Prompt Photons + Jets in DIS

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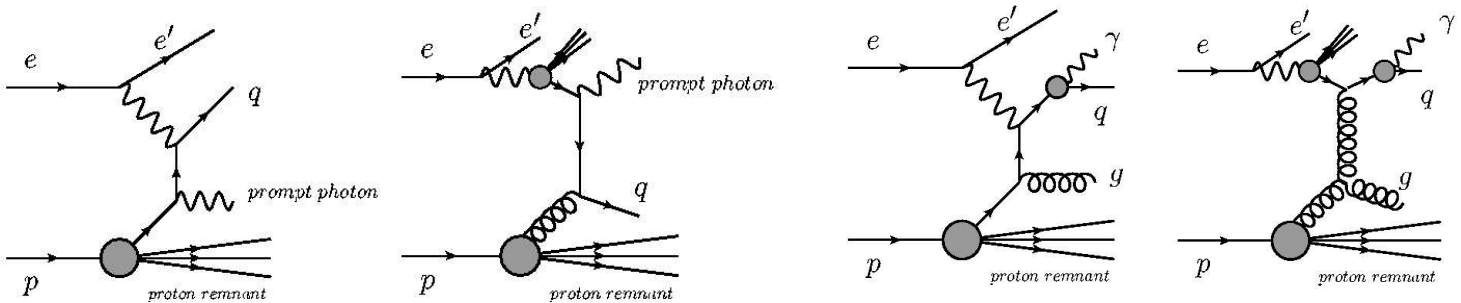
17. March 2011
Group preliminary

Outline

- Data and MC samples
- Event selection cuts
- Control plots
- f_{max}, δz fits
- Jet energy correction
- Comparison with M.Forrest results (inclusive photons)
- Systematic effects
- Q^2 reweighting procedure
- Differential cross sections
- Acceptance, efficiency and purity
- 1st and 2nd analysis comparison
- Summary

DIS ep collision



- Prompt photons are high transverse energy final state photons which are emitted directly during the hard scattering process
- Prompt photons do not undergo the hadronization process, therefore theoretical calculations can be done with better precision
- The final state photon is a particle which arrives in the detector after participating in the actual hard scattering process and so it can provide direct information of the process and the proton structure

Used Data and MC samples

Data

- 040506e, 0607p
- $\int Ldt = 332\ \mathrm{pb}^{-1}$

MC

- PYTHIA (signal)
- ARIADNE (background)

Event Selection Cuts

Phase Space

- $10 < Q^2 < 350\mathrm{GeV}^2$

Cleaning Cuts

- $-40 < Z_{\mathrm{vtx}}/cm < 40$
- $35\ \mathrm{GeV} < \mathrm{E} - \mathrm{p_z} < 65\ \mathrm{GeV}$

Electron Cuts

- $\mathrm{Siecorr} > 10\ \mathrm{GeV}$
- $140^\circ < \theta_{el} < 180^\circ$
- $-14.8 < e_x/\mathrm{cm} < 14.8$
- $-14.6 < e_y/\mathrm{cm} < 12.5$

Triggers

- SPP02 trigger for 0405e
- SPP09 trigger for 06e, 0607p

Prompt Photon Phase Space

- $4 < E_\gamma/\mathrm{GeV} < 15$
- $-0.7 < \eta_\gamma < 0.9$

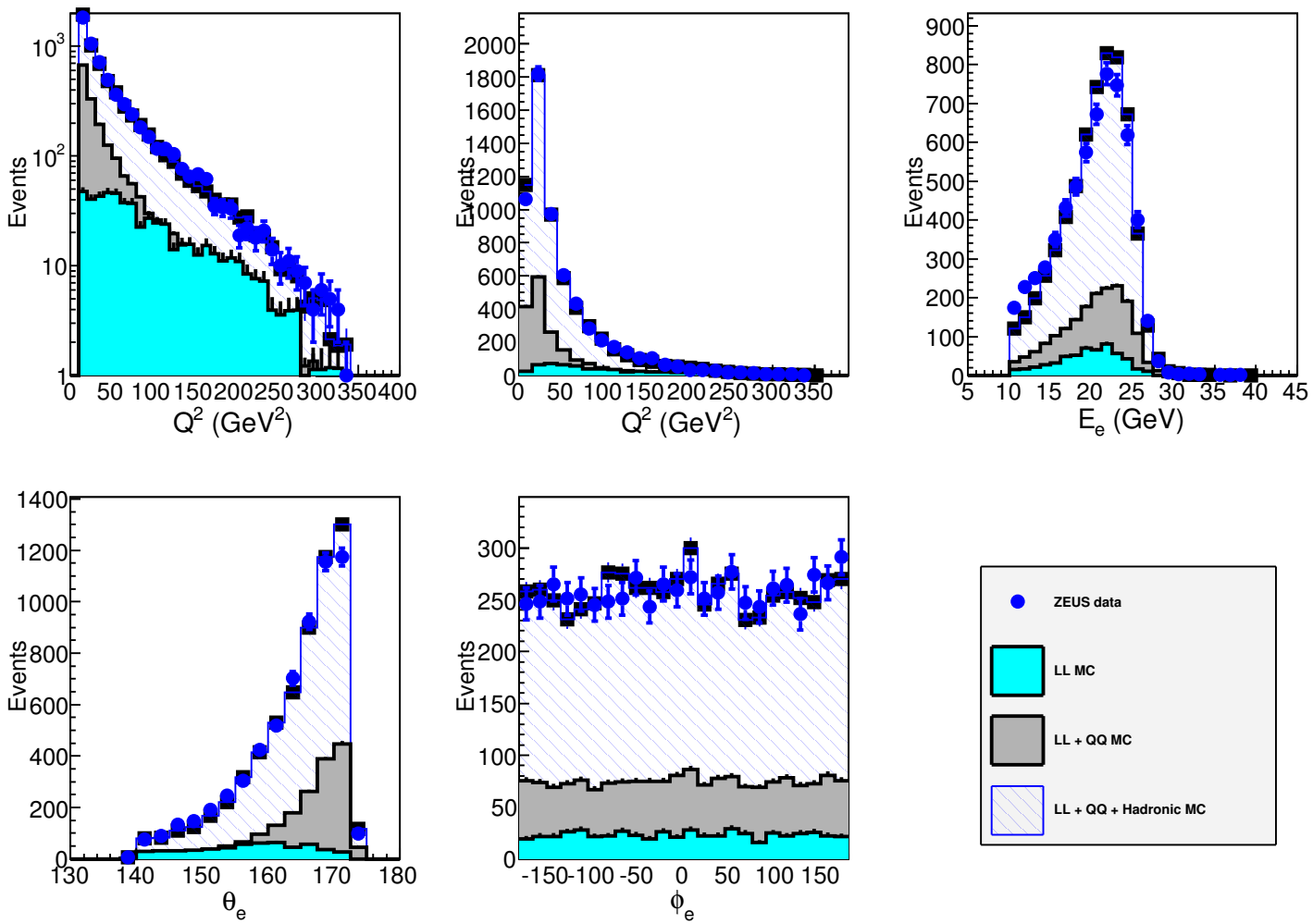
Prompt Photon Cleaning Cuts

- $\Delta r < 0.2$
- $\frac{\mathrm{E_{EMC}}}{\mathrm{E_{HAC}+E_{EMC}}} > 0.9$
- $\frac{\mathrm{E}_\gamma}{\mathrm{E_{jet\ containing\ }\gamma}} > 0.9$

Jet Selection

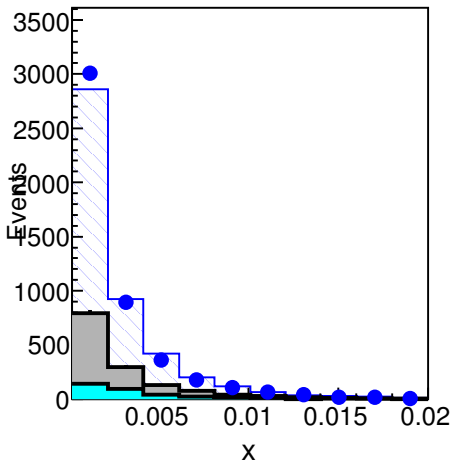
- based on zufos
- $E_{T,jet}^{corr} > 2.5\mathrm{GeV}$
- $-1.5 < \eta_{jet} < 1.8$

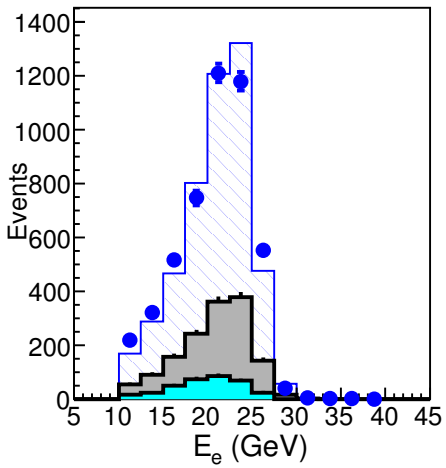
Control Plots (1/4)

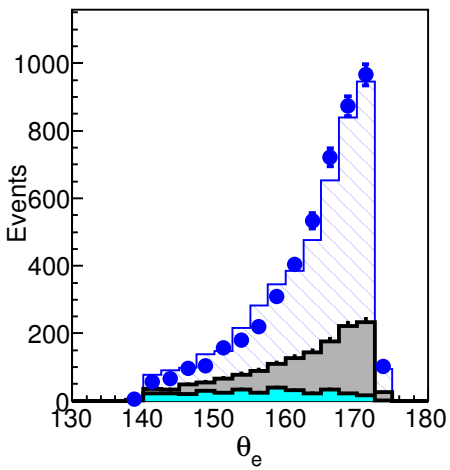


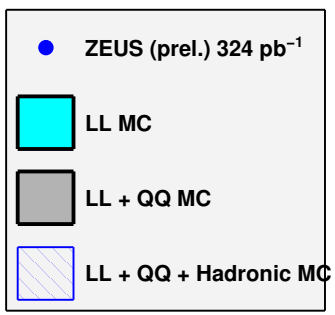
- Reasonable agreement for cinematic variables

Control Plots (2/4)



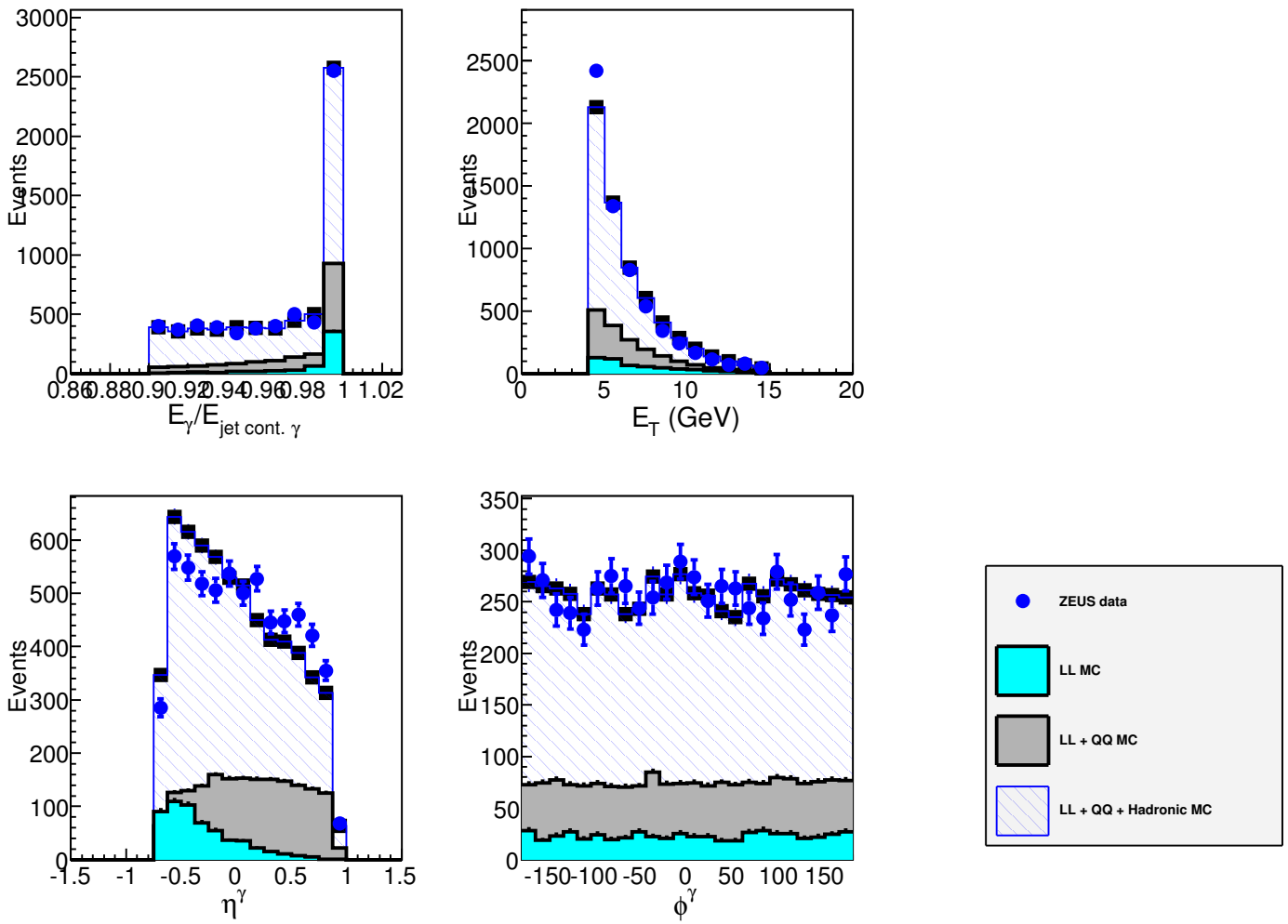






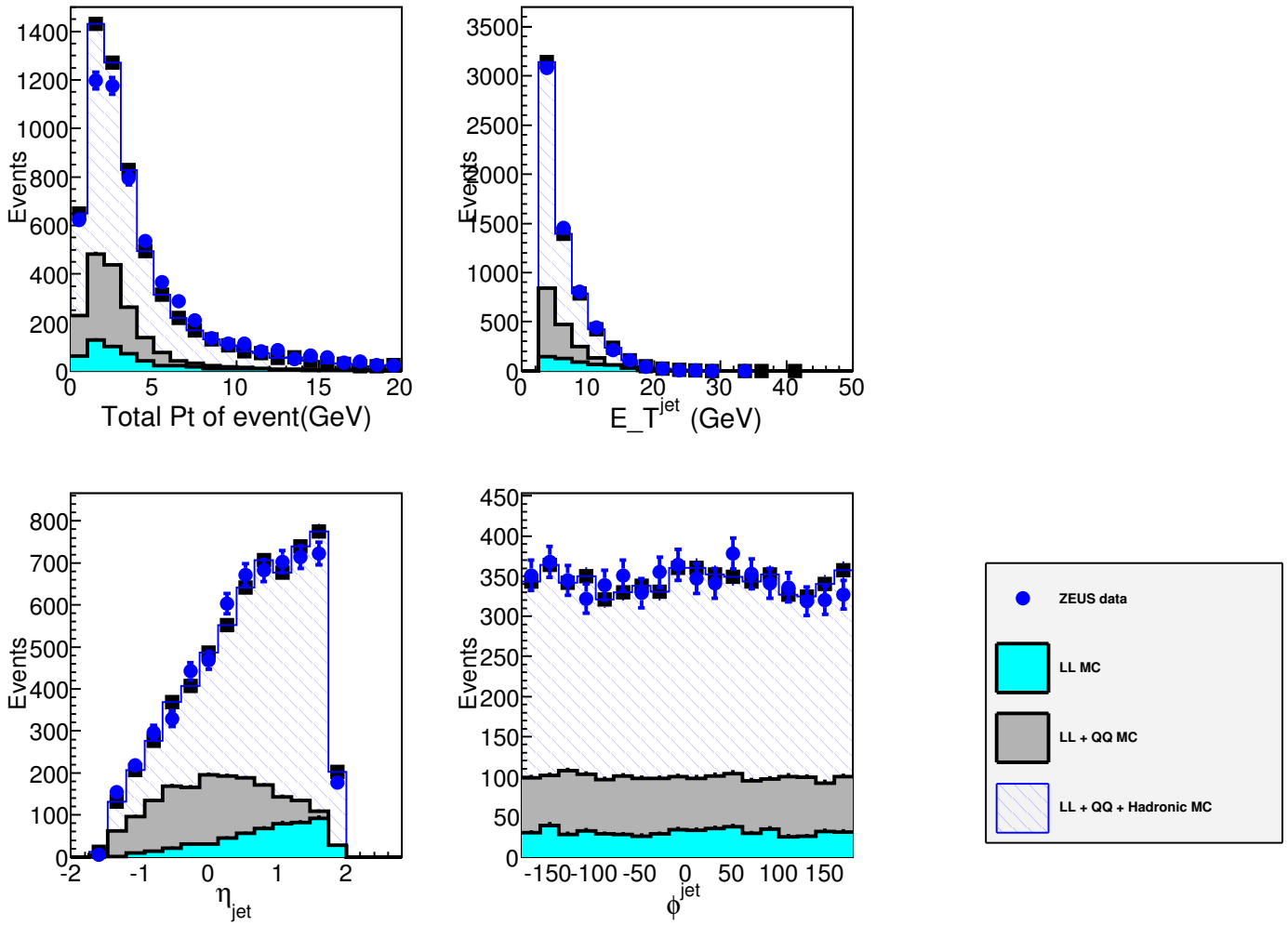
- Mc describes Data well

Control Plots (3/4)



