Search of VH(H$\rightarrow$ cc) in full hadronic channel

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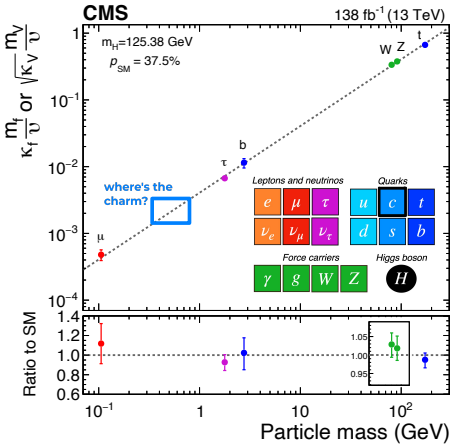
Motivation

- Discover of Higgs boson in 2012
  - Interest in its properties
  - Coupling with SM particles
    - Stronger for 3^{rd} generation
  - Probing the couplings for 2^{nd} generation
- Validate Standard Model (SM) predictions
- Search for physics beyond the SM

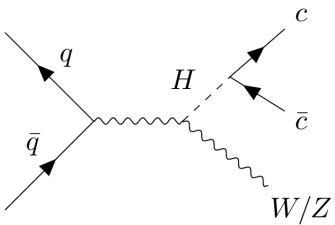


https://doi.org/10.1038/s41586-022-04892-x

Production process and Decay

- Higgs produced in association with a vector boson (Z,W)
- Choose the decay channel
  - Leptonic: $Z \to \nu\nu$, $Z \to \ell\ell$, $W \to \ell\nu$ $[\ell = e, \mu]$
  - **Hadronic:** V$\to q\bar{q}$
    - Higher branching fraction
    - Not yet explored at CMS

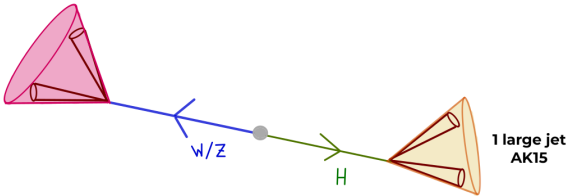
	leptons	hadrons
Z	3.7294 ± 0.0108 $(\ell^+\ell^- + \mu^+\mu^-)$	69.911 ± 0.056
	20.000 ± 0.055 (invisible $\to \nu\,\nu$)	
W	10.86 ± 0.09 $(\ell\,\nu)$	67.41 ± 0.27



Merged-jet topology

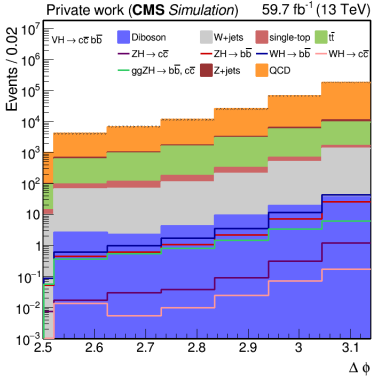
- Two back-to-back large jets AK15 (R=1.5)
  - distinguish signal from background by regressed jet mass + flavor tagging
- Challenge: reduce backgrounds
  - multijets process (QCD)
  - V + jets
  - single top and $t\bar{t}$ production

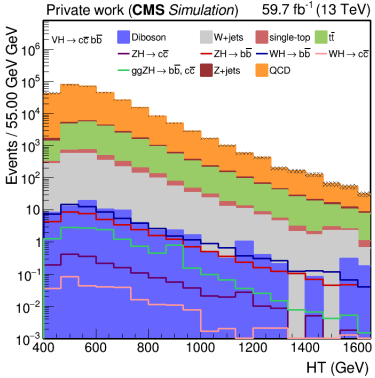
- Project goals:
  - Optimize analysis selections
  - Asses channel sensitivity



