

Light Charged Higgs Bosons in Two-Higgs Doublet Models

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[arXiv: 1504.06624]

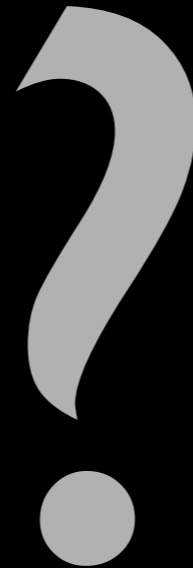


THE UNIVERSITY
OF ARIZONA

Unanswered Questions

Higgs mass?

Neutrino oscillations?



Dark Matter?

And others...

New models often predict additional Higgs bosons

New models often predict additional Higgs bosons

Two Higgs Doublet Models

MSSM

NMSSM

Particle Spectrum

$$\langle \Phi_1 \rangle = \begin{pmatrix} 0 \\ \frac{v_1}{\sqrt{2}} \end{pmatrix} \quad \langle \Phi_2 \rangle = \begin{pmatrix} 0 \\ \frac{v_2}{\sqrt{2}} \end{pmatrix} \quad \longrightarrow \quad \Phi_i = \begin{pmatrix} \text{Re}(\phi_i^+) + i\text{Im}(\phi_i^+) \\ (v_i + \rho_i + i\eta_i)/\sqrt{2} \end{pmatrix}$$

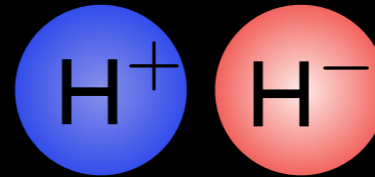
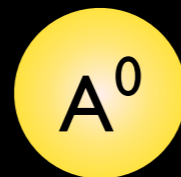
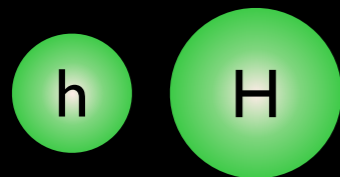
Eight degrees of freedom

Two CP-even
scalars

One CP-odd
pseudoscalar

Two charged
Higgs bosons

Three would-be
Goldstone bosons



Charged Higgs Challenges

H^\pm

top

H^\pm

Light (< 174 GeV)

Heavy (> 174 GeV)



Soft final state particles

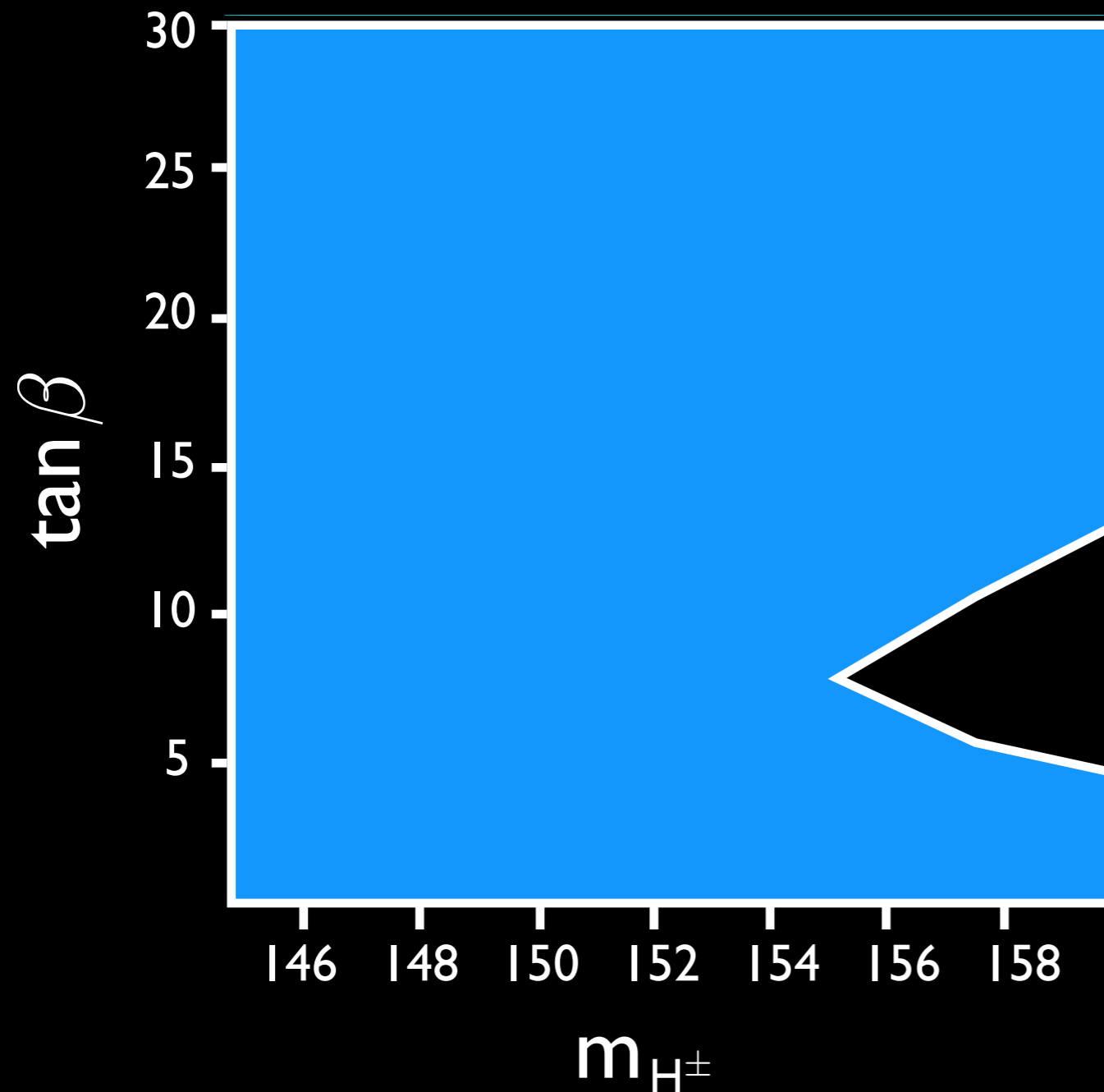
Off-shell production - rare




Cleaner leptonic decays suppressed



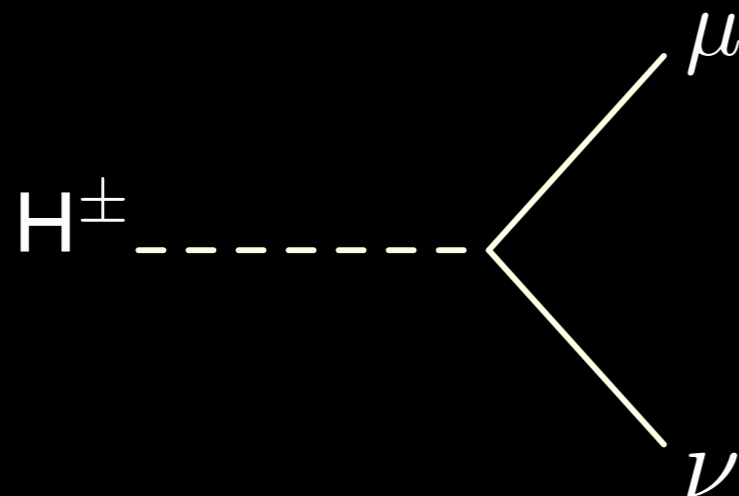
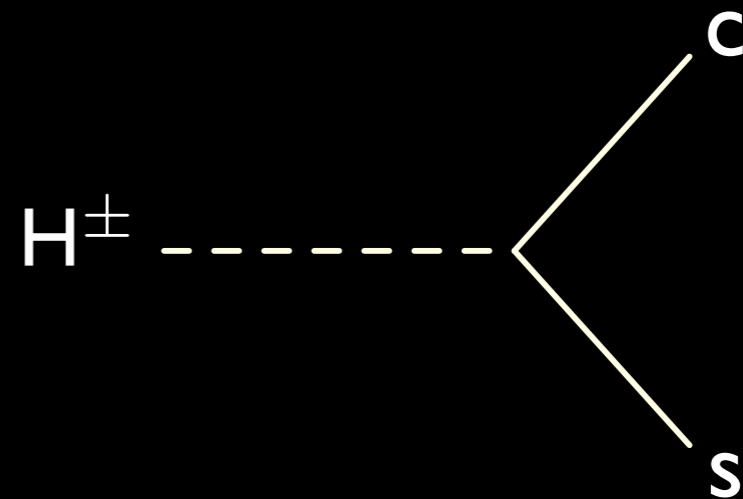
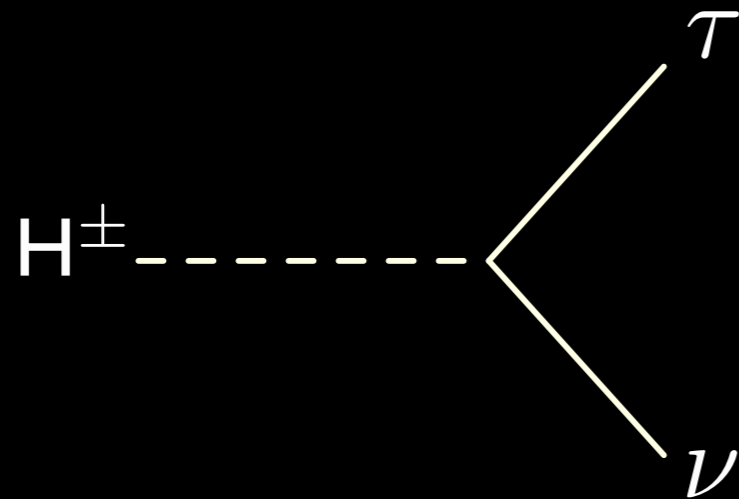
Current Limits on Light Charged Higgs




