

Closing the window on WIMP Dark Matter?

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First, which WIMP?

- Odd EW multiplet with $Y=0$ (both scalars and fermions)! ...why?



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- Odd EW multiplet with $Y=0$ (both scalars and fermions)! ...why?
 - Minimal DM candidates: depend on n and M only
 - No coupling to Z boson
 - Stable IR physics
- How many multiplets?
 - Perturbative unitarity: $n < 15$



How to compute the mass?

$$\begin{cases} \frac{dY}{dx} = -\frac{s(x)}{xH(x)} \langle \sigma v \rangle_0 \left(1 - \frac{x}{3g_{*s}(x)} \frac{dg_{*s}}{dx} \right) (Y^2(x) - Y_{eq}^2(x)) \\ \langle \sigma v \rangle_0 = \frac{\pi \alpha_2^2 (2n^4 + 17n^2 - 19)}{16g_\chi M_\chi^2} \end{cases}$$



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INACCURATE!

- Important physics is missing!

-Particles feel forces: Sommerfeld enhancement

$$\langle \sigma v \rangle_0 \rightarrow \begin{cases} \langle \sigma v \rangle = S_{Som}(x) \langle \sigma v \rangle_0 \\ S_{Som}(x) \propto |\psi(0)|^2 \end{cases}, \quad -\frac{\nabla^2 \psi}{M_\chi} + V\psi = E\psi$$

How to compute the mass?

