

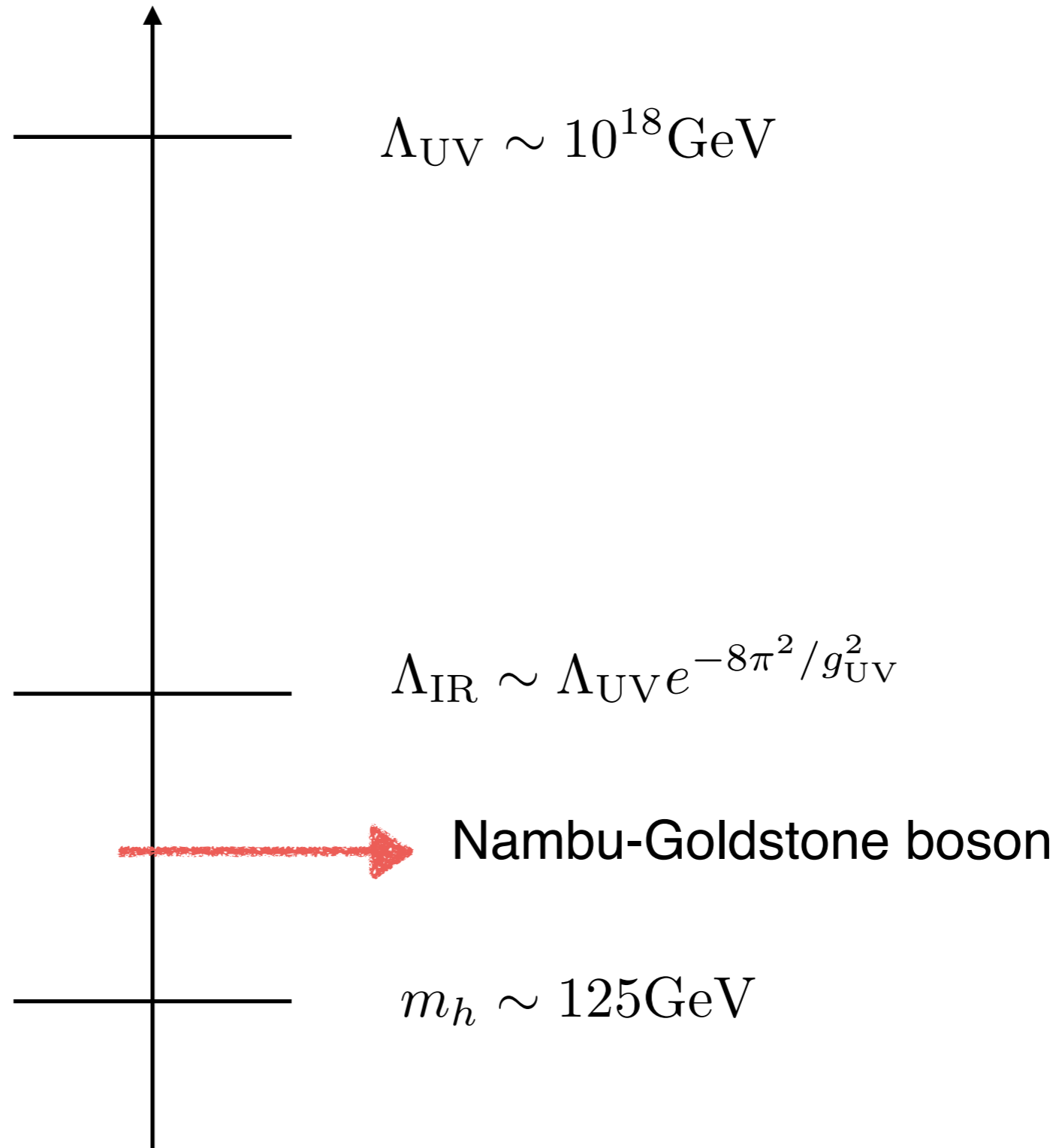
Composite Resonances at the High Energy Muon Collider

Da Liu

PITT PACC

With L.T. Wang and K.P. Xie
To appear soon

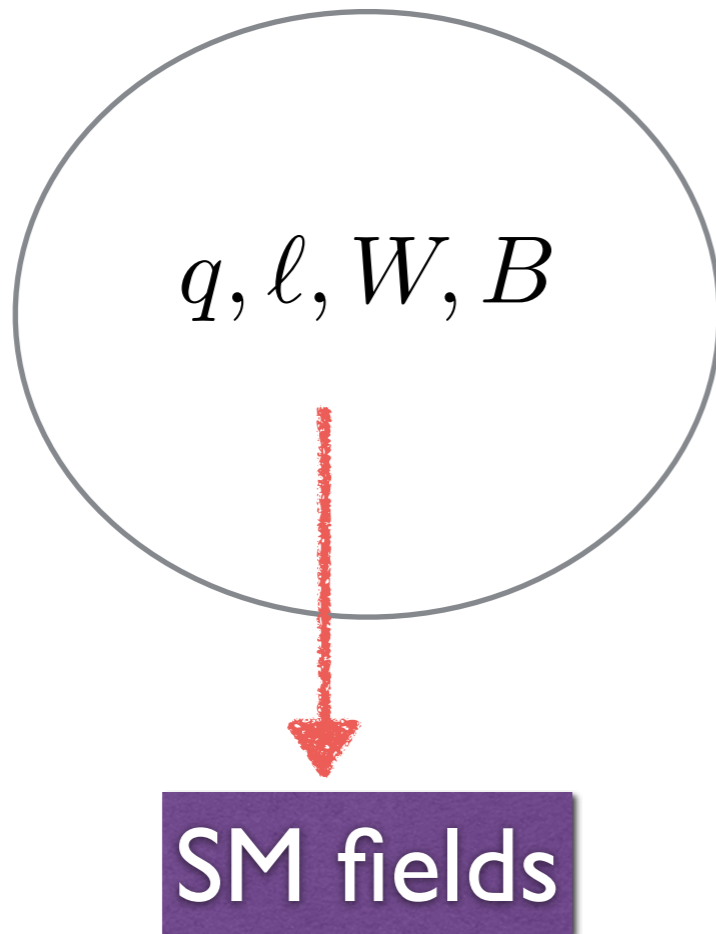
Compositeness



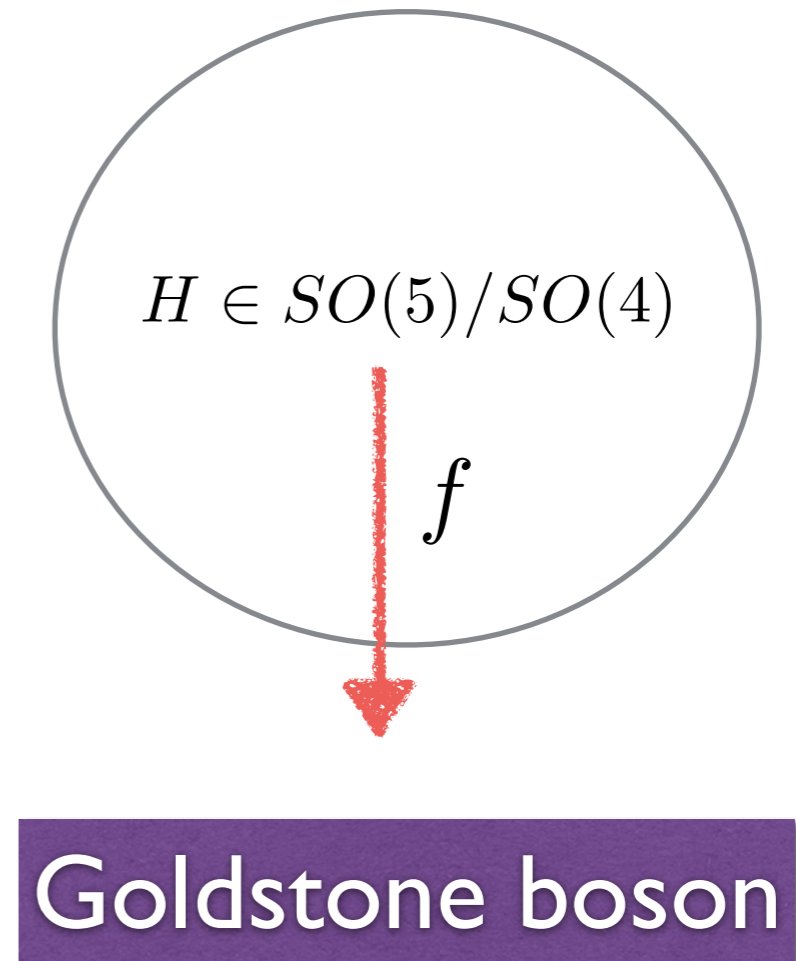
Enhanced shift symmetry!

