BCAL Dynamic Range from the Simulation with FLUKA

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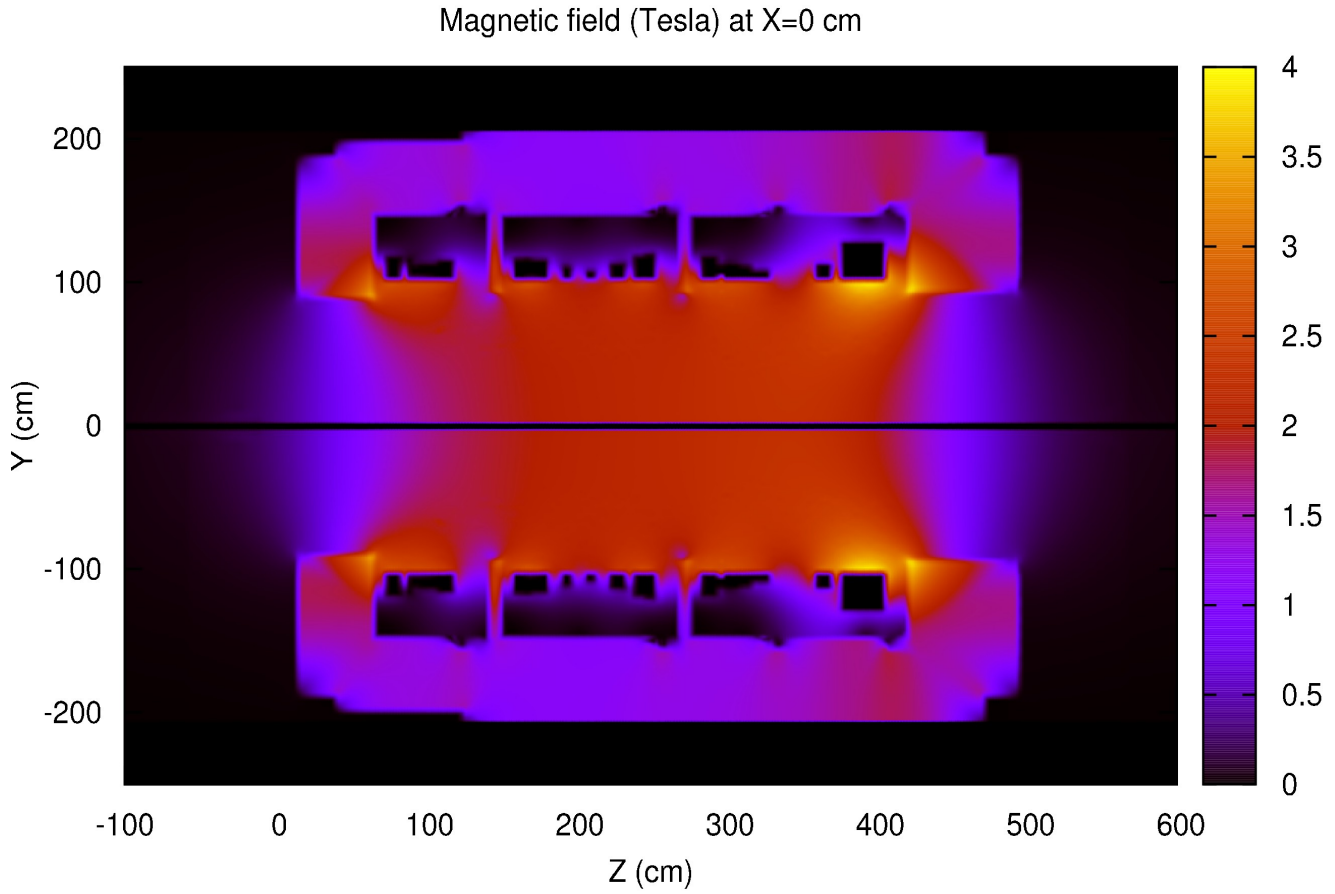
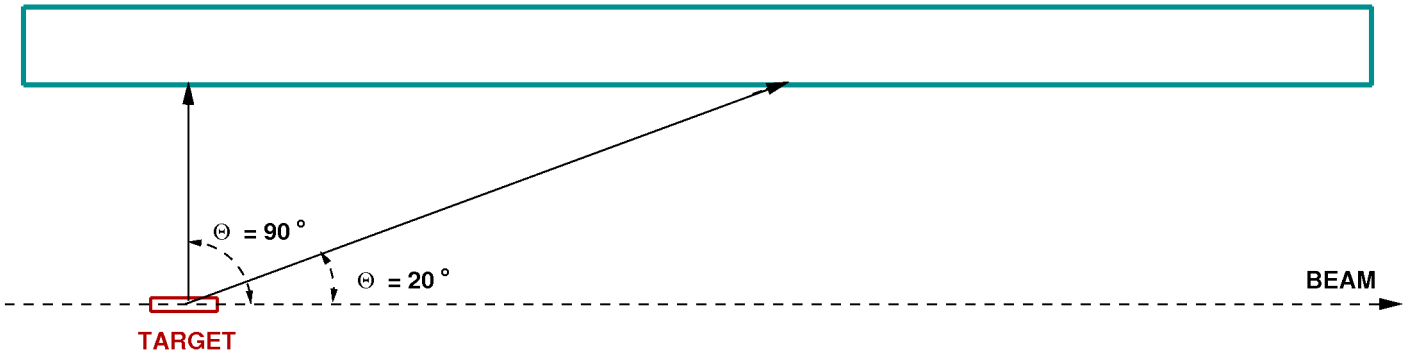
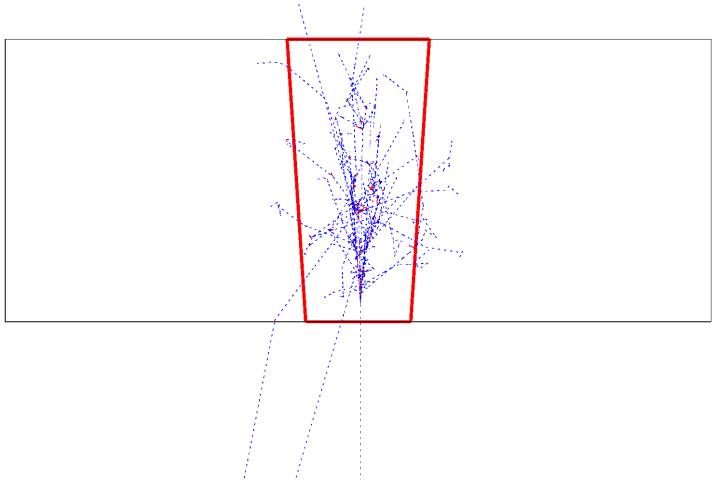
Field Map ANSYS 20081209-1_150.dat
Linear interpolation between grid points



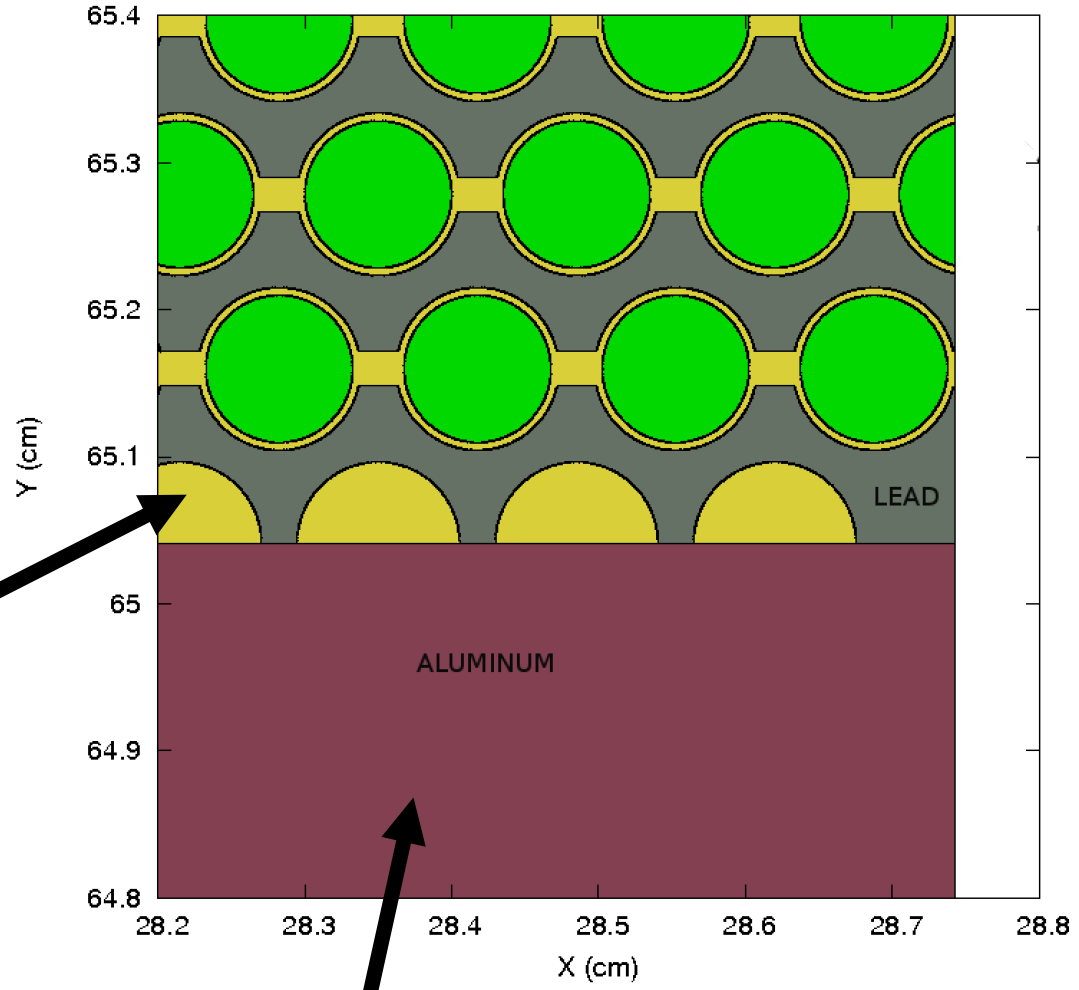
Geometry: Side View



Geometry: Front View



Realistic BCAL Geometry



Glue pockets

8-mm top Al plate

* **Photon “beam” diameter = 1 cm**

* **Attenuation with 2-exponent function (530 & 91 cm)**
  NB: from tests with bare fibers

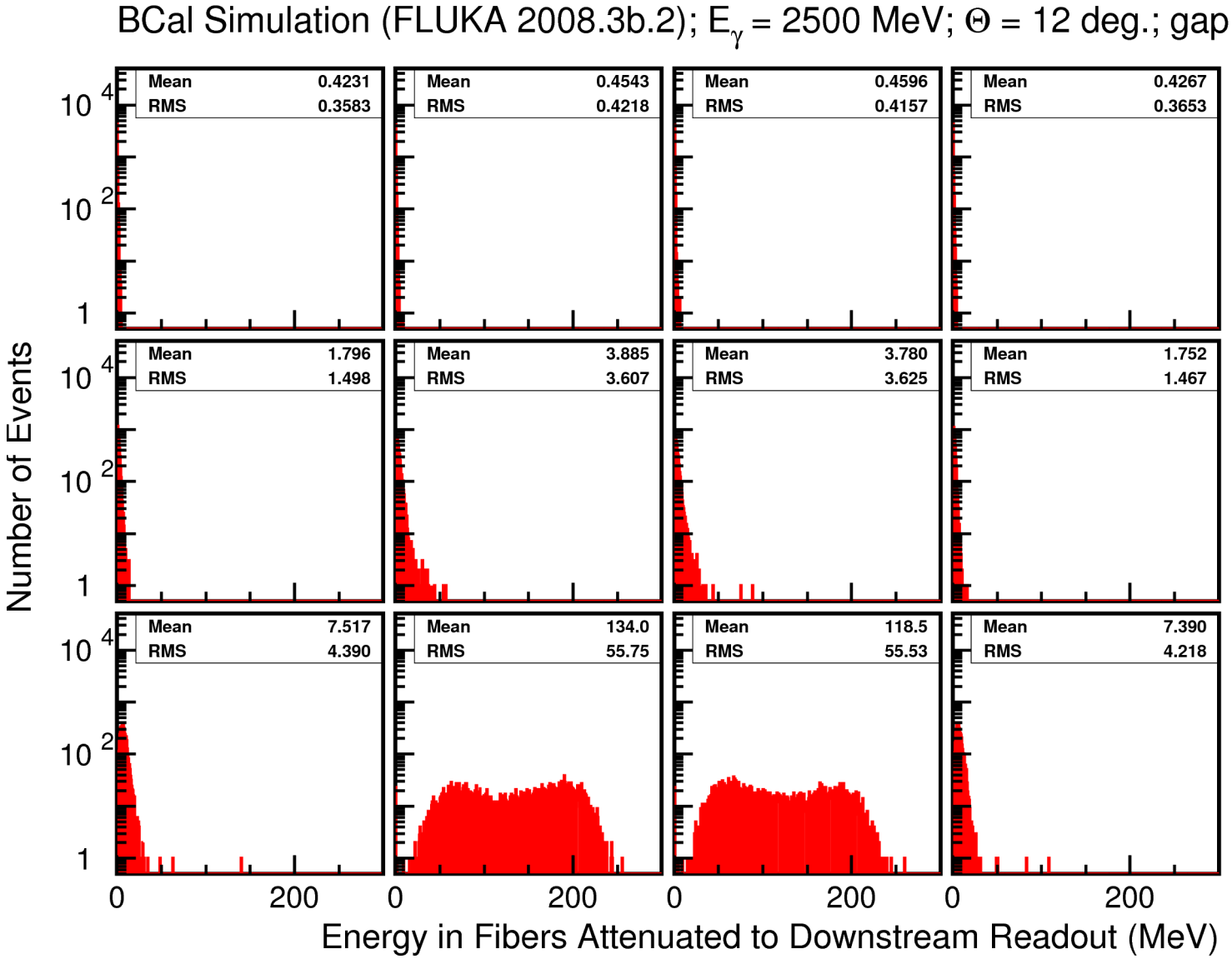
* **N_{pe} spectra are convolution of energy deposition spectra with Poisson distribution and Gaussian PMT response function**

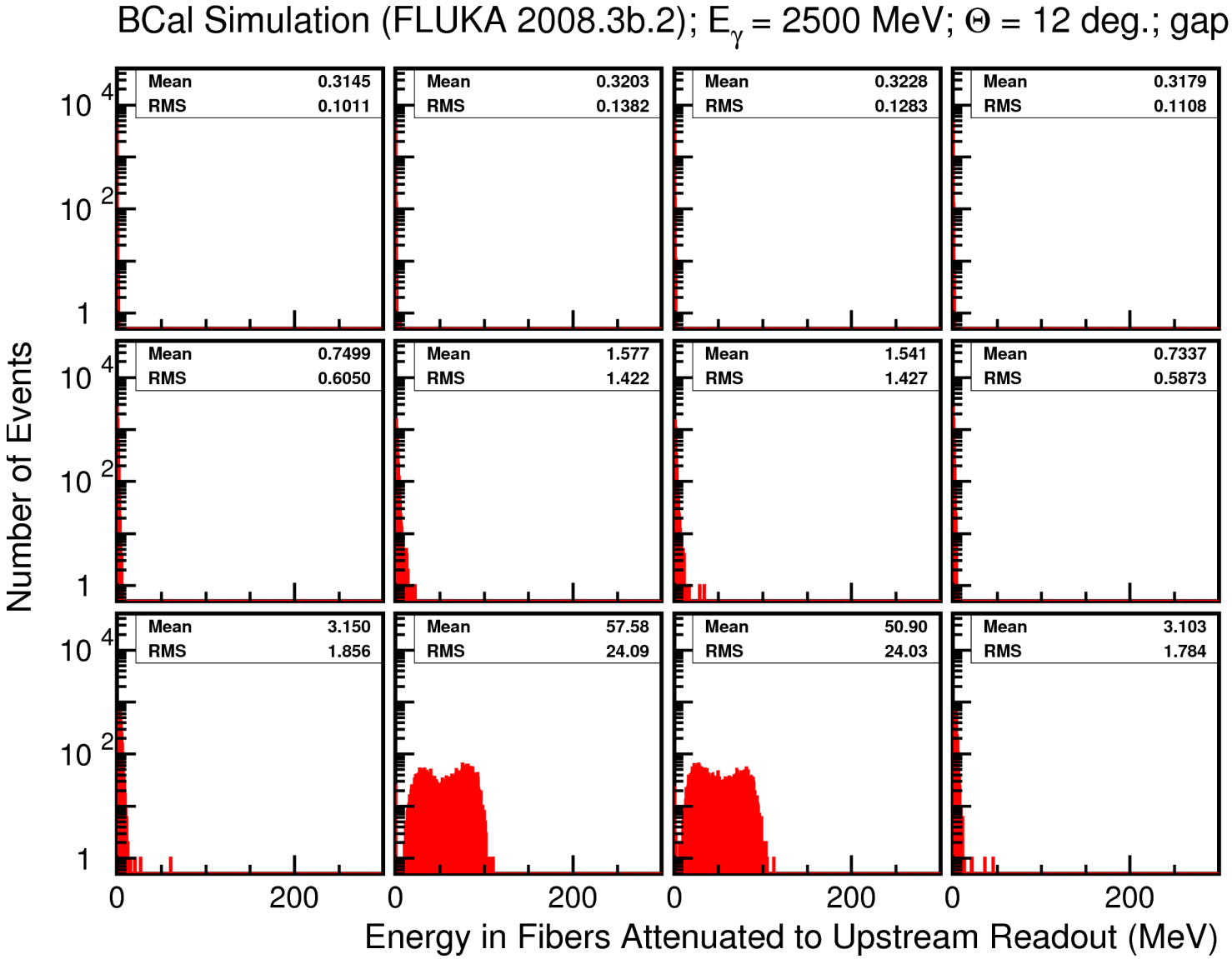
* **MeV-to-mean-N_{pe} factor is from tests with bare fibers (shipment 3), and corresponds to 7.5 phe from the single fiber and Sr^{90} source at the 200-cm distance from the photocathode of the calibrated Hamamatsu R329-02 PMT**

