$WH \rightarrow l\nu bb$ Status

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DØ France

Lyon, May 3rd 2010

Event pre-Selection

- Dataset p17 and p20 (IIb1 + IIb2)
- Trigger Selection:

  Electron: Super-OR (EM + Jet and EM Triggers)

  Muon: Inclusive Triggers
- Integrated Luminosity ~ 5.3 fb^{-1} in each channel
- Vjets 03-05-00

- Require Single Lepton: $p_T^l > 15$ GeV

  $W \to e\nu$: Medium Electron ($|\eta| < 1.1$) or Top Tight Electron ($1.5 < |\eta| < 2.5$)

  $W \to \mu\nu$: Muon $|\eta| < 2.0$: (Medium quality, nseg=+3, central track match, tight isolation)

  (Muon $|\eta| < 1.6$ for now)
- Veto on Second Lepton (Orthogonality to ZH)
- $\not\!\!E_T > 20$ GeV, Triangle Cut: $M_T^W > 40 - 0.5\,\not\!\!E_T$, $H_T > 60(80)$ GeV for 2jet (3jet) Samples
- Preselect Events with Exactly 2 or Exactly 3 Jets
  - JCCB Jets (Cone R=0.5) / Vertex Confirmed in p20
  - Jet $|\eta| < 2.5$, Jet $p_T > 20$ GeV

Inclusive Muon Trigger Correction

- Inclusive Muon Trigger Prob. via Single Muon:

$$\text{Trig.Prob}_{\text{incl}} = \text{Trig.Prob}_{\text{SM}} + \text{Trig.Prob}_{\text{jets}}$$

$$\text{Trig.Prob}_{\text{jets}} = \frac{N^{\text{Data}}_{\text{incl}} - N^{\text{Data}}_{\text{SM}}}{N^{\text{MC}}_{\text{incl}}}$$

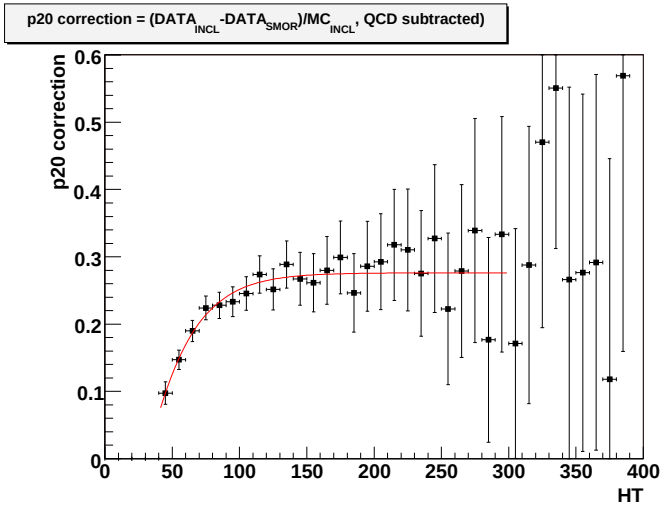
(Reduces to Data/ MC Ratio for jet $|\eta| > 1.6$)

- Single Muon Parameterized in η_{det},ϕ - and Inst. Luminosity
- Various Changes for Single Muon Term include:

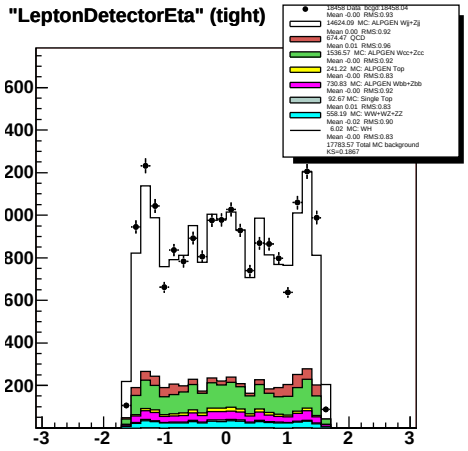
  Muon ID / Looser DCA cut / Re-derived Efficiencies

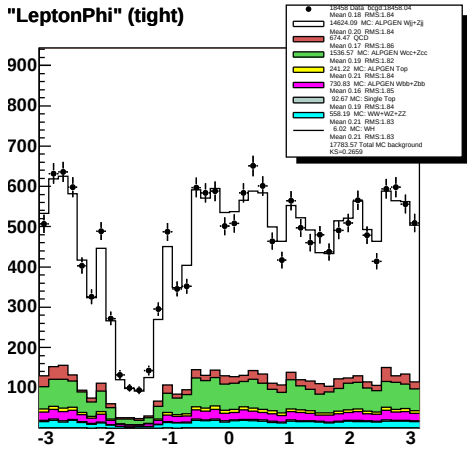
  Corrections to Triggers (e.g OR-ing of Prescales)

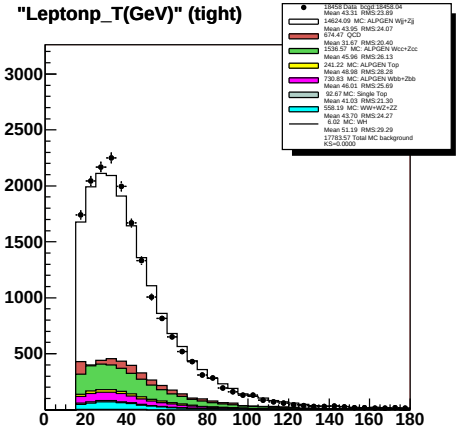
- Inclusive Muon Correction ($|\eta| < 1.6$)