Excluded, assuming
 $BR(H^\pm \rightarrow \tau\nu) = 100\%$

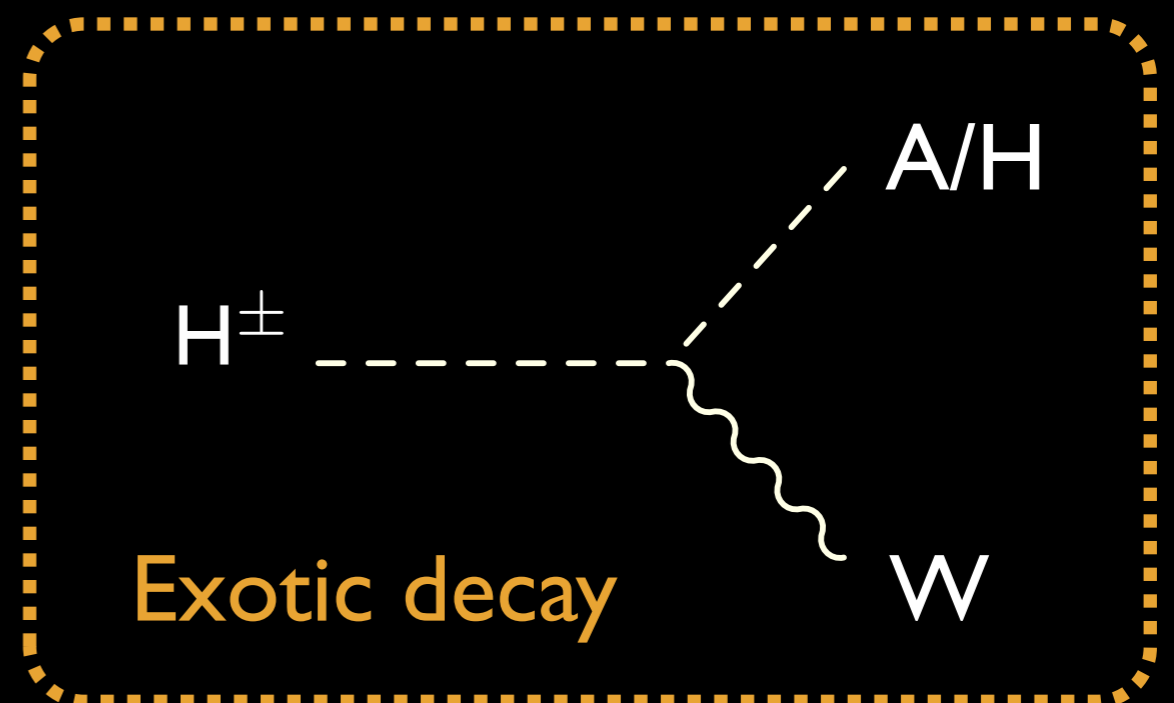
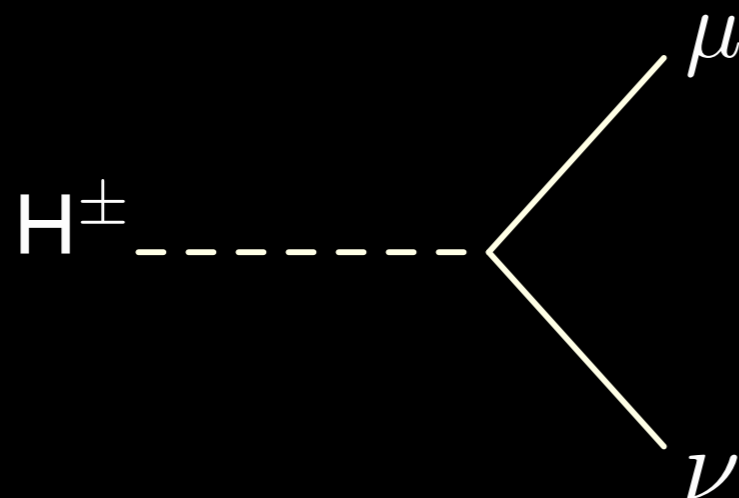
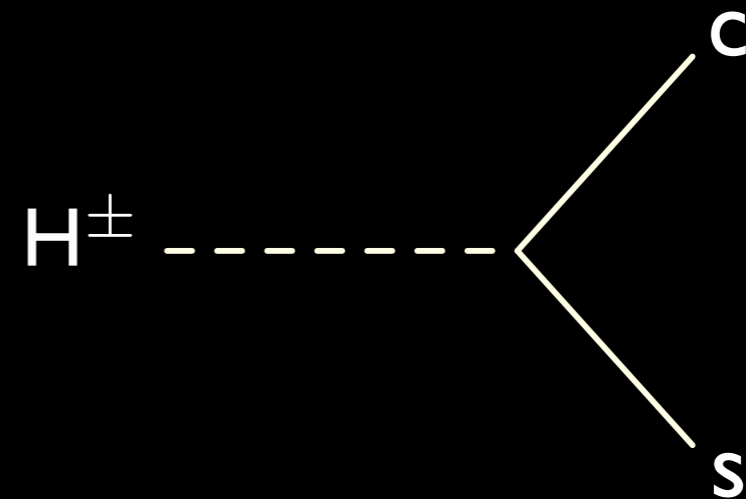
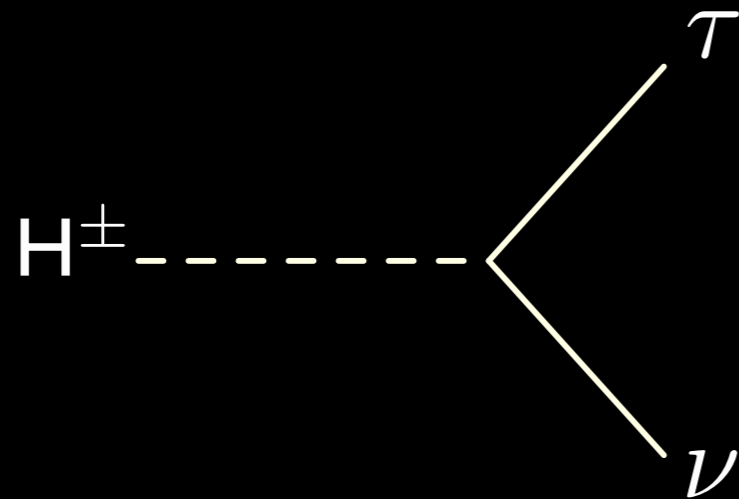
Source:
CMS Analysis, September 2014