Composite Higgs models: Assumption I

Elementary

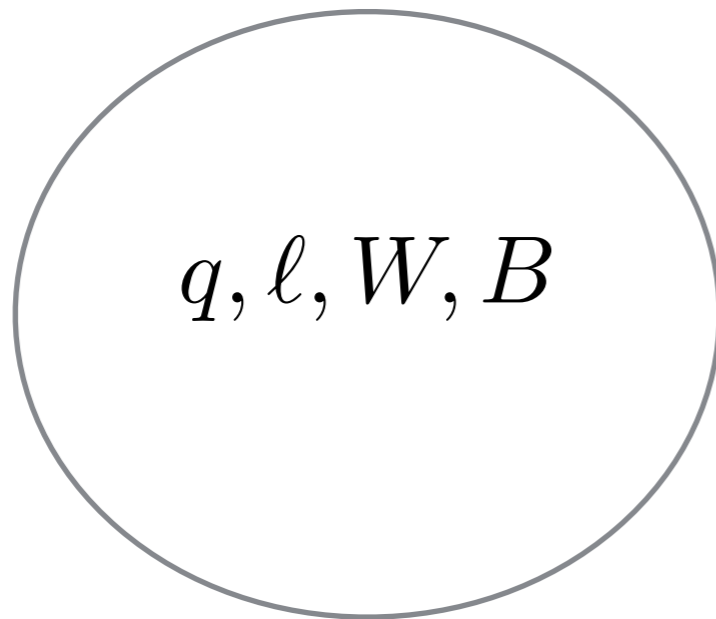


Strong

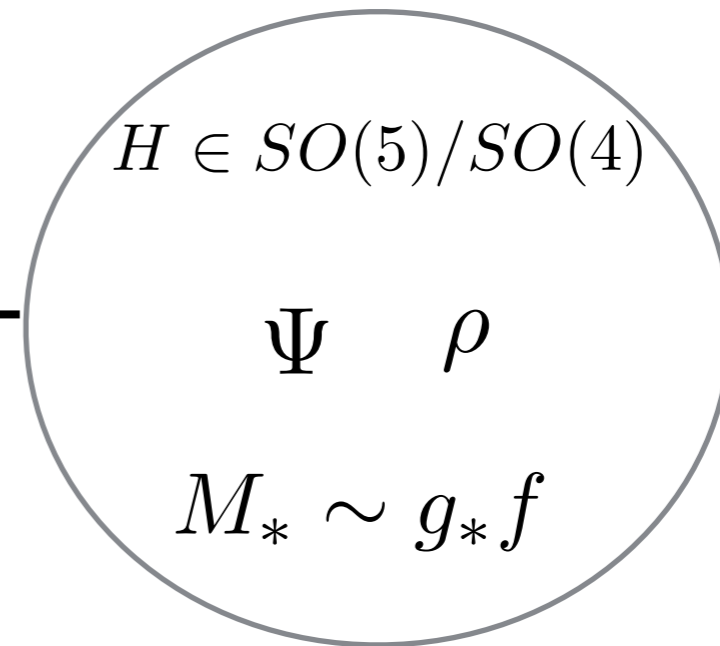


Composite Higgs models: Assumption II

Elementary



Strong



y_f, g, g'

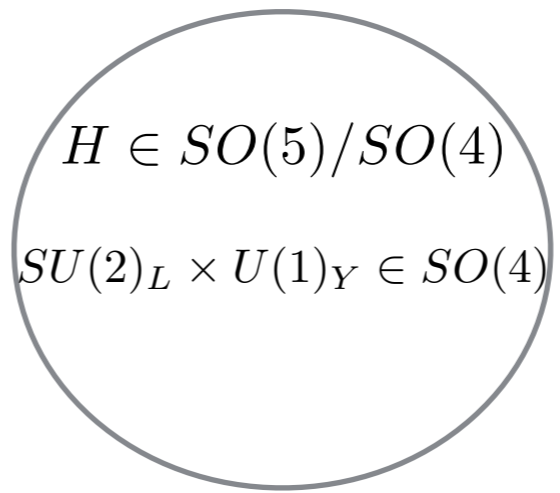


Partial Compositeness

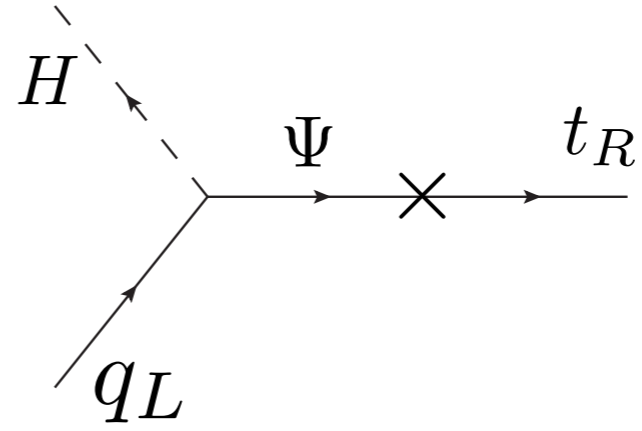
$$\xi = \frac{v^2}{f^2}$$

Partial compositeness: top quark mass

$$y_L \bar{q}_L^{I_L} \mathcal{O}_{I_L} + y_R \bar{t}_R^{I_R} \mathcal{O}_{I_R}$$



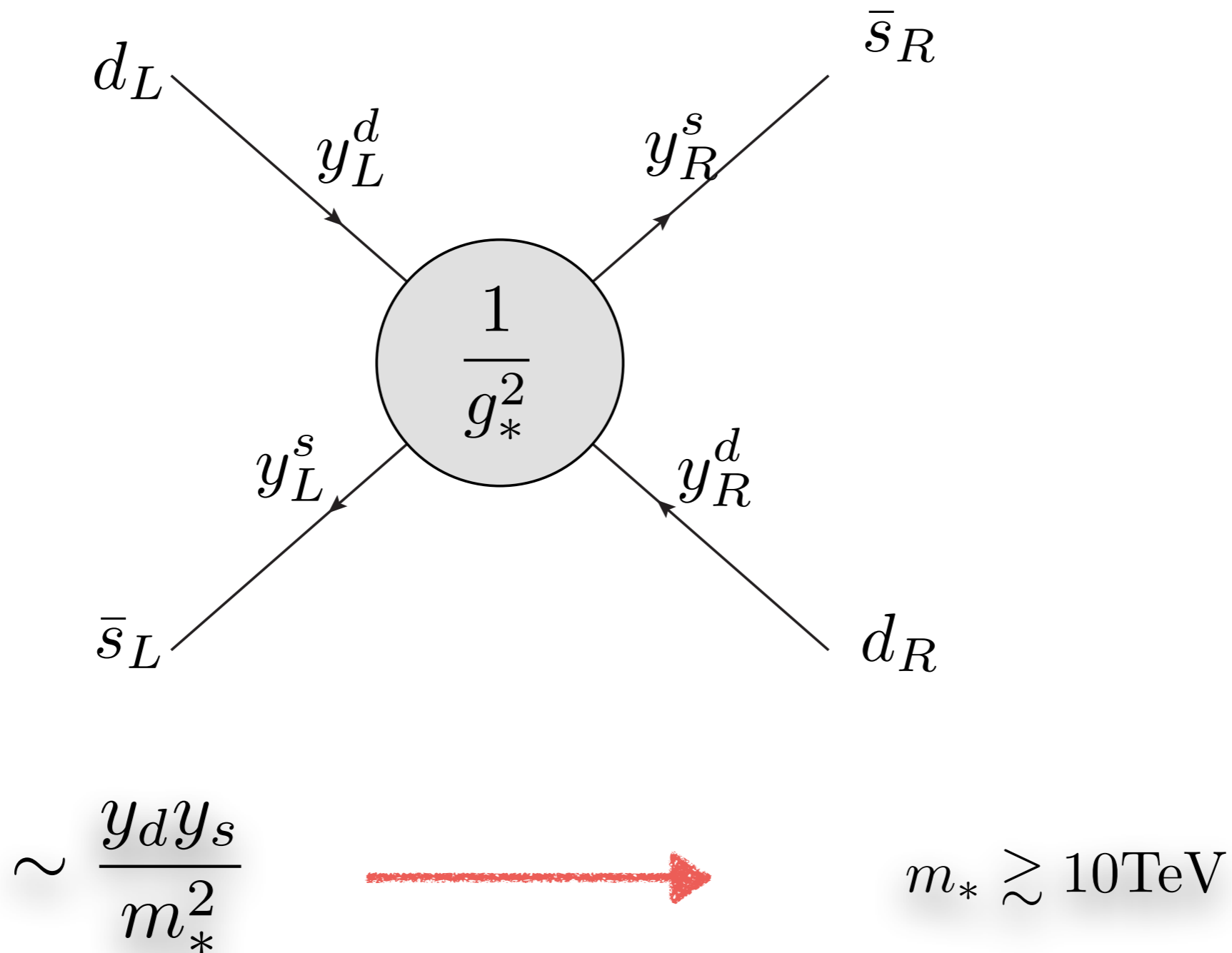
$$y_L \bar{q}_L H \Psi_R + y_R f \bar{t}_R \Psi_L$$



$$\frac{y_L y_R f}{M_\Psi} \bar{q}_L \tilde{H} t_R$$

$$y_t \sim \frac{y_L y_R}{g_*}$$

Partial compositeness: Flavor



Targets at the Muon Collider

- Probe the on-shell resonances up to kinematical limits
- Measure the couplings as precise as possible

