WH Analysis

- Intro (advertisement)
- Basic Selection
- Additional Cuts
- Comments/Improvement?
- A Roadmap

Intro

Current (and final pre-TeV?)

$M_H > 115$ GeV ?	(S.M, LEP)
$M_h > 90$ GeV	(SUSY, LEP)
$M_H < 170$ GeV	(indirect, loose)
$M_h < 130$ GeV	(SUSY req.)

TeV Run I: Limits, 100x too high

Details of Run II study group (SHWG):
http://fnth37.fnal.gov/higgs/higgs3.ps.gz
(also Bhat et.al. Hep/ph-0001152)

Critique of SHWG (Hobbs, 10/99)
http://www-d0.fnal.gov/Run2Physics/d0_private/minutes/minutes_03.html

W+bb Background (theory):
Phys. Rev. D60 (1999) 011501

Basic Selection, W+ 2 bjets

1 e(μ), p_T>20 GeV, $|\eta| < 2$

$\not{E}_T$ > 20 GeV

$\geq$ 2 tagged jets, E_T>15 GeV, $|\eta|$<2

(probably tight/loose)

Source		σ*B (fb)	ε(%)
WH, M=110		62.3	13
Bkg,	Wbb	3500	5.6
	WZ	165	10
	tt	2200	9
	tb	220	5.2
	tqb,tq	800	3.3

Basic, con't

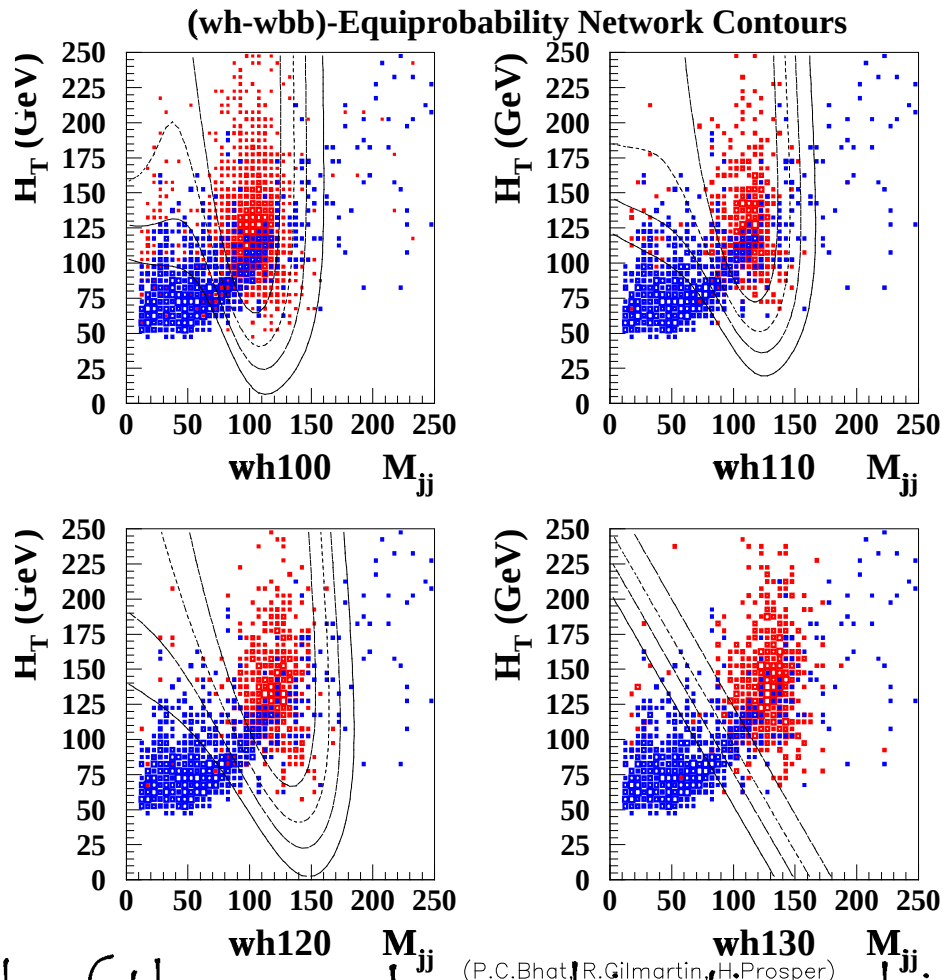
And look at the effect of the selection cuts:

	WH	Wbb	WZ
1 lepton	0.53	0.48	0.48
E_T(lepton)	0.40	0.36	0.34
MET	0.35	0.29	0.29
double-tag	0.13	0.056	0.094

The background cross sections are generally poorly known (20-30% relative)

Additional Selection

- Main feature:
  - bb system has a definite mass, M_H
  - always end up using M_{bb}...
- Considered many other variables
  - Kinematic: H_T, E_T^e
  - Shape: Aplanarity, sphericity
  - Others; $\Delta R(jj)$, ...
- and Different techniques
  - square cuts, grid search, theoretical range ($\pm 2\sigma$), multivariate



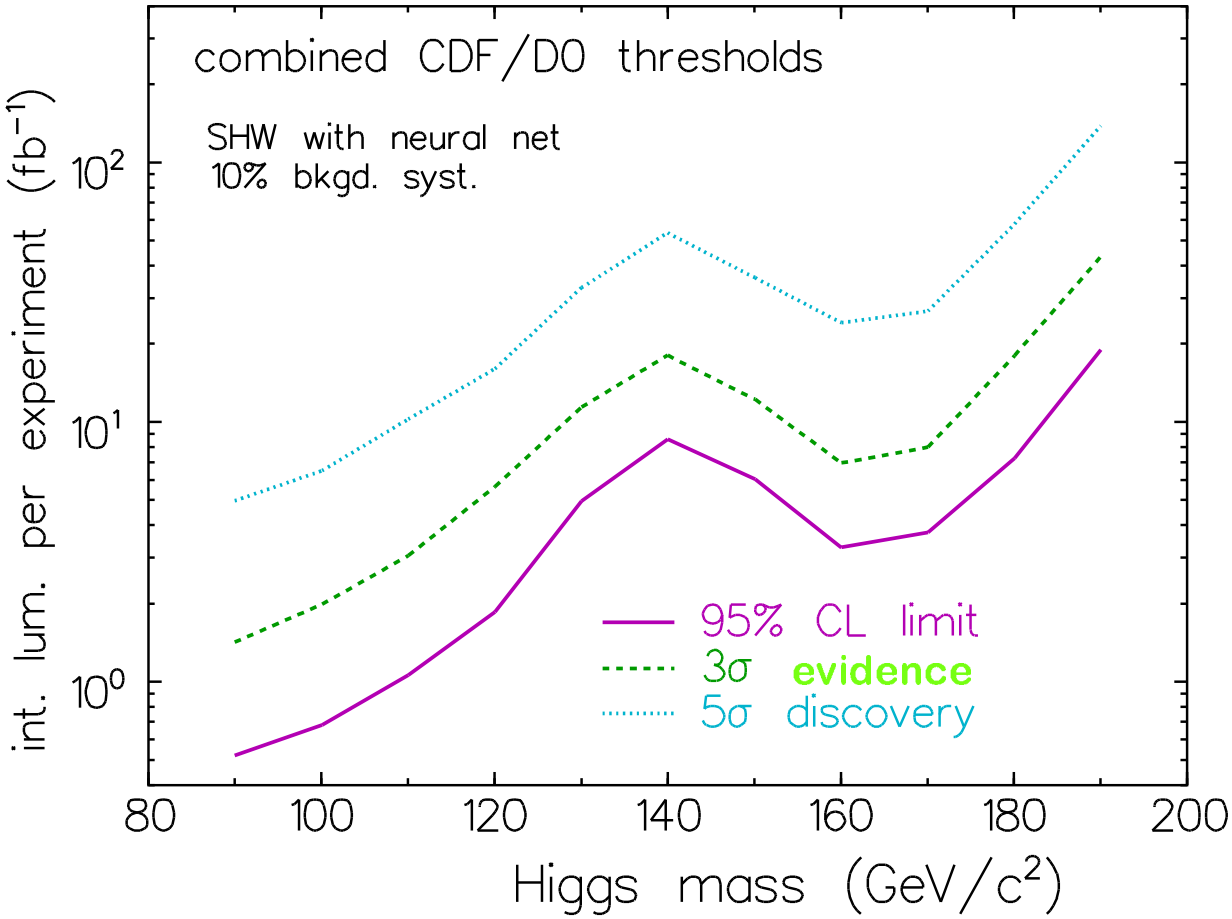
(P.C.Bhat, R.Gilmartin, H.Prosper)

