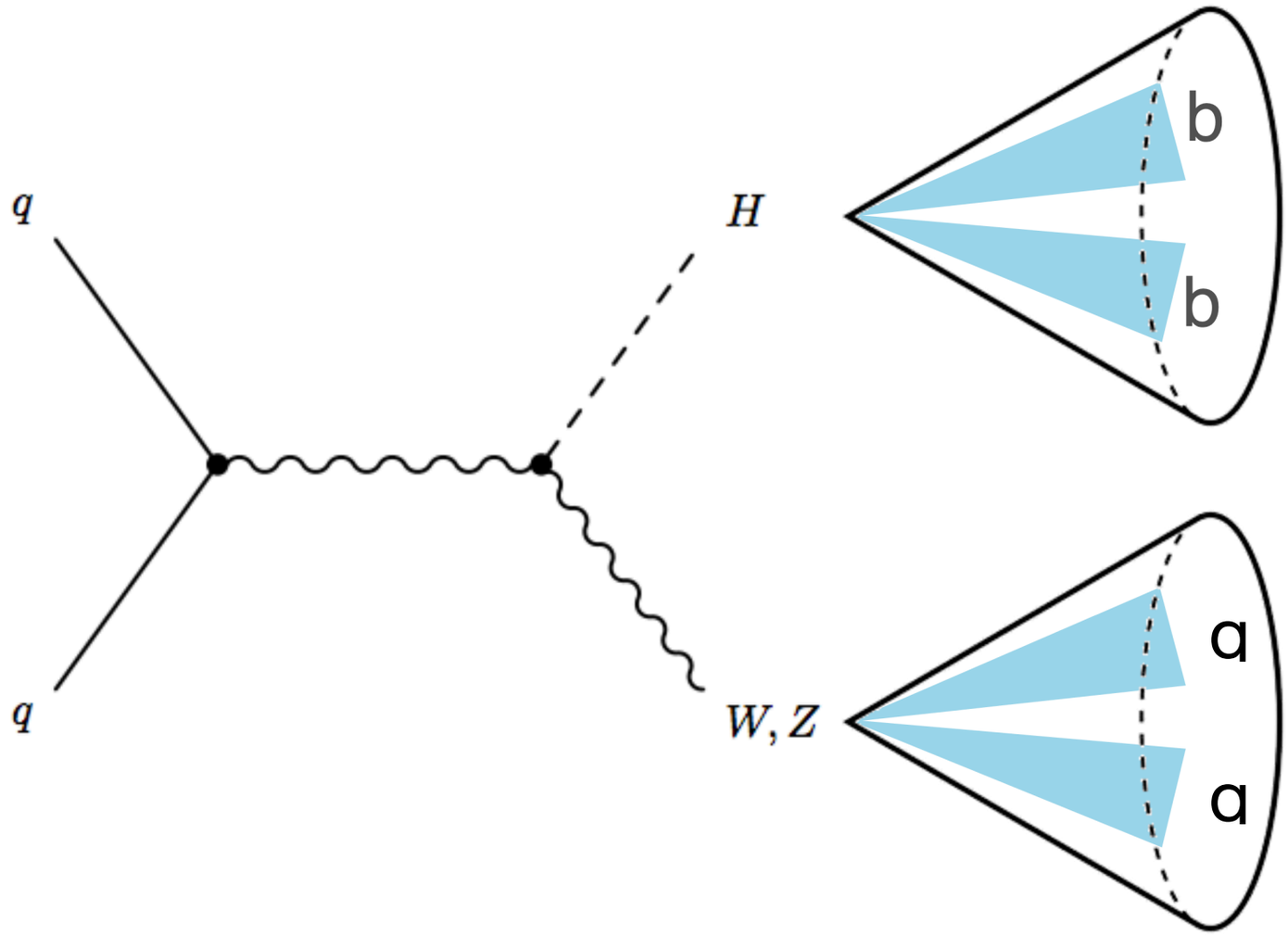
CMS-PAS-HIG-24-017

V(qq)H(bb) in the boosted Higgs channel



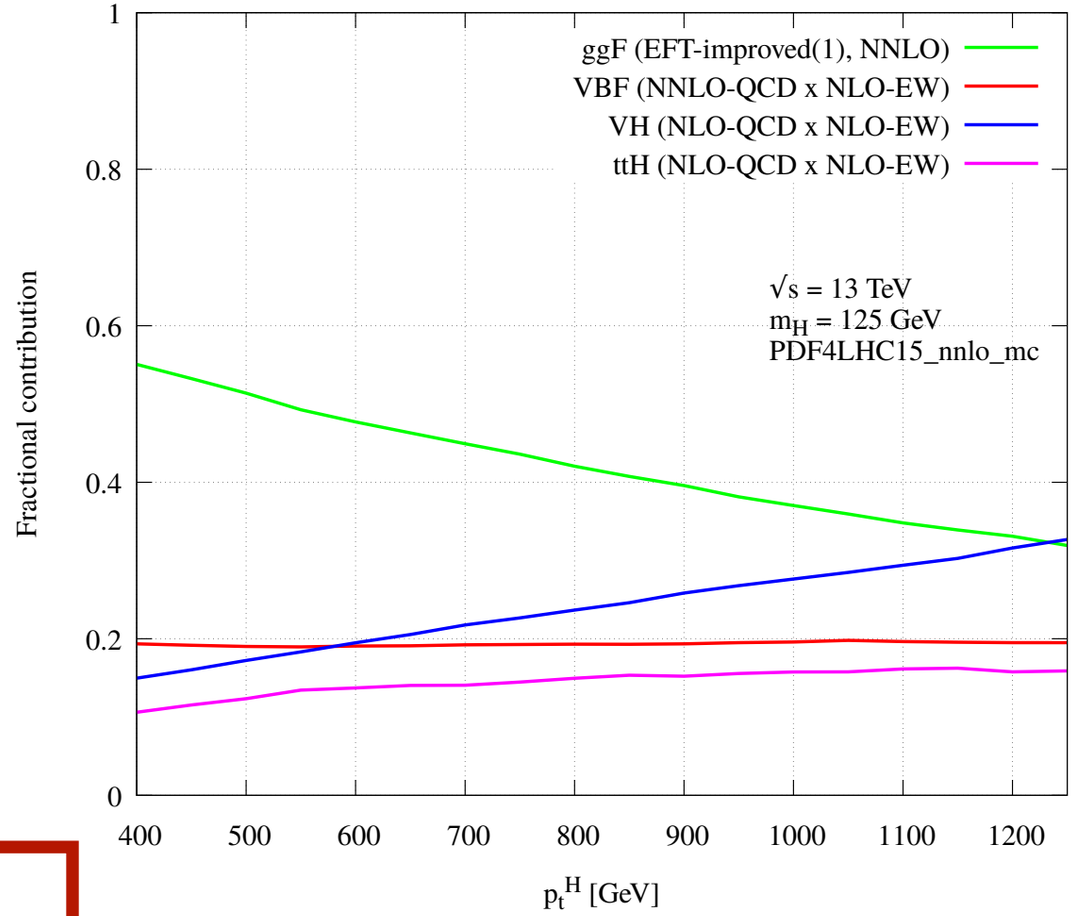
Duc Hoang (dhoang@mit.edu) for the CMS Collaboration

Recontres de Moriond Electroweak 2025

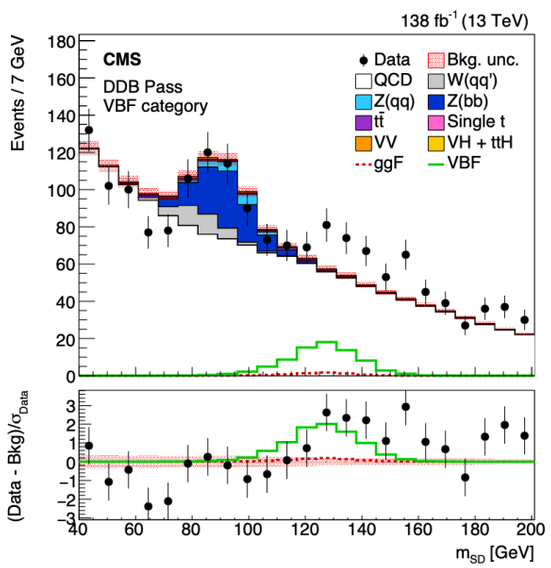
