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

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On the behalf of the ATLAS/mono-h → bb analysis group
LHC DM WG contribution
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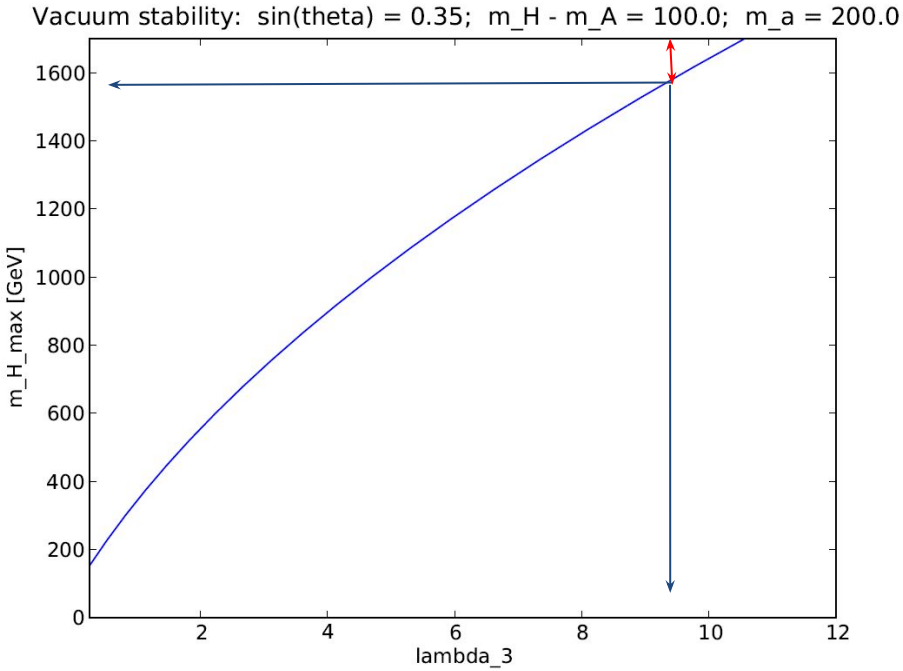
Vacuum Stability: Problem

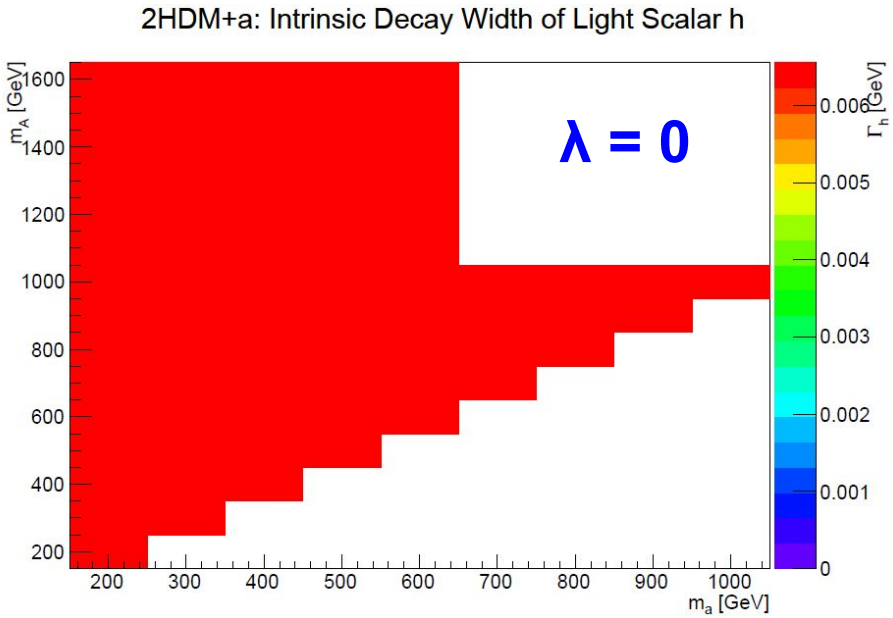
- Jose No: in BM3 and the m_a vs. m_A grid the vacuum is not stable
- fixing this requires having $\lambda_3 >= (m_h/v)^2$ *and*
  - m_H low
  - sin(θ) small
  - m_H-m_A low
  - λ_3 large
- all options either limit the maximum m_A (m_H) or reduce x-sec and/or signal diversity
- Q: can we avoid this?

