Phenomenology of partially composite standard model

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Introduction

- a Higgs boson was discovered around 125 GeV
- the SM is consistent, but Higgs potential looks unnatural
- some dynamics might be behind it

- many models with dynamics are proporsed
  - ⋆composite Higgs
  - ⋆Little Higgs
  - ⋆gauge Higgs
  - ⋆walking technicolor
  - ⋆...

  → predict new gauge bosons
  (W', W_H, ρ_{TC}, ...)

- It is worthwhile to study phenomenology of W' and Z'

- Let us study a model with W' and Z'

Model

- electroweak gauge symmetry: $SU(2)_0$ x $SU(2)_1$ x $U(1)_2$
- matters and their gauge charges:

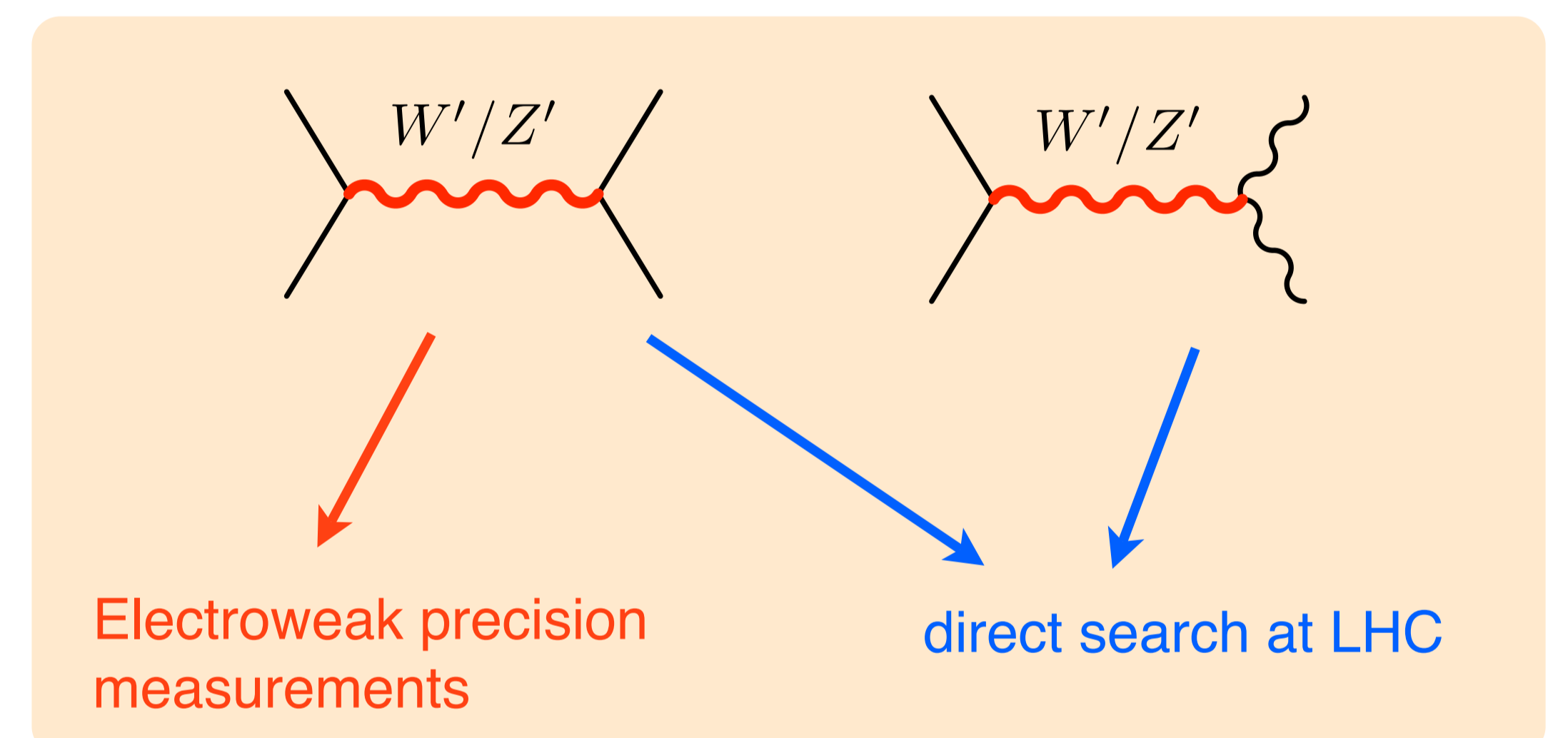| fields	$SU(2)_0$	$SU(2)_1$	$U(1)_2$	$SU(3)_c$
H_1	**2**	**2**	0	1
H_2	**1**	**2**	1/2	1
H_3	**2**	**1**	1/2	1
Q_L	**2**	**1**	1/6	**3**
L	**2**	**1**	-1/2	1
u_R	**1**	**1**	2/3	**3**
d_R	**1**	**1**	-1/3	**3**
e_R	**1**	**1**	-1	1

