Tevatron Results on SM Higgs Search in the High Mass Region

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On behalf of the CDF and D0 Collaborations

Lathuile 2012, La Thuile, Italy
Febrary 27-March 3, 2012

Outline

- Search Foundation and Higgs detection modes
- CDF and D0 detection methods in High Mass
- Results, implications, next steps

Higher Physics Reach

Single Top

M_t

M_W

Higgs

Susy

New

hadronic

WW,WZ,ZZ

ZZ

Top (t)

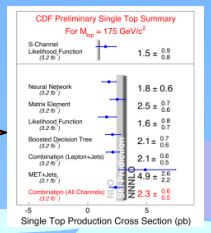
Top(ttbar)

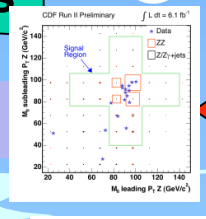
WZ(bb)

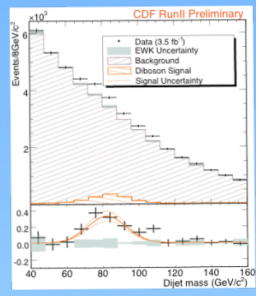
WZ

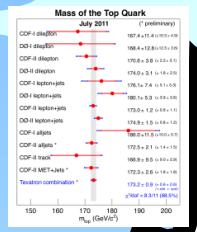
Bottom

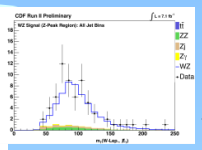
Jets

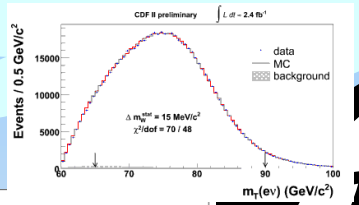


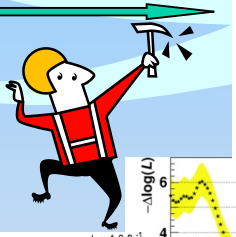


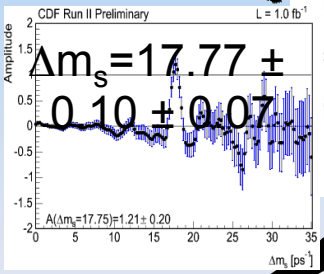


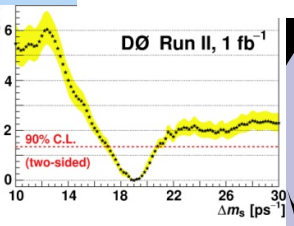


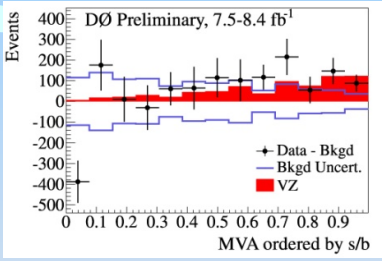






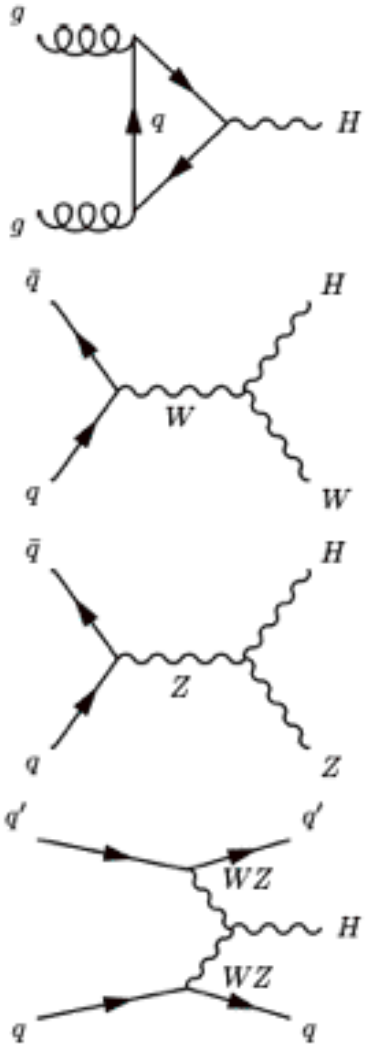






Build on mountain of measurements

SM Higgs Production and Decay

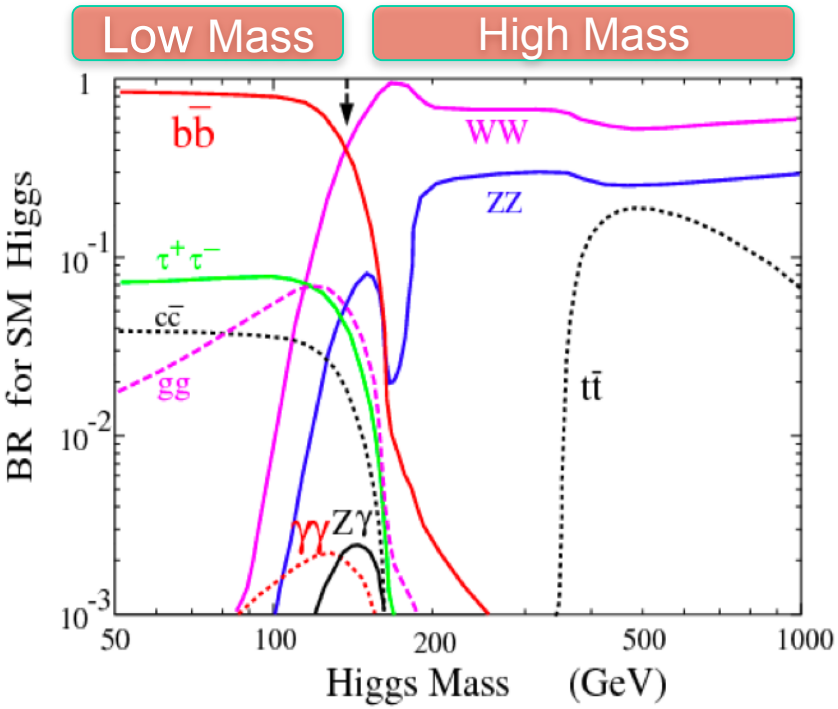


Gluon Fusion

(dominates)

