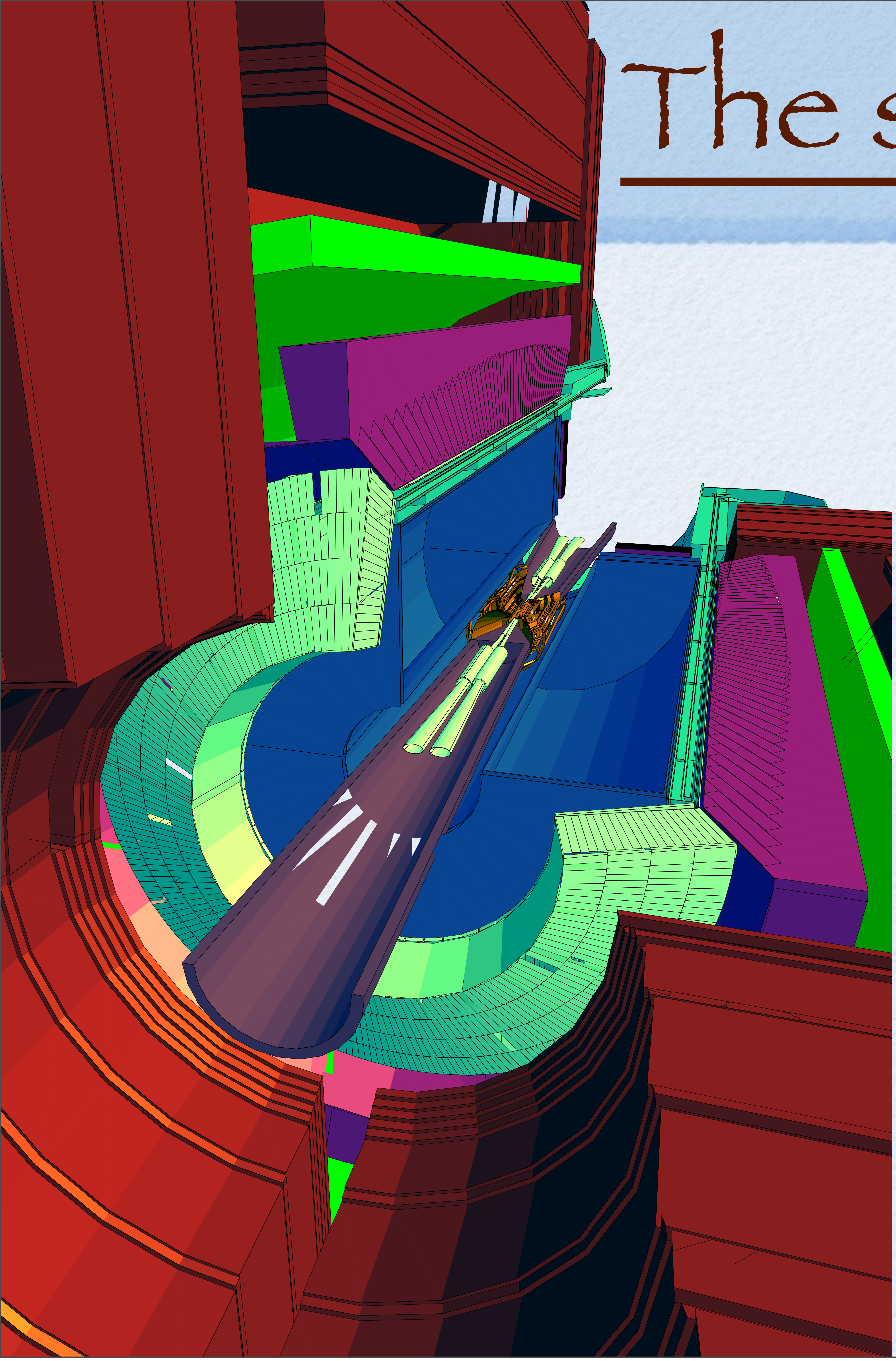
M.D.I. & Backgrounds (fews on MDI)

E.P.

Talk outline

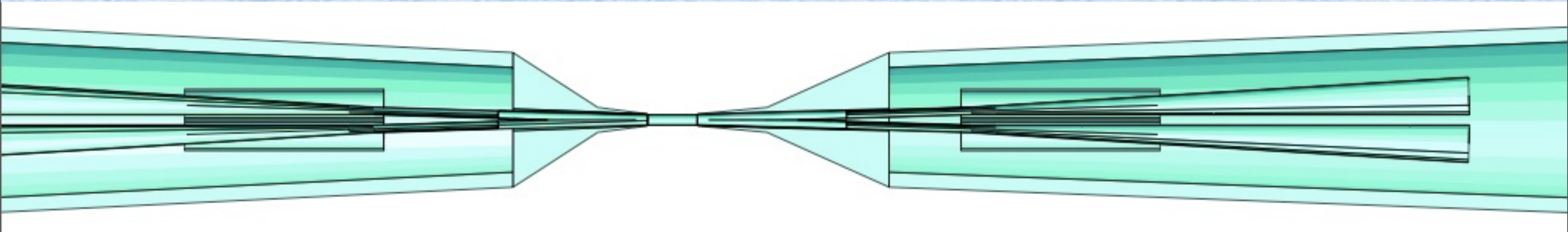
- Big Monte Carlo Production: 0.8 million bunch crossings
- Results
- Cross checks
- Next steps

The simulated model



- P3 IR design
- Shields/naked beam line
- Wolfram shields 3cm thick
- Full fledged Super*B* detector, i.e. **All options in**
- Contributions from:
  Gigi Cibinetto,
  Maur Munerato,
  Giuseppe Finocchiaro,
  Stefano Germani,
  Leonid Burmistrov,
  Doug Roberts,
  Riccardo Cenci,
  Chih-hsiang Cheng

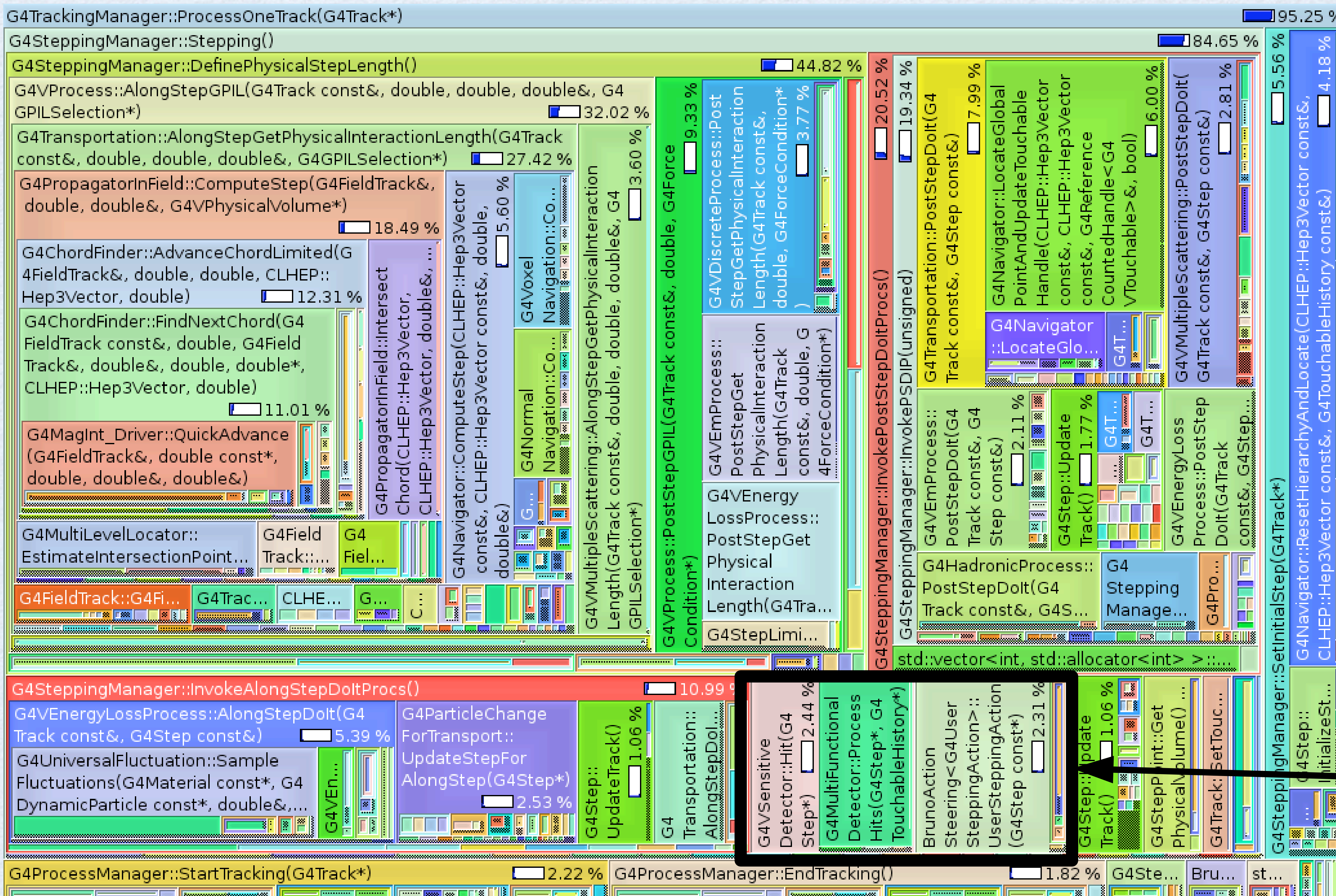
Beam line model



- Mike P4 model. Her @ 7 GeV, s @ (10.58 GeV)^2
- 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, then it is not simulated.

Andrea Di Simone

Bruno: profiling



Hit production, MCTruth processing

20100317 Annecy Andrea Di Simone - INFN Roma Tor Vergata

Bruno: profiling

- Most of the processing time goes into G4 internals (physics, geometry, magnetic field)
- Bruno's overhead is limited to ~5%
  - Basically only hit production and MCTruth recording
  - Remarkable, but to be checked with different events
- This can mean three things
  - We are not adding much to the basic G4 functionality (true)
  - What we are adding, we are adding carefully (*probably* true)
  - The physics part (production cuts) is not optimized yet, i.e. its fraction is somewhat overestimated, i.e. Bruno's impact is underestimated (true)

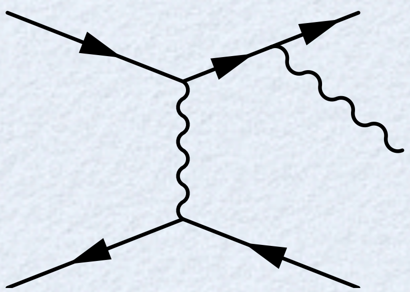
Production

- Web based job management tools developed by Luca Tomassetti and Armando Fella was a piece of cake
- Jobs babies sitting made by Luca and Armando was exquisite

Simulated process

- 3 sets generated with running cut off parameters:

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



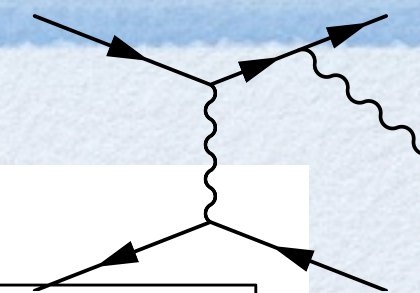
$$\Delta E \equiv \frac{E_\gamma}{E_{beam}} \to 0 \quad (\sigma \to \infty)$$

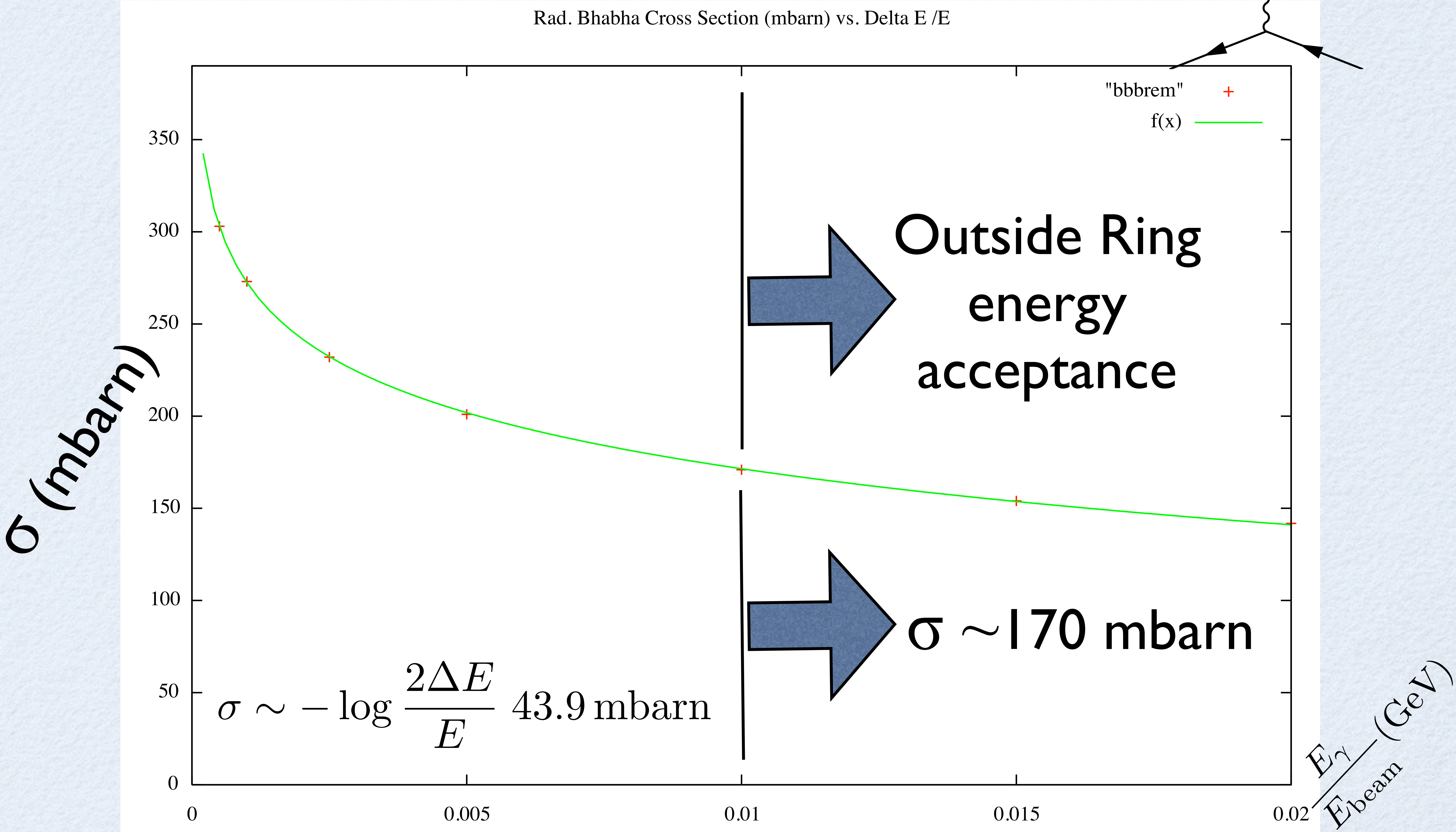
$$\Delta E \in \{10\%, 5\%, 0.2\%\}$$

- Physics is better approximated by smaller Delta E (longer CPU time, as usual)
- 2 Physics lists compared (High Precision neutron, vs. QGSP_BERT)

