EXO-12-041 Approval [Backup]

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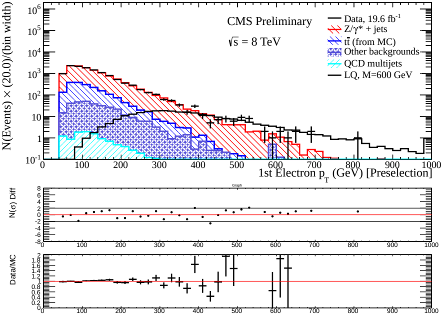
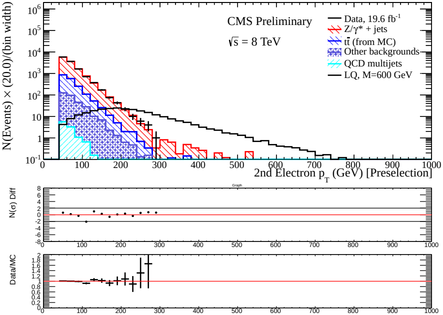
Tuesday, June 24, 2014

eejj preselection: electron p_{T}

Leading electron p_{T}

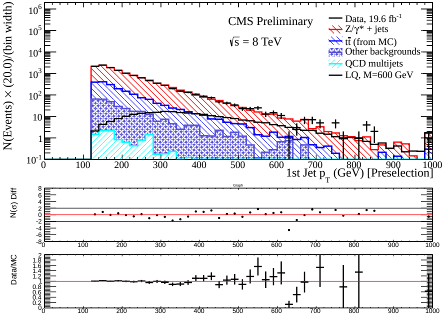


Second leading electron p_{T}

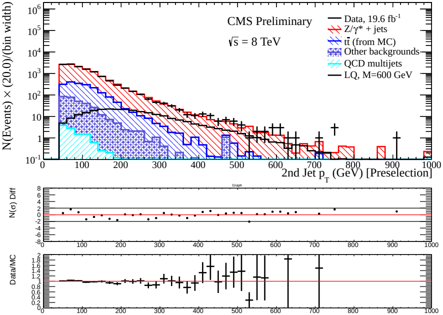


eejj preselection: jet p_T

Leading jet p_T

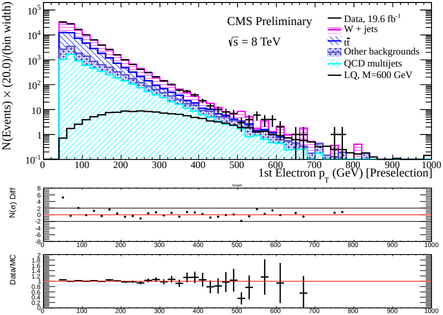


Second leading jet p_T



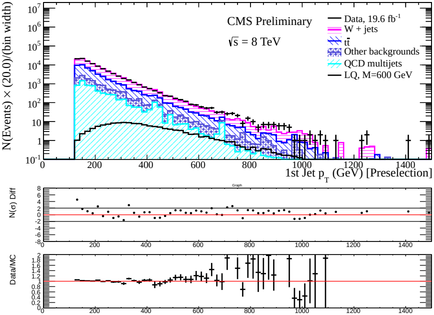
$e\nu jj$ preselection: electron p_T

Electron p_T

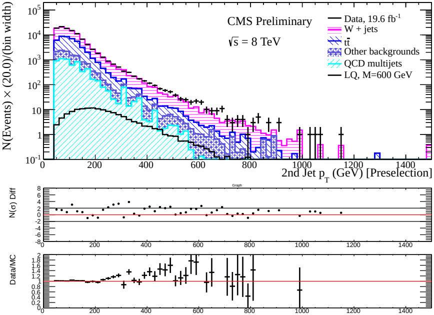


$e\nu jj$ preselection: jet p_T

Leading jet p_T



Second leading jet p_T



$t\bar{t}$ background in *eejj* analysis: weights

Muon $\|\eta\|$ range	Weight applied to $e\mu jj$ events
$0.0 < \|\eta\| \leq 0.9$	$\mathcal{C} = 0.458 \pm 0.005$ (stat) ± 0.005 (syst)
$0.9 < \|\eta\| \leq 1.2$	$\mathcal{C} = 0.409 \pm 0.005$ (stat) ± 0.005 (syst)
$1.2 < \|\eta\| \leq 2.1$	$\mathcal{C} = 0.400 \pm 0.005$ (stat) ± 0.005 (syst)

$t\bar{t}$ background in *eejj* analysis: triggers

HLT path	Run range
HLT_Mu40_eta2p1_v9	190456 - 196531
HLT_Mu40_eta2p1_v10	198063 - 199608
HLT_Mu40_eta2p1_v11	199698 - 208686

QCD background: triggers

HLT path	Run range	Effective $\mathcal{L}_{int}$(pb^{-1})
HLT_Photon30_CaloIdVL_v11	190456 - 190738	0.029672
HLT_Photon30_CaloIdVL_v12	190782 - 191419	0.086121
HLT_Photon30_CaloIdVL_v13	191691 - 196531	0.690924
HLT_Photon30_CaloIdVL_v14	198022 - 208686	2.043
HLT_Photon50_CaloIdVL_v7	190456 - 190738	0.231664
HLT_Photon50_CaloIdVL_v8	190782 - 191419	0.669828
HLT_Photon50_CaloIdVL_v9	191691 - 196531	5.374
HLT_Photon50_CaloIdVL_v10	198022 - 208686	15.894
HLT_Photon75_CaloIdVL_v10	190456 - 190738	1.385
HLT_Photon75_CaloIdVL_v11	190782 - 191419	4.019
HLT_Photon75_CaloIdVL_v12	191691 - 196531	32.243
HLT_Photon75_CaloIdVL_v13	198022 - 208686	95.363
HLT_Photon90_CaloIdVL_v7	190456 - 190738	2.769
HLT_Photon90_CaloIdVL_v8	190782 - 191419	8.038
HLT_Photon90_CaloIdVL_v9	191691 - 196531	69.509
HLT_Photon90_CaloIdVL_v10	198022 - 208686	198.024
HLT_Photon135_v4	190456 - 190738	96.404
HLT_Photon135_v5	190782 - 191419	398.151
HLT_Photon135_v6	191691 - 196531	543.603
HLT_Photon135_v7	198022 - 208686	12581
HLT_Photon150_v1	190456 - 190738	96.404
HLT_Photon150_v2	190782 - 191419	398.151
HLT_Photon150_v3	191691 - 196531	4824.
HLT_Photon150_v4	198022 - 208686	14304