All of the good combinations bias M_{bb} spectrum (or direct cut)

Get (Events/fb)

	M_H=110	120	130
Signal	4.8	4.4	3.7
Bkg	19	26	46

The overall answer (all channels)



For $M_H < 130$, sensitivity about equal in WH, ZH (including nn modes)

Comments

- Statistical Significance, (gaussian)
  - $\mathcal{S} \equiv S/\sqrt{B} = \frac{\sigma_S A_S}{\sqrt{\sigma_B A_B}}\sqrt{\mathcal{L}}$

    ($\mathcal{S}$=3 is 3σ effect)

    $$\mathcal{L} = \mathcal{S}^2 \frac{\sigma_B A_B}{(\sigma_S A_S)^2}$$

  - improvements in signal enter quadratically. Improvement in bkg linearly

If $A_S \ll 1$, then work on signal, otherwise drive down bkg

Comments

Often in searches B = few events and effective statistical (im)precision is large so systematics have modest impact.
For WH,

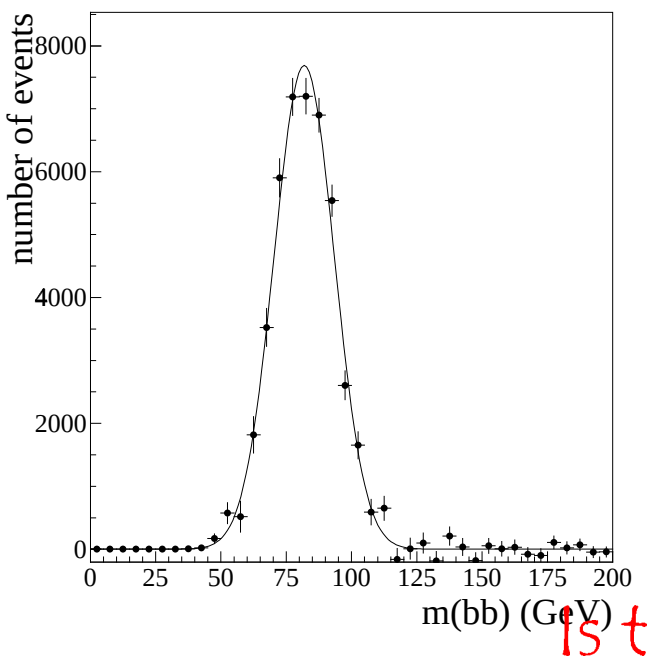
$$B = 25 - 500 \text{ evts},$$
$$\text{so } 1/\sqrt{B} = 5\text{–}20\%$$

and systematic studies are more important

Optimization must also worry about systematics...

