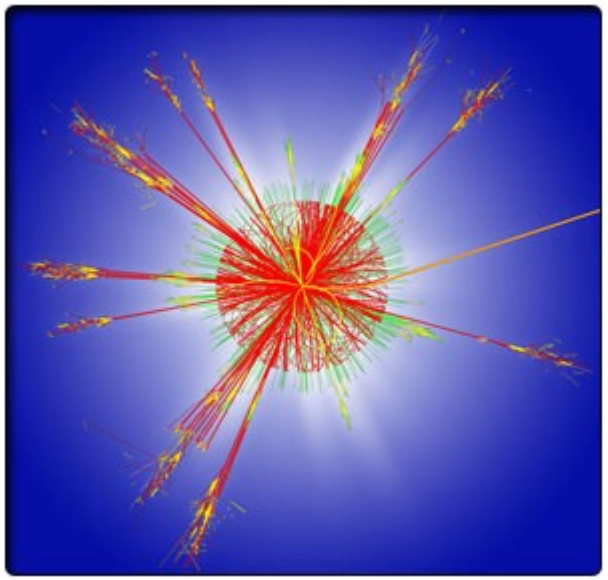
Beam-Related Background Analysis for Jet/Etmiss Physics



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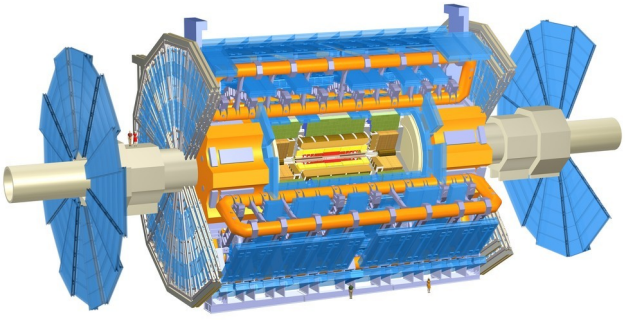
Thanks to: S. Caron, R.J. Teuscher, A.A. Nepomuceno, D. Berge, W. Kozaneck, H. Okawa

Outline



- Beam-Gas
- Single-Beam
- J1
- Jet EM fraction
- Conclusions/Future Work

Beam-Gas

Beam-Gas (Monte Carlo)

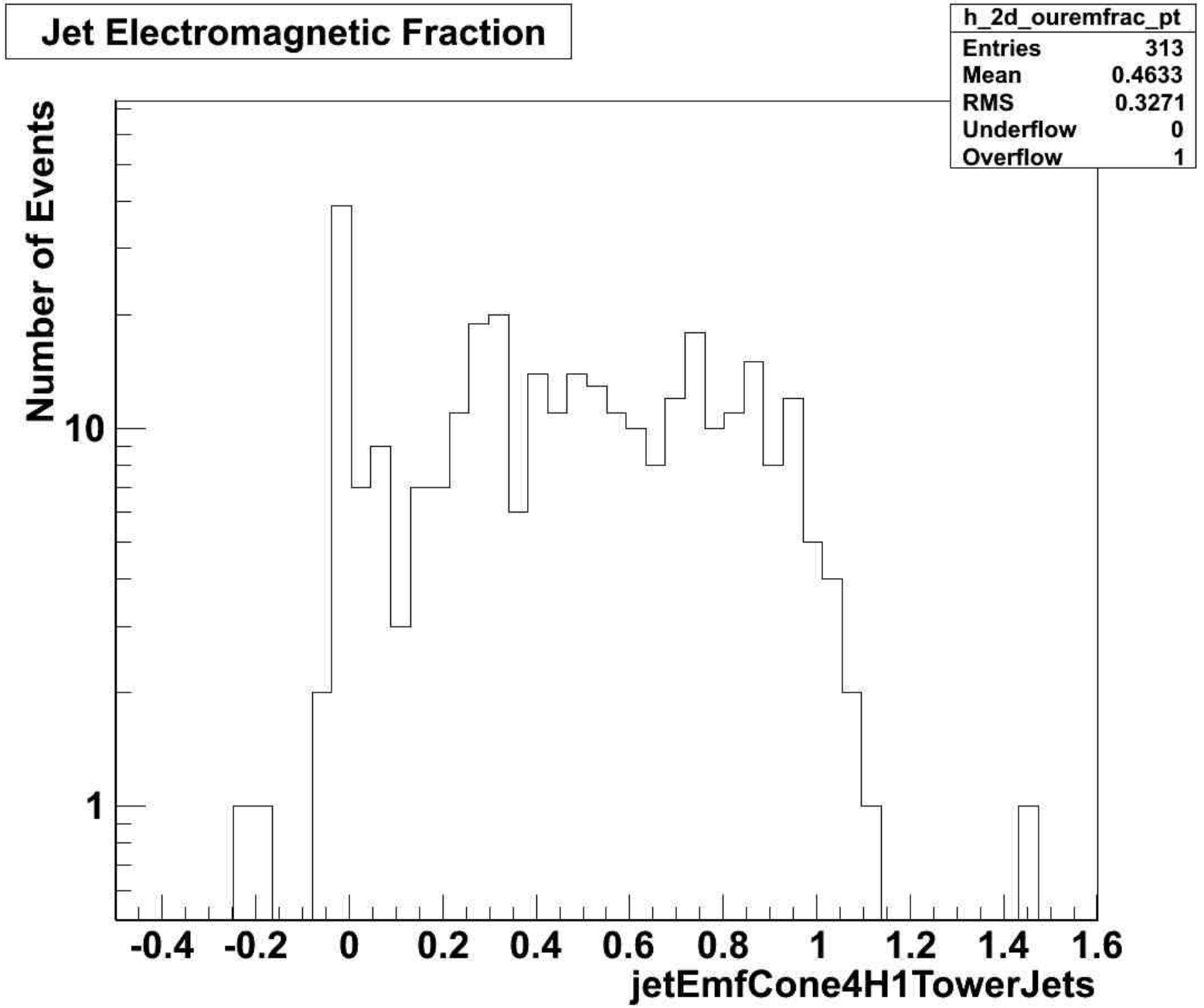
- Beam-gas interactions comprise the second term of machine-induced backgrounds (MIB).

- The quality of the Etmiss reconstruction depends strongly on the ability to reject accelerator- and detector-related backgrounds.

- We used 10 TeV collision expectancy samples (97279 events).

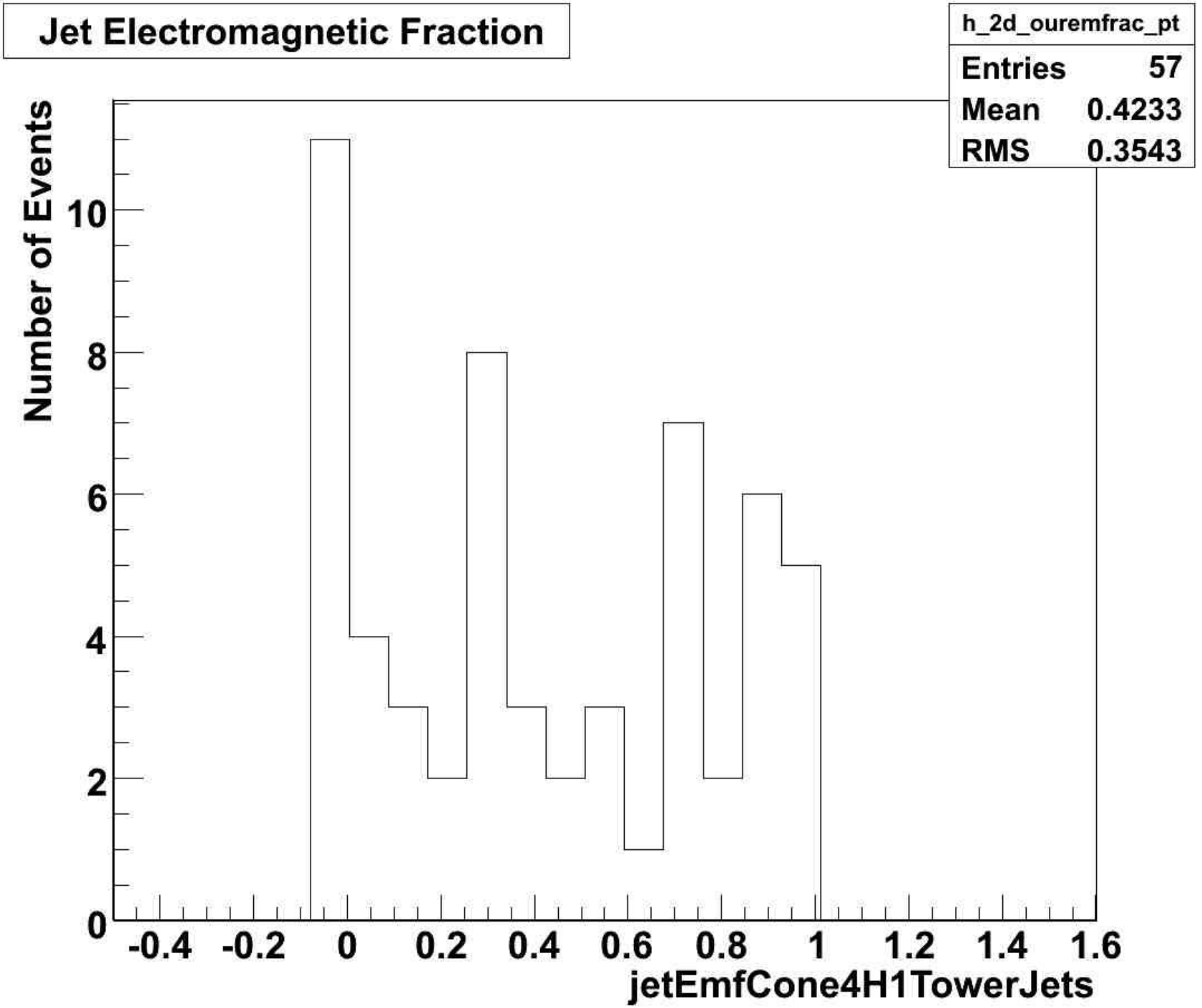
- MC simulates impact of protons on H/C/O at rest.

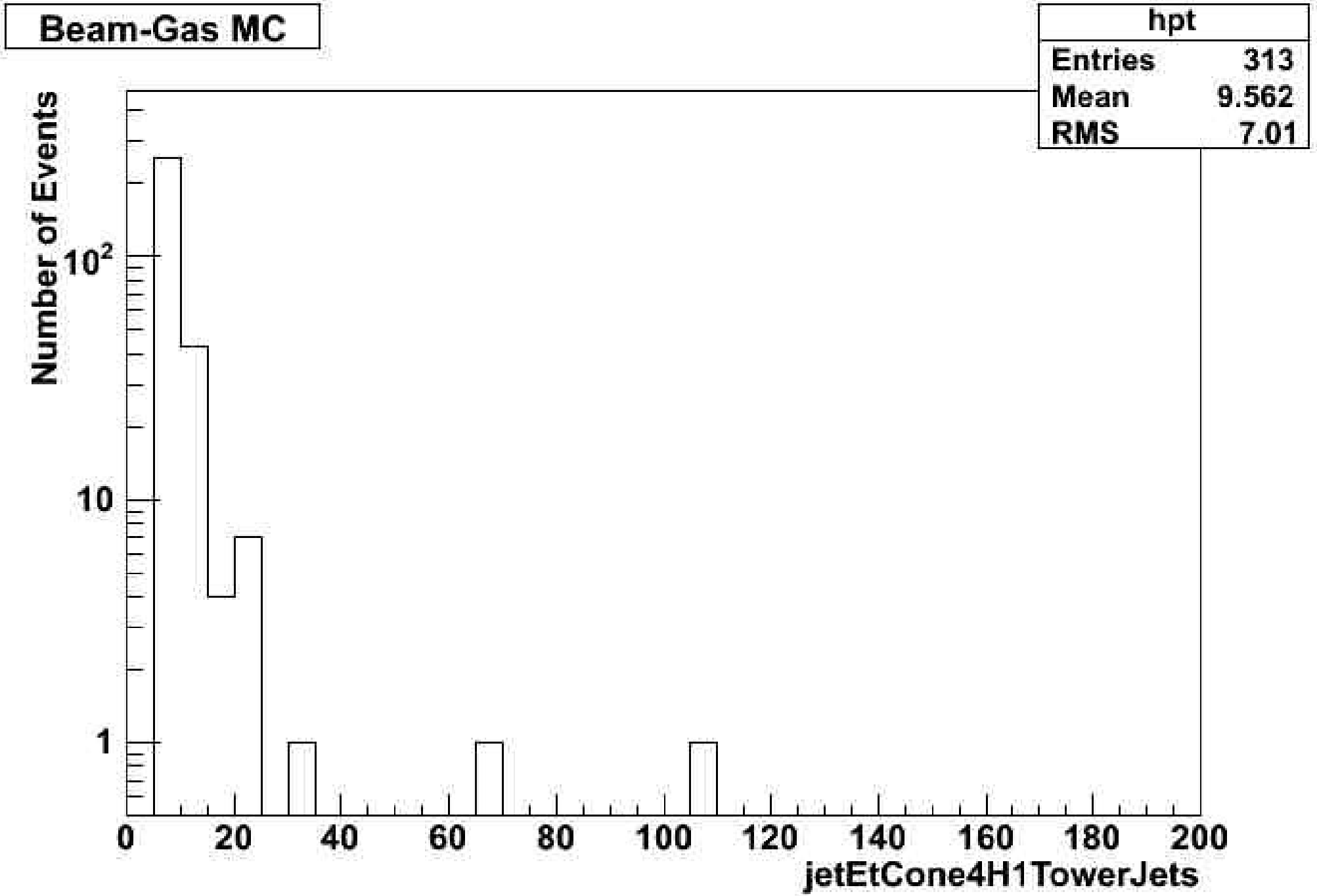
Beam-Gas MC (10 TeV)