Single Muon



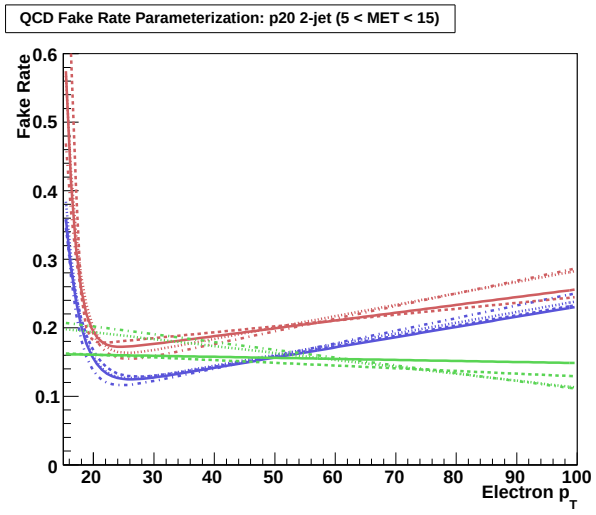




$\Rightarrow$ Inclusive Correction for $|\eta| > 1.6$ to be Included

QCD Background / Fake Rates

- QCD contributions in Tight and Loose Samples determined using Unbinned Matrix Method



$\Rightarrow$ Fake Rate Inputs are obtained for $5 < \not\!\!E_T < 15$ GeV

$\Rightarrow$ Electron Channel Fake rates in 3 eta regions

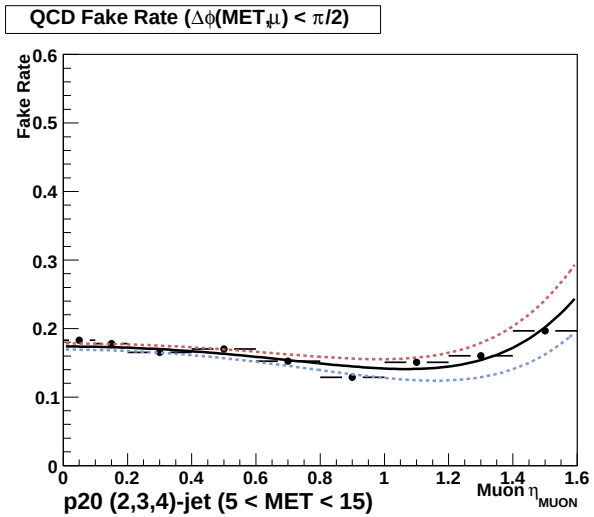
Central $\eta < 0.7$

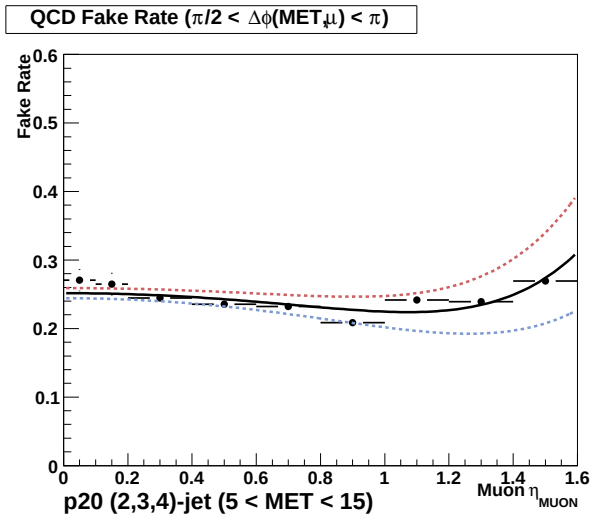
Central $0.7 < \eta < 1.1$

Forward $1.5 < \eta < 2.5$

$\Rightarrow$ Each are further subdivided in four $\Delta\phi(MET, e)$ Regions

- Accommodate Lower Muon Channel Statistics with Broader Binning





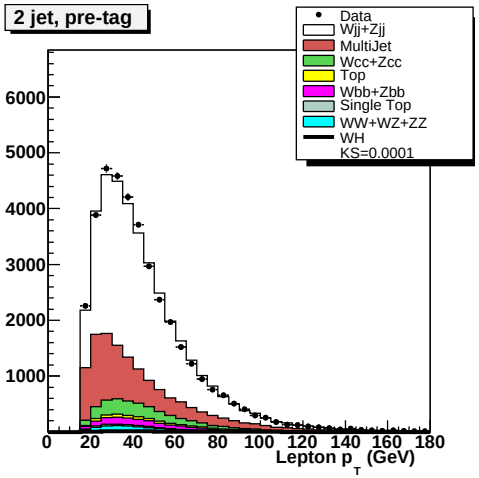
$\Rightarrow$ Two $\Delta\phi(MET, \mu)$ Regions

- Fake Rate Determination now being applied in Muon Channel

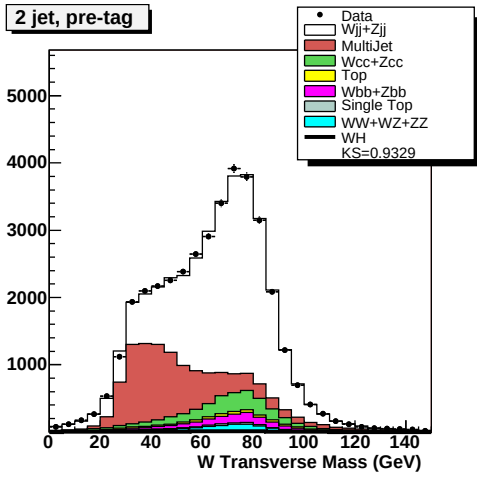
Preselection Comparisons (p20 electron)

- Increased Data Set:

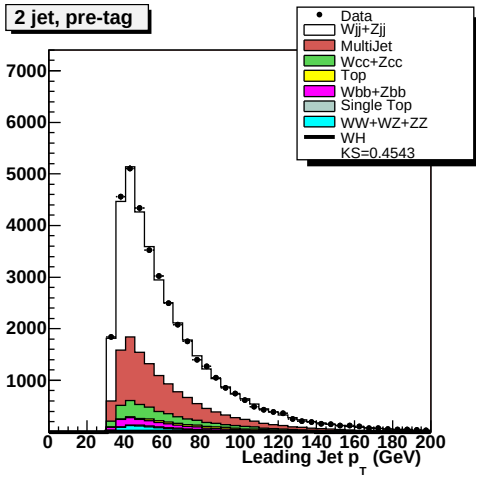
Lepton p_T



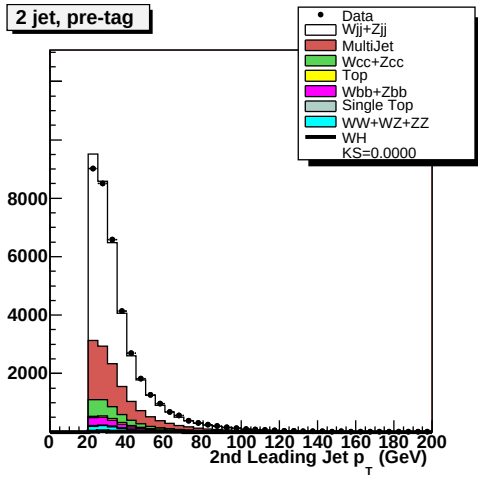
W Transverse Mass



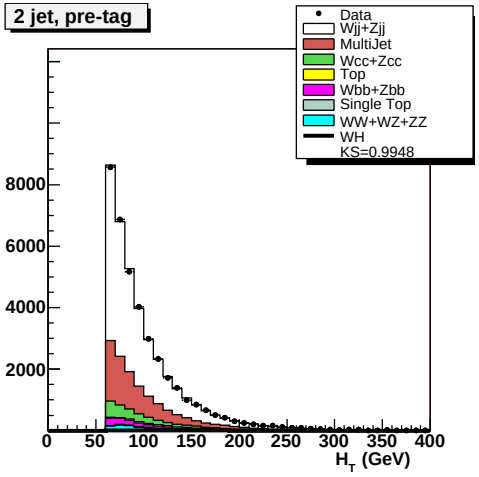
Leading Jet p_T



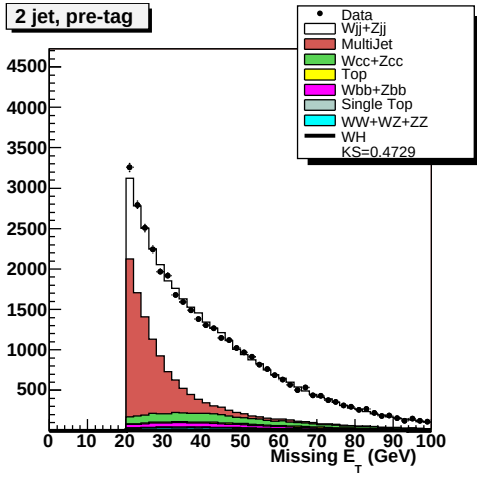
Second Leading Jet p_T



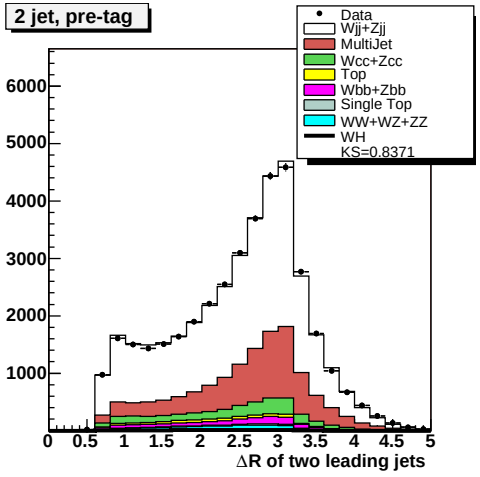
H_T Variable



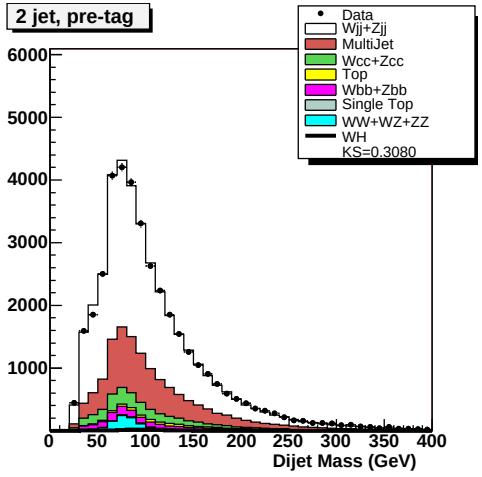
E_T Imbalance



ΔR_{jj}



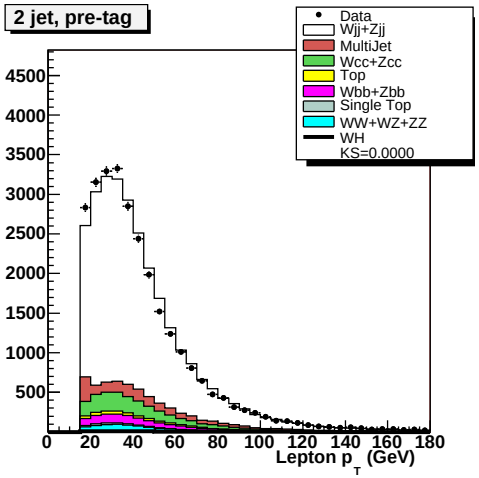
Dijet Inv. Mass



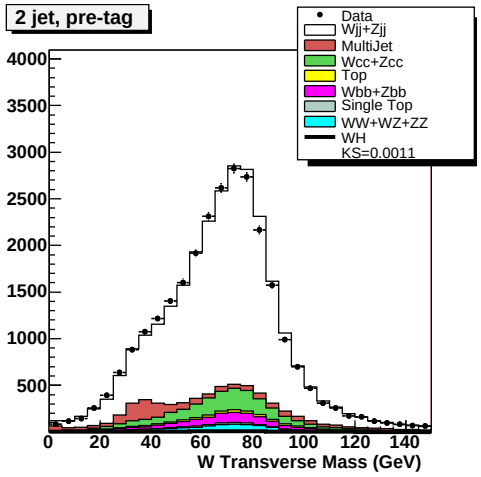
Preselection Comparisons (p20 muon)

