Fixes of the data simulation
May 2018 data

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DER FORSCHUNG | DER LEHRE | DER BILDUNG

Simulation fixes

- Problems:
  - 40 layers in simulation
  - MIP peak shifted to above 1
- Solutions:
  - Fixing the number of layers in TestBeamSetup_HCAL.xml file: Has been checked, works!
  - Using the MIP calibration fit to adapt the MIP peak position (using 40 GeV muons): Works!
    - Checked log likelihood method: difference < 1%
    - Checked various binnings: difference < 1%
    - Looked at different distributions: MIP peak very close to 1 (for data not yet)
- New issue:
  - energySum and nHits still slightly shifted to larger values after applying the fixes
    - nHits maximum at 38 (correct!) but whole distribution shifted slightly

Checked fitting (40 GeV muons)

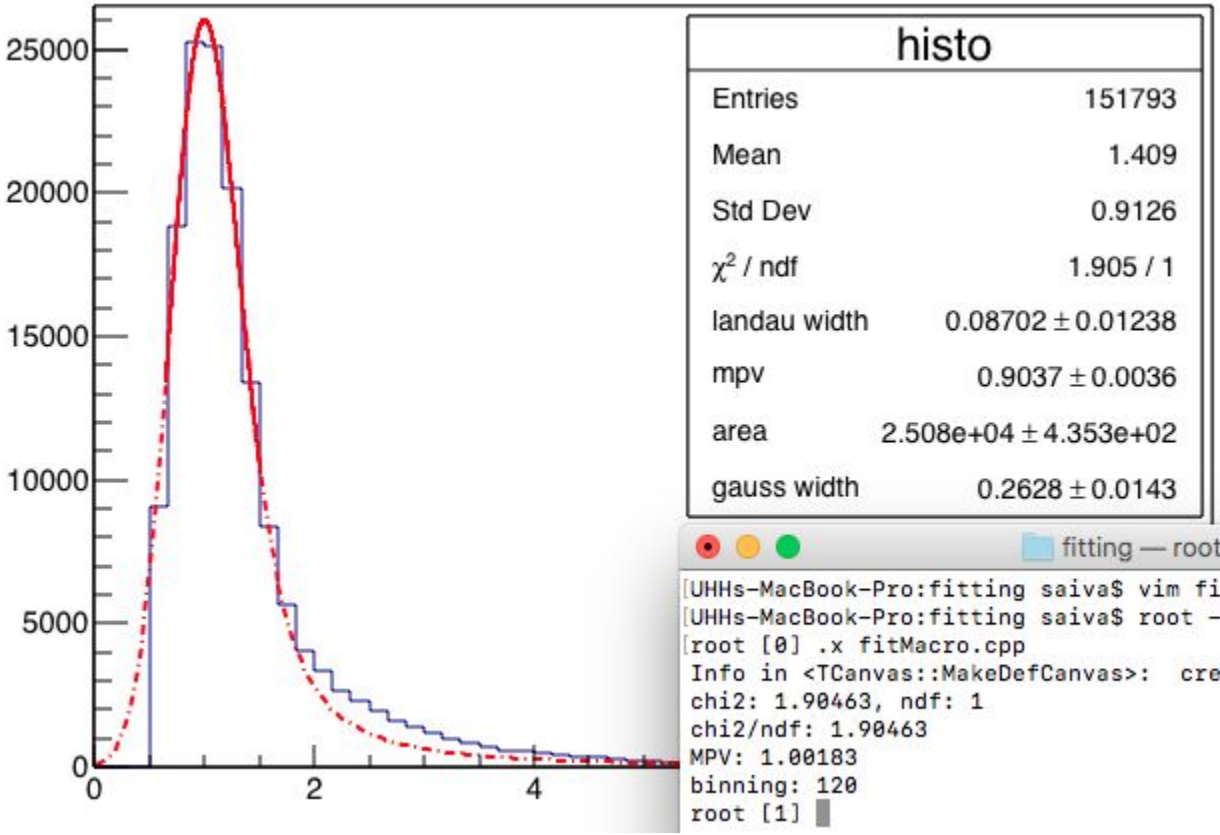
0.1 MIP/bin
MPV: 1.00334

0.01 MIP/bin
MPV: 0.994925

```
MPV: 1.00216
binning: 160
root [1] .q
UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
UHHs-MacBook-Pro:fitting saiva$ root -l
root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2/ndf: 5.76027
MPV: 1.00334
binning: 180
UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
UHHs-MacBook-Pro:fitting saiva$ root -l
root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
root [1] .q
UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
