Search for SM Higgs in the $WH \rightarrow l\nu b\bar{b}$ Channel using ~2fb^{-1}

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Introduction to *WH* Search

<u>Higgs Boson</u> : the only particles not discovered in the Standard Model

✓ It is possible to search Higgs boson directly at Tevatron!!

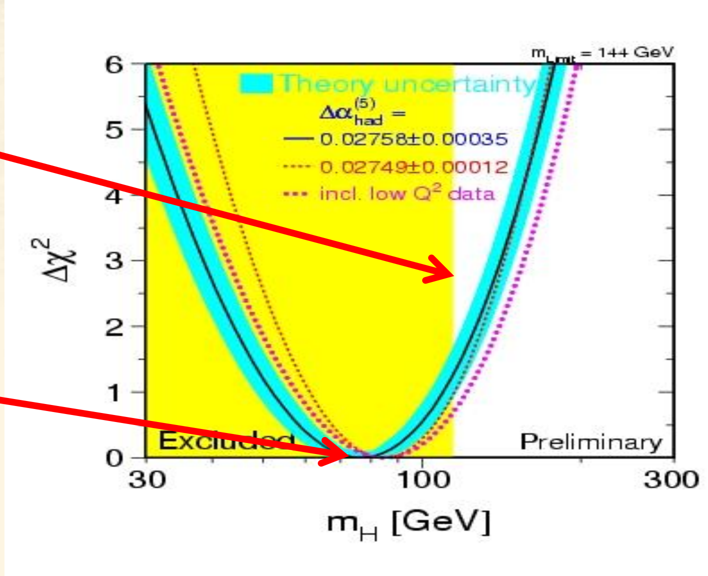
<u>Constraint on Higgs Mass</u>

114.4 GeV (LEPII) < m_H < 182 GeV

<u>Most Probable Value (EW global fitting)</u>

$m_H = 76^{+33}_{-24}$ GeV

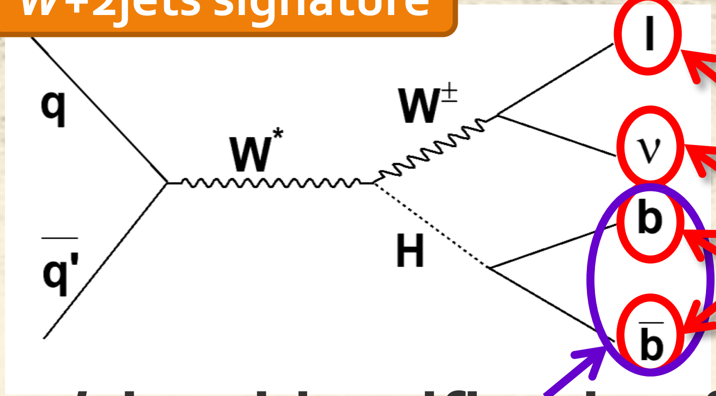
Standard Model prefers low mass Higgs Boson !!



***<u>WH</u>* <u>channel</u> ($\sigma_{pp\rightarrow WH}$ ~ 0.2 pb) : One of promising channels in low mass Higgs search at Tevatron**

Event Selection and *b* Jet Identification

W+2jets signature



Event Selection

- ✓ High p_T lepton
- ✓ High missing E_T
- ✓ Exactly two high E_T jets

(High p_T lepton + High missing E_T: *W* boson selection; all three: *W* + 2 jets selection)

- ***b*** **jets identification from Higgs** is **crucial** in this analysis
  ➔ Extract Higgs signal from huge *W*+jets backgrounds
- Use various *b* jets identification algorithms

b Jets Selection

1. Double *b*-tagged events (tight+tight)
2. Double *b*-tagged events (tight+loose)

→ ✓ High S/B ✓ Low statistics

3. Single *b*-tagged events

→ ✓ High statistics ✓ Low S/B

Event Yield

Double *b*-tagged events	tight+tight	tight+loose
Signal (m_H = 115 GeV)	1.11±0.14	0.94±0.11
Expected Background	80.62±18.75	86.99±17.99
Observed data	83	90

Dominant Backgrounds

- ✓ $W+b\bar{b}$, $W+c\bar{c}$ (~48%)
- ✓ $t\bar{t}$ (~21%)

Single *b*-tagged events	
Signal (m_H = 115 GeV)	2.35±0.15
Expected Background	809.61±159.38
Observed data	805