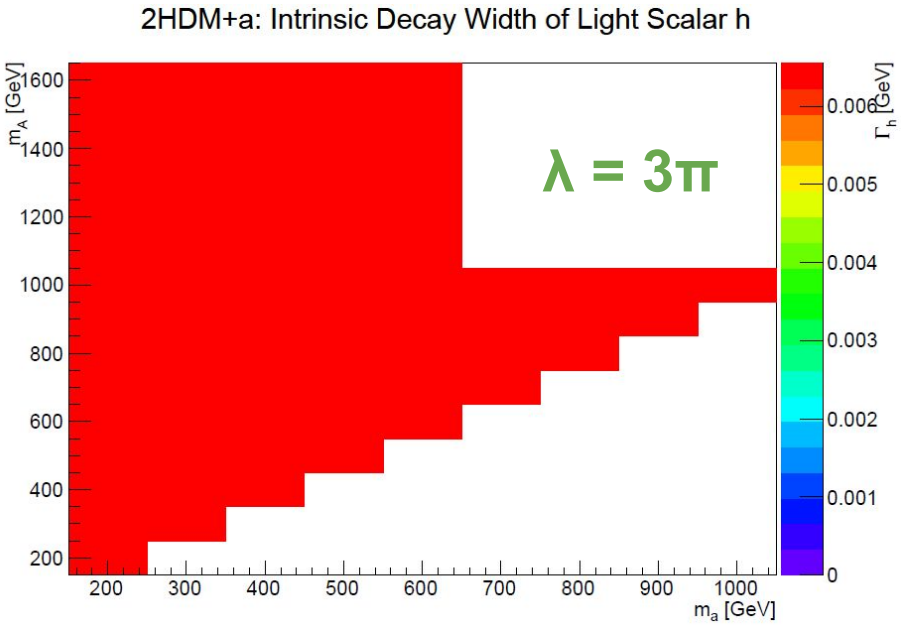
Vacuum Stability: Solution

- solution suggested by Martin Bauer: fix the relation $\lambda_3 = \lambda_{P1} = \lambda_{P2} =: \lambda$
  - no change in g_{Aah}
  - → the signals should not 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