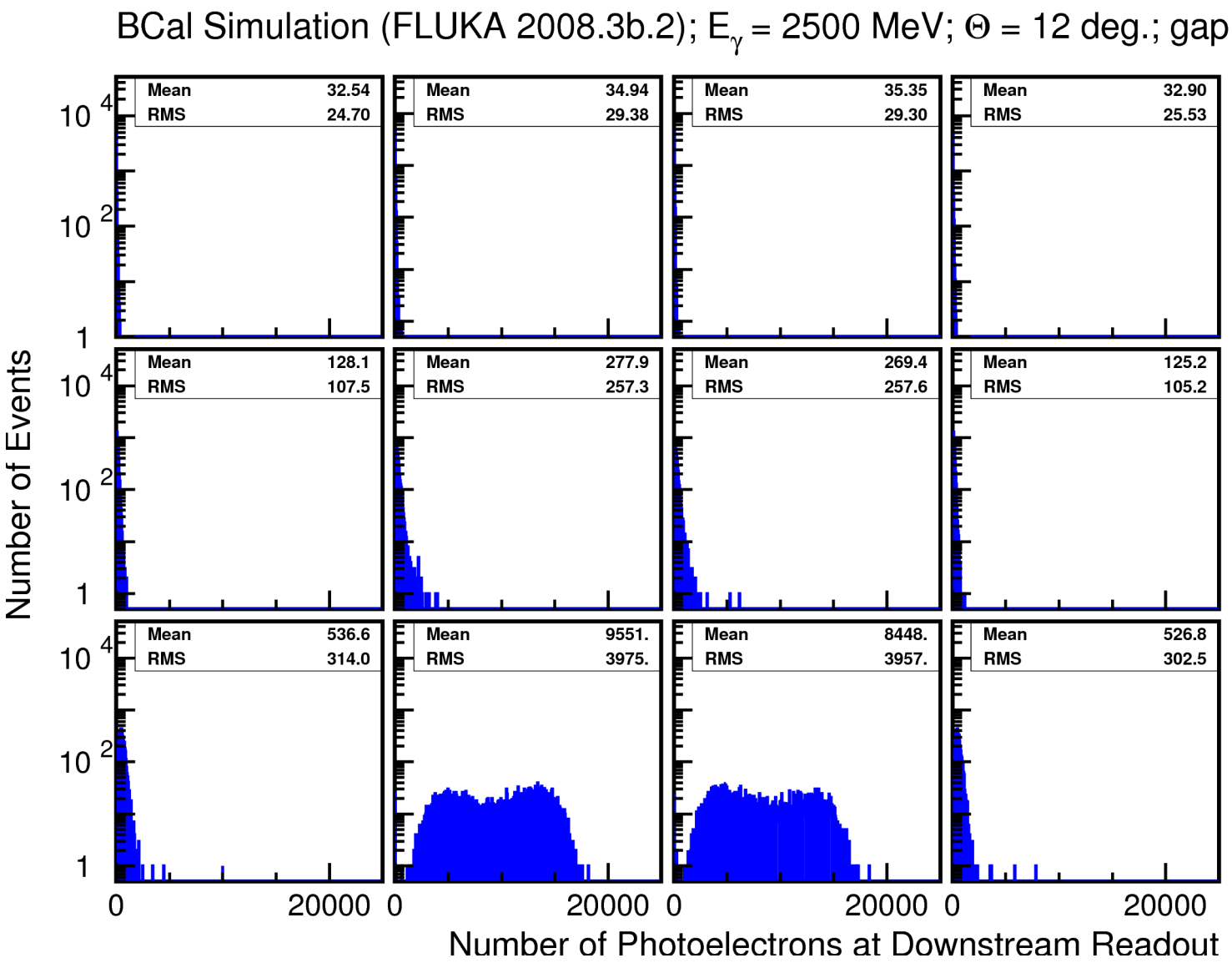
2500-MeV/c photons at Θ=12 degrees
(hit BCAL at about 30 cm from downstream readout)

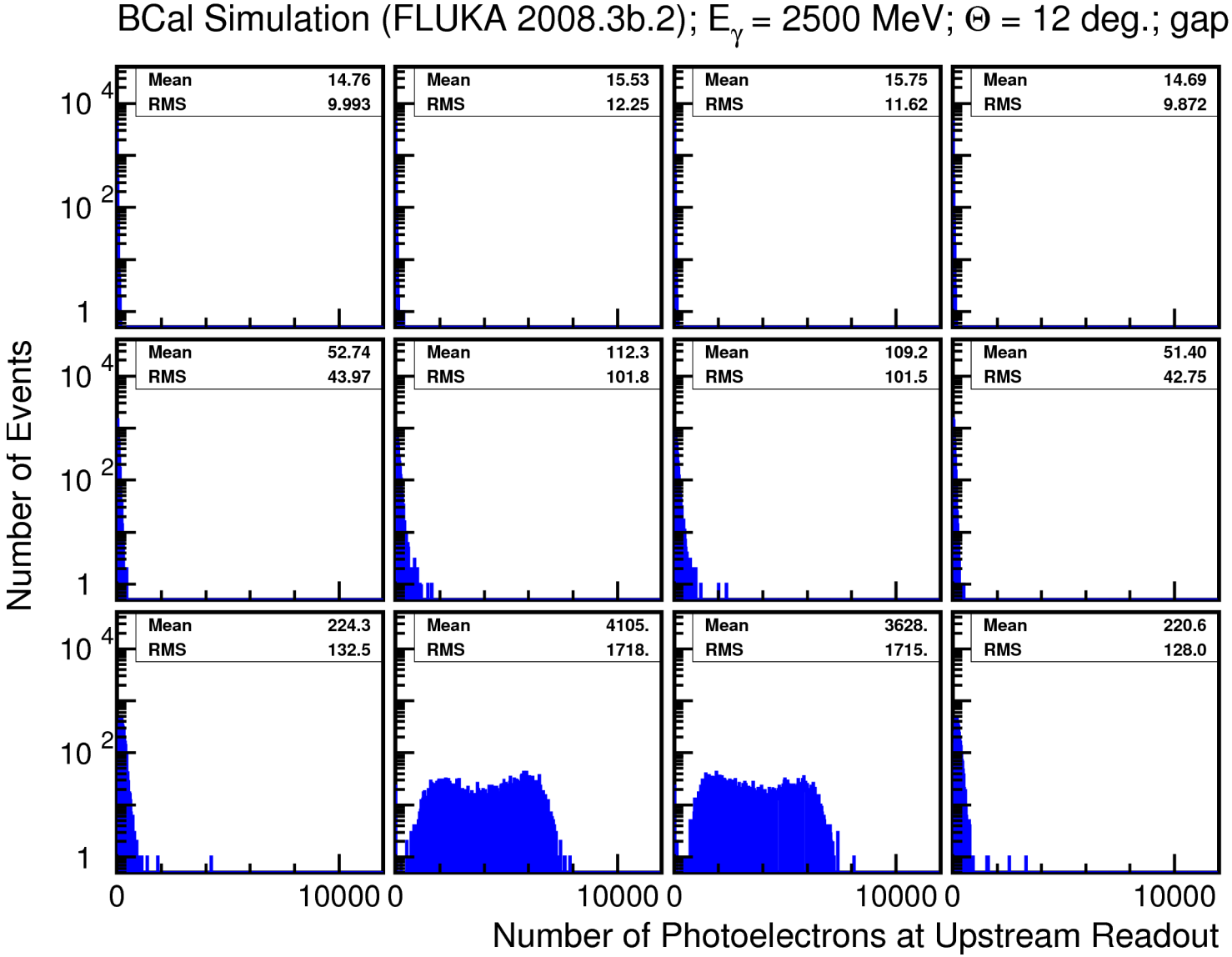
"gap": middle-of-the-module hit
(in between 2 readout segments)

"center": hit in the center of readout segment
(about 1 cm shift from "gap" hit position)

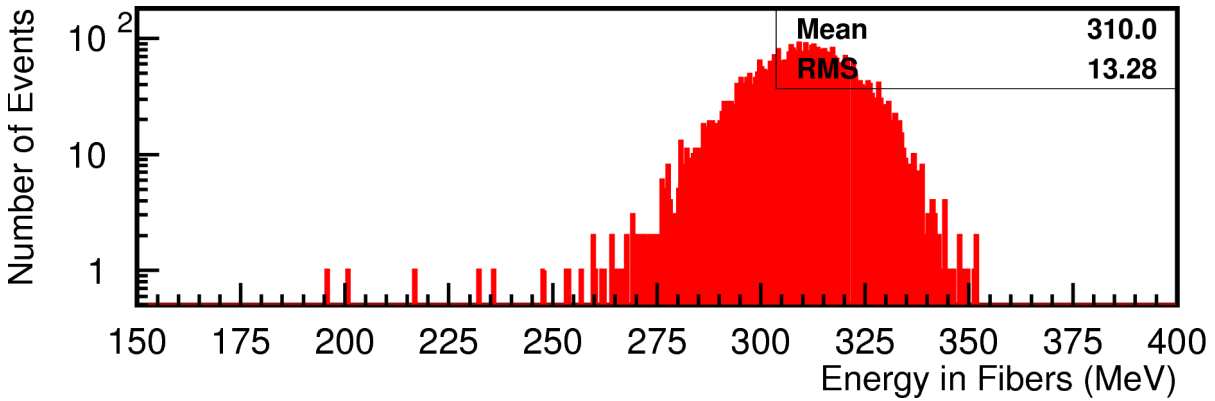

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; gap
Mean 0.4231
RMS 0.3583
Mean 0.4543
RMS 0.4218
Mean 0.4596
RMS 0.4157
Mean 0.4267
RMS 0.3653
Mean 1.796
RMS 1.498
Mean 3.885
RMS 3.607
Mean 3.780
RMS 3.625
Mean 1.752
RMS 1.467
Mean 7.517
RMS 4.390
Mean 134.0
RMS 55.75
Mean 118.5
RMS 55.53
Mean 7.390
RMS 4.218
Number of Events
Energy in Fibers Attenuated to Downstream Readout (MeV)

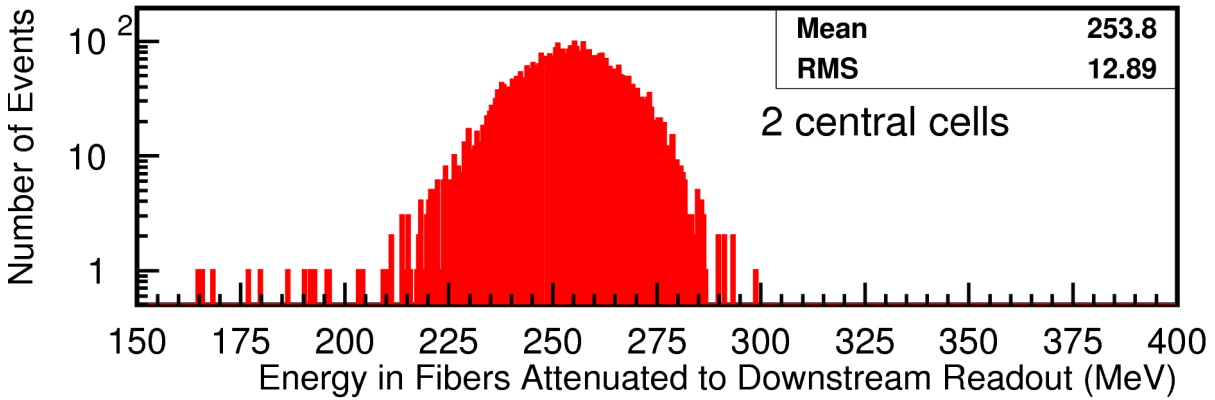

BCal Simulation (FLUKA 2008.3b.2); E$_\gamma$ = 2500 MeV; Θ = 12 deg.; gap
Mean 0.3145
RMS 0.1011
Mean 0.3203
RMS 0.1382
Mean 0.3228
RMS 0.1283
Mean 0.3179
RMS 0.1108
Mean 0.7499
RMS 0.6050
Mean 1.577
RMS 1.422
Mean 1.541
RMS 1.427
Mean 0.7337
RMS 0.5873
Mean 3.150
RMS 1.856
Mean 57.58
RMS 24.09
Mean 50.90
RMS 24.03
Mean 3.103
RMS 1.784
Number of Events
Energy in Fibers Attenuated to Upstream Readout (MeV)

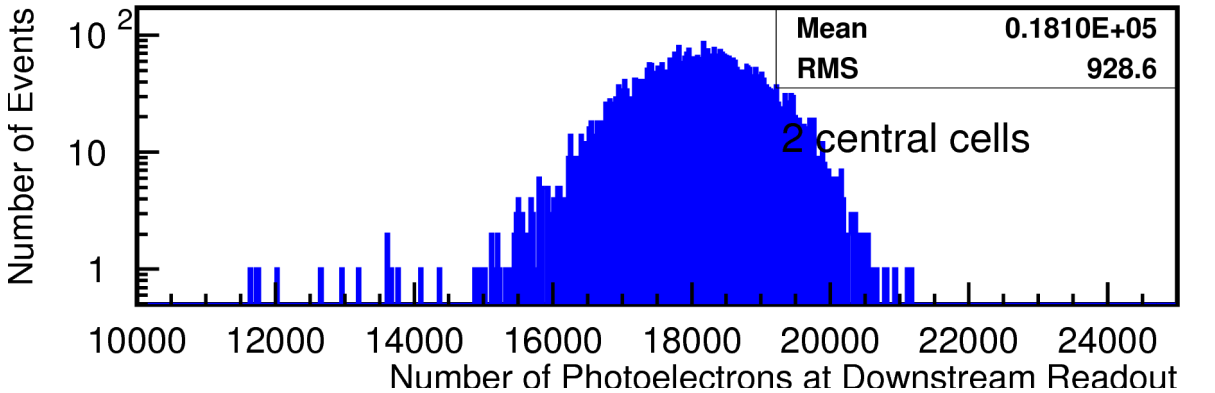

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; gap
Mean 32.54
RMS 24.70
Mean 34.94
RMS 29.38
Mean 35.35
RMS 29.30
Mean 32.90
RMS 25.53
Mean 128.1
RMS 107.5
Mean 277.9
RMS 257.3
Mean 269.4
RMS 257.6
Mean 125.2
RMS 105.2
Mean 536.6
RMS 314.0
Mean 9551.
RMS 3975.
Mean 8448.
RMS 3957.
Mean 526.8
RMS 302.5
Number of Events
Number of Photoelectrons at Downstream Readout
0
20000
1
10
10^2
10^4