Primary decay modes of the Light Charged Higgs



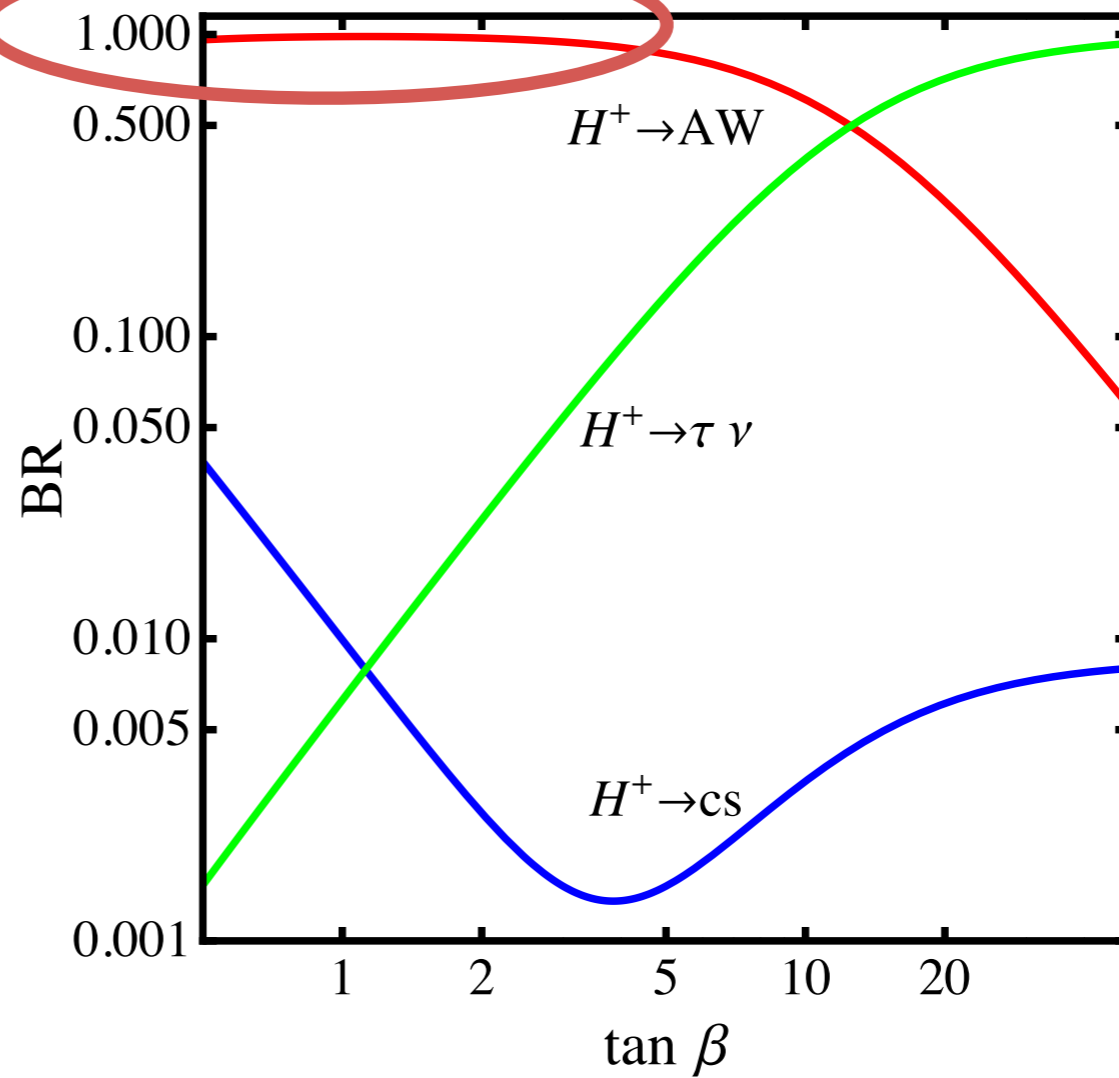
Decays to Standard
Model particles

Primary decay modes of the Light Charged Higgs

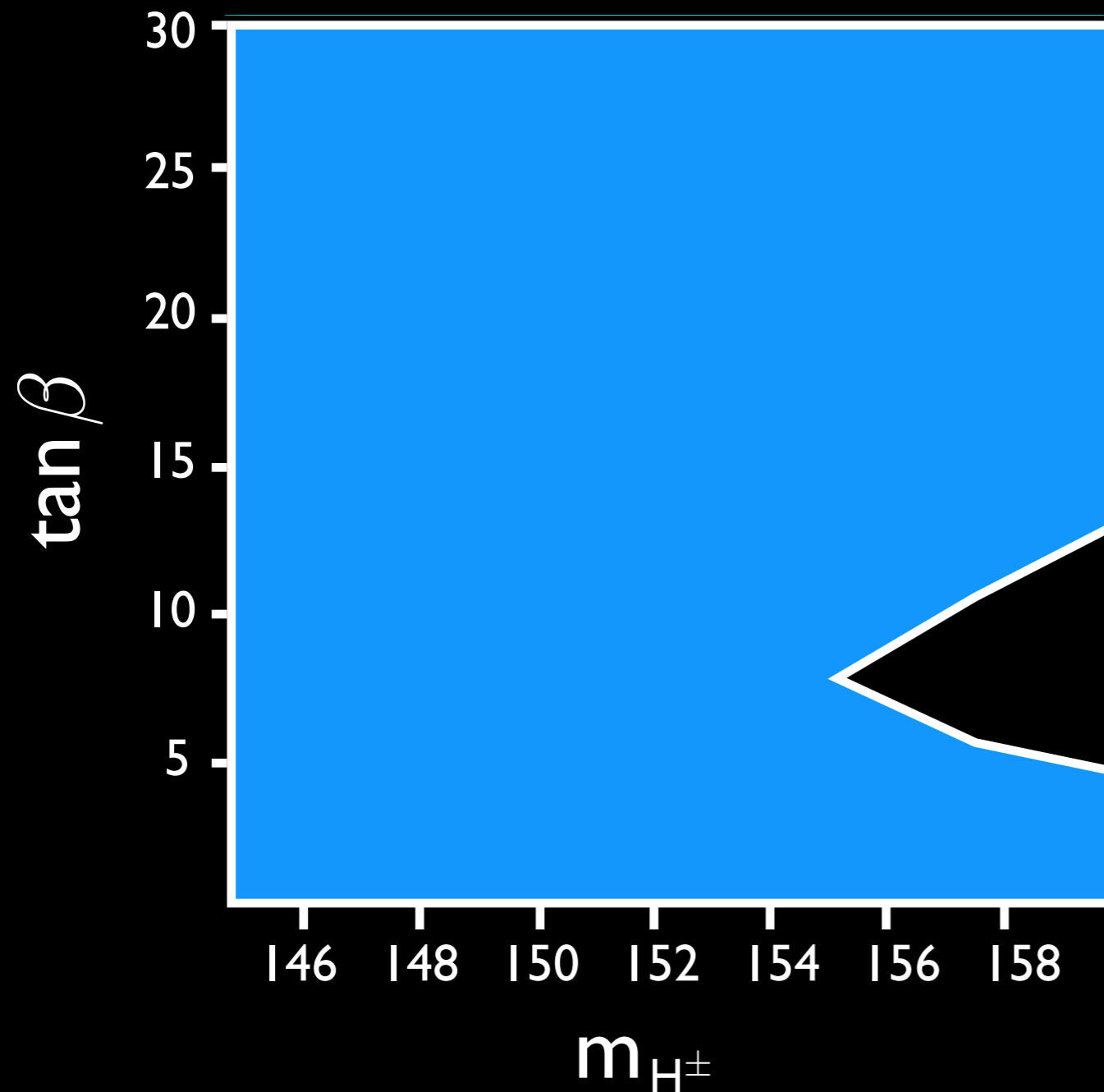


Branching Ratios

Exotic decay
dominates for
low $\tan \beta$

