RHUL Analyses Plans regarding Top Physics

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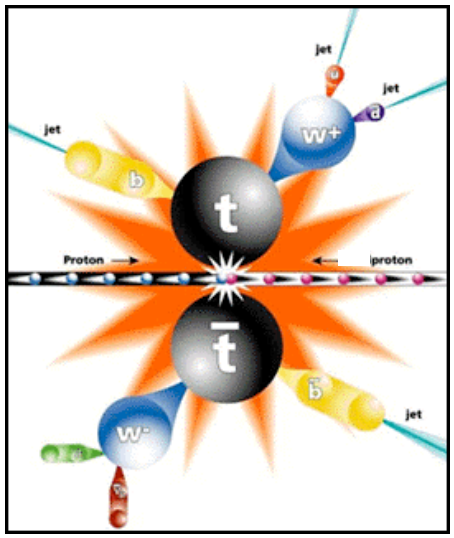
For the RHUL group

UK Top meeting June 17th 2008

Outline

- Lepton+Jet commissioning tt cross-section analysis
- Top as Tool: ttH($\rightarrow$WW)



From R. Bailey (Top 2008)

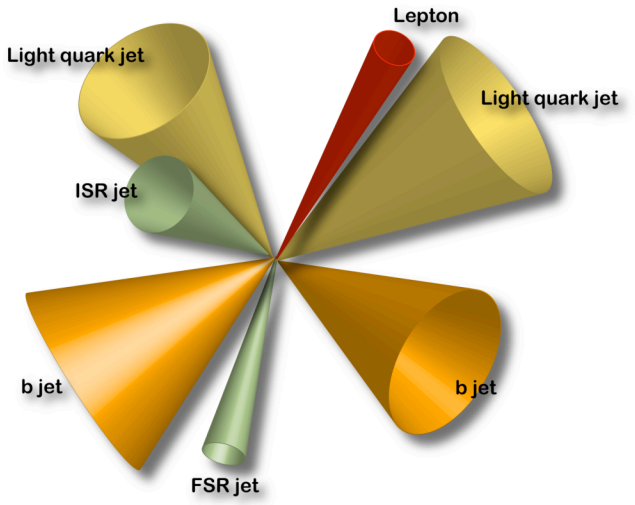
Month	Phase	Days physics	Efficiency factor	Peak luminosity	Delivered luminosity
Jan	Cooldown and Hardware Commissioning and Machine checkout				
Feb					
Mar					
Apr					
May					
June					
Jul					
Aug	Beam Commissioning Physics run				
Sep					
Oct					
Nov		40	0.1	$5\ 10^{31}$	20 pb^{-1}
Dec	Shutdown				
Jan					
Feb					
Mar	Machine checkout				
Apr	75ns Commissioning				
May	Physics run	150	0.2	10^{33}	2.5 fb^{-1}
June					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					

