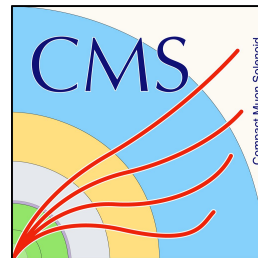
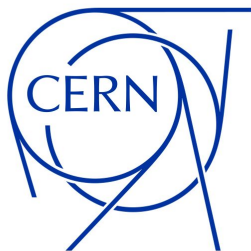


Searches for dark sector signatures with CMS

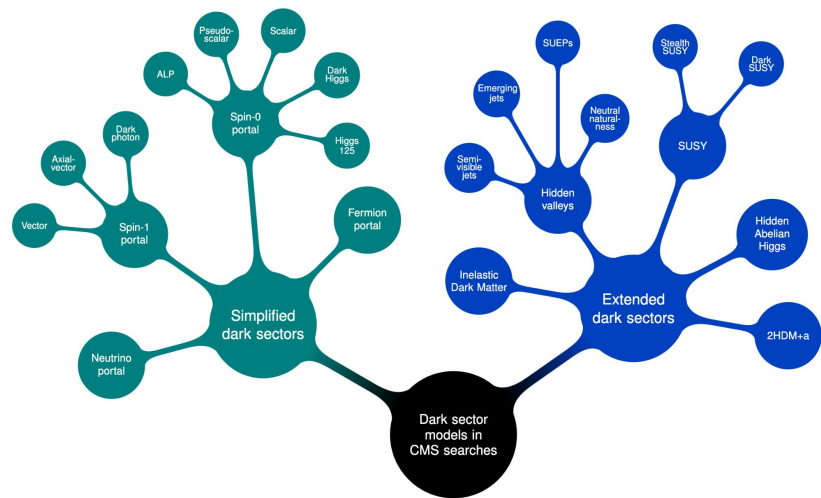
Jaime León Holgado on behalf of the CMS Collaboration

