# Trilepton Analysis: The $WH \rightarrow WWW \rightarrow l\nu l\nu l\nu$ Signal

## Dividing by Jet Bins and In/Out $Z$ Peak

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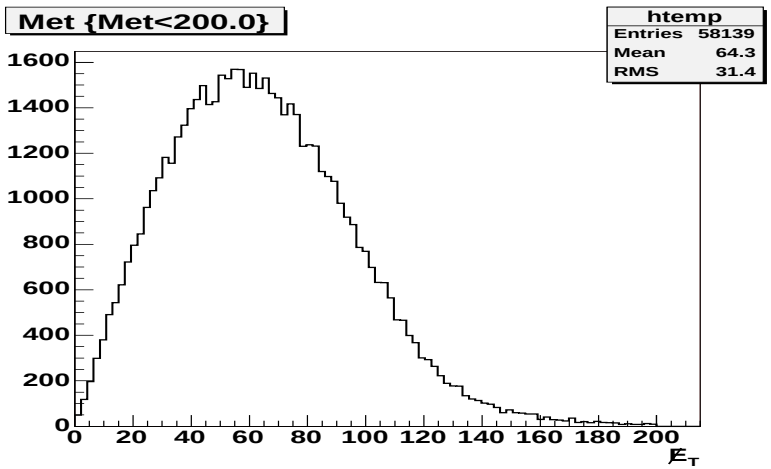
# Summary

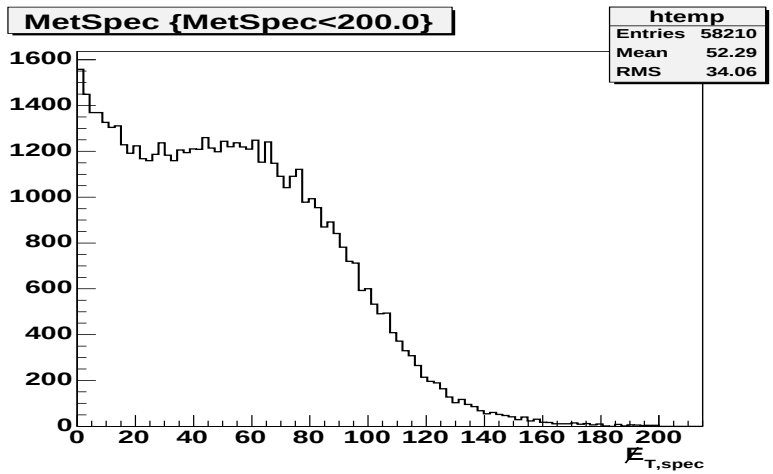
# Updates

- Update Preselection
- Better statistics$\Rightarrow$ can use official ntps instead of modelling fake rates.
- Statistical errors
- Update `nGenForType` for $WH \rightarrow l\nu l\nu l\nu$, mistake in counting. Affects weighting.
- Use all standard signal ntps.

# $\not{E}_T$ vs. $\not{E}_{T,spec}$

The $H \rightarrow WW$ dilepton analyses cut on $\not{E}_{T,spec}$, but for trileptons much of the signal is at low $\not{E}_{T,spec}$. So I'm switching to a $\not{E}_T < 20.0$ GeV cut instead.

