Photoproduction of isolated photons with a jet at HERA. Reweighting

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Motivation

Signal MC is a sum of 4 components and is dependent on ratios in which those components are combined.

Old control plots had too large direct fraction in low x_γ region and resolved in high x_γ: PYTHIA 50/40/5/5 which is ratio for all x_γ. This was not the case with other calculations (acceptance, cross-sections) – x_γ was accounted for there.

This resulted in following control plots which suggested that reweighting is necessary:
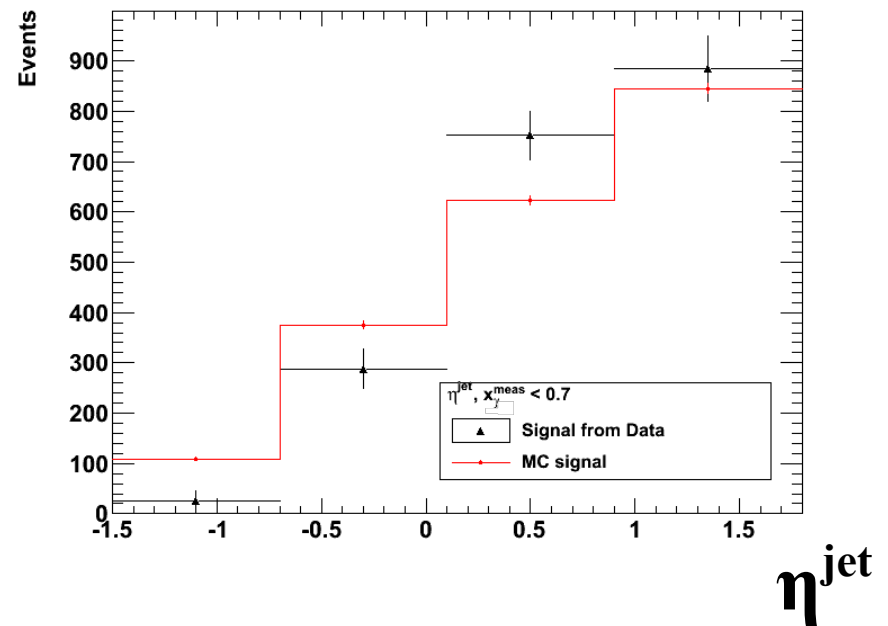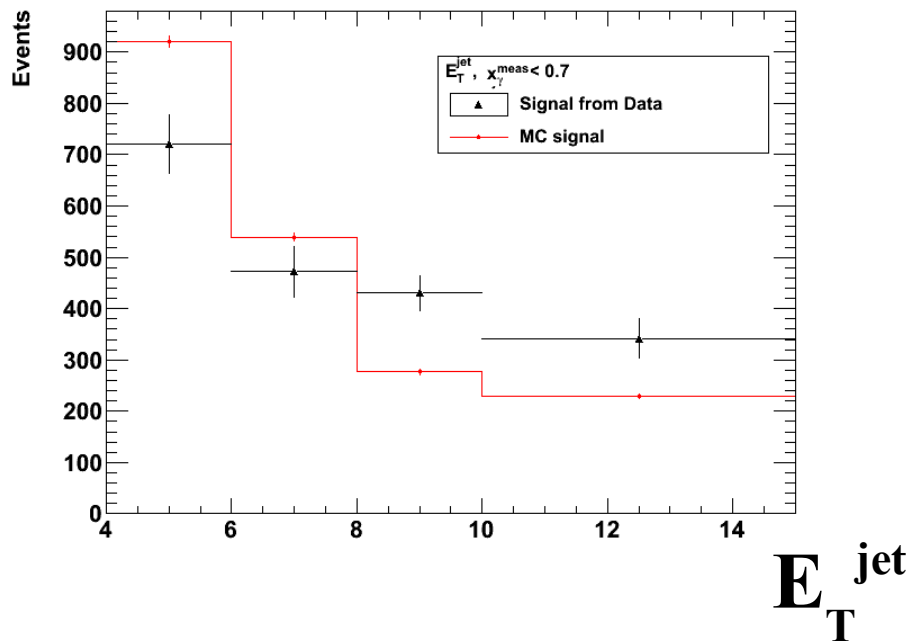
Data Samples

Data: HERA II 04p, 04/05e, 06e, 06p, 07p (Common Ntuples v06d) 374 pb^{-1}

MC Signal: 04p, 05e, 06e, 06p, 07p (CN v06b PYTHIA, HERWIG – for systematic) Direct, Resolved

MC Background: 04p, 04/05e, 06e, 06p, 07p (CN v06b PYTHIA - Heavy Flavour Group, Jet – Sebastian's + Filtered, HERWIG – for systematic) Direct, Resolved

Cuts

Event Selection

Trigger HPP16 on

$0.2 < y_{JB} < 0.7$

$| Zvtx | < 40$ cm

$|BCAL \, time| < 10$ ns

Cal $p_T < 10$ GeV

No SINISTRA electron with Prob > 0.9 and Yel < 0.7

Prompt Photon Selection

Tufo[0] =31

$-0.7 < \eta^{zufo} < 0.9$

$6 < E_T^{zufo} < 15$ GeV

$E^{zufo}/E^{jet} > 0.9$

ZufoEemc/ZufoEcal>0.9

track isolation in cone 0.2

$x_\gamma < 0.7$, $x_\gamma < 0.8$ or $x_\gamma > 0.8$

Jet Selection

$-1.5 < \eta^{jet} < 1.8$

$4 < E_T^{\,jet} < 35$ GeV

Truth level selection

$Q^2 < 1$ GeV^2

$0.2 < y_{JB} < 0.7$

Particle type 29

$-0.7 < \eta^{particle} < 0.9$
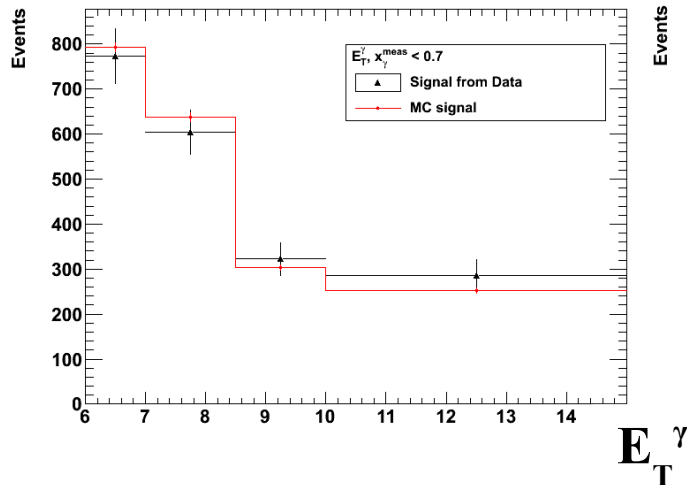
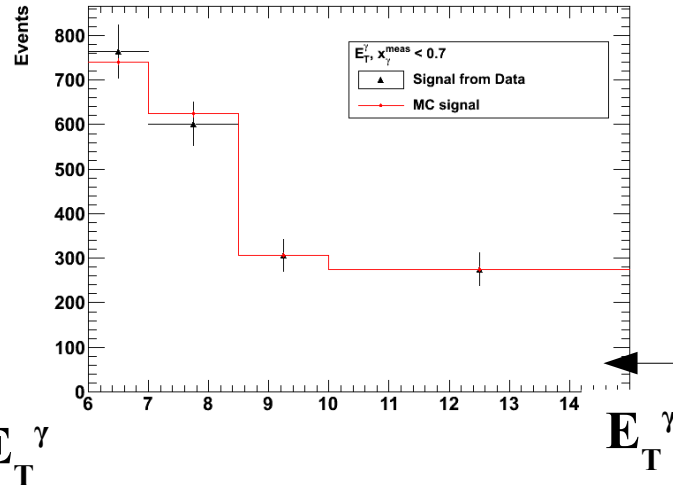$6 < E_T^{particle} < 15$ GeV

$E^{particle}/E^{jet} > 0.9$

Changing ratio of components in signal MC. $x_\gamma < 0.7$

Previously shown plots had ratio of dir/res/dir-rad/res-rad as 50/40/5/5 – determined from detector level x_γ fit in all x_γ range. New plots have this ratio adjusted accordingly as it changes when separate x_γ ranges are considered.
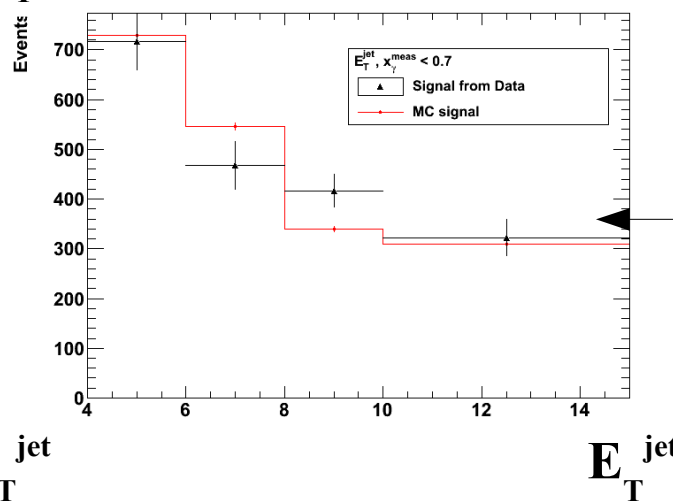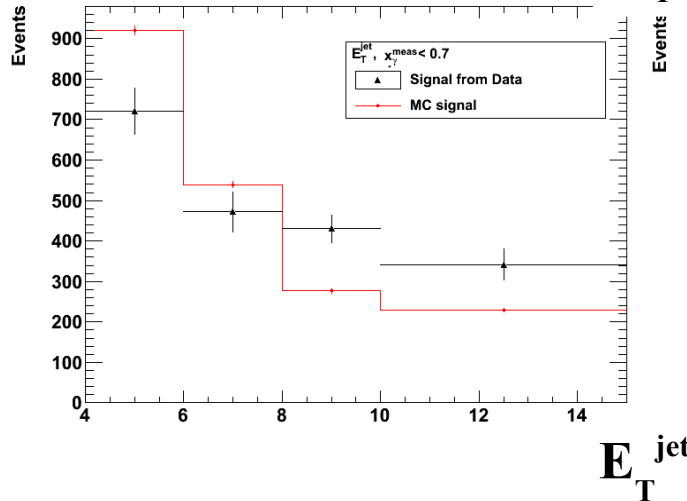
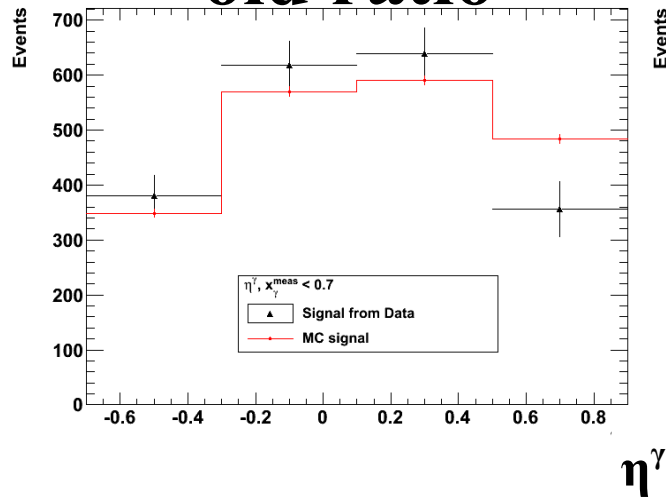## old ratio

new ratio

New ratio, xgamma<0.7:

10/75/5/10

Not a significant change in E_T^γ description

E_T^{jet} looks better now

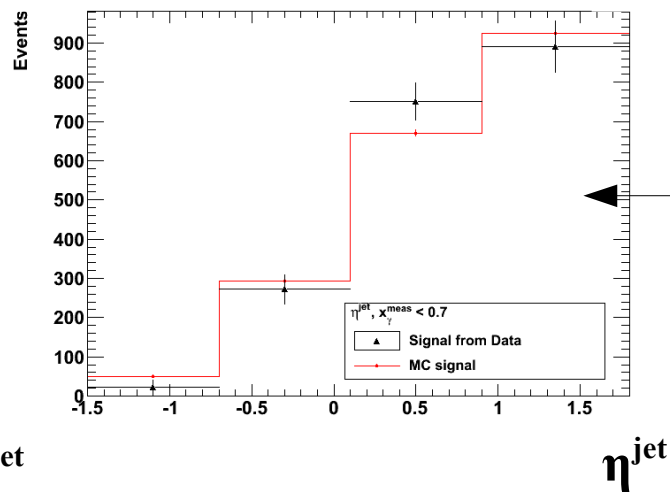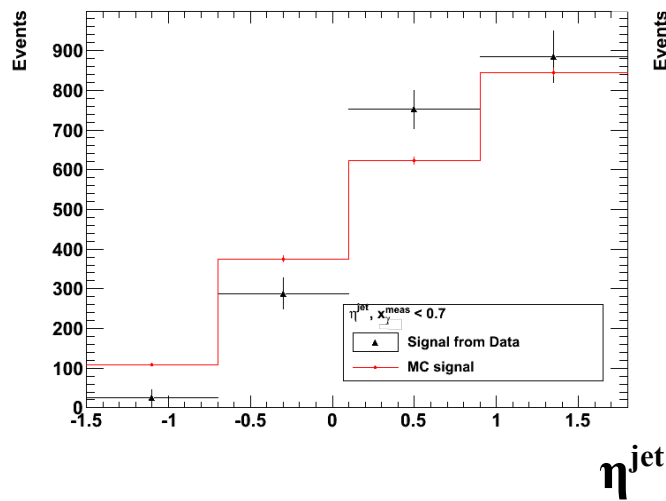# Changing ratio of components in signal MC. $x_\gamma < 0.7$

old ratio
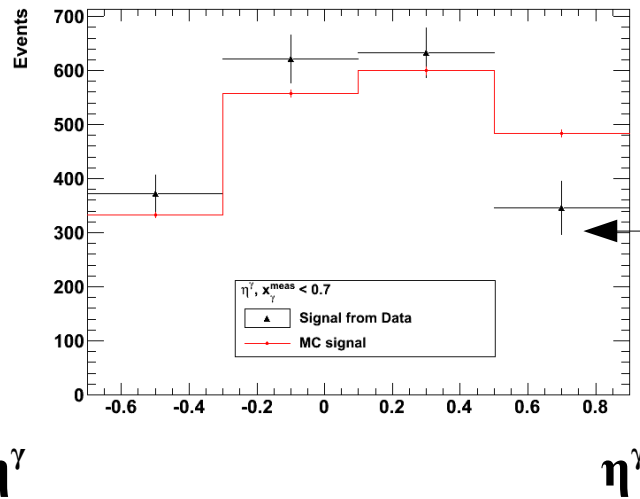
new ratio

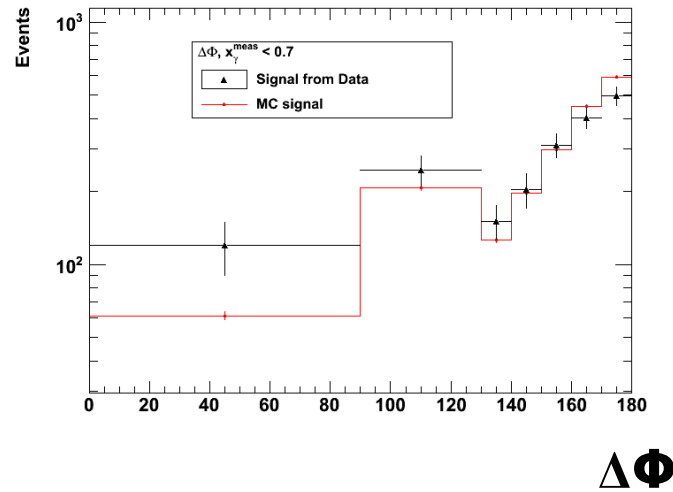η^γ still looks not so good.
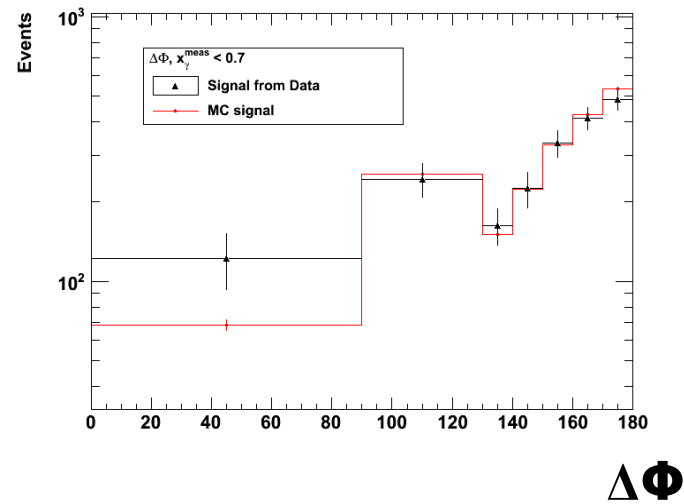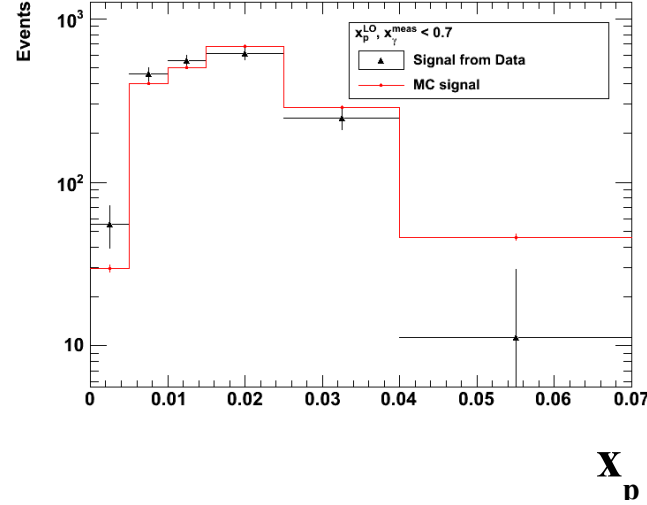Considered for reweighting

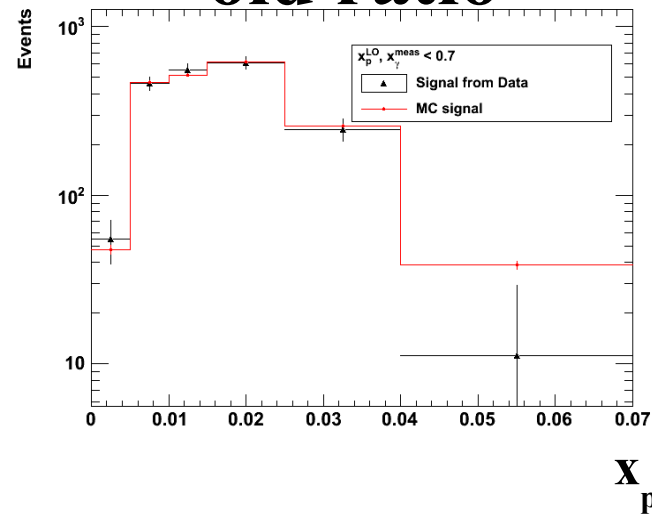η^{jet} description improves

Changing ratio of components in signal MC. $x_\gamma < 0.7$
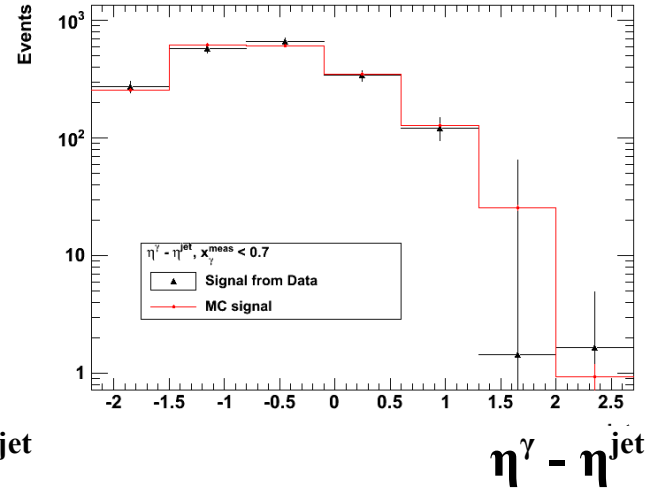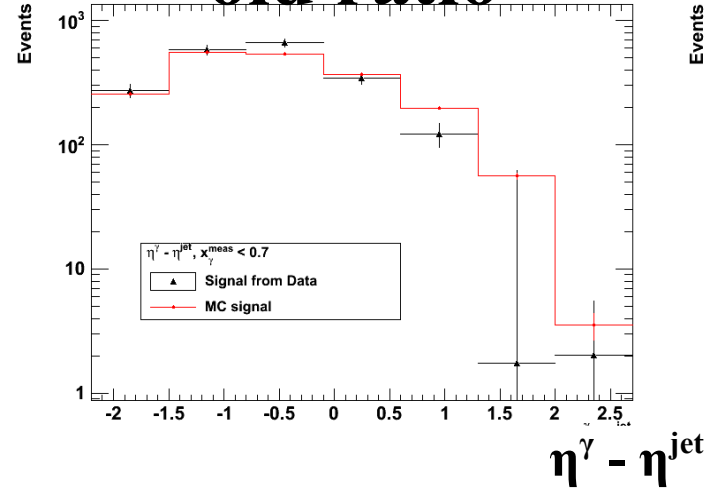
old ratio

new ratio

x_p and $\Delta\Phi$ get slightly worse.

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Changing ratio of components in signal MC. x_γ < 0.7

old ratio

new ratio

$\eta^\gamma - \eta^{jet}$ looks better.

Control plots with new ratio. Conclusion

Similar changes in presented variables are also observed in $x_\gamma < 0.8$ region (in backup section) – for low x_γ region examine effect of reweighting η^γ.

$x_\gamma > 0.8$

old ratio

new ratio

New ratio, xgamma<0.8:

82/13/4/1
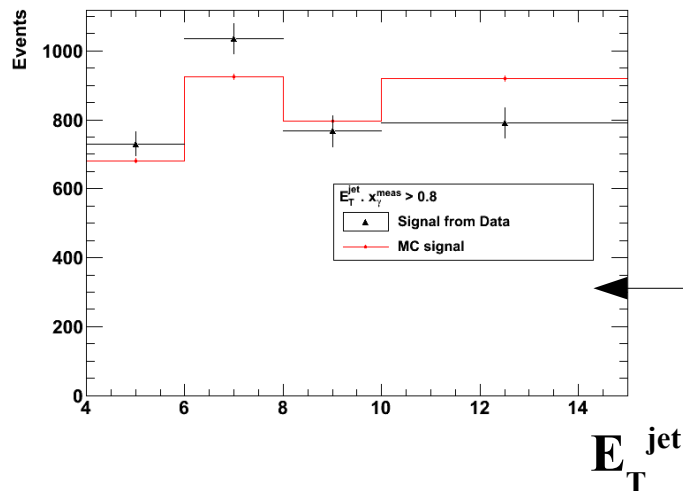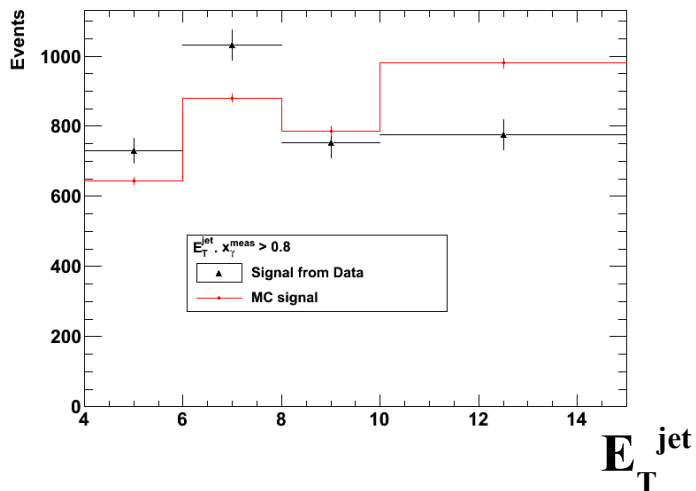
E_T^{jet} does not change much
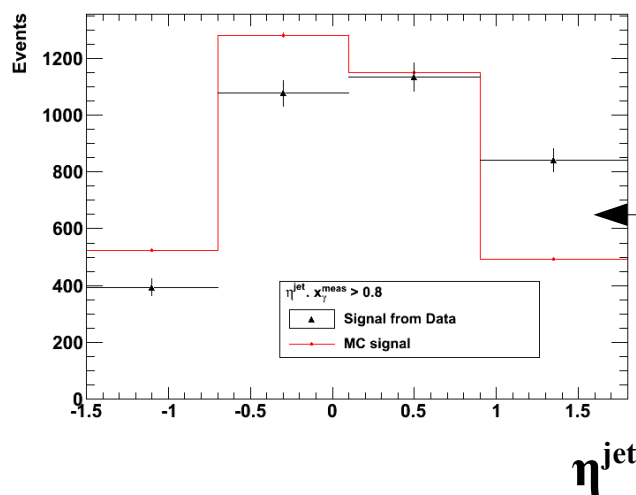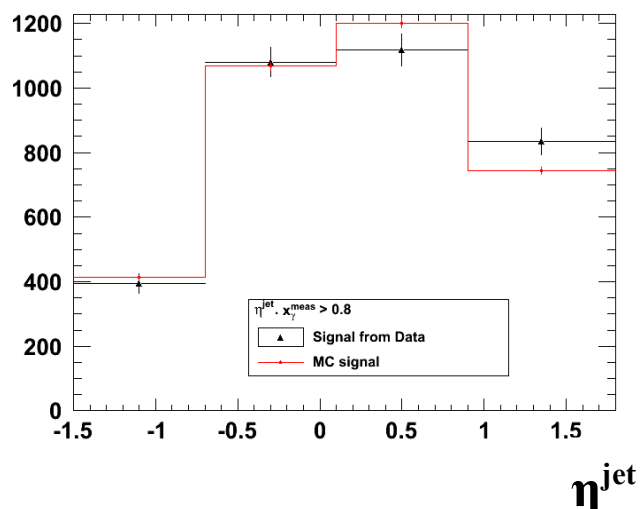
η^{jet} description gets worse

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For $x_\gamma > 0.8$ reweight E_T^{jet} and η^{jet}.

