LHC Discovery Potential

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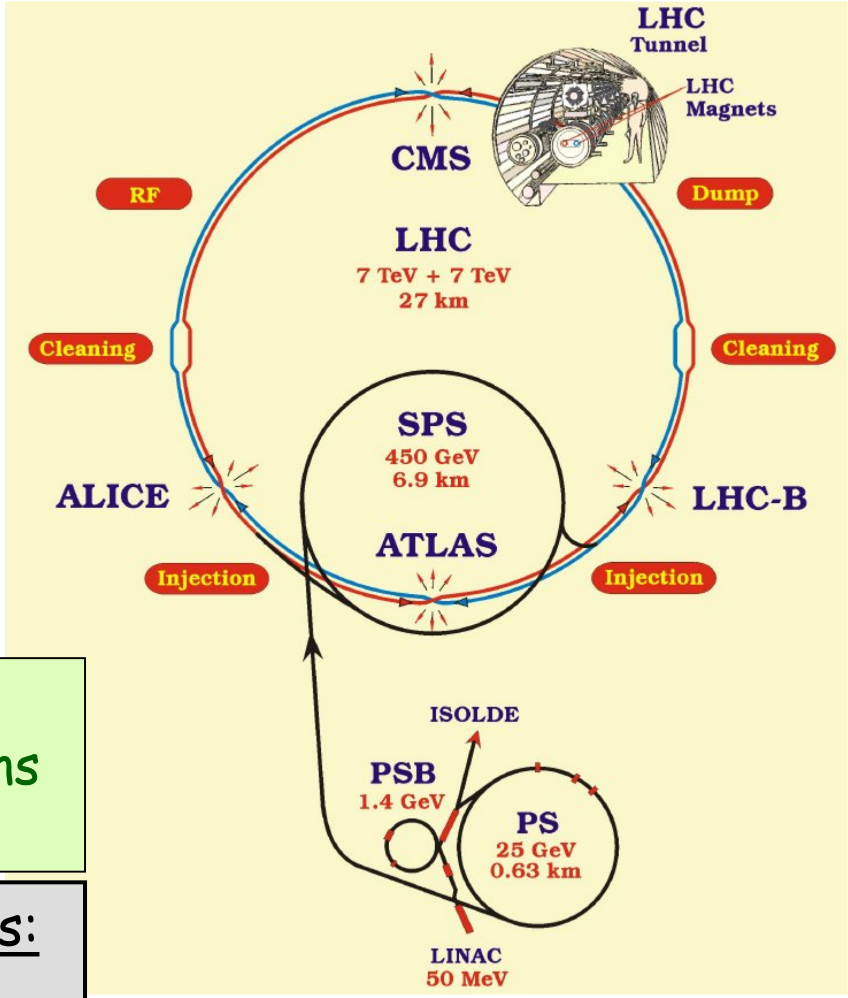
LHC Potential for Discovery

- Standard Model Higgs Boson:
- MSSM Higgs: discovery perspectives for the LHC experiments
- Super Symmetry (SUSY)
- Beyond the Standard Model (non SUSY): Large extra dimensions, extended gauge symmetries
- CP violation and rare decays

All the results assume full operative detector (full detector installed, final performances in terms of alignment, calibration, etc.)

Large Hadron Collider (LHC)

Injection Energy	0.45 TeV
Collision Energy	7 TeV
Dipole field at 7 TeV	8.33 T
Design Luminosity	10^{34} cm^{-2} s^{-1}
Luminosity Lifetime	10 h
Protons per bunch	10^{11}
Bunches per beam	2808
Bunch spacing	25 ns
DC Beam Current	0.56 A

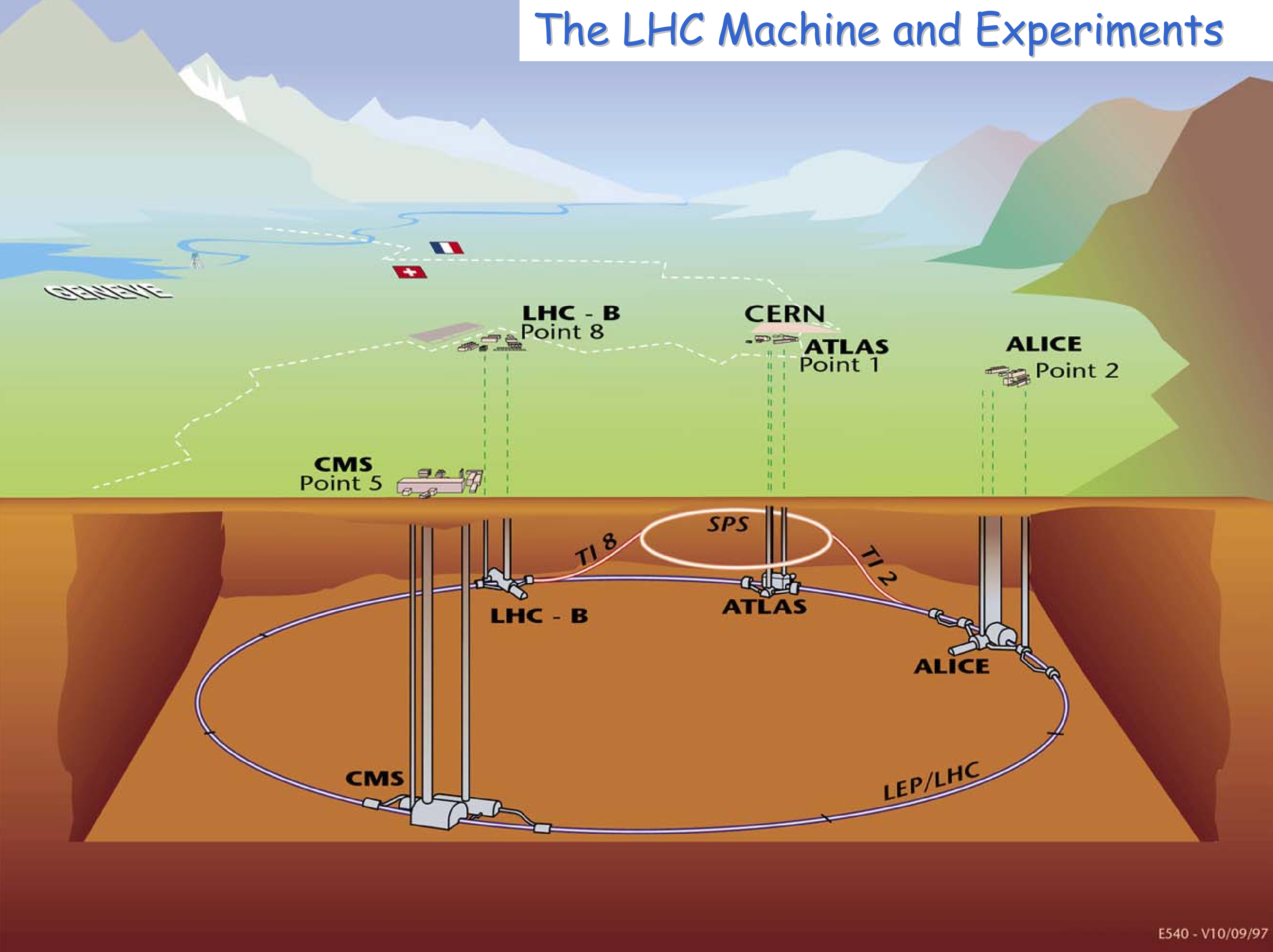


- ≈ 1 GHz interaction rate
- ≈ 23 minimum bias interactions per bunch crossing (pile-up)

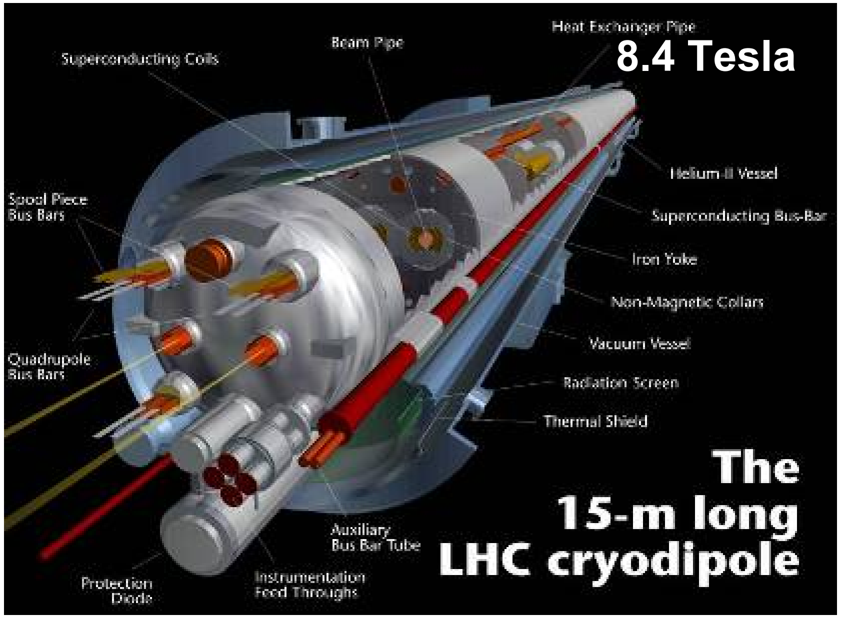
Extreme demands on detectors:

- high granularity
- high data-taking rate
- high radiation environment

The LHC Machine and Experiments

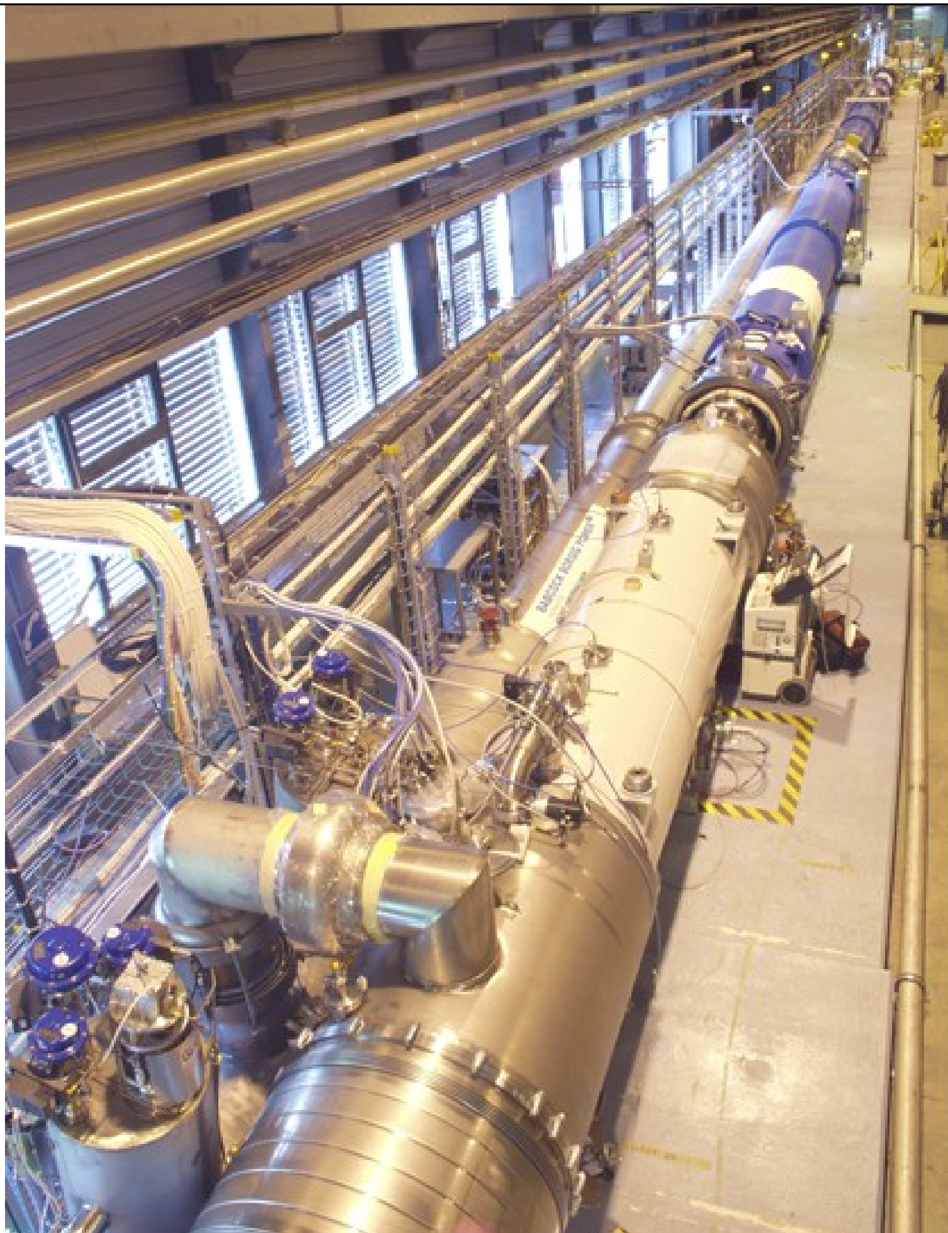


The LHC machine



More than half of the 1232 dipoles are produced

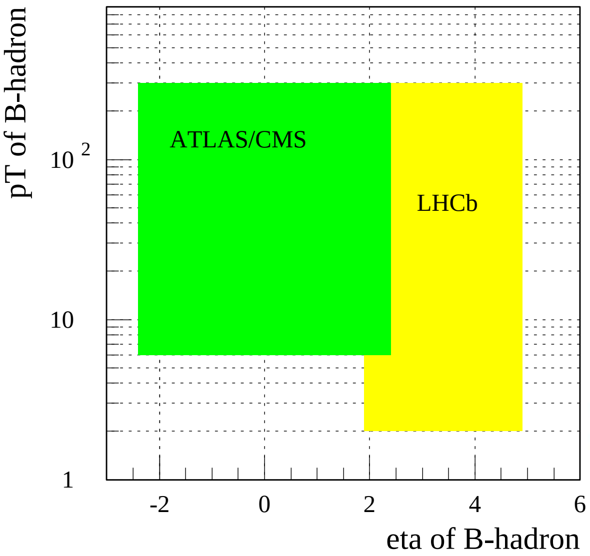
First full LHC cell (~ 120 m long) :
6 dipoles + 4 quadrupoles;
successful tests at nominal current (12 kA)

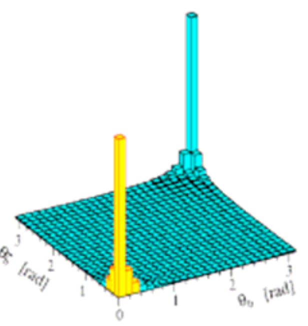


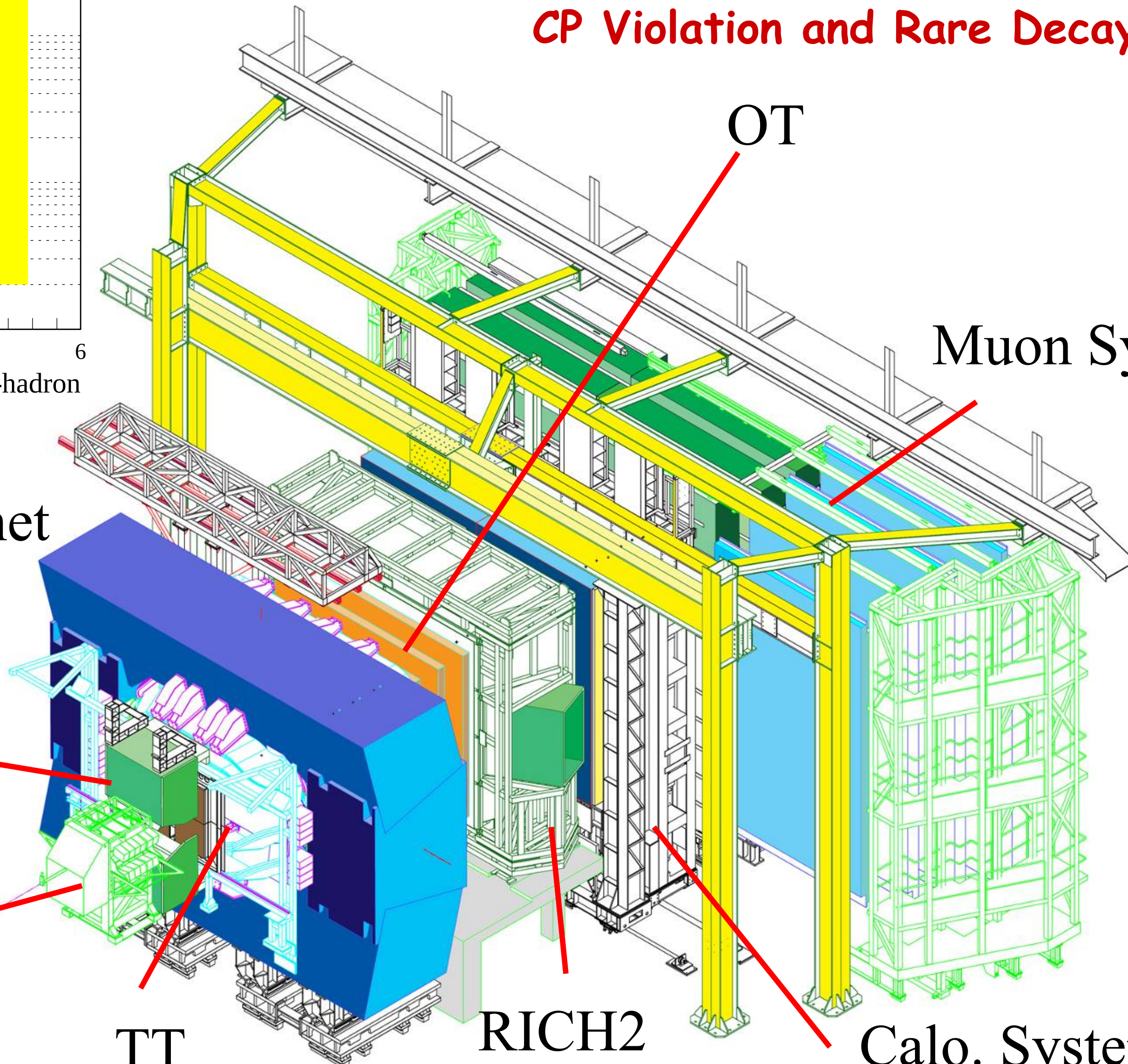
Lowering of the first dipole into the tunnel (March 2005)

