The Physics Potential of the ATLAS Experiment at the LHC

- Introduction, Detector Aspects
- Standard Model Physics
  - W - mass and couplings
  - Top Quark Physics
- Search for the Higgs Boson
  - SM and MSSM Higgs Bosons
  - Measurement of Higgs Boson Parameters
- Physics beyond the Standard Model
  - SUSY signatures
  - New Gauge bosons, Leptoquarks,......

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The experimental scenario at the LHC

- p p collisions at $\sqrt{s} = 14$ TeV
- starting date: $\sim$ 2005
- initial luminosity: $\mathcal{L} = 1.0\ 10^{33}$ cm^{-2} sec^{-1}

  $\int \mathcal{L}dt \ = \ 10\ fb^{-1}$ per year
  (expected period of 3 years)
- high luminosity: $\mathcal{L} = 1.0\ 10^{34}$ cm^{-2} sec^{-1}

  $\int \mathcal{L}dt \ = \ 100\ fb^{-1}$ per year
- ultimate reach:

  $\int \mathcal{L}dt \ = \ 300\ fb^{-1}$ $<$ 10 years
- $\sigma_{inel.} = 70$ mb

  $\Rightarrow$ 23 inelastic pp-collisions per bunch crossing, i.e. every 25 ns

  $\Rightarrow\sim$700 charged particles with $P_T > 150$ MeV per crossing

Detector Requirements

- Good measurement of leptons and photons

  (over momentum range from a few GeV ($b \to l\nu$) to a few TeV ($W' \to l\nu$))

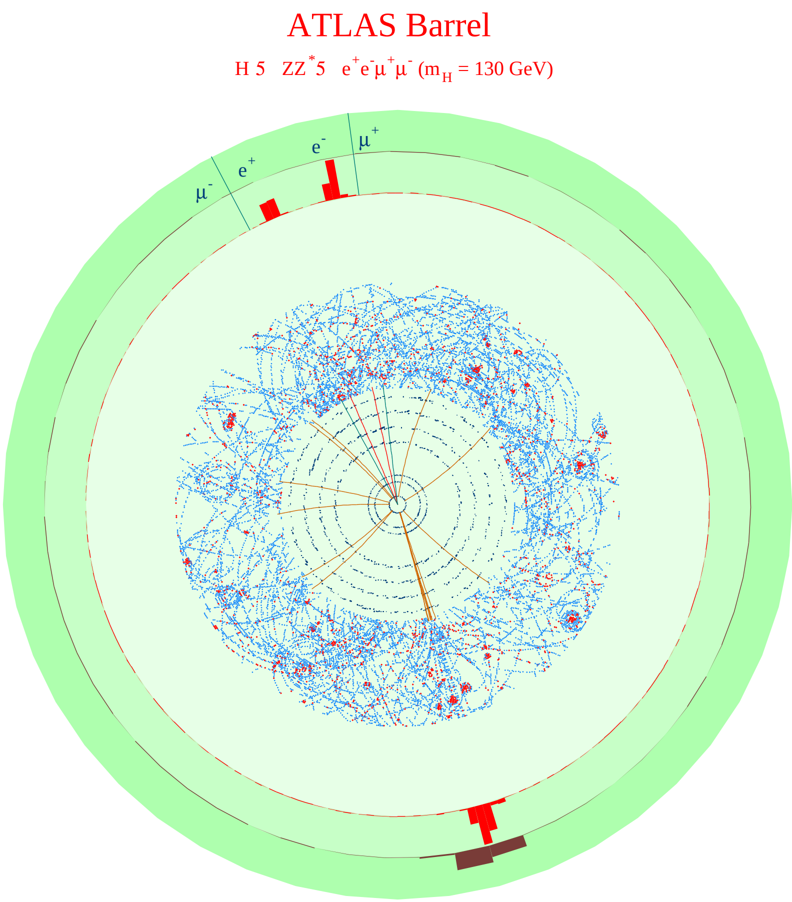
- Good measurement of missing transverse energy E_T^{miss}

  (calorimeter coverage down to $|\,\eta\,| < 5.0$)

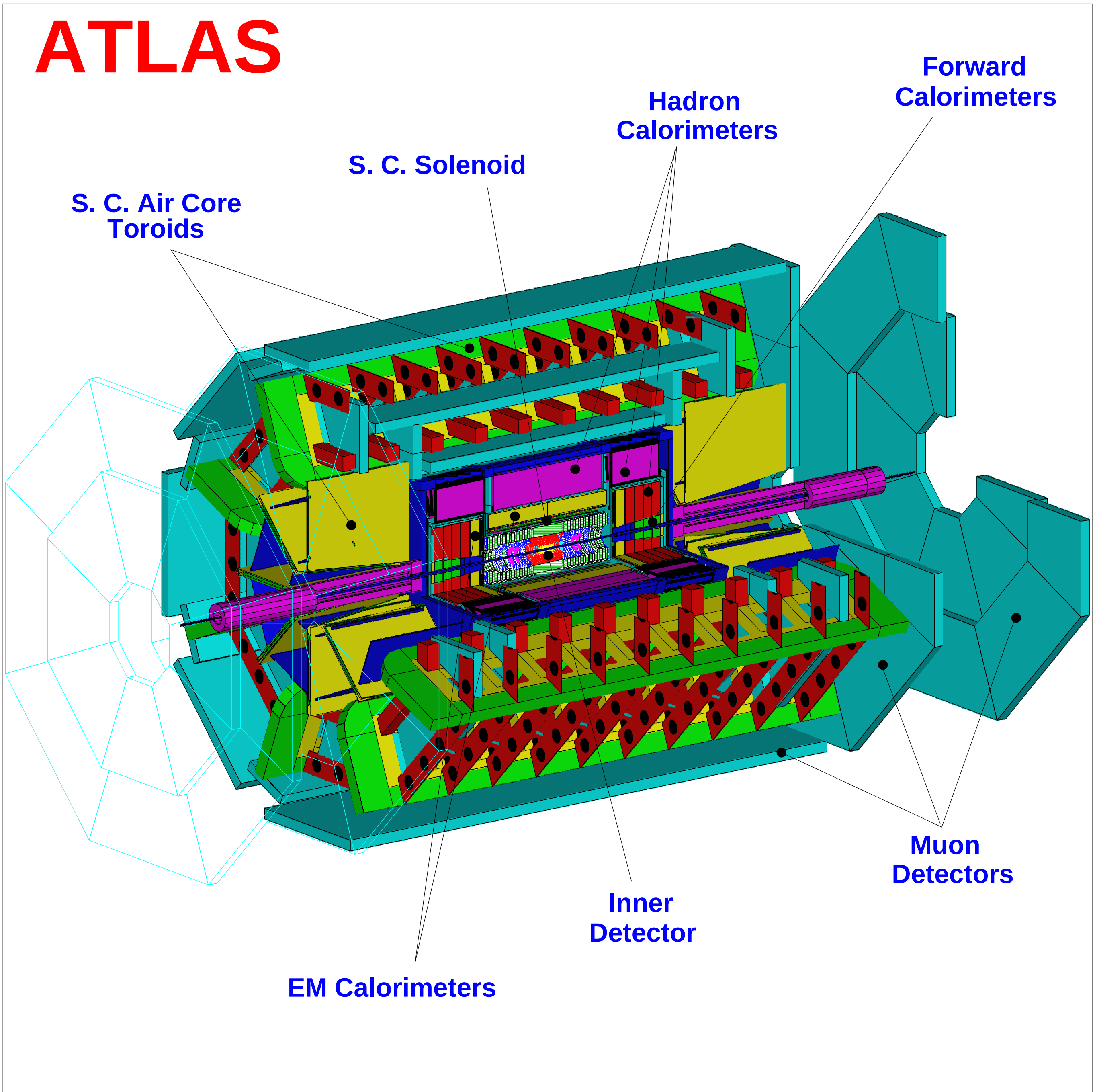
- Efficient b-tagging

- fast detectors (LHC bunch crossing time: 25 ns)

- rad. hard detectors and electronics

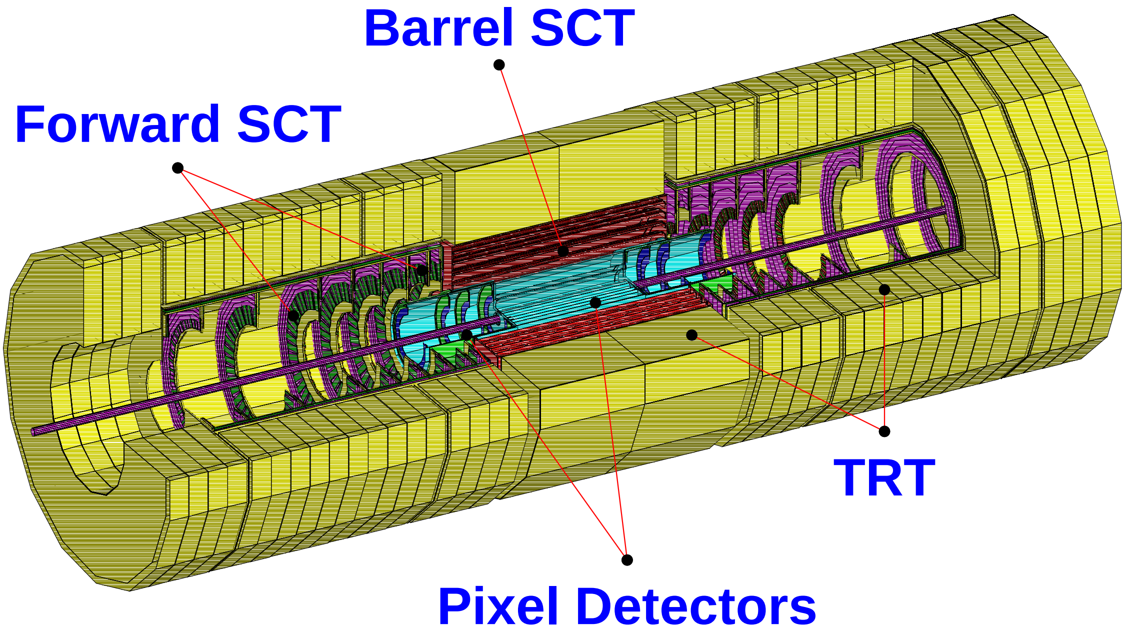


The ATLAS Detector

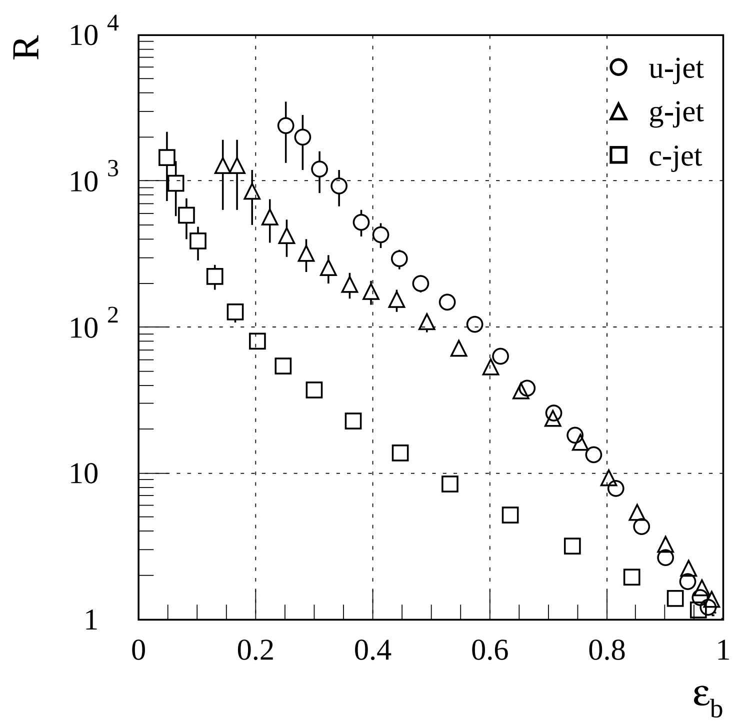


- stand alone muon toroid system
- reliable liquid argon calorimetry down to $|\eta| < 5.0$
- silicon pixel and strip layers, transistion radiation tracker

