Anomalous Production of Photon+Jets (+MET)

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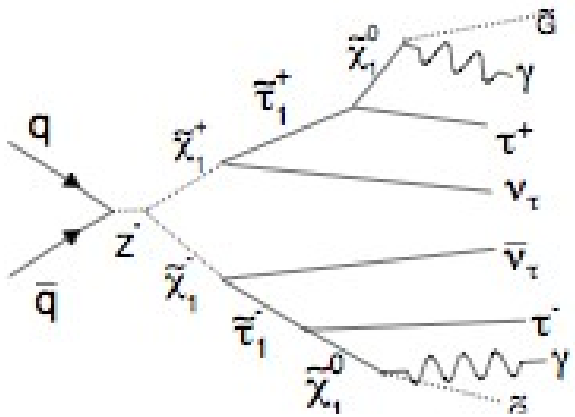
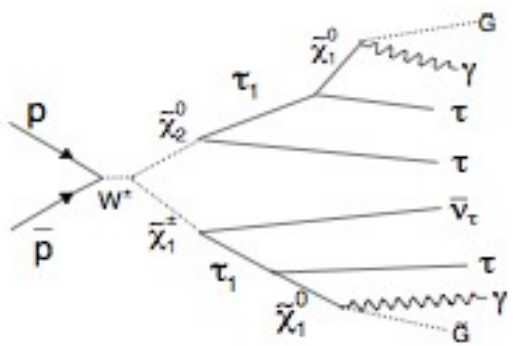
Fermilab

Outline

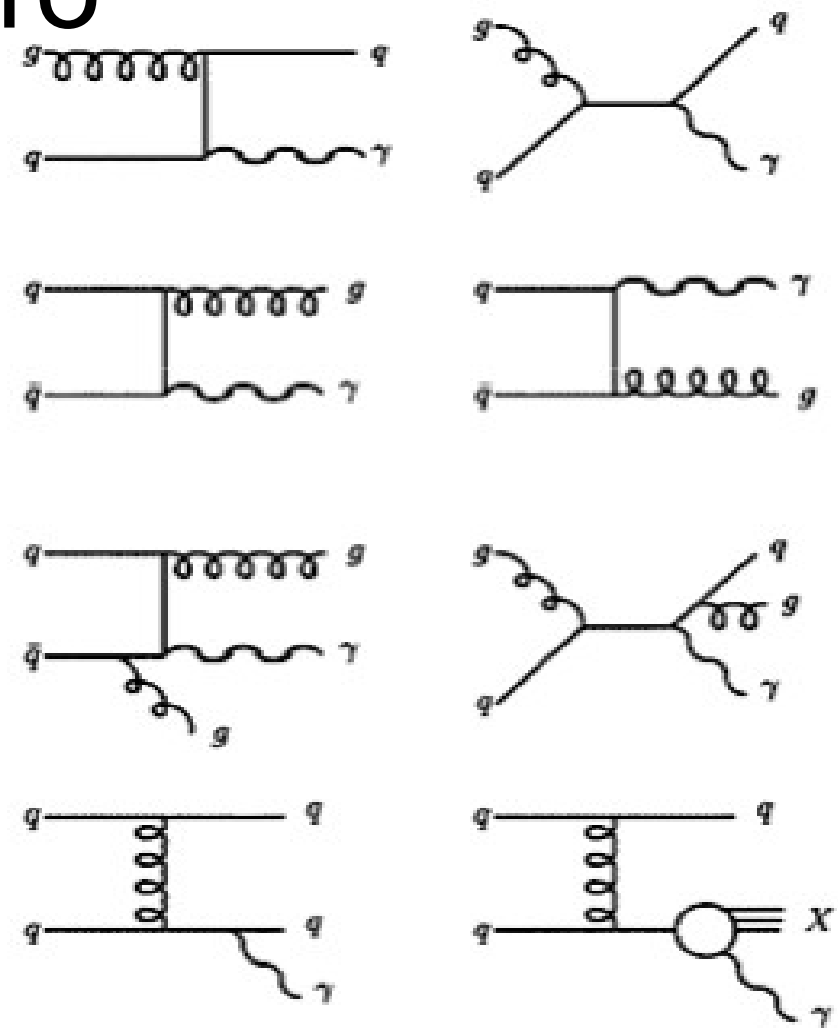
- Intro
- Triggers and Datasets
- Event, Photon, Jet and Signal Selection
- Backgrounds
- Results

Intro





SUSY GMSB processes for Photon+Jet production (source 8378)



SM- Tree level diagrams for Photon+Jet production

Triggers and Datasets

- Triggers
  - PHOTON_25ISO, 50 and 70
- Datasets
  - cph10d,0h,0i,0j (up to p.13) Lum = 2.4 fb^{-1}
- Photon MC
  - QCD group, PYTHIA, Pt min 22 GeV, jqcdfh
- W/Z MC
  - EWK group, PYTHIA, W->e+nu (wewkfe, wewkge) & Z/gamma*-> e+e (zewk6d, zewkad)

Event Selection

- Require at least one of the three triggers
  - PHOTON_25ISO, 50 and 70
- must be in good run list (v19_pho)
- >=1 Class 12 vertices
- z < 60 cm
- Photon+>=1 Jet or Photon+>=2 Jets

Photon selection

Variable	Cut value
detector	central
E_T^{corr}	> 30 GeV
CES X and Z fiducial	$\lvert X_{CES}\rvert \leq 21$ cm 9 cm $\leq \lvert Z_{CES}\rvert \leq 230$ cm
Had/Em	$\leq 0.125 \;\lVert\; \leq 0.055 + 0.00045 \times E^{corr}$
$E_T^{Iso(corr)}$ in cone 0.4	$\leq 0.1 \times E_T^{corr}$ if $E_T^{corr} < 20$ GeV $\leq 2.0 + 0.02 \times (E_T^{corr} - 20)$ if $E_T^{corr} > 20$ GeV
average CES χ^2 (Strips+Wires)/2	≤ 20
N tracks in cluster (N3D)	≤ 1
Track p_T	$< 1 + 0.005 \times E_T^{corr}$
Track Iso(0.4)	$< 2.0 + 0.005 \times E_T^{corr}$
2nd CES cluster $E \times sin(theta)$ (both wire and strip E individually)	$\leq 0.14 \times E_T^{corr}$ if $E_T^{corr} < 18$ GeV $\leq 2.4 + 0.01 \times E_T^{corr}$ if $E_T^{corr} \geq 18$ GeV

Jet Selection

- Cone size =0.4, JetClu
- Remove identified EM objects
- Corrected up to level 6 (UE), particle jet.
- Require one or more jets with Et >15 GeV
- Can be in Central or plug (DetEta<3.0)

Selecting the Photon + Jets Signal

- a photon passing tight photon ID cuts
- in-time (> -4.8ns & <4.8ns)
- reject events with a trackless muon stubs in first 400 pb-1.
- reject photon and electron events
- reject di-photon events
- reject if beam halo
- 1 or more Jets

Backgrounds

- Non-collision
  - PMT spikes
  - Beam halo
  - Cosmics
- SM processes with MET, where e->gamma
  - largely from Ws.
  - smaller contributions from Zs, di-boson, tau ...
- QCD fake MET

All predictions are data based!

Rejection

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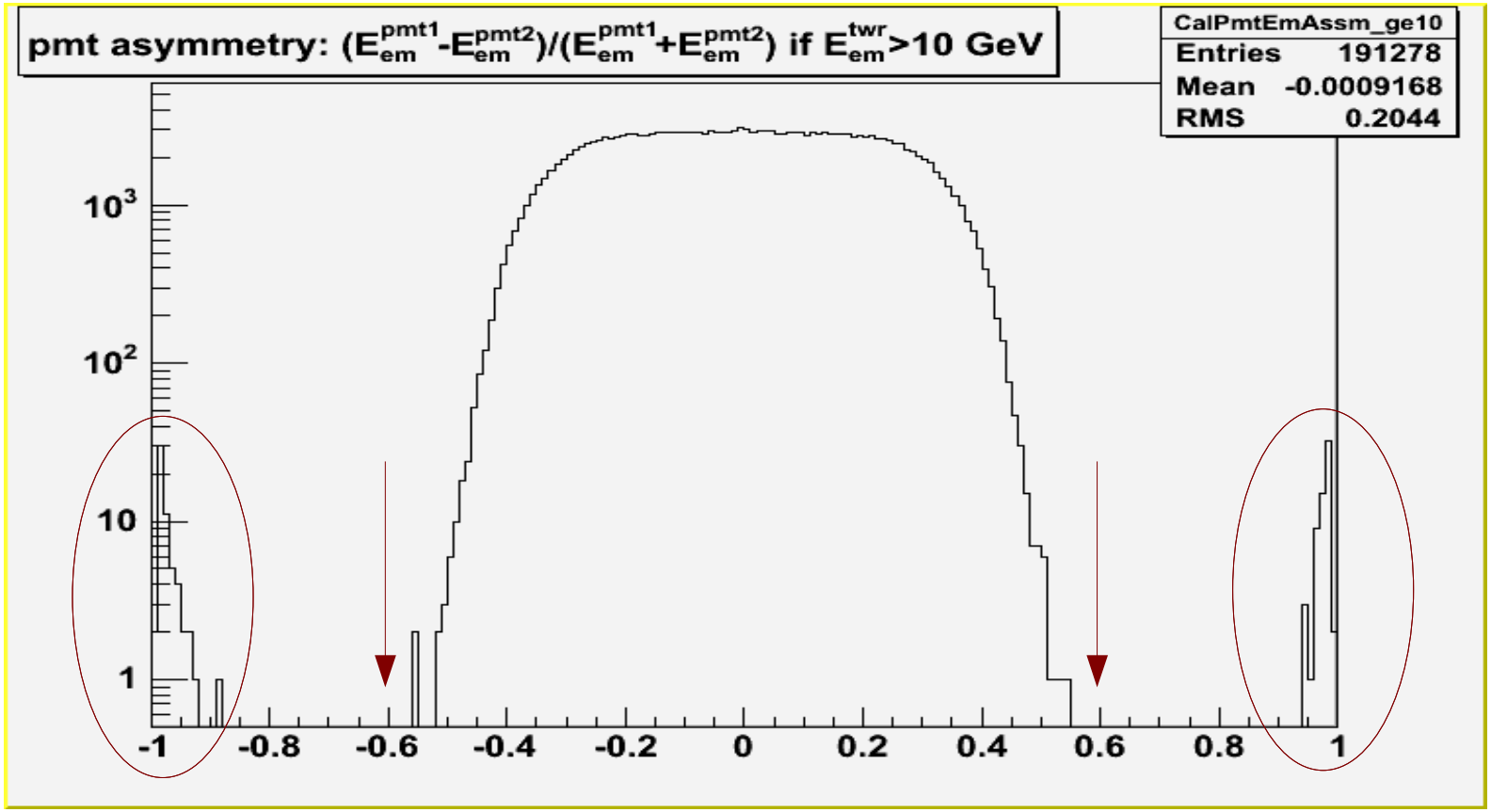
Backgrounds:Non-collision: PMT spikes

