Simplified SIMPs and the LHC

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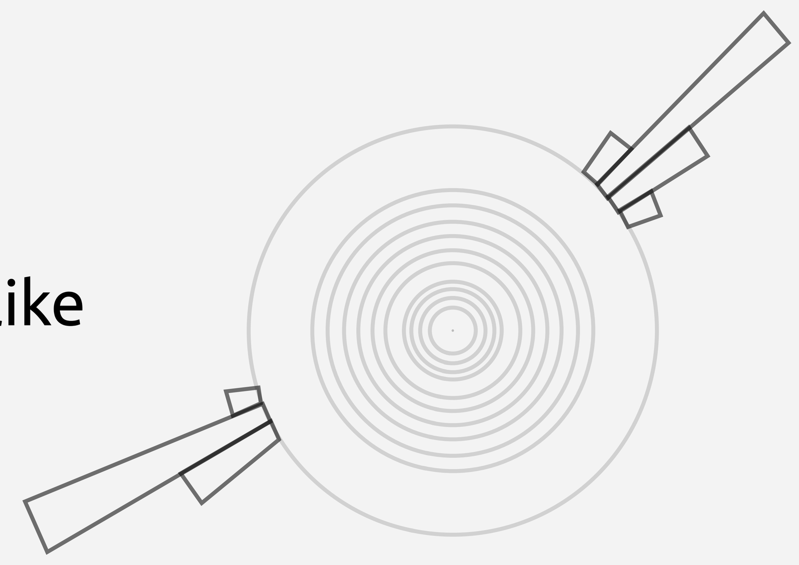
Strongly Interacting Massive Particles

Constraints from...

- ... underground direct detection ⟶ large cross section
- ... DM-nucleon bound states ⟶ opposite sign couplings
- ... earth heat flow ⟶ asymmetric dark matter
- ... black hole formation ⟶ fermionic dark matter

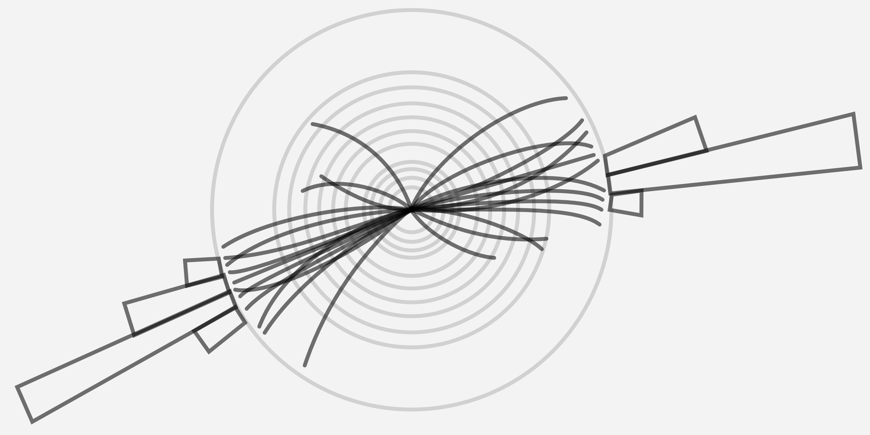
Signature at the LHC :

Neutral, Stable, Strongly interacting ⟶ Neutral hadron-like trackless jets



Background :

QCD ⟶ charged jets



Discriminate between signal and background :