Dominant Backgrounds

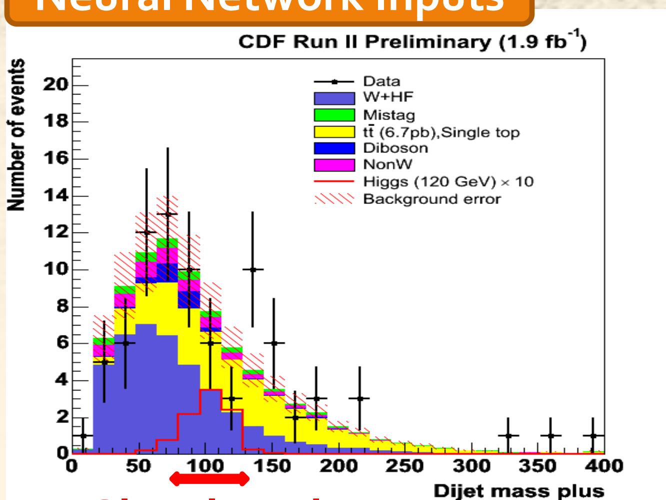
- ✓ $W+b\bar{b}$, $W+c\bar{c}$ (~47%)
- ✓ QCD fake (~23%)
- ✓ fake *b*-tag (~13%)

Forward electron contribution is added in final result (Signal acceptance ~10% gain)

