# Low mass Higgs search with ATLAS

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on behalf of the ATLAS collaboration

Parallel session EW symmetry breaking

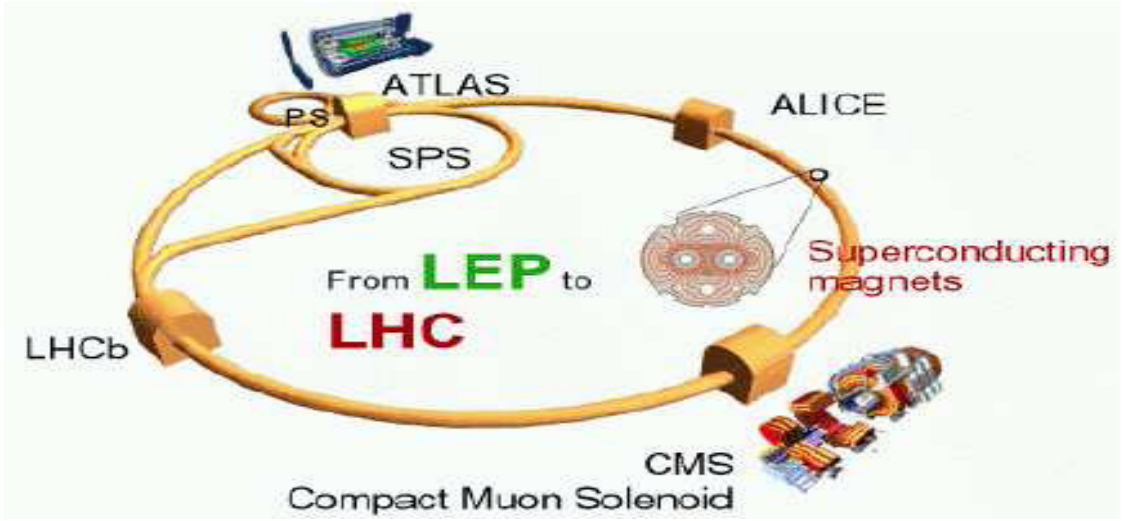
DPF meeting

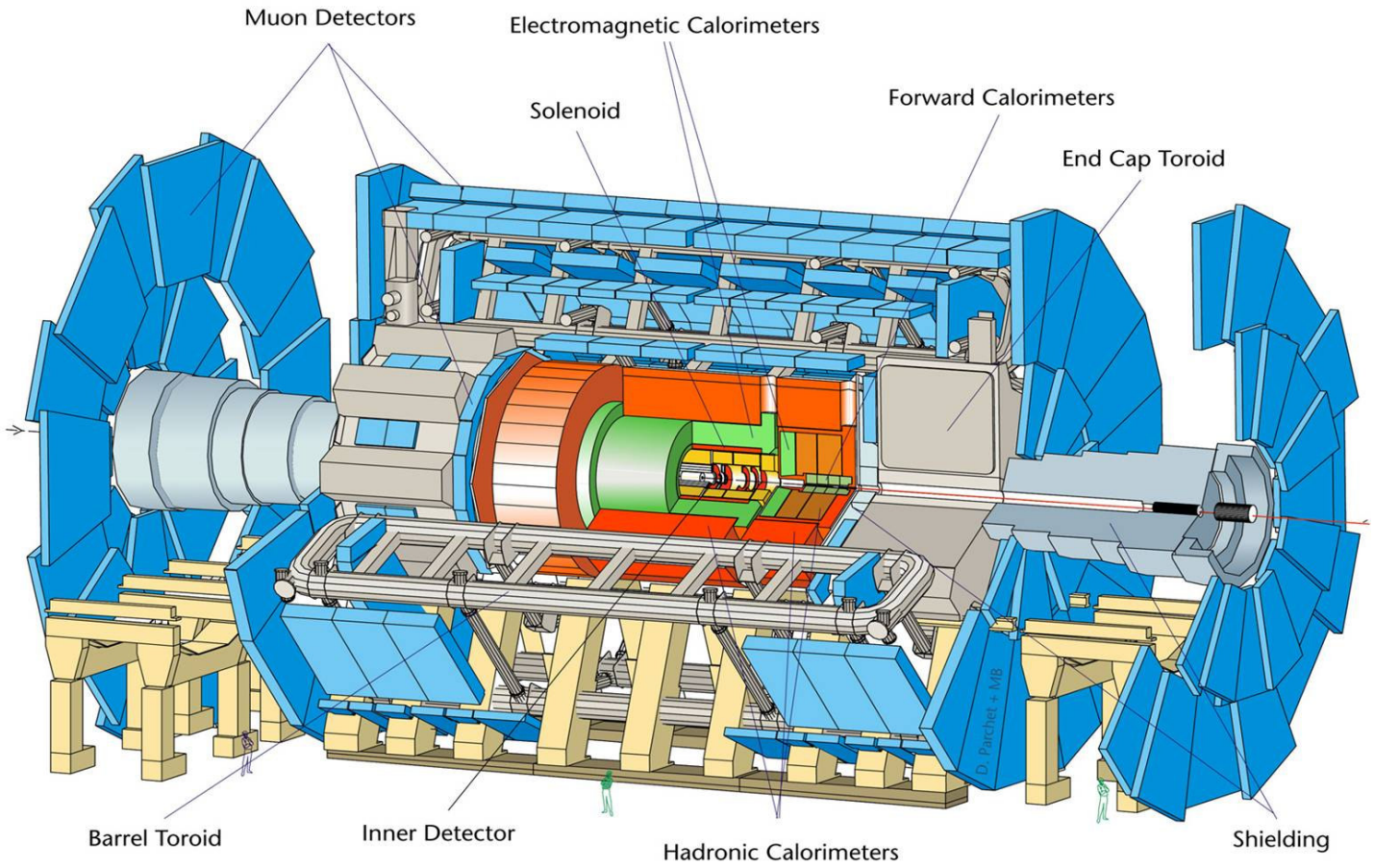
Riverside, August 26-31 2004

