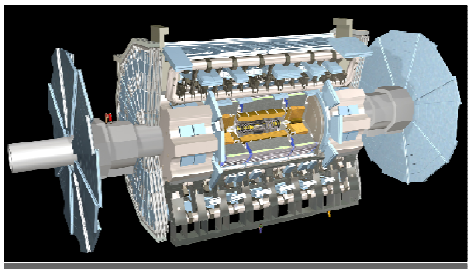
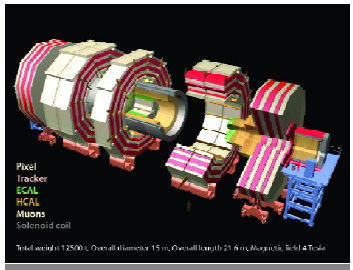
Hadron Collider Physics Symposium

Evian, France

16 – 20 November, 2009





Search for SM Higgs boson at LHC

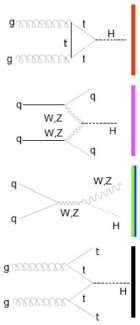
Higgs production at LHC

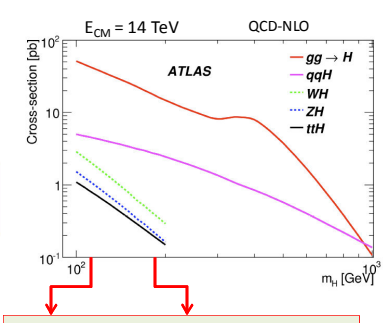
Typical BKG cross-sections:

qq ~ 100mb; bb ~ 100 μb

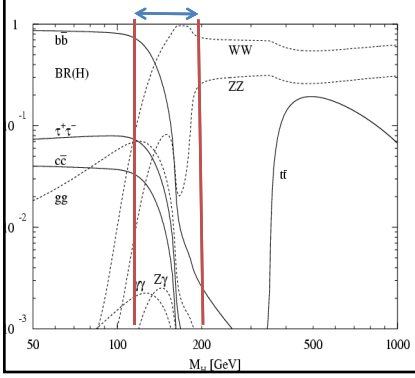
W,Z-jets ~ 50-100 nb;

tt ~ 1 nb





114.4GeV < m_H < 157GeV @95%CL



M_H<140 GeV:

H → bb (cc) dominant: QCD BKG!

H → ττ large

H → γγ few per mill

M_H>140 GeV

H→ WW* Dominant

H→ ZZ* (deep ~ $2M_W$)

2

Main "Discovery" channels

M_H<130 GeV

- **H → γγ**
  - σxBR ~ 90 (qqH 9) fb
- **qqH → qqττ → qq l ν ν + x**
  - σxBR ~ 120 fb

M_H>130 GeV

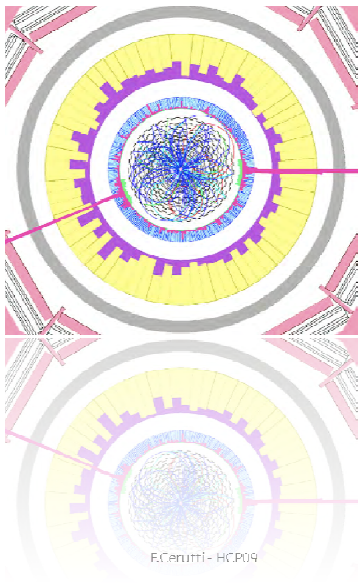
- **H → ZZ* → 4l**
  - σxBR ~ 12 fb
- **(qq)H → (qq)WW* → l ν l ν**
  - σxBR ~ 990 (qqH 110) fb

Backup material on **W,ZH with H→bb (High-Pt), Higgs properties**

General comments on Results

- Bulk of results based on recent publications: 2008-2009:
  - G4-based Simulation of Signal and BKG's + Expected detector (mis)calibrations and performance vs L taken into account
  - Pile-up effects "Low Luminosity" studied for several channels
  - Improved understanding on Higher Order QCD corrections on Signal and BKG: jets important: VBF, Jet Veto, …
- Talk focused on "Low" =10-30 fb^{-1} or "Very Low"=1-2 fb^{-1} integrated luminosity and E_{CM} = 14 TeV .. with 1 Exception

H → γγ

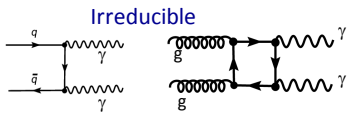


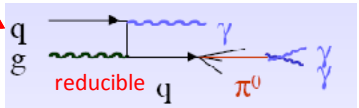
H → γγ

- huge γ/jet rejection needed to keep reducible background under control

  $\sigma_{jj,\gamma j} > 10^6\ \sigma_{\gamma\gamma}$

- $M_{\gamma\gamma}$ resolution crucial to observe Mass peak over continuous background
  - $S/\sqrt{B} \sim 1/\sqrt{\sigma(M_{\gamma\gamma})}$
- Large fraction of γ→e+e-: to be taken into account
- Need reconstruction of primary vertex: IP has large spread in z

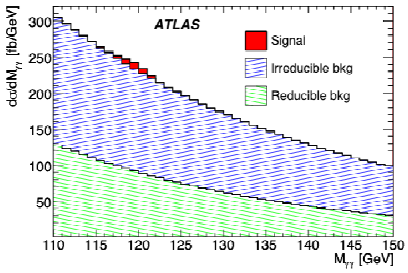


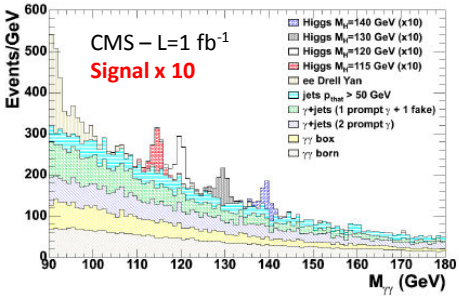


H → γγ

Inclusive analysis:

- 2 isolated High-P_T γ (trigger)
- Look for MASS PEAK: $M_{\gamma\gamma}$
- CMS and ATLAS similar BKG
- CMS better mass resolution
- Small S/B
- BKG prediction VERY difficult:
  - DATA $M_{\gamma\gamma}$ side-bands
- Very robust channel requires
  - γ-ID, E-resolution and Isolation





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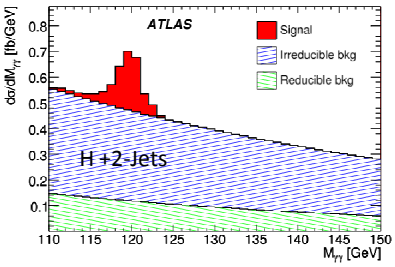
H → γγ