- Increased Data Set

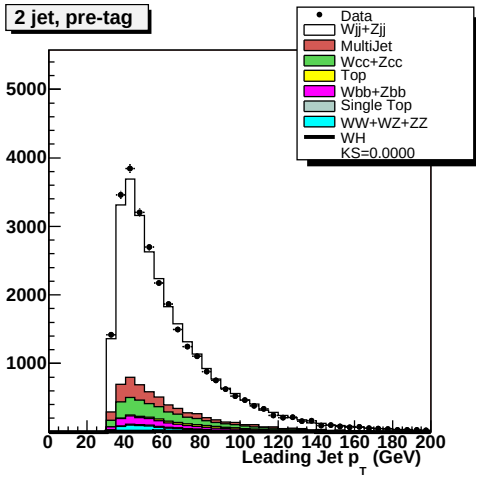
Lepton p_T



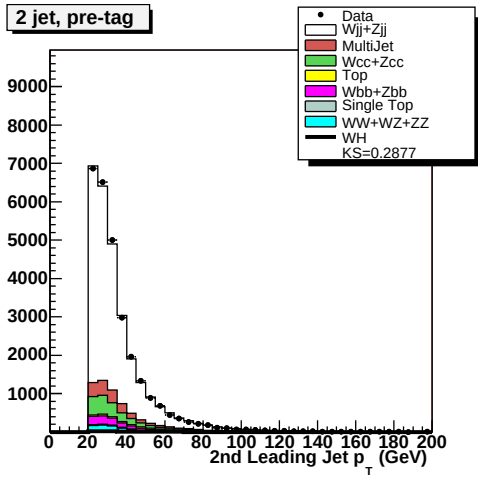
W Transverse Mass



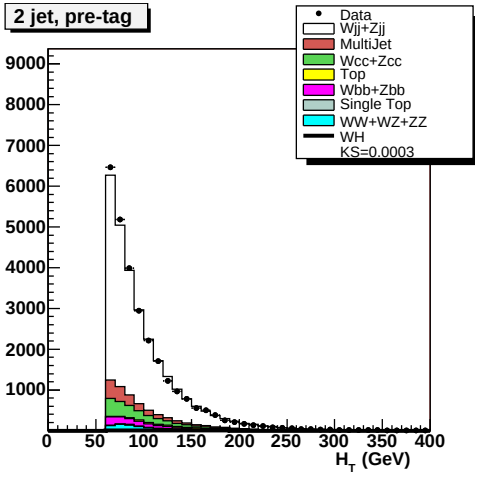
Leading Jet p_T



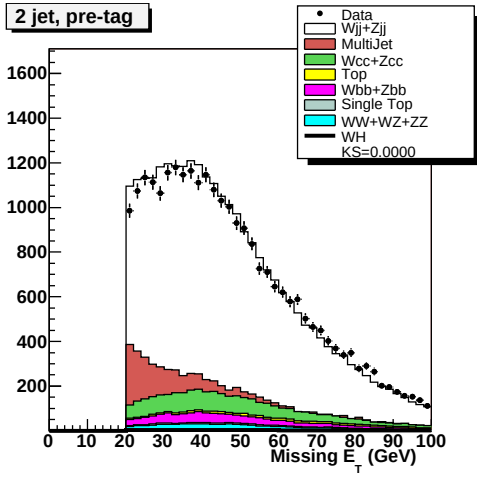
Second Leading Jet p_T



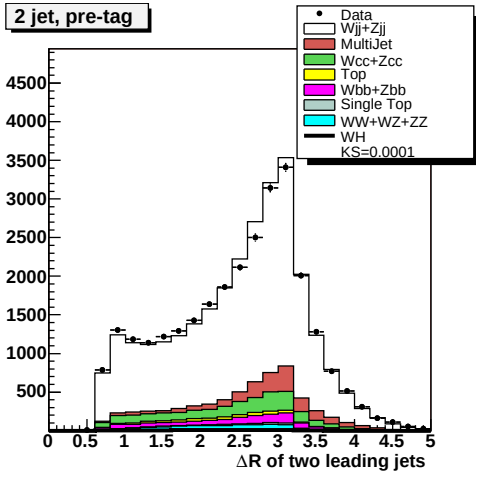
H_T Variable



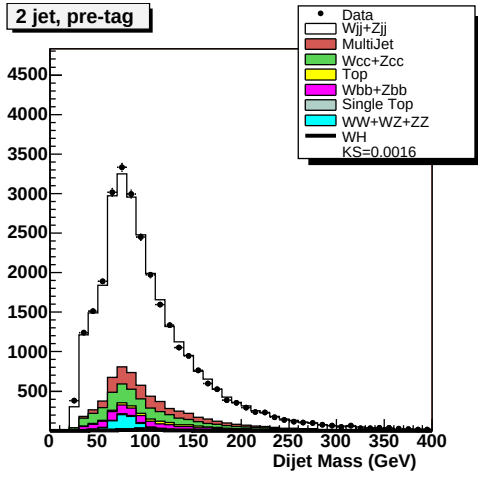
E_T Imbalance



ΔR_{jj}