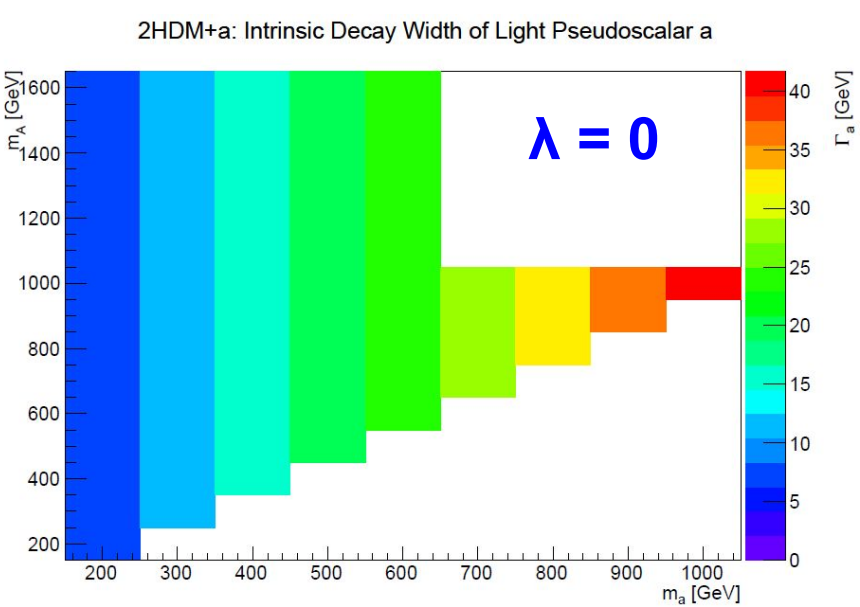
Γ_h = 6.554 MeV

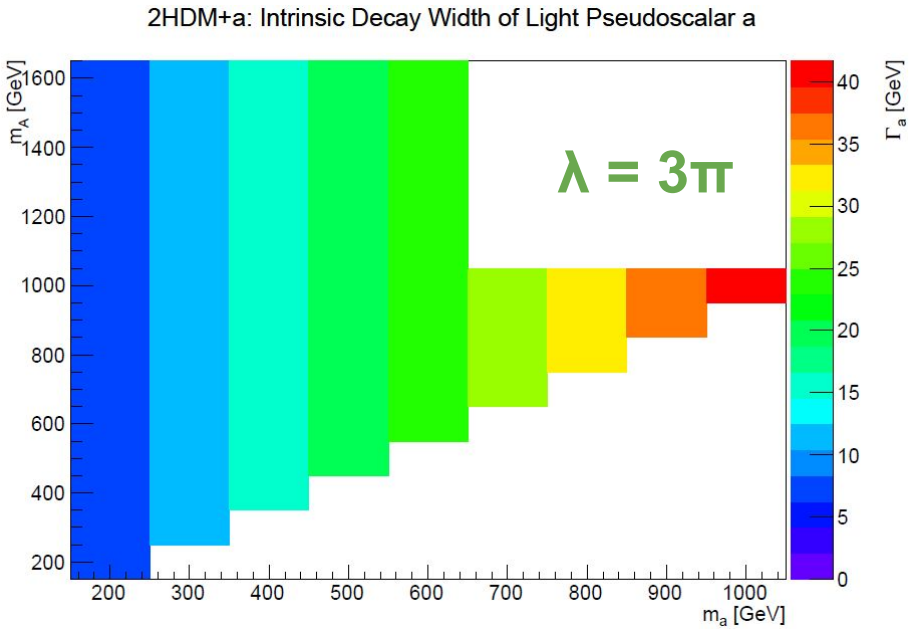
⇒ No significant difference

Γ_h = 6.548 MeV

(PDG: Γ_h < 13 MeV)

