MDI & Background report

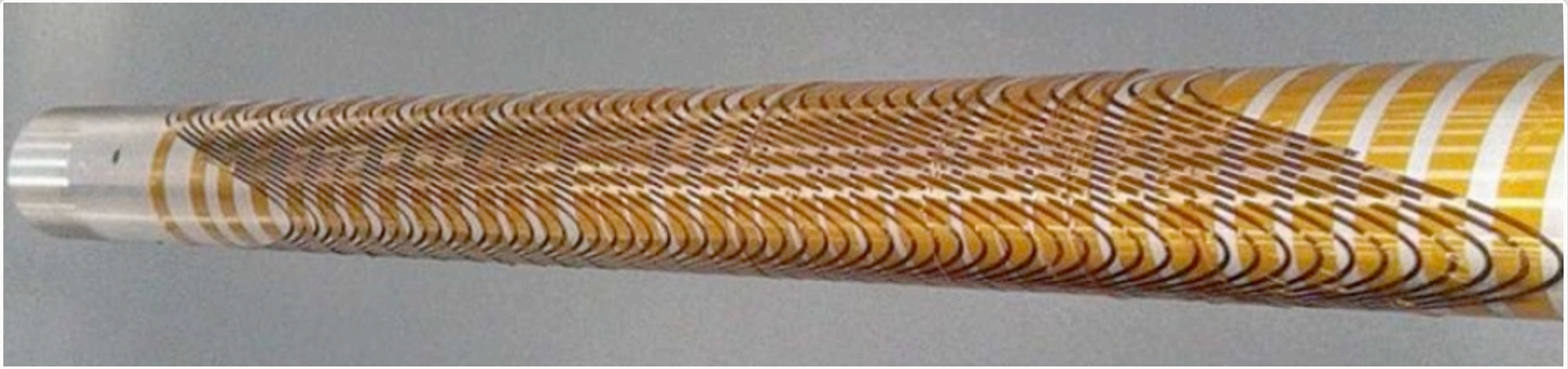
E.Paoloni (INFN & Università di Pisa)

for the MDI & Background simulation team

Sessions And Contributions

- MDI sessions
  - Results of the QD0 test in Genova (P. Fabbricatore)
  - Touschek and beam gas bkg. reduction (M. Boscolo)
  - Pairs background studies (C. Rimbault)
  - EMC background report (S. Germani)
  - Additional shield studies for the FDIRC (A. Perez)
  - Report from Vienna (E.P.)
- Integration session
  - Quick demounting procedure (F. Bosi)
  - Mechanical support of the tungsten shields (F. Raffaelli)
- Background simulation + computing session
  - Software advances (A. Di Simone)
  - Improvements on detector model (A. Perez)
  - Report on the Beam gas effects in detectors (A.Perez, L.Burmistrov, S.Germani, V. Santoro)
- Other parallell sessions contibutions (R. Cenci, N.Neri, E. Manoni)

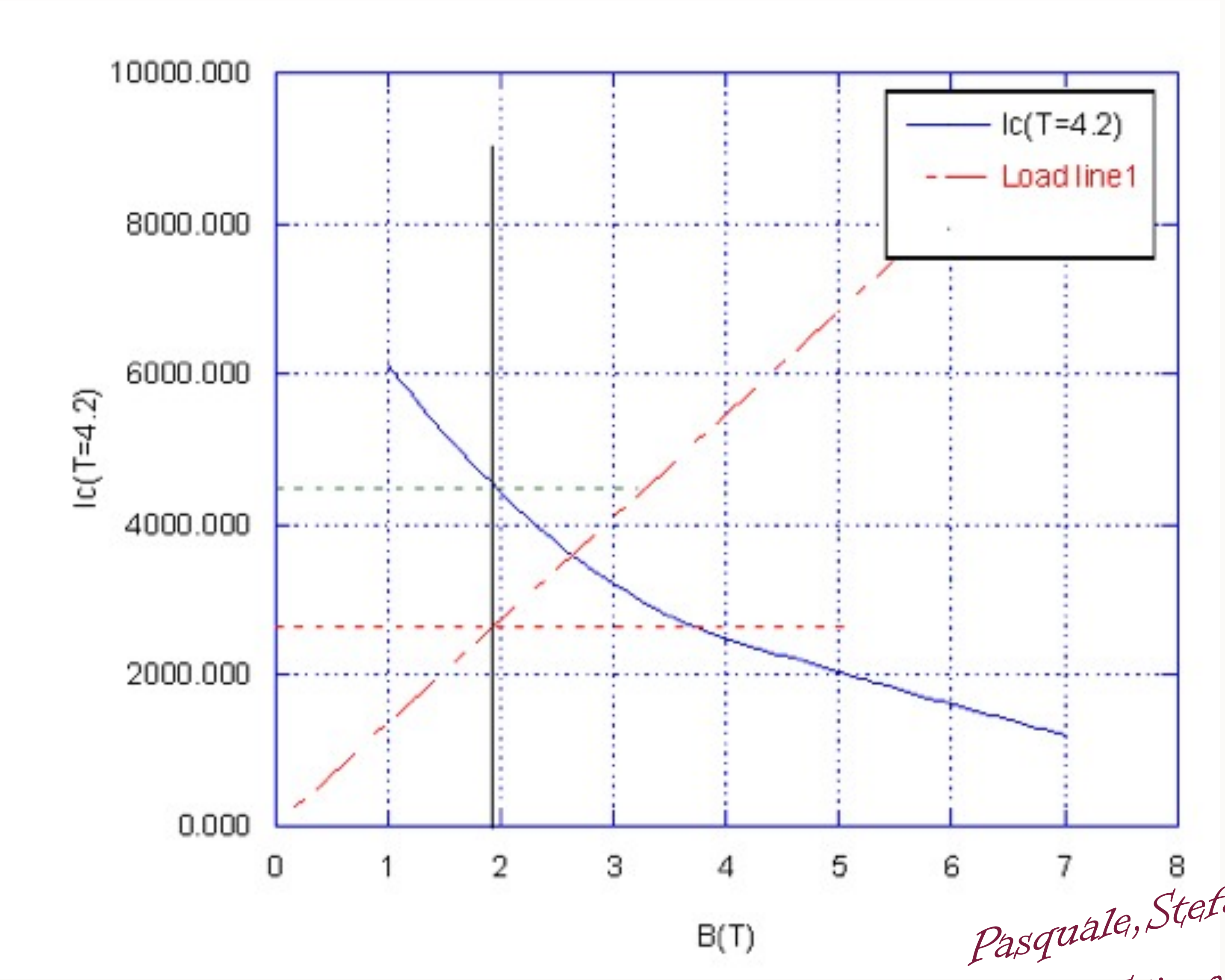
QD0 PROTOTYPE

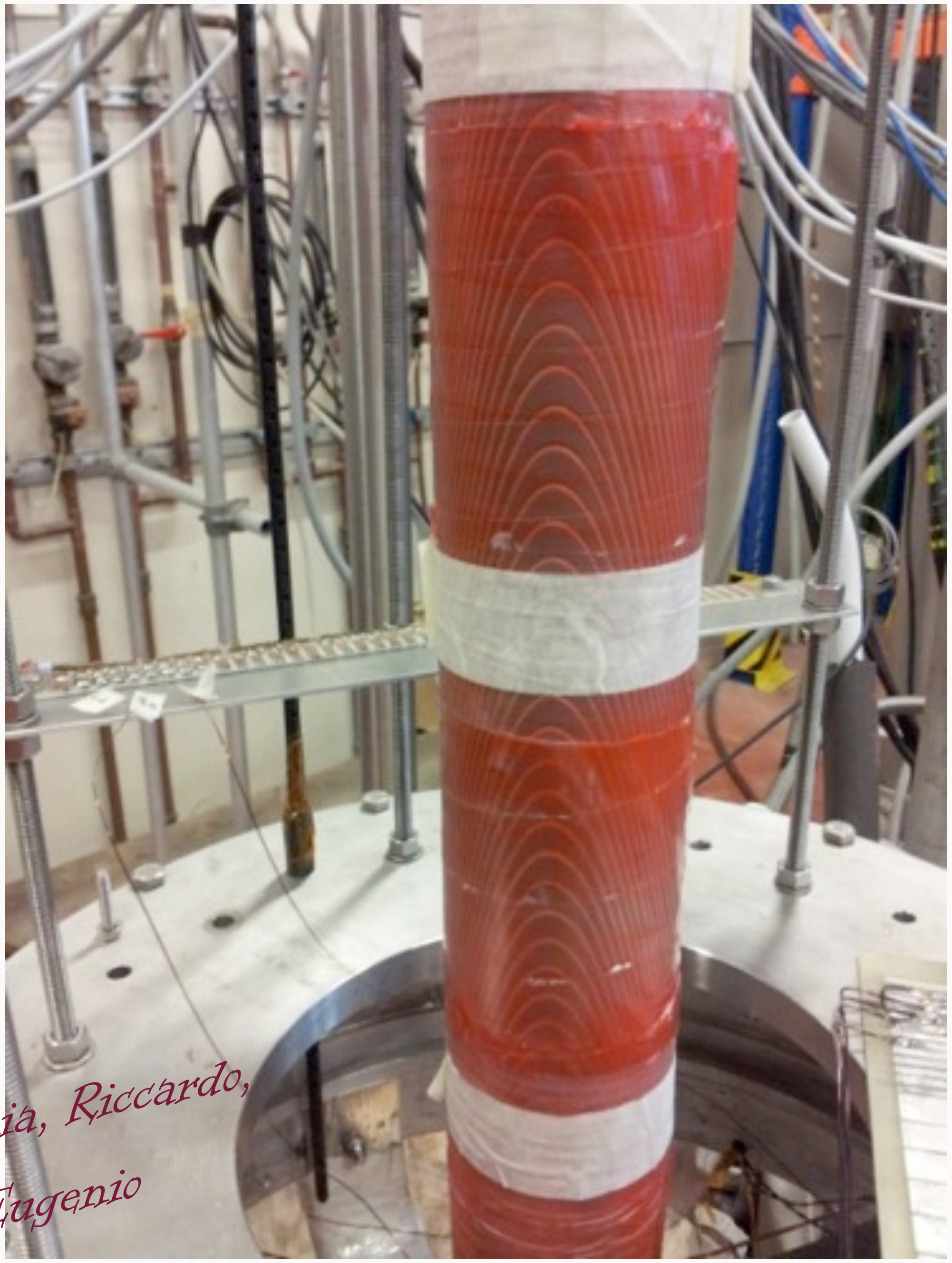


- The main challenge of the very final doublet is the QD0
  - It must generate a large field gradient to provide the strong vertical focusing needed to reach our goal 10^3 Hz/nb (10^{36} Hz/cm^2)
  - Its thickness is limited to ~ 5 mm
  - Very high current densities and very limited amount of material to handle a quench crysis

Prototype Characteristics

- The prototype QD0 was tested in December and January. We expected safe operation up to 2650 A and wanted to investigate the limits.





Pasquale, Stefania, Riccardo, Filippo, Eugenio

RESULTS OF THE TEST IN GENOVA

- The model was successfully tested. It was fed with a current of 2750 A. The limitation seemed to be of mechanical nature (mechanical disturbances). Further test are planned for better investigate this aspect.

