On the behaviour of composite resonances breaking LFU

Mikael Chala (IPPP)

With **M. Spannowsky**. *arXiv:1803.02364*

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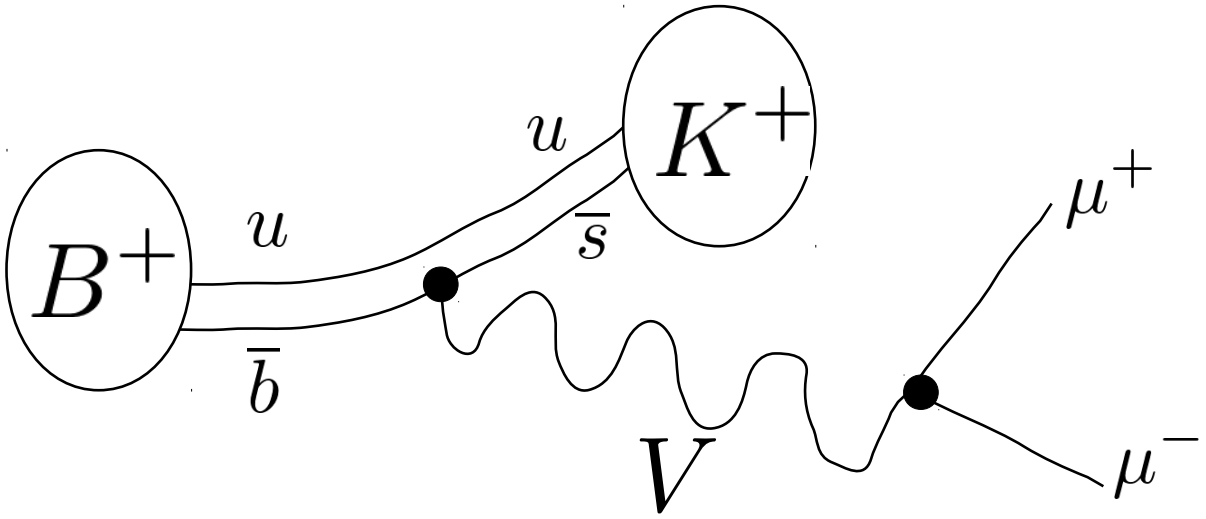

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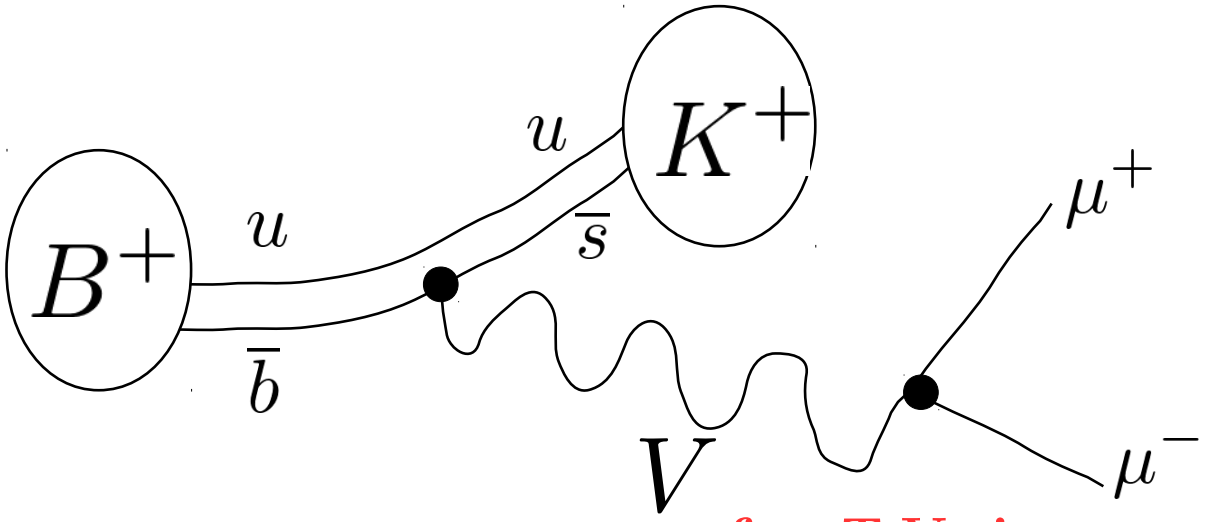

few TeV size, so natural in other models of new physics (e.g. Composite Higgs models)

The simplified Lagrangian

$$\Delta\mathcal{L} = \frac{1}{2} m_V^2 V_\mu V^\mu + J_\mu V^\mu + \cdots$$

$$J_\mu = g_{V\ell\ell} \lambda^\ell_{ij} \overline{\ell^i_L} \gamma_\mu \ell^j_L + g_{Vqq} \lambda^q_{ij} \overline{q^i_L} \gamma_\mu q^j_L$$

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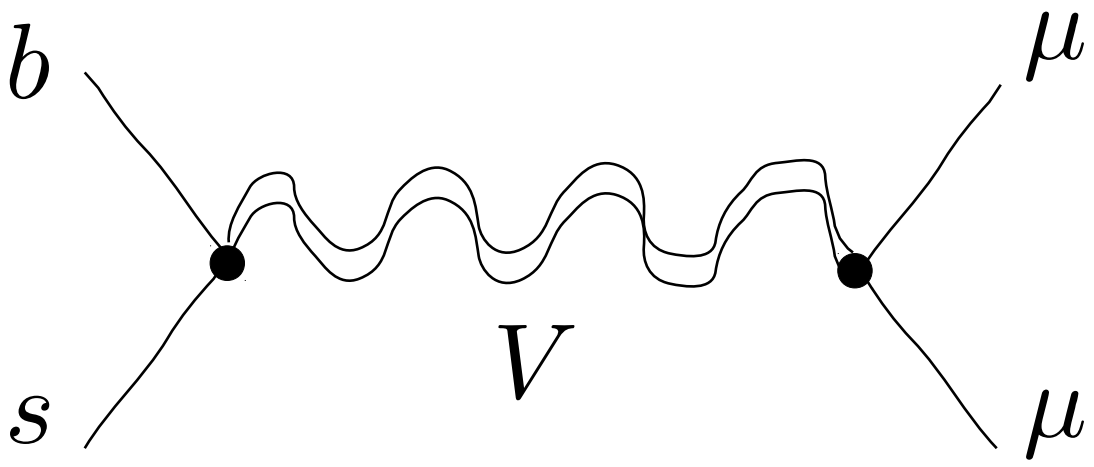
$$\Rightarrow \quad g_{Vqq} \sim 0.05 \frac{m_V^2}{\text{TeV}^2}$$

The origin of these couplings in composite Higgs models



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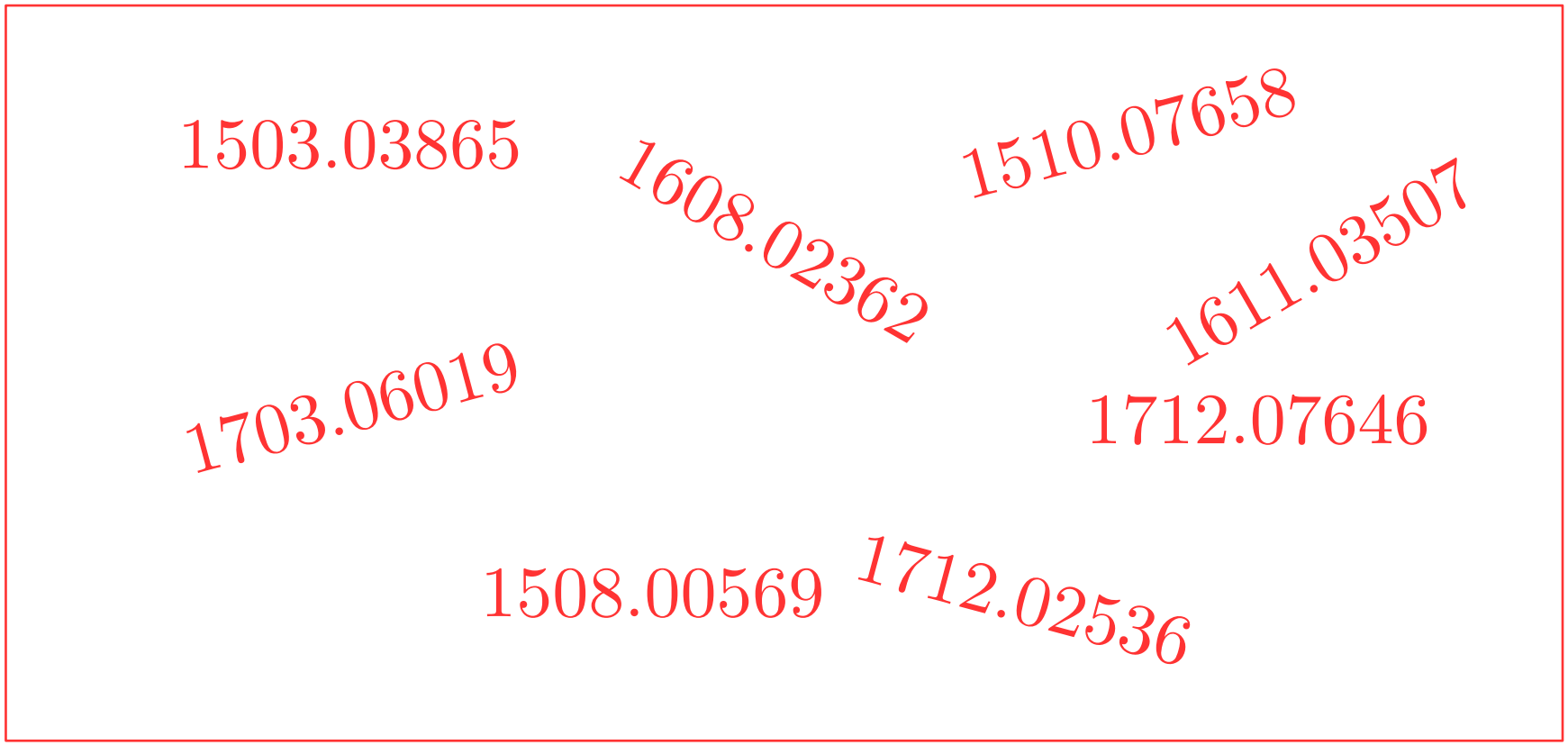

The composite Higgs paradigm

(a high-energy copy of QCD)

UV

GeV scale

IR

$$L \sim m_q \, \overline{q_L} q_R + SU(2)_L \times SU(2)_R$$

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$$p, n, \Delta, \Sigma, \ldots$$

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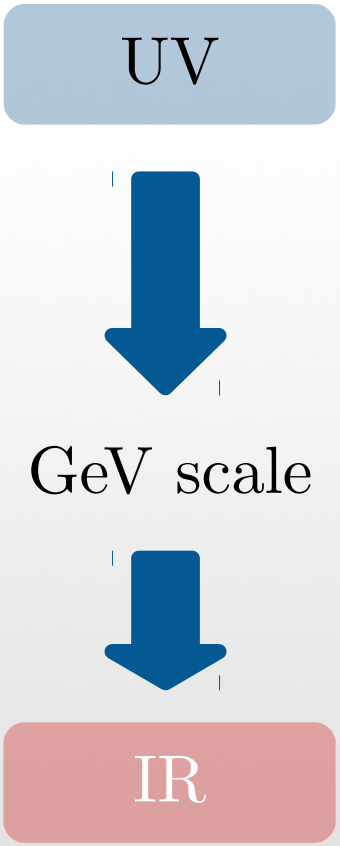

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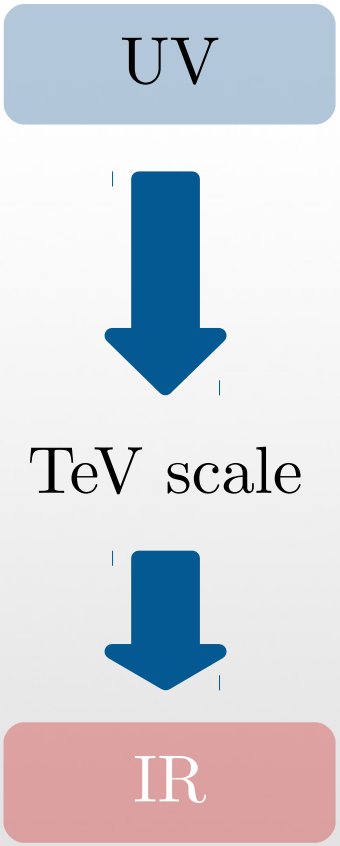

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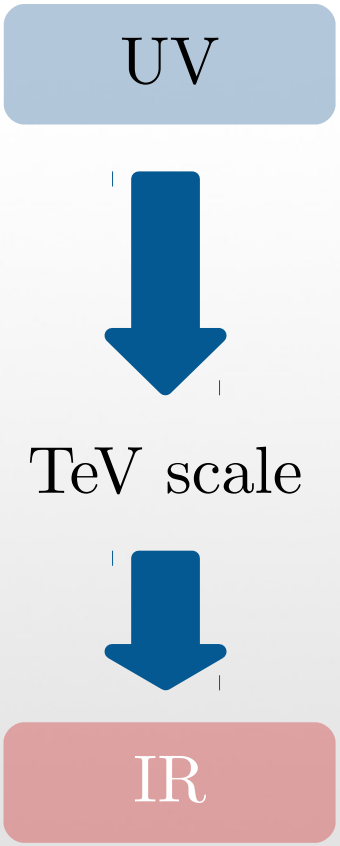

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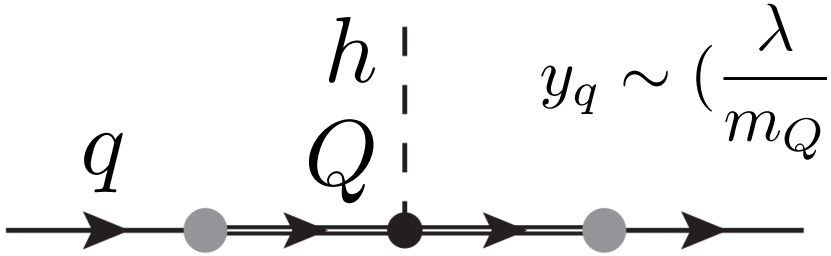

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True for all composite resonances!

