DCH Background using FullSim Geometry update for fTOF test

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Background Phone Meeting

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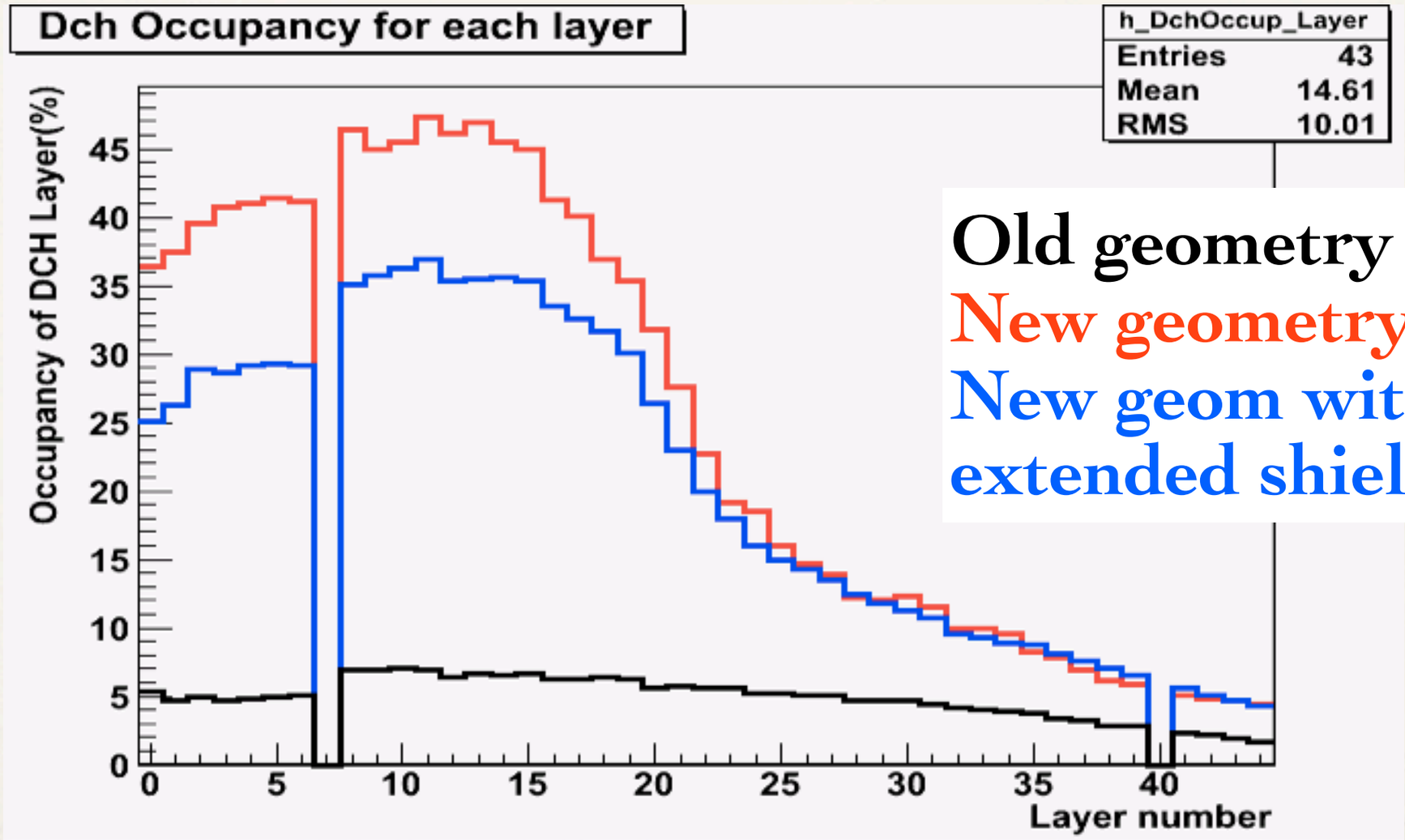
Outline

- Increase of occupancy with new geometry
- Understanding the "step size" problem
- Shorten Dch model, space needed by new fTOF detector

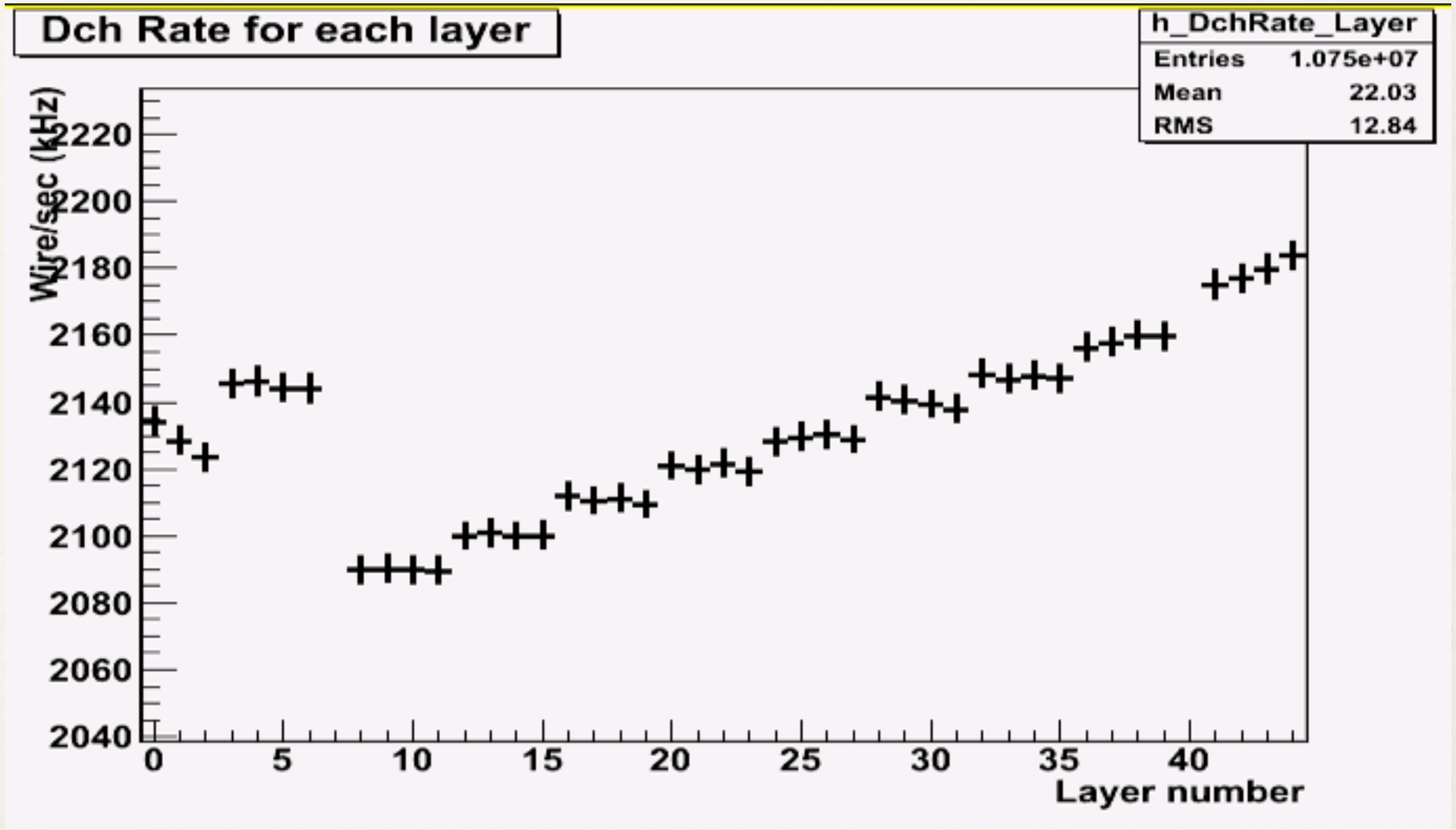
Increase in Dch occupancy

- Occupancy with extended tungsten shield
- Better, but not like before
- Need to correctly model asap beam pipes and shielding: plug and horseshoe like in Babar)



Validation with single particle

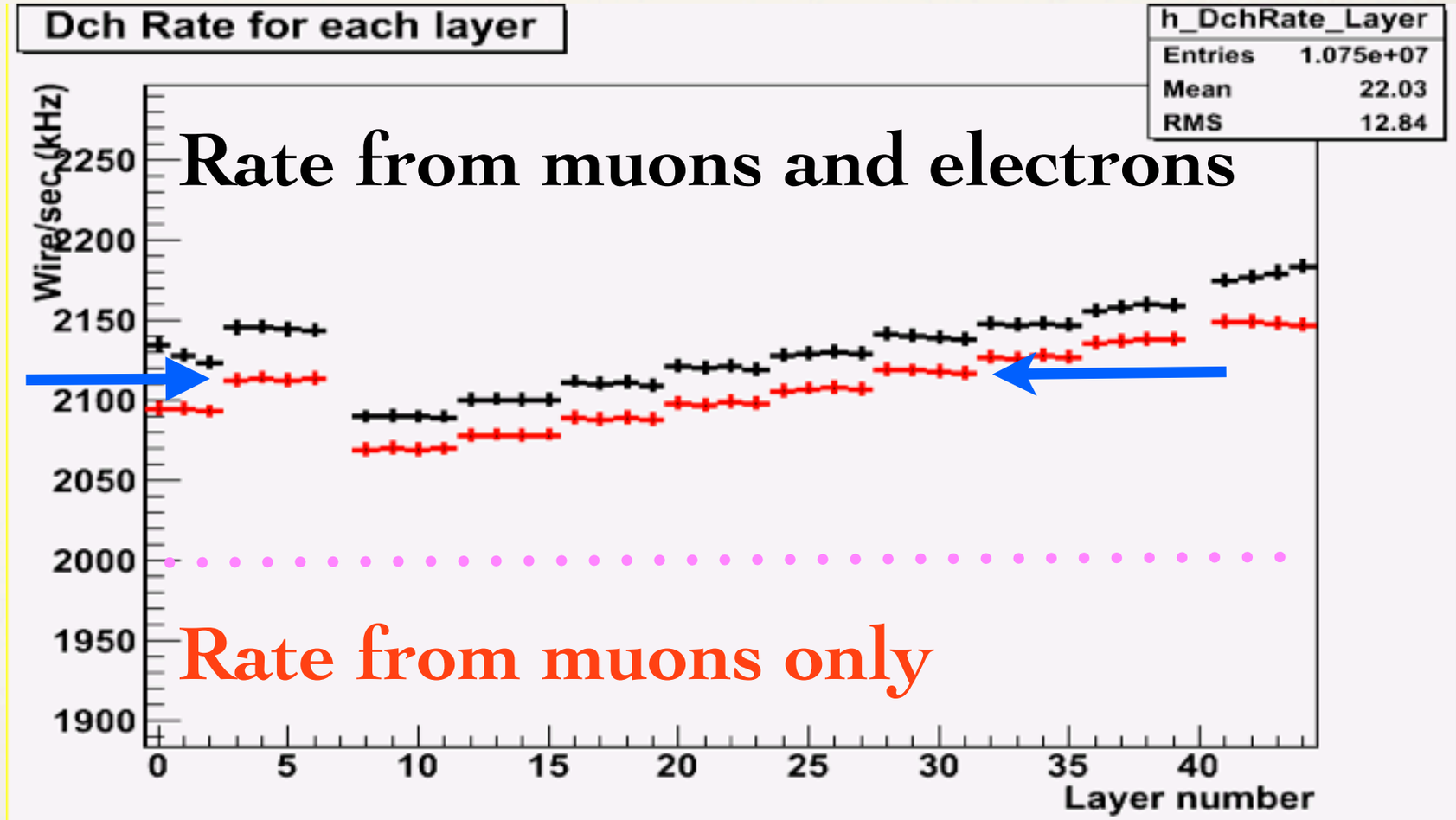
- Studying rate for single particle
  - Muons, 1 GeV, theta 90 degrees
  - 2 MHz freq, 2 muons per DCH integrating time
  - Approx 120-250 cells per layer, ~1% occupancy expected
- Two effects create rate over 2 MHz:
  - track curvature
  - deltaRays
- Rate seems flat on the same superlayer (M. Piccolo)