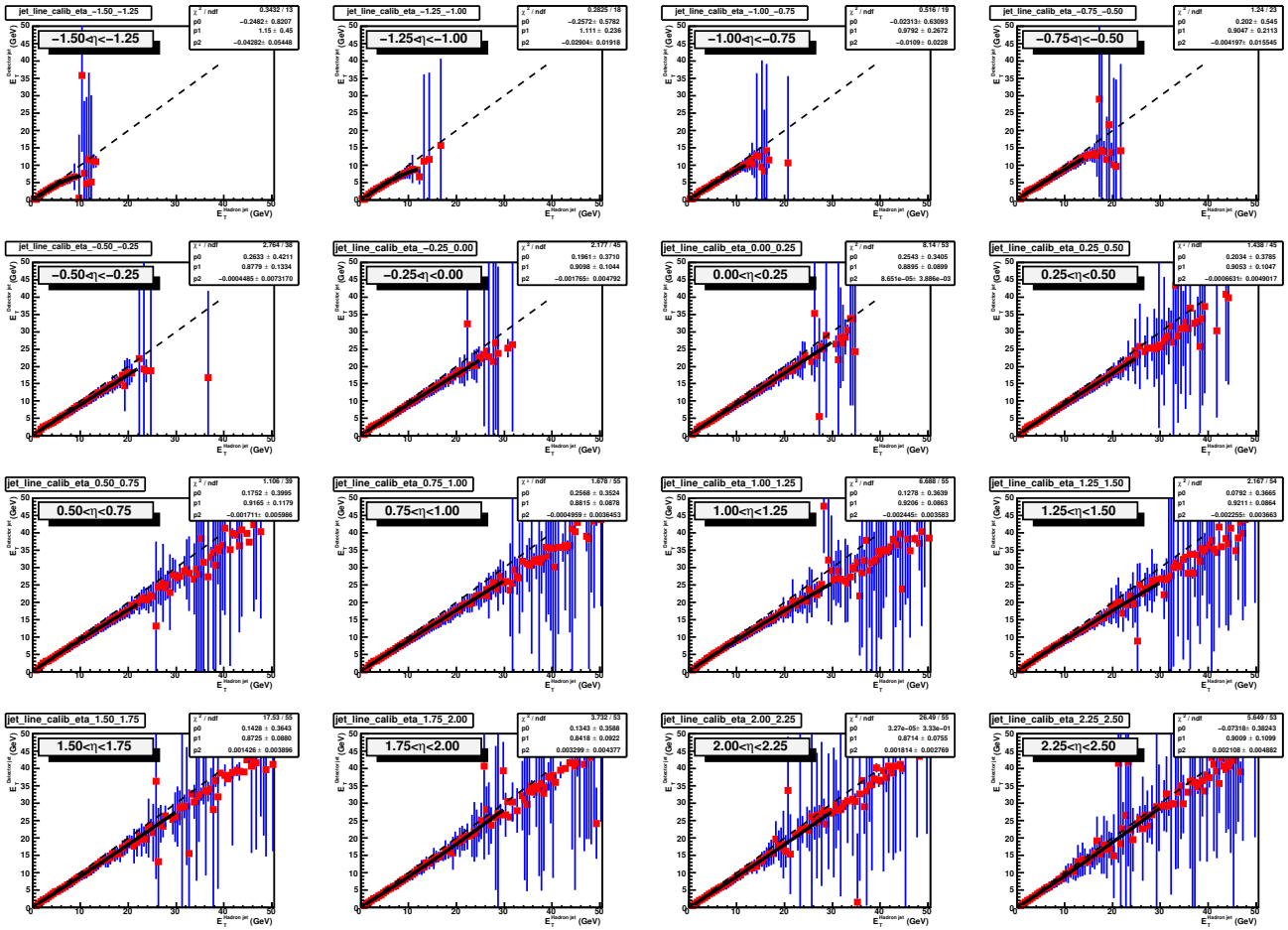
- Good agreement for photon variables

Control Plots (4/4)



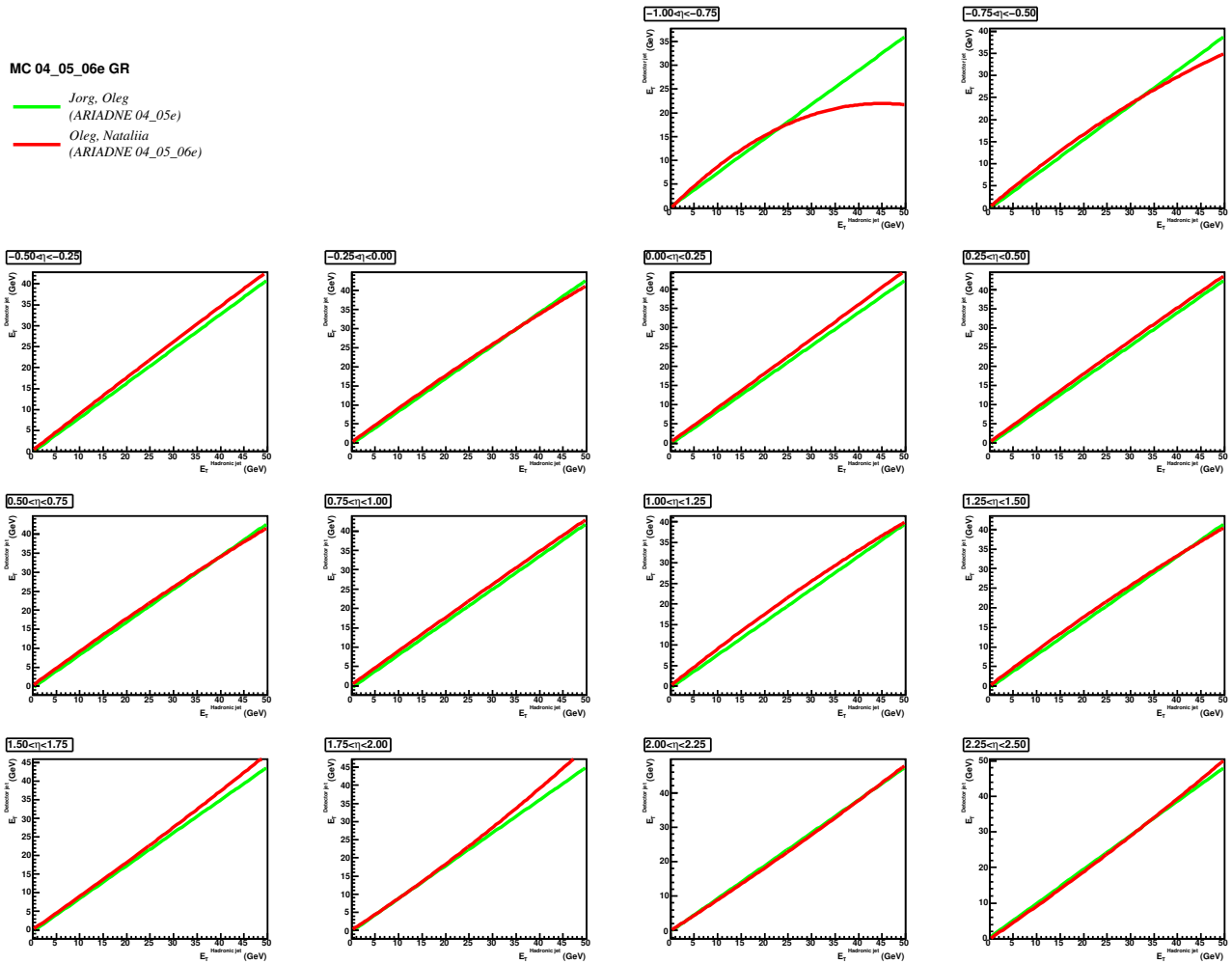
- Reasonable agreement for jet parameters

Jet energy correction (electrons)



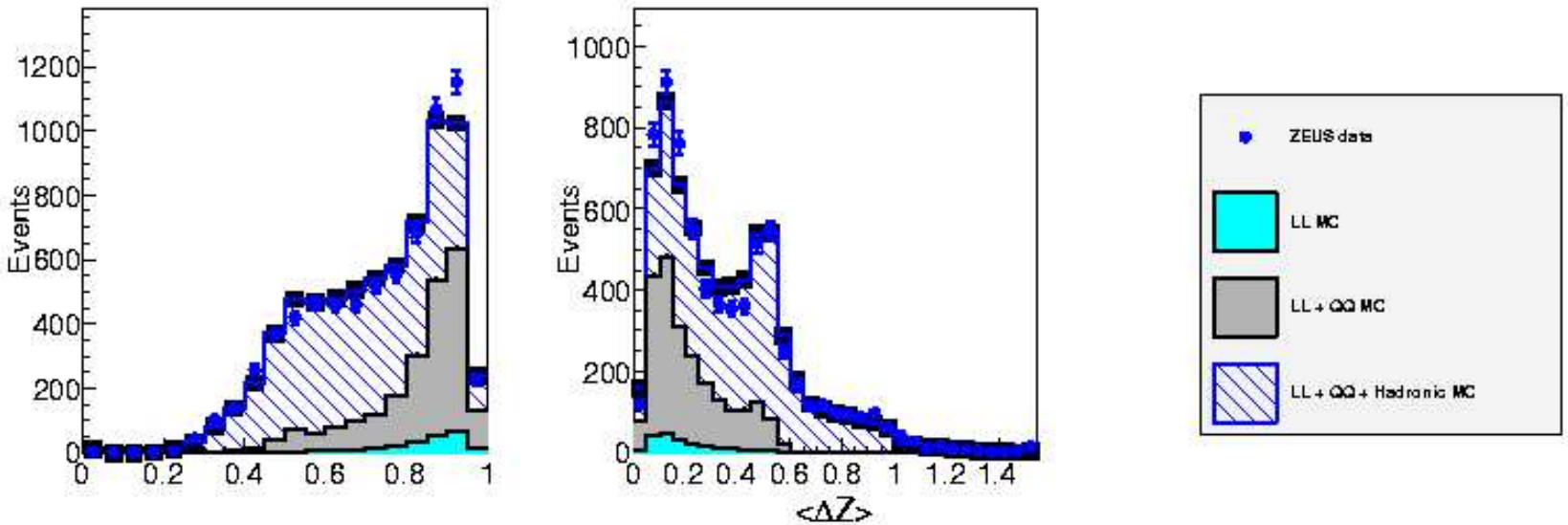
- First degree polynomial function was decided to use because of better description of the shape.
- This is OLD plot ! This plot will be replaced !

Jet energy correction (electrons), comparison with Jörg



- This is OLD plot ! This plot will be replaced !

f_{max}, δz definition

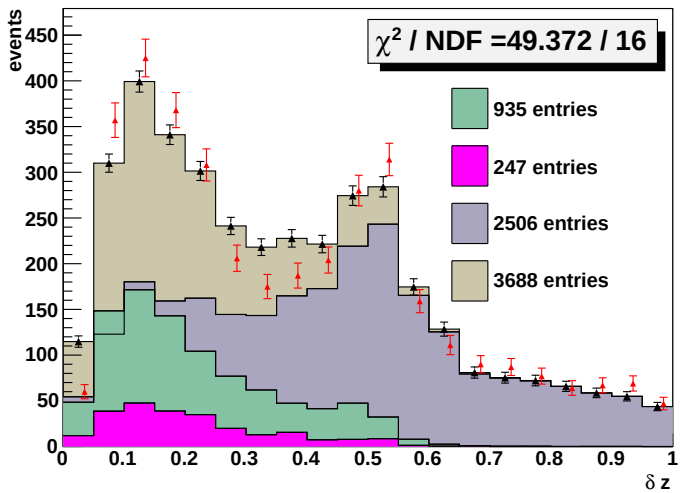


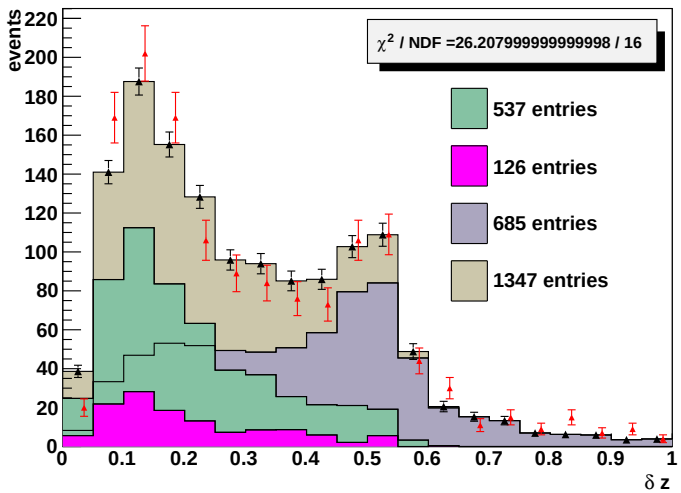
- f_{max} - ratio of the energy in the highest energy cell of a cluster to the total energy of a cluster
- δz - energy weighted mean width of the electromagnetic cluster in Z direction:

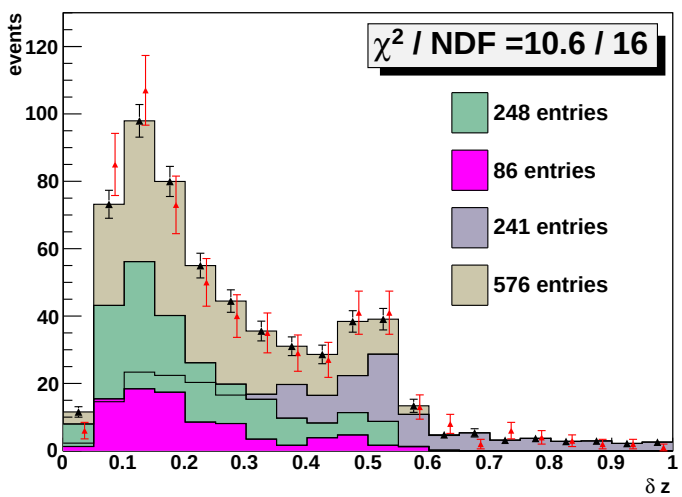
$$\delta z = \frac{\sum_i |Z_i - Z_{cluster}|}{W_{cell} \sum_i E_i}$$