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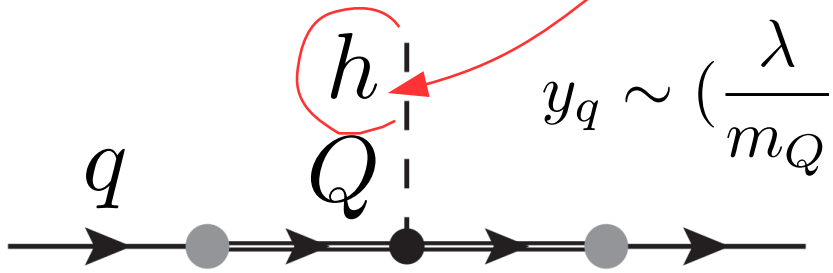

$$y_q \sim (\frac{\lambda}{m_Q})^2$$

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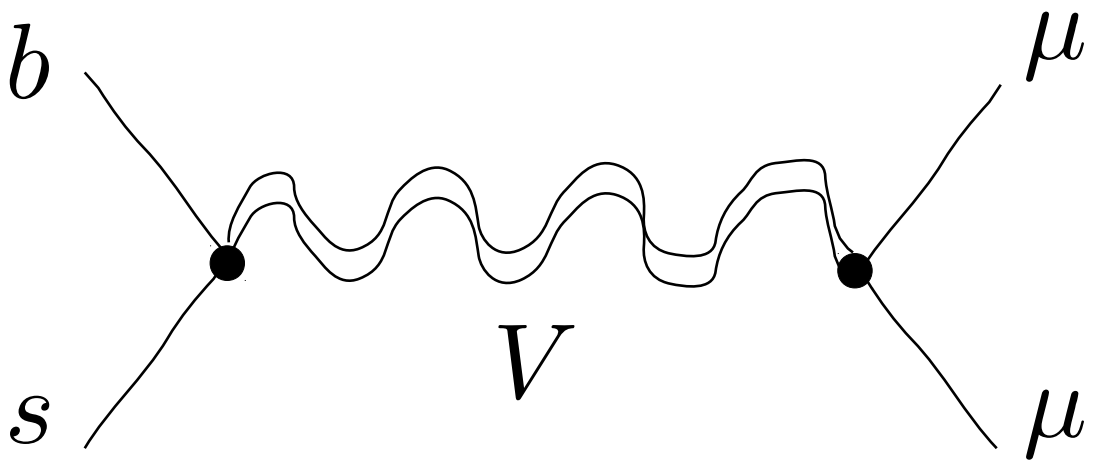

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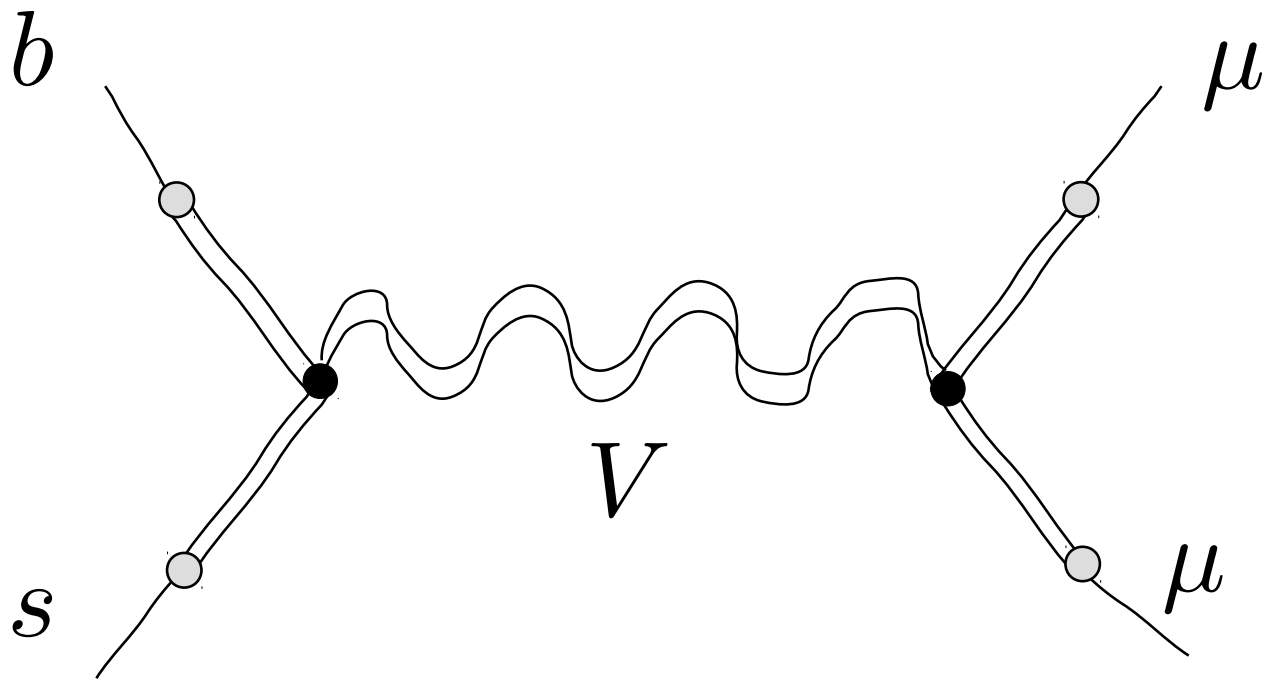

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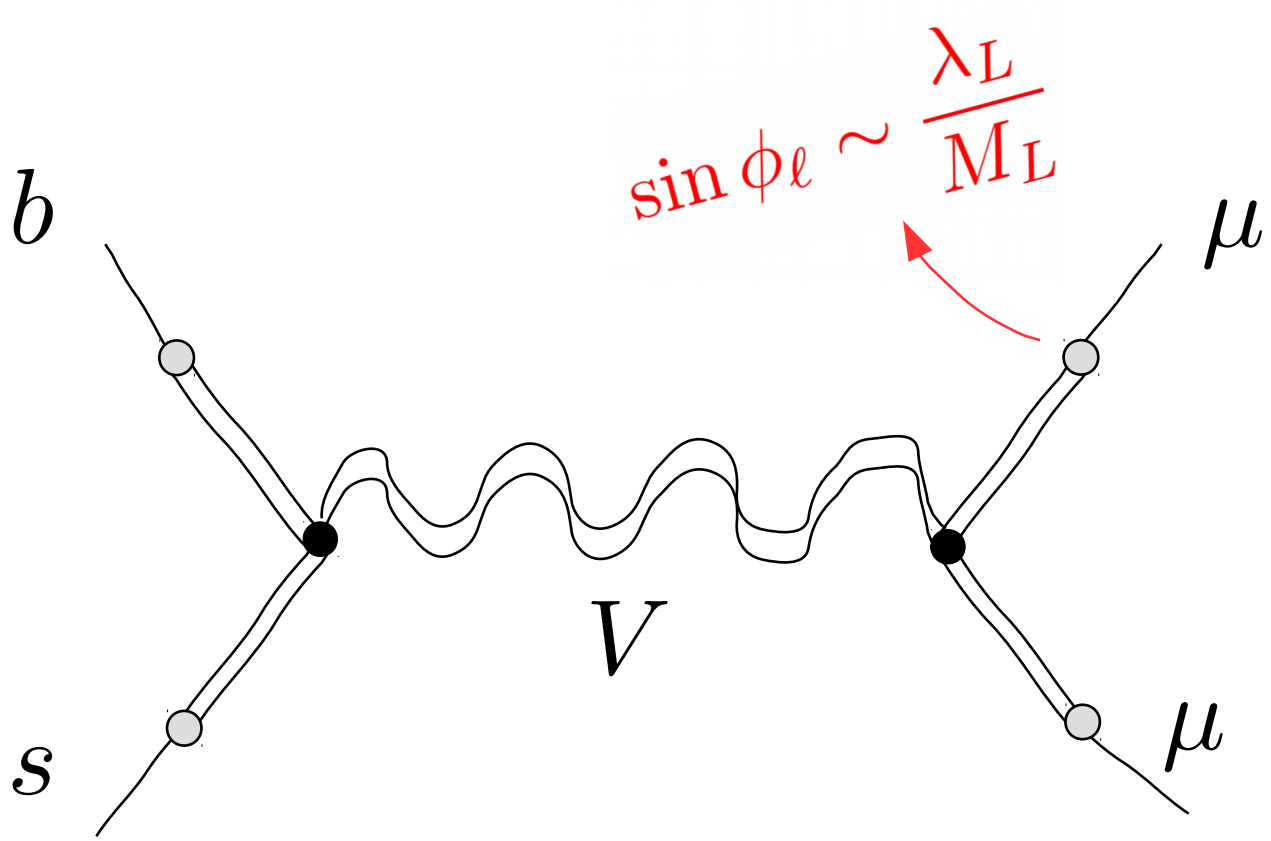

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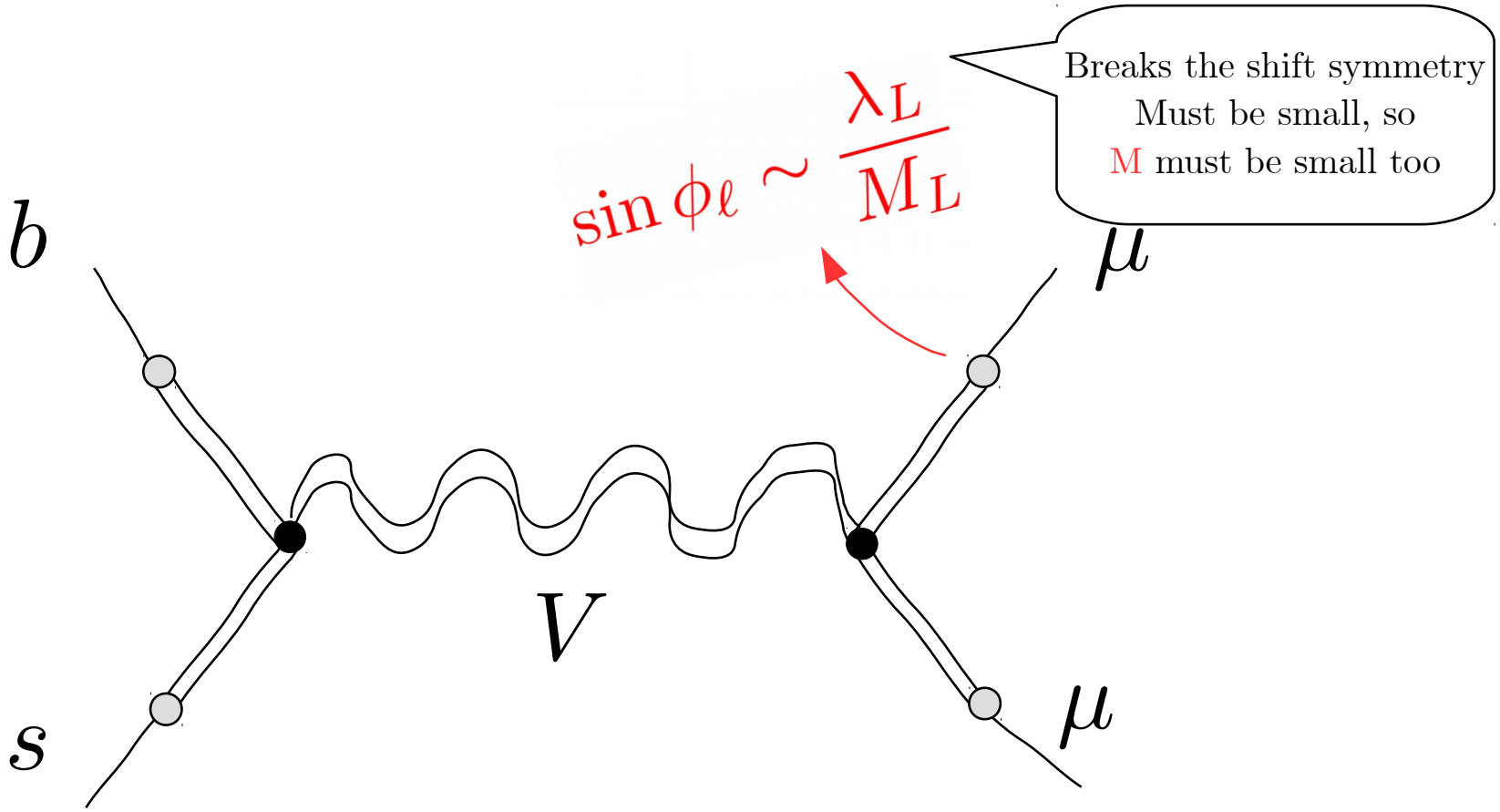