More validation

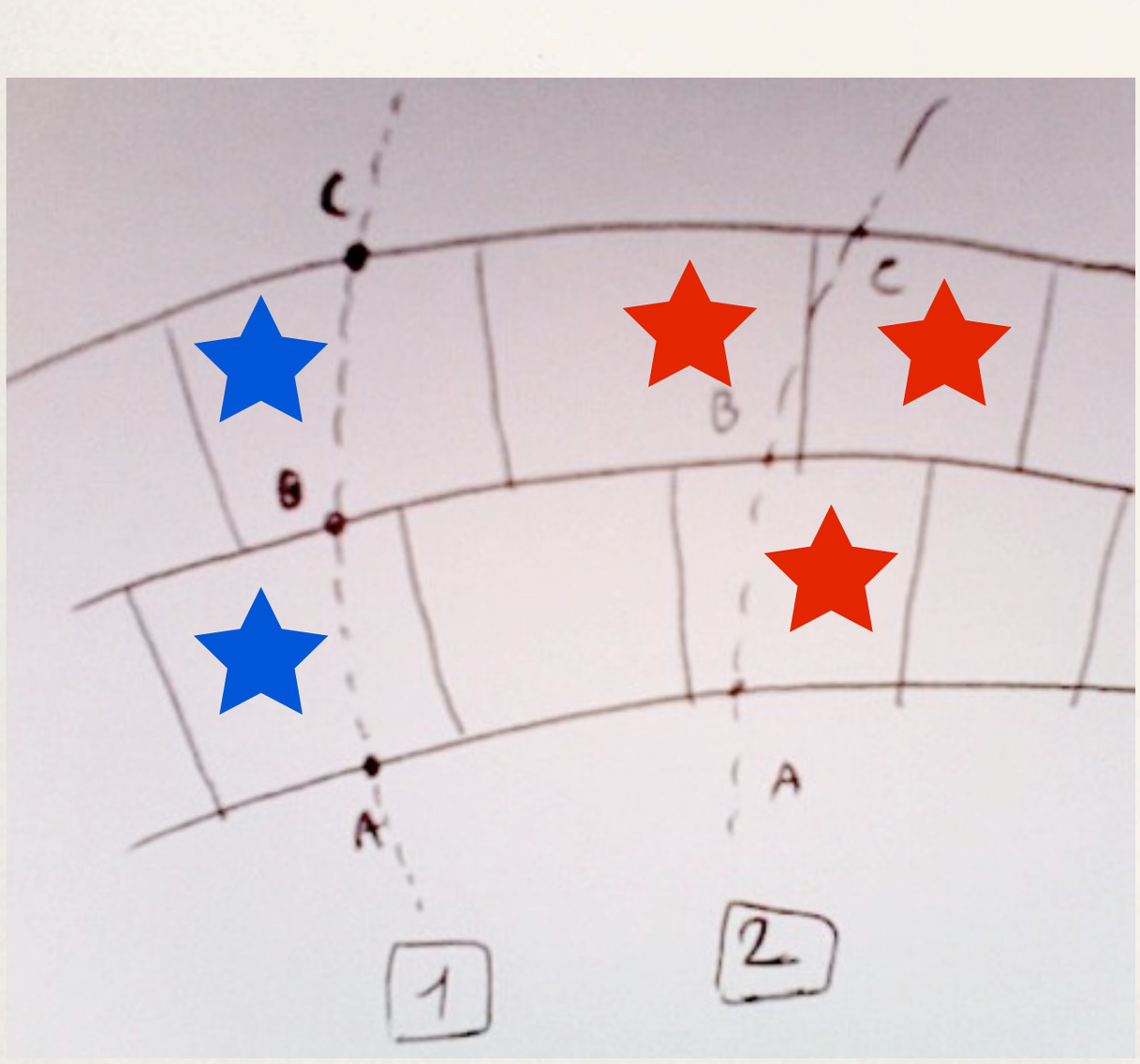
- Delta rays can be removed
- Rate is even more flat
- Pure geometric cause: additional rate depends only from cell phi angle, not from cell size

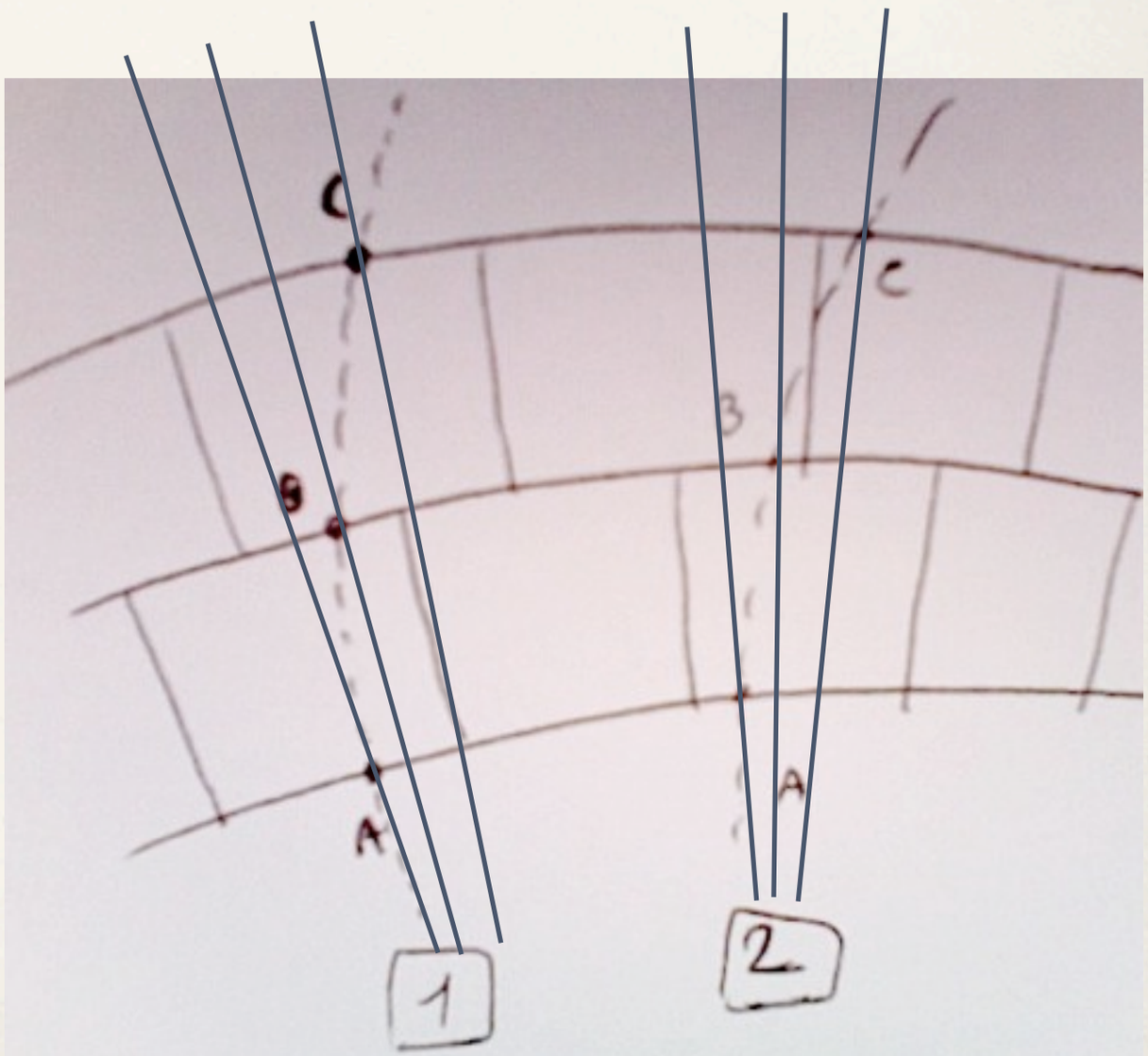
- **Layers around 5 and 30** have the same numbers of cells
- Phi angle of the track between entering and leaving point in the cell vs phi angle of the cell



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

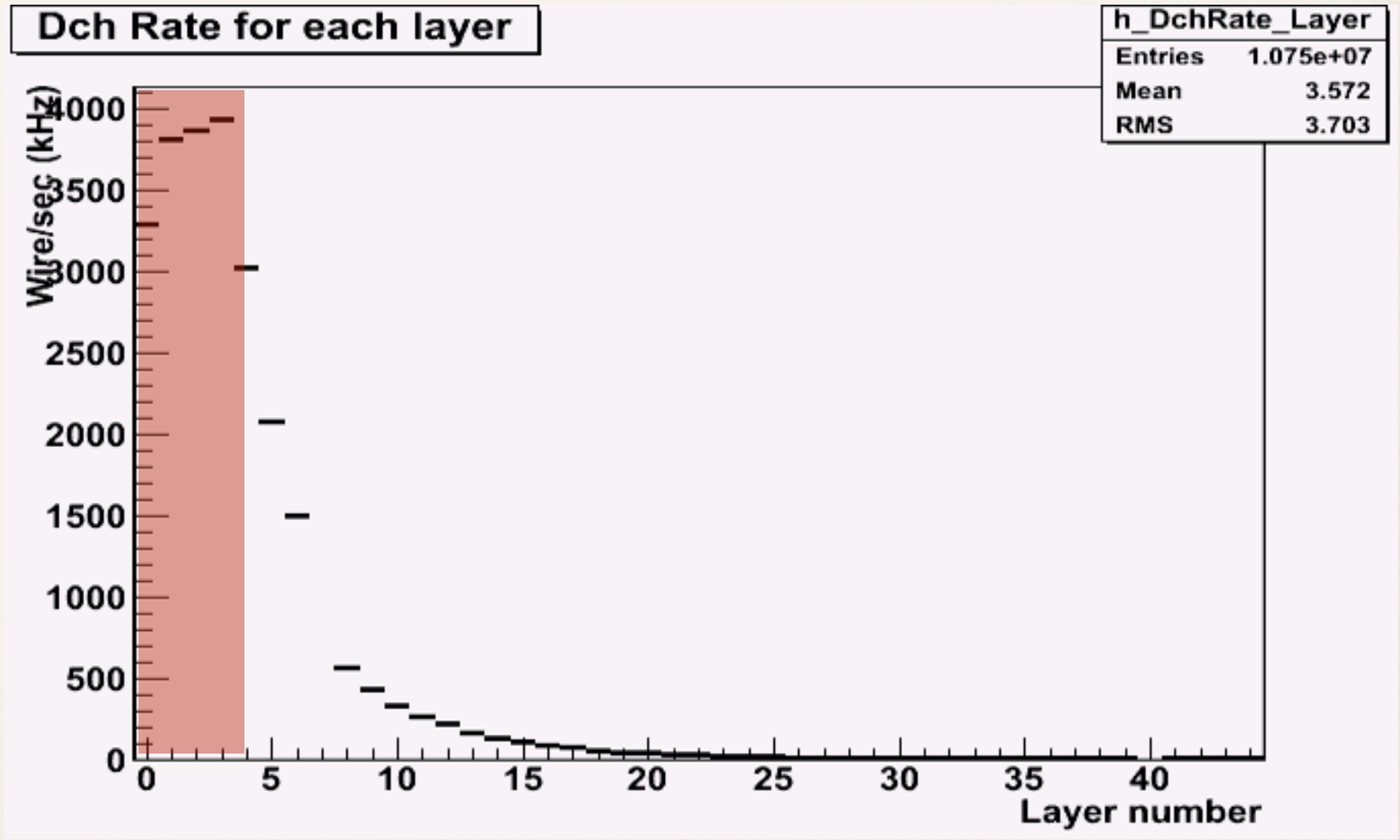




More single particles...