QCD background: closure test method (1/2)

- Define closure test sample:
  - Single photon trigger (same as calculation)
  - Exactly two loose electrons
  - At least one jet
  - $m_{ee} > 110$ GeV, to improve QCD purity
  - $\not{E}_T < 100$ GeV, to improve QCD purity
- Subtract contribution from non-QCD processes using MC
- Predict N(events) with exactly one HEEP electron and at least one jet with fake rate:

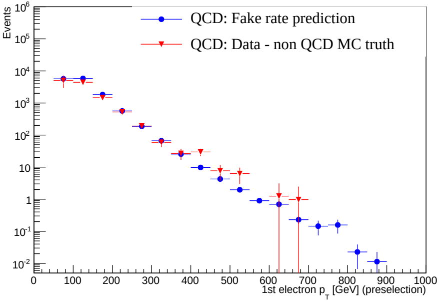
$$N_{eejj}^{QCD} = \sum_{\substack{\text{loose} \\ eejj \text{ events}}} P(e_{1,\text{ tight}} | e_{1,\text{ loose}} : p_T, \eta) \cdot P(e_{2,\text{ tight}} | e_{2,\text{ loose}} : p_T, \eta)$$

QCD background: closure test method (2/2)

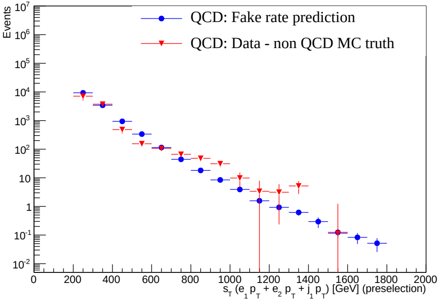
- Finally, compare predicted vs observed N(events) with exactly one HEEP electron:
  - N(predicted) $= 13100 \pm 400$
  - N(observed) $= 12100 \pm 400$
  - N(predicted)/N(observed) $= 1.08 \pm 0.05$
- After applying $S_T = p_T(e_1) + p_T(e_2) + p_T(j) > 450$ GeV (comparable to final selection S_T cut), agreement worsens:
  - N(predicted) $= 599 \pm 53.6$
  - N(observed) $= 876 \pm 46.7$
  - N(predicted)/N(observed) $= 1.46 \pm 0.15$
- Best agreement given 1σ fluctuation at $S_T > 450$ is 30%, so we assign a systematic uncertainty of 30% per electron to the QCD background estimate.

QCD background: closure test plots

Leading electron p_T

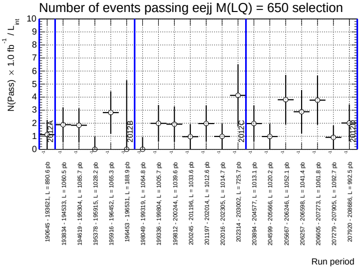


S_T

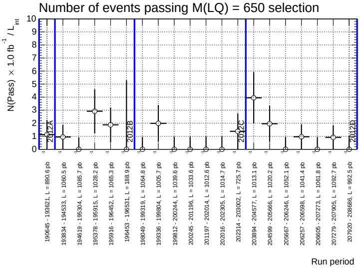


Run period dependence

Events passing *eejj*
$M_{LQ} = 650$ GeV selection



Events passing $e\nu jj$
$M_{LQ} = 650$ GeV selection



Events passing final selection in both analyses are evenly distributed in time

Data-driven background using muons: overview

- Use muon events to simulate electron events:
  - $eejj$ analysis: use $\mu\mu jj$ events

$$N^{\text{data}}_{eejj} = \mathcal{C}_{\mu\mu jj} \times N^{\text{data}}_{\mu\mu jj} = \left(\frac{\epsilon^{\text{trigger}}_{ejj}}{\epsilon^{\text{trigger}}_{\mu}} \times \frac{\epsilon^{\text{reco/ID/Iso}}_{eejj}}{\epsilon^{\text{reco/ID/Iso}}_{\mu\mu jj}} \right) \times N^{\text{data}}_{\mu\mu jj}$$

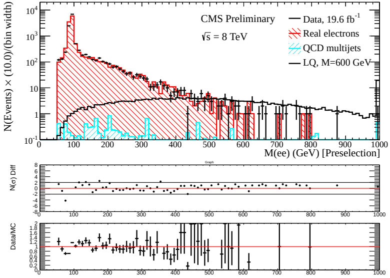
  - $e\nu jj$ analysis: use $\mu\nu jj$ events

$$N^{\text{data}}_{e\nu jj} = \mathcal{C}_{\mu\nu jj} \times N^{\text{data}}_{\mu\nu jj} = \left(\frac{\epsilon^{\text{trigger}}_{ejj}}{\epsilon^{\text{trigger}}_{\mu}} \times \frac{\epsilon^{\text{reco/ID/Iso}}_{e\nu jj}}{\epsilon^{\text{reco/ID/Iso}}_{\mu\nu jj}} \right) \times N^{\text{data}}_{\mu\nu jj}$$

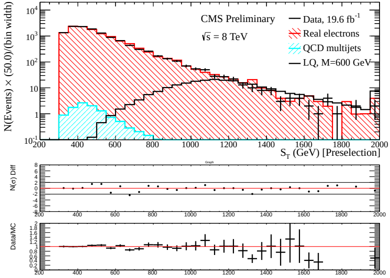
- Still use QCD fake rate method to model "fake" electrons
- Only used as a cross-check!