QCD@LHC2026 (Oxford, United Kingdom)
October 1st, 2026

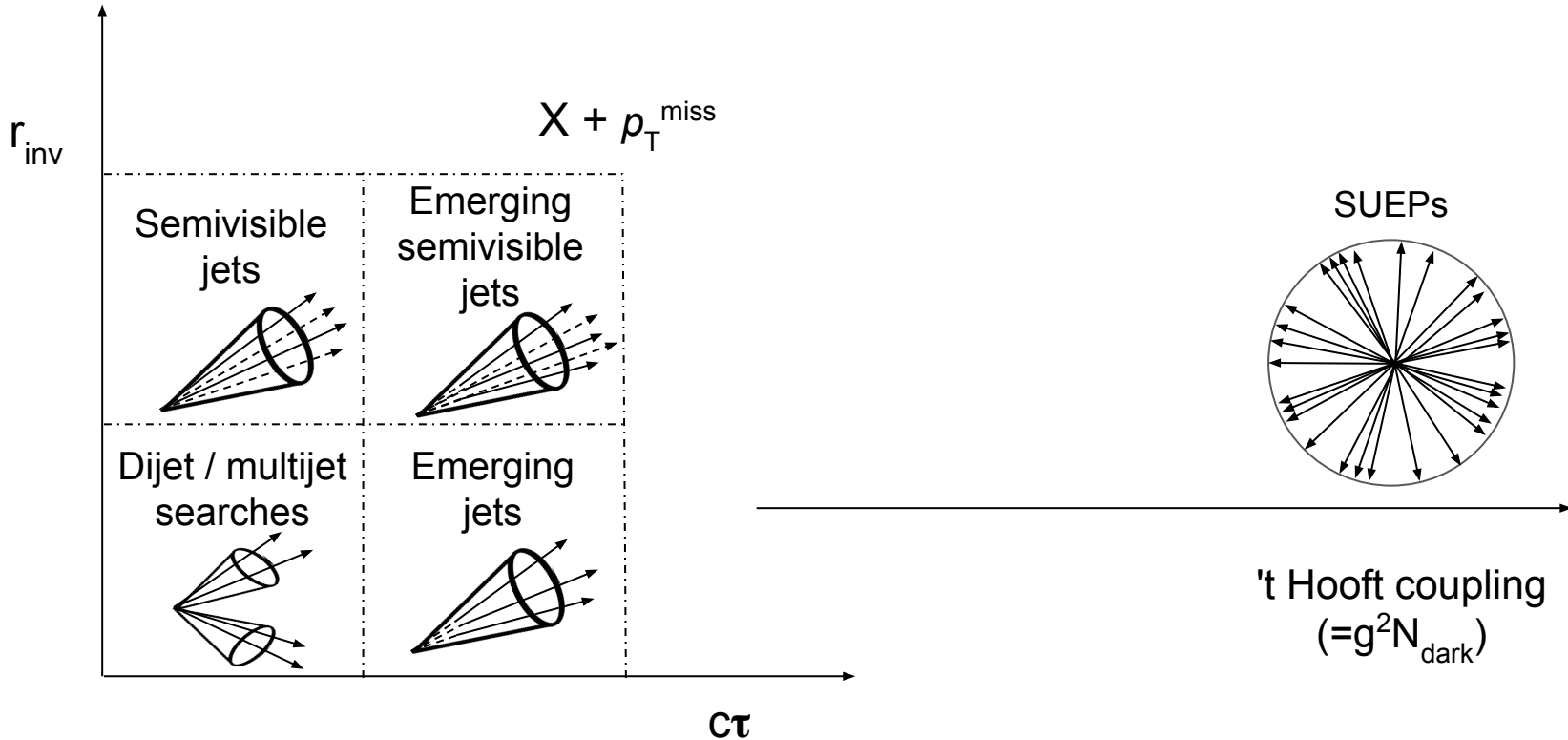


Introduction

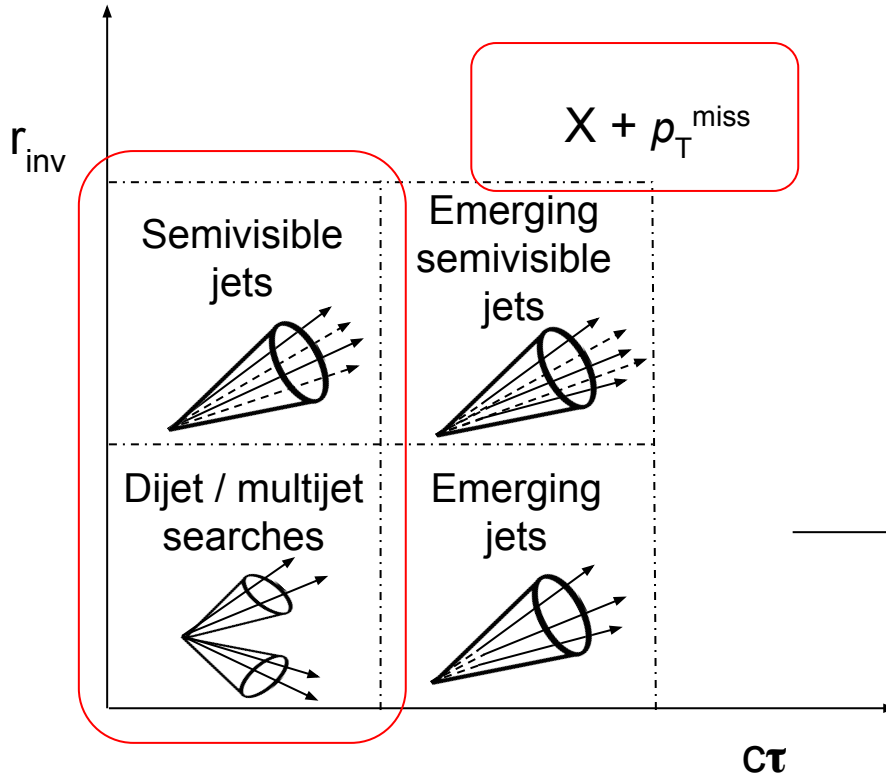
- The Dark Sector is a set of yet-unobserved quantum fields and their corresponding new particles.
- Some of these particles can be unstable, decaying back to **SM particles**.
- Others can be stable, becoming potential **dark matter candidates**.
- CMS has a very wide Dark Sector program.
 - We will focus today on the most recent results with **hadronic final states**.