Phil Harris Lab@IIIii

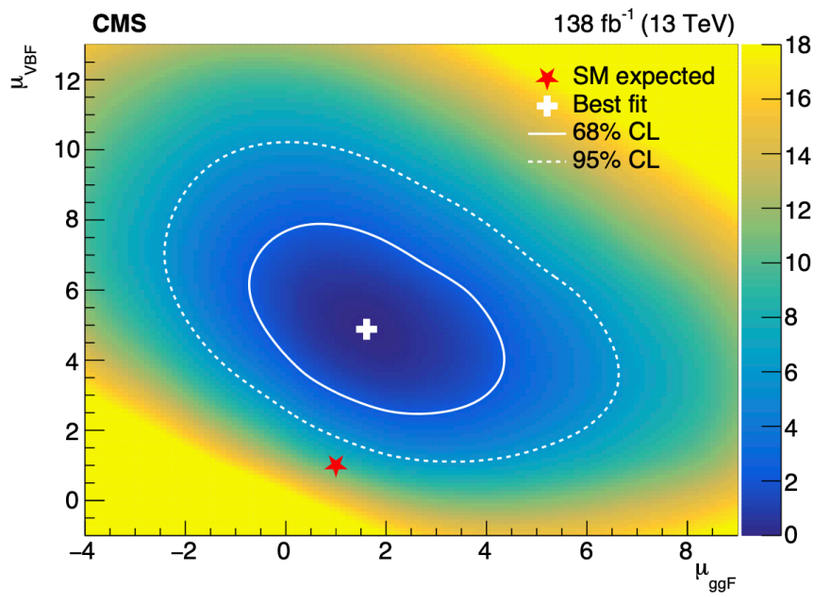
Motivation

- VH has high cross section at high p_T
- Largest branching ratios for all VH channels, making it the ***most sensitive channel*** at high p_T.
- Possible access to new physics, including modified Higgs self-coupling.

