Resonant diboson production searches in the boosted topology at CMS

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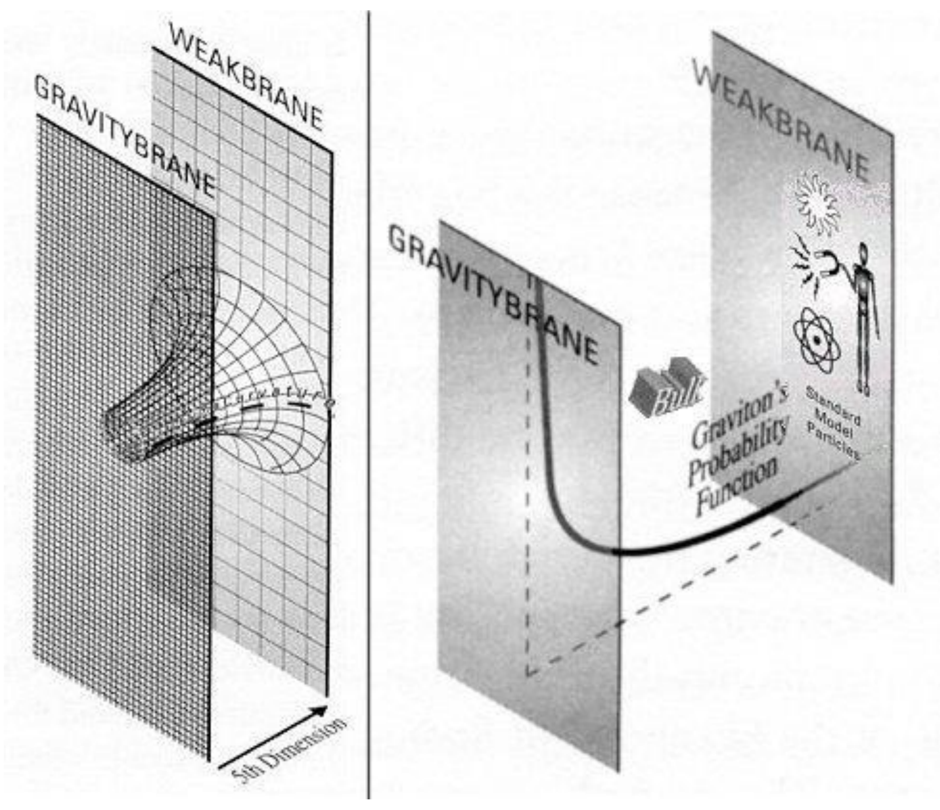
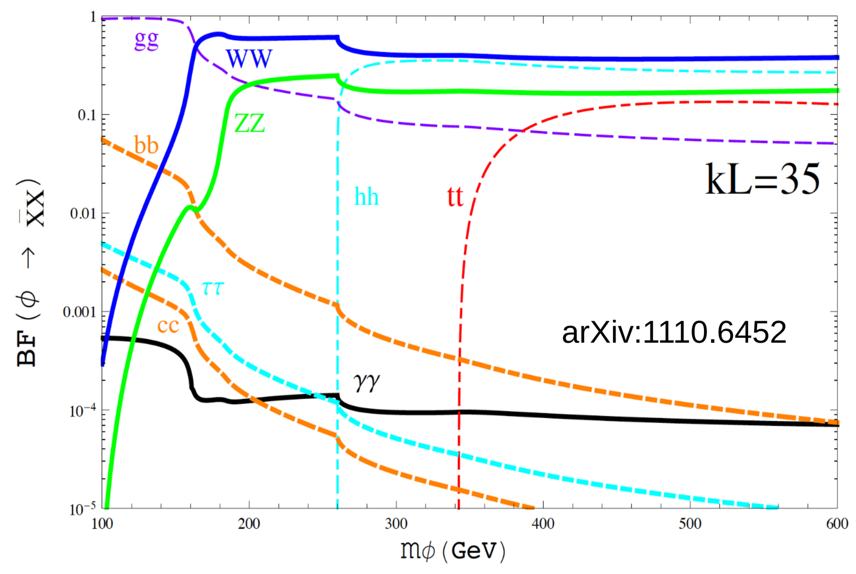
Theoretical motivation

Why is gravity much weaker than the weak force in nature?