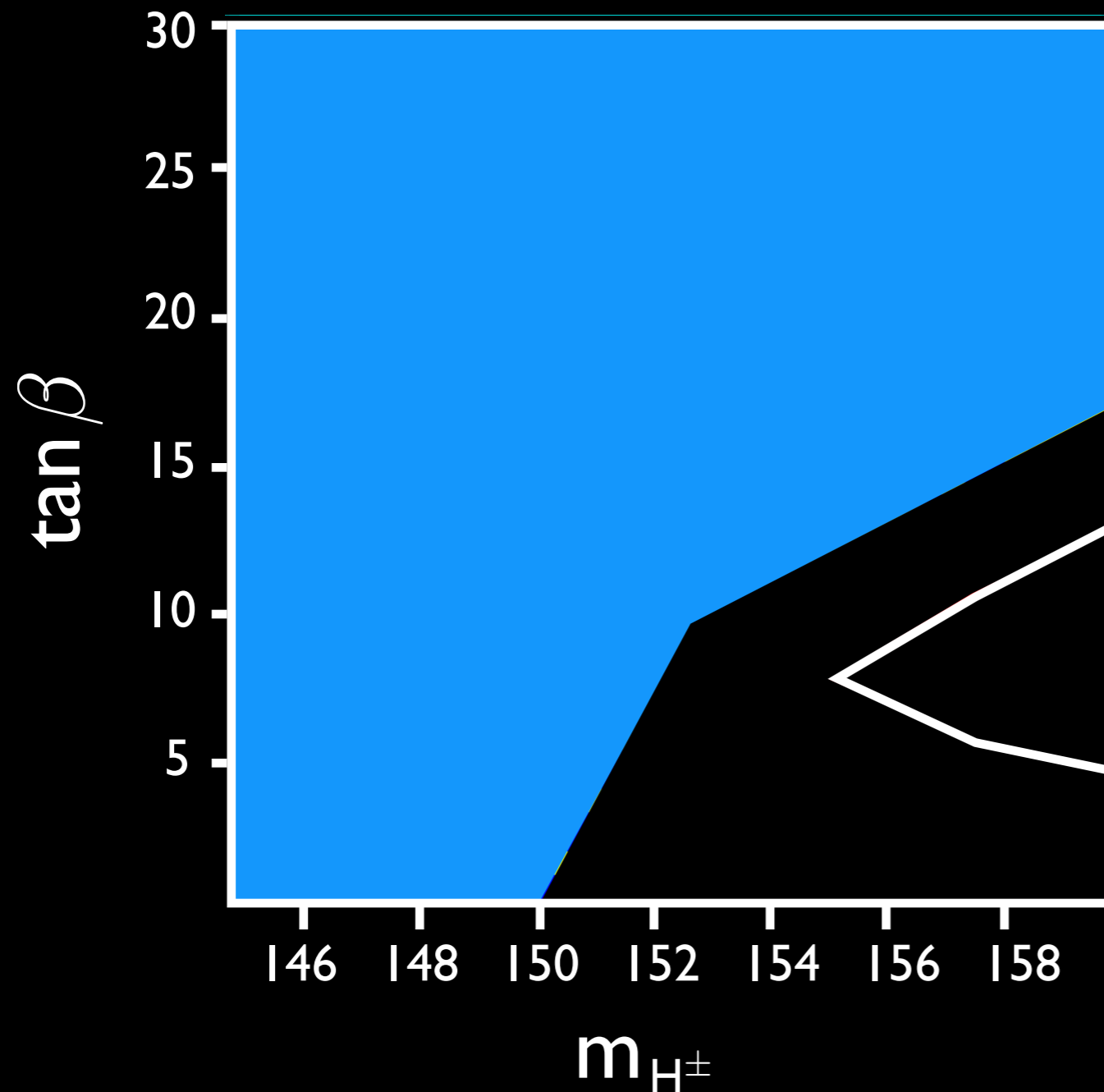


Current Limits



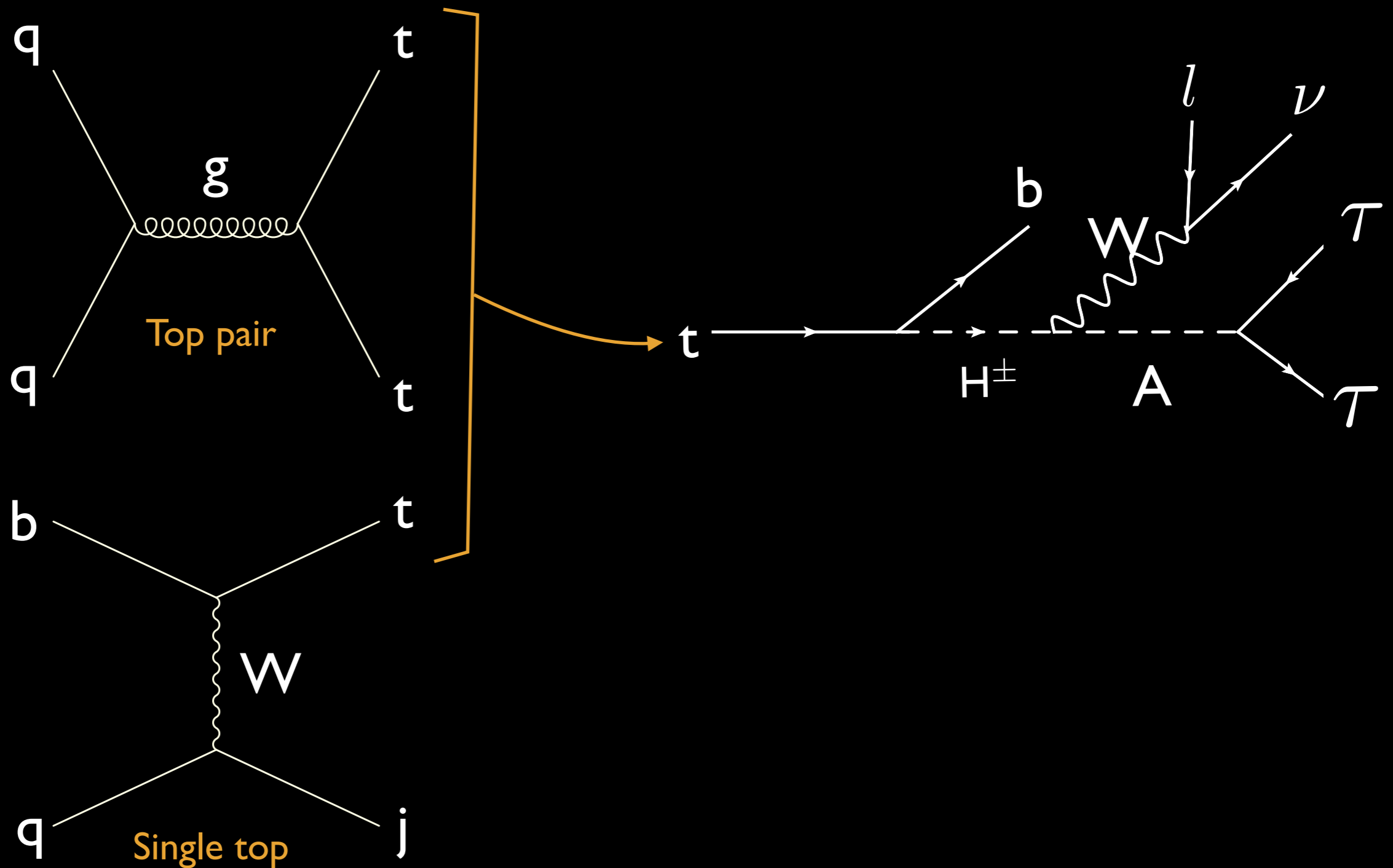
Excluded, assuming
 $BR(H^\pm \rightarrow \tau \nu) = 100\%$

Relaxed Limits

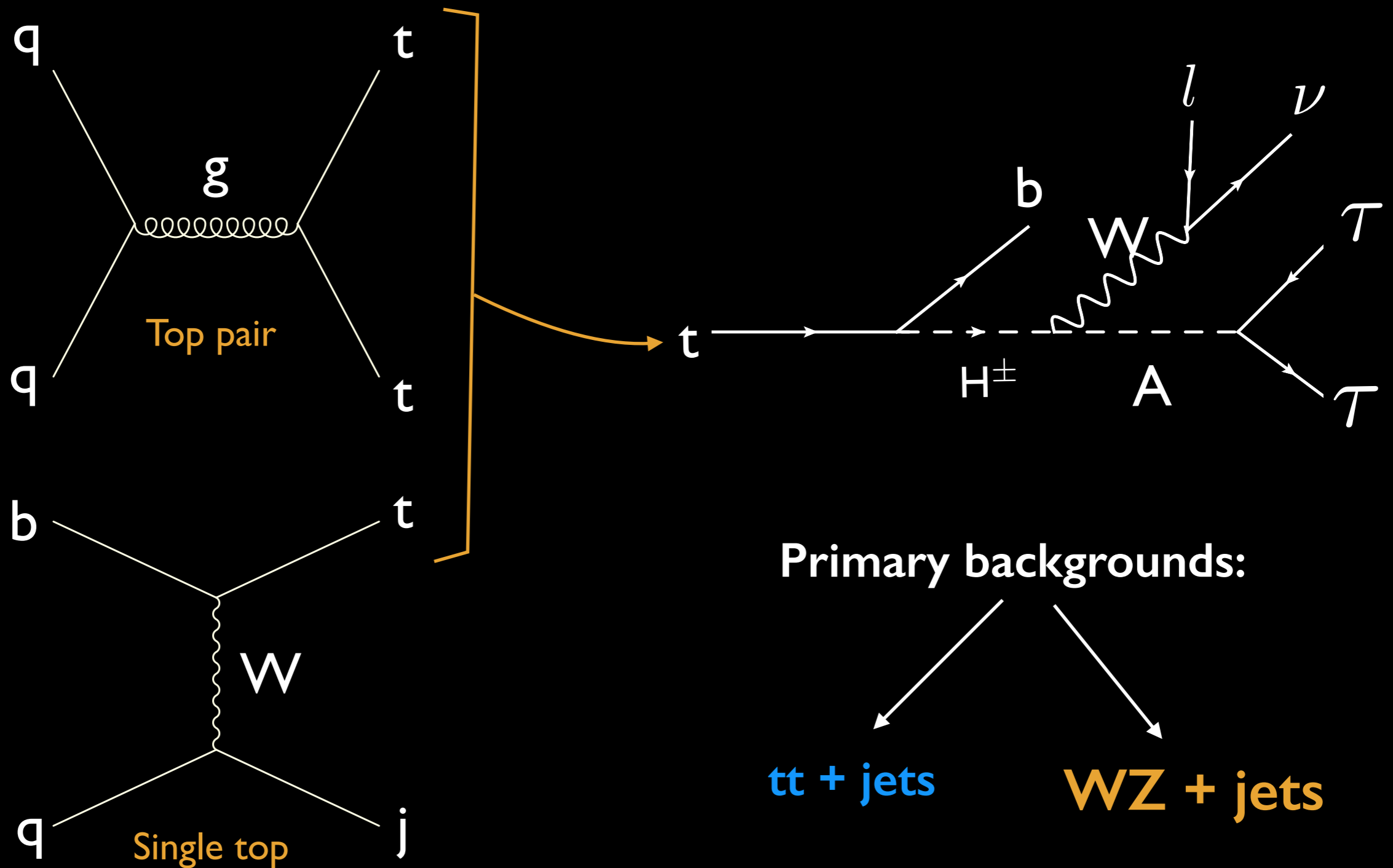


Excluded, if
 $H^\pm \rightarrow AW$ is possible
(Assuming existence of
A with mass 70 GeV)