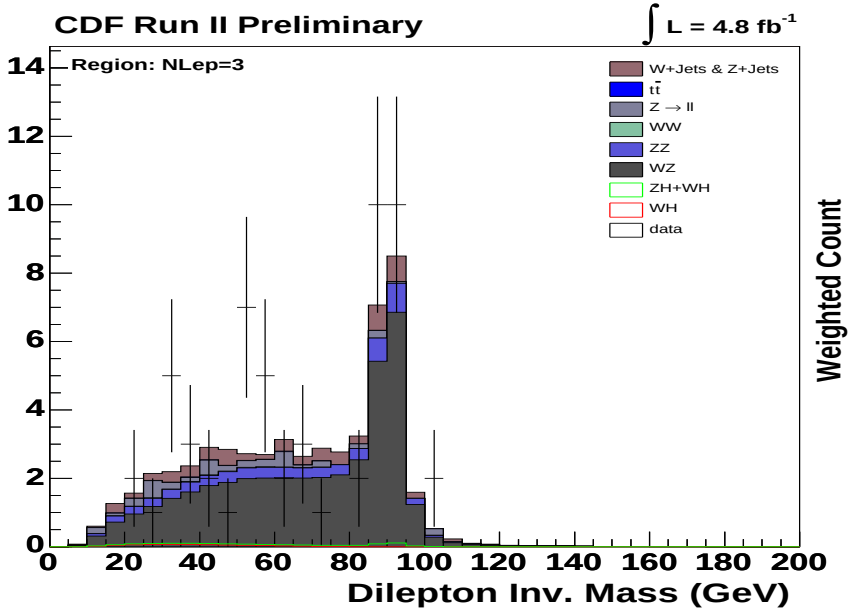


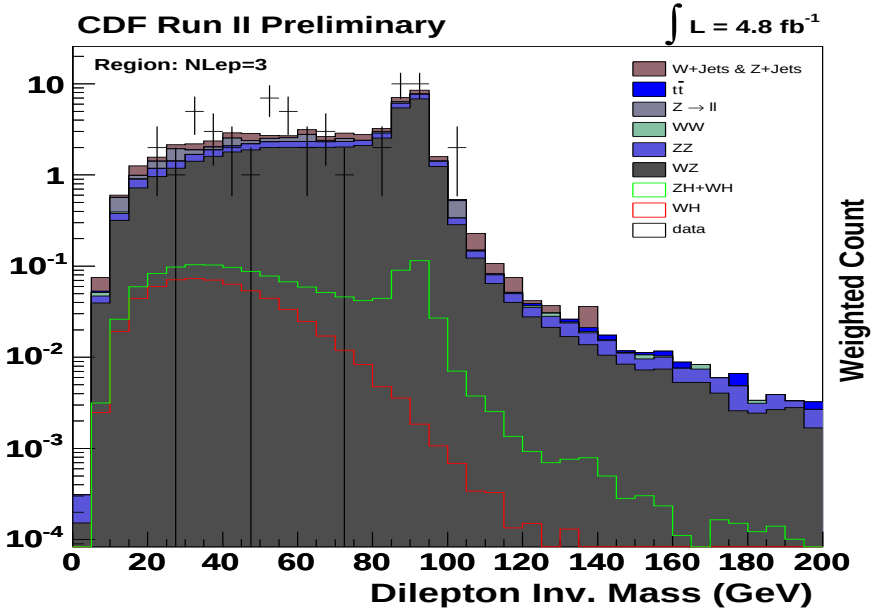



# Full Preselection

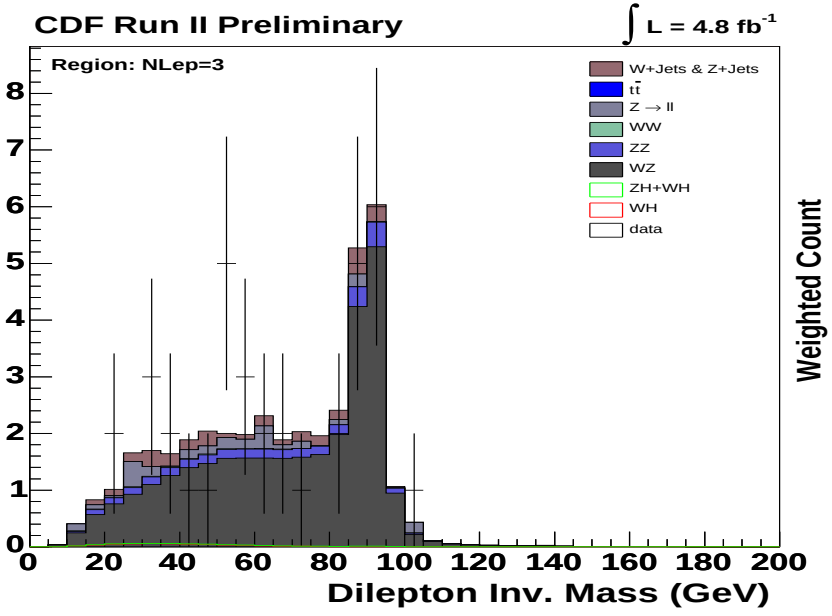
- $\not{E}_T < 20.0$ GeV
- Basic Lepton ID (for two or three leptons)
- Good Run (accesses a list of good runs)
- Triggered Lepton (trigger bits passed for data)
- Max $\Delta$ z_0 within limits
- Trilepton identified for event, but not same-sign analysis trileptons.

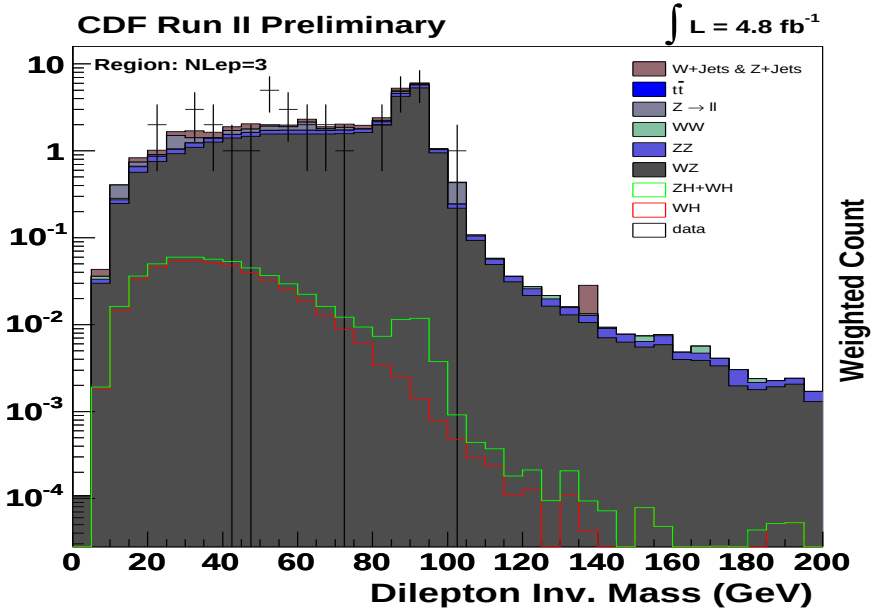
# Dilepton Inv. Mass Stack, All Jet Bins