The magnet production proceeds very well and is on schedule, also the quality of the magnets is very good

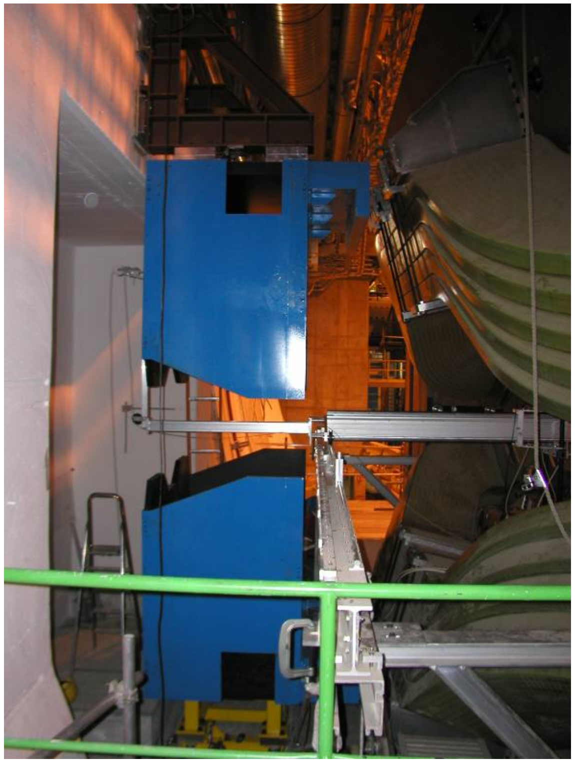
LHCb Spectrometer







LHCb Experimental Area



RICH1 shielding-box in front of magnet

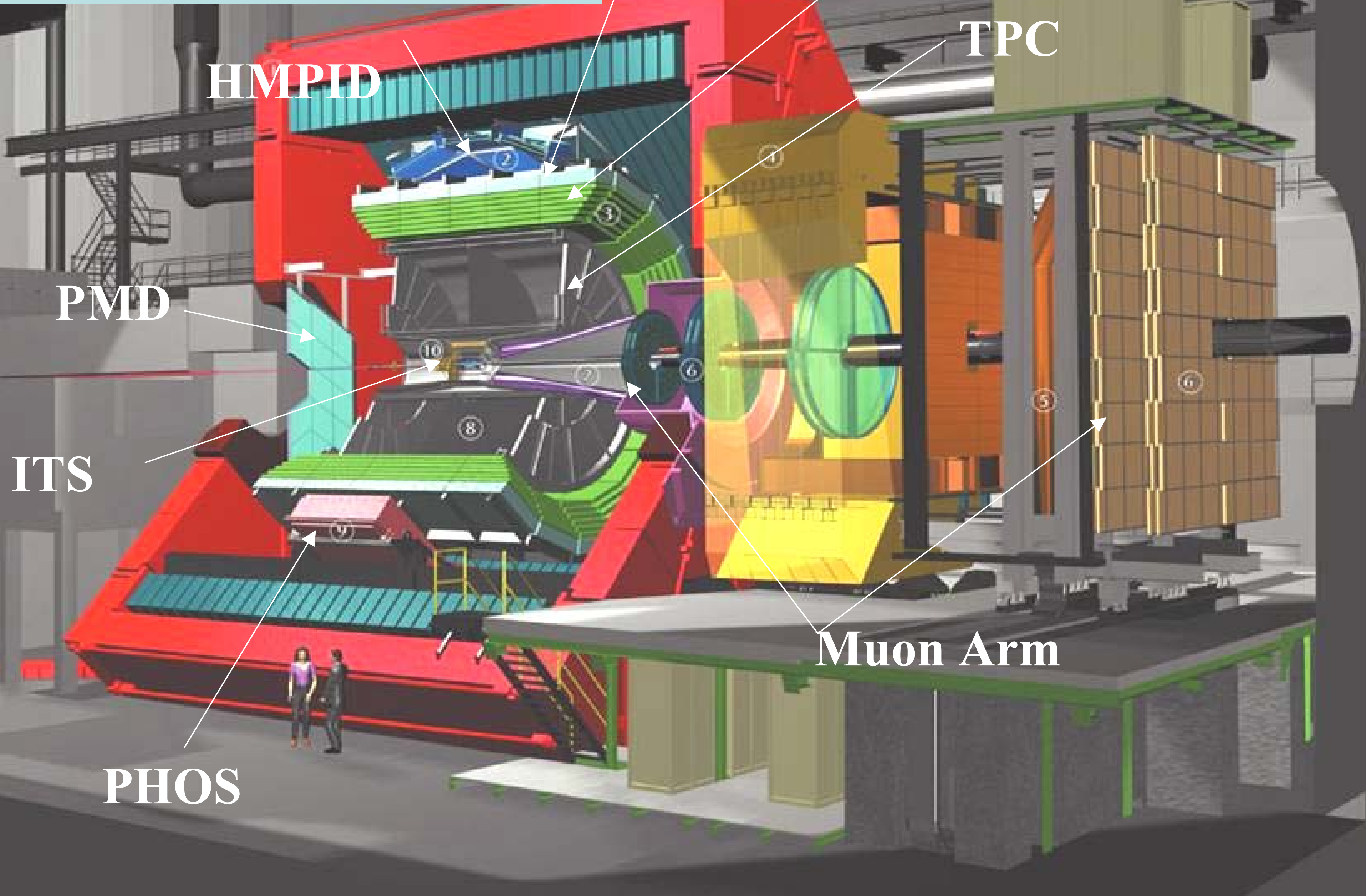
magnet

Ecal

Hcal

Fe muon filters

ALICE: A Large Ion Collider Experiment at CERN LHC



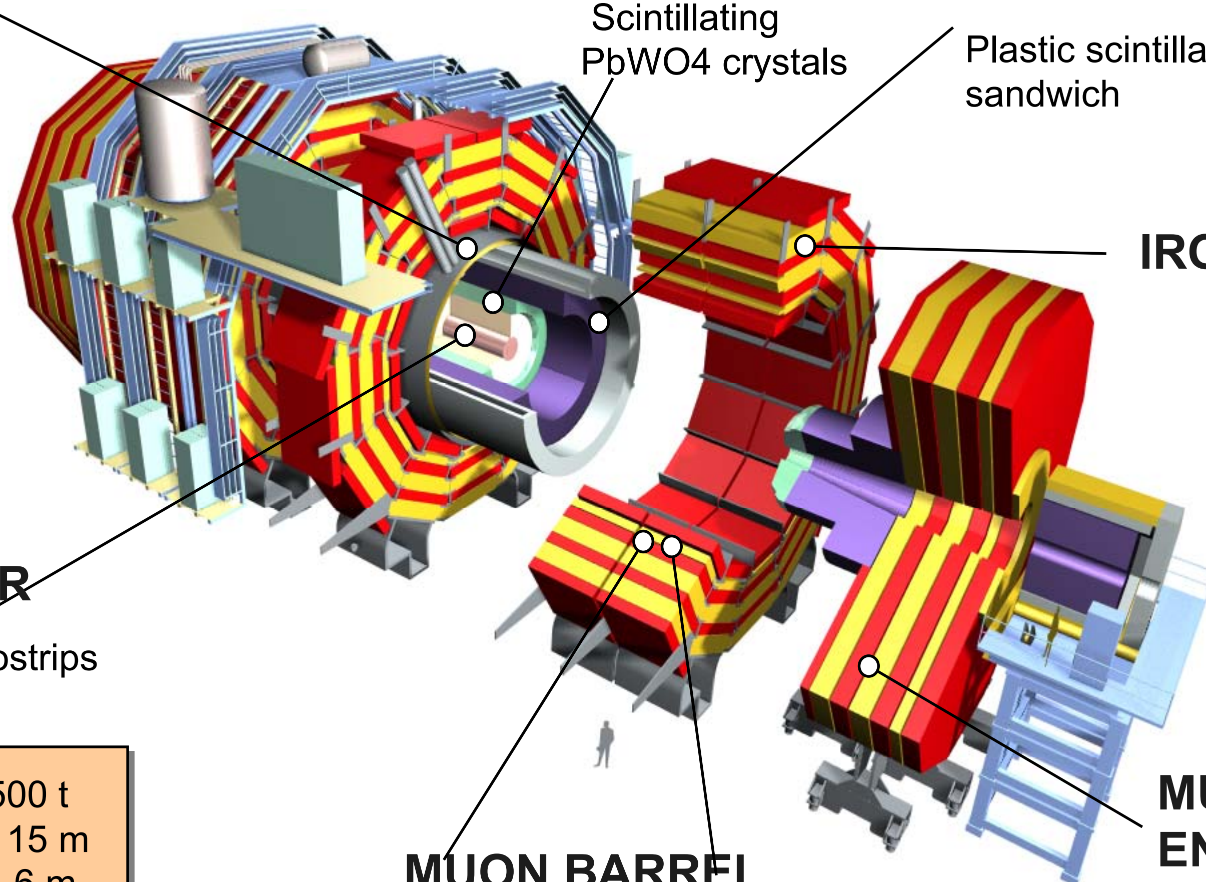
Detector

Size: 16 x 26 meters

Weight: 10,000 tons

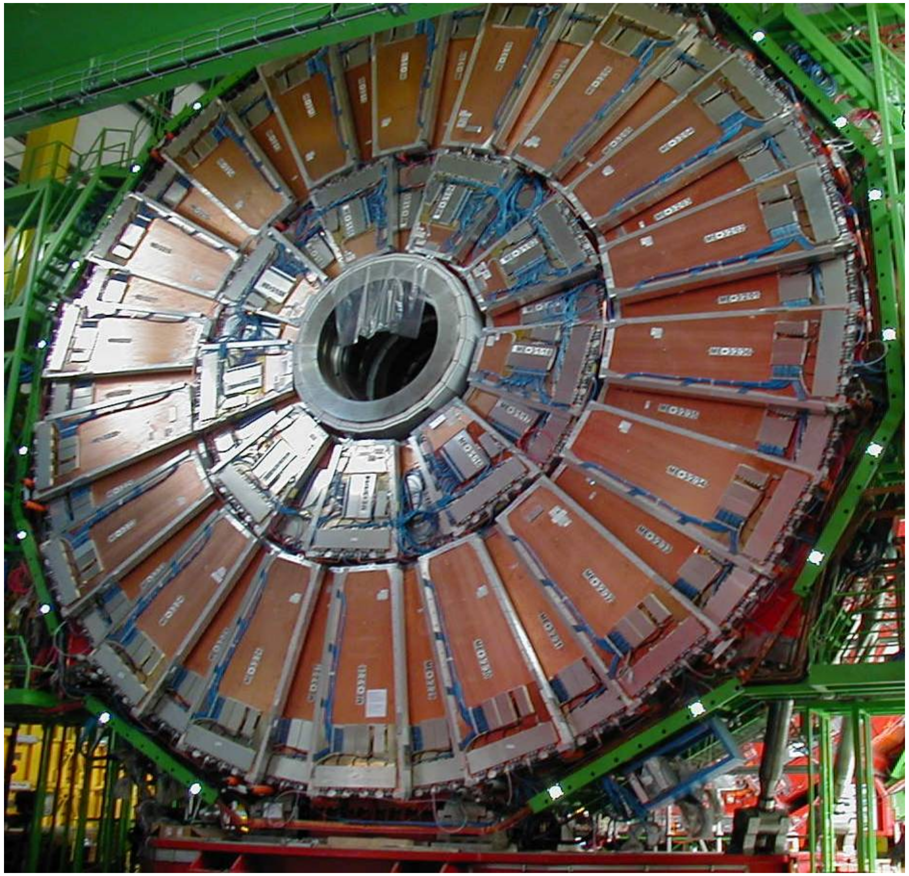

• still largest magnet
– magnet volume: 12 m long, 12 m high
– 0.5 T solenoidal field
The ALICE Magnet:
ready for the experiment to move in!

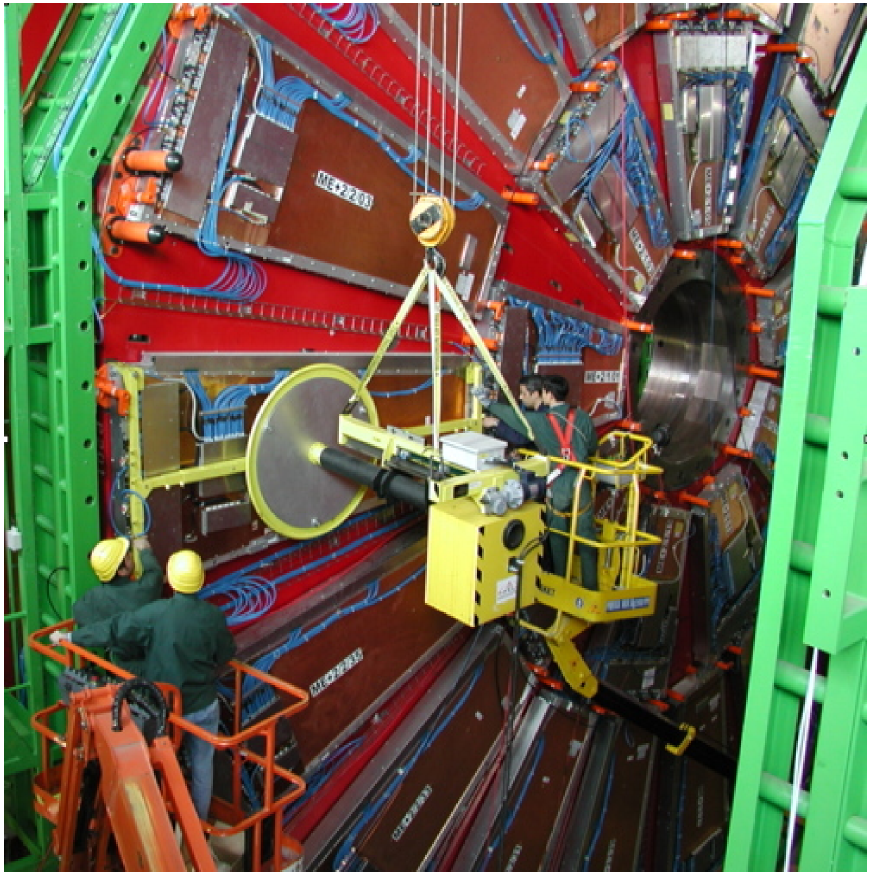
CMS: Compact Muon Solenoid



Total weight : 12,500 t
Overall diameter : 15 m
Overall length : 21.6 m
Magnetic field : 4 Tesla

CMS Endcap Muon Spectrometer





All 400 chambers produced !

