

Searching for Top-philic Dark Matter

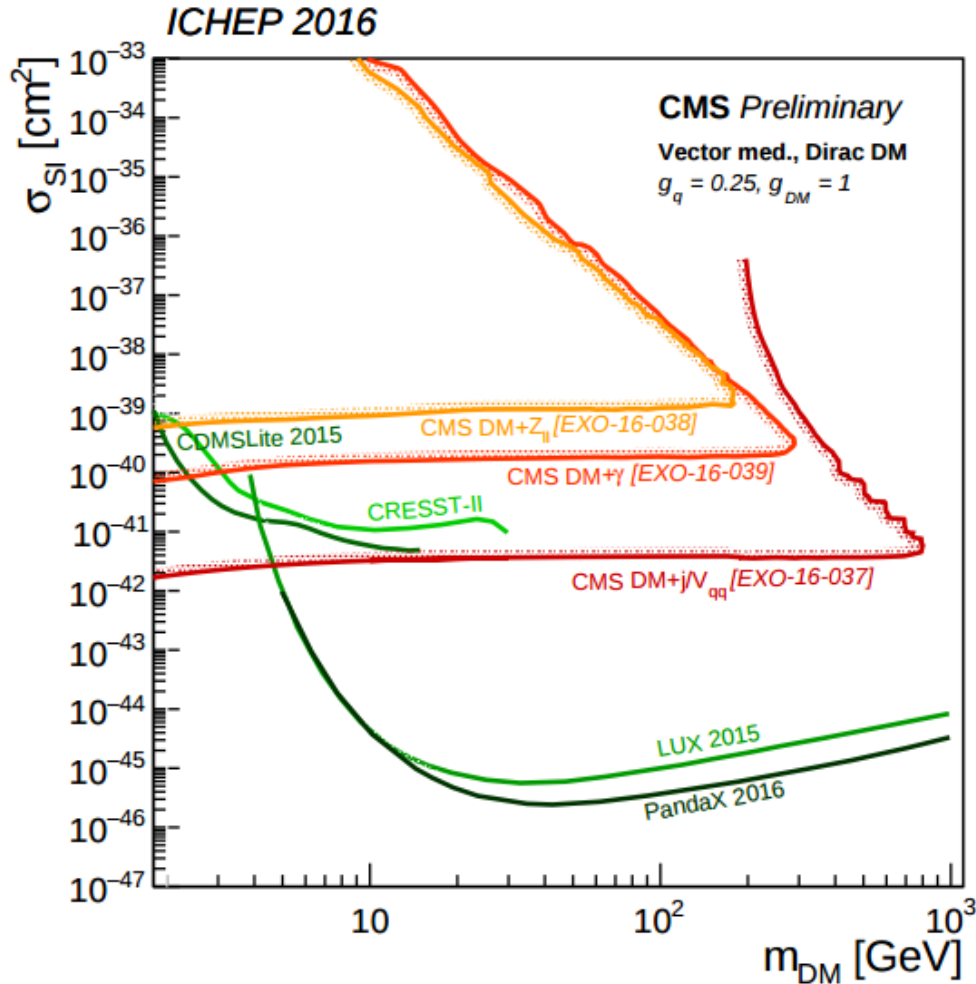
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Rutgers University



In collaboration with:
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Angelo Monteux, David Shih