# Outline

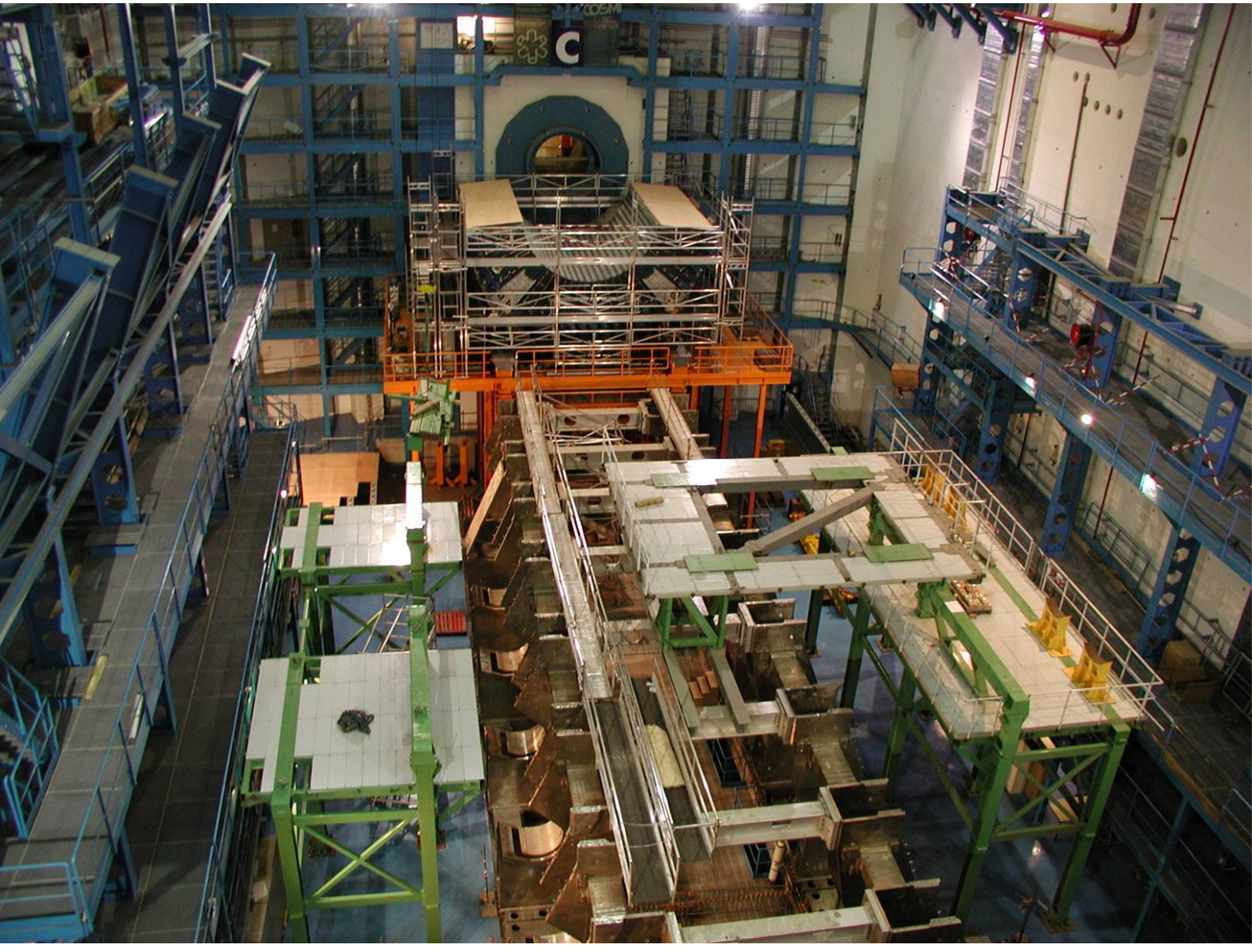
- LHC and ATLAS
- SM Higgs production and decays at LHC
- SM Higgs searches :
  - ✓ *gg* fusion → $\gamma\gamma$ , *zz**, *ww**
  - ✓ vector boson fusion (VBF) → *ww**, $\tau\tau$
- SUSY Higgs searches
- Higgs measurements