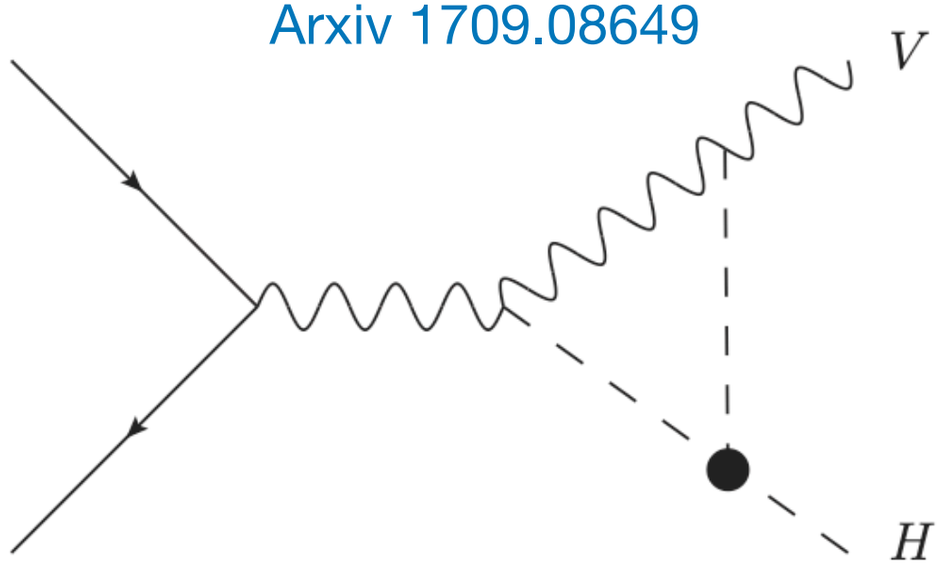


- Test 2.7σ excess from SM recently observed in VBF channel [JHEP 12 (2024) 035].

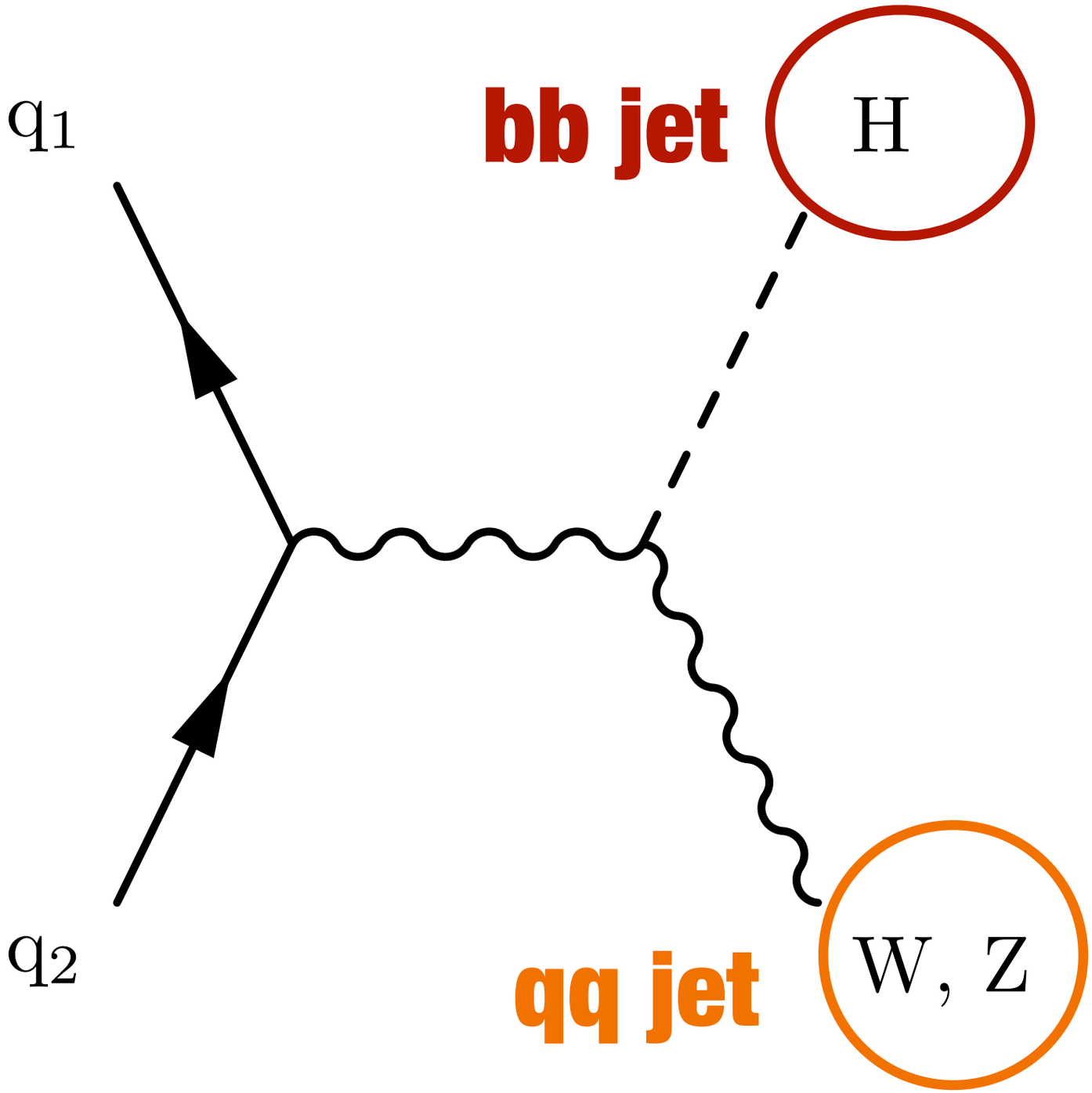




Arxiv 1709.08649



Event selection



CMS PAS BTV-22-001

$$PN^{MD}_{BBvsQQ} = \frac{PN^{MD}_{Xbb}}{PN^{MD}_{Xbb} + PN^{MD}_{Xcc} + PN^{MD}_{Xqq}}$$