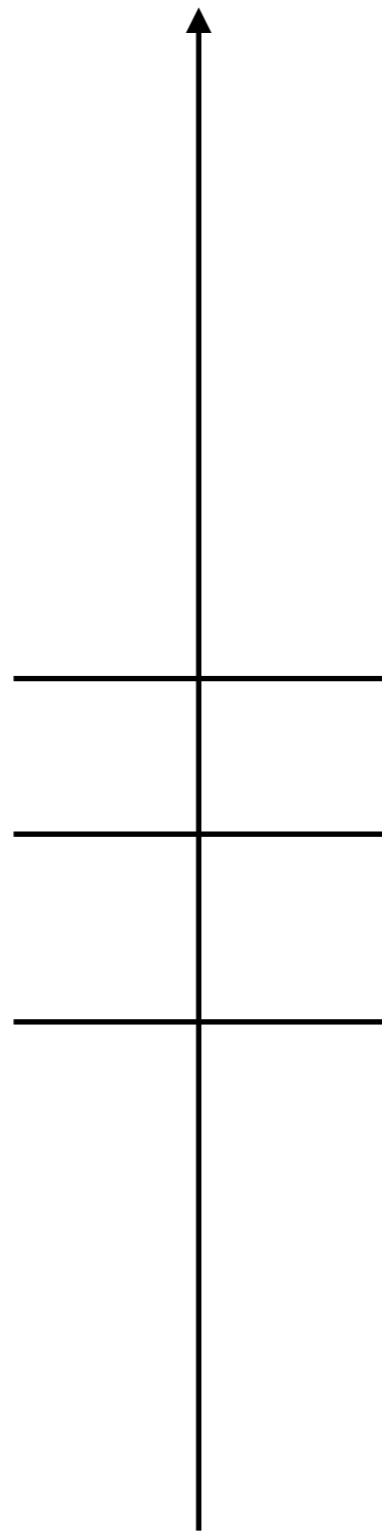
Direct Resonance searches

$$\rho_L = (3, 1)$$

$$Q = \left(\begin{array}{c} T \\ B \end{array} \right)_{\frac{1}{6}}$$

$$Q_X = \left(\begin{array}{c} X_{5/3} \\ X_{2/3} \end{array} \right)_{\frac{7}{6}}$$

