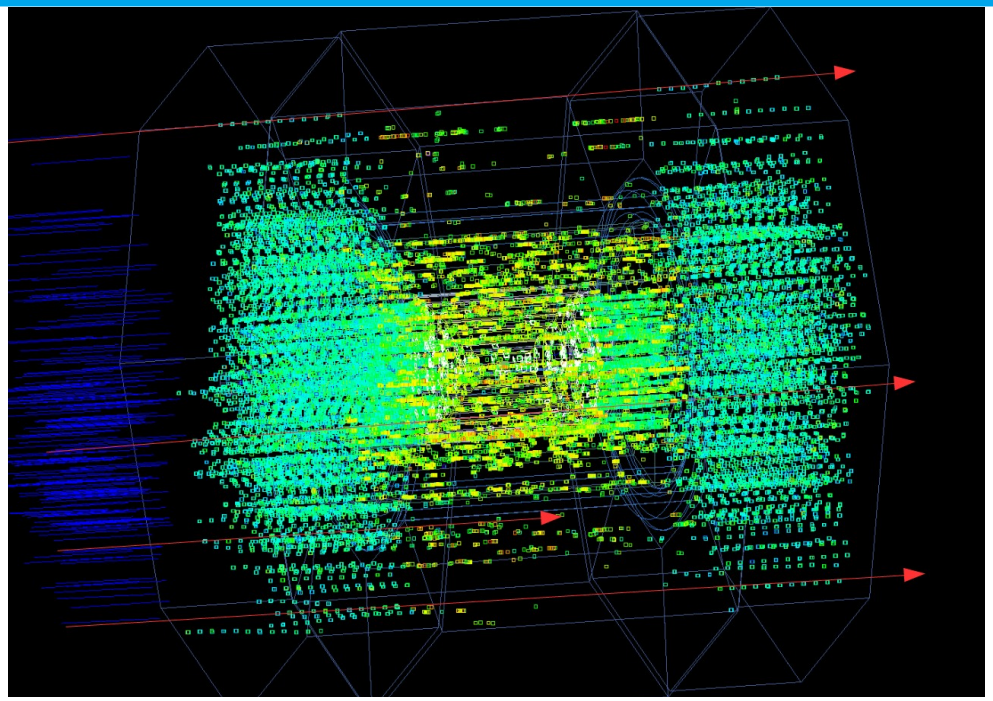
The impacts of the muon spoiler background on the ILC detector performance



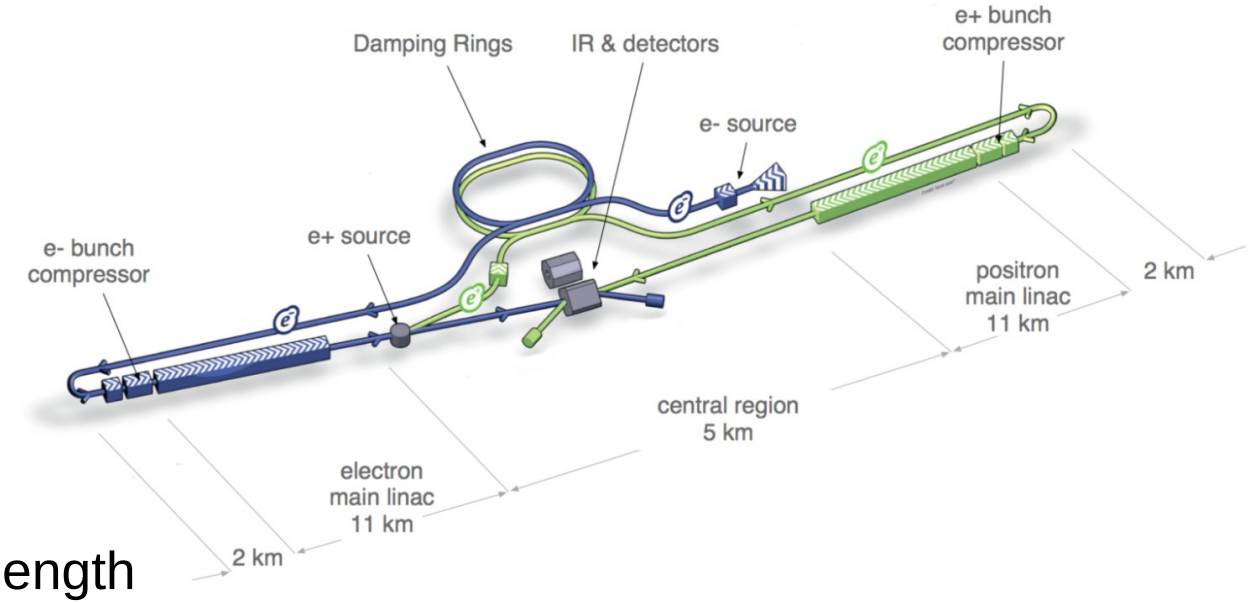
Jonas Glombitza, RWTH Aachen
Summer student in the ATLAS group
Supervisor: Anne Schuetz, Dr. Marcel Stanitzki
Hamburg, 8.9.2016

HELMHOLTZ ASSOCIATION

DESY

The ILC – International Linear Collider

> Planned e-/e+ collider in Kitakami mountains (Japan)



> 31 km length

> Center of mass energy 500 GeV

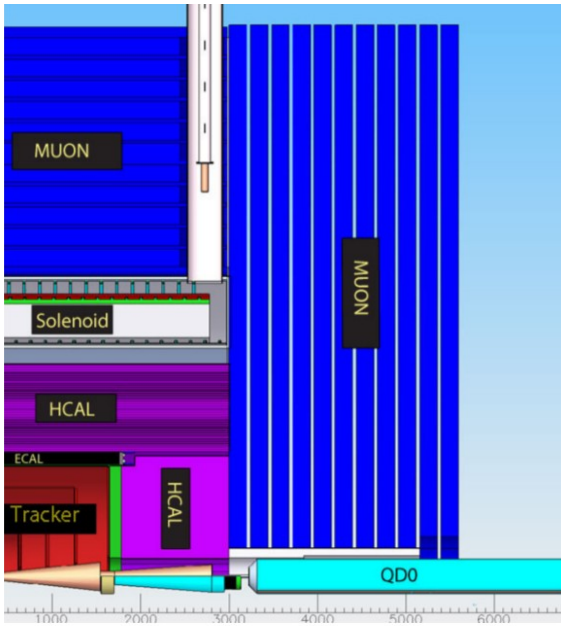
> Leptonic collisions

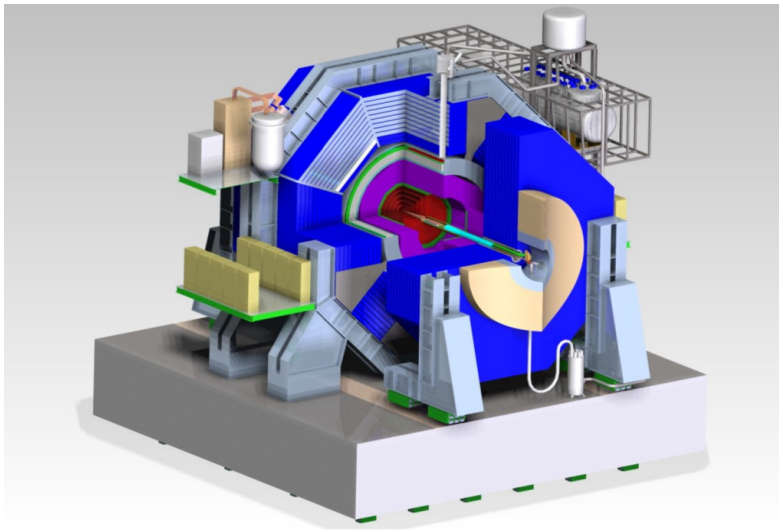
- Small detector occupancy
- Electro weak interaction

> Very small background in comparison to hadron colliders

The SiD – Silicon Detector

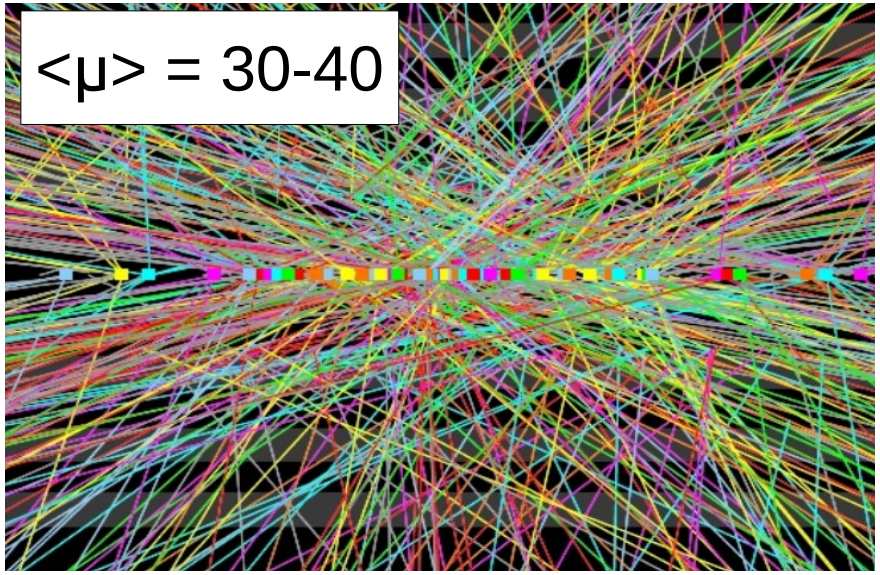
- Compact Silicon Detector
  - Every subdetector has silicon cells
- 7 subdetectors
  - ECAL, HCAL, Tracker, VertexTracker, MuonChamber, BeamCal, LumiCal
- Height: ~14 m Length: ~12 m
- Weight: 10 kt
- Solenoid field: ~ 5 T





From LHC to ILC

LHC



From LHC to ILC

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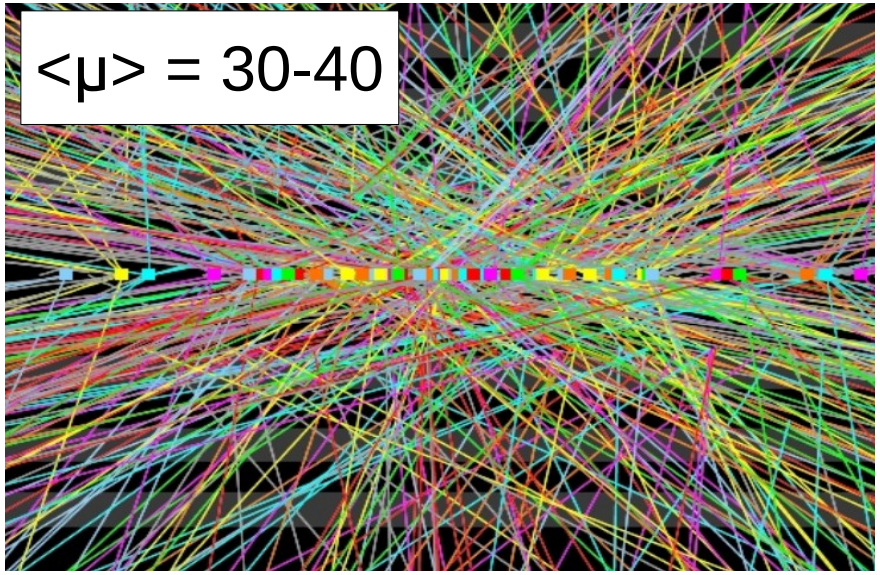
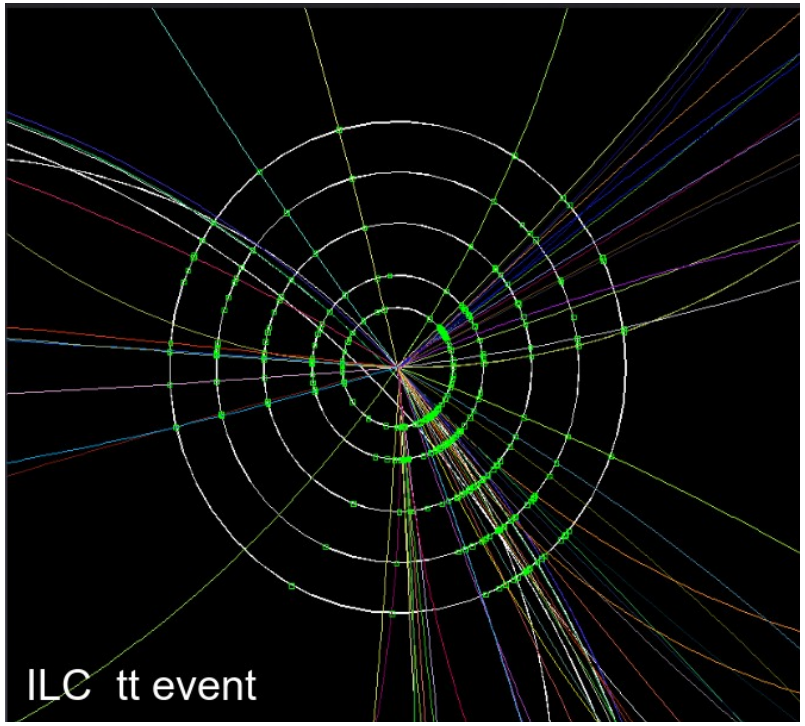


ILC



> Moving from ~ 30-40 interactions per crossing
→ to 1 event per train (~1300 crossings)

Background studies for the SiD

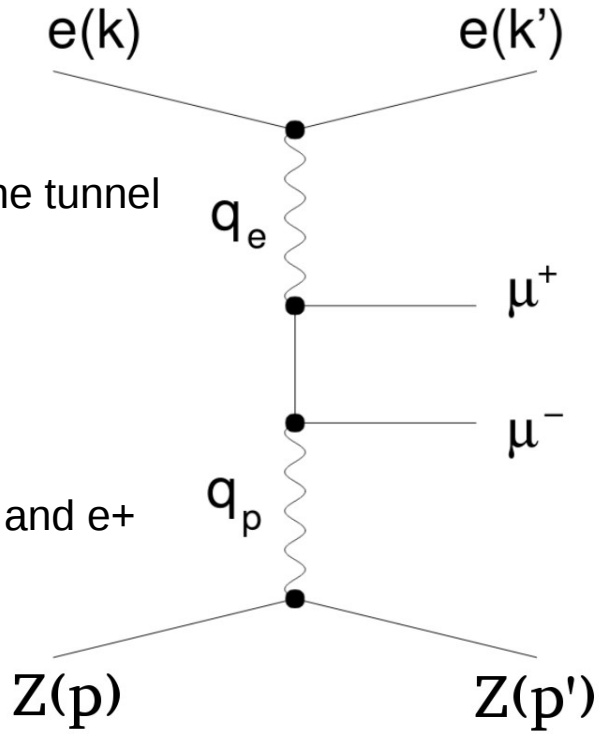
> Aim of every experiment is a high signal/background ratio

> Focus on my analysis: muon background

- Bethe-Heitler process:

  → beam interacts with surrounding matter in the tunnel

- Parallel incoming muons



> Used Data for the analysis

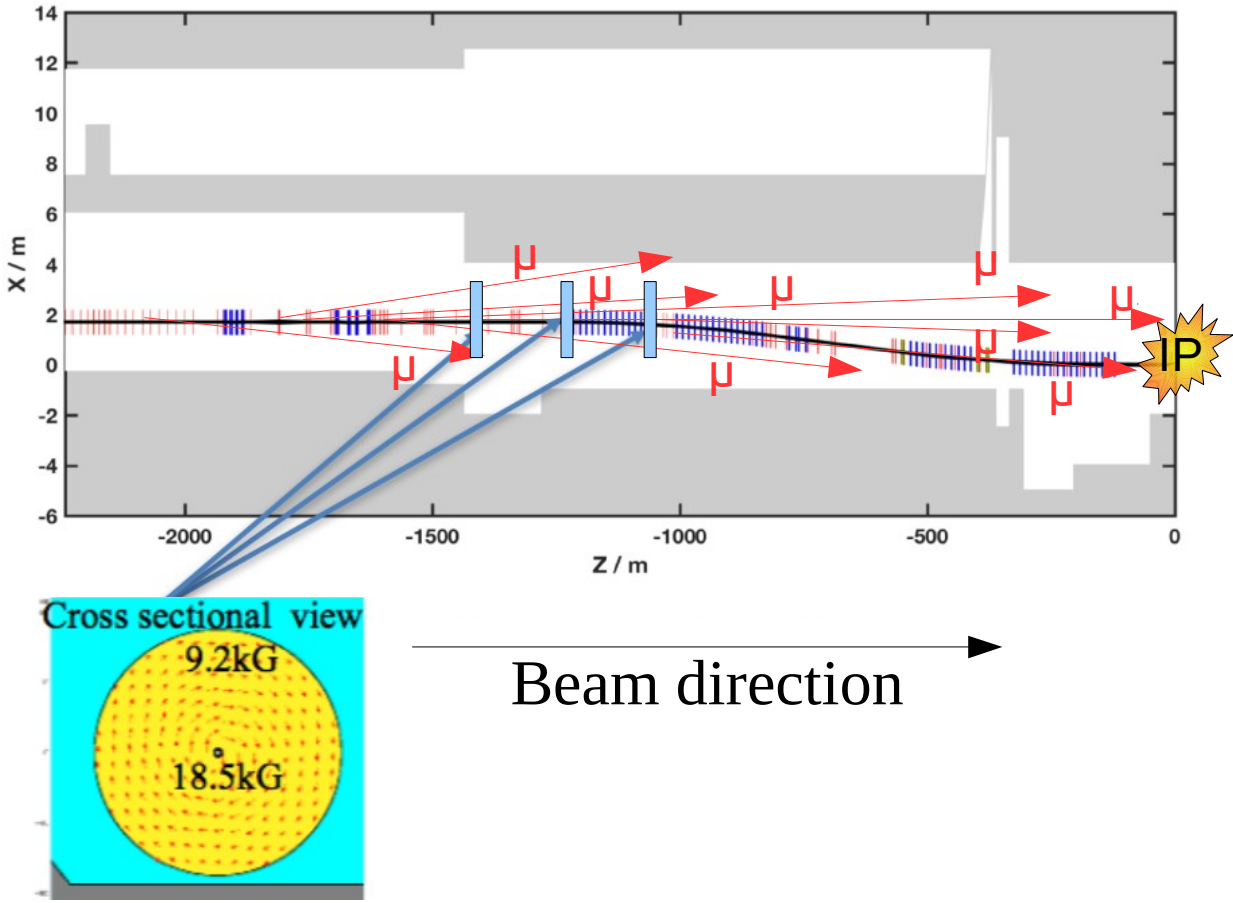
- Muons out of 5 trains (5 * 1312 bunches) of e- and e+
- MUCARLO (mainly muon production)
- SLIC (interaction with detector matter)

Muon shielding – Scenario A

Scenario:
Spoiler

- Install 3 “Donut Spoiler”
- Magnetized
- Radius: 70 cm
- Length: 5 m

Look from above on the beam tunnel



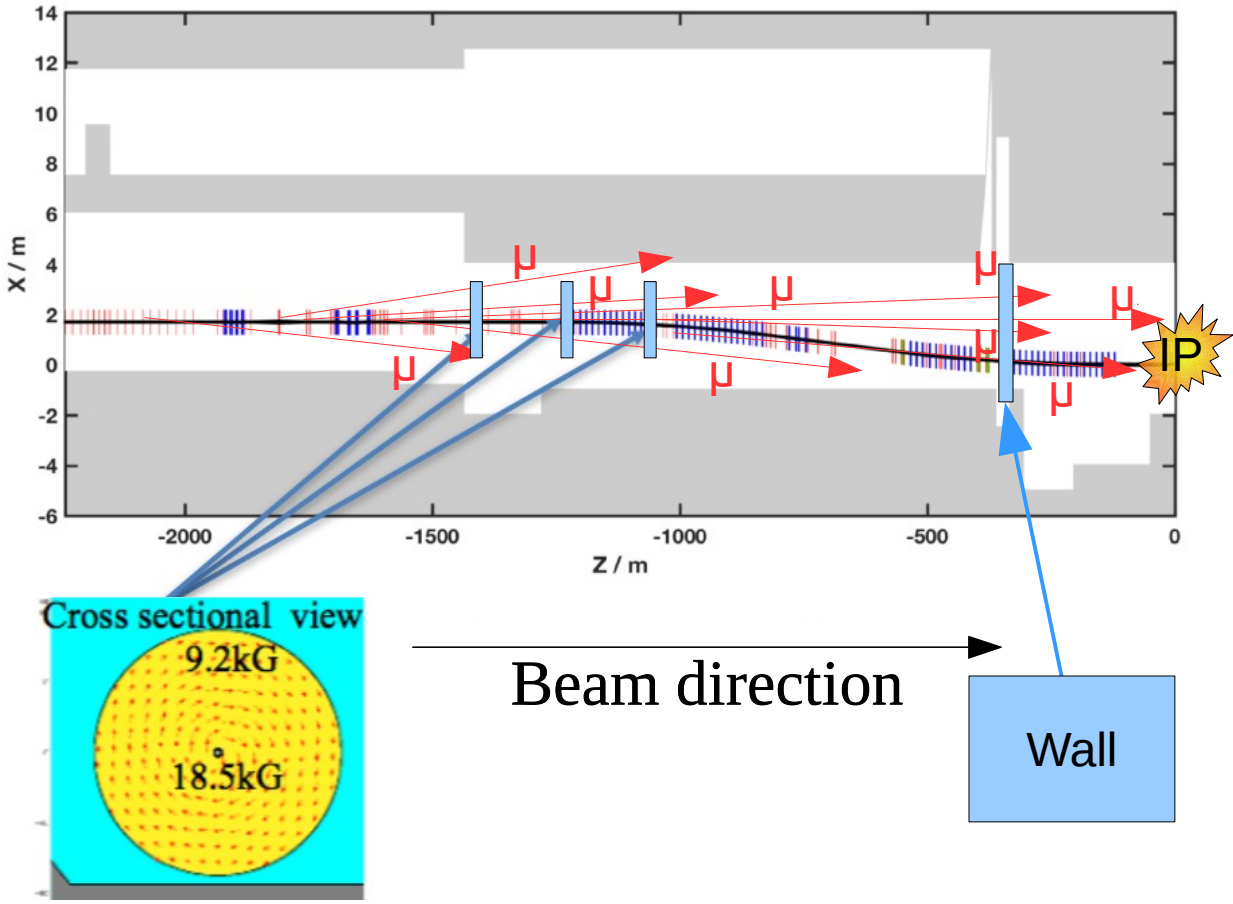
Muon shielding – Scenario B

Scenario:

Spoiler + Wall

- Install 3 “Donut Spoiler”
- Magnetized
- Radius: 70 cm
- Length: 5 m
- Install 5 m thick copper wall

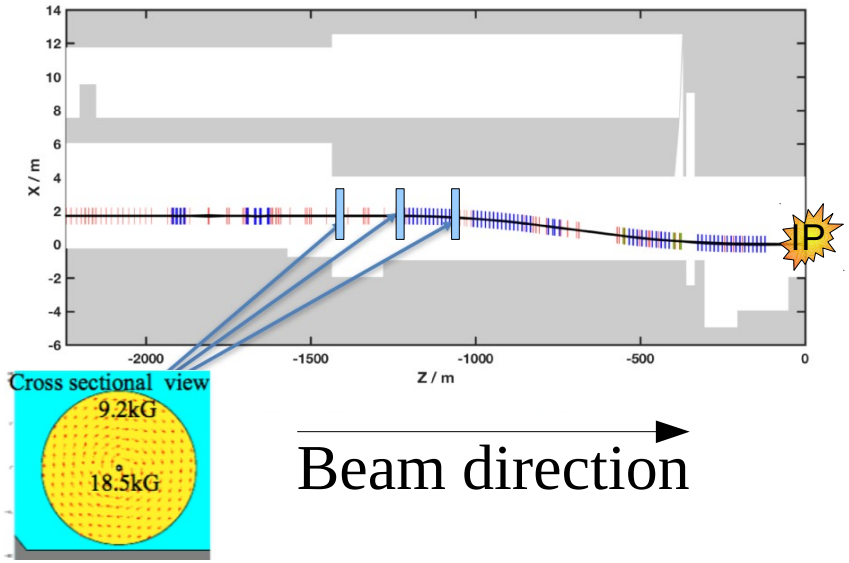
Look from above on the beam tunnel



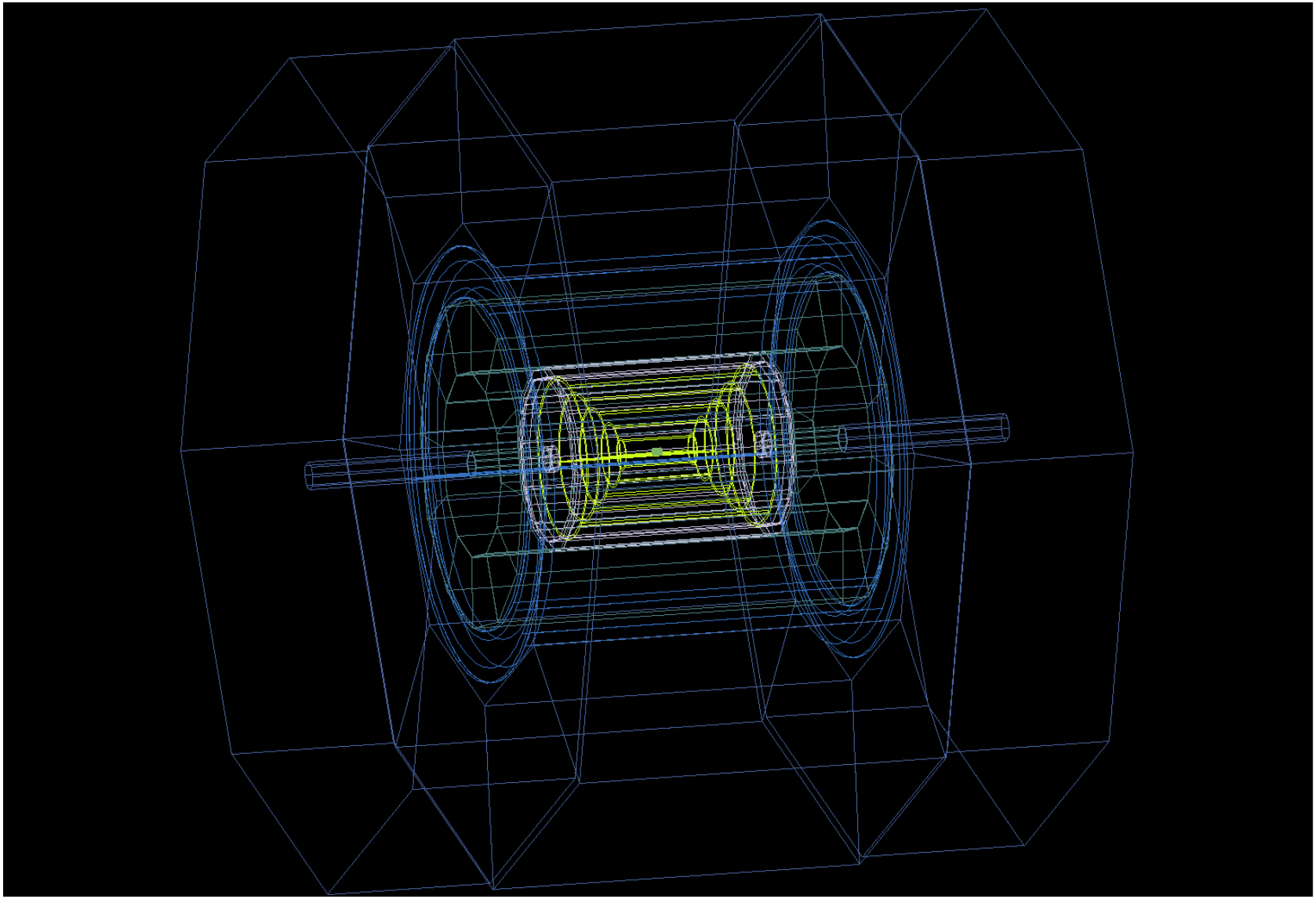
Main motivation

- Does the only-spoiler scenario provide an adequate muon shielding?
  - Safety issues
  - Costs