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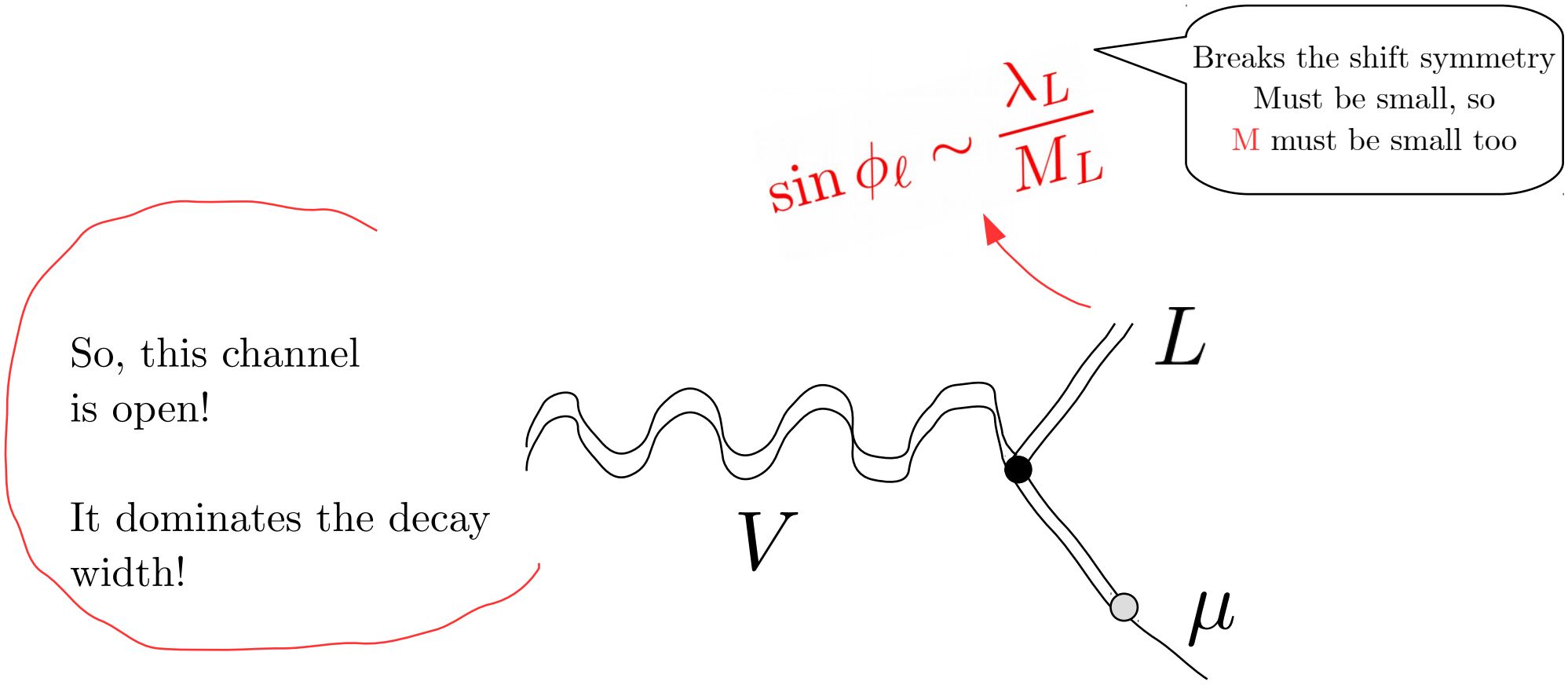

Current bounds on vector-like fermions

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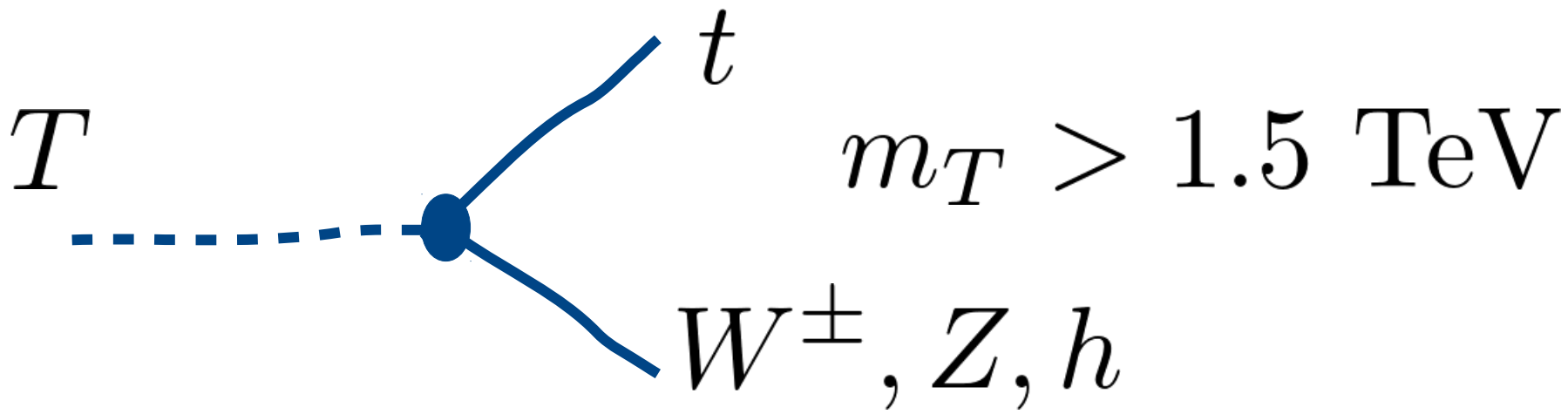
- Heavy quarks are produced in pairs via QCD (no model dependence)



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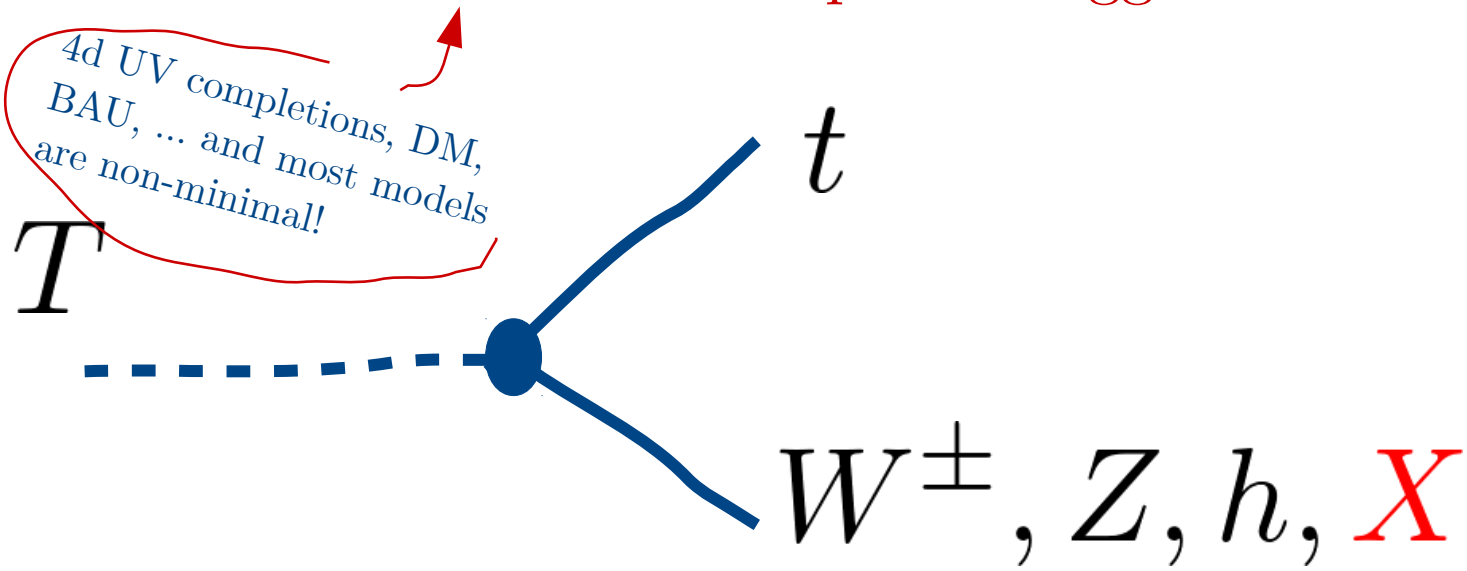

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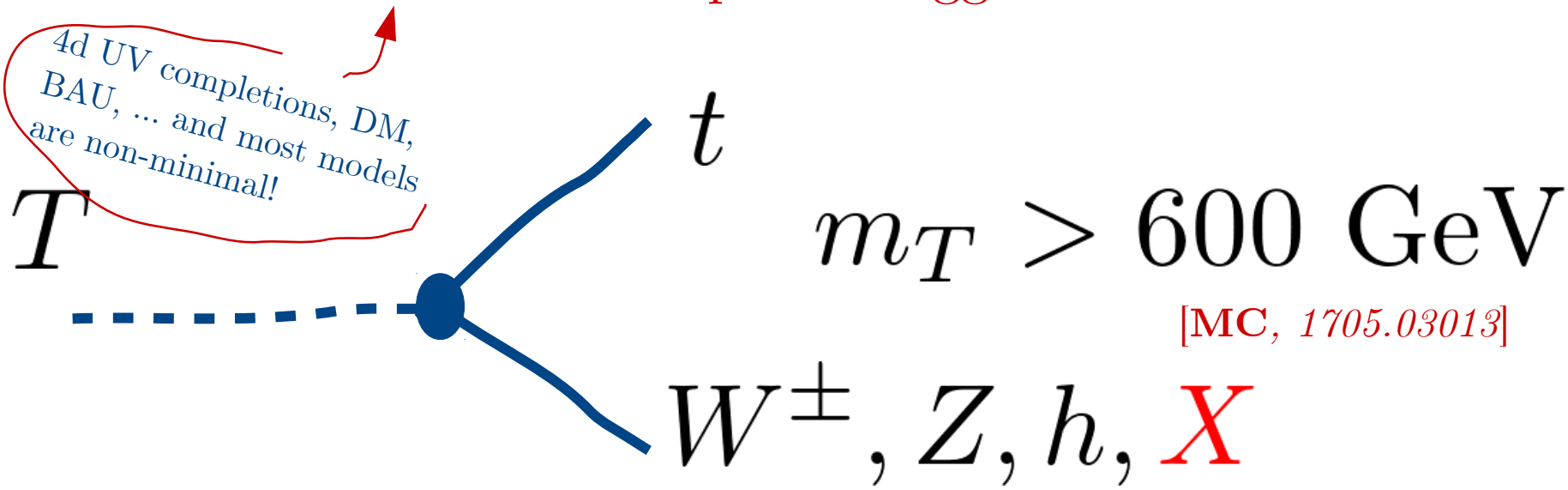
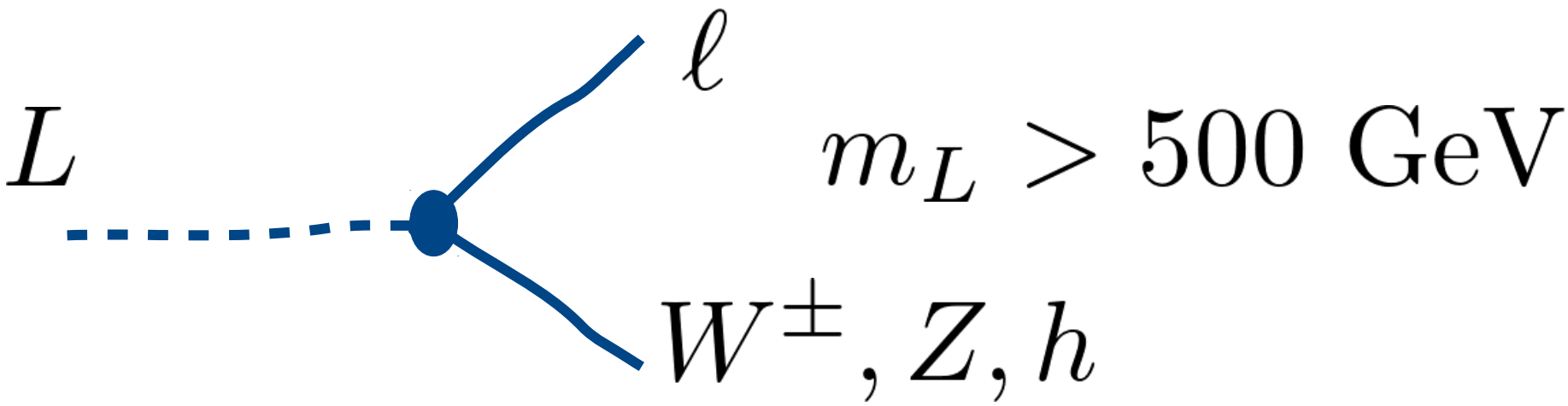


$$m_T > 600 \text{ GeV}$$

[**MC**, *1705.03013*]

