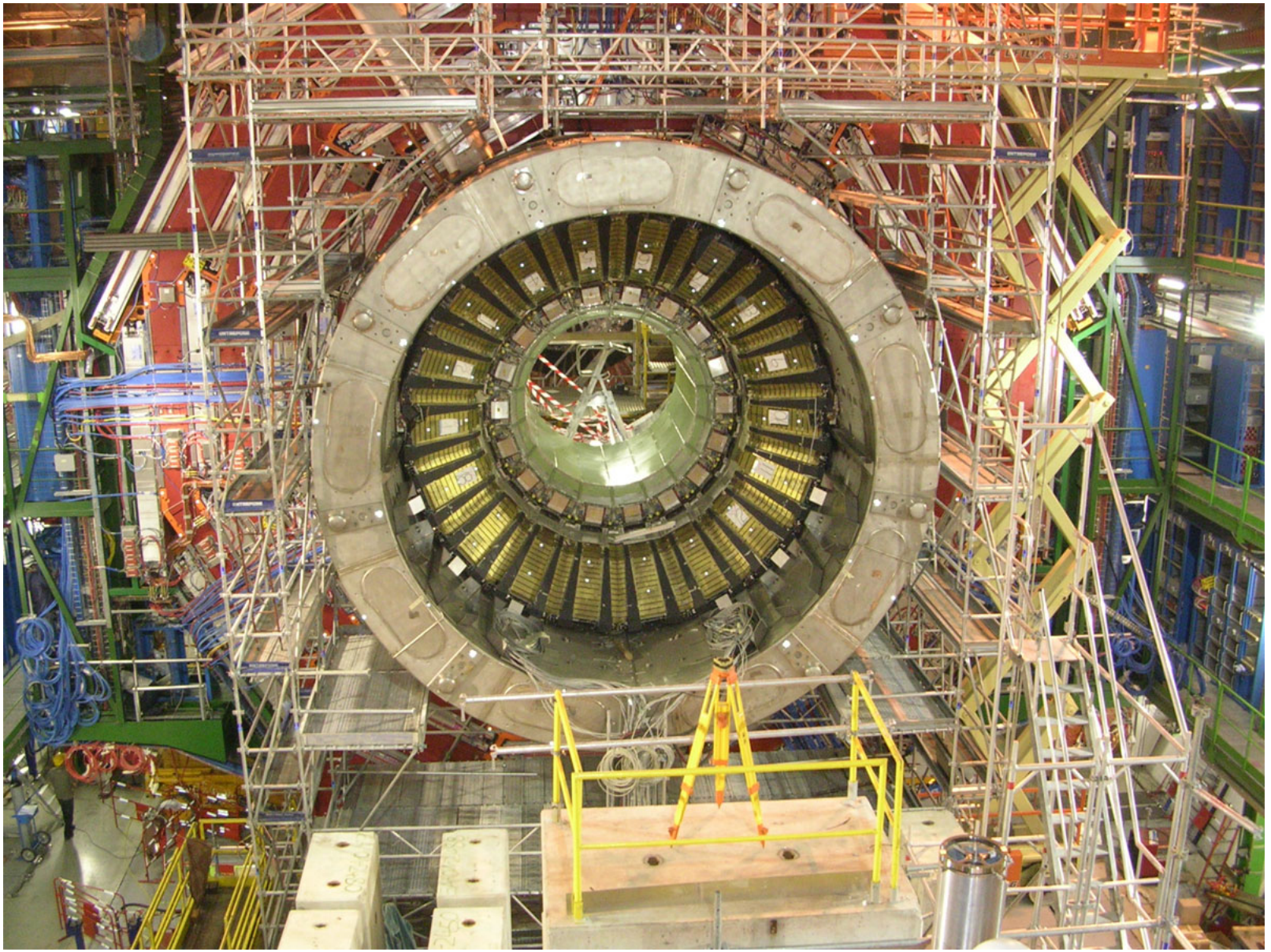
Higgs WG : Experimental report

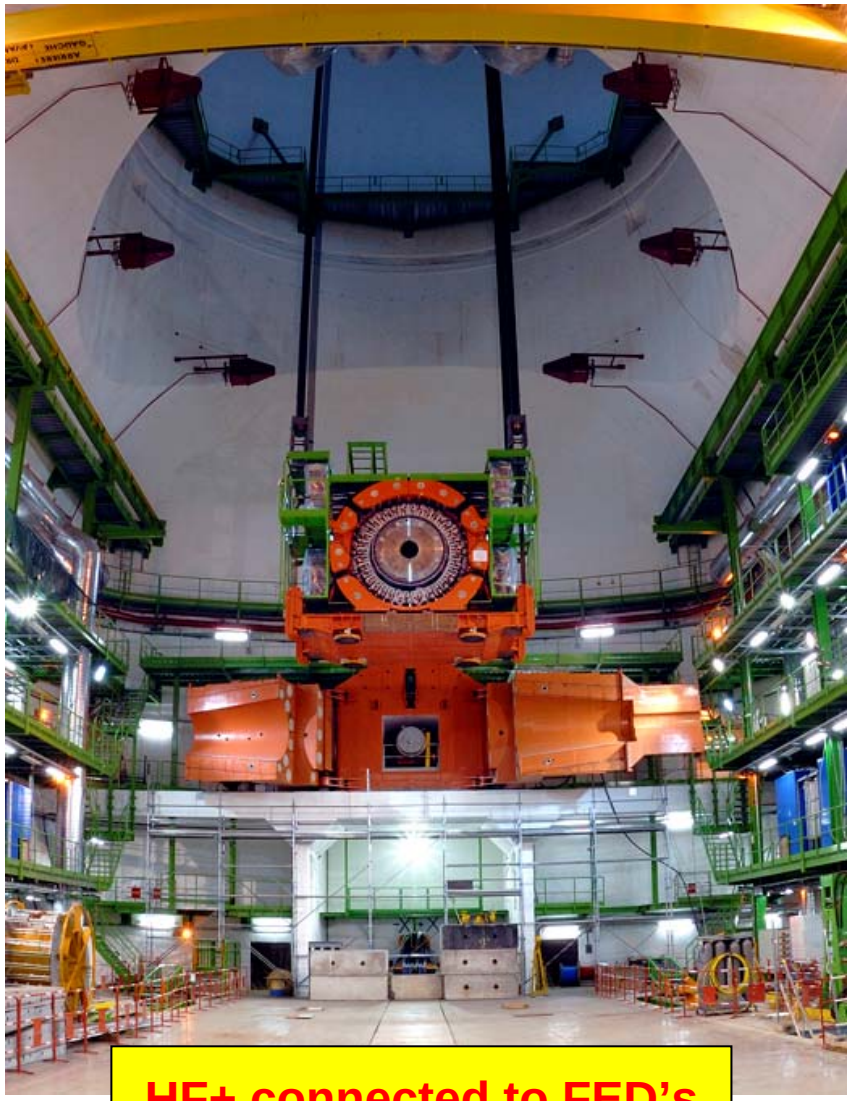
A. Nikitenko, 21st June, LH07

- Introduction
- Go through some Les Houches topics

CMS underground: EB- Installation Completed (22 May)



CMS: HF+ commissioned. May



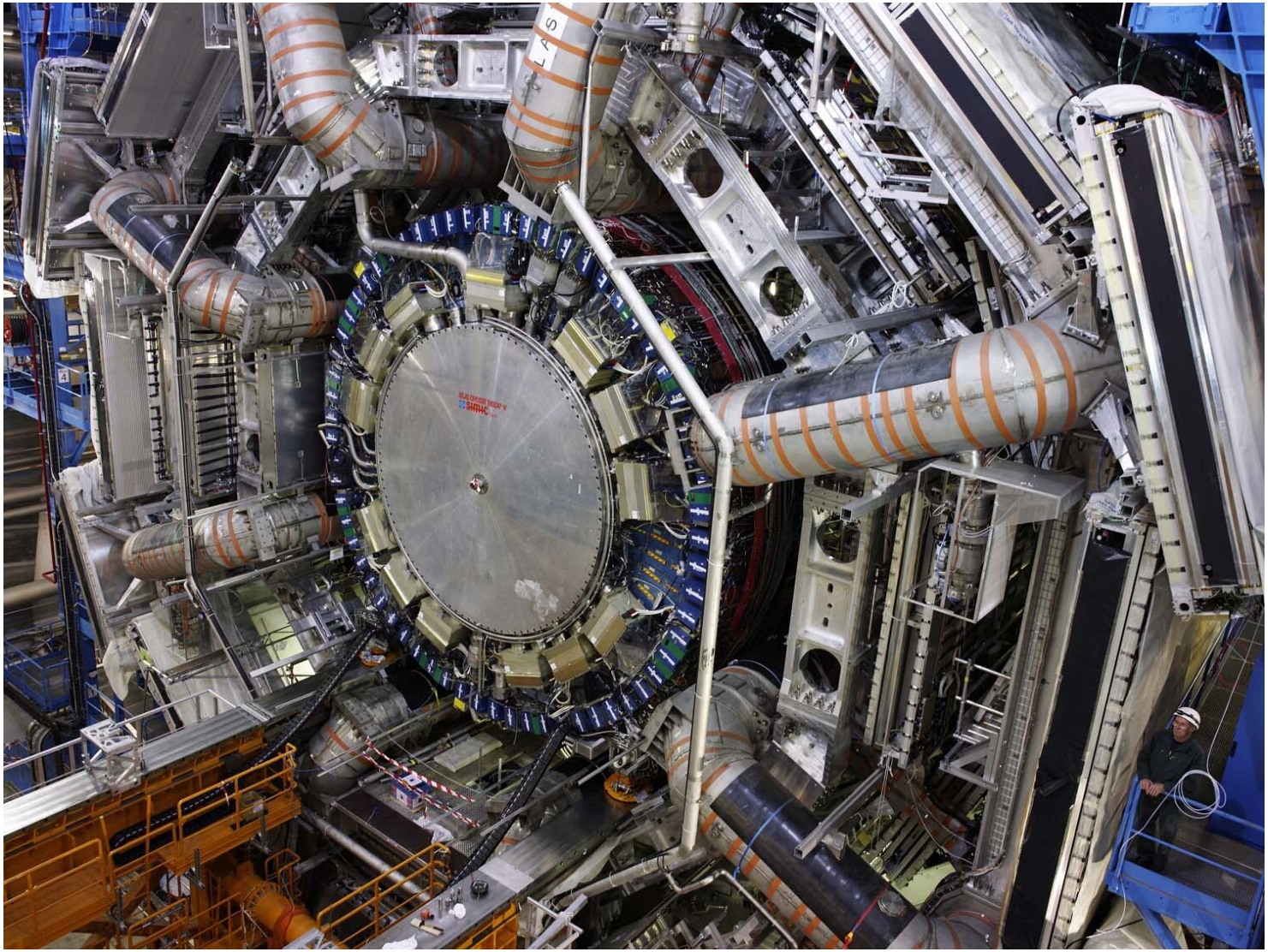
HF+ connected to FED's

March 2008:

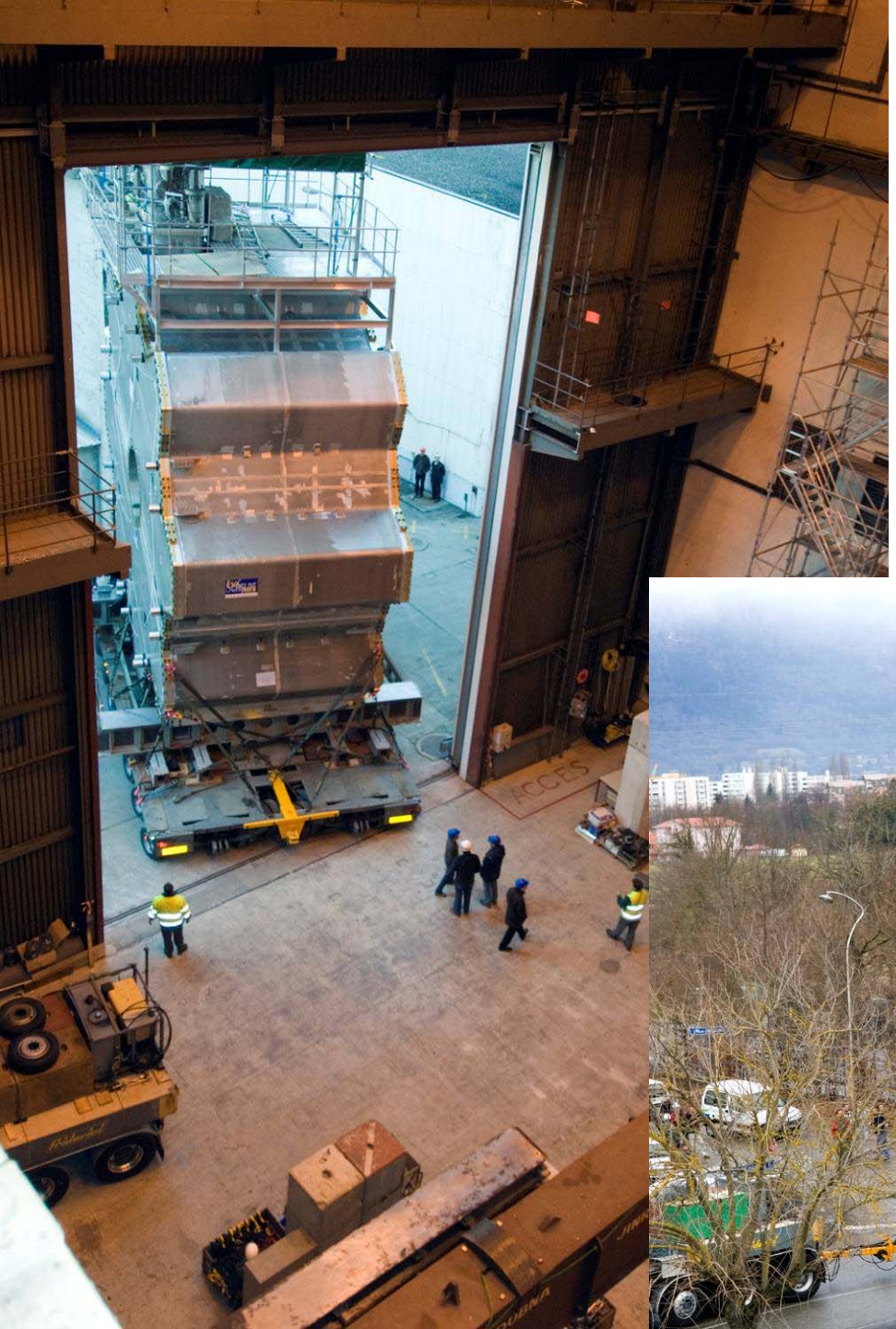
CMS is closed and field ON.

Taking cosmic data

ATLAS: Calorimeter status, June 07



ATLAS side A (with the calorimeter end-cap partially inserted, the LAr end-cap is filled with LAr)



End-Cap Toroids

The first End-Cap Toroid was transported from Hall 191 to the outside test station in front of Hall 180 where it was mechanically cold tested at LN temperature (excellent results)

Now it is at Point-1 and will be lowered this week!

The integration of the second ECT went also well, and the tests just ended now in Hall 191

ECT-C installation to follow in early July

Data taking at 14 TeV starts in the middle of 2008

Present Higgs mass constraints

SM Higgs

SM vs MSSM Higgs

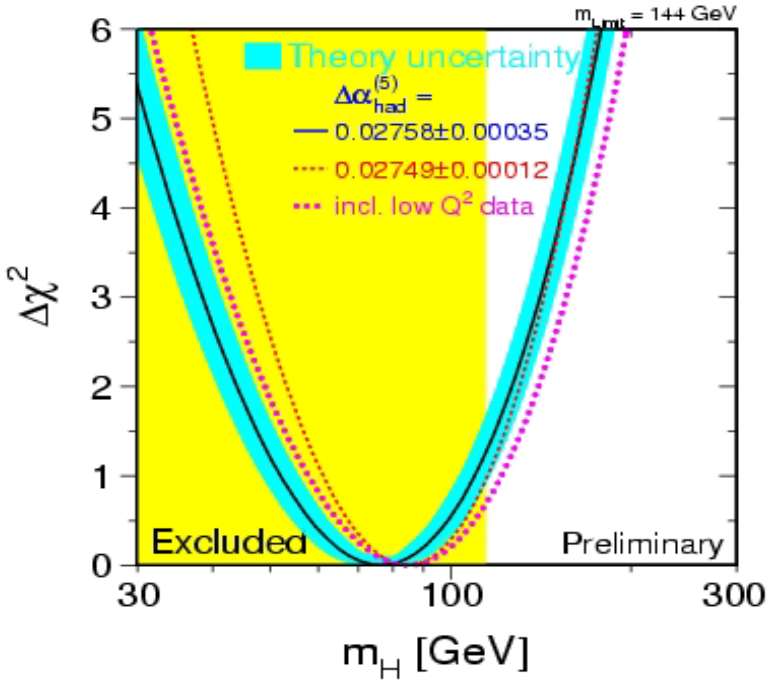
Indirect constraints from precision EW data :

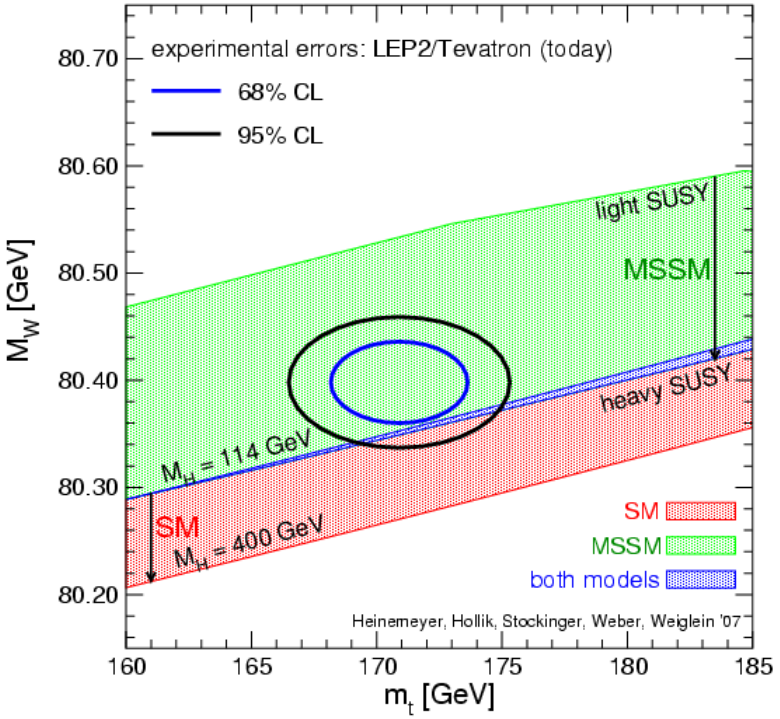
M_H < 186 GeV with Run-I/II prelim. (2005)

M_H < 166 GeV (2006, ICHEP06)

2007: M_t = 170.9 GeV, M_W = 80.398 GeV

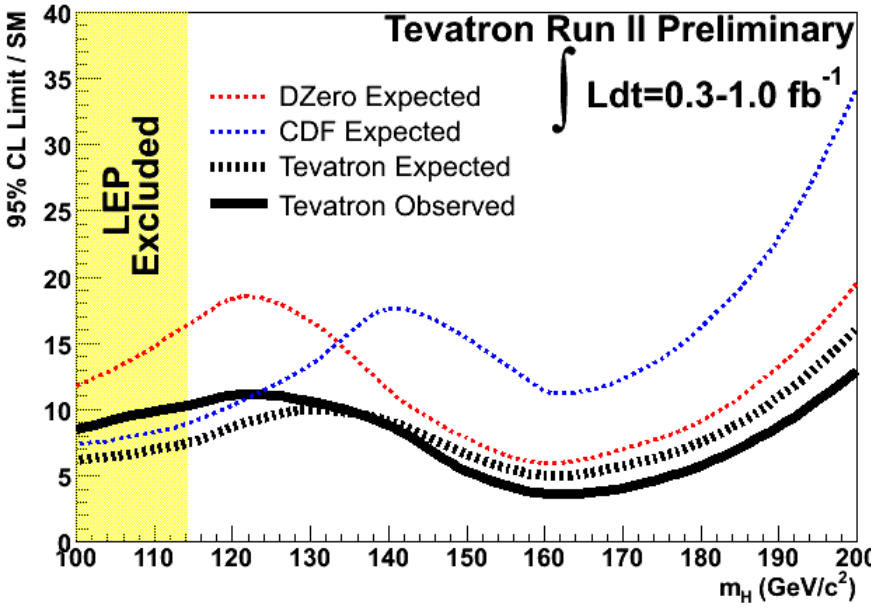
2007: M_H<144 at 95% C.L.





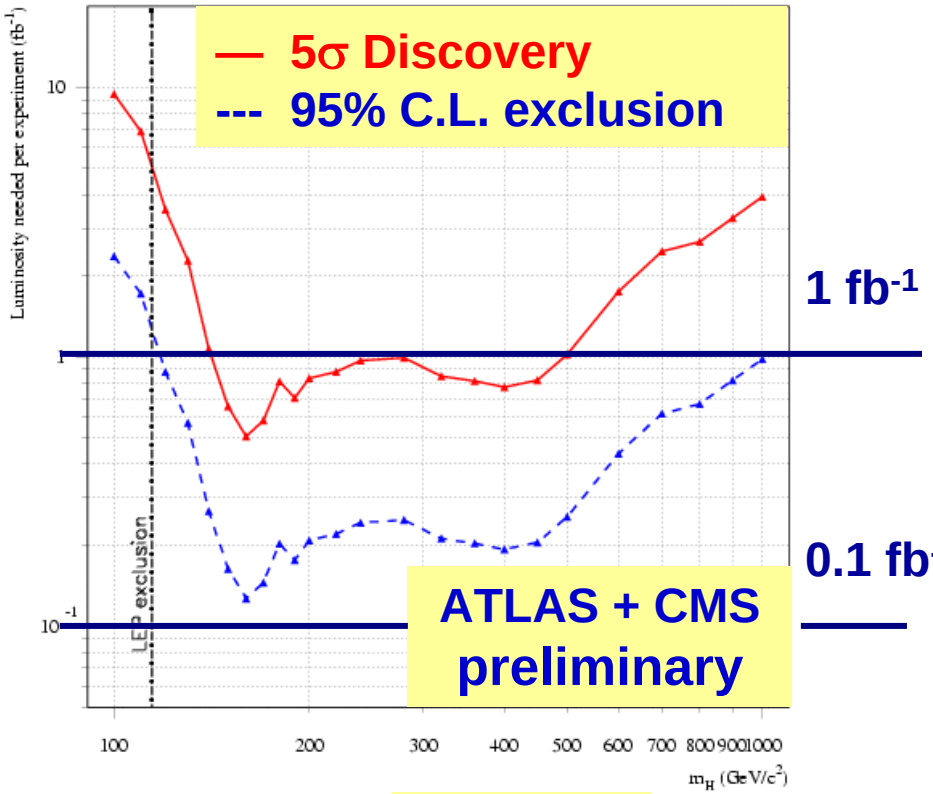
Direct limit from LEP: M_H > 114.4 GeV

Exclusions and discoveries for SM Higgs ...



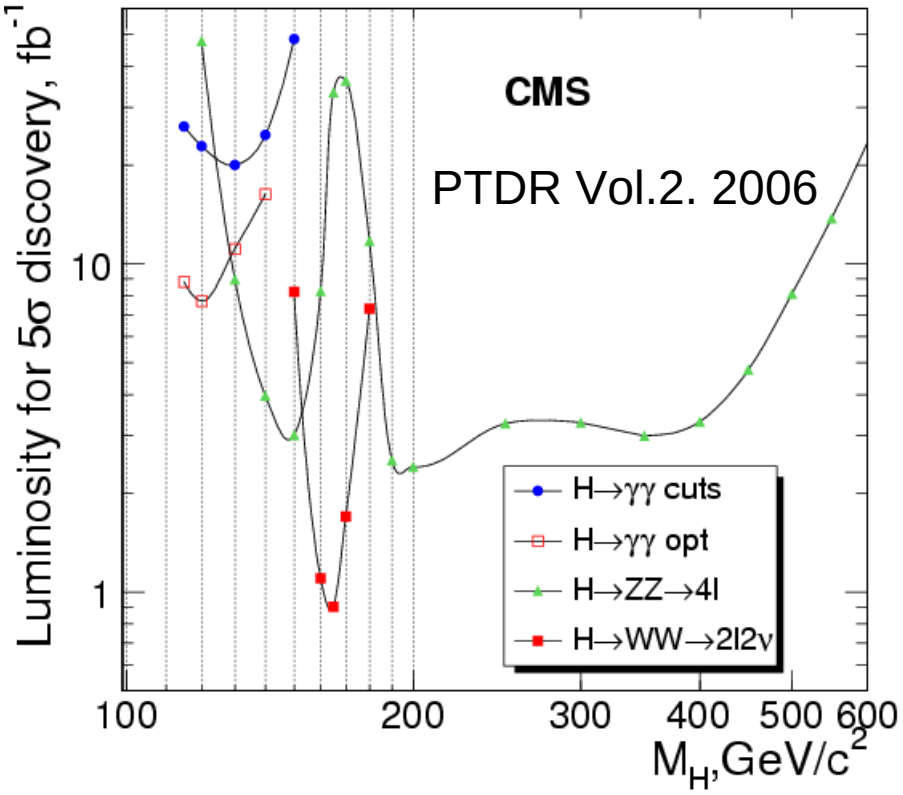
Tevatron 2006: reported on ICHEP06

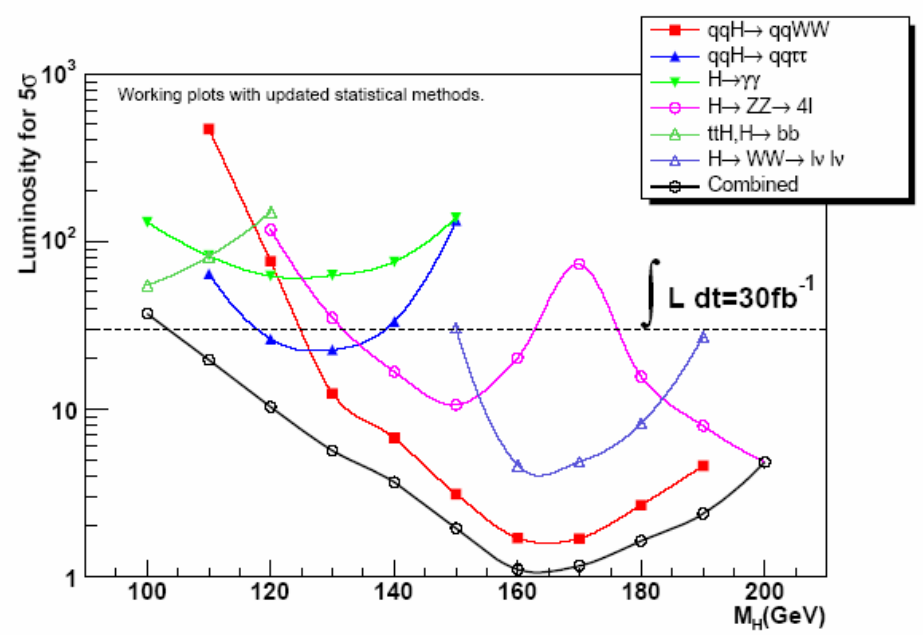
∫ Ldt (fb^{-1}) needed per experiment



m_H (GeV)

ATLAS and CMS SM Higgs physics:
luminosity needed for 5σ discovery

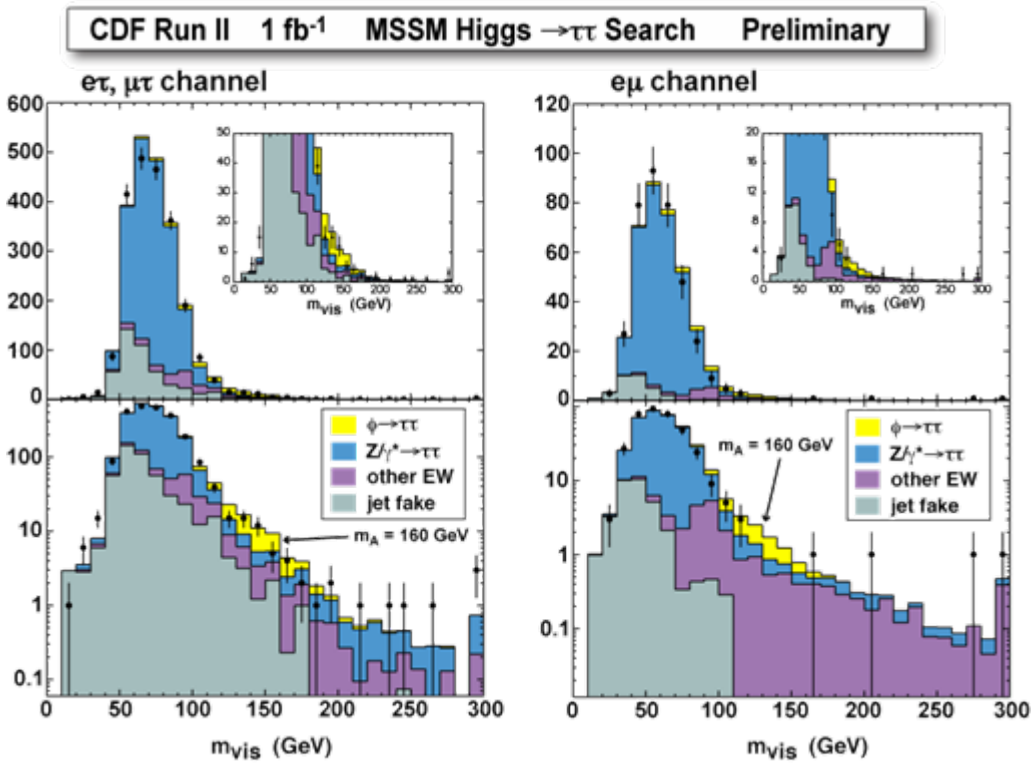


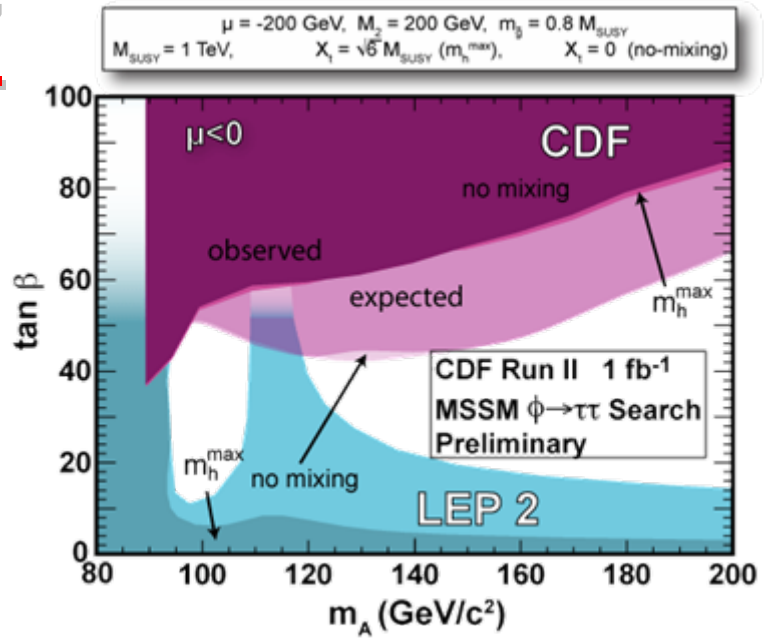


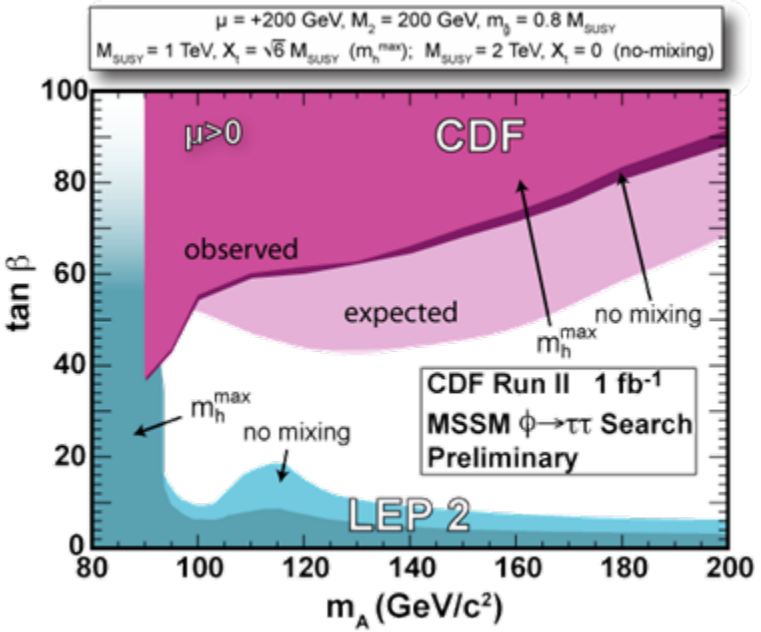
Exclusions for MSSM Higgs: Tevatron 2007

– M_A-tanβ exclusion region in MSSM no mix./m_h^{max} scenarios

From J. Conway talk. Aspen 2007







CMS and ATLAS* Higgs studies this year are mostly concentrated on reach with < 1 fb^{-1} of data

* This statement is only partially true for ATLAS,
M. Schumacher, private communication,
Les Houches dinner, 20th June, 2035

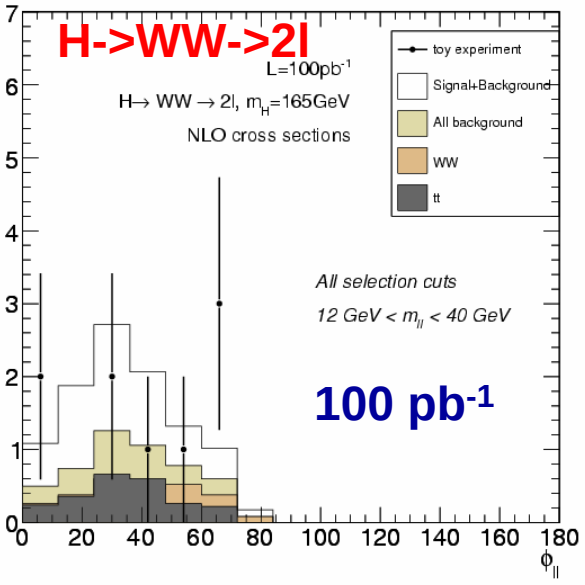
CMS Higgs analyses 2007-08; * = LHCC paper

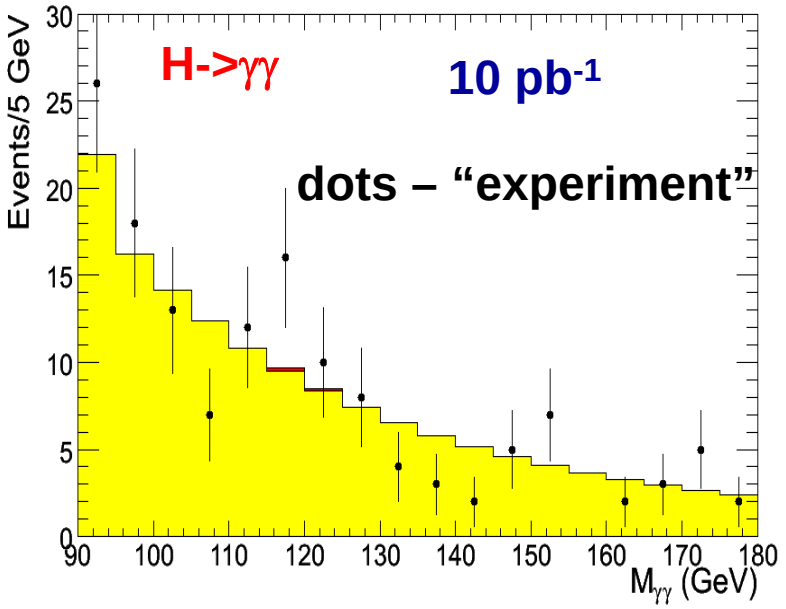
Production	Decay	
SM inclusive	$ZZ^{(*)} \rightarrow 4\,\ell$	07-08*
	$WW^{(*)} \rightarrow 2\,\ell\,2\nu$	07-08*
	$\gamma\gamma$	07-08
SM VBF (qqH)	$\tau\,\tau$	07-08
SUSY, $gg \rightarrow (bb)\phi$	$\mu\mu$	07-08
SUSY, t-> $bH^{\pm}$, gb>$tH^{\pm}$	$\tau\,\nu$	07-08
SUSY gg $\rightarrow$(bb)A/H	$\tau\,\tau$	08
SUSY, qq->qqH	invisible	08
« Other physics in 07 »: NMSSM, CPV, ... < 10 %		

CMS “Higgs plots” for 10 and 100 pb^{-1}

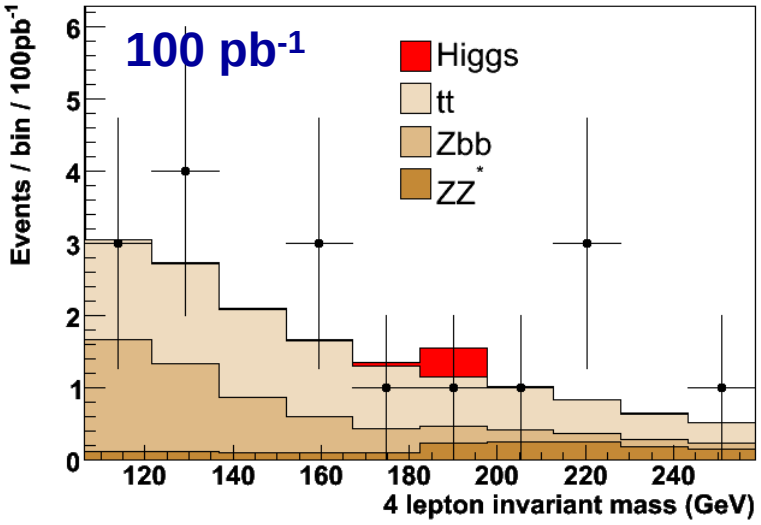
do not propagate !

H->WW->2*l*, H->ZZ->4*l* and H->γγ





H->ZZ->4l

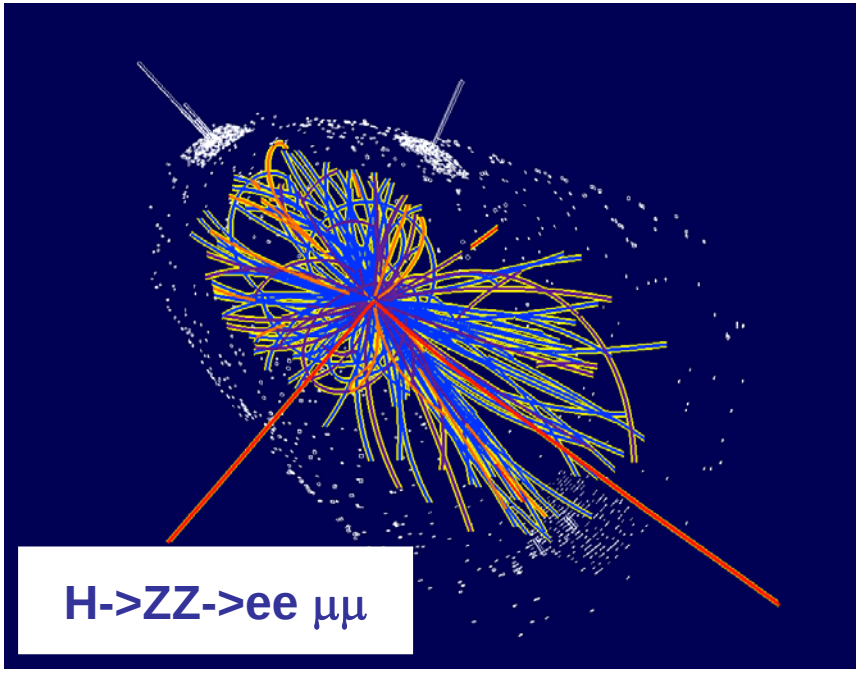


Program for Les Houches; main topics:

- **Understanding high order corrections for signal and background and their impact on the corresponding kinematics**
- **Measurement of the background to Higgs from the data**
- **Higgs rates as signal for physics beyond the Standard Model**
- **Early (< 30-60 fb-1) non SM Higgs signatures in NMSSM, CPV MSSM, Models with extra singlets/triplets,….**

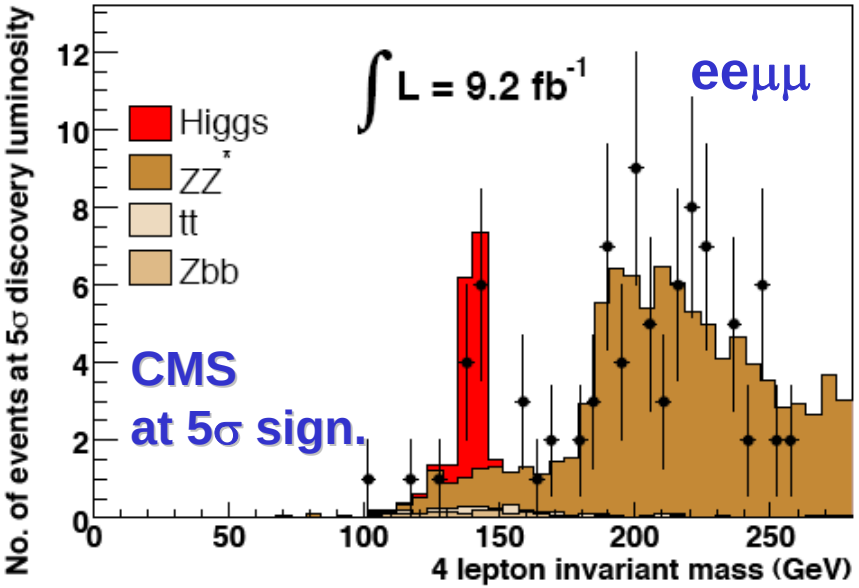
Going through some sub-topics: next slides ….

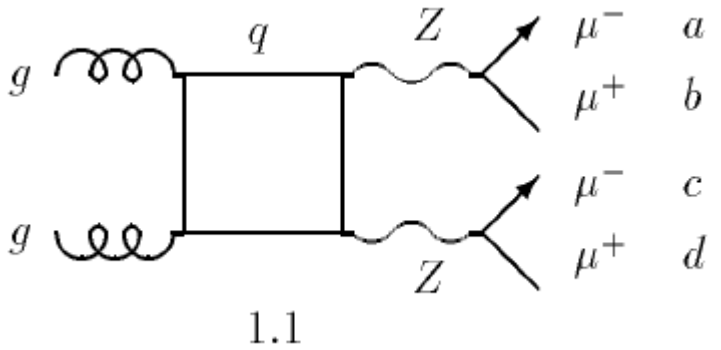
H->ZZ->4l; golden LHC mode



The gg->Z(*)/γ*+Z(*)/γ* generator for H->ZZ(*)->4l analysis is vital

no gg->ZZ generation included

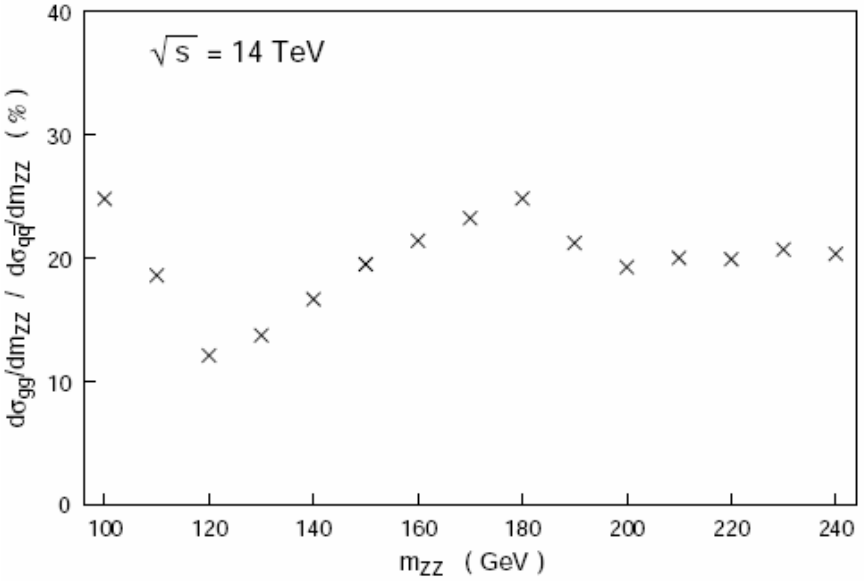




1.1

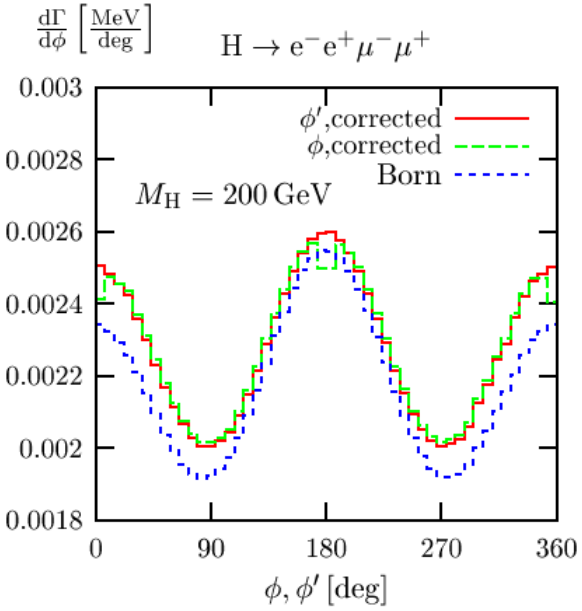
LO(gg->ZZ*->4μ) / LO(qq->ZZ*->4μ) ~ 0.2
J.J. van Der Bij et al. hep-ph/9404295

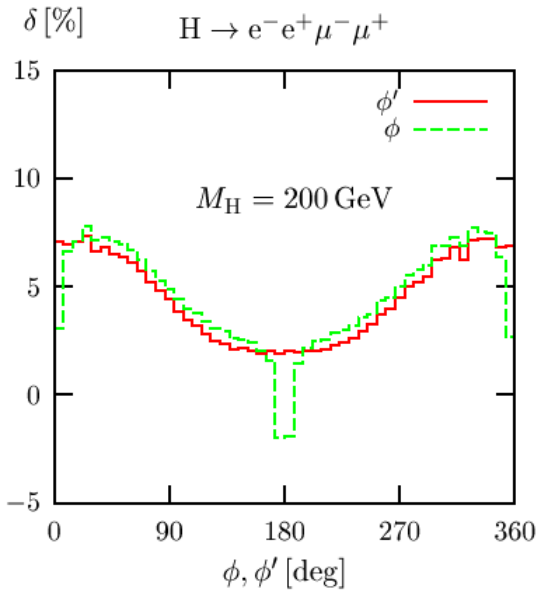
"take in hands" gg->ZZ generator by N. Kauer et al. (1st LH session):
kinematics , comparison with with qq->ZZ, effect on discovery;
D. Giordano (CMS), S. Horvat (ATLAS)

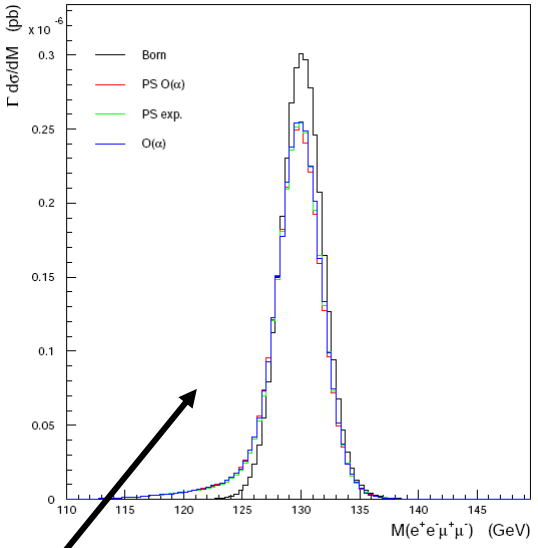


EW corrections to H->ZZ->4l:
“take in hands” PROPHECY4F (S. Horvat, ATLAS)

A. Bredenstein, A. Denner, S. Dittmaier, M.M. Weber
hep-ph/0604011, hep-ph/0611234
Change in angular distributions : important for CP measurement



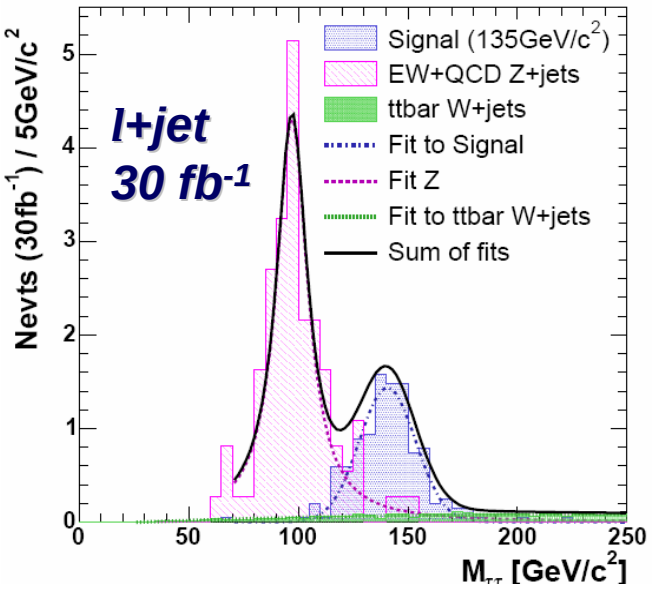




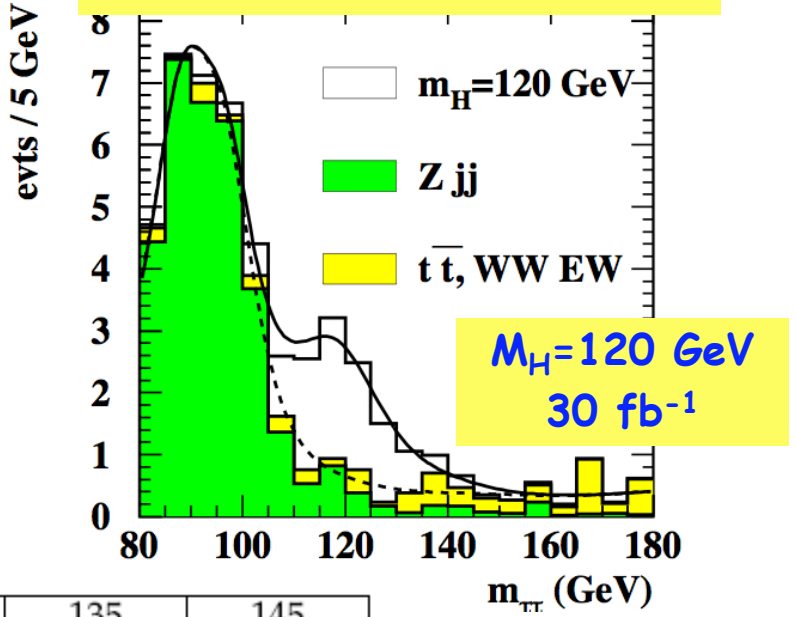
C.M. Carloni Calambe et al. hep-ph/0604033
Effect of QED corrections on Higgs mass measurement

qqH forever !...

CMS, qqH, H->ττ->l+jet, PTDR06
full simulation



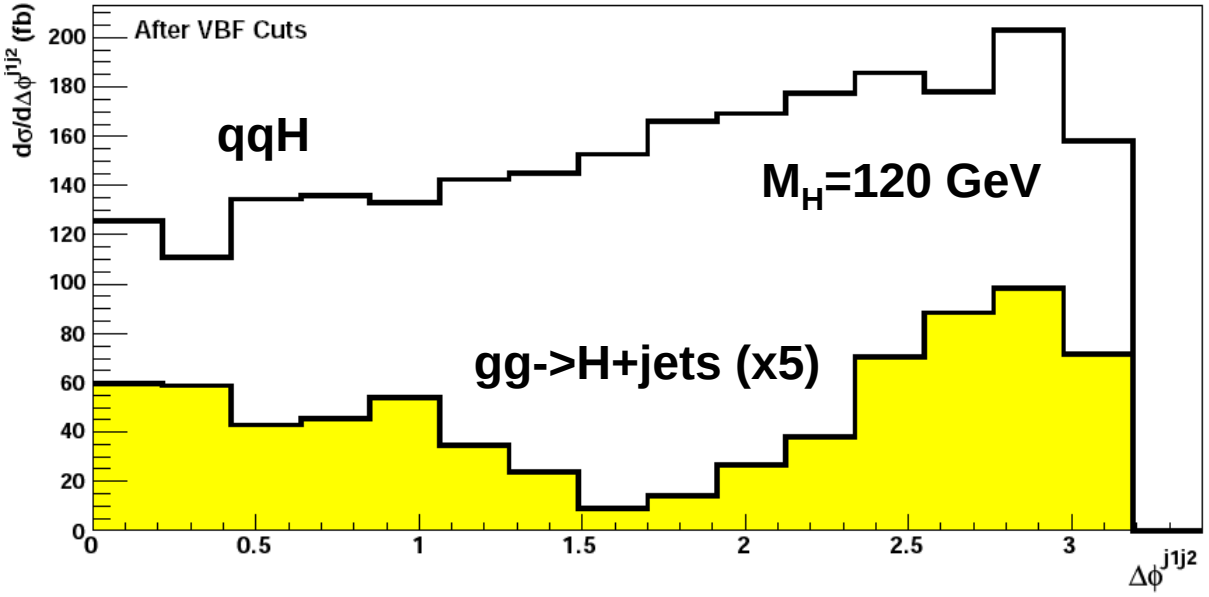
H(→ττ→2l) +≥2jets
ATLAS

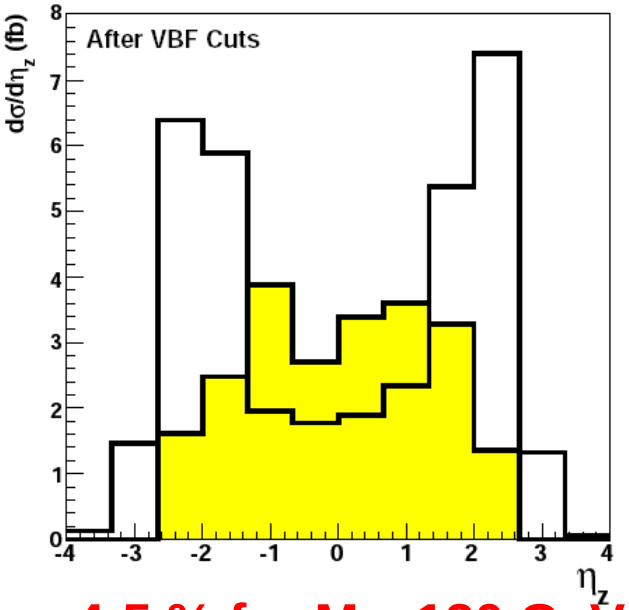


M_H [GeV]	115	125	135	145
Production σ [fb]	4.65×10^3	4.30×10^3	3.98×10^3	3.70×10^3
$\sigma\times$BR(H$\to\tau\tau\to lj$) [fb]	157.3	112.9	82.38	45.37
N_S at 30 fb^{-1}	10.5	7.8	7.9	3.6
N_B at 30 fb^{-1}	3.7	2.2	1.8	1.4
Significance at 30 fb^{-1} (σ_B = 7.8%)	3.97	3.67	3.94	2.18
Significance at 60 fb^{-1} (σ_B = 5.9%)	5.67	5.26	5.64	3.19

gg->H+jj “background” to qqH signal

gg->H+jets with ALPGEN+MLM matching, qqH with PYTHA;
M.V. Acosta and A. Nikitenko arXiv:0705.3585





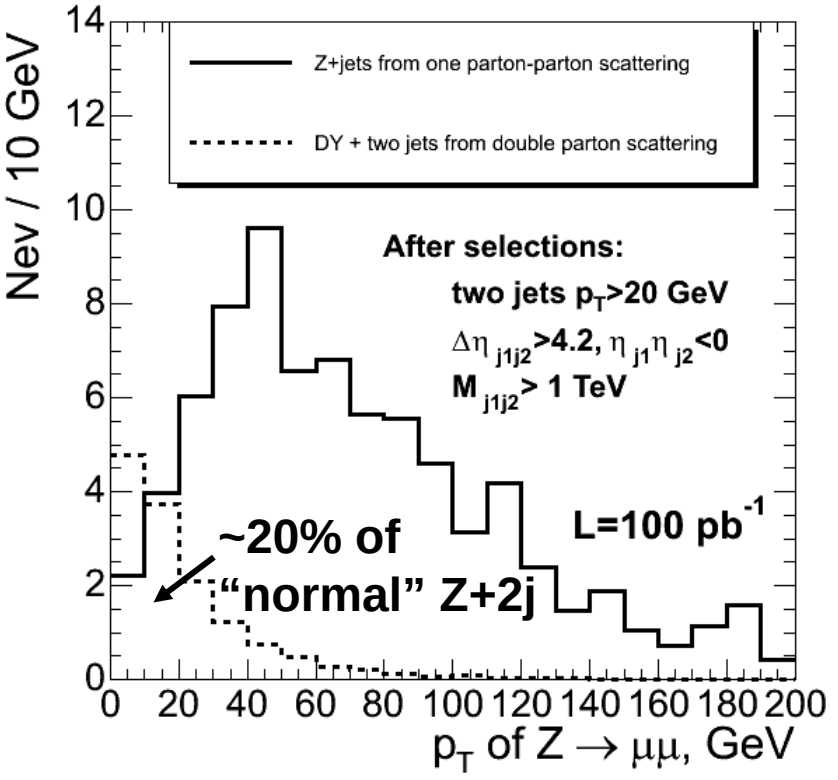
After experimental like selection contribution is ~ 4-5 % for M_H=120 GeV
(see all details Monica’s talk this week)

Continue for heavier Higgs, comparison with NLO ….
with F. Puccinini, D. Zeppenfeld, …

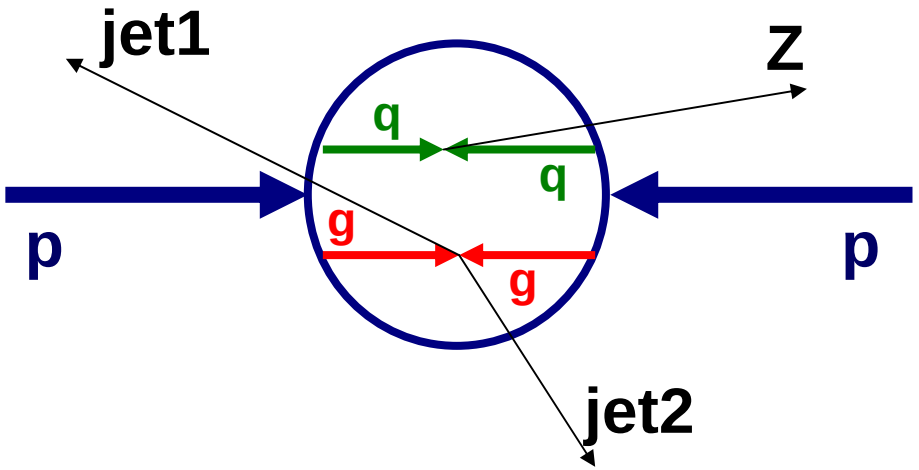
… other qqH related topics

- **Z+2jet background to H->ττ from double parton scattering**
  - Z plus jj , Z+j plus jj (one jet is lost)
    - A. Nikitenko + …
- **Central Jet veto efficiency from data**
  - Z+jj
    - M.V. Acosta, M. Schumacher, …
  - CJV efficiency for signal using single top events
    - M. Schumacher, …
- **Jet veto or track veto ?**
  - A. Nikitenko, … idea is taken from the paper "Rapidity Gaps in Higgs Production" by Yu. L. Dokshitzer, V.A. Khoze and T. Sjostrand. 1991

Z+jets background from double parton scattering
very preliminary
particle level simulation



Hard double parton interactions can produce an additional Z+jets background to qqH, H->ττ signal



$\sigma^{D}_{(A,B)} = (m/2)\,\sigma_A\sigma_B / \sigma_{eff}$, (m=2 for A=Z, B=di-jets)

σ_{eff}=14.5 mb

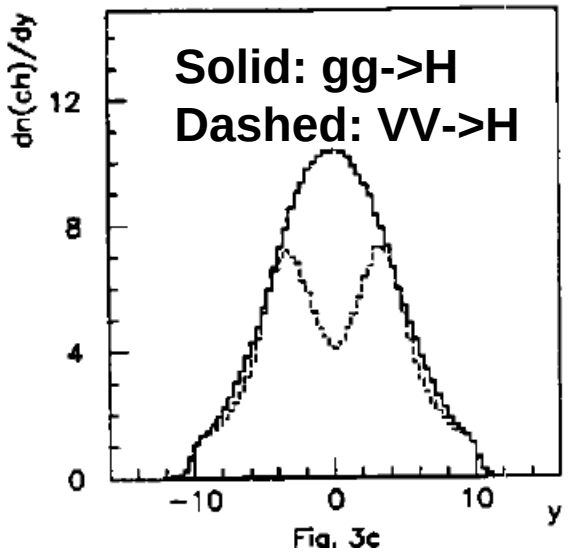
from CDF: F. Abe et al., Phys.Rev. D56 (1997) 3811

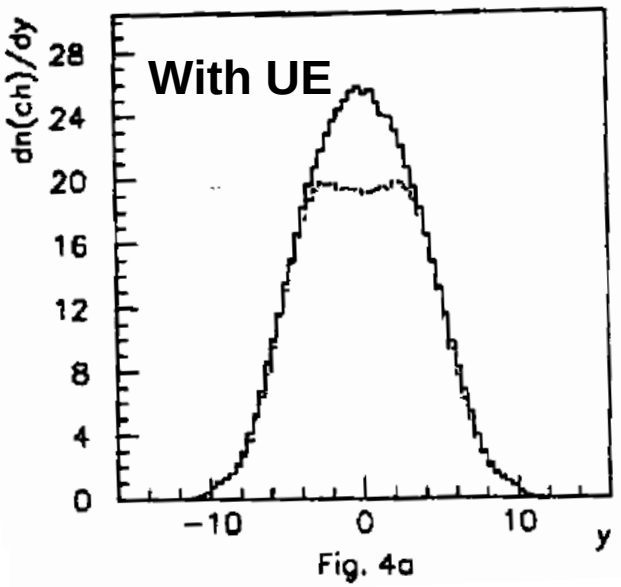
Expectations at LHC: σ_{eff} ~ 20 mb (T. Sjostrand, private communication)

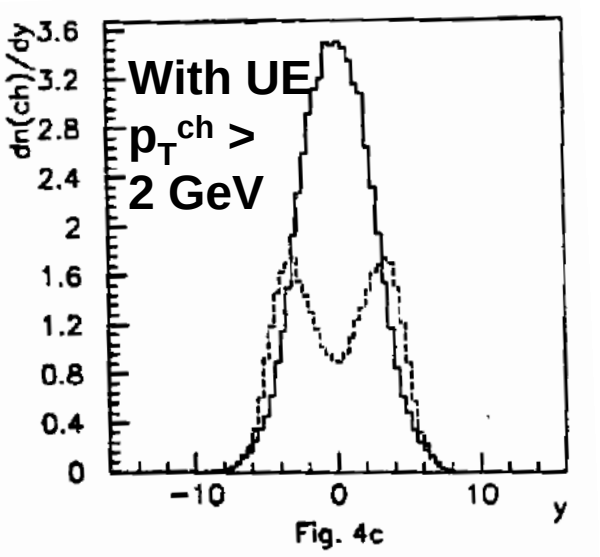
Longitudinal correlations in double-parton PDF can have sizable effect (Snigirev, Korotkikh hep-ph/0404155, Treleani et al. hep-ph/0507052)

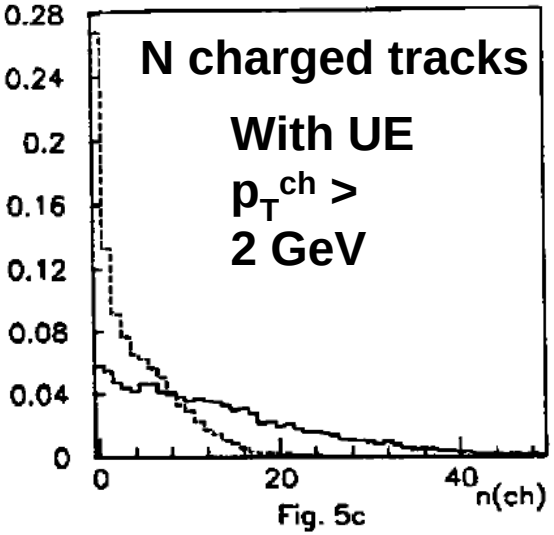
Jet veto or track counting veto ?

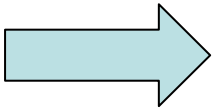
Yu. L. Dokshitzer, V.A. Khoze, T. Sjostrand Phys.Lett., B274 (1992) 116.
plots for M_H=200 GeV at sqrt(s)=40 TeV (!)









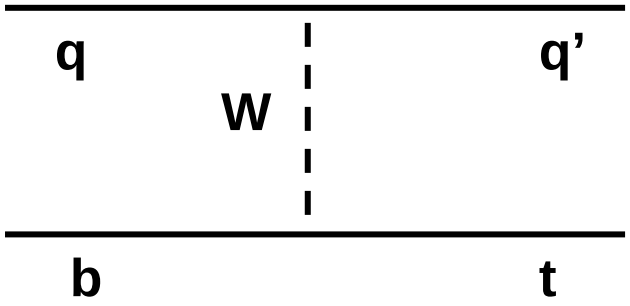


Check with 14 TeV and present model of UE:

what is more efficient and robust. Jet veto or track counting veto ?

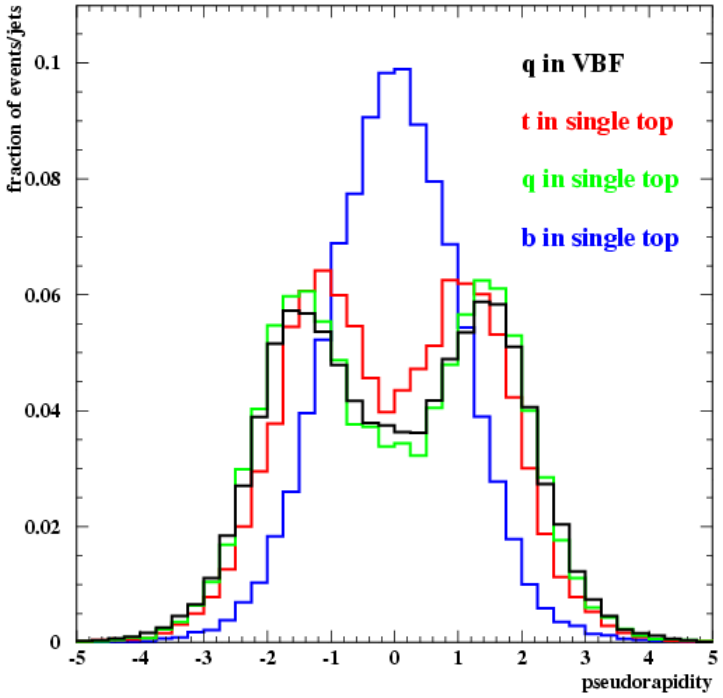
Measure CJV efficiency in qqH signal using single top events

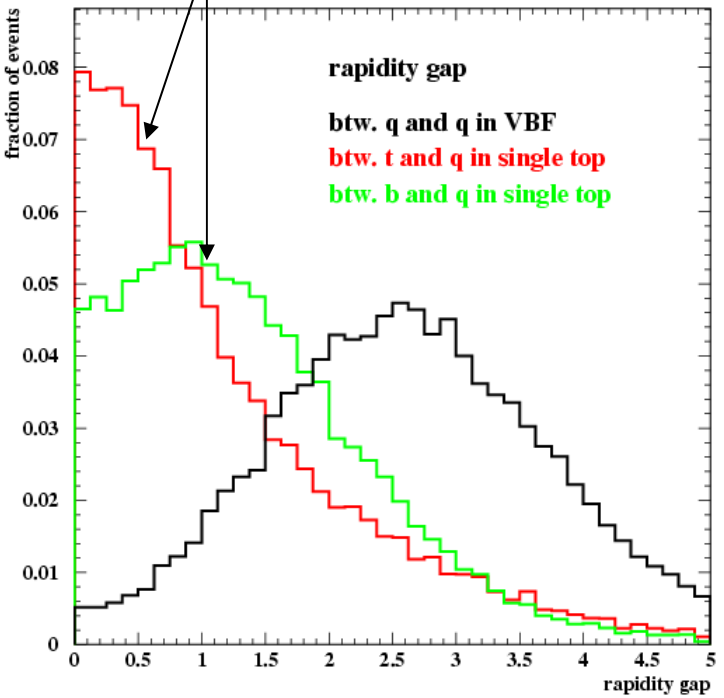
M. Schumacher



No color exchange as in qqH !

Why different from qqH ? Need to be understood





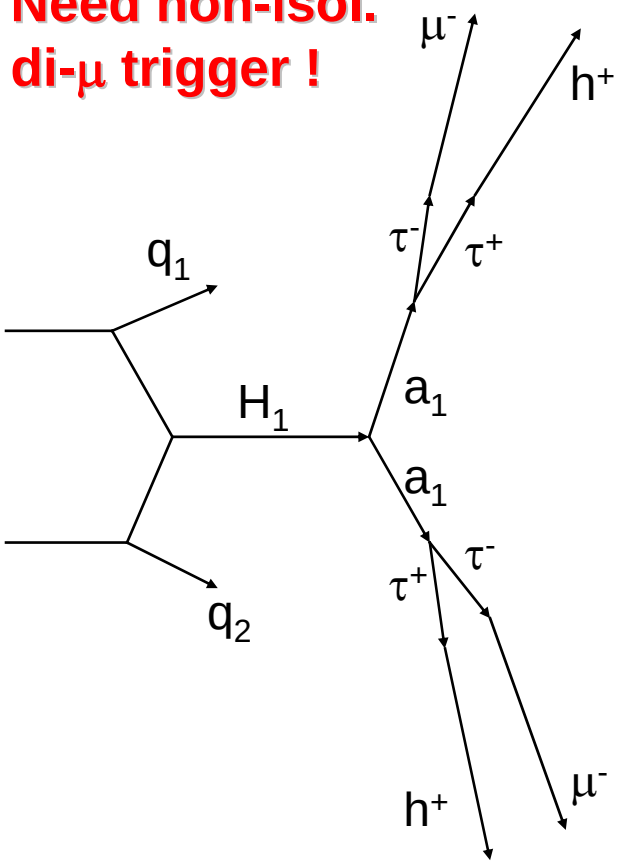
Non SM Higgs physics (at 30-60 fb^{-1})

- **Higgs sector in NMSSM**
  - **S. Lehti, I. Rottlaender, A. Nikitenko, M. Schumacher, C. Shepherd with S. Moretti, M. Muhlleitner, S. Hesselback,….**
- **Light H^+ in CPV MSSM: t->bH^+, H+->WH_1, H_1->bb**
  - **A. Nayak, C. Shepherd (CMS) with R. Godbole, S. Heinemeyer, …**
- **Emphasis on topologies which require:**
  - **New triggers**
  - **Dedicated selections and reconstruction**
- **……**

“Low fine-tuning” NMSSM points

qqH_1, H_1->a_1a_1->$\tau\tau\tau\tau$->$\mu\mu jj$

Need non-isol. di-μ trigger !

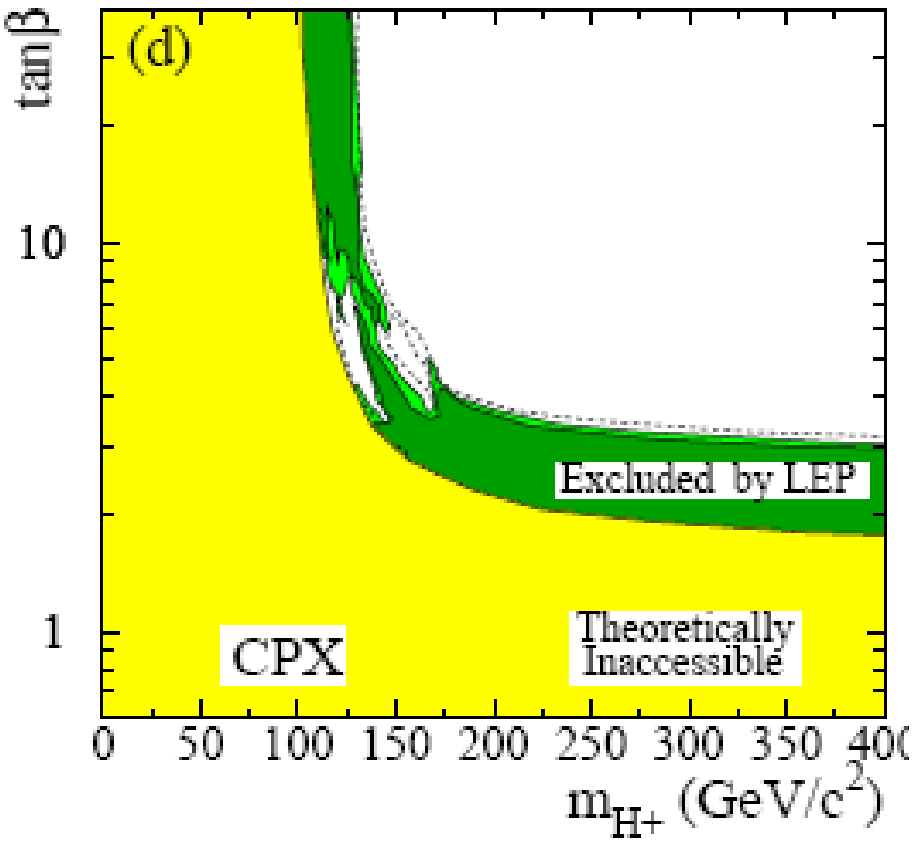


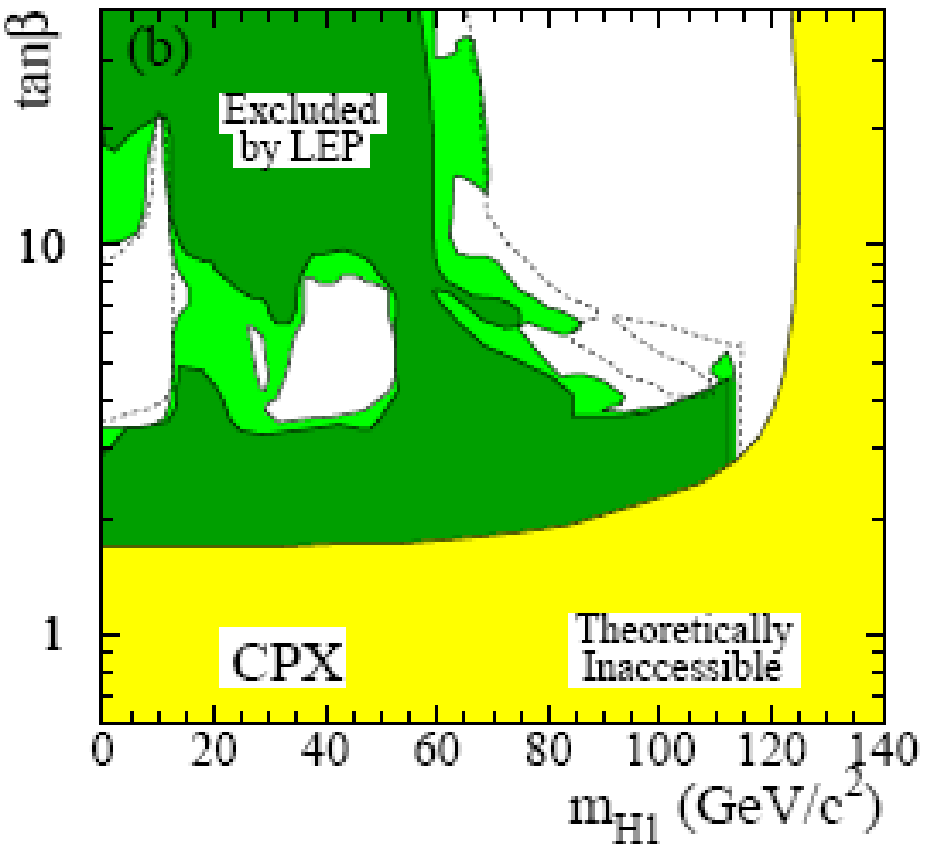
R. Dermisek and J.F. Gunion
See in CPNSH group report
hep-ph/0608079

M_{H_1}/M_{A_1} (GeV)	Branching Ratios		
	$H_1 \to b\bar{b}$	$H_1 \to A_1A_1$	$A_1 \to \tau\bar{\tau}$
98.0/2.6	0.062	0.926	0.000
100.0/9.3	0.075	0.910	0.852
100.2/3.1	0.141	0.832	0.000
102.0/7.3	0.095	0.887	0.923
102.2/3.6	0.177	0.789	0.814
102.4/9.0	0.173	0.793	0.875
102.5/5.4	0.128	0.848	0.938
105.0/5.3	0.062	0.926	0.938

This point is taken for analyses with 4τ->$\mu\mu jj$ final state (CMS): qqH_1 and WH_1 (motivated by S. Moretti et al. hep-ph/0608233)

The H^+ in CPV MSSM



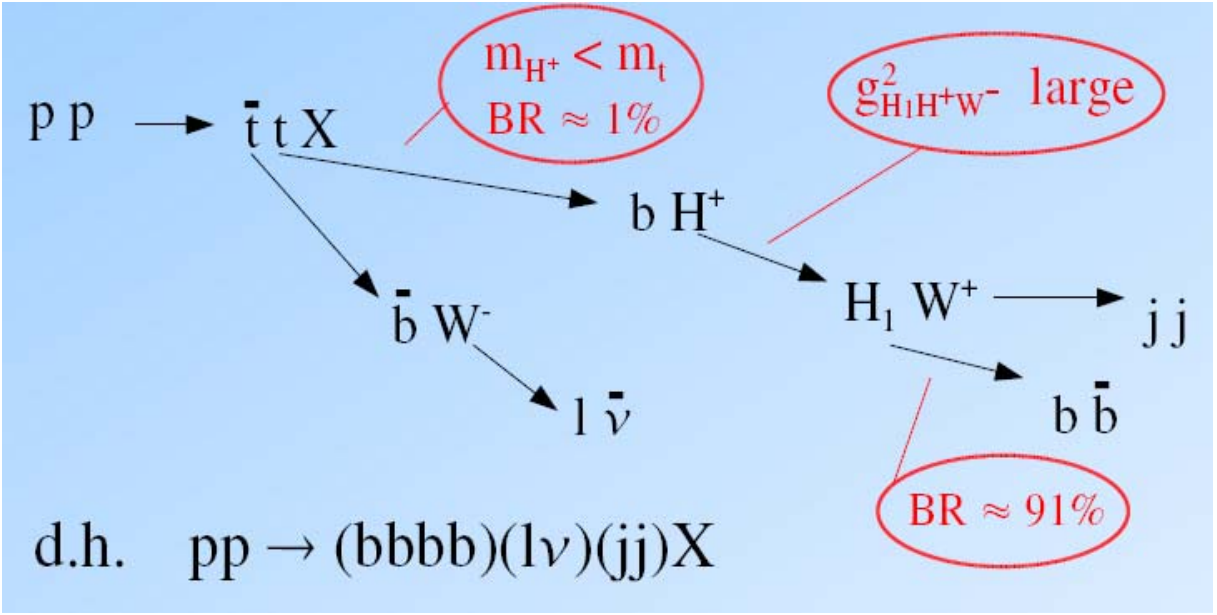


LEP Higgs working group, hep-ex/0602042), M_t=174.3 GeV
present M_t=170.9 +/- 1.8 GeV

most promising channel to close the hole is : tt→ bW bH$^+$, H$^+$→W H_1, H_1→bb final state: 4b 2j l is same as ttH, H→bb !

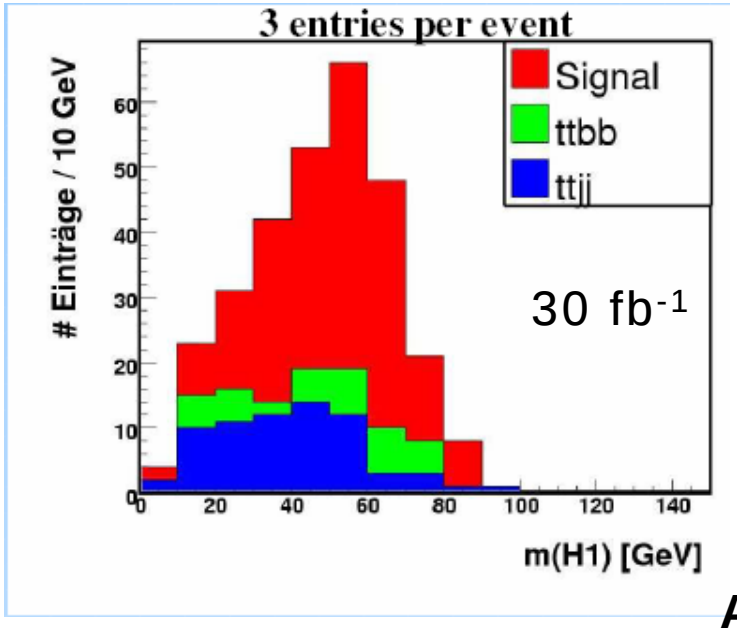
D.K. Ghosh, R.M. Godbole and D.P. Roy, Phys.Lett. B628, 131 (2005)

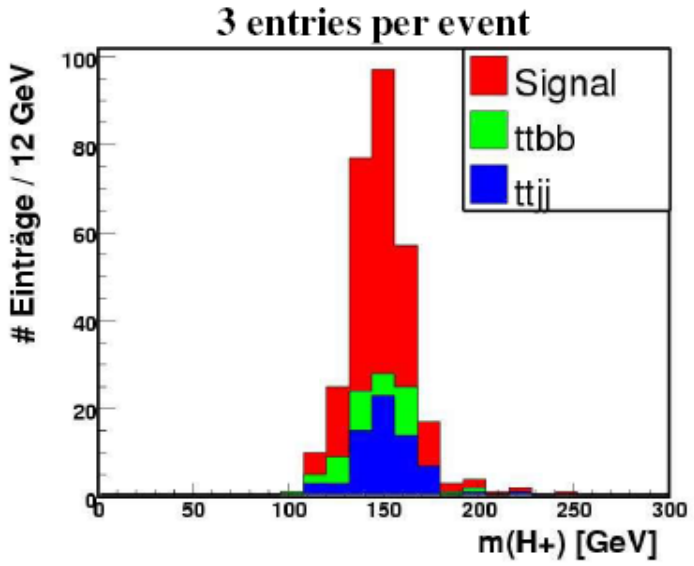
$tt \rightarrow H^+bWb, H^+ \rightarrow WH_1, H_1 \rightarrow bb$ (Marc Lehmacher, ATLAS)



reconstruction of top quark 4-momenta

3-fold ambiguity in assigning b quarks to H boson decay



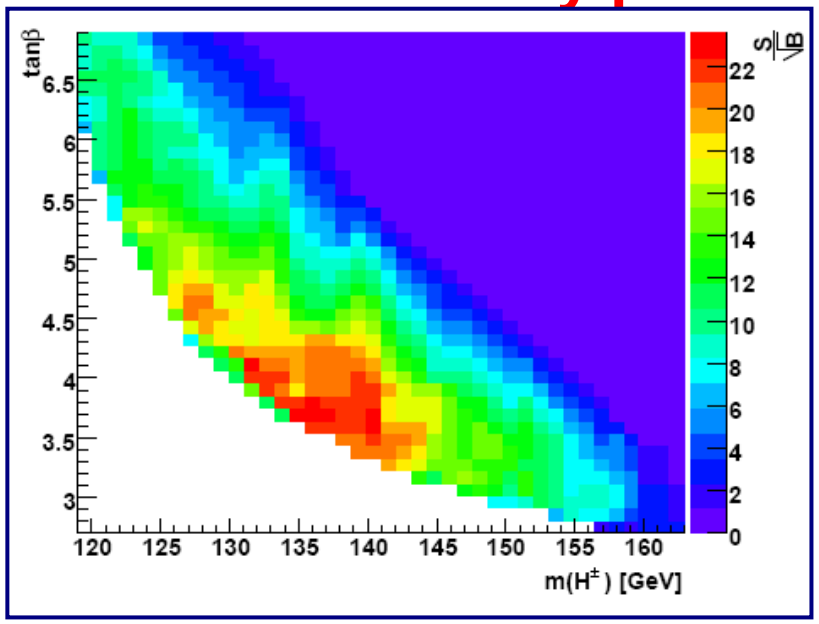


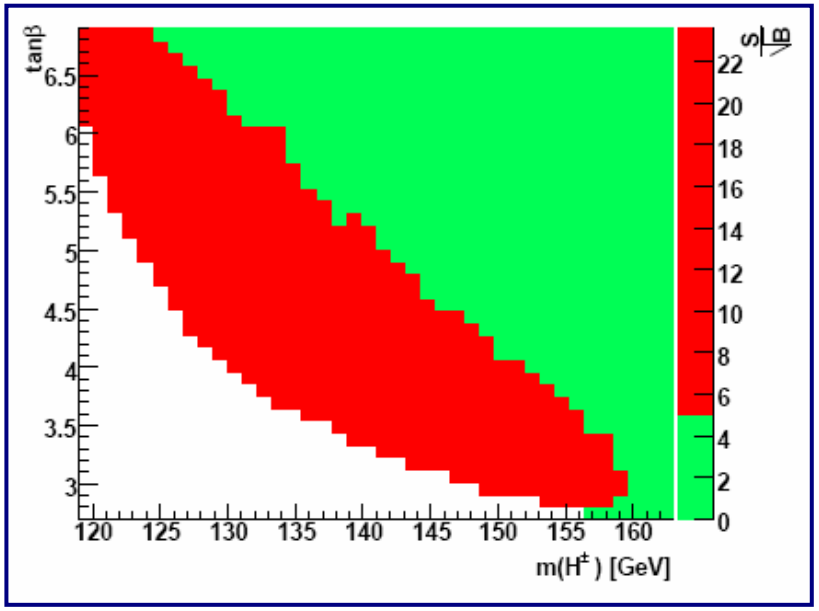
$m_{H^+} = 135$ GeV
$m_{H_1} = 54$ GeV
$\sigma = 1{,}3$ pb