UHHs-MacBook-Pro:fitting saiva$ root -l
root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2/ndf: 21.0998
MPV: 0.994925
binning: 2000
UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
UHHs-MacBook-Pro:fitting saiva$ root -l
root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2: 1.90463, ndf: 1
chi2/ndf: 1.90463
MPV: 1.00183
binning: 120
root [1] .q
UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
UHHs-MacBook-Pro:fitting saiva$ root -l
root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2: 980.069, ndf: 40
chi2/ndf: 24.5017
MPV: 0.998601
binning: 1000
root [1] .q
UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
UHHs-MacBook-Pro:fitting saiva$ root -l
root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2: 12215, ndf: 431
chi2/ndf: 28.3411
MPV: 0.996047
binning: 10000
```

- all very close to 1!
- difference of < 1%
- very similar for 120 GeV

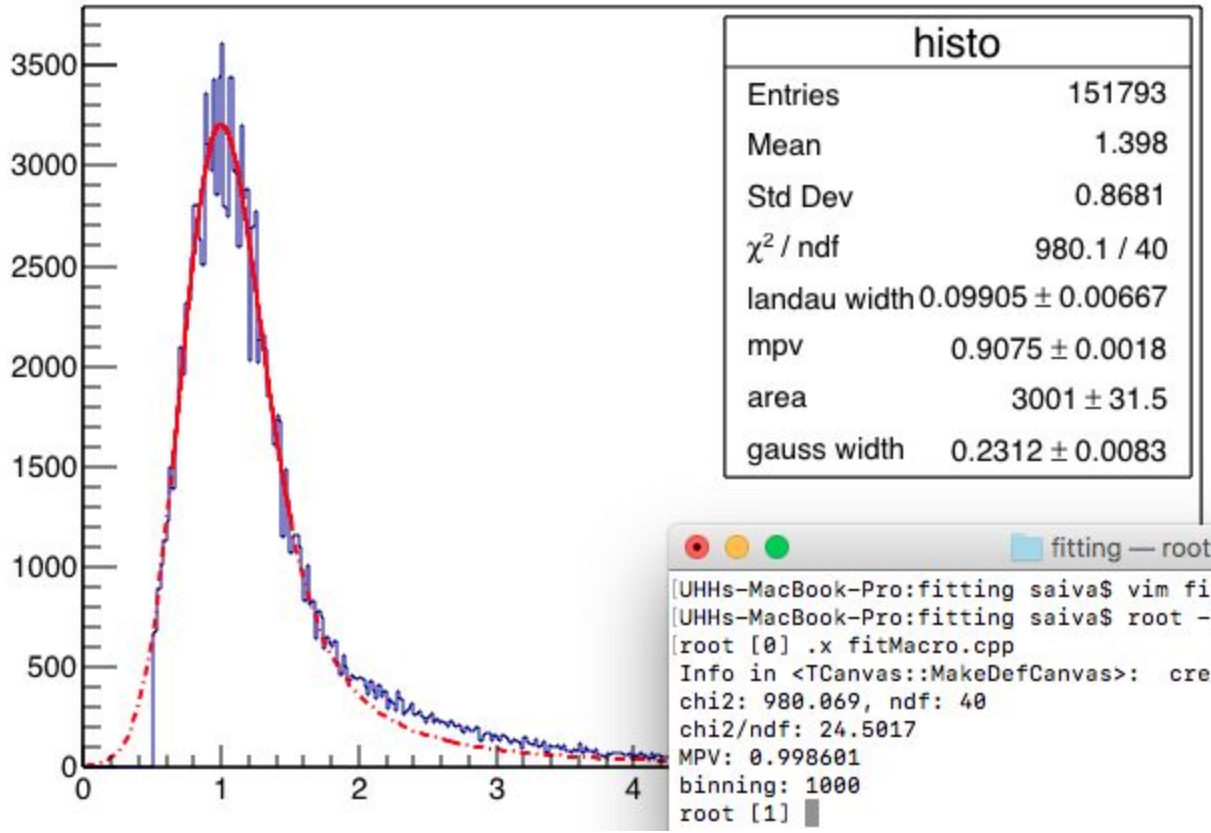
0.16 MIP/bin



histo	
Entries	151793
Mean	1.409
Std Dev	0.9126
χ^2 / ndf	1.905 / 1
landau width	0.08702 ± 0.01238
mpv	0.9037 ± 0.0036
area	2.508e+04 ± 4.353e+02
gauss width	0.2628 ± 0.0143

```
fitting — root.exe ◂ root -l — 80×9
[UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
[UHHs-MacBook-Pro:fitting saiva$ root -l
[root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2: 1.90463, ndf: 1
chi2/ndf: 1.90463
MPV: 1.00183
binning: 120
root [1]
```