- Can reject 100% using PMT asymmetry.



Rejection

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Backgrounds:Non-collision: Beam halo

- Use topological cuts (cdfnote:8409)

Increase rejection power

Halo Type	Selection Cut
0	seedWedge > 8 || Nhad > 1
1	seedWedge > 4 & Nhad > 1
2	seedWedge > 4 & Nhad > 2
3	seedWedge > 7 & Nhad > 2
4	seedWedge > 8 & Nhad > 2
5	seedWedge > 8 & Nhad > 3

Increase efficiency

seedWedge = number of EM towers (Et>0.1 GeV) in same wedge as photon
Nhad = number of plug HAD towers (Et>0.1 GeV) in same wedge as photon

Rejection

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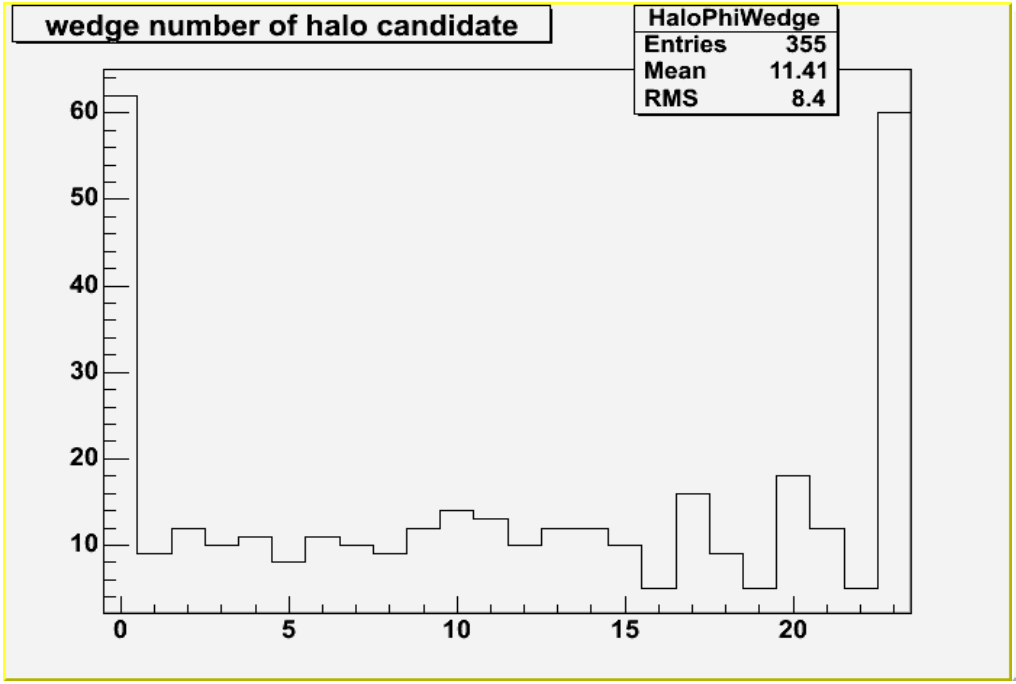
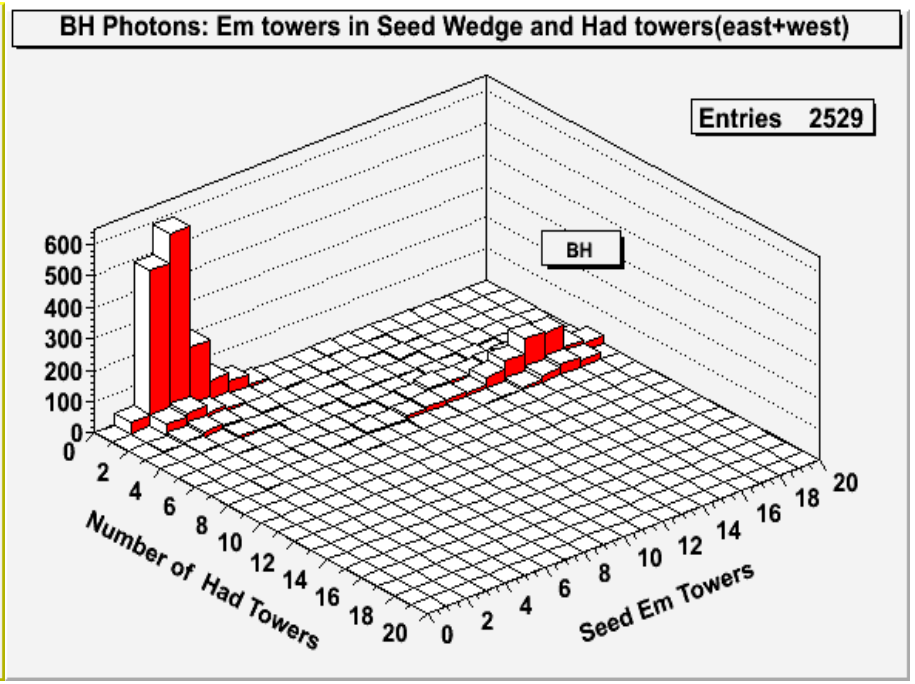
Backgrounds:Non-collision: Beam halo

SAMPLE PLOTS





Halos from no vertex events.

Estimation

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Backgrounds:Non-collision: Beam halo

- use electrons to measure mis-id rates and to estimate the remainder.
  - use photon-like electron ID cuts and e + Jet events

Halo Type	Mis-ID rates
0	68%
1	55%
2	16%
3	6.5%
4	4.1%
5	1.2%

Expect 3065 events!

Template

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Backgrounds:Non-collision: Beam halo

- start with a tight photon
- in-time (> - 4.8ns & < 4.8ns)
- select beam halo using halo cuts (type 5)
- 1 or more Jets

Template

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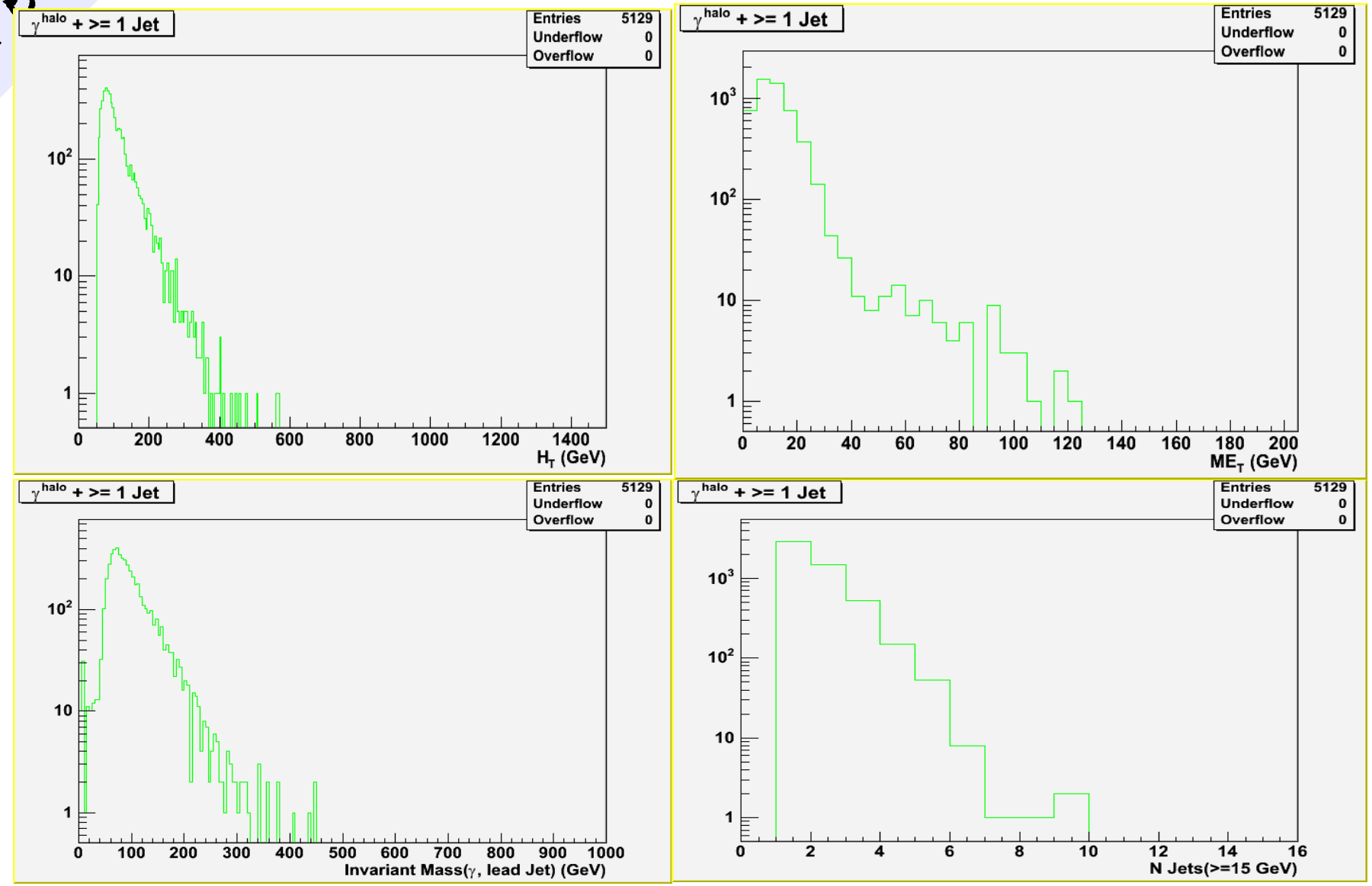
Backgrounds:Non-collision: Beam halo