ATLAS Inner Detector



b-tagging performance (high luminosity):



Cross sections and production rates

$\mathcal{L} = 1.0 \cdot 10^{33}$ cm^{-2} sec^{-1}

Process	σ	Events/s	Events/year
$W \to e\nu$	15 nb	15	10^8
$Z \to ee$	1.5 nb	1.5	10^7
$t\bar{t}$	800 pb	0.8	10^7
$b\bar{b}$	500 μb	10^5	10^{12}
QCD jets ($P_T > 200$ GeV)	100 nb	10^2	10^9
$\tilde{g}\tilde{g}$ ($m_{\tilde{g}} = 1$ TeV)	1 pb	0.001	10^4
Higgs			
($m_H = 0.2$ TeV)	10 pb	0.01	10^5
($m_H = 0.8$ TeV)	1 pb	0.001	10^4

- Large production rates

  LHC is a top, b, W, Z ... factory

- Mass reach for new particles up to TeV range

- Precision measurements are dominated by systematic uncertainties

W Physics

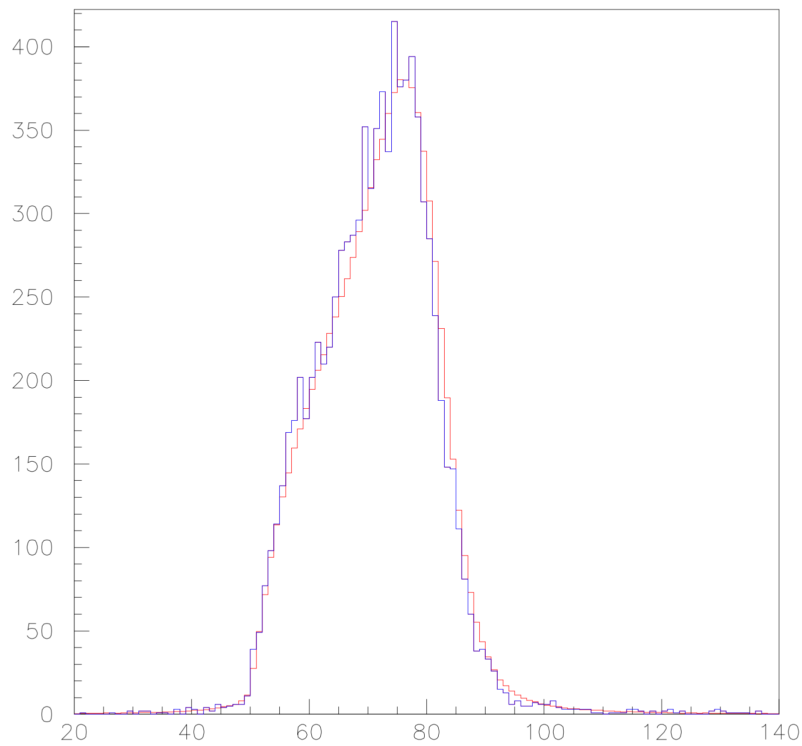
Physics motivation

- W mass measurement
  $\Rightarrow$ test of the Standard Model: $m_Z, m_W, m_{top} \rightarrow m_H$
  - year 2005: $\Delta m_W < 30$ MeV (LEP2 + TeVatron)
  - LHC goal: $\Delta m_W \sim 15$ MeV
- Test of QCD in W-production
  cross section measurement, distribution of $P_T(W)$

Experimental numbers:

- $\int \mathcal{L} dt \;=\; 10\ fb^{-1}$: $\Rightarrow 60 \cdot 10^6$ well measured $W \rightarrow l\nu$
- background conditions from pile-up events at low lumi. (2 evts./bunch crossing) similar to TeVatron today
- $\Rightarrow$ standard transverse mass technique can be used:

$$m_T \;=\; \sqrt{2P_T^e P_T^\nu(1 - \cos\Delta\Phi)}$$

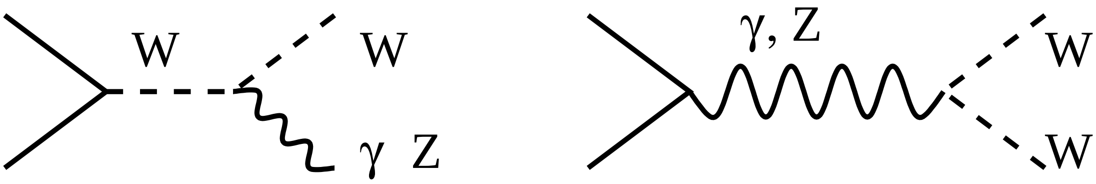


Preliminary estimate of Δm_W

source	Δm_W (CDF) $W \to e\nu$	Δm_W (ATLAS) $W \to e\nu$
Statistics	145 MeV	$<$ 2 MeV
E/p scale	120 MeV	15 MeV
E/p resolution	80 MeV	5 MeV
Recoil model	60 MeV	5 MeV
W width	20 MeV	7 MeV
PDF	50 MeV	10 MeV
Radiative decays	20 MeV	$<$10 MeV
$P_T(W)$	45 MeV	5 MeV
Background	10 MeV	5 MeV
Total	230 MeV	$<$ 25 MeV

- Total error per lepton species and per experiment estimated to be $\pm$ 25 MeV.
- main uncertainties: lepton energy scale
  (goal is uncertainty of $\pm$0.02%)
- many systematics can be controlled in situ, using the $Z \to ll$ sample
  ($P_T(W)$, recoil model, detector resolution, ...)

Triple Gauge Boson couplings



- Probe non-Abelian structure of $SU(2) \times U(1)$ and sensitive to New Physics

- general assumptions (Lorentz invariance, P,C inv.):
  $\Rightarrow$ $WW\gamma$ and WWZ couplings specified by five parameters: $g_1^Z, \lambda_\gamma, \lambda_Z, \kappa_\gamma, \kappa_Z$

  $WW\gamma$-vertex: related to

  – magnetic moment $\mu_W = \frac{e}{2M_W} \left(g_1^Z + \kappa_\gamma + \lambda_\gamma\right)$

  – quadrupole moment $Q_W = -\frac{e}{M_W^2} \left(\kappa_\gamma - \lambda_\gamma\right)$

  Standard Model: $g_1^Z = \kappa_V = 1$
  $\lambda_V = 0$

  year 2005: known to better than 10^{-2} from LEP2+TeVatron

$W\gamma$	$\rightarrow$	$l\nu\gamma$	studied
WZ	$\rightarrow$	$l\nu ll$	studied
WW	$\rightarrow$	$l\nu l\nu$	large $t\bar{t}$ background

- Sensitivity from:

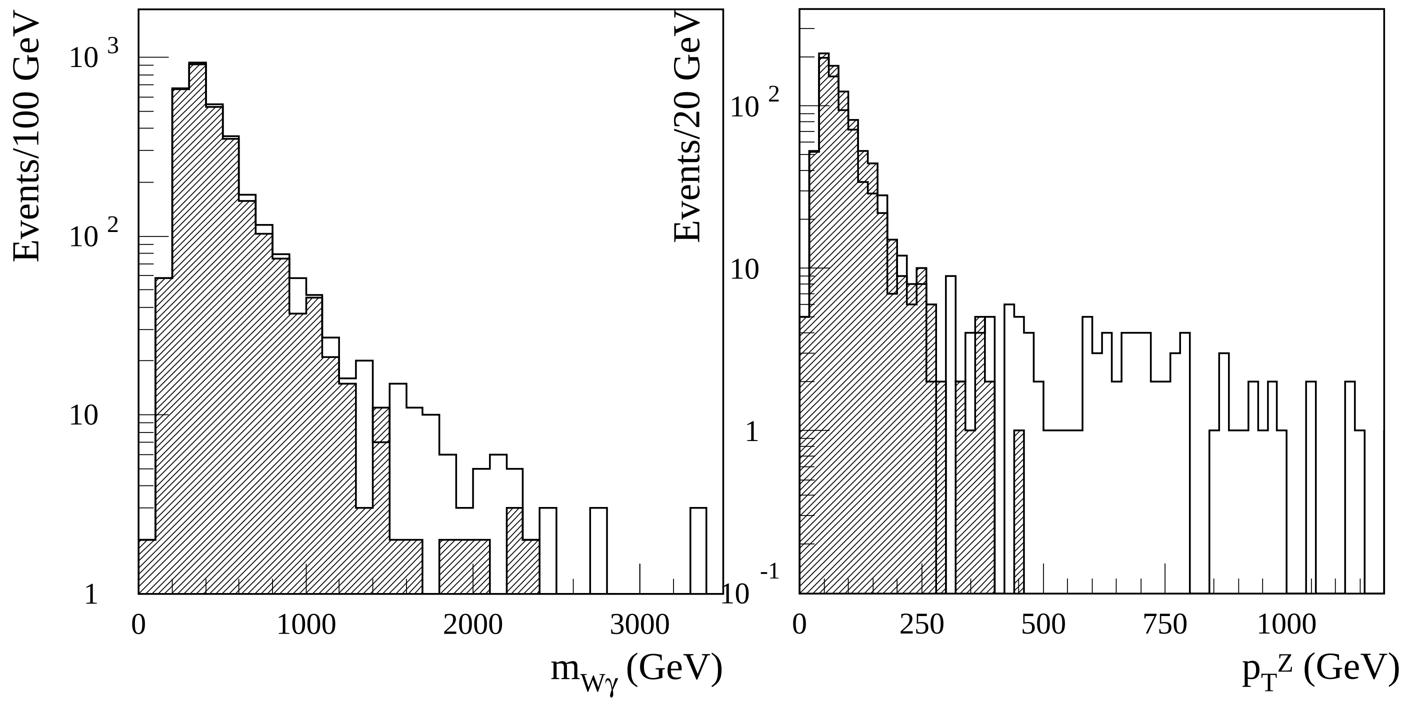
  – cross section measurements: λ-type, increase with s

  – P_T and angular distributions: constrain κ-type

ATLAS sensitivity on TGC

$W\gamma$
30 fb−1 : ∼3000 events
$\lambda_\gamma = 0.01$

WZ
30 fb−1 : ∼1200 events
$\Delta g_Z^1 = 0.05$



$\int \mathcal{L} dt = 30\ fb^{-1}$

Coupling	95% C.L.
Δg_Z^1	0.008
λ_γ λ_Z	0.0025 0.0060
$\Delta\kappa_\gamma$ $\Delta\kappa_Z$	0.035 0.070

Systematics under study

Top Physics

Physics motivation:

- Measurement of top parameters

  mass, couplings (V_{tb}), rare top decays,
  study of polarisation and single top production

  (aim to improve on measurements from the TeVatron)

  $\sigma(t\bar{t}) \sim$ 830 pb $\Rightarrow 10^7 t\bar{t}$ pairs per year at low L

- $t\bar{t}$ production is the main background for New Physics (Higgs, SUSY,...)

