Search for low mass resonances

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On behalf of the ATLAS and CMS collaborations

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60th Rencontres de Moriond on “Electroweak Interactions & Unified Theories”,
15-22 March 2026, La Thuile (Italy)

Some introduction

There are a lot of BSM models on the market, addressing the shortcomings of the SM:

- Dark matter
- Matter-antimatter asymmetry
- Strong CP problem

These models predict the existence of new particles: a, …, ϕ, …, Z_D, Z'

In this talk, we focus on the search for new prompt resonances at low mass and the techniques to be sensitive to them.

Outline of the talk

With a lot of new results !

1. Dimuon resonances
2. Dielectron/Diphoton resonances
3. Ditau resonances
    3.b Ditau/Dimuon resonances
4. Dijet resonances

Summary

Outline of the talk

1. Dimuon resonances
2. Dielectron/Diphoton resonances
3. Ditau resonances
   - 3.b Ditau/Dimuon resonances
4. Dijet resonances

Summary

Other BSM talks from ATLAS and CMS speakers:

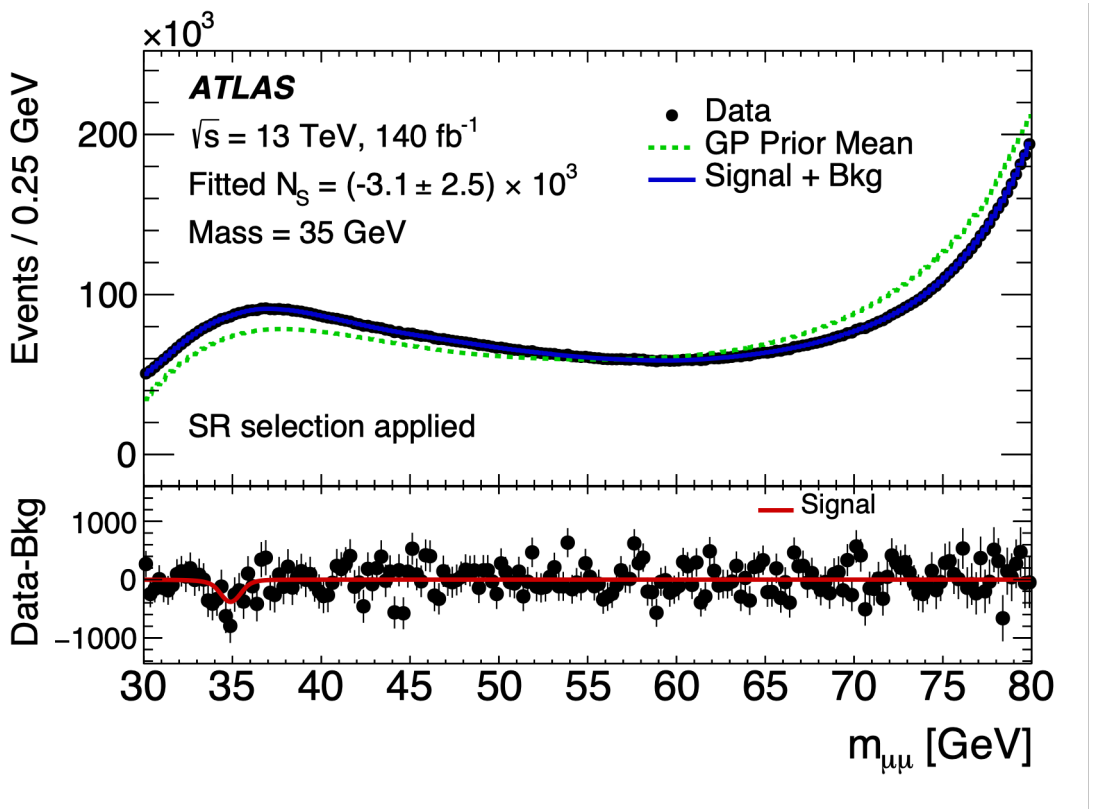
- Searches for Supersymmetry, by C. Ohm
- Search for top-philic resonances with 4 top quarks, by D. Stafford
- Searches for new physics with photons, by A. Agapitos
- Searches for DV and unconventional signatures, by J. K. Anders
- Searches for VLQ and LQ, by S. Grancagnolo
- Searches for new physics at high object masses (CMS), by A. Malara
- Searches for massive LLP and DV (ATLAS), by D. Rousso
- Searches for other exotica, by C. K. Koraka
- Search for deviations within the EFT framework, by M. Ojeda
- Searches for new physics with top quarks, by F. Lemmi
- Searches for BSM single Higgs, by S. Gascon-Shotkin
- Multiple-Higgs searches, by V. Dao

1. Dimuon resonances in 35-75 GeV

[hep-ex] 2601.21361

- Model-independent search, also interpreted as Z' or $Z_D \rightarrow \mu^+\mu^-$
- Mixture of triggers in Run2 dataset
- Challenge: background description → ML technique (Gaussian process regression technique) to obtain non-parametric fit
  - Prior mean parametrized on generator-smeared samples.
  - Covariance matrix assuming bin-to-bin correlations decrease as a function of the distance between bins in the $m_{\mu\mu}$ spectrum
  - Different hyper-parameter configurations are used for distinct resonance masses.

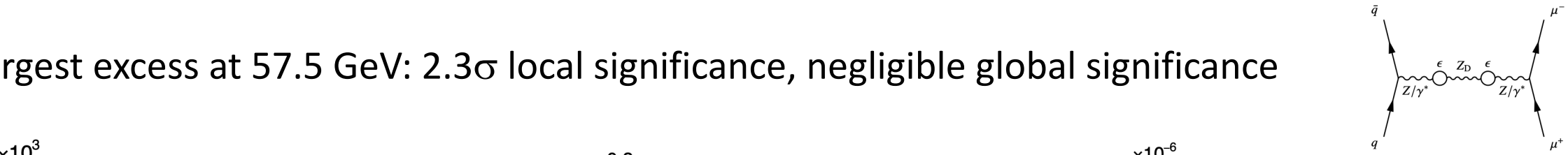
Trigger type	Matching criteria	p_T [GeV]
Single muon	At least one muon matched to a single-muon trigger	> 27
Asymmetric dimuon	Leading muon matched to the high-p_T trigger object	> 23
	Subleading muon matched to the trigger low-p_T object	> 10
Symmetric dimuon	Both muons matched to the two trigger objects	> 15

