Search for the SM Higgs Boson with "$H \rightarrow \tau\tau$" Decay Mode at CDF

Simultaneous Search for

[WH + ZH + VBF + gg->H] → $\tau\tau$+2jets

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Joint Experimental-Theoretical Physics Seminar

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Fermilab

Outline

i. Introduction(Tevatron/CDF/Higgs)

ii. CDF Higgs Search Overview

iii. Motivation of $\tau\tau$+2jets Analysis

iv. Analysis

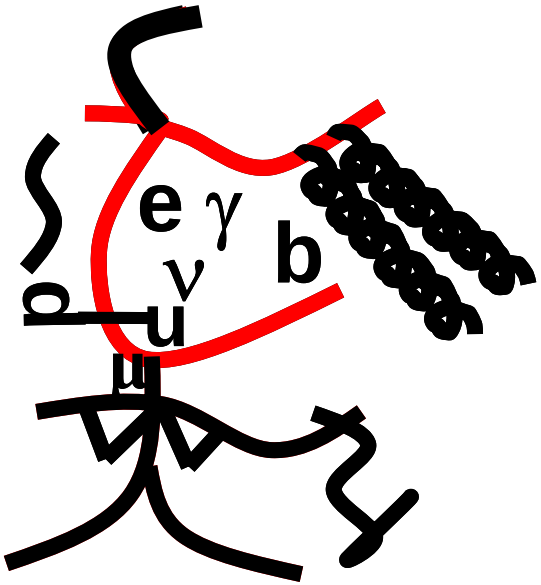
→ τ ID/Reconstruction
→ Event Selection
- Signal Expectation
- Background Estimate & Modeling
→ Neural Net Optimization

v. Results with 2fb^{-1}

← Mainly focus on this part !

vi. Combined Tevatron Limits

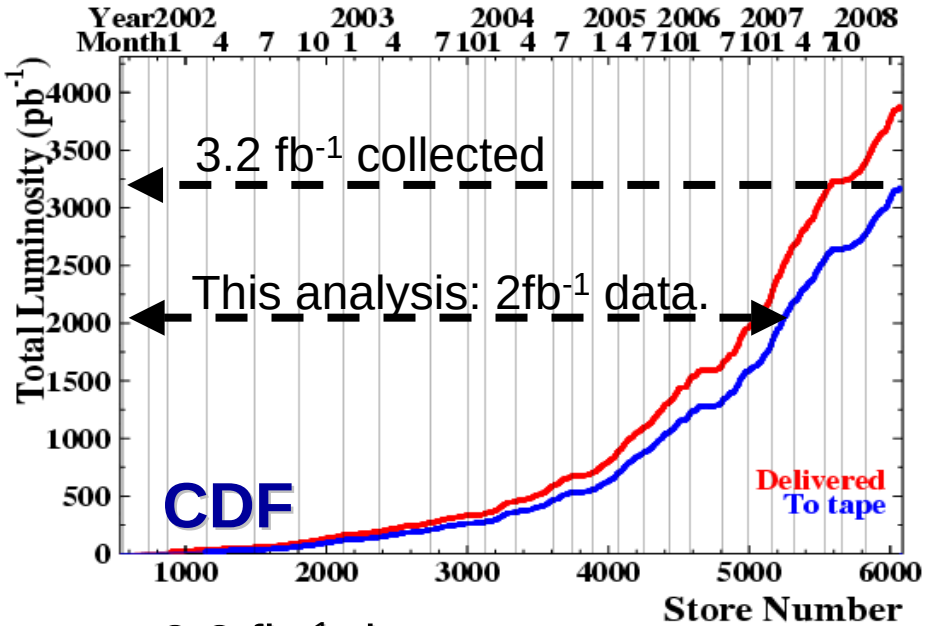
vii. Summary and Future



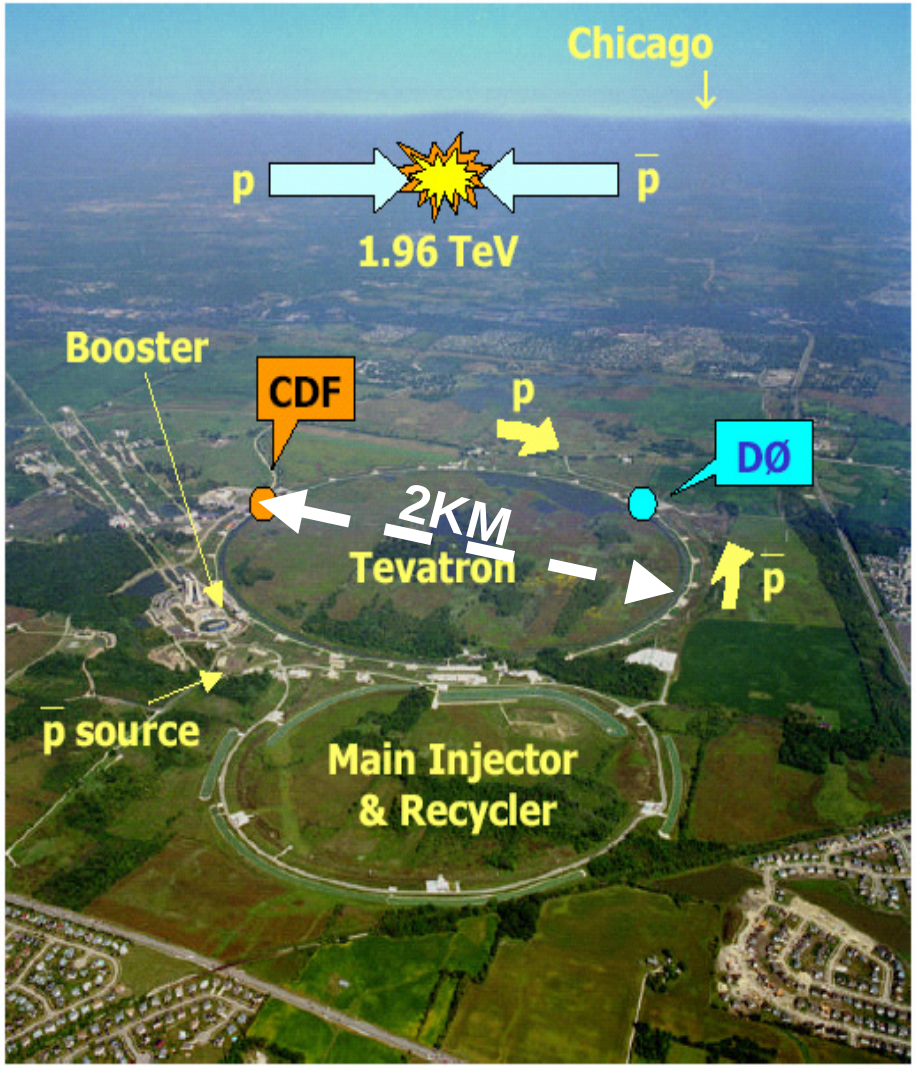
want to put "H" in there….

Tevatron Accelerator

- $p\bar{p}$ collisions at 1.96 TeV
  - Still the world's Highest Energy for next few months (!?)
- 36x36 @ 396 ns bunch crossing



- ~ 3.2 fb^{-1} data on tape.
- Initial instantaneous luminosity
  Record: 3.2 x10^{32}cm^{-2}s^{-1}
- ~ 6 fb^{-1} expected by end of 2009

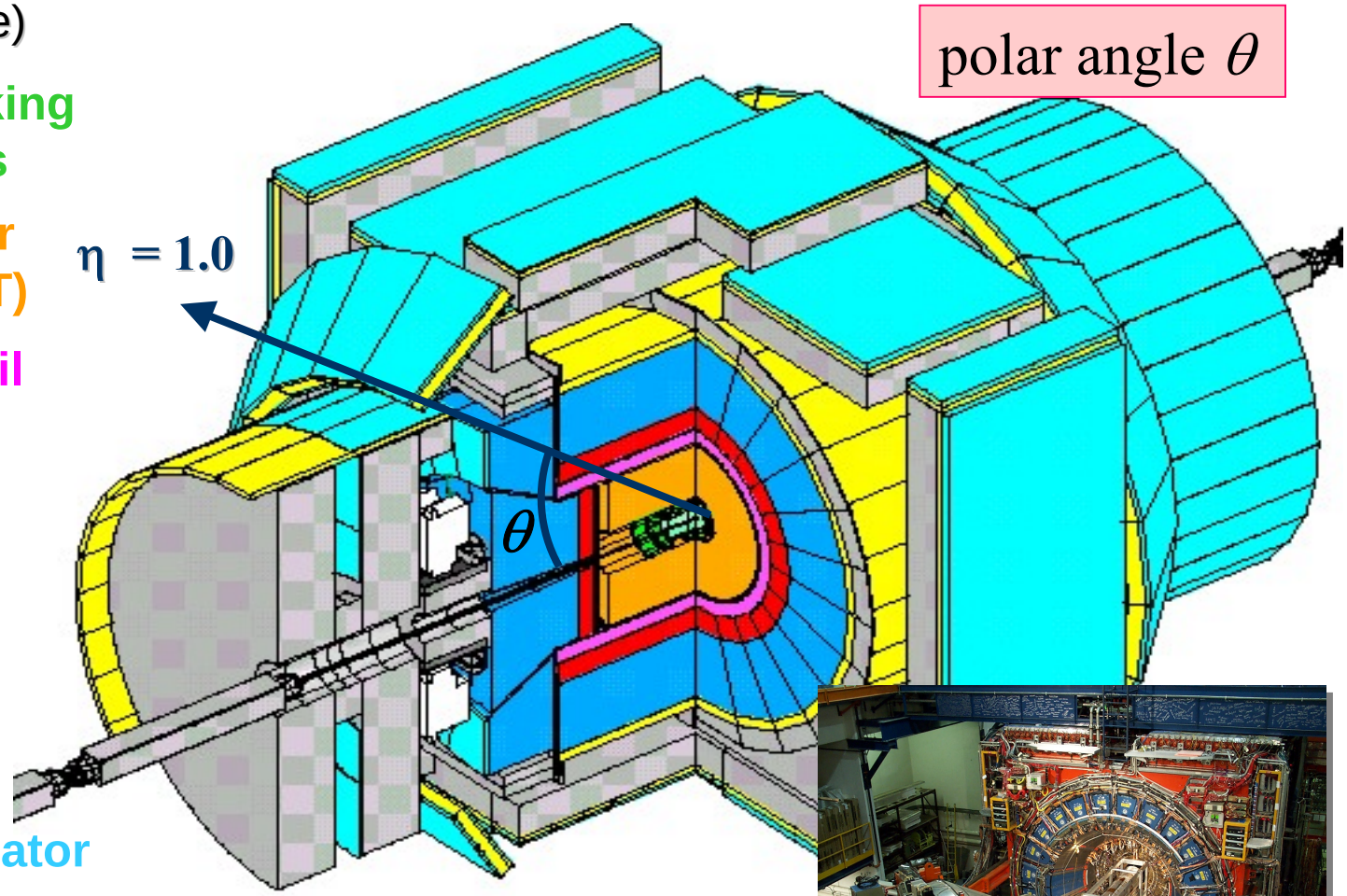


The CDF II Detector

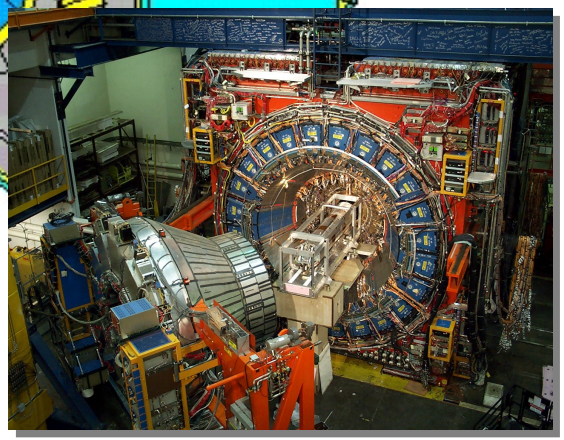
Innermost (Beam pipe)

- Silicon Tracking Detectors
- Central Outer Tracker (COT)
- Solenoid Coil
- EM Calorimeter
- Hadronic Calorimeter
- Muon Drift Chambers
- Muon Scintillator Counters
- Steel Shielding

Outermost

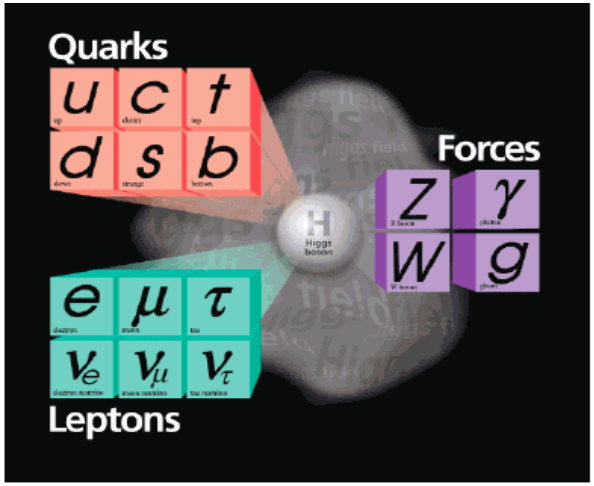


$$\eta = -\log(\tan(\theta/2))$$

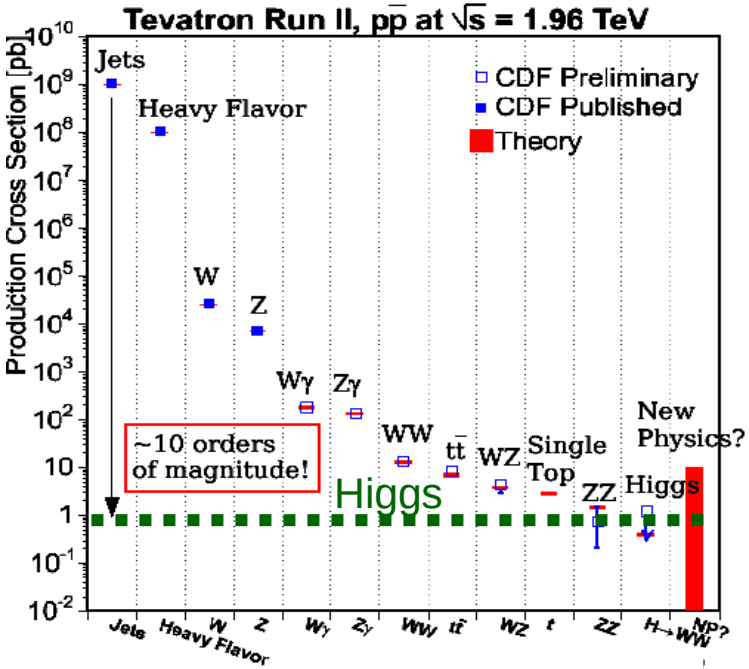


Standard Model Higgs Boson

- The Standard Model has been well tested against experimental data and so far provided great success in particle physics.
  - BUT one particle undiscovered yet.
    - -> "Higgs Boson" :
      - "Origin of Mass" for all fermions & W/Z bosons.
      - "Origin of Electroweak symmetry breaking".
      - Spin 0, Charge 0 (in the SM).



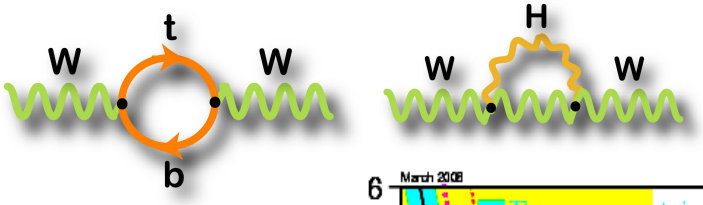
- Why so difficult to find Higgs ?
  - Small production cross section.
  - Large backgrounds (W/Z+jets, QCD fake etc).
  - The SM (by itself) does not predict the value of the Higgs boson mass directly. (possible through radiative corrections though)
  - We don't even know if it exists or not !



- Challenging but the most important task in High Energy Physics.

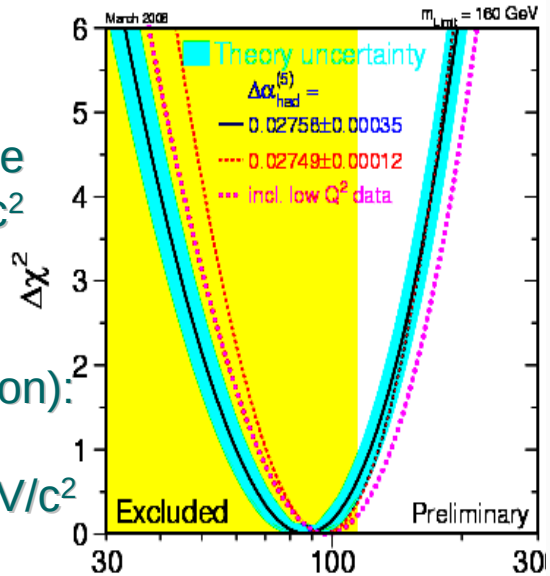
Higgs Mass Constraint

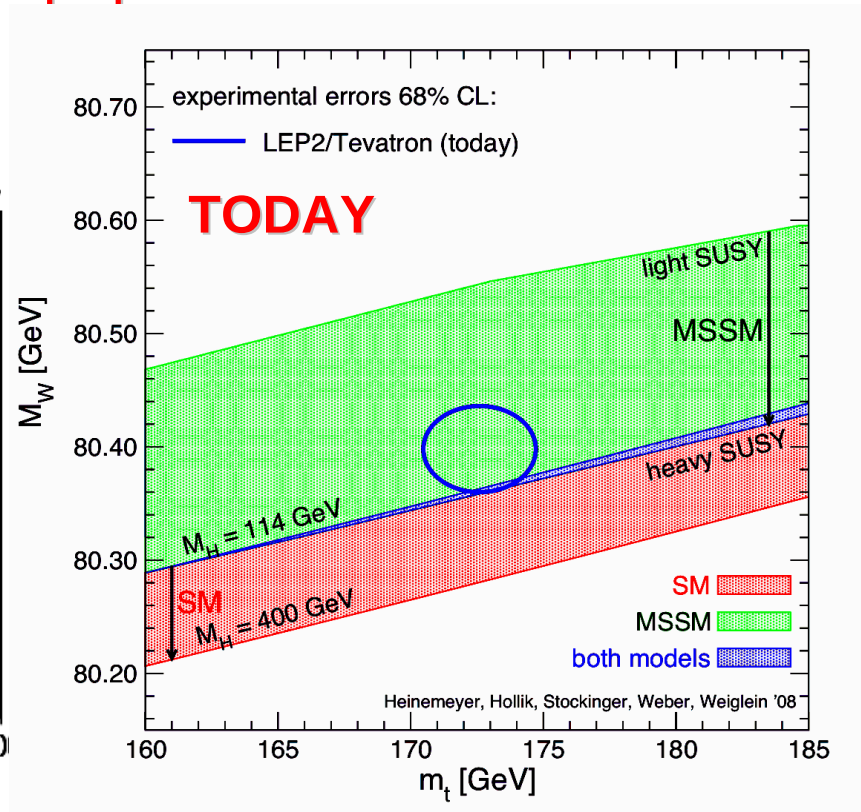
- Direct search @ LEP : Excludes M_H<114.4 GeV @ 95% C.L.
- Indirect Constraint : From electroweak global fit (via loop correction).
  → Precise measurements of W and top quark mass are crucial !