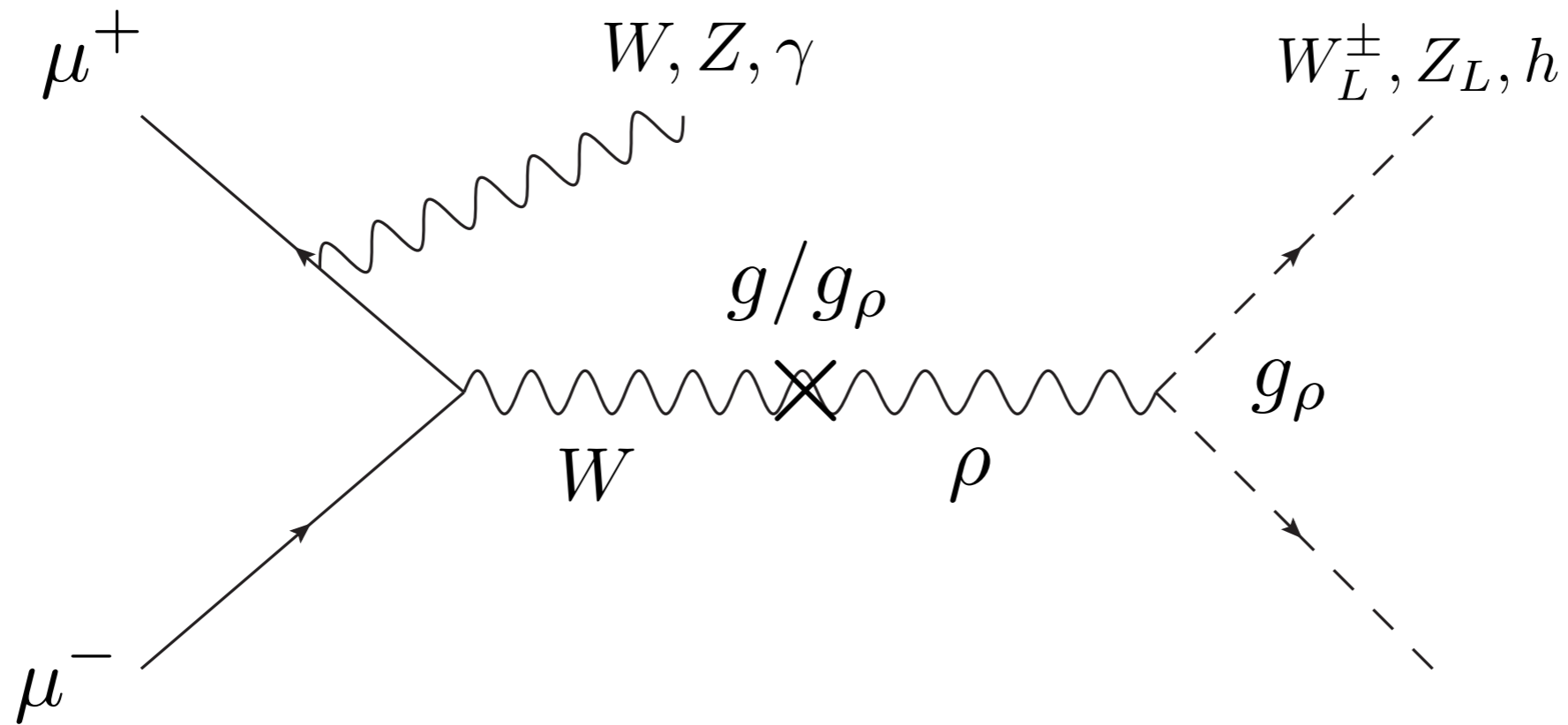
$$m_\rho = a_\rho g_\rho f$$



$$M_T = \sqrt{M_\Psi^2 + y_L^2 f^2}$$

$$M_{X_{5/3}} = M_\Psi$$

Spin-1 resonances: DY-like

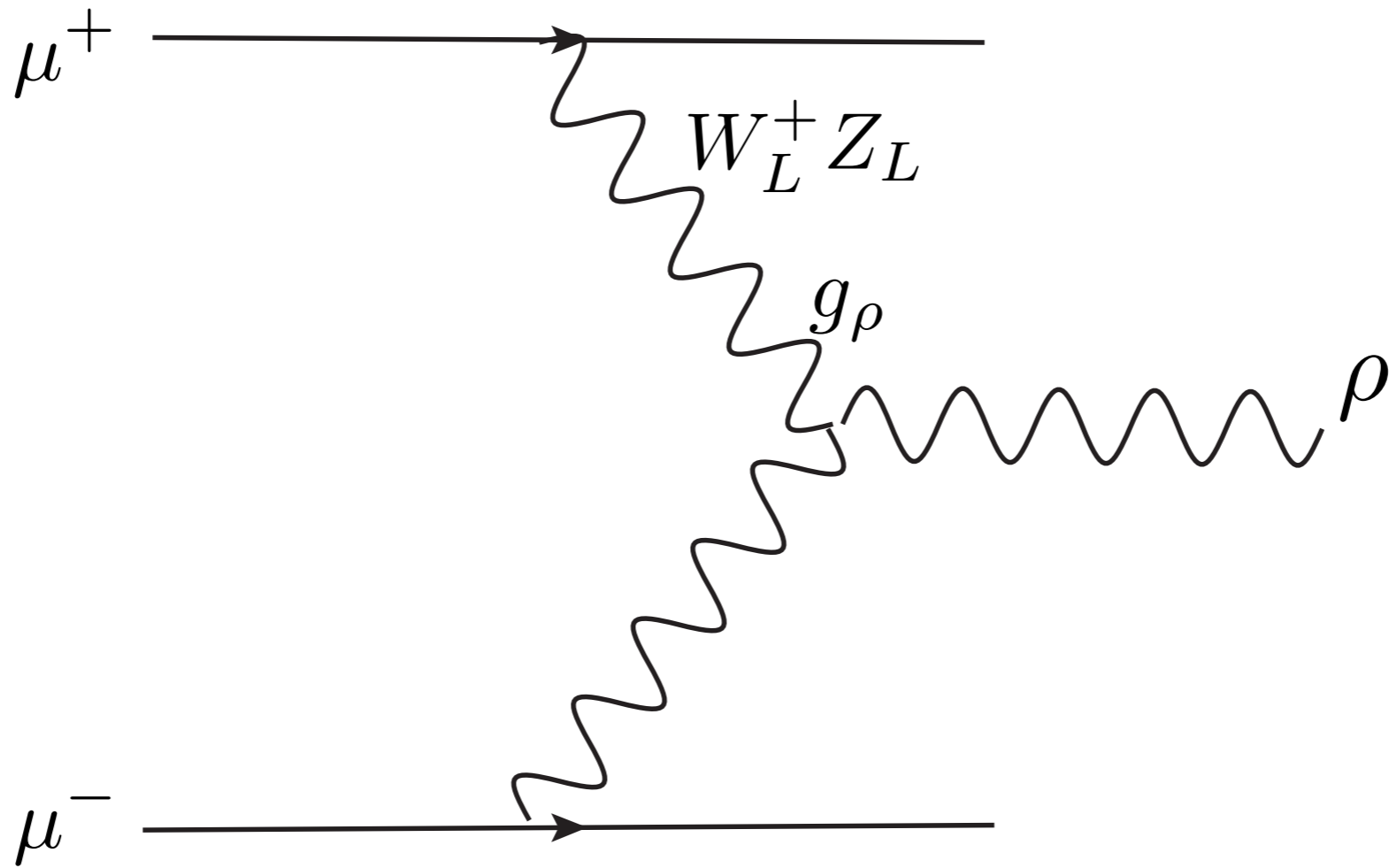


$$\sigma \sim \frac{1}{E_\gamma} \sim \frac{1}{s - M_\rho^2}$$

$$\text{BR}_{VV+Vh} \gtrsim 80\%, \quad \text{for } g_\rho > 3$$

DL, L.T.Wang and K. P. Xie
Working in progress

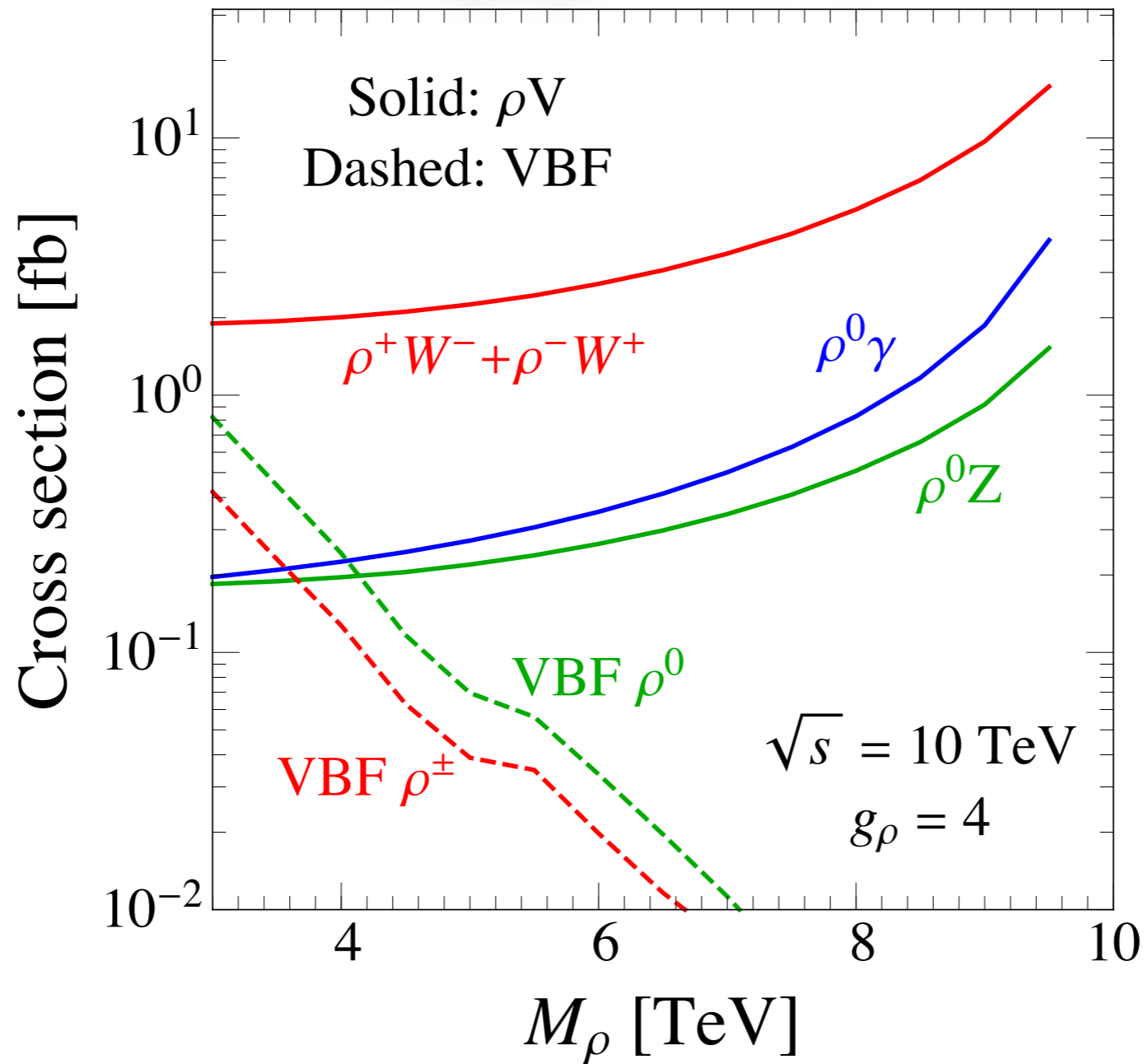
Spin-1 resonances: VBF



Spin-1 resonances: XS

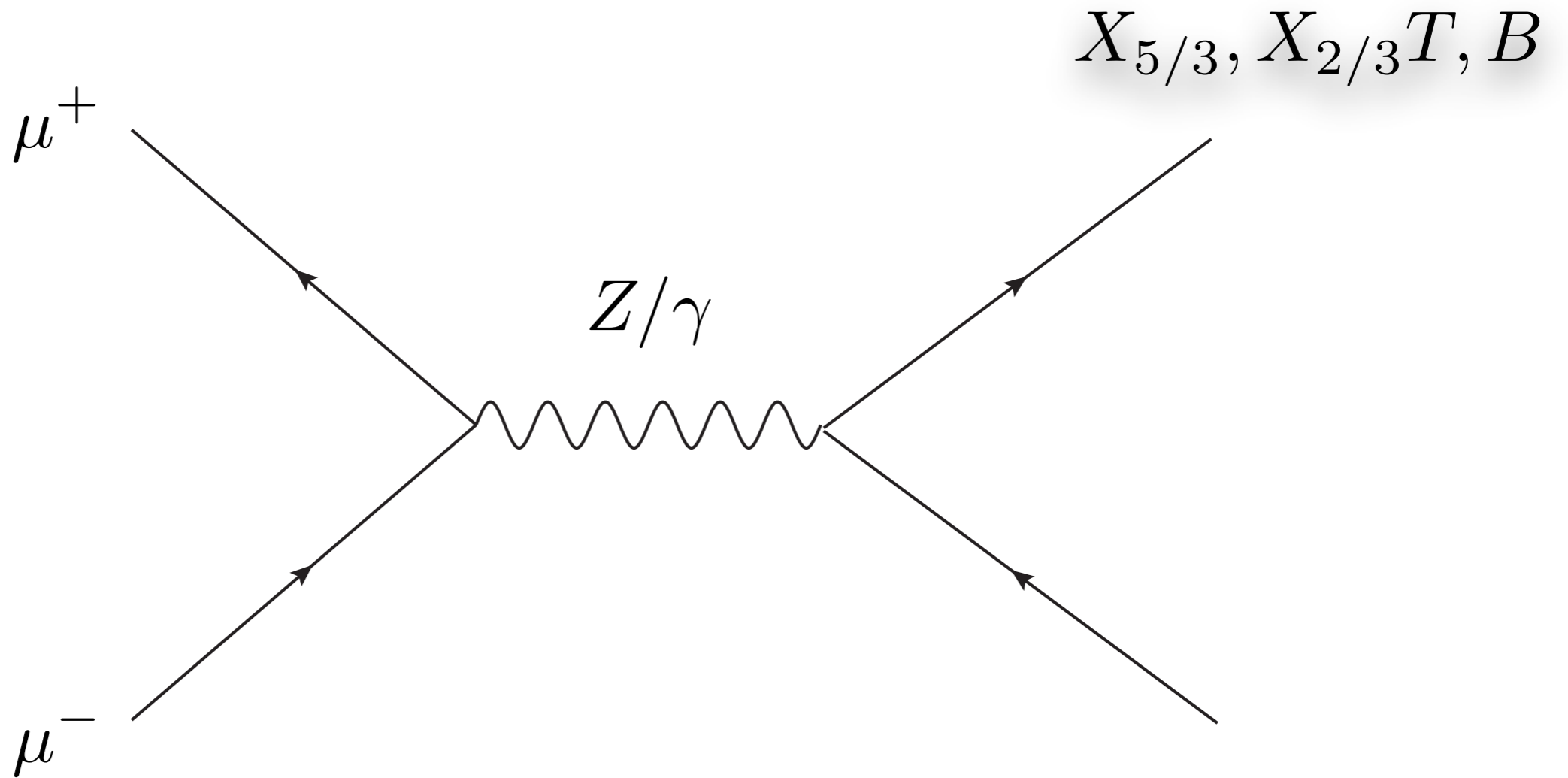
$$\sqrt{s}_{\mu^+\mu^-} = 10\text{TeV}$$