Mitchell Workshop, TAMU 2017

DD vs Colliders

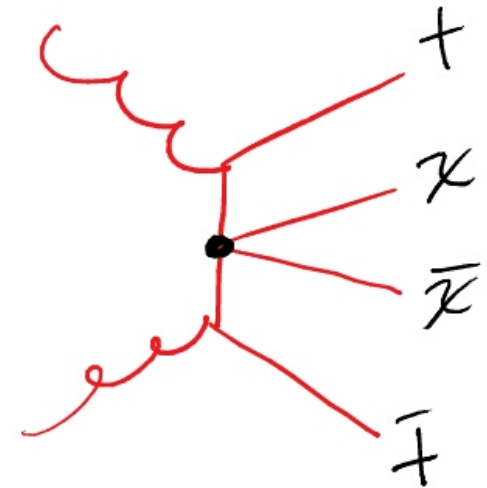
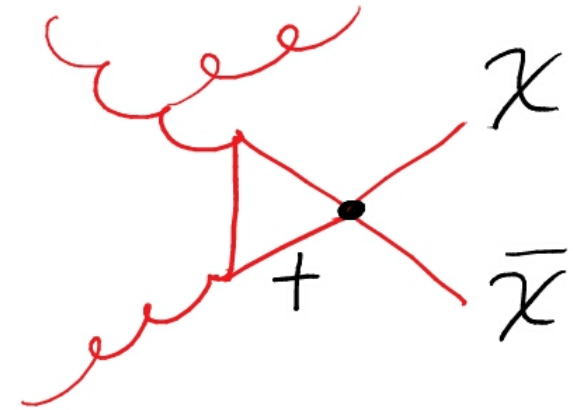
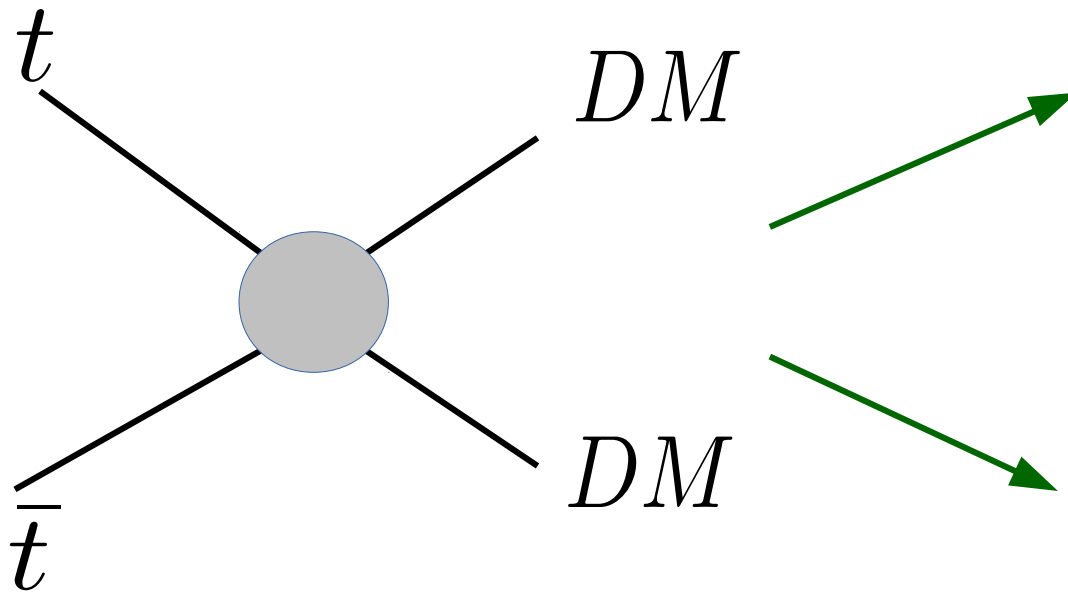


CMS – ICHEP: DP-2016/057

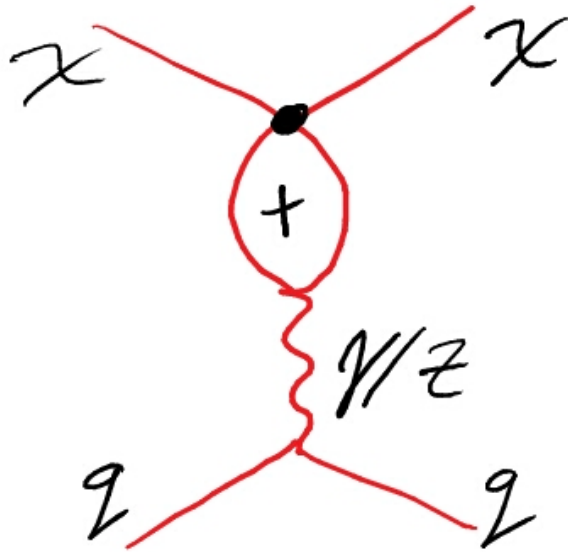
Operator	SI / SD	Suppression
$\mathcal{O}_1^f = \bar{\chi}\chi \bar{q}q$	SI	—
$\mathcal{O}_2^f = \bar{\chi}i\gamma^5\chi \bar{q}q$	SI	q^2
$\mathcal{O}_3^f = \bar{\chi}\chi \bar{q}i\gamma^5q$	SD	q^2
$\mathcal{O}_4^f = \bar{\chi}\gamma^5\chi \bar{q}\gamma^5q$	SD	q^4
$\mathcal{O}_5^f = \bar{\chi}\gamma^\mu\chi \bar{q}\gamma_\mu q$	SI	—
$\mathcal{O}_6^f = \bar{\chi}\gamma^\mu\gamma^5\chi \bar{q}\gamma_\mu q$	SI / SD	v^2 / q^2
$\mathcal{O}_7^f = \bar{\chi}\gamma^\mu\chi \bar{q}\gamma_\mu\gamma^5q$	SD	v^2 or q^2
$\mathcal{O}_8^f = \bar{\chi}\gamma^\mu\gamma^5\chi \bar{q}\gamma_\mu\gamma^5q$	SD	—
$\mathcal{O}_9^f = \bar{\chi}\sigma^{\mu\nu}\chi \bar{q}\sigma_{\mu\nu}q$	SD	—
$\mathcal{O}_{10}^f = \bar{\chi}i\sigma^{\mu\nu}\gamma^5\chi \bar{q}\sigma_{\mu\nu}q$	SI	q^2