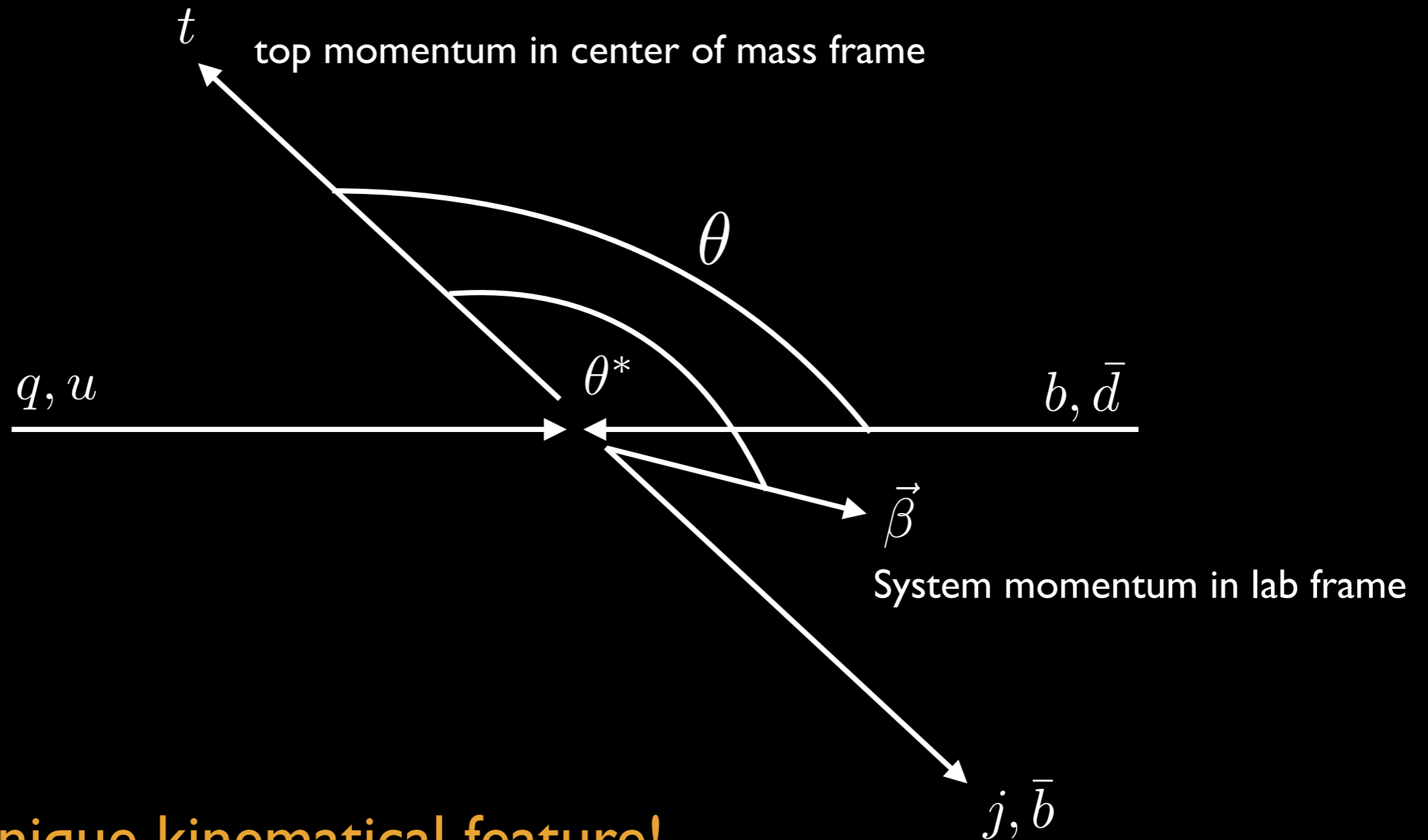
Our search channel



Our search channel

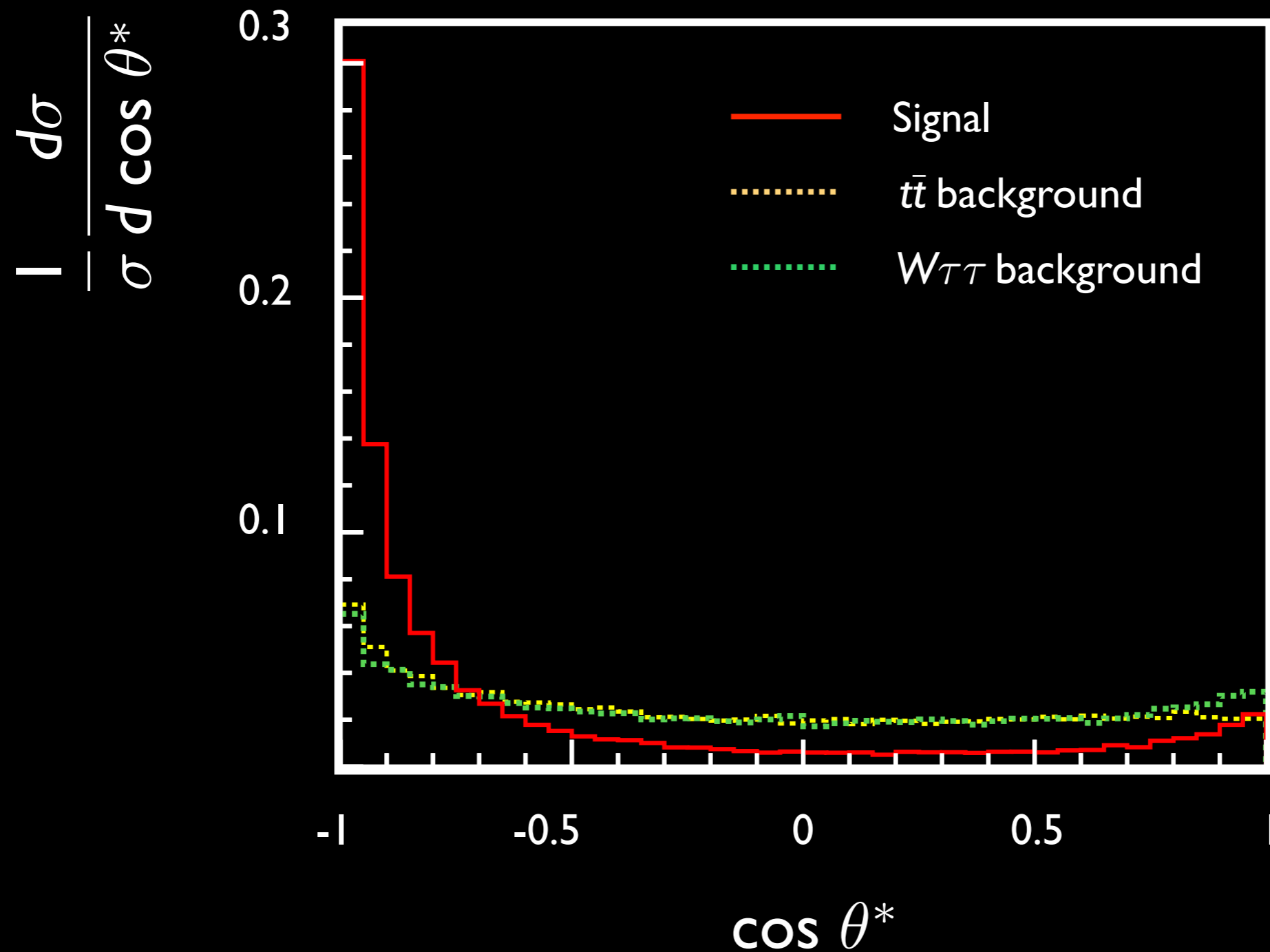


Angular Correlations in Single Top Production

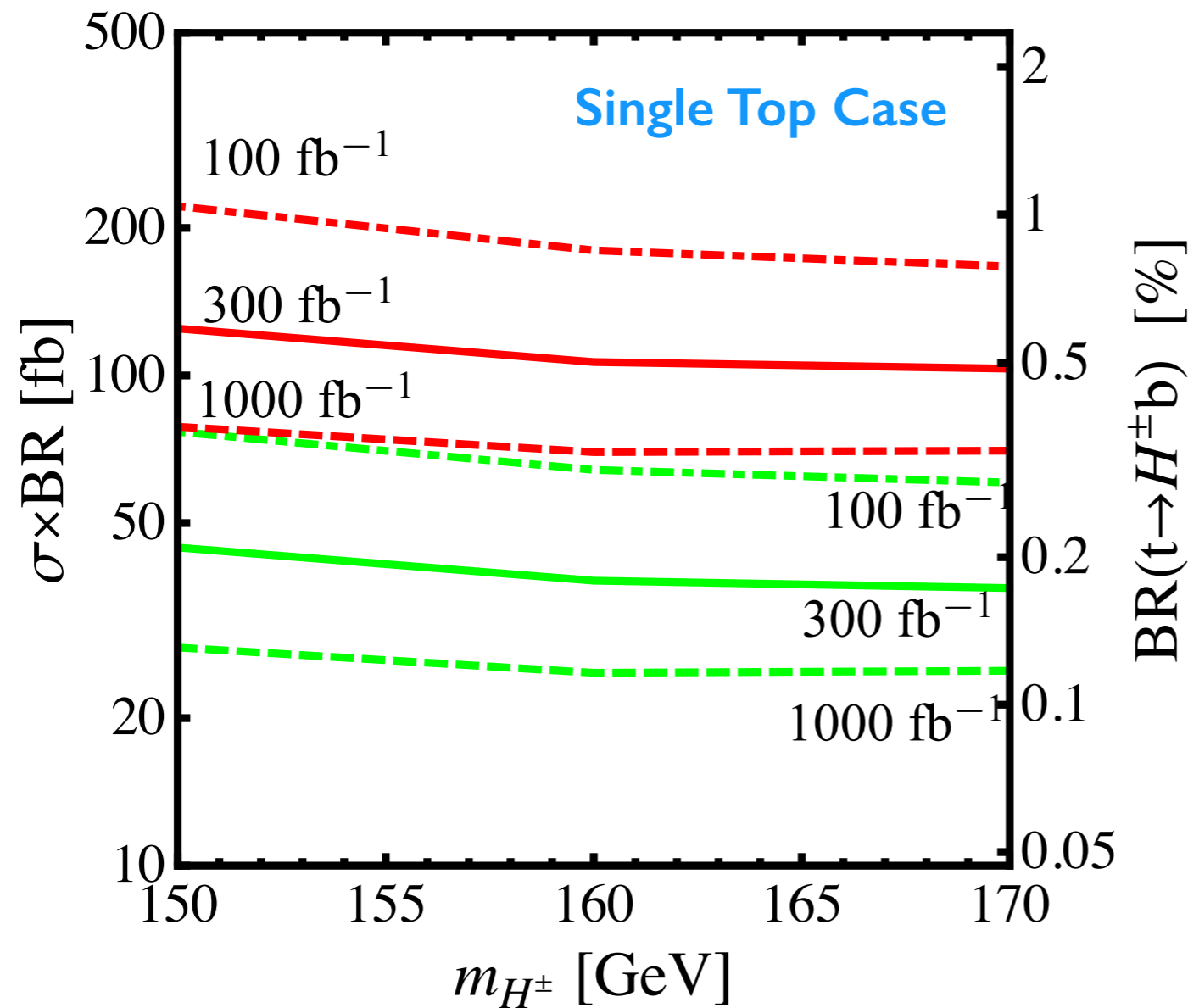


A unique kinematical feature!