Data-driven background using muons: *eejj* (1/2)

m_{ee} at *eejj* preselection



S_T at *eejj* preselection



- "Real electrons": *eejj* events with no fake electrons (modeled with $\mu\mu jj$)
- Difference in muon vs. electron p_T resolution $\Longrightarrow$ difference in m_{ee} peak

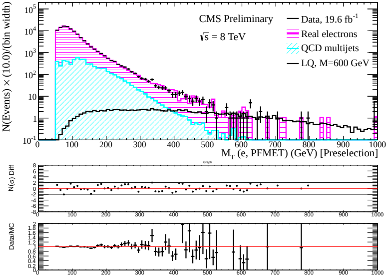
Data-driven background using muons: *eejj* (2/2)

M_{LQ}	LQ Signal	Real electrons (from data)	QCD (from data)	Data	Total Background
Presel	-	12399.1 ± 110.7	10.87 ± 0.10	12442	12410.0 ± 110.7
300	12855.1 ± 75.9	1146.7 ± 33.6	5.282 ± 0.052	1244	1152.02 ± 33.63
350	6137.3 ± 31.6	677.3 ± 25.8	3.215 ± 0.036	736	680.54 ± 25.84
400	2928.6 ± 14.2	353.0 ± 18.7	1.696 ± 0.023	389	354.66 ± 18.65
450	1429.7 ± 6.8	201.4 ± 14.1	0.890 ± 0.016	233	202.24 ± 14.10
500	727.5 ± 3.4	126.3 ± 11.2	0.485 ± 0.011	148	126.78 ± 11.16
550	389.2 ± 1.8	70.0 ± 8.3	0.2758 ± 0.0084	81	70.25 ± 8.30
600	213.96 ± 0.98	43.4 ± 6.5	0.1527 ± 0.0065	57	43.56 ± 6.54
650	119.31 ± 0.55	26.6 ± 5.1	0.0760 ± 0.0040	36	26.67 ± 5.12
700	69.09 ± 0.32	16.7 ± 4.1	0.0448 ± 0.0029	17	16.77 ± 4.06
750	40.86 ± 0.19	10.8 ± 3.3	0.0258 ± 0.0023	12	10.85 ± 3.26
800	24.81 ± 0.11	8.8 ± 2.9	0.0193 ± 0.0022	7	8.85 ± 2.94
850	15.147 ± 0.068	5.9 ± 2.4	0.0111 ± 0.0015	5	5.89 ± 2.40
900	9.303 ± 0.042	4.9 ± 2.2	0.0069 ± 0.0012	3	4.91 ± 2.19
950	5.770 ± 0.026	4.9 ± 2.2	0.00451 ± 0.00085	1	4.90 ± 2.19
1000	3.659 ± 0.017	2.0 ± 1.4	0.00374 ± 0.00082	1	1.97 ± 1.39
1050	2.442 ± 0.011	2.0 ± 1.4	0.00374 ± 0.00082	1	1.97 ± 1.39
1100	1.6055 ± 0.0068	2.0 ± 1.4	0.00374 ± 0.00082	1	1.97 ± 1.39
1150	1.0686 ± 0.0044	2.0 ± 1.4	0.00374 ± 0.00082	1	1.97 ± 1.39
1200	0.7108 ± 0.0029	2.0 ± 1.4	0.00374 ± 0.00082	1	1.97 ± 1.39

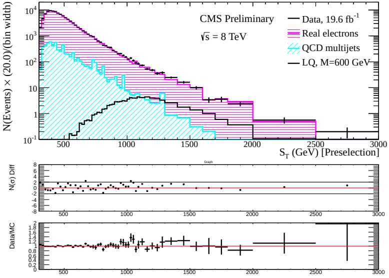
- 36 events observed at M(LQ) $= 650$
- MC analysis predicts 20.49 ± 2.14 (stat) $\pm$ 1.01 (syst)
- DD analysis (this table) predicts 26.67 ± 5.12 (stat)

Data-driven background using muons: $e\nu jj$ (1/2)

$m_{T,\,e\nu}$ at $e\nu jj$ preselection



S_T at $e\nu jj$ preselection



- "Real electrons": $e\nu jj$ events with no fake electrons (modeled with $\mu\nu jj$)
- $m_{T,\,e\nu}$ in $\mu\nu jj$ events reweighted to match data

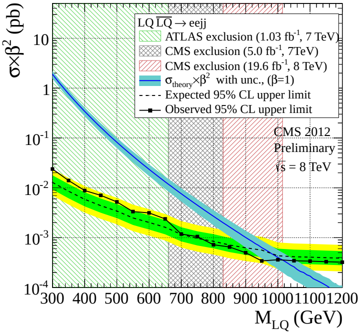
Data-driven background using muons: $e\nu jj$ (2/2)