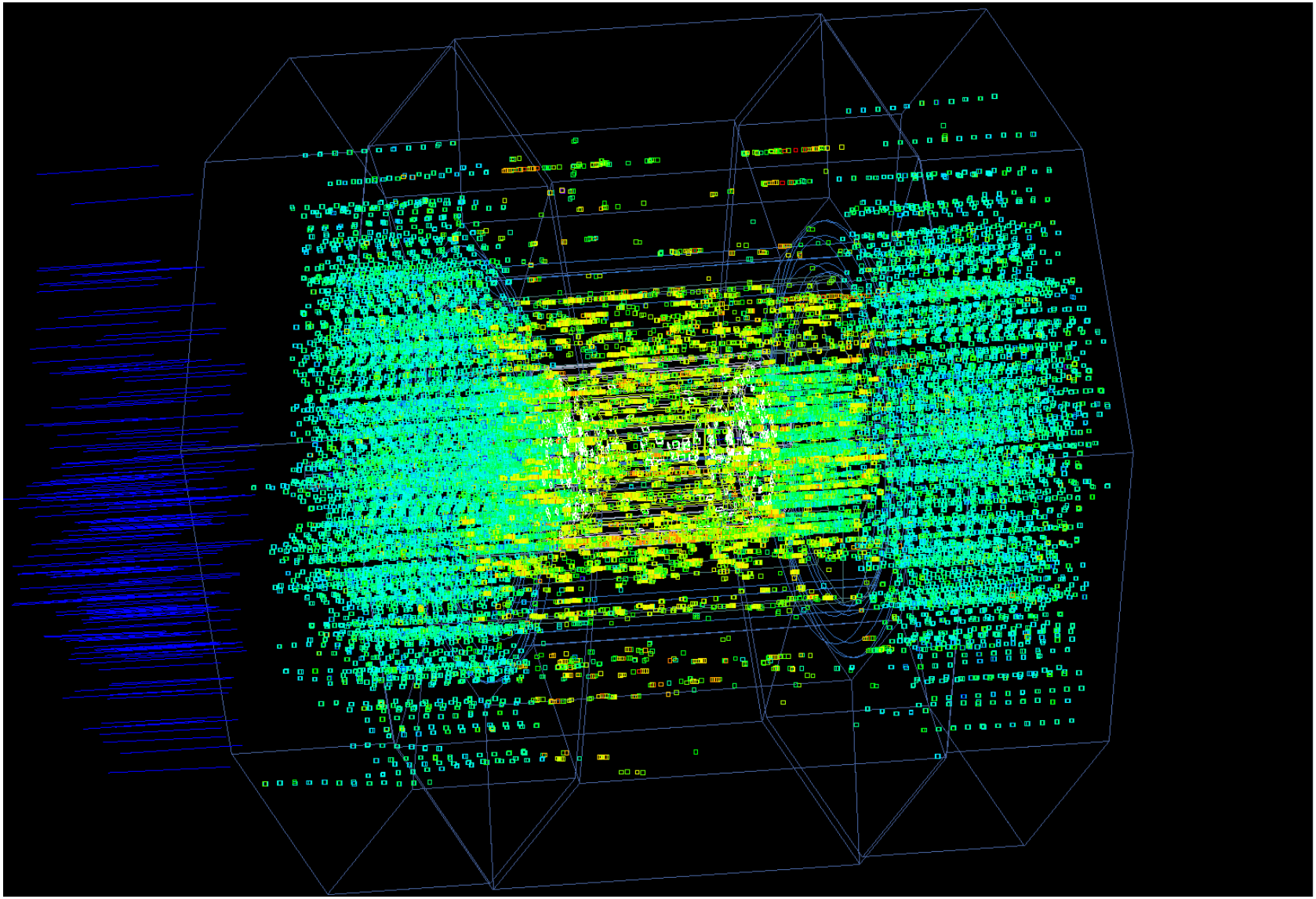
Look from above on the beam tunnel



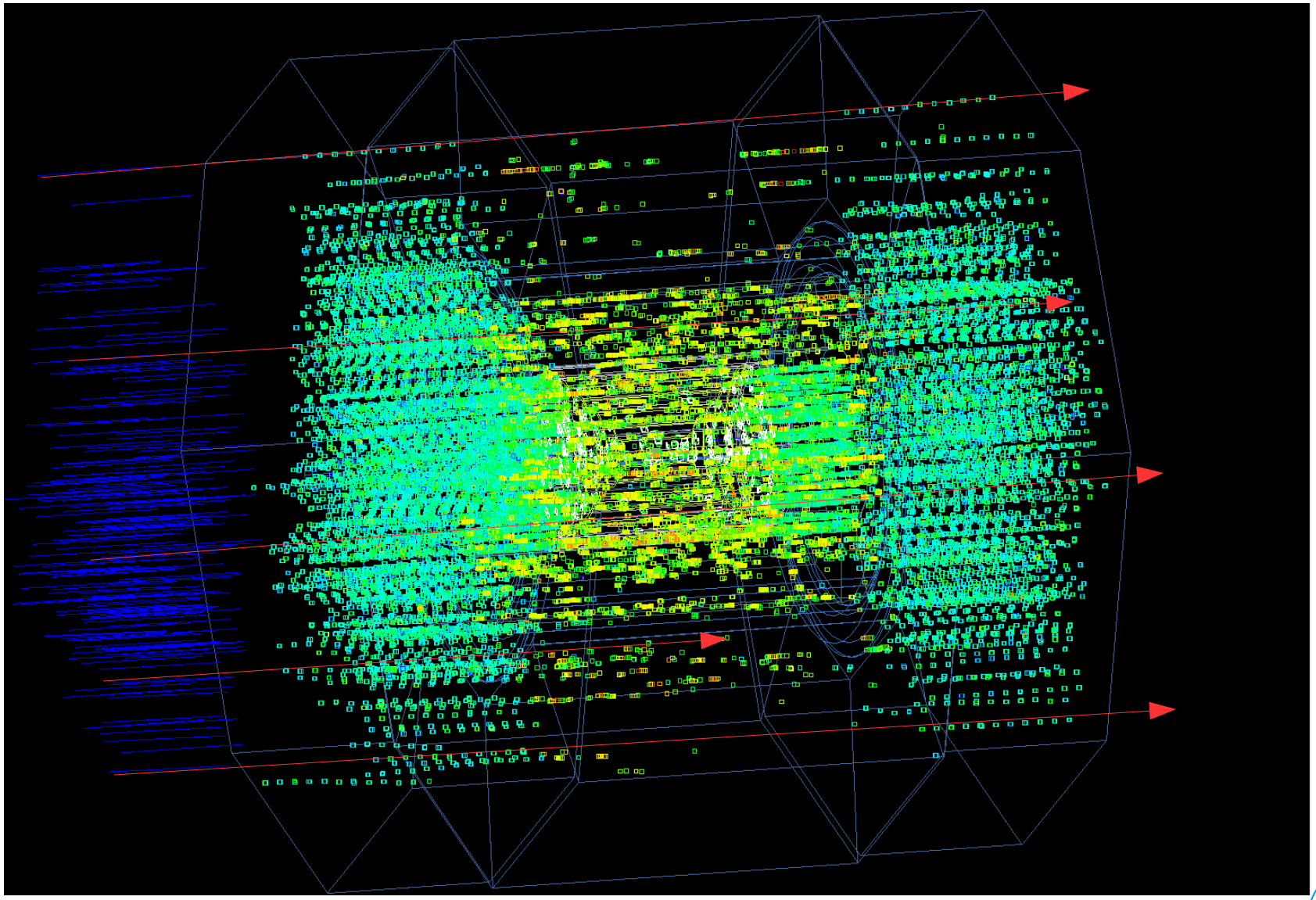
SiD - without muons



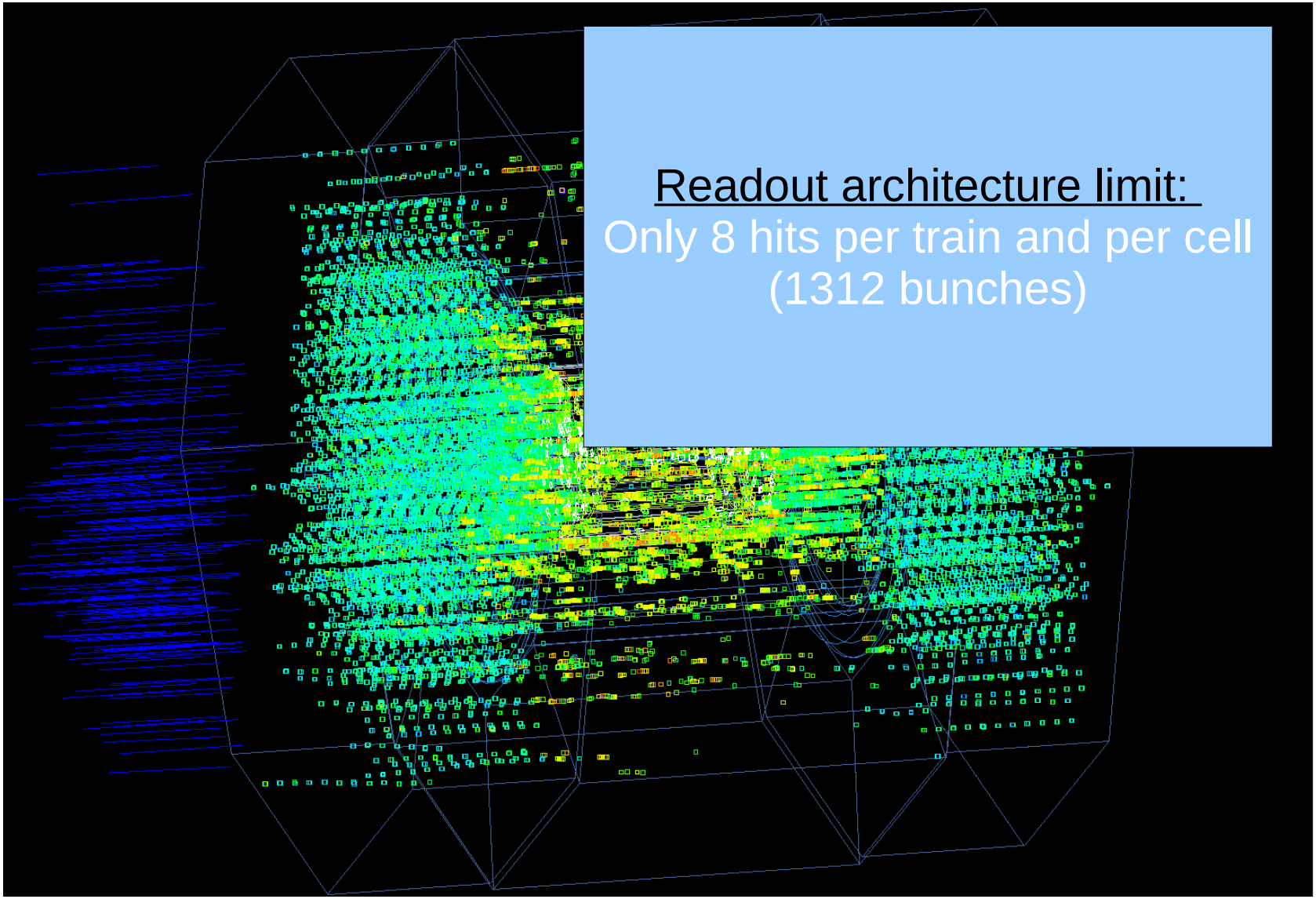
SiD - after incoming muons



SiD - after incoming muons



Multiple cell hits

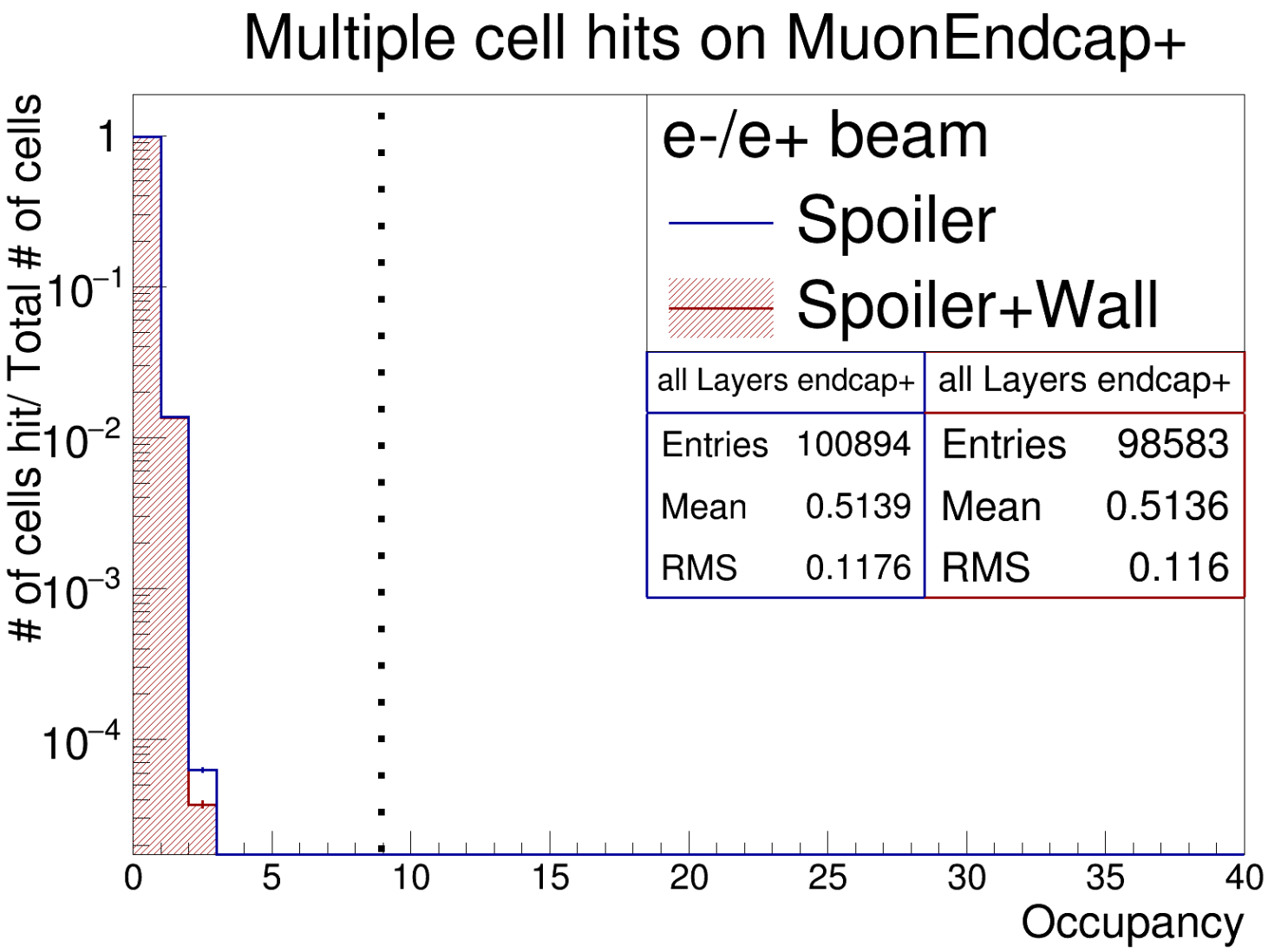


Results

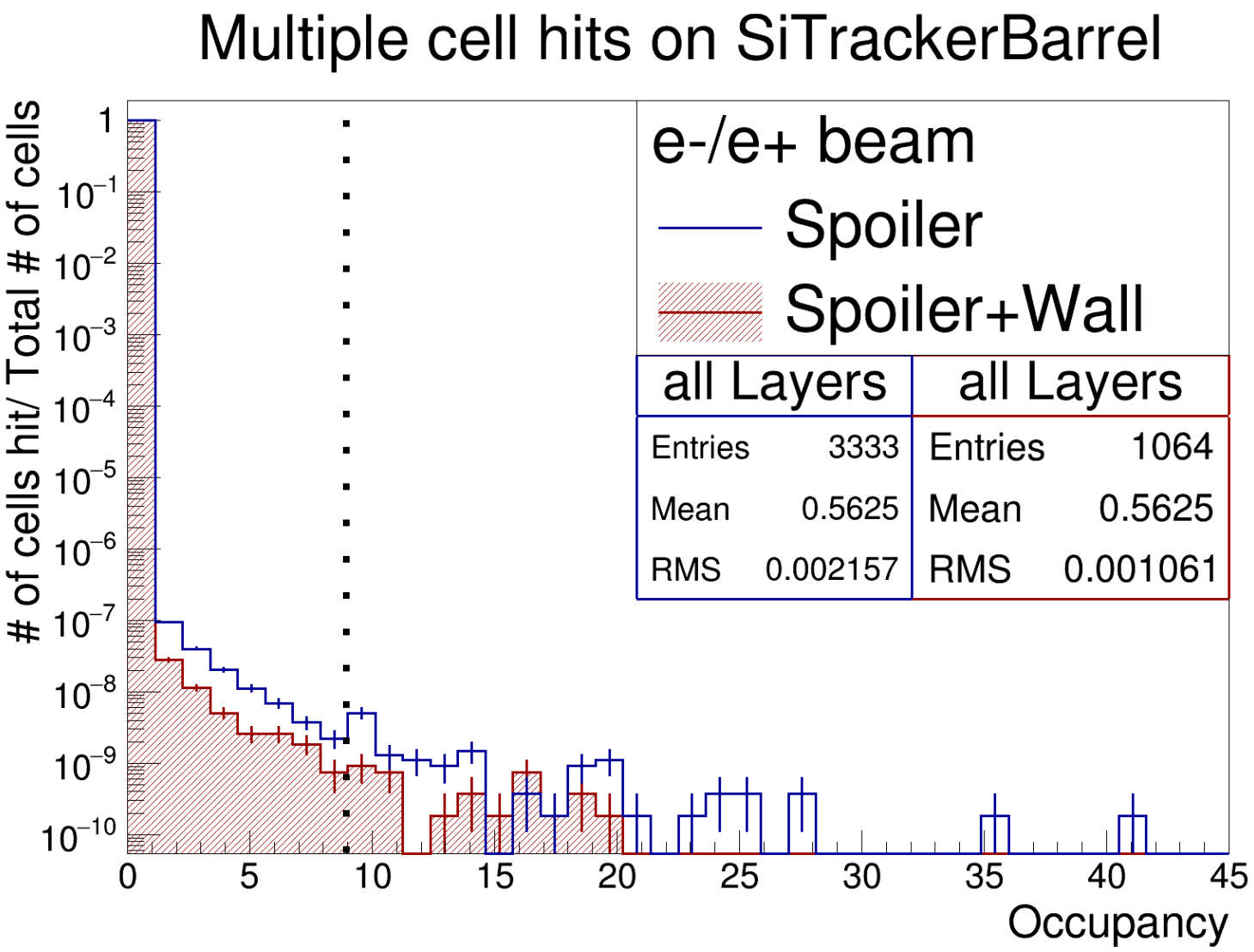
> **Analysis results:**

- » Multiple cell hits
- » Averaged cell hits
- » Spatial muon distribution
- » Energy distribution