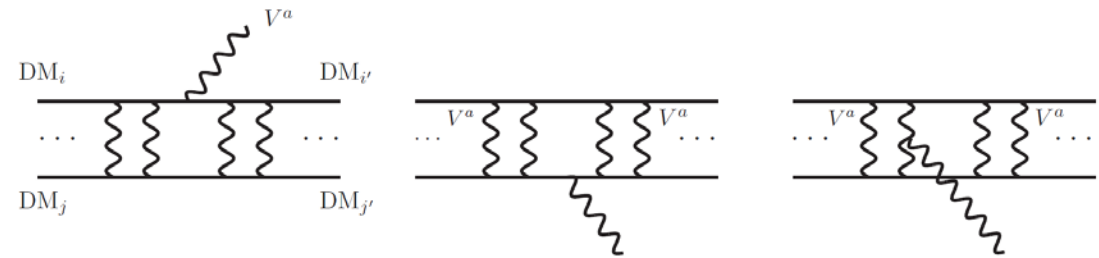


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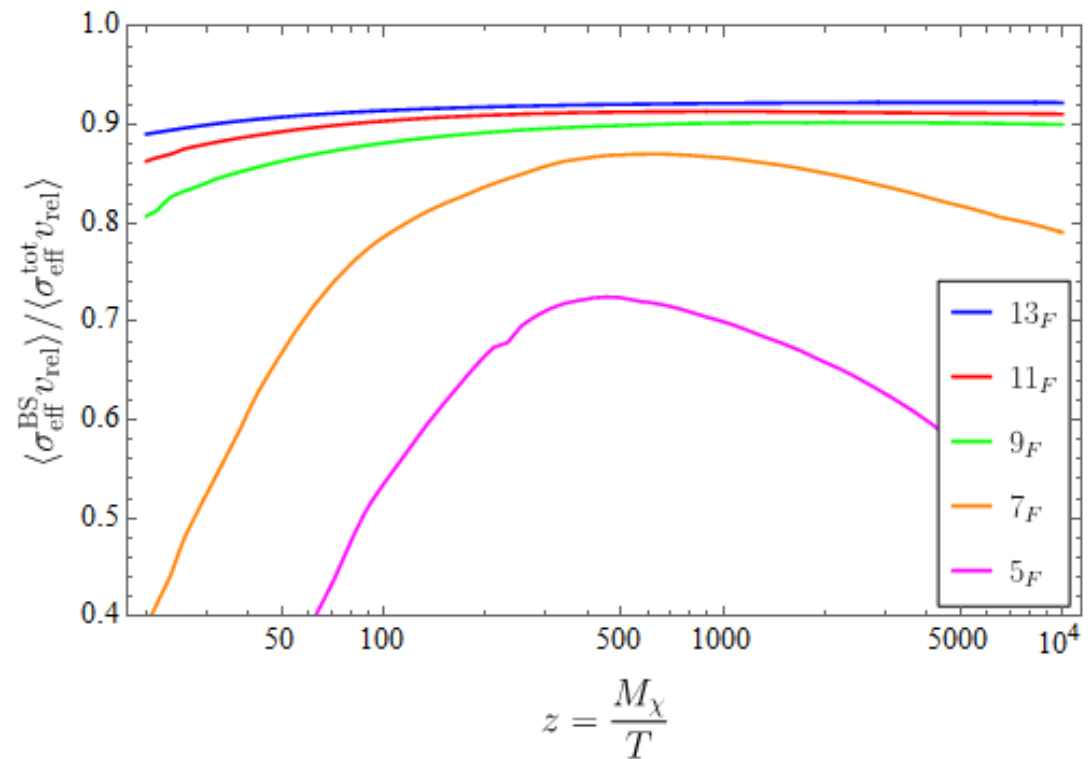
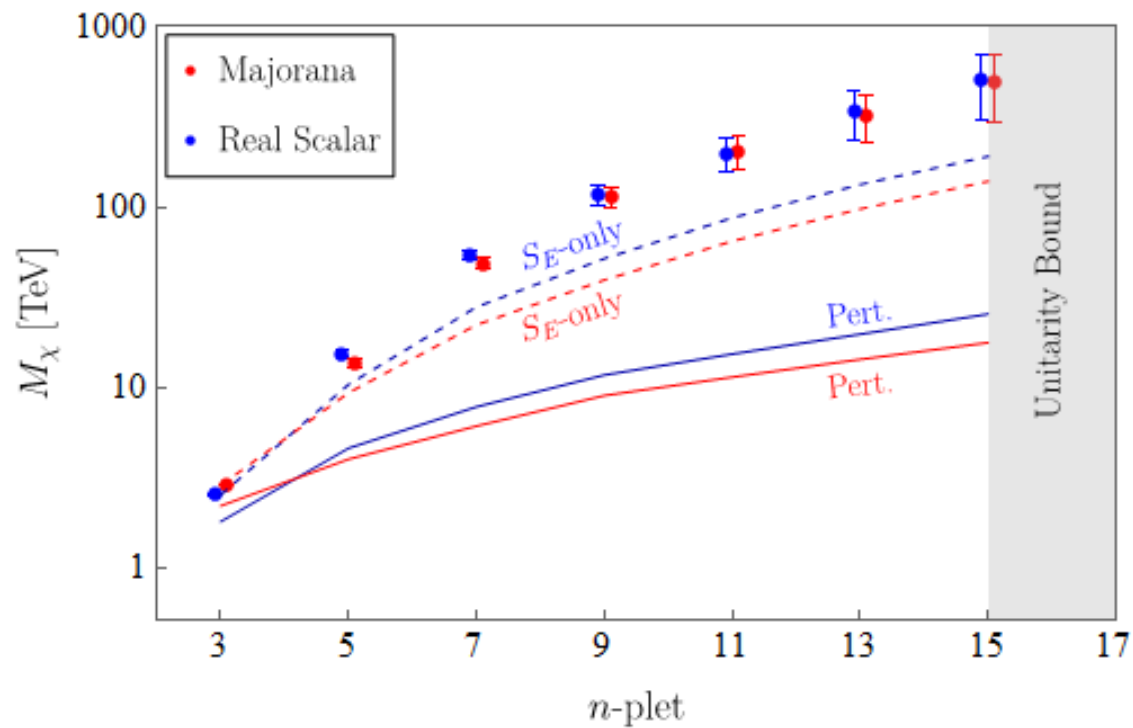
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-Bound state formation

