A model-independent analysis of the FASER(2) reach for light particles in B and D decays

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In collaboration with Noam Burger, Jonathan L. Feng and Yael Shadmi

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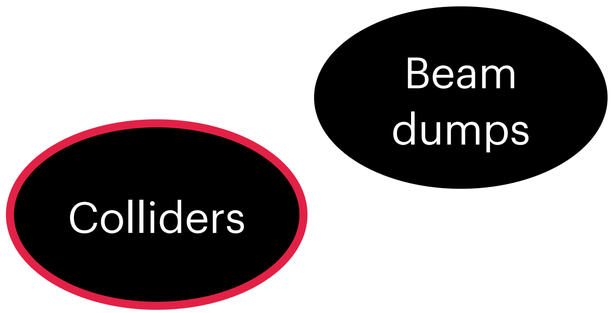

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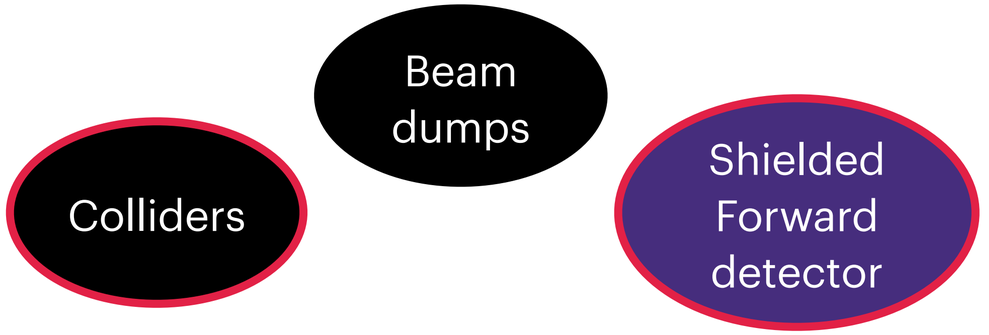

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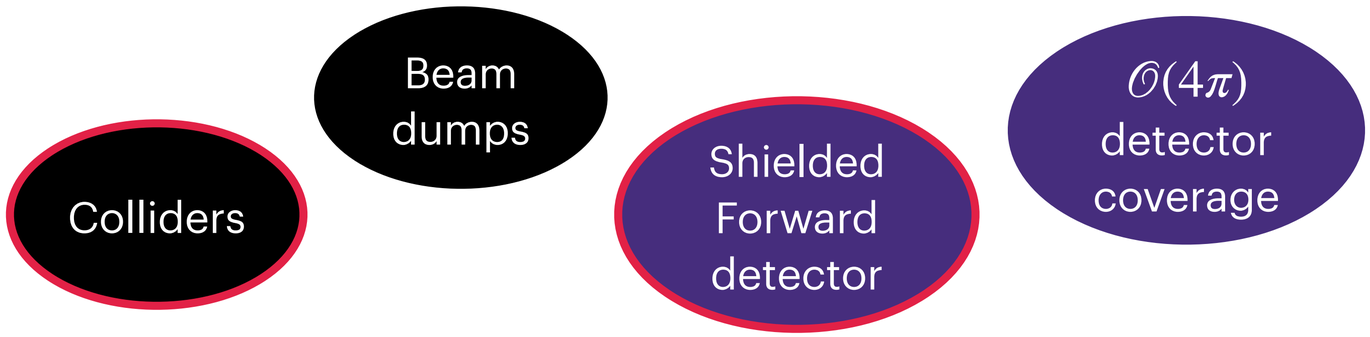

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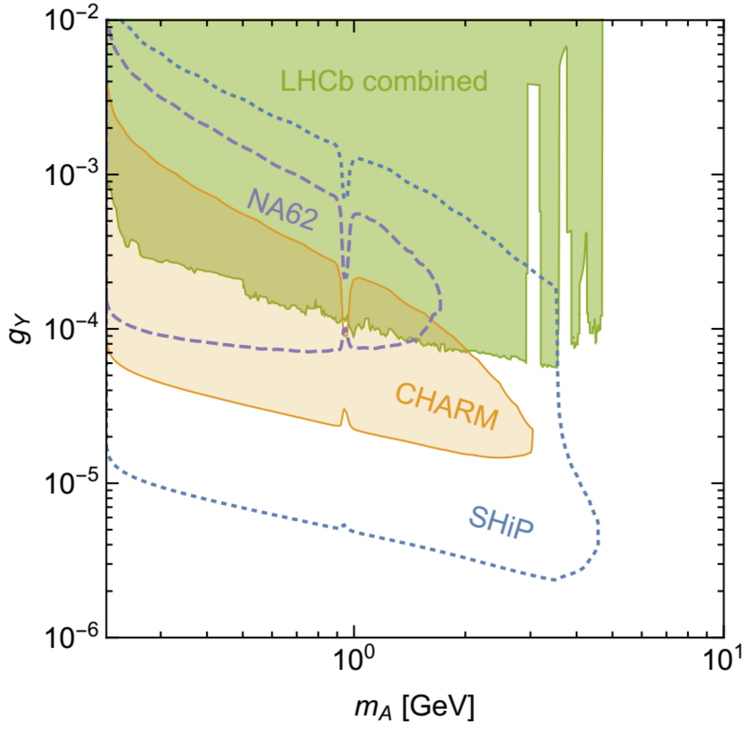

$$\mathcal{L} = i\, g_Y \sum_{f=q,\ell} \frac{m_f}{v} A\, \bar{f}\gamma^5 f$$

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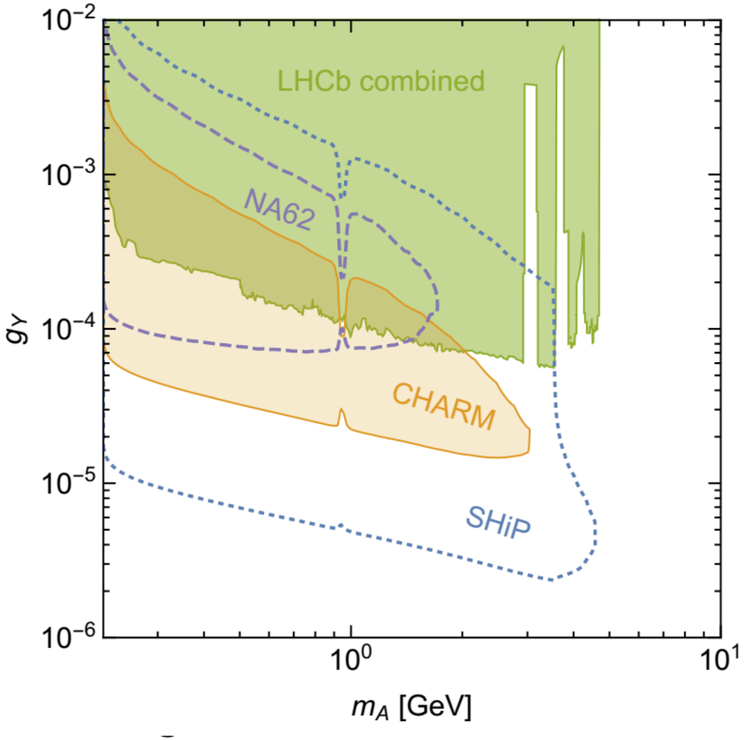

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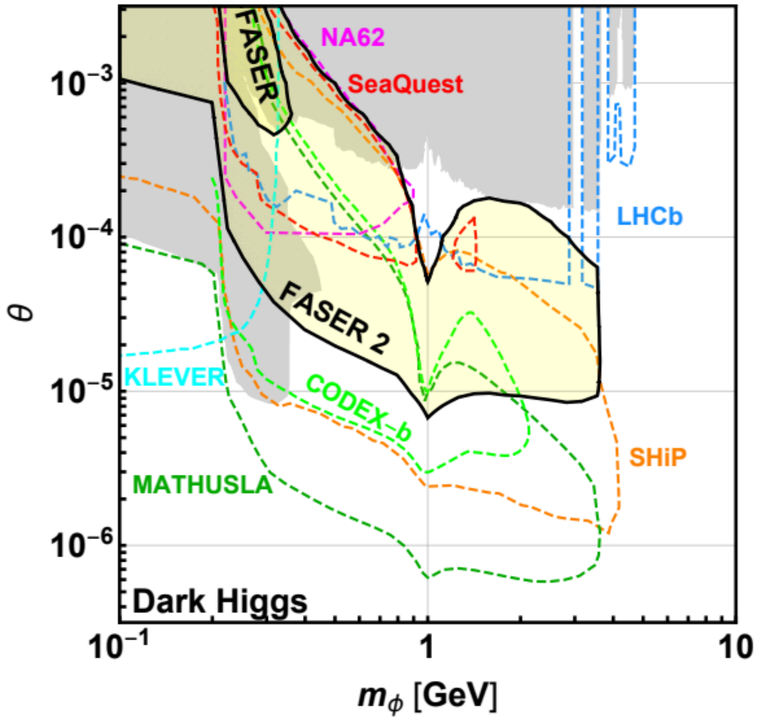

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FASER Collaboration *Phys.Rev.D* 99 (2019) 9, 095011

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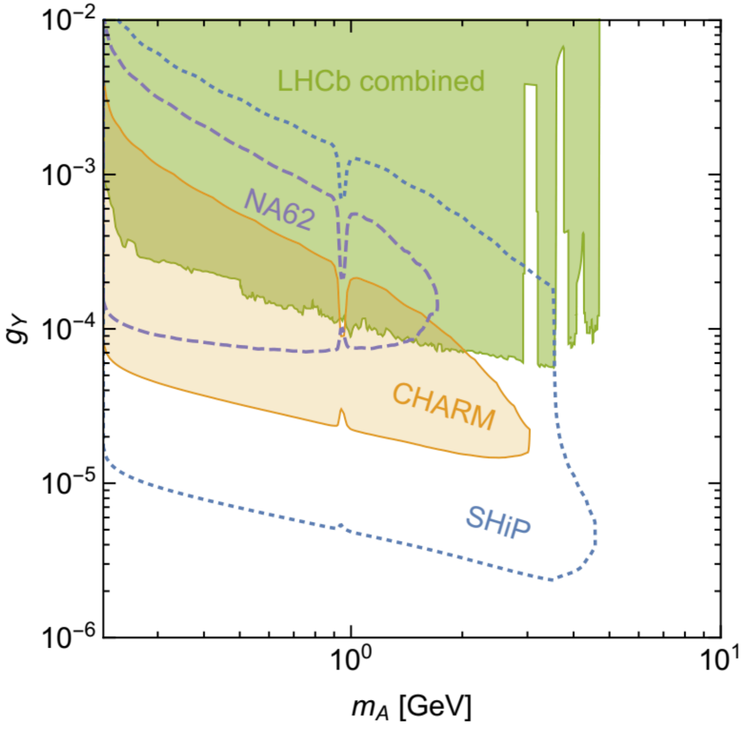

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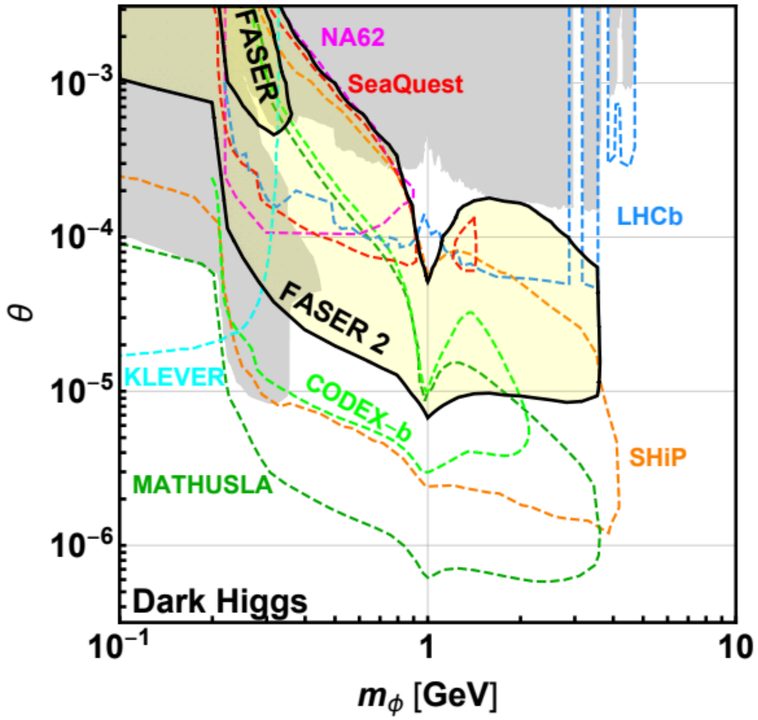