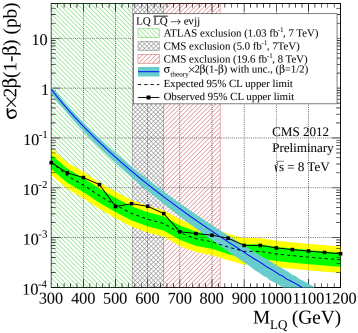
M_{LQ}	LQ Signal	Real electrons (from data)	QCD (from data)	Data	Total Background
Presel	-	99103.1 ± 323.9	5950.5 ± 20.1	105164	105053.6 ± 324.5
300	4641.6 ± 49.8	2346.6 ± 51.1	117.9 ± 1.5	2455	2464.50 ± 51.11
350	2112.1 ± 21.1	827.0 ± 29.3	59.11 ± 0.97	908	886.15 ± 29.31
400	945.8 ± 9.3	343.0 ± 18.4	32.88 ± 0.69	413	375.86 ± 18.38
450	457.5 ± 4.5	144.5 ± 11.8	14.13 ± 0.42	192	158.64 ± 11.81
500	226.7 ± 2.2	77.8 ± 8.6	7.76 ± 0.30	83	85.55 ± 8.60
550	118.2 ± 1.2	28.3 ± 5.2	3.89 ± 0.21	44	32.18 ± 5.17
600	64.65 ± 0.64	13.2 ± 3.5	2.29 ± 0.17	28	15.53 ± 3.54
650	36.25 ± 0.36	9.5 ± 3.0	1.18 ± 0.12	18	10.65 ± 3.00
700	21.18 ± 0.21	4.7 ± 2.1	0.85 ± 0.10	6	5.58 ± 2.12
750	12.56 ± 0.12	1.8 ± 1.3	0.514 ± 0.091	4	2.32 ± 1.28
800	7.412 ± 0.073	0.90 ± 0.90	0.317 ± 0.067	3	1.22 ± 0.90
850	4.591 ± 0.045	$0.000^{1.14}_{-0.00}$	0.117 ± 0.029	2	$0.117^{+1.140}_{-0.029}$
900	2.853 ± 0.028	$0.000^{1.14}_{-0.00}$	0.076 ± 0.024	1	$0.076^{+1.140}_{-0.024}$
950	1.791 ± 0.017	$0.000^{1.14}_{-0.00}$	0.069 ± 0.023	1	$0.069^{+1.140}_{-0.023}$
1000	1.272 ± 0.011	$0.000^{1.14}_{-0.00}$	0.069 ± 0.023	1	$0.069^{+1.140}_{-0.023}$
1050	0.8788 ± 0.0074	$0.000^{1.14}_{-0.00}$	0.069 ± 0.023	1	$0.069^{+1.140}_{-0.023}$
1100	0.6063 ± 0.0049	$0.000^{1.14}_{-0.00}$	0.069 ± 0.023	1	$0.069^{+1.140}_{-0.023}$
1150	0.4196 ± 0.0032	$0.000^{1.14}_{-0.00}$	0.069 ± 0.023	1	$0.069^{+1.140}_{-0.023}$
1200	0.2894 ± 0.0021	$0.000^{1.14}_{-0.00}$	0.069 ± 0.023	1	$0.069^{+1.140}_{-0.023}$

- 18 events observed at M(LQ) = 650
- MC analysis predicts 7.54 ± 1.20 (stat) $\pm\ 0.52$ (syst)
- DD analysis (this table) predicts 10.65 ± 3.00 (stat)

Data-driven background using muons: limits

$\beta = 1.0$: *eejj* analysis, μ-bkgd. $\beta = 0.5$: $e\nu jj$ analysis, μ-bkgd.





- Expected limits: $M_{LQ} < 980$ (890) GeV for *eejj* ($e\nu jj$)
- Observed limits: $M_{LQ} < 1015$ (825) GeV for *eejj* ($e\nu jj$)

Data-driven background using muons: conclusion

- Data-driven predictions agree with MC predictions at final selection ($M_{LQ} = 650$ GeV) within stat. uncertainties in both analyses
- Conclusion: Data-driven background prediction confirms MC background prediction
- However:
  - Data-driven prediction mean values are higher than MC
  - Data-driven stat uncertainty is larger than MC
  - So the significance of the excess with data-driven background estimates is less than the significance with MC background estimates
  - And the sensitivity of the analysis with data-driven background estimates is worse than the sensitivity with MC background estimates

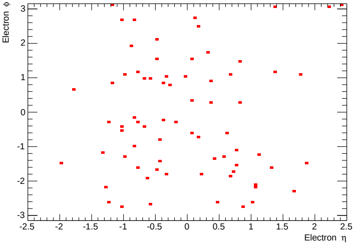
Comparison with LQ2

M_{LQ}	$eejj$ Total Background	$eejj$ Data	$\mu\mu jj$ Total Background	$\mu\mu jj$ Data
300	1444.96 ± 13.65	1539	$1415 \pm 20 \pm 45$ (syst)	1461
350	726.71 ± 9.78	759	$730 \pm 15 \pm 16$ (syst)	714
400	399.70 ± 7.23	423	$384.8 \pm 10.7 \pm 9.3$ (syst)	394
450	208.02 ± 5.18	235	$205.3 \pm 7.6 \pm 5.5$ (syst)	210
500	118.74 ± 4.00	145	$121.6 \pm 5.7 \pm 4.8$ (syst)	128
550	71.50 ± 3.25	94	$68.1 \pm 4.2 \pm 2.7$ (syst)	75
600	42.44 ± 2.40	67	$44.7 \pm 3.4 \pm 2.0$ (syst)	44
650	26.99 ± 1.93	43	$28 \pm 2.6 \pm 1.3$ (syst)	24
700	16.42 ± 1.52	22	$18.6 \pm 2.2 \pm 1.3$ (syst)	15
750	10.27 ± 1.23	14	$9.32\,^{+1.29}_{-1.22} \pm 0.87$ (syst)	11
800	5.08 ± 0.77	10	$6.53\,^{+1.2}_{-1.13} \pm 0.85$ (syst)	9
850	2.97 ± 0.54	4	$3.88\,^{+1.0}_{-0.92} \pm 0.67$ (syst)	5
900	1.71 ± 0.41	3	$1.47\,^{+0.81}_{-0.37} \pm 0.43$ (syst)	3
950	1.04 ± 0.31	1	$0.83\,^{+0.91}_{-0.26} \pm 0.29$ (syst)	1
1000	0.62 ± 0.24	0	$0.383\,^{+0.894}_{-0.171} \pm 0.031$ (syst)	0
1050	0.62 ± 0.24	0	$0.383\,^{+0.894}_{-0.171} \pm 0.031$ (syst)	0
1100	0.62 ± 0.24	0	$0.383\,^{+0.894}_{-0.171} \pm 0.031$ (syst)	0
1150	0.62 ± 0.24	0	$0.383\,^{+0.894}_{-0.171} \pm 0.031$ (syst)	0
1200	0.62 ± 0.24	0	$0.383\,^{+0.894}_{-0.171} \pm 0.031$ (syst)	0