Comments

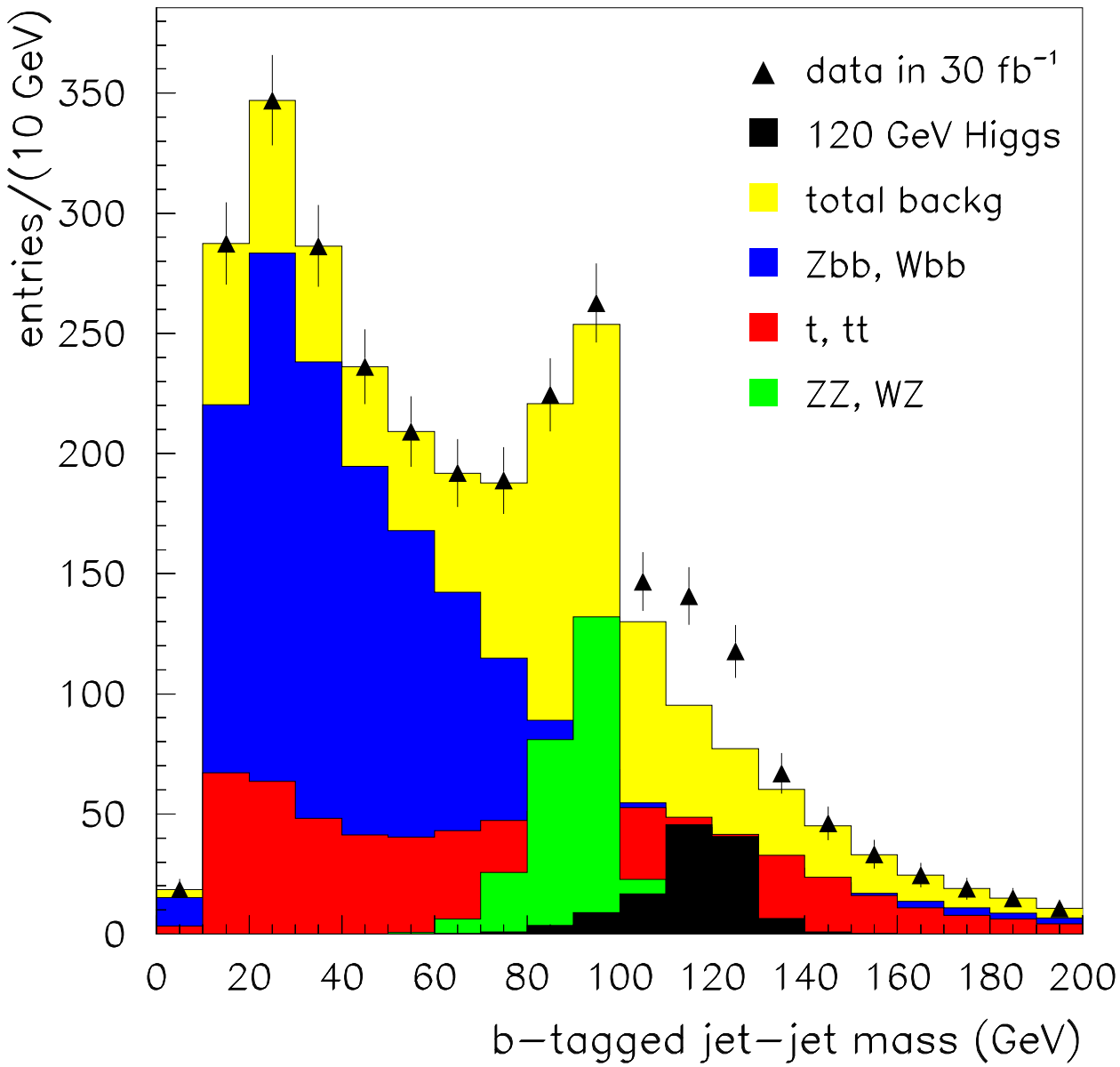
- $Z \rightarrow bb$
  - energy scale corrections
  - demonstrate bb mass resolution using data
  - check efficiency vs. purity using ratio $Z \rightarrow bb / Z \rightarrow ee(\mu\mu)$