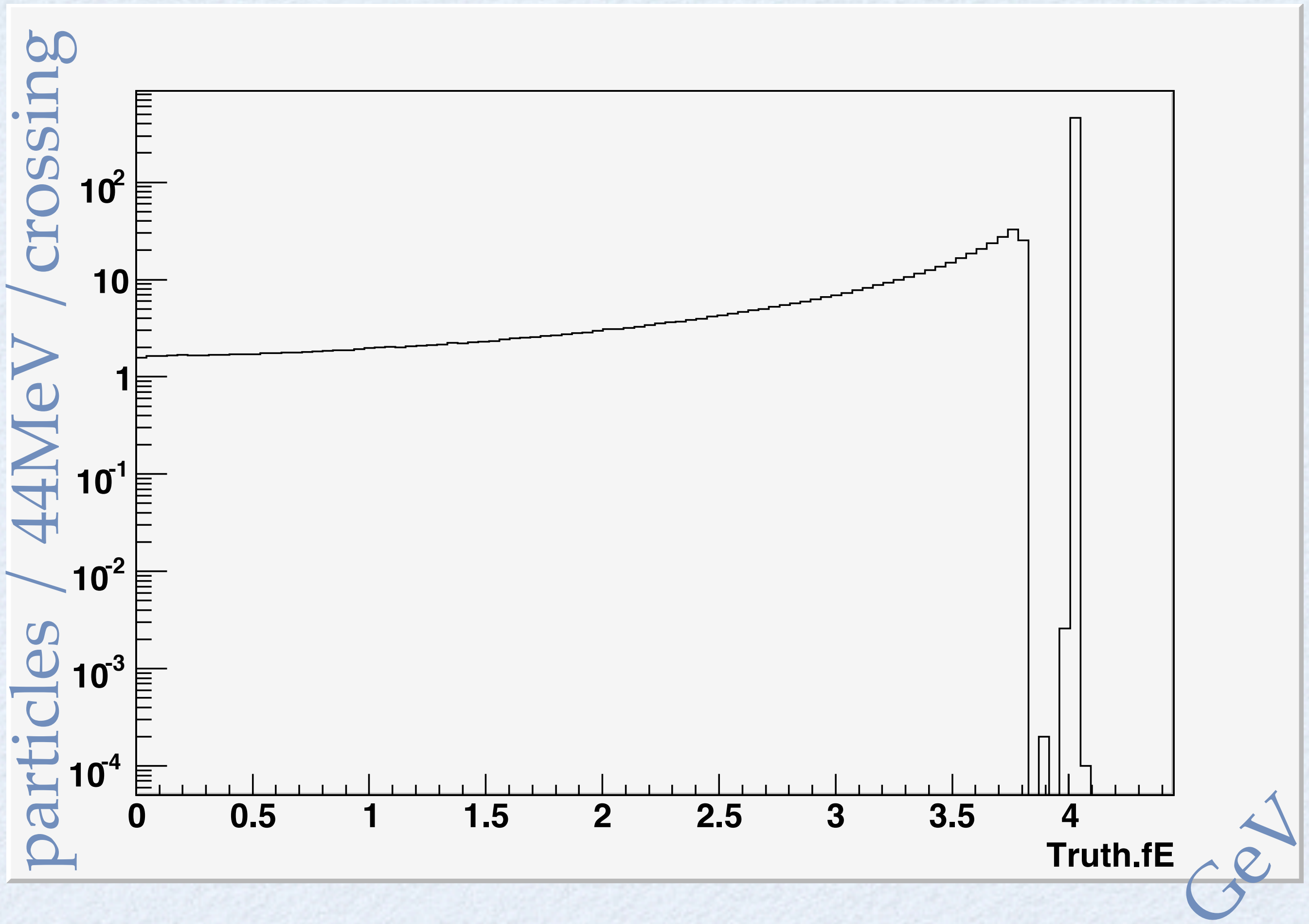
Monte Carlo Production

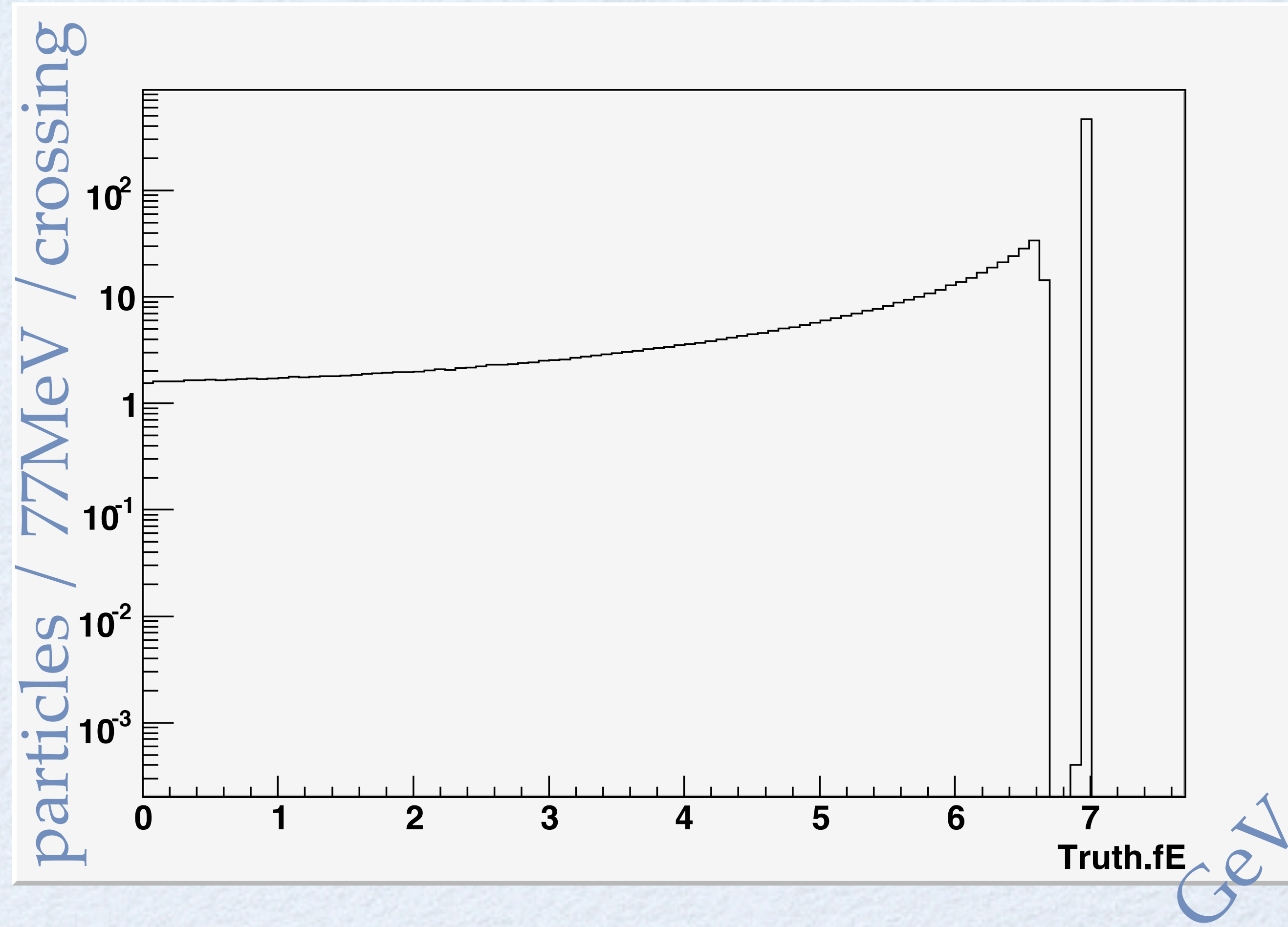
$$e^+e^- \rightarrow e^+e^-\gamma \quad (\gamma \sim\parallel e^-)$$