CSC installation

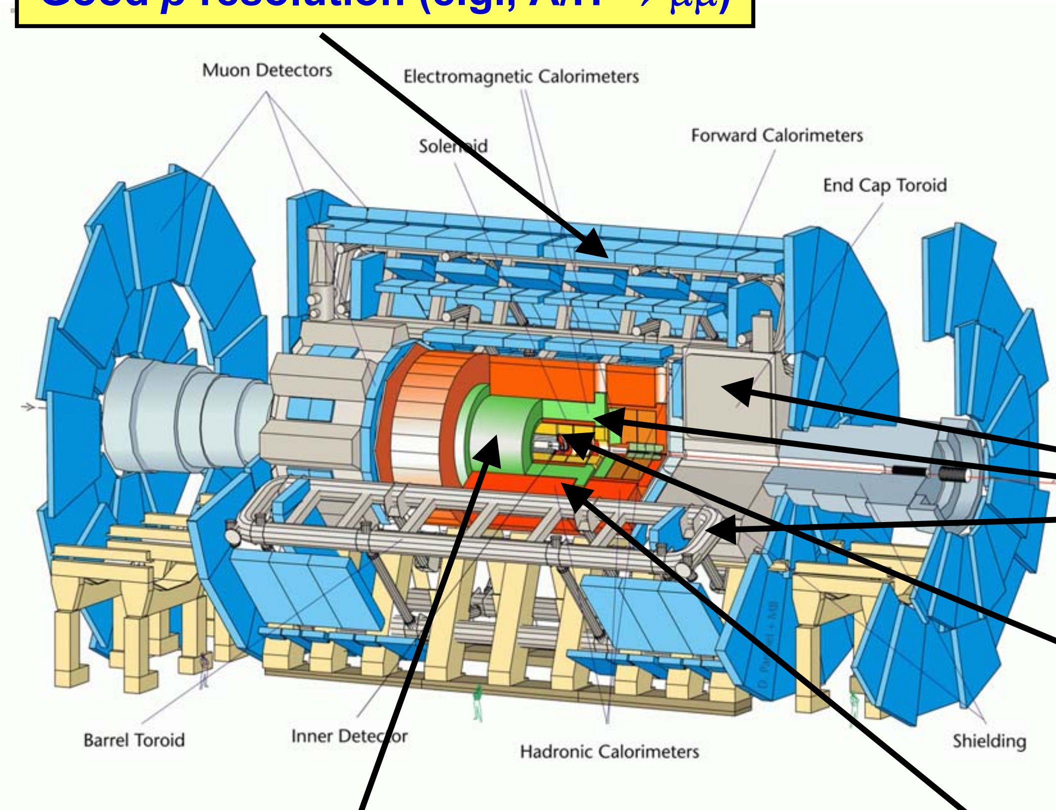
60% CSCs installed, 50% commissioned with cosmic rays

The ATLAS Detector

Muon Detectors $|\eta| < 2.7$
Fast response for trigger
Good *p* resolution (e.g., A/H → μμ)

ATLAS = A Toroidal LHC ApparatuS

Length: ~40m
Radius: ~10m
Weight: ~ 7000 t
El. Channels: ~10^8
Cables: ~3000 km

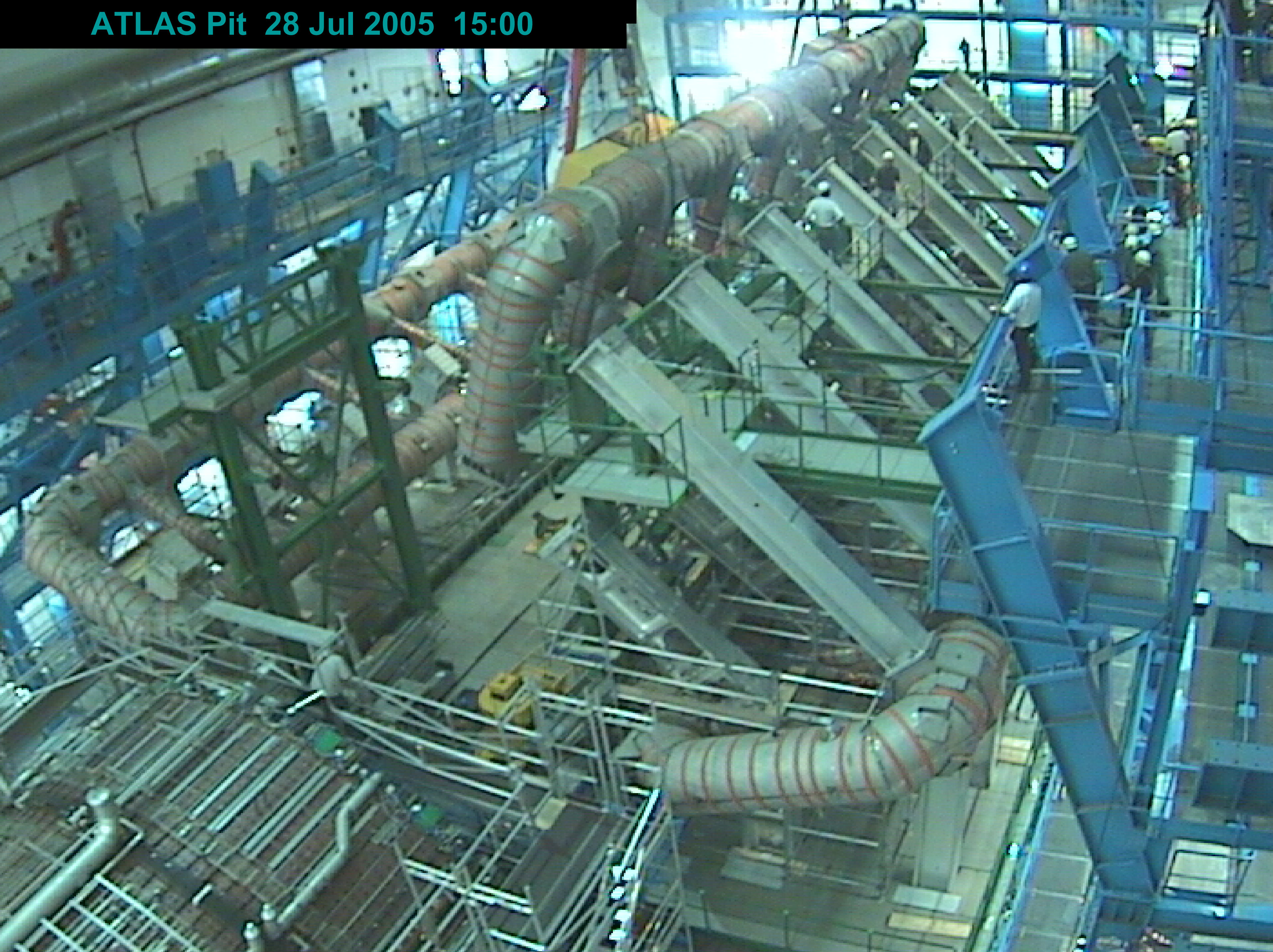


Magnet System
Central Solenoid (2T)
Air core Toroids (4T)

Inner Detector
High efficiency tracking
Good impact parameter res.
(e.g., H → bb) $|\eta| < 2.5$

Electromagnetic Calorimeters
excellent electron/photon identification
Good *E* resolution (e.g., H→γγ) $|\eta| < 3.2$

Hadron Calorimeters
Good jet and E_T miss performance
(e.g., H →ττ) $|\eta| < 4.9$


ATLAS Pit 28 Jul 2005 15:00

SM Higgs Boson

- The Higgs boson mass is not theoretically predicted. Both theoretical and experimental limits exist

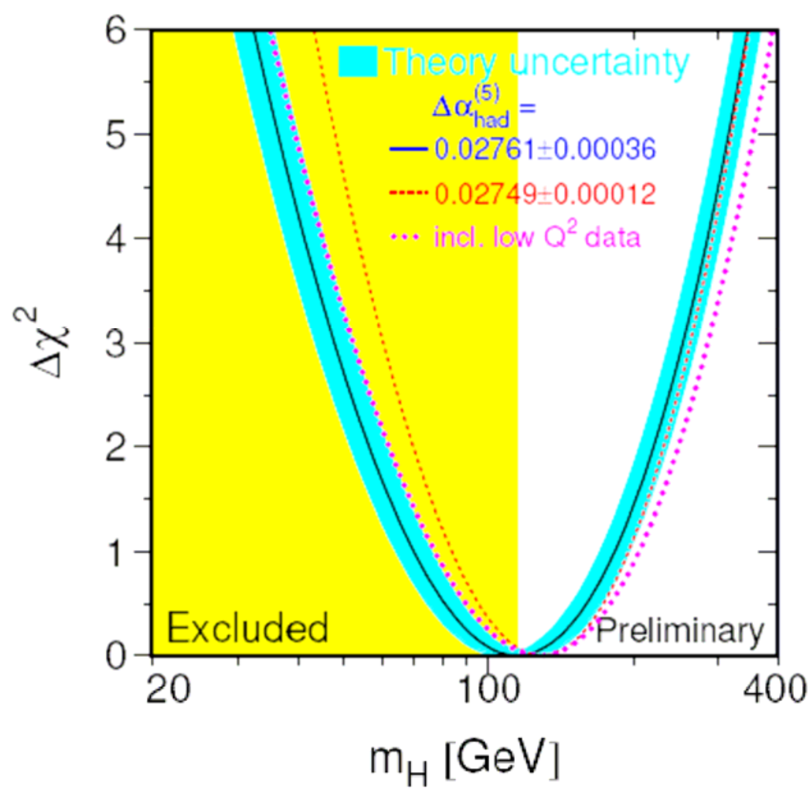
From direct LEP search:

$M_H > 114.4$ GeV

From the Electroweak fit of the standard model

$M_H < 260$ GeV

$M_H > 1$ TeV is theoretically forbidden



The LHC experiments will cover the range from the LEP limit up to the TeV scale

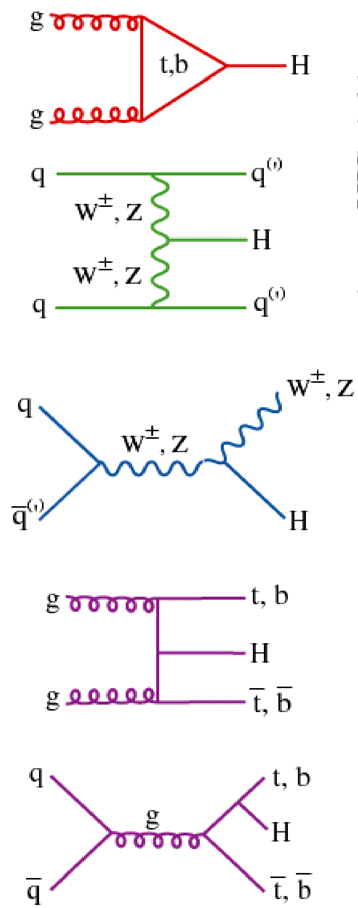
SM Higgs Production @ LHC

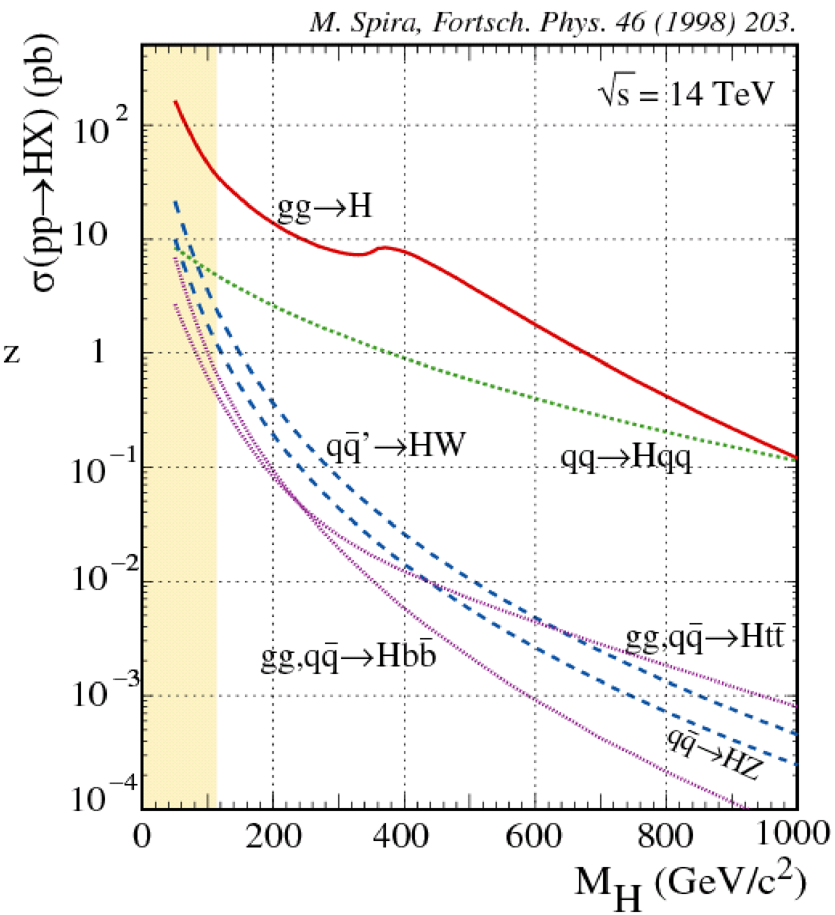
Gluon Fusion
- dominant process

Vector Boson Fusion
- 20% of gg @ 120GeV

Associated Production
- W or Z (1-10% of gg)

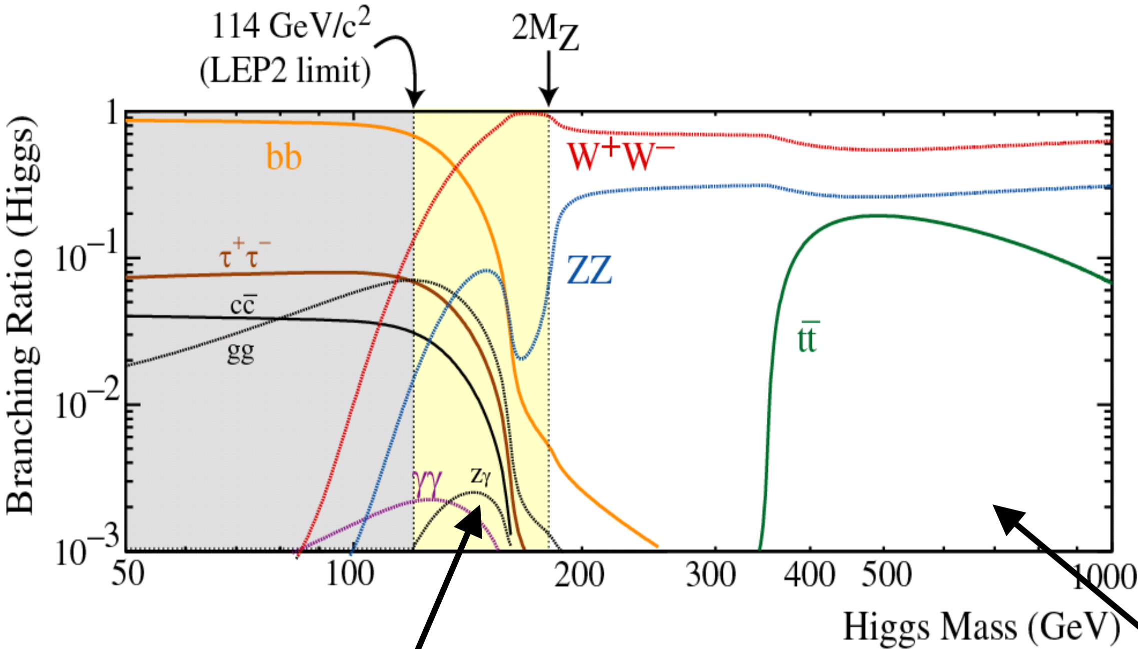
Associated Production
- $t\bar{t}$ or $b\bar{b}$ (1-5% of gg)





4 production mechanism ➡ key to measure H-boson parameters

Main Discovery Channels



Dominant BR for $m_H < 2m_Z$:

σ ($H \to b\bar{b}$) ≈ 20 pb;

σ ($b\bar{b}$) ≈ 500 μb

for m(H) = 120 GeV

→ no hope to trigger or extract fully had. final states

→ look for final states with λ, γ (λ = e,μ)

Low mass region: m(H) < 2 m_Z :

$H \to \gamma\gamma$: small BR, but best resolution

$H \to bb$: good BR, poor resolution ➔ $t\bar{t}H$, WH

$H \to \tau\tau$: via VBF

$H \to ZZ^* \to 4\lambda$

$H \to WW^* \to \lambda\nu\lambda\nu$ or $\lambda\nu jj$: via VBF

m(H) > 2 m_Z :

$H \to ZZ \to 4\lambda$

$qqH \to ZZ \to \lambda\lambda\ \nu\nu$ *

$qqH \to ZZ \to \lambda\lambda\ jj$ *

$qqH \to WW \to \lambda\nu jj$

* for m_H > 300 GeV forward jet tag

Higgs Decay into $\gamma\gamma$

The Higgs decay into $\gamma\gamma$ is a challenge for the EM calorimeters.