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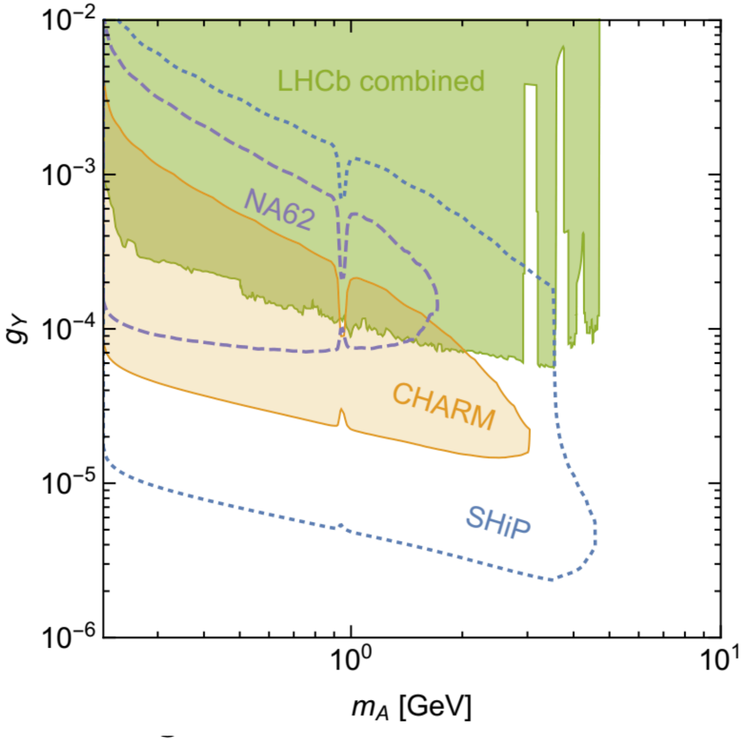

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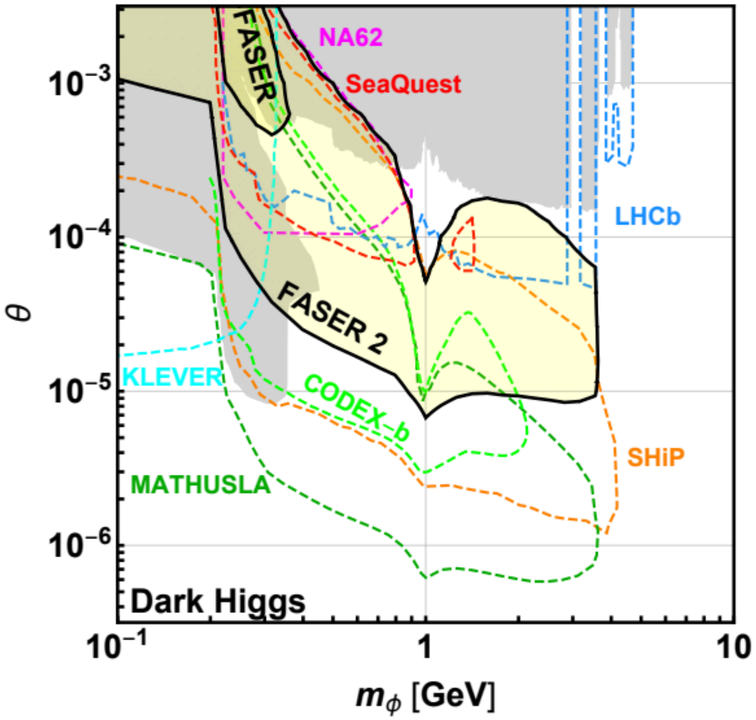

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-Hard to recast to other models

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2. Explore flavored models where D meson decay is a motivated channel

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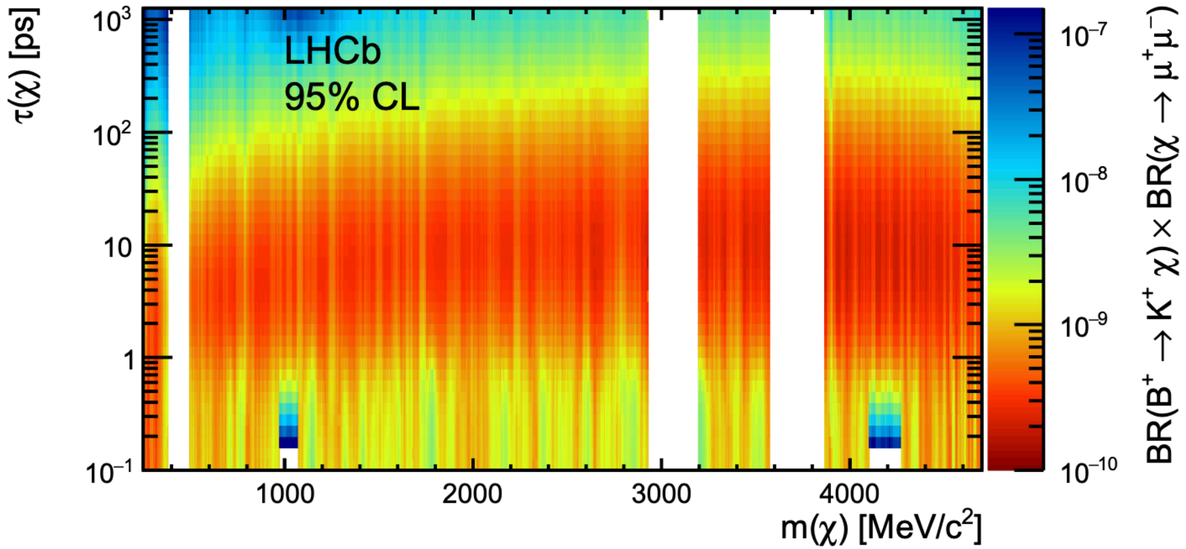

LHCb collaboration, Phys.Rev.D 95 (2017) 7, 071101

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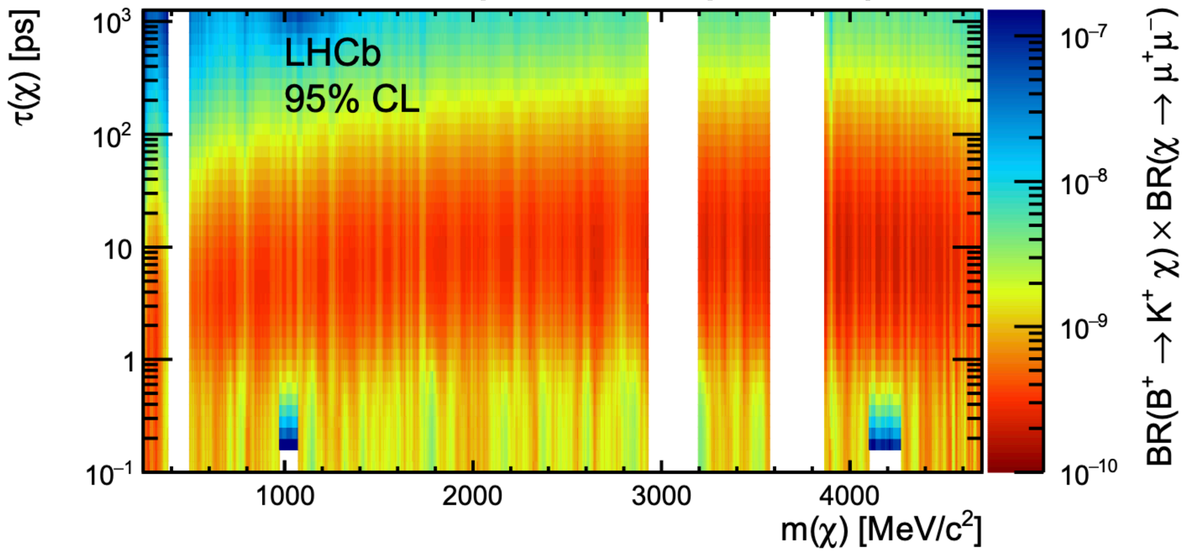

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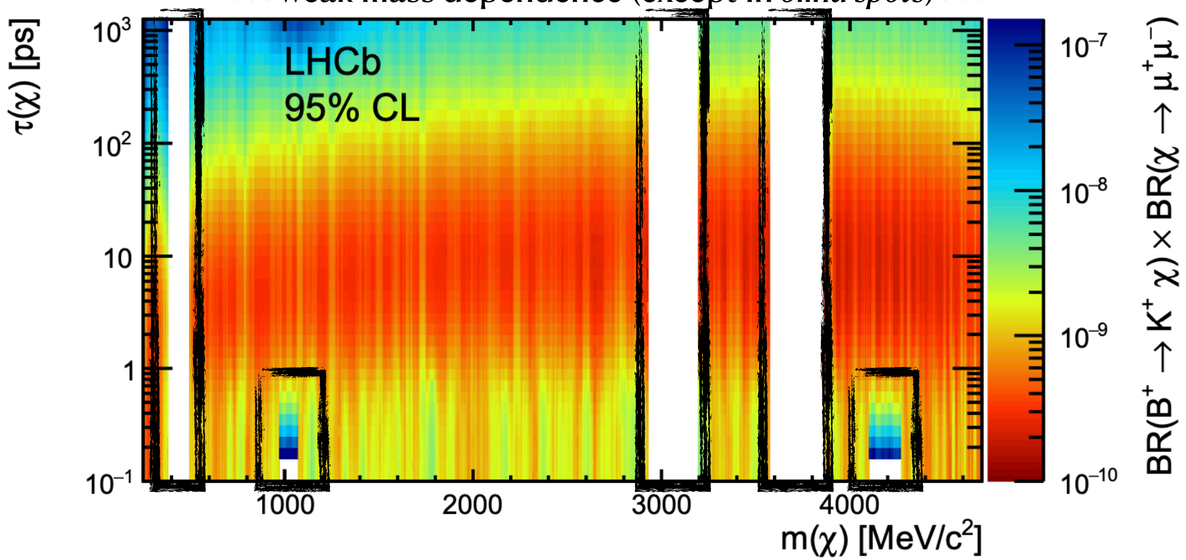

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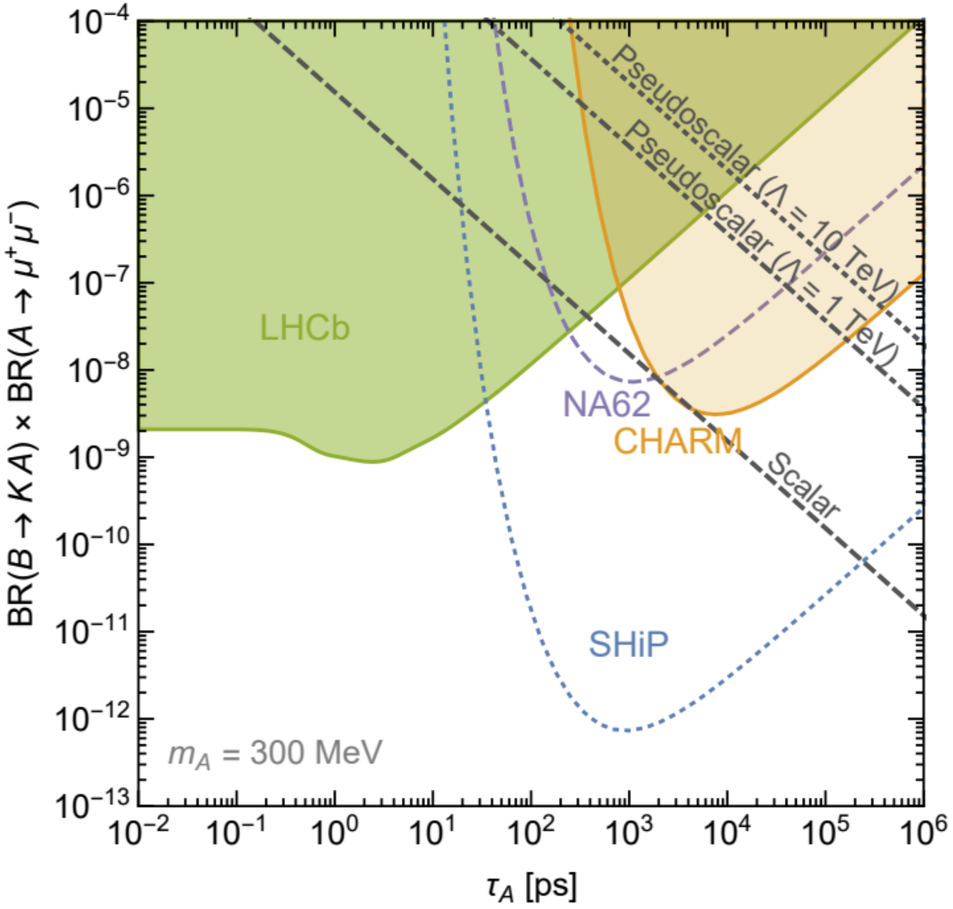