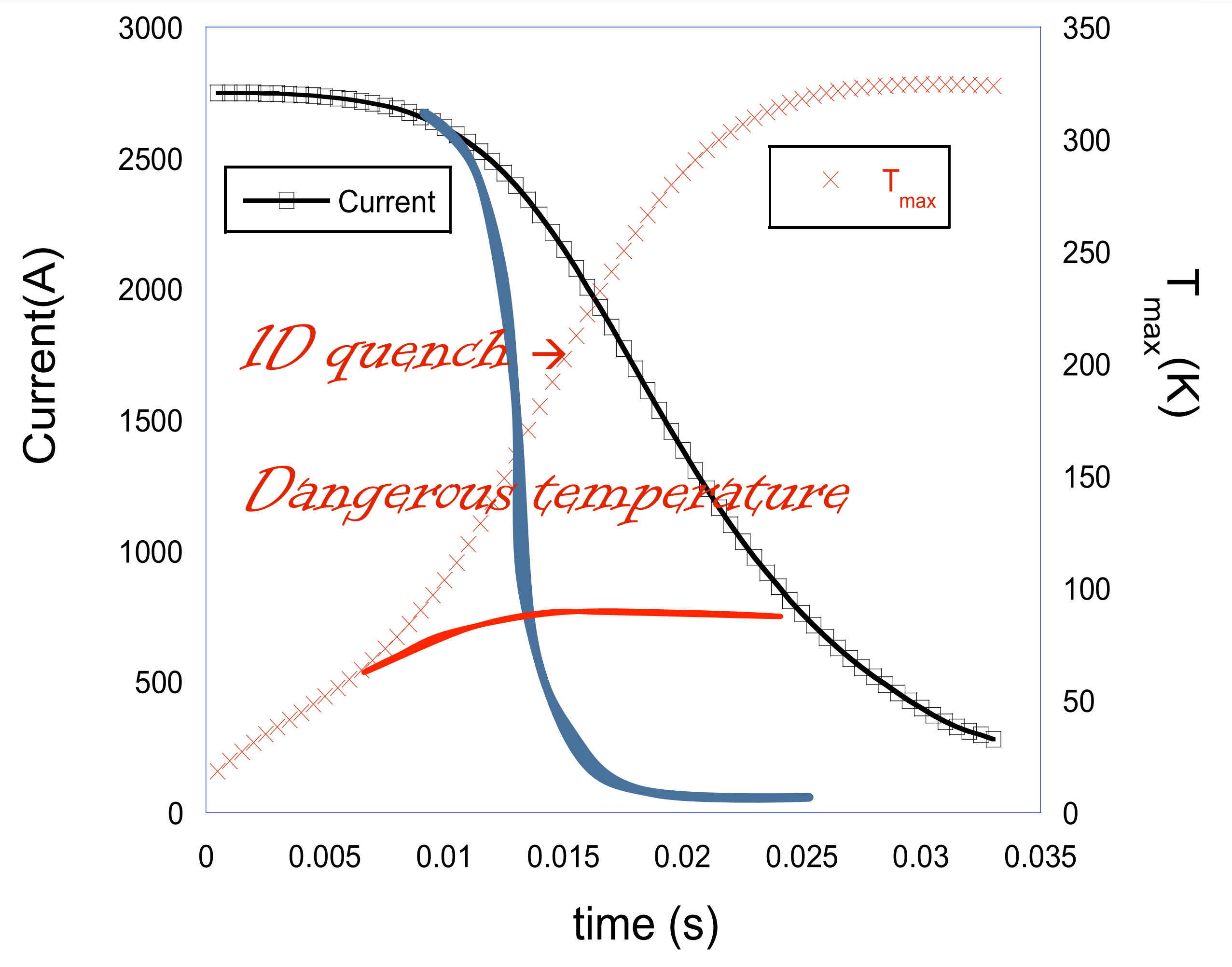
- It was observed that:

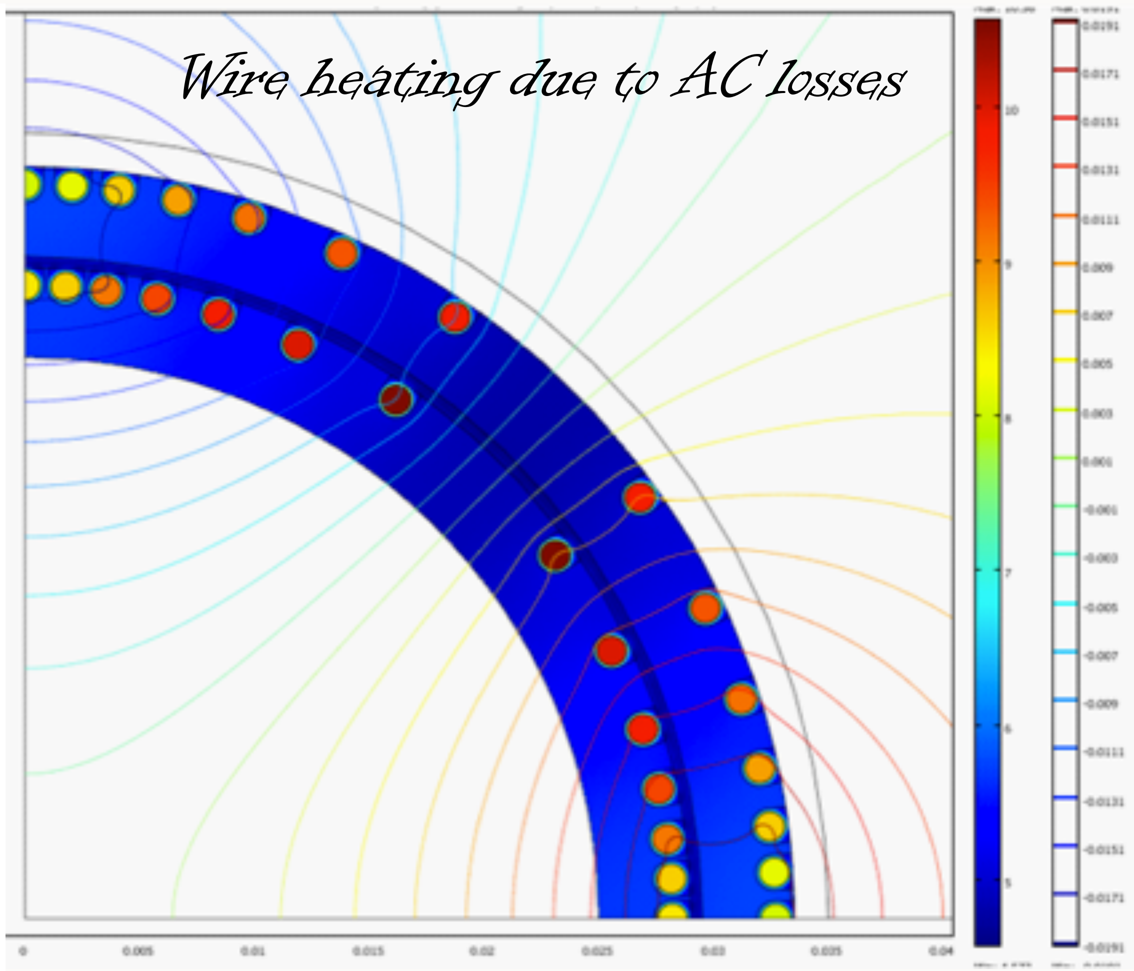
1. Training started at 2300 A
2. The quench protection might have triggered some 'quenches'
3. *The magnet restored soon SC state after quench (eventually with a few 10A still stored!)*
4. The quench protection was dis-connected and the magnet survived to many quenches.

- Why the magnet does behave so well?

Sometimes Unpredicted Surprises Are Nice

- Why the magnet behaves so well?





- We need to redo measurements with fast acquisition for verifying this occurrence

- The magnet heating after 8 ms. The AC losses in the wires causes a temperature increase over the critical one, quenching ***almost the entire*** magnet

Pasquale

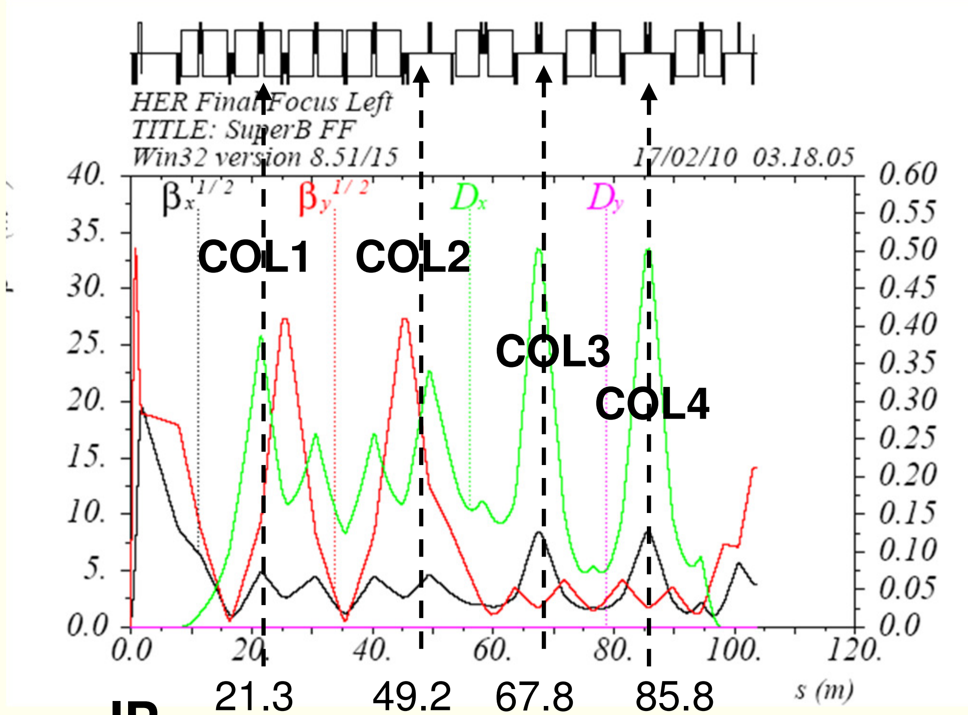
SINGLE BEAM BACKGROUNDS

Touschek IR background rates

|s|< 2 m

HER (e+):

no collimators = 2.5 MHz × 978 bunches = 2.4 GHz/beam
with collimators = 6.95 kHz × 978 bunches = 6.8 MHz/beam



Collimator set: (mm)

	internal / external
Col1	-9 / +12
Col2	-9 / +25(out)
Col3	-18 / +12
Col4	-12 / +18

(pipe is -25 /+25 mm)

no collimators τ_{TOU} = 26 minutes
with collimators τ_{TOU} = 22 minutes

Manuela Boscolo

SINGLE BEAM BACKGROUNDS

LER Touschek IR background rates

I_b =2.5 mA

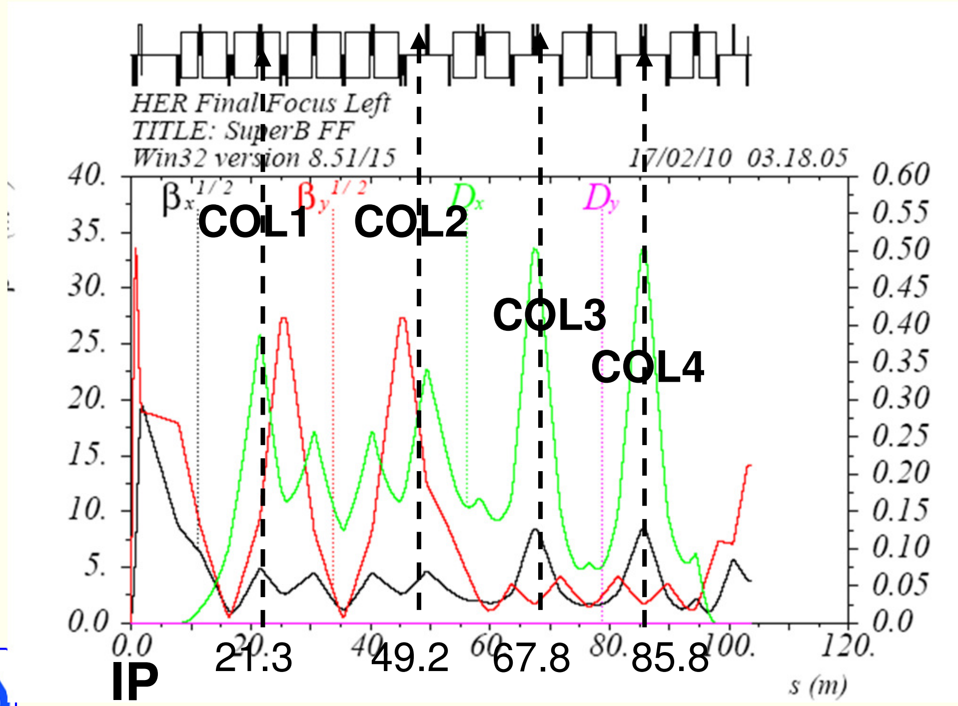
|s|< 2 m

With IBS: ε_x =2.4 nm

Collimators inserted further
With a 1.3 IR rates reduction

with collimators = 73.3 kHz/bunch × 978 bunches =72 MHz/beam

with collimators τ_{TOU} = 420 s (7 minutes)