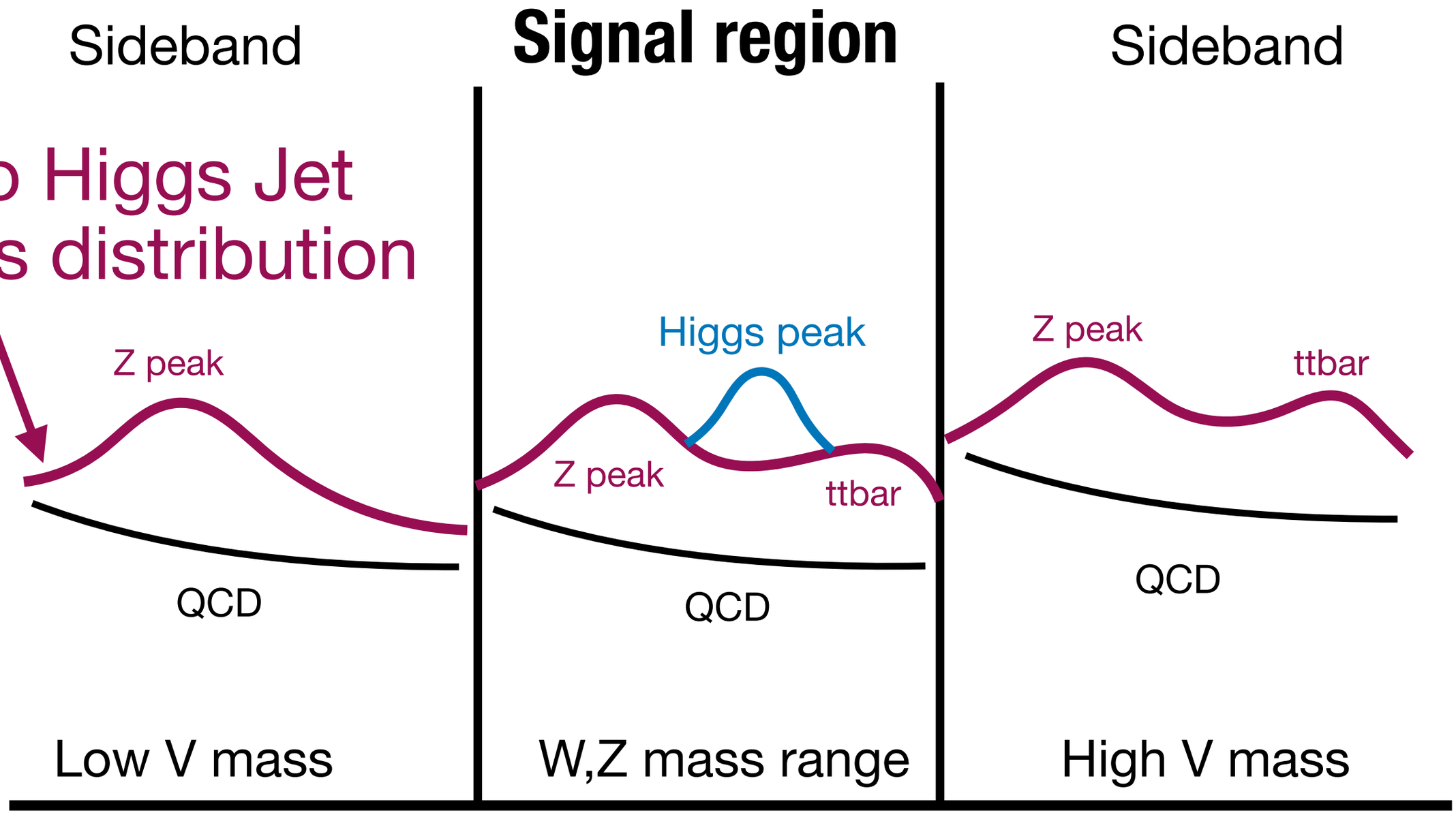
$$PN^{MD}_{QCD} = 1 - (PN^{MD}_{Xbb} + PN^{MD}_{Xcc} + PN^{MD}_{Xqq})$$

$$= 1 - PN^{MD}_{\text{2-prong}}$$

Higgs and Vector Boson Candidates are selected using ParticleNet-MD tagging scores

