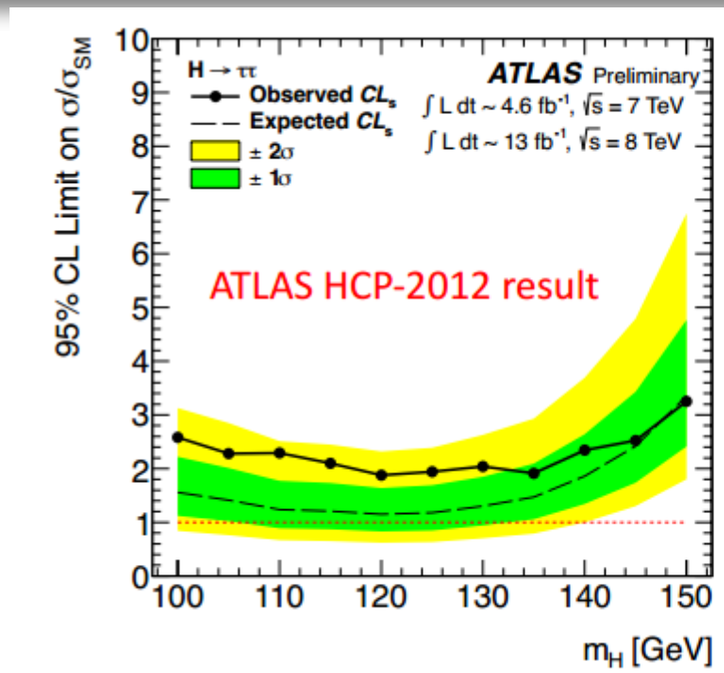
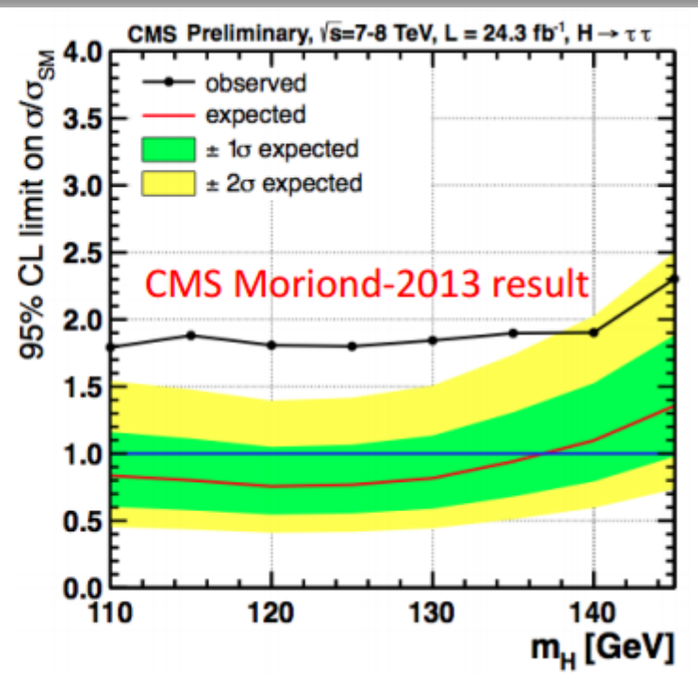
H->TauTau considerations