Collimator set: (mm)

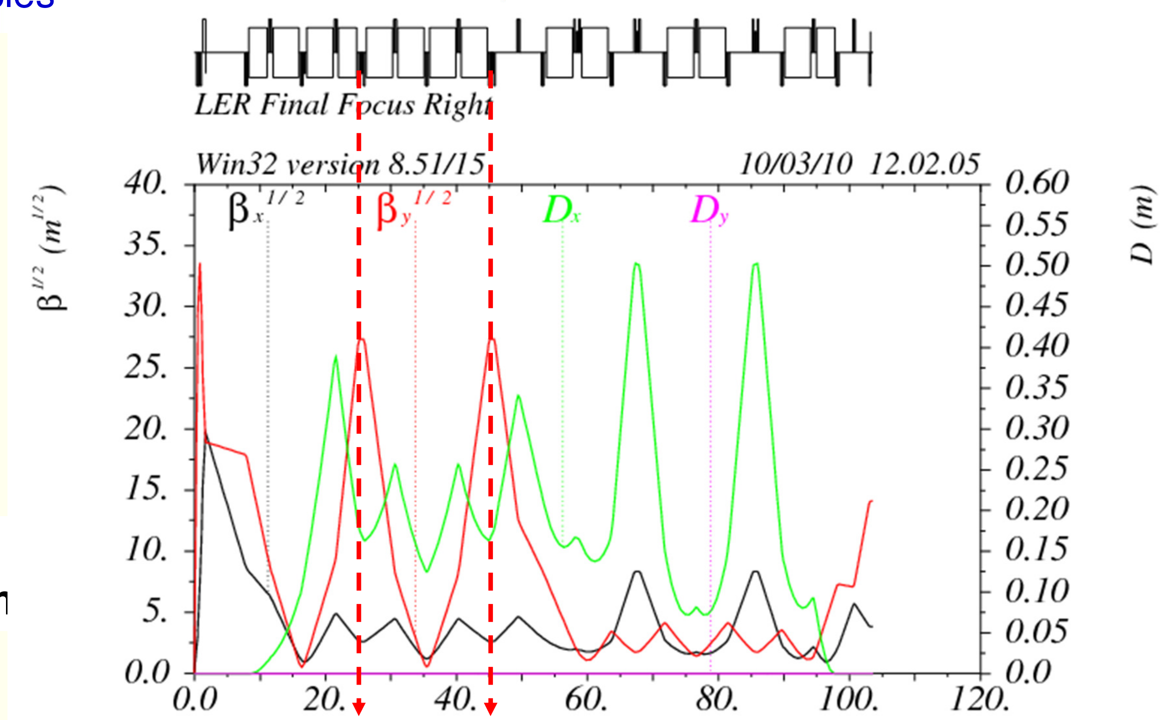
	internal / external
Col1	-9 / +12
Col2	-10 / +18
Col3	(out)-25 / +12
Col4	-12 / +16

Manuela Boscolo

BEAM GAS

Vertical COLLIMATORS in the Final Focus

To be added to the Horizontal ones, placed to intercept Touschek scattered particles



25

HER Beam-gas Coulomb scattering

P = 1 nTorr constant along ring, Z = 8

HER	τ (s)	IR losses/beam
no collimators	4590	10.5 GHz
with vertical Collimators	**3040**	**3.7 MHz**

About a factor 950 in IR losses reduction

no collimators =10.8 MHz/bunch × 978 bunches=10.5GHz/beam
with collimators = 3.8 kHz/bunch × 978 bunches= 3.7 MHz/beam

Collimator set: (mm)

	internal / external
HCol1	-9 / +12
HCol2	-9 / +25(out)
HCol3	-18 / +12
HCol4	-12 / +18
VCol1	**-4.5 / +4.5**
VCol2	**-4.5 / +4.5**

Set of values optimized for Touschek

28

LER Beam-gas Coulomb scattering

P = 1 nTorr constant along ring, Z = 8

LER	τ (s)	IR losses/beam
no collimators	2520	25 GHz
with vertical Collimators	2350	**36 MHz**

About a factor 700 in IR losses reduction

no collimators = 26 MHz/bunch × 978 bunches =25.4 GHz/beam
with collimators = 36.7 kHz/bunch × 978 bunches=36 MHz/beam

Collimator set: (mm)

	internal / external
HCol1	-10 / +14
HCol2	-10 / +18
HCol3	(out)-25 / +12
HCol4	-12 / +16
VCol1	**-6 / +6**
VCol2	**-6 / +6**

There is margin of further IR rate reduction,
As for the HER, Vcol set may be re-checked if secondaries not satisfactory (we still have margin in lifetime)

31

Manuela Boscolo

- Collimators optimized for the V12 lattice with a realistic model of the IR layout from Mike

PAIRS BACKGROUND

Comparison

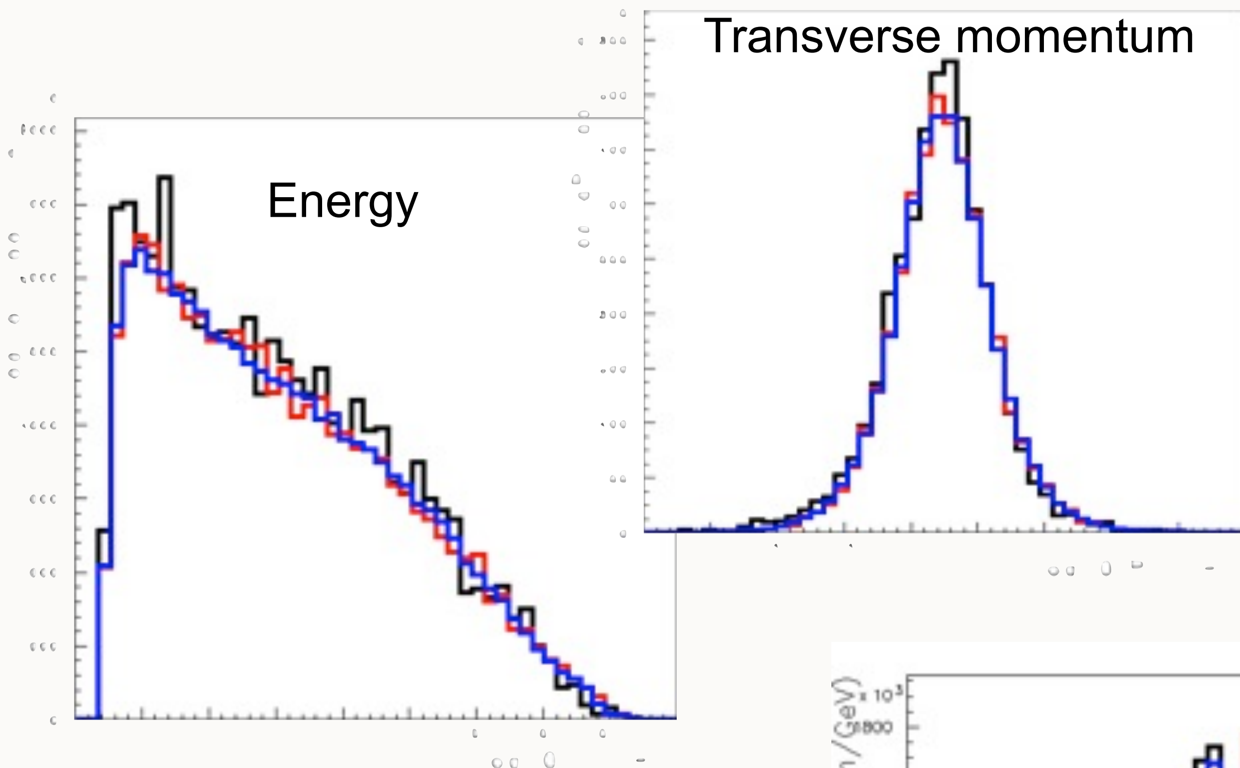
BDK / DIAG36 / GP++FastSim

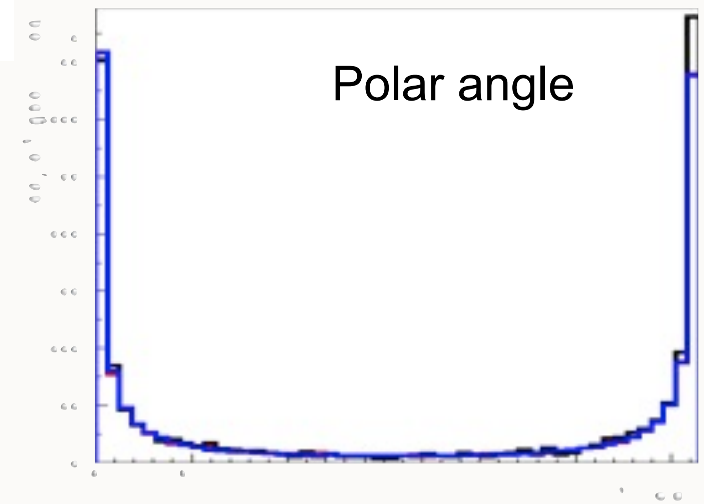
(7.30±0.03) 10^6 nbarn

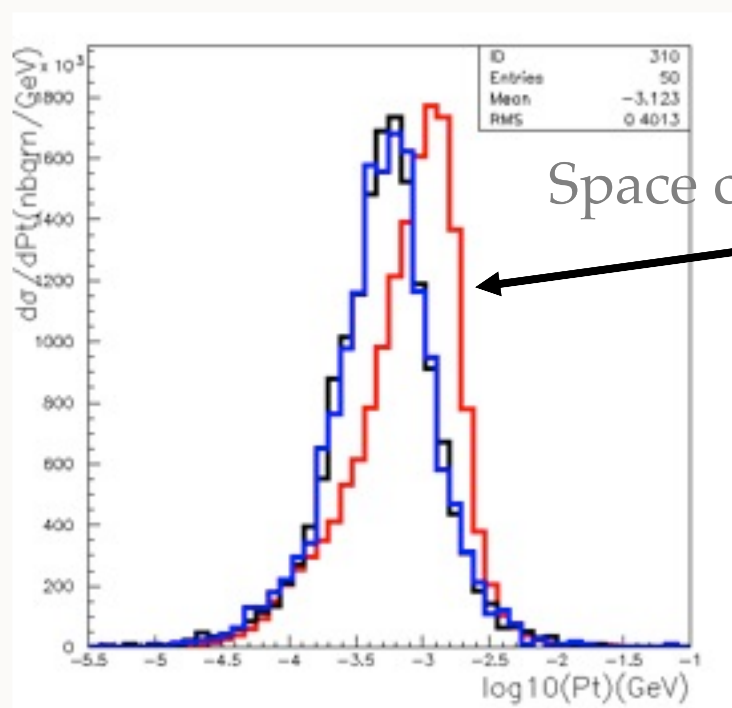
(7.7±0.4) 10^6 nbarn

7.28 10^6 nbarn

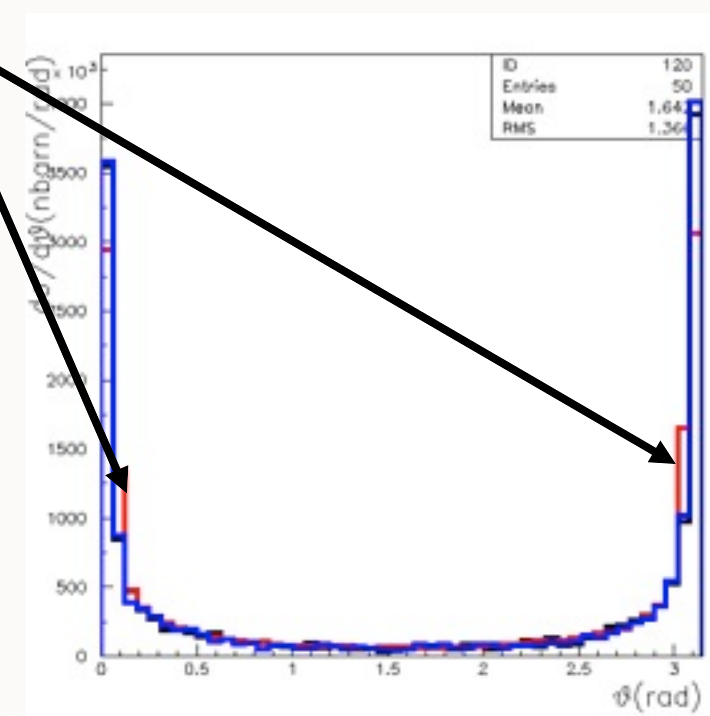
Cecile Rimbault







Space charge effects



- Very nice agreement among generators
- Space charge effects simulated with Guinea Pig++: small reduction foreseen for the L0 rate