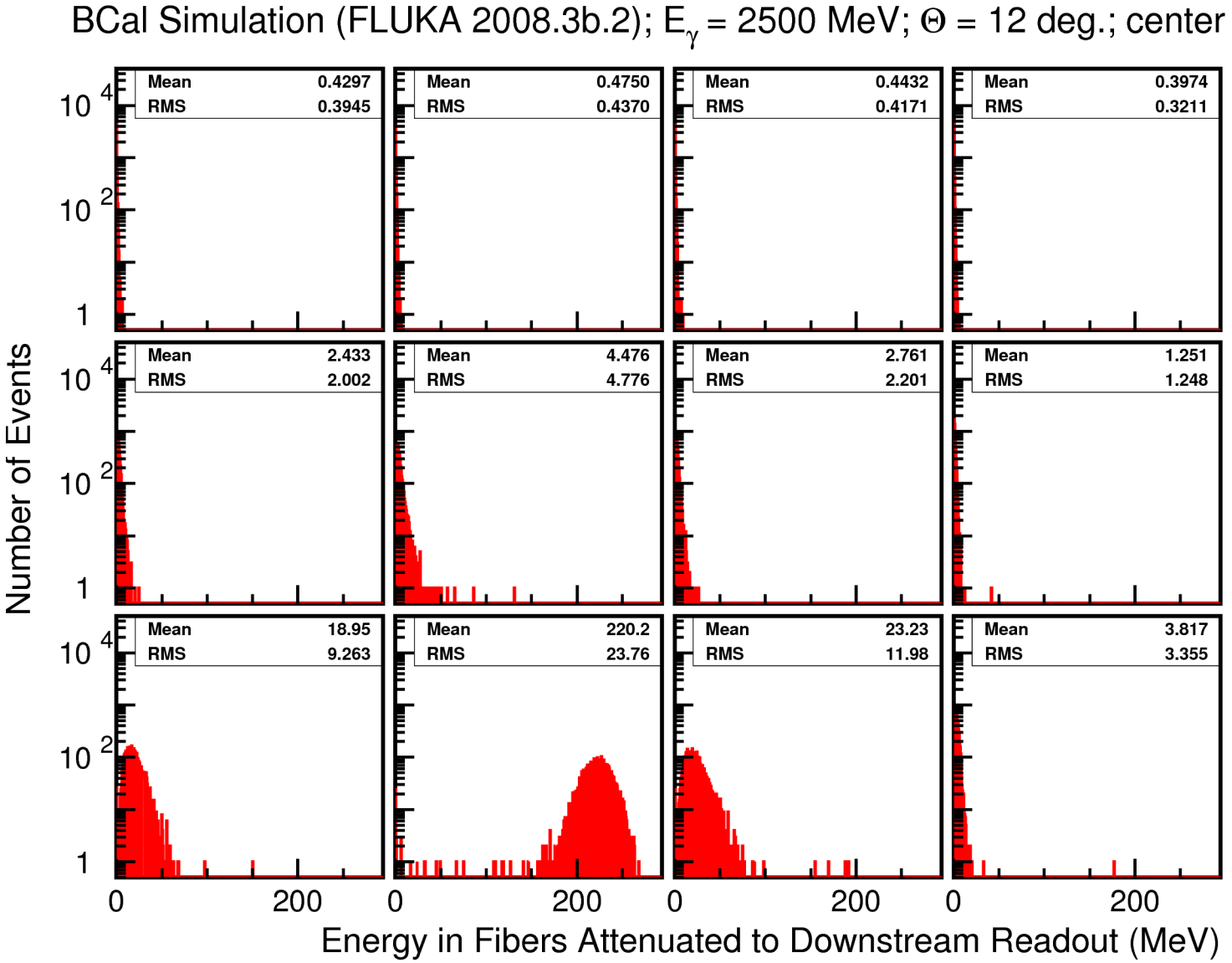

BCal Simulation (FLUKA 2008.3b.2); E$_\gamma$ = 2500 MeV; Θ = 12 deg.; gap
Mean 14.76
RMS 9.993
Mean 15.53
RMS 12.25
Mean 15.75
RMS 11.62
Mean 14.69
RMS 9.872
Mean 52.74
RMS 43.97
Mean 112.3
RMS 101.8
Mean 109.2
RMS 101.5
Mean 51.40
RMS 42.75
Mean 224.3
RMS 132.5
Mean 4105.
RMS 1718.
Mean 3628.
RMS 1715.
Mean 220.6
RMS 128.0
Number of Events
Number of Photoelectrons at Upstream Readout
0
10000

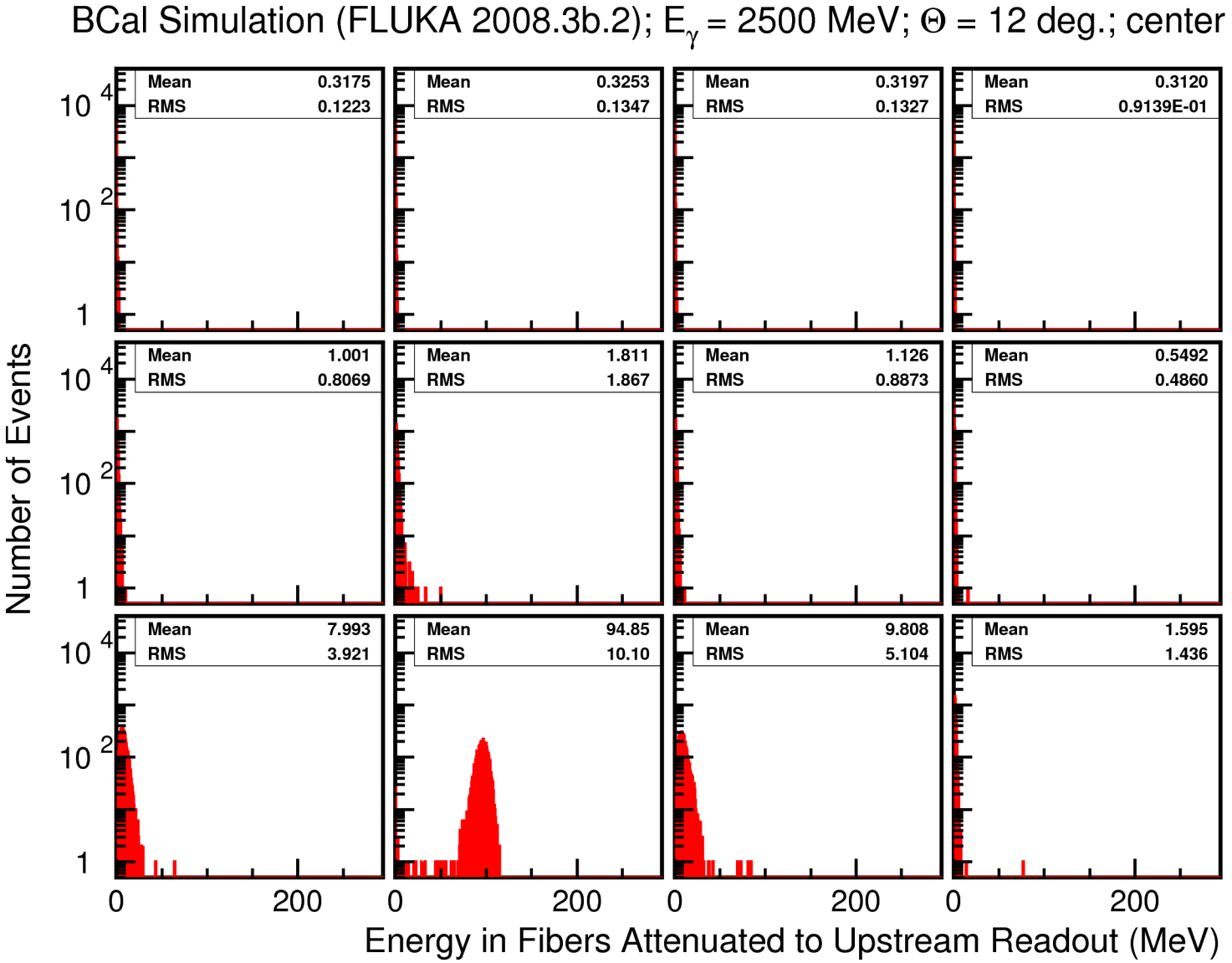
BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; gap

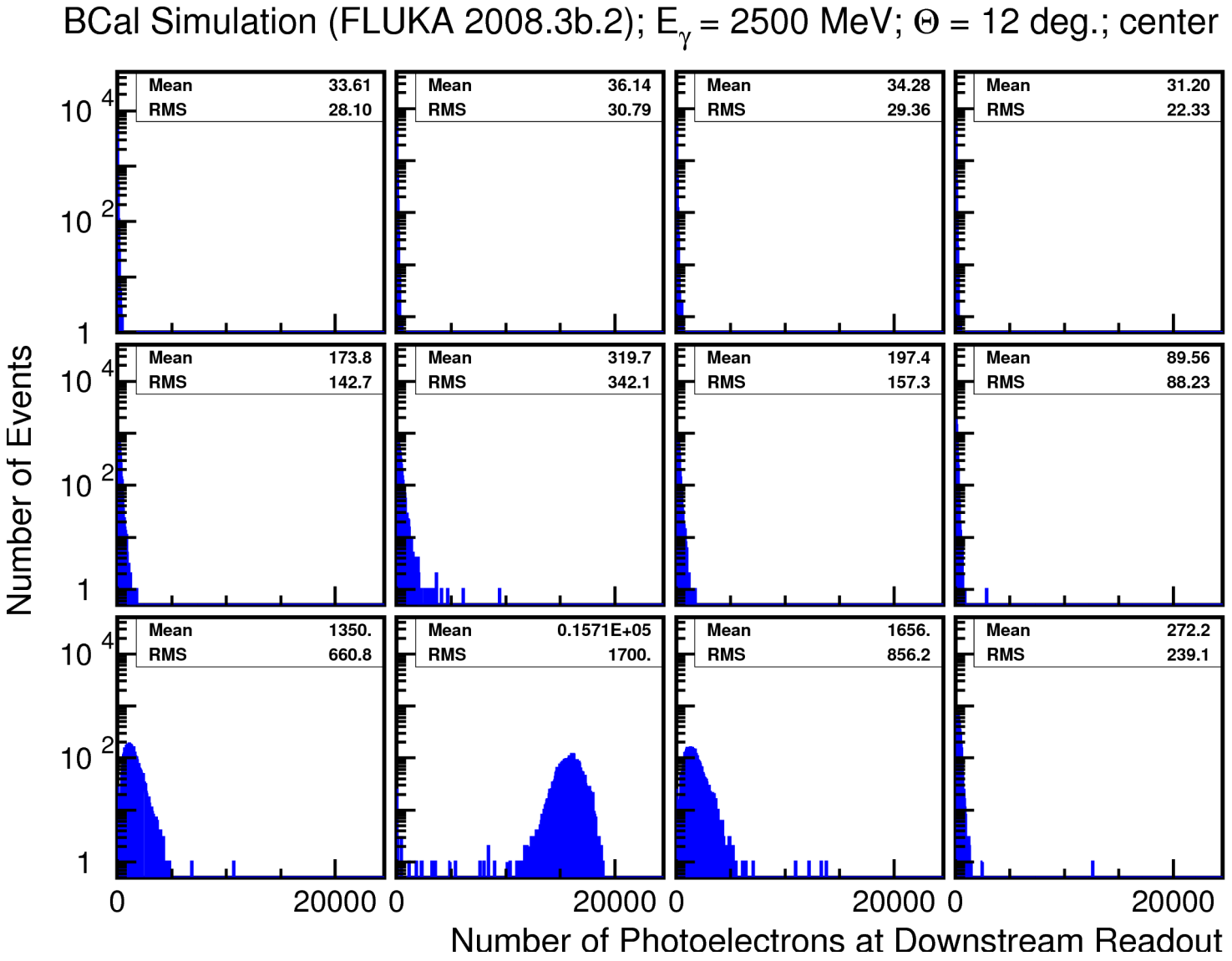




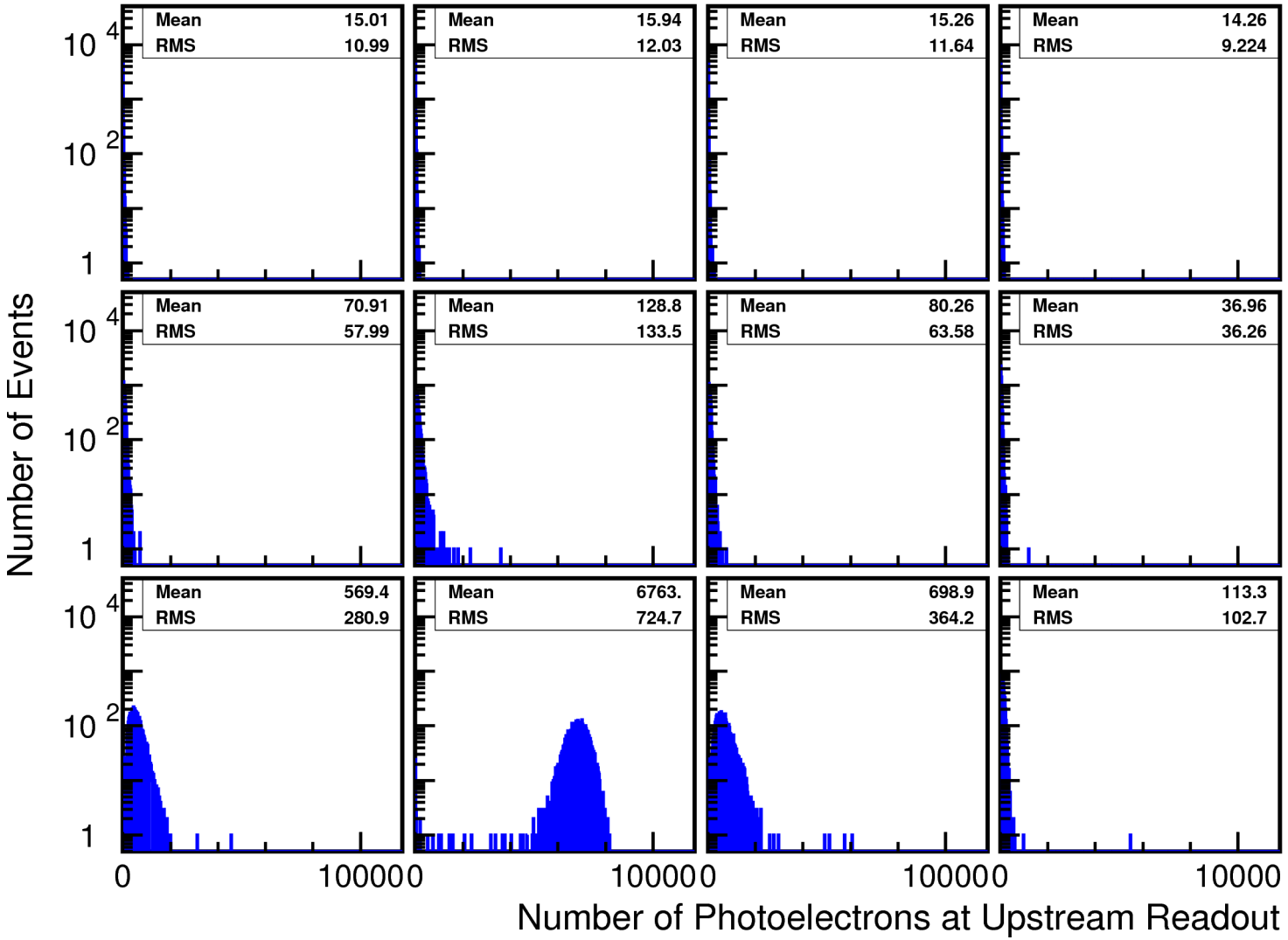



BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; center
Mean 0.4297
RMS 0.3945
Mean 0.4750
RMS 0.4370
Mean 0.4432
RMS 0.4171
Mean 0.3974
RMS 0.3211
Mean 2.433
RMS 2.002
Mean 4.476
RMS 4.776
Mean 2.761
RMS 2.201
Mean 1.251
RMS 1.248
Mean 18.95
RMS 9.263
Mean 220.2
RMS 23.76
Mean 23.23
RMS 11.98
Mean 3.817
RMS 3.355
Number of Events
Energy in Fibers Attenuated to Downstream Readout (MeV)


BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; center
Mean 0.3175
RMS 0.1223
Mean 0.3253
RMS 0.1347
Mean 0.3197
RMS 0.1327
Mean 0.3120
RMS 0.9139E-01
Mean 1.001
RMS 0.8069
Mean 1.811
RMS 1.867
Mean 1.126
RMS 0.8873
Mean 0.5492
RMS 0.4860
Mean 7.993
RMS 3.921
Mean 94.85
RMS 10.10
Mean 9.808
RMS 5.104
Mean 1.595
RMS 1.436
Number of Events
Energy in Fibers Attenuated to Upstream Readout (MeV)


BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; center
Mean 33.61
RMS 28.10
Mean 36.14
RMS 30.79
Mean 34.28
RMS 29.36
Mean 31.20
RMS 22.33
Mean 173.8
RMS 142.7
Mean 319.7
RMS 342.1
Mean 197.4
RMS 157.3
Mean 89.56
RMS 88.23
Mean 1350.
RMS 660.8
Mean 0.1571E+05
RMS 1700.
Mean 1656.
RMS 856.2
Mean 272.2
RMS 239.1
Number of Events
Number of Photoelectrons at Downstream Readout
0
20000

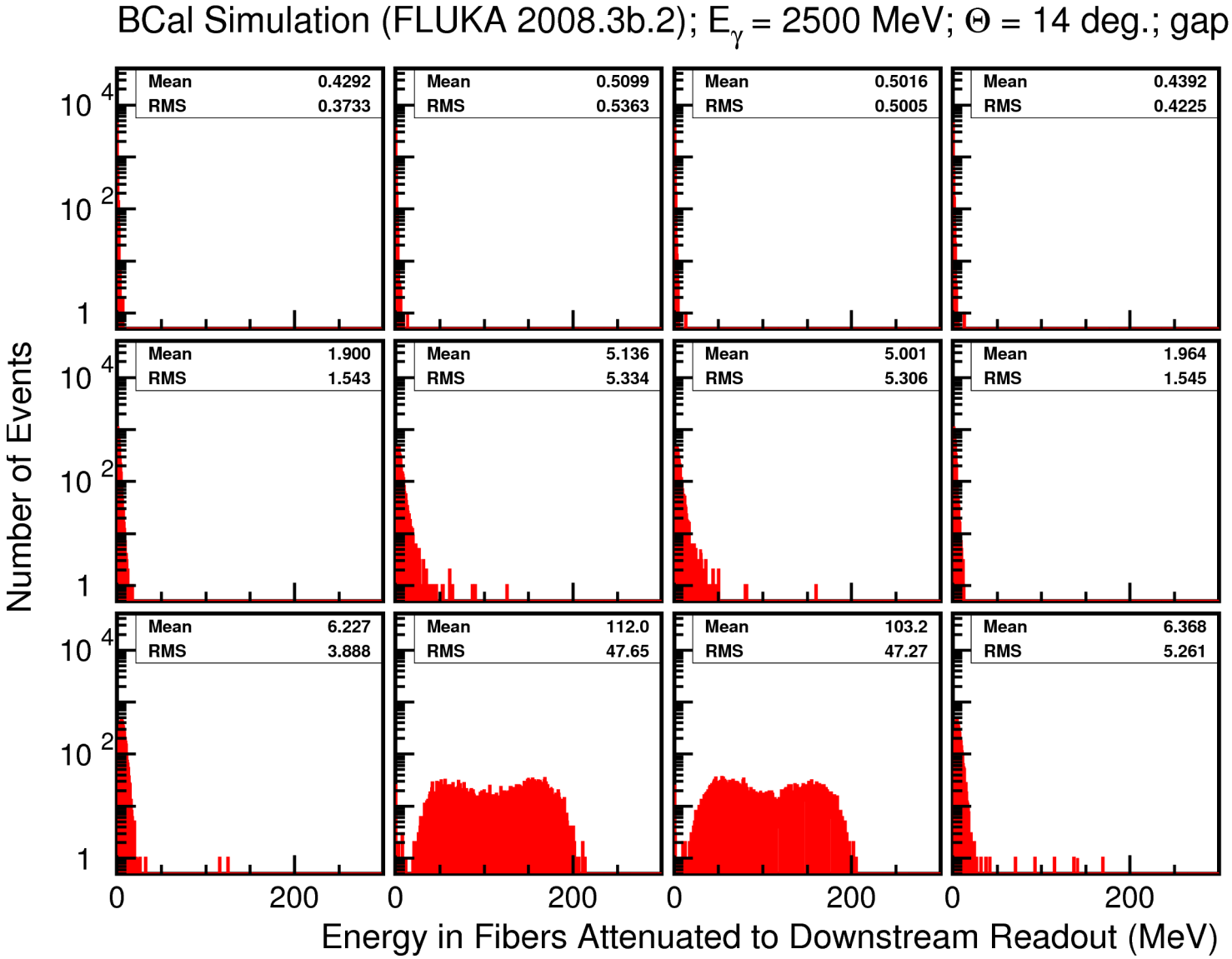
BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 12 deg.; center

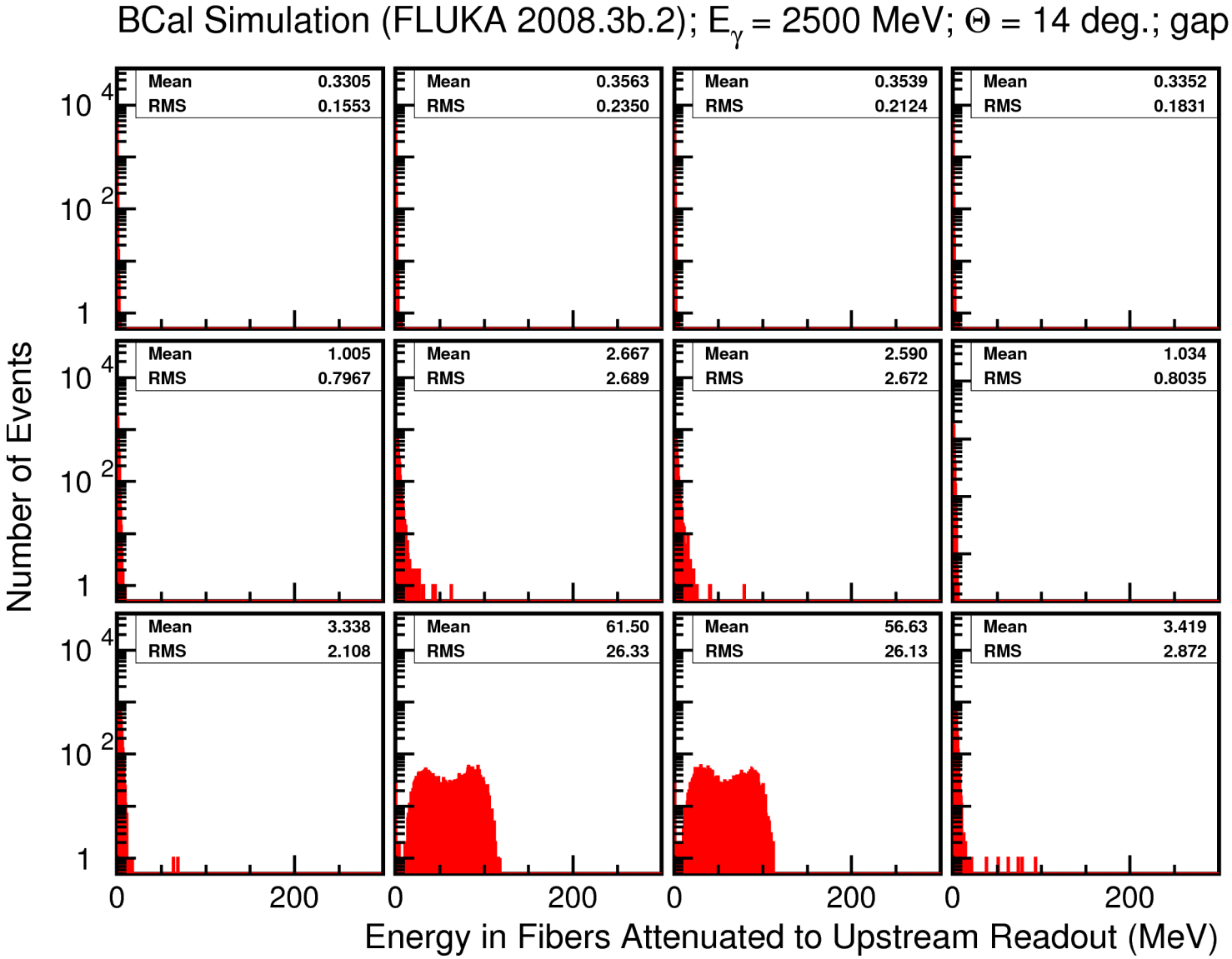


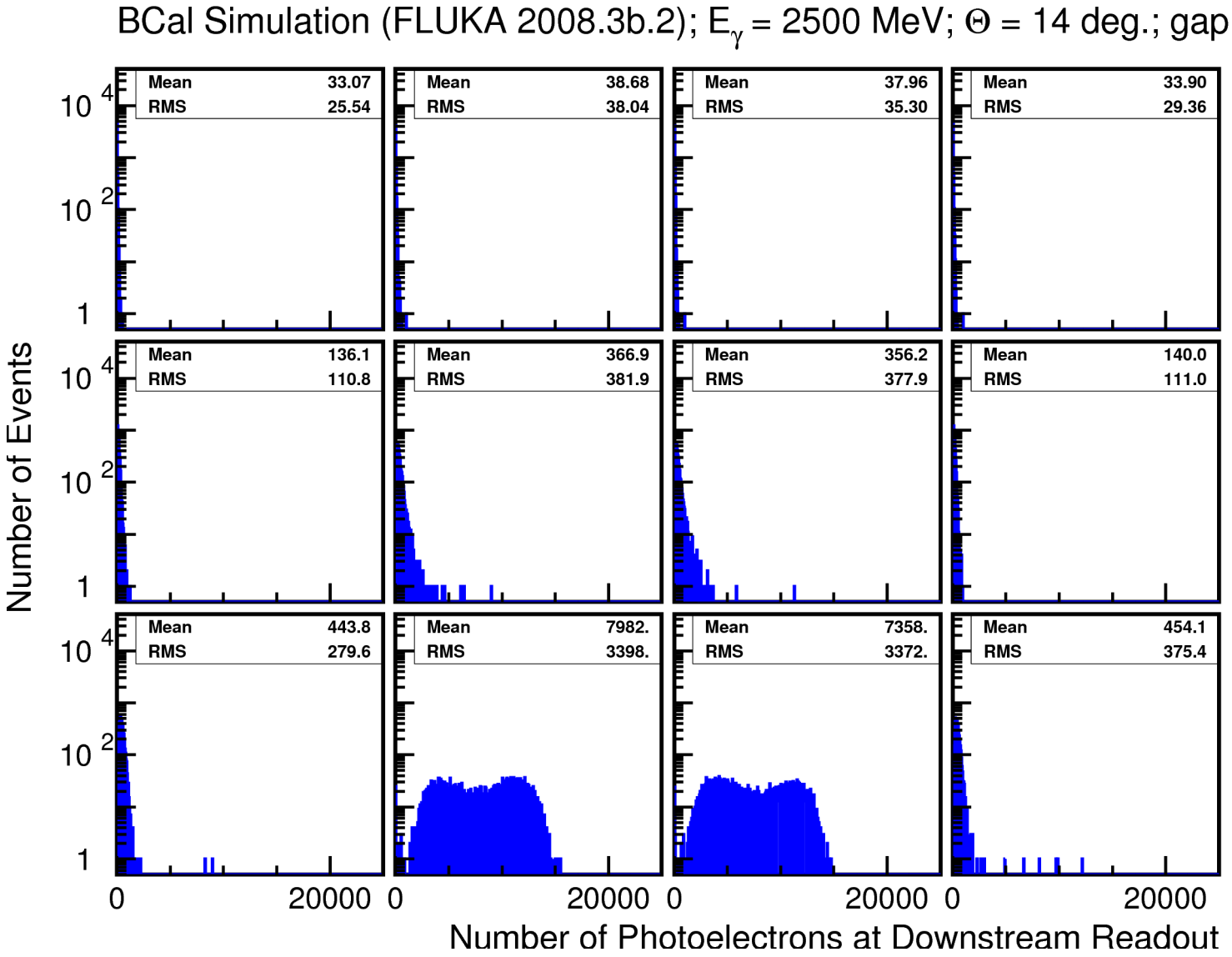
2500-MeV/c photons at Θ=14 degrees
(hit BCAL at about 90 cm from downstream readout)

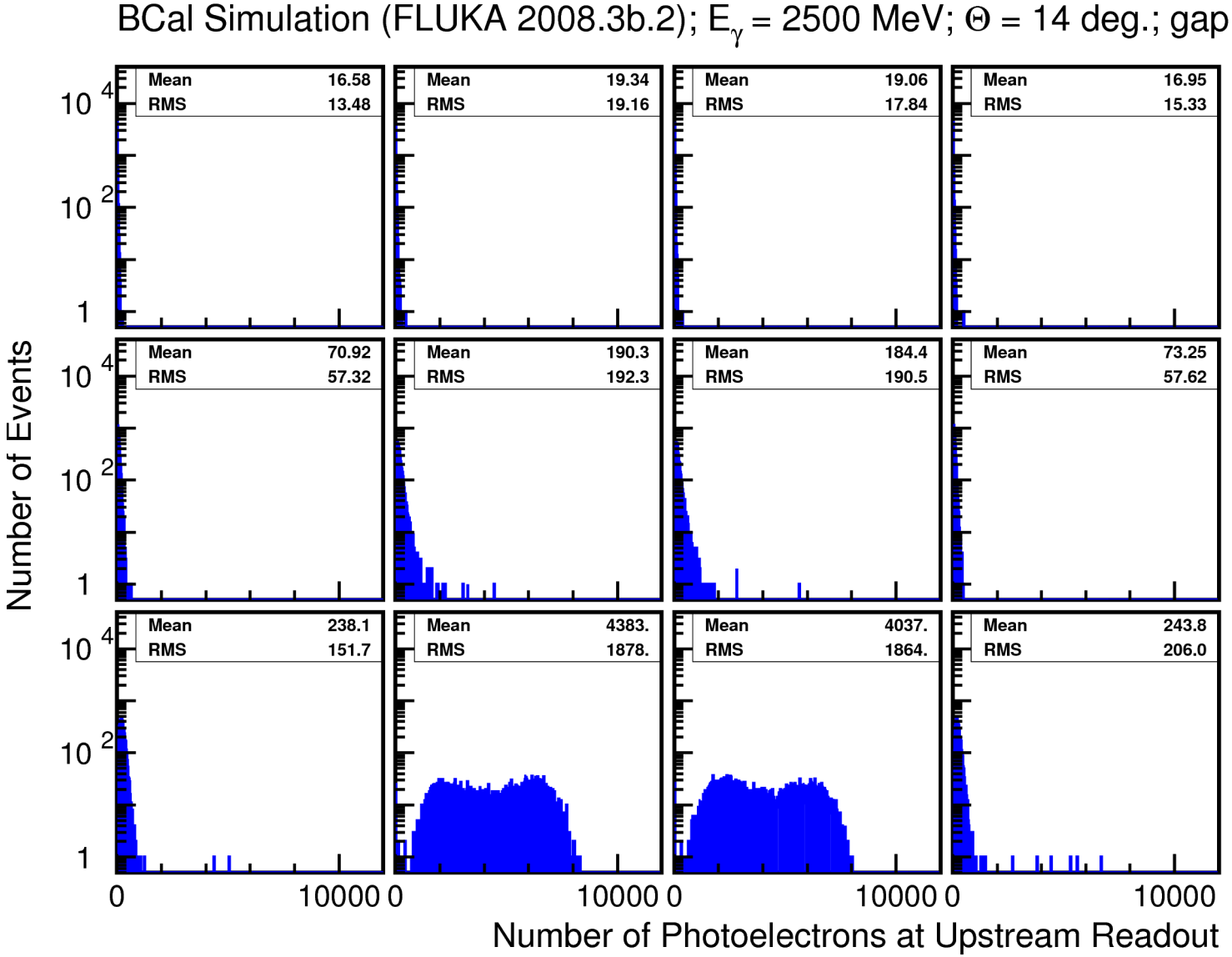
“gap”: middle-of-the-module hit
(in between 2 readout segments)

“center”: hit in the center of readout segment
(about 1 cm shift from “gap” hit position)

