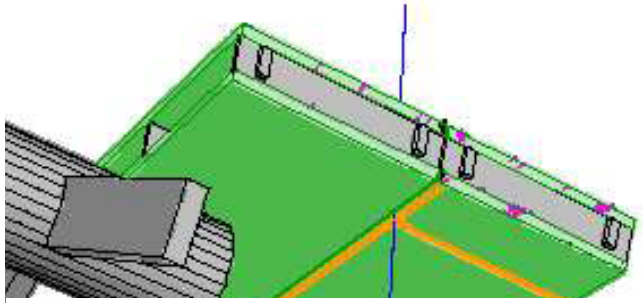
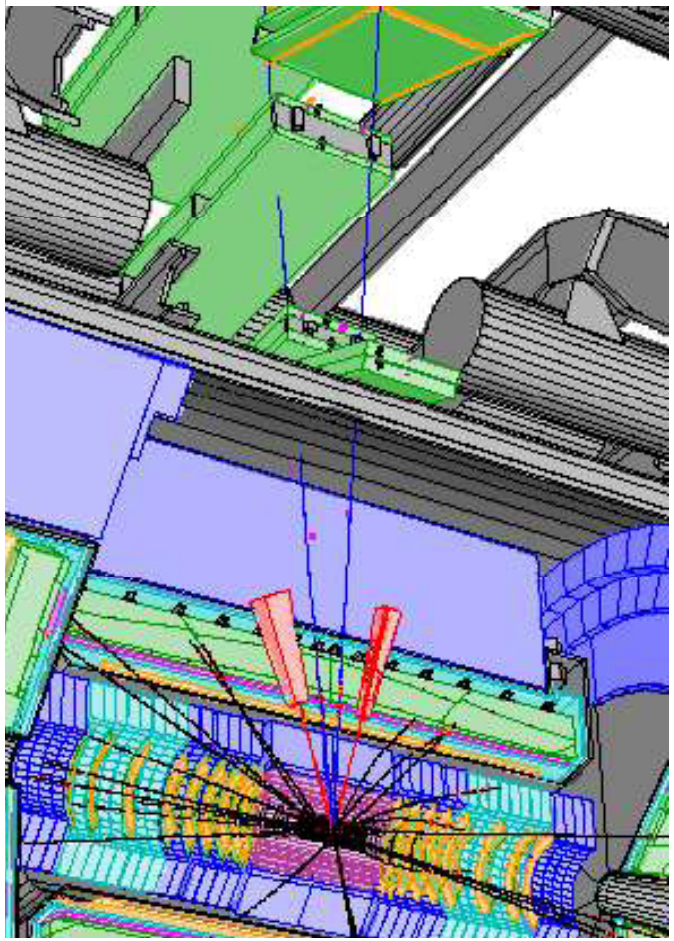


Trigger Menus for Initial Running



Outline:

- Introduction
- Characteristic event rates
- Menus for $10^{31}cm^{-2}s^{-1}$
- Discussion

Ricardo Gonçalo (RHUL)
Trigger Menus Meeting – May 22, 2007

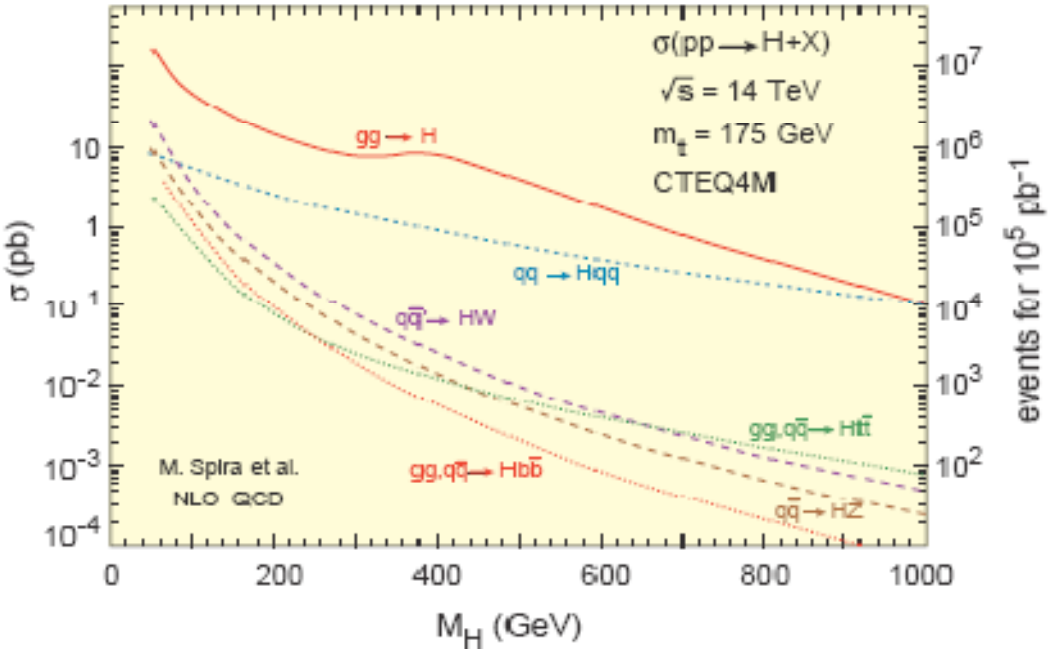
- The aim of this meeting is to get input from Higgs analyses on trigger issues
  - What triggers do we need to keep data for Higgs analyses?
  - What are we likely to get for the first year/2 years?
  - What do we have now?