0.02 MIP/bin

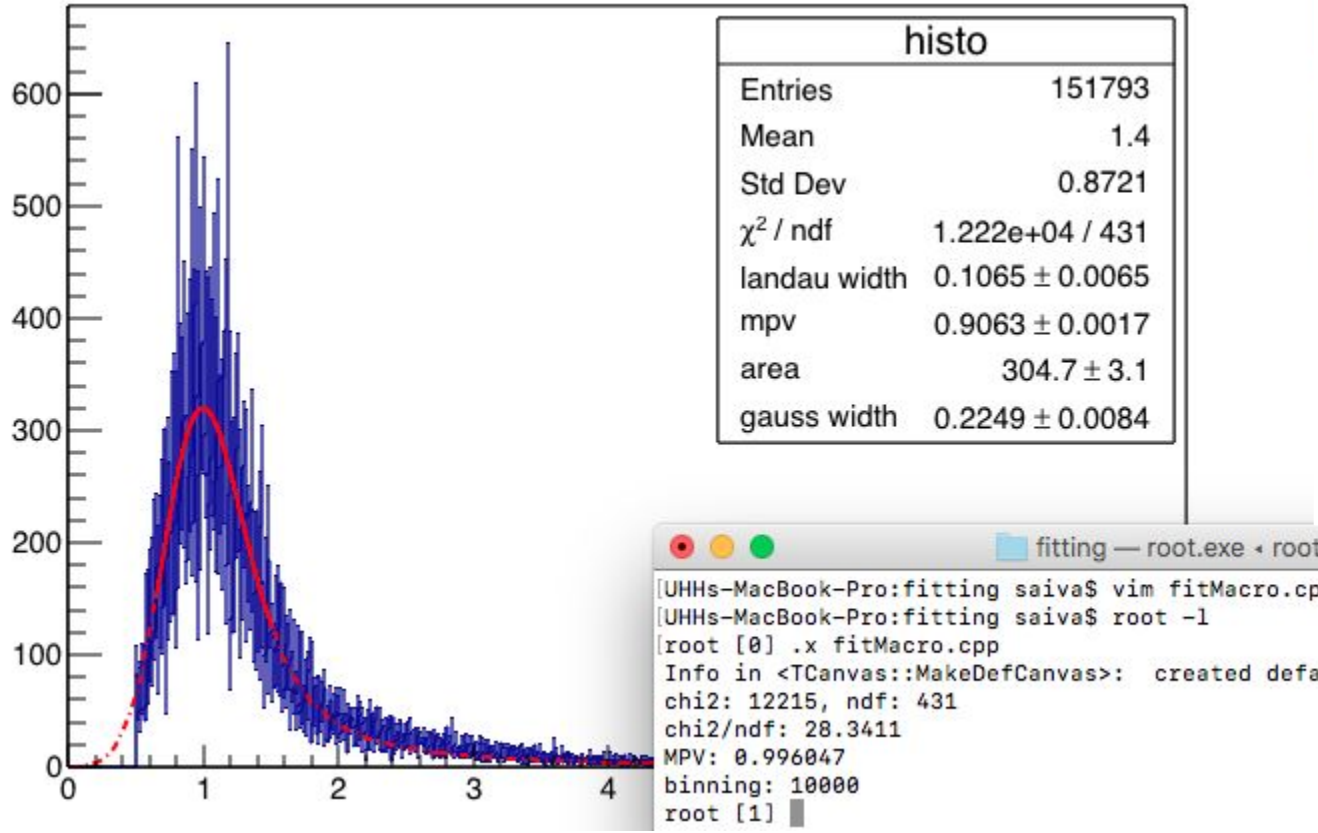


histo	
Entries	151793
Mean	1.398
Std Dev	0.8681
χ^2 / ndf	980.1 / 40
landau width	0.09905 ± 0.00667
mpv	0.9075 ± 0.0018
area	3001 ± 31.5
gauss width	0.2312 ± 0.0083

fitting — root.exe ◂ root -l — 80×9

```
[UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
[UHHs-MacBook-Pro:fitting saiva$ root -l
[root [0] .x fitMacro.cpp
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2: 980.069, ndf: 40
chi2/ndf: 24.5017
MPV: 0.998601
binning: 1000
root [1]
```