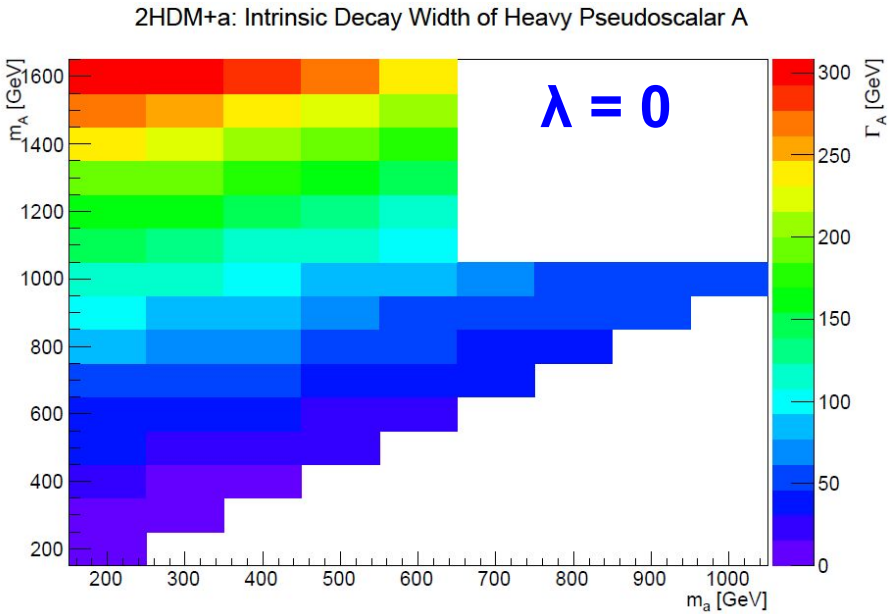
Width comparison: a

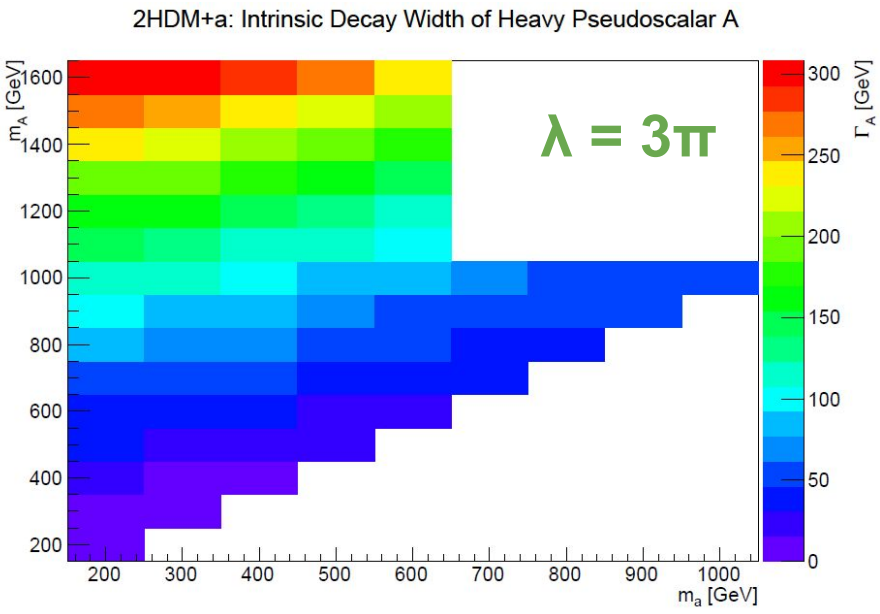




⇒ No significant difference

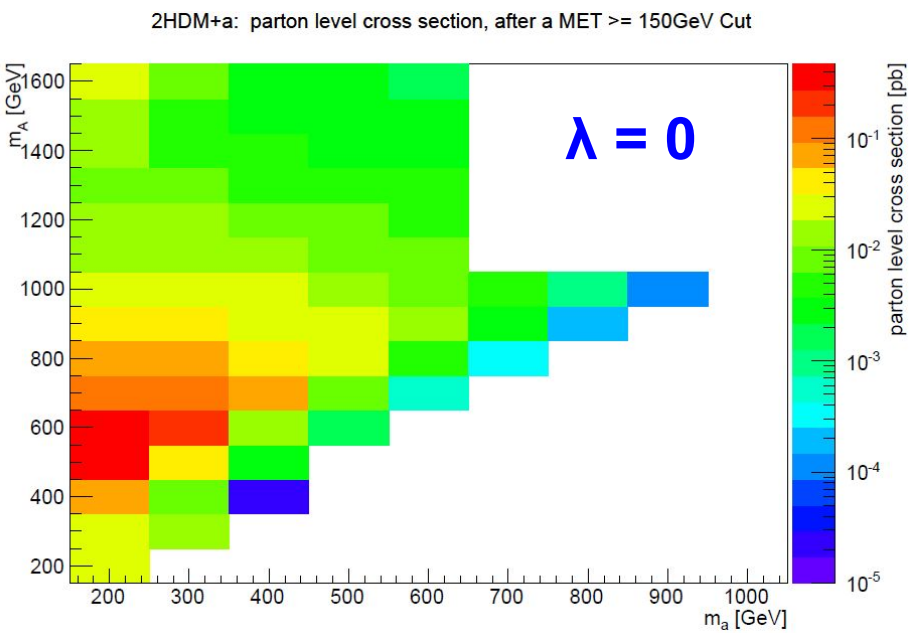
Width comparison: A

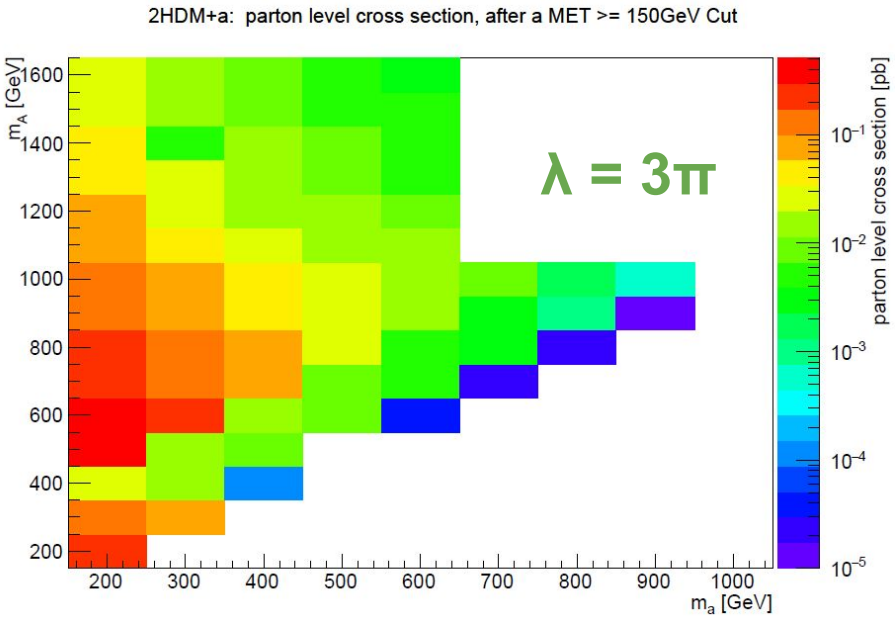




⇒ No significant difference