> Top Mass (Tevatron):
2008 Tevatron Average
M_{top}= 172.6±1.4 GeV/c^2
-> ~0.8% precision

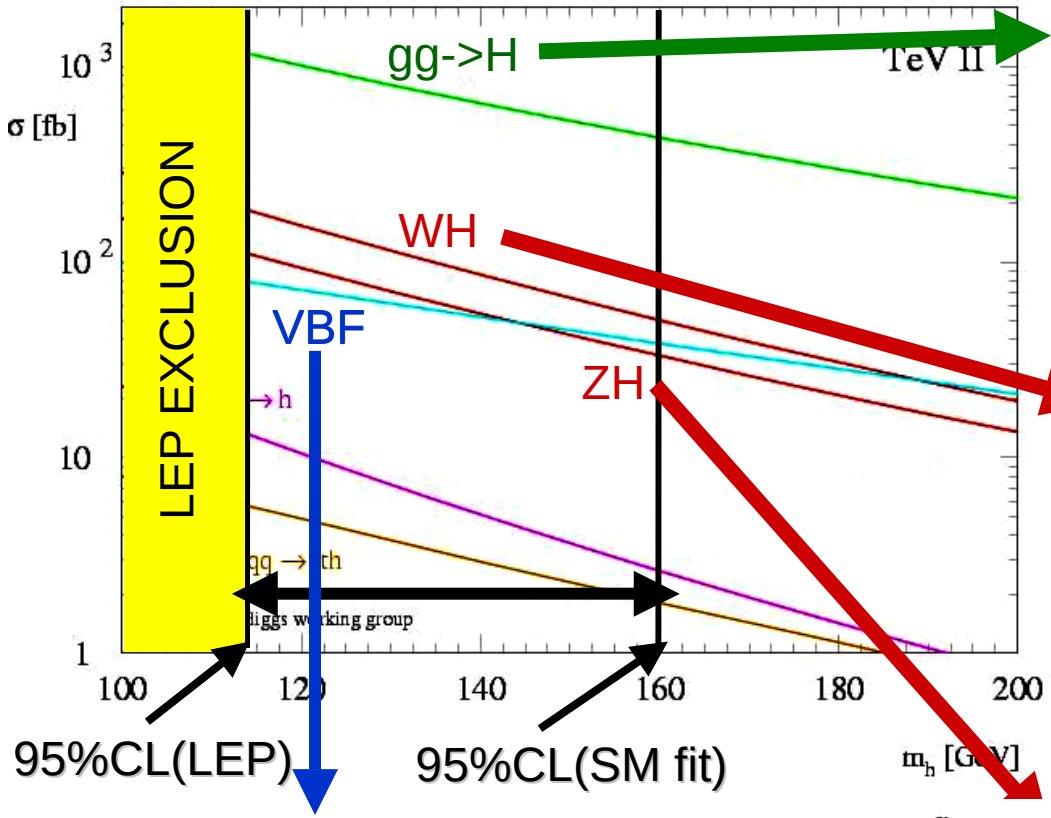
> W Mass (LEP2/Tevatron):
2008 World Average
M_W=80.398±0.025 GeV/c^2
-> ~0.03% precision !



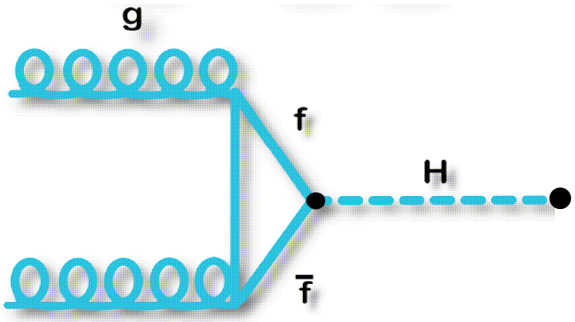


- The most probable value from SM global fit : $87 \pm^{36}_{27}$ GeV
  Upper bound (95% C.L) : < 160 GeV

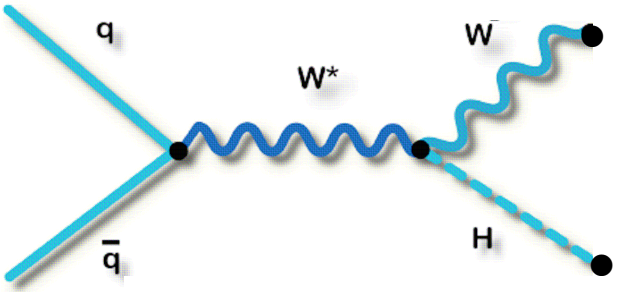
SM Higgs Production at Tevatron



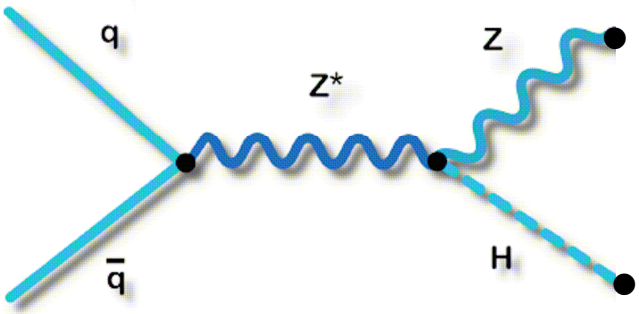
1) Gluon Fusion Production



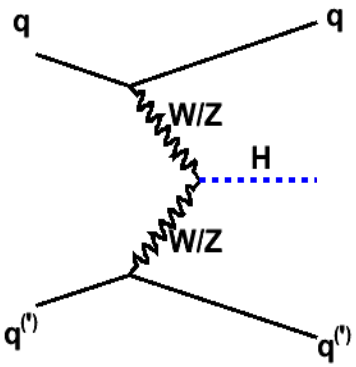
2) WH Associated Production



3) ZH Associated Production

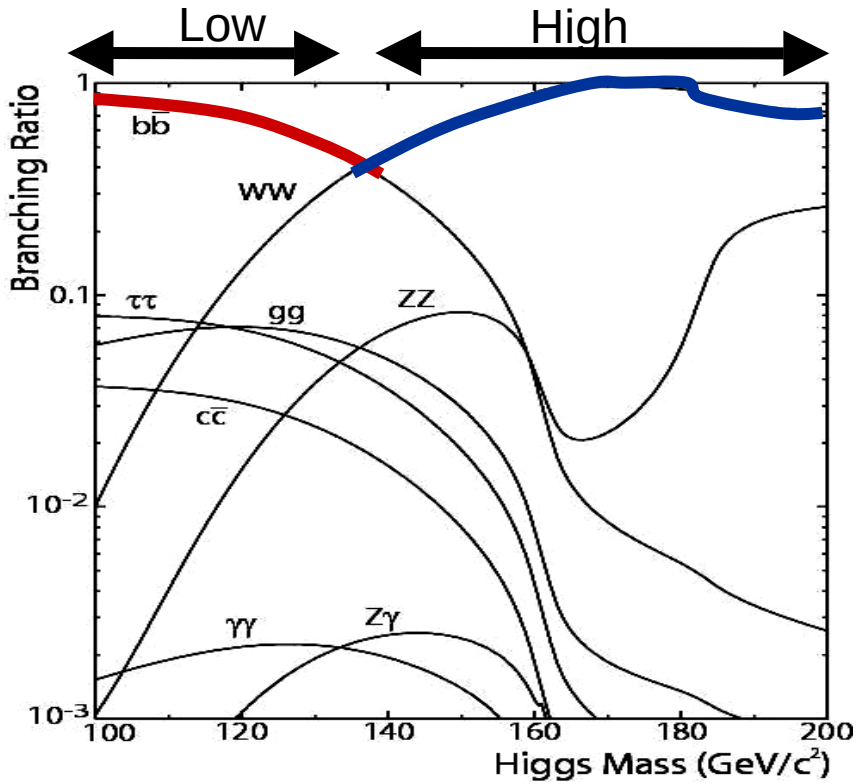


4) Vector Boson Fusion (VBF) Process



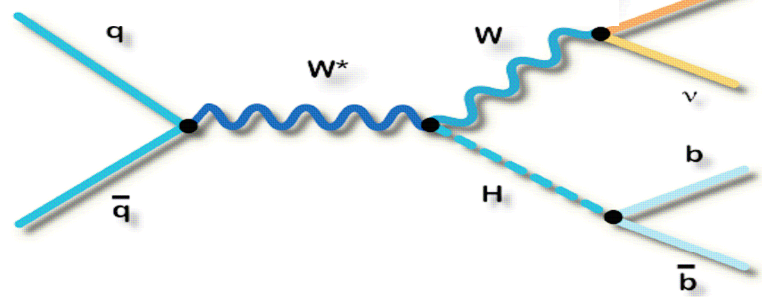
This analysis uses ALL processes !
→ Details later.

Higgs Decay & Final State (Low Mass)

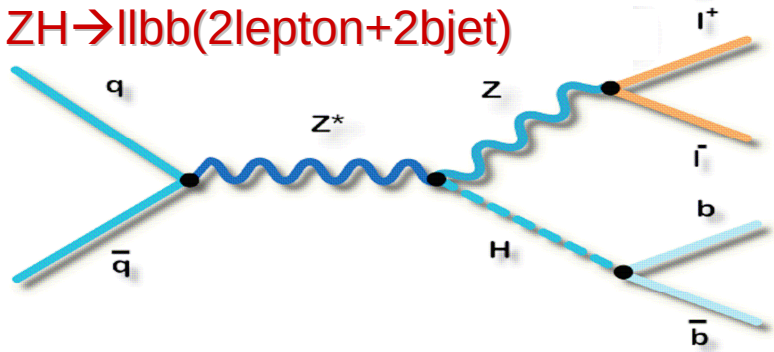


Low Mass Higgs at Tevatron

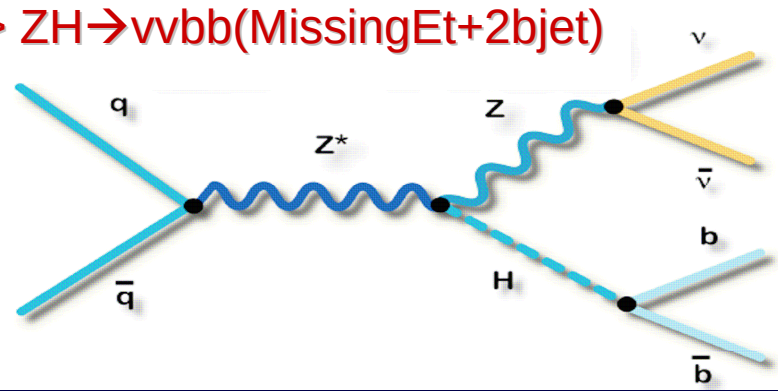
> WH→lνbb(Lepton+Met+2bjet)



> ZH→llbb(2lepton+2bjet)



> ZH→ννbb(MissingEt+2bjet)

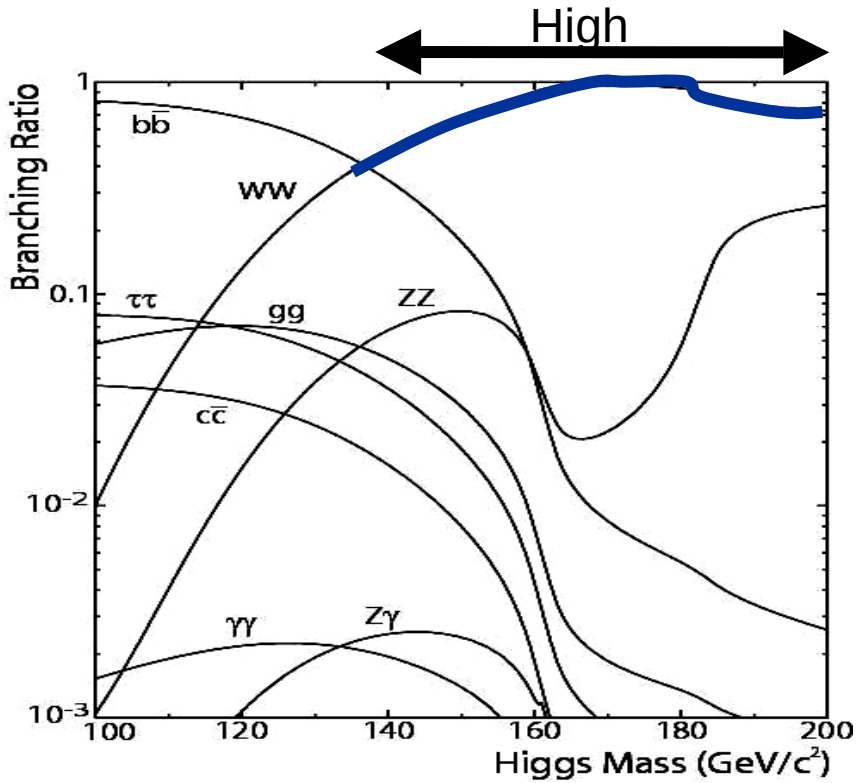


> $N^{sig} = \sigma^{prod} \times BR(H\rightarrow) \times BR(W/Z\rightarrow) \times \varepsilon \times L$

W →	lν	2jets
BR(%)	33%	67%

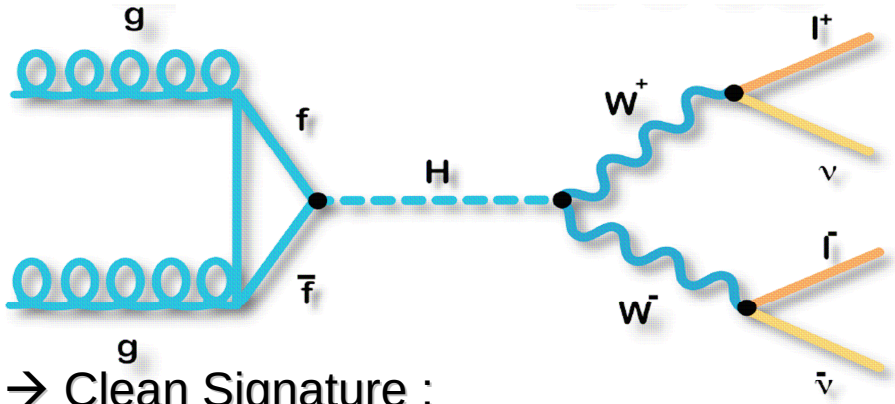
Z →	ll	νν	2jets
BR(%)	10%	20%	70%

Higgs Decay & Final State (High Mass)



High Mass Higgs at Tevatron

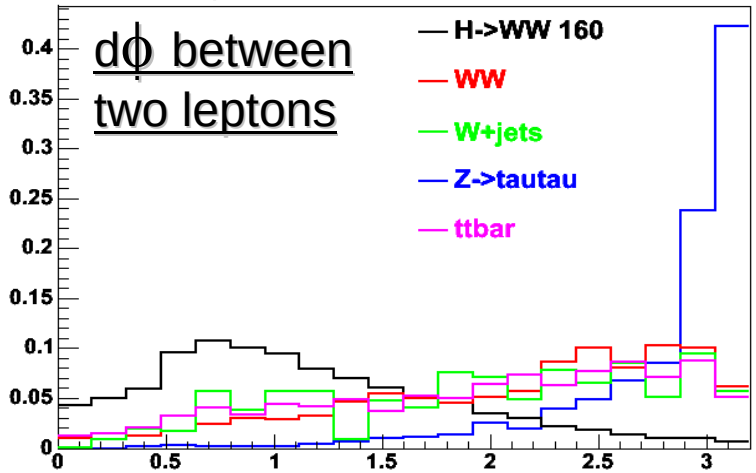
> Gluon Fusion Production



→ Clean Signature :

- "2 high-Pt Leptons+Large MissingEt"

& e.g. dϕ(lep,lep) is very powerful !



> $N^{sig} = \sigma^{prod} \times BR(H\rightarrow) \times BR(W\rightarrow) \times \varepsilon \times L$

W →	lν	2jets
BR(%)	33%	67%

Z →	ll	νν	2jets
BR(%)	10%	20%	70%

~1 Year Ago : When this analysis started

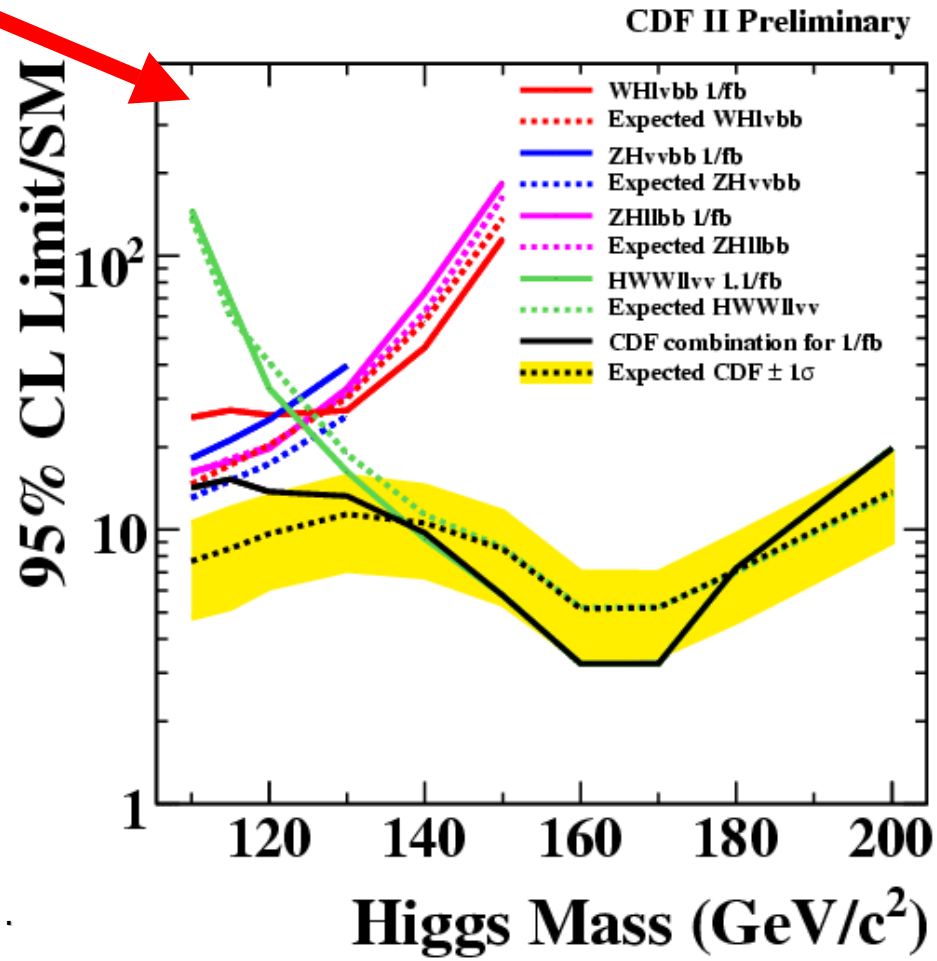
Very OLD !!! In 2006 (all with 1fb^{-1}) → The latest will be shown later in this talk.

- How to read the right plot ?
  - It is a 95% C.L upper limit divided by the SM prediction.
    → So if we reach 1 → that Higgs mass point is excluded !

Q. Trying to find or exclude the Higgs ?
Of course, trying to discover it.
In fact, this analysis was optimized to get the highest S/sqrt(B).
However, unless we find a strong smoking-gun in data, we should try to exclude it as soon as possible !
Either case, it opens new era.

- In each analysis, many hard works have been done to improve sensitivity.
  Extending lepton ID, Improving btagging quality using advanced technique , data driven bkg etc….

~100 people are heavily involved in and making enormous efforts to obtain even 5-10% improvement !!!



Here we need new ideas !
→This analysis is part of it

Ideas : "ττ" mode in SM Higgs Search

> Aim: Improve Low Mass Higgs search sensitivity.
- Looking at different decay mode (H→ττ) is very important in a physics sense.(all others use H→bb)
- Difficult due to smaller BR(10% compared to H→bb).