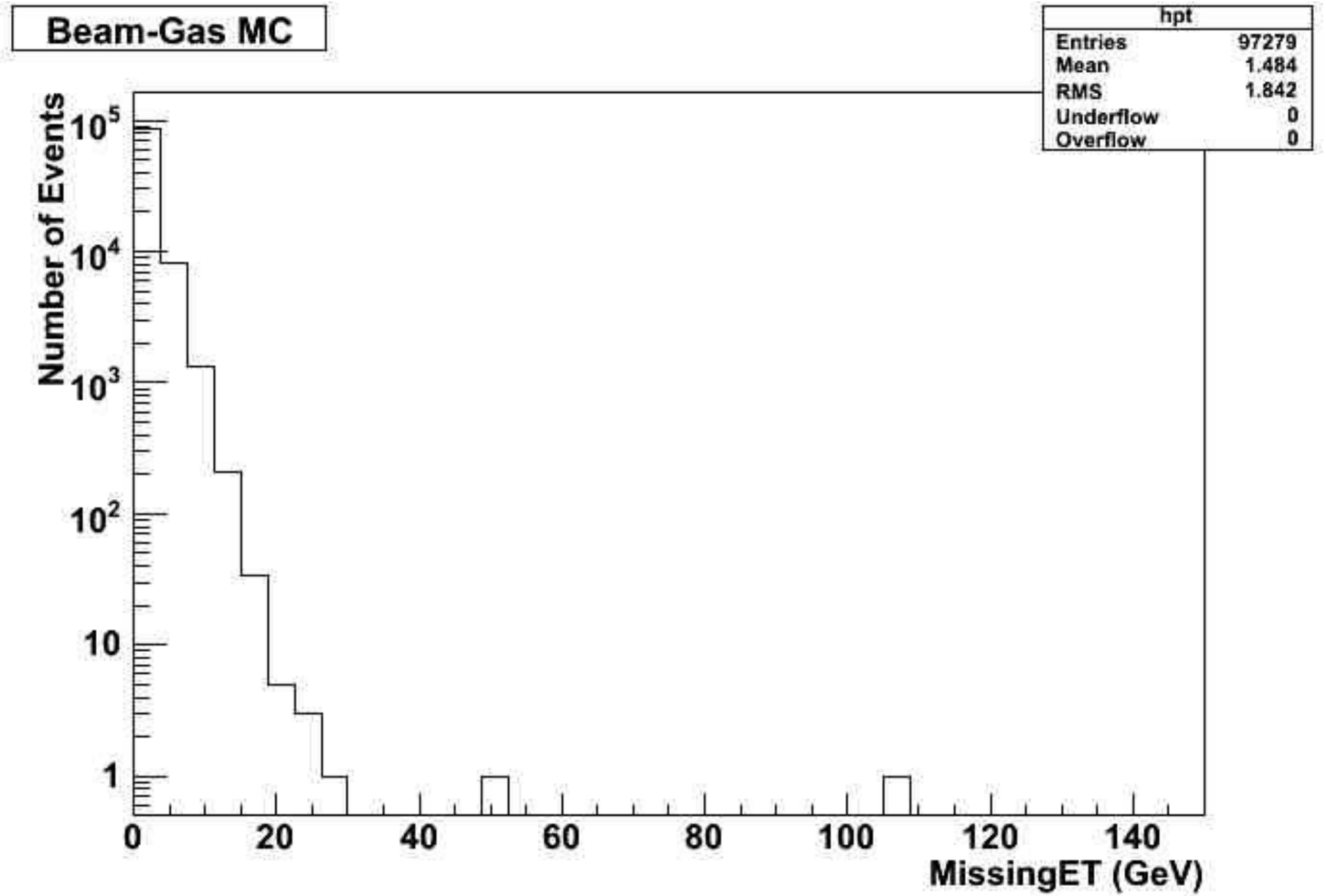


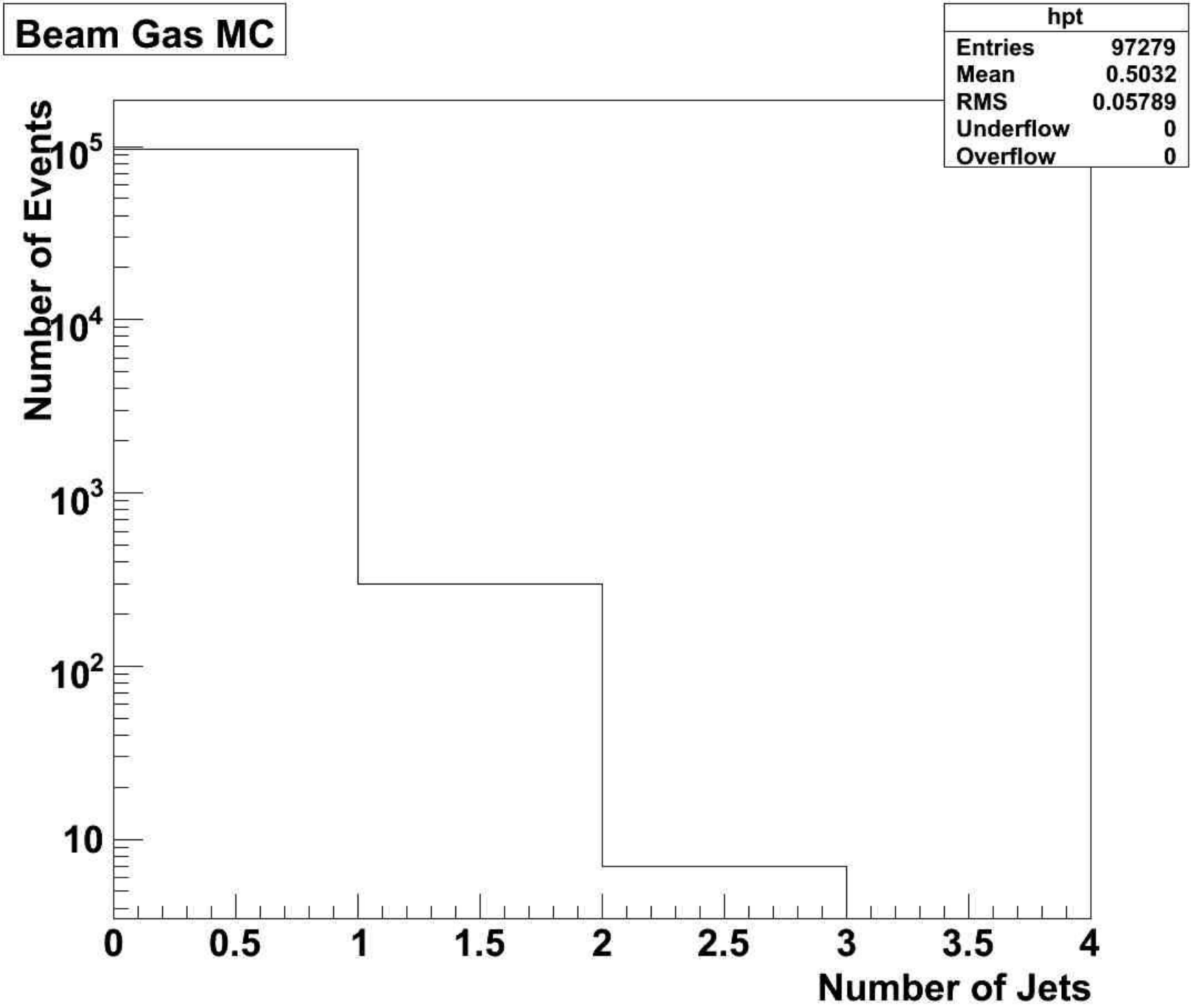
$$\text{Jet EM Fraction} = \frac{\text{(Sum of Energy Deposit in jet in EMB, EMEC)}}{\text{(Sum of Energy Deposit in jet for all layers)}}$$

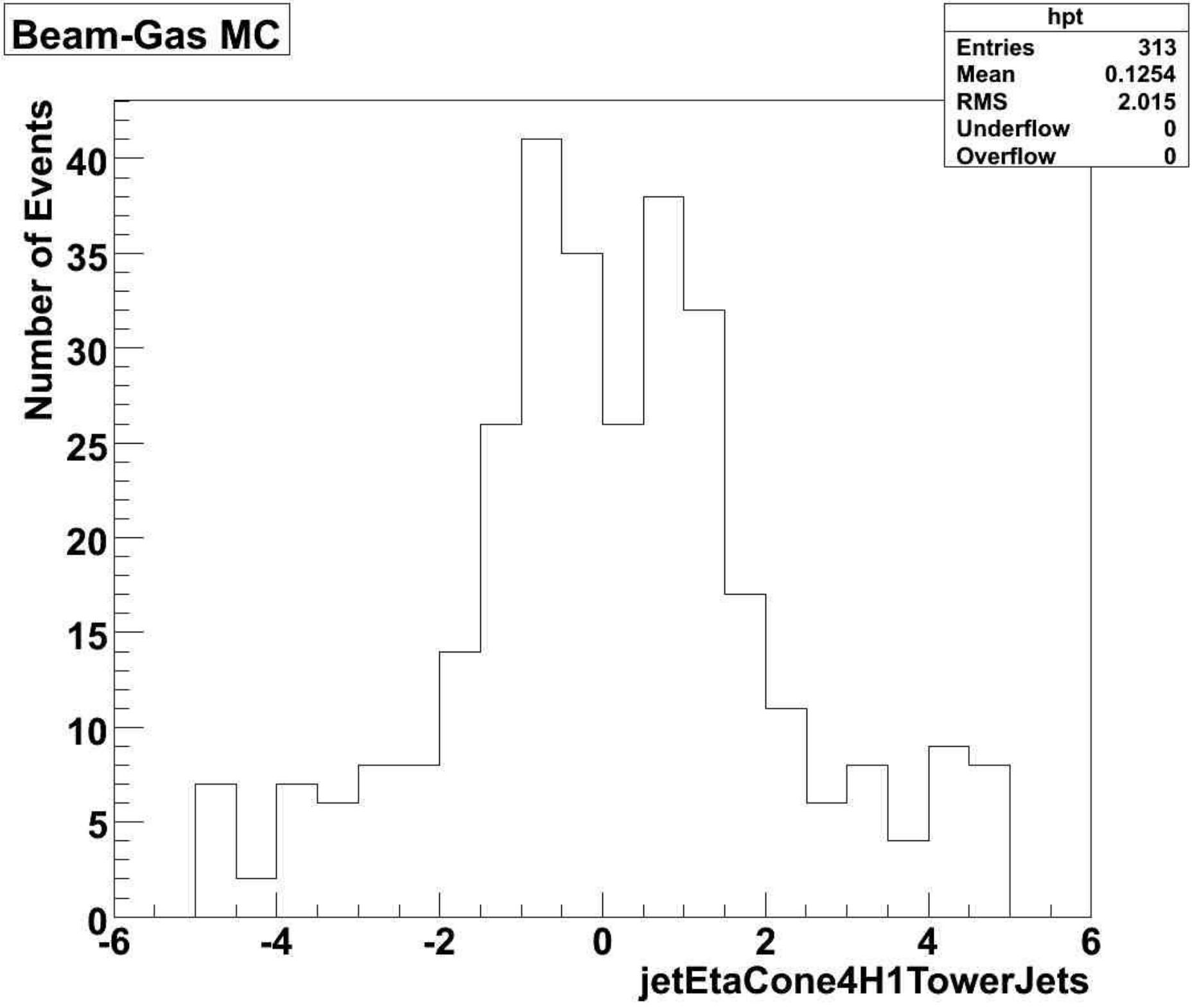
Beam-Gas MC (10 TeV, JetEt > 10 GeV)