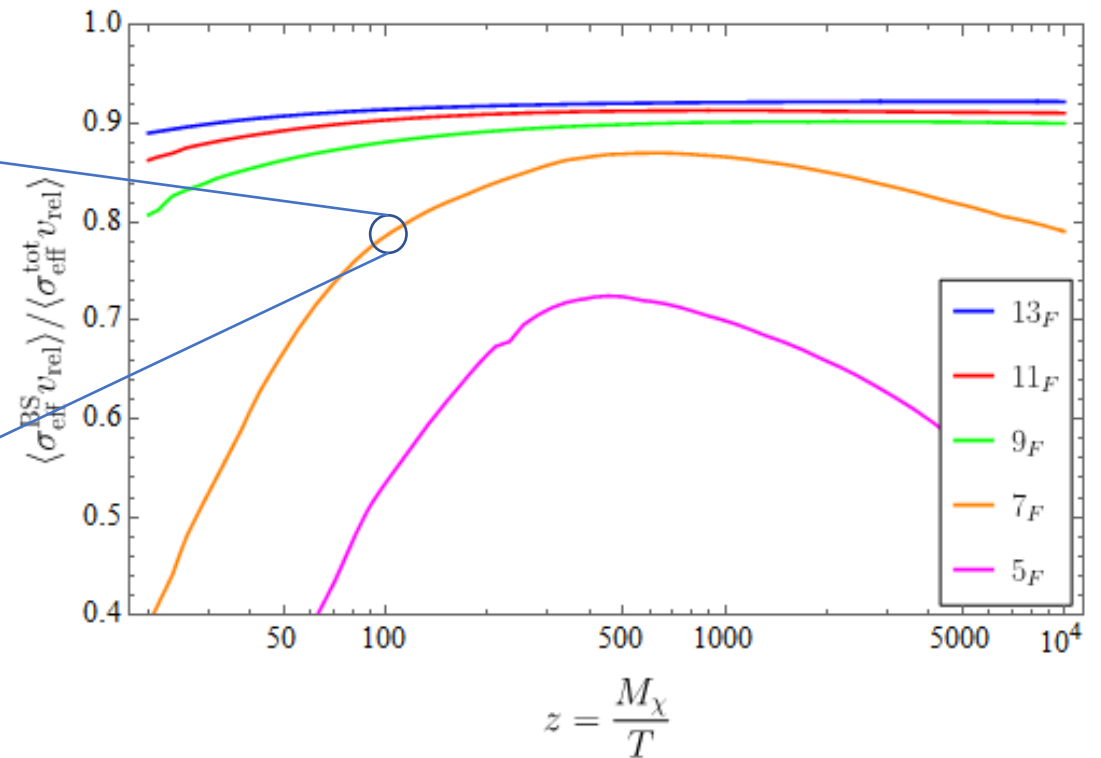
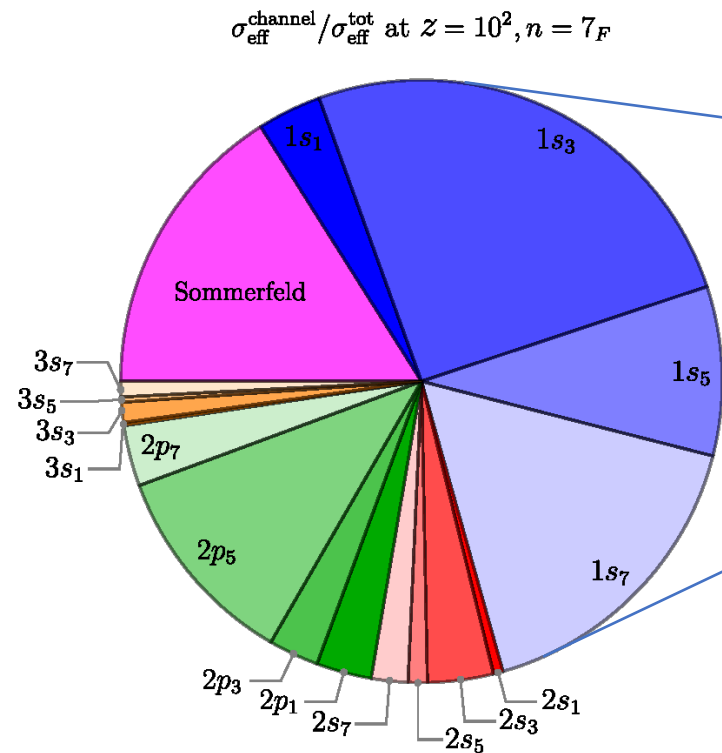


$$S(x) = S_{Som}(x) + \left[\frac{\langle \sigma v \rangle_0}{\langle \sigma_I v \rangle} + \frac{g_\chi^2 \langle \sigma v \rangle_0 M_\chi^3}{2g_I \Gamma_{ann}} \left(\frac{1}{4\pi x} \right)^{\frac{3}{2}} e^{-xE_{BI}/M_\chi} \right]^{-1}$$