Simone & Zinonas

Summary of comparisons

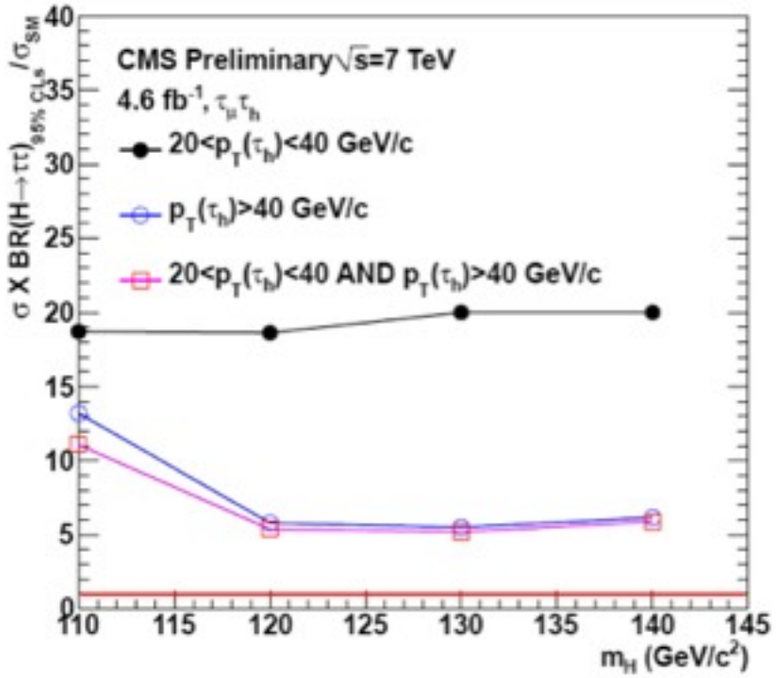




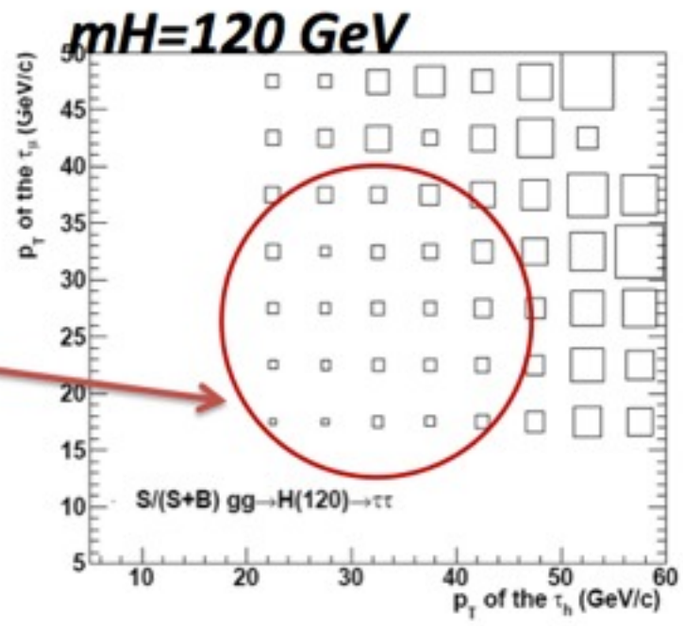
- ATLAS analyzed ~ 18/fb while CMS ~ 24/fb
- object ID and selections practically the same
  - tau ID from CMS can give more handles to constraint tau ES
- Mass reconstruction is equivalent
- analysis strategies similar but not identical
  - CMS has categorized as number of jets and low/high tau pT
- Treatment of syst. uncertainties quite similar
  - CMS may be a bit more conservative with the use of bin-by-bin uncertainties
- ATLAS does not include a VH category in all channels (just started)
- ATLAS result does not consider contributions from H->WW* (orthogonal selection cuts)
- Question is : from where the larger CMS sensitivity comes from?