Angular distribution - Signal vs. Background



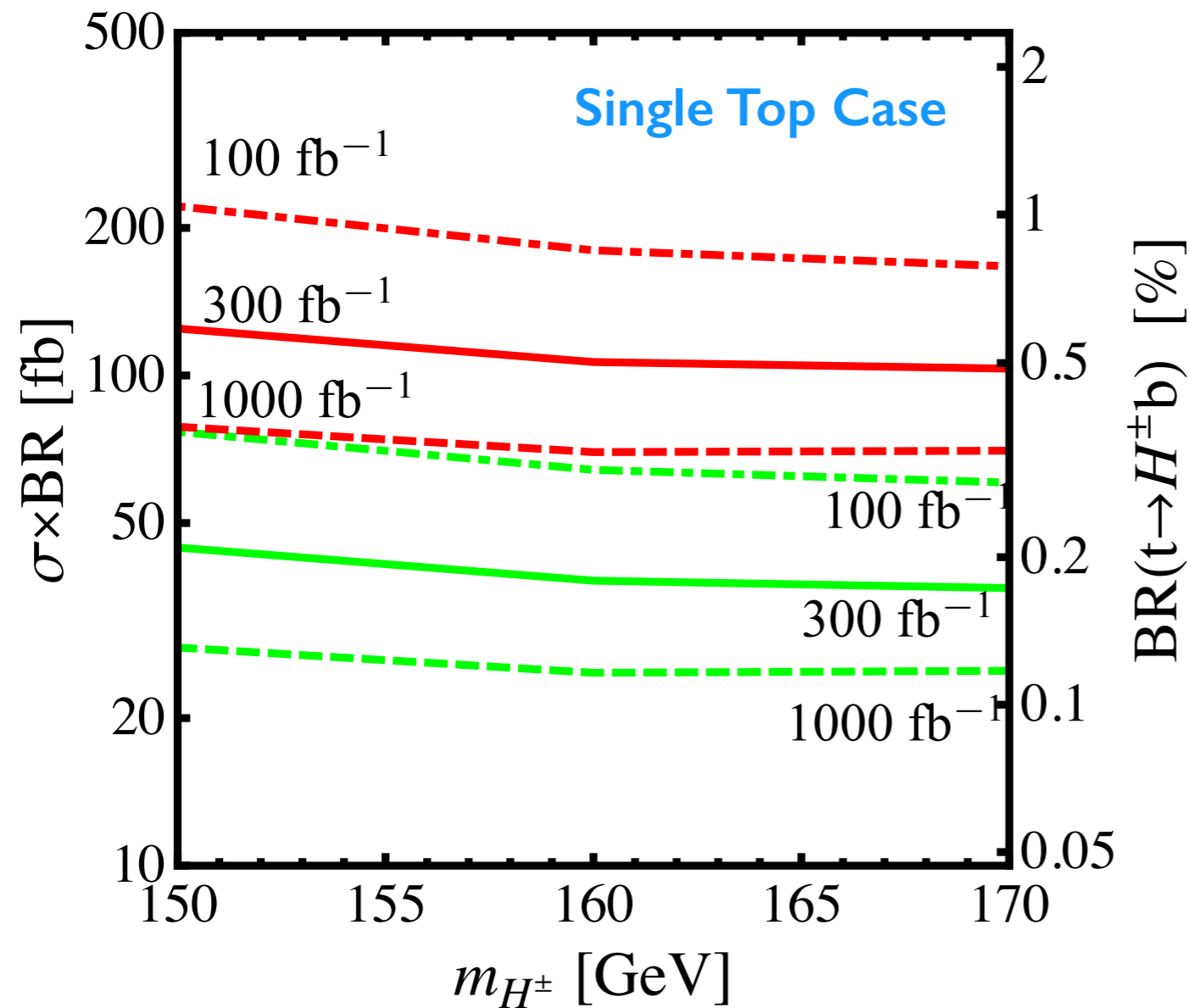
Model-independent Limits



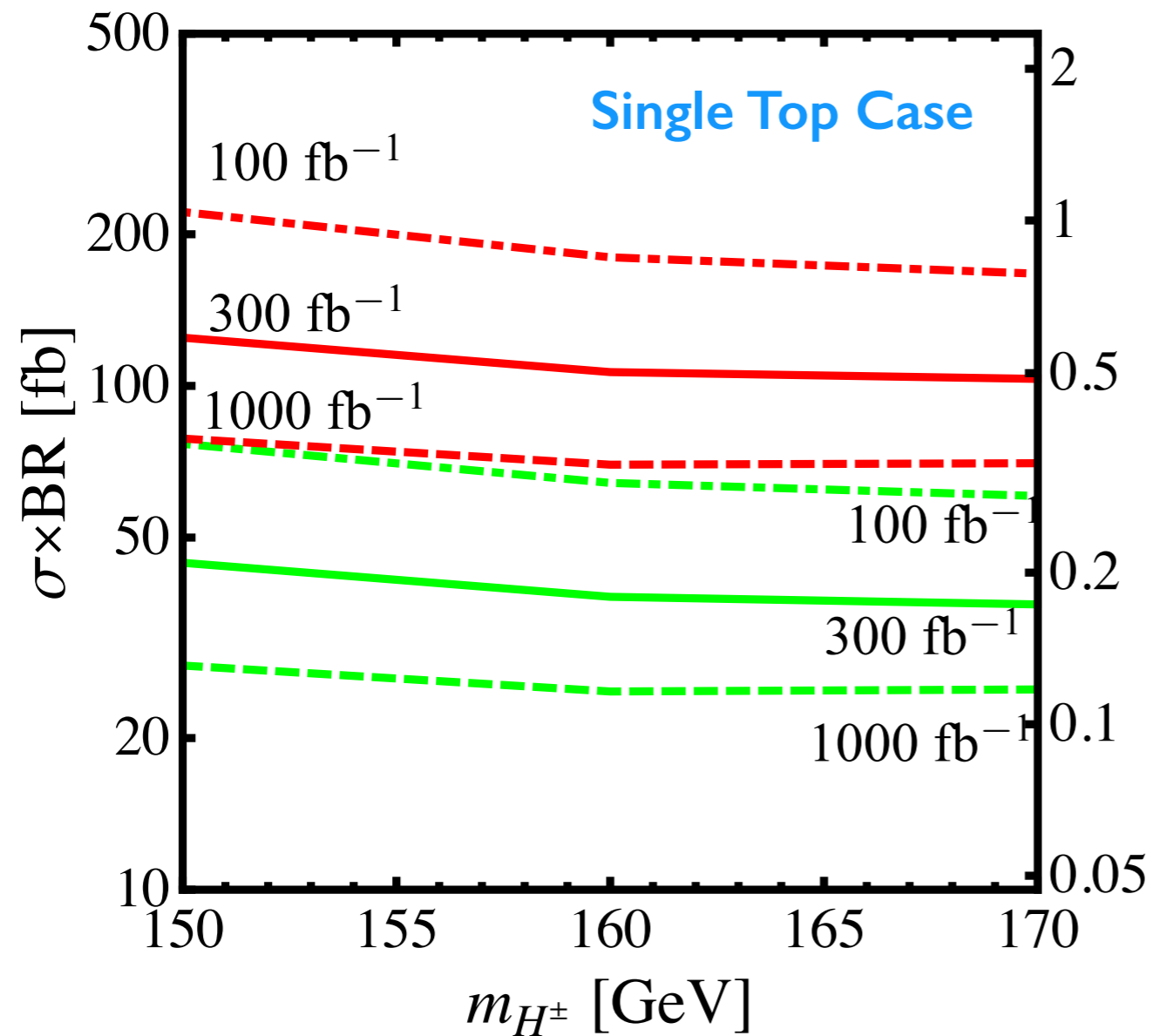
Red: Discovery
Green: Exclusion
@ 14 TeV LHC

More data
↓
Stronger bounds!