# LHC and ATLAS



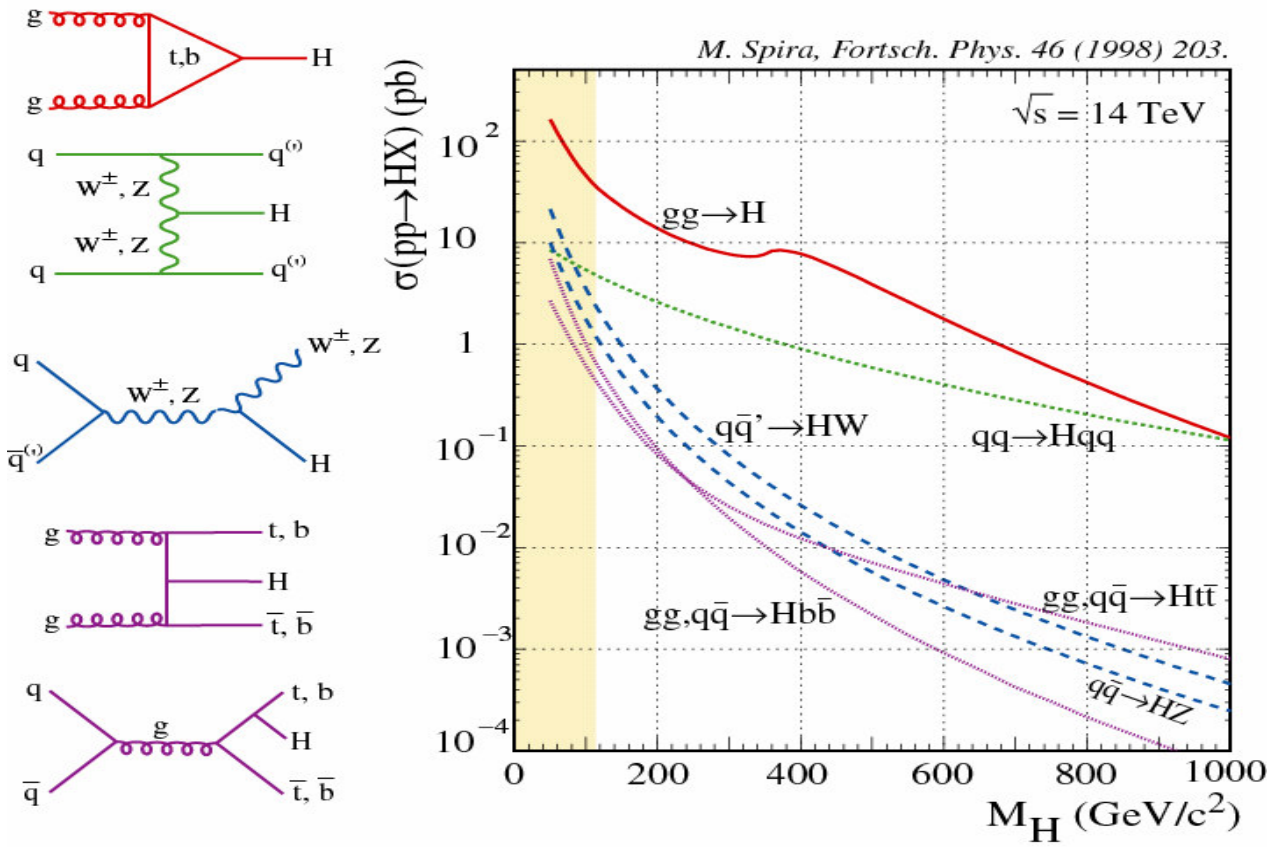



# ATLAS cavern, 22nd June

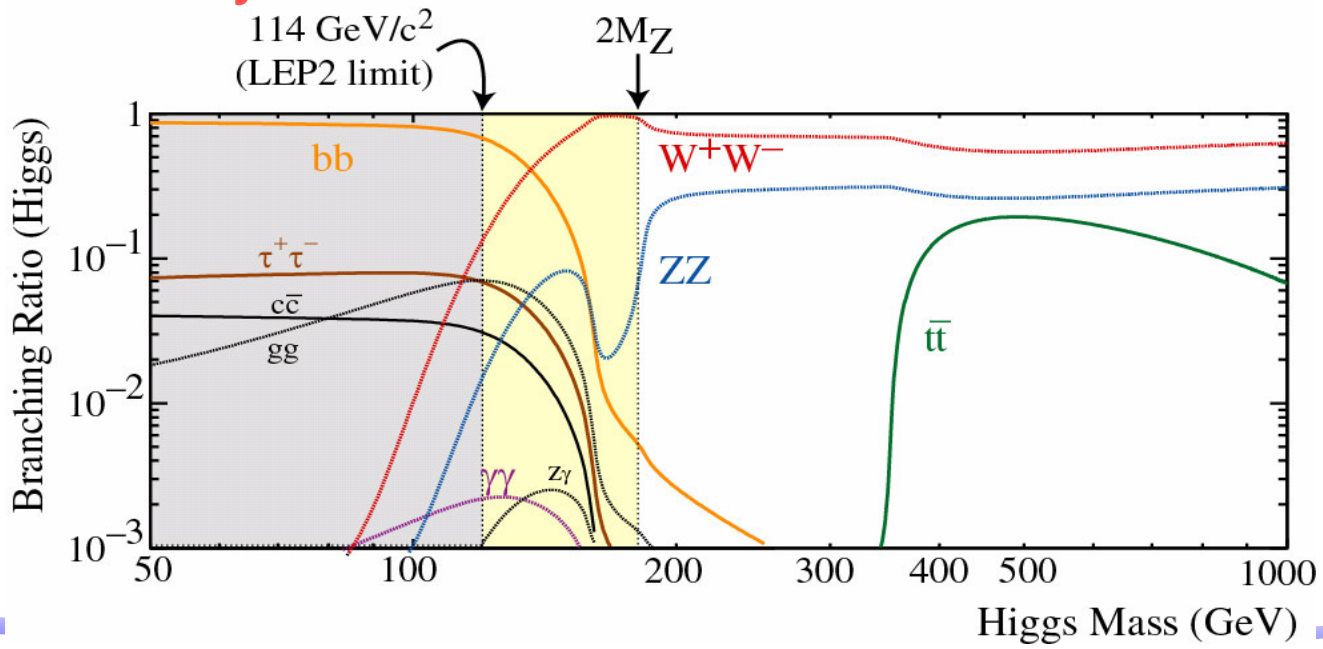


# SM Higgs at LHC

## Production :

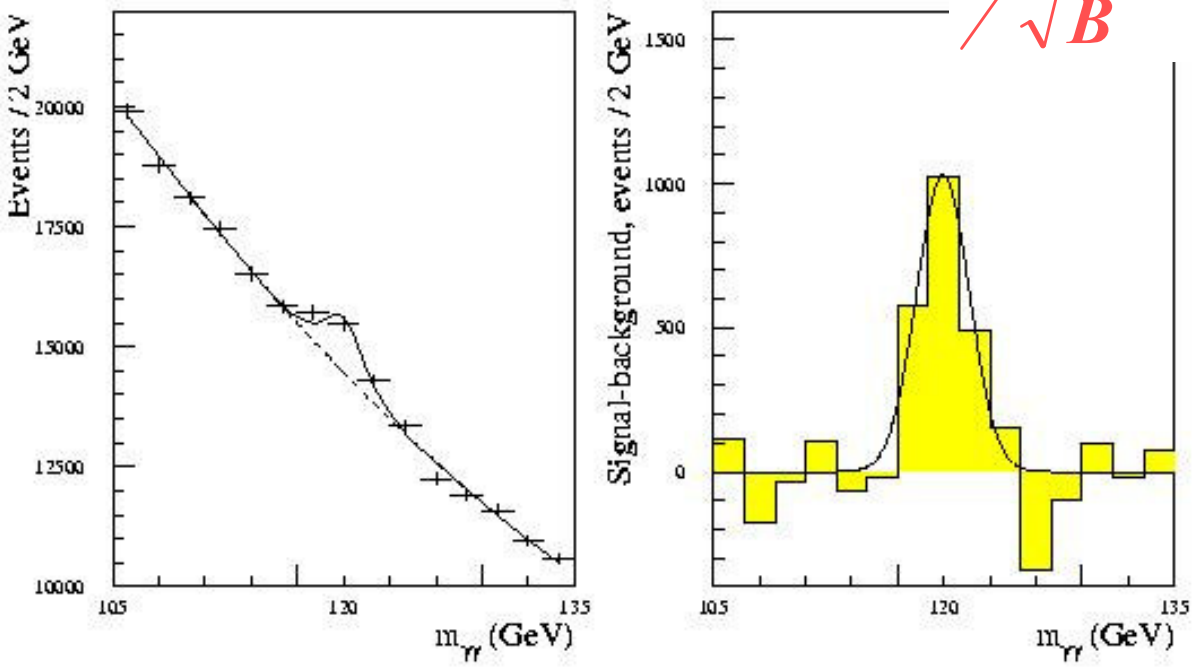



## Decay :



# $gg \rightarrow H \rightarrow \gamma\gamma$

- $H \rightarrow \gamma\gamma$ very low BR but very distinct final state, promising at low mass
- backgrounds :
  - ✓ irreducible : $\gamma\gamma$ production
  - ✓ reducible (mis-id) : jet-jet, $\gamma$-jet, $\gamma^*/Z \rightarrow ee$
- ➔ requires :
  - ✓ very good EM calorimeter performance
