Non-anomalous Discrete R-symmetry, Extra Matters, and Enhancement of the Lightest SUSY Higgs Mass

arXiv:1108.2402

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(Univ. of Tokyo)

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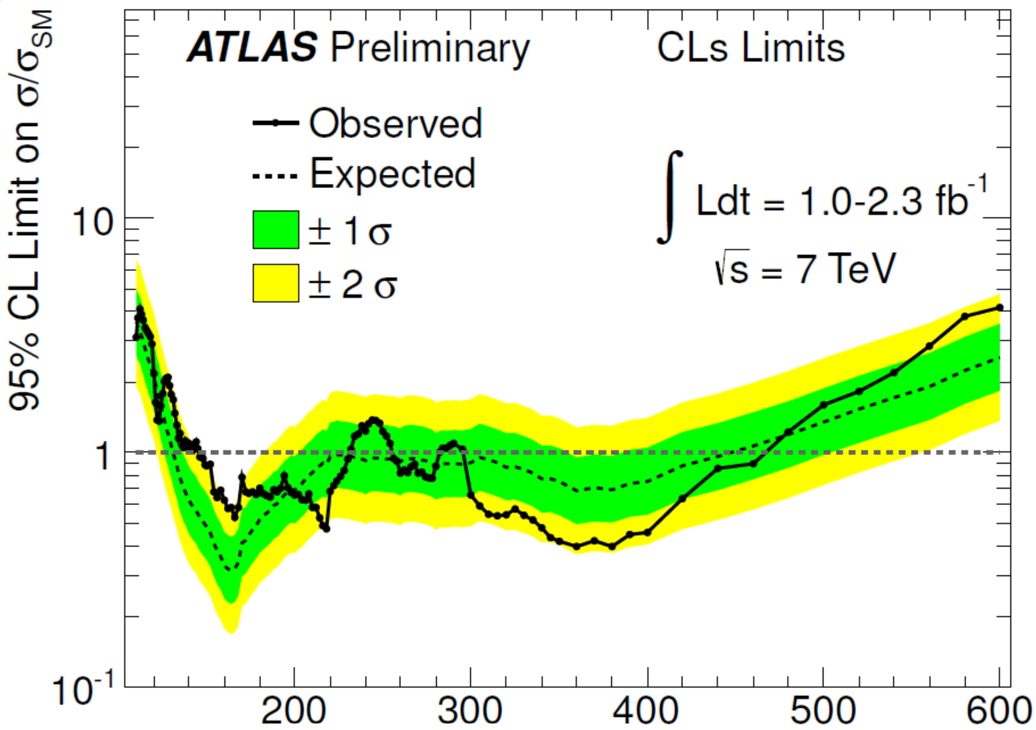
Ryosuke Sato,
Tsutomu T. Yanagida

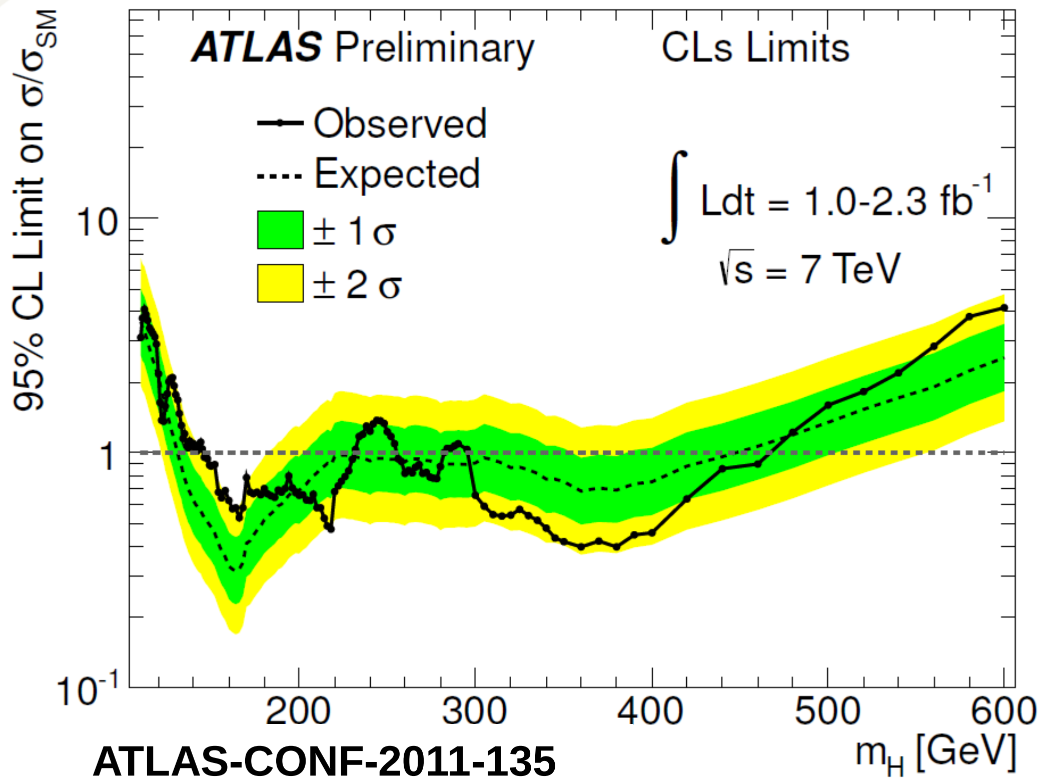
LHC experiments



ATLAS-CONF-2011-135

- **Higgs boson search has reached over a wide region!**

LHC experiments



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  -> fine-tuning, g-2, … What's going on in physics beyond the SM?

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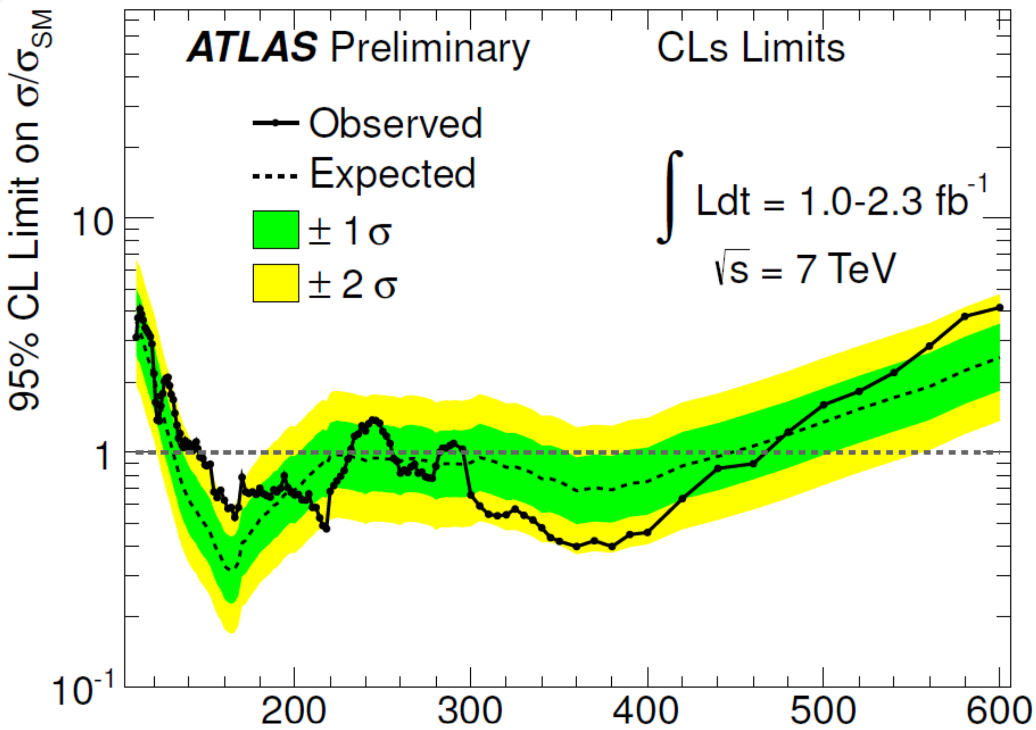

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First Hint of New physics will come from Higgs boson!

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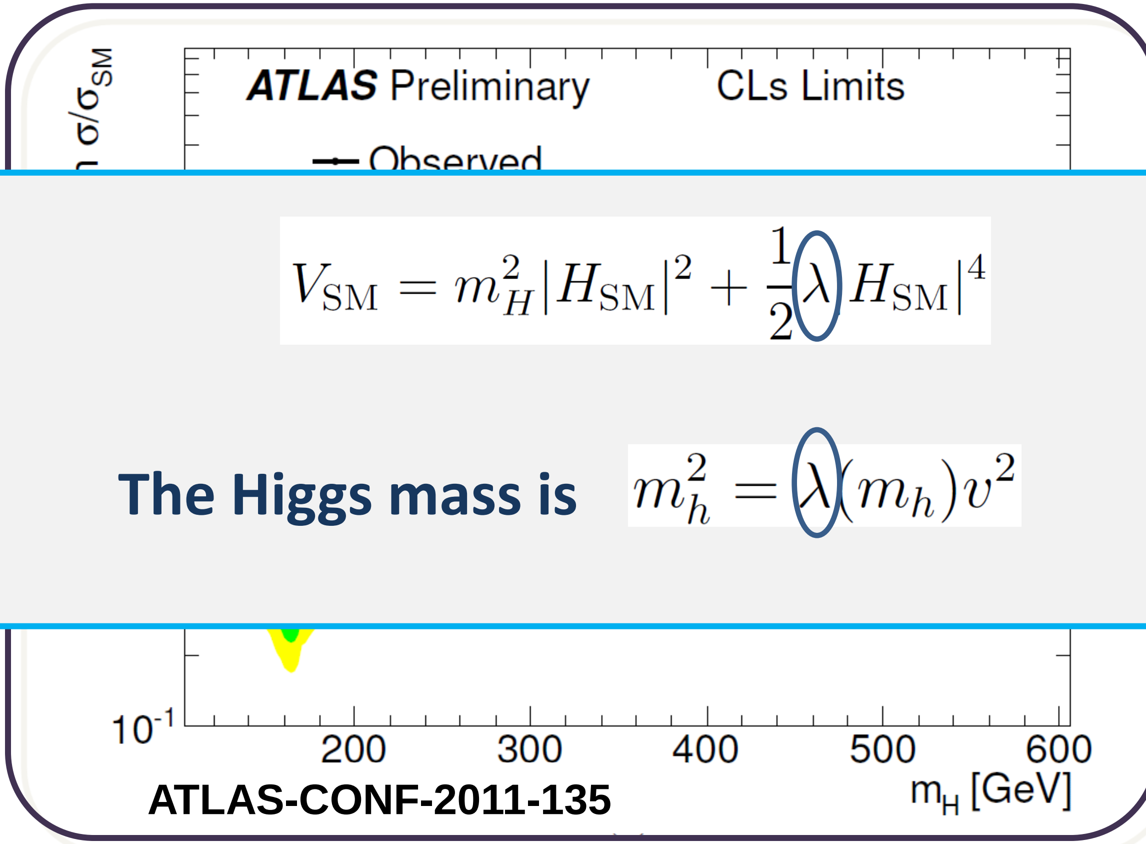

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$$V_{\rm SM} = m_H^2 |H_{\rm SM}|^2 + \frac{1}{2}\lambda |H_{\rm SM}|^4$$

The Higgs mass is $m_h^2 = \lambda(m_h) v^2$

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In this talk,

- Introduction
  - Why Higgs?
  - Why low-energy Supersymmetry?
  - What is MSSM Higgs prediction?

- What is the SUSY Higgs prediction?
  - Non-anomalous discrete R-symmetry case
  - Possibility of Mimicked Higgs signal

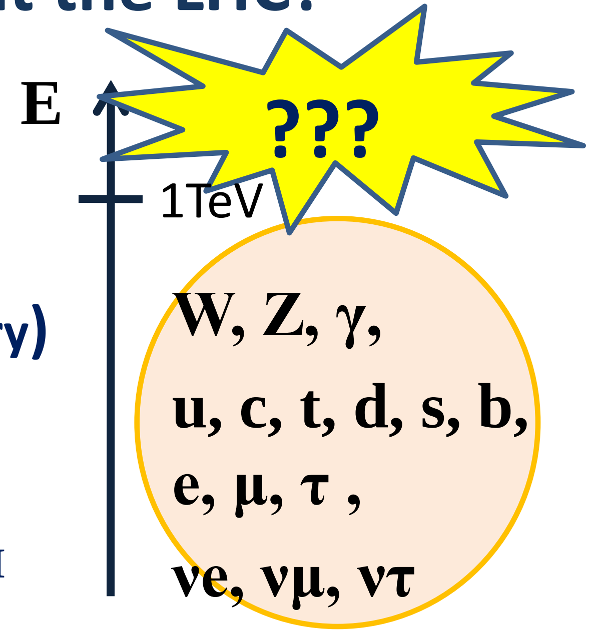
- Summary

Introduction

- Why Higgs?
- Why low-energy SUSY?
- What is MSSM Higgs prediction?

Introduction

What will appear at the LHC?



