# SUSY Electroweakinos including Higgs in the final state

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University of Arizona

Next steps in the Energy Frontier - Hadron Colliders, 27th August 2014

# Motivation

## Why Electroweakinos?

- natural SUSY: light Gauginos and Higgsinos
- neutralino: DM candidate

} Theory

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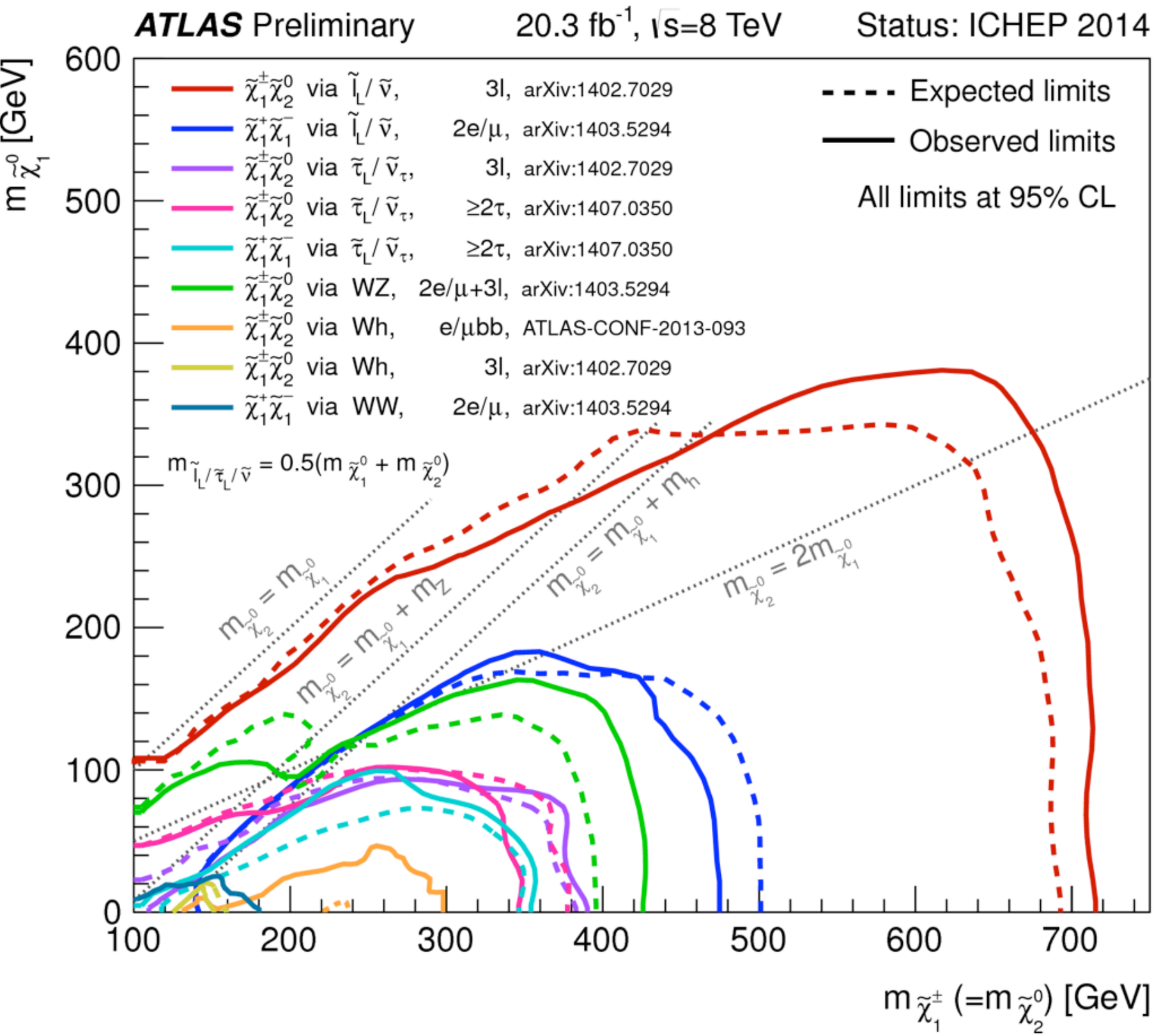
## Why Higgs final state?

- Now we have the Higgs!
- neutralinos/charginos: small electroweak production
- current search: focus on slepton assisted channels
- current reach: limited
- Higgs final state: another possible decay channel

# The Current Status



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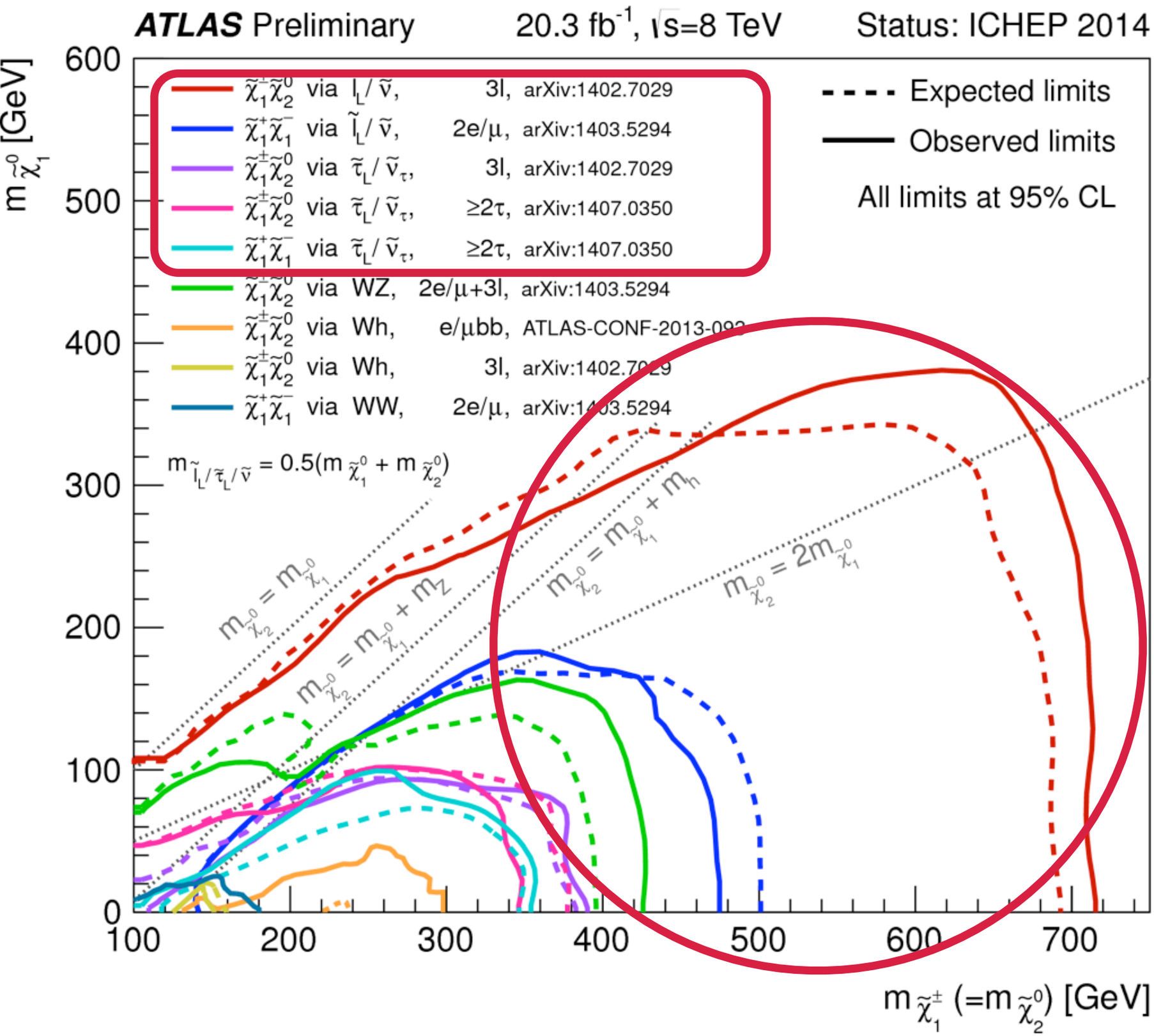


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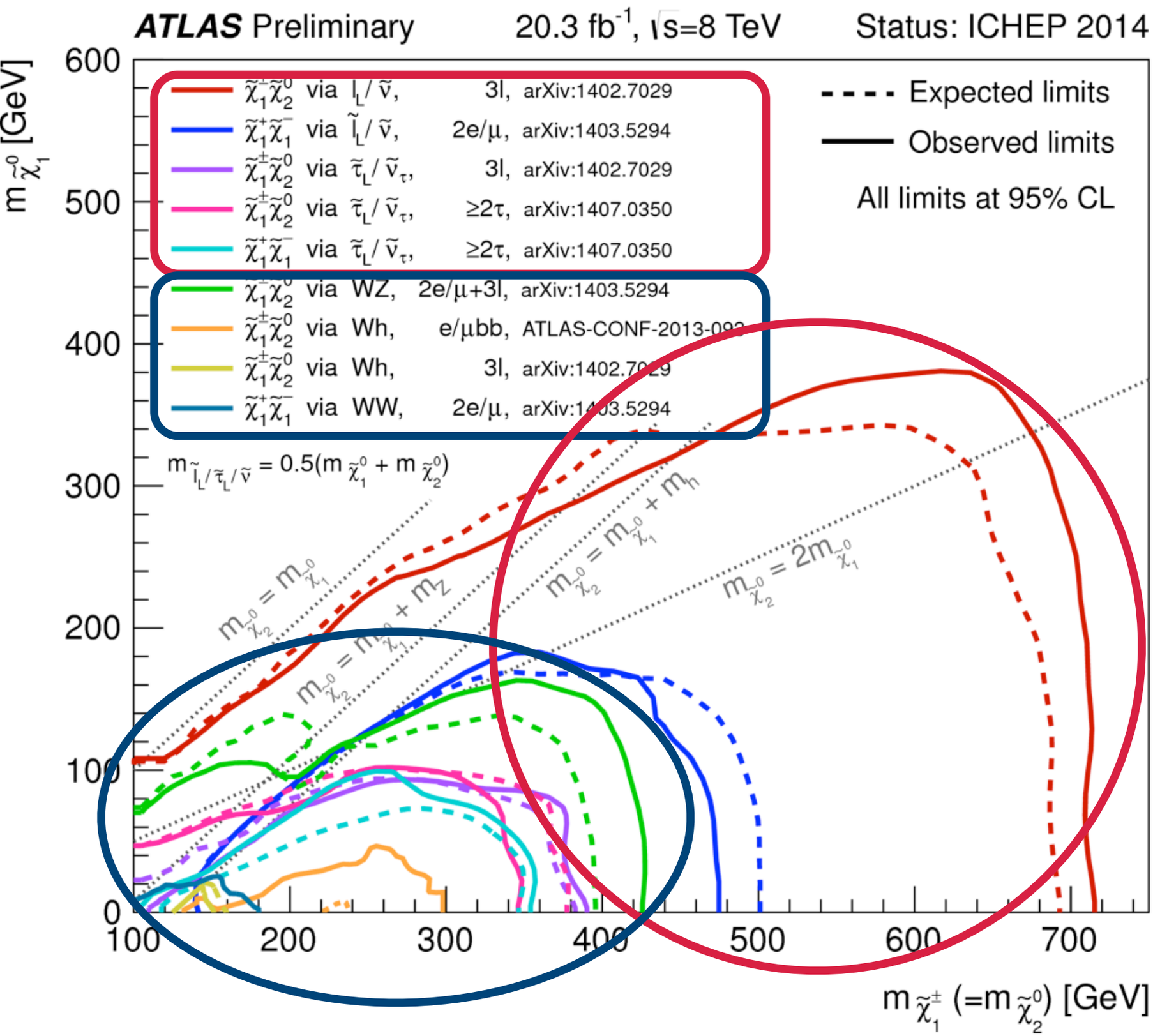


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100% BR

→ realistic BR

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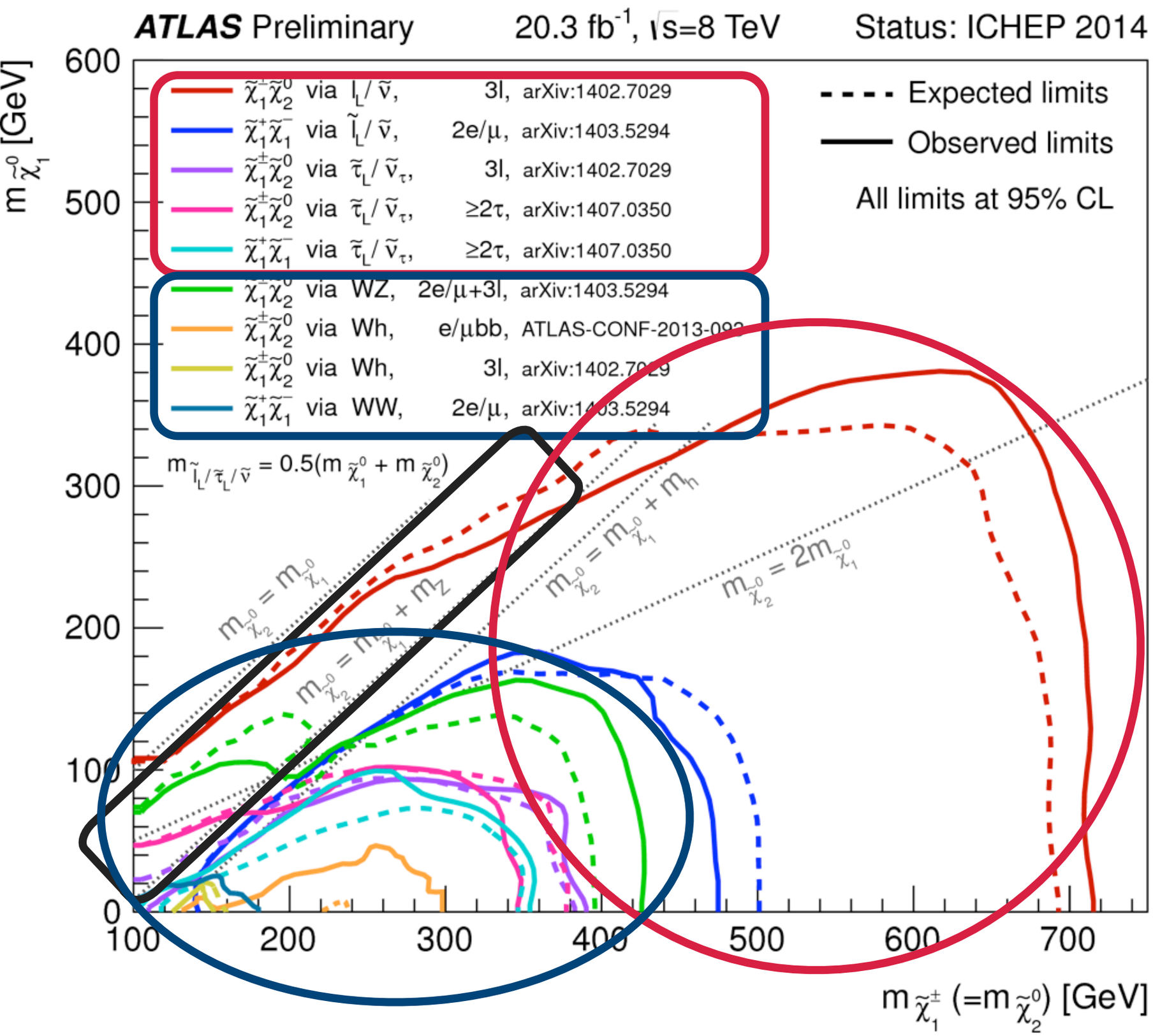


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large $m_{\tilde{\chi}_2^0} - m_{\tilde{\chi}_1^0}$

→ compressed spectrum

# Electroweakino Decay

## Depend on mass hierarchy

SUSY mass parameters:

| | |
|---|---|
| Bino | $M_1$ |
| Wino | $M_2$ |
| Higgsino | $\mu$ |

↓

Neutralinos

$$\chi_1^0,\ \chi_2^0,\ \chi_3^0,\ \chi_4^0$$

Charginos

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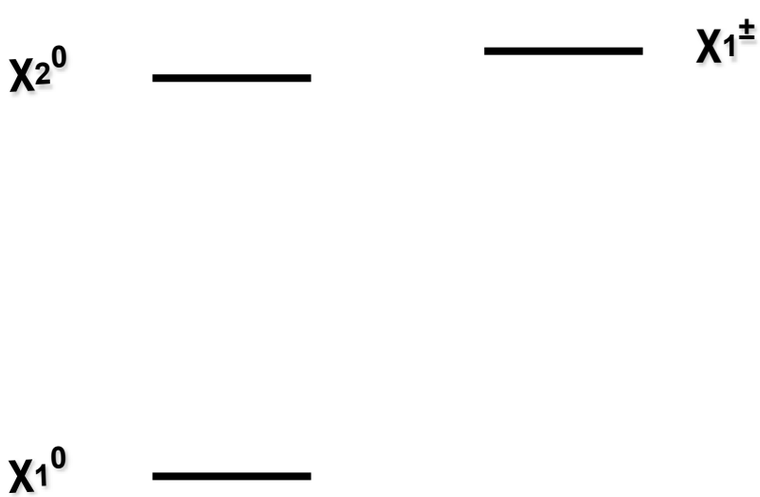


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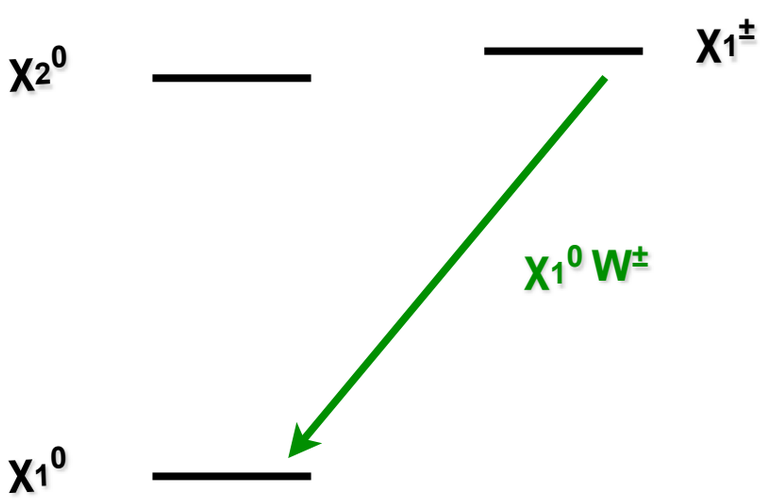