  - ✓ excellent $\gamma/jet$ and $\gamma/e$ rejection
- $m_H = 120$ GeV, $\mathcal{L} = 100$ fb$^{-1}$ ➔ $S/\sqrt{B} = 6.5$ :

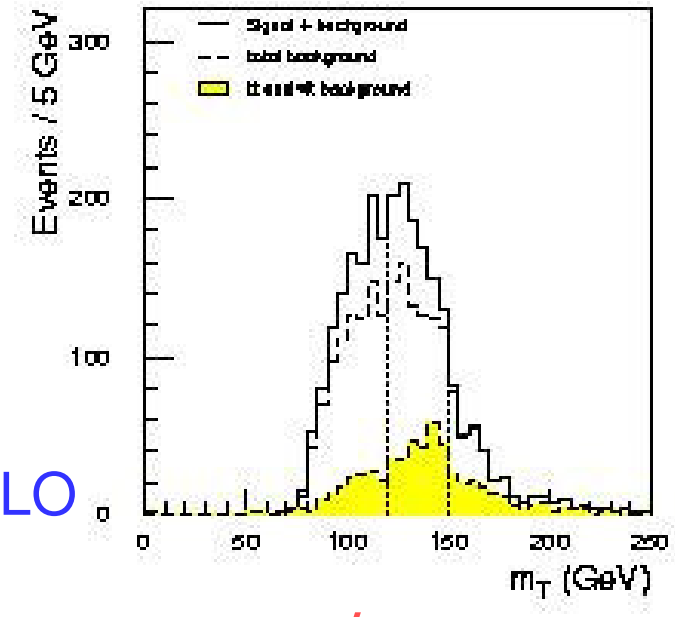


# $gg \rightarrow H \rightarrow ZZ^{(*)}, WW^{(*)}$

- $H \rightarrow ZZ^* \rightarrow 4l$ ($l = e$ or $\mu$) :
  - ✓ very clean signature
  - ✓ backgrounds :
    - irreducible : $ZZ^*$ or $Z\gamma^*$ production
    - reducible : tt, Zbb, $ZZ \rightarrow ll\tau\tau$
  - ✓ sensitivity recently improved by Neural Network analysis by ~20%
  - ✓ $H \rightarrow ZZ^* \rightarrow ee\tau\tau$ under investigation

- $H \rightarrow WW^* \rightarrow l\nu l\nu$ ($l = e$ or $\mu$) :
  - ✓ less clean but dominant
  - ✓ transverse $m_H$ reco
  - ✓ backgrounds:
    - irreducible: WW* ,$WZ^{(*)}$, $ZZ^{(*)}$
    - reducible: tt, Wt, Wbb, bb, W+jets
  - ➔ recently estimated @NLO

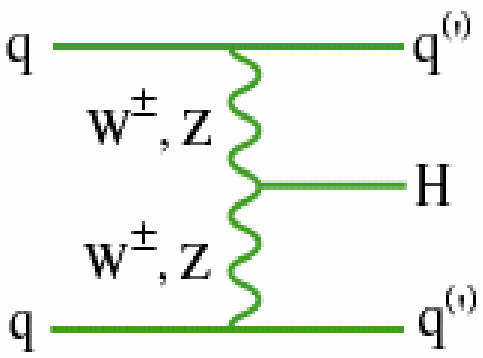
$m_H$ =150 GeV, $\mathcal{L}$ = 30 fb$^{-1}$



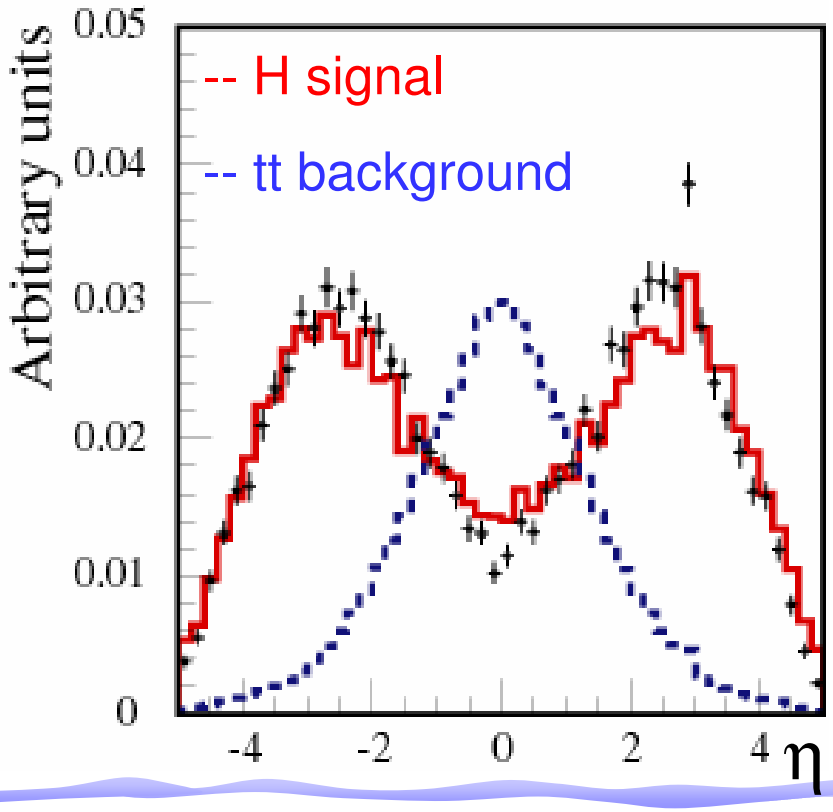

- ➔ requires very good leptons and $\not{E}_t$ reco

# VBF production

- for $m_H < 2m_Z$, VBF ~ 20 % of total production
- distinct final state :
  - ✓ 2 very forward high Pt jets
  - ✓ no central jet activity