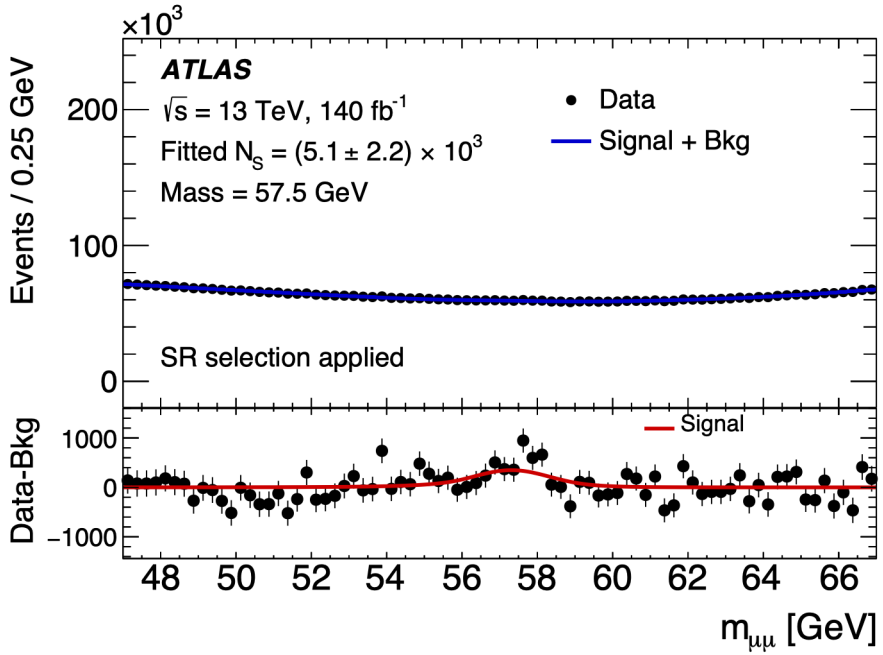


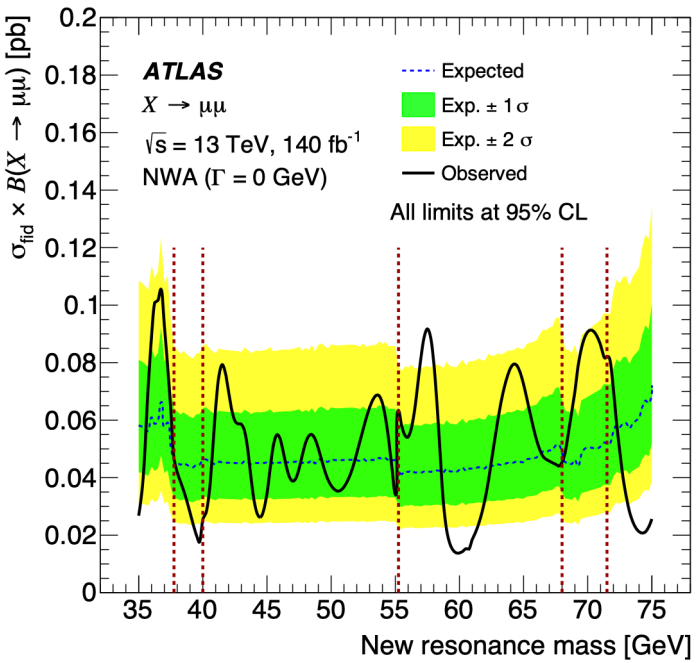
1. Dimuon resonances in 35-75 GeV

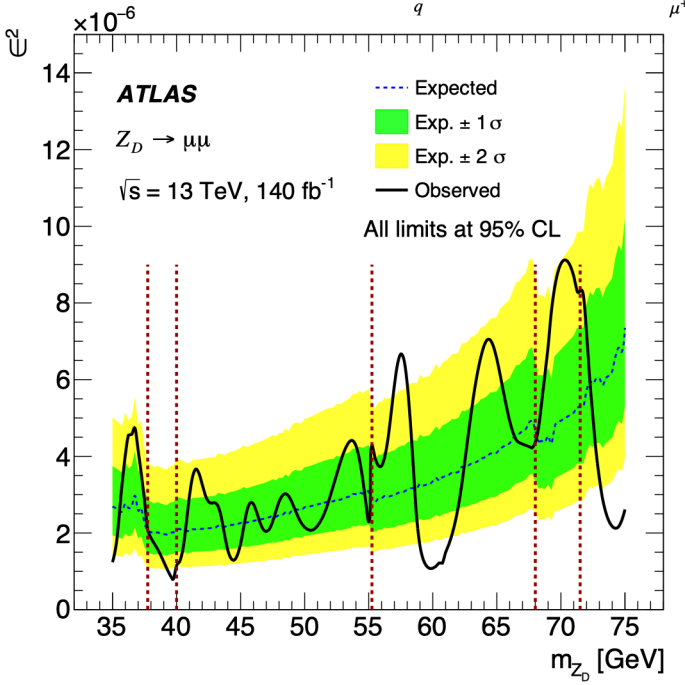
[hep-ex] 2601.21361

- Largest excess at 57.5 GeV: 2.3σ local significance, negligible global significance









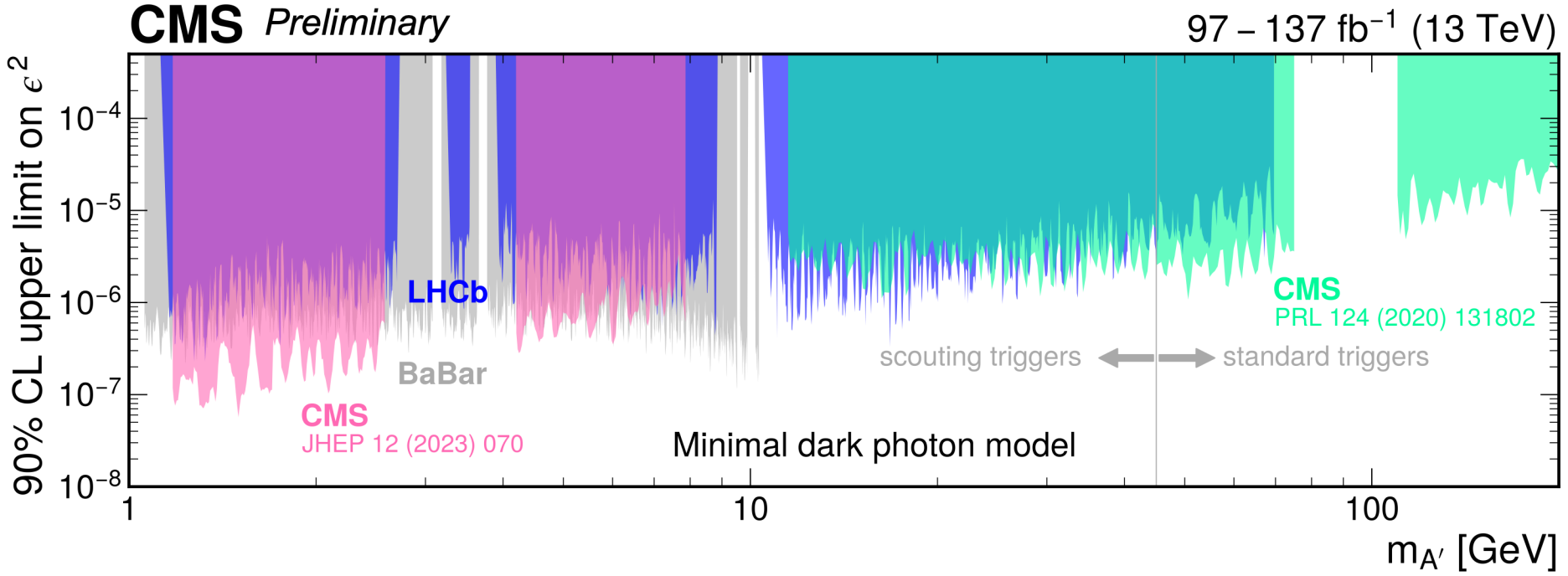
- Limits on dark photon kinetic mixing: Improved sensitivity in the 35-45 GeV range, with respect to CMS and LHCb results

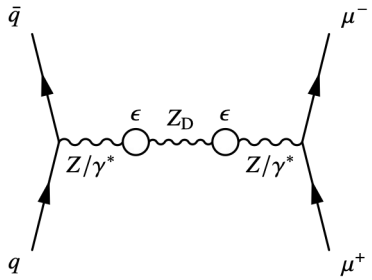
1. Dimuon resonances in 1-200 GeV

New web site for CMS BSM Summary Plots

SummaryPlots

- At low mass, use of scouting data (store HLT information to allow larger trigger rate)