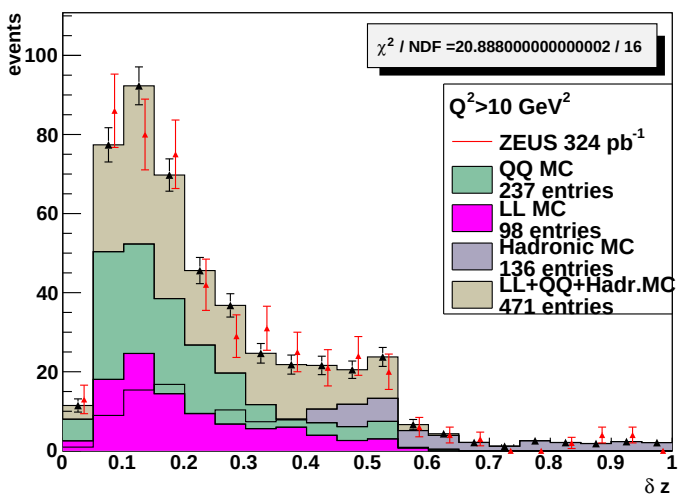
- Since the δz distribution has a more complex structure and gives better fit results, it was choosen to define the prompt photon fraction in Data

fits: δz/Et

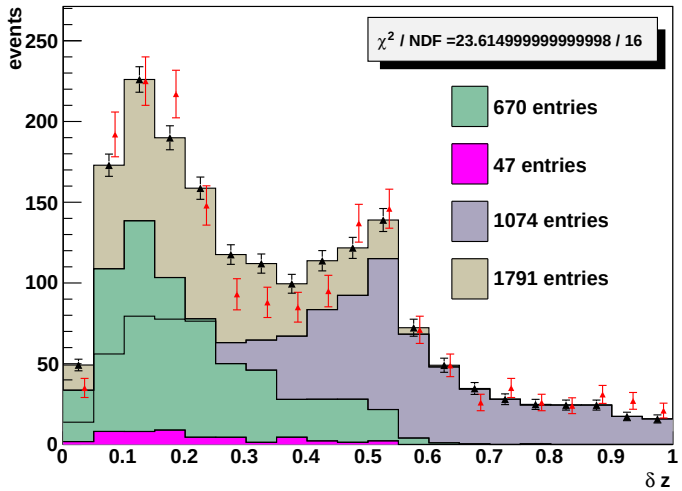


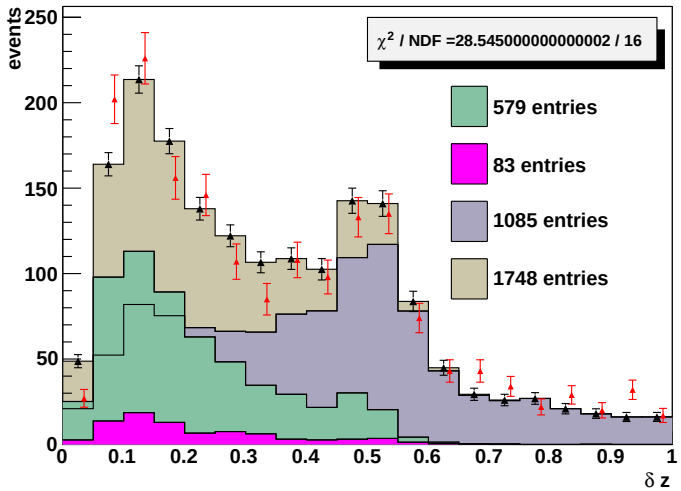


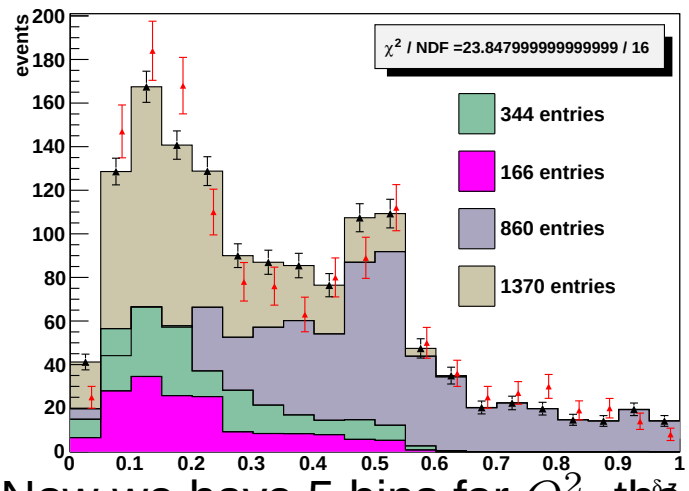


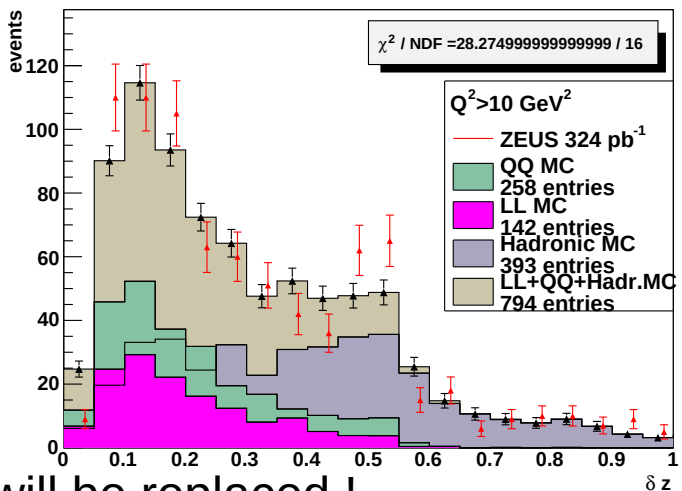


fits: $\delta z/Q^2$



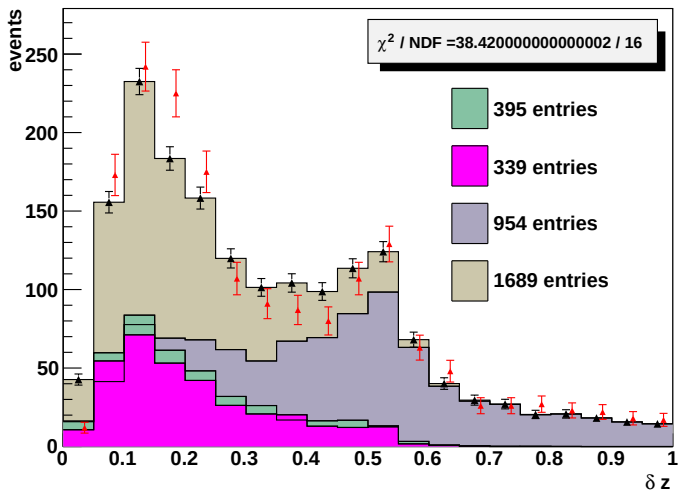


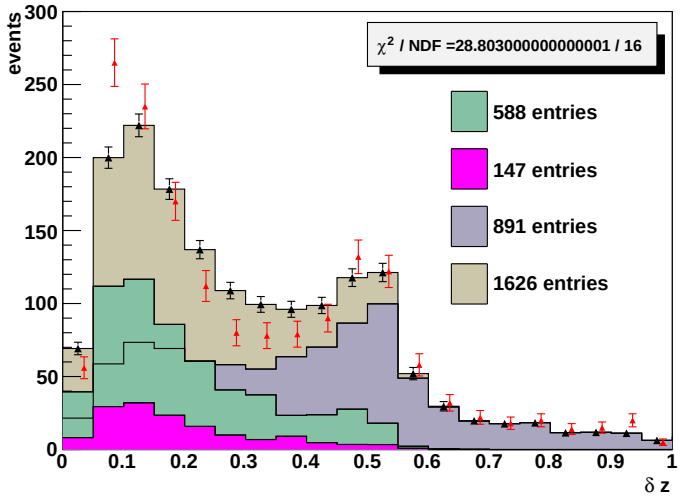


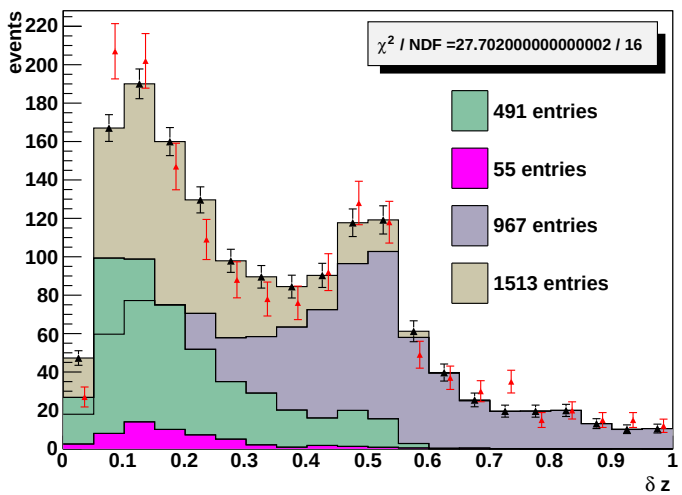


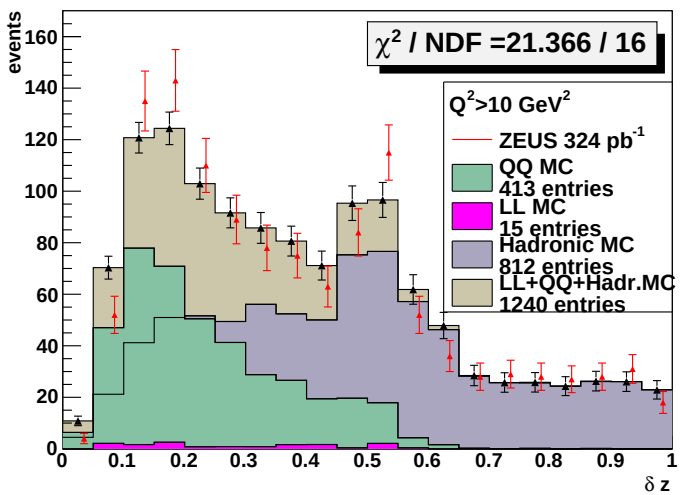
- Now we have 5 bins for Q^2, the plot will be replaced !