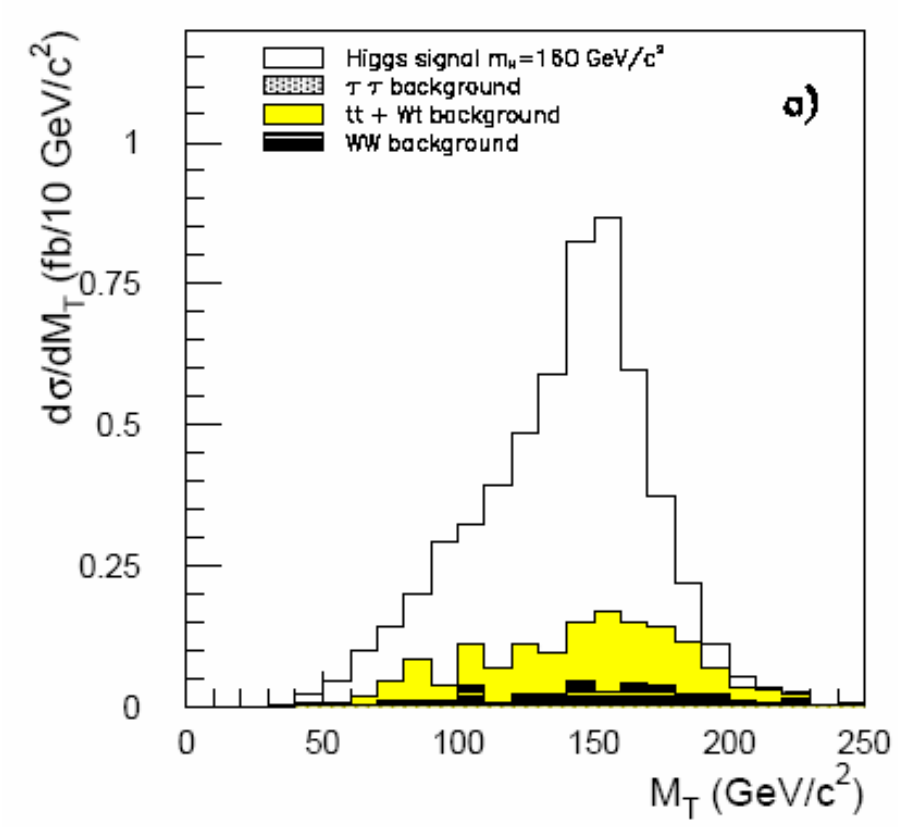



- ➔ major issues :
  - ✓ forward jets tagging (~80 % per jet)
  - ✓ jet identification (central jet veto)



# VBF → H → ww*

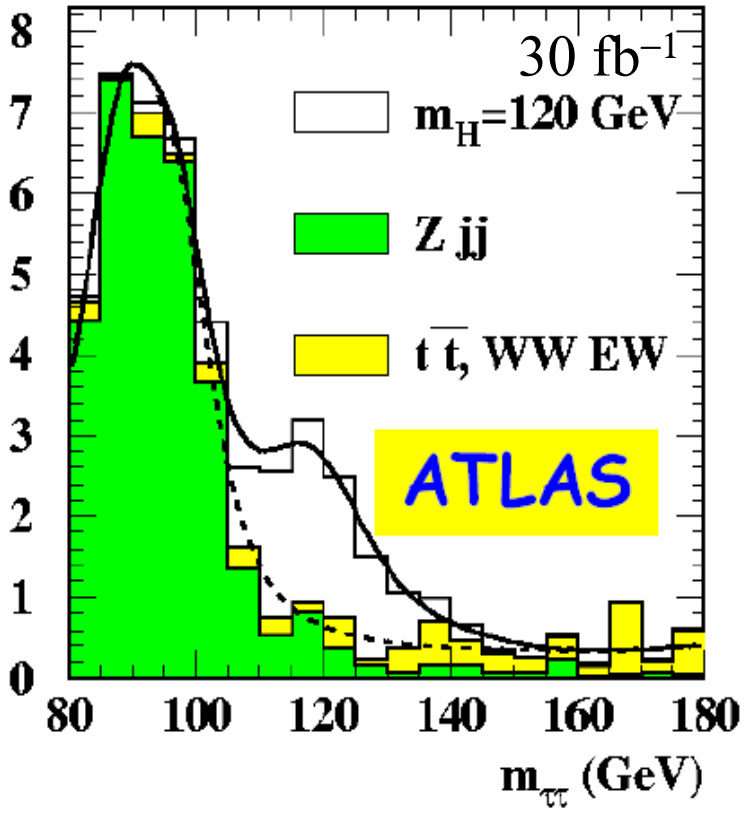
- decay : H → ww* → *lνlν*, *lνjj*
- main backgrounds :
  - ✓ tt, Wt
  - ✓ dibosons + jets, γ*/Z + jets, W + jets, ττ + jets
- transverse mass reconstruction




