Update on DCH Background Study with Bruno

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SuperB General Meeting, Frascati (ITALY)

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Status and Outline

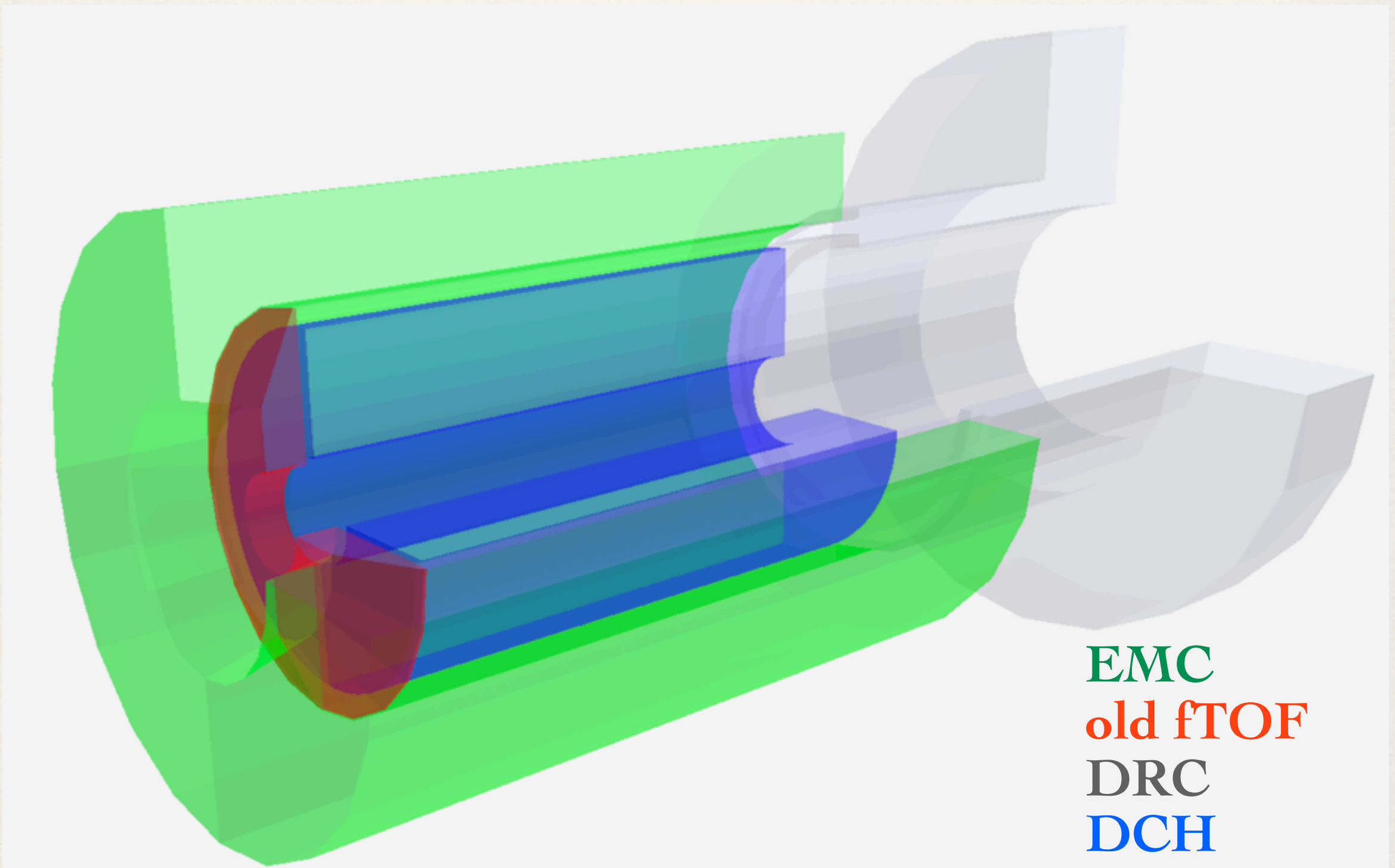
- After the December meeting:
  - Method to compute the occupancy has been checked, Ok
  - Problem: inconsistency in the results is likely due to approximate simulation of low energy em processes, results are ok using only tracks with Einc > 5MeV
  - Problem: increase in occupancy using the new geometry with extended pipes
- Outline:
  - Optional geometry for testing the new forward PID detector
  - High occupancy with Dec 2010 geometry (already covered by Dana)
  - Understanding the simulation using single particles, alternatives to limit step size in Dch volume

Optional Geometry for fTOF test

fTOF test

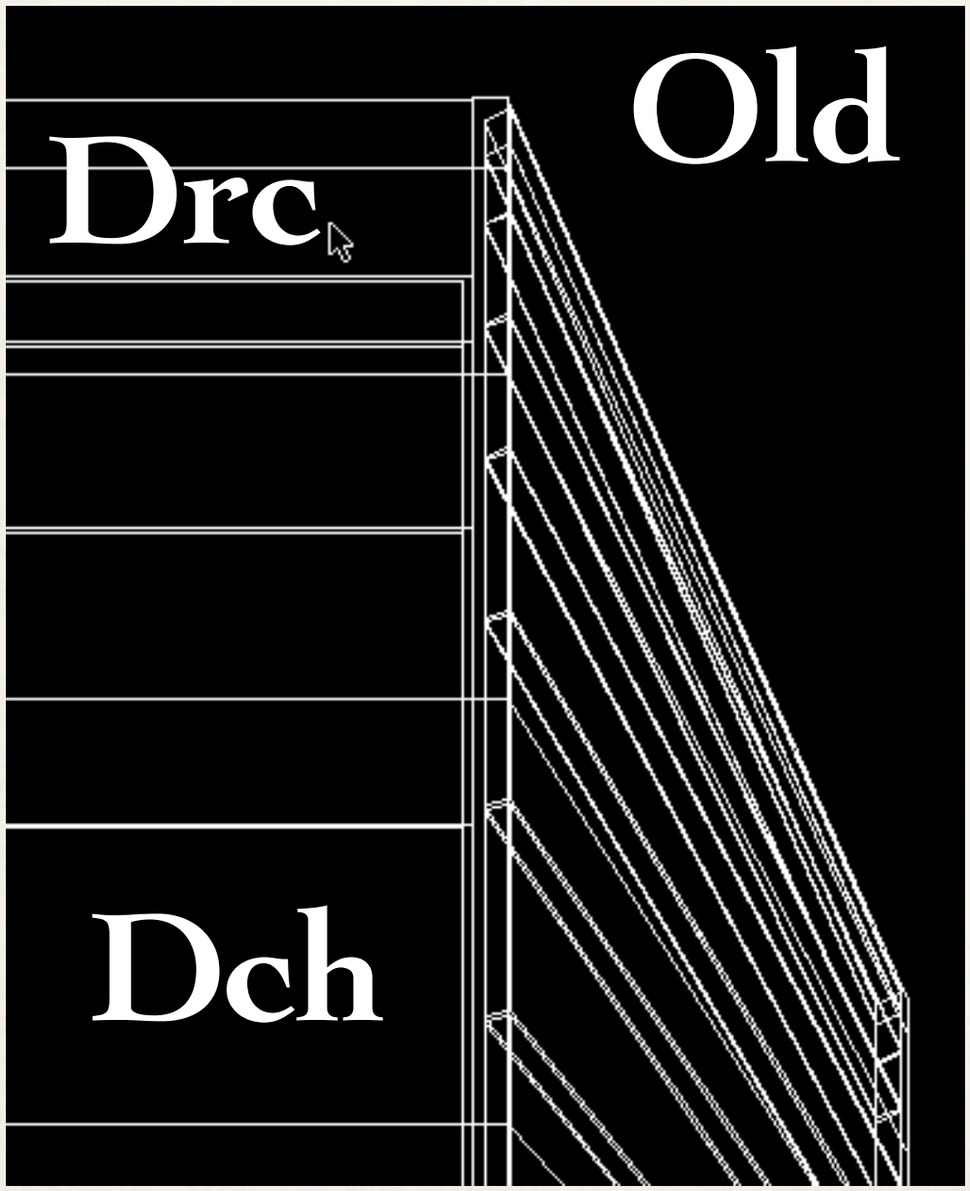
- Request to make room for new fTOF geometry
  - Short Dch, 5 cm
  - Move Drc 5 cm in bwd direction
  - It's not possible to move Emc, projective geometry of crystals
- Committed in **r418**
  - Optional geometry, need to modify main gdml (instructions per email and on svn comment)
  - Add also tungsten shielding extension made by Eugenio
- Overlaps checks done, ok