(M_H=115 GeV)

l: e or μ	σ x BR
WH→lνbb	28.7fb
ZH→ννbb	15.6fb
ZH→llbb	7.8fb

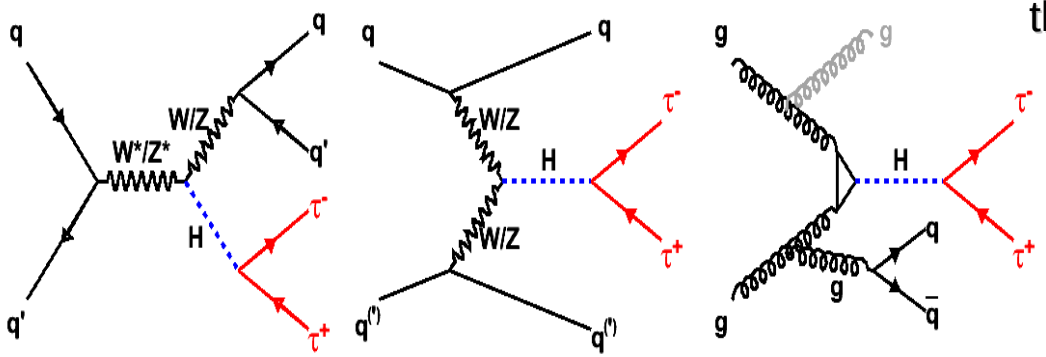
Process	Final State	σx BR (M_H=115)
WH→lνττ	Lepton+Met+2τ	4.3fb
WH→jjττ	2τ+2jet	8.8fb
ZH→llττ	2lepton+2τ	0.8fb
ZH→ννττ	Met+2τ	1.6fb
ZH→jjττ	2τ+2jet	5.5fb
VBF H→ττ	2τ+2jet	5.8fb
gg->H→ττ	2τ(+>=2jet)	83.2fb(~8fb)

WH+ZH+VBF+ggH→2τ+2jets
* Total σ x BR is ~ 28 fb !!!
- Comparable to existing analyses.

W →	lν	2jets
BR(%)	33%	67%

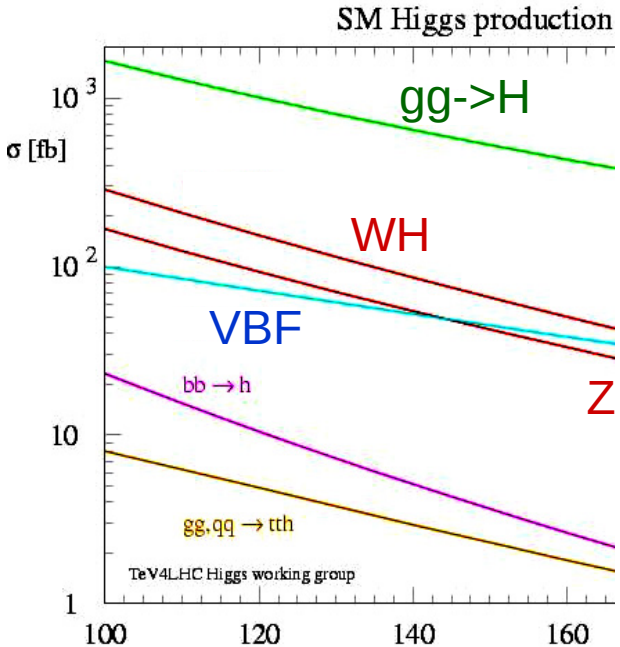
Z →	ll	νν	2jets
BR(%)	10%	20%	70%

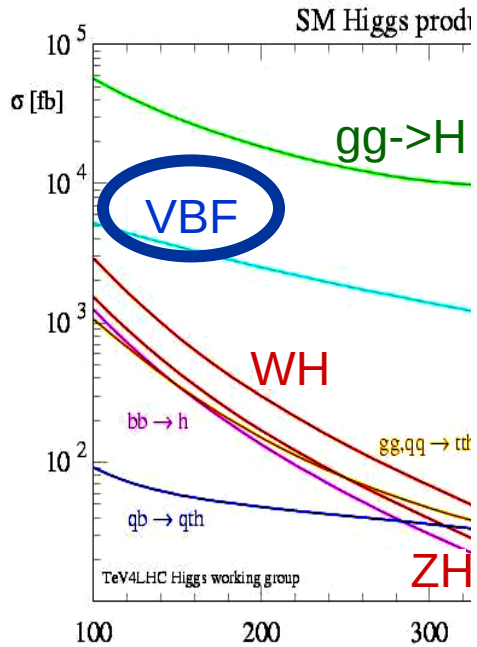
Of course tau decay, detection efficiency and backgrounds have to be taken into account, But with L=2fb^{-1}, "56 events" are produced at the collision if the Higgs is there !

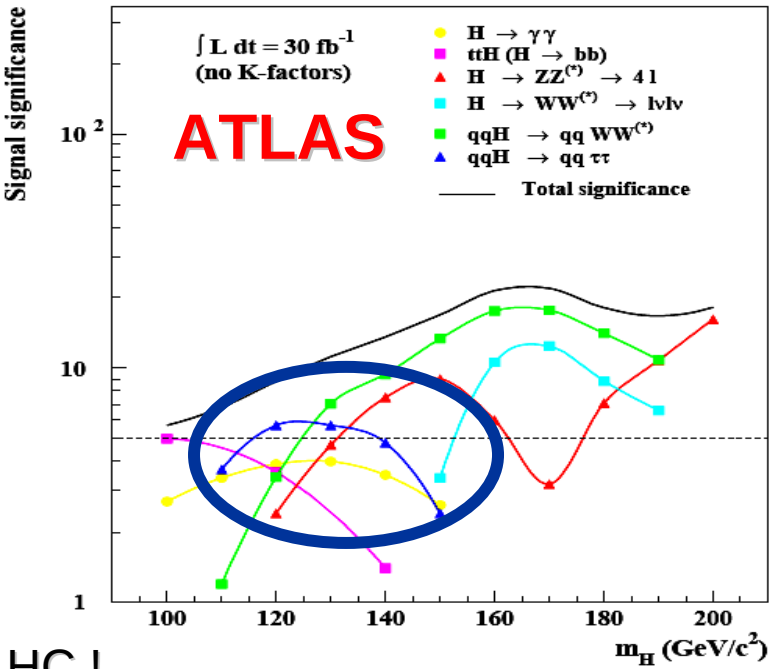


- Simultaneous search by adding "4 SM Higgs processes" is completely new !
- Dominant background is expected to be Z→ττ+jets that can be well handled. (w.r.t. normalization & shape).

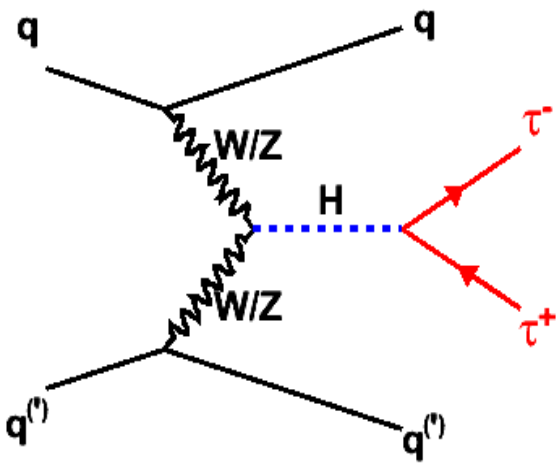
Another Motivation : TeV4LHC



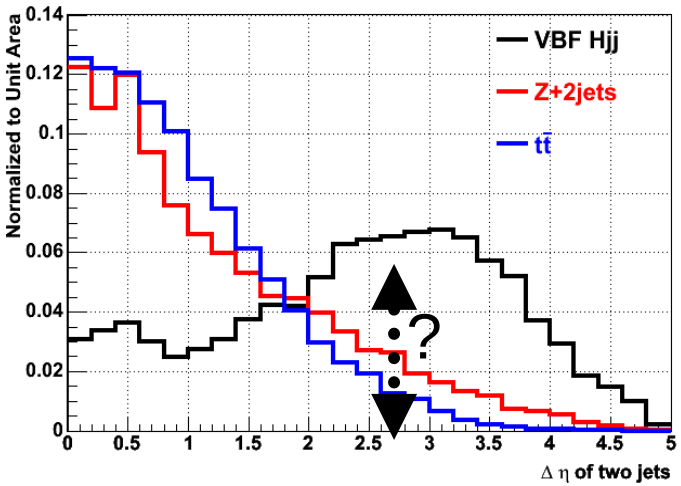




* VBF H→ττ+2jets plays a very important role in LHC !



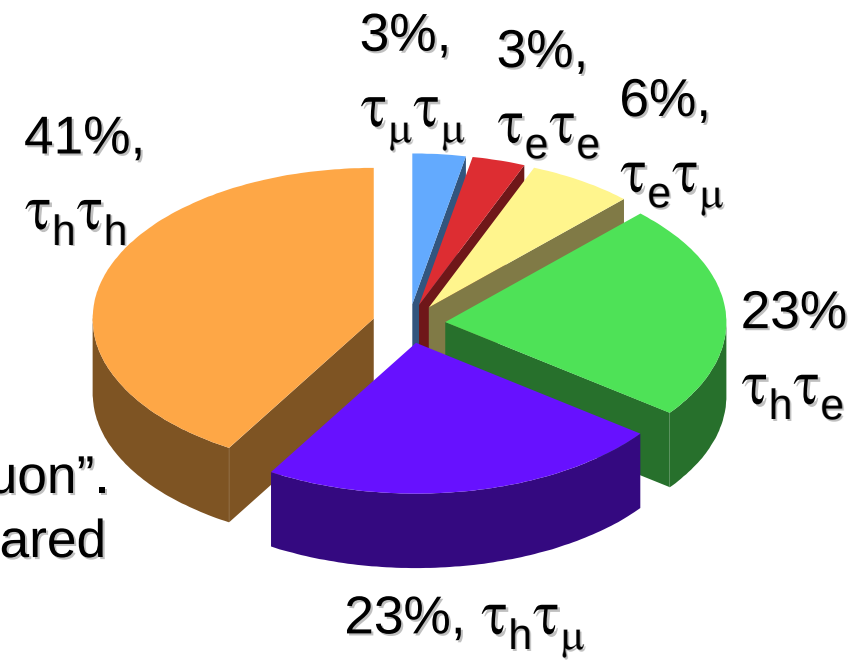
> Two very forward jets
- → Large rapidity gap between two jets.
- → Clean ττ signature in central region.
- → It would (might) be useful to look at this final state at Tevatron !



About Tau Lepton

- Heavy lepton : Mass = 1.78 GeV
- Short lived lepton
  - Mean lifetime: 291 ps ($c\tau$ =87 μm)
- Detection (Decay Mode) :
  - **Leptonic Decay : BR=~35%**
    - > $\tau^{\pm} \rightarrow e^{\pm} (\mu^{\pm})\nu_{e(\mu)}\nu_{\tau}$
      - → Look for isolated "electron" or "muon".
        - → But Pt is relatively small compared to ones from W or Z decay.
  - **Hadronic Decay : BR=~65% (~40% associated with π^0)**
    - > "1prong" (50%): $\tau^{\pm} \rightarrow \nu_{\tau} + h^{\pm} + n(\pi^0)$
    - > "3prong" (15%): $\tau^{\pm} \rightarrow \nu_{\tau} + h^{\pm}h^{\mp}h^{\pm} + n(\pi^0)$

← It is just a narrow jet with low track multiplicity (1 or 3 tracks). so the "key" is track and π^0 reconstructions.



- In case of 2 τ's (this analysis):

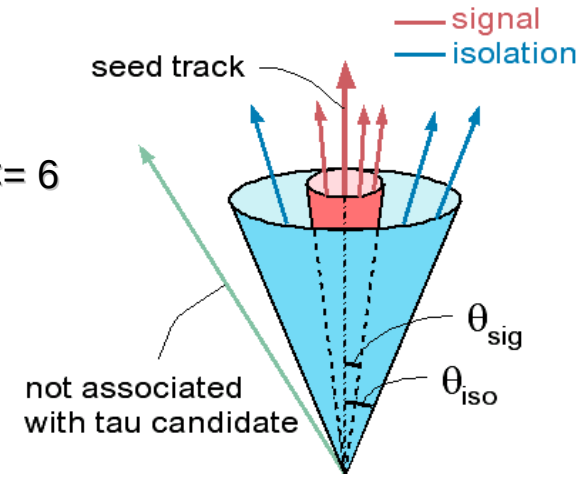
$\tau_{lep}\tau_{lep}$: BR=12% (Small but feasible with eμ)

$\tau_{lep}\tau_{had}$: BR=46% → "Used in this study" (Golden Mode in this channel)

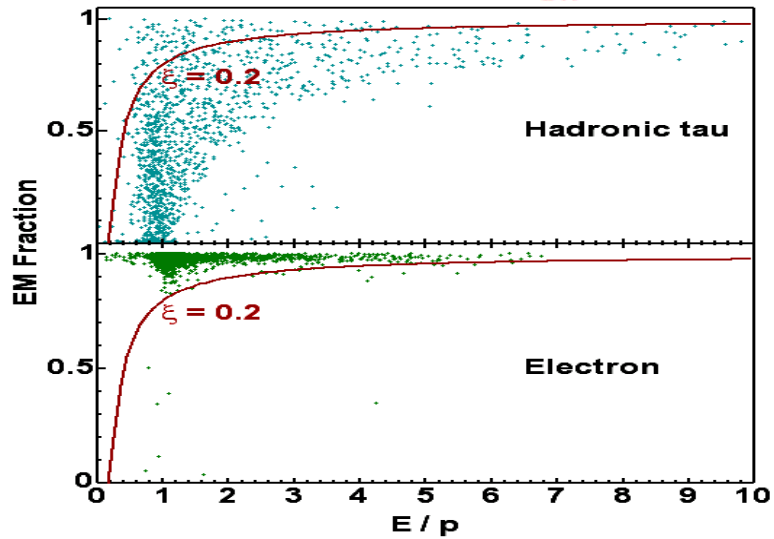
$\tau_{had}\tau_{had}$: BR=41% (Large QCD background)

τ_{had} Identification at CDF

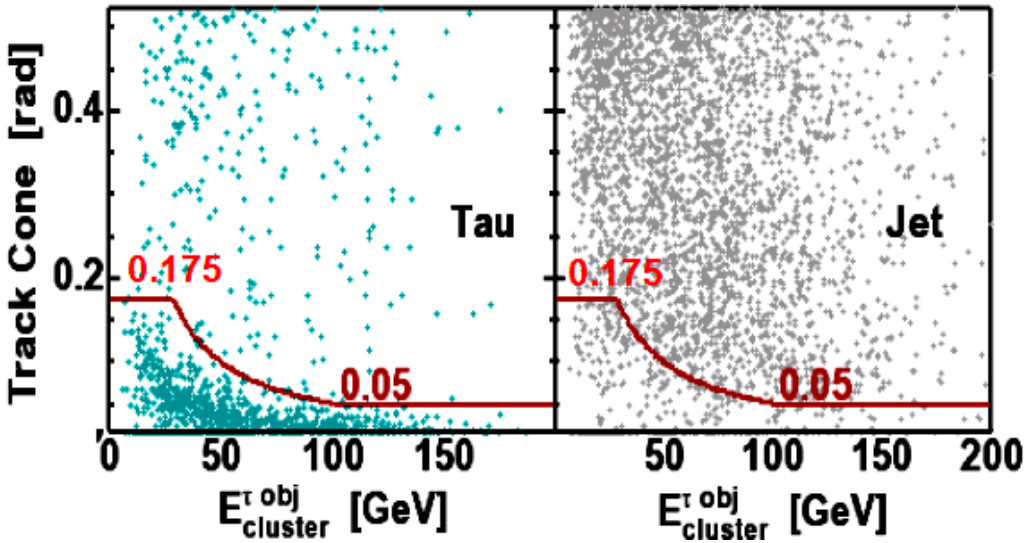
- Basic Selection Cuts
  Et(seedtwr) > 6.0
  Et(sh-twr) > 1.0 -> N(twr) <= 6
  Pt(seedtrk) > 6.0,
  Pt(sh-trk) > 1.0
  Et(pi0) > 0.5
  Cluster |detector eta|<1.0



- Electron Removal by
  ξ: Had Energy / Σp_{trk} > 0.2



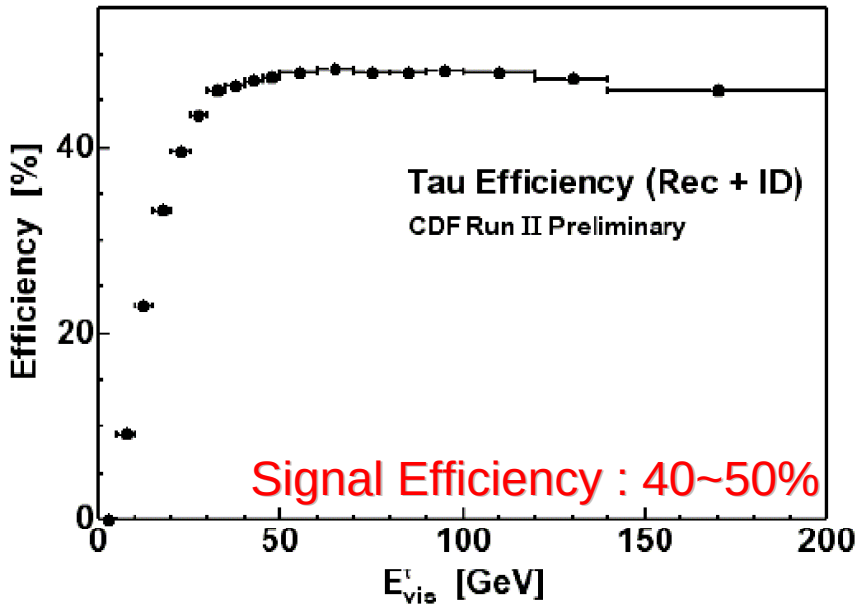
- Signal Cone Definition:
  - Using Energy Dependent Shrinking Signal Cone

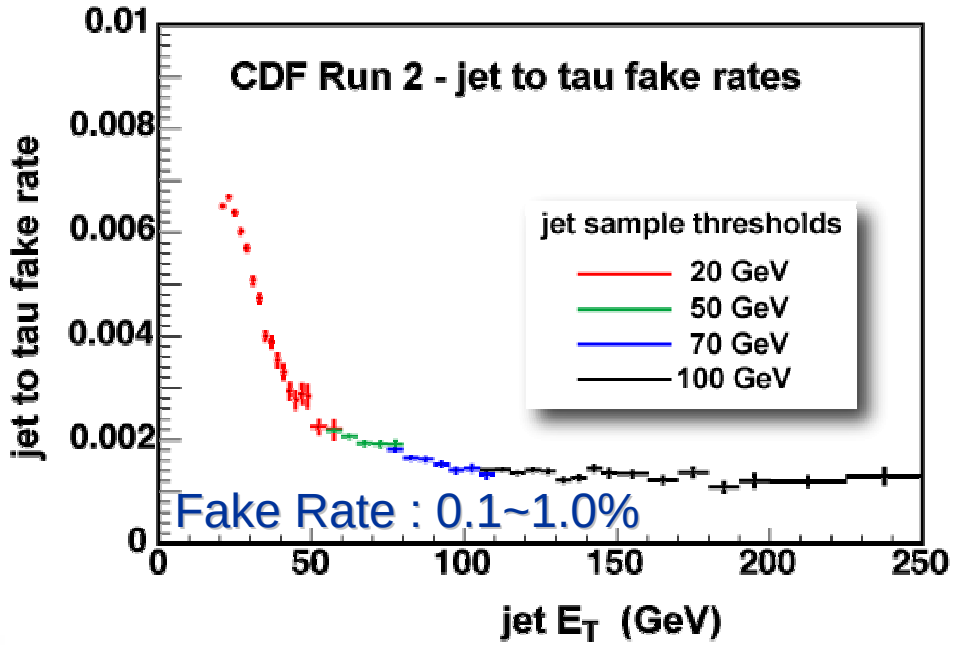


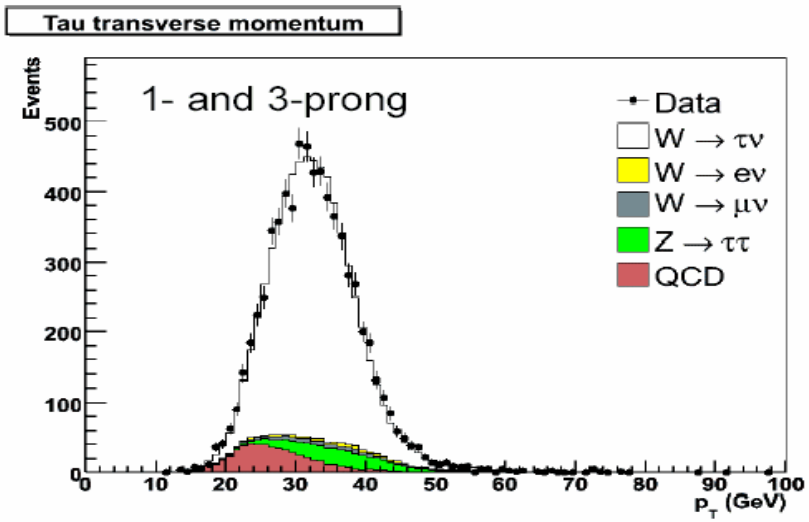
N of track in signal cone	==1 or 3
N of track in isolation cone	== 0
N of π^0 in isolation cone	== 0
Calorimeter Iso.	<0.1
Visible τ Mass	<1.8 GeV
Visible τ Pt	>15 GeV

- Visible τ = Sum of tracks and π^0 candidates in signal cone.