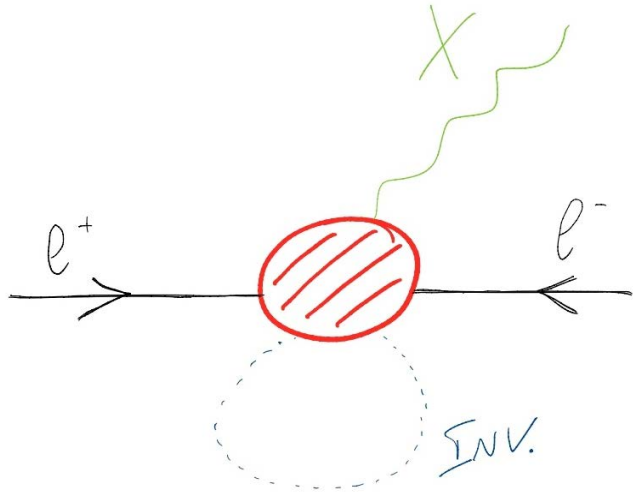
Results



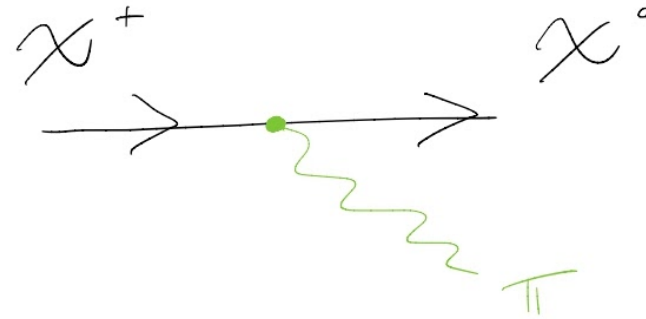
Results



Gone with the WIMP: muon collider

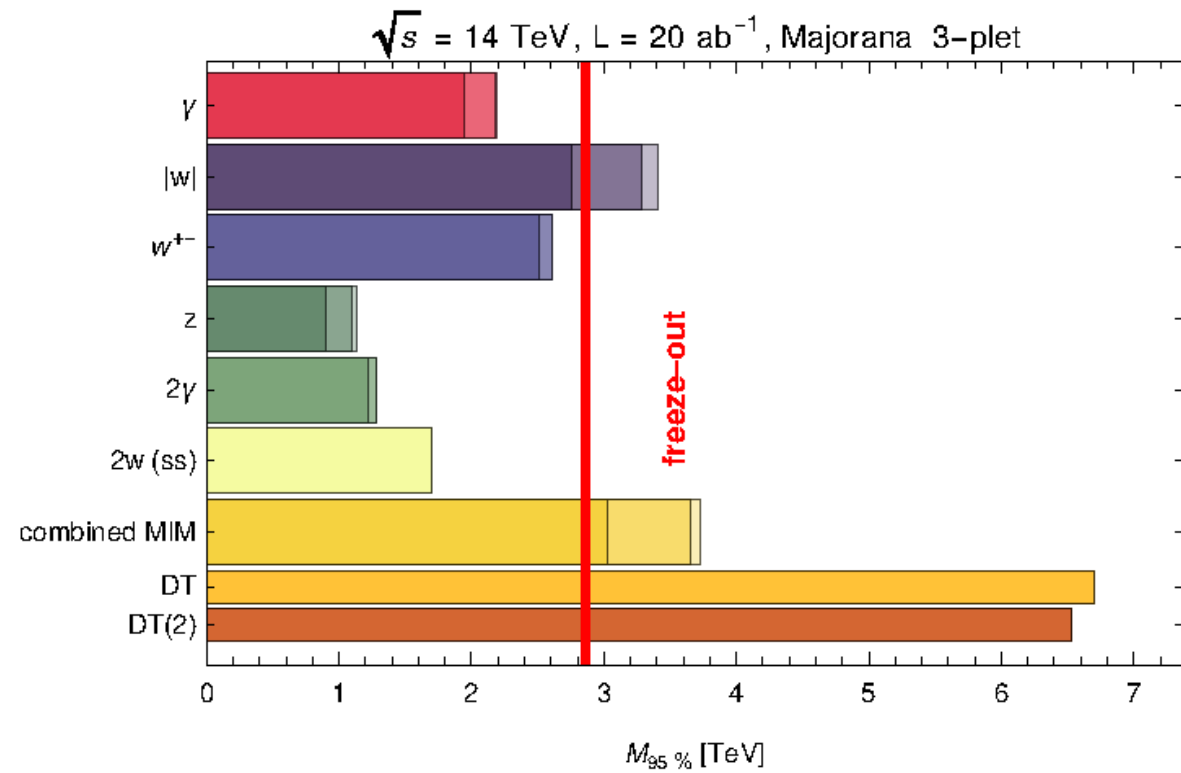
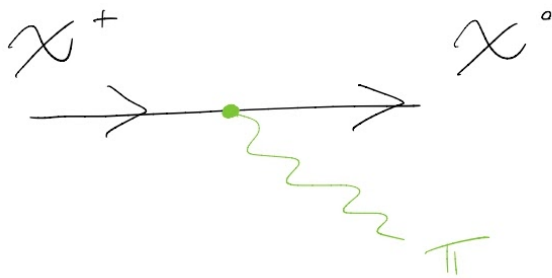
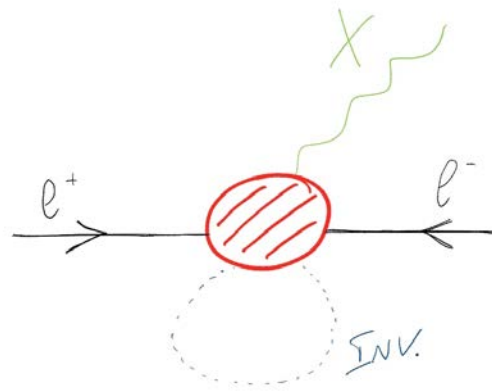