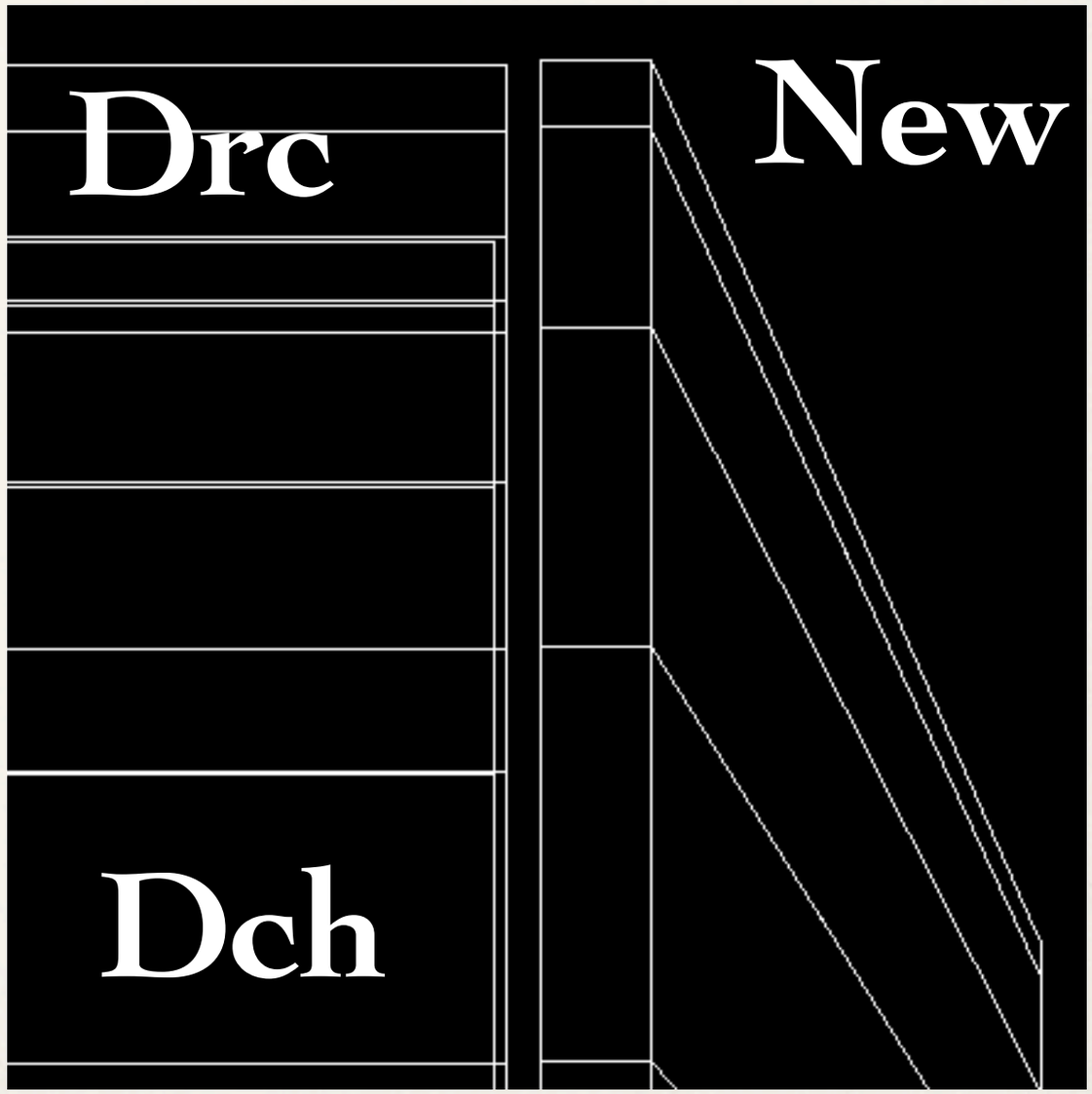
fTOF test



fTOF test

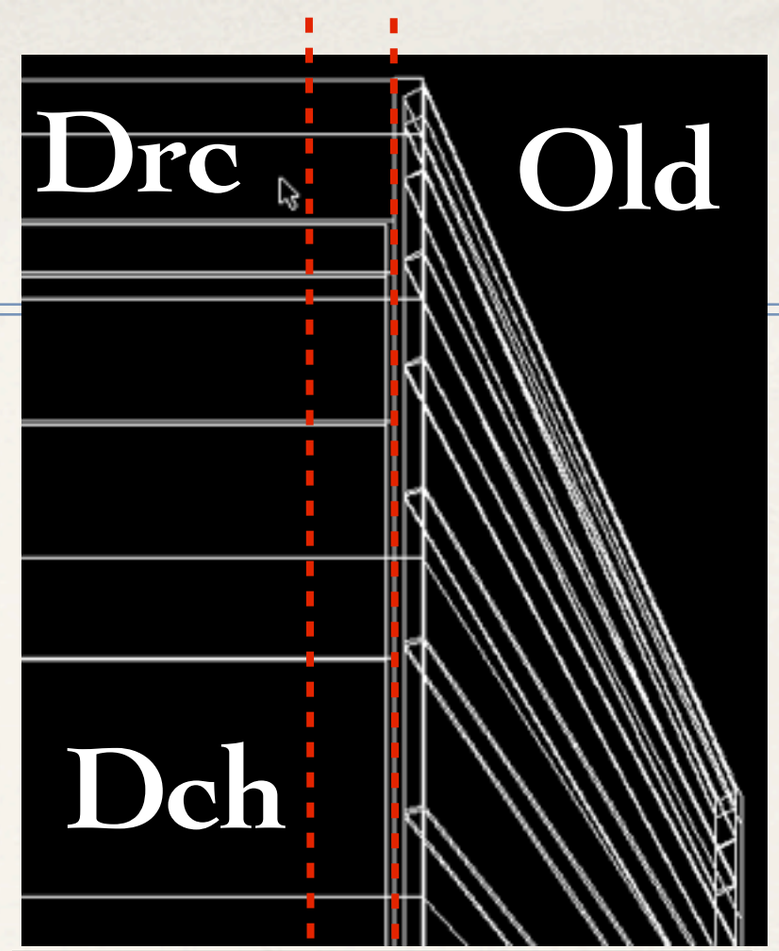
- fTOF, DCH, DRC

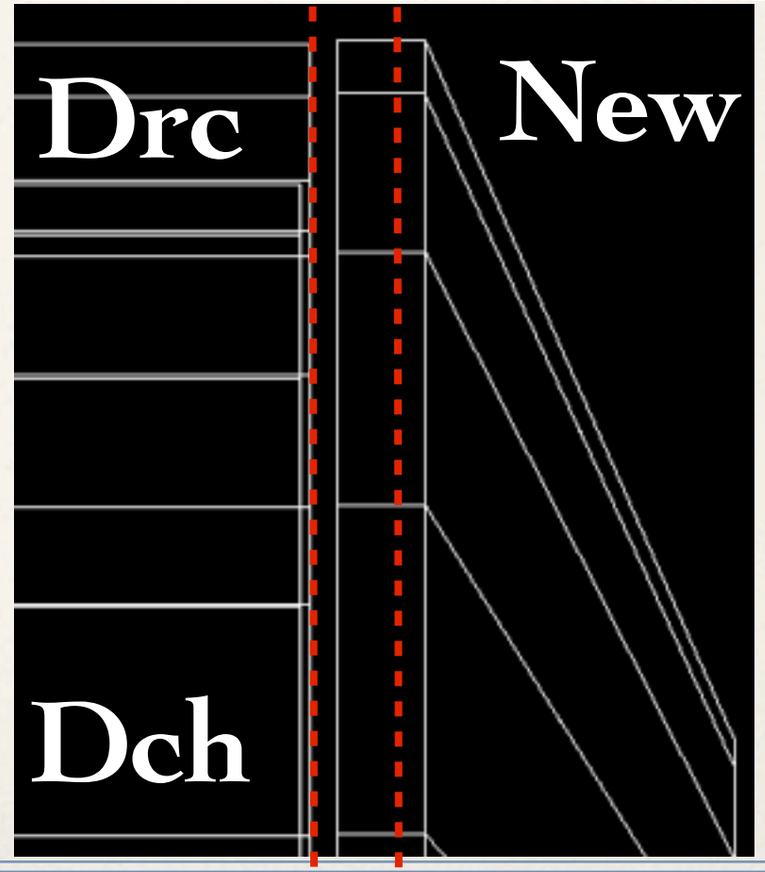




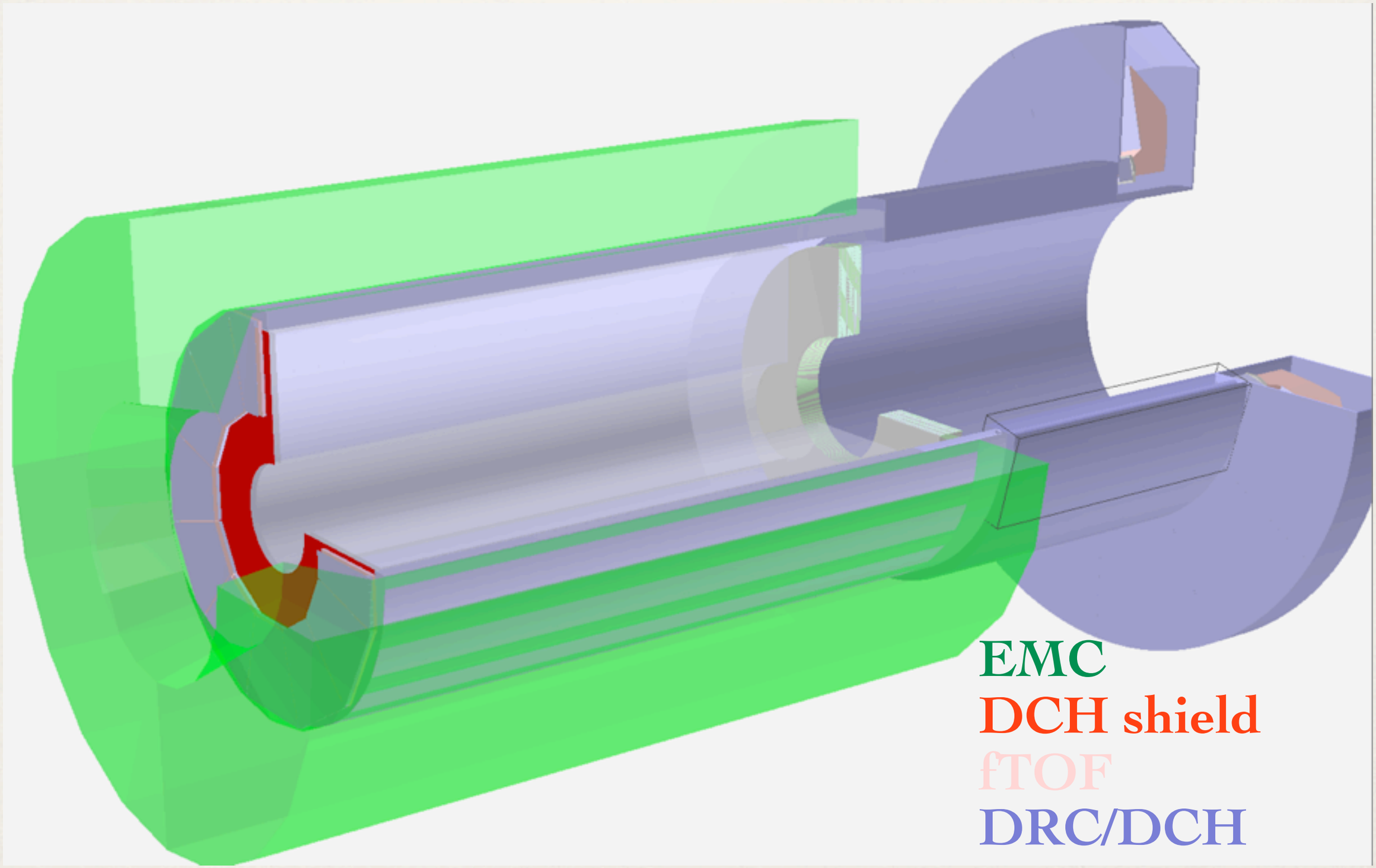
fTOF test

- fTOF, DCH, DRC
- Space between the two dashed lines





fTOF test



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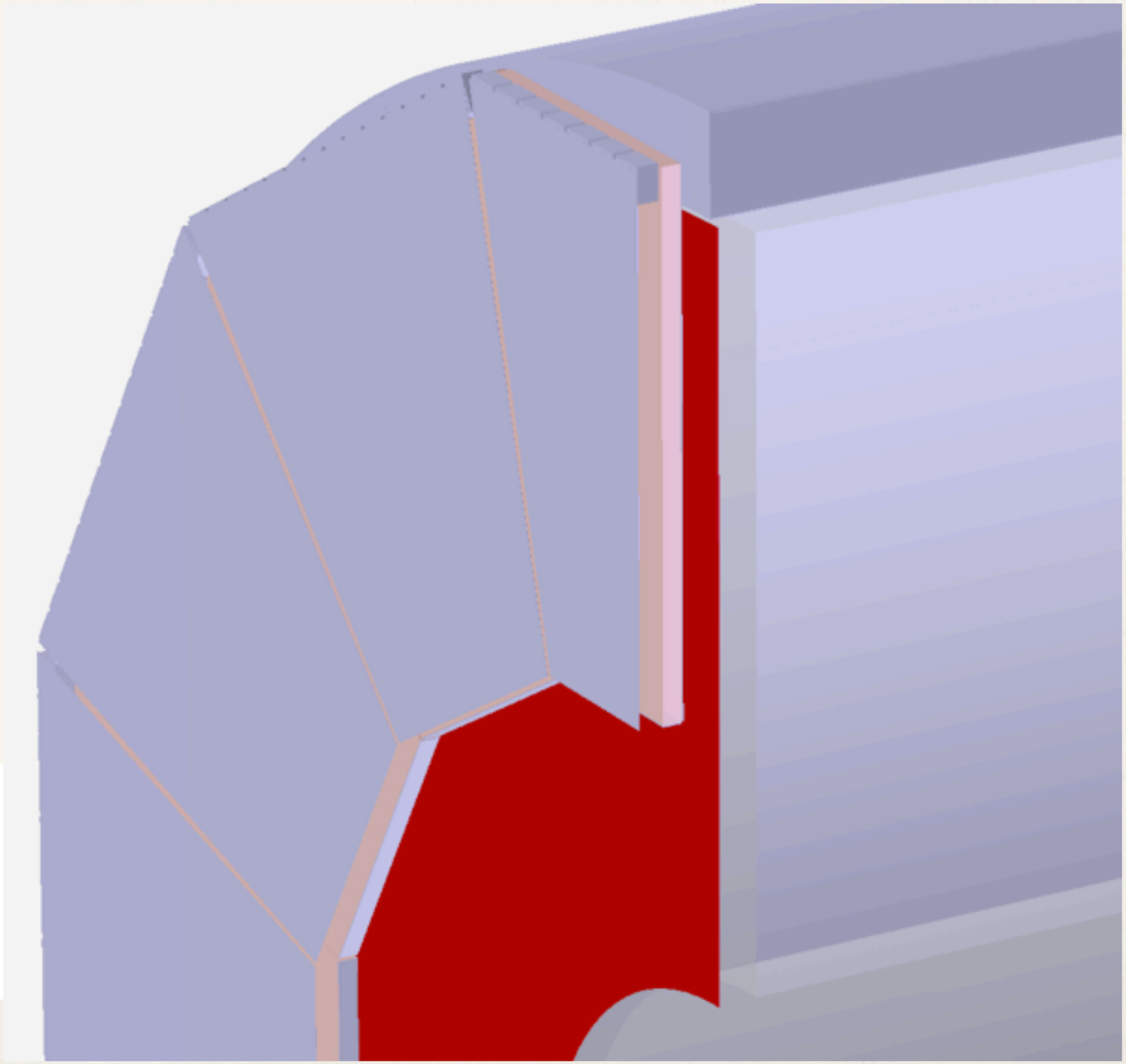