Safety Factor: Forewords

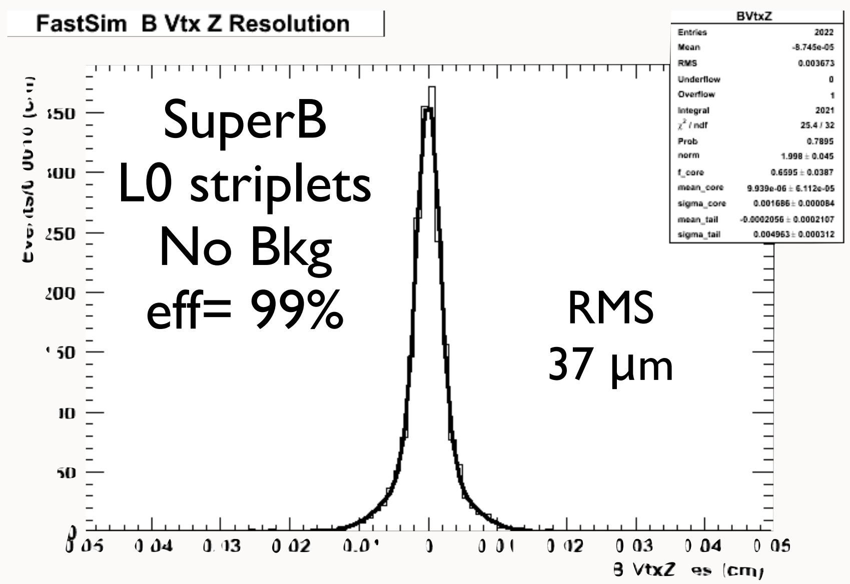
- Although our confidence on the present background model increased a lot after the Vienna meeting we have not to forget the main purpose of the Safety Factor
- History teach us that the main background source was always discovered *ex post* and never foreseen *a priori*
- The present background predictions are based on an ideal machine (IP in the nominal origin, orbits on nominal trajectories, nominal vacuum, perfect scraping system)

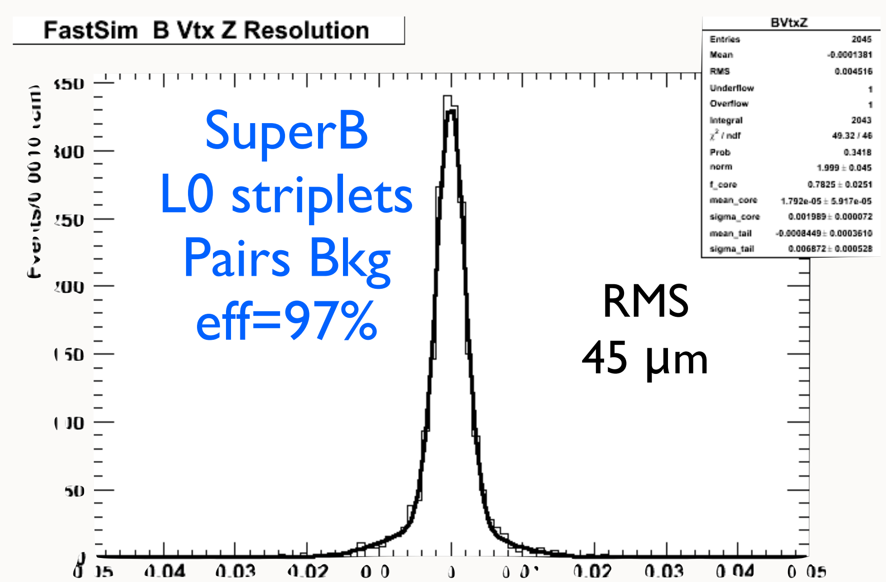
SAFETY FACTOR = 5

- The Tech Board decided that a reasonable safety factor to be taken into account is *5*
- What about optimization? Do we have to optimize for nominal? For x5?
- *You have to build a detector with reasonable performances in all the scenarios (1x to 5x)*
  - *Shaping time configurable at run time as an example...*