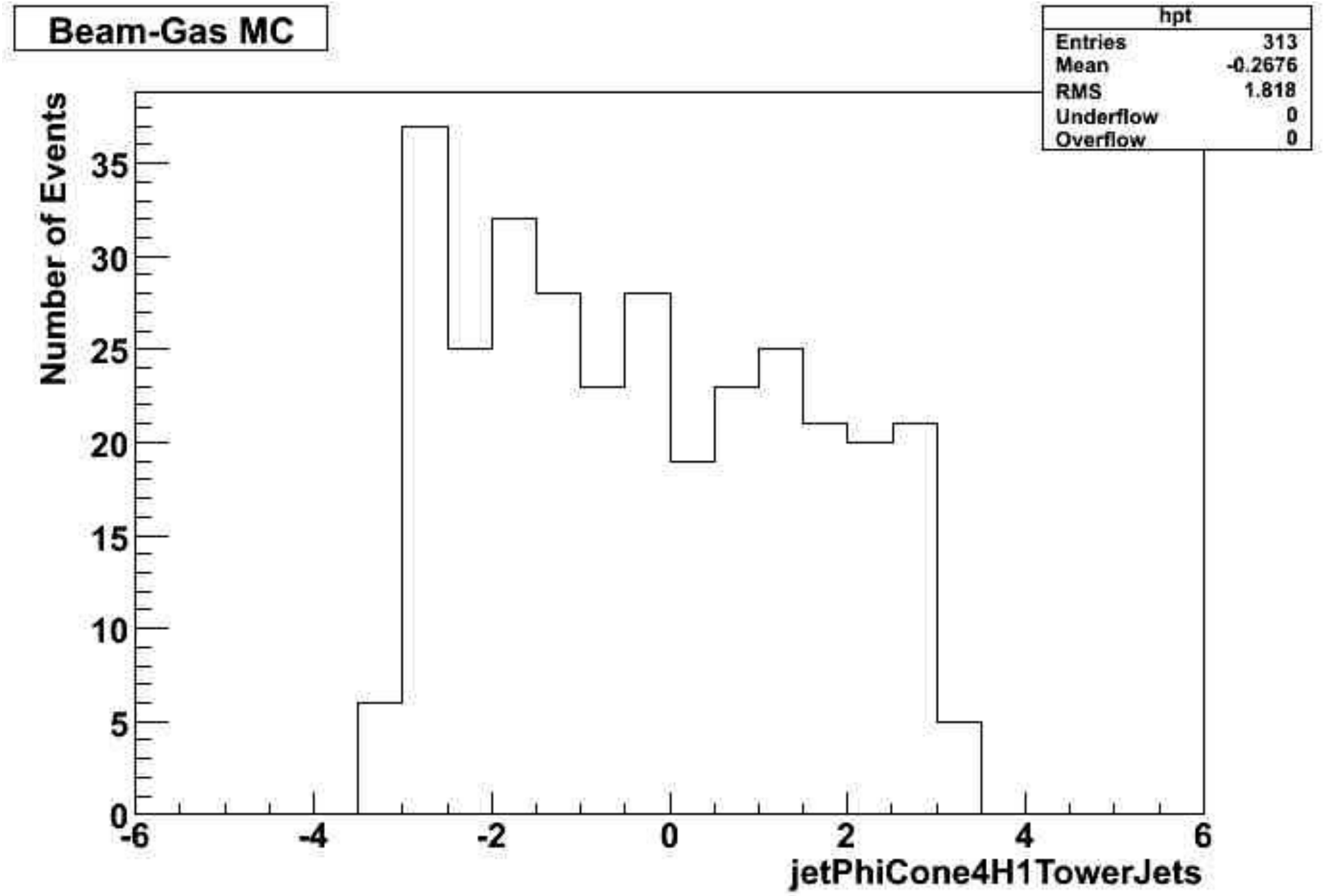



Beam-Gas MC
hpt
Entries 313
Mean 9.562
RMS 7.01
Number of Events
10²
10
1
0
20
40
60
80
100
120
140
160
180
200
jetEtCone4H1TowerJets


Beam-Gas MC
hpt
Entries 97279
Mean 1.484
RMS 1.842
Underflow 0
Overflow 0
Number of Events
10^5
10^4
10^3
10^2
10
1
0
20
40
60
80
100
120
140
MissingET (GeV)


Beam Gas MC
hpt
Entries 97279
Mean 0.5032
RMS 0.05789
Underflow 0
Overflow 0
Number of Events
10^5
10^4
10^3
10^2
10
0
0.5
1
1.5
2
2.5
3
3.5
4
Number of Jets


Beam-Gas MC
hpt
Entries 313
Mean 0.1254
RMS 2.015
Underflow 0
Overflow 0
Number of Events
0
5
10
15
20
25
30
35
40
-6
-4
-2
0
2
4
6
jetEtaCone4H1TowerJets


Beam-Gas MC
hpt
Entries 313
Mean -0.2676
RMS 1.818
Underflow 0
Overflow 0
Number of Events
0
5
10
15
20
25
30
35
-6
-4
-2
0
2
4
6
jetPhiCone4H1TowerJets

- **Beam-Gas event**

  (Monte Carlo)

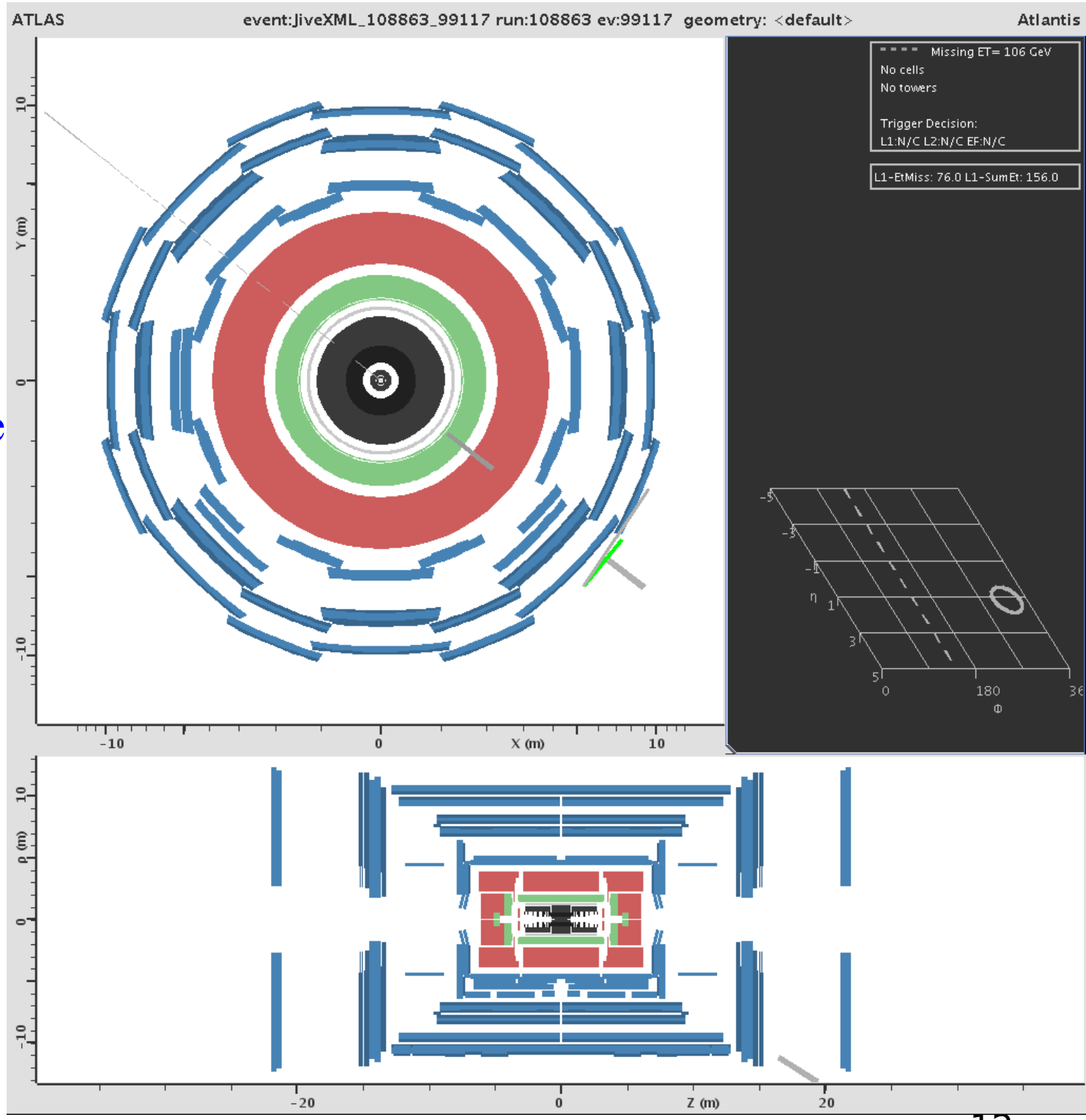
This simulated beam gas event is predicting a 106 GeV jet transverse energy event (so 106 GeV MET).

ET = 105.896 GeV

E = 188.763 GeV

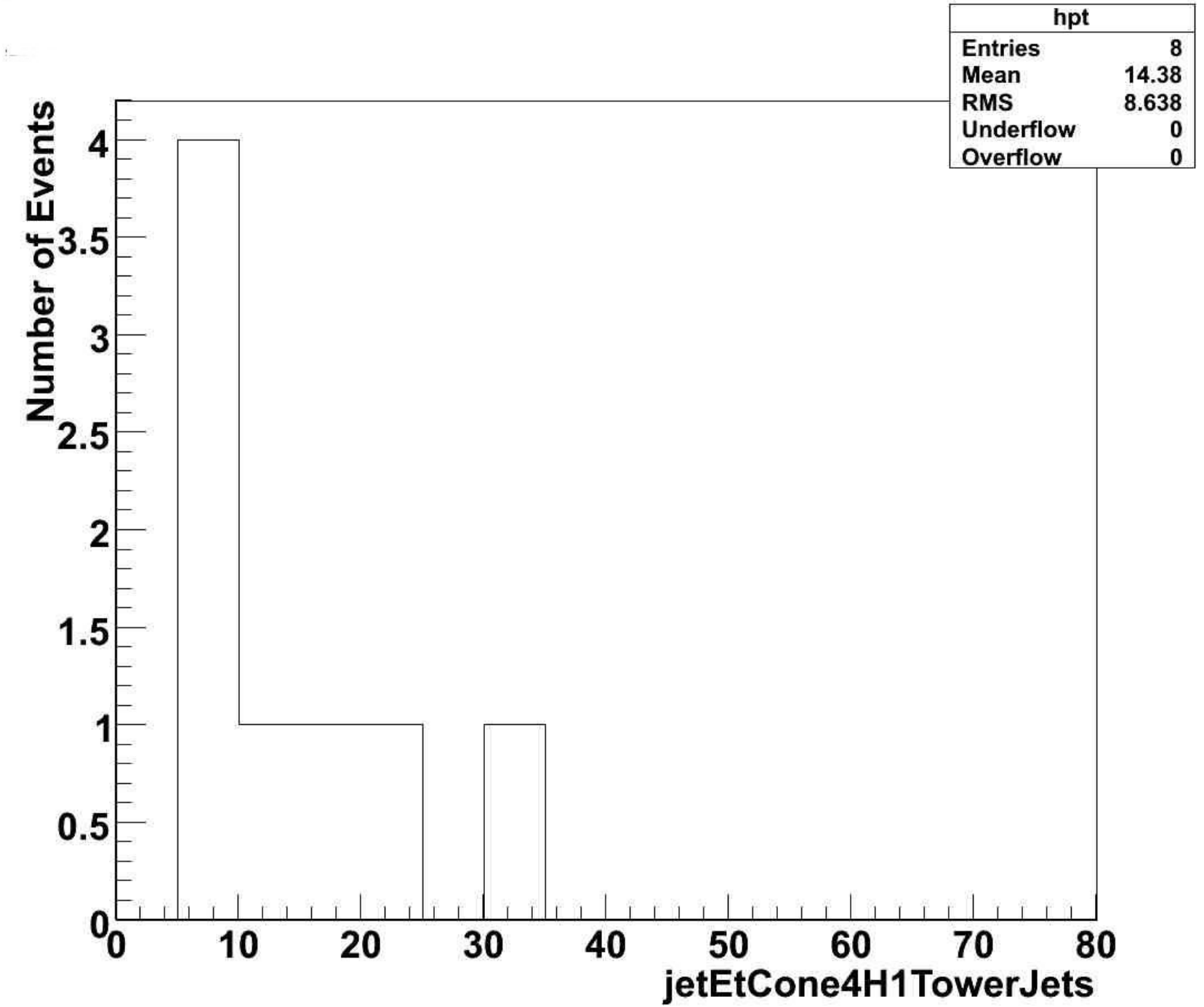
$\eta = 1.181$

$\Phi = 321.794°$ (5.616 rad)



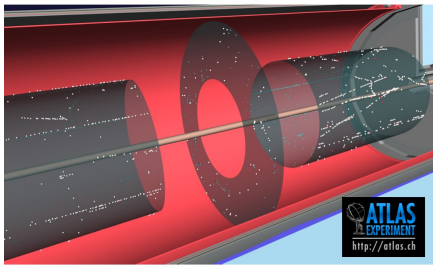
Beam-Halo MC

(1.00 E+05 events)