WH Search Strategies

- Check the excess of observed data with Neural Network discriminant

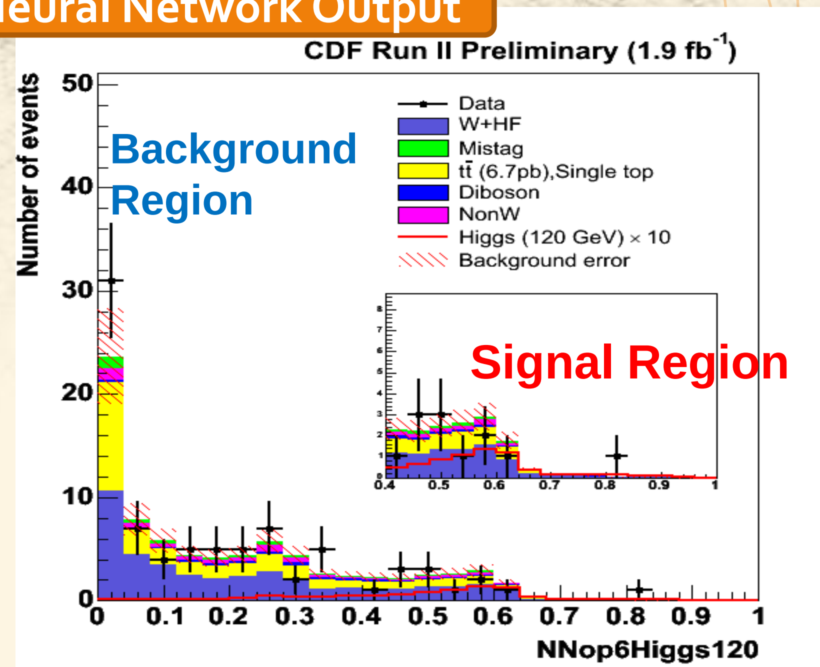
Neural Network Inputs



Signal Region

Optimize discrimination between signal and backgrounds

Neural Network Output



<u>Other input variables</u>

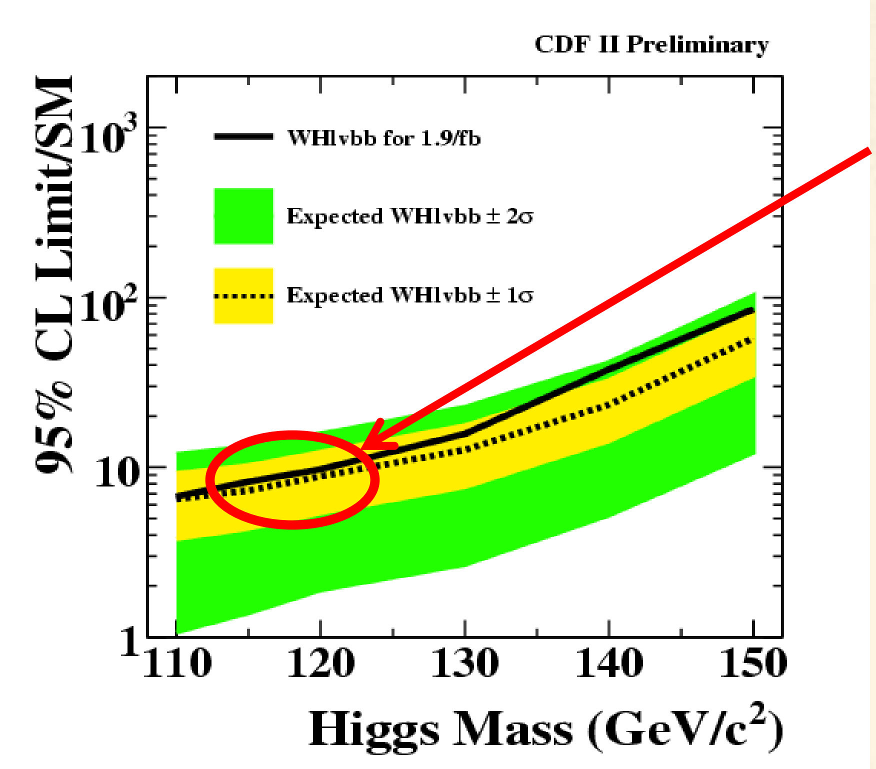
- p_T of *W* + 2 jet system
- ΔR(lepton-ν)
- p_T imbalance
- ΣE_T (loose jet)
- Minimum $M_{l\nu j}$

Search sensitivity improves by ~60%, compared to previous analysis, which includes NN discriminant, b-tag optimization and forward electron