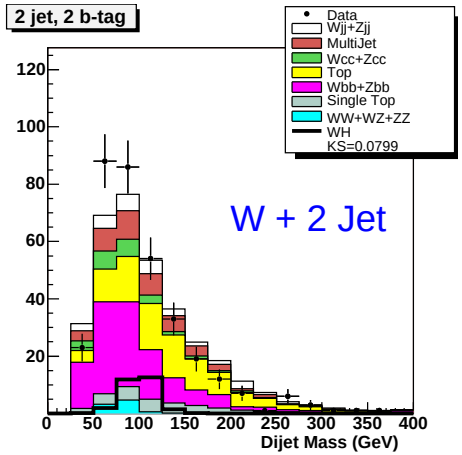
Dijet Inv. Mass

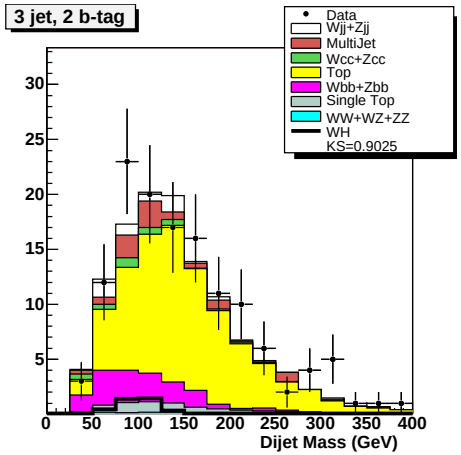


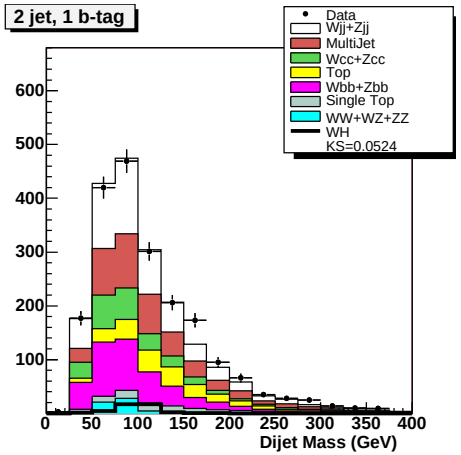
b-tagged Samples

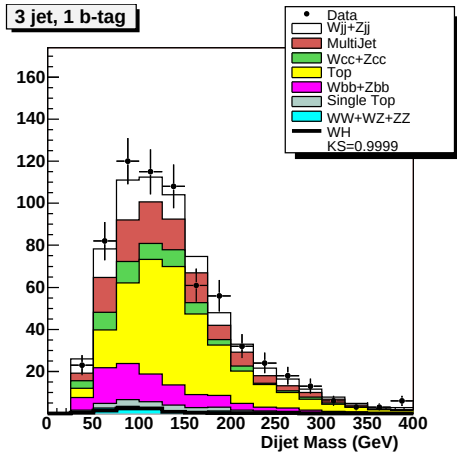
- Default b-jet NN: Double Tag Sample (OL Operating point) and Single Tag Sample (TI Operating Point)

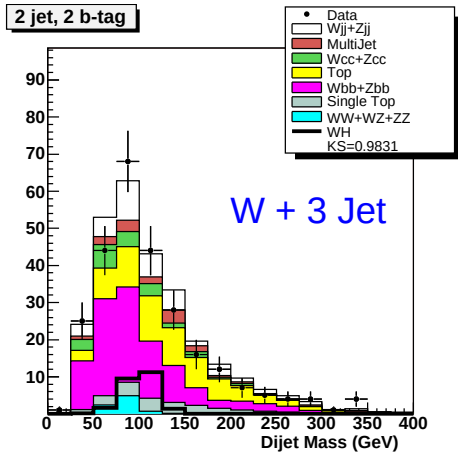
DT (W+2jet) DT (W+3jet) ST (W+2jet) ST (W+3jet)