Current bounds on vector-like fermions

- Heavy leptons are produced in pairs via EW interactions, so much weaker constraints *[1306.1525], [1007.4206]*



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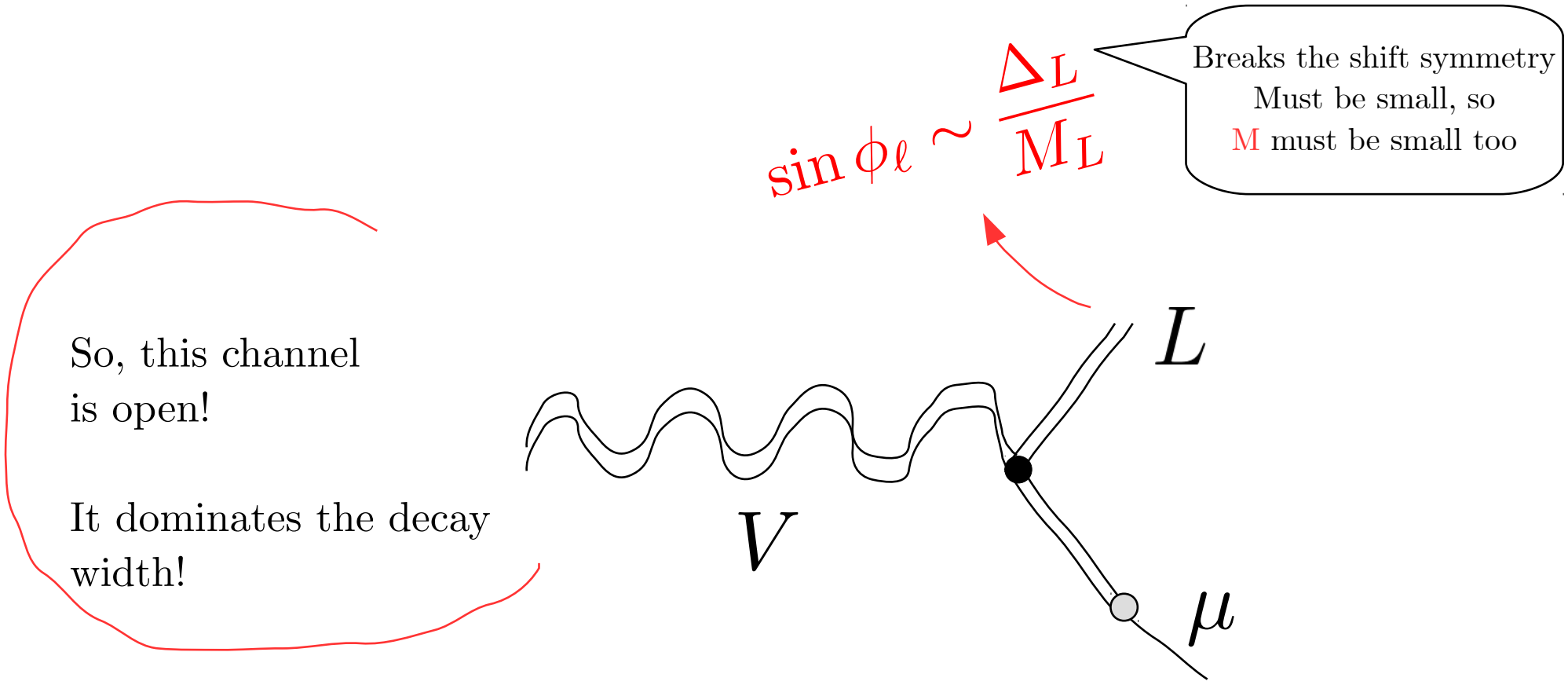
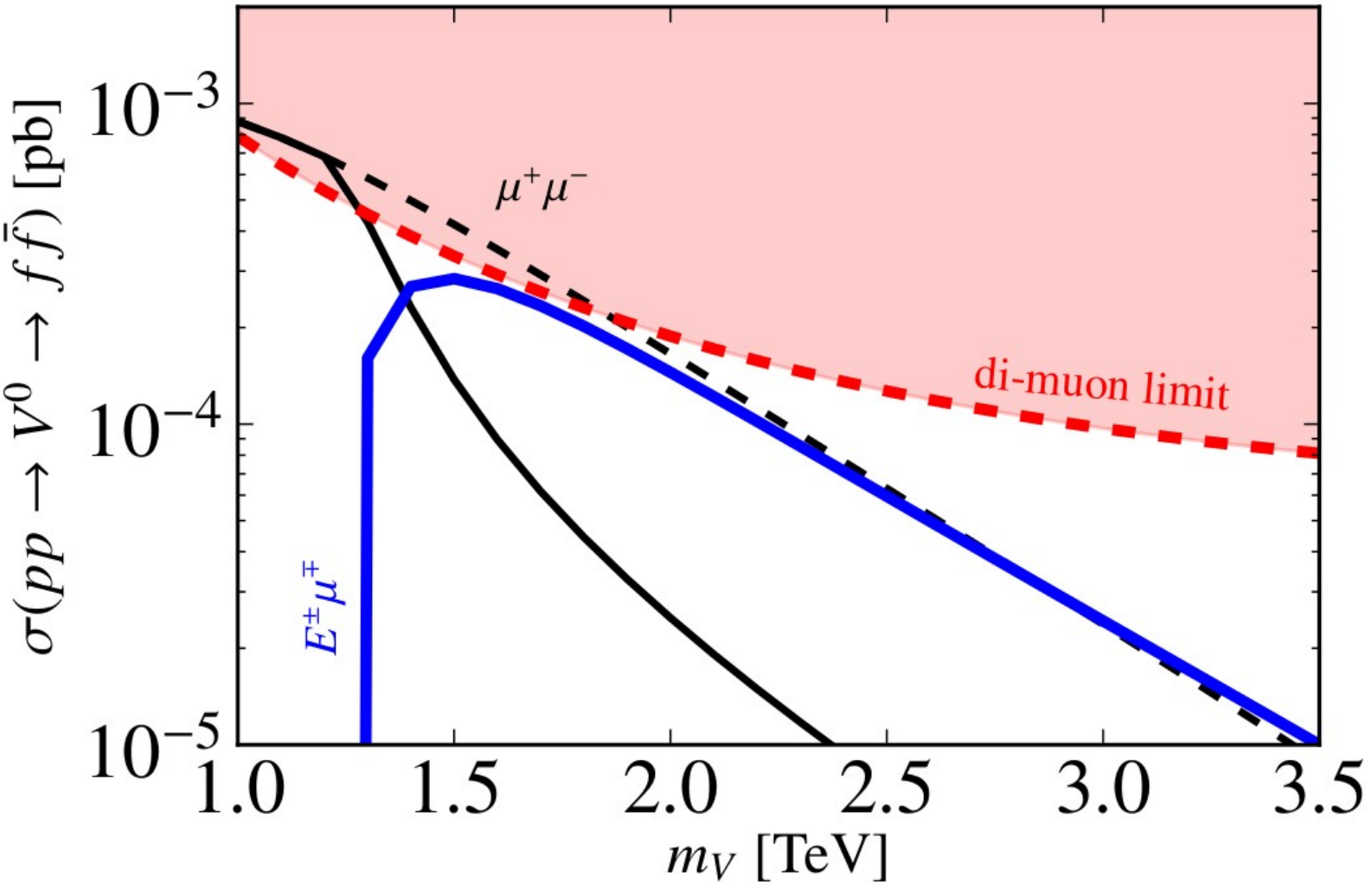


The actual reach of di-muon searches



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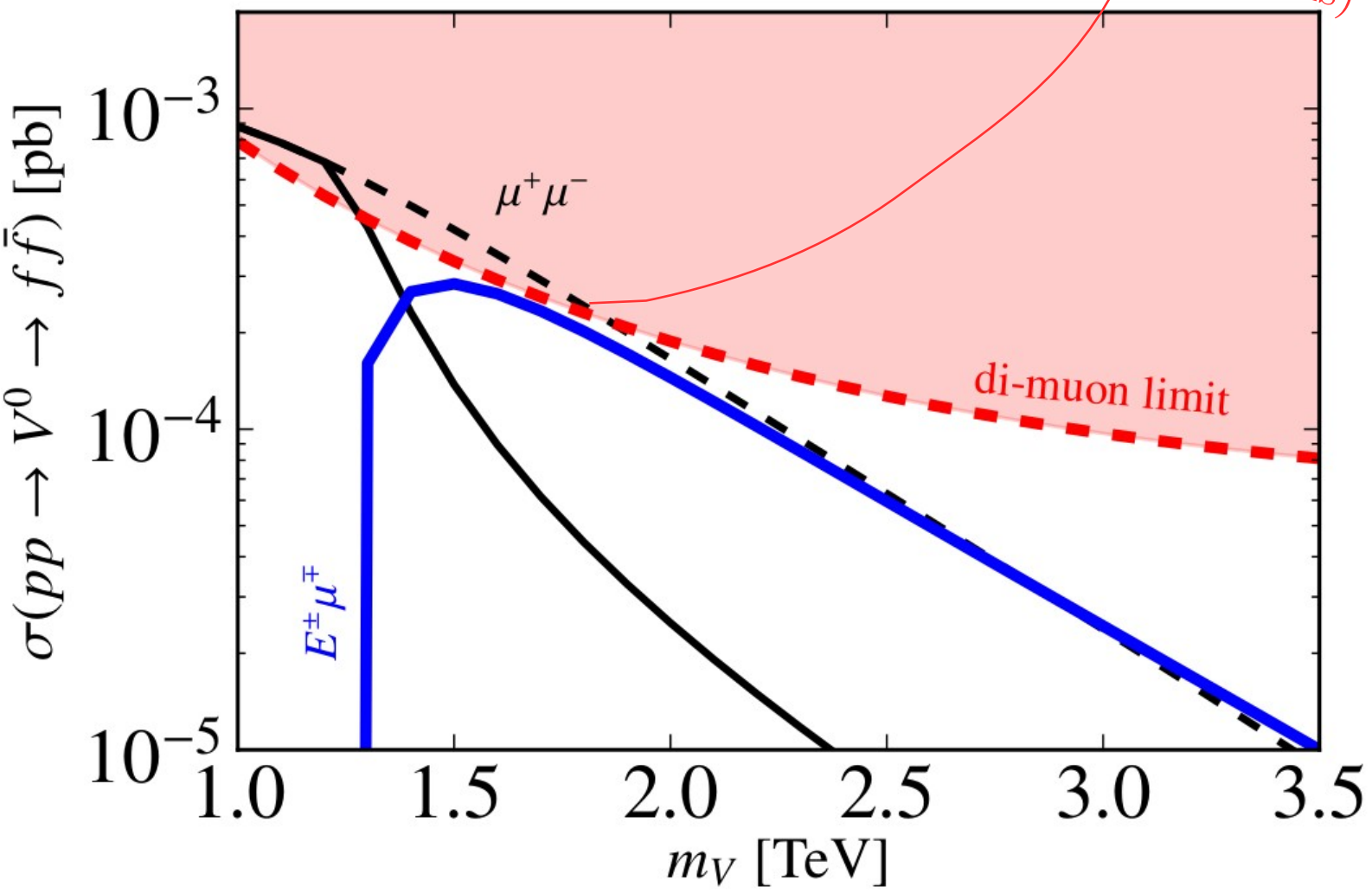

