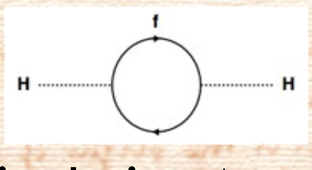
Search for new heavy bosons with b-tagged jets in the boosted regime with CMS

Jennifer Ngadiuba

Benjamin Kilminster, Clemens Lange, Andreas Hinzmann (Physics Department UZH)

The Higgs mass hierarchy problem

The Higgs mass gains quantum corrections from fermion loops



M_H^2 (125 GeV) = M_0^2 + δM_H^2

$$\delta M_H^2 = -2\frac{|\lambda_f|^2}{16\pi^2}\Lambda^2 + \dots$$

fine tuning: Λ ~ gravitational scale ~ M_{Planck} ~ 10^{18}

If new physics at the TeV scale exists ... Λ ~ 1 TeV

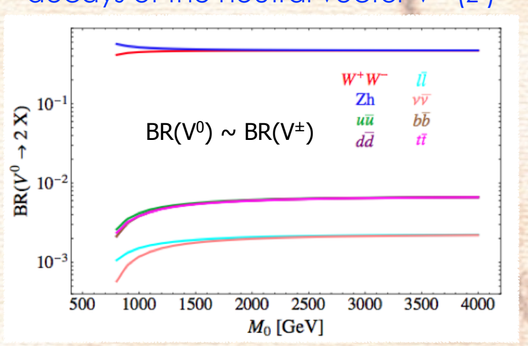
- Supersymmetry
- Compositeness/Extra Dimensions

The composite Higgs model

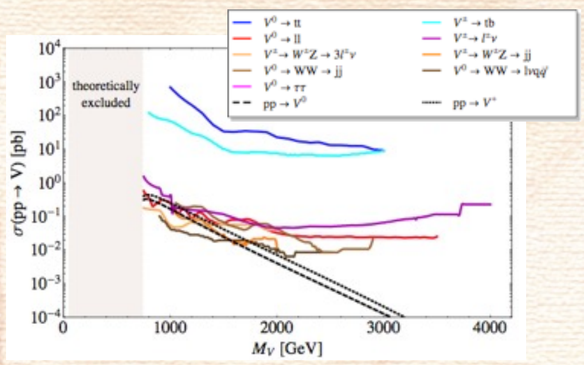
The Higgs boson is considered as a pseudo Nambu-Goldstone boson that couples to the SM particles and to new heavier gauge bosons, such as **Z′** and **W′**, with masses in the TeV region

- in this scenario the neutral (V^0) and the charged ($V^\pm$) heavy resonance decay primarly to SM vector bosons (W,Z,Higgs)

Branching Ratios for the two body decays of the neutral vector V^0 (Z′)

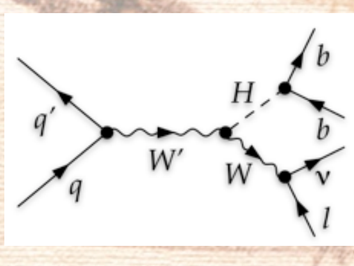


Bounds on the production cross sections



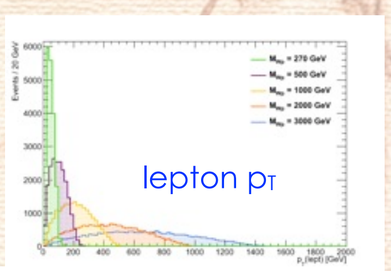
W′ signal: **W′ → WH → bb̄ℓν**

One of the first analyses attempting to look for exotic final states with a **Higgs boson**

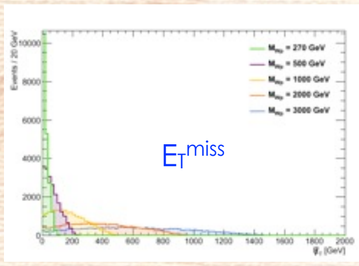


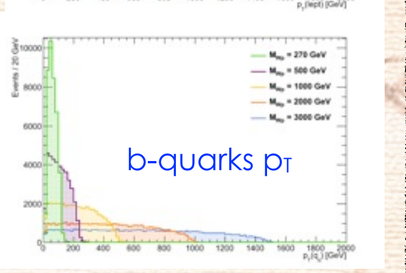
Signature:

- one high p_T isolated lepton
- large missing transverse energy
- two high p_T b-jets