➔ **No Significant excess in signal region**

95% C.L. Upper Limit on *WH* channel

- Set 95% C.L. upper limit using a binned maximum likelihood technique
- Final result combines three *b*-tagging categories



Result

✓ Observed(Expected) upper limit is 8.2(7.3) times higher than SM in m_H ~115 GeV

✓ Analysis is limited statistically

Future Prospect

✓ increase acceptance (isolated tracks)

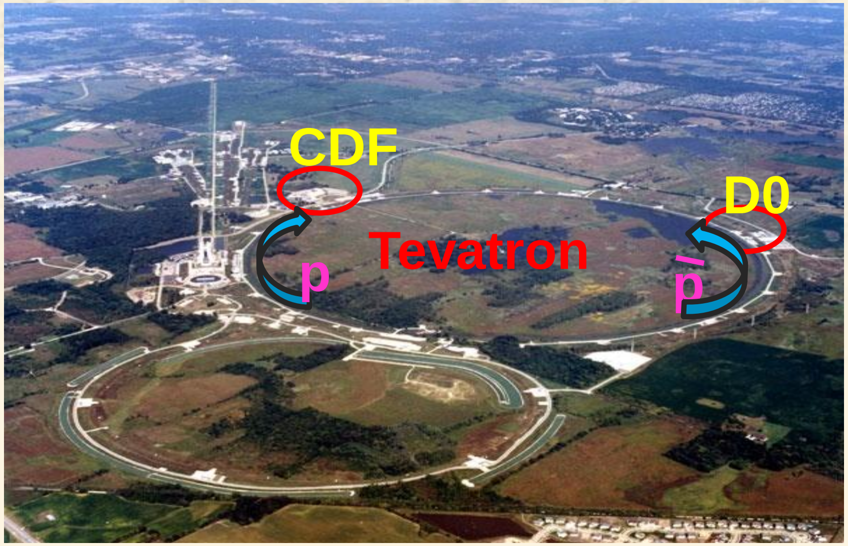
✓ Improve *b*-tag, jet energy resolution and more advanced multivariate technique