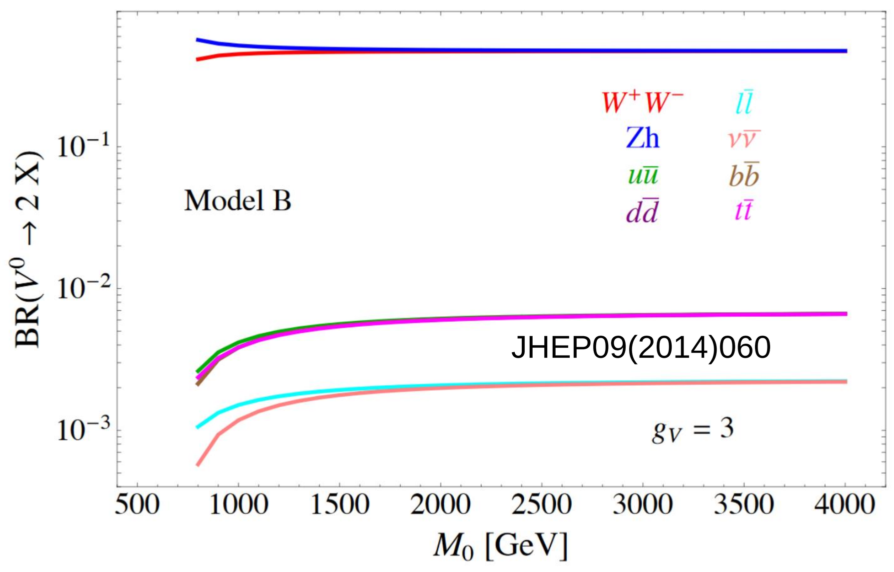
This is one of the big unanswered questions of particle physics. New physics scenarios try to answer these questions. Some models attempt to explain this by increasing the number of spatial dimensions, e.g. warped extra dimensions, while others introduce new interactions, as in the case with extended gauge theories.



The existence of new neural particles, i.e. Kaluza-Klein excitations of both spin-0 (radion) and spin-2 (graviton), is predicted.



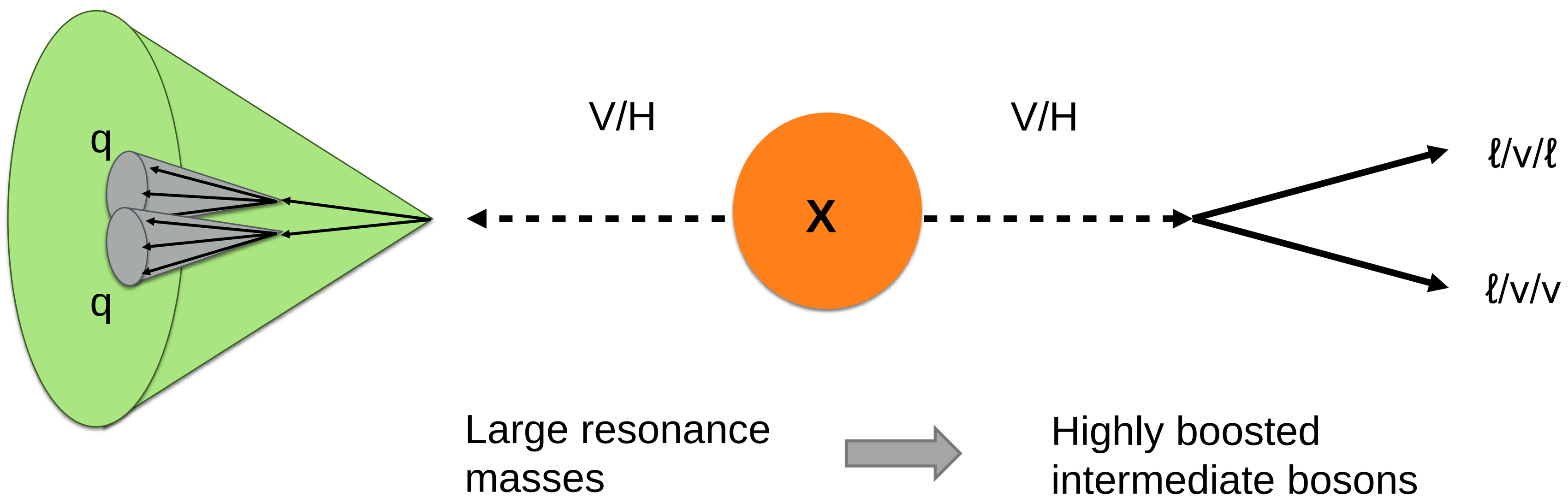
Composite and little Higgs theories predict new particles of spin-1 (V'): charged W' and neutral Z'.