Rejection

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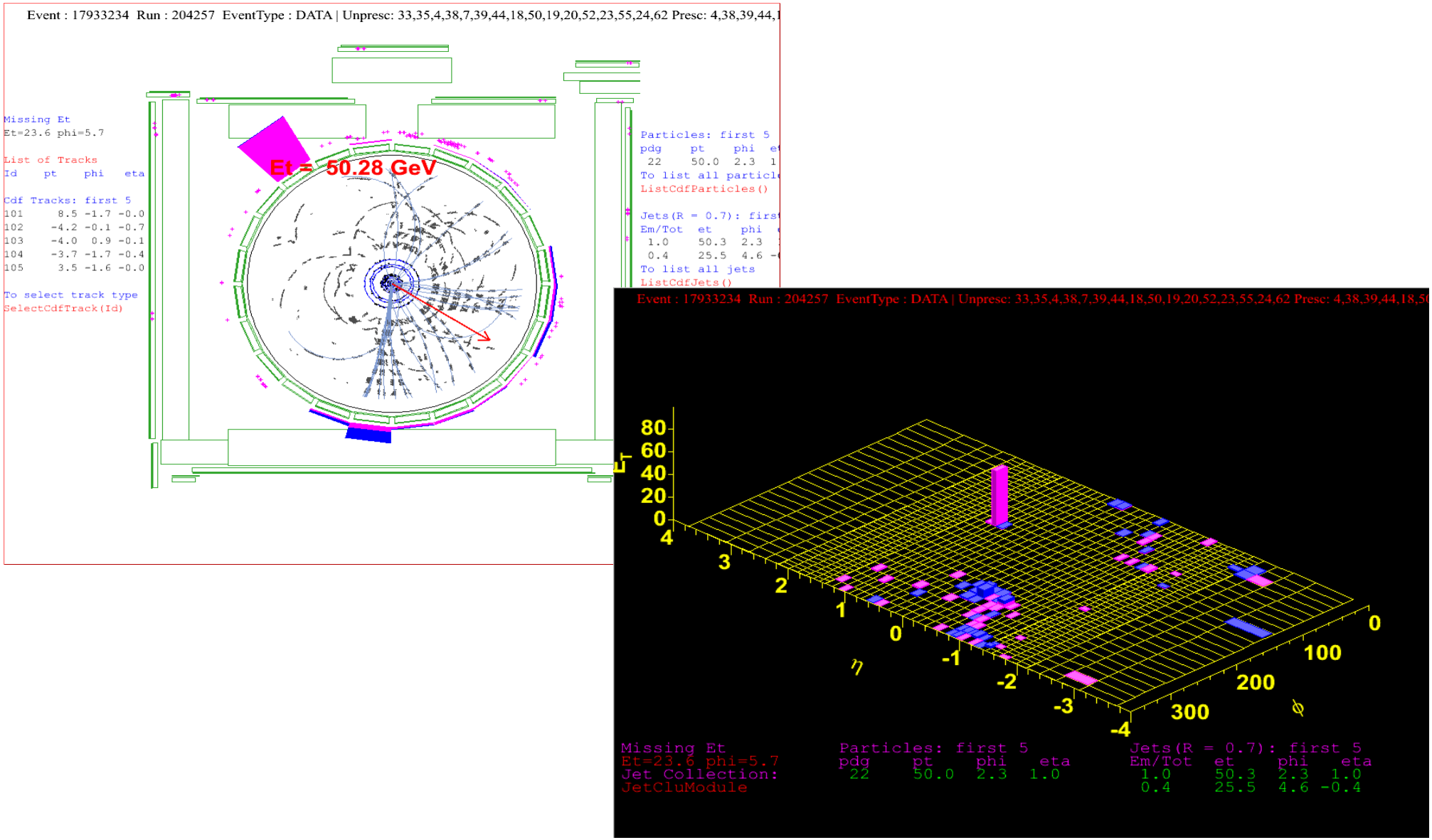
Backgrounds:Non-collision: Cosmic

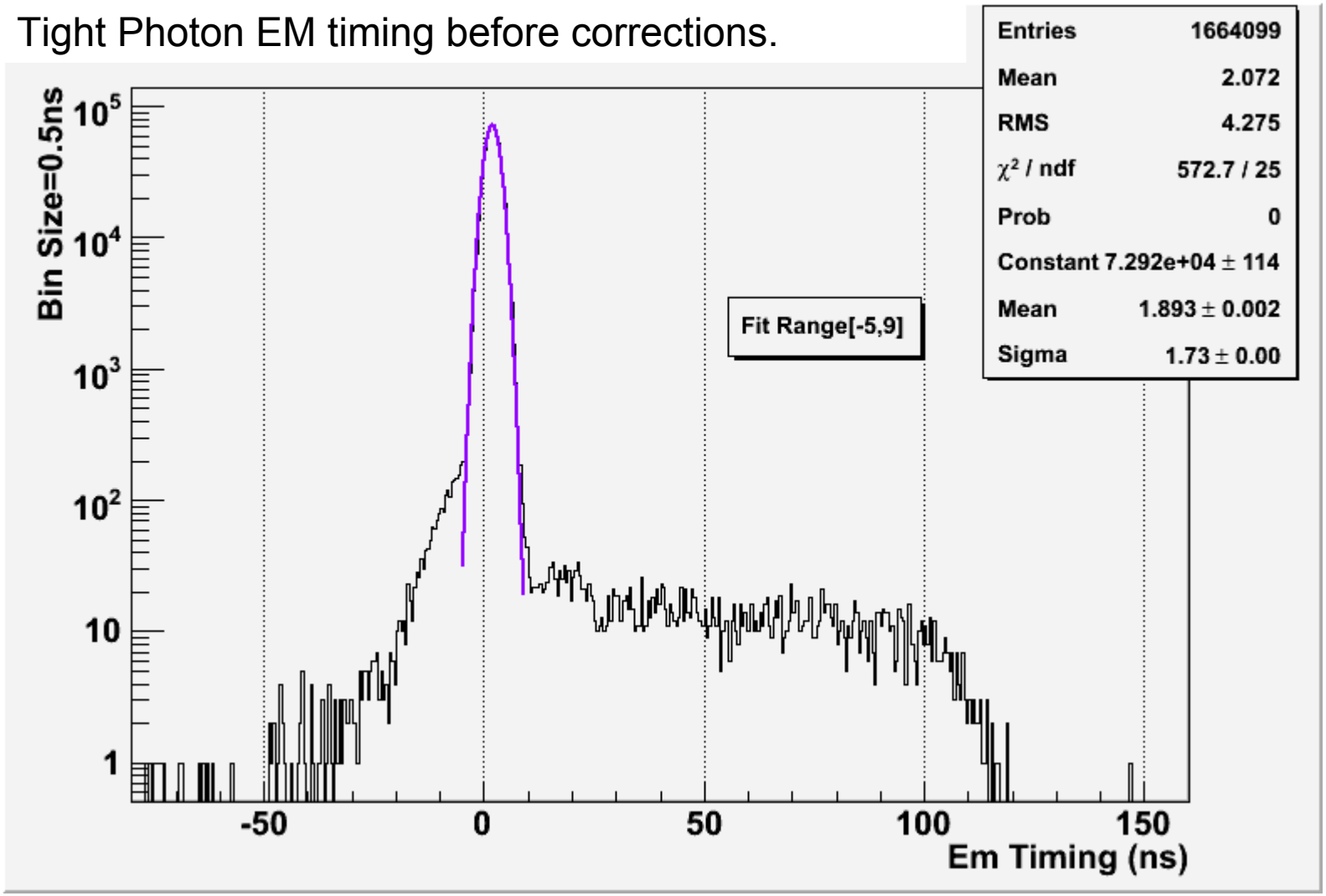
- Use EM timing
  - require photon to be in-time (>-4.8ns & <4.8ns) for events after 1st 400 pb^{-1}.
- Veto all event with trackless muon stubs in first 400 pb^{-1}.

