2HDM+a mono-h→ bb: Update: fixing Vacuum Stability

Lars Henkelmann, Oleg Brandt, On the behalf of the ATLAS/mono-h \rightarrow bb analysis group LHC DM WG contribution 28.06.2017





SIC

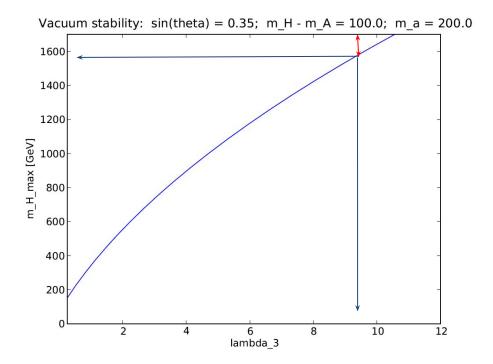
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Vacuum Stability: Problem

- Jose No: in BM3 and the m_a vs. m_A grid the vacuum is not stable
- fixing this requires having $\lambda_3^{"} \ge (m_h^{'}/v)^2$ and
 - \circ m_H low
 - \circ sin(θ) small
 - \circ m_H-m_A low
 - \circ λ_3 large
- all options either limit the maximum m_A (m_H) or reduce x-sec and/or signal diversity
- Q: can we avoid this?

Vacuum Stability: Solution

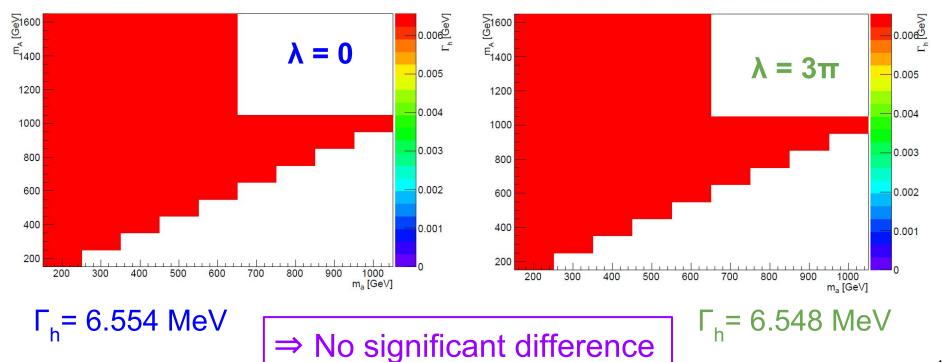
- solution suggested by Martin Bauer: fix the relation $\lambda_3 = \lambda_{P1} = \lambda_{P2} =: \lambda$
 - no change in g_{Aah}
 - $\rightarrow \text{ the signals should not} \\ \text{change}$
- today: tried this for the mass grid
- put $\lambda = 3\pi$
 - large enough that most of mass grid is stable
 - also large enough for stable BM3
 - if (huge) 3π works, any smaller value should work too



Width comparison: h

2HDM+a: Intrinsic Decay Width of Light Scalar h

2HDM+a: Intrinsic Decay Width of Light Scalar h

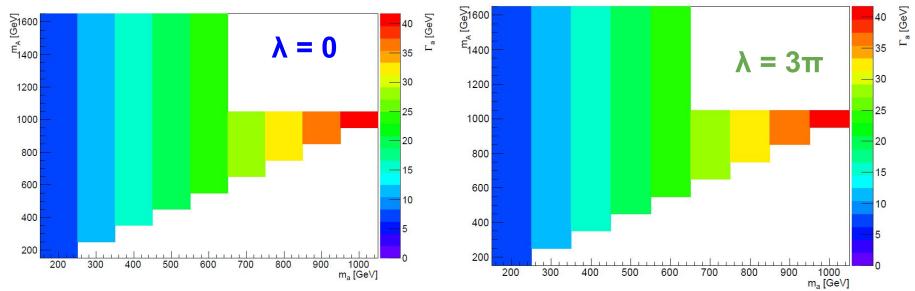


(PDG: $\Gamma_h < 13 \text{ MeV}$)