Predicted new particles have large couplings to bosons.

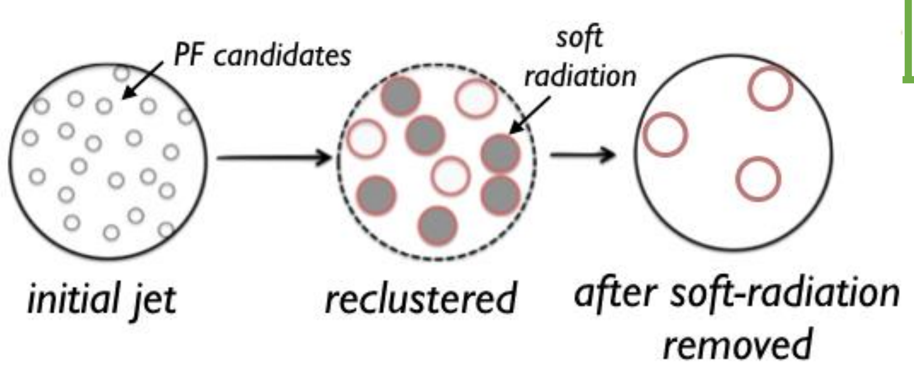
qq

A large jet cone (R=0.8) is used in order to contain all the decay particles of the boson.

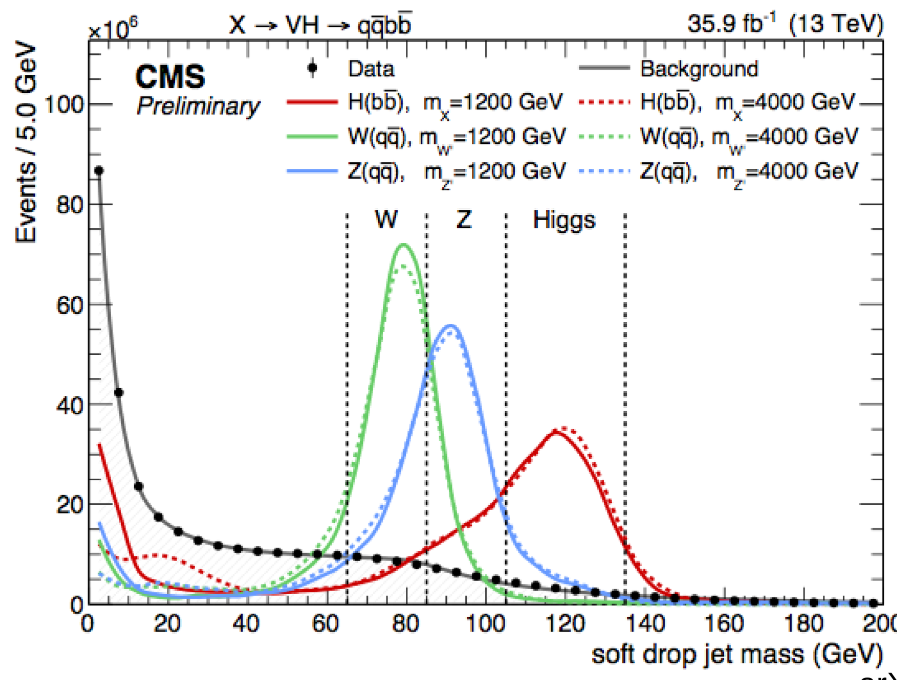


Grooming

Grooming techniques distinguish between jets originating from single quarks/gluons or bosons by filtering out soft and large angle emissions in the jets.