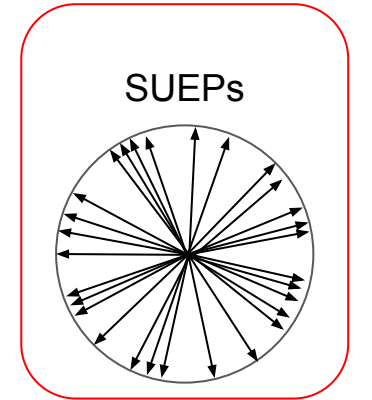
Dark sector signatures in CMS



Dark sector signatures in CMS



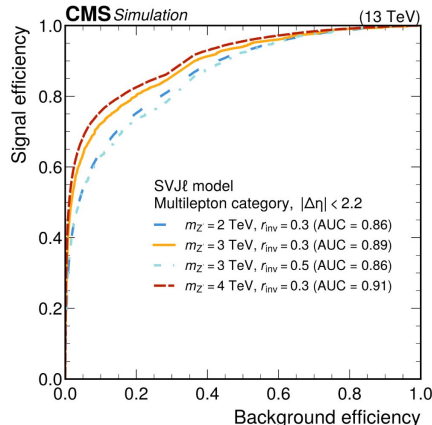
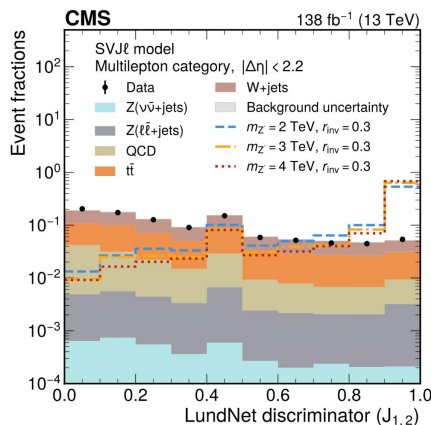
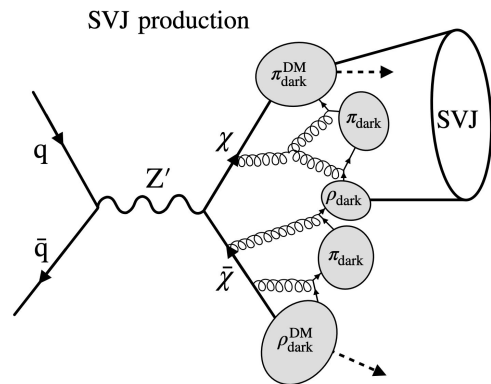
Covered in this talk



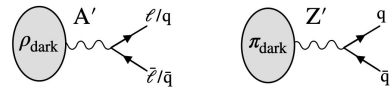
't Hooft coupling
($=g^2 N_{\text{dark}}$)

Search for lepton-enriched semivisible jets

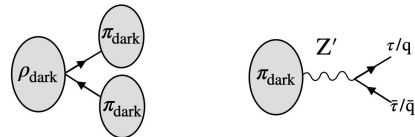
- **First search** for resonant production of SVJ enriched in leptonic content.
- Two scenarios under consideration.
- Extension of the LundNET GNN tagger used to distinguish SM and SVJ jets.



SVJ ℓ scenario

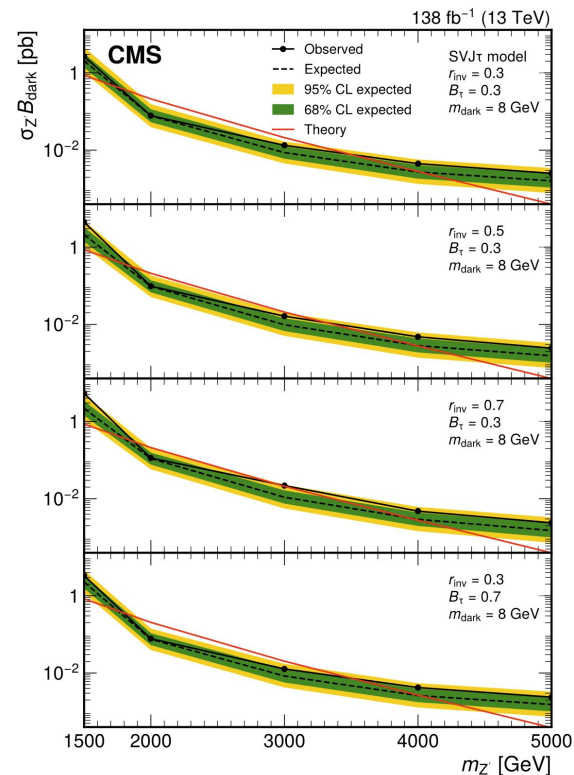
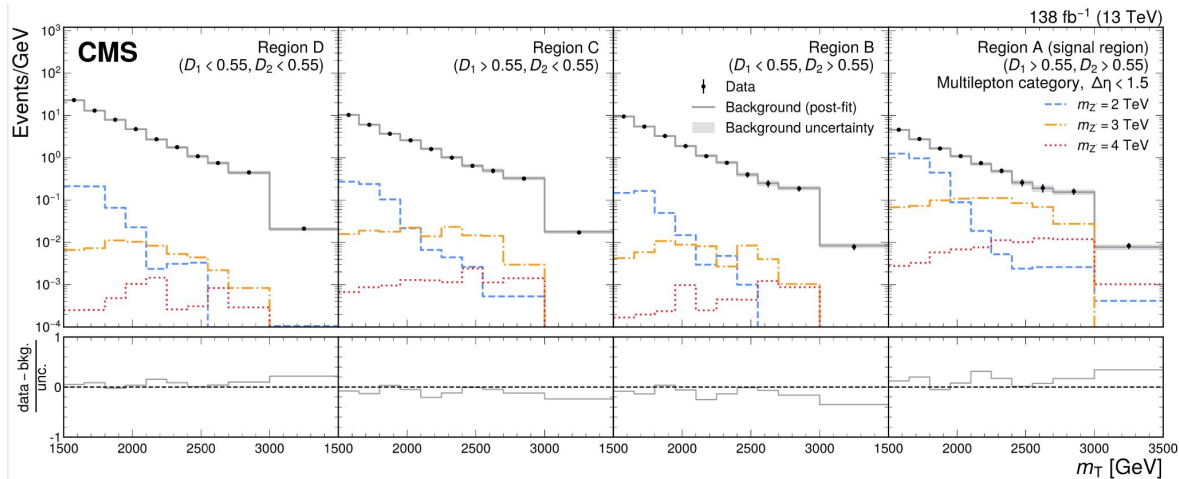