What we know

Non-linear σ model (low energy effective theory)

Global : $SU(2)_L \times SU(2)_R \rightarrow SU(2)_C$

Gauge : $SU(2)_L \times U(1)_Y \rightarrow U(1)_{EM}$

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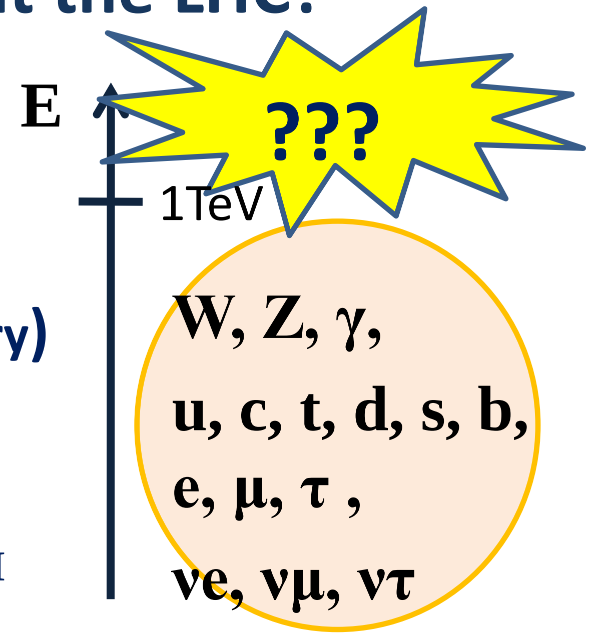

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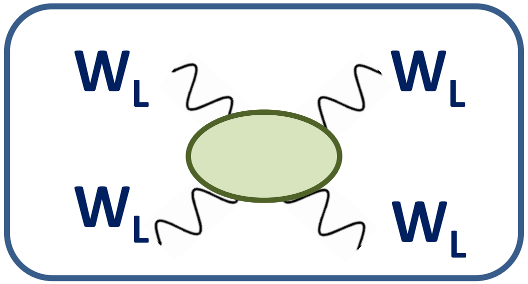
Unitarity violation ($\gtrsim$ 1 TeV)



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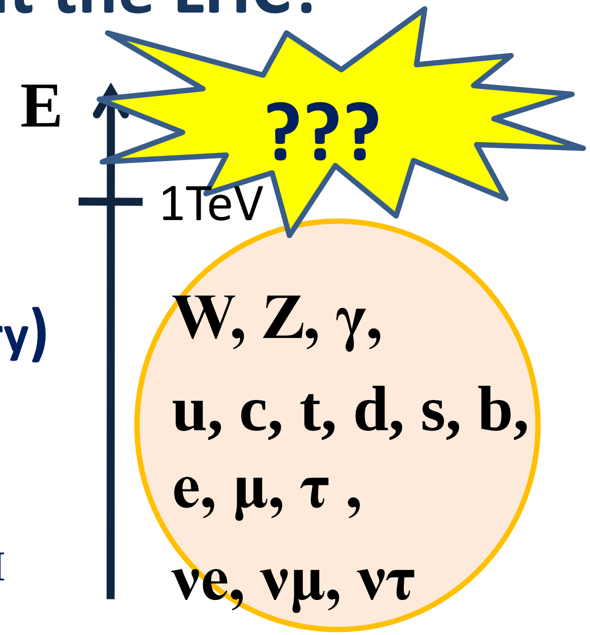

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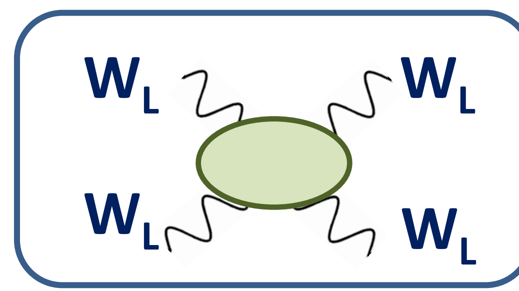


@ $\lesssim$ TeV scale, an important discovery exists!

Is it Higgs boson?

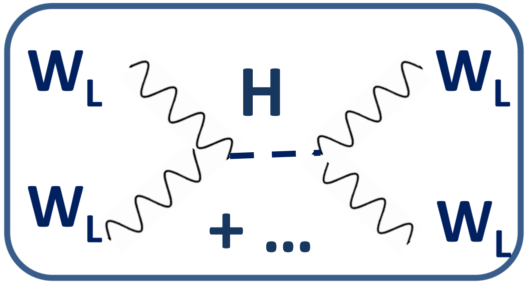
Introduction

What will appear at the LHC?

- **Higgs boson**

  is the last undiscovered particle in the SM.

  - **Higgs will restore the unitarity of W_LW_L scatt.**



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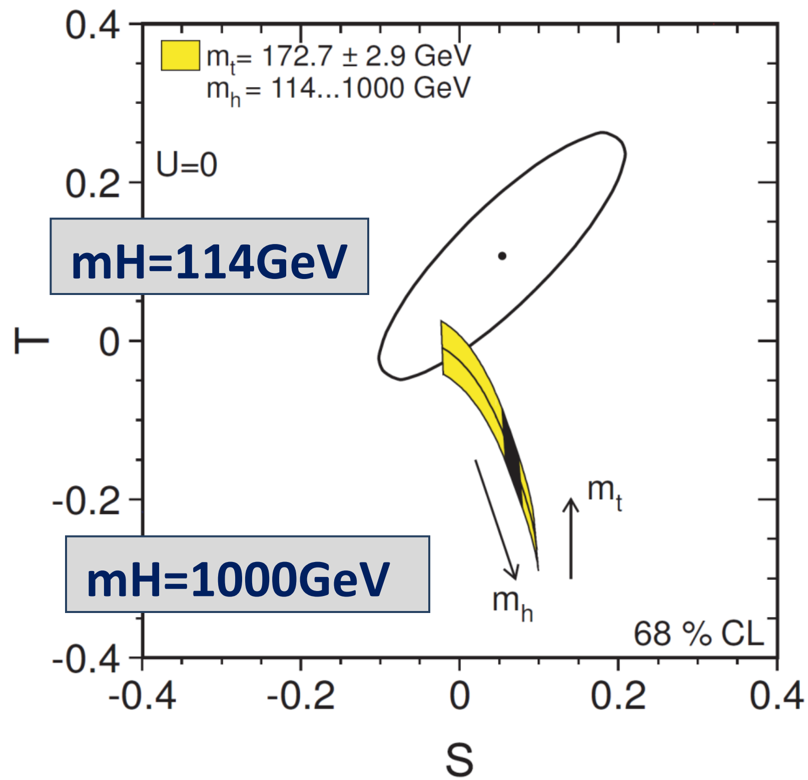
  - EWPMs (Electroweak Precision measurements) are consistent with light Higgs boson.



http://lepewwg.web.cern.ch/LEPEWWG/plots/summer2005/s05_stu_contours.eps

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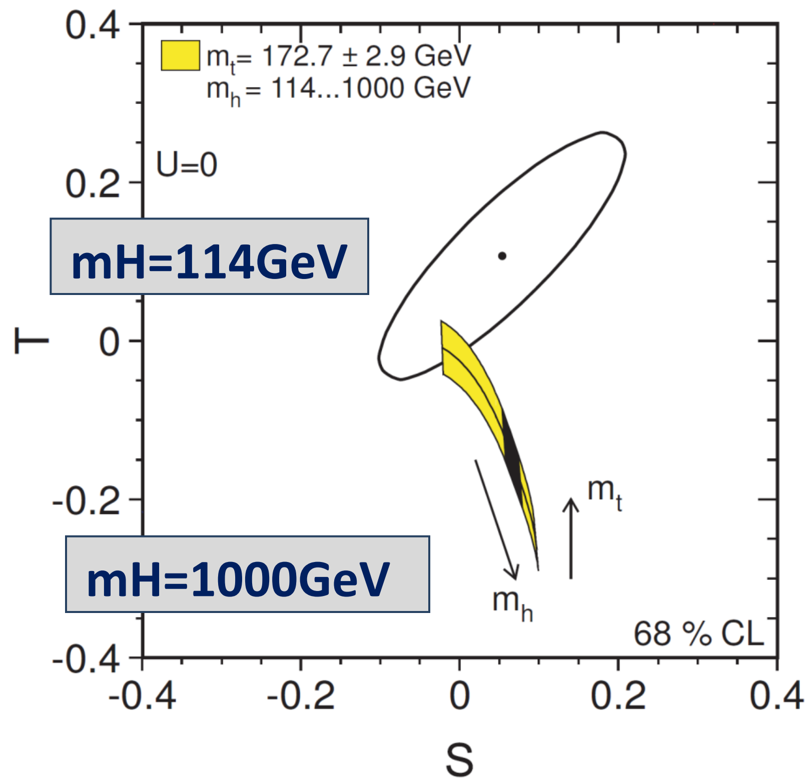
  - **SM (light Higgs) is good for data.**



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What about it for theoretical side?

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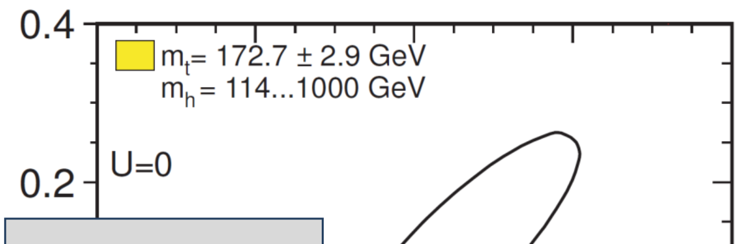
  Hierarchy probrem



- **The Higgs mass:**

$$m_h^2 / 2 = - m^2 + \delta m_h^2$$

$$\delta m_h^2 \sim (y_t^2/16\pi^2)\, \Lambda^2$$

$$\sim (y_t^2/16\pi^2)\, M_{Pl}^2$$

http://lepewwg.web ... ps

Introduction

What will appear at the LHC?

Supersymmetry

- One of the solution to the hierarchy problem.

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Higgs Potential gauge coupling !

$$V = m_1^2|H_1^0|^2 + m_2^2|H_2^0|^2 + (m_3^2 H_1^0 H_2^0 + \mathrm{h.c.}) + \underline{\underline{\frac{g^2+g'^2}{8}}}(|H_1^0|^2 - |H_2^0|^2)^2$$

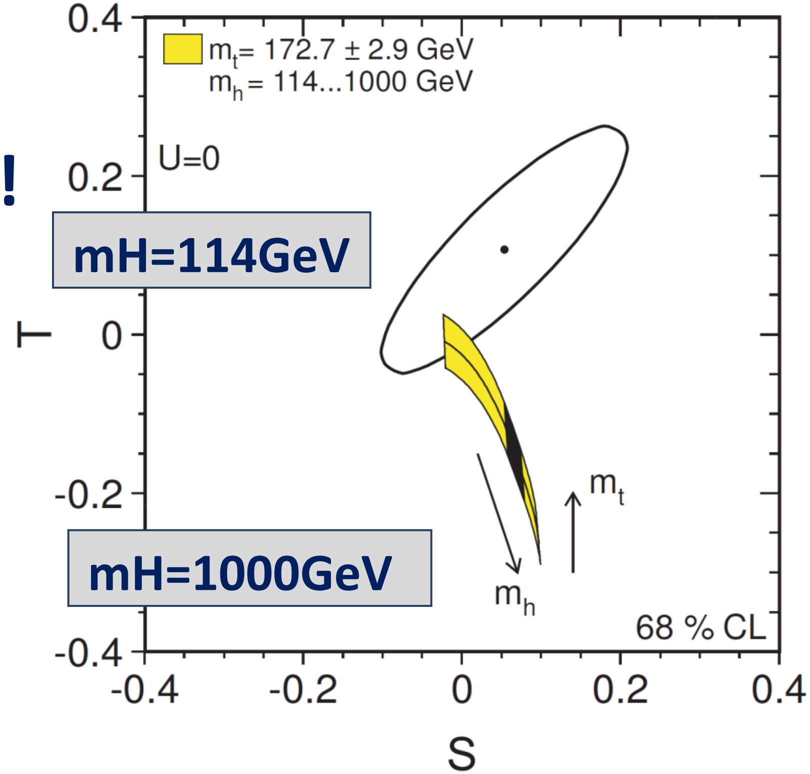
In MSSM (Minimal Supersymmetric Standard Model), the lightest Higgs boson mass, m_h~ mZ at tree level.

Introduction

What will appear at the LHC?

Supersymmetry

- One of the solution to the hierarchy problem.
  (Quadratic div. terms of the Higgs mass are canceled.)
- Light Higgs
  + R-parity
  → consistent with EWPM !



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Sounds like a good idea!

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- GUT

  Gauge coupling unification is also a plausible possibility. So, hereafter, we consider scenario which valid up to GUT scale perturbatively.