✓ Aim to gain another 50% and triple the dataset by 2010

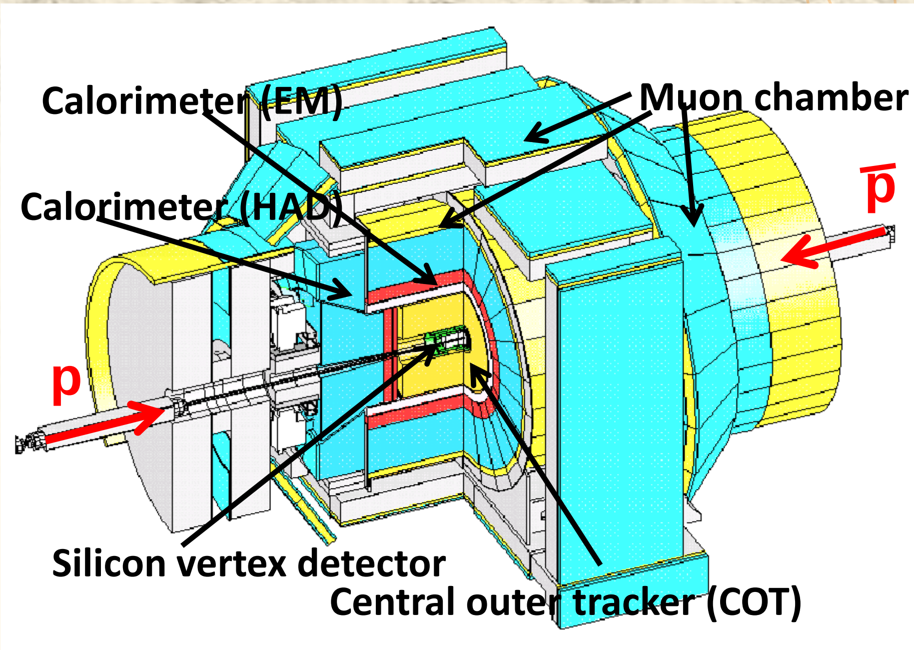
BACK UP

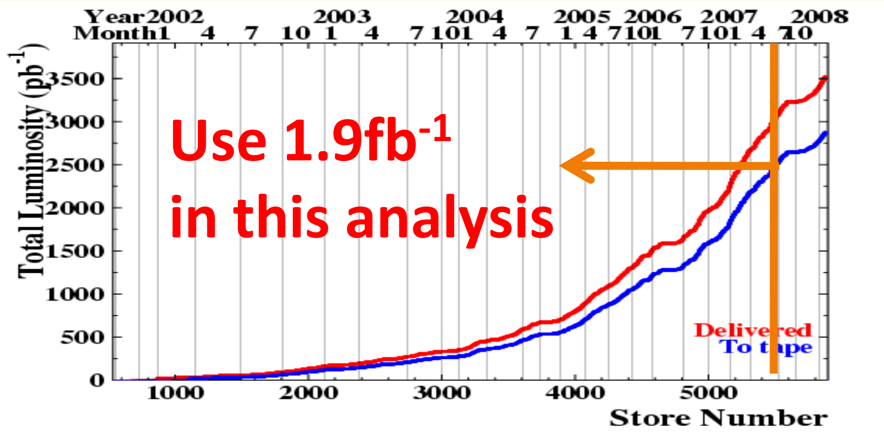
Tevatron and CDF

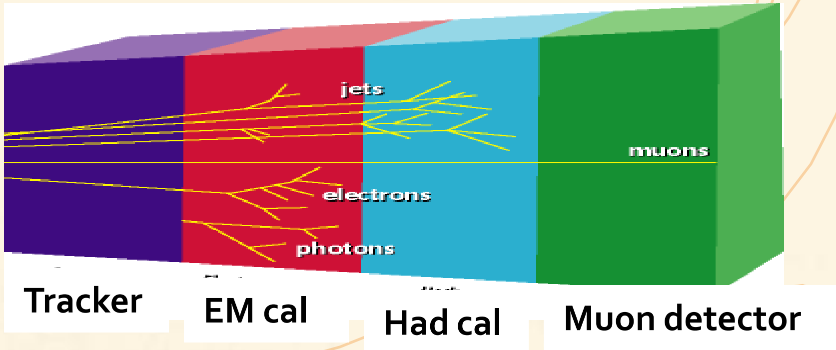
- $p\bar{p}$ collider : c.m. energy 1.96 TeV
- Direct Higgs search is capable in Tevatron only



