Emerging jets Phenomenology

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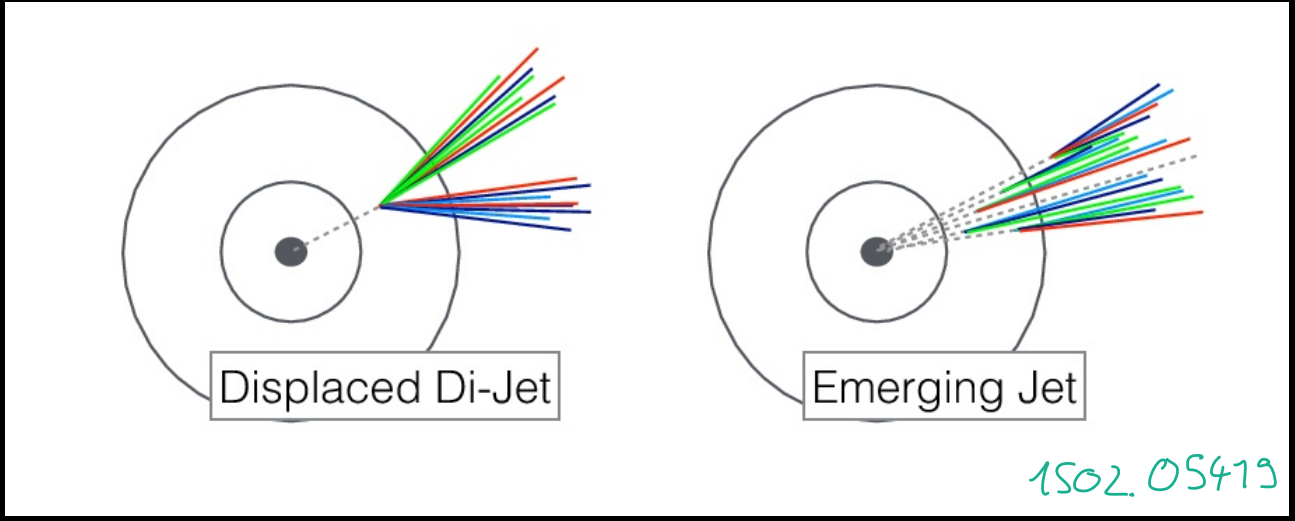
MITP Youngsters: Colours in Darkness

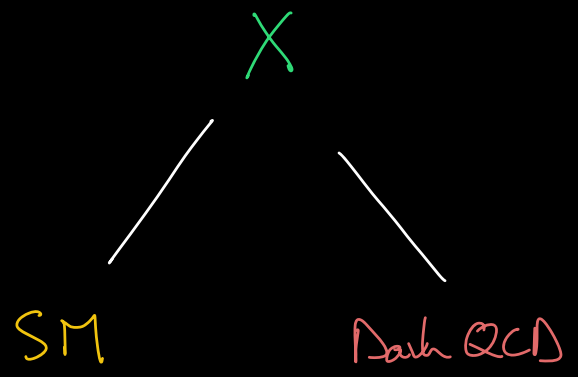
Oct 17, 2023

What are Emerging jets?

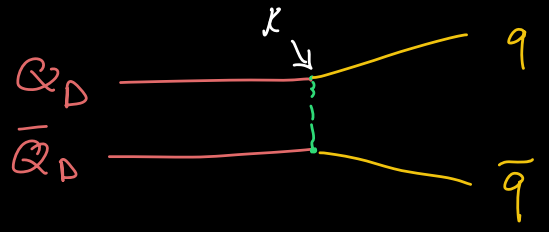


* "Dark shower" of dark pions
* Many displaced vertices inside single jet cone
* Jet emerges inside detector → strategy for searches