τ_{had} Reconstruction Quality







> About the same quality as btagging

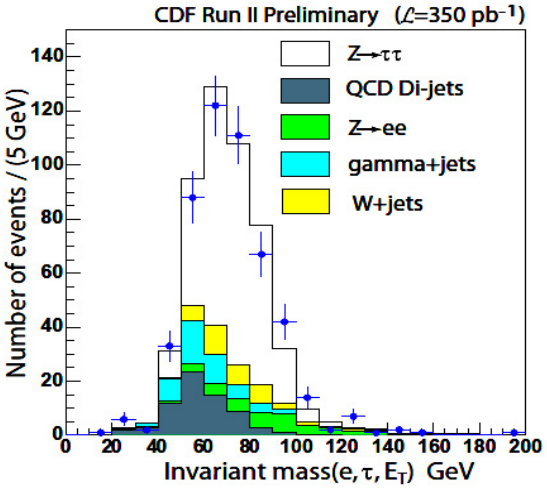
←Comparing visible τ Pt in W→$\tau\nu$ sample.

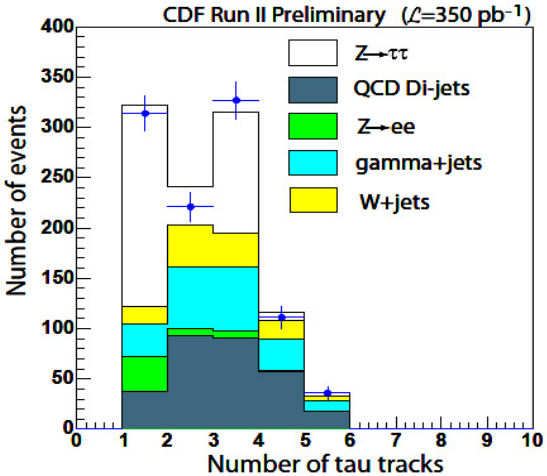
- Energy Scale between data and MC is consistent within 1% → Great modeling !

ττ mode is well established at CDF !

■ Z→ττ Measurement

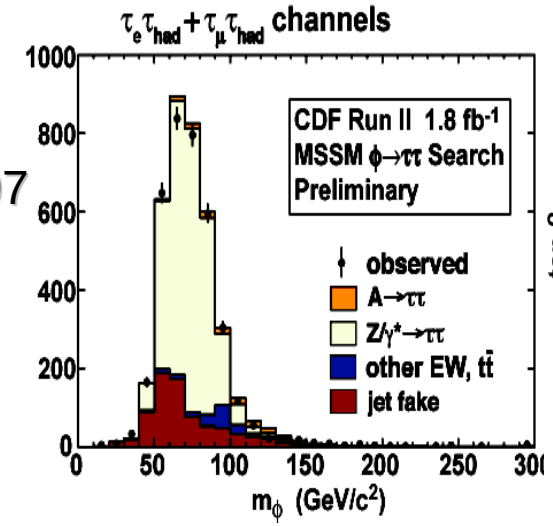
σ(Z→ττ) = 263±23(stat.)±21(syst.)pb
σ(theory) = 251±5pb
* PRD75 092004 (2007)

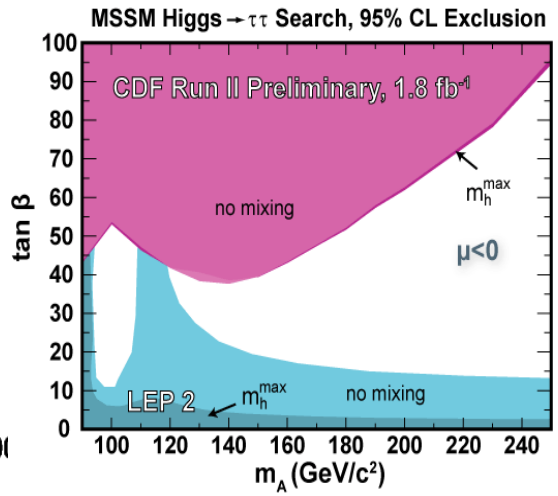




■ MSSM H→ττ analysis

- W&C by A. Anastassov, Feb.2007
* PRL96 011802 (2006)





→ Tau Object has been well validated and widely used for various physics case.
So it is time to use and optimize ττ mode for SM Higgs Search specifically !

Analysis Roadmap

Blind Analysis

→ Ideas, yes you need ideas !
→ Basic feasibility studies
  → Generate Signal MC.
    32 samples(this analysis)
    → 13M events in total !
  → How many signal events ?

→ What kinds of Background ?
  - How to estimate ?
  - How to model ?
    - MC or data driven ?
  - can be well handled ?

→ What trigger ?
→ Trigger Efficiency
→ Data/MC Scale Factors
→ All Calibrations OK ?

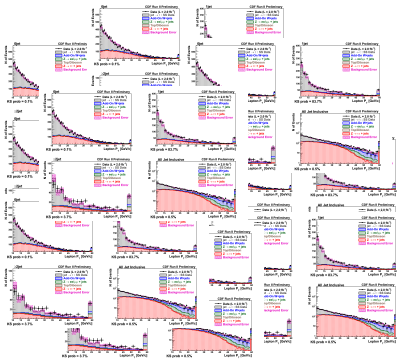
Higgs Signal MC | **SM Backgrounds** | **Real Data**

→ Determine event selection criteria.
  → Basic Particle ID works well ? Is it good enough ?
  → Optimize cuts (hard cuts) or keep events as many as possible ?

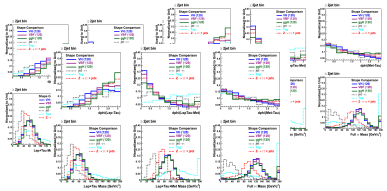
Event Selection

→ Careful Comparisons of Data and Prediction (in Control Regions)
  → Check Estimation and Kinematics Shapes
    → Ask if we understand data very well.
      → Determine Final Analysis Strategy
        → Counting ? 1D variable Fit ? or….

Source	Model	$e/\mu+\tau_h+0$jet	$e/\mu+\tau_h+1$jet	$e/\mu+\tau_h+\geq 2$jet	Grand Total
$Z\to\tau\tau+$jets	ALPGEN	2746.8±290.7	465.1±108.3	99.1±25.9	3310.9±304.8
$Z\to ll+$jets	ALPGEN	216.9±23.0	48.3±7.8	11.7±2.2	276.8±32.2
tt	PYTHIA	0.10±0.02	2.2±0.4	16.9±2.7	19.3±3.0
Diboson	PYTHIA	21.9±3.0	7.6±1.1	4.6±0.8	34.0±4.8
jet $\to\tau_{had}$	SS data	3289±57.2	876±29.6	220±14.8	4365±66.1
Add-on $W+$jets	ALPGEN	414.9±61.7	90.6±14.9	21.5±3.2	526.1±70.6
Total Background		6669.6±290.8	1498.8±116.8	373.8±32.4	8542.1±422.8
		Control Region	Control Region	Signal Region	-
Observed ($2\ fb^{-1}$)		6653	1571	410	8634



Multivariate Technique (NN,ME,LH,BDT etc)



→ Analysis Optimization
  → Estimate Systematic Uncertainty
    → Evaluate the expected sensitivity

Open the Box !

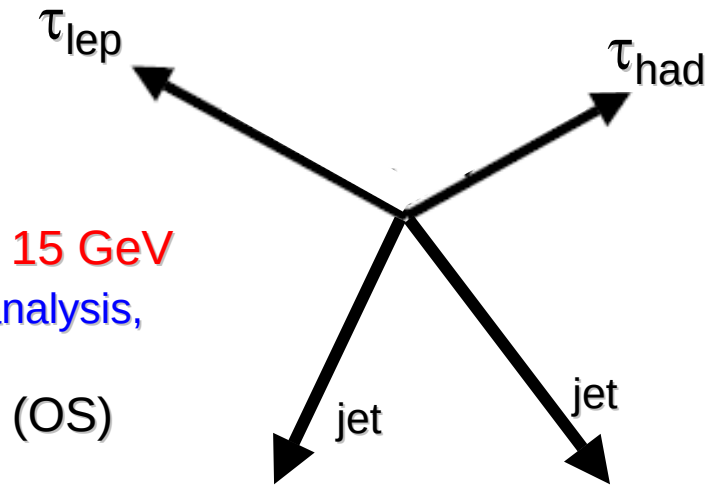
Results : Set the limits (or claim discovery ?)

Check the results
→ All bkg are as expected ?
→ Any unexpected behavior ?

Event Selection & Signal Expectation

- **Luminosity : 2fb^{-1}**

- **Event Selection :**
  1. == 1 Central Lepton with Pt > 10 GeV
  2. == 1 tight Hadronic Tau with visible Pt > 15 GeV
     → CDF has dedicated trigger for Z(or H)→ττ analysis, called 'lepton+track' trigger !
  3. Lepton and Tau has to be Opposite Sign (OS)
  4. >=2jets with Et > 15 GeV and $|\eta| < 2.5$



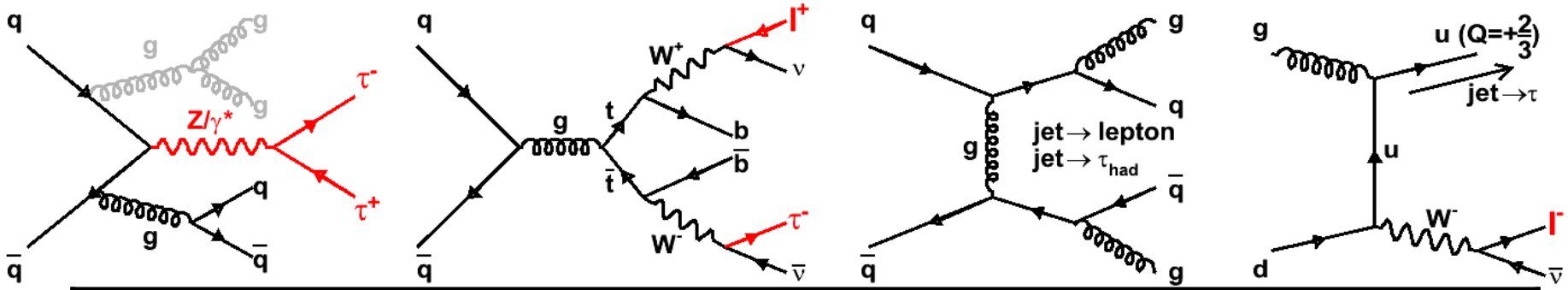
- **Signal Yield: M_H = 120 GeV**

$2fb^{-1}$	0jet	1jet	≥2jet	Total
WH(120)	0.0019±0.0003	0.04±0.001	0.176±0.003	0.22±0.003
ZH(120)	0.0011±0.0002	0.02±0.001	0.114±0.002	0.14±0.002
VBF(120)	0.0086±0.0005	0.05±0.001	0.122±0.002	0.19±0.002
ggH(120)	1.29±0.01	0.64±0.010	0.259±0.006	2.19±0.020
Total	1.31±0.01	0.75±0.010	0.672±0.007	2.73±0.021

- **Reference Numbers :**

  WH→lvbb(120@1.9/fb):
  → 2 btags: Signal 1.7 ev | Background 170 ev
  → 1 btag : Signal 1.8 ev | Background 800 ev

Backgrounds in $\tau_{lep}\tau_{had}$+2jets

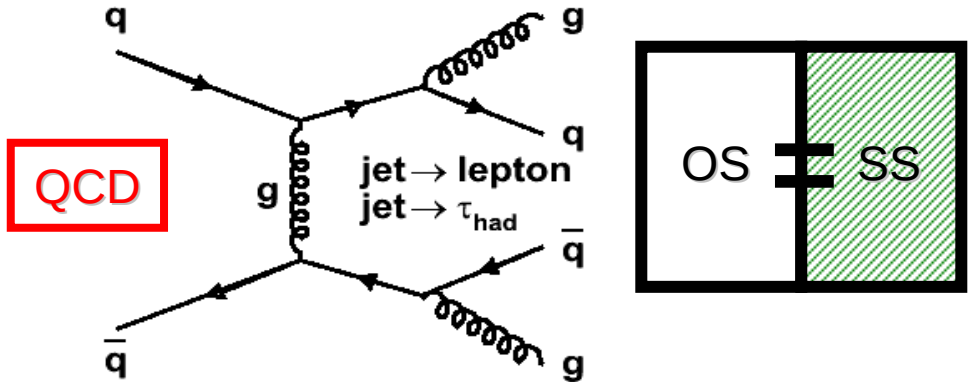


Source	Estimate	Shape	Comments
Z→ττ+jets	MC	MC	ALPGEN: K-factor(NLO)=1.4
Z→ee/μμ+jets	MC	MC	ALPGEN: K-factor(NLO)=1.4
ttbar	MC	MC	PYTHIA: Top Mass = 175GeV (6.7pb)
Diboson	MC	MC	PYTHIA: (WW/WZ/ZZ)
Jet→τ fake - QCD Multijets - γ+jets - W+jets (SS) - Low Mass Z	SS data	SS data	→ Very complicated and hard to model. - Can not use MC !. → Directory use "SS data", some small corrections have to be made for Z+jets and W+jets. - Details will be described later.
Additional W+jets ($=N_{OS}-N_{SS}$)	Data	MC	Need to estimate K-factor & N_{OS}/N_{SS} ratio in Data. → Details later.

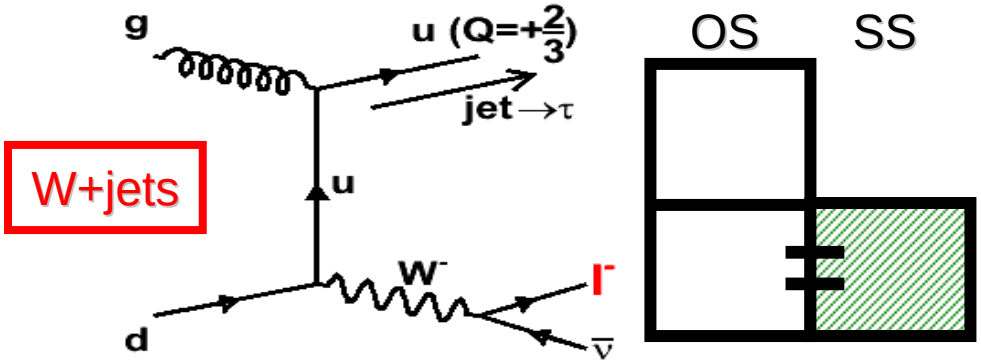
Using Same Sign Data for jet→τ_{had}

- In order to use SS data directly to model jet→ τ_{had} backgrounds, We made some assumptions first.
  → 3 issues to be addressed :

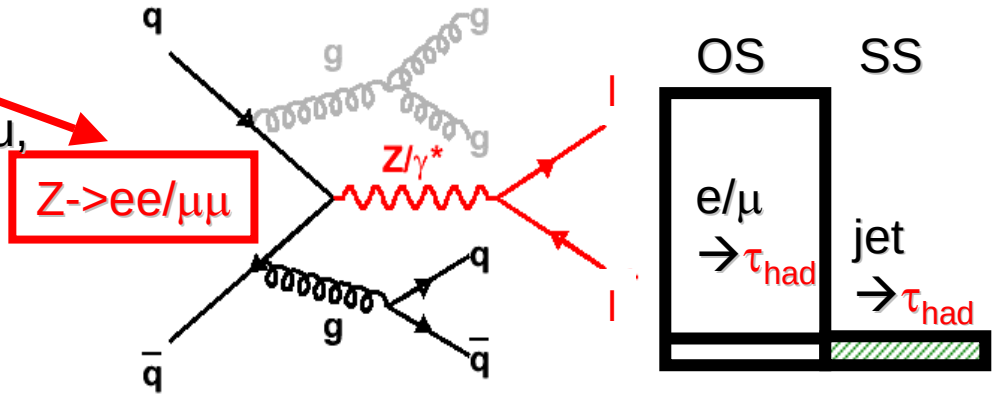
1. Check if QCD SS=OS.



2. Asymmetry in W+jets event due to charge correlation between W and outgoing quark.
   → Typically $N_{OS} > N_{SS}$
   > Need to know N of OS-SS event and add extra contribution to OS.

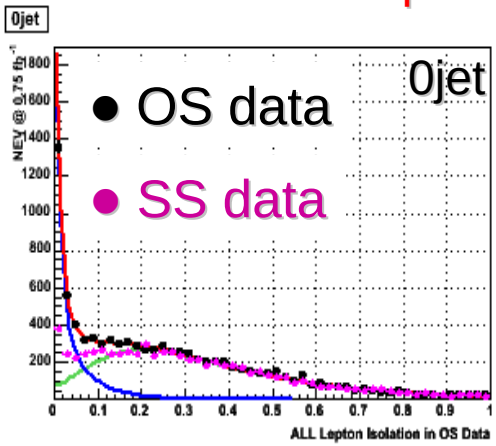


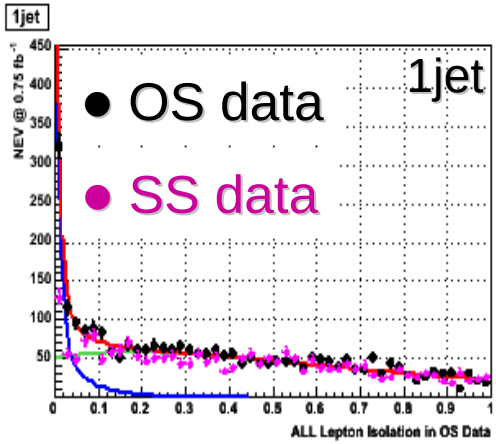
3. In DY events, if e/μ→tau 100% OS. But if one lepton is missed and jet→tau, there is an overlap between SS data and OS MC.
   -> Need to avoid double counting in MC estimate.

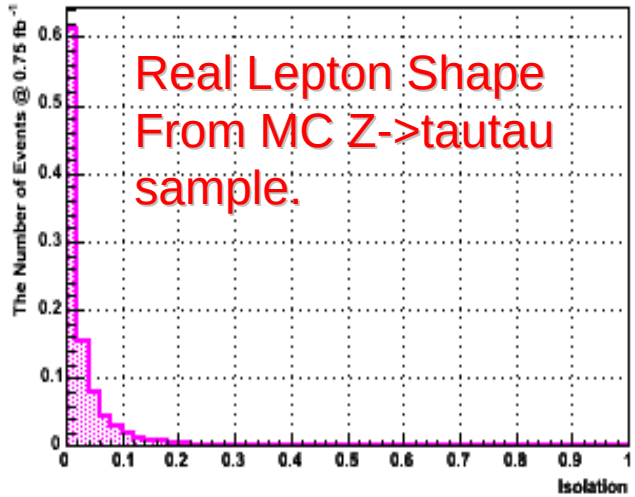


Check of QCD Events (OS=SS ?)