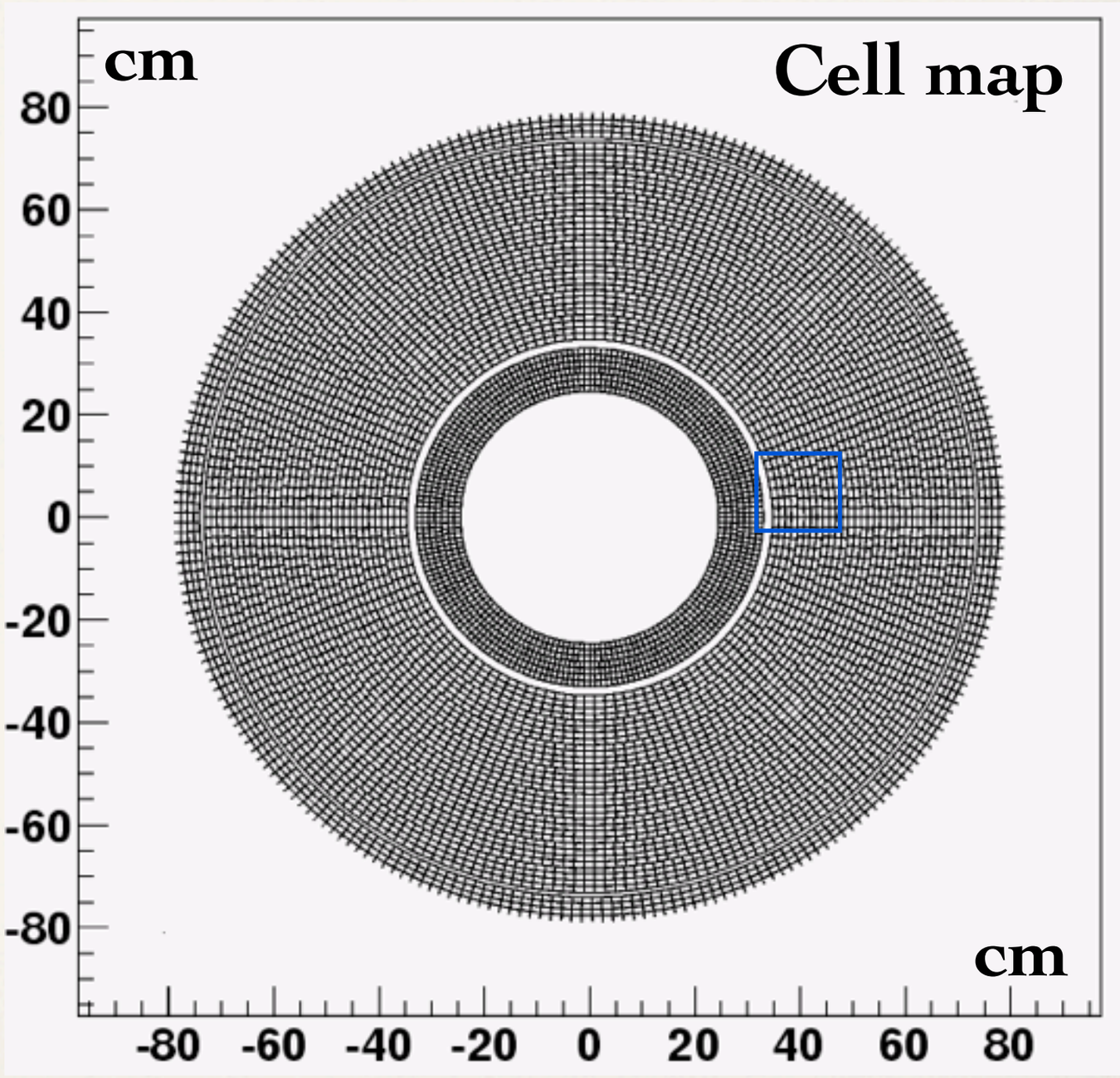
- Low energy electrons, 1.5 MeV, 45 degrees, pT = 1 MeV, radius 2.2 cm, **23-30 cm** from IP
- They should fire around 2 cells per layer -> rate 4 MHz

- 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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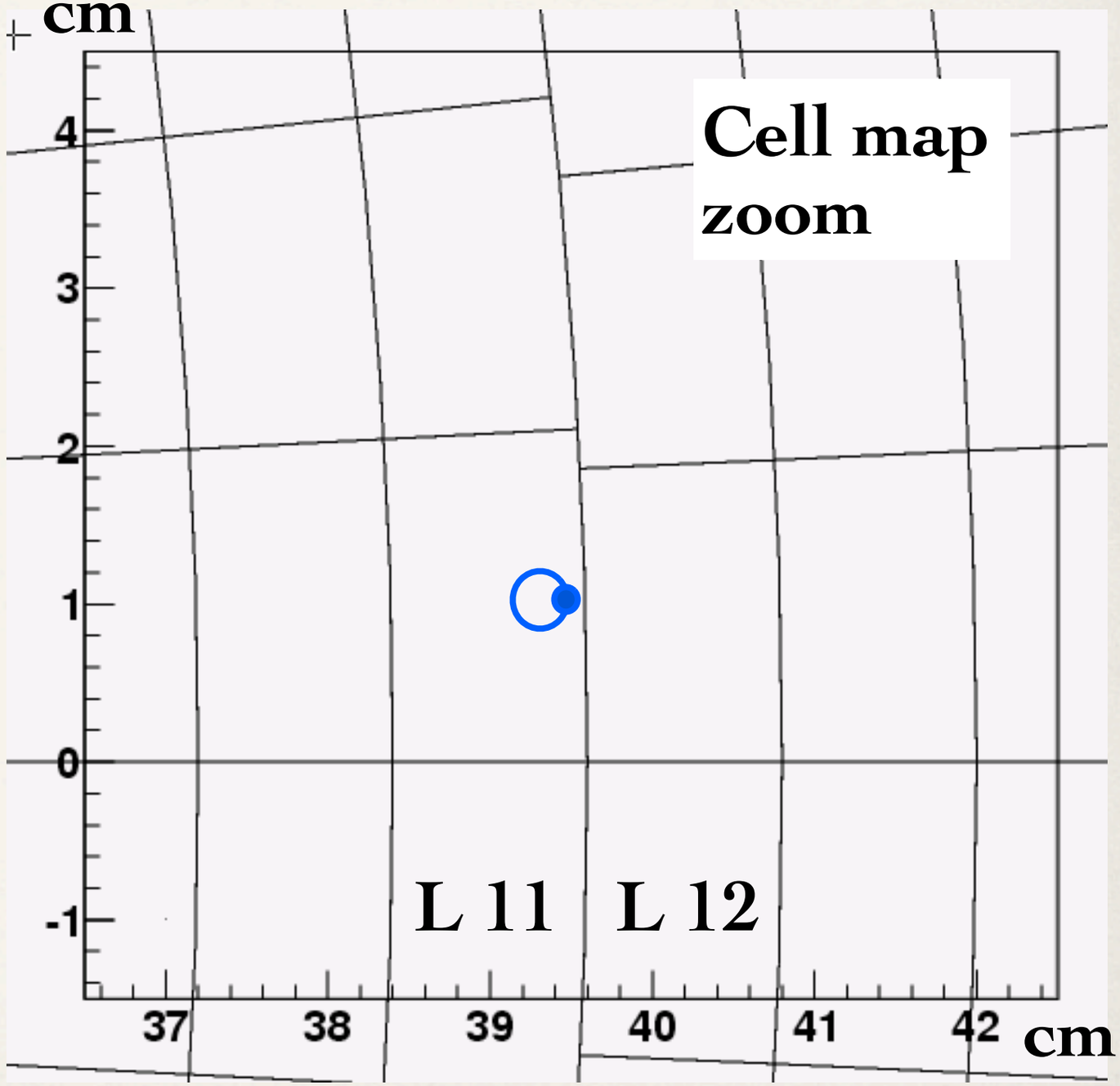
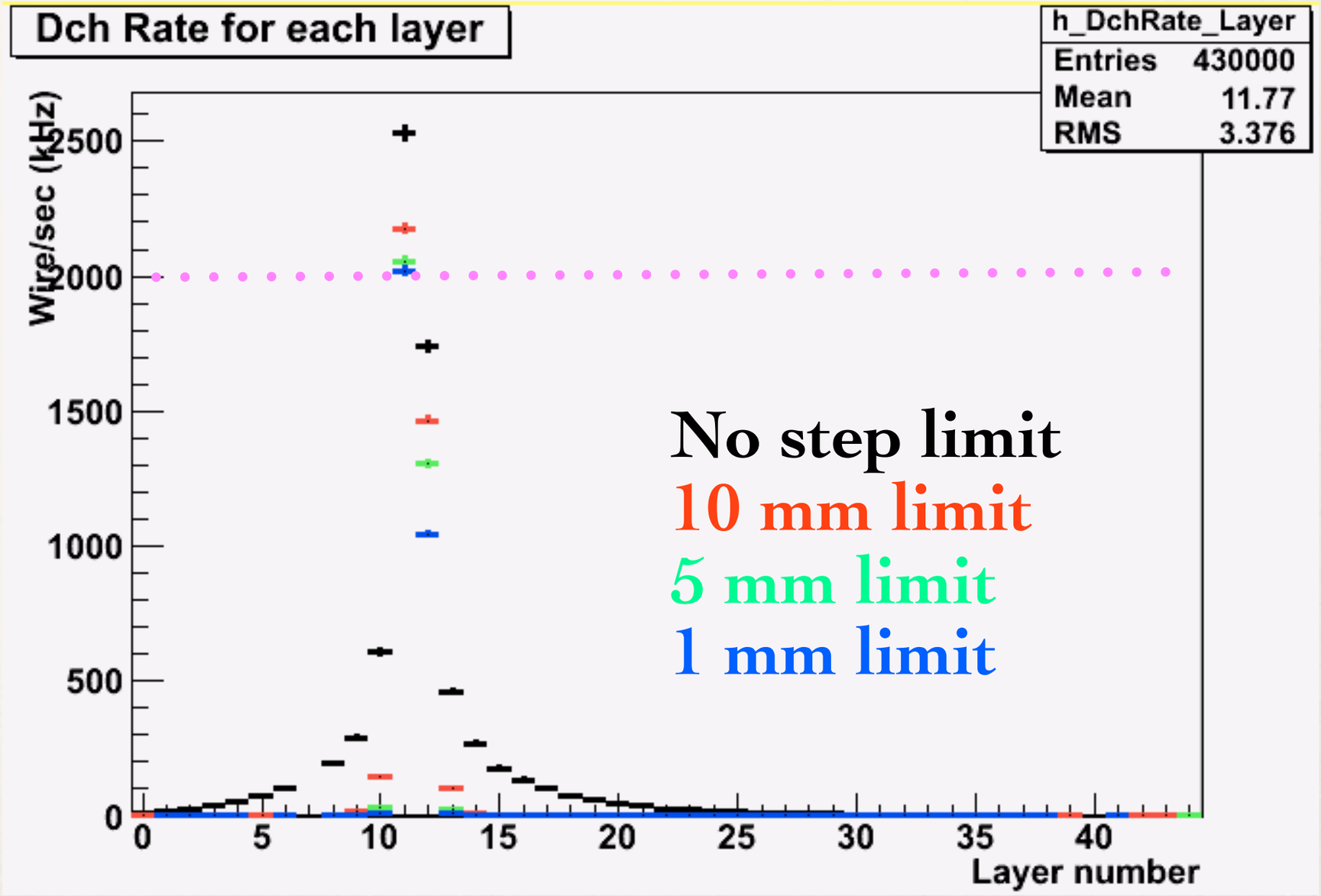