in moose notation:
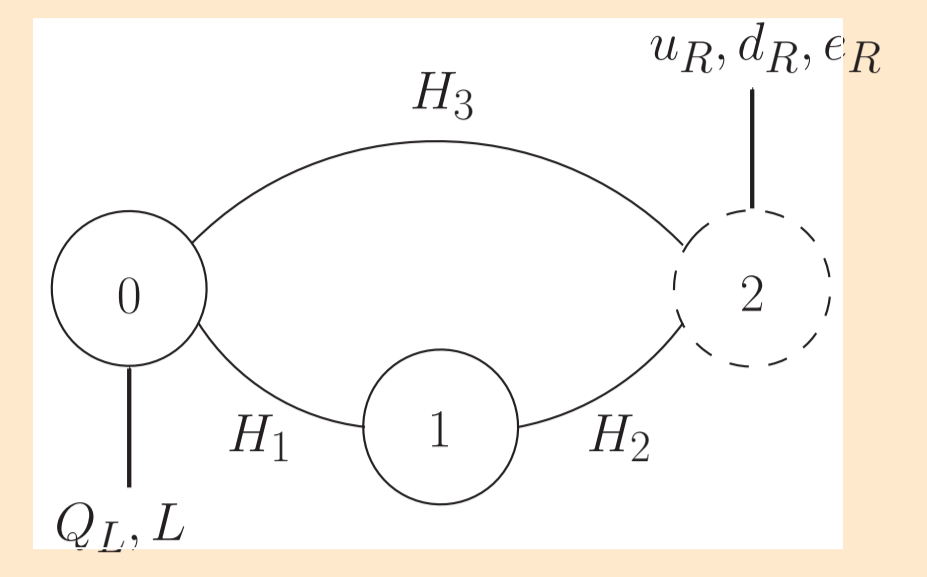
- $\mathcal{G}_{SM} \simeq SU(2)_0 \times U(1)_2$
- H_1, H_2, and W' can be regarded as composite states under some circumstance from the analogy of Hidden local symmetry

Bounds on W'

Electroweak precision measurements

g_l values

v_3 = 200 GeV

$g_l > 4\pi$

direct search at LHC

No solusions for m_W and $m_{W'}$
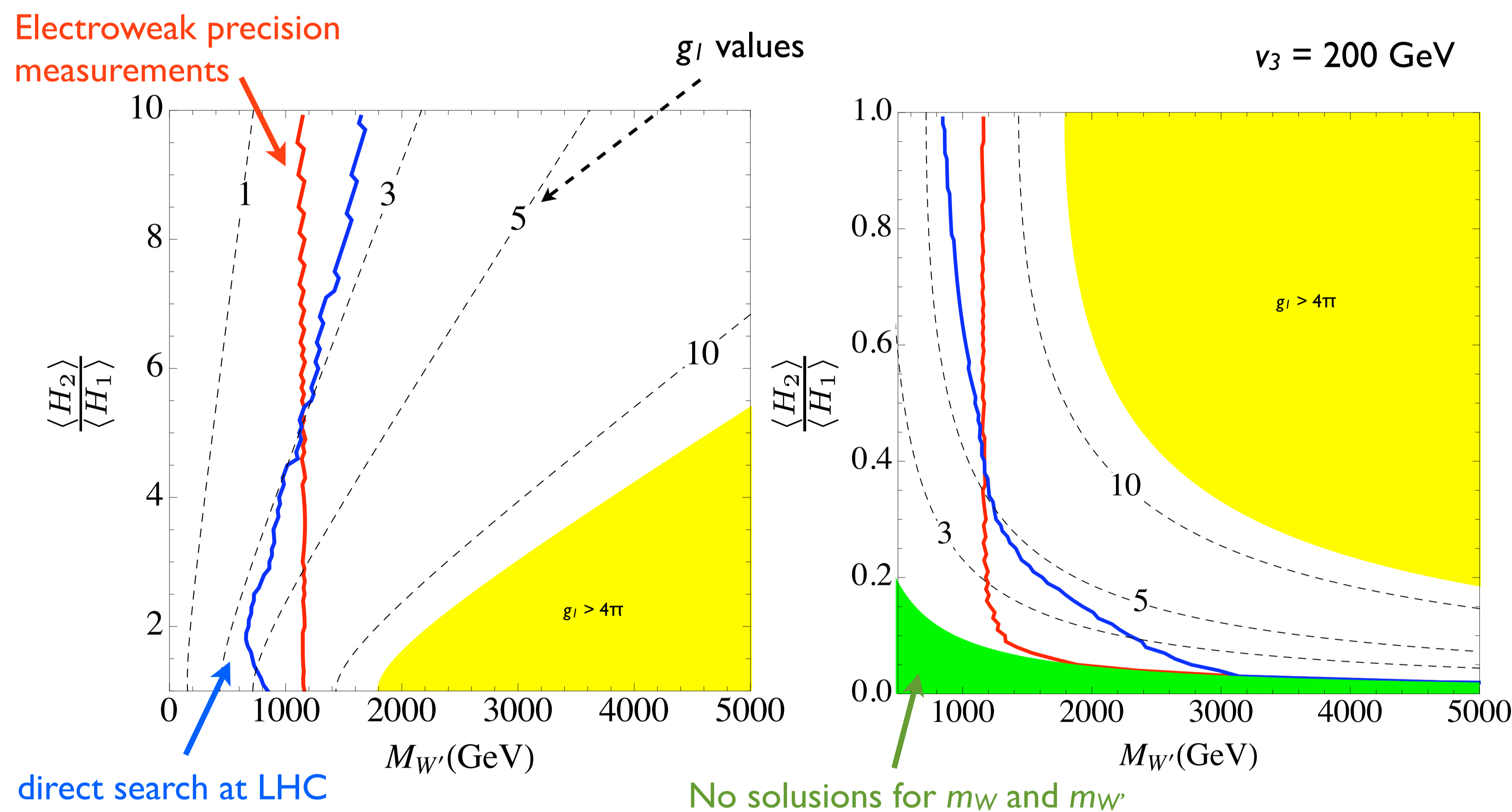
- $m_{W'} > 1$ TeV
- W' can be lighter than 3 TeV, within the reach of LHC

