

Many light Higgs bosons in the NMSSM

Radovan Dermisek

Indiana University, Bloomington

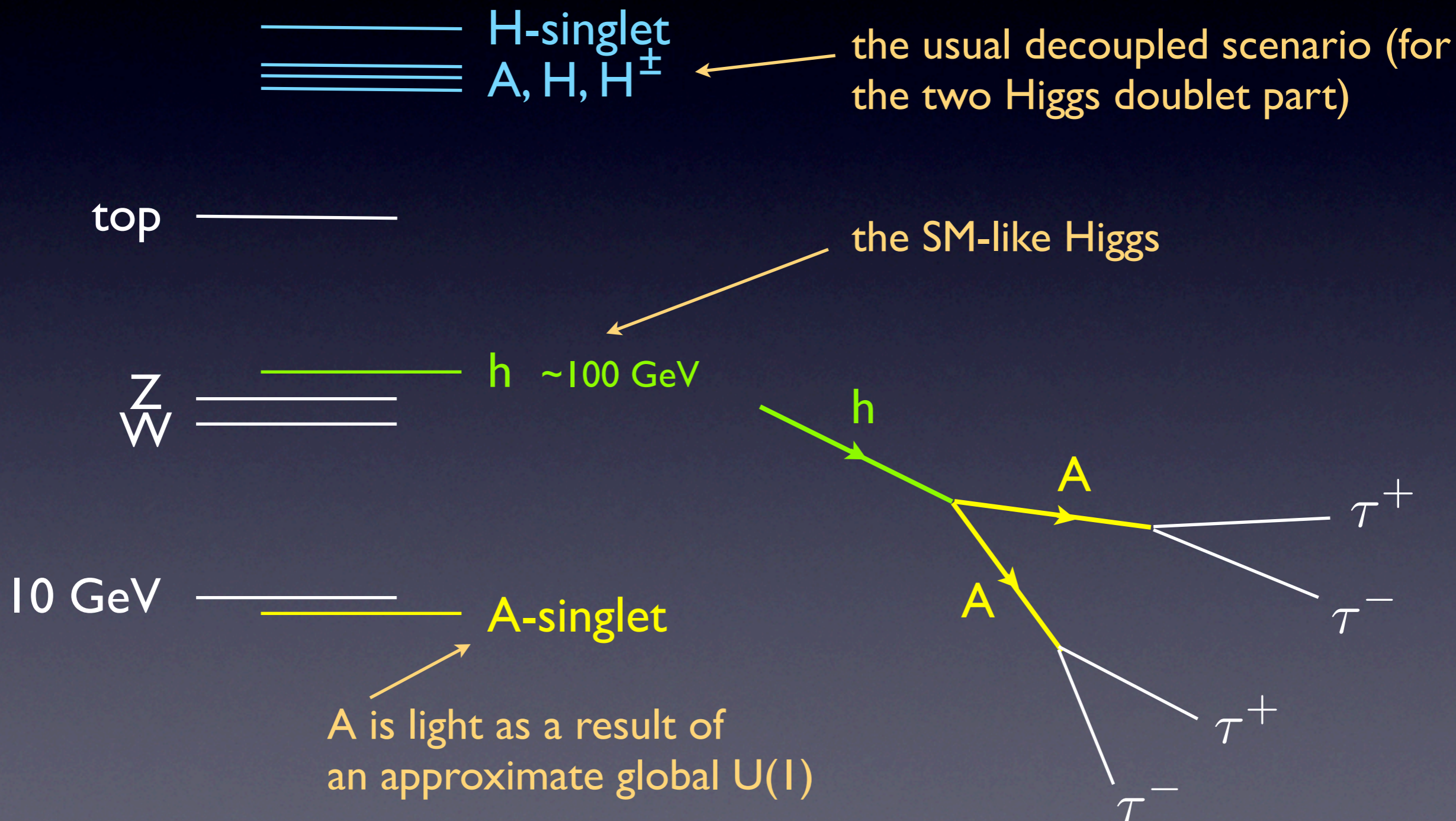
R.D., [arXiv:0806.0847 \[hep-ph\]](#), [arXiv:0807.2135 \[hep-ph\]](#)

R.D. and J. Gunion, [arXiv:0811.3537 \[hep-ph\]](#)

related to a series of papers with J. Gunion

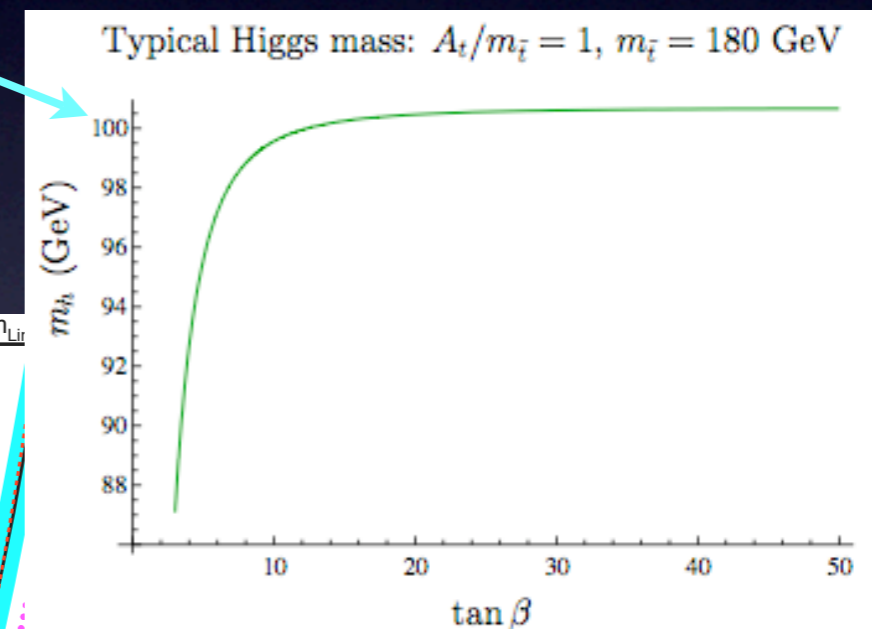
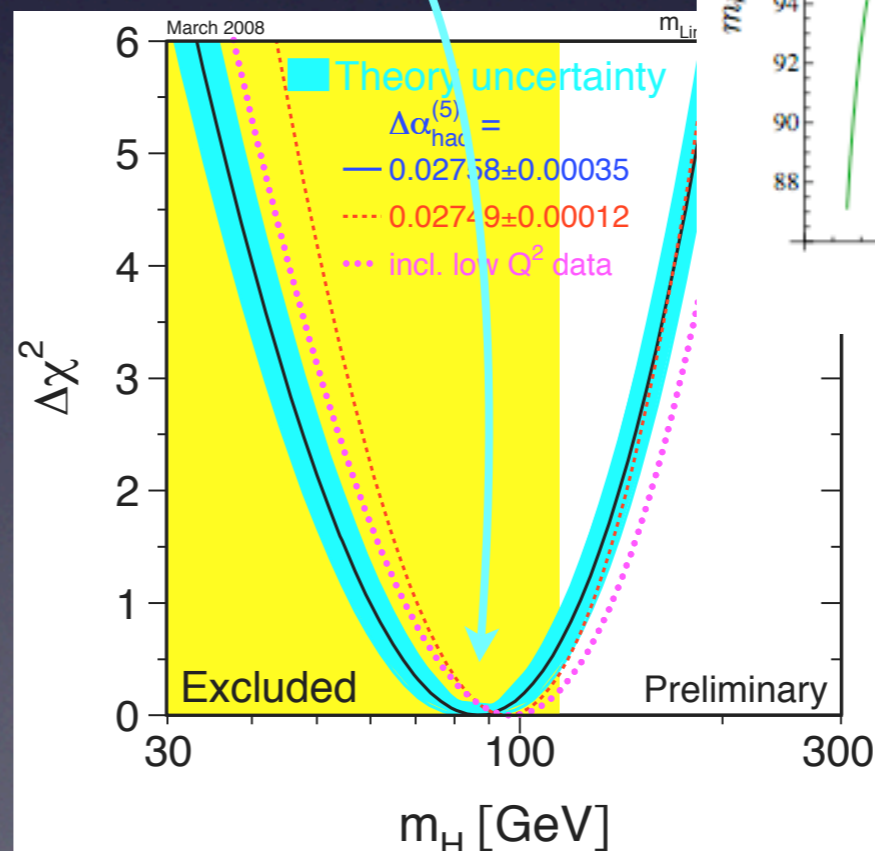
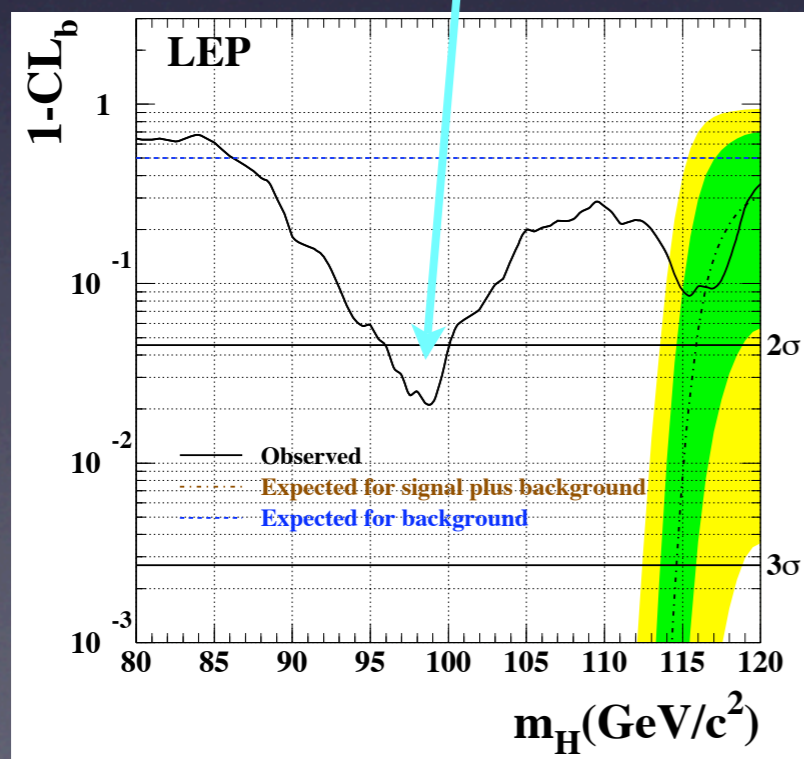
NMSSM with a light singlet CP odd Higgs