Single electrons, 1 GeV

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

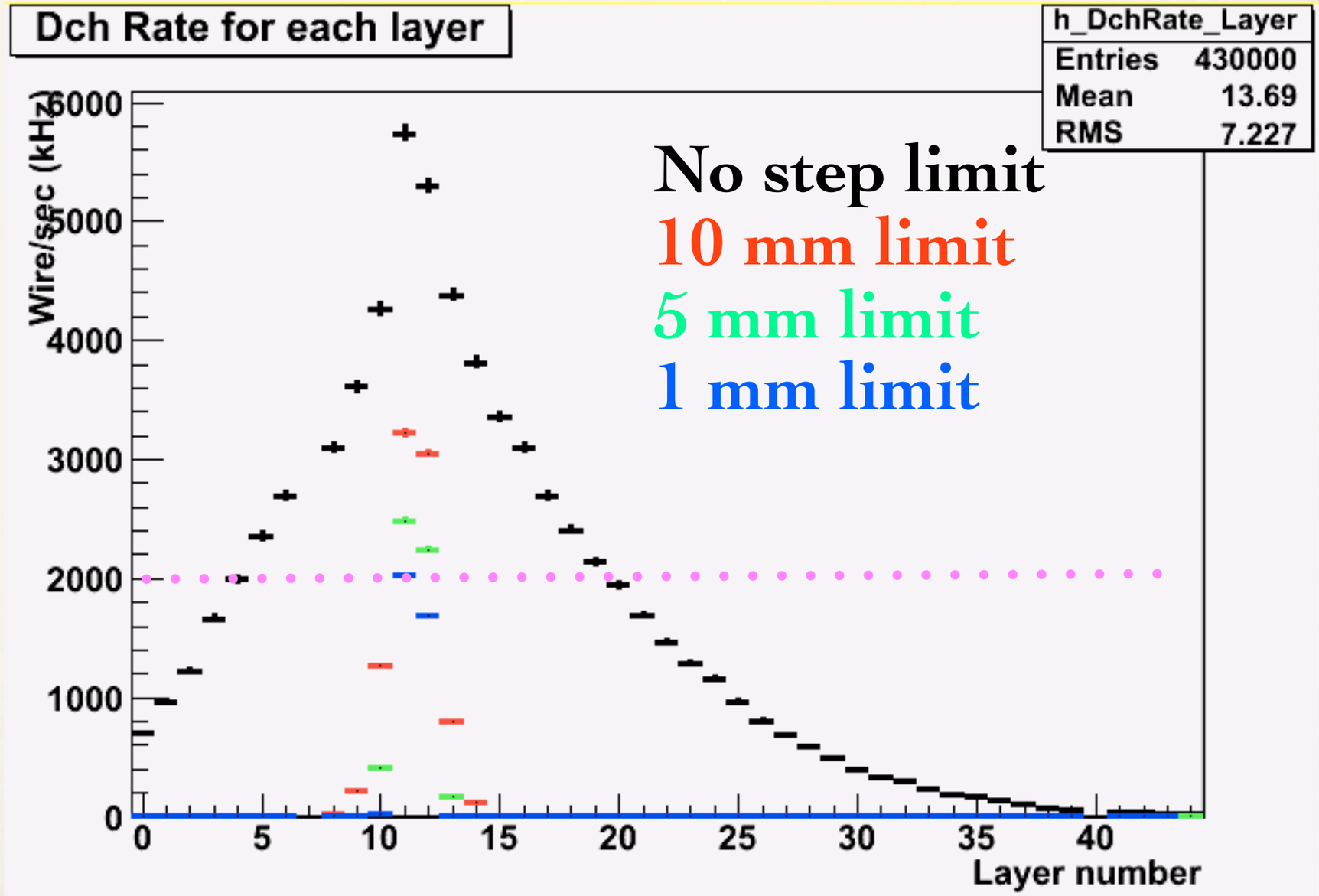
- Tails on both side
  - Multiple scattering
  - Delta rays



Single electrons, 1 MeV

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

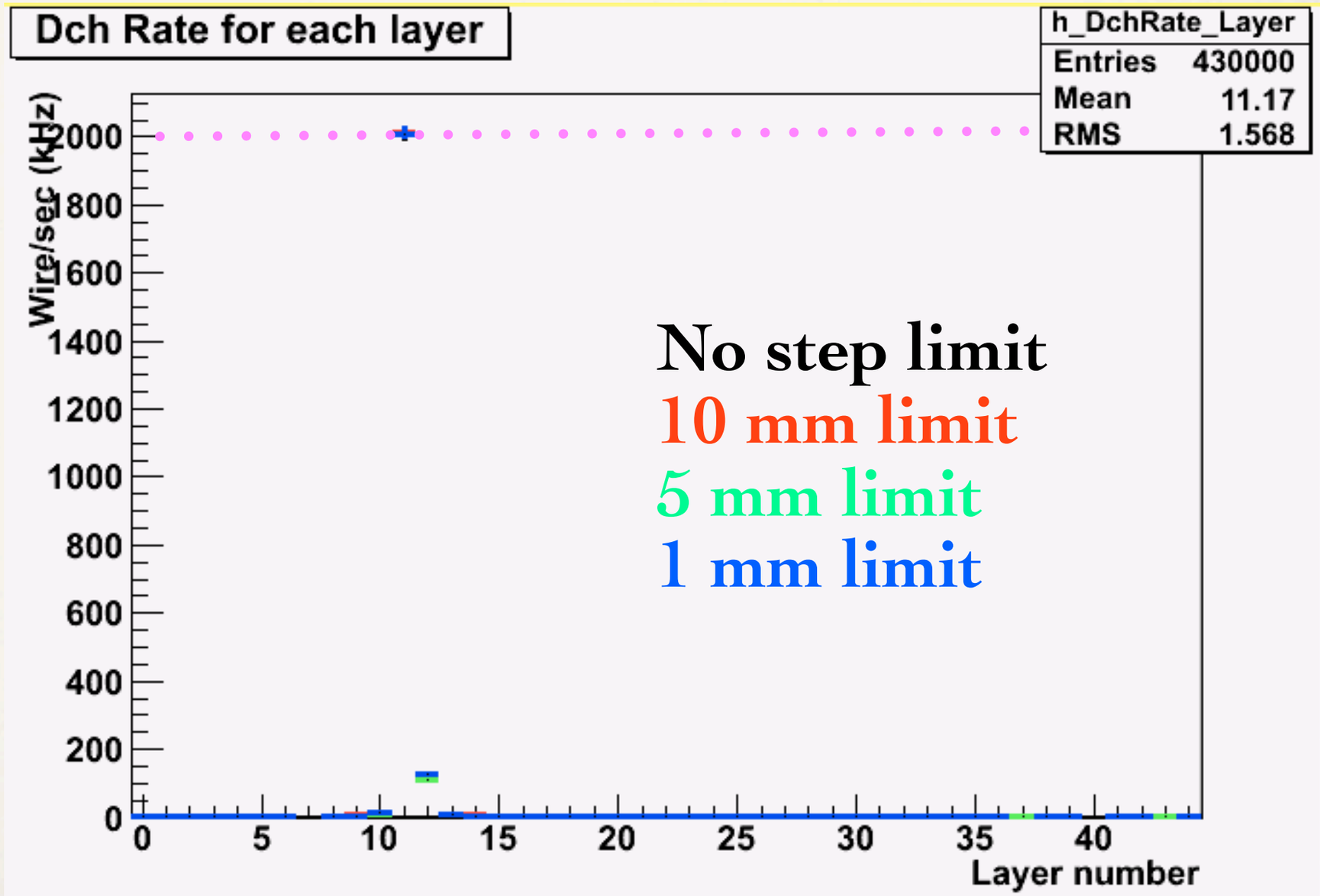
- Bigger effect at low energy
- Only simulation with 1 mm step limit gives good results
- When G4 applies the multiple scattering correction for a long step, the description is not accurate
- General overestimation of occupancy



Single electrons, 1 MeV, no MSc

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

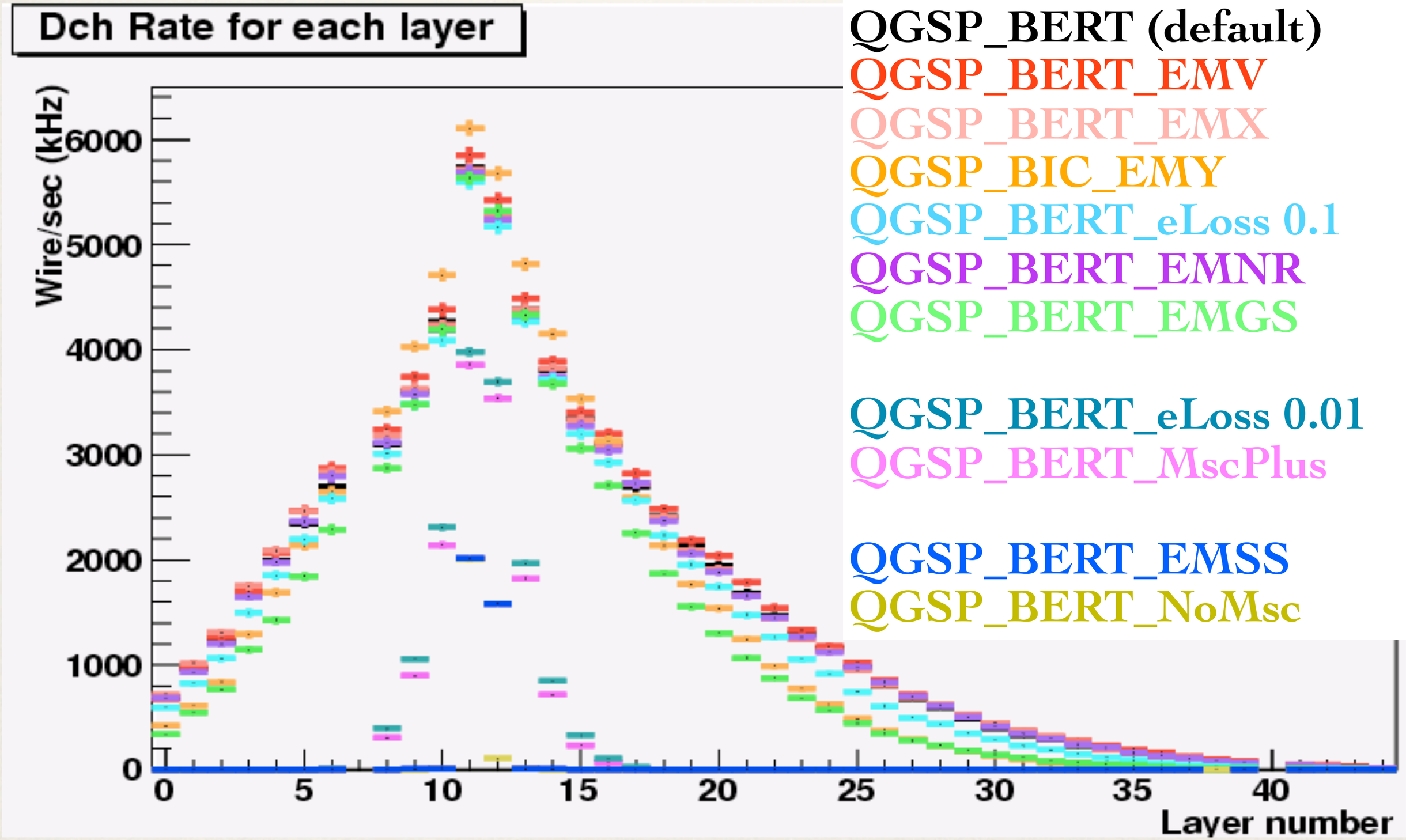
- To obtain realistic results we should turn it on
- Hit on layer 12 probably from delta rays
- Multiple scattering is responsible for most of the discrepancy