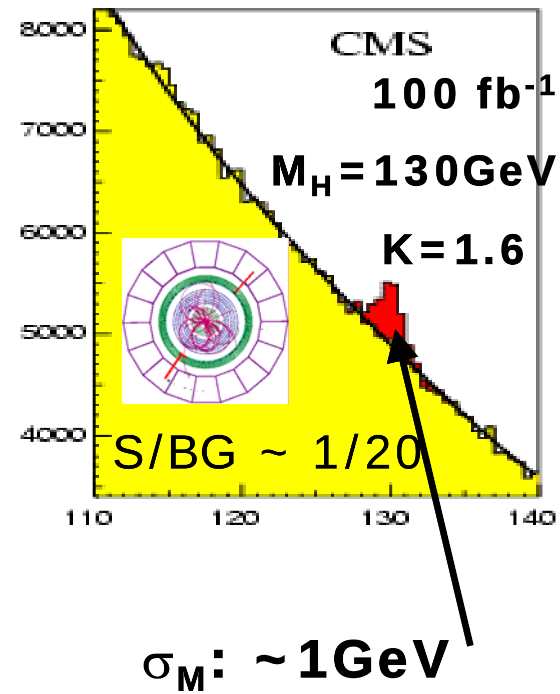
Key points: calorimeter resolution (and linearity), id of photons vs rejection against π_0

CMS(barrel, measured with 5x5 crystal array)

$$\frac{\sigma}{E} = \frac{2.7\%}{\sqrt{E(GeV)}} \oplus \frac{0.155}{E(GeV)} \oplus 0.55\%$$

ATLAS (barrel, module 0 at TestBeam, $\eta = 0$)

$$\frac{\sigma}{E} = \frac{9.2\%}{\sqrt{E(GeV)}} \oplus 0.47\%$$



Calorimeter segmentation is critical to reject jets. For ~80% efficiency, the jet rejection factor is 1000 to 4000, depending on the E_T

Dedicated algorithm for the recovery of photon conversion (~1/3) in the material in front of the EM calorimeter

Main backgrounds: irreducible $\gamma\gamma$ dominant. γj and jj together are half the irreducible background

Higgs Decay into ZZ

Final states investigated: 2e2μ, 4μ, 4e

Irreducible background from direct ZZ production

Reducible background coming mainly from tt,Zbb

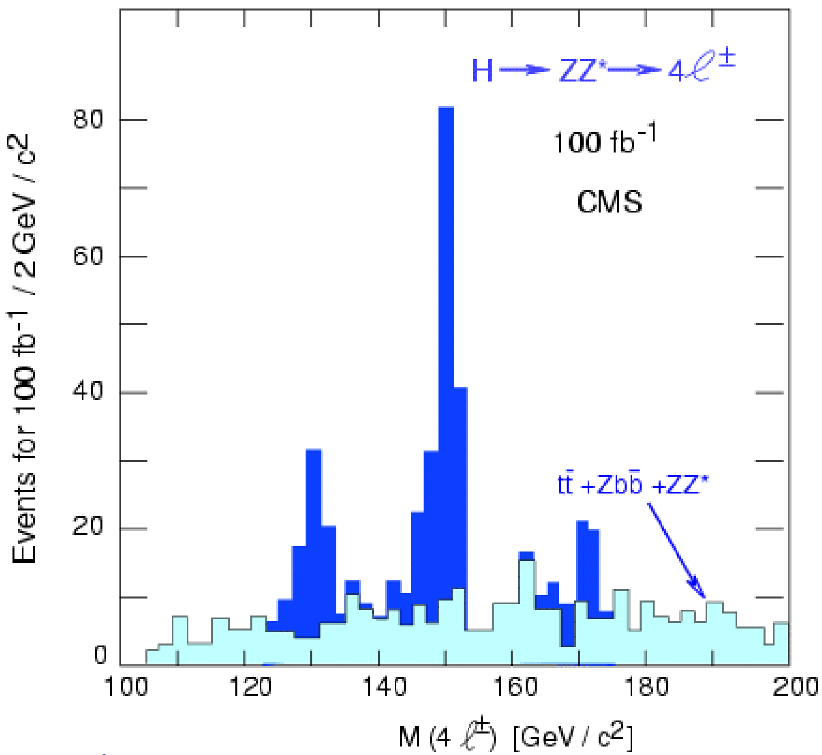
The reducible background are strongly reduced by isolation criteria on the leptons and by b-veto

The channel is useful for the Higgs discovery in the ranges

130 GeV < M_H < 150 GeV

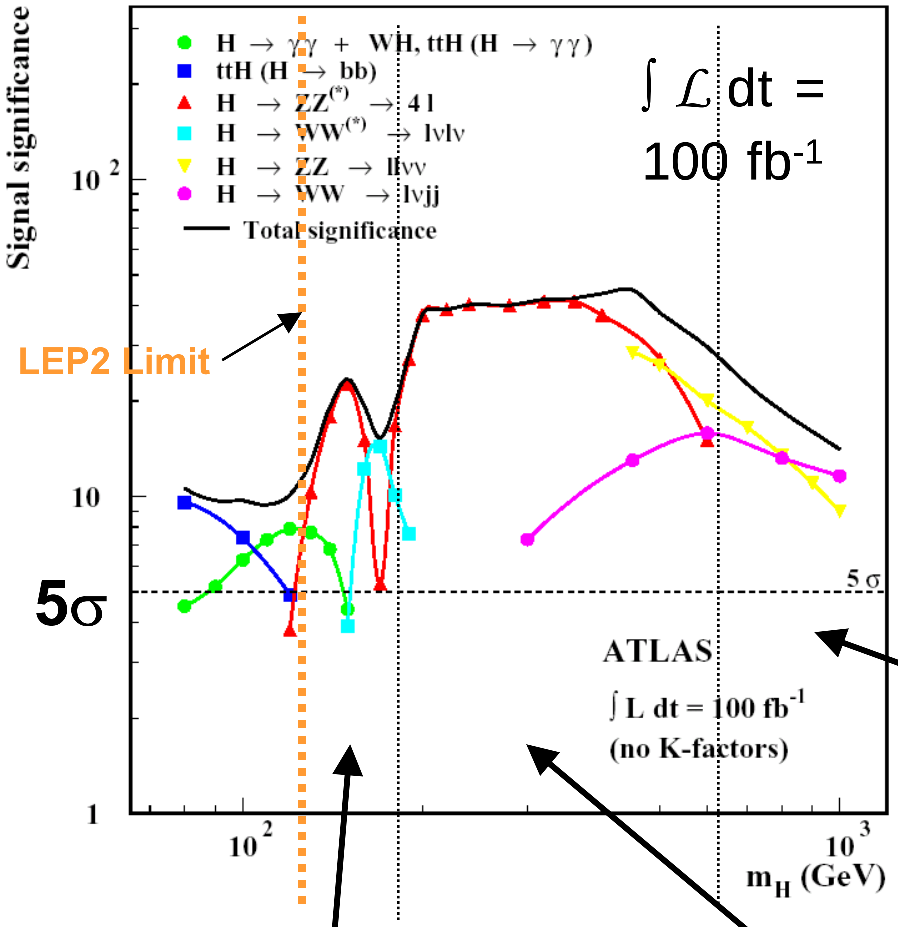
and

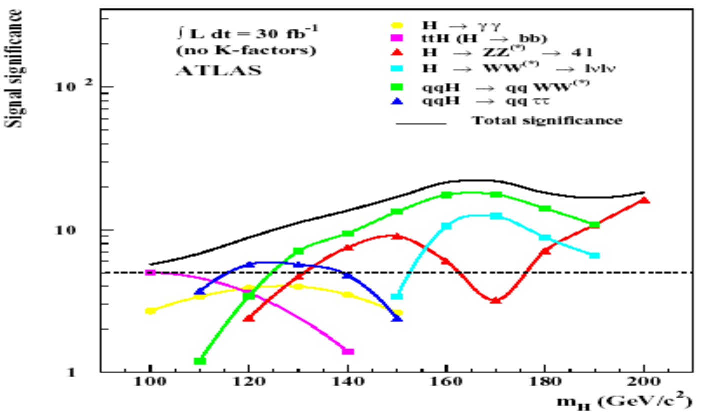
180 GeV < M_H < 600 GeV



(H→WW is opened at ~160 GeV)

Overall Higgs Significance for $\mathcal{L}$ = 100 fb^{-1}





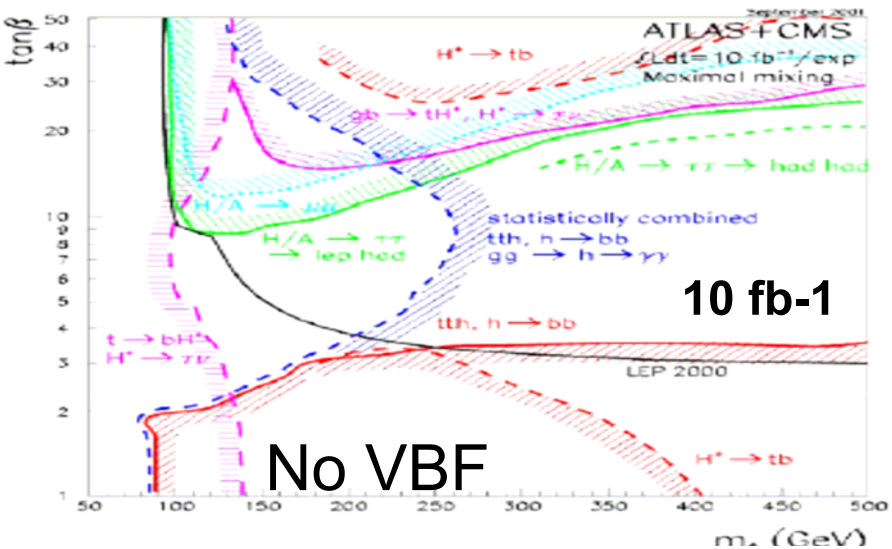
VBF channels improve the low mass region!

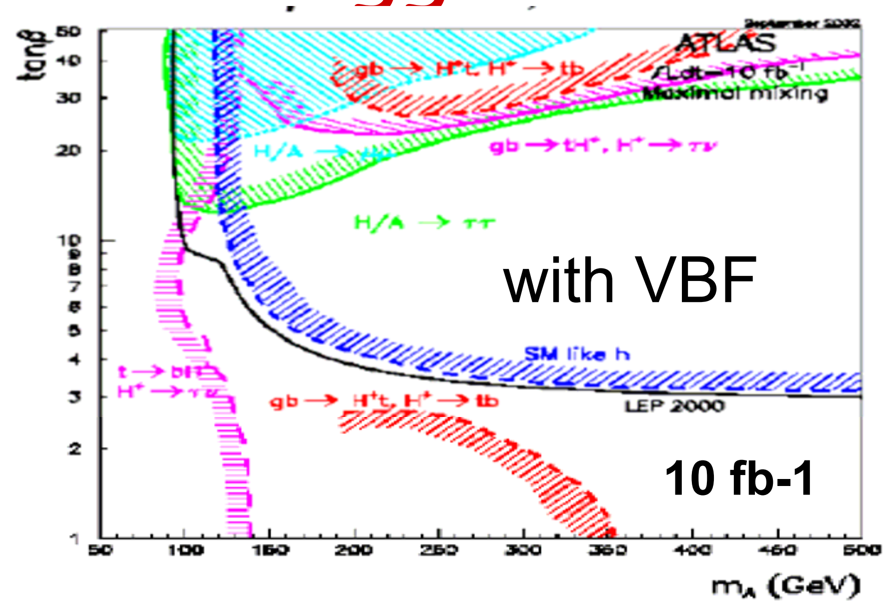
700 GeV < m_H < 1 TeV:
need H → ZZ → λλνν, λλjj
H → WW → λνjj

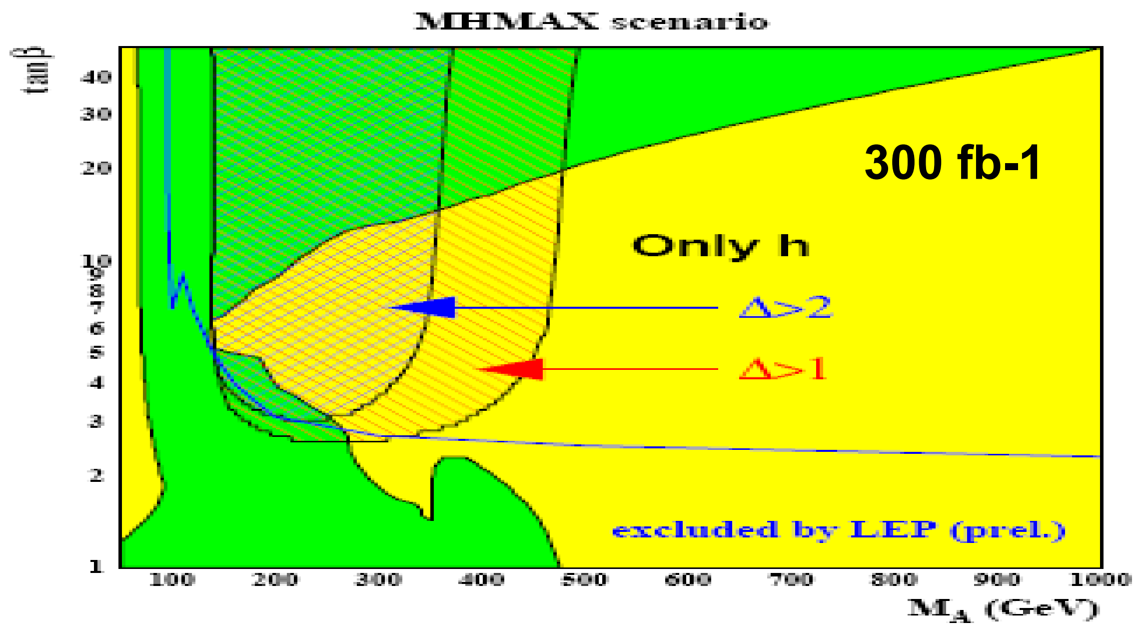
114 GeV < m_H < 190 GeV:
several complementary channels

190 GeV < m_H < 700 GeV:
easy with H → ZZ → 4λ

Prospects for Extended Higgs Sector



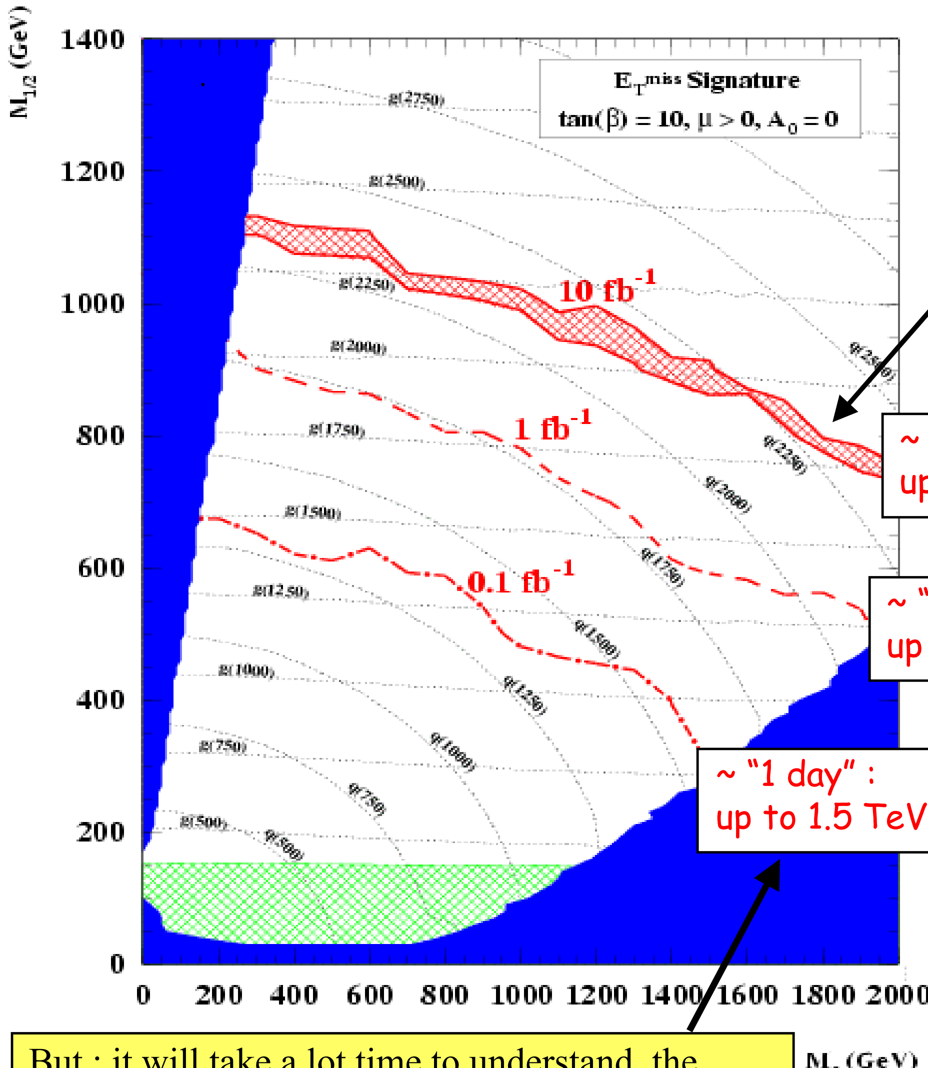




$$R = \frac{BR(h \to \tau\tau)}{BR(h \to WW)} \qquad \Delta = \frac{R_{MSSM} - R_{SM}}{\sigma_{erw}}$$

Still in a region we can disentangle looking at the ratio between the BR into $\tau\tau$ and WW. Anyway, it is difficult….

Super Symmetry - mSUGRA Reach



5 σ contours

band indicates factor ± 2 variation in in background estimate

~ 100 days : up to 2.3 TeV

~ "10 days" : up to 2 TeV

~ "1 day" : up to 1.5 TeV

But : it will take a lot time to understand the detectors and the backgrounds …

Can be discovered up to $m_{\tilde{q}\tilde{g}} \sim$ 2.5-3.0 TeV

$\sigma(\tilde{q}\tilde{q}, \tilde{g}\tilde{g}, \tilde{q}\tilde{g}) \sim$ pb

($m_{\tilde{q}\tilde{g}} \sim$ 1 TeV)

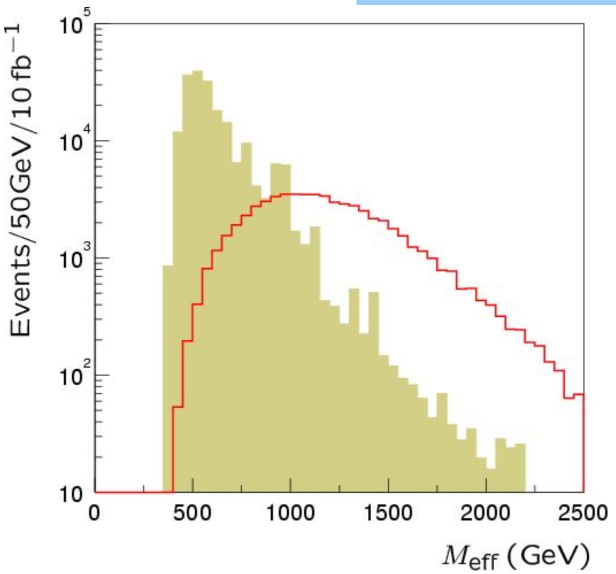
signature: cascade with many jets, leptons, W, Z, b, top in the final state

… can ATLAS/CMS perform precise measurements (masses, couplings etc.)?