DCH shield
fTOF quartz
DRC/DCH

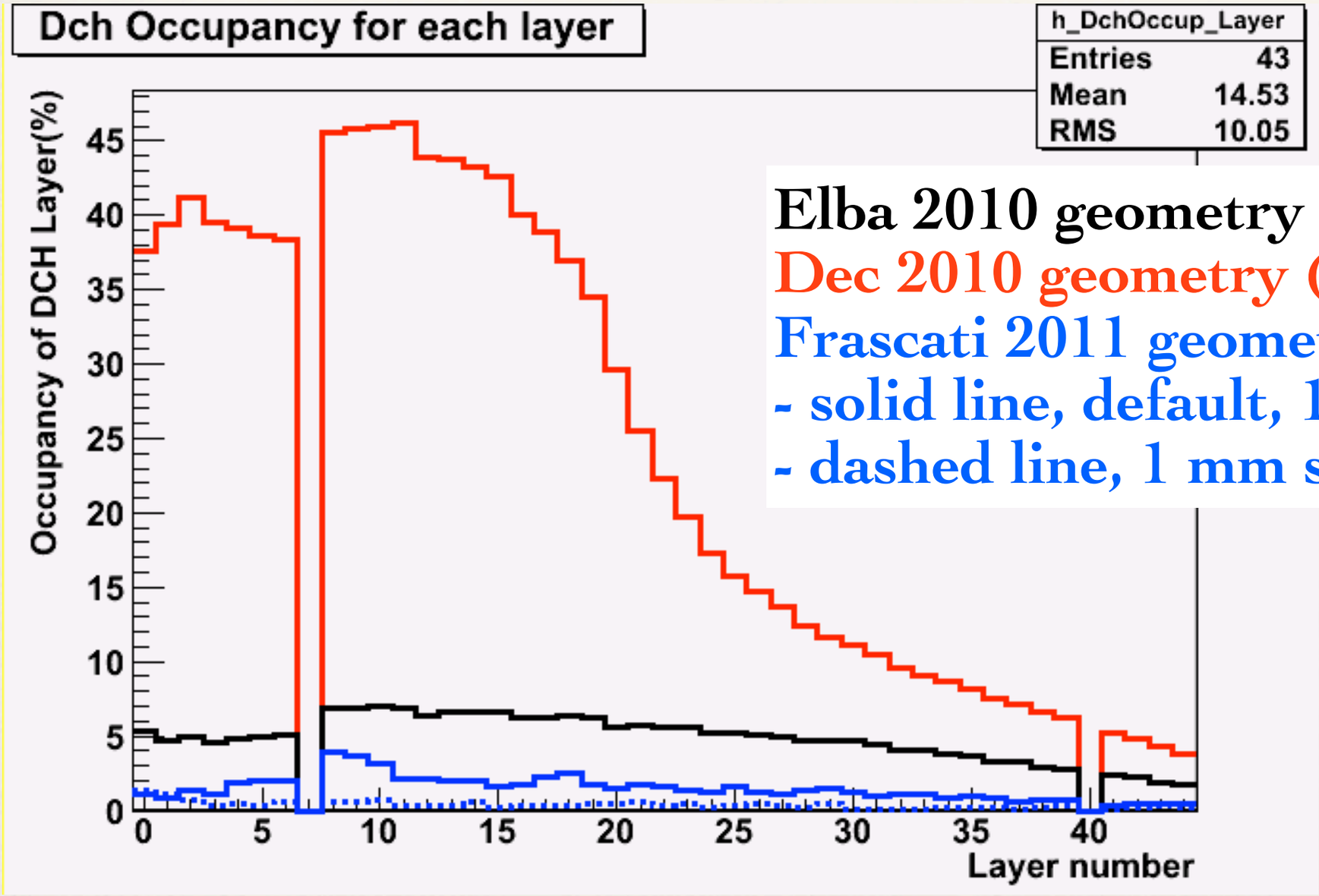
High occupancy with Dec 2010 geometry

New productions

- **RadBhabha**, samples of 50k evts
- New CIPE geometry (Frascati 2011)
  - Extended pipes
  - Full shielding and plugs
  - New magnets configuration
- Two samples:
  - Default configuration
  - Step length limited at 1mm in the Dch gas volume

Occupancy per layer, RadBhabha

- Occupancy back to normal level, smaller than before
- Confirmed over-estimation if no step limit



Elba 2010 geometry

Dec 2010 geometry (extended pipes)

Frascati 2011 geometry (CIPE)

- solid line, default, 1.35%

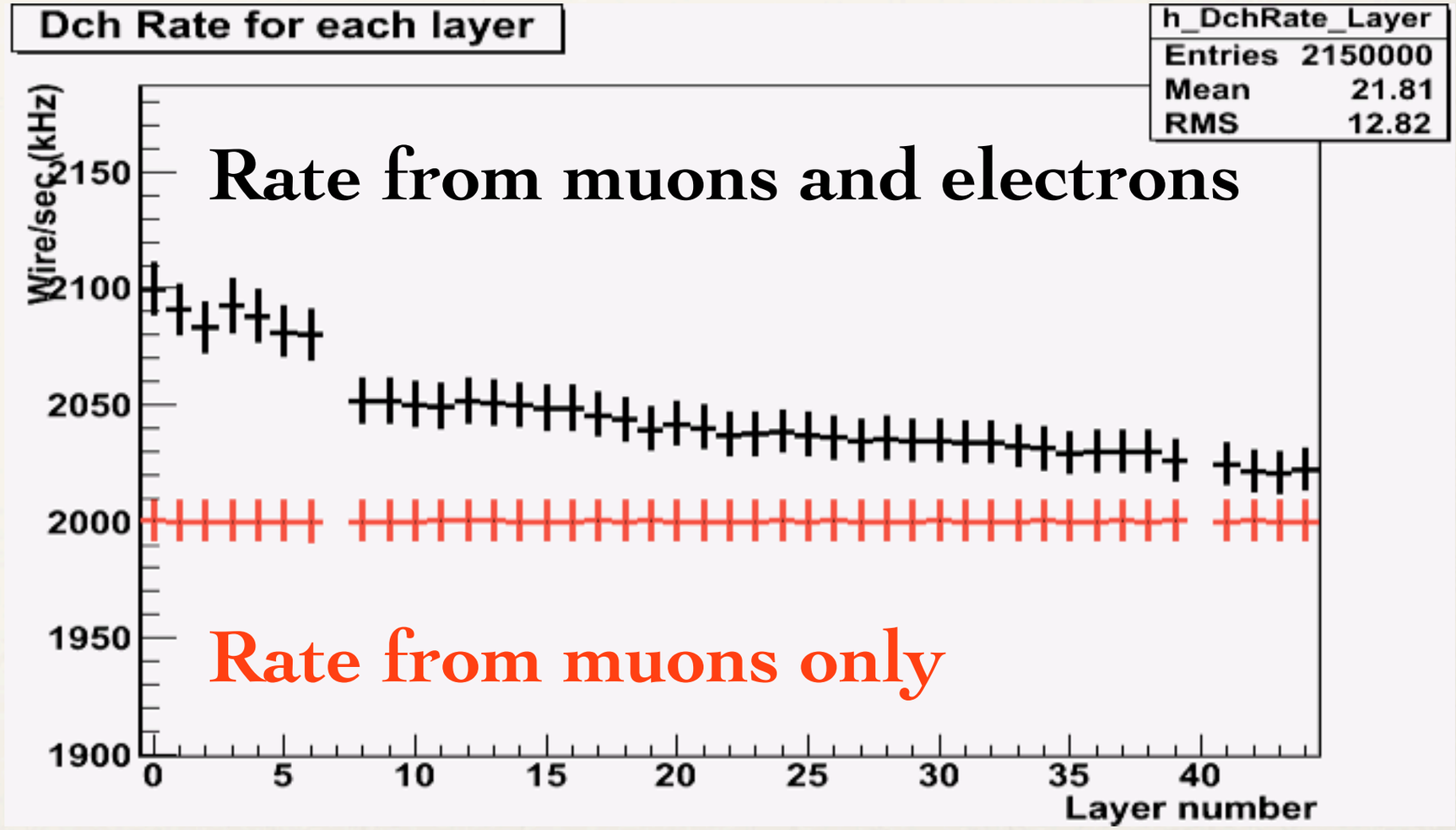
- dashed line, 1 mm step limit 0.35%

Simulating single particles...

Method validation

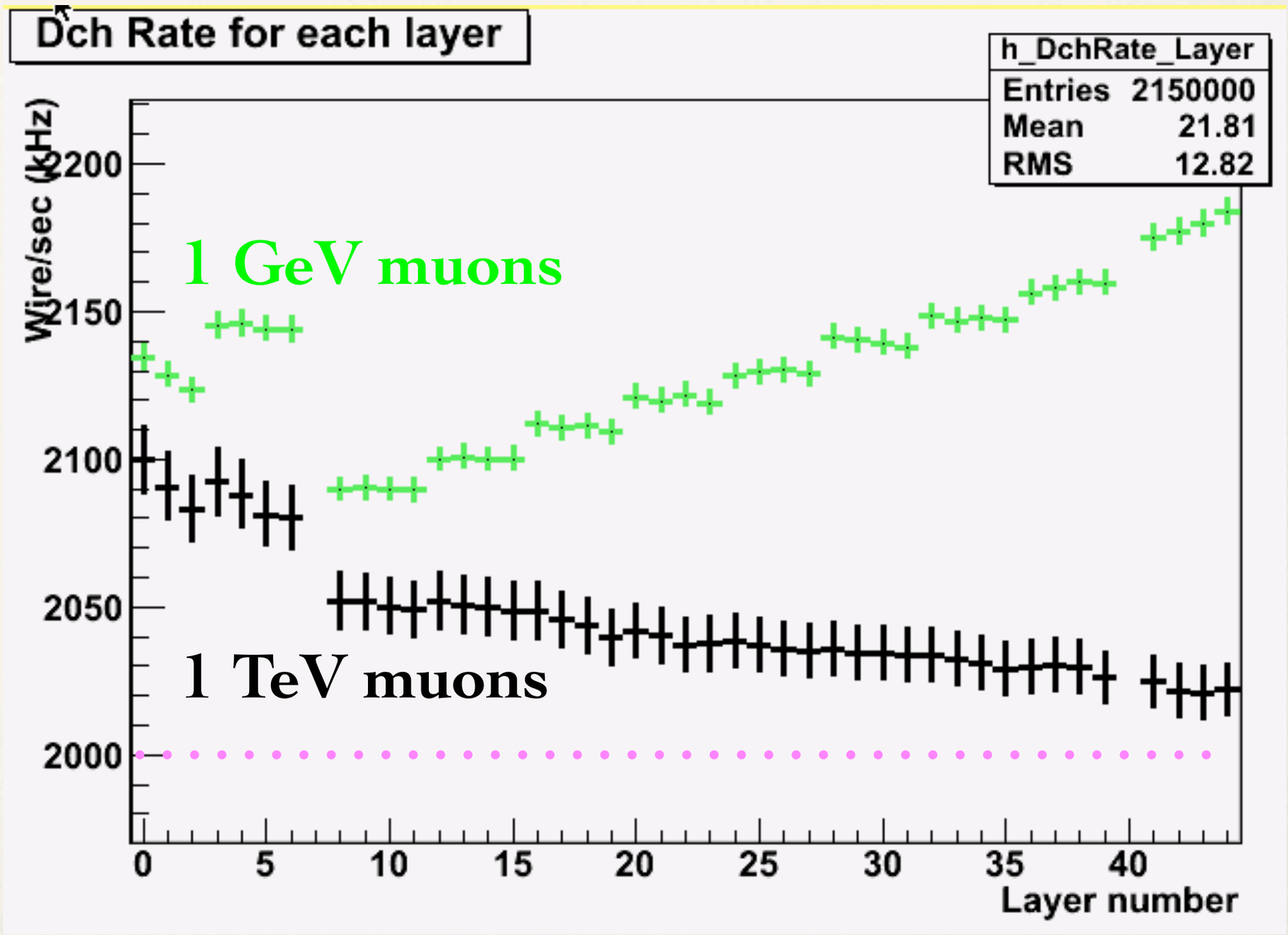
- Trying to get a flat rate for single particle
  - Muons, **1 TeV**, theta 90 degrees
  - **2 MHz** freq, 2 muons per DCH integrating time
  - Approx 120-250 cells per layer, ~1% occupancy expected