η^γ reweighting. x$_γ$ < 0.7

Before reweighting
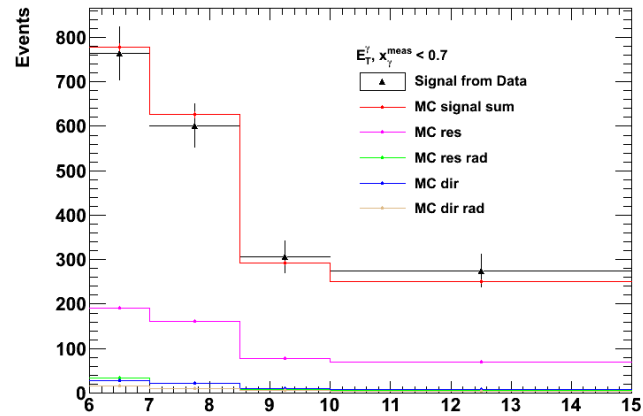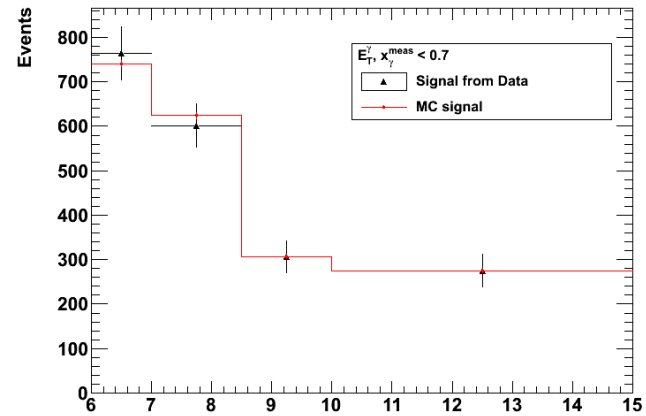
After reweighting
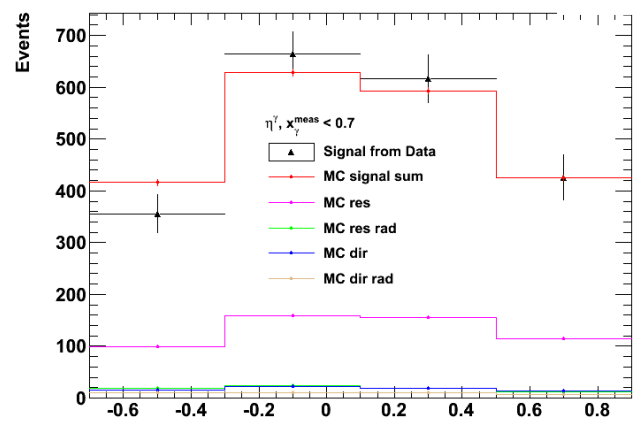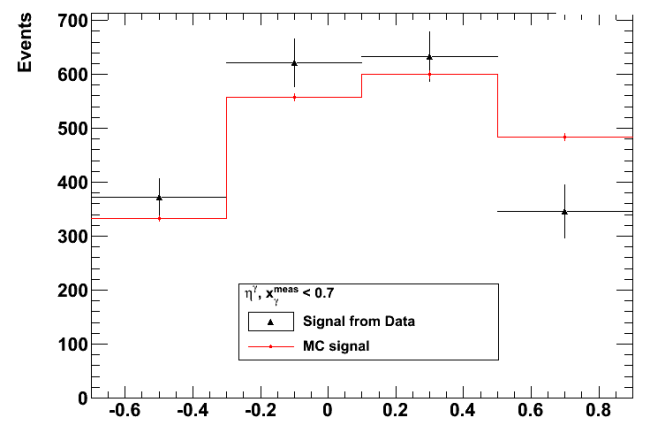
η^γ reweighted using function determined from four bins: weight = a*η^γ + b

E$_T^γ$ does not change much.

η^{γ} reweighting. $x_{\gamma} < 0.7$

Before reweighting

After reweighting
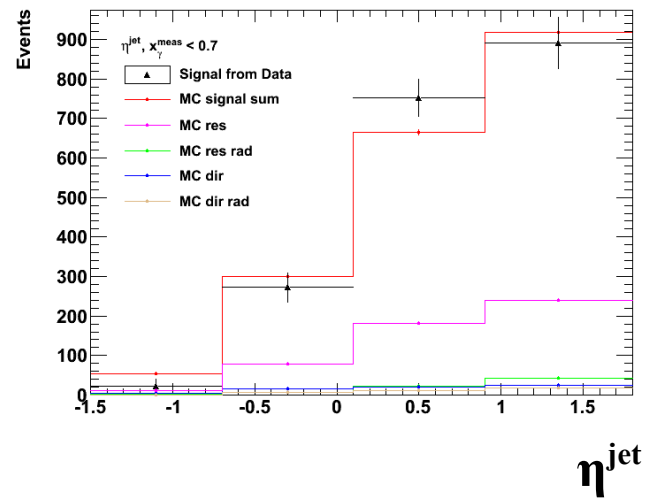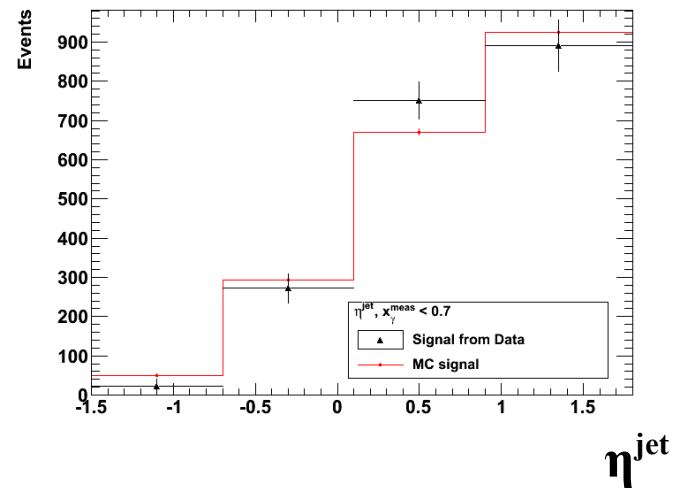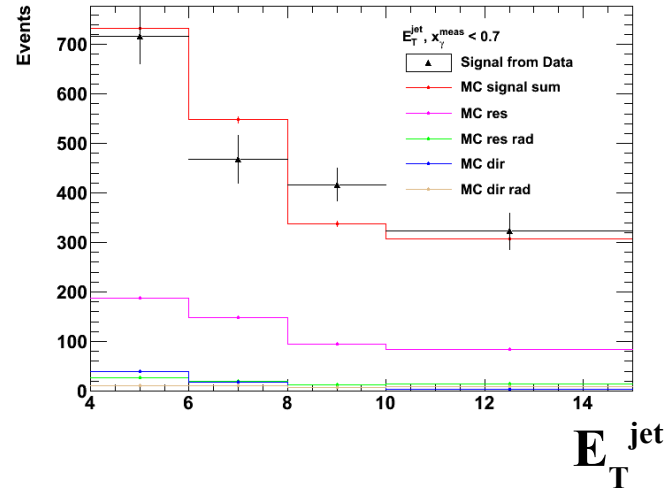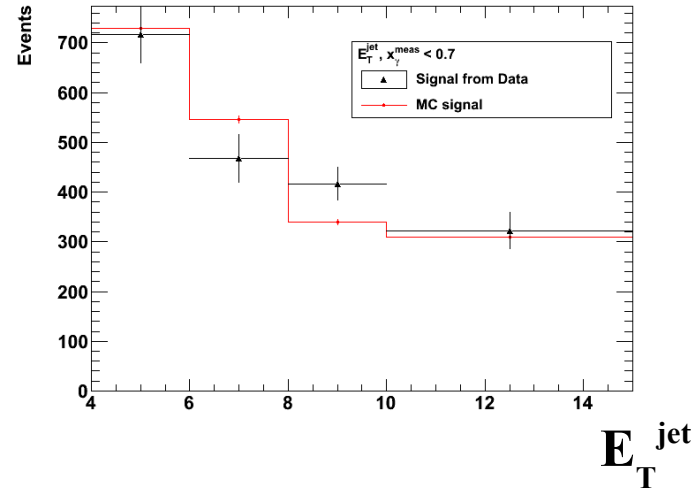
η^{jet} becomes slightly worse described.

η^{γ} reweighting. $x_{\gamma} < 0.7$

Before reweighting
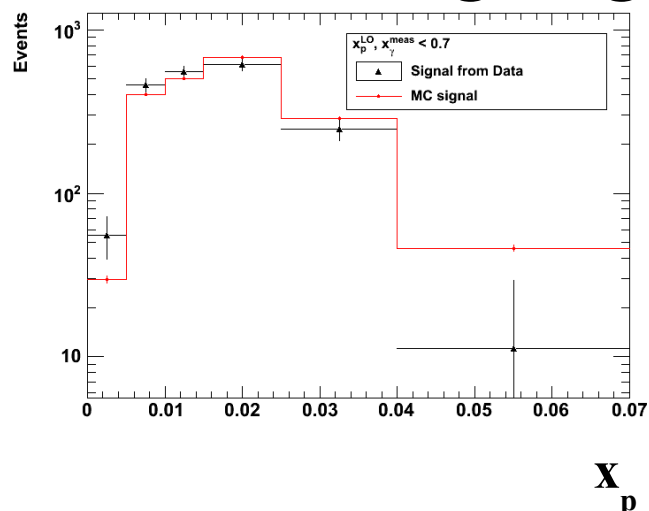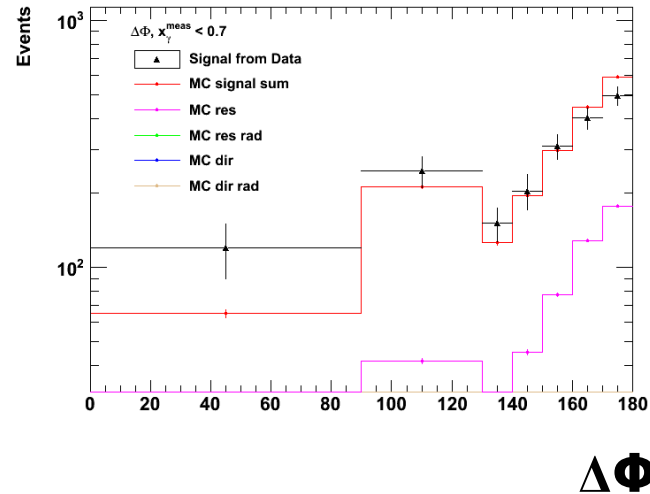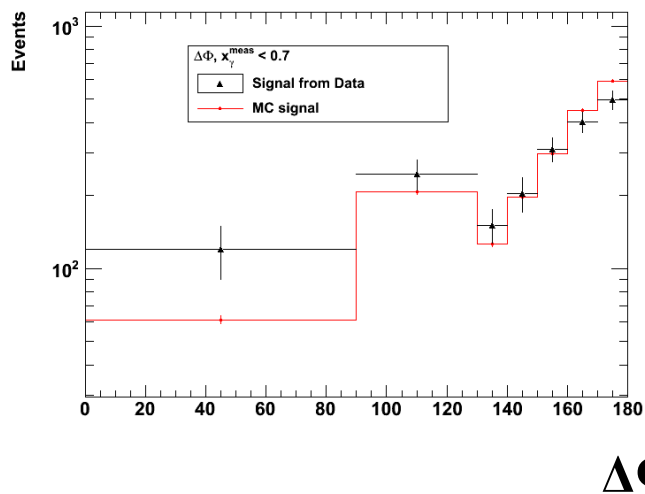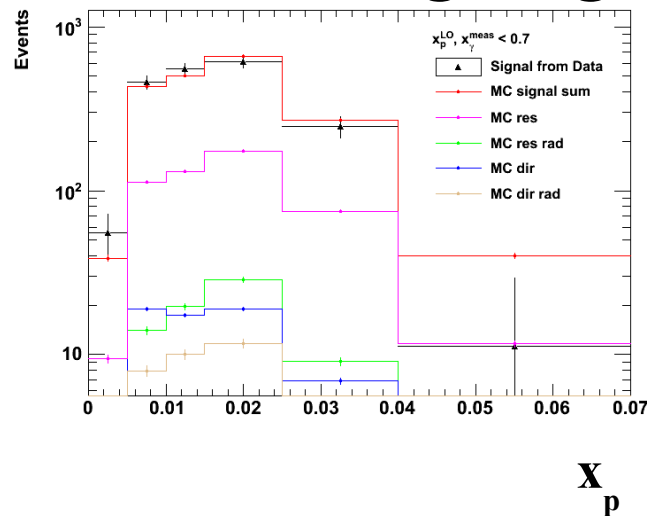
After reweighting

x_p becomes slightly better, but $\Delta\Phi$ does not change noticeably.