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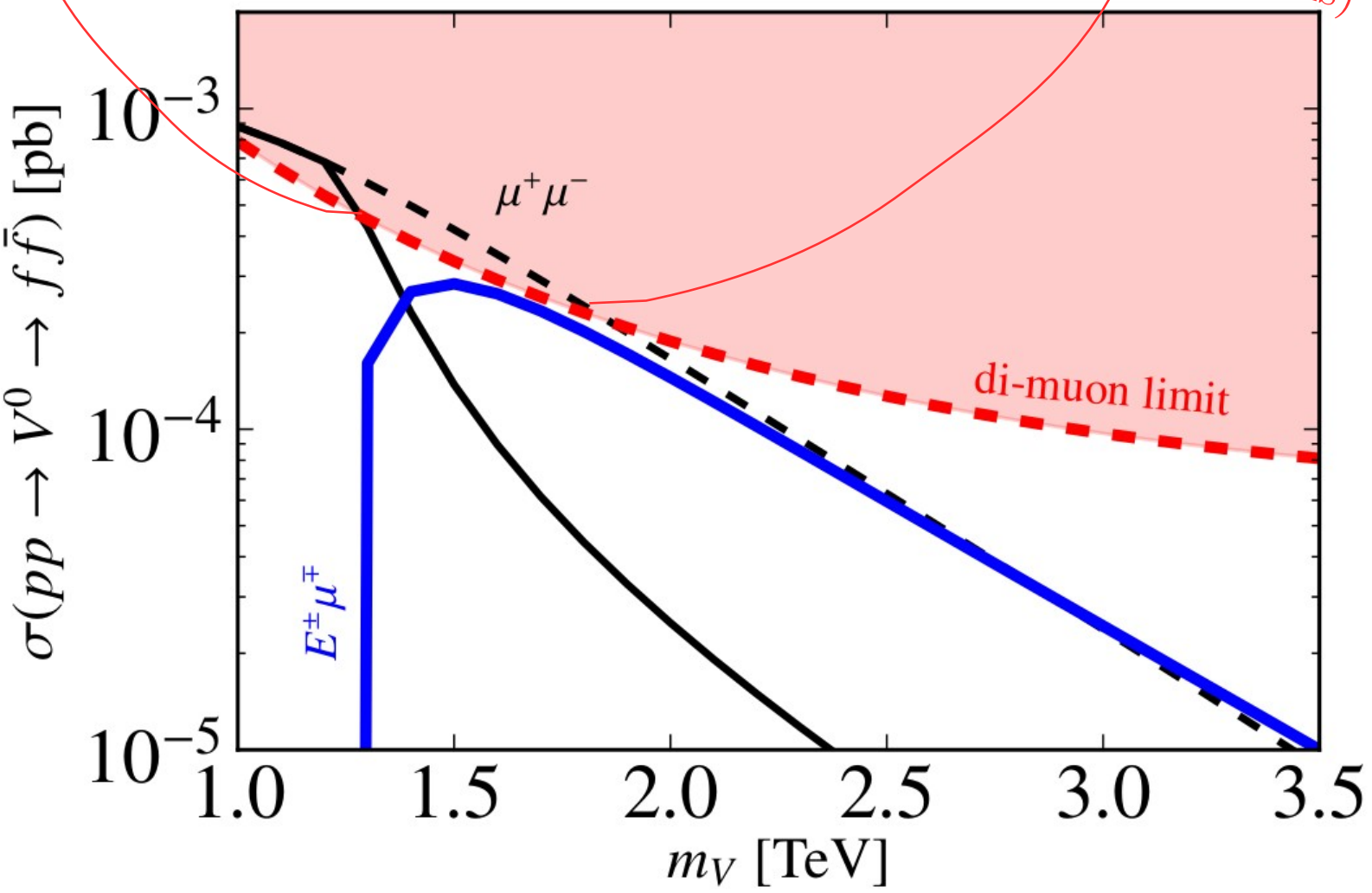

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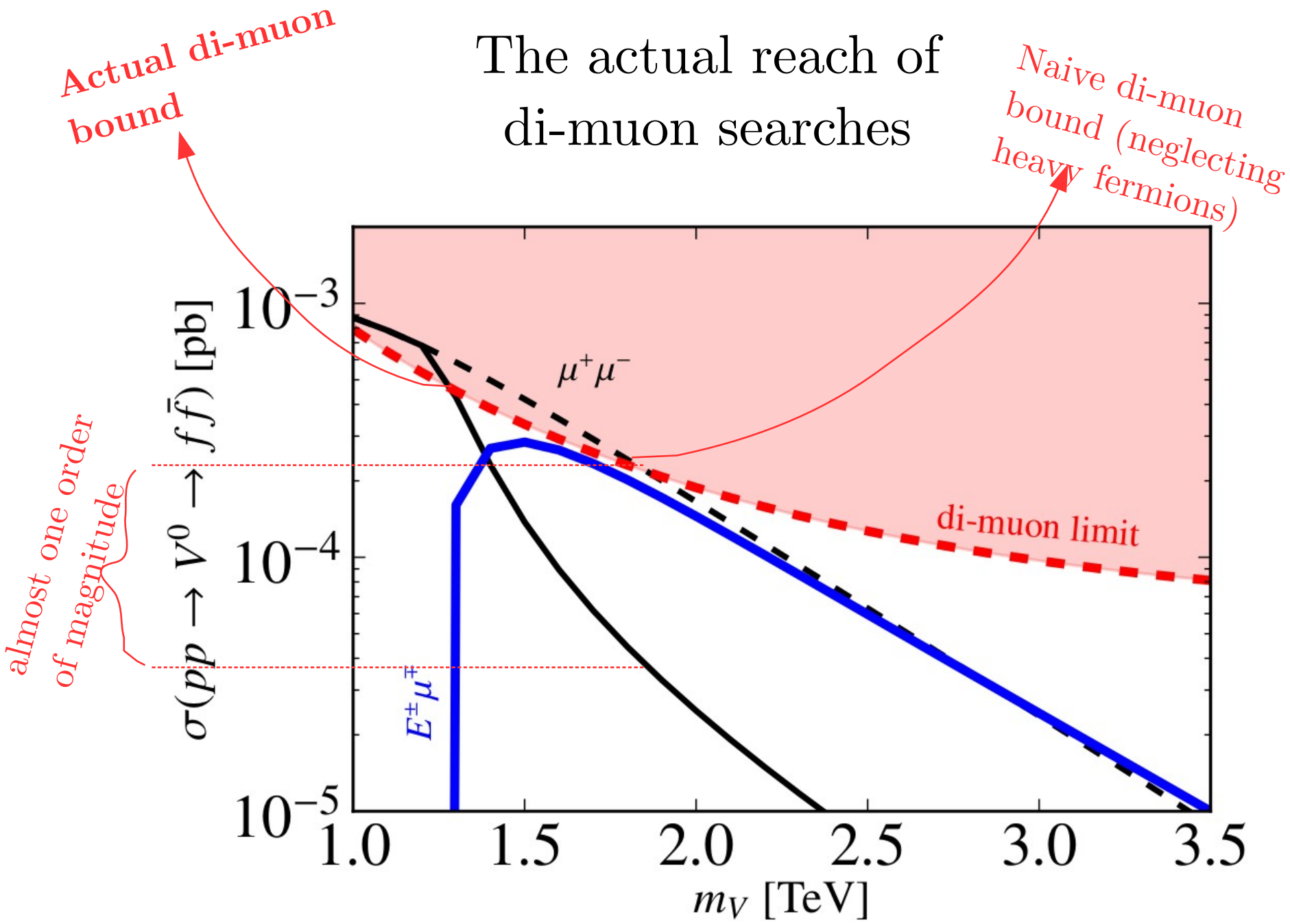
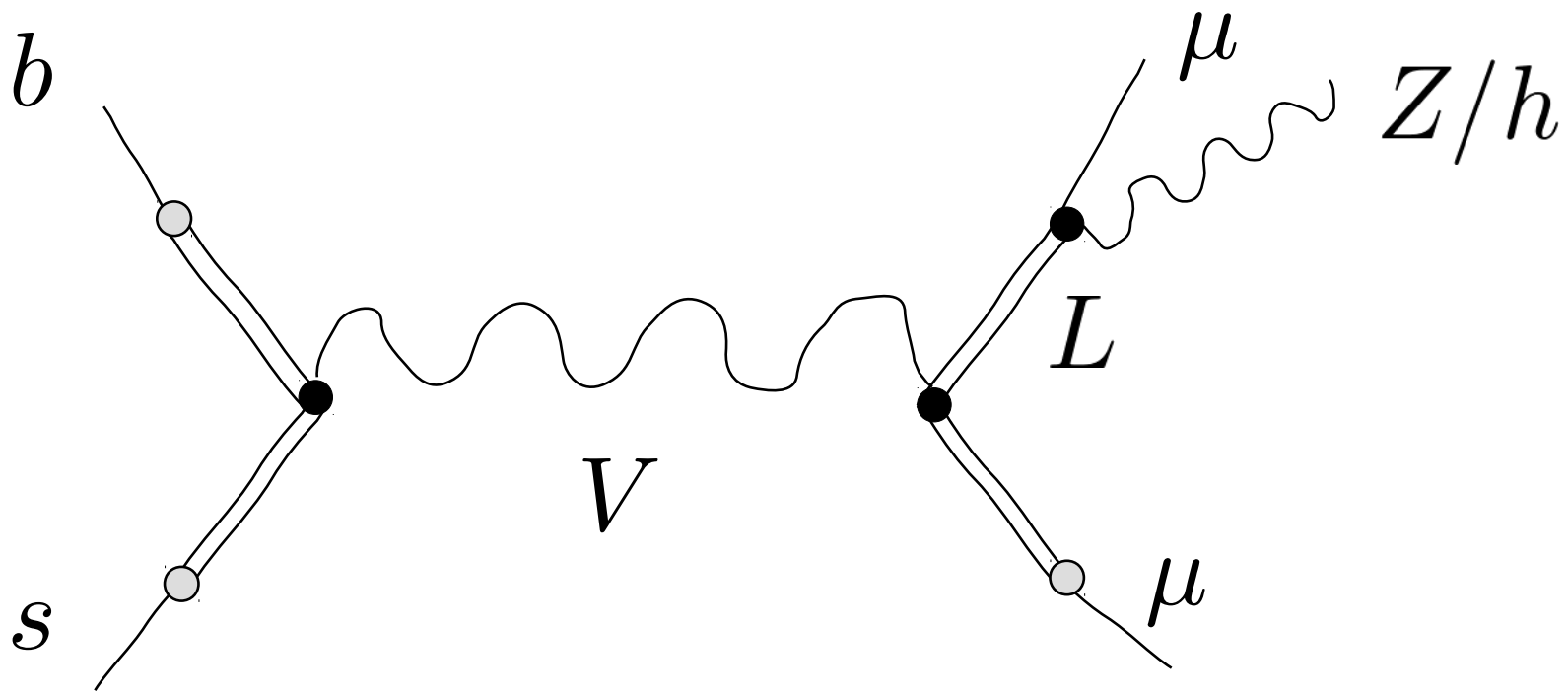


Leptonic Z decay gives very few events, so we consider hadronic decays of:



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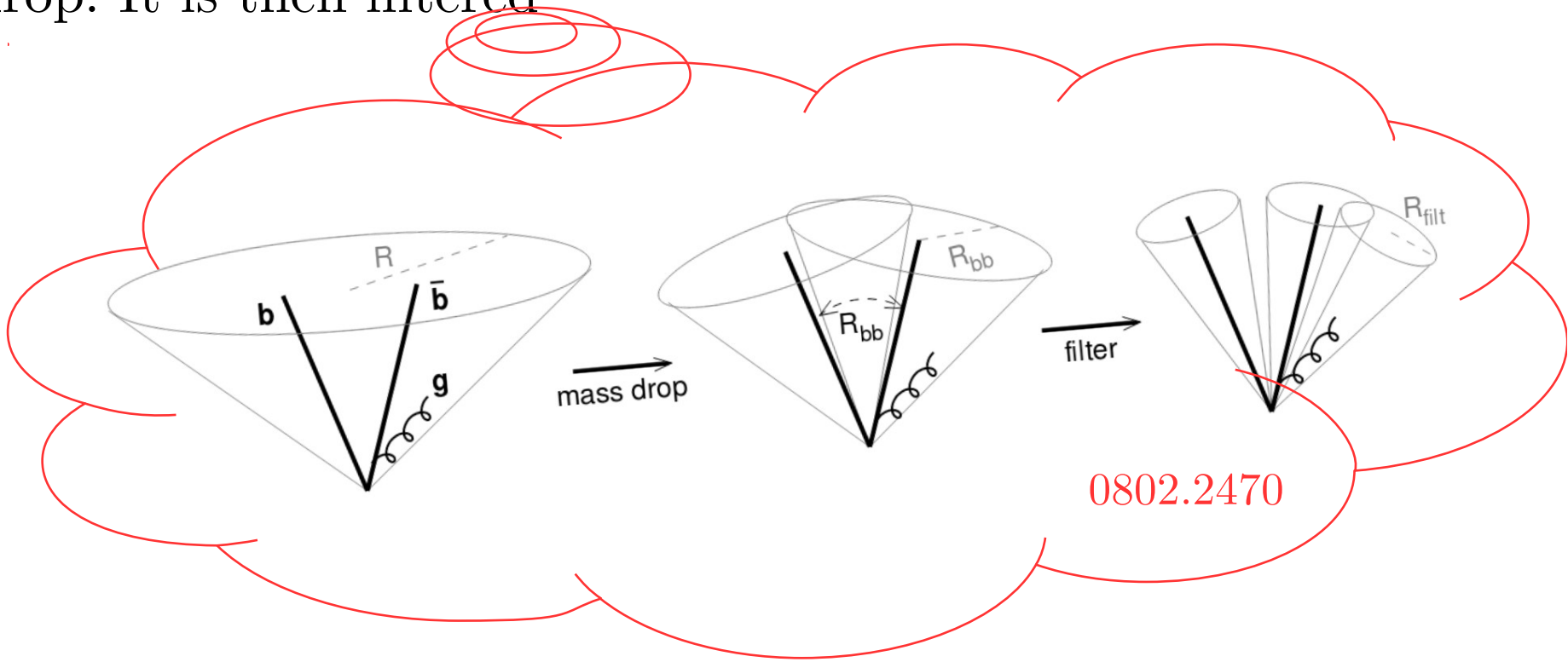