CDF Detector

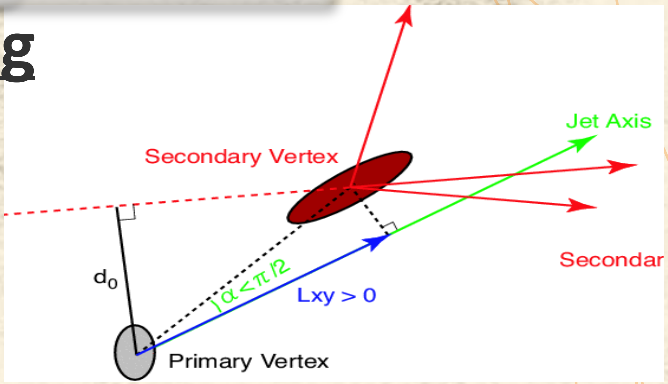




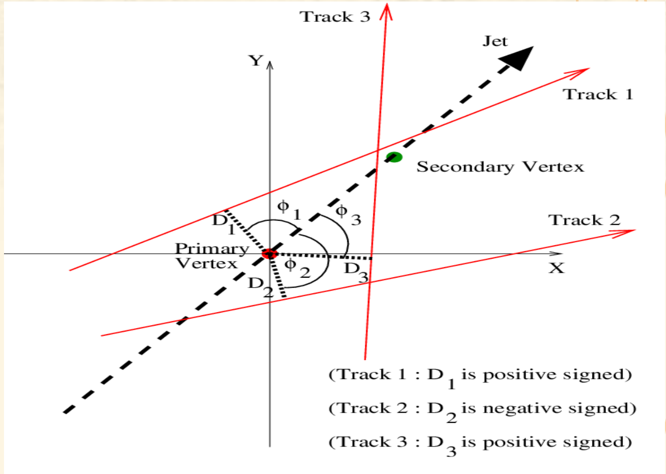


b Flavor Tagging Algorithm

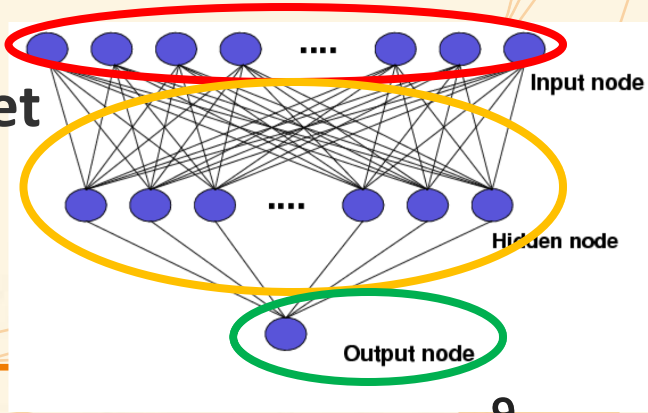
1. **Secondary Vertex (SECVTX) *b*-tagging**
   - ✓ Identify *b*-jets using the long lifetime of *b* hadron
   - ✓ tagging eff : ~40%, fake rate : ~ 1%



2. **Jet Probability *b*-tagging**
   - ✓ Identify *b*-jets using impact parameter of track in jets
   - ✓ tagging eff : ~50%, fake rate : ~5%



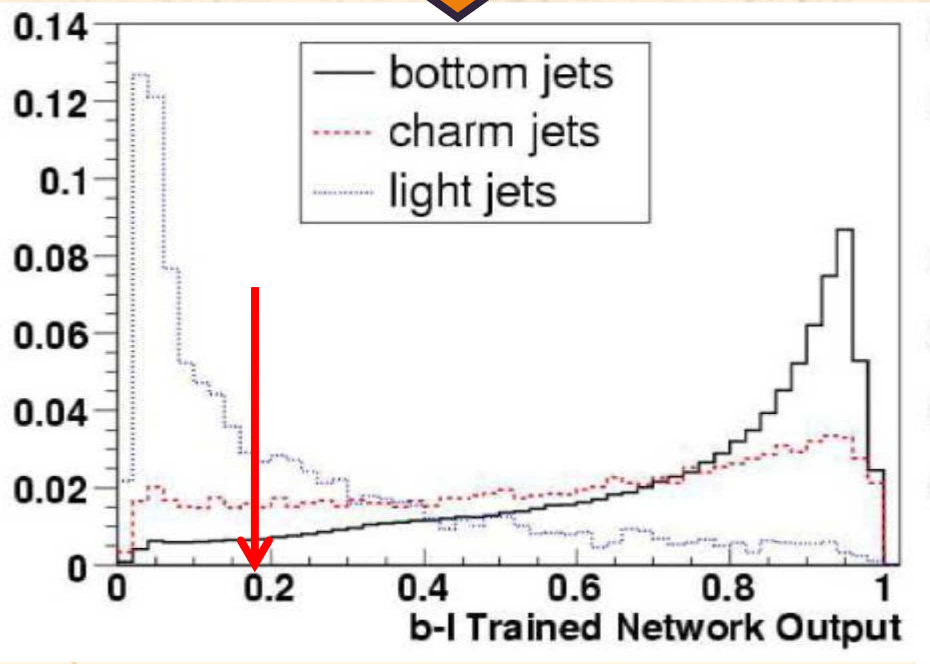
3. **Neural Network (NN) *b*-tagging**
   - ✓ Use 16 jet parameters (L_{xy}, N_{trk}, M_{vtx} …)
   - ✓ Optimize NNs to separate *b*-jet from *c*-jet and light-jet
   - ✓ Keep 90% *b*-jet, reject 65% light-jet, 50% *c*-jet (for SECVTX tagged jets)