pick two leading p_T large-radius jets > 450 GeV

Fit strategy

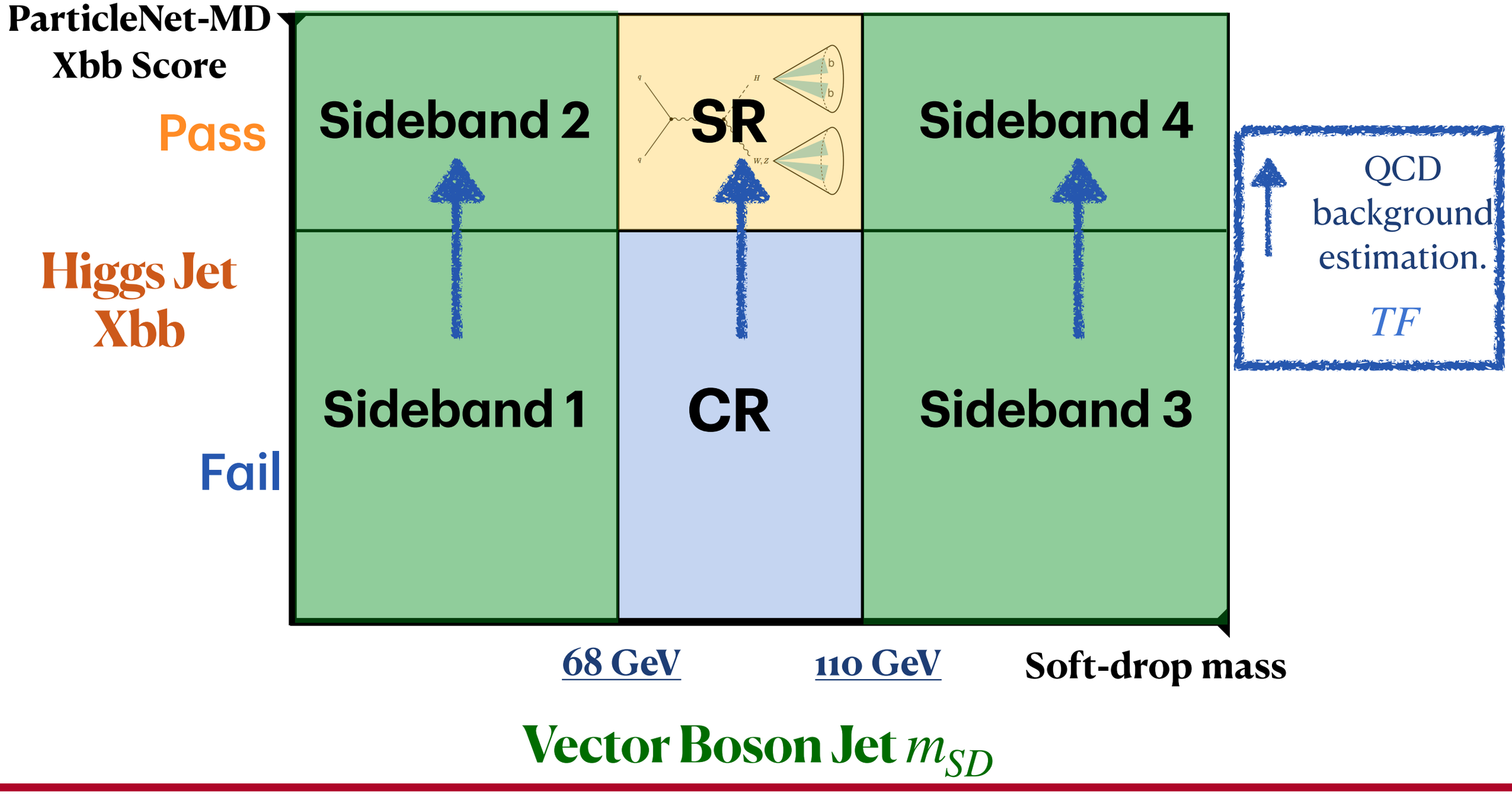


Binned in Vector Boson Jet Mass

Signal & Control Region

Partitioned space into 6 regions

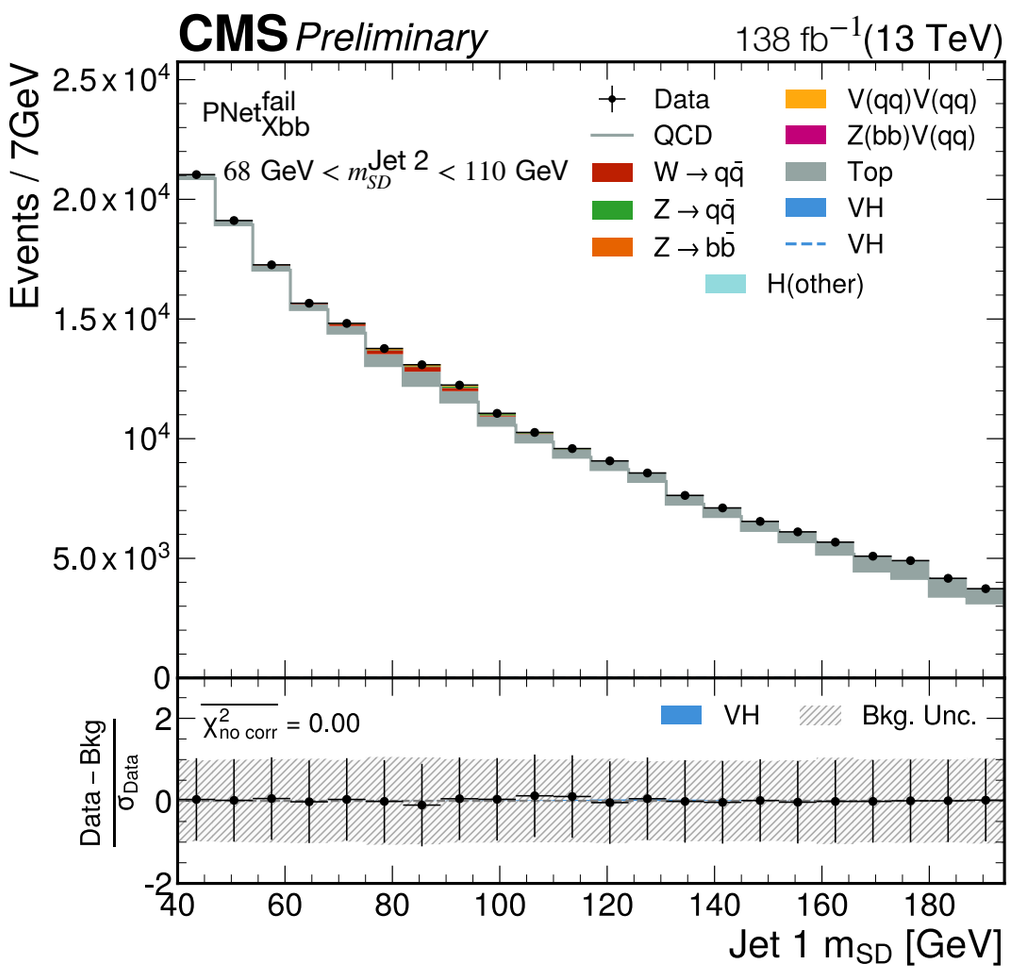
= 3 V mass bins x 2 ParticleNet-MD Xbb pass/fail