Mono-X searches

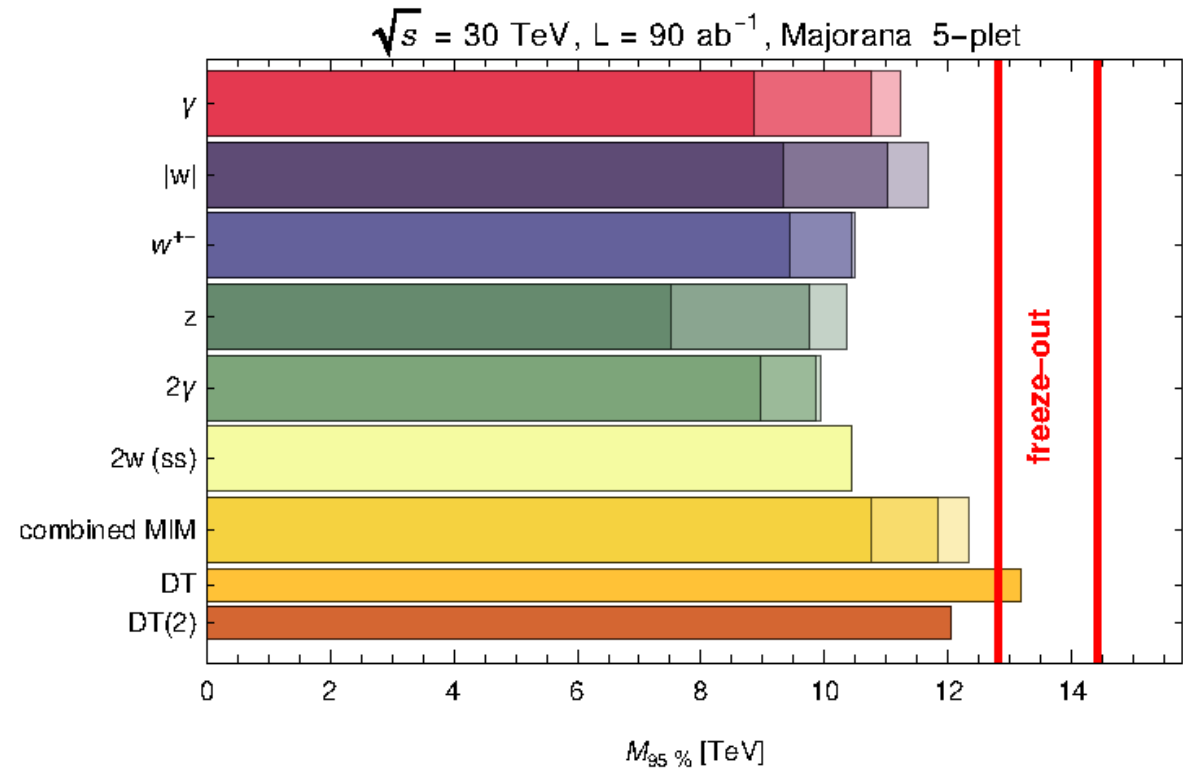
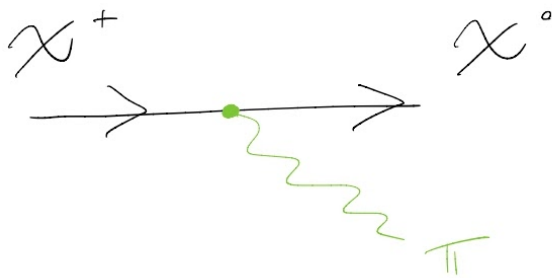
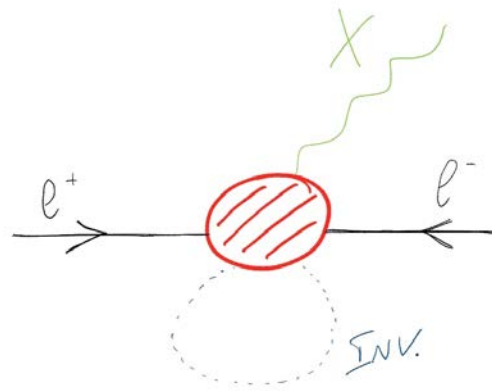