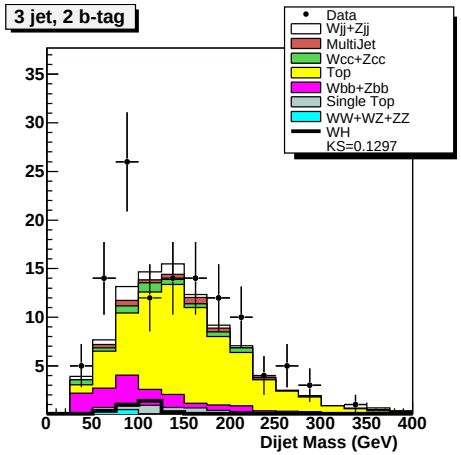


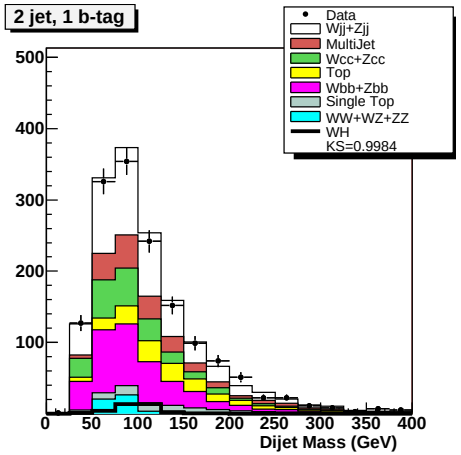


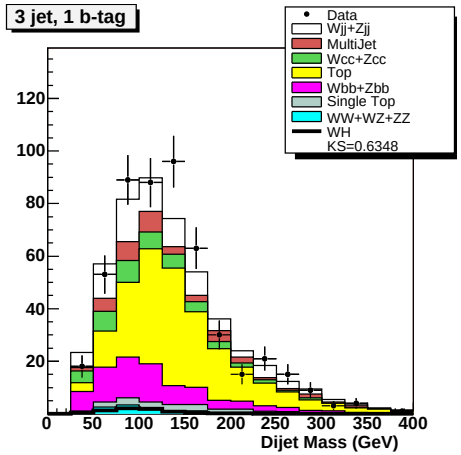












Tau Veto : Orthogonality to ZH

- Application of Tau Veto tested in different scenarios

Single b-Taggged

	2 Jets (No veto)	2 Jets with veto	Difference	R(Veto/No Veto)
Data	1342.00	1323.00	19.000000	0.9858
Wjj+Zjj	395.30	389.91	5.390000	0.9864
Wcc+Zcc	198.62	196.86	1.760000	0.9911
Top	133.37	120.39	12.980000	0.9027
Wbb+Zbb	339.52	338.40	1.120000	0.9967
Single Top	68.30	68.10	0.200000	0.9971
WW/WZ/ZZ	54.95	53.93	1.020000	0.9814
WH	3.23	3.22	0.010000	0.9969
QCD	163.00	155.82	7.180000	0.9560
Total MC background	1190.05	1167.58	22.470000	0.9811

Double b-tagged

	2 Jets (No veto)	2 Jets with veto	Difference	R(Veto/No Veto)
Data	240.00	226.00	14.000000	0.9417
Wjj+Zjj	18.58	18.22	0.360000	0.9806
Wcc+Zcc	19.69	19.42	0.270000	0.9863
Top	65.52	56.75	8.770000	0.8661
Wbb+Zbb	97.01	96.89	0.120000	0.9988
Single Top	19.53	19.50	0.030000	0.9985
WW/WZ/ZZ	8.35	8.30	0.050000	0.9940
WH	2.27	2.26	0.010000	0.9956
QCD	14.62	13.97	0.650000	0.9555
Total MC background	228.68	219.07	9.610000	0.9580

$\Rightarrow$ Veto against any Tau is Applied

Systematics

- Systematics then Evaluated on the Signal and Background Channels Individually
- Additional Smoothing Applied to Suppress Statistical Fluctuations

Electron 2-Jet: Taggability

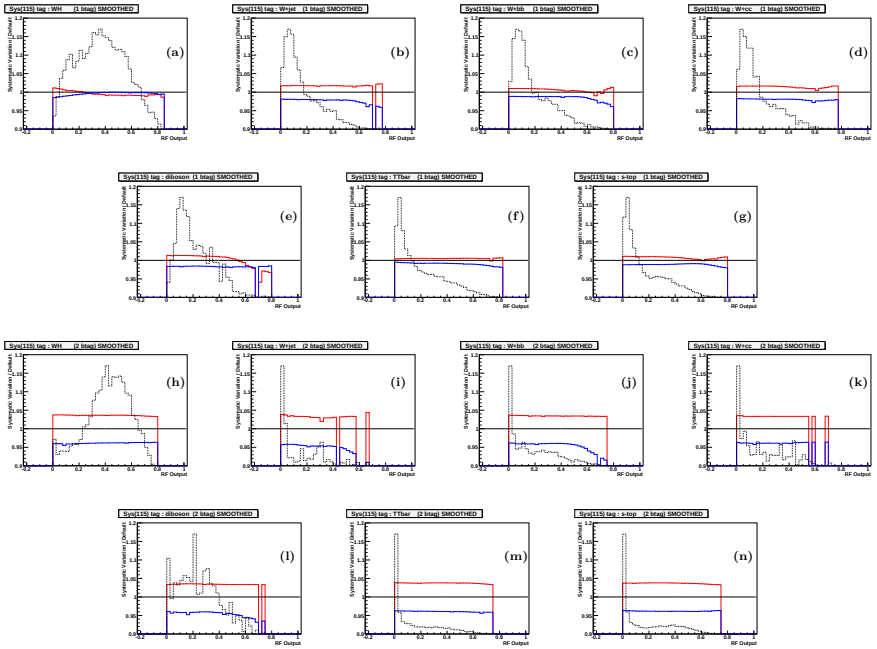


Figure 213: **Electron Systematics (2-jet)** *TAGGABILITY* $\pm 1\sigma$ *variation evaluated on the RF output (with smoothing applied). Fig. (a-g) are single tag samples, Fig. (h-n) are double tag samples. The red line shows the* $+1\sigma$ *variation, the blue line shows* -1σ *variation in each sample: Fig.(a,h) WH, (b,i) W+jj, (c,j) W+bb, (d,k) W+cc (e,l) Diboson, (f,m) ttbar and (g,n) single top.*