0.002 MIP/bin

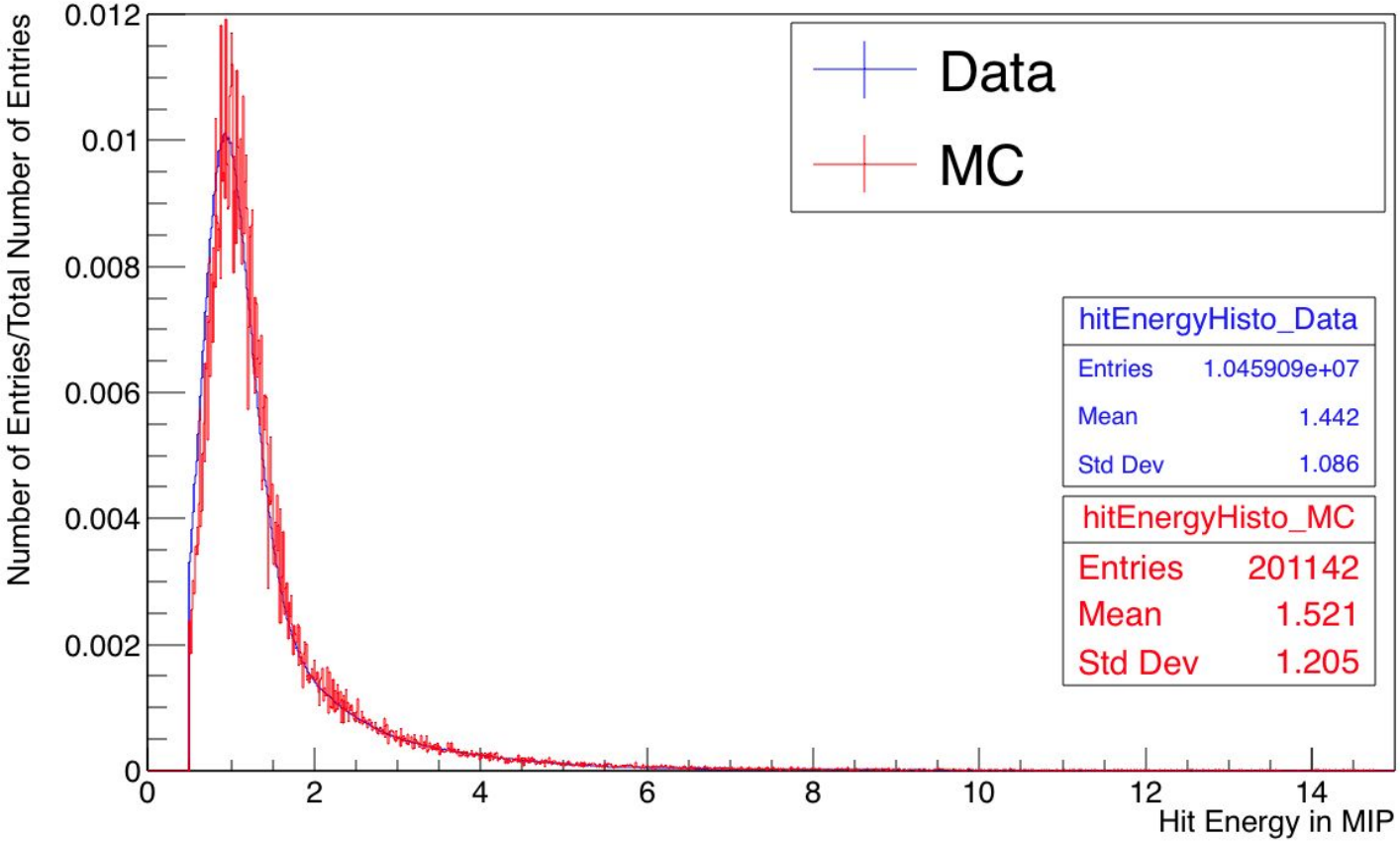


histo	
Entries	151793
Mean	1.4
Std Dev	0.8721
χ^2 / ndf	1.222e+04 / 431
landau width	0.1065 ± 0.0065
mpv	0.9063 ± 0.0017
area	304.7 ± 3.1
gauss width	0.2249 ± 0.0084