- To have a flat rate we need to neglect delta rays and electrons kicked out from the chamber wall



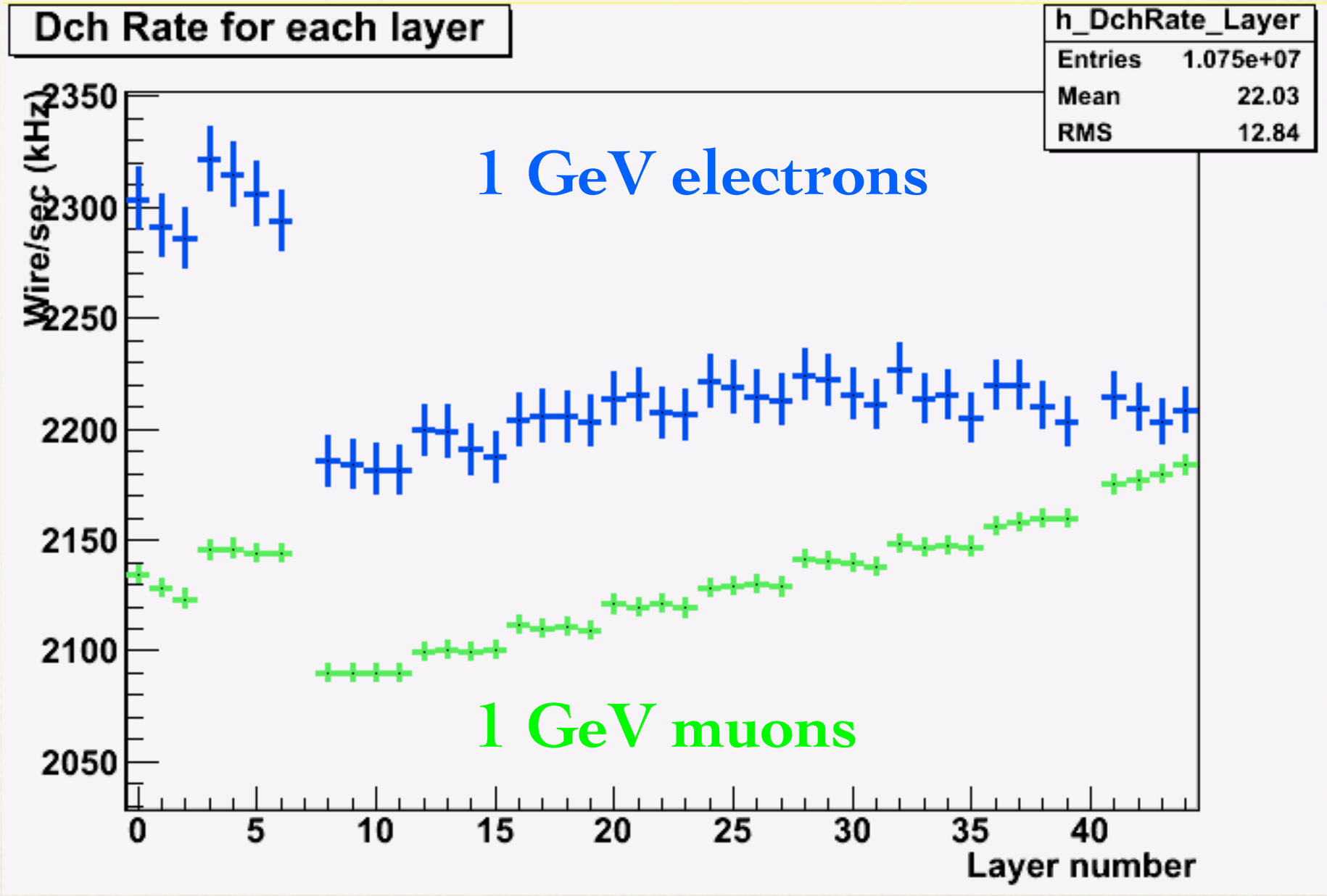
Validation

- Comparison between muons of 1 TeV and 1 GeV
- Curvature of tracks increases rate on outer layers



Validation

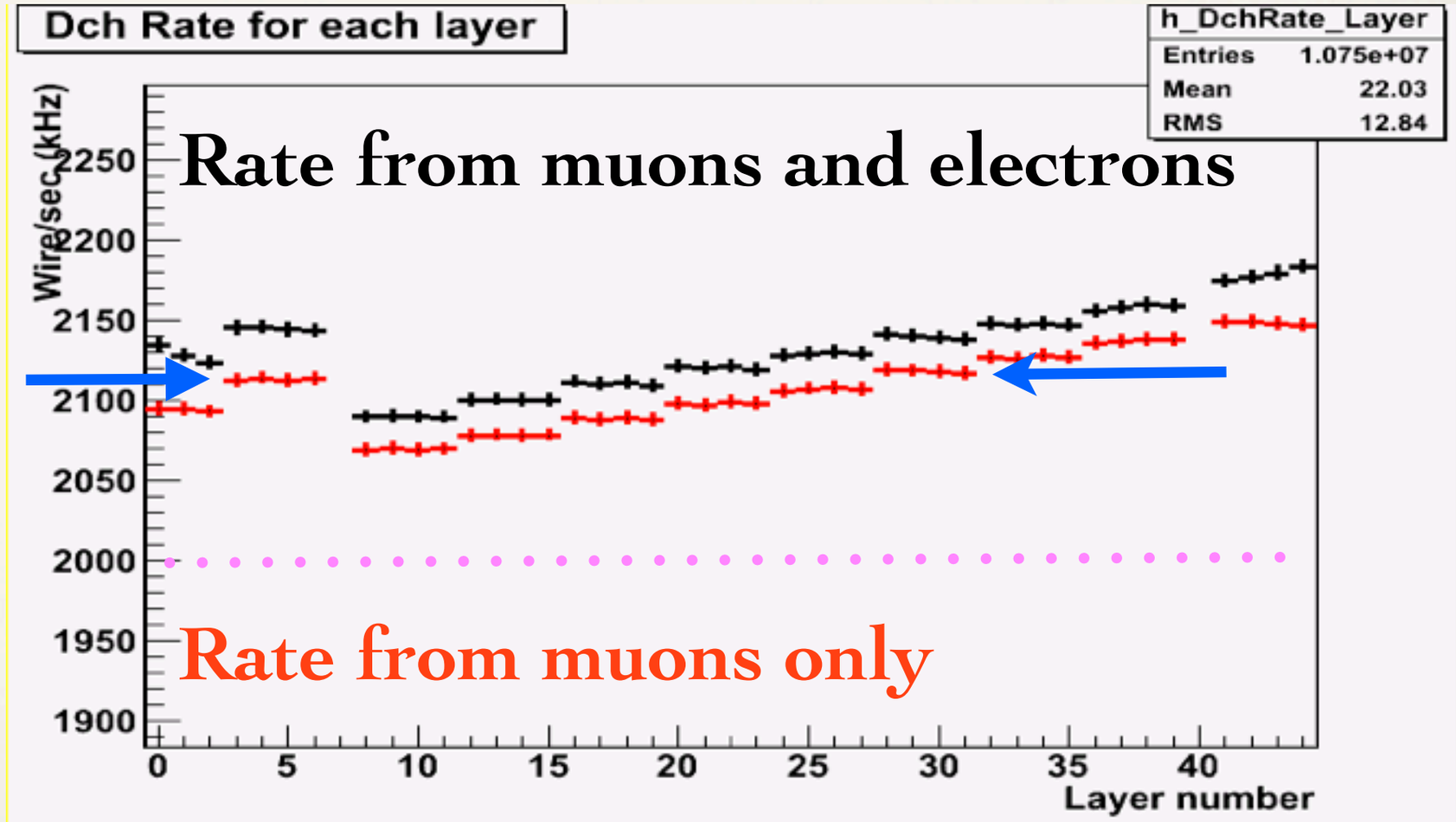
- Comparison between muons and electrons of 1 GeV
- No difference between electrons and positrons



More validation

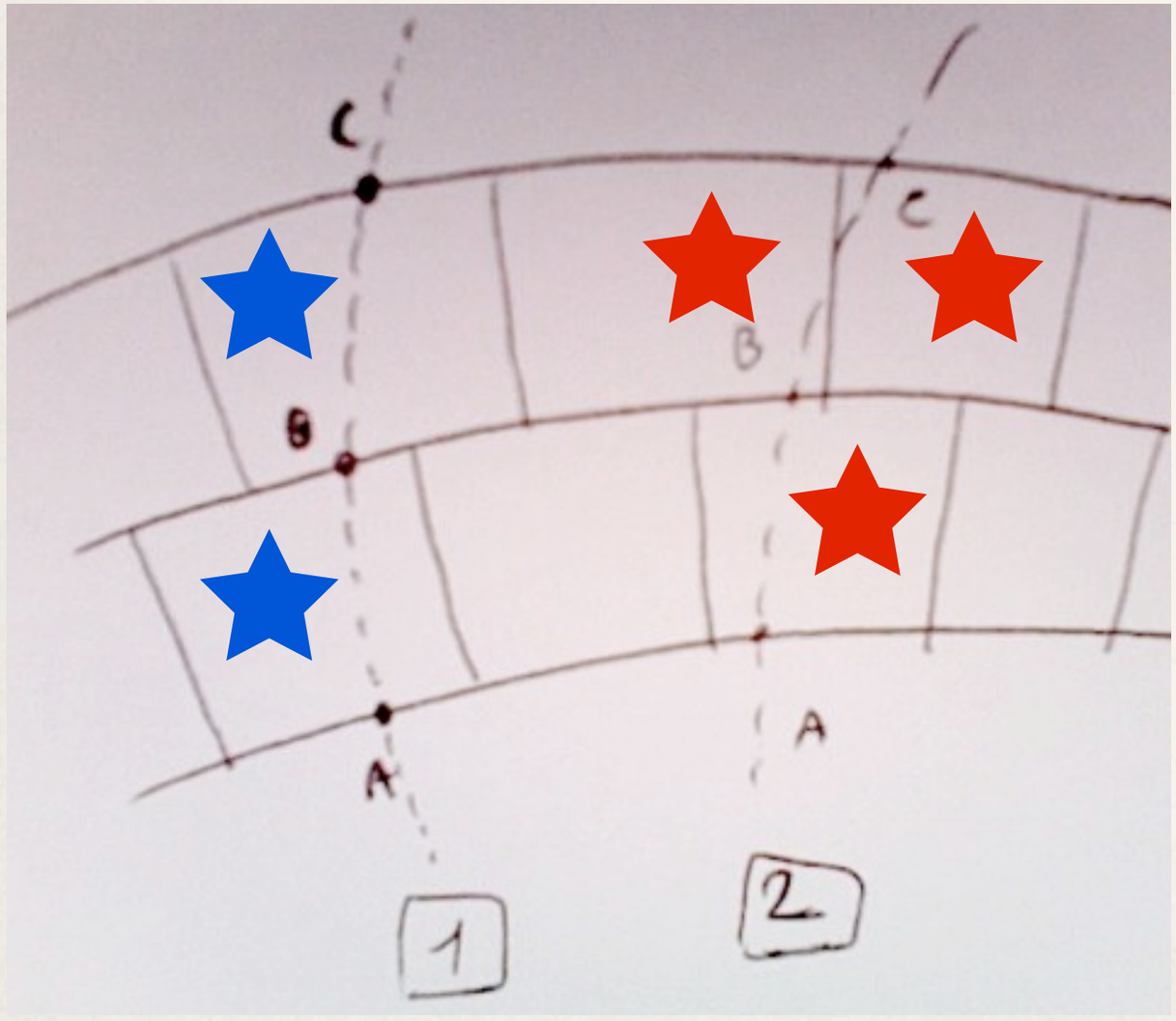
- Rate flatness over each super-layer
- Muons, **1 GeV**, theta 90 degrees
- Removing hit from electrons rate is even more flat
  - Pure geometric cause: additional rate depends only from cell phi angle, not from cell size