η^γ reweighting. x_γ < 0.7

$$\eta^\gamma \text{ reweighting. } x_\gamma < 0.7$$

Before reweighting
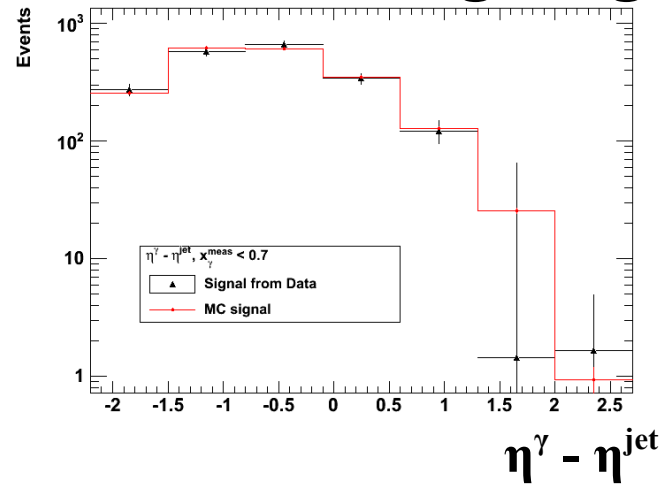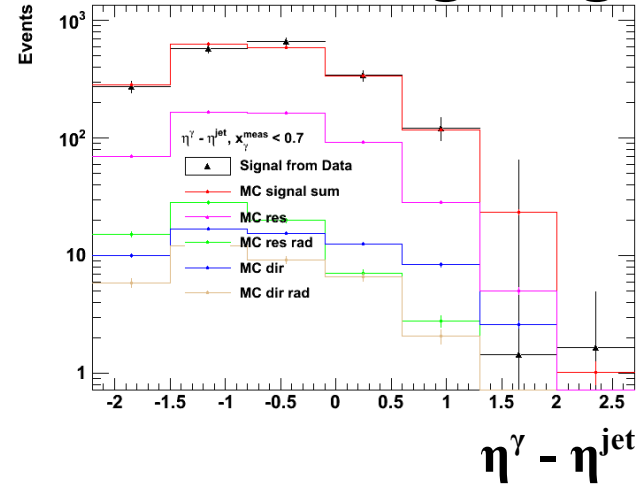
After reweighting

No noticeable improvement in $\eta^\gamma - \eta^{jet}$ description.

Conclusion: η^γ reweighting in low x_γ region has no significant effect on control plots.

E_T^{jet} and η^{jet} reweighting. $x_\gamma > 0.8$

Before reweighting
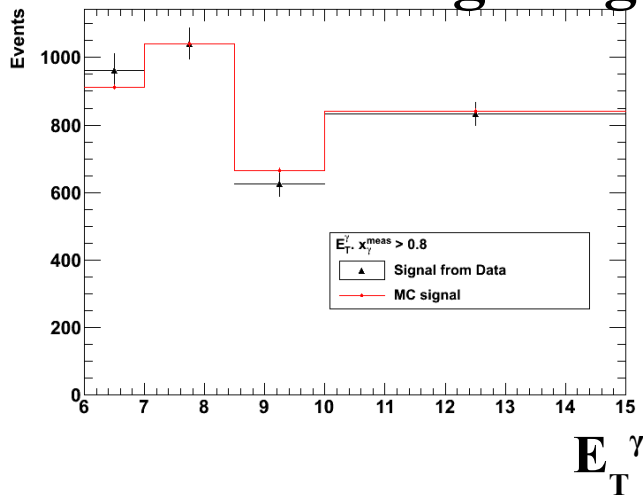
After reweighting
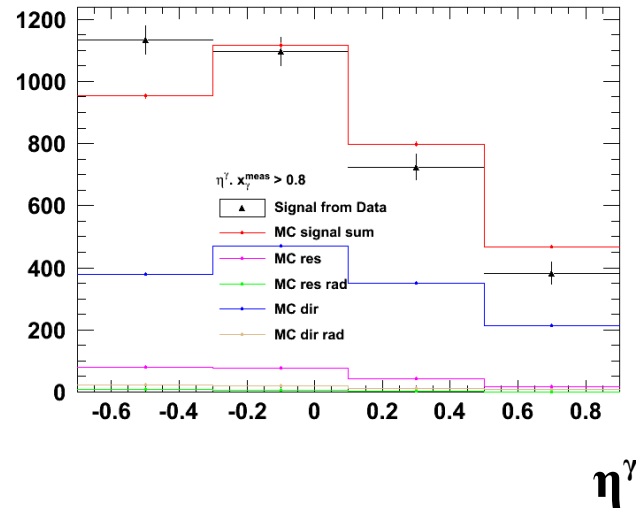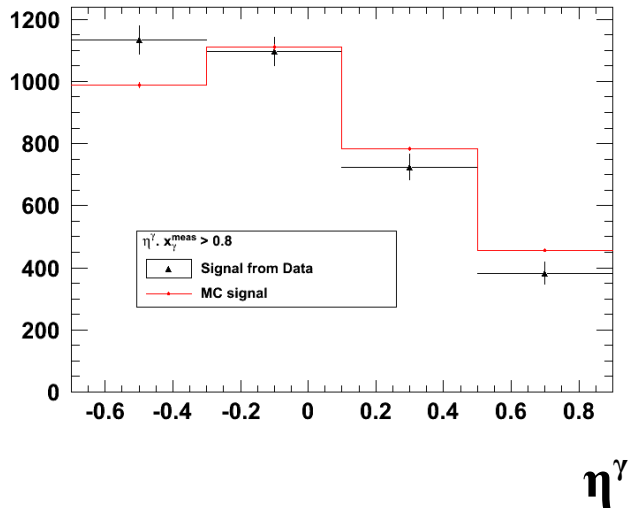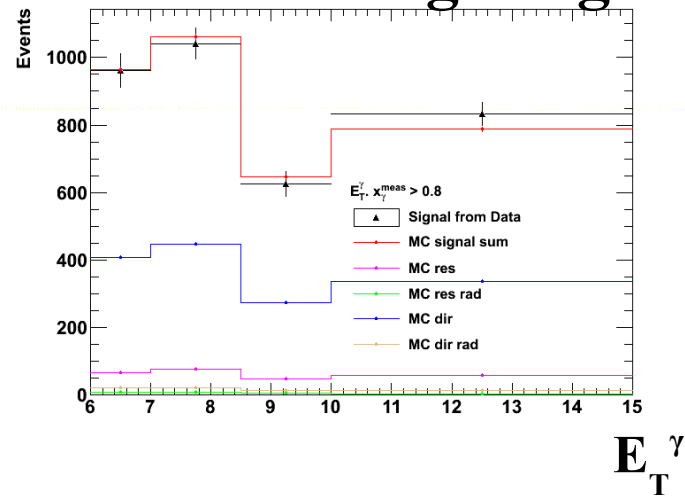
E_T^{jet} and η^{jet} reweighting using four weights from four bins of each variable.
No significant changes in description of E_T^γ and η^γ.

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E_T^{jet} and η^{jet} reweighting. $x_\gamma > 0.8$

Before reweighting
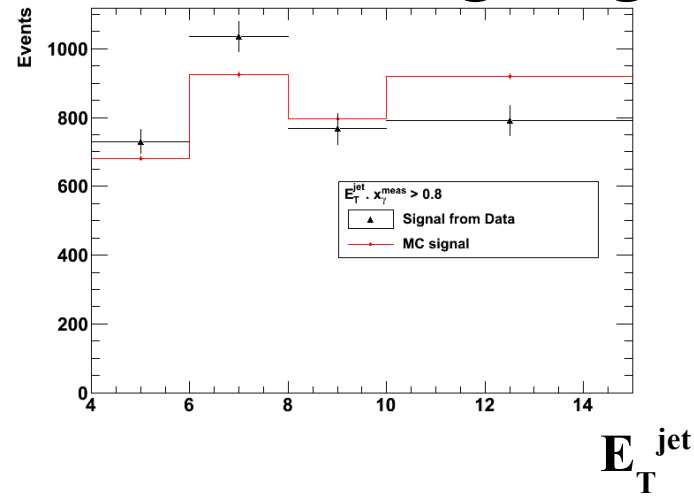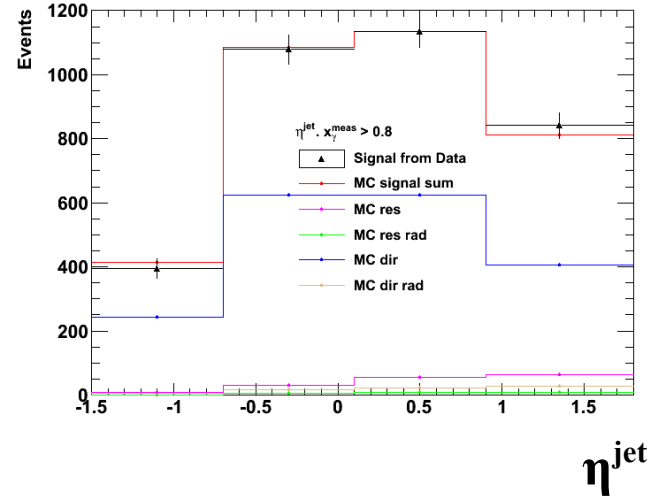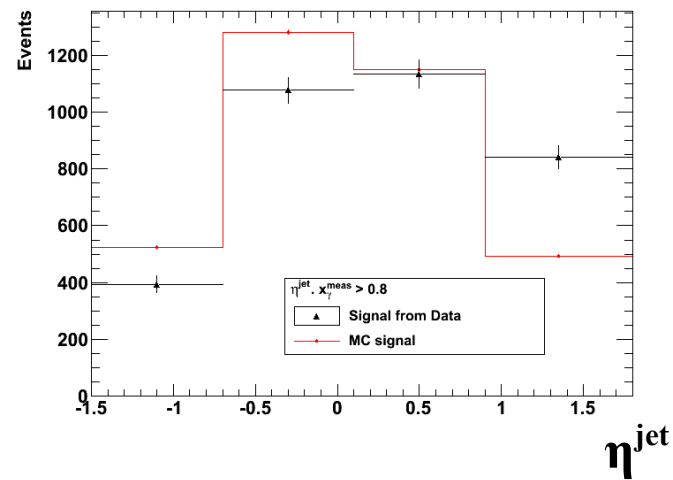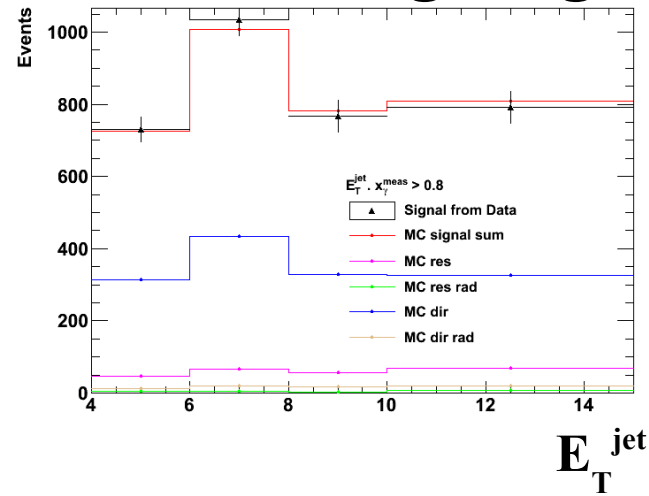
After reweighting

Reweighted MC shows good agreement with data.