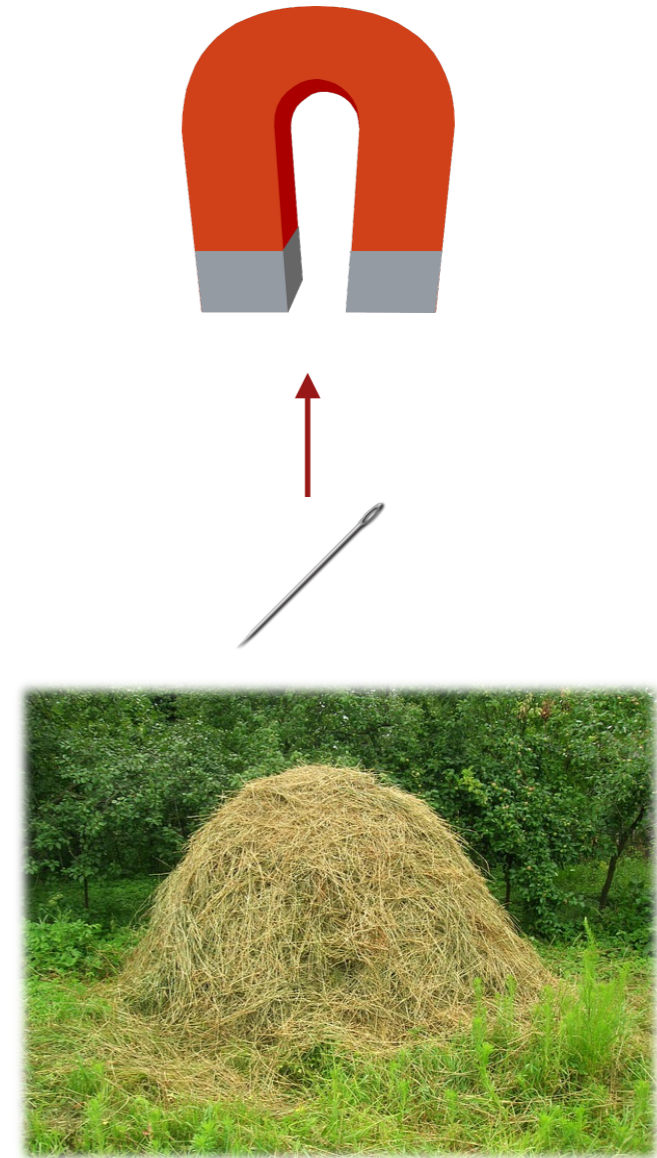
Model-independent Limits



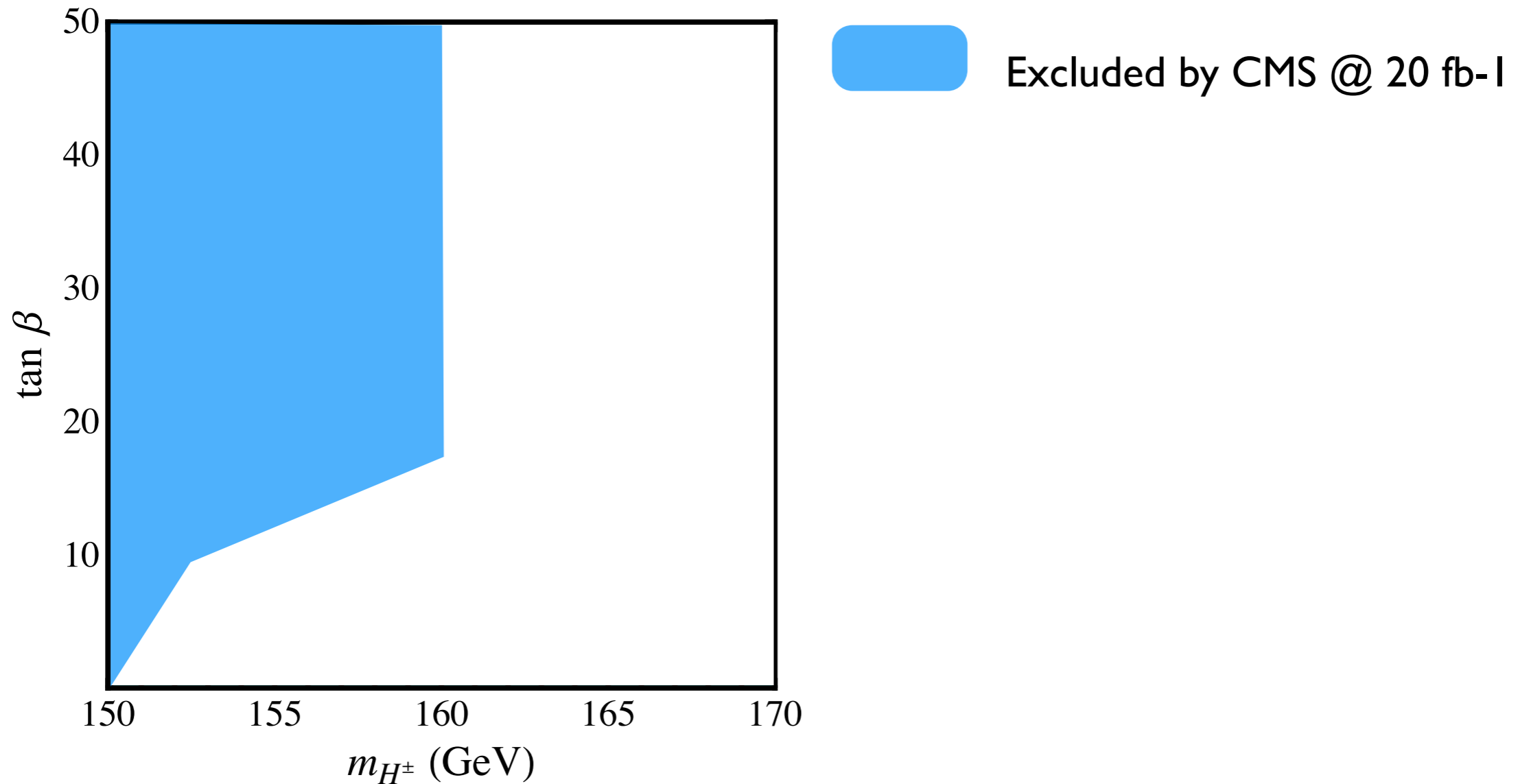
Model-independent Limits



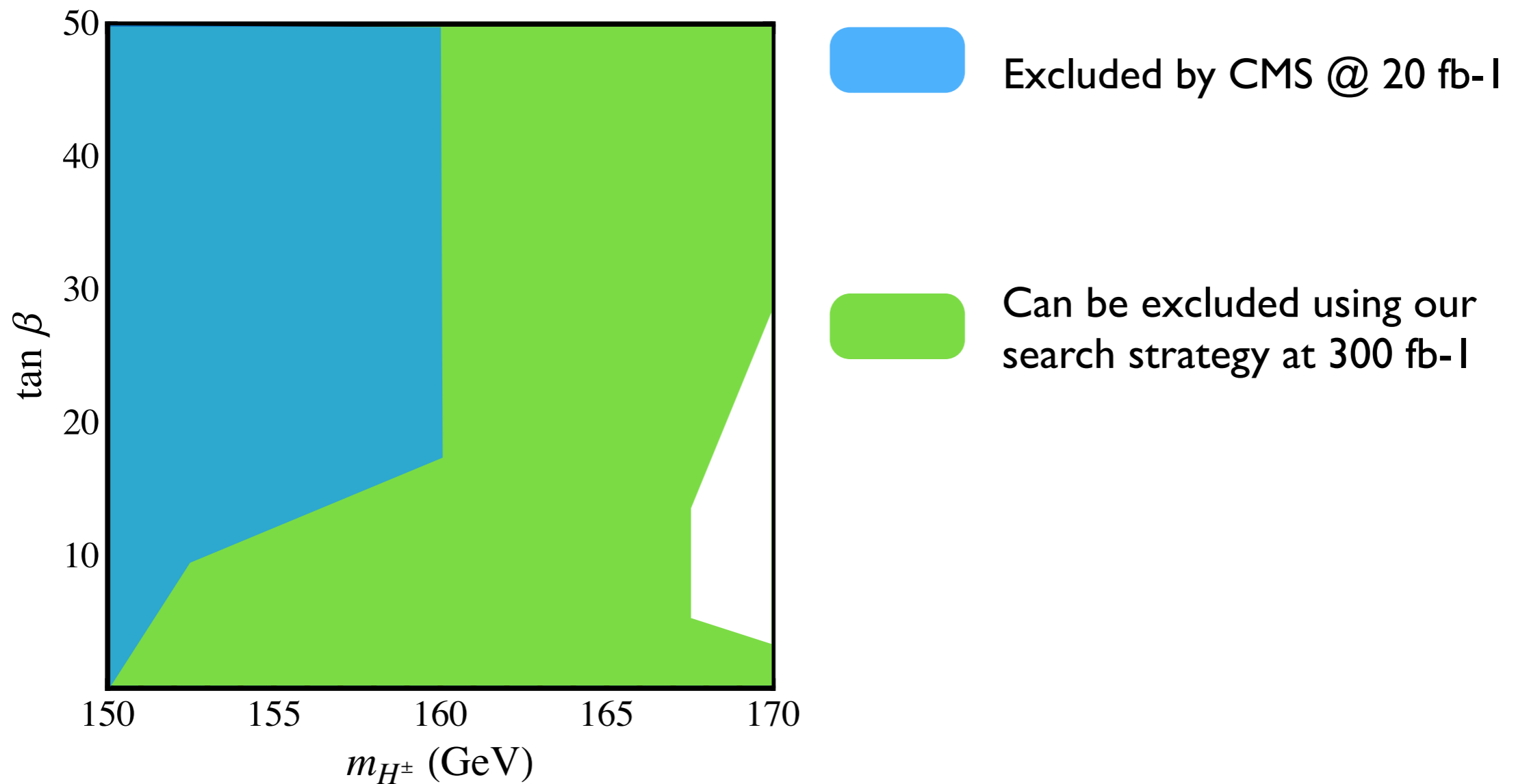
$BR(t \rightarrow H^\pm b)$ [%]