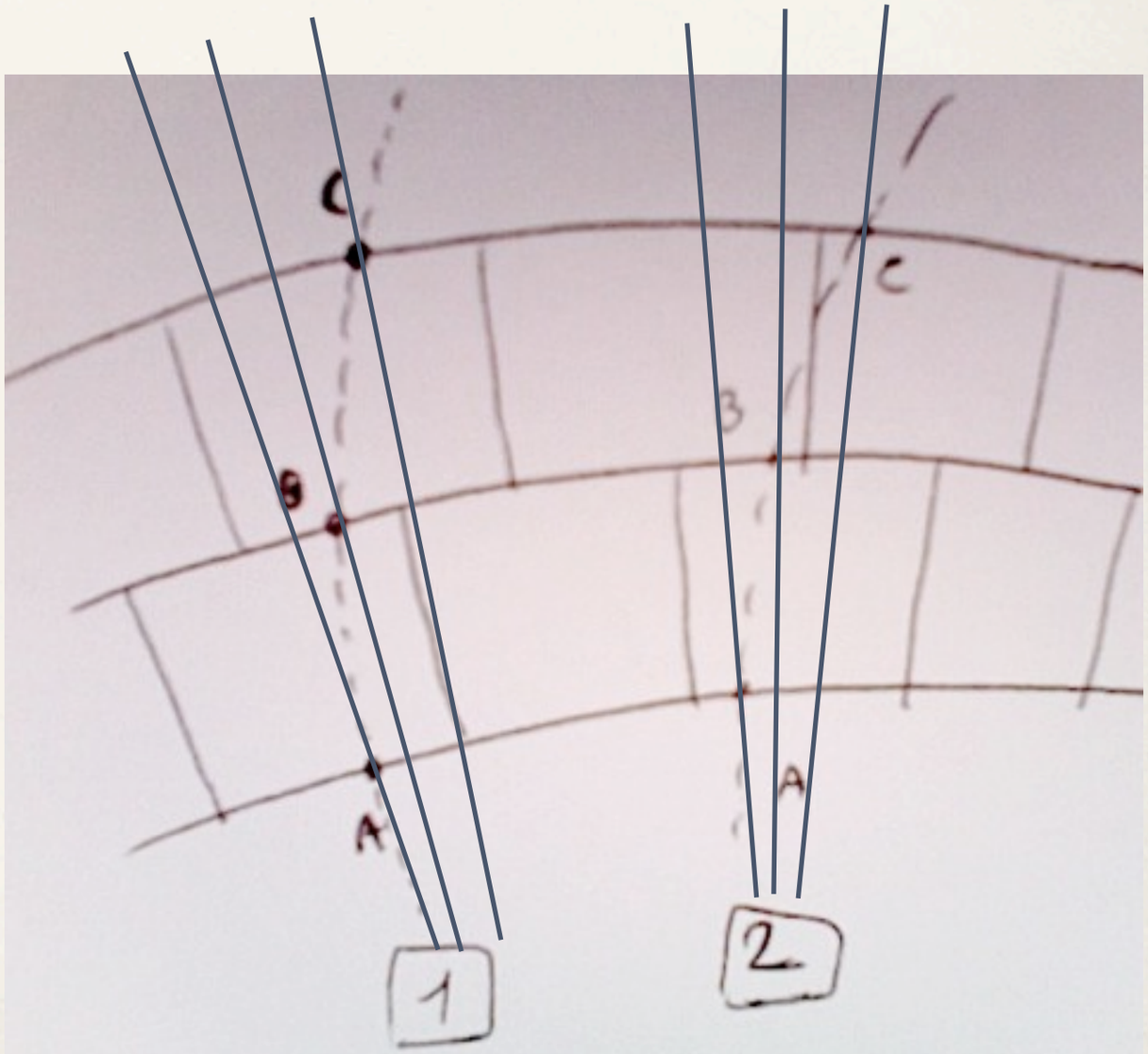
- **Layers around 5 and 30** have the same numbers of cells
- Phi angle of the track between entering and leaving point in the cell vs phi angle of the cell



Update on validation

- **Track 1** fires one cell on each layer
- **Track 2** fires one cell on first layer and two on the second
- Phi angle of the track when enters and leaves the cell

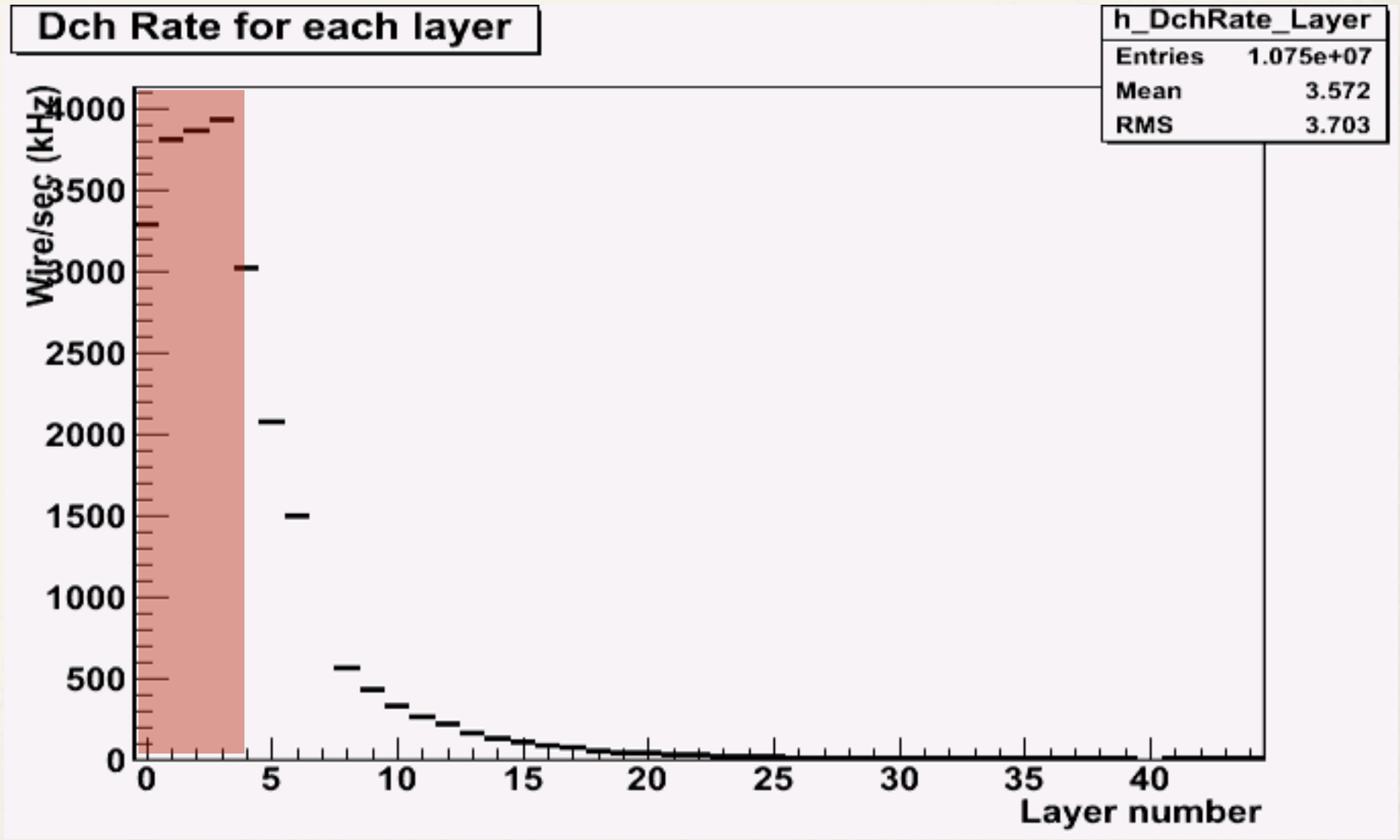




More single particles...

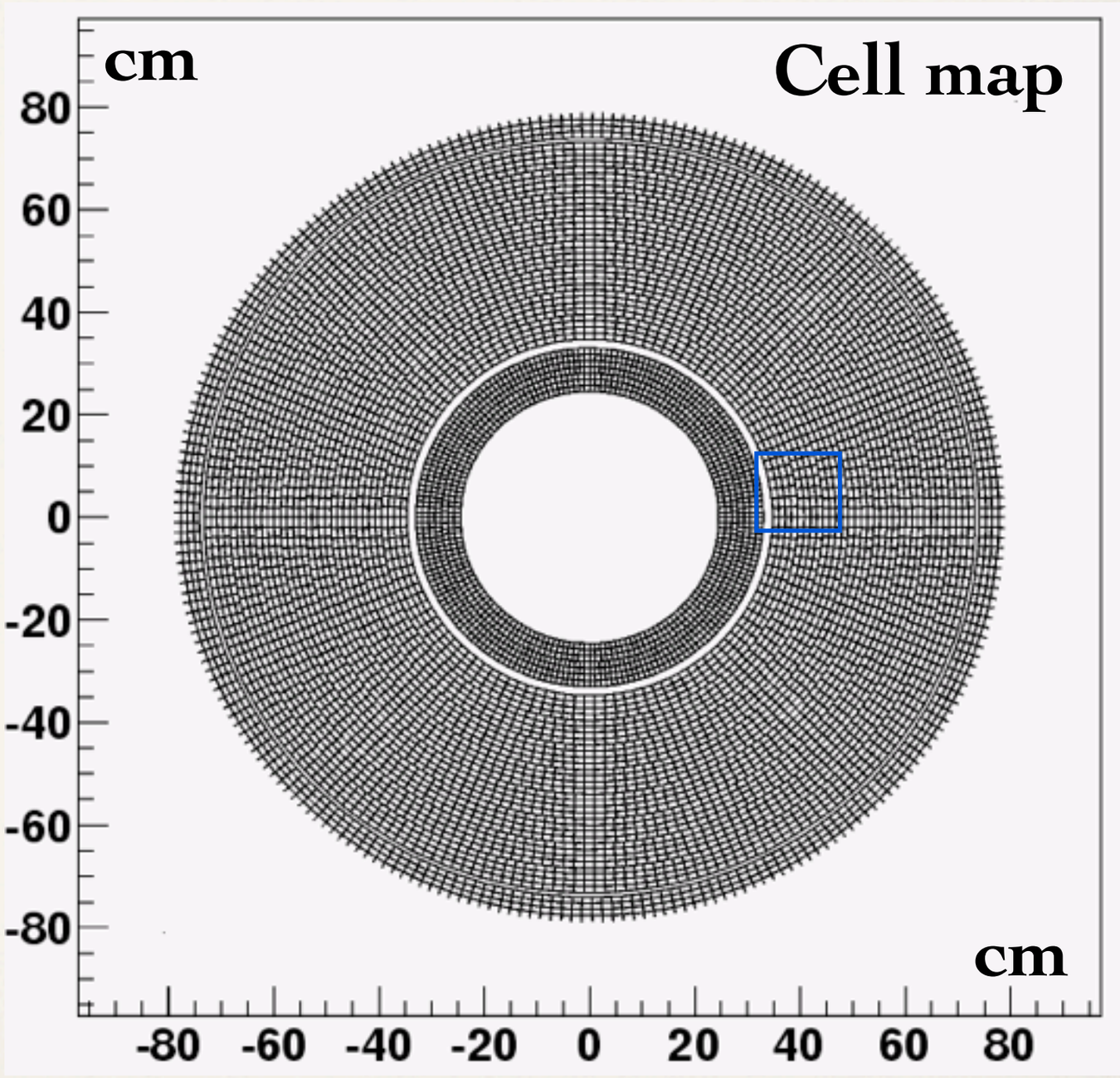
- Low energy electrons, 1.5 MeV, 45 degrees, pT = 1 MeV, radius 2.2 cm, **23-30 cm** from IP
- They should fire around 2 cells per layer -> rate 4 MHz

- Electrons are supposed to go along z: it's not true, hits above layer 5
- Multiple scattering plays an important role



Smart single particles...