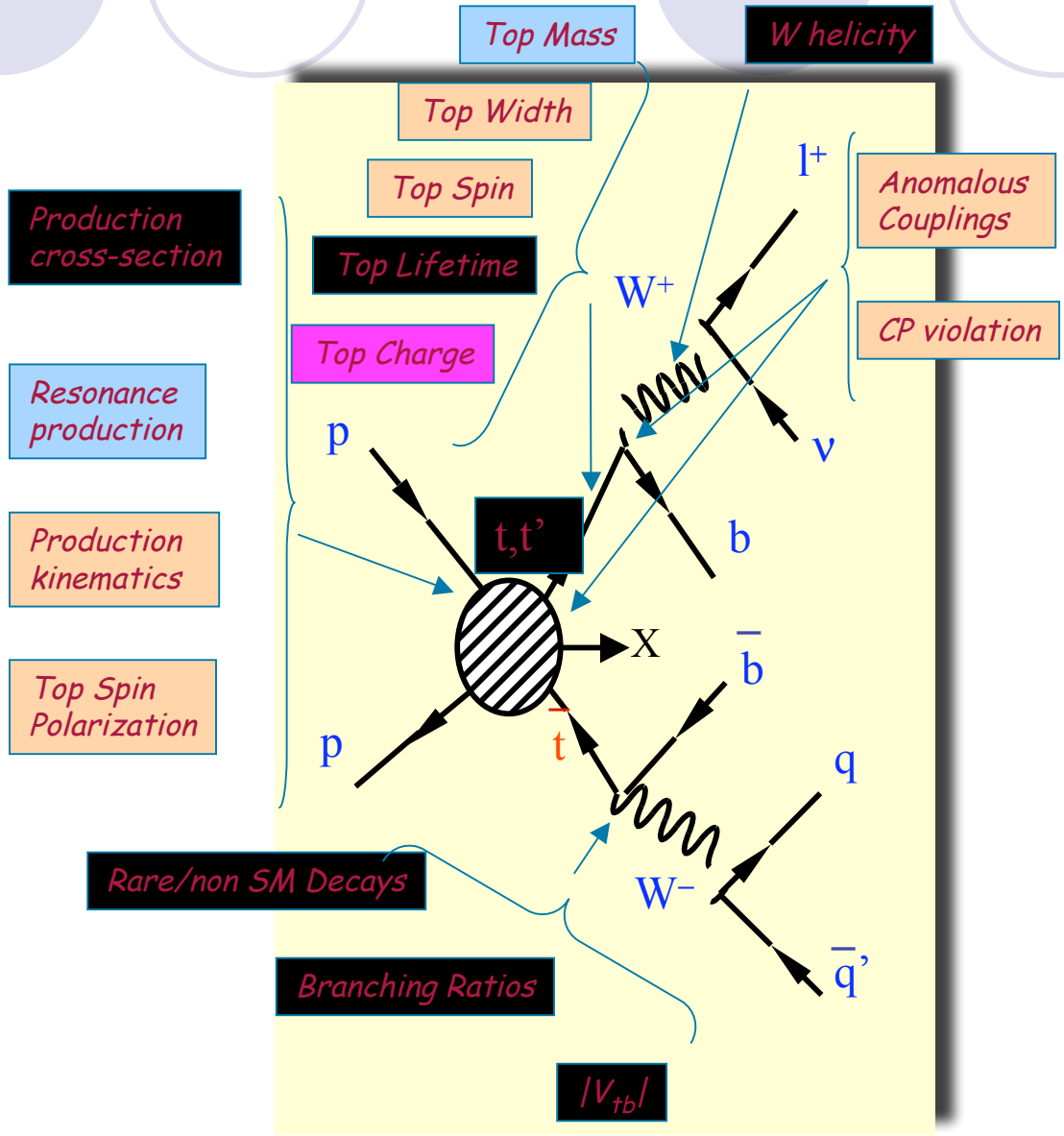
10 TeV

14 TeV

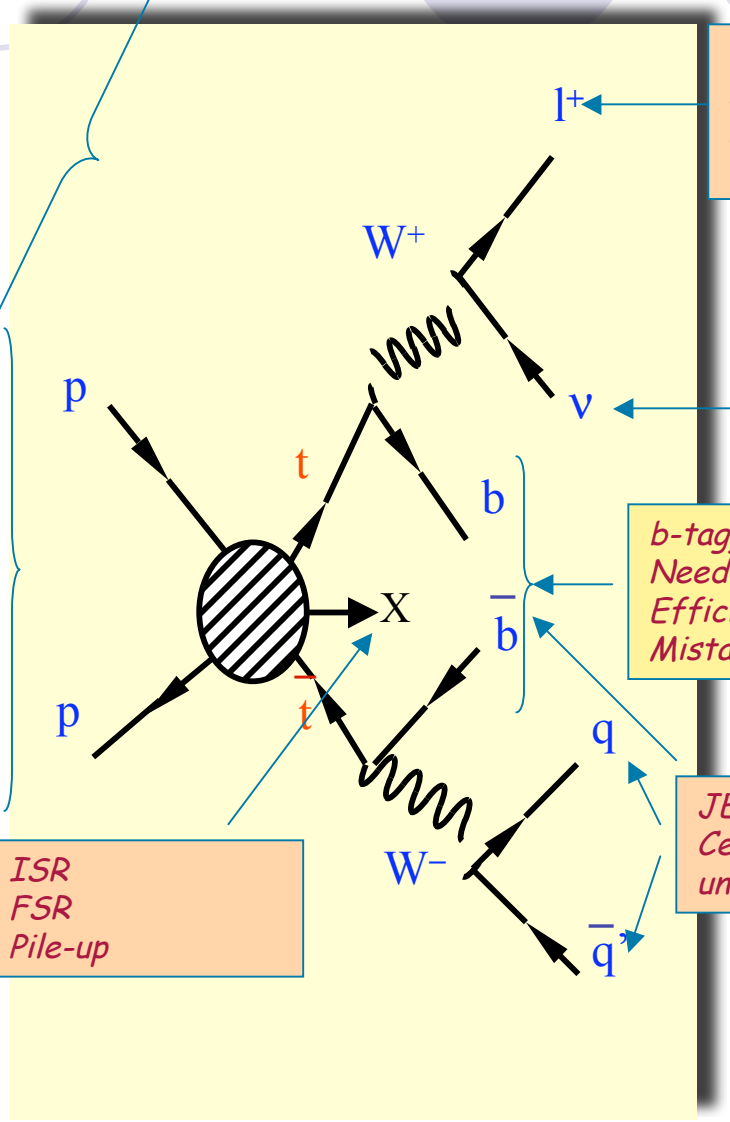
$t\bar{t}$ cross-section in L+J channel

- Realistically 2008-2009 will entirely be commissioning years
- Before we can claim new physics (including in the top sector), imperative to establish SM processes
  - Including Top signal
- Top requires a lot of understanding of the detector
  - Important to push for this to happen with the 10TeV run