$$L = 10\text{ab}^{-1}$$

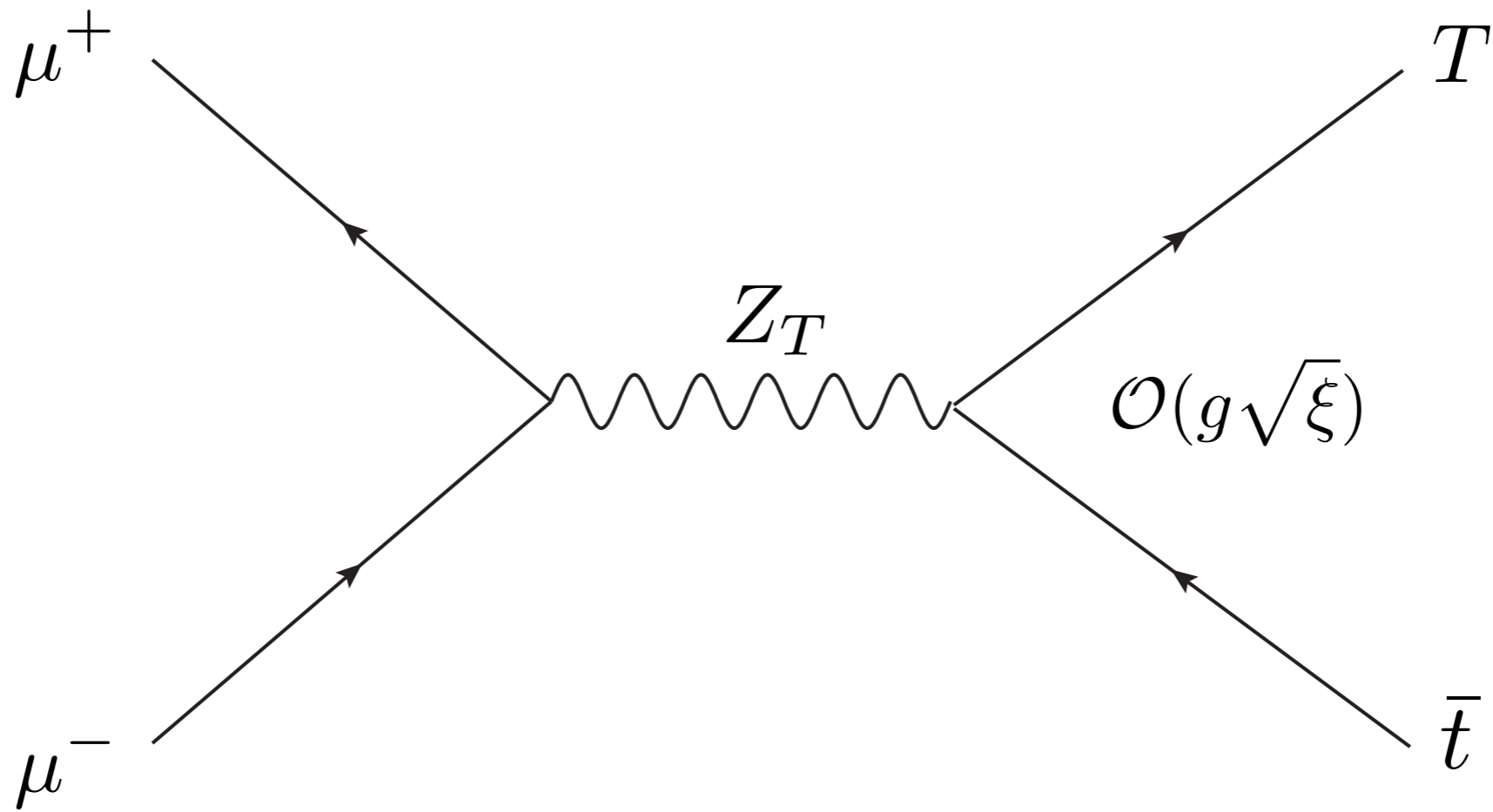


$$N \sim \mathcal{O}(100)$$

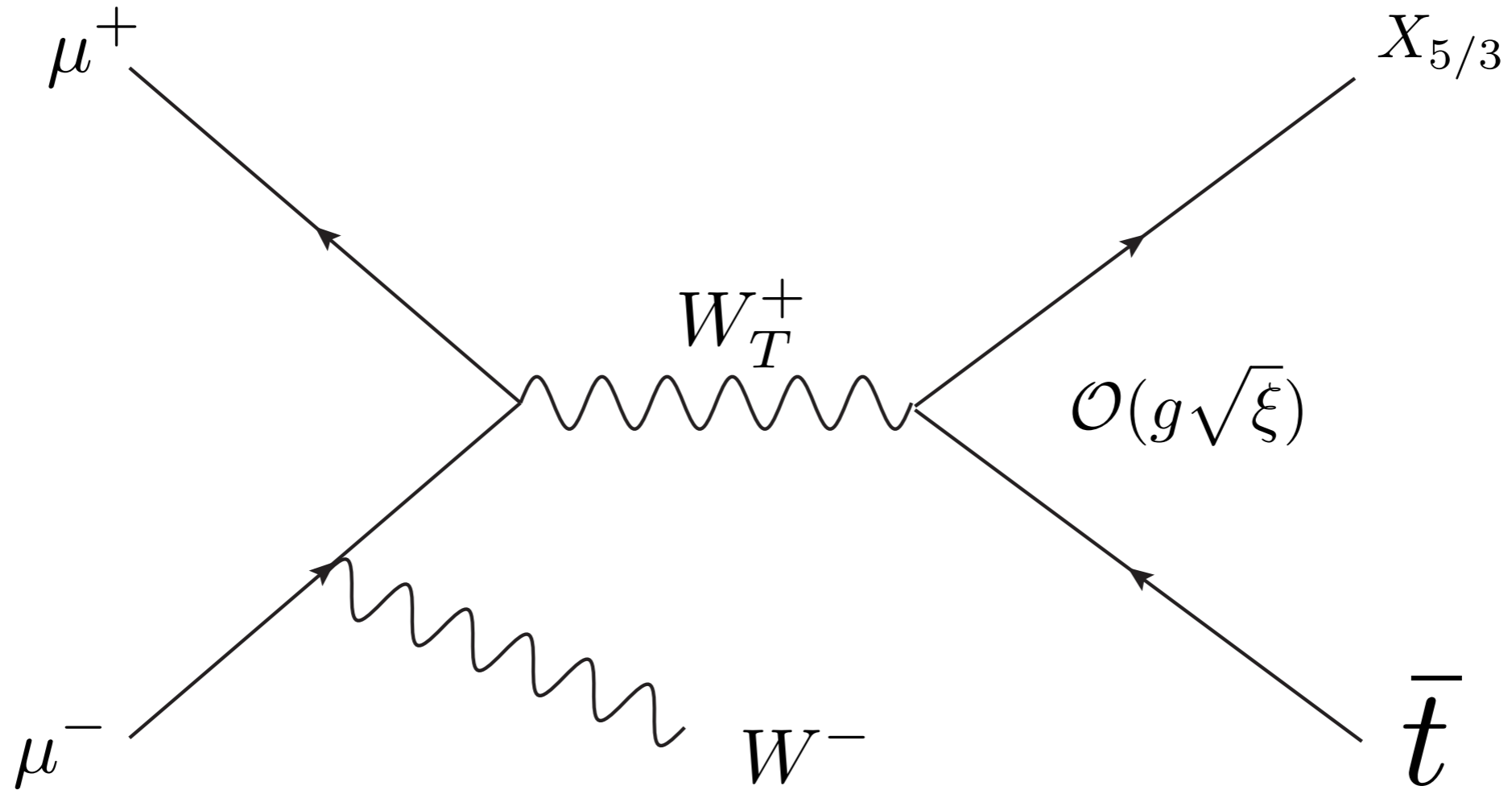
Top partners: DY Pair



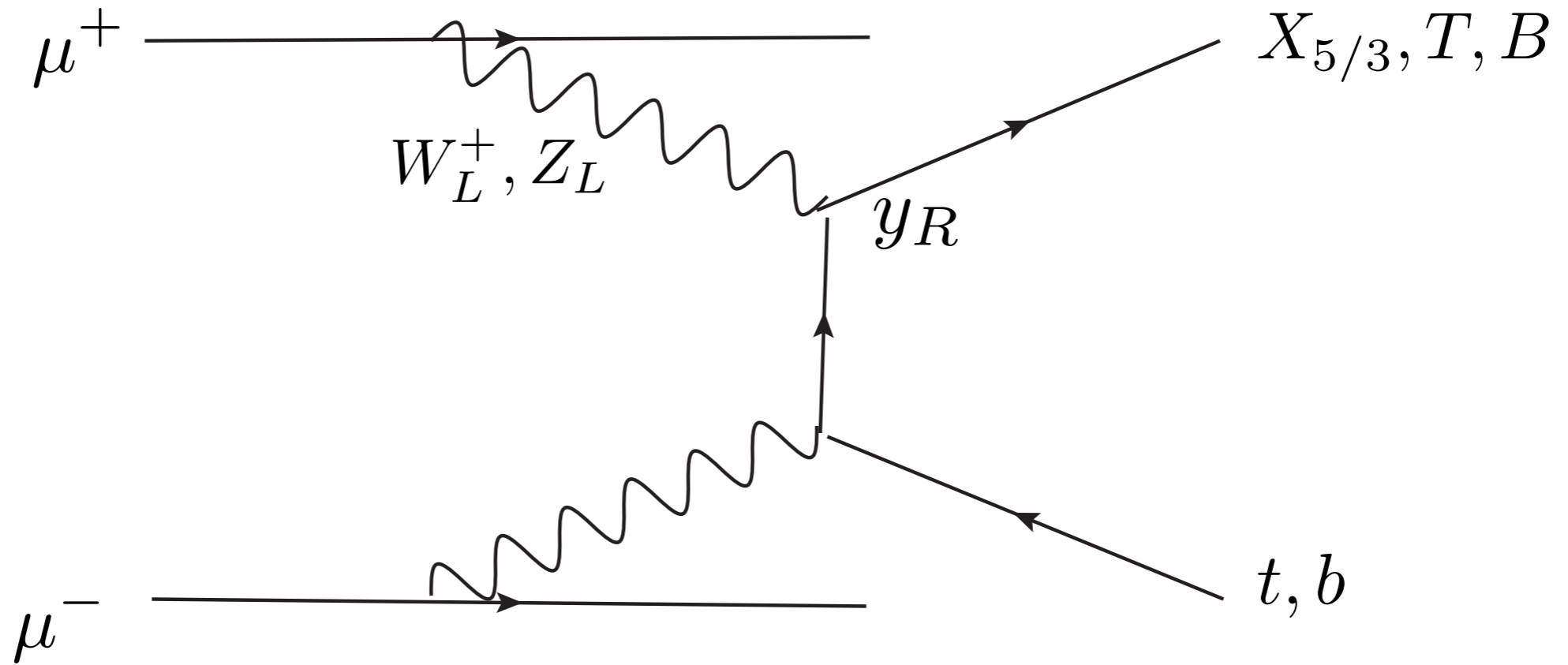
Top partners: DY Single