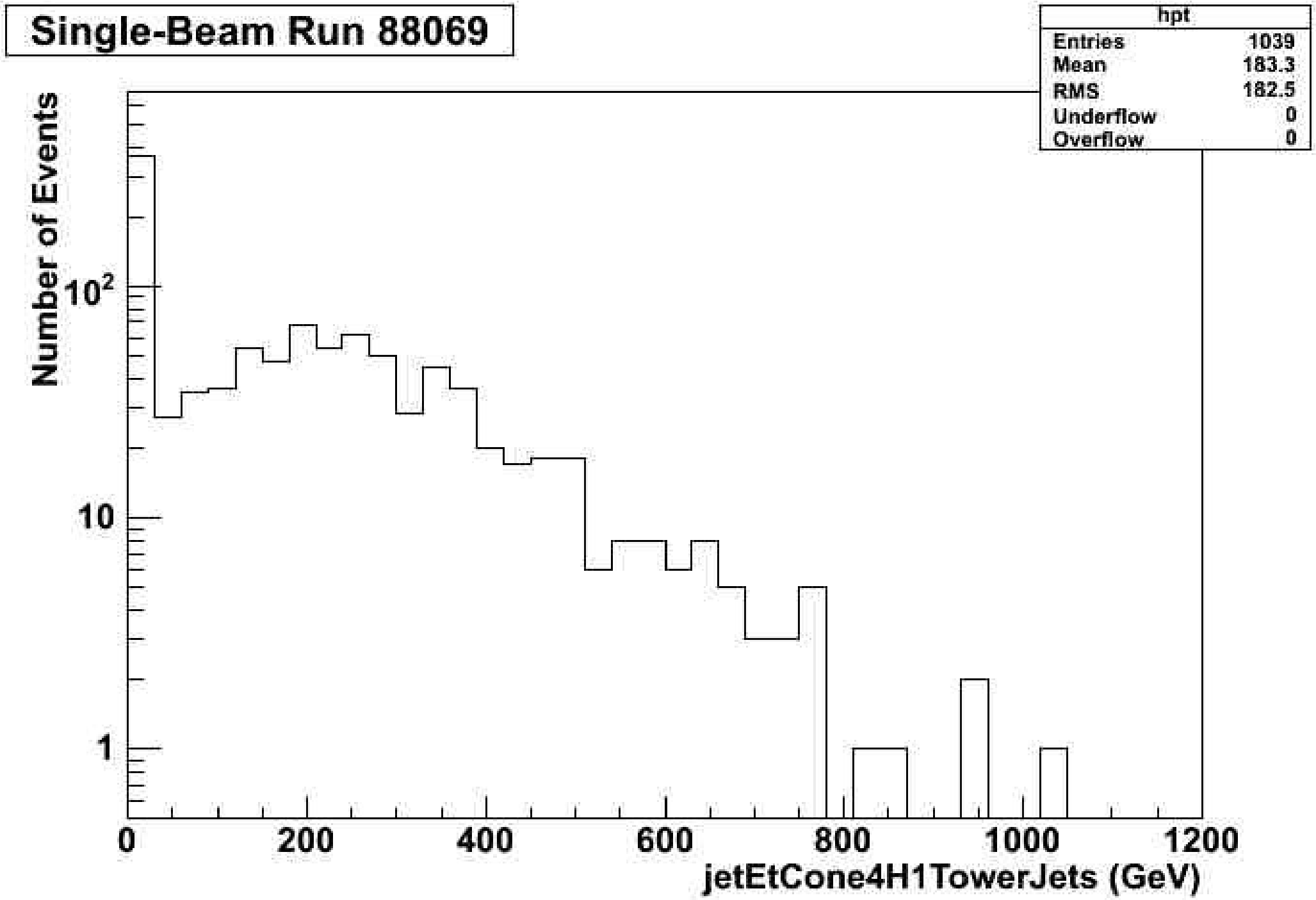
Single-Beam

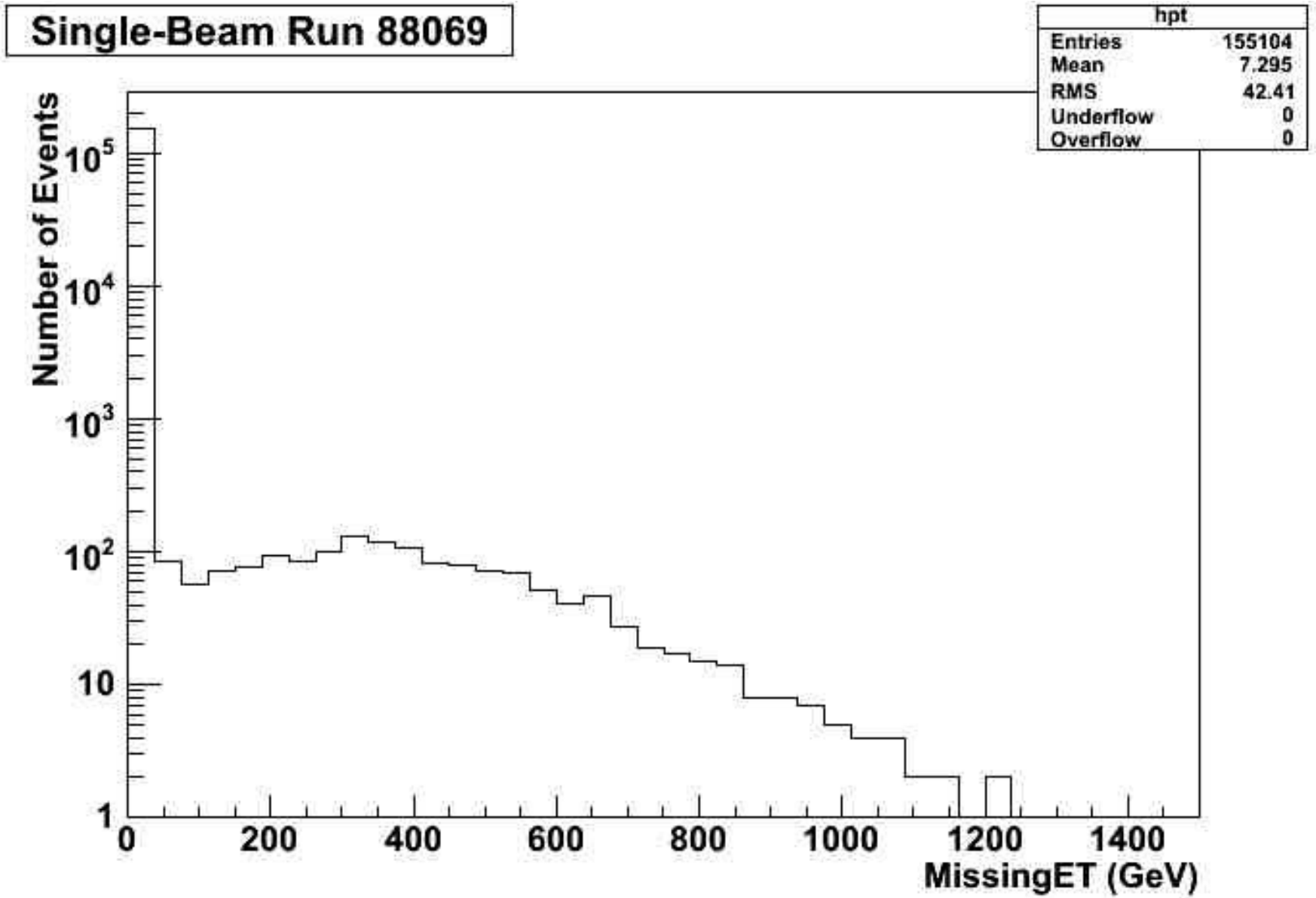
SB run 88069

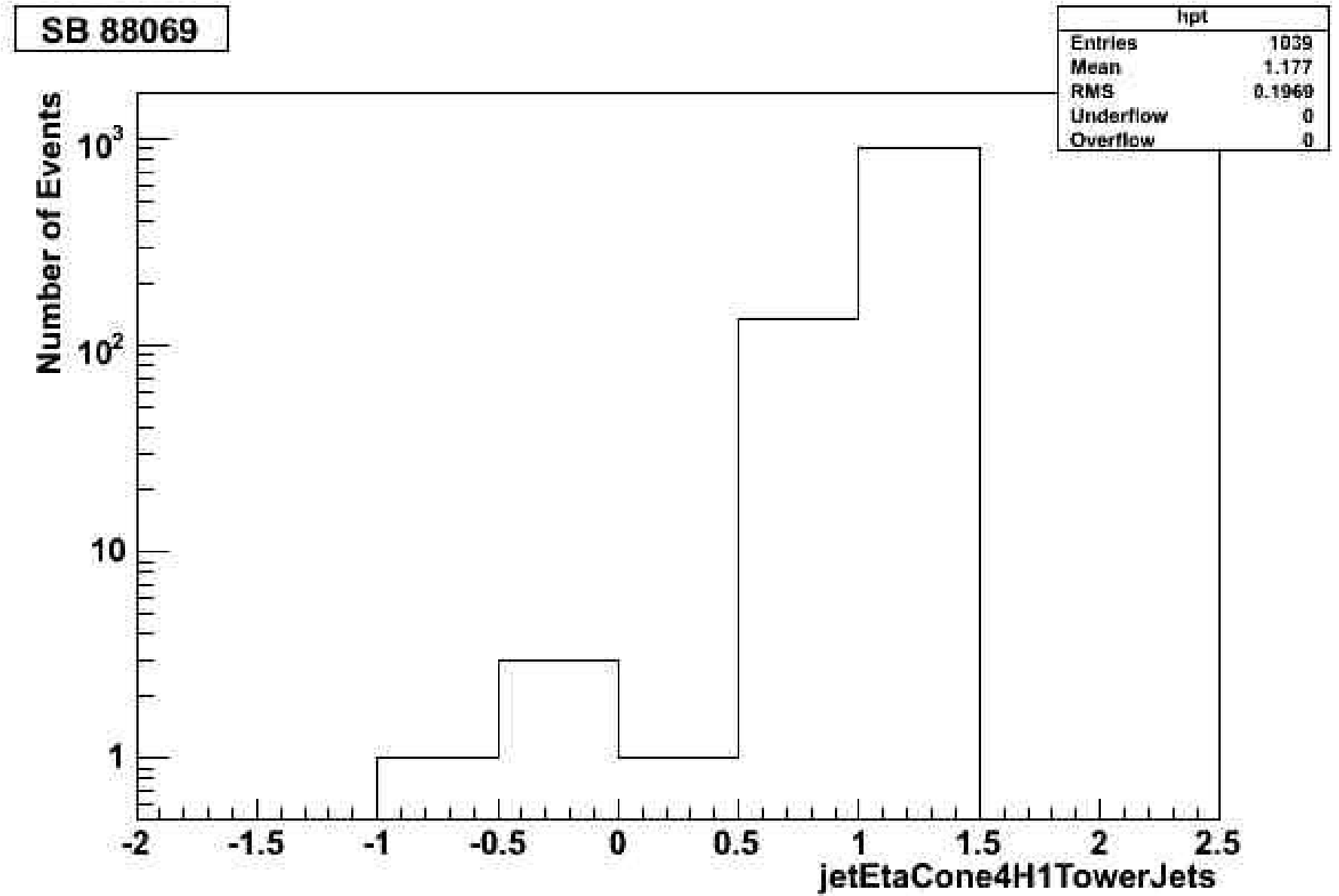


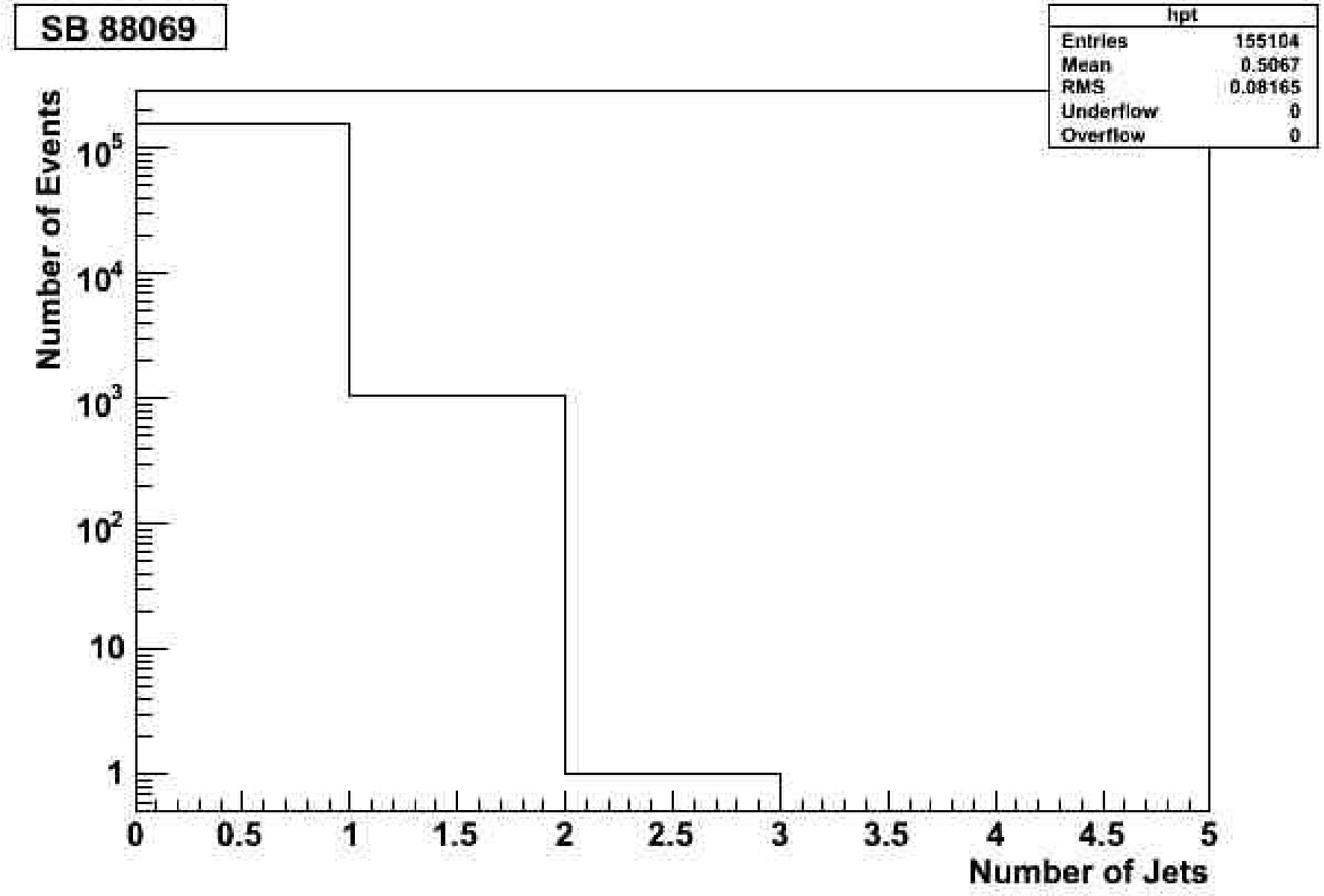
beam halo event seen in ATLAS

- Changed run for a more suitable one for beam-background studies (thanks to D. Berge)
- 2008-09-11
- No TRT, no RPC, no LAr.
- Jet energies are higher then I expected (still splashes?)
- Other possibilty would be run 88128 but it has very low statistics and no jets.