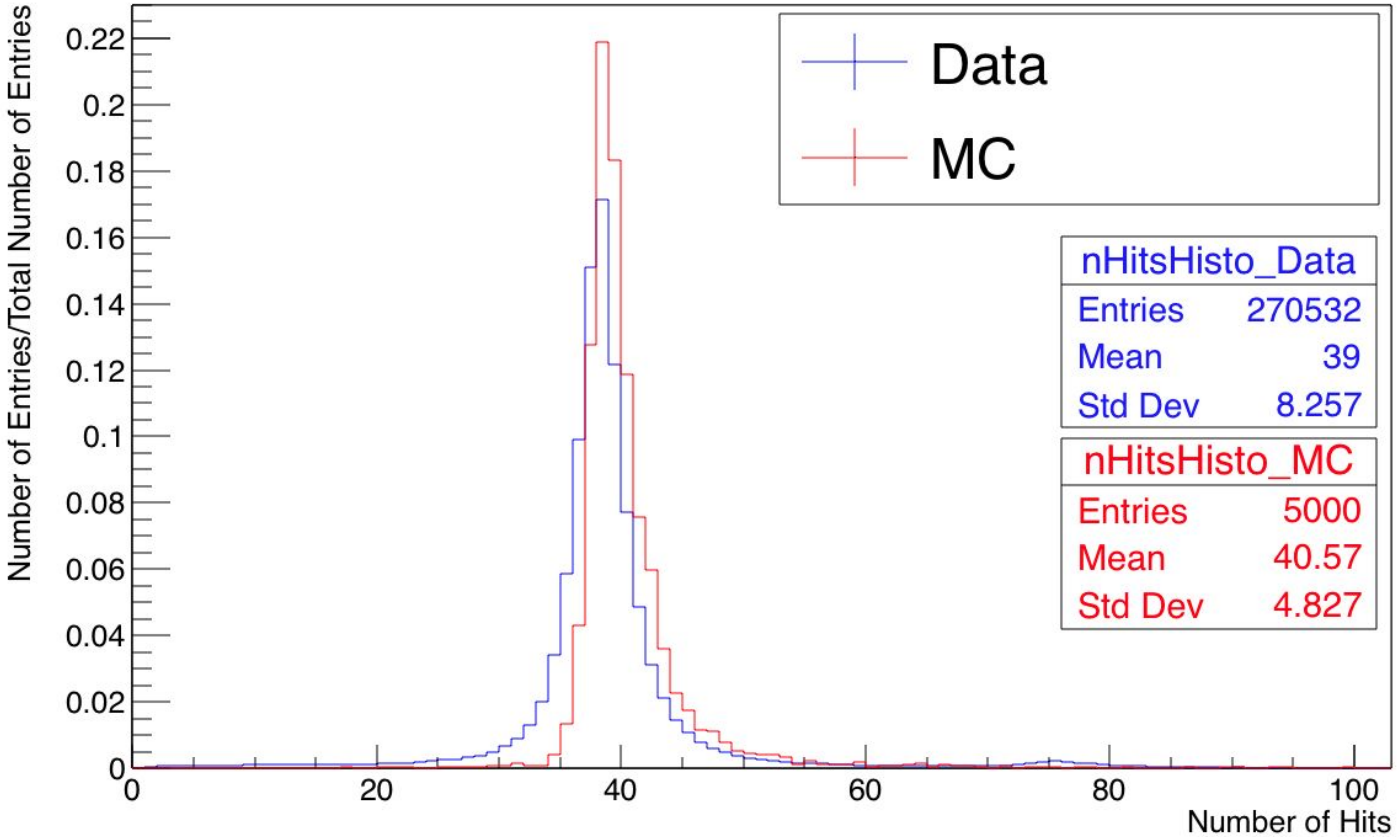
fitting — root.exe ◂ root -l — 80×9

```
[UHHs-MacBook-Pro:fitting saiva$ vim fitMacro.cpp
[UHHs-MacBook-Pro:fitting saiva$ root -l
[root [0] .x fitMacro.cpp
 Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
chi2: 12215, ndf: 431
chi2/ndf: 28.3411
MPV: 0.996047
binning: 10000
root [1]
```