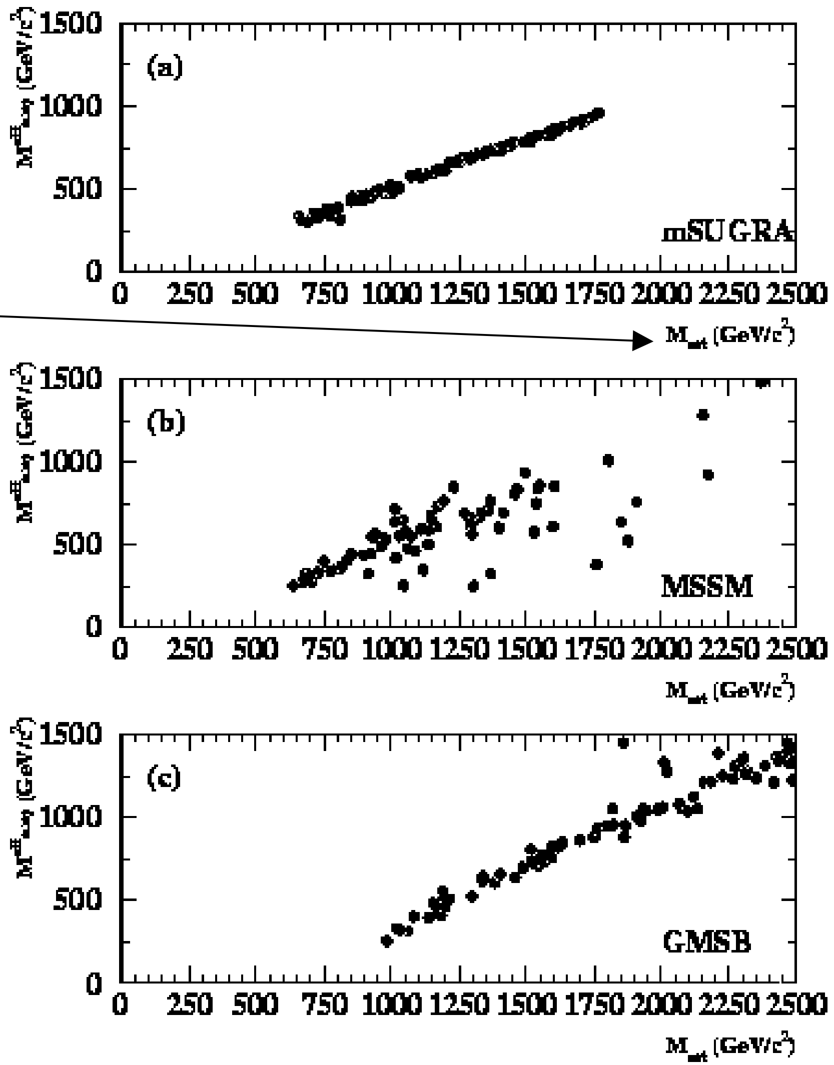
SUSY Mass Scale

For 'Jets + E_T^{miss} + 0 leptons' events, define:

$$M_{eff} = E_T^{miss} + \sum_{j=1}^{Njets} p_T^j$$



Peak position is related to the SUSY mass scale



$$M_{eff}^{SUSY} = \left(M^{SUSY} - \frac{M_\chi^2}{M^{SUSY}} \right)$$

$$M^{SUSY} = \min\{mass(\tilde{u}), mass(\tilde{g})\}$$

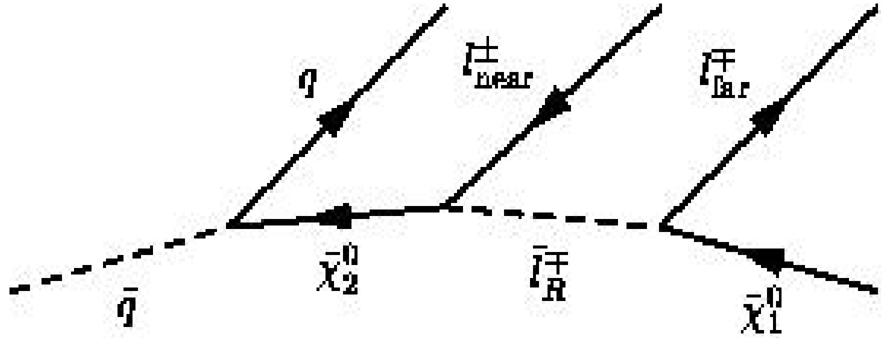
Dilepton Edge

Leptonic decays for χ^0_2 in large part of parameter space:

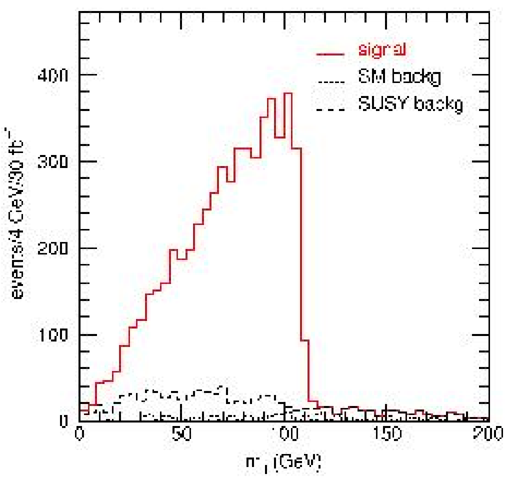
$$\tilde{\chi}_2^0 \to l^+ l^- \tilde{\chi}_1^0$$

$$\tilde{\chi}_2^0 \to \tilde{l}_R\, l \to l^+ l^- \tilde{\chi}_1^0$$

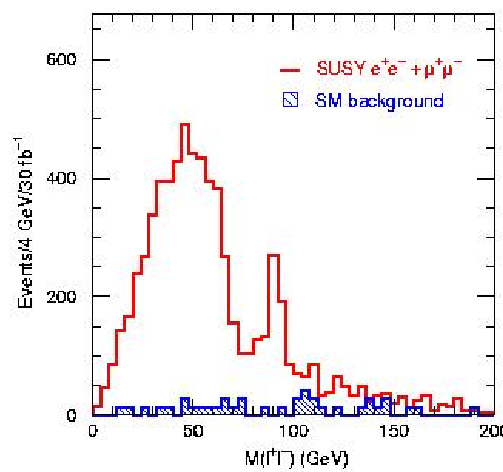
$$\tilde{\chi}_2^0 \to Z \tilde{\chi}_1^0$$



The shape of m_{ll} distribution shows whether 2 or 3 body decays



Decay to l and slepton



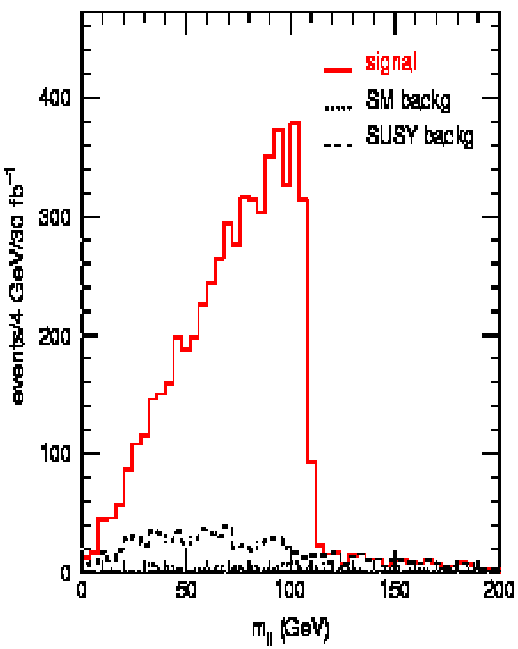
Decay to $l\,l\,\chi^0_1$ and $Z\,\chi^0_1$

Dilepton Edge Example

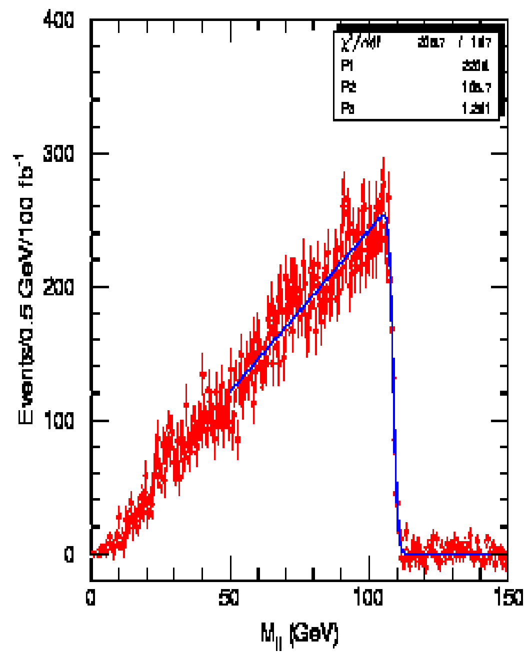
m_0 = 100 GeV, $m_{1/2}$ = 300 GeV

Expected edge position for signal:

$$M_{ll}^{max} = M(\tilde{\chi}_2^0)\sqrt{1-\frac{M^2(\tilde{l}_R)}{M^2(\tilde{\chi}_2^0)}}\sqrt{1-\frac{M^2(\tilde{\chi}_1^0)}{M^2(\tilde{l}_R)}} = 108.93\ \mathrm{GeV}$$



Signal after cuts



Flavour subtraction

SM background is primarily tt → jjllνν.
Signal is SF only,
OF subtraction removes SM background.

Edge position fitted to give mass relations at % level with 100 fb^{-1}

Mass Measurements

Edges give handle on sparticle masses:

$\ell^+\ell^-$

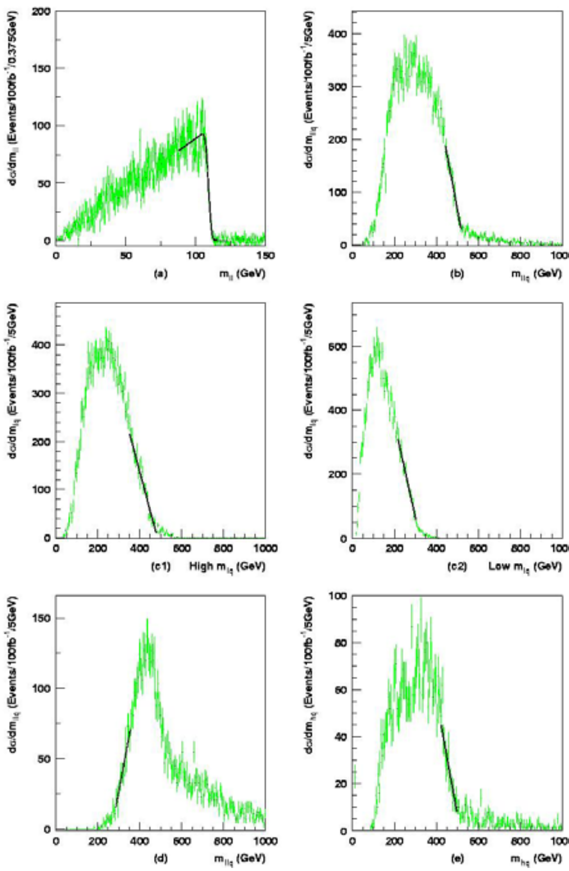
$\ell\ell q$ edge

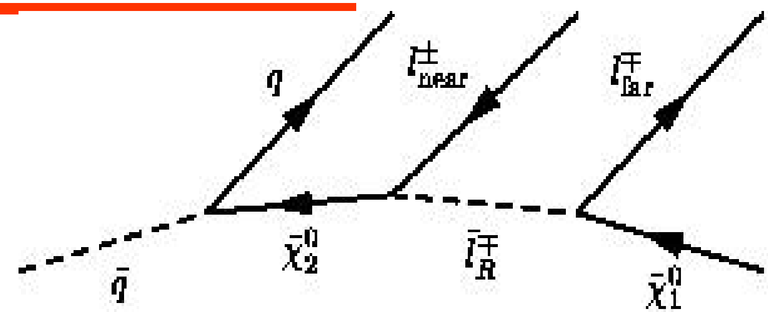
ℓq high

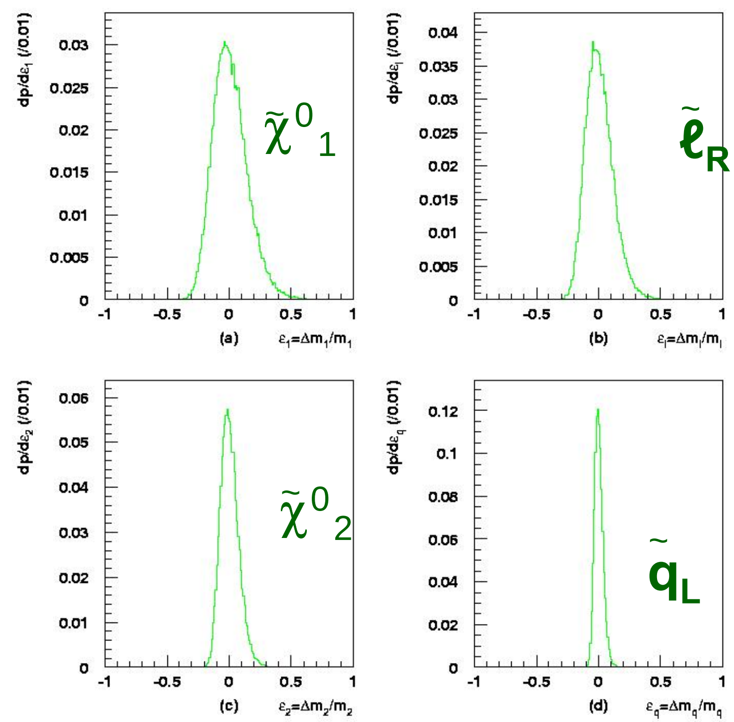
ℓq low

$\ell\ell q$ thr.

hq







Masses can be measured to ~ 3 - 12 %

BSM: Selected of topics

- **Extended gauge symmetries:**
  - Heavy Gauge bosons: Z′,W′
  - Little Higgs
  - LRSM: H++, Z′, W′, Majorana N…
  - **Heavy fermions**
  - **Isosinglet quarks (E6 down, Top)**

  Flavour Changing Neutral Current

  Compositeness:
  - **Excited fermions (electrons, quarks)**

  Leptoquarks
- **Extra dimensions**

  Large extra dimensions:
  - direct Graviton production
  - **Virtual exchange of gravitons**
  - Black Holes

  Small extra dimensions:
  - KK excitations of gauge bosons: W, Z and g
  - **Universal extra dimensions**
  - Coupling unification

  Warped extra dimensions:
  - RS radion
  - Narrow Graviton resonance

Little Higgs Model (2001)

(see hep-ph/0301040)

- Quadratic divergences

bosons ⟷ new fermions
cancellations
fermions ⟷ new bosons

Supersymmetry

Little Higgs

bosons ⟷ new bosons
cancellations
quark t ⟷ new quark t

New particules

- Heavy gauge bosons

Z_H W_H A_H

- Heavy quark top

T

- Heavy Higgses

ϕ^0 ϕ^+ ϕ^{++}

NB : SM Higgs remains with the same properties (BR ...)

- Symmetries and pseudo-Goldstone bosons

	big scale		electroweak scale
global symmetry	SU(5)	symmetry breaking →	SO(5)
local symmetry			$SU(2)_L \times U(1)_Y$

Goldstone bosons massless → electroweak symmetry breaking → pseudo-Goldstone bosons "light" mass

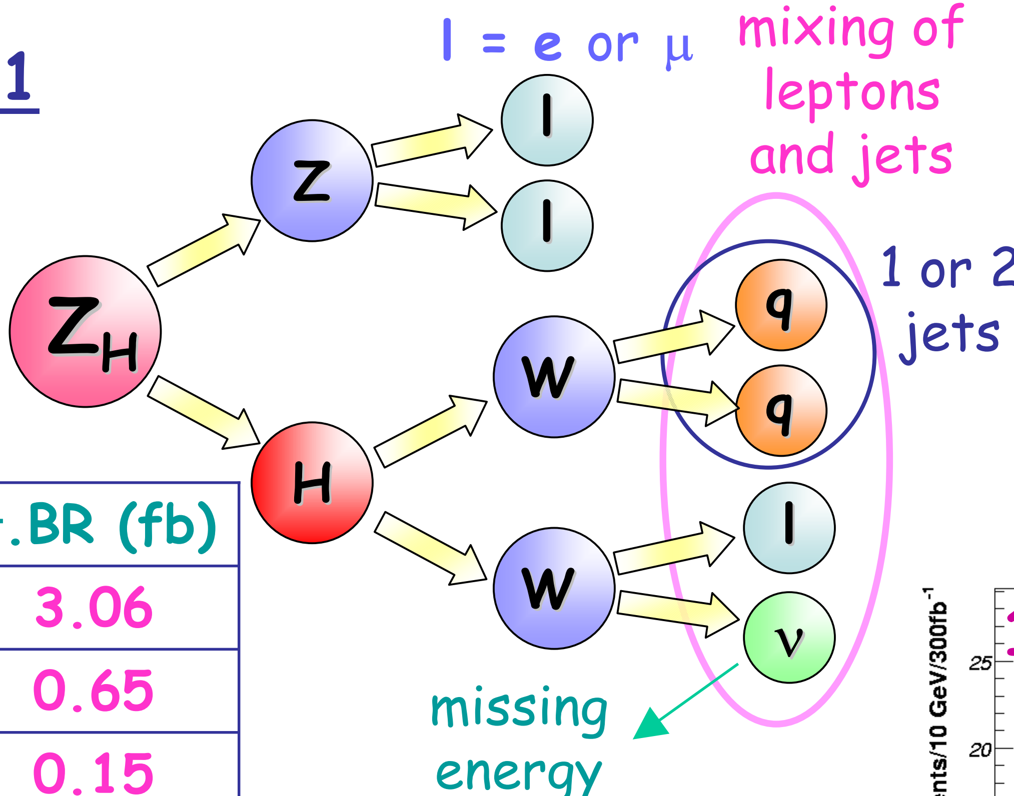
- To note

effective model up to Λ=10 TeV, compatible with experimental constraints

28

M(H)=200 GeV (1)