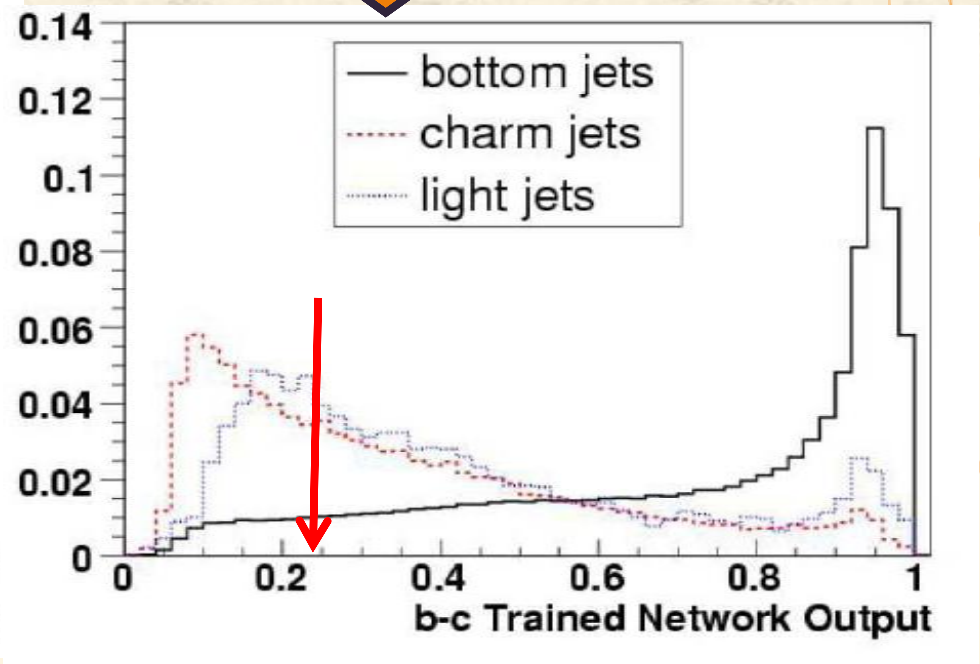


NN *b*-tagging performance

- Two neural network output selection are required

$NNout_{bl}$ > 0.182 $NNout_{bc}$ > 0.242

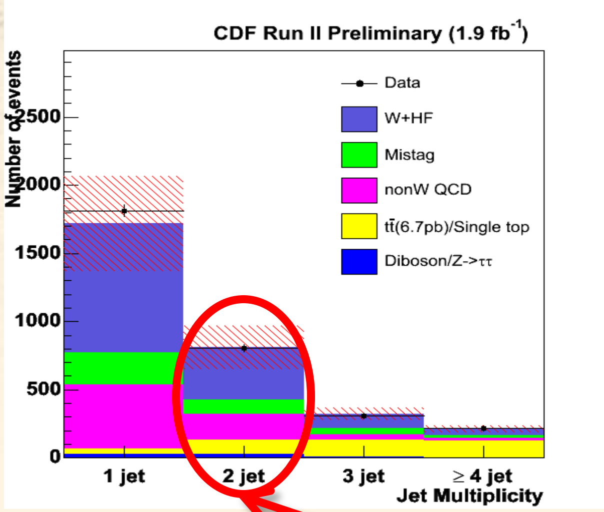




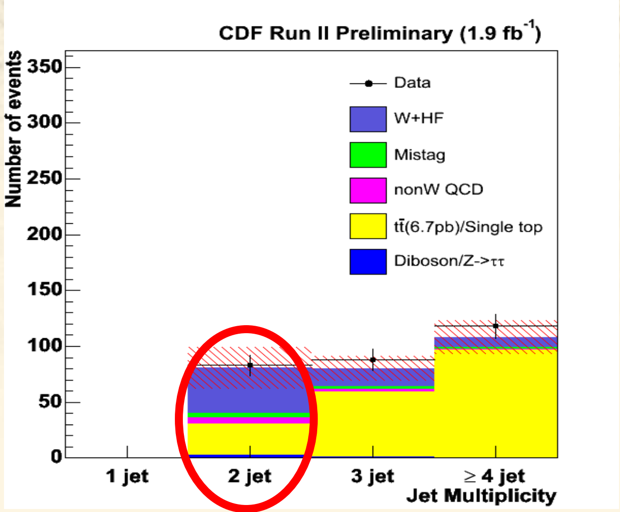
Keep 90% *b* jets after SECVTX *b*-tagging
Reject 65% light jets, 50% *c* jets

Background estimation

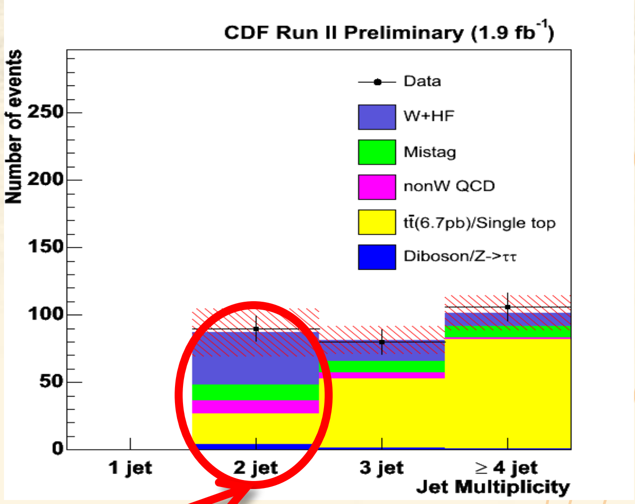
Single *b*-tagged events



Double *b*-tagged events (tight + tight)



Double *b*-tagged events (tight + loose)