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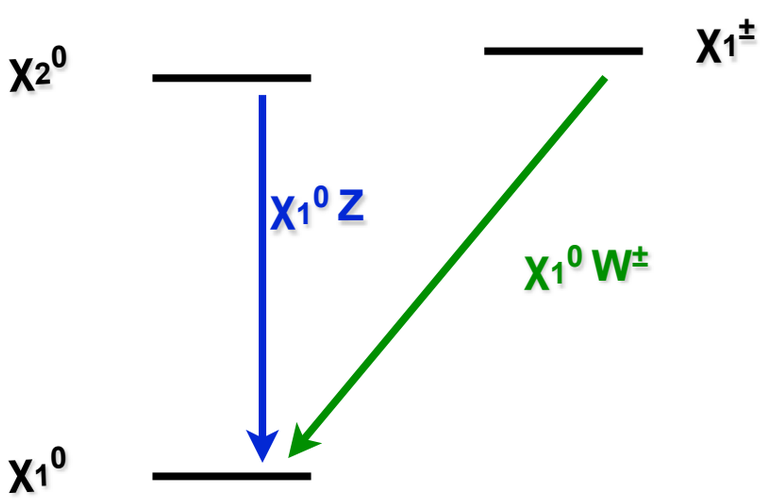


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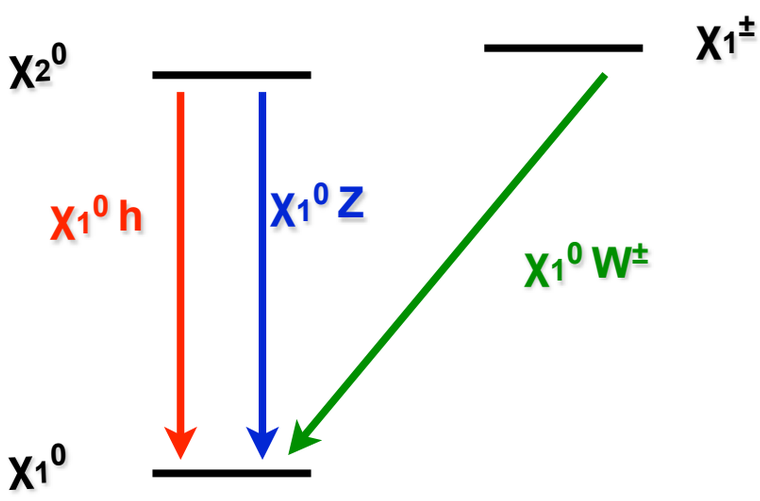


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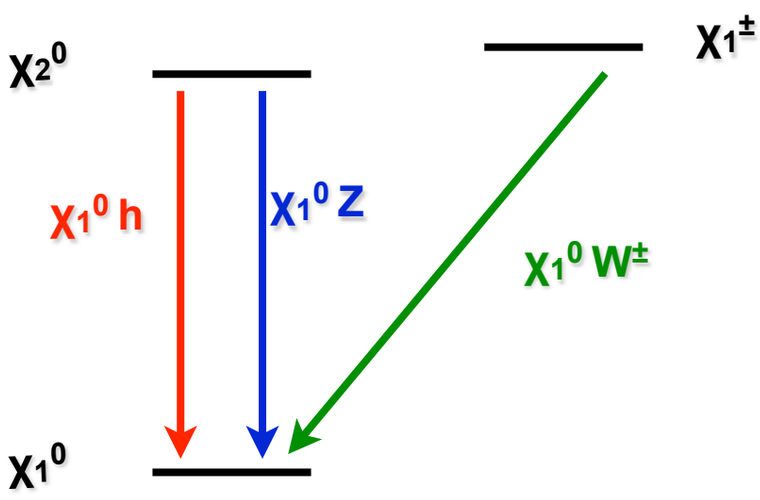


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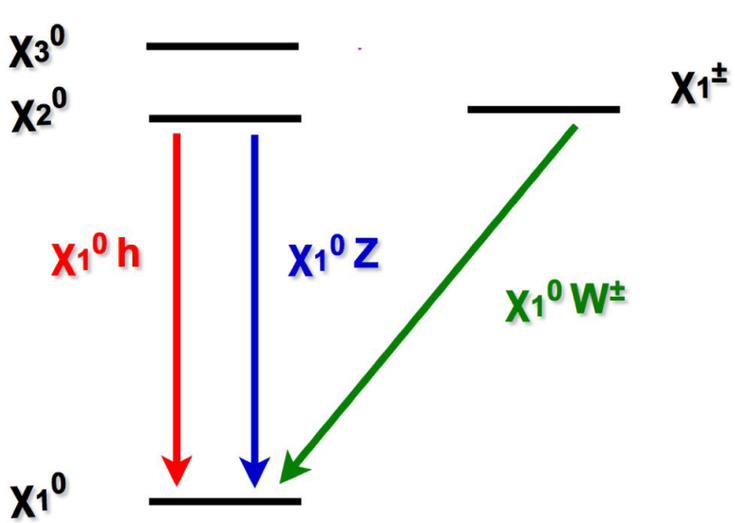


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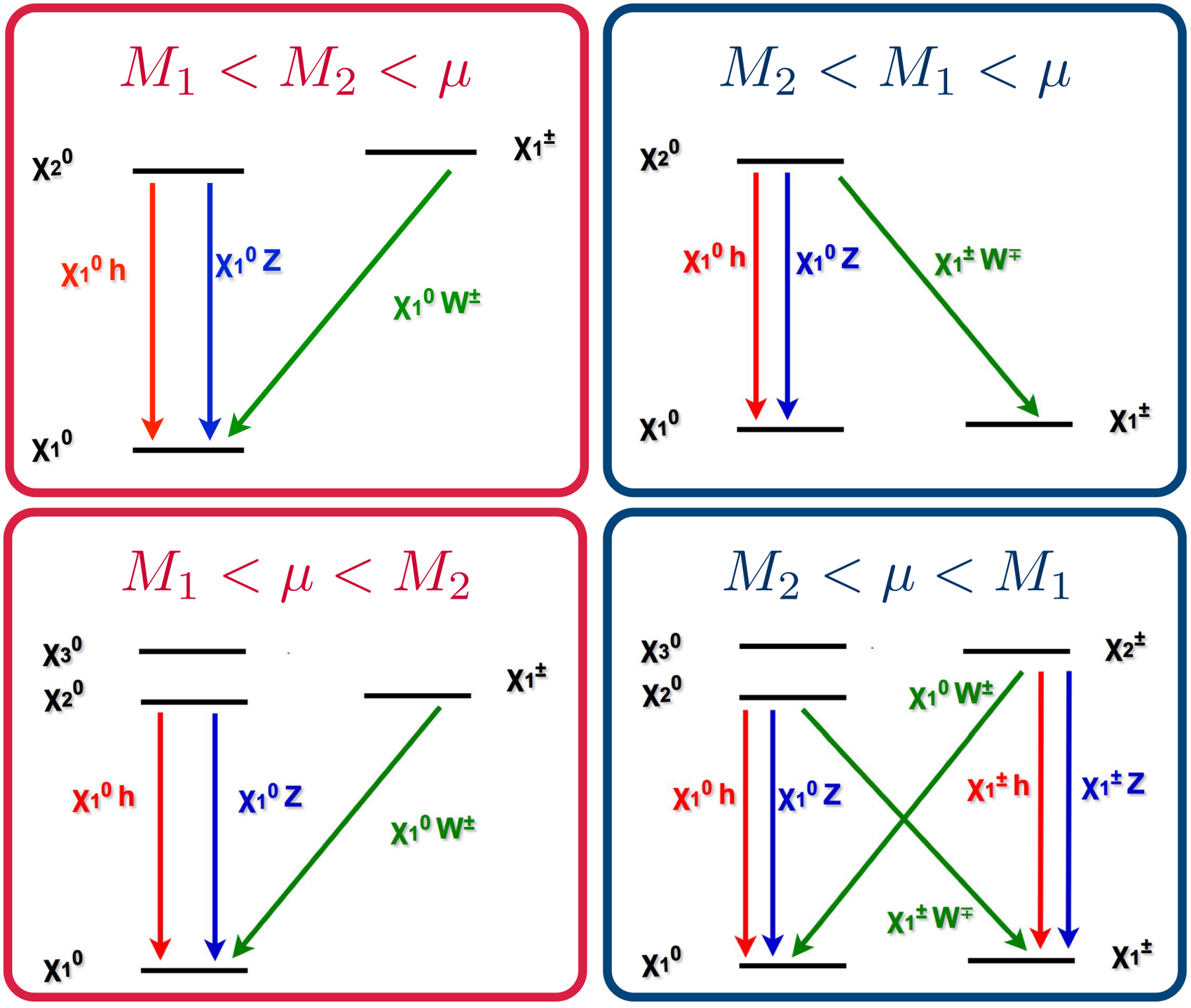

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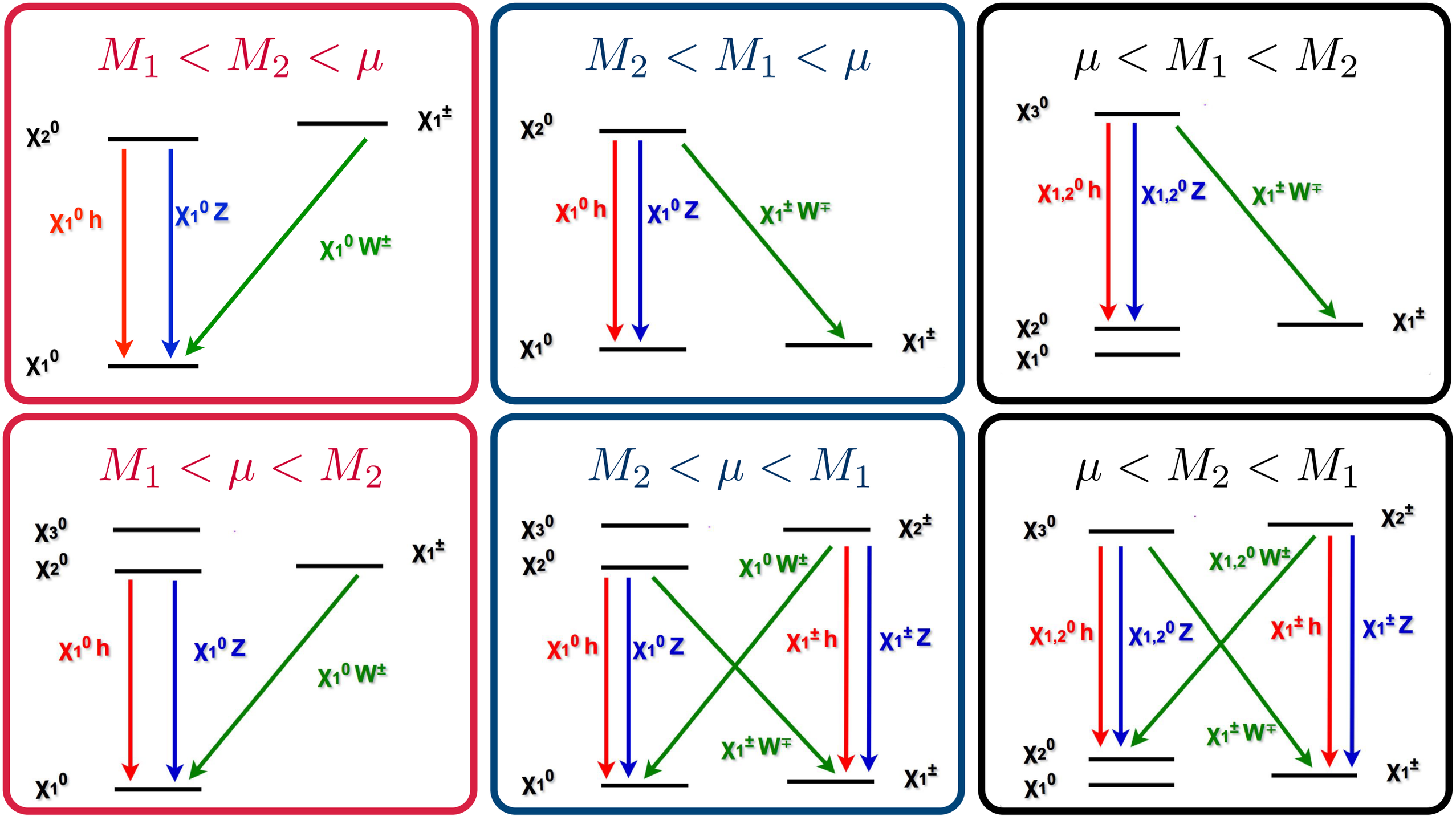

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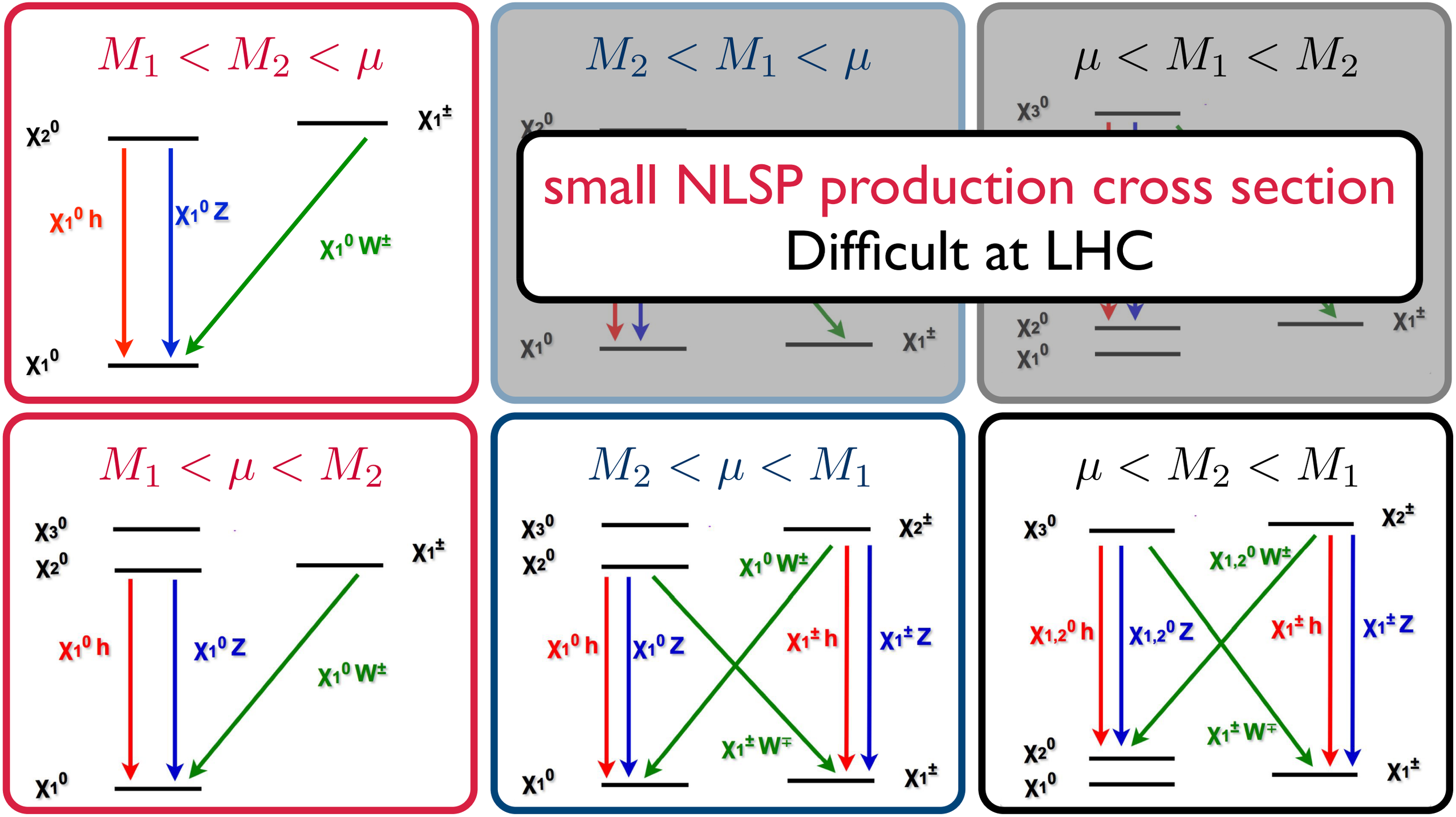