E_T^{jet} and η^{jet} reweighting. $x_\gamma > 0.8$
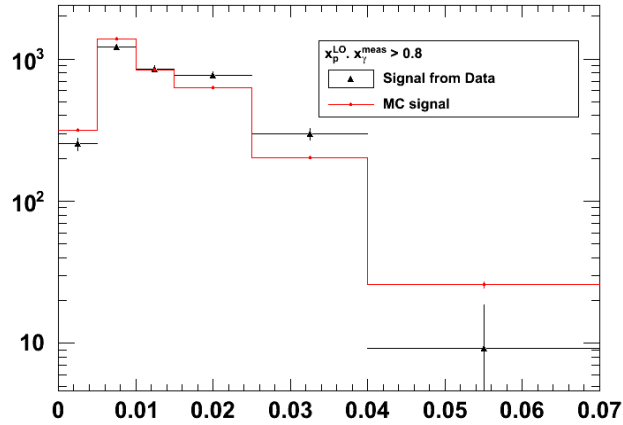
Before reweighting
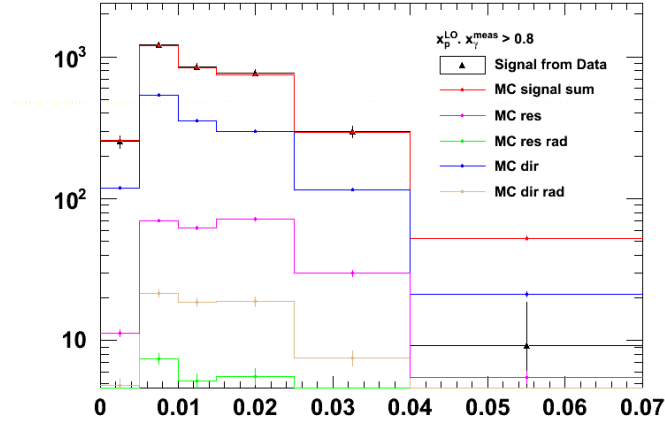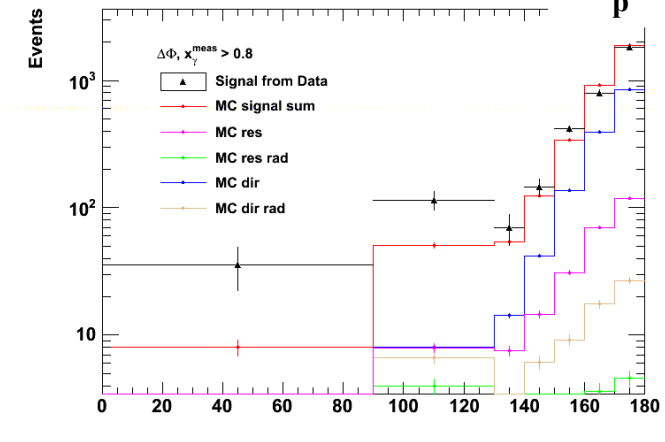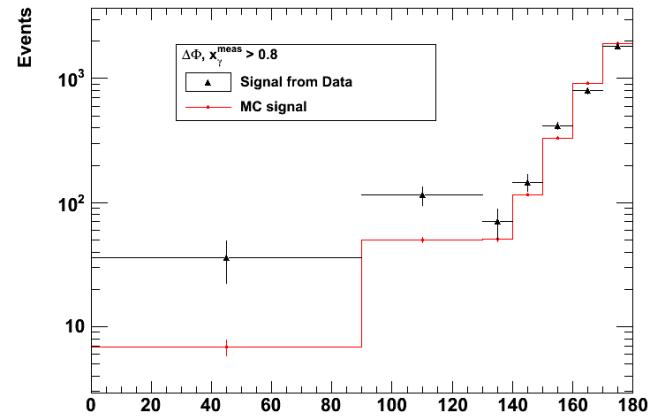
After reweighting

x_p is better, but $\Delta\Phi$ does not change noticeably.

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E_T^{jet} and η^{jet} reweighting. $x_\gamma > 0.8$

Before reweighting
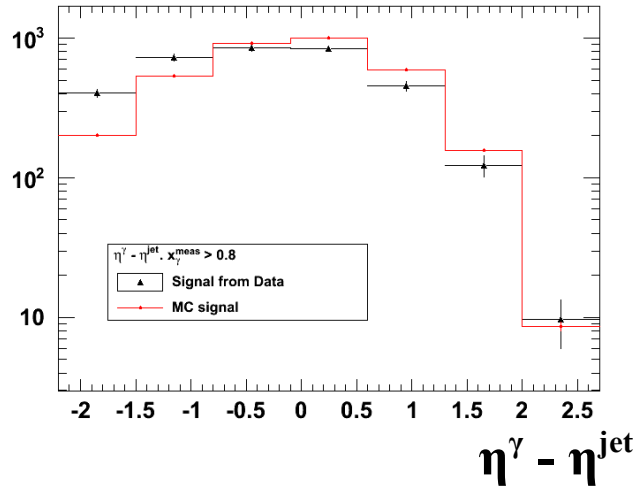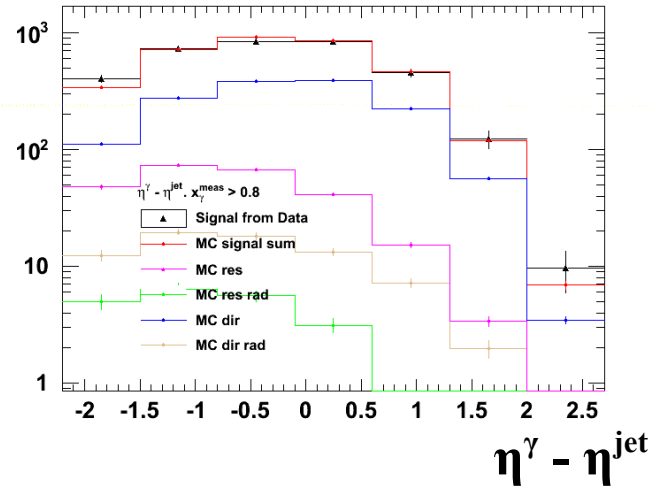
After reweighting

$\eta^\gamma - \eta^{jet}$ description improves.

Conclusion: E_T^{jet} and η^{jet} reweighting in high x_γ region somewhat improves description of data in control plots.

Influence of η^γ reweighting on cross sections. $x_\gamma < 0.7$

Influence of η^γ reweighting on cross sections. $x_\gamma < 0.7$

Typical change in numbers – E_T^γ

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.02115	8.88493	7.90227	19.87959
0.46046	9.43463	6.01201	21.46577
0.54776	13.55742	9.99940	25.49549
-0.07939	15.57437	9.52430	27.96578

One of the largest changes in numbers – $\Delta\Phi$

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.70576	29.21109	37.68657	20.57569
1.12197	16.23909	12.05958	9.29073
1.16235	18.07979	10.05445	21.70686
1.07254	18.15206	7.29886	14.64605
0.46932	13.29016	5.06154	25.75553
0.40879	11.37467	6.02153	32.58705
0.26832	10.04184	7.54624	34.59761

Typical changes are within 1%, with few rising to 2%. Same applies to $x_\gamma <$ 0.8 region.

Influence of E_T^{jet} and η^{jet} reweighting on cross sections. $x_\gamma > 0.8$

Typical change in numbers – E_T^γ

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
0.84709	6.74467	9.94547	3.96994
1.45196	6.13560	10.11802	4.94386
2.46370	7.97564	12.04530	7.66010
2.35856	6.50554	8.05481	6.61268

One of the largest changes in numbers – $\Delta\Phi$

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.41200	44.98235	285.62784	46.24307
3.52670	22.03499	3.63720	7.71639
6.69300	30.71102	9.58727	25.40608
5.66588	18.44736	20.23751	10.20680
3.37063	9.44069	19.23090	3.82390
2.76544	7.22001	7.61005	5.13912
2.78652	4.64076	6.71255	7.38203

Typical changes are within 3%, with few rising to 7%, but still being smaller than uncertainties.

Conclusion

Reweighting in x_γ regions studied.

η^γ reweighting in low x_γ region provides little improvement of control plots and 1-2% changes in cross-sections.

E_T^{jet} and η^{jet} reweighting in $x_\gamma > 0.8$ region improves control plots, but gives small (compared to uncertainties) changes in cross-sections.

Future plans

Present for preliminary status as soon as possible.

Backup slides

Changing ratio of components in signal MC. $x_\gamma < 0.8$
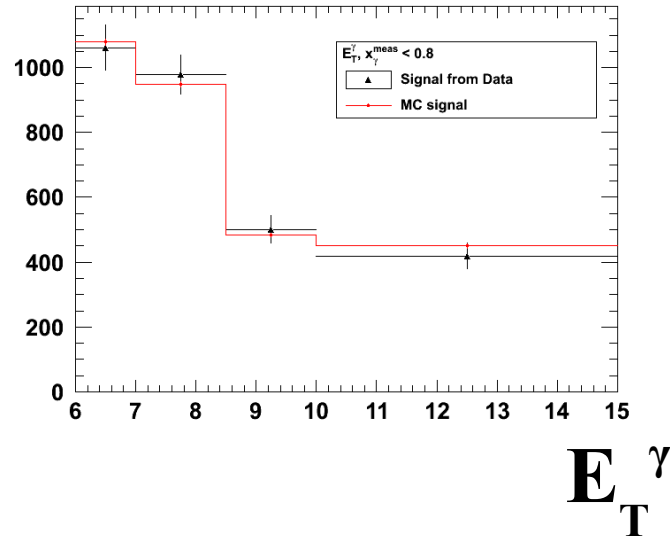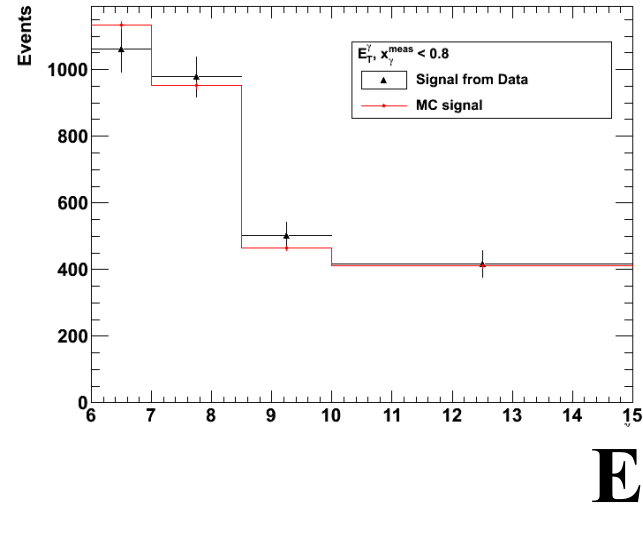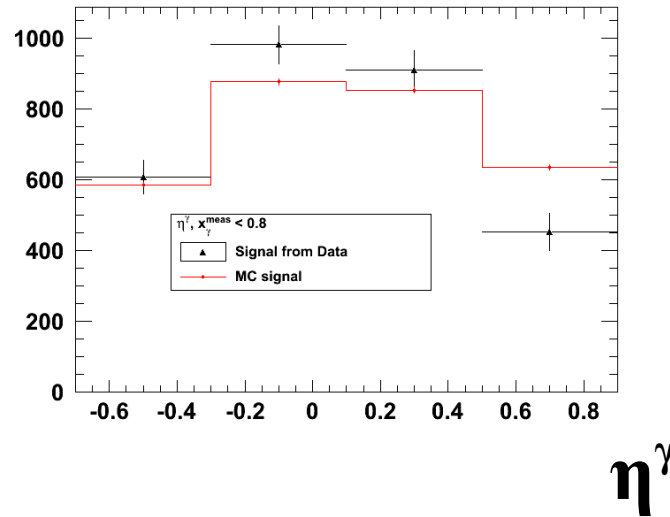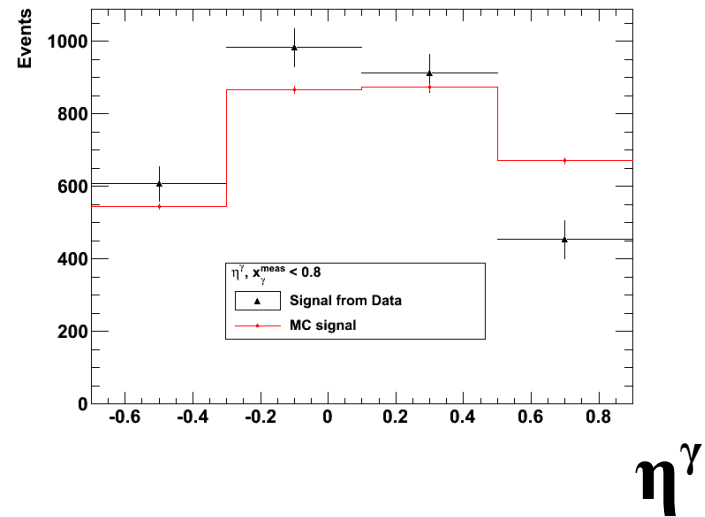
old ratio   new ratio

New ratio, xgamma<0.8:

16/69/6/9

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Changing ratio of components in signal MC. $x_\gamma < 0.8$

old ratio   new ratio

Changing ratio of components in signal MC. $x_\gamma < 0.8$

old ratio   new ratio

23
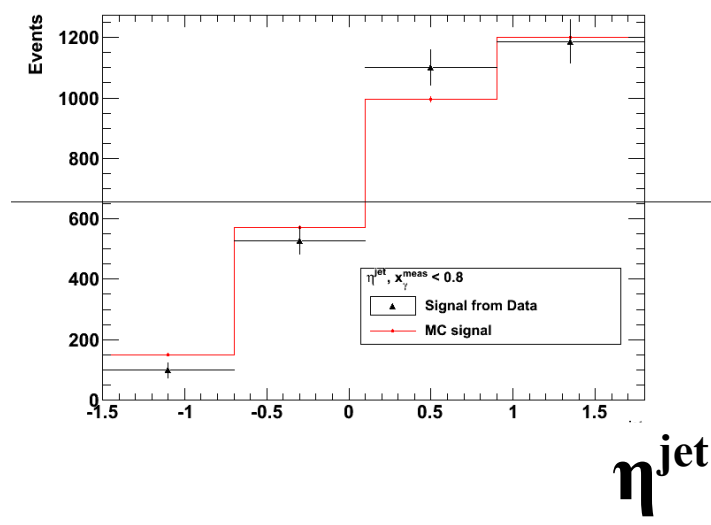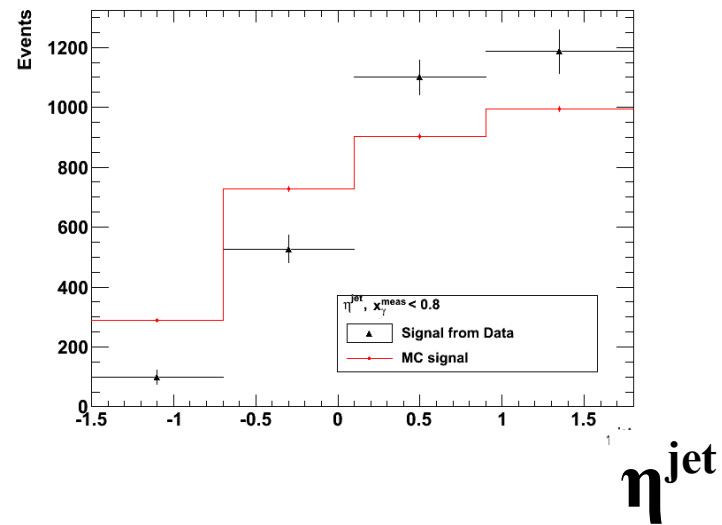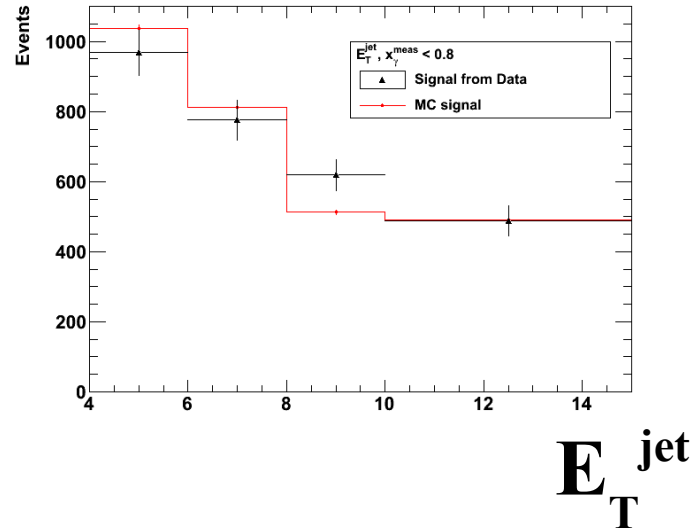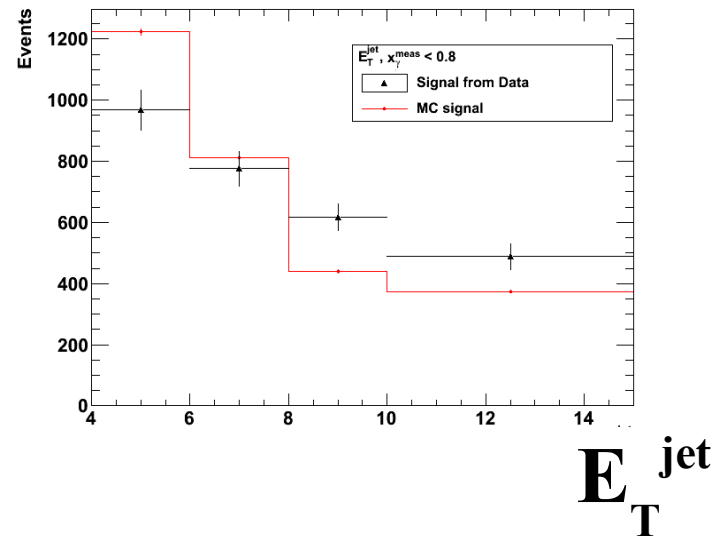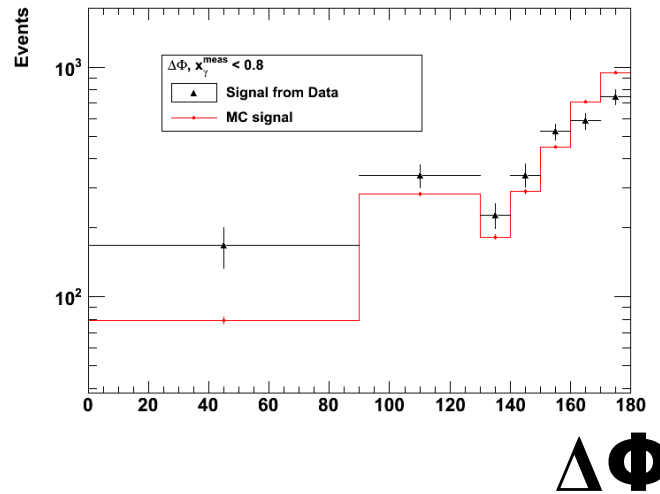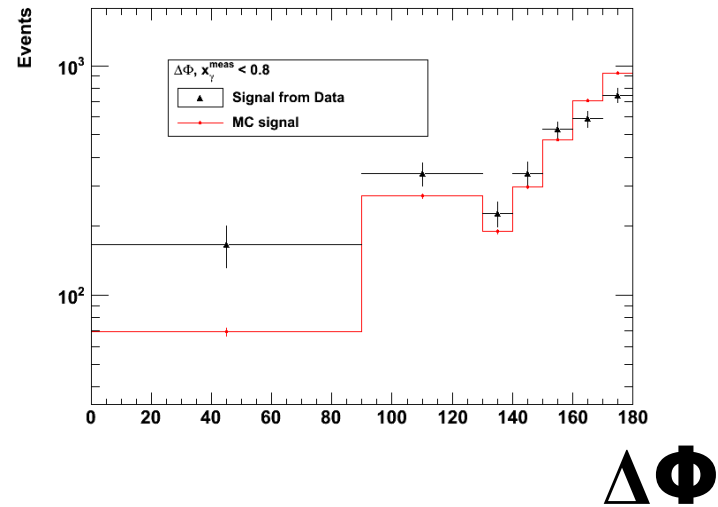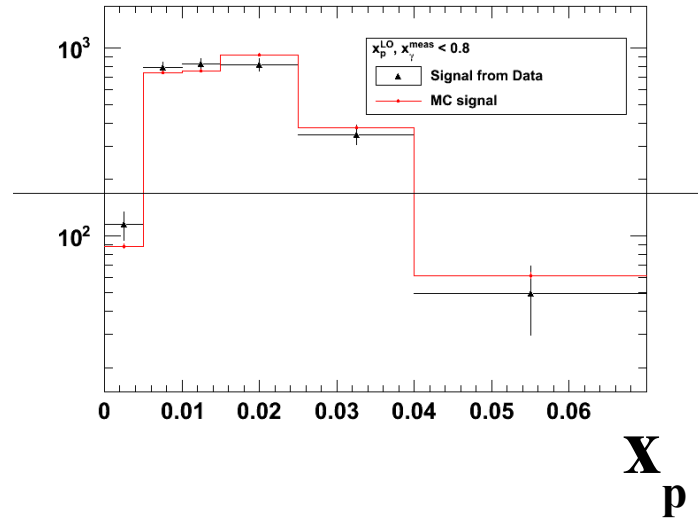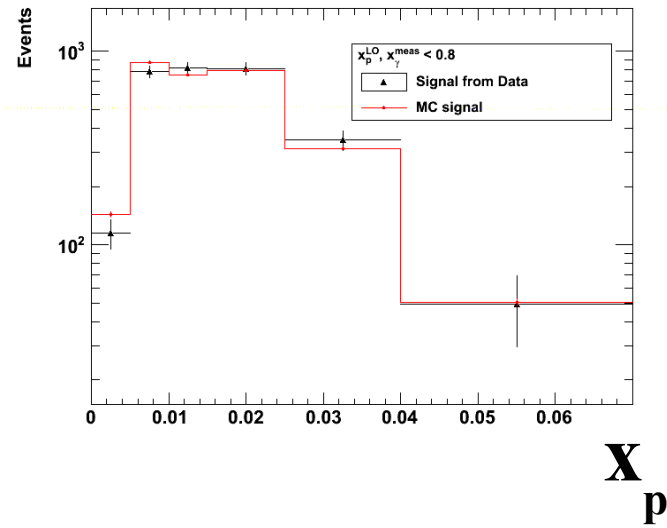
Changing ratio of components in signal MC. $x_\gamma < 0.8$

old ratio   new ratio
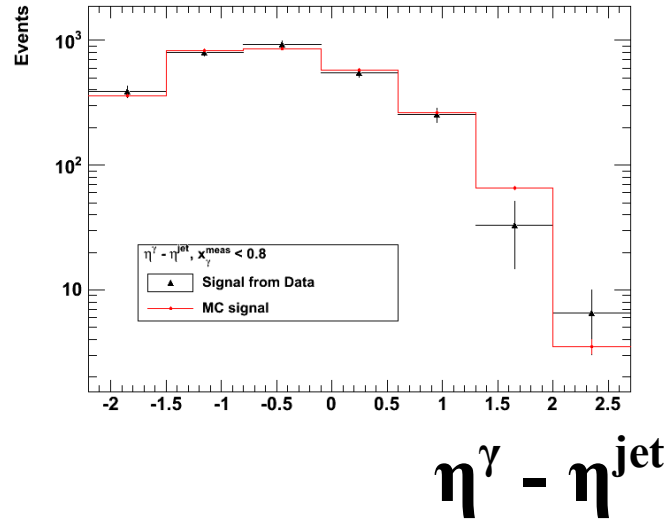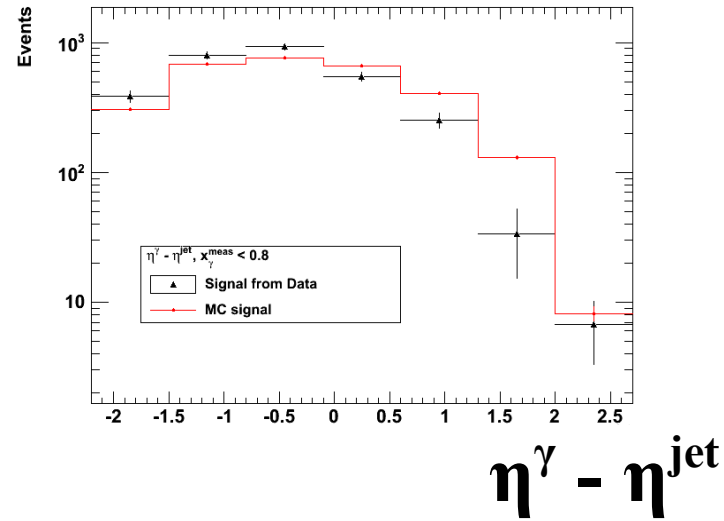
Changing ratio of components in signal MC. $x_\gamma > 0.8$

old ratio
new ratio
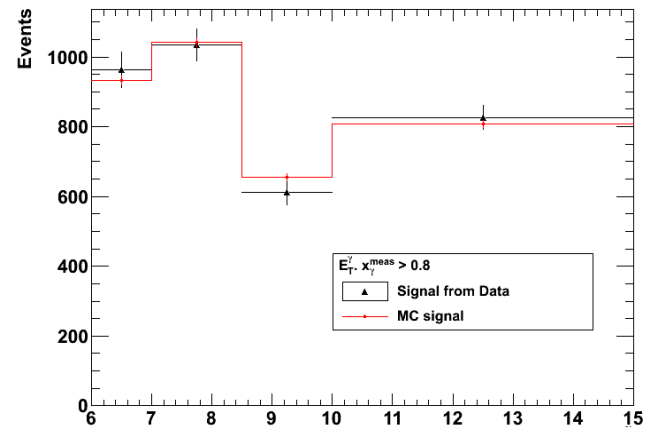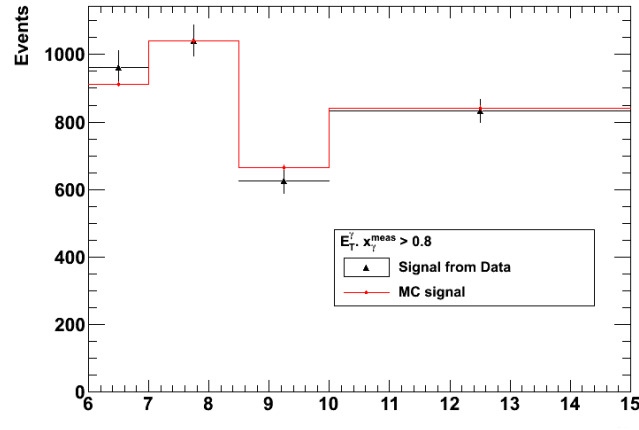
New ratio, xgamma<0.8:

82/13/4/1

Changing ratio of components in signal MC. $x_\gamma > 0.8$
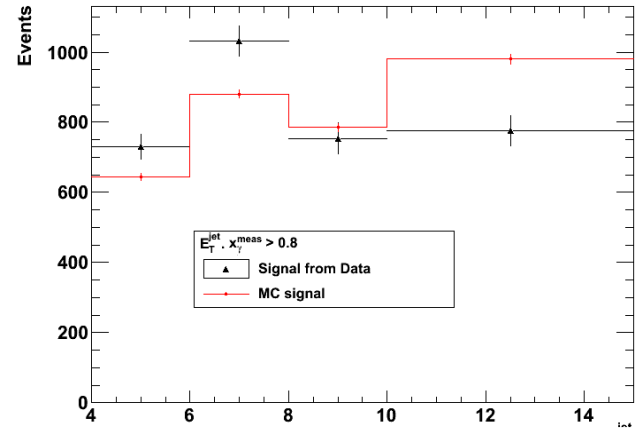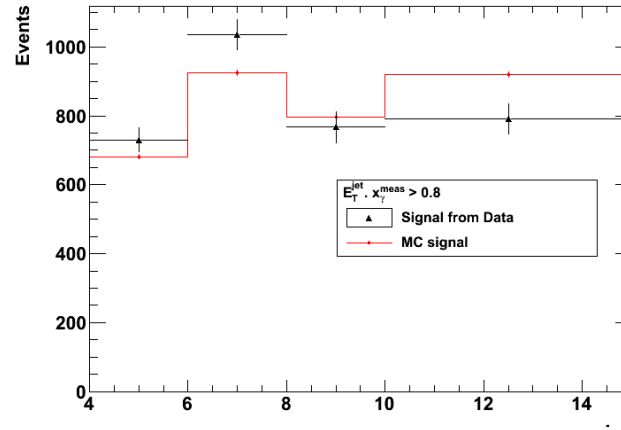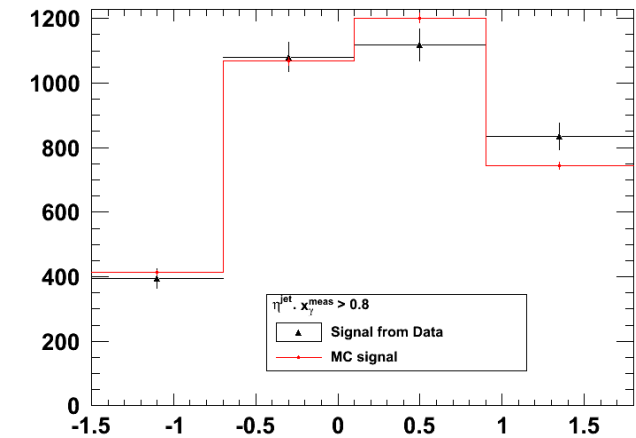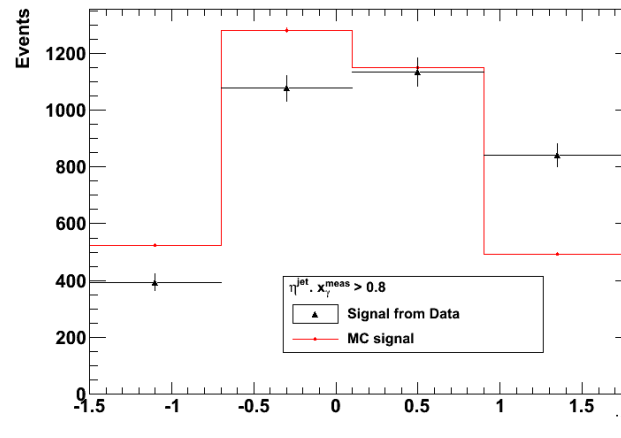
old ratio

new ratio

Changing ratio of components in signal MC. $x_\gamma > 0.8$

old ratio   new ratio

Changing ratio of components in signal MC. $x_\gamma > 0.8$

old ratio   new ratio

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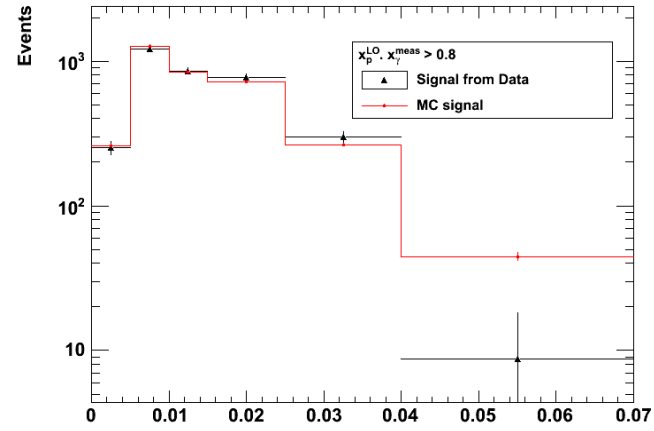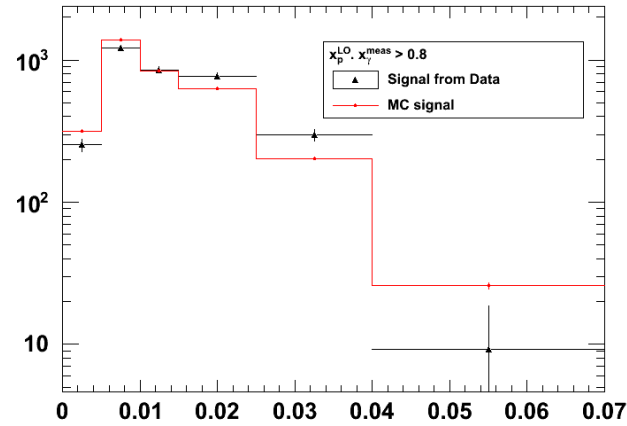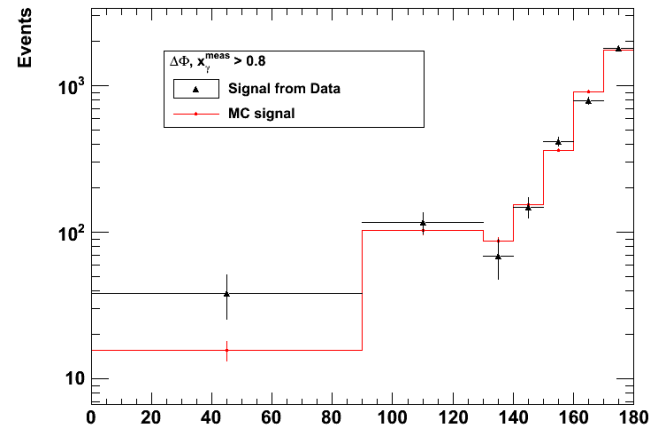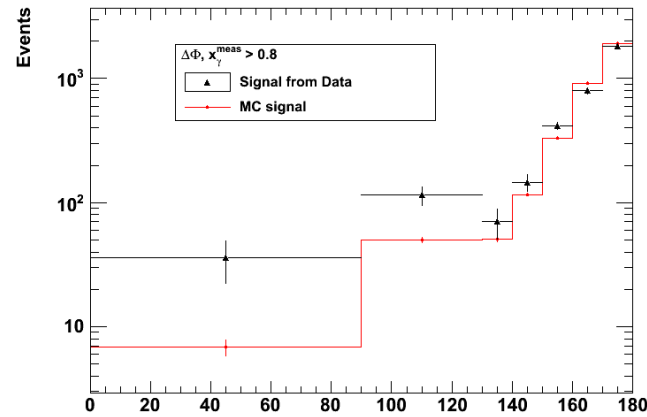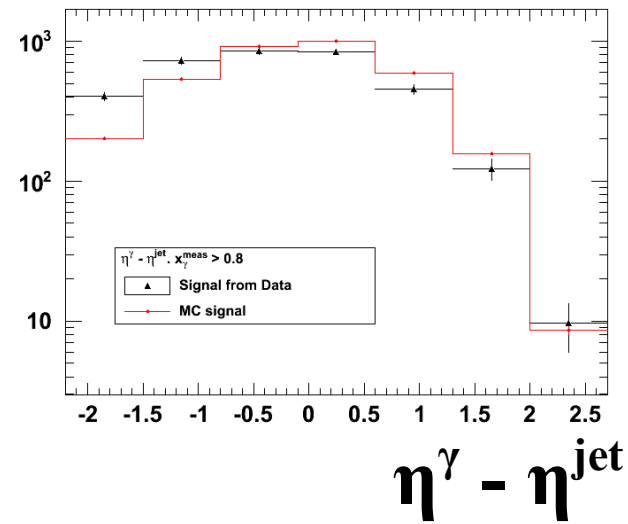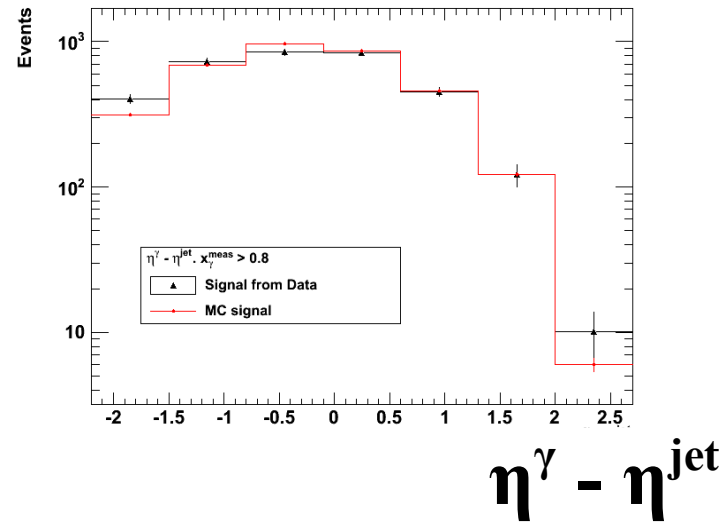
PYTHIA. Cross sections. $x_\gamma > 0.8$

Before reweighting
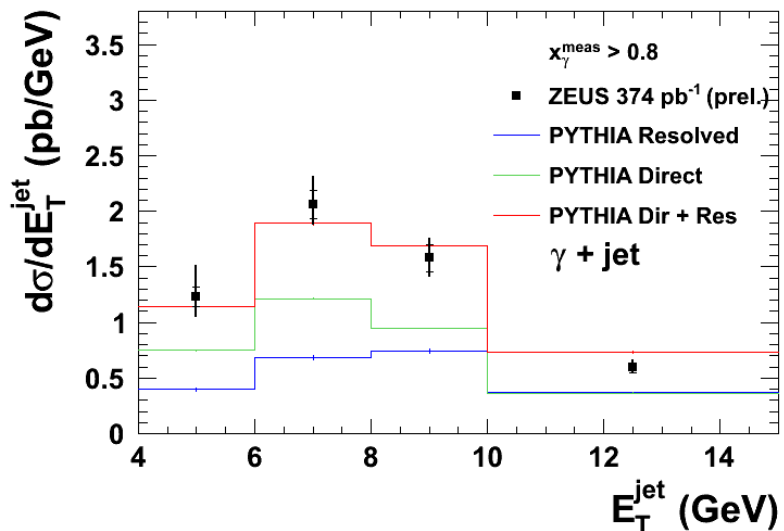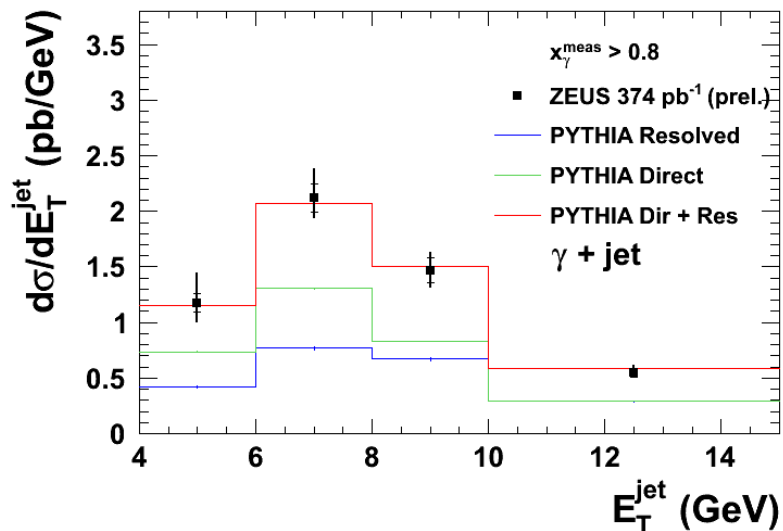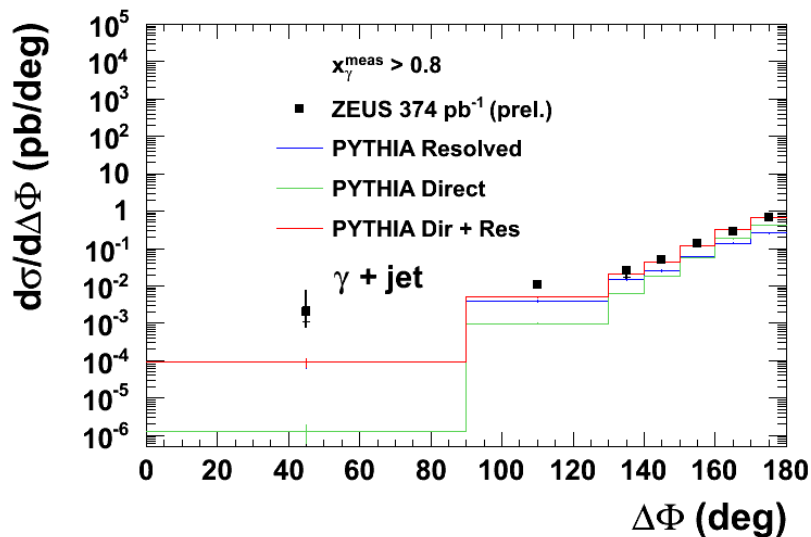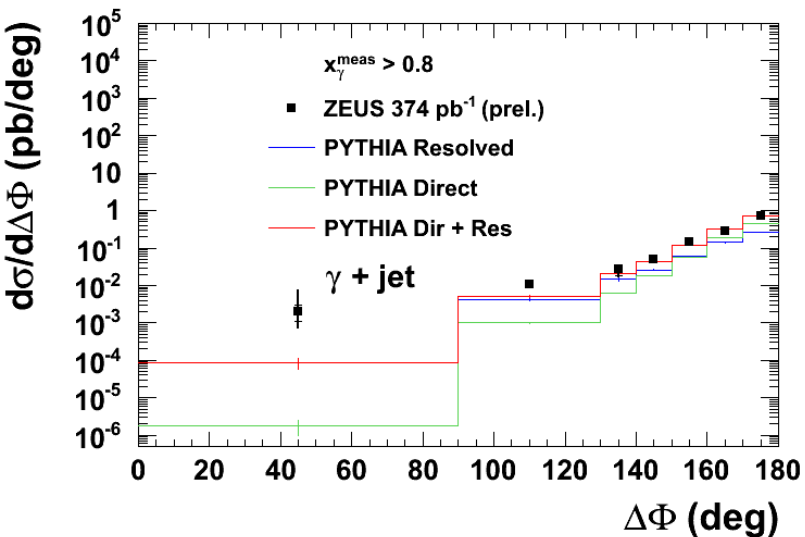
After reweighting

PYTHIA Direct and Resolved on plots do not contain radiative component.