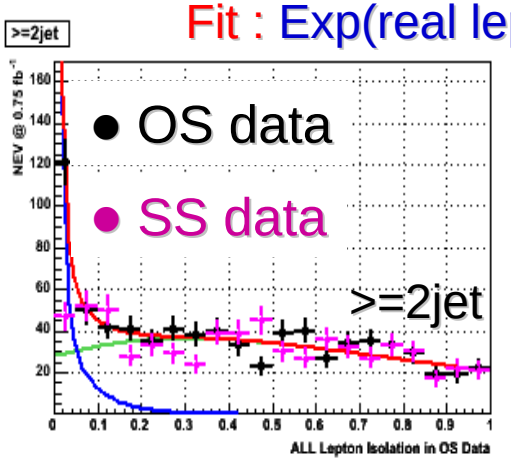
> Lepton Isolation is a nice variable to check QCD rate.

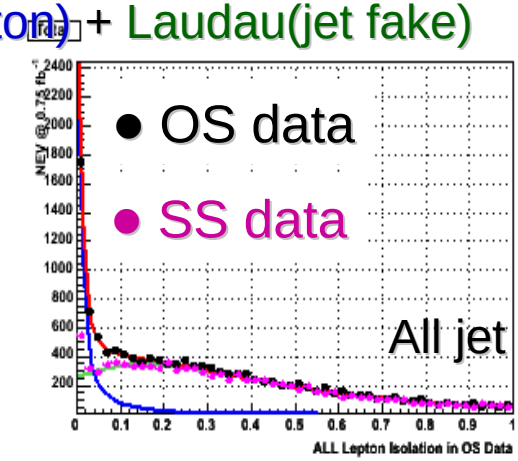


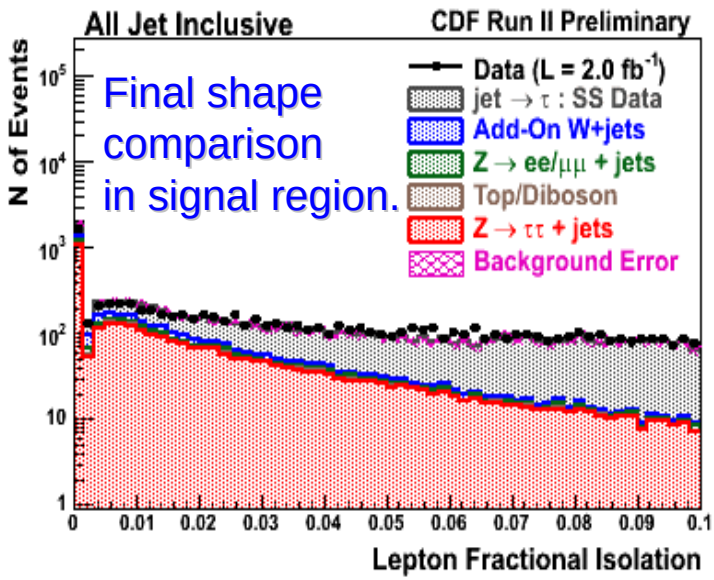




Fit : Exp(real lepton) + Laudau(jet fake)





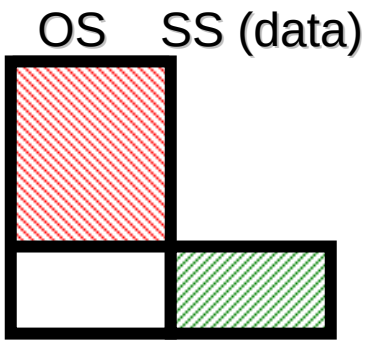


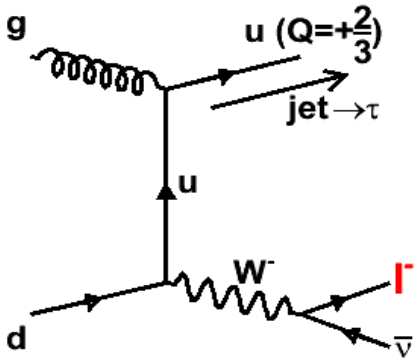
> Expected N of events from the fit (Exp+Landau) are consistent between OS and SS within uncertainties.

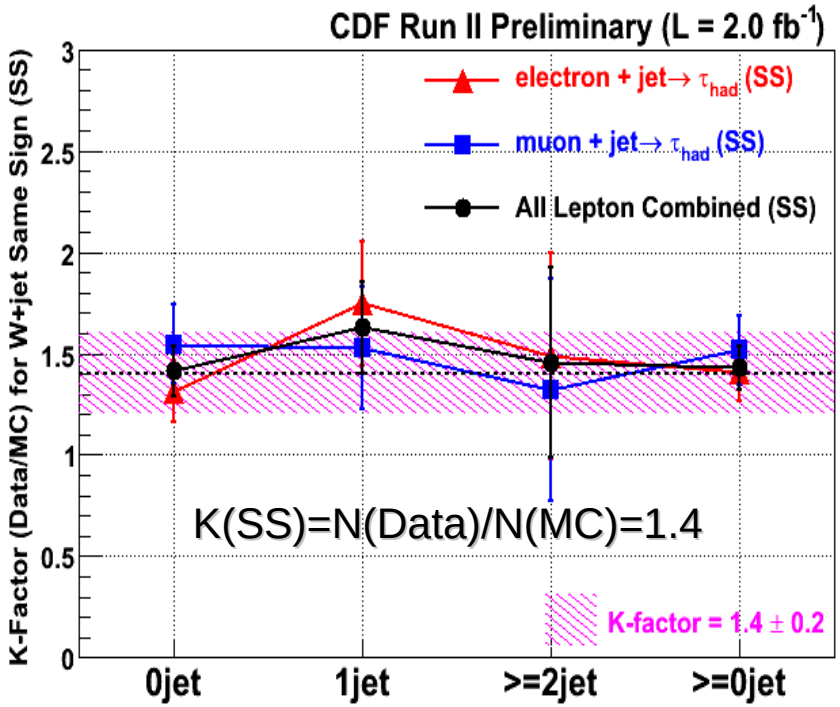
> Agreement between data and final prediction looks great → OS=SS assumption is verified.

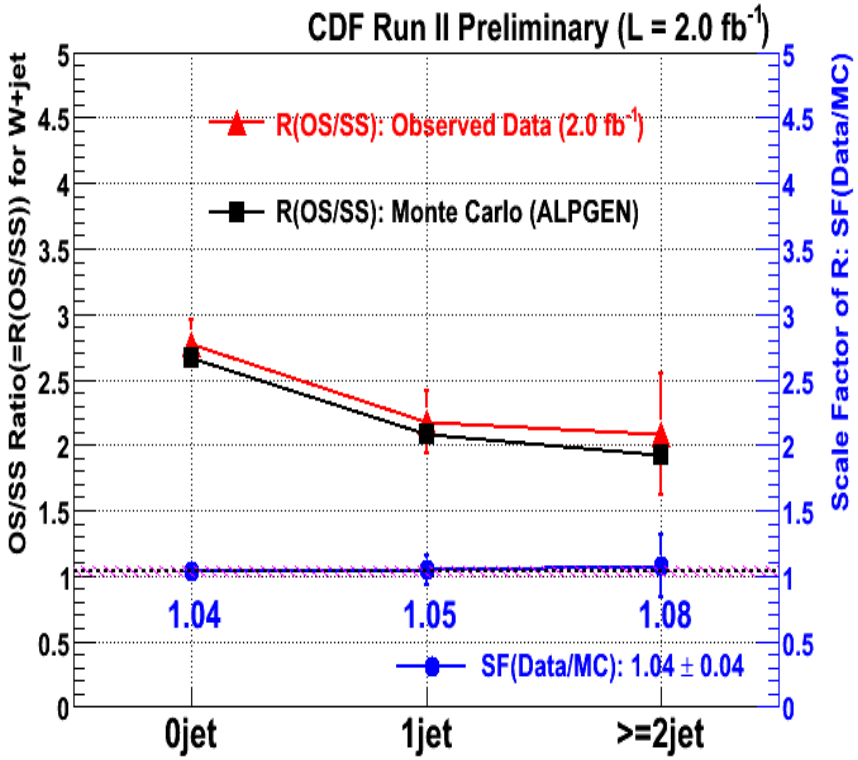
Add-on W+jets Contribution

> What we want is $N_{OS} - N_{SS}$ (Add-on W+jets)
> Two unknowns :
1. Overall K-factor (expected 1.4 (NLO)).
2. SS/OS ratio.
   - "Loose tau ID" sample with Met & Mt cuts to purify W+jets events (other backgrounds are subtracted).

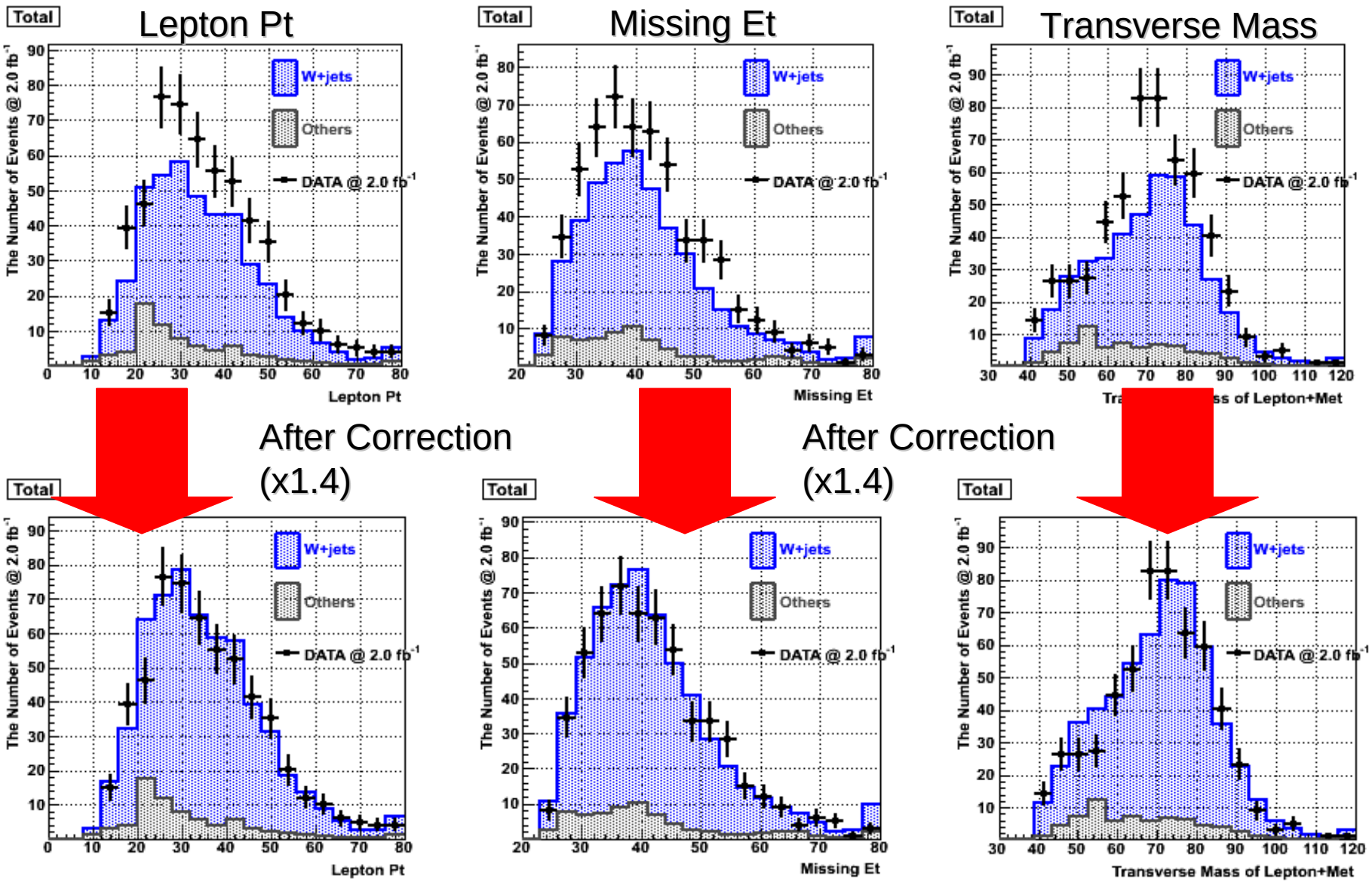








Kinematics Check of SS W+jets Kfactor



Background Summary

Source	Model	$e/\mu+\tau_h+0jet$	$e/\mu+\tau_h+1jet$	$e/\mu+\tau_h+\geq 2jet$	Grand Total
$Z\rightarrow\tau\tau+jets$	ALPGEN	2746.8±260.7	465.1±108.3	99.1±25.9	3310.9±394.8
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$t\bar{t}$	PYTHIA	0.10±0.02	2.2±0.4	16.9±2.7	19.3±3.0
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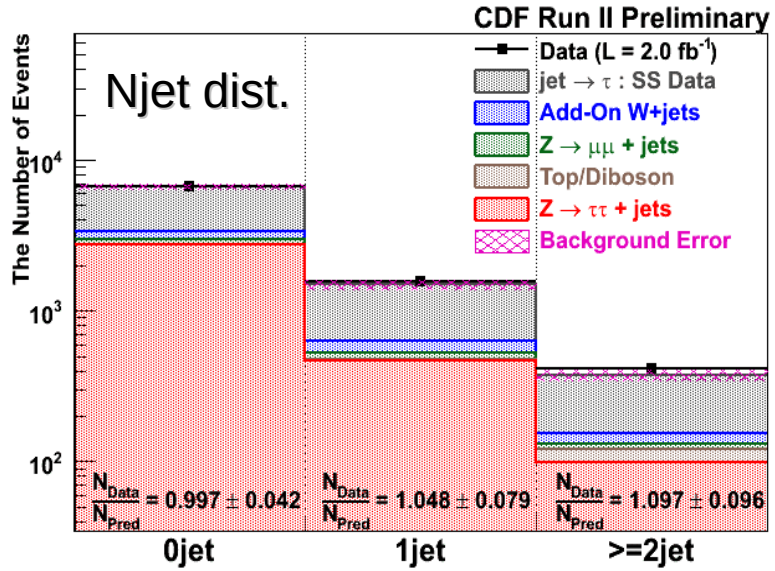
Add-on $W+jets$	ALPGEN	414.9±61.7	99.6±14.9	21.5±3.2	536.1±79.6
Total Background		6669.6±290.8	1498.8±116.8	373.8±32.4	8542.1±422.8
		Control Region	Control Region	Signal Region	-
Observed ($2\ fb^{-1}$)		6653	1571	410	8634



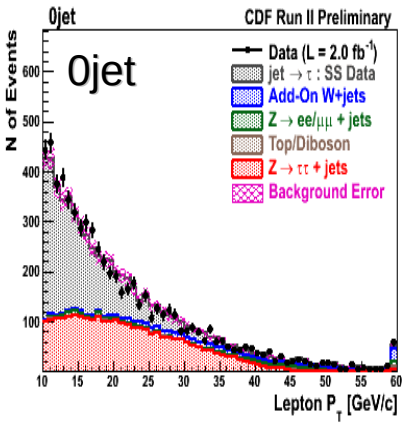
- Dominated by fake and Z→ττ others are relatively small.

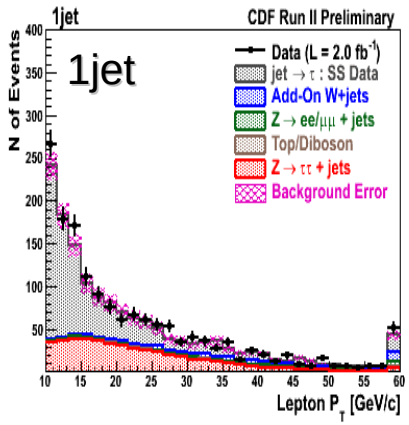
- Z→ττ cross section check.
  σ = 263.5 ± 3.8 pb (stat.only)
  (systematic error: ~10%)
  NNLO theory (σ= 251.3 ± 5.0pb)

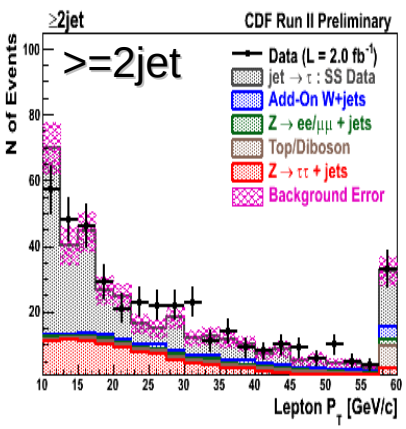
→ Consistent within uncertainties.

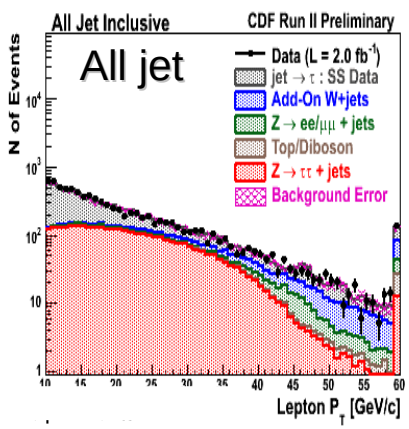
Kinematics : Lepton Pt & Missing Et

Lepton Pt

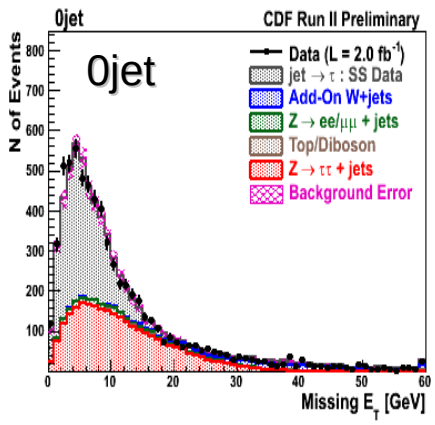


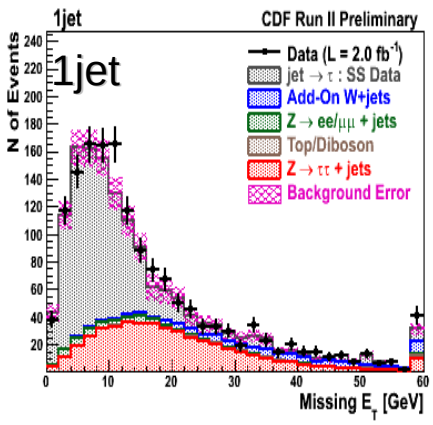


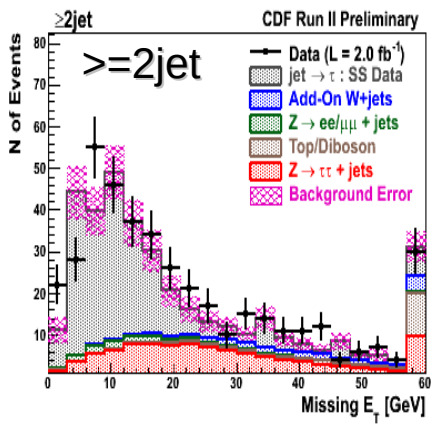


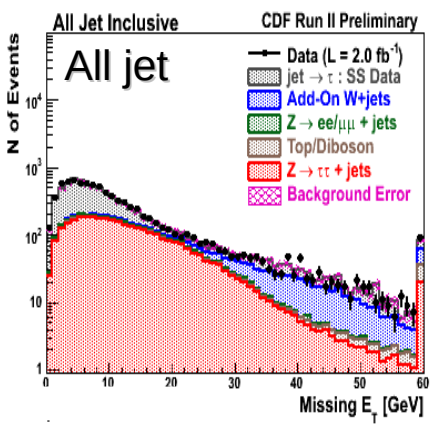


Missing Et (Met)