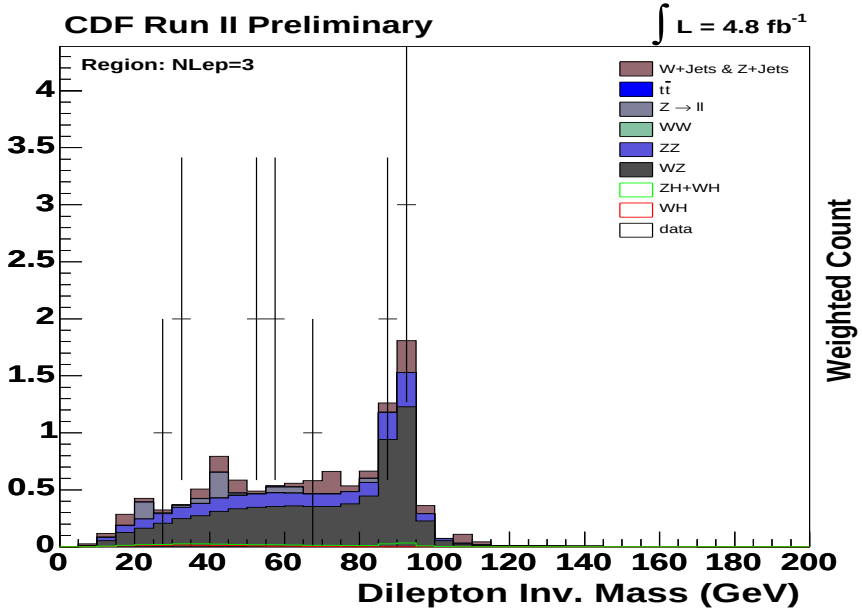



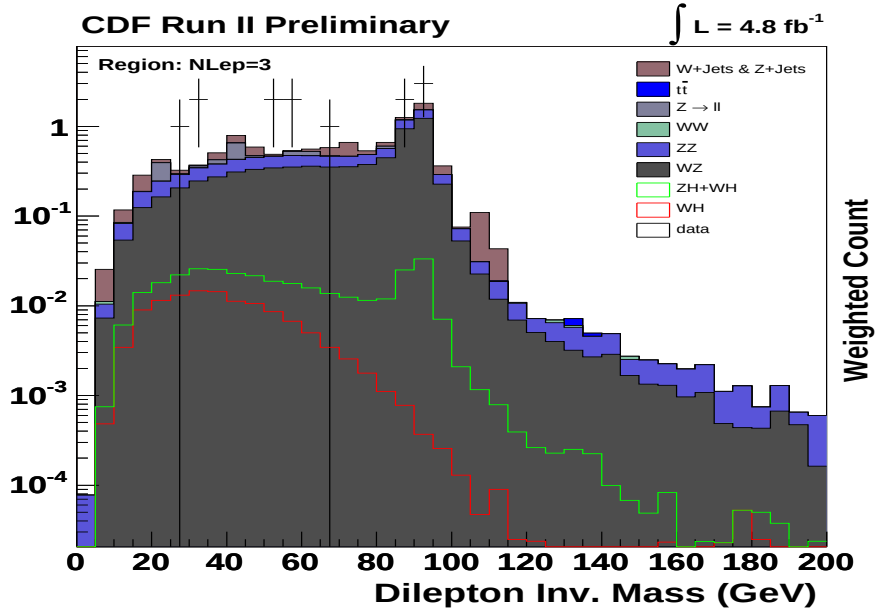
# Dilepton Inv. Mass Stack,NJet=0



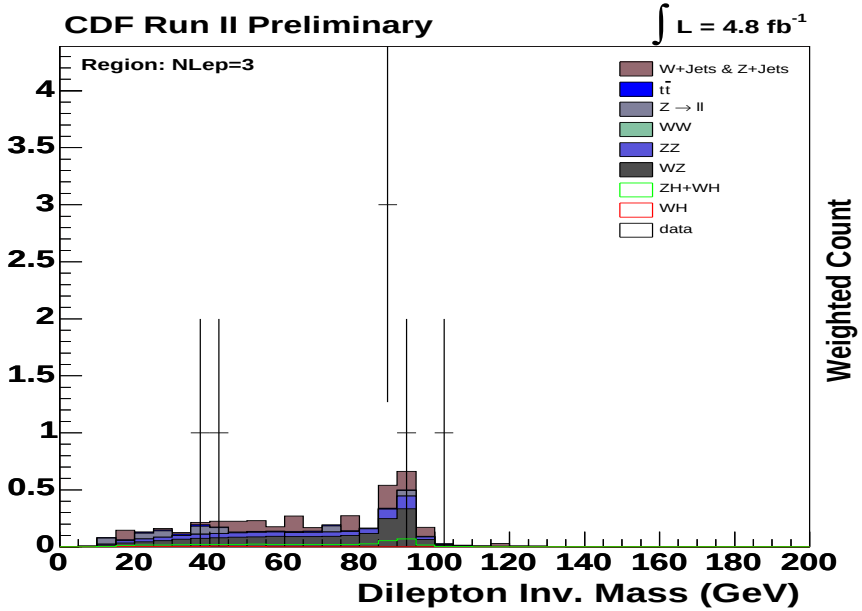



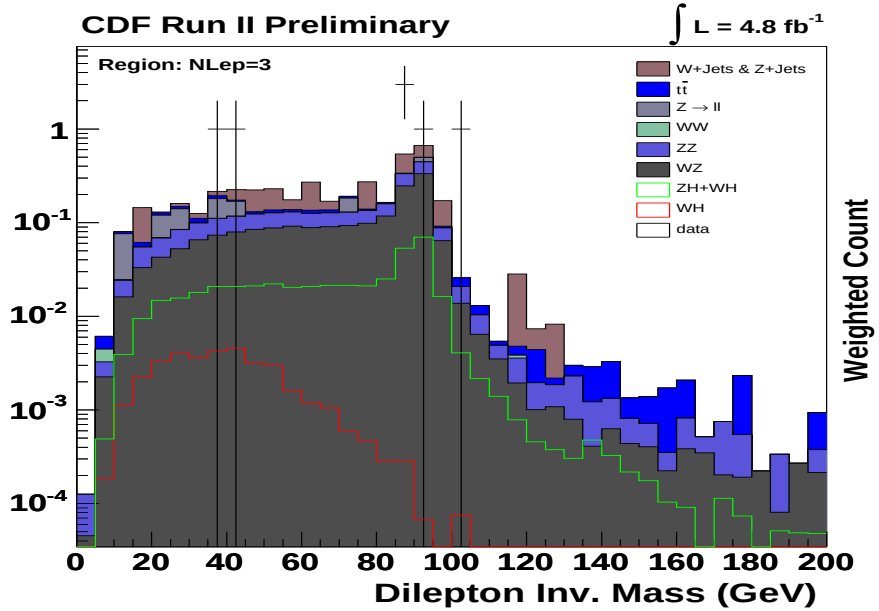
# Dilepton Inv. Mass Stack,NJet=1



# Dilepton Inv. Mass Stack,NJet$\geq$2



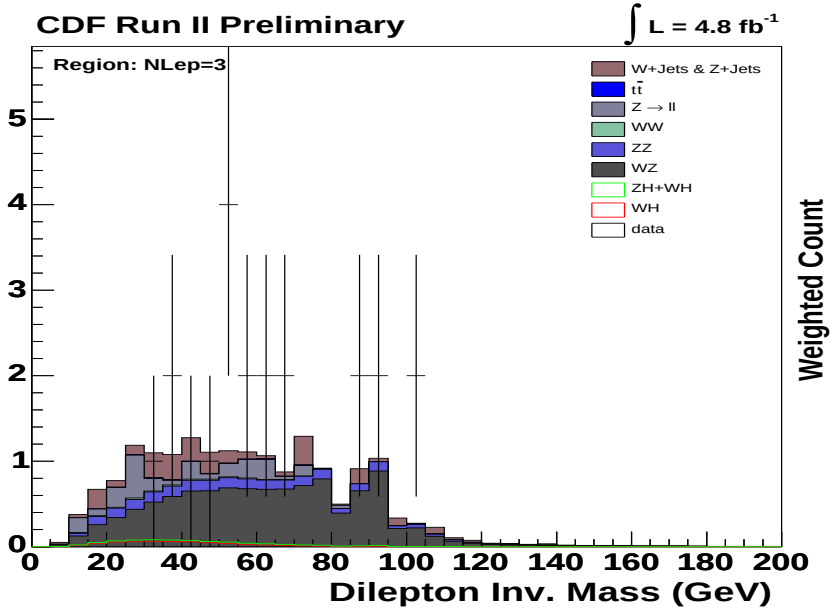



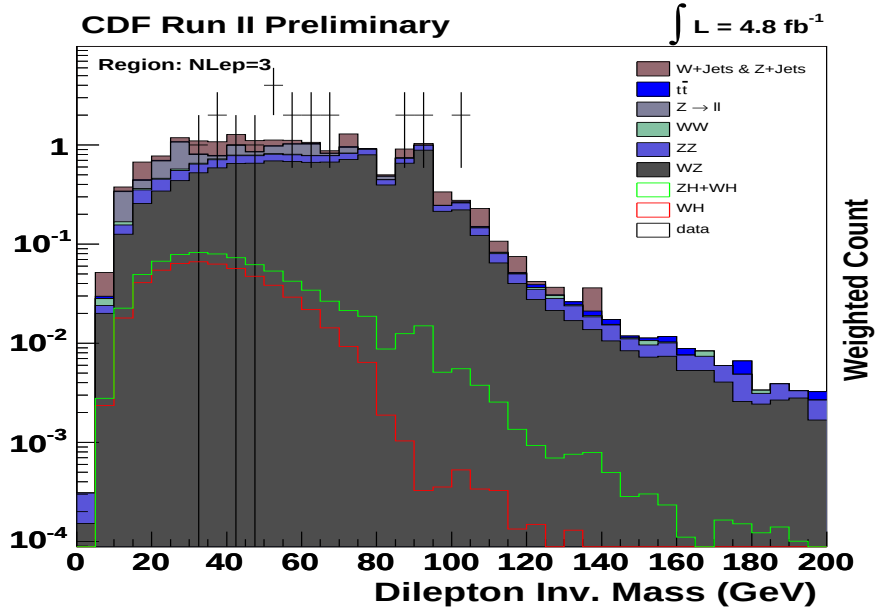
# Dilepton Inv. Mass Stack Table

| Process | All Jet Bins | NJet=0 | NJet=1 | NJet$\geq$ 2 |
|---|---|---|---|---|
| $WH160$ Signal | 0.61 | 0.46 | 0.12 | 0.04 |