R.D. and J. Gunion (2005)



Motivation for modified Higgs decays:

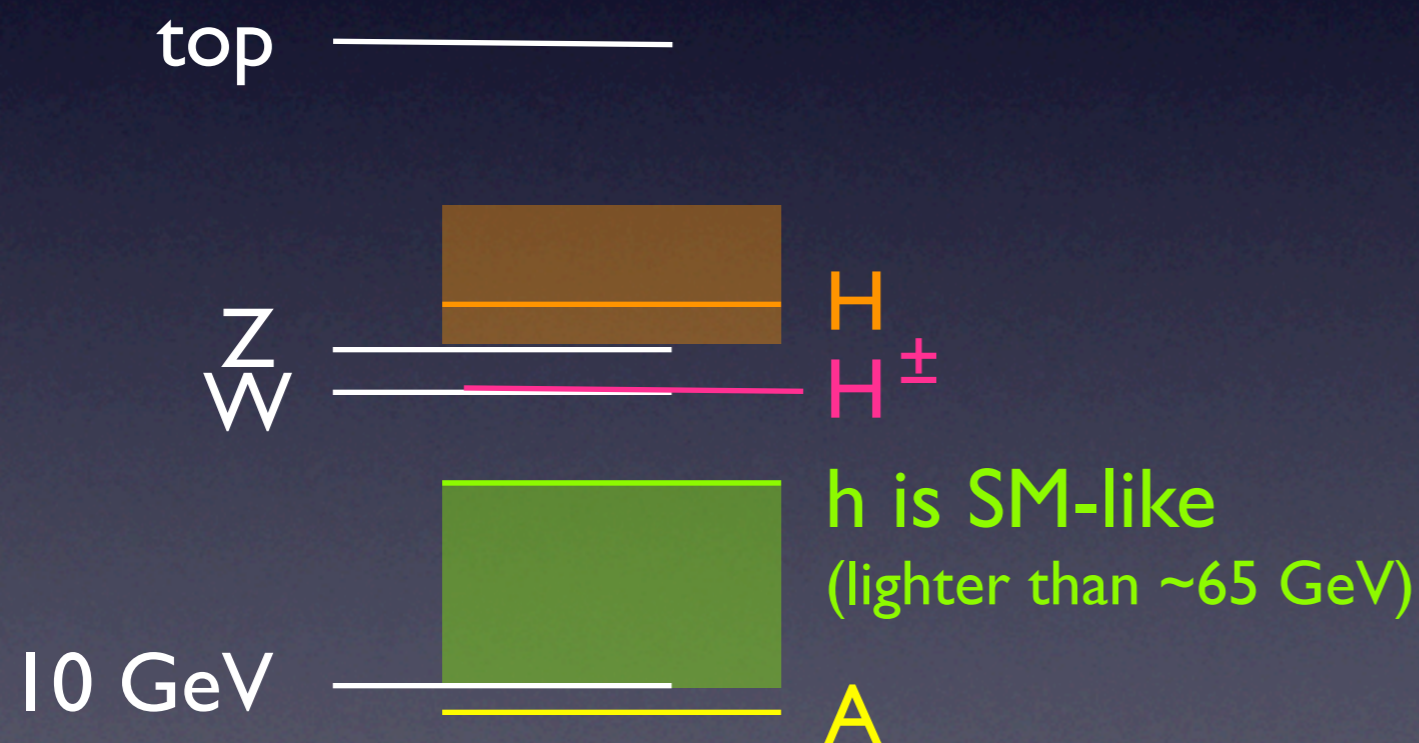
- ◆ arise in many models beyond the SM
- ◆ allow the SM-like Higgs significantly below LEP limits
 - wanted by generic SUSY/natural EWSB
 - preferred by precision EW data
 - indicated by LEP data



Models with an MSSM-like light CP odd Higgs

R.D., arXiv:0806.0847 [hep-ph]

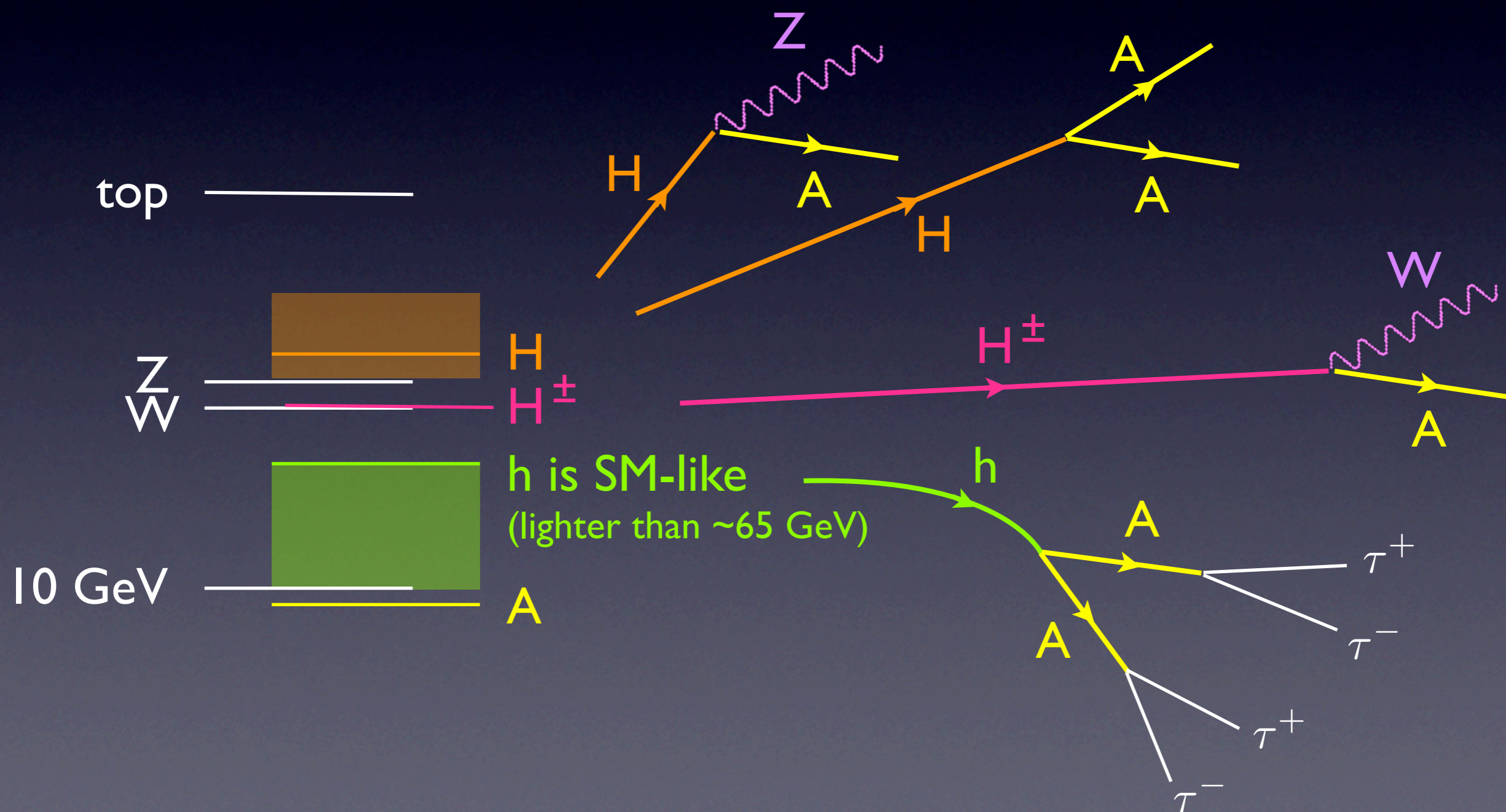
MSSM with $\tan \beta \lesssim 2.5$:



Models with an MSSM-like light CP odd Higgs

R.D., arXiv:0806.0847 [hep-ph]