fits: $\delta z/\eta$

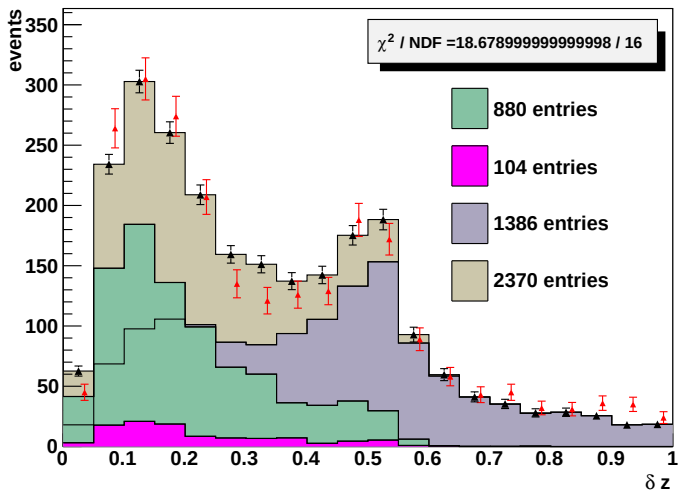


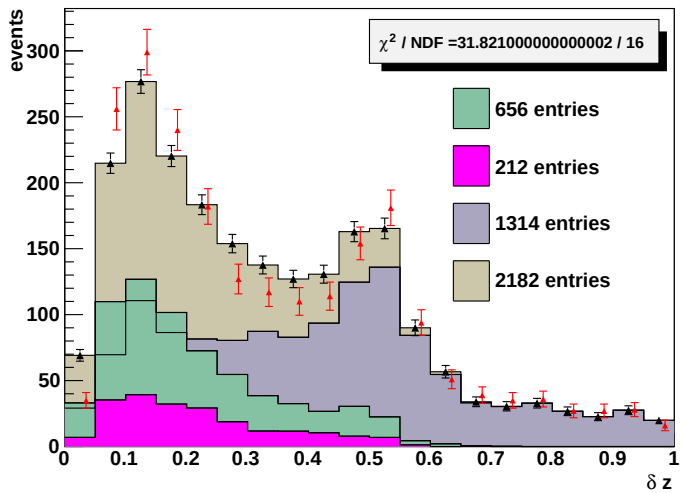


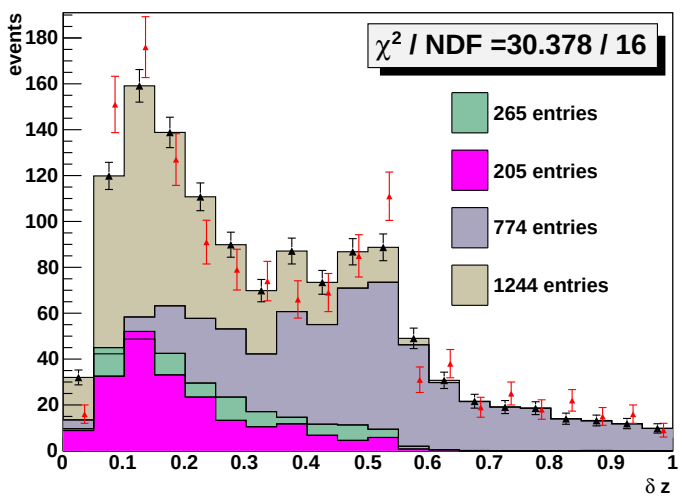


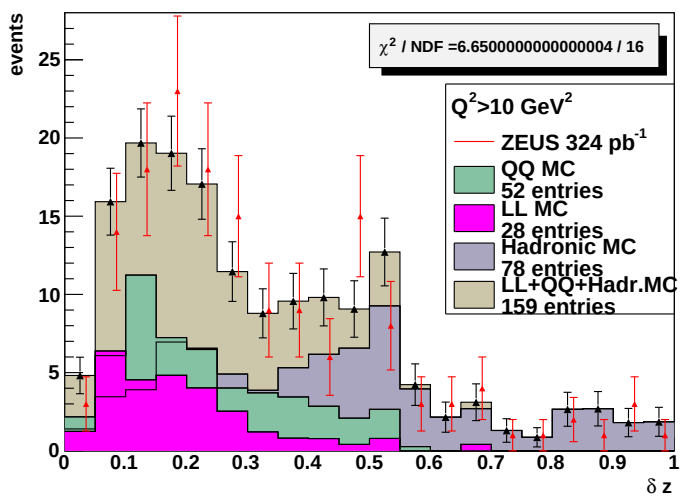


fits: δz/x

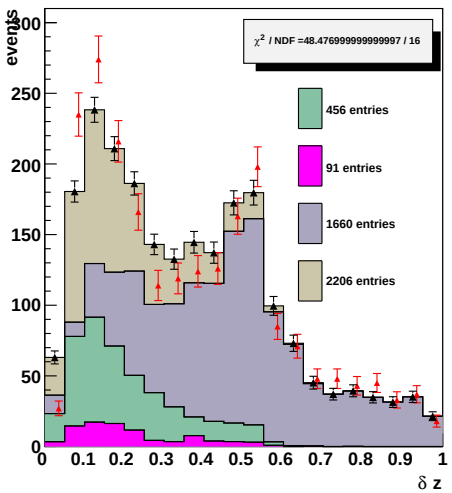


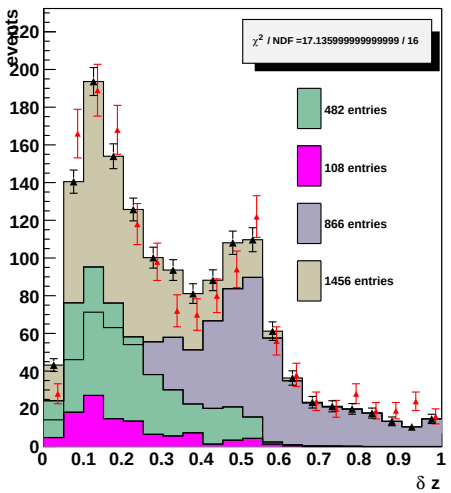


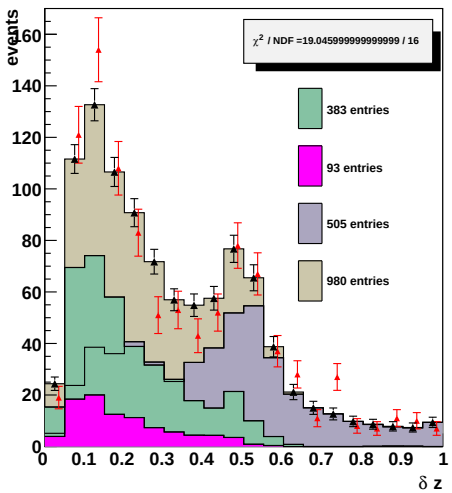


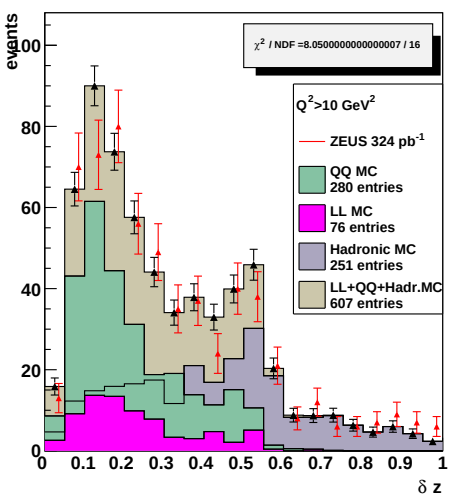


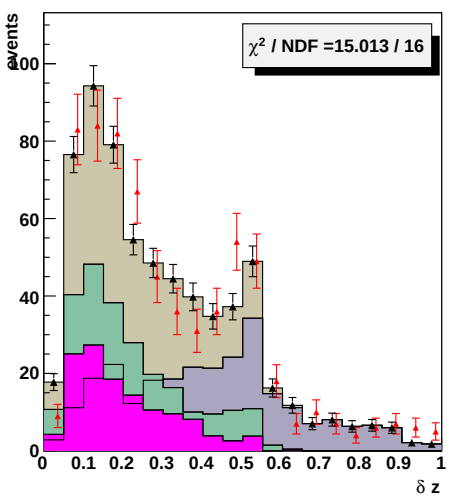
fits: $\delta z / E_{T,jet}$

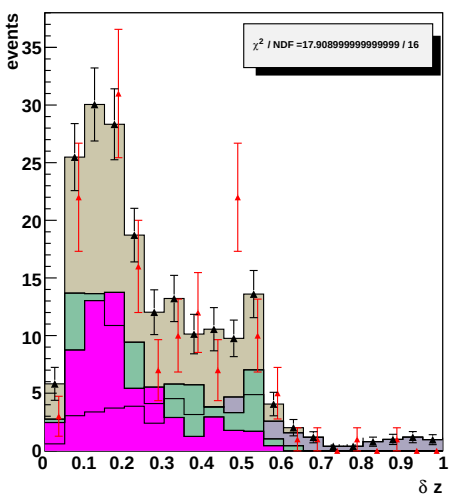




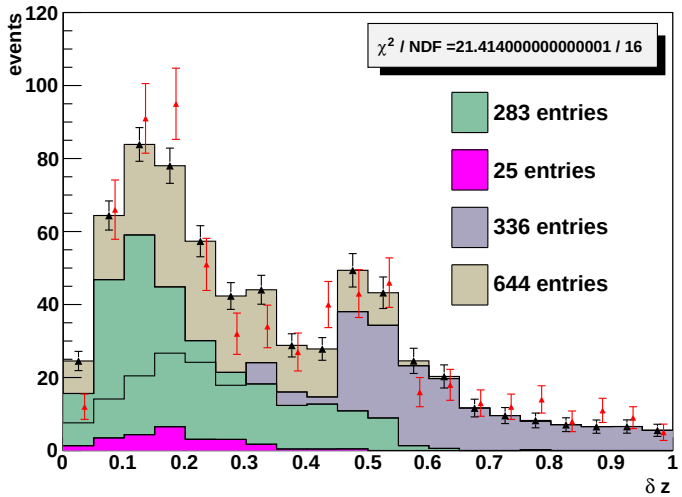


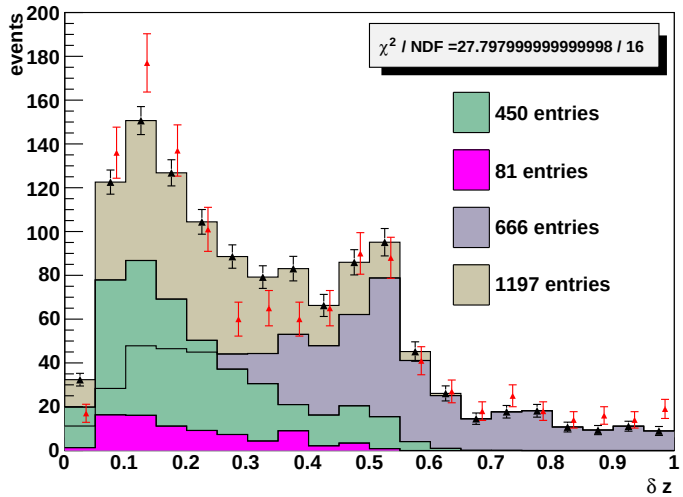


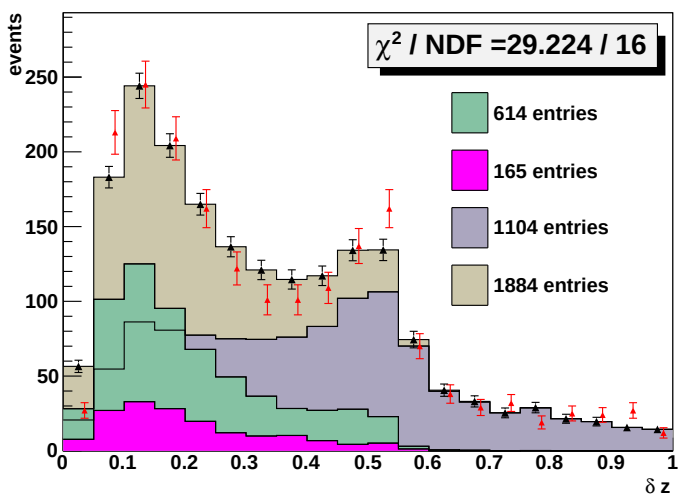


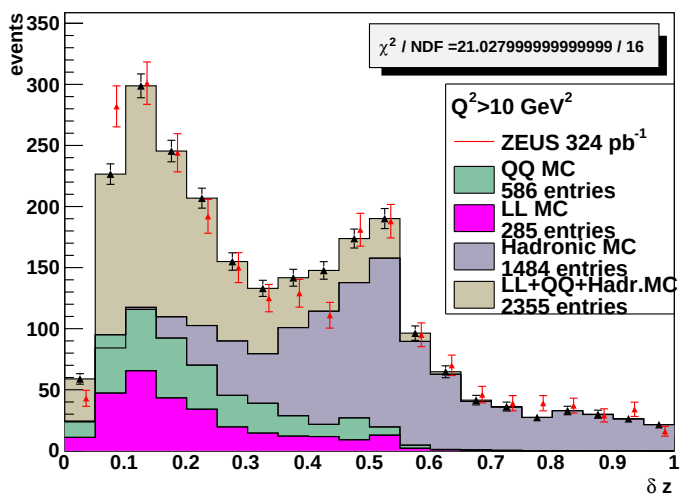


fits: $\delta z/\eta_{jet}$

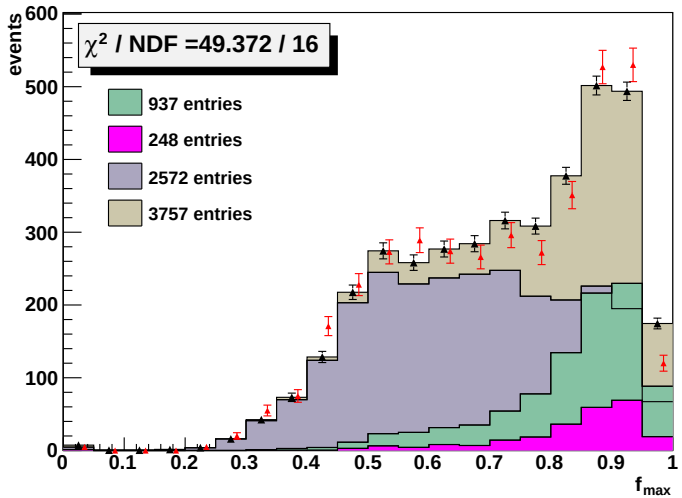


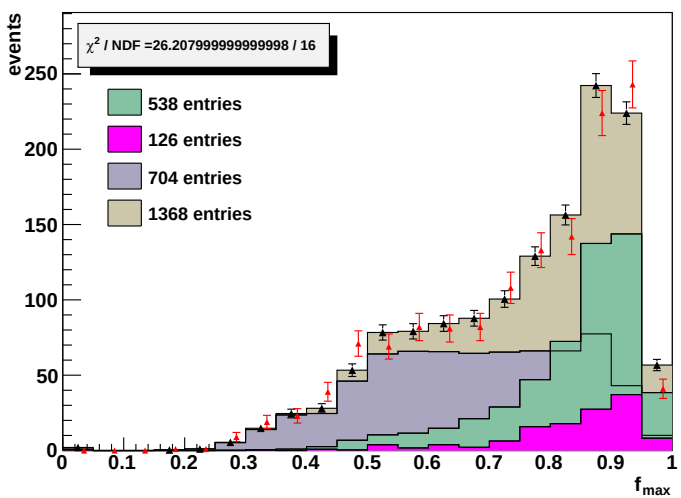


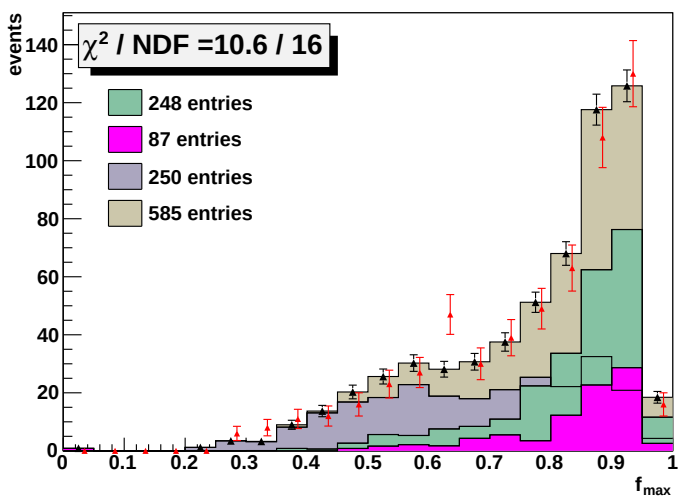


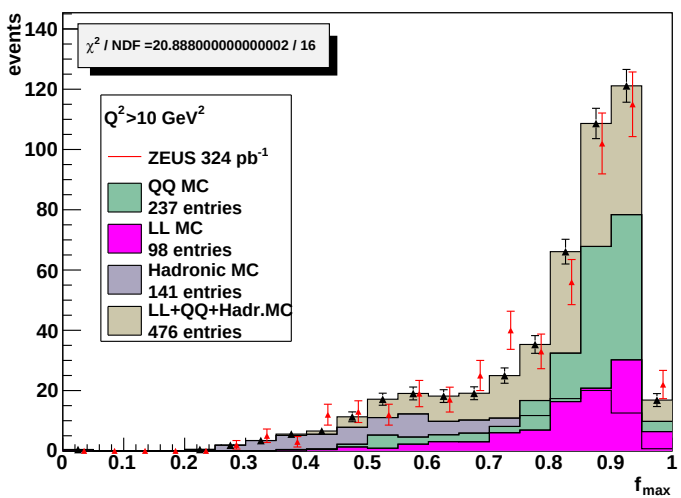


fits: f_{max}/Et

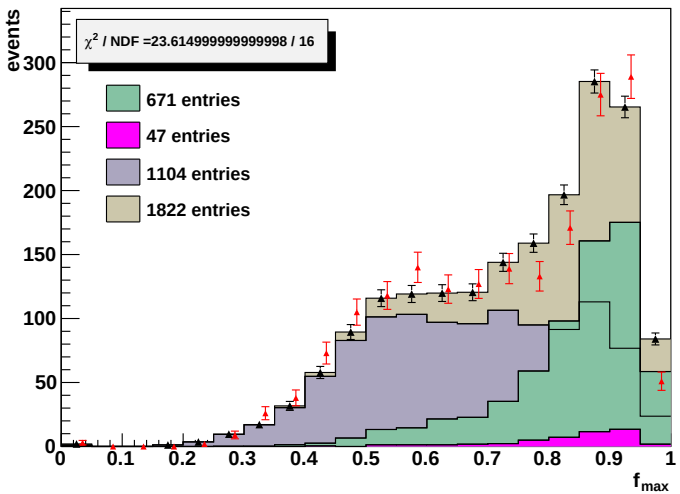

χ^2 / NDF =49.372 / 16
937 entries
248 entries
2572 entries
3757 entries
events
f_{max}

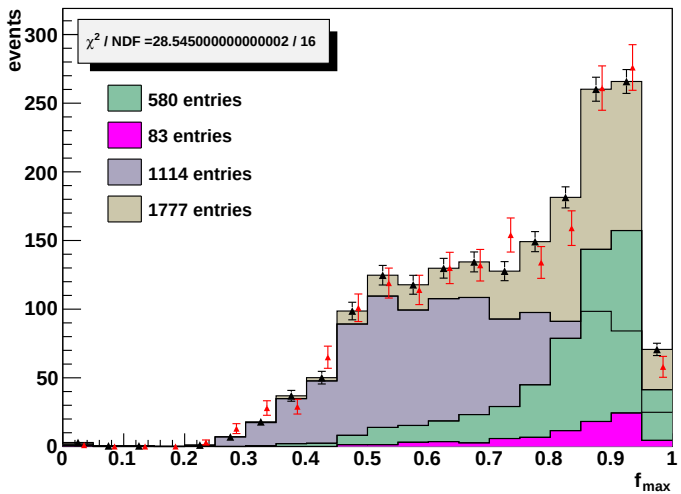

χ^2 / NDF =26.207999999999998 / 16
538 entries
126 entries
704 entries
1368 entries
events
f_{max}

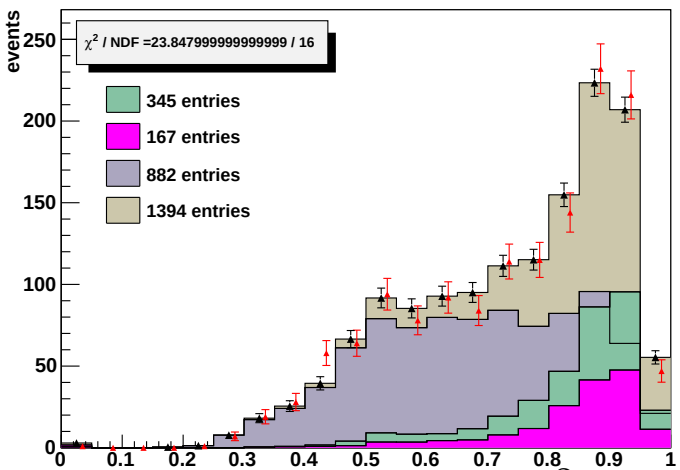

χ^2 / NDF =10.6 / 16
248 entries
87 entries
250 entries
585 entries
events
f_{max}