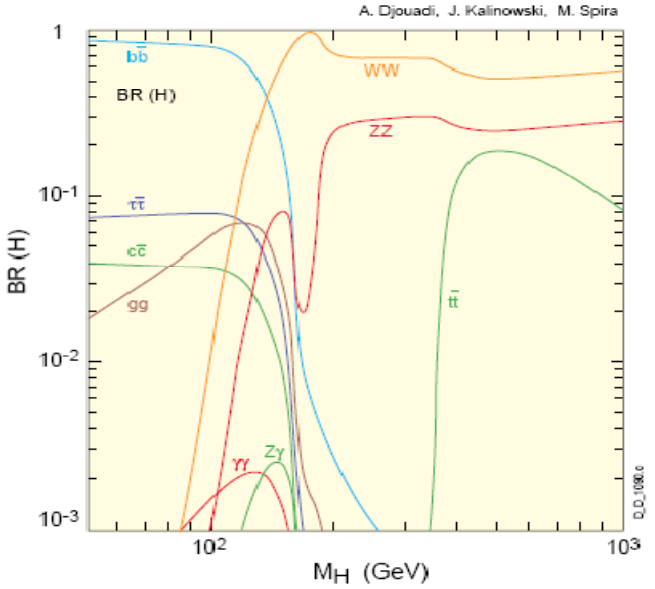
- Initial menu for 10^{31} $cm^{-2}s^{-1}$ presently being defined by trigger community
  - This will provide the first physics papers from ATLAS:
    - charged particle multiplicity
    - total cross section
    - …

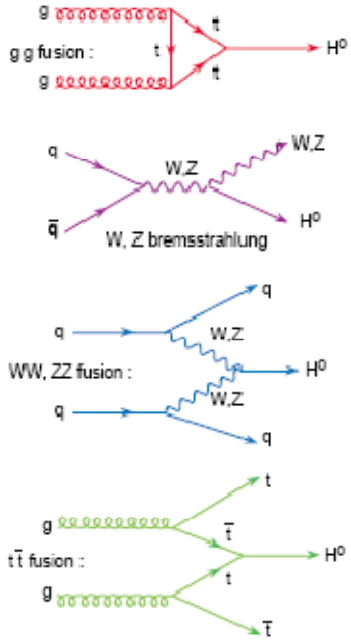
- Menu for 10^{32} $cm^{-2}s^{-1}$ is difficult to guess
  - It will depend a lot of what is found with 10^{32} $cm^{-2}s^{-1}$
  - BUT: most surely will be used for some SM measurements

- Initial menus based on high-lumi menus
  - Use softer cuts than for high lumi
  - This can mean both pT and quality cuts

- In Standard Model minimal Higgs sector:
  - Main production mode is gluon fusion
  - Vector boson fusion (VBF) comes second in most of allowed M_H range
- Main branching ratio to b-quark pair up to M_H~135 GeV
  - $H \rightarrow \tau\tau$ lower by factor of ~10
  - Hard to distinguish from QCD background
- …and to a WW pair above M_H~135 GeV
  - Much cleaner signal but smaller rate
  - $H \rightarrow WW \rightarrow l^{\pm}\nu + X$ (BR~30%)







Higgs production rates

Standard Model NLO (ATL-COM-PHYS-2007-024) events/day vs. average lumin. ($cm^{-2}s^{-1}$)