Assumptions / Modelling

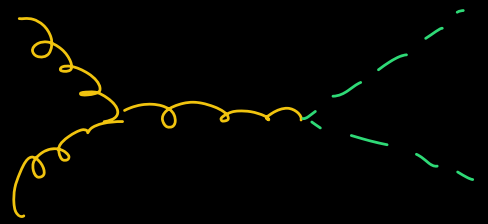


* Heavy (TeV scale) mediator
* Equal dark pion lifetimes



$$\Gamma \sim \frac{\kappa^4}{\pi_X^4} m_q^2 f_D^2 m_{\pi_D}$$

* Pair production of X at LHC

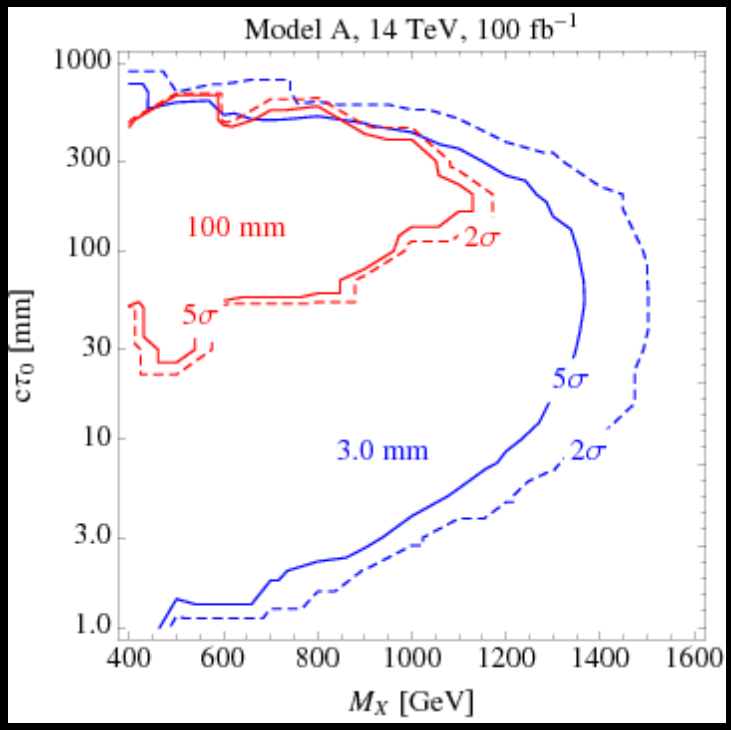


[DU in Pythia Hidden Valley module]