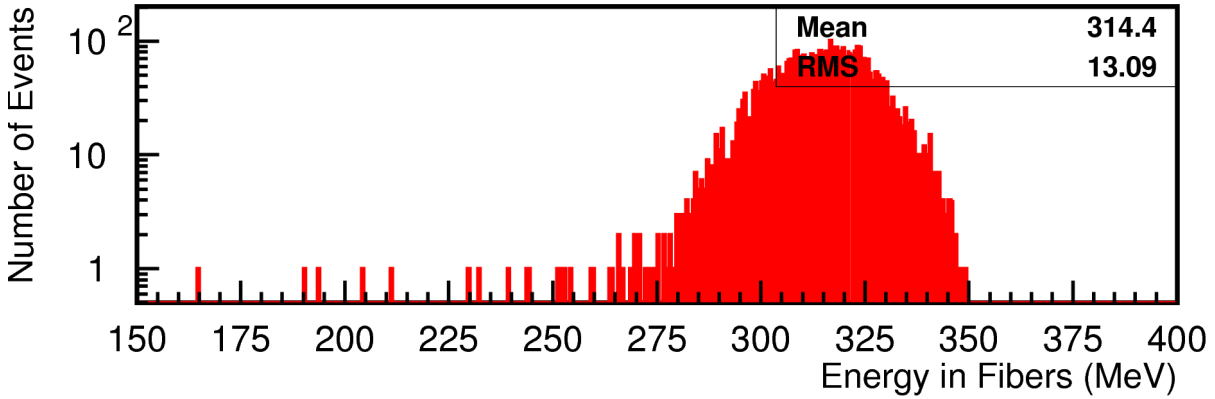

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; gap
Mean 0.4292
RMS 0.3733
Mean 0.5099
RMS 0.5363
Mean 0.5016
RMS 0.5005
Mean 0.4392
RMS 0.4225
Mean 1.900
RMS 1.543
Mean 5.136
RMS 5.334
Mean 5.001
RMS 5.306
Mean 1.964
RMS 1.545
Mean 6.227
RMS 3.888
Mean 112.0
RMS 47.65
Mean 103.2
RMS 47.27
Mean 6.368
RMS 5.261
Number of Events
Energy in Fibers Attenuated to Downstream Readout (MeV)

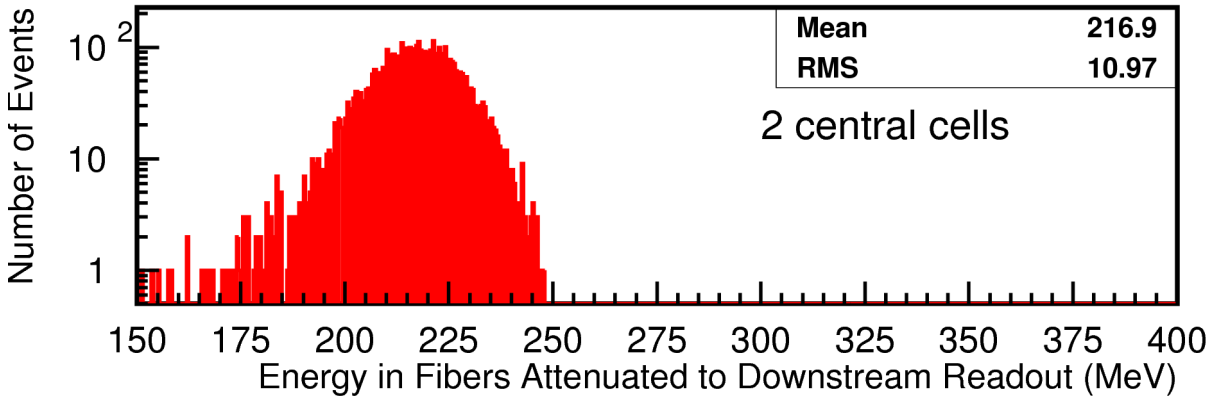

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; gap
Mean 0.3305
RMS 0.1553
Mean 0.3563
RMS 0.2350
Mean 0.3539
RMS 0.2124
Mean 0.3352
RMS 0.1831
Mean 1.005
RMS 0.7967
Mean 2.667
RMS 2.689
Mean 2.590
RMS 2.672
Mean 1.034
RMS 0.8035
Mean 3.338
RMS 2.108
Mean 61.50
RMS 26.33
Mean 56.63
RMS 26.13
Mean 3.419
RMS 2.872
Number of Events
Energy in Fibers Attenuated to Upstream Readout (MeV)

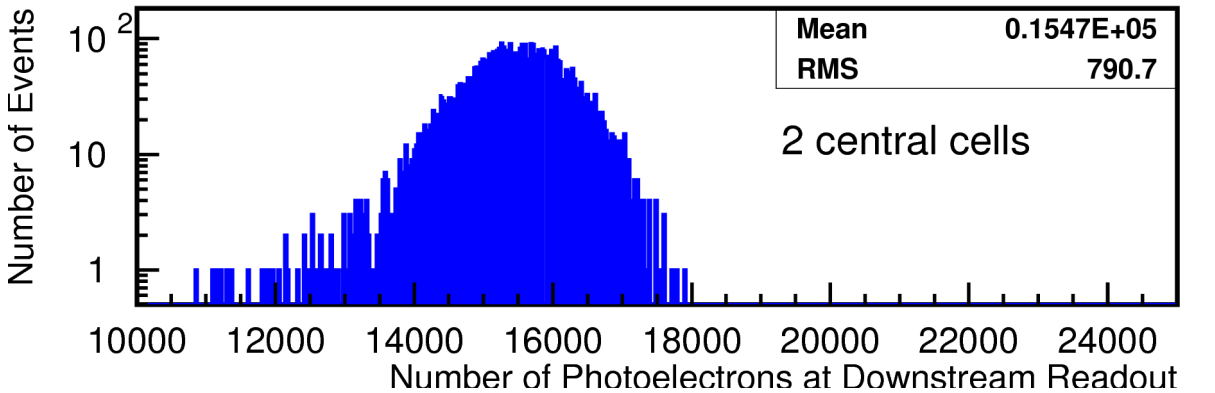

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; gap
Mean 33.07
RMS 25.54
Mean 38.68
RMS 38.04
Mean 37.96
RMS 35.30
Mean 33.90
RMS 29.36
Mean 136.1
RMS 110.8
Mean 366.9
RMS 381.9
Mean 356.2
RMS 377.9
Mean 140.0
RMS 111.0
Mean 443.8
RMS 279.6
Mean 7982.
RMS 3398.
Mean 7358.
RMS 3372.
Mean 454.1
RMS 375.4
Number of Events
Number of Photoelectrons at Downstream Readout
0
20000
1
10^2
10^4

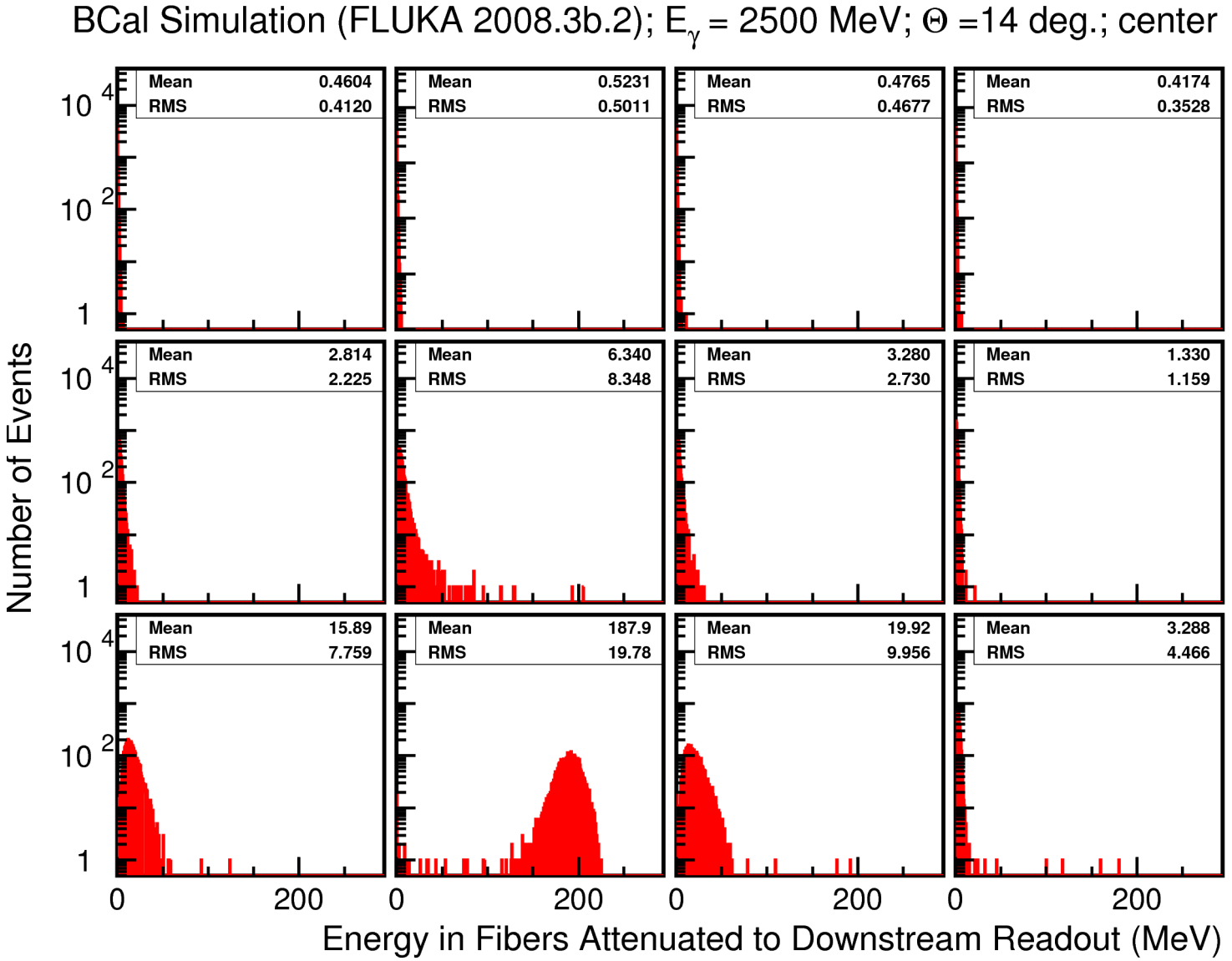

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; gap
Mean 16.58
RMS 13.48
Mean 19.34
RMS 19.16
Mean 19.06
RMS 17.84
Mean 16.95
RMS 15.33
Mean 70.92
RMS 57.32
Mean 190.3
RMS 192.3
Mean 184.4
RMS 190.5
Mean 73.25
RMS 57.62
Mean 238.1
RMS 151.7
Mean 4383.
RMS 1878.
Mean 4037.
RMS 1864.
Mean 243.8
RMS 206.0
Number of Events
Number of Photoelectrons at Upstream Readout

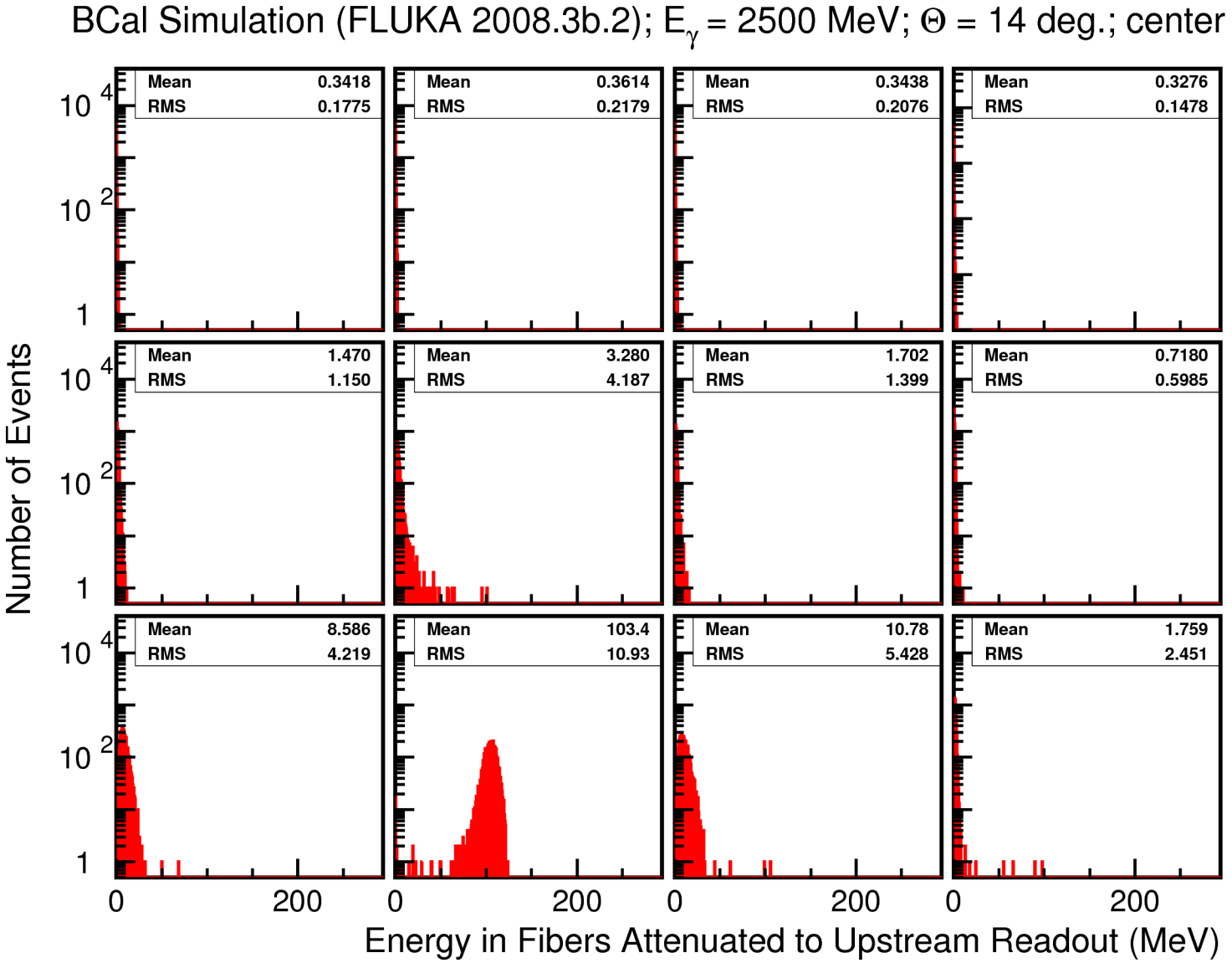
BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; gap