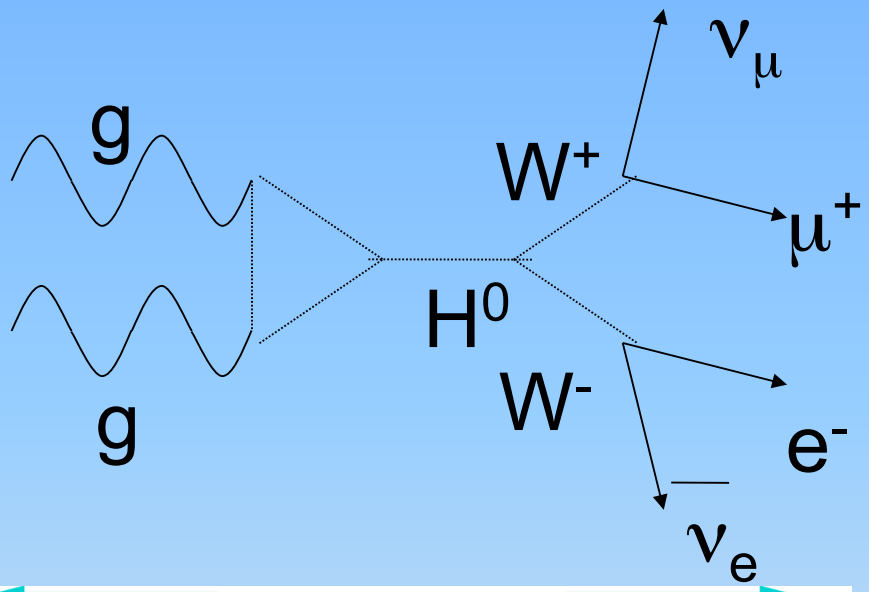
Associated production

Vector Boson Fusion

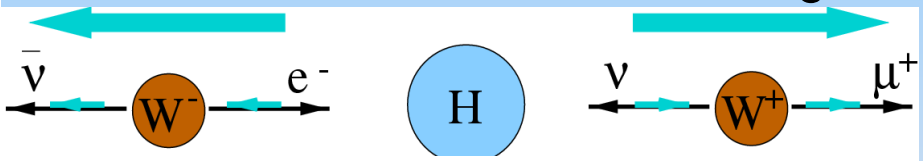


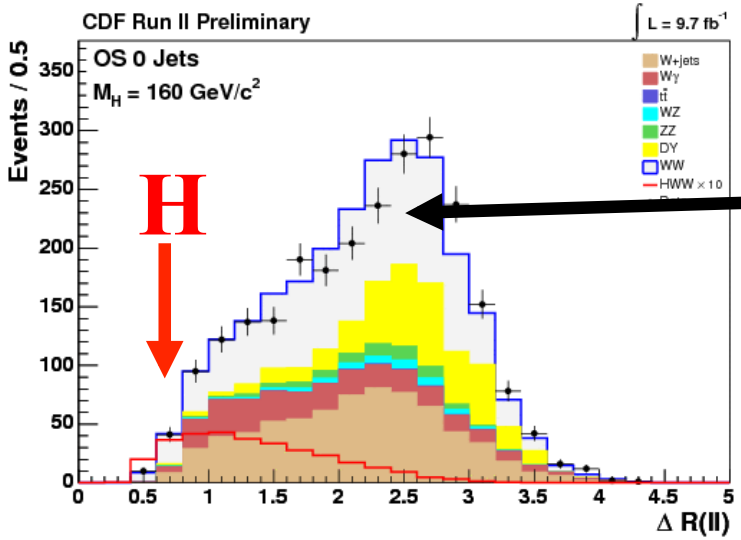
- Trigger: 1 High Pt e or μ
- Focus on Decays: WW → ee, eμ, μμ, eτ, μτ + ν's
- Separate channels by dileptons (D0), N_{jets}
- Event Selection: High Pt Leptons, Missing E_T

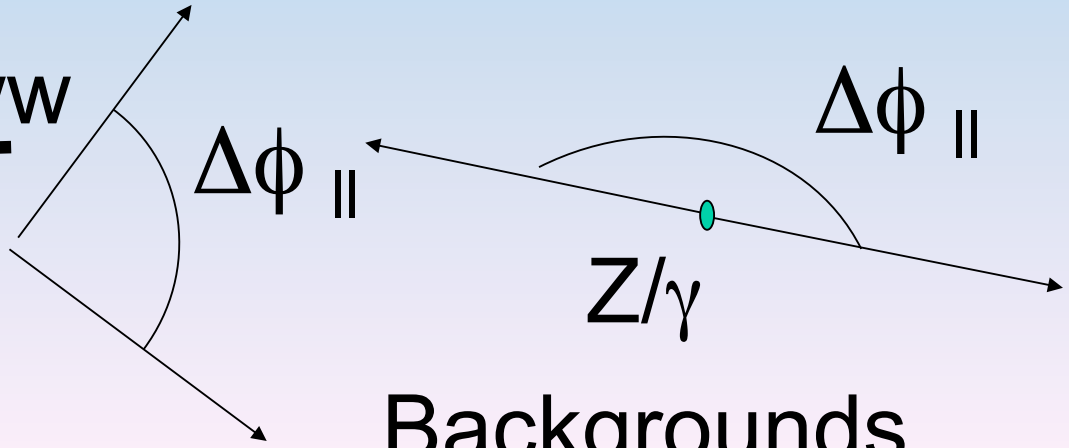
HWW Production Features



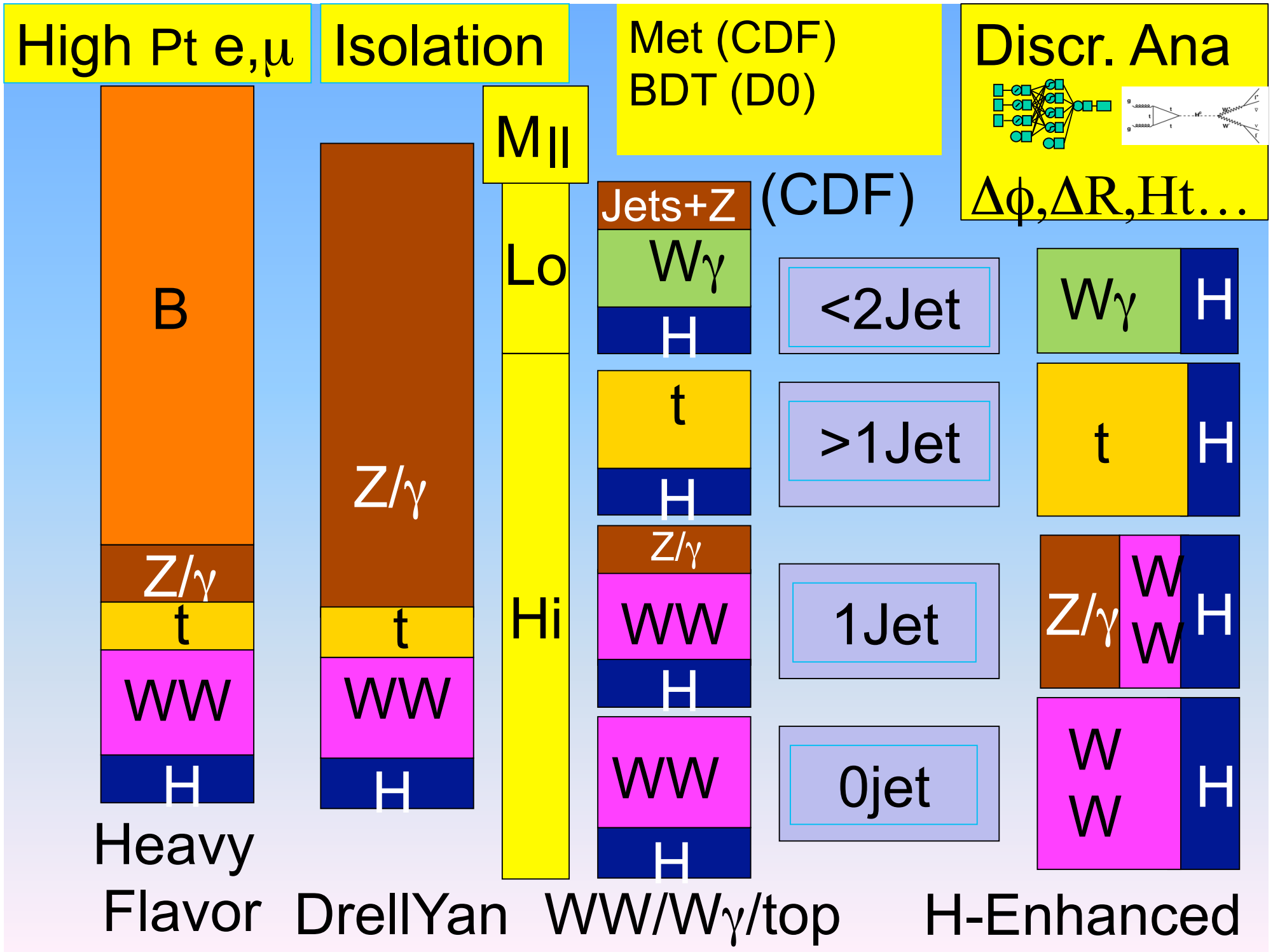
- High Pt Leptons not back to back
- Spin 0 Higgs correlates spins of leptons: charged leptons (**low $\Delta\phi_{ll}$**), two neutrinos (**High MET**) tend to be closely aligned with one another.