Additional handles used in ATLAS

- Improve CUT analysis add
  - H+1-Jet
  - H+2-Jets → VBF
    - S/B more favorable
- Alternative Likelihood fit:
  - Categories: $|\eta_\gamma|$, #conv-γ , N-Jets
  - Variables: $M_{\gamma\gamma}$, $P_{T\gamma\gamma}$, $|\cos(\theta^*)|$
- Categories sensitive to $\sigma(M_{\gamma\gamma})$ and production mechanism
- More Sensitive to BKG description:

  $M_{\gamma\gamma}$ side-bands → BKG Properties from DATA



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H → γγ

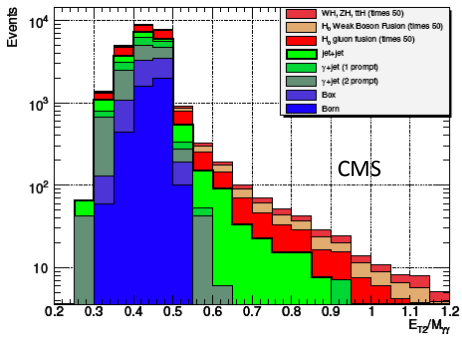
CMS

CUT analysis:

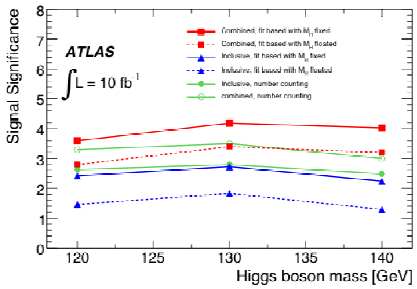
- Categories: lateral shower shape and η_γ

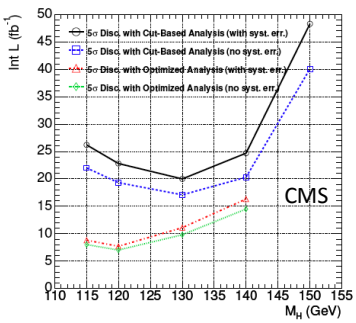
Optimized analysis:

- In addition to $M_{\gamma\gamma}$:
  - NN-isol-γ, $E_{T\gamma}/M_{\gamma\gamma}$, $P_{L_{\gamma\gamma}}$, $|\delta\eta|$,...
- BKG shapes at LO only:
  - On REAL data **BKG should come from $M_{\gamma\gamma}$ side-bands**



H → γγ





ATLAS

Significance: M_H=130 GeV; L=10 fb^{-1}

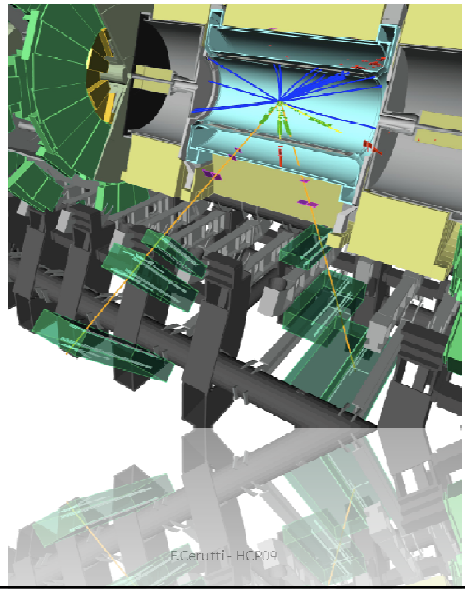
- **Likelihood variables+categ: 4.2σ**
  - Lik. M_H float: **look-elsewhere -0.8σ**

Discovery with Likelihood ~ 14 fb^{-1}

CMS: M_H=120 GeV:

- CMS Optimized analysis:
  - **Discovery ~10fb-1**

H → ZZ* → 4 l

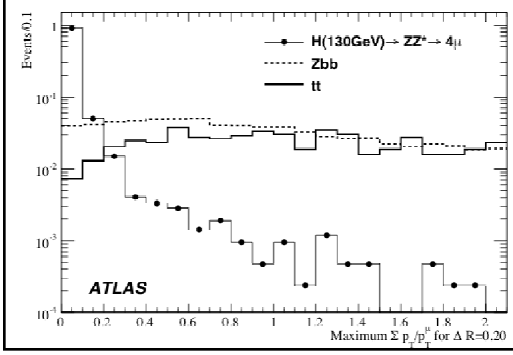


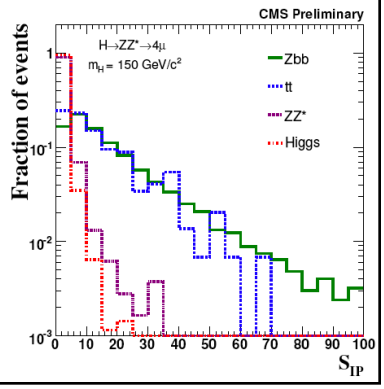
H → ZZ* → 4 l

- GOLDEN channel region 130-160 GeV (+ above 180 GeV)
- Small σxBR but small BKG after simple selection
  - Narrow mass peak in 4l final state
  - Crucial lepton efficiency: $S/\sqrt{B} \sim \varepsilon_l^2$
- Main backgrounds:
  - **ZZ* → 4l** "irreducible" can be normalized from **data side-bands**
  - Zbb with Z→ 2l plus 2l from b-decays
  - tt → Wb Wb with 2l from W's and 2l from b-decays
  - (Z-jet with Z→ 2l and 2 mis-identified leptons also considered)

H → ZZ* → 4 l

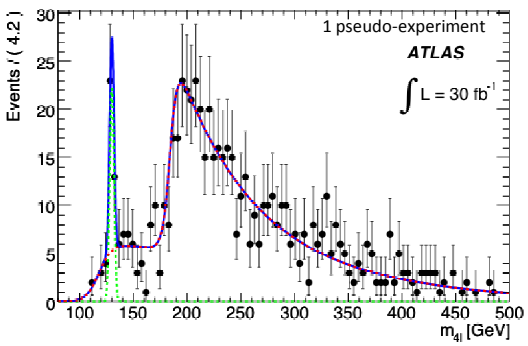
- Zbb, tt and Z-jet are reducible 2l NOT prompt:
  - Require lepton isolation: calorimeters + ID tracker
    - Pt dependent lepton isolation better rejection of Zbb
  - Require leptons from main vertex: IP significance cut