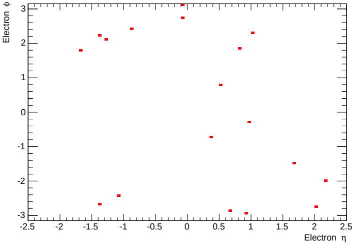
- Apply S_T , m_{ej}^{min} , and $m_{\ell\ell}$ cuts from LQ2 (`EXO-12-042`)
- $eejj$ bkgd prediction, $\mu\mu jj$ bkgd prediction, and $\mu\mu jj$ data agree well
- Discrepancy comes from $eejj$ data

Electron η vs. ϕ

Events passing *eejj*
$M_{LQ} = 650$ GeV selection



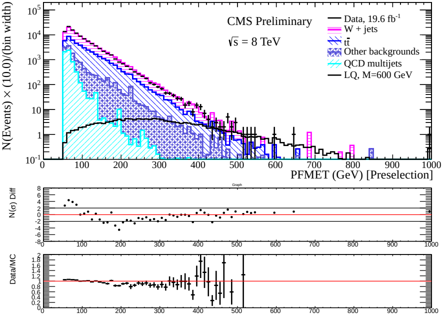
Events passing *eνjj*
$M_{LQ} = 650$ GeV selection



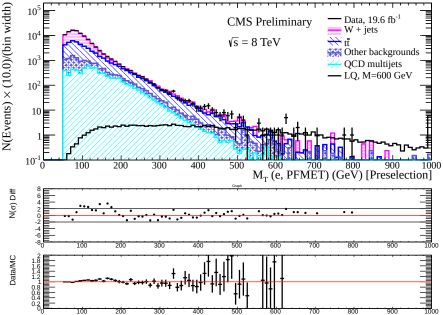
Electrons in events passing final selection in both analyses are evenly distributed in the ECAL

$\not{E}_T$ and $m_{T,\, e\nu}$ before reweighting

$\not{E}_T$ before reweighting



$m_{T,\, e\nu}$ before reweighting



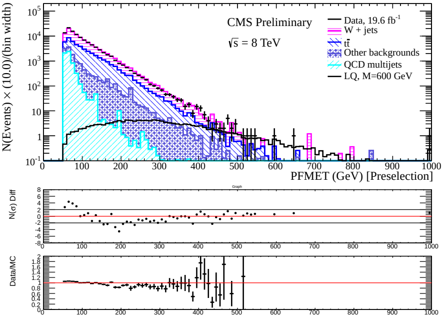
Can we improve agreement in these distributions by reweighting?

Reweighting method

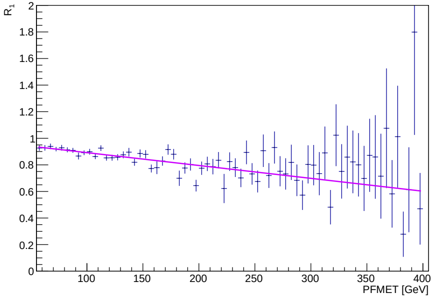
- Find weight functions for both $\not{E}_{\mathrm{T}}$ and $m_{\mathrm{T},\,\mathrm{e}\nu}$ at $e\nu jj$ preselection:
  1. Do not apply any $\mathrm{W}^{\pm}$+jets or $t\bar{t}$ rescaling
  2. Find and apply weight function for $\not{E}_{\mathrm{T}}$ first
  3. Then find and apply weight function for $m_{\mathrm{T},\,\mathrm{e}\nu}$
  4. Finally, find and apply new $\mathrm{W}^{\pm}$+jets and $t\bar{t}$ rescaling
- Compare $m_{\mathrm{T},\,\mathrm{e}\nu}$ and $\not{E}_{\mathrm{T}}$ dists. before and after reweighting
- Repeat final selection for both $eejj$ and $e\nu jj$ analysis

Find $\not\!\!E_T$ function

$\not\!\!E_T$ before reweighting



$\not\!\!E_T$ reweighting function



Get reweighting function by fitting:

$$\mathcal{R}_1(\not\!\!E_T) = \frac{N_{i,\mathrm{Data}}(\not\!\!E_T) - N_{i,\mathrm{QCD}}(\not\!\!E_T)}{N_{i,\mathrm{W+jets}}(\not\!\!E_T) + N_{i,t\bar{t}}(\not\!\!E_T) + N_{i,\mathrm{Other}}(\not\!\!E_T)}$$

$\not{E}_T$ function details

- Use the following linear fit function to define $\not{E}_T$ reweighting:

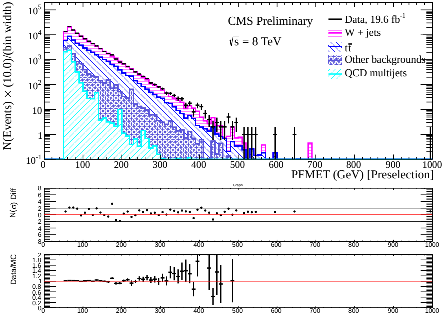
$$w_1(\not{E}_T) = a_0 + a_1 \cdot \not{E}_T$$

- Fit returns the following parameters:

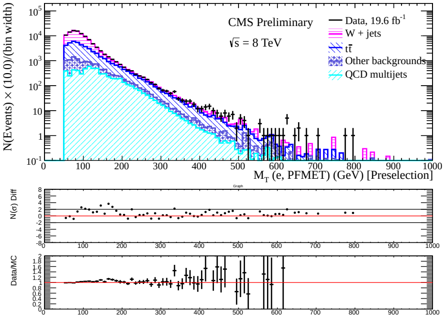
Parameter symbol	Parameter title	Mean value	Uncertainty
a_0	Linear offset	0.989	0.0112
a_1	Linear slope	$-9.67 \cdot 10^{-4}$	$8.86 \cdot 10^{-5}$