Simulated $Z \rightarrow bb$ signal (after bkg subtraction) in 2 fb^{-1} (Uli)

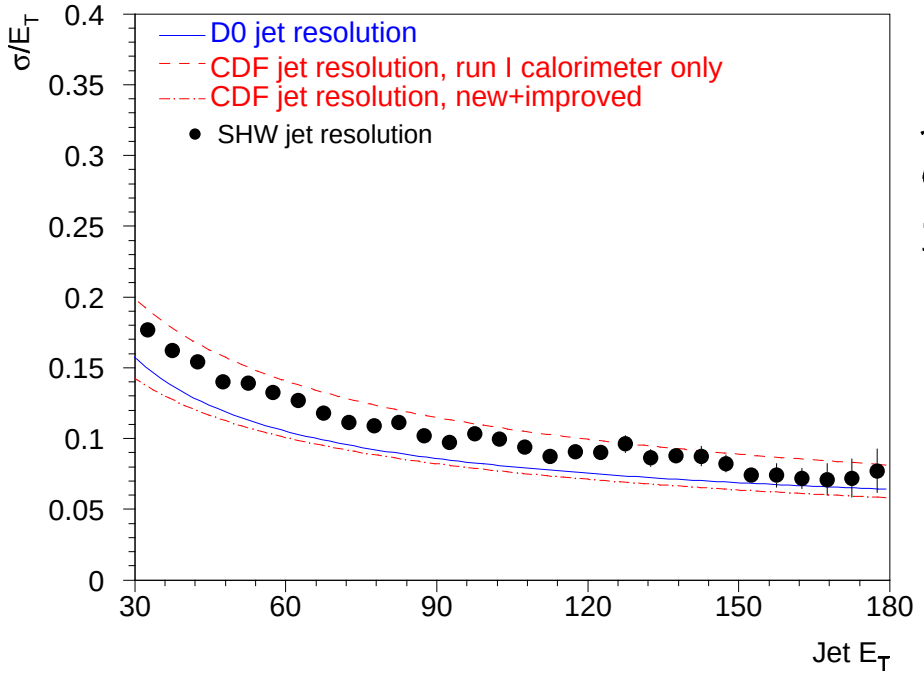
Is this really necessary?

You bet...


entries/(10 GeV)
0
50
100
150
200
250
300
350
0
20
40
60
80
100
120
140
160
180
200
b−tagged jet−jet mass (GeV)
data in 30 fb^{-1}
120 GeV Higgs
total backg
Zbb, Wbb
t, tt
ZZ, WZ

Comment: Mass Resolution

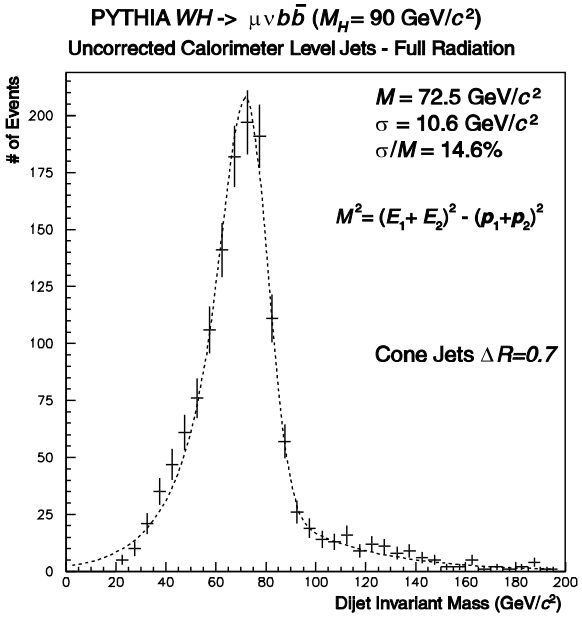
For SHWG assume a 30% better resolution for data than SHW simulation, which is apparently OK

