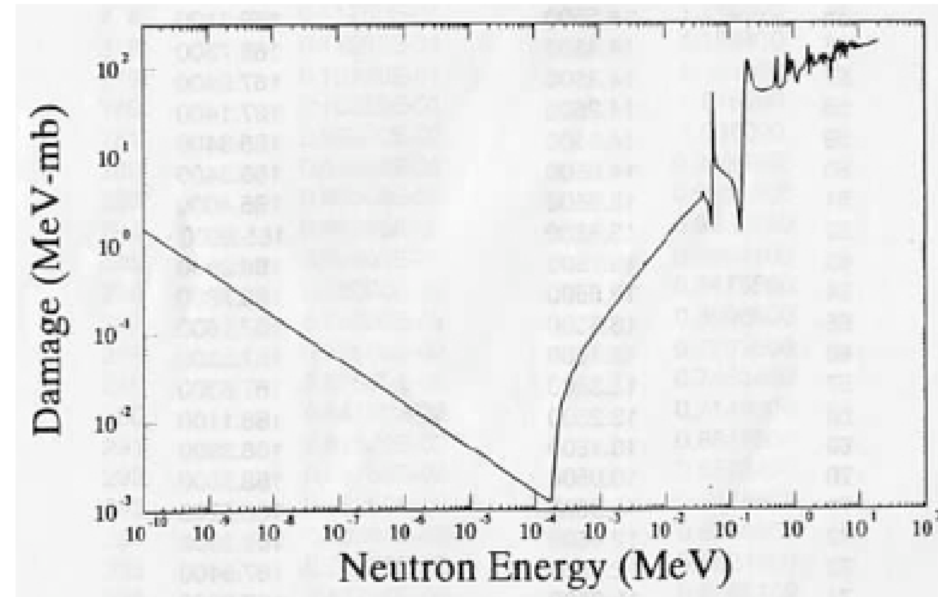
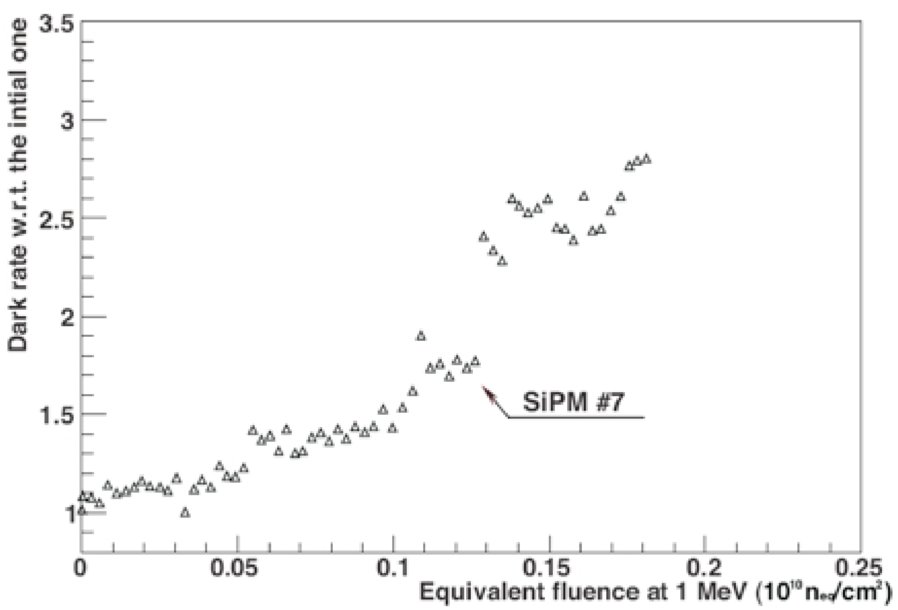


FIG. A1.1 Silicon Damage Function



5. Conclusion

Several Silicon Photo-Multipliers have been exposed to an intense neutron flux integrating up to a total fluence of $7.32\times10^{10}n_{eq}/cm^2$. Their performance were for the first time studied before, during and after the irradiation thanks to the use of a controlled neutron source (the ENEA FNG). The drawn currents were found to increase up to a factor 30 while the dark counts up to 300. The detection efficiency measured with cosmic rays, drop from above 95% to around 75%. From the measurements shown we conclude that Silicon Photo-Multipliers performance would start deteriorating after an irradiation of few $10^8 n_{eq}/cm^2$. A dedicated experiment at so low rates is being planned in order to better quantify the break-down fluence.