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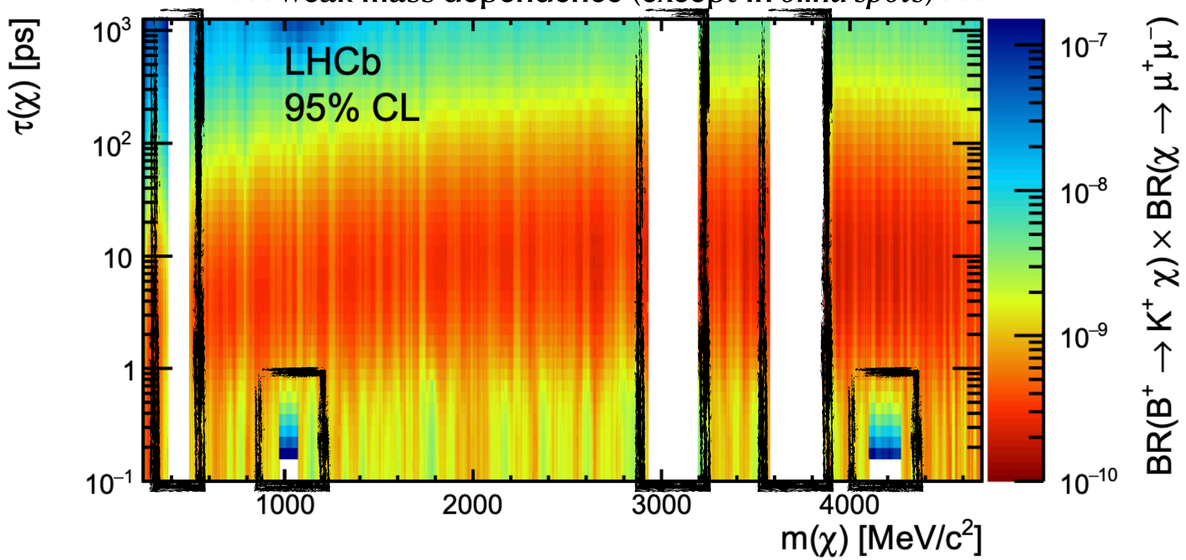

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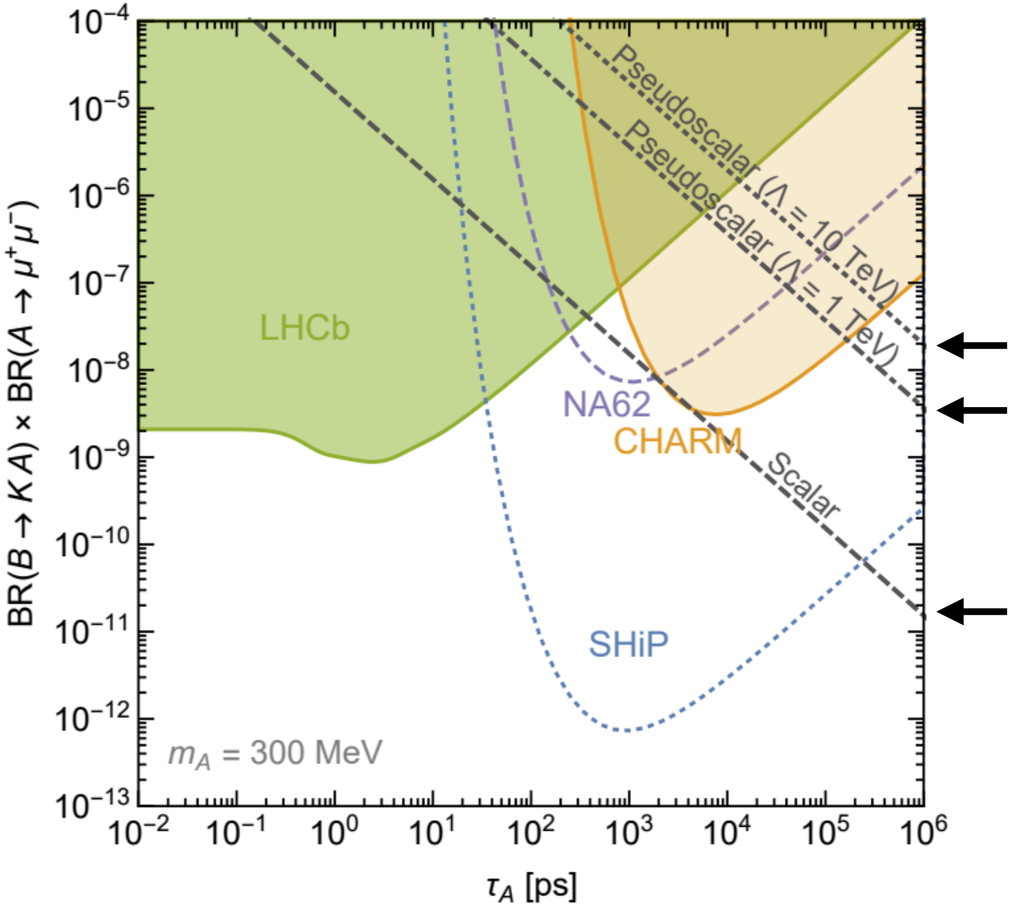

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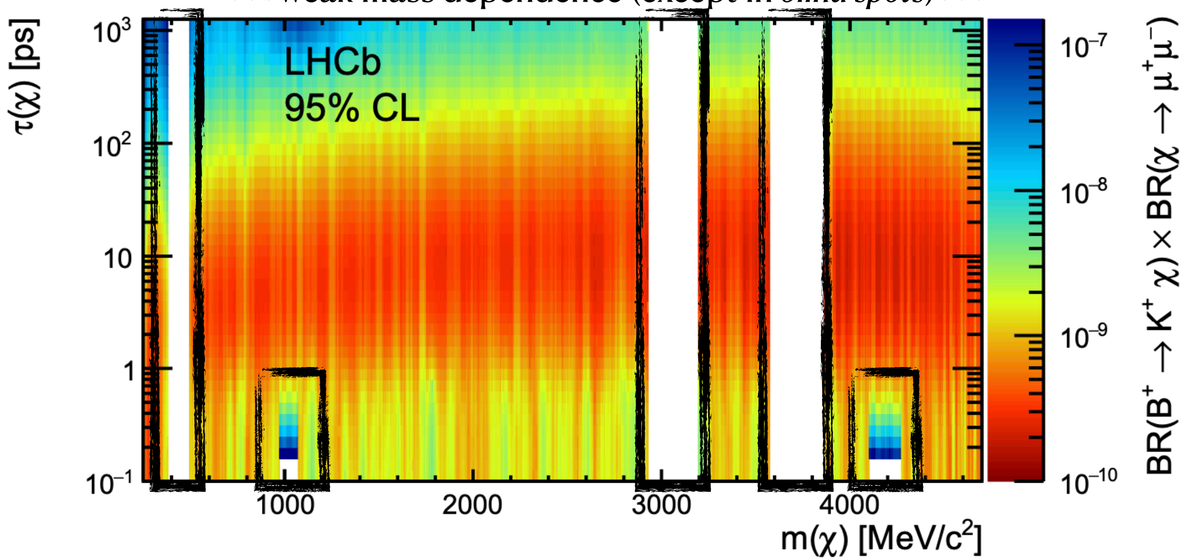

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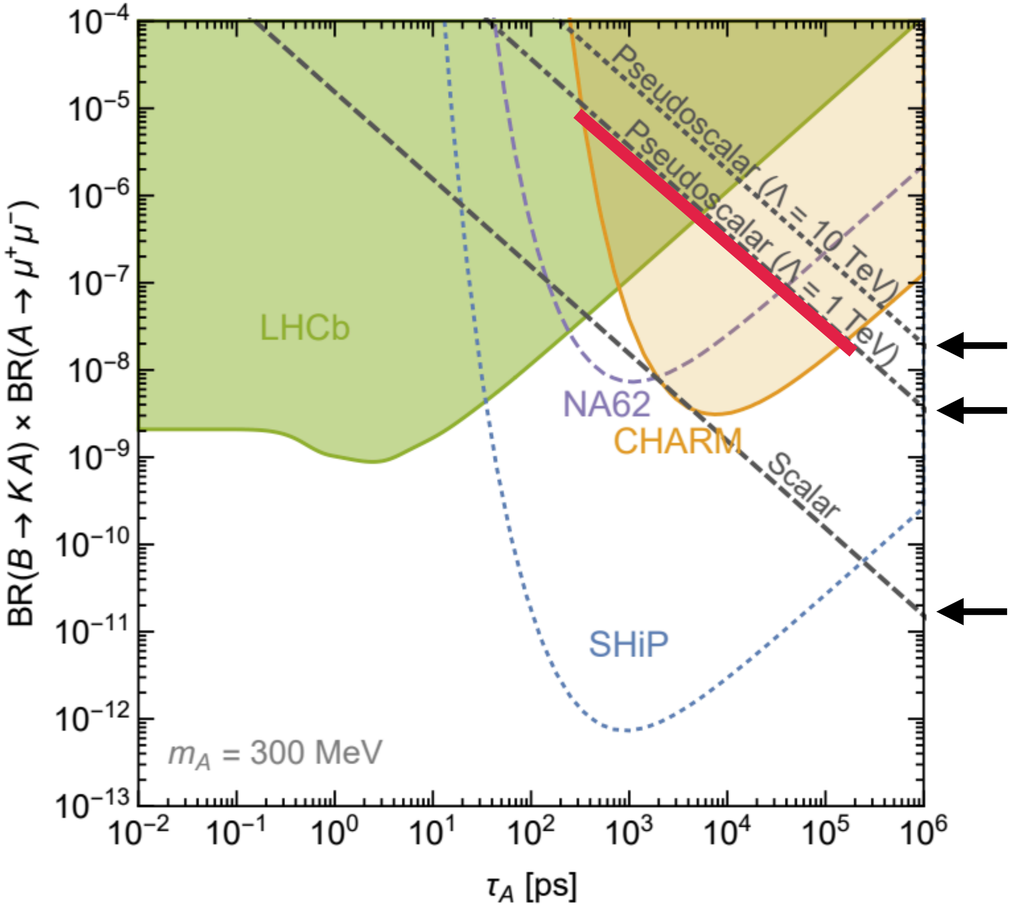

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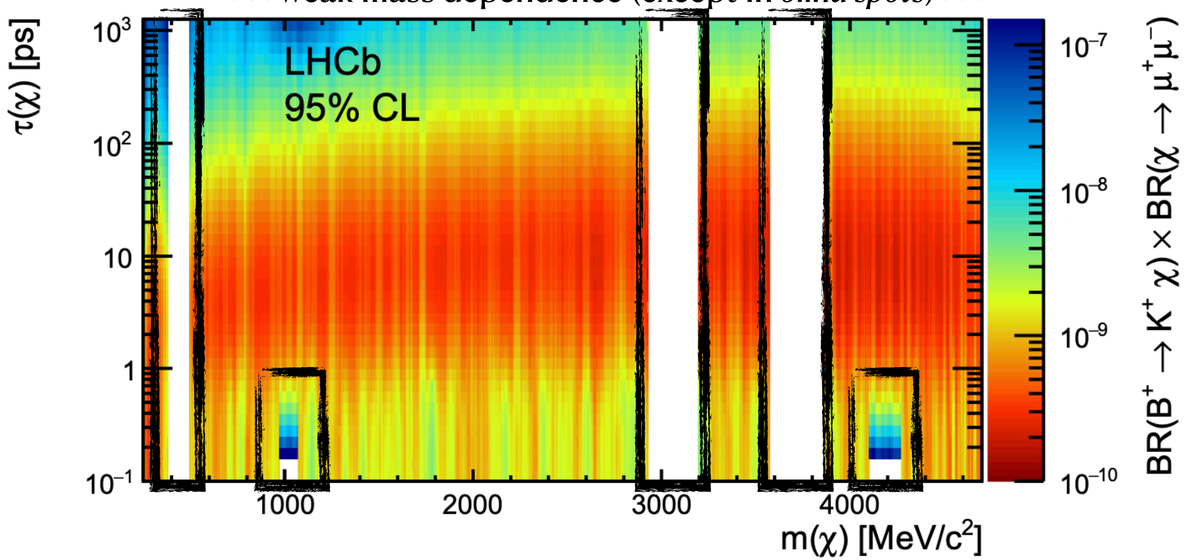

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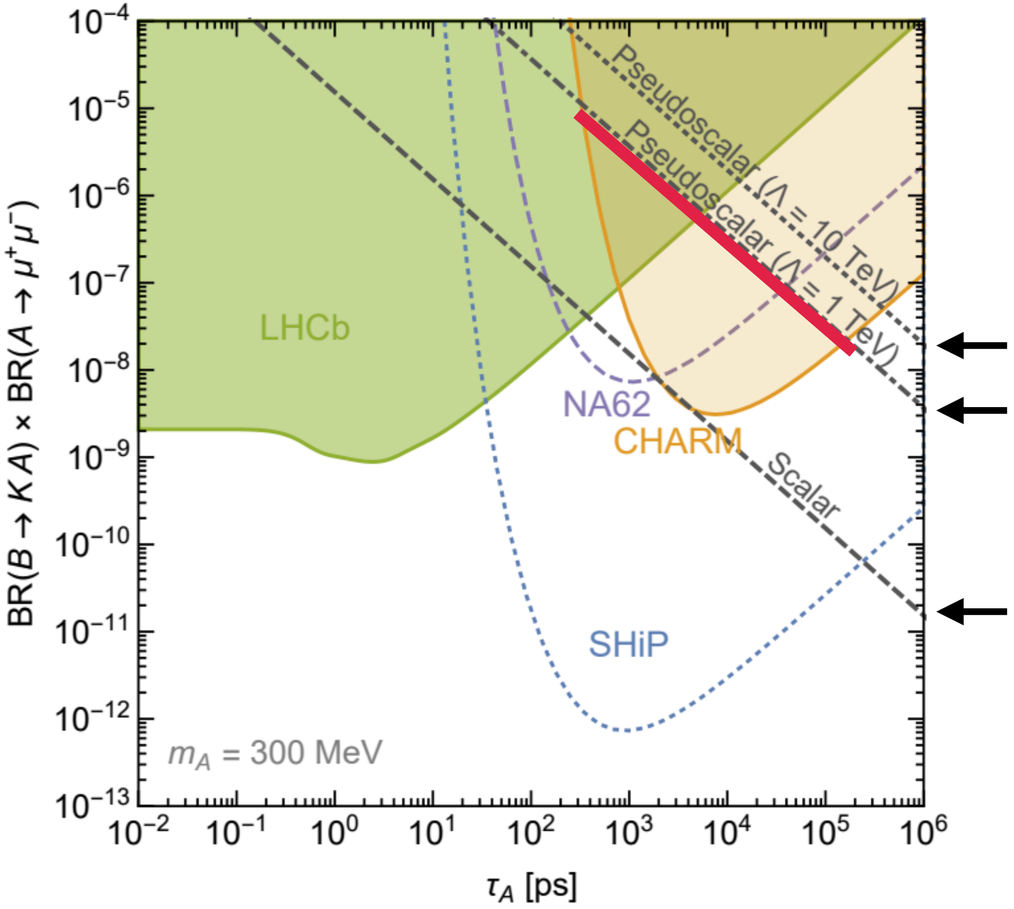