Single-Beam Run 88069
hpt
Entries 1039
Mean 183.3
RMS 182.5
Underflow 0
Overflow 0
Number of Events
10²
10
1
0
200
400
600
800
1000
1200
jetEtCone4H1TowerJets (GeV)


Single-Beam Run 88069
hpt
Entries 155104
Mean 7.295
RMS 42.41
Underflow 0
Overflow 0
Number of Events
10^5
10^4
10^3
10^2
10
1
0
200
400
600
800
1000
1200
1400
MissingET (GeV)


SB 88069
hpt
Entries 1039
Mean 1.177
RMS 0.1969
Underflow 0
Overflow 0
Number of Events
10^3
10^2
10
1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
jetEtaCone4H1TowerJets


SB 88069
hpt
Entries 155104
Mean 0.5067
RMS 0.08165
Underflow 0
Overflow 0
Number of Events
10^5
10^4
10^3
10^2
10
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Number of Jets

Beam-gas estimates

- No straightforward way of estimating the expected rate of beam-gas or beam-halo, since it depends on the beam conditions.

- Our strategy was to make a first estimate based on previous work by Boonekamp et al.

- We considered two scenarios: close to interaction point (IP) and whole ATLAS cavity.

Source

Boonekamp et al: “Cosmic Ray, Beam-Halo and Beam-Gas Rate Studies for ATLAS Commissioning”

- numbers for 2 month of single beam run with 30% efficiency
- reduction factor of 200 compared to high lumi run

Beam Halo:

- only muons are taken into account
- vacuum quality of $3 \cdot 10^{-8}$ Torr
- secondaries with E < 20 MeV discarded

Beam Gas:

- gas composition: H_2, CH_4, CO, CO_2
- 10^{13} molecules/m^3 and molecule species
- assuming uniform densities throughout the whole cavern

Beam Gas

Window (z)	Rate (kHz)	Total numbers of events
$\pm$ 23 m	60	1.1×10^{11}
$\pm$ 3.5 m	9	1.7×10^{10}
$\pm$ 20 cm	0.6	1.0×10^{9}

Inelastic beam-gas collision rates integrated over
whole ATLAS cavity (23 m)
Inner Detector acceptance (3.5 m)
close to IP (20 cm)

The rate of beam-gas interactions is proportional to the beam intensity and residual gas pressure in the beam pipe.

Total numbers of events correspond to 2 months single beam with 30% data taking efficiency

Estimation

assuming LHC Luminosity: $2 \cdot 10^{33}$ $cm^{-2}s^{-1} = 2 \cdot 10^{-3}$ $pb^{-1}s^{-1}$

for integrated luminosity of 100 pb^{-1} we need $5 \cdot 10^{4}$ s

Number of events for 100pb^{-1}, worst and best case scenarios

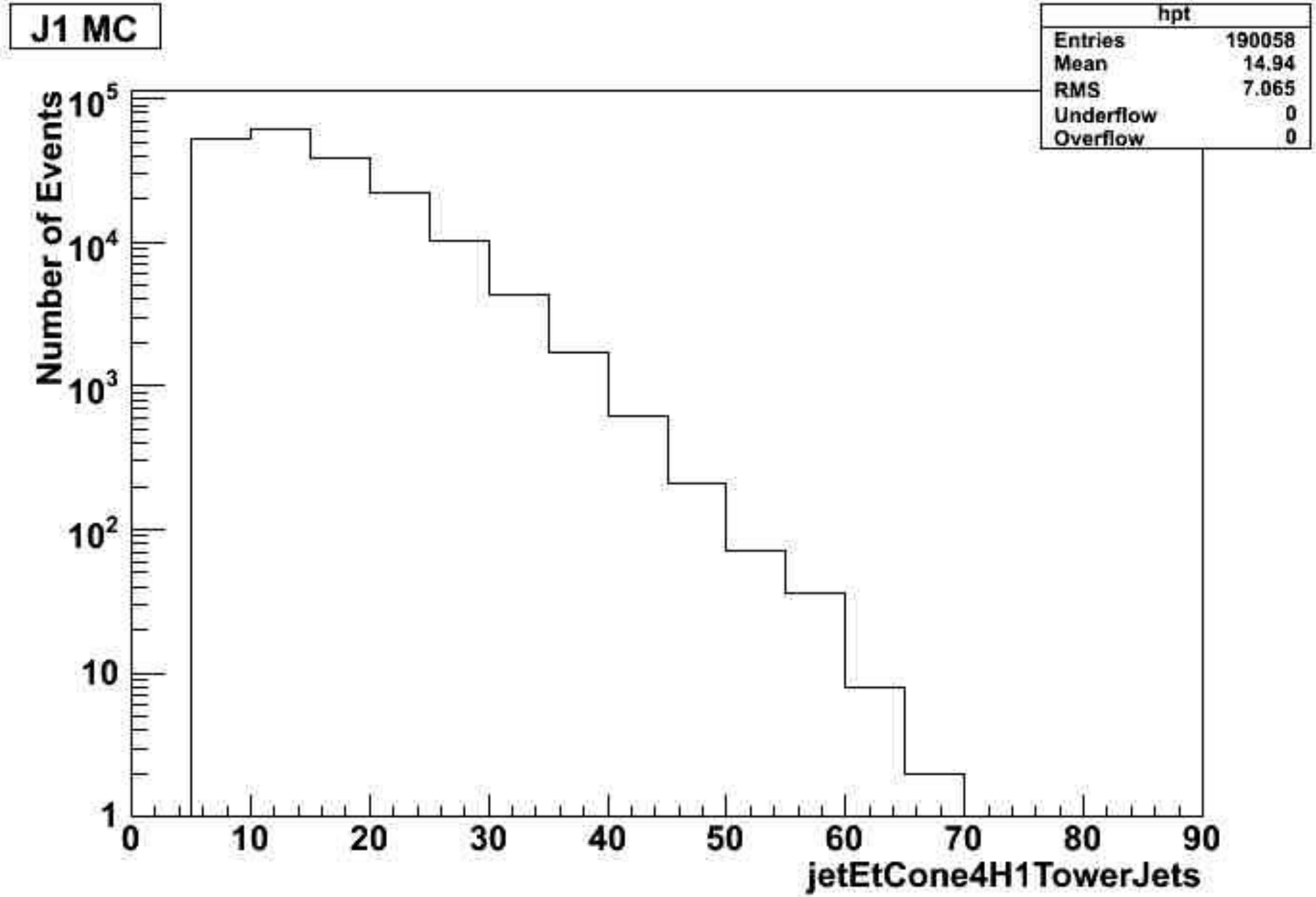
Beam Halo

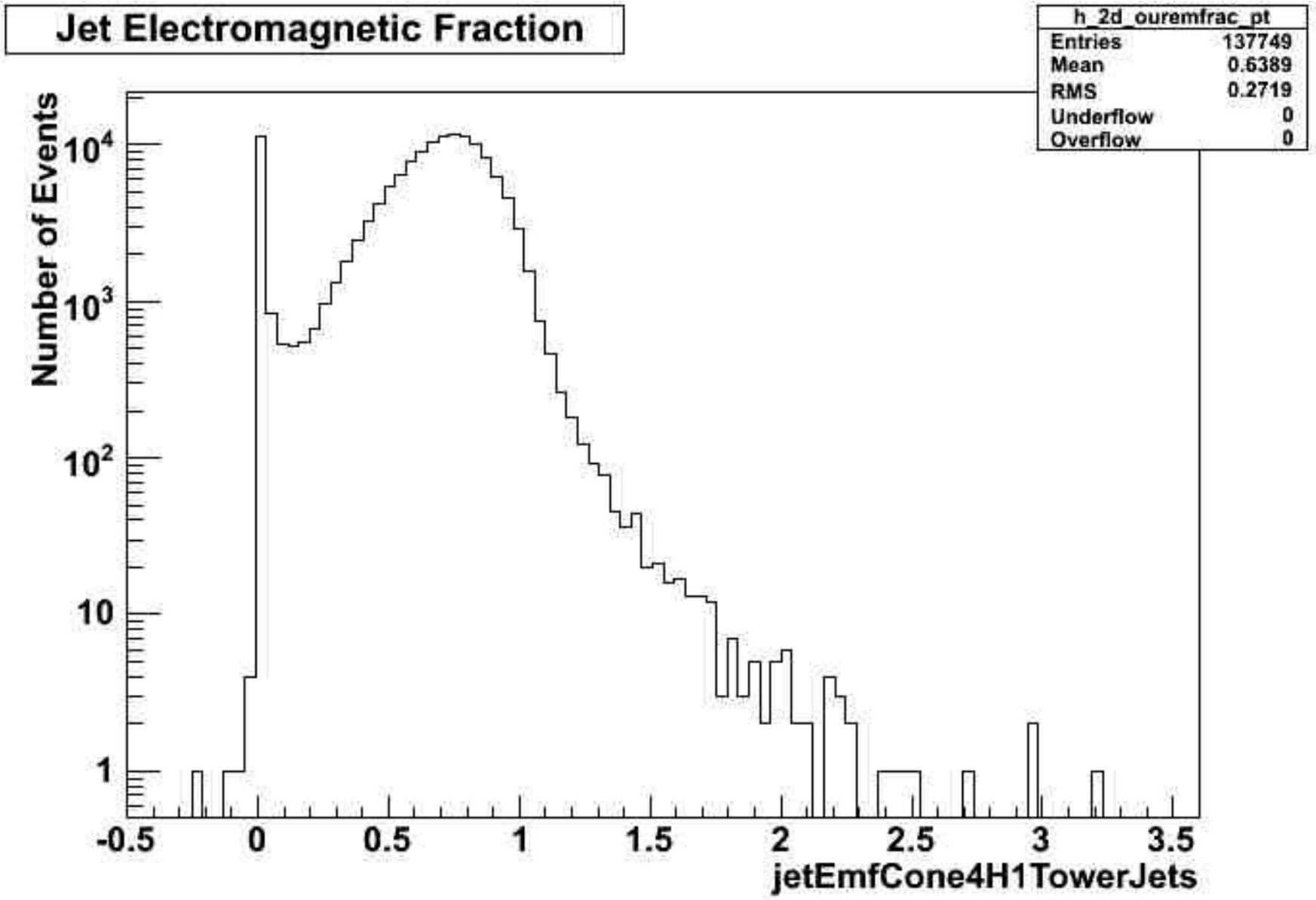
	Rate/Hz	Total number of events
close to IP	20	1.00E+06
whole cav.	11800	5.90E+08

Beam Gas

	Rate/kHz	Total number of events
close to IP	120	6.00E+09
whole cav.	12000	6.00E+11

