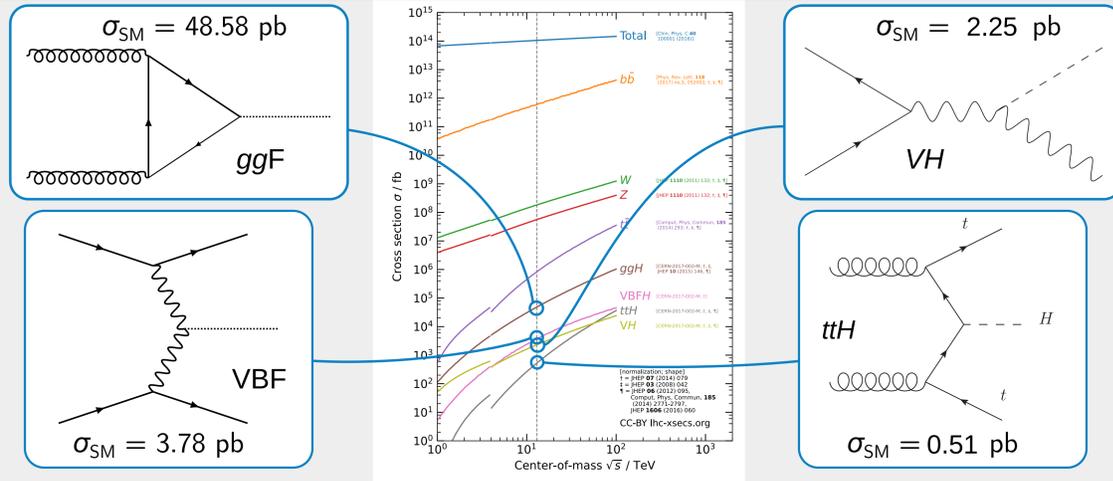


Measurement of the Higgs boson coupling to τ leptons in proton-proton collisions at $\sqrt{s} = 13\text{TeV}$ with the ATLAS detector at the LHC

FRANK SAUERBURGER
ON BEHALF OF THE ATLAS COLLABORATION

HIGGS BOSON PRODUCTION

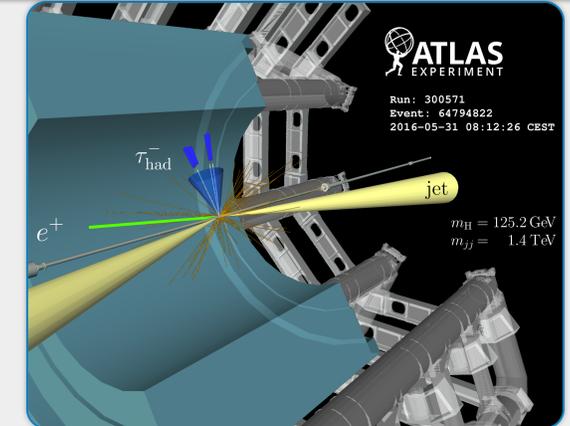
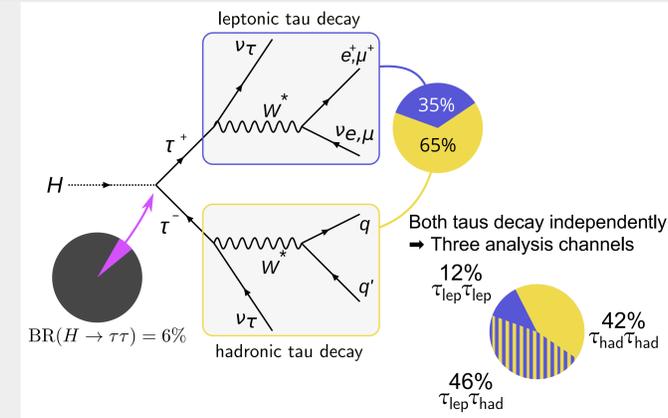
LHC-XSECS.ORG



- Gluon Fusion (ggF) has highest Higgs boson production cross section at LHC
- Vector Boson Fusion (VBF) has clear signature of two forward jets in opposite hemispheres
- Measurements also for Higgs boson production in association with a vector boson (VH) and top quark pair (ttH)
- Dedicated signal regions for each production mode
- Measuring processes at $O(10^{-10})$ of total cross section

ANALYSIS STRATEGY

PHYS. REV. D 99, 072001 (2019)



- Reconstruction of leptonically decaying τ not attempted, detected as e or μ
- Hadronically-decaying taus reconstructed using a dedicated algorithm, making use of tracking and calorimeter information
- Mass of Higgs system reconstructed using Missing Mass Calculator [1] (MMC) considering E_T^{miss} from multiple neutrinos
- Main background $Z \rightarrow \tau\tau$ estimated with NNLO (QCD) MC, normalized to kinematically embedded $Z \rightarrow ll$ control regions
- Data-driven technique to estimate jets misidentified as hadronic tau ($\tau_{\text{lep}}\tau_{\text{had}}$, $\tau_{\text{had}}\tau_{\text{had}}$) or leptons ($\tau_e\tau_\mu$). Other types of object mis-identifications estimated with MC.

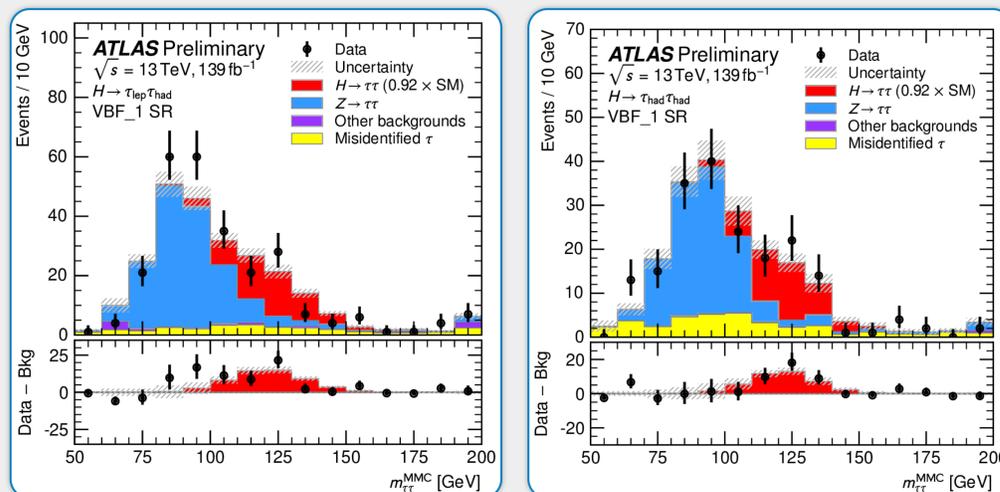
MACHINE LEARNING

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- Boosted Decision Trees (BDT) used to define VBF, VH , and ttH enriched signal regions
- BDTs trained to identify signal events and reject background events
- Classifier validated in control regions

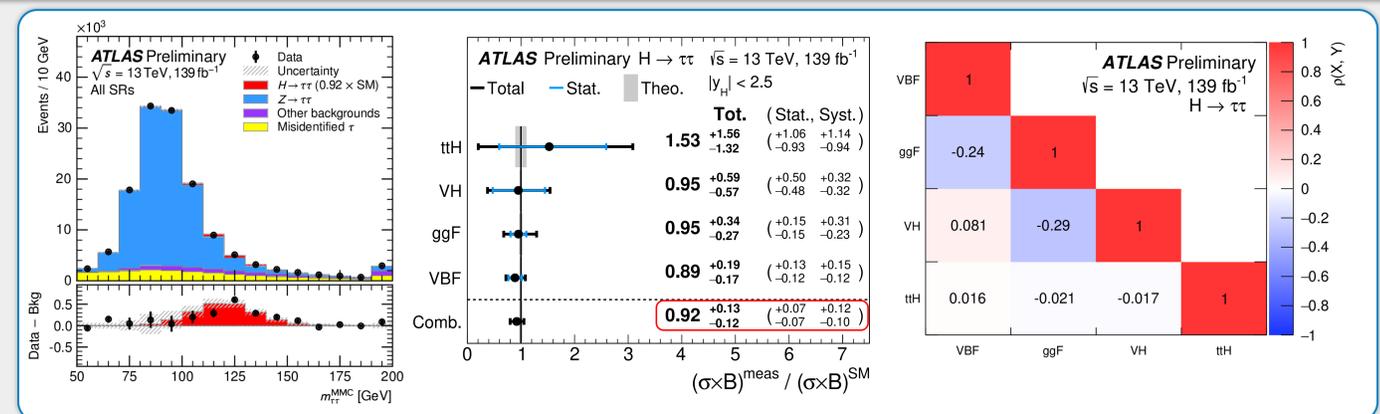
Example: VBF Tagger

- Tagger trained to identify VBF topology based on jet quantities
- $Z \rightarrow \tau\tau$ and ggF treated as background
- Cut on VBF Tagger score defines VBF_1 region
- 94% of the signal in enriched region is from VBF production



CROSS-SECTION MEASUREMENT

ATLAS-CONF-2021-044



- Cross section measurement in agreement with Standard Model prediction:

$$\sigma_{H \rightarrow \tau\tau}^{\text{obs}} = 2.89 \pm 0.21 \text{ (stat)}^{+0.37}_{-0.32} \text{ (syst)} \text{ pb}$$
- Evidence for ggF at 3.9σ (obs.)
- First VBF $H \rightarrow \tau\tau$ observation at 5.3σ (obs.)
- Cross sections measured in 9 Simplified Template Cross Section [2] categories (not shown)
- Largest systematic uncertainty from signal theory uncertainties (8.1%)
- Largest experimental uncertainties: Uncertainties related to Jet / E_T^{miss} (4.2%), MC statistical uncertainty (3.7%)