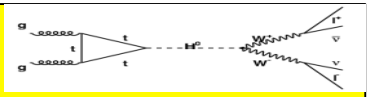
Backgrounds

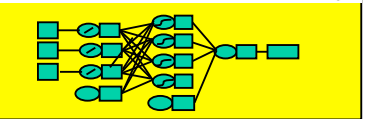

High Pt e,μ
Isolation
Met (CDF)
BDT (D0)
Discr. Ana
Δφ,ΔR,Ht…
M_ll
Lo
Hi
(CDF)
B
Z/γ
t
WW
H
Z/γ
t
WW
H
Jets+Z
Wγ
H
t
H
Z/γ
WW
H
WW
H
<2Jet
>1Jet
1Jet
0jet
Wγ
H
t
H
Z/γ
W
W
H
W
W
H
Heavy Flavor
DrellYan
WW/Wγ/top
H-Enhanced

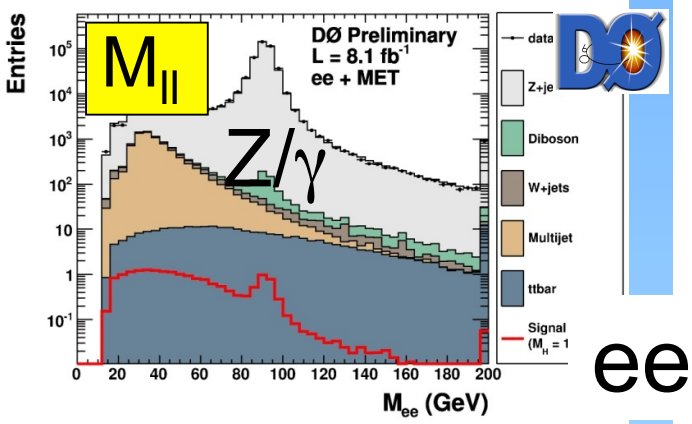
Dileptons,Iso p_t>15,10GeV/c

BDT or $M_t(e\mu)$ (0,1,≥2 Jet)