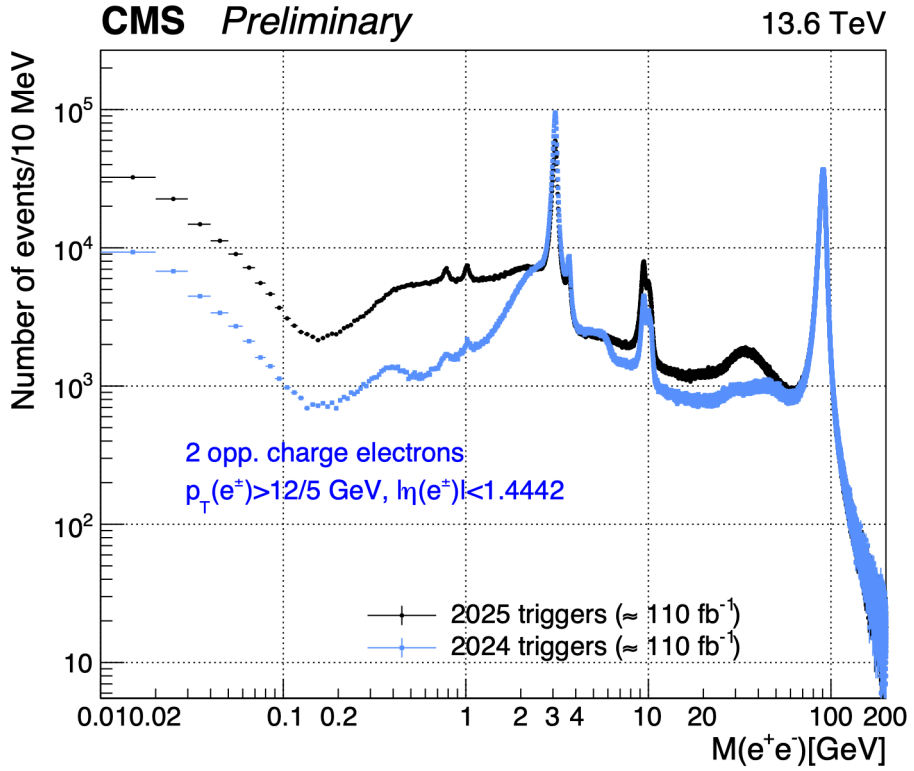


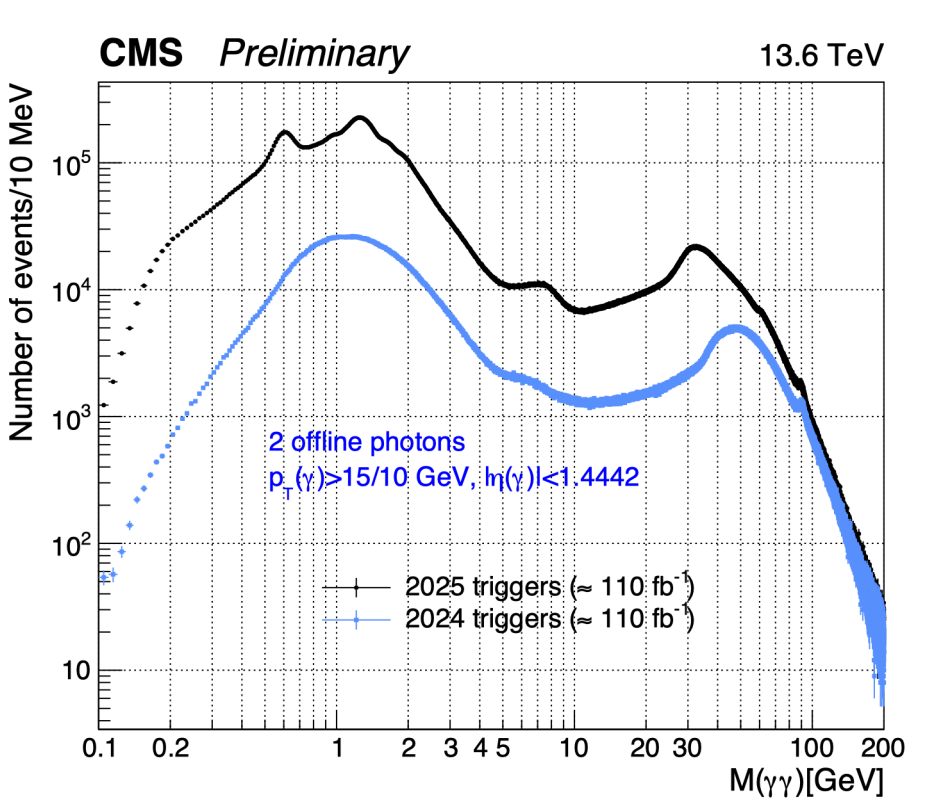
More information on Scouting: [hep-ex] 2403.16134

2. Dielectron/Diphoton resonances

DP-2026-001

- New triggers in 2025 to target pairs of isolated electrons or photons of moderate transverse energy (E_T≈10-15 GeV).



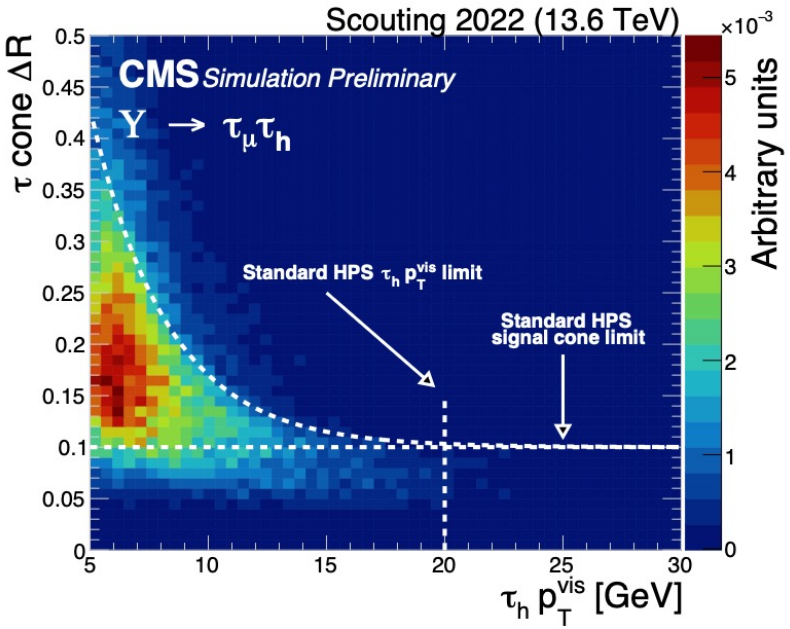


- Substantial gain allowing improved sensitivity to new resonances at low mass!