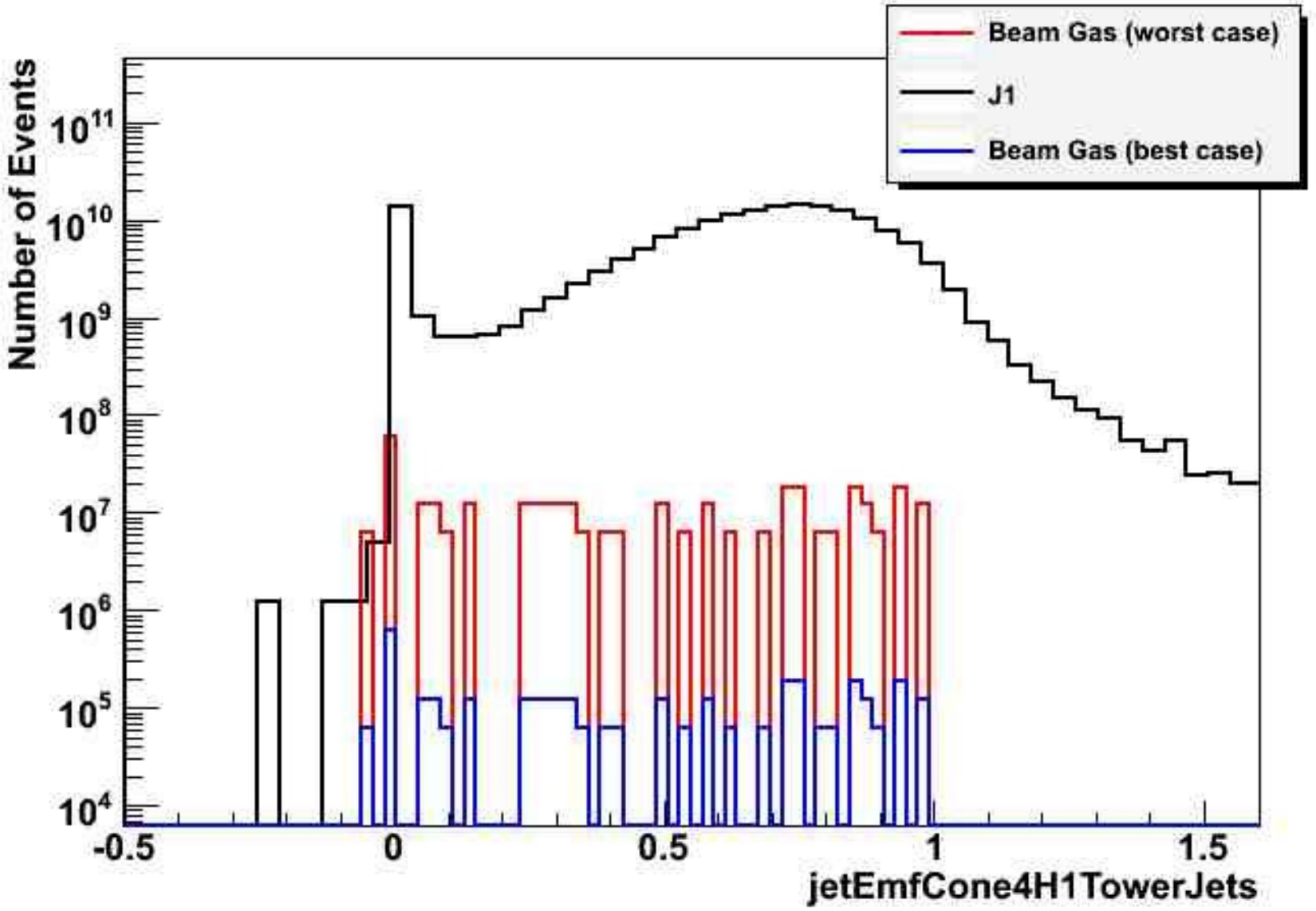
J1 Samples


J1 MC
hpt
Entries 190058
Mean 14.94
RMS 7.065
Underflow 0
Overflow 0
Number of Events
10^5
10^4
10^3
10^2
10
1
0 10 20 30 40 50 60 70 80 90
jetEtCone4H1TowerJets



$$\text{Jet EM Fraction} = \frac{\text{(Sum of Energy Deposit in jet in EMB, EMEC)}}{\text{(Sum of Energy Deposit in jet for all layers)}}$$

Jet EM fraction for jet ET > 10 GeV

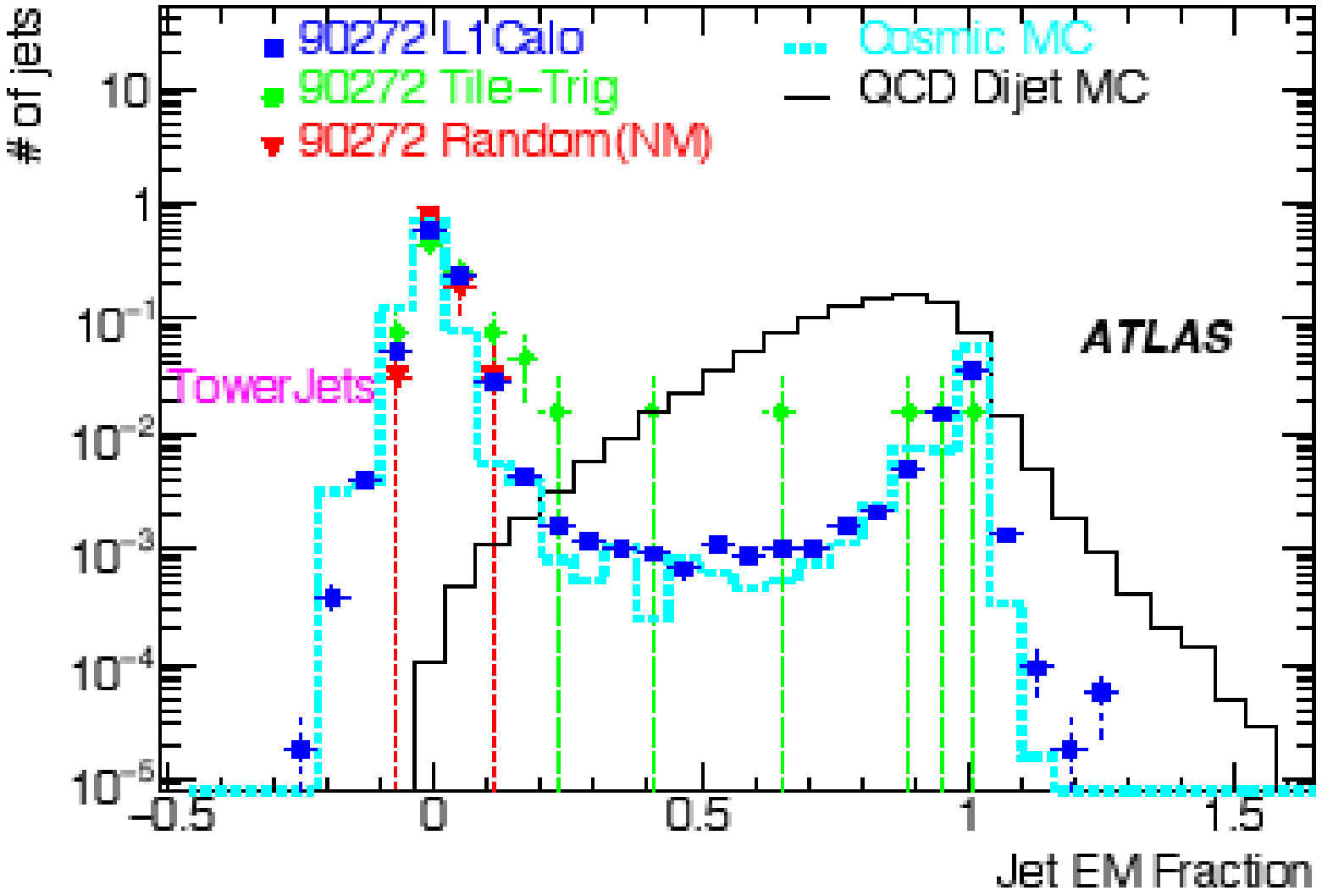


Conclusions/Future Work

- Waiting for new beam-halo samples.
- Trying to identify beam-gas events in single-beam (if any) based on what I see in simulations (energy, eta, phi etc).
- Jet EM fraction was not great as I expected to clean the beam-gas, but shows that even for the the very worst scenario it is not a very worrying problem (low rate).
- We will also try run 88128, see what happens.
- We expect jet EM fraction to work better for beam-halo.

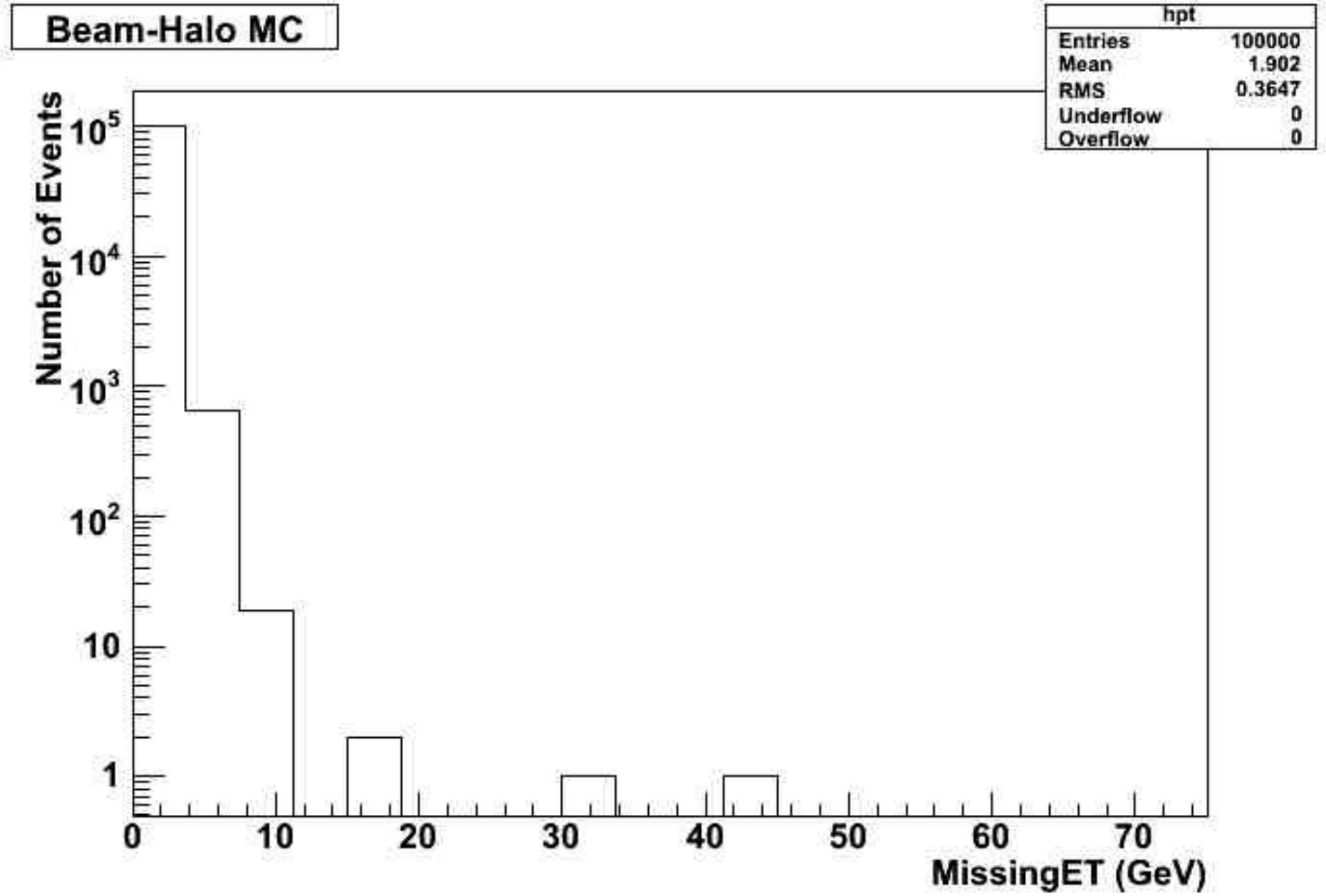
Back-up

Jet EMF for cosmics

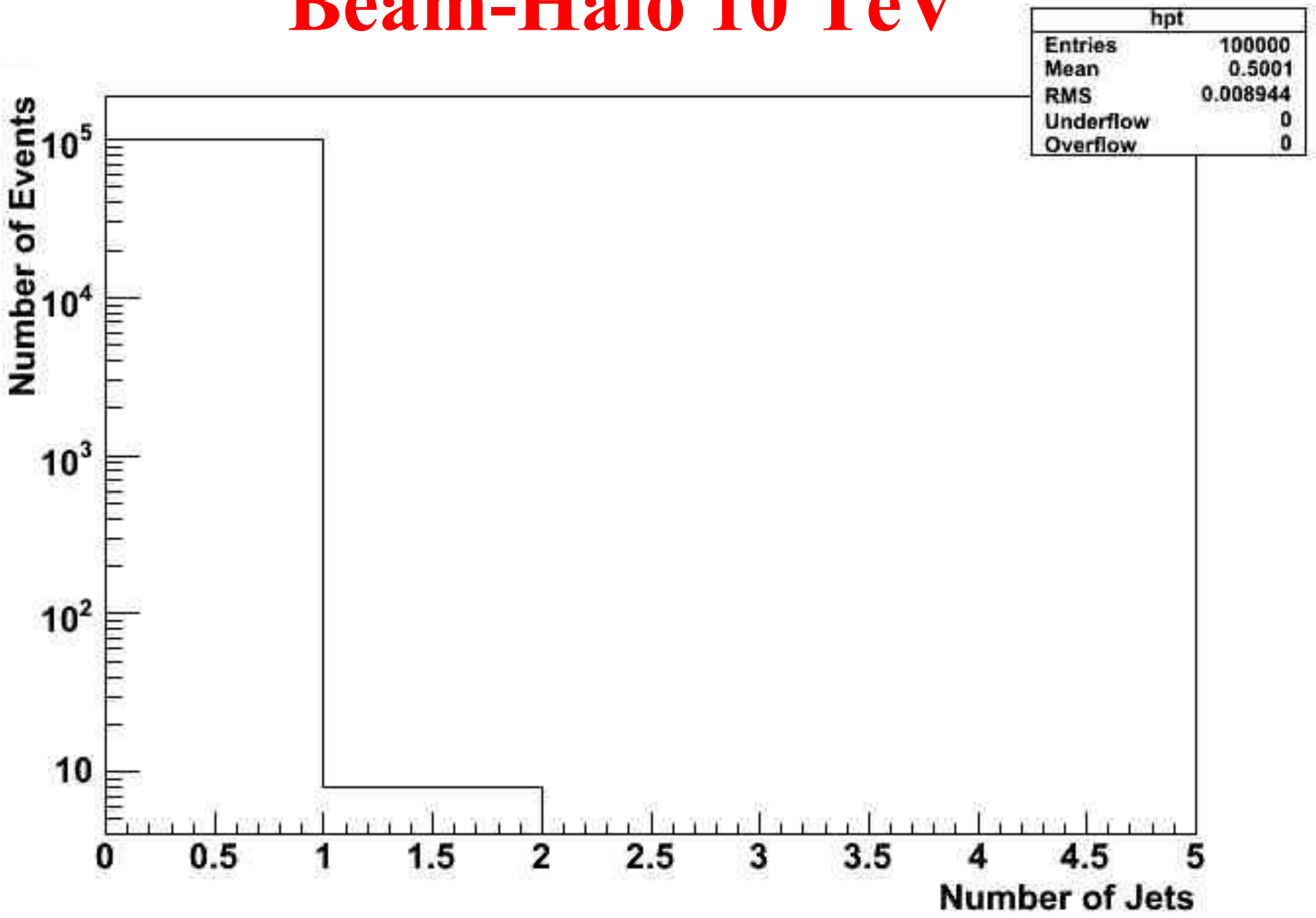


H. Okawa et al (ATL-COM-CAL-2008-007)

Beam-Halo


Beam-Halo MC
hpt
Entries 100000
Mean 1.902
RMS 0.3647
Underflow 0
Overflow 0
Number of Events
10^5
10^4
10^3
10^2
10
1
0
10
20
30
40
50
60
70
MissingET (GeV)