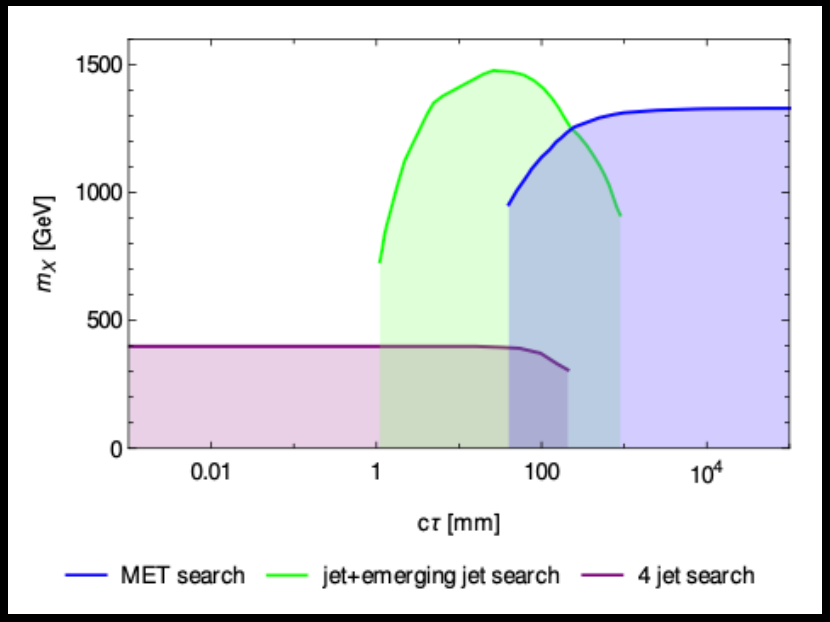
Carloni, Sjostrand, 2010

LHC reach assuming

- $c\tau$, M_X as free parameters
- fix $f_\pi = m_\pi$ to benchmark values



Complementarity with other searches



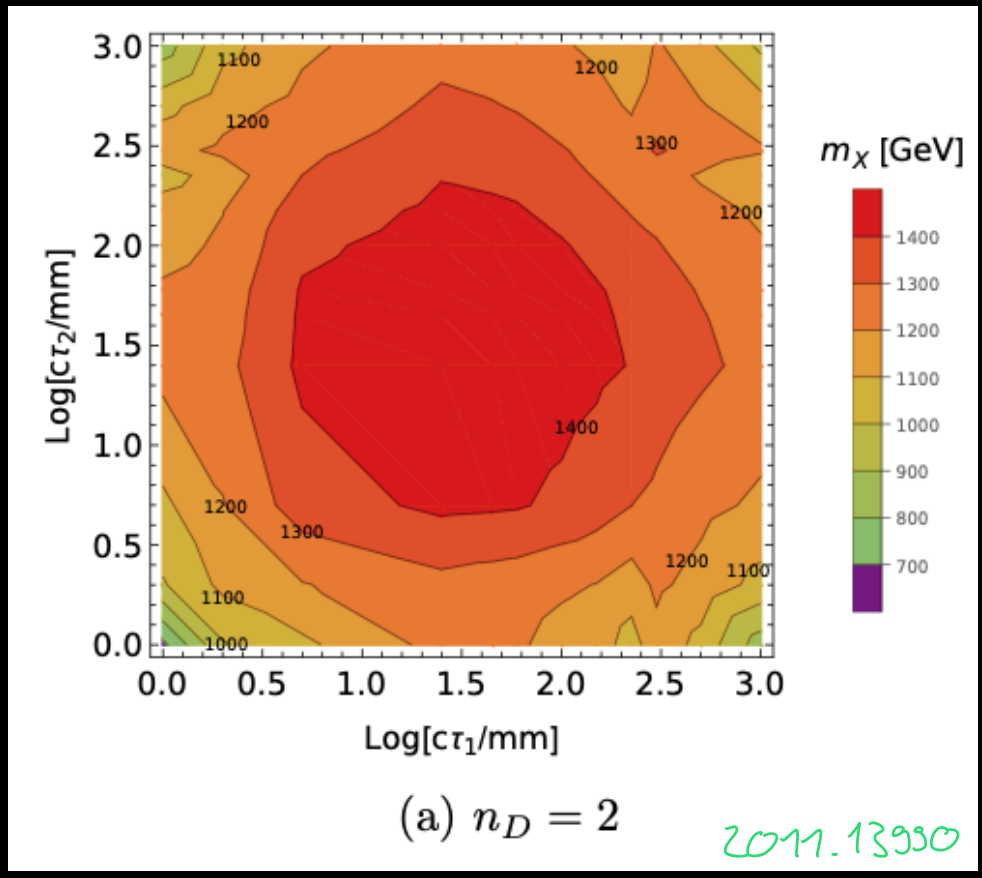
2011.13930 with H. Mies, C. Scherb

Only the simplest case. In general, expect

* Mix of stable/unstable dark pions (s-channel med.)
  (semi-visible jets → T. Cohen, tomorrow)
* Different flavors of dark pions (t-channel)
  ↳ flavour constraints, fixed target, rare top decays
  ↳ mix of lifetimes
* pure glue dark sector (D. Curtin et al)
* conformal limit → SUEP

Some results. 1. Recast for lifetime mix:

* Recast of CMS $e\gamma$ search
* Assuming 1:1 ratio of τ_1 to τ_2
* Somewhat limited by Pythia implementation