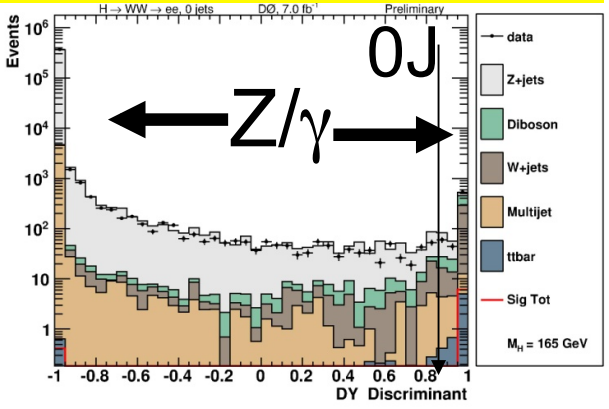
BDT 58 H^0

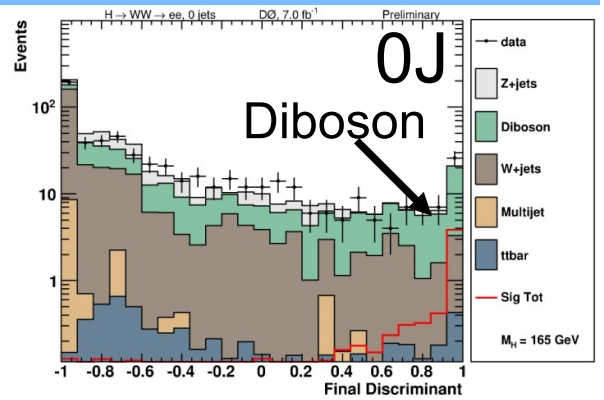


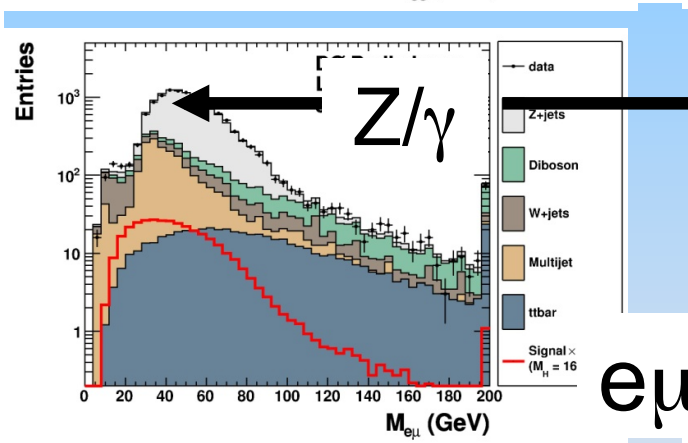




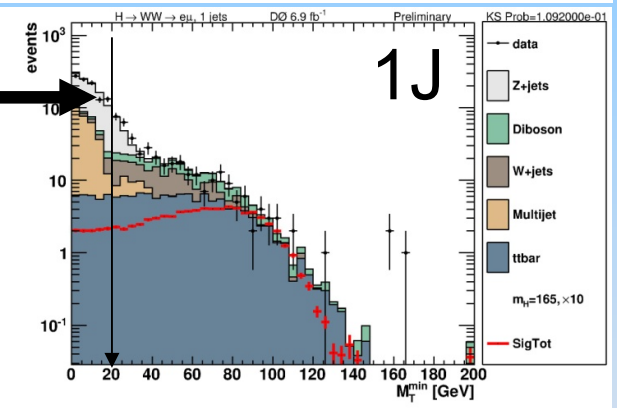
ee

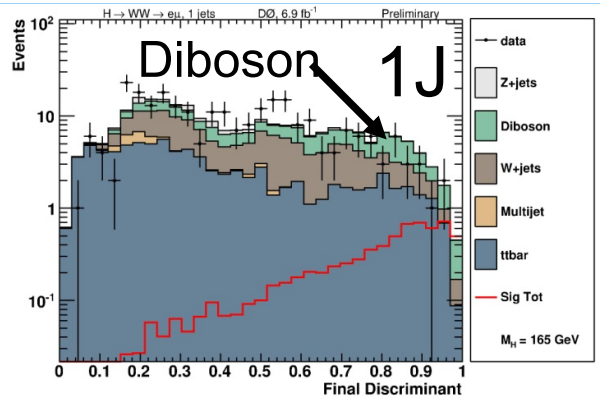


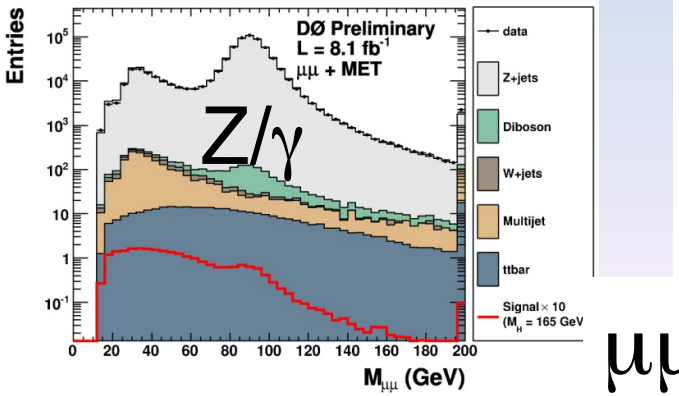




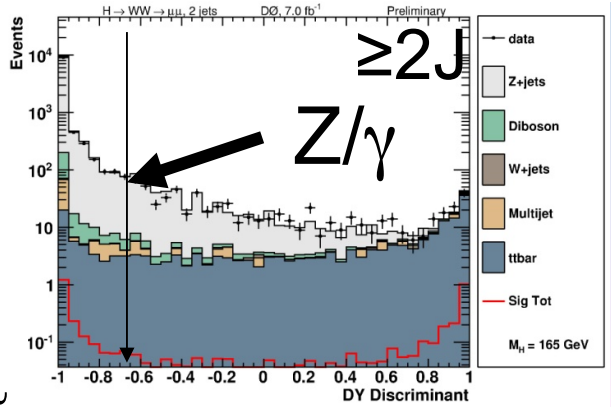
eμ

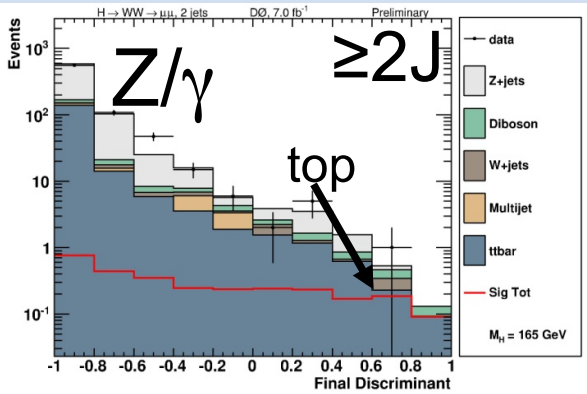






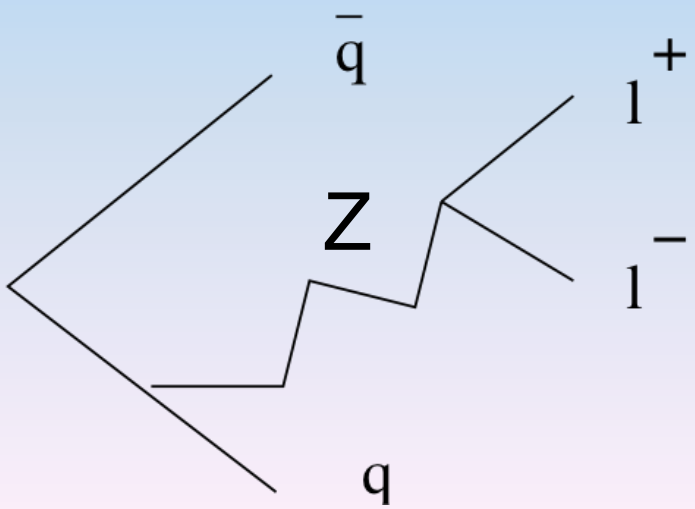
μμ

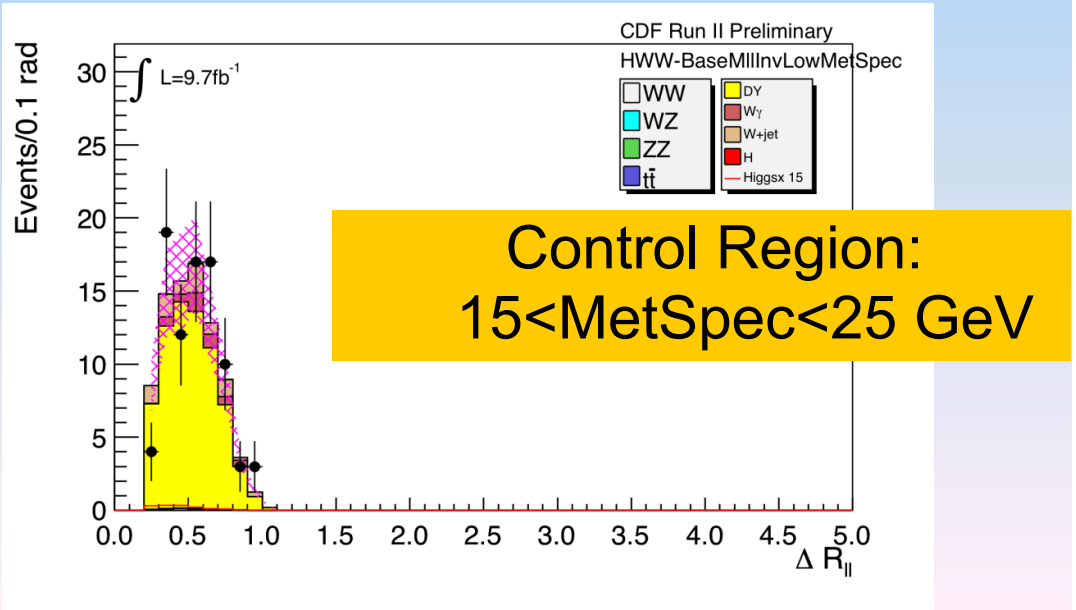




CDF Improvements

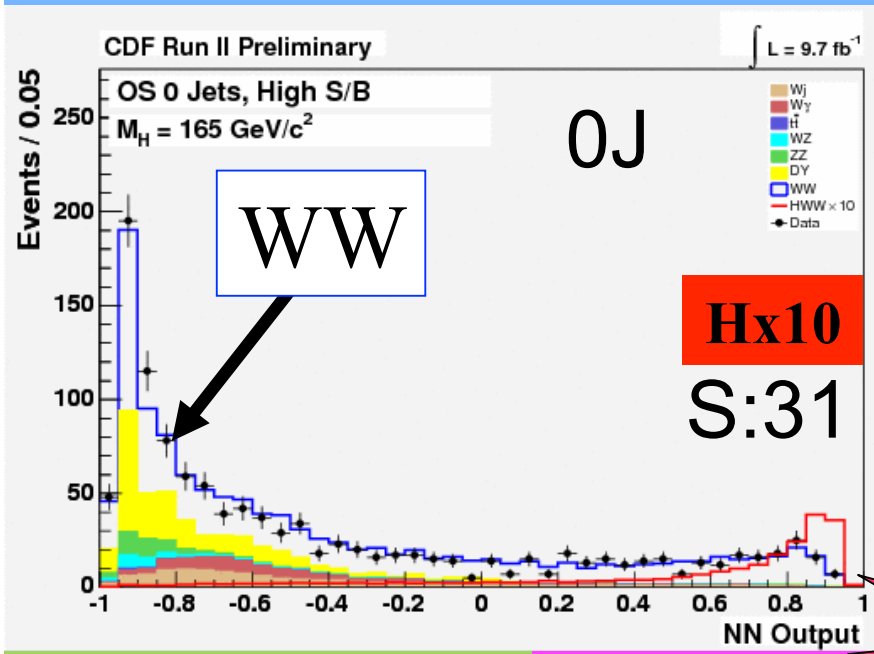
- 0,1 jet: M_H-dependent optimization of NN variables
- ≥2 jet: Alpgen model : use M_{jj} for WH->lν lνjj and rapidity diff for VBF.
- M_{ll}<16 GeV/c^2:
  - MadGraph Wγ: ΔR≥0.1 (was 0.2): 8.5% more Higgs@ M_H=160 GeV/c^2
  - MadGraph Jets +Z: Better modeling of Drell Yan