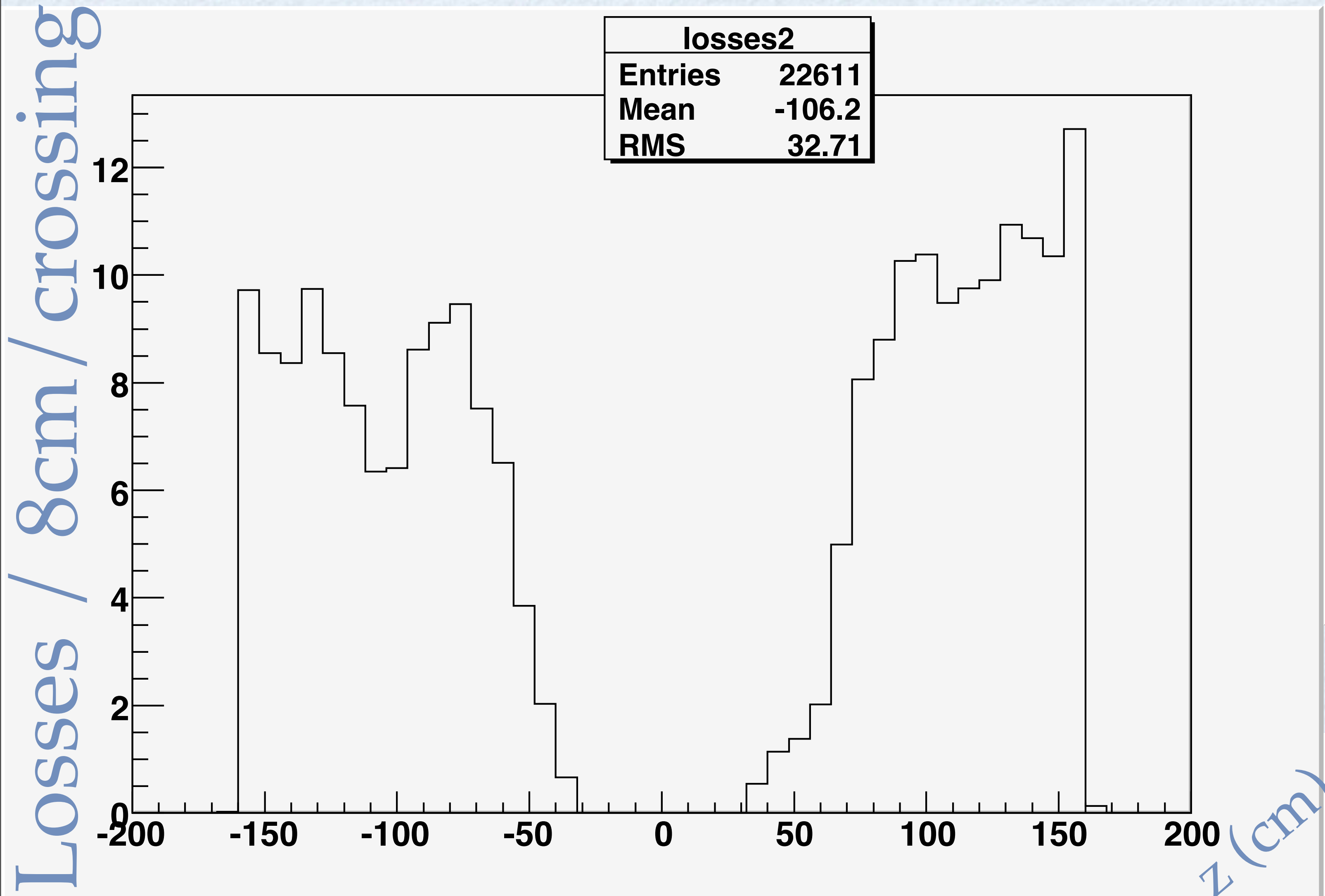
A look at the far tails

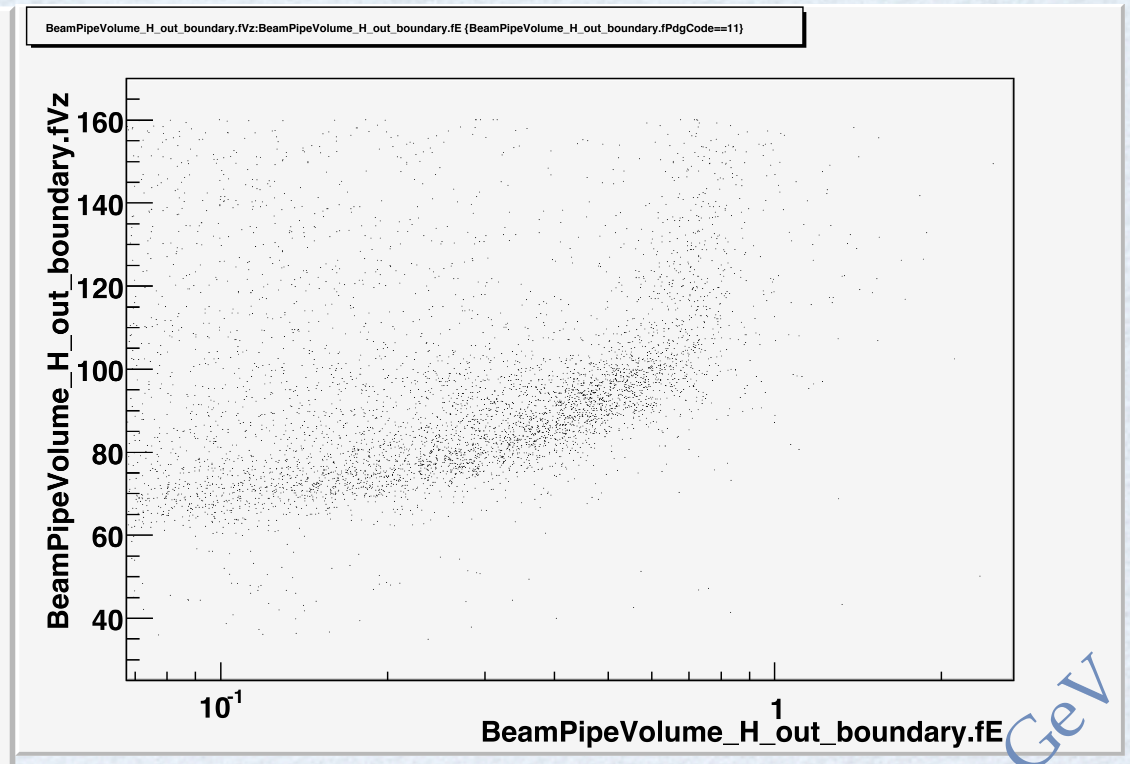


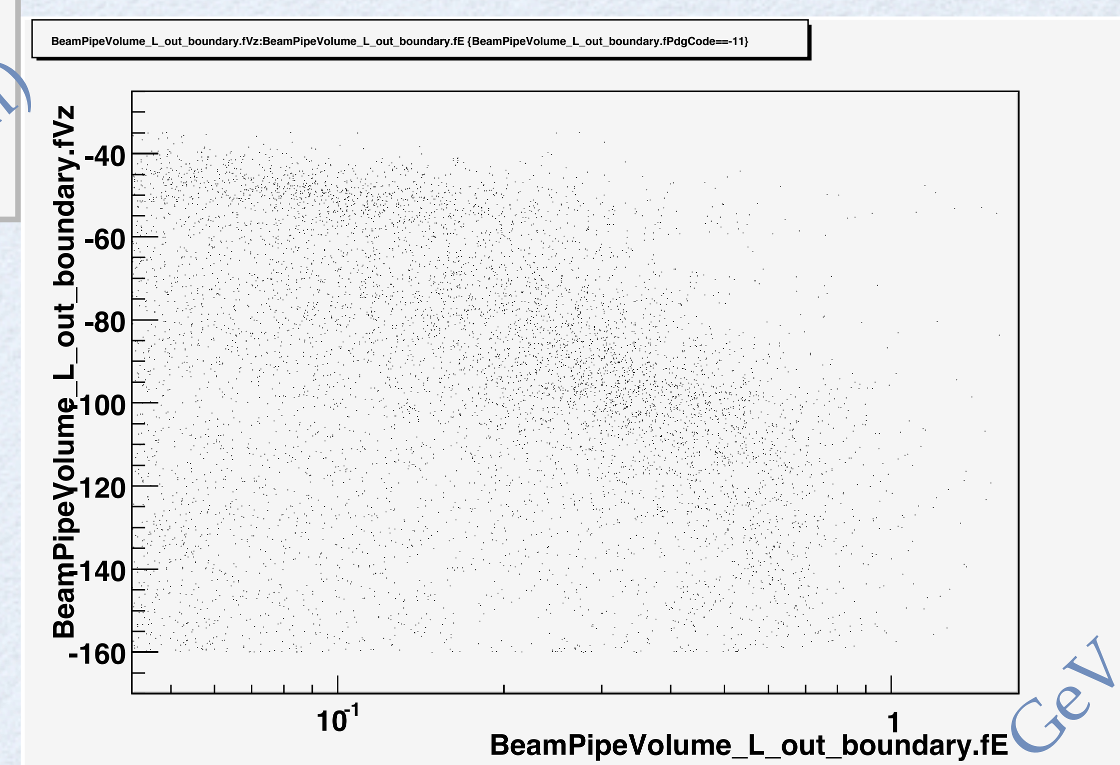


- Cross sections predicted by BBBrem very slowly decreasing with energy loss

Rad Bhabha losses @ IP



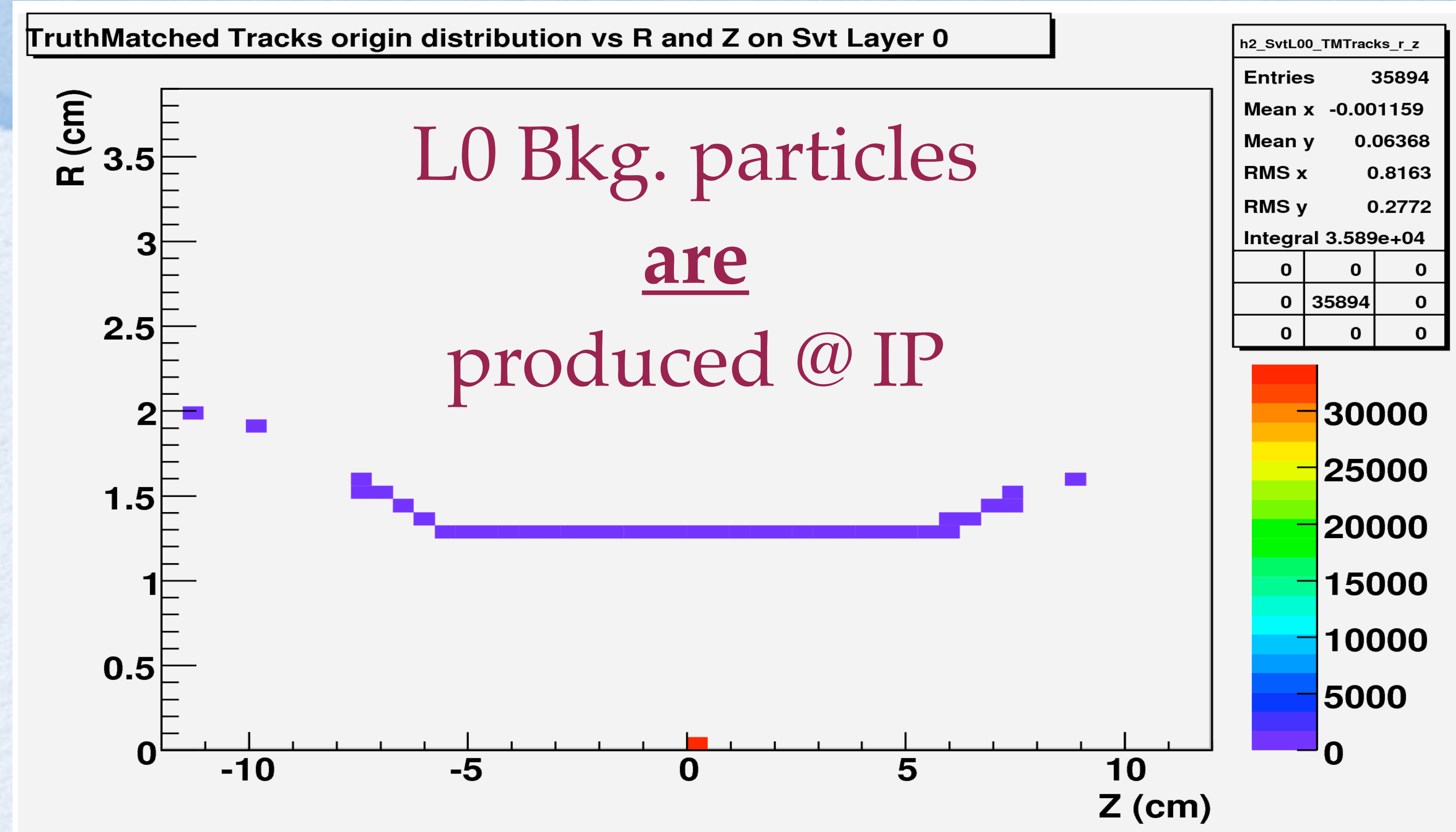




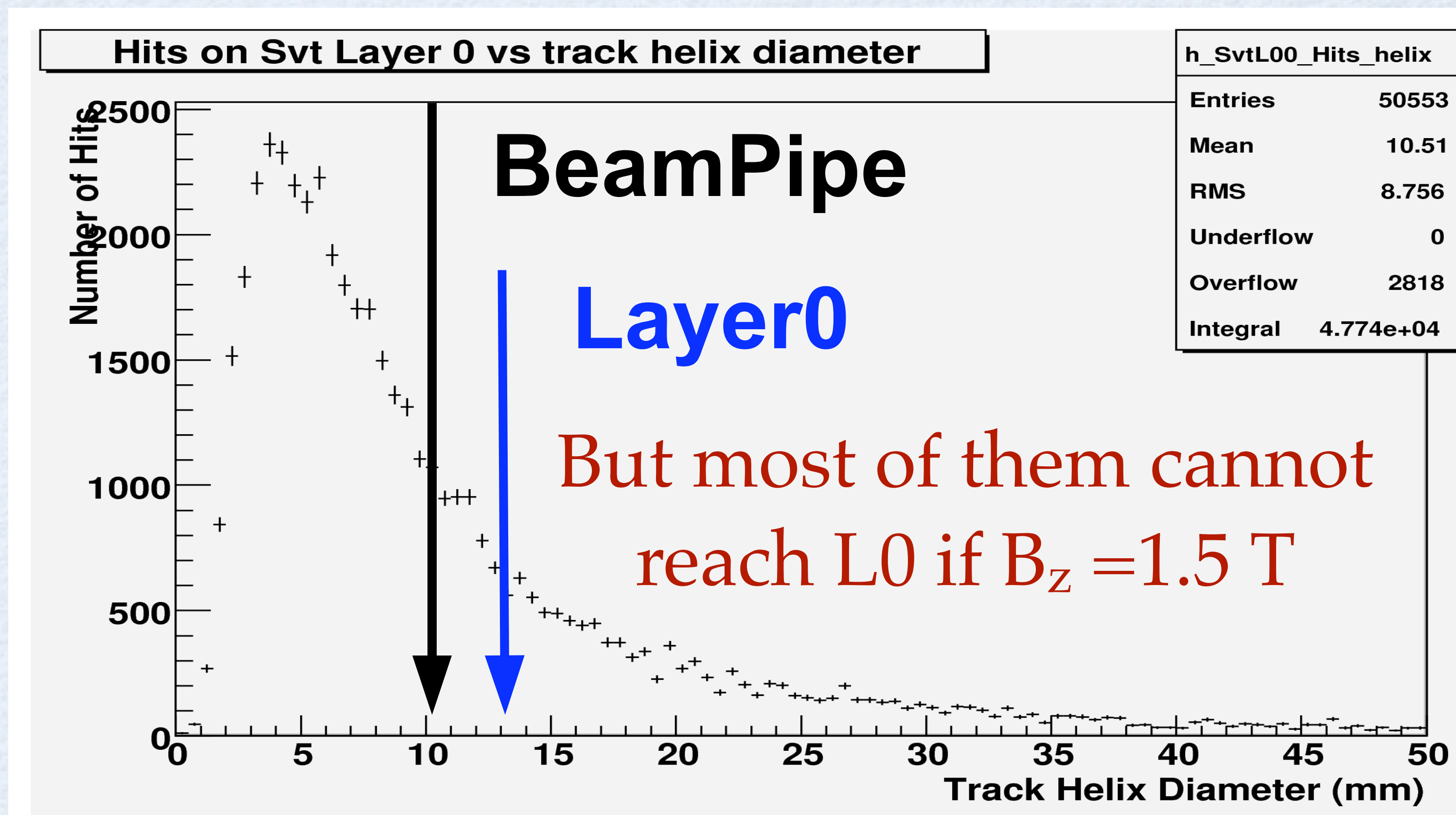
- Particles lost (e^+ e^-) downstream the IP

SVT (Riccardo Cenci)

SVT Layer	Cluster rate (kHz/cm^2)	Pixel rate (kHz/cm^2)
~~Layer 0~~	~~858~~	~~8016~~
Layer 1	62	116
Layer 2	38	71
Layer 3	15	28
Layer 4	3.4	5.4
Layer 5	2.1	3.4



- Layer 1-5 seems ok
- Layer 0 overestimated by the poor approximation adopted for the B_z field inside the beam line