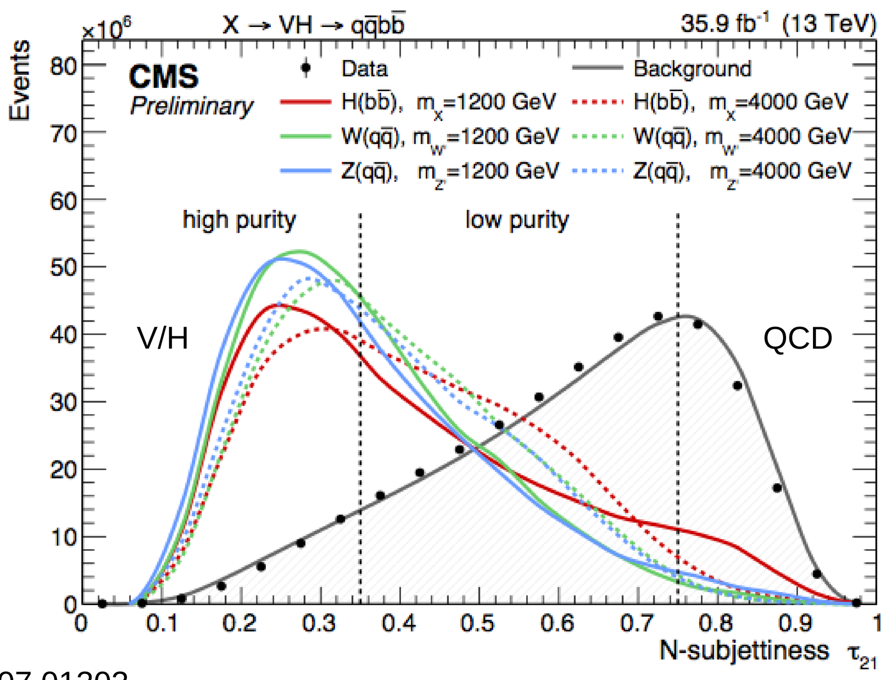


Groomed jet mass



Resolving jet substructure

τ_{21}: The ratio τ_2/τ_1 is a measure of how 2- versus 1-prong like a jet is, allowing the discrimination between jets originating from single quark/gluon and those originating from the decay of a V/H boson decaying into two quarks.



arXiv:1707.01303

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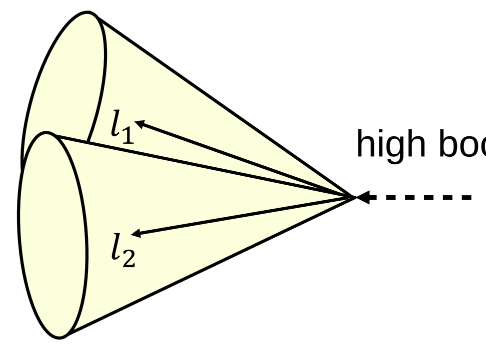
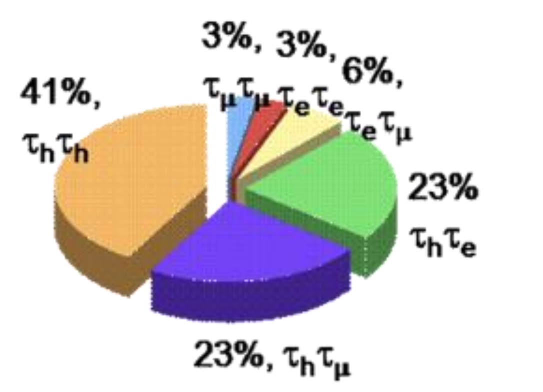
If the vector bosons are highly boosted, the leptons are very close to one another.



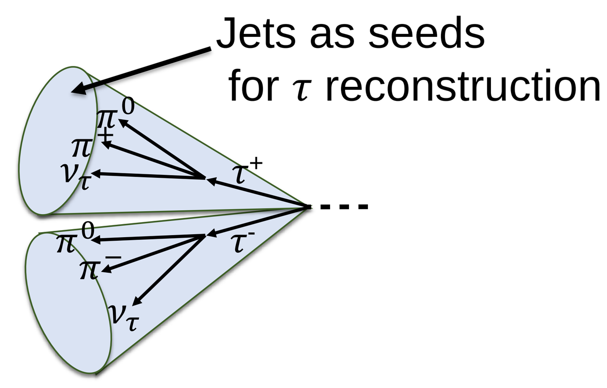
In this case, the lepton isolation has to be modified in order to remove unwanted particles stemming from the background, without removing the other lepton from the V/H decay.