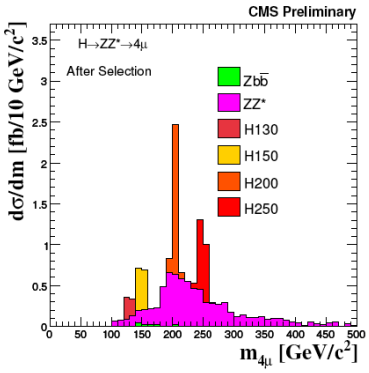




H → ZZ* → 4 l

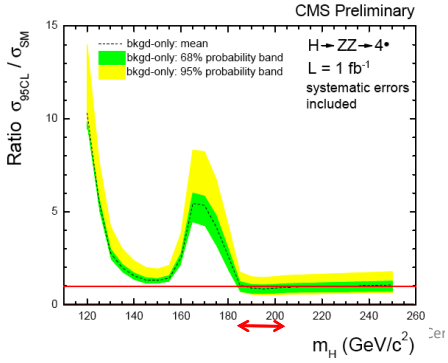
- After non-prompt rejection ZZ* dominant background (Zbb neglig.)
- Look for Mass-peak + BKG from side-bands
- Systematics ZZ* mass-shape: small only relevant at ZZ thresh.

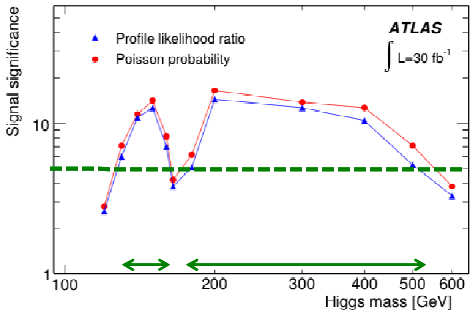




H → ZZ* → 4 l

- CMS at L = 1fb^{-1}: BKG norm. from Z-jet and + MC to extrapolate to ZZ*:
  - Stat Error on ZZ* from 20% → negligible
- Discovery: 130-160 range with 30fb^{-1} for single-experiment
  - Additional variables: P_T4l , M_{ll}, angular-variables (related to J^{PC}) can improves sensitivity (not used here to be less model dependent)



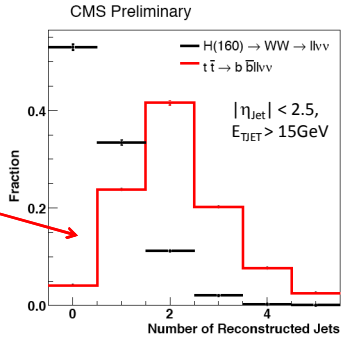


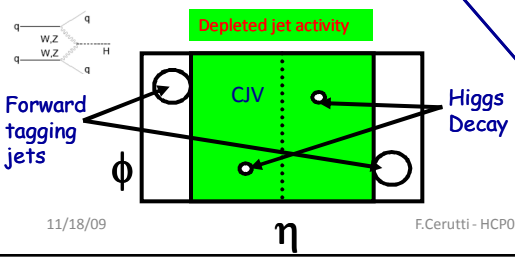
H → WW → l ν l ν

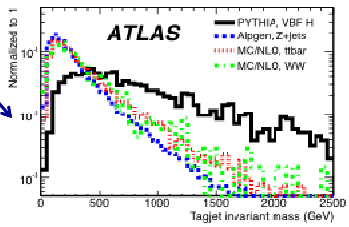
- Channel with Largest statistical power: accessible "very Low"-L
  - ~σxBR x L(1 fb^{-1}) → 1000 events produced
- 2 Isolated Leptons ensure efficient trigger
- No mass peak but some discriminating variables:
  - Systematics on BKG From DATA "control samples"

H → WW → l ν l ν

- Main BKG's
  - tt → WbWb → ll νν bb
  - WW QCD+EW irreducible
  - W-jet, Z-Jets, WZ, ZZ, tW
- **0-Jets: veto** strongly reduces tt
- **2-Jets = VBF signature** reject WW(QCD)
  - Forward jet tag: $|\Delta\eta_{jj}|$, M_{jj}
  - **+ Central Jet Veto**



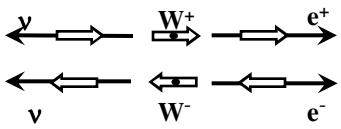


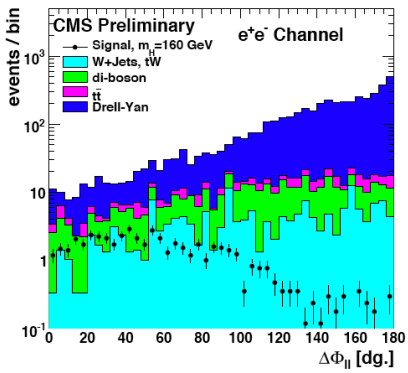


H → WW → l ν l ν

CMS: WW → 2l 2ν + 0 Jets

- Multivariate Optimized Analysis: for $1fb^{-1}$
- Main discriminating observables:
  - $\Delta\Phi_{ll}$, M_{ll}, E_T-miss
- + variables combined in NN:
  - $\Delta\eta_{ll}$, M_{Tll} , …

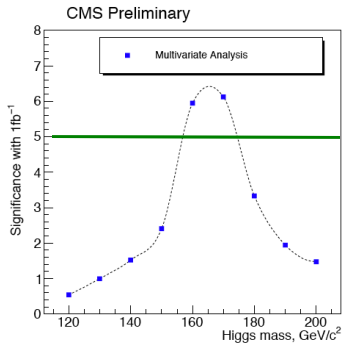




H → WW → l ν l ν

CMS: WW → 2l 2ν + 0 Jets

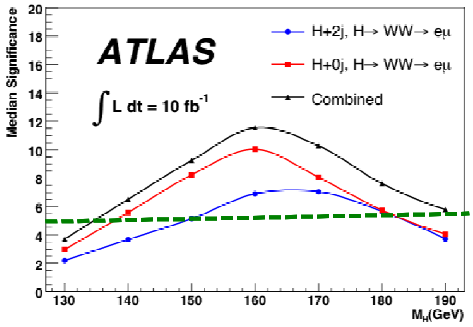
- WW and tt BKG Normalization from data
  - N_B(signal region)=α x N_B(Control Region)
  - α from MC
- Main Control Samples:
  - tt: [Signal=jet veto]<->[Control=2 jet tag]
  - WW: Central Jet Veto + Mll > 115 GeV
- Estimated BKG unc.: 22% WW and 18% tt
- Detector systematics included: Jet energy scale, detector misalign., lumin., E_T-miss modeling, …

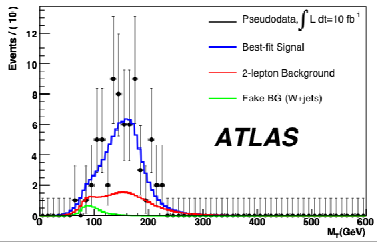


H → WW → e ν μ ν

ATLAS: WW → eμ 2ν + 2 Jets

- VBF-NN tag based on:
  - $|\Delta\eta_{jj}|$, M_{jj}, E_T-3rd-Jet
- + b-jet veto
- Likelihood fit to BKG and Signal:
  - 2 regions from $\Delta\Phi_{ll}$ "S"+"Control"
  - 2 Variables: VBF-NN tag and M_T
- JES systematics on NN-Output
- M_H free in LR fit: **"look elsewhere" effect included**



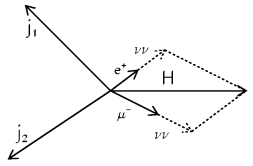


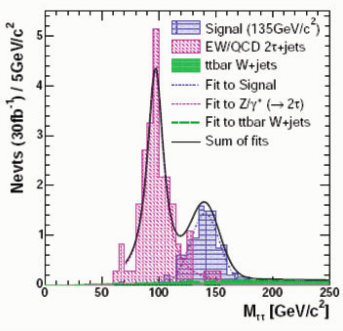
qqH → qq ττ

- Covers M_H<140 GeV region:
  - Final states: ττ → lννlνν and ττ → lννhν
- M_H >> m_τ Higgs mass reconstructed under "collinear approximation"

$$M_H = m_{\tau\tau} = \frac{m_{ll}}{\sqrt{x_1 x_2}} \qquad x_i = \frac{P_{l_i}}{P_{l_i} + P_i^{miss}}$$

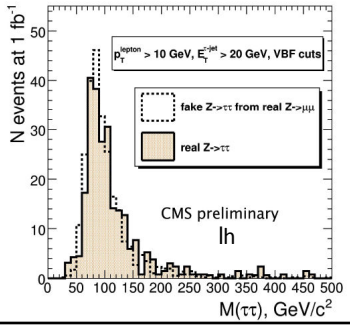
- Main BKGs:
  - Z+jets → ττ "irreducible"
  - tt, W+jets
- M_H resolution ~10-15% dominated by E_T-miss: broad signal over BKG tails
- VBF suppress Z+j, tt, W+j: Large S/B
  - Cut on Central-Jet-Veto, M_{jj}, $\Delta\eta_{jj}$

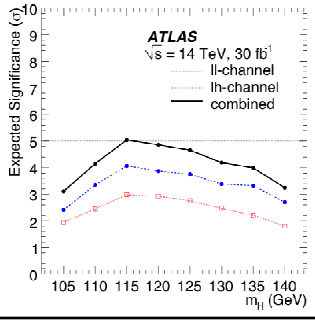




qqH → qq ττ

- Main BKG's shapes and normalizations from DATA "control samples"
- Z→ ττ BKG mass shape From DATA:
  - Z→μμ+jets same SIGNAL selection one apart from E_T-miss
  - Substitute "real" μ with simulated τ same P
  - "Emulated" sample: Z→ ττ mass shape and normalization
- Additional control samples used by ATLAS and CMS for other BKGs
- About 50 fb^{-1} needed to discover M_H=[114-130]
- 115 GeV Higgs discovered with 30 fb^{-1} 1 experiment





LHC at 10 or 6 TeV

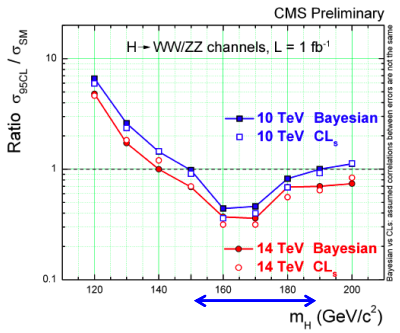
CMS - Impact of LHC-E_{CM}

H→ WW+ZZ at 200GeV

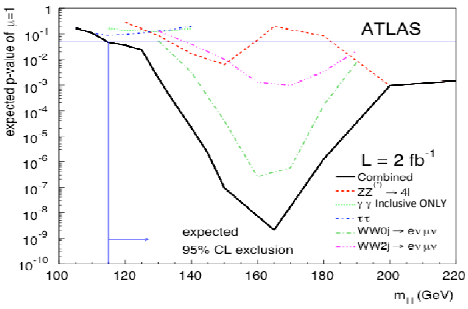
- S and BKG $\sigma(E_{CM})$:
  - BKG decrease less than S
- Acceptance: small effect

- At 10 TeV
  - Effect on $S/\sqrt{B} \sim 0.7$
  - "L-equivalent" ~2
- At 6 TeV
  - Effect on $S/\sqrt{B} \sim 0.3$
  - "L-equivalent" ~ 9

Process	$\frac{\sigma_{\sqrt{s}=10\,TeV}}{\sigma_{\sqrt{s}=14\,TeV}}$	$\frac{\sigma_{\sqrt{s}=6\,TeV}}{\sigma_{\sqrt{s}=14\,TeV}}$
tt	0.450	0.113
Wt	0.450	0.113
WW	0.650	0.320
WZ	0.650	0.320
ZZ	0.650	0.320
$Z \to \ell\ell$	0.681	0.371
$W \to \ell\nu$	0.681	0.371
$gg \to H$	0.540	0.190



Summary on exclusion



Full **mass range** can be excluded by **1 exp.** with **2fb^{-1} @ 14 TeV**

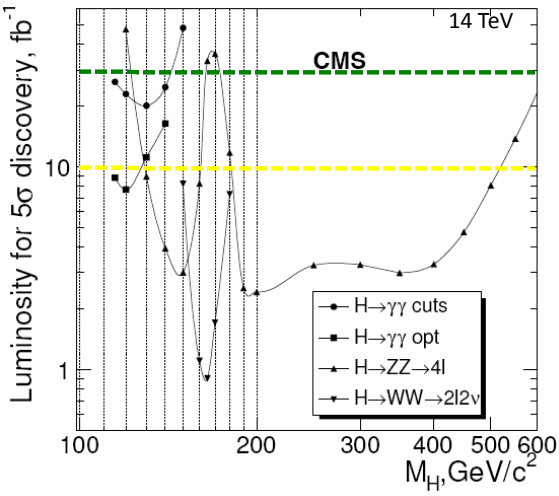
At **10 TeV WW(+ZZ) 1fb^{-1}** exclusion in **high mass region** for **1fb^{-1}**

! low mass region covered with combination of **γγ + VBF-ττ** channels. **The latter requires** well understood: **E_T-miss resolution, Jet Energy scale !**

! high mass region WW: very challenging from both **experimental** and **theoretical** point of view **!**

Detector commissioning well advanced
! ET-miss and **Jet calibration** requires **collisions !**

Summary on discovery



full mass range with covered with **CUT Based and 30 fb^{-1} :**

γγ and ZZ*→ 4l

very **ROBUST** channels:
MASS PEAK over smooth bkg!

Required:
✓**GOOD LHC performance**
✓**γ and lepton ID + isolation + E-resolution**

Other powerful channels
VBF-ττ and **WW→ llνν combination** and/or provide redundancy

Conclusions

Discovery 5σ equivalent:

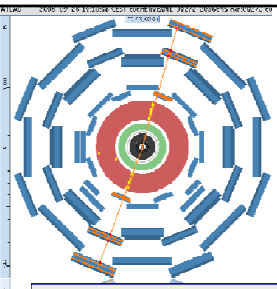
- Full mass range covered at LHC with "Narrow Mass Peak Final States" almost independent of MC simulation >10 fb^{-1} at 14 TeV

Exclusion 95%CL:

- ATLAS and CMS already competitive with ~1fb^{-1} at 10 TeV → 2011 ?

Roadmap to SM Higgs results

- Collision data needed to complete commissioning and calibration our detectors: some powerful channels involve Jet + ET-miss measurements
- Measure other SM known processes (BKG) before jumping into Higgs searches



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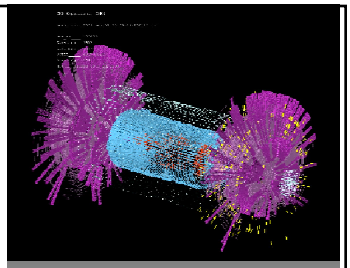

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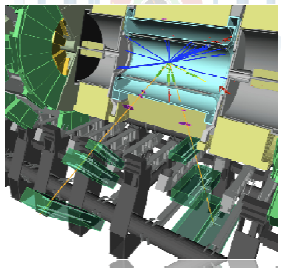
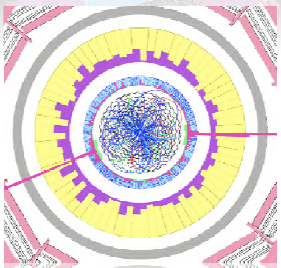


20??



Backup Slides

Bibliography

- ATLAS:
  - Expected performance of the ATLAS experiment : detector, trigger and physics CERN-OPEN-2008-020
  - HW and HZ Channels at High Transverse Momenta ATL-PHYS-PUB-2009-088
- CMS:
  - CMS Physics TDR: Nucl. Part. Phys. 34 995-1579
  - H to ZZ*: HIG-08-003: Search for SM Higgs to ZZ*
  - H to WW: HIG-08-006: Search for SM Higgs to WW*
  - VBF H to tau-tau: HIG-08-008: Search for SM Higgs to VBF $\tau\tau$

LHC performance

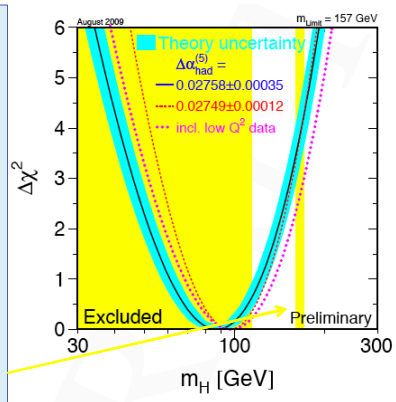
LHC "nominal/guessed" performance

- "Low" Luminosity: 10 fb^{-1}/year at 14 TeV
- "High" Luminosity: 100 fb^{-1}/year at 14 TeV
- 2010 expectation: 0.3 fb^{-1} at 7-10 TeV
- 2011: long shut down to reach 14 TeV or run at 10 TeV ??

SM Higgs: M_H constraints

SM: EW/Gauge part fully described with few free parameters

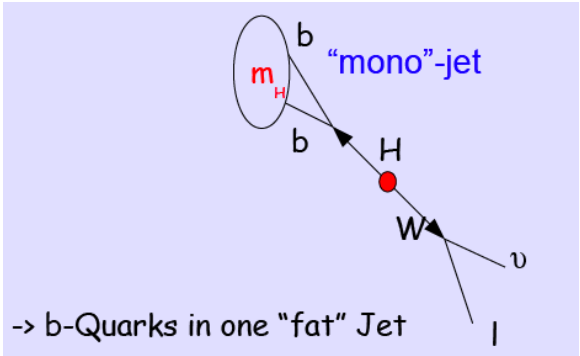
- Indirect: EW Observables precisely measured at LEP, TEVATRON, SLD:
  - **M_H<157 GeV @ 95% CL**
- Direct search at LEP e^+e^- → HZ:
  - **114.4 GeV<M_H @ 95% CL**
- Direct search at TEVATRON (Desai and Jindariani talks)



- SM: Fermion masses and flavor physics: much less satisfactory part → many free arbitrary parameters
- SM with Higgs has other theoretical weakness: hierarchy problem, coupling unification, …

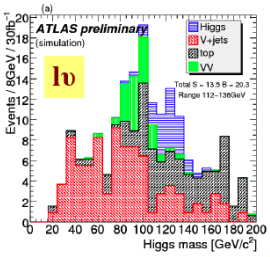
Other channels: WH, ZH

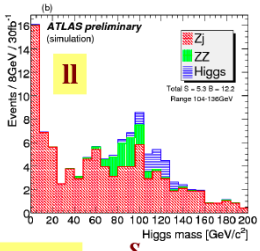
- Recently studied by ATLAS: Important to measure bb final state for couplings:
  - Highly-boosted WH, ZH → ll, lν , νν + bb
  - Isolated leptons or/and large ET-mis
  - Dedicated jet reconstruction and b-tagging

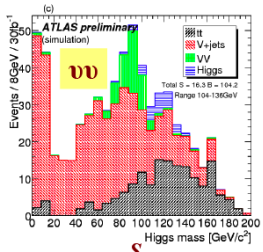


Other channels: WH, ZH

- Much better S/B then ttH with H→ bb
- It looks promising for coupling measurement







$L^{int.} = 30\ fb^{-1}: \frac{S}{\sqrt{B}} = 3.0$

M_H = 120 GeV

$\frac{S}{\sqrt{B}} = 1.5$

$\frac{S}{\sqrt{B}} = 1.6$

Combined: $\frac{S}{\sqrt{B}} = 3.7$

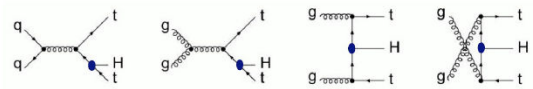
(Pile-Up not yet included)

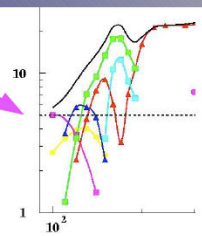
- S/B much better than for ttH
- Different backgrounds for different channels
- Still good sensitivity including systematics (e.g. S/√B = 3.0 for 15% uncertainty on all backgrounds)

C. Waiser

H → bb

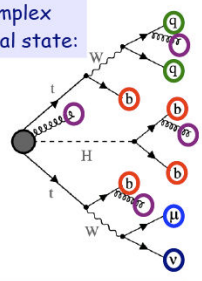
ttH a promising search channel some years ago:



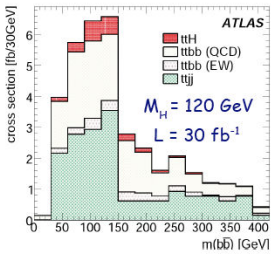


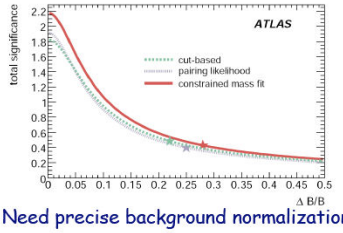
Access to top-Higgs Yukawa coupling!

Complex final state:



Now:





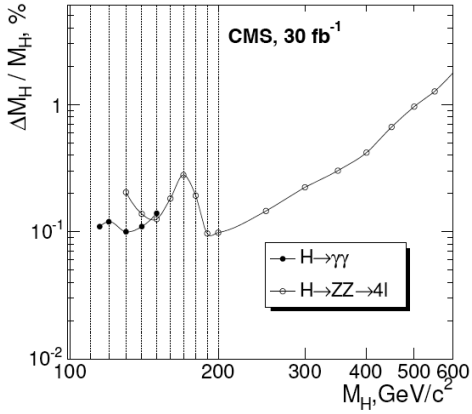
- Need precise background normalization!
- Has to come from data!
- Pile-Up: impact on selection efficiency and mass resolution

Main Backgrounds: ttbb, ttjj

→ ttH has disappeared from latest sensitivity plots!

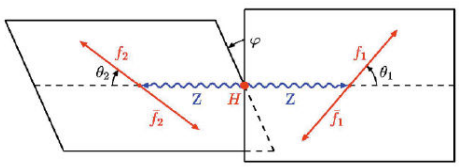
Higgs Mass

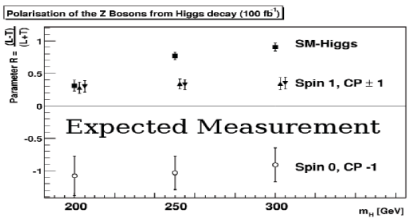
- Mass can be measured in $\gamma\gamma$ nand ZZ* channels with great accuracy (<1%)

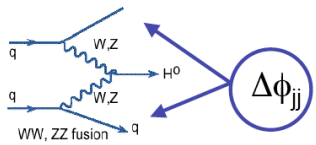


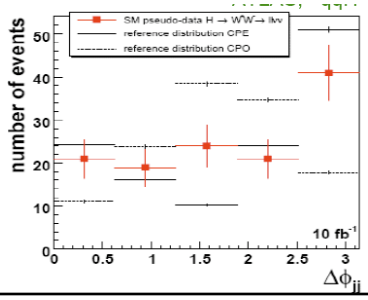
Higgs J^{PC}

J^{PC} can be looked at in ZZ and qqH→qqWW final state



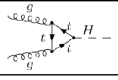
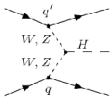
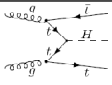
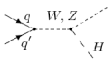


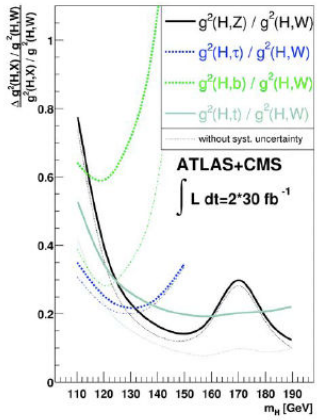




Higgs couplings

Using all available process and assuming only 1 Higgs boson relative widths can be determined

Production		Decay	Range of masses
	Gluon-Fusion ($gg \to H$)	$H \to ZZ \to 4l$	110 GeV - 200 GeV
		$H \to WW \to l\nu\, l\nu$	110 GeV - 200 GeV
		$H \to \gamma\gamma$	110 GeV - 150 GeV
	VBF ($qq\,H$)	$H \to ZZ \to 4l$	110 GeV - 200 GeV
		$H \to WW \to l\nu\, l\nu$	110 GeV - 190 GeV
		$H \to \tau\tau \to l\nu\nu\, l\nu\nu$	110 GeV - 150 GeV
		$H \to \tau\tau \to l\nu\nu\, \mathrm{had}\nu$	110 GeV - 150 GeV
		$H \to \gamma\gamma$	110 GeV - 150 GeV
	$t\bar{t}H$	$H \to WW \to l\nu\, l\nu\, (l\nu)$	120 GeV - 200 GeV
		$H \to b\bar{b}$	110 GeV - 140 GeV
		$H \to \tau\tau$ (not included)	110 GeV - 150 GeV
		$H \to \gamma\gamma$	110 GeV - 120 GeV
	WH	$H \to WW \to l\nu\, l\nu\, (l\nu)$	150 GeV - 190 GeV
		$H \to \gamma\gamma$	110 GeV - 120 GeV
	ZH	$H \to \gamma\gamma$	110 GeV - 120 GeV

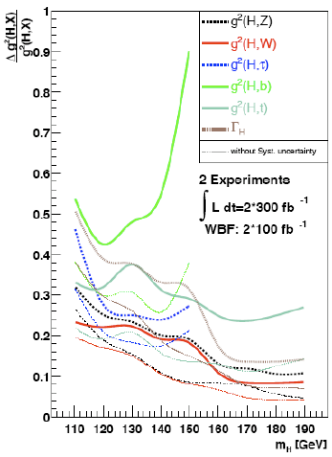


Higgs couplings

If also SM particle content is assumed then

Measure rates -> cross sections and BR's -> couplings

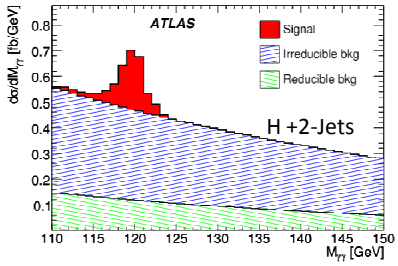
Production		Decay	
σ_{ggH}	$\propto g_t^2$	$\mathrm{BR}(\mathrm{H} \to \mathrm{WW})$	$\propto \frac{g_W^2}{\Gamma_H}$
σ_{VBF}	$\propto a\, g_W^2 + b\, g_Z^2$	$\mathrm{BR}(\mathrm{H} \to \mathrm{ZZ})$	$\propto \frac{g_Z^2}{\Gamma_H}$
$\sigma_{t\bar{t}H}$	$\propto g_t^2$	$\mathrm{BR}(\mathrm{H} \to \tau\tau)$	$\propto \frac{g_\tau^2}{\Gamma_H}$
σ_{WH}	$\propto g_W^2$	$\mathrm{BR}(\mathrm{H} \to \mathrm{b\bar{b}})$	$\propto \frac{g_b^2}{\Gamma_H}$
σ_{ZH}	$\propto g_Z^2$	$\mathrm{BR}(\mathrm{H} \to \gamma\gamma)$	$\propto \frac{(a\, g_W - b\, g_t)^2}{\Gamma_H}$

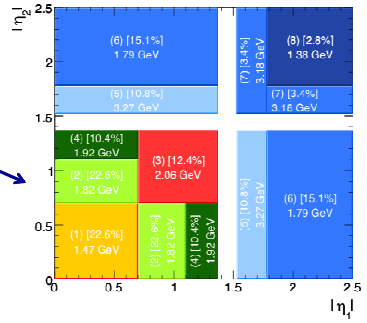


H → γγ

Additional handles used in ATLAS

- Improve CUT analysis add
  - H+1-Jet
  - H+2-Jets → VBF
    - S/B more favorable
- Alternative Likelihood fit:
  - Categories: $|\eta_\gamma|$, N-Jets, #conv-γ
  - Variables: $M_{\gamma\gamma}$, $P_{T\gamma\gamma}$, $|\cos(\theta^*)|$
- Categories sensitive to $\sigma(M_{\gamma\gamma})$
- More Sensitive to BKG description:
  - $M_{\gamma\gamma}$ side-bands → BKG Properties from DATA

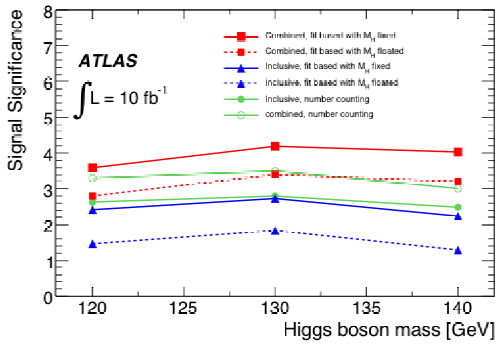




F.Ceruttii-HCP09

H → γγ

- ATLAS Results: Significance at M_H=130 GeV; L=10 fb^{-1}
  - CUT Inclusive: 2.8 σ
  - **CUT Adding H+1jet and H+2Jets selections: 3.5 σ**
  - **Likelihood with more variables/categories: 4.2 σ**
  - Likelihood M_H "floated" → "look-elsewhere" effect: **-0.8 σ**



Integrated Luminosity for Discovery
M_H=130 GeV

CUT based:
Inclusive: ~ 32 fb^{-1}
Adding 1,2-Jet category ~ 20 fb^{-1}

Likelihood based:
Likelihood ~ 14 fb^{-1}
Likelihood + MH "float" ~22 fb^{-1}

H → γγ

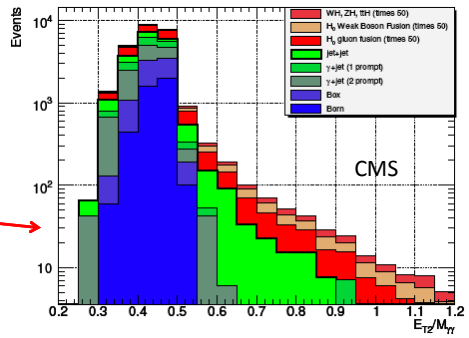
CMS

CUT analysis:

- Categories based on lateral shower shape and η_γ

Optimized analysis:

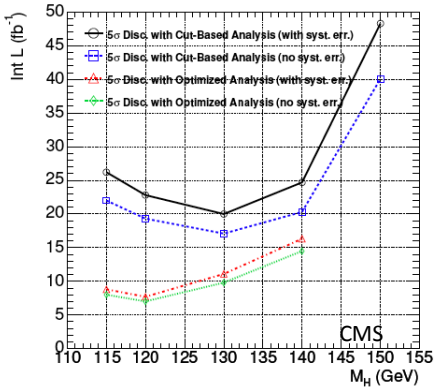
- In addition to $M_{\gamma\gamma}$:
  - NN-isol-γ, $E_{T\gamma}/M_{\gamma\gamma}$, $P_{L\gamma\gamma}$, $|\delta\eta|$,...
- BKG shapes at LO only:
  - Some impact on $E_{T\gamma}$
  - On REAL data **BKG should come from $M_{\gamma\gamma}$ side-bands**



H → γγ

CMS: M_H=120 GeV:

- CMS CUT based
  - **Discovery ~23 fb^{-1}**
  - **Exclusion 4.4 fb^{-1}**
- CMS Optimized analysis:
  - **Discovery ~10fb-1**

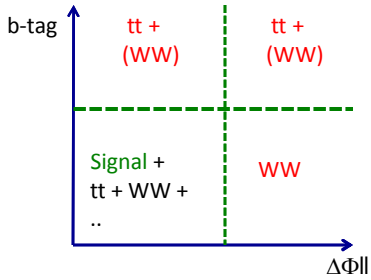


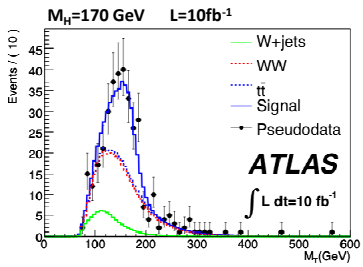
Analysis	5 σ discovery no syst	5 σ discovery syst	3 σ evidence no syst	3 σ evidence syst	95% exclusion no syst	95% exclusion syst
counting exp.	27.4	48.7	10.0	13.2	4.5	6.5
1 category	24.5	39.5	8.9	11.5	4.1	5.8
4 categories	21.3	26.0	7.5	9.1	3.5	4.8
12 categories	19.3	22.8	7.0	8.1	3.2	4.4