- Electrons at different energies, but same transverse momentum: 1 mm of helix radius
  - 1 GeV, 100 MeV, 10 MeV, 1 MeV
- Electrons located at one specific **point** of Dch: only one cell fired
- 4 configuration: no step limit, 10mm, 5mm, 1mm
- Expected rate: 2 MHz



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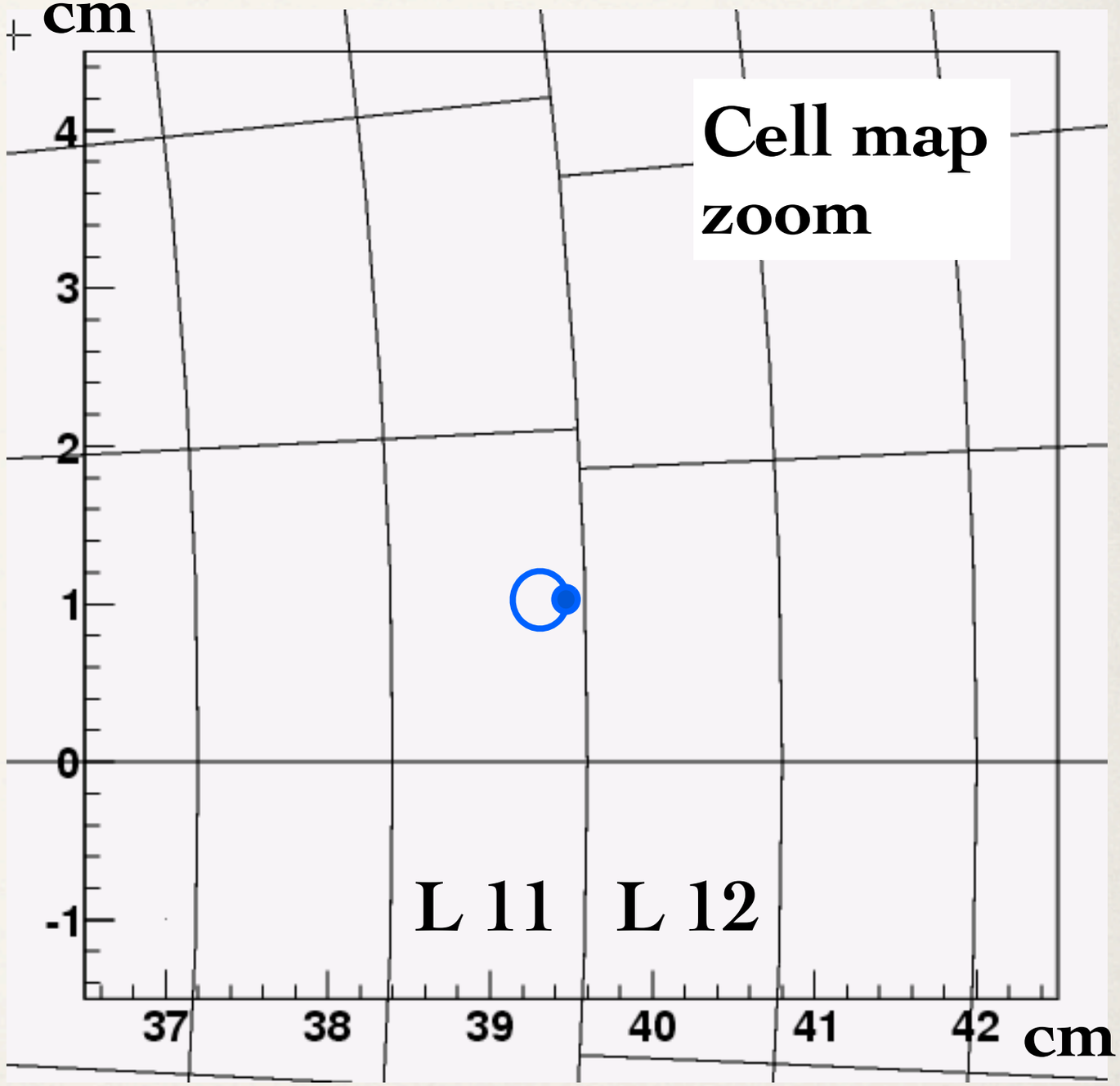
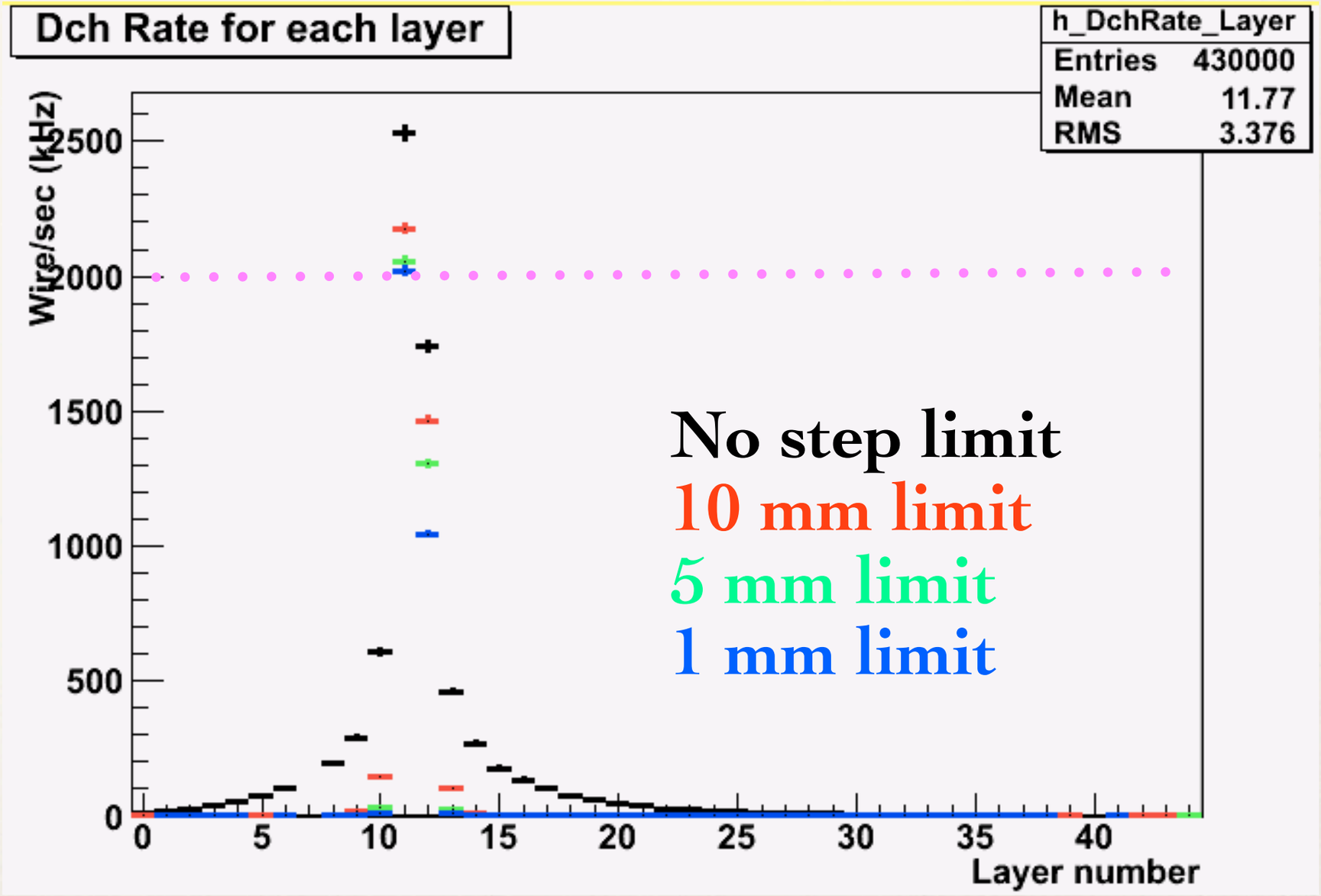


Single electrons, 1 GeV

- Default configuration
- Without step limit rate is above **2 MHz**

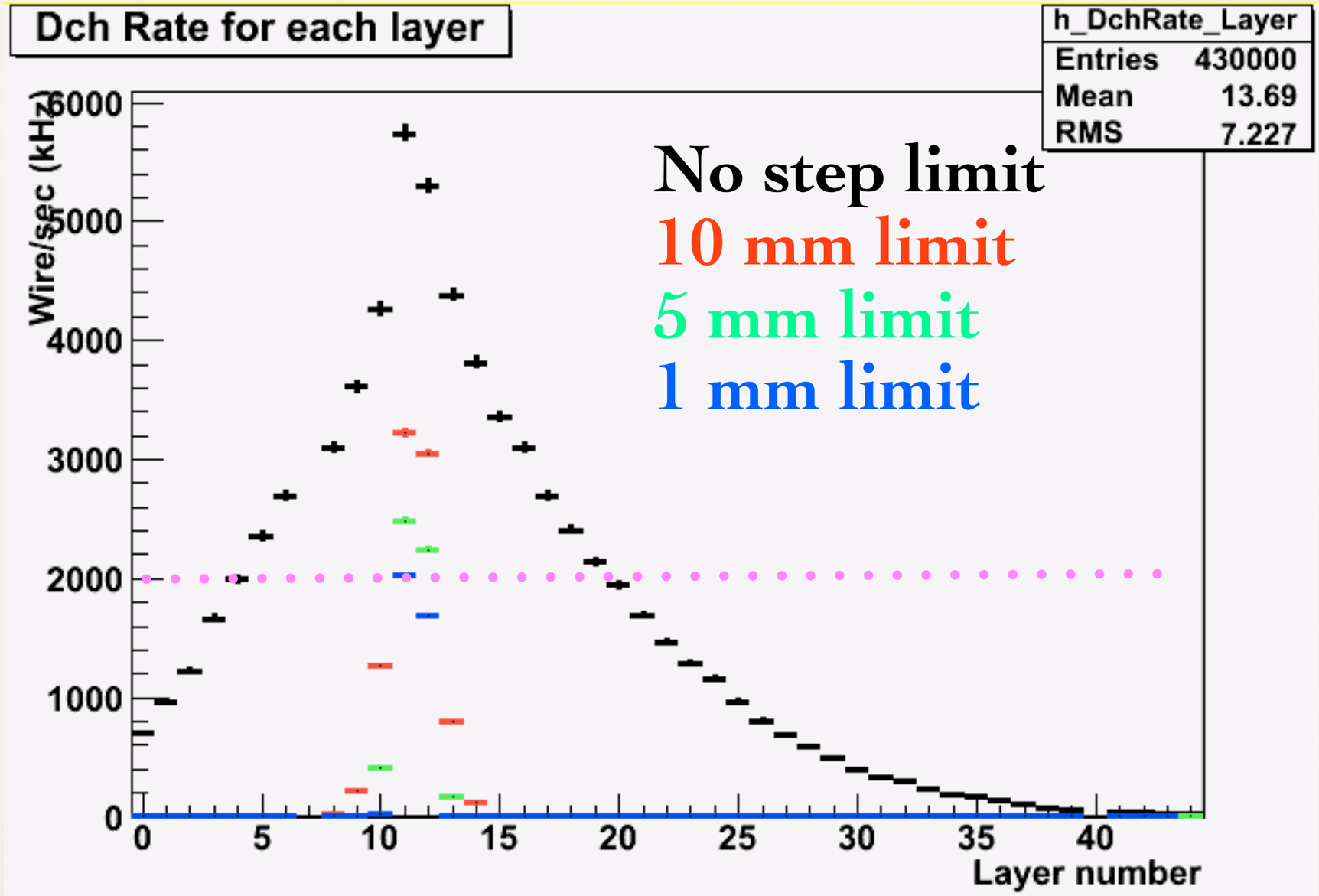
- Tails on both side
  - Multiple scattering
  - Delta rays