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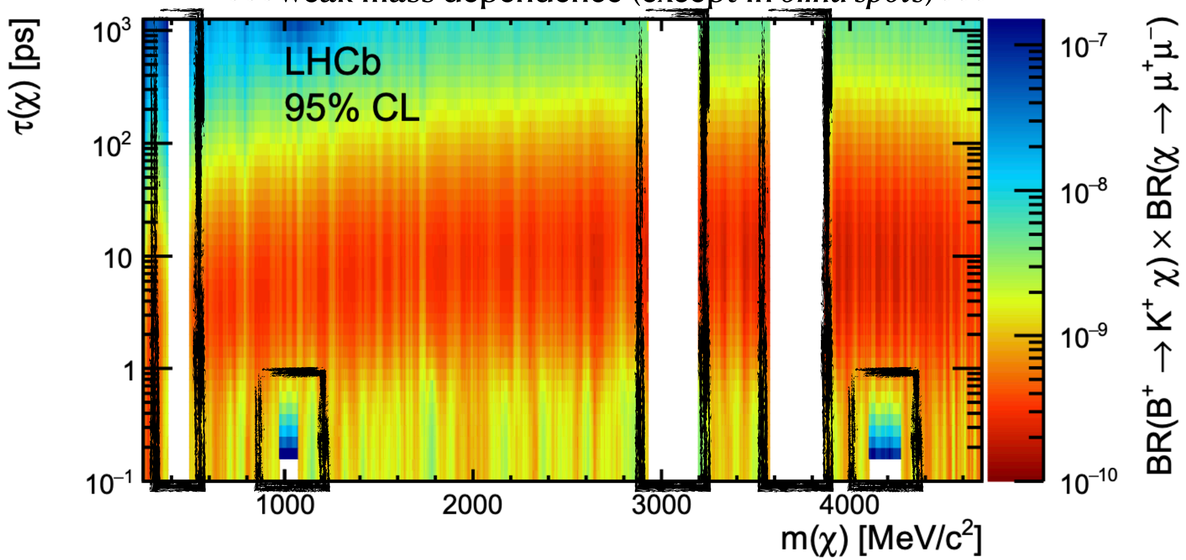

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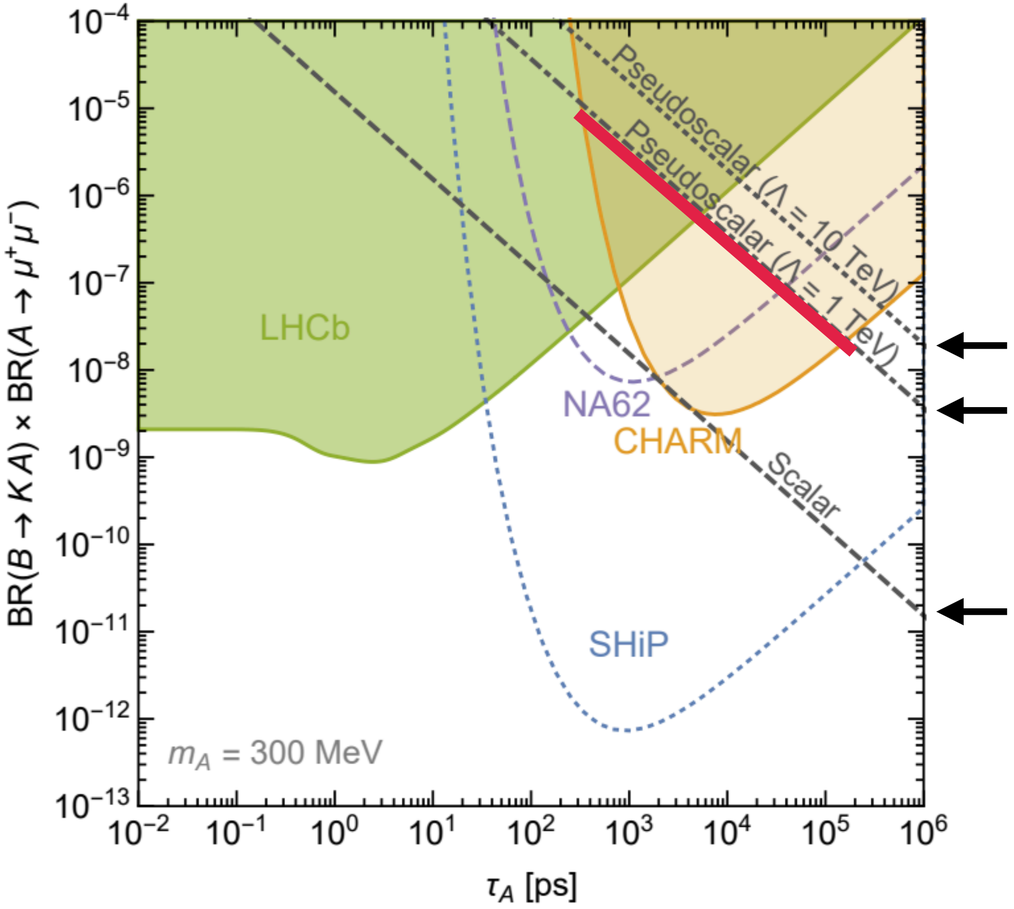

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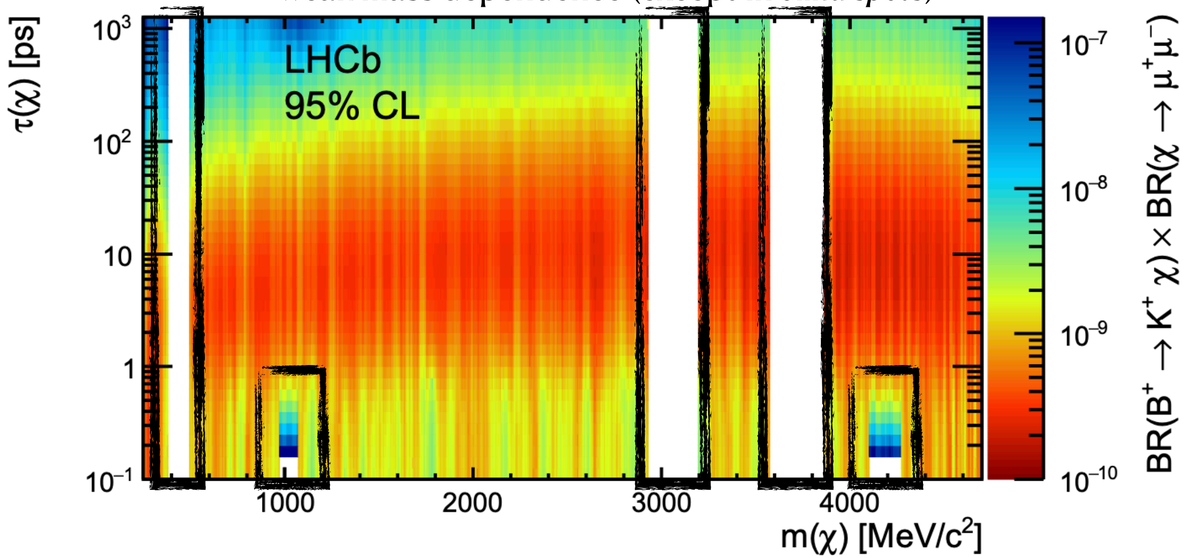

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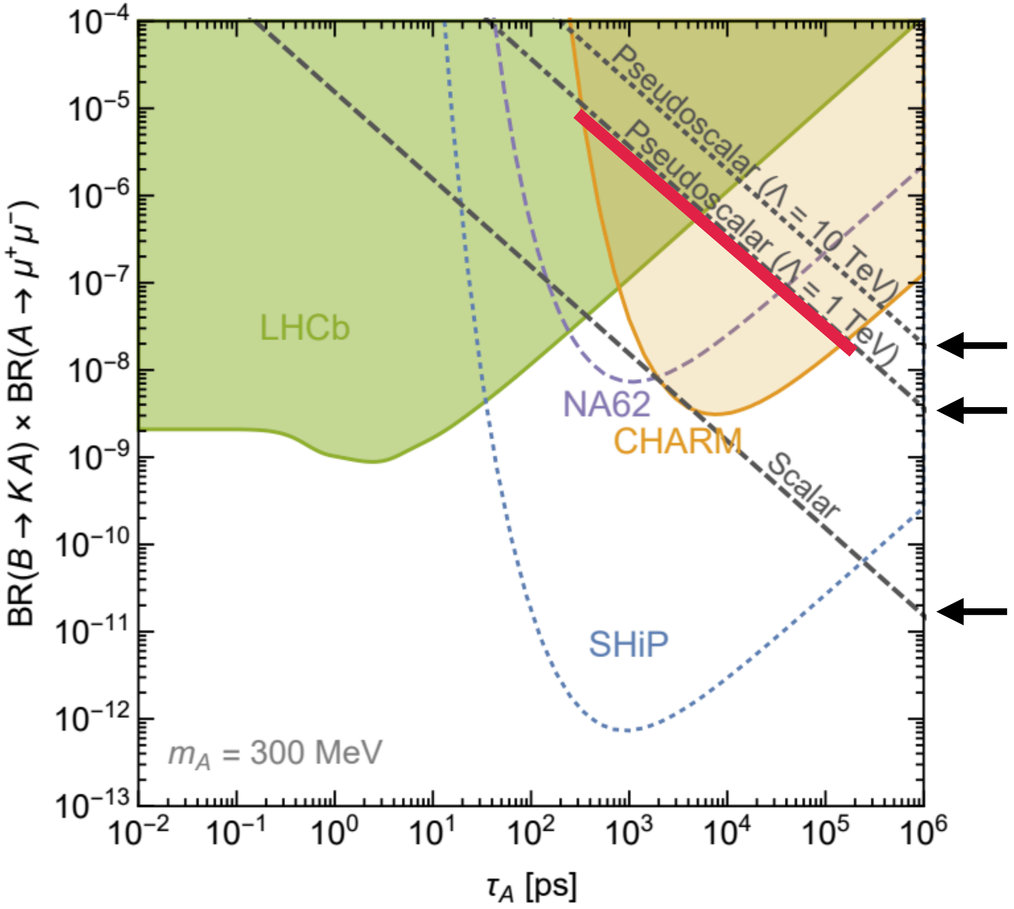

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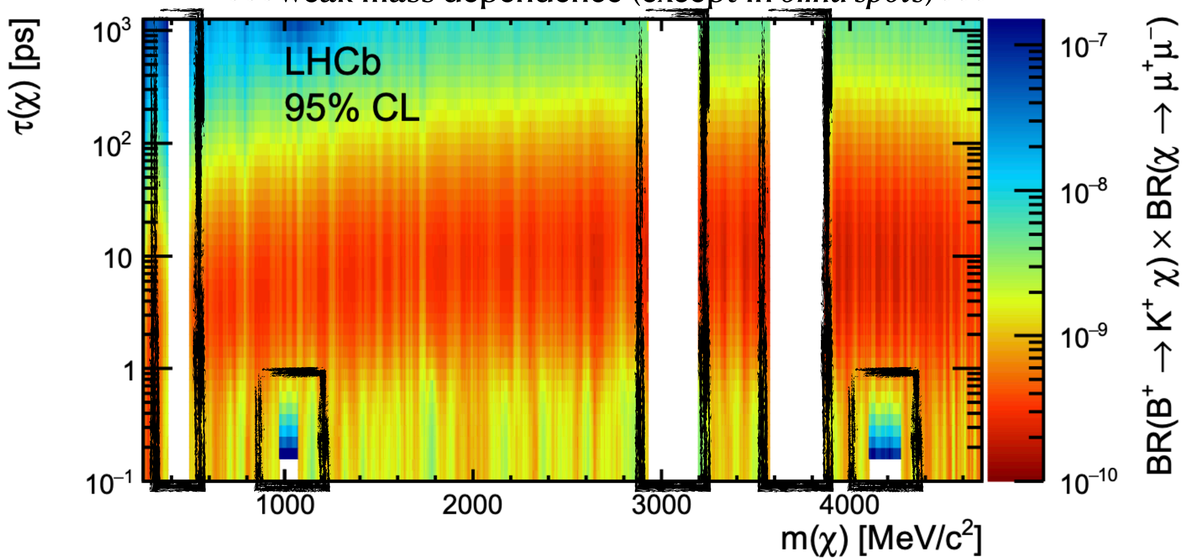