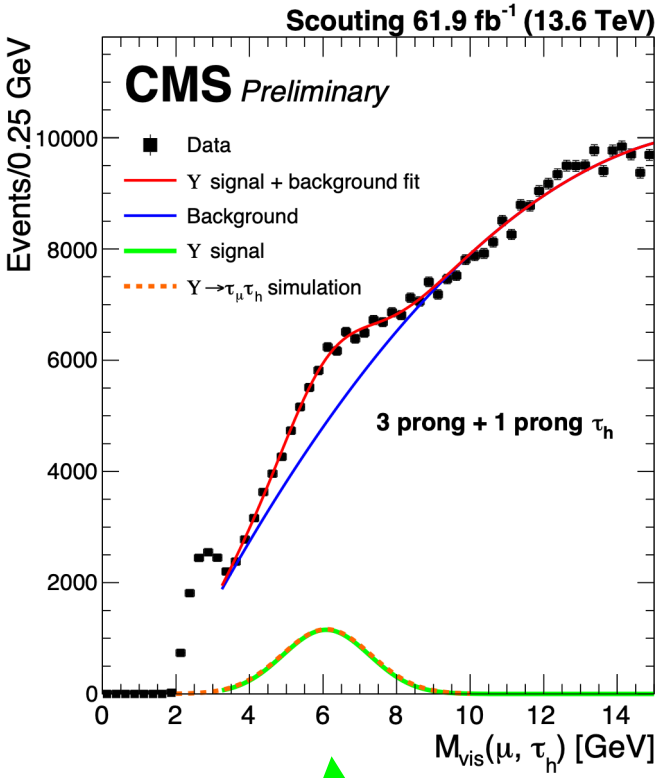
3. Ditau resonances in 20-60 GeV

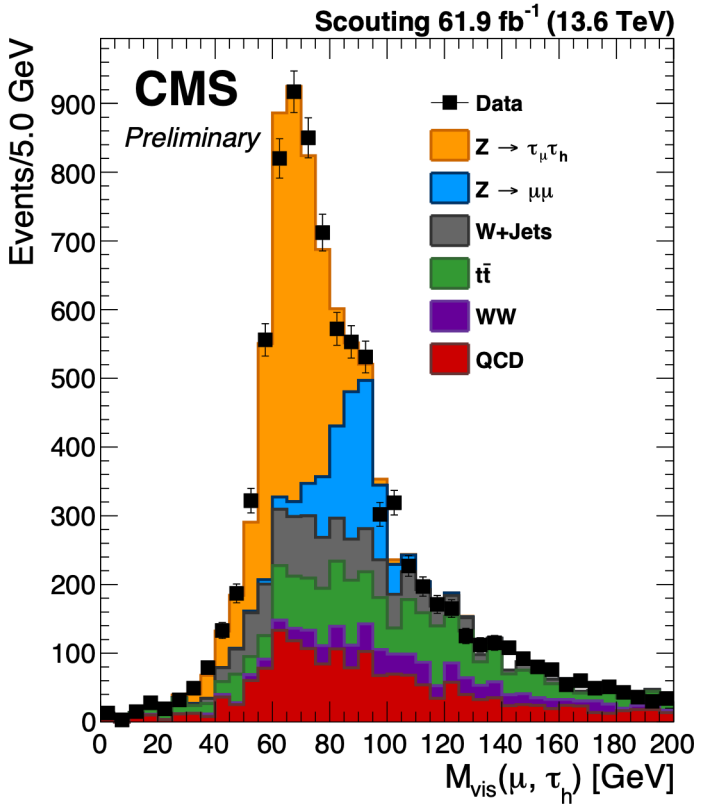
EXO-24-012

- $\phi \rightarrow \tau_h \tau_\mu$ in 2022-2023 scouting data
- Mixture of triggers selecting EM or Had activity
- Challenge: reconstruction of low p_T τ_h



CMS-NOTE-2024-006



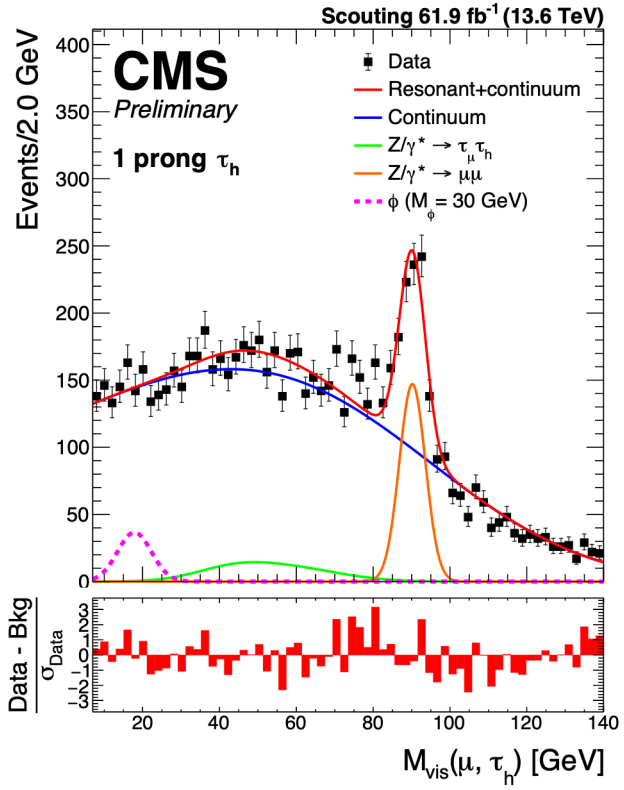


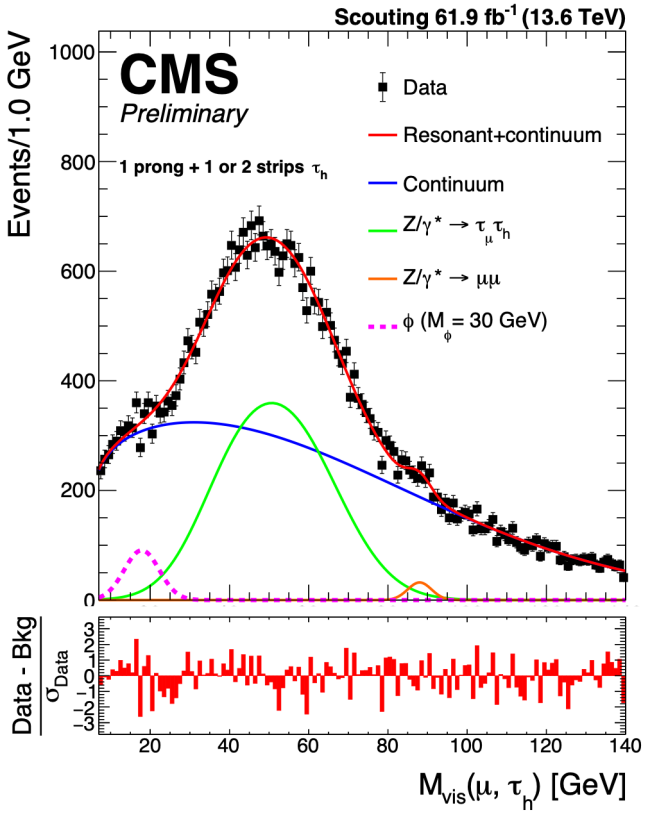
Compatible with $\Upsilon \rightarrow \tau\tau$!
First time at hadron collider !

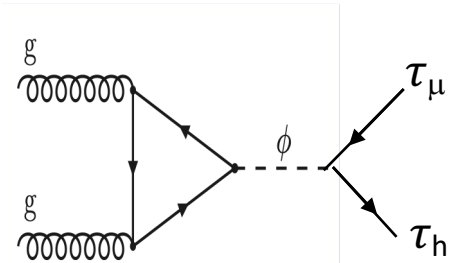
3. Ditau resonances in 20-60 GeV

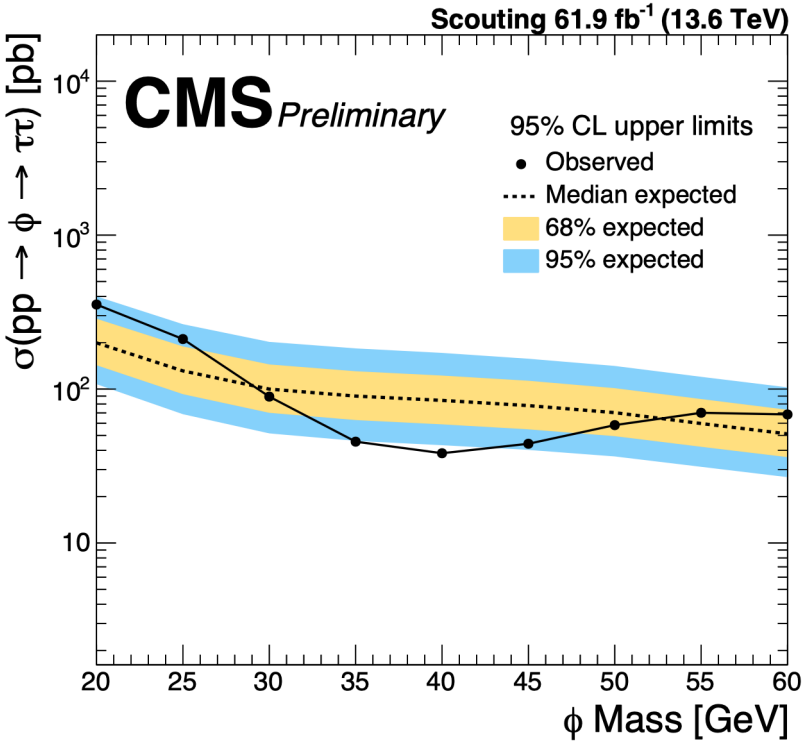
EXO-24-012

- $\phi \rightarrow \tau_h \tau_\mu$ in 2022-2023 scouting data







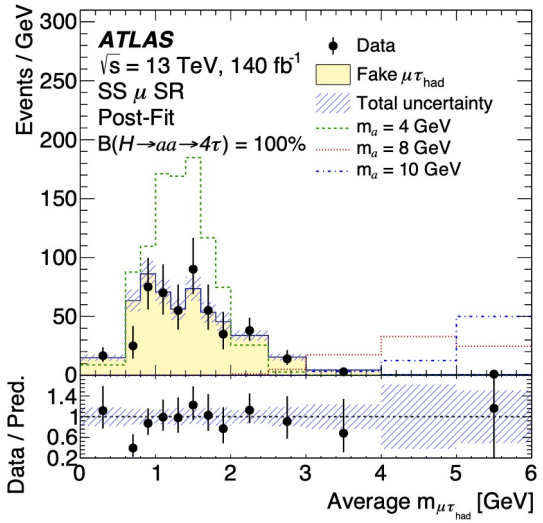


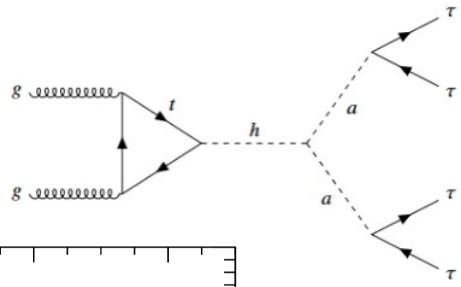
The M_{vis} range corresponding to ϕ masses from 20 to 60 GeV is 10 to 40 GeV