Freytsis&Ligeti, arXiv:1012.5317

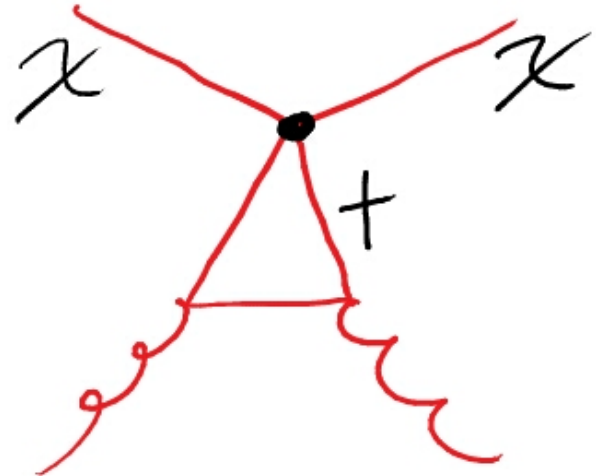
Top-philic DM: Colliders



Top-philic DM: DD



$$\mathcal{M} \sim \frac{1}{\Lambda^2} \bar{\chi} \gamma^\mu \chi \bar{N} \gamma_\mu N$$

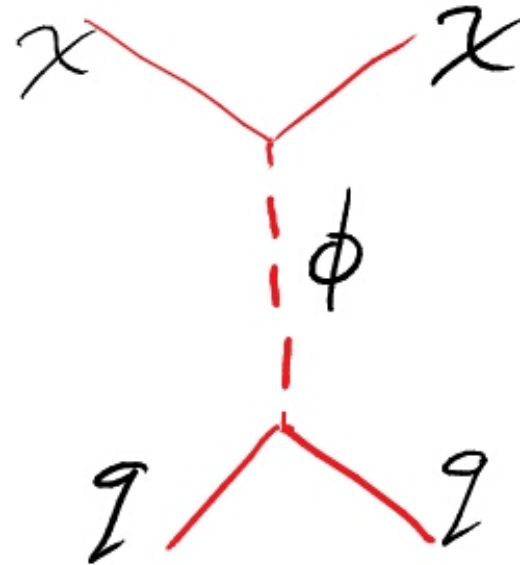
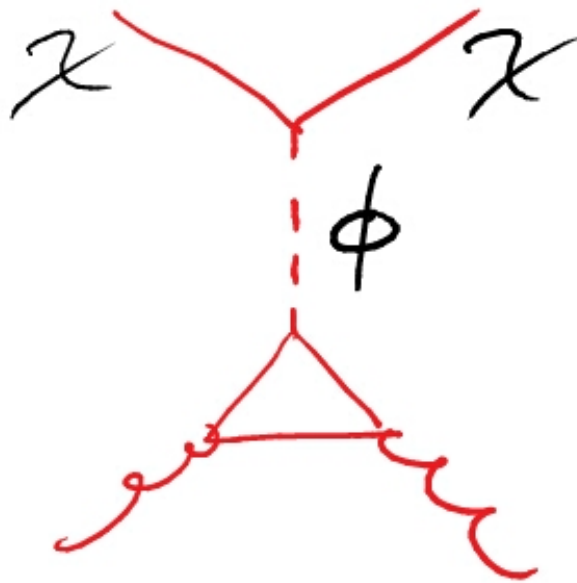


$$\mathcal{M} \sim \frac{1}{\Lambda^2} \bar{\chi} \chi \bar{N} N$$

Models - Scalar

$$\mathcal{L}_\phi \supset g\phi\bar{\chi}\chi + \sum_q \frac{g_q y_q}{\sqrt{2}} \phi \bar{q}q$$

Couple like quark yukawas, top naturally dominant portal



Models - Pseudoscalar

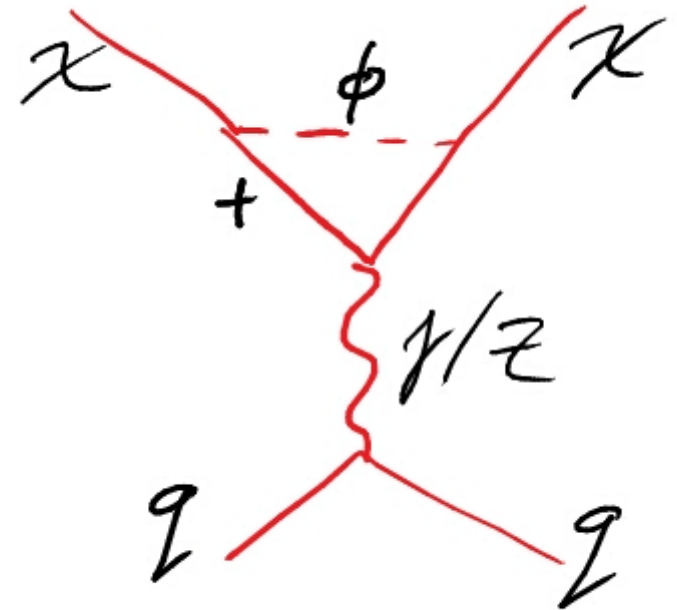
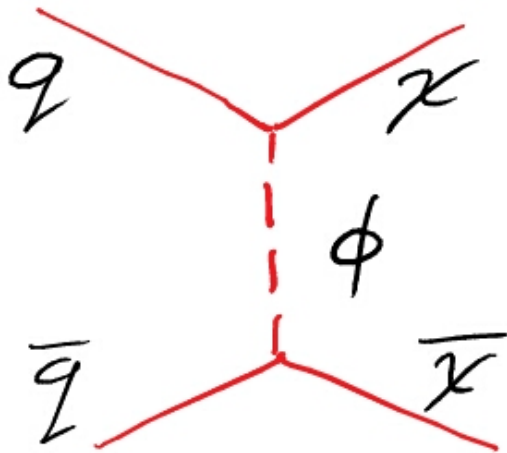
$$\mathcal{L}_A \supset igA\bar{\chi}\gamma_5\chi + \sum_q \frac{ig_q y_q}{\sqrt{2}} A\bar{q}\gamma_5 q$$