Width comparison: a

2HDM+a: Intrinsic Decay Width of Light Pseudoscalar a



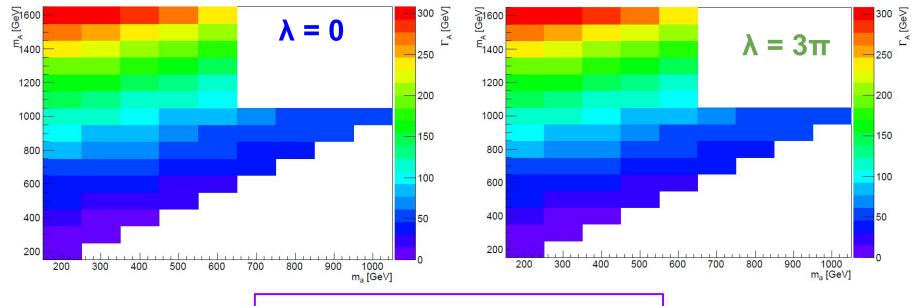


 \Rightarrow No significant difference

Width comparison: A

2HDM+a: Intrinsic Decay Width of Heavy Pseudoscalar A

2HDM+a: Intrinsic Decay Width of Heavy Pseudoscalar A



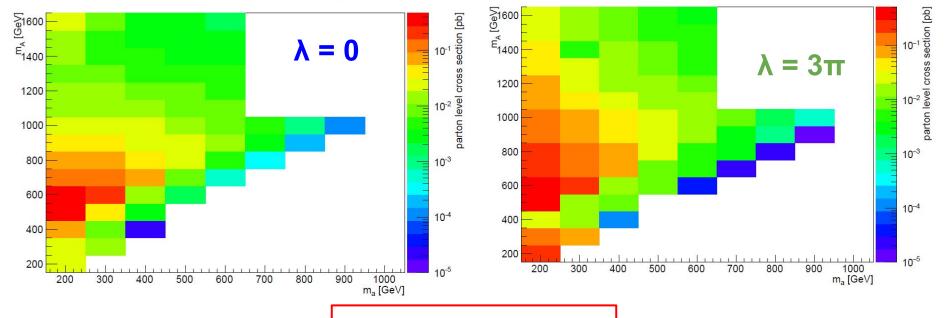
 \Rightarrow No significant difference

Cross Section comparison

2HDM+a: parton level cross section, after a MET >= 150GeV Cut

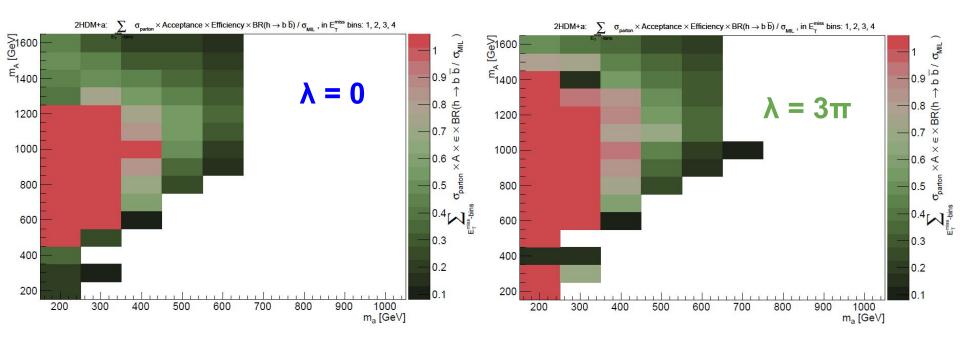
2HDM+a: parton level cross section, after a MET >= 150GeV Cut

7



 \Rightarrow large difference

Sensitivity comparison



 \Rightarrow large difference

MET Spectra comparison

2HDM+a ma=400.0-900.0 mA=1000.0 mH=1100.0 sin(theta)=0.35

cross section [pb]

 10^{-3}

 10^{-4}

 10^{-5}

200

cross section [pb] -0_-5 2HDM+a ma=400.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=400.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=500.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=600.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=500.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=700.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 = Зт 2HDM+a ma=800.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=600.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=900.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 $\lambda = 0$ 2HDM+a ma=700.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=800.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 2HDM+a ma=900.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 10^{-3} 10^{-4} 400 600 800 1000 10^{-5} E^{miss} [GeV] 200 600 800 1000 400 E^{miss}_T [GeV]

2HDM+a ma=400.0-900.0 mA=1000.0 mH=1100.0 sin(theta)=0.35 alt.

 \Rightarrow large difference

Summary

- Fix to vacuum stability:
 - $\circ \quad \lambda_{P1} = \lambda_{P2} = \lambda_3 = 3\pi$
 - expected no change in signals
 - definitely changes MET-spectra, but small in resonant peak region
 - still get diverse signals
 - more sensitivity for many mass points
 - I do not understand where this change comes from
 - comments?
 - Works OK as a fix
- Currently generating MC to do comparison in BM3

Backup

Additional width studies

Width comparison: H

2HDM+a: Intrinsic Decay Width of Heavy Scalar H

[____250 ____ [∕a1600 9] [♥] 1400 [/ə5] ^н 250 λ = 0 $\lambda = 3\pi$ m_a [GeV] m_a [GeV]

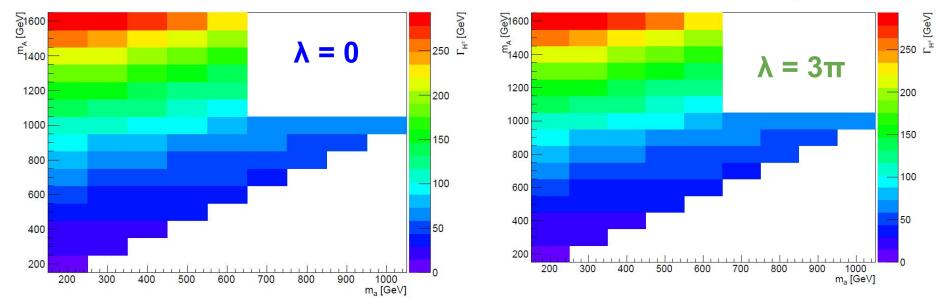
 \Rightarrow No significant difference

2HDM+a: Intrinsic Decay Width of Heavy Scalar H

Width comparison: H⁺⁻

2HDM+a: Intrinsic Decay Width of Massive Charged Scalar H[±]

2HDM+a: Intrinsic Decay Width of Massive Charged Scalar H^{\pm}



 \Rightarrow No significant difference