small NLSP production cross section

Difficult at LHC

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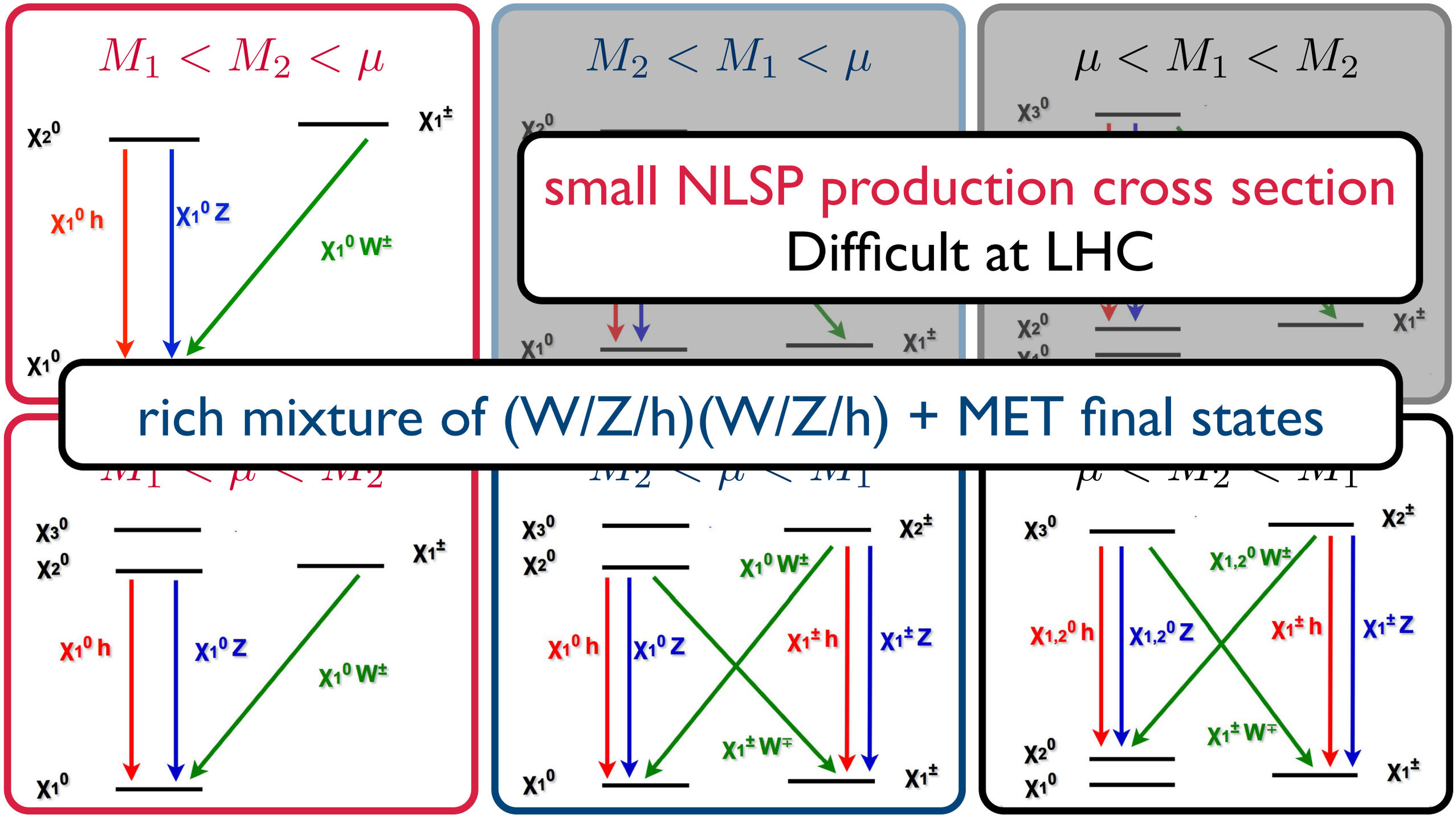


small NLSP production cross section

Difficult at LHC

rich mixture of (W/Z/h)(W/Z/h) + MET final states

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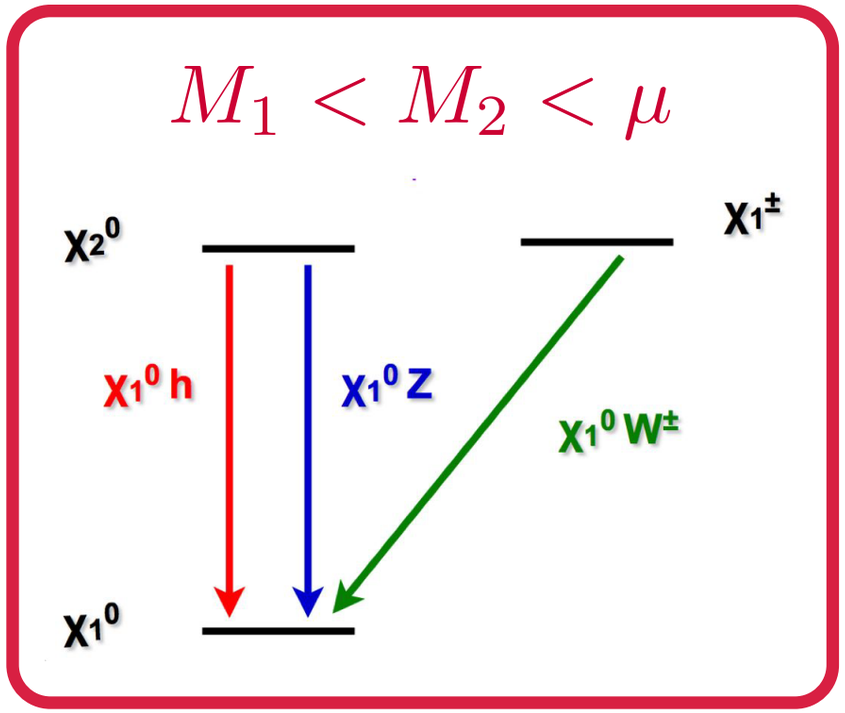

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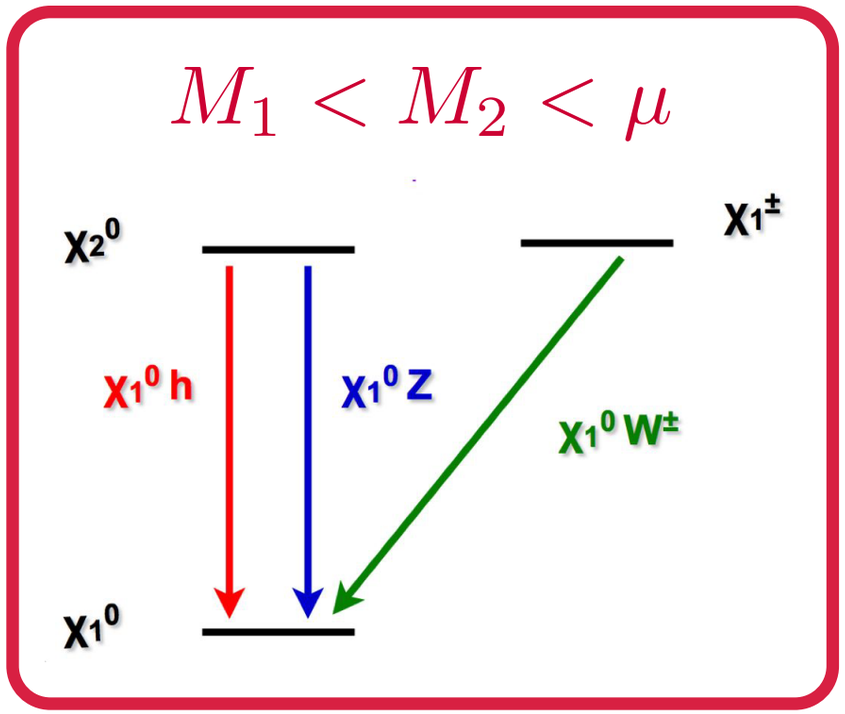


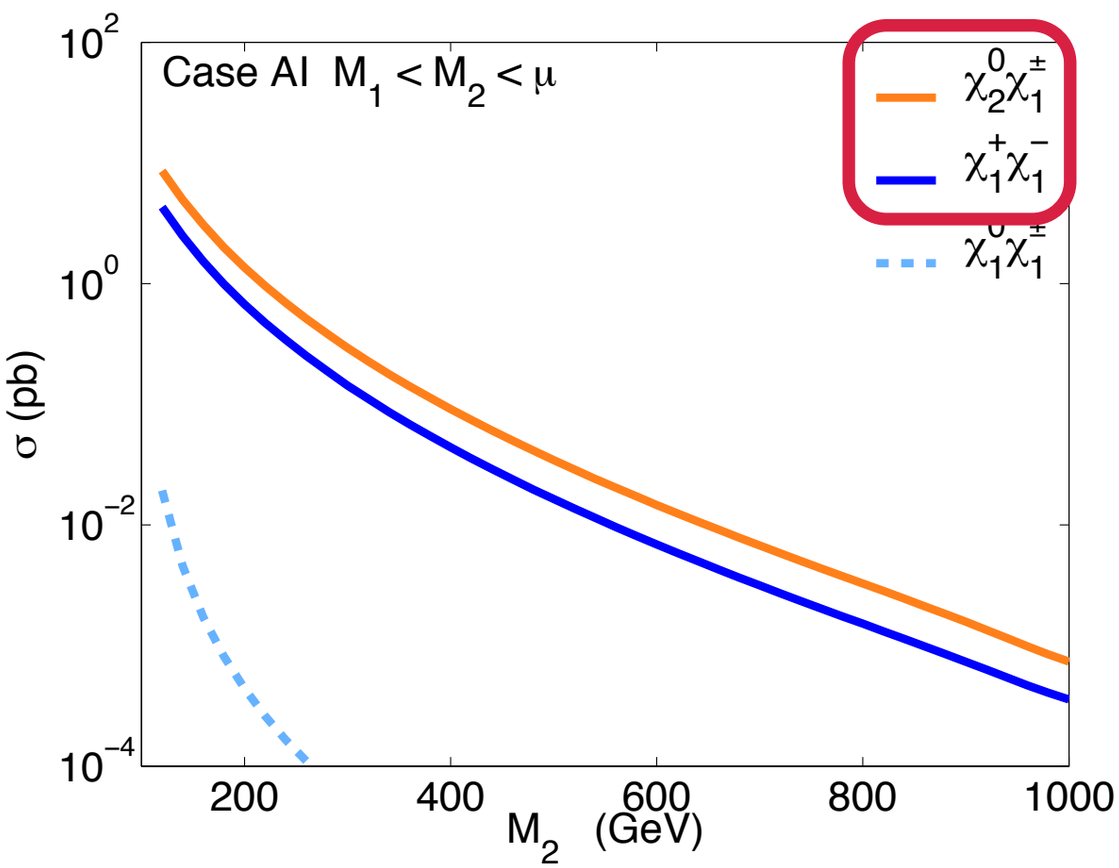


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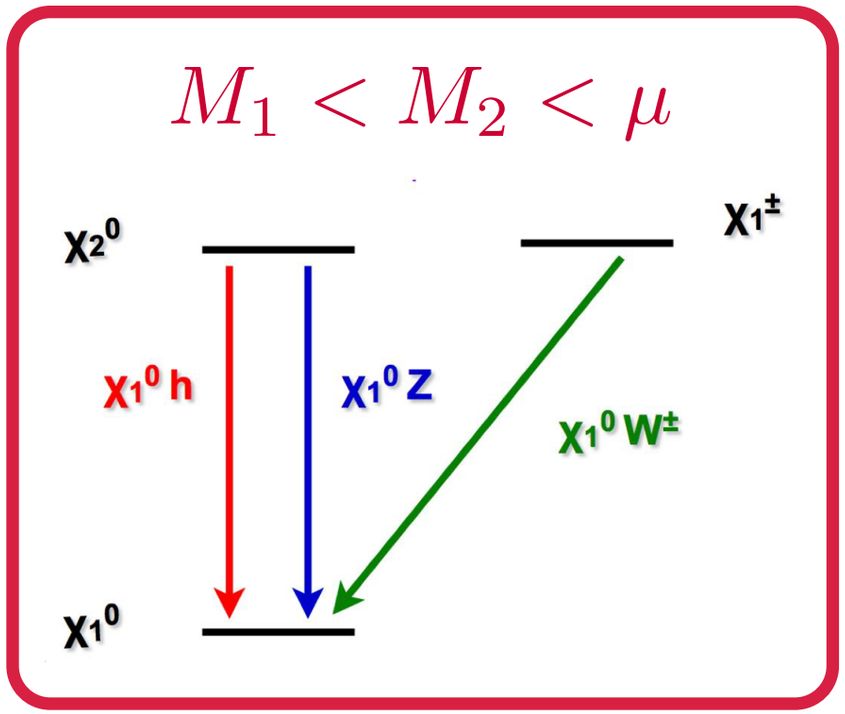


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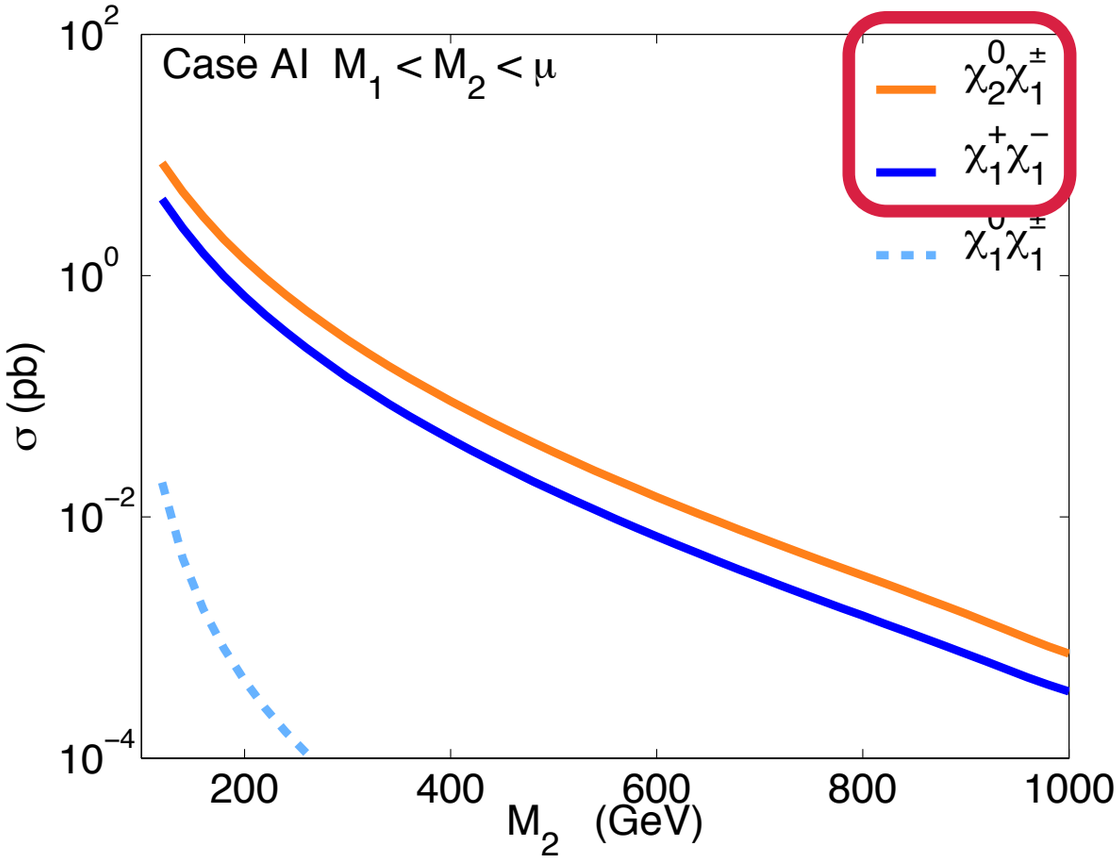
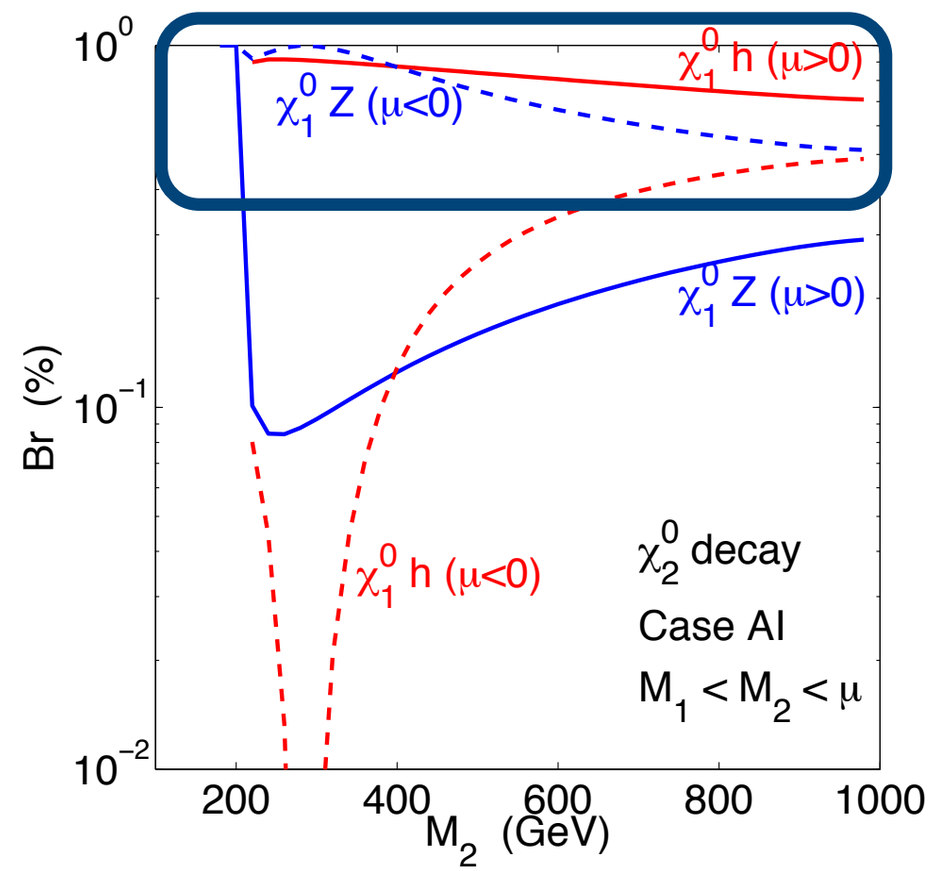
- for $\Delta m > m_h$: $\chi_1^0 h$-channel dominates



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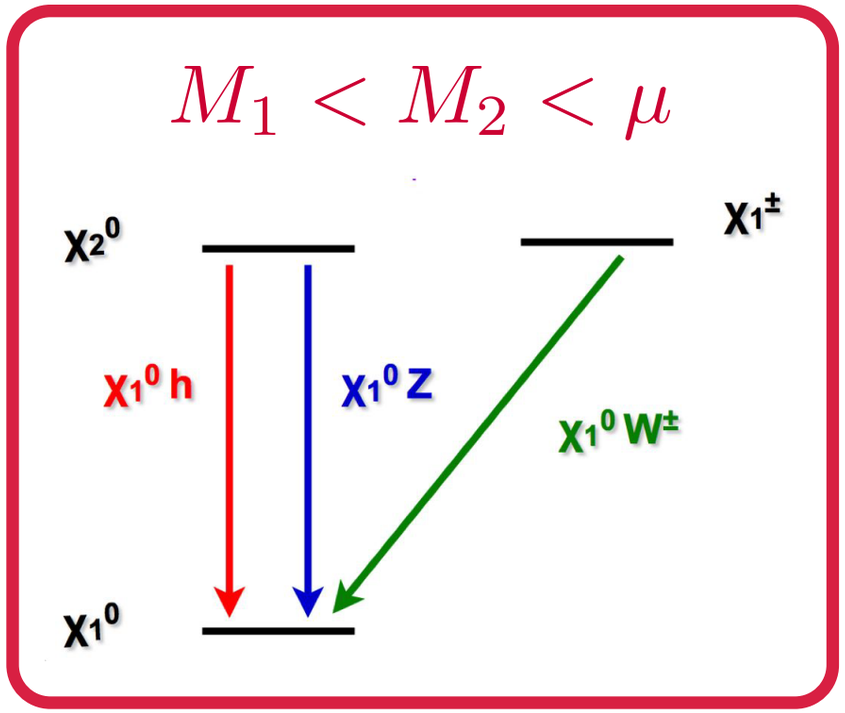