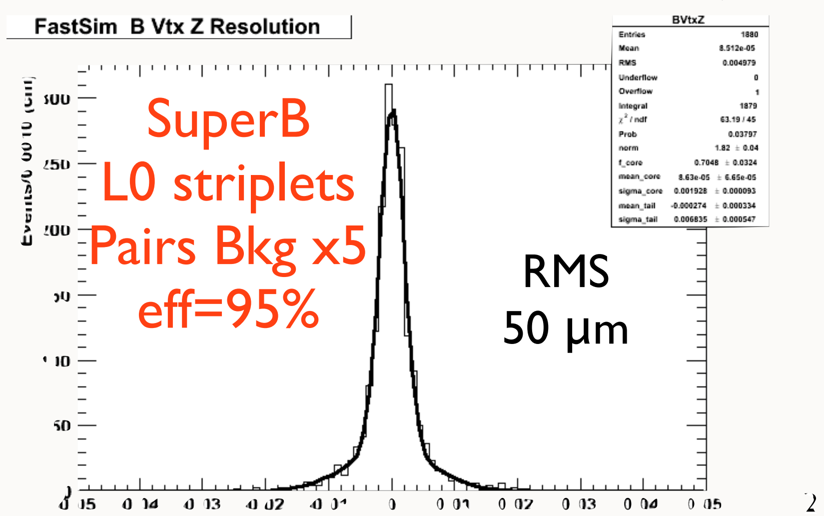
PAIRS BACKGROUND

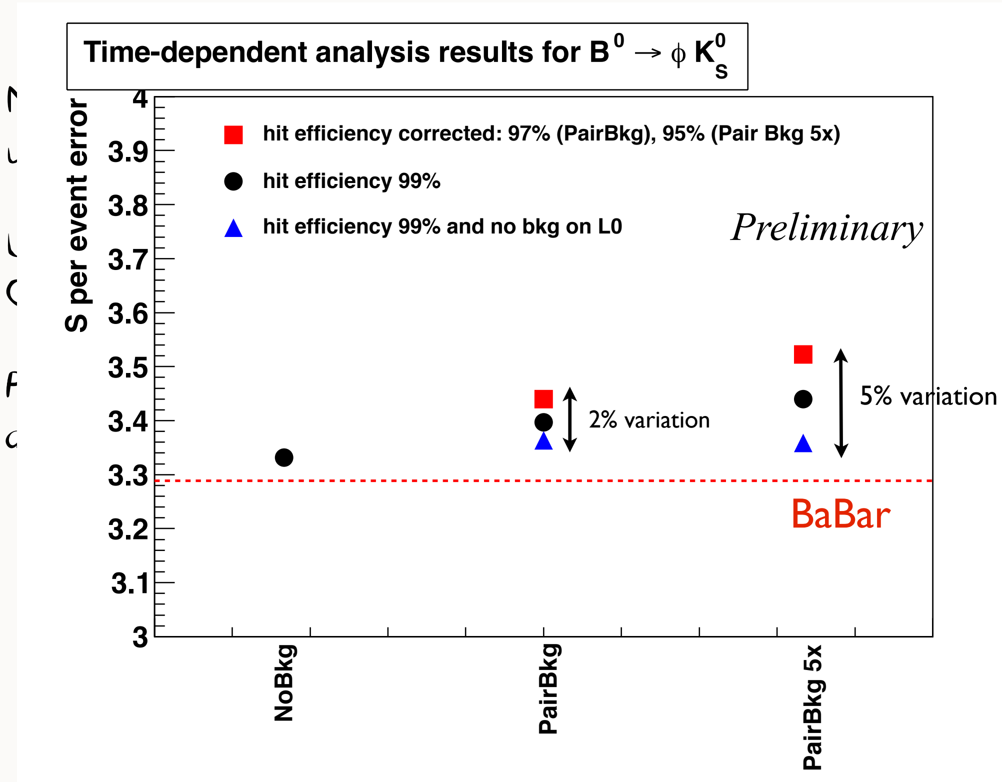
Decay vertex resolution



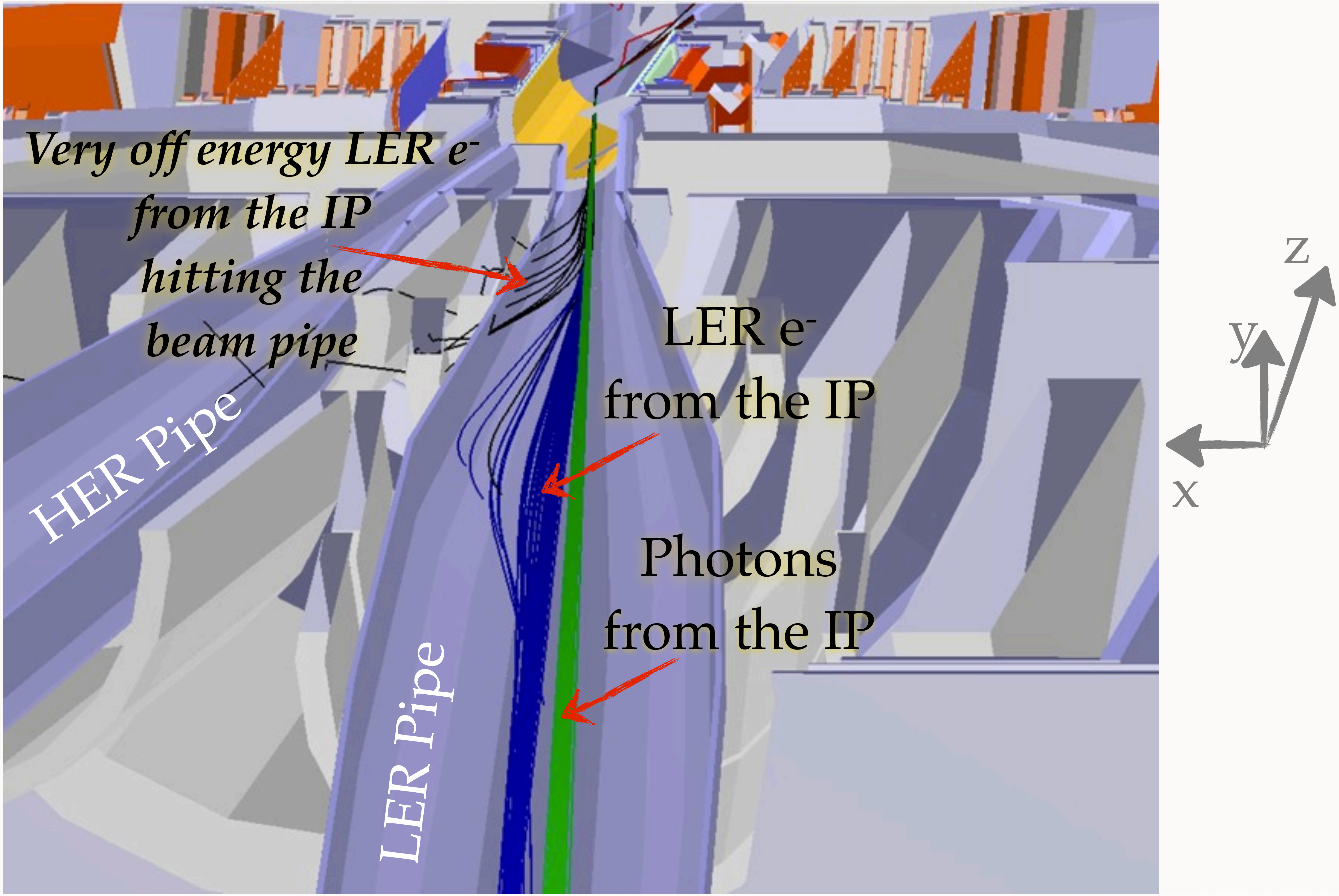


Nicola Neri

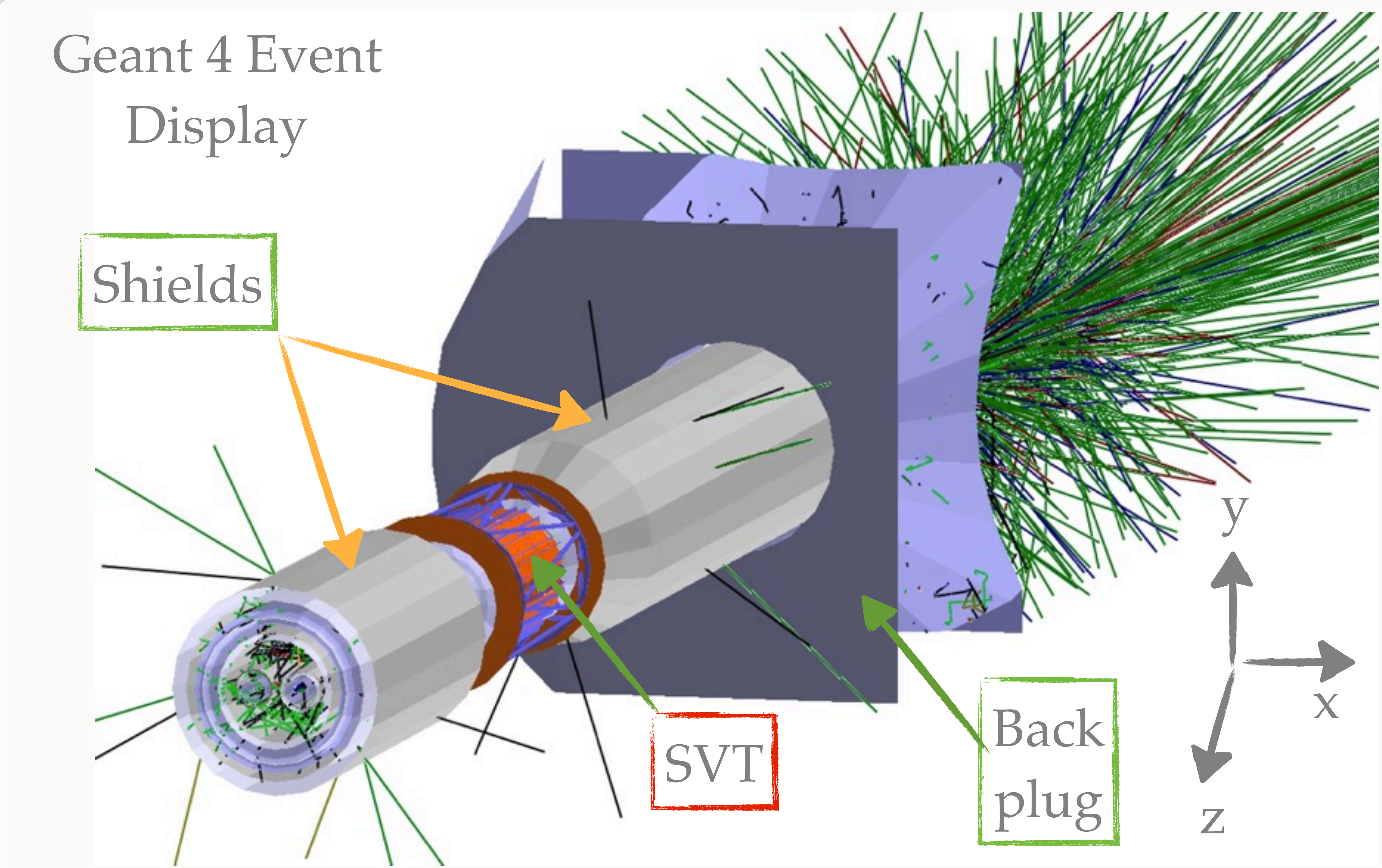




RADIATIVE BHABHA (PRIMARIES ONLY)