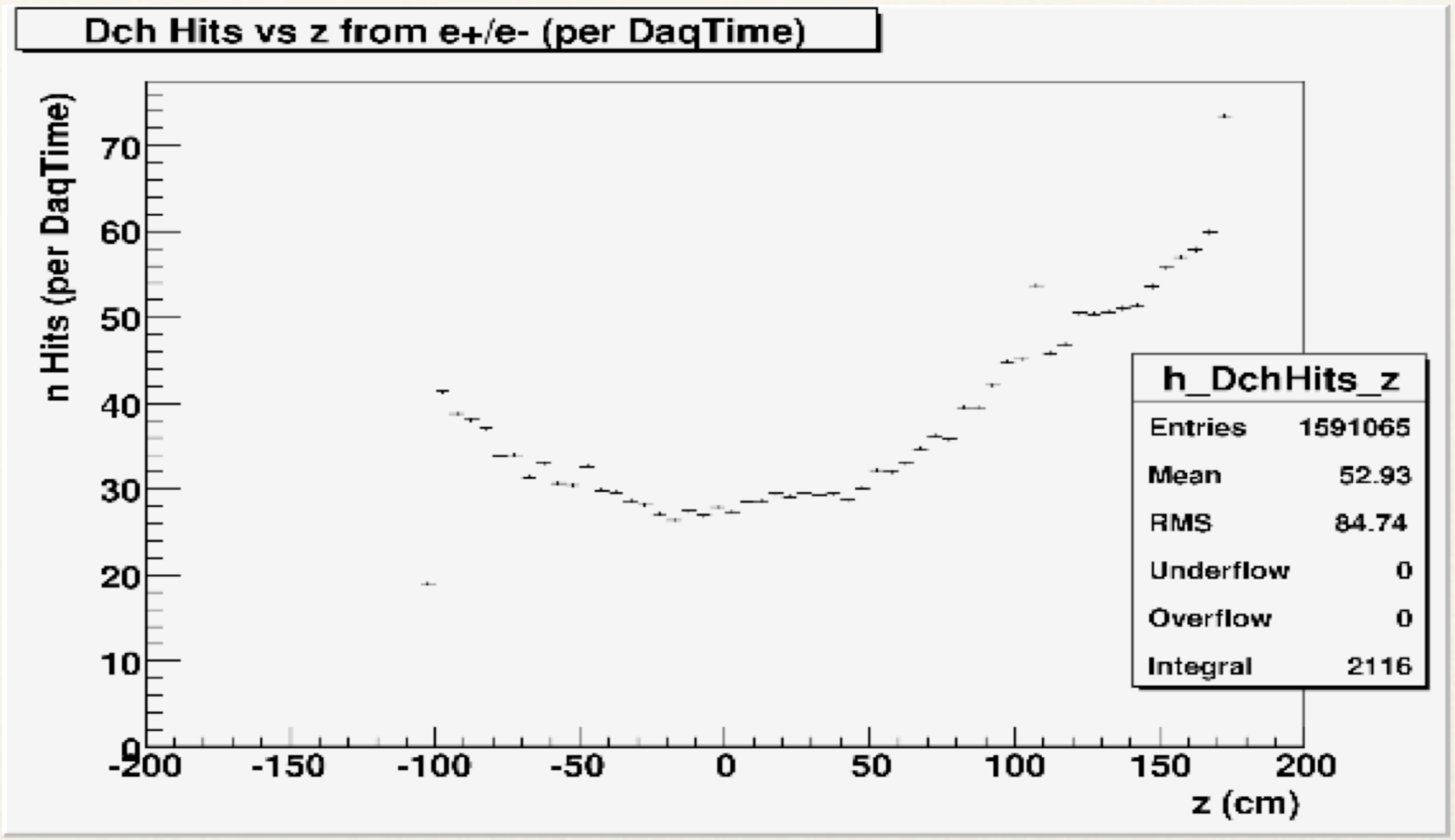


DCH

- 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

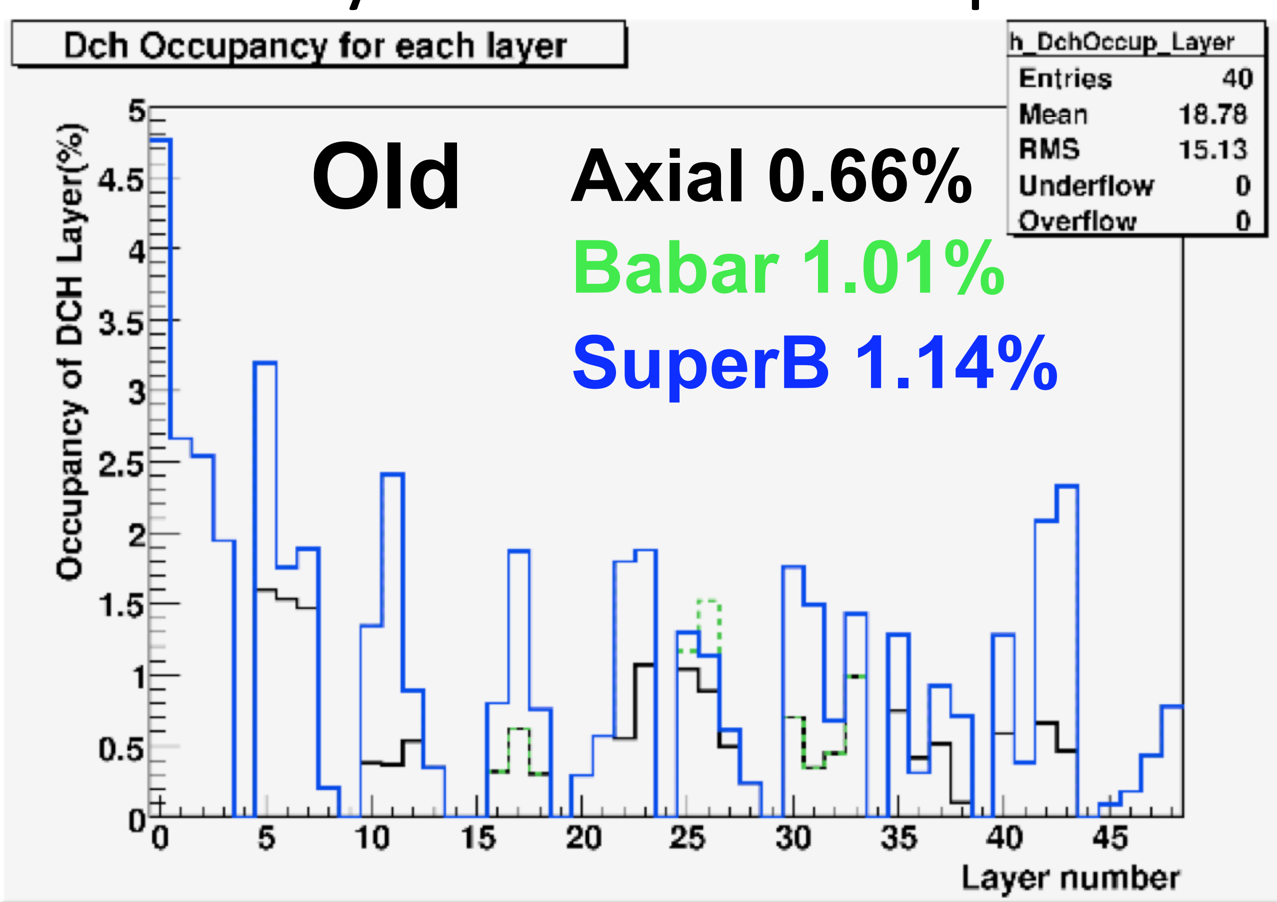


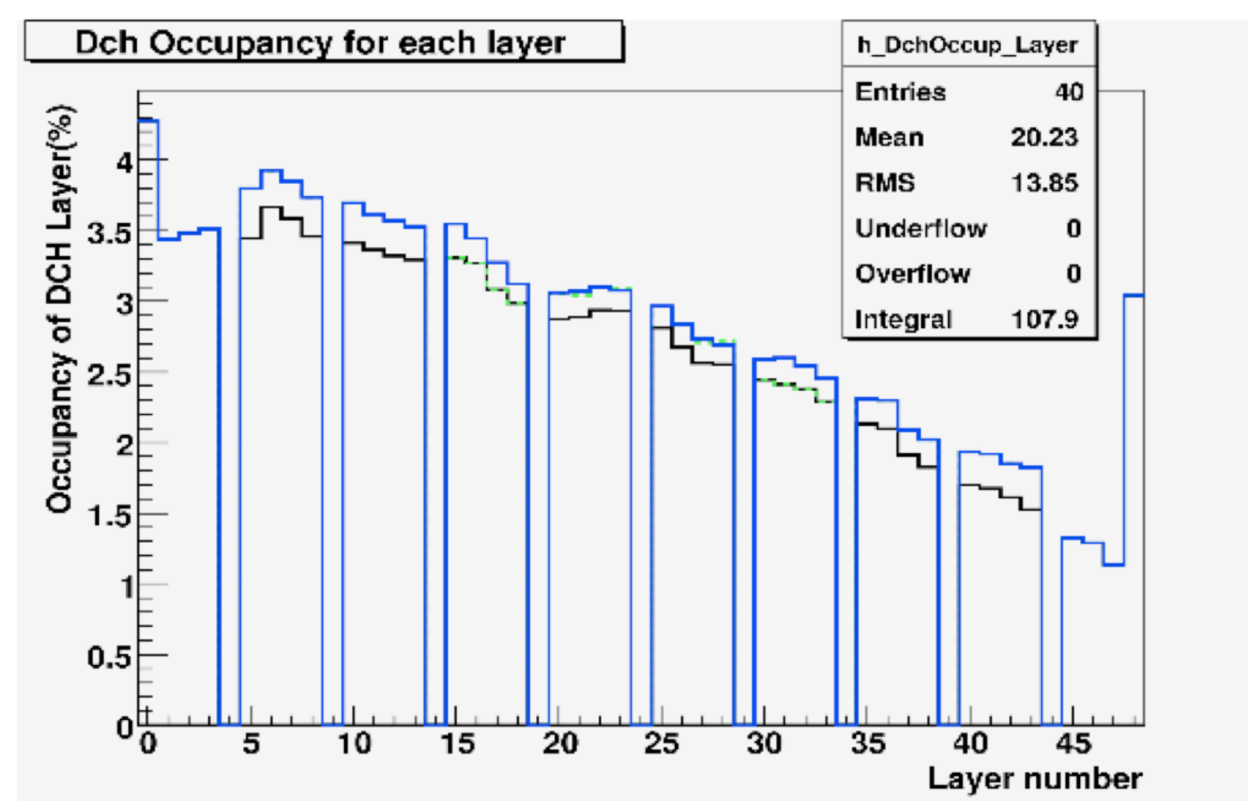
DCH: Riccardo Cenci (work in progress)

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%

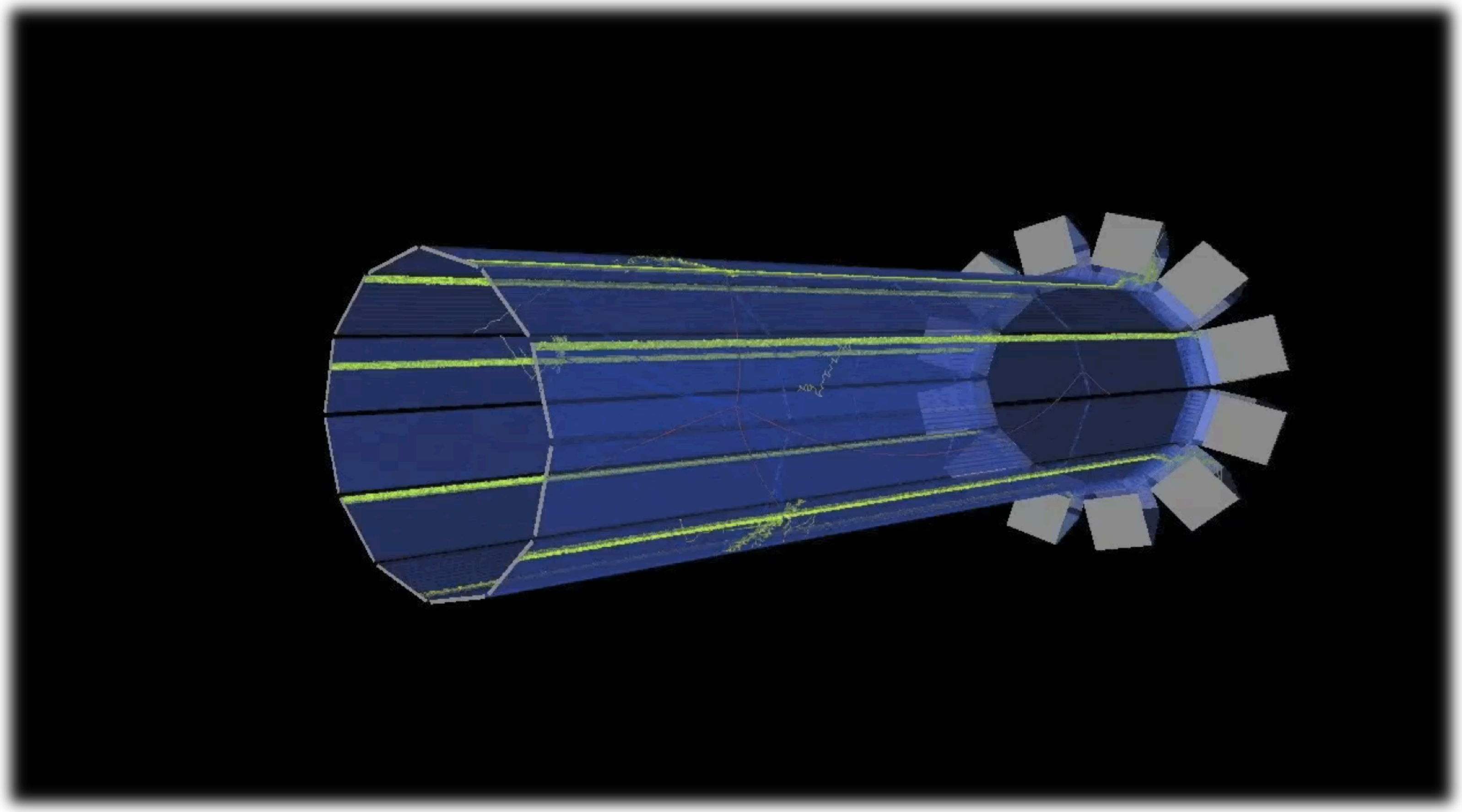




DIRC: Doug Roberts

- DIRC GDML model put in the Super*B* winter model.
- This is an optically capable model, i.e. it tracks Cerenkov photons, deals with interfaces between different materials (like glue and quartz bars), bounces photons off mirrors

Track and Optical Photon Simulation

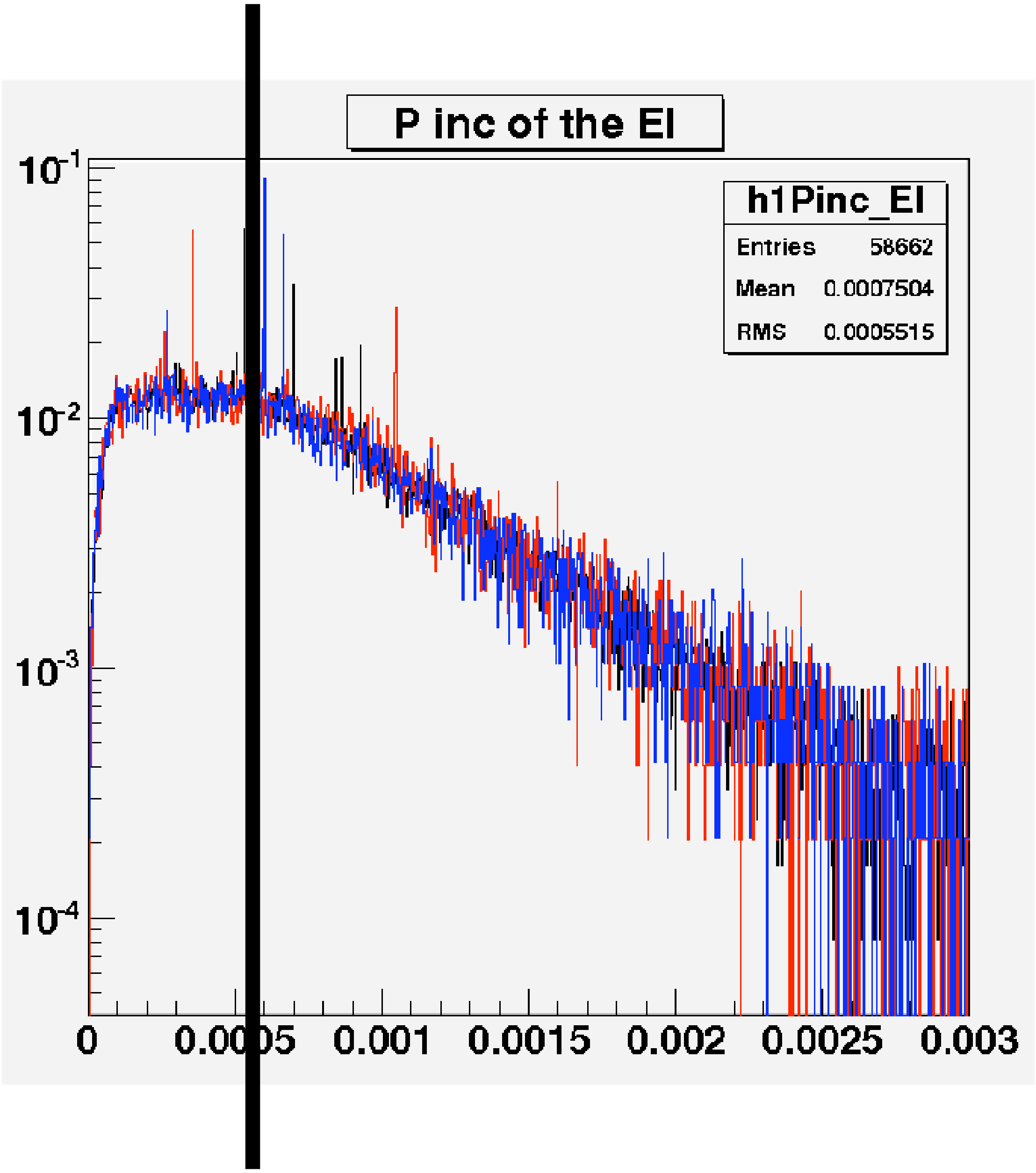


- Doug developed a Geant4 program capable to fully simulates the Cerenkov production, propagation and detection
- minors patchworks needed to incorporate its code in Bruno
- Andrea and E. (I) will be glad to give to Bruno the possibility to simulate all the focusing DIRC from first principle.