ττ

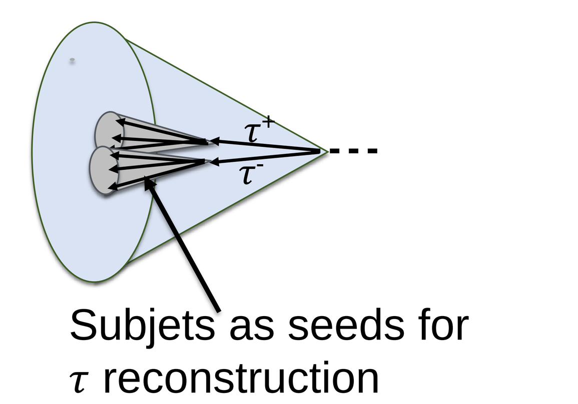
The reconstruction of tau leptons is challenging due to the plethora of possible final states, like $e\nu_e\nu_\tau$, $\mu\nu_\mu\nu_\tau$, $h^\pm\nu_\tau$, $h^\pm\pi^0\nu_\tau$ and $3h^\pm\pi^0\nu_\tau$.

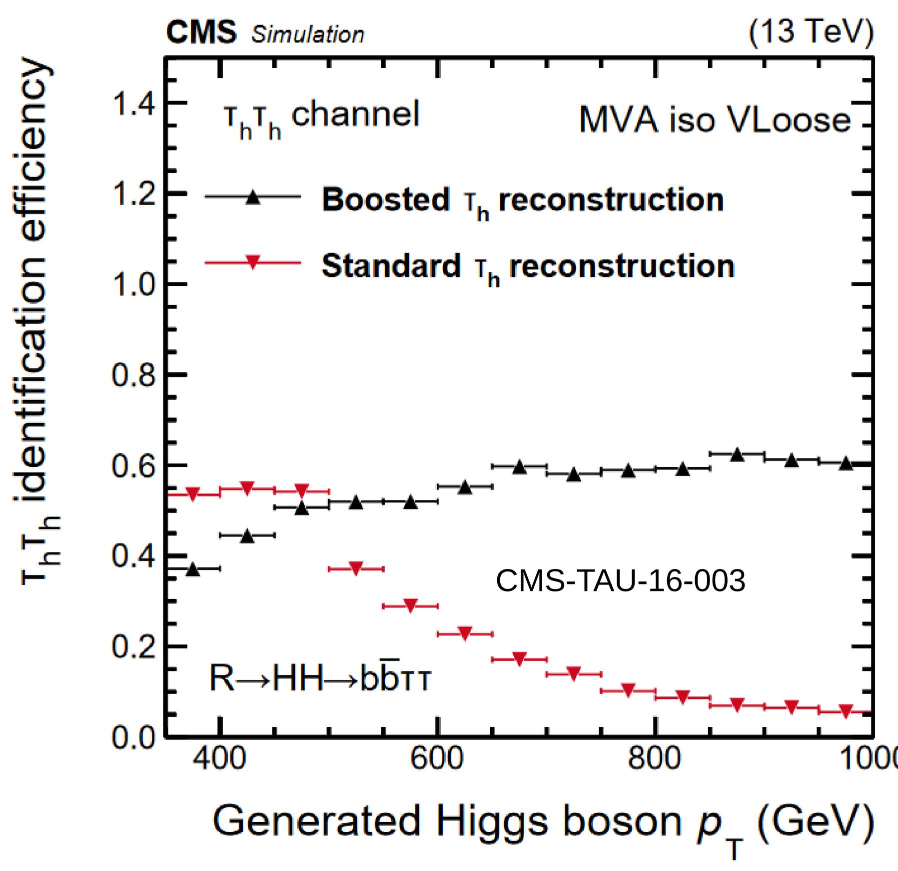


Standard reconstruction for τ_h



Boosted reconstruction for τ_h