Largest changes in data cross-section numbers up to 7% are observed in E_T^{jet} and $\Delta\Phi$, possibly due to resolution. Use of weight function instead of reweighting directly reduces changes in E_T^{jet} down to 3-5%.

PYTHIA is normalised on data in the same way as control plots and not the same way as shown before – when it was divided by corresponding PYTHIA luminosity and made to fit all x_γ distribution to determined K-factors.

Cross sections after reweighting. $x_\gamma < 0.7$

E_T^γ

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.02115	8.88493	7.90227	19.87959
0.46046	9.43463	6.01201	21.46577
0.54776	13.55742	9.99940	25.49549
-0.07939	15.57437	9.52430	27.96578

η^γ

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
-0.38336	11.48093	7.12238	26.64861
-0.12262	8.64774	7.03980	19.68631
0.06707	8.76494	6.15909	30.95800
0.07325	15.48277	4.84658	14.59719

E_T^{jet}

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
0.83553	8.75676	6.22857	12.65866
0.28682	11.49290	4.24800	18.05219
0.72842	10.66039	10.40676	42.45291
1.08682	14.24768	8.85026	42.12814

η^{jet}

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
0.70045	91.52304	41.94953	48.85194
-0.16017	14.90446	6.31872	17.20633
0.46584	7.79552	6.87293	28.50701
1.22916	8.44025	6.98935	18.79230

Cross sections after reweighting. $x_\gamma < 0.7$

x_p

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
-1.62608	33.29721	25.46780	35.61900
-0.10973	10.63434	12.03040	12.44220
1.06624	9.59324	7.25163	13.56960
1.54509	9.81224	4.48257	9.44296
0.59126	17.25030	5.22125	10.34960
-0.34037	173.16620	163.49707	60.38692

$\Delta\Phi$

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.70576	29.21109	37.68657	20.57569
1.12197	16.23909	12.05958	9.29073
1.16235	18.07979	10.05445	21.70686
1.07254	18.15206	7.29886	14.64605
0.46932	13.29016	5.06154	25.75553
0.40879	11.37467	6.02153	32.58705
0.26832	10.04184	7.54624	34.59761

$\eta^\gamma - \eta^{jet}$

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
-0.29523	14.16548	7.16117	8.41719
-0.04026	9.97129	7.33676	9.10193
0.41521	8.69454	7.42275	9.40377
0.30206	12.44137	11.96929	8.24504
0.87445	24.10867	13.91511	20.81064
0.20334	4508.87436	1741.46696	151.11111
0.27469	213.93067	97.67168	55.10791

Cross sections after reweighting. $x_\gamma < 0.8$

E_T^γ

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.12657	7.36254	8.28743	13.72739
0.91359	7.02693	6.42261	16.08822
0.36816	9.85589	7.21152	25.36650
-0.12060	11.20144	7.20464	24.63455

η^γ

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
-0.29294	9.15367	8.95906	18.66590
-0.05964	6.60158	6.82085	17.52720
0.12528	6.92165	6.65162	22.85801
0.13196	12.70623	6.43695	11.16619

E_T^{jet}

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.14668	7.41832	6.13695	9.48326
0.66873	8.19427	5.13158	13.36471
0.27851	8.58599	9.68016	31.46981
0.54337	10.42944	9.06418	36.35473

η^{jet}

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
0.21970	26.47509	16.29368	34.16596
0.88465	9.82771	8.48009	13.30603
0.44149	6.30784	8.26800	22.43770
1.13590	7.09034	7.05847	14.29149

Cross sections after reweighting. $x_\gamma < 0.8$

x_p

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
-0.63117	20.00682	28.81980	43.75760
0.61707	7.74735	10.65260	11.05250
1.25576	7.61267	5.49431	11.56580
1.36130	8.48150	4.05174	8.39084
0.82435	13.27667	5.10680	15.60650
-0.61376	44.79438	24.35581	24.89739

$\Delta\Phi$

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.85061	24.09152	40.10767	20.89502
1.41799	13.26960	10.75382	6.23456
1.27061	14.47693	10.39956	14.59427
1.03199	13.12002	6.09966	12.60831
0.56774	9.41306	5.48223	18.30366
0.66903	9.14126	6.28014	23.64906
0.49861	8.18150	8.65281	25.34154

$\eta^\gamma - \eta^{jet}$

relative difference, eta-gamma reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
-0.33968	12.22543	6.28754	6.37228
0.07480	8.18509	6.84252	9.26971
0.72249	7.04785	8.28180	9.65841
0.28252	9.37118	8.70830	10.60761
0.43067	14.81926	8.16375	13.00744
0.31434	57.83203	37.96196	25.90851
0.31323	66.48444	41.38471	28.97373

Cross sections after reweighting. $x_\gamma > 0.8$

E_T^γ

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
2.50937	6.74467	9.94547	3.96994
2.59037	6.13560	10.11802	4.94386
4.88484	7.97564	12.04530	7.66010
3.21226	6.50554	8.05481	6.61268

η^γ

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
2.33861	5.67940	9.56164	6.20956
3.50605	5.74899	6.68234	5.67285
2.64318	7.64800	9.12403	4.72866
2.29359	12.24065	13.67649	4.59547

E_T^{jet}

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
4.47823	7.13529	22.11376	13.18033
-2.71222	6.14907	10.66742	6.51635
7.07319	7.61027	8.00728	8.04703
7.40973	7.17444	9.59462	6.86970

η^{jet}

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
2.12701	10.66583	8.83472	8.02874
0.41792	5.99457	6.38850	3.26848
3.03566	5.93385	9.28783	5.77908
0.40199	6.80835	12.34331	7.39239

Cross sections after reweighting. $x_\gamma > 0.8$

x_p

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.12995	13.25948	10.21670	7.36712
0.67405	5.52488	9.17026	6.88987
3.55433	6.88191	10.26720	3.82786
4.90144	7.34802	8.28983	3.54251
2.79818	12.45523	3.73525	6.65138
1.76386	108.27534	164.11402	48.16188

$\Delta\Phi$

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
1.41200	44.98235	285.62784	46.24307
3.52670	22.03499	3.63720	7.71639
6.69300	30.71102	9.58727	25.40608
5.66588	18.44736	20.23751	10.20680
3.37063	9.44069	19.23090	3.82390
2.76544	7.22001	7.61005	5.13912
2.78652	4.64076	6.71255	7.38203

$\eta^\gamma - \eta^{jet}$

relative difference, Et-jet and eta-jet reweighted [%]	stat. error [%]	syst. error up [%]	syst. error down [%]
0.83908	9.94481	16.18389	7.40462
3.49961	7.37828	6.84614	6.24370
1.82544	6.77663	12.12461	5.55667
0.52100	6.83849	8.23187	4.03880
-0.07447	10.37481	7.06096	6.94774
-0.45839	22.85009	15.26736	12.05086
-1.10782	50.88430	31.30936	21.14635

HERWIG Systematic

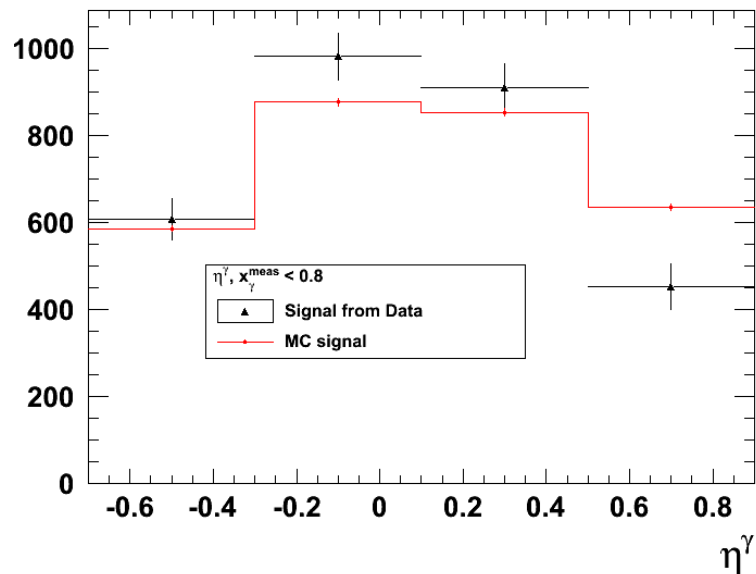

E_T^{jet}, X_γ^{meas} > 0.8 HERWIG
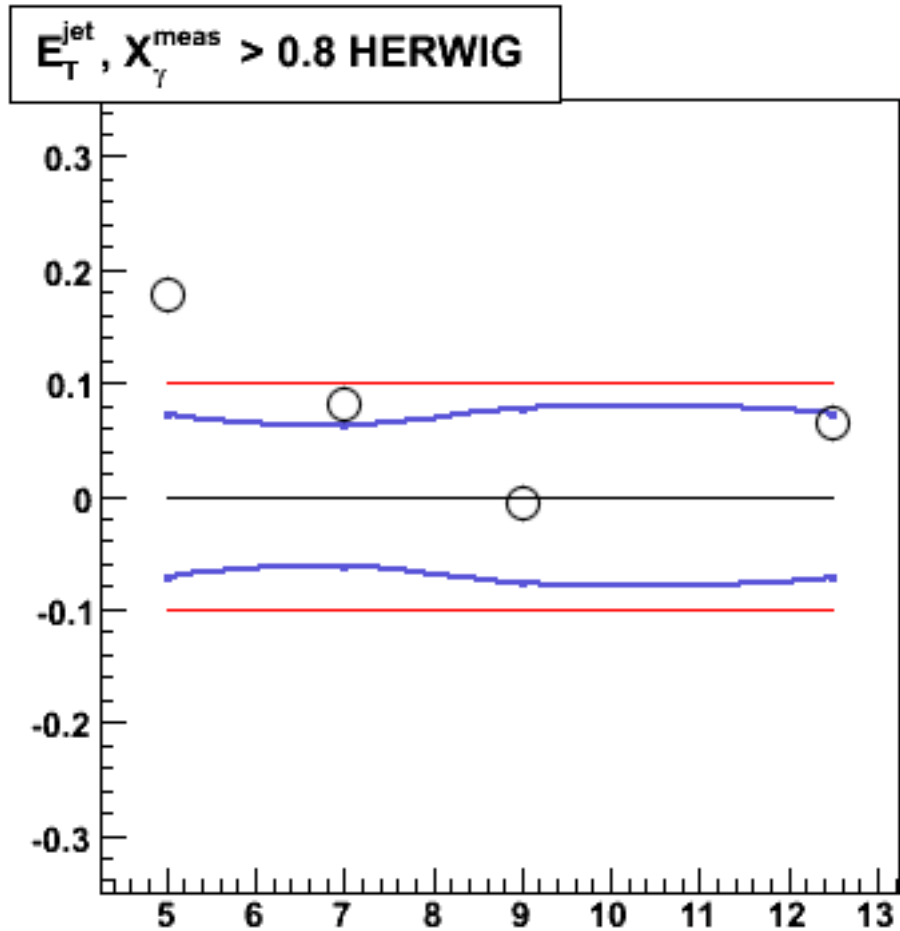
No correlation between reweighting and use of HERWIG.

When reweighted second bin increases while others decrease.

HERWIG control plots

HERWIG shows similar to PYTHIA discrepancies between data and MC.
Ratios adjusted according to x_γ region.

PYTHIA

HERWIG