Electron 2-Jet: PDF 7/8

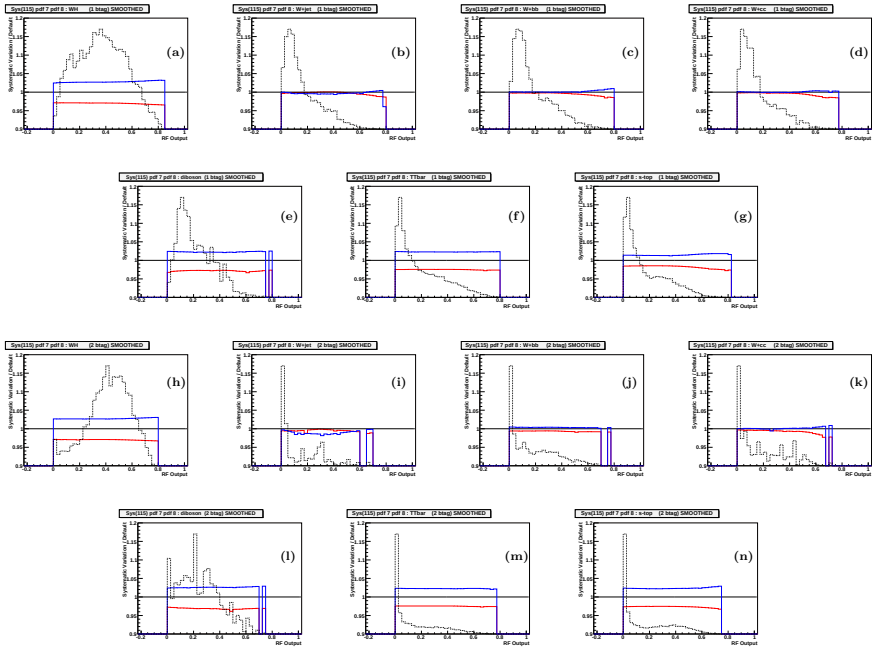


Figure 219: **Electron Systematics (2-jet)** Variations of select PDF uncerainties (with smoothing applied). A total of 40 PDF variations are made, each contributing to the final set of systematics. PDF variations 7 (red line) and 8 (blue line) are shown: Fig. (a-g) are single tag samples, Fig. (h-n) are double tag samples. Fig.(a,h) WH, (b,i) W+jj, (c,j) W+bb, (d,k) W+cc (e,l) Diboson, (f,m) ttbar and (g,n) single top.

- In Total $\sim$ 240 Systematic Analyses:

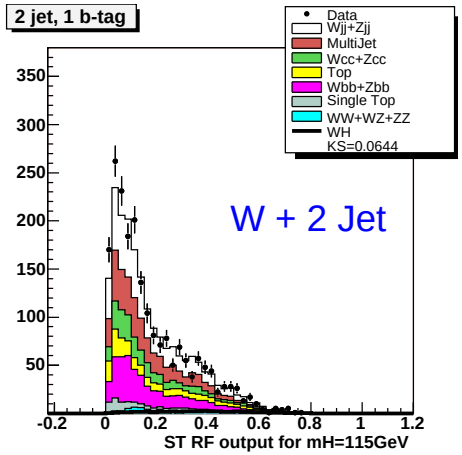
232 238

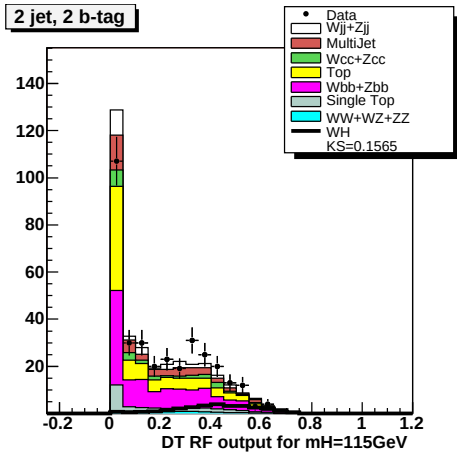
(40 PDF sets / QCD / Jet ID / JES / JSSR / mlm / j1, j2, deltaR / taggability / Alpgen UE , Scale / vcj / EMID / beam / B-id)

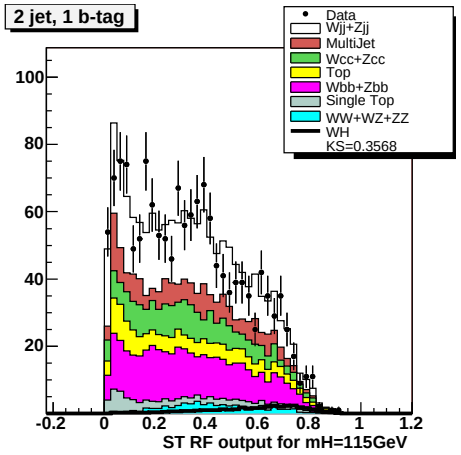
Random Forest Outputs

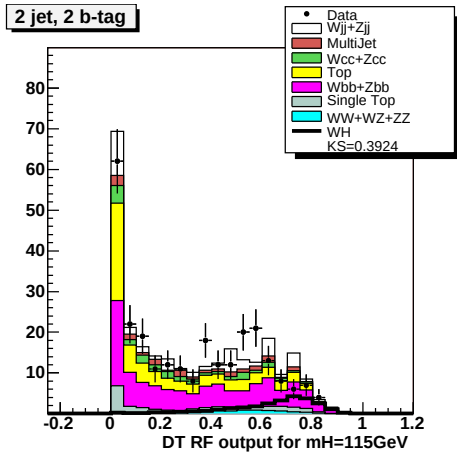
- Random Forest Output on p20 Sample

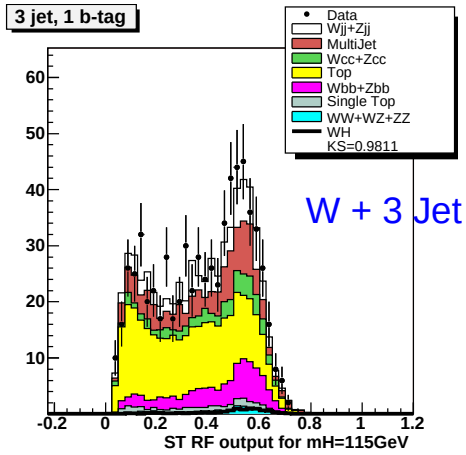
ST (electron) DT (electron) ST (muon) DT (muon)