- ➔ requires very good leptons and $\not{p}_t$ reco

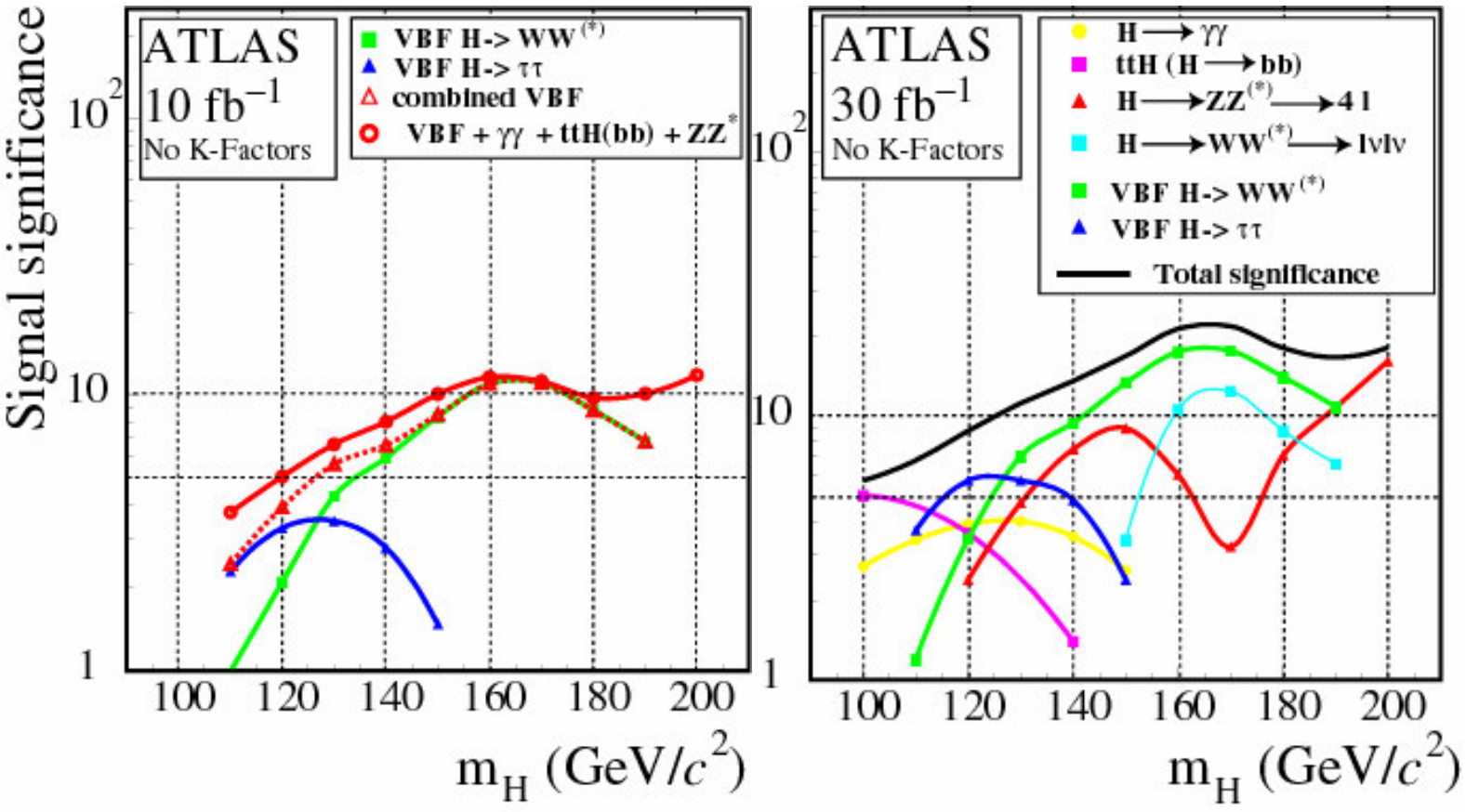
# VBF → H → ττ

- decay : H → ττ → *lνν lνν*, *lνν had*ν
- main backgrounds :
  - ✓ tt, Wt
  - ✓ dibosons + jets, $\gamma^*/Z$ + jets, W + jets, ττ + jets
- $m_{\tau\tau}$ reconstruction (resolution ~ 10%)