From arXiv:1002.3480v1

- "New Snowmass Year" having $1.5\cdot10^7$ seconds.
- BaBar simulation was 10 times below the measurement: at least a factor 10 of safety factor is likely to be taken into account

Different configurations

The shielding is very powerful for electrons and photons but is also a good neutron generators

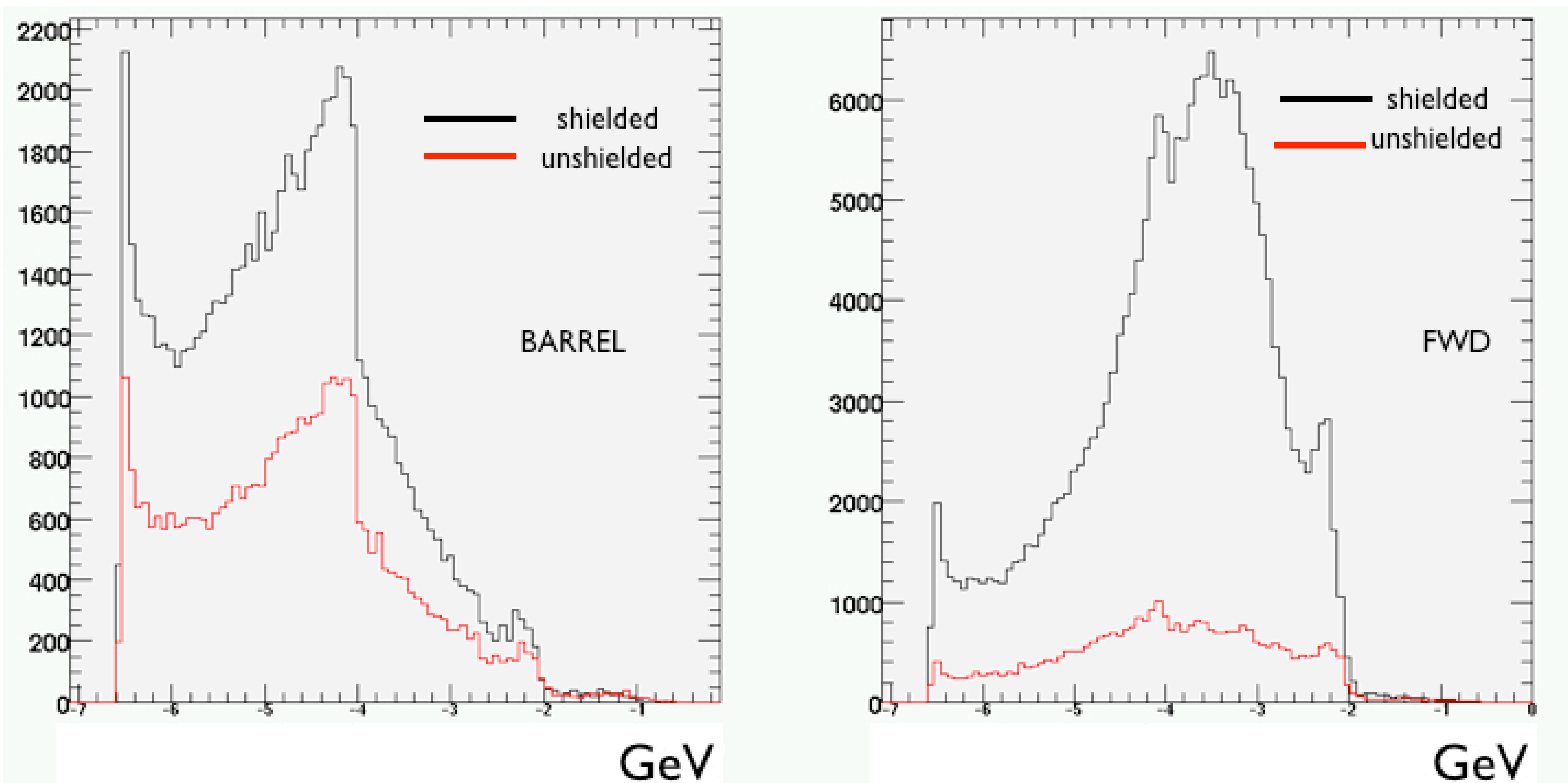


Figure: Energy distribution of neutron crossing the barrel and forward endcap boundary with log-scale