  ($t\bar{t} \rightarrow W\ b\ W\ b\ \rightarrow\ l\ \nu\ b\ jet\ jet\ b$,

  high P_T leptons, b-jets, jets, P_T^{miss})

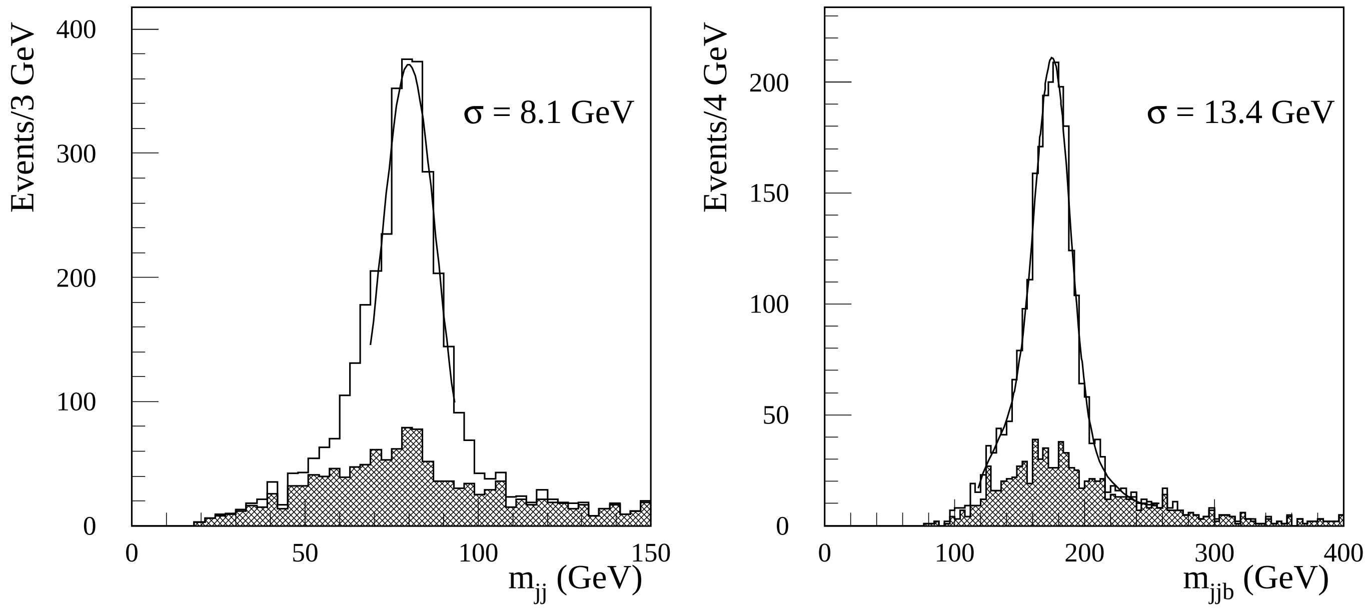
- $W \rightarrow$ jet jet decays provide a calibration of the hadronic/jet energy scale

Measurement of m_{top}

- year 2005: $\Delta m_{top} \sim 3$ GeV (TeVatron)
- Best channel for mass measurement:

  $t\bar{t} \rightarrow Wb\ Wb \ \rightarrow\ l\ \nu\ b\ jet\ jet\ b$

- after all cuts: 130.000 $t\bar{t}$ events in 10 fb^{-1}, $S/B \sim 65$



results from full detector simulation

Contribution	Δm_{top} (GeV)
statistics	< 0.07
u,d,s jet scale	0.3
b-jet scale	0.7
b-fragmentation	0.3
initial state rad.	0.3
final state rad.	1.2
background	0.2
Total	$\sim$ 1.5 GeV

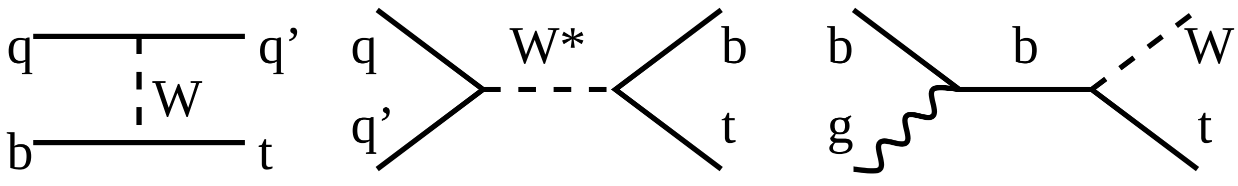
Other Measurements

- Cross section measurement, $\sigma_{t\bar{t}} < 10\%$
  (limited by uncertainty on luminosity)

- Sensitivity to FCNC top couplings:

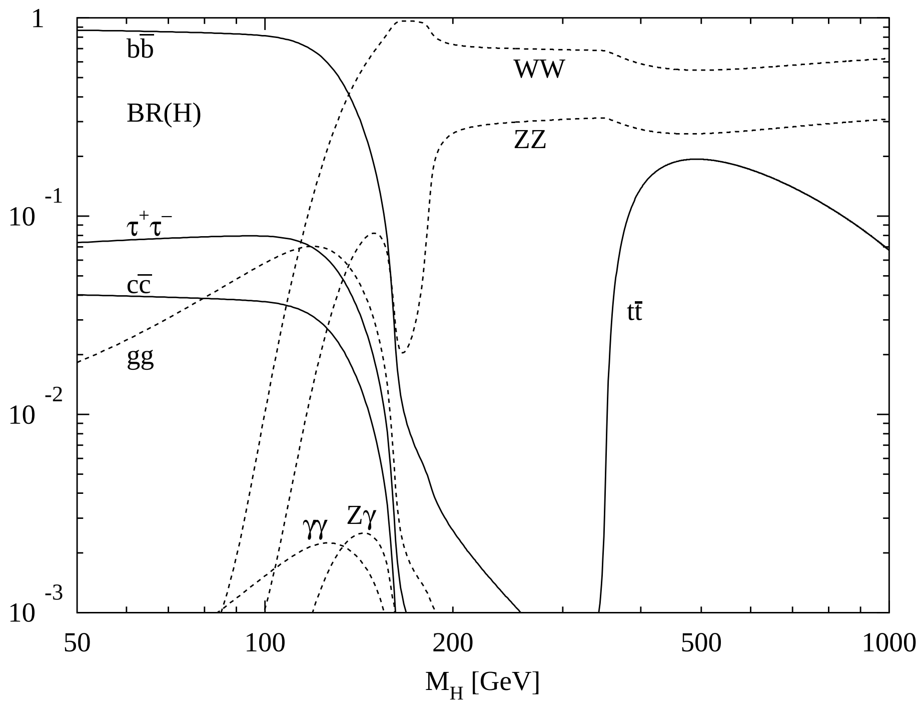
			$\int \mathcal{L}dt = 100\ fb^{-1}$
$BR(t \to Zq)$	$<$	10^{-4}	5σ discovery limit
$BR(t \to \gamma q)$	$<$	10^{-4}	5σ discovery limit
$BR(t \to gq)$	$<$	$7 \cdot 10^{-3}$	95% C.L.

- Single Top production: $\sigma \sim 300$ pb (40% of $t\bar{t}$)



  - probe $W - tb$ vertex,
    $\to$ sensitive to new physics
  - measure V_{tb} to $\sim 10\%$ (syst. limited)
  - measure W, top polarisation
    $\to$ anomalous couplings, ...

Standard Model Higgs decays



Important channels at LHC:

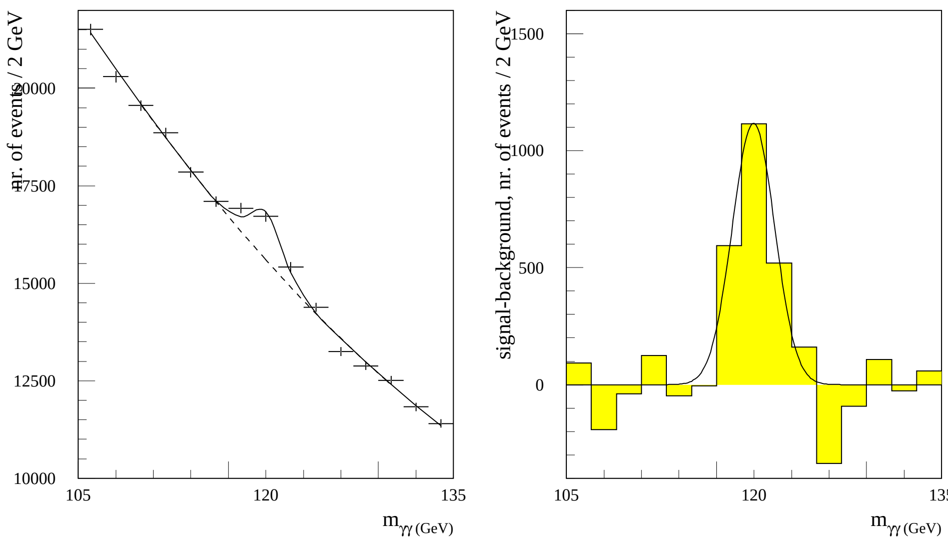
- $H \to \gamma\gamma$, $WH, t\bar{t}H,$ $H \to \gamma\gamma$
- $WH, t\bar{t}H,$ $H \to b\bar{b}$
- $H \to Z\ Z^{(*)} \to l^+l^-\ l^+l^-$
- $H \to W\ W^* \to l^+\nu\ l^-\nu,\ WH \to WWW^{(*)} \to l\nu l\nu l\nu$
- $H \to Z\ Z \to l^+l^-\ \nu\bar{\nu}$
- $H \to Z\ Z \to l^+l^-\ jet\ jet$
- $H \to W\ W \to l\nu\ jet\ jet$

$H \to \gamma\gamma$ Signals

Signal	σBr = 43 fb, (m_H = 100 GeV)
$\gamma\gamma$- background (irreducible)	$d\sigma/dm_{\gamma\gamma} \sim$ 1200 fb/GeV ($m_{\gamma\gamma}$ = 100 GeV)
QCD Jet background	$\sigma_{\gamma,jet}/\sigma_{\gamma\gamma} \sim 1000$, (reducible) $\sigma_{jet,jet}/\sigma_{\gamma\gamma} \sim 2 \cdot 10^6$

Analysis:

- Two isolated photons, $P_T^1 > 40$ GeV and $P_T^2 > 25$ GeV, $|\,\eta\,| < 2.5$
- Good γ/jet separation
  $\Rightarrow$ QCD jet background at the level of 10-20% of the irreducible $\gamma\gamma$ background
- good mass resolution: $\sigma_m = 1.3$ GeV for $m_H = 100$ GeV



Signal significance: 100 fb^{-1}

m_H (GeV)	100	120	140
Signal events	960	1200	930
$\gamma\gamma$ background	44700	30300	20800
γ-jet, jet-jet background	6700	4400	3900
Stat. significance	4.7 σ	6.9 σ	6.3 σ

$t\bar{t}H,\ H \rightarrow b\bar{b}$

complex final state:

$t\bar{t}$ H $\rightarrow$ $Wb\ W\bar{b}$ $b\bar{b}$ $\rightarrow$ $l\nu b$ $q\bar{q}b$ $b\bar{b}$