Introduction

- Why Higgs?
- Why low-energy SUSY?
- **What is MSSM Higgs prediction?**

Introduction

Higgs signal in SUSY

MSSM Higgs mass

LEP bound

At tree-level: $m_h^2 \leq m_Z^2 \cos^2(2\beta)$ $\Leftrightarrow$ $(m_h \gtrsim 114.4$ GeV$)$

Loop: $m_h^2 \leq m_Z^2 \cos^2(2\beta)$ $+ \Delta m_h^2$

$$\Delta m_h^2 \sim \frac{3y_t^4 v^2}{2\pi^2}\left[\log\frac{m_{\tilde{t}}^2}{m_t^2} + \frac{1}{4}\underbrace{\left(\frac{a_t^2}{m_{\tilde{t}}^2} - \frac{a_t^4}{12 m_{\tilde{t}}^4}\right)}\right]$$

$m_{\tilde{q}} = m_{\tilde{t}}$

Maximum at the at = √6 mstop

Introduction

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In MSSM, the allowed Higgs mass (m_h > 114.4 GeV) is achieved by large A term.

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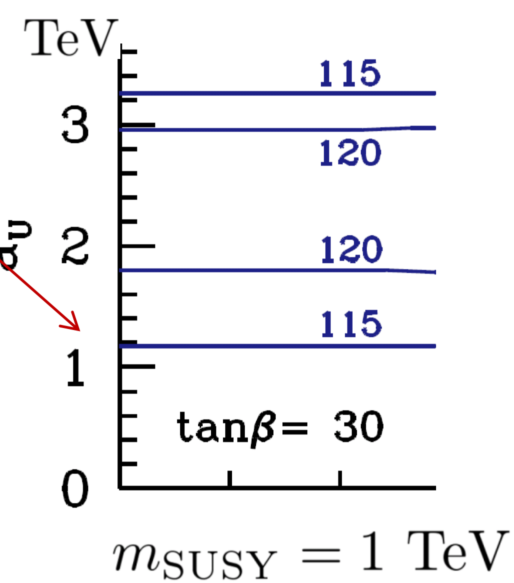

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Higgs signal in SUSY

MSSM : $m_h \lesssim$ 125 GeV (M_{SUSY} ~ 1 TeV) M. S. Carena and H. E. Haber, '03

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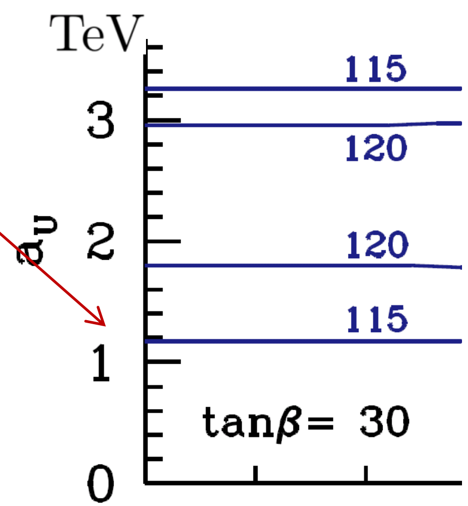

$m_{\mathrm{SUSY}} = 1$ TeV

Fine-tuning or Gauge mediation scenario is disfavored??

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NMSSM : $m_h \lesssim$ 140 GeV (M_{SUSY} ~ 1TeV) U. Ellwanger and C. Hugonie, '07

If Higgs mass bound is relaxed by new quartic coupling, λ, tanbeta become small in order to increase the tree level contribution:

$$m_h^2 \leq m_Z^2 \cos^2(2\beta) + \lambda^2 v^2 \sin^2(2\beta)$$

muon g-2 anomaly cannot be explain in a slightly heavy Higgs mass case??

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LEP Higgs bound (mh > 114.4 GeV)
has already restricts SUSY strictly!

- Large A term in MSSM?
- Small tanbeta in NMSSM? ...

It implies some SUSY model?

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- Non-anomalous discrete R-symmetry case

What is the SUSY Higgs prediction?

- **Non-anomalous discrete R-symmetry case**

M. Asano, T. Moroi, R. Sato, T. T. Yanagida

arXiv:1108.2402

Discrete R-symmetry

Higher dim. Supergravity (e.g. superstring)

R-symmetry $\xrightarrow{\text{compactification}}$ discrete subgroup Z_{NR}

- **Smallness of μ term:**

Discrete R-sym. can forbid the SUSY-invariant mass term:

$$\cancel{\mu H_u H_d}$$

When the ~~R-sym.~~ is linked to ~~SUSY~~, the $\mu \sim m_{3/2} \sim 1\text{TeV}$.

⇨ Electroweak scale μ term is naturally explained.

Discrete R-symmetry

Higher dim. Supergravity (e.g. superstring)

$$\text{R-symmetry} \xrightarrow{\text{compactification}} \text{discrete subgroup } Z_{NR}$$

- **Smallness of μ term:**
- **Suppressing proton decay**

$$\cancel{W = \frac{1}{\Lambda} QQQL + \frac{1}{\Lambda} \bar{U}\bar{U}\bar{D}\bar{E}}$$

Discrete R-symmetry

Higher dim. Supergravity (e.g. superstring)

$$\text{R-symmetry} \xrightarrow{\text{compactification}} \text{discrete subgroup } Z_{NR}$$

- Smallness of μ term:
- Suppressing proton decay
- Cosmological constant

Due to Z_{NR} sym., $$< W > = 0$$

(as long as Z_{NR} sym is unbroken)

(as we will discuss later)

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K. Kurosawa, N. Maru and T. Yanagida '01

But, in MSSM, Discrete R-symmetry is anomalous

in the case which the charge assignment consists with GUT!

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⇨ Introduction of extra matter

⇨ Higgs mass may be changed by the extra matter contribution

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Discrete R-symmetry

Minimal SUSY SU(5) GUT

$$W_{\rm GUT} \sim \Phi_{\bf 10}\Phi_{\bf 10}H + \Phi_{\bf 10}\bar{\Phi}_{\bar{\bf 5}}\bar{H} + \bar{\Phi}_{\bar{\bf 5}}\bar{N}\bar{H} + \frac{1}{2}M_N\bar{N}\bar{N} + \mu_H H\bar{H}$$

(Z_{NR} charge of Grassmann coordinate θ = α)

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(Z_{NR} charge of Grassmann coordinate $\theta = \alpha$)

- From Yukawa & Majorana mass term

$$\begin{aligned} 2\phi_{\bf 10} + h &= 2\alpha \mod N \\ \phi_{\bf 10} + \bar{\phi}_{\bar{\bf 5}} + \bar{h} &= 2\alpha \mod N \\ \bar{\phi}_{\bar{\bf 5}} + \bar{\nu} + h &= 2\alpha \mod N \\ 2\bar{\nu} &= 2\alpha \mod N \end{aligned}$$

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- **From μ term**

forbid Planck scale μ:

$$h + \bar{h} = 0 \mod N,$$

Giudice-Masiero:

$$h + \bar{h} \neq 2\alpha \mod N,$$

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(Cosmological Constant) $\Rightarrow$ **< W > = 0**

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EW scale μ term

$$h + \bar{h} = 0 \mod N,$$
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$$h + \bar{h} = 0 \quad \mathrm{mod}\ N,$$

$$h + \bar{h} \neq 2\alpha \quad \mathrm{mod}\ N,$$

$$\Rightarrow \quad 2\alpha \neq 0 \quad \mathrm{mod}\ N$$

Anomaly cancellation condition

$$Z_{NR}[SU(3)_C]^2 \ : \ \frac{3}{2}\left\{3(\phi_{\bf 10} - \alpha) + (\bar{\phi}_{\bar{\bf 5}} - \alpha)\right\} + 3\alpha = \frac{N}{2}k,$$

$$Z_{NR}[SU(2)_L]^2 \ : \ \frac{3}{2}\left\{3(\phi_{\bf 10} - \alpha) + (\bar{\phi}_{\bar{\bf 5}} - \alpha)\right\} + \frac{1}{2}\left\{(h - \alpha) + (\bar{h} - \alpha)\right\} + 2\alpha = \frac{N}{2}k'$$

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Anomaly cancellation condition

$$Z_{NR}[SU(3)_C]^2 \ : \ \frac{3}{2}\{3(\phi_{\mathbf{10}}-\alpha)+(\bar{\phi}_{\bar{\mathbf{5}}}-\alpha)\}+3\alpha = \frac{N}{2}k,$$
$$Z_{NR}[SU(2)_L]^2 \ : \ \frac{3}{2}\{3(\phi_{\mathbf{10}}-\alpha)+(\bar{\phi}_{\bar{\mathbf{5}}}-\alpha)\}+\frac{1}{2}\{(h-\alpha)+(\bar{h}-\alpha)\}+2\alpha = \frac{N}{2}k'$$

$$\Rightarrow \quad 3\alpha = \frac{N}{2}k, \qquad \alpha = \frac{N}{2}k'.$$

Discrete R-symmetry

Minimal SUSY SU(5) GUT

$$\boxed{W_{\rm GUT} \sim \Phi_{\bf 10}\Phi_{\bf 10}H + \Phi_{\bf 10}\bar{\Phi}_{\bar{\bf 5}}\bar{H} + \bar{\Phi}_{\bar{\bf 5}}\bar{N}\bar{H} + \frac{1}{2}M_N\bar{N}\bar{N} + \mu_H H\bar{H}}$$

(Z_{NR} charge of Grassmann coordinate $\theta = \alpha$)

Yukawa & Majorana mass term

$$\begin{aligned} 2\phi_{\bf 10} + h &= 2\alpha \mod N \\ \phi_{\bf 10} + \bar{\phi}_{\bar{\bf 5}} + \bar{h} &= 2\alpha \mod N \\ \bar{\phi}_{\bar{\bf 5}} + \bar{\nu} + h &= 2\alpha \mod N \\ 2\bar{\nu} &= 2\alpha \mod N \end{aligned}$$

EW scale μ term

$$h + \bar{h} = 0 \mod N,$$
$$h + \bar{h} \neq 2\alpha \mod N,$$

$$\Rightarrow \boxed{2\alpha \neq 0 \mod N}$$

conflict

Anomaly cancellation condition

$$Z_{NR}[SU(3)_C]^2 \;:\; \frac{3}{2}\{3(\phi_{\bf 10}-\alpha)+(\bar{\phi}_{\bar{\bf 5}}-\alpha)\} + 3\alpha = \frac{N}{2}k,$$
$$Z_{NR}[SU(2)_L]^2 \;:\; \frac{3}{2}\{3(\phi_{\bf 10}-\alpha)+(\bar{\phi}_{\bar{\bf 5}}-\alpha)\} + \frac{1}{2}\{(h-\alpha)+(\bar{h}-\alpha)\} + 2\alpha = \frac{N}{2}k'$$

$$\Rightarrow \boxed{\begin{aligned} 3\alpha &= \frac{N}{2}k, \\ \alpha &= \frac{N}{2}k'. \end{aligned}}$$

⇒ **Additional contribution from extra matter is needed.**

Discrete R-symmetry

--- To realize a non-anomalous discrete R-symmetry ---

- Introduce vector-like matter as the extra matter
- The mass is generated through Giudice-Masiero mechanism

m ~ 1 TeV, $\quad \phi' + \bar{\phi}' = 0 \mod N$

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numbers of $\mathbf{5}+\bar{\mathbf{5}}$ and $\mathbf{10}+\bar{\mathbf{10}}$ pairs $n_{\mathbf{5}'} + 3n_{\mathbf{10}'} \leq 4$

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$$Z_{NR}[SU(3)_C]^2 \quad : \quad (3 - n_{\mathbf{5}'} - 3n_{\mathbf{10}'})\alpha = \frac{N}{2}k,$$

$$Z_{NR}[SU(2)_L]^2 \quad : \quad (1 - n_{\mathbf{5}'} - 3n_{\mathbf{10}'})\alpha = \frac{N}{2}k'.$$

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$\Leftrightarrow$

EW scale μ term:

$$\boxed{2\alpha \neq 0 \mod N}$$

Consistent !!

N= 4 or 20, ex. N=4,

	$\bar{5}_{\rm SM}$	$10_{\rm SM}$	N	5_H	$\bar{5}_H$	$10_{\rm ex}$	$\bar{10}_{\rm ex}$	θ
Z_{4R}	1	1	1	0	0	1	-1	1

Discrete R-symmetry

- **We introduce 10 + 10bar because it may couple to the up-type Higgs & change the lightest Higgs boson physics.**

$$\Phi'_{\mathbf{10}} = Q + U + E \qquad \bar{\Phi}'_{\bar{\mathbf{10}}} = \bar{Q} + \bar{U} + \bar{E}$$

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$$W = y_t t_R^c q_L H_u + y_U U Q H_u + M_U \bar{U} U + M_Q \bar{Q} Q$$

$$\begin{aligned} \mathcal{L}_{\rm soft} &= m_{\tilde{q}}^2 |\tilde{q}_L|^2 + m_{\tilde{t}}^2 |\tilde{t}_R^c|^2 + m_{\tilde{Q}}^2 |\tilde{Q}|^2 + m_{\tilde{\bar{Q}}}^2 |\tilde{\bar{Q}}|^2 + m_{\tilde{U}}^2 |\tilde{U}|^2 + m_{\tilde{\bar{U}}}^2 |\tilde{\bar{U}}|^2 \\ &\quad + (y_t A_t \tilde{t}_R^c \tilde{q}_L H_u + y_U A_U \tilde{U} \tilde{Q} H_u + \text{h.c.}), \end{aligned}$$

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$$+ (y_t A_t \tilde{t}_R^c \tilde{q}_L H_u + \boxed{y_U A_U \tilde{U} \tilde{Q} H_u + \text{h.c.}}),$$

New terms

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New terms

Extra matter mass generated by Giudice-Masiero ~ 1TeV

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Assuming a little hierarchy between EW scale & SUSY particle mass, we estimate the Higgs mass by using the effective theory.