SVJ τ scenario



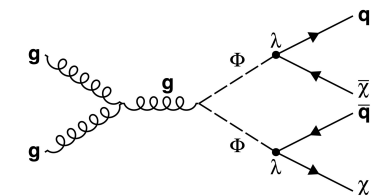
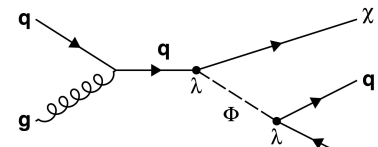
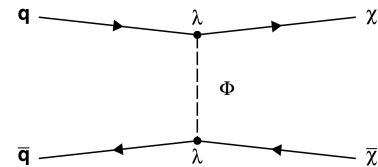
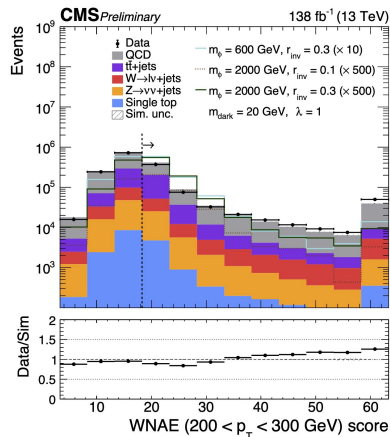
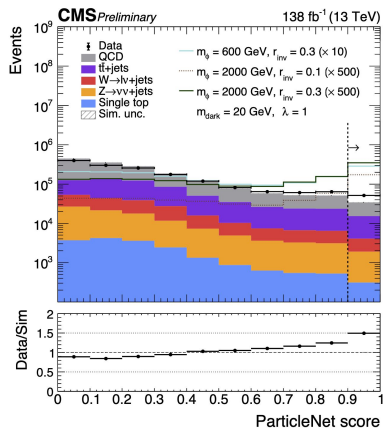
Search for lepton-enriched semivisible jets

- Dijet transverse mass m_T used as search variable.
- Background estimation performed using a mass-decorrelated ABCDisCoTEC method.
- Z' masses **excluded between 1.5 and 4.7 TeV**.