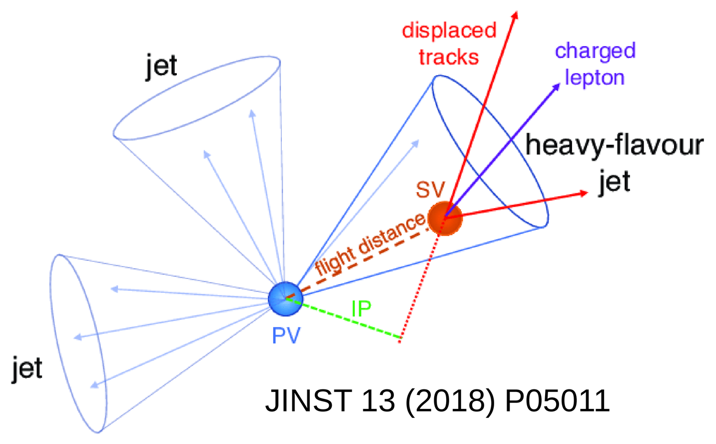


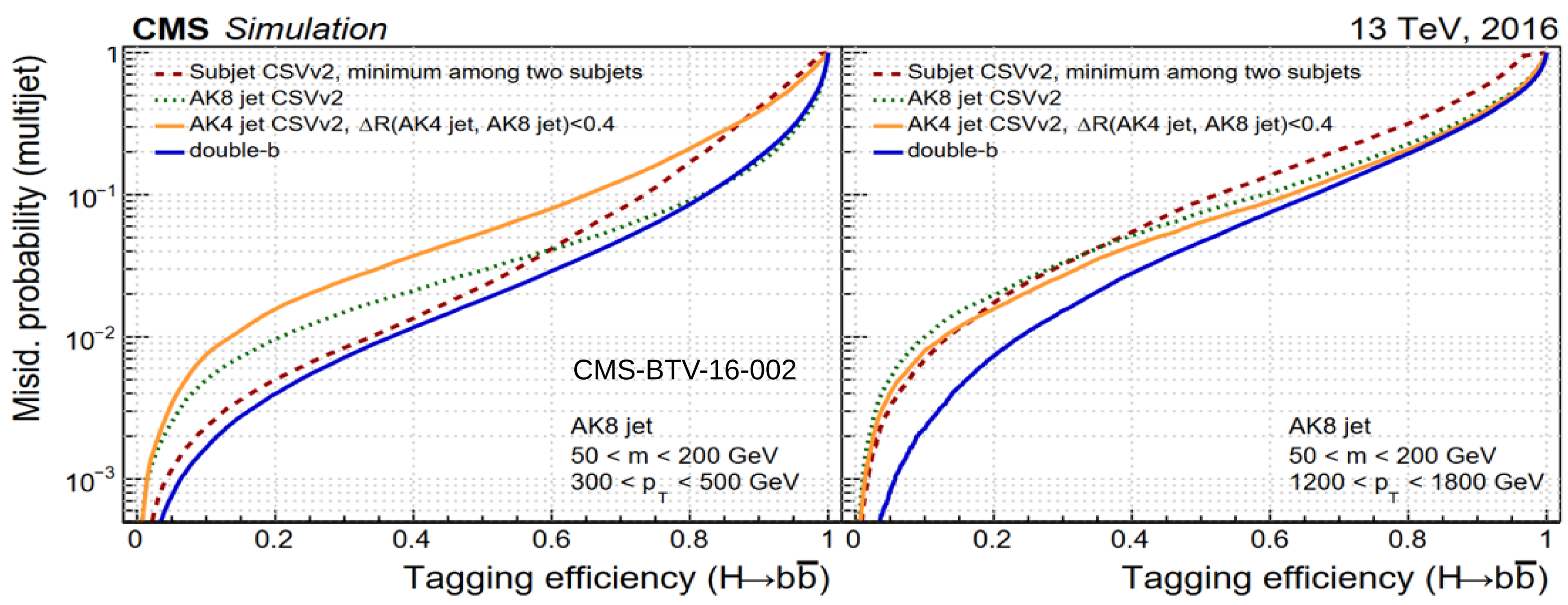


bb

Jets originating from b quark hadronization can be identified by a secondary vertex due to the longer lifetime of the B hadrons.

For jets originating from the Higgs boson decay to b quarks either the large-cone jet or the subjets can be b tagged.