Multiple cell hits – Muon Chamber



Multiple cell hits - Tracker



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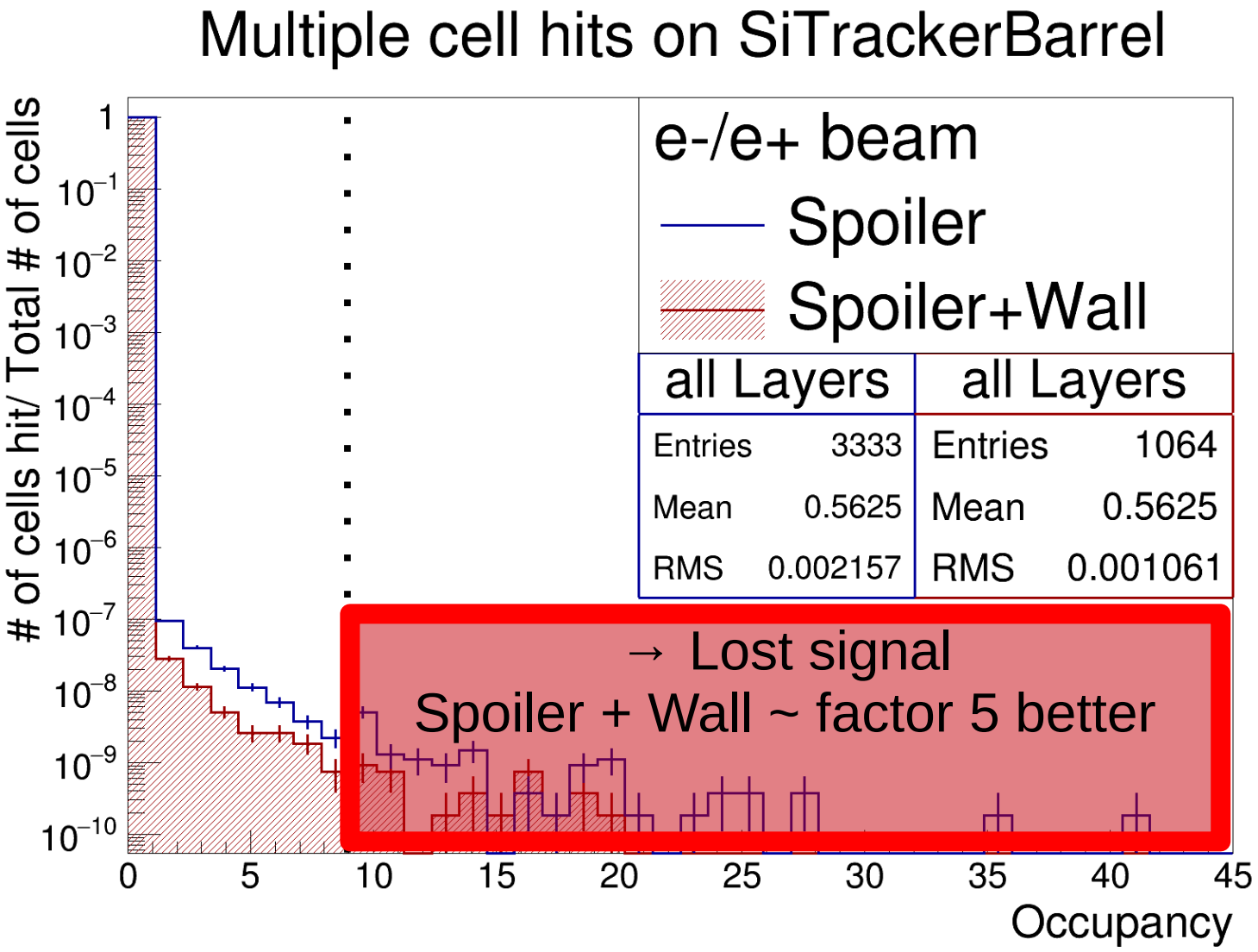
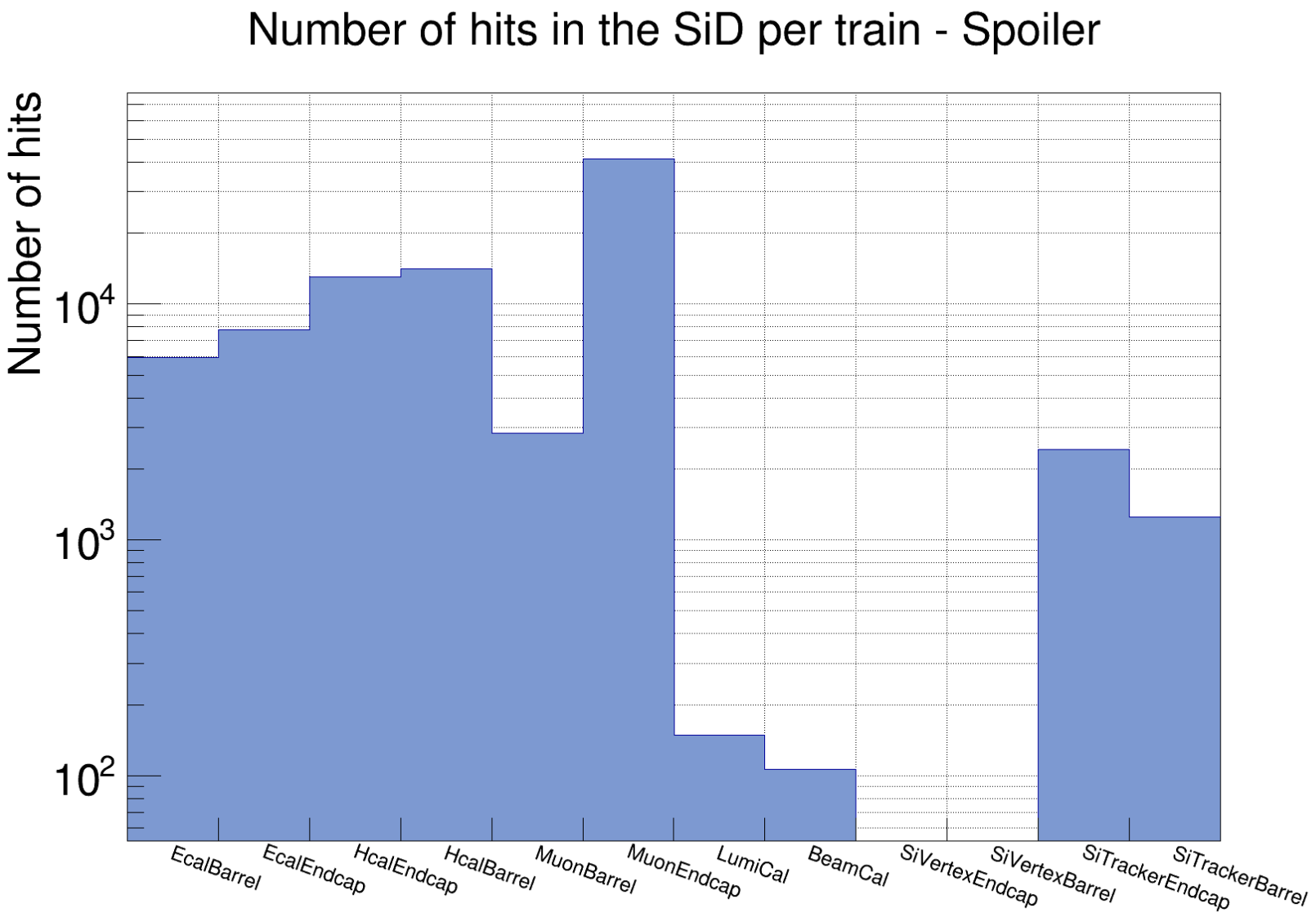
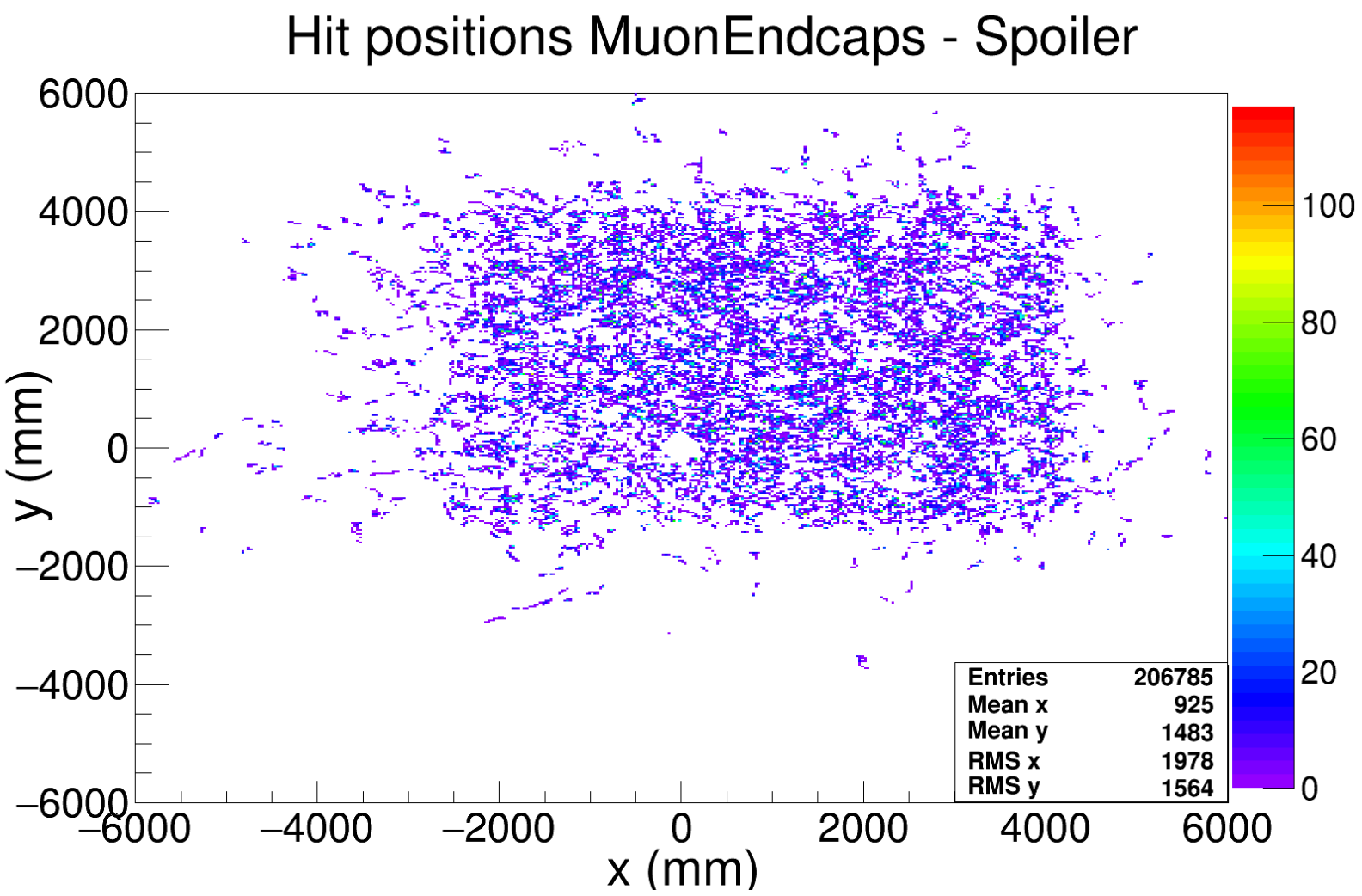


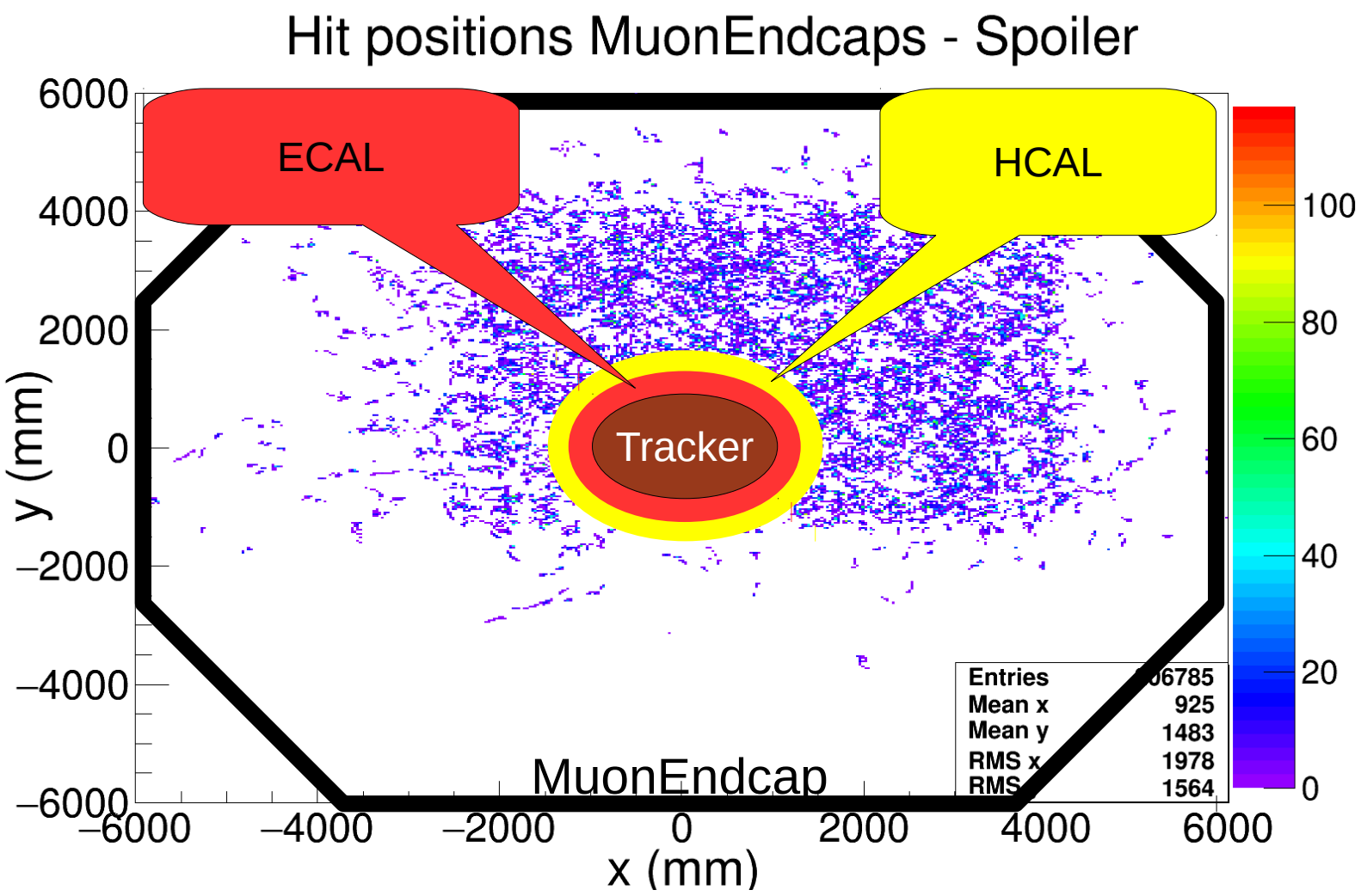
Average number of cell hits per train – Spoiler scenario