Signal 1



$M(Z_H)$	σ.BR (fb)
1000	3.06
1500	0.65
2000	0.15

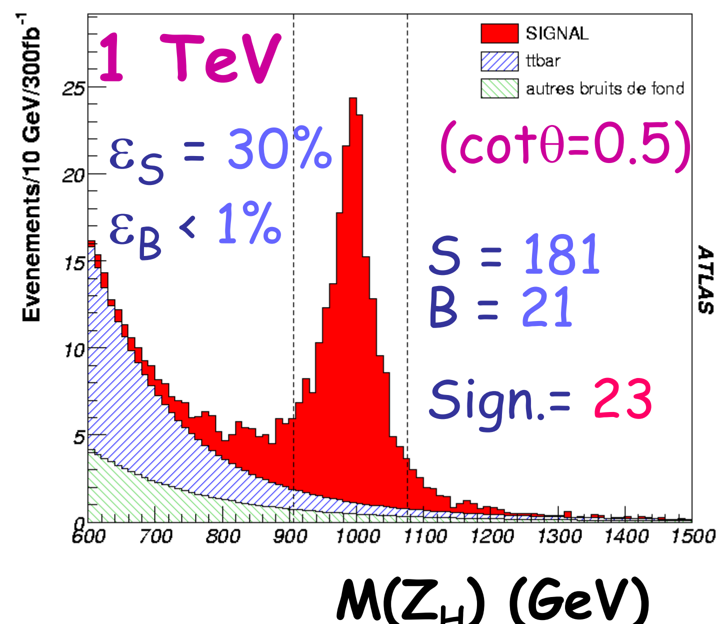
(cotθ=0.5)

Backgrounds

	σ.BR (fb)
$t\bar{t}$ (3l)	3376
WZ(3l)	388
ZZ(4l)	71
H(4l)	47
others	<13

Most efficient cuts

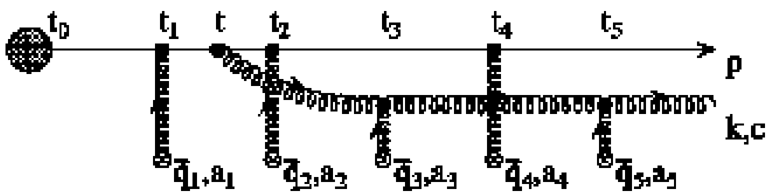
- on reconstructed masses of H and Z_H/W_H
- on transverse impulsion of the Higgs and the W going in quarks

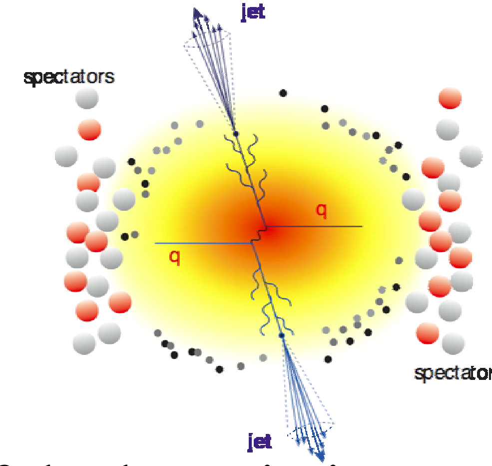


Heavy Ion: Jet quenching

Energy loss of fast partons by excitation and gluon radiation

larger in QGP





- Suppression of high-z hadrons and increase of soft hadrons in jets.

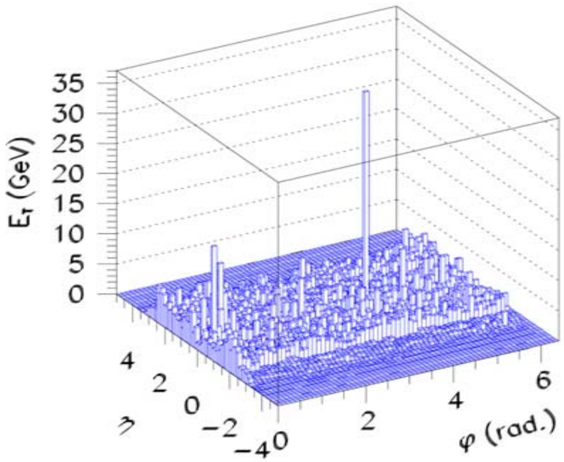
- Induced gluon radiation results in the modification of jet properties like a broader angular distribution.

Could manifest itself as an increase in the jet cone size or an effective suppression of the jet cross section within a fixed cone size.

- **Measuring jet profile is the most direct way to observe any change.**

Heavy Ion: Jet Studies

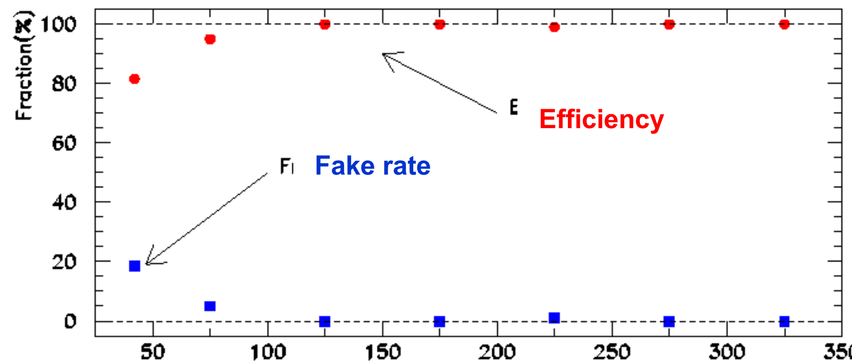
PYTHIA jets embedded with central Pb-Pb HIJING events

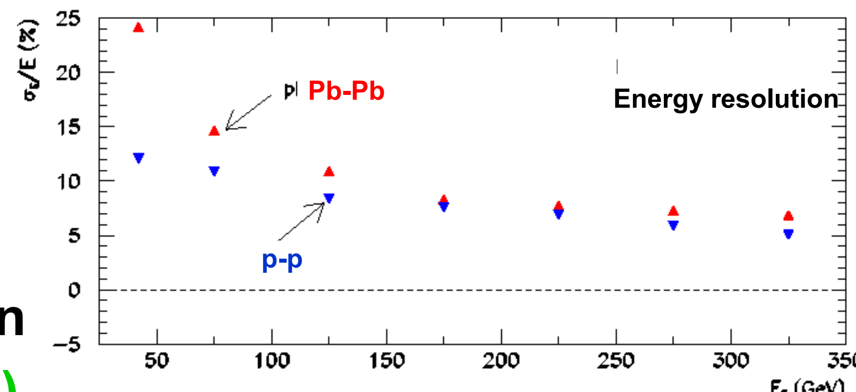


First attempt of reconstruction:

sliding window algorithm $\Delta\Phi \mathrm{x} \Delta\eta = 0.4 \mathrm{x} 0.4$ with splitting/merging after background energy subtraction (average and local)

Pb-Pb collisions (b= 0 –1 fm)





- For E_T > 75GeV: efficiency > 95%, fake < 5%
- Good energy resolution

At LHC, we have a chance to fully reconstruct the jets and to measure a jet inclusive cross section

Conclusions

- LHC Experiments can discover the Higgs in range from LEP2 limit 114 GeV to 1 TeV
- SM Higgs observed with 10 fb^{-1}:
  - Vector Boson Fusion significantly enhances sensitivity for low and medium m_H:
  - Known channels ($H \rightarrow bb$, $\gamma\gamma$, 4λ…) well assessed
- Most of MSSM plane explored with 10 fb^{-1}
- LHC Experiments will find TeV scale SUSY if it is there. The first 10 fb^{-1} will reach up to ~ 2 TeV
- Evidence for extended gauge symmetries, extra dimensions, flavor violation, etc are expected to turn up at the LHC
- Heavy Ion program, evidence of quark-gluon plasma
- CP violation studies and search for rare decays

Back - up Slides

Light Higgs Search: VBF

Motivation

- Strong discovery potential for $m_H < 190$ GeV
- Determine Higgs parameters
- Also good for Invisible Higgs

Production

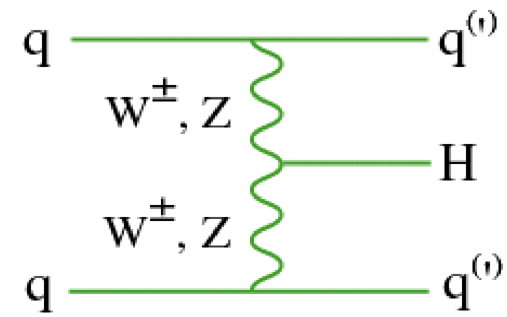
- σ = 4 pb = 20% of total σ (m_H = 120 GeV)

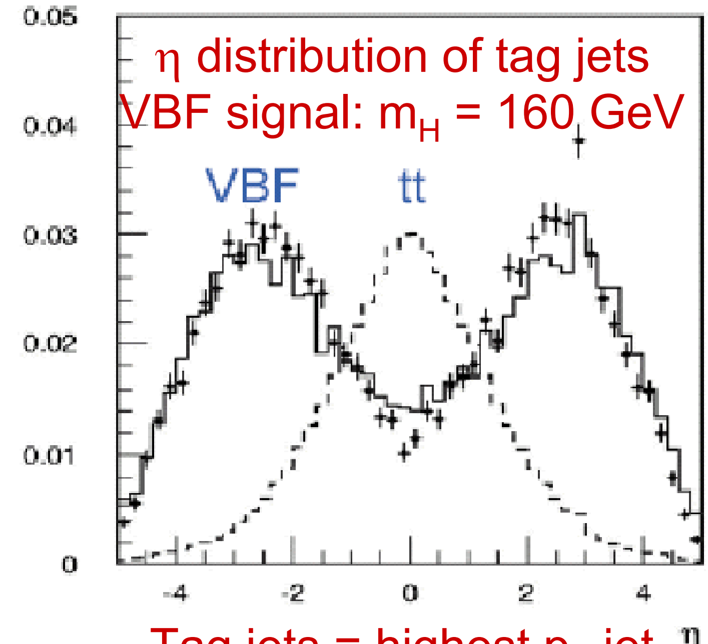
Decays

- $H \to WW^* \to \lambda\nu\lambda\nu, \lambda\nu qq'$
- $H \to \tau\tau \to \lambda\nu\nu\lambda\nu\nu, \lambda\nu\nu j$

Distinct Final States

- Fragmentation of q which emitted W,Z
  - ➔ Two high p_T jets with large $\Delta\eta$ (opposite hemispheres)
- Lack of colour exchange in initial state
  - ➔ Little jet activity in central region
  - ➔ central jet veto

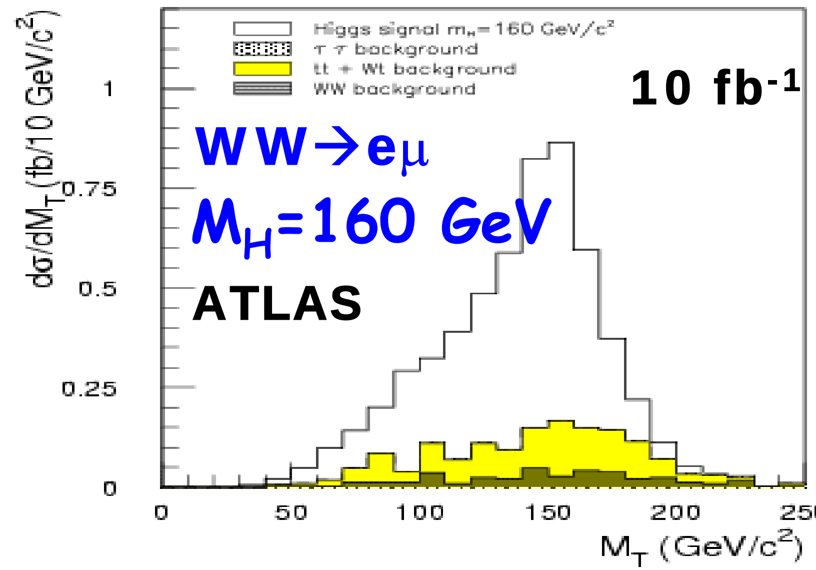




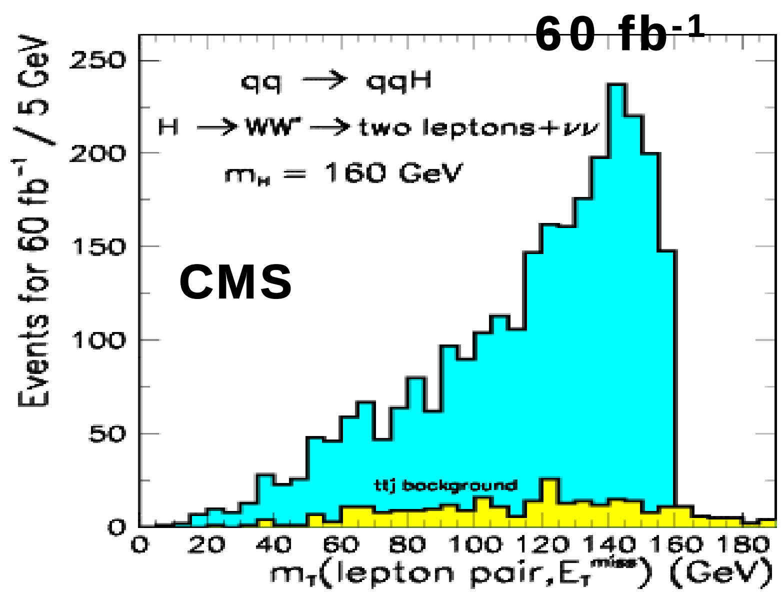
Tag jets = highest p_T jet in each η-hemisphere

VBF H→WW

- Two isolated leptons:
  - pT> (20 GeV, 15 GeV)
- Two forward tag jets:
  - pT > (40 GeV, 20 GeV); $\Delta\eta$>3.8
  - (e ≈ 50% with fake ≈ 1% @ 10^{34})
- Central jet veto: pT<20 GeV
- lepton angular correlations **(anti-correlation of W spins from H decay)**
  - $\delta\phi\lambda\lambda$, $\cos\theta\lambda\lambda$, $m\lambda\lambda$



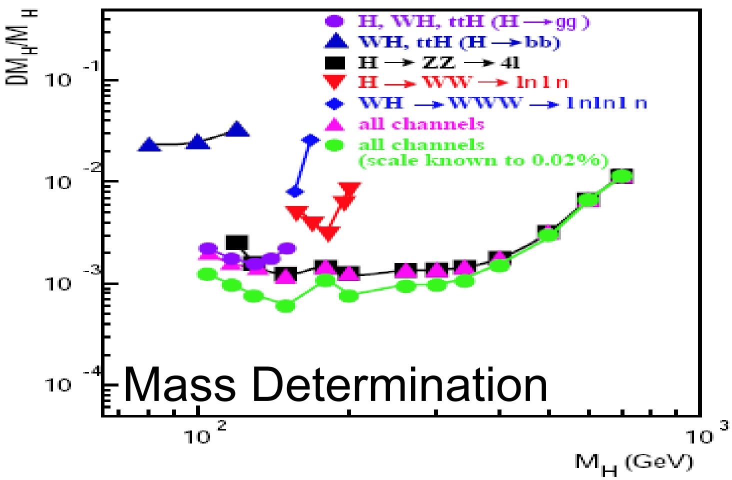
The normalization of the background can be estimated at 10% level from data. Background shape taken from MC

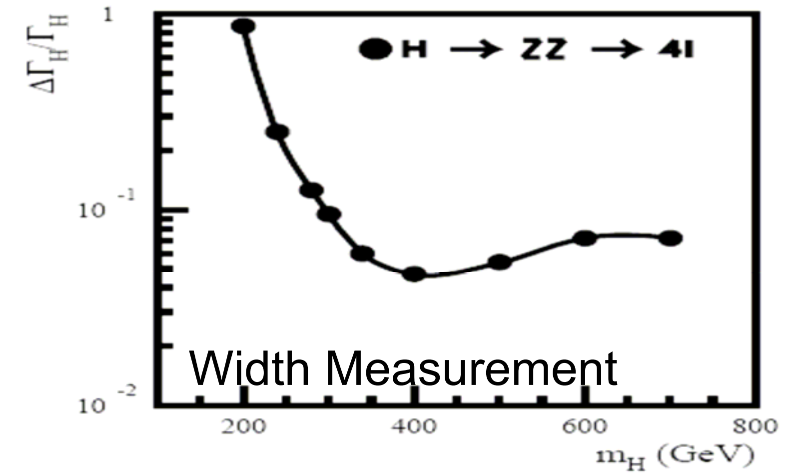


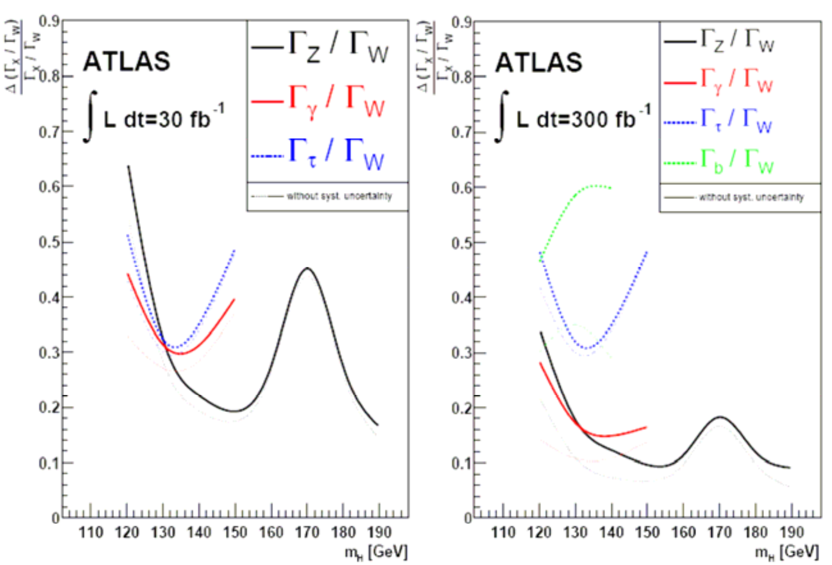
The channel is one of the most promising for