| $ZH160$ Signal | 0.69 | 0.09 | 0.21 | 0.39 |
| Background Stack | 55.7 | 39.5 | 11.5 | 4.7 |
| Total Background + MC signal | 57.0 | 40.1 | 11.8 | 5.1 |
| data(4.8 fb$^{-1}$) | 56$\pm$7.5 | 36$\pm$6.0 | 13$\pm$3.7 | 7$\pm$ 2.6 |

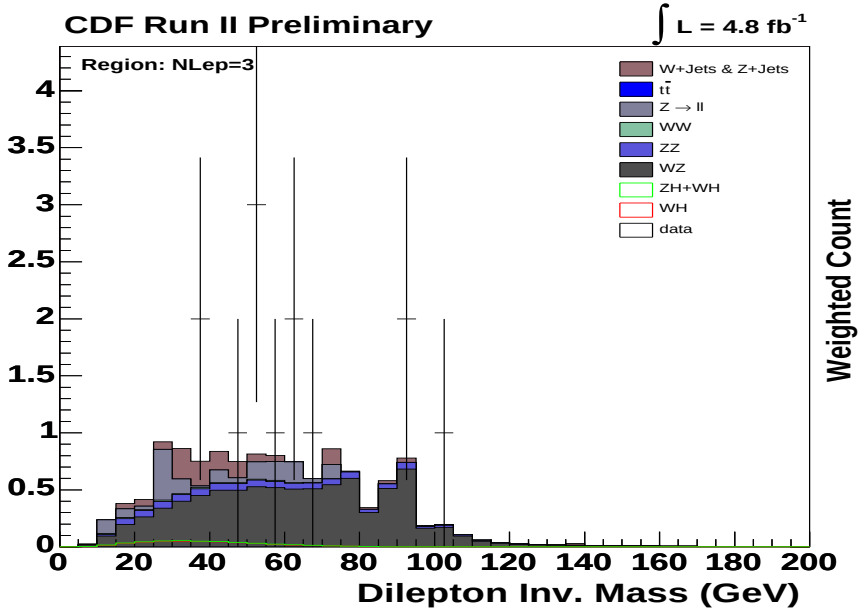
# Dimass, No $Z$-Peak, All Jet Bins

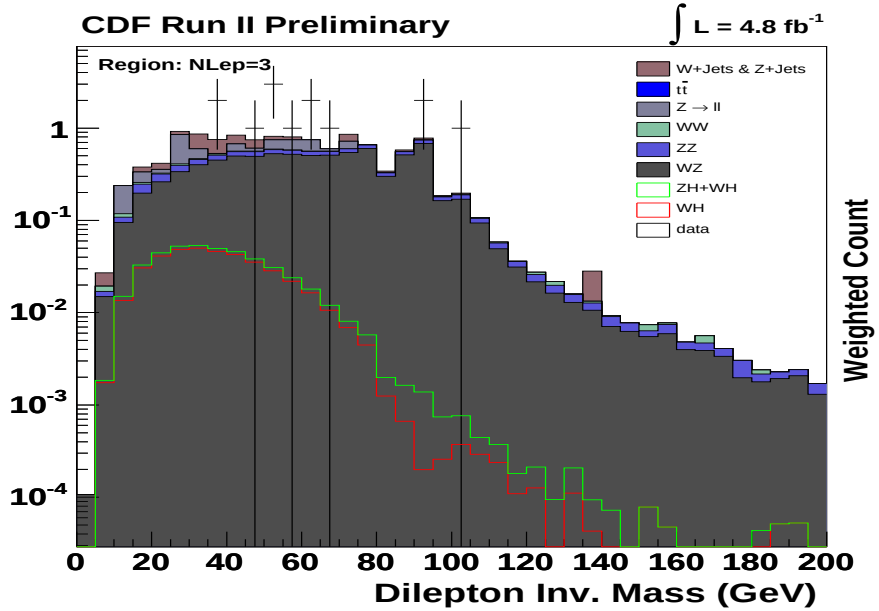
Outside $Z$-peak ($91 \pm 10.0$ GeV): If any dimass combination with opposite sign and same flavor is inside the $Z$ mass window, do not fill the event.