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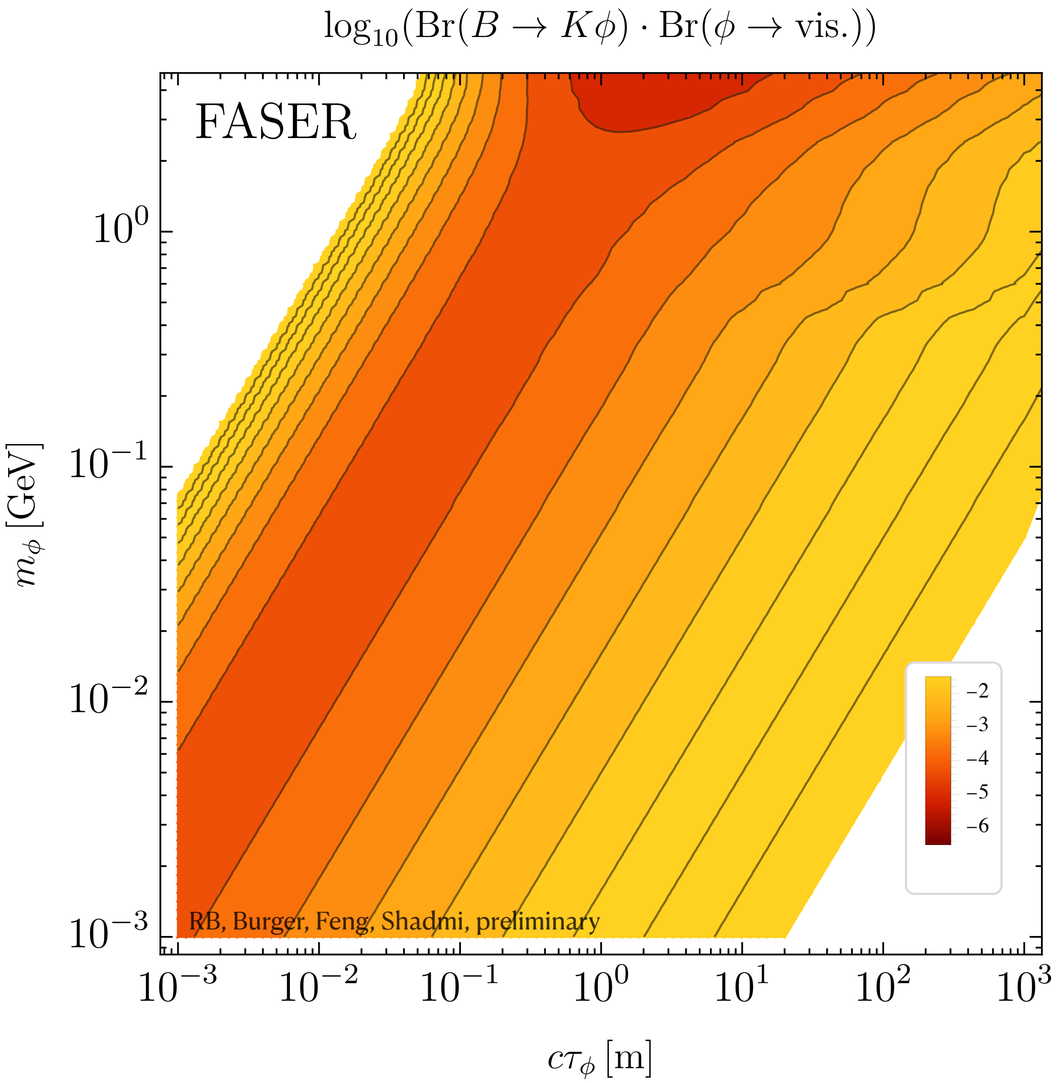

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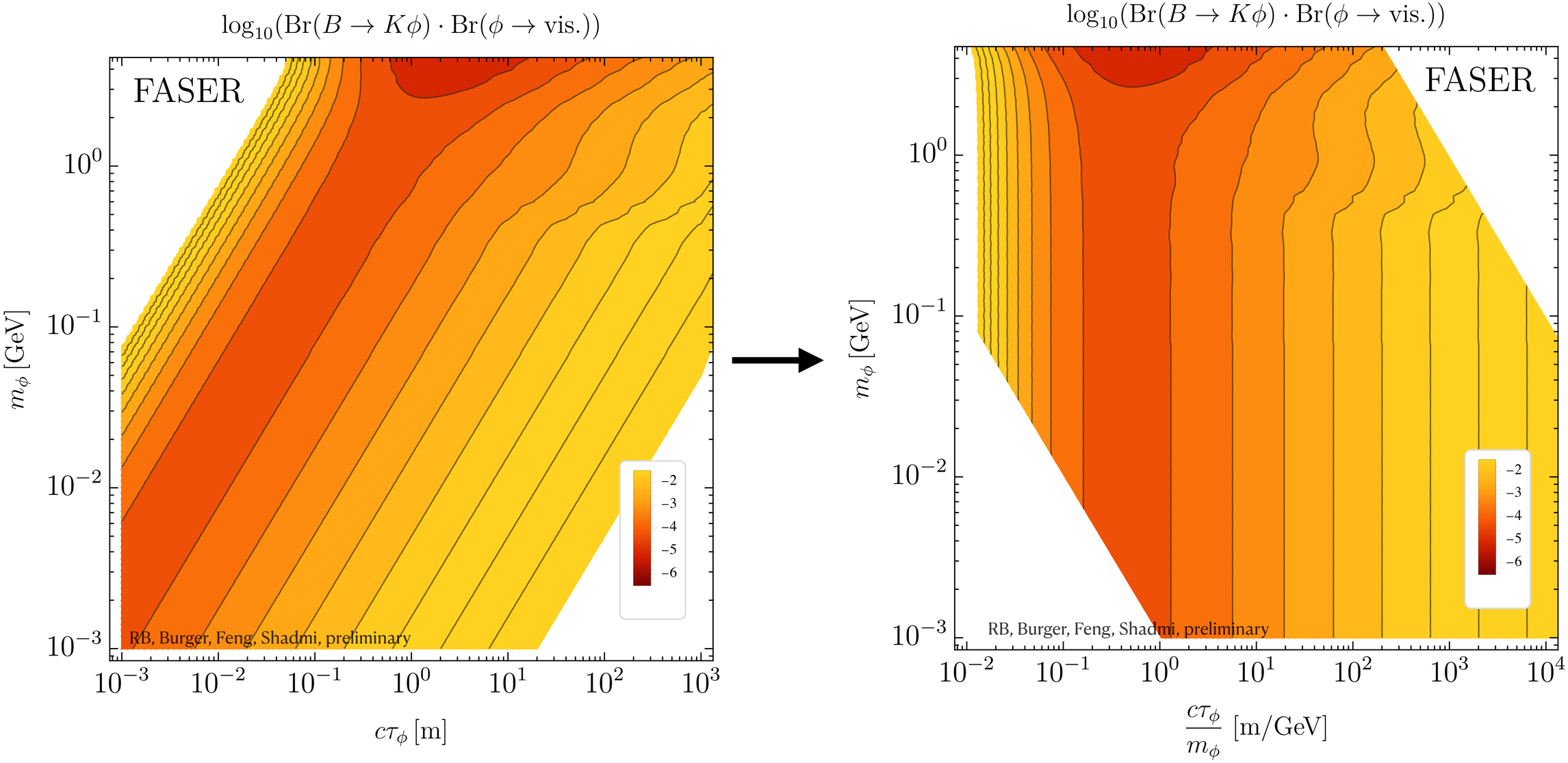

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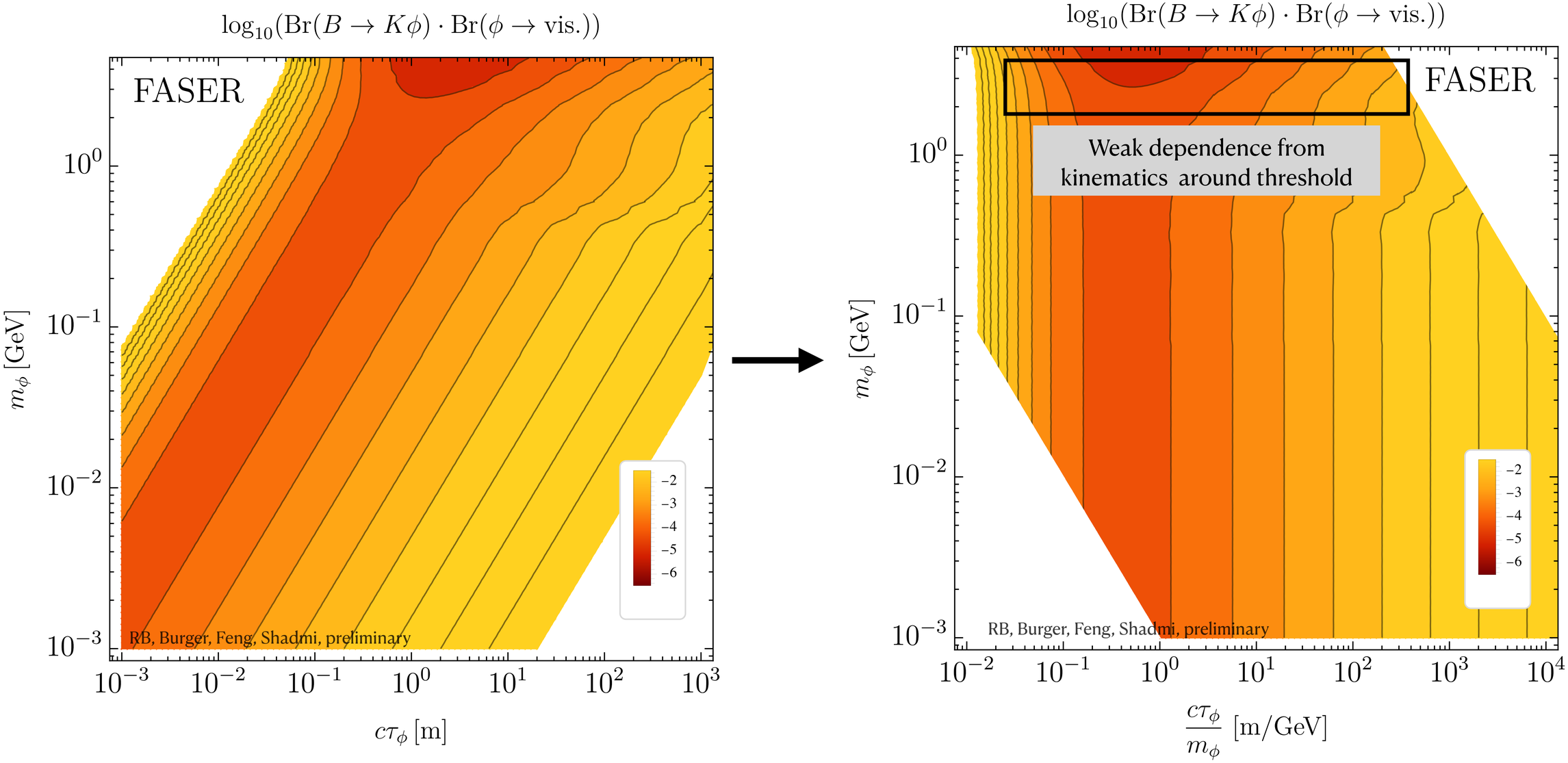