fTOF: Leonid Burmistrov, Ganna Dolinskaya

- Work just started, first results are coming out
- Optical properties of the quartz are not specified, hence Cerenkov light simulation is not carried on by Geant4
- Work in progress

Cerenkov threshold for electrons

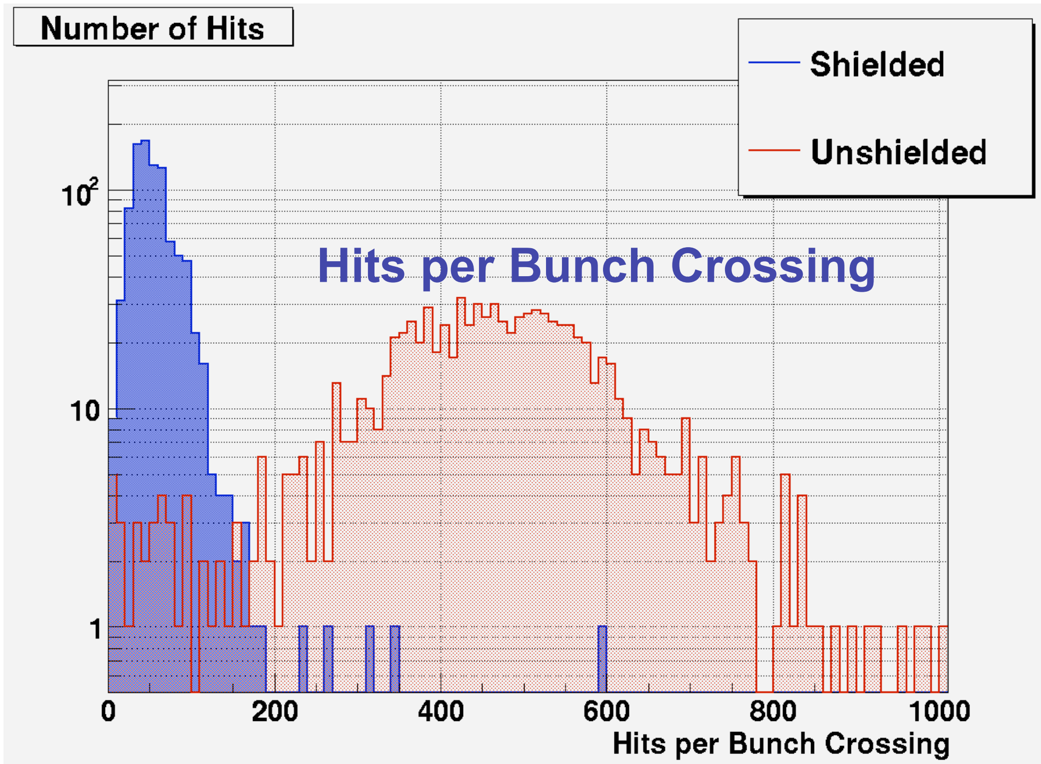


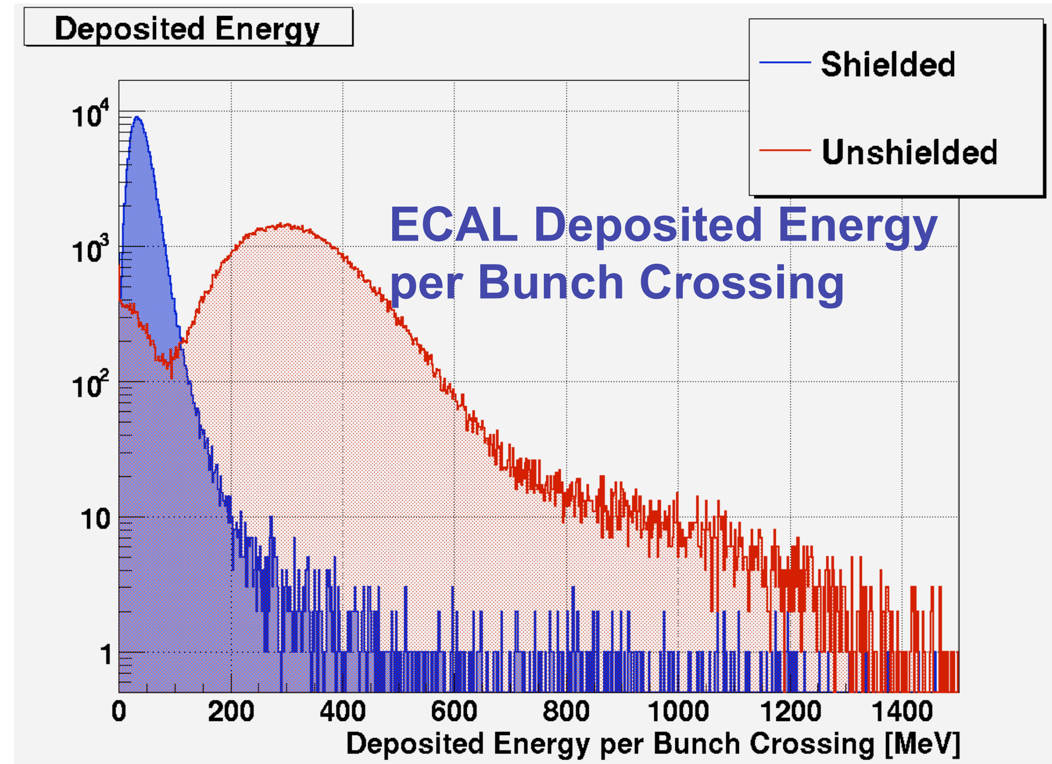
Momentum of incoming electron
Number normalized by n bunch X

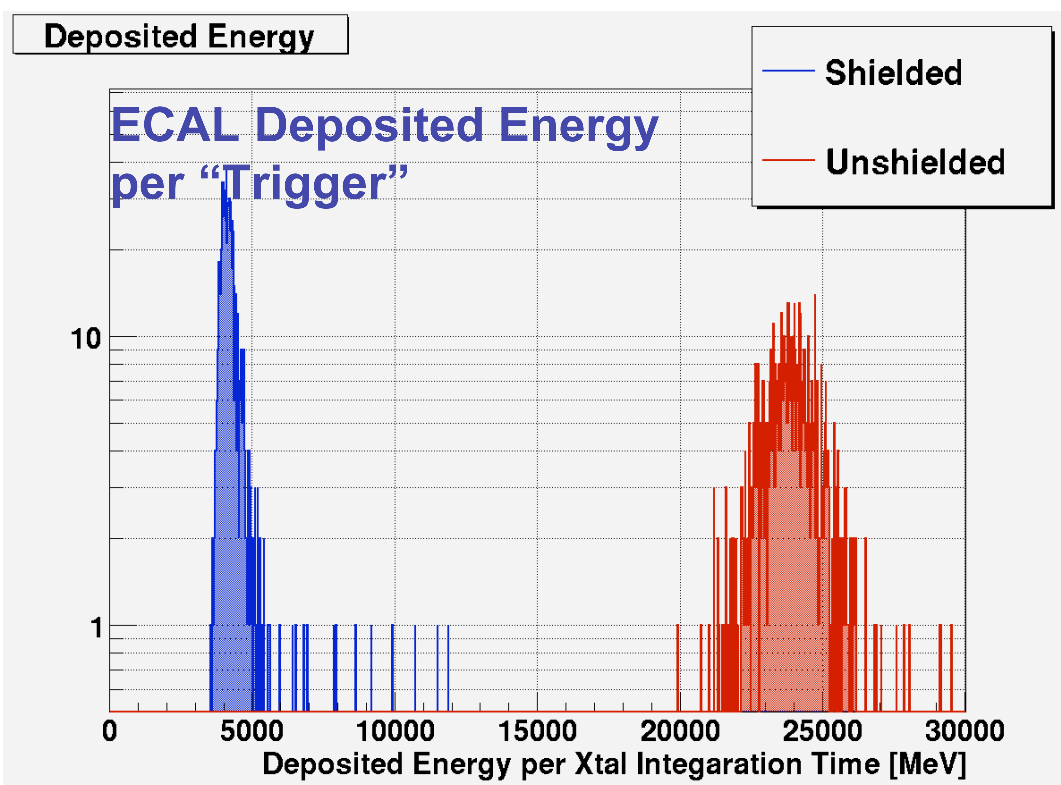
- Wolf shielded (black)
- Wolf shielded DeltaE 0.05 (blue)
- Wolf shielded DeltaE 0.002 (red)