Beam-Halo 10 TeV



Beam Halo

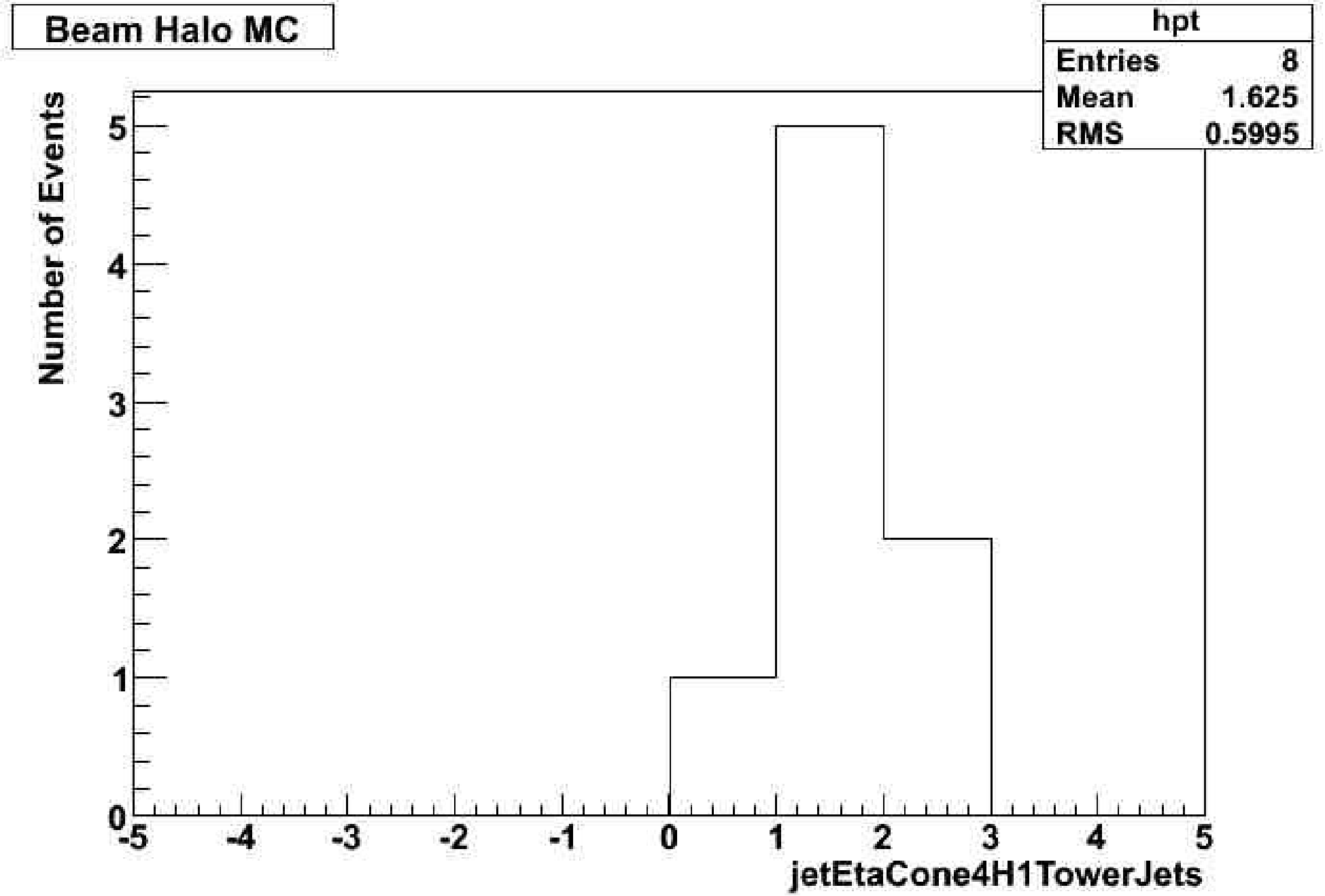
Particle species	Flux (kHz)
All	1750
Charged hadrons	1515
Neutrons	130
Muons	105

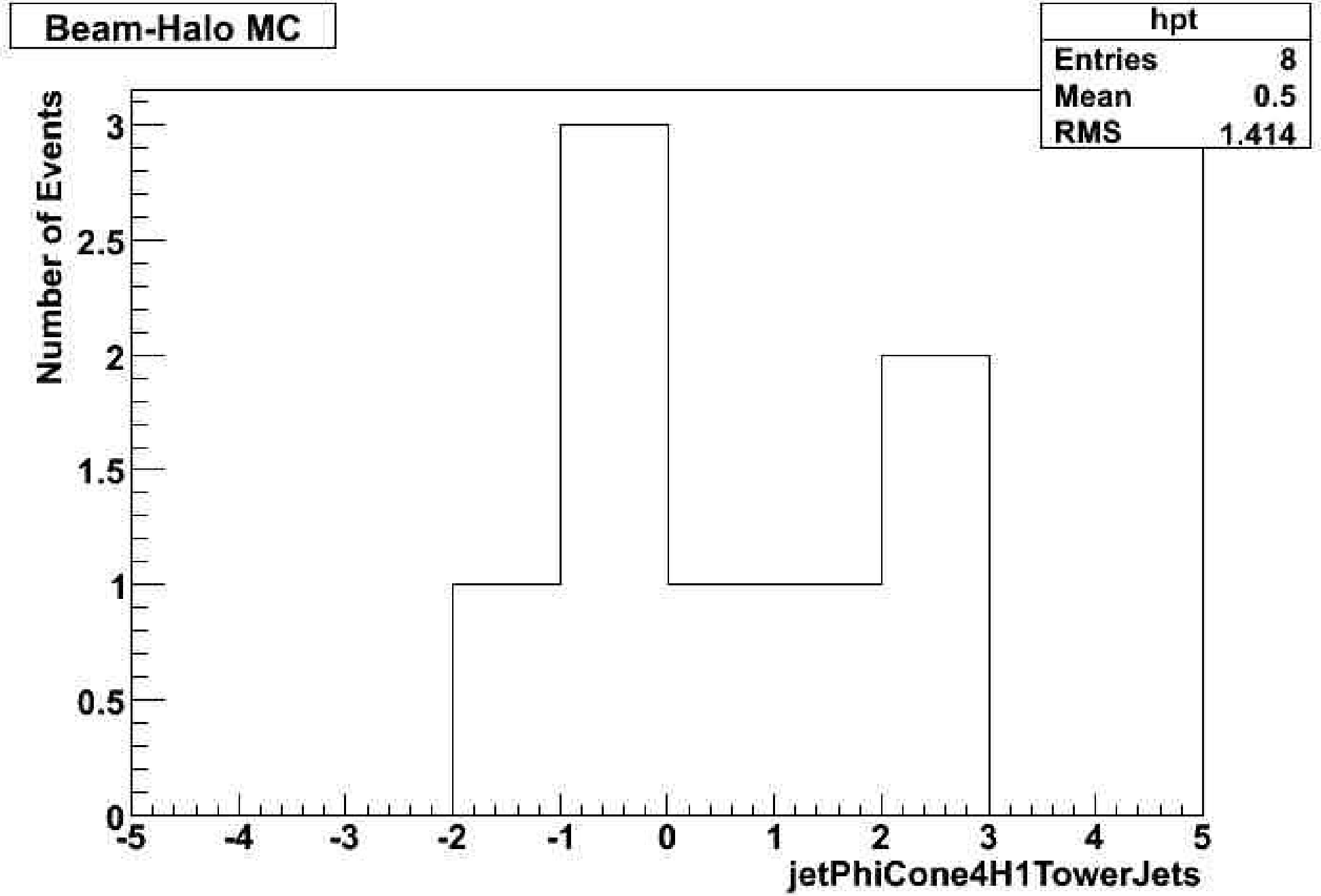
Total beam-halo particle flux for single beam (taken from the note)

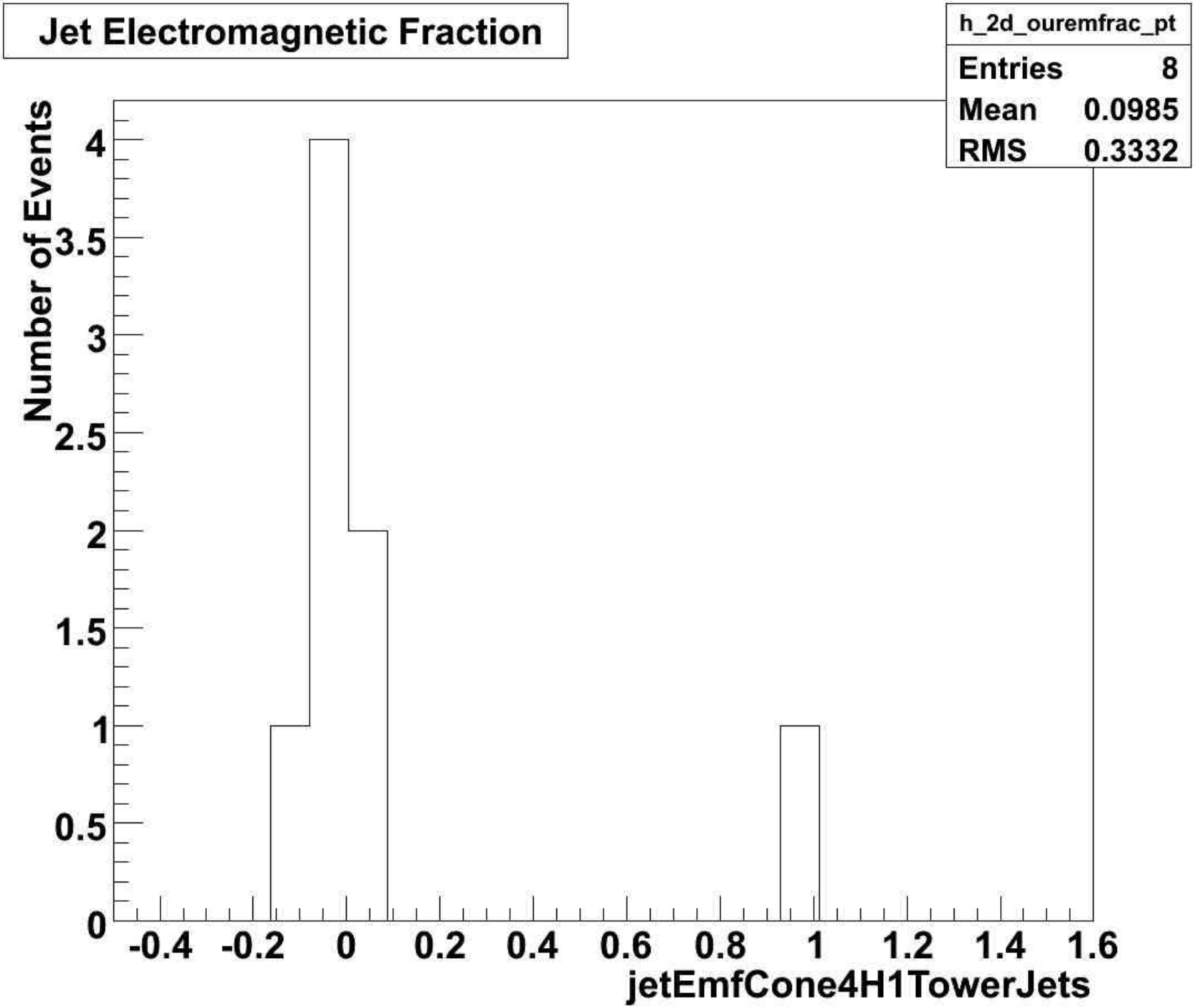
Detector	Rate (Hz)	Total number of events
MDT (end-cap)	59	1.0×10^{8}
MDT (barrel)	29	5.2×10^{7}
TRT	15	2.7×10^{7}
SCT	29	4.9×10^{7}
Pixels	0.4	6.7×10^{5}
EM calorimeter	1.2	2.1×10^{6}
Tile calorimeter	1.3	2.3×10^{6}
HEC	0.3	5.3×10^{5}
FCAL	0.1	1.8×10^{5}