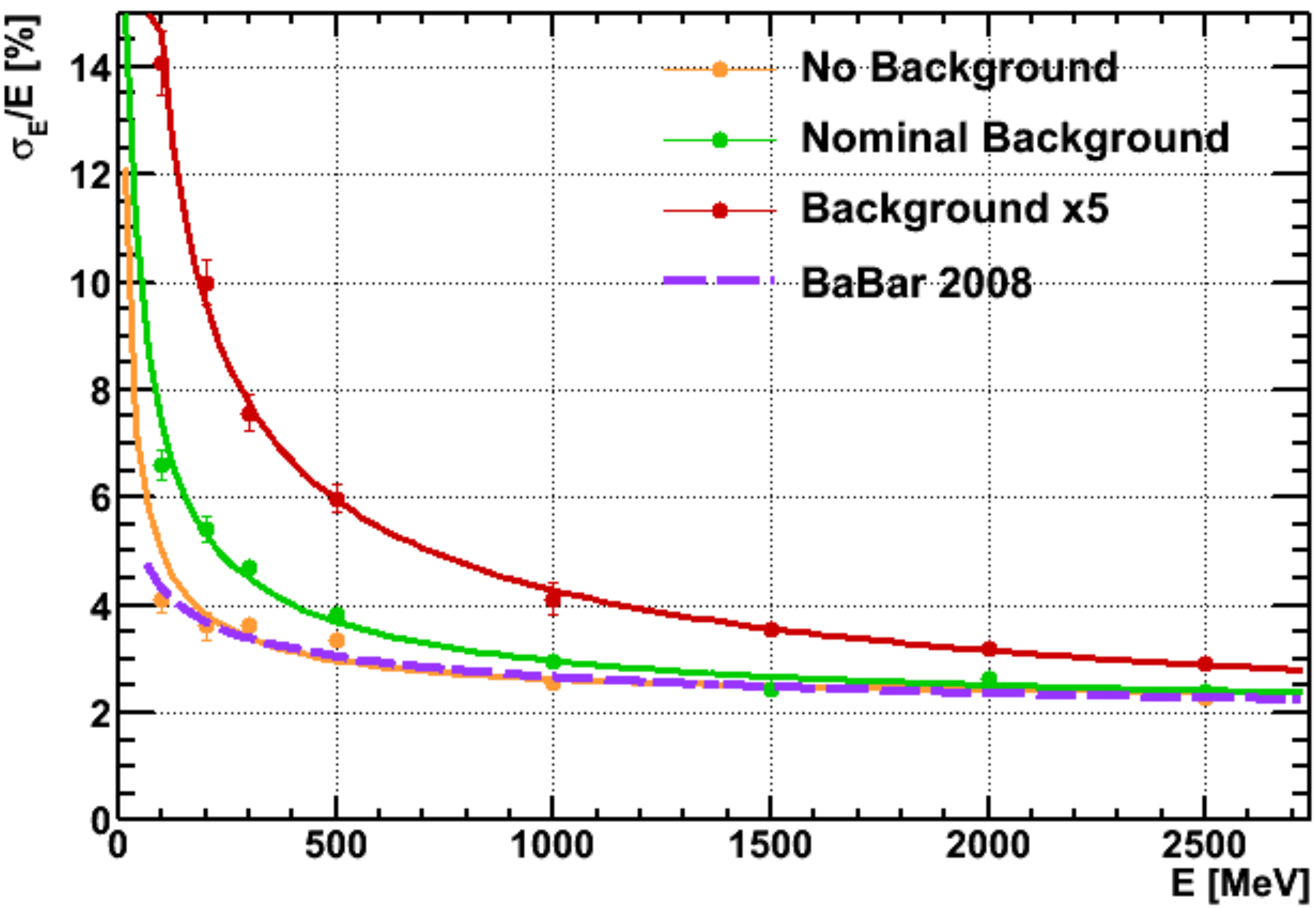


1 BUNCH CROSSING: SECONDARIES



EMC Performances

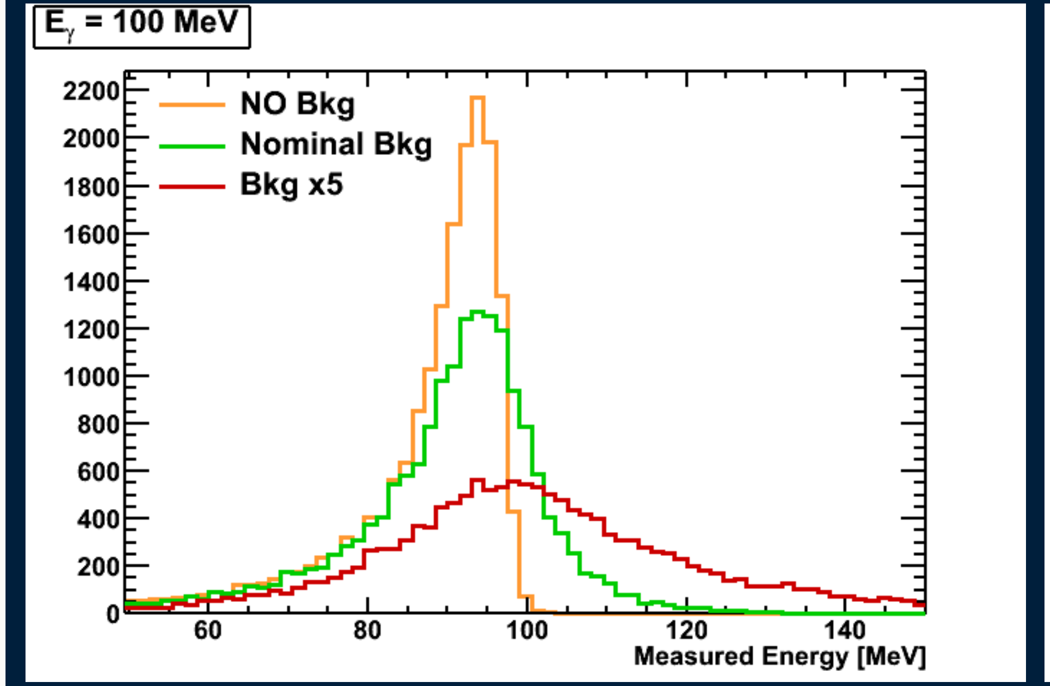
Barrel – Eres vs Background Level

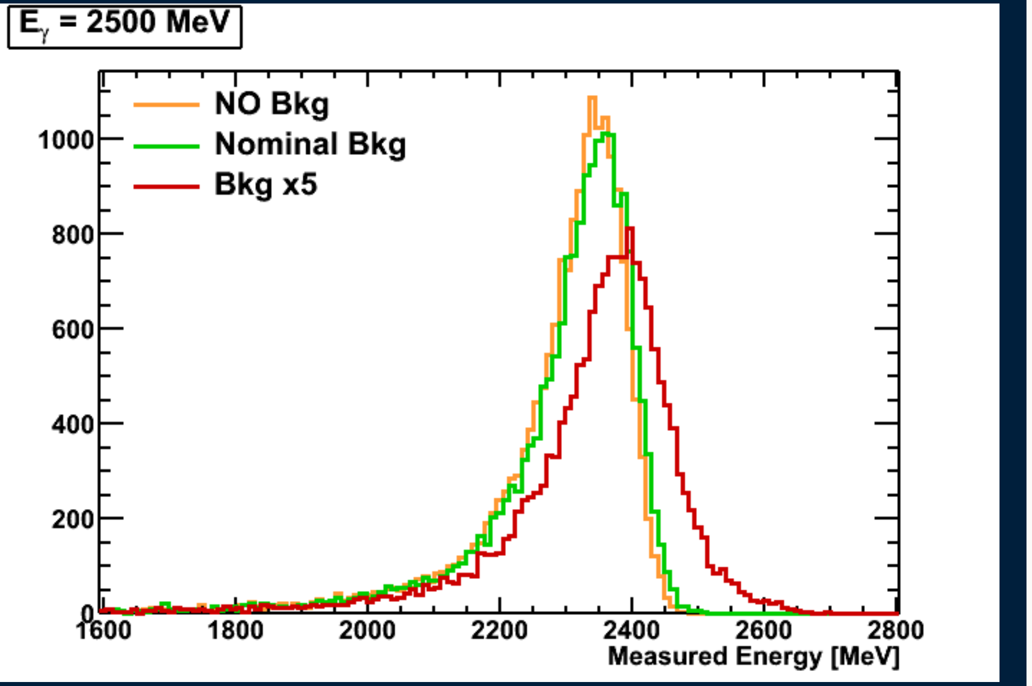


Stefano Germani

Cluster resolution

Barrel Energy distributions



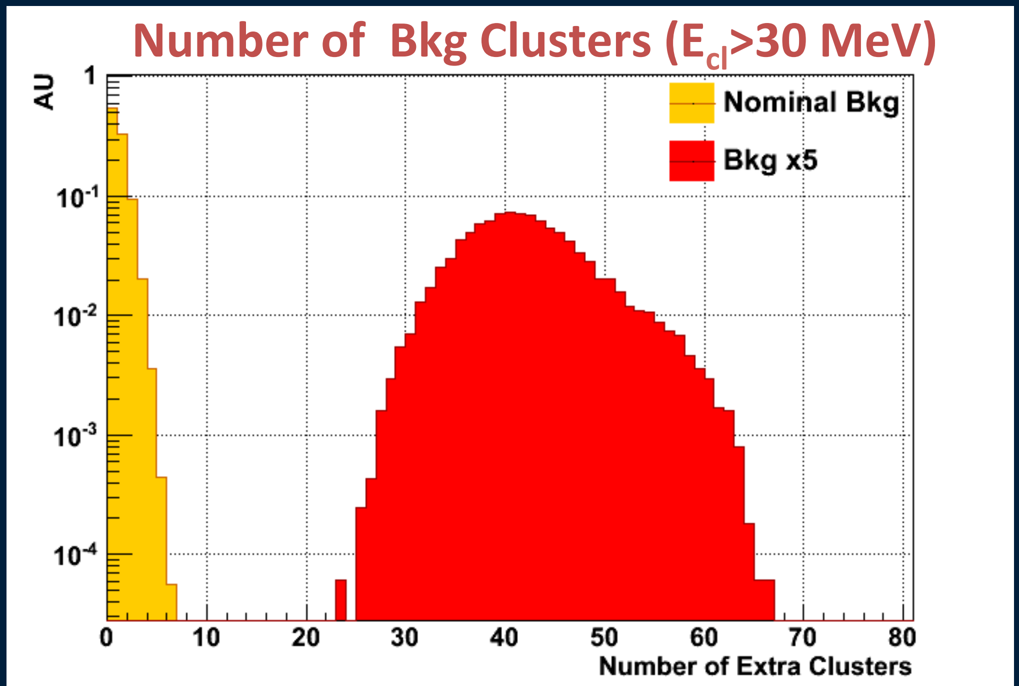


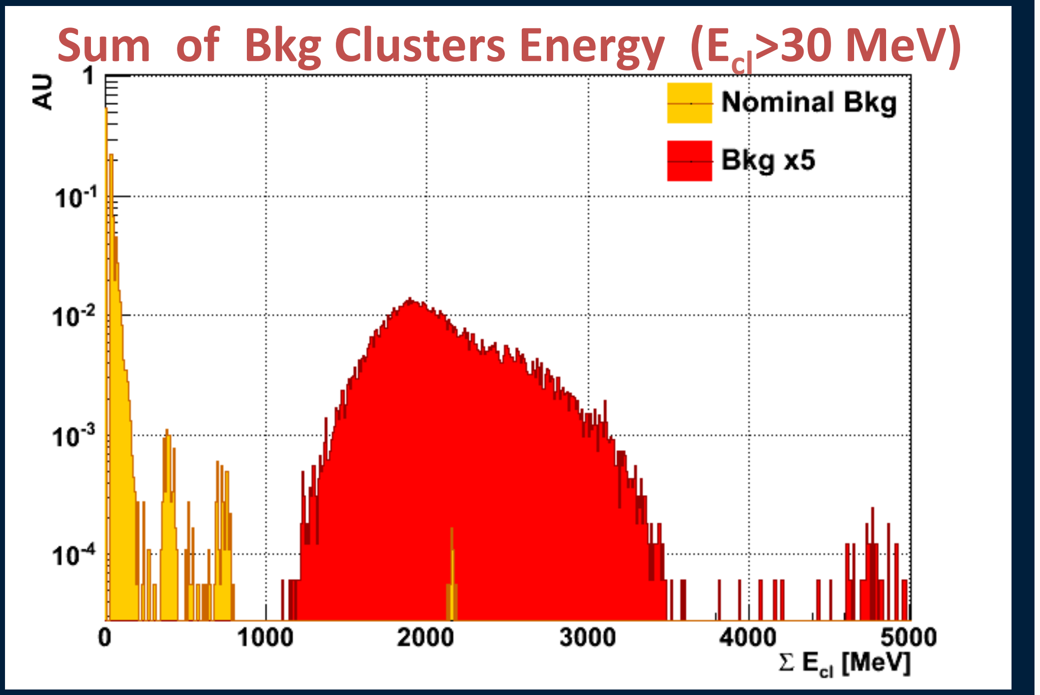
→Background has significant impact on Energy Resolution
→Background shifts peak energy toward higher values
- ✓ Background adds extra energy to signal crystals

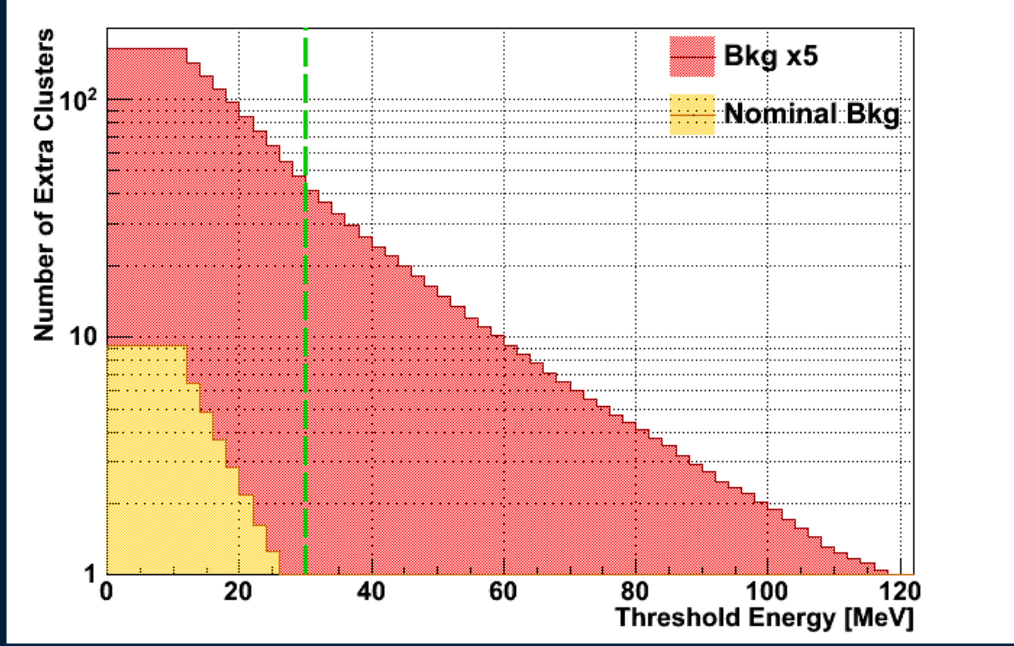
Stefano Germani

Cluster Multiplicity

Number of Clusters







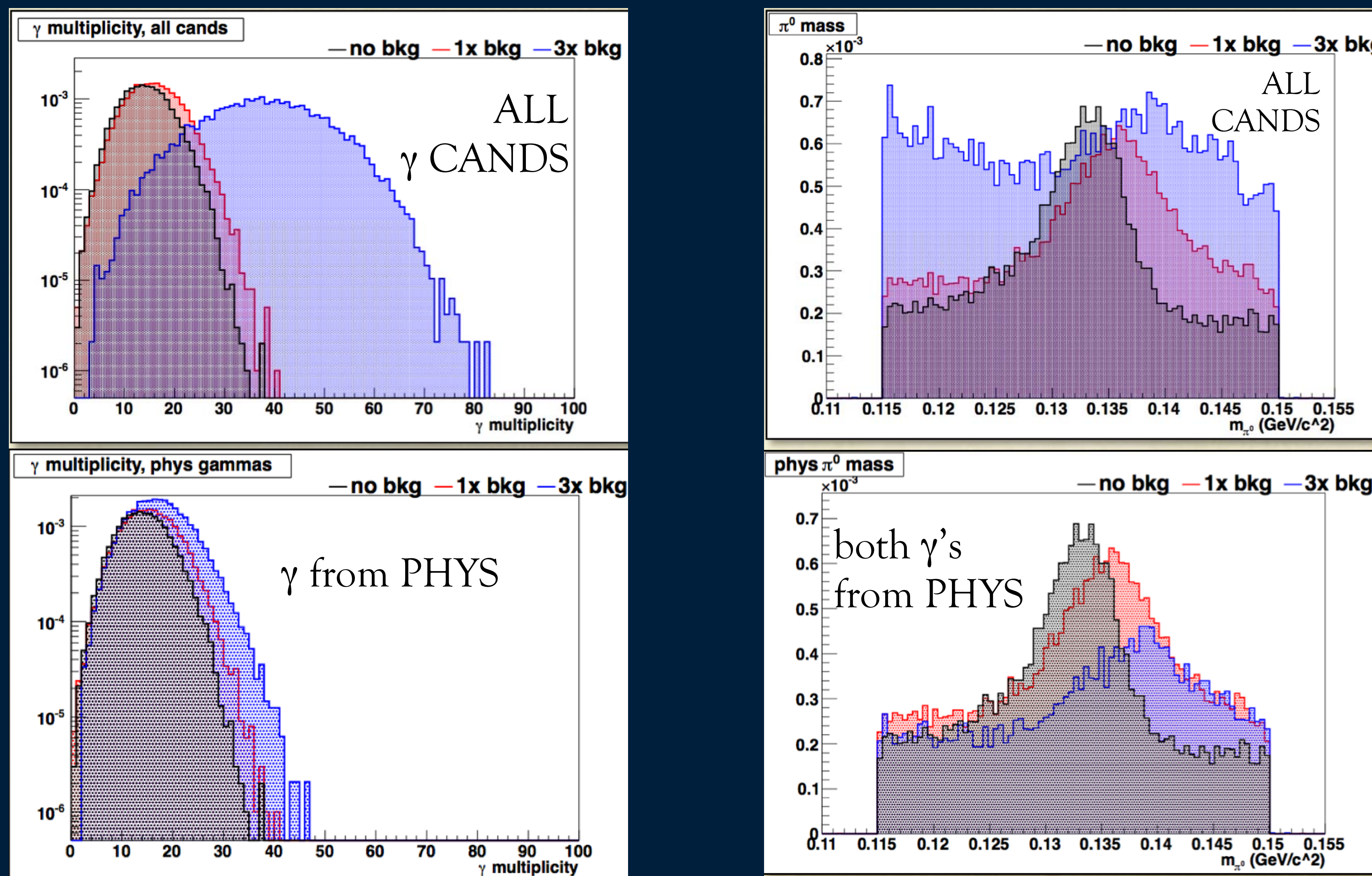
- ✓ Large difference between nominal background and x5 safety factor
- ✓ High multiplicity with x5 background

Stefano Germani

Consequences on Physics

Bkg Impact with FastSim – Gamma, pi0

B B generic sample



See E. Manoni talk at EMC I parallel session

http://agenda.infn.it/getFile.py/access?contribId=277&sessionId=27&resId=0&materialId=slides&confId=4441

Elisa Manoni

How To Get Rid of This few MeV Gammas?