Backgrounds:Non-collision: Cosmic

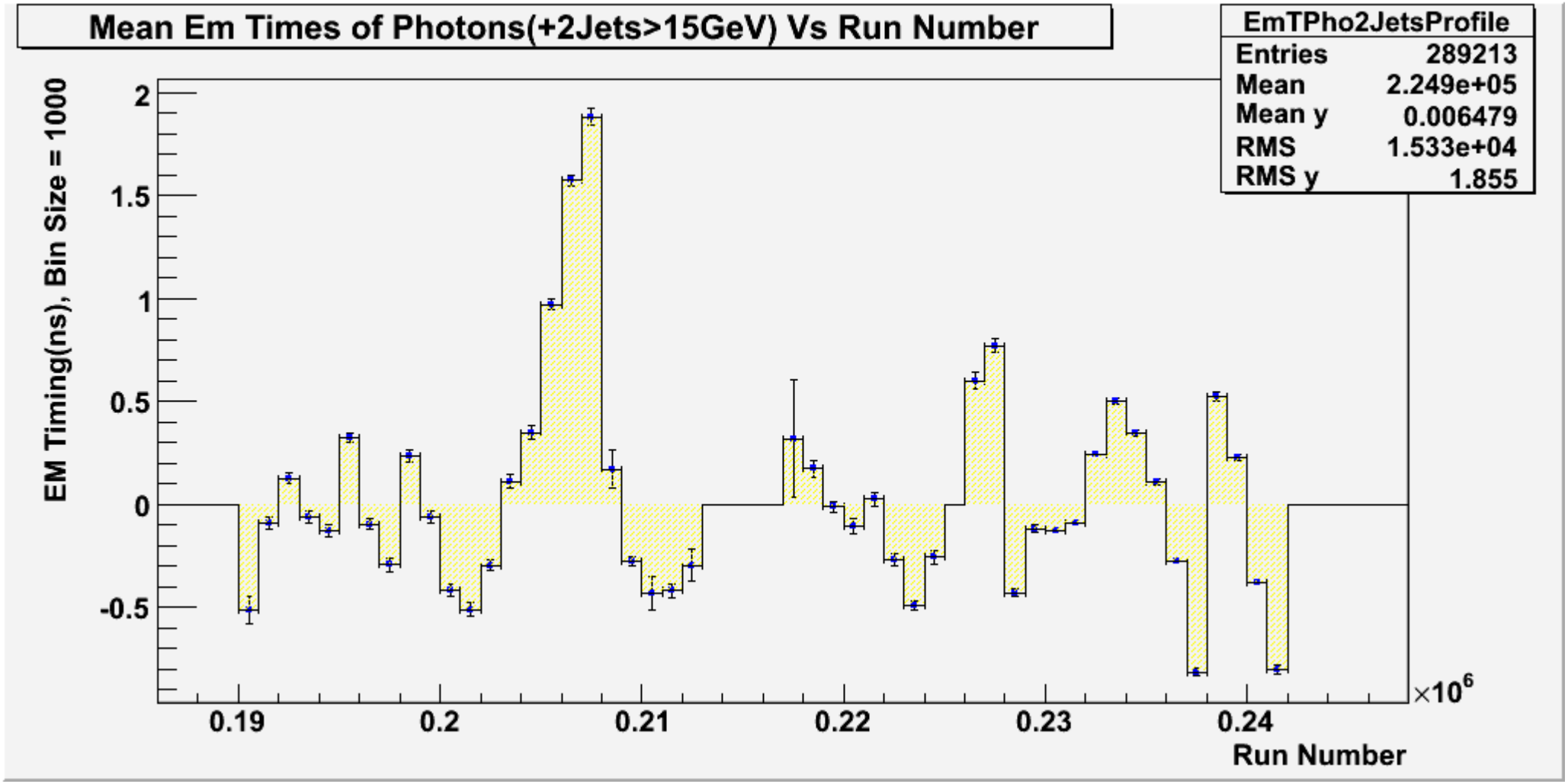


Backgrounds:Non-collision: Cosmic

Tight Photon EM timing before corrections.



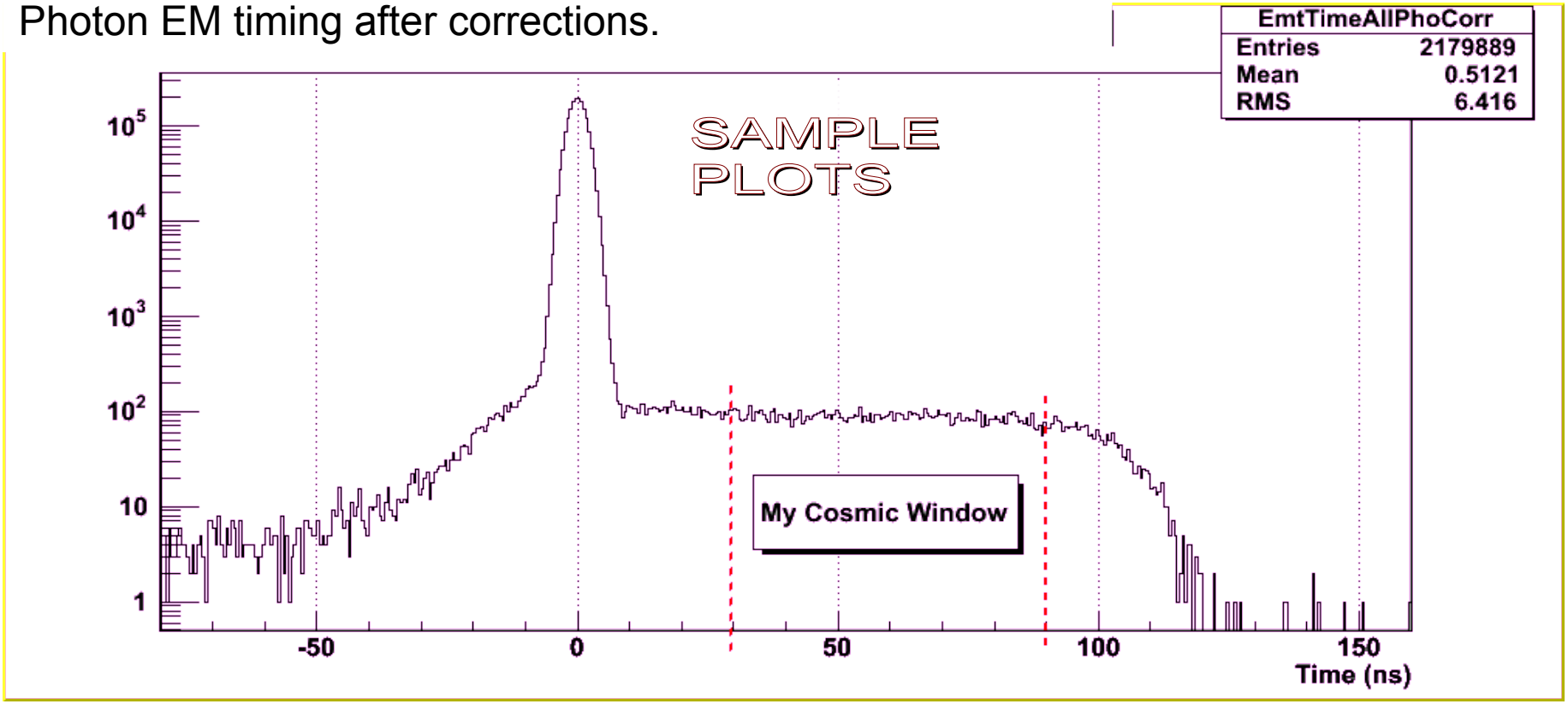
Backgrounds:Non-collision: Cosmic



- Got corrections to EM timing thanx to Max.

Backgrounds:Non-collision: Cosmic

Photon EM timing after corrections.