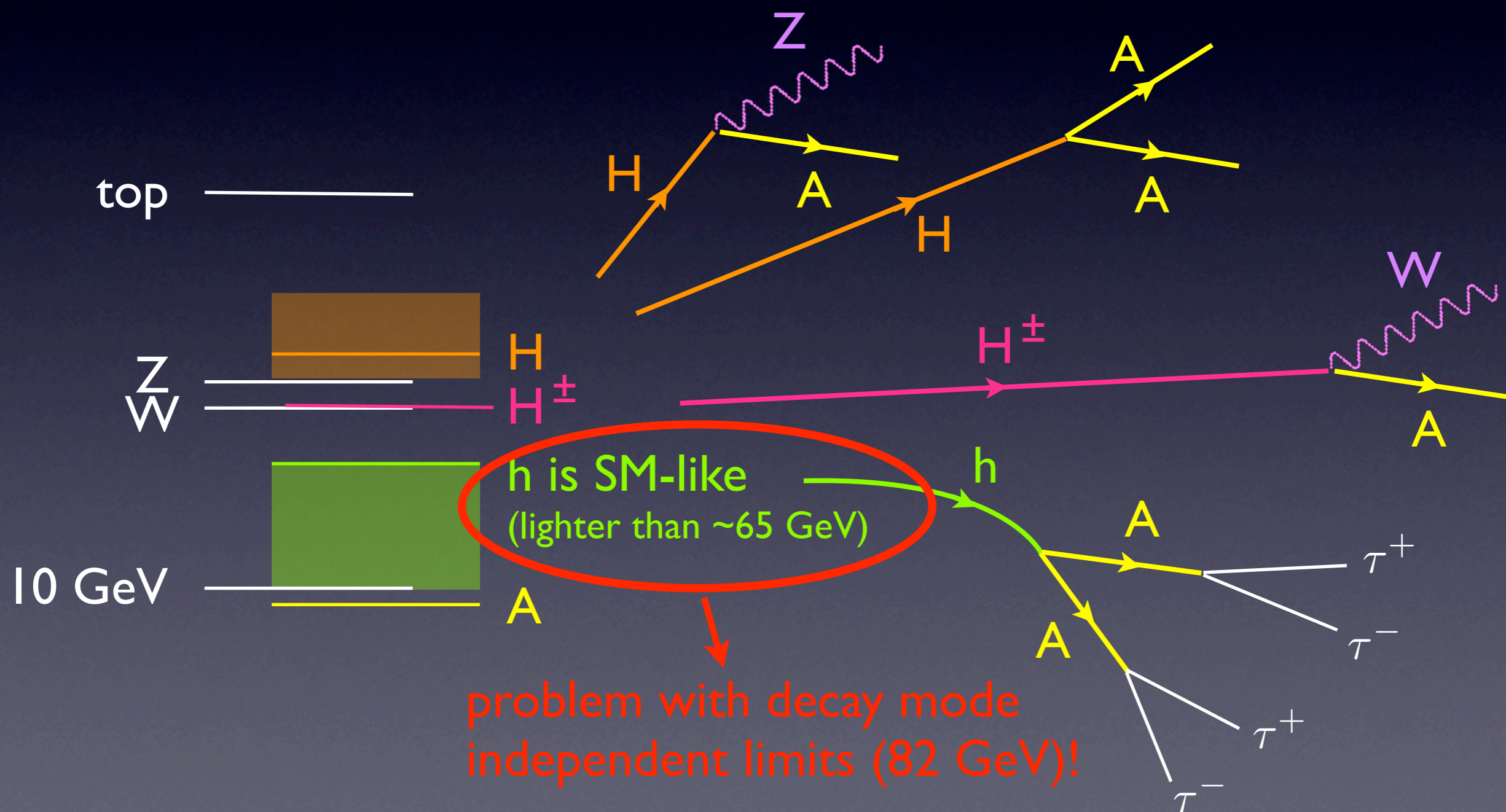
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MSSM with $\tan \beta \lesssim 2.5$:

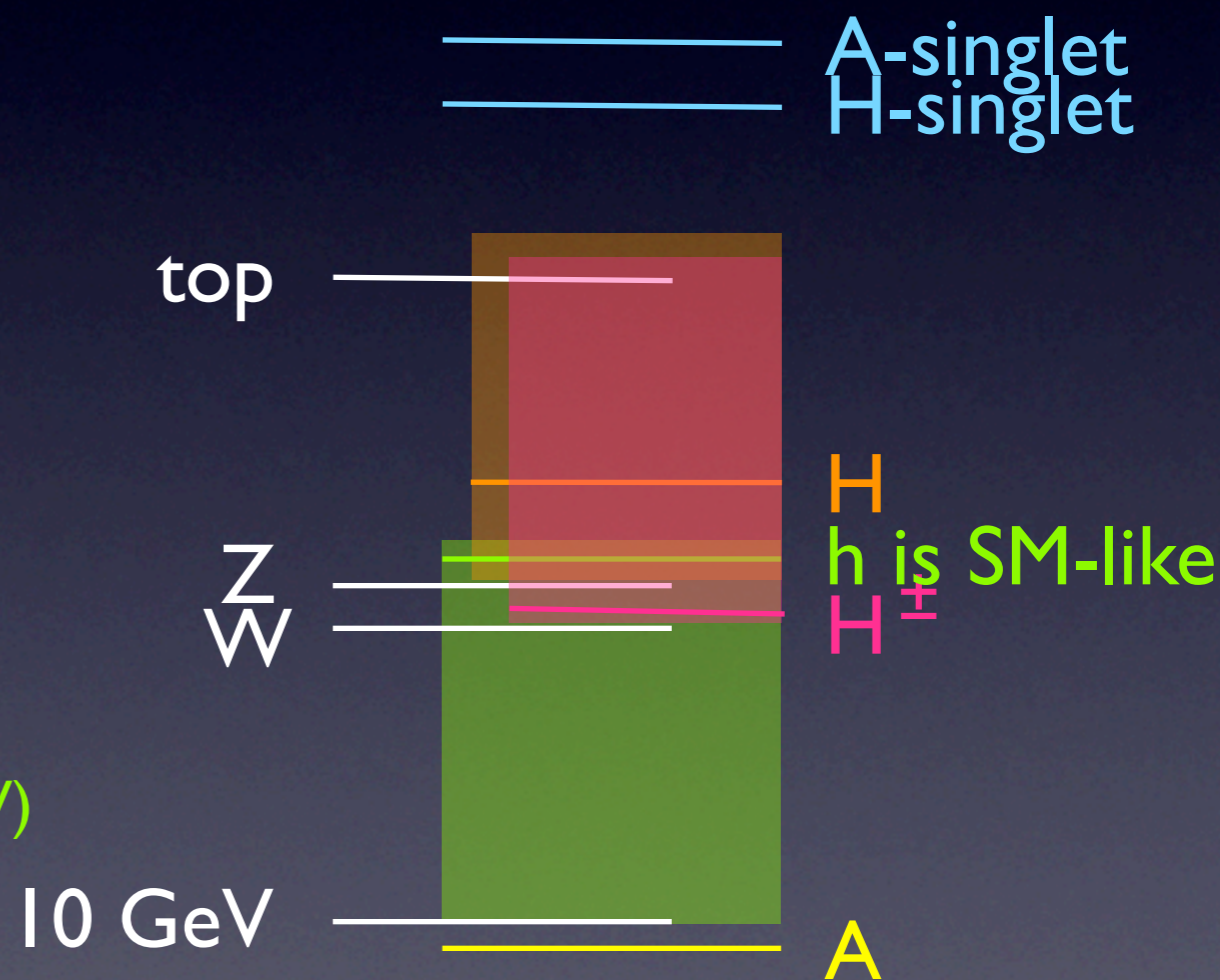
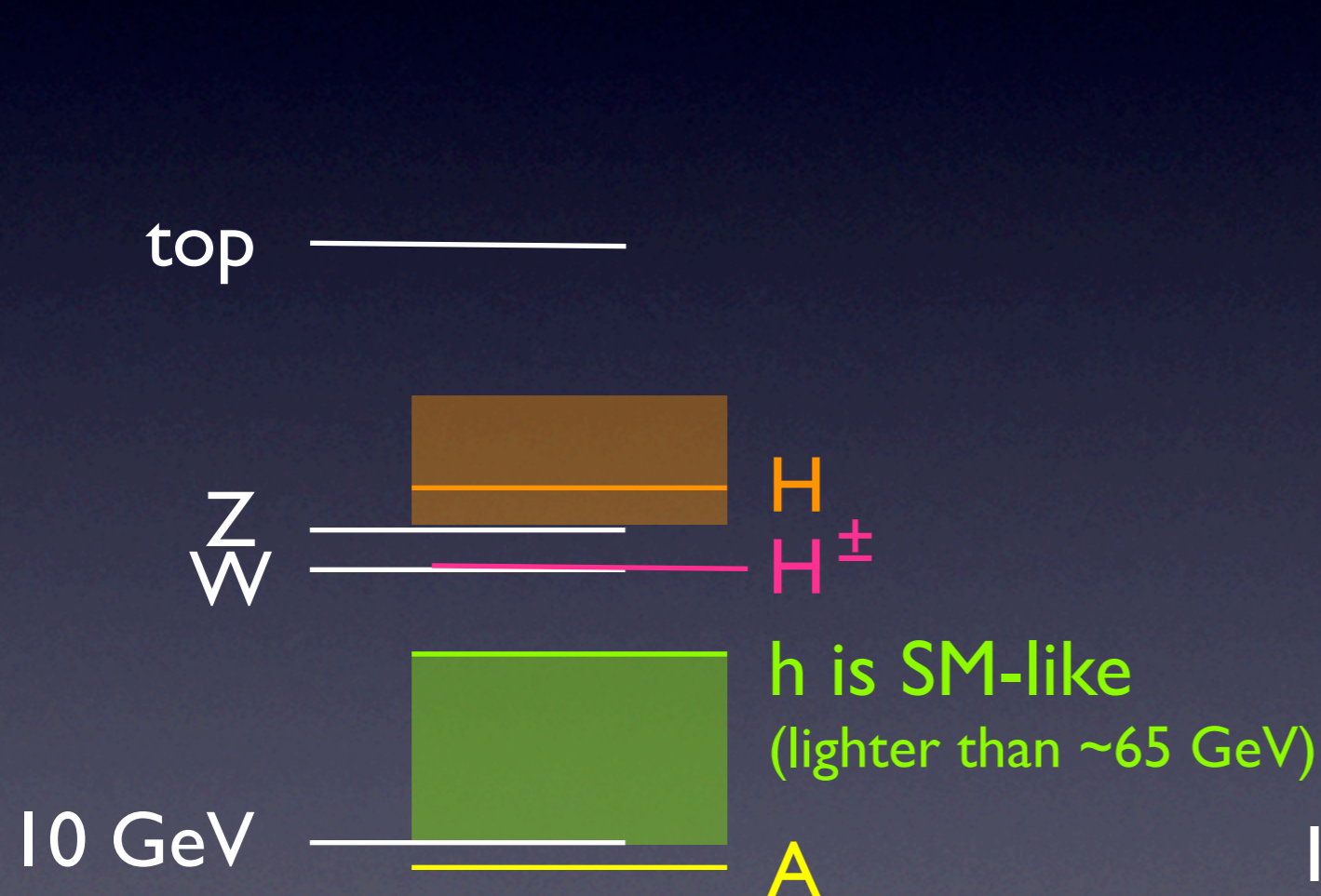