Top partners: DY-like Single

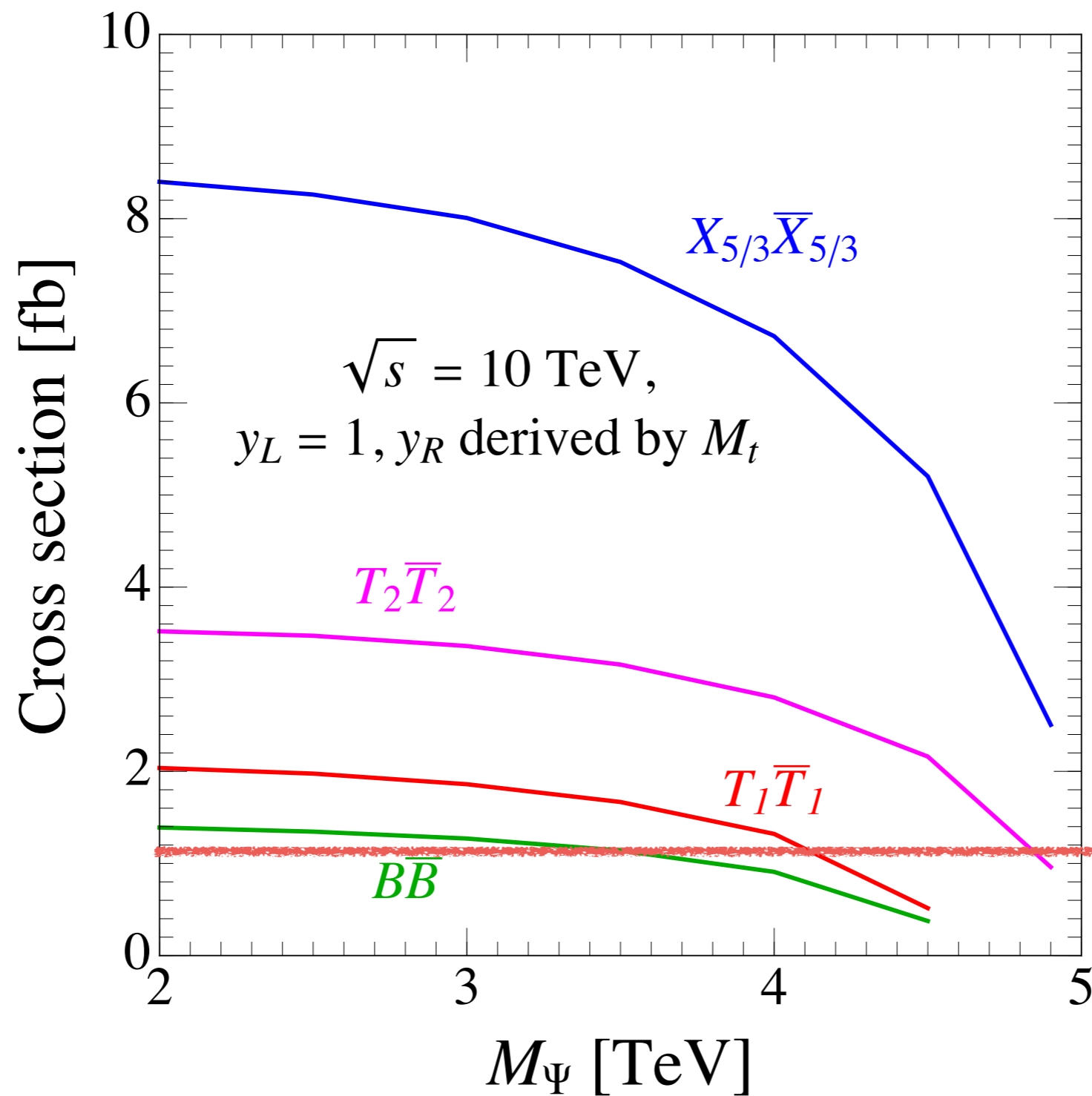


Top partners: VBF



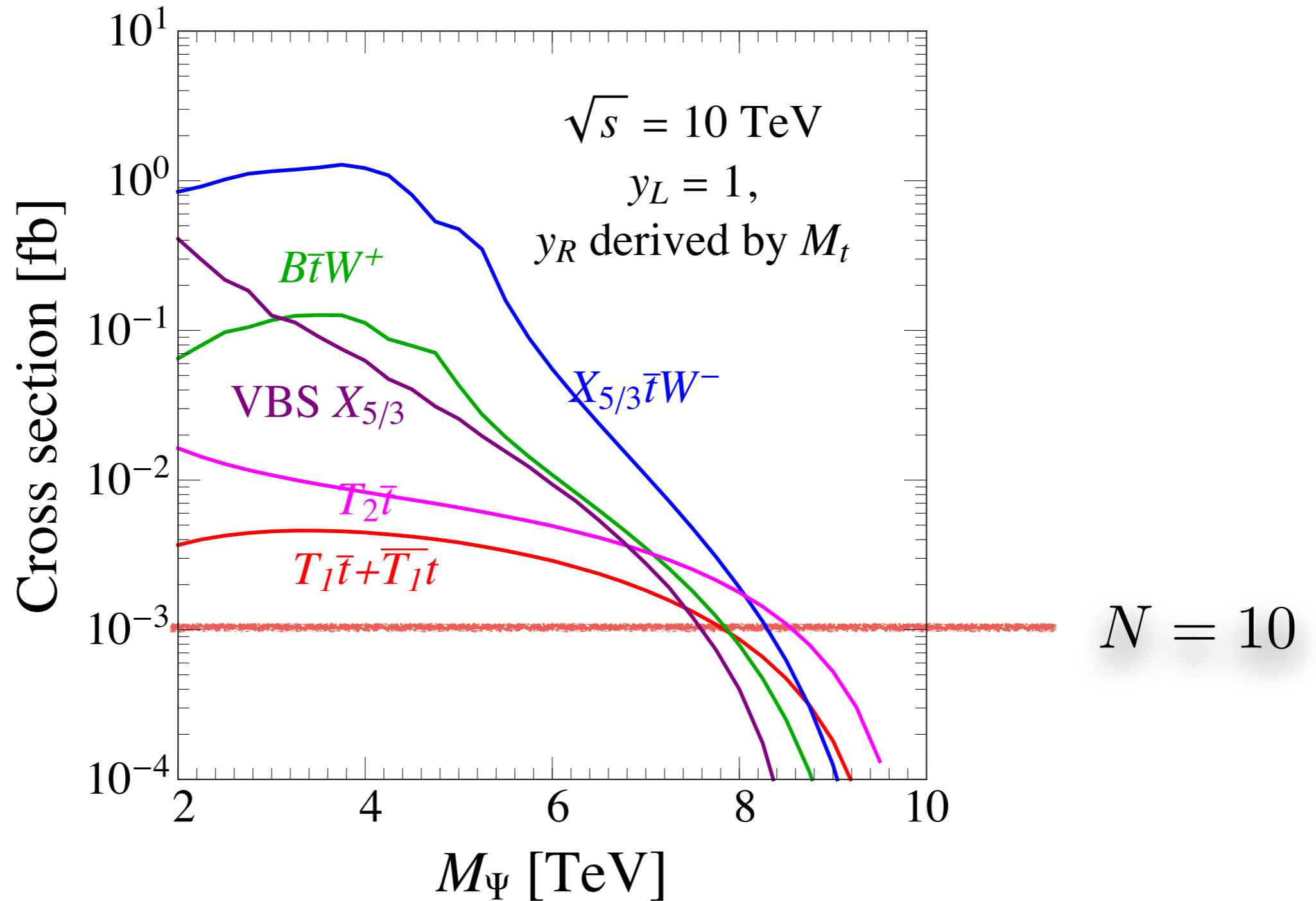
Relevant for large y_R

Top partners: Pair production XS