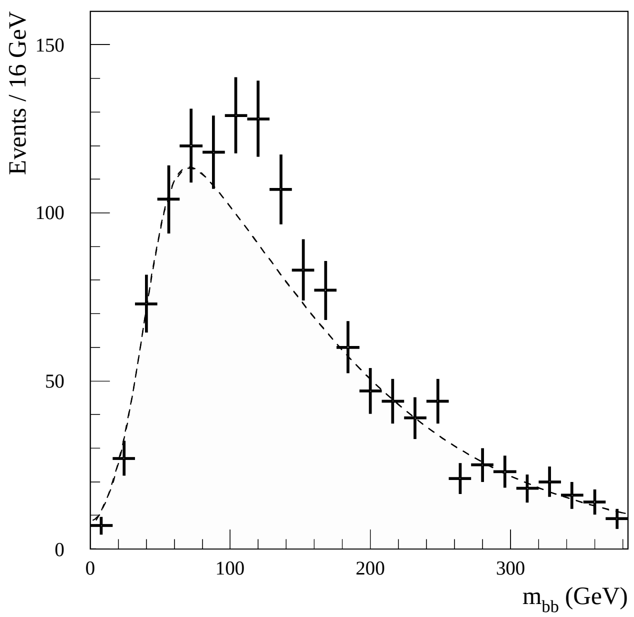
- Isolated Lepton: (provides the trigger)

- Full reconstruction of both top quarks

require:	4 tagged b jets,	$P_T > 15GeV$,	$\mid \eta \mid < 2.5$
	2 non-b jets,	$P_T > 15GeV$,	$\mid \eta \mid < 2.5$

  reconstruct both W's ($q\bar{q}$ and $l - P_T^{miss}$-system, use W-mass constraint)

- Pair two b-jets with the two W's



$\int \mathcal{L}dt = 30\ fb^{-1}$:

$m_H = 120$ GeV

Signal: 40 events
Backgr.: 130 events

Stat. sign. $= 3.6\ \sigma$

Conclusions:

- Signal extraction in low mass region looks possible
- Good b-tagging is essential
- Knowledge of the background shape is important at low mass (dominant background is $t\bar{t}jj \Leftarrow$ input from top analysis)

$H \rightarrow WW^{(*)} \rightarrow l\nu l\nu$

Difficulties:

- No reconstructed mass peak, final state contains two neutrinos
  $\Rightarrow$ signal claim from excess of events above the Standard Model background

- Small signal and large backgrounds

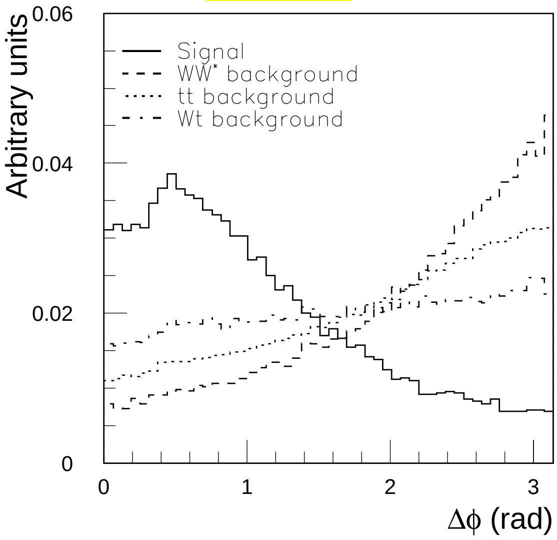
$\sigma BR\ (H \rightarrow WW^{(*)} \rightarrow l\nu l\nu)$	0.8 pb,	$m_H = 170$ GeV
$WW^{(*)} \rightarrow l\nu l\nu$	4.8 pb	
$t\bar{t} \rightarrow WWb\bar{b} \rightarrow l\nu l\nu + X$	38.6 pb	

Signal selection:

- 2 isolated leptons: $P_T^1 > 20$ GeV, $P_T^2 > 10$ GeV, $|\eta| < 2.5$

- exploit angular correlation between the two leptons (spin correlations in $H \rightarrow WW^{(*)}$ decays)

$\Delta\phi_{ll}$



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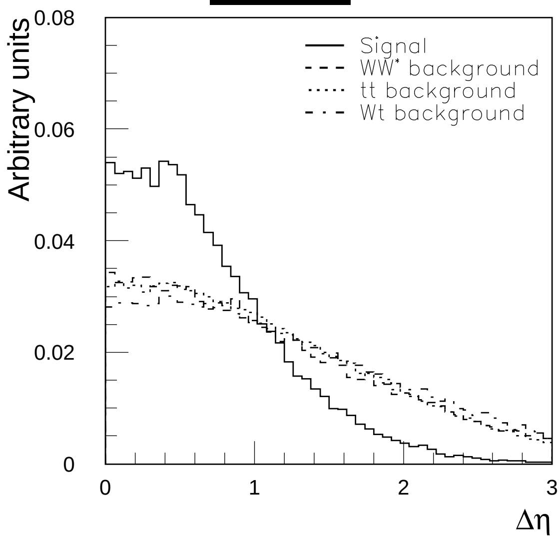
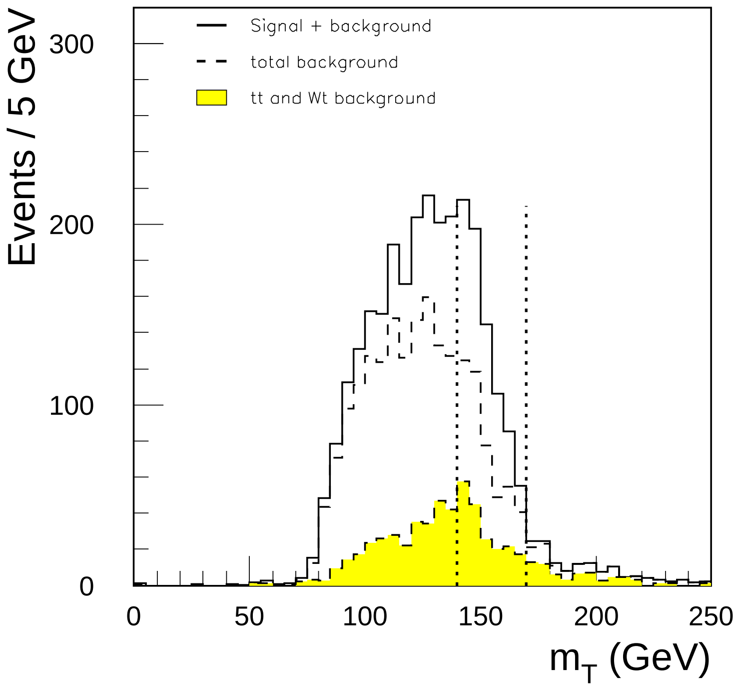


- Jet Veto in central region, (reject $t\bar{t}$ background)

M.Dittmar, H.Dreiner, Phys.Rev. D55 (1997) 167.

Transverse mass distributions

$H \to WW^{(*)} \to l\nu\ l\nu$

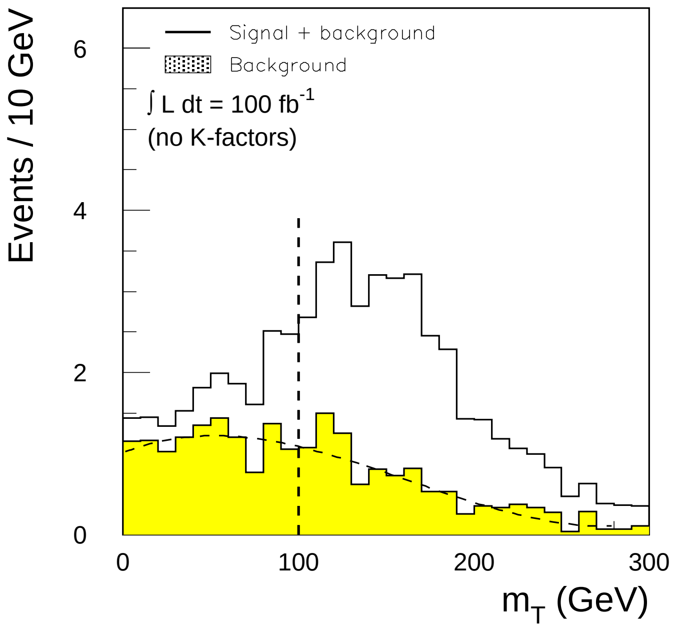


$\int \mathcal{L}dt = 30\ fb^{-1}$,
$m_H = 170$ GeV

Signal: 330 events
Backgr.: 430 events,
($WW^{(*)}$: 260)

Stat. sign.: 11.2 σ
(incl. 5% syst.)

Associated production channel $WH \to WWW^{(*)} \to l\nu\ l\nu\ l\nu$



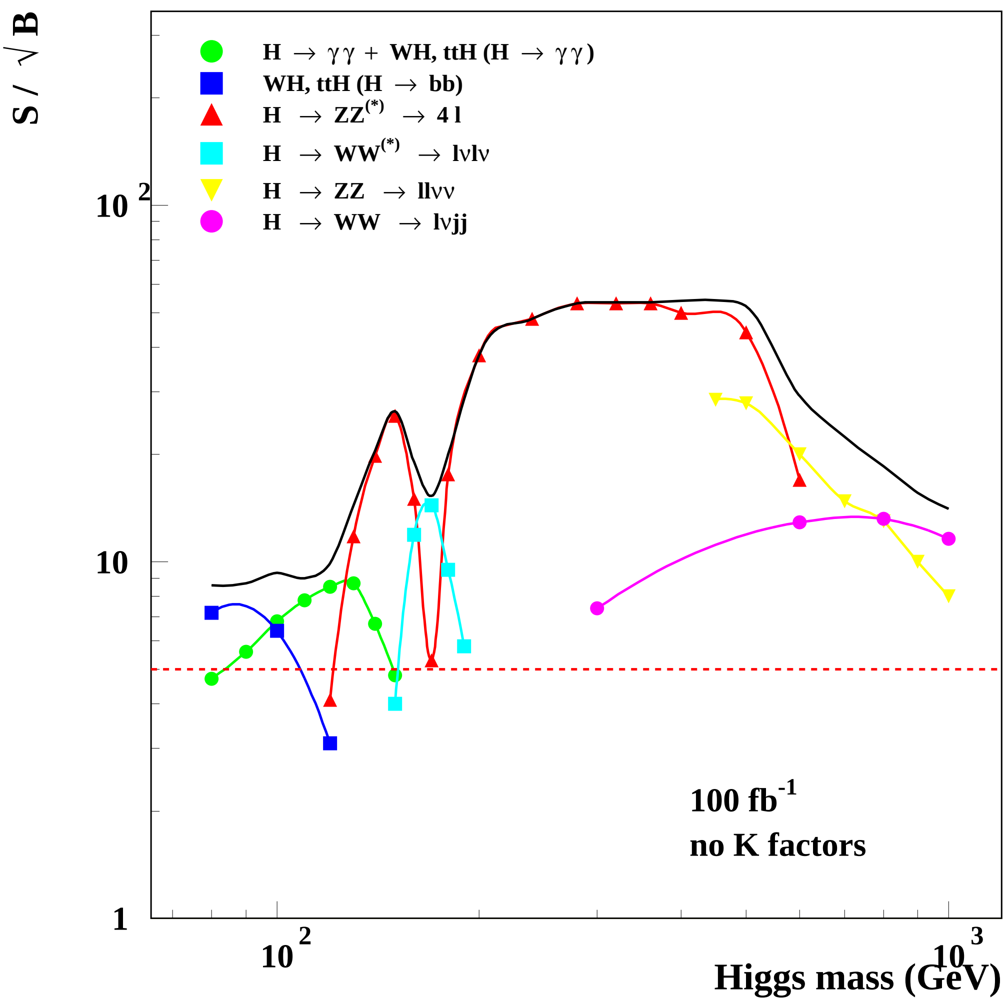
$\int \mathcal{L}dt = 100\ fb^{-1}$,
$m_H = 160$ GeV

Signal: 25 events
Backgr.: 10 events

Stat. sign. $= 6.1\ \sigma$
(incl. 5% syst.)