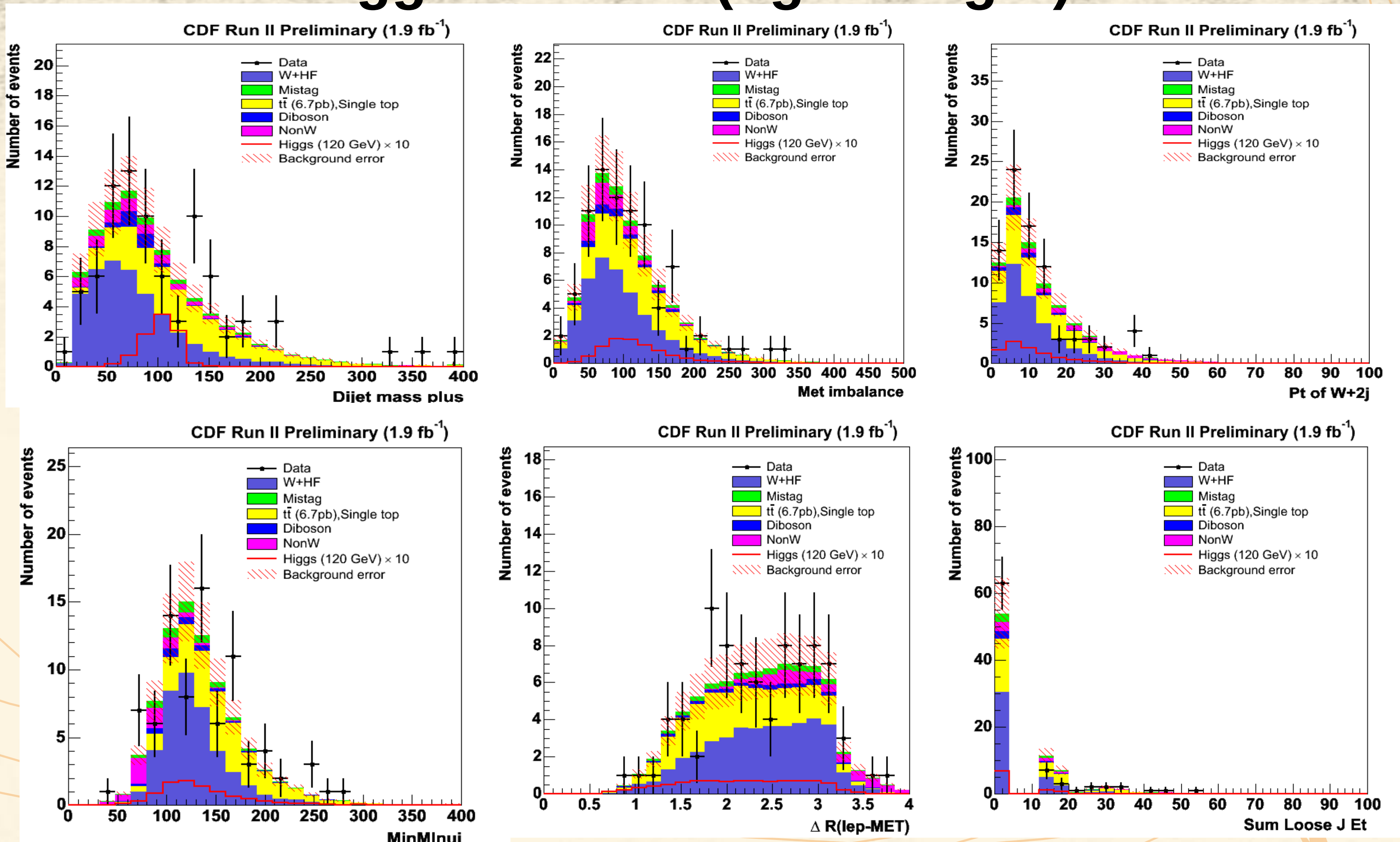


Signal Region (W + 2 jets evens)

- **1, 3 and 4 jets events are verified as a control region**

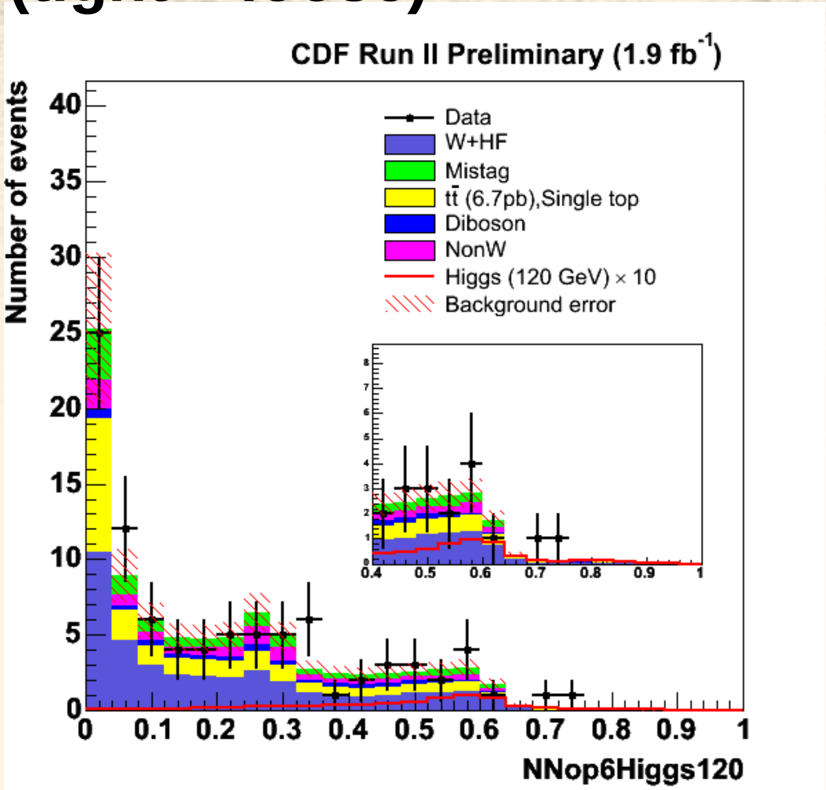
Neural Network Input variables

Double *b*-tagged events (tight + tight)



Neural Network output

Double *b*-tagged events (tight + loose)



Single *b*-tagged events