Models with an MSSM-like light CP odd Higgs

R.D., arXiv:0806.0847 [hep-ph], R.D. and J. Gunion, arXiv:0811.3537 [hep-ph]

MSSM with $\tan \beta \lesssim 2.5$:

NMSSM with $\tan \beta \lesssim 2.5$:



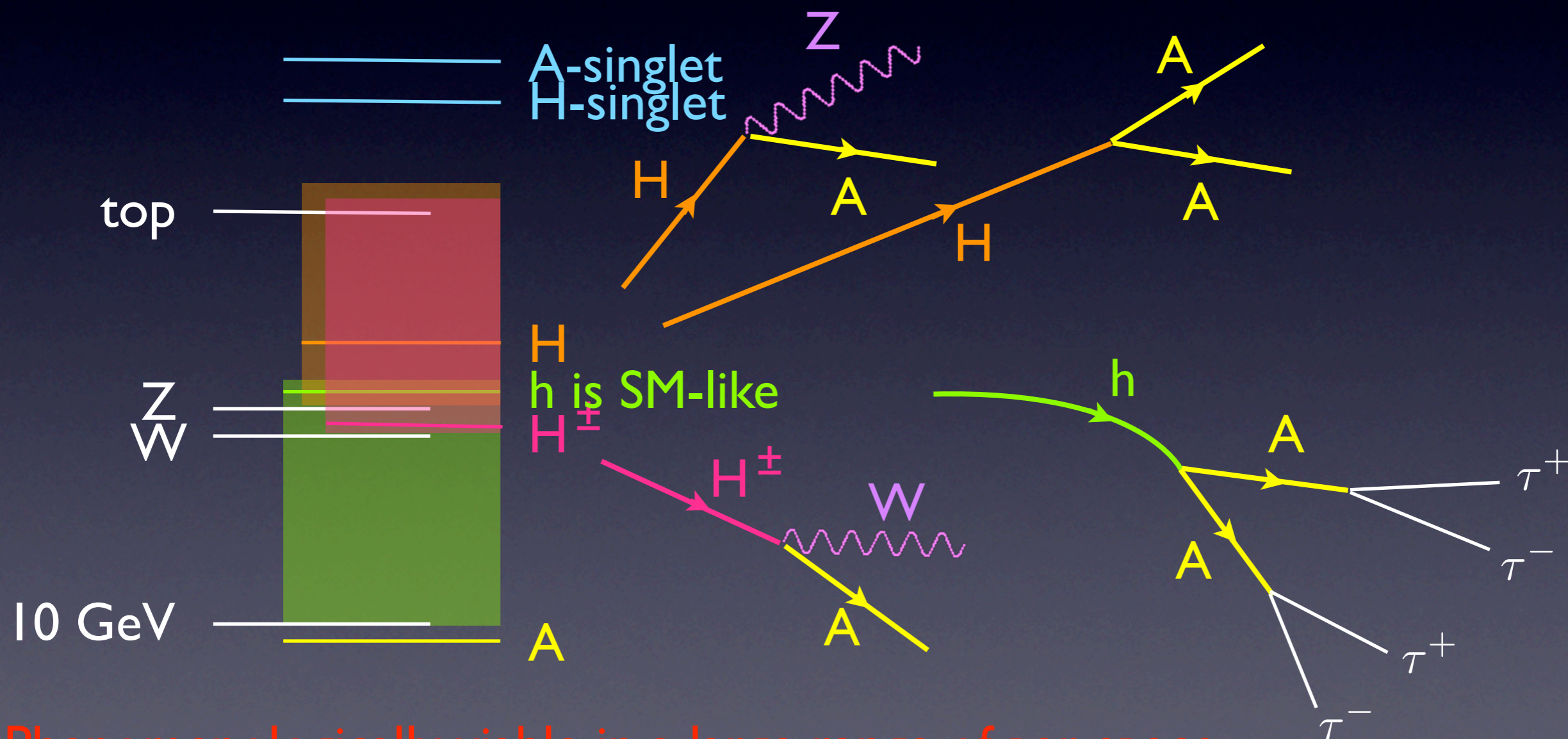
NMSSM provides an additional contribution to the mass of the SM-like Higgs: $m_h^2 \simeq \dots + \lambda^2 v^2 \sin^2 2\beta + \dots$

$$W \supset \lambda S H_u H_d$$

Models with an MSSM-like light CP odd Higgs

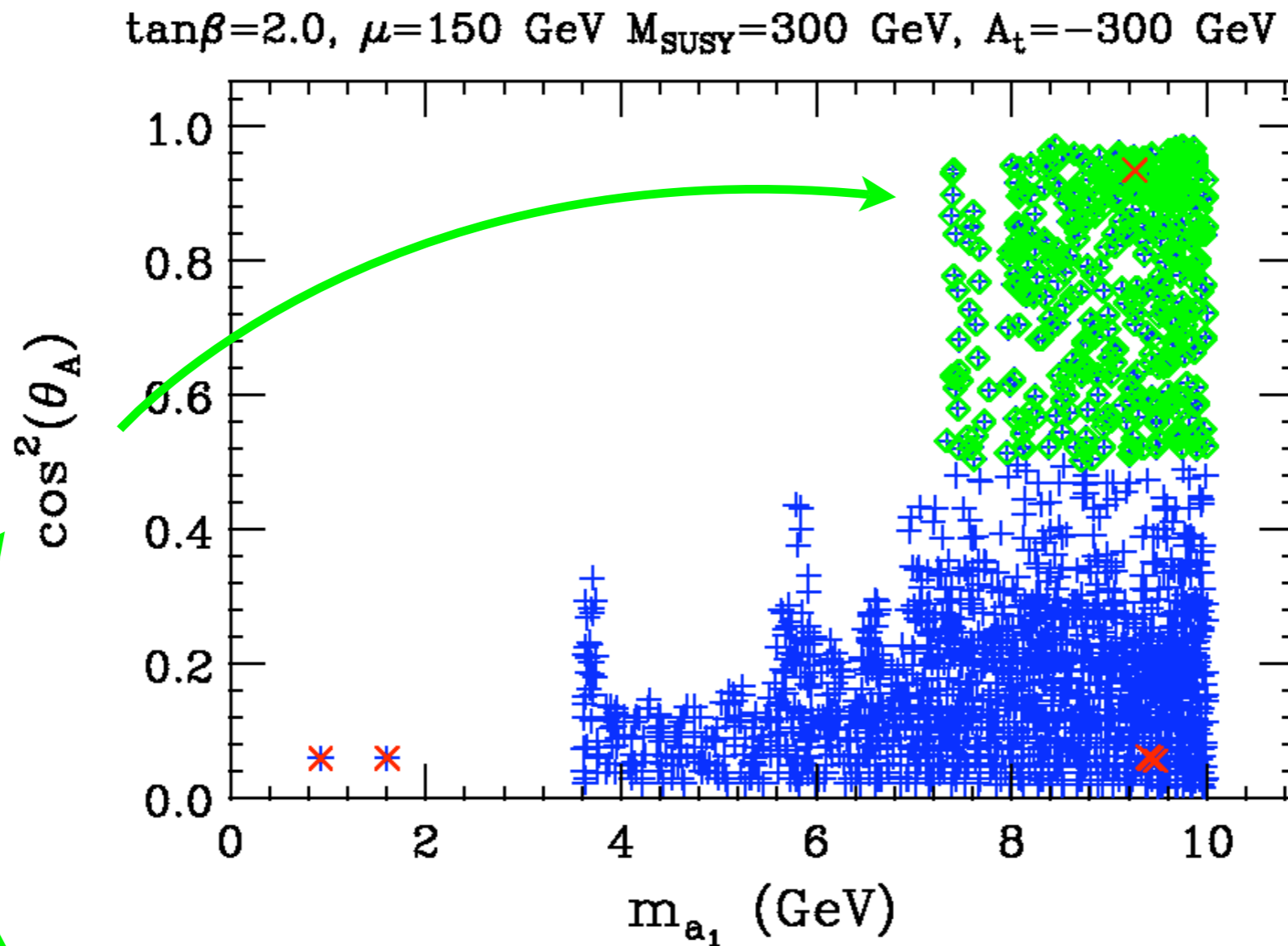
R.D., arXiv:0806.0847 [hep-ph], R.D. and J. Gunion, arXiv:0811.3537 [hep-ph]