Process	M_H (GeV)	σ (pb)	Higgs decays	10^{30}	10^{31}	10^{32}	10^{33}	10^{34}
Gluon fusion	120	36.51	68% bbar	**3.1**	31	**315**	3154	**31544**
	140	27.86	48% WW*	**2.4**	24	**240**	2407	**24071**
	180	17.88	93% WW*	**1.5**	15	**154**	1545	**15448**
VBF	120	4.47	68% bbar	**0.4**	3.9	**39**	386	**3862**
	140	3.81	48% WW*	**0.3**	3.3	**33**	329	**3292**
	180	2.87	93% WW*	**0.2**	2.5	**25**	248	**2480**
WH	120	1.73	68% bbar	**0.15**	1.5	**15**	150	**1499**
	140	1.35	48% WW*	**0.09**	0.9	**9**	92	**917**
	180	0.46	93% WW*	**0.04**	0.4	**4**	39	**394**
ZH	120	0.921	68% bbar	**0.08**	0.8	**8**	80	**796**
	140	0.569	48% WW*	**0.05**	0.5	**5**	49	**491**
	180	0.247	93% WW*	**0.02**	0.2	**2**	21	**213**
ttH	120	0.669	68% bbar	**0.06**	0.6	**6**	58	**578**
	140	0.431	48% WW*	**0.04**	0.4	**4**	37	**372**
	180	0.204	93% WW*	**0.02**	0.2	**2**	18	**177**

Characteristic event rates

- Samples of b, W, Z, top, collected in the beginning, will be precious to prepare higher-luminosity triggers :
  - Trigger debugging and optimisation
  - Testing and tuning of reconstruction algorithms
  - Modelling of the background
  - Finding non-beam background sources
  - Learning how to handle detector noise
  - etc… (a very big etc)

(cross sections from TDR) **events/day vs. average luminosity ($cm^{-2}s^{-1}$)**

Process	σ (pb)	10^{30}	10^{31}	10^{32}	10^{33}	10^{34}
bbar (incl.)	$500x10^6$	**$43x10^6$**	$4.3x10^8$	**$4.3x10^9$**	$4.3x10^{10}$	**$4.3x10^{11}$**
inclusive W	140000	**12096**	$120x10^3$	**$1.2x10^6$**	$1.2x10^7$	**$1.2x10^8$**
Inc.W, W→lν	35532	**3070**	$31x10^3$	**$0.3x10^6$**	$3.1x10^6$	**$2.1x10^7$**
inclusive Z	43000	**3715**	$37x10^3$	**$0.4x10^6$**	$3.7x10^6$	**$3.7x10^7$**
Inc.Z, Z → l^+l^-	3405	**294**	2942	**$29x10^3$**	$0.3x10^6$	**$0.3x10^7$**
ttbar (incl.)	590	**51**	510	**5098**	$50x10^3$	**$5x10^4$**

What we have now (12.0.6)

Trigger Menu: CSC-06

Signatures for trigger studies and validation:

e10, e10TRTxK, g10, tau10, tauNoCut, mu6, mu6i, jet20kt, jet20, 2jet20, 3jet20, 4jet20, frjet10, fljet10, met10

"Physics" signatures:

2e15i, e25i, e60, 2g20i, g60, Zee, tau15, tau15i, tau20i, tau25i, tau35i, mu20, jet160, 2jet120, 3jet65, 4jet50, bjet35

[e25i = "at least one isolated electron 95% efficient at 25 GeV"]
[jet160 = "at least one jet with E_{tT} > 160 GeV"]

- Warning: Muon L1 thresholds are exclusive (will be made consistent in release 13)
  - L1_mu10: 10 GeV < pT < 20 GeV
  - L1_mu20: 20 GeV < pT < 40 GeV
  - L1_mu40: pT > 40 GeV
- Mixed signatures not in CSC, need to be emulated manually (will be in release 13)
  `https://twiki.cern.ch/twiki/bin/view/Atlas/TrigTutorialRetrieveDecision`
- Caveat: forward jets (frjet10, fljet10) and Zee not working properly (fixed for rel. 13)

Initial plans

Trigger Menu: Jet triggers for 10^{31} $cm^{-2}s^{-1}$

T. Le Compte (for SM): `http://indico.cern.ch/conferenceDisplay.py?confId=10035`
S. Eckweiler (for SM): `http://indico.cern.ch/conferenceDisplay.py?confId=12053`