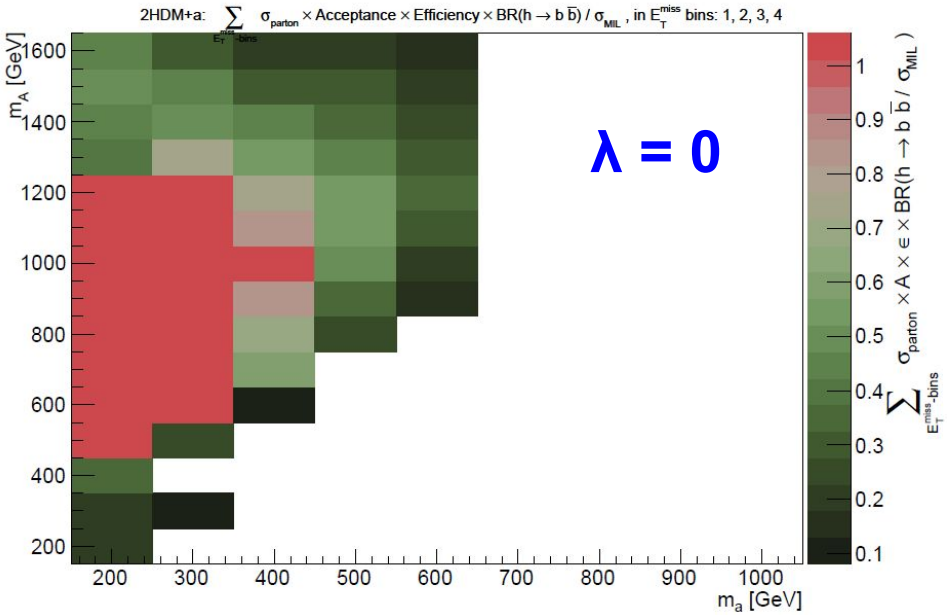
Cross Section comparison

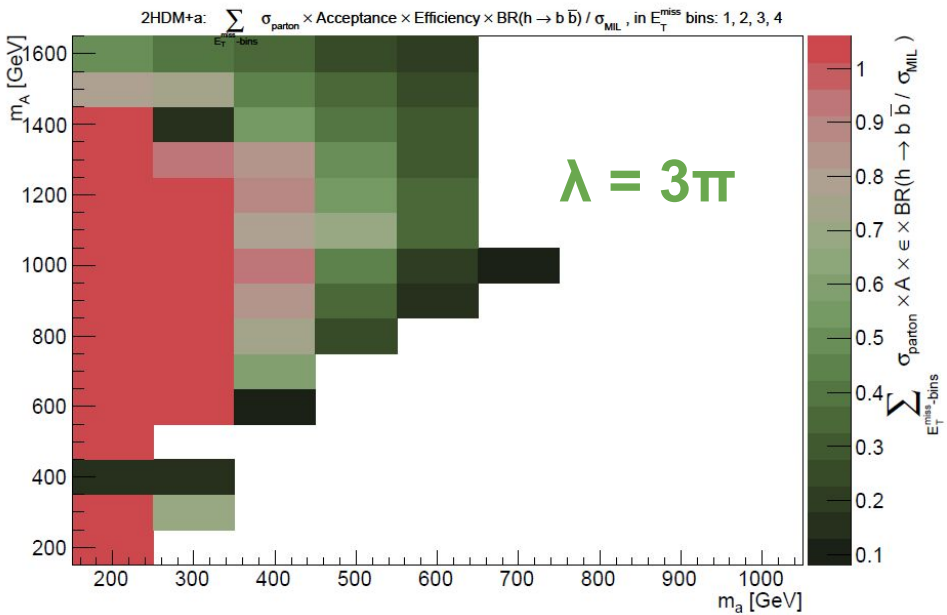




⇒ large difference

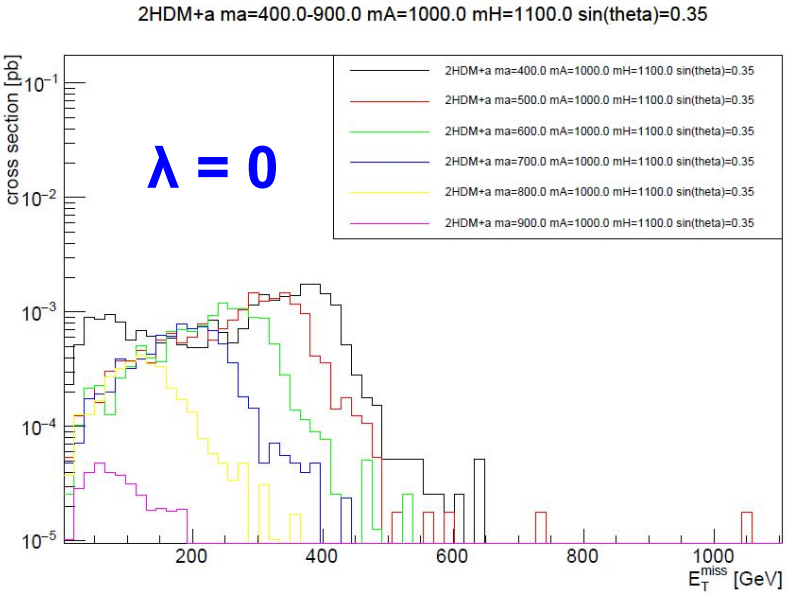
Sensitivity comparison

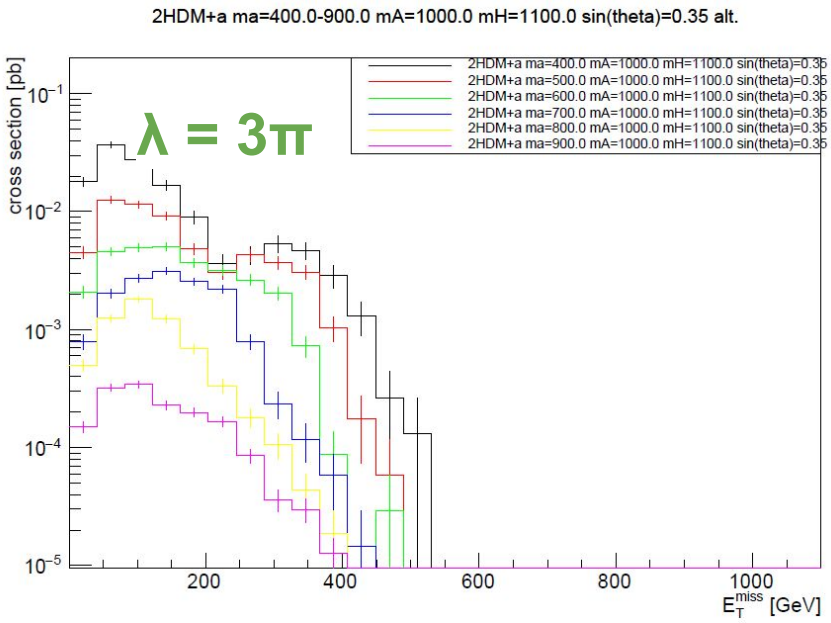