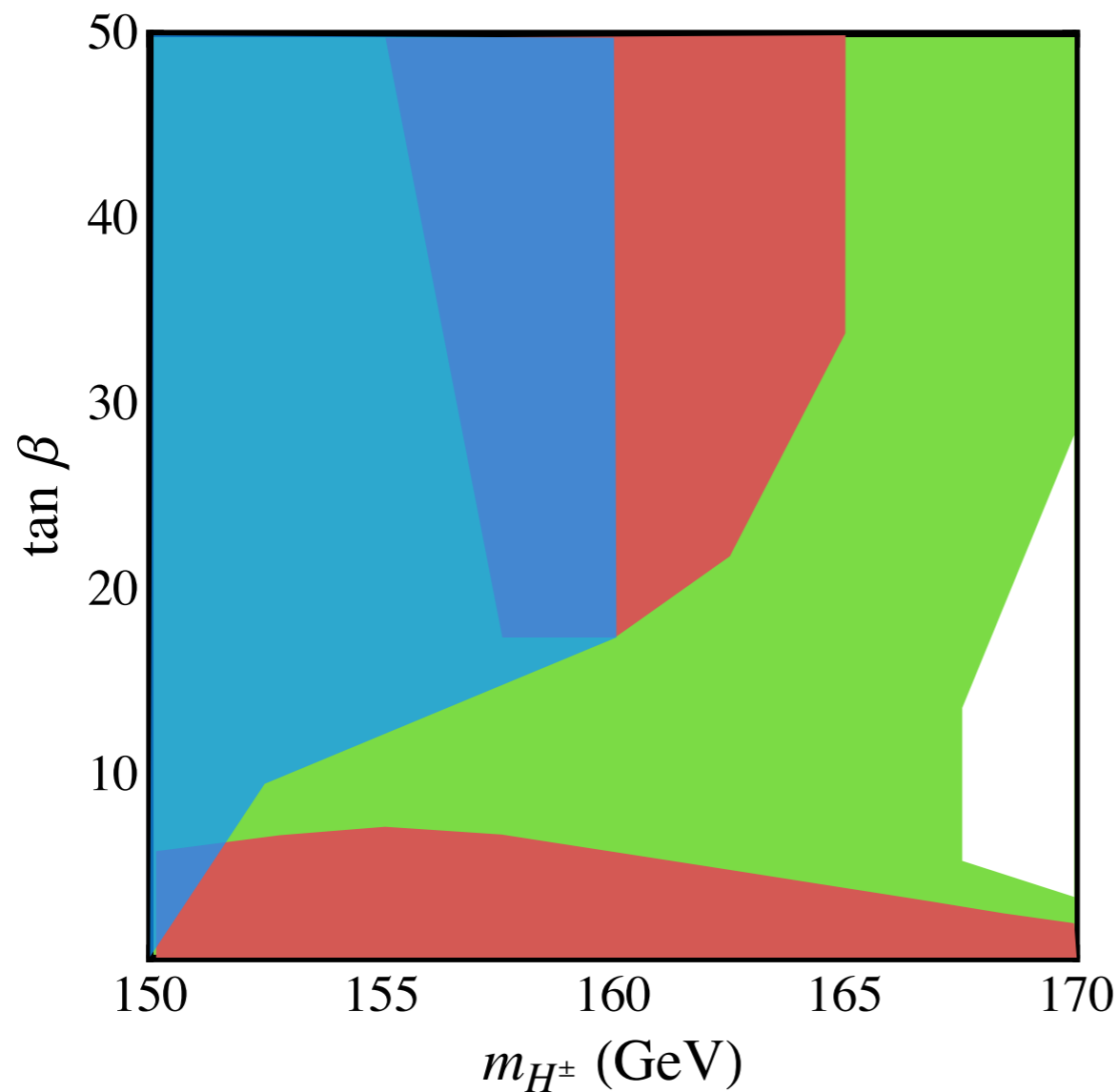
2HDM Implications



2HDM Implications



2HDM Implications



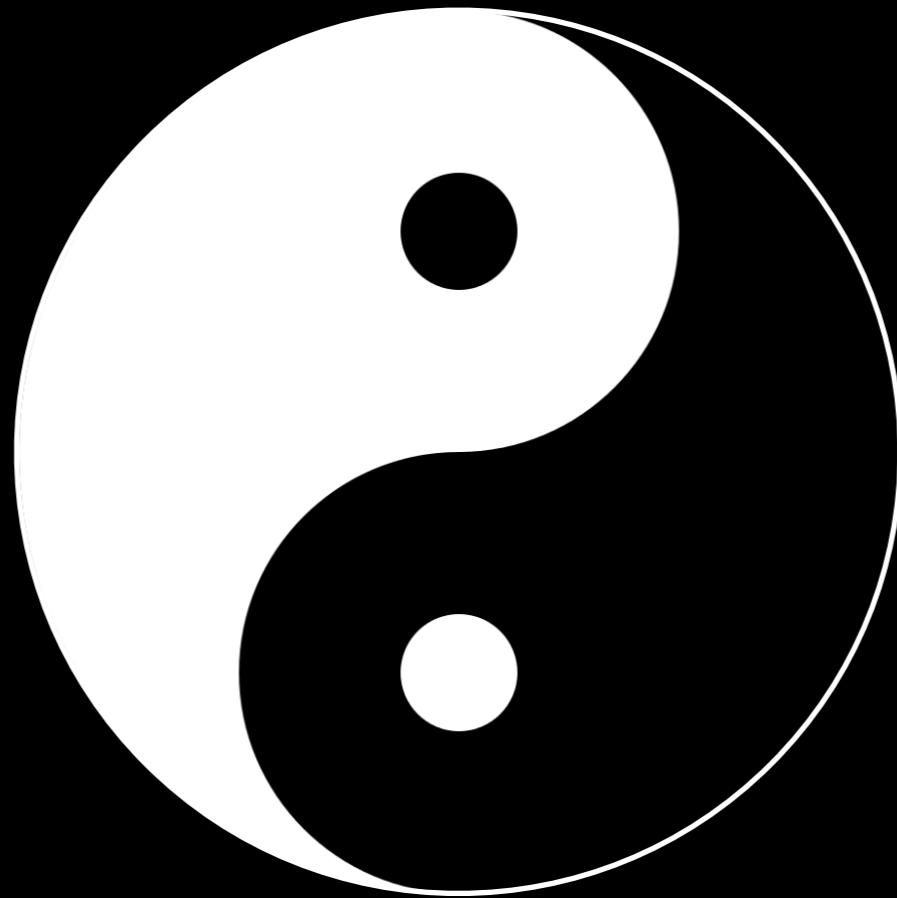
Excluded by CMS @ 20 fb-1

Can be excluded using our search strategy at 300 fb-1

Can be discovered using our search strategy @ 300 fb-1

Conclusion

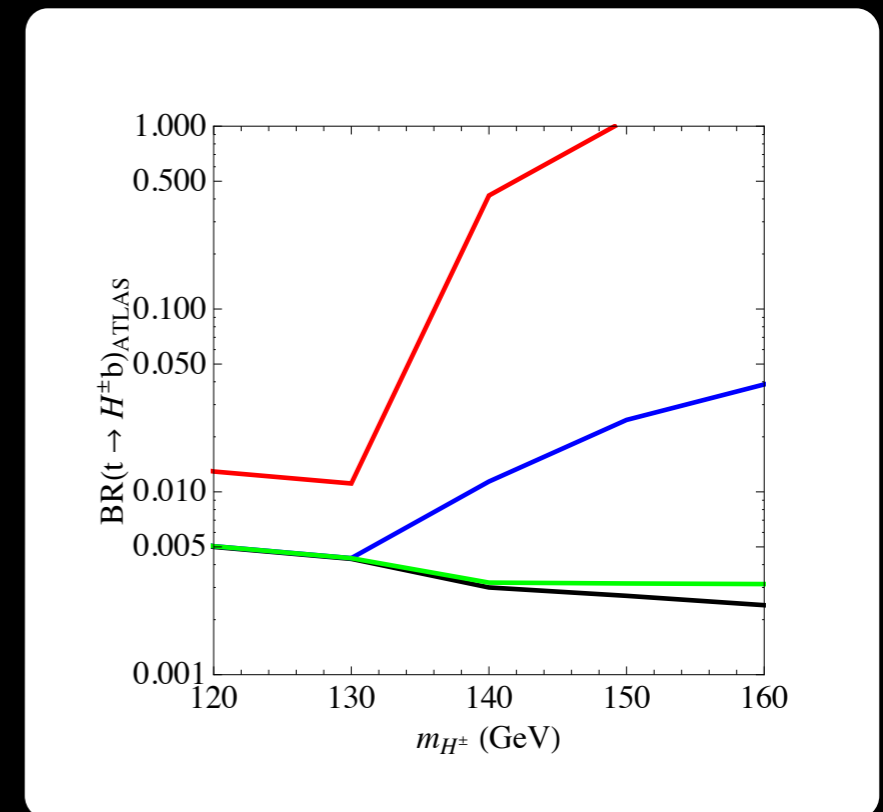
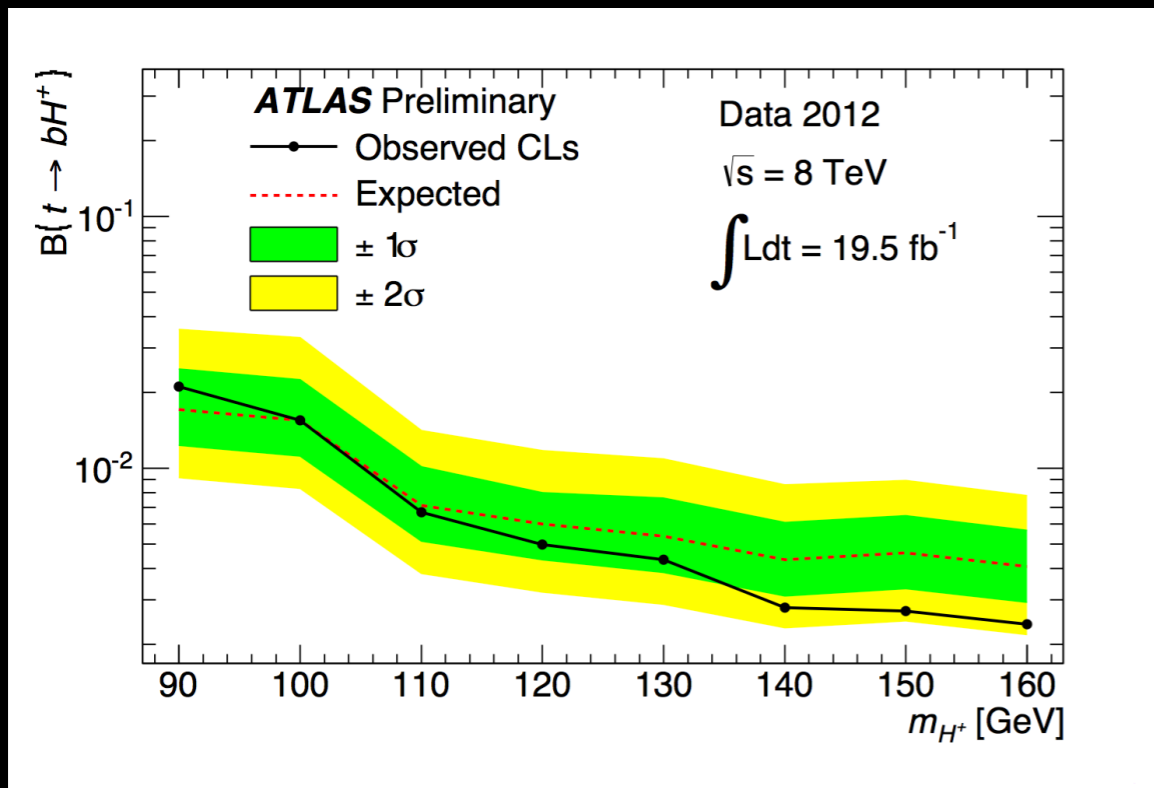
Conventional
decay channels



Exotic decay
channels

Backup Slides

Assuming $B(H^+ \rightarrow \tau\nu) = 1$



$B(t \rightarrow bH^+)$ for $m_{H^+} = 150$ GeV is 0.27%
(Upper limit)

Not applicable here since the charged Higgs can decay to AW as well!