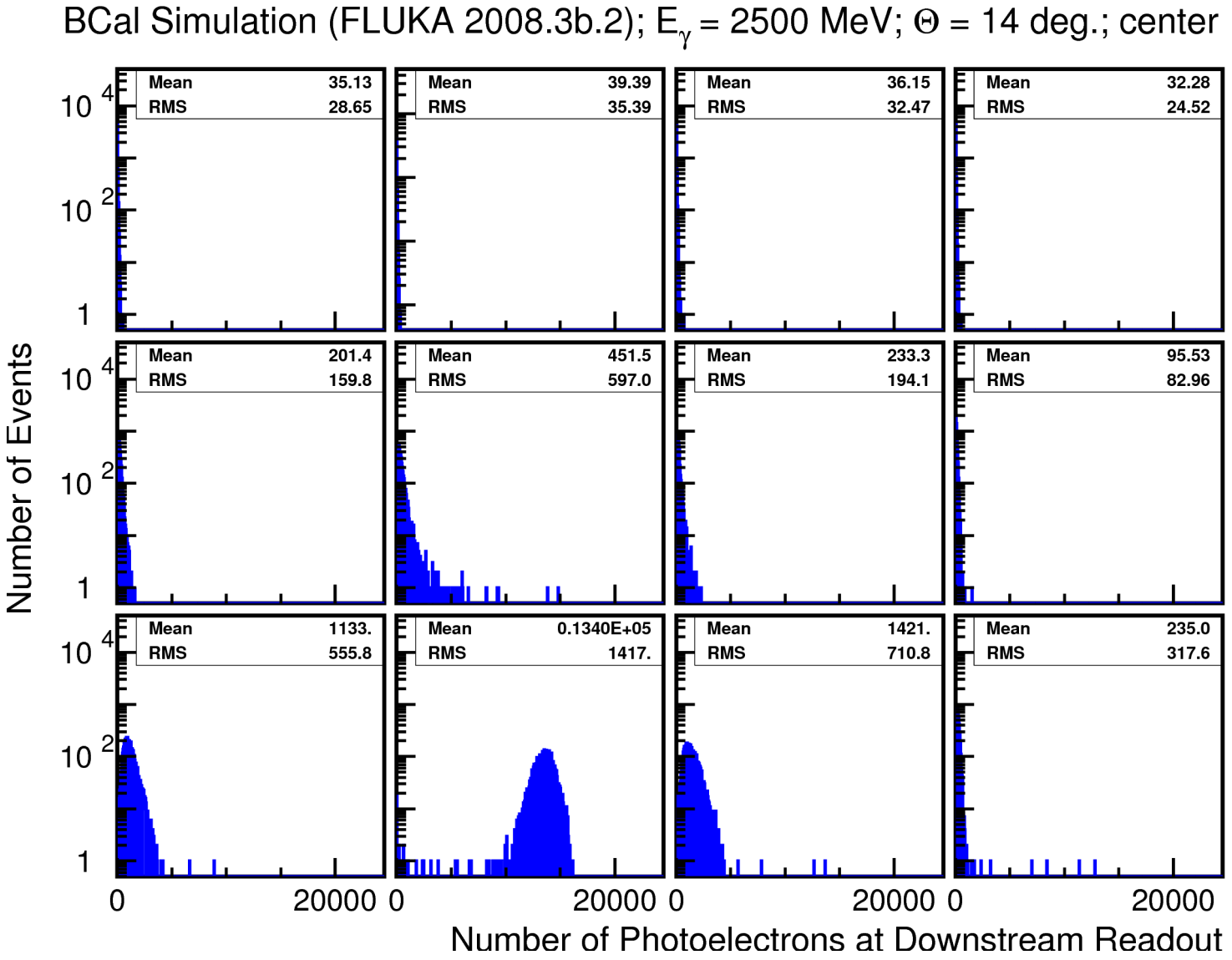




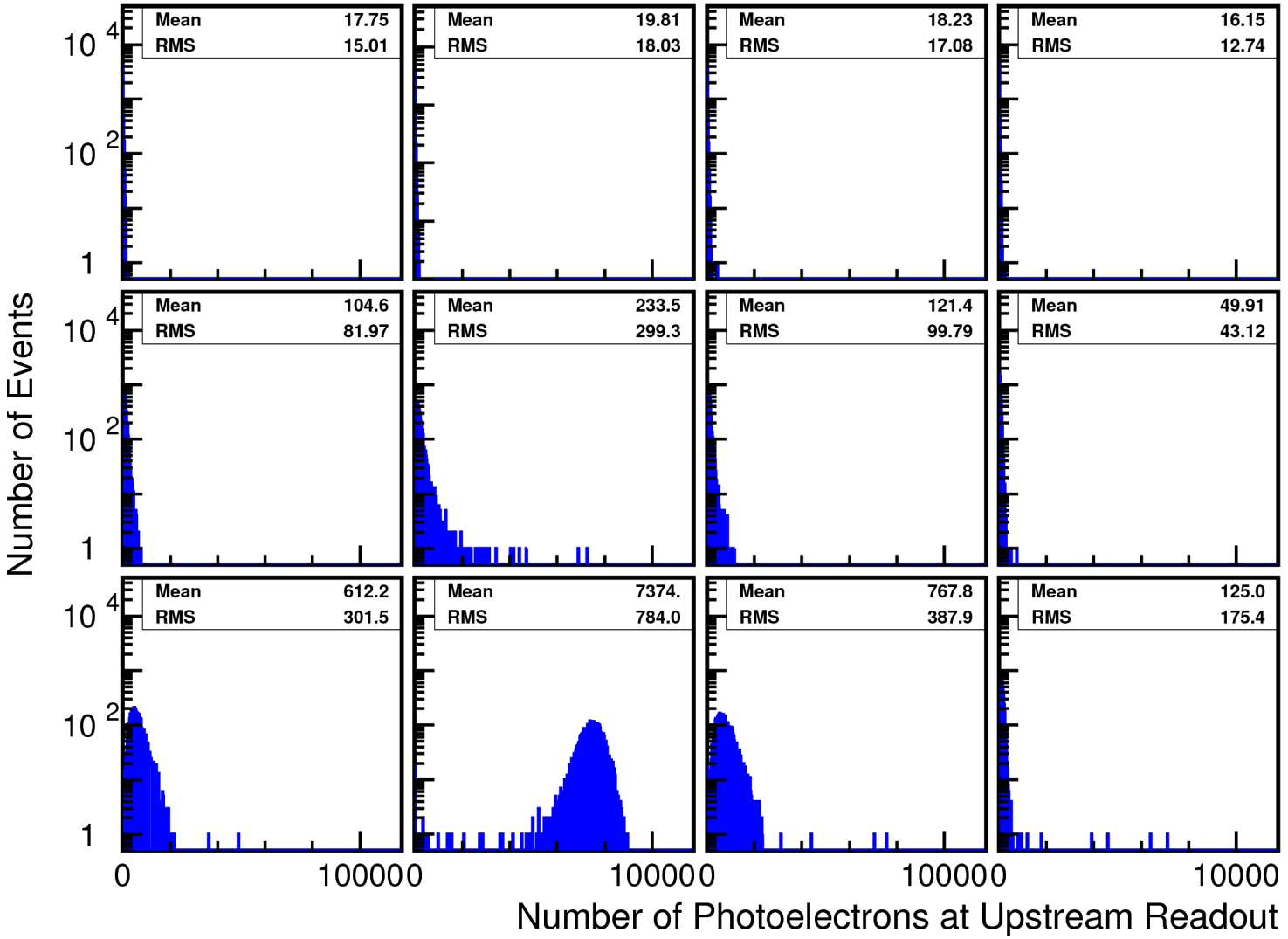



BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ =14 deg.; center
Mean 0.4604
RMS 0.4120
Mean 0.5231
RMS 0.5011
Mean 0.4765
RMS 0.4677
Mean 0.4174
RMS 0.3528
Mean 2.814
RMS 2.225
Mean 6.340
RMS 8.348
Mean 3.280
RMS 2.730
Mean 1.330
RMS 1.159
Mean 15.89
RMS 7.759
Mean 187.9
RMS 19.78
Mean 19.92
RMS 9.956
Mean 3.288
RMS 4.466
Number of Events
Energy in Fibers Attenuated to Downstream Readout (MeV)


BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; center
Mean 0.3418
RMS 0.1775
Mean 0.3614
RMS 0.2179
Mean 0.3438
RMS 0.2076
Mean 0.3276
RMS 0.1478
Mean 1.470
RMS 1.150
Mean 3.280
RMS 4.187
Mean 1.702
RMS 1.399
Mean 0.7180
RMS 0.5985
Mean 8.586
RMS 4.219
Mean 103.4
RMS 10.93
Mean 10.78
RMS 5.428
Mean 1.759
RMS 2.451
Number of Events
Energy in Fibers Attenuated to Upstream Readout (MeV)

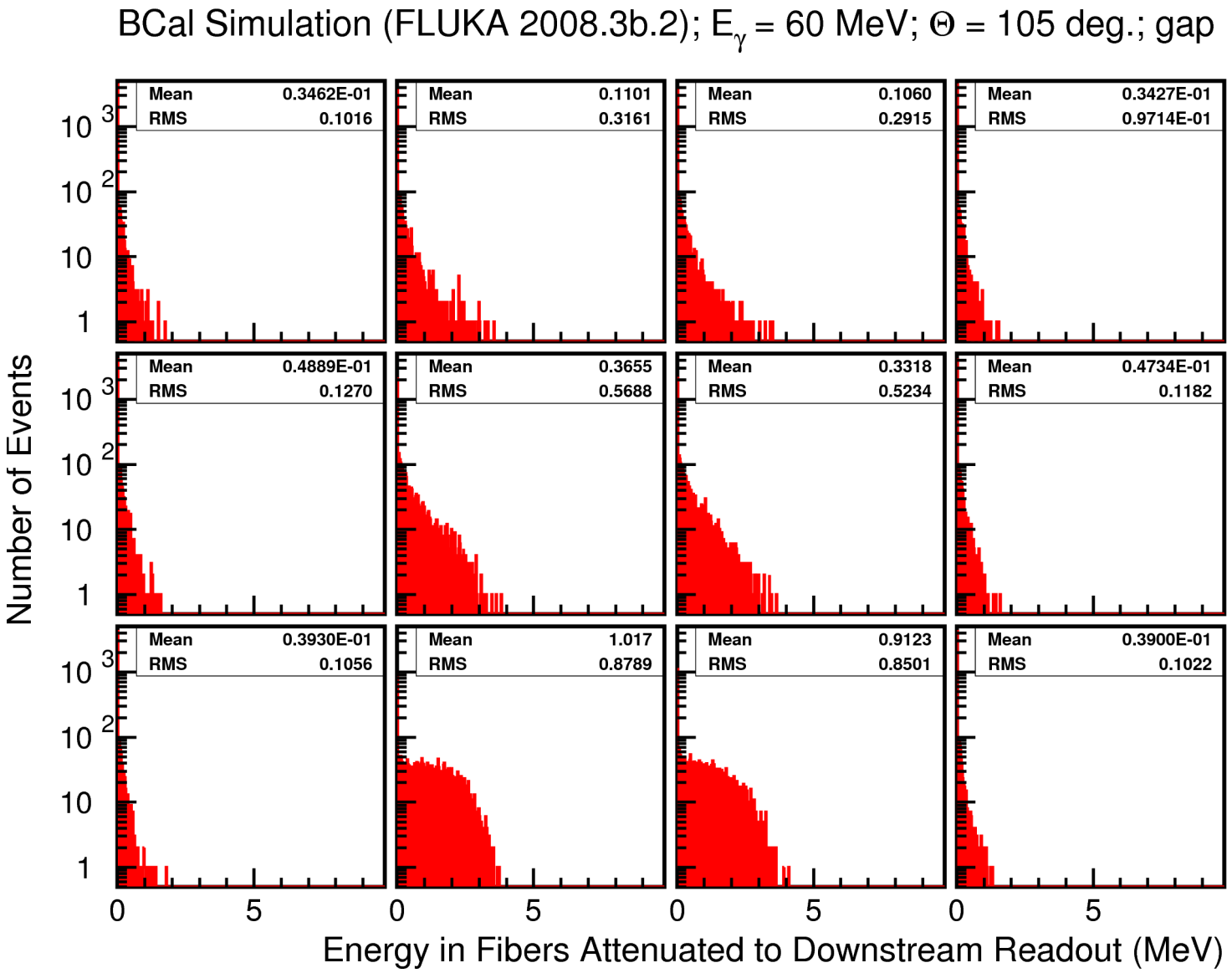

BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; center
Mean 35.13
RMS 28.65
Mean 39.39
RMS 35.39
Mean 36.15
RMS 32.47
Mean 32.28
RMS 24.52
Mean 201.4
RMS 159.8
Mean 451.5
RMS 597.0
Mean 233.3
RMS 194.1
Mean 95.53
RMS 82.96
Mean 1133.
RMS 555.8
Mean 0.1340E+05
RMS 1417.
Mean 1421.
RMS 710.8
Mean 235.0
RMS 317.6
Number of Events
10 4
10 2
1
0
20000
Number of Photoelectrons at Downstream Readout

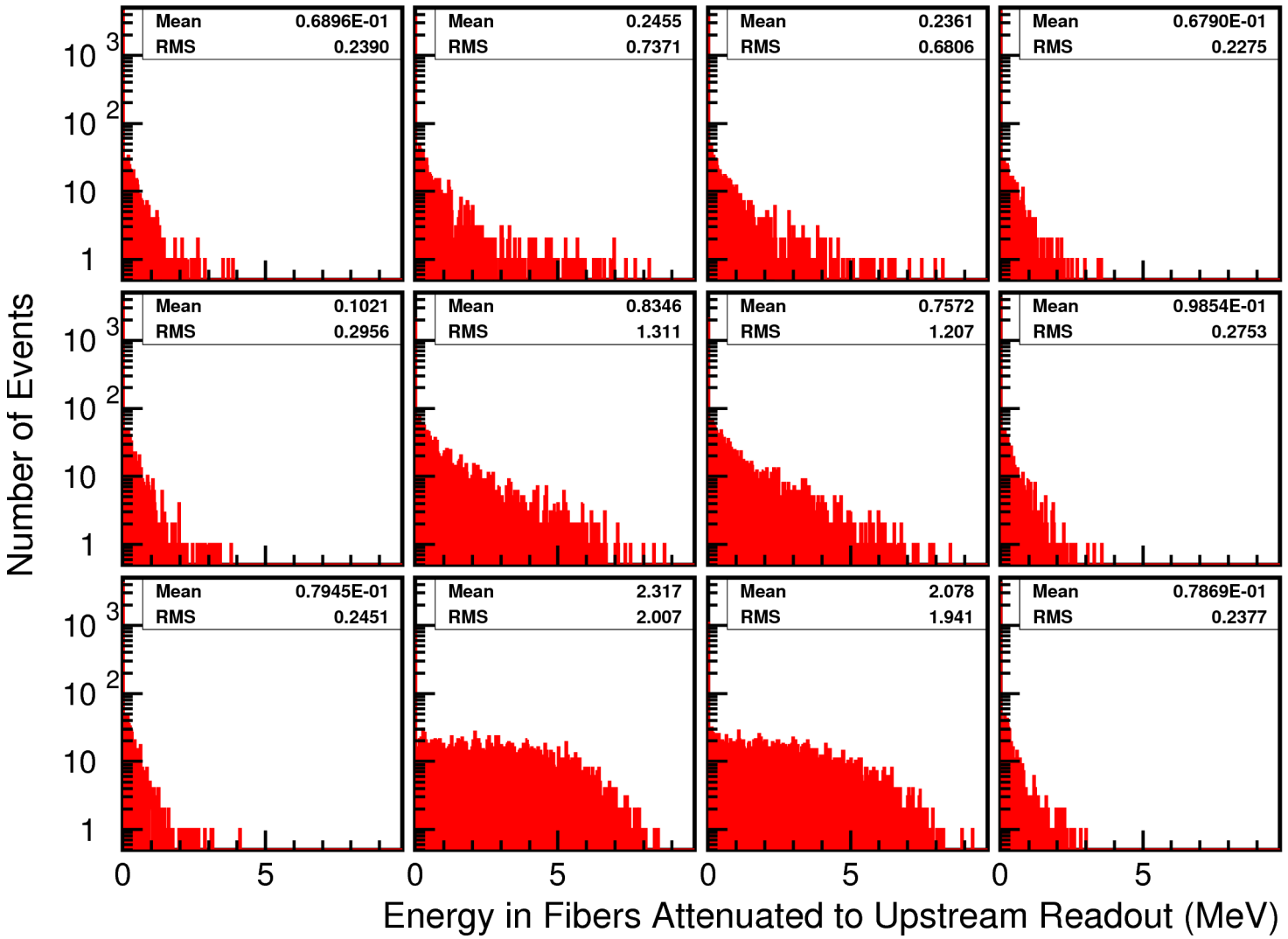
BCal Simulation (FLUKA 2008.3b.2); E_γ = 2500 MeV; Θ = 14 deg.; center