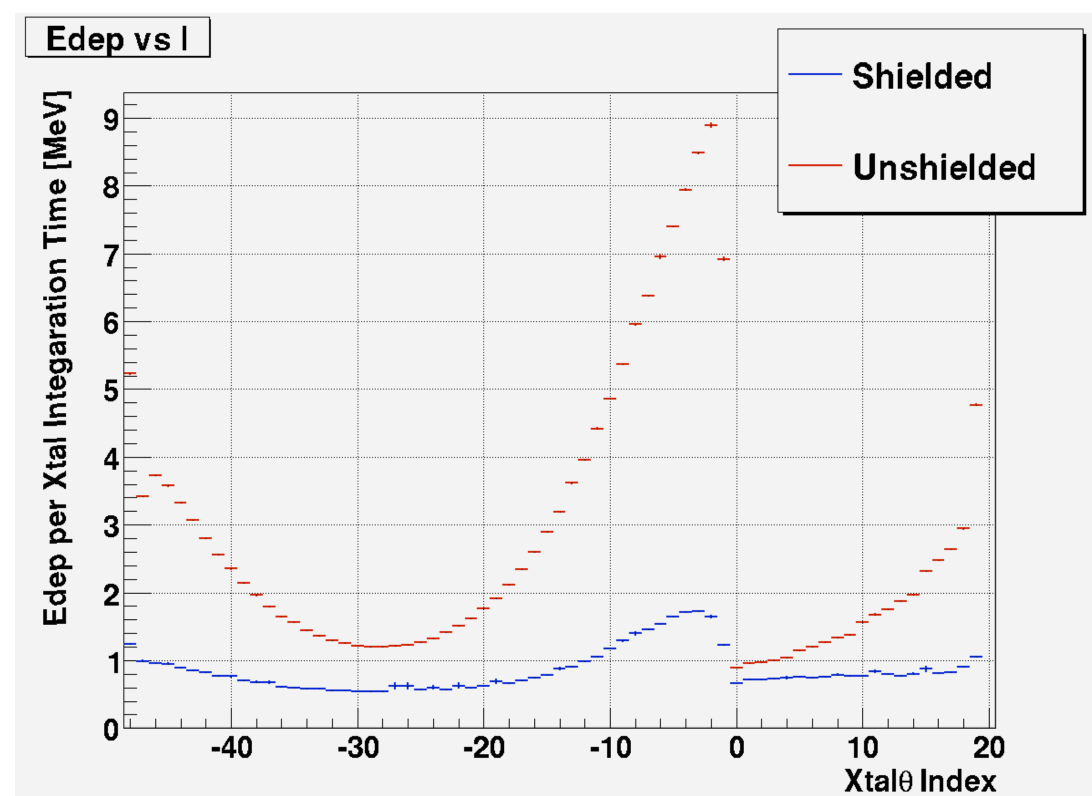
EMC: Stefano Germani

Shielded - Unshielded

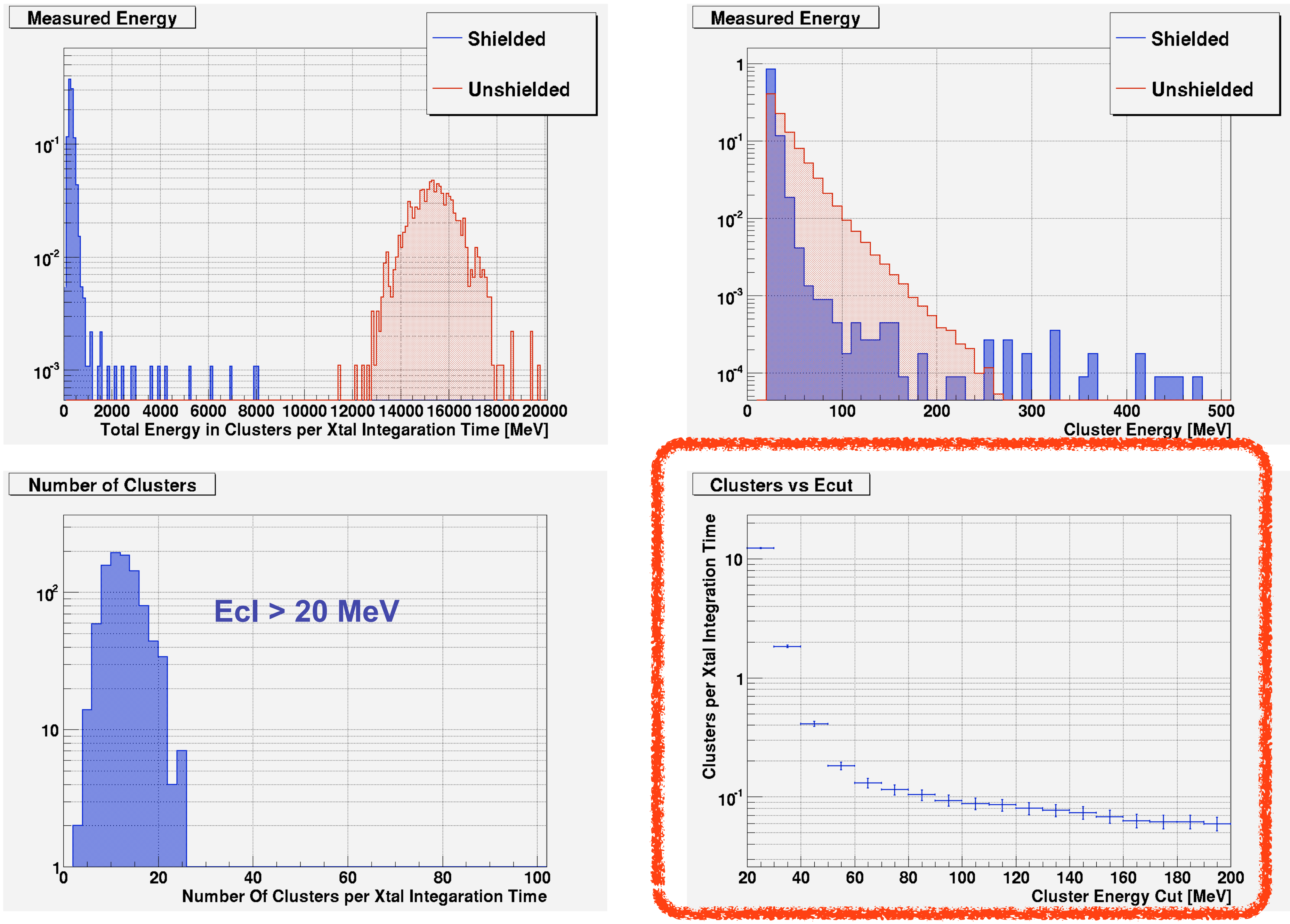




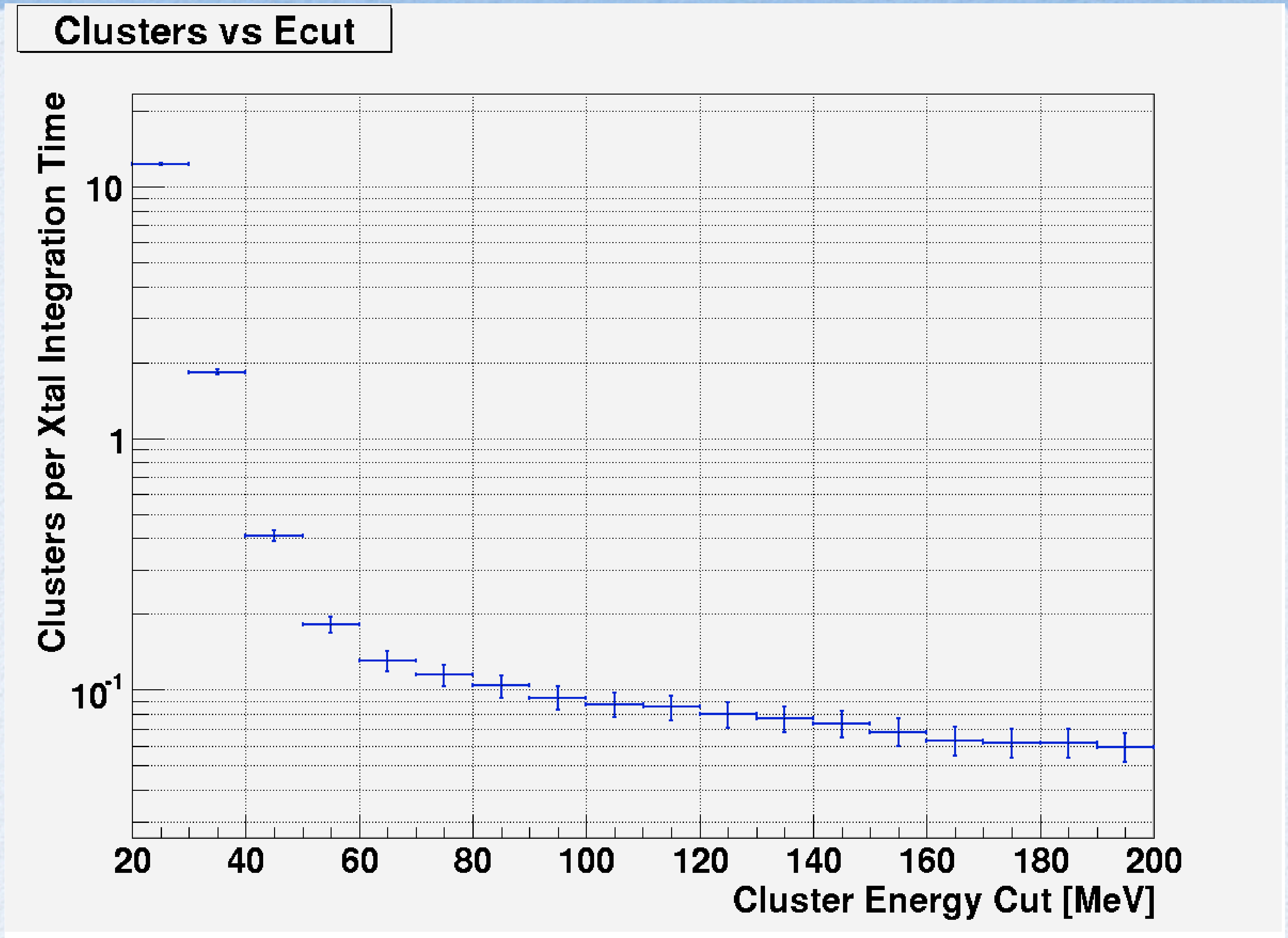




Clusters

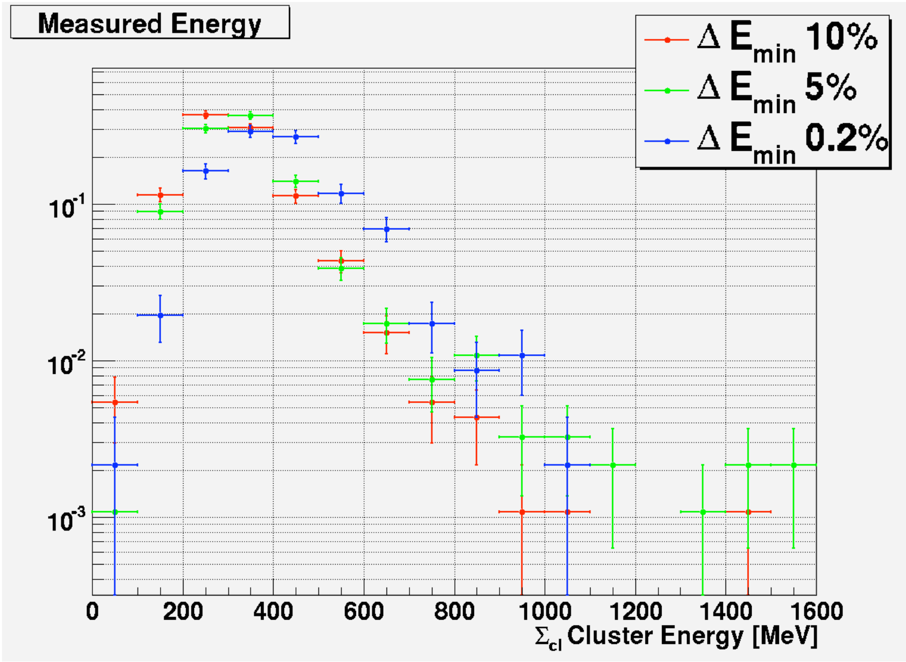

Measured Energy
Shielded
Unshielded
Total Energy in Clusters per Xtal Integration Time [MeV]
Measured Energy
Shielded
Unshielded
Cluster Energy [MeV]
Number of Clusters
Ecl > 20 MeV
Number Of Clusters per Xtal Integration Time
Clusters vs Ecut
Clusters per Xtal Integration Time
Cluster Energy Cut [MeV]

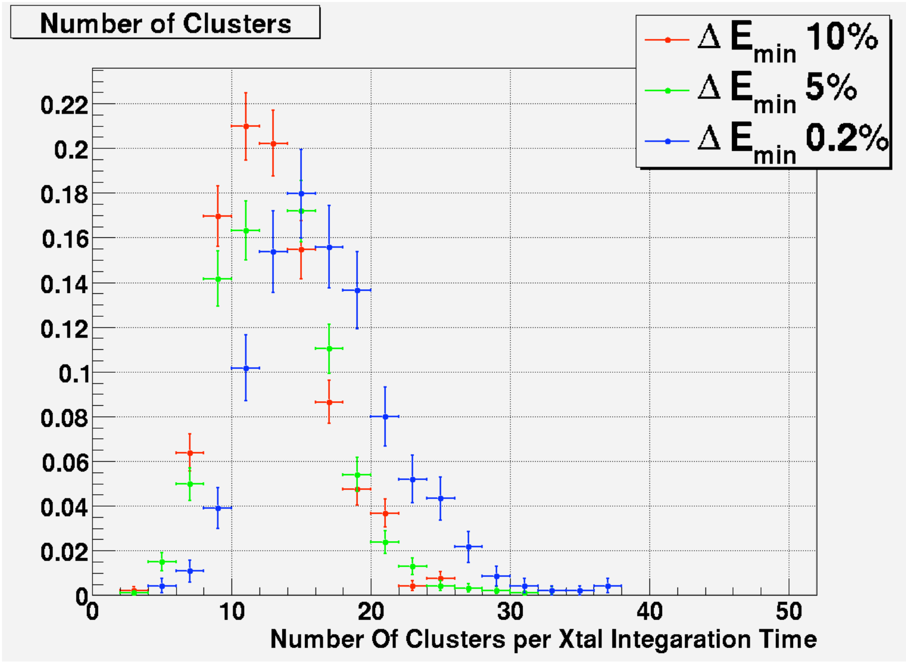
Bkg. Cluster multiplicity

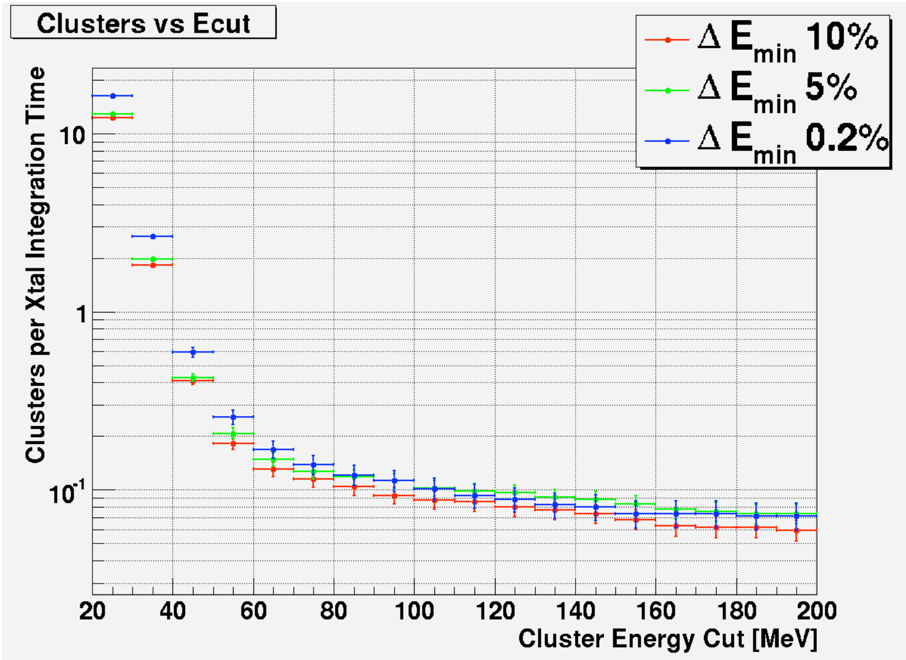


If you want to use the EMC as a veto, then you have to require Cluster E > 40 MeV (Thumbometric Estimates Dept.)

Delta Emin : Clusters







- There is a significant difference between the 10% and 0.2% cuts
- Need to check what happens at lower cut energies

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.