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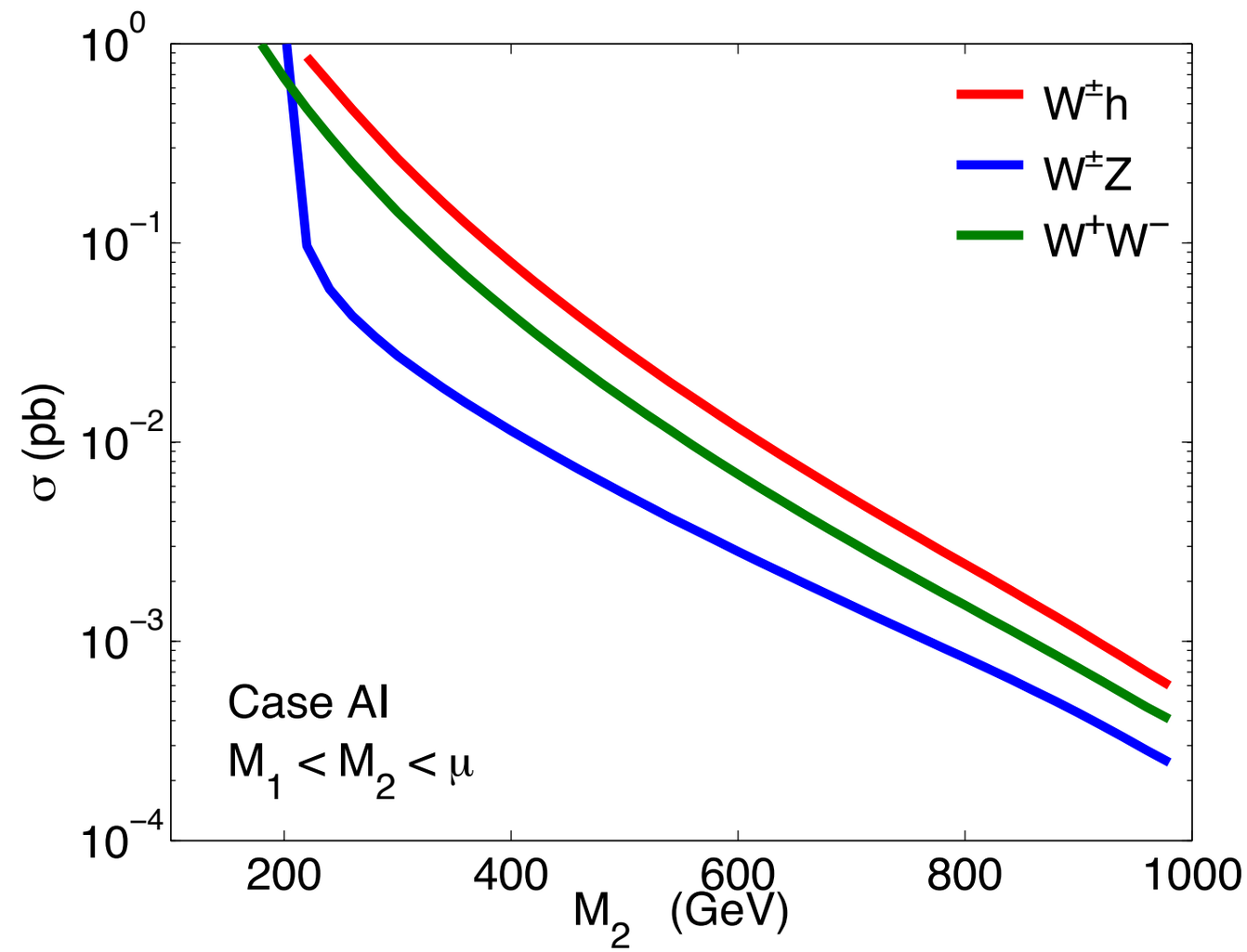
Wh final state dominates!



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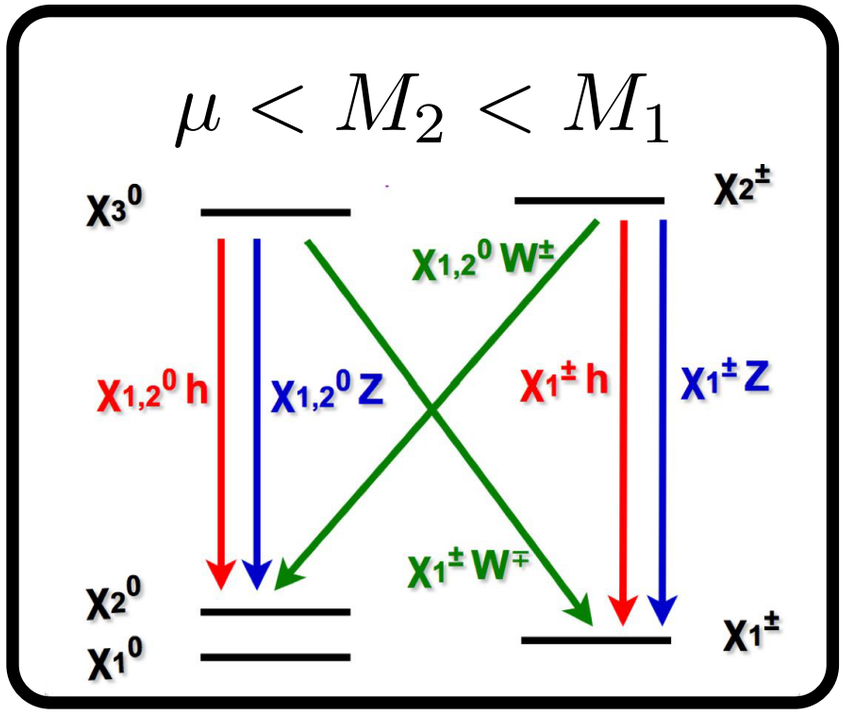

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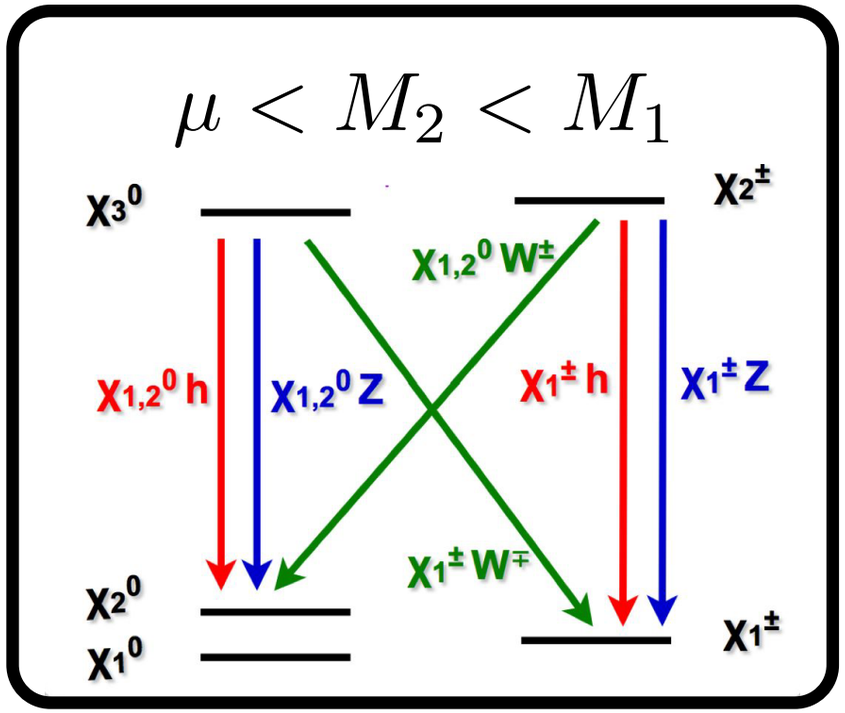


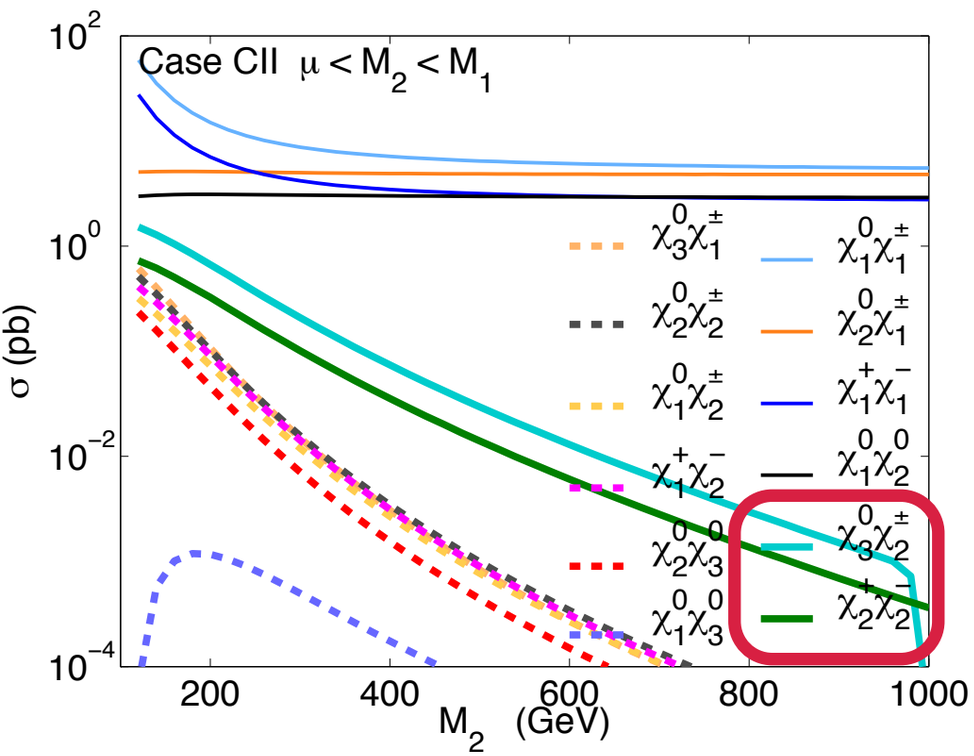


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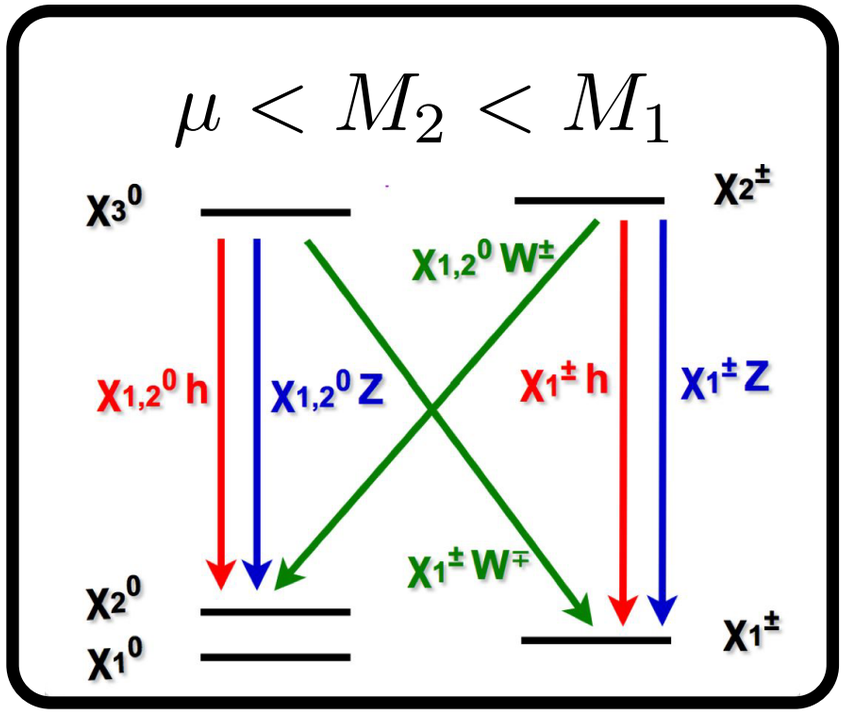


**Production:**

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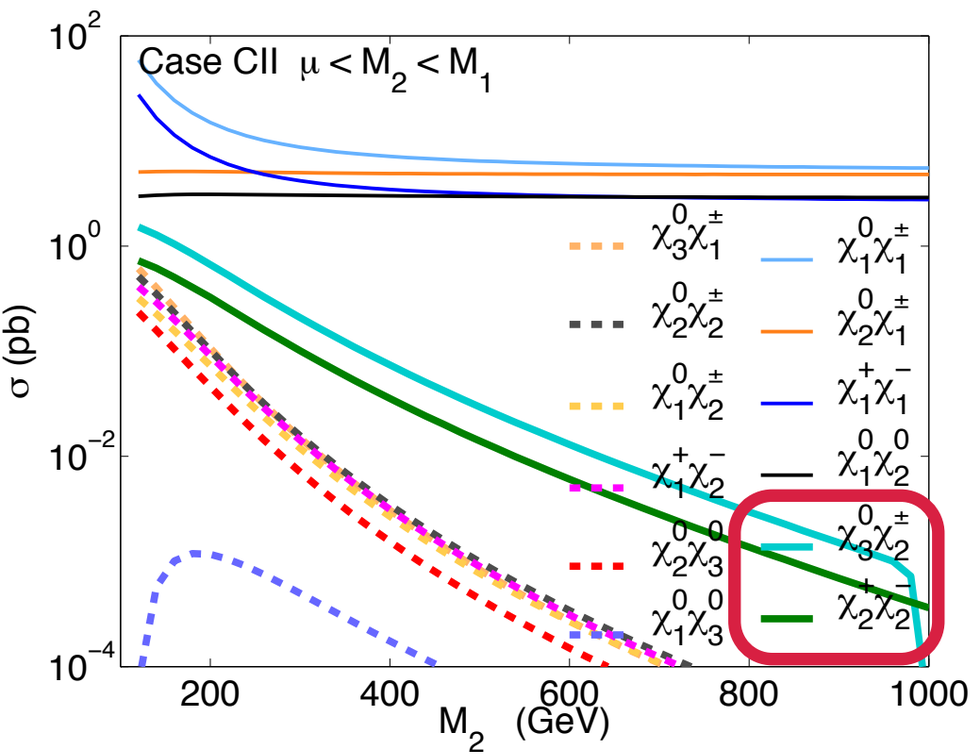
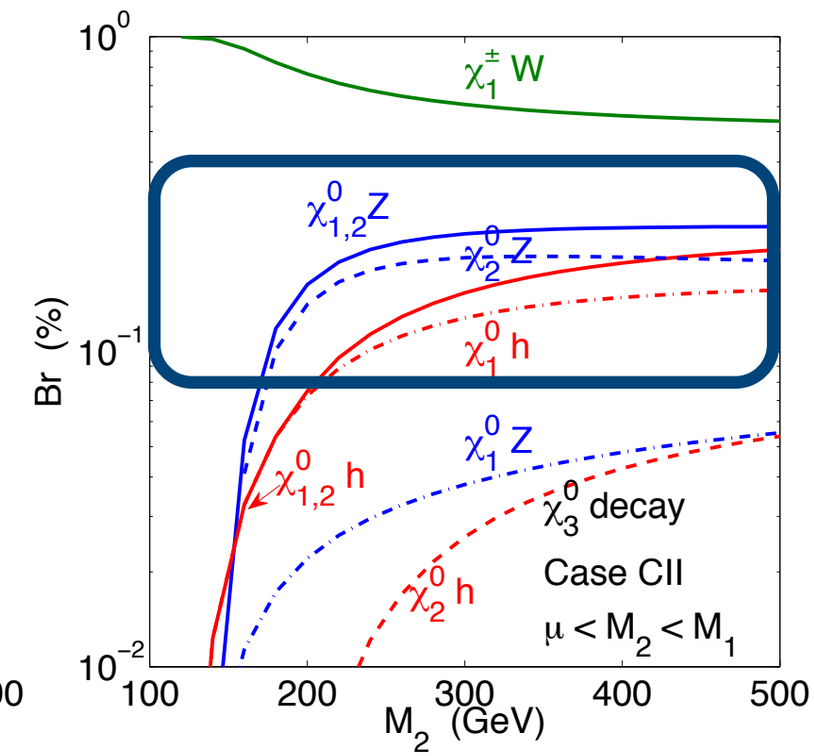
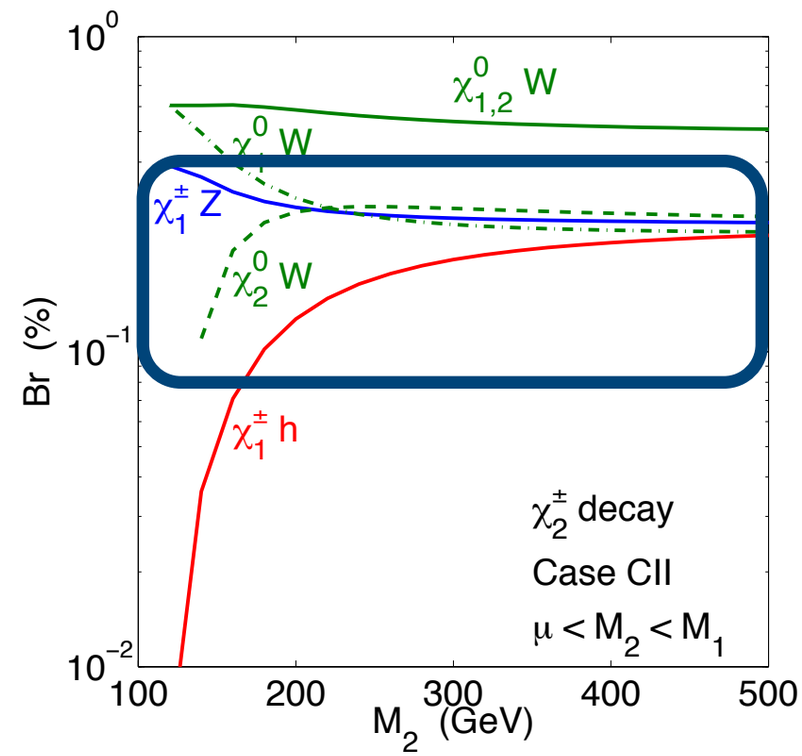
**Decay:**