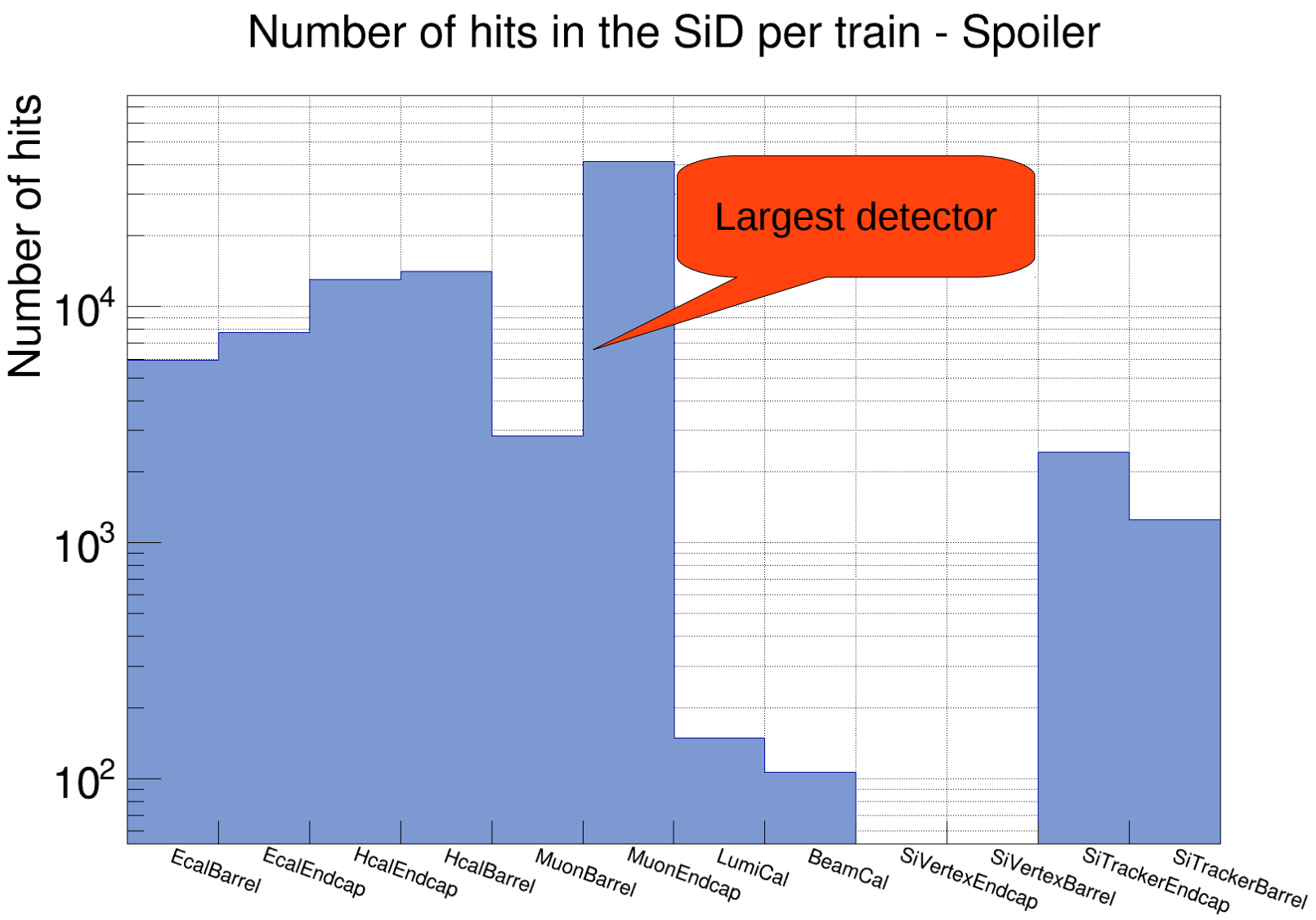
Hit positions MuonEndcaps – Spoiler scenario



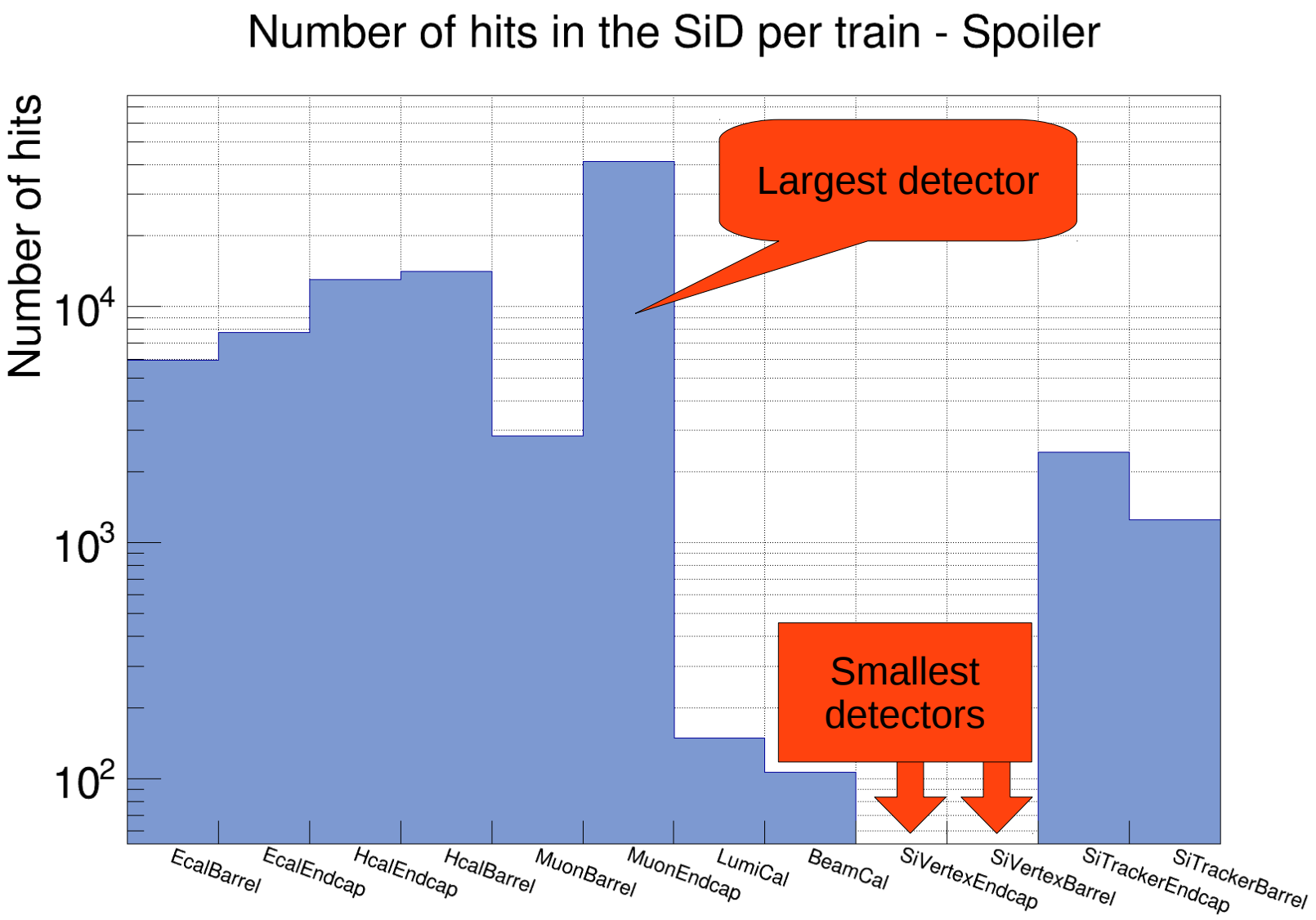
Hit positions in MuonEndcaps



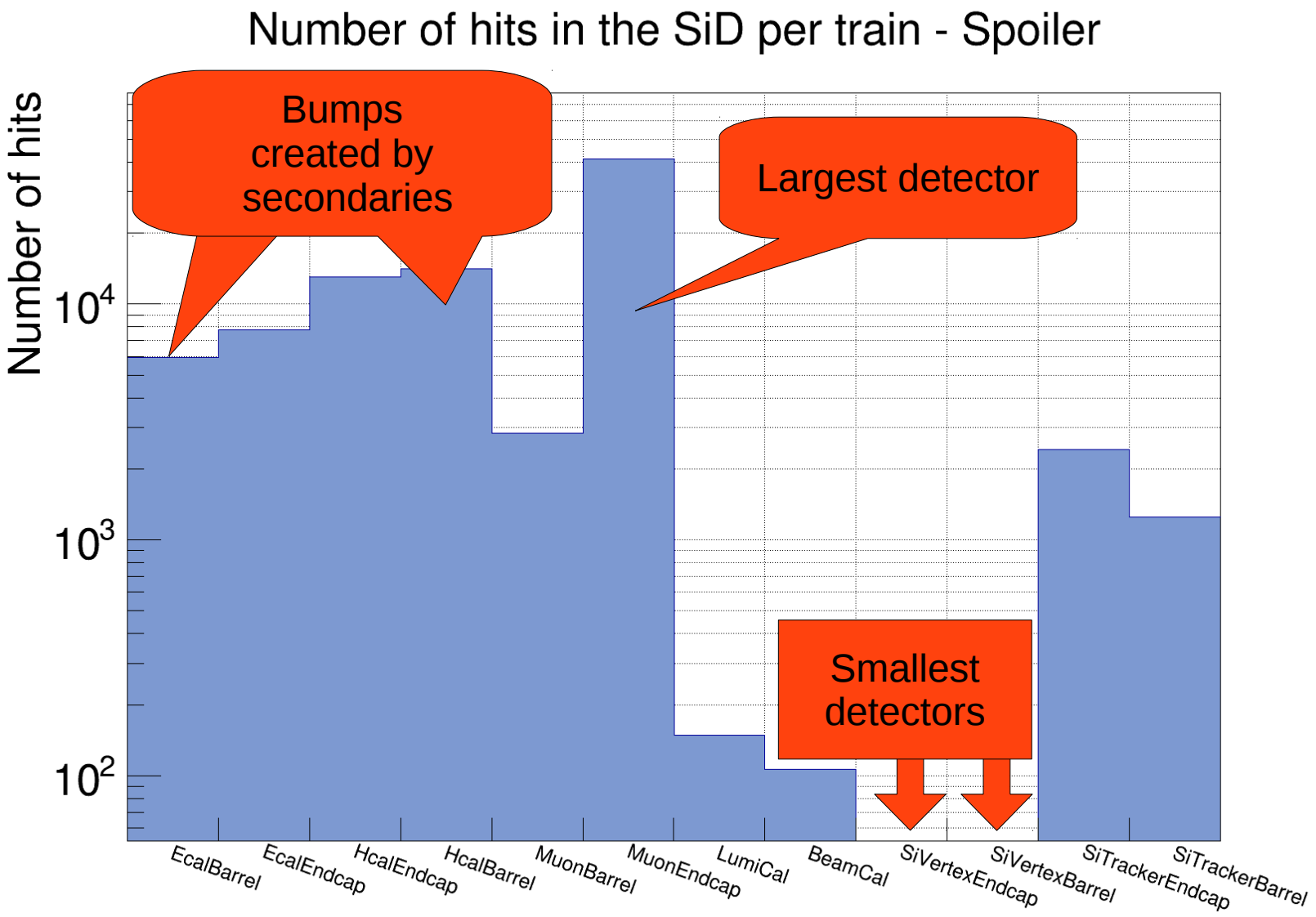
Average number of cell hits per train – Spoiler scenario



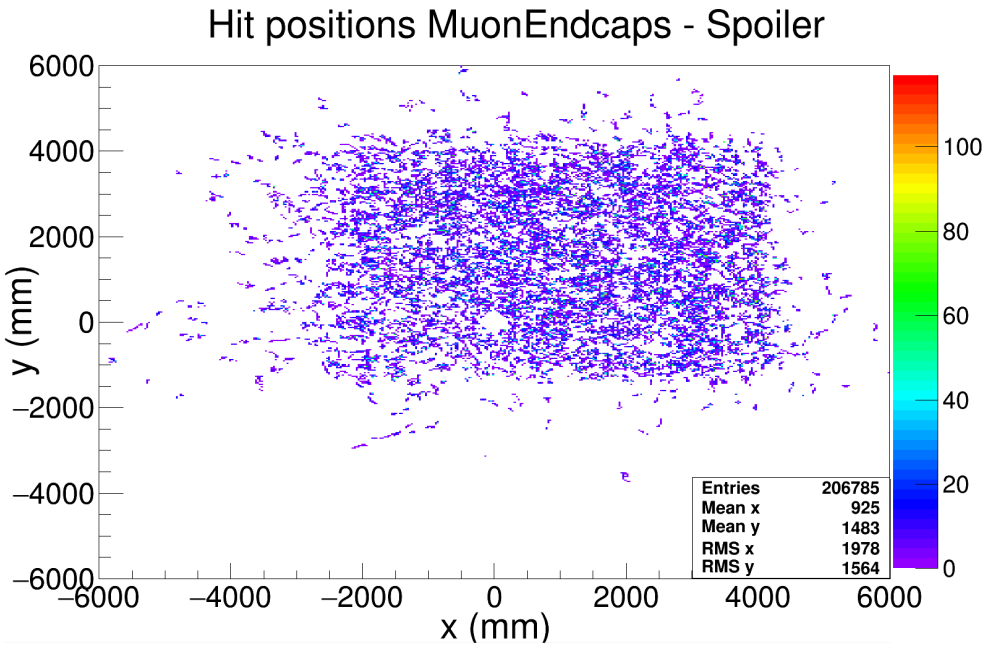
Average number of cell hits per train – Spoiler scenario