135 GeV < M_H <190 GeV

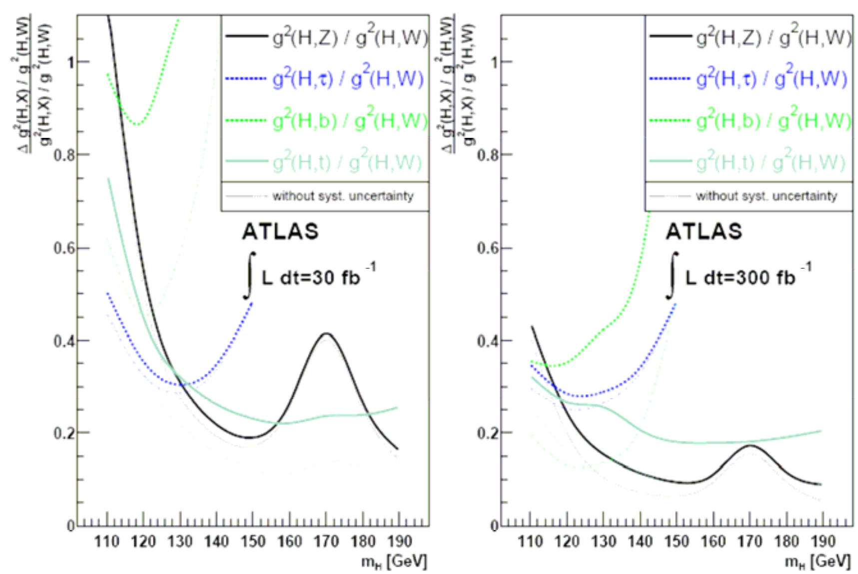
Determination of Higgs Parameters







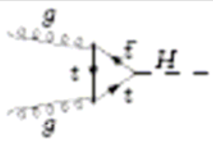
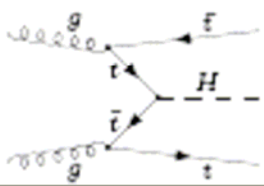
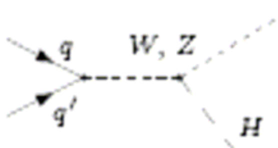
Ratios of Partial Widths



Ratios of Couplings

Determination of Coupling Parameters

Overview of signal channels

Production		Decay	mass range
	Gluon-Fusion ($gg \to H$)	$H \to ZZ \to 4l$	110 GeV - 200 GeV
		$H \to WW \to l\nu\, l\nu$	110 GeV - 200 GeV
		$H \to \gamma\gamma$	110 GeV - 150 GeV
	WBF ($qq\,H$)	$H \to ZZ \to 4l$	110 GeV - 200 GeV
		$H \to WW \to l\nu\, l\nu$	110 GeV - 190 GeV
		$H \to \tau\tau \to l\nu\nu\; l\nu\nu$	110 GeV - 150 GeV
		$H \to \tau\tau \to l\nu\nu\; \mathrm{had}\nu$	110 GeV - 150 GeV
		$H \to \gamma\gamma$	110 GeV - 150 GeV
	$t\bar{t}H$	$H \to WW \to l\nu\, l\nu\, (l\nu)$	120 GeV - 200 GeV
		$H \to b\bar{b}$	110 GeV - 140 GeV
		$H \to \gamma\gamma$	110 GeV - 120 GeV
	WH	$H \to WW \to l\nu\, l\nu\, (l\nu)$	150 GeV - 190 GeV
		$H \to \gamma\gamma$	110 GeV - 120 GeV
	ZH	$H \to \gamma\gamma$	110 GeV - 120 GeV

Determination of Coupling Parameters

Extracting Higgs Boson couplings information

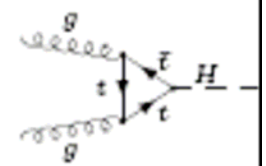
Problem : GF and H $\longrightarrow \gamma\gamma$ are loop-induced. What is the coupling ?

Assumption : Only SM particles couple to Higgs boson

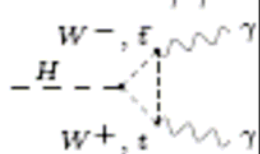
$\longrightarrow$ Express all Higgs Boson production and decay modes by couplings

Higgs Boson production	Higgs Boson decay
$\sigma_{ggH} = \alpha_{\mathrm{GF}} \cdot g_t^2$ (no b-loop)	$\mathrm{BR(H \rightarrow WW)} = \beta_W \cdot \frac{g_W^2}{\Gamma_H}$
$\sigma_{WBF} = \alpha_{\mathrm{WF}} \cdot g_W^2 + \alpha_{\mathrm{ZF}} \cdot g_Z^2$	$\mathrm{BR(H \rightarrow ZZ)} = \beta_Z \cdot \frac{g_Z^2}{\Gamma_H}$
$\sigma_{t\bar{t}H} = \alpha_{t\bar{t}H} \cdot g_t^2$	$\mathrm{BR}(\mathrm{H} \rightarrow \tau\tau) = \beta_\tau \cdot \frac{g_\tau^2}{\Gamma_H}$
$\sigma_{WH} = \alpha_{WH} \cdot g_W^2$	$\mathrm{BR(H \rightarrow b\bar{b})} = \beta_b \cdot \frac{g_b^2}{\Gamma_H}$
$\sigma_{ZH} = \alpha_{ZH} \cdot g_Z^2$	$\mathrm{BR}(\mathrm{H} \rightarrow \gamma\gamma) = \frac{(a\, g_W - b\, g_t)^2}{\Gamma_H}$

Gluon-Fusion



H $\rightarrow \gamma\gamma$



Γ_H **not known** $\longrightarrow$ **Measurement of** $\frac{g_Z^2}{g_W^2}$, $\frac{g_\tau^2}{g_W^2}$, $\frac{g_b^2}{g_W^2}$, $\frac{g_t^2}{g_W^2}$ **and** $\frac{g_W^2}{\sqrt{\Gamma_H}}$

MSSM

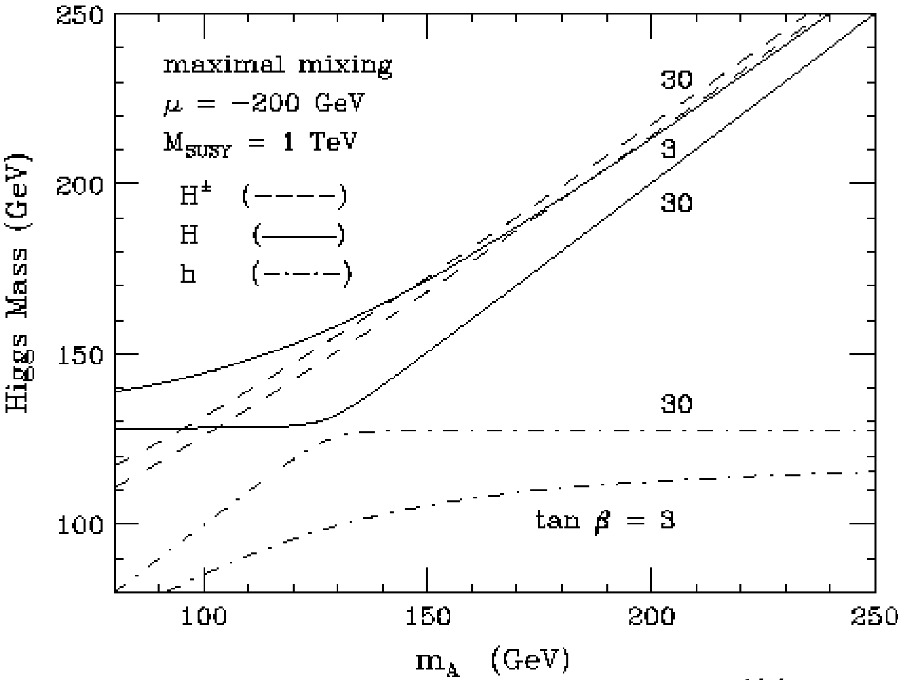
Minimal Supersymmetric extension: two Higgs doublets ⇒ 8 degrees of freedom (5 particles):

CP-even : h,H   CP-odd: A   Charged: H^+,H^-

Couplings to SM particles modified w.r.t. SM. Decay into third generation fermions enhanced at high tgβ

	g_u	g_d	g_V
h	cosα/sinβ	-sinα/cosβ	sin(β-α)
H	sinα/sinβ	cosα/cosβ	cos(β-α)
A	1/tgβ	tgβ	0

At high M_A the heavy bosons degenerate in mass while the h saturate at a limit value (around 130 GeV)



Super Symmetry (SUSY)

The ability of the LHC to search for SUSY has been investigated in the self-consistent Frameworks of:

- Super Gravity: SUGRA
  - SUSY is broken in a hidden sector: Gravity is the sole messenger
  - The Lightest Super Symmetric Particle (LSP) is χ^0_1 : stable, neutral, weakly interacting $\Rightarrow$ transverse missing energy
- Gauge Mediated Super Symmetry Breaking: GMSB
  - SUSY is broken in a hidden sector: particles get mass through SU(3)xSU(2)xU(1) gauge interactions
  - Grivitino is the LSP. NLSP = neutralino or stau, short or long-lived
- R-parity Violation
  - In SUSY possible to violate both L and B-number $\Rightarrow$ rapid proton decay : R-parity eliminates the "offending" terms. No reason why R should be a symmetry of the Langrangian
  - For the proton to remain stable, either L or B violating terms should be absent
  - The LSP no longer stable
- …

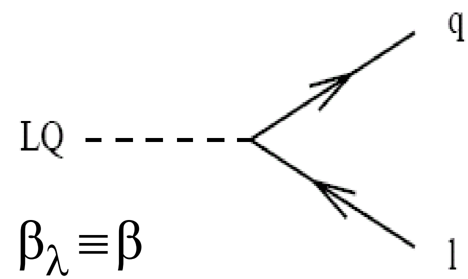
LeptoQuarks

- **Predicted by a lot of models:**

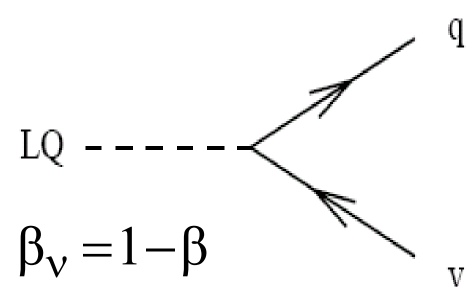
  Higher Gauge symmetries, Compositeness, Technicolor…

- **Two Types: scalars and vectors**

- **Couples to $\lambda^{\pm}q$ and/or νq**
- **Production** $qq \rightarrow LQ\ LQ$ and $gg \rightarrow LQ\ LQ$
- **Decays:**
  - LQs decay to $\lambda^{\pm}q$ and/or νq with branching ratios β_{ℓ}, β_{ν} = 0, 0.5, 1 (depending on the quantum numbers)



$\beta_{\lambda} \equiv \beta$



$\beta_{\nu} = 1 - \beta$

Sensitivity to LeptoQuarks I

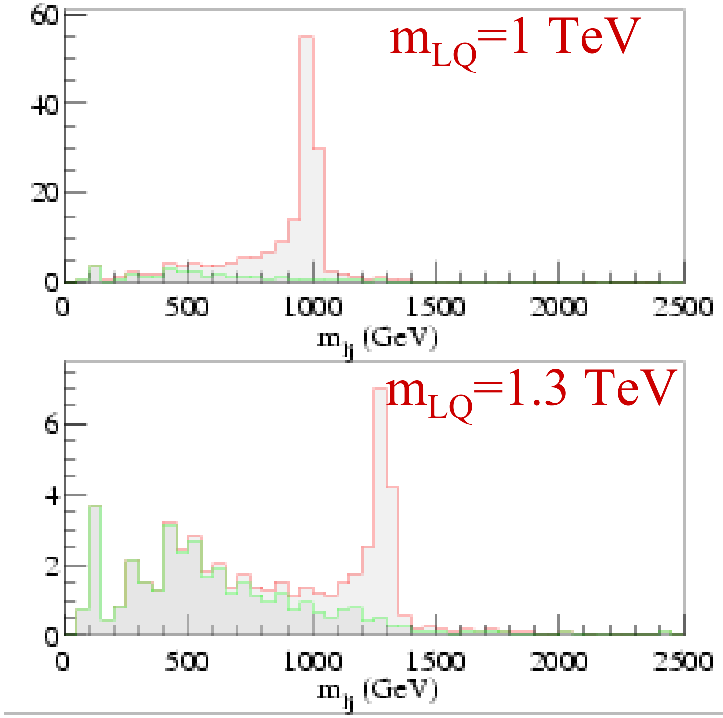
- Fast simulation: Scalar LQ
  - LQ LQ → $\ell^+ q \ell^- q$ and $\nu q \nu q$
  - 2 jets+2 leptons: 1st and 2nd generation
    - High Pt isolation + High m_{lj} cut
    - → sensitivity: m_{LQ}=1.0 TeV
  - 2 leptons + Et: 3rd generation
    - *b*-jets+non isolated leptons+topo
    - →up to m_{LQ}~1.3 TeV

ATL-COM-PHYS-1004-071

- Full simulation: under progress

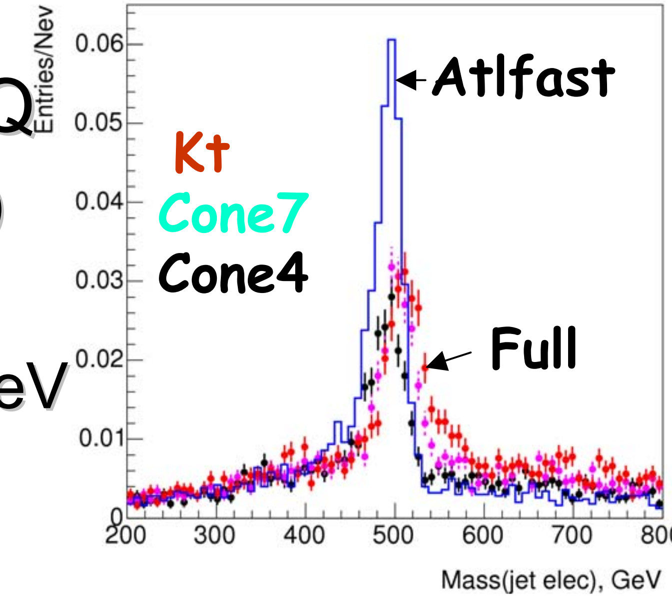
(30 fb^{-1})

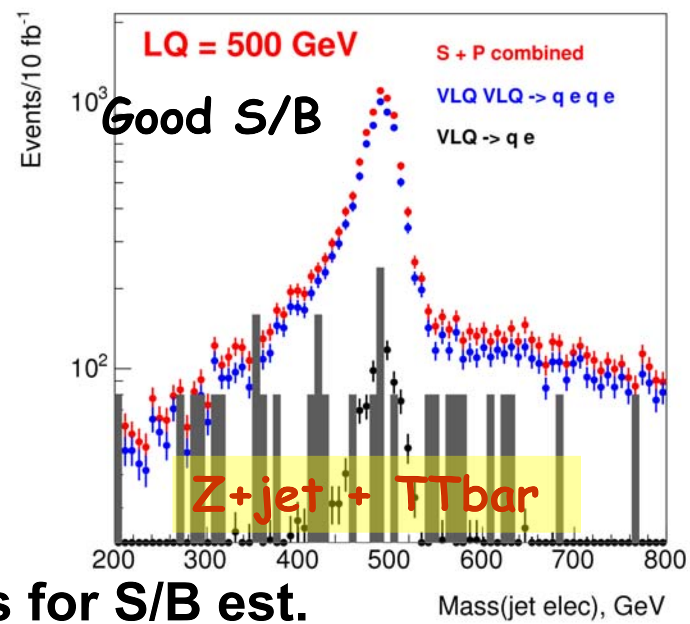
2 jets + 2 leptons



Sensitivity to LeptoQuarks II

- Fast Simulation: Vector + Scalar LQ
  - Single+double production (CompHep)
    - →sensitivity: m_{LQ}=1.3 TeV
- Full Simulation: Vector LQ M=0.5, 1 TeV
  - Geant4(9.0.4) + AOD (10.0.1).
    - 2 electrons with Pt > 90 (100) GeV/c, |η|<2.5
    - At least 1 jet with Pt > 70 (100) GeV/c, |η|<2.5
    - Elec sel.: Likelihood (> 0.6) or isEM cuts ,
    - ΔR > 0.1, opposite sign
    - Jets selection: ΔR separation > 0.1 ,
    - EMfrac/Ptjet cut, Ht sum>800 (1500) GeV,
    - Cut on ee mass (Zmass veto).