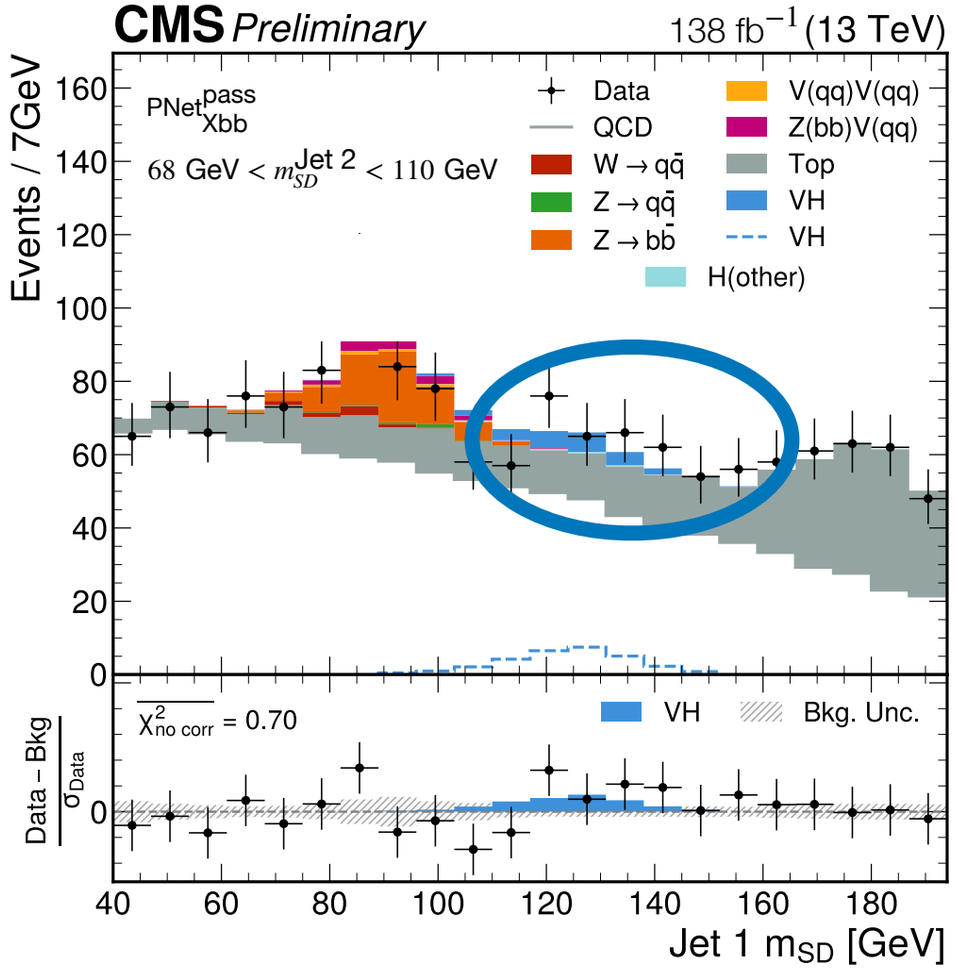


Results

Best sensitivity at high p_T for all VH channels

	$\mathcal{L}$ [fb^{-1}]	VH signal strength	VZ signal strength
Early 2016	19.5	$1.02^{+2.52}_{-2.23}$	$-0.15^{+1.77}_{-1.77}$
Late 2016	16.8	$1.34^{+2.20}_{-1.87}$	$-0.83^{+1.53}_{-1.53}$
2017	41.5	$0.00^{+1.26}_{-1.18}$	$1.20^{+1.28}_{-1.28}$
2018	59.8	$1.04^{+1.22}_{-1.10}$	$-0.40^{+0.92}_{-0.92}$
Combined	138	$0.72^{+0.75}_{-0.71}$	$0.09^{+0.63}_{-0.63}$