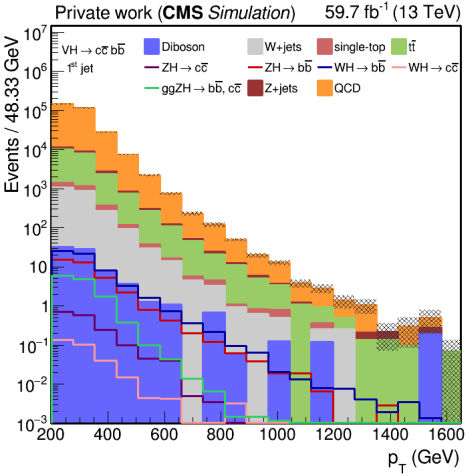
First results with MC

- Azimuthal angle ($\Delta\phi$) $\rightarrow$jets back-to-back
- HT: scalar sum of jet tranverse energies
- Loose preselections on jet tagging score and event kinematics

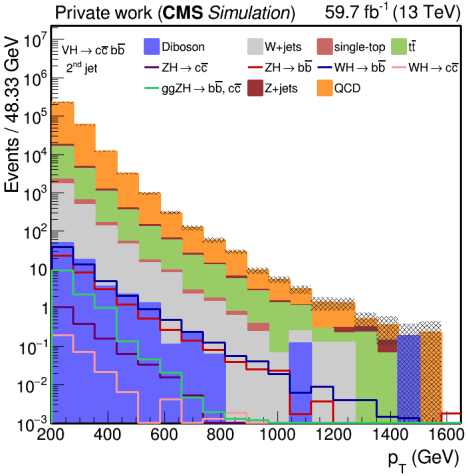




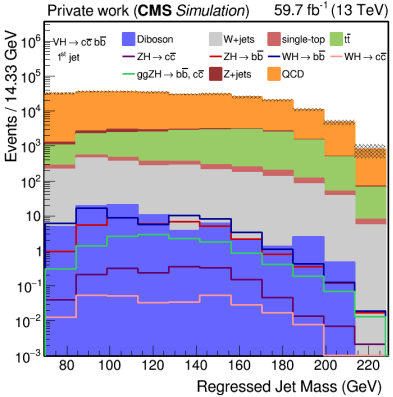
- p_{T} of the 1^{st} jet

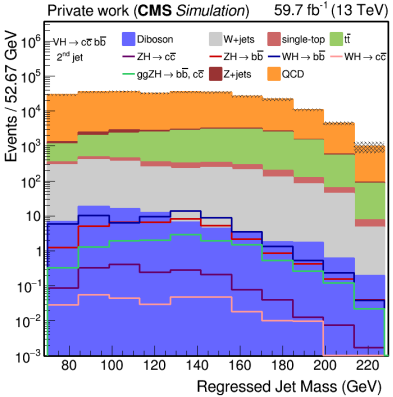


- p_{T} of the 2^{nd} jet



- Hard to distinguish between H and V candidate
- Working on optimization of this separation





Conclusions and summary

- Higgs couplings measurements
  - one of the primary goals of the LHC physics program
  - approaching the H-to-charm coupling sensitivity
- Main challenges in VH(cc) full hadronic analysis:
  - Reduce background
  - Choose the H candidate
- Optimize the analysis selections for hadronic channel and assess channel sensitivity
- Get familiar with the data format and analysis code (*done*)
- Compare available CMS datasets in terms of trigger efficiency (*ongoing*)

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Thank you! Obrigada!

Backups

- Previous measurements
- Workflow
- Common selections

Previous measurements

- CMS Collaboration
  - leptonic channel, $138\ \mathrm{fb}^{-1}$ [Phys. Rev. Lett. 131, 061801 (2023)]
  - leptonic channel, $36\ \mathrm{fb}^{-1}$ [JHEP 03 131 (2020)]
  - Higgs boson properties overview [Nature 607 (2022)]
- ATLAS Collaboration
  - leptonic, $36\ \mathrm{fb}^{-1}$ [Phys. Rev. Lett. 120, 211802 (2018)]
  - full hadronic, VH(bb), $137\ \mathrm{fb}^{-1}$ [Phys. Rev. Lett. 132, 131802 (2024)]

First plots with requirements and selections

Choose H candidate

Trigger selection→ best trigger path

Analysis Selections

Common Selections:

$2.5 < \Delta\phi < 3.14$
$\mathrm{Ht} > 400$ GeV
$p_T(\mathrm{H}) > 300$ GeV
$p_T(\mathrm{V}) > 300$ GeV

Flavor tagging:

1^{st} AK15 jet with higher bb score
2^{nd} AK15 jet with higher cc score
$\rightarrow$ switch