- High W branching ratio
- h-channel can compete with Z-channel



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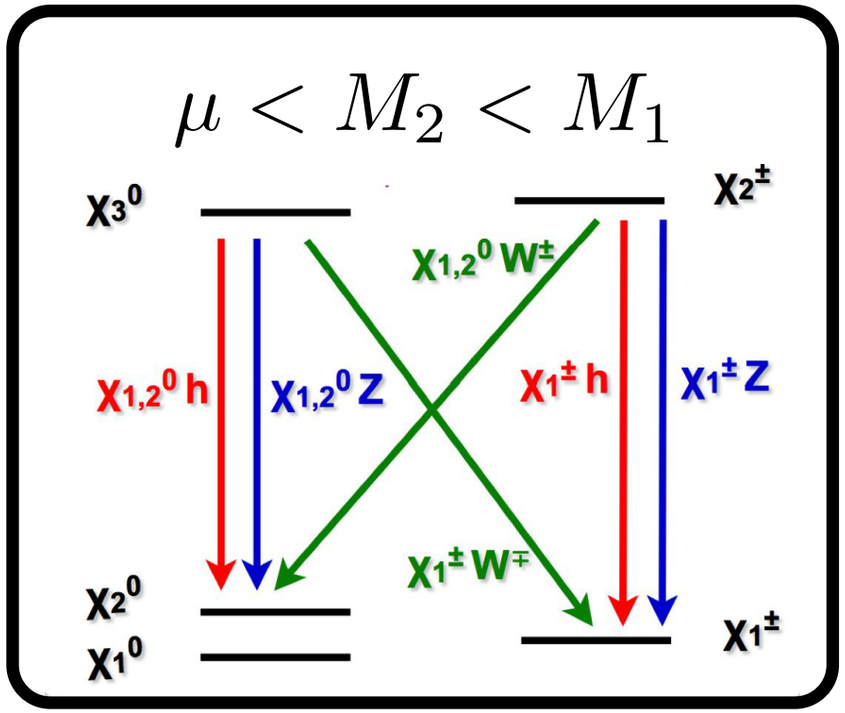


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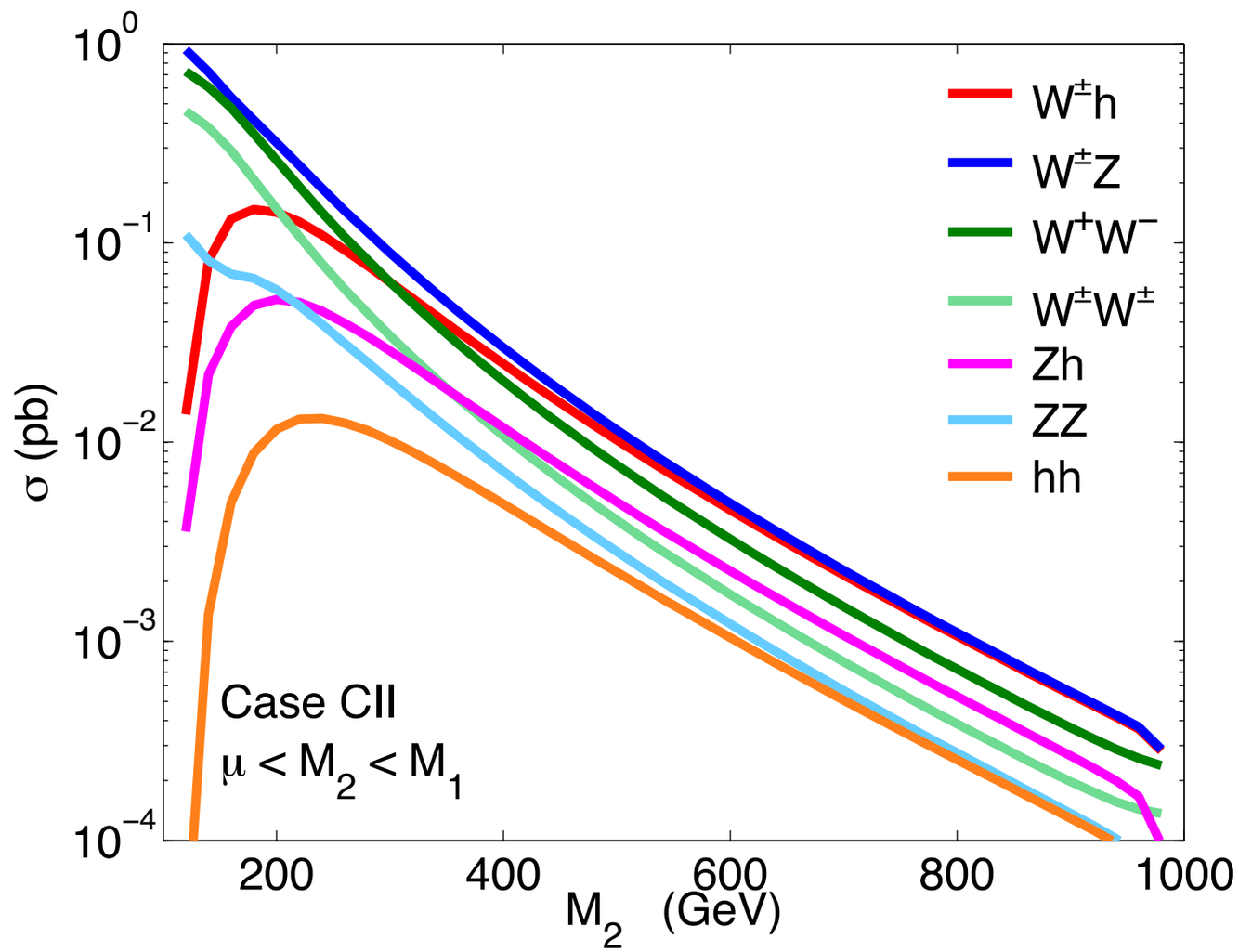
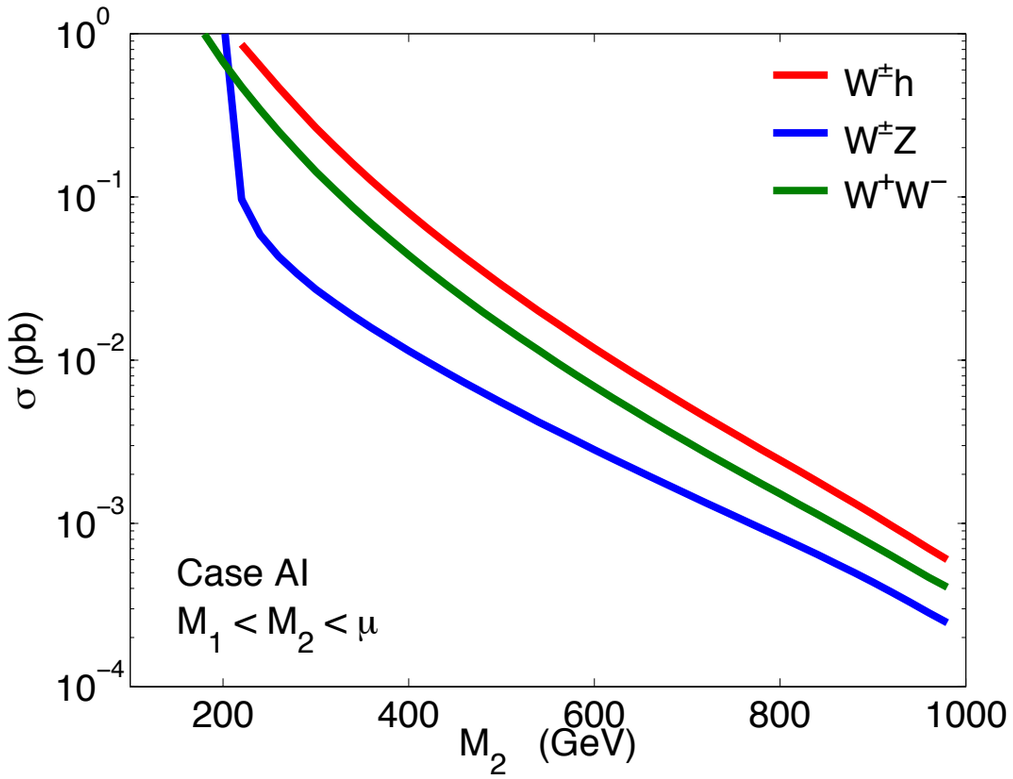
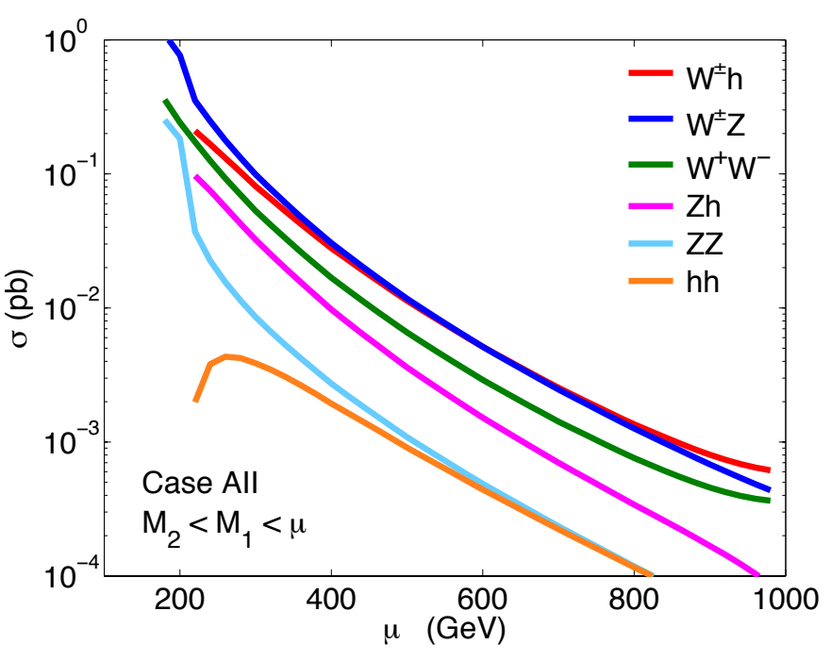
Wh copiously produced

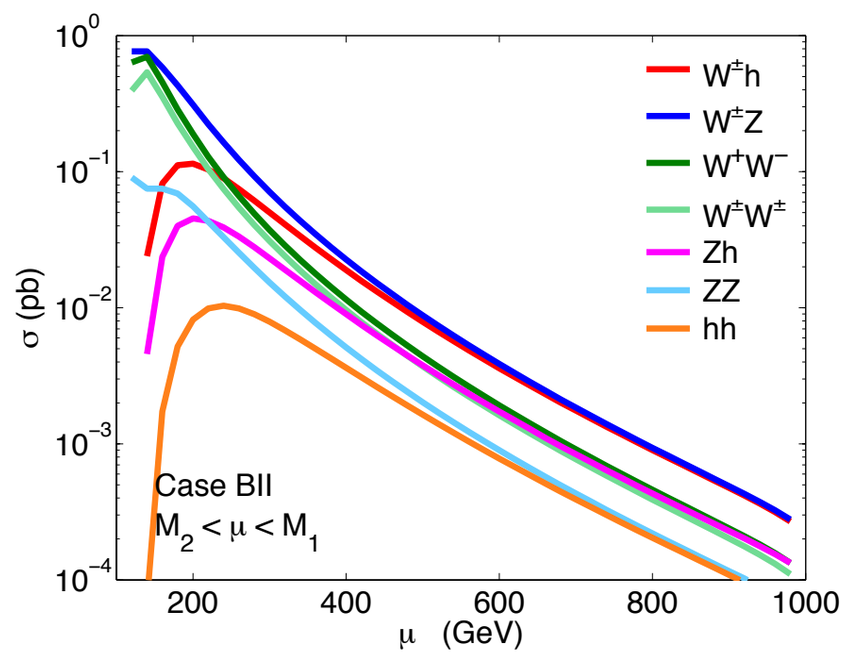


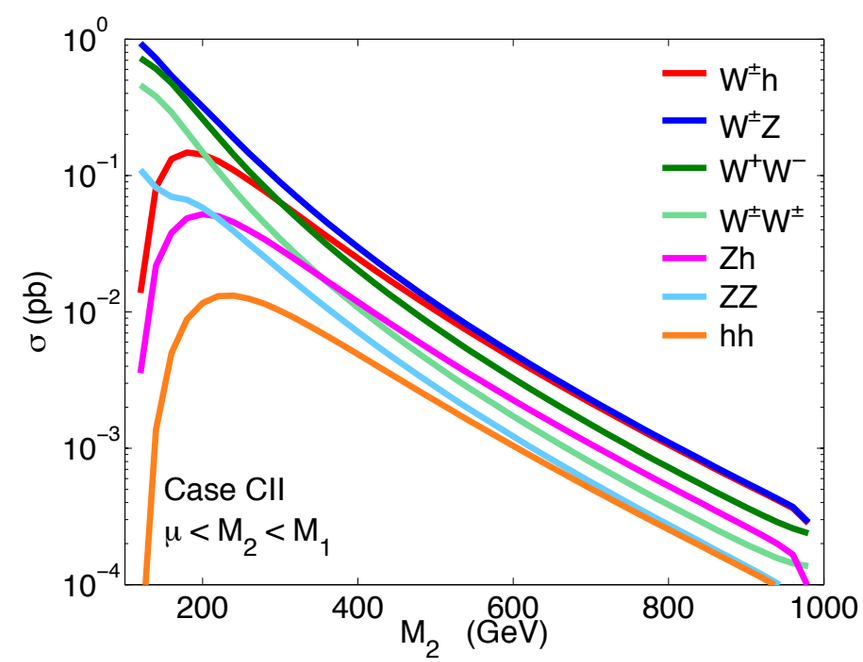
# Higgs Channels




- BR(WZ)<100%
  sometimes highly suppressed
- Wh complementary to WZ channel
  new discovery potential
- Zh could also be important
- hh usually small