Run1 dataset perspective

Example of past CMS improvements

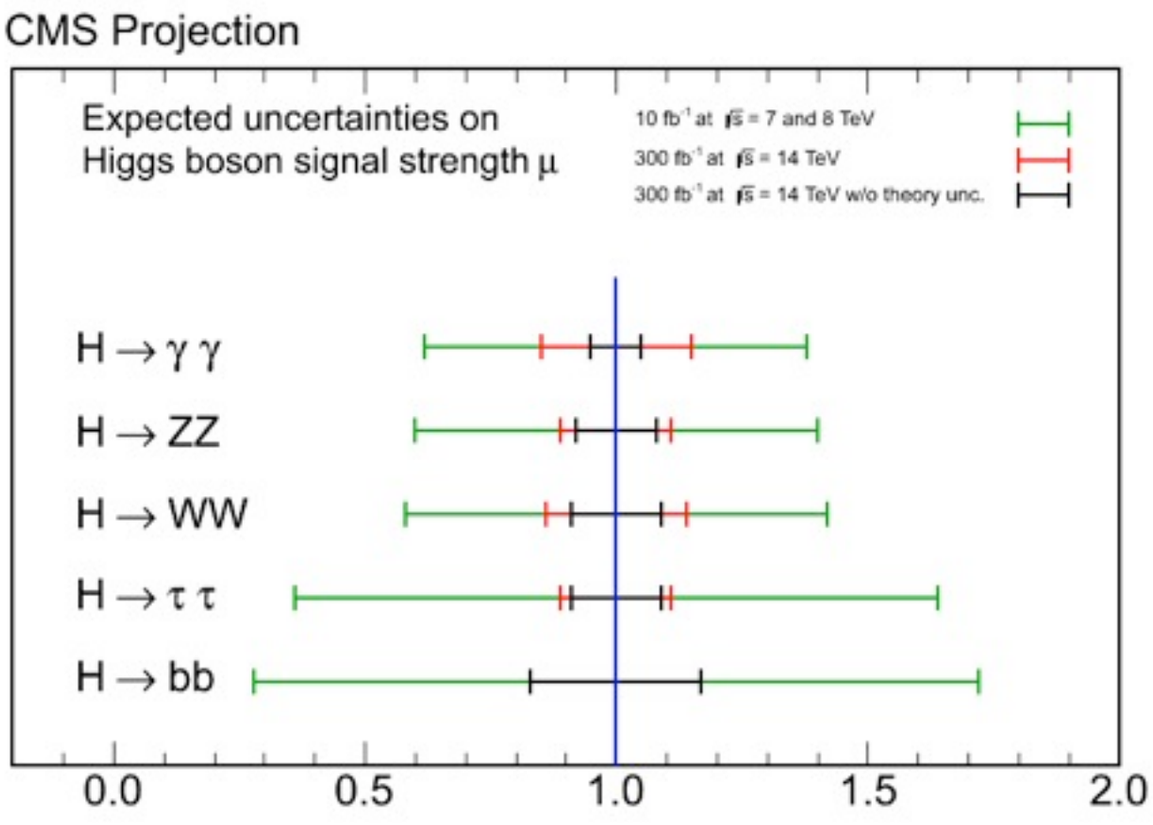


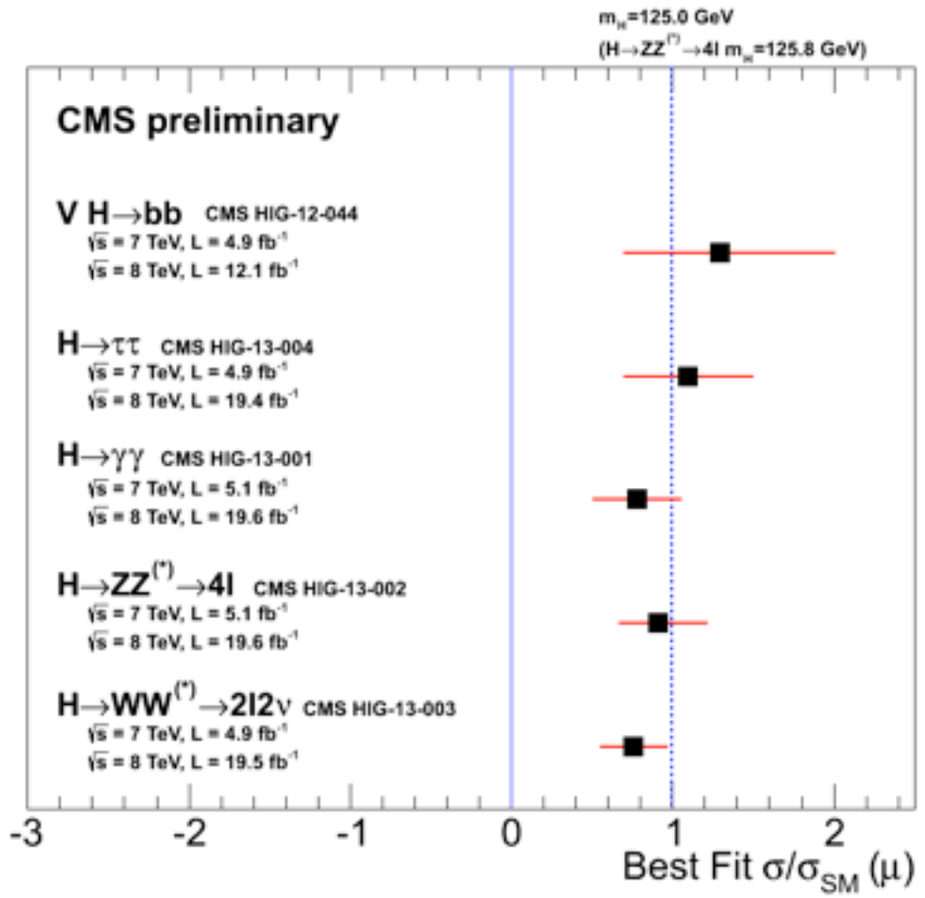
What's the benefit from these guys ?



- CMS is working on improving categorization and making the analysis even more "robust"
  - we will stay with cut based approache
- ATLAS @ 4.6+13 fb-1 expected limit=1.18xSM and p0=1.7σ
  - Projections for 24.6 fb-1 limit=1.07xSM and p0=1.84σ
  - Projections for 24.6 fb-1 with analysis improvements: limit=1.01xSM and p0=1.95σ

High luminosity projections

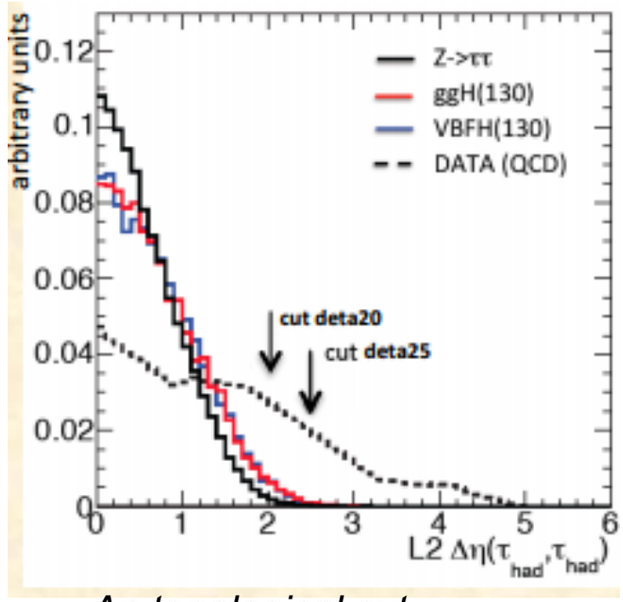




- Simple extrapolation from datacards
  - assuming the same reconstruction/trigger/selections

