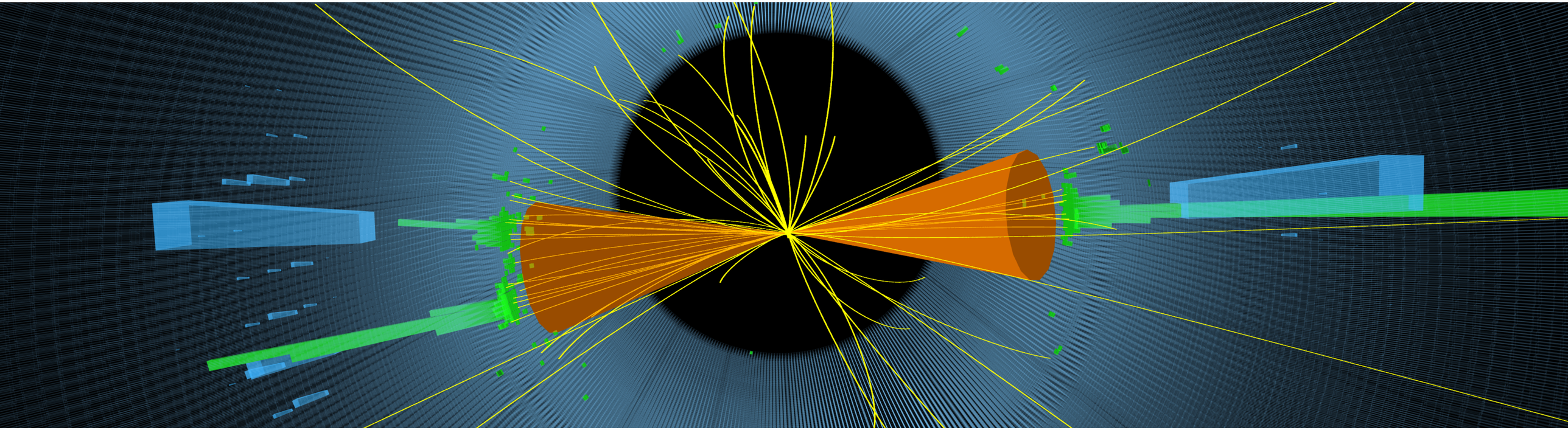
New Physics Searches in Boosted Diboson Final States at CMS



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for CMS Collaboration

BOOST 2021
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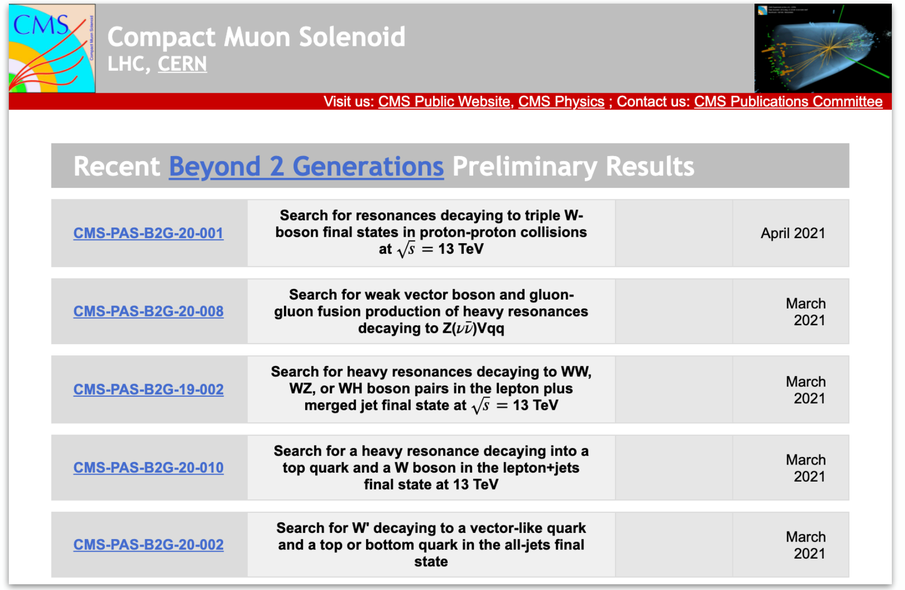
Recent Boosted Diboson Results from CMS

- This talk summarizes **five new CMS results on searches for boosted diboson production** using **boosted-jet techniques** to target a variety of BSM signals:
  - B2G-20-013: **Z[Z/W/H]→qqll** (resonant & nonresonant)
  - B2G-20-003: **X→aa→4b**
  - B2G-20-005: **X->HH->4b**
  - B2G-20-007: **X→HH→bb+leptons**
  - B2G-21-001: **VBF HH→4b** (nonresonant)



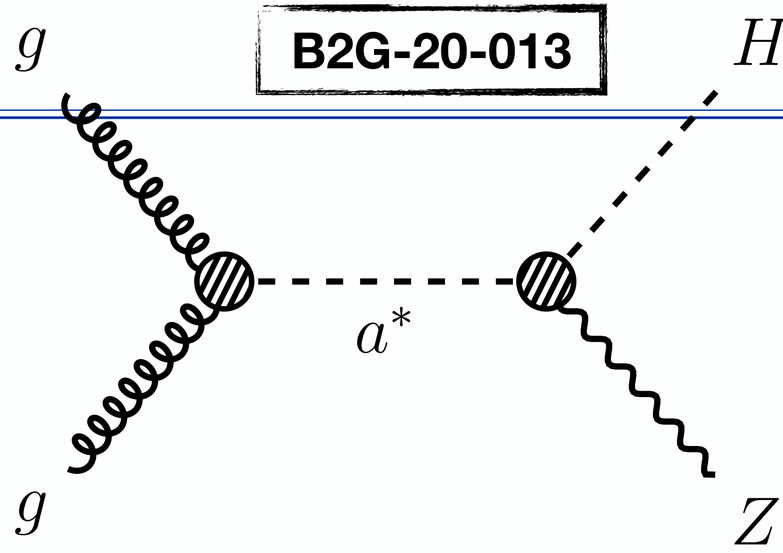
Analysis summaries available at CMS web pages