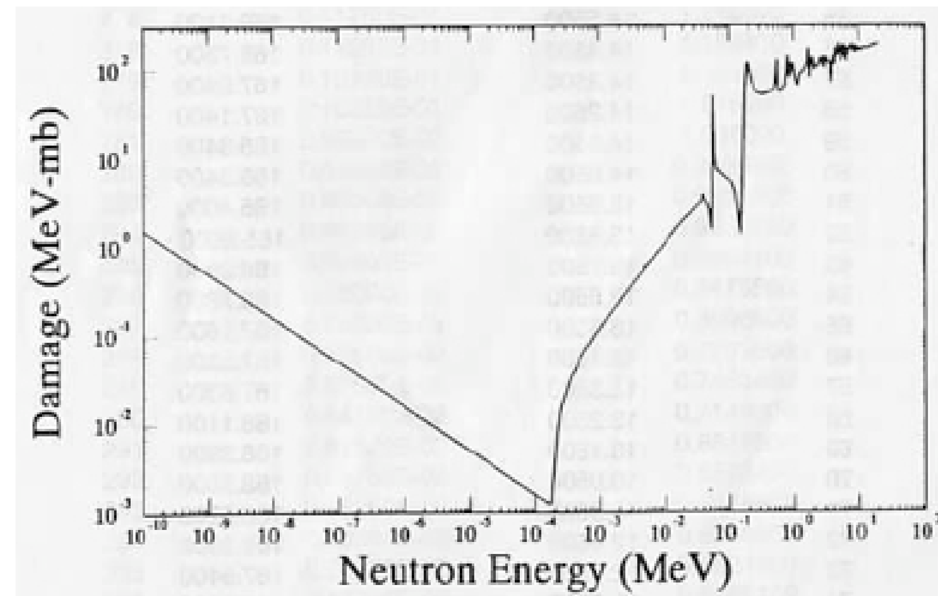
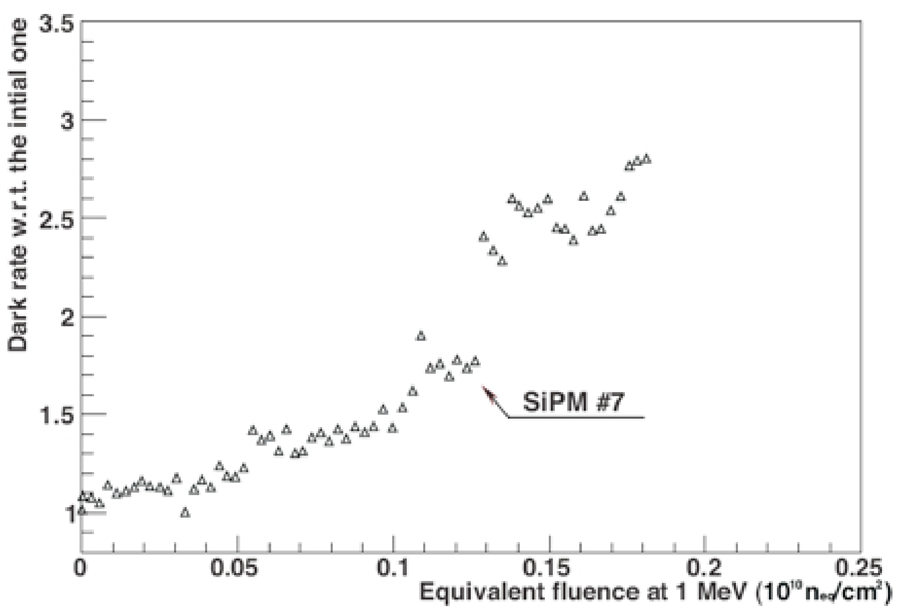


FIG. A1.1 Silicon Damage Function



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 $10^8n_{eq}/cm^2$. 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 $1.5 \cdot 10^7$ 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

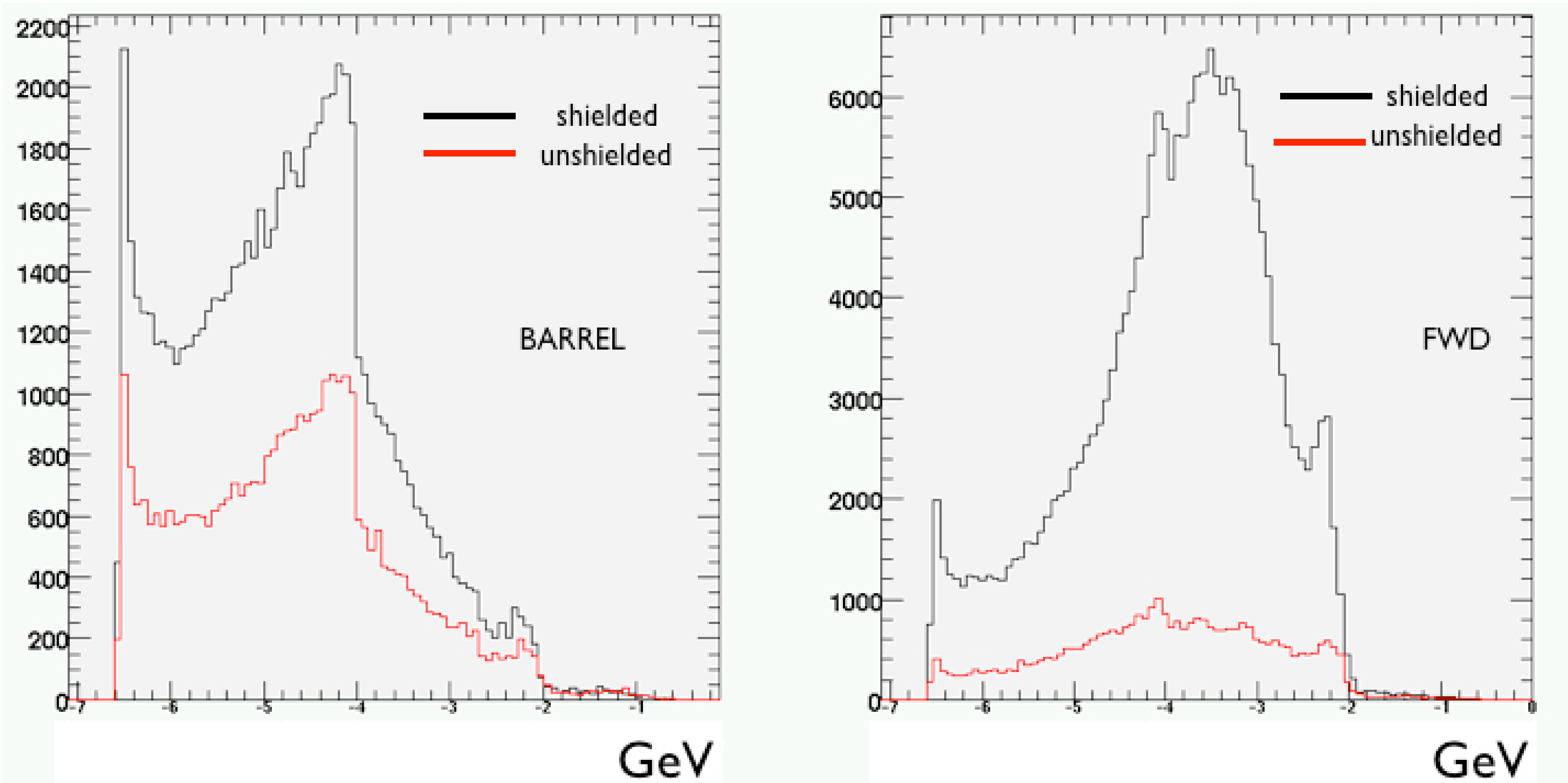


Figure: Energy distribution of neutron crossing the barrel and forward endcap boundary with log-scale

Different configurations I

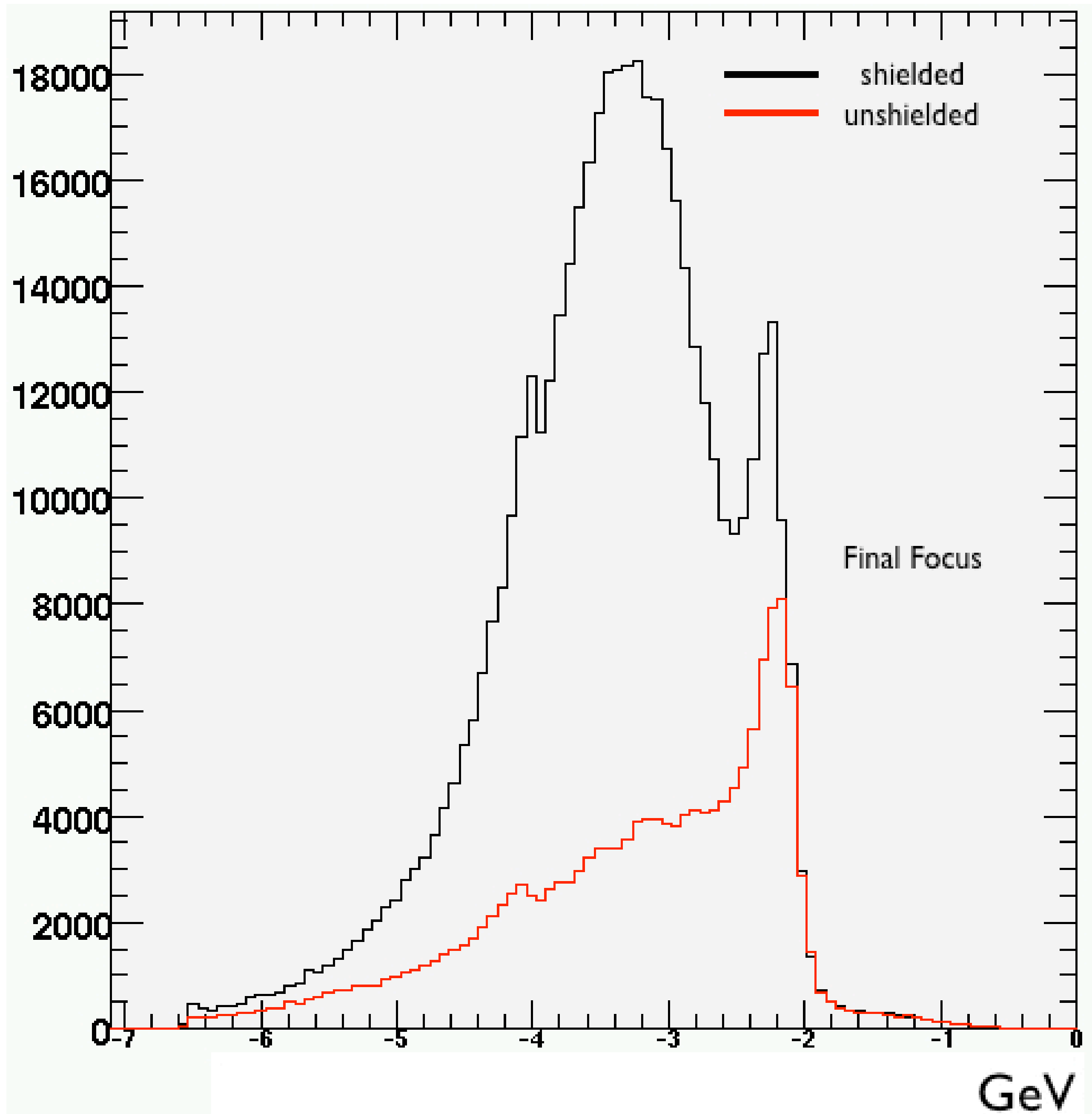
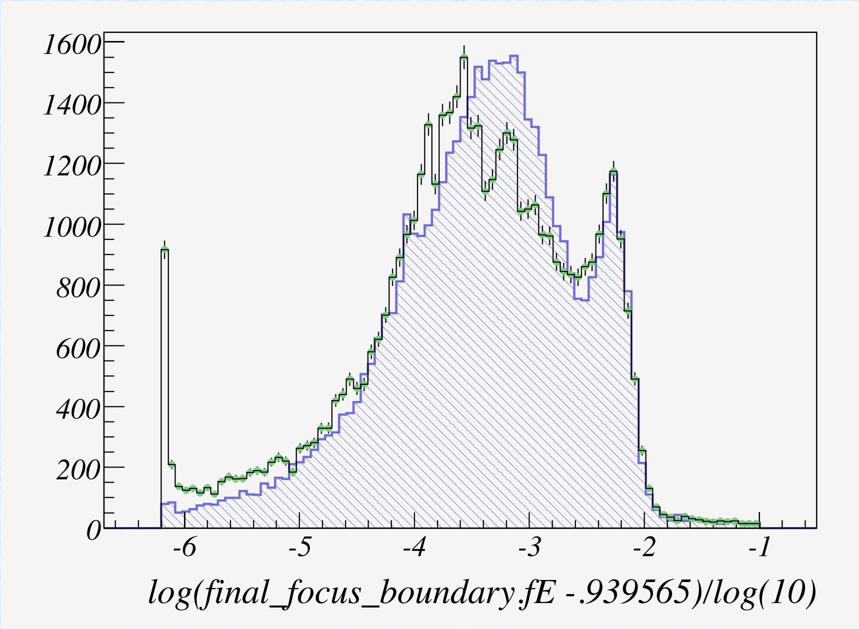


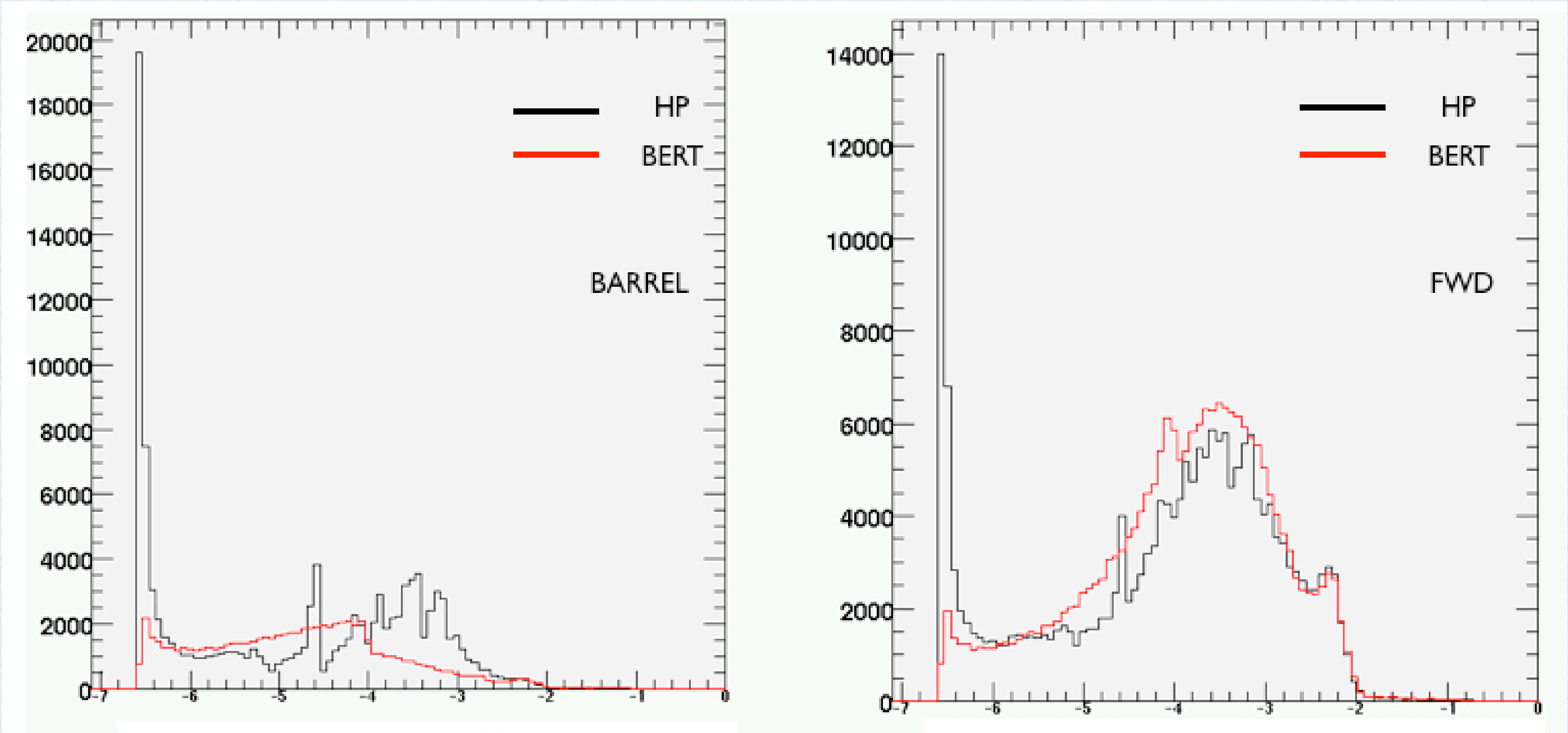
Figure: Energy distribution of neutron crossing the final focus boundary with log-scale