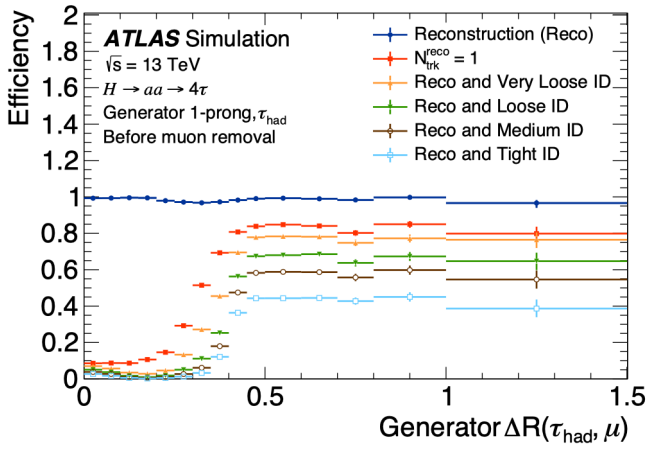
3. Ditau resonances in 4-15 GeV

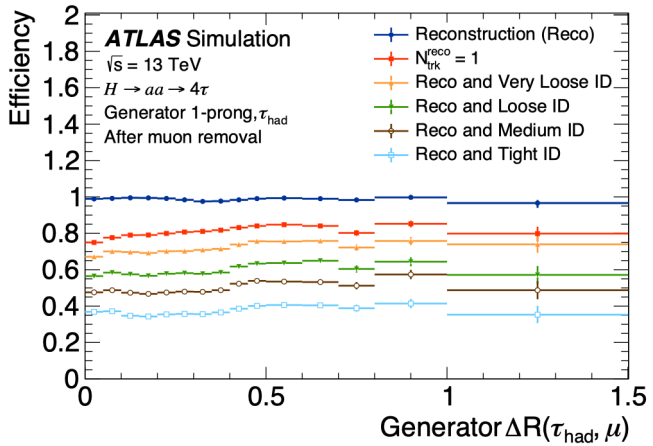
[hep-ex] 2503.05463

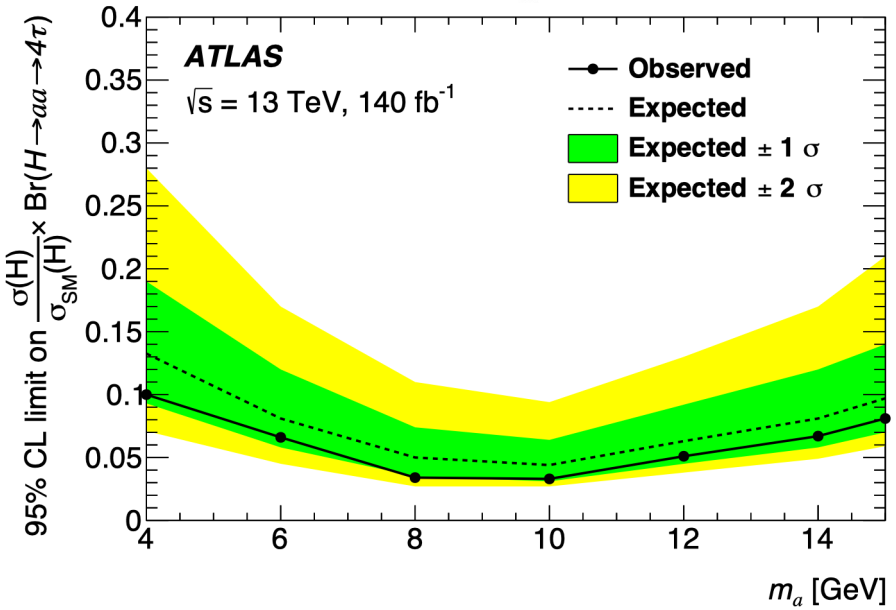
- $H \to aa \to \tau_h\tau_\mu\,\tau_h\tau_\mu$ in the range $2m_\tau < m_a < 2m_b$ → highly boosted
- Trigger: 2 high p_T muons, 140 fb^{-1}
- Challenge: reconstruction of τ_h in boosted $\tau_h\tau_\mu$
  - muon removal technique (also used by CMS for $H \to aa \to \mu^+\mu^-\tau^+\tau$)









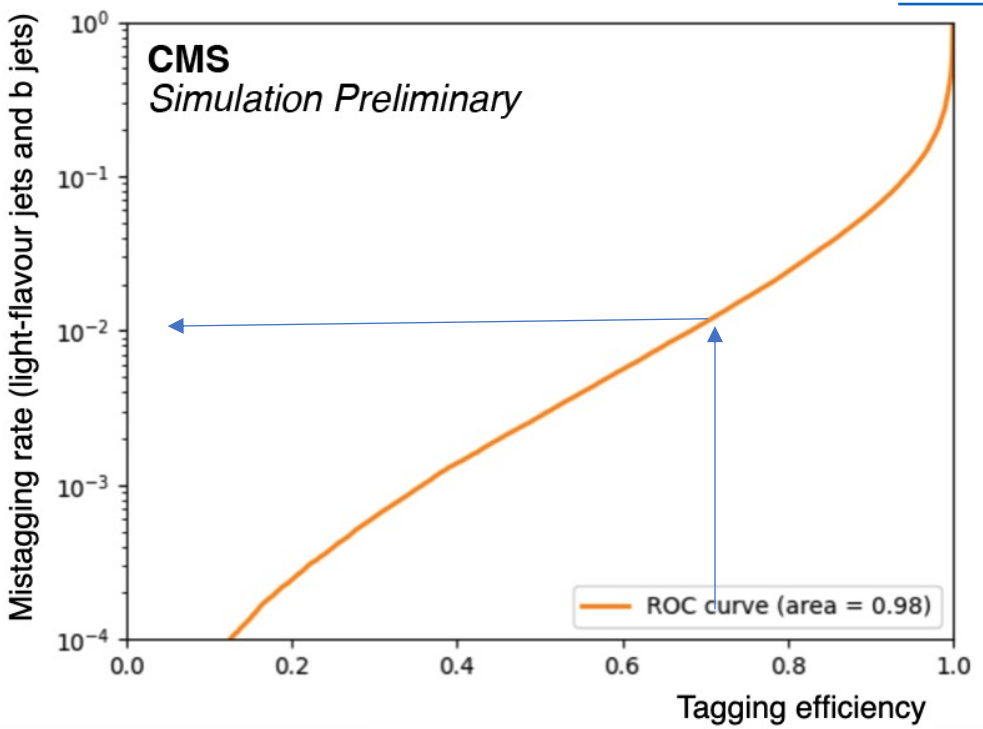


3.b Ditau/Dimuon resonances in 4-21 GeV

SUS-23-005

- $H \to aa \to \mu^+\mu^- \tau\,\tau$, considering $\tau_h\tau_\mu$, $\tau_h\tau_e$, $\tau_h\tau_h$, $\tau_e\tau_\mu$