ATLAS di-tau triggers

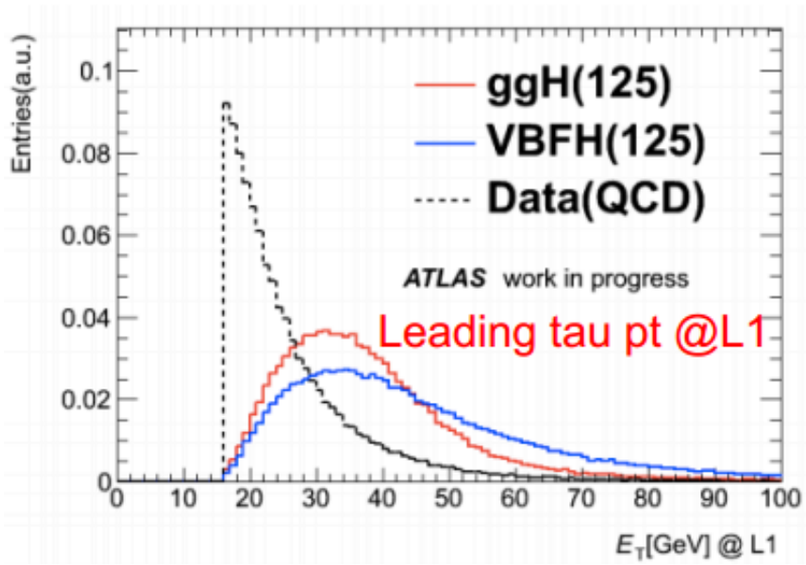
1. The had-had analysis is driven by the pT thresholds in the 2tau trigger
2. $H \rightarrow \tau_{had}\tau_{had}$: 2 soft and asymmetric hadronic taus
3. Raising the pT on the subleading tau kills the signal acceptance
4. The proposed triggers for Run2 are too hard
5. TOPOLOGICAL cuts are required at L1! (eg VBF cuts, δη(τ,τ) cut)