Beam halo muon rates for subsystems for single beam (taken from the note)

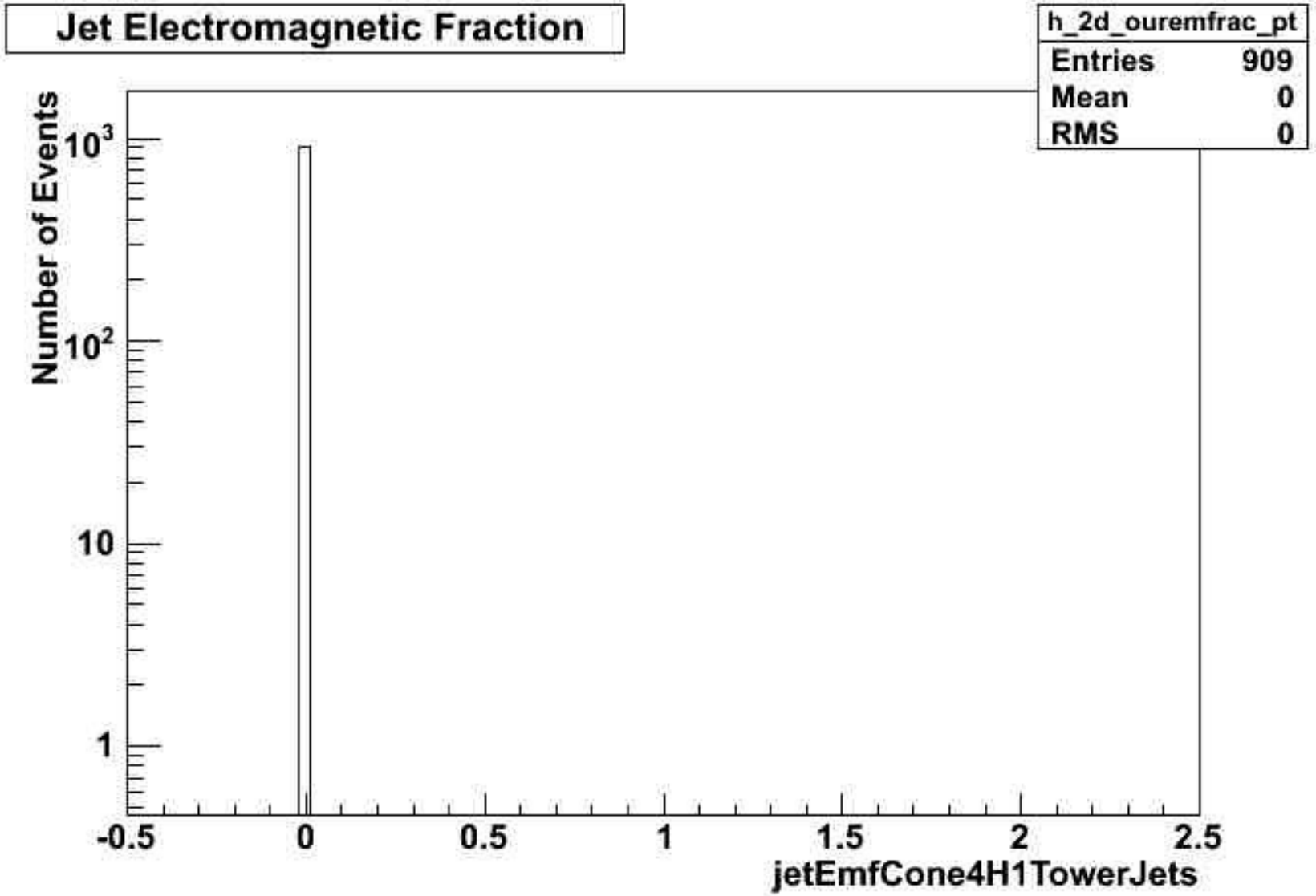
Total numbers of events correspond to 2 months single beam with 30% data taking efficiency


Beam Halo MC
hpt
Entries 8
Mean 1.625
RMS 0.5995
Number of Events
0
1
2
3
4
5
-5
-4
-3
-2
-1
0
1
2
3
4
5
jetEtaCone4H1TowerJets


Beam-Halo MC
hpt
Entries 8
Mean 0.5
RMS 1.414
Number of Events
0
0.5
1
1.5
2
2.5
3
-5
-4
-3
-2
-1
0
1
2
3
4
5
jetPhiCone4H1TowerJets

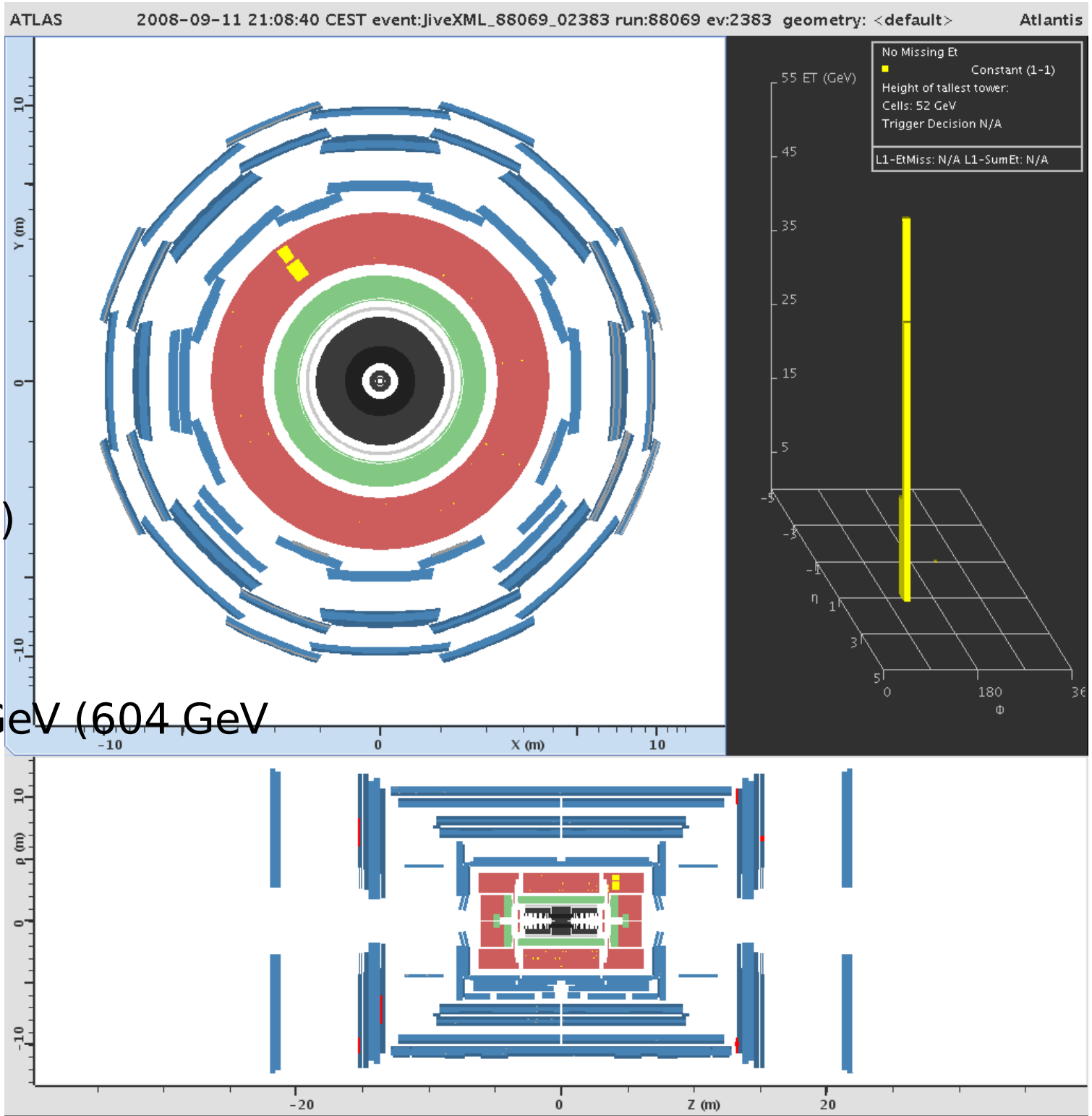

Jet Electromagnetic Fraction
h_2d_ouremfrac_pt
Entries 8
Mean 0.0985
RMS 0.3332
Number of Events
0
0.5
1
1.5
2
2.5
3
3.5
4
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
jetEmfCone4H1TowerJets

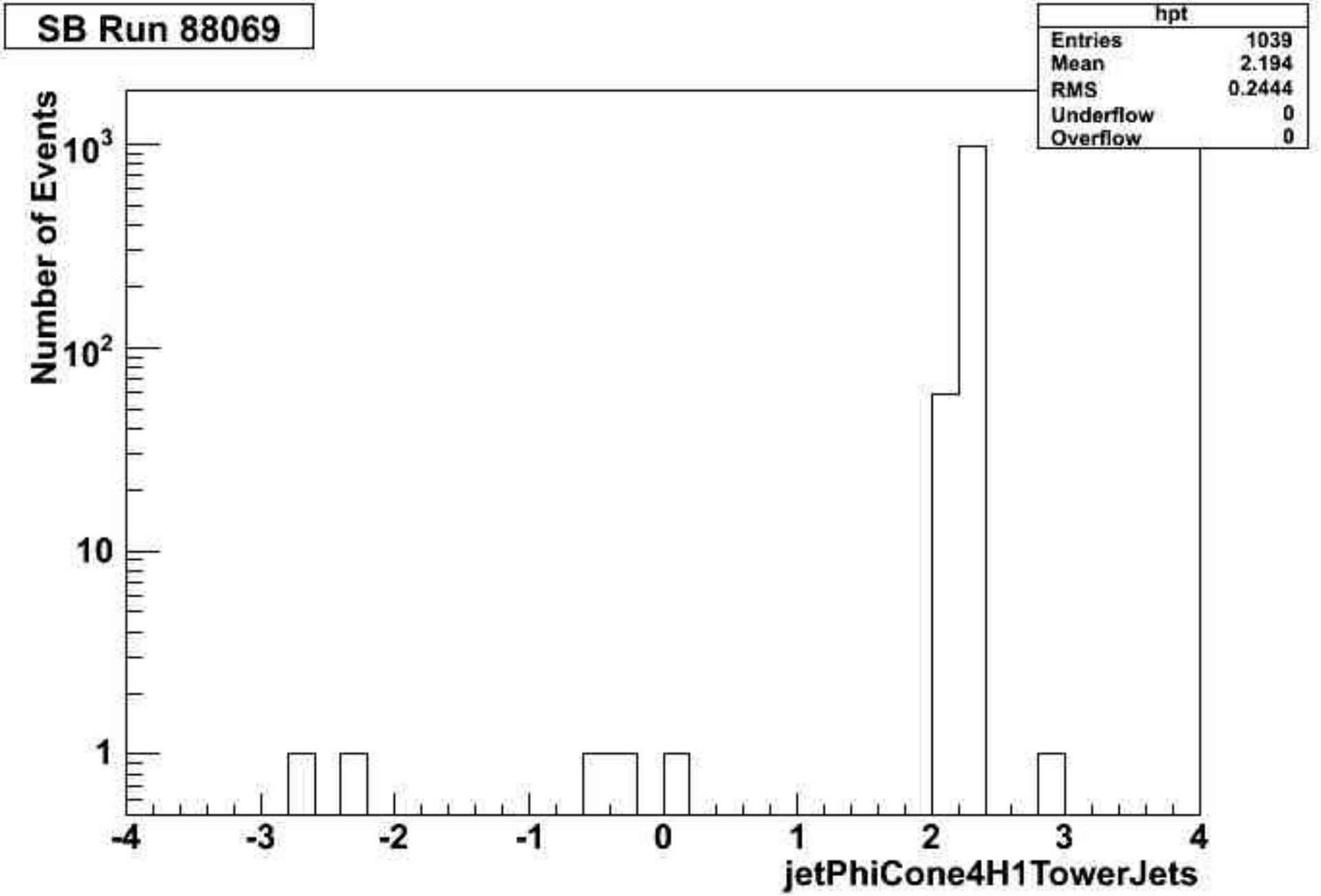
LAr was off for 88069



This is the 1036 GeV jetEt event (although you cannot see the jet (problem in the rec?)

the big cell has 1050 GeV (604 GeV ET)




SB Run 88069
hpt
Entries 1039
Mean 2.194
RMS 0.2444
Underflow 0
Overflow 0
Number of Events
10^3
10^2
10
1
-4
-3
-2
-1
0
1
2
3
4
jetPhiCone4H1TowerJets