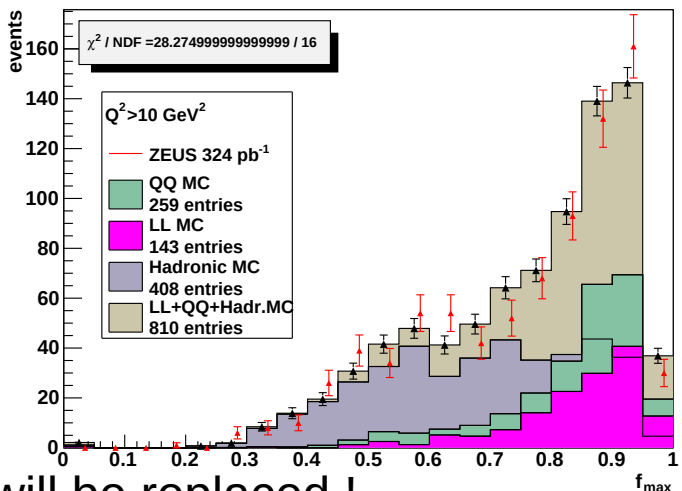

χ^2 / NDF =20.888000000000002 / 16
Q^2>10 GeV^2
ZEUS 324 pb^{-1}
QQ MC
237 entries
LL MC
98 entries
Hadronic MC
141 entries
LL+QQ+Hadr.MC
476 entries
events
f_{max}

fits: f_{max}/Q^2



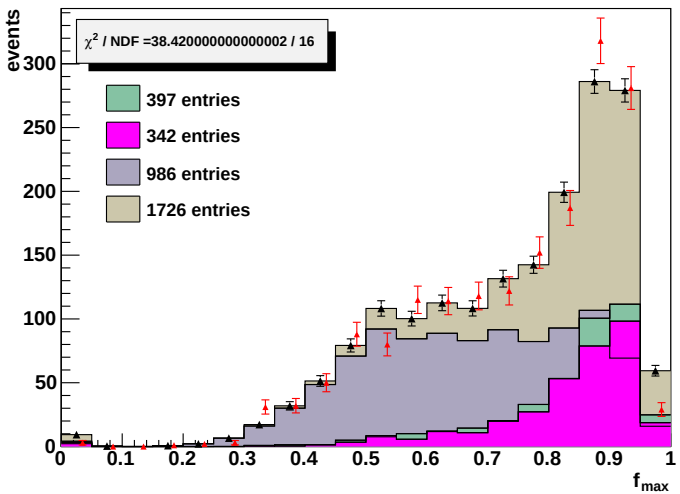


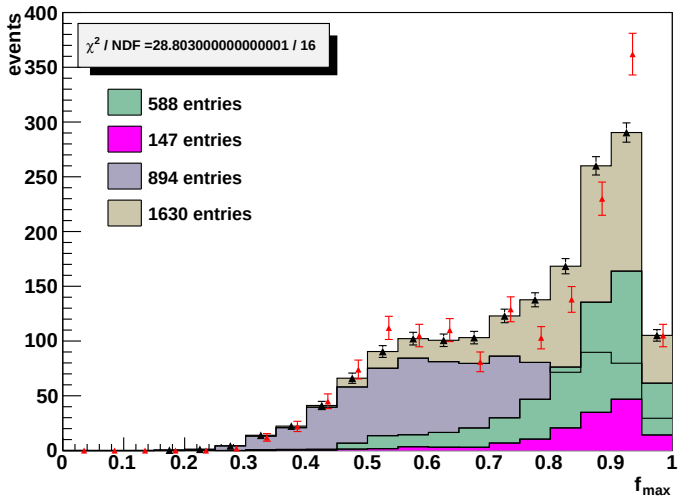


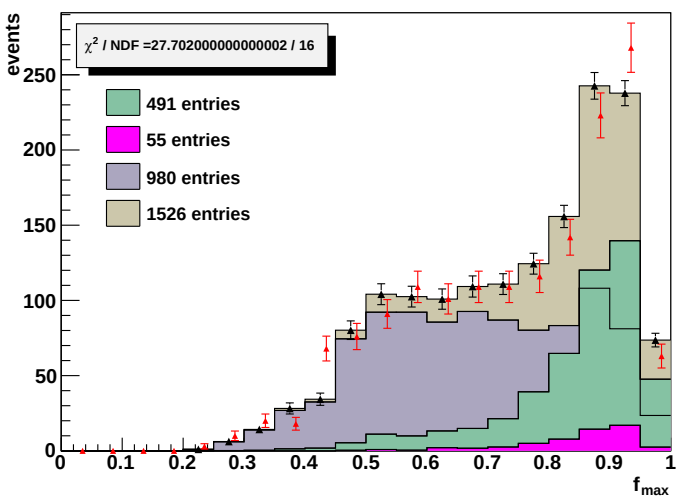


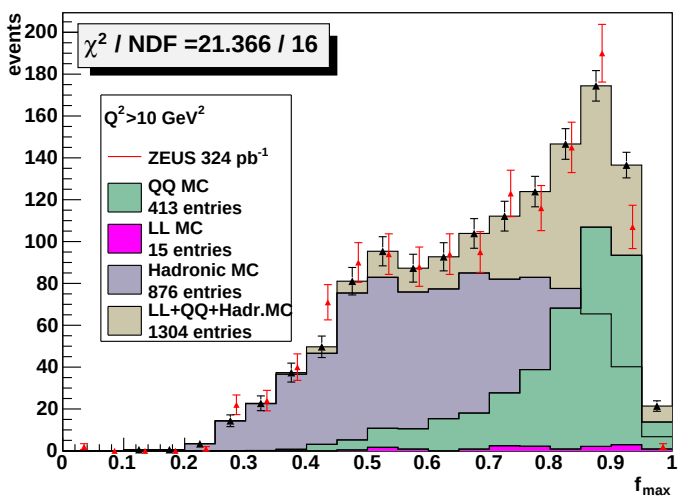
- Now we have 5 bins for Q^2, the plot will be replaced !

fits: f_{max}/η

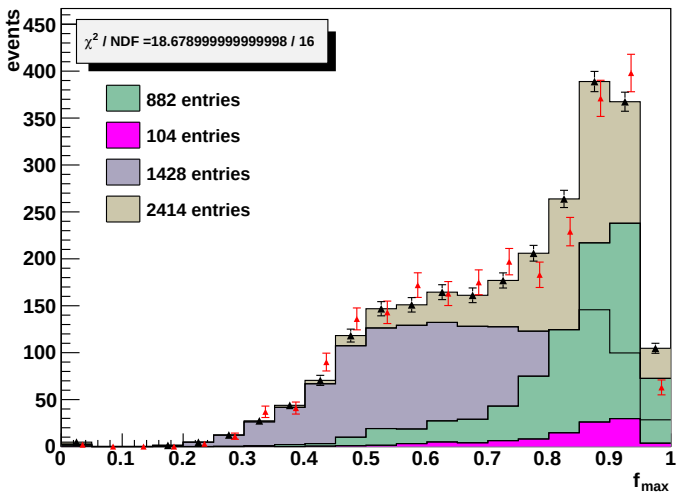


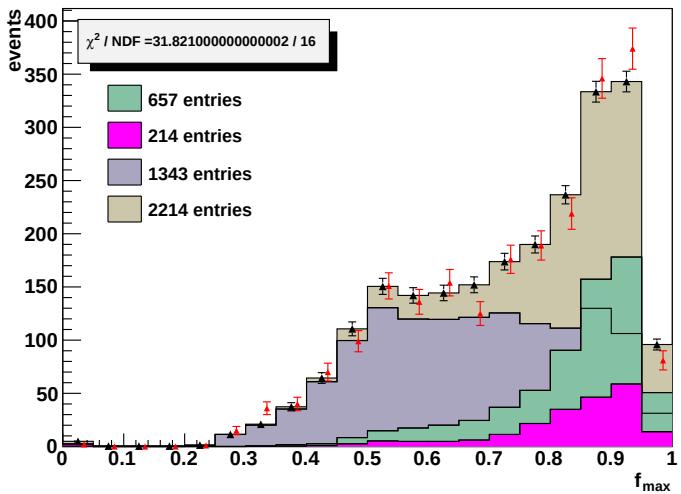


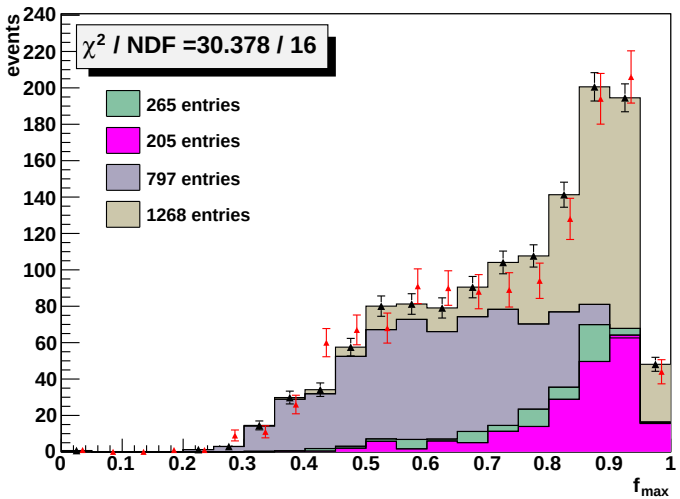


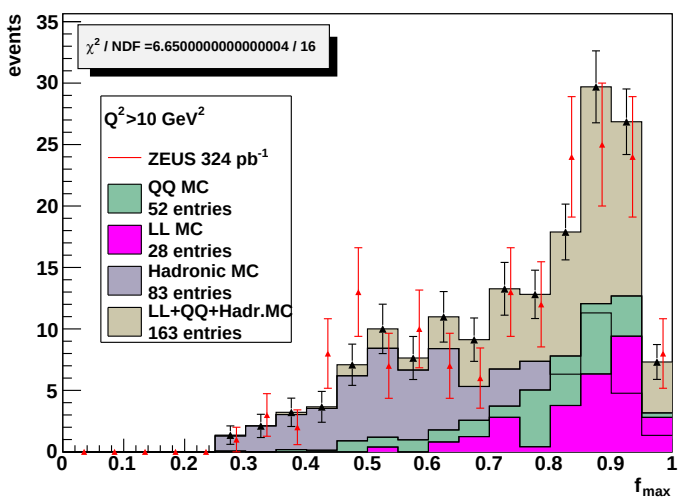


fits: f_{max}/x

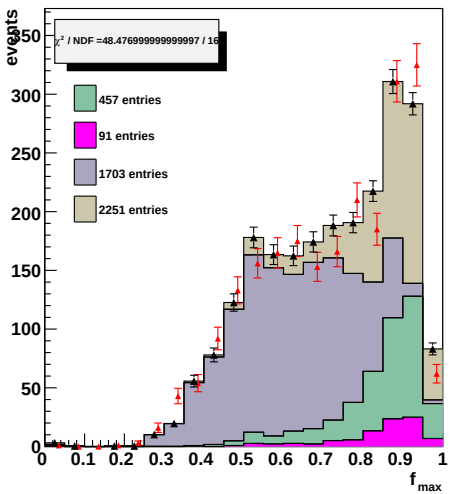

χ² / NDF =18.678999999999998 / 16
882 entries
104 entries
1428 entries
2414 entries
events
f_max

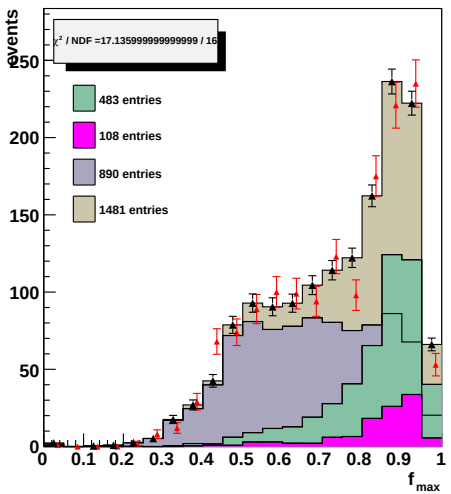

χ² / NDF =31.821000000000002 / 16
657 entries
214 entries
1343 entries
2214 entries
events
f_max

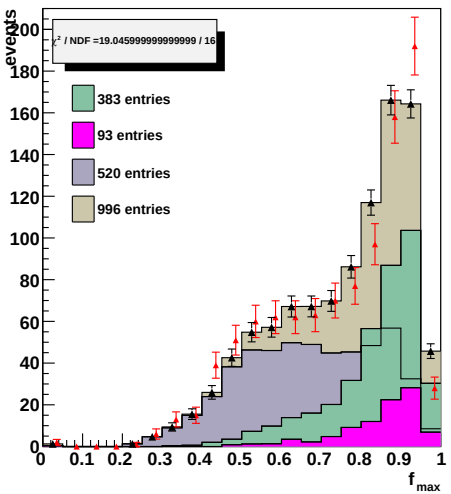

χ² / NDF =30.378 / 16
265 entries
205 entries
797 entries
1268 entries
events
f_max

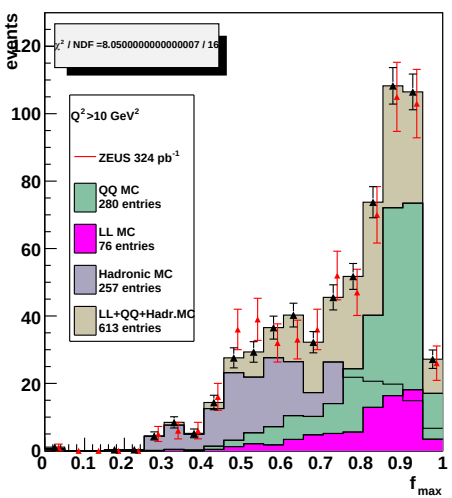

χ² / NDF =6.6500000000000004 / 16
Q²>10 GeV²
ZEUS 324 pb⁻¹
QQ MC
52 entries
LL MC
28 entries
Hadronic MC
83 entries
LL+QQ+Hadr.MC
163 entries
events
f_max

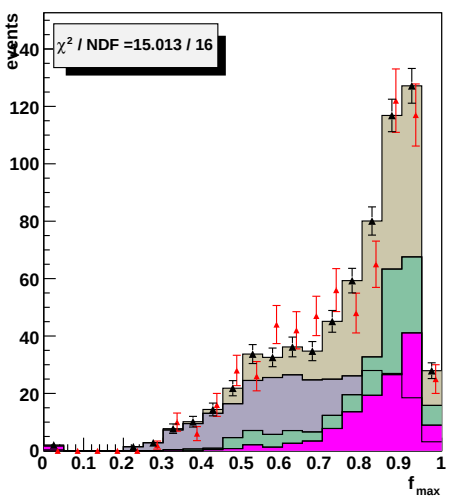
fits: $f_{max}/E_{T,jet}$

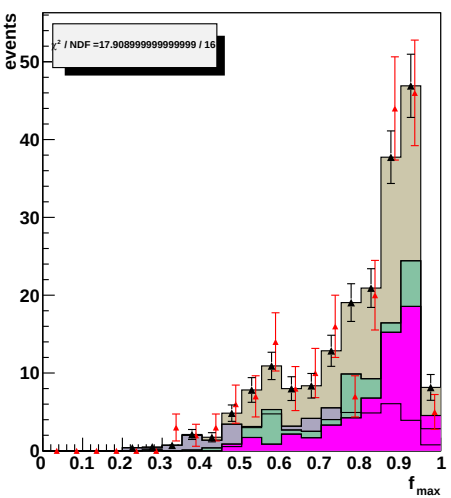




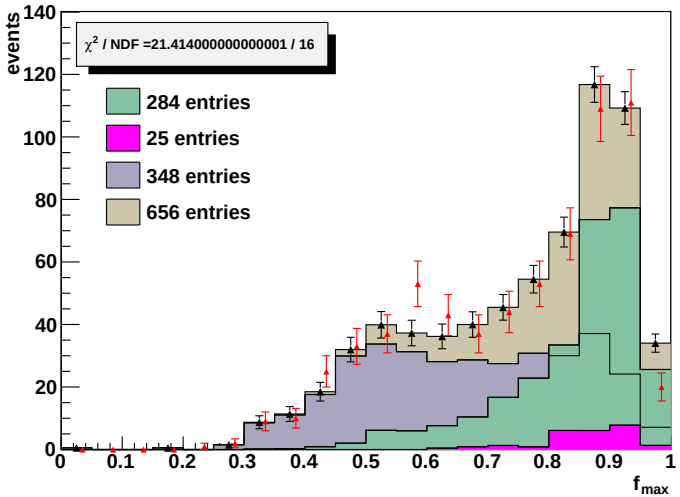


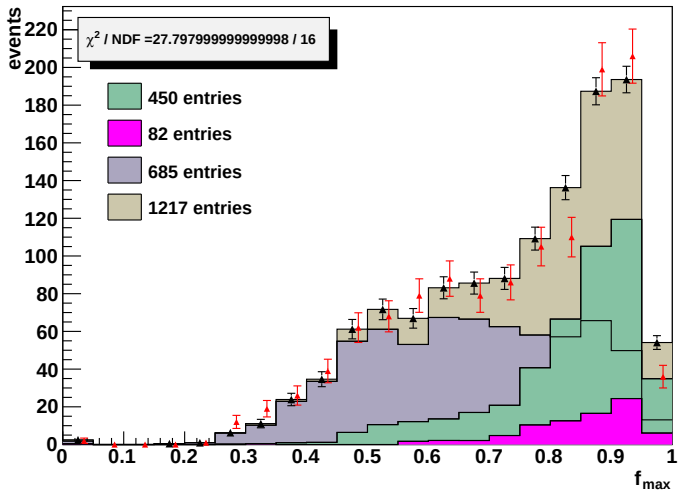


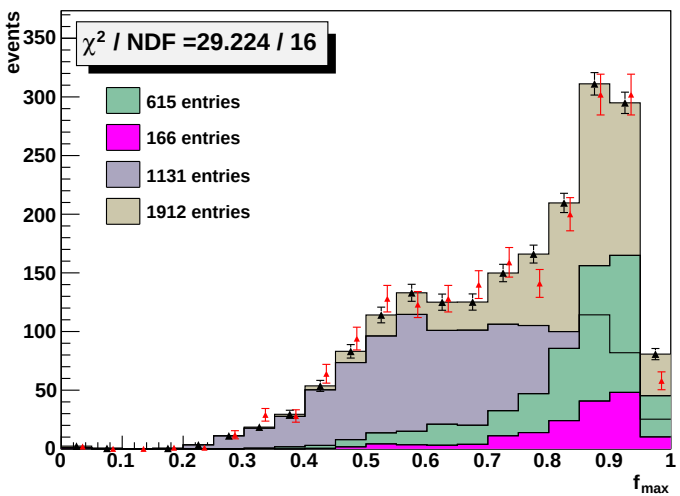


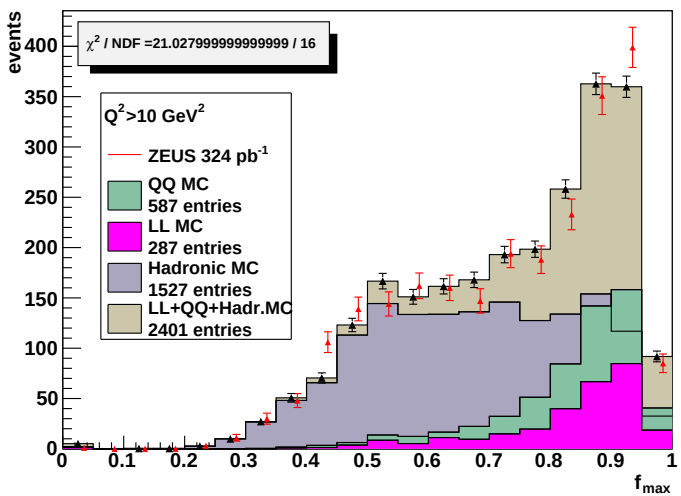


fits: f_{max}/η_{jet}









M.Forrest's Cuts

Phase Space

- $10 < Q^2 < 350\mathrm{GeV}^2$

Cleaning Cuts

- $-40 < Z_{\mathrm{vtx}}/cm < 40$
- $35\ \mathrm{GeV} < \mathrm{E} - \mathrm{p_z} < 65\ \mathrm{GeV}$