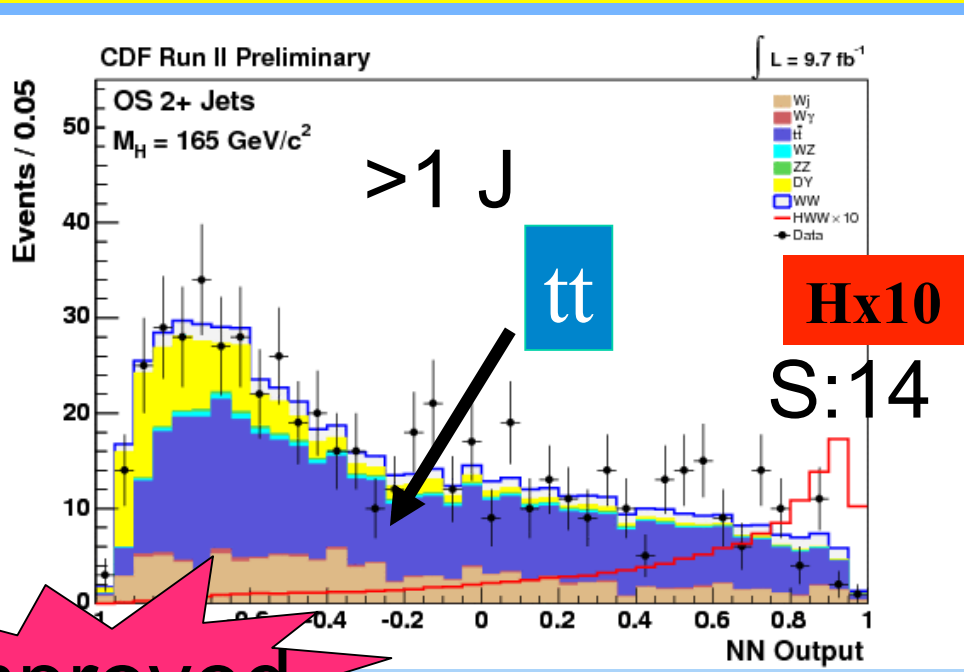




CDF 9.7 fb^{-1}

Expect 67 Signal Events →Total W/D0: 125

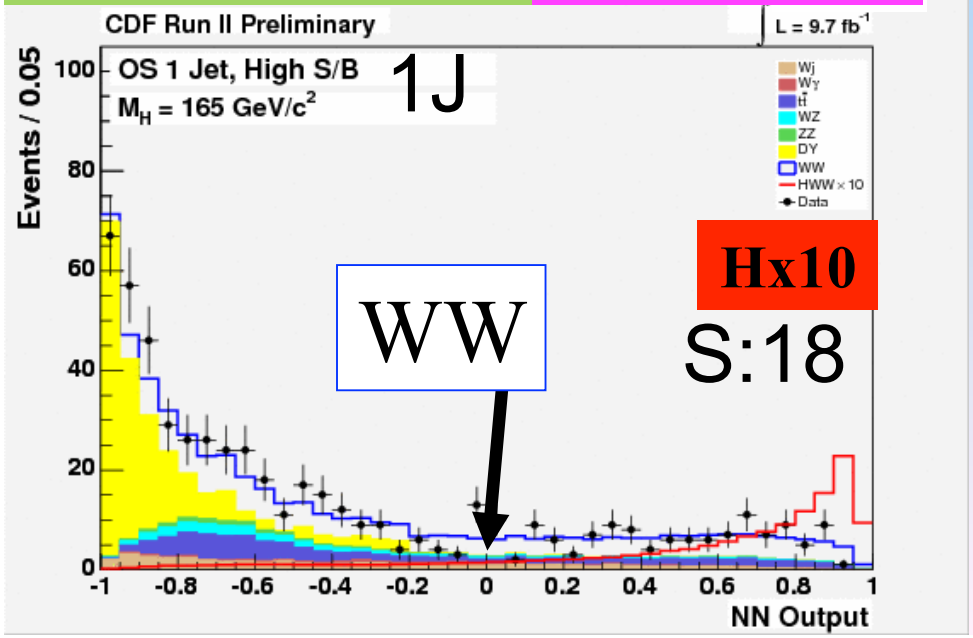


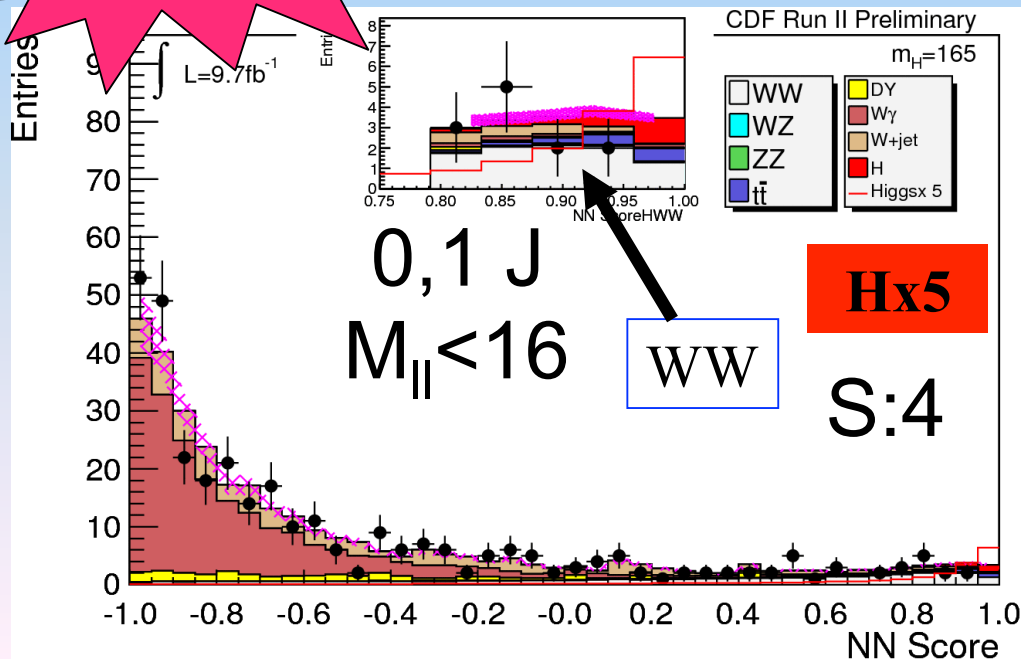


Improved

Fit Background

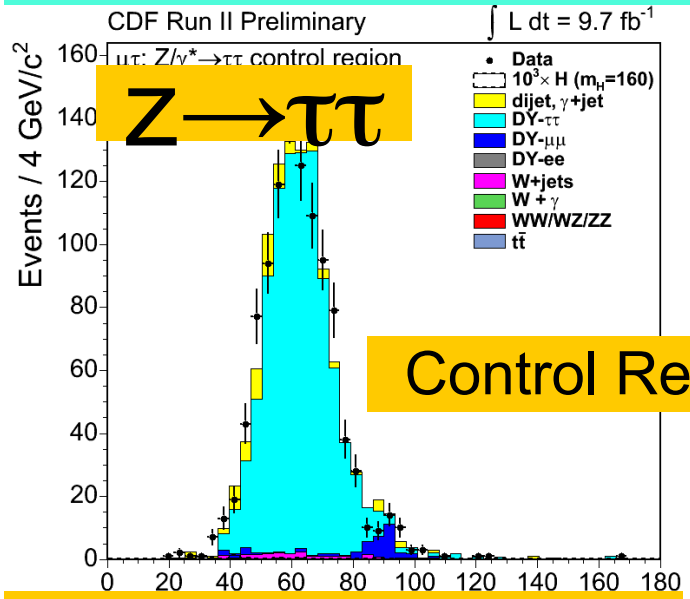
Search H





WW→eτνν,μτνν

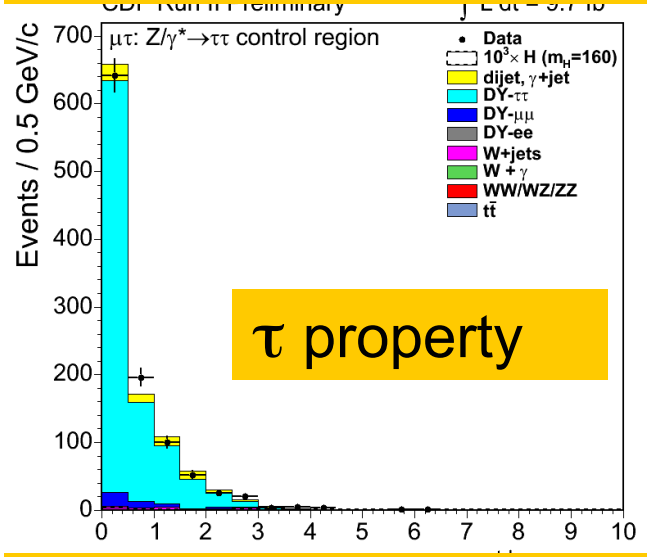
- Control Region: Determine systematics, measure background rates:
- W+jet: $\Delta\phi_{\tau l} > 2$
- QCD: MET < 20 GeV
- DY Z(ττ):$\Delta\phi_{ll,MET} < 0.5$