Same shape for kinematical distributions

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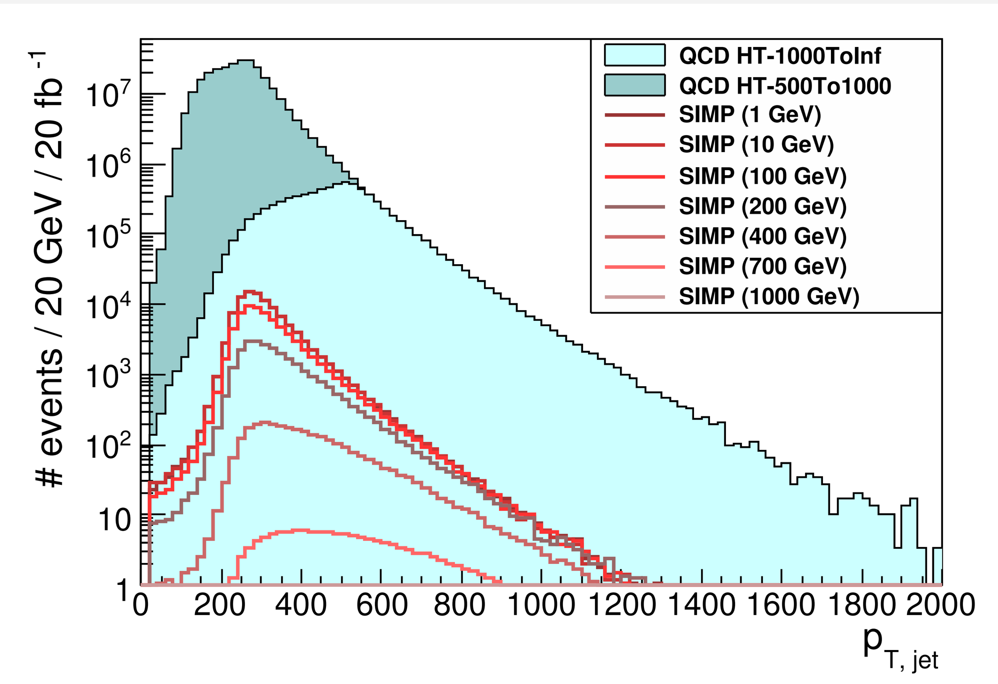
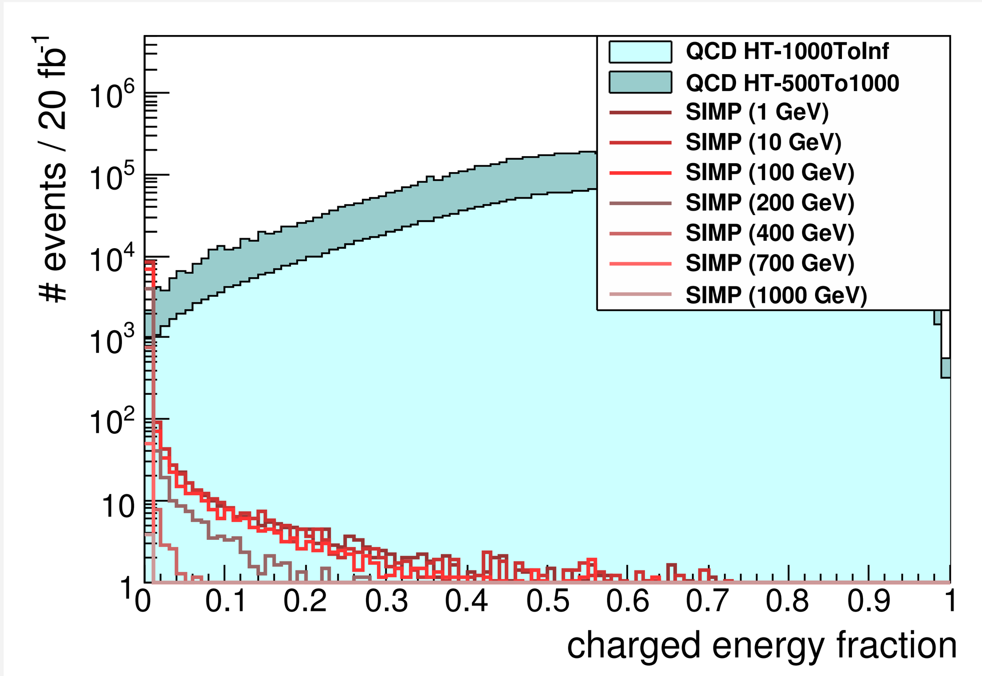
Look for other variable



Preselection: $|\eta| < 2.5$, $p_T > 250$ GeV



Jet charged energy fraction = $\sum p_{T,\mathrm{charged}} / p_{T,\mathrm{jet}}$

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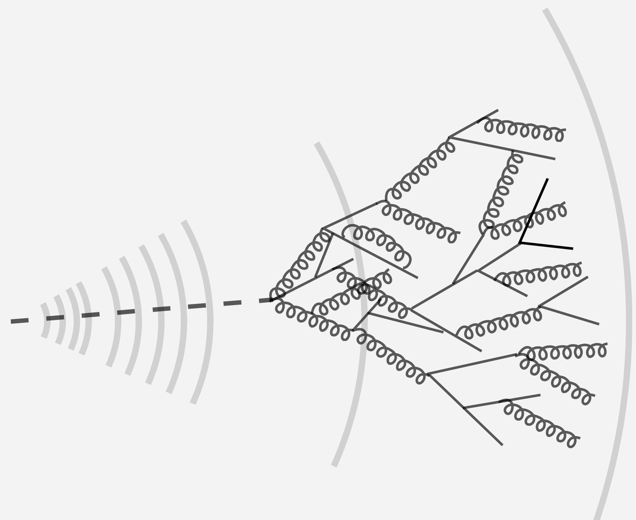
Determine optimal cut