NMSSM with $\tan \beta \lesssim 2.5$:



Phenomenologically viable in a large range of par. space
(no need for heavy SUSY), all Higgses produced already at LEP!

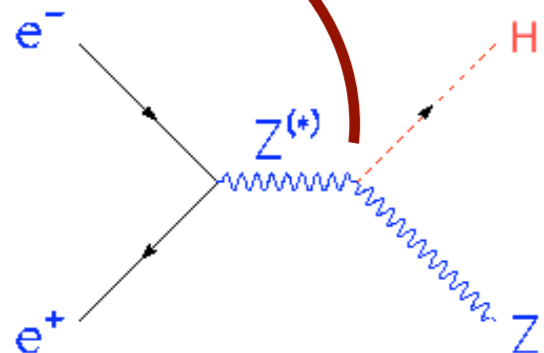
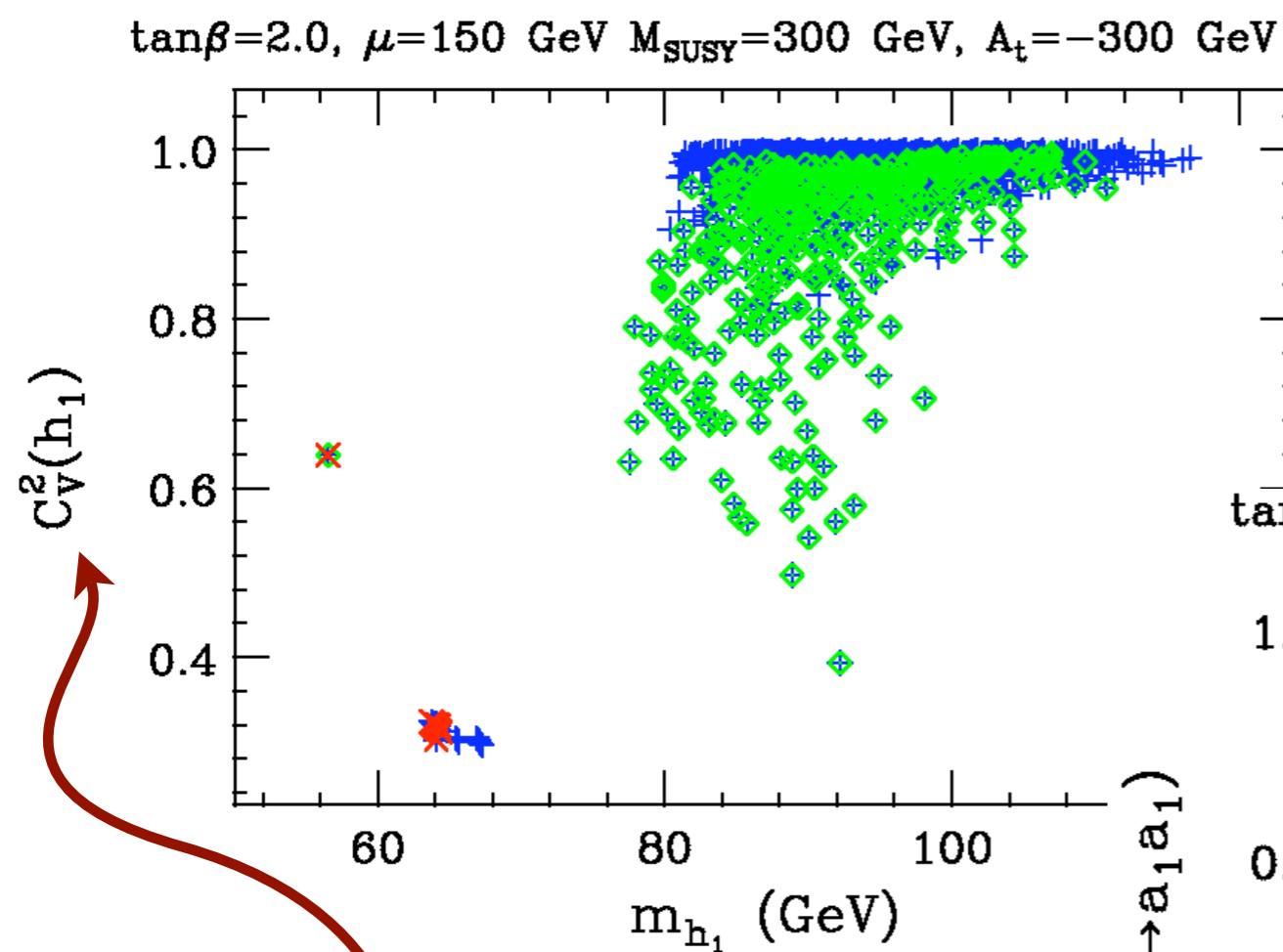
NMSSM with a light doublet-like CP-odd Higgs:



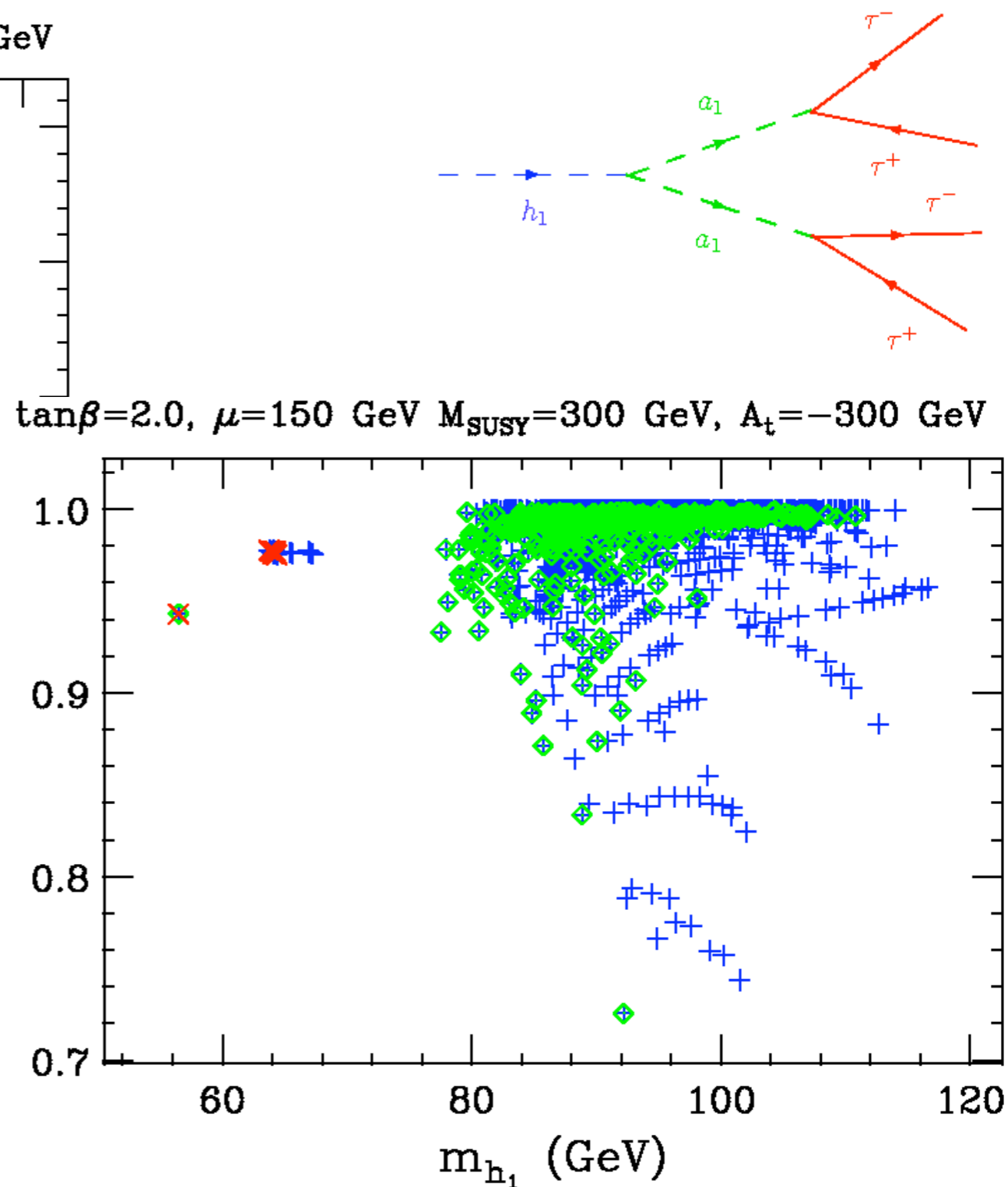
$$a_1 \equiv \cos \theta_A a_{MSSM} + \sin \theta_A a_S$$