Z→ττ

Control Region

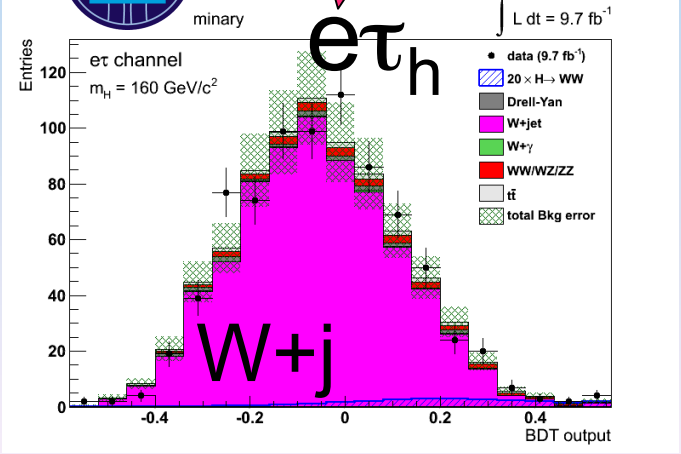
MIτ: invariant mass



τ property

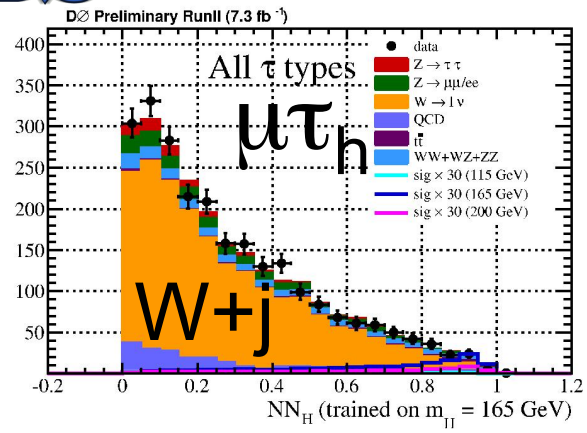
Sum track pt in τ cone

Improved



eτh

W+j



μτh

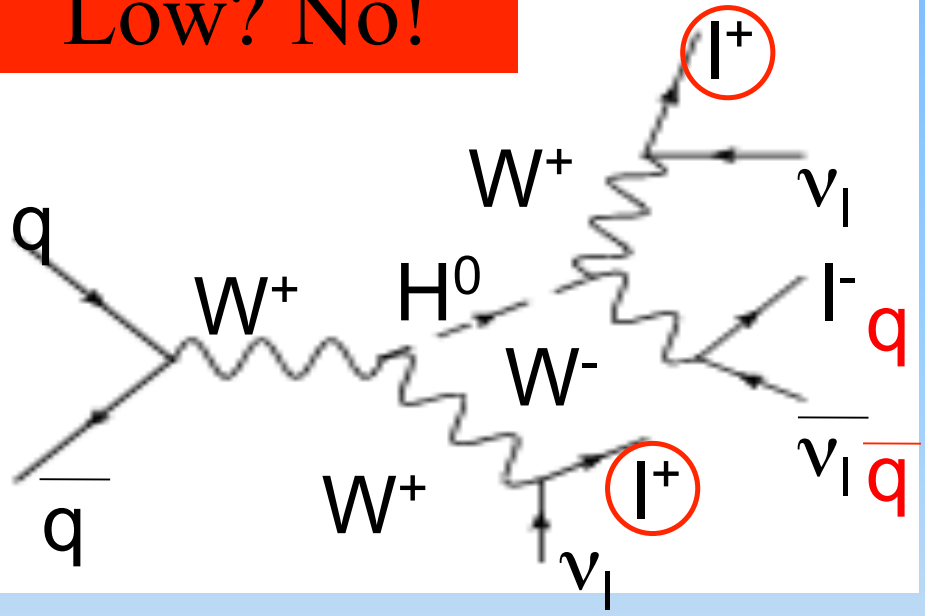
W+j

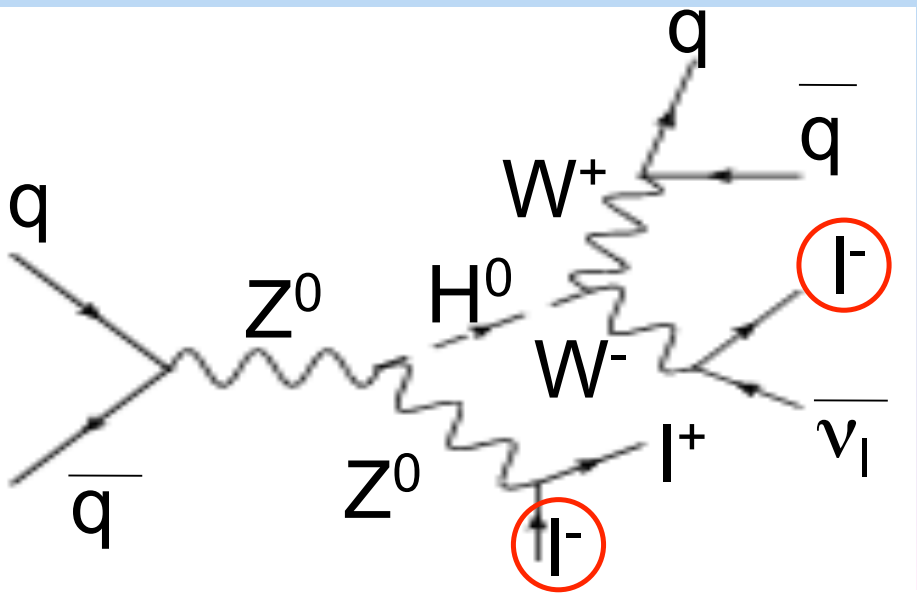
Expected Signal:CDF e,μ 2.4 D0μ:5.3

Same sign Dileptons(CDF/D0), Trileptons(CDF)

No Rate? Too Low? No!

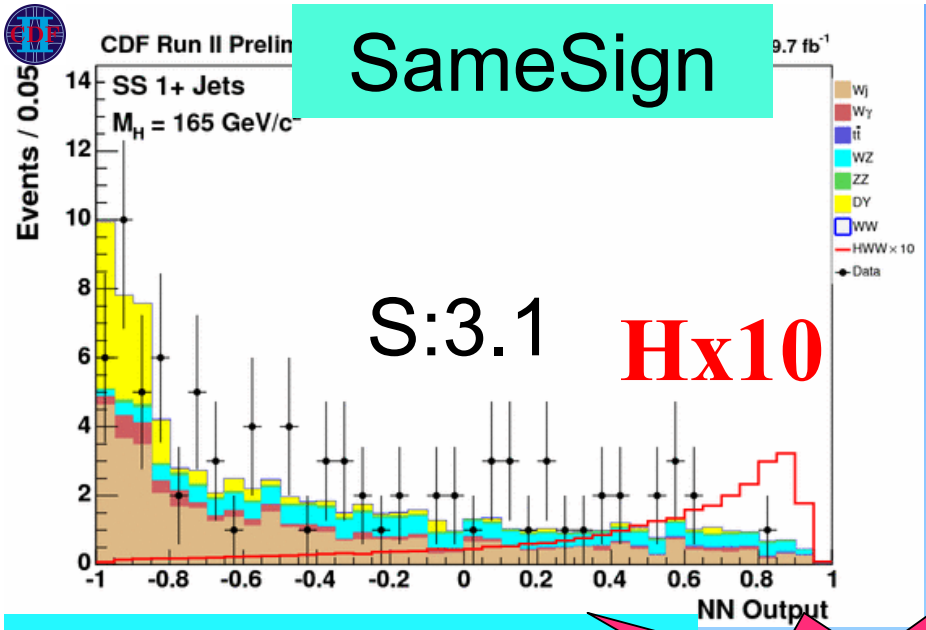
Different Channel
Different Systematics
Different Background



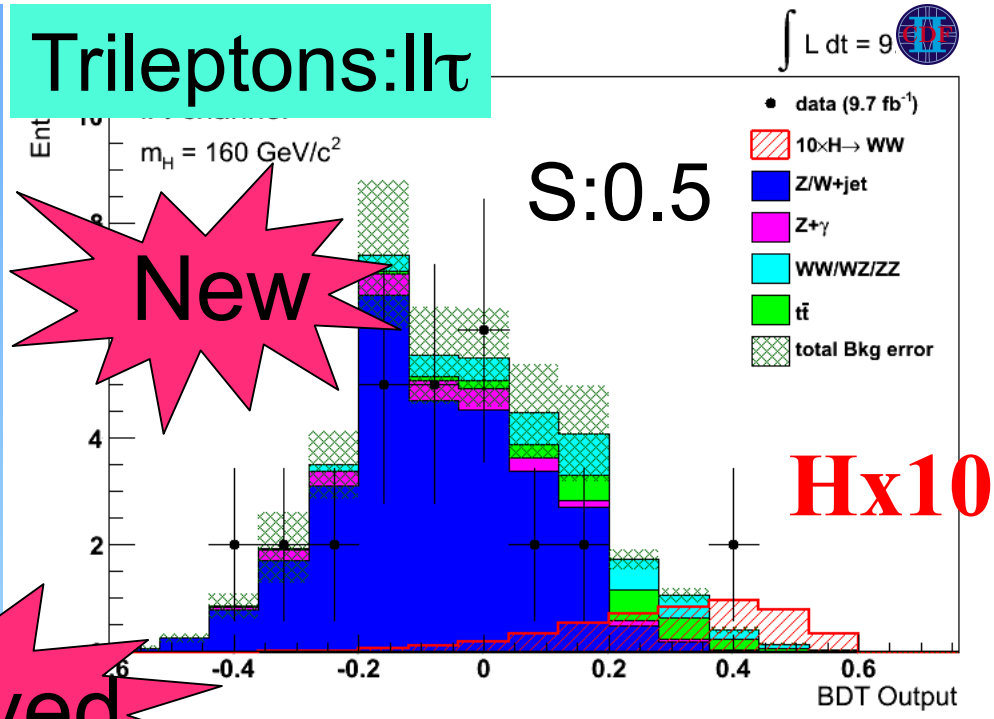


- Same Sign dileptons, **Improved (CDF)**: optimized training:
  - WH
  - ZH
- Trileptons:
  - WH
  - ZH
  - **NEW (CDF)**: $ll\tau_{hadronic}$:

SameSign



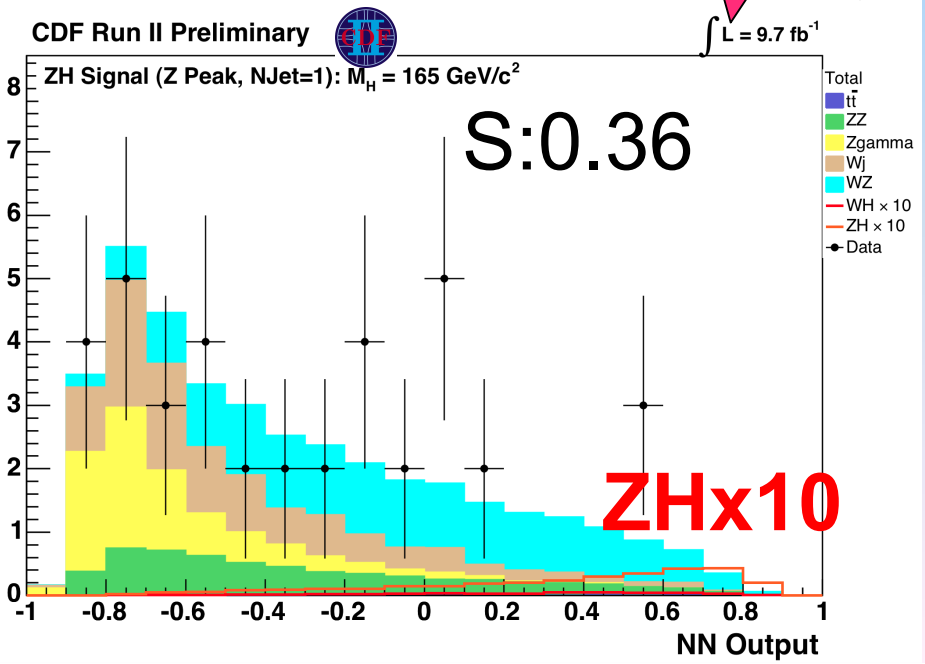
Trileptons:llτ

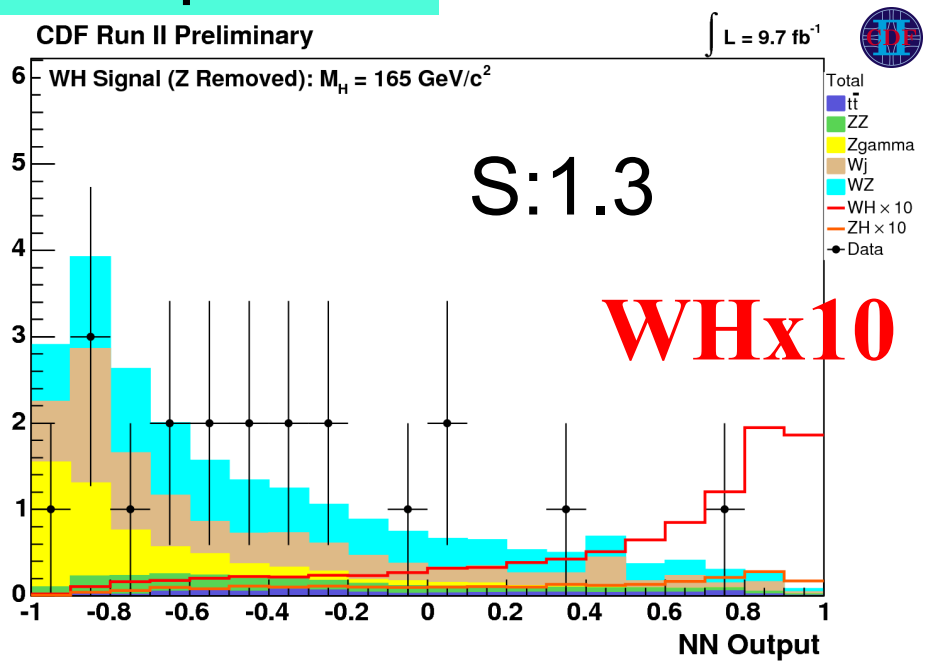


Low, Different Background(WZ)