Search sensitivity depends on **SIMP inelastic interaction cross section** :

Shower fully contained in calorimeter



$\sigma_{\chi N} = \sigma_{hadronic}$

Late shower development

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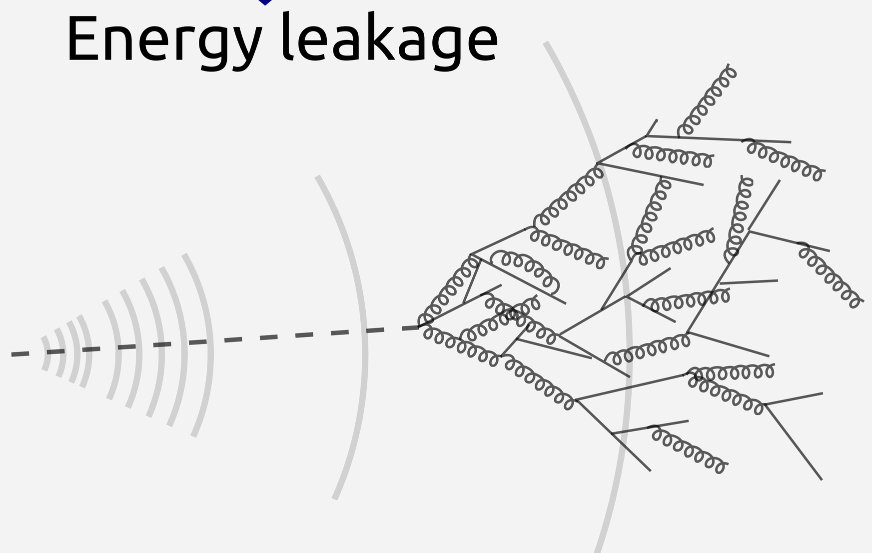
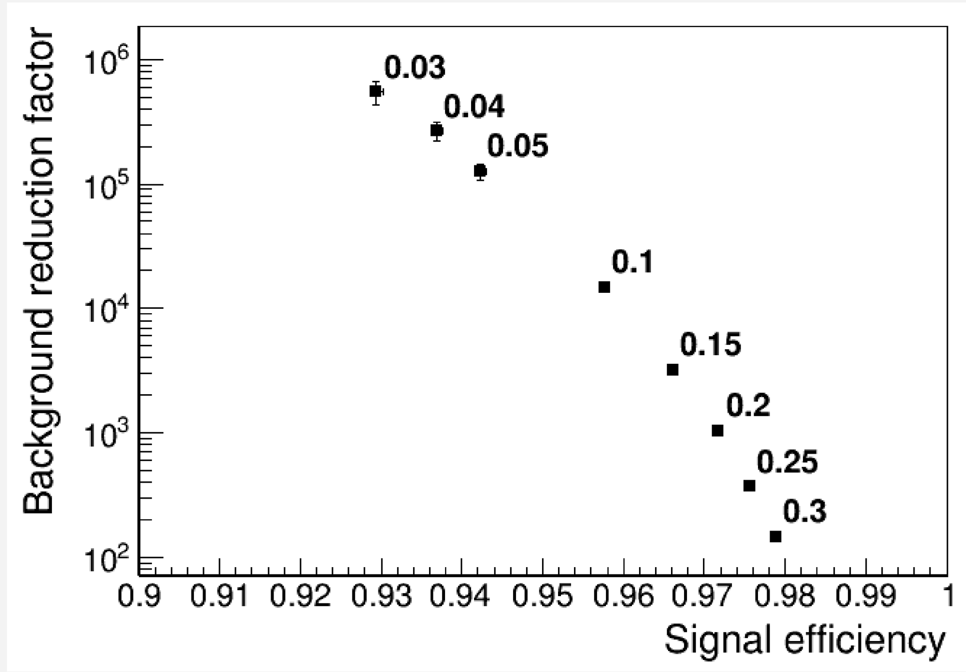
Energy leakage