Estimation

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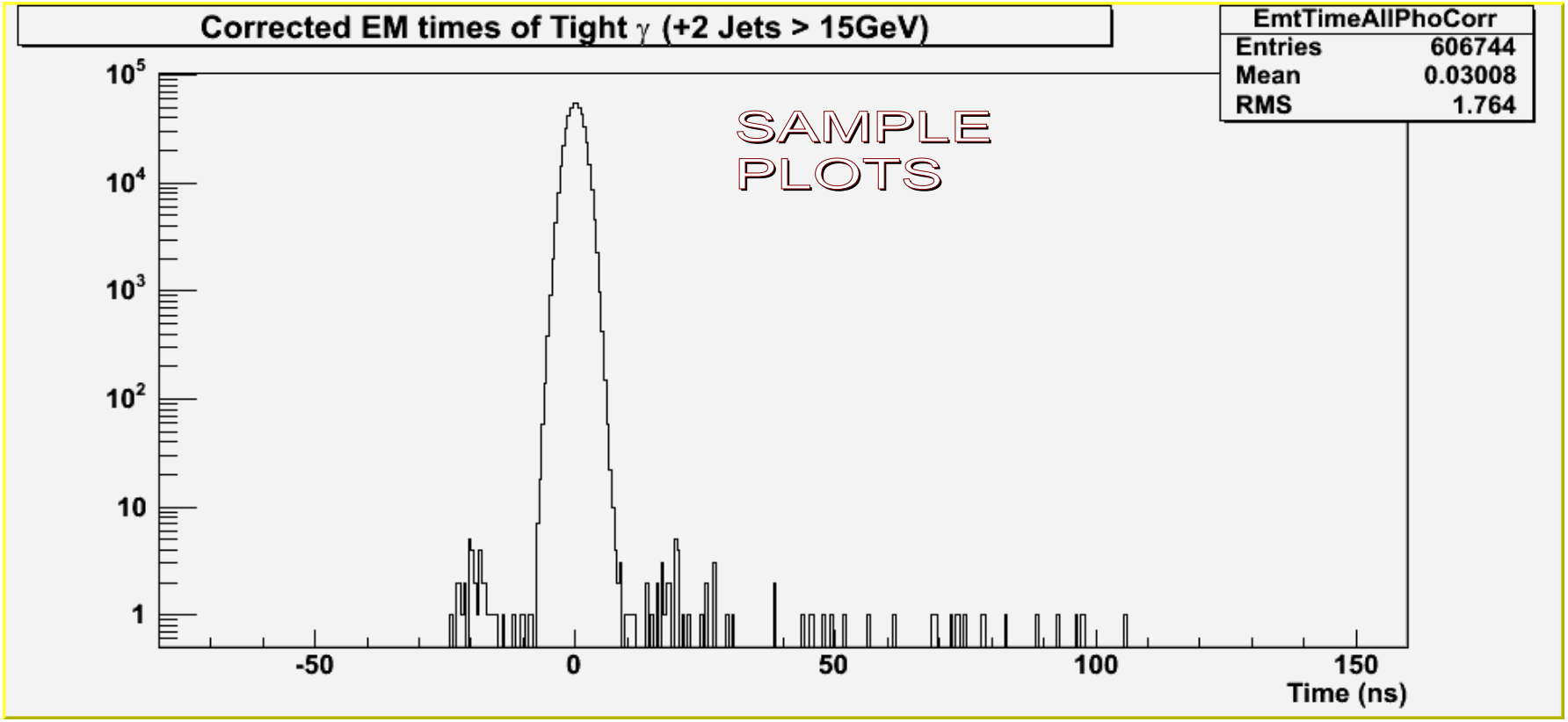
Backgrounds:Non-collision: Cosmic

- Pick time window >30ns and < 90ns
- Count how many has trackless muon stubs.



Estimation

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Backgrounds:Non-collision: Cosmic

- Expect 5 events for the period with timing.
- 23 events in first 400 pb^{-1}.

Template

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Backgrounds:Non-collision: Cosmic

- Tight photon
- Time between >30ns and < 90ns
- Exclude first 400pb^{-1}
- 1 or more Jets

Template

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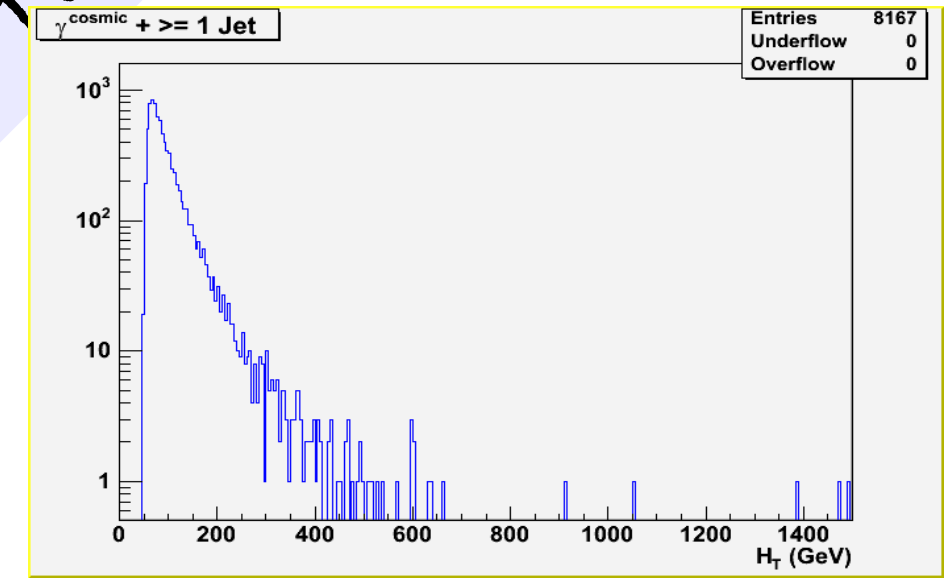
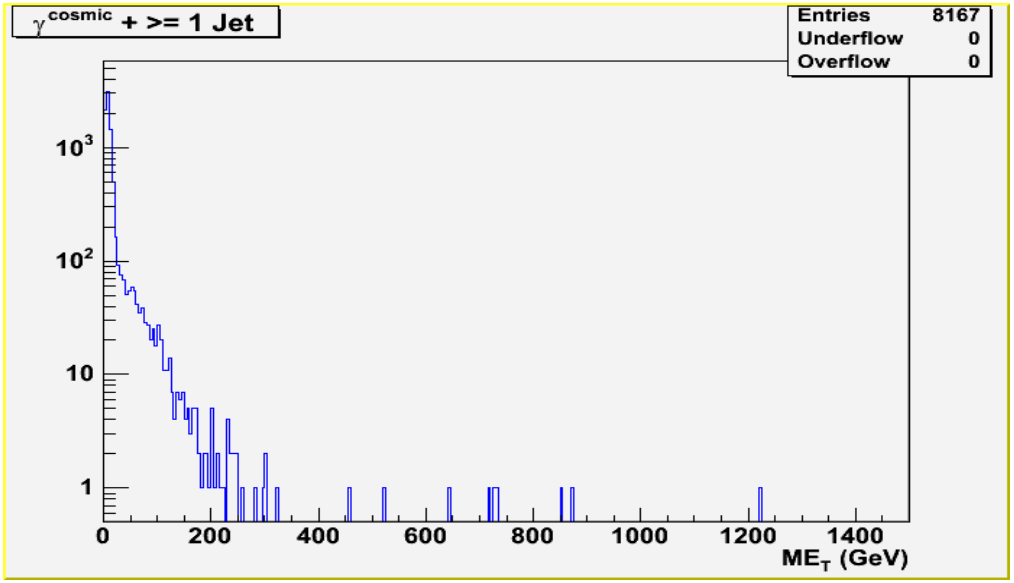
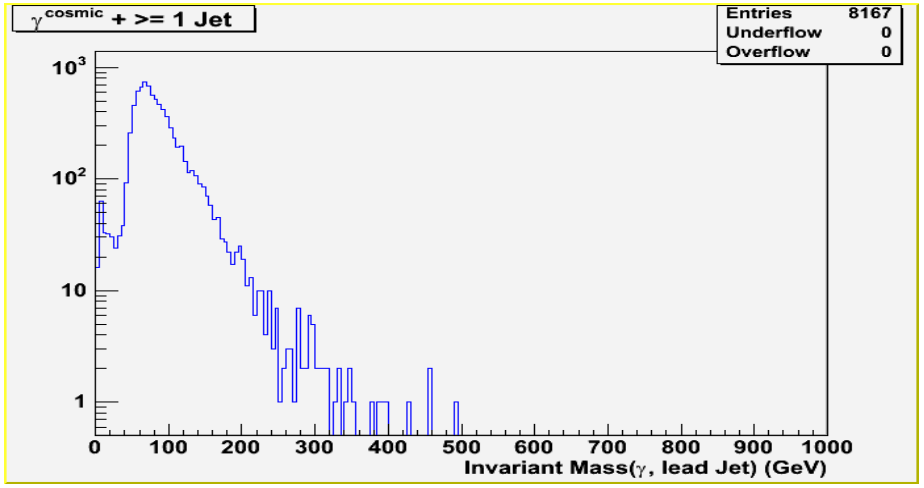
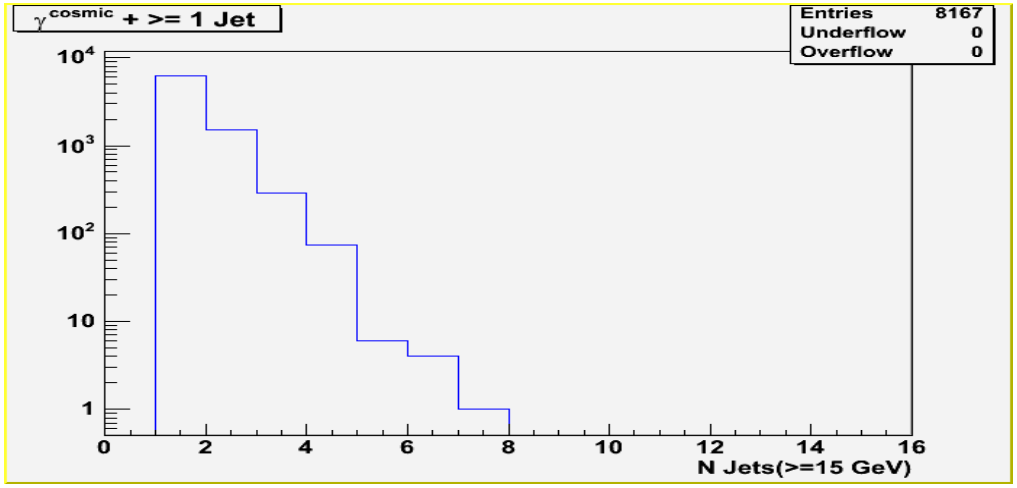
Backgrounds:Non-collision: Cosmic









Rejection

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Backgrounds:SM Processes: Electron

- Use Phoenix rejection (~60% eff. Et>35GeV)