Improved

Trileptons

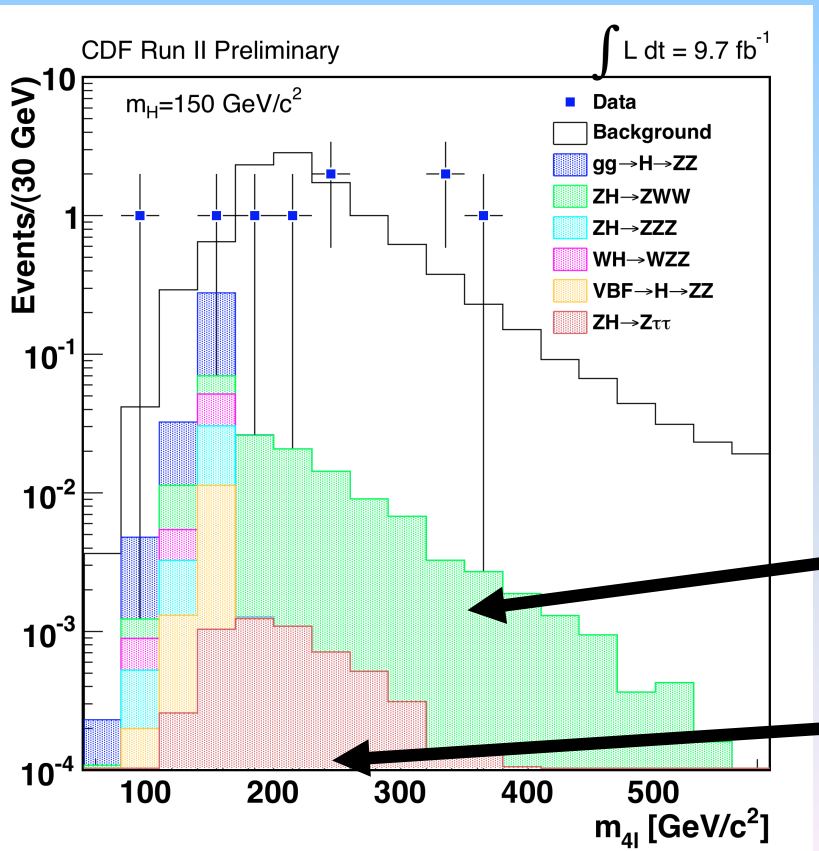




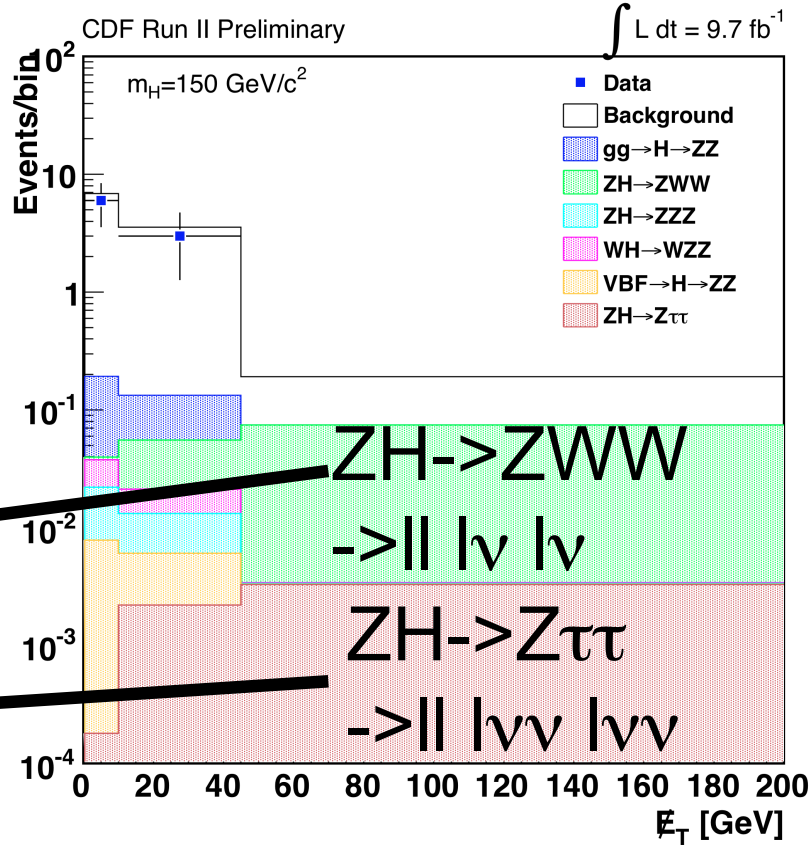
H➔ZZ(*)➔4l

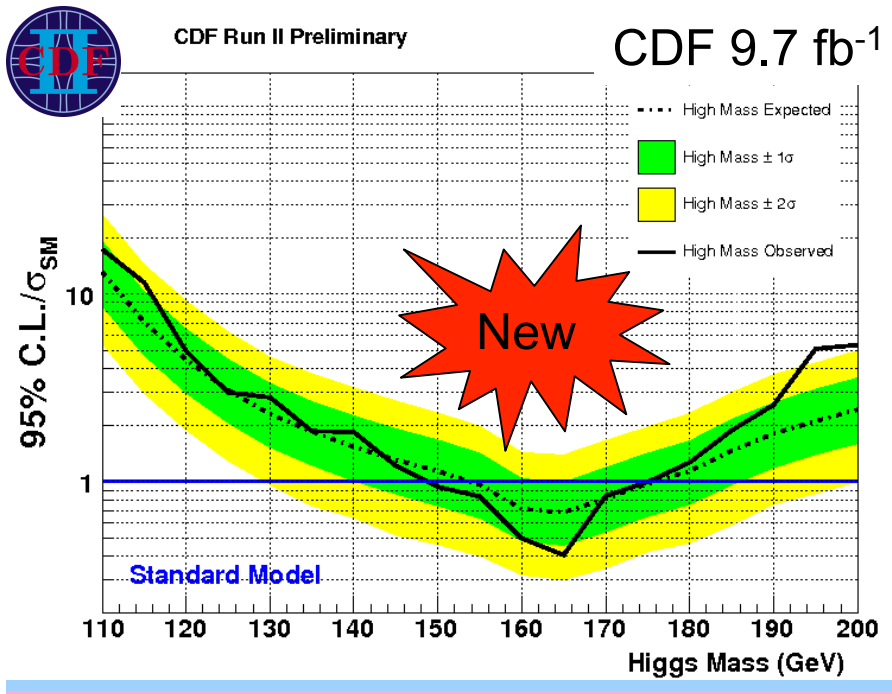
- Four leptons, p_T > 20, 10, 10, 10 GeV/c
- gg->H->ZZ, ZH->ZWW->ll lν lν
- Bin in **MET** to see ZWW; 2d fit.

Improved



S:0.41
@150

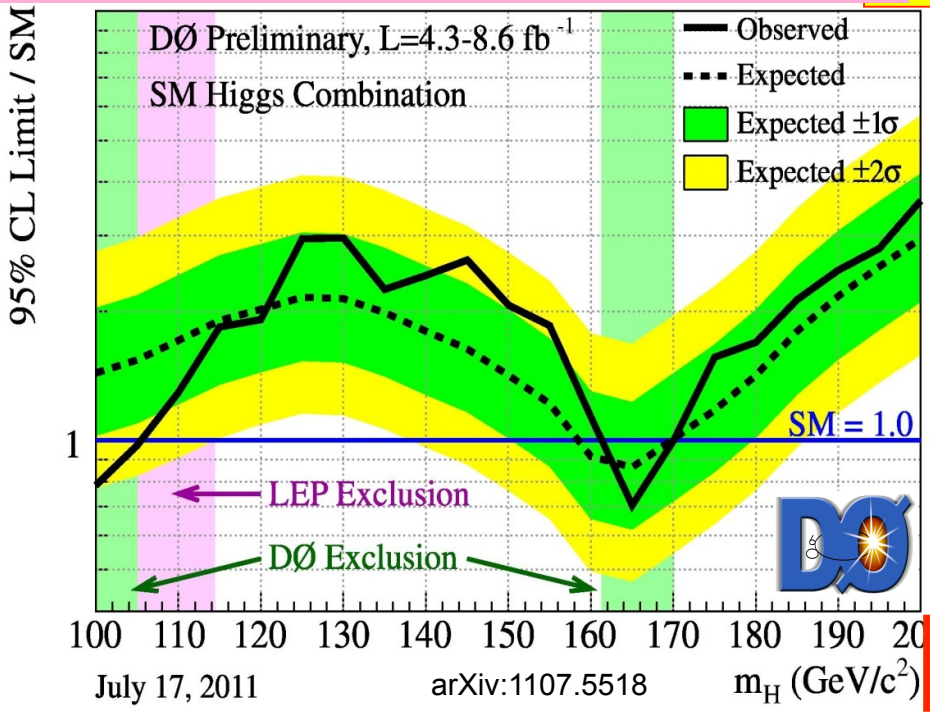


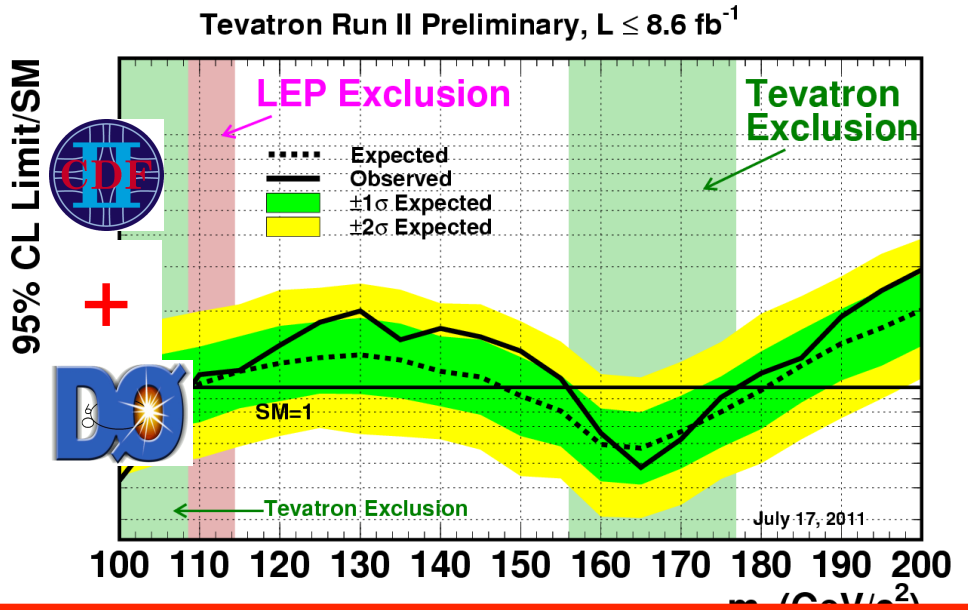


- 8.2 – 9.7 fb^{-1}: 8.5% better
- 2Jet, $M_{ll} \leq 16$ GeV/c^2,τ trilepton, ZZ with MET, optimized M_H-dependent training on 0,1Jet
- All together: 12% better @165!
- CDF Sensitivity close to TeV sensitivity in July2011.

New D0 Result, New Tev soon

July 2011 Tev Sensitivity: 148-180 GeV/c^2





SM Exclusion156-177GeV/c^2

Summary

- "No channel too small" strategy successful: different, backgrounds, systematics, S/B and many channels.
- Combined Tevatron results coming next week. Up to now exclude the Standard Model Higgs at 95% CL for $156 \leq M_H \leq 177$ GeV/c^2.
- Updated CDF results for full Tevatron data sample: Exclusion 148-173, Expected 153-177: comparable to July 2011 Tevatron sensitivity.

M_H (GeV/c^2)	8.2 fb^{-1}		9.7 fb^{-1}		Improvement
	Expected σ/σ_{SM}	Observed σ/σ_{SM}	Expected σ/σ_{SM}	Observed σ/σ_{SM}	
125	3.38	3.28	3.08	2.98	9%
165	0.78	0.77	0.69	0.40	12%

CDF High Mass Higgs limits for Feb/March 2011

High Mass	110	115	120	125	130	135	140	145
$-2\sigma/\sigma_{SM}$	5.39	2.95	1.88	1.29	0.96	0.74	0.64	0.52
$-1\sigma/\sigma_{SM}$	8.61	4.71	2.97	2.05	1.52	1.22	1.01	0.86
Median/σ_{SM}	**13.06**	**7.07**	**4.47**	**3.08**	**2.29**	**1.85**	**1.53**	**1.31**
$+1\sigma/\sigma_{SM}$	19.03	10.25	6.51	4.49	3.34	2.67	2.24	1.91
$+2\sigma/\sigma_{SM}$	26.57	14.32	9.21	6.28	4.62	3.75	3.17	2.69
Observed/σ_{SM}	**17.28**	**11.52**	**4.96**	**2.98**	**2.81**	**1.85**	**1.84**	**1.22**

150	155	160	165	170	175	180	185	190	195	200
0.46	0.40	0.32	0.30	0.34	0.42	0.47	0.58	0.75	0.86	1.00
0.74	0.64	0.48	0.46	0.54	0.65	0.75	0.96	1.18	1.40	1.59
1.13	**0.96**	**0.71**	**0.69**	**0.81**	**0.97**	**1.13**	**1.46**	**1.80**	**2.10**	**2.42**
1.66	1.41	1.03	0.99	1.19	1.41	1.65	2.15	2.63	3.10	3.57
2.32	1.97	1.43	1.39	1.65	1.95	2.31	2.99	3.71	4.30	4.99
0.94	**0.83**	**0.50**	**0.40**	**0.84**	**0.99**	**1.26**	**1.87**	**2.56**	**5.10**	**5.33**