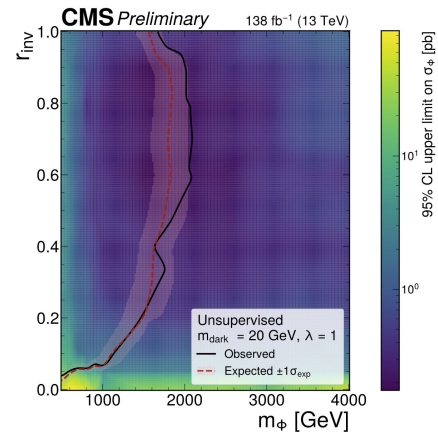
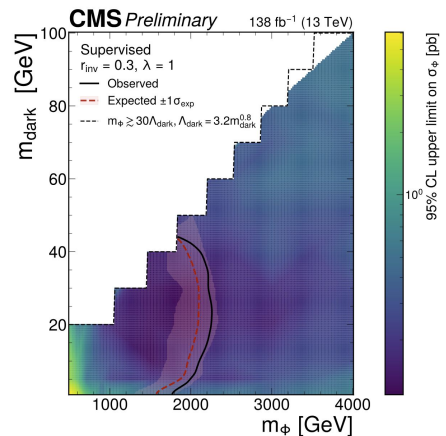
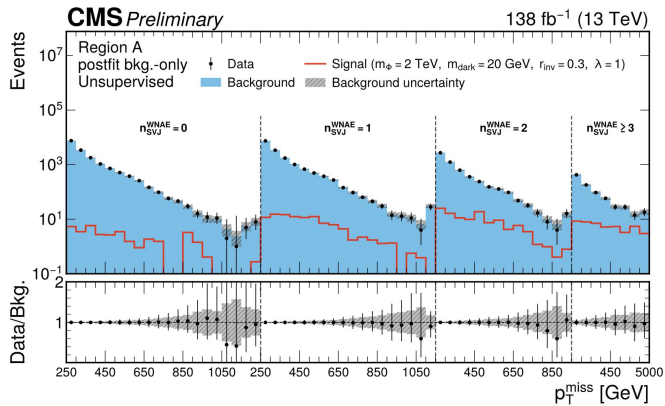
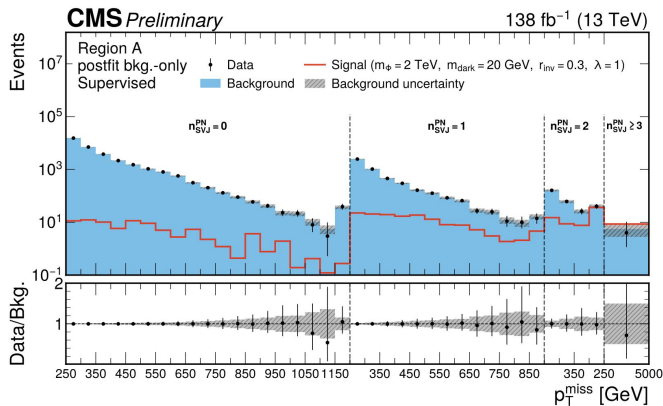
Nonresonant production of semivisible jets

- Nonresonant production of semivisible jets is even more difficult to distinguish from SM QCD.
- Two strategies in place:
 - **Supervised** ParticleNet tagger.
 - **Unsupervised** Wasserstein normalized autoencoder (WNAE).



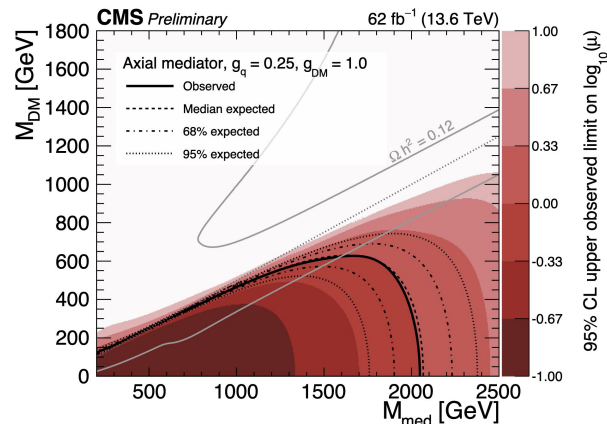
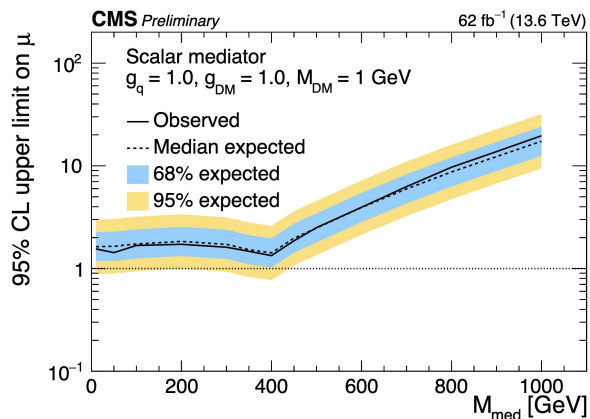
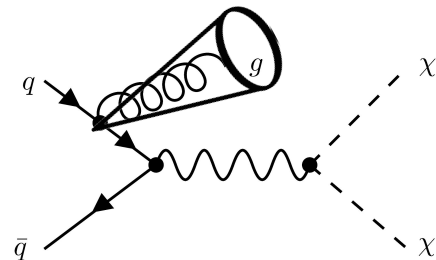
Nonresonant production of semivisible jets

- p_T^{miss} used as search variable.
- Signal region categorised in terms of number of tagged jets.
- Background estimated with an ABCDisCoTEC method.
- **Wide range of signal hypotheses excluded.**