IFR Physics list comparison



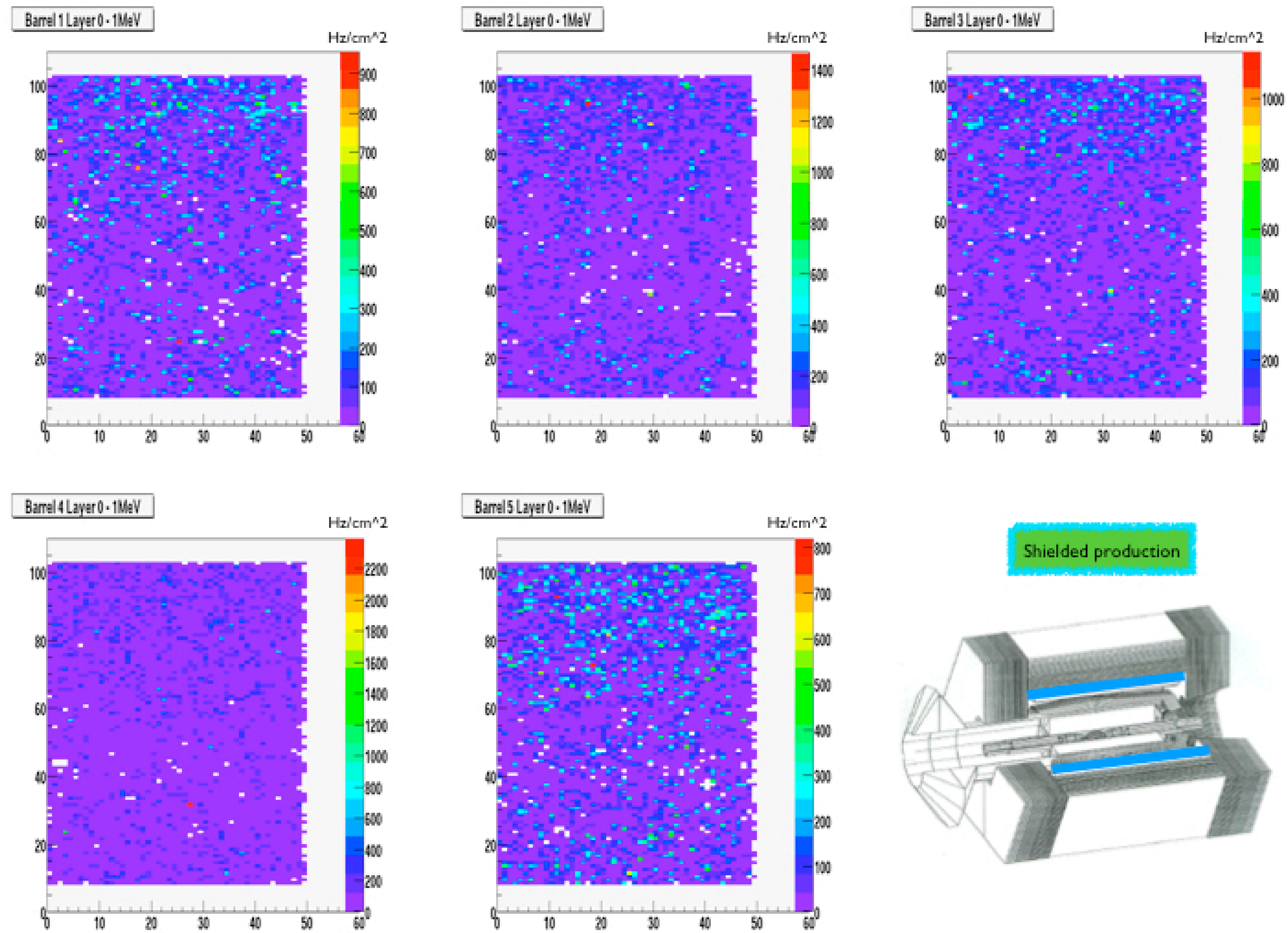
Neutron energy spectrum at the final focus boundary: High precision neutron in green, QGSP in violet

Neutron energy spectrum at the IFR boundary: High precision neutron in black, QGSP in red



IFR

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.

Tungsten Shield: cost & weight

- In 2007 a 11 cm thick Tungsten Shield was required,
  - Plansee extimated: 660k€


PLANSEE GmbH
Siebenbürgerstrasse 23
86983 Lechbruck am See
GERMANY
www.plansee.com

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Offerta

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20196295 / 16.01.2007

Il vostro numero del cliente
113282 / 4E

- In the mean while:
  - Mike improved the final focus
  - Manuela and Pantaleo improved Touschek lifetime and carefully placed beam jaws
- Now 3 cm seems adequate:
  - 2 Tons of Tungsten
  - 400k€ seems an adequate extimates given the volatility of tungsten prices

Neutron shield

- Sames things happens again and again (R.Musil)

SSC-N-545
14 September 1988

Reduction of the Neutron Albedo Flux
in the Vertex Detector Region of a Generic SSC Detector

T. A. Gabriel and R. A. Lillie
Oak Ridge National Laboratory, Oak Ridge TN 37830

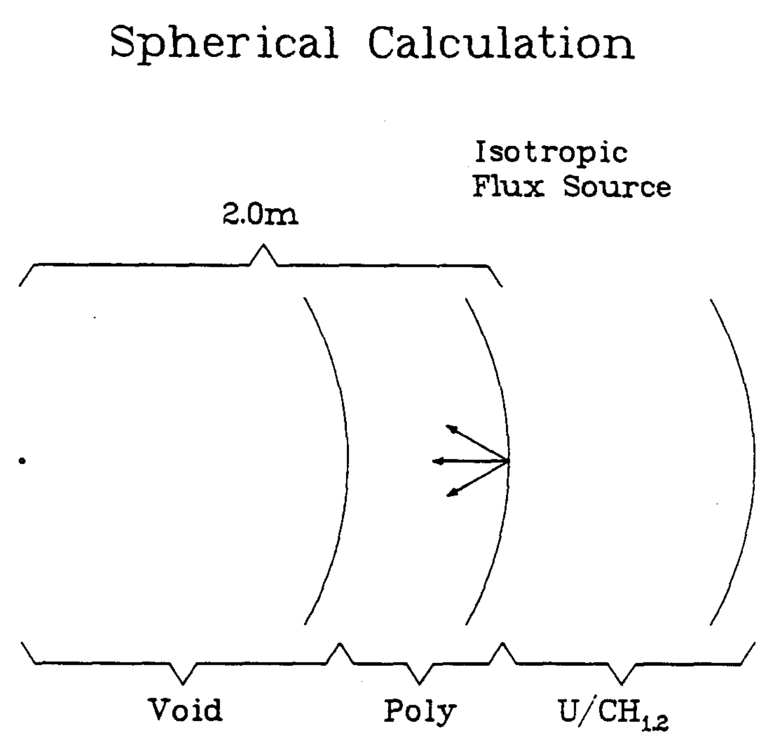

Fig. 1. Geometry of the generic SSC detector.

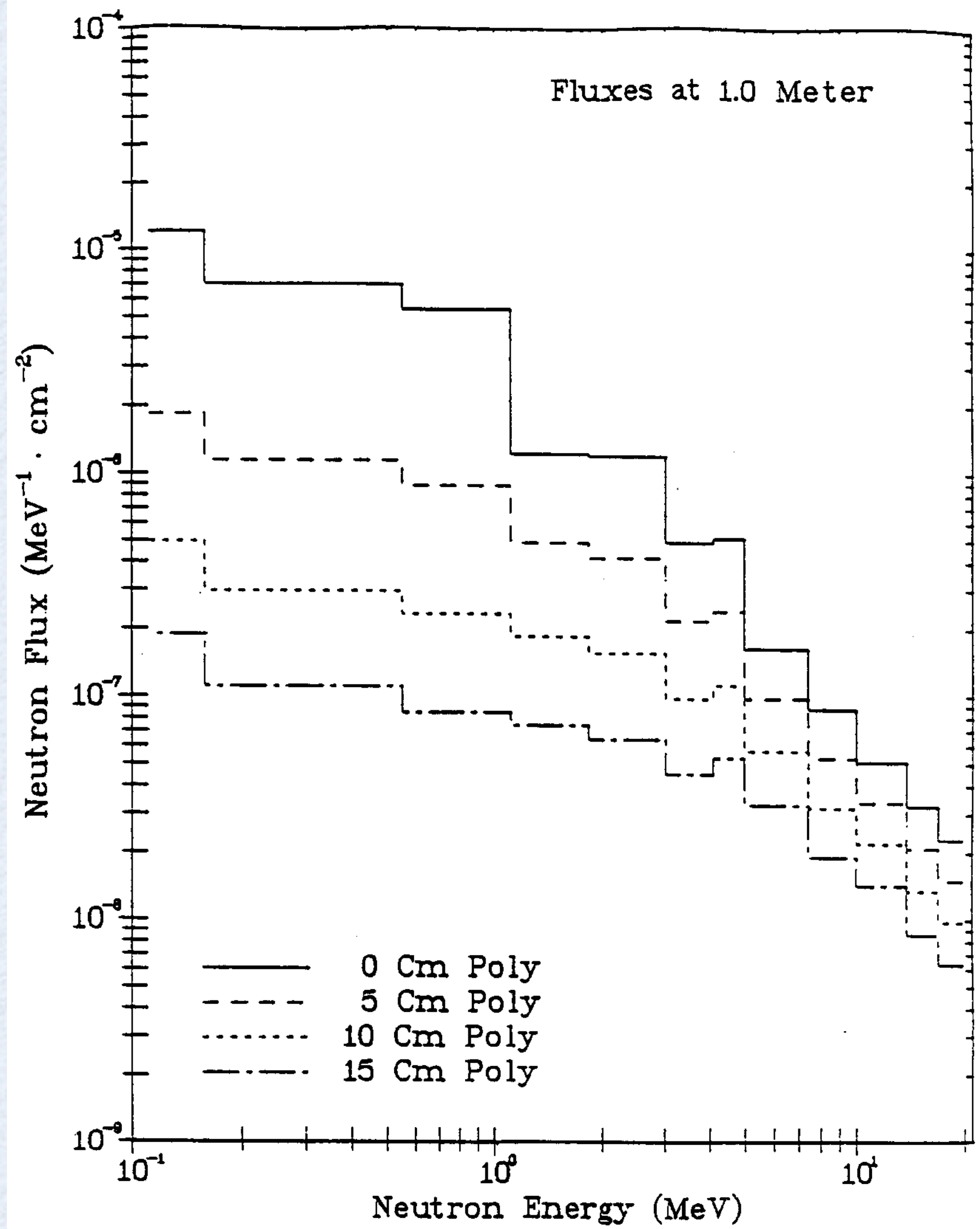

Fig. 3. Reduction in the neutron flux due to various thicknesses of polyethylene.

Conclusions I

- DCH and EMC really do not love the "*naked*" option
- 3cm thick tungsten seems the minimum thickness needed for rad Bhabha shielding
  - I will feel more confortable allocating 6 cm for shields
- IFR really do not love the "*tungsten dressing*" option
- Neutrons moderation absorption must be cured (extra space around the beam line for polyethilene 20 cm ??)
- SiPM local shields? 50% & 50% ?

Conclusions II

- EMC observes a non negligible running of the rates and multiplicities with DeltaE
- IFR observes a significant discrepancy on the neutron energy spectrum
- Next production will have smaller cut on DeltaE, HP option, longer timing cuts for neutrons (more CPU time)

Short term To do list (Elba)

- G4 Model of the latest and grethest Mike IR design
- More accurate model of the beam line material
- Optimization of the tungsten shield. Thickness modulation, polyethylene layer
- G4 Code development (Optical DIRC)
- Production of ~ 1M bunch crossing

Backup

Small Angle Radiative Bhabha Scattering in the No-recoil Approximation

G.Pancheri
INFN,Laboratori Nazionali di Frascati,I00044, Frascati (Rome), Italy

Abstract

A simple analytical formula is derived for the total rate of small angle radiative Bhabha scattering, using the no-recoil approximation. This expression illustrates how radiative processes soften the forward angle singularity so that the cross-section for all electrons which have radiated an energy larger that a given amount ΔE, is only logarithmically divergent as $m_e \to 0$.

the integrated cross-section takes the form

$$\sigma_{RB}^{soft} \approx \frac{32\alpha}{3} r_0^2 \int_{x_0}^{1} \frac{dx}{x} log\left(\frac{s}{m_e^2}\frac{1-x}{x}\right) \tag{18}$$

with $x_0 = \frac{\Delta E}{E}$. Retaining only the leading logarithmic contribution, one then gets

$$\sigma_{RB}^{LLO} \approx \frac{64\alpha}{3} r_0^2 log(\frac{E}{\Delta E}) log(2\gamma) = \frac{16}{3}\pi r_0^2 \beta_e log(\frac{E}{\Delta E}) \tag{19}$$

with

$$\beta_e = \frac{4\alpha}{\pi} log(2\gamma)$$

and $\gamma = E/m_e$. The LLO expression just obtained coincides with the one from ref. [2, 3],

Acknowledgements

The author is indebted to R. Baldini, M. Bassetti, M.Greco, M.Preger, A.Zallo and to V.Khoze and Y.Srivastava for enlightening discussions and stimulating conversations on this topic.