Discrete R-symmetry

Below M_{SUSY}, there are only SM-like Higgs doublet H_{SM}

$$V_{\rm SM} = m_H^2 |H_{\rm SM}|^2 + \frac{1}{2}\lambda |H_{\rm SM}|^4$$

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The Higgs mass is $m_h^2 = \lambda(m_h) v^2$

⇧

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Stop loop contribution

extra matter contribution

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$$\delta\lambda' \sim \frac{3y_U^4 \sin^4\beta}{8\pi^2} \ln\left(\frac{M_U^2 + m_{\tilde{U}}^2}{M_U^2}\right) - \frac{y_U^4 \sin^4\beta}{32\pi^2} \frac{A_U^4 - (8M_U^2 + 12m_{\tilde{U}}^2)A_U^2 + 8M_U^2 m_{\tilde{U}}^2 + 10m_{\tilde{U}}^4}{(M_U^2 + m_{\tilde{U}}^2)^2}$$

$$M_Q = M_U \ (\text{at } \mu = M_{\rm SUSY})$$
$$m_{\tilde{Q}}^2 = m_{\tilde{\bar{Q}}}^2 = m_{\tilde{U}}^2 = m_{\tilde{\bar{U}}}^2$$

Discrete R-symmetry

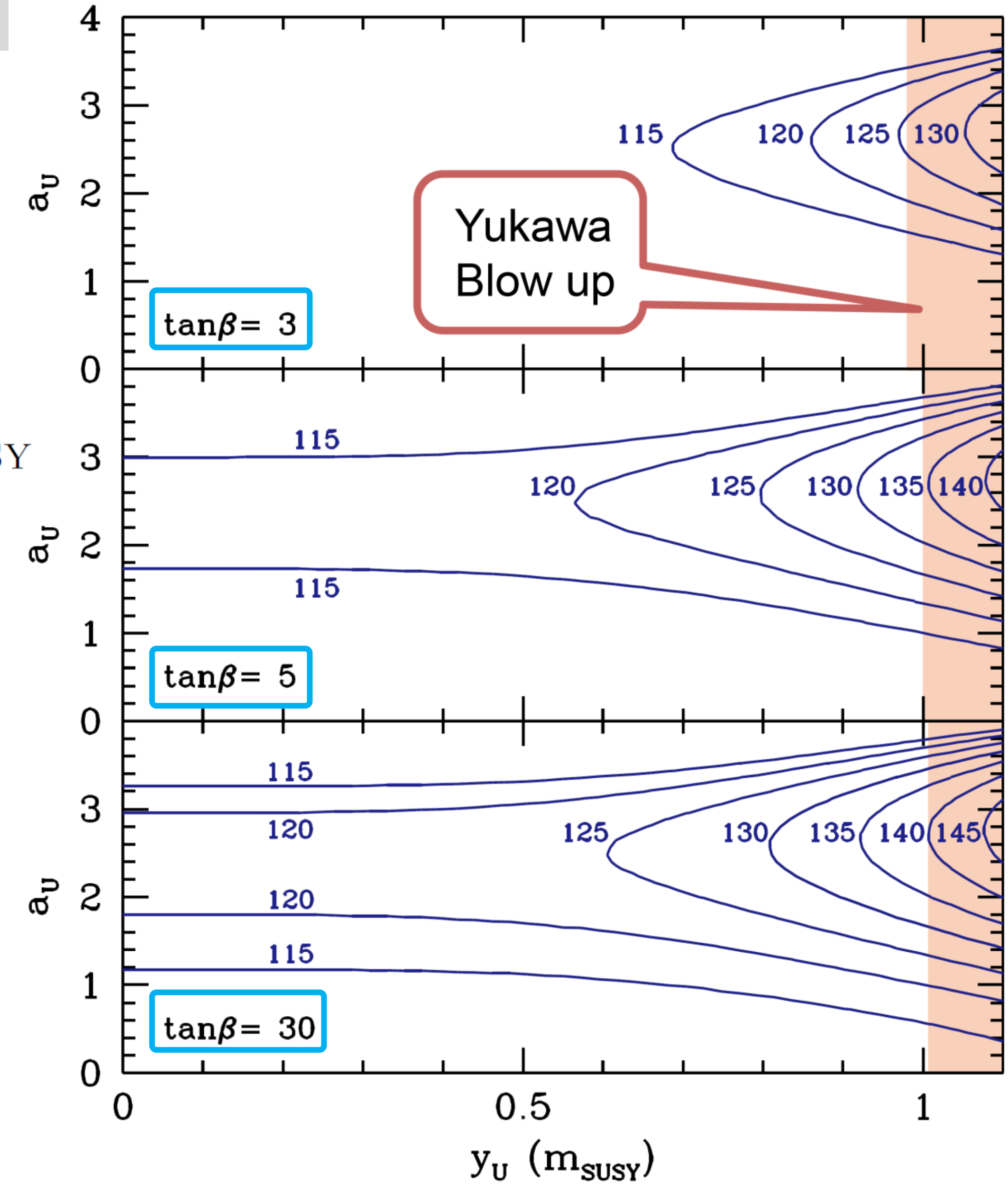
Numerical result:

$$a_t = a_U$$

$$M_Q = M_U = M_E =$$
$$m_{\rm SUSY} = 1\ \text{TeV}$$

$$A_t = a_t m_{\rm SUSY}$$

< Higgs mass >



Discrete R-symmetry

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$$m_{\rm SUSY} = 1\ {\rm TeV}$$

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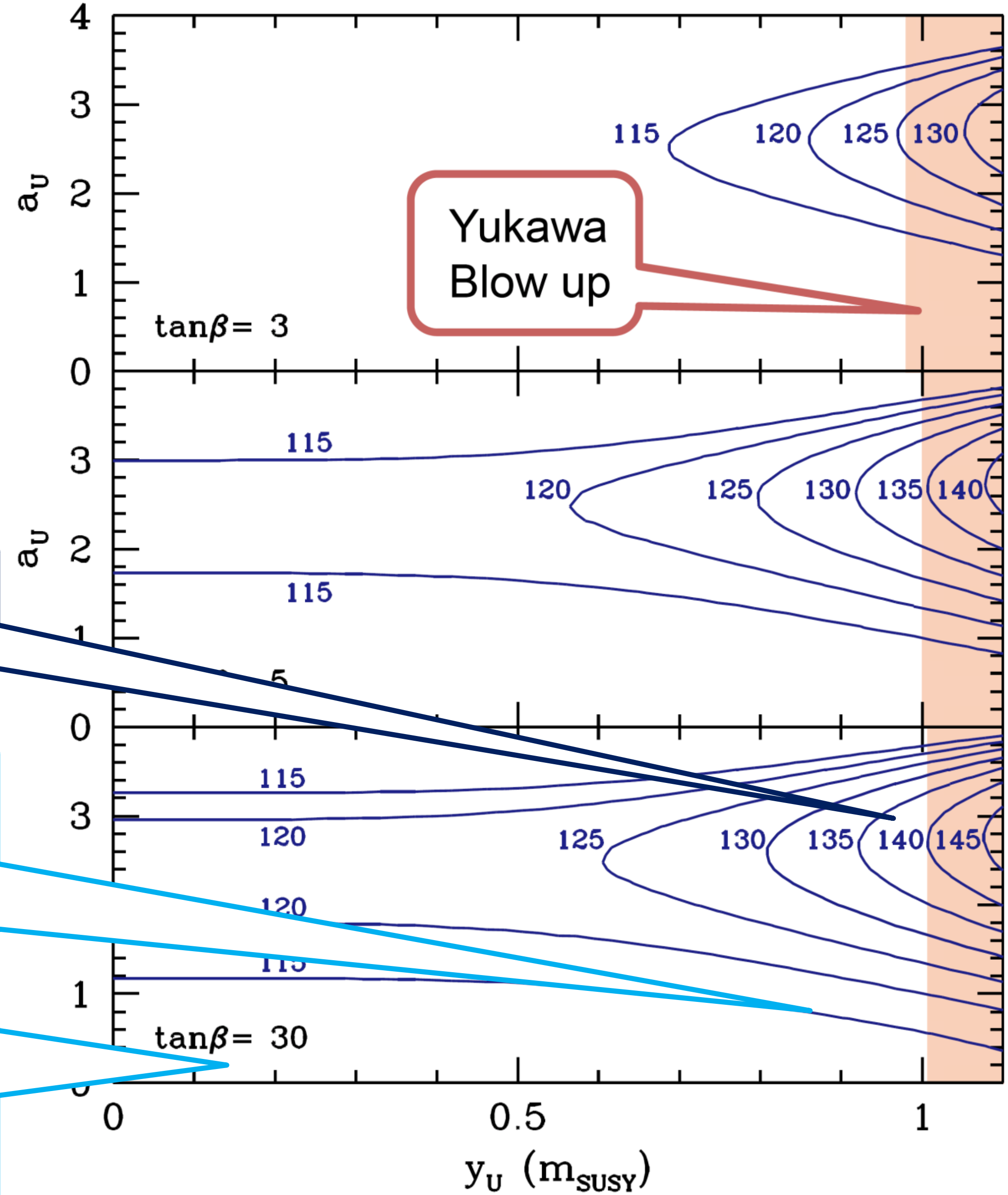

Higgs mass can be heavier than MSSM case!

There are the allowed parameter even in small A term region!

Unlike NMSSM, tanbeta can be take a large value!

Considering non-anomalous discrete R-symmetry,

Higgs physics become change.

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Next question:

Furthermore, if LHC will report an unguessed Higgs signal, can SUSY also explain the signal?

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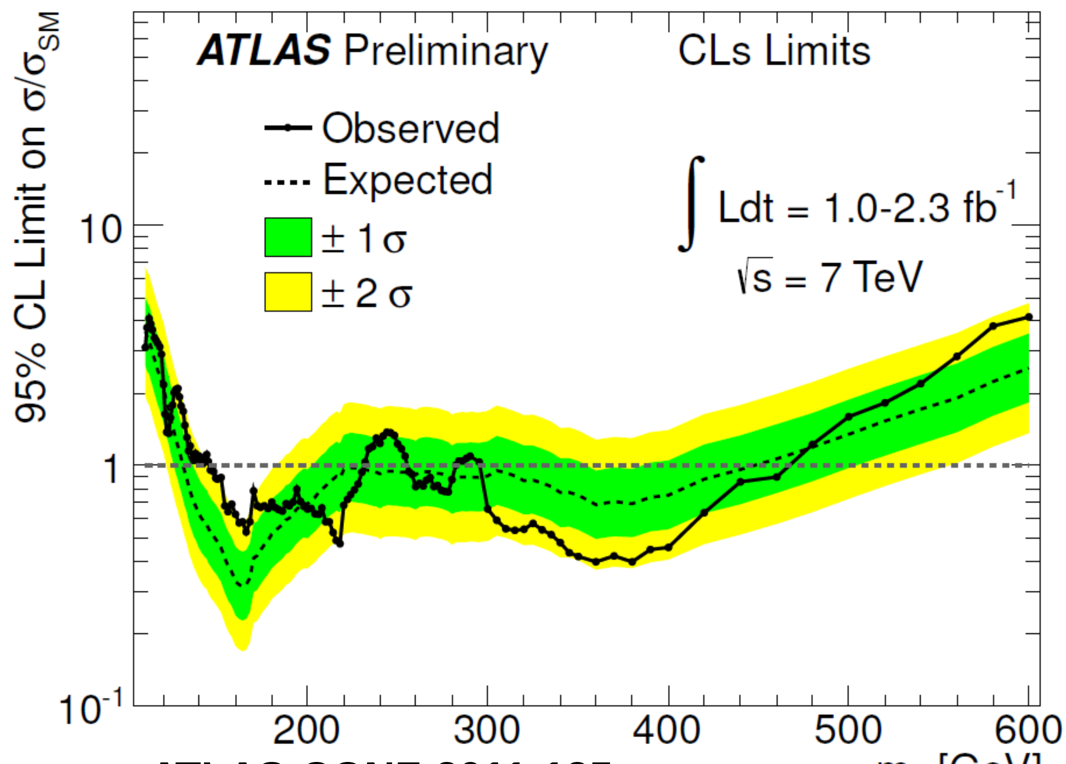