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

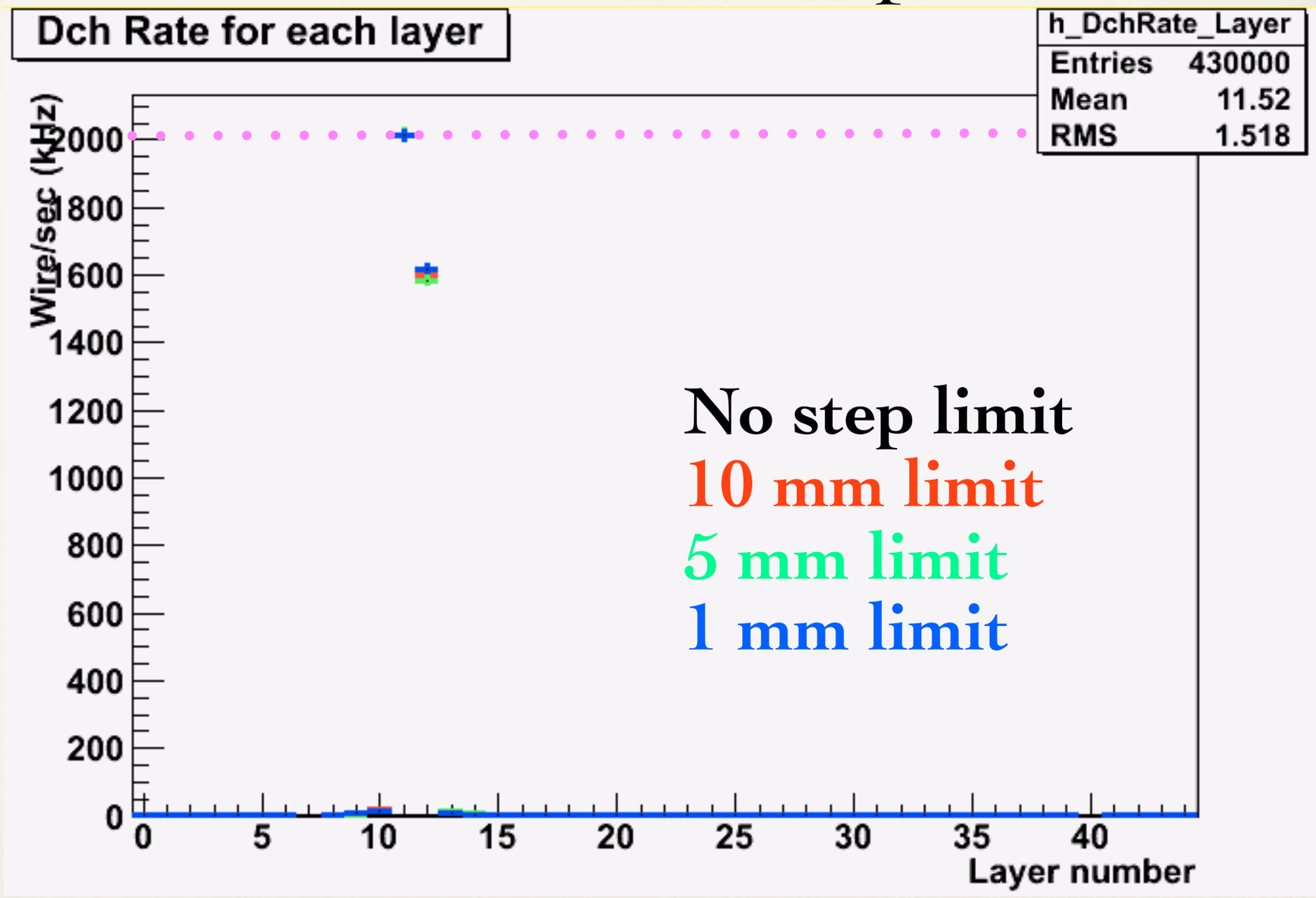
QGSP_BERT_eLoss 0.01
QGSP_BERT_MscPlus

QGSP_BERT_EMSS
QGSP_BERT_NoMsc

Single electrons, 1 MeV, SS

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

- Not easy to use this in full simulation, technical problems:
- bigger output files and longer running time
- tricky to activate the process only on Dch (found a recipe on G4 forum, but not implemented yet)



Brief summary

- Culprit of dependance from step size limits is the multiple scattering
- Solution 1: simulating track in Dch with reduced step, 10, 5 or 1 mm
  - Bigger files and longer running time
- Solution 2: single Coulomb scattering
  - Excellent, but more technical problem than Solution 1
  - Bigger files and longer running time
- Bkg is always overestimated: from some dedicated simulation with SS

Single Particle Dch - 1 MeV	CPU time	File size
10 mm	x1.25	x3
5 mm	x1.6	x5
1 mm	x4	x22
Single Scattering	x5	x24

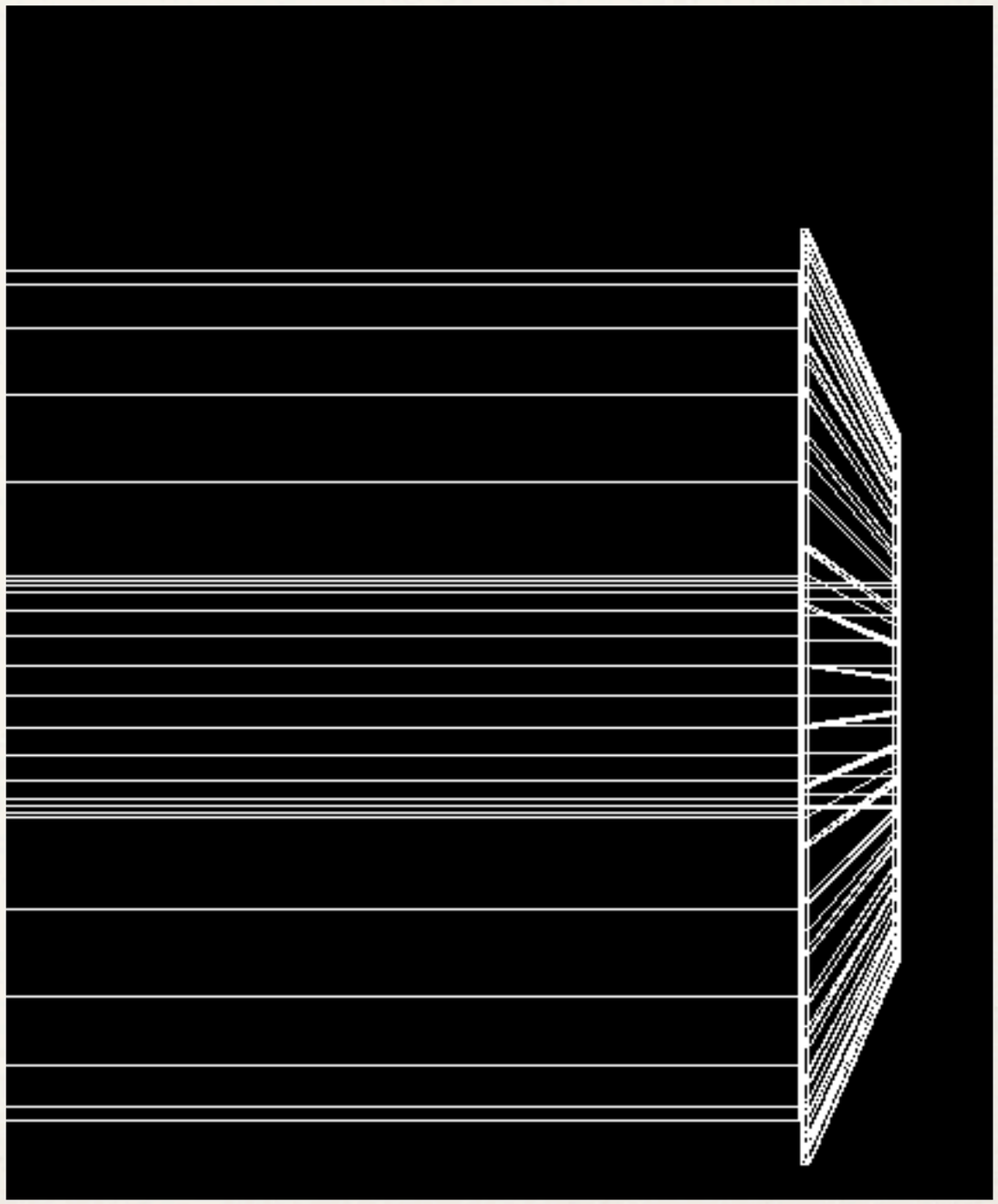
Radiative Bhabha	CPU time	File size
Single Scattering	x7	(x4.3?)

fTOF test

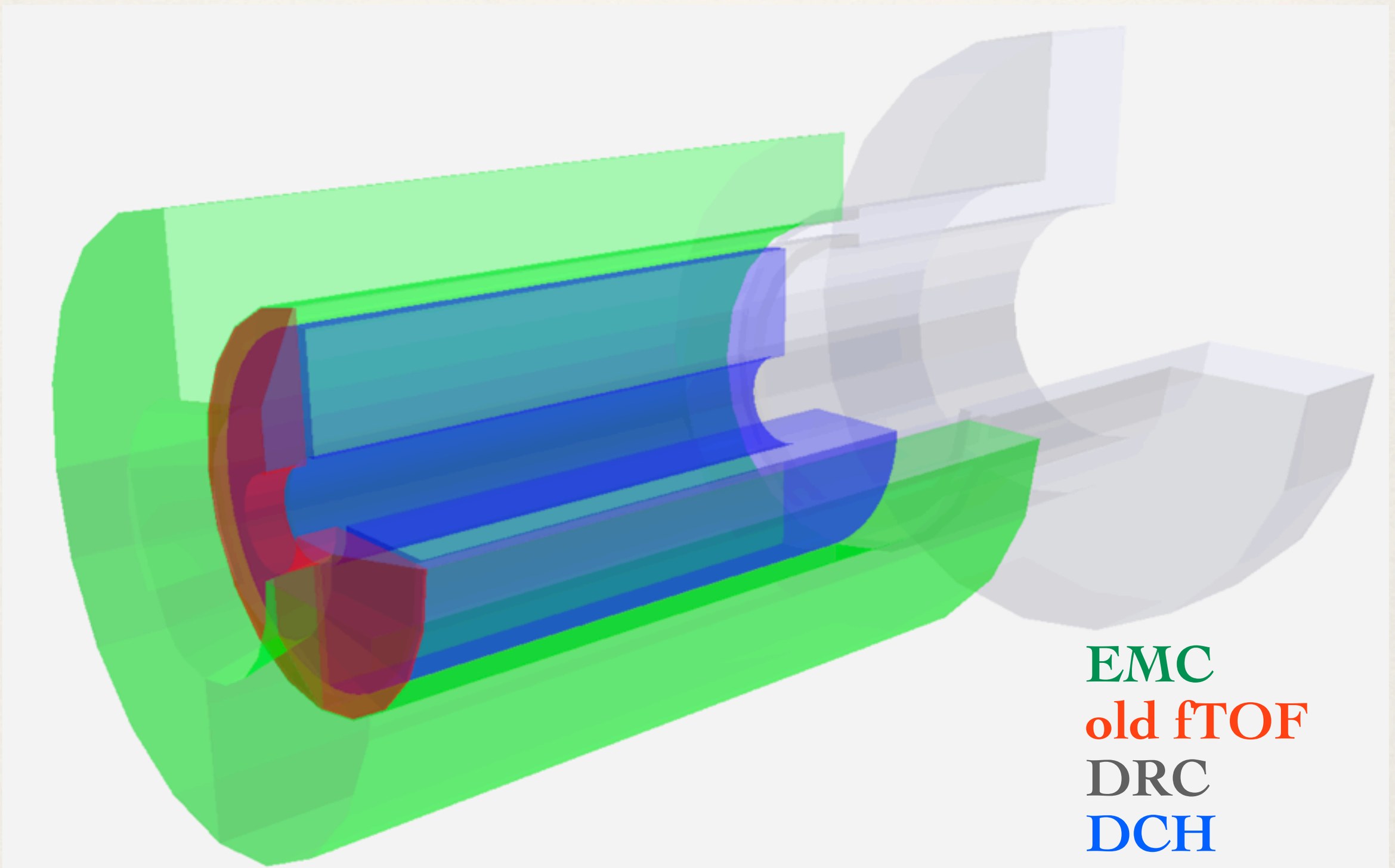
- Request to make room for new fTOF geometry
  - Short Dch, 5 cm
  - Move Drc 5 cm in bwd direction
  - It's not possible to move Emc, projective geometry of crystals
- Done using r414 (latest geometry), already committed, **r418**
  - Optional geometry, need to modify main gdml (instructions per email and on svn comment)
  - Add also tungsten shielding extension made by Eugenio
- Overlaps checks done, ok