Single electrons, 1 MeV

- Default configuration
- Without step limit rate is above 2 MHz

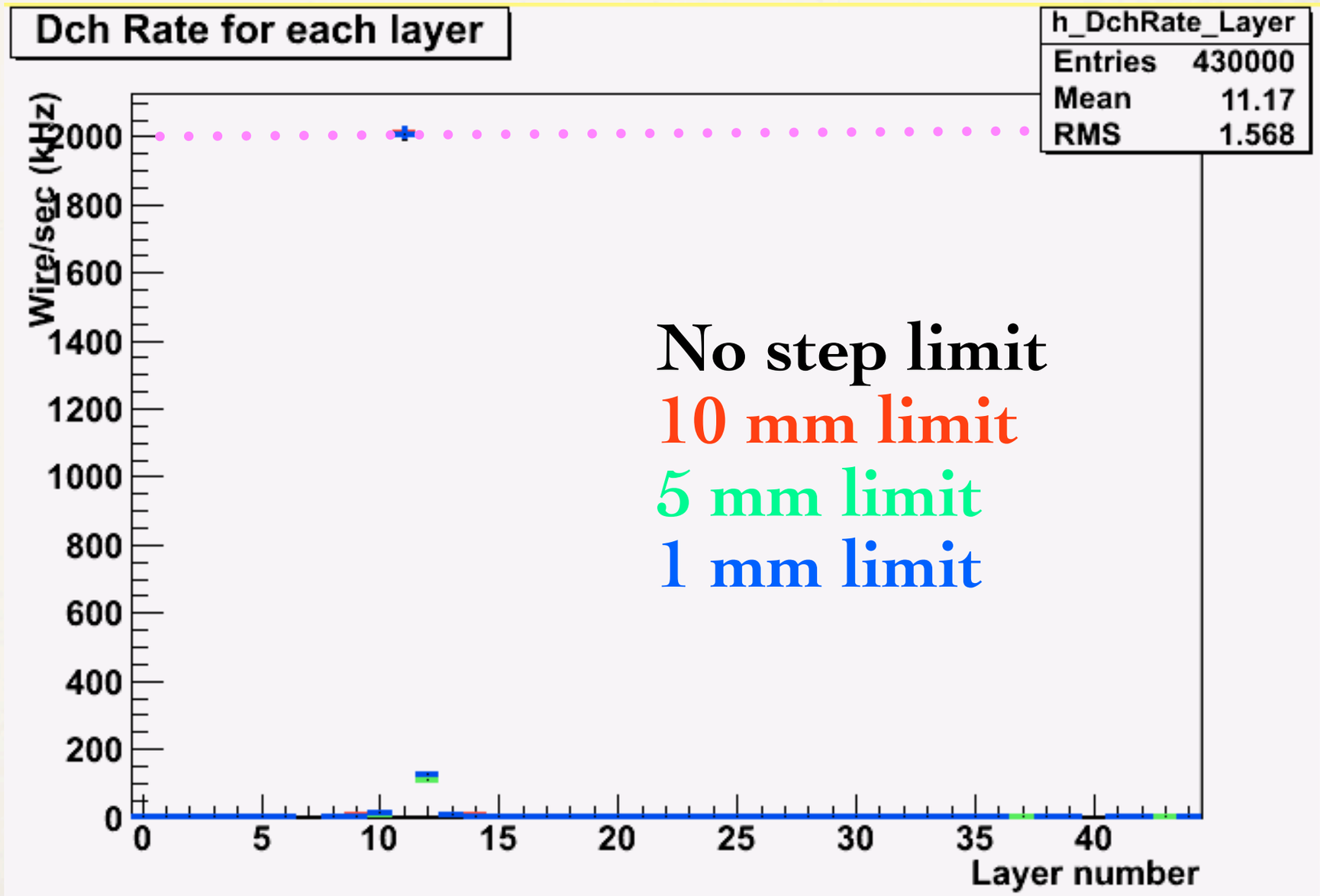
- Bigger effect at low energy
- Only simulation with 1 mm step limit gives good results
- When G4 applies the multiple scattering correction for a long step, the description is not accurate
- General overestimation of occupancy



Single electrons, 1 MeV, no MSc

- Multiple scattering can be disactivated
- Rates are consistent with different step limits

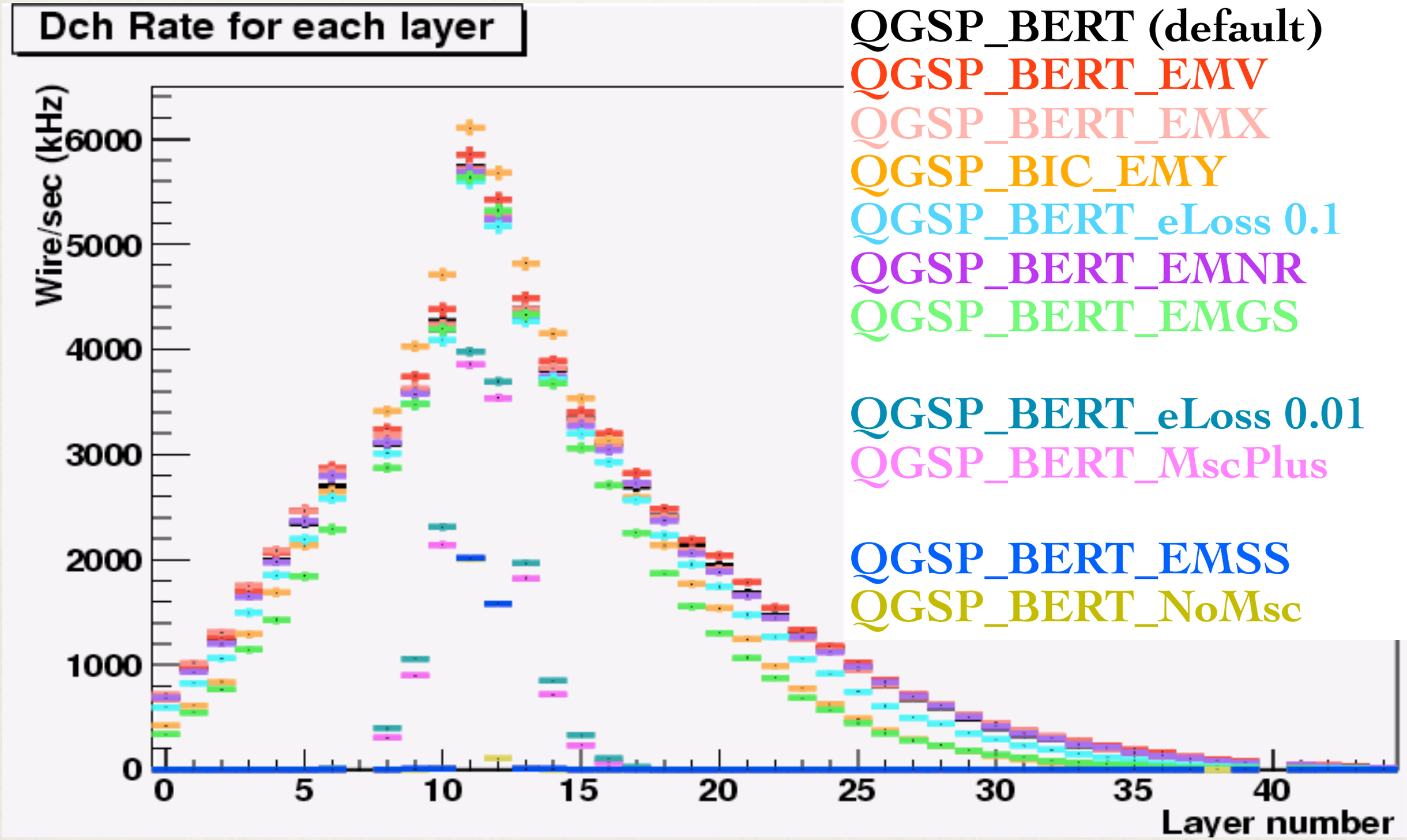
- To obtain realistic results we should turn it on
- Hit on layer 12 probably from delta rays
- Multiple scattering is responsible for most of the discrepancy



More configurations...

- Other physics lists (default is **QGSP_BERT**):
  - **QGSP_BERT_EMV**: parameters of electromagnetic processes tuned to yield better cpu performance with only slightly less precision
  - **QGSP_BERT_EMX**: sub-cutoff option for ionisation processes and higher production threshold than in default EM physics
  - **QGSP_BIC_EMY**: most advanced options allowing precise simulation at low and intermediate energies
  - **QGSP_BERT_eLoss0.1**, **QGSP_BERT_eLoss0.01**: limit on energy loss per step, 10% and 1%
  - **QGSP_BERT_MscPlus**: improved parameters for multiple scattering
  - **QGSP_BERT_EMNR**: single Coulomb scattering process instead of the multiple scattering for ions with energy less than 100 MeV/nucleon
  - **QGSP_BERT_EMGS**: Goudsmit-Saunderson multiple-scattering model
  - **QGSP_BERT_EMSS**: single Coulomb scattering instead of multiple scattering

More configurations...



