HIGGS DECAYS TO b-QUARK PAIRS (IN ASSOCIATED PRODUCTION) @CMS

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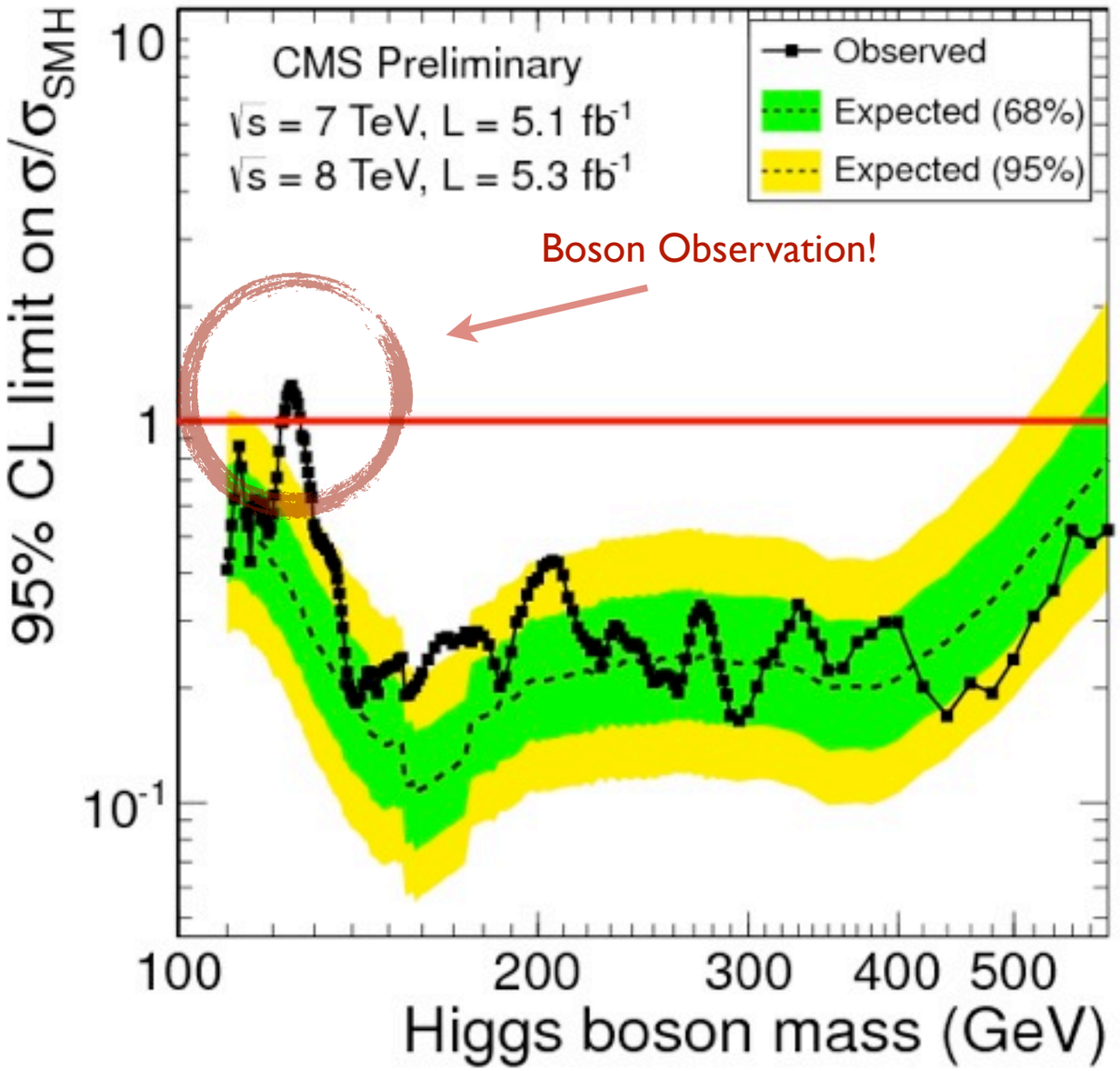
OUTLINE

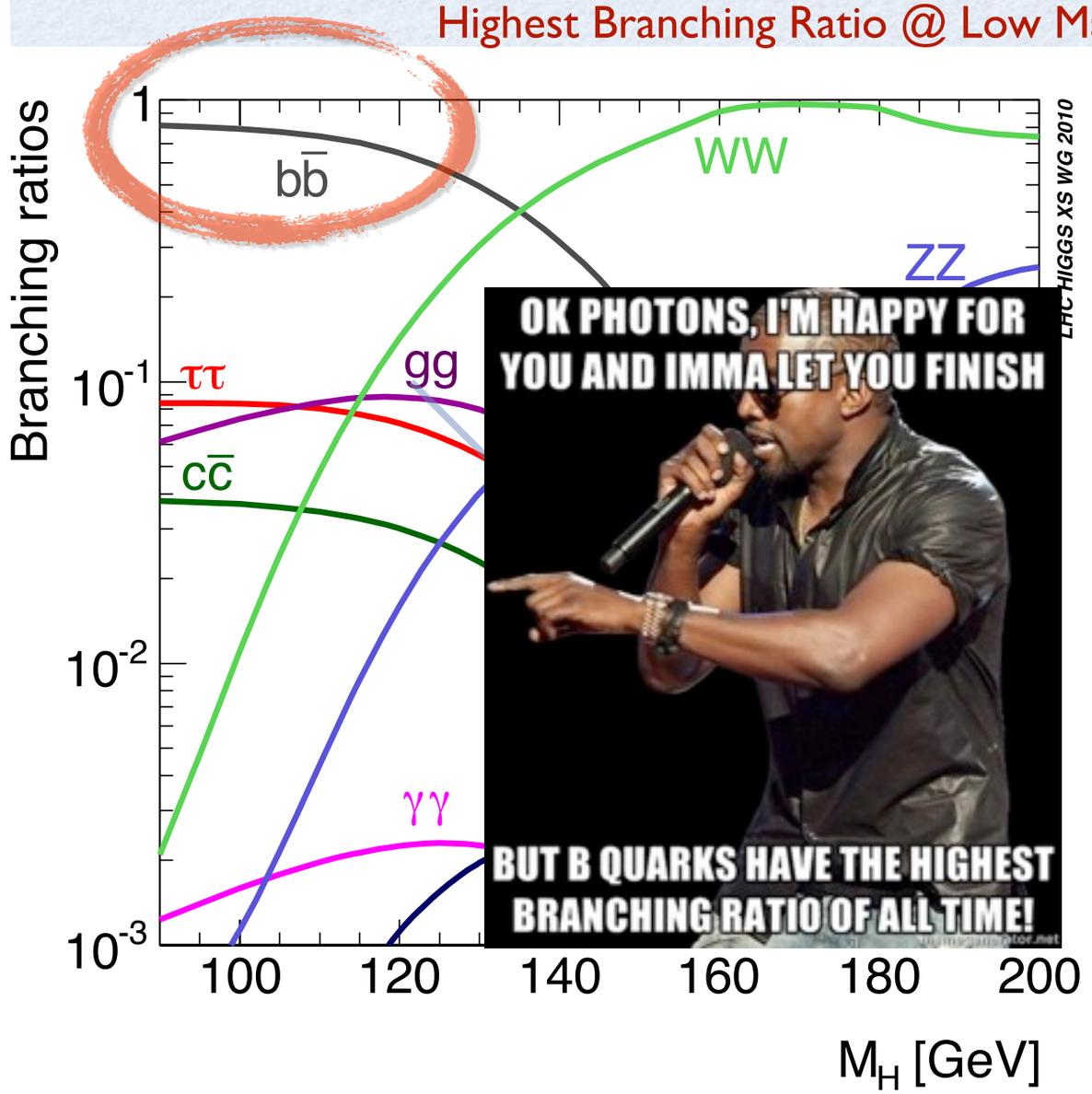
- Motivation:
  - Why Low Mass?
  - Why Associated Production?
- Analysis Strategy:
  - How to find a needle in a haystack
- Results
- Conclusions

Motivation

Low Mass Higgs: highest branching ratio to bb



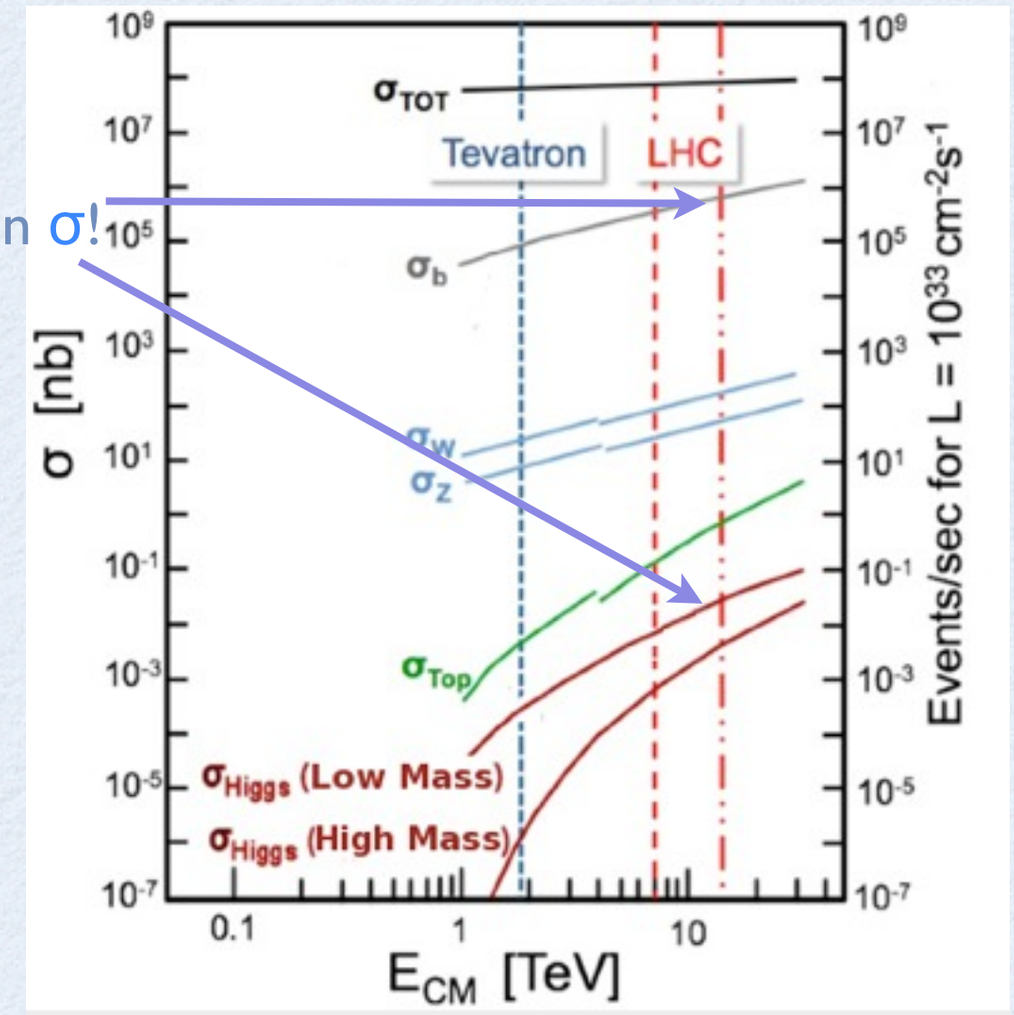
Highest Branching Ratio @ Low Mass!



Motivation

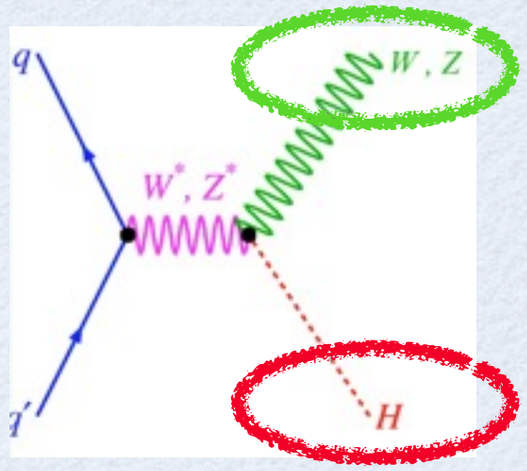
Very High Levels of Background Looking for b pairs alone!

10^7 difference in σ!



Solution:

- Look for Associated Production with a Vector Boson.



- The presence of W/Z Boson brings down $\sigma_{Background}$ ~ 10 nb (from 10^5!)

ANALYSIS STRATEGY

UF

How to find a needle in a haystack? Use a 12500 ton detector!

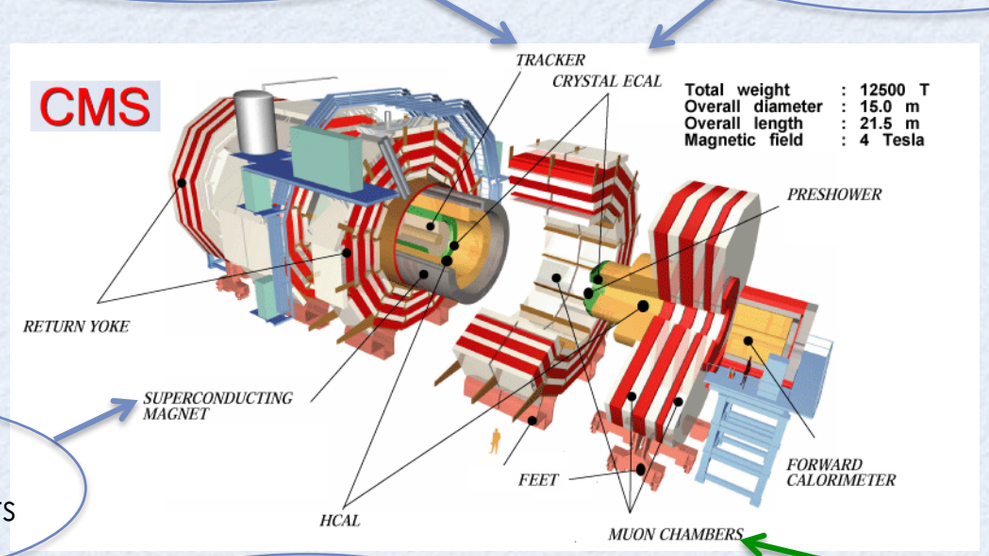
Tracker

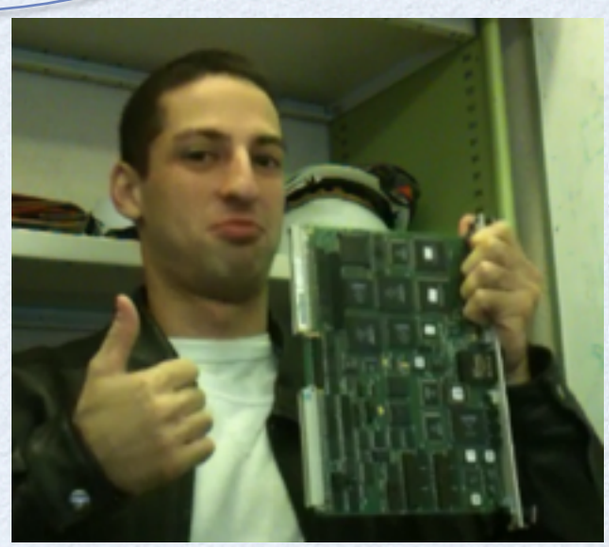
b Jet identification (CSV)
Charged lepton tracking

ECAL

Energy measurement of charged leptons

The entire CMS detector is used in this analysis!





Provides field for p_T measurements

Magnet

Energy measurement of jets

HCAL

Momentum reconstruction of muons (vector bosons!)

Muon System

My Responsibilities:

- On-call expert
- Software maintenance
- Hardware maintenance
- Optimization studies
- Firmware upgrades and improvements

ANALYSIS STRATEGY

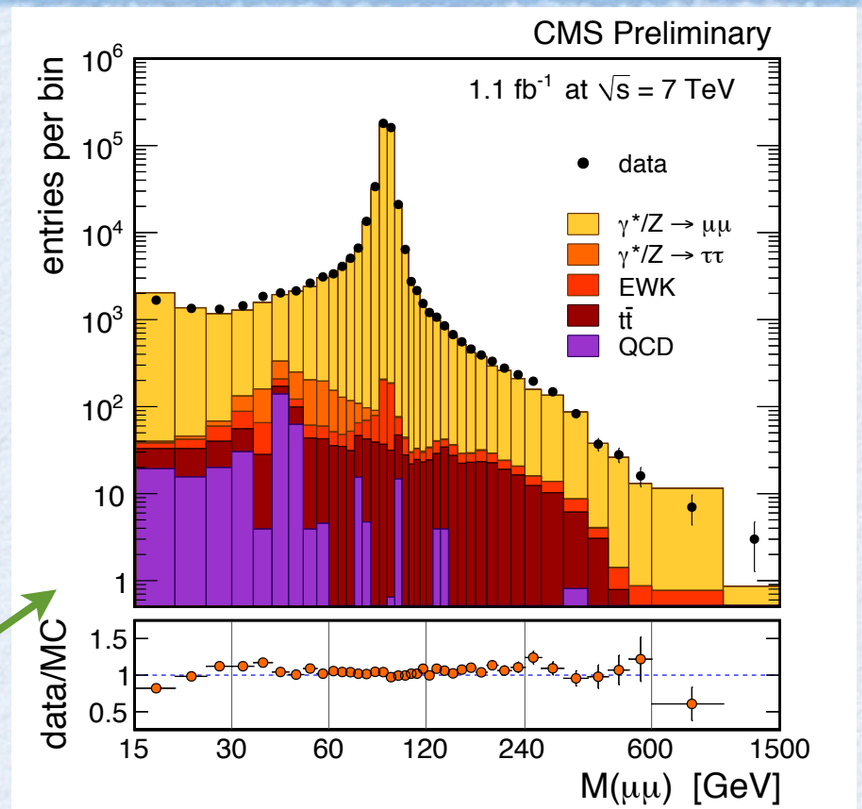
- 5 Channels:
  ZllH, Wlν, Zννh (l = e, μ)

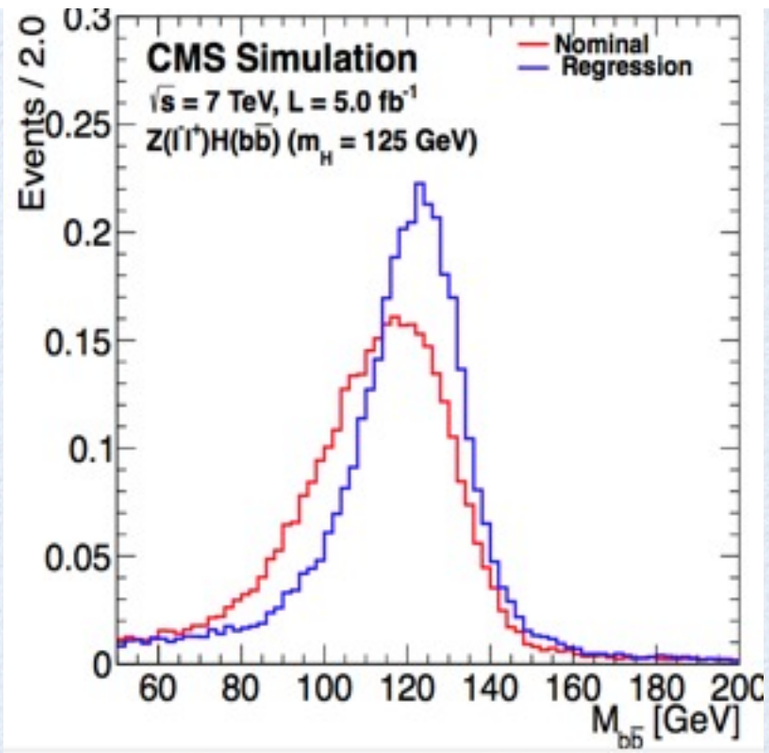
- 2 High momentum b-tagged jets required

- 0,1,2 Lepton final states:
  0: Looking for Z→2 ν's: Large MET (160 GeV+)
  1: Looking for a W: Med MET (30 GeV+)
  2: Looking for a Z: Dilep. Invariant Mass 75-105 GeV

- b-jet energy regression - improves dijet mass resolution 15%

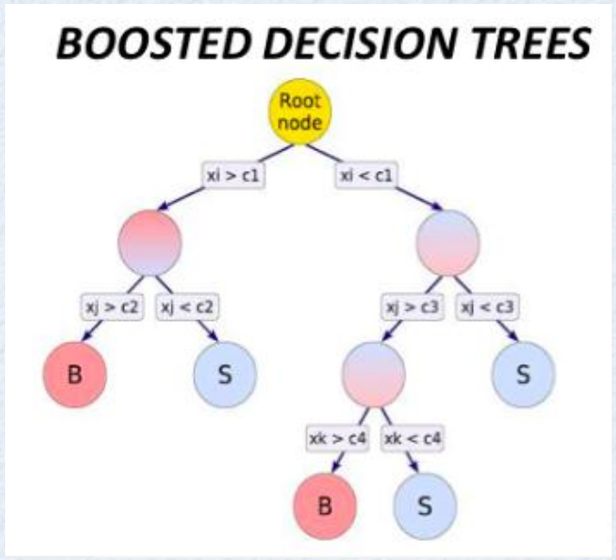
- Control Regions enriched in $t\bar{t}$/V+jets used to:
  - Verify that data shapes agree with Monte Carlo
  - Used to find normalization scale factors
  - Helps predict the expected background in signal region





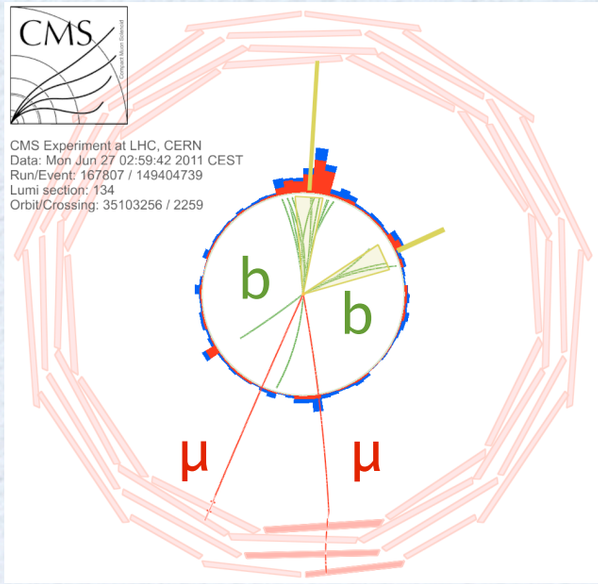
ANALYSIS STRATEGY

UF

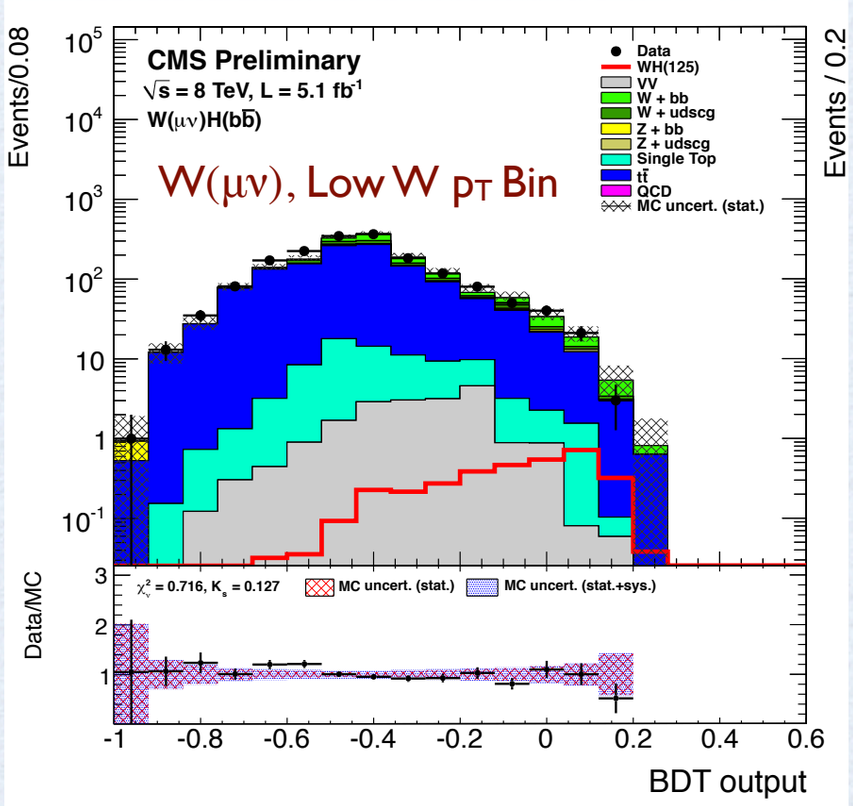


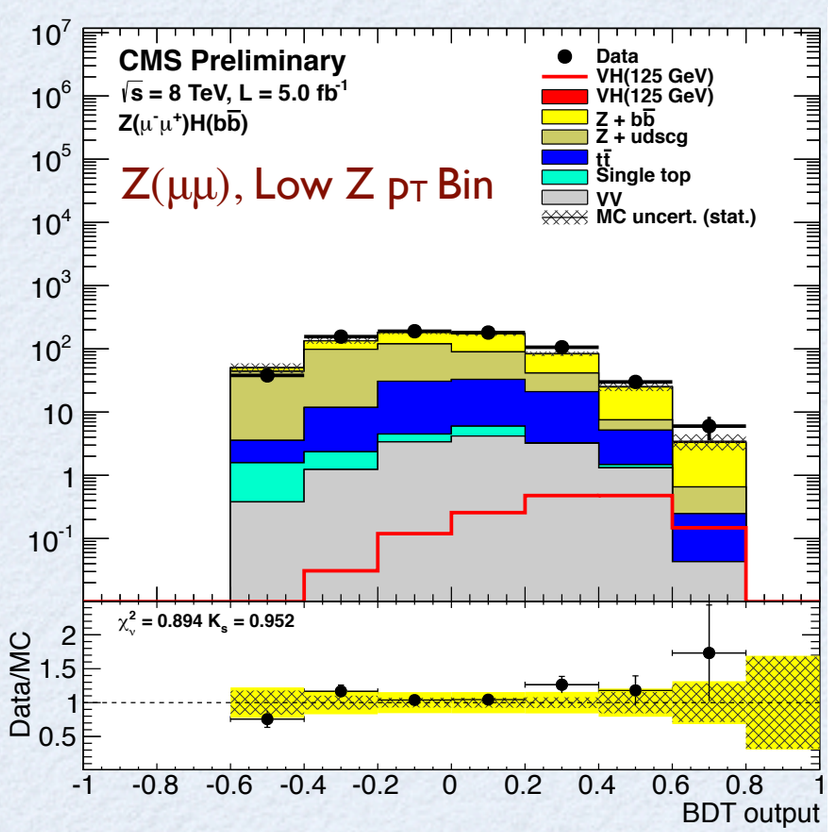
Variables used in BDTs:

