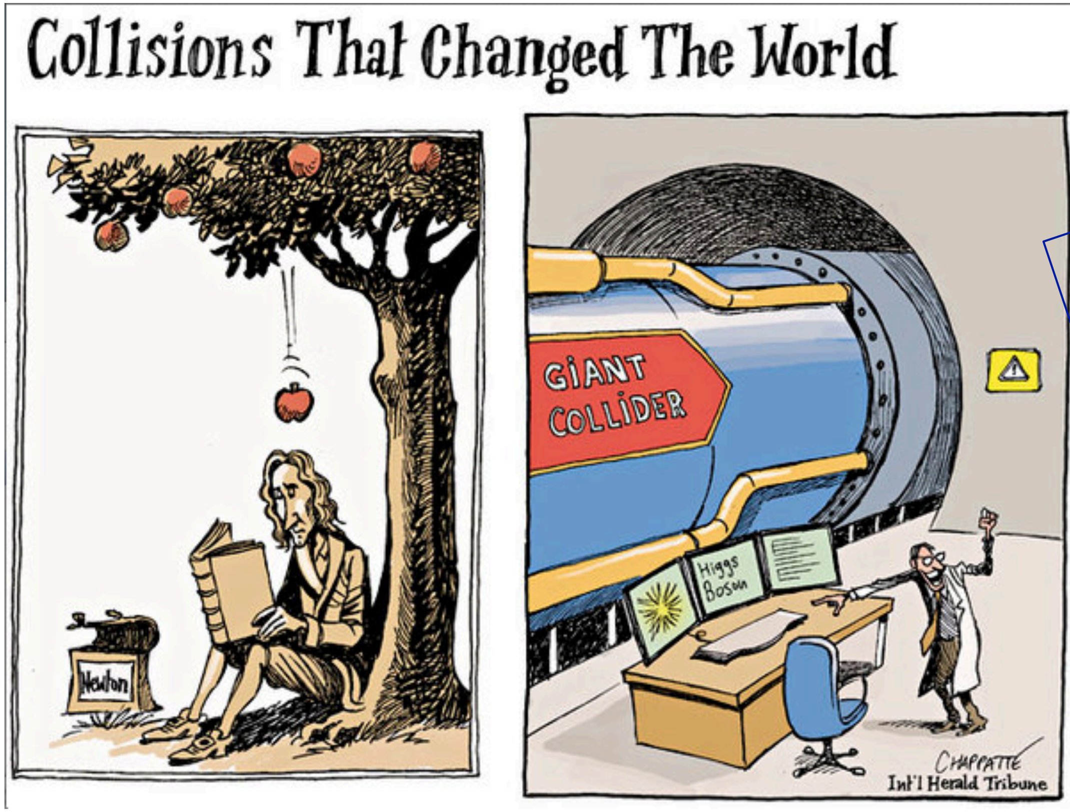
SM Higgs Boson searches in CMS



WELL ....
NOT YET !!!

Chiara Mariotti

Introduction

- The LHC started 9 years after the end of LEP.
- The detectors were ready and soon we realized that we were indeed understanding them.
- The start-up from the physics point of view was very successful and we got immediately tons of results!
- The statistical precision is enough already now to distinguish the relevance of Higher Order (NLO vs LO and more).

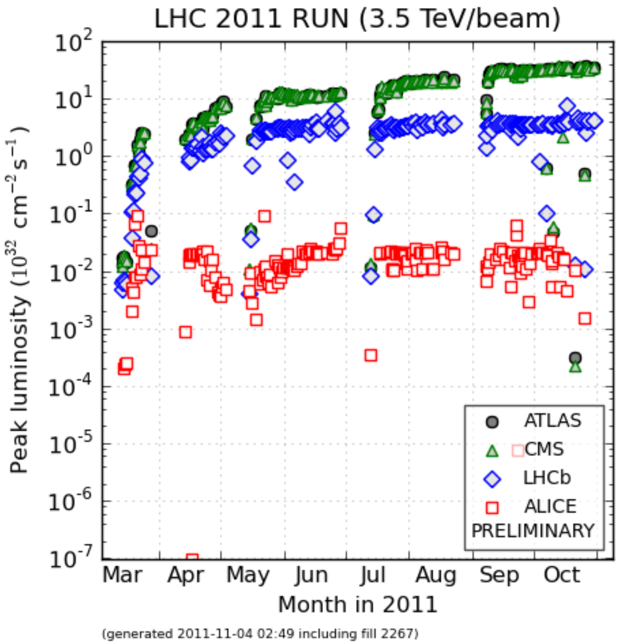
  W.r.t. LEP, theoretical predictions are ready in advance and can match the experimental precision…
- There is still a long way to go (at 8 TeV, 14 TeV and …) and we all hope to discover the Higgs (!) but also something new, maybe totally unexpected.

LHC in 2011

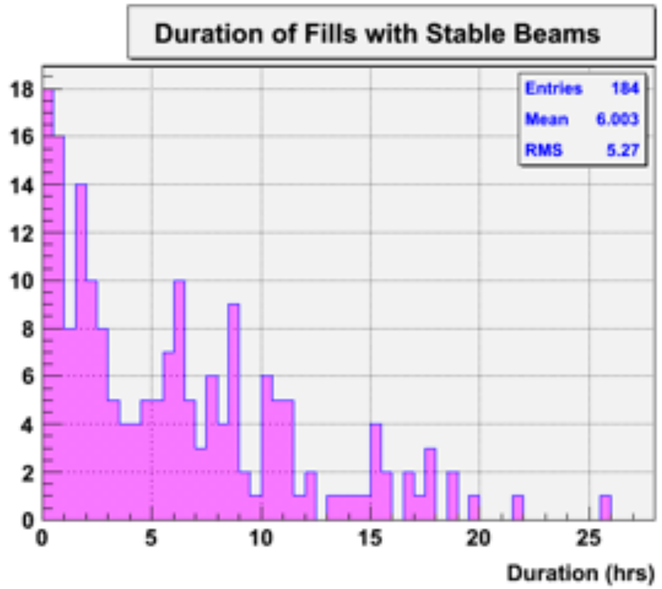
Simply magnificent !!!

Peak Lumi

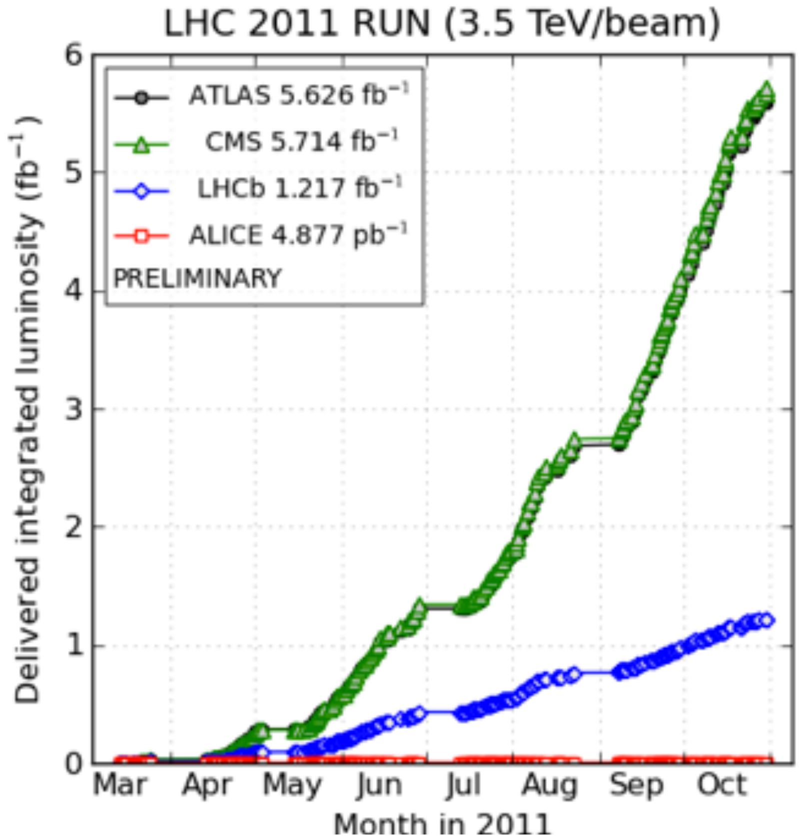
3.3×10^{33}



Best Fill

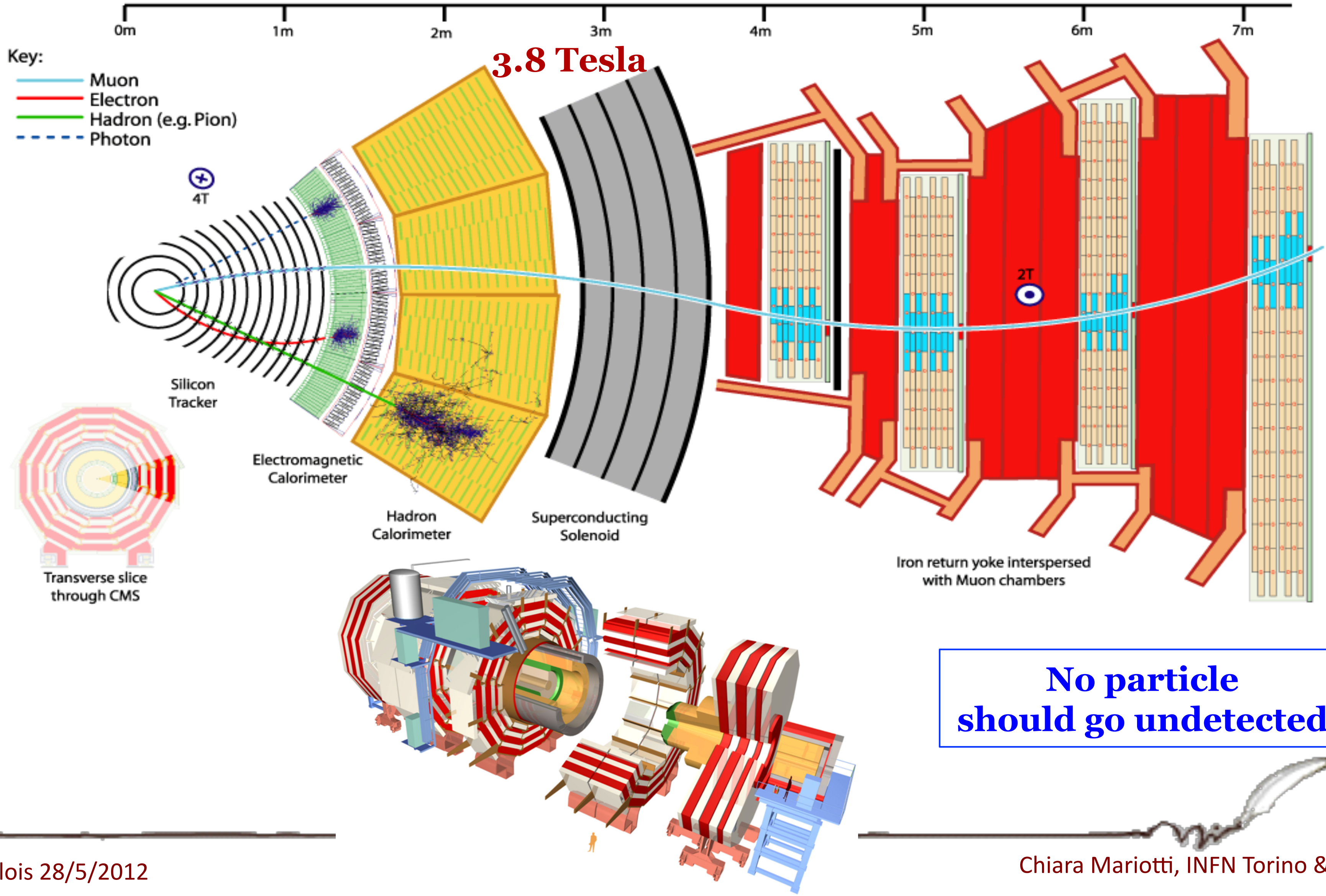


Total Lumi



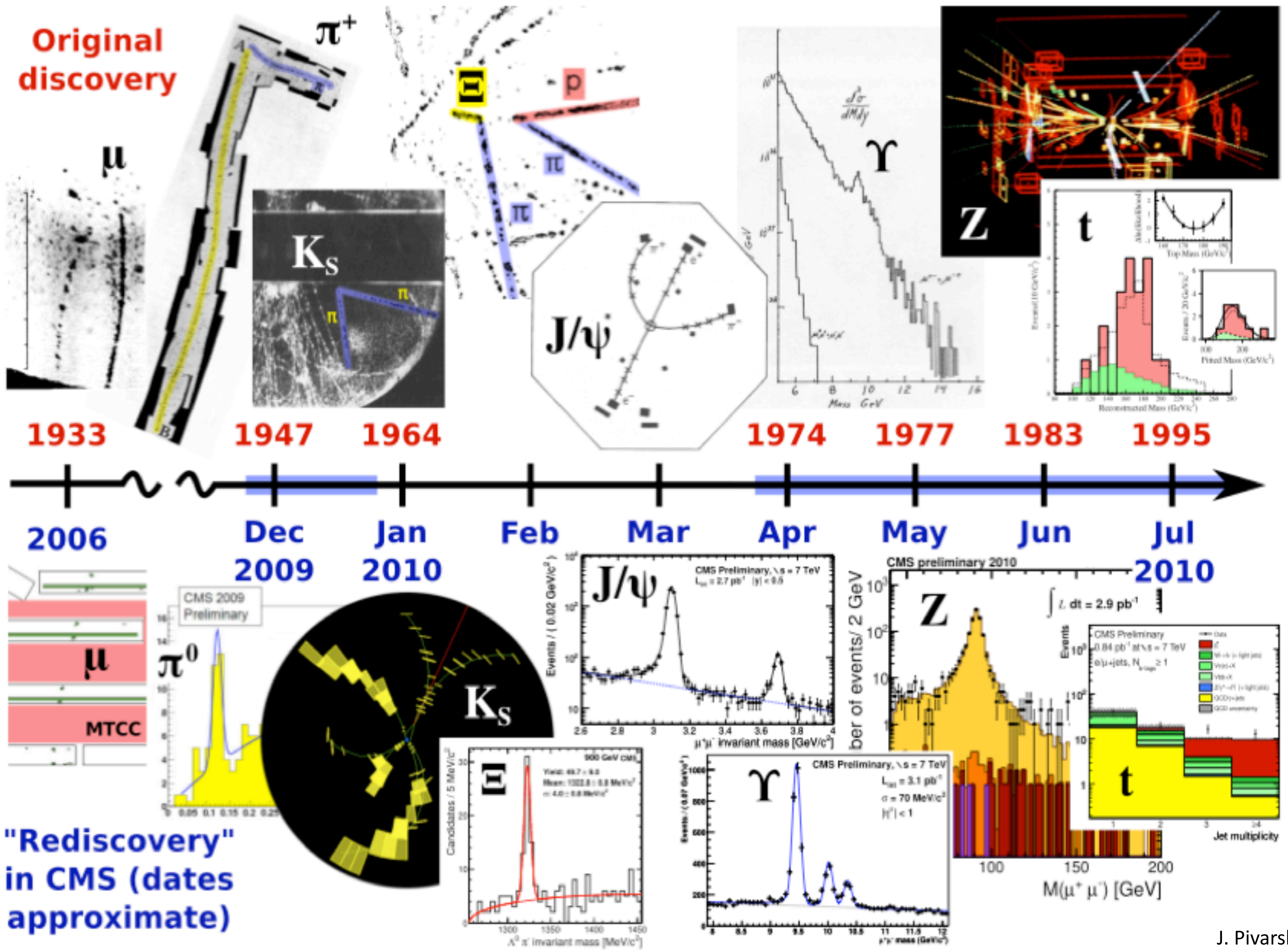
~90% recorded by the ATLAS and CMS

The Experiments: CMS



No particle should go undetected

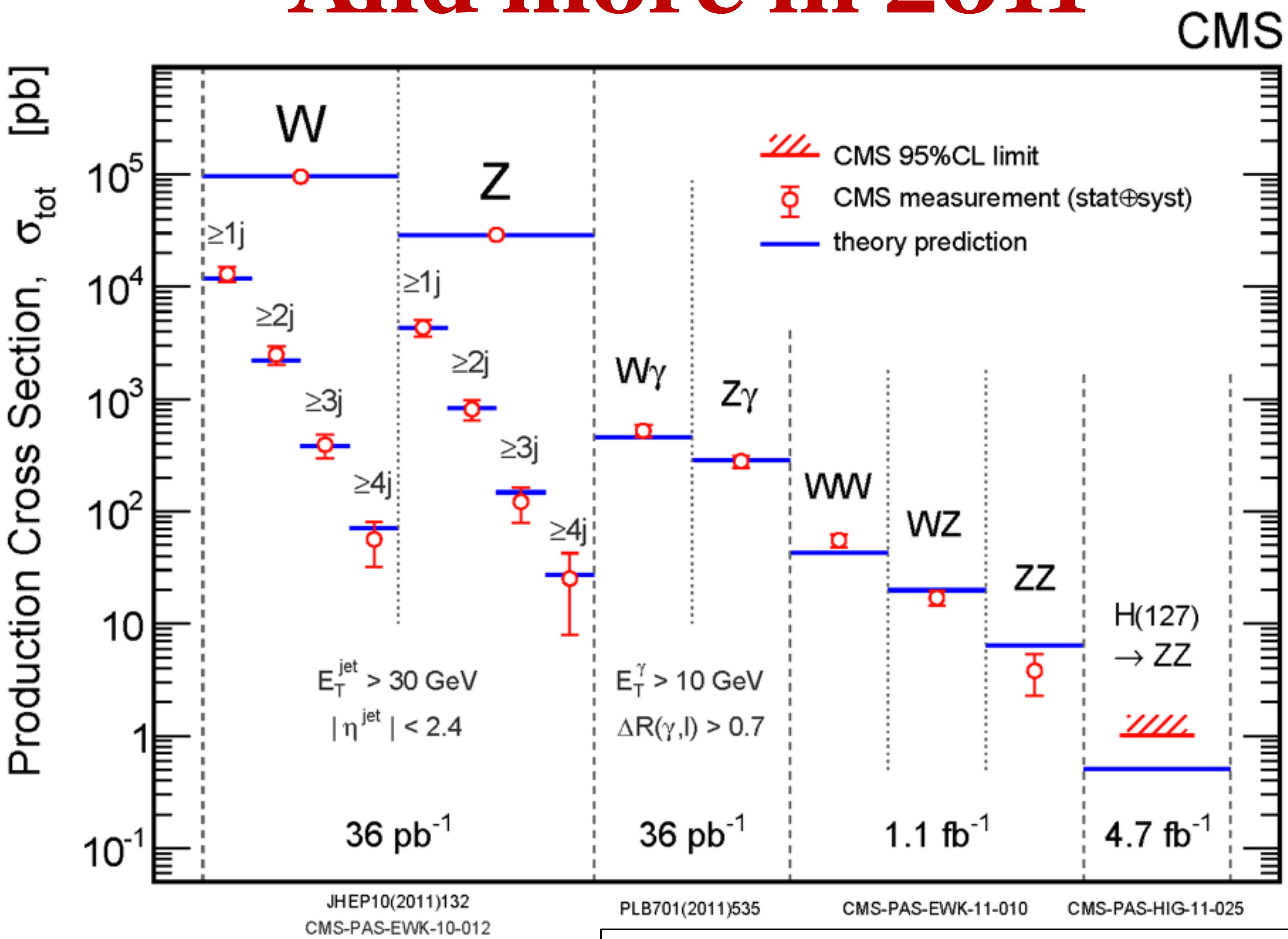
S.M. rediscovery in 2010



J. Pivarski

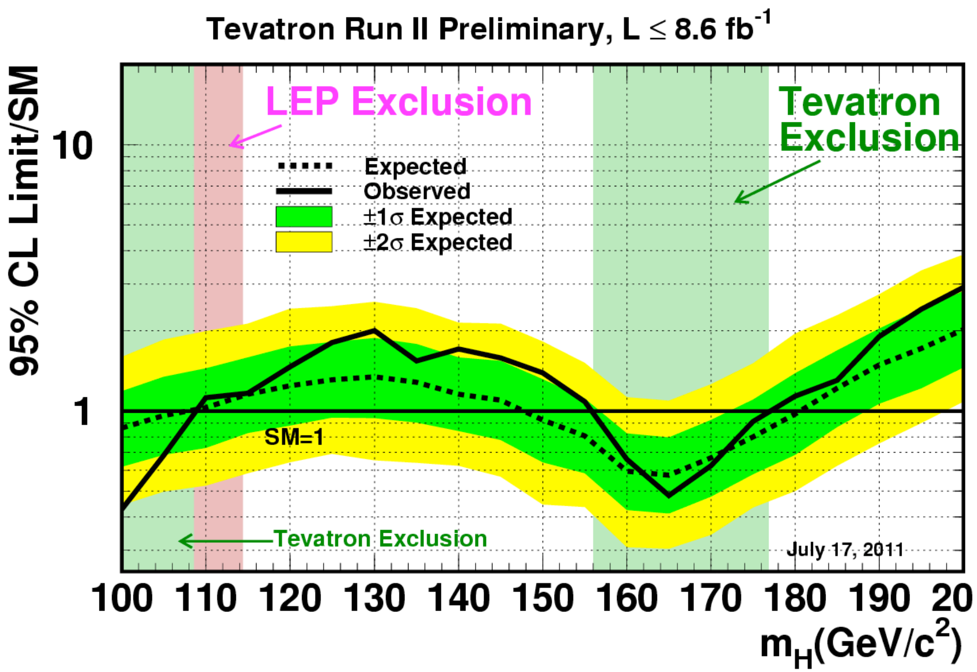
RN

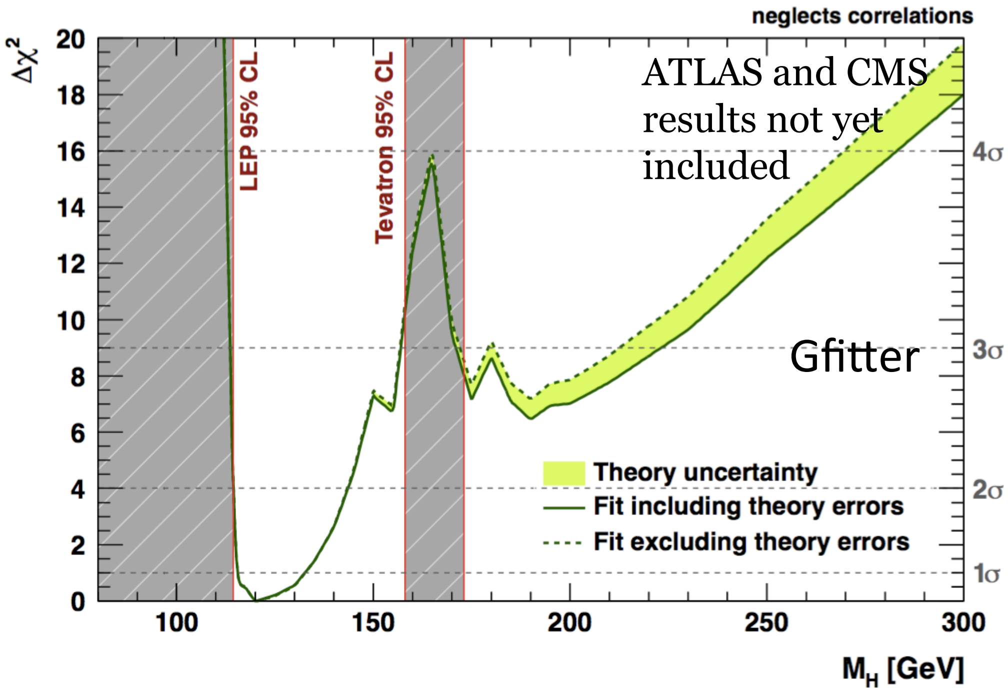
And more in 2011



In our present dataset (~ 5 fb^{-1}) we have (after selection cuts):
~ 30 M $W \rightarrow \mu\nu$, $e\nu$ events
~ 3 M $Z \rightarrow \mu\mu$, ee events
~ 60000 top-pair events

The Higgs before LHC





- Direct searches
  - LEP: M_H>114.4 GeV at 95% CL
  - Tevatron: $|M_H$-166$|$>10 GeV at 95% CL
- Indirect constraints from precision EW measurements
  - $M_H = 96^{+31}_{-24}$ GeV, M_H<169 GeV at 95% CL (standard fit)
  - $M_H = 120^{+12}_{-5}$ GeV ,M_H<143 GeV at 95% CL (including direct searches)

The LHC Higgs Cross Section WG

- About 2.5 years ago, exactly the day LHC was delivering the first collision to the experiments, a group formed by TH and EXP (the LHC Higgs Cross Section WG) was founded in order to provide precise Higgs predictions.

- The goal was to access the most advanced theory predictions for the Higgs Cross Section and Branching Ratio: central value and uncertainties

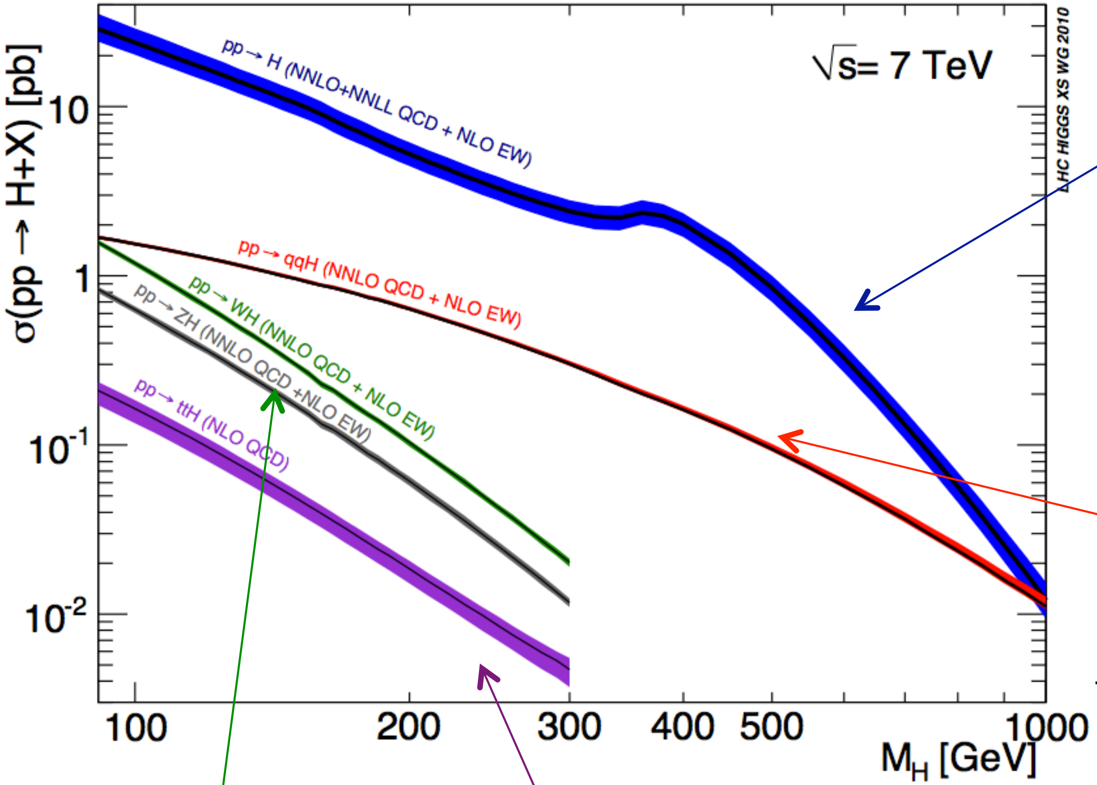
⬇

- Experiments are thus from day "1" coherently using the **COMMON INPUTS** provided by the LHC H XS WG (CERN-2011-002, "YR1", and CERN-2012-002, "YR2").

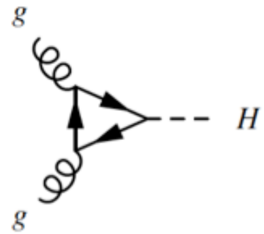
  This facilitates the comparison and the combination* of the individual results

*LHC Higgs Combination group. Only experimentalists

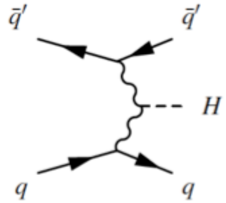
Inclusive Cross Sections



ggF: NNLO+NNLL QCD + NLO EW

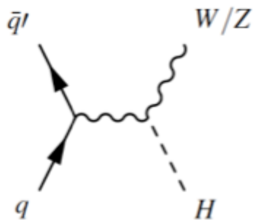


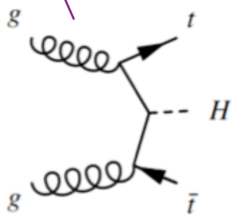
qqH: NNLO QCD + NLO EW



WH: NNLO QCD + NLO EW

ZH: NNLO QCD + NLO EW





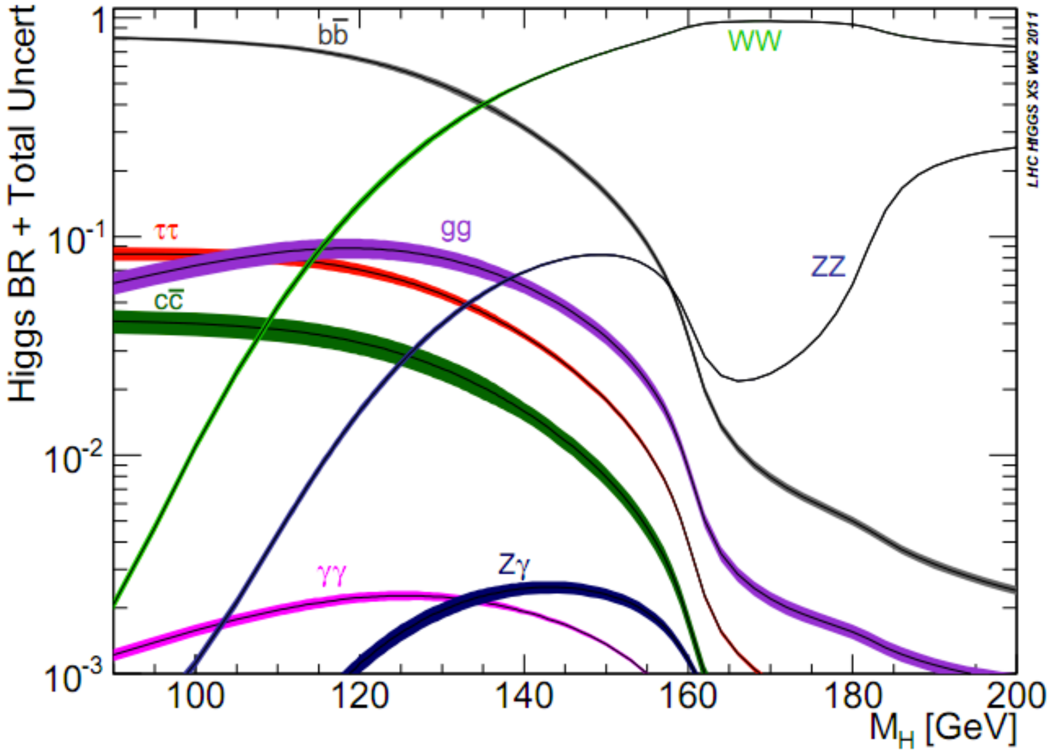
	$K_{NNLO/NLO}$ ($K_{NLO/LO}$)	Scale	PDF+a_S	Total error
ggF	+25% (+100%)	+12% -7%	±8%	+20 -15%
VBF	<1% (+5-10%)	±1%	±4%	±5%
WH/ ZH	+2-6% (+30%)	±1%	±4%	±5%
ttH	- (+5-20%)	+4% -10%	±8%	+12 -18%

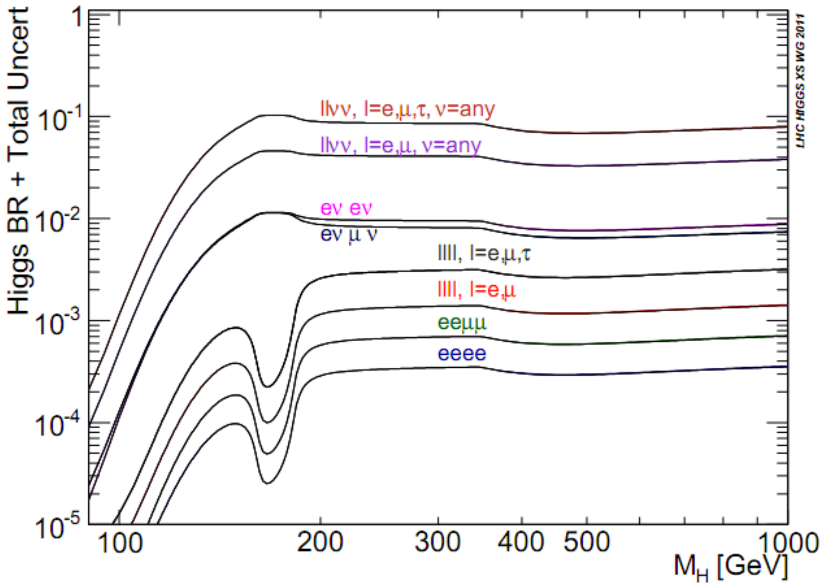
ttH: NLO QCD

Branching Ratios

$$\Gamma_H = \Gamma^{HD} - \Gamma^{HD}_{ZZ} - \Gamma^{HD}_{WW} + \Gamma^{Proph.}_{4f} + \Gamma^{HD}_{\gamma\gamma}\delta^{QED}_{\gamma ff}$$

MH	Decay	THU	PU	Total
120 GeV	H→γγ	±2.9%	±2.5%	±5.4%
	H→bb	±1.3%	±1.5%	±2.8%
	H→ττ	±3.6%	±2.5%	±6.1%
150 GeV	H→WW	±0.3%	±0.6%	±0.9%
	H→ZZ	±0.3%	±0.6%	±0.9%

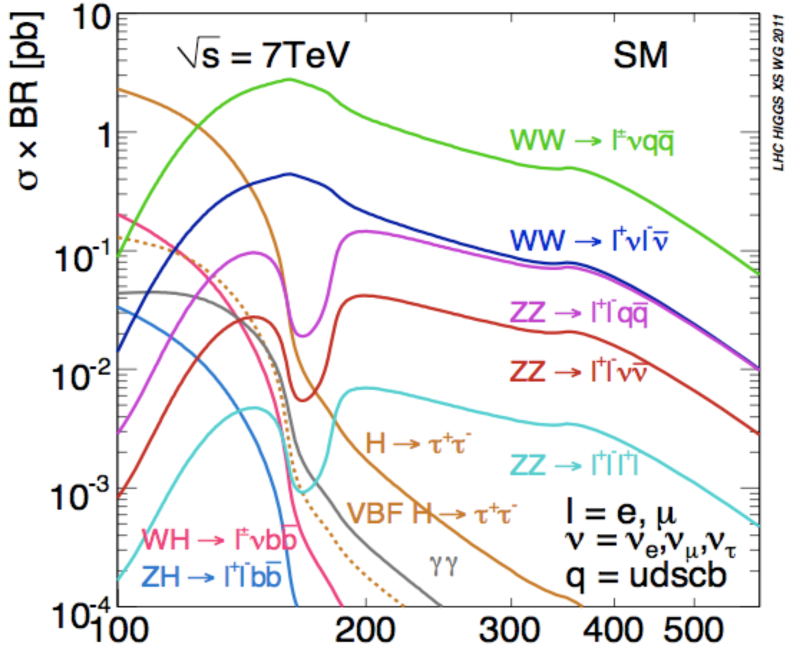


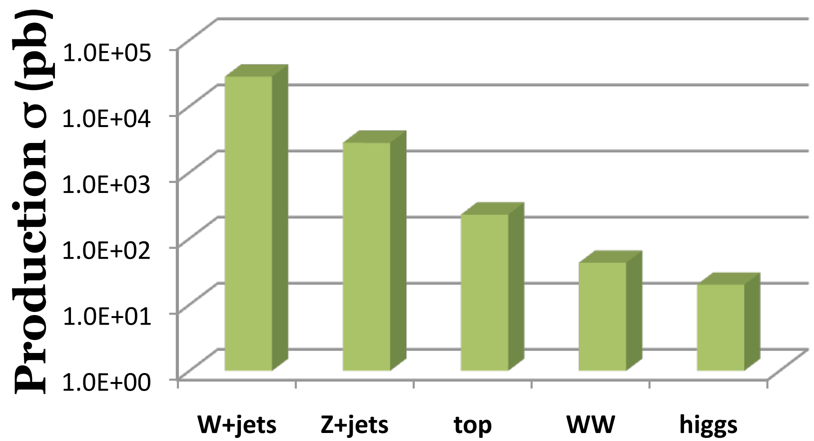


HD=HDecay

Proph = Prophecy4f   NLO QCD+NLO EW

Higgs search strategy

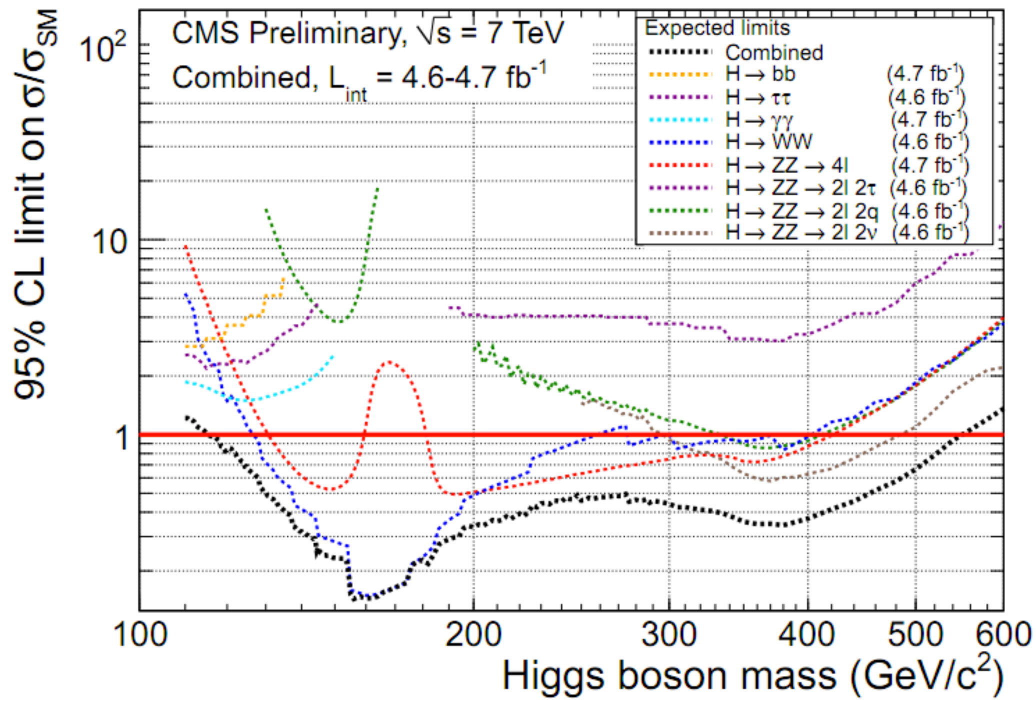




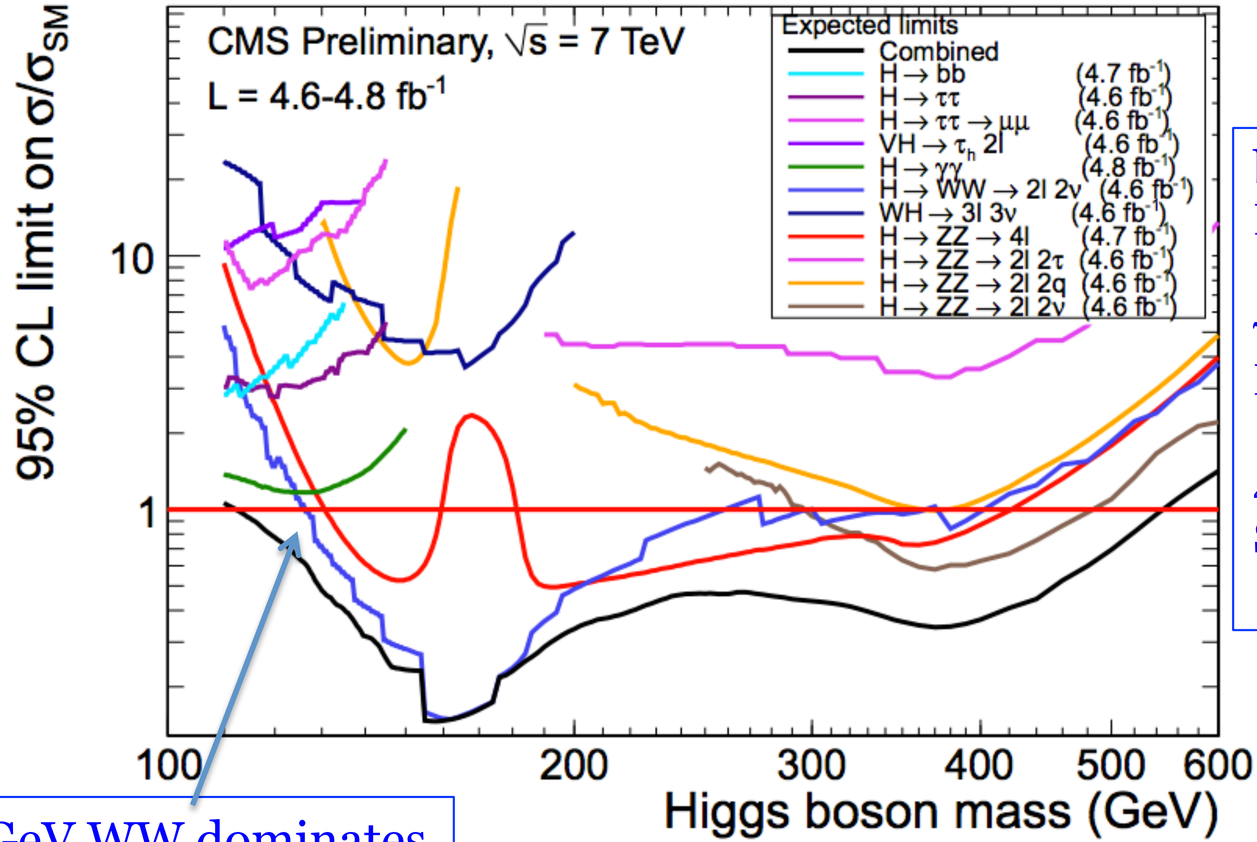
Higgs production cross section tiny compared to other QCD and EWK processes

Events expected to be produced with $L = 1\ fb^{-1}$

m_H, GeV	WW→lvlv	ZZ→4l	γγ
120	127	1.5	43
150	390	4.6	16
300	89	3.8	0.04



Higgs search strategy



bb/ττ/WW
Poor mass resol

γγ and 4l
Excellent mass resol

4l is ~backg free
Single event has
an impact

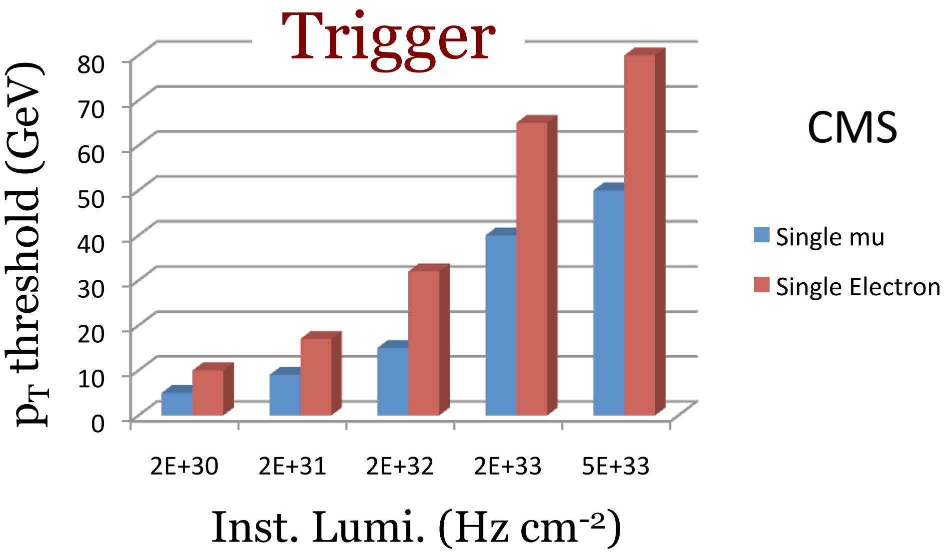
Above ~123 GeV WW dominates
At lower masses γγ takes over

m_H < 135 GeV
H -> γγ exclusion and discovery
H -> 4l exclusion and discovery
H -> WW/ττ/bb

140 < m_H < 180 GeV
H -> WW->2l2ν
ZZ->4l also

m_H>180 GeV
H ->ZZ channels for discovery
H->WW->lνjj

The challenge of the high Lumi

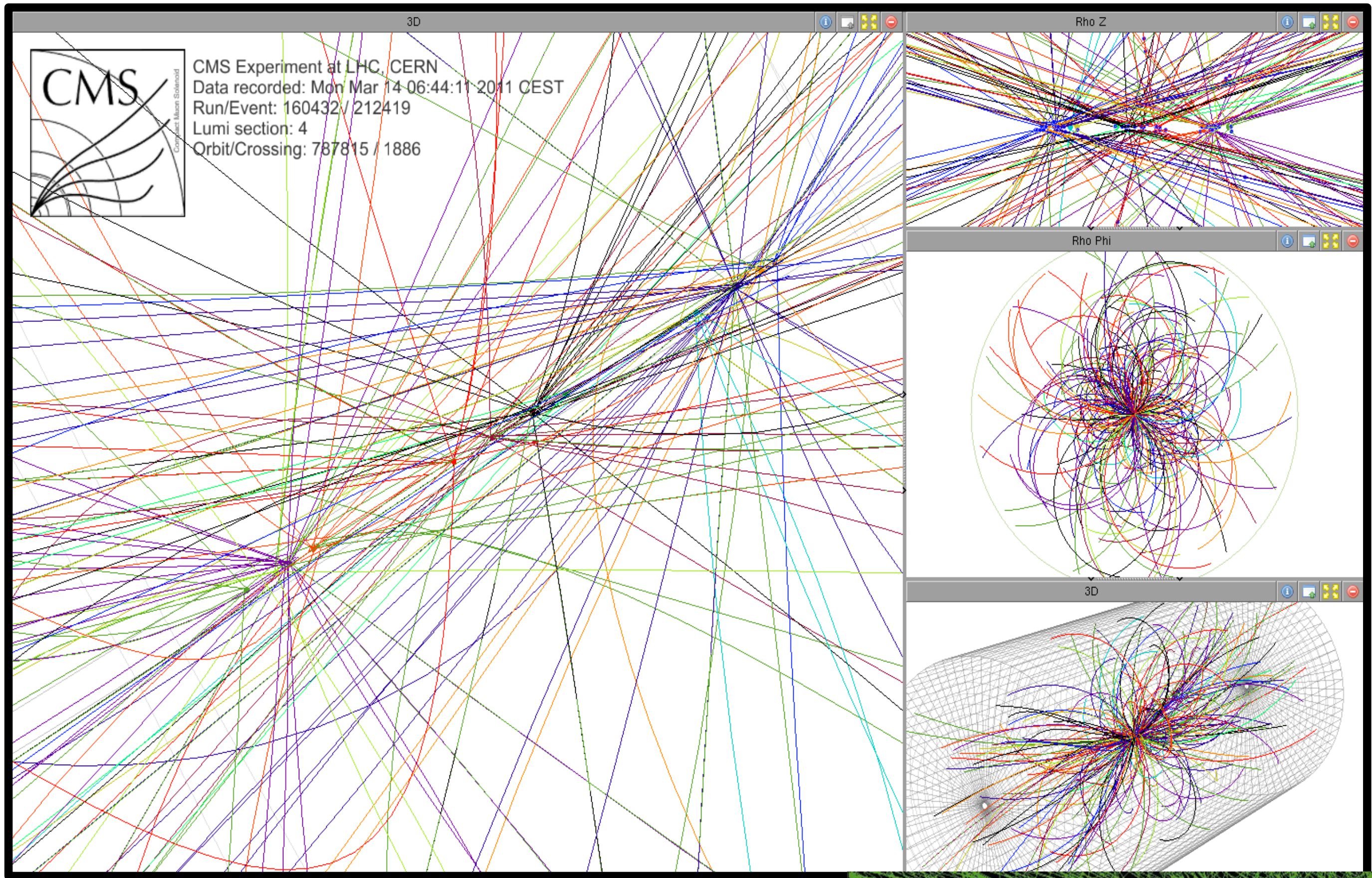


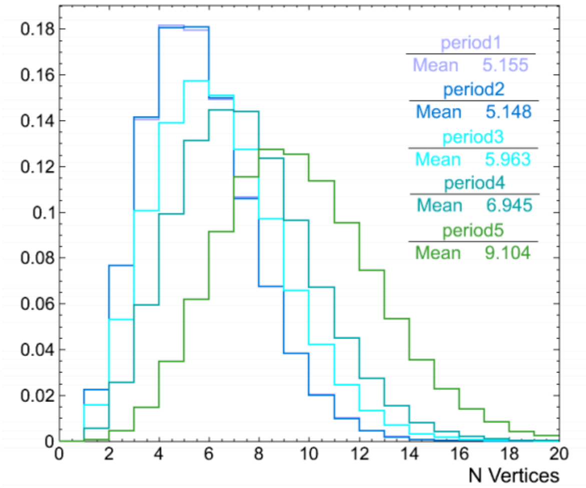
Evolution of trigger threshold for single non isolated leptons vs inst. lumi

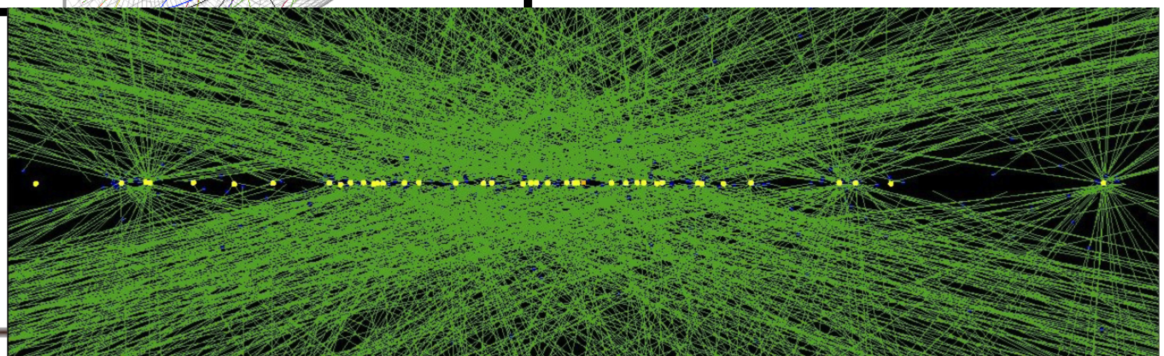
- Inclusive triggers have reached such high thresholds that can not be used anymore for many analyses
- In the context of each analysis dedicated triggers suitable for the specific final state have to be devised:
  - H->WW->lνlν, H->ZZ-> 4l: Double mu and double electron thresholds at (17,8) GeV
  - H->γγ: Double photon (36,18) GeV
- Challenging for the low mass Higgs searches

Pile-up: a "manageable nuisance"

V.Sharma



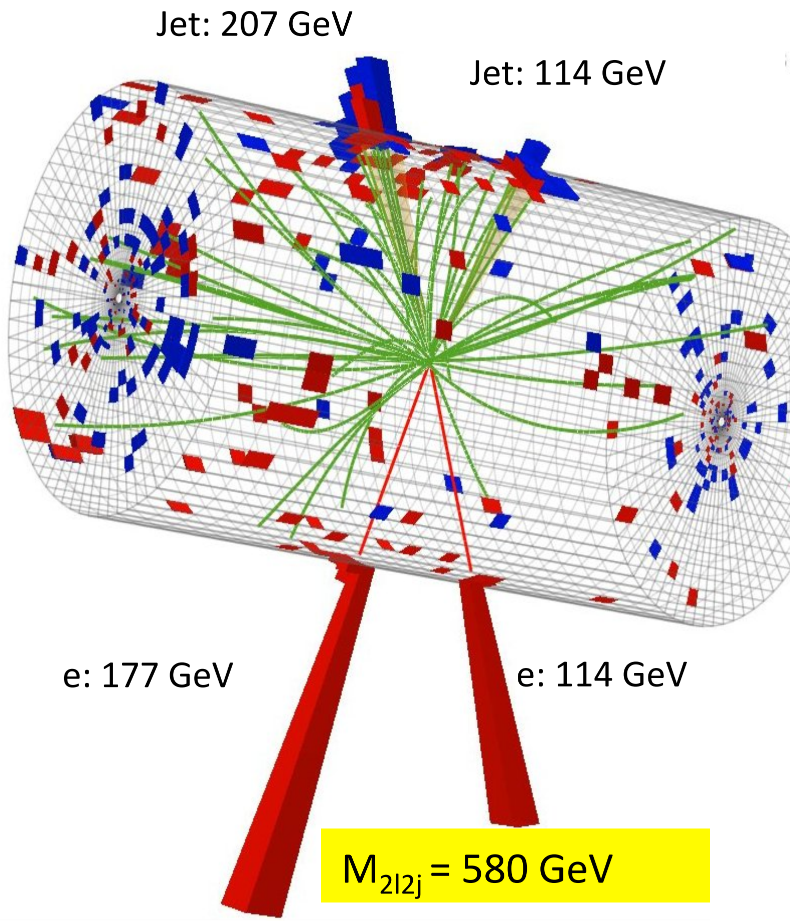




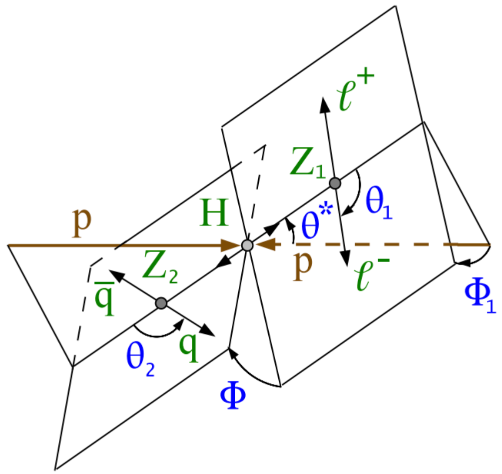
Event with 40 reconstructed vertices from the high PU fill

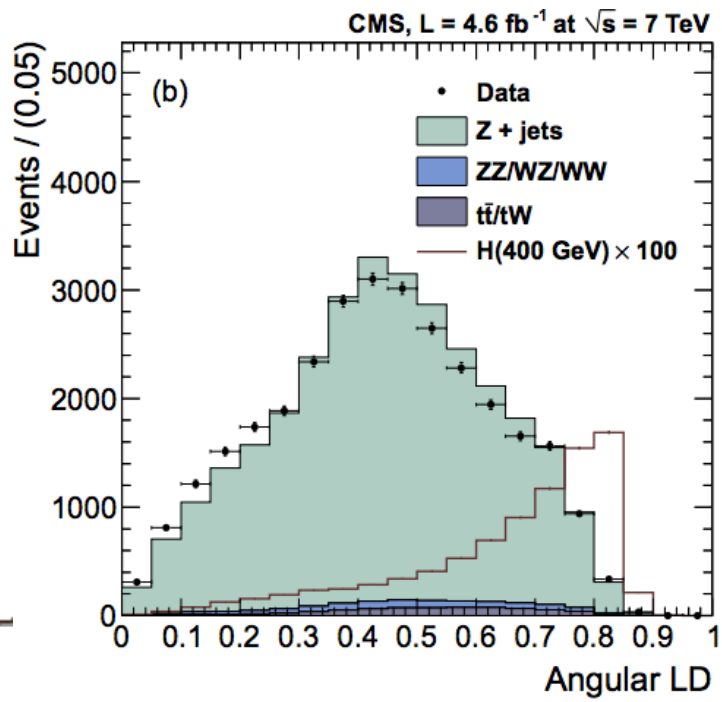
The High Mass

H→ZZ→llqq

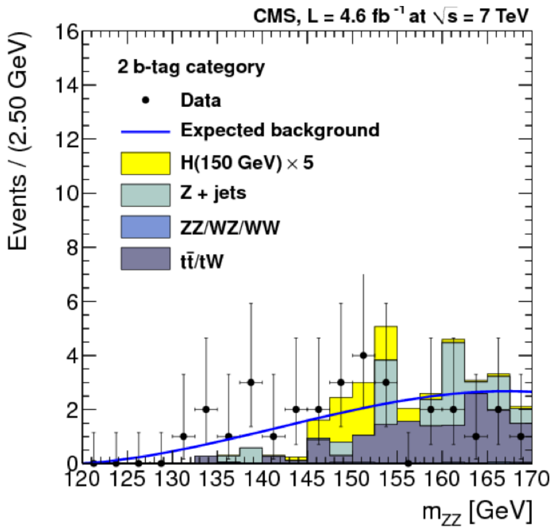


- Highest rate amongst all H → ZZ final states
- Search for a peak (σ~10 GeV) in M_{2l2j} distribution
- Events categorized by presence of 0, 1, 2 b-jets
- Major background: Z+jets ; ttbar suppressed by ME_T requirement
- CMS: Use 5 angles of scalar H → ZZ → 2l2q in a likelihood discriminant
- Background shape, normalization ← data sideband

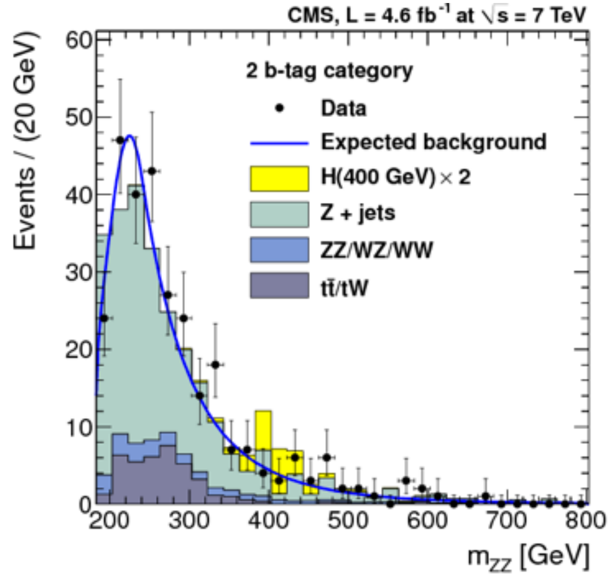




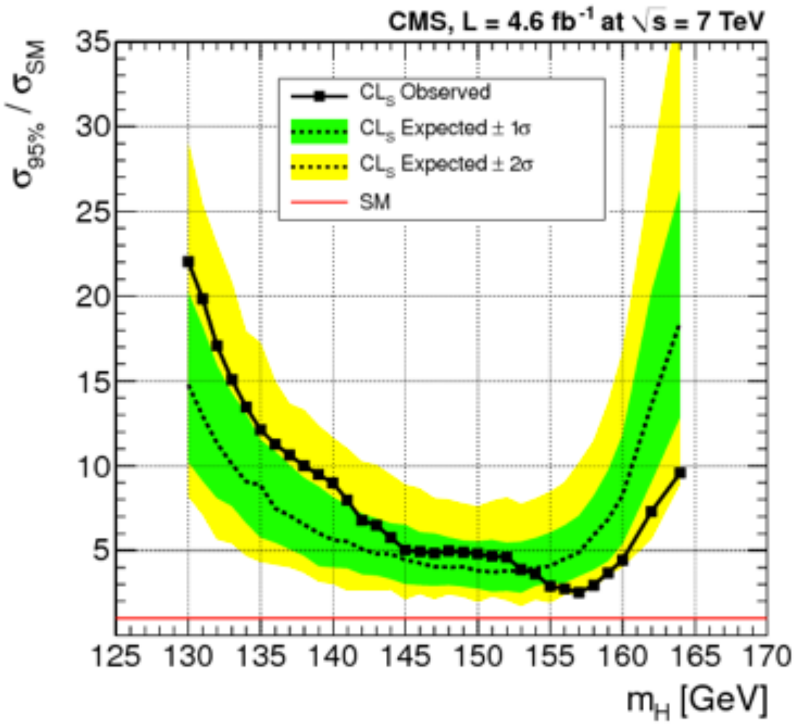
H → ZZ → llqq



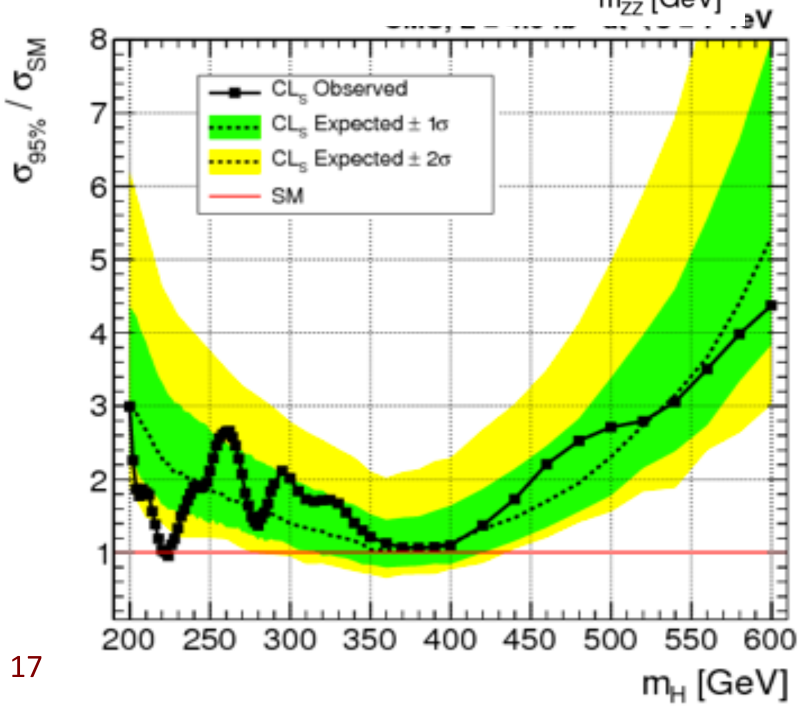
CMS, L = 4.6 fb^{-1} at $\sqrt{s}$ = 7 TeV
2 b-tag category
Data
Expected background
H(150 GeV) × 5
Z + jets
ZZ/WZ/WW
$t\bar{t}$/tW
Events / (2.50 GeV)
m_{ZZ} [GeV]



CMS, L = 4.6 fb^{-1} at $\sqrt{s}$ = 7 TeV
2 b-tag category
Data
Expected background
H(400 GeV) × 2
Z + jets
ZZ/WZ/WW
$t\bar{t}$/tW
Events / (20 GeV)
m_{ZZ} [GeV]

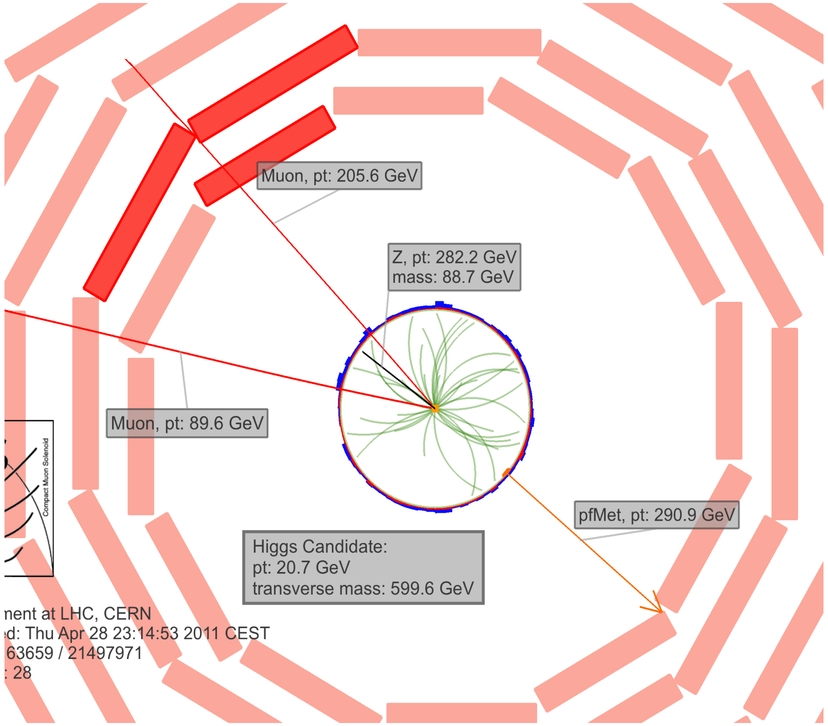


CMS, L = 4.6 fb^{-1} at $\sqrt{s}$ = 7 TeV
CL_s Observed
CL_s Expected ± 1σ
CL_s Expected ± 2σ
SM
$\sigma_{95\%} / \sigma_{SM}$
m_H [GeV]

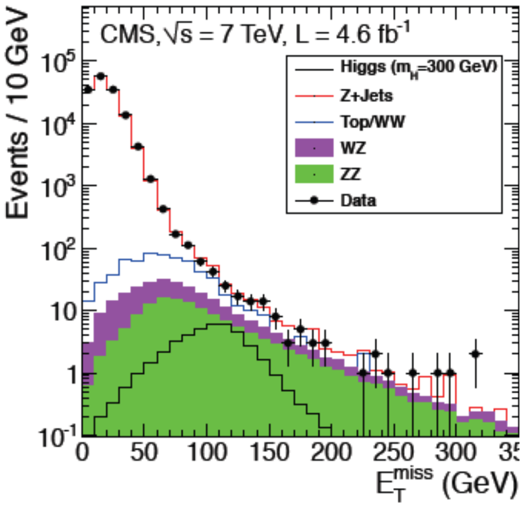


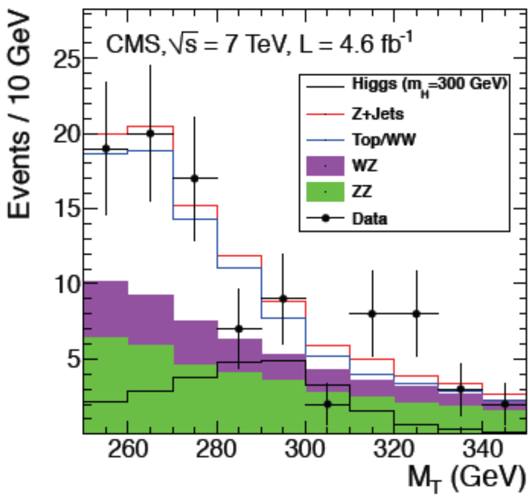
CL_s Observed
CL_s Expected ± 1σ
CL_s Expected ± 2σ
SM
$\sigma_{95\%} / \sigma_{SM}$
m_H [GeV]

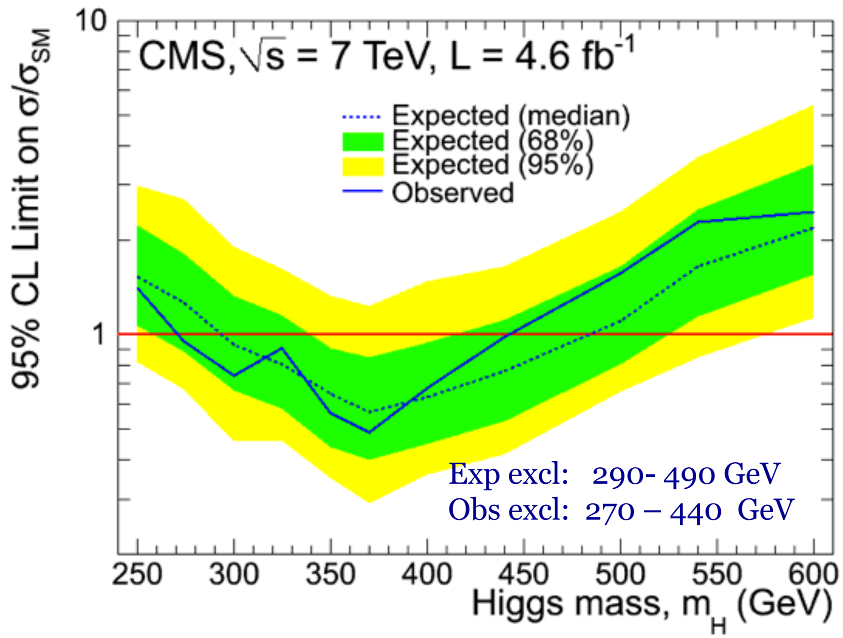
H→ZZ→llνν



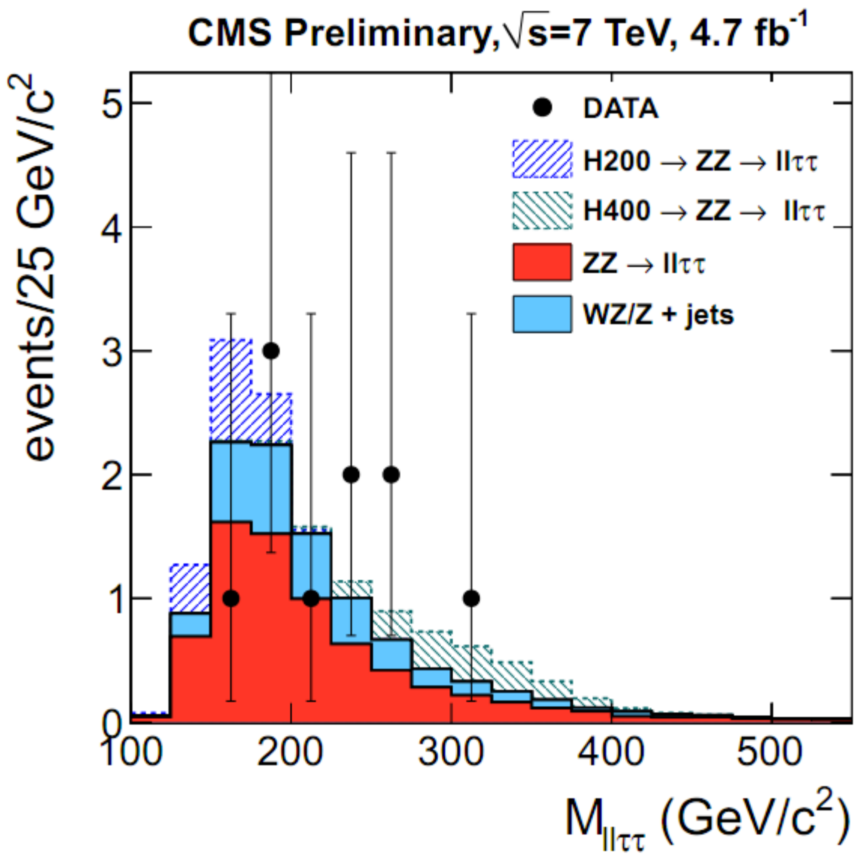
- Z→ ll candidate : $M_Z \pm 15$ GeV; P_T (ll) > 25 GeV
- Use $M_T{}^2 = (\sqrt{P_{TZ}{}^2 + M_Z{}^2} + \sqrt{MET^2 + M_Z{}^2})^2 - (\vec{P_{TZ}} + \vec{MET})^2$
- Major backgrounds: Z+Jets, ttbar & WZ
  - ME_T requirement to suppress Z + jets by x10^5
  - Anti b-tag to suppress ttbar
- Residual ZZ, WZ background estimate from MC
- Residual backgrounds estimated from data
  - γ + jets (for Z+Jets) ; eμ sample (for ttbar +WW)

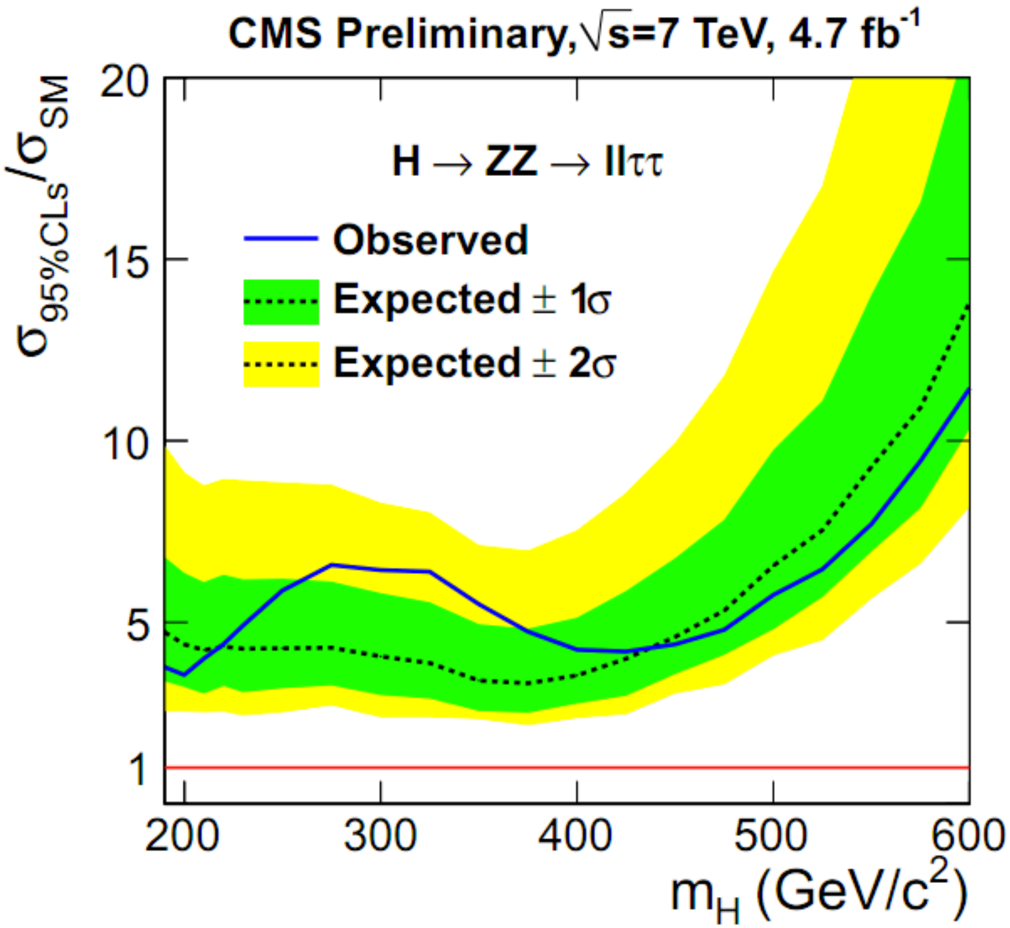






H → ZZ → 2l 2τ

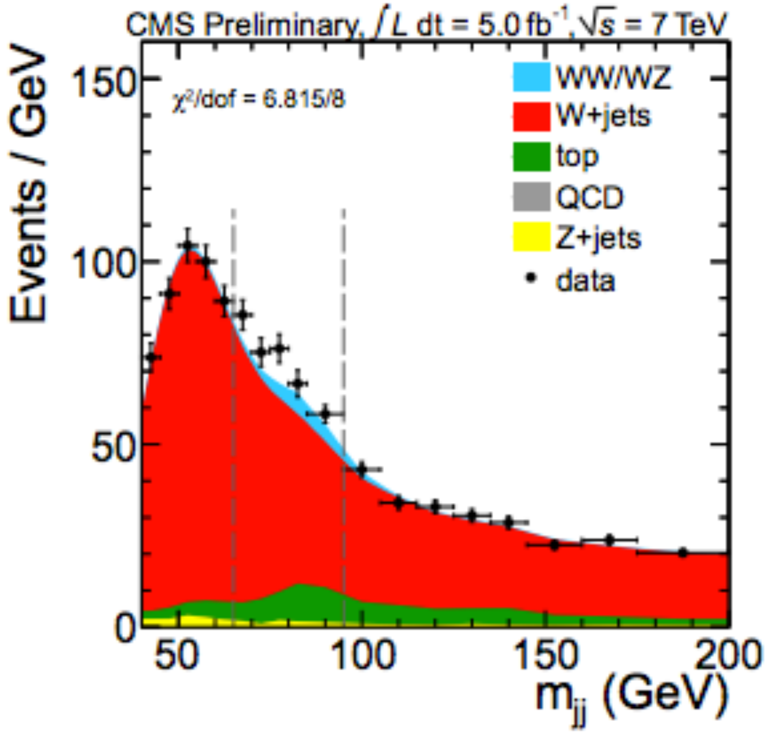


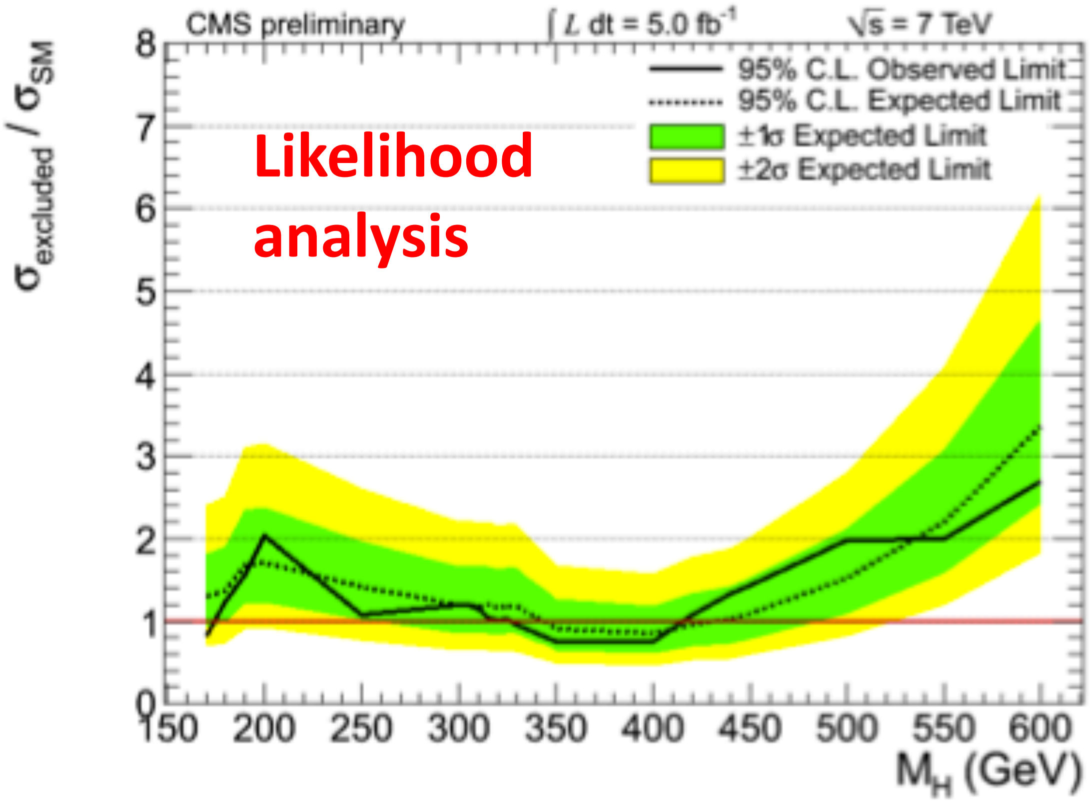


- Using both $\tau_{had}\tau_{had}$ and $\tau_{had}\tau_{l}$ final states
- Requires $30<M_{\tau}<80$ GeV

H → WW → lvjj

- New from CMS
- Studied mass range 170-600 GeV
- Mass shape analysis using $M_{l\nu jj}$
  - For the neutrino use MET and inpose W mass constraint

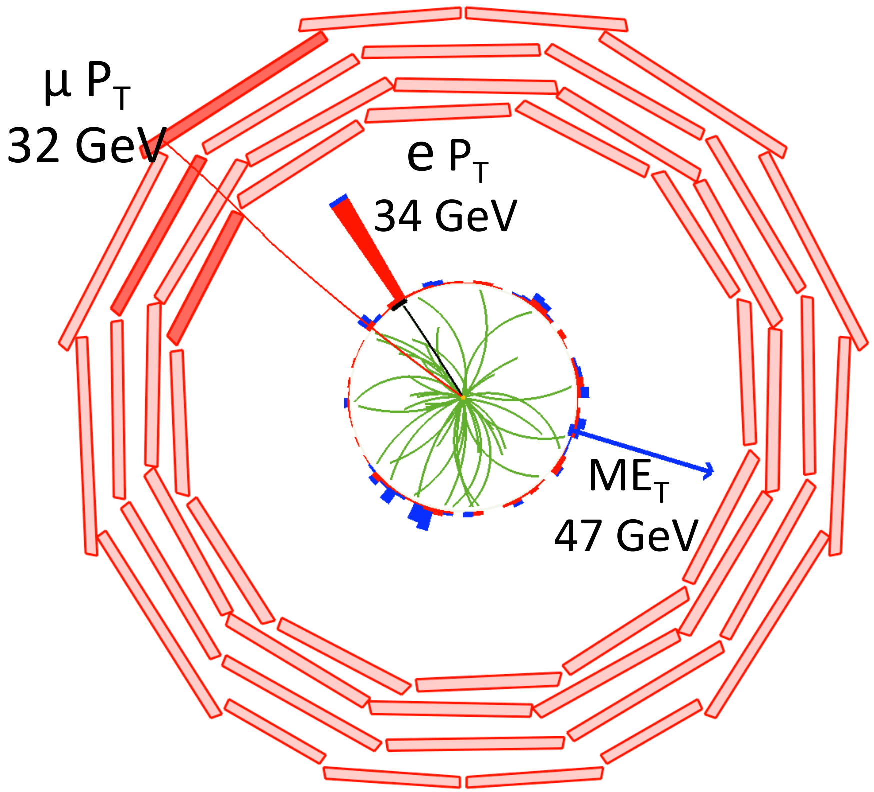




327-415 GeV excluded at 95% CL

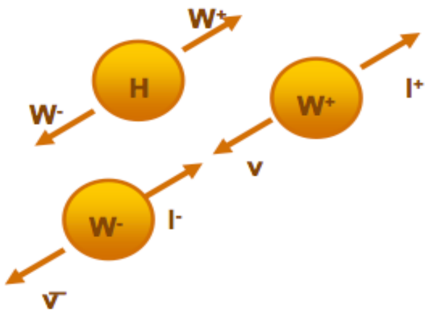
The Low Mass

H → WW→lνlν

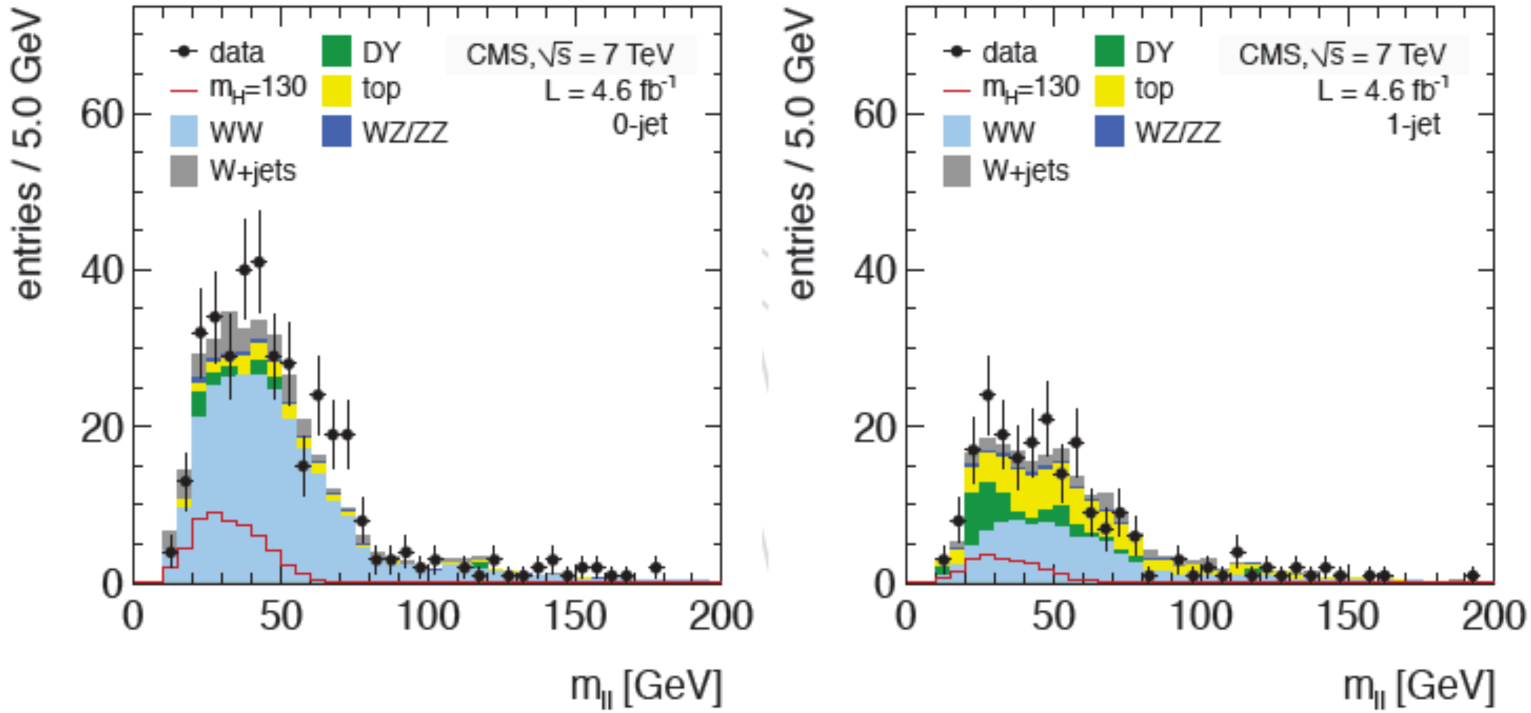


- Channel with highest sensitivity
- No mass reconstruction, signal extraction from event counting
- Clean signature:
  - 2 isolated, high p_T leptons with small opening angle
  - High ME_T
  - Analysis performed on exclusive jet multiplicities (0, 1, 2-jet bins)
- Analysis optimized depending on the Higgs mass hypothesis
  - p_T^l, M_{ll}, M_T, Df as discriminating variables
  - VBF selections for the 2-jet case

Vectors from the decay of a scalar and V-A structure of W decay lead to small leptons opening angle (especially true for on-shell Ws)



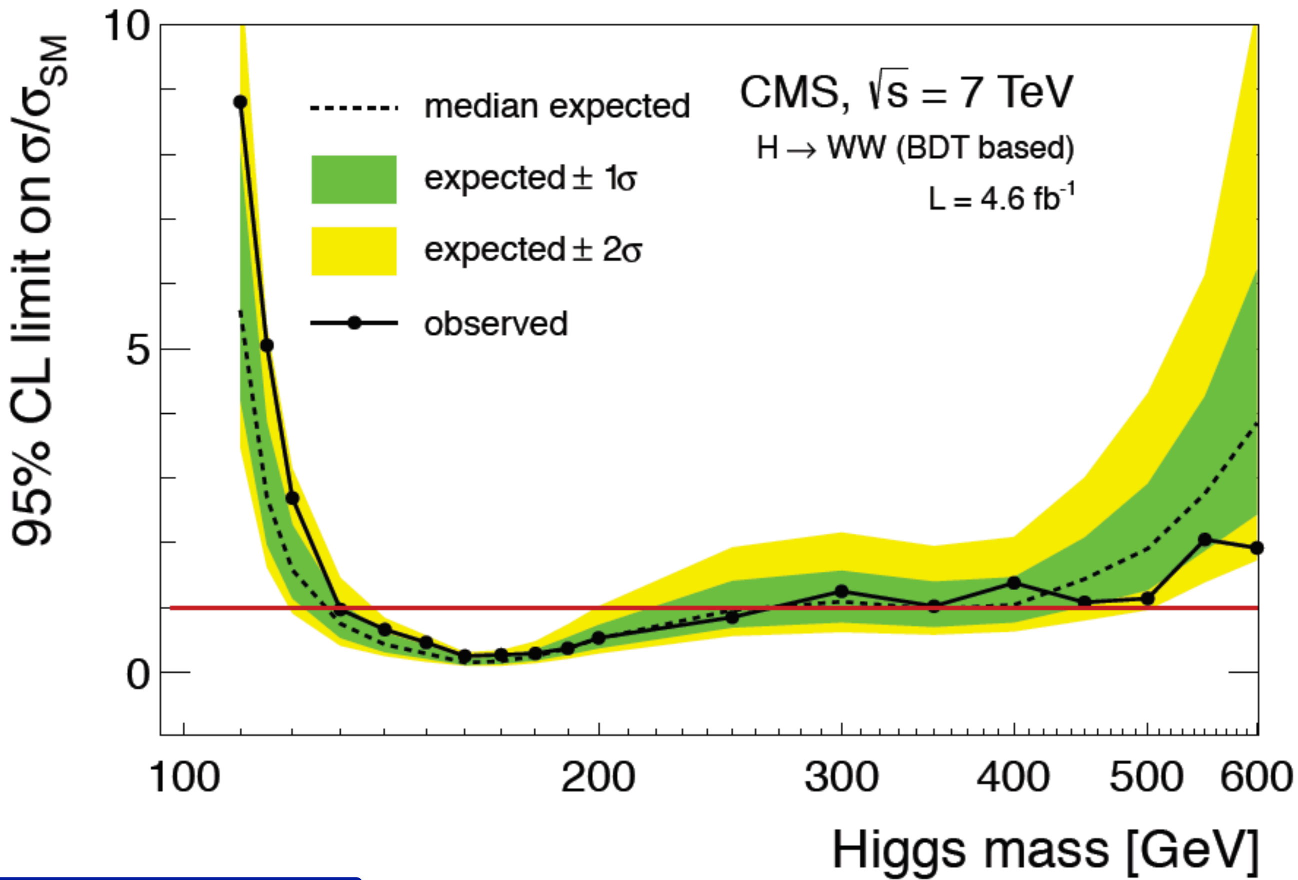
H →WW



- Drell –Yan: Suppressed by M_{ll} and ME_T cuts (pileup affect MET)
- W+jets (with one jet faking a lepton): lepton ID is important
- Top (tt and single top): b-tag veto (or additional soft muon)
- WW: M(ll), MT and Δϕ

All the background are estimated from DATA in “control regions”

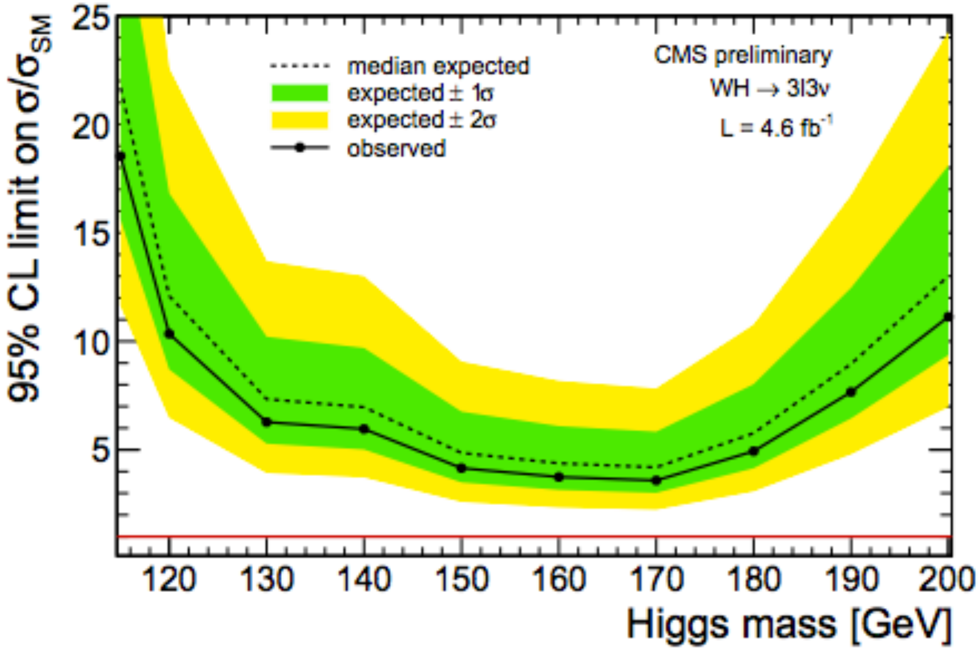
H→WW→lνlν

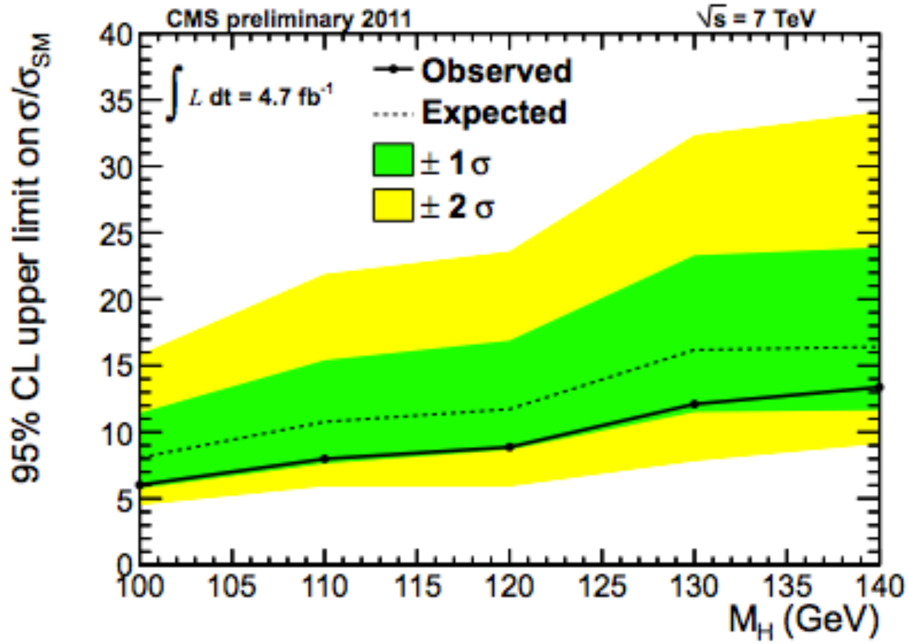


Exp excl: 127 – 270 GeV
Obs Excl: 129 – 270 GeV

Category	H mass	Data	All MC	H →WW
0 jets	130	193	191.5±14	45.2±2.1
1 jets	130	105	79.9±7.7	17.6±0.8
2 jets	130	10	13.3±4	2.7±0.2

VH→3l3ν



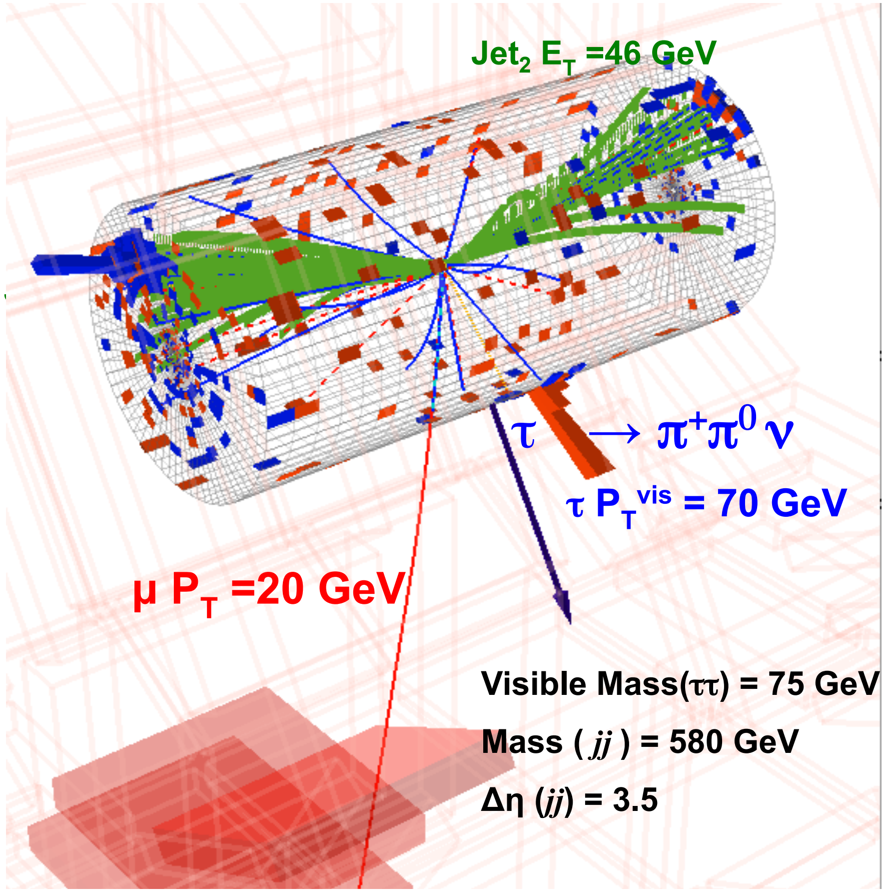


HW →WWW→ 3 l (e,μ) + 3ν

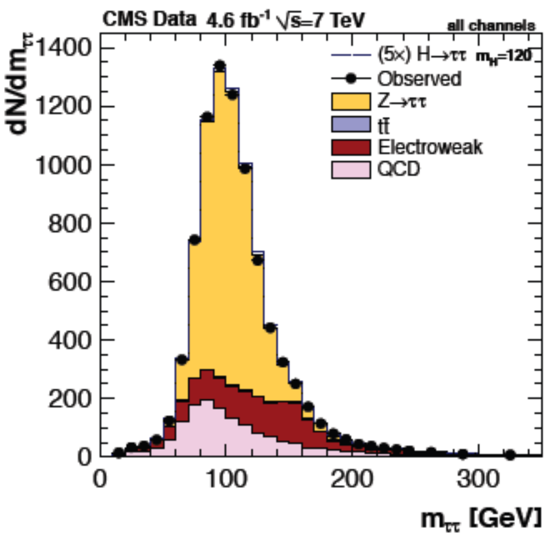
HW → WWW → e/μ +μ + τ + 3ν
HW → ττW → e/μ+ μ + τ + 3ν

Combination of all VH processes soon published

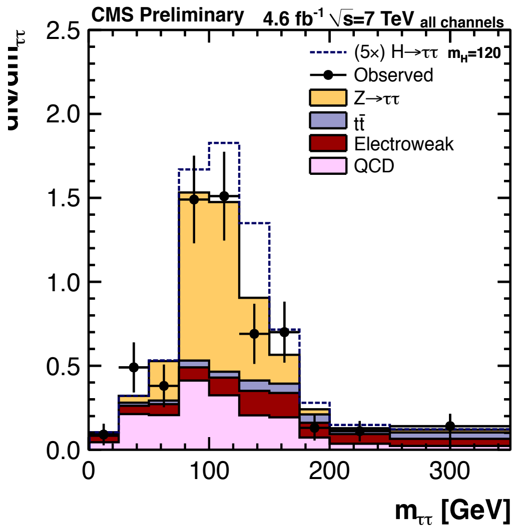
H → ττ

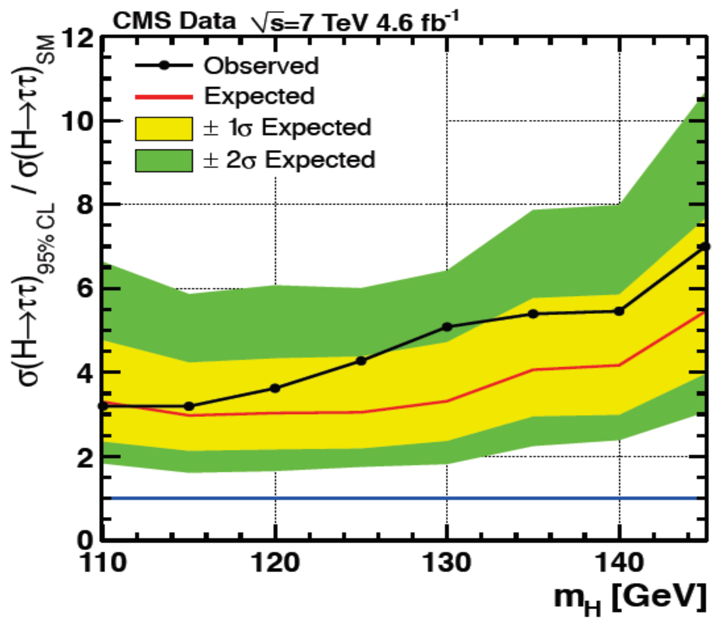


Inclusive /1 boosted jet



VBF modes are cleanest





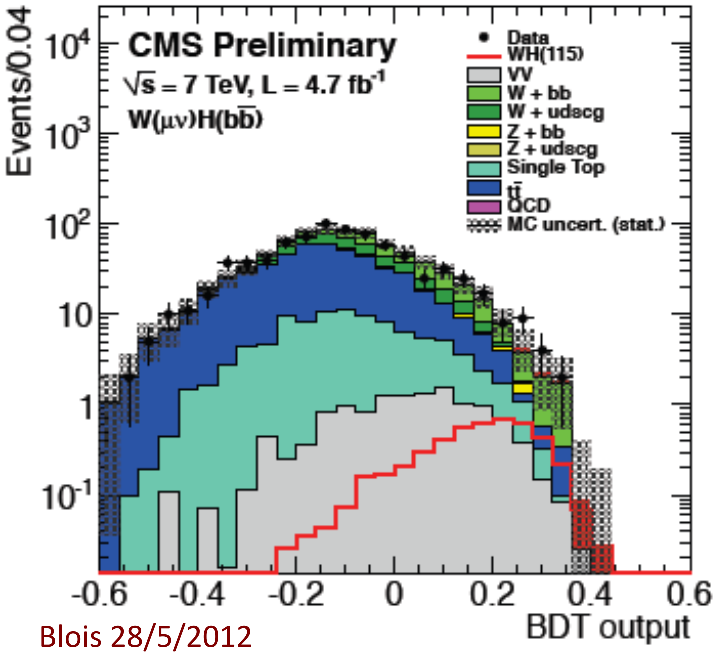
Search in

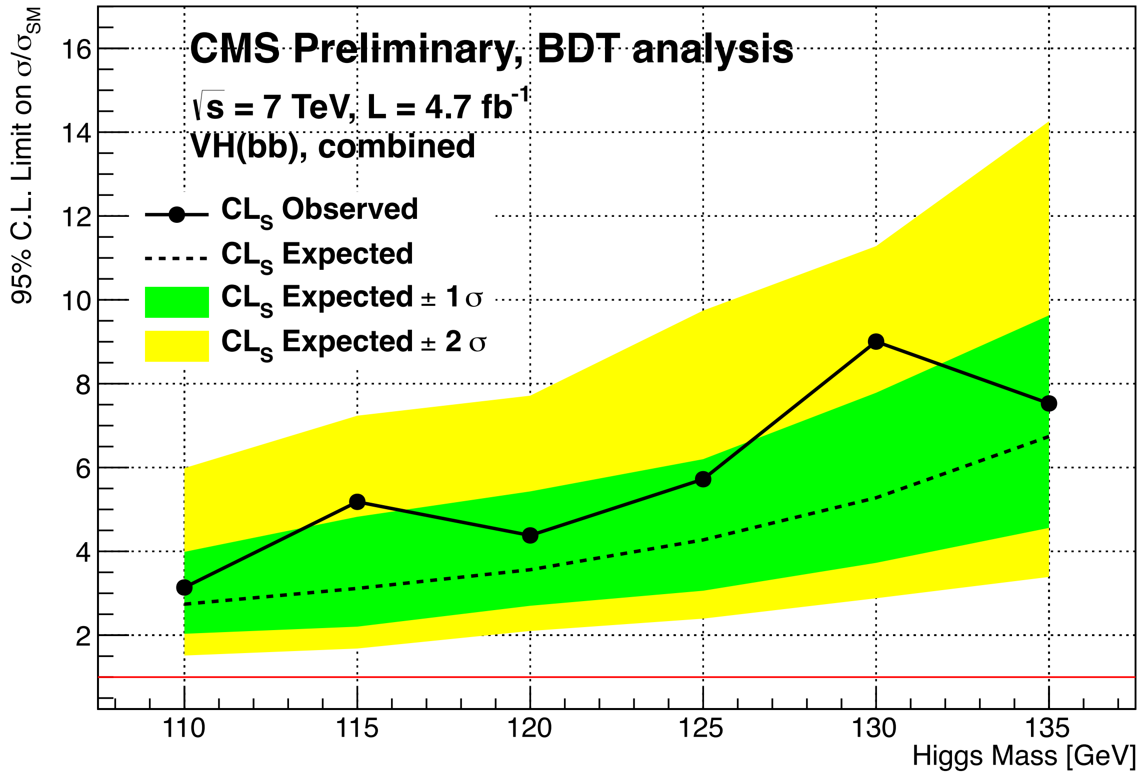
$\tau_e + \tau_h$, $\tau_\mu + \tau_h$, $\tau_e + \tau_\mu$

Background:
QCD,
EWK Z → ττ (irreducible)

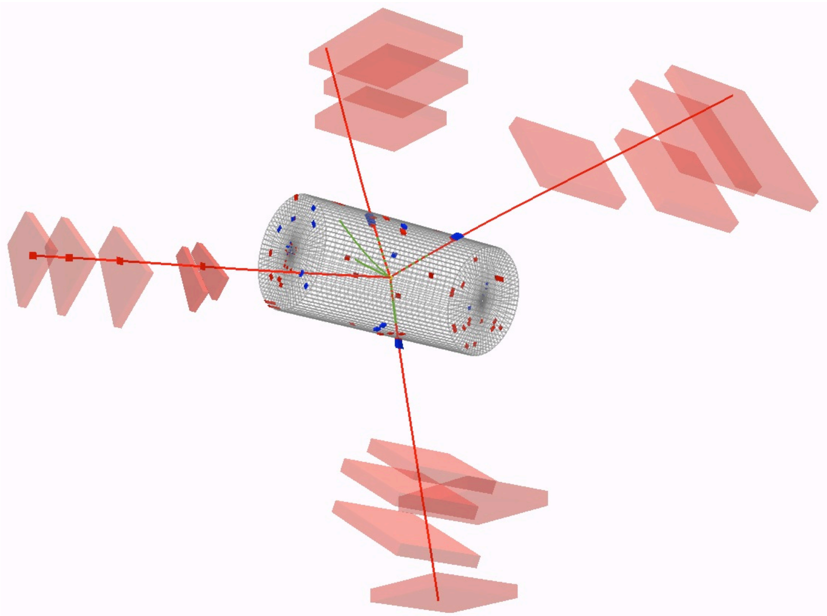
VH → bb

- CMS exploits the W/Z+H associate production with the Higgs heavily boosted
  - Require p_T^{bb}>100 (150) GeV for ZH (WH)
- Topology is very clear, several final states considered:
  - *lνbb, llbb, ννbb*
  - Δφ(V,H), tight b-tagging





H → ZZ → 4l

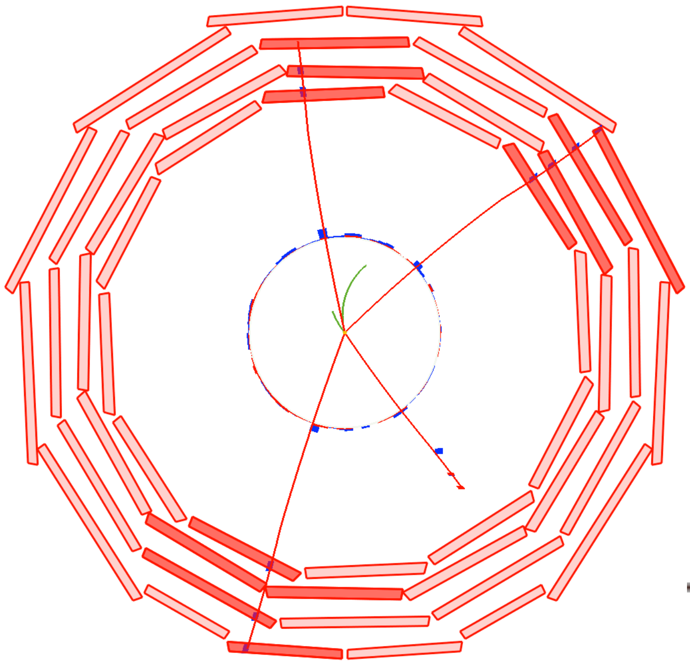


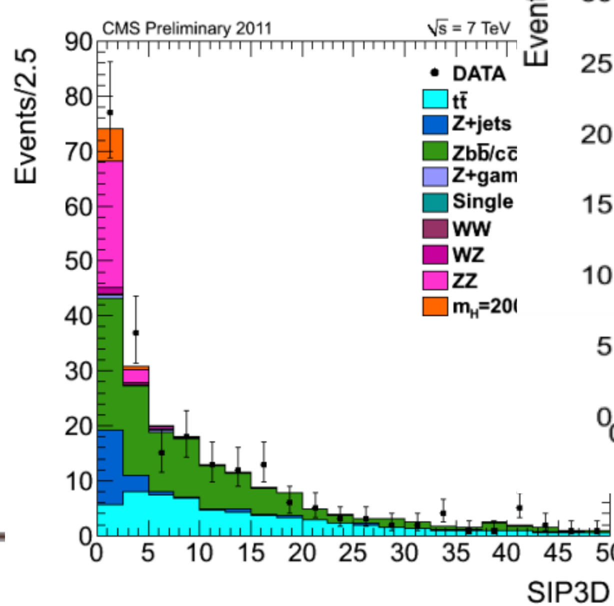
The final states considered are 4μ, 4e, 2e2μ

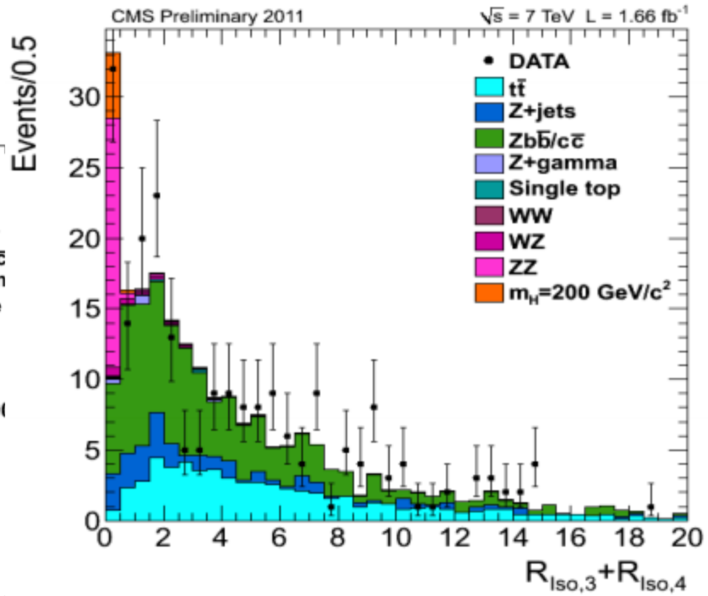
Very tiny cross section ->
thus highest efficiency must be conserved

Very clean final state:

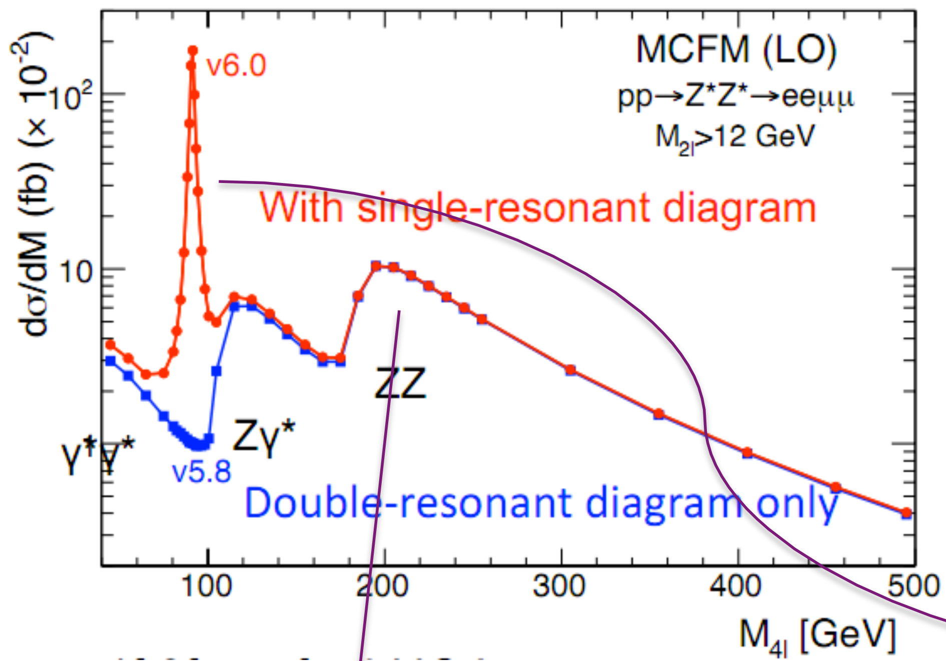
- 4 leptons of high p_T,
- isolated
- coming from the primary vertex

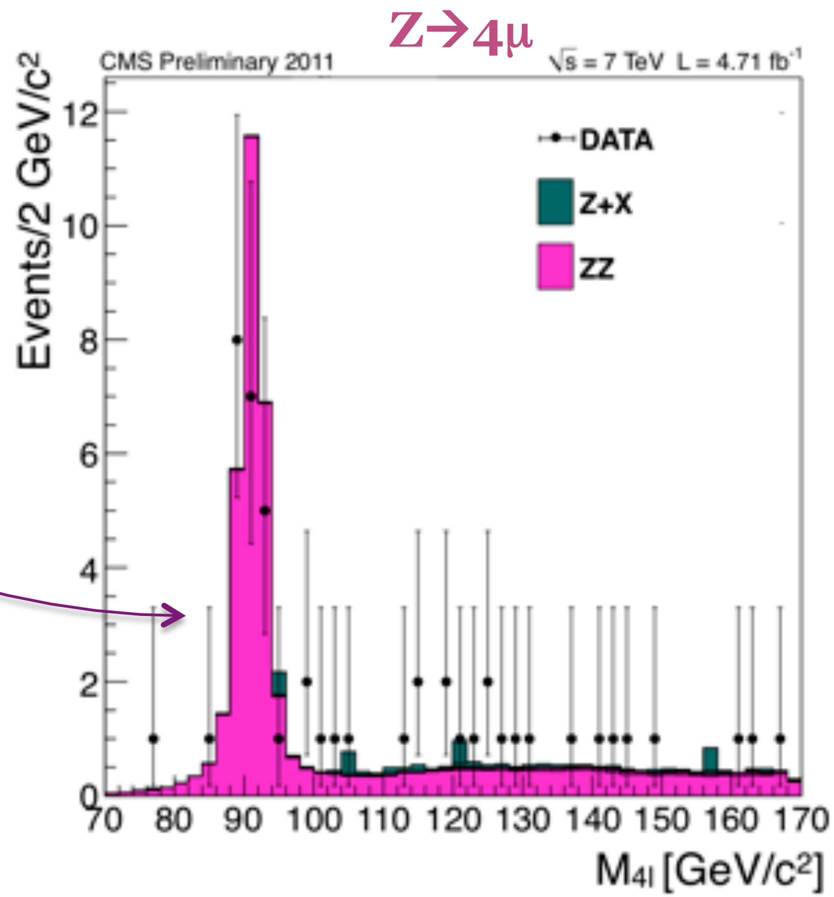






pp → 4l



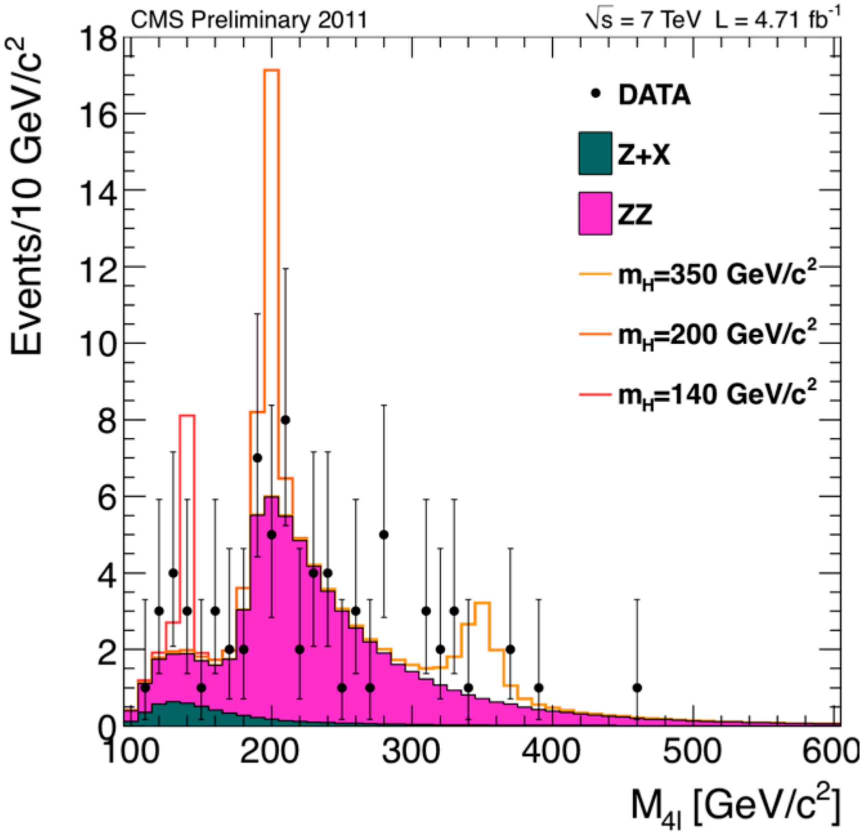


Measurement of the ZZ cross section with both Z on shell (60<MZ<120):

$$\sigma(pp \to ZZ + X) \times \mathcal{B}(ZZ \to 4\ell) = 28.1^{+4.6}_{-4.0}(\text{stat.}) \pm 1.2(\text{syst.}) \pm 1.3(\text{lumi.})\ \text{fb}$$

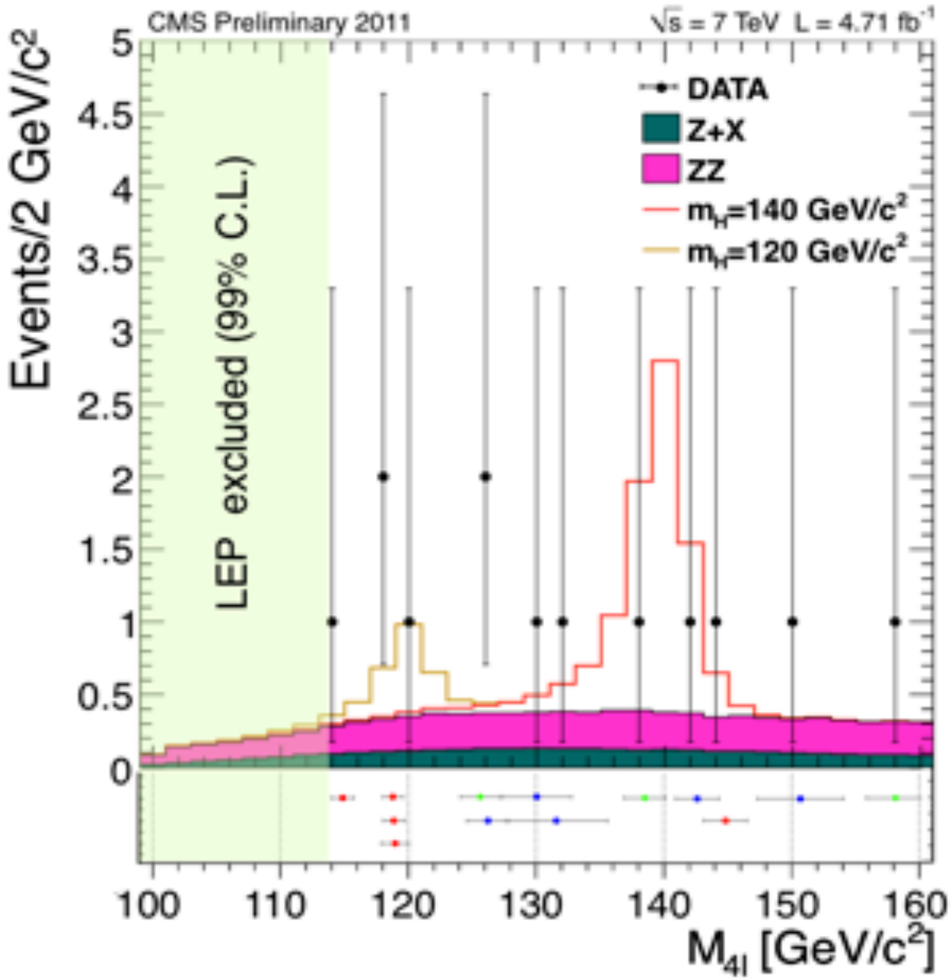
To be compared with the SM XS = 27.9 +- 1.9 fb

Results: H→ZZ→4l

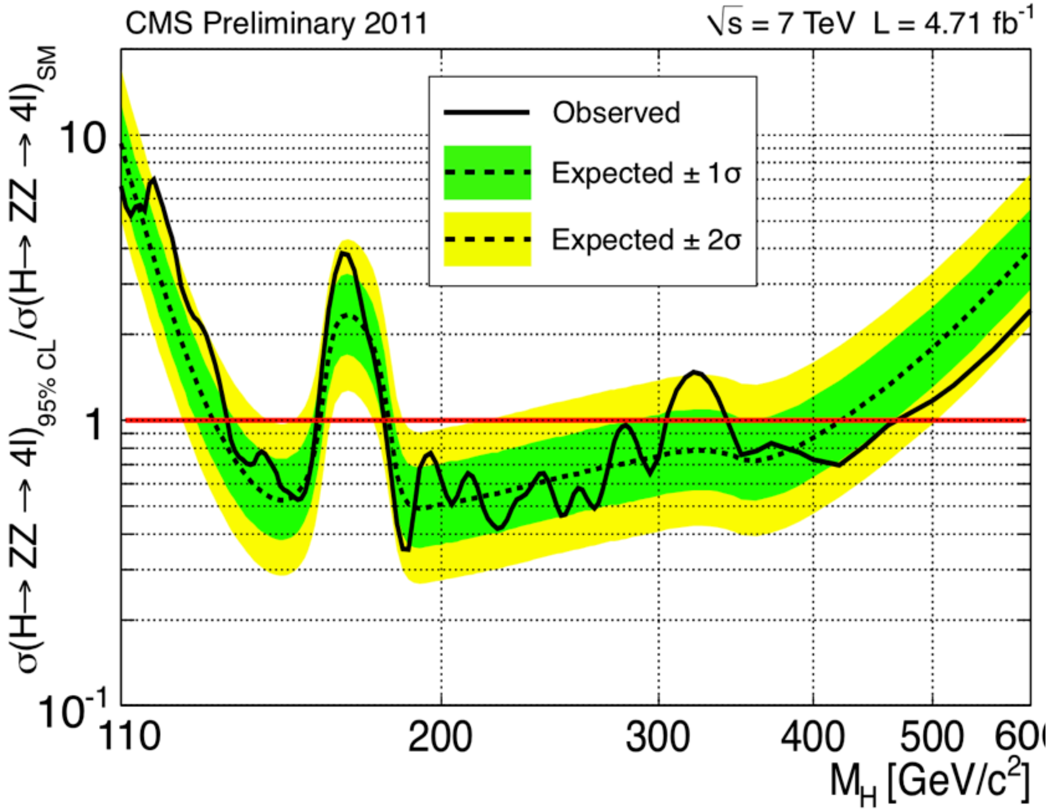


For M_{4l}>100 GeV
Data: 72 Observed
MC: 67.1 ± 6.0

For 100<M_{4l}<160 GeV
Data: 13 observed
MC: 9.5 ± 1.3

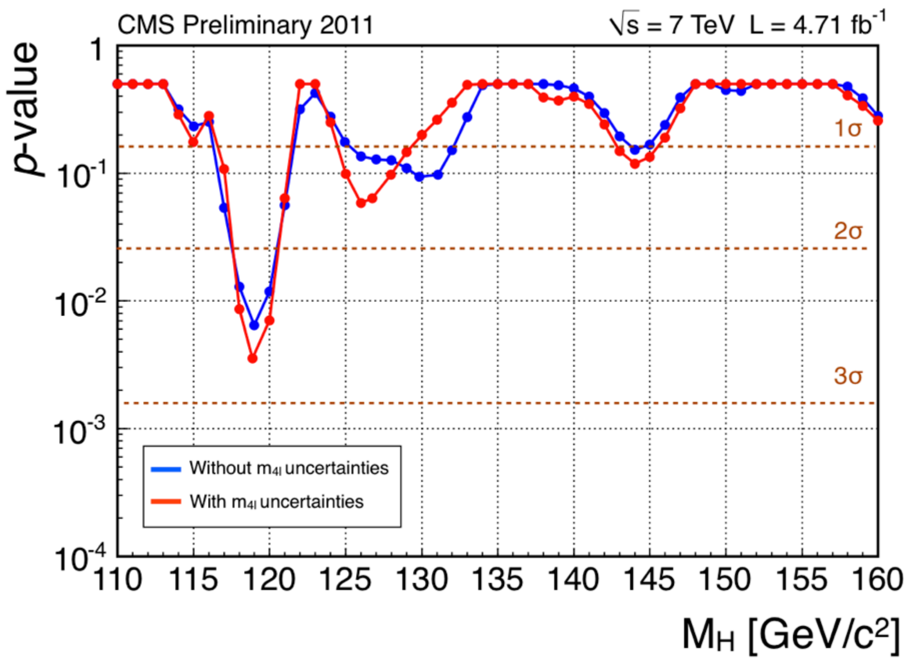


Results

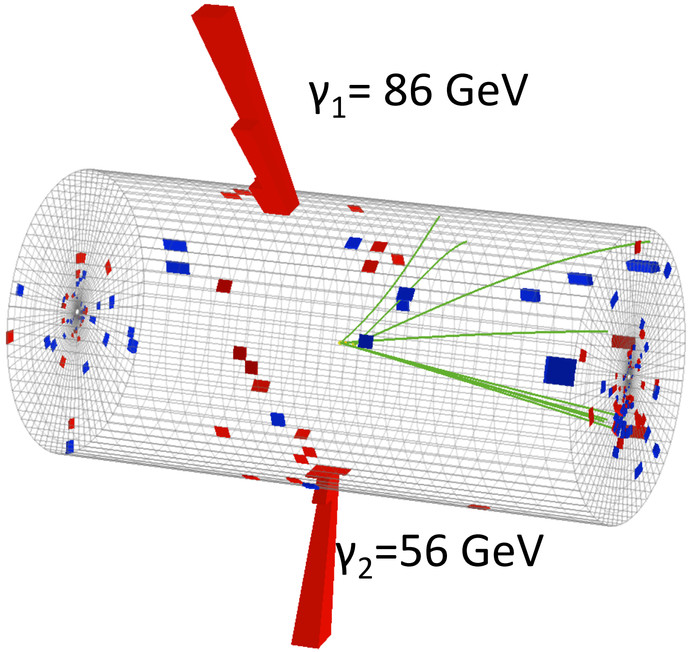


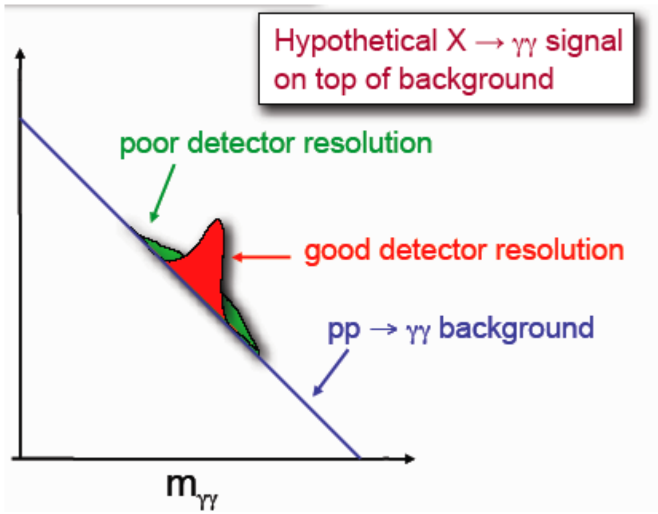
Excluded:
134 < mH < 158 GeV,
180 < mH < 305 GeV
and 340 < mH < 460 GeV.

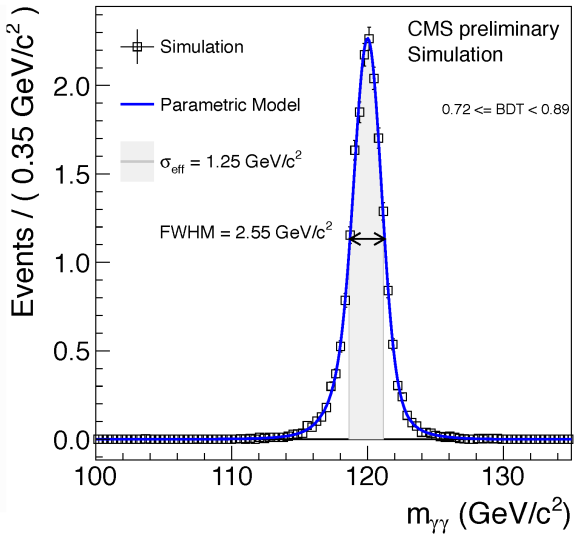
P-value: The significance of the local fluctuations with respect to the standard model expectation. To reject a background only hypotesis.



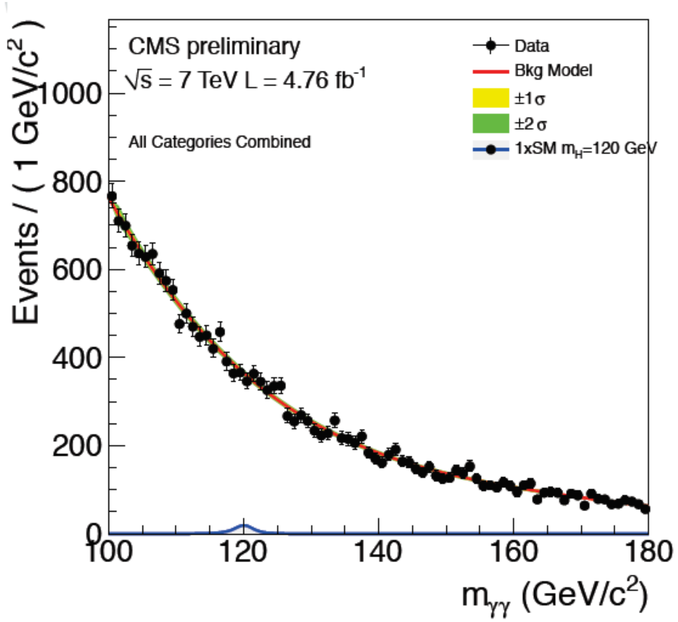
H → γγ



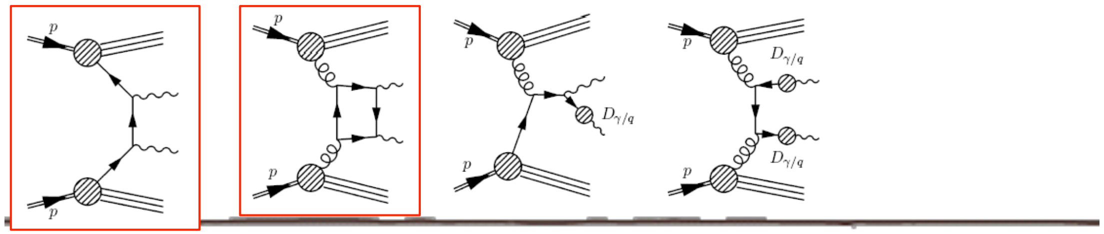




Signature: 2 energetic, isolated γ, narrow mass peak



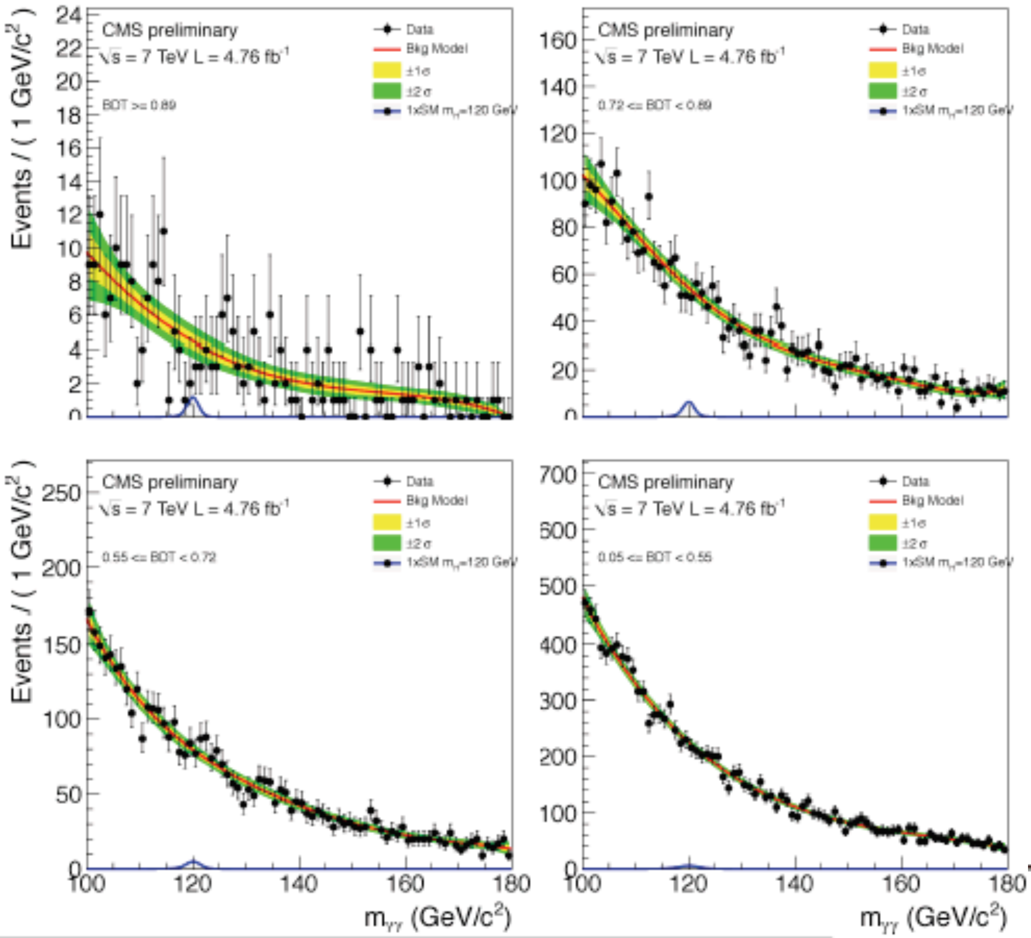
Background: Large & partly irreducible QCD.
Measured from $M_{\gamma\gamma}$ sidebands in data



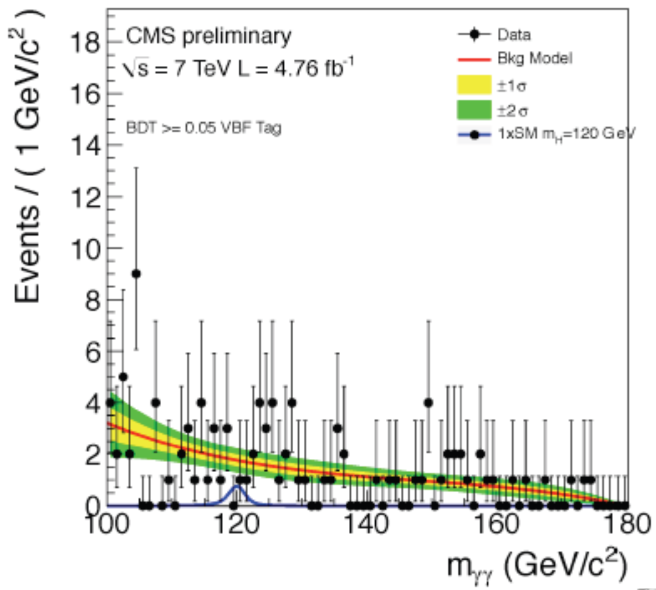
CMS: H→γγ

- A new analysis: variables combined in a BTD
- Sensitivity improved by about 40% in integrated luminosity
- 4 classes of events (by varying S/B) plus the VBF category.

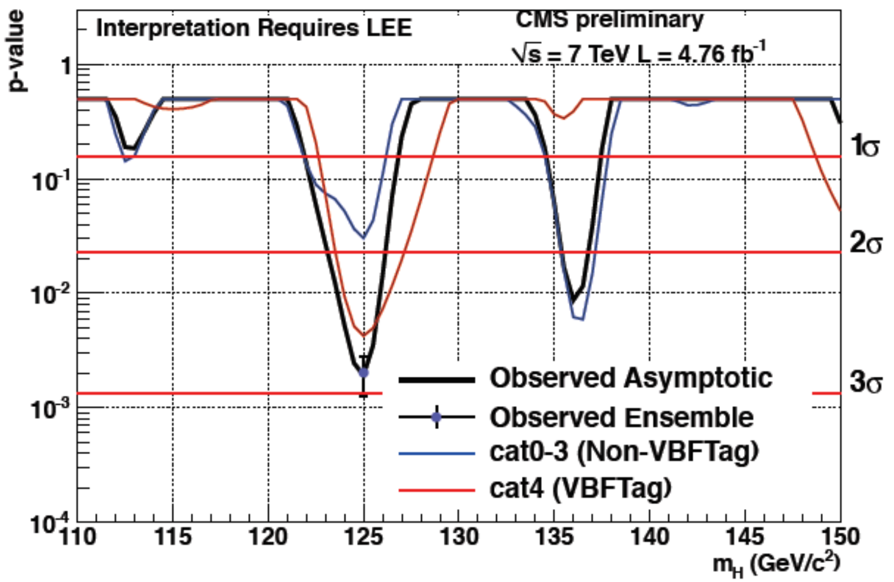
Events passing VBF selection removed

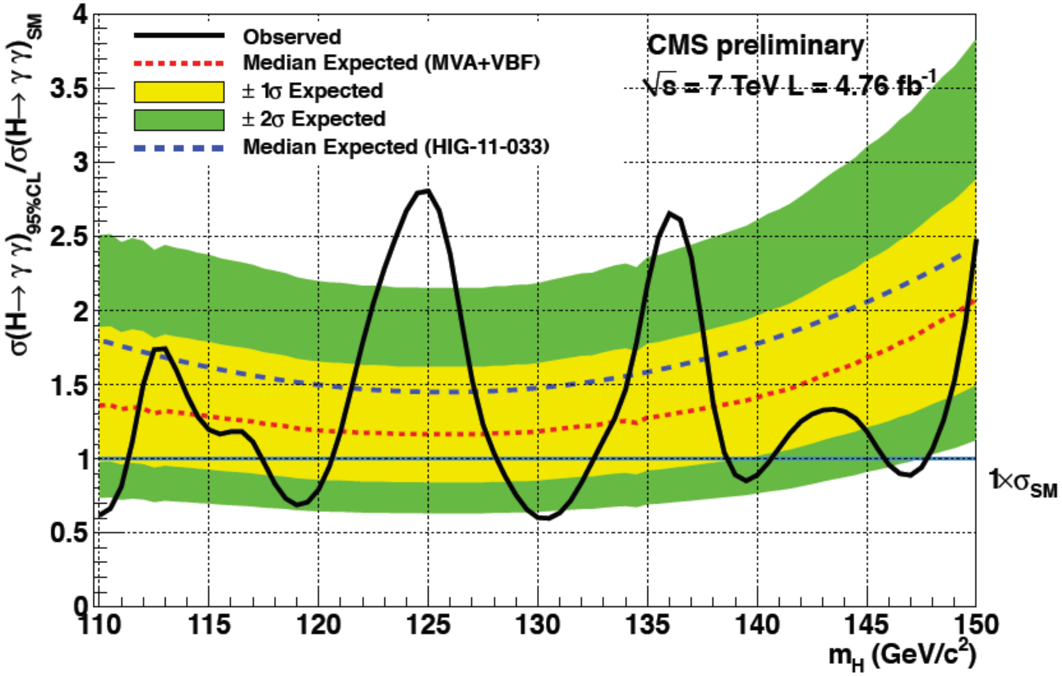


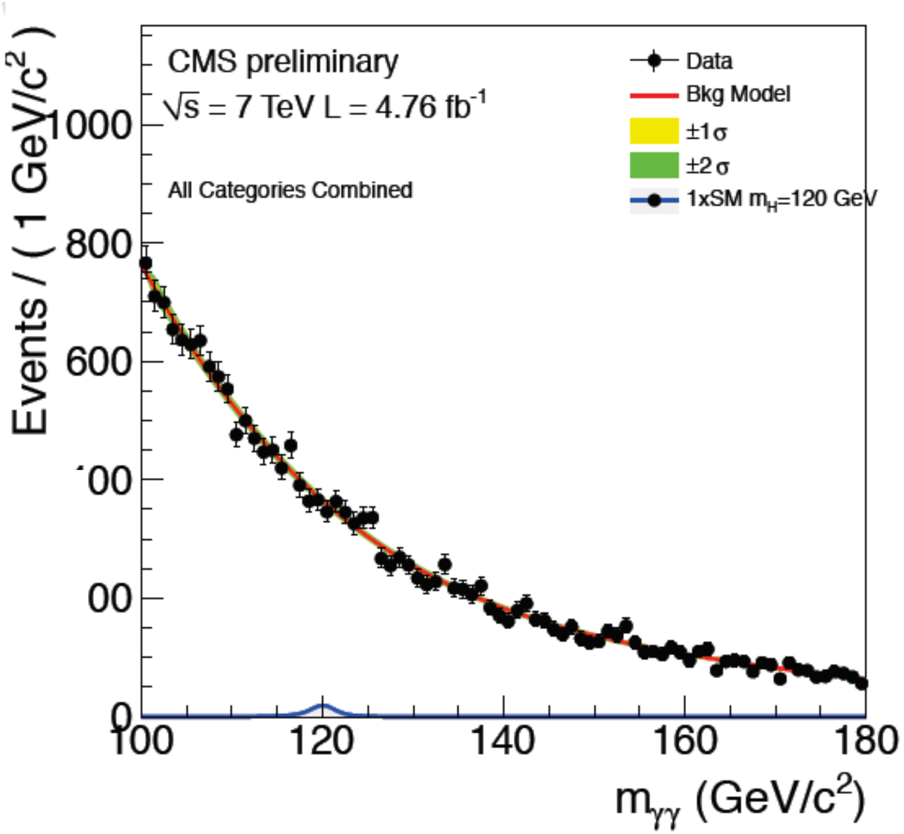
Dijet tag selection has high s/b, ~1/3



Results H → γγ



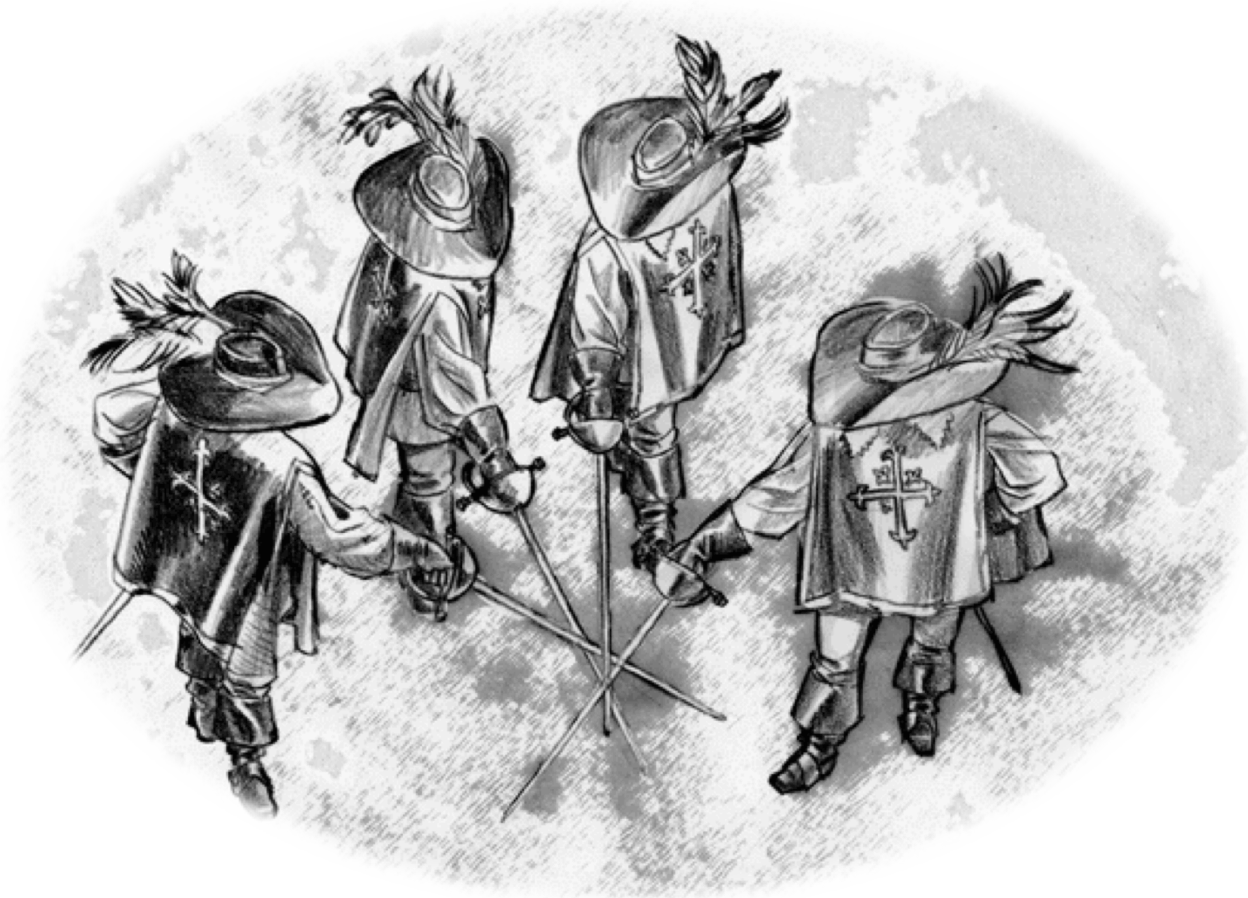




Fit to the background:
5 order polinomial

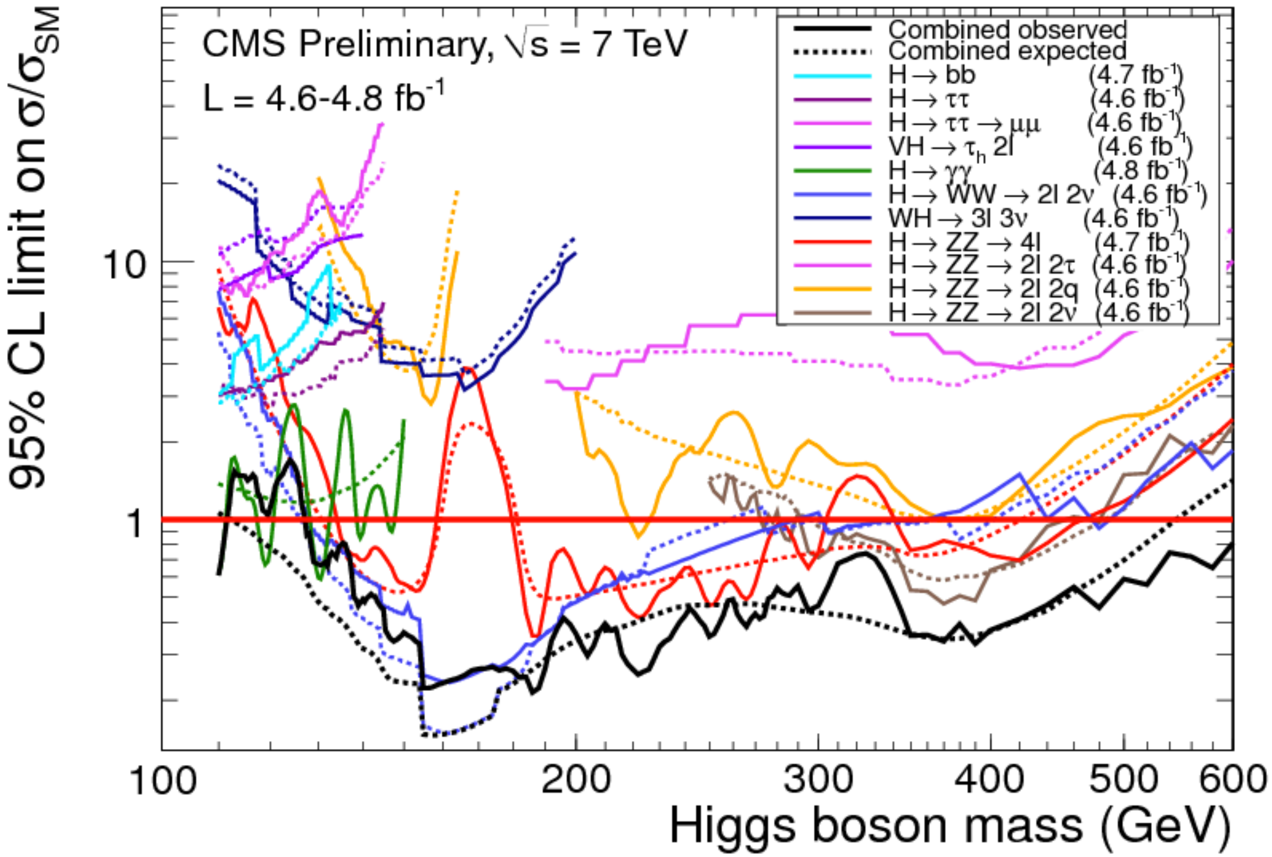
Chiara Mariotti, INFN Torino & CERN

Combination !



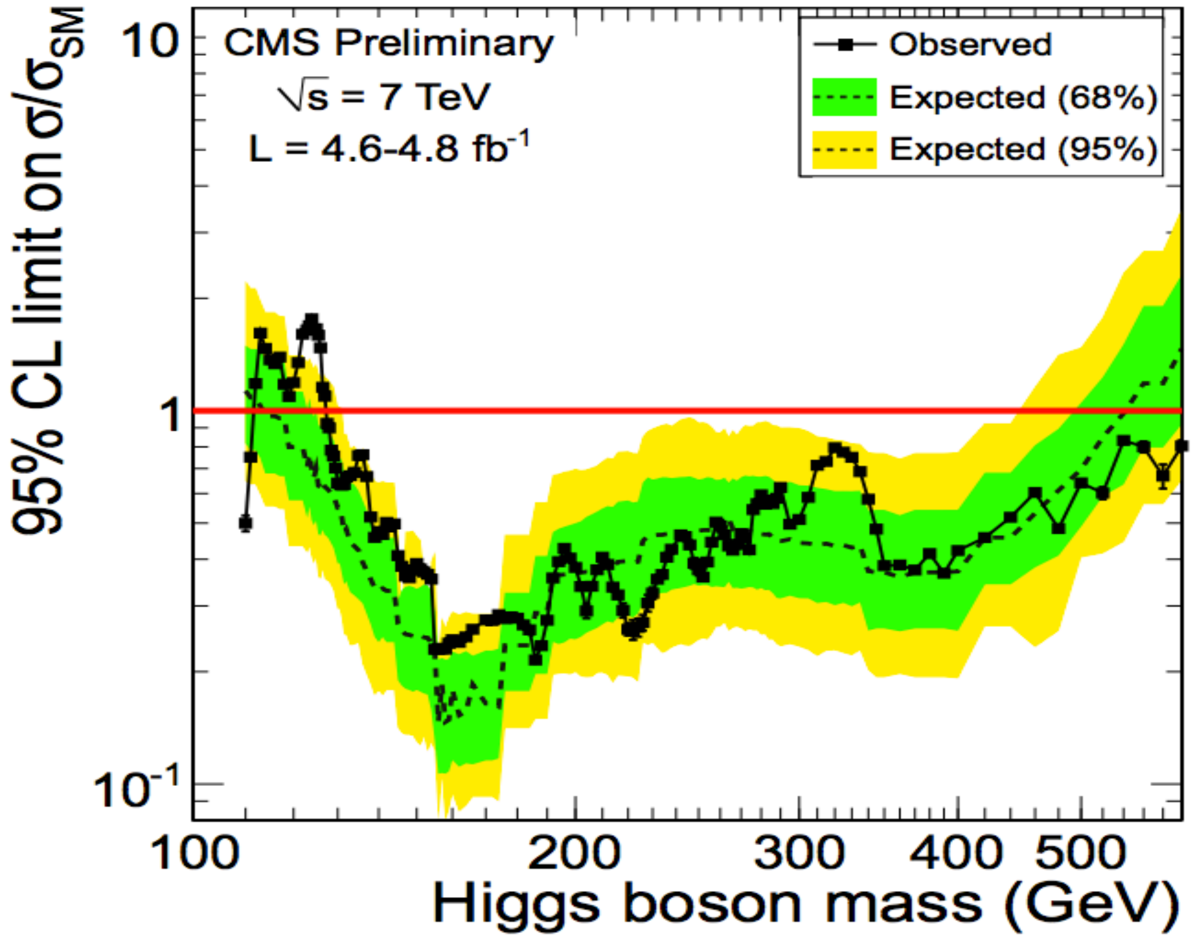
G. Petrucciani

Channel by channel



11 channels:

CMS: the SM Higgs as of today



Expected at 95% CL:

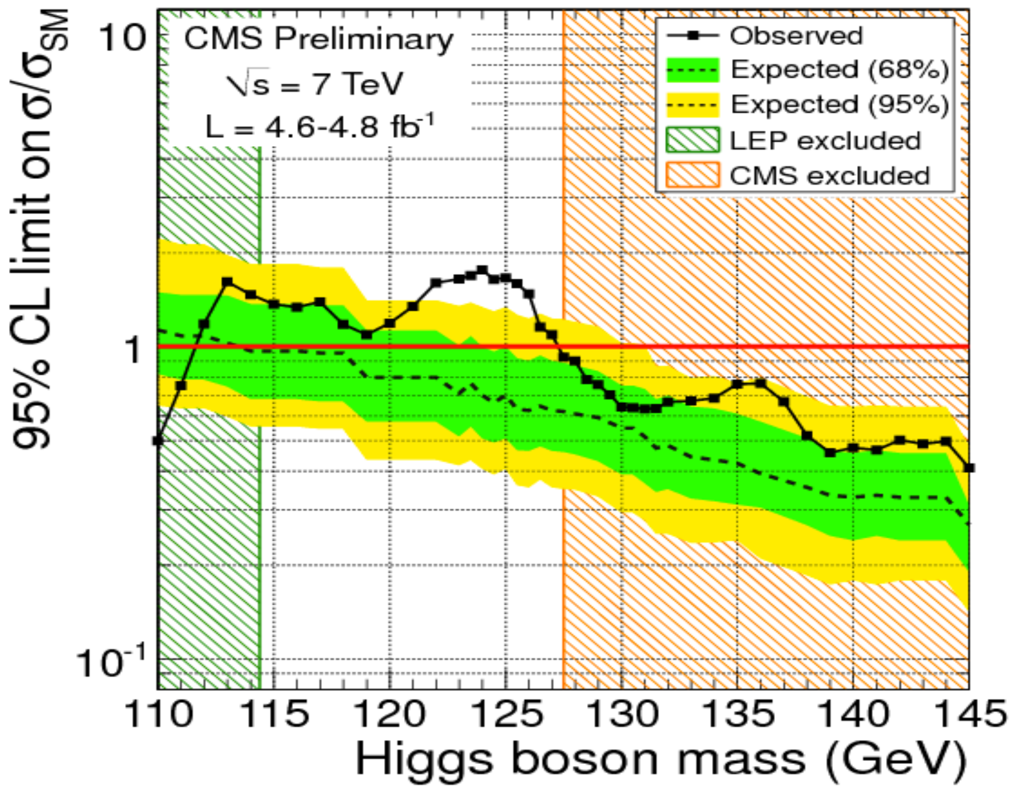
$114.5 < M_H < 543$ GeV

Observed at 95% CL:

$127.5 < m_H < 600$ GeV

Observed at 99% CL: $129. < m_H < 525$ GeV

Low Mass Range



Observed at 95% CL:

$127.5 < m_H < 600$ GeV

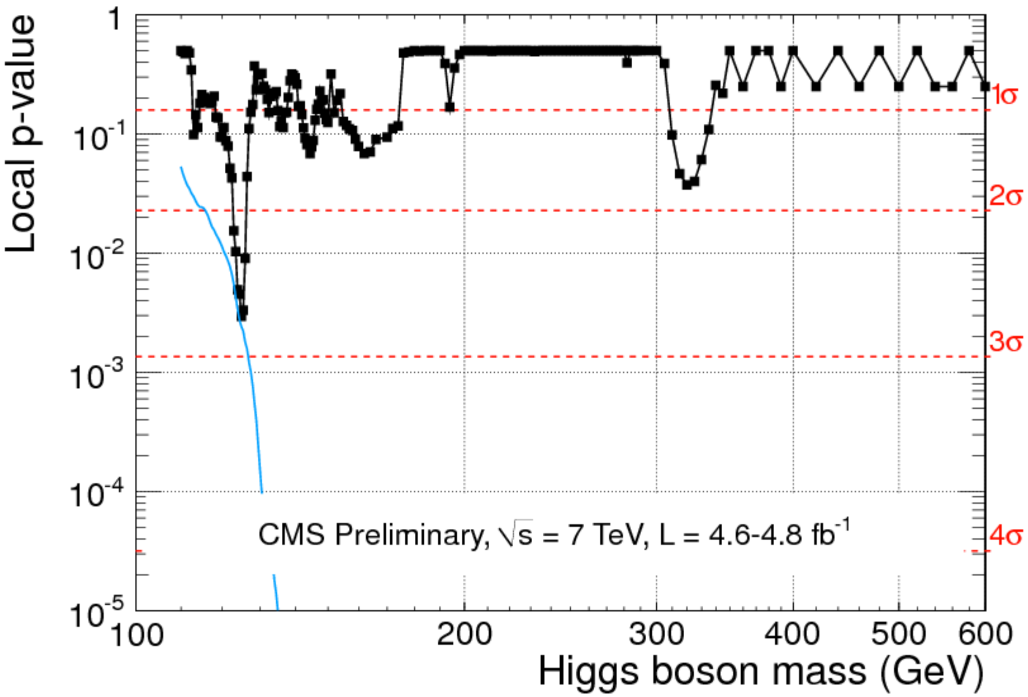
the observed exclusion
is weaker than expected

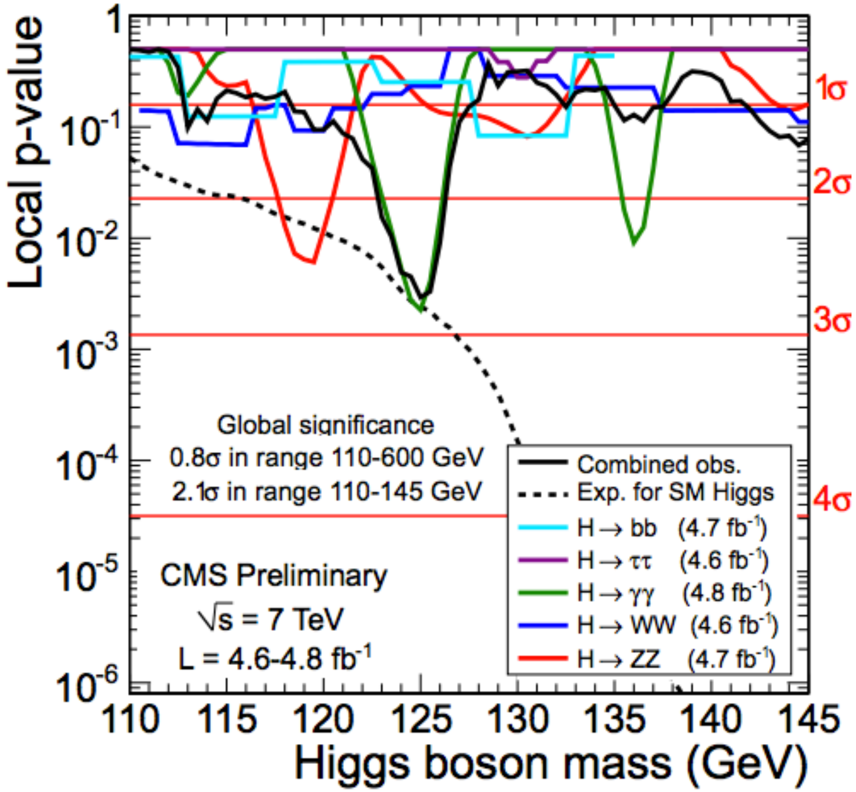
Expected at 95% CL:

$114.5 < M_H < 543$ GeV

Consistency with B only Hypothesis

- Excesses are quantified using p-values: use to reject a background only hypotesis





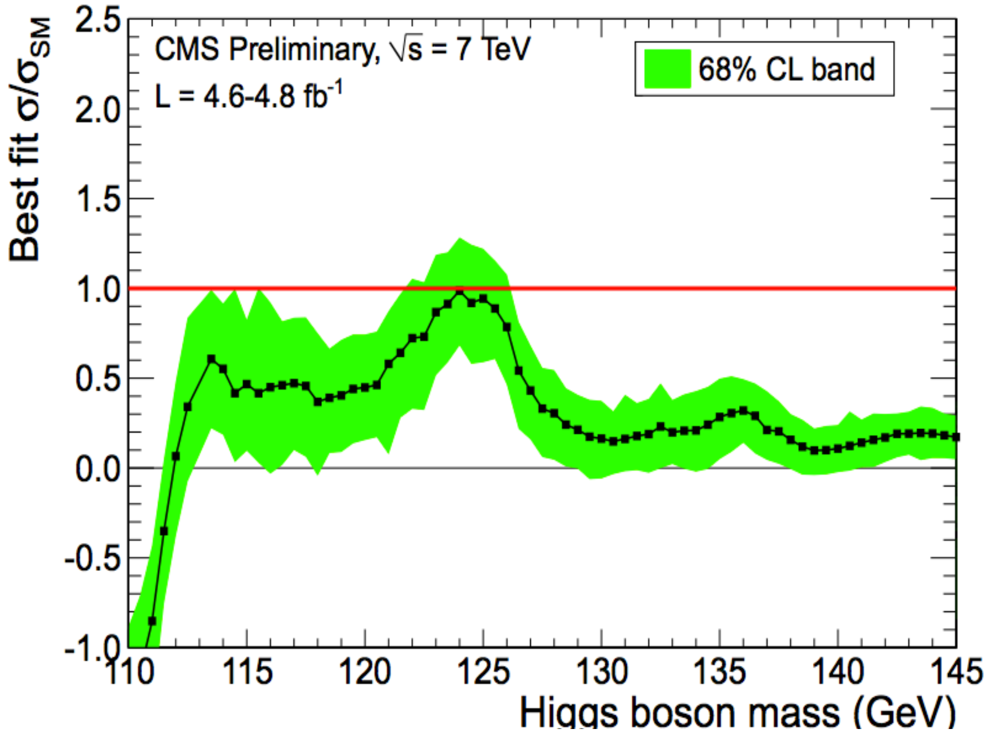
Max. deviation from background-only observed for m_H~125 GeV

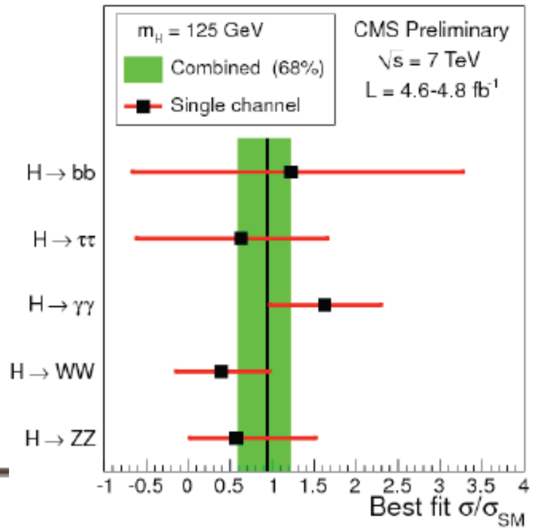
119 GeV: 3 H→4l events
124 GeV: H→2γ events
325 GeV: 9 H→4l events

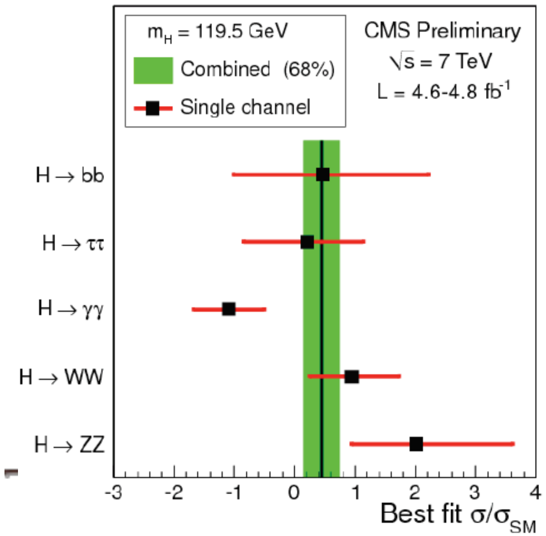
γγ: 2.9σ at 125 GeV
4l: 2.5σ at 119.5 GeV

Observed local significance 2.8 σ at 125 GeV (expected 2.9 σ)
Global 2.1 σ

Best Fit for Signal Strength w.r.t. SM Rate

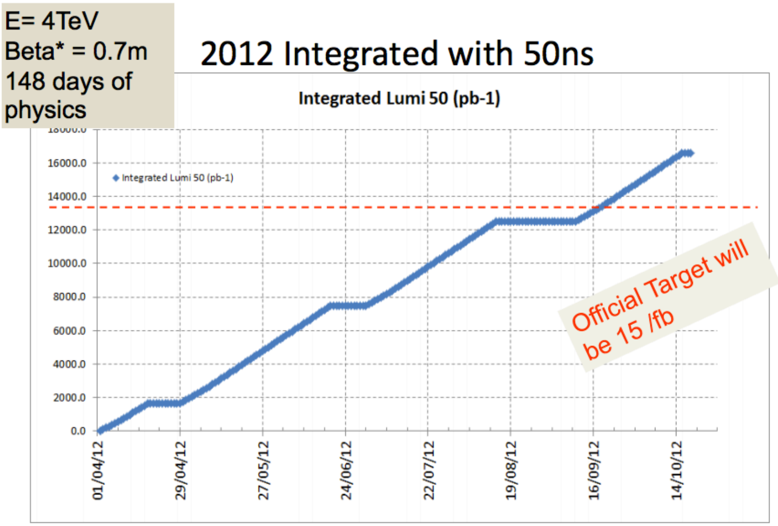






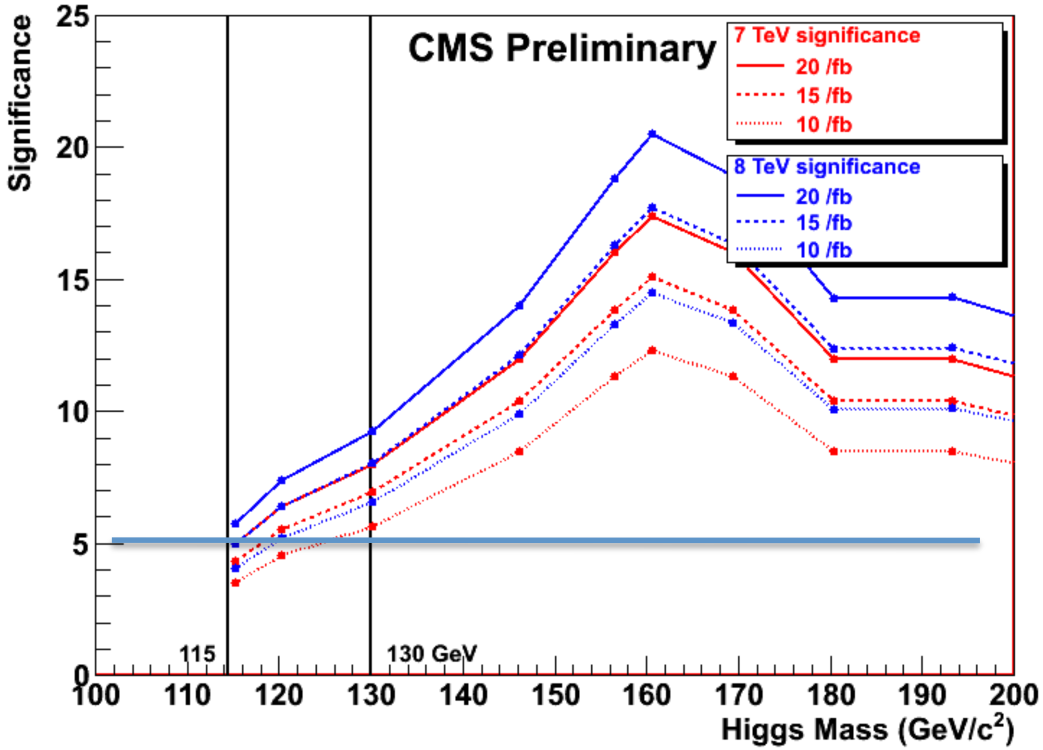
Near future

By the end of the 8 TeV run in 2012, the luminosity collected will hopefully allow us to have 5 sigma everywhere.
Maybe difficult at 115 Gev
The very high mass will be investigated as well.

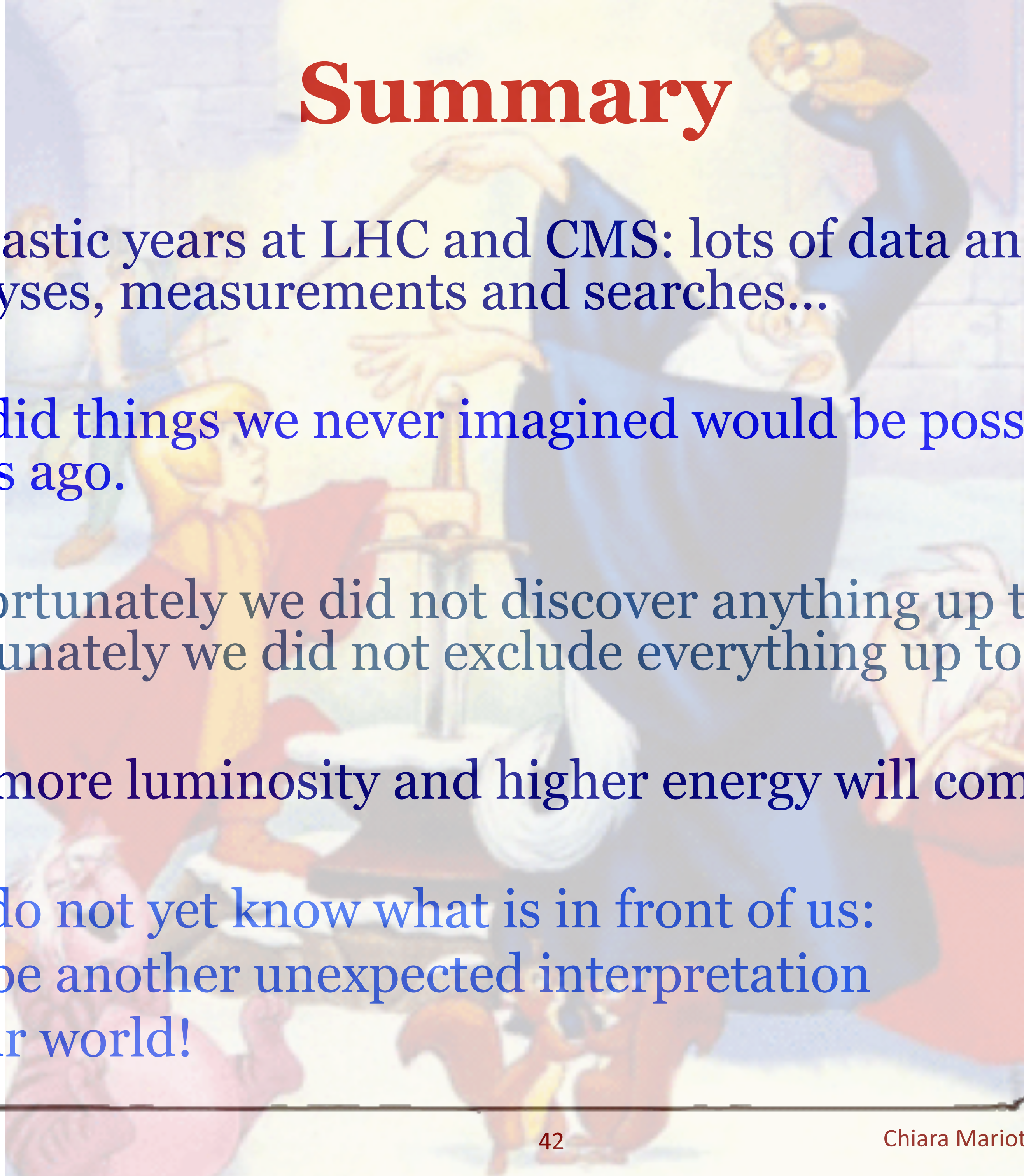


Steve Myers

~ 5fb^{-1} by ICHEP
~ 15 fb^{-1} by Nov



By the end of 2012 five sigma everywhere, maybe difficult at 115 GeV

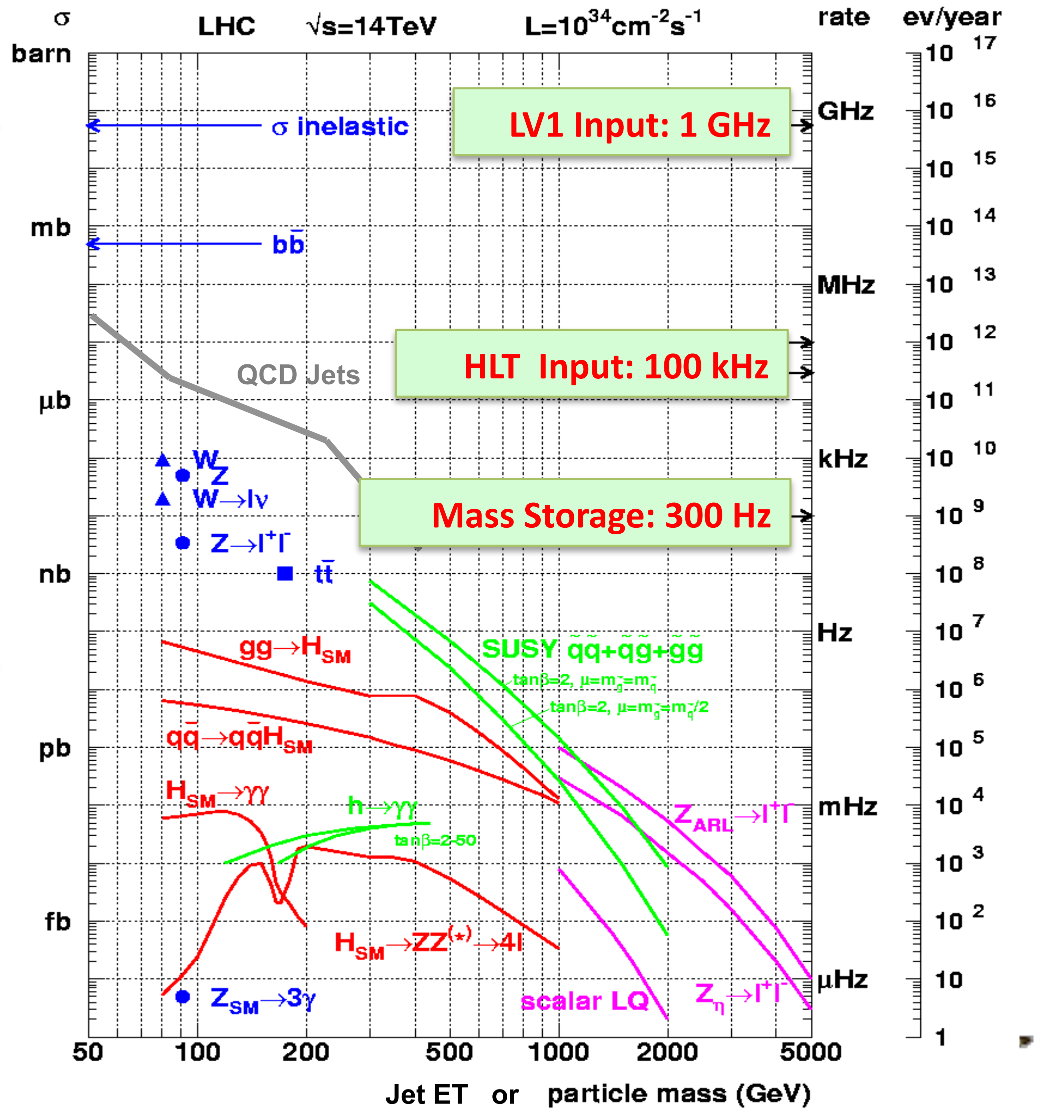


Summary

- Fantastic years at LHC and CMS: lots of data and analyses, measurements and searches…
- We did things we never imagined would be possible 2 years ago.
- Unfortunately we did not discover anything up to now/ Fortunately we did not exclude everything up to now!
- But more luminosity and higher energy will come.
- We do not yet know what is in front of us: maybe another unexpected interpretation of our world!

backup

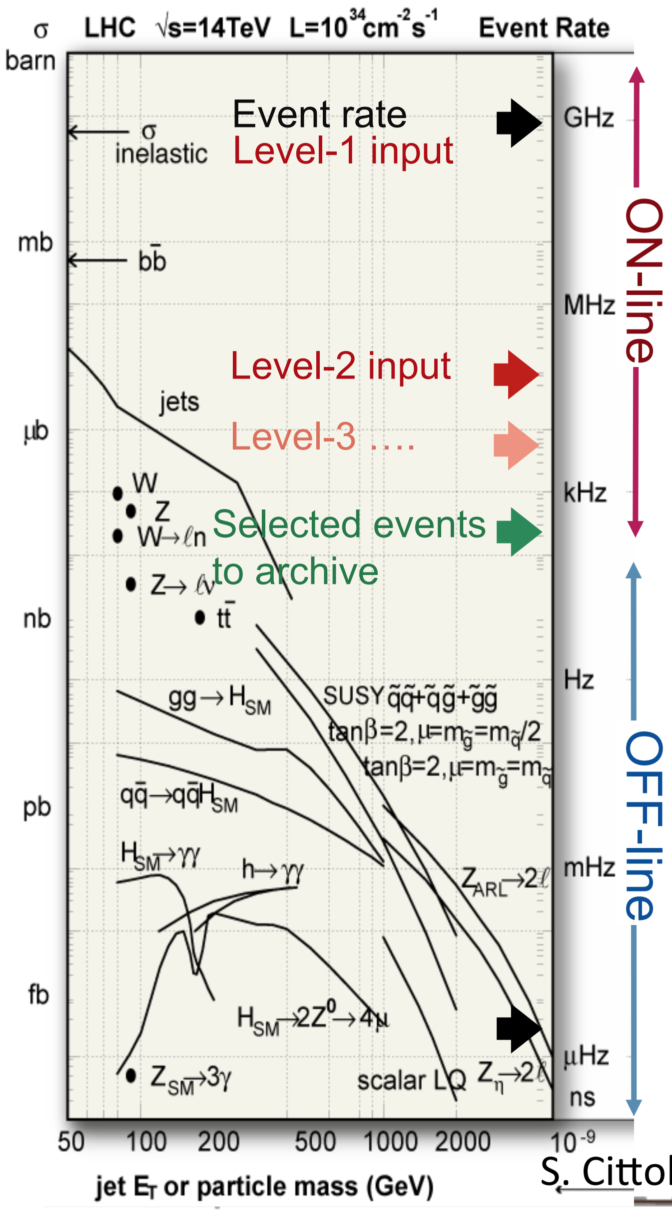
Production rates at LHC



10^{10}

"At LEP every event is signal.
At LHC every event is background."
Sam Ting, LEPC, Sept-2000

Trigger



S. Cittolin

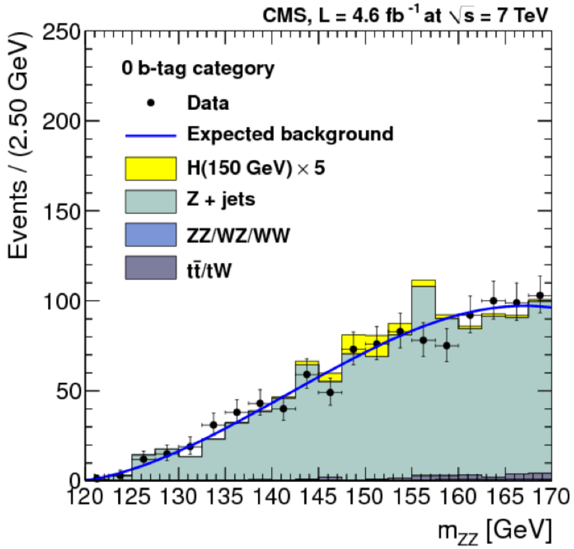
- At LHC the collision rate will be 40 MHz
  The Event size ~1 Mbyte

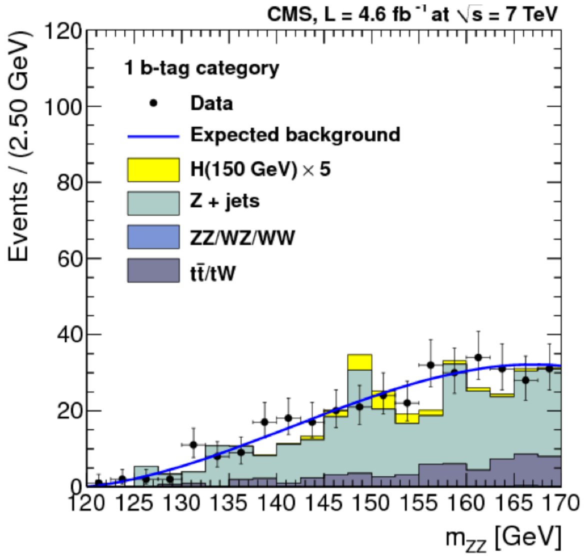
  Band width limit ~ 100 Gbyte →
  Mass storage rate ~100 Hz

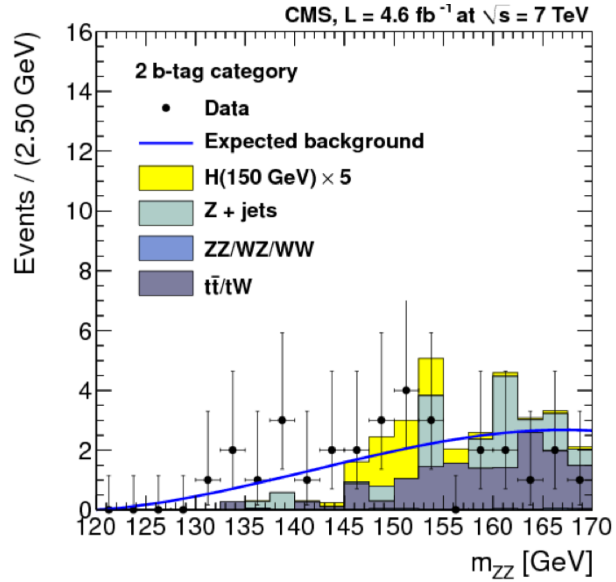
Thus we should select the events with
"the Trigger"

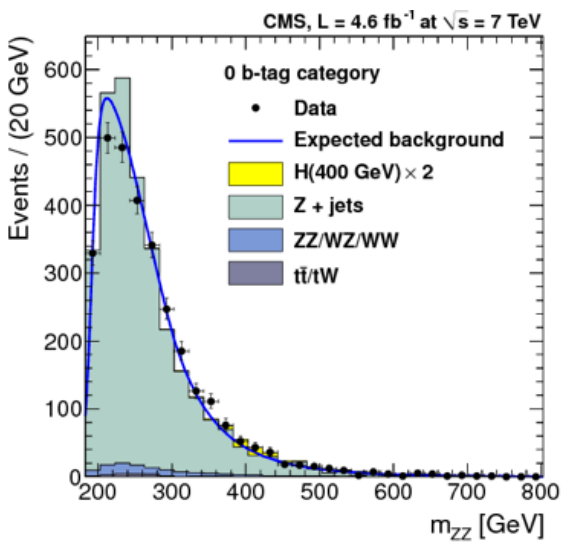
- Level-1 Trigger input 40 MHz
- Level-2 Trigger input 100 kHz (HLT for CMS)
- Level-3 Trigger input xx kHz (HLT for Atlas)

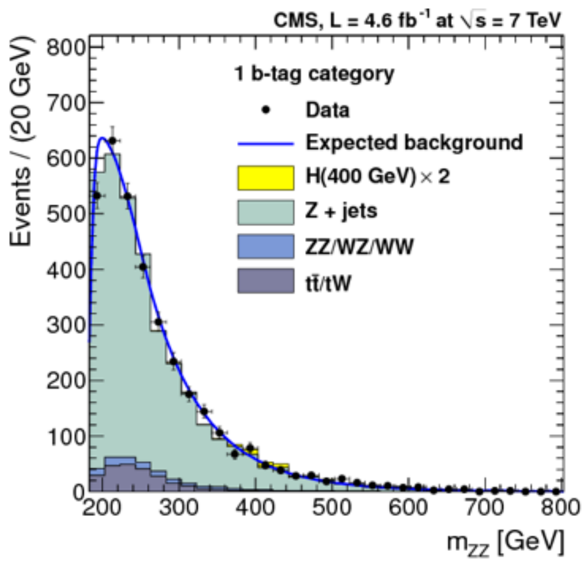
M_{ZZ}

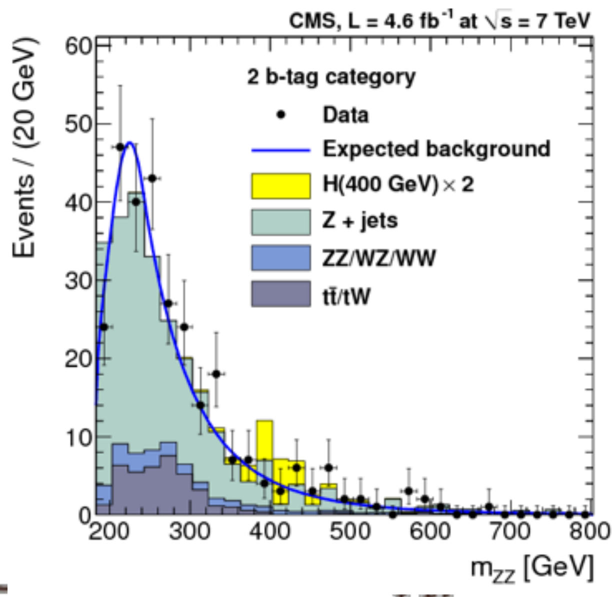

CMS, L = 4.6 fb⁻¹ at √s = 7 TeV
0 b-tag category
Data
Expected background
H(150 GeV) × 5
Z + jets
ZZ/WZ/WW
tt̄/tW
Events / (2.50 GeV)
m_ZZ [GeV]


CMS, L = 4.6 fb⁻¹ at √s = 7 TeV
1 b-tag category
Data
Expected background
H(150 GeV) × 5
Z + jets
ZZ/WZ/WW
tt̄/tW
Events / (2.50 GeV)
m_ZZ [GeV]


CMS, L = 4.6 fb⁻¹ at √s = 7 TeV
2 b-tag category
Data
Expected background
H(150 GeV) × 5
Z + jets
ZZ/WZ/WW
tt̄/tW
Events / (2.50 GeV)
m_ZZ [GeV]

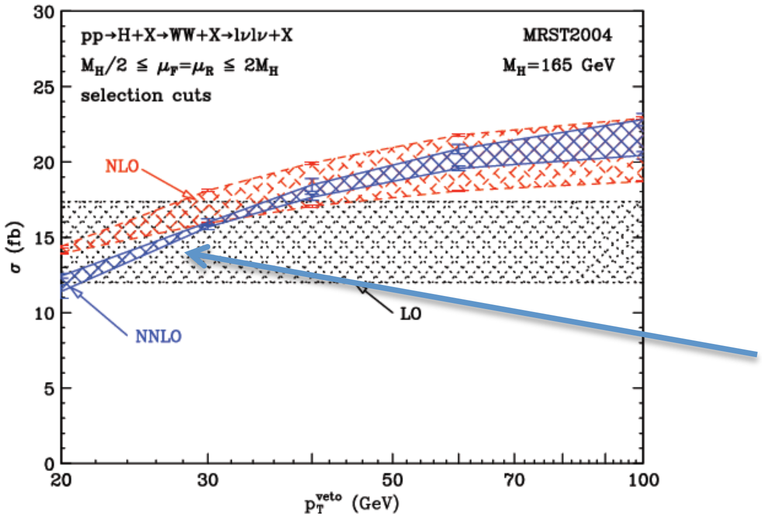

CMS, L = 4.6 fb⁻¹ at √s = 7 TeV
0 b-tag category
Data
Expected background
H(400 GeV) × 2
Z + jets
ZZ/WZ/WW
tt̄/tW
Events / (20 GeV)
m_ZZ [GeV]


CMS, L = 4.6 fb⁻¹ at √s = 7 TeV
1 b-tag category
Data
Expected background
H(400 GeV) × 2
Z + jets
ZZ/WZ/WW
tt̄/tW
Events / (20 GeV)
m_ZZ [GeV]


CMS, L = 4.6 fb⁻¹ at √s = 7 TeV
2 b-tag category
Data
Expected background
H(400 GeV) × 2
Z + jets
ZZ/WZ/WW
tt̄/tW
Events / (20 GeV)
m_ZZ [GeV]

WW+ 0, 1, 2 jets

The NNLO band overlaps with the NLO one for $p_T^{veto} \geq 30$ GeV



WW + 0 jet: Veto jet of p_T>30 GeV
WW + 1 jet: 1 jet of p_T>30 GeV
WW + 2 jet: 2 jet of p_T>30 GeV - VBF like

Asking jet veto, means "eliminate" diagrams with real gluon emission

The HWW analysis is divided in 3 regions: +0, +1 and +2 jets.

To get the correct TH uncertainty on the XS in the three regions:

Theoretically we can compute: σ_{total}, $\sigma_{\geq 1}$, $\sigma_{\geq 2}$, thus

$$\sigma_0=\sigma_{total}-\sigma_{\geq 1}\ ,\ \sigma_1=\sigma_{\geq 1}-\sigma_{\geq 2},\ \sigma_{\geq 2}$$

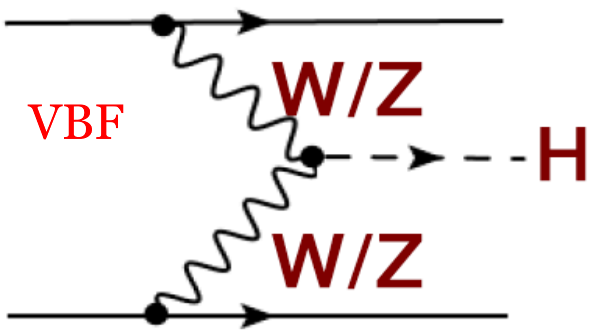
TH uncert:

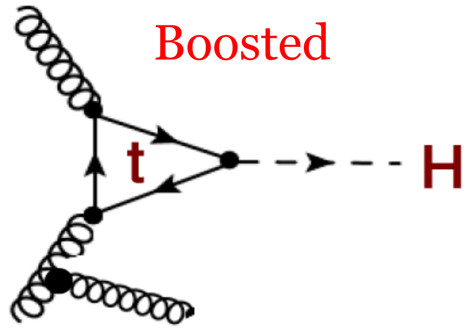
- $\delta\sigma_{\geq 0}=\delta\sigma_{total}$ From Yellow Report (i.e. HNNLO/FEHIP)
- $\delta\sigma_{\geq 1}$ HNNLO/FEHIP or MCFM (identical)
- $\delta\sigma_{\geq}$ HNNLO/FEHIP gives LO, MCFM NLO

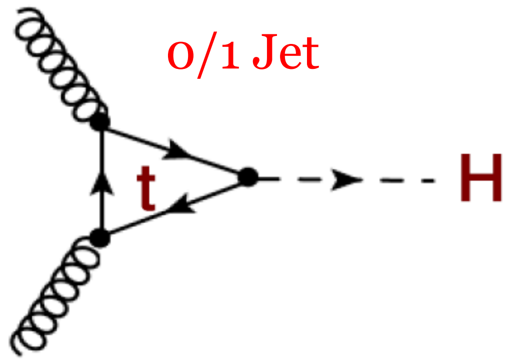
$\delta\sigma_{\geq 0}$	+12-7%
$\delta\sigma_{\geq 1}$	±20%
$\delta\sigma_{\geq 2}$	±30% (NLO) ±70% (LO)

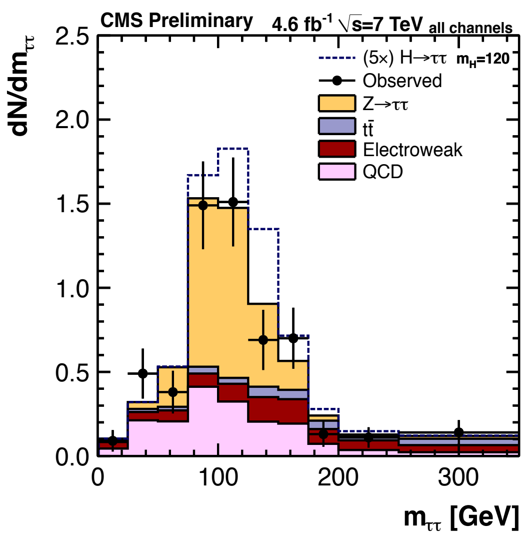
CMS: H → ττ

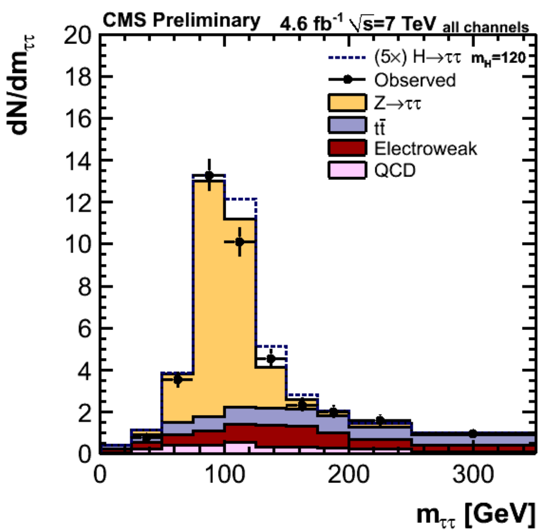
optimize sensitivity by splitting in jet/topology categories: VBF highest sensitivity but all production modes considered: gg→H, VBF, W(Z)H, ttH

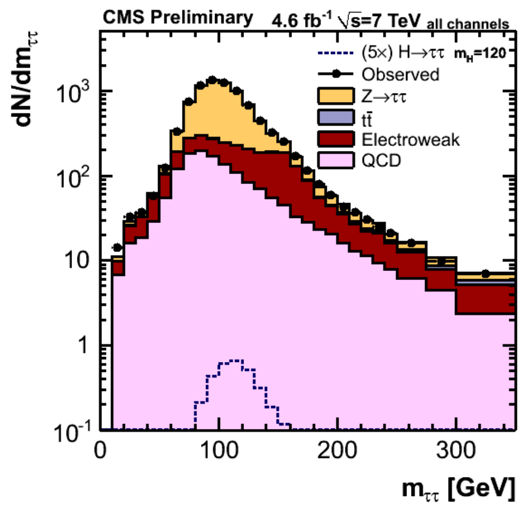






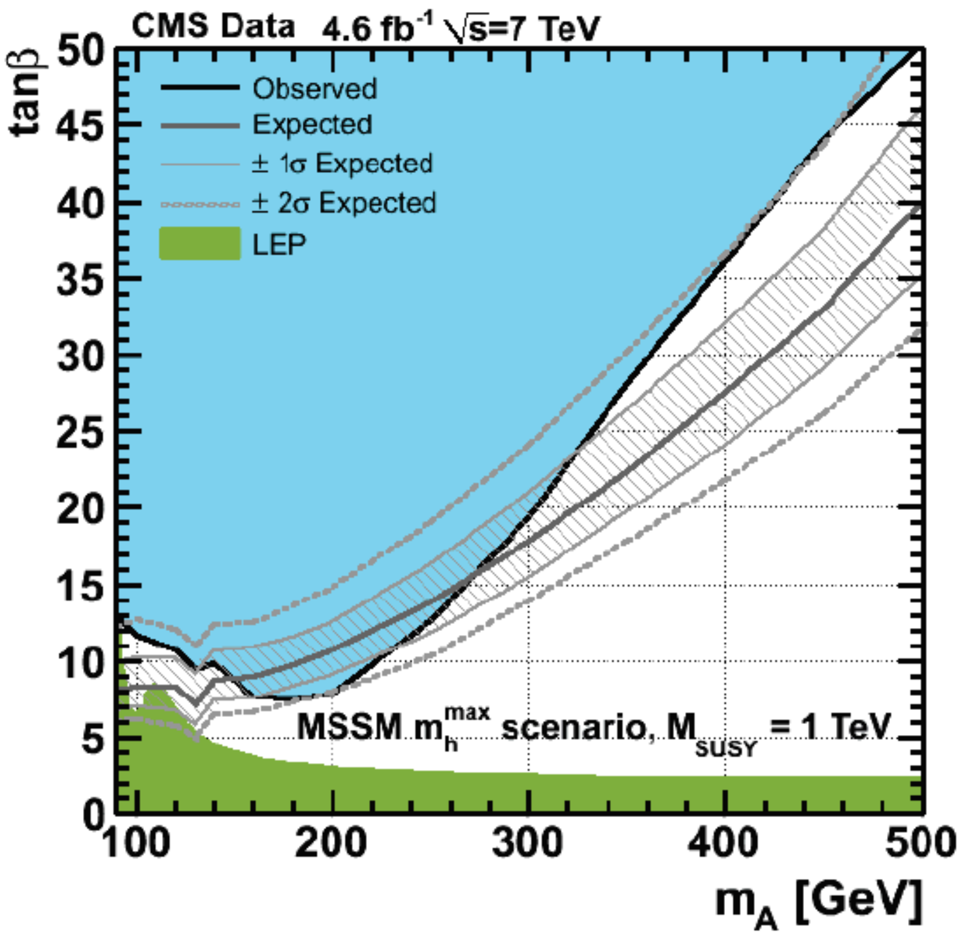


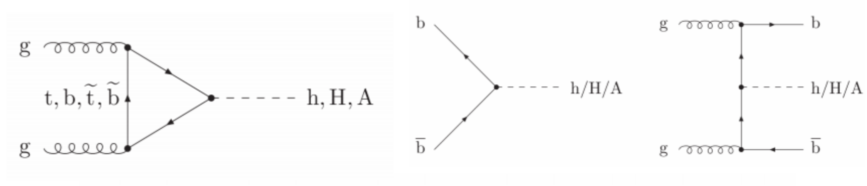




Sig/BG	1/24	1/75	1/460
Signal	6±1	14±2	180±20
Background	140±10	1050±170	83000±4000