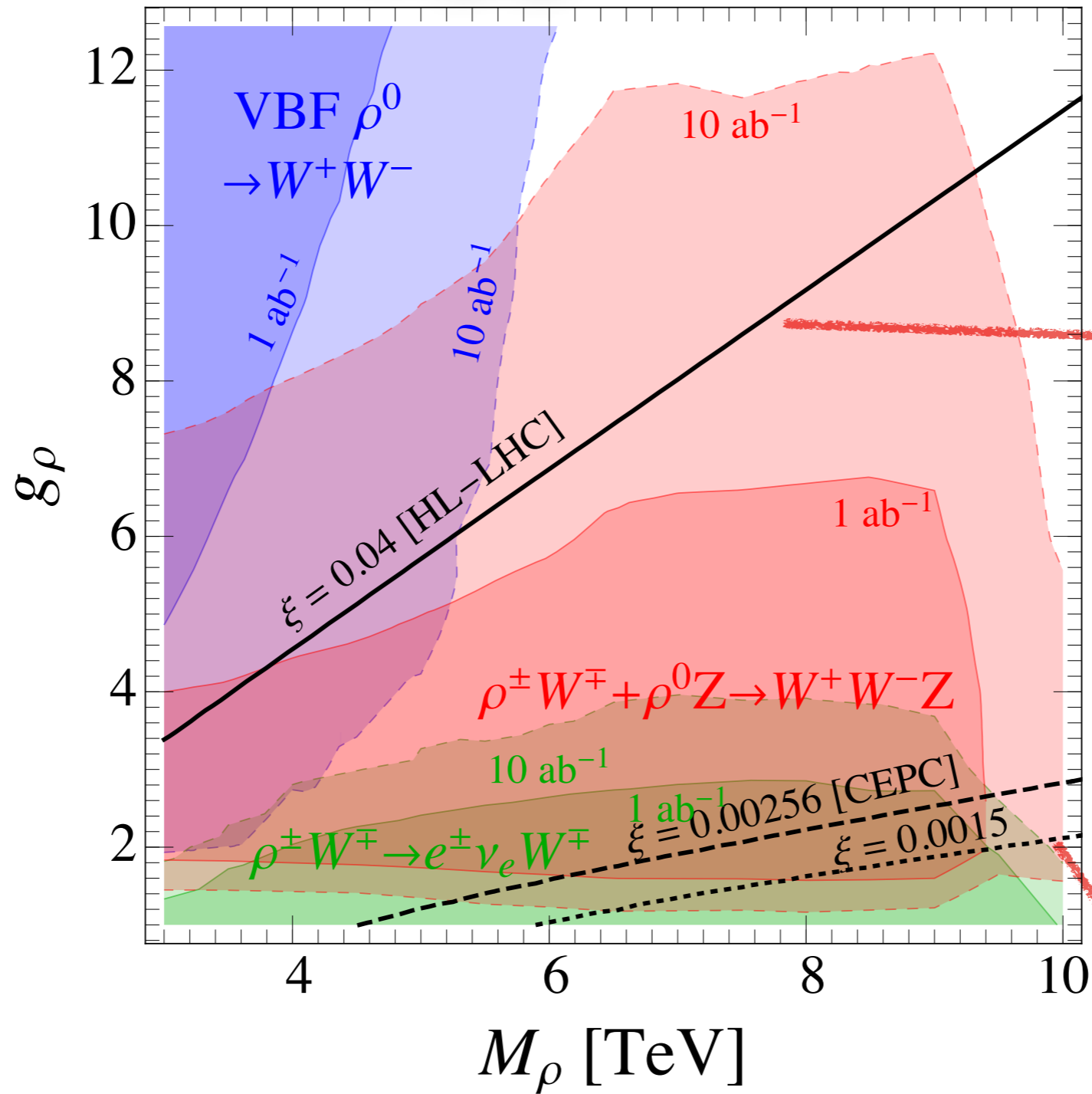
$$N = 10^4$$

Top partners: Single production



Projection: Spin-1

$$\sqrt{s}_{\mu^+\mu^-} = 10\text{TeV}$$



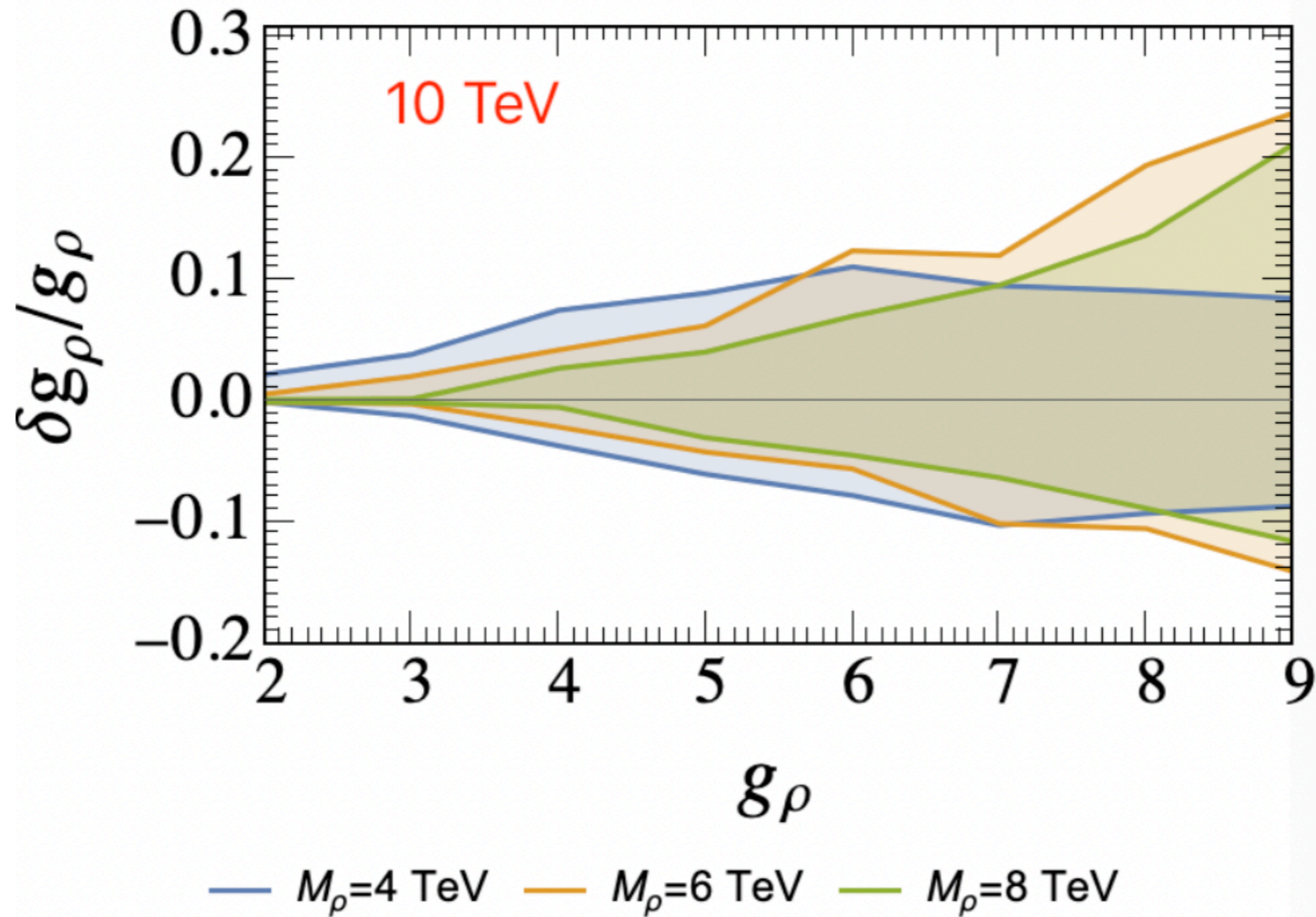
$$M_\rho = \frac{1}{\sqrt{2}} g_\rho f$$