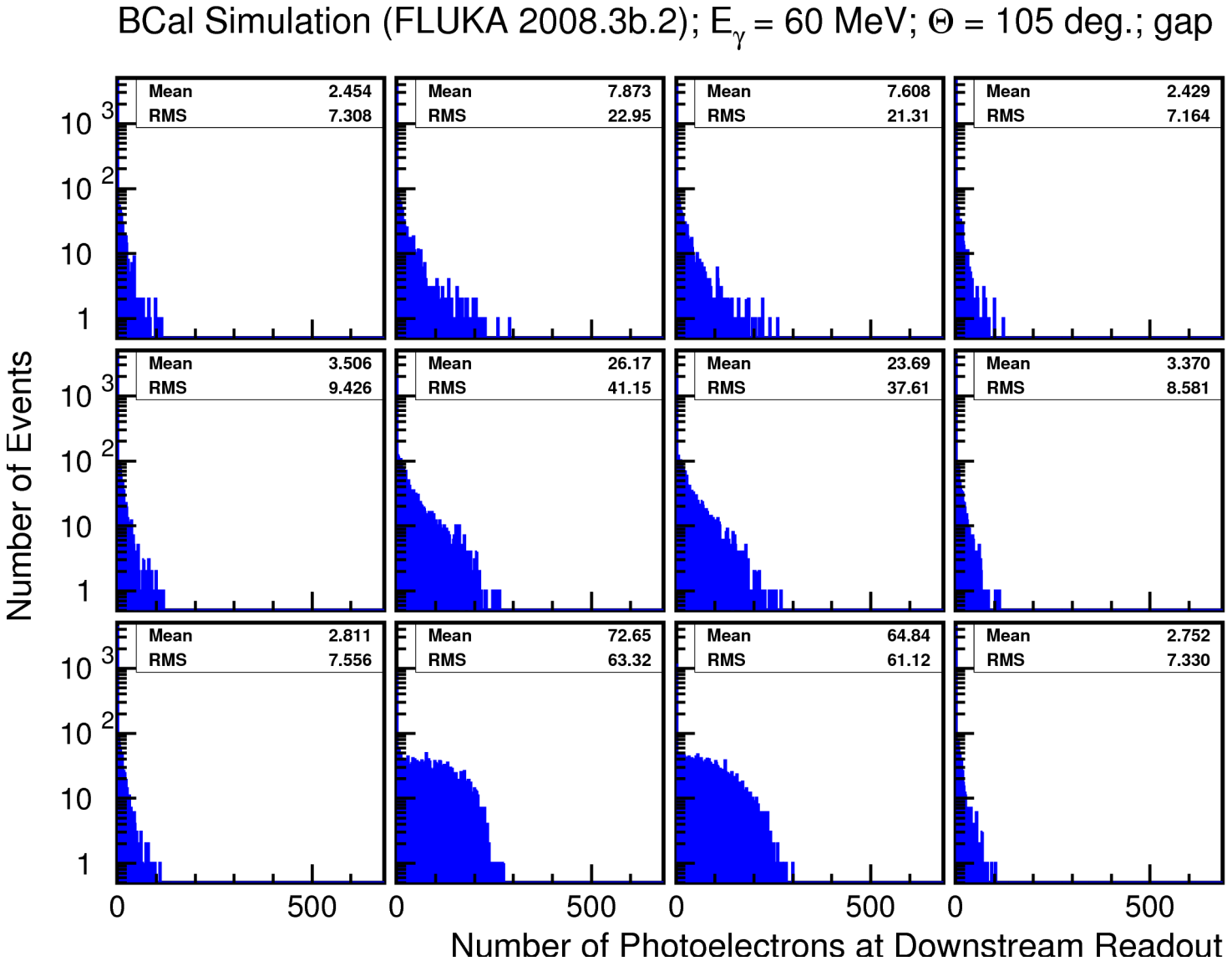


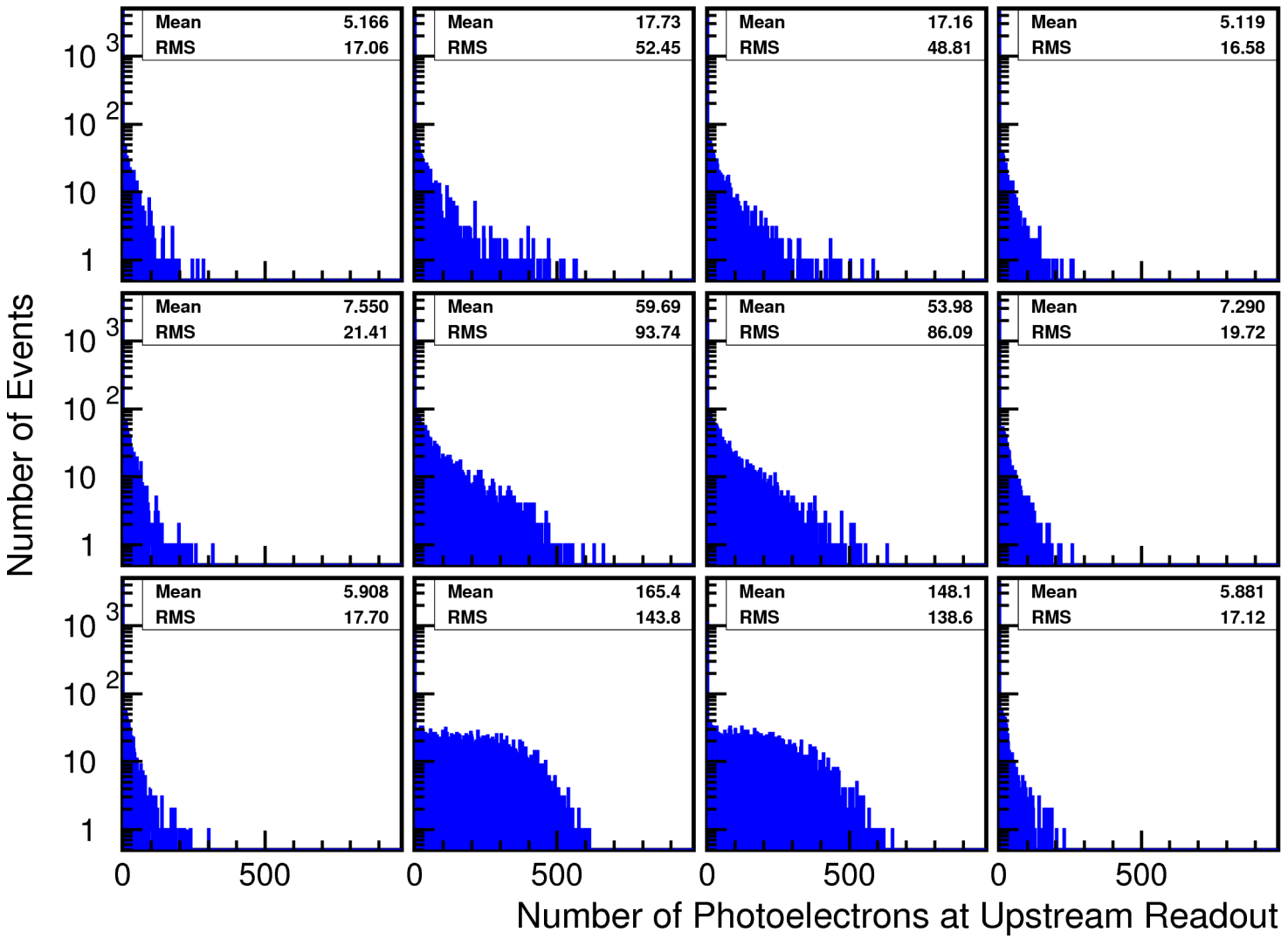
60-MeV/c photons at Θ=105 degrees
(hit BCAL at about 30 cm from upstream readout)

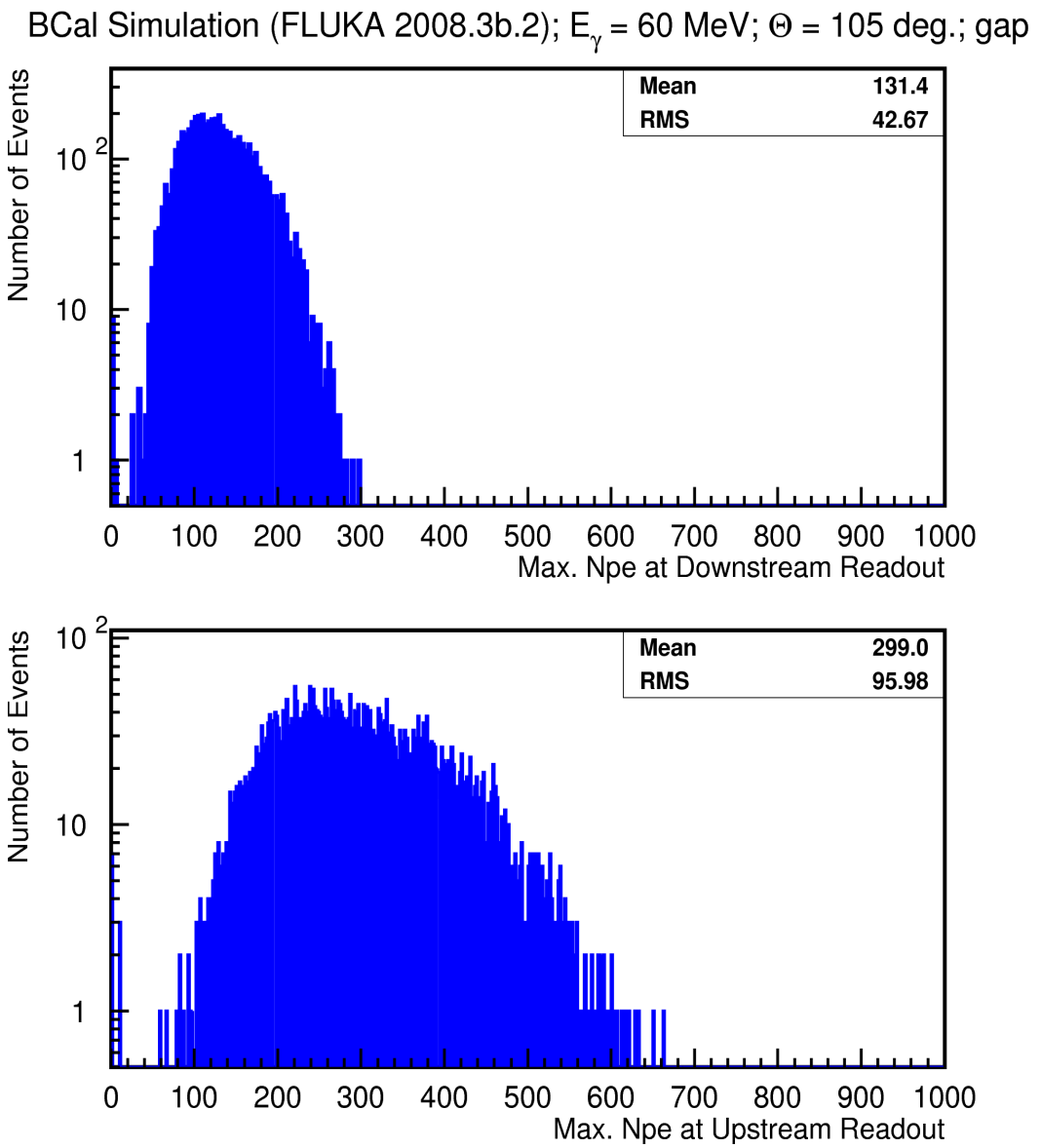
“gap”: middle-of-the-module hit
(in between 2 readout segments)


BCal Simulation (FLUKA 2008.3b.2); E_γ = 60 MeV; Θ = 105 deg.; gap
Mean 0.3462E-01
RMS 0.1016
Mean 0.1101
RMS 0.3161
Mean 0.1060
RMS 0.2915
Mean 0.3427E-01
RMS 0.9714E-01
Mean 0.4889E-01
RMS 0.1270
Mean 0.3655
RMS 0.5688
Mean 0.3318
RMS 0.5234
Mean 0.4734E-01
RMS 0.1182
Mean 0.3930E-01
RMS 0.1056
Mean 1.017
RMS 0.8789
Mean 0.9123
RMS 0.8501
Mean 0.3900E-01
RMS 0.1022
Number of Events
Energy in Fibers Attenuated to Downstream Readout (MeV)


BCal Simulation (FLUKA 2008.3b.2); E_γ =60 MeV; Θ = 105 deg.; gap
Mean 0.6896E-01
RMS 0.2390
Mean 0.2455
RMS 0.7371
Mean 0.2361
RMS 0.6806
Mean 0.6790E-01
RMS 0.2275
Mean 0.1021
RMS 0.2956
Mean 0.8346
RMS 1.311
Mean 0.7572
RMS 1.207
Mean 0.9854E-01
RMS 0.2753
Mean 0.7945E-01
RMS 0.2451
Mean 2.317
RMS 2.007
Mean 2.078
RMS 1.941
Mean 0.7869E-01
RMS 0.2377
Number of Events
Energy in Fibers Attenuated to Upstream Readout (MeV)


BCal Simulation (FLUKA 2008.3b.2); E_γ = 60 MeV; Θ = 105 deg.; gap
Mean 2.454
RMS 7.308
Mean 7.873
RMS 22.95
Mean 7.608
RMS 21.31
Mean 2.429
RMS 7.164
Mean 3.506
RMS 9.426
Mean 26.17
RMS 41.15
Mean 23.69
RMS 37.61
Mean 3.370
RMS 8.581
Mean 2.811
RMS 7.556
Mean 72.65
RMS 63.32
Mean 64.84
RMS 61.12
Mean 2.752
RMS 7.330
Number of Events
Number of Photoelectrons at Downstream Readout
0
500
1
10
10^2
10^3

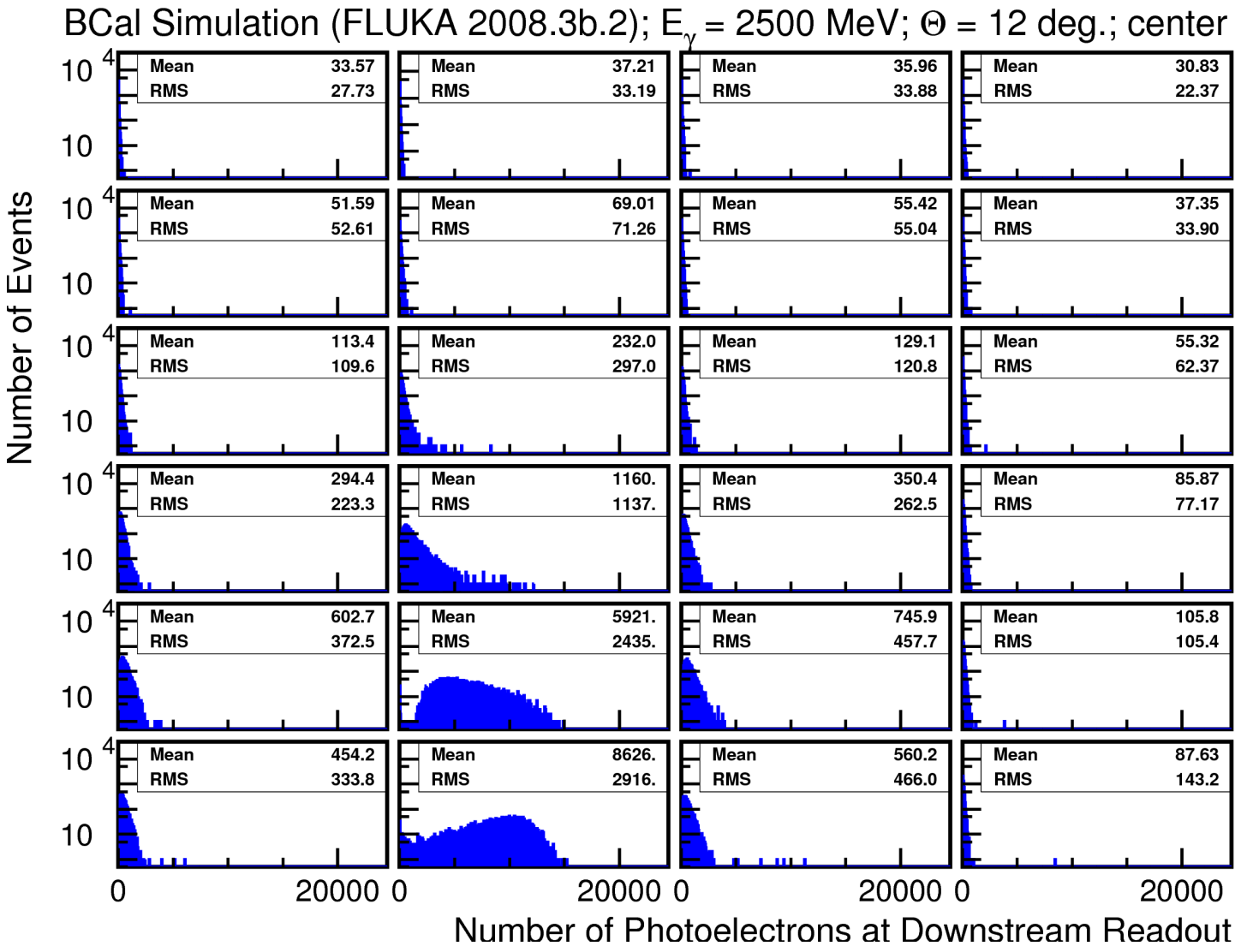

BCal Simulation (FLUKA 2008.3b.2); E_γ = 60 MeV; Θ = 105 deg.; gap
Mean 5.166
RMS 17.06
Mean 17.73
RMS 52.45
Mean 17.16
RMS 48.81
Mean 5.119
RMS 16.58
Mean 7.550
RMS 21.41
Mean 59.69
RMS 93.74
Mean 53.98
RMS 86.09
Mean 7.290
RMS 19.72
Mean 5.908
RMS 17.70
Mean 165.4
RMS 143.8
Mean 148.1
RMS 138.6
Mean 5.881
RMS 17.12
Number of Events
Number of Photoelectrons at Upstream Readout
0
500
1
10
10^2
10^3