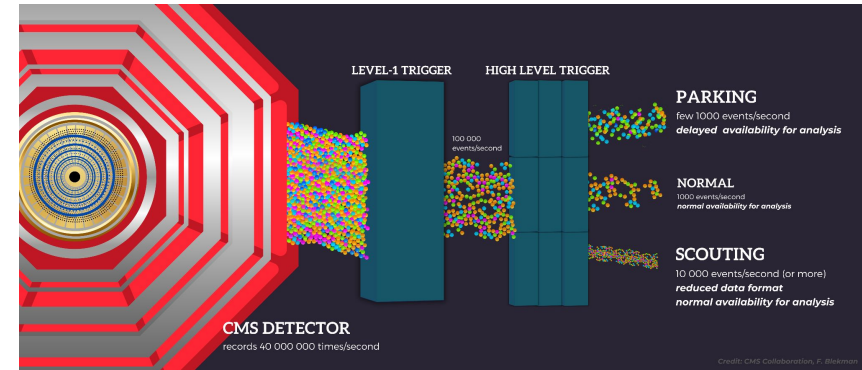
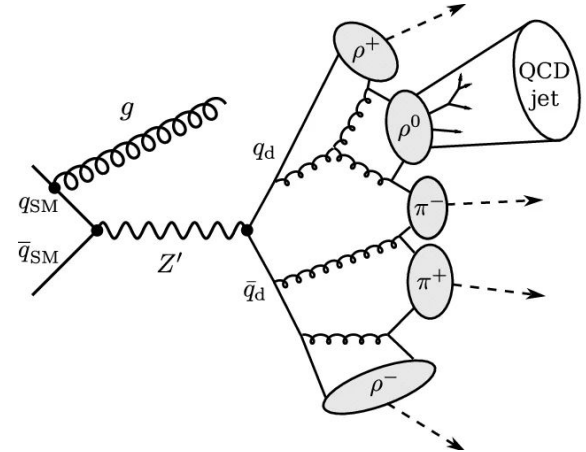
Search for monojet + p_T^{miss}

- Event topology: large p_T^{miss} recoiling against at least one high p_T jet.
- Background estimated from a simultaneous fit to five lepton-enriched control regions.
- Results interpreted in terms of different benchmarks: $H \rightarrow \text{invisible}$, simplified Spin-0 and Spin-1 DM models, and models with large extra spatial dimensions



Additional data streams

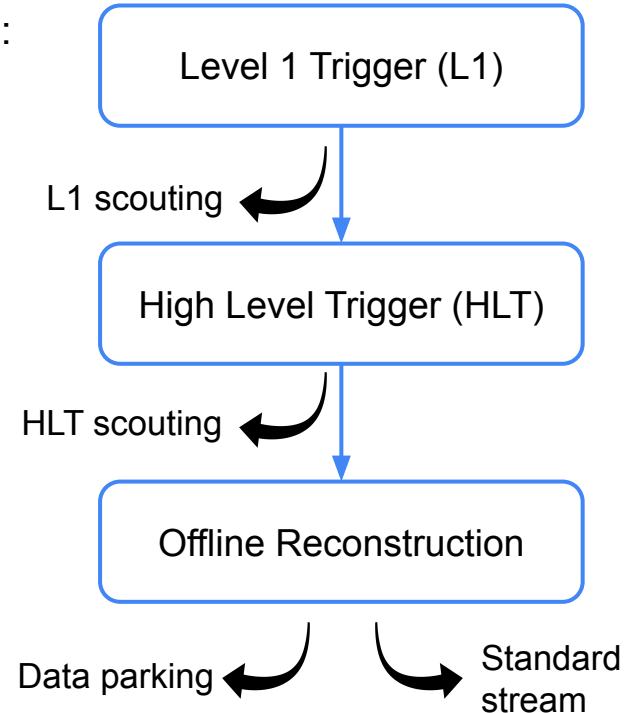
- In Dark Sector searches we often look for low-energy final states.
- Triggering on these final states is usually impossible due to the increasing background rates.
- Possible alternatives:
 - Triggering on other objects
 - **New data-taking strategies** that can avoid the standard data-taking limitations.



Additional data streams

CMS has introduced three new data streams during Run 2 and Run 3:

- **Data parking:**
 - Delayed offline reconstruction.
 - x2-3 acquisition rate thanks to the lower thresholds.
- **HLT scouting:**
 - No offline reconstruction.
 - Trigger-level objects and calibrations.
 - x10 acquisition rate thanks to the (even) lower thresholds.
- **L1 scouting:**
 - Storing only objects reconstructed by the L1 system.
 - No L1-accept required – potentially 40 MHz!
 - First public result already available ([arXiv:2601.20063](https://arxiv.org/abs/2601.20063), accepted in PLB).
 - Big improvement expected in HL-LHC thanks to the upgraded L1 trigger system.