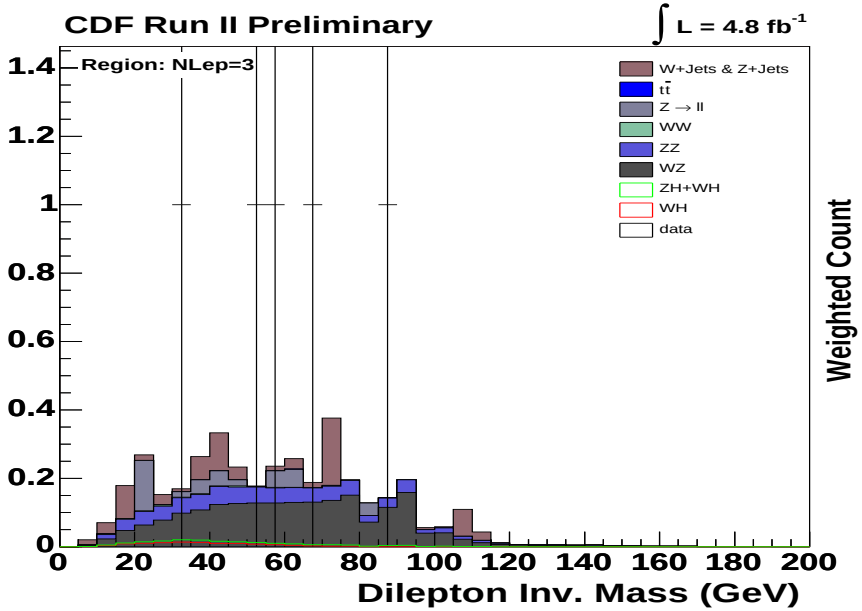



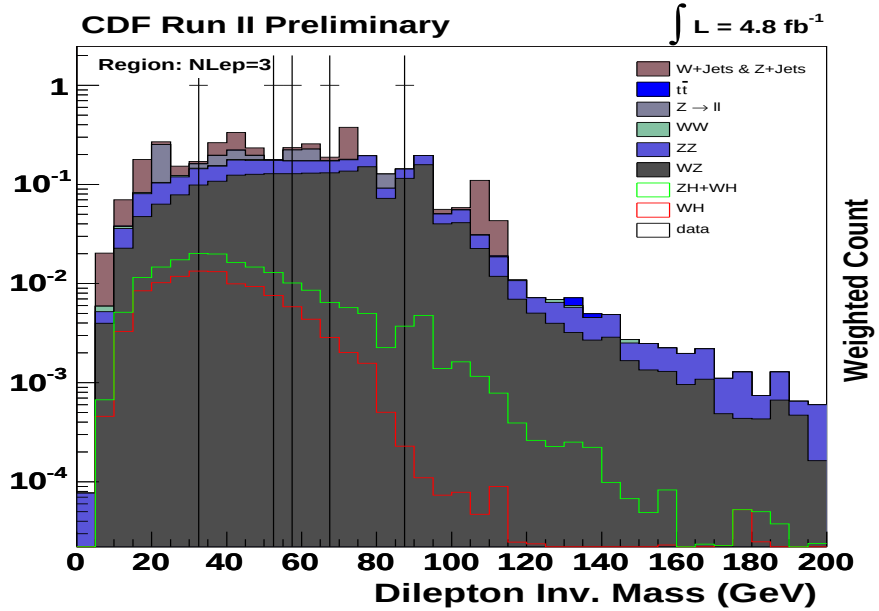
# Dimass, No $Z$-Peak, NJet=0



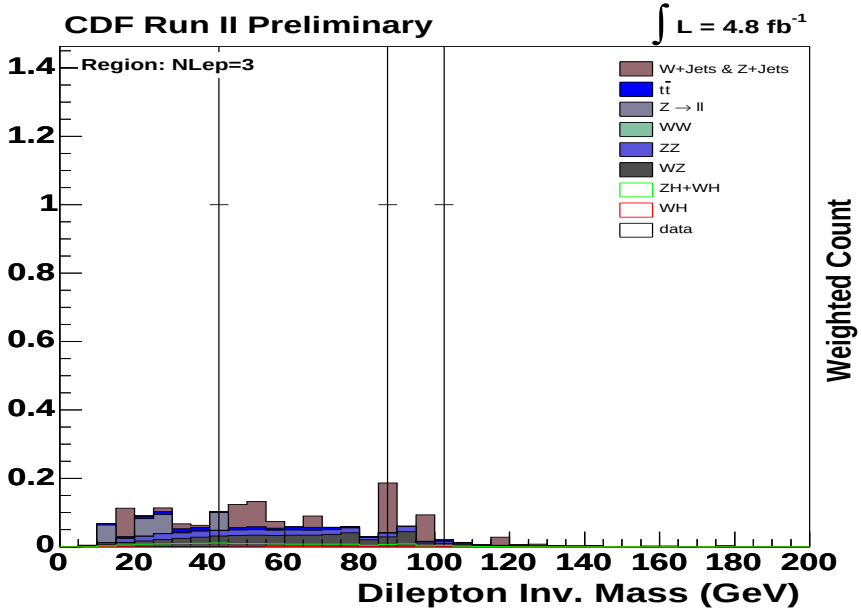



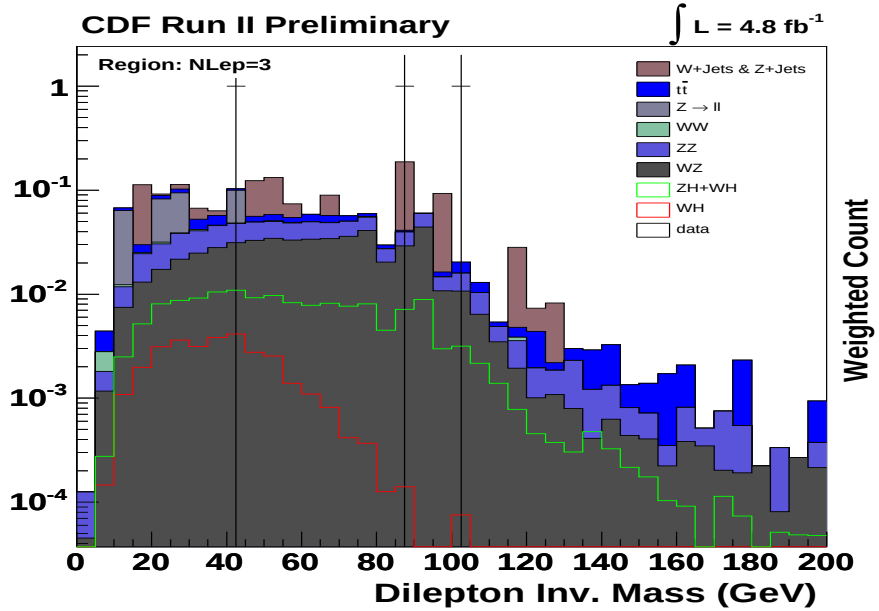
# Dimass, No $Z$-Peak, NJet=1



# Dimass, No $Z$-Peak, NJet$\geq$2



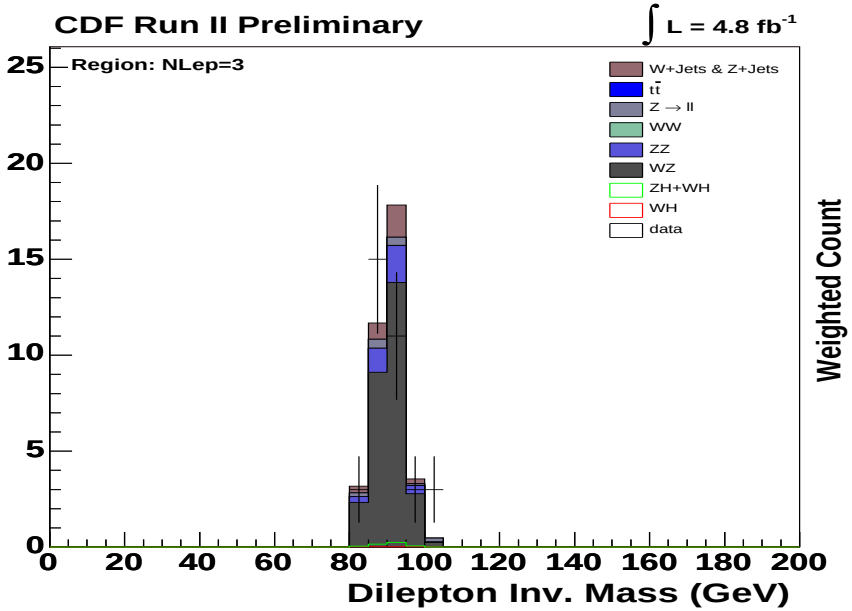



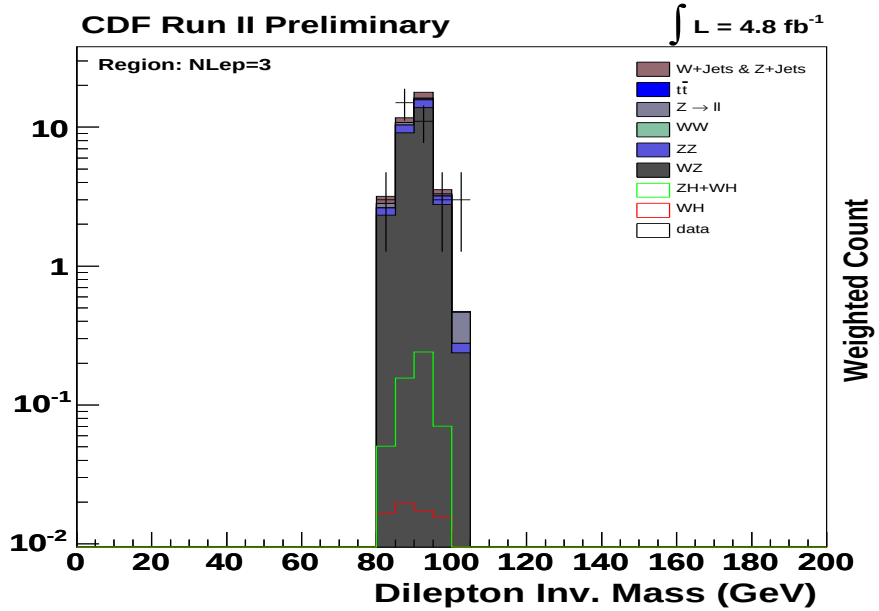
# Dimass, No $Z$-Peak Table

| Process | All Jet Bins | NJet=0 | NJet=1 | NJet$\geq$ 2 |
|---|---|---|---|---|
| $WH$160 Signal | 0.54 | 0.40 | 0.11 | 0.03 |
| $ZH$160 Signal | 0.23 | 0.04 | 0.08 | 0.12 |
| Background Stack | 18.5 | 12.5 | 4.10 | 1.84 |
| Total Background + MC signal | 19.3 | 12.9 | 4.29 | 1.99 |
| data(4.8 fb$^{-1}$) | 21$\pm$4.7 | 13$\pm$3.6 | 5$\pm$2.45 | 3$\pm$1.73 |