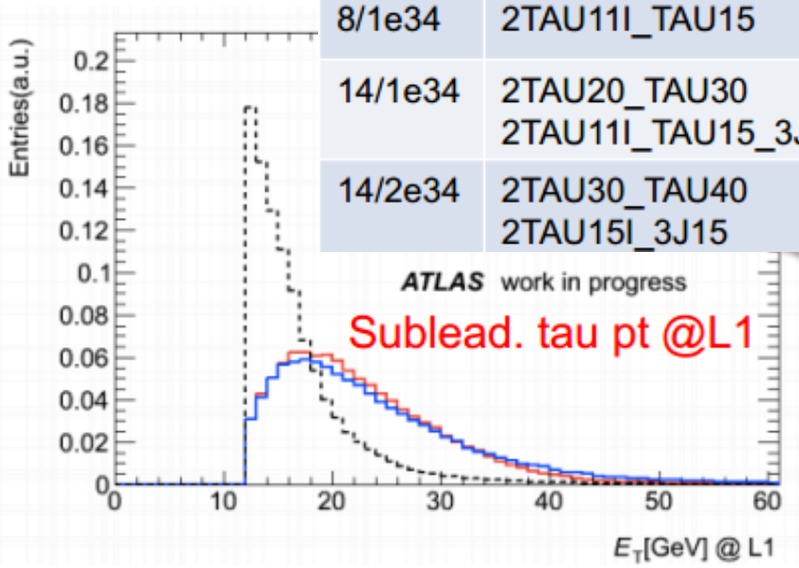


Δη topological cut

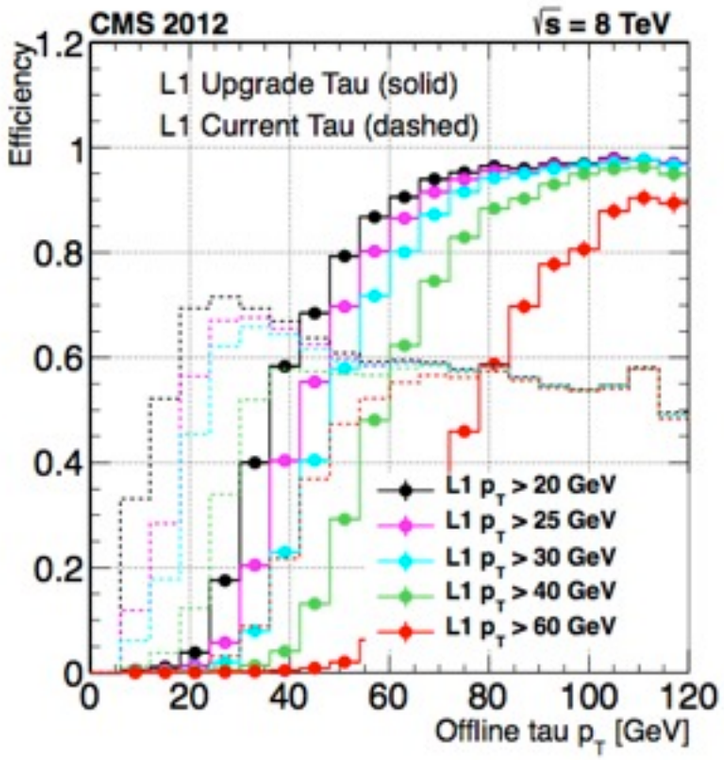
First draft of the 14TeV menu

√s/Lumi	L1 Item	Offline [GeV]	Rate [KHz]
8/1e34	2TAU11I_TAU15	40,25	20
14/1e34	2TAU20_TAU30 2TAU11I_TAU15_3J10	80,50 40,25,50(j)	12.6 19.7
14/2e34	2TAU30_TAU40 2TAU15I_3J15	100,80 2x40,50(j)	9.4 14.3





New L1 seeds from CMS



New L1 Tau has improved turn on efficiency but will lead to higher offline thresholds

Final State / Trigger	Current, 1.1e34	Upgrade, 1.1e34	Current, 2.2e34	Upgrade, 2.2e34
$\mu\tau_h$ / IsoMu+Tau	-	25.6%	-	25.1%
$\mu\tau_h$ / Single Mu	42.6%	50.6%	19.4%	42.0%
$\mu\tau_h$ / Single IsoMu	-	48.1%	-	43.3%
$\mu\tau_h$ / Single IsoMu OR IsoMu+Tau	-	51.3%	-	48.4%
$e\tau_h$ / IsoEG+Tau	-	17.7%	-	17.7%
$e\tau_h$ / Single IsoEG	24.4%	41.3%	14.0%	32.5%
$e\tau_h$ / Single IsoEG OR IsoEG+Tau	24.4%	44.3%	14.0%	39.0%
$\tau_h\tau_h$ / IsoTau+Tau	3.3%	13.9%	3.3%	10.2%
$\tau_h\tau_h$ / Single IsoTau	15.9%	53.7%	13.2%	50.1%
$\tau_h\tau_h$ / Single IsoTau OR IsoTau+Tau	17.2%	53.7%	14.9%	50.1%

	Current Level-1 $L = 1.1 \times 10^{34}$ cm^{-2}s^{-1}			Upgraded Level-1 $L = 1.1 \times 10^{34}$ cm^{-2}s^{-1}		
Trigger Algorithm	Rate [kHz]	95% Threshold [GeV]	Plateau Efficiency	Rate [kHz]	95% Threshold [GeV]	Plateau Efficiency
Single e/γ	12	46	1.0	14	45	1.0
Single iso e/γ	10	38	0.9	13	27	0.9
Single Mu	12	23	0.95	14	18	0.92
Single iso Mu	NA	NA	NA	14	17	0.84
Single Tau	NA	NA	NA	15	88	0.95
Single iso Tau	10	65	0.3	14	71	0.7
iso e/γ + e/γ	10	24 15	0.9	9.6	22 16	0.9
(iso)Mu + Mu	6.3	18 10	0.9	9.5	14 10	0.8
(iso)Tau + Tau	7.5	36 36	0.1	6.4	60 56	0.67
iso e/γ + Mu	9.6	21 11	0.85	14	19 10	0.85
(iso)Mu + e/γ	3.3	18 14	0.95	6.4	16 14	0.83
iso e/γ + Tau	NA	NA	NA	4.5	21 57	0.86
isoMu + Tau	NA	NA	NA	5.6	14 45	0.8

Primary Tau Triggers

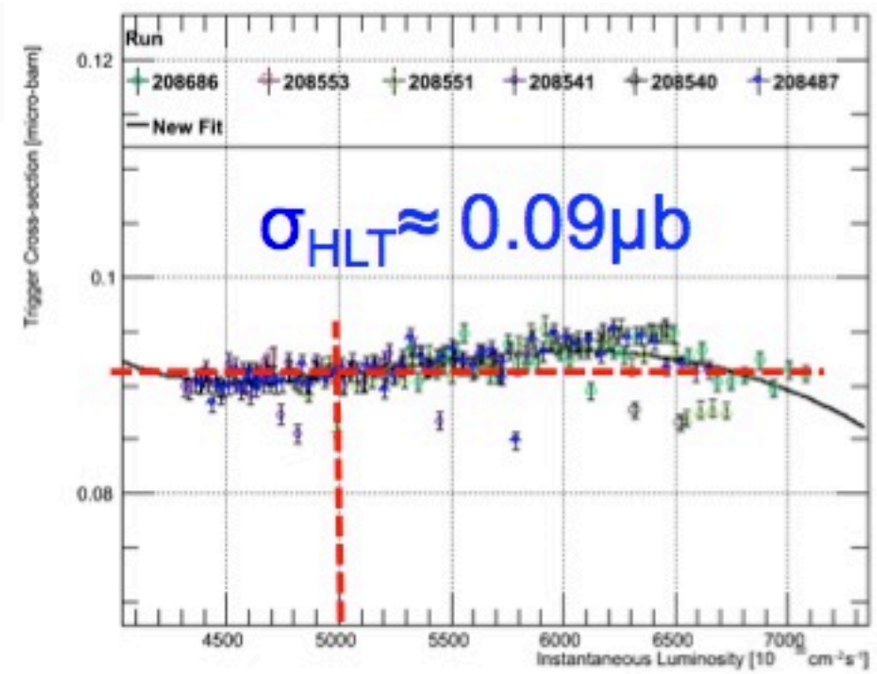
$L = 1e34\ cm^{-2}s^{-1}$ Rates for previous and new (bold) triggers