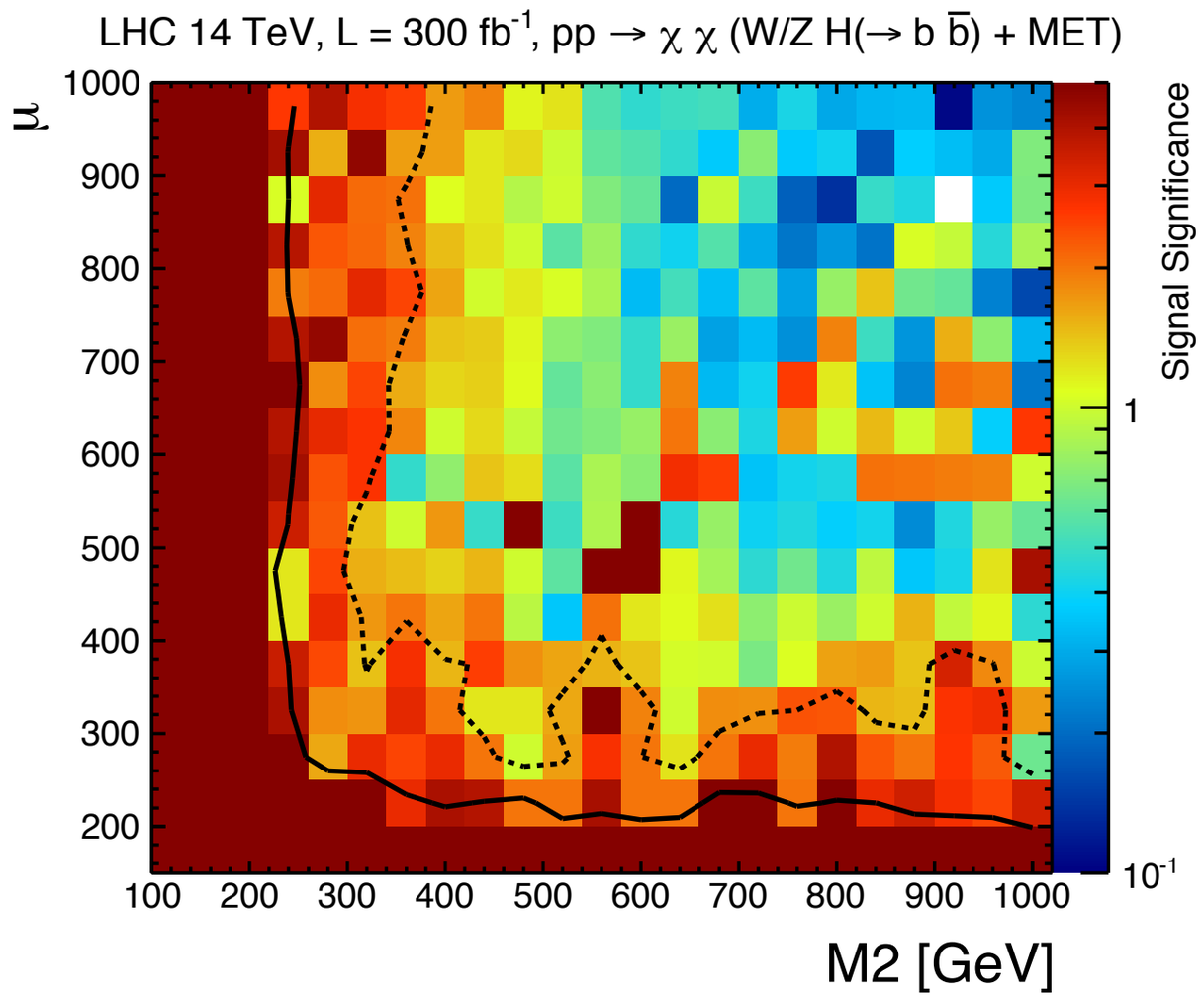


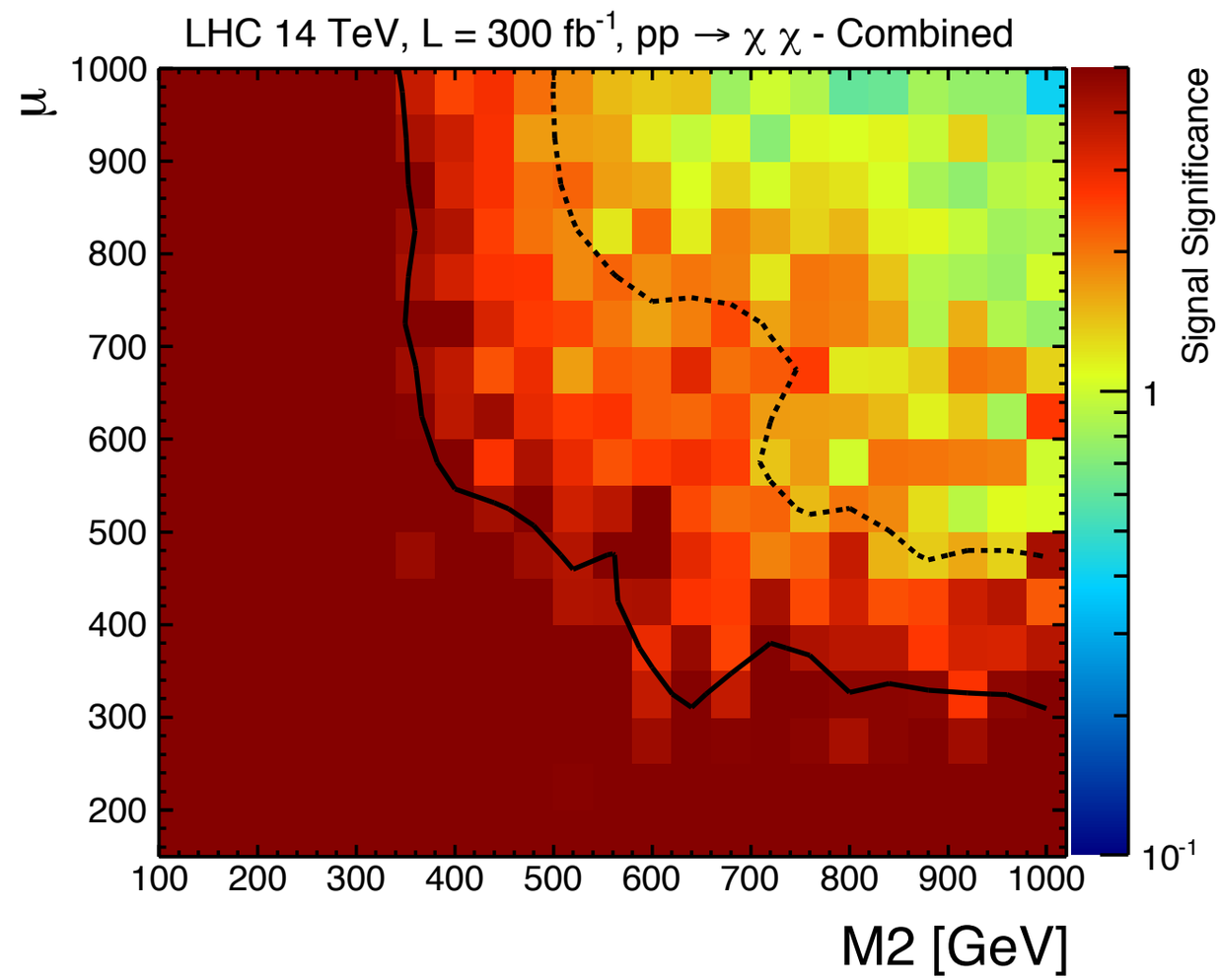



# Reach of Wh/Zh Search

## Wh+Zh-channel




## All channels combined




For details of analysis see: [arXiv:1404.0682]

Unique Signal

Wh/Zh complementary to WZ/ZZ

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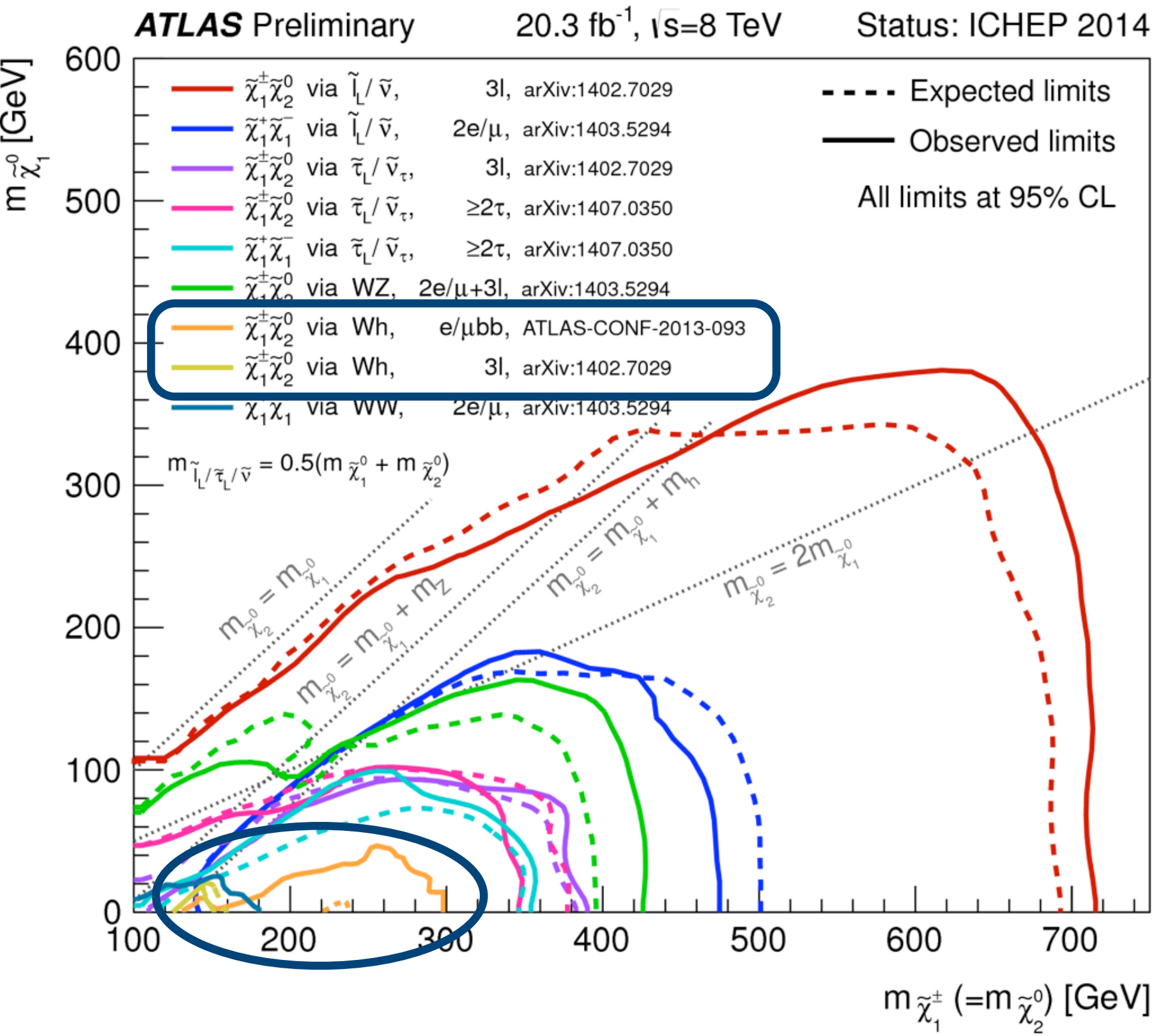


Current Limits

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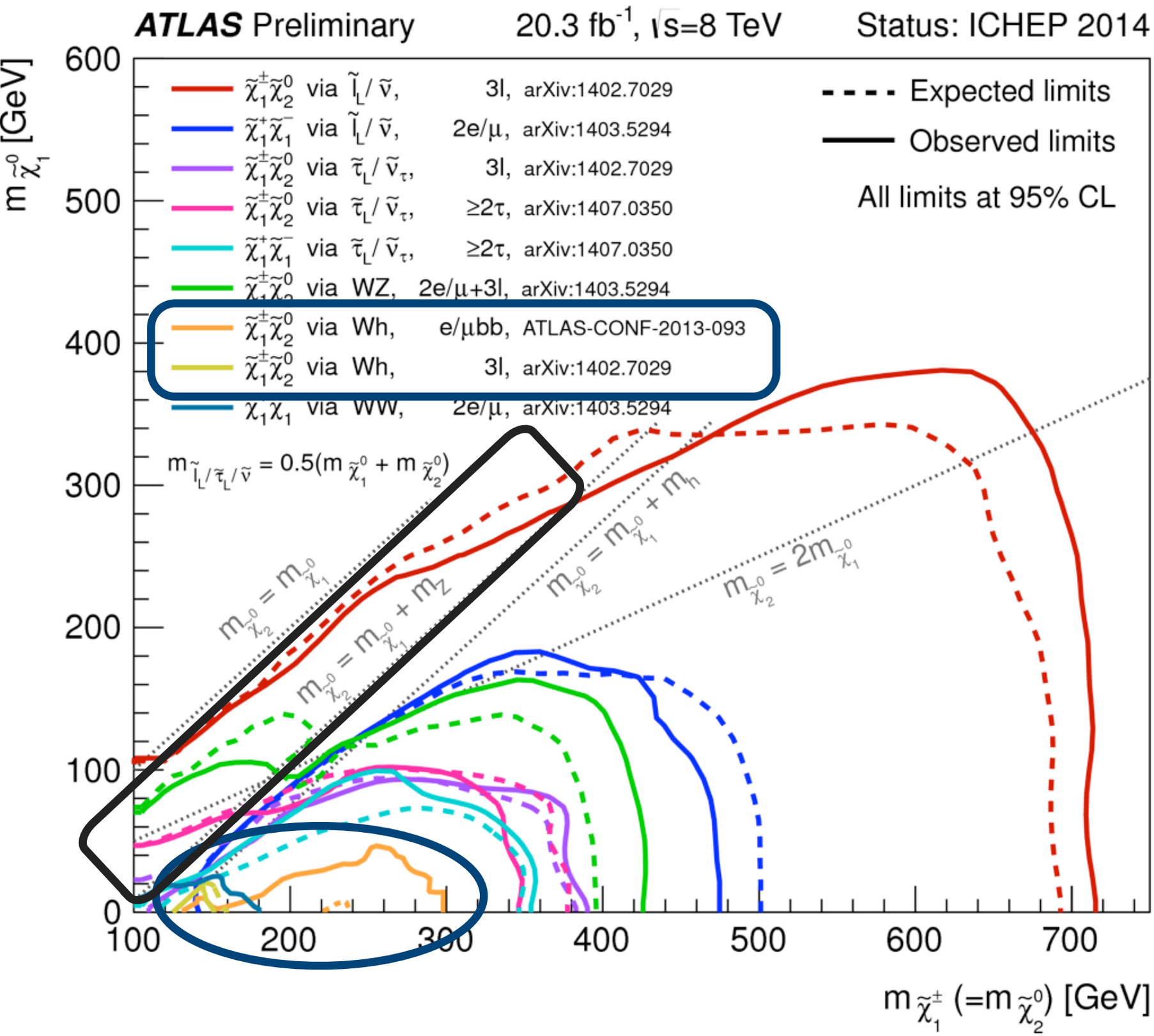


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compressed spectrum

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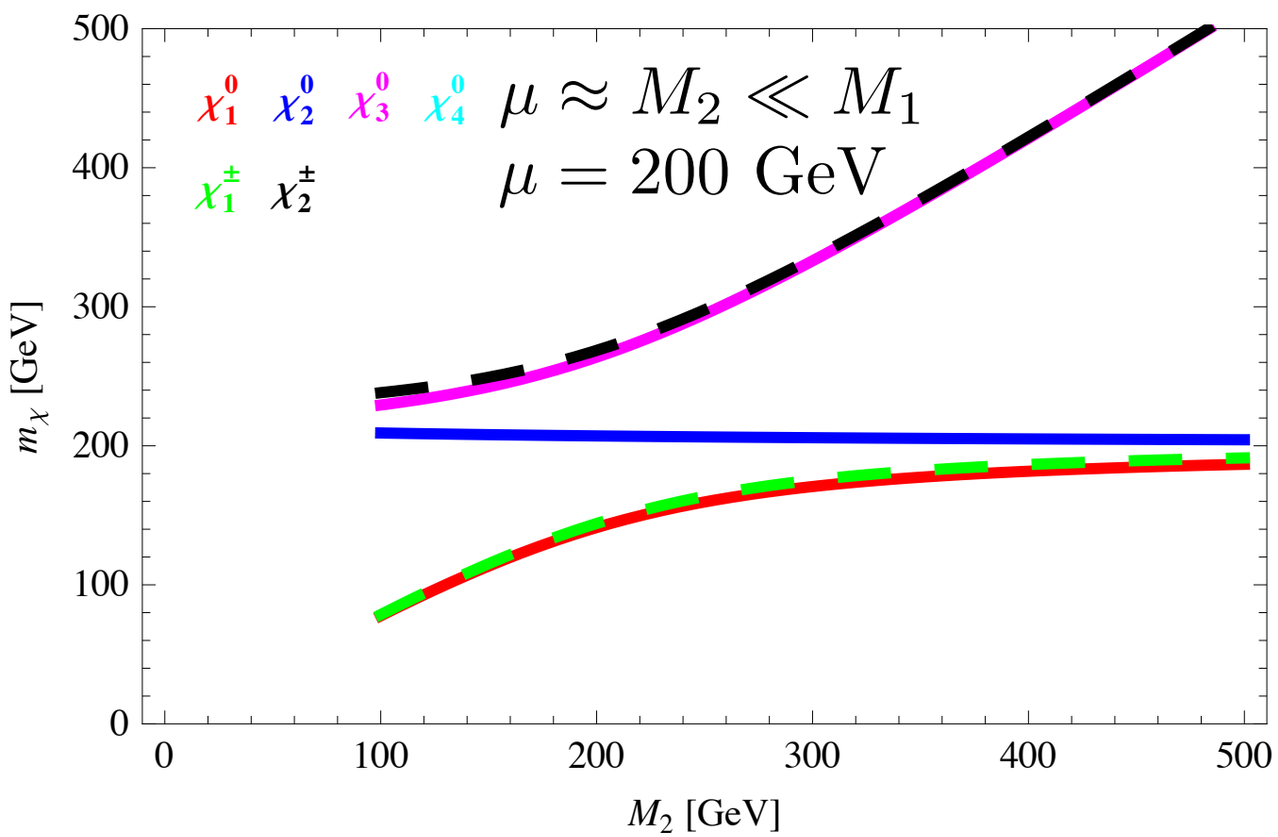

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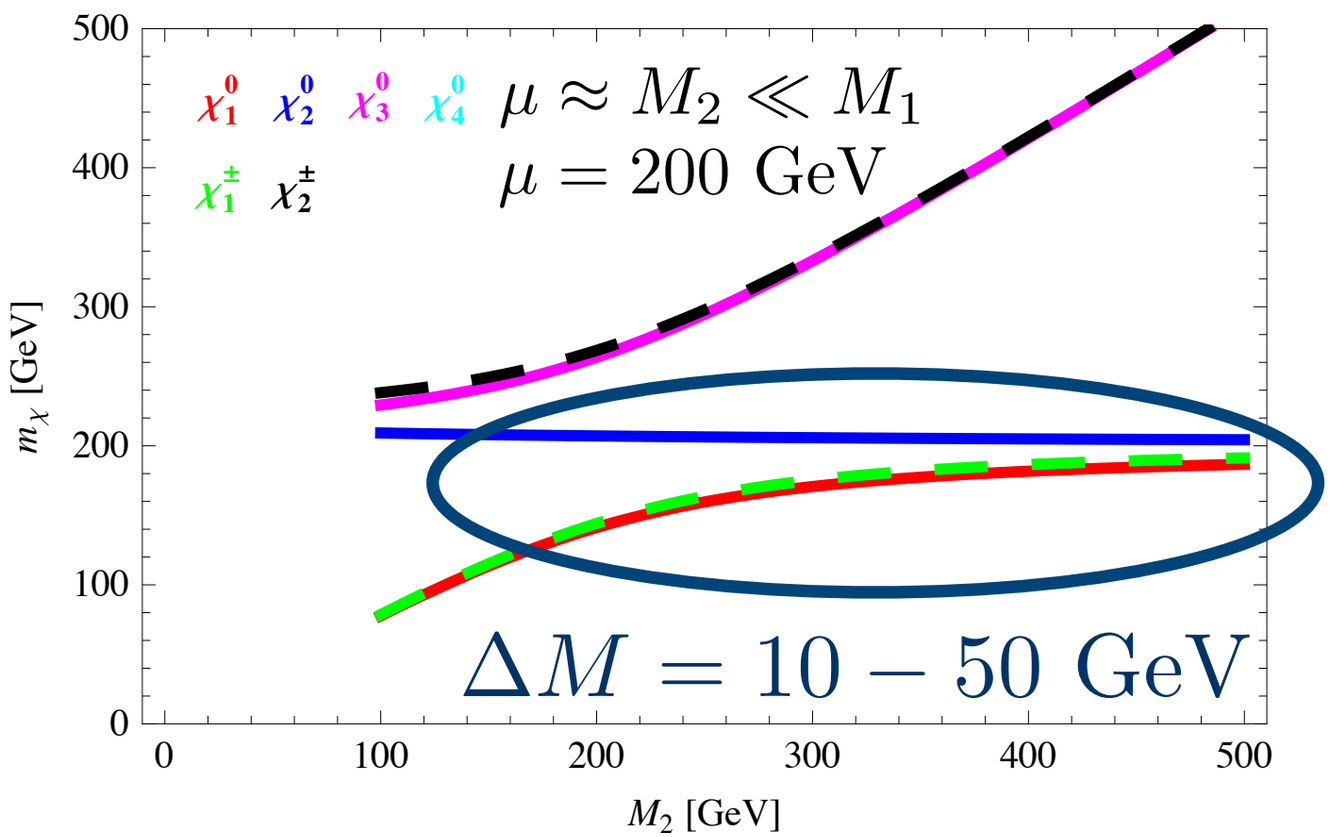