- Couplings also proportional to yukawas
- Colliders physics is quite similar to scalar, however DD and ID are starkly different:
- Scalar:
 - DD: Spin-Independent
 - ID: **p-wave**
- Pseudo-Scalar:
 - DD: **Spin-Dependent, q^4**
 - ID: s-wave

Models – “t-channel”

$$\mathcal{L}_t \supset \sum_i g_i \phi_i \bar{u}_i P_L \chi + h.c.$$

$$\phi : (3, 1)_{2/3}$$



Models

Scalar

$$\mathcal{L}_\phi \supset g\phi\bar{\chi}\chi + \sum_u \frac{gy_u}{\sqrt{2}}\phi\bar{u}u$$

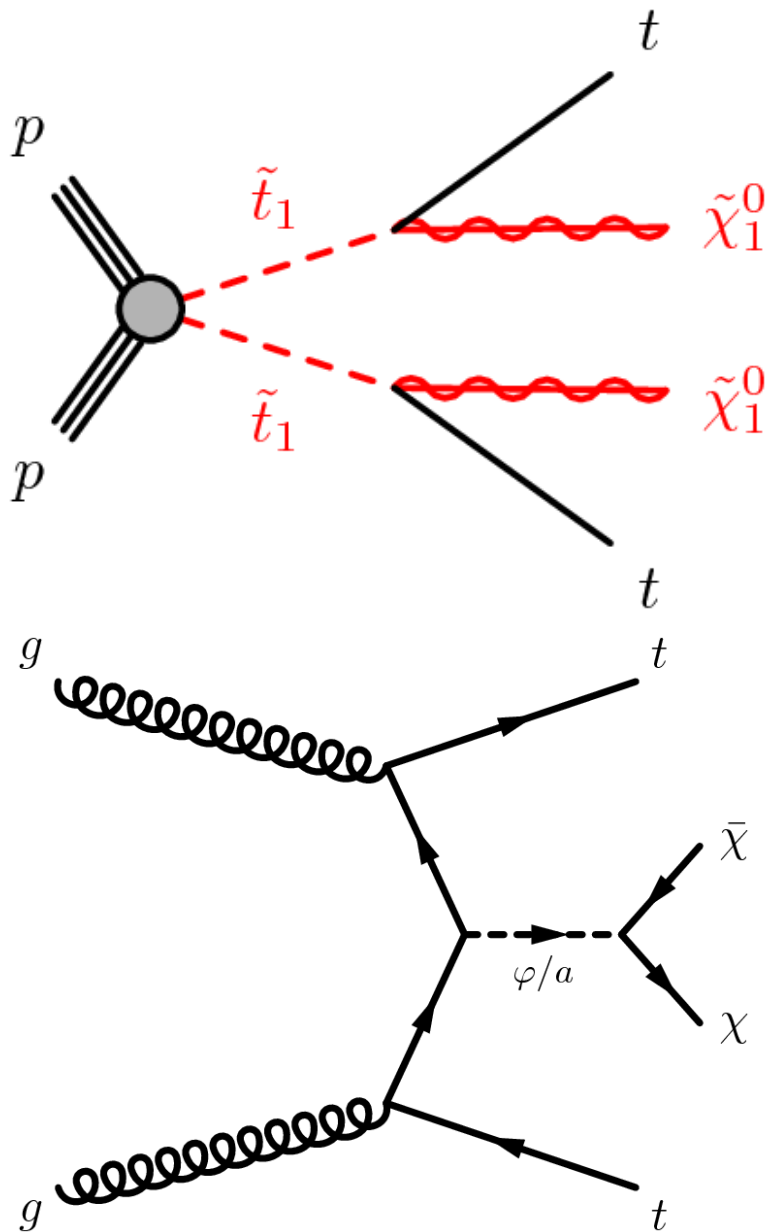
Pseudo-Scalar

$$\mathcal{L}_A \supset igA\bar{\chi}\gamma_5\chi + \sum_u \frac{igy_u}{\sqrt{2}}A\bar{u}\gamma_5u$$

Colored Scalar

$$\mathcal{L}_t \supset g\phi\bar{t}P_L\chi + h.c.$$

ttbar+MET searches



CMS:

0L: SUS-16-030

1L: SUS-16-028

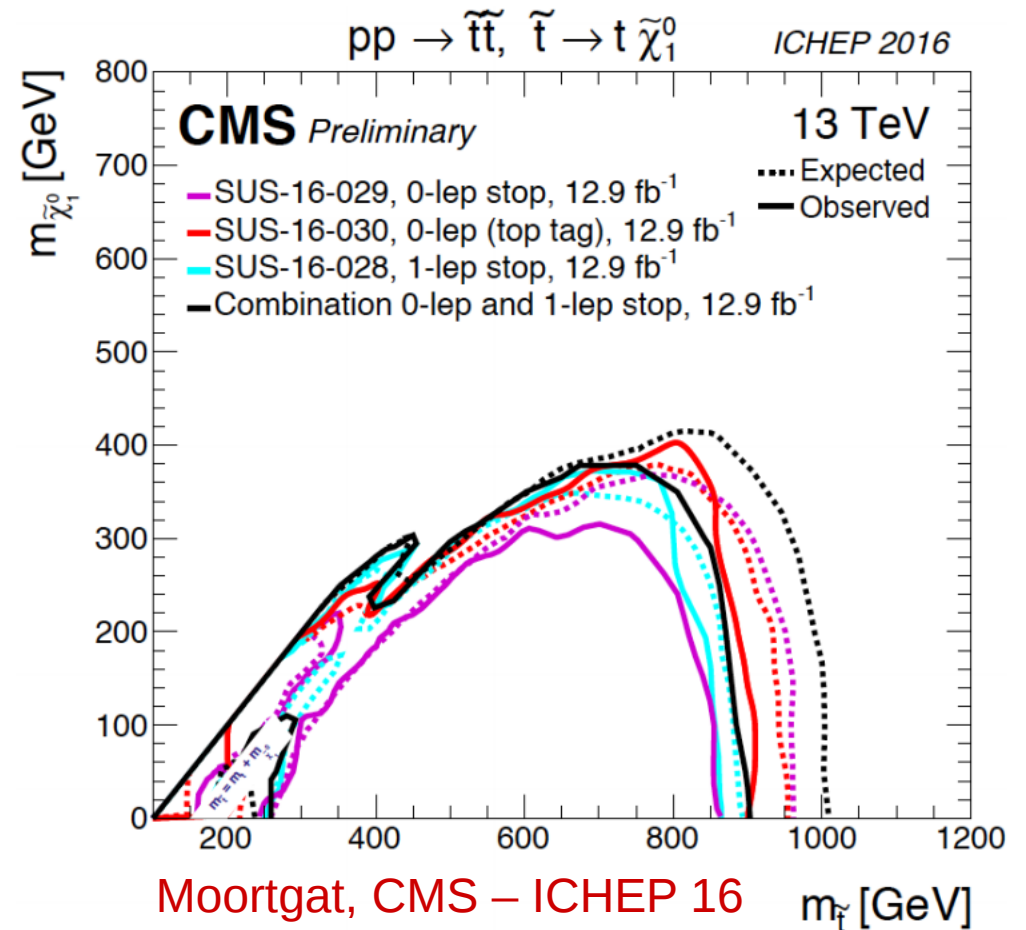
2L: SUS-16-027

ATLAS:

0L: CONF-2016-077

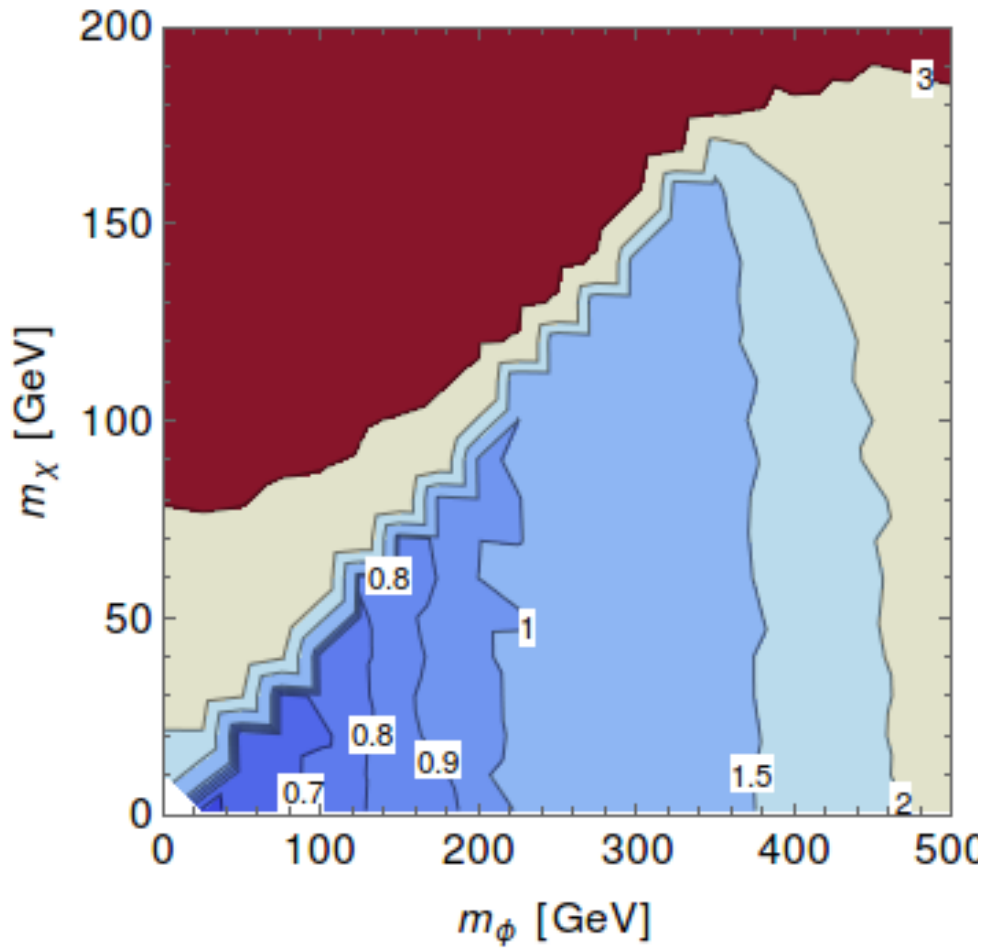
1L: CONF-2016-050

2L: CONF-2016-076

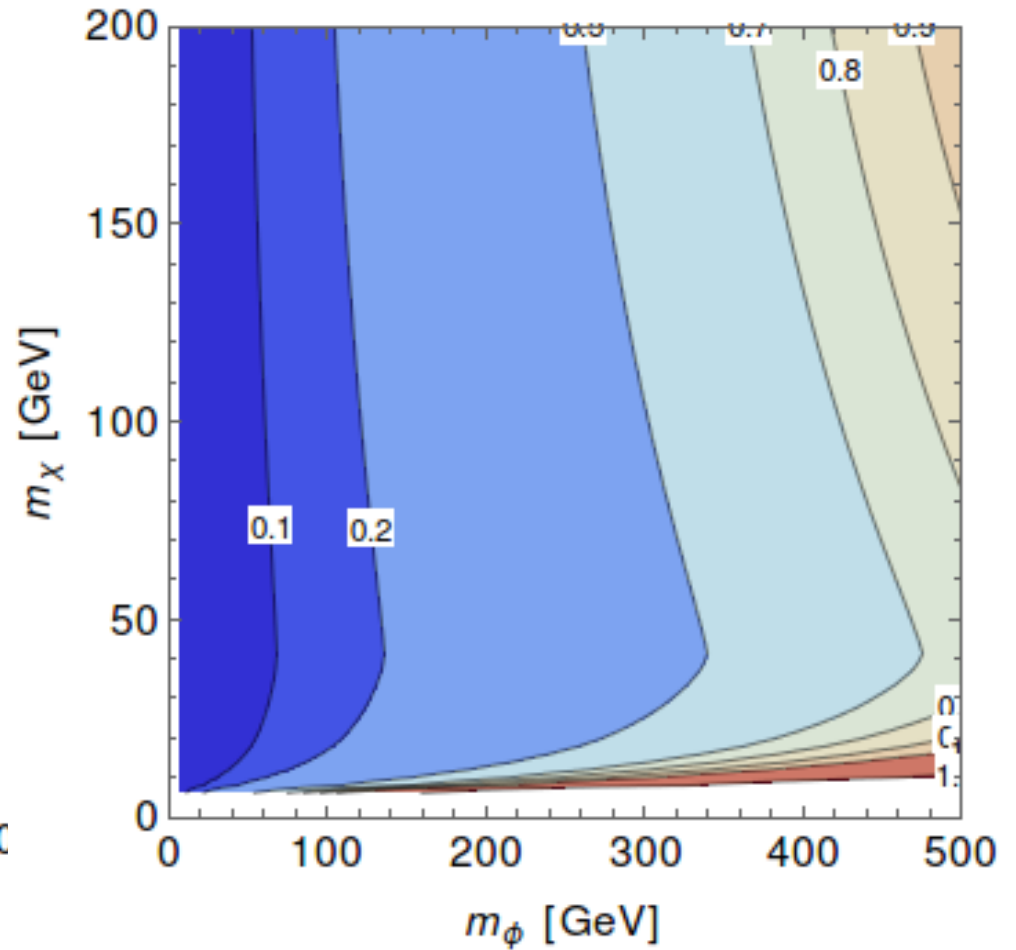


Results - Scalar

Scalar: $t\bar{t}$ +MET



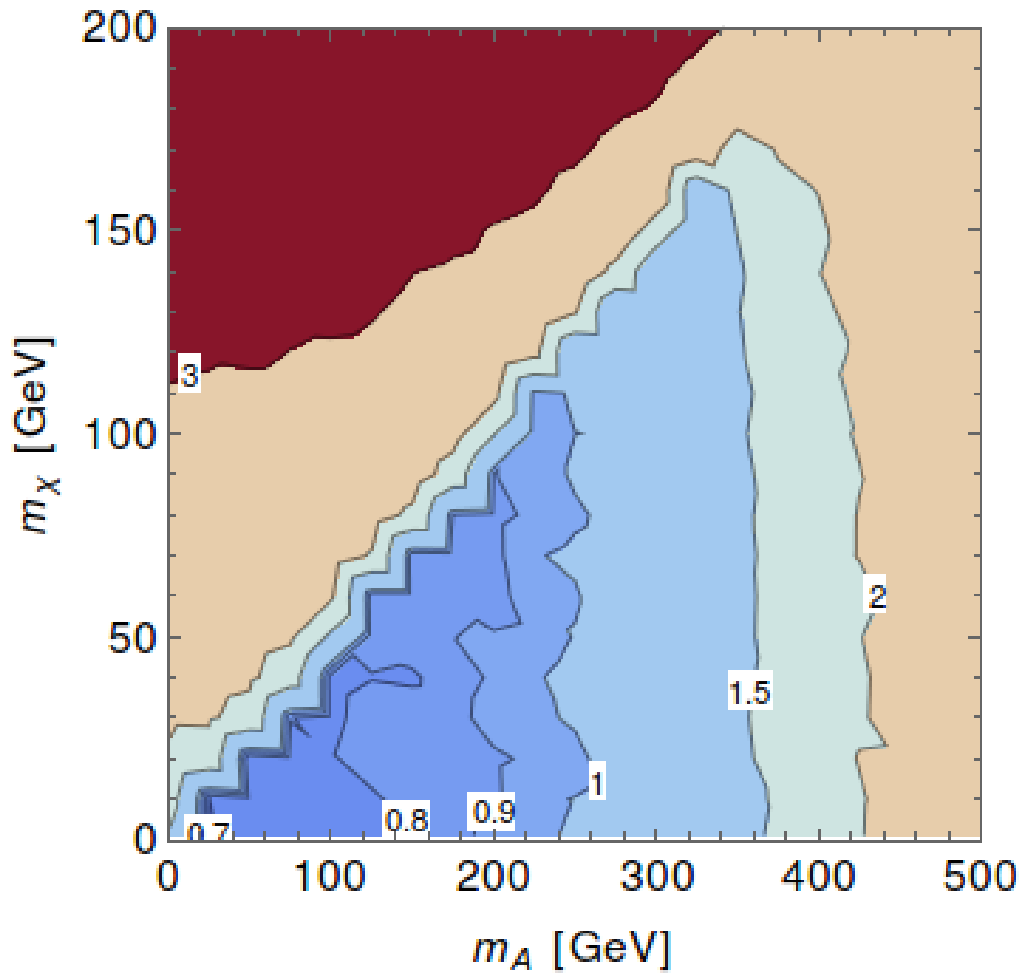
Scalar: DD



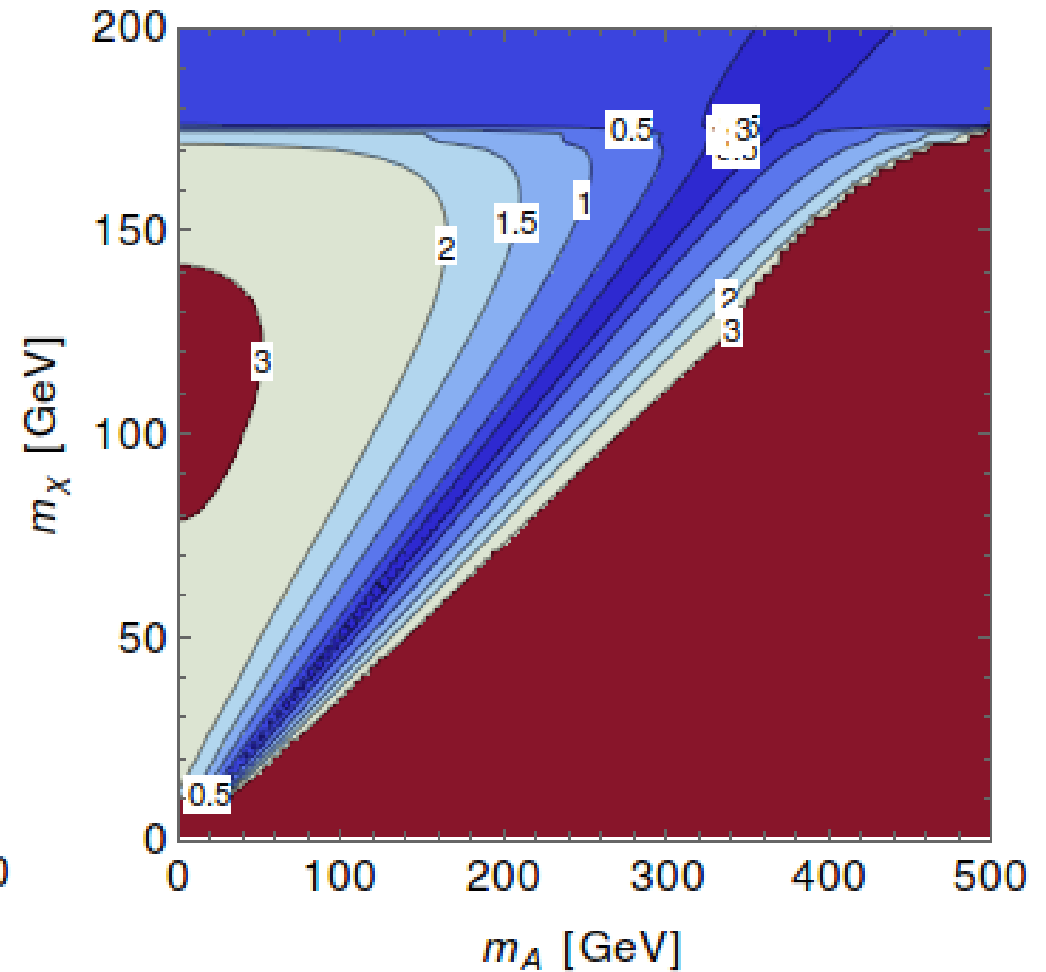