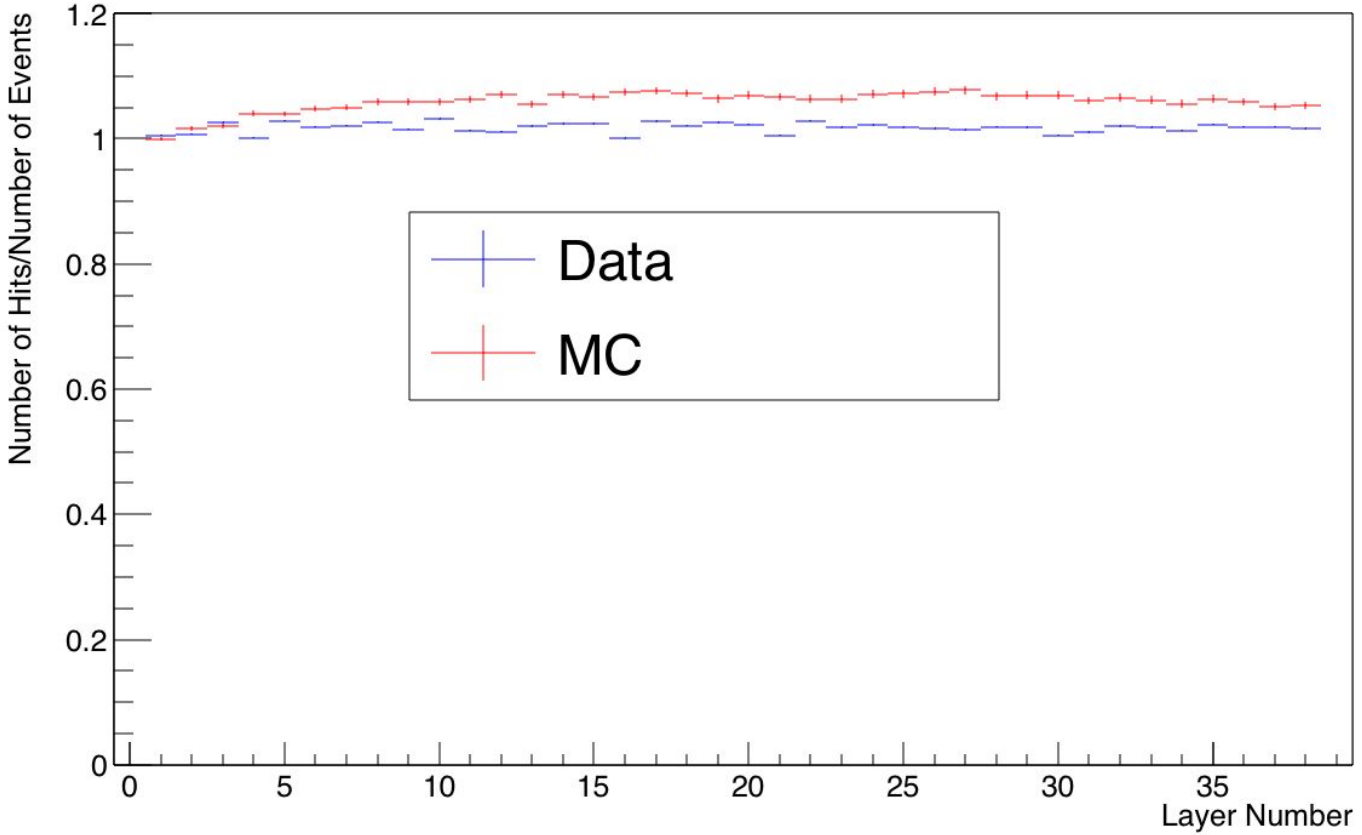
40 GeV muons


Number of Entries/Total Number of Entries
0.012
0.01
0.008
0.006
0.004
0.002
0
0
2
4
6
8
10
12
14
Hit Energy in MIP
Data
MC
hitEnergyHisto_Data
Entries 1.045909e+07
Mean 1.442
Std Dev 1.086
hitEnergyHisto_MC
Entries 201142
Mean 1.521
Std Dev 1.205