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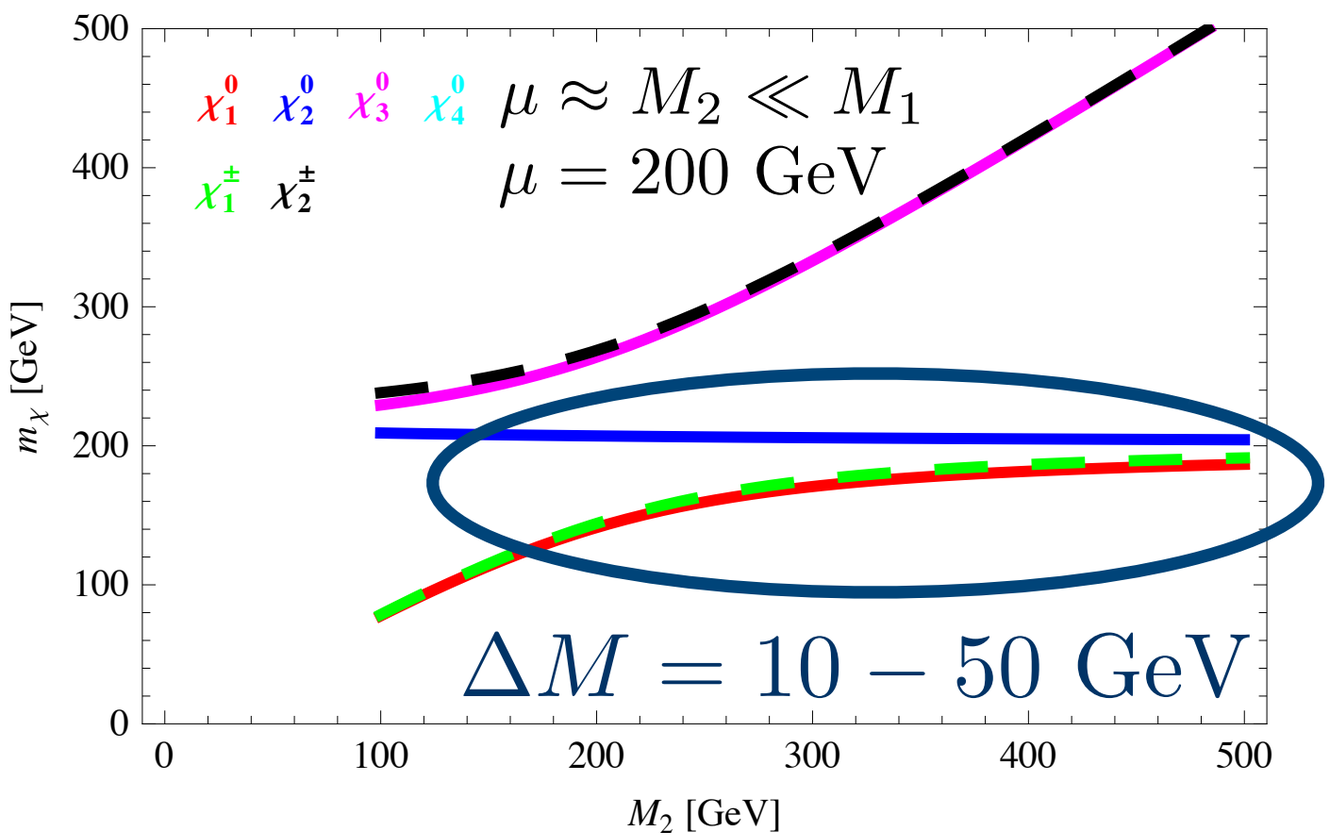


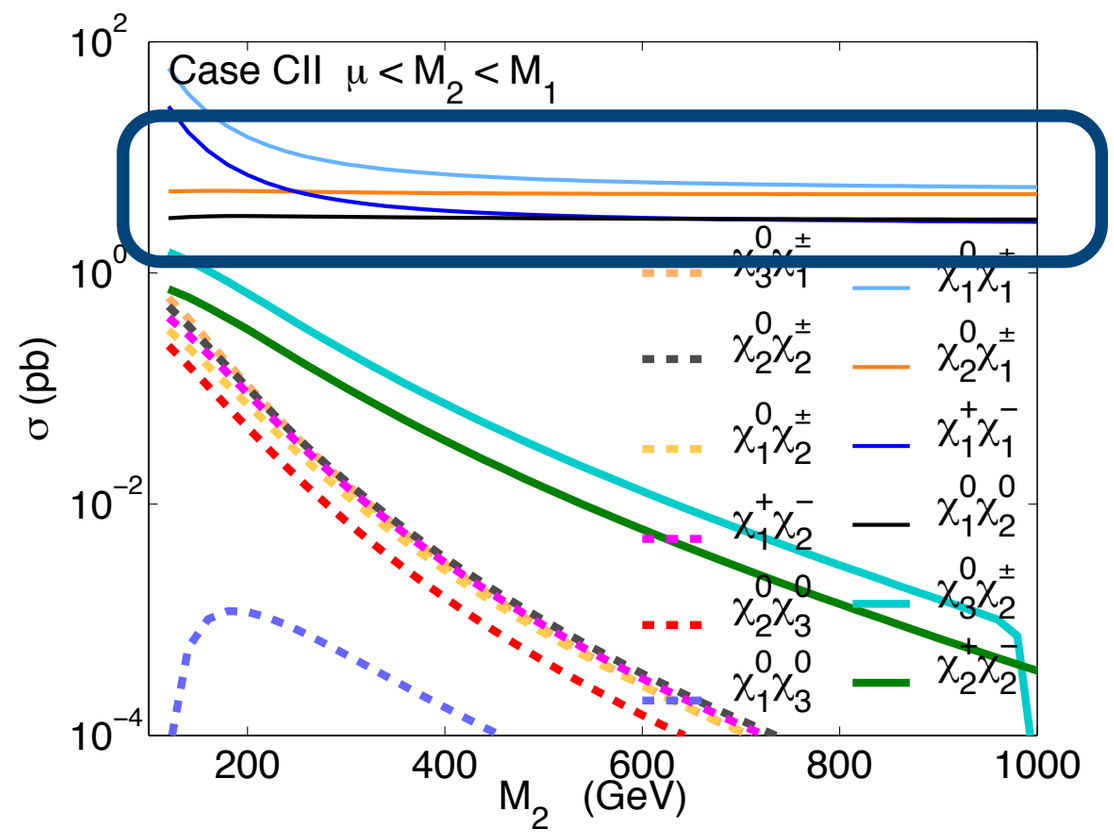


cross section is large

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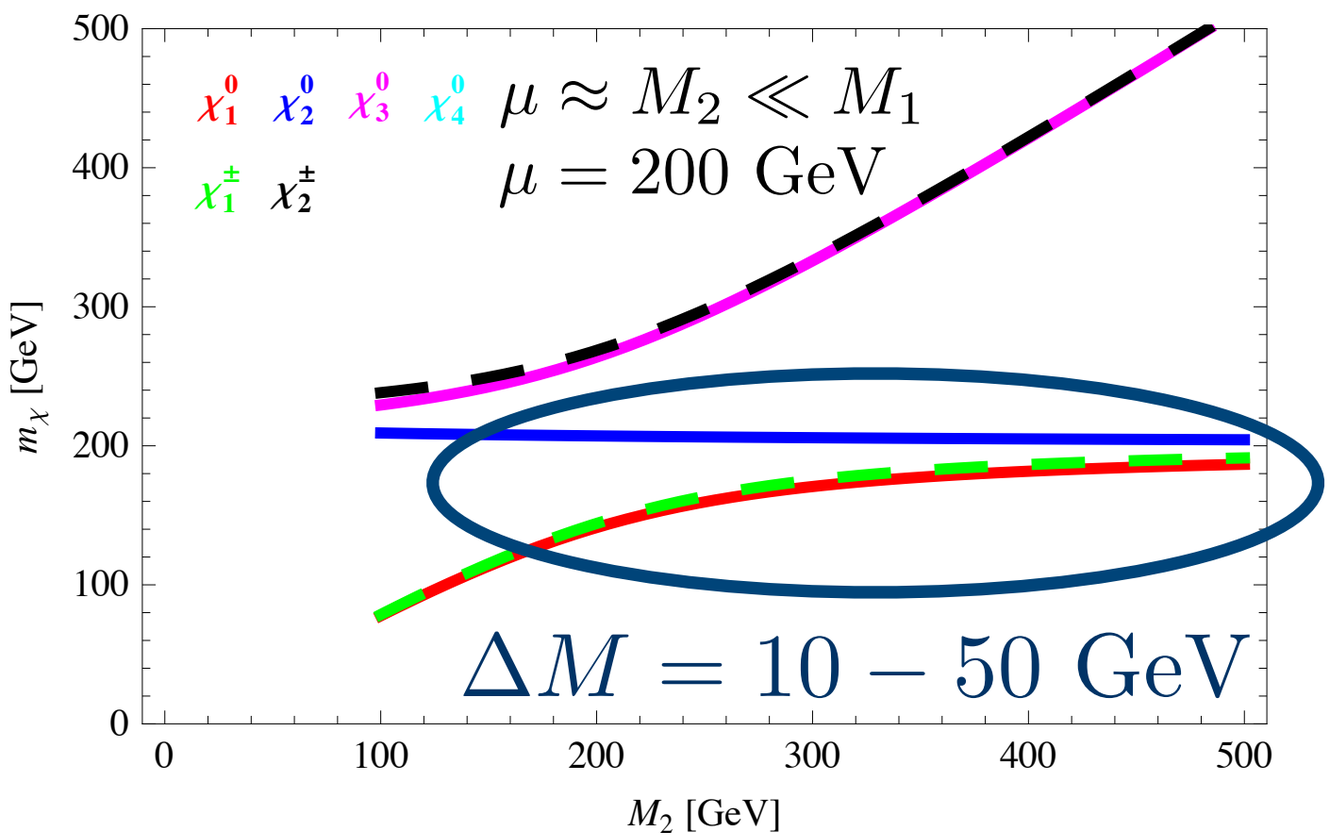


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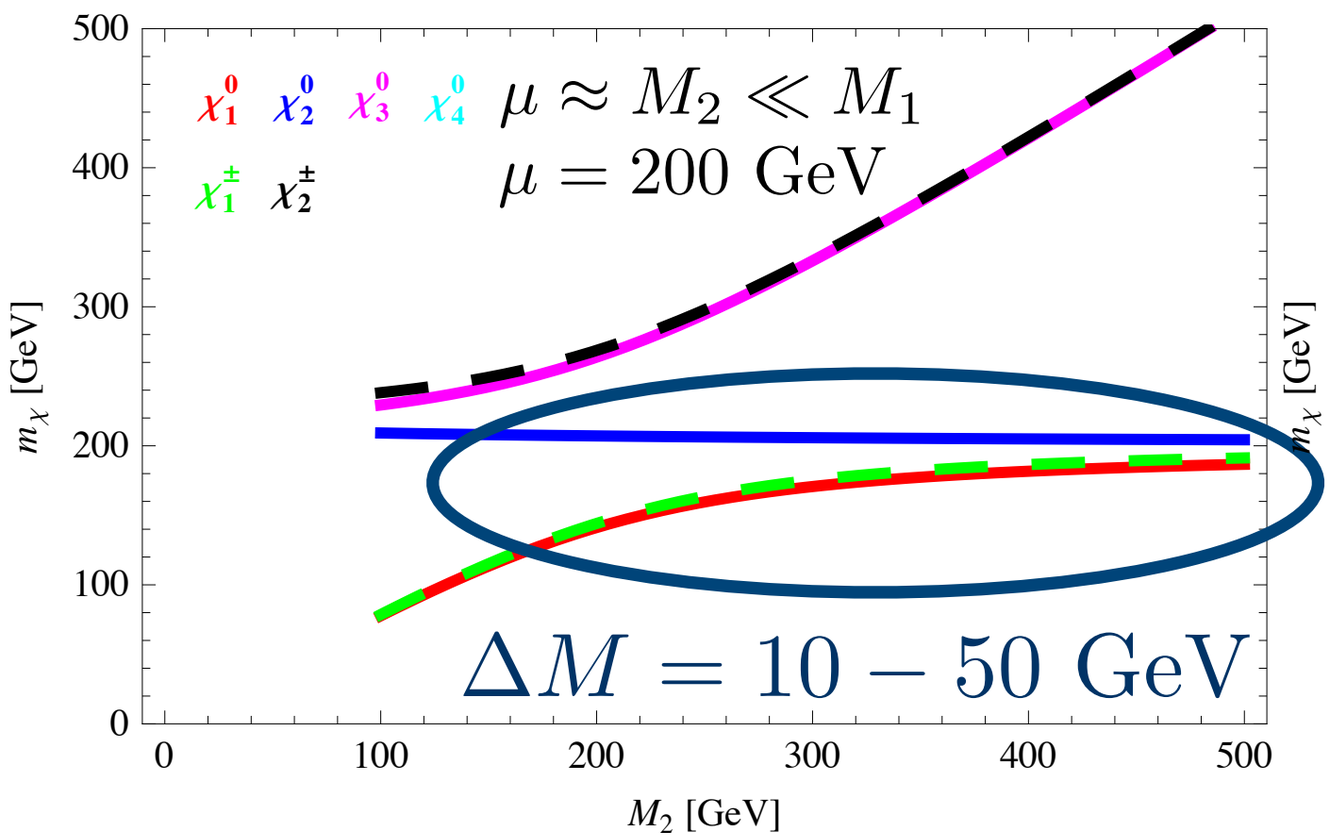
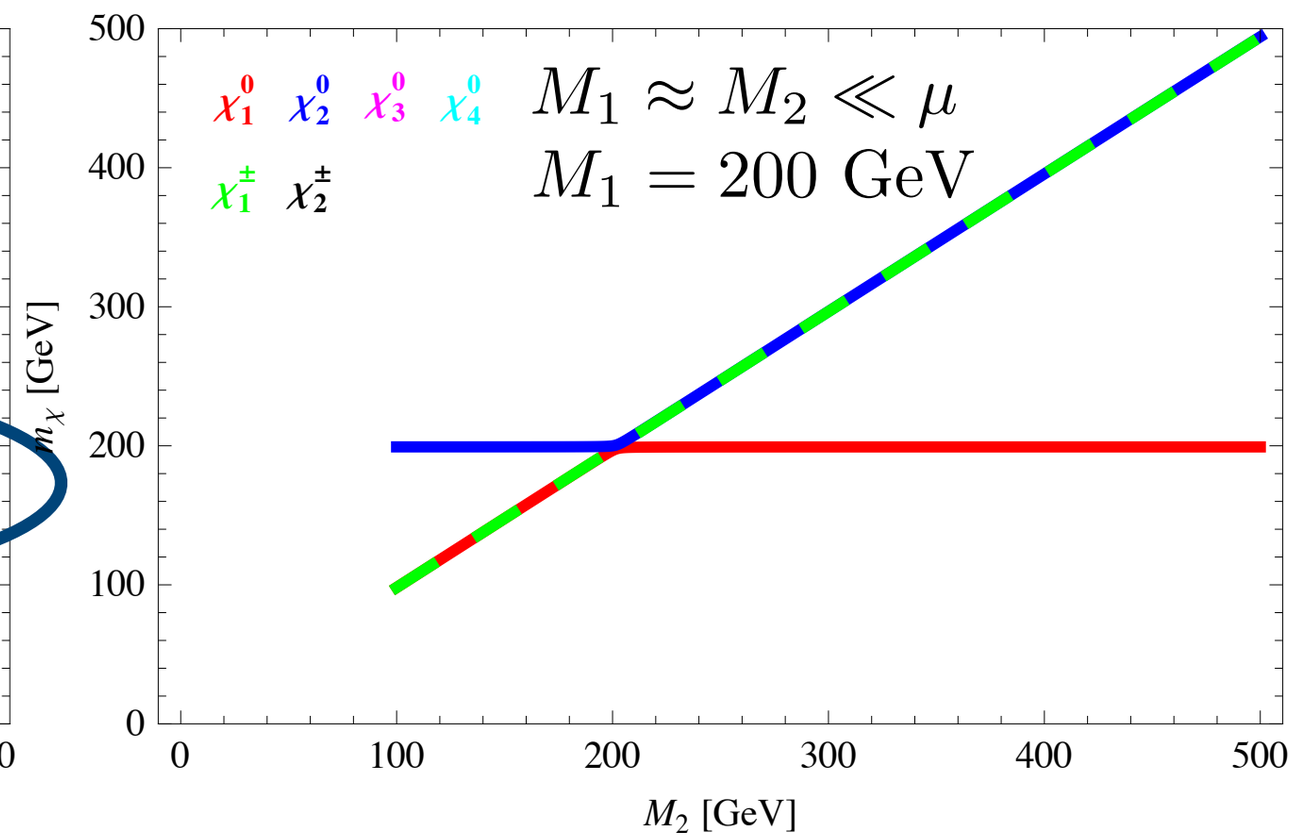