Backgrounds:SM Processes: Electron

Variable	Cut value
detector	central
conversion	no
corrected E_T	> 30 GeV
CES fiduciality	$\lvert X_{CES}\rvert \leq 21$ cm 9 cm $\leq \lvert Z_{CES}\rvert \leq 230$ cm
average CES χ^2	≤ 20
Had/Em	$\leq 0.055 + 0.00045 \times E$
$E_T^{Iso(corr)}$ in cone 0.4	$\leq 0.1 \times E_T$ if $E_T < 20$ GeV $\leq 2.0 + 0.02 \times (E_T - 20)$ if $E_T \geq 20$ GeV
N3D tracks in cluster	$= 1, 2$
E/p of 1st track	$0.8 \leq E/p \leq 1.2$ if $p_T < 50$ GeV no cut if $p_T \geq 50$ GeV
2nd track p_T if N3D $= 2$	$\leq 1.0 + 0.005 \times E_T$
TrkIso(0.4) - p_T 1^{st}trk	$\leq 2.0 + 0.005 \times E_T$
E_T of 2nd CES cluster (wire and strip)	$\leq 0.14 \times E_T$ if $E_T < 18$ GeV $\leq 2.4 + 0.01 \times E_T$ if $E_T \geq 18$ GeV
$\lvert\Delta z\rvert = z_{vtx} - z_{trk}$	≤ 3 cm

Photon-like electron ID cuts

Estimation

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Backgrounds:SM Processes: Electron

- Using photon-like electron ID cuts to identify electrons and use fake rate function (cdfnote 8220 -Sasha Pronko et.al.)
- Expect 1281+/-147+/-4

Template

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Backgrounds:SM Processes: Electron

- electron passing photon-like electron ID cuts
- in-time
- not a conversion electron
- use fake rate
- 1 or more Jets

Template

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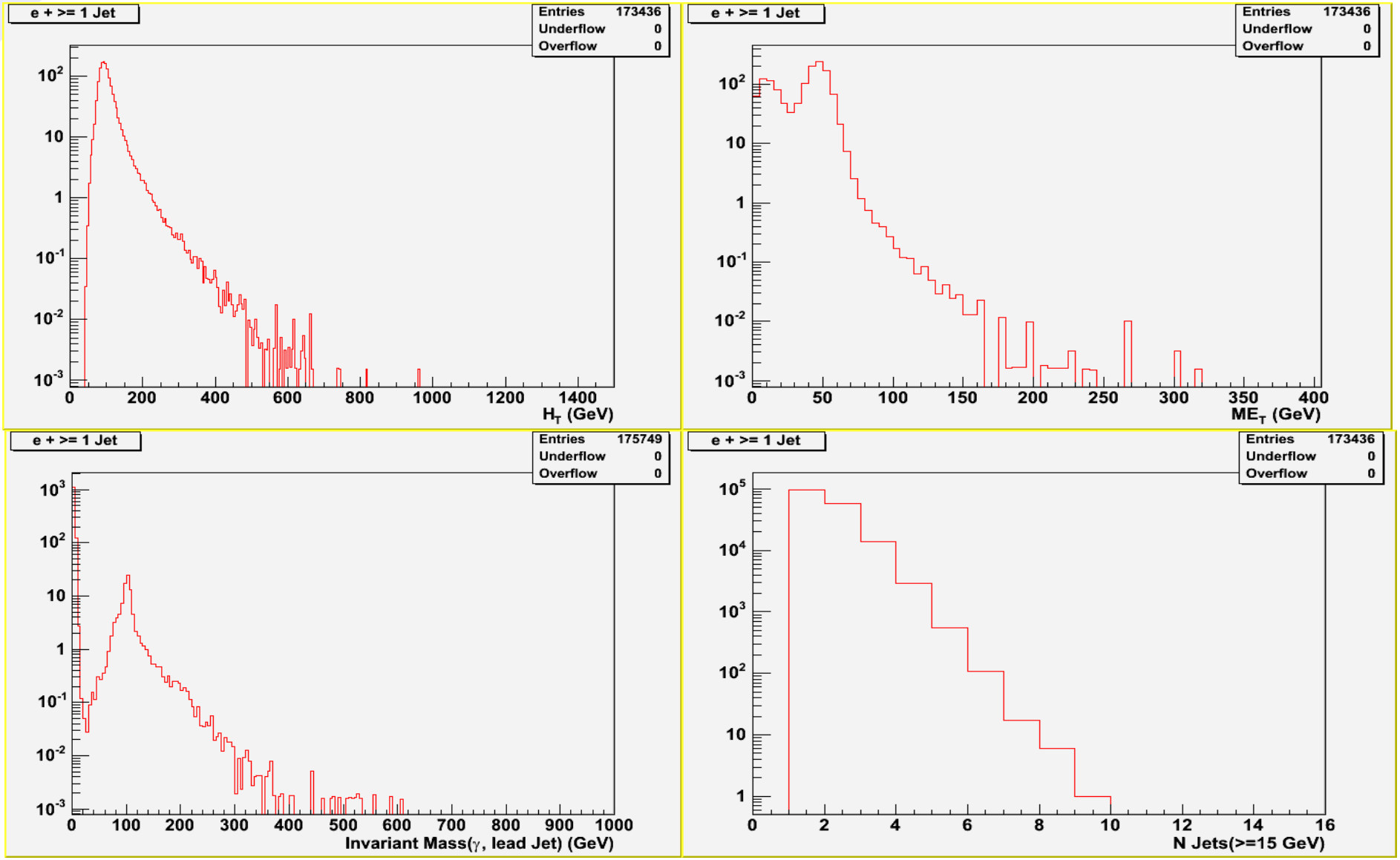
Backgrounds:SM Processes: Electron



Cross checks

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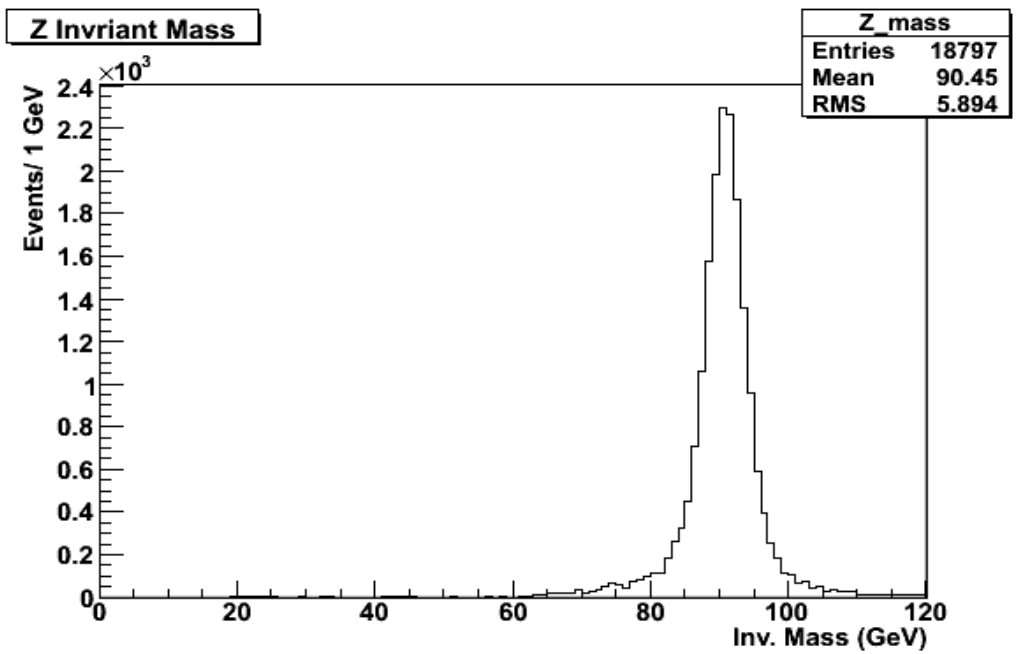
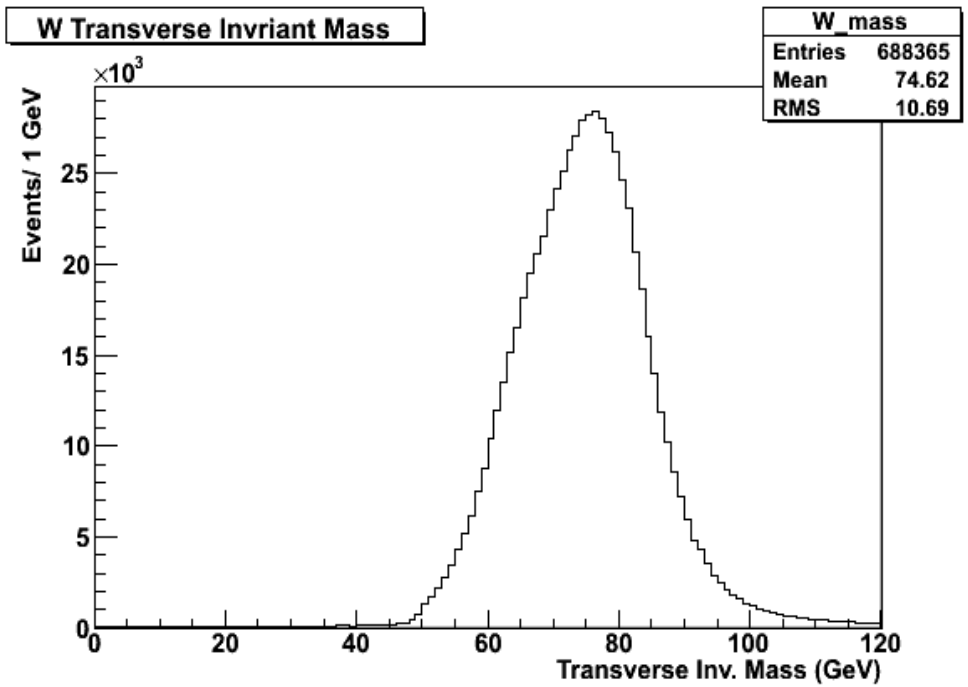
Backgrounds:SM Processes: Electron