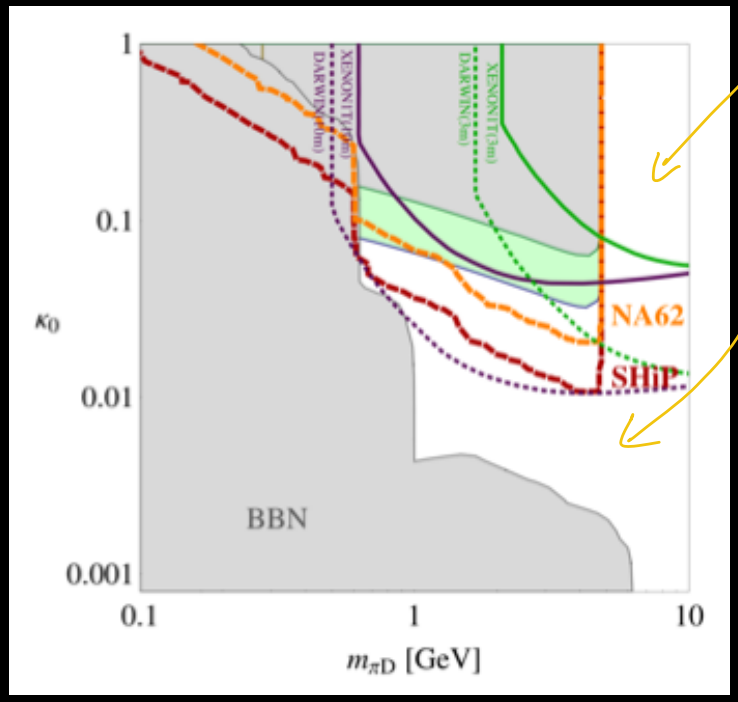


(a) $n_D = 2$

2011.13930

with H. Mies, C. Scherb

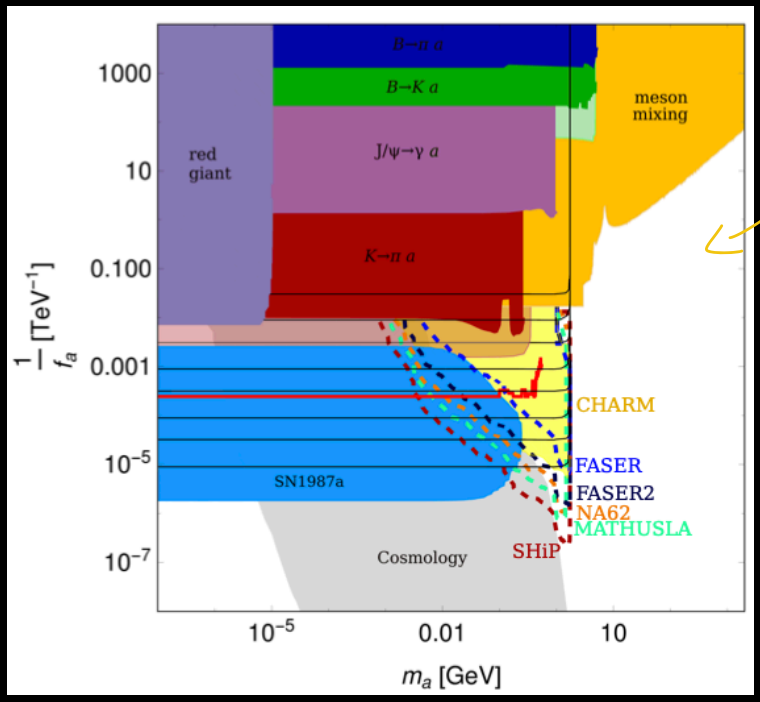
2. Flavour, fixed target, cosmology



LHC goes here

"down portal"