Top Mass
W helicity
Top Width
Top Spin
Top Lifetime
Top Charge
Production cross-section
Resonance production
Production kinematics
Top Spin Polarization
Rare/non SM Decays
Branching Ratios
$|V_{tb}|$
Anomalous Couplings
CP violation
l^+
W^+
ν
b
t,t'
p
p
X
$\bar{b}$
$\bar{t}$
q
W^-
$\bar{q}'$

Data Driven backgrounds:
W+jets
QCD
MC backgrounds:
Diboson
Single-top



Electron-muon understanding:
Lepton ID
Lepton trigger
Fake rates

MET understanding

MC generators
PDF

b-tagging:
Need algorithm
Efficiency
Mistag rate

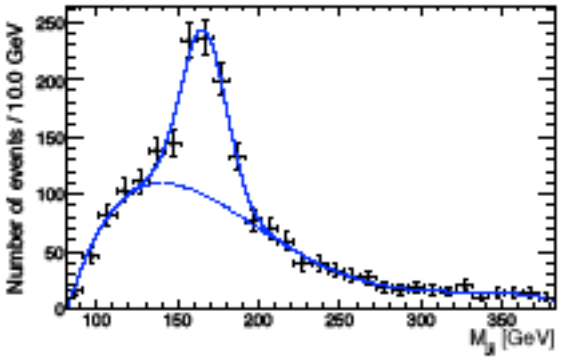
Parton assignment

JES:
Central values
uncertainties

ISR
FSR
Pile-up

$t\bar{t}$ Cross-section in L+J channel

- T6 CSC note
- Best selection:
  - 1 e or μ p_T>20 GeV
  - ME_T > 20 GeV
  - ≥ 4 jets p_T>20 GeV
  - ≥ 3 jets p_T>40 GeV
  - 1 of 3 $|m_{jj}-M_W|$ < 10 GeV



- W+jets:
  - Scale from Z+jets
  - For 100pb-1: 50% uncertainty
  - With 1fb-1: 20%
- QCD: smaller than W+jets…

Electron channel

Sample	default	W const.
$t\bar{t}$	2555	1262
hadronic $t\bar{t}$	11	4
W+jets	761	241
single top	183	67
$Z \to ll$ +jets	115	35
$W\,b\bar{b}$	44	15
$W\,c\bar{c}$	19	6
WW	7	4
WZ	4	1
ZZ	0.5	0.2
Signal	2555	1262
Background	1144	374
S/B	2.2	3.4

Source	Likelihood fit		Counting method (elec)	
	Electron	Muon	Default	W const.
Statistical	10.5	8.0	2.7	3.5
Lepton ID efficiency	1.0	1.0	1.0	1.0
Lepton trigger efficiency	1.0	1.0	1.0	1.0
50% more W+jets	1.0	0.6	14.7	9.5
20% more W+jets	0.3	0.3	5.9	3.8
Jet Energy Scale (5%)	2.3	0.9	13.3	9.7
PDFs	2.5	2.2	2.3	2.5
ISR/FSR	8.9	8.9	10.6	8.9
Shape of fit function	14.0	10.4	-	-

Likelihood method: $\Delta\sigma/\sigma = (7(\text{stat}) \pm 15(\text{syst}) \pm 3(\text{pdf}) \pm 5(\text{lumi}))\%$

Counting method: $\Delta\sigma/\sigma = (3(\text{stat}) \pm 16(\text{syst}) \pm 3(\text{pdf}) \pm 5(\text{lumi}))\%$