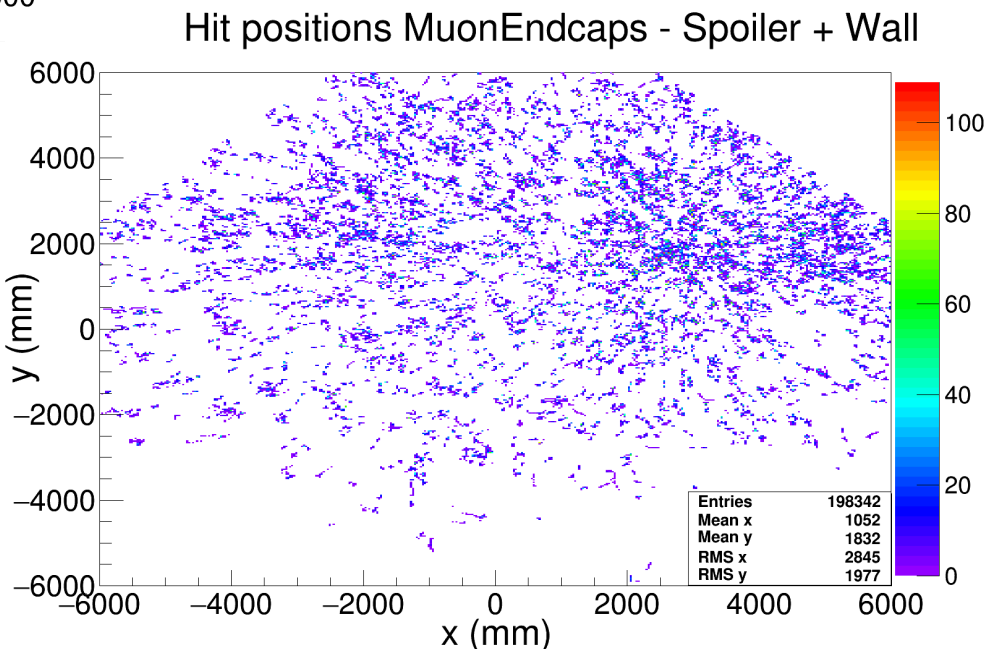
Average number of cell hits per train – Spoiler scenario



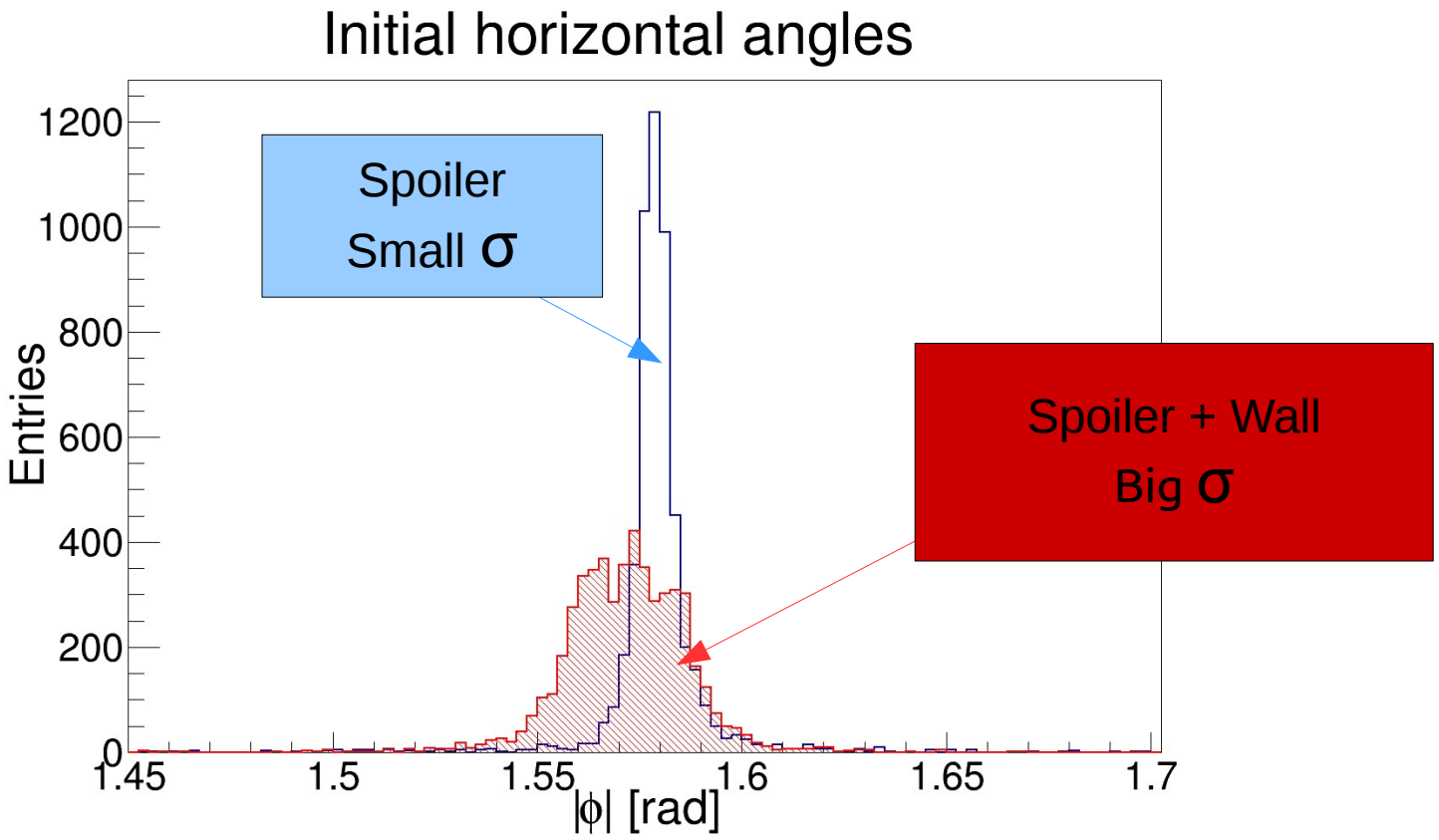
Hits positions on muon endcaps – 5 trains



- A clear difference of the spatial distribution can be seen
- The distribution is shifted upwards and to the right

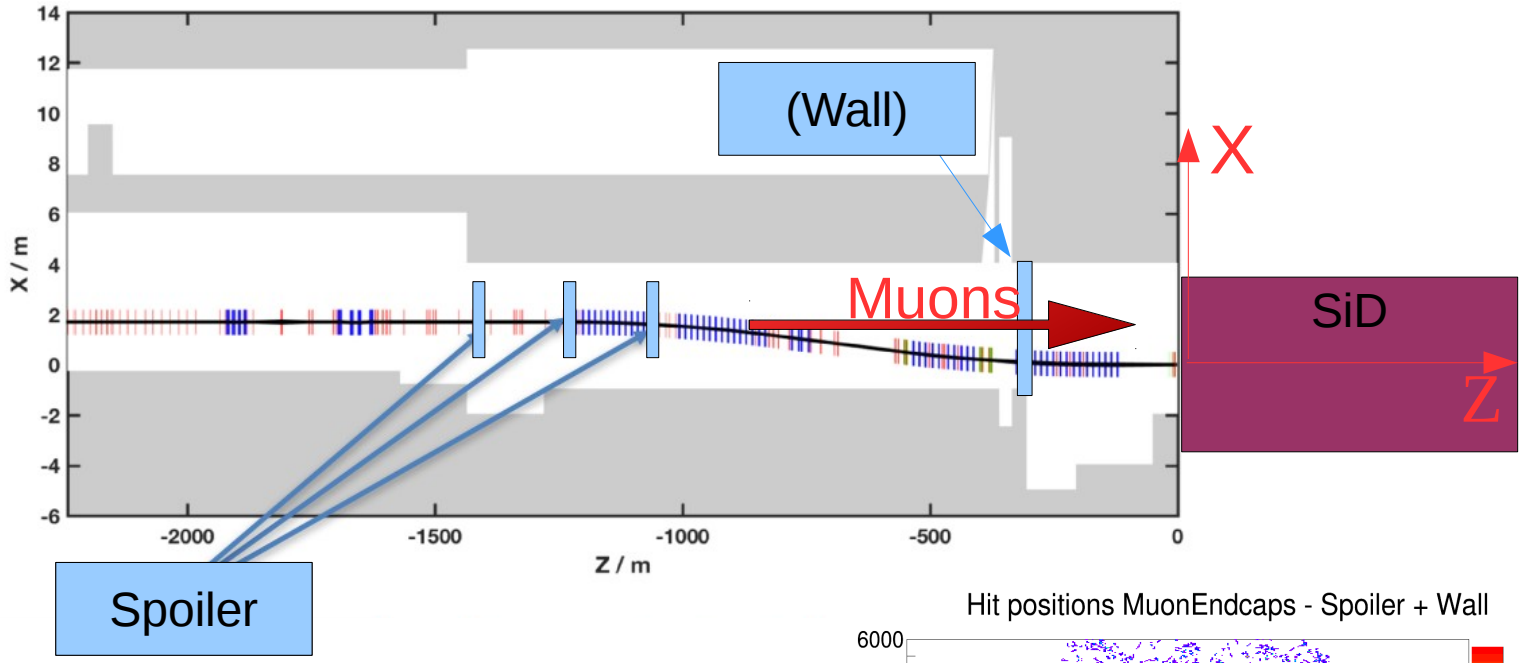


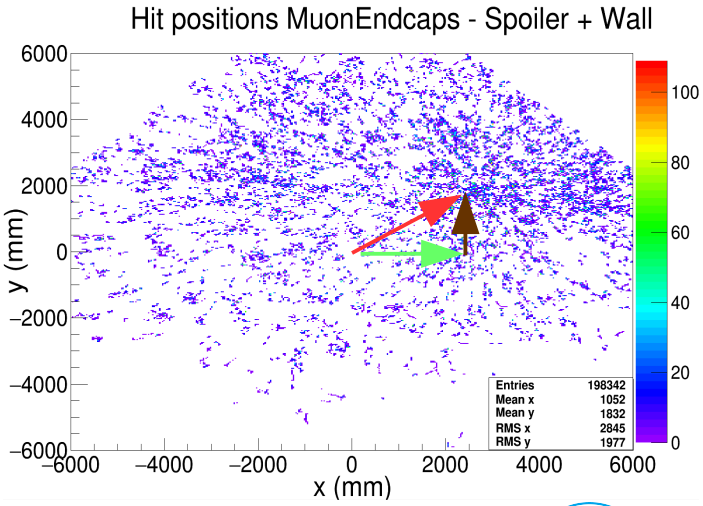
Defocussing difference



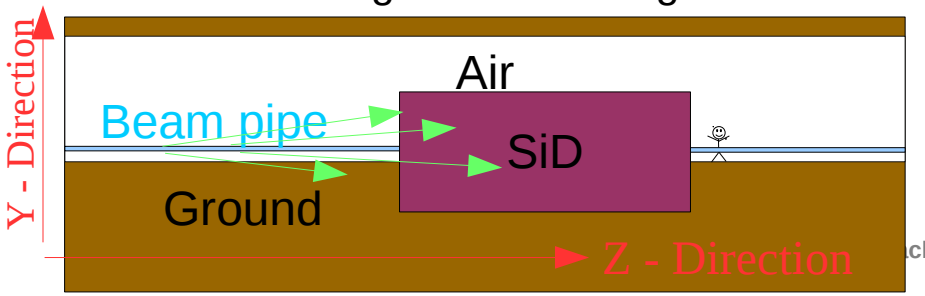
- Wider angular distribution
- The wall is defocussing the muons via multiple scattering
  - The muon hits are more homogeneous distributed in the SiD

Shifting of the incoming muons





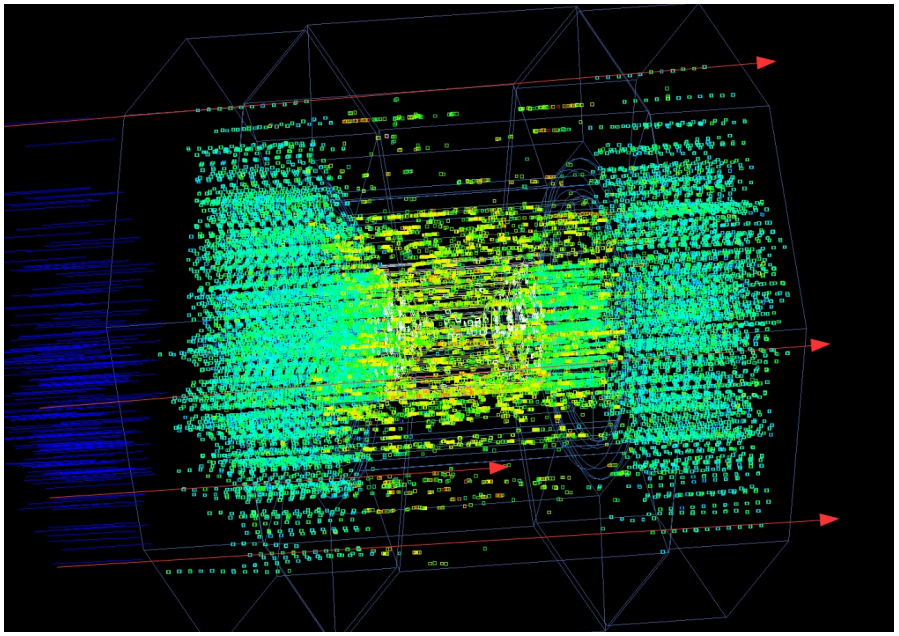
- Beam pipe is curved
- Beam pipe close to floor
  - High tunnel ceiling



Summary + Conclusion

- I investigated in different impacts of the muon spoiler background
  - Study on the “Spoiler” and “Spoiler + Wall” scenario
- Spoiler + Wall has better muon suppression
  - For the Tracker a difference of factor ~ 5 was found
  - Will be even higher – because in the only-spoiler scenario even more muons in absolute numbers will penetrate in the SiD
- For final statement, higher statistic is needed
- Alignment of tracker with high energy muons
  - Clear horizontal tracks through tracker
- Results will be used for ILC accelerator design decisions
  - Scientific paper will include my results