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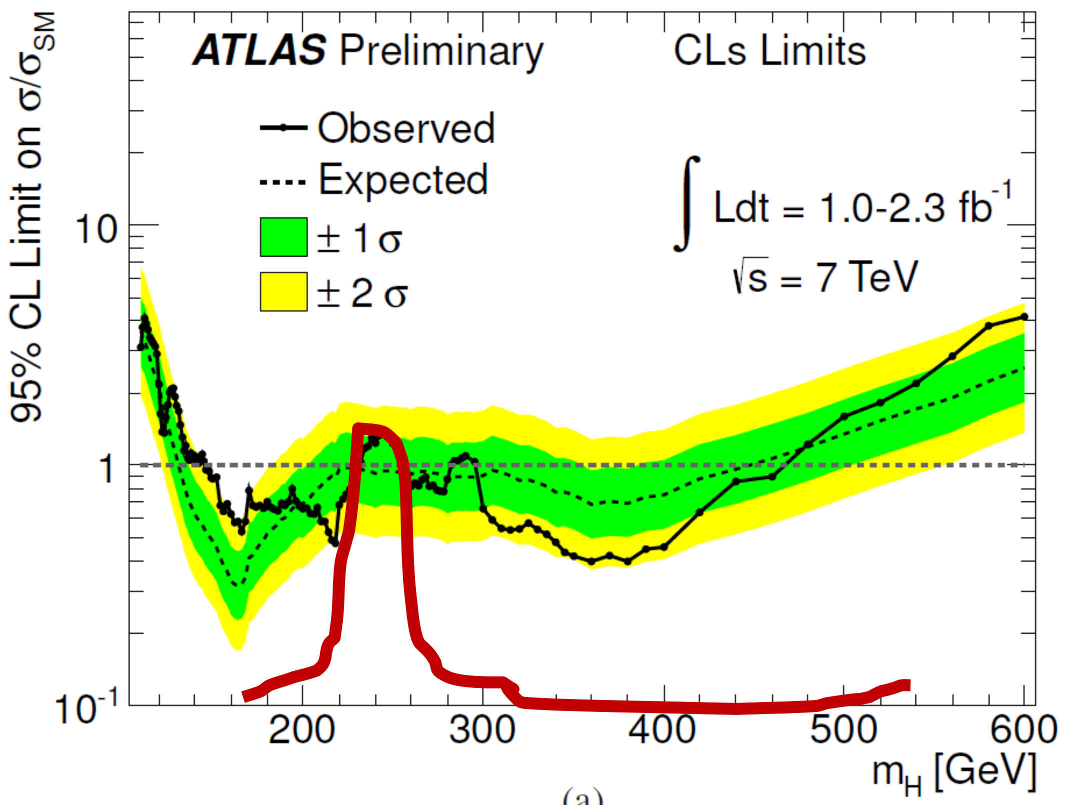

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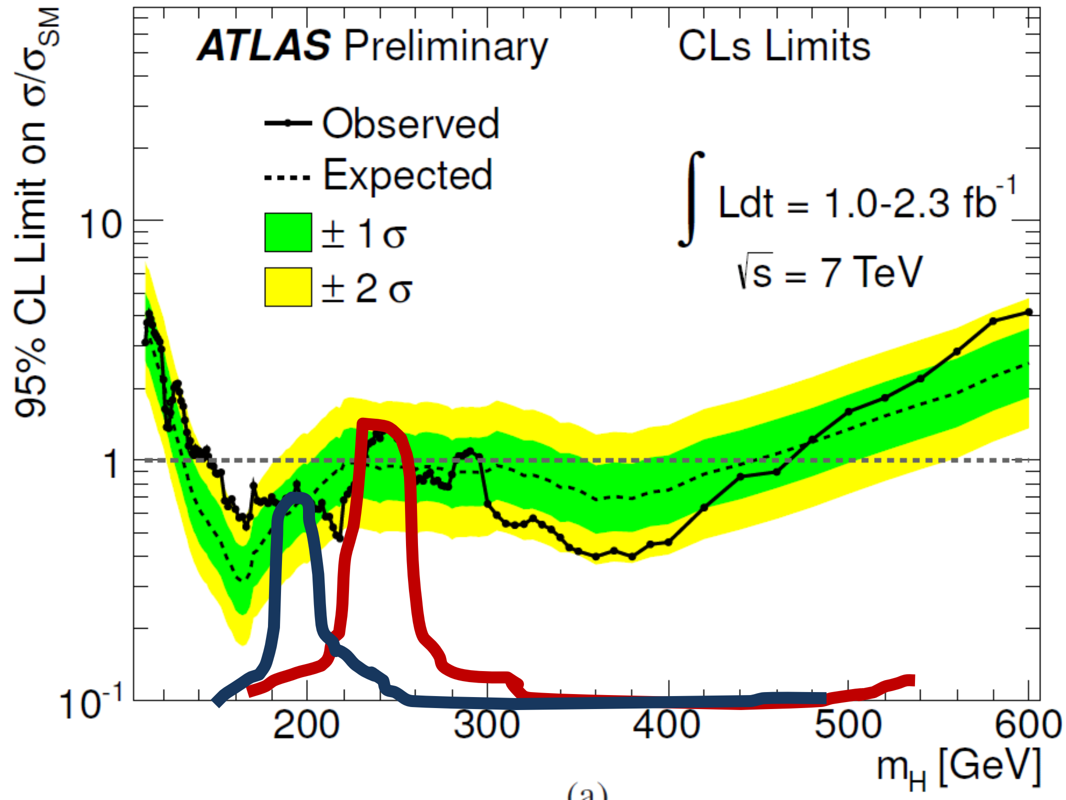

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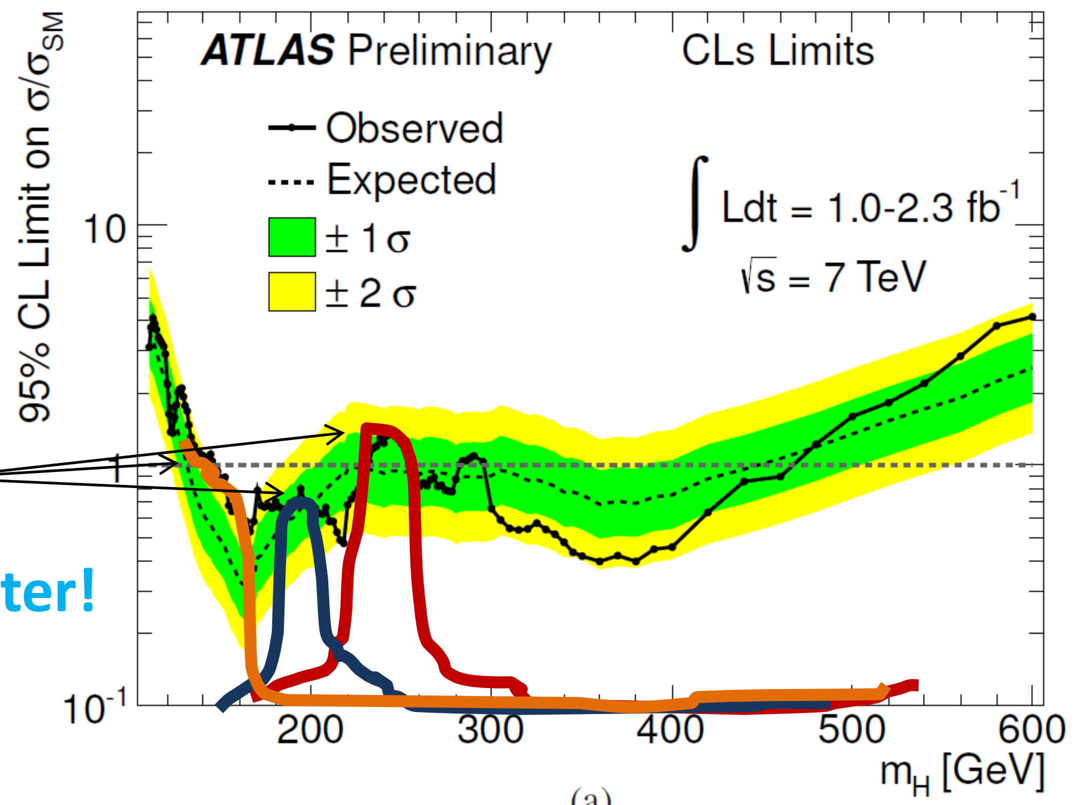
SUSY can also explain these signal In NMSSM + vector-like matter!



What is the SUSY Higgs prediction?

- Possibility of Mimicked Higgs signal

M. Asano, T. Moroi, N. Yokozaki

arXiv:1107.4523

Mimicked Higgs signal

NMSSM + vector like matter

- Singlet behave like a SM Higgs at LHC
  for wide range of the singlet mass.
- The $\sigma_{signal}/\sigma_{SM}$ could take on a wide range of values.

⇨ Even if heavy Higgs like signal will appear at LHC,
Low-energy SUSY is not immediately excluded.

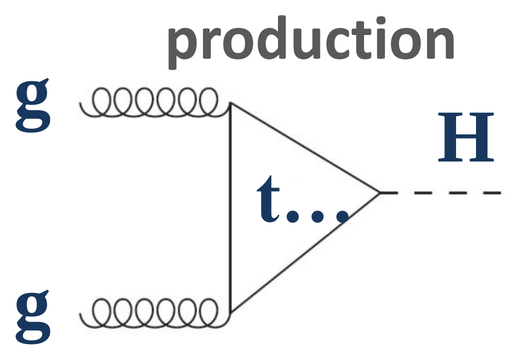
How SM Higgs is mimicked

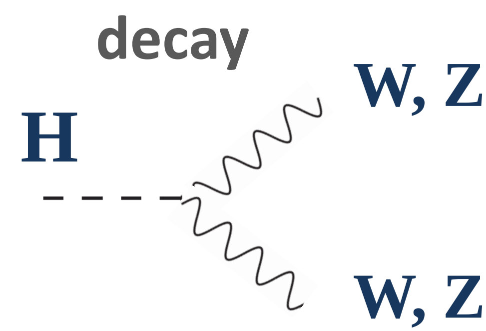
at the LHC

How SM Higgs is mimicked

Basic idea

SM Higgs





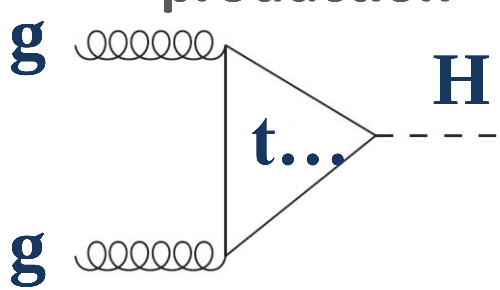
Now, the most efficient production process is the **gluon fusion** which induced by the top-loop diagram.

How SM Higgs is mimicked

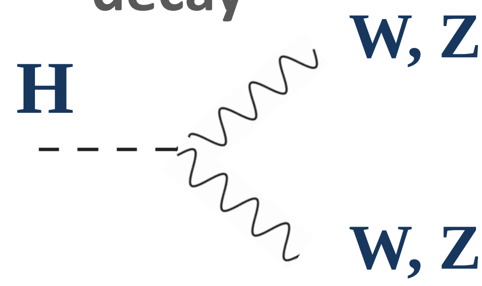
Basic idea

SM Higgs

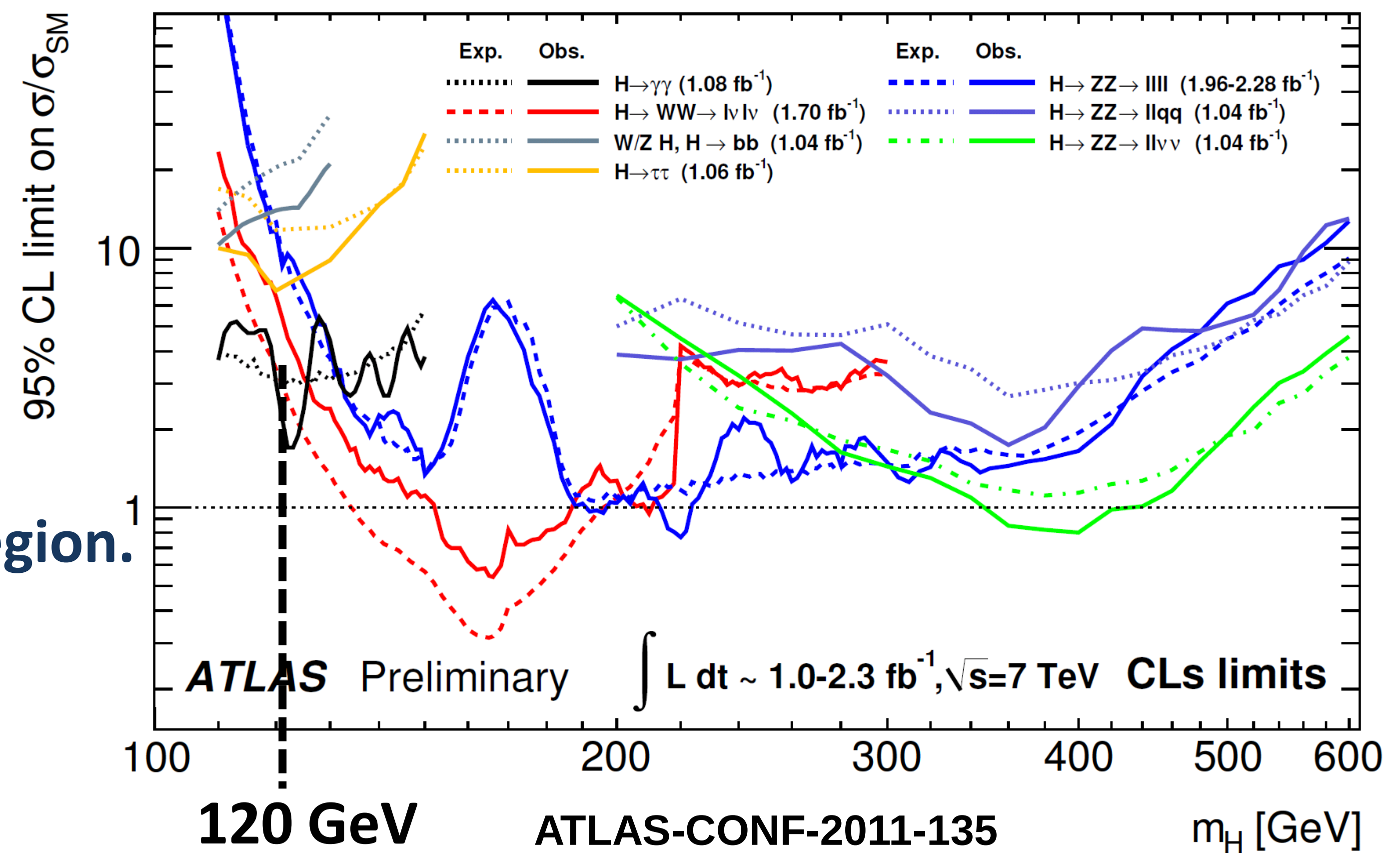
production



decay



WW, ZZ decay
channel have
good sensitivity
except
light Higss mass region.