fTOF test

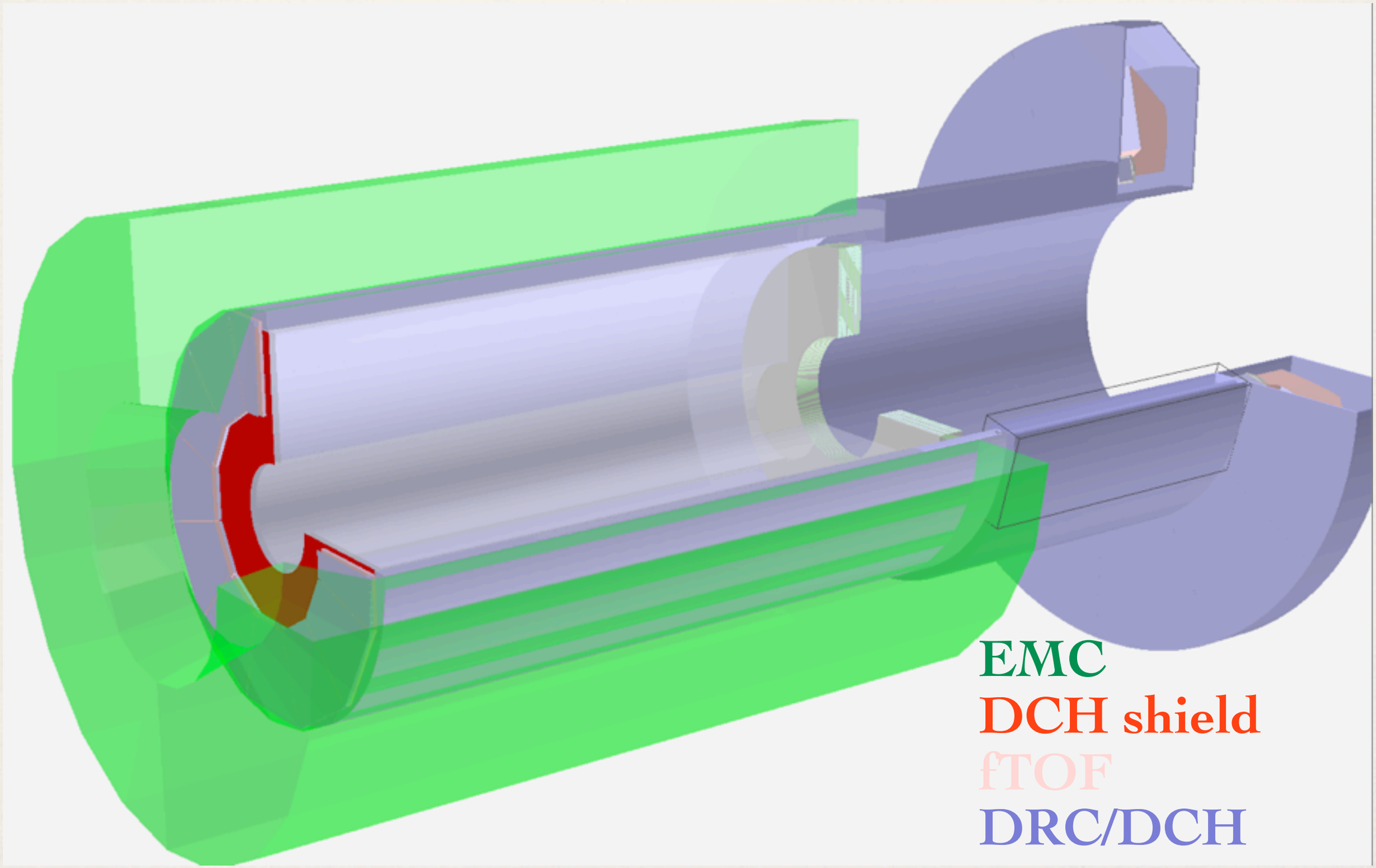
- Side view
- Old geometry
  - Dch container
  - Old TOF (TOF.gdml)
- Wired view:
  - containers plus some volumes