$$C_{a_1 b \bar{b}} = \cos \theta_A \tan \beta$$

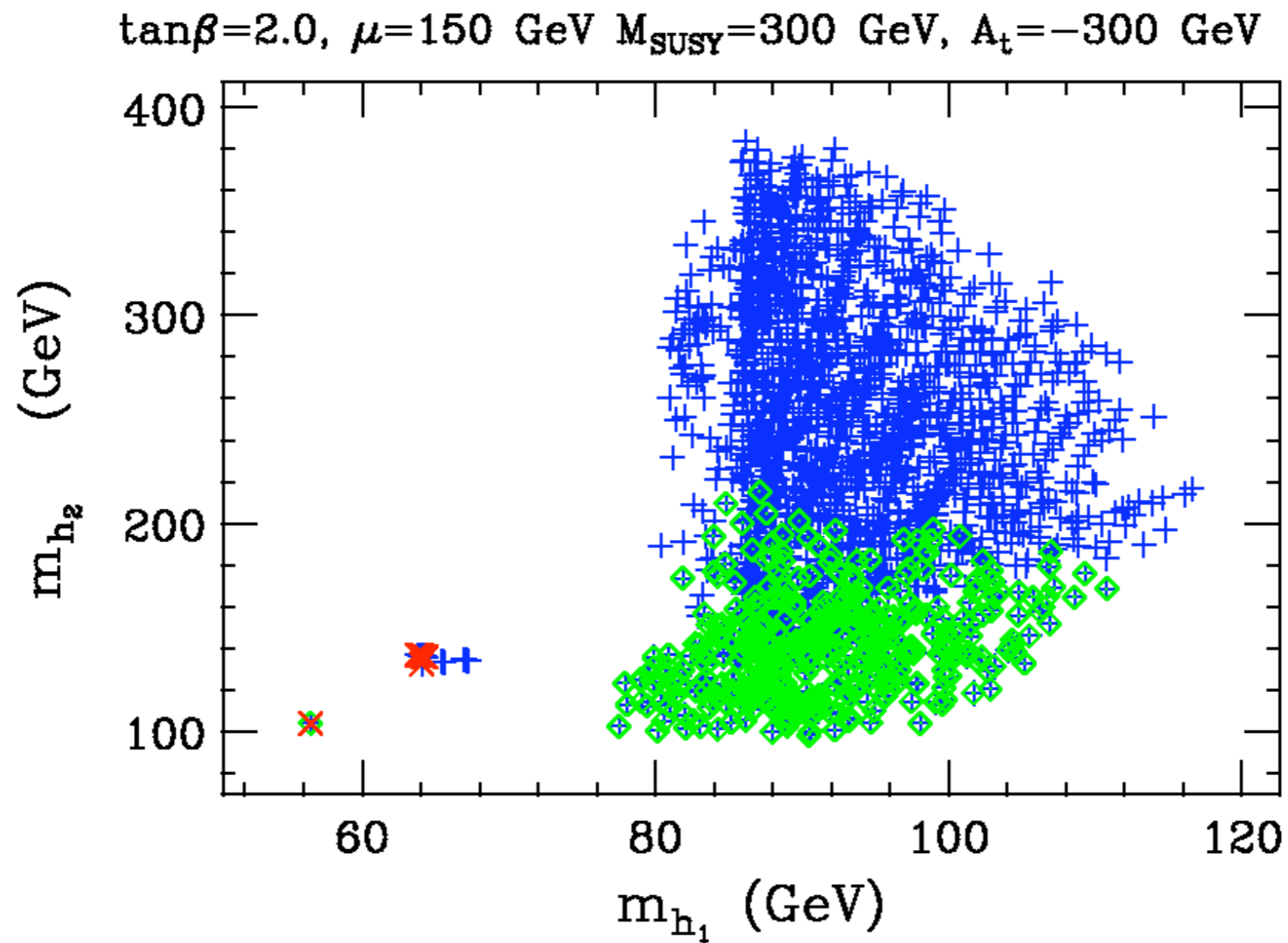
SM-like CP-even Higgs:



$BR(h_1 \rightarrow a_1 a_1)$

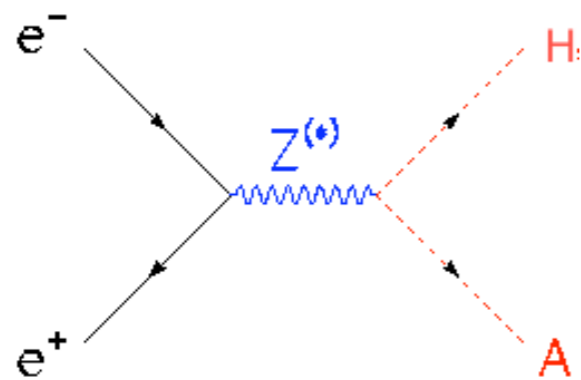
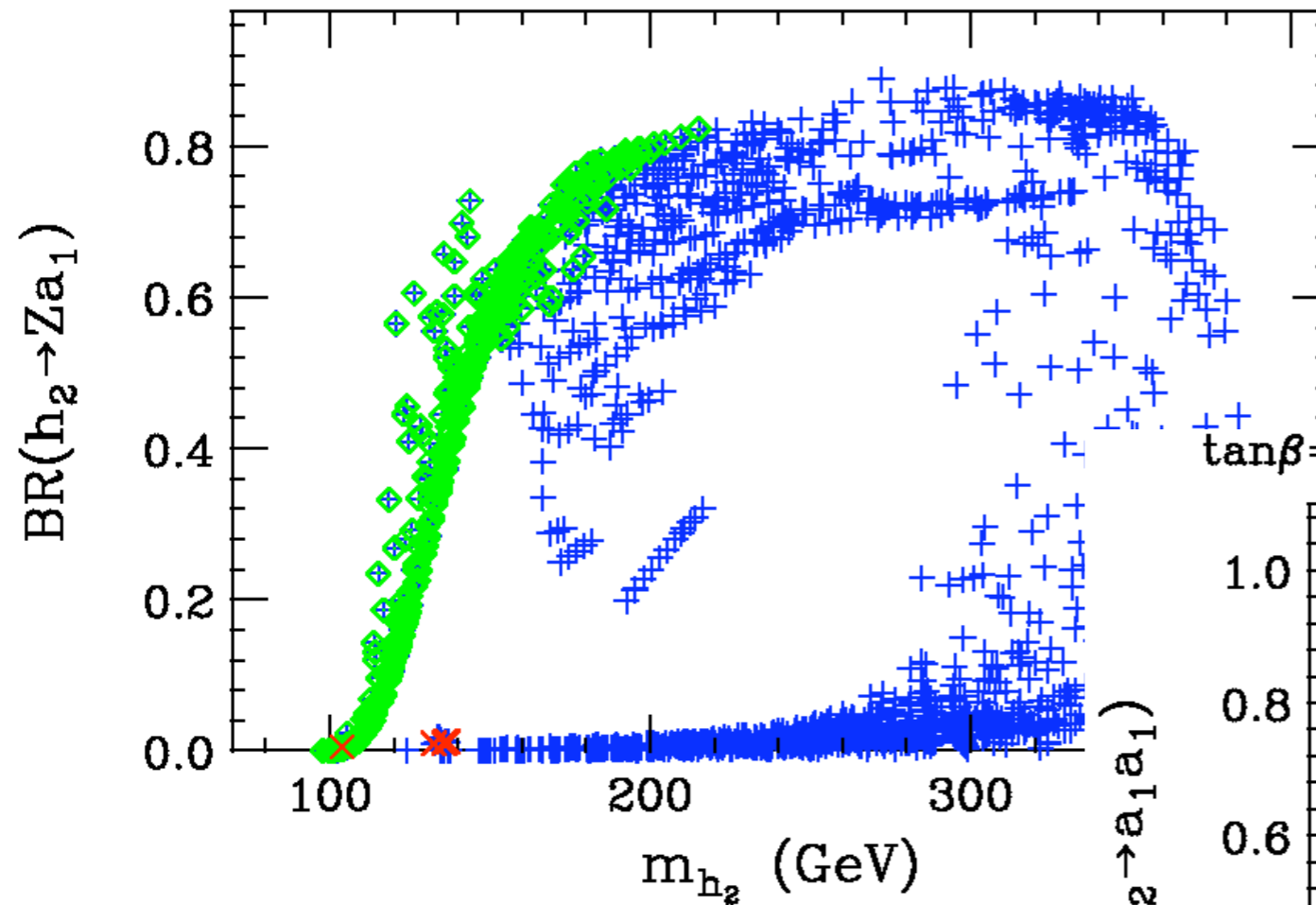