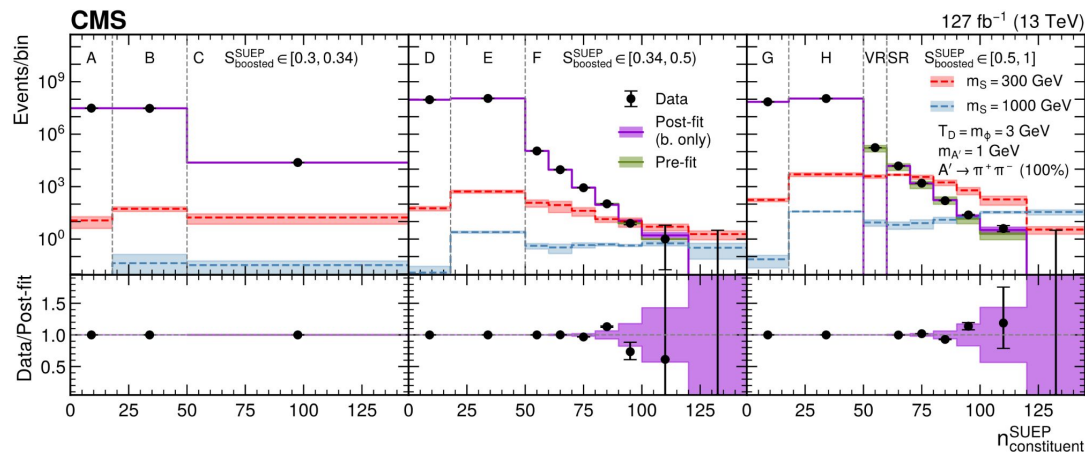
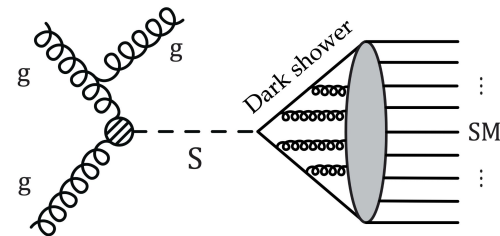


Search for SUEPs using data scouting

- Profiting from the scouting paradigm:
 - Objects under consideration (PF candidates, PF jets, and vertices) are reconstructed by the High Level Trigger.
 - Trigger threshold on the ISR jet can be lowered

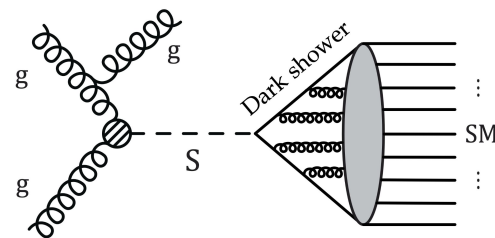
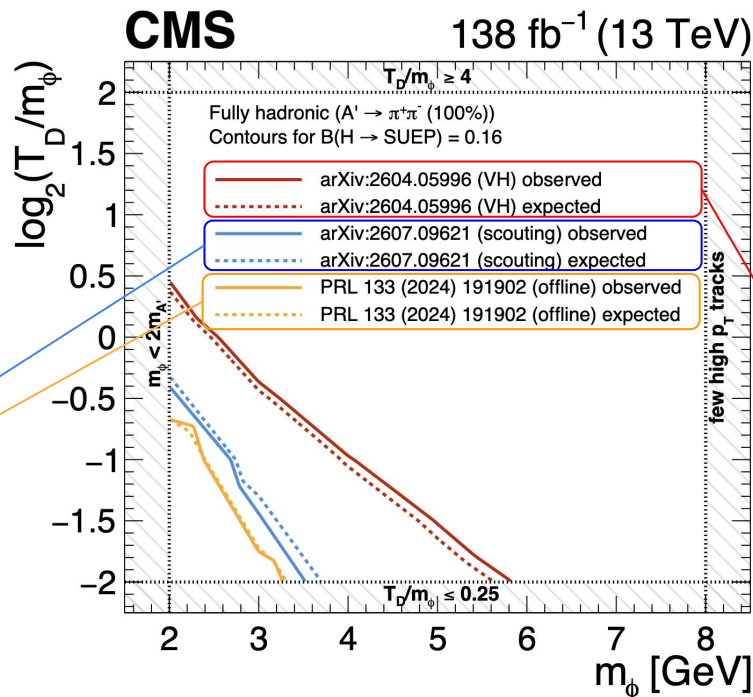
from 1 TeV to 410 GeV.