H → WW → e ν μ ν

ATLAS: WW → eμ 2ν + 0 Jets

- Pre-select: 2 high-P_T l, M_{ll}, E_T-miss
- 4 regions based b-tag and $\Delta\Phi_{ll}$:
  - 1 SIGNAL-enriched and 3 BKG-Dominated
- Two variables M_T, P_T^{WW} in 4 regions
- Max-Likelihood Fit to:
  - Signal significance
  - BKG normalization + (Some) shapes: absorb Higher Order QCD corrections on P_T^{WW}
- BKG sys → stat errors from data
- Test statistics LR: $\lambda = L_{s+b}/L_b$

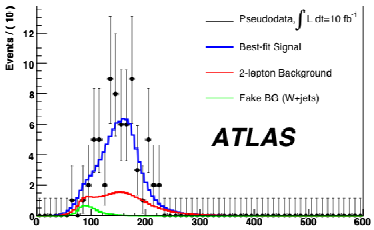


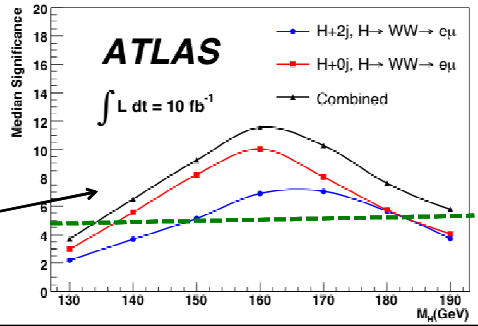


H → WW → e ν μ ν

ATLAS: WW → eμ 2ν + 2 Jets

- VBF-NN tag based on:
  - $|\Delta\eta_{jj}|$, M_{jj}, E_T-3rd-Jet
- + b-jet veto
- Likelihood fit to BKG and Signal:
  - 2 regions from $\Delta\Phi_{ll}$"S"+"Control"
  - 2 Variables: VBF-NN tag and M_T
- BKG Dominated by tt
- JES systematics on NN-Output
- M_H free in LR fit: **"look elsewhere" effect included**

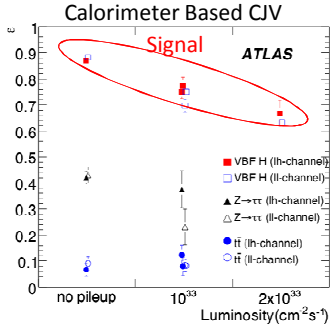




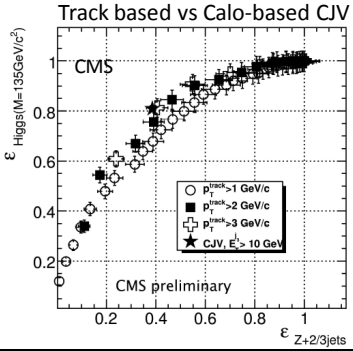
qqH → qq ττ

- Main selection variables:
  - high-PT Isolated l(s) → trigger
  - Hadronic τ ID (lh channel only)
  - Central Jet Veto (CJV) → Sensitive to pileup
  - b-jet veto: against tt
- Track-based "central jet veto" less sensitive to pile-up effects investigated

Calorimeter Based CJV

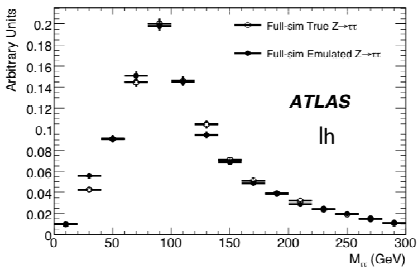


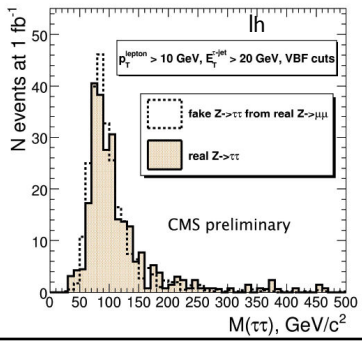
Track based vs Calo-based CJV



qqH → qq ττ

- Both experiments developed techniques to get main BKG's shape and normalization from DATA "control samples"
- Z→ ττ mass shape dominated by E_T-miss performance: TAILS
  - Z→μμ+jets with selection identical to SIGNAL one apart from E_T-miss and $m_{\tau\tau}$
  - Then substitute "real" μ with simulated τ
  - "Emulated" sample used to predict Z→ ττ mass shape and normalization

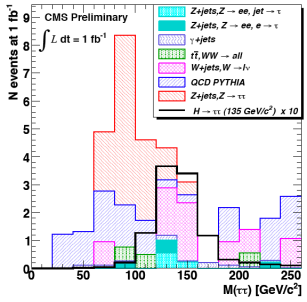


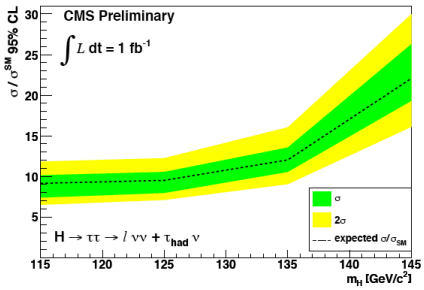


qqH → qq ττ

Additional CMS control samples:

- QCD: Same-Sign vs O-Sign for lh events selected with non-isolated leptons
- QCD Mass shape derived from data reversing lepton isolation criteria
- Other BKG's (tt) Normalized to inclusive cross-section measurements and extrapolated in signal region with MC
- Syematics on extrapolation included
- For exclusion systematics on signal also included: dominated by Jet Energy Scale assumed to be ~7%

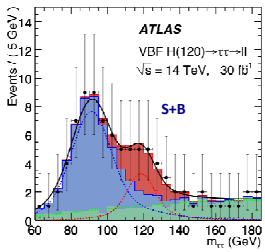


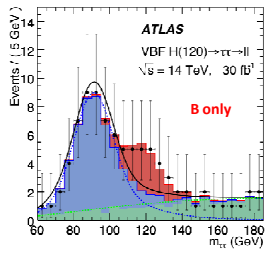


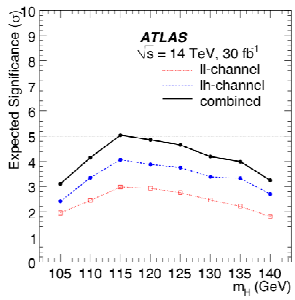
qqH → qq ττ

Results from ATLAS:

- Profile Likelihood method applied to get expected sign.
- Fit to
  - $M_{\tau\tau}$
  - "$m_{\tau\tau}$-Emulated"
  - BKG "control samples"
- Most of systematic uncertainties translated into statistical errors
- For Exclusion signal sys from experimental effects (dominated by JES) added
- About 50 fb^{-1} needed to cover the [114-130] mass range







30 fb^{-1} discover 130 GeV