Searching for Dark Photons using Maverick Top Partners

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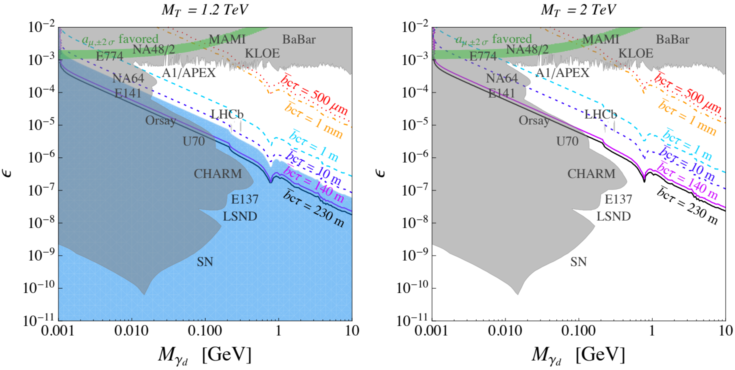
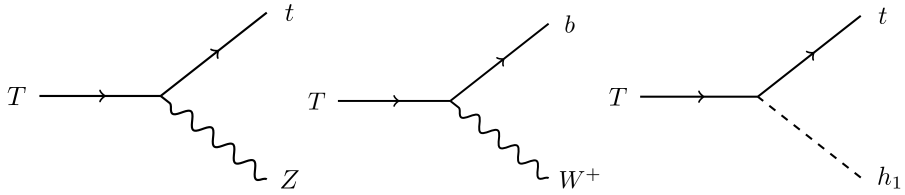
arXiv: 1904.05893



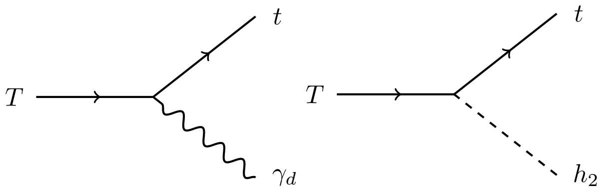
Outline

What is a Maverick Top?

Typical top partner electroweak decay modes

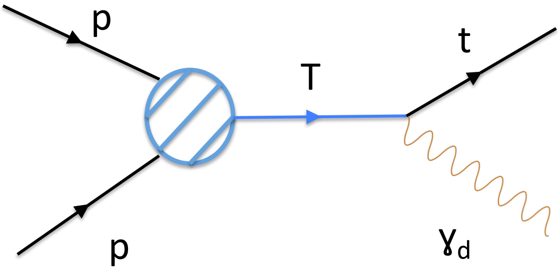


Maverick top partners have additional decay modes



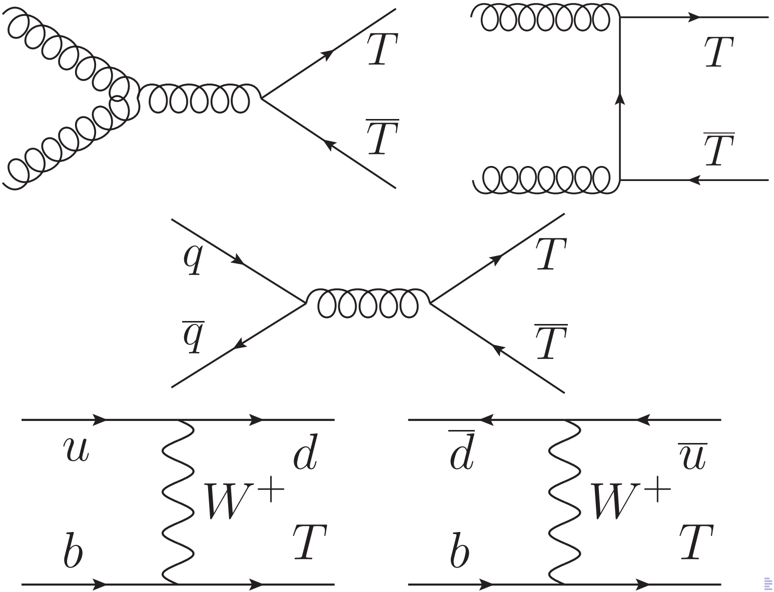
Portal Matter

The dark photon production depends on QCD and not small parameter ϵ



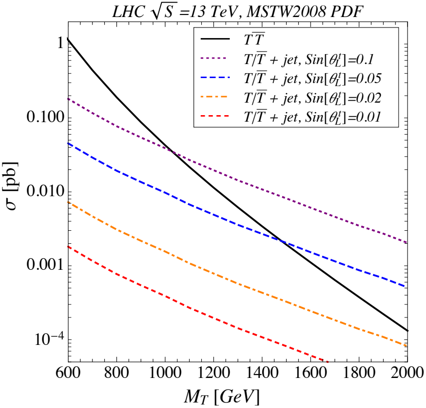
Standard Model → Portal Matter → Dark Sector