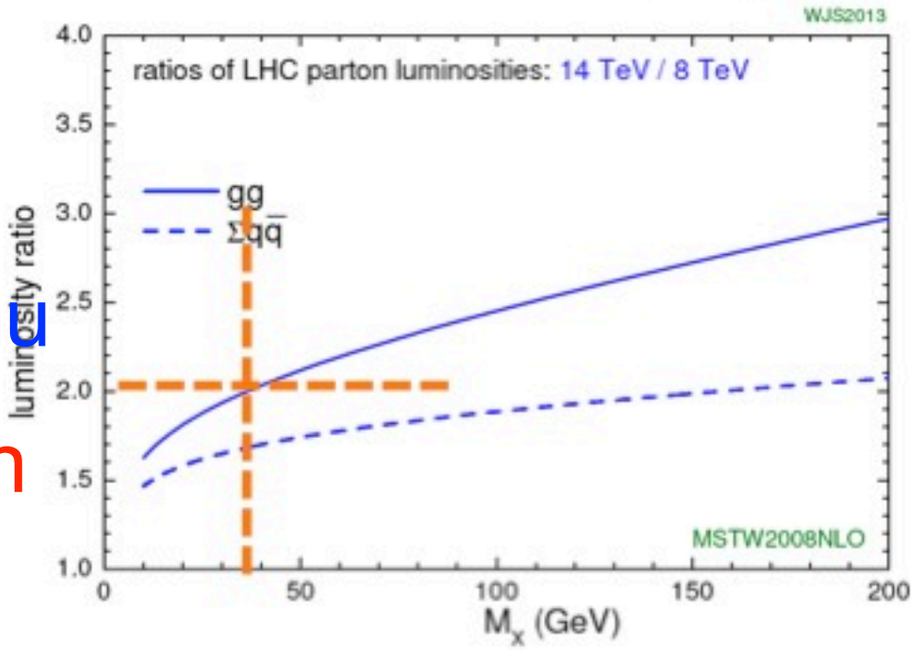
Menu	L1 [Hz]	L2 [Hz]	EF [Hz]
tau29Ti_medium1_tau20Ti_medium1	L1_2TAU11I_TAU15: 17223	582	26.0
tau27Ti_medium1_L2loose_tau18Ti_medium1_L2loose		734	36.5
tau27Ti_loose2_tau18Ti_loose2_deta25 **tau27Ti_loose2_tau18Ti_loose2_deta25 (before bug-fix)** (tau27Ti_loose2_tau18Ti_loose2)		**1395** **855** (1747)	**48.2** **31.6** (67.6)
tau27Ti_loose2_tau18Ti_loose2_vbf		435.6	2.73
tau18Ti_medium1_L2loose_e18vh_medium1	L1_2TAU11I_EM14VH: 8451	268.0	6.2
tau18Ti_loose2_e18vh_medium1_deta25		**305.9**	**7.2**
e18vh_medium1_vbf_2L1TAU11I_EM14VH		**225.6**	**4.83**
tau20_medium1_L2loose_mu15	L1_TAU8_MU10: 4080	132.9	24.2
tau20_loose2_mu15_deta25		**141.4**	**23.6**
mu15_vbf_L1TAU8_MU10		**48.1**	**14.6**

New cuts (topological trigger and VBF trigger) reduce rate significantly
+ extra L1 FJ/CJ trigger seeded VBF trigger