Disappearing tracks

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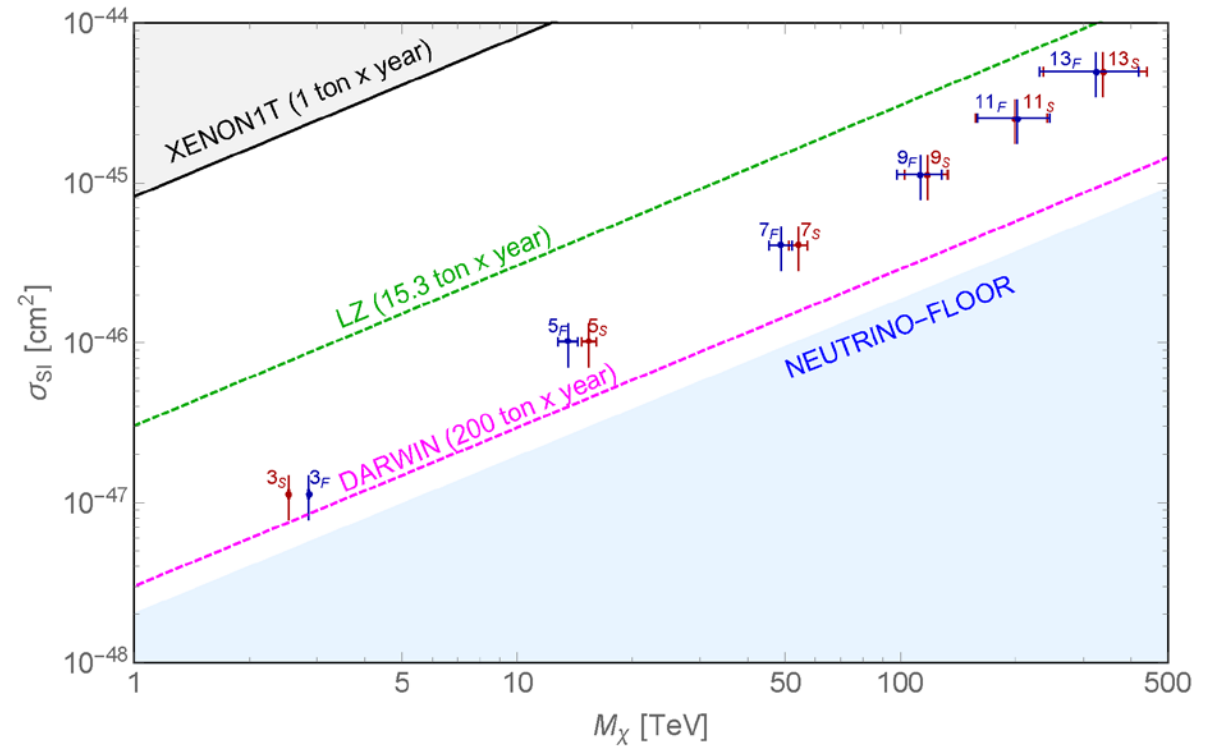
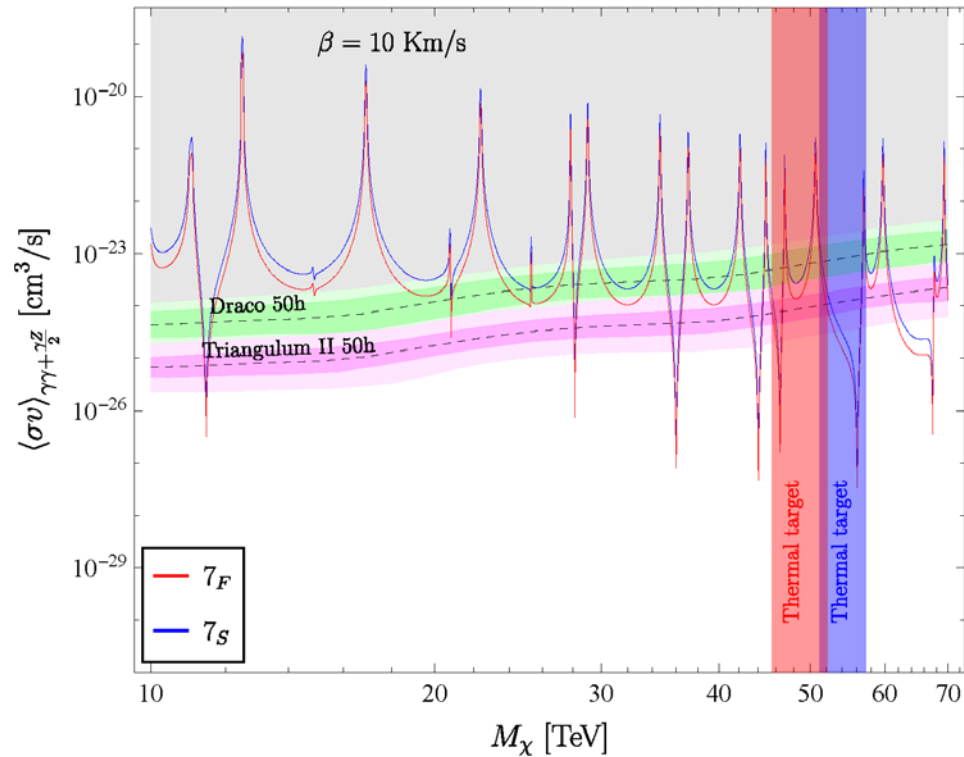