BACKUP - SLIDES



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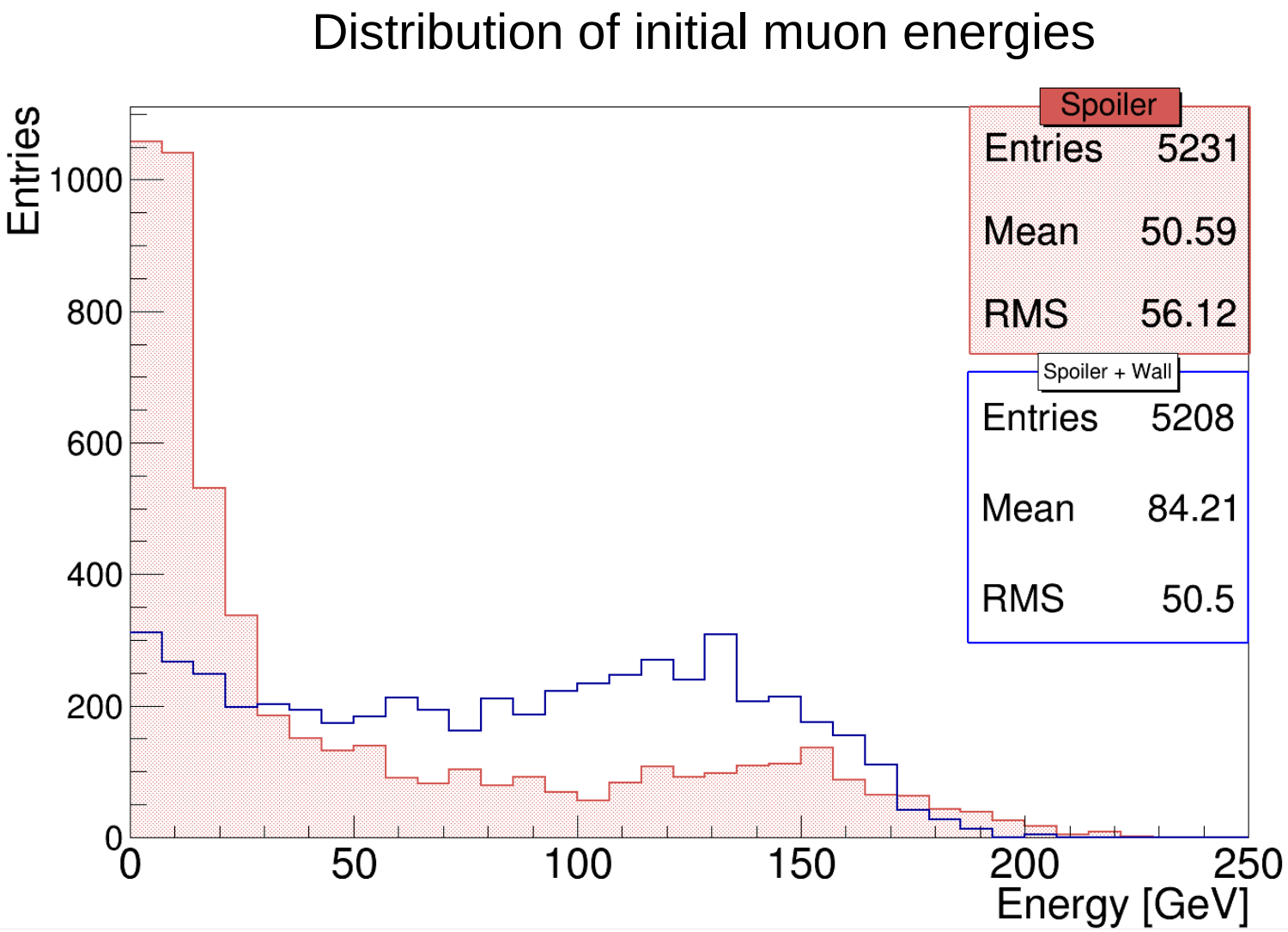
Supervisor: Anne Schuetz, Dr. Marcel Stanitzki

Hamburg, 6.9.2016

HELMHOLTZ ASSOCIATION

DESY

Energy distribution of the muons



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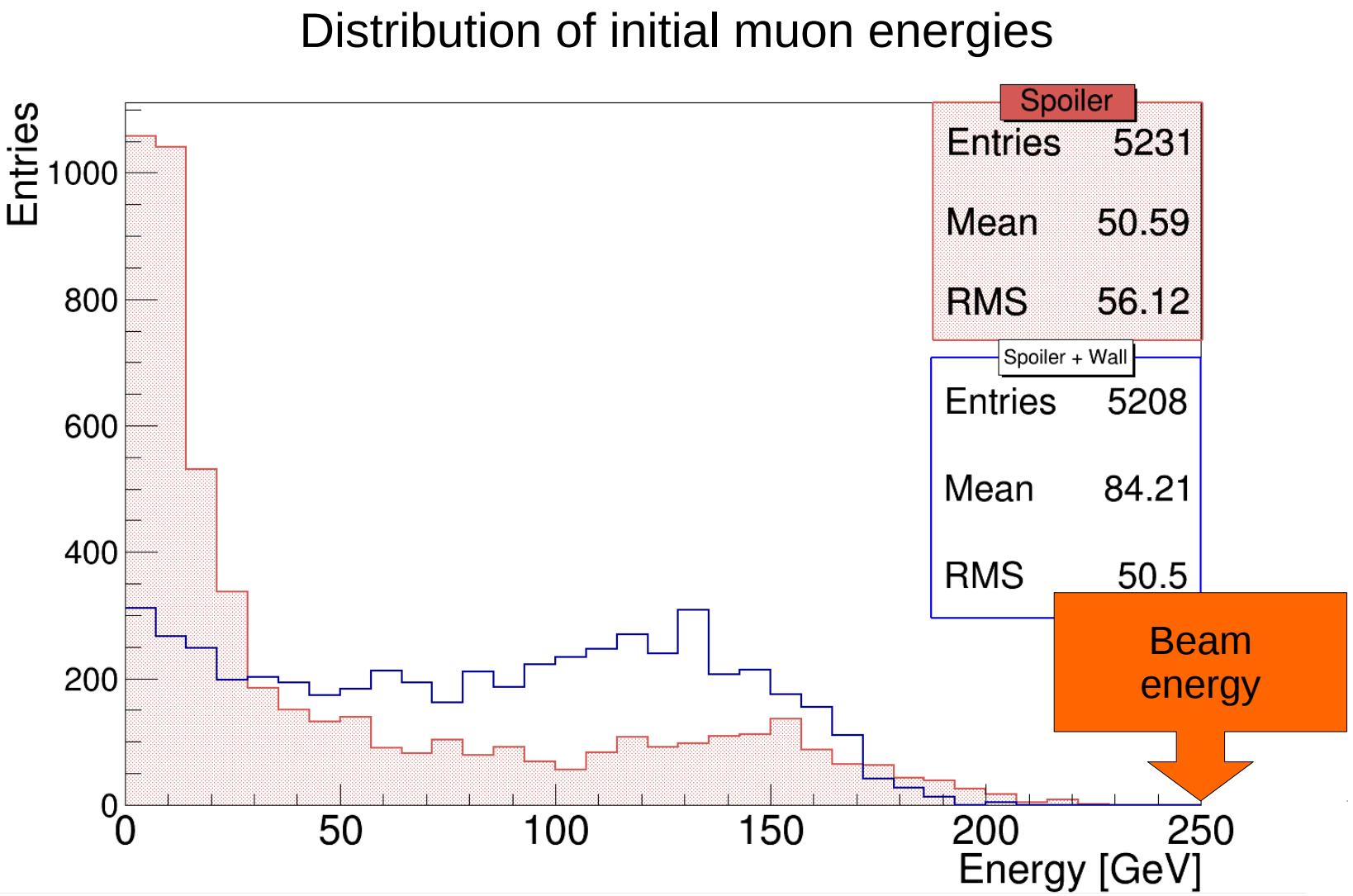

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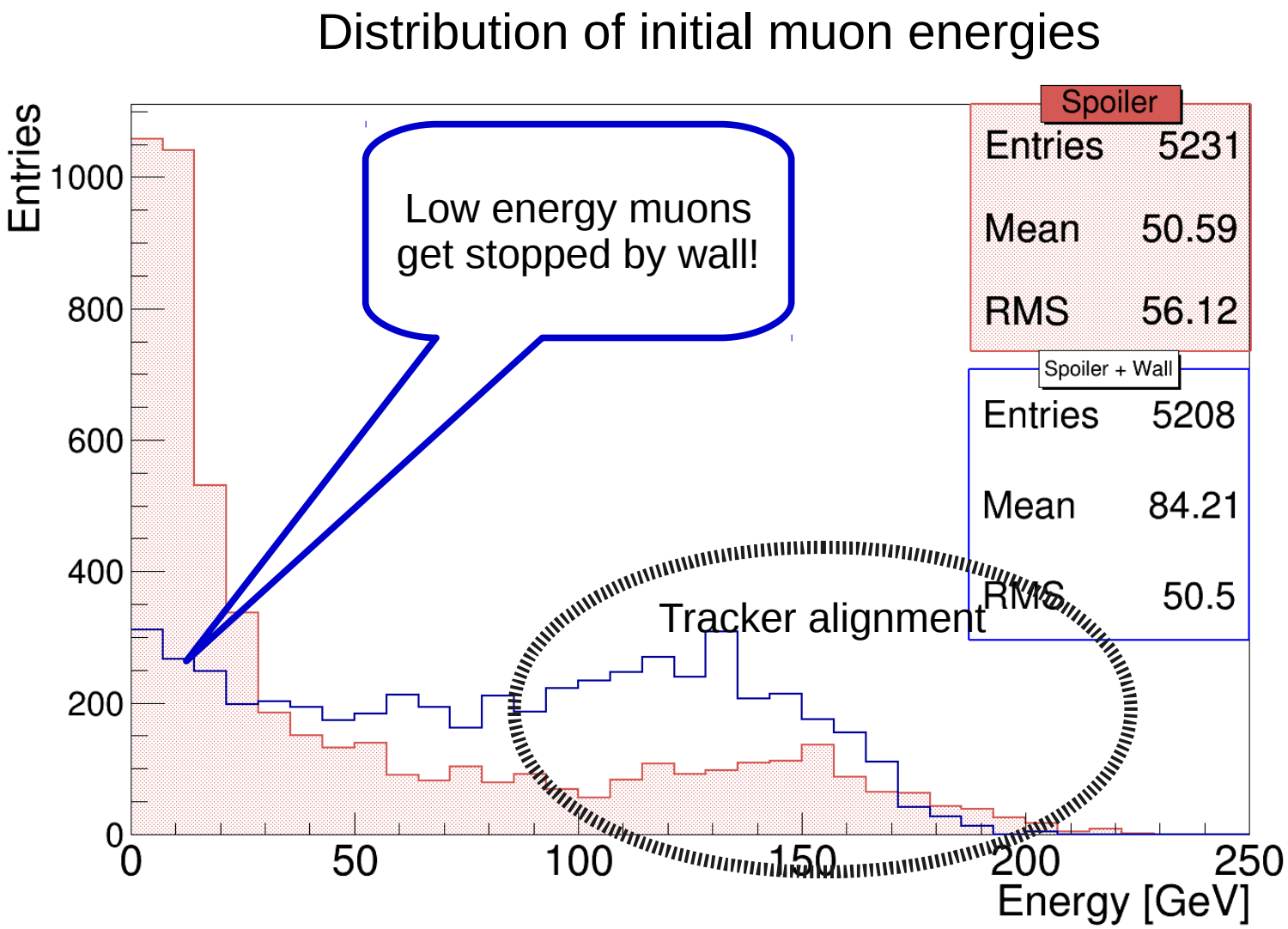
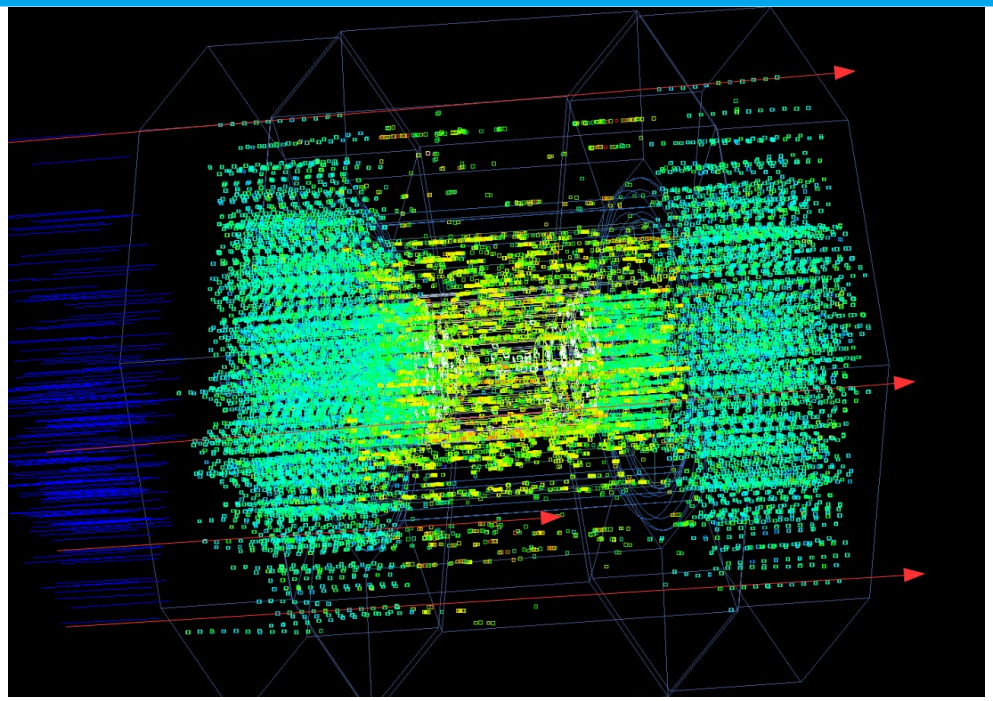


Summer student talk



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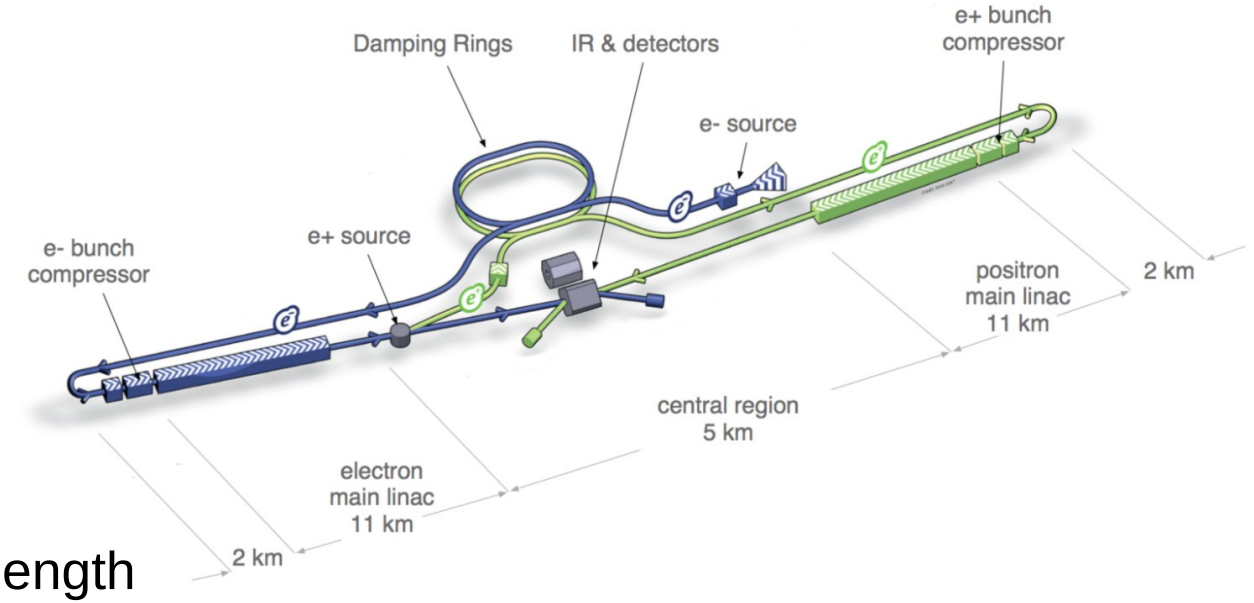