QGSP_BERT (default)
QGSP_BERT_EMV
QGSP_BERT_EMX
QGSP_BIC_EMY
QGSP_BERT_eLoss 0.1
QGSP_BERT_EMNR
QGSP_BERT_EMGS

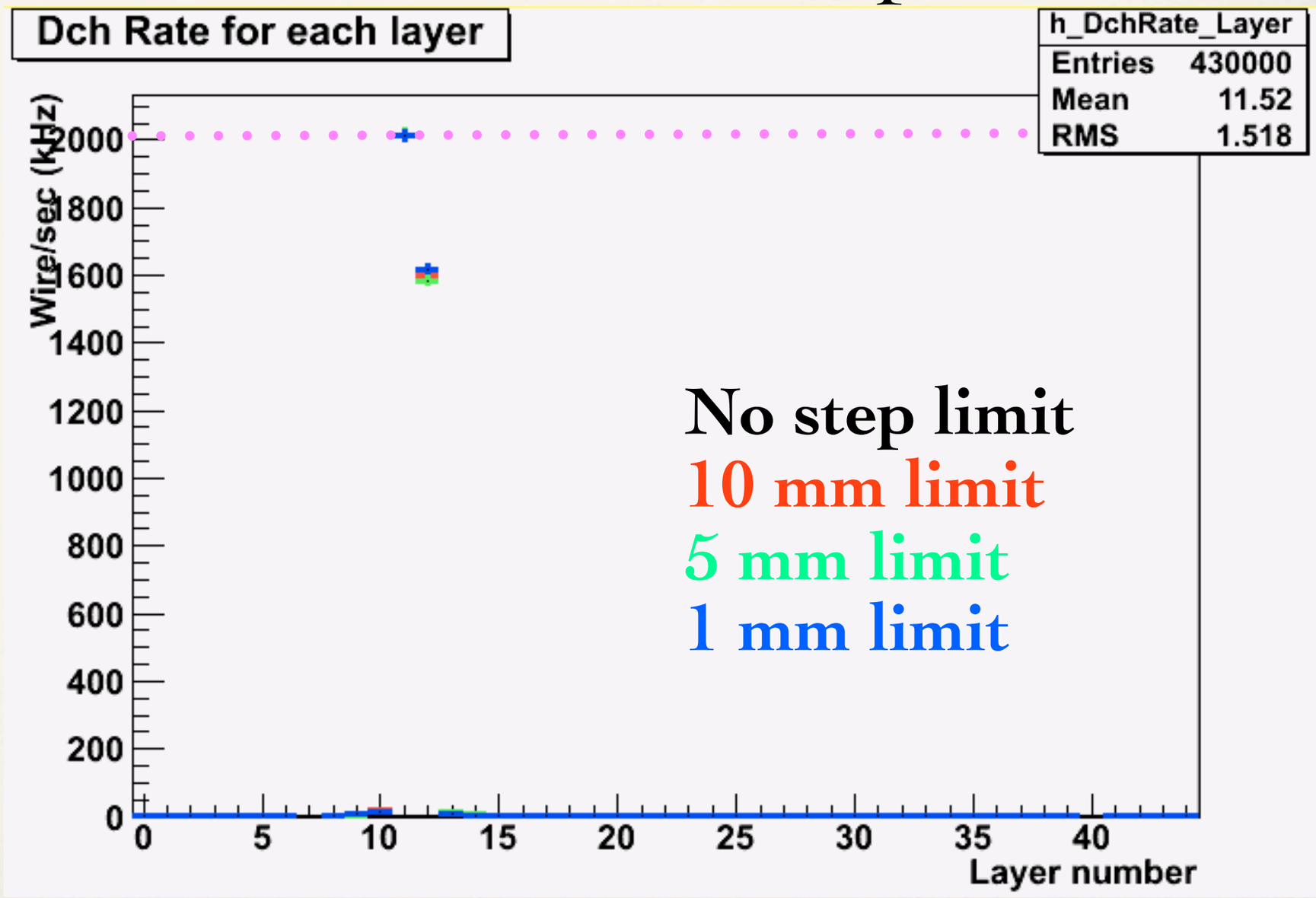
QGSP_BERT_eLoss 0.01
QGSP_BERT_MscPlus

QGSP_BERT_EMSS
QGSP_BERT_NoMsc

Single electrons, 1 MeV, SS

- Single Coulomb scattering
- Rates are consistent with different step limits

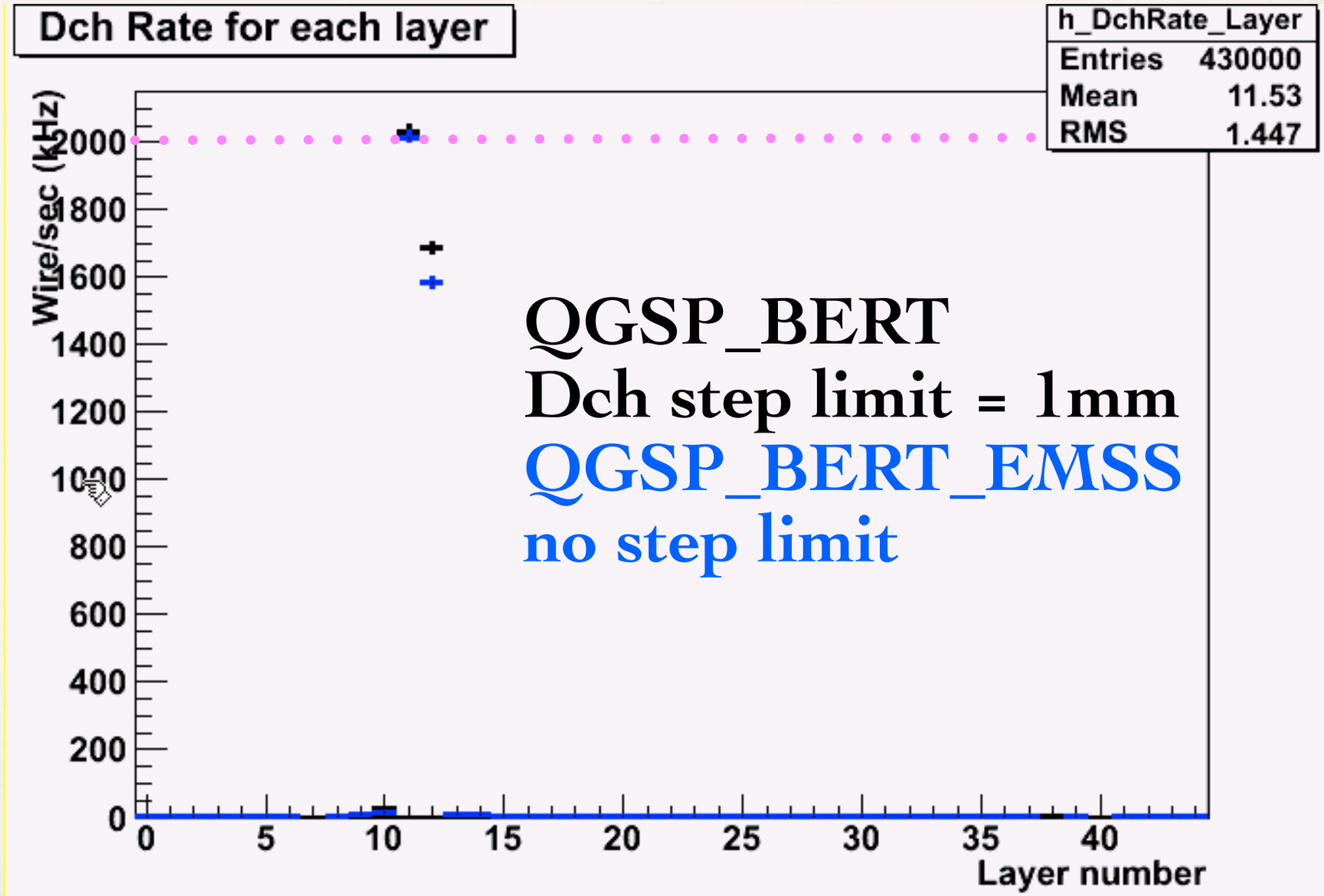
- Using only this in full simulation increases a lot the running time
- Thanks to Andrea, now we can enable it only in a specific region (done in my private release, not committed yet)



Single electrons, 1 MeV

- Single Coulomb scattering vs 1 mm step limit
- Small difference

- IMHO, we should use single scattering, because it allows us to have a reliable simulation in the gas volume w/o introducing artificial parameters



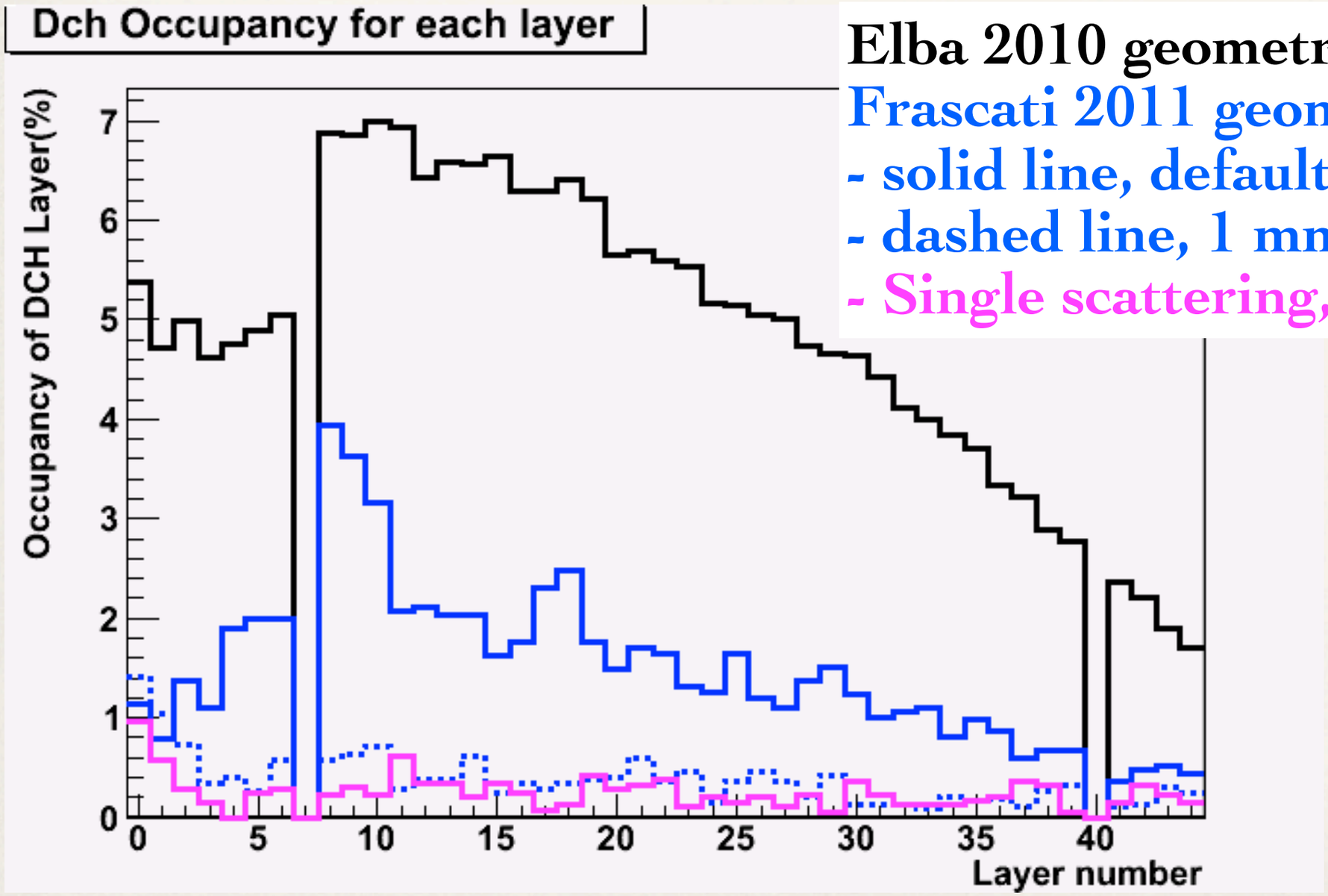
Summary

- Culprit of dependance from step size limits is the multiple scattering
- Bkg is always overestimated: from some dedicated simulation with SS
- Solution 1: simulating track in Dch with reduced step, 10, 5 or 1 mm
  - Artificial parameter
  - Bigger files and longer running time
- Solution 2: single Coulomb scattering (activated only for the gas volume)
  - No artificial parameters
  - Same files size and running time

Radiative Bhabha (100 evts)	CPU time	File size
Prod 2011 CIPE geom	19h	400M
Prod 2011 CIPE geom 1 mm step limit	21h	478M
My Prod CIPE geom Single Scat	17.3h	395M

Occupancy per layer, RadBhabha

- Single scattering simulation comparable with multiple scattering plus 1 mm step limit



Elba 2010 geometry

Frascati 2011 geometry (CIPE)

- solid line, default, 1.35%

- dashed line, 1 mm step limit 0.35%

- Single scattering, 0.24%

Conclusions

- Optional geometry for testing the new forward PID detector
- Confirmation that high occupancy with Dec 2010 geometry was due to extended pipes and missing shielding/plugs
- Using the single particles:
  - Occupancy algorithm has been validated
  - Multiple scattering effect on Dch track has been understood
- Reliable simulation for Dch tracks can be obtained using:
  - 1 mm step limit in the Dch volume (artificial parameter)
  - Replacing multiple scattering with single scattering in the Dch volume

fTOF test

- New fTOF geometry, FTOFnewGeometry04022011.gdml provided by Leonid Burmistrov