  → highly boosted
- Trigger: 1 isolated muon, 140 fb^{-1}
- Challenge: reconstruction of the boosted $\tau\tau_h$
  - Lepton removal technique
  - Boosted DeepDiTau tagger (to discriminate against light and b jets)



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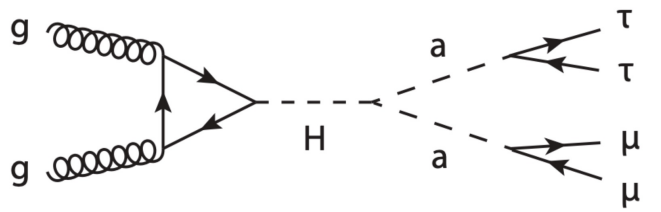
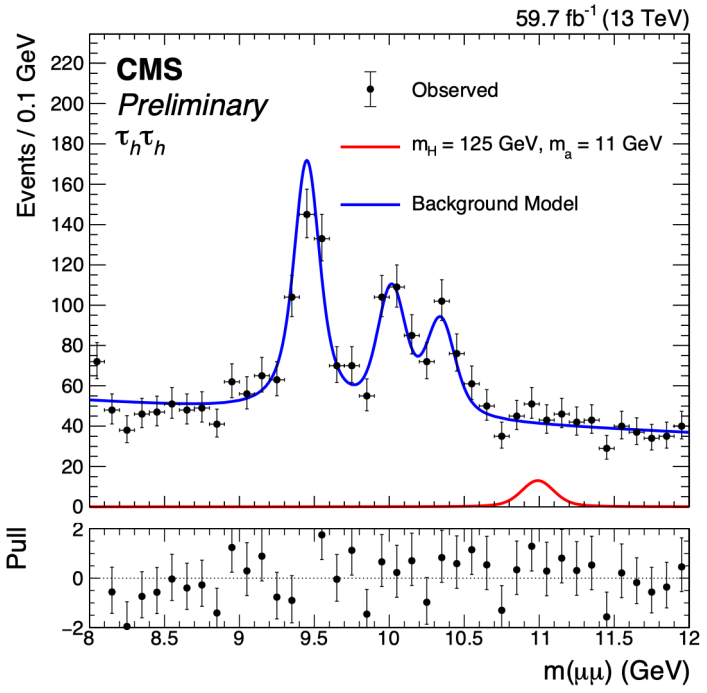
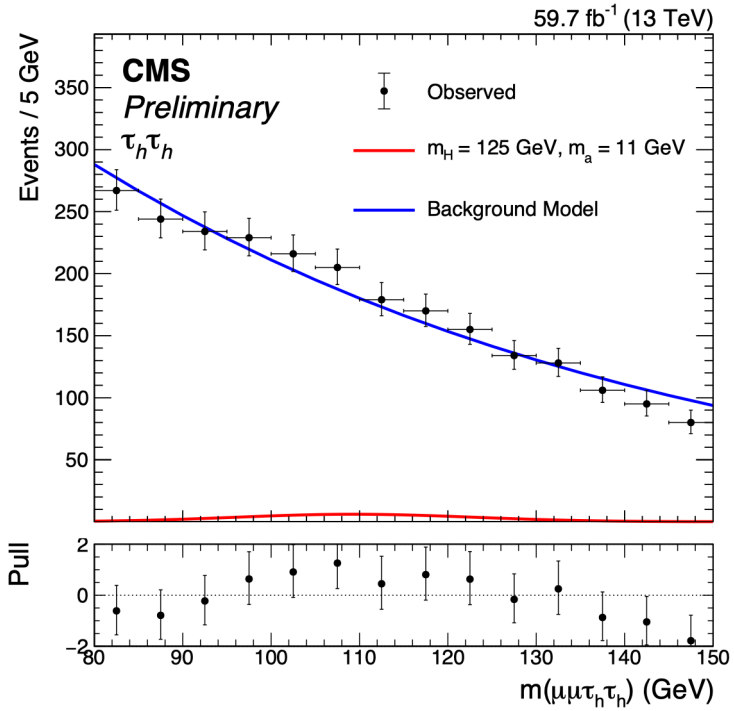
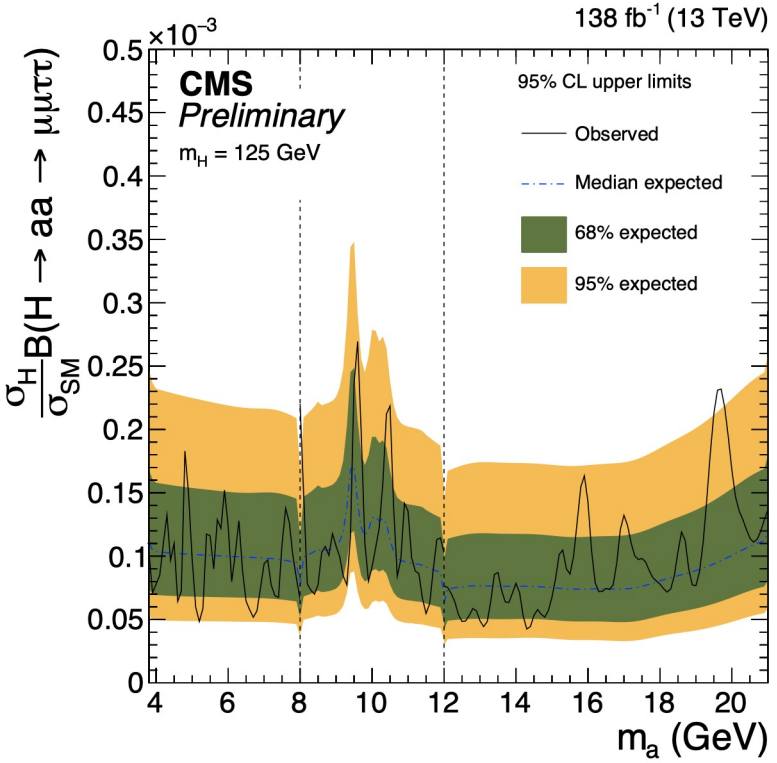