BCal Simulation (FLUKA 2008.3b.2); E_γ = 60 MeV; Θ = 105 deg.; gap
Mean 131.4
RMS 42.67
Number of Events
Max. Npe at Downstream Readout
Mean 299.0
RMS 95.98
Number of Events
Max. Npe at Upstream Readout

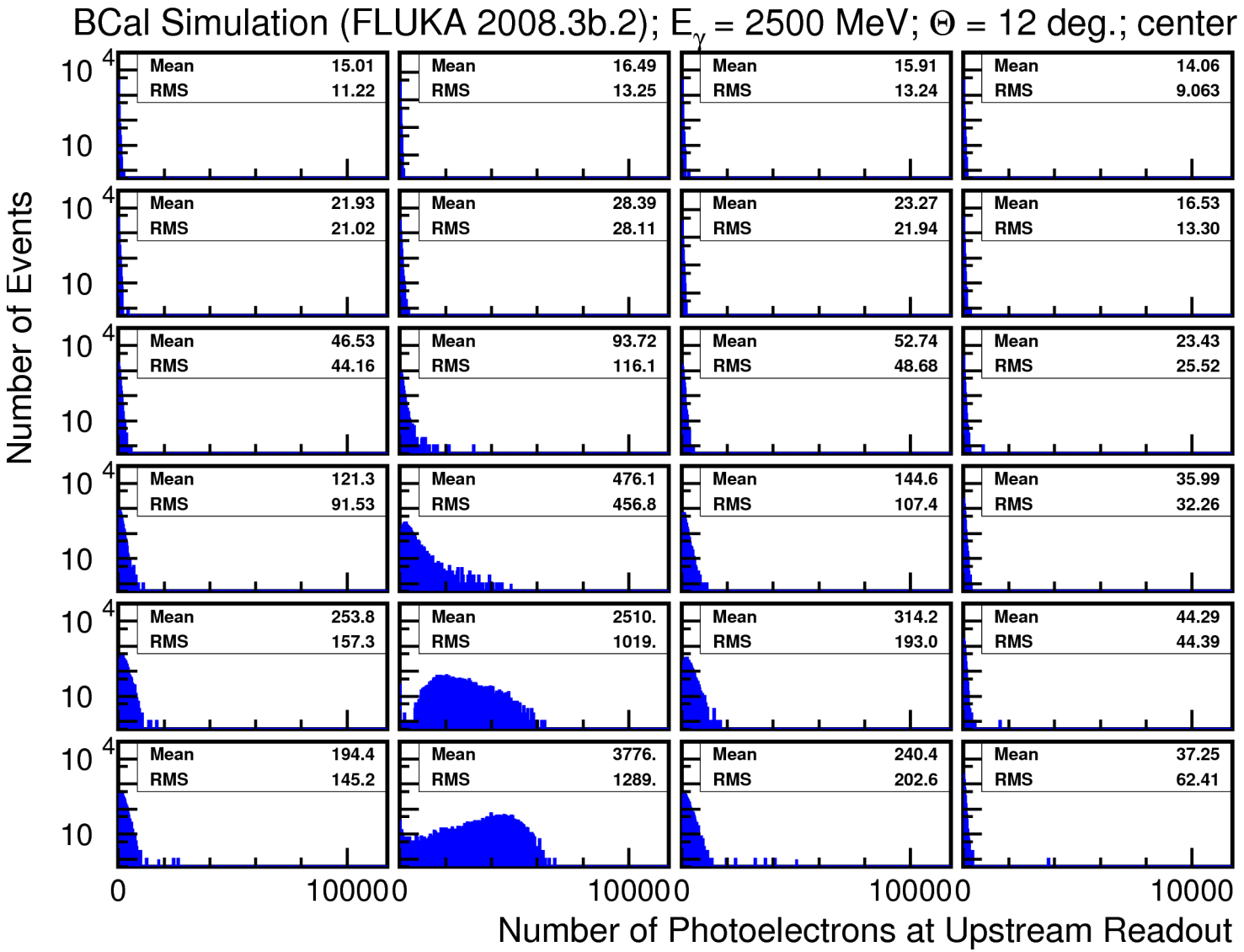
2500-MeV/c photons at Θ=12 degrees
(hit BCAL at about 30 cm from downstream readout)

2x2 cm^2 readout segments (THE NEXT SLIDES ONLY)
Only fine-segmented part of BCAL module is presented

"center": hit in the center of readout segment
(about 1 cm shift from "gap" hit position)



2x2 cm² segmentation

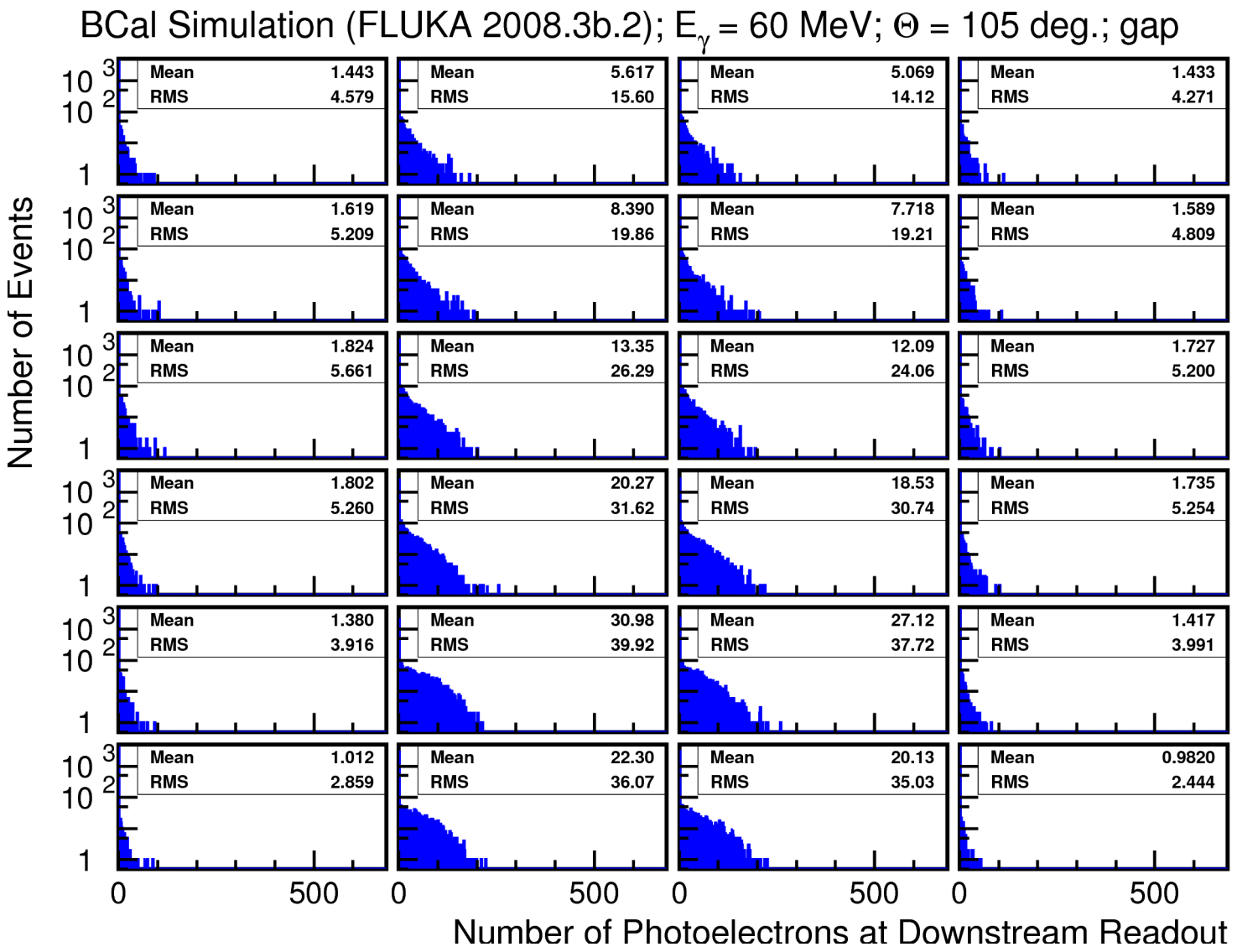


2x2 cm² segmentation

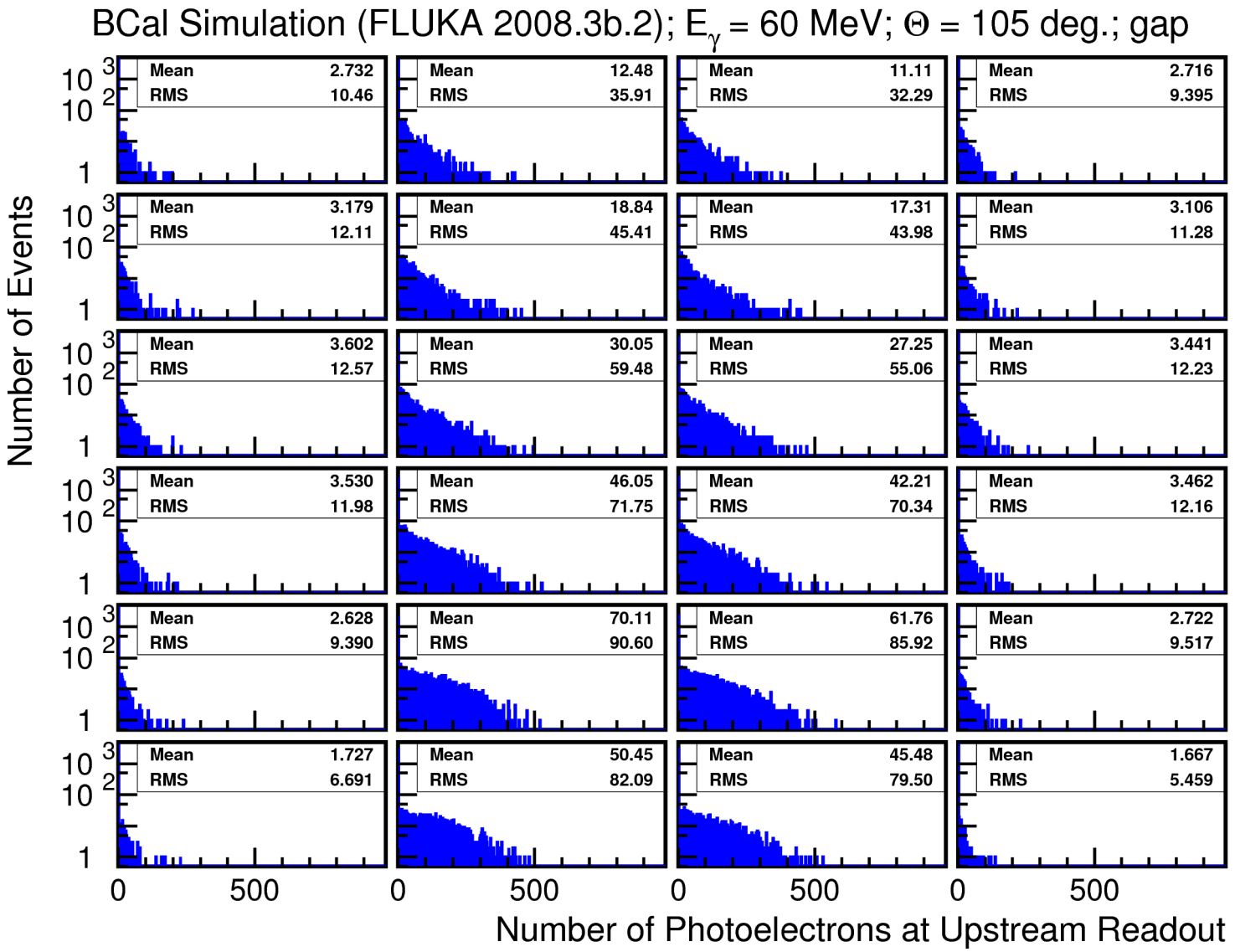
60-MeV/c photons at Θ=105 degrees
(hit BCAL at about 30 cm from upstream readout)

2x2 cm^2 readout segments (THE NEXT SLIDES ONLY)
Only fine-segmented part of BCAL module is presented

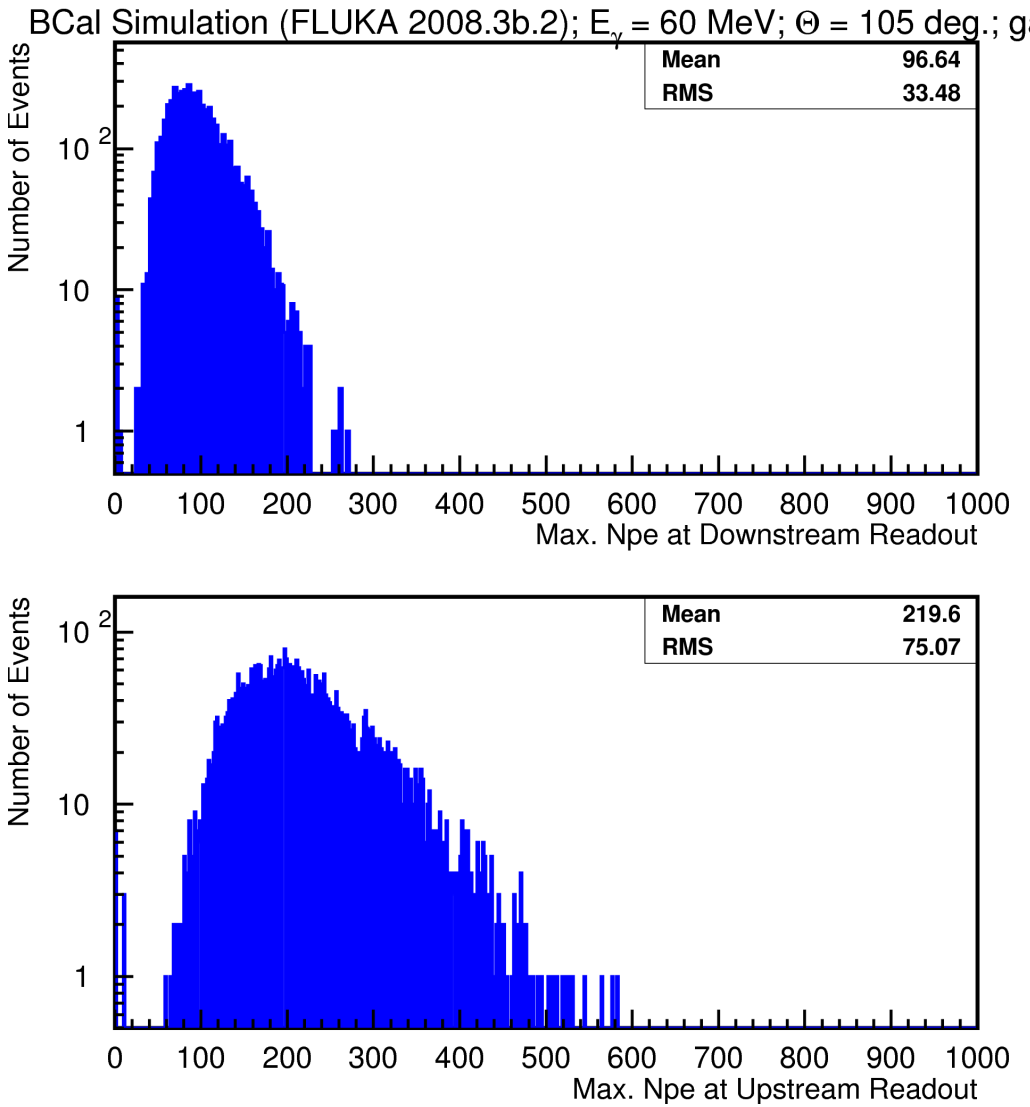
"gap": middle-of-the-module hit
(in between 2 readout segments)



2x2 cm² segmentation



2x2 cm² segmentation



2x2 cm² segmentation