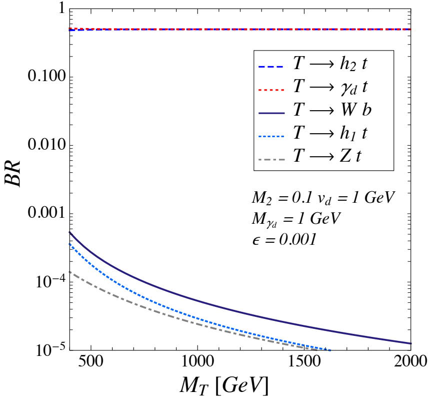
Maverick Top Production Channels



Maverick Top Production and Decay

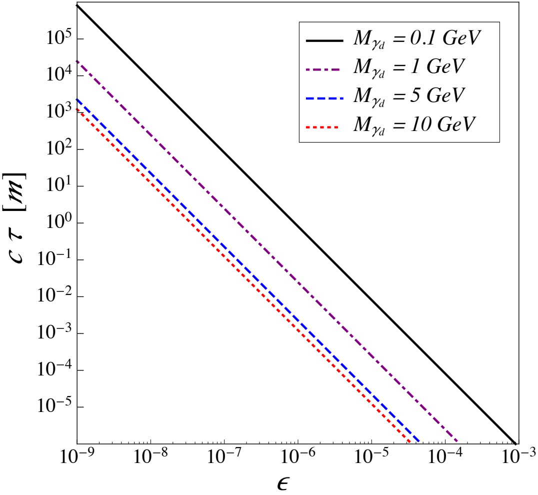
Maverick top is produced at QCD rate and then decays half of the time to a dark photon. Hence, dark photon production is independent of epsilon and produced at about the QCD rate.



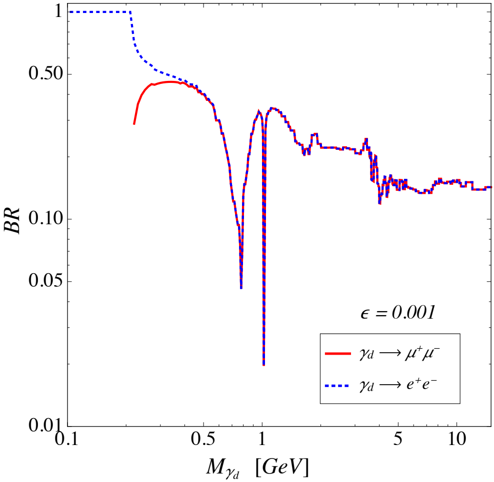


Dark Photon Decay Length

Lots of variability in the decay length depending on the model parameters.