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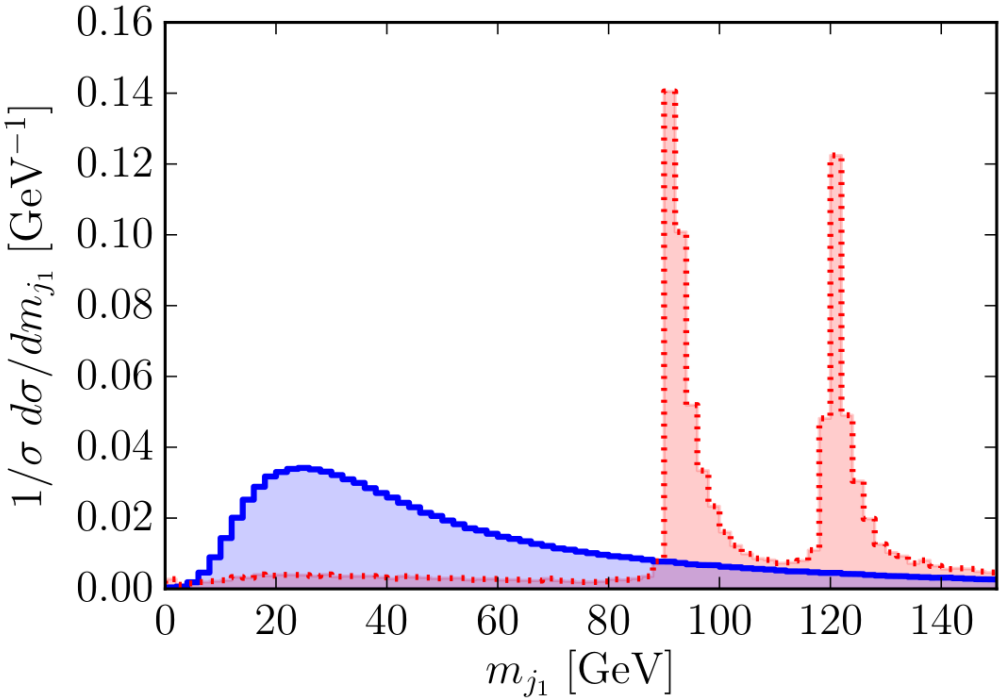

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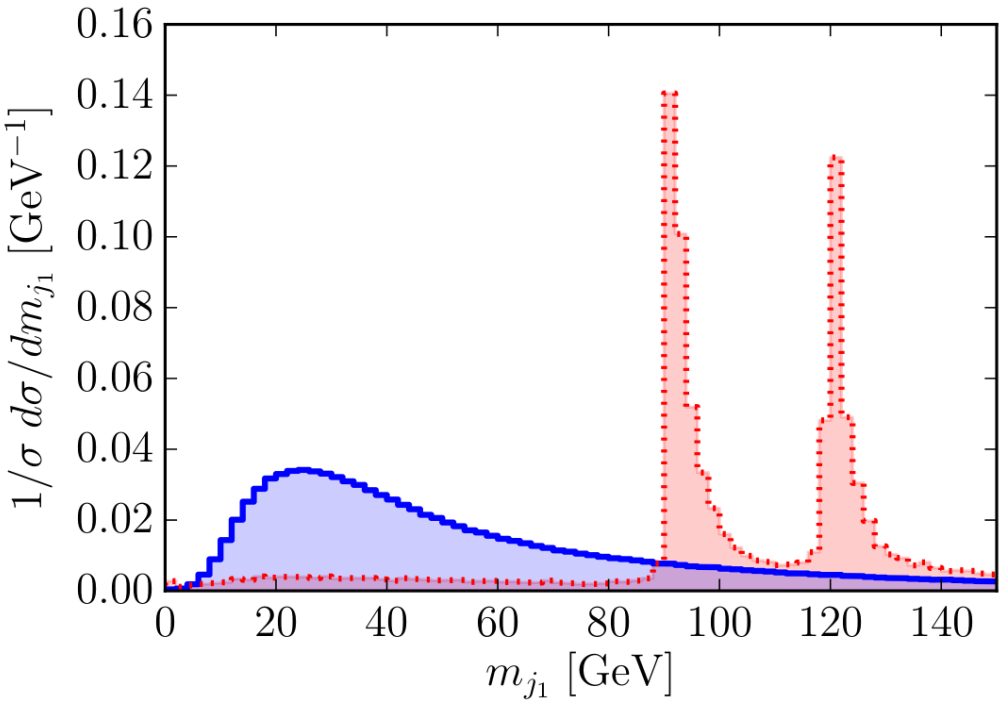

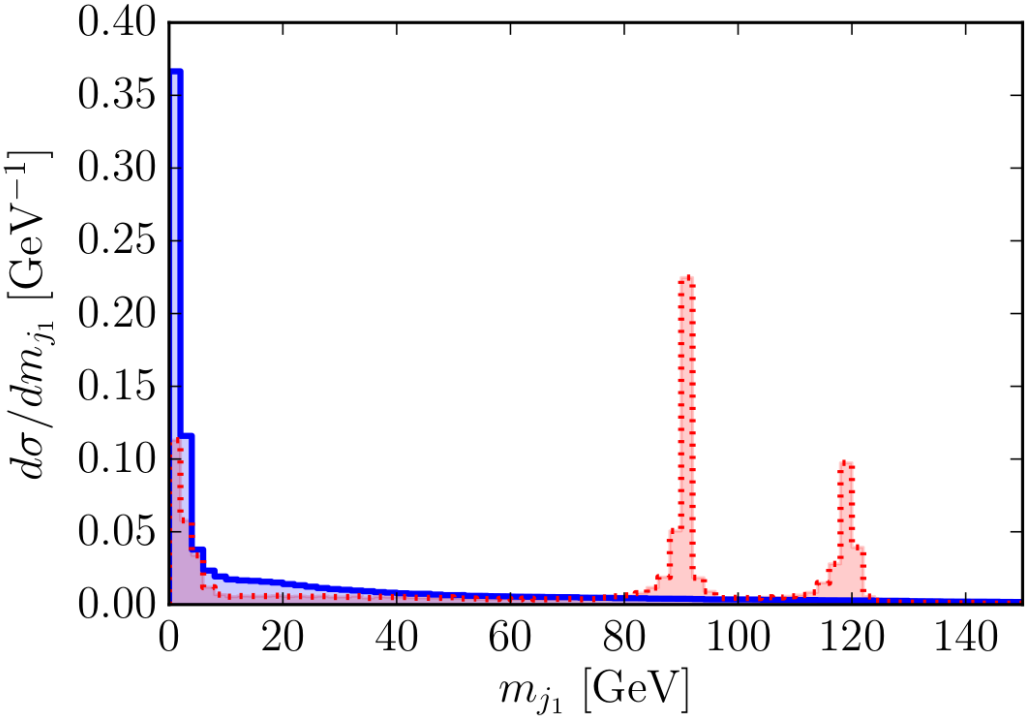

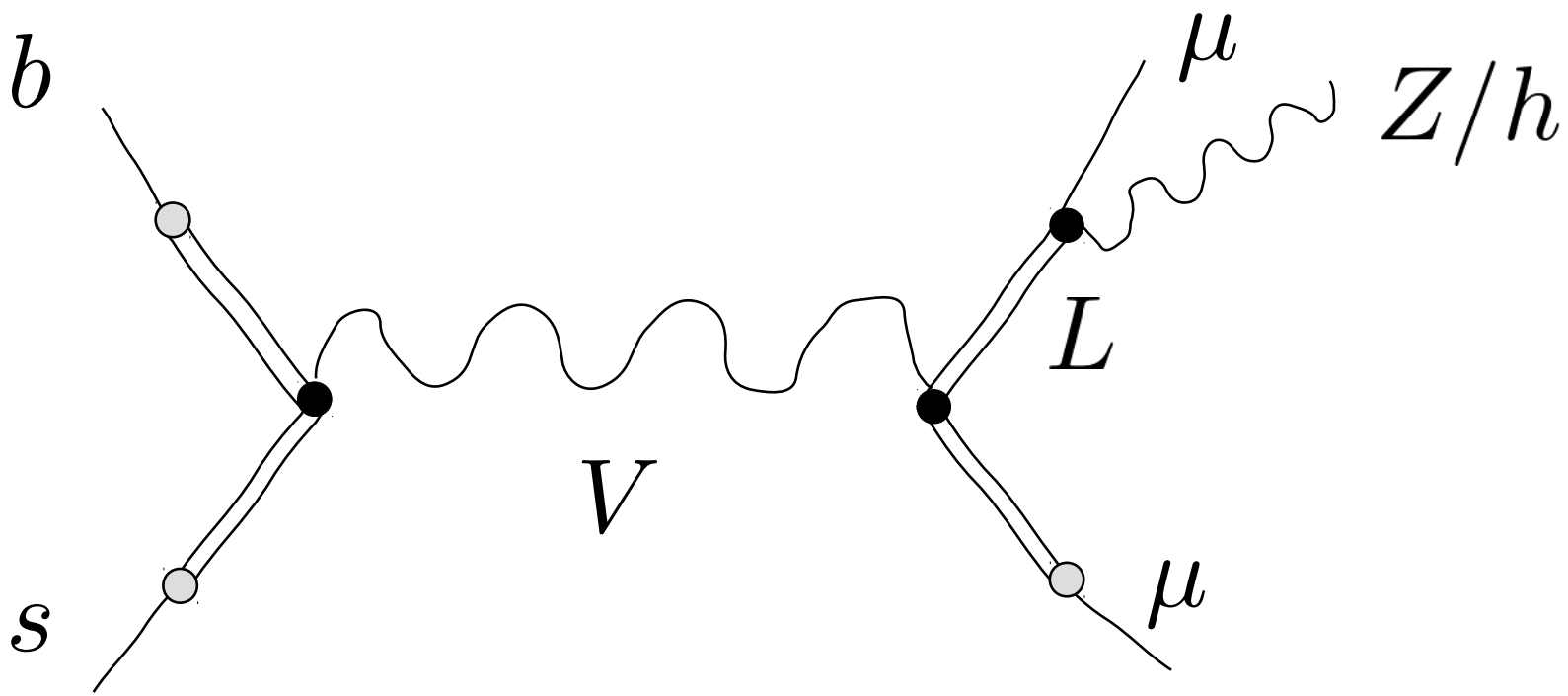
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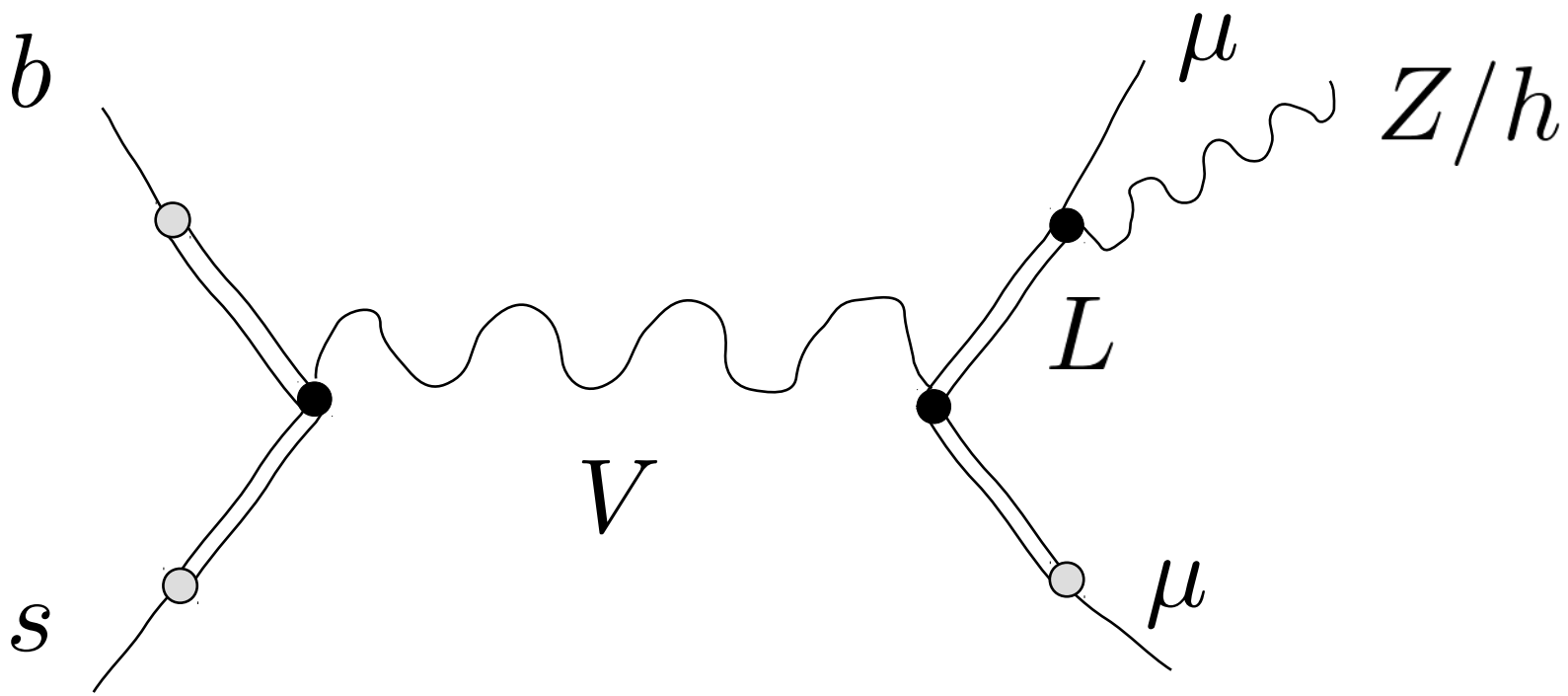
$\mu^+\mu^- + 1 - 2\ jets, p_T^\mu > 100\ GeV$