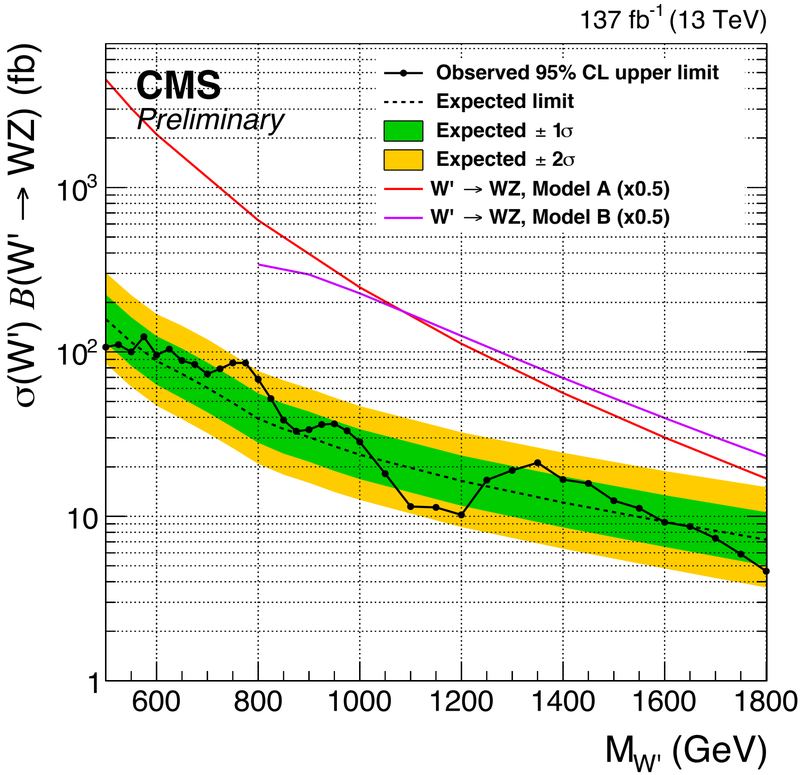
- These analyses have several aspects in common:
  - Looking for deviations from the SM at **high diboson invariant mass**
  - Hadronic H/W/Z decays reconstructed as **AK8 jets, ML jet classifiers** used to identify them
  - **Multi-category fit strategies** that enable data-driven estimation of (dominant) backgrounds
  - Based on the ~**140 fb^{-1}** of LHC pp data collected by CMS in 2016–2018