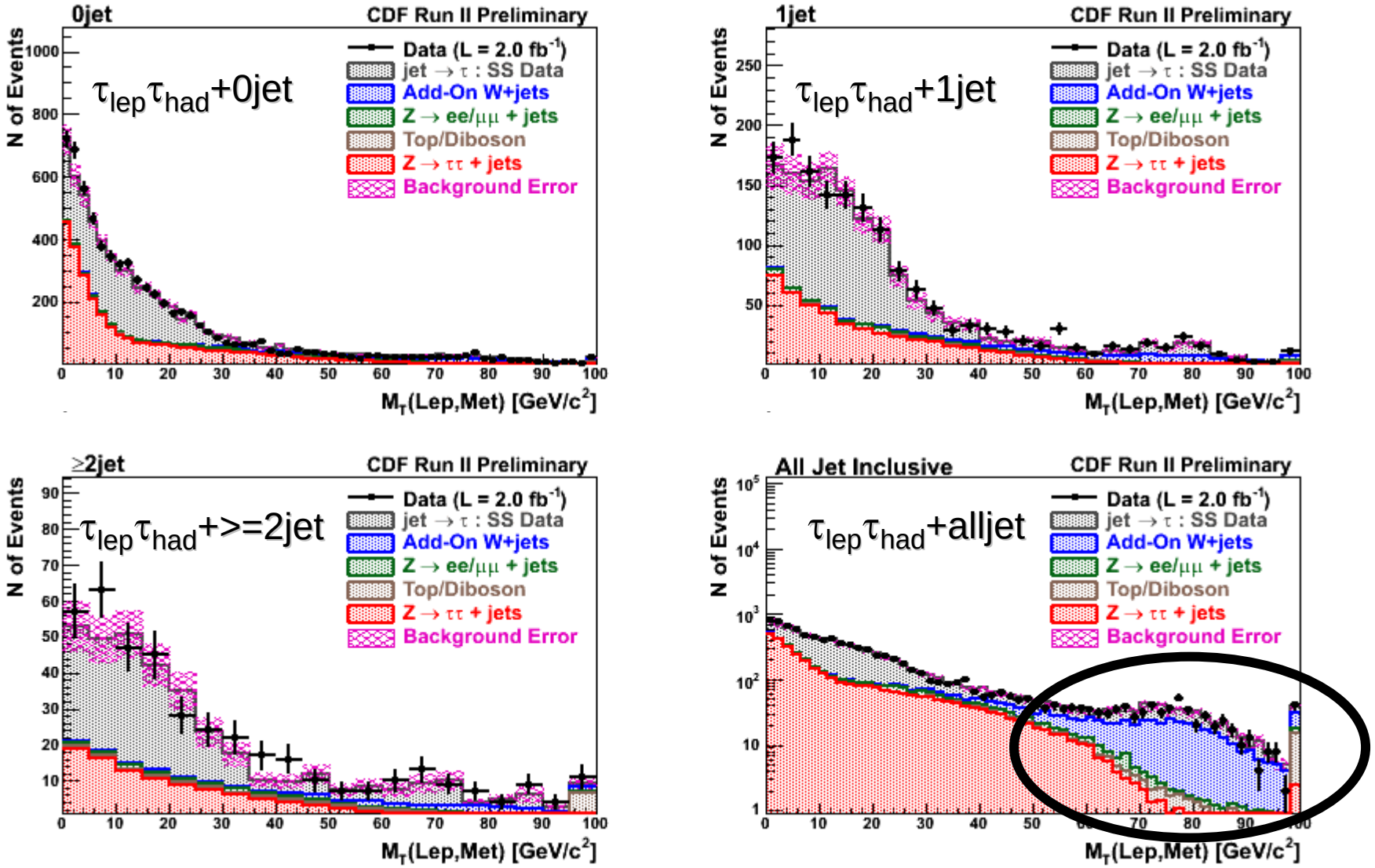






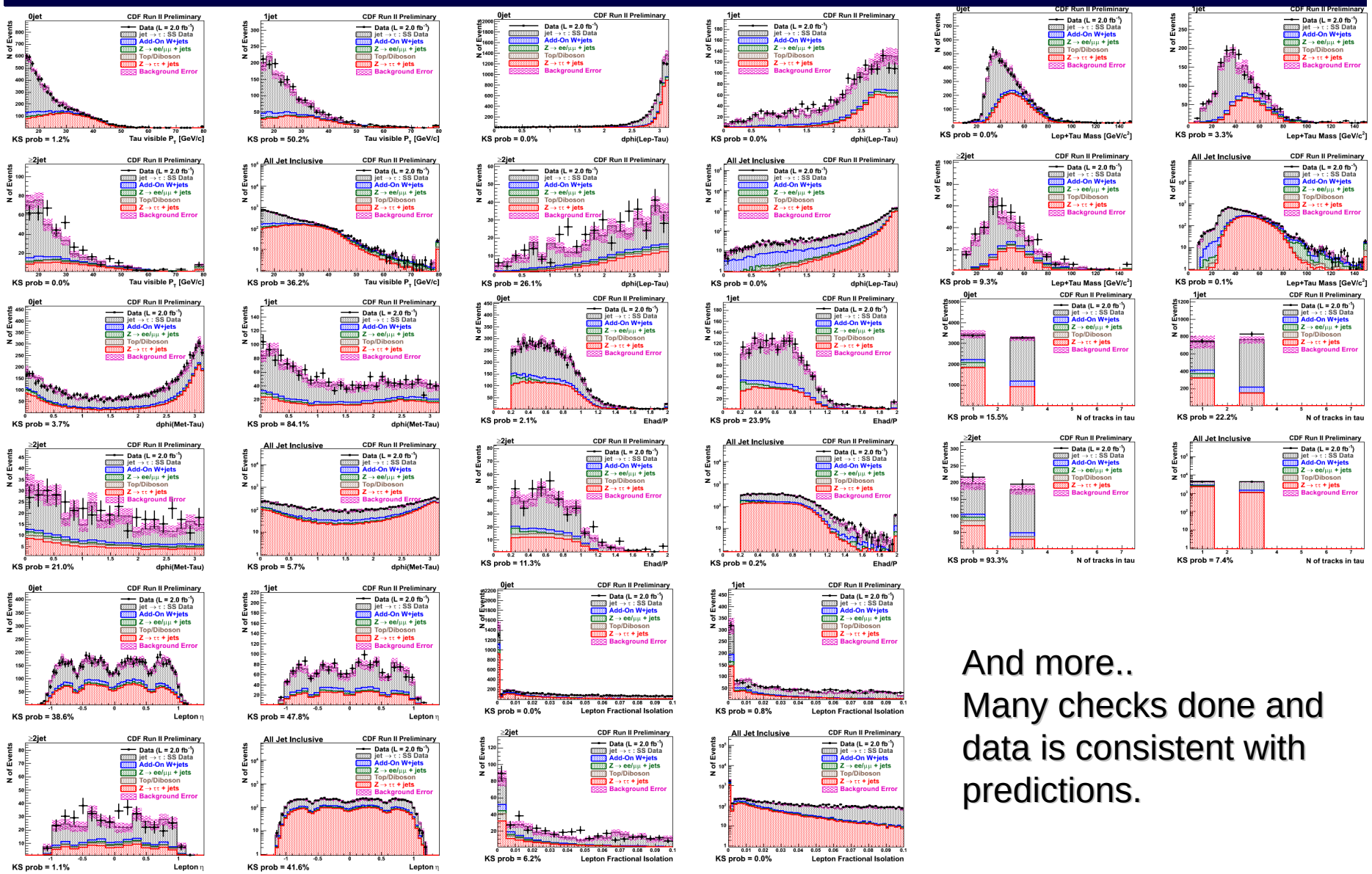


Kinematics : Mt(Lepton.Met)



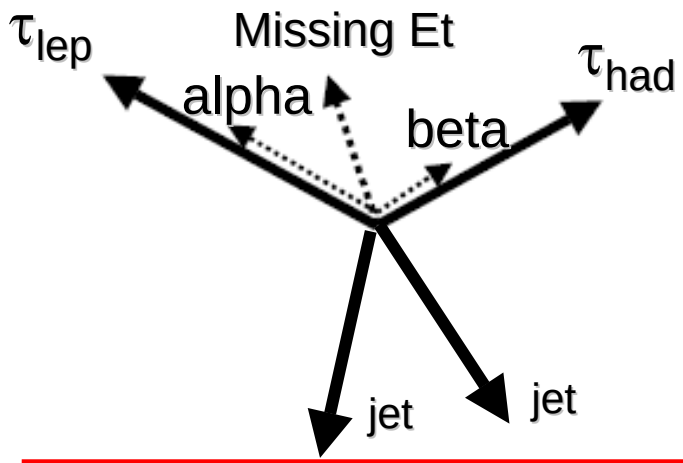
W+jets Correction works pretty well !!!

More & More



And more..
Many checks done and data is consistent with predictions.

Full ττ Mass : Collinear Approximation

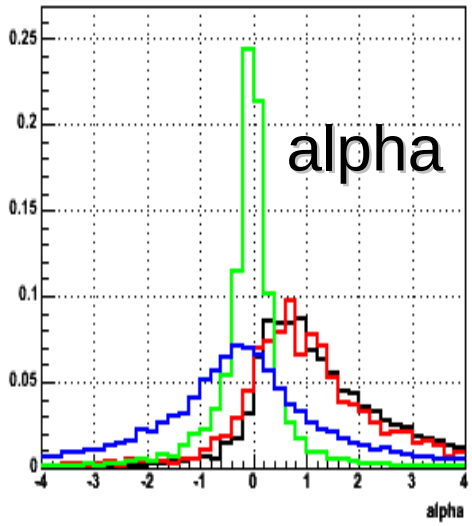


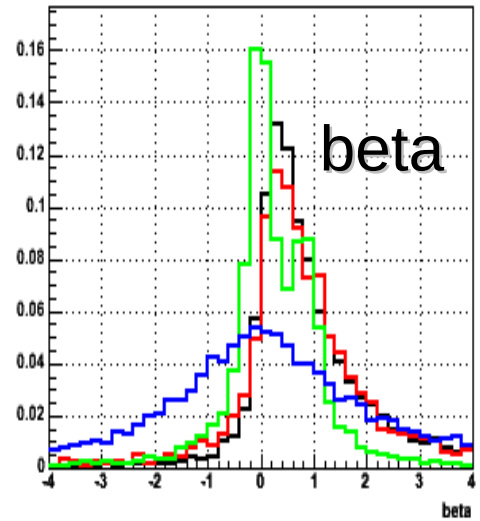
τ_{lep} = (1+alpha)x Lepton

τ_{had} = (1+beta) x Visible Tau

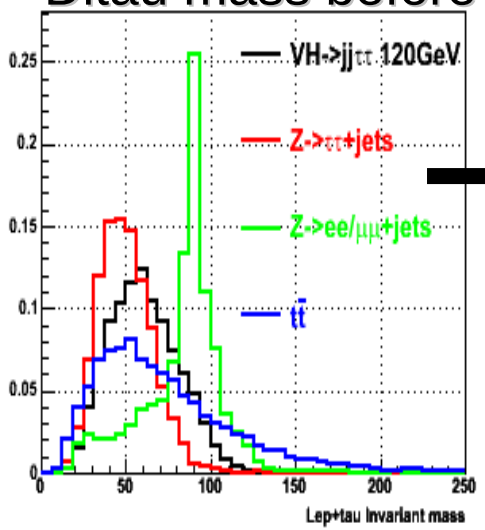
> For signal, alpha and beta should be both positive.

alpha>0 & beta>0	Efficiency
Higgs Signal	~80%
Z->ττ	~78%
ttbar	~27%
W+jets	~10%

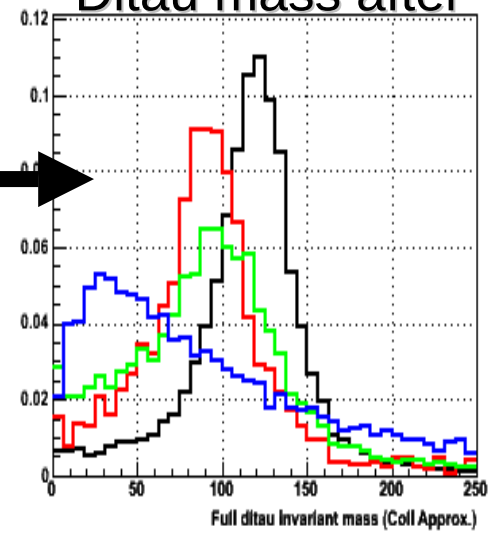




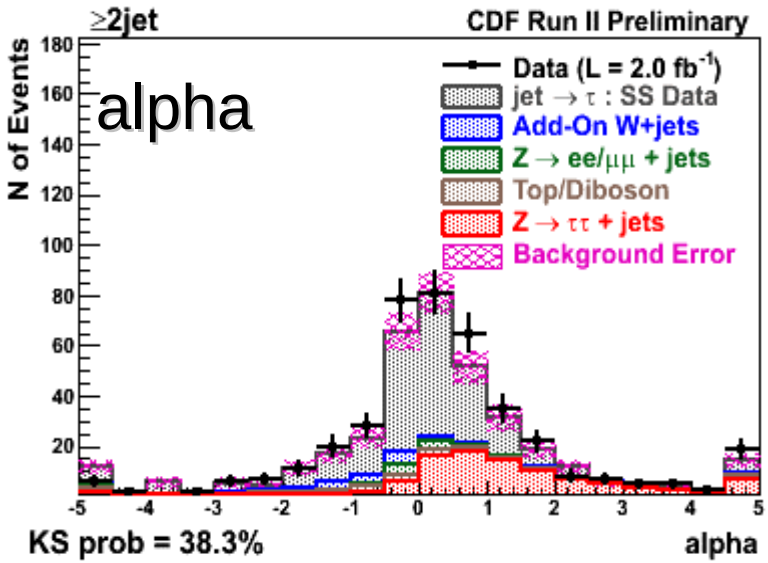
Ditau mass before

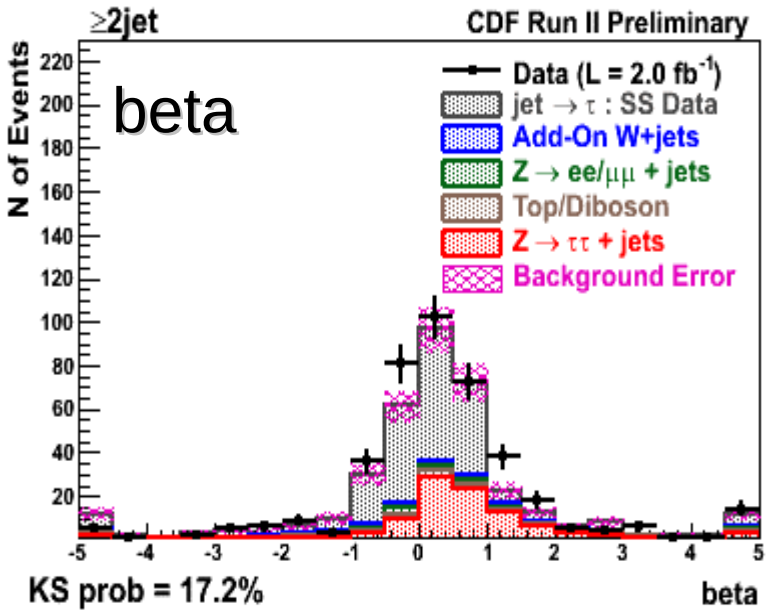


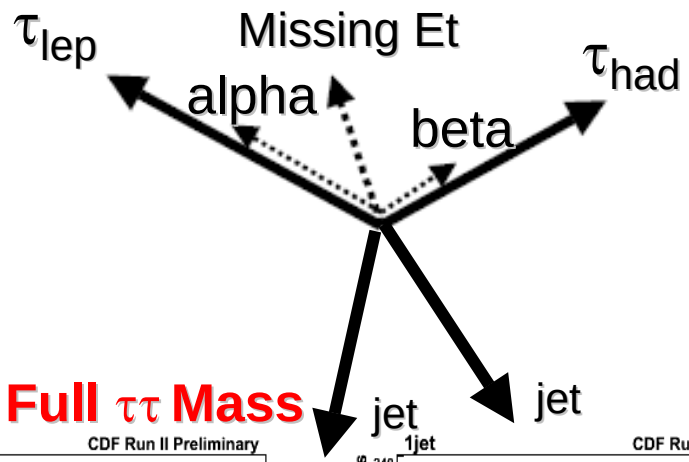
Ditau mass after



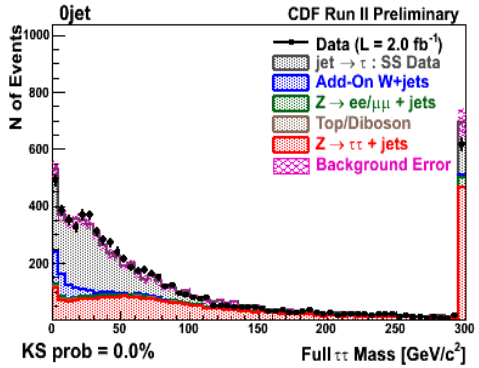
Full ττ Mass : Collinear Approximation

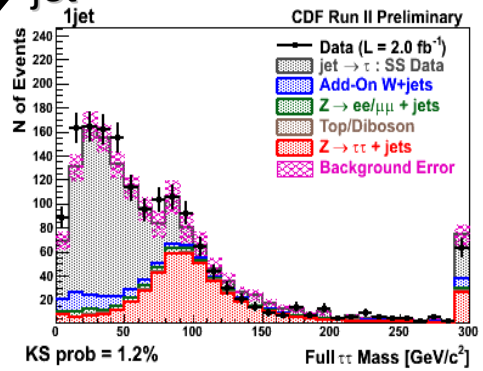


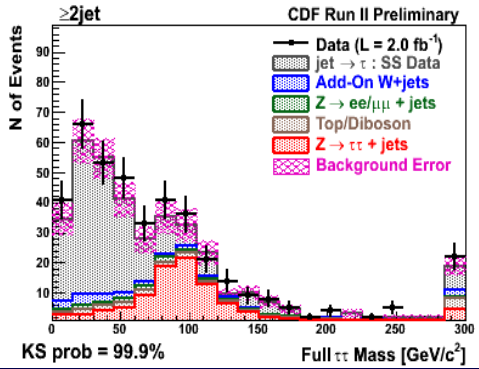


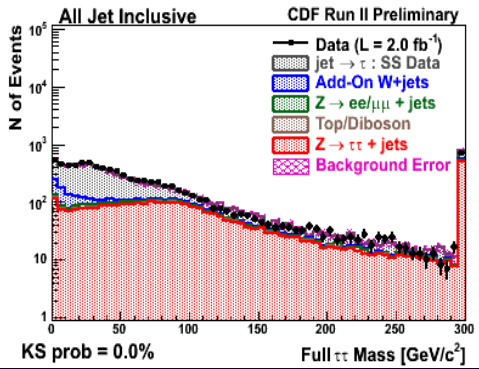


Data: Full ττ Mass









Analysis Optimization
~ Neural Network Analysis ~

Why Multivariate Technique ?

1. Because… S/B is quite small.

→ Counting experiment is impossible.
→ Event selection is minimum to retain as many signal events as possible.
→ Lots of variables to discriminate signal from background still unused.

2. Because… No miracle variable

→ Each variable has its own discrimination power with some correlation to others, but no single magic variable exist !