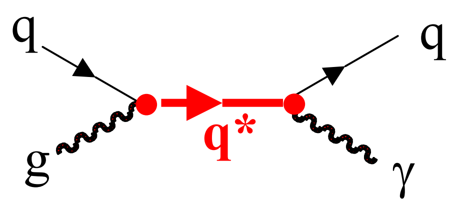
- Low Reco efficiency ~ 50% of Atlfast !
- Need to improve selection criteria.
- Need more B/G (esp.Z+jet) high-Pt events for S/B est.

Excited fermion production: excited quarks

- **Predicted by compositeness:**
- **Transitions between ordinary and excited fermions:**

$$L = \frac{1}{2\Lambda}\bar{q}^*_R\sigma^{\mu\nu}\left(g_s f_s G^a_{\mu\nu} + g f \frac{\tau}{2}W_{\mu\nu} + g' f' \frac{Y}{2}B_{\mu\nu}\right)q_L + h.c.$$

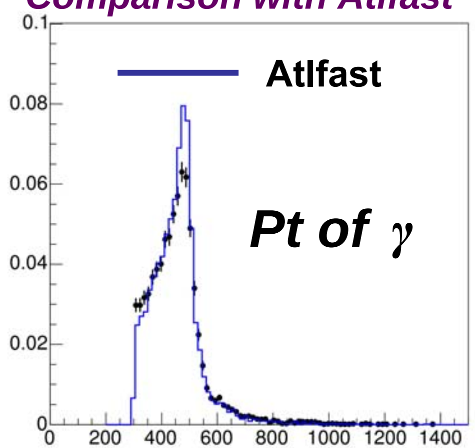
$$f_s = f = f' = 1$$



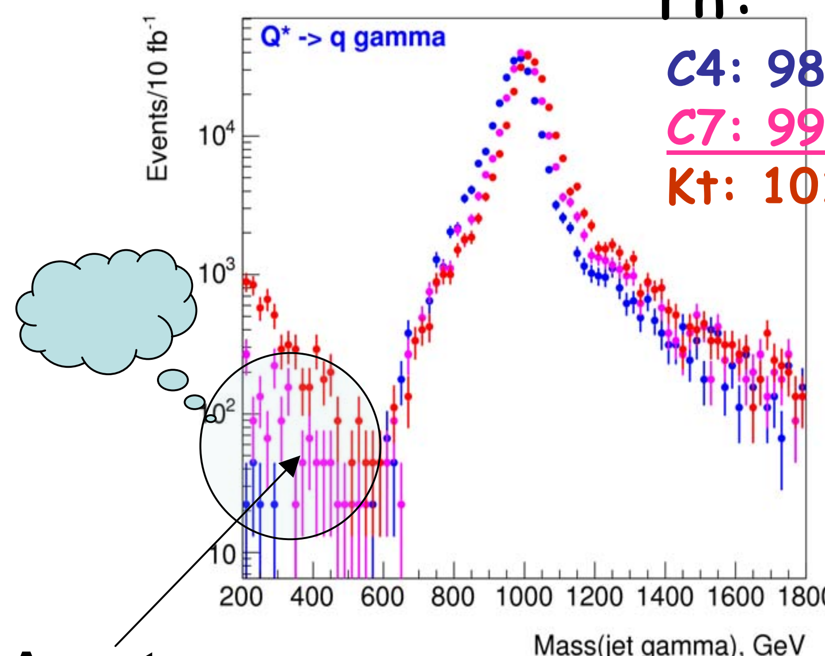
- **Full Simulation Study: m=1000 GeV**

Cuts: Pt > 300 GeV
$|\eta| < 2.5$
$\Delta R\gamma j > 0.1$

Comparison with Atlfast

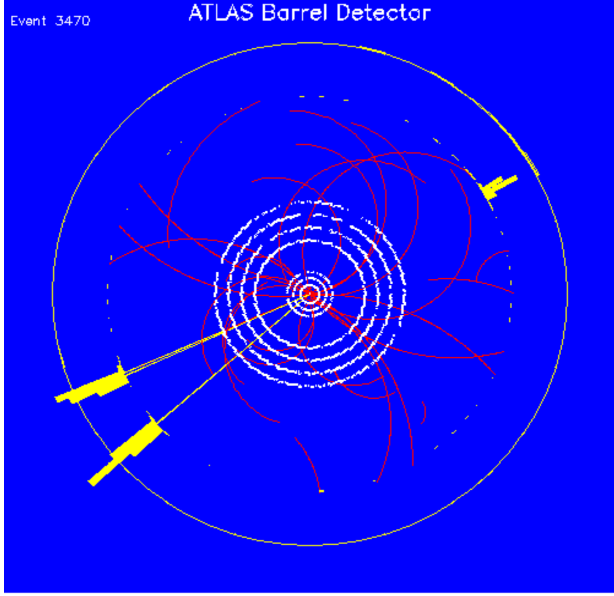


Fit:
C4: 980 GeV
C7: 999 GeV
Kt: 1014 GeV



Area to investigate

Excited electron production:



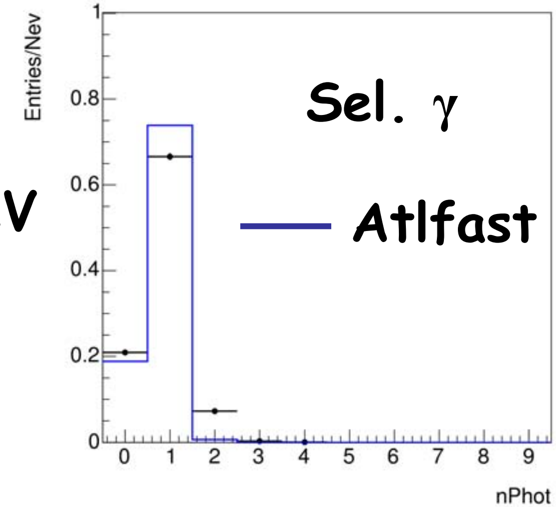
Mass of 1000 GeV,
Generated by Pythia
xSec=133 pb

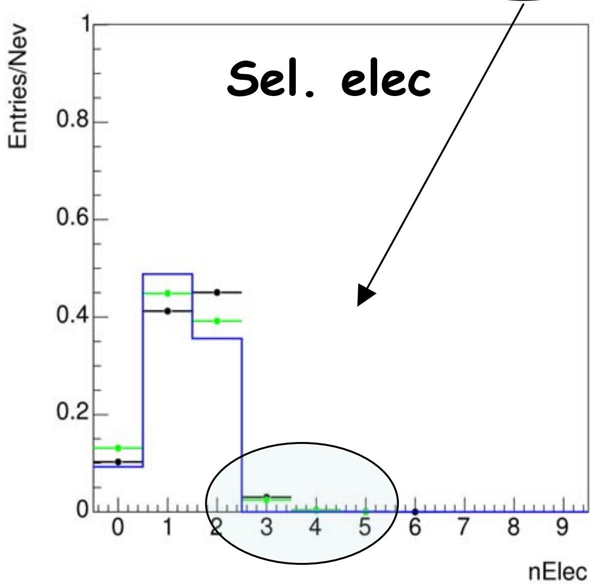
$pp \rightarrow ee^* \rightarrow ee\gamma$

Single production

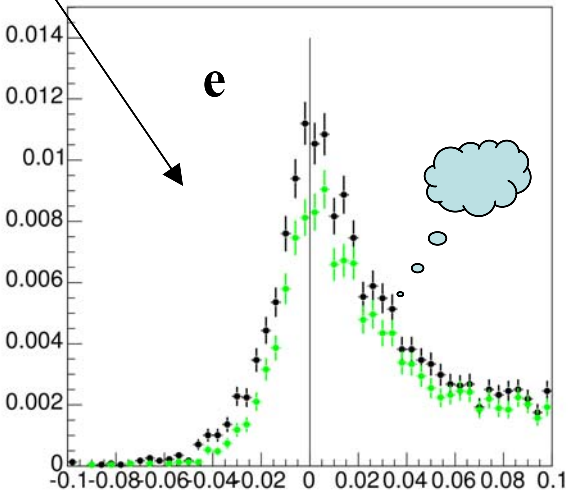
Cuts: 2 electrons and 1 photon with Pt>300 GeV and |η|<2.5

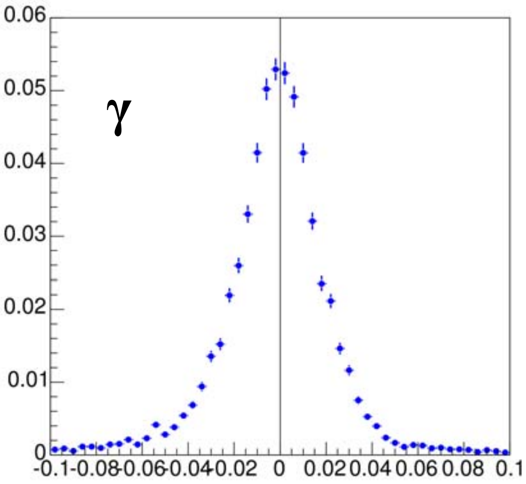
Elec selection: Lk(>0.6) or isEM

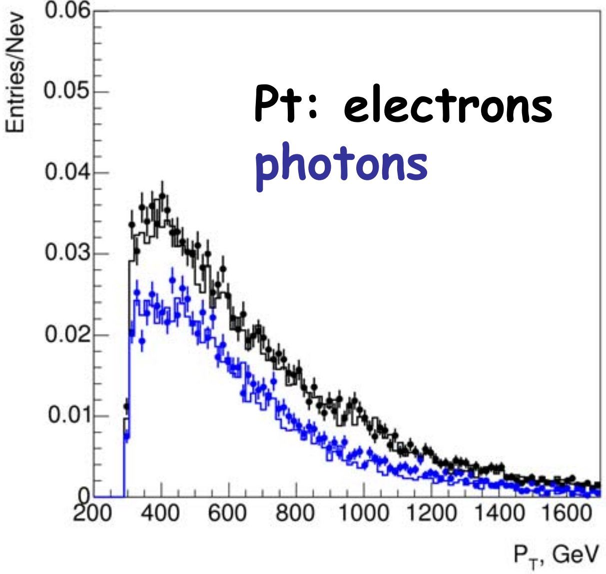


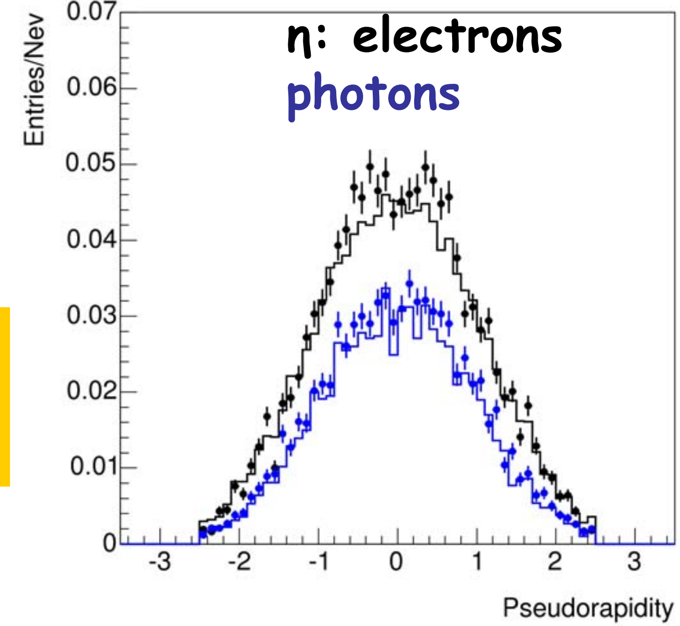


Pt resolution: [Pt-Pt^{MC}]/Pt

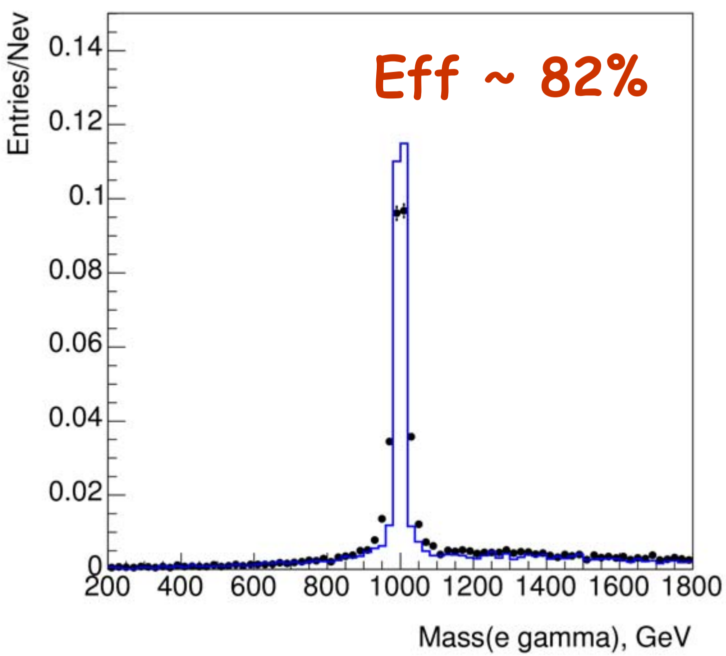


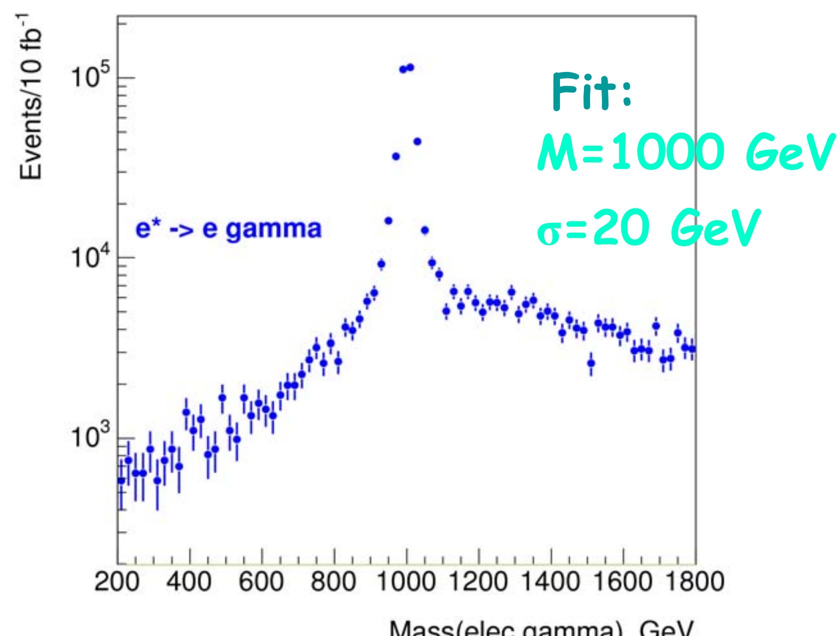






Comparison with Atlfast





Clean narrow signal is expected

Heavy gauge Bosons

Masses

$M(Z_H) \approx M(W_H)$ degenerate

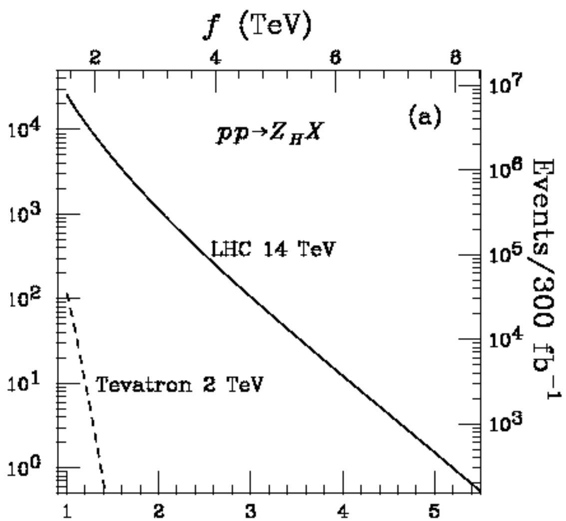
$$M(Z_H / W_H) < 6 \text{TeV}/c^2 \left(\frac{M(H)}{200 \text{GeV}/c^2} \right)^2$$

cotθ is a parameter of the Model (analog to $\theta_{Weinberg}$)

cross-sections and BR are determined by **cot**θ

Production (Z_H)

σ (fb)

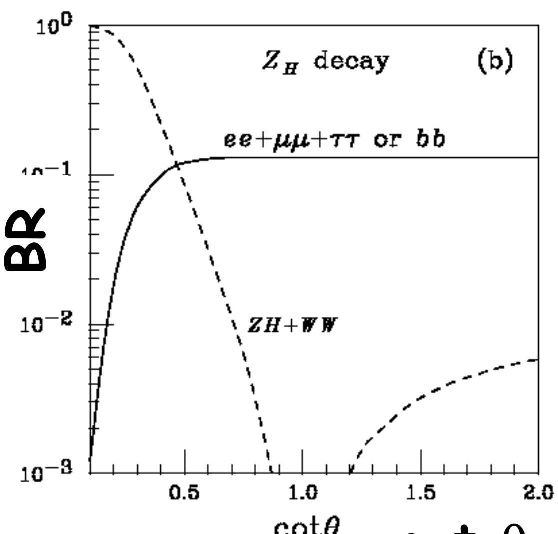


M(Z_H) (TeV)

$\sigma(W_H) = 2\ \sigma(Z_H)$

Decays (Z_H)

BR



cot θ

$BR(W_H \rightarrow WH) = BR(Z_H \rightarrow ZH)$

Characteristic decays

$Z_H \rightarrow Z\,H$

$W_H \rightarrow W\,H$

if a Z' and W' are discovered via a leptonic decay, these modes allow to say if they come from the Little Higgs model or not (thanks to **cot**θ)