Apply $\not\!\!E_T$ function

$\not\!\!E_T$ after $\not\!\!E_T$ reweighting



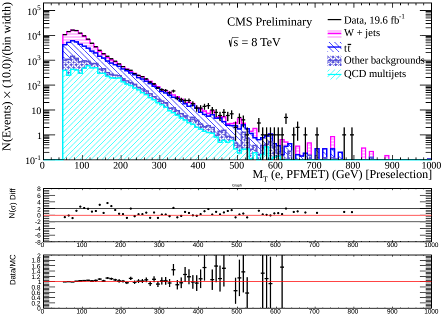
$m_{T,\,e\nu}$ after $\not\!\!E_T$ reweighting



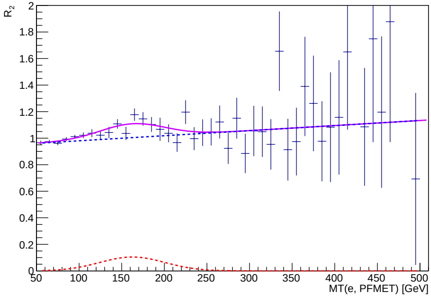
$\not\!\!E_T$ distribution improved, but $m_{T,\,e\nu}$ still needs help

Find $m_{\mathrm{T},\ e\nu}$ function

$m_{\mathrm{T},\ e\nu}$ after $\not{E}_{\mathrm{T}}$ reweighting



$\not{E}_{\mathrm{T}}$ reweighting function



Get reweighting function by fitting:

$$\mathcal{R}_2(m_{\mathrm{T},\ e\nu}) = \frac{\mathrm{N}_{i,\mathrm{Data}}(m_{\mathrm{T},\ e\nu}) - \mathrm{N}_{i,\mathrm{QCD}}(m_{\mathrm{T},\ e\nu})}{\mathrm{N}_{i,\mathrm{W+jets}}(m_{\mathrm{T},\ e\nu}) + \mathrm{N}_{i,t\bar{t}}(m_{\mathrm{T},\ e\nu}) + \mathrm{N}_{i,\mathrm{Other}}(m_{\mathrm{T},\ e\nu})}$$

$m_{\mathrm{T,\,e}\nu}$ function details

- Use the following linear fit function to define $m_{\mathrm{T,\,e}\nu}$ reweighting:

$$w_2(m_{\mathrm{T,\,e}\nu}) = b_0 + b_1 \cdot m_{\mathrm{T,\,e}\nu} + B \cdot e^{-\frac{1}{2}\cdot\left(\frac{m_{\mathrm{T,\,e}\nu}-\mu}{\sigma}\right)^2}$$

- Fit returns the following parameters:

Parameter symbol	Parameter title	Mean value	Uncertainty
b_0	Linear offset	.942	0.0181
b_1	Linear slope	$3.82 \cdot 10^{-4}$	$1.68 \cdot 10^{-4}$
B	Gaussian constant	0.104	0.0279
μ	Gaussian width	38.2	11.6
σ	Gaussian mean	162	10.1

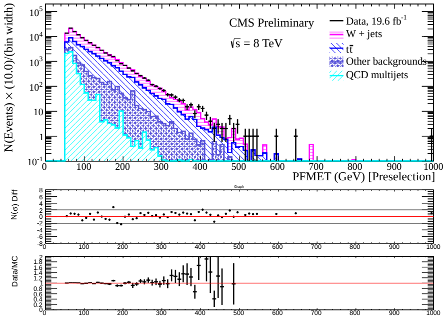
Rescale $W^{\pm}$+jets and $t\bar{t}$

- First apply $w_{\text{total}} = w_1(\not{E}_{\text{T}}) \cdot w_2(m_{\text{T, e}\nu})$ to each MC event
- Then rescale $W^{\pm}$+jets and $t\bar{t}$ as before
- Note: no $W^{\pm}$+jets and $t\bar{t}$ rescaling applied so far

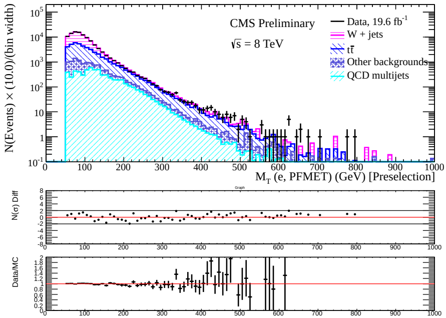
$$N^1_{\text{data}} = \mathcal{R}_{t\bar{t}} N^1_{t\bar{t}} + \mathcal{R}_W N^1_W + N^1_{\text{QCD}} + N^1_{\text{Others}} \qquad \mathcal{R}_{t\bar{t}} = 1.08 \pm 0.03\ (\text{stat}) \pm 0.01\ (\text{syst})$$
$$N^2_{\text{data}} = \mathcal{R}_{t\bar{t}} N^2_{t\bar{t}} + \mathcal{R}_W N^2_W + N^2_{\text{QCD}} + N^2_{\text{Others}} \qquad \mathcal{R}_{\text{W}} = 0.97 \pm 0.02\ (\text{stat}) \pm 0.01\ (\text{syst})$$

Apply $\not\!\!E_{\mathrm{T}}$ and $m_{\mathrm{T},\,e\nu}$ reweights and rescale MC

$\not\!\!E_{\mathrm{T}}$ after all reweighting



$m_{\mathrm{T},\,e\nu}$ after all reweighting



Agreement much better in both $\not\!\!E_{\mathrm{T}}$ and $m_{\mathrm{T},\,e\nu}$ distributions after reweighting and rescaling