Electron Cuts

- $\mathrm{Siecorr} > 10\ \mathrm{GeV}$
- $139.8° < \theta_{el} < 171.9°$
- $-14.8 < e_x/\mathrm{cm} < 14.8$
- $-14.6 < e_y/\mathrm{cm} < 12.5$

Triggers

- FLT level slots - any of: 28, 30, 36, 39, 40, 41, 43, 44, 46, 47
- TLT level slots - any of: DIS03, SPP02, SPP09, HFL17
- SLT level slots - any of: SLT1, SLT2, SLT3, DIS01, DIS07

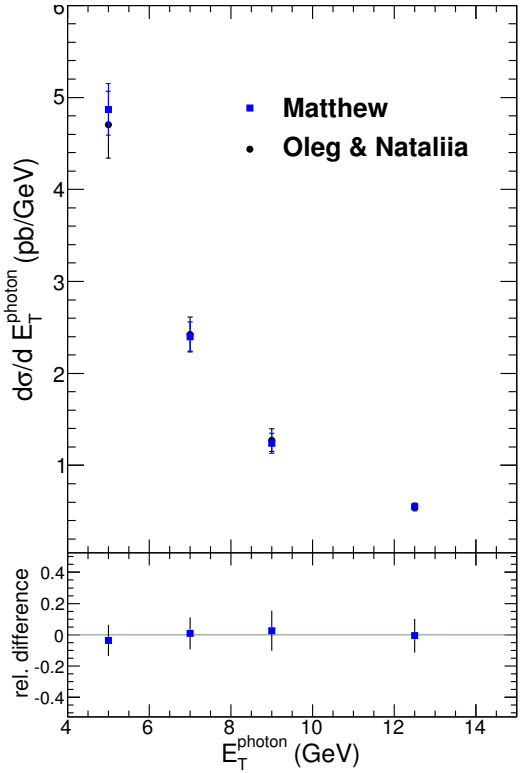
Prompt Photon Phase Space

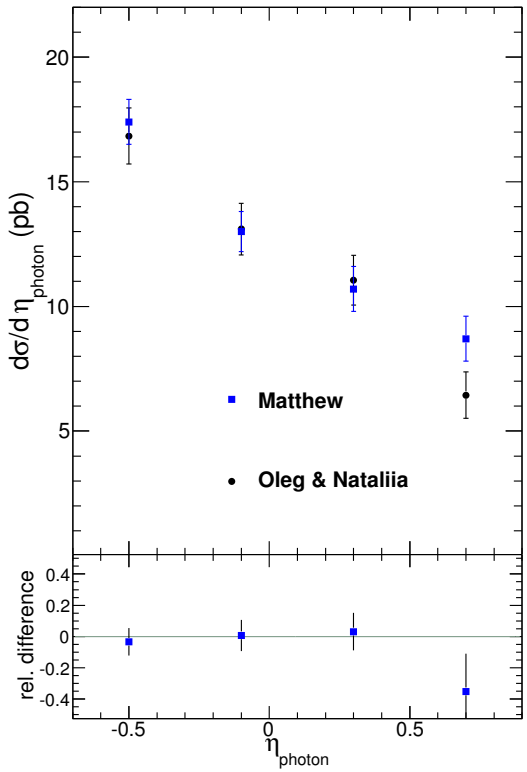
- $4 < E_\gamma/\mathrm{GeV} < 15$
- $-0.7 < \eta_\gamma < 0.9$

Prompt Photon Cleaning Cuts

- $\Delta r < 0.2$
- $\frac{\mathrm{E_{EMC}}}{\mathrm{E_{HAC}}+\mathrm{E_{EMC}}} > 0.9$
- $f_{max} > 0.05$
- 0 ¡ δz ¡ 0.8

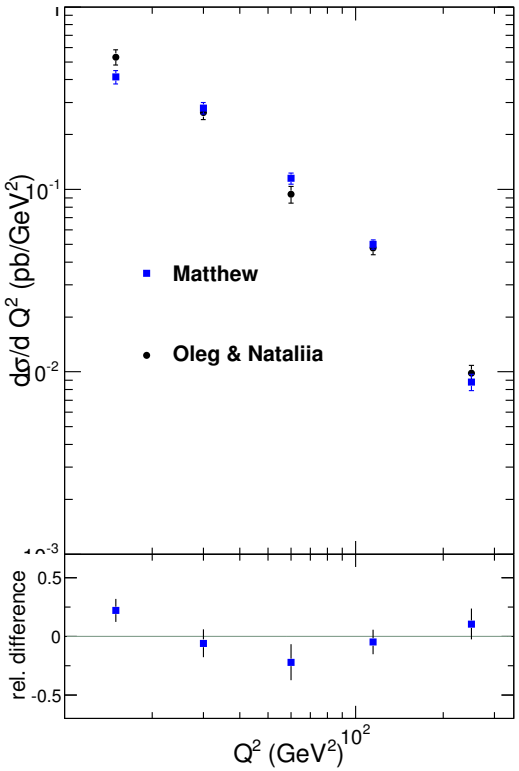
Comparison with M.Forrest results (inclusive photons)

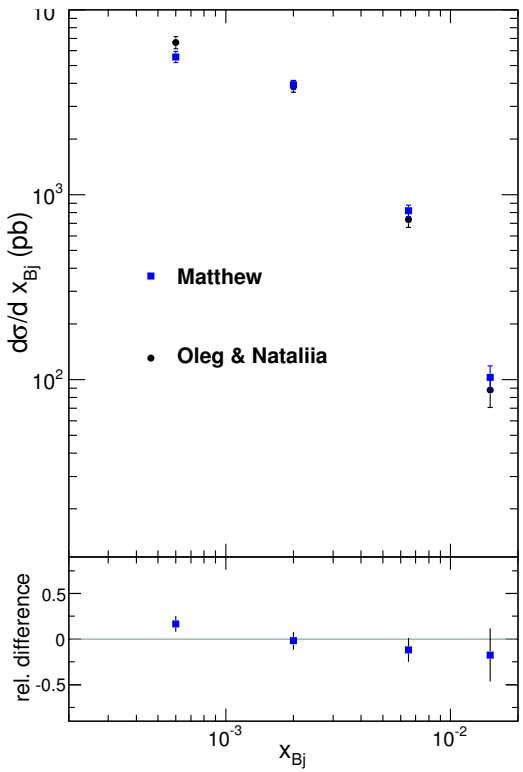




- Discrepancy in first E_T^{photon} bin may stay because we using reprocessed data and that we have twice the statistics for the MC ariadne background.
- η_{photon}: good except for the last bin (low statistics and very different elec-5 - zufos).

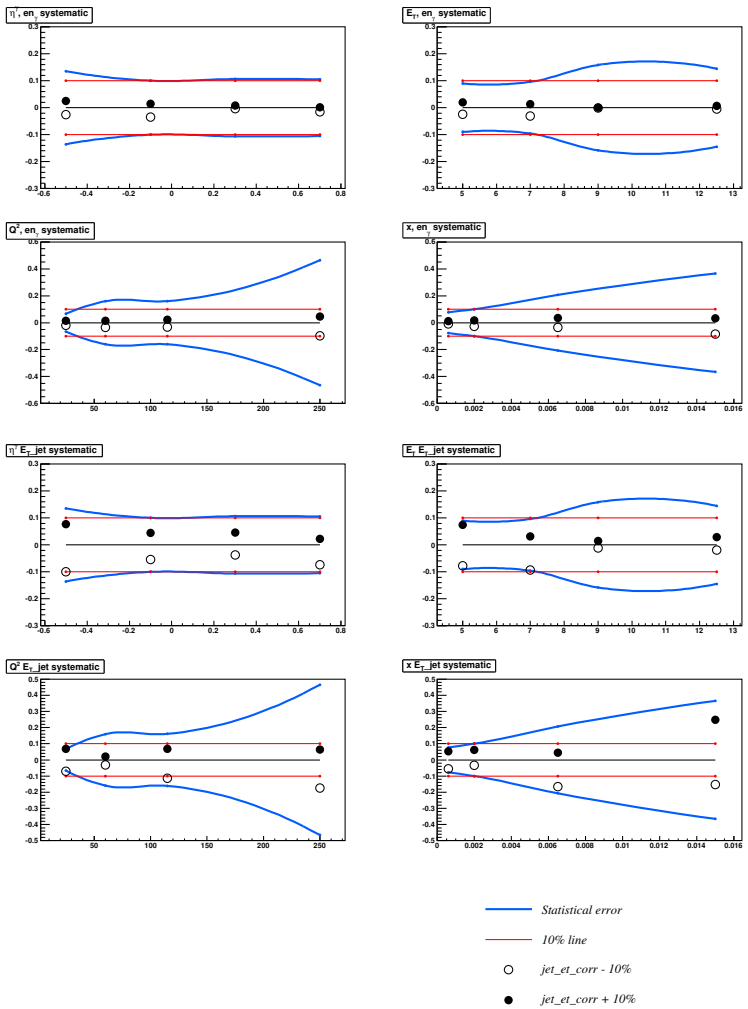
Comparison with M.Forrest results (inclusive photons)





• Q^2 and x: some discrepancy is 1st bins maybe becouse of the electron reconstruction changed during reprocessing and becouse of the additional ARIADNE background.

Studying of systematic effects (1/2)



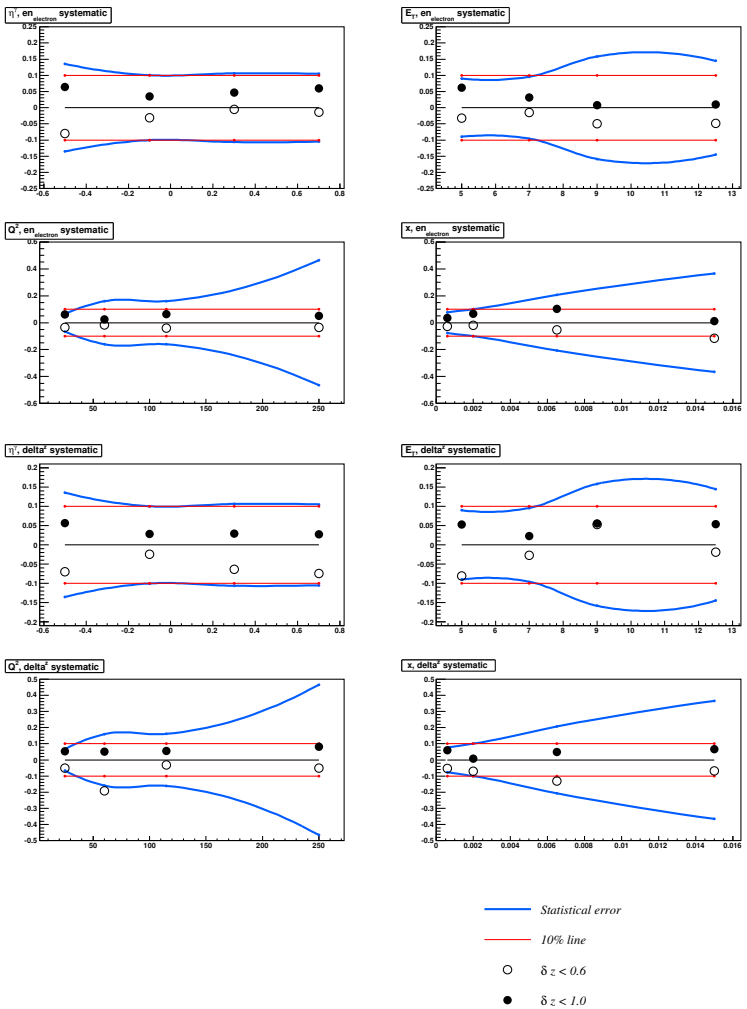
Photon energy $\pm 2\%$

- Photon energy in Data has been multiplied by 1.02 and 0.98
- Resulting deviation is less then 3-4$\%$ in most bins
- Systematics plots will be redone !

Jet energy $\pm 10\%$

- Jet energy in Data has been multiplied by 1.1 and 0.9
- Resulting deviation is up to 20$\%$
- Systematics plots will be redone !

Studying of systematic effects (2/2)



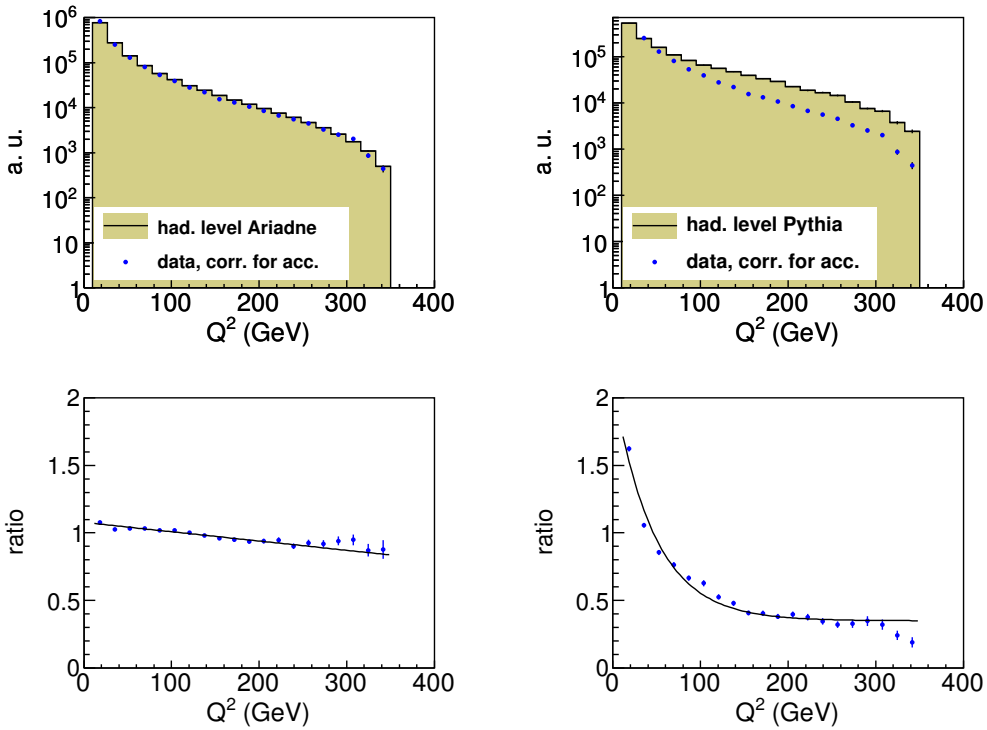
Electron energy $\pm 2\%$

- Electron energy in Data has been multiplied by 1.02 and 0.98
- Resulting deviation is 5-10$\%$
- Systematics plots will be redone !