Extrapolating the HLT rate

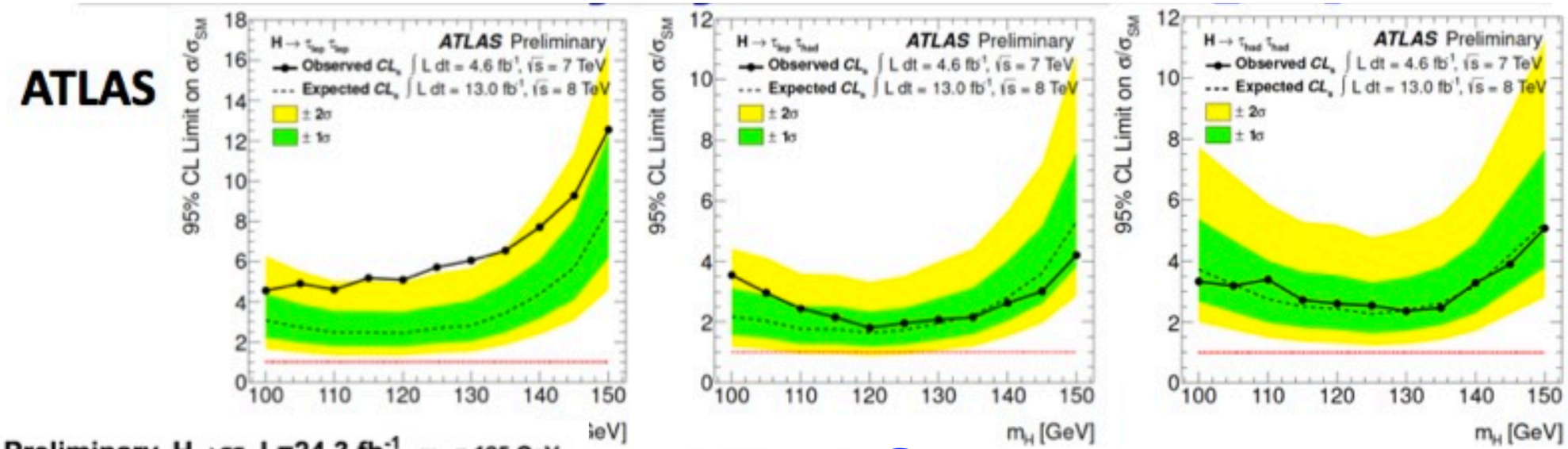
- 8 TeV cross section is 0.09 microb
  - 5e33 $cm^{-2}s^{-1}$, 8 TeV
  - small dependence on PU
- In 2015 we expect:
  - a factor 2 due to the doubling of the luminosity
  - a factor ~ 1.5 - 2 due to the increased cross section (from 8 TeV to 13 TeV)
- Expected (averaged) rate ~ 1.2 kHz
  - extrapolated with the present menu
- Need to improve HLT reconstruction
- Reconsider PAG strategy