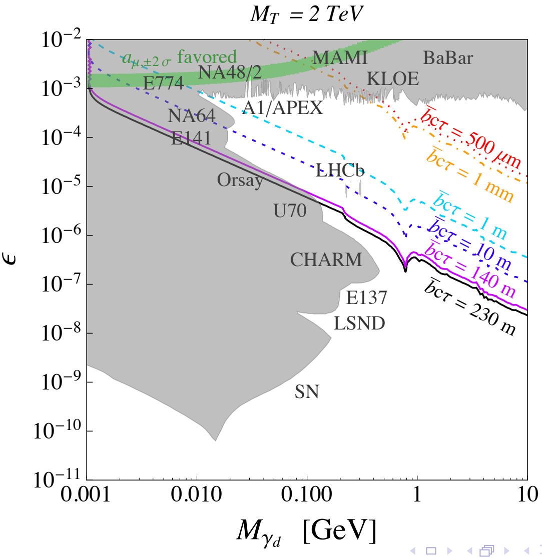
Dark Photon Branching Ratio



Curtin (2014) arXiv: 1412.0018

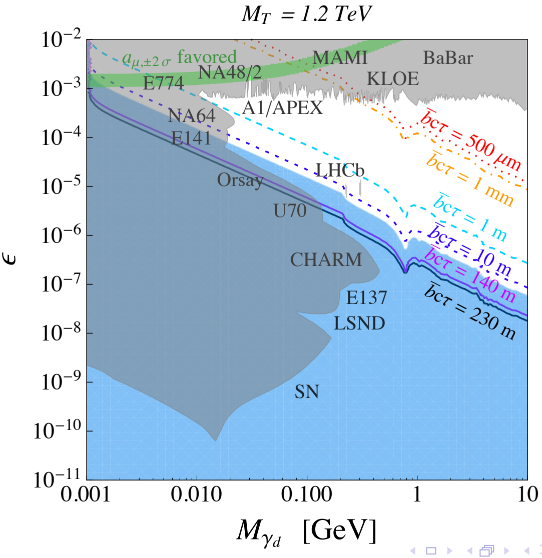
Dark Photon Collider Phenomenology

There is a rich decay phenomenology in the open parameter space.



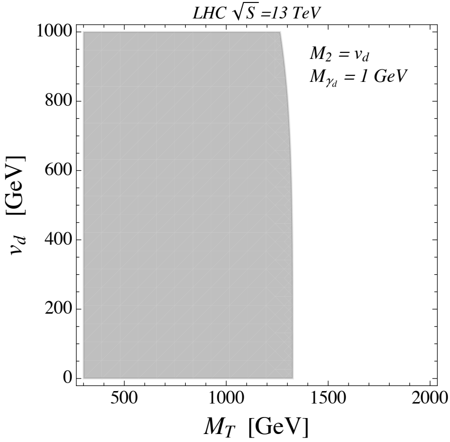
Dark Photon Collider Phenomenology

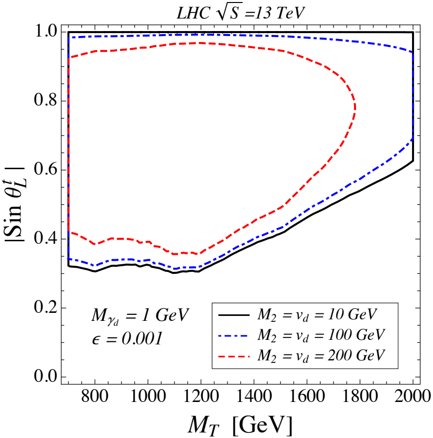
Rule out longer decay lengths by recasting stop searches



Questions?

Reinterpreting Stop Searches





CMS-PAS-SUS-19-005, Aaboud (2018) arXiv: 1812.09743

Dark Photon Hadronic Decays

$$R(M_{\gamma_d}) \equiv \frac{\sigma(e^+e^- \to hadrons)}{\sigma(e^+e^- \to \mu^+\mu^-)}$$

$$\begin{aligned}\Gamma^{tot}_{\gamma_d} &= R(M_{\gamma_d})\Gamma(\gamma_d \to \mu^+\mu^-) + \sum_{f=e,\mu,\tau,\nu_e,\nu_\mu,\nu_\tau} \Gamma(\gamma_d \to f\bar{f}) \\ &\approx \frac{\varepsilon^2 e^2}{12\,\pi} M_{\gamma_d}\left[R(M_{\gamma_d}) + \sum_{\ell=e,\mu\tau} \theta(M_{\gamma_d} - 2\,M_\ell)\right]\end{aligned}$$

M. Tanabashi et al. "Review of Particle Physics" , Phys. Rev. D98.3 (2018)

Boost Factor

$$d = \bar{b} c \tau$$

$$\bar{b} = \frac{|\vec{p}_{\gamma_d}|}{M_{\gamma_d}} = \frac{1}{2 M_{\gamma_d} M_T} \sqrt{(M_T^2 - M_{\gamma_d}^2 - M_t^2)^2 - 4 M_{\gamma_d}^2 M_t^2}$$

$$\xrightarrow[M_T \gg M_{\gamma_d}, M_t]{} \frac{M_T}{2 M_{\gamma_d}},$$

$$d = 580\ \mu\mathrm{m} \times \frac{7}{R(M_{\gamma_d}) + \sum_{\ell=e,\mu\tau} \theta(M_{\gamma_d} - 2\, M_\ell)} \times \left(\frac{M_T}{1\ \mathrm{TeV}}\right) \left(\frac{1\ \mathrm{GeV}}{M_{\gamma_d}}\right)^2 \left(\frac{10^{-4}}{\varepsilon}\right)^2 .$$