δZ fit range

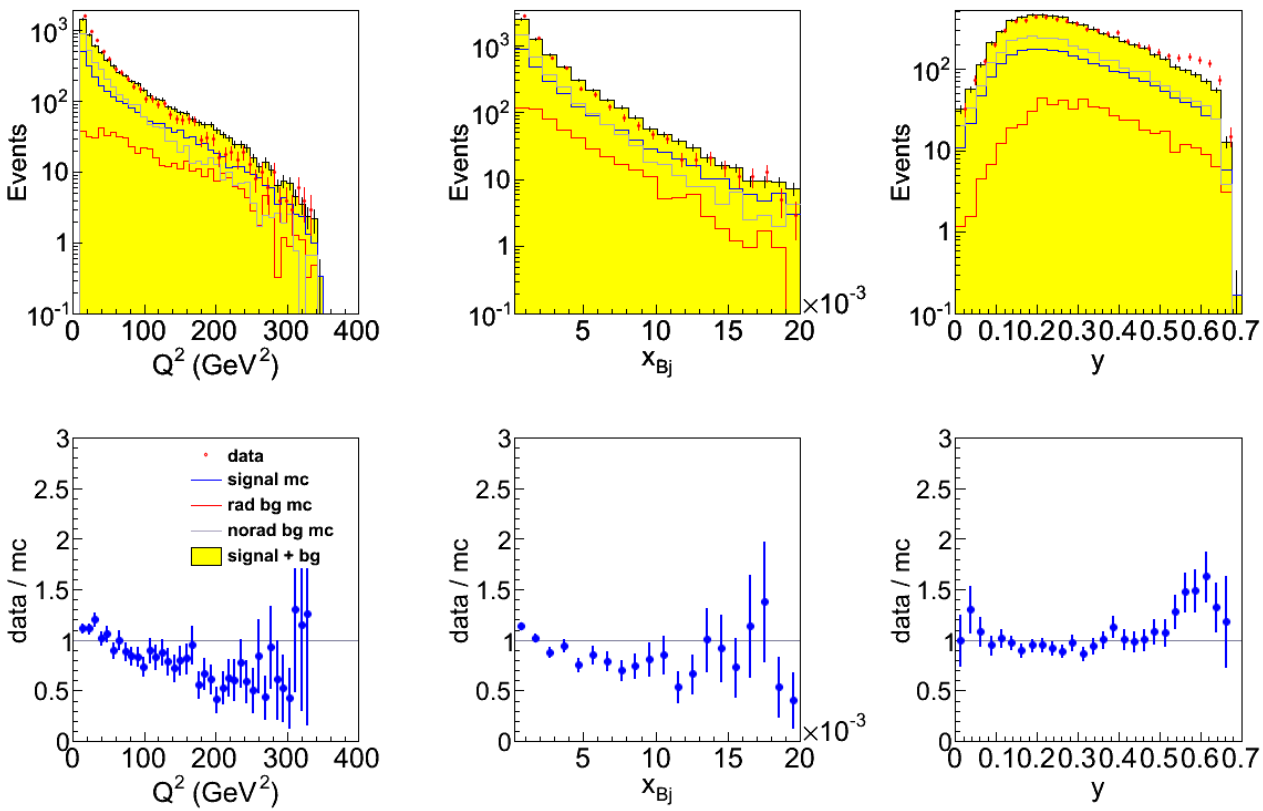
- δz fit range has been changed from [0, 0.8] to [0, 0.6] and [0, 1.]
- Resulting deviation in most of bins is less then 8$\%$
- Systematics plots will be redone !

data/MC ratio 0405e (before Q^2 reweighting)



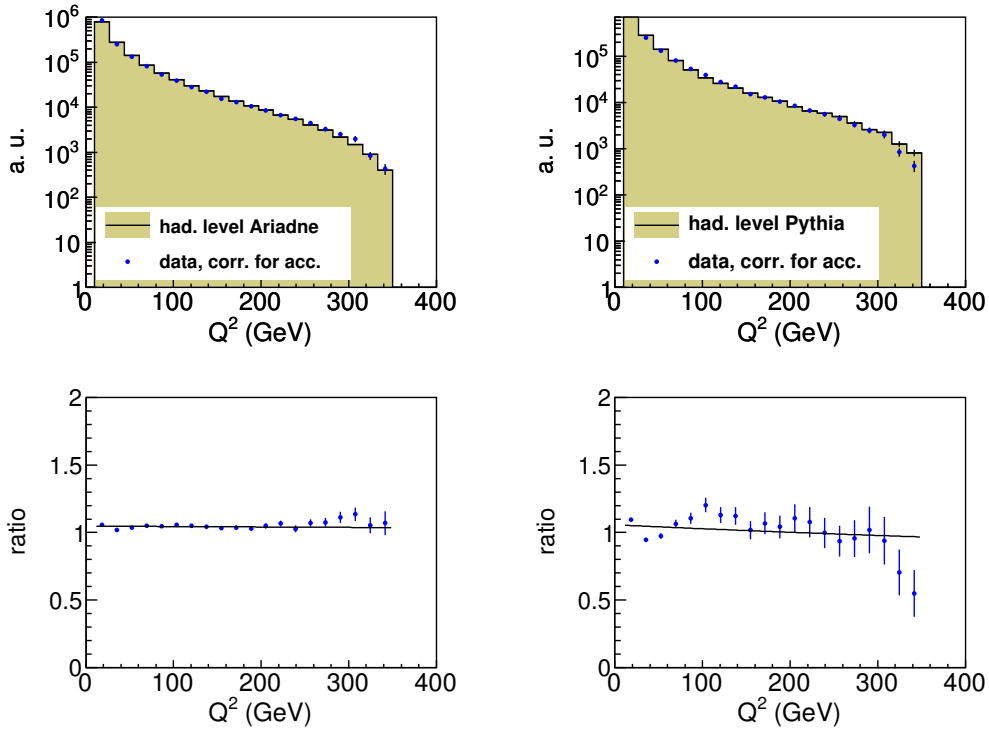
- Q^2 distributions for inclusive-DIS events for Data and MC (Pythia, Ariadne) (corrected for acceptance effects)
- Ariadne is described normal, Pythia is described not good
- Reweighting function for Pythia: ratio = par0*Exp(par1*Q^2) + par2
- Reweighting function for Ariadne: ratio = par0 + par1*Q^2

Control Plots 0405e (before Q^2 reweighting)



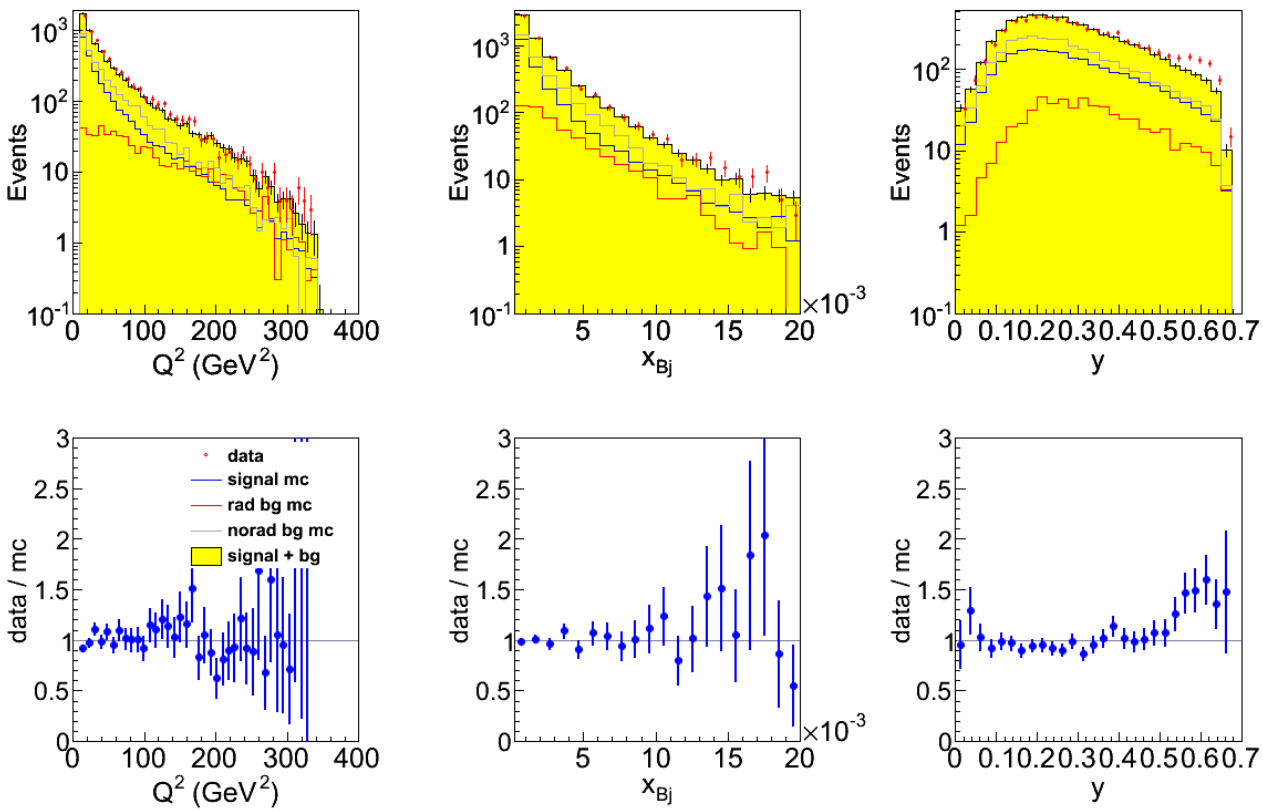
- Control plots for prompt photon + jet events: agreement is not very satisfied

data/MC ratio 0405e (after Q^2 reweighting)



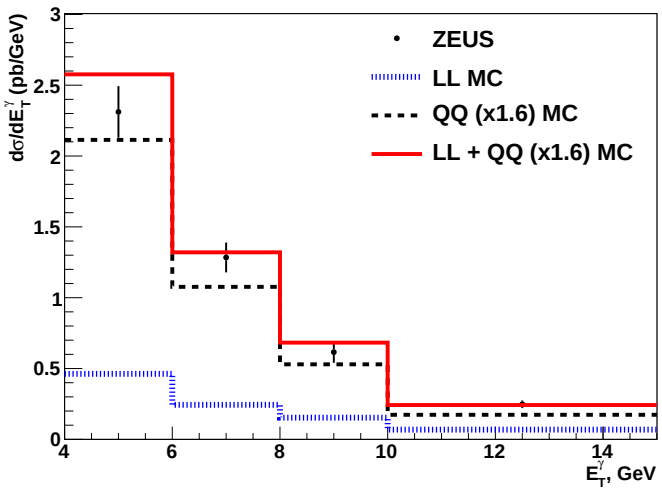
- Q^2 distributions for inclusive-DIS events for Data and MC (Pythia, Ariadne) (corrected for acceptance effects)
- Ariadne and Pythia have improoved thier distributions

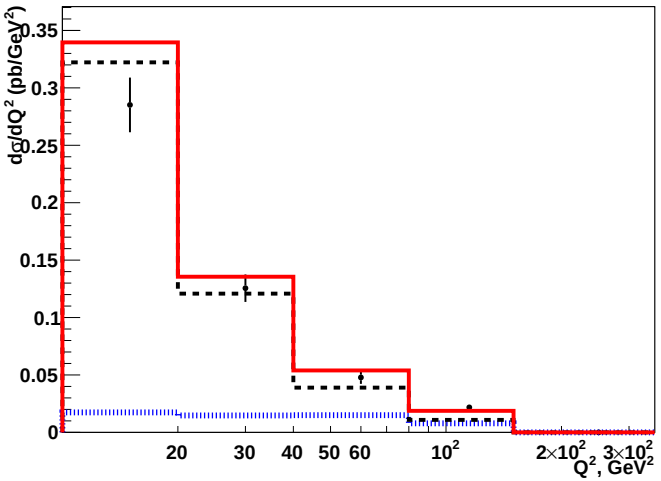
Control Plots 0405e (after Q^2 reweighting)

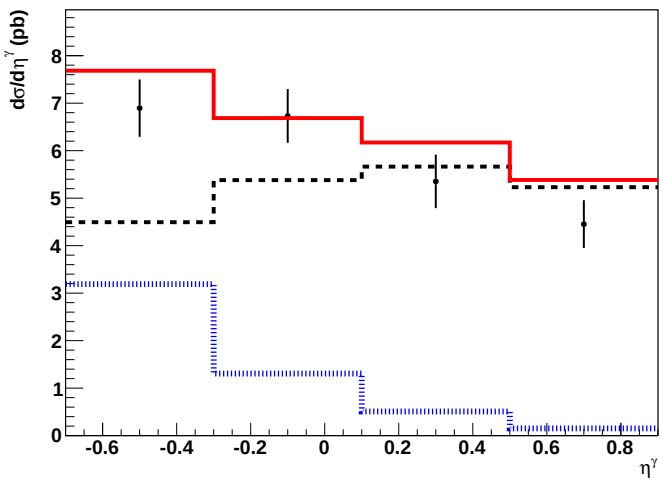


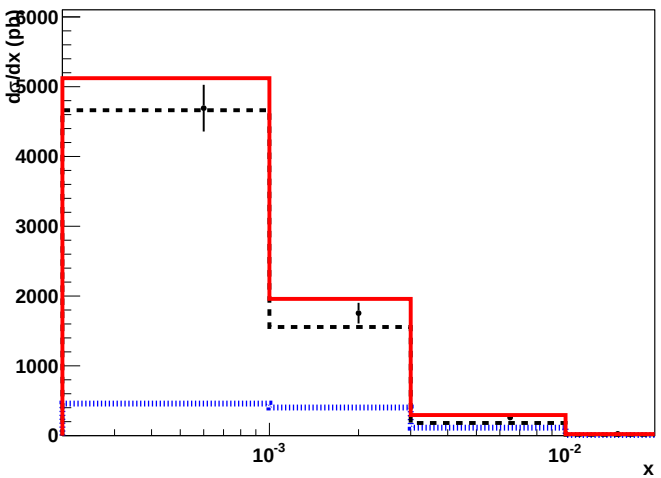
- Control plots for prompt photon + jet events: agreement is significally better

Differential cross sections

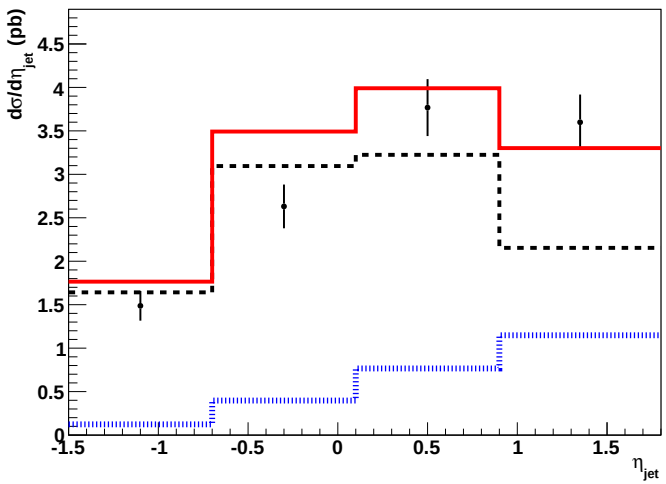


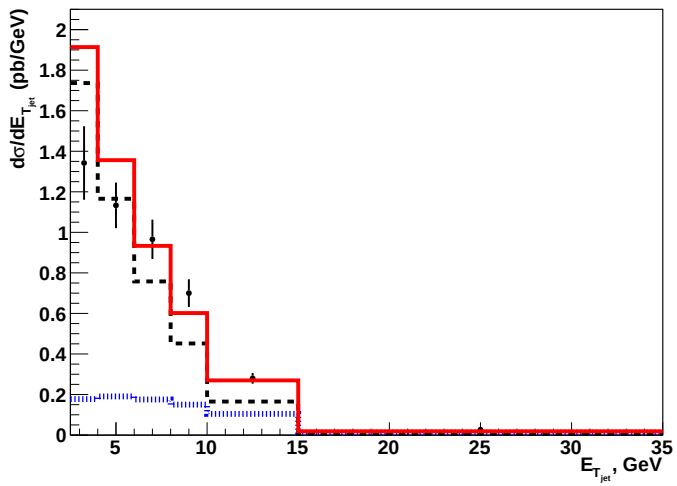






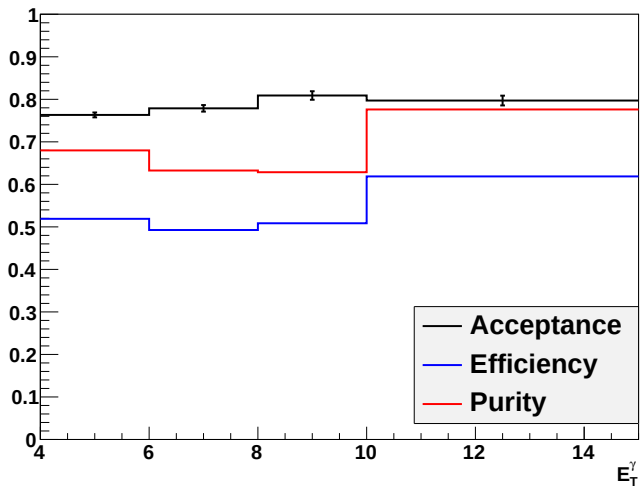
Cross sections as functions of jet variables