1803.08080 w. S. Renner



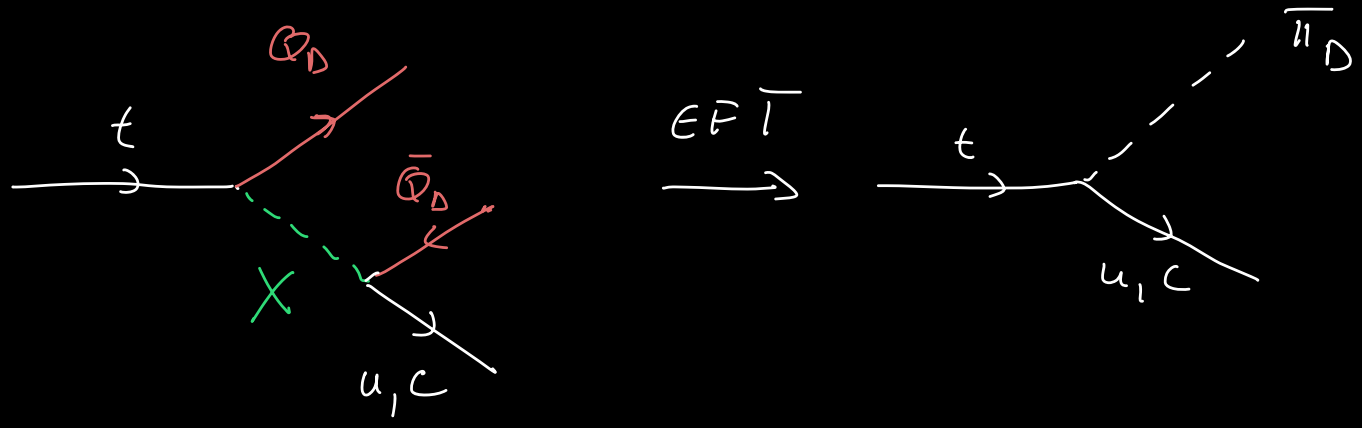
LHC

"up portal"

Using charming ALP EFT

2107.07803 w. A. Carmona C. Scherb

Dark pions from top decays



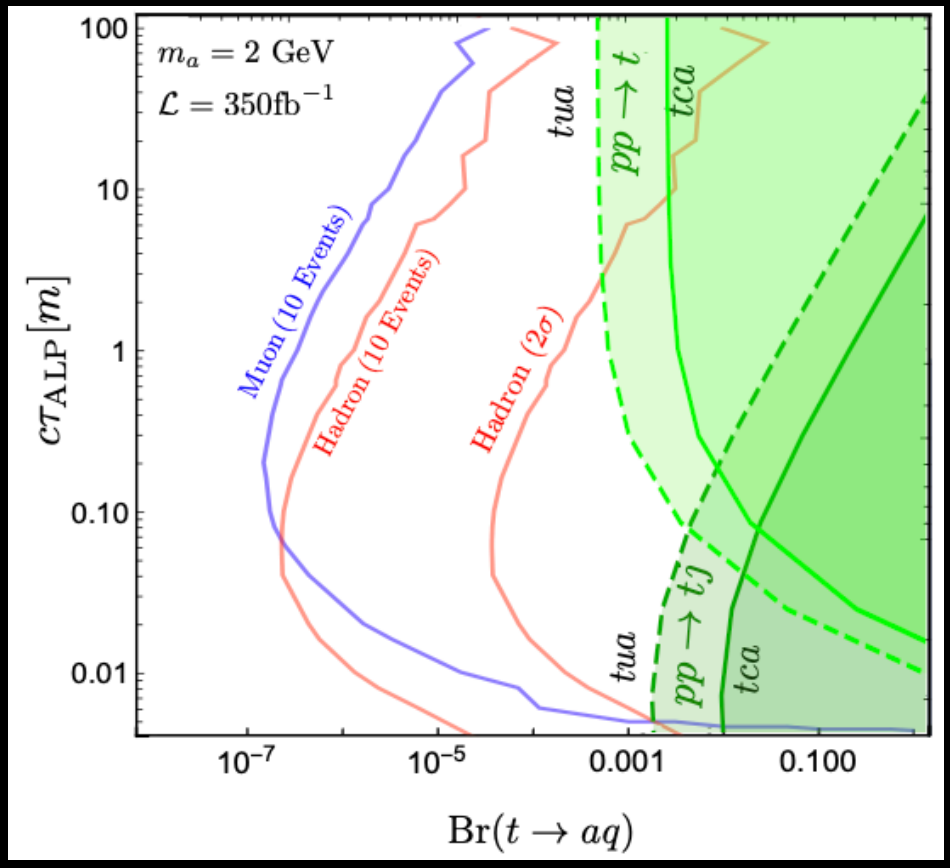
Search for exotic top decays

$$t\bar{t} \longrightarrow t\,\bar{u}\,\bar{\pi}_D$$

↳ displaced decay to hadrons

Dark pions from top decays

Expected limits on exotic top BR in top + LLP search



Green: Recast of single top searches

2202.09371
w. A. Carmona, F. Elahi, C. Scherb

Model building (t-channel models)

* two dark quarks → minimal model with QCD like phenomenology (dark pions)