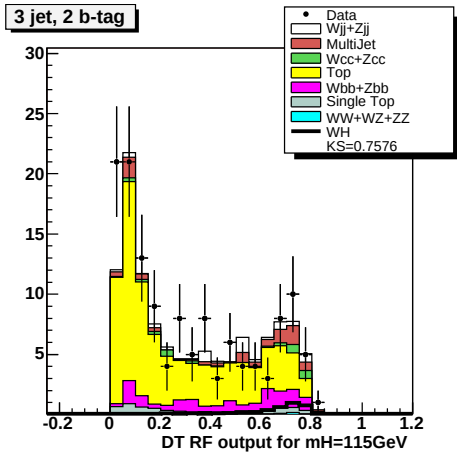


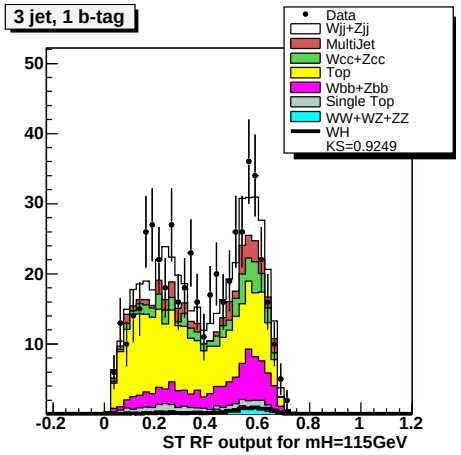


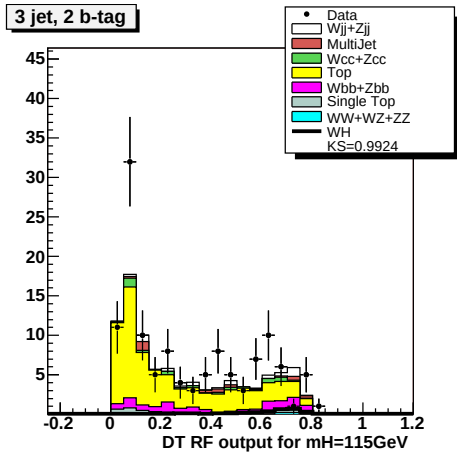












- Same RF Technique Now Used for W+2jet and W+3jet Channels

Random Forest CLFast Limits

- Ratios to SM Expectation

Lepton-Photon 09

Channel	CLFast Expected (Obs) Ratio to SM
p20 2-Jet electron	7.0 (9.8)
p20 2+3 Jet electron	6.7 (10.8)
p20 2-Jet muon	7.0 (7.5)
p20 2+3 Jet muon	6.8 (8.3)
p17 2-Jet electron	13.2 (14.2)
p17 2+3 Jet electron	12.9 (13.4)
p17 2-Jet muon	12.1 (10.4)
p17 2+3 Jet muon	11.7 (9.7)

Random Forest

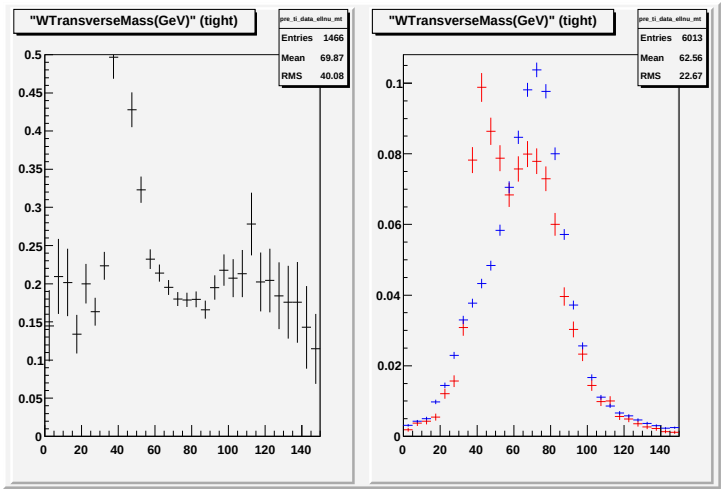
Channel	CLFast Expected Ratio to SM
p20 2-Jet electron	6.1
p20 2+3 Jet electron	5.9
p20 2-Jet muon	5.6
p20 2+3 Jet muon	5.4
p17 2-Jet electron	12.5
p17 2+3 Jet electron	12.1
p17 2-Jet muon	11.8
p17 2+3 Jet muon	11.4

- Fully Combined Exp. Limit (without systematics) $\sim 3.7 \times$ SM @ $M_H = 115$ GeV

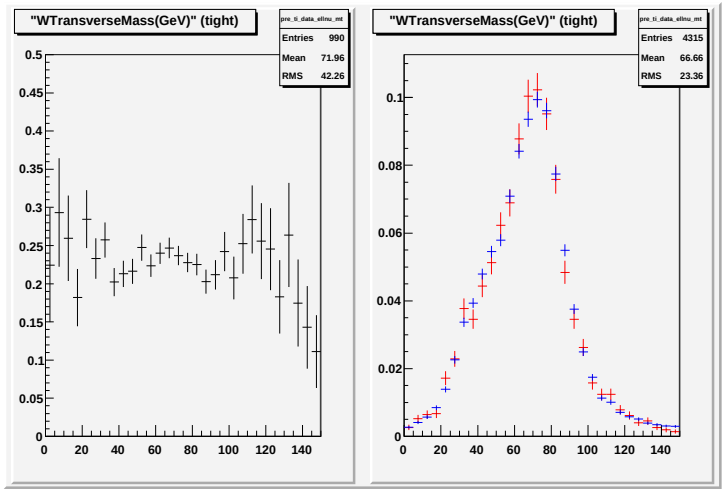
WH Improvements

- Testing IIB-3 Dataset: Muon Channel - Ratio of 30% IIb-3 / (IIb-1 + IIb-2)

Before



After



⇒ See Florian's talk for Electron Channel

- New Electron-ID

  Loose → Point O, Tight CC → Point 1, Tight EC → Point 2

- 30 New Muon-ID Combinations Studied (need QCD before taking decision)
- b-ID NN → MVA, Continuous Tagging
- Jet Energy Resolution Studies → See Jonathan's talk
- Investigating Other Variables (Track based missing p_T etc.,)
- New WH Analysis Software

Summary and Outlook

- Current Round of Improvements / Extensions are Underway
- Analysis Note (with Central $\eta_\mu < 1.6$ Region) in Progress
- Updated version with full η_μ range to follow