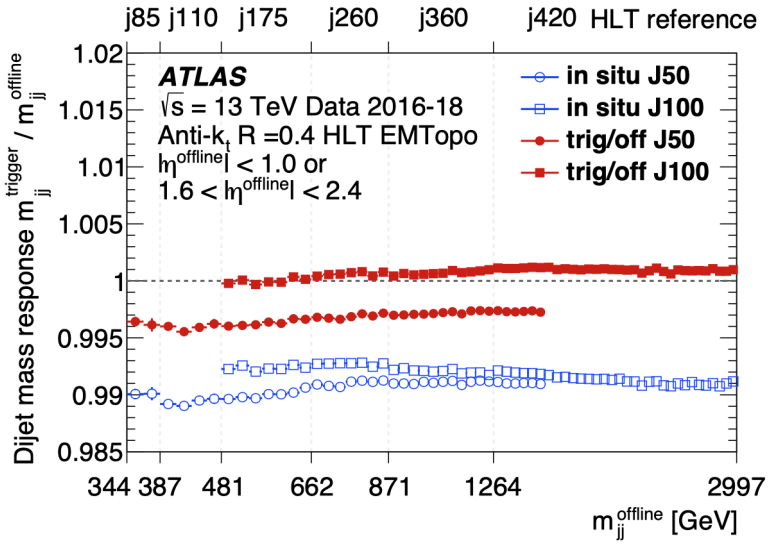


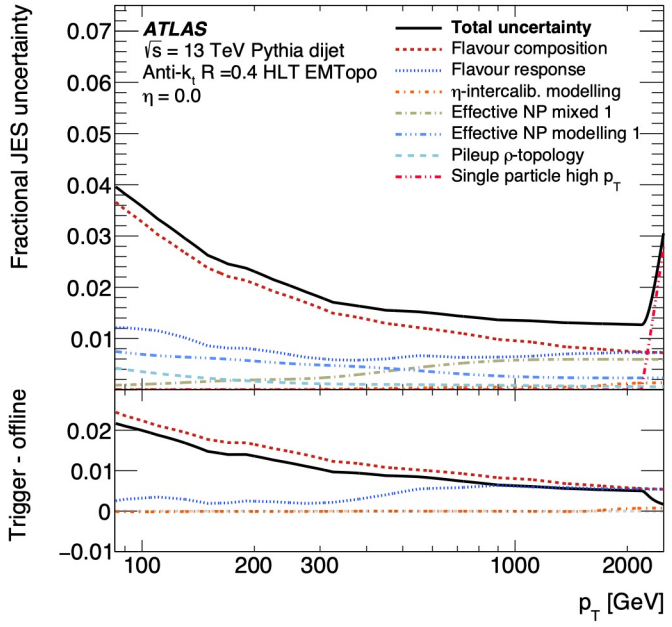


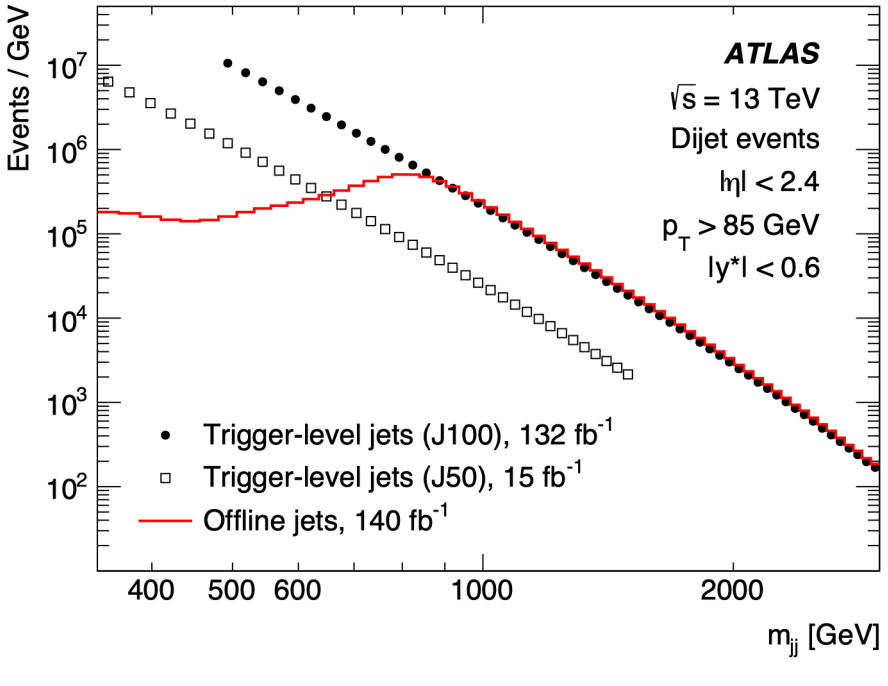
4. Dijet resonances in 375-1800 GeV

[hep-ex] 2509.01219

- $Z' \rightarrow q\bar{q}$
- Trigger-Level Analysis (TLA) with reduced information for the jets (no tracking information).
- Triggers: Jet w/ p_T> 100 GeV and at end-of-fill w/ p_T> 50 GeV
- Challenge: Jet calibration