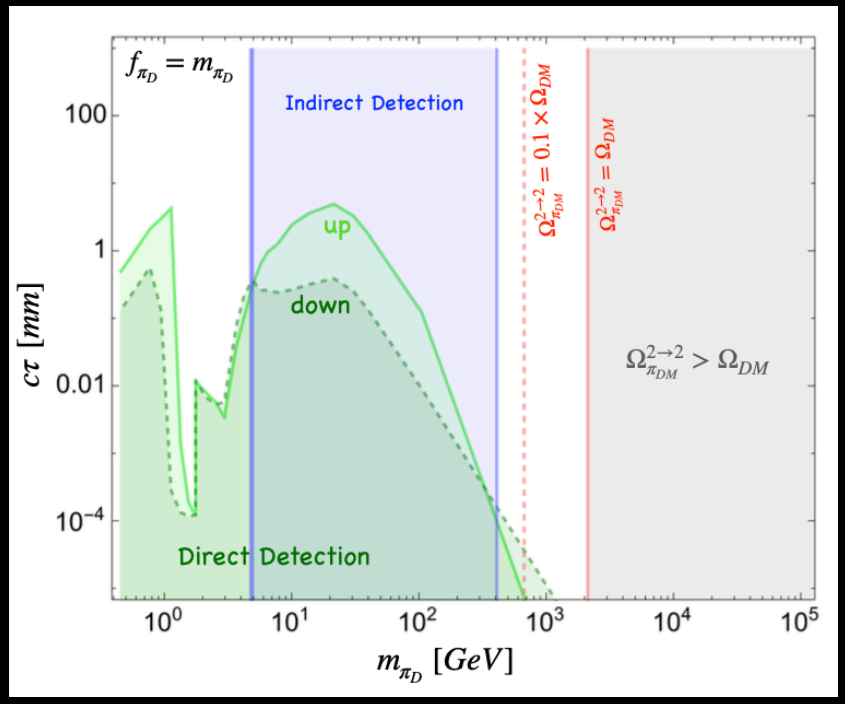
* 4 dark quarks → stable dark pions from SU(4) dark flavour

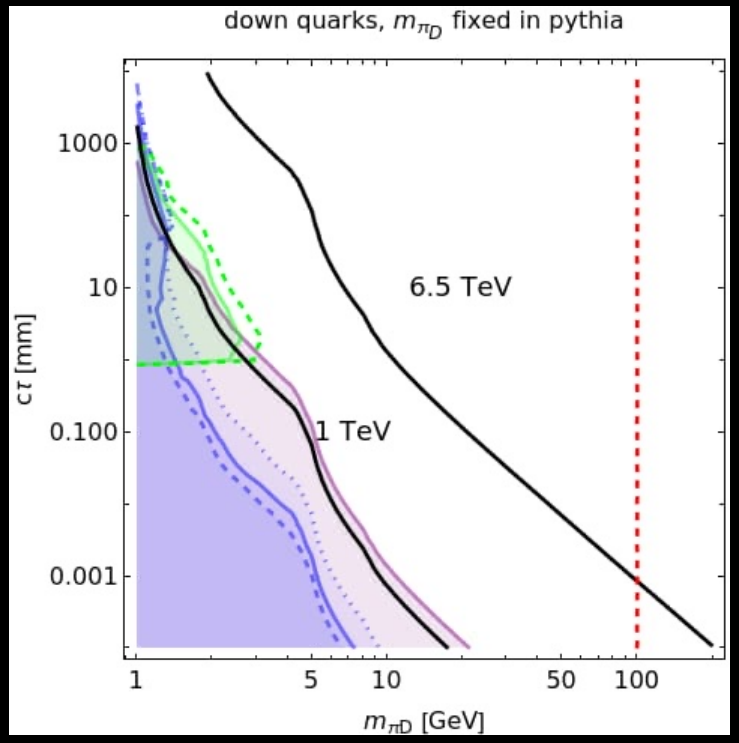
↳ Relic abundance from $\pi\pi \to \pi\pi$ scatterings including stable and unstable dark pions

in progress w. A. Carmona, F. Elahi, C. Scherb

Dark pion DM from flavour

Preliminary





Complementarity of LLP and direct detection

in progress w. A. Carmona, F. Elahi, C. Scherb

Summary:

Realistic dark sectors are { rich, complicated }

Collider phens done piece-wise, difficult to capture full breadth

Looking forward to the new ideas presented here