Hadronically decaying

10 TeV Muon Collider
see T. Han, DL, I. Low and X. Wang

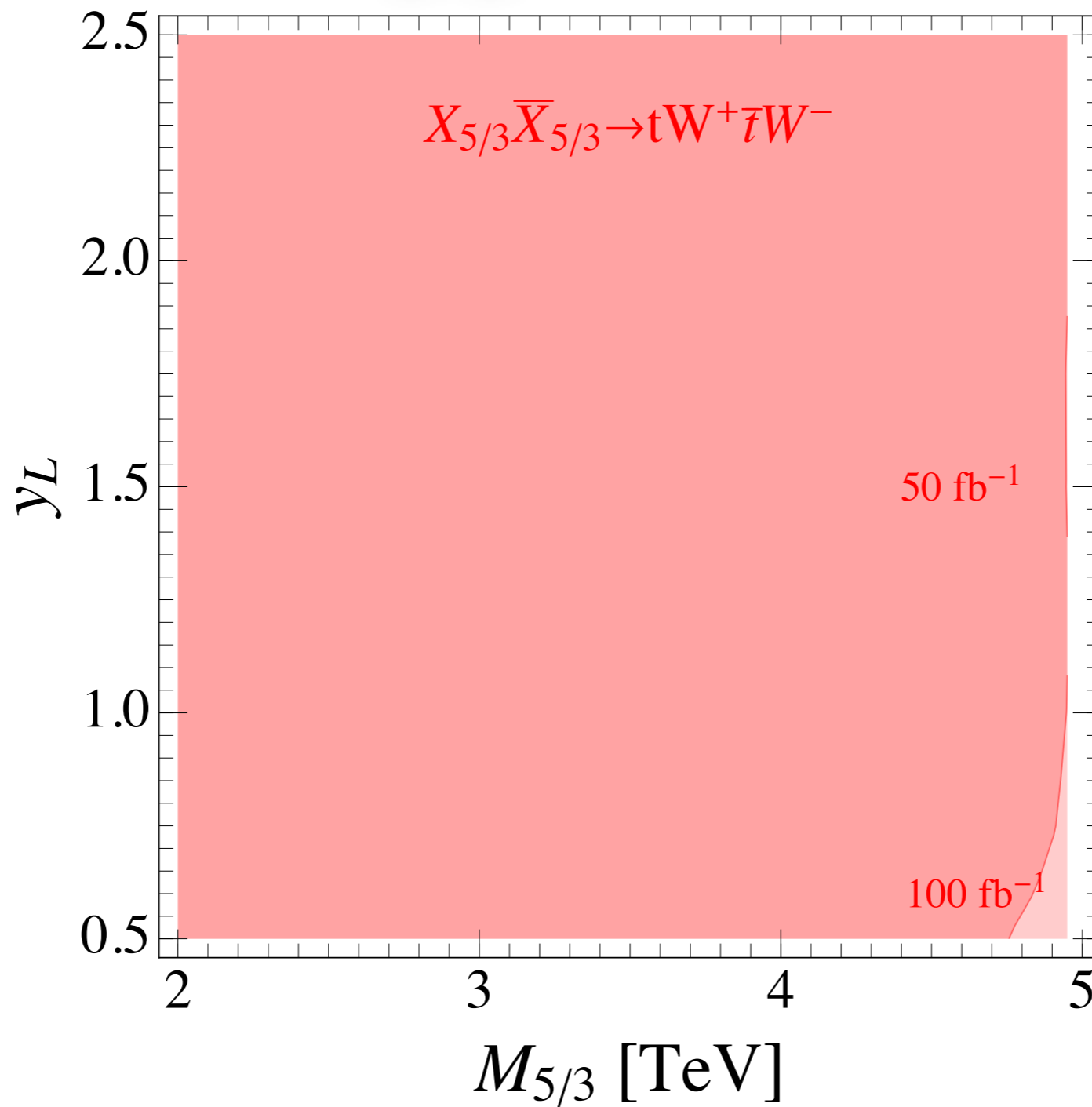
Coupling Measurement

$$\sqrt{s}_{\mu^+\mu^-} = 10\text{TeV}$$



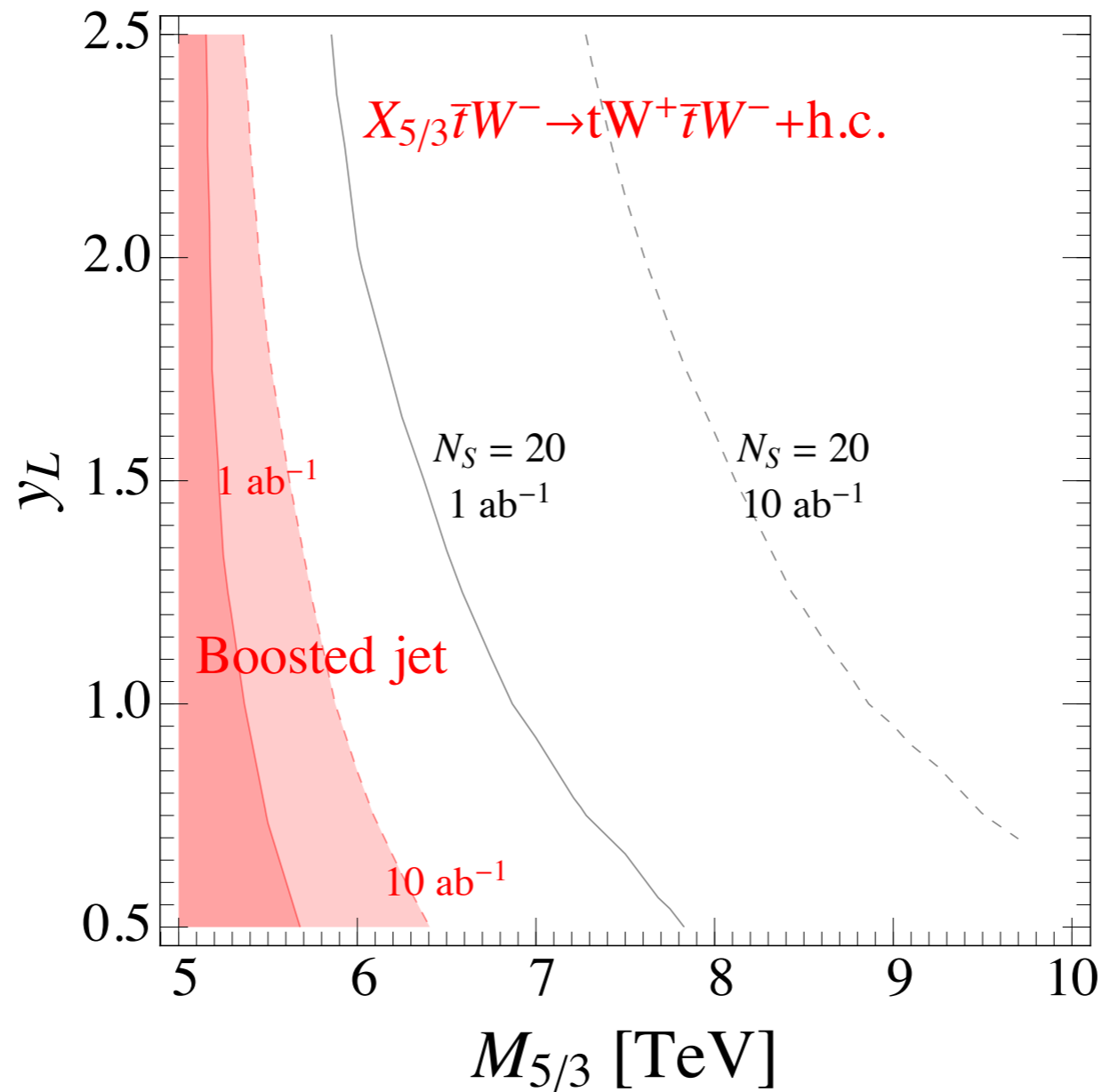
Projection: top partner

$$\sqrt{s}_{\mu^+\mu^-} = 10\text{TeV}$$



Projection: top partner

$$\sqrt{s}_{\mu^+\mu^-} = 10\text{TeV}$$



Conclusion

- Most of the parameter space can be covered by the spin-one resonances
- Top partner above 5 TeV needs more study

Back-up slides