⇒ large difference

MET Spectra comparison





⇒ large difference

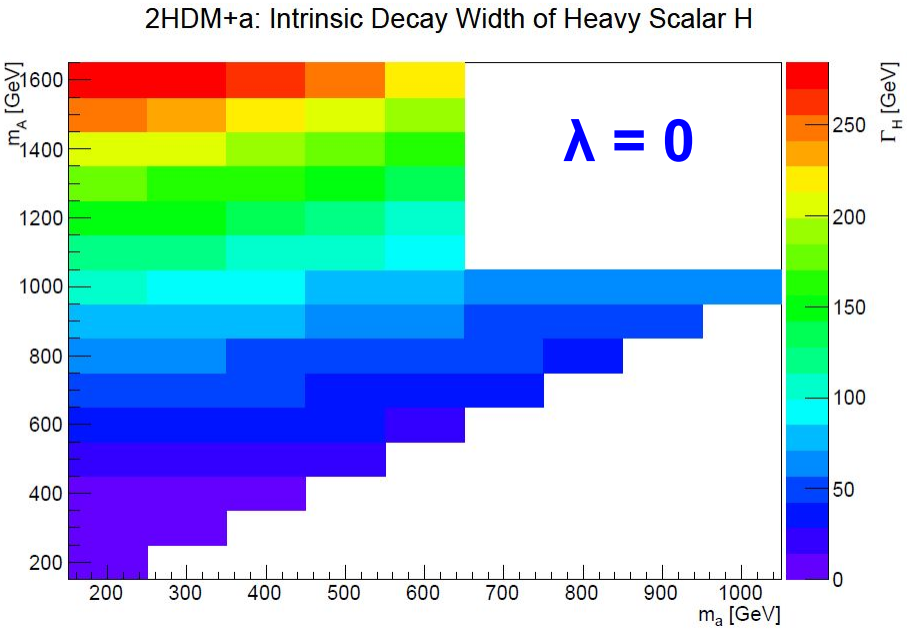
Summary

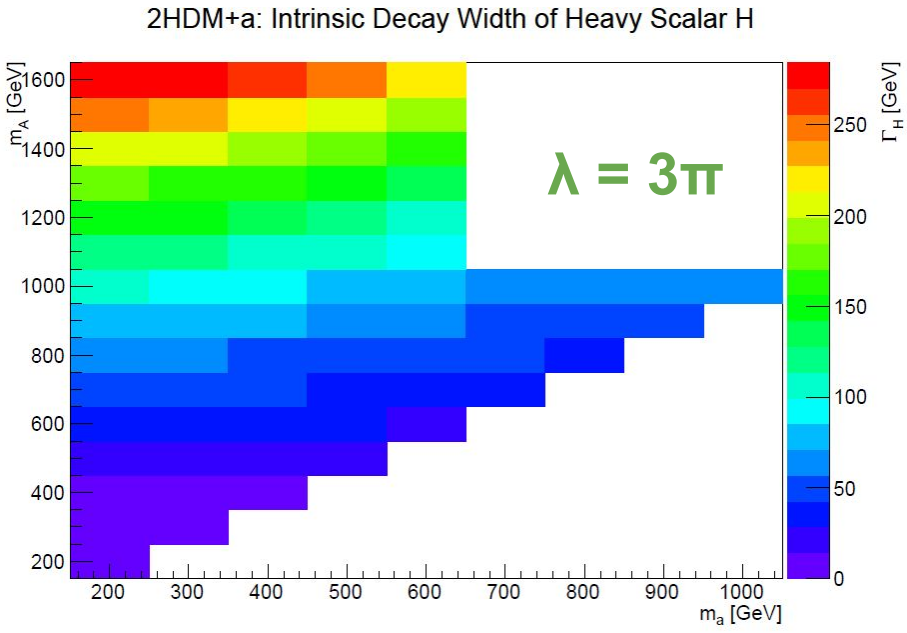
- Fix to vacuum stability:
  - $\lambda_{P1} = \lambda_{P2} = \lambda_3 = 3\pi$
  - expected no change in signals
  - definitely changes MET-spectra, but small in resonant peak region
    - still get diverse signals
    - more sensitivity for many mass points
    - I do not understand where this change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