$e\nu jj$ final selection before reweighting

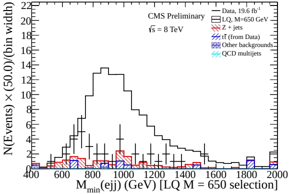
M_{LQ}	LQ Signal	$W^{\pm}$+jets	$t\bar{t}$	QCD	Other	Data	Total background
Presel	-	58284.8 ± 197.0	32196.7 ± 69.8	5950.5 ± 20.1	6590.8 ± 231.6	105164	103022.8 ± 312.6
300	4765.5 ± 51.1	822.1 ± 22.4	1191.3 ± 12.0	117.9 ± 1.5	210.5 ± 7.7	2455	$2341.90 \pm 26.58 \pm 163.90$ (syst)
350	2168.4 ± 21.6	275.9 ± 14.5	441.4 ± 7.2	59.11 ± 0.97	102.1 ± 5.4	908	$878.55 \pm 17.08 \pm 58.66$ (syst)
400	971.1 ± 9.6	110.4 ± 7.8	184.2 ± 4.7	32.88 ± 0.69	51.5 ± 3.8	413	$378.98 \pm 9.91 \pm 24.79$ (syst)
450	469.7 ± 4.6	53.1 ± 5.8	74.7 ± 3.0	14.13 ± 0.42	25.7 ± 2.7	192	$167.64 \pm 7.06 \pm 11.01$ (syst)
500	232.7 ± 2.3	20.5 ± 3.3	34.4 ± 2.0	7.76 ± 0.30	15.3 ± 2.1	83	$77.99 \pm 4.41 \pm 4.83$ (syst)
550	121.4 ± 1.2	8.6 ± 1.8	14.9 ± 1.4	3.89 ± 0.21	7.8 ± 1.6	44	$35.24 \pm 2.76 \pm 2.18$ (syst)
600	66.37 ± 0.66	2.3 ± 1.0	7.08 ± 0.93	2.29 ± 0.17	4.6 ± 1.2	28	$16.27 \pm 1.84 \pm 0.96$ (syst)
650	37.22 ± 0.37	0.41 ± 0.29	3.82 ± 0.70	1.18 ± 0.12	2.13 ± 0.92	18	$7.54 \pm 1.20 \pm 0.52$ (syst)
700	21.74 ± 0.21	0.41 ± 0.29	2.61 ± 0.60	0.85 ± 0.10	0.58 ± 0.24	6	$4.45 \pm 0.71 \pm 0.34$ (syst)
750	12.90 ± 0.13	$0.00^{+0.94}_{-0.00}$	1.75 ± 0.47	0.514 ± 0.091	0.27 ± 0.15	4	$2.535^{+1.062}_{-0.504} \pm 0.20$ (syst)
800	7.610 ± 0.075	$0.00^{+0.94}_{-0.00}$	1.10 ± 0.37	0.317 ± 0.067	0.27 ± 0.15	3	$1.696^{+1.019}_{-0.404} \pm 0.13$ (syst)
850	4.713 ± 0.046	$0.00^{+0.94}_{-0.00}$	0.90 ± 0.34	0.117 ± 0.029	0.140 ± 0.087	2	$1.153^{+0.999}_{-0.353} \pm 0.08$ (syst)
900	2.929 ± 0.028	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.076 ± 0.024	0.084 ± 0.069	1	$0.530^{+0.962}_{-0.226} \pm 0.04$ (syst)
950	1.839 ± 0.018	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.069 ± 0.023	0.084 ± 0.069	1	$0.524^{+0.962}_{-0.226} \pm 0.04$ (syst)
1000	1.306 ± 0.012	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.069 ± 0.023	0.084 ± 0.069	1	$0.524^{+0.962}_{-0.226} \pm 0.04$ (syst)
1050	0.9022 ± 0.0076	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.069 ± 0.023	0.084 ± 0.069	1	$0.524^{+0.962}_{-0.226} \pm 0.04$ (syst)
1100	0.6225 ± 0.0050	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.069 ± 0.023	0.084 ± 0.069	1	$0.524^{+0.962}_{-0.226} \pm 0.04$ (syst)
1150	0.4308 ± 0.0032	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.069 ± 0.023	0.084 ± 0.069	1	$0.524^{+0.962}_{-0.226} \pm 0.04$ (syst)
1200	0.2971 ± 0.0022	$0.00^{+0.94}_{-0.00}$	0.37 ± 0.21	0.069 ± 0.023	0.084 ± 0.069	1	$0.524^{+0.962}_{-0.226} \pm 0.04$ (syst)

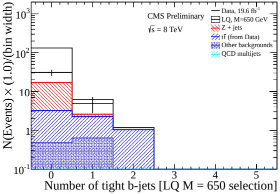
$e\nu jj$ final selection after reweighting

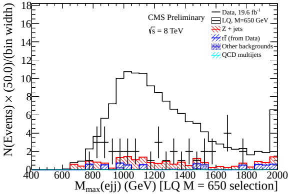
M_{LQ}	W+Jets	$t\bar{t}$	QCD	Other	Data	Total BG
Presel	59725.3 ± 201.9	33176.5 ± 71.7	5950.5 ± 20.1	5943.8 ± 205.5	105164	104796.0 ± 297.6
300	859.6 ± 23.1	1233.0 ± 12.4	117.9 ± 1.5	187.6 ± 6.907	2455	2398.04 ± 27.16
350	280.4 ± 14.4	446.3 ± 7.3	59.11 ± 0.97	88.6 ± 4.649	908	874.28 ± 16.83
400	108.5 ± 7.7	180.6 ± 4.6	32.88 ± 0.69	43.7 ± 3.229	413	365.71 ± 9.55
450	50.5 ± 5.5	70.8 ± 2.8	14.13 ± 0.42	21.3 ± 2.257	192	156.75 ± 6.62
500	19.0 ± 3.0	31.6 ± 1.9	7.76 ± 0.30	12.4 ± 1.734	83	70.81 ± 3.93
550	7.9 ± 1.7	13.3 ± 1.2	3.89 ± 0.21	6.3 ± 1.288	44	31.36 ± 2.43
600	2.2 ± 0.9	6.13 ± 0.80	2.29 ± 0.17	3.5 ± 0.959	28	14.08 ± 1.57
650	0.43 ± 0.30	3.22 ± 0.59	1.18 ± 0.12	1.59 ± 0.736	18	6.43 ± 1.00
700	0.43 ± 0.30	2.17 ± 0.50	0.85 ± 0.10	0.35 ± 0.150	6	3.80 ± 0.61
750	$0.00^{+0.94}_{-0.00}$	1.49 ± 0.41	0.514 ± 0.091	0.117 ± 0.061	4	$2.116^{+1.025}_{-0.420}$
800	$0.00^{+0.94}_{-0.00}$	0.87 ± 0.30	0.317 ± 0.067	0.116 ± 0.061	3	$1.308^{+0.986}_{-0.313}$
850	$0.00^{+0.94}_{-0.00}$	0.70 ± 0.27	0.117 ± 0.029	0.054 ± 0.032	2	$0.874^{+0.975}_{-0.278}$
900	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.076 ± 0.024	0.019 ± 0.012	1	$0.366^{+0.948}_{-0.159}$
950	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.069 ± 0.023	0.019 ± 0.012	1	$0.359^{+0.948}_{-0.159}$
1000	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.069 ± 0.023	0.019 ± 0.012	1	$0.359^{+0.948}_{-0.159}$
1050	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.069 ± 0.023	0.019 ± 0.012	1	$0.359^{+0.948}_{-0.159}$
1100	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.069 ± 0.023	0.019 ± 0.012	1	$0.359^{+0.948}_{-0.159}$
1150	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.069 ± 0.023	0.019 ± 0.012	1	$0.359^{+0.948}_{-0.159}$
1200	$0.00^{+0.94}_{-0.00}$	0.27 ± 0.16	0.069 ± 0.023	0.019 ± 0.012	1	$0.359^{+0.948}_{-0.159}$