- Fast Sim studies from Elisa includes only photons with an energy > 8 MeV
- We will try to improve the tungsten shield shape (hope is the last to die)
- Any Secret Weapon around?
    - Still some improvement on the IR layout, we have to interact with Mike

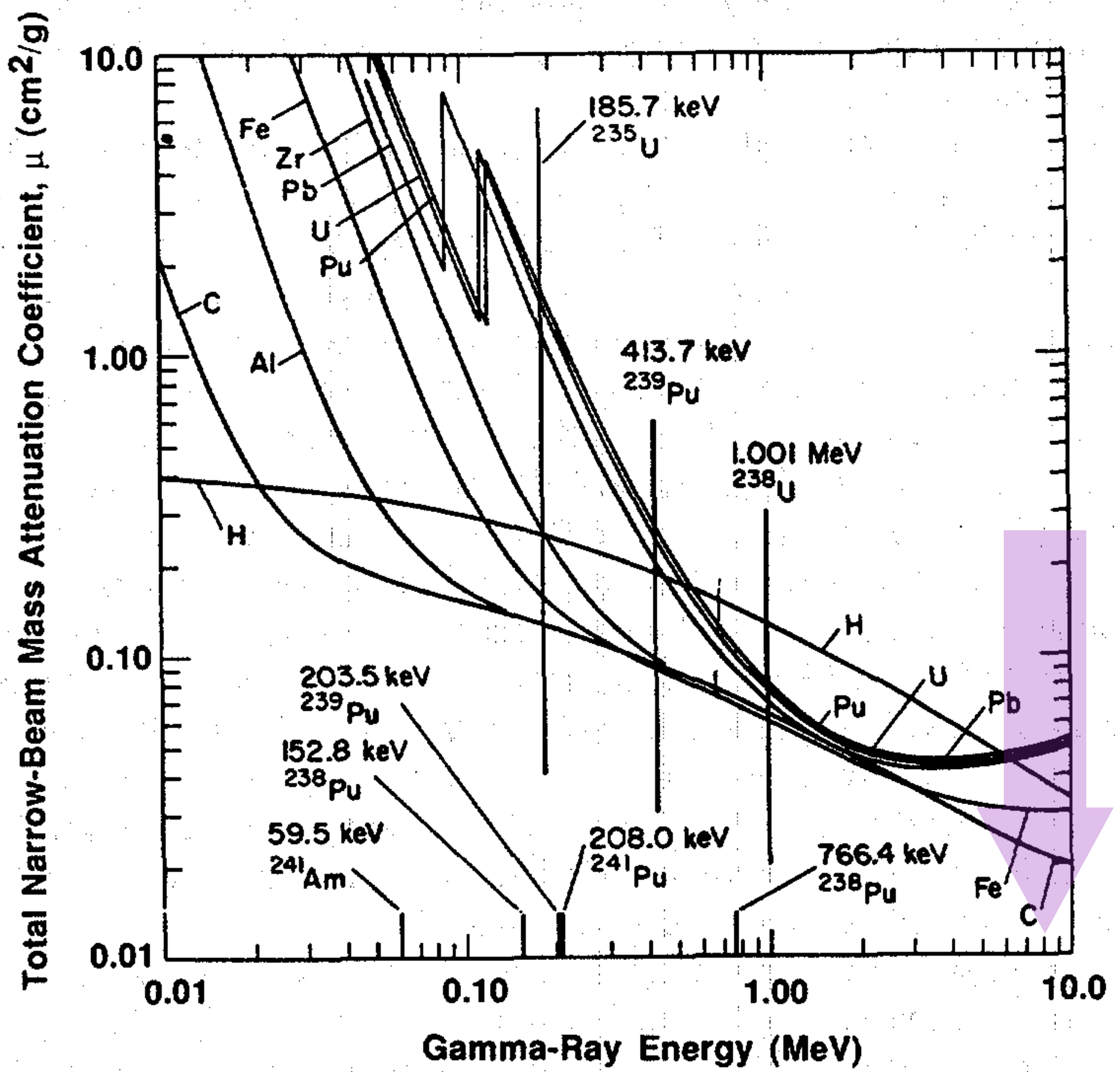
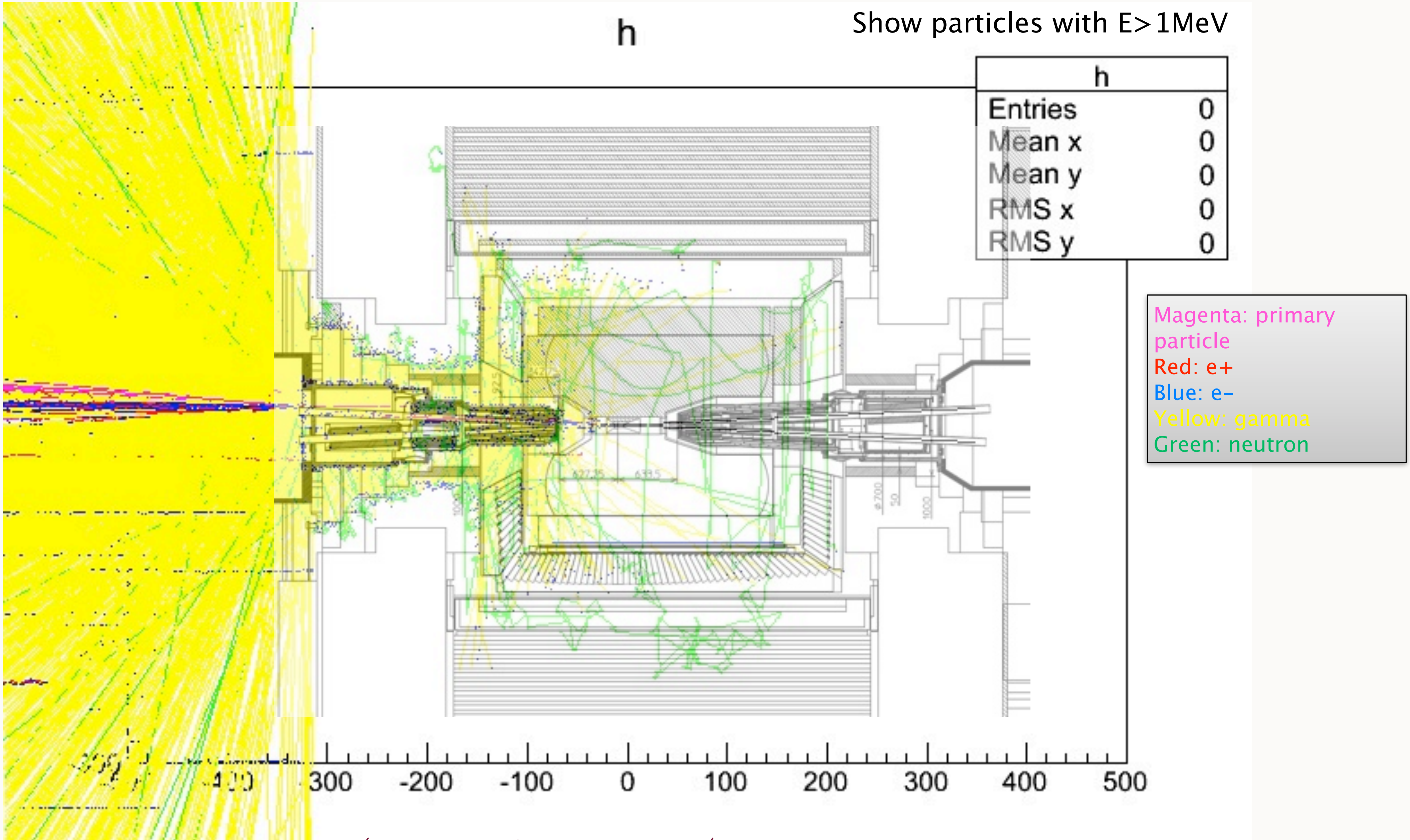


Fig. 2.12 Mass attenuation coefficients of selected elements. Also indicated are gamma-ray energies commonly encountered in NDA of uranium and plutonium.

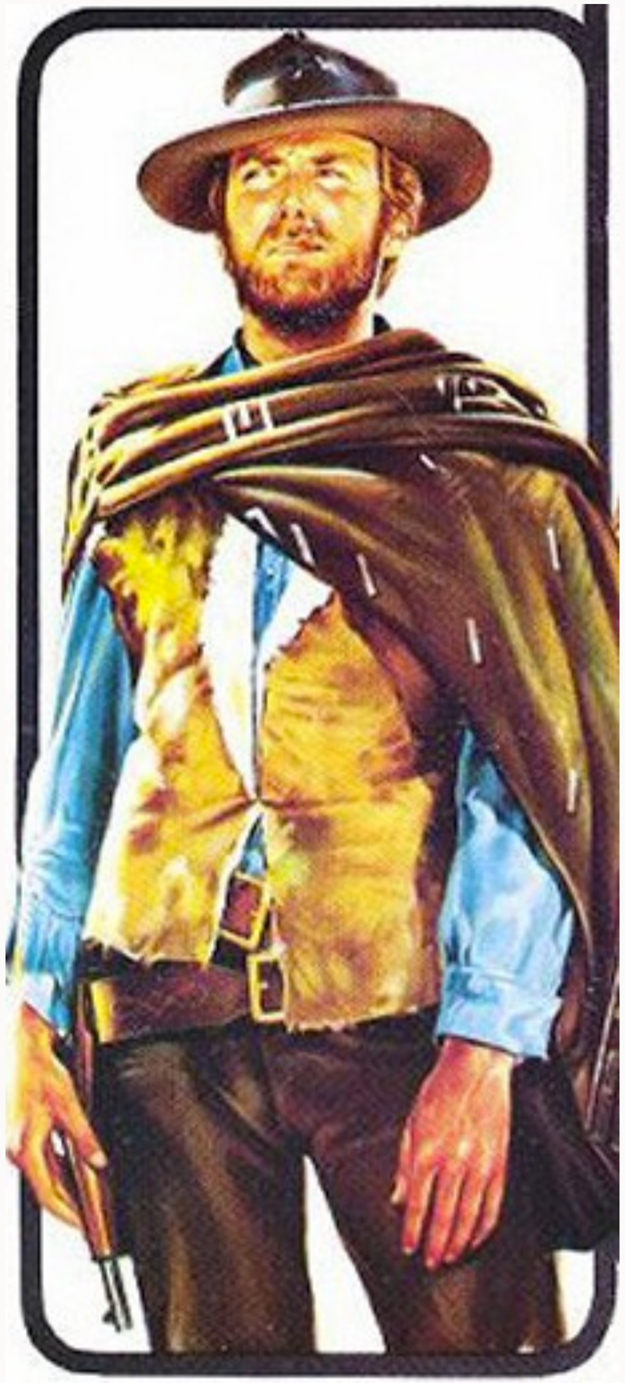
We Are in Good Company...