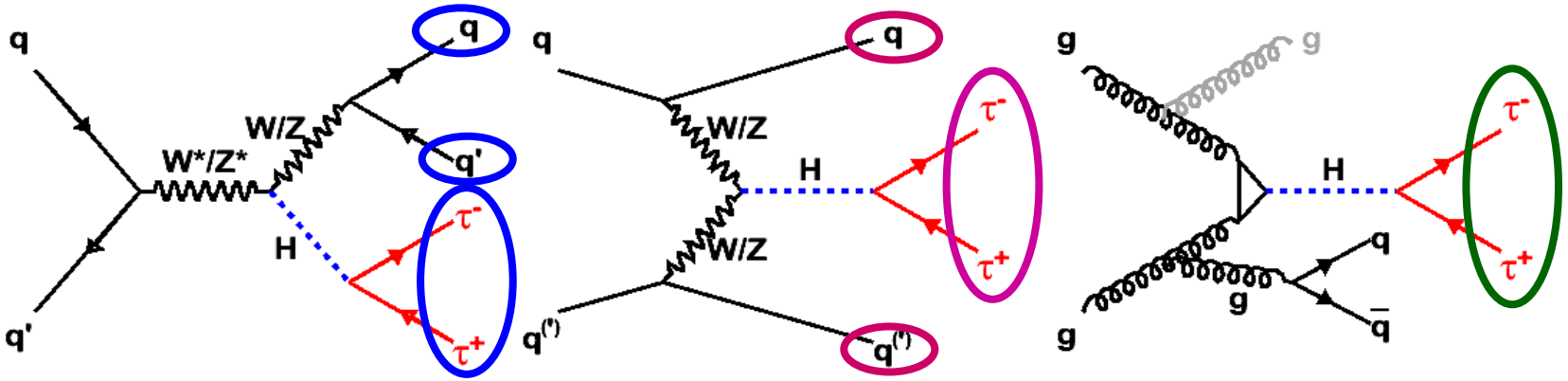
3. Because… We have great understandings of

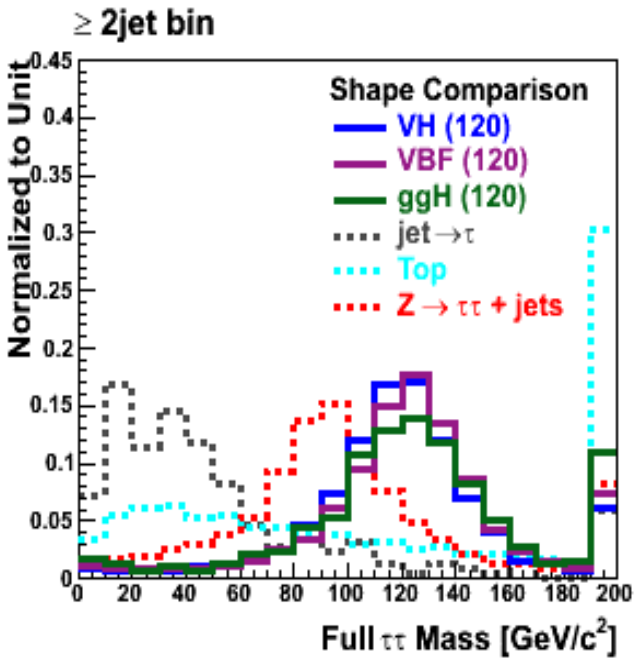
1. Background Estimate (e.g. $Z \rightarrow \tau\tau$ Cross section Measurement)
2. Kinematics Shape (more than 50 checked !)
3. Correlation between kinematics variables.

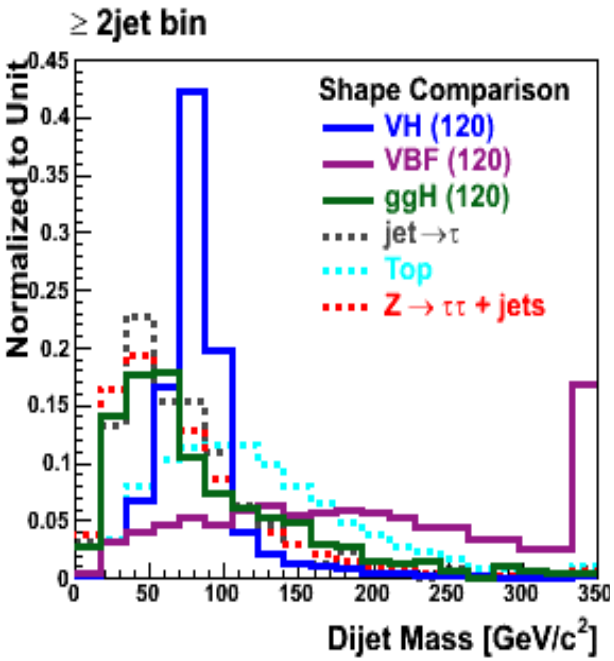
← Yes, it is only possible when we understand data very well and know how to handle it !

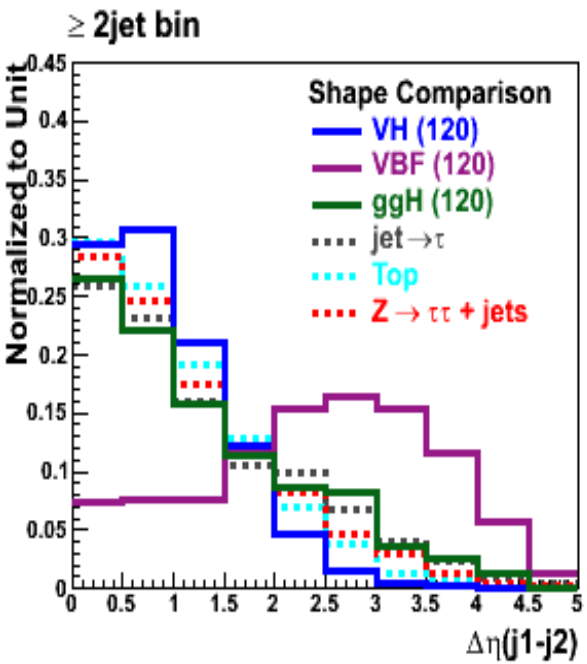
"Multivariate Technique" to increase search sensitivity !

Examples of Good Discriminant



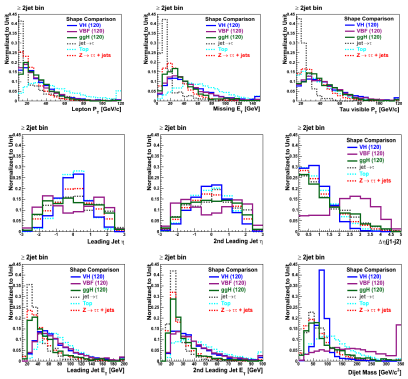






Putting together into Neural Network

Concept: Localize Signal and Background apart from each other by multi-inputs (kinematics).



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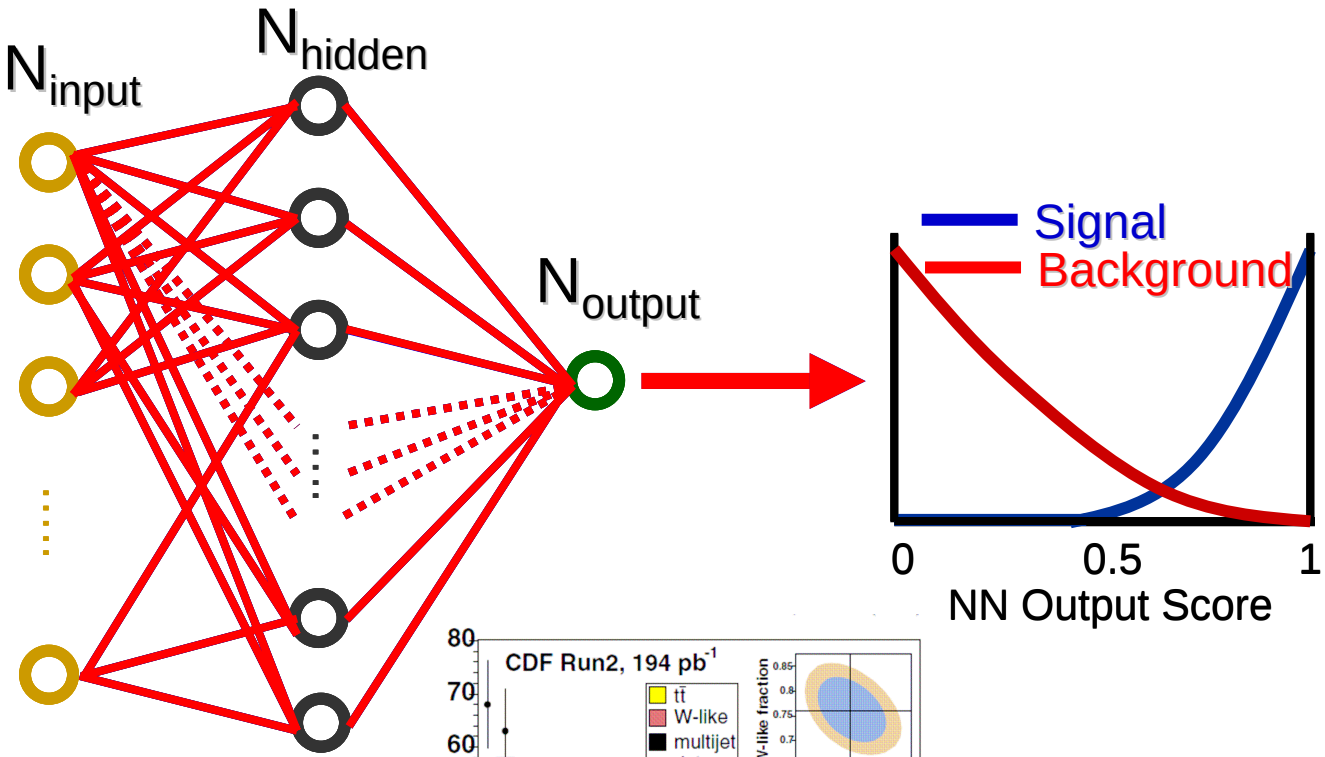
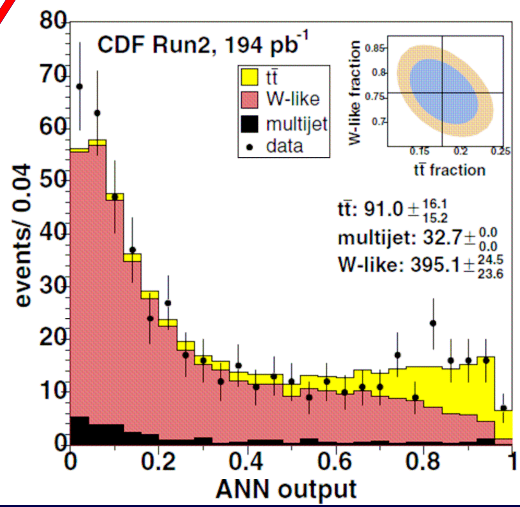




- NN training determines weights for each path and thresholds for each node to maximize separation performance.

← Good NN example : "tt cross section measurement at CDF" PRD 72 052003 (2005)

NN Configuration

Source	Model	$e/\mu + \tau_h + \geq 2jet$
$Z \rightarrow \tau\tau + jets$	ALPGEN	*99.1±25.9
$Z \rightarrow ll + jets$	ALPGEN	11.7±2.2
$t\bar{t}$	PYTHIA	* 16.9±2.7
Diboson	PTYHIA	4.6±0.8
$jet \rightarrow \tau_{had}$	SS data	*220±14.8
Add-on $W + jets$	ALPGEN	21.5±3.2
Total Background		373.8±32.4
		Signal Region
Observed ($2\ fb^{-1}$)		410

- After careful optimization for possible NN configurations and analysis procedures, the best procedure turned out to train 3NN:
  - NN (Mixed Signal vs Z→ττ)
  - NN (Mixed Signal vs Top)
  - NN (Mixed Signal vs QCD)

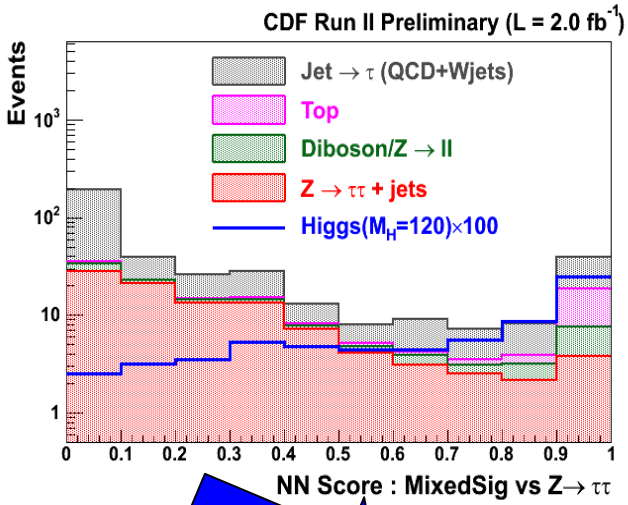
  Then select minimum of the three score to make the final distribution (1D).

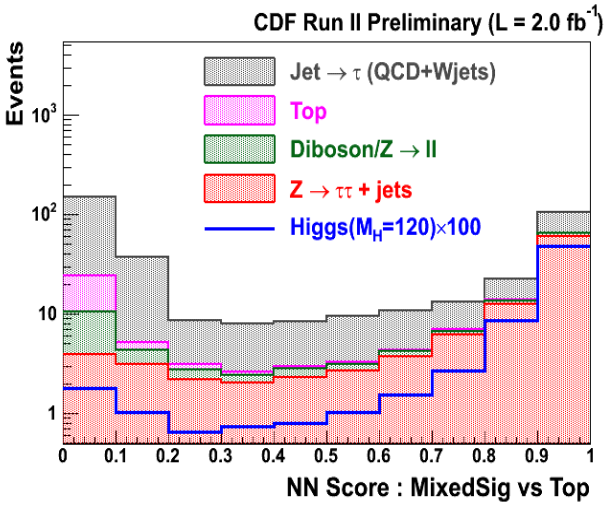
- List of input variables for each NN training.

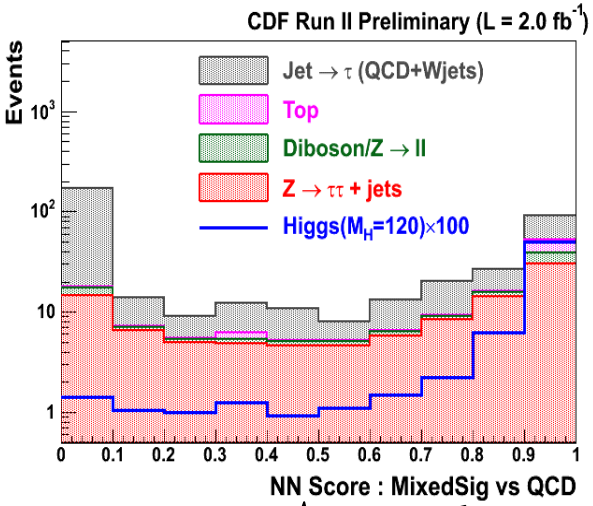
Signal Background	Mixed Signal $Z(\tau\tau)$	Mixed Signal $t\bar{t}$	Mixed Signal QCD
1: Lepton Pt			
2: $\not\!\!E_T$			
3: Vis. τ Pt		√	
4: SeedPt		√	
5: M(jj)	√		
6: Ht	√		√
7: Mt($l\not\!\!E_T$)		√	
8: 1stJet Et			
9: d$\phi(l,\not\!\!E_T)$		√	√
10: d$\phi(l\tau,\not\!\!E_T)$			
11: M($l\tau$)			
12: M($\tau\tau$)	√	√	√
13: d$\phi(l,\tau)$	√	√	
14: dη(j,j)			
15: d$\phi(\not\!\!E_T,\tau)$			
16: M($l\tau\not\!\!E_T$)	√	√	√
$N_{input}(\surd)$	5	7	4

- NN is trained at each Higgs mass point (115-150 GeV).

NN Templates

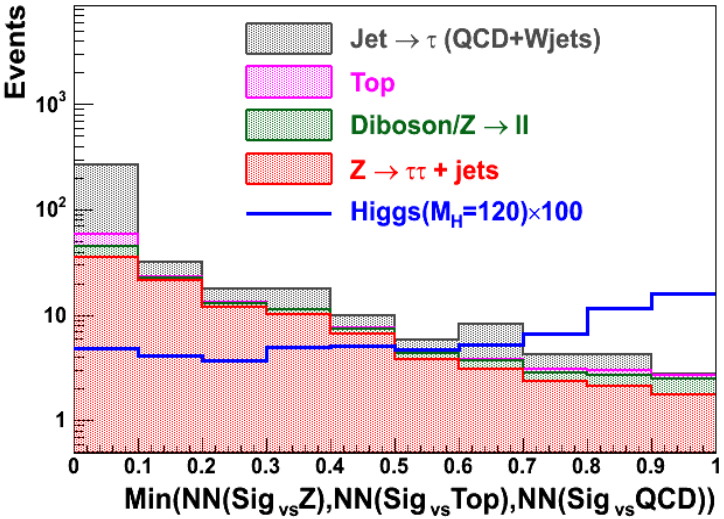






Select Minimum Score from three NN outputs

> For a given event, calculate 3 NN scores, then select minimum of the three.



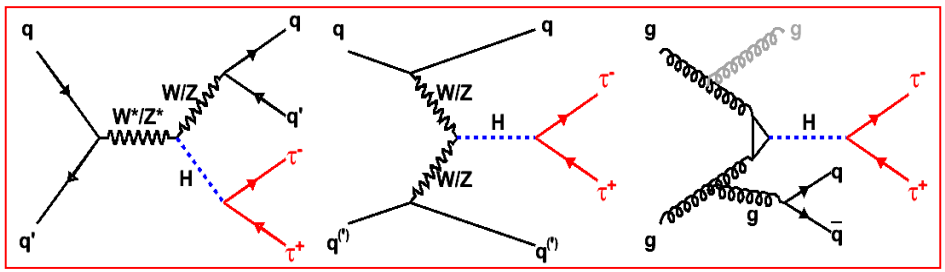
← This is the final NN shape to be fitted.

> Procedure is actually very simple !

Signal Systematic Uncertainty

Systematic Uncertainties for Higgs Signal (%)				
Source	WH PYTHIA	ZH PYTHIA	VBF PYTHIA	ggH PYTHIA
Luminosity	6.0	6.0	6.0	6.0
$\lvert Z_{vtx} \rvert$	0.5	0.5	0.5	0.5
e Trig.	0.3	0.3	0.3	0.3
μ Trig.	1.0	1.0	1.0	1.0
τ Trig.	3.0	3.0	3.0	3.0
e ID	2.4	2.4	2.4	2.4
μ ID	2.6	2.6	2.6	2.6
τ ID	3.0	3.0	3.0	3.0
MC Stat.	1.0	1.0	1.0	2.0
PDF	1.2	0.9	2.2	4.9
ISR/FSR	2.0/0.3	0.9/0.5	2.5/1.2	12.3/1.3
JES	3.4	3.1	4.1	13.5
σ	5.0(NNLO)	5.0(NNLO)	10.0(NLO)	10.0(NNLO)
Total	~10.1	~10.0	~13.8	~22.8

> Typically ~10% in total.
> Larger in gg→H+2jets due to "jet" related uncertainties (JES and ISR).
> JetEnergyScale shape systematic is also taken into account.