MSSM ϕ



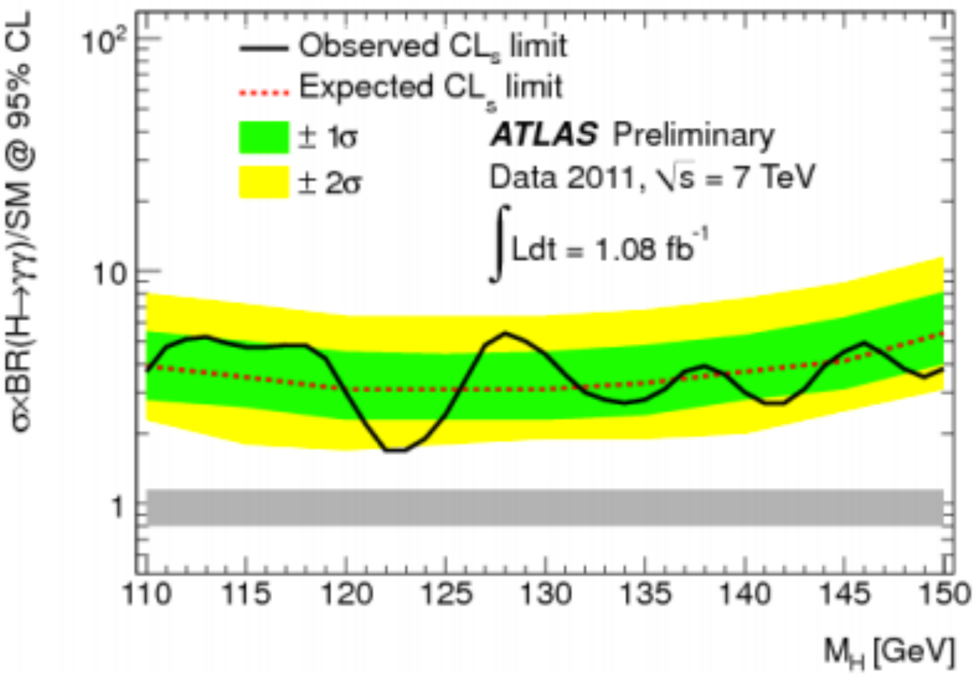


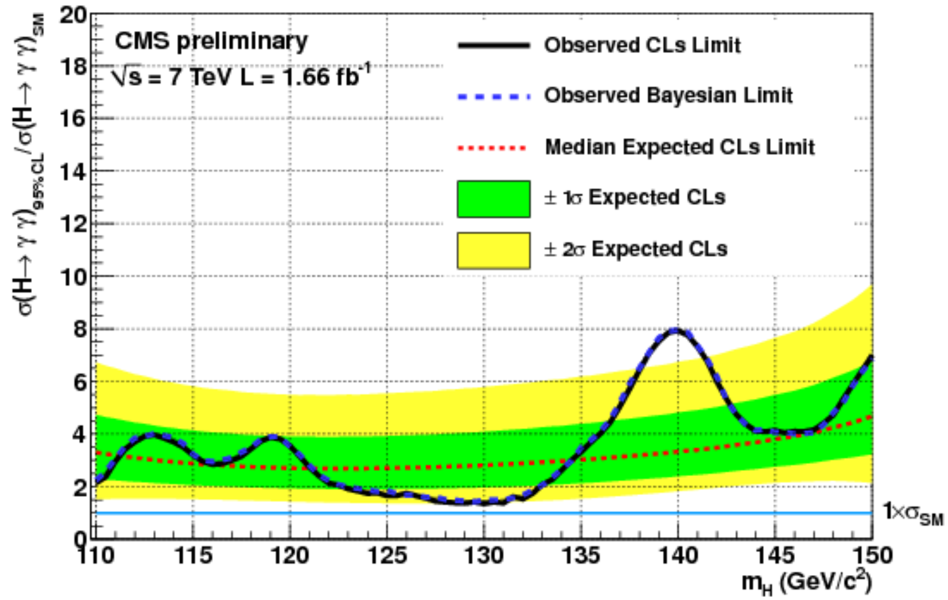
$\phi \rightarrow \tau\tau$
Combining btag
and non btag events

- Most sensitive channel for neutral Higgs searches in the context of SUSY models
  - Large portion of tanβ-M_A plane excluded

H → γγ, in the summer

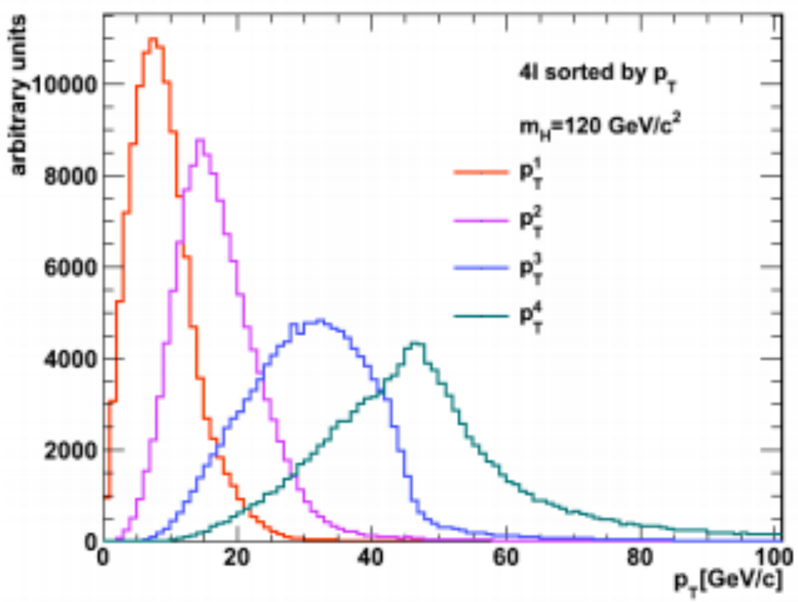
Dominated by gg-fusion



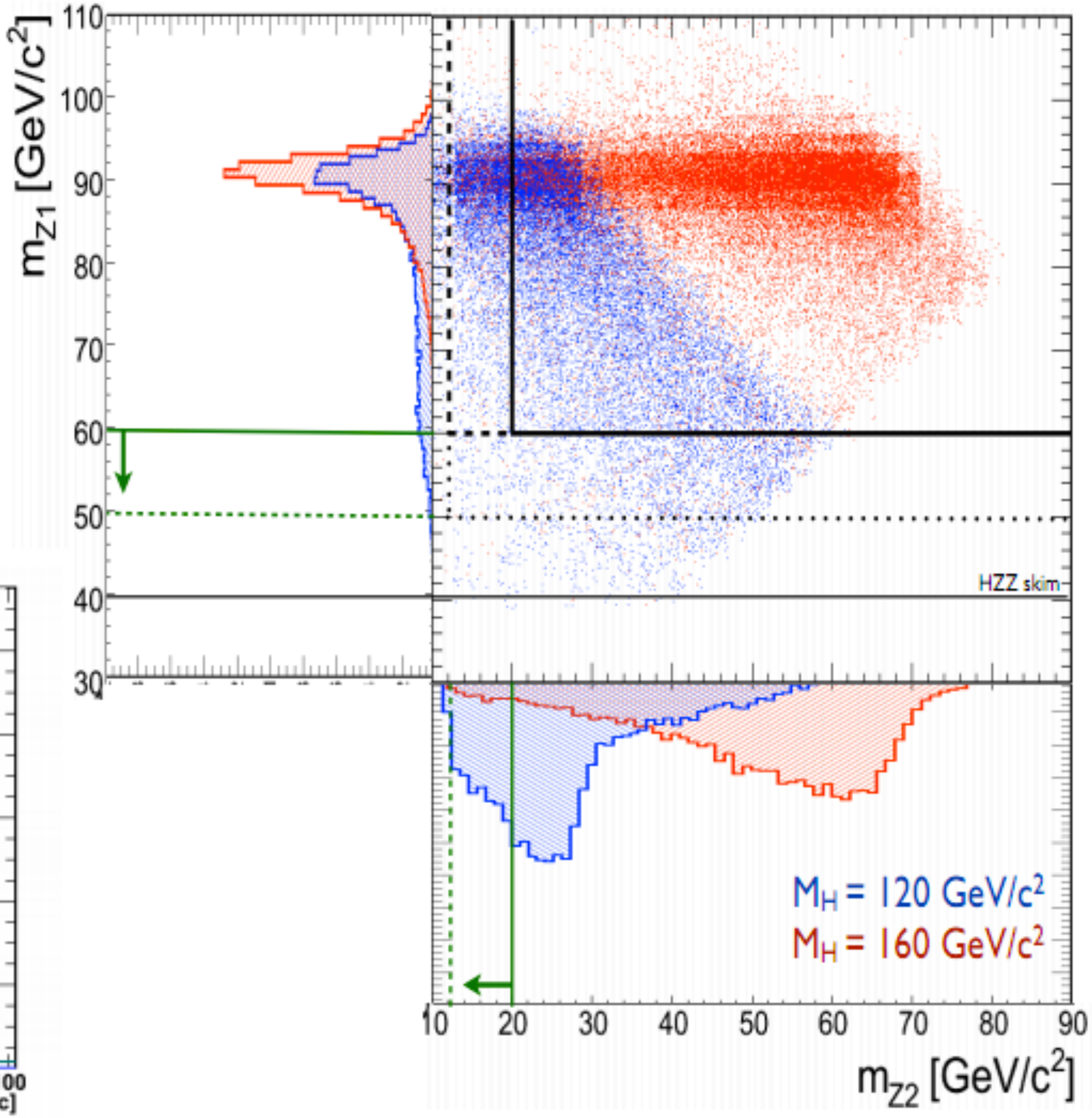


- Two high pt, isolated photons, pointing to a PV
- Different photon categories treated differently.
- M(γγ) resolution very similar.
- Results very similar
- Fluctuations: excess and deficit…. We will see!

M_{Z1} vs M_{Z2}



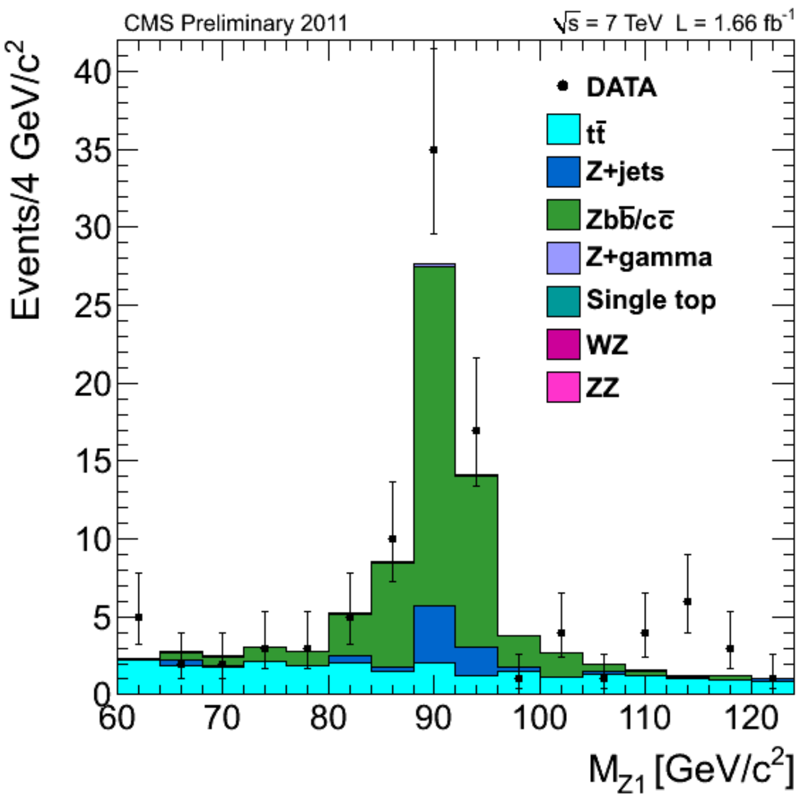
arbitrary units
10000
8000
6000
4000
2000
0
0
20
40
60
80
100
p_T [GeV/c]
4l sorted by p_T
m_H=120 GeV/c^2
p_T^1
p_T^2
p_T^3
p_T^4



m_Z1 [GeV/c^2]
110
100
90
80
70
60
50
40
30
HZZ skim
10
20
30
40
50
60
70
80
90
m_Z2 [GeV/c^2]
M_H = 120 GeV/c^2
M_H = 160 GeV/c^2

Zbb + tt → 4l

- Reducible backgrounds (Zbb/tt) is measured in a dedicated control region:
  - Same requirements for the on-shell Z candidate as for the signal
  - Relaxed selections on charge, flavor and isolation and inverted IP cut for the other lepton pair
  - From this plot we can disentangle Zbb from tt, by fitting the "Z peak" and a polinomial for tt.
  - Comparing data/MC, we can get the k-factor (MC are at LO or NLO)

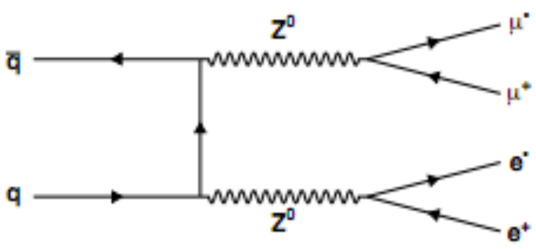


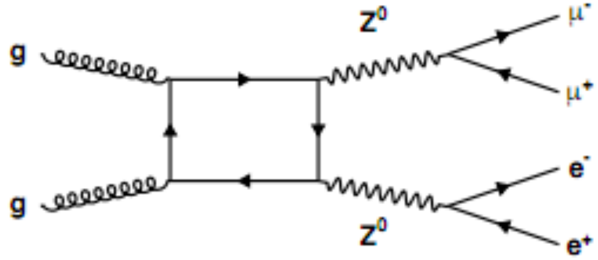
The background

Irreducible background:

$qq \rightarrow ZZ^{(*)} \rightarrow 4l$

$gg \rightarrow ZZ^{(*)} \rightarrow 4l$



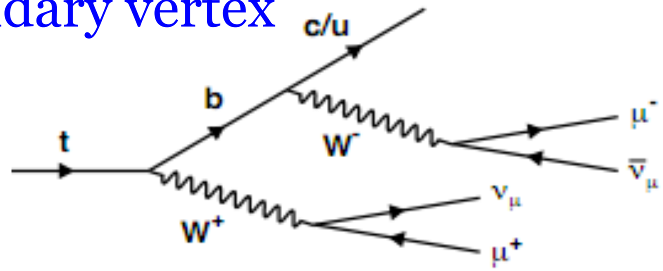


Reducible background:

Zbb/Zcc and **tt pair** production.

I.e. events with B hadrons decaying semileptonically

Leptons are inside jets and originating from secondary vertex

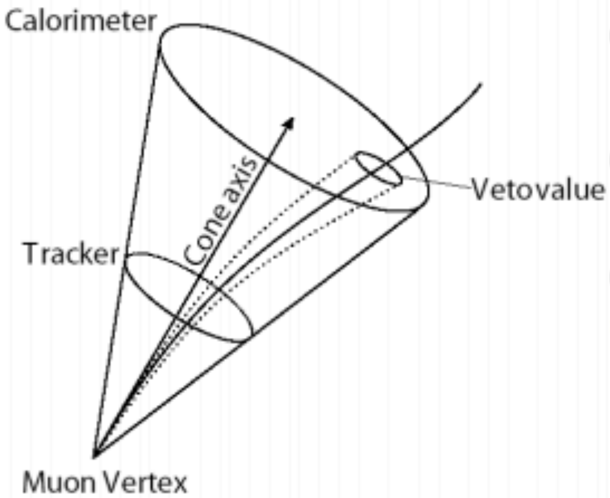


Instrumental background:

QCD and **Z/W+light jets**. Events with jets faking leptons (mostly electrons)

Isolation

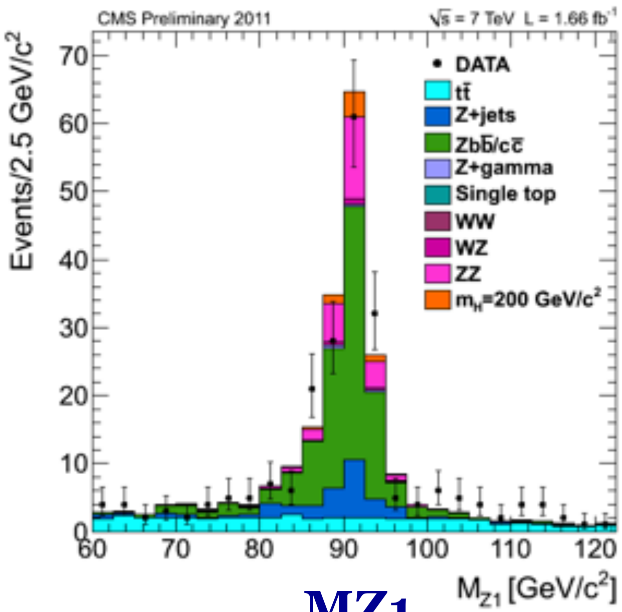
The requirement that the energy flow in the vicinity of a muon is below a certain threshold helps discriminating muons from W/Z from muons produced as a result of QCD processes.



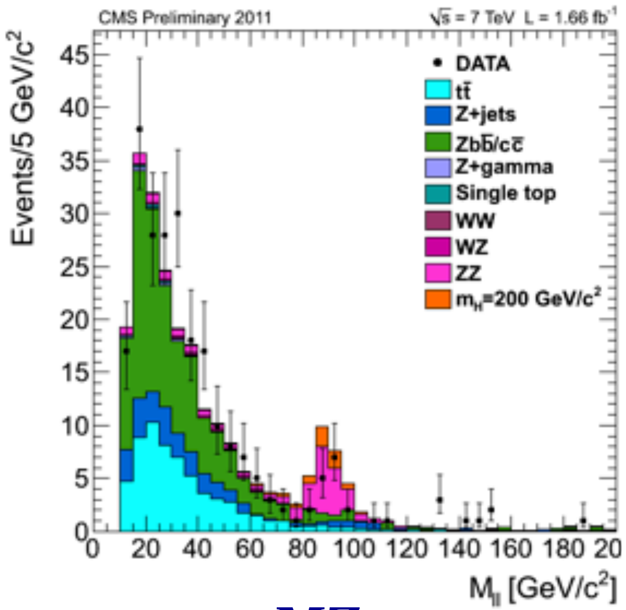
- $R^{Tk}_{Iso} = [TK_{iso03} / p_T]$
- $R_{Iso} = [(TK_{iso03} + ECAL_{iso03} + HCAL_{iso03})/p_T]$
- **H->4l analysis: a cut on the sum of R_{Iso} of the two least isolated leptons < 0.35 is chosen**
  - $R_{Iso} < 0.15$ usual working point for W/Z lepton selection

ECAL and HCAL contributions are affected by pile-up conditions
To have a pile-up robust analysis R_{Iso} must be corrected by the average energy flow in the event
[Fast-jet correction]

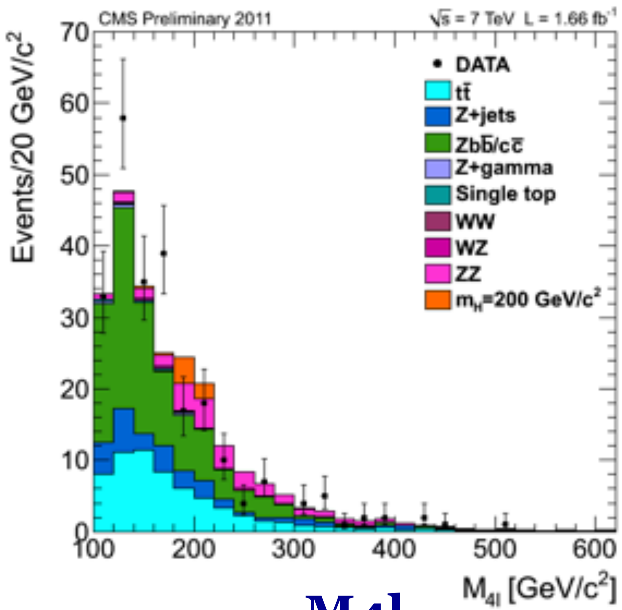
$H \rightarrow ZZ \rightarrow 4l$



MZ1



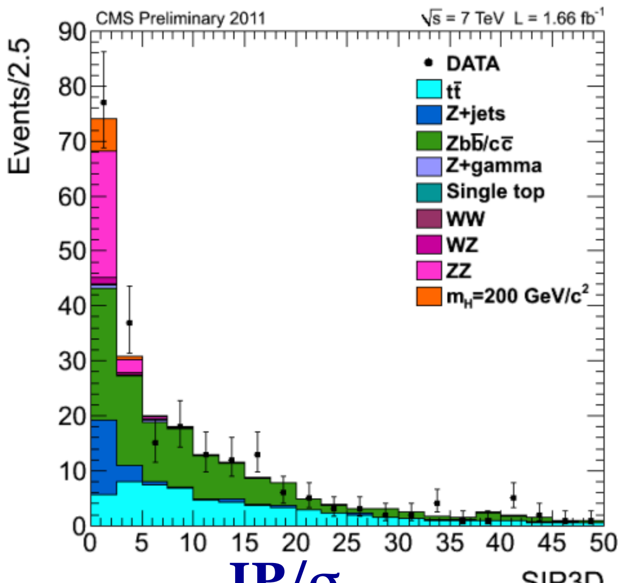
MZ2



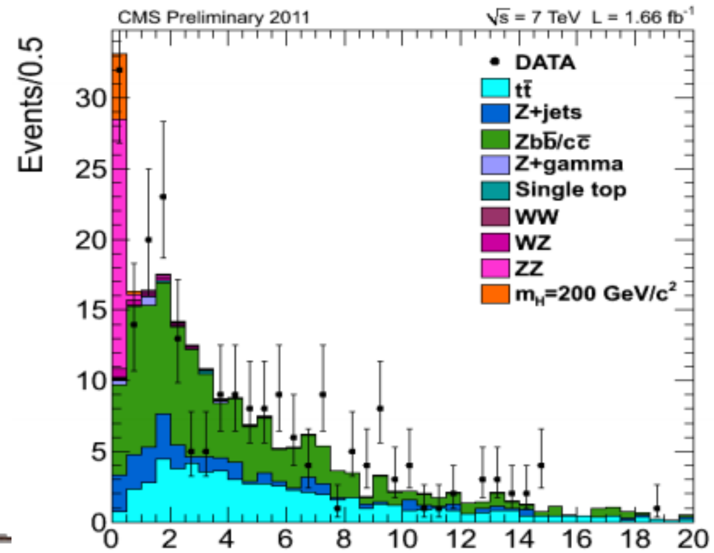
M4l

2 leptons of pT>20, 10 GeV
Isolated and from PV ->
the couple closest to MZ

PLUS
2 leptons of pT>5 (7) GeV
with M>20 GeV
Isolated and from PV

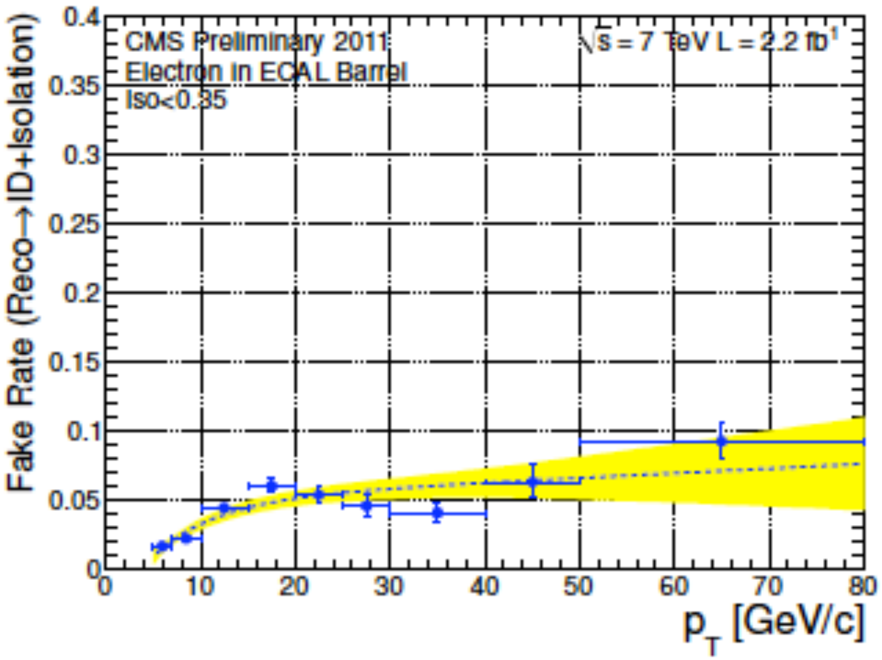


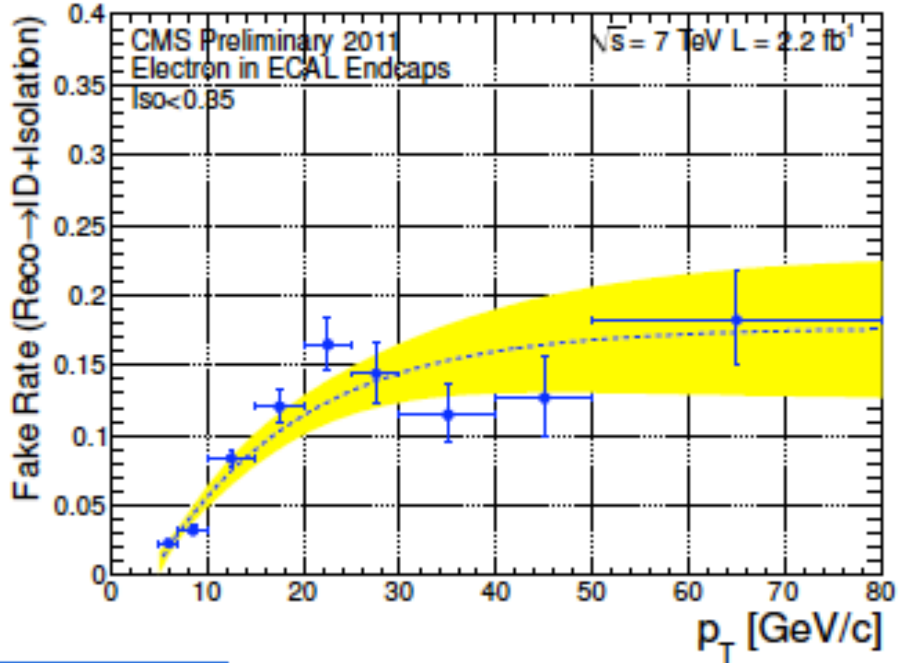
IP/σ_{IP}



ISO

Z+jets





In the Z1+1 leptons sample:
the probabiity that a muon/electron with relaxed ID and ISO passes the analysis requests

More checks done on the Z1+SS vs Z1+OS samples.

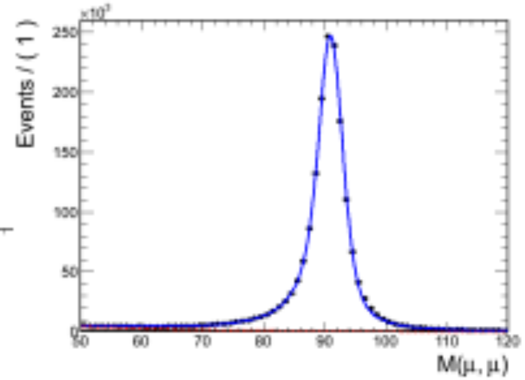
ZZ continuum

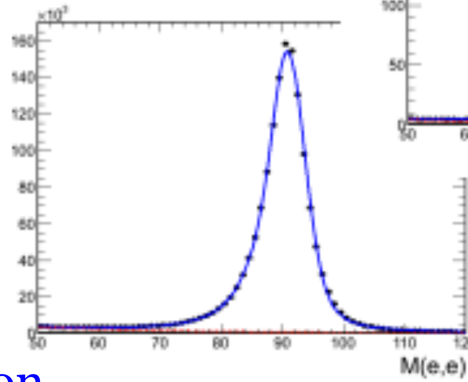
- Directly from MC:

$$\left(\sigma_{NLO}^{q\bar{q}\to ZZ\to 4l} \times \varepsilon_{MC}^{q\bar{q}\to ZZ\to 4l} + \sigma_{LO}^{gg\to ZZ\to 4l} \times \varepsilon_{MC}^{gg\to ZZ\to 4l}\right) \times L$$

- Normalization to Z rate in data

$$\frac{\sigma_{NLO}^{q\bar{q}\to ZZ\to 4l} + \sigma_{LO}^{gg\to ZZ\to 4l}}{\sigma_{NNLO}^{q\bar{q}\to Z\to 2l}} \times \frac{\varepsilon_{MC}^{ZZ\to 4l}}{\varepsilon_{MC}^{Z\to 2l}} \times N_{data}^{Z\to ll}$$

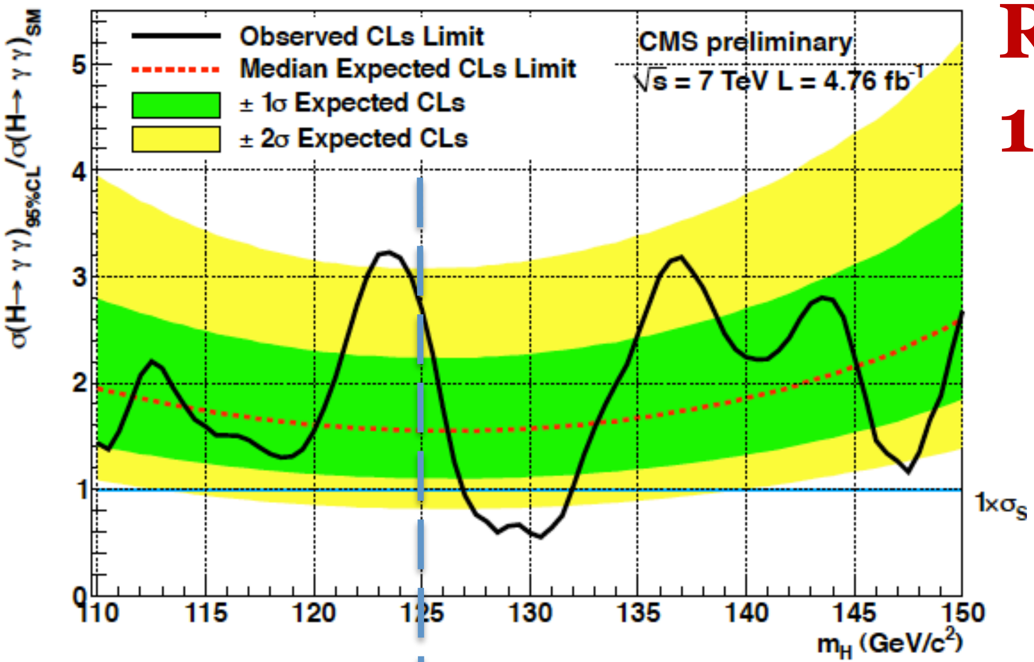


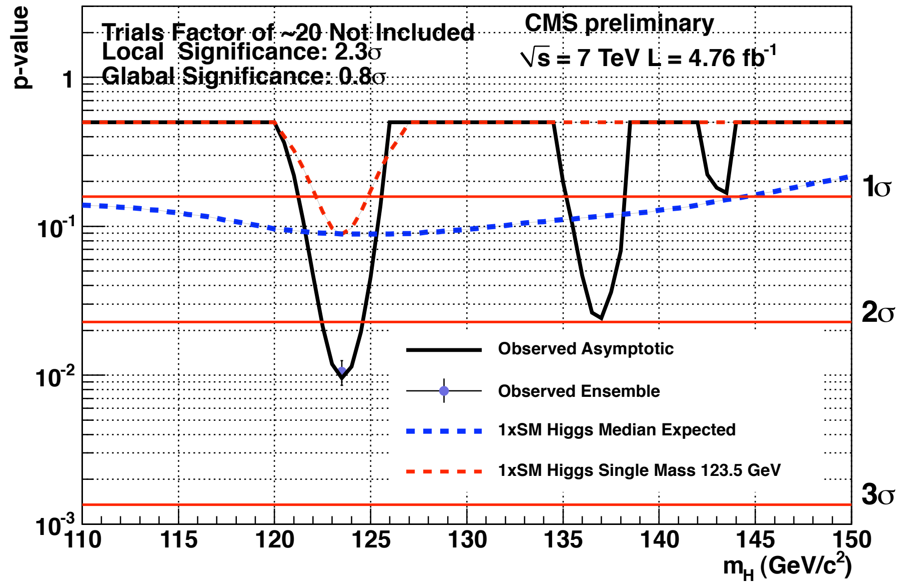


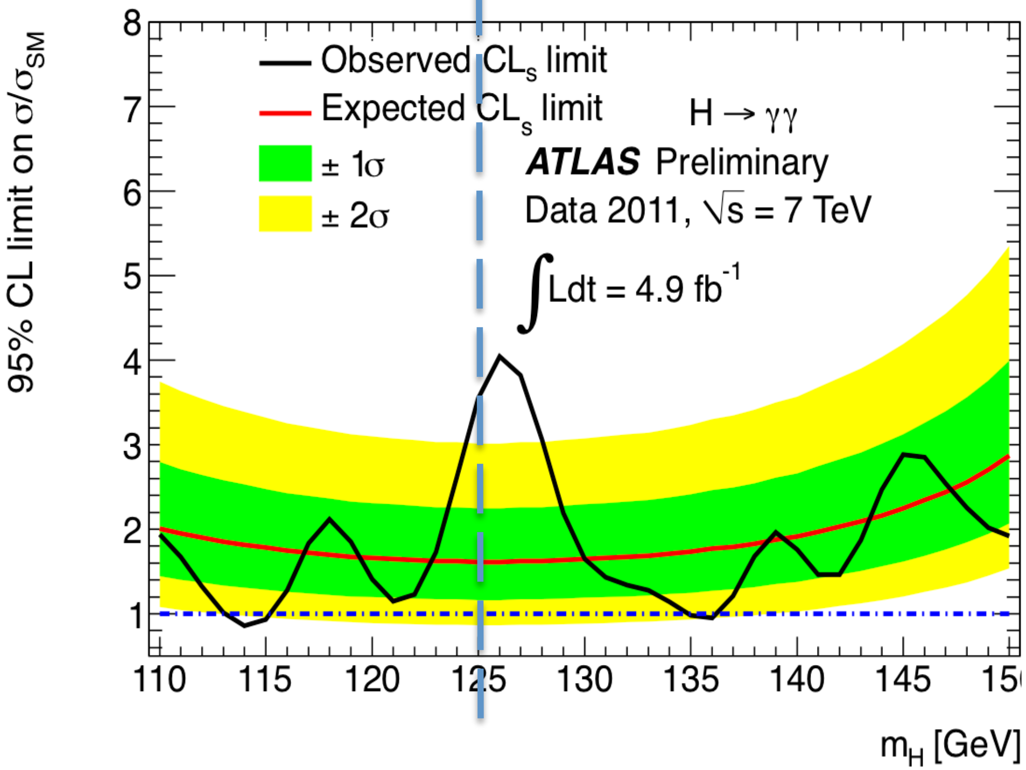
  - The luminosity uncert. cancel in the ratio
  - The TH uncertainties as YR prescription ~ 10% (PDF4LHC prescription + QCD scale)