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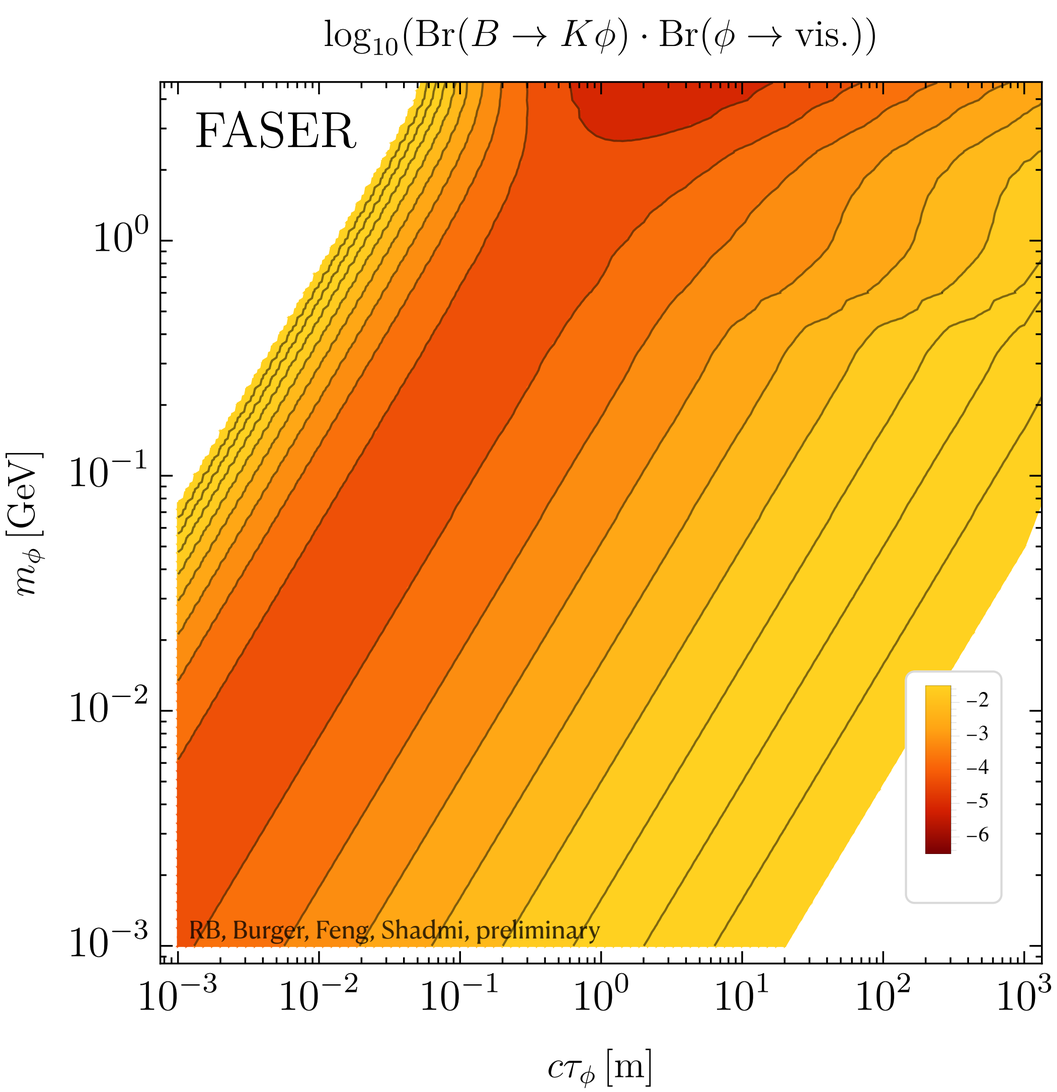
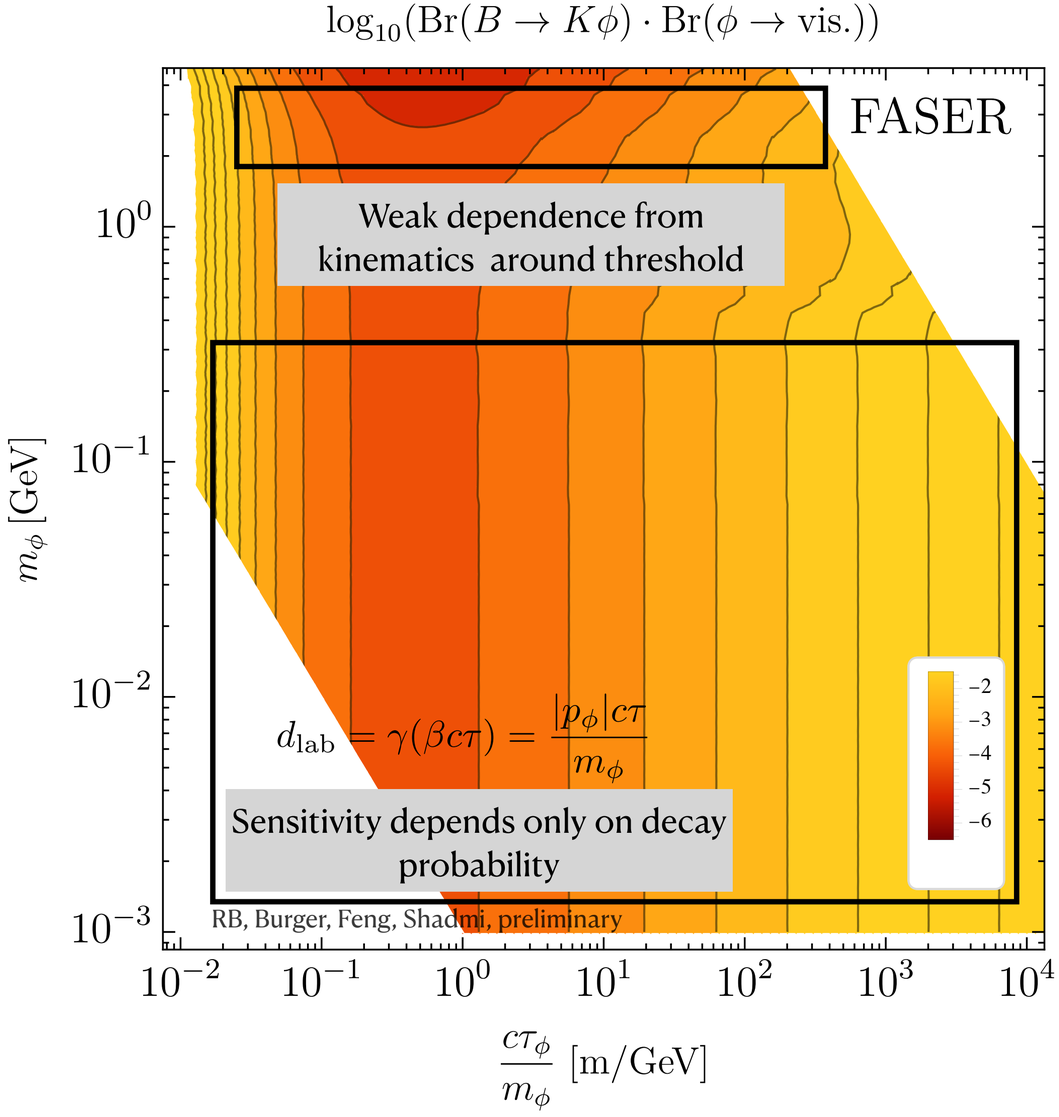
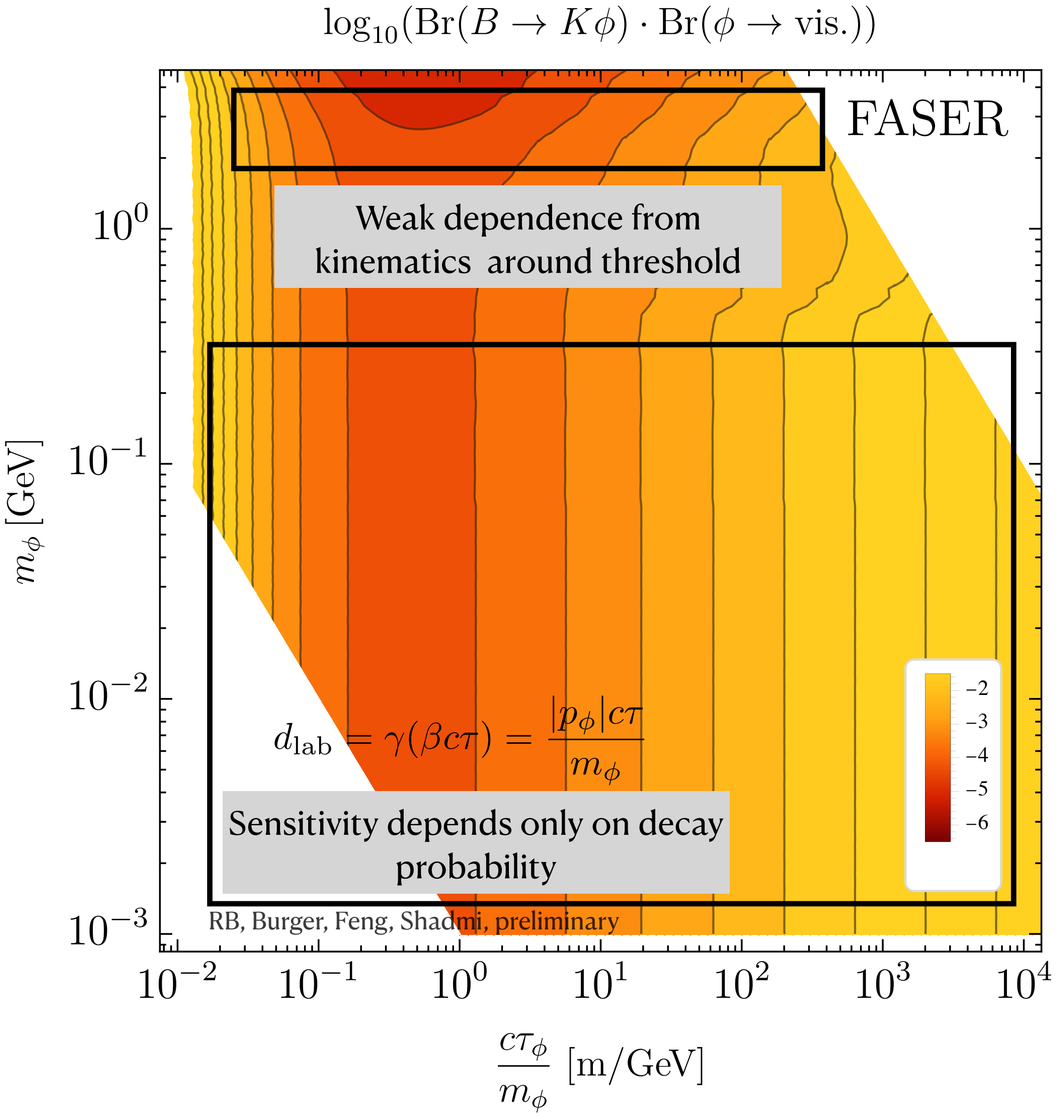




Model independent reach - B mesons

Sensitivity peaks at

$$d_L \sim L$$

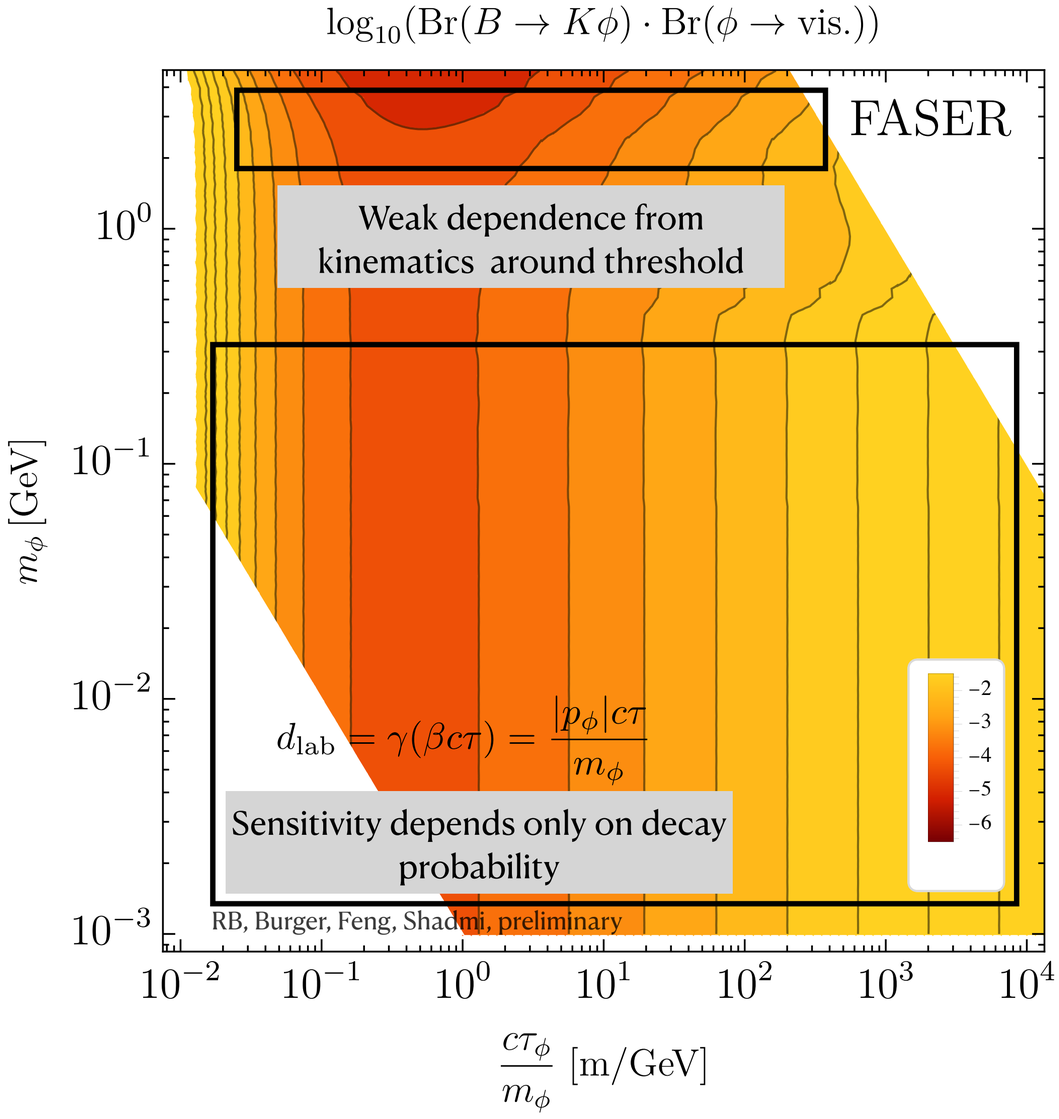


Model independent reach - B mesons

Sensitivity peaks at

$$d_L \sim L$$

$$\rightarrow \frac{c\tau_\phi}{m_\phi} \sim \frac{L}{\langle p_B \rangle} \sim \frac{500\,\mathrm{m}}{1.5\ \mathrm{TeV}} \sim 0.3\,\frac{\mathrm{m}}{\mathrm{GeV}}$$