W'/Z' W'/Z'

Electroweak precision measurements   direct search at LHC

Higgs signal strength

- Higgs boson is the linear combination of h_1, h_2, and h_3: $h = \omega_h^1 h_1 + \omega_h^2 h_2 + \omega_h^3 h_3$
- If h_1 and h_2 are composite objects, $|\omega_h^1|^2 + |\omega_h^2|^2$ gives the compositeness of the Higgs boson

$\mu(gg \to h \to \gamma\gamma)$ $\mu(gg \to h \to ff)$ $\mu(gg \to h \to WW)$ $\mu(gg \to h \to ZZ)$
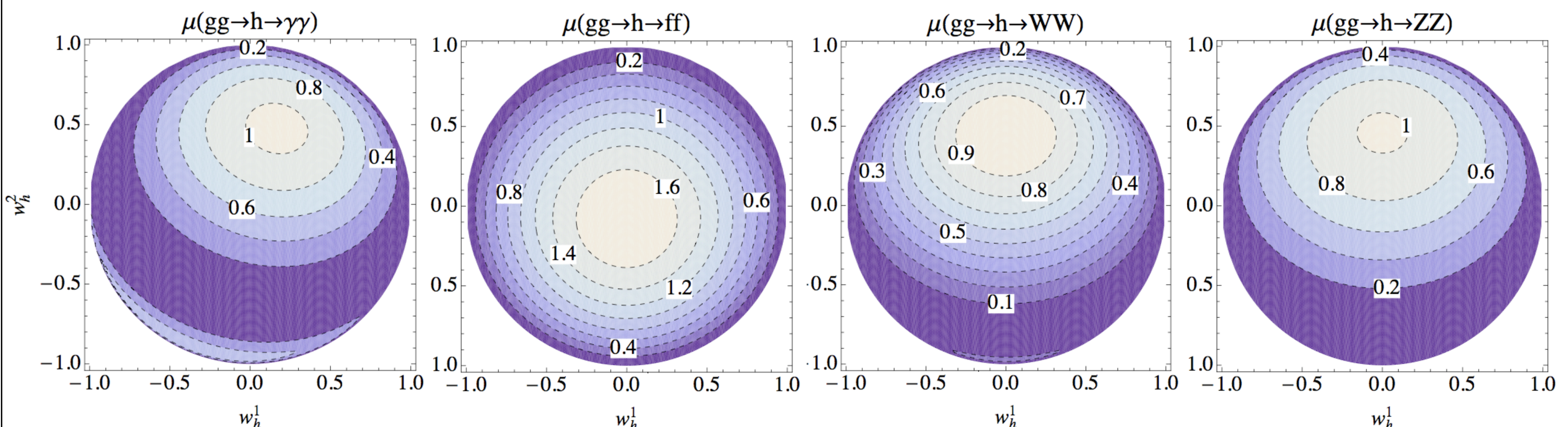
- $\omega_h^1 \sim 0$, $\omega_h^2 \sim 0.5$ looks consistent with SM
- $(\omega_h^1)^2 + (\omega_h^2)^2 \sim 30\%$
- compositeness of 125GeV Higgs is 30%

$$\frac{\langle H_2 \rangle}{\langle H_1 \rangle} = 0.1$$
$$v_3 = 200 \text{ GeV}$$
$$m_{W'} = 2.5 \text{ TeV}$$