Summary of the Standard Model Higgs Search

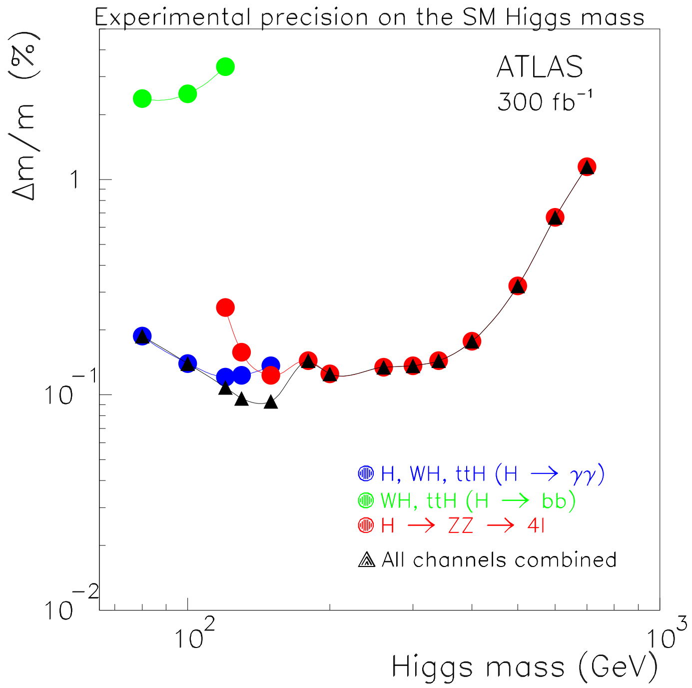
Scenario after 100 fb^{-1}:



- ATLAS has a good sensitivity over the full mass range from 90 GeV to ∼ 1 TeV
- In most case more than one channel available
- The full mass range can already be covered by ATLAS after running three years at low luminosity

Measurement of Higgs Boson parameters

Higgs mass:

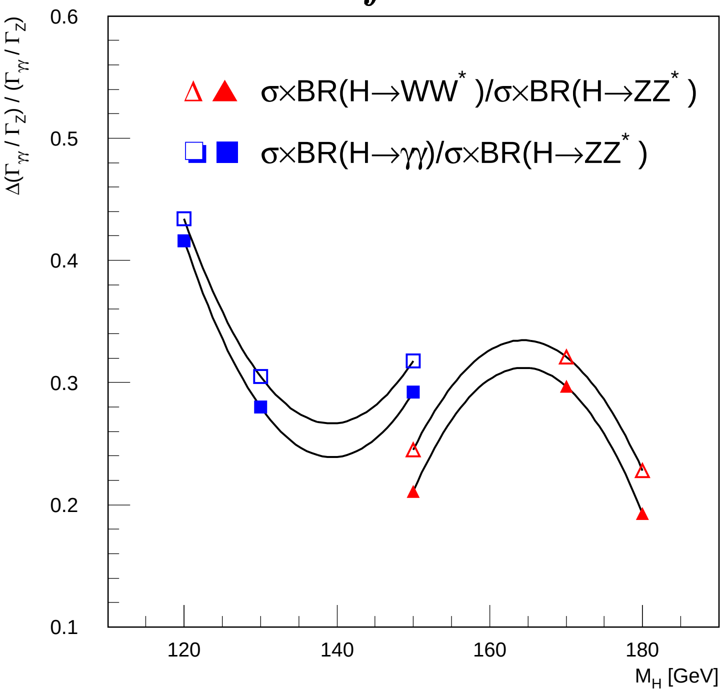


no theoretical errors,
e.g. mass shift for large Γ_H
(resonant/non-resonant
interference effect)

dominant systematic
uncertainty: l/jet scale

Couplings to bosons:

100 fb^{-1}



direct measurement:

$$\frac{\sigma \times BR(H \to WW^{(*)})}{\sigma \times BR(H \to ZZ^{(*)})}$$

$$= \frac{\Gamma_g \Gamma_W}{\Gamma_g \Gamma_Z} = \frac{\Gamma_W}{\Gamma_Z}$$

QCD corrections cancel

ATLAS studies of the MSSM Higgs sector concentrate on two scenarios:

1. SUSY particle masses are large, $m_{SUSY} = 1$ TeV,
   Higgs boson decays to SUSY particles are kinematically forbidden

2. Studies in the framework of SUGRA models
   - SUSY particles are light and appear in Higgs decays, competing with SM decay modes
   - Light Higgs particles appear in decays of SUSY particles
     Search for the $h \to b\bar{b}$ decay

     later: after SUSY discussion

Important Channels in the MSSM Higgs search

- The Standard Model decay channels
  - $h \rightarrow \gamma\gamma$
  - $h \rightarrow b\bar{b}$
  - $H \rightarrow ZZ^* \rightarrow l^+l^-l^+l^-$

  ($\gamma\gamma$ and $ZZ*$ decay modes are suppressed w.r.t. SM)

  evaluation of performace based on SM results

- Modes strongly enhanced at large $\tan\beta$:
  - $H/A \rightarrow \tau^+\tau^-$
  - $H/A \rightarrow \mu^+\mu^-$

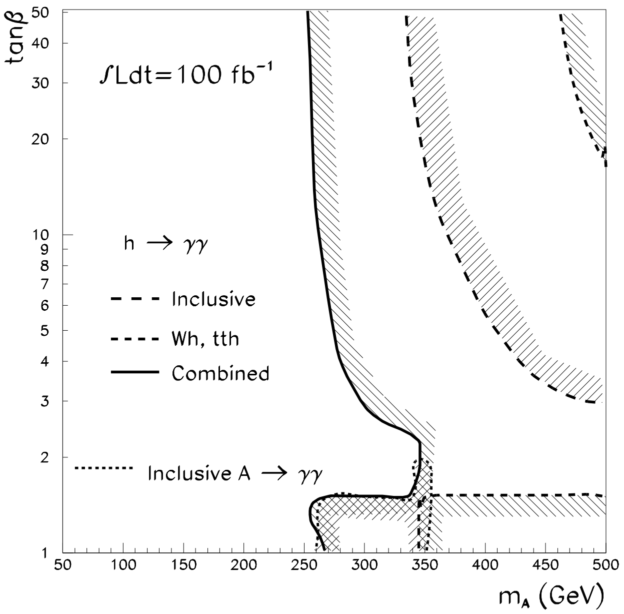
- Other interesting channels:
  - $H/A \rightarrow t\bar{t}$
  - $H/A \rightarrow Zh \rightarrow l^+l^- \gamma\gamma$
    $\rightarrow l^+l^- b\bar{b}$
  - $H \rightarrow hh$
  - $t \rightarrow H^+b, \quad H^+ \rightarrow \tau\nu$

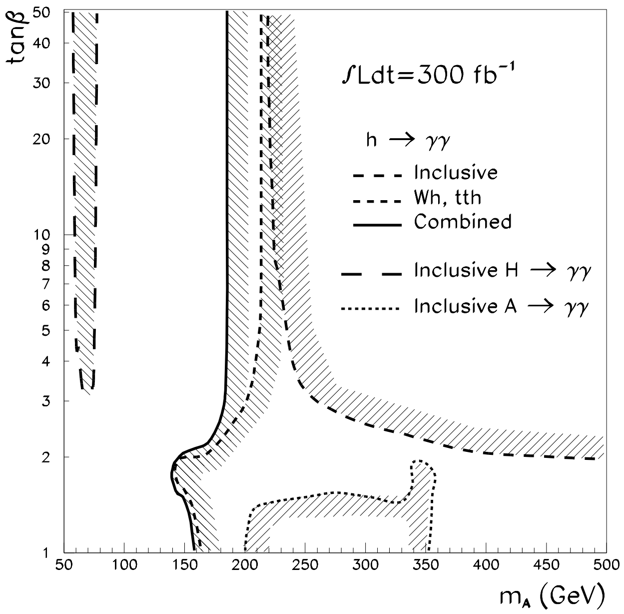
assume: $m_{SUSY} = 1$ TeV
$m_{top} = 175$ GeV
$A_t = 0.$ (pessimistic for LHC)