Backup

Additional width studies

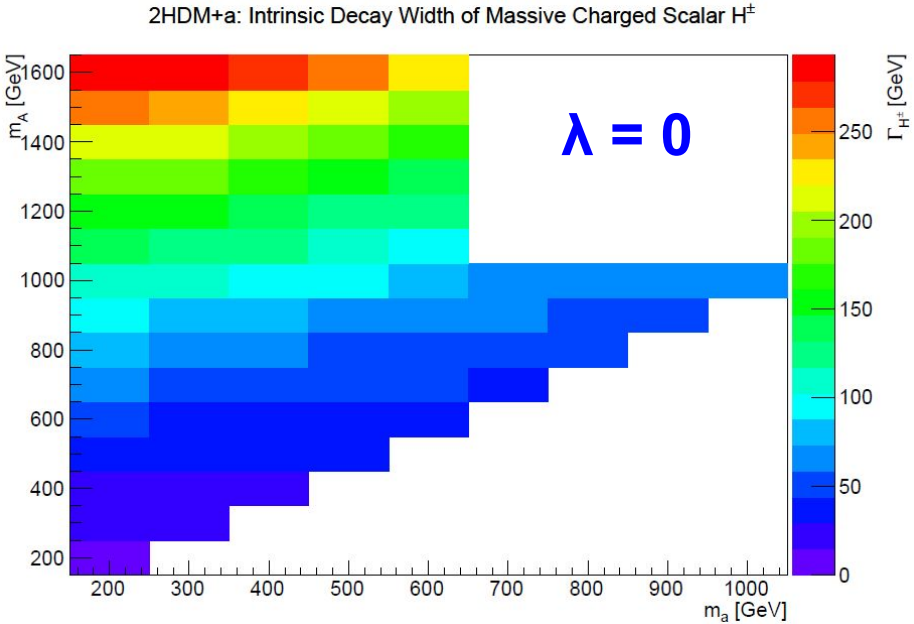
Width comparison: H

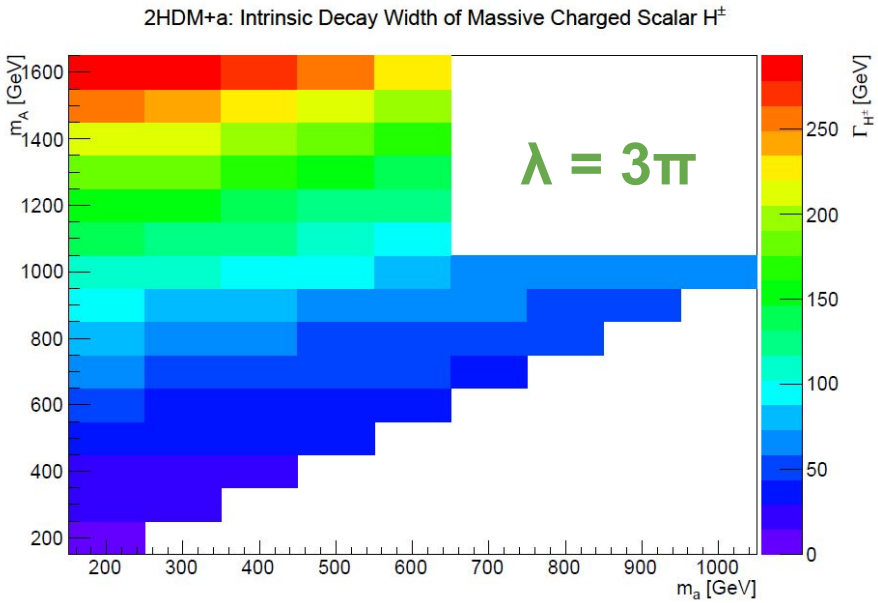




⇒ No significant difference

Width comparison: H^{+-}





⇒ No significant difference