	$\epsilon(BP)$	$\epsilon(b)$
2 muons	90	99
$\geqslant 1$ jet, j_1 tagged and filtered	70	45
$p_T^{\mu_{1,2}} > 200$ GeV	93	16
80 GeV $< m_{j_1} <$ 130 GeV	58	7.0
Total	34	0.49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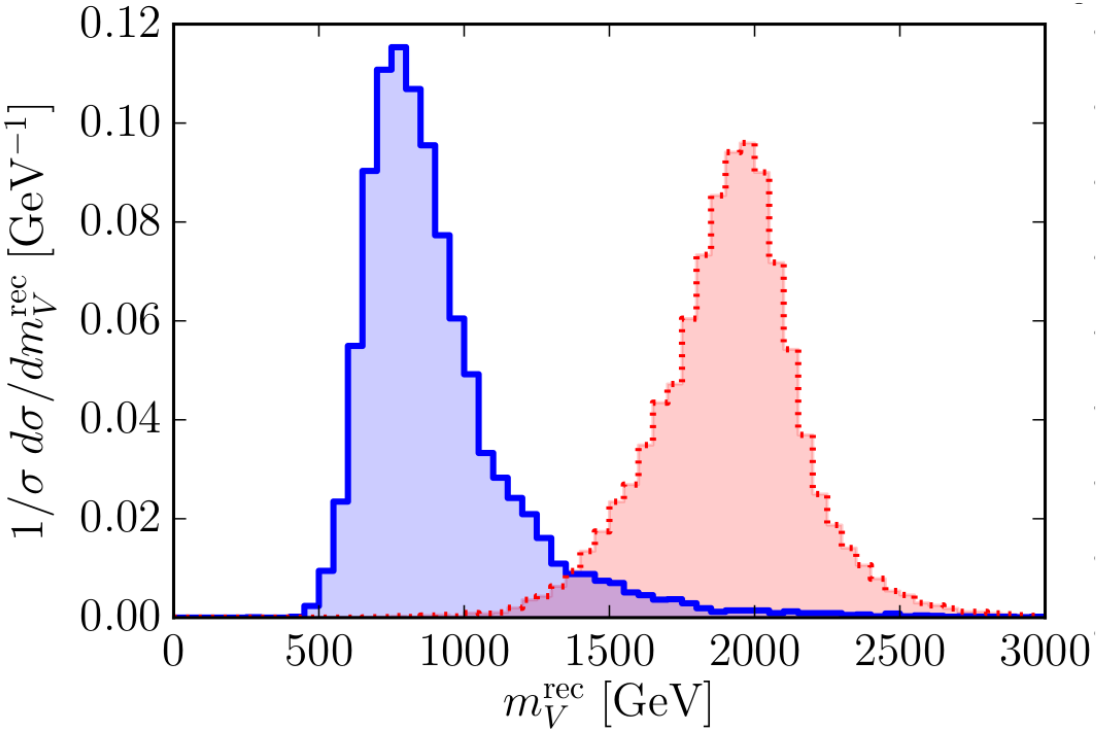

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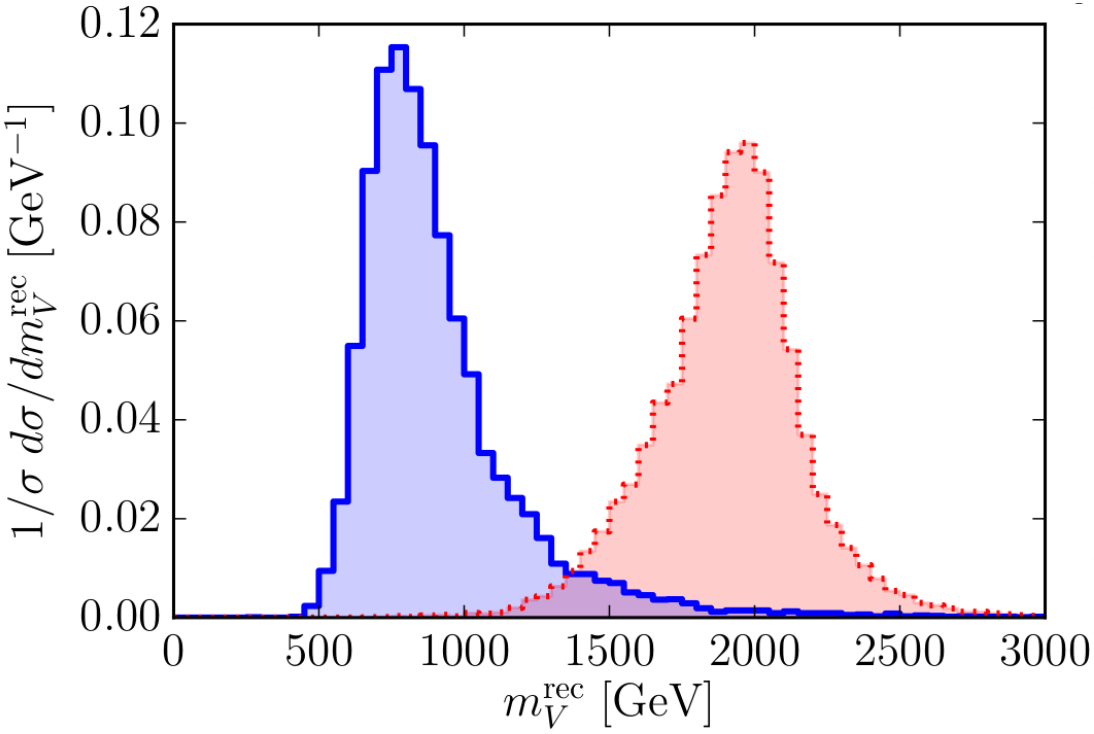

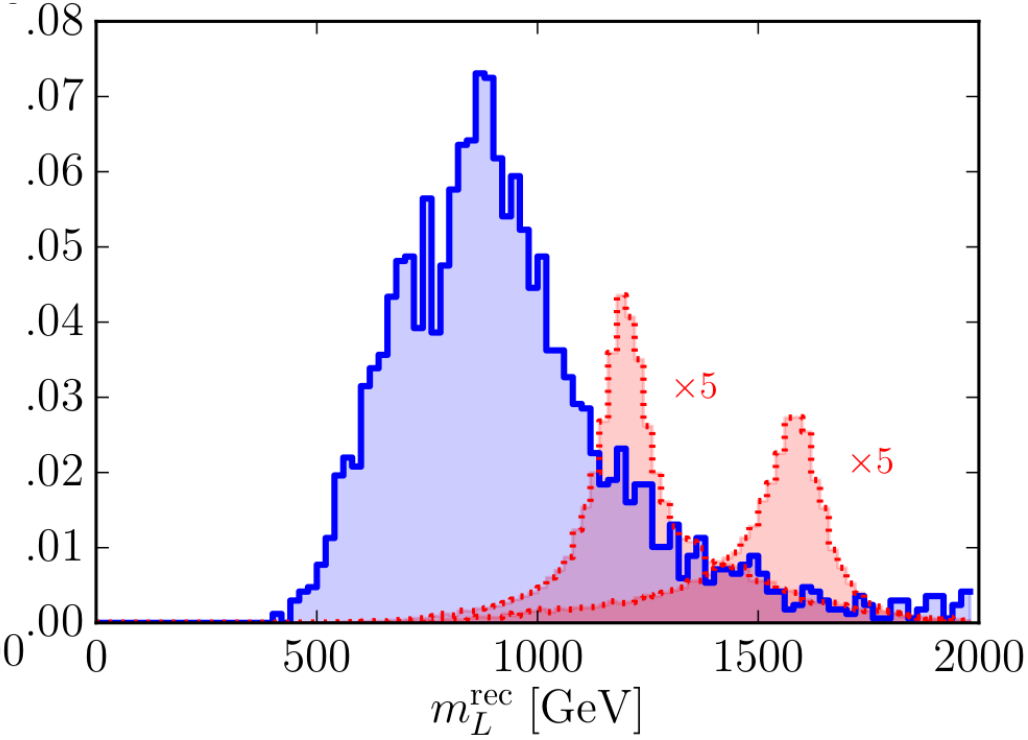

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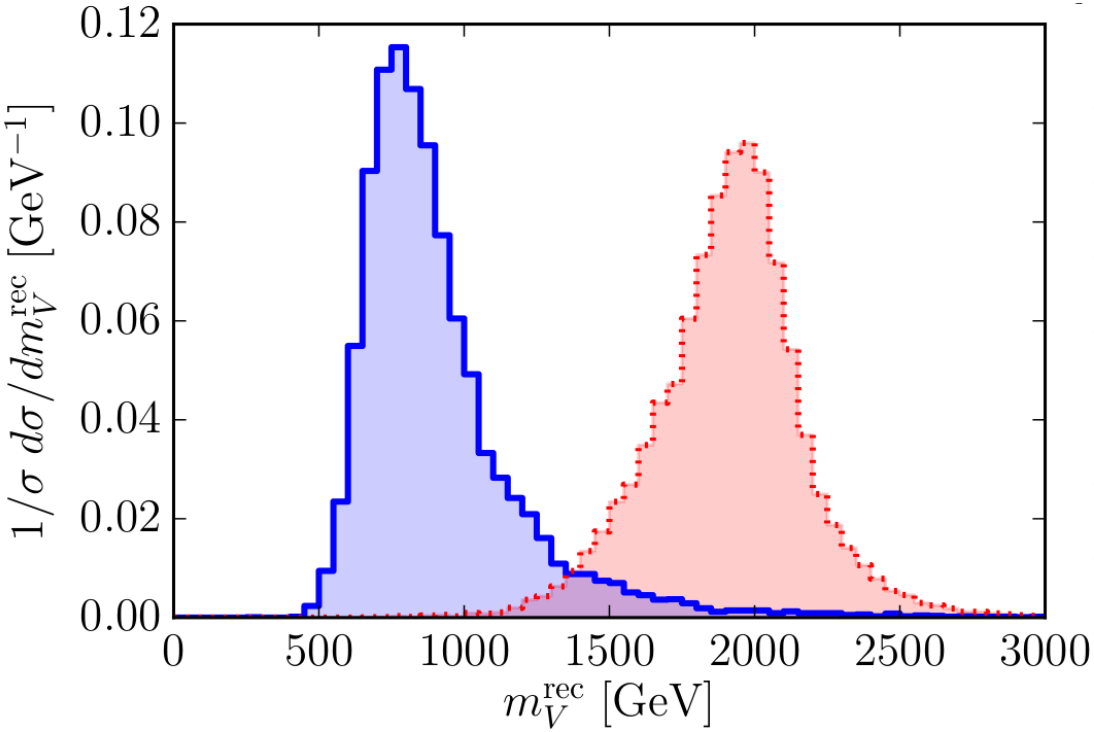
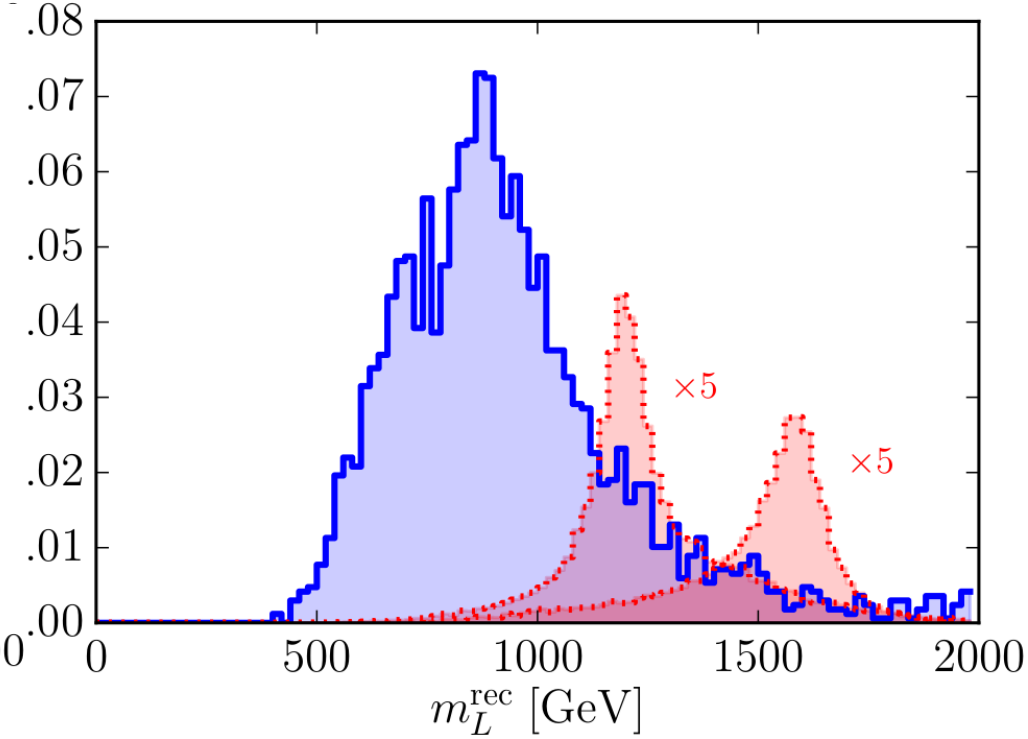
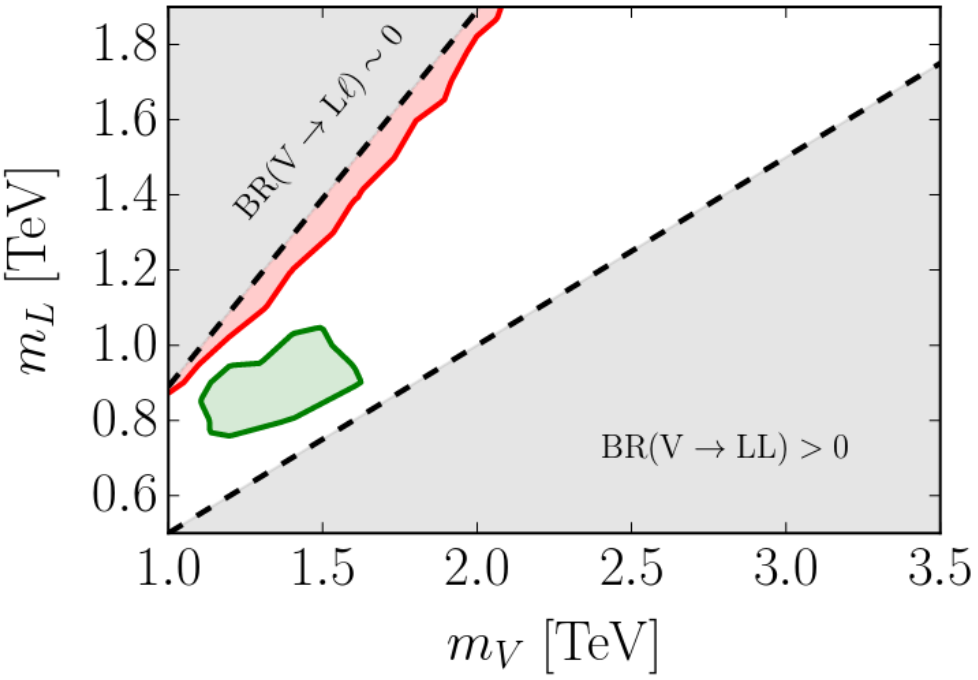
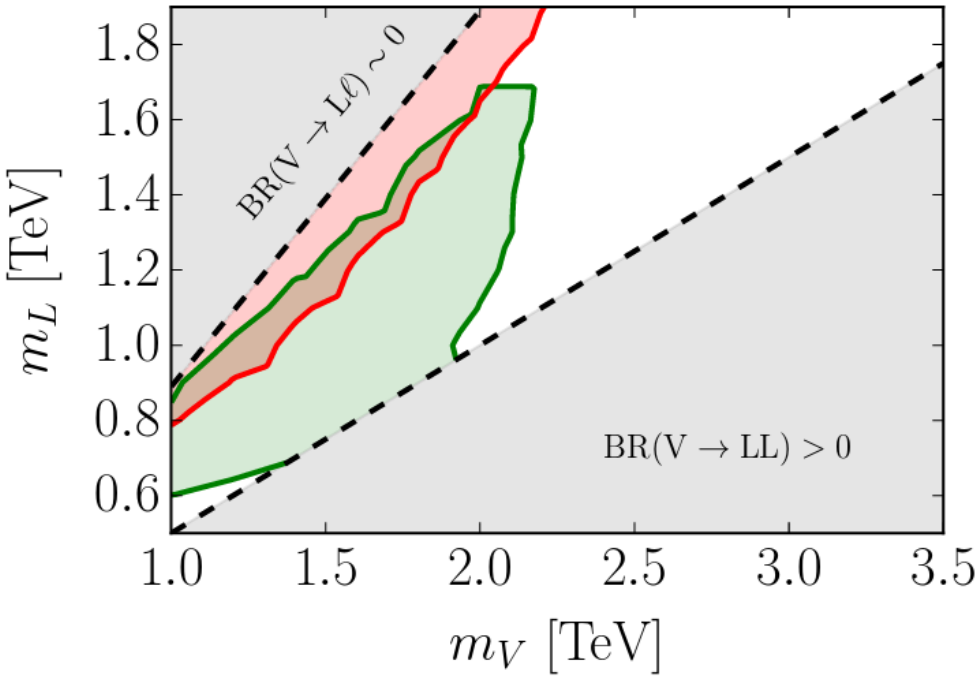




Given our ignorance on m_V and m_L, we set further cuts depending on these parameters. In particular, we require $m_V^{\rm rec} > 0.75 \times m_V$, $|m_L^{\rm rec} - m_L| < 100$ GeV.

Final results





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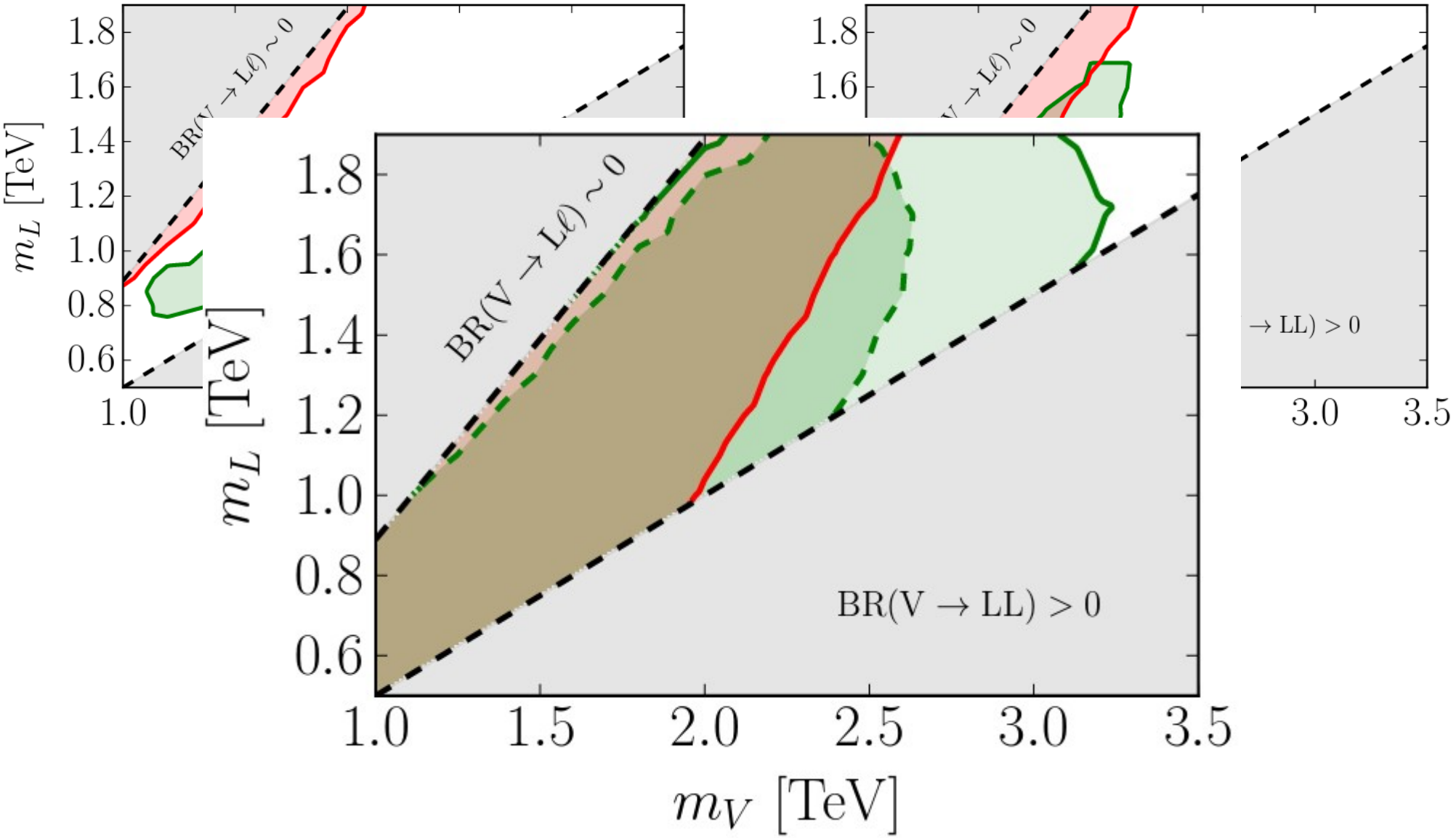

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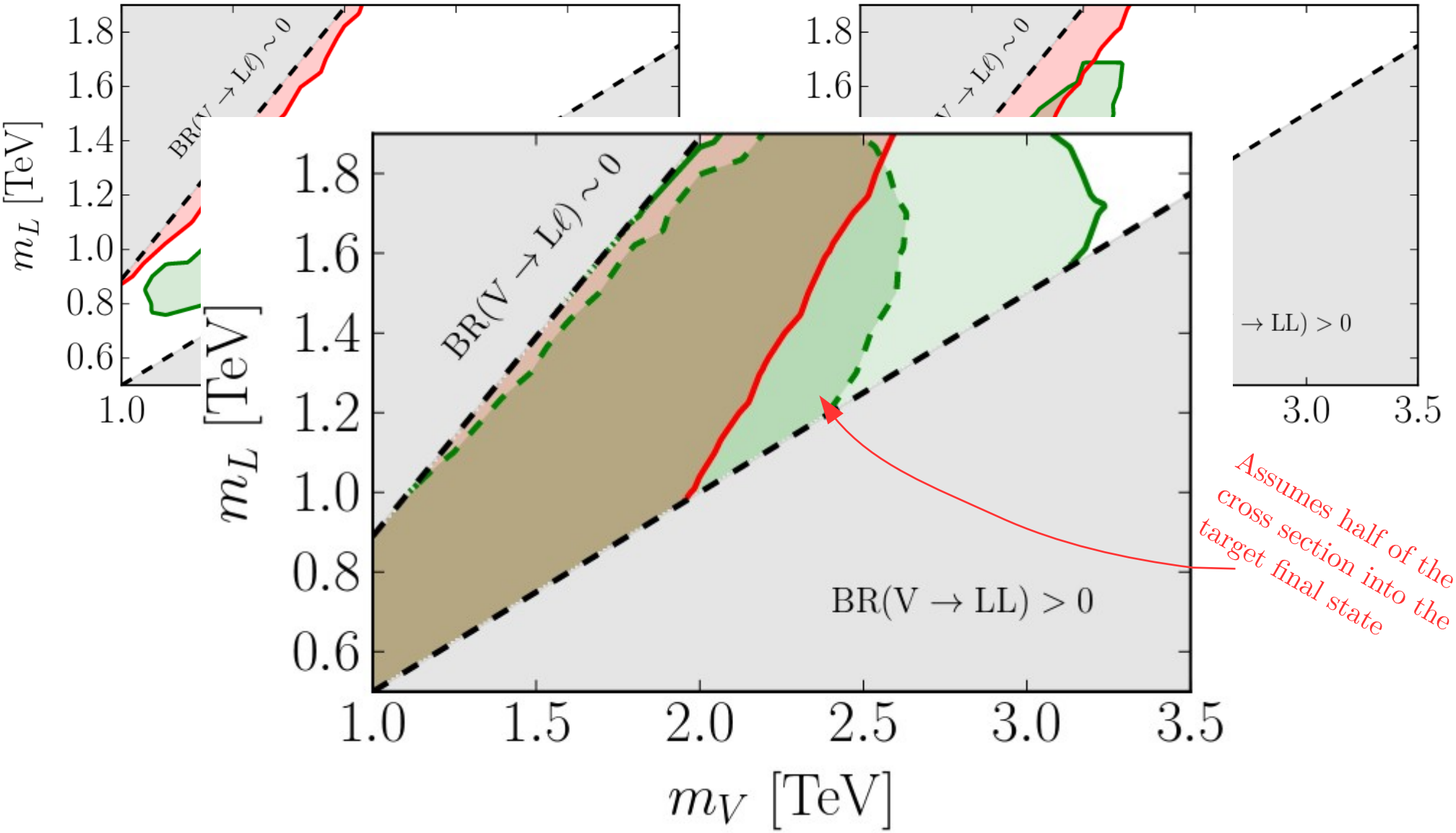

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- Some of the allowed regions can already be probed at the 95 % CL with our dedicated analysis.
- With more luminosity, *e.g.* 300/fb (3000/fb), heavier resonances can be tested, *e.g.* mV = 2 (3) TeV.