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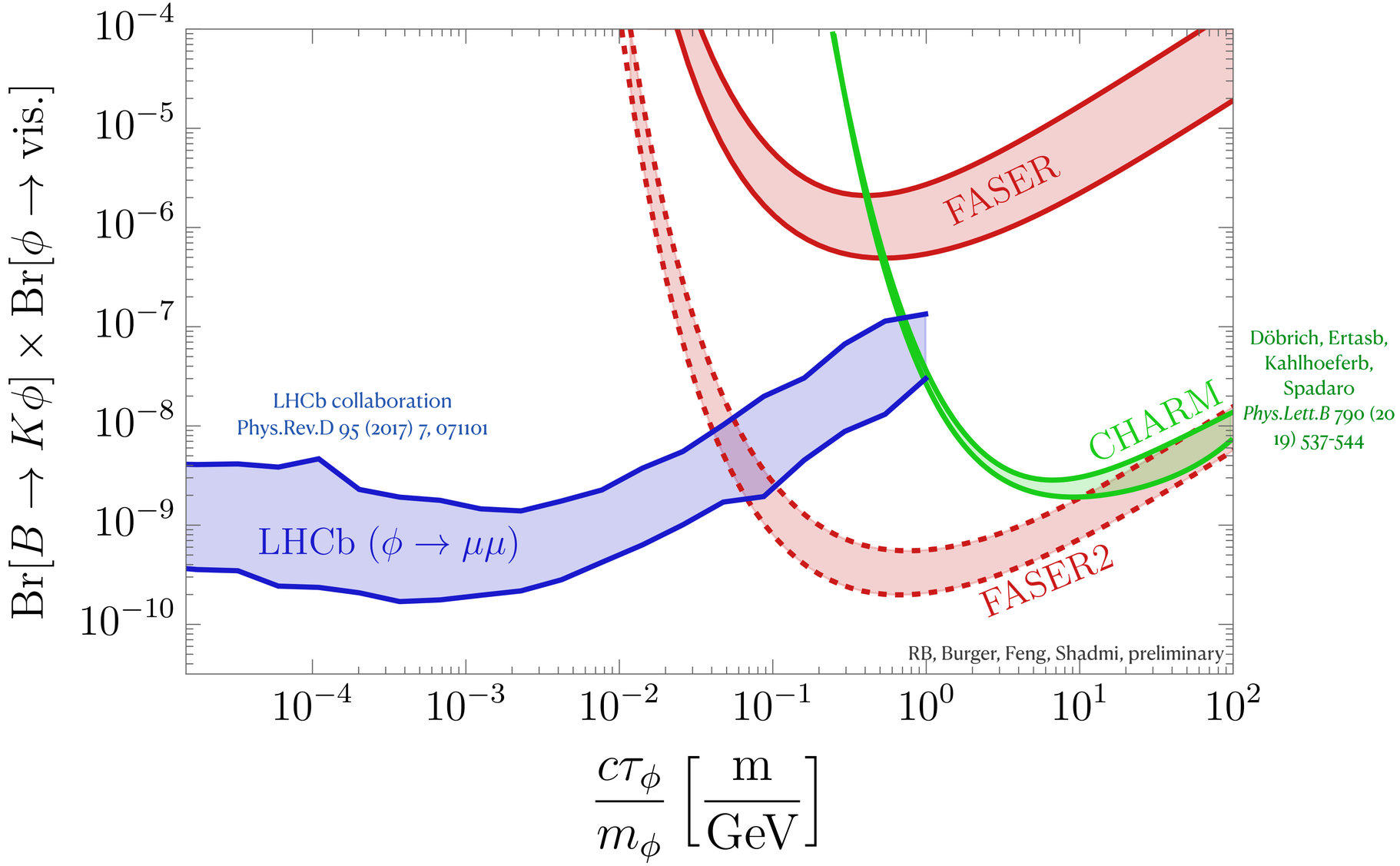
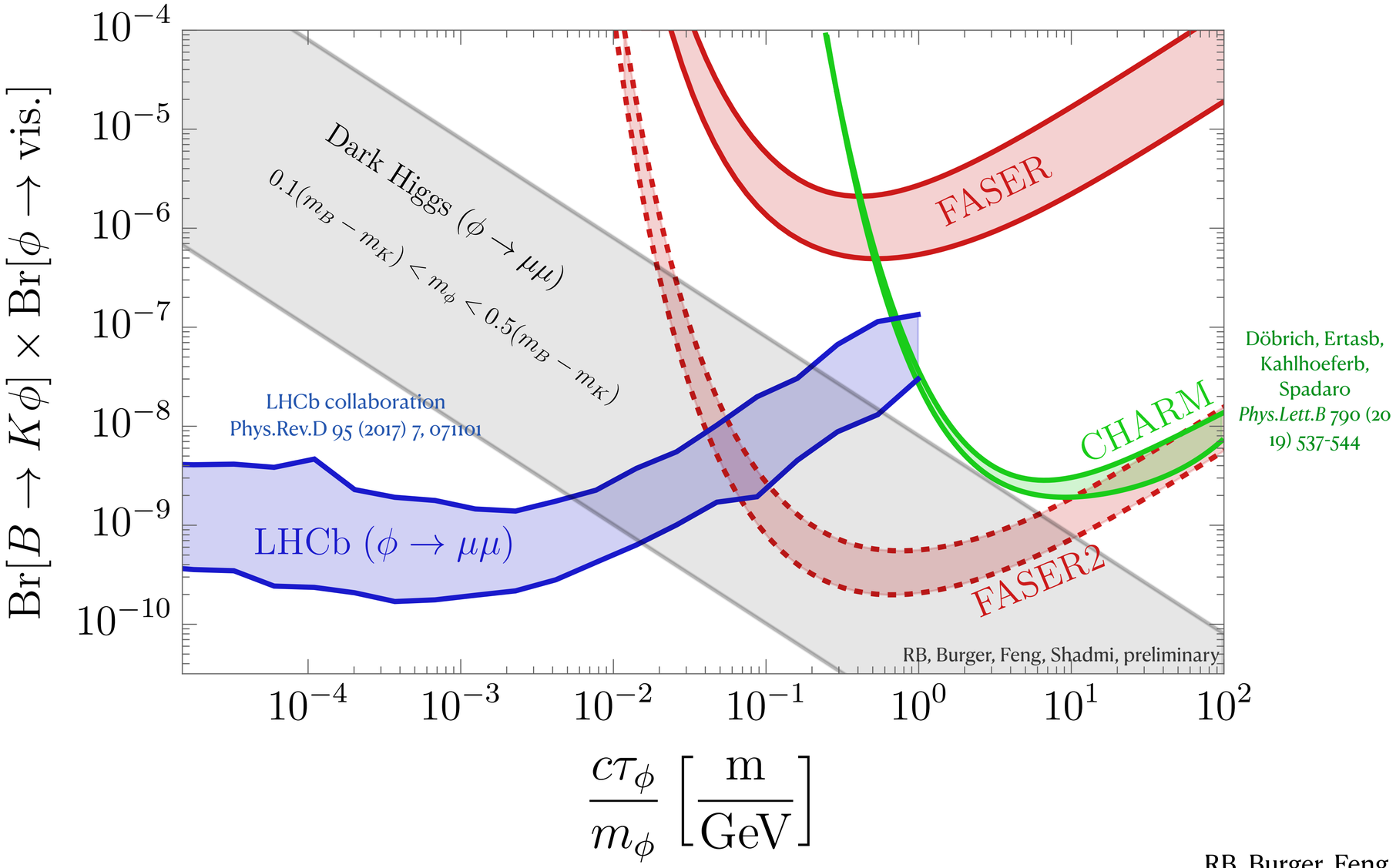


Döbrich, Ertasb, Kahlhoeferb, Spadaro *Phys.Lett.B* 790 (2019) 537-544

Model independent reach - B mesons



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RB, Burger, Feng, Shadmi, in progress

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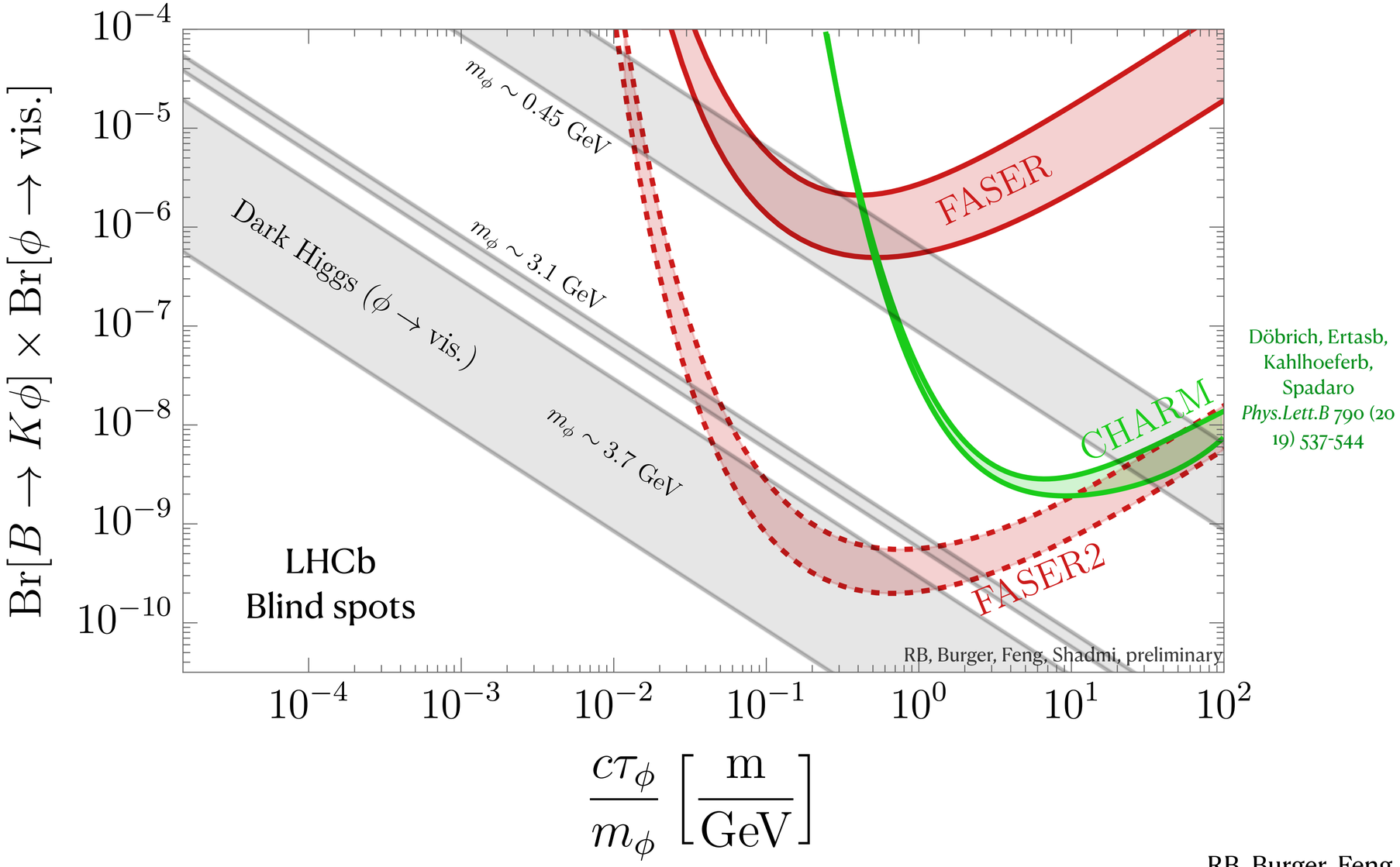

