Search for dijet resonances using events with three jets at CMS

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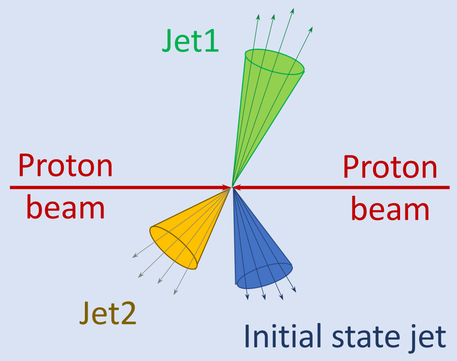
Introduction

Dijet resonance search using events with **three jets** aims to find a **new massive particle** that couples to quarks. The **additional jet** can be **radiated** from the **initial state** of the process.

The **main goal** of this search is to **cover** a mediator **mass region** of **350-700 GeV** with help of **additional jet from the initial state** and **calo-scouting**.

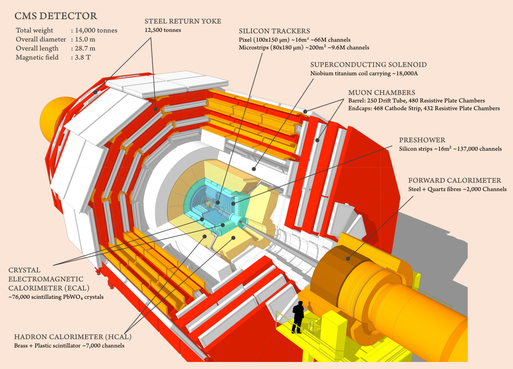


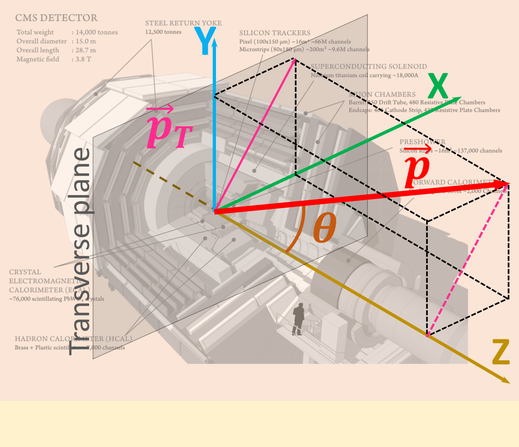
CMS detector

Compact Muon Solenoid is one of the two biggest experiments at the **LHC**. It consists of:

- Tracker
- Electromagnetic calorimeter (ECAL)
- **Hadronic calorimeter (HCAL)**
- Muon chambers

The main kinematic variables are **transverse momentum $\mathbf{p_T}$** and **pseudorapidity**.



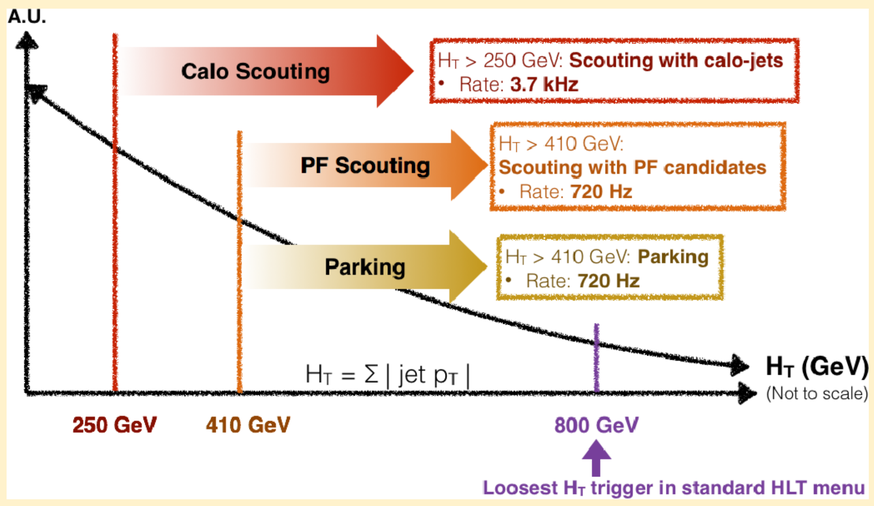


Calo scouting

Trigger system at CMS:

- Level-1 trigger: reduces event rate from 40 MHz to 100 kHz
- **High Level Trigger (HLT)**: reduces event rate from 100 kHz to 1 kHz.

Trigger uses $H_T = \sum p_T$ to select events. The lowest threshold after HLT can be too high for some analyses. **Data scouting** allows to **reconstruct the data at the HLT level** and decrease H_T selection.

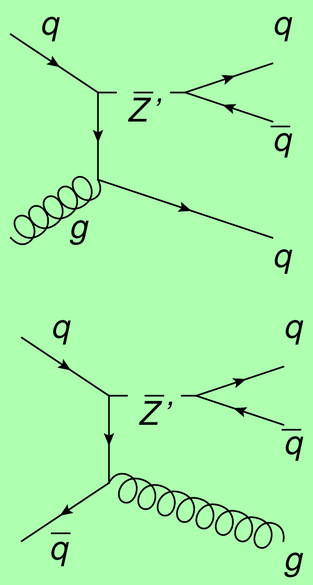


Calo scouting uses the set of scintillators in the HCAL – **calorimeter tower** as a jet signature. It allows to store less data per event and increase the event rate, which is essential for this analysis.

Signal: Z'

This search can be interpreted as a **dark matter mediator (Z') search**. This mediator **is created by the annihilation of quarks or gluons** and which then **decays to the pair of quarks**.

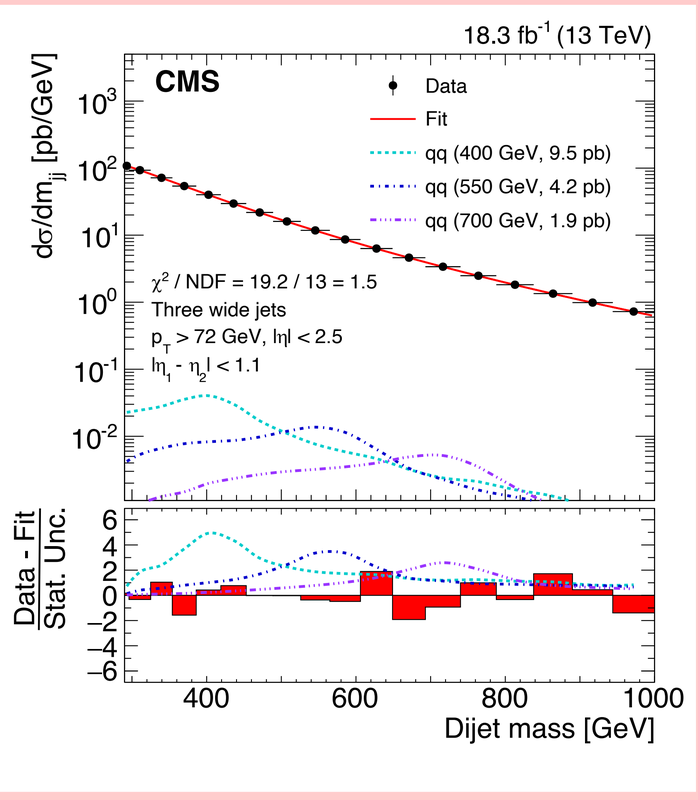
We assume **two jets with the highest p_T come from decaying resonance Z' and the third from the initial state**.



Backgrounds

The main background of this analysis is **multi jet QCD background**. The background is estimated by **fitting** the data with a **smooth function**.

If **signal** is present, a "**bump**" should appear over the **smooth background**.



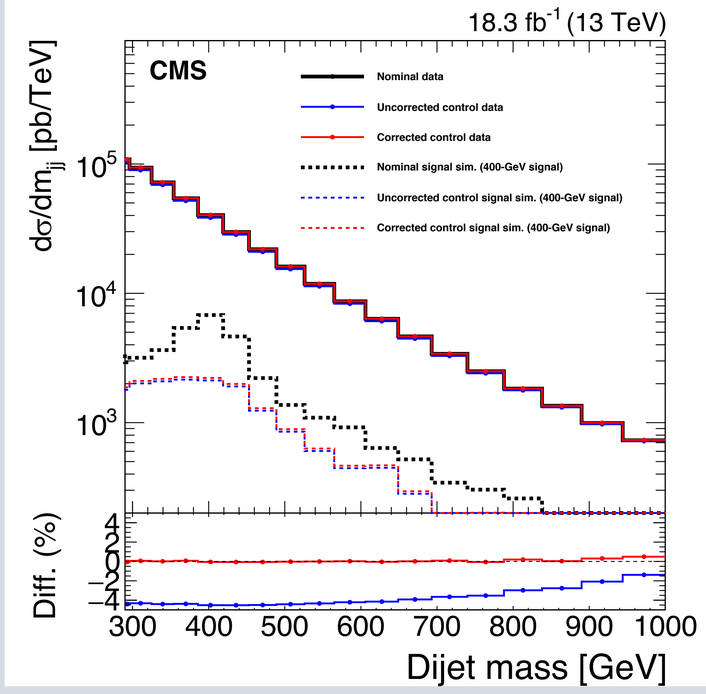
Event selection

We use $18.3\,\mathrm{fb}^{-1}$ of data collected by **CMS** during **2016** and select events with **three jets** with $p_T > 72$ **GeV** and $|\eta| < 2.5$ **and require $|\Delta\eta| < 1.1$ between two jets with the largest p_T**.

The **dijet mass shape depends on the third jet $\mathbf{p_T}$ selection**. If the selection is **too low** or **too high**, dijet mass spectrum **shifts to higher values**, due to **trigger inefficiency and kinematic effect**.
The both cases cause the shrinking of the fit range.

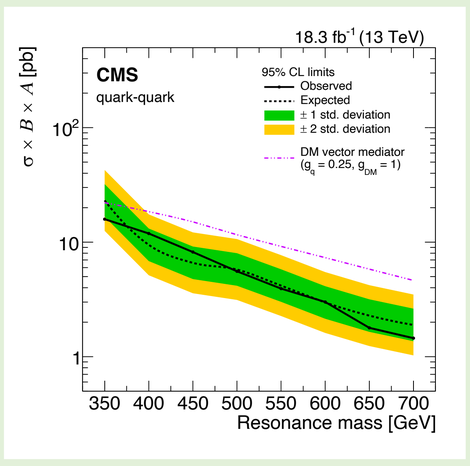
Thus, **third jet $\mathbf{p_T}$, fit range** and the **function** are chosen using **automated iterative procedure**.

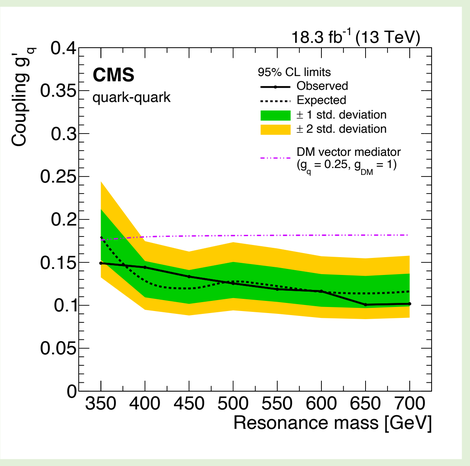
We use **modified signal region (MSR)** for that, by **flipping the sign of η of the second jet**.



Results and conclusion

- **No bump is observed** and we proceed to set **upper limit** on the **product of the signal production cross section, branching ratio and acceptance** (left)
- The **upper limit** on the coupling g'_q of the **vector resonance that couples only to quarks** are presented as well (right).
- These two plots **compares results** with the predictions of a **model** with $m_{DM} = 1\ GeV$, $g_q = 0.25$ and $g_{DM} = 1$.
- These **results** are the **strongest limit for resonances decaying to light-flavor quarks for 350-450 GeV range**.





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