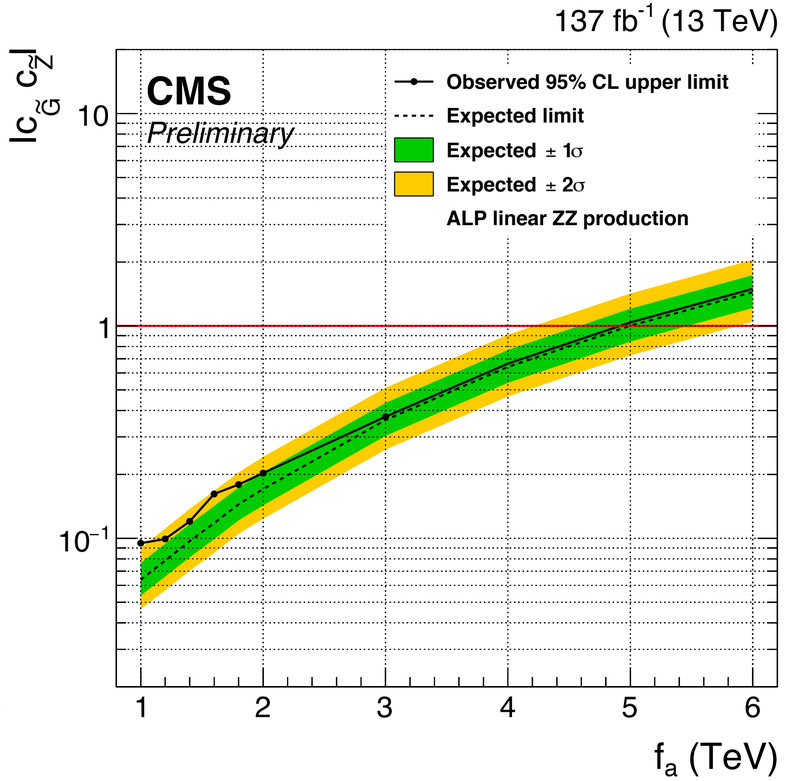
Z[Z/W/H]→qqll

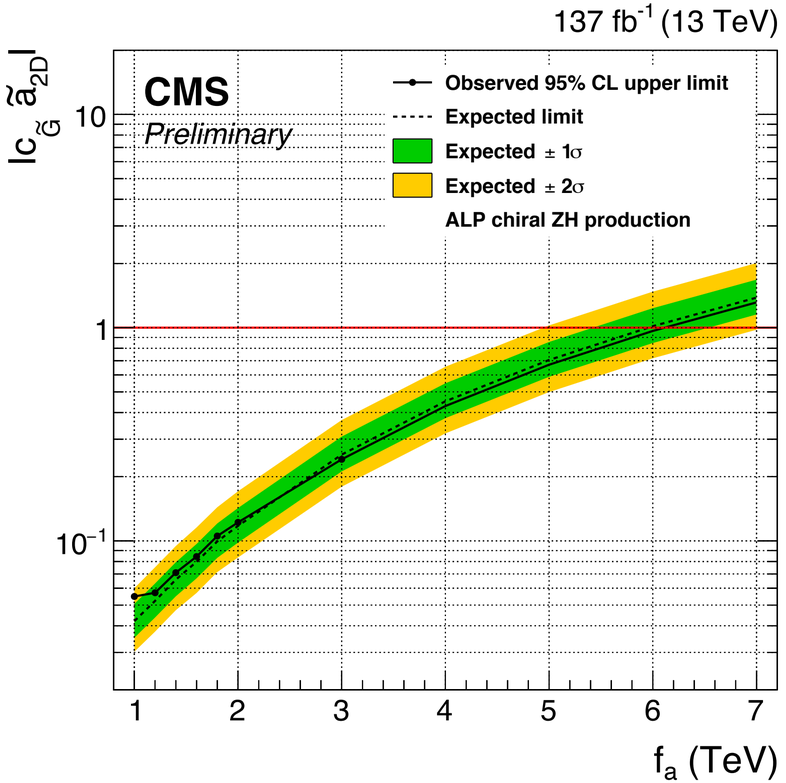
B2G-20-013

- Search for **axion-like particles** in diboson final states
  - **Resonant** production: W'→WZ and G→ZZ
  - **Nonresonant** ALP-mediated ZZ or ZH production searched for the **first time** at the LHC



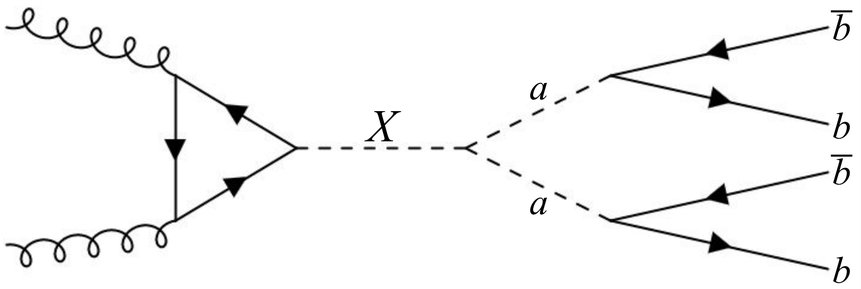




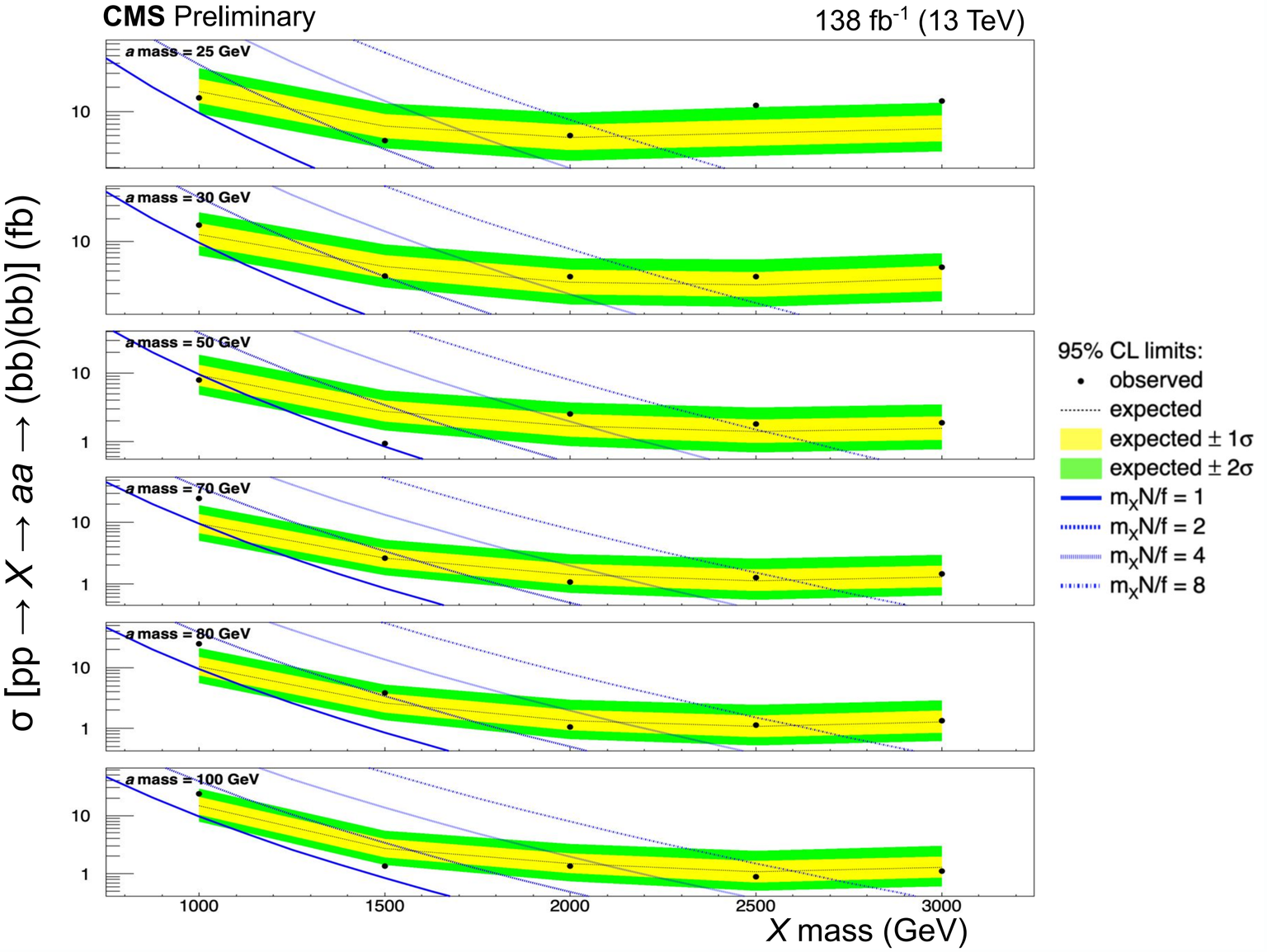


X→aa→4b

B2G-20-003

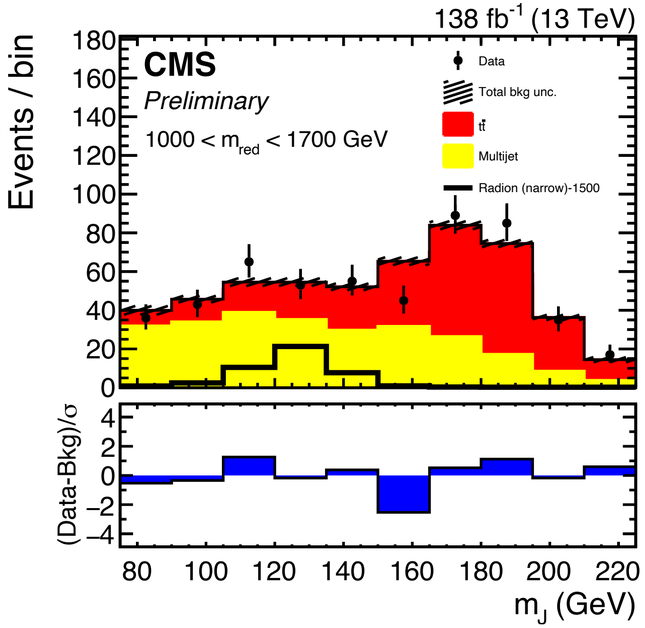


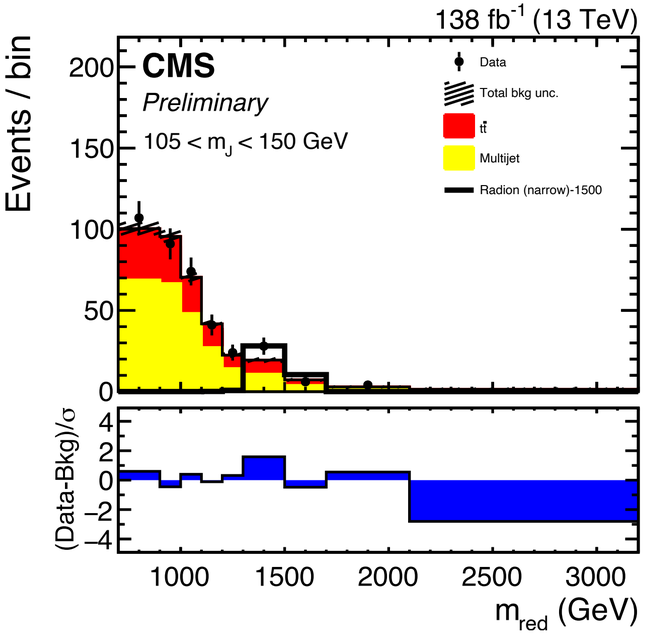
- Search for a **1–3 TeV resonance X** decaying to **25–100 GeV scalars a**
  - For these masses, a scalars are very boosted so the **a→bb decay products are contained inside a single AK8 jet**
- This is the **first search at the LHC** for this process
  - In usual X→HH searches, cuts on the Higgs candidate mass make them insensitive to lighter scalars



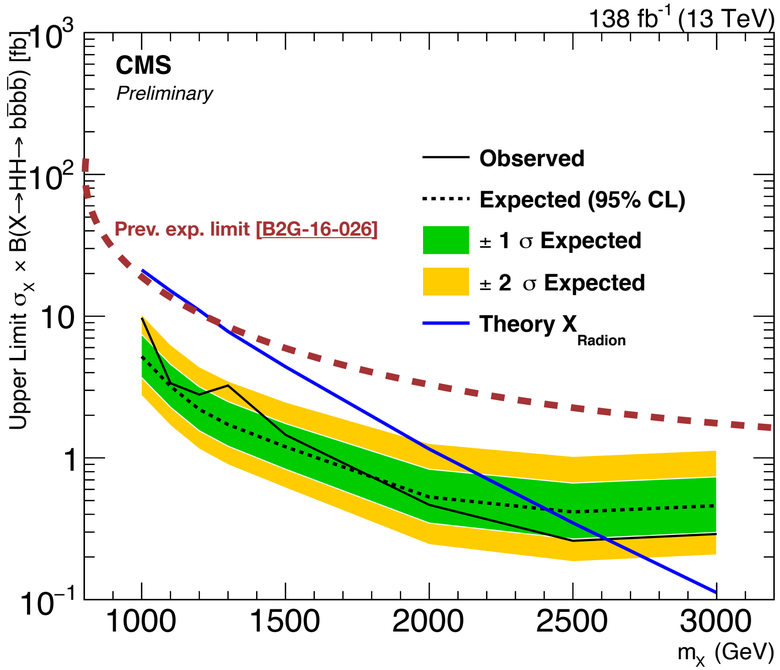
X→HH→4b

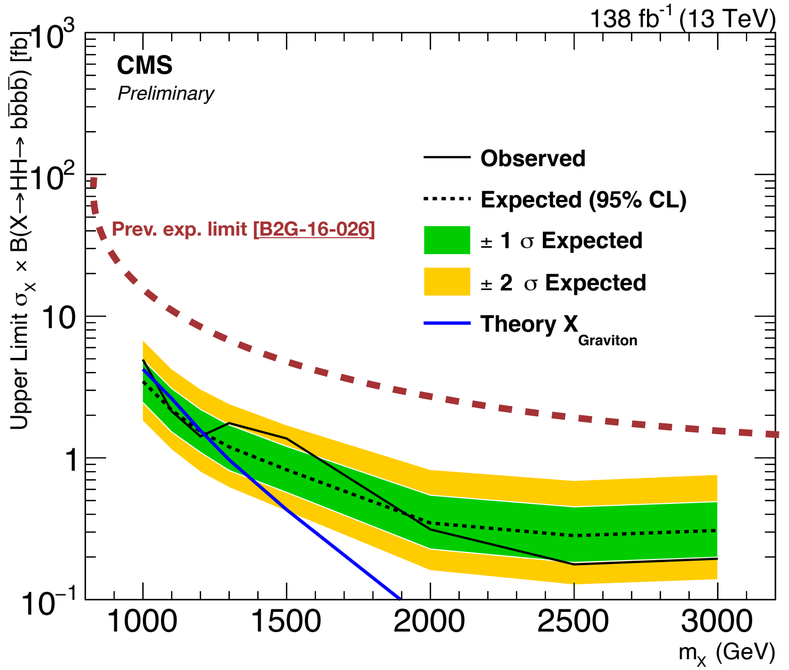
B2G-20-004





- Search for a **1-3 TeV resonance X** decaying to **125 GeV Higgs bosons**
  - **DeepAK8-MD** provides **2.5x sensitivity gain** w.r.t. double-b
  - **New semi-resolved** category with **one AK8 jet** and **two b-tagged AK4** jets
  - **Upper limits** set on the production of **spin-0 radions** (left) and **spin-2 gravitons** (right), predicted in warped extra dimension models, **significant improvement** in sensitivity compared to 2016-only results

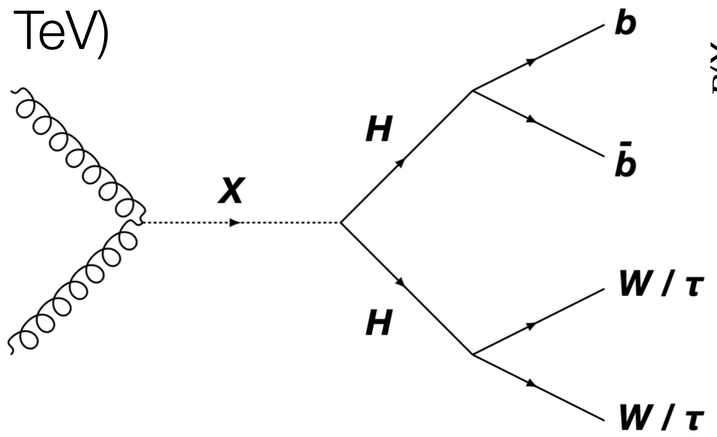


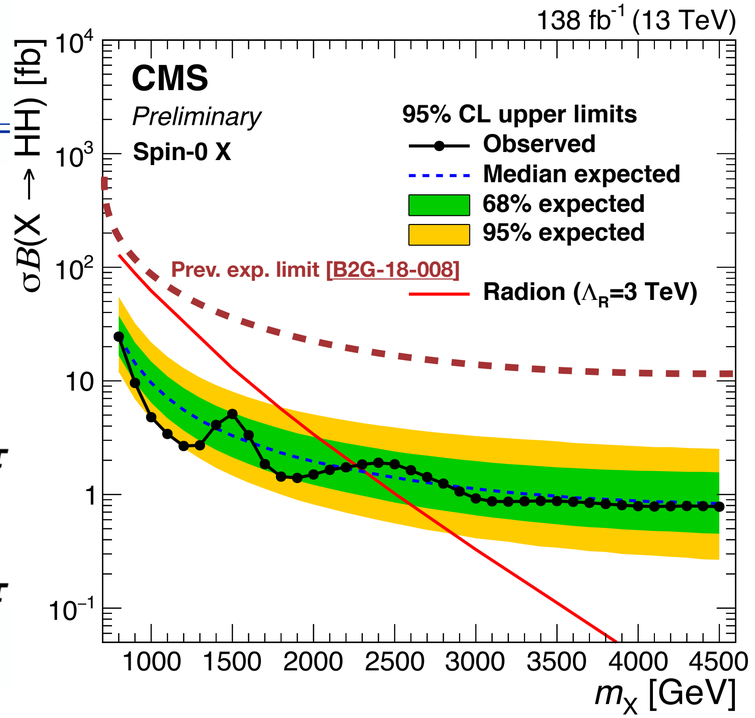


X→HH→bb+leptons

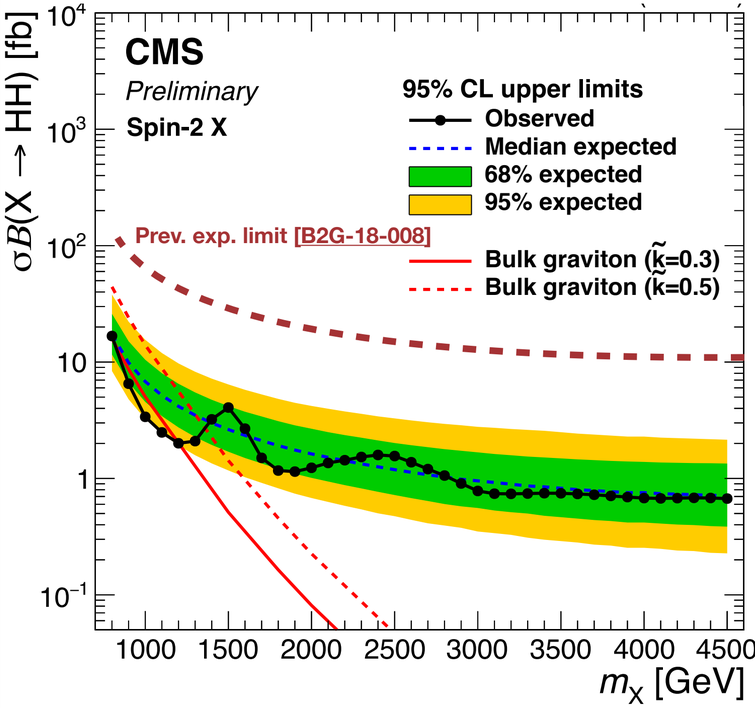
B2G-20-007

- Search for a **massive resonance X** (0.8–4.5 TeV) decaying to **SM Higgs bosons** (125 GeV)
  - **H→bb** decay reconstructed as an **AK8 jet (DeepAK8)**
  - **H→WW*→**lνlν (or **H→ττ→**lννlνν) decays considered as follows:
    - **Semileptonic** channel: AK8 qq jet (low τ_{21}) + an electron or muon
    - **New dilepton channel**: two isolated leptons and large p_T^{miss}



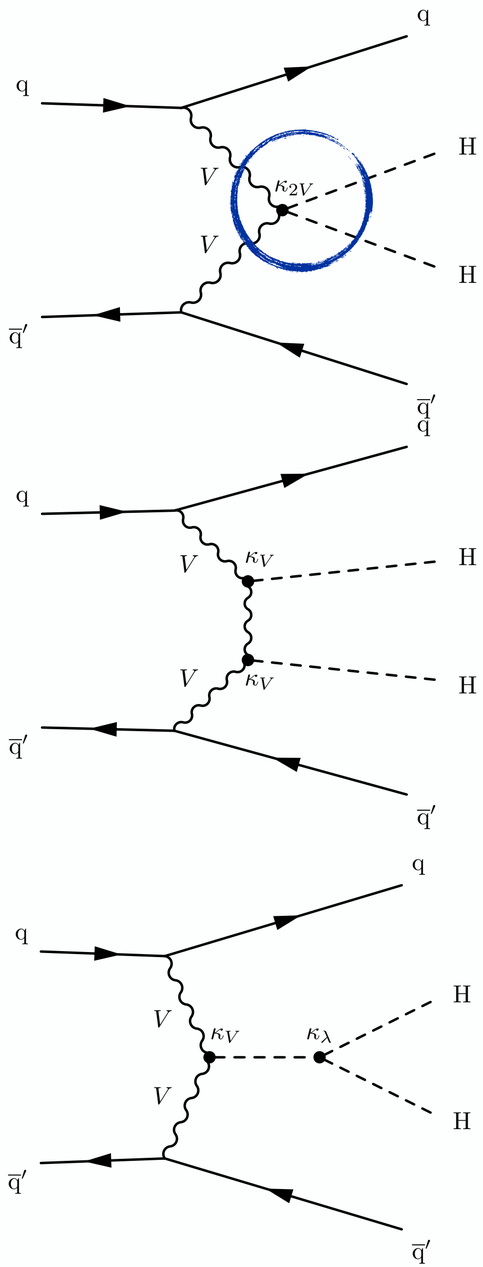


- **Upper limits** set on the production of **spin-0 radions** (left) and **spin-2 gravitons** (right) predicted in warped extra dimension models
  - **Significant improvement** compared to 2016-only results, mostly due to addition of the **dilepton** category
  - **Strongest exclusion limits** to date for X → HH production modes with leptons in the final state

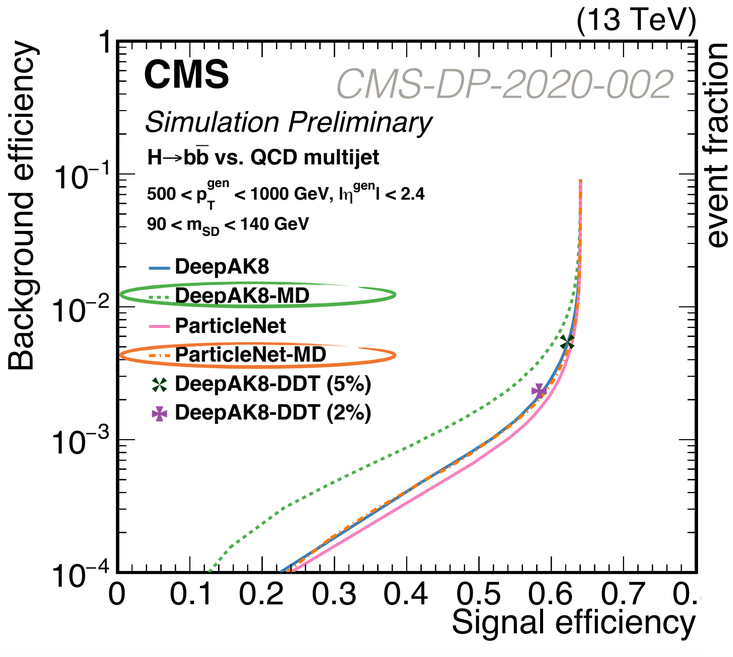


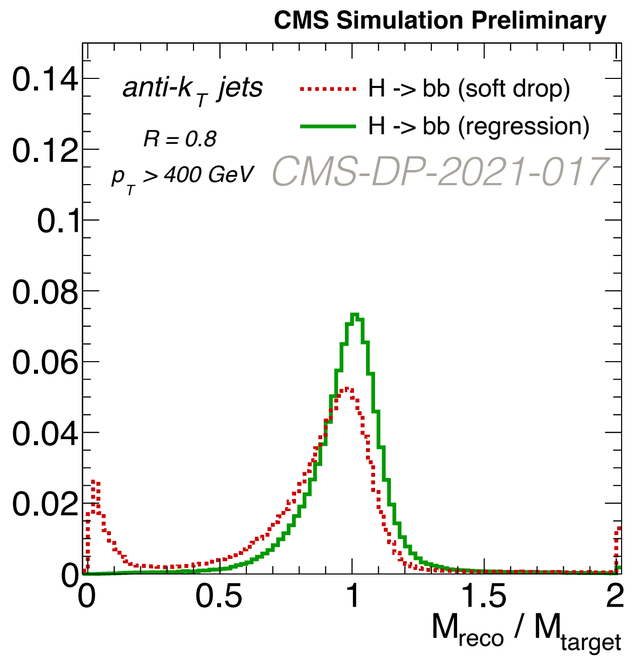
VBF HH→4b

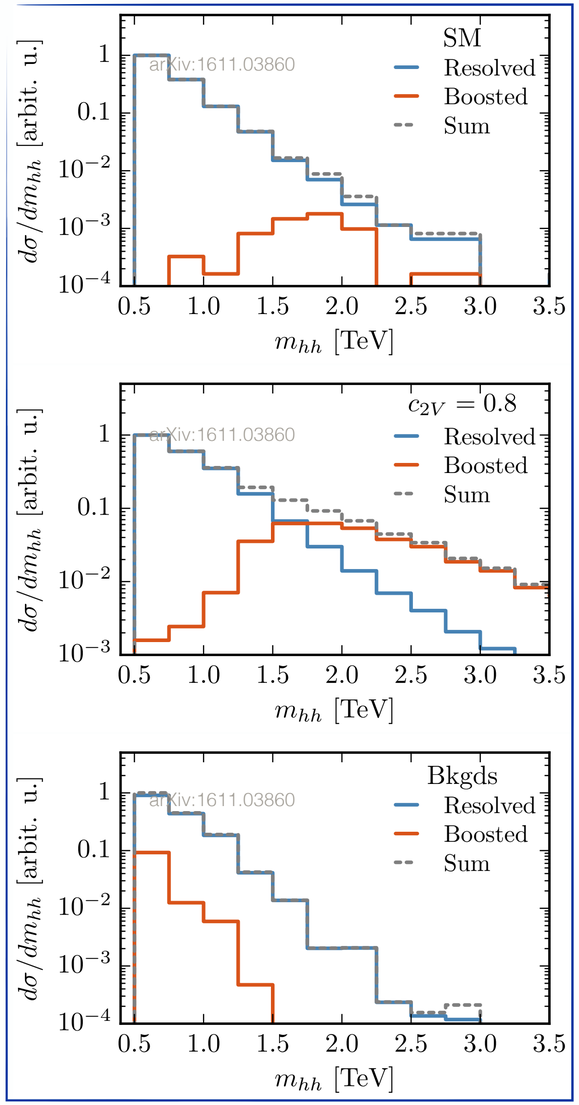
B2G-21-001



- Most nonresonant HH searches probe the Higgs self-coupling via the ggF production mode, but the subleading mode, i.e. **VBF HH production has unique sensitivity for the VVhh coupling (κ_{2V})**
  - In BSM scenarios with **modified couplings**, **a significant fraction of signal becomes boosted** (arXiv:1611.03860)
  - This new CMS analysis searches for the **VBF HH in a boosted topology for the first time,** specifically targeting nonresonant production with anomalous couplings
  - First CMS analysis to apply **ParticleNet** for H→bb identification

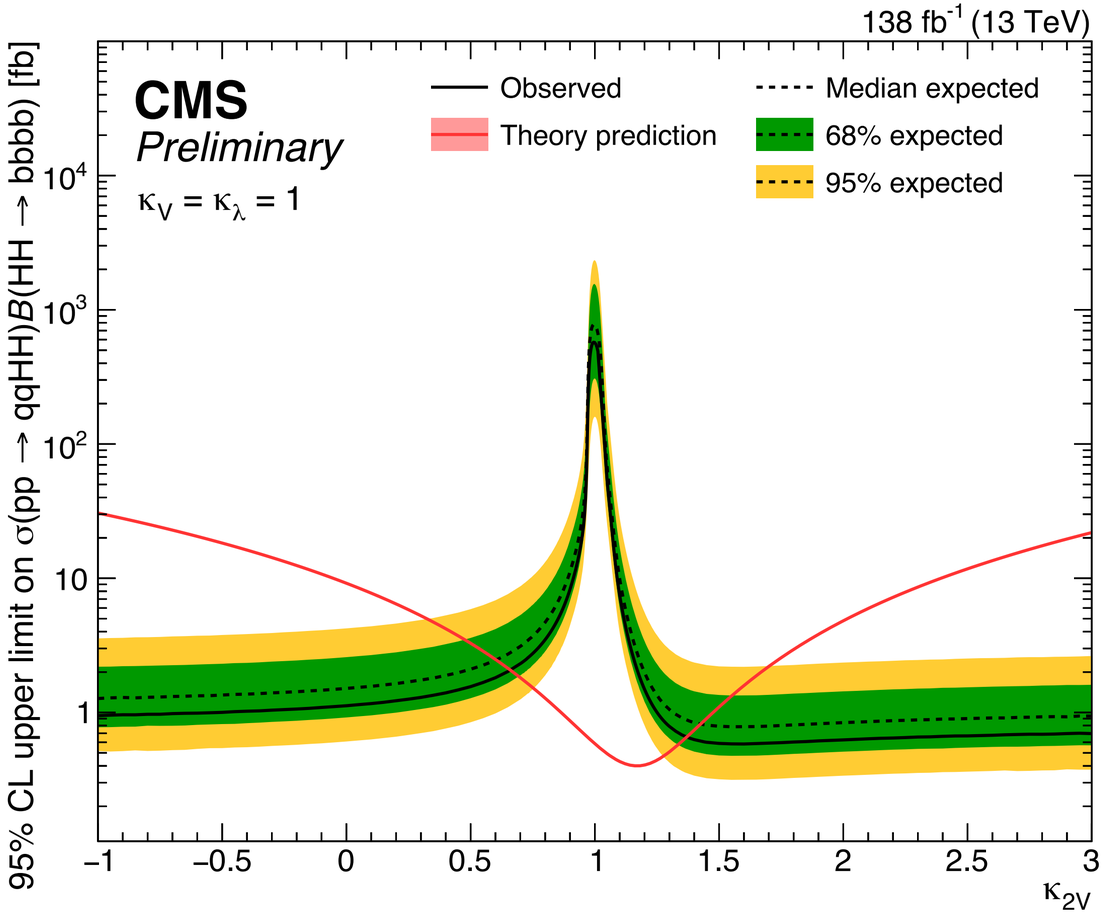


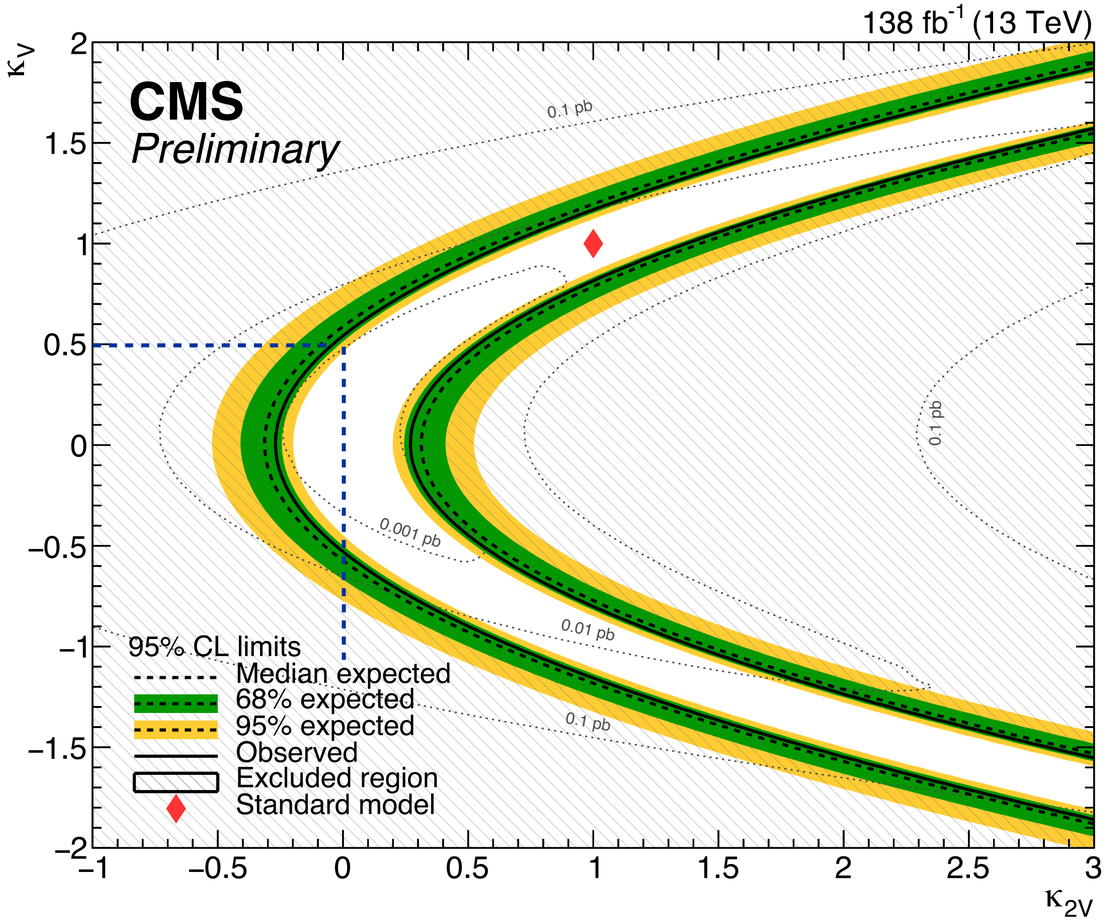




VBF HH→4b: Results

B2G-21-001





- Upper limits on VBF HH production set as a function of κ_{2V}, with other couplings fixed to SM values
  - Values outside $0.6 < \kappa_{2V} < 1.4$ excluded
  - **Strongest constraint so far, $\kappa_{2V}=0$ excluded for the first time**

- 2D limit scan excludes κ_{2V} for when $\kappa_{2V} > 0.5$, with other couplings fixed to SM values
  - Previous (single-Higgs) results suggest that κ_V has a value close to 1 [arXiv:1809.10733]

Now let's discuss!