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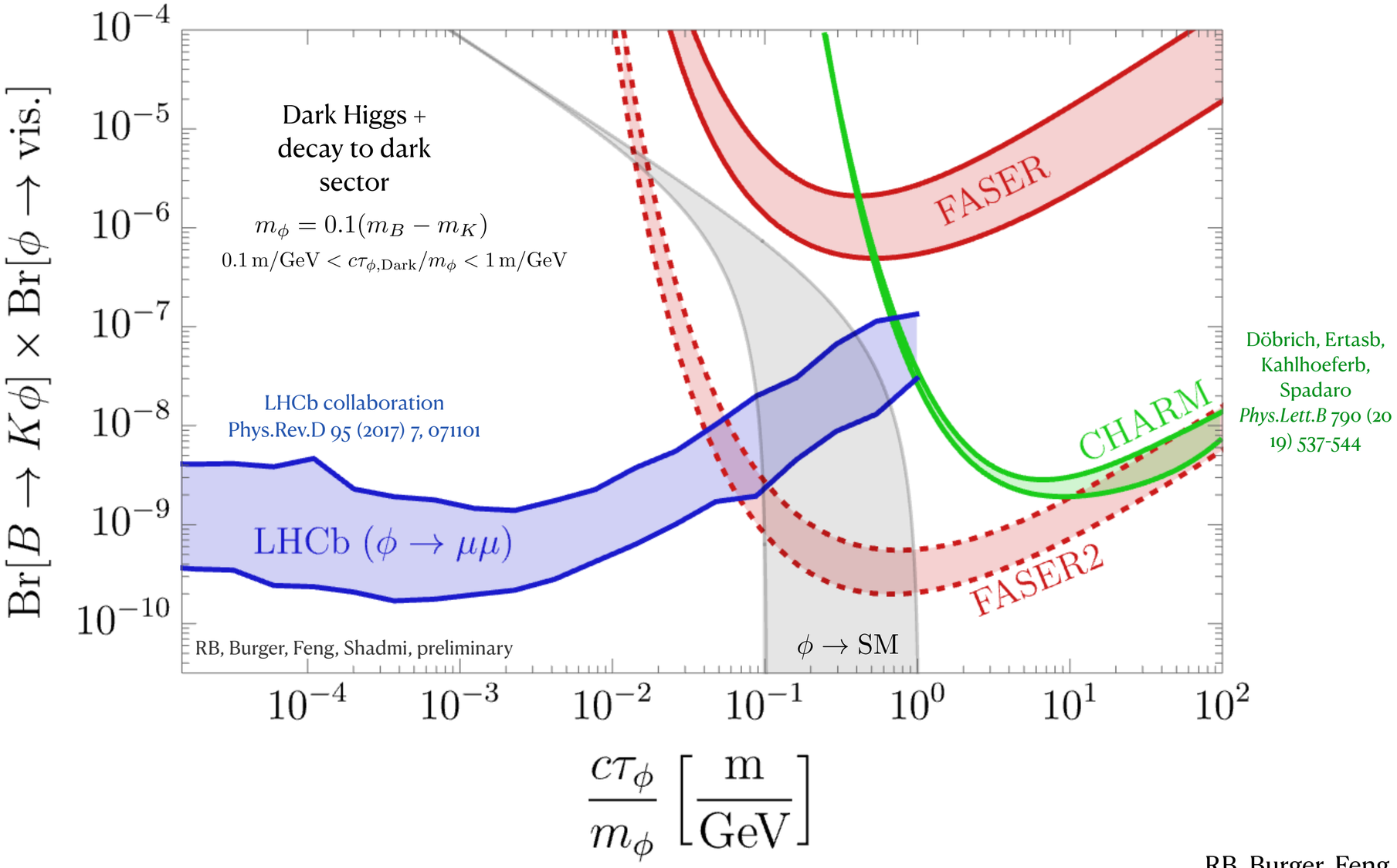

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RB, Burger, Feng, Shadmi, in progress

Model independent reach: flavor

B meson decays are typically the dominant channel in MFV-like models e.g. Dark Higgs

Döbricha, Ertasb, Kahlhoeferb, Spadaro *Phys.Lett.B* 790 (2019) 537-544
FASER Collaboration *Phys.Rev.D* 99 (2019) 9, 095011
Kling, Li, Song, Su, Su *JHEP* 08 (2023) 001

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Decay	sd	cu	bd	bs
$\mathrm{BR}(P_1 \to P_2 + a)$	7.3×10^{-11} [85]	no analysis	4.9×10^{-5} [86]	4.9×10^{-5} [86]
$\mathrm{BR}(P_1 \to P_2 + a)_{\mathrm{recast}}$	no need	8.0×10^{-6} [87]	2.3×10^{-5} [88]	7.1×10^{-6} [89]
$\mathrm{BR}(P_1 \to P_2 + \nu\bar{\nu})$	$1.47^{+1.30}_{-0.89} \times 10^{-10}$ [85	no analysis	0.8×10^{-5} [90]	1.6×10^{-5} [90]
$\mathrm{BR}(P_1 \to V_2 + a)$	3.8×10^{-5} [91]	no analysis	no analysis	no analysis
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Camalich, Pospelov, Vuong, Ziegler, Zupan
Phys.Rev.D 102 (2020) 1, 015023

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Flavored models coupled to the up sector could be probed in D meson decays!

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e.g. ALPs:
Carmona, Scherb, Schwaller *JHEP* 08 (2021) 121
Camalich, Pospelov, Vuong, Ziegler, Zupan *Phys.Rev.D* 102 (2020) 1, 015023
Bauer, Neubert, Renner, Schnubel, Thamm *JHEP* 09 (2022) 056

Flavored CP-even scalar models

$$\mathcal{L}_X = \left(\frac{C_{ij}^U}{\Lambda} \tilde{H} \phi \bar{Q}_i U_j + \frac{C_{ij}^D}{\Lambda} H \phi \bar{Q}_i D_j + \text{h.c.} \right) + \frac{C_{gg}}{\Lambda} \phi G^{\mu\nu} G_{\mu\nu} + \ldots$$

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1) C_{ij}'s MFV-like (Froggatt-Nielsen)

Froggatt, Nielsen, *Nucl.Phys.B* 147 (1979) 277-298
Leurer, Nir, Seiberg *Nucl.Phys.B* 398 (1993) 319-342

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2) $C^U \gg C^D$ e.g. generated @ tree-level vs. one-loop

RB, Burger, Feng, Shadmi, in progress

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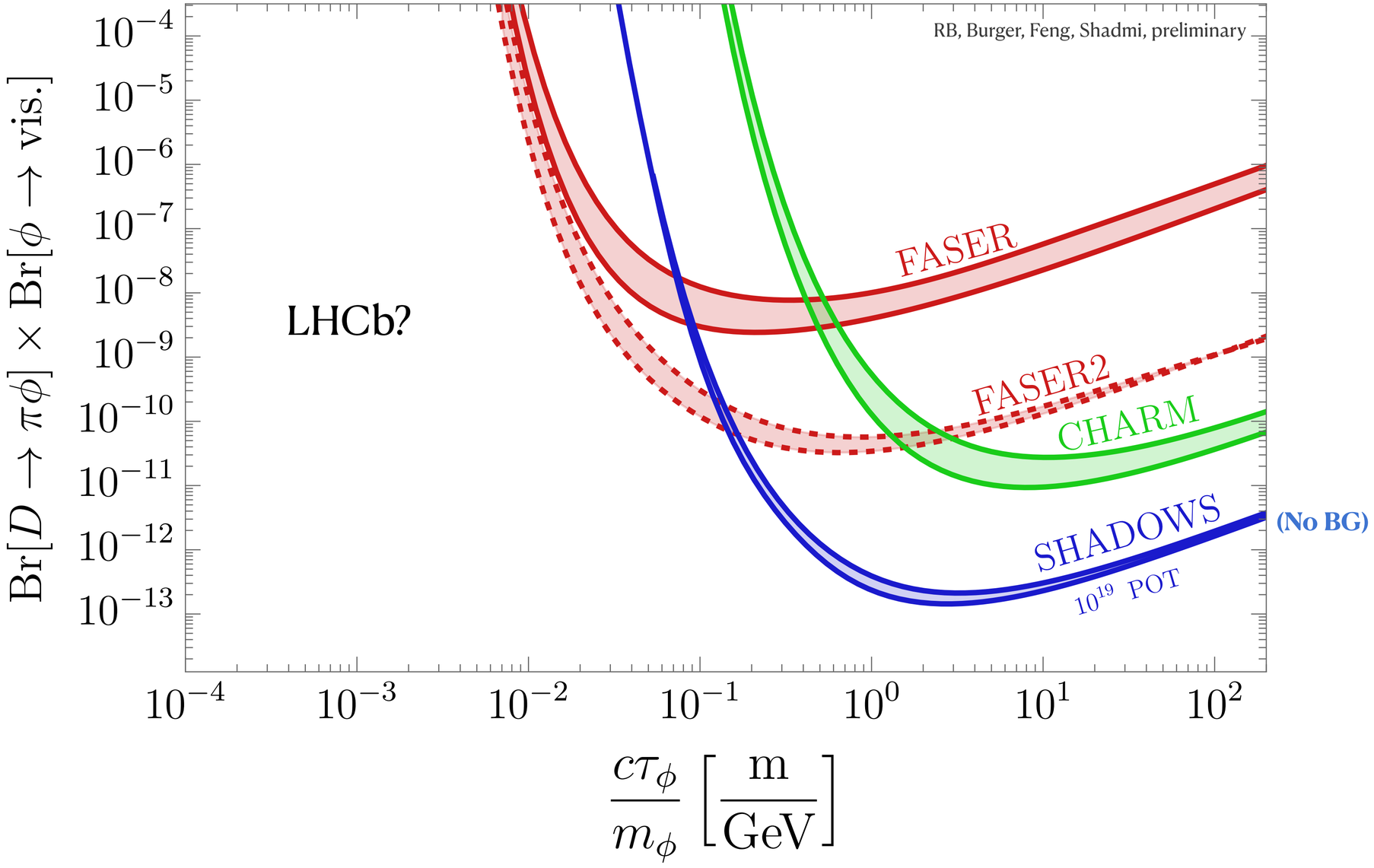

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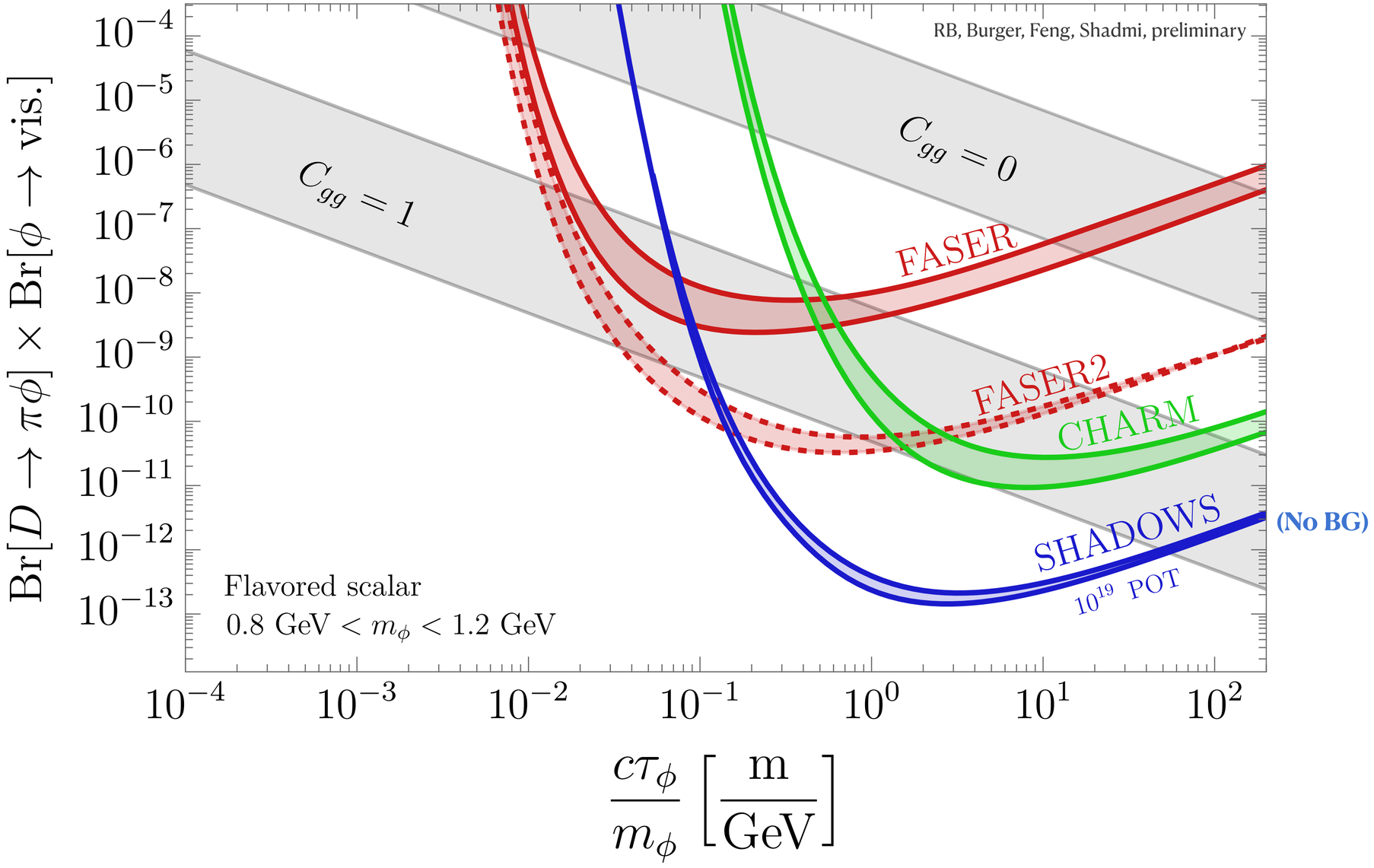

(No BG)

Summary

- Model-independent approach to meson decay sensitivities/bounds

- First calculation for D meson decays sensitivities in FASER/FASER2 and recast of CHARM

Outlook

- Add additional projections from other proposed experiments

- Explore phenomenology of CP-even flavored scalar models