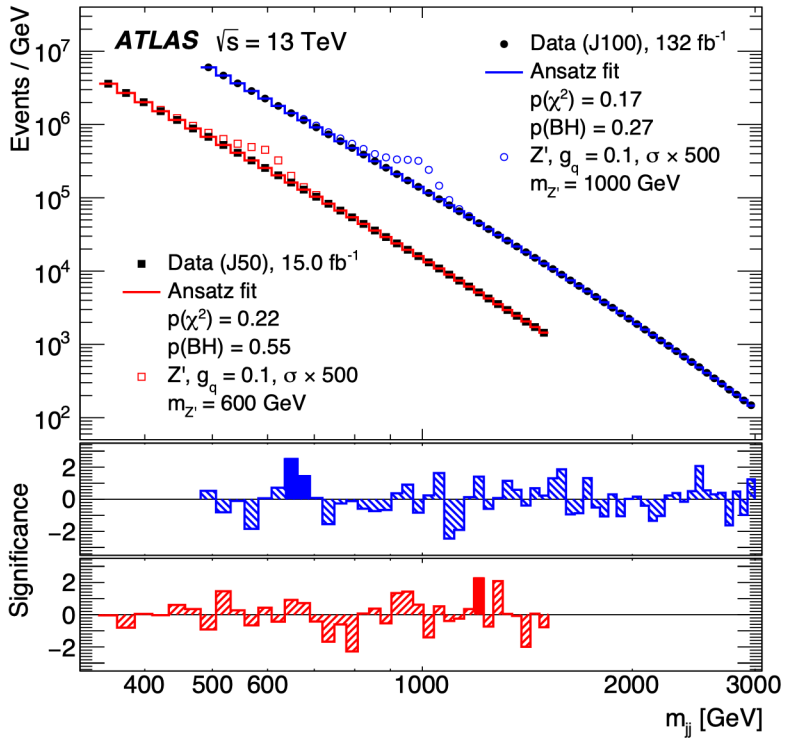
4. Dijet resonances in 375-1800 GeV

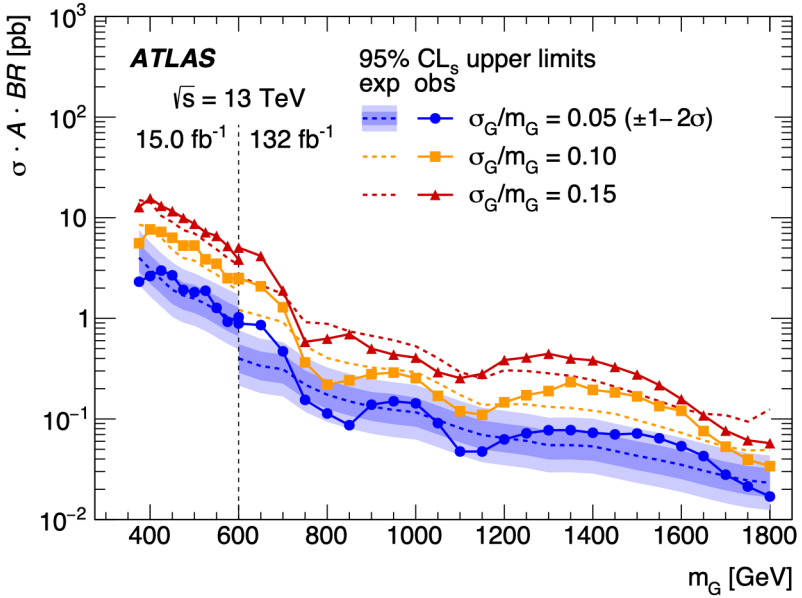
NEW Rencontres de Moriond since 1966

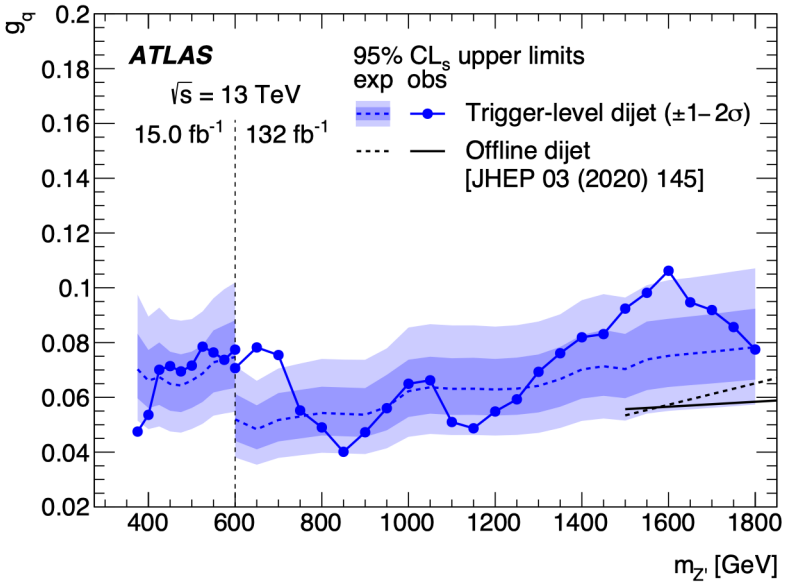
ATLAS EXPERIMENT

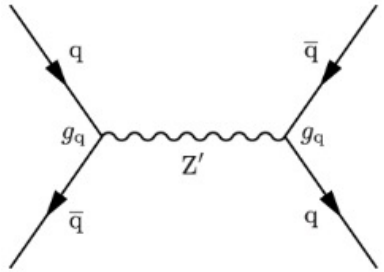
[hep-ex] 2509.01219

- Largest excess at 650 GeV: 3.4σ local significance, 2.2σ global







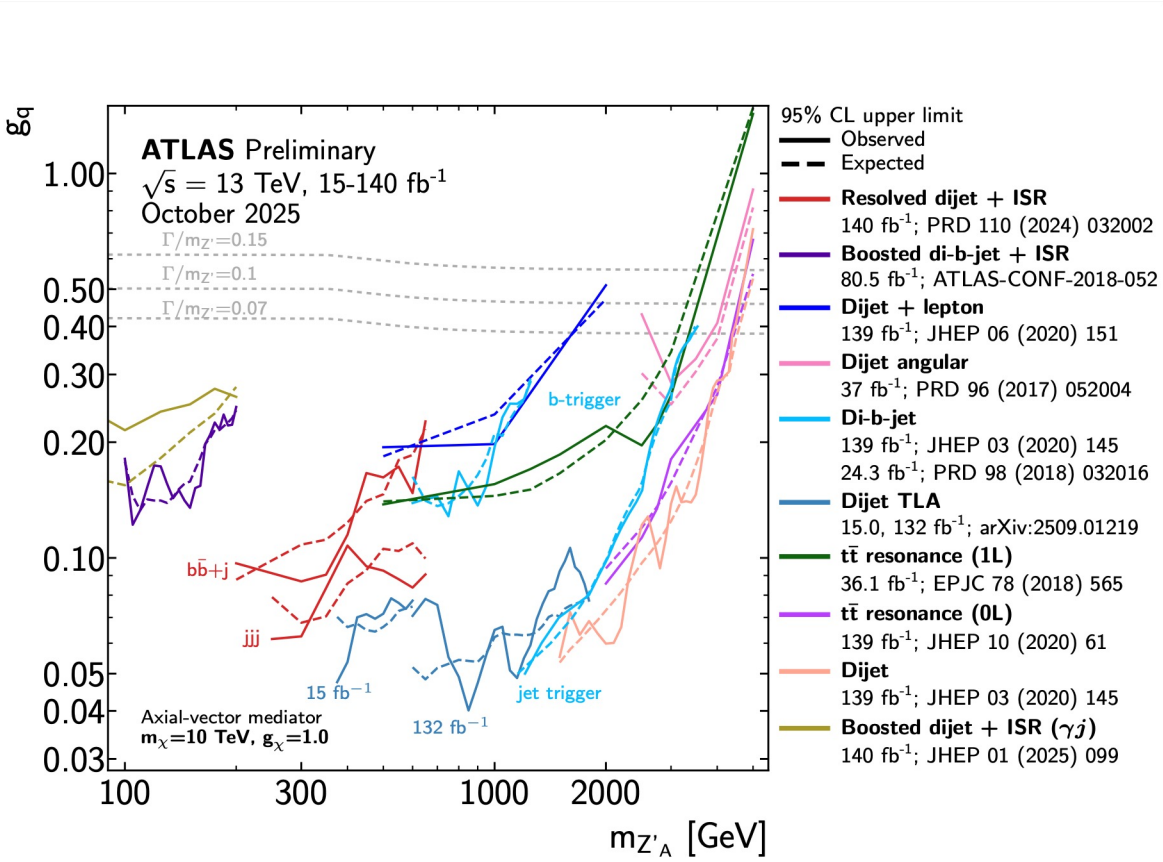


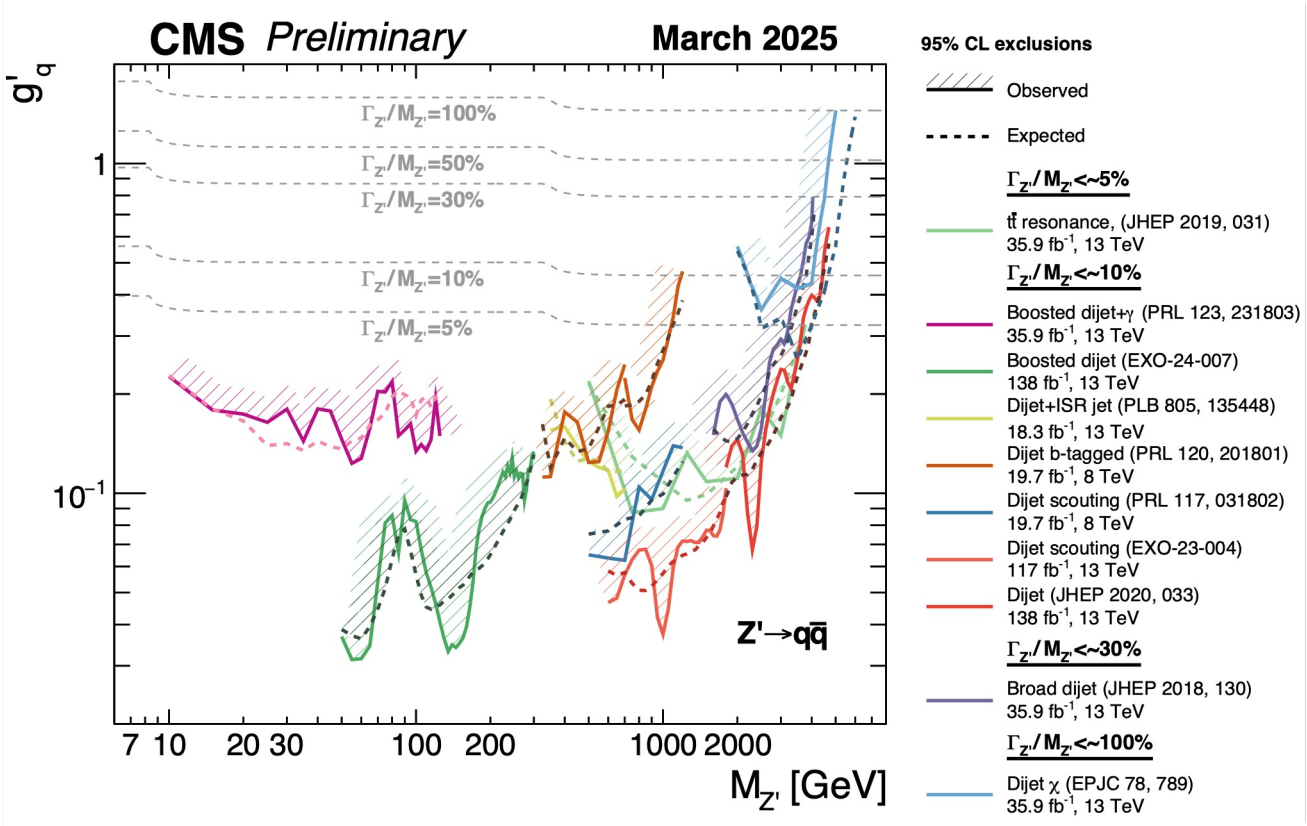
Similar CMS expected limits in 600-1800 GeV (accepted by JHEP [hep-ex] 2510.21641)

4. Dijet resonances

SummaryPlots

SummaryPlots





Summary

Searches for low mass resonances at LHC require addressing certain technical challenges:

- Triggers: new triggers targeting low E_T in standard menu or using scouting/TLA
- Object reconstruction: dedicated reco for low pT and merged objects
- Background estimate: new ML technique for sculpted mass spectrum

No sign of new physics yet but more data on disk still to be analyzed.

Stay tuned !