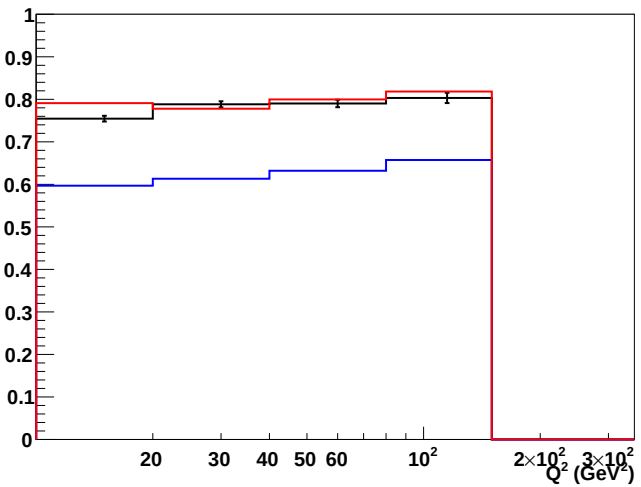


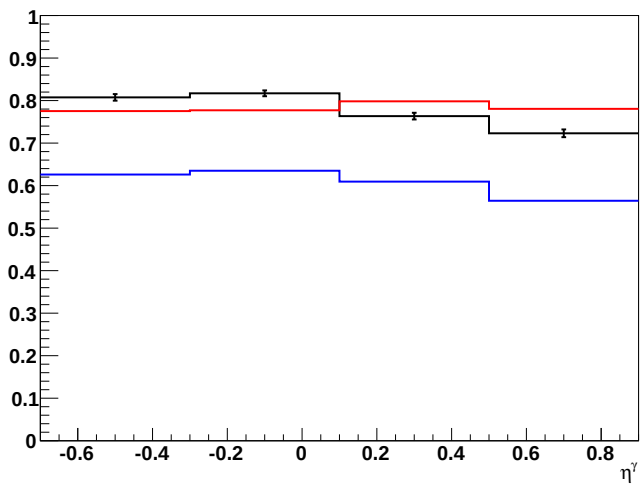


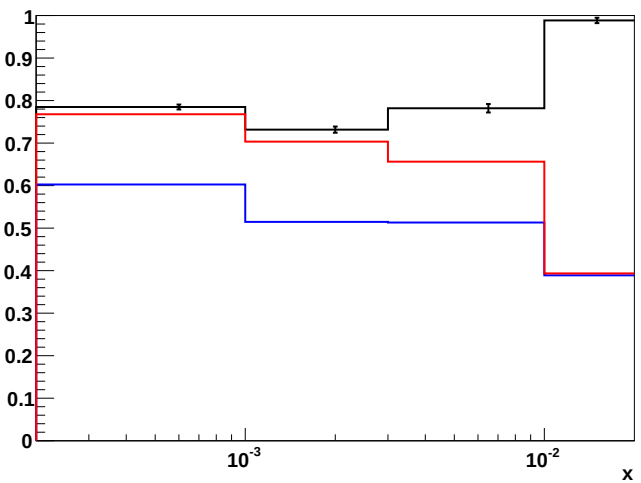
- Bins of η_{jet} -1.5; -0.7; 0.1; 0.9; 1.8
- Bins of $E_{T,jet}$ 2.5; 4.; 6.; 8.; 10.; 15.; 35.

Acceptance, efficiensy, purity (signal MC)

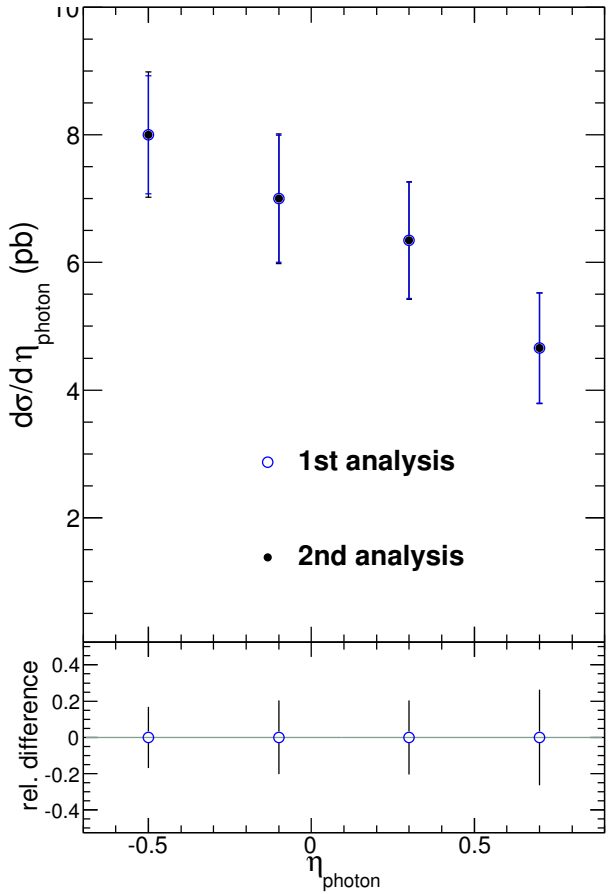






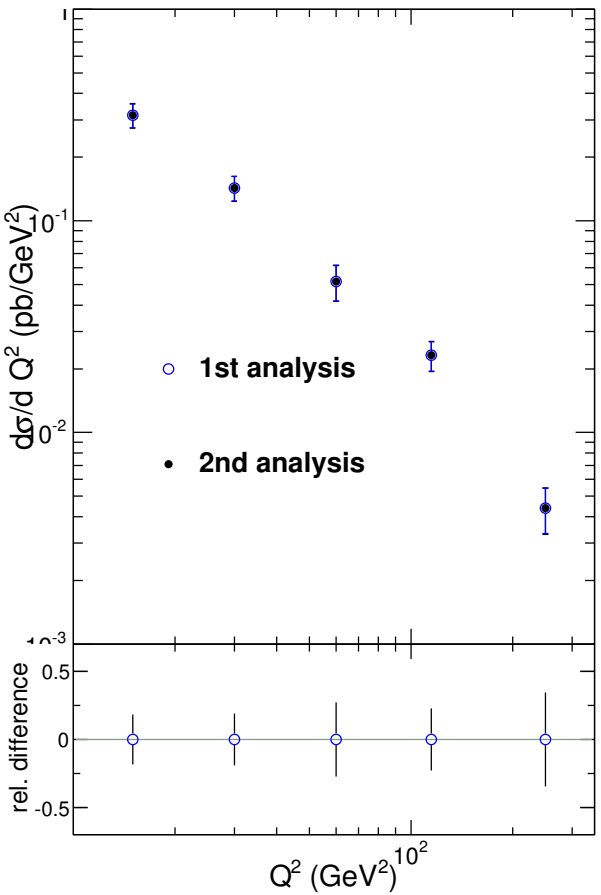


Comparison of 1st and 2nd analysis, 0405e, eta_γ



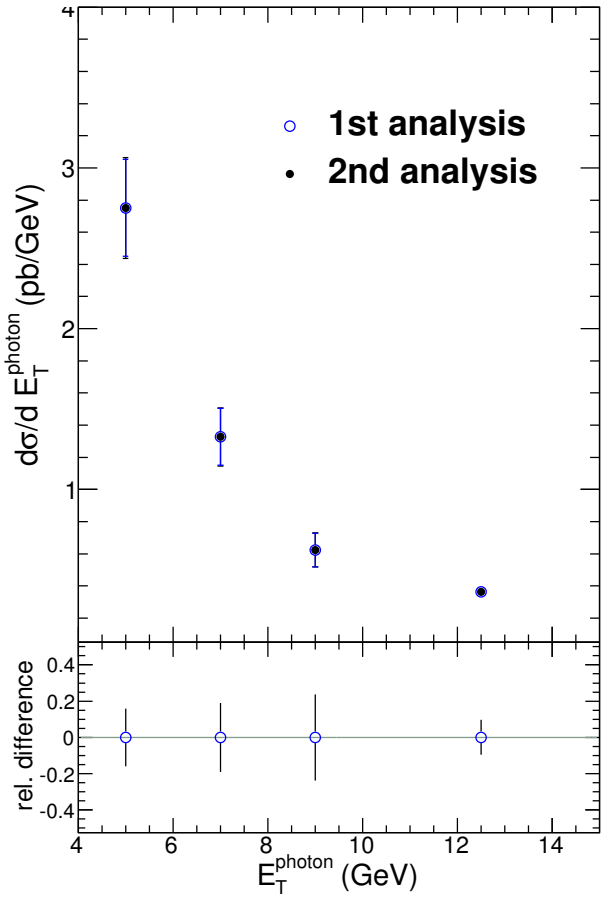
- Distributions of selected events with photon + jet are compared
- Agreement in 1st and 2nd analysis is very high (less then 0.001%)

Comparison of 1st and 2nd analysis, 0405e, Q^2



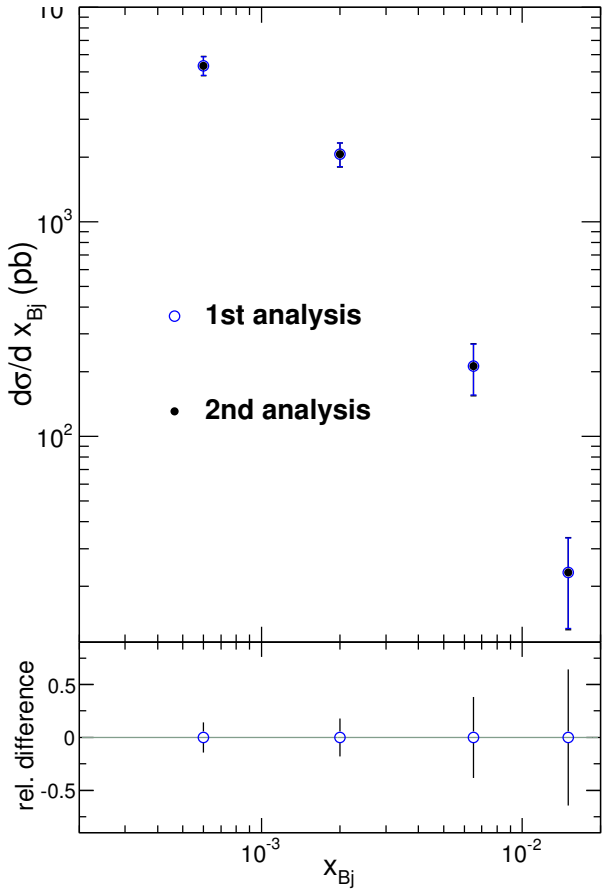
- Distributions of selected events with photon + jet are compared
- Perfect agreement of 1st and 2nd analysis

Comparison of 1st and 2nd analysis, 0405e, E_T



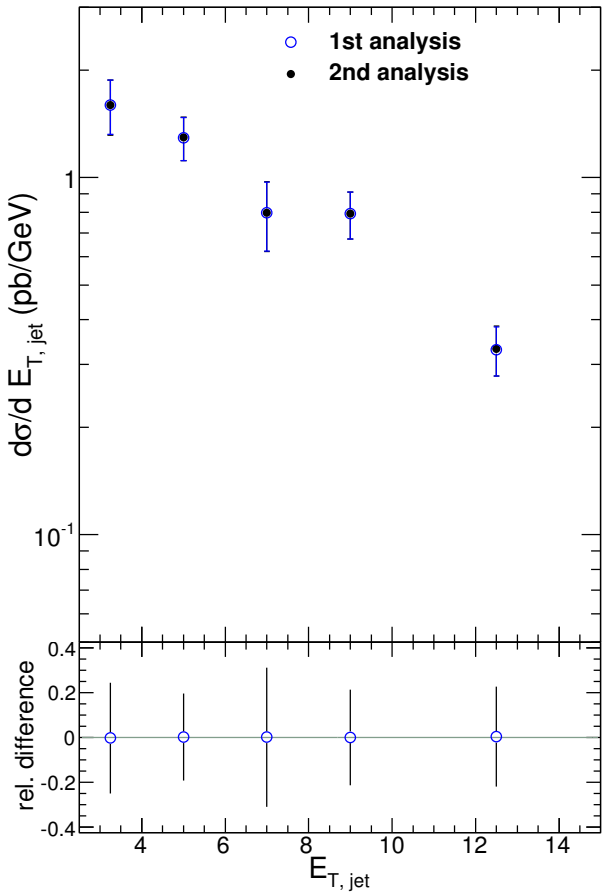
- Distributions of selected events with photon + jet are compared
- Very good agreement in 1st and 2nd analysis

Comparison of 1st and 2nd analysis, 0405e, x



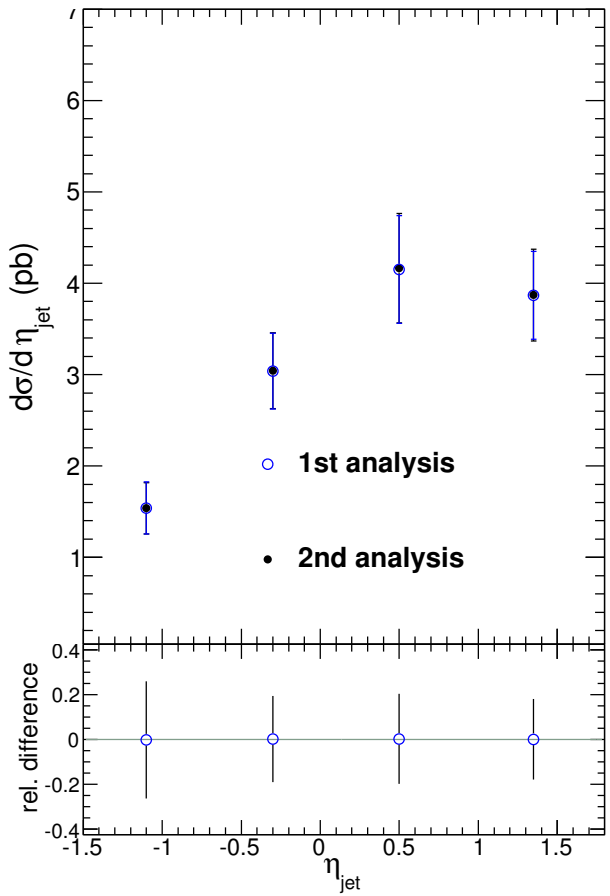
- Distributions of selected events with photon + jet are compared
- Discrepany in 1st and 2nd analysis is less then 0.001%

Comparison of 1st and 2nd analysis, 0405e, $E_{T,jet}$



- Distributions of selected events with photon + jet are compared
- Perfect agreement of 1st and 2nd analysis

Comparison of 1st and 2nd analysis, 0405e, η_{photon}



- Distributions of selected events with photon + jet are compared
- Agreement in 1st and 2nd analysis is very high

Summary

- Differential cross sections for prompt photon + jets production have been measured.
- Previous theoretical predictions are higher than our data (but coincide with the H1 data for gamma + jet in their kinematical region).