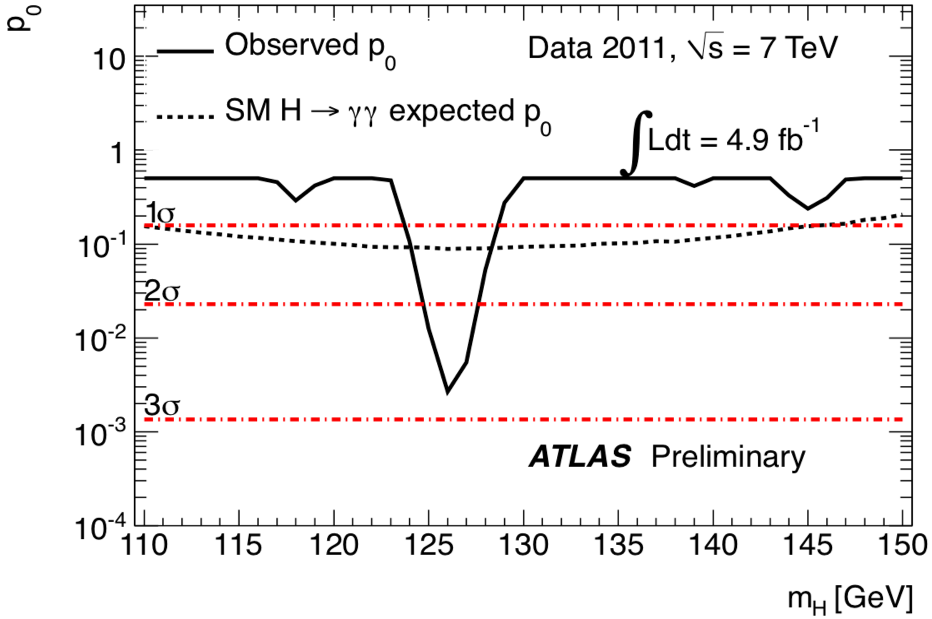
- Results: the two agree within %

Results : R and p-value 13 -Dec - 2012

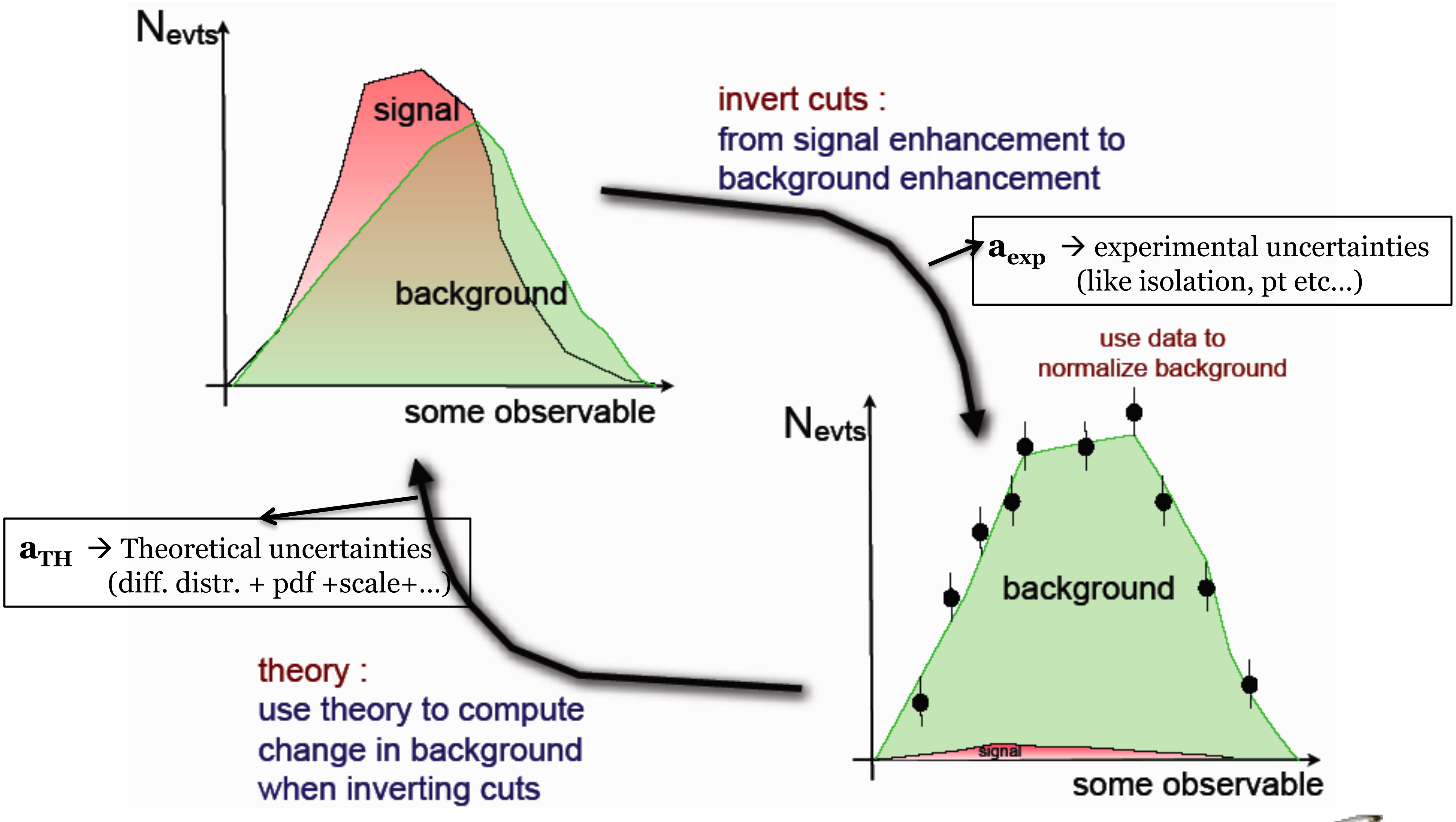








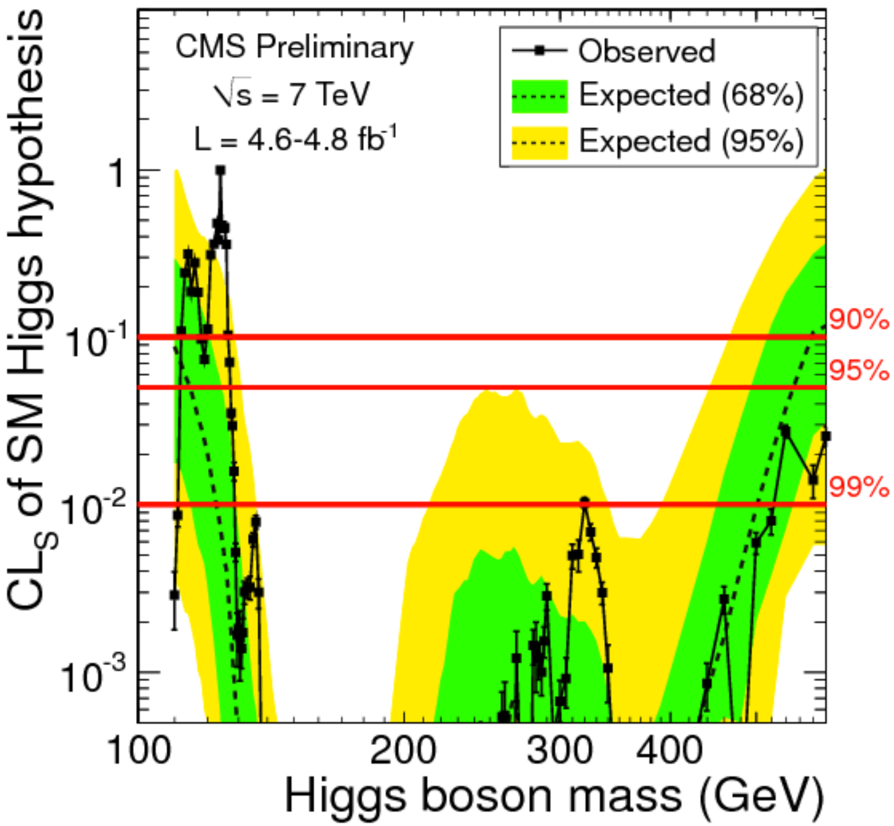
The control of the background



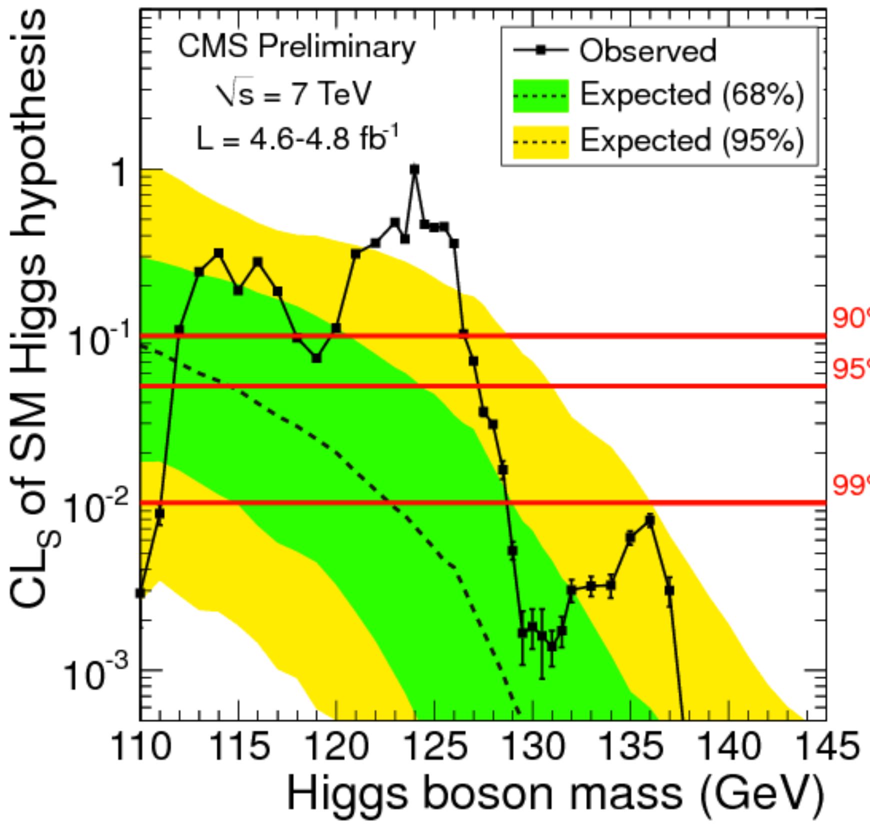
$N^B_{(signal\ region)} = a_{exp} * a_{TH} * N^B_{control\ region}$

a_{exp} - uncorr between exp
a_{TH} - 100% correlated

CLs



CMS Preliminary
√s = 7 TeV
L = 4.6-4.8 fb⁻¹
Observed
Expected (68%)
Expected (95%)
90%
95%
99%
CLS of SM Higgs hypothesis
1
10⁻¹
10⁻²
10⁻³
100
200
300
400
Higgs boson mass (GeV)



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Expected (68%)
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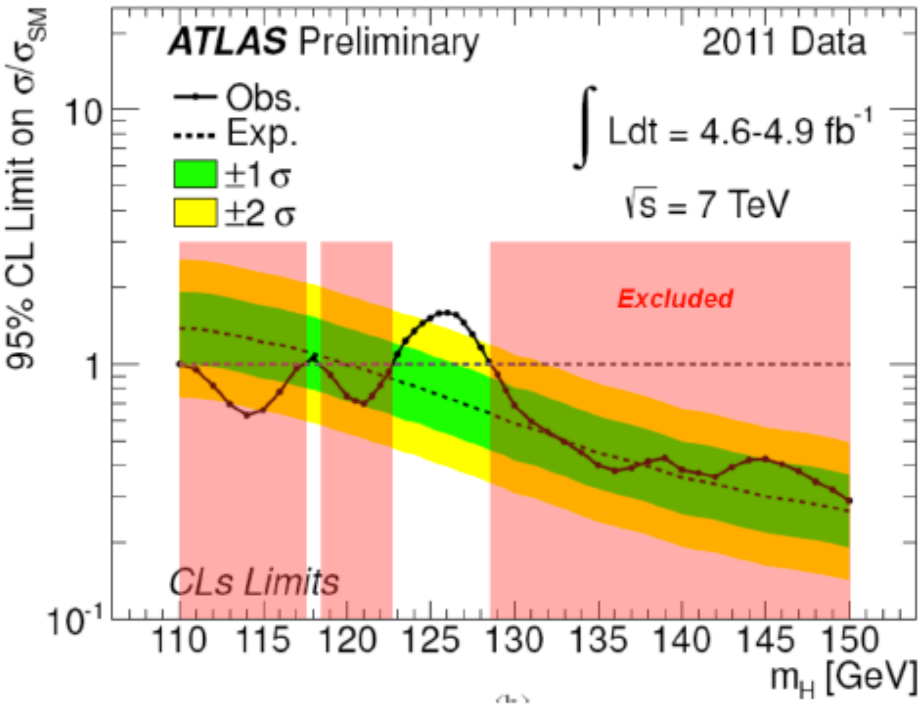
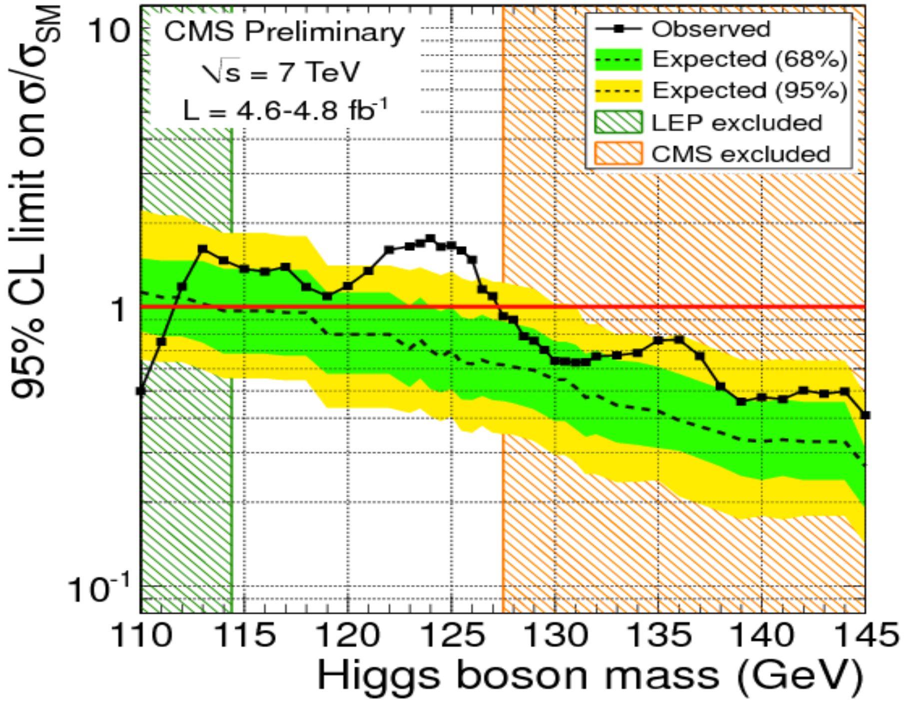
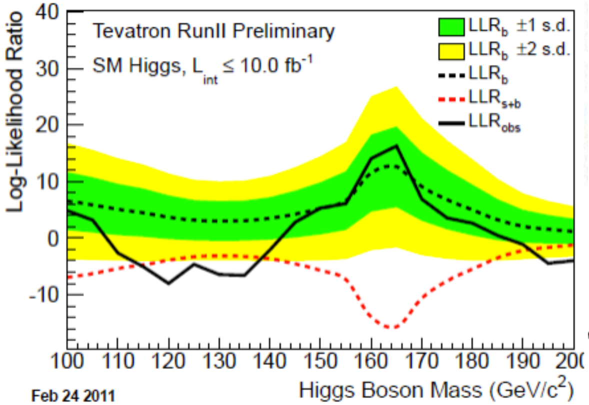
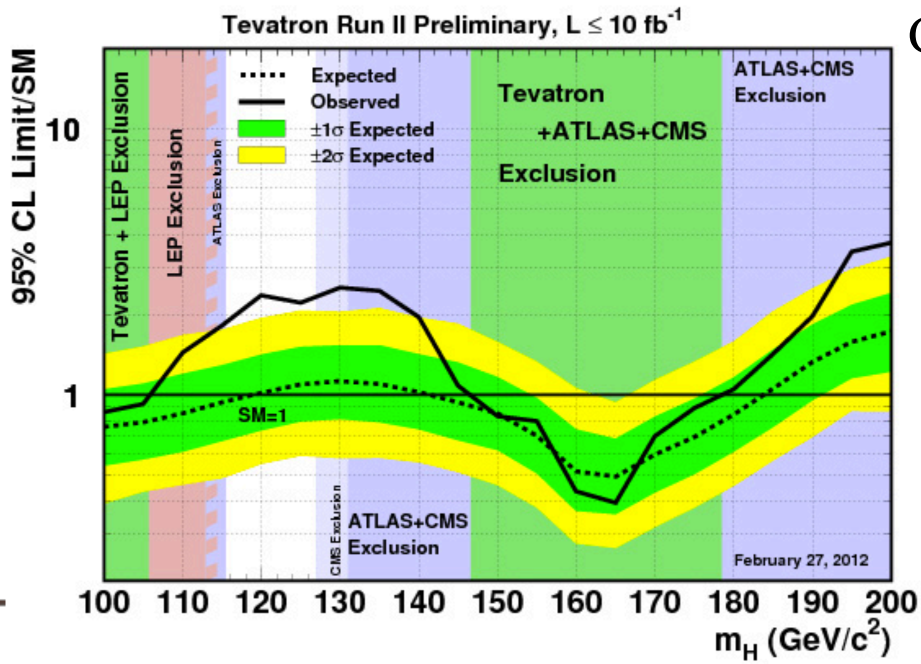
CLS of SM Higgs hypothesis
1
10⁻¹
10⁻²
10⁻³
110
115
120
125
130
135
140
145
Higgs boson mass (GeV)





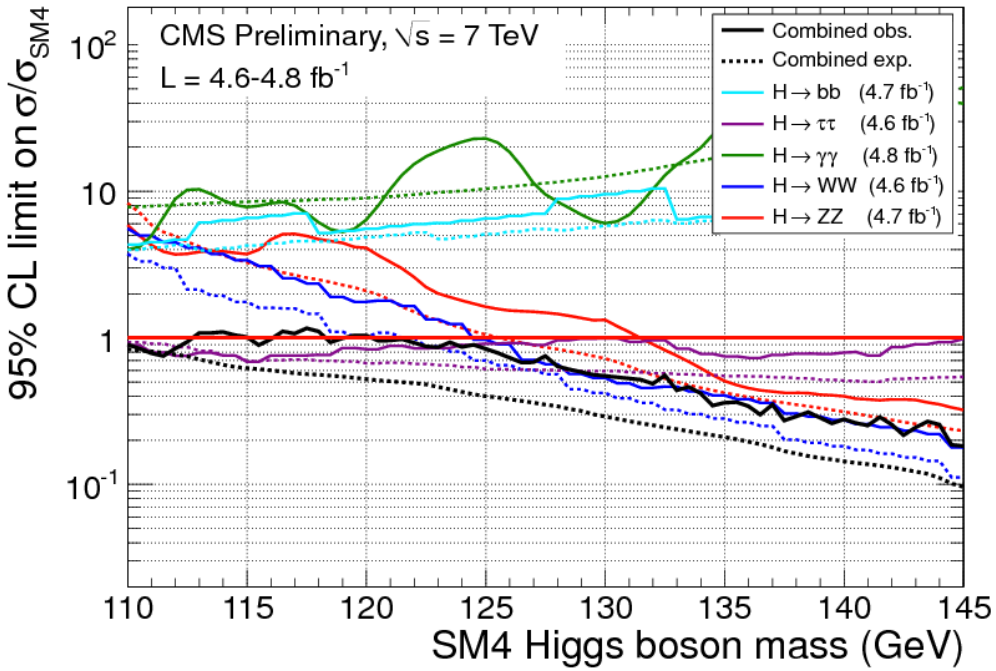
...and TEVATRON

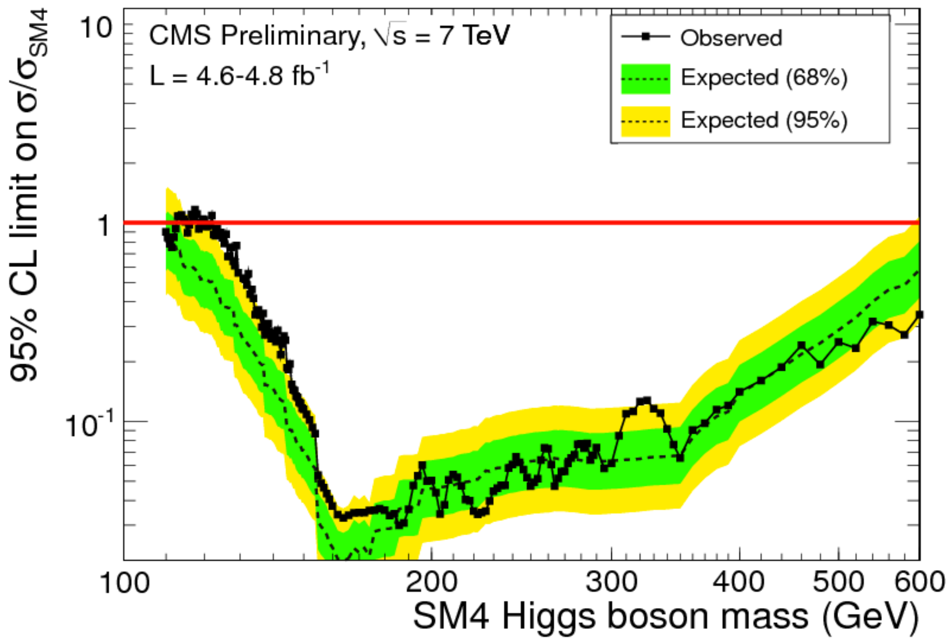




Global significance
~2.2 σ

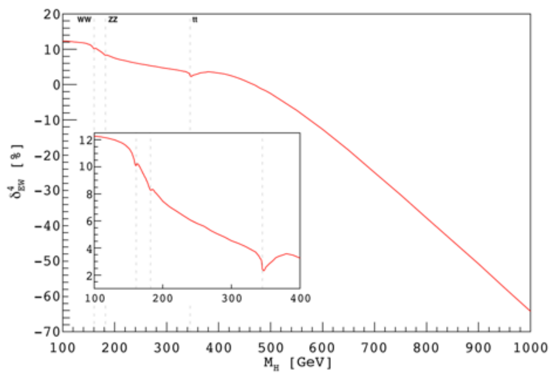
Higgs in the SM4

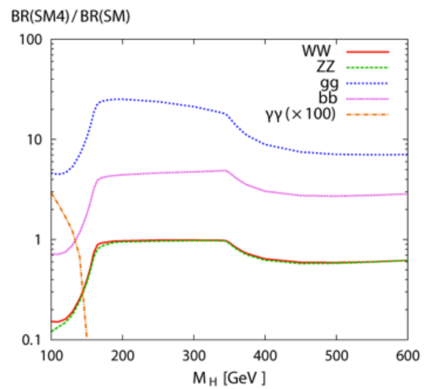




Excluded in the range: 120 - 600 GeV

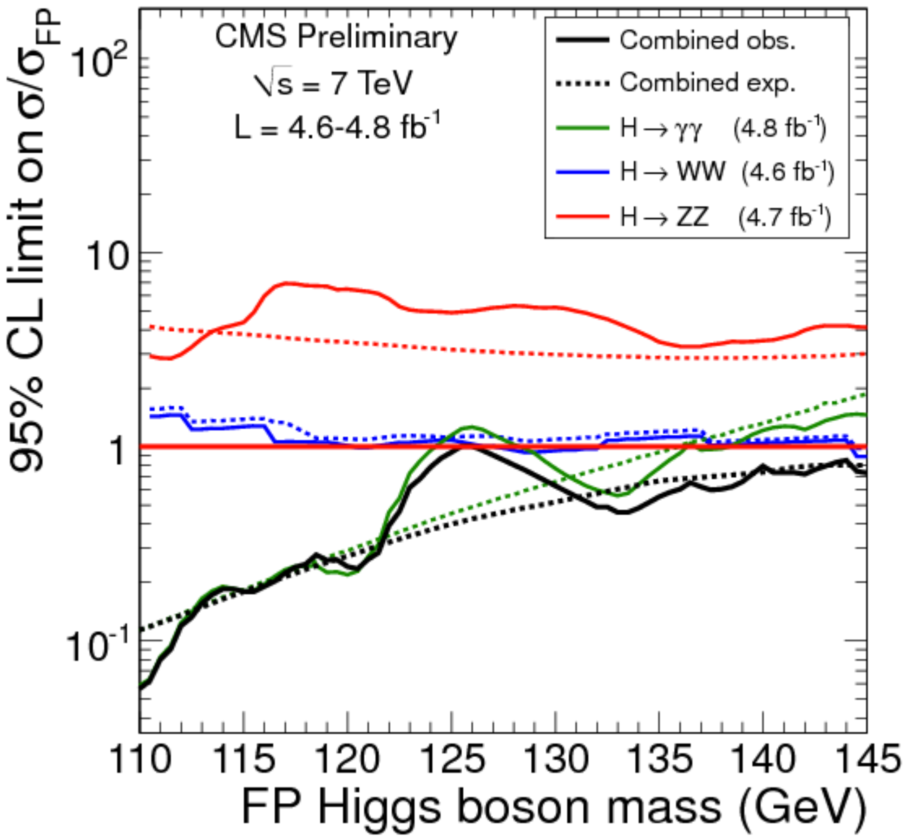
New values from CERN 2012-002 including EW correction to production and decay

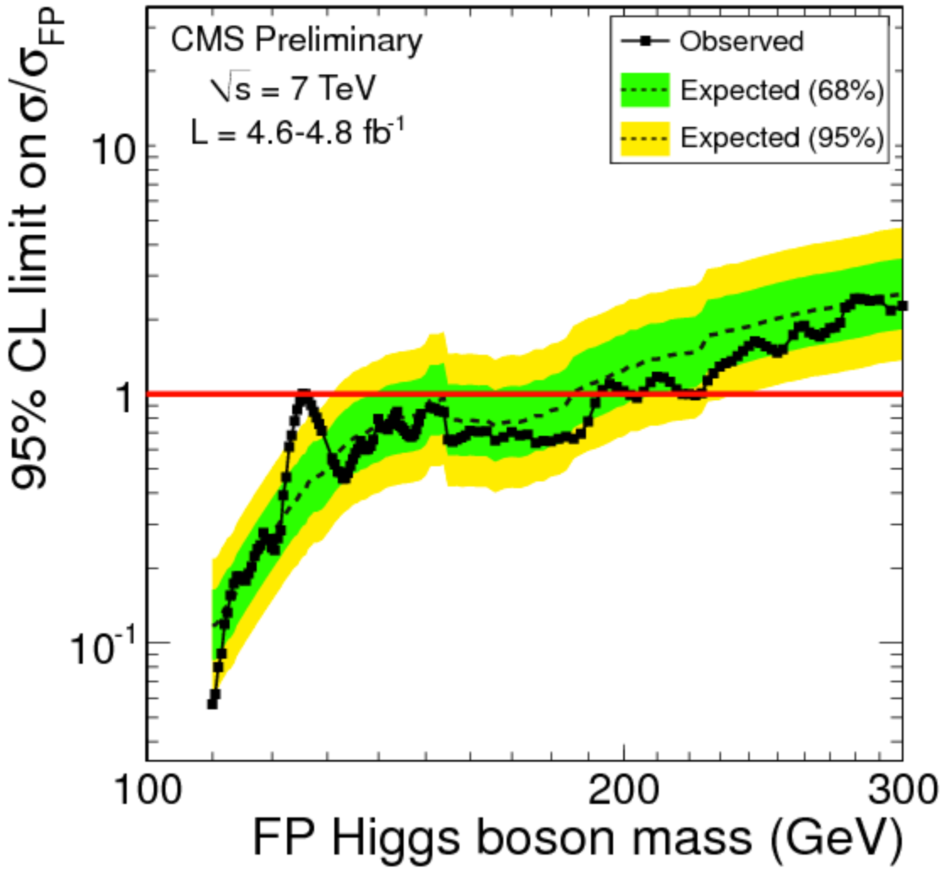




Chiara Mariotti, INFN Torino & CERN

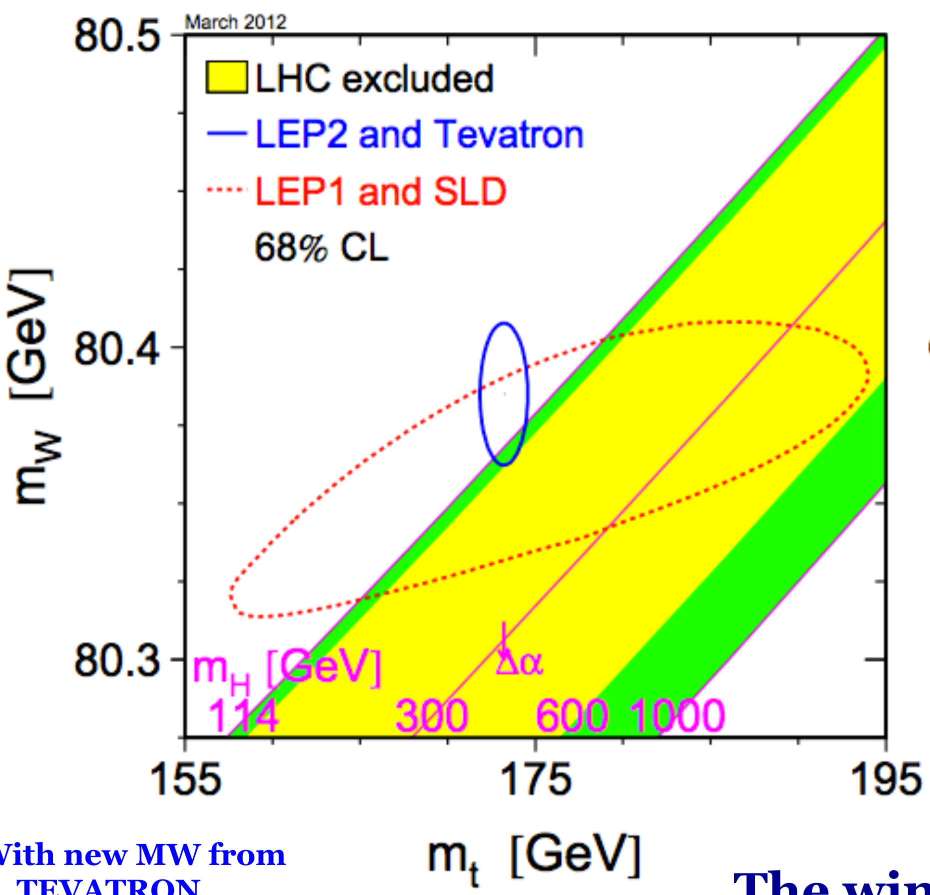
Limits in the Fermiophobic scenario

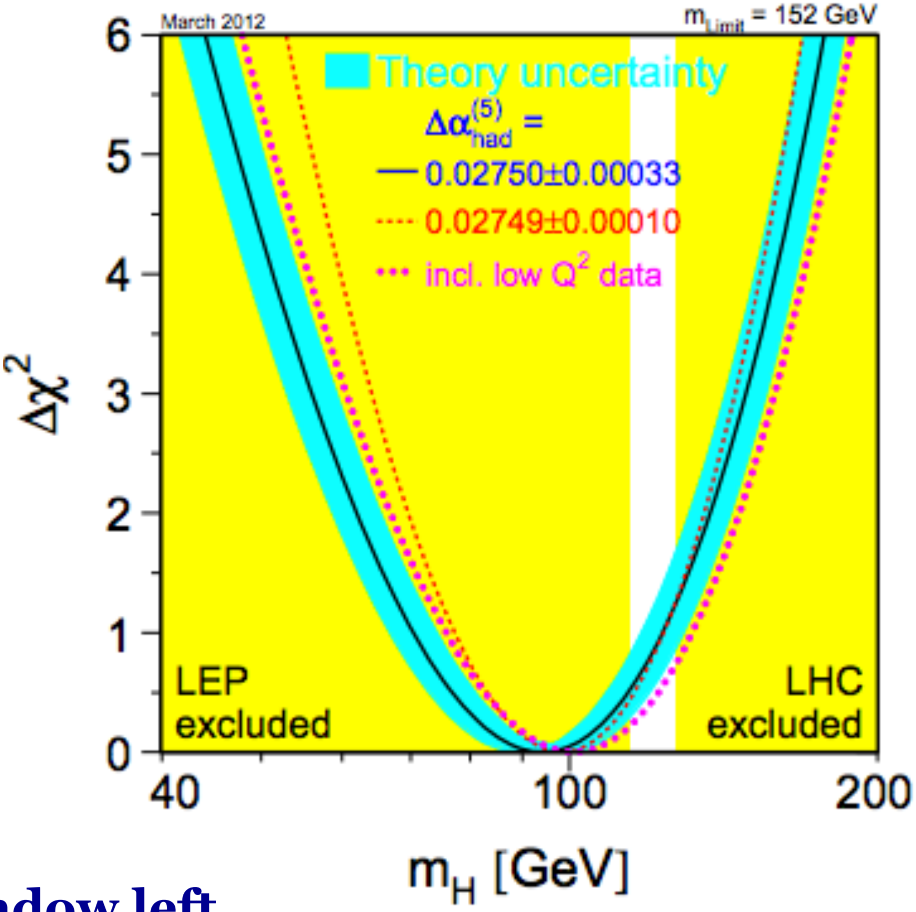




Excluded in the range: 110 – 192 GeV

The SM Higgs as of today





With new MW from TEVATRON MW= 80.375±0.15

The window left is between ~117 – 127 GeV in agreement with EW precision physics