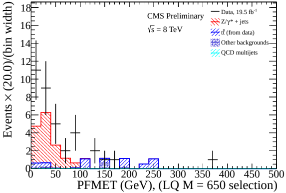
- Discrepancy at 650 selection increases after reweighting
- No change made to the analysis

eejj extra plots

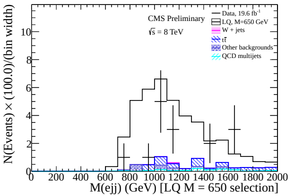


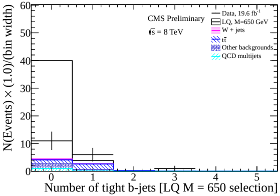


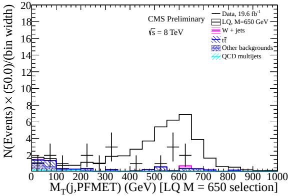


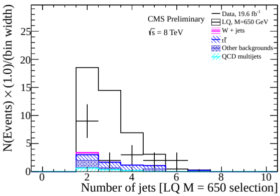


$e\nu jj$ extra plots

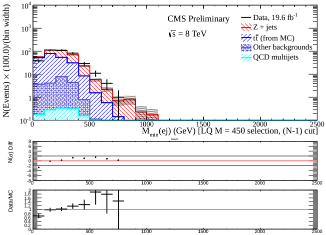


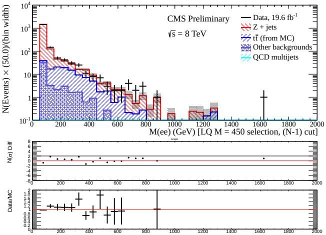


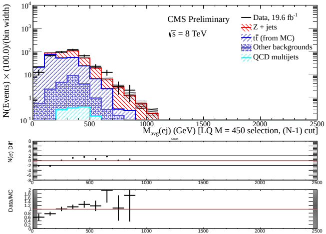


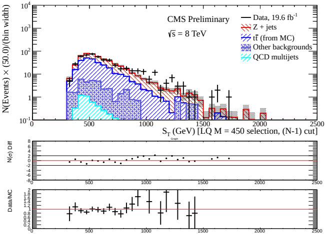


eejj N-1 plots: M(LQ) = 450 selection

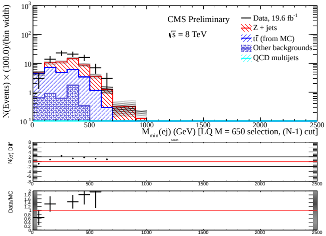


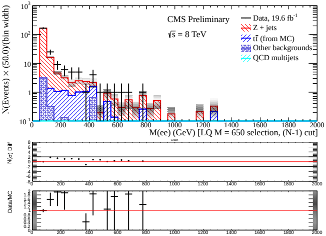


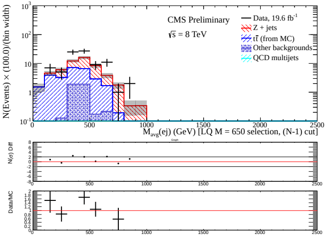


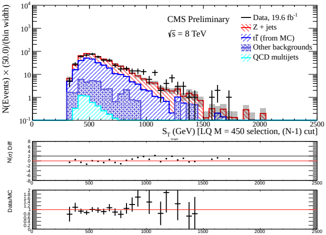


eejj N-1 plots: M(LQ) = 650 selection

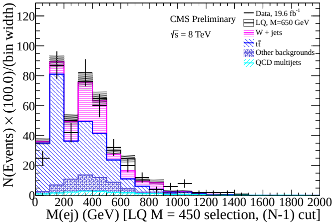


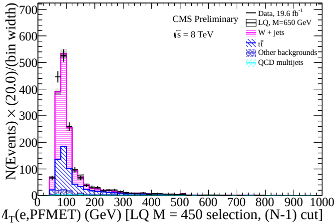


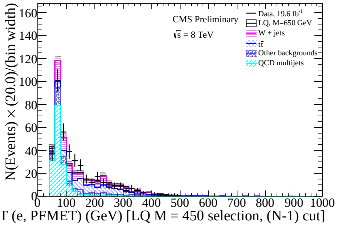


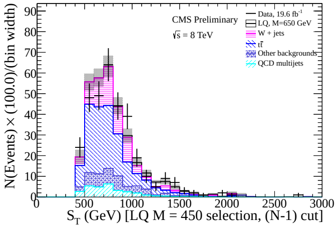


$e\nu jj$ N-1 plots: M(LQ) = 450 selection









$e\nu jj$ N-1 plots: M(LQ) = 650 selection