- W cross section = 3052 pb^{-1} (2782 pb^{-1} - cdfnote-6939)
- Z cross section = 279.3 pb^{-1} (255.2 pb^{-1} - cdfnote-6939)





Cross checks

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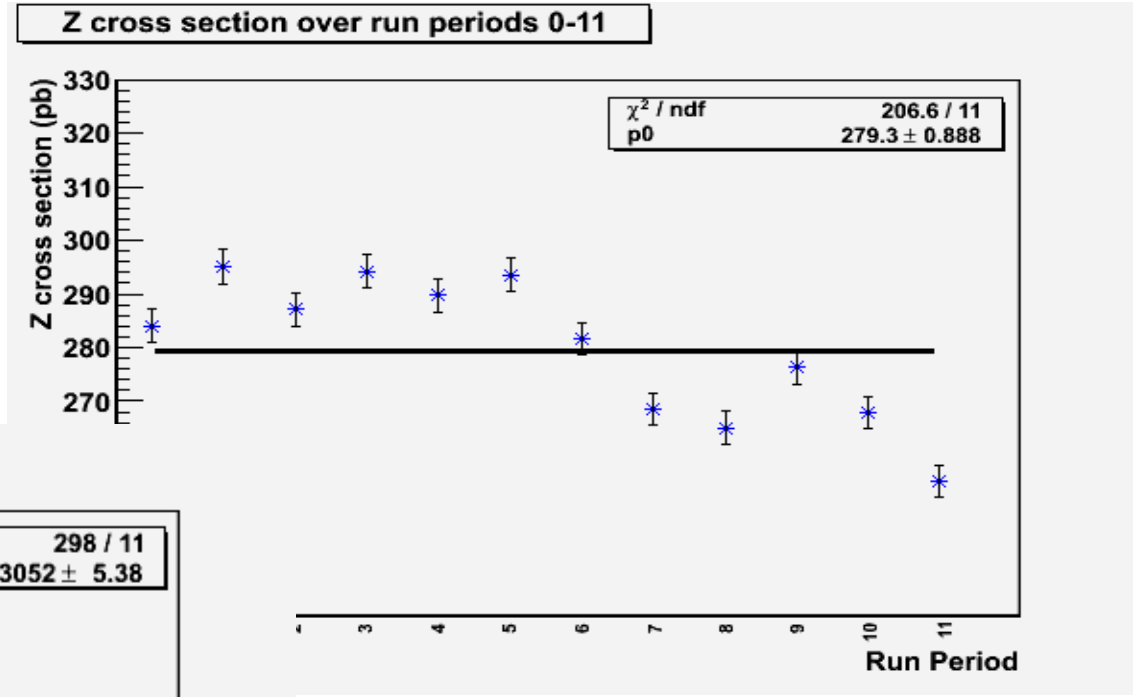
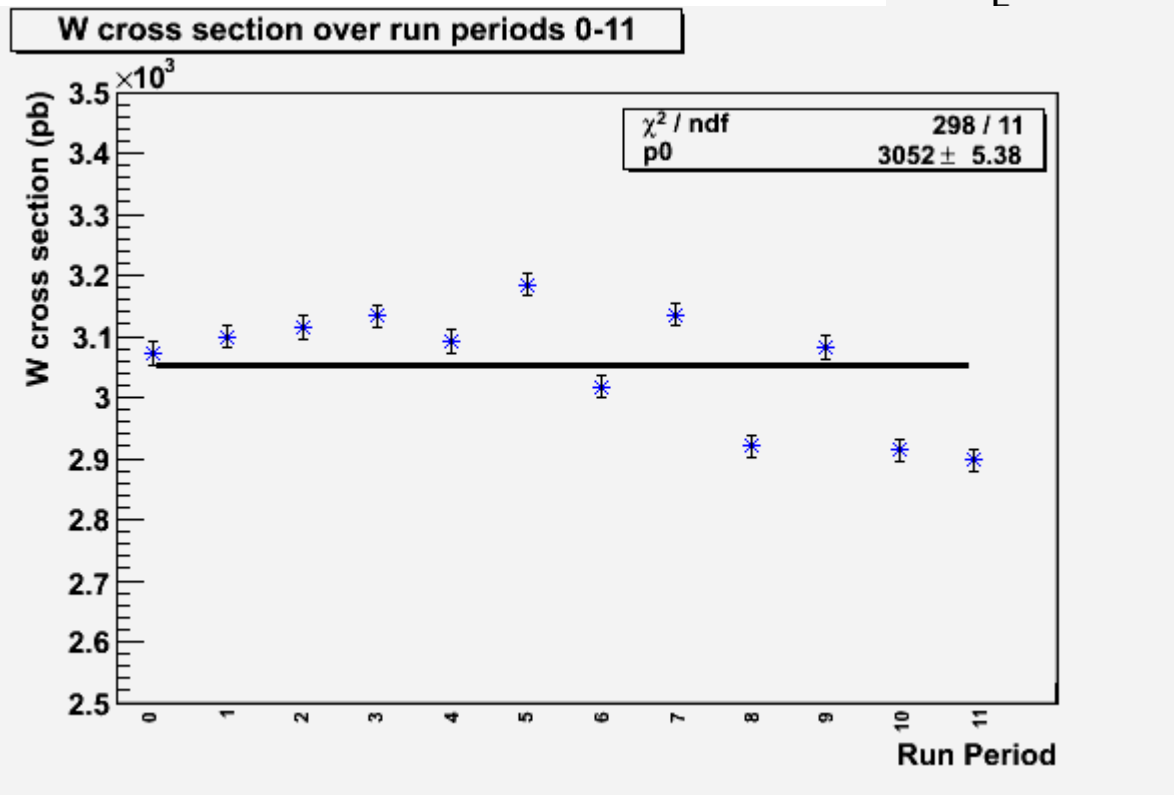
Backgrounds:SM Processes: Electron