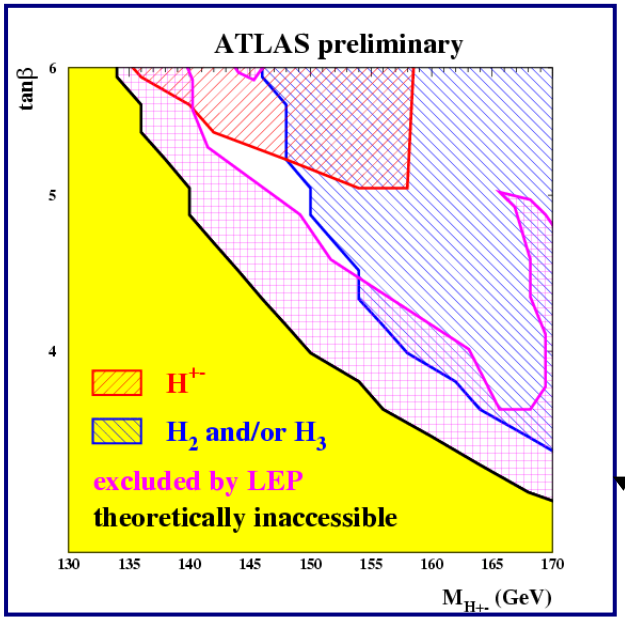
$$\frac{S}{\sqrt{B}} \approx 11$$

ATLASFAST

ATLAS: discovery potential in CPX scenario with 30 fb^{-1}







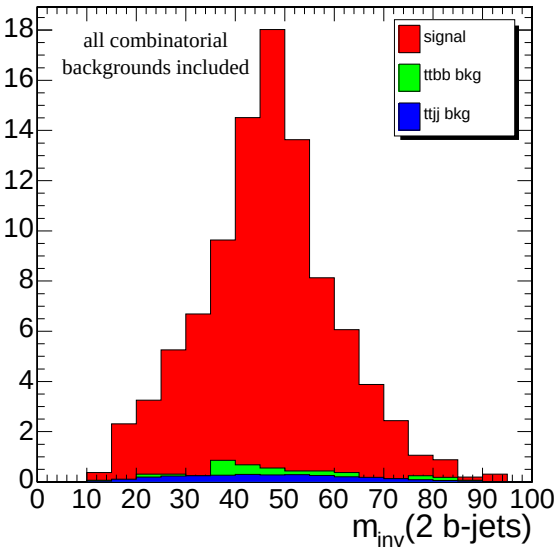
- seems quite promising to cover one of the holes
- to do: systematic uncertainties optimisation of selection

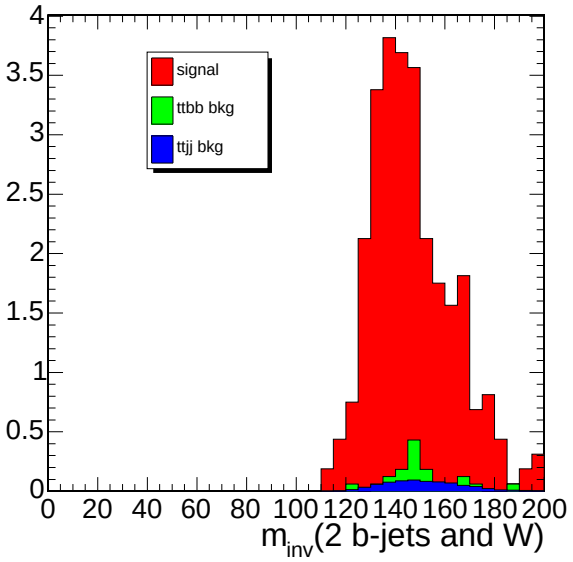
ATLAS scan in CPV MSSM:
M. Schumacher, published in CPNSH proc.

CMS study is on going:
A. Nayak (TIFR) + C. Shepherd, J. Cole (RAL)

The major background to 2 b-jet invariant mass comes from the combinatorial backgrounds which may make the distribution very wide and have long tail. But a clear peak on top of it helps to chose the correct b-jet pair for the H^+ reconstruction.

30 fb^{-1}; PYTHIA particle level plots, assuming ε_b=0.5, mistagging 0.01.



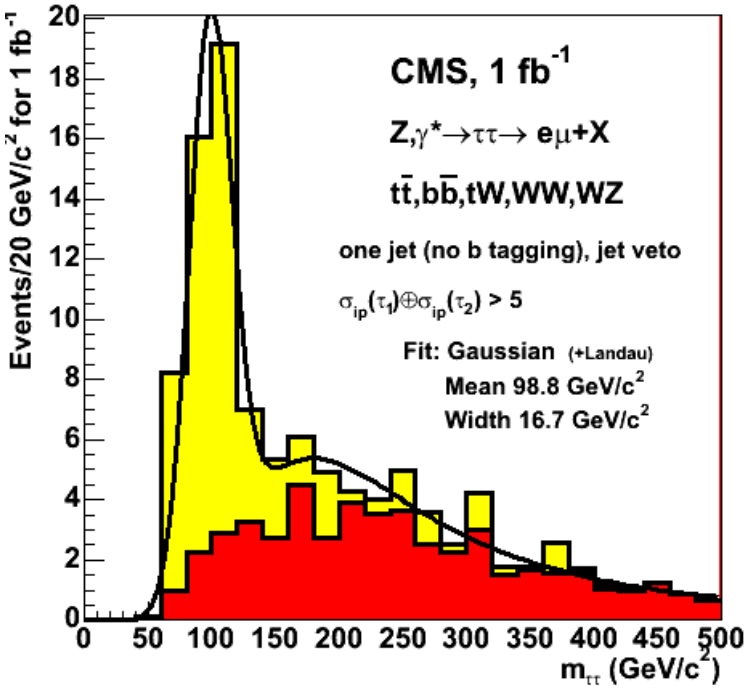


Full detector simulation and trigger is on the way.
Makes things much worse …

First Higgs WG
“kick off” meeting today
15.00 in Auditorium

THE END

- **Example II: Z->ττ as benchmark for H->ττ**
  - **Rescaling from 30 fb^{-1} studies by S. Lehti CMS Note 2006/101 A. Kalinowski + A.N. CMS Note 2006/074**



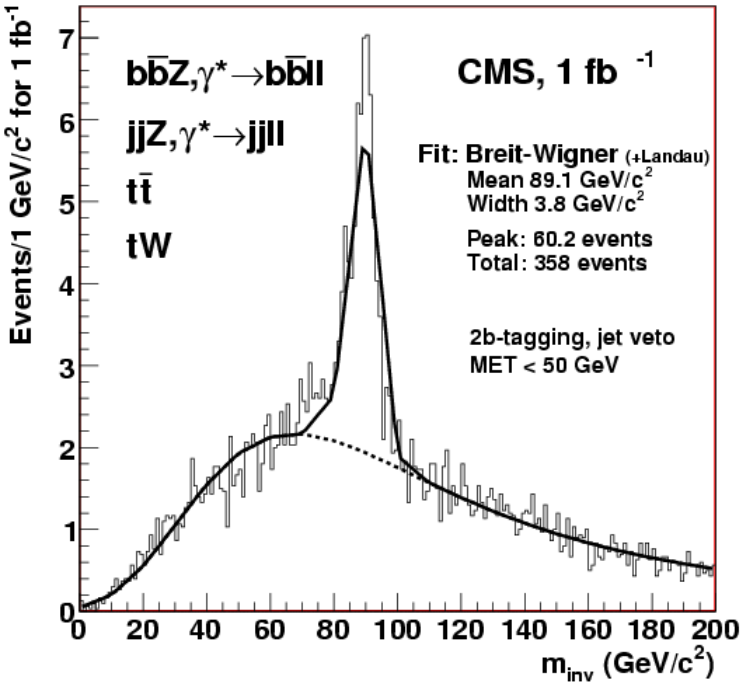
Expected at 1 fb^{-1} after selections:

- **~ 40 Z->ττ->e+μ**
- **~ 35 Z->ττ->μ+j (17% bkg)**

- **Example III: bbZ, Z->*ll* as benchmark for bbA->ττ (and bkg. H->ZZ->4l, …); gb->bZ(A) vs gg->bbZ(A)**
  - **Rescaling from 30 fb^{-1} studies by S. Lehti CMS Note 2006/101**

Expected at 1 fb^{-1} after selections with double b tagging:

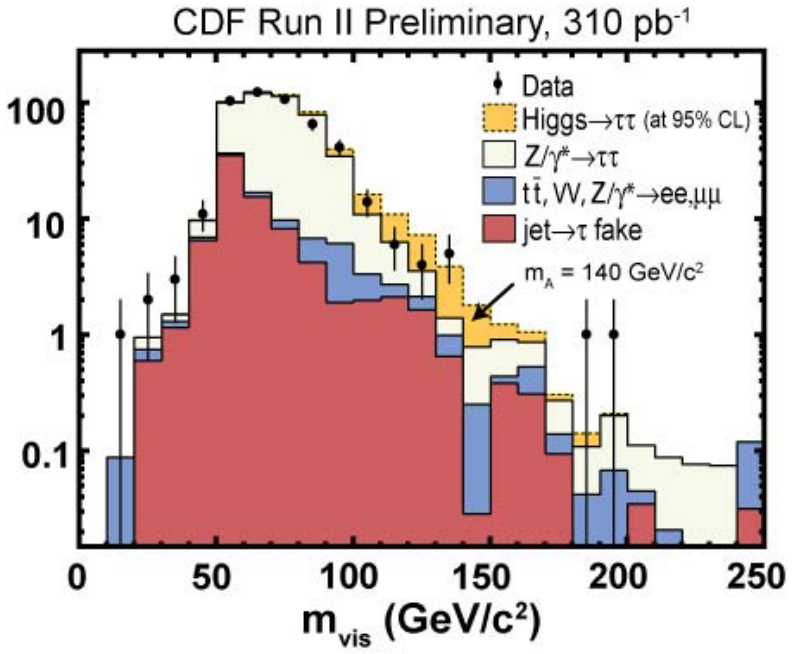
- **~ 25 bbZ, Z->ee+μμ**
- **Bkg: 4 DY + 7 tt~**



Z->ττ: Tevatron (CDF) vs LHC (CMS)

- **CMS expects ~ 40 events at 1 fb^{-1}; rescaling from 30 fb^{-1}**
  CDF got already ~ 400 events with 310 pb^{-1} ! Why ?
  - *obvious reasons:*
    - *Softer cuts on p_T^l and p_T^τ*
      - 10, 15 GeV vs. 20, 45 GeV
      - M_{vis} vs M_Z reco
    - *But CMS has better S/B after sel.*
      - 6.0 (CMS) vs 4.5 (CDF)
- **LHC has less favorable S/B than Tevatron:**
  - HLC/Tev(Z) ~ 7.5*
  - LHC/TeV(W) ~ 7.5*
  - LHC/TeV(tt~) ~ 120**
  - HLC/TeV(bb~$_{incl}$) ~ 10***

hep-ex/0508051, Z->e/μ + jet



- 405 events Z->*l*+jet
- 75 events W+jet + bb~
- 16 events tt~, VV, Z->μμ,ee

* J. Stirling talk at Tev4LHC, ** D. Rainwater et all, hep-ph/0303092, *** E. Norrbin, T. Sjostrand EPJ, C 17, 137-161 (2000)