i.e. no mixing, SUSY particles do not appear in Higgs decays

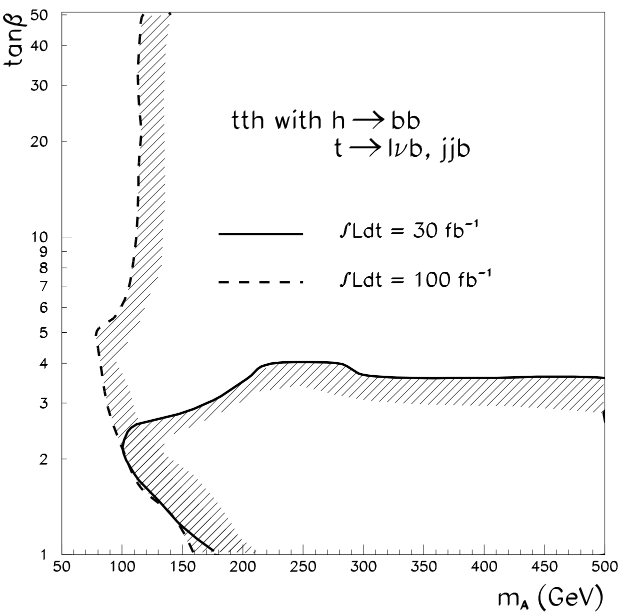
The three main channels

$h \to \gamma\gamma$

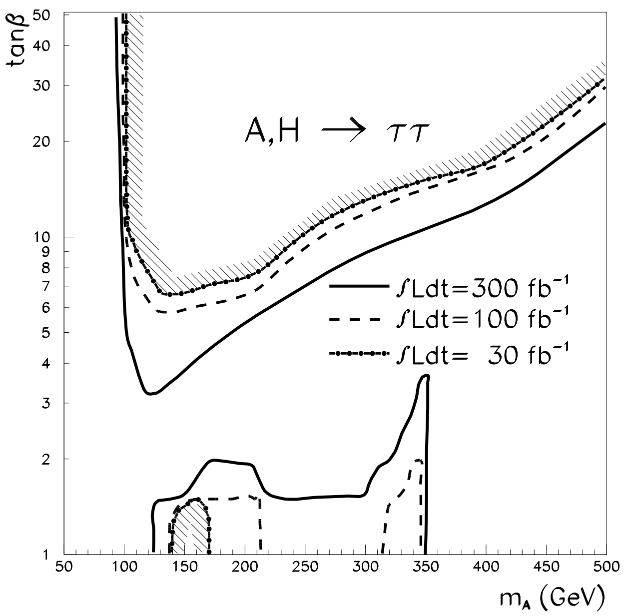




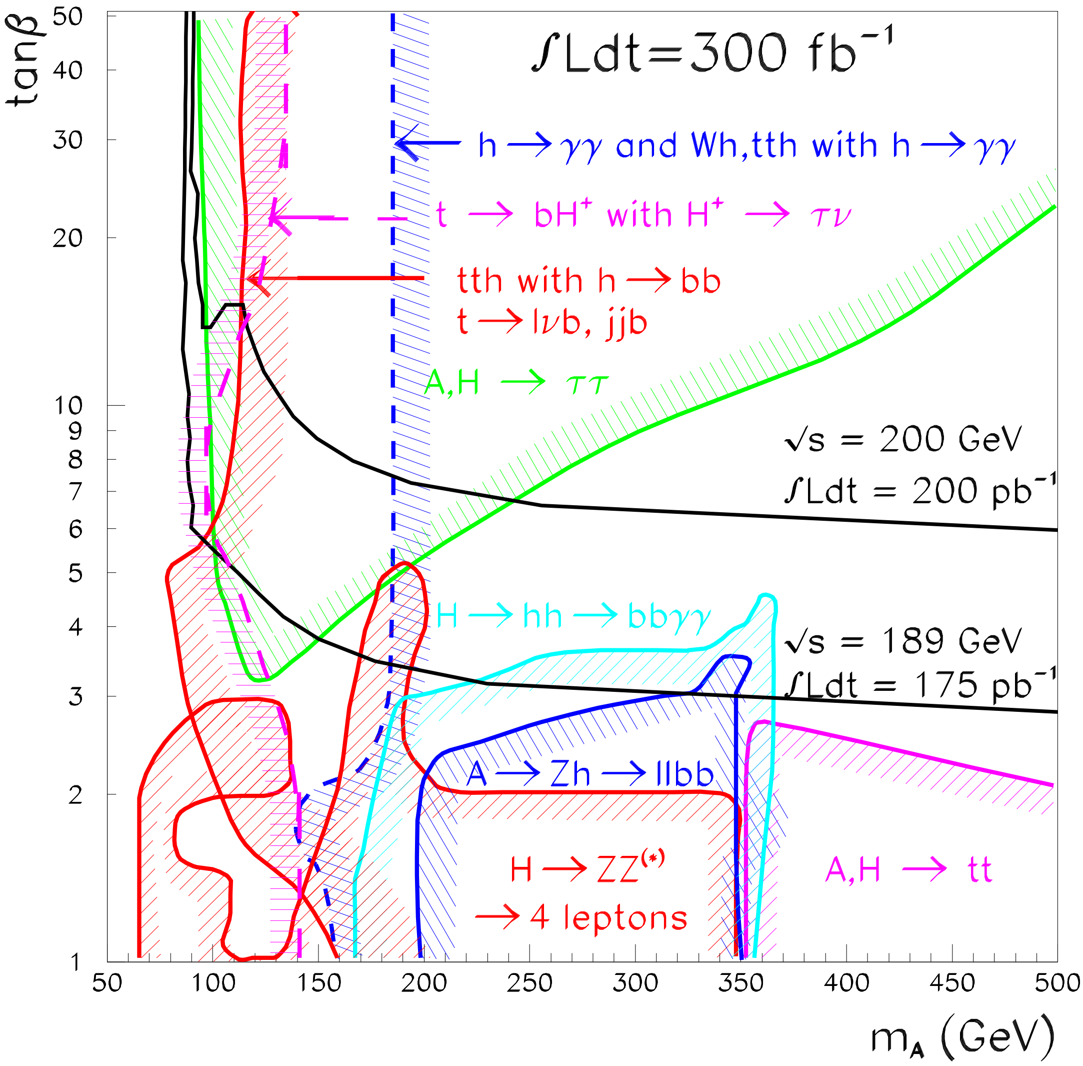
$t\bar{t}h, h \to b\bar{b}$



$A, H \to \tau\tau$



Summary of the MSSM Higgs Search



- Full parameter space covered, SM and MSSM can be distinguished for almost all cases

- Most part of the parameter space covered by at least two channels, except low m_A region (covered by LEP200)

- if h discovered at LEP200: ⇒ heavy Higgs bosons (A/H) should be observable at LHC for $m_A <\sim 2\ m_{top}$

- if A,h discovered at LEP200:
  the charged Higgs should be seen at LHC

- Discovery of heavy Higgses ($m_A >$ 500 GeV) seems to be difficult ($t\bar{t}$ decay mode)

Higgs in SUGRA

Lightest Higgs h:

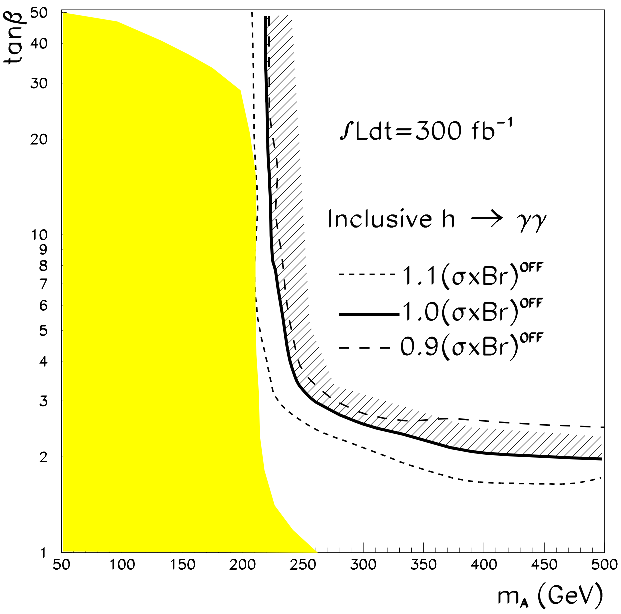
- Decay of $h \to \tilde{\chi}_1^0 \tilde{\chi}_1^0$ is kinematically closed in the allowed SUGRA parameter space

- SUSY particles in loops affect the production and decays

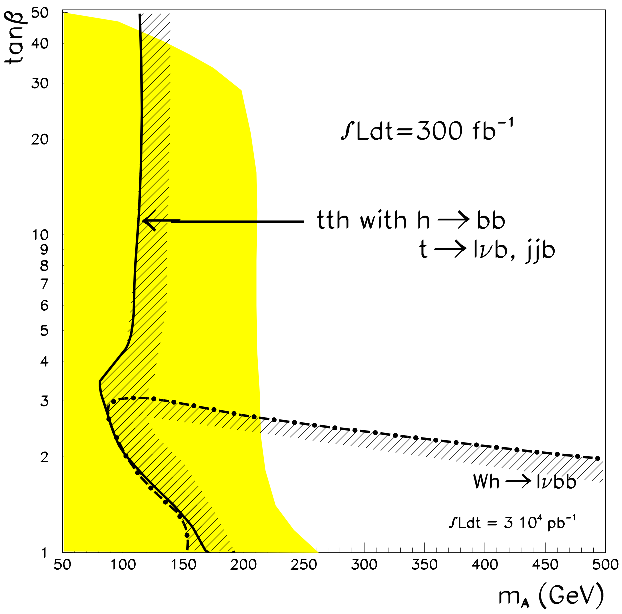
  $\sigma \cdot Br(h \to \gamma\gamma)$ is found to be in the range of $\pm 10\%$ of the SM value

Observation of h in the SM channels is preserved

$h \to \gamma\gamma$



$t\bar{t}h, h \to b\bar{b}$

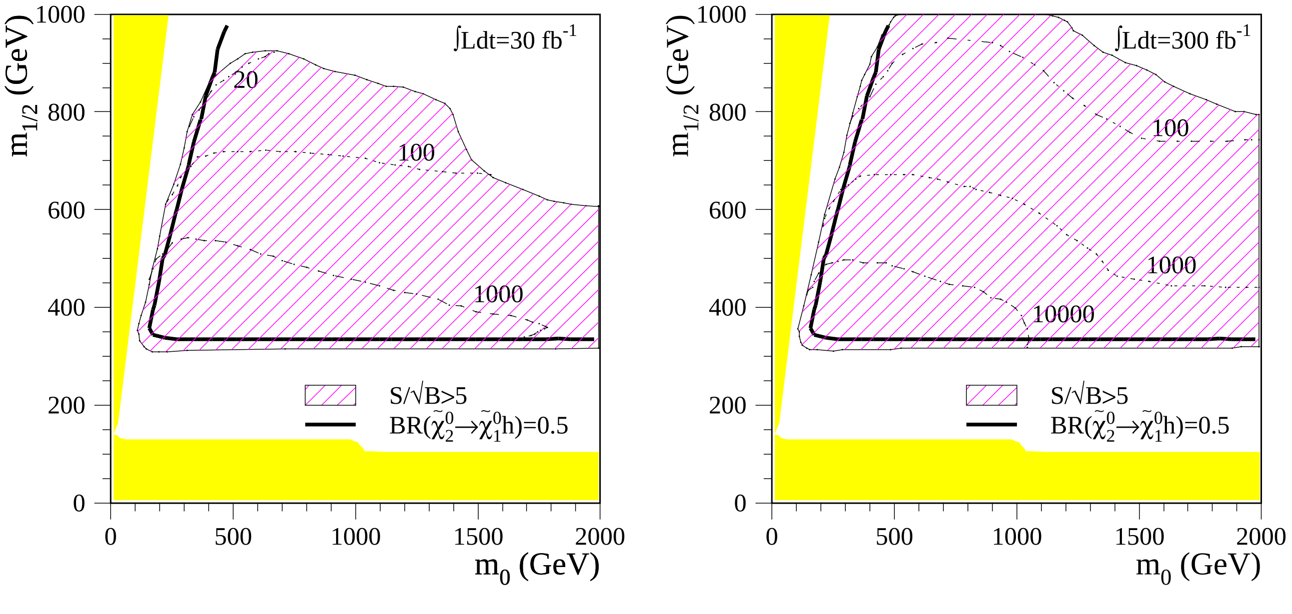


$h \to b\bar{b}$

- Use $h \to b\bar{b}$ decay mode in SUSY events to discover the h
- Analysis as described above for SUGRA point 5