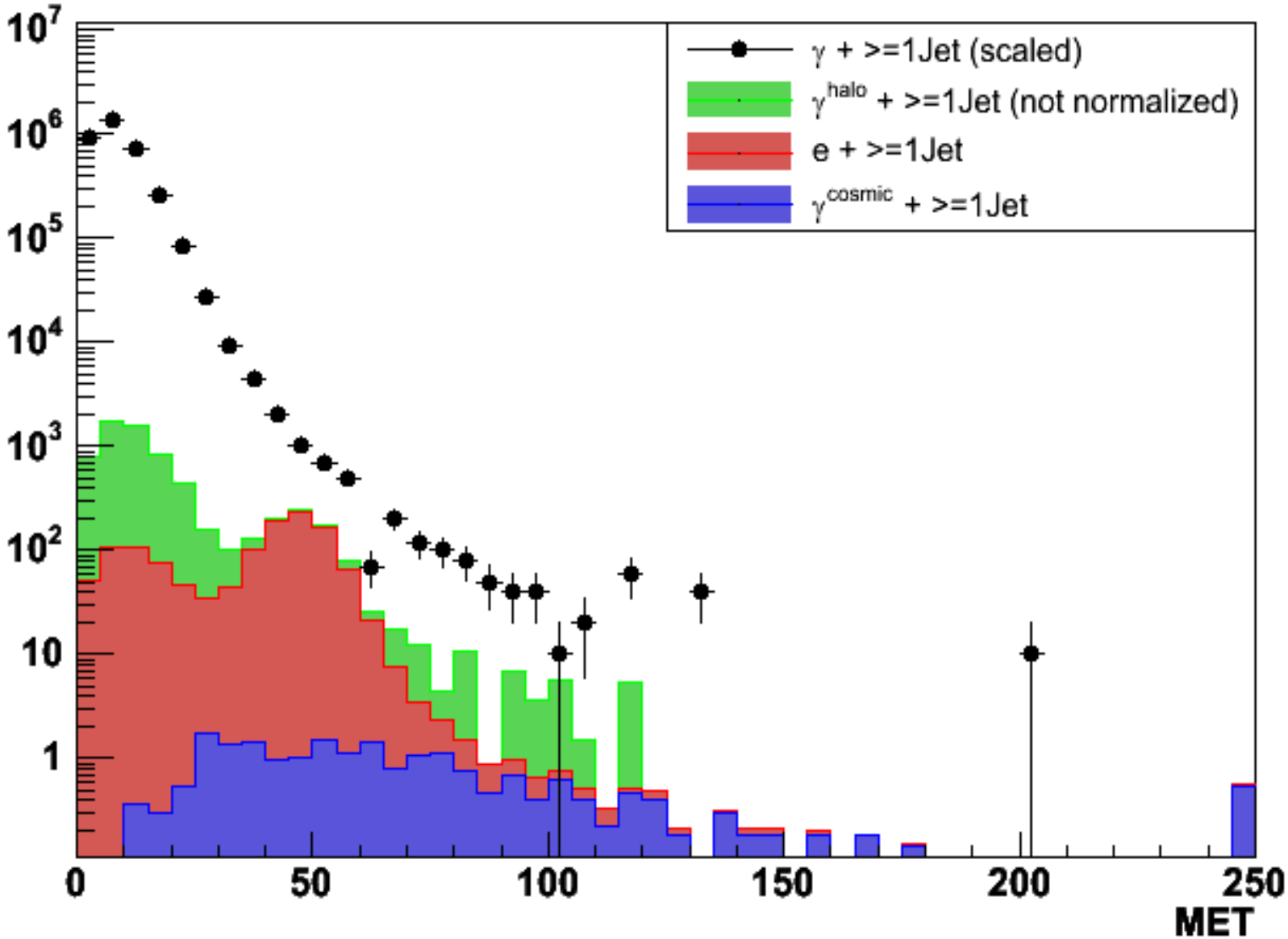




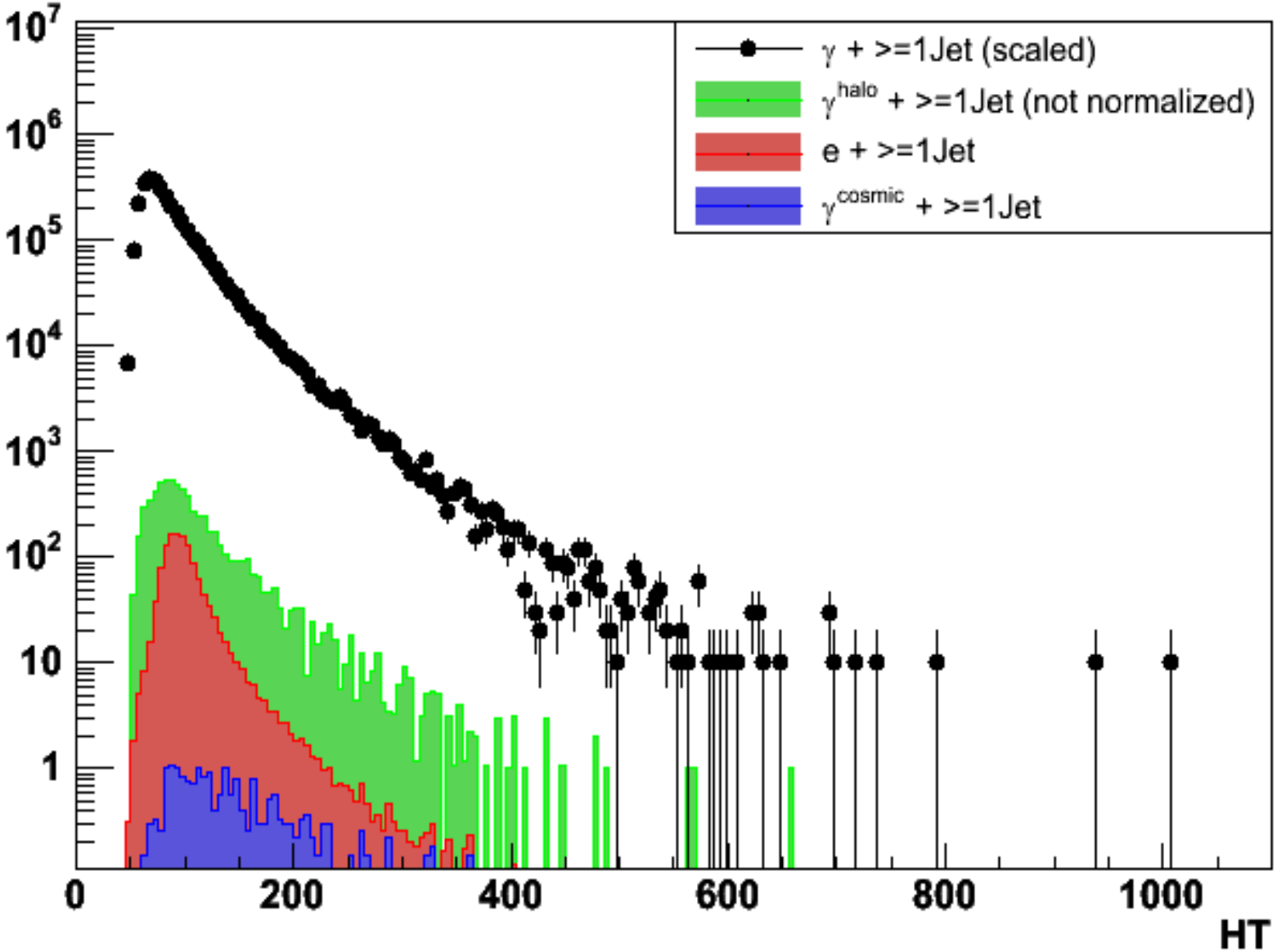
Summary of Backgrounds

	Expected
	for >=1 Jets
Cosmic	23
Beam halo	3065
Electron	1281+/-147 +/- 4

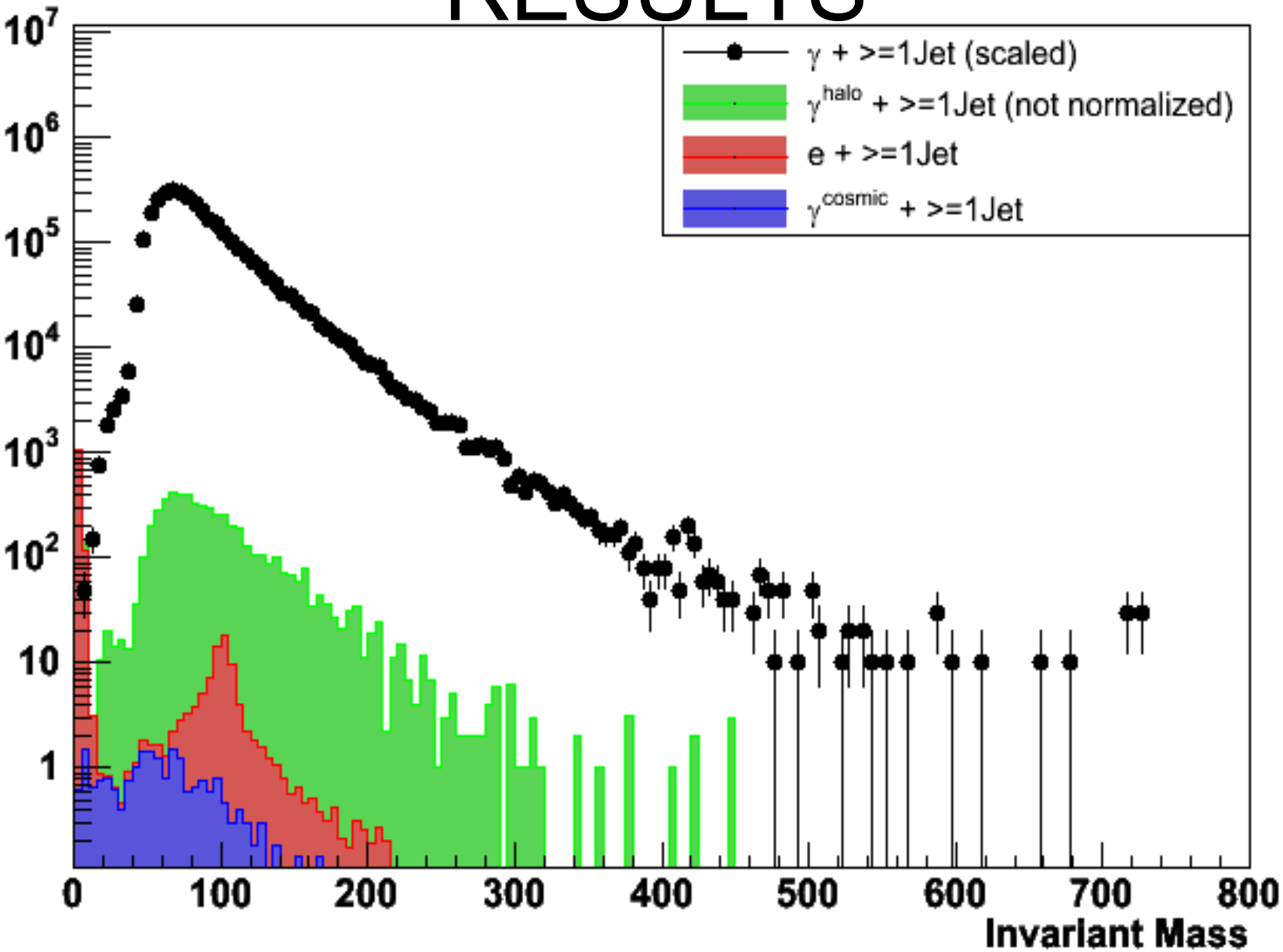
RESULTS


γ + >=1Jet (scaled)
γ^halo + >=1Jet (not normalized)
e + >=1Jet
γ^cosmic + >=1Jet
10^7
10^6
10^5
10^4
10^3
10^2
10
1
0
50
100
150
200
250
MET

RESULTS


γ + >=1Jet (scaled)
γ^halo + >=1Jet (not normalized)
e + >=1Jet
γ^cosmic + >=1Jet
10^7
10^6
10^5
10^4
10^3
10^2
10
1
0
200
400
600
800
1000
HT

RESULTS


γ + >=1Jet (scaled)
γ^halo + >=1Jet (not normalized)
e + >=1Jet
γ^cosmic + >=1Jet
10^7
10^6
10^5
10^4
10^3
10^2
10
1
0
100
200
300
400
500
600
700
800
Invariant Mass

Thank you.

- Special thanks to Karen (Baylor) for writing down the correction during my practice talk.