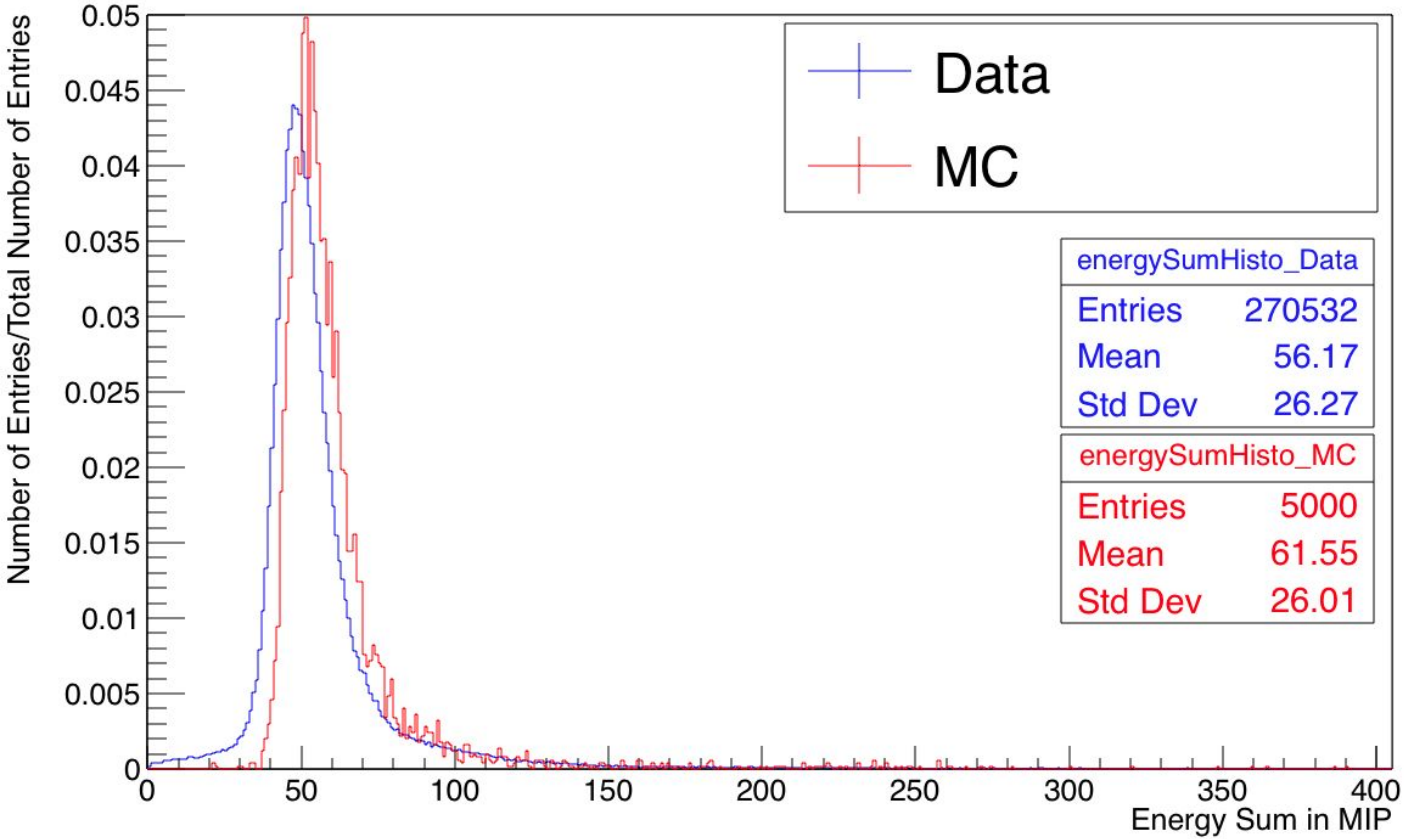
40 GeV muons


Number of Entries/Total Number of Entries
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
Number of Hits
Data
MC
nHitsHisto_Data
Entries 270532
Mean 39
Std Dev 8.257
nHitsHisto_MC
Entries 5000
Mean 40.57
Std Dev 4.827