- ➔ requires very good $\not{E}_t$ and τ reco

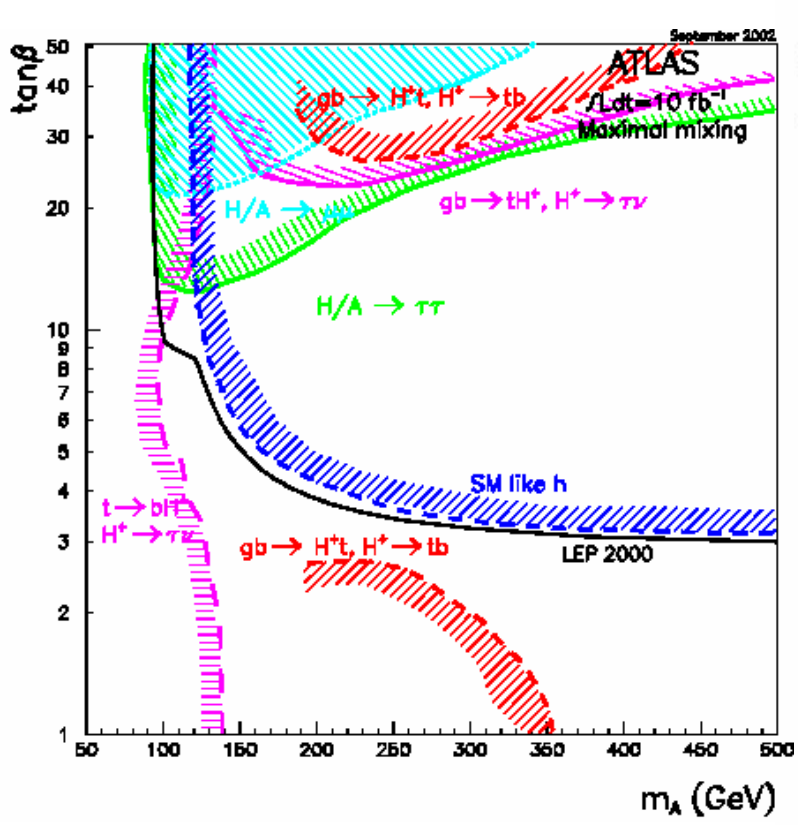
# SM Higgs sensitivity

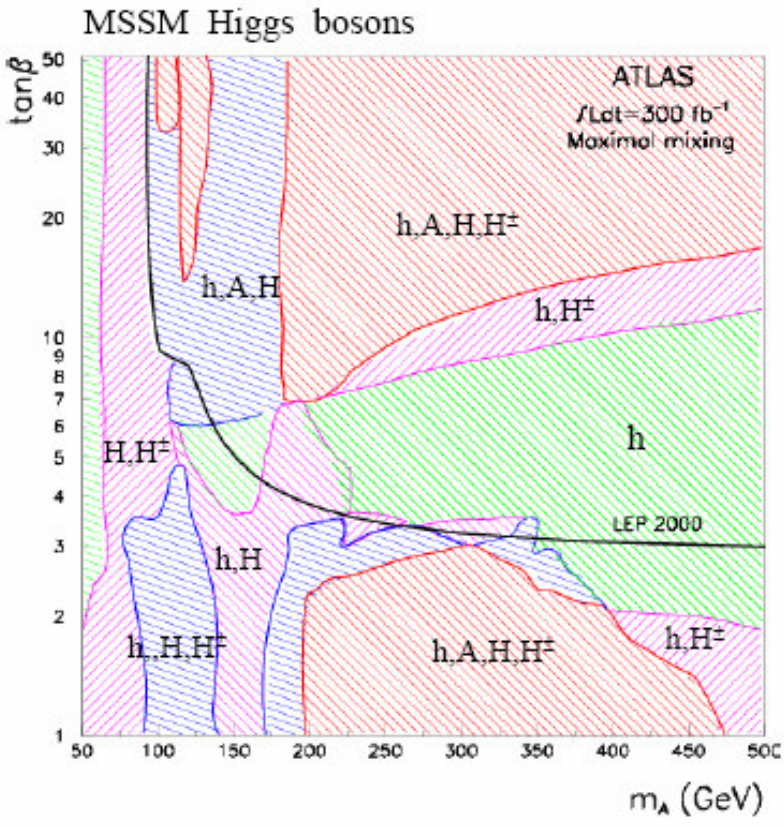



- 5σ discovery can be reached over the full mass range with 30 fb$^{-1}$
- VBF studies significantly improve the low mass range Higgs search

# MSSM Higgs

- MSSM → 5 Higgs : h, H, A, and $H^{\pm}$
- $m_h$<150 GeV
- same modes as SM Higgs, but ≠ rates

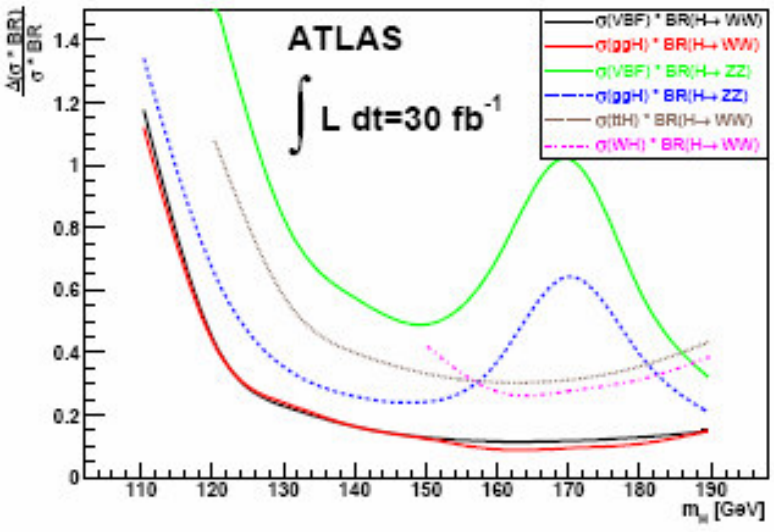


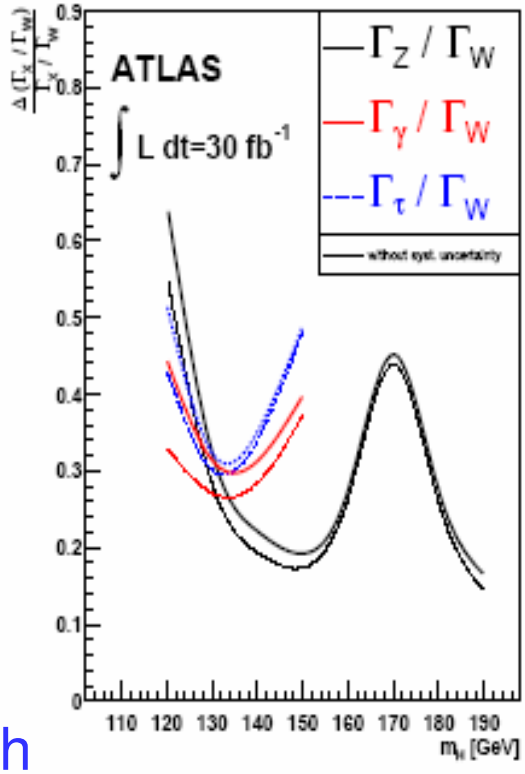




- Large part of the parameter space covered with 10 $fb^{-1}$, full coverage needs 100 $fb^{-1}$

# Higgs measurements

- "Higgs" discovered ➔ really a Higgs boson? SM or SM-like? …
- ➔ requires precise measurements :
  - ✓ mass : accuracy 0.1-1%
  - ✓ σ×BR : assume CP-even, spin 0
  - ✓ ratios of widths : assume only 1 Higgs




  - ✓ couplings : ratios (assume only SM particles couple with Higgs) or absolute values (constrain $\Gamma_H$)
- at least verify if it's a SM-like Higgs boson

# Conclusion

- SM Higgs :
  - ✓ full mass range covered with 30 $fb^{-1}$
  - ✓ VBF channels dominate sensitivity for low mass Higgs
- MSSM Higgs :
  - ✓ large part of parameter space covered with 10 $fb^{-1}$
  - ✓ more than one Higgs can be discovered in a large parameter space ➔ SM-MSSM distinction
- Higgs Measurements :
  - ✓ mass accuracy 0.1-1%
  - ✓ global fit + theoretical assumptions
    - ➔ $\sigma \times BR$, ratios of widths, ratios of couplings, absolute couplings
- ➔ need excellent detector performances