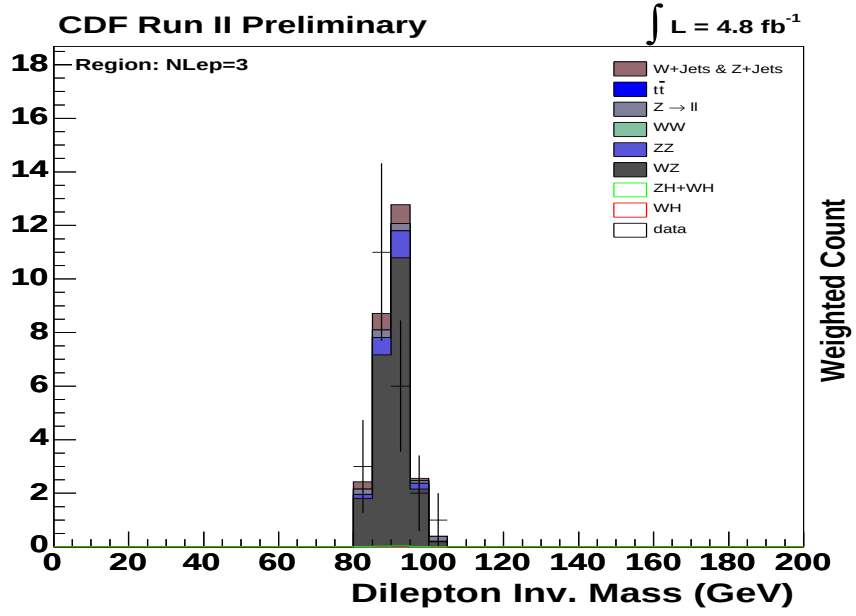
# Dimass, Inside $Z$-Peak, All Jet Bins

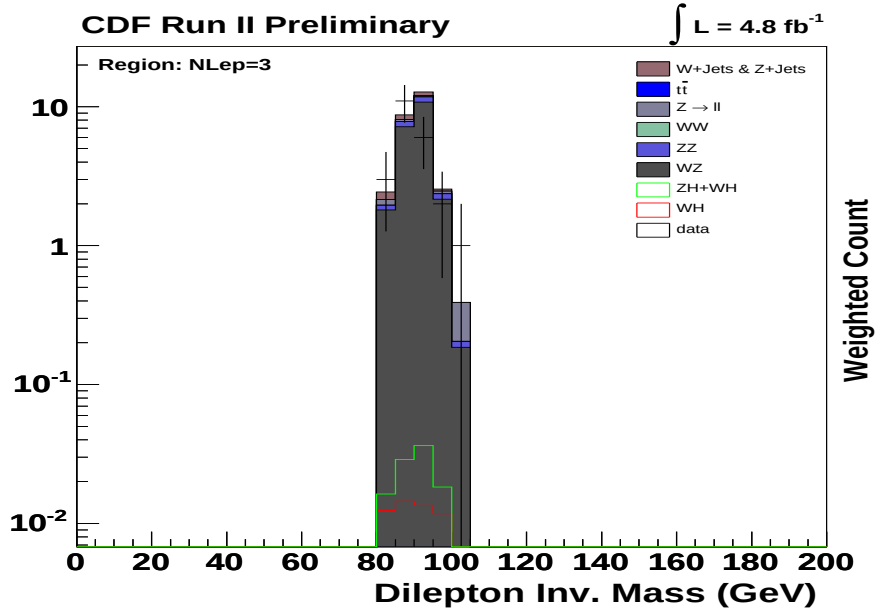
Plot the dimass value that falls within 91$\pm$10.0 GeV. If more than one does, use higher(highest) value.