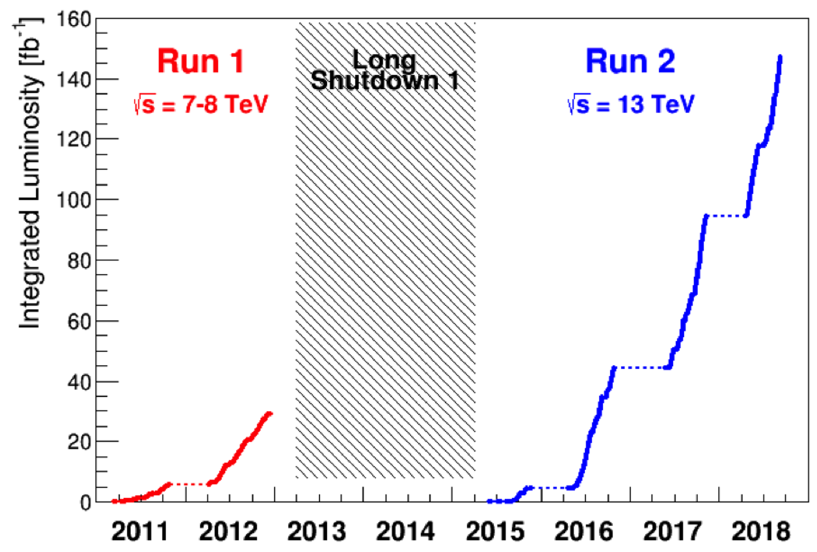




Summary

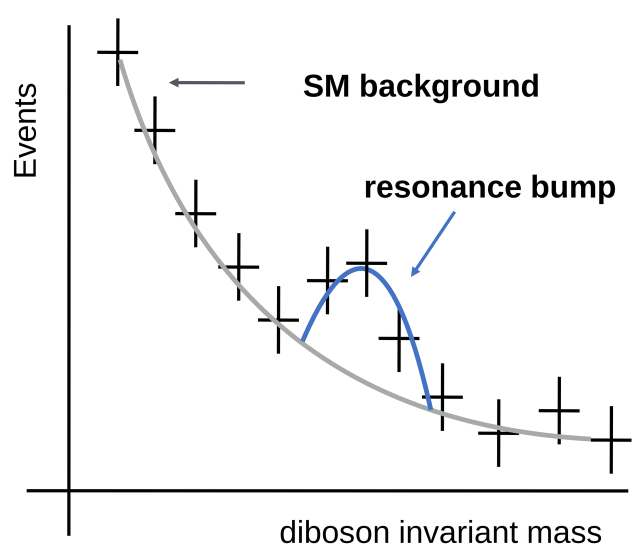
Analyses of Run 1 and Run 2 (2016) data showed no significant deviations with respect to the Standard Model expectations, and exclusion limits on the production cross section of these predicted new resonances were set.

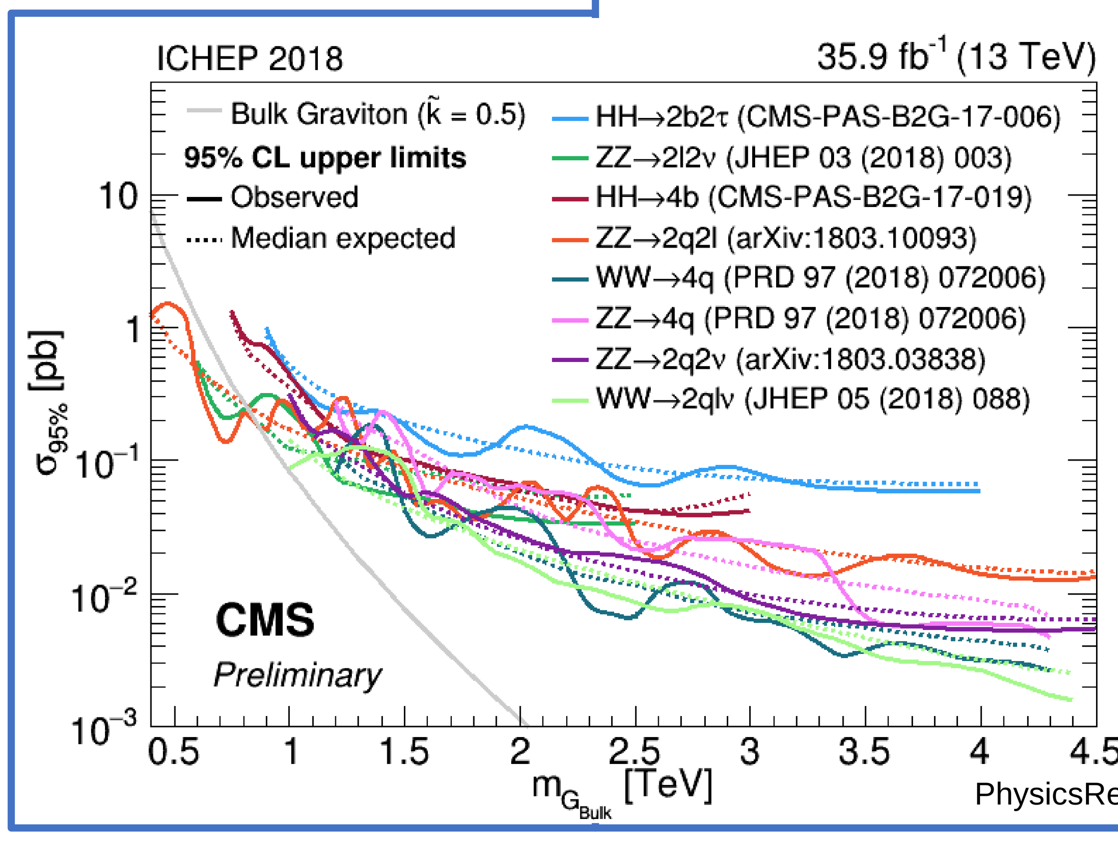
However, who knows what the remaining 60% of unanalyzed LHC data will reveal.