fTOF test

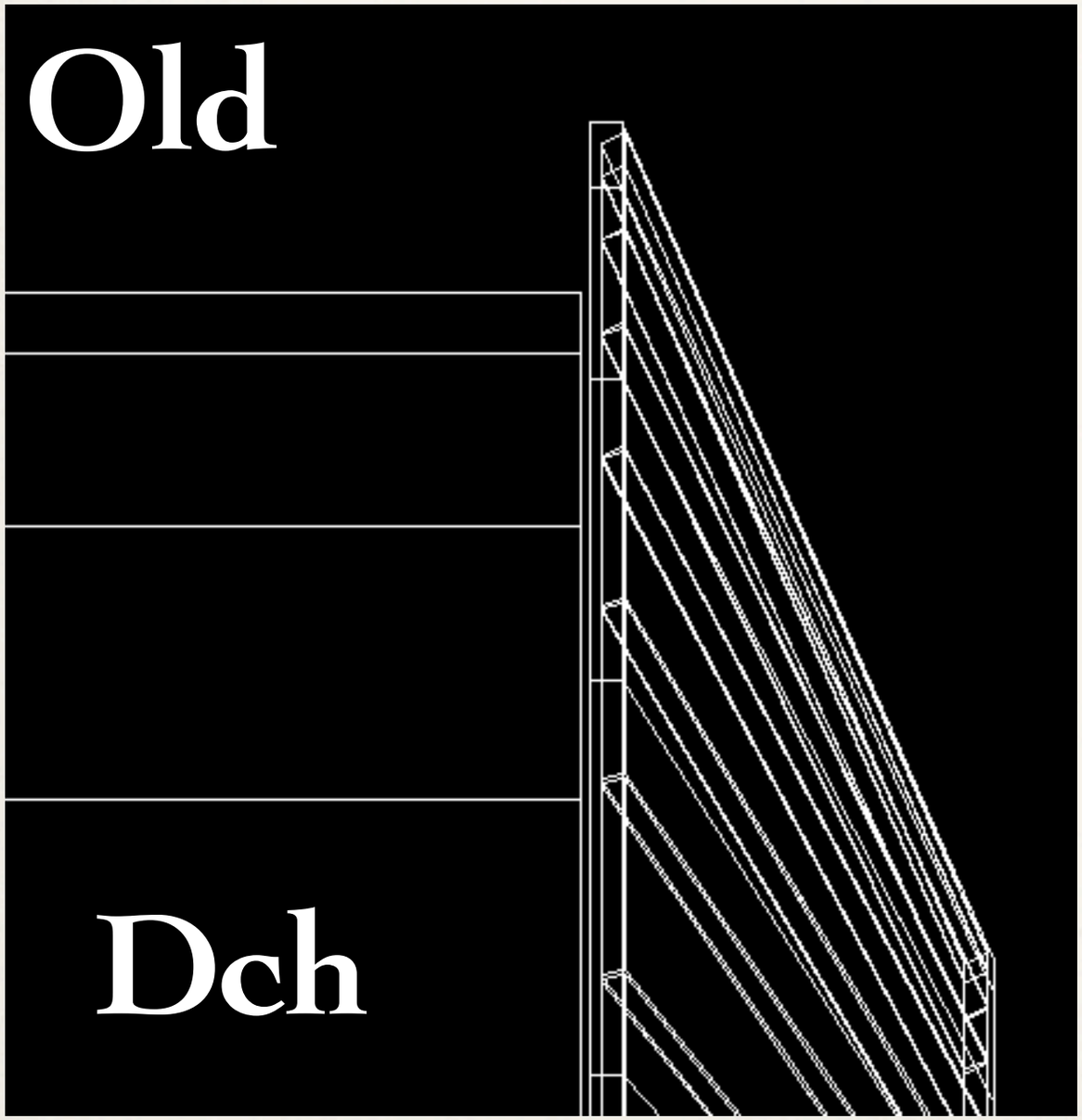


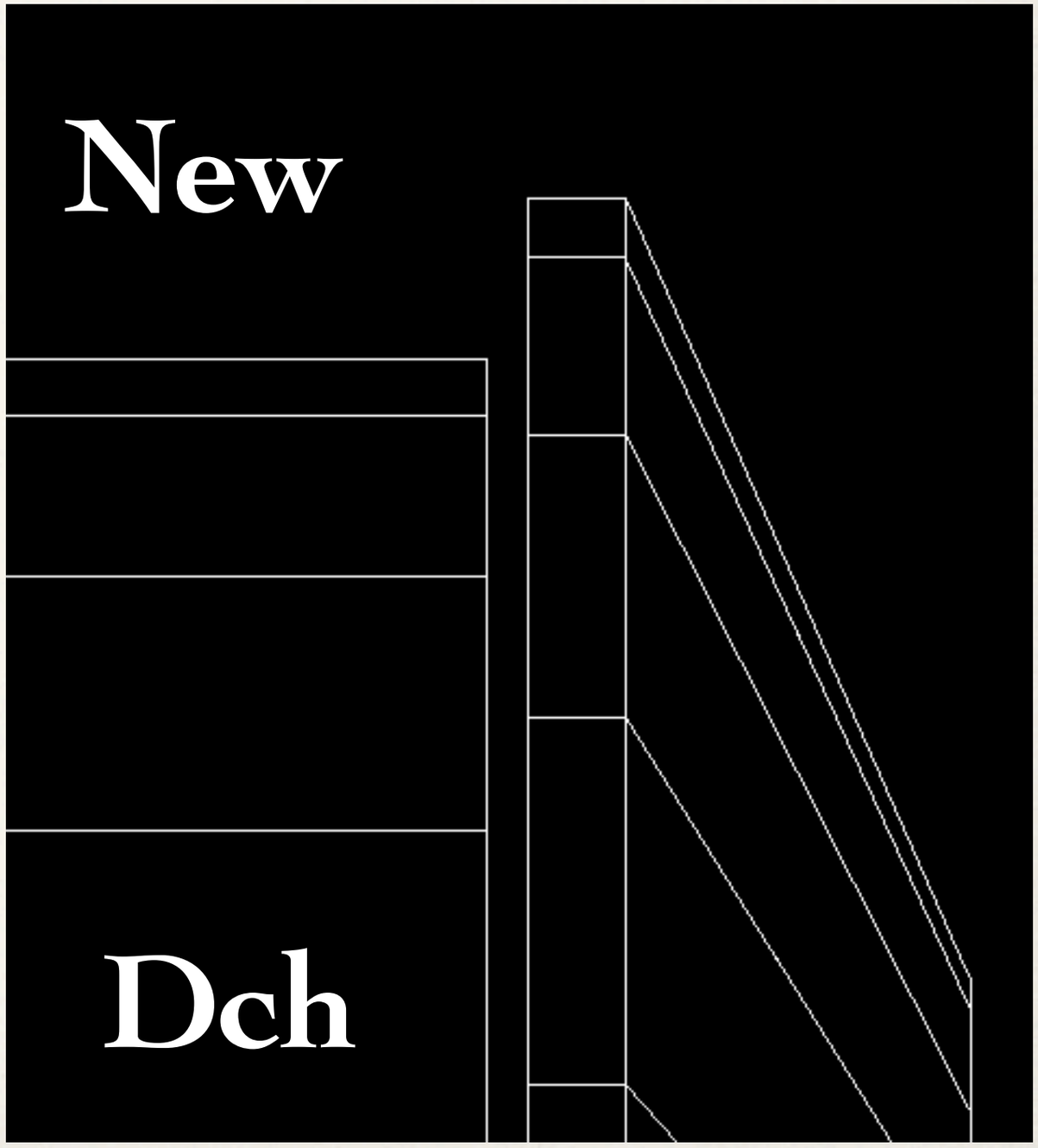
fTOF test



fTOF test

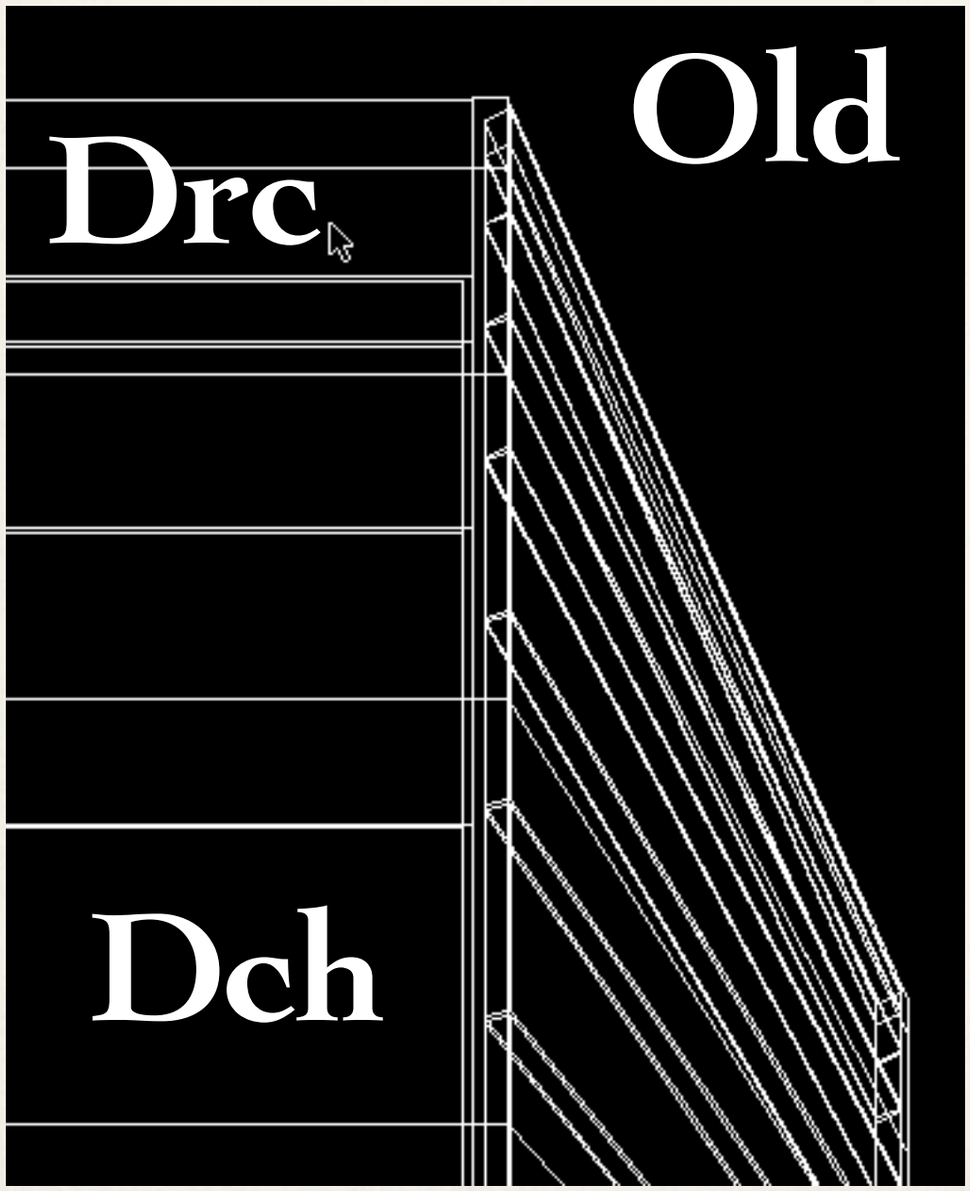
- Side view

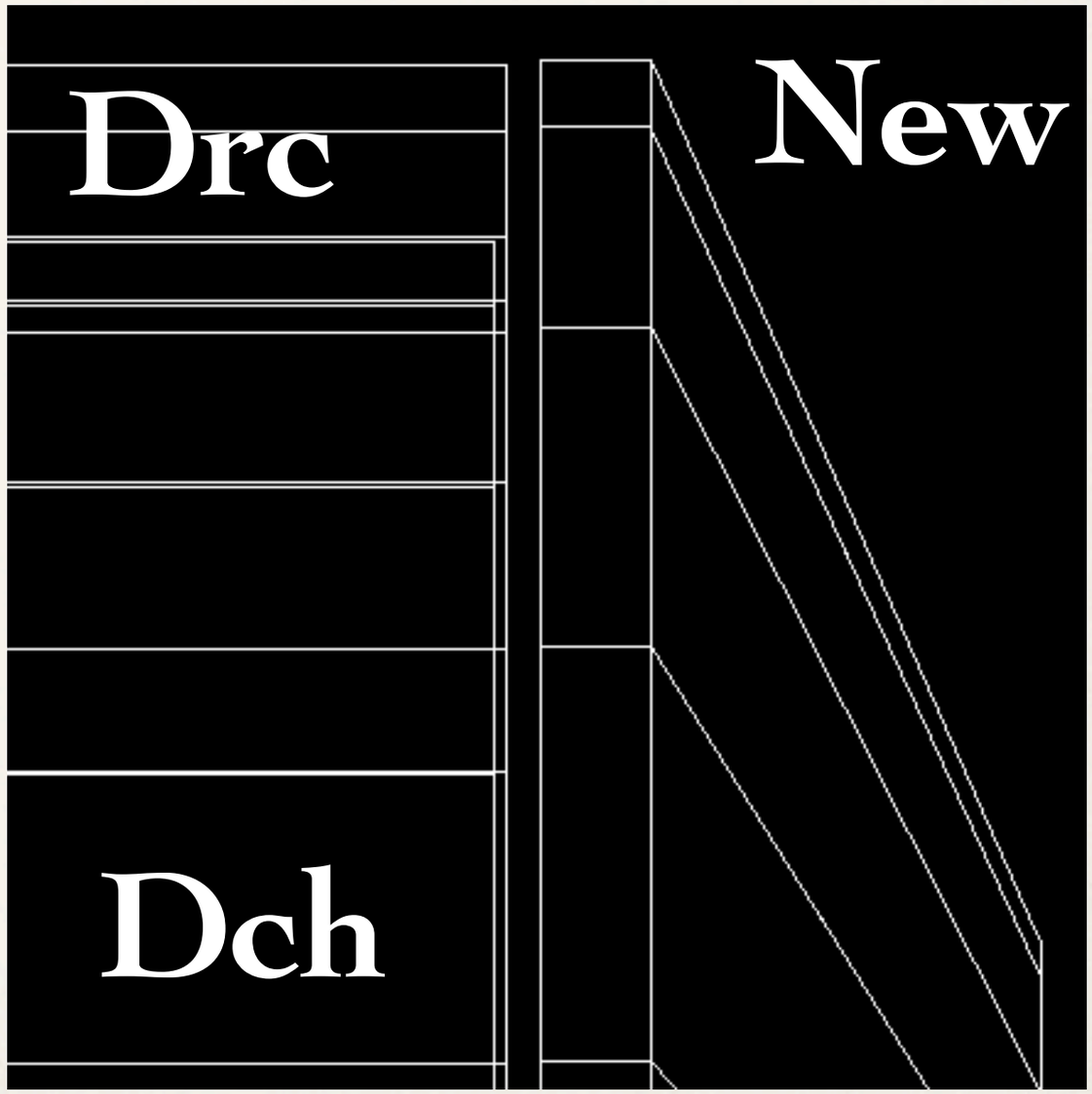




fTOF test

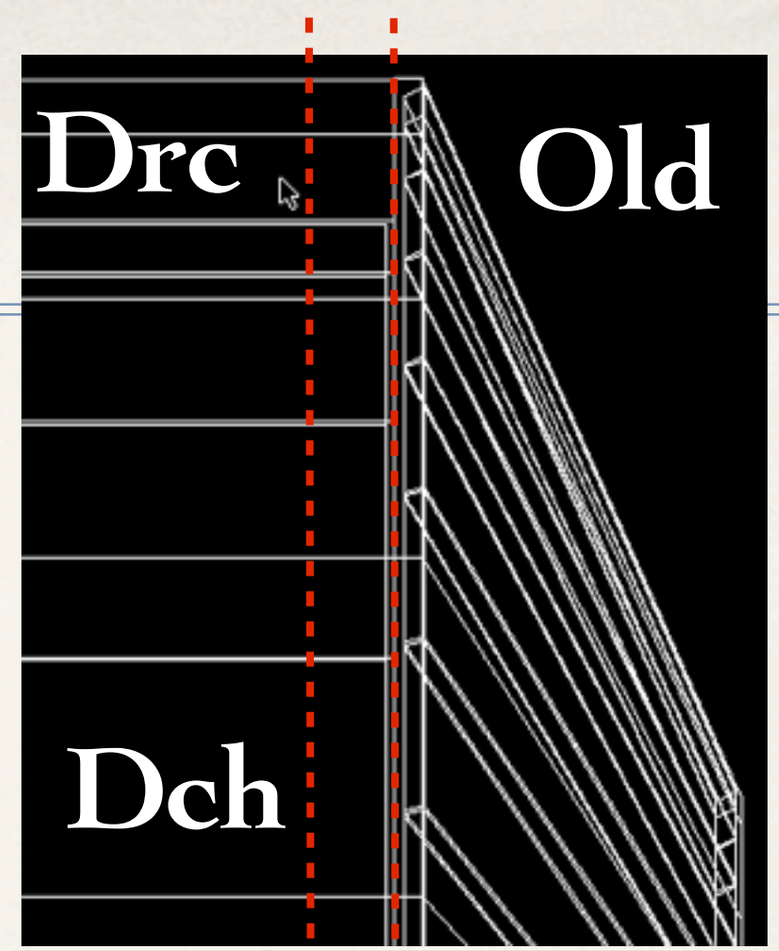
- fTOF, DCH, DRC

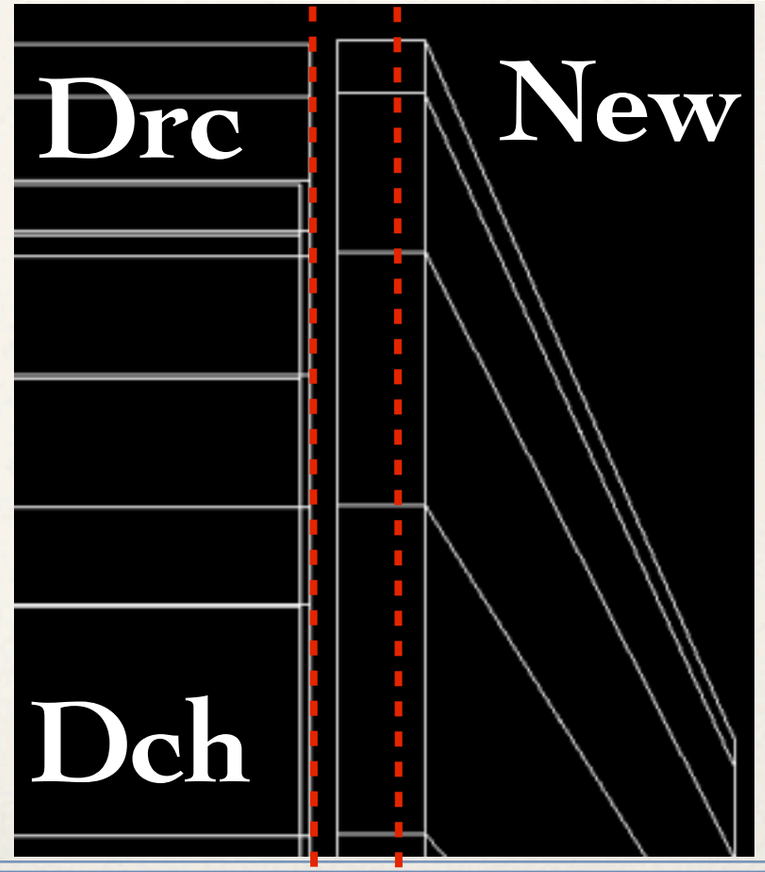




fTOF test

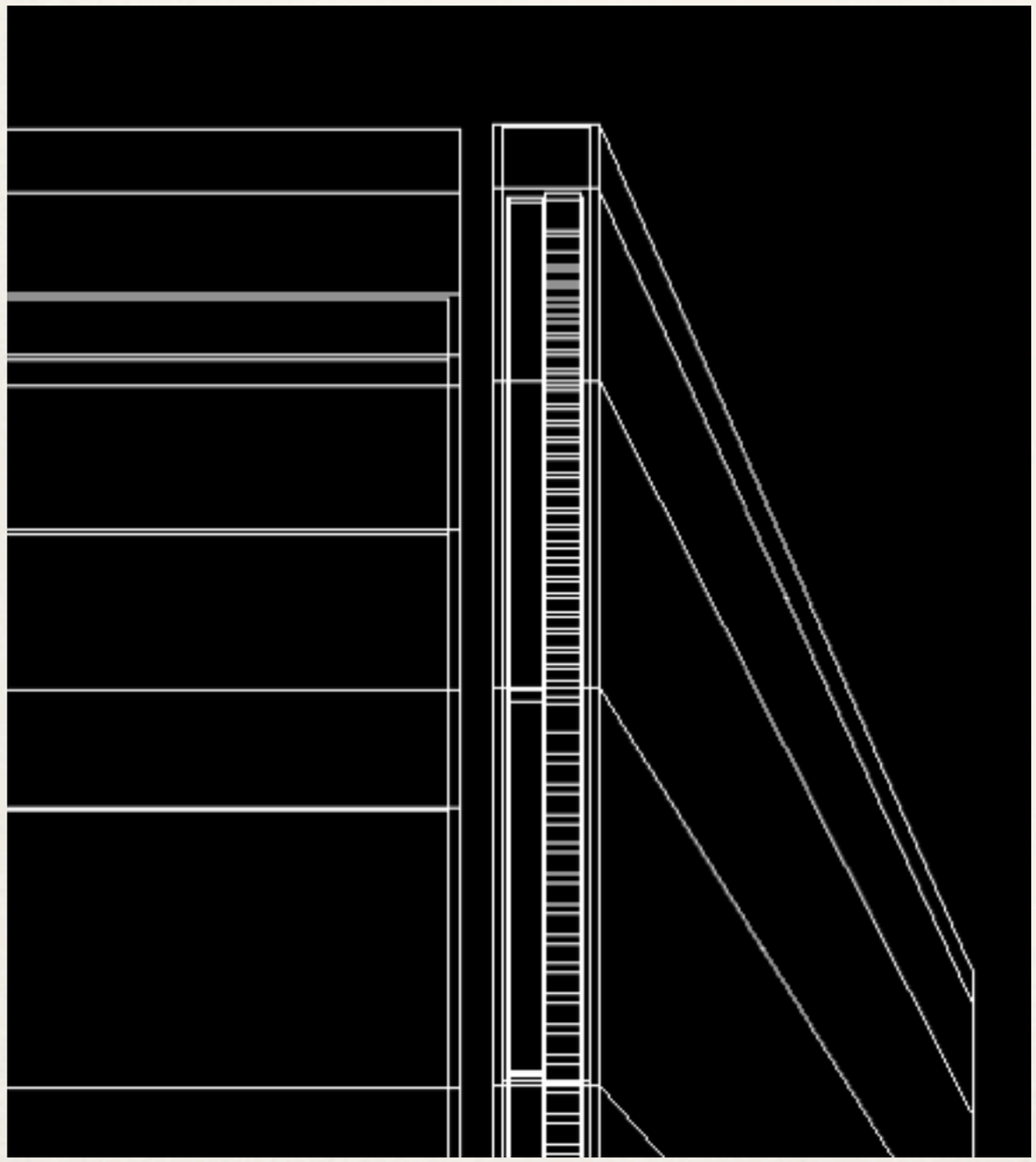
- fTOF, DCH, DRC
- Space between the two dashed lines

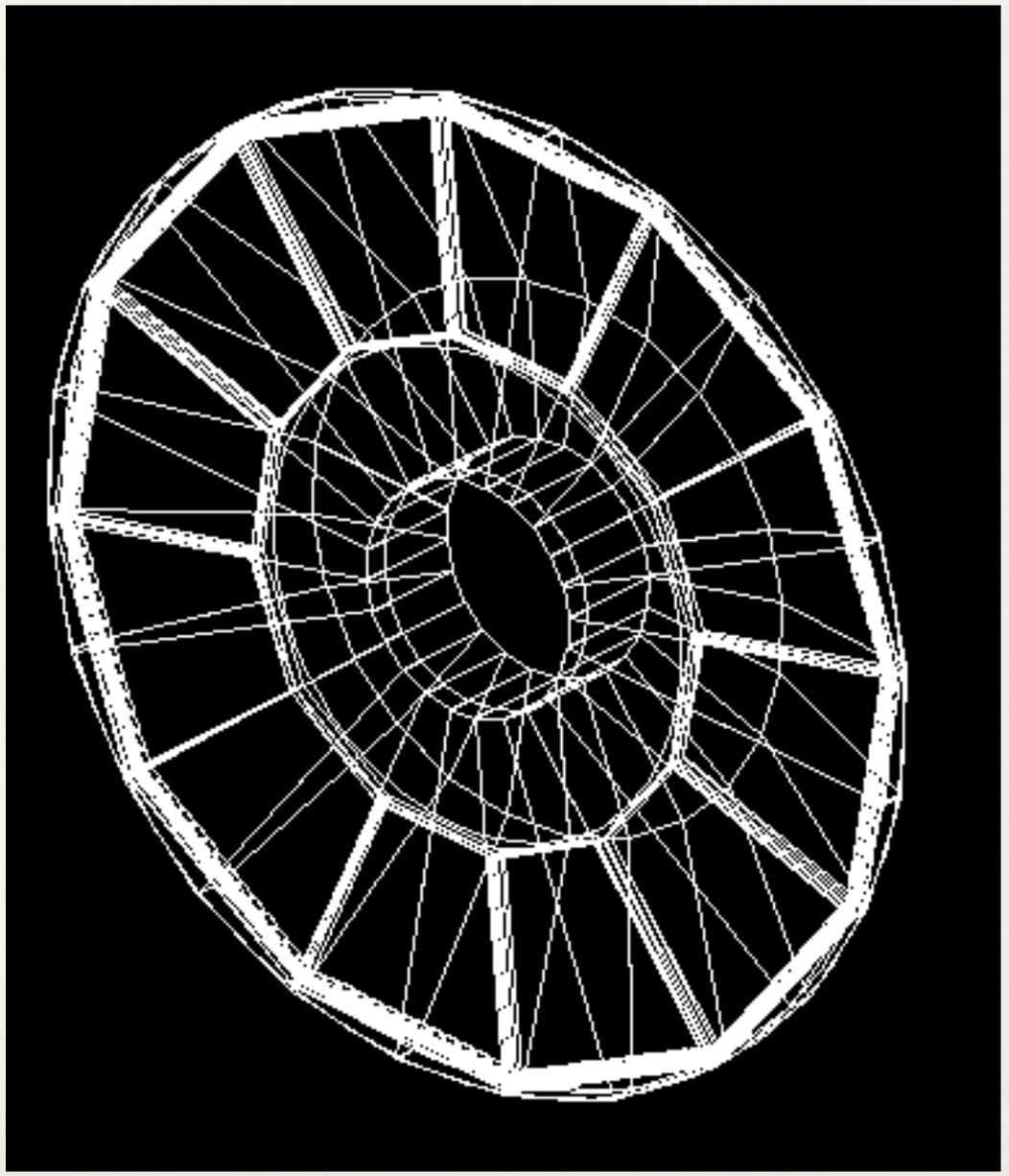




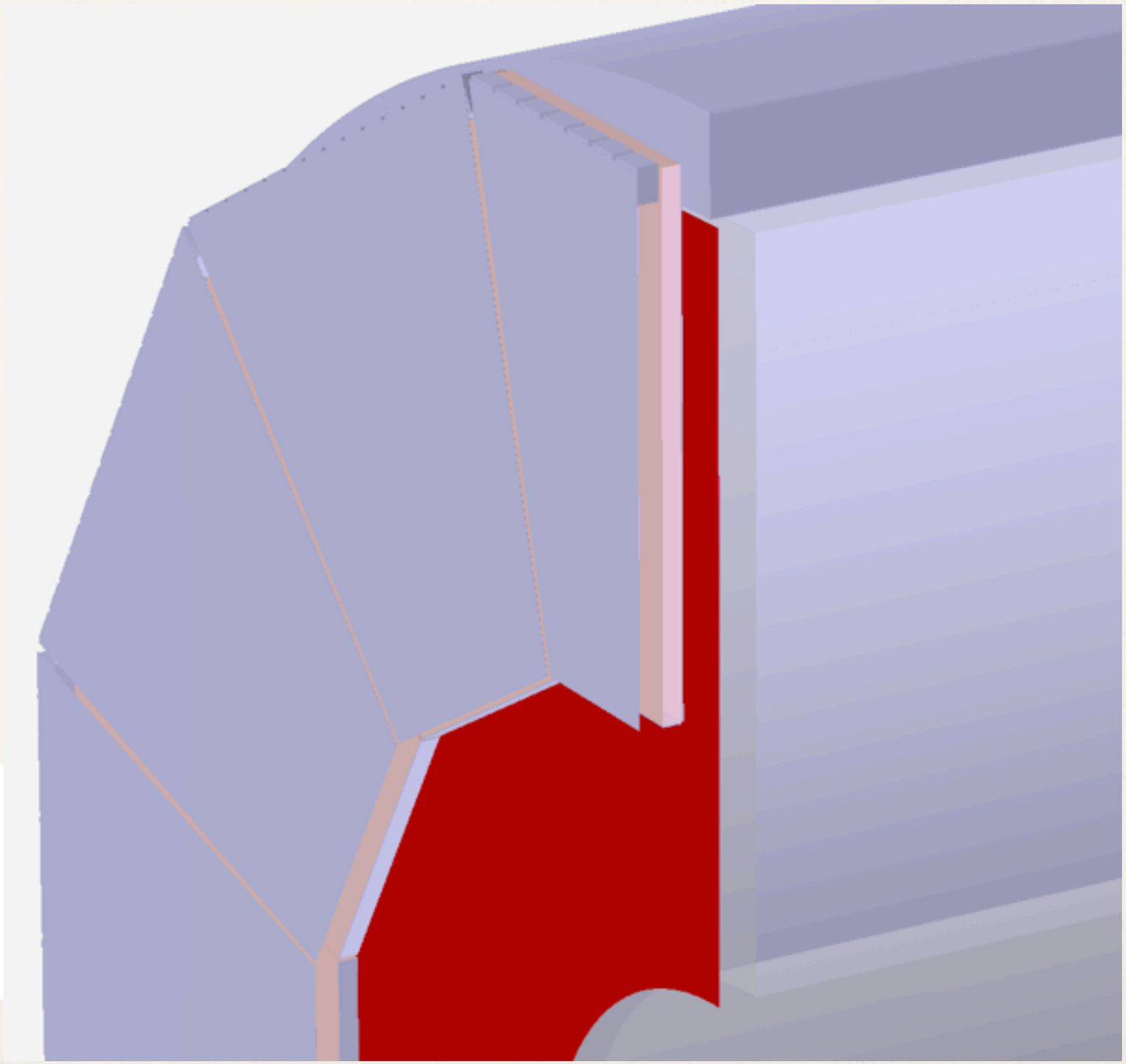
fTOF test

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





fTOF test



DCH shield
fTOF quartz
DRC/DCH

Conclusions

- Increase of occupancy with new geometry due to non-shielded beam pipes
  - Additional structures need to be included (plug, horseshoe, mech supports)
- "Step size" problem:
  - Due to poor simulation of multiple scattering
  - Two solutions available, both with technical issues, need to choose one
  - Better understanding of the problem, feasible an evaluation of the occupancy overestimation
- Shorten Dch model for fTOF test has been implemented