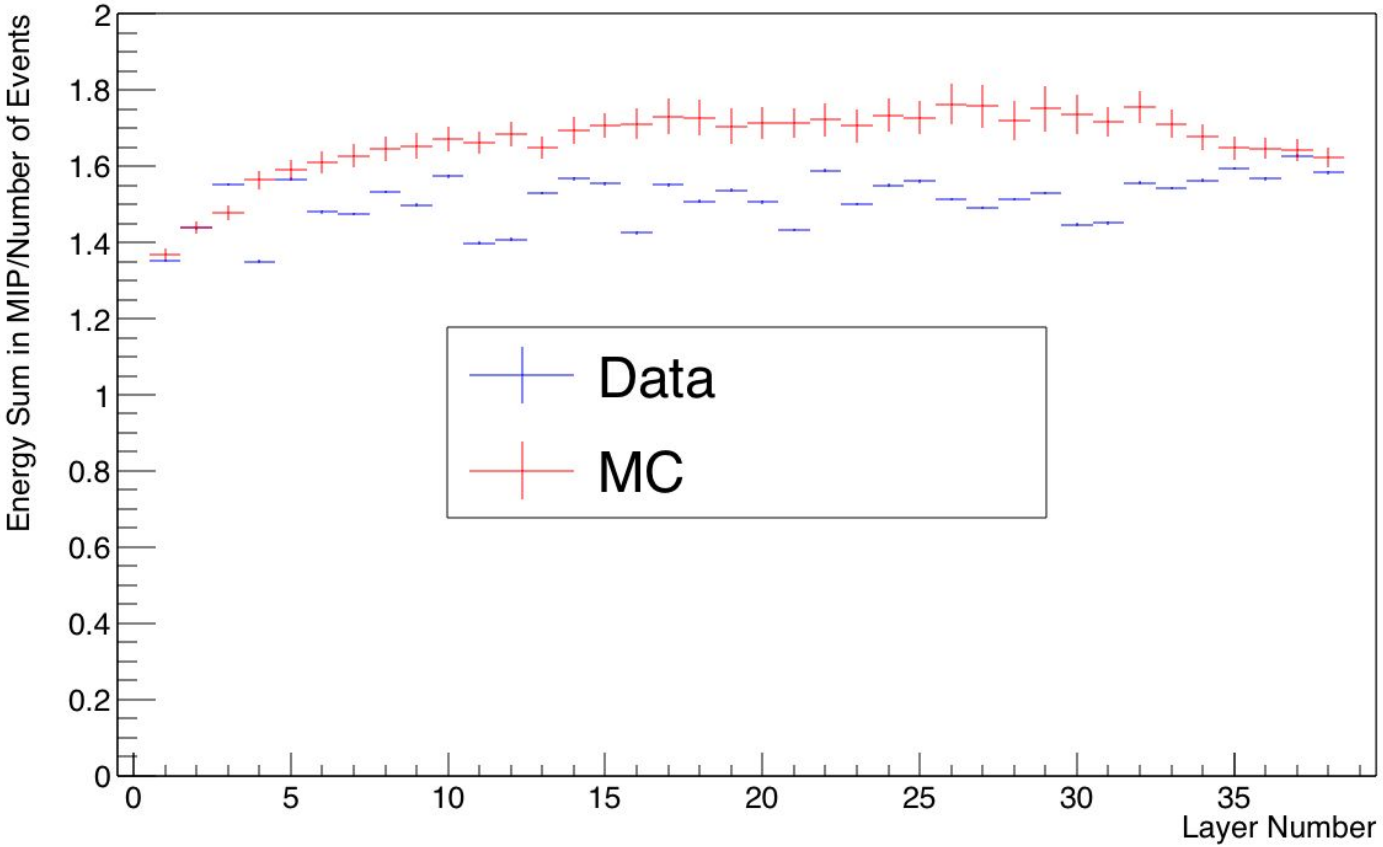
40 GeV muons


Number of Hits/Number of Events
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
Layer Number
Data
MC

40 GeV muons


Number of Entries/Total Number of Entries
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250
300
350
400
Energy Sum in MIP
Data
MC
energySumHisto_Data
Entries 270532
Mean 56.17
Std Dev 26.27
energySumHisto_MC
Entries 5000
Mean 61.55
Std Dev 26.01

40 GeV muons


Energy Sum in MIP/Number of Events
Layer Number
Data
MC
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
5
10
15
20
25
30
35

Simulation fixes

- Problems:
  - 40 layers in simulation
  - MIP peak shifted to above 1
- Solutions:
  - Fixing the number of layers in TestBeamSetup_HCAL.xml file: Has been checked, works!
  - Using the MIP calibration fit to adapt the MIP peak position (using 40 GeV muons): Works!
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    - Checked various binnings: difference < 1%
    - Looked at different distributions: MIP peak very close to 1 (for data not yet)
- New issue:
  - energySum and nHits still slightly shifted to larger values after applying the fixes
    - nHits maximum at 38 (correct!) but whole distribution shifted slightly
- Ongoing: pion simulation