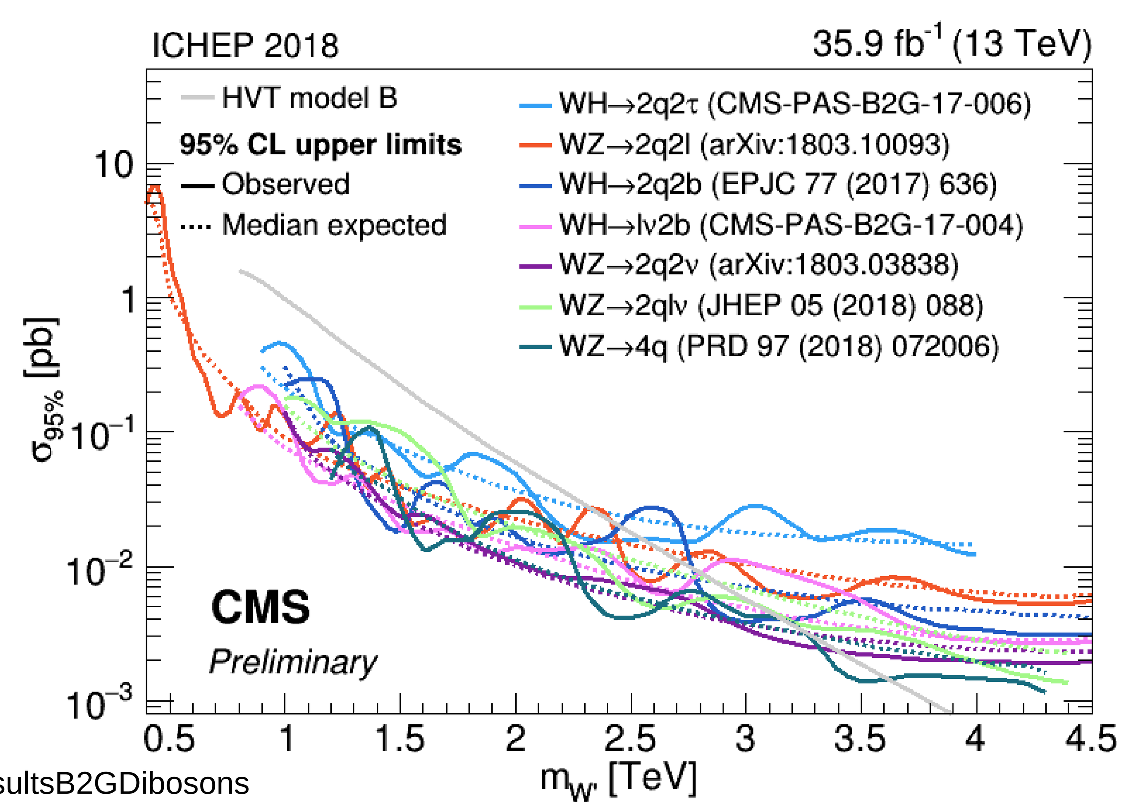


Search for resonance

After the two bosons are identified, the invariant mass of the system is reconstructed. The new resonance would manifest itself as an excess of events in a localized region on top of a smoothly-falling background spectrum.







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