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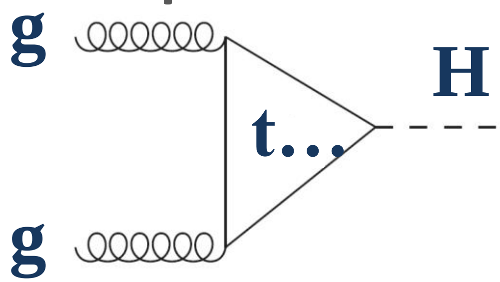
How SM Higgs is mimicked

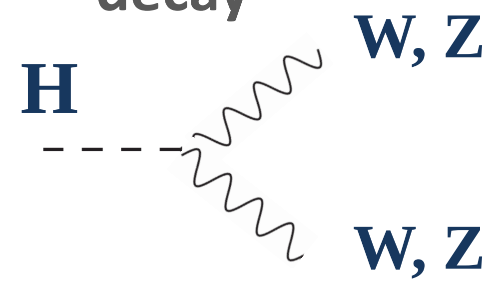
Basic idea

SM Higgs

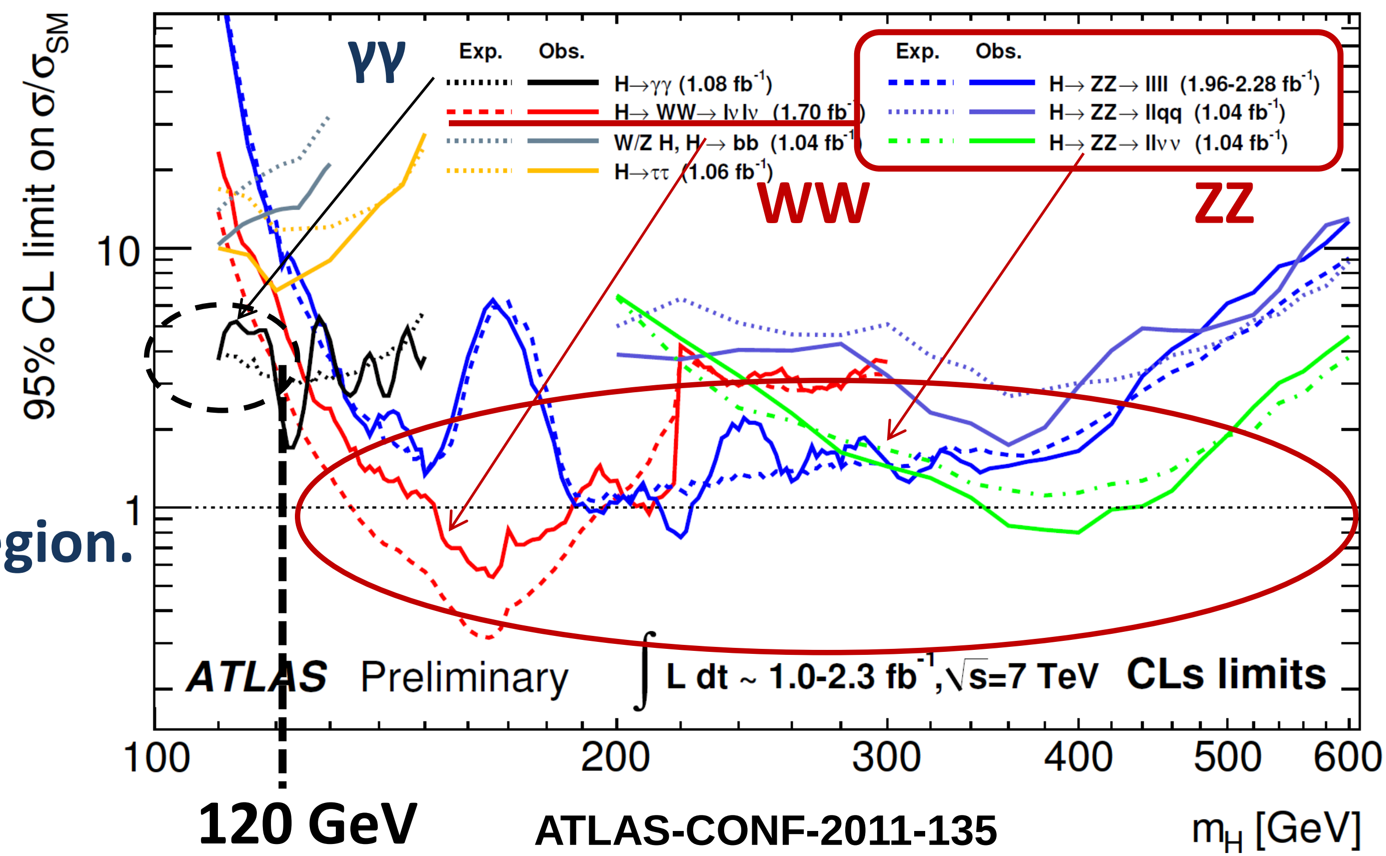
production



decay



WW, ZZ decay channel have **good sensitivity** except light Higss mass region.



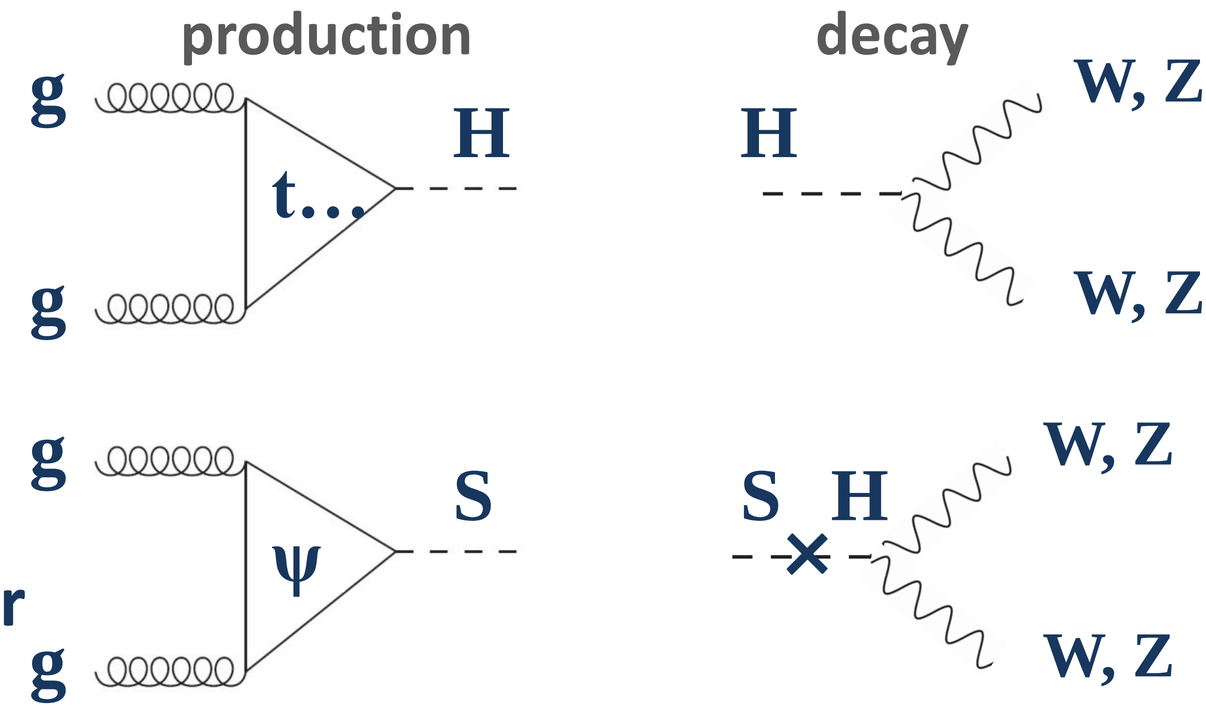
How SM Higgs is mimicked

Basic idea

SM Higgs

Singlet +

vector-like matter

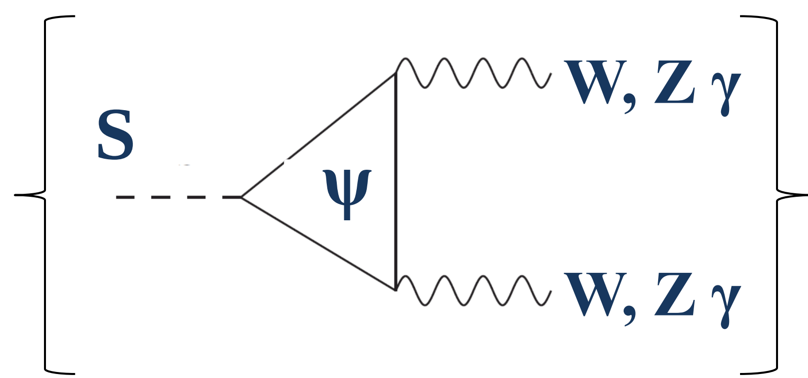


- Procudtion:

  vector-like matter loop.

- Decay:

  mixing of S & H



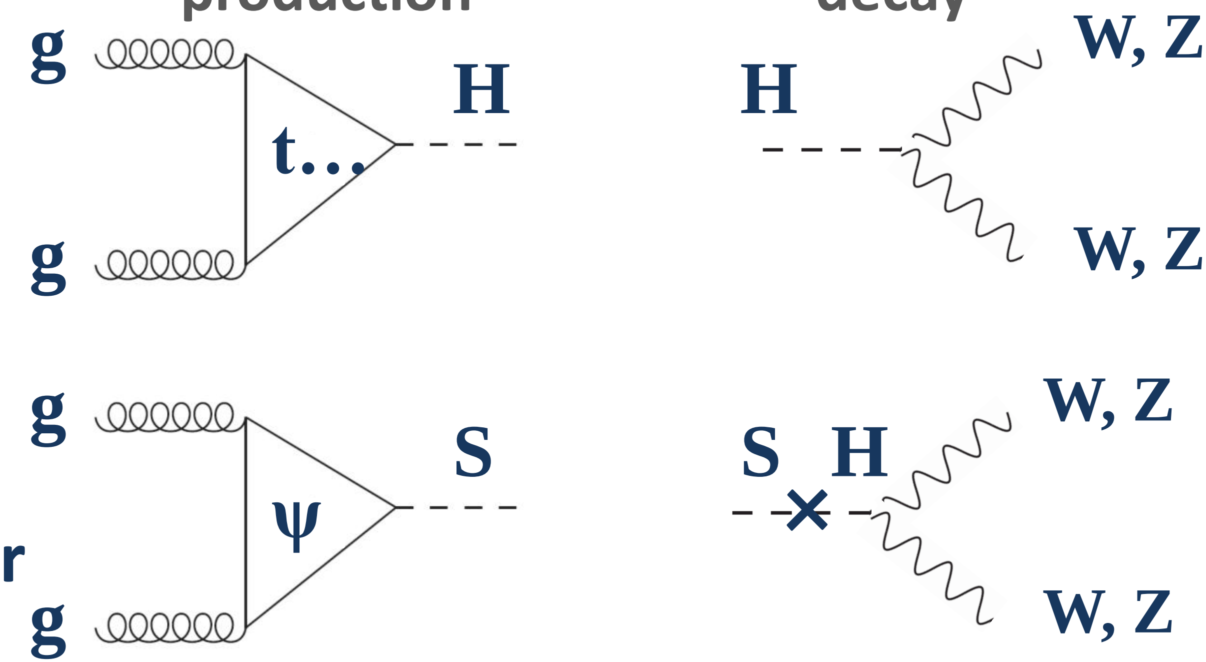
How SM Higgs is mimicked

Basic idea

production decay

SM Higgs

Singlet + vector-like matter



The ratio of the cross section, pp → Higgs →VV:

$$R_{VV} \equiv \frac{\sigma(pp \to \mathbf{S} \to VV)}{\sigma(pp \to h_{\rm SM} \to VV)} = \frac{\Gamma(S\to gg)\, Br(S\to VV)}{\Gamma(H\to gg)\, Br(H\to VV)}$$

The singlet can behave like a SM Higgs!