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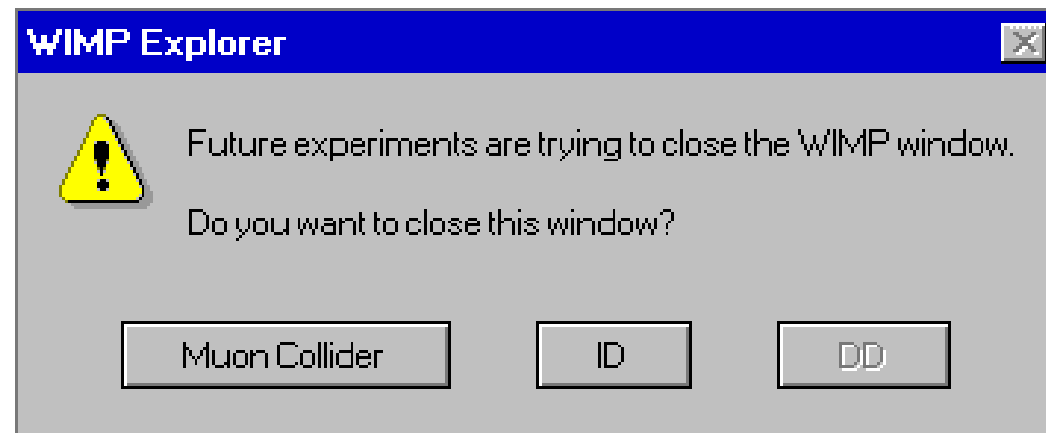


Gone with the WIMP: ID and DD

CTA prospects



Conclusions



Thanks for the attention!