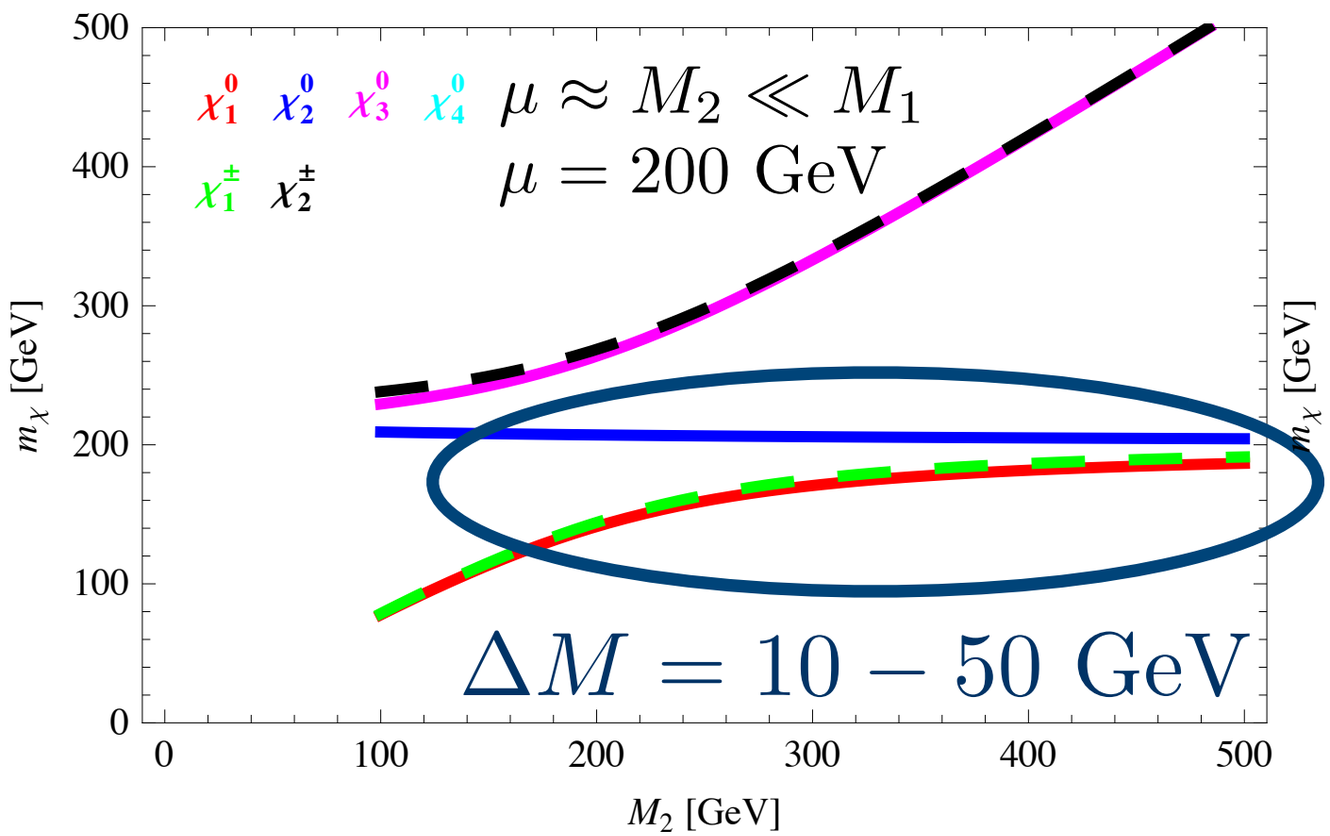

cross section is large

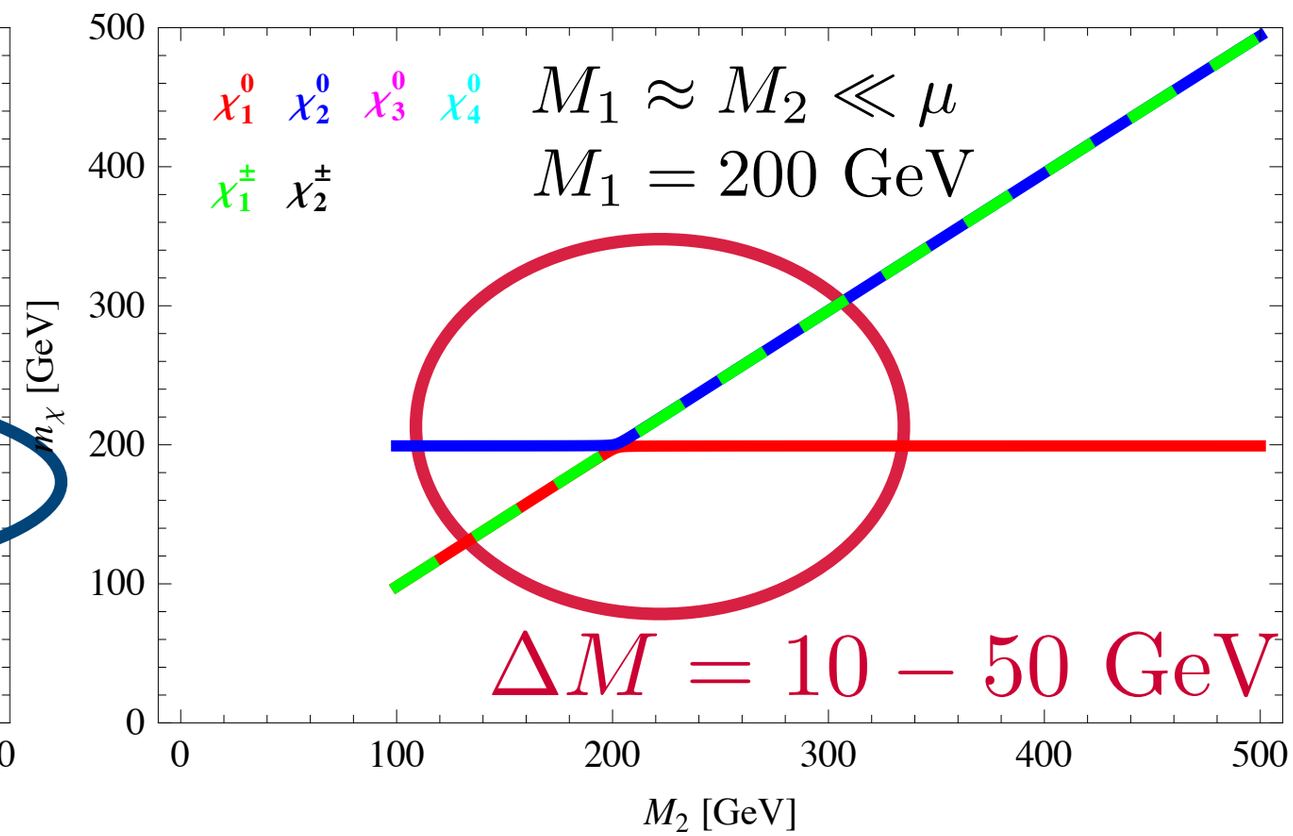
# Compressed Spectrum

## Motivation

- Wino or Higgsino LSP: $m_{\chi_1^\pm} - m_{\chi_1^0} \approx 5 - 30 \text{ GeV}$
- SUSY models with correct density of dark matter

  Bino/Wino or Bino/Higgsino are degenerate: $M_1 \approx M_2$ or $M_1 \approx \mu$

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# Compressed Spectrum

## Search Channels

Monojet + MET

[1004.4902, 1307.5952, 1404.0682]

VBF + MET

[1004.4902, 1308.0335]

absence of hard leptons

model independent

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## Search becomes challenging for small mass splitting

→ Next talks

- Liantao Wang: Dark Matter, WIMPS or Axions
- Bashkar Dutta: Vector Boson production associated with new physics

# Conclusion

## Current searches are limited:

- sleptons might be heavy
- BR(WW,WZ) < 100%
- compressed spectrum

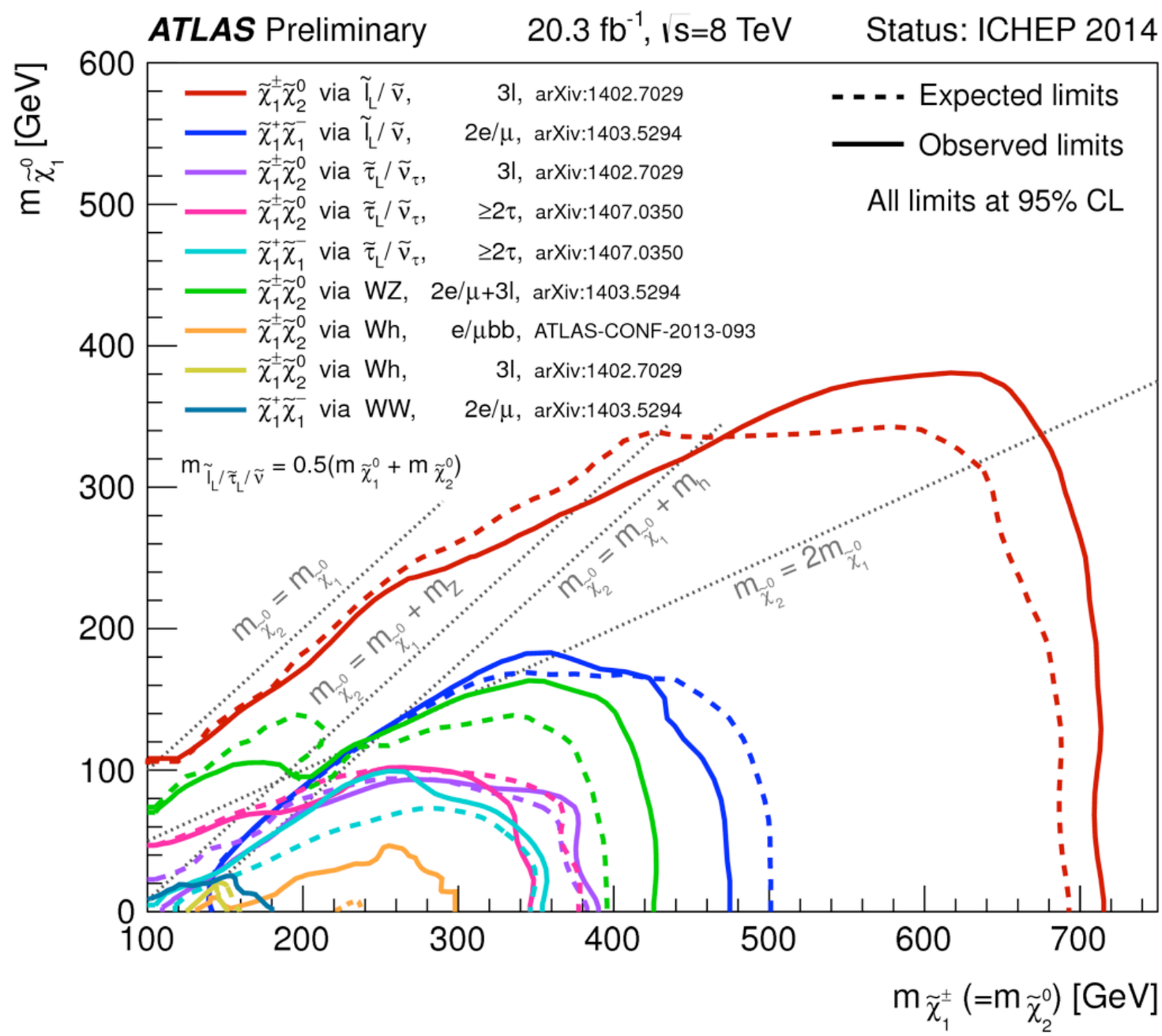
## Different possible decays

- rich mixture of (W/Z/h)(W/Z/h) + MET final states!
- Wh can be dominant

→ WZ limits weakend

→ new discovery potential

## Compressed Spectrum



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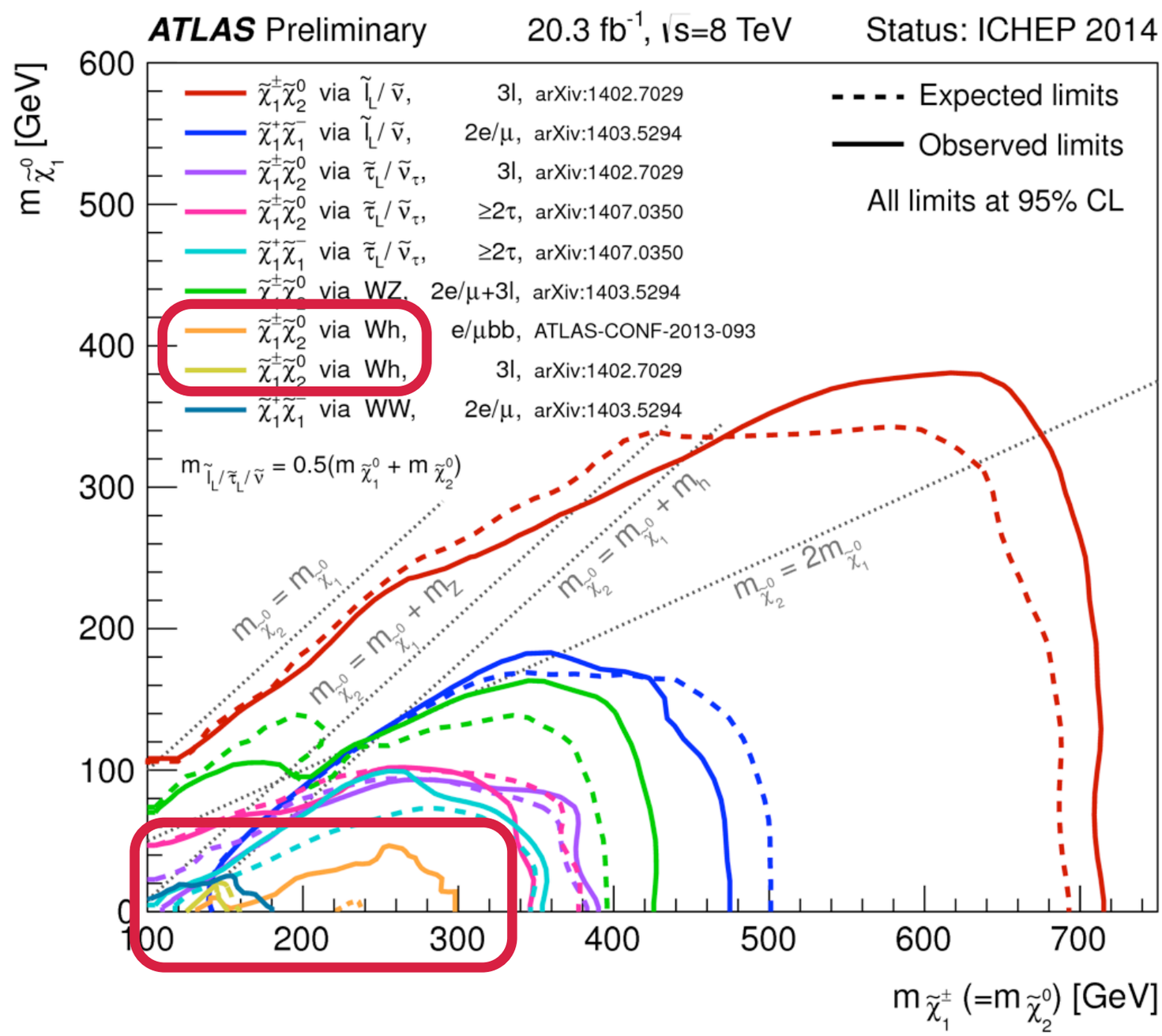
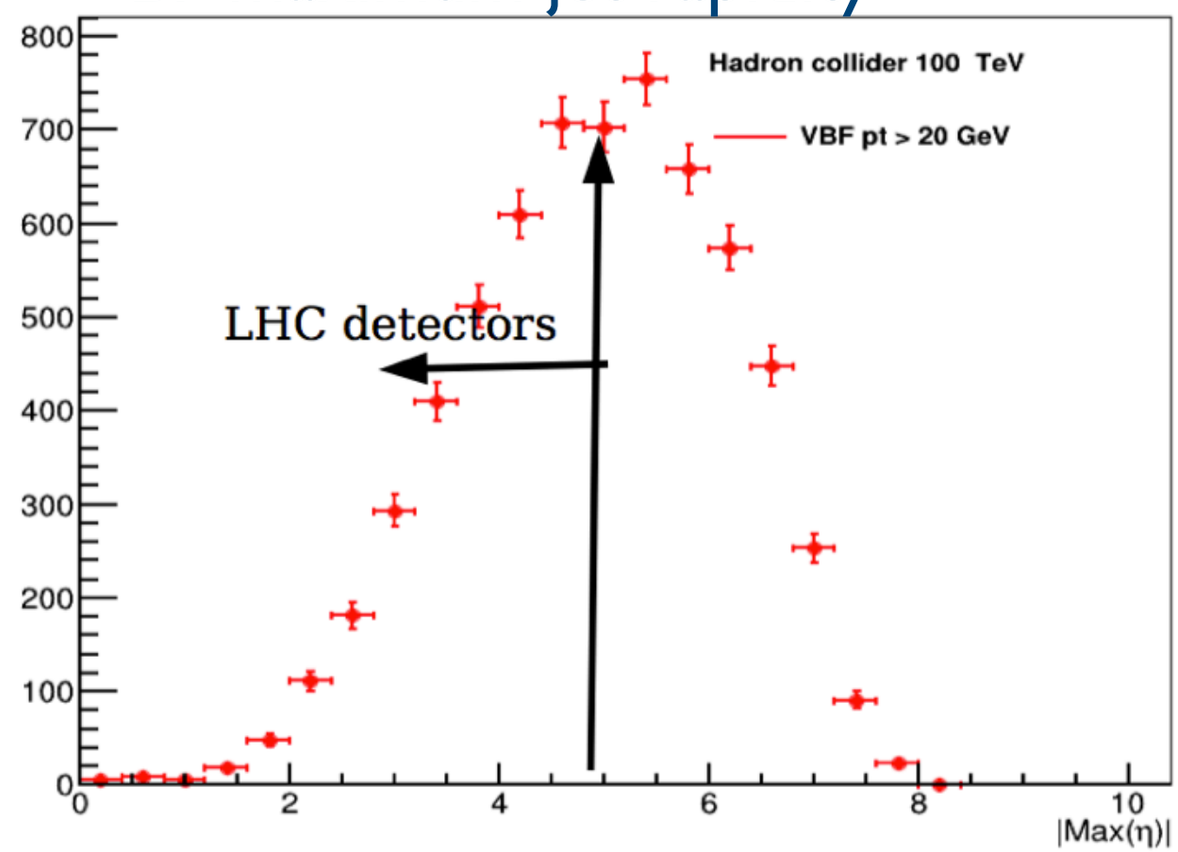


# Backup: Compressed Spectrum Studies at 100 TeV

- search Strategy: Monojets, Soft Leptons, VBF, Disappearing Tracks
- small mass splitting 20-50 GeV
- inclusion of pile up
- realistic detector card

VBF maximum jet rapidity




Sanjay Padhi, CFHEP Symposium on Circular Collider Physics