excluded regions in the SUGRA parameter space

$\tan\beta = 10, \ \mu > 0$

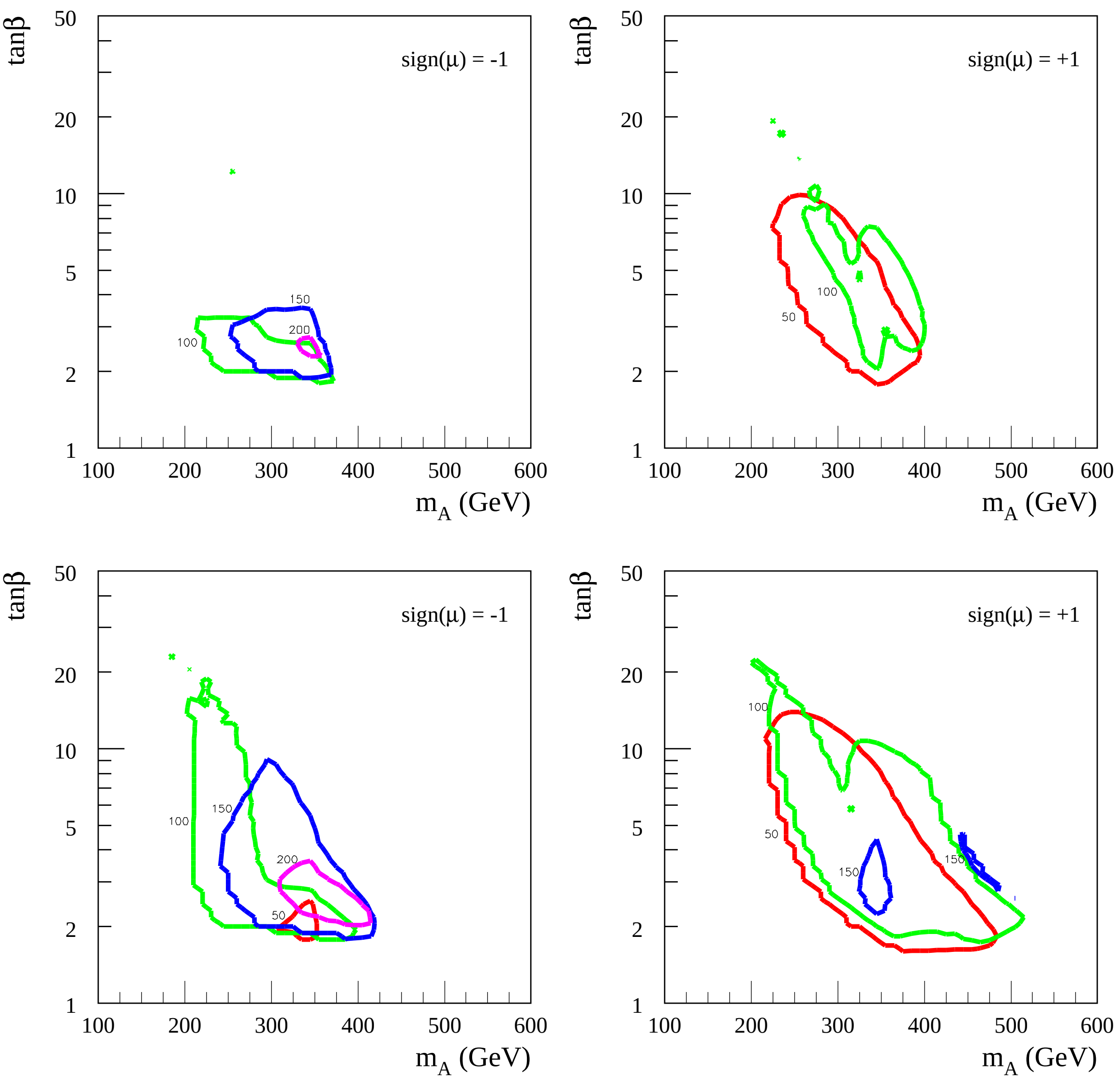


H,A $\rightarrow$ Neutralinos

- H and A Higgs bosons are heavy in many SUGRA models
- Decay modes are strongly affected by SUSY particles
- $H, A \rightarrow \tilde{\chi}_1^0\tilde{\chi}_1^0, \tilde{\chi}^+\tilde{\chi}^+$ decay channels are open over a significant fraction of the SUGRA parameter space

Decay mode: $H, A \rightarrow \tilde{\chi}_2^0\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 l^+ l^- \tilde{\chi}_1^0 l^+ l^-$

excluded regions in the SUGRA parameter space



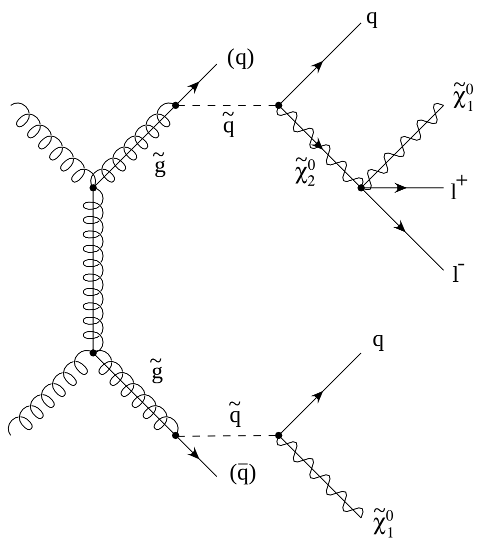
The Search for SUSY

- If SUSY exists at the electroweak scale, a discovery at LHC should be easy

- Gluinos and squarks are strongly produced.

  They decay through cascades to the lightest SUSY particle $\tilde{\chi}_1^0$

  $\Rightarrow$ combination of Jets, Leptons, E_T^{miss}



- 1.Step:
  Look for deviations from the Standard Model

  Example: Multijet + E_T^{miss}-Signature

- 2. Step:
  Establish SUSY mass scale, use inclusive variables

  Example: effective mass distribution

- 3. Step:
  Determine Model parameters

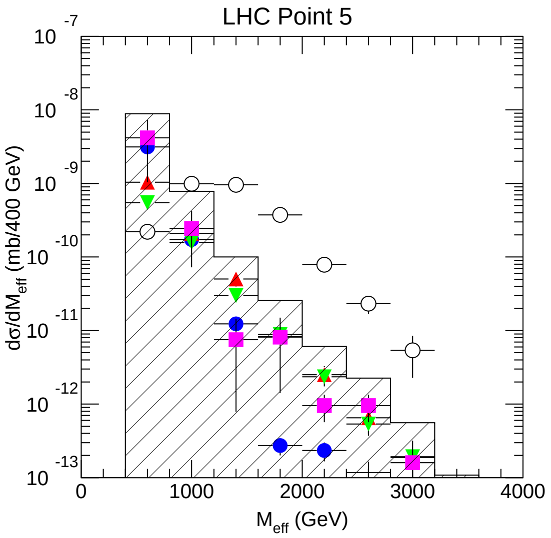
Squarks and Gluinos

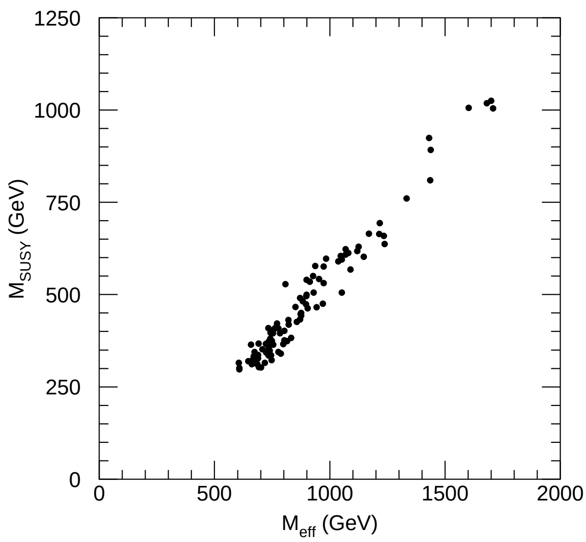
Experimental signature:

Several jets with large transv. momentum
missing transverse energy

define effective mass:

$$M_{eff} = E_T^{miss} + P_T^1 + P_T^2 + P_T^3 + P_T^4$$
$$M_{SUSY} = \min\ (M_{\tilde{g}},\ M_{\tilde{u}_R})$$



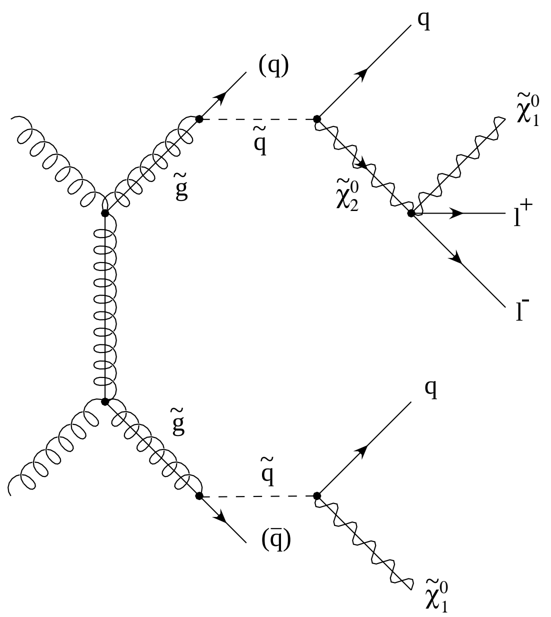


- good correlation between M_{eff} and M_{SUSY} (spread is shown for 100 minimal SUGRA models selected at random, $m_0, m_{1/2}$ and A_0 varied)

	Gluino mass limits $\int \mathcal{L}dt = 1\ fb^{-1}$	$\int \mathcal{L}dt = 100\ fb^{-1}$
$m_{\tilde{q}} = 2\ m_{\tilde{g}}$	1050 GeV	1600 GeV
$m_{\tilde{q}} \sim m_{\tilde{g}}$	1800 GeV	2300 GeV
$m_{\tilde{q}} = m_{\tilde{g}}\ /\ 2$	2600 GeV	3600 GeV

Determination of Model Parameters

- Determination of model parameters is difficult (two missing $\tilde{\chi}_1^0$, not enough constraints to reconstruct mass peaks)
- Reconstruct partially the decay chain



possible starting points:

$\tilde{\chi}_2^0 \quad \rightarrow \tilde{\chi}_1^0 h \quad \rightarrow \tilde{\chi}_1^0 \; b\bar{b}$

$\tilde{\chi}_2^0 \quad \rightarrow \tilde{l}^{\pm} l^{\mp} \quad \rightarrow \tilde{\chi}_1^0 \; l^+ l^-$

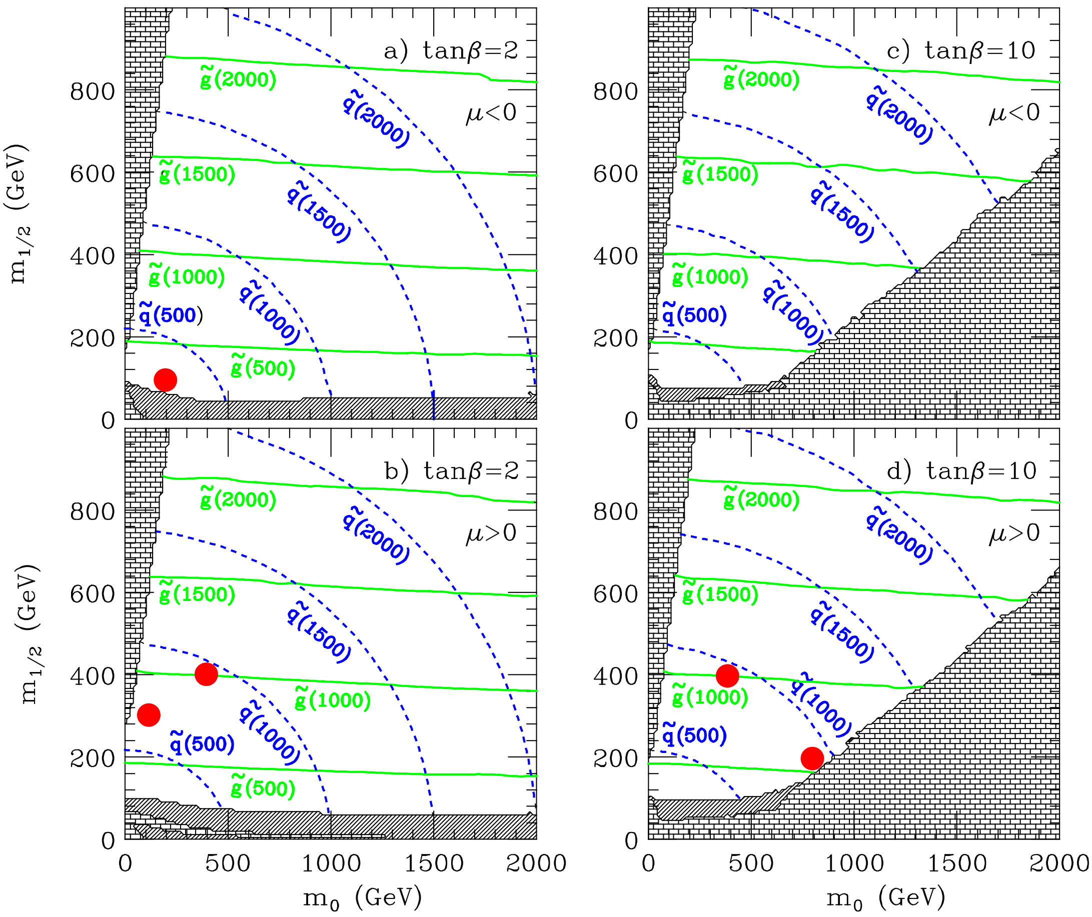
$\tilde{\chi}^+ \quad \rightarrow \tilde{\chi}_1^0 W \quad \rightarrow \tilde{\chi}_1^0 \; q\bar{q}$