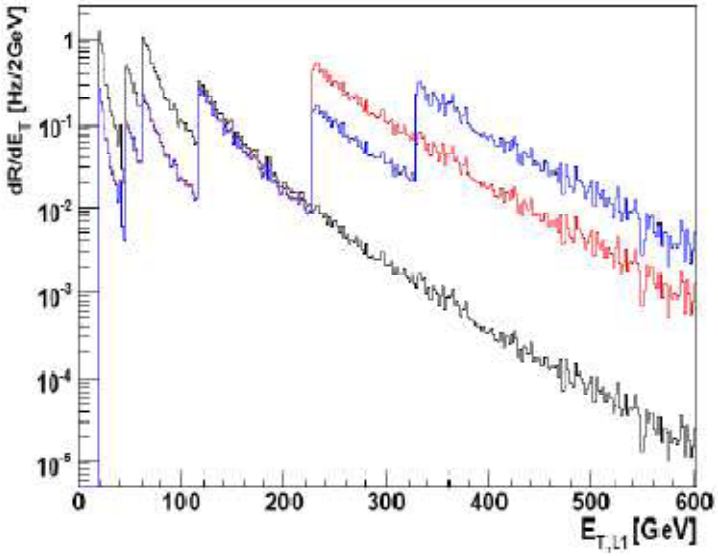
- Design trigger menu to optimally sample jet-spectrum for cross-section measurements and efficiency determination.
- Concentrate initially on L1 selection.
- Aim for ~ 10 Hz of L1 unprescaled jet triggers and a total ~20 Hz.
- Use DC3 di-jet samples J0-J8 reconstructed with release 12.0.3 (no pile-up)

Pre-scale factors for different jet triggers

threshold [GeV]	10^{31}	$5*10^{32}$	$2*10^{33}$
18 -> J33	2000	452000	1.920.00
46 -> J70	63	15000	60000
60 -> J90	7	1620	6700
114 -> J160	1	60	247
228 -> J300	1	1	13
328 -> J410	1	1	1
unprescaled rate	6 Hz	13 Hz	9.8 Hz

4j90
3j90+j160 (backup for merged jets in 4j90)

Note: Trigger names used here correspond to threshold needed for 95% efficiency w/r to offline



Trigger Menu: Electron triggers for 10^{31} $cm^{-2}s^{-1}$

M.Wieler (e/gamma), T.Le Compte (SM), F.Paige (SUSY), T.Wengler (Top):
http://indico.cern.ch/conferenceDisplay.py?confId=10035

- Single electron with p_T>20 GeV (or 25 GeV)
  - Isolation/tight quality cuts acceptable
  - For example, e25i at 10^{31} $cm^{-2}s^{-1}$ with very loose cuts. Need to study efficiency of calorimeter-only selection, cal+track, etc.
- Di-electron trigger with looser cuts
- SUSY will need lowest electron threshold possible (e15i?)
- Will likely depend mostly on single electron trigger for top physics.

Trigger Menu: Muon triggers for 10^{31} $cm^{-2}s^{-1}$

T.Le Compte (SM), F.Paige (SUSY), T.Wengler (Top):
http://indico.cern.ch/conferenceDisplay.py?confId=10035

- Single muon with p_T>20 GeV (or 25 GeV)
- Di-muon trigger with looser cuts
- Ensure di-muon triggers covering whole p_T range
- Will likely depend mostly on single muon trigger for top physics.

Initial plan

Trigger Menu: Simple Draft for 10^{31} $cm^{-2}s^{-1}$

- My attempt at collating together latest suggestions from different physics groups
- Obviously missing a lot of potential triggers but could be used at least as a first glimpse of the big picture to seed further trigger studies.
- Does not take into account
  - specific needs for monitoring/commissioning/validation
  - "forced-accept" events or "HLT pass-through" mode
  - All possible prescaled triggers unless specified in recent studies.

e10i (p)	mu4 (p)	j410	mu4+Jpsi(mu4,mu4)
e20i (p)	mu6 (p)	j300	mu4+Jpsi(e5,e2)
e25i	mu20	j160	mu4+Ds
2e15i	2mu4 (p?)	j90 (p~10)	mu4+B(mu4,mu4)
e60	2mu6	j70 (p~100)	
		j33 (p~2000)	
		4j90	
		3j90+1j180	e10+mu6
g20 (p)	tau10 (p)		e10+xE20
g40 (p)	tau25i (p)		g25+xE25
g60	tau35i	xE30	mu6+xE20
2g20	2tau10i	xE60	tau15i+xE20

Talks and discussion

- The idea is to have a lively discussion…