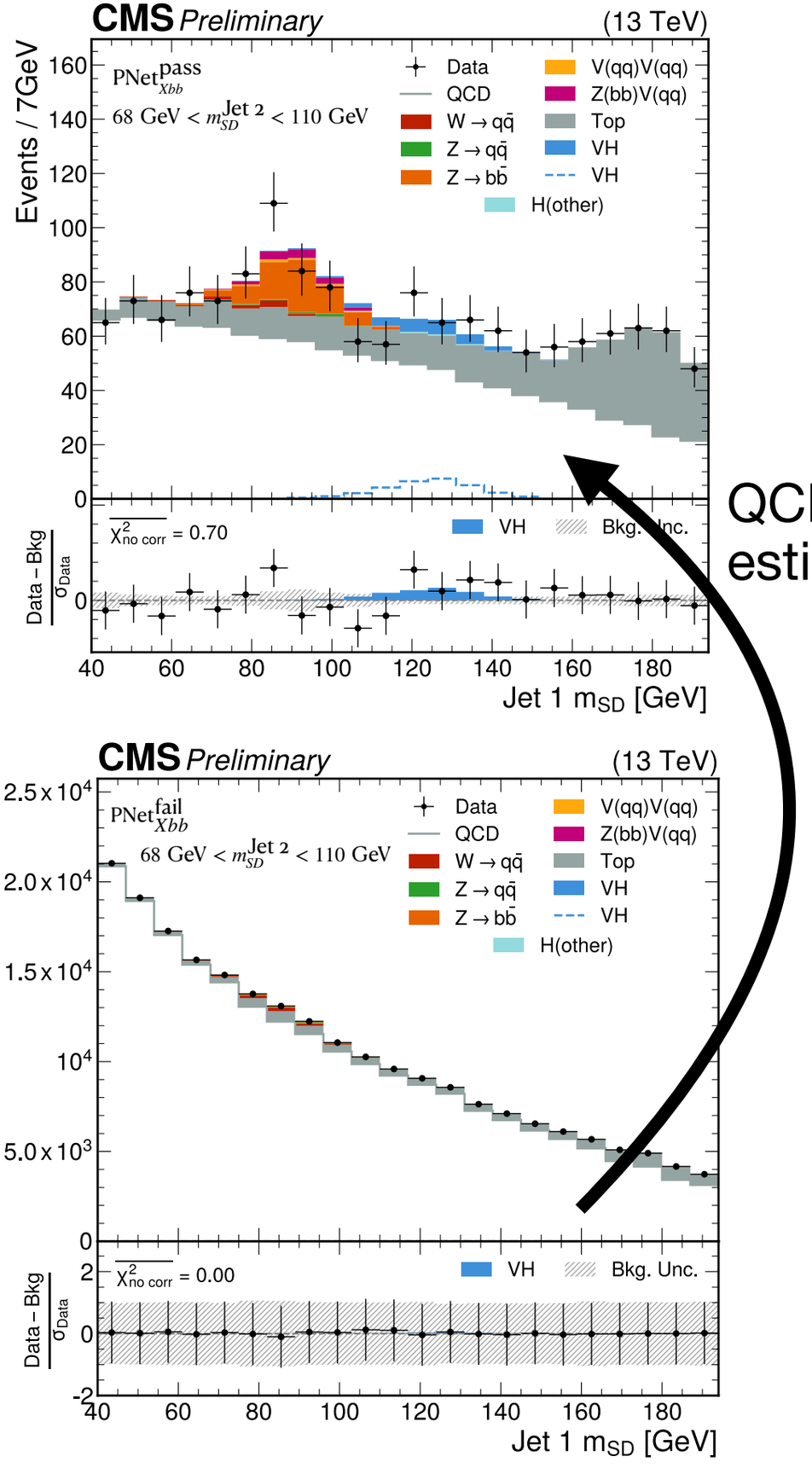


No excess!

Back up

Background

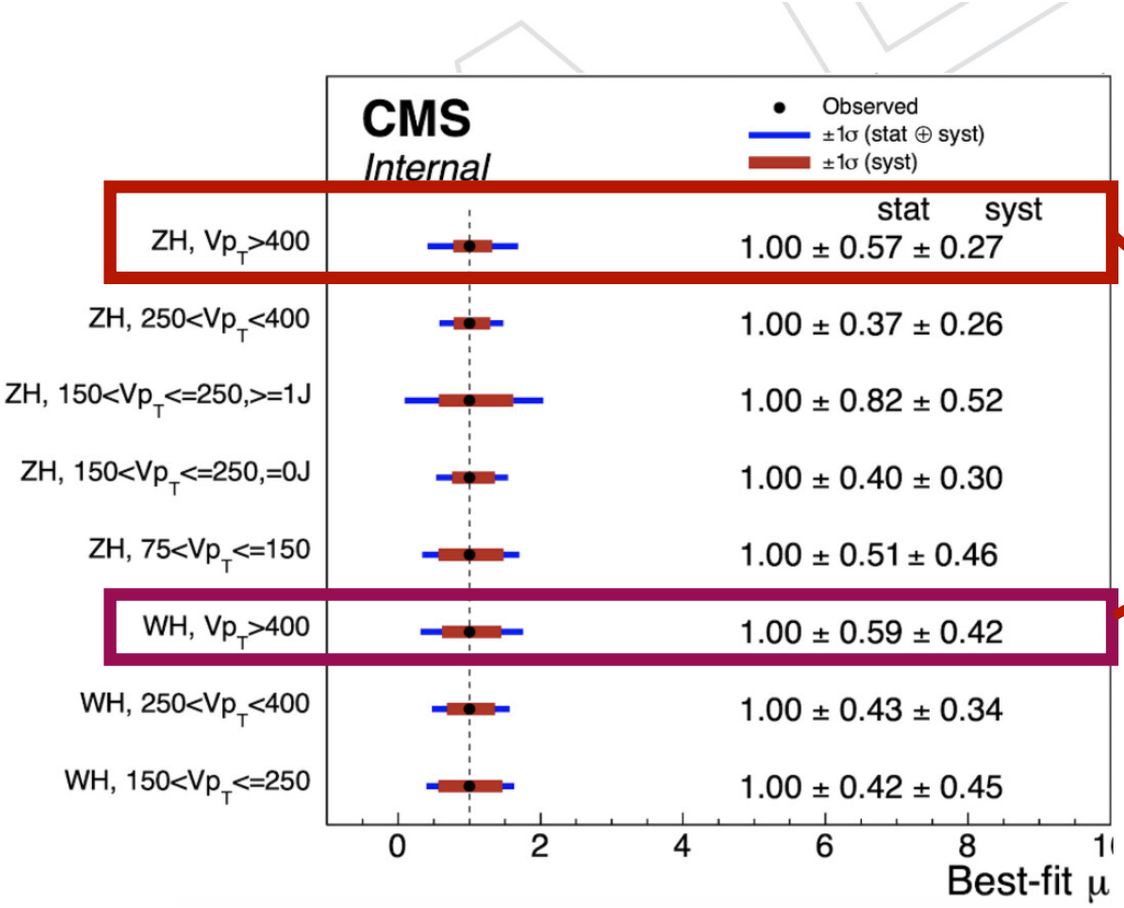
- **QCD multijet:** from data with “rhalphabet” method.
- **W(qq)/Z(qq)/Z(bb)/H(bb)**+ jets from MC.
- **TTbar, Single T:** simultaneously fitting TTbar CR.
- Jet-tagged scale factors for **V(qq)V(qq)/V(qq)H(bb)/ V+jets/H+jets:** W-enriched CR.
- **<u>Small:</u>** W(lv) + jets, DY + jets, etc.