- start at the bottom of the decay chain, work backwards
  example: endpoint of $m(l^+l^-)$ determines (m$\tilde{\chi}_2^0$ - m$\tilde{\chi}_1^0$)
- measure combinations of masses precisely
- global fit $\Rightarrow$ constrain model parameters

Which modes are available depends on the SUSY model and parameters.

ATLAS: discussed in framework of SUGRA models, 5 study points
m_0, $m_{1/2}$ and $\tan\beta$ can be determined with a precison at the percent level

The LHCC SUGRA Points



bricked and cross-hatched regions are excluded by theoretical constraints or by experimental data

SUGRA parameters:

m_0	common scalar mass at GUT scale
$m_{1/2}$	common gaugino mass at the GUT scale
$\tan\beta$	
A_0	common trilinear term
$sgn(\mu)$	sign of Higgsino mass parameter

use *point 5 to illustrate the methods*

Point 5: Mass Spectrum and decay modes

SUGRA Parameters

$m_0 = 100$ GeV
$m_{1/2} = 300$ GeV
$A_0 = 300$ GeV
$\tan\beta = 2.1$
$sign(\mu) = +$

Particle	Mass (GeV)
$\tilde{g}$	770
$\tilde{q}_L$	690
$\tilde{q}_R$	660
$\tilde{t}_1$	490
$\tilde{\ell}_L$	240
$\tilde{\ell}_R$	157
χ_1^0	121
χ_2^0	232
h	93
H	640

total cross section is dominated by $\tilde{q}\tilde{q}$, $\tilde{q}\tilde{g}$, and $\tilde{g}\tilde{g}$ -production;
large SUSY cross section: $\sigma_{SUSY} = 20$ pb

Decay modes of $\tilde{\chi}_2^0$:

Br $(\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 h) = 70\%$
Br $(\tilde{\chi}_2^0 \rightarrow \tilde{l}_R l) = 10\%$ per lepton flavour

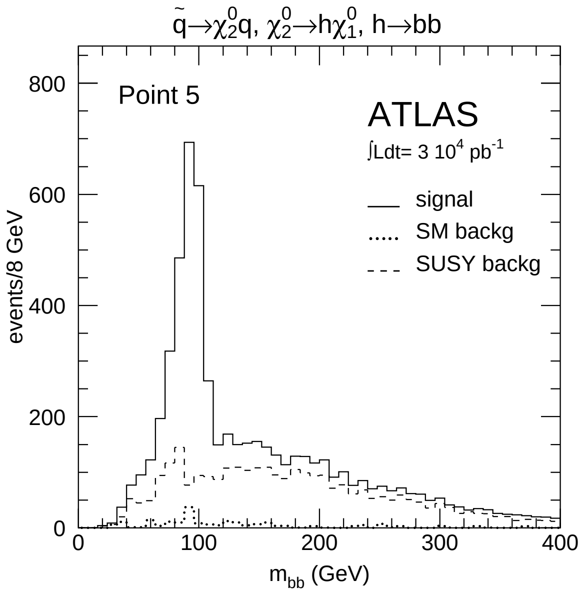
$pp \to \tilde{q}_L \tilde{q}_R$: $\quad \tilde{q}_R \to \tilde{\chi}_1^0 q$

$\tilde{q}_L \to \tilde{\chi}_2^0 q \to \tilde{\chi}_1^0 hq \quad \to \tilde{\chi}_1^0 b\bar{b}q$

The $h \to b\bar{b}$ is a clean signature/tag in SUSY events;
E_T^{miss}-cut can be used to suppress the large SM background

Selection cuts:

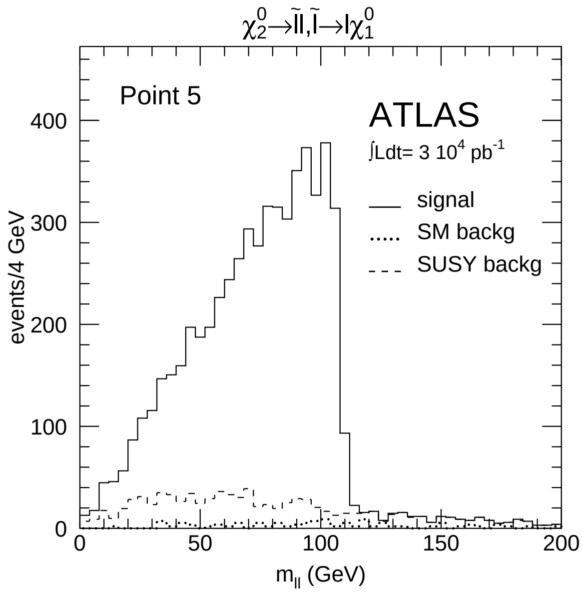
- 2 tagged b-jets, $P_T > 50$ GeV
- veto 3. b-jet
- 2 non b-jets (jet_1, jet_2) $P_T > 100$ GeV
- $E_T^{miss} > 300$ GeV
- veto isolated leptons



$$\tilde{\chi}_2^0 \to \tilde{l}_R l \to \tilde{\chi}_1^0 ll$$

Selection cuts:

- 2 leptons, same flavour, opp. charge
- large jet multiplicity
- $E_T^{miss} > 300$ GeV



very sharp edge on invariant mass of two leptons:
$m_{l^+l^-}^{max} = f(m_{\tilde{\chi}_2^0}, m_{\tilde{\chi}_1^0}, m_{\tilde{l}_R})$

Summary of Measurements in Point 5

Measurement	Expected value (GeV)	Error for 30 fb^{-1} (GeV)	Error for 300 fb^{-1} (GeV)
m_h	93	±1.0	±0.2
$m_{\ell^+\ell^-}$ edge	109	±0.5	±0.2
$m_{\tilde{\ell}_R}$	157	±1.9	±0.5
$m_{\tilde{\ell}_L}$	240	±10	±3
$m_{\tilde{q}_L}$	690	±12	±7
$m_{\tilde{q}_R}$	660	±20	±10
$m_{\tilde{g}}$	770	±20	±11
$m_{\tilde{t}_1}$	490		±50

Results of final parameter fit:

SUGRA parameter	Error for 30 fb^{-1}	Error for 300 fb^{-1}
$m_0 = 100$ GeV	±5 GeV	±3 GeV
$m_{1/2} = 300$ GeV	±8 GeV	±4 GeV
$\tan\beta = 2.1$	±0.11	±0.02

- m_0, $m_{1/2}$ and $\tan\beta$ can be determined with a precison at the percent level
- $sgn\ \mu$ unambiguously determined ($Br(\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 h)$)
- A_0 remains unconstraint, due to small influence on the phenomenology at the el.weak scale

Similar results have been obtained for the other points

Beyond SUSY, a few examples

Excited quarks: $q^* \rightarrow q\gamma$, up to: $m \sim$6 TeV

Leptoquarks, up to: $m \sim$1.5 TeV

Monopoles: $pp \rightarrow \gamma\gamma pp$, up to: $m \sim$20 TeV

Lepton flavour viol. $\tau \rightarrow \mu\gamma$: $10^{-6} - 10^{-7}$

Compositeness, up to: $\Lambda \sim$ 40 TeV

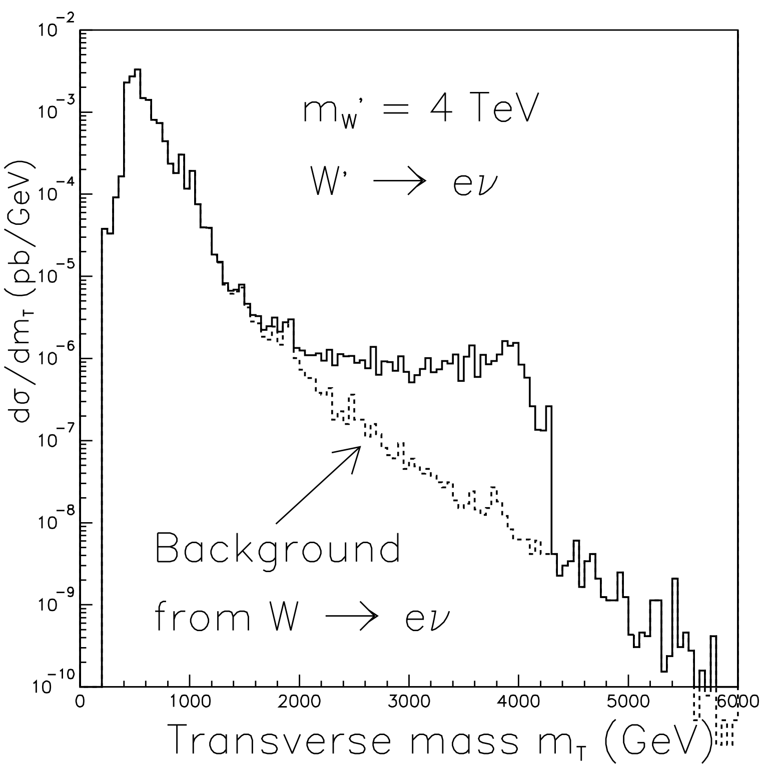
from di-jet and Drell-Yan,

needs calorimeter linearity better than 2%

$Z' \rightarrow ll, jj$, up to: $m \sim$5 TeV

$W' \rightarrow l\nu$, up to: $m \sim$6 TeV

$$\int \mathcal{L} dt \; = \; 100 \; fb^{-1}$$



Conclusions

- The ATLAS experiment at the LHC has a huge discovery potential for new physics:
  - SM Higgs: full mass range
  - MSSM Higgs: cover $(m_A, \tan\beta)$ plane fully
  - SUSY: $m_{\tilde{q}}$, $m_{\tilde{g}}$ up to $\sim$ 2 TeV, large discovery potential in MSSM, GMSB, RPV models
  - W', Z', ... up to $\sim$ 5 TeV
- Great potential also for precision measurements:
  - m_W to $\sim$ 20 MeV
  - many measurements in the top sector
  - m_H to 0.1%
  - fundamental SUGRA parameters to $\sim$ % level