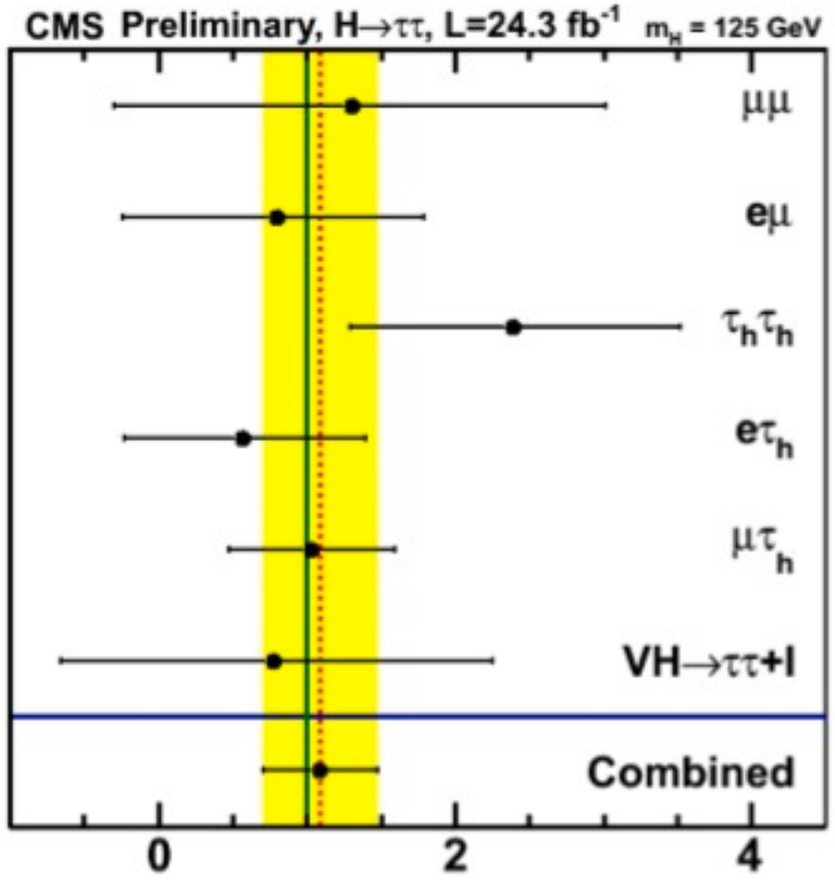




Backup

Comparison per channels





ATLAS signal mostly driven by l+l channels

CMS has some excess in every channel but mostly in muTau and full hadronic

Primary Tau Triggers - 2012

L = 1e34 $cm^{-2}s^{-1}$

uncombined hadronic di-tau triggers

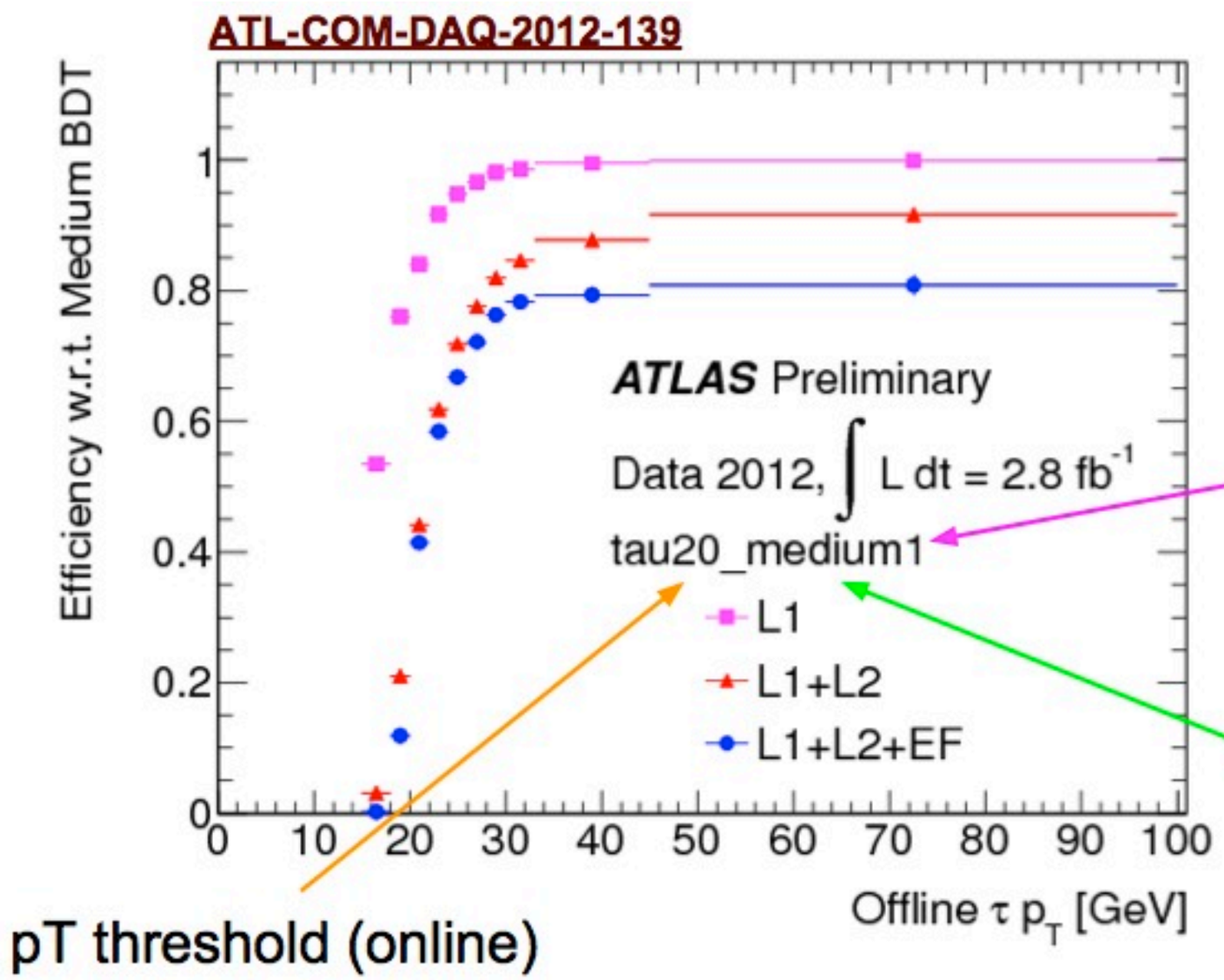
Menu	L1 [Hz]	L2 [Hz]	EF [Hz]
tau29Ti_medium1_tau20Ti_medium1	L1_2TAU11I_TAU15: 17223	582	26.0
tau20Ti_medium1_e18vh_medium1	L1_2TAU11I_EM14VH: 8451	247.2	5.13
tau20_medium1_mu15	L1_TAU8_MU10: 4080	99.2	17.5
tau29Ti_medium1_xe50_tclcw_tight	L1_TAU15I_XE35: 2311	154.1	9.8
tau125_medium1	L1_TAU40: 7012	34.6	2.5
2tau38T_medium1	L1_2TAU20: 7775	47.0	3.06
tau38T_medium1_e18vh_medium1	L1_2TAU11_TAU20_EM14VH: 9920	70.4	4.34
+ tau100_loose1_tau70_loose1 (Period B)	L1_2TAU20: 7775	15.8	1.86
+ tau27Ti_medium1_L2loose_ tau18Ti_medium1_L2loose (Period E)	L1_2TAU11I_TAU15: 17223	734	36.5
+ tau18Ti_medium1_L2loose_e18vh_medium1 (period E)	L1_2TAU11I_EM14VH: 8451	268.0	6.2

L1 tau trigger unchanged during 2012

Δz0 cut minimizes pileup dependence of L2 and EF trigger

Ref

L1 turn on from ATLAS



L1 Triggers for 2015

- Combined triggers still needed at HLT
  - L1 single electron and single muon trigger with isolation should be ok
- Improvements expected for the tau L1