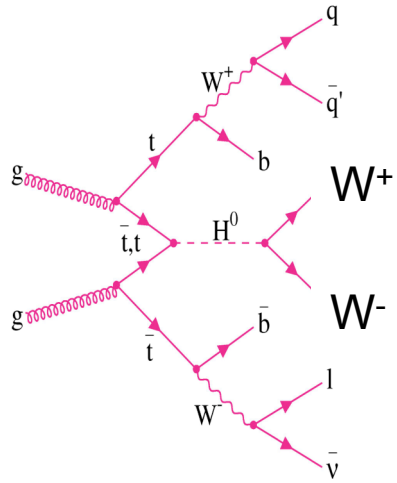
$t\bar{t}$ Cross-section in L+J channel

- My activities:
  - Reproduce CSC numbers
  - Try χ^2 a-la-CDF instead of using m_{jj} cut
  - Look into:
    - Trigger efficiencies
    - W+jets backgrounds
    - QCD backgrounds
    - JES determination

$$\chi^2 = \sum_{i=l,\,jets} \frac{(p_t^{i,meas} - p_t^{i,fit})^2}{\sigma_i^2} + \sum_{i=x,y} \frac{(p_i^{UE,meas} - p_i^{UE,fit})^2}{\sigma_i^2}$$
$$+ \frac{(M_{jj} - M_W)^2}{\Gamma_W^2} + \frac{(M_{lv} - M_W)^2}{\Gamma_W^2} + \frac{(M_{bjj} - M_{fit})^2}{\Gamma_t^2} + \frac{(M_{blv} - M_{fit})^2}{\Gamma_t^2}$$

$t\bar{t}H(\rightarrow WW)$ activities

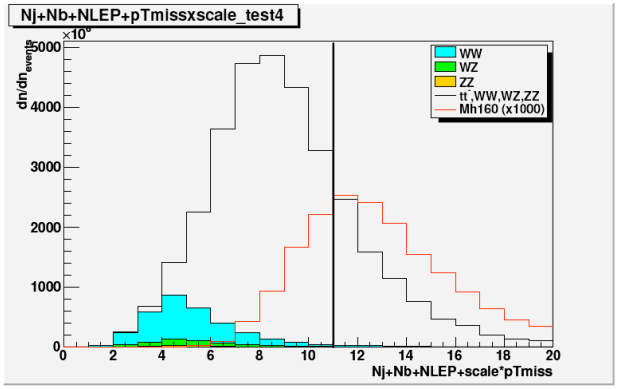
- Pedro & Clive (ATLFAST study)
- Motivation:
  - Determination of CP parity of h,A using kinematics of t and $\bar{t}$
- Channels:
  - $H\rightarrow\gamma\gamma$: 100fb^{-1} needed
  - Now look at $H\rightarrow WW$, keeping in mind that the 2 top's need to be reconstructed
- Preselection cuts:
  - $|\eta|<3.2$ for jets and muons
  - $|\eta|<2.5$ for b-jets and electrons
  - $\geq$ 1 trigger lepton ($p_{Te}>25$GeV, $p_{T\mu}>20$GeV)

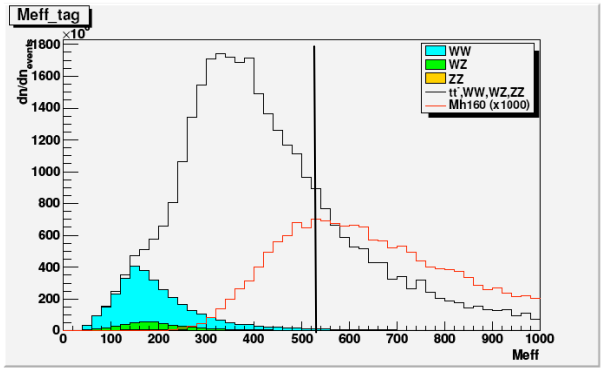


	Mh120	Mh140	Mh160	ttbar	WW	WZ	ZZ	bktotal
N_{MC}	15704	16209	16704	21889	16674	8946	5993	
Eff	0.39	0.41	0.42	0.27	0.24	0.18	0.12	
Norm to 10fb^{-1}			1095.52					1.58e+06
$S/\sqrt{B}$	0.28	0.67	0.87					

ttH(→WW) activities

- $t\bar{t}$ is overwhelming background
- 2 promising discriminating variables
  - $N_j+N_b+N_l+\beta p_{Tmiss}>11$
    - $\beta=0.05$
  - $H_T= |p_{T,miss}| + \sum_{i=e,\mu,jets(pT>20GeV/C)} |p_{T,i}|$ > 525GeV
- Next steps:
  - Focus on Top and W reconstruction cuts





	Mh120	Mh140	Mh160	ttbar	WW	WZ	ZZ	bktotal
N_{MC}	9772	10937	11815	5469	441	230	123	
Eff	0.24	0.27	0.29	0.07	6.3e-03	4.6e-03	2.46e-03	
Norm to $10fb^{-1}$			774.88					344037
$S/\sqrt{B}$	0.37	0.98	1.32					

Conclusions

- Top physics will be very important to understand the detector
- Most fundamental aspect is cross-section
  - Could even show sign of NP (SU(4) as big as W+jets!)
- Top reconstruction will help for many other signals:
  - eg ttH