QCD estimation

Expected sensitivity from HIG-20-001

CMS AN-2019/229 - Figure 282



A rough combination of uncertainty here is:

$$\sigma_{ZH}^{Vp_T>400} = \sqrt{0.57^2 + 0.27^2} = 0.63$$

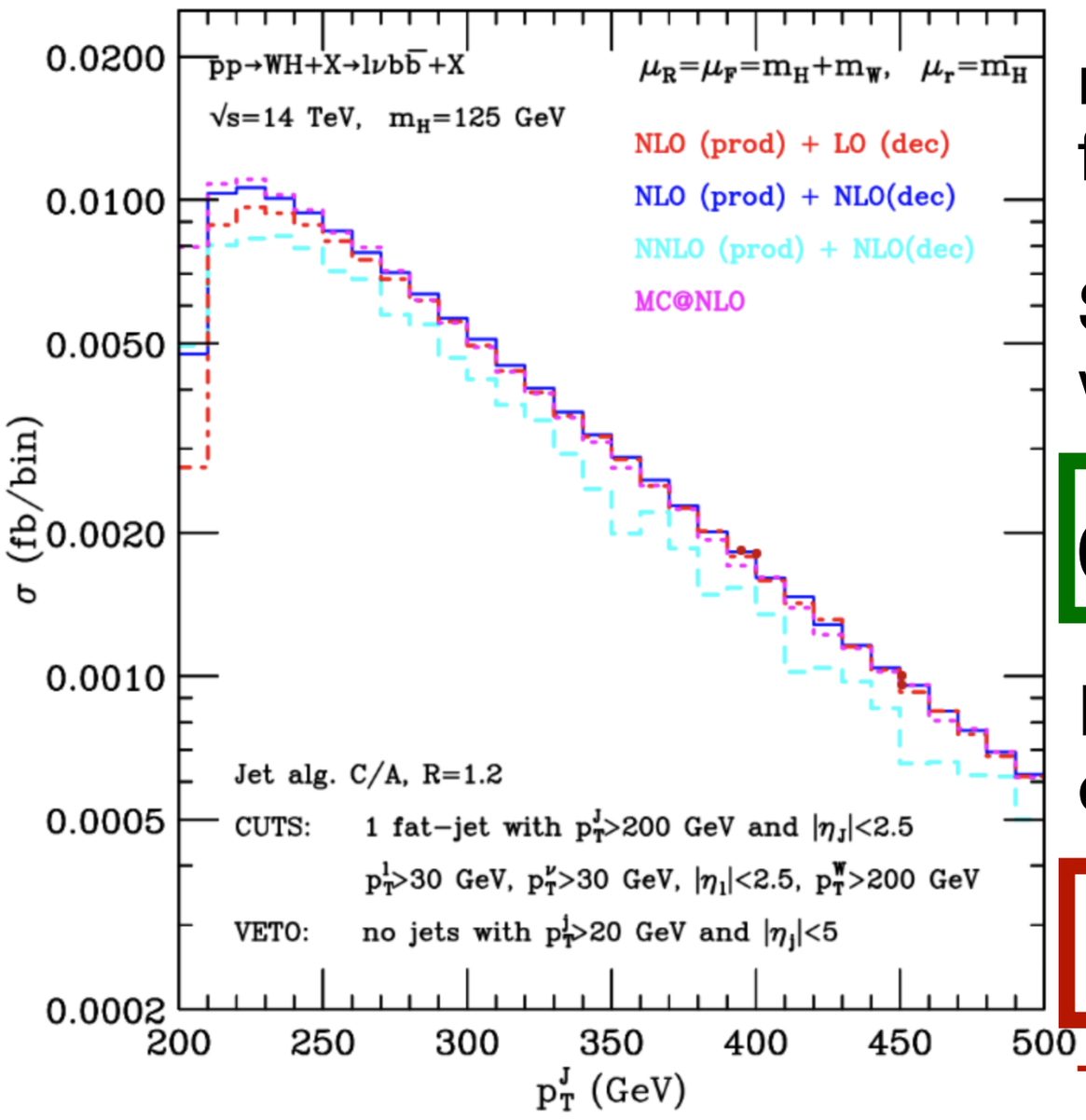
$$\sigma_{WH}^{Vp_T>400} = \sqrt{0.59^2 + 0.42^2} = 0.72$$

$$\sigma_{tot} = \frac{1}{\frac{1}{(\sigma_{ZH}^{Vp_T>400})^2} + \frac{1}{(\sigma_{WH}^{Vp_T>400})^2}}$$

$$= 0.47$$

It could get slightly worse if the systematics are correlated

Moving from 400 to 450 GeV



https://arxiv.org/pdf/1312.1669

The cross section here falls by roughly a factor of 2 moving from 400 to 450 GeV.

So the estimated uncertainty would be:

$$0.47 \times \sqrt{2} = 0.66$$

Meanwhile, the all-hadronic expted signal strength:

$$1 \pm 0.57$$

Therefore, all hadronic VH is mostly equivalent, if not better than semileptonic VH to probe high p_T regime.