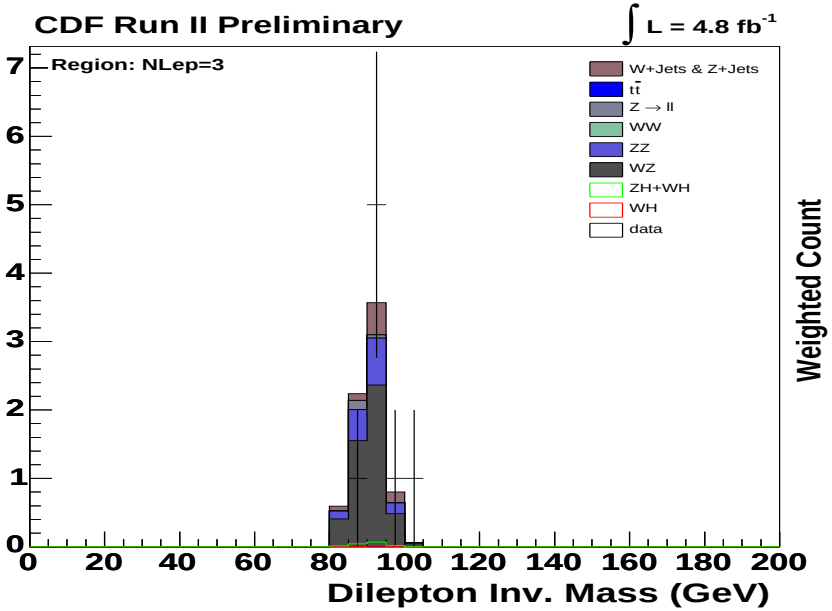



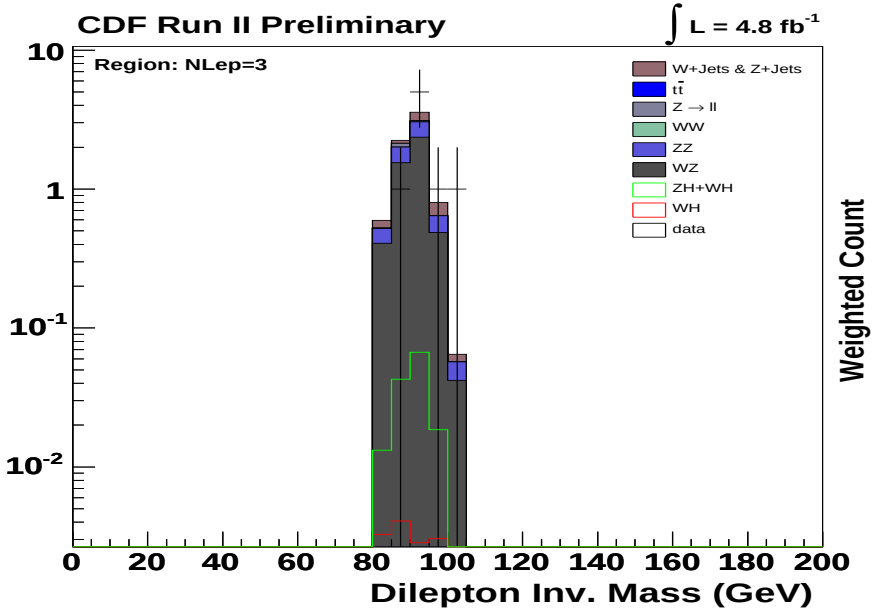
# Dimass, Inside $Z$-Peak, NJet=0



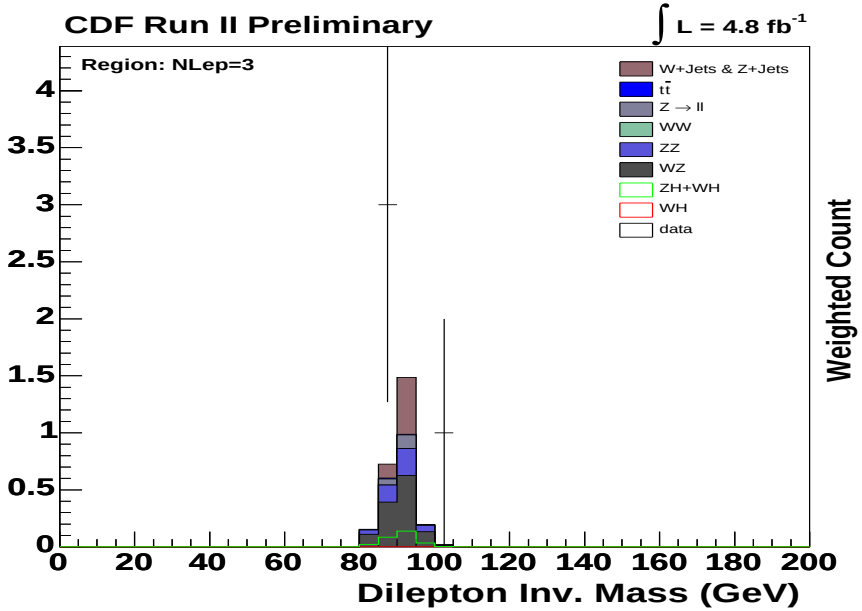



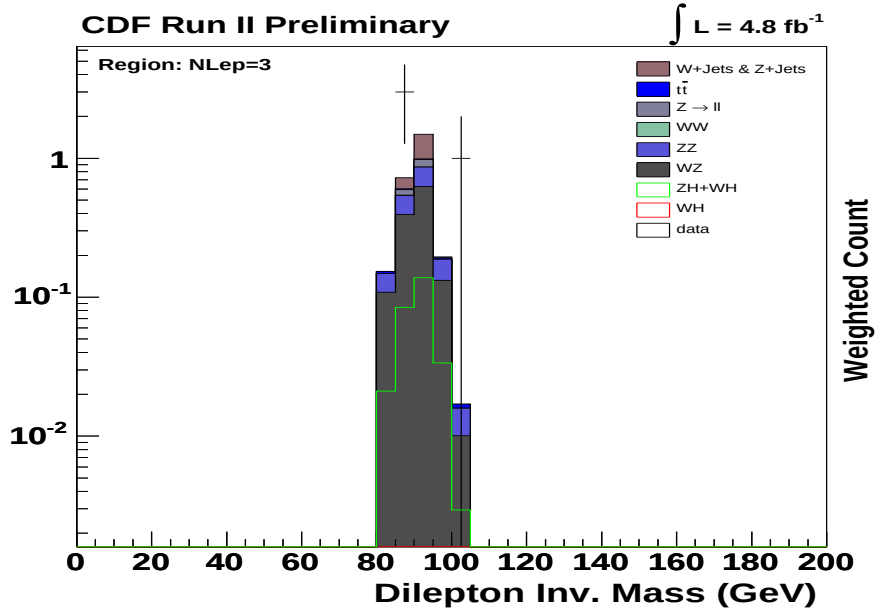
# Dimass, Inside $Z$-Peak, NJet=1



# Dimass, Inside $Z$-Peak, NJet$\geq$2



# Dimass, Inside $Z$-Peak Table

| Process | All Jet Bins | NJet=0 | NJet=1 | NJet$\geq$ 2 |
|---|---|---|---|---|
| $WH$160 Signal | 0.07 | 0.05 | 0.01 | 0.004 |
| $ZH$160 Signal | 0.45 | 0.05 | 0.13 | 0.28 |
| Background Stack | 37.2 | 27.0 | 7.41 | 2.86 |
| Total Background + MC signal | 37.7 | 27.1 | 7.55 | 3.14 |
| data(4.8 fb$^{-1}$) | 35$\pm$5.9 | 23$\pm$4.8 | 8$\pm$2.83 | 4$\pm$2.00 |

# Weighting Master Formula for MC

Each event for the dilepton mass is weighted by this upon filling the histogram.

$$\text{weight} = \frac{\left[\sigma \cdot \mathcal{B} \cdot \int \mathcal{L}dt\right] \texttt{sf} \cdot \varepsilon_{\text{filter}}}{\text{nGenForType}}$$

$$\texttt{sf} = \varepsilon^{i}_{\text{vertex}} \cdot \varepsilon^{i}_{\text{lep I.D.}} \cdot \varepsilon^{i}_{\text{trigger eff.}} \cdot \text{fake rate}^{i} \cdot \text{conversion factor}^{i}$$

- Presently using $\int \mathcal{L}dt = 4800\ \text{pb}^{-1}$
- $\varepsilon_{\text{filter}}$: eff. of filter on generated MC.
- nGenForType: Number of events generated for a process.
- $\varepsilon^{i}_{\text{vertex}}$: Run dependent eff. of the $Z$-vertex position requirement ($|z_0| < 60$ cm)
- $\varepsilon^{i}_{\text{lep I.D.}}$: lepton I.D. scale factor for event i.
- $\varepsilon^{i}_{\text{trigger eff.}}$: trigger eff. for event i
- If `ntp` generated in "Fakes" mode, include the fake rate in the scale factor `sf` for each event.
- Scale up by 1.3 for $W\gamma$ and $Z\gamma$ events if there is a lepton-$\gamma$ match–account for mismodeling of conversion factor and/or material.

$$\not{E}_{T,\textbf{spec}} \equiv \not{E}_T \textbf{ if } \Delta\phi(\not{E}_T, \textbf{nearest lepton or jet}) > \frac{\pi}{2}$$

$$\not{E}_{T,\textbf{spec}} \equiv \not{E}_T \cdot \sin(\Delta\phi) \textbf{ if } \Delta\phi(\not{E}_T, \textbf{nearest lepton or jet}) < \frac{\pi}{2}$$