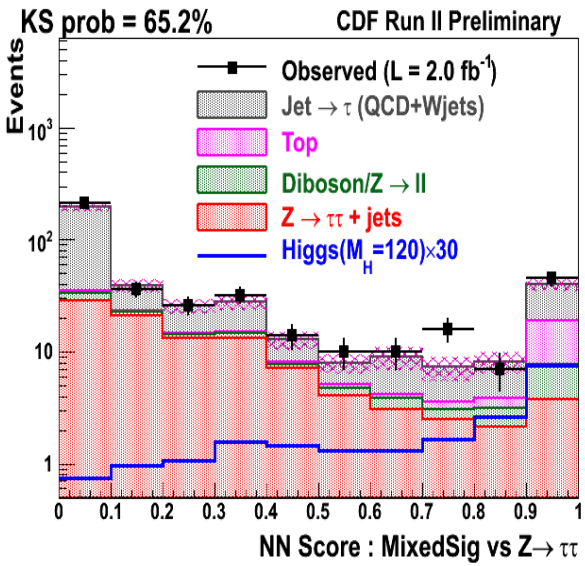


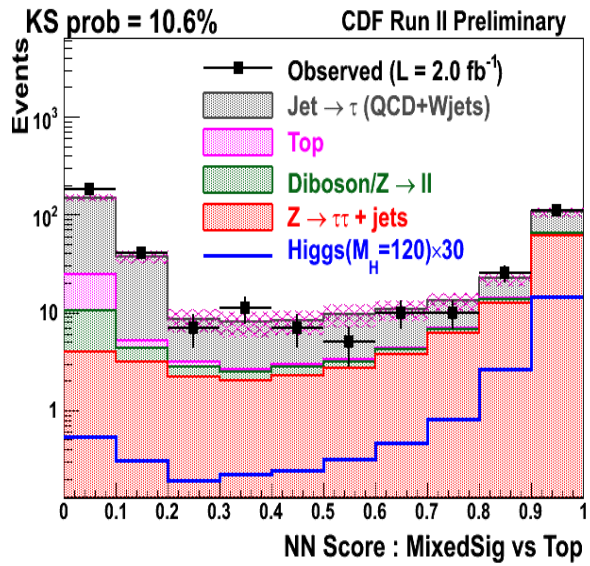
Systematic Uncertainty on Background

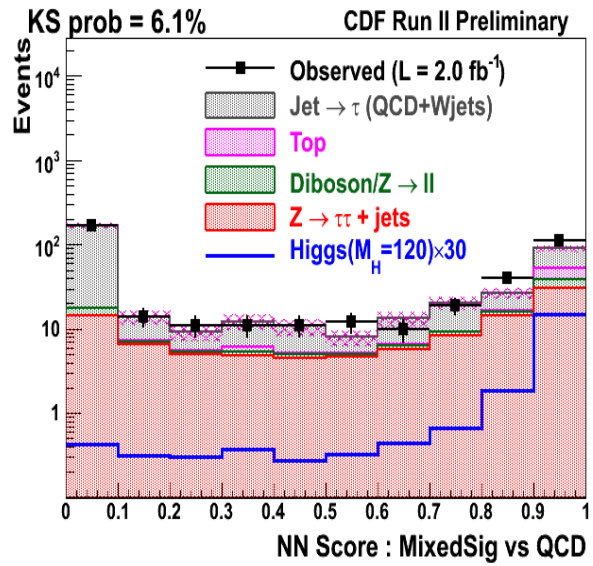
Systematic Uncertainties on Background Acceptance (%)						
Source	$Z \to \tau\tau$ ALPGEN	$Z \to ll$ ALPGEN	$t\bar{t}$ PYTHIA	Diboson PYTHIA	$jet \to \tau$ SS Data	Add. Wjet ALP+Data
Luminosity	6.0	6.0	6.0	6.0	-	-
$\|Z_{vtx}\|$	0.5	0.5	0.5	0.5	-	-
e Trig.	0.3	0.3	0.3	0.3	-	-
μ Trig.	1.0	1.0	1.0	1.0	-	-
τ Trig.	3.0	3.0	3.0	3.0	-	-
e ID	2.4	2.4	2.4	2.4	-	-
μ ID	2.6	2.6	2.6	2.6	-	-
τ ID	3.0	3.0	3.0	3.0	-	-
JES	15.6	13.0	2.0	9.5	-	
MC Stat.	~0.5	~4.0	~1.0	~1.0	-	~1.0
Systematic Uncertainties for Background Normalization and Modeling (%)						
σ or Norm.	2.2	2.2	13.4	10.0	SS Stat.	14.8(KF)
MC Model	20	10	-	-	-	-

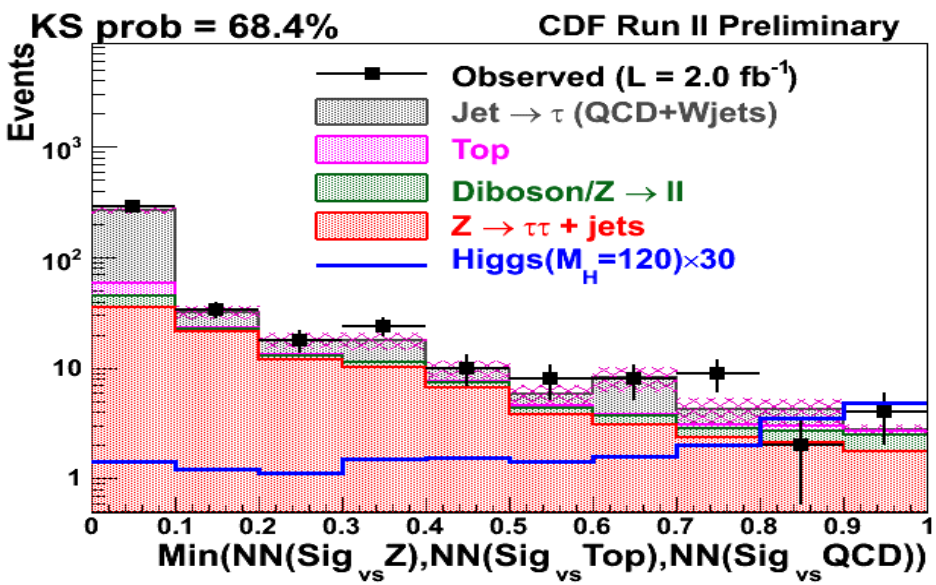
> All Jet→tau fake backgrounds are data-driven (SS data),
→ Only statistical uncertainty on SS data is assigned as systematics.
> Also normalization for W+jets coming from data,
→ The error of normalization is only needed. (K-factor = 1.4 ± 0.2)

Finally.... Open the Box









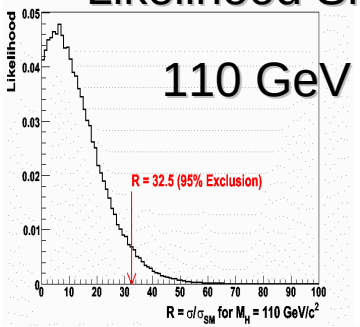
No significant excess in signal region unfortunately..

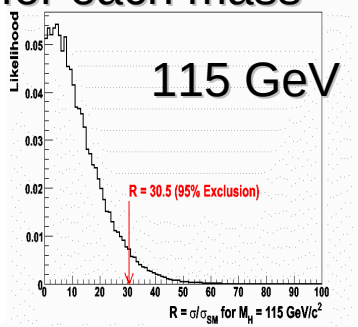
→ Proceed to set 95% C.L. limit.

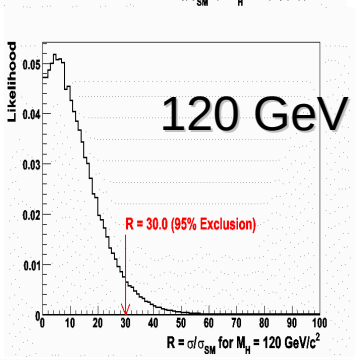
Observed Limits (95% C.L.)

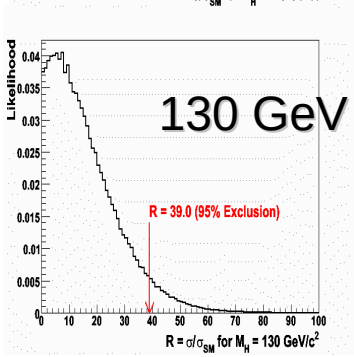
> Binned Likelihood Technique.

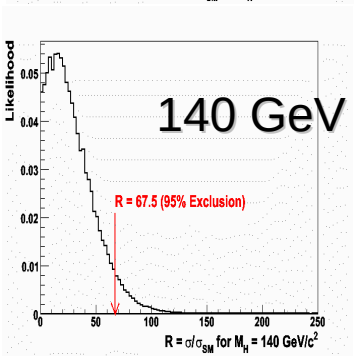
Likelihood Shape for each mass

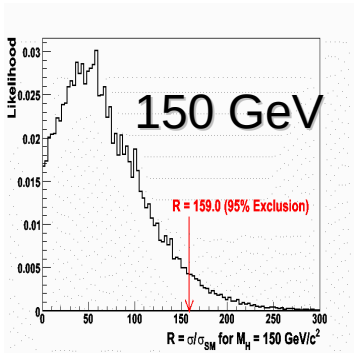




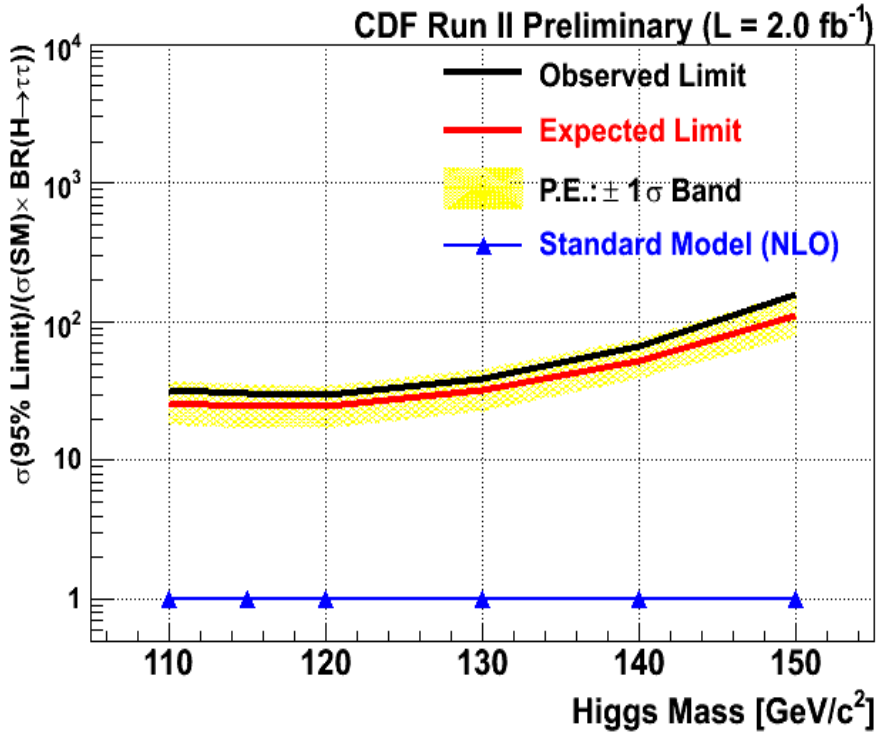






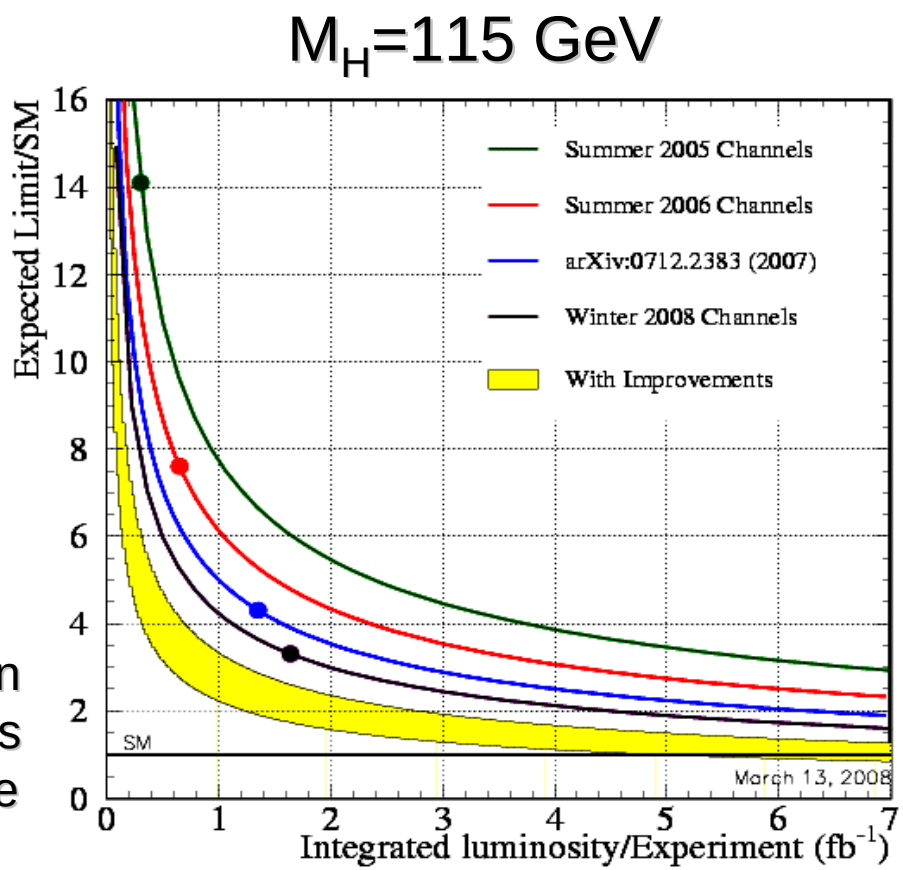


Mass	Expected Median	Expected Mean (RMS)	Observed
110	$25.8^{+11.5}_{-7.5}$	27.4(10.1)	32.5
115	$24.8^{+10.5}_{-7.5}$	26.1(9.4)	30.5
120	$24.2^{+10.0}_{-7.0}$	25.6(9.0)	30.0
130	$32.3^{+13.1}_{-9.5}$	34.6(13.1)	39.5
140	$52.8^{+22.5}_{-13.5}$	55.2(20.2)	67.5
150	$111.7^{+49.5}_{-33.0}$	119.0(42.3)	159.0



Impact of This Analysis

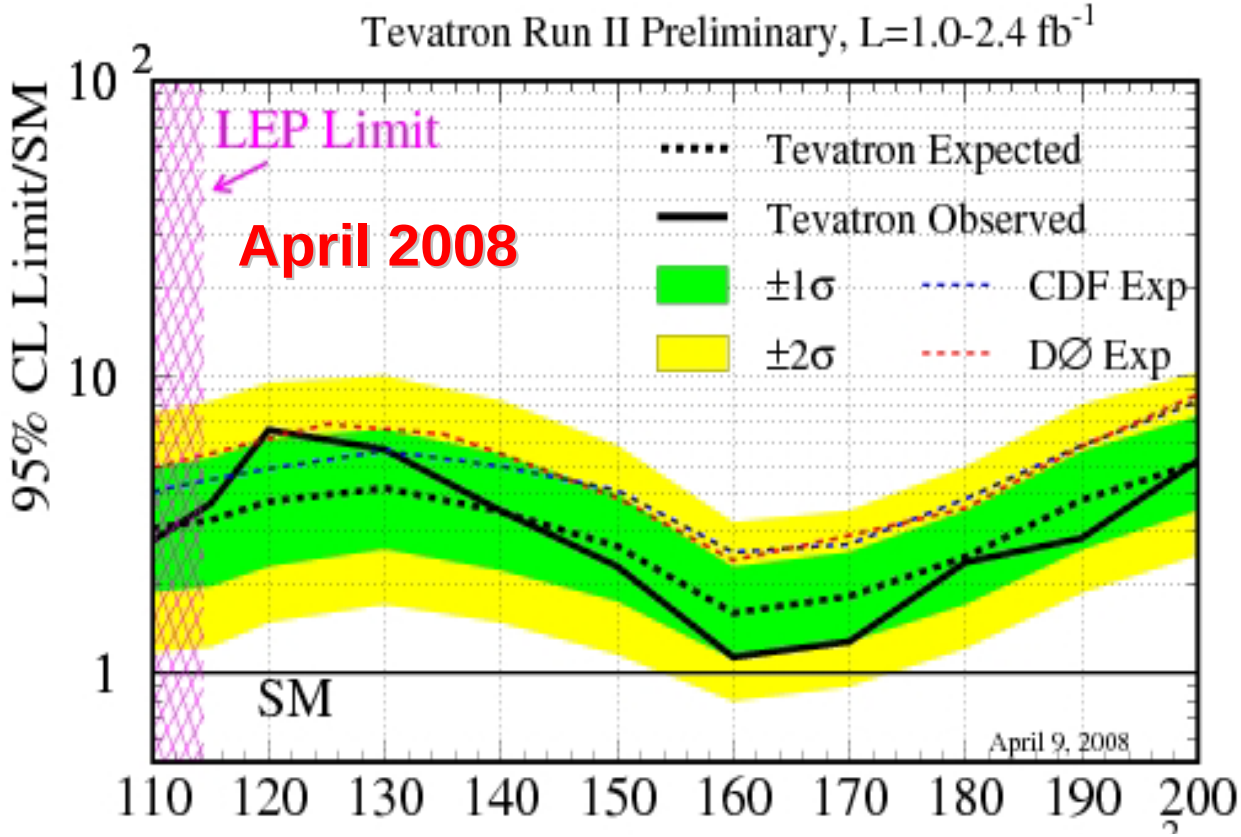
- This result added 10% improvement to low mass CDF combined results !!!
  - Statistically independent to other existing analyses (H→bb)
  - Almost no correlation for systematic uncertainty. In H→bb, bjet related error is dominant.
- Right plot:
  - History & Projection for exclusion limit.
  - This analysis is one of the main improvement for a transition from 2007 to 2008 projection !



- Putting all together, small improvement can make a big difference. e.g. 4 improvements with 10% each are equivalent to double the luminosity.

- Exclusion of 115 GeV Higgs should be possible with expected improvements and ~6 fb^{-1} data (If Higgs doesn't exist).

The Latest Tevatron Limits



At M_H=115 GeV:
Expected Limit : 3.3 x SM
Observed Limit : 3.7 x SM

At M_H=160 GeV:
Expected Limit : 1.6 x SM
Observed Limit : 1.1 x SM

Yes, we are landing to SM, fasten your seatbelt !

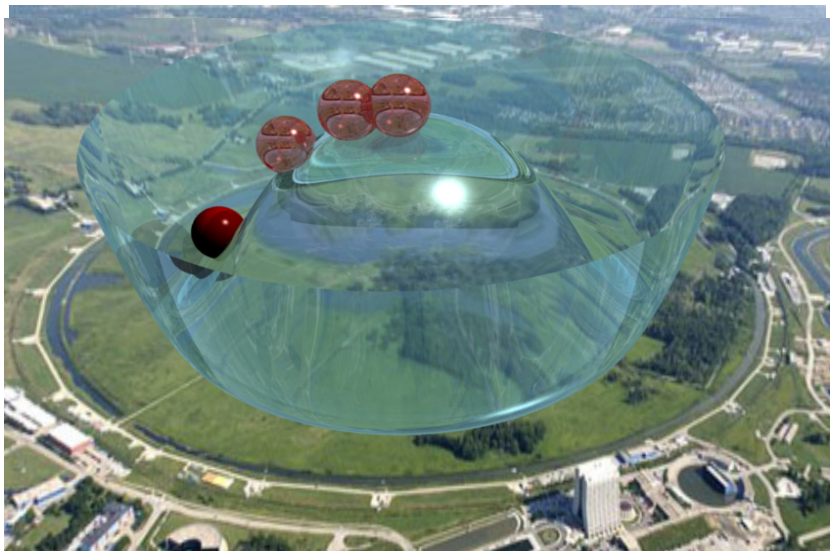
Summary & Future

- This is the first dedicated search for the SM Higgs decaying to $\tau\tau$.
- Simultaneous fit of 4 signal processes gave ~30% sensitivity compared to other single analysis (e.g. WH→lvbb).
- In combination, this result added ~10% improvement to the CDF sensitivity.
- This analysis is a good example of connection between Tevatron & LHC (for VBF→$\tau\tau$+2jets) in terms of background estimate and modeling.

- Future

This is just a beginning of analysis.

- Adding 0jet/1jet from gg→H.
- Adding lep-lep, had-had mode.
- Extend it to H→WW→l$\nu\tau\nu$ for high mass Higgs search.
- Use different trigger path e.t.c.
- Even more..



✓ A comment from CDF spokespeople:

This demonstrates the determination with which CDF is pursuing every corner of phase space to gather evidence for the Higgs at the Tevatron !

CDF/Tevatron Never Give Up !