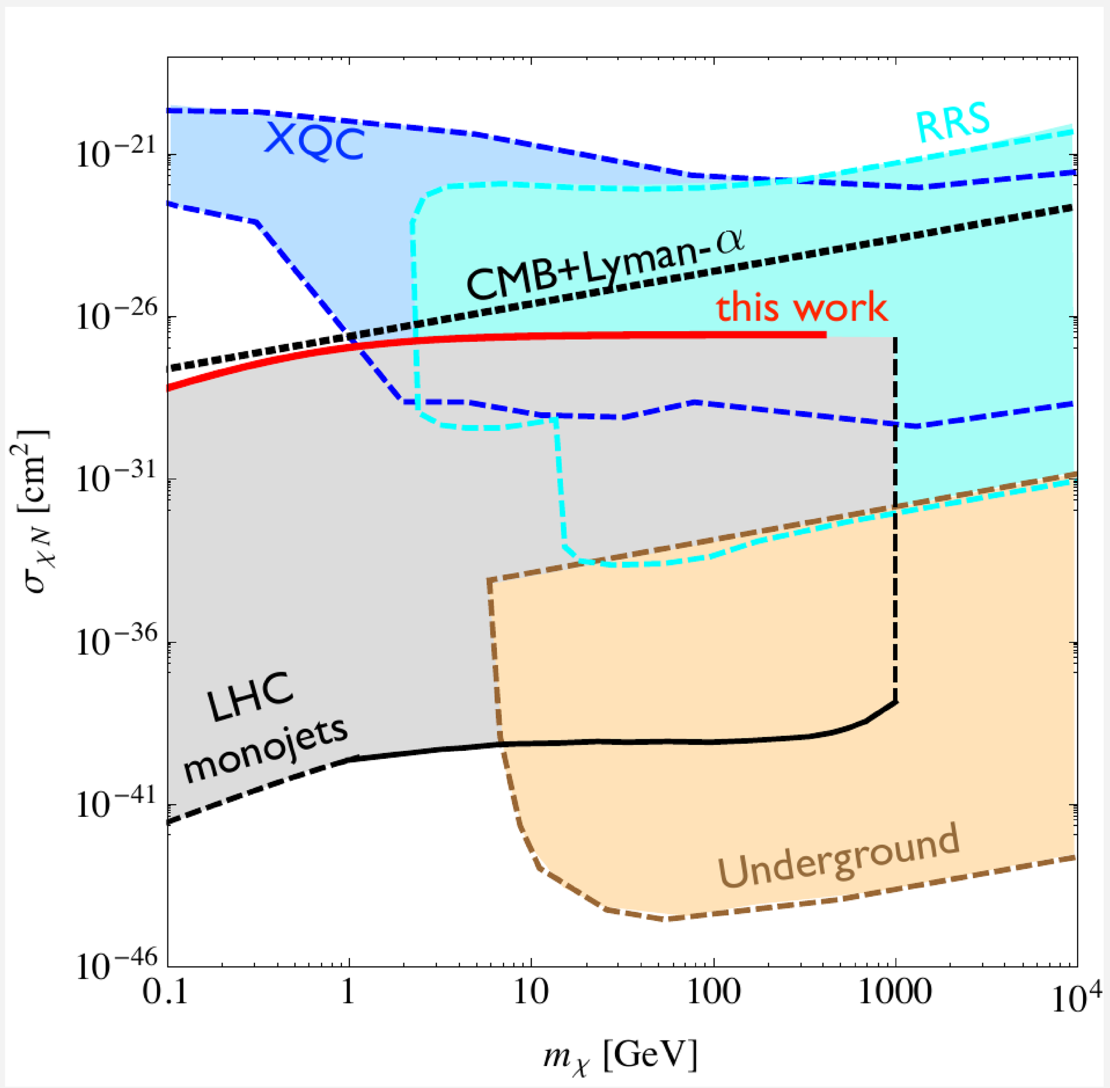
$\sigma_{\chi N} = 0.1\sigma_{hadronic}$



- Apply charged energy fraction cut on both jets
- Find optimal cut value
- Aim for high signal efficiency and high background reduction

- Better sensitivity expected for **vector** mediator than for **scalar** mediator
- For $\sigma_{\chi N} = \sigma_{hadronic}$, **discovery potential** for SIMP masses up to 400 GeV
- For $\sigma_{\chi N} = 0.1\sigma_{hadronic}$, discovery can be reached for SIMP masses up to 100 GeV
- Lower $\sigma_{\chi N}$ ⟶ no longer trackless jets, but **missing energy**

- Translate into **limits** on the elastic interaction cross section
- No observation ⟶ **exclude** parameter space above red line
- **Complementary** to missing energy searches
- Assumption in the plot: SIMP is dominant form of dark matter



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