How SM Higgs is mimicked

at the LHC

more detail …

How SM Higgs is mimicked

more detail

Simplest setup

We introduce the gauge singlet superfield: S

N_5-pairs of vector-like chiral multiplets: $D_i\ (\mathbf{3}, \mathbf{1}, -\frac{1}{3}),\quad L_i\ (\mathbf{1}, \mathbf{2}, -\frac{1}{2}),$

$\bar{D}_i\ (\bar{\mathbf{3}}, \mathbf{1}, \frac{1}{3}),\quad \bar{L}_i\ (\mathbf{1}, \mathbf{2}, \frac{1}{2}),$

Motivated by NMSSM,

$$W \supset \lambda S H_u H_d + \frac{1}{3}\kappa S^3 + y_D S \bar{D}_i D_i + y_L S \bar{L}_i L_i$$

$$\mathcal{L}_{\rm soft} \supset -m_{H_d}^2 |H_d|^2 - m_{H_u}^2 |H_u|^2 - m_S^2 |S|^2 - \left(\lambda A_\lambda S H_u H_d + \frac{1}{3}\kappa A_\kappa S^3 + {\rm h.c.}\right)$$

How SM Higgs is mimicked

more detail

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Vector-like matter mass: $m_D = y_D v_s$

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Assuming the perturbativity of the Yukawa coupling constant, the colored fermions are expected to be lighter than $\sim v_s$

How SM Higgs is mimicked

more detail

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mu parameter in MSSM: $\mu_{\text{eff}} = \lambda v_s$

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Parameters:

$$A_\lambda\,,\; A_\kappa\,,\; \lambda,\; \kappa,\; m_{H_d}^2,\; m_{H_u}^2,\; m_S^2$$

How SM Higgs is mimicked

more detail

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$$v_s = \langle S \rangle$$

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Parameters:

$$\boxed{A_\lambda\,,\ A_\kappa\,, m_Z,\ \tan\beta,\ v_s\,, \mu_{\text{eff}}\,,\ m_{h_2}}$$

How SM Higgs is mimicked

more detail

Simplest setup

We introduce the gauge singlet superfield: S

N_5-pairs of vector-like chiral multiplets: $D_i\ (\mathbf{3},\mathbf{1},-\frac{1}{3}),\ \ L_i\ (\mathbf{1},\mathbf{2},-\frac{1}{2}),$

$\bar{D}_i\ (\bar{\mathbf{3}},\mathbf{1},\frac{1}{3}),\ \ \bar{L}_i\ (\mathbf{1},\mathbf{2},\frac{1}{2}),$

Motivated by NMSSM

mu parameter in MSSM: $\mu_{\rm eff} = \lambda v_s$

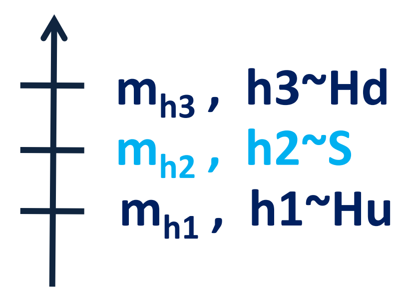
Vector-like matter mass: $m_D = y_D v_s$

$$W \supset \boxed{\lambda S} H_u H_d + \frac{1}{3}\kappa S^3 + \boxed{y_D S} \bar{D}_i D_i + y_L S \bar{L}_i L_i \qquad v_s = \langle S \rangle$$

$$\mathcal{L}_{\rm soft} \supset -m_{H_d}^2 |H_d|^2 - m_{H_u}^2 |H_u|^2 - m_S^2 |S|^2 - \left(\lambda A_\lambda S H_u H_d + \frac{1}{3}\kappa A_\kappa S^3 + {\rm h.c.}\right)$$

Parameters:

$$\boxed{A_\lambda\,,\ A_\kappa\,, m_Z,\ \tan\beta,\ v_s\,, \mu_{\rm eff}\,, m_{h_2}}$$



How SM Higgs is mimicked

at the LHC

Numerical results

How SM Higgs is mimicked

at the LHC

Numerical results

Parameters:

$$\boxed{A_\lambda\,,\; A_\kappa\,, m_Z,\; \tan\beta,\; v_s\,, \mu_{\rm eff}\,, m_{h_2}}$$

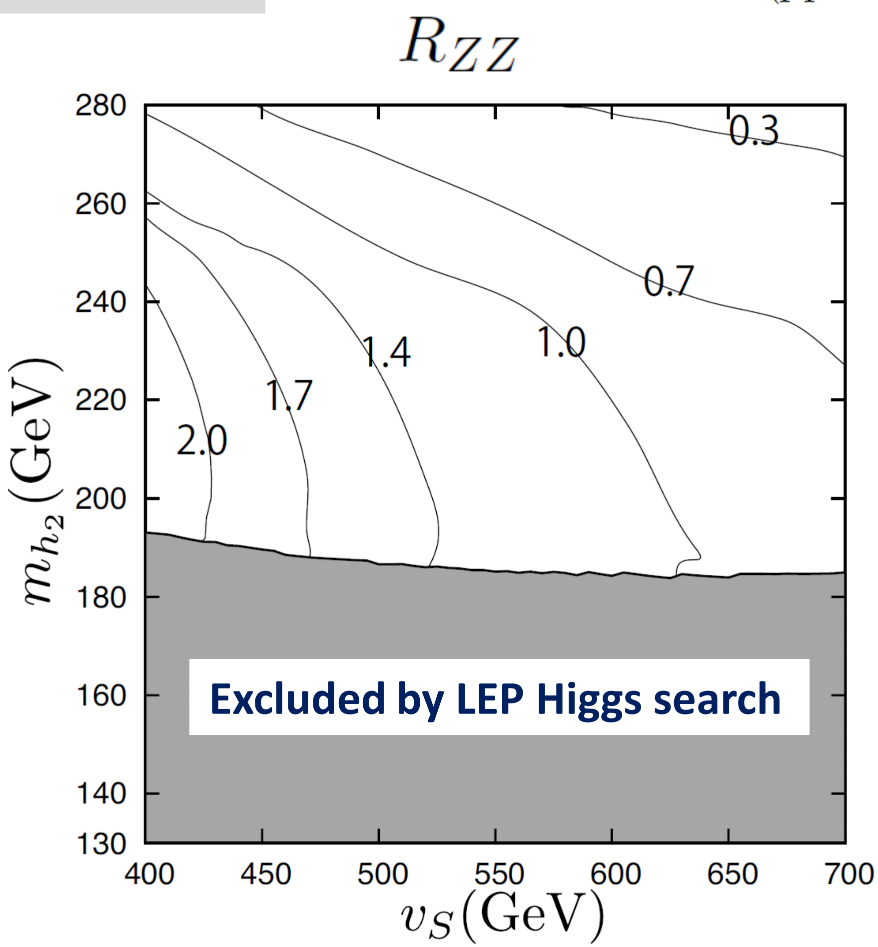
$$A_\lambda = 500\ \mathrm{GeV},\;\; A_\kappa = -100\ \mathrm{GeV}$$

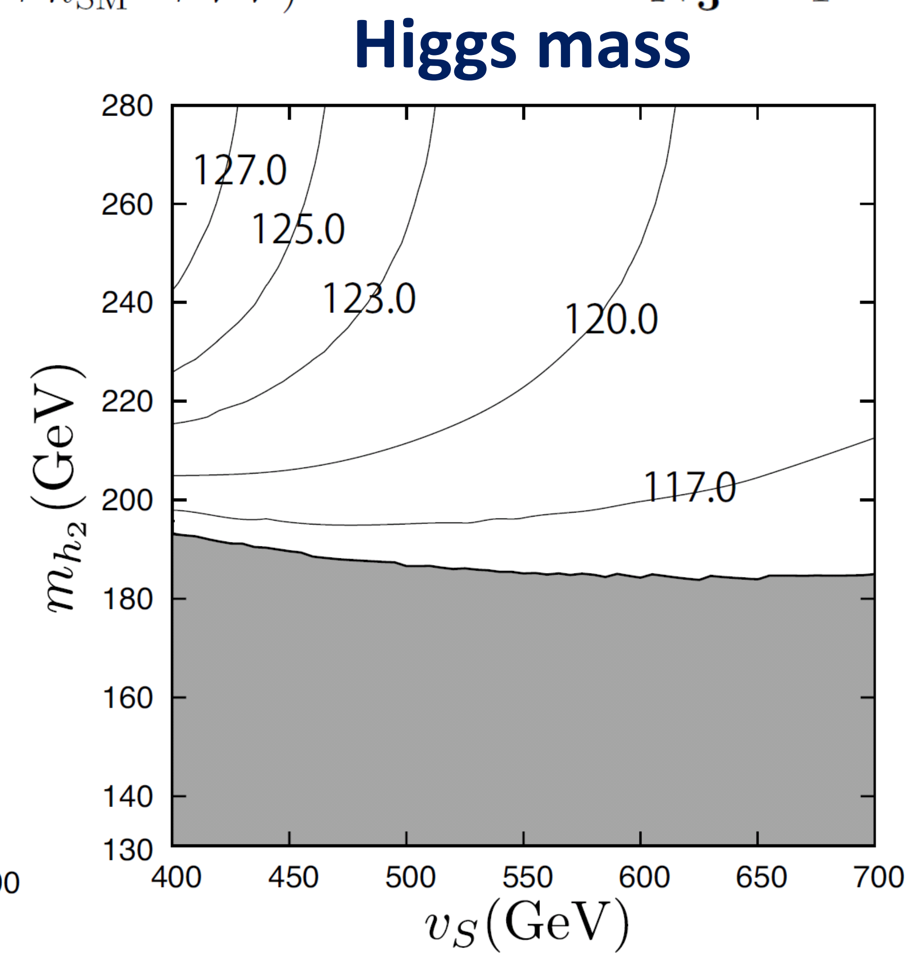
Results

$$R_{VV} \equiv \frac{\sigma(pp \to h_2 \to VV)}{\sigma(pp \to h_{\rm SM} \to VV)}$$

$\sqrt{s} = 7\mathrm{TeV}$

$N_{\mathbf{5}} = 4$





$\tan\beta = 3 \quad \mu_{\rm eff} = 250$ GeV

$A_t = 2$ TeV

Contours of constant R_{ZZ} , lightest Higgs boson mass

(The behavior of $\mathbf{R_{WW}}$ is almost identical)