Courtesy Nakayama - San

Conclusions I (The Good)

- The thin quadrupole concept demonstrated to be viable
  - The construction of a new prototype closer to the present QD0 characteristics is in progress
- The first mechanical draft of the tungsten shields support had been proposed
- The quick mounting/demounting procedure definition is in progress
- The single beam backgrounds are under control
- The background picture in Belle-II is in fairly good agreement with our



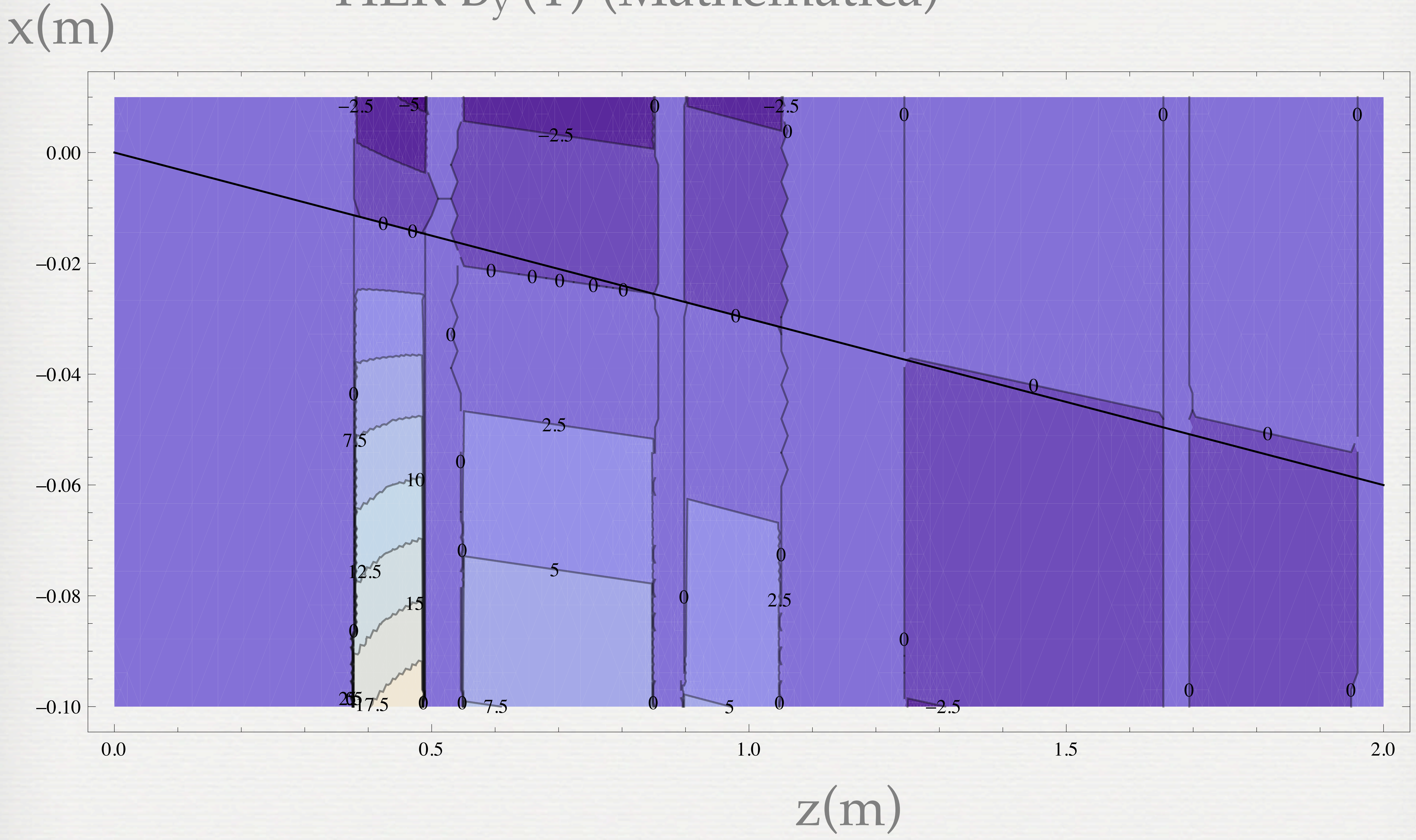
Conclusions II (the Bad and the Ugly)

- The radiative Bhabha background x Safety factor kills the EMC performances
  - The pi0 and hadronic B reconstruction is heavily spoiled already with a Safety factor = 3
- How to get rid of most of the ~MeV photons glowing from the beam line?
  - Tungsten shield thickness
  - IR layout
- Hard work foreseen for the next month on this topic

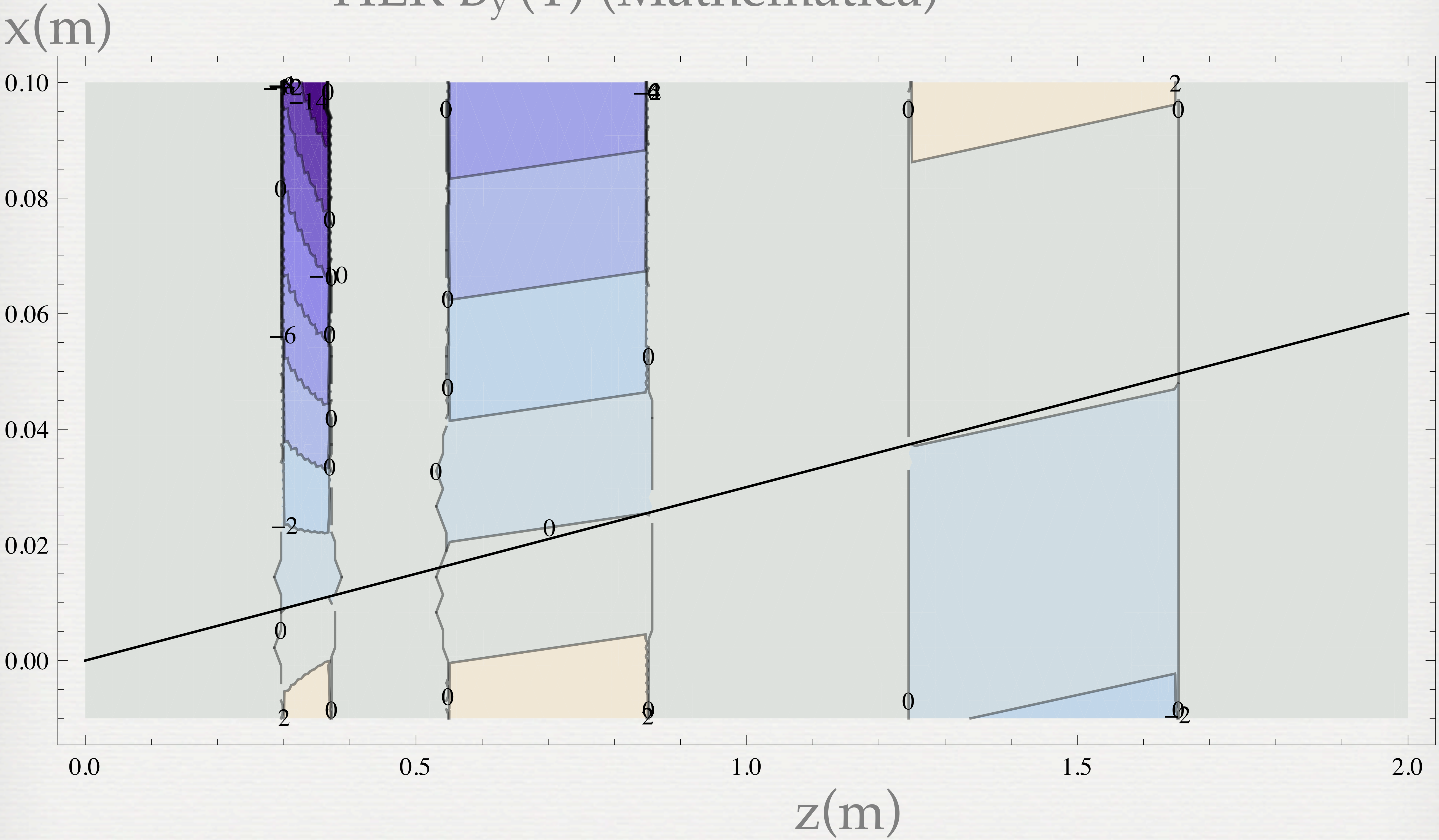
Thank you

For your Attention

HER B_y (T) (Mathematica)

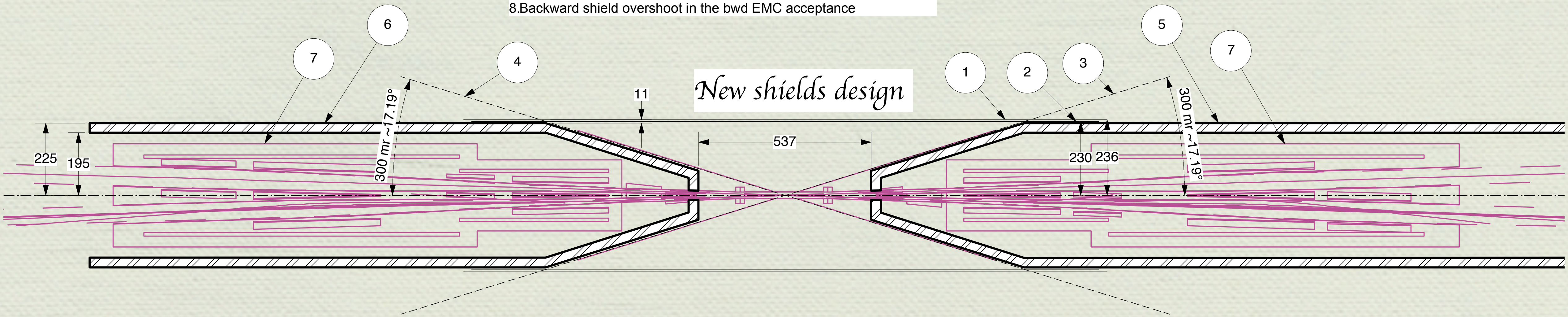


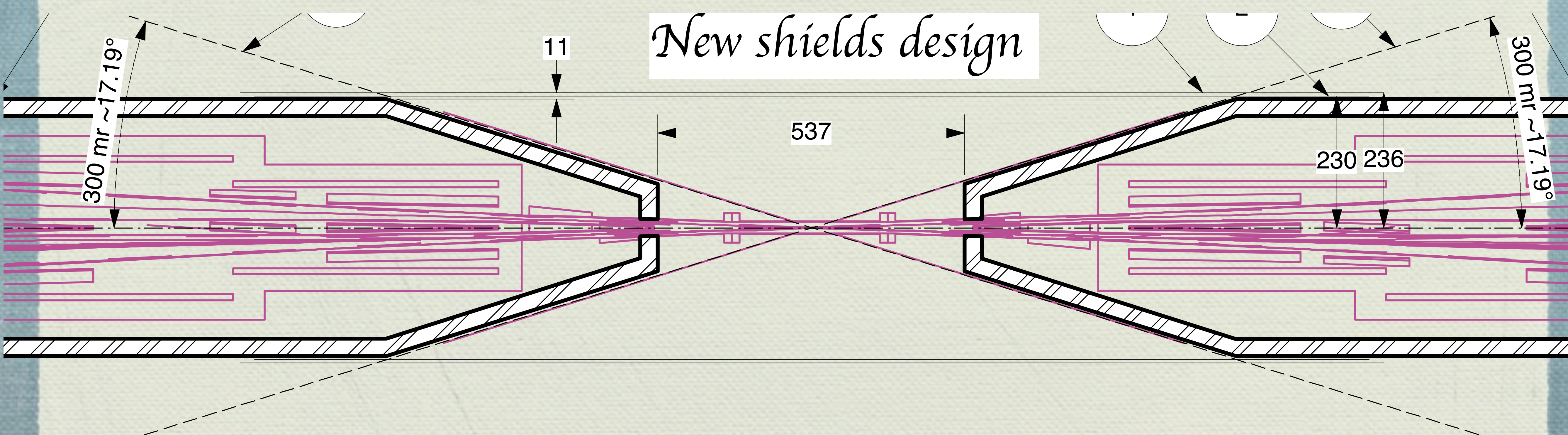
HER B_y (T) (Mathematica)



Mechanical interface: boundaries

General Notes
1.DCH internal radius
2.Geant4 DCH boundary envelope
3.Forward acceptance limit
4.Backward acceptance limit
5.Forward shield
6.Backward shield
7.Final focus cryostat
8.Backward shield overshoot in the bwd EMC acceptance





Generator Level Comparison