> 31 km length

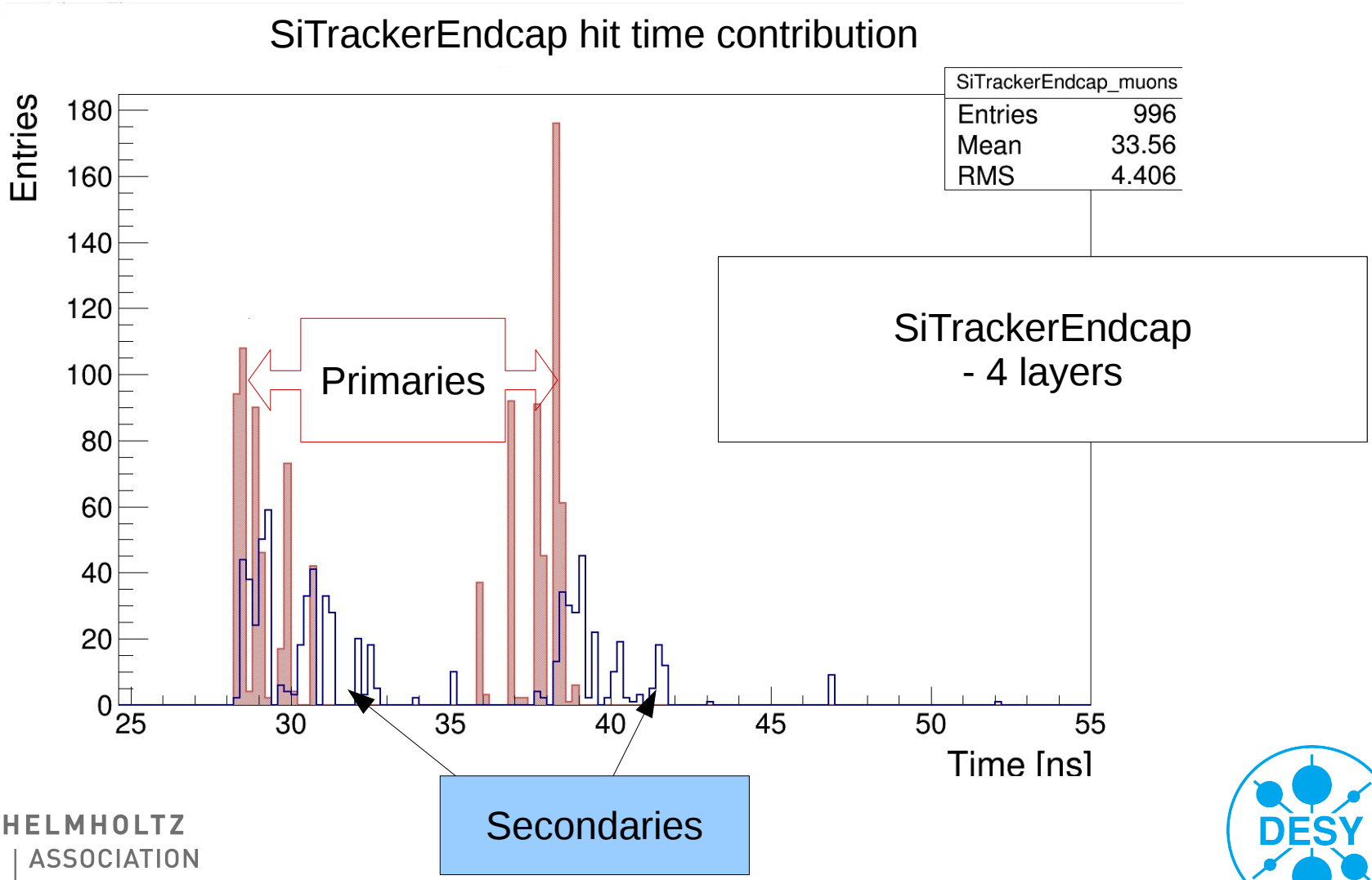
> Center of mass energy 500 GeV

> Leptonic collisions

- Small detector occupancy
- Electro weak interaction

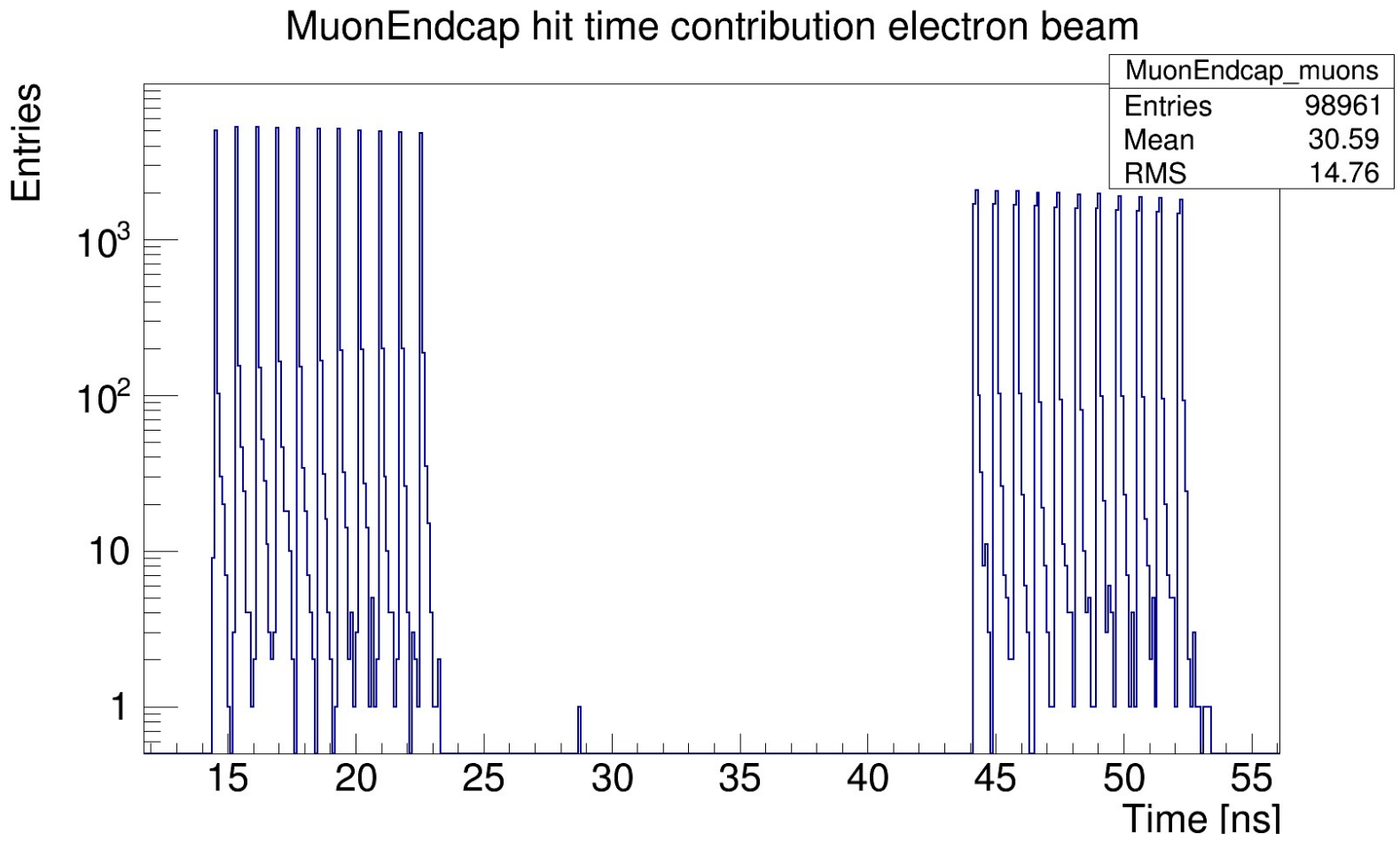
> Very small background in comparison to hadron colliders

SiTrackerEndcap



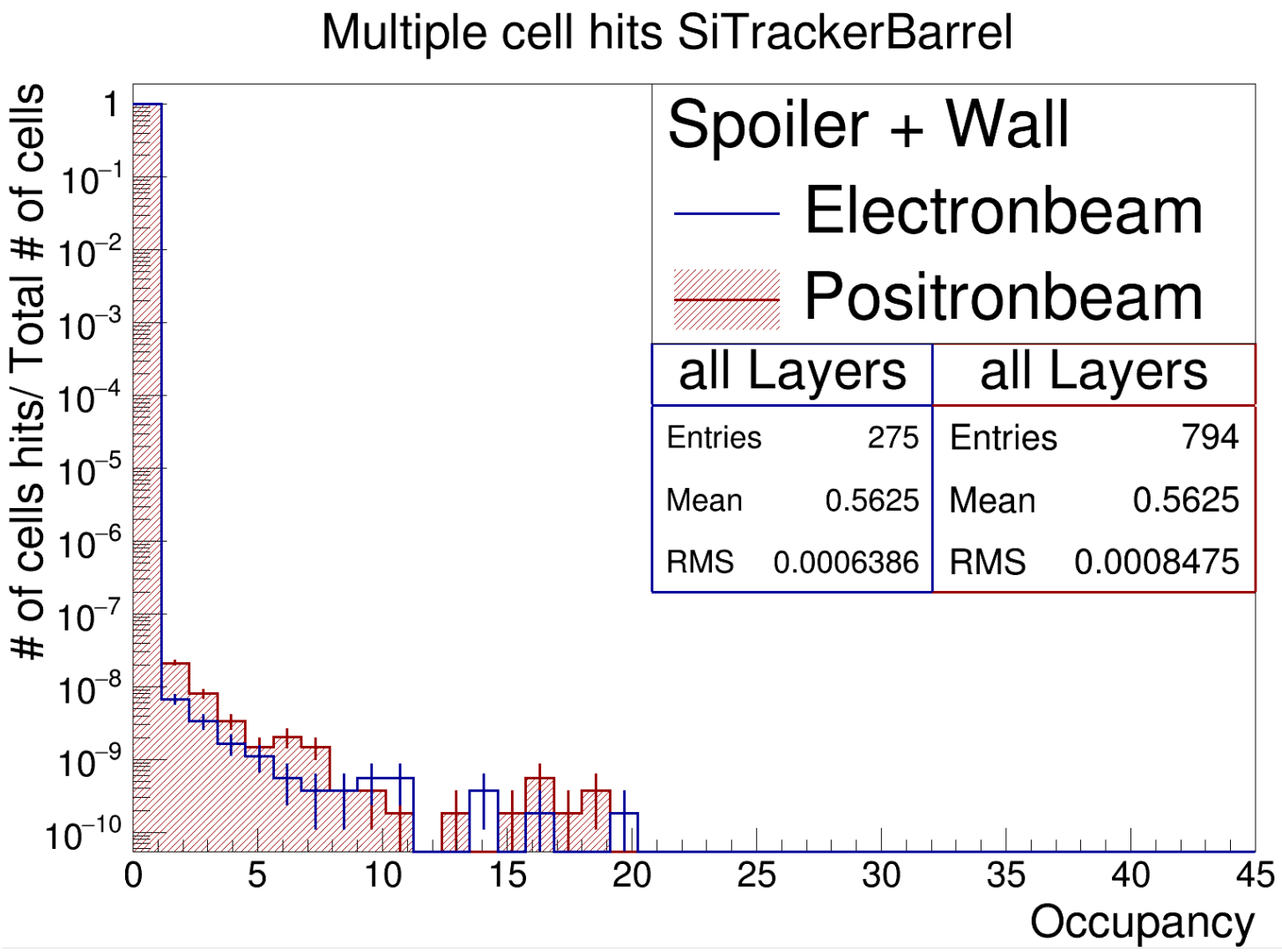
HELMHOLTZ ASSOCIATION

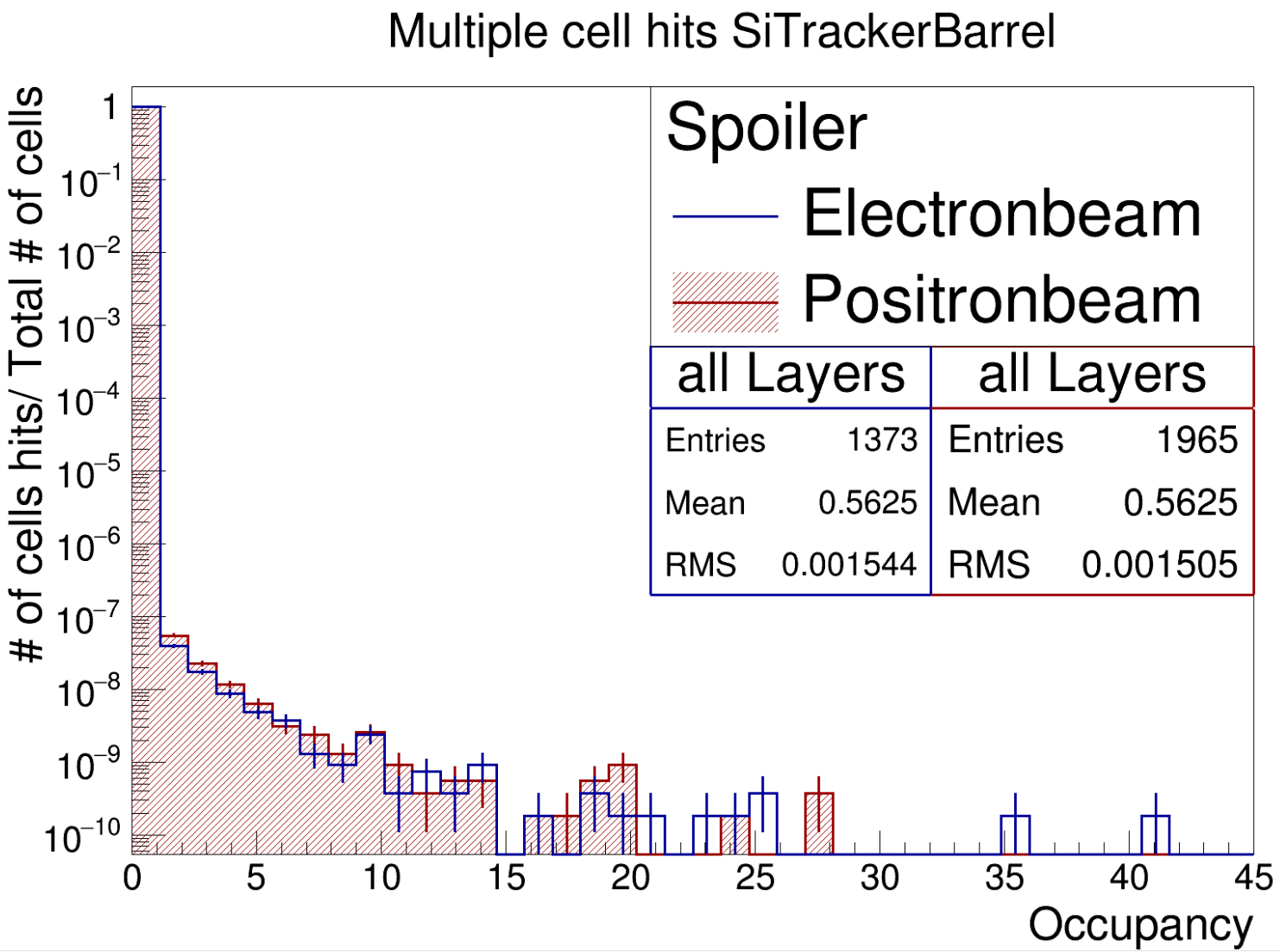
DESY



MuonEndcap
- 11 layers

Electron vs Positron




Multiple cell hits SiTrackerBarrel
# of cells hits/ Total # of cells
Occupancy
Spoiler
Electronbeam
Positronbeam
all Layers
Entries 1373
Mean 0.5625
RMS 0.001544
all Layers
Entries 1965
Mean 0.5625
RMS 0.001505

Vertical angle distribution