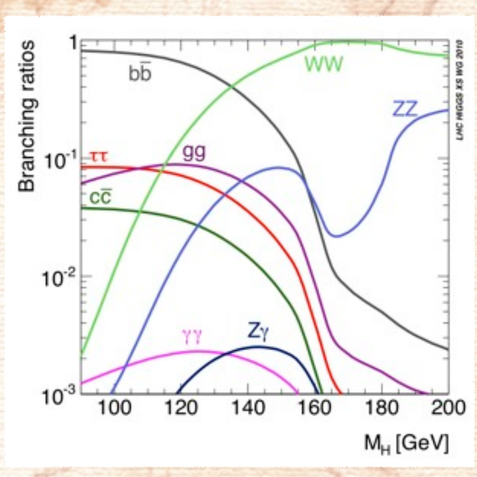


``boosted´´ decay products





H → bb : dominant Higgs decay mode

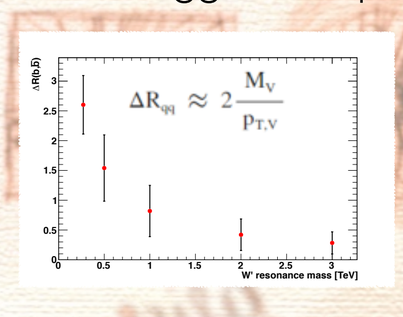


Overwhelmed by the large irreducible background from QCD production

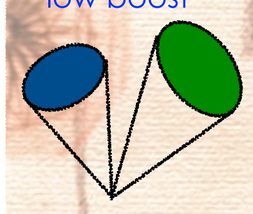
The presence of the vector boson in the final state highly suppresses the QCD background while also providing an efficient trigger path

Higgs-jet identification

For large enough boost (depending on the resonance mass))the b-jets from the Higgs are expected to merge into a single jet



low boost



high boost

fat jet R = 0.8

A large-radius jet (fat jet) is used to identify the Higgs-jet
➜ **Cambridge-Aachen algorithm with R=0.8**

The **pruned jet mass** is chosen as the main observable for the Higgs-tagging:

- signal region: 110-135 GeV
- low side band: 40-65 GeV
- high side band: 135-150 GeV

jet substructures algorithm

The **jet pruning algorithm** is used to identify jets originating from heavy objects (W,Z or H) studying the substructures of the merged jet:

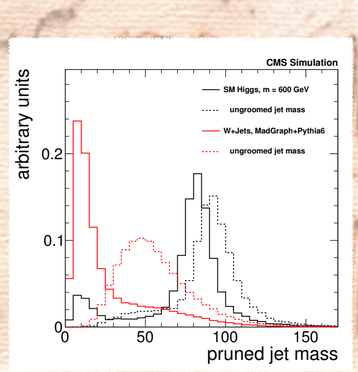
- start from a large-radius jet (CA with R=0.8)
- recluster the jet constituents and evaluate the hardness and angular separation of the last recombination
- remove the softest subjet if conditions not satisfied

hardness

$$z = \frac{\min(p_{T,i}, p_{T,j})}{p_{T,JET}} > 0.1$$

angular separation

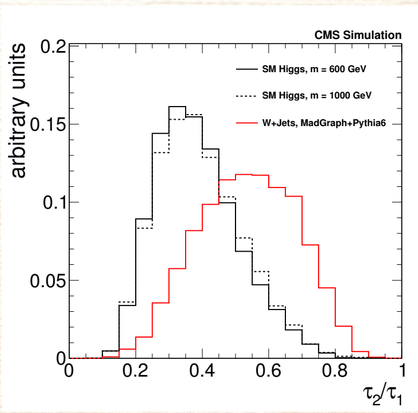
$$\Delta R < 0.5\frac{M_{JET}}{p_{T,JET}}$$



Pruning the jet mass gives improved discrimination power by suppressing background jet masses to zero while preserving the signal jet mass near the Higgs mass

Additional sensitivity is achieved by means of the **N-subjettiness algorithm:**

- start from unpruned jets
- check the topological compatibility between the jet and the hypothesis of N subjets
- compute τ_N and use the ratio τ_2/τ_1 to discriminate signal from background



$$\tau_N = \frac{1}{d_0}\sum_k p_{T,k}\min\{\Delta R_{1,k}, \Delta R_{2,k}, \dots, \Delta R_{N,k}\}$$

b-tagging

The background associated with light quark jets is suppressed exploiting the b-jet special signature:

- secondary vertex displaced from the primary vertex
- large multiplicity of charged tracks with high impact parameter

The **Combined Secondary Vertex** algorithm is used to combine all these information in one disciminator