- Events with two very wide jets ($R=1.5$) are selected – SUEP jet (the one with the most constituents) and ISR.
- Background estimated with an extended ABCD method using the number of constituents and the SUEP jet sphericity.



Search for SUEPs using data scouting

Scouting analysis provides **better results** than the **original offline** search.



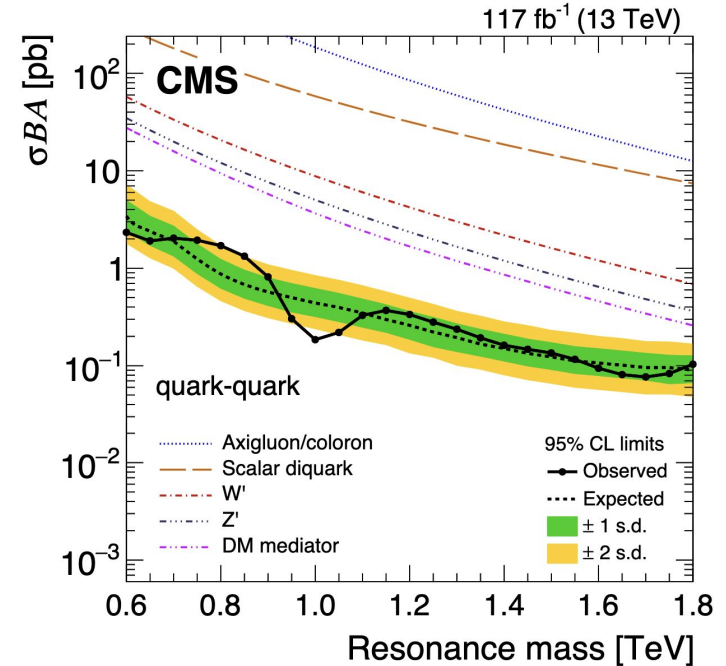
[Phys. Lett. B 879 \(2026\) 140671](#)

Additional search where the scalar S is the Higgs boson produced in association with a vector boson.

Requiring leptonic triggers to reduce the multijet contribution.

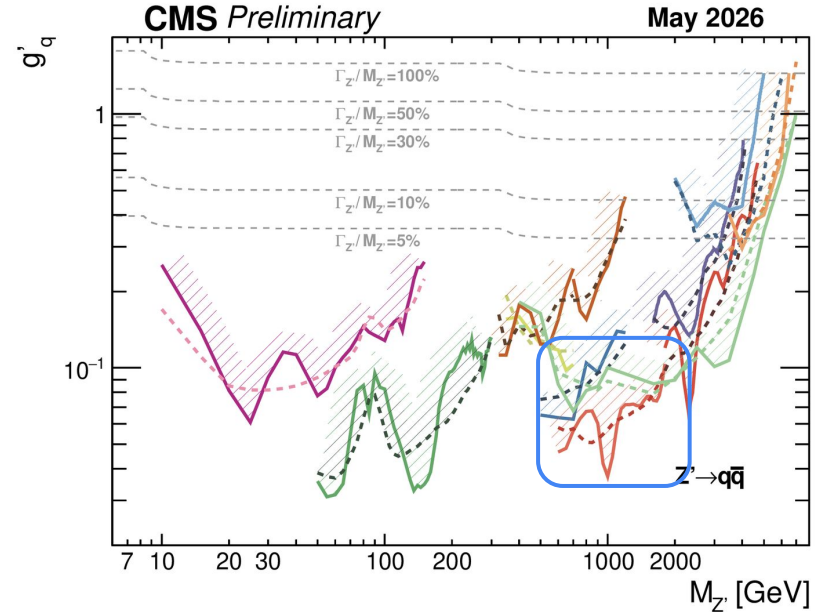
Search for dijet resonances using data scouting

- Model independent search for narrow dijet resonances with masses between 0.6 and 1.8 TeV.
- Triggering using only calorimeter jets to lower the threshold as much as possible (**250 GeV**).
- Upper limits on the $\sigma \times B \times A$ are provided for new particles decaying into qq, qg, or gg.



Search for dijet resonances using data scouting

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- Triggering using only calorimeter jets to lower the threshold as much as possible (**250 GeV**).
- Upper limits on the $\sigma \times B \times A$ are provided for new particles decaying into $q\bar{q}$, qg , or gg .
- Providing exclusion ranges for the universal quark coupling as a function of the Z' boson mass – **Best results in its mass range!**



https://cms-summary-searches.docs.cern.ch/dijet_summary/

Summary

- The CMS dark sector program covers a diverse set of models and a broad parameter space.
- Novel analysis strategies and data-taking methods are expanding our physics reach.
- Exciting new results are expected in the near term and throughout Phase-2!