DD limits from LUX, arXiv:1608.07648

Results – Pseudoscalar

PseudoScalar: $t\bar{t}$ +MET

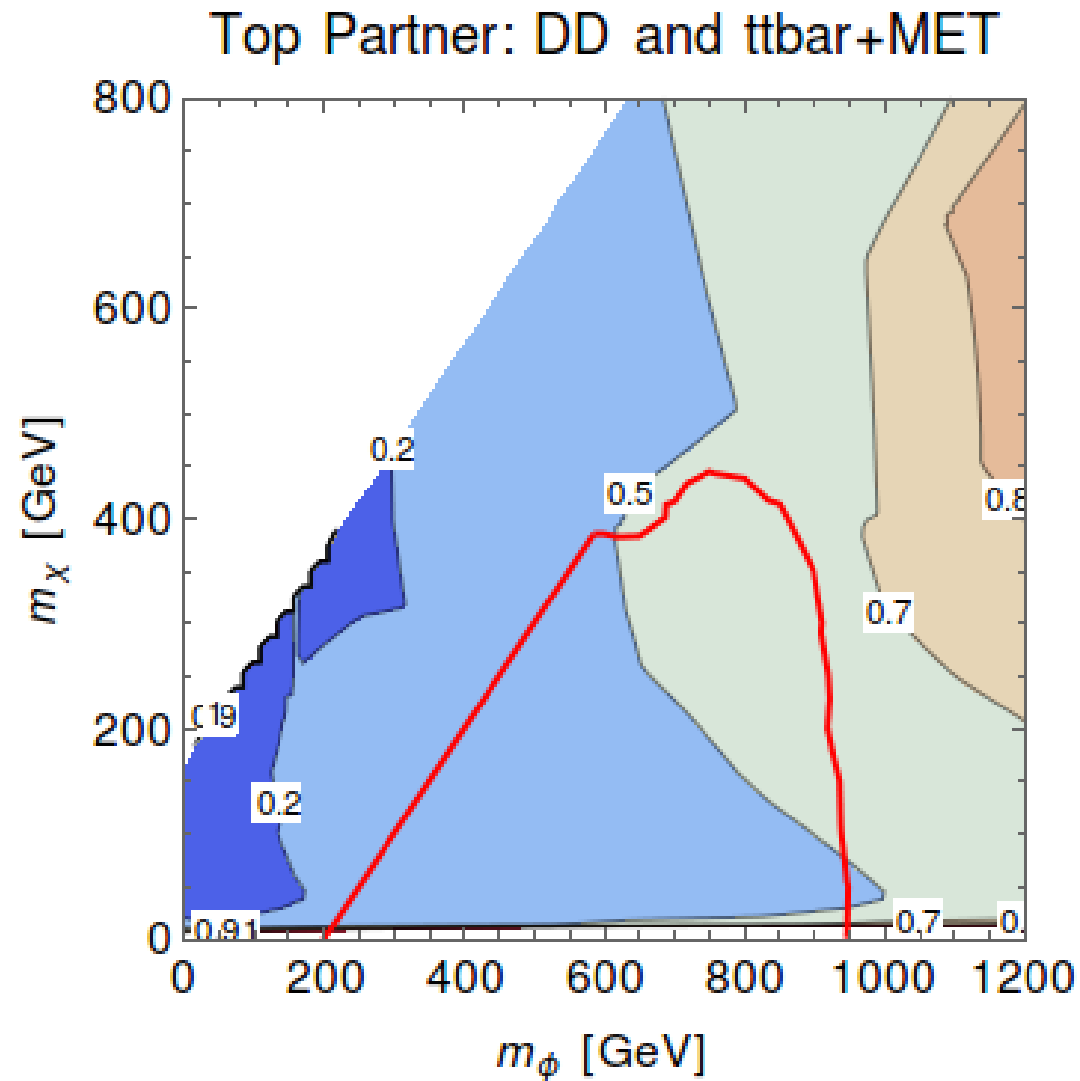


PseudoScalar: ID



Fermi+MAGIC arXiv:1601.06590

Results – Colored Scalar



Conclusions

- **Don't despair!** There's still rich pheno to explore where colliders play a crucial role
- Top-philic models are well motivated and evade some of the strongest DM constraints
- Keep an eye out for our paper which will include Moriond updates and broader recasting efforts

Thank you! Questions?