Heavy CP-even Higgs:

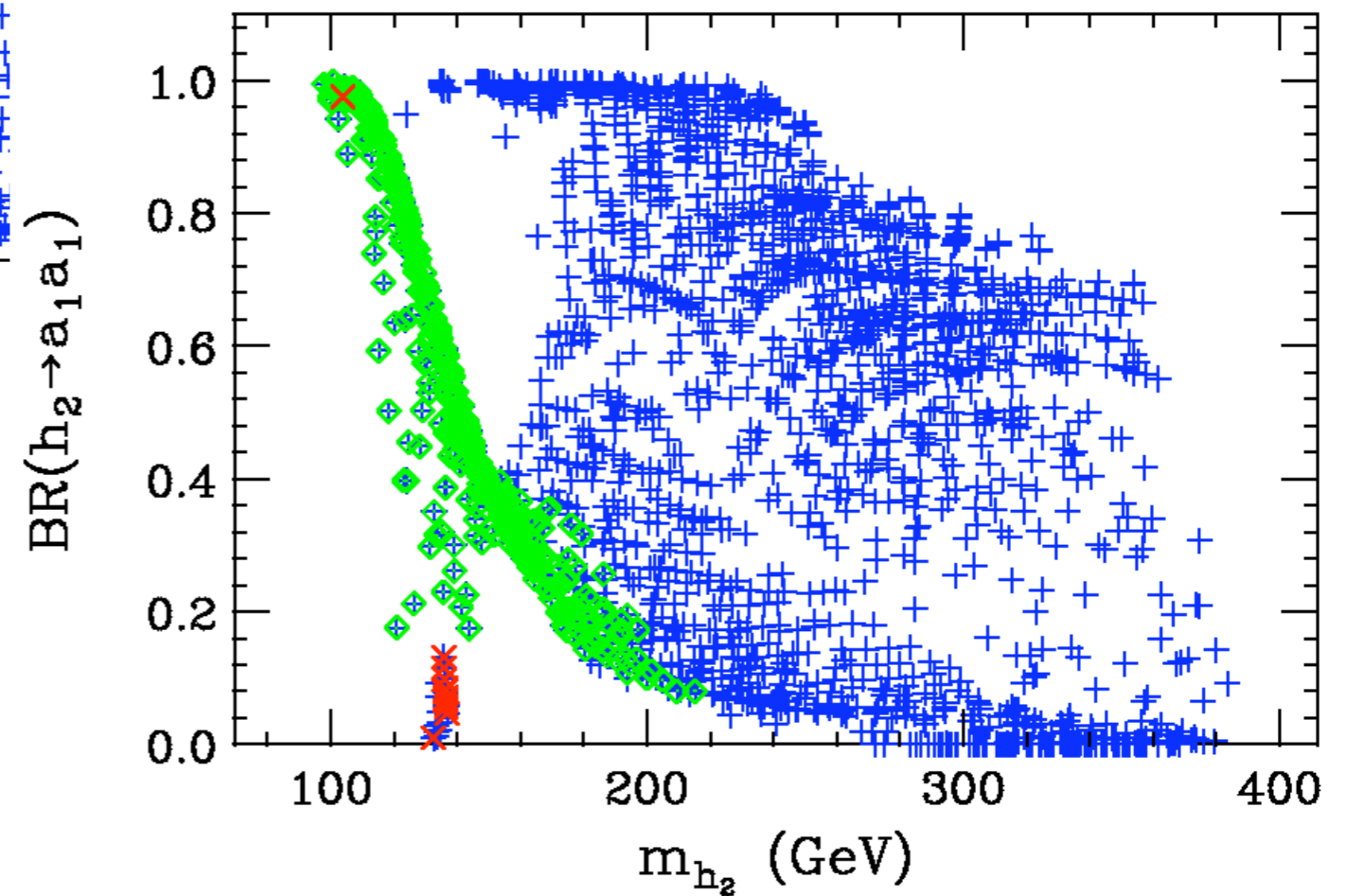


Heavy CP-even Higgs:

$\tan\beta=2.0$, $\mu=150$ GeV $M_{\text{SUSY}}=300$ GeV, $A_t=-300$ GeV

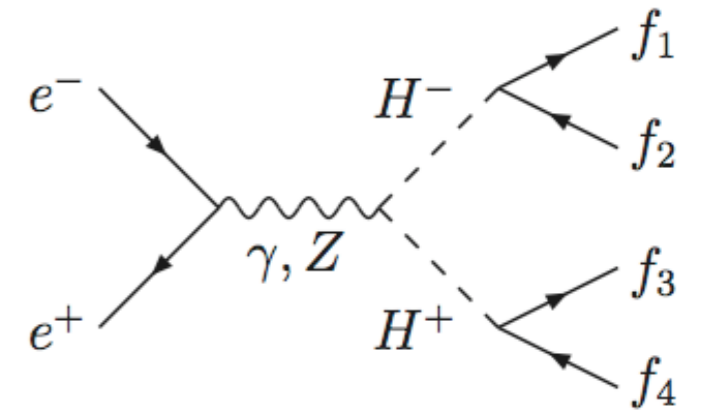
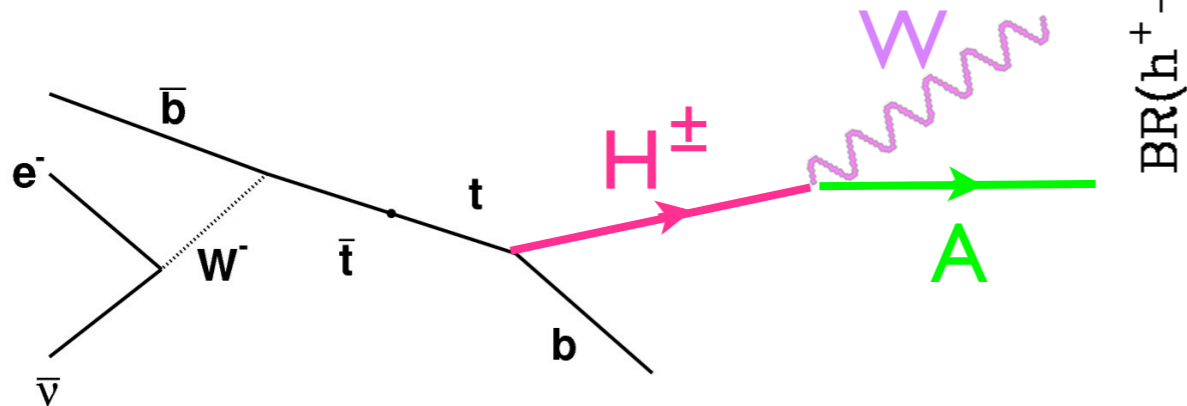
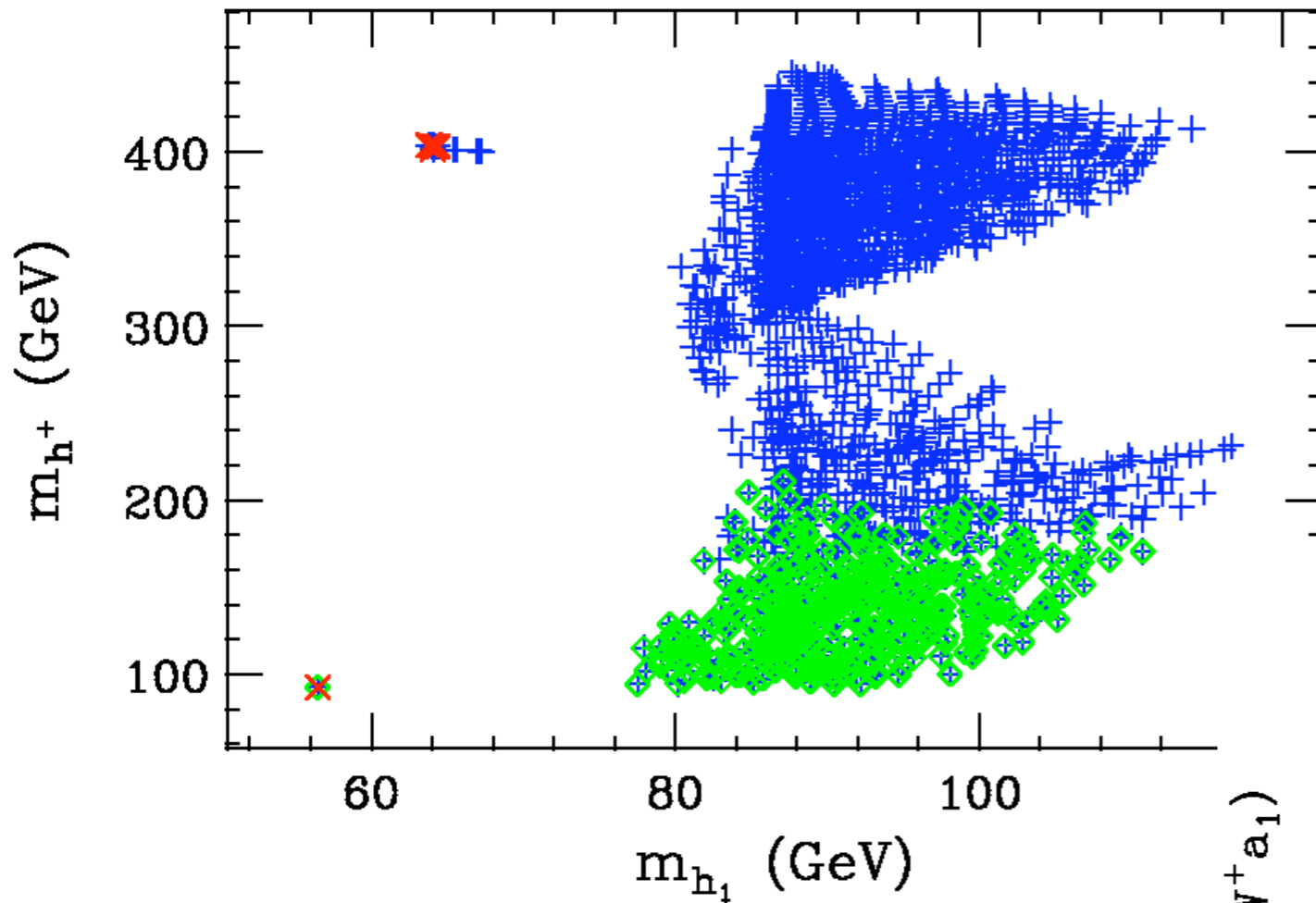