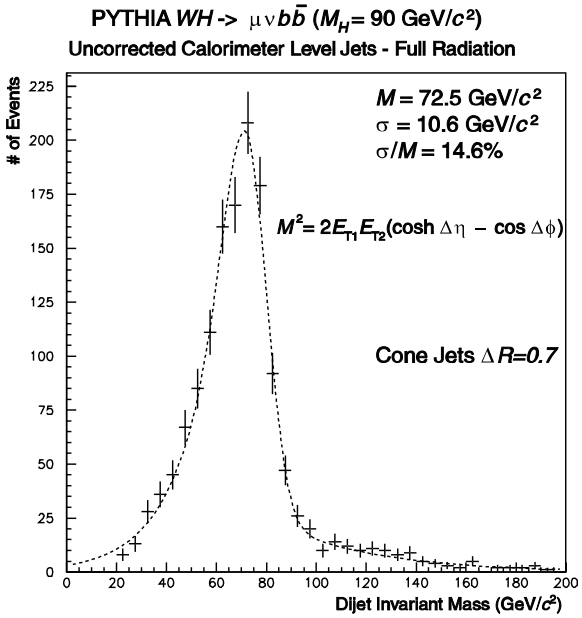


Jet-g balancing CDF or D0 and SHW resolution

since it looks like we're already there...

But we need to watch out for tails





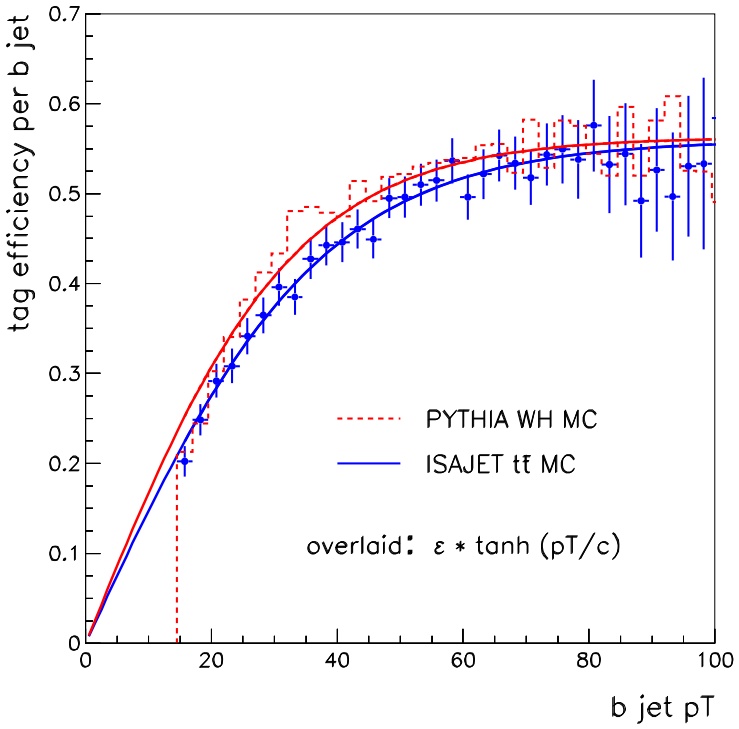
A high priority is to check this…

Comment: Tagging

- Once basic tagging works
  - keep working on improvements
  - Higgs jets lower E_T than tt:

    2nd jet, $\langle E_T \rangle$ = 30 GeV

    turn on



  - increase purity (e.g., direction constraint)

Roadmap

- Short term: Use D0 code, not SHW
  - generate MC
  - run basic selection
  - get expected answers?
- Longer term
  - triggers (and efficiencies)
  - optimization
  - data verification
- What happens in 2 fb^{-1}?
  - Measure the bkgs (not been done)
  - single top (for physics)
  - technicolor?