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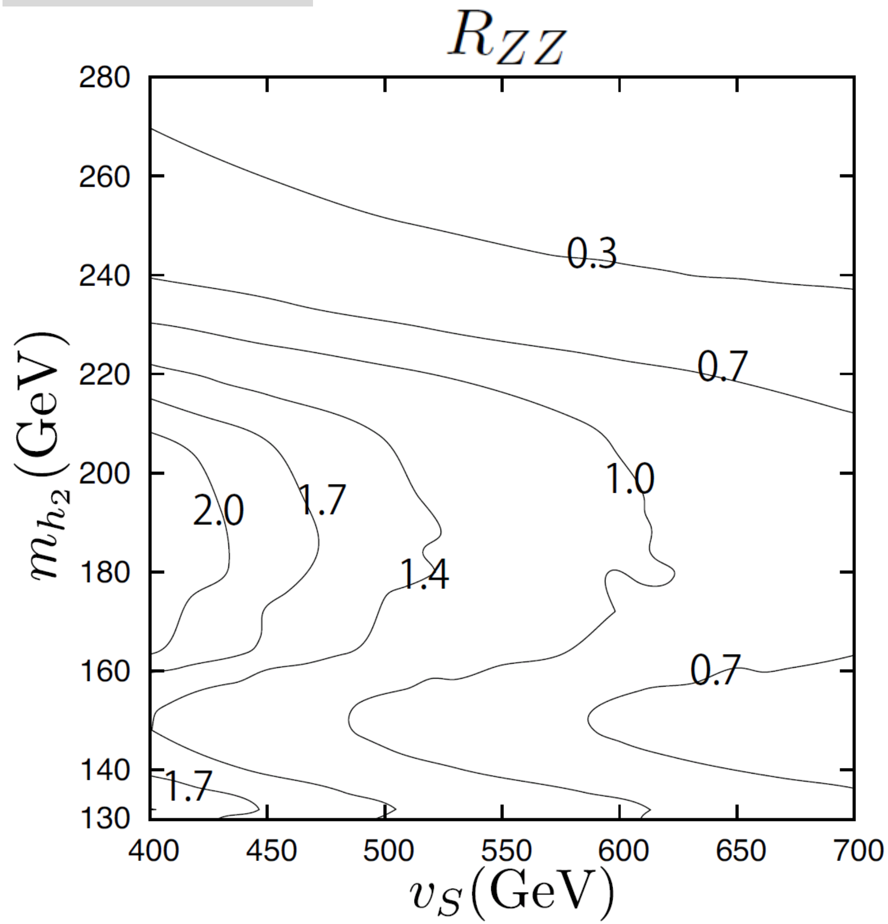
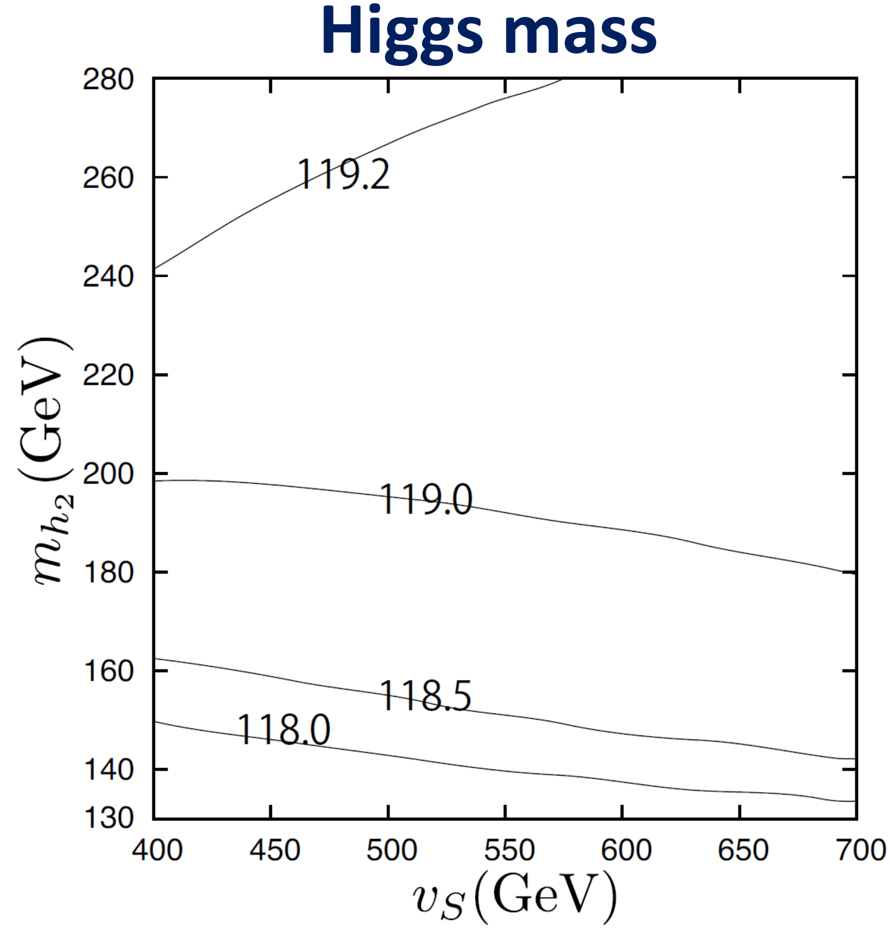


$\tan\beta = 5$ and $\mu_{\text{eff}} = 110$ GeV



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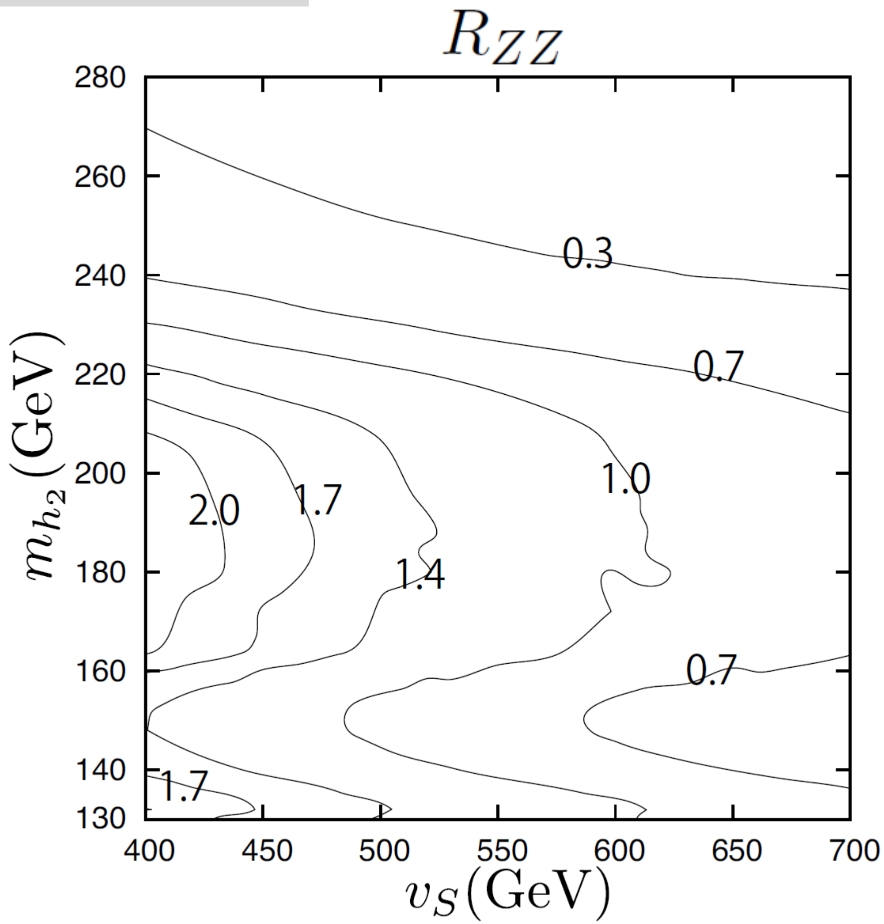

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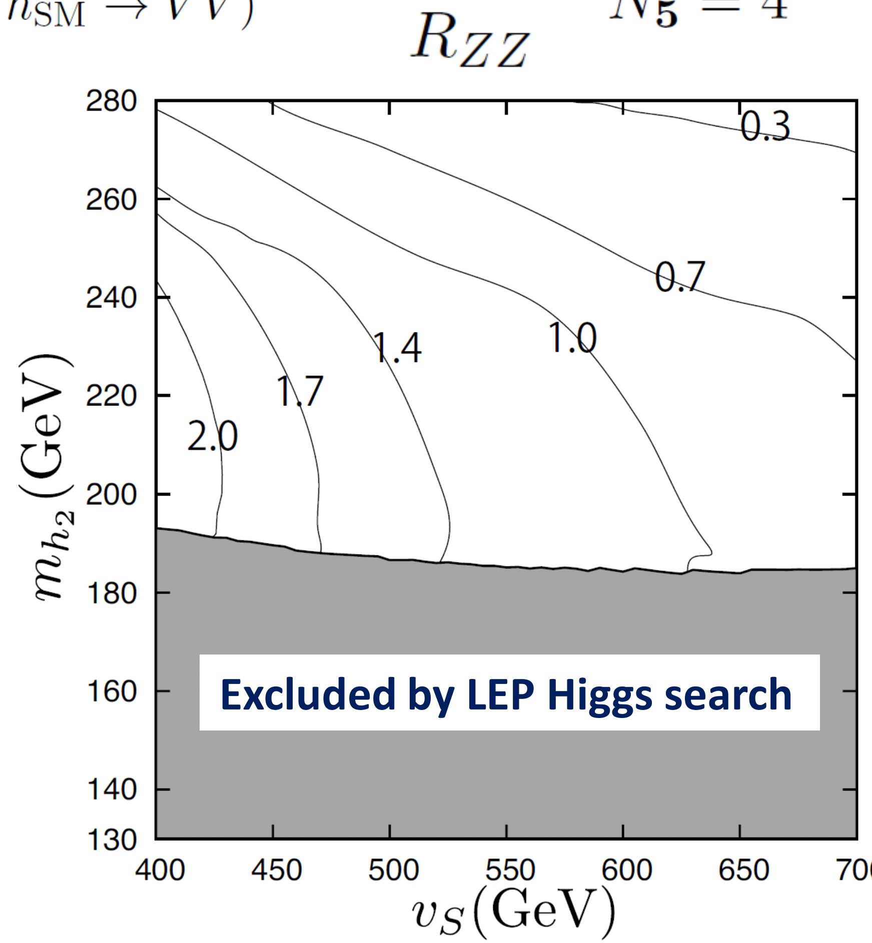


$\tan\beta = 3 \quad \mu_{\mathrm{eff}} = 250$ GeV

The SM-Higgs-like signal at the LHC can be mimicked by the singlet scalar for wide range of the singlet mass.

(the R_{VV} take also on a wide range of values.)

Mimicked Higgs signal

When Higgs signals are discovered at LHC,
can we identify that it is really Higgs discovery?
(If it is heavy, is low-energy SUSY immediately excluded?)

⇨ Answer is No. SUSY is not excluded immediately.

- It is possible that the singlet may behave as SM Higgs for wide range of the singlet mass.
  (e.g. NMSSM + vector-like matter)

- Lightest neutral Higgs will also discovered.
- vector-like matter exists.

In this talk,

- Introduction
  - Why Higgs?
  - Why low-energy Supersymmetry?
  - What is MSSM Higgs prediction?

- What is the SUSY Higgs prediction?
  - Non-anomalous discrete R-symmetry case
  - Possibility of Mimicked Higgs signal

- **Summary**
  - **Higgs sector has fruitful information of SUSY models**
  - **Various Higgs signals can be also explained by SUSY**

summary

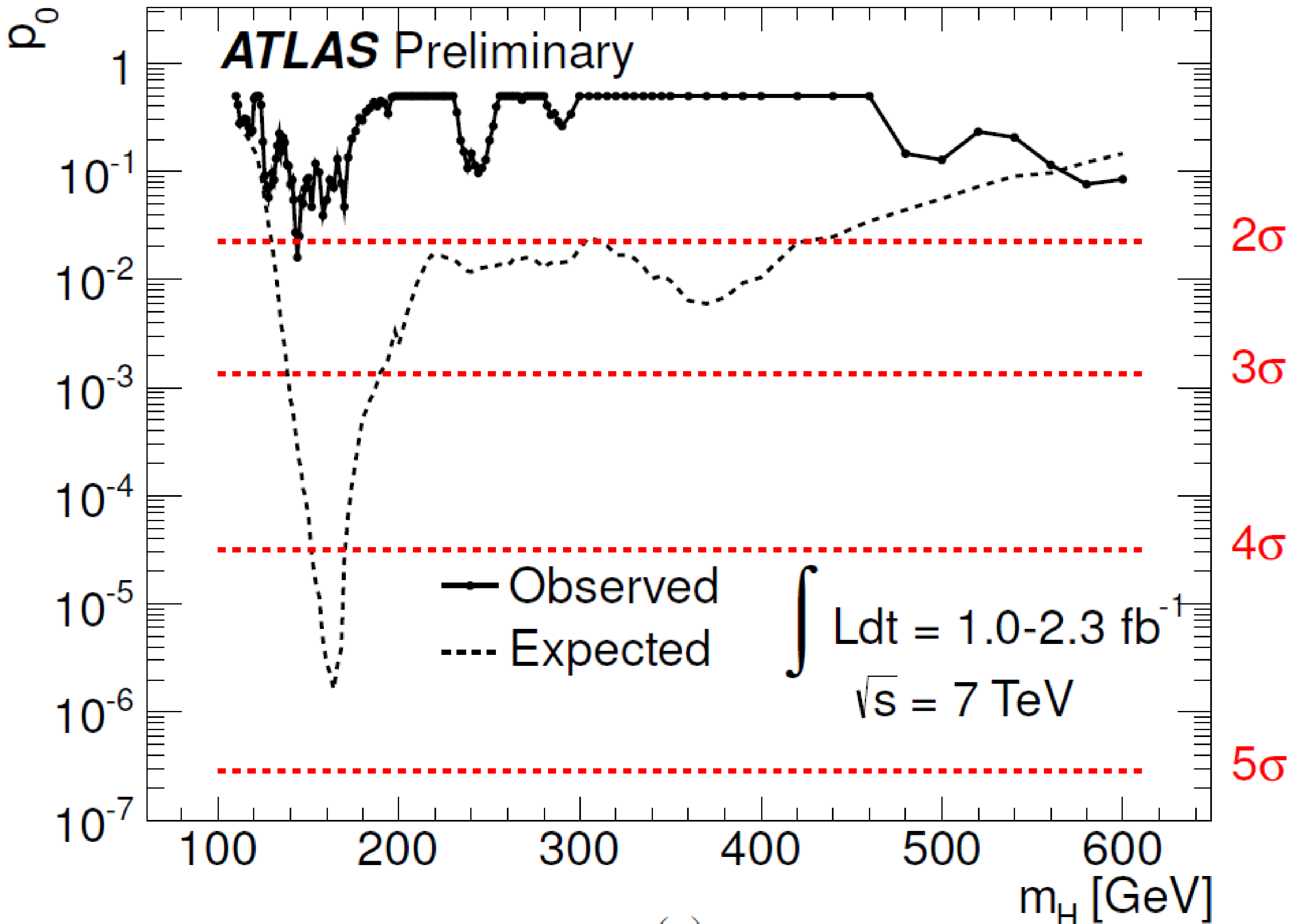
Various Higgs signal may appear at the LHC even if the TeV new physics is low-energy supersymmetry.

⇒ Higgs mass and the physics is very important information of the identification of the model in various SUSY models.

Full understanding of the relation between model and Higgs LHC signal is important.

Thank you!

backup



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