$\tan\beta=2.0$, $\mu=150$ GeV $M_{\text{SUSY}}=300$ GeV, $A_t=-300$ GeV



Charged Higgs:

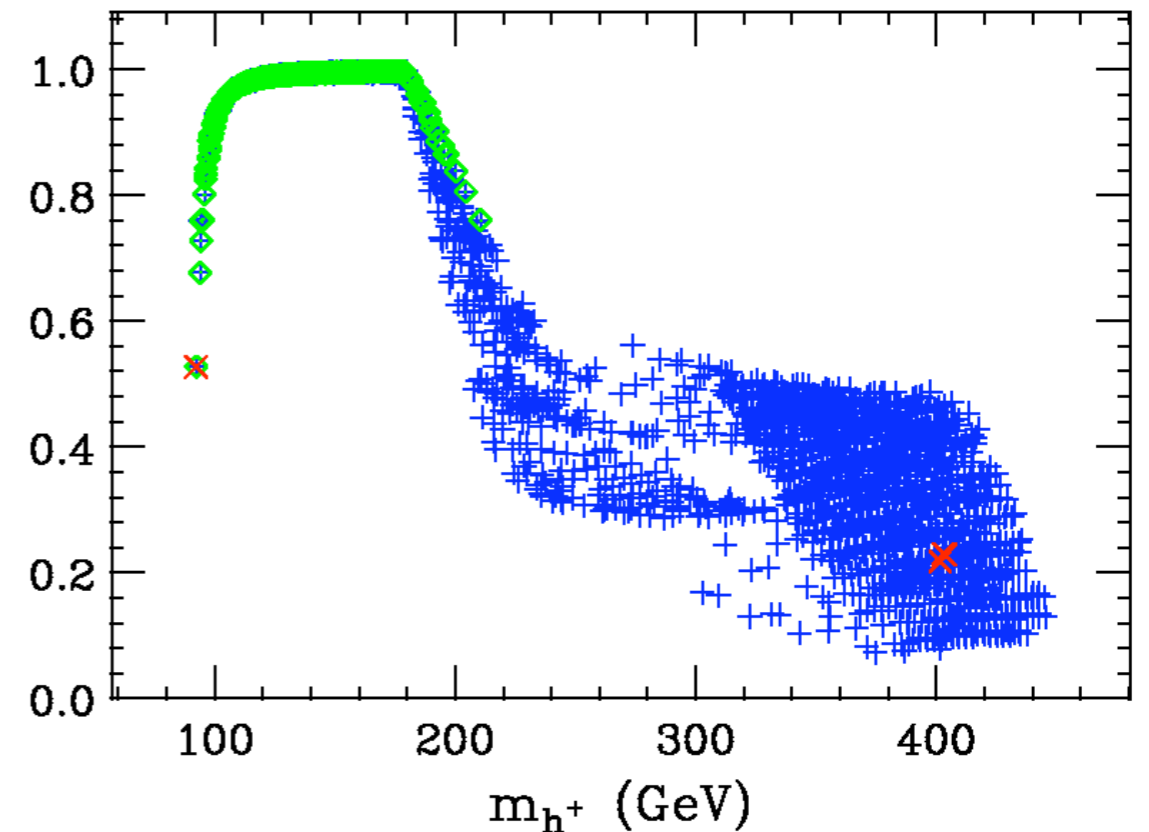
$\tan\beta=2.0, \mu=150 \text{ GeV}, M_{\text{SUSY}}=300 \text{ GeV}, A_t=-300 \text{ GeV}$



if $m_{H^\pm} \simeq m_{W^\pm}$, it would contribute to the measurement of the **lepton universality in W decays**, there is a 2.8σ deviation!

R.D., arXiv:0807.2135 [hep-ph]

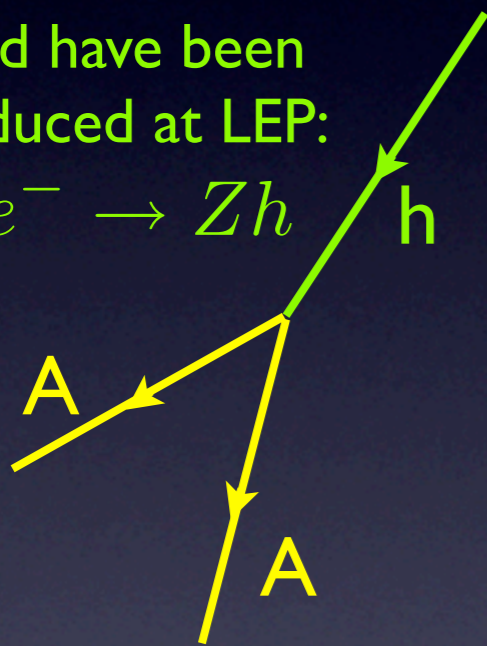
$\tan\beta=2.0, \mu=150 \text{ GeV}, M_{\text{SUSY}}=300 \text{ GeV}, A_t=-300 \text{ GeV}$



If the light CP-odd Higgs is doublet like:

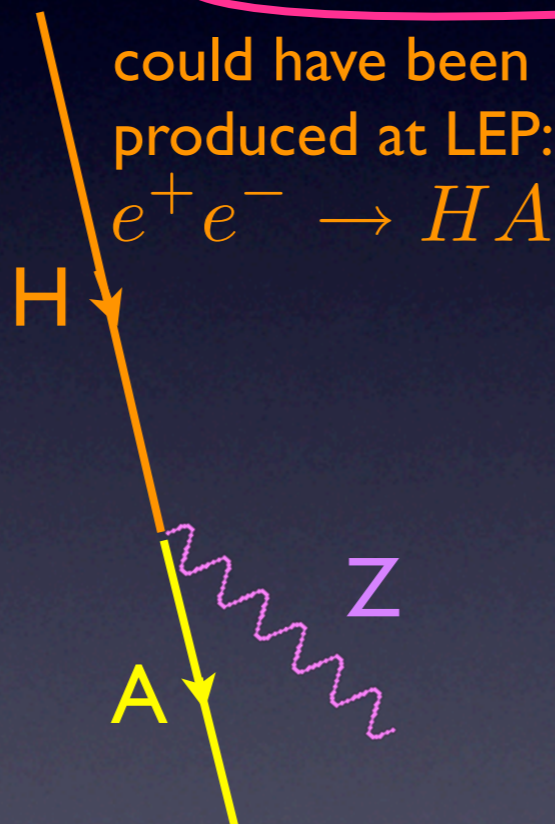
- ◆ all the Higgses (from two Higgs doublets) would be fairly light
- ◆ all the Higgses: h, H, H^\pm would decay through the CP odd Higgs: A

could have been
produced at LEP:
 $e^+e^- \rightarrow Zh$



ongoing search at L3,
studies and searches for
Tevatron and LHC

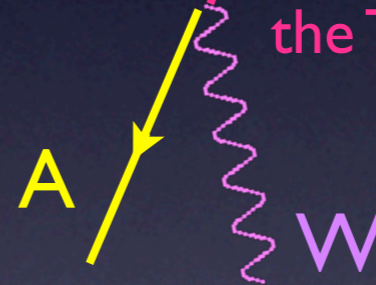
could have been
produced at LEP:
 $e^+e^- \rightarrow HA$



no searches or studies

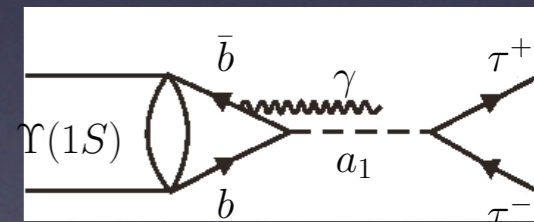
H^\pm

could have been
pair produced at
LEP, or in top
quark decays at
the Tevatron



no searches

could have
been
produced at
B factories



R.D., J. F. Gunion and B. McElrath, hep-ph/0612031
ongoing searches at B factories

- ◆ the extra singlet is not necessary

the scenario can be viable in many other models!