Different configurations I

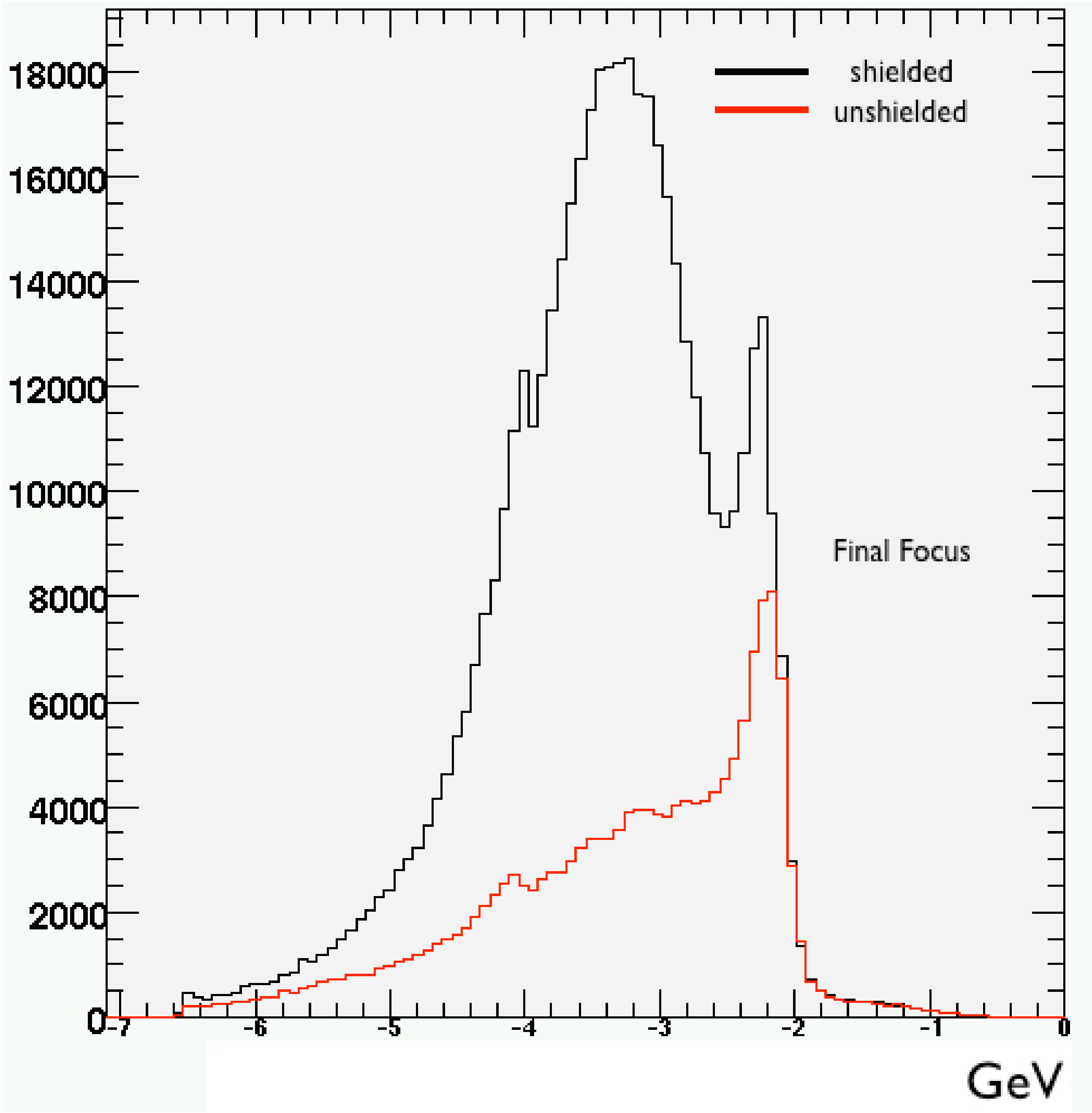
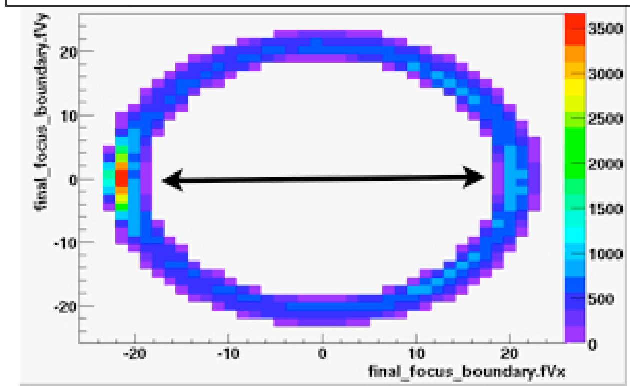


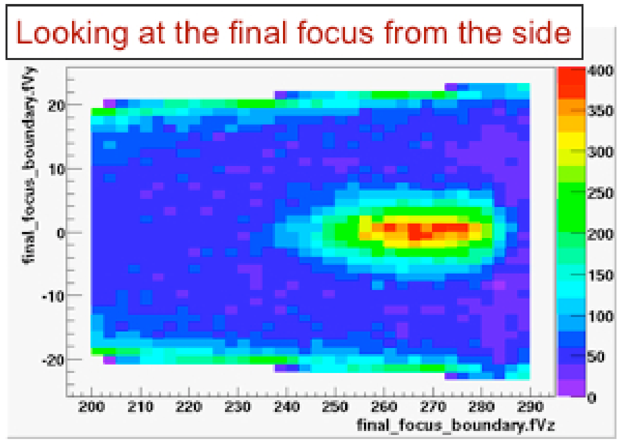
Figure: Energy distribution of neutron crossing the final focus boundary with log-scale

Hot Spot

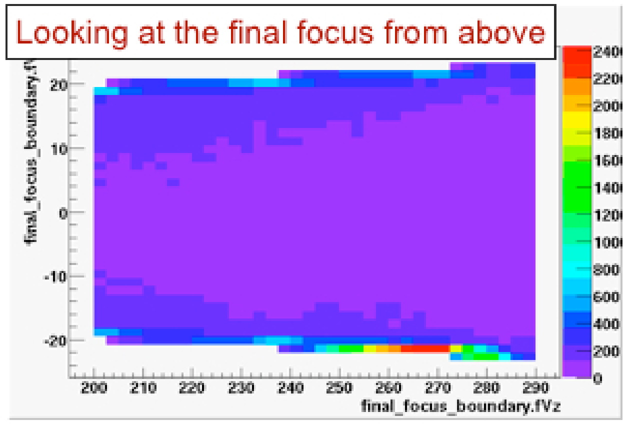
Looking at the final focus from the FWD side



Looking at the final focus from the side



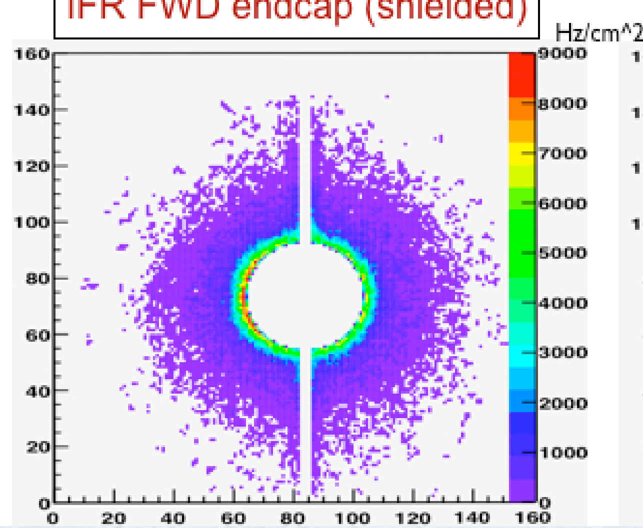
Looking at the final focus from above



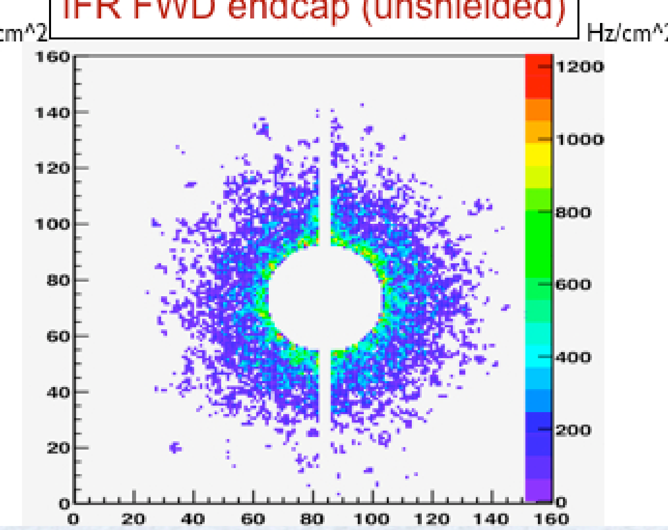
- The hot spot is visible in all the projections of the final focus (3 left plots).
- The rate of the hot spot is of the order of $100kHz/cm^2$, more than six times higher than the same region on the opposite side as denoted by the black arrow on the upper-left plot.
- There is a similar spot (wider along the beam pipe direction) about 1.5 m backward from the IP.
- The effect of this source is visible also on the inner ring of the IFR forward endcap (bottom center plot): the left half has higher rate.
- It seems to be an effect of the Wolf-Shield since such effect disappears in the unshielded production (bottom right).
- B.t.w. the maximum neutron rate on the IFR endcap inner ring with the shielding is almost one order of magnitude higher wrt the non-shielded configuration.
- The energy distributions are pretty much consistent to the ones showed before.

- Anyway the neutron rate produced by the spot doesn't drive the total final focus rate.

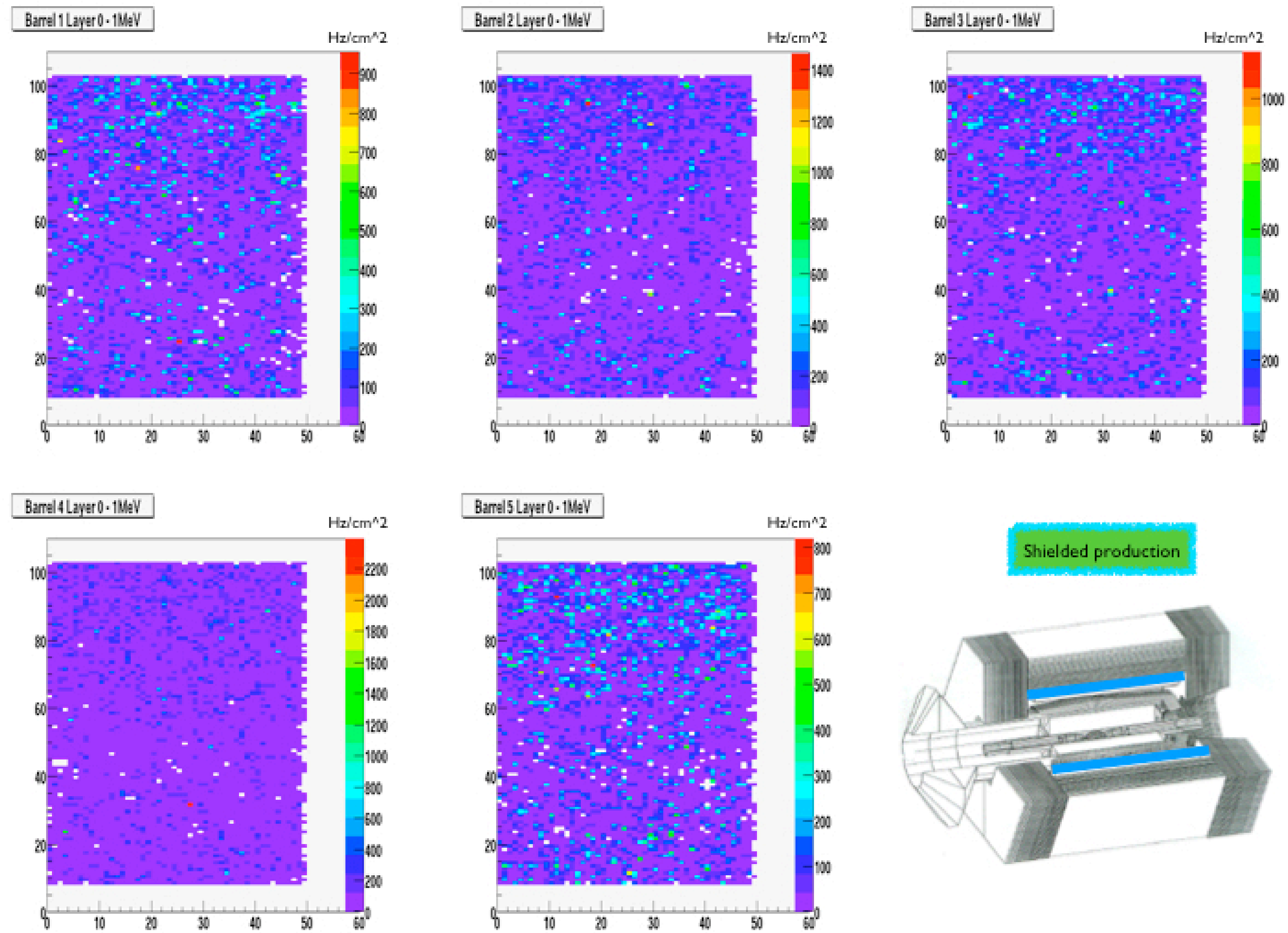
IFR FWD endcap (shielded)



IFR FWD endcap (unshielded)



Barrel Layer 0 rate Normalized to 1MeV energy



- From this data it appears that neutron rate on the inner layers of the barrel is more than one order of magnitude above the tolerable threshold for the SiPMs without considering any safety factor.

Conclusions

- 3cm thick tungsten seems the minimum thickness needed for rad Bhabha shielding
- I will feel more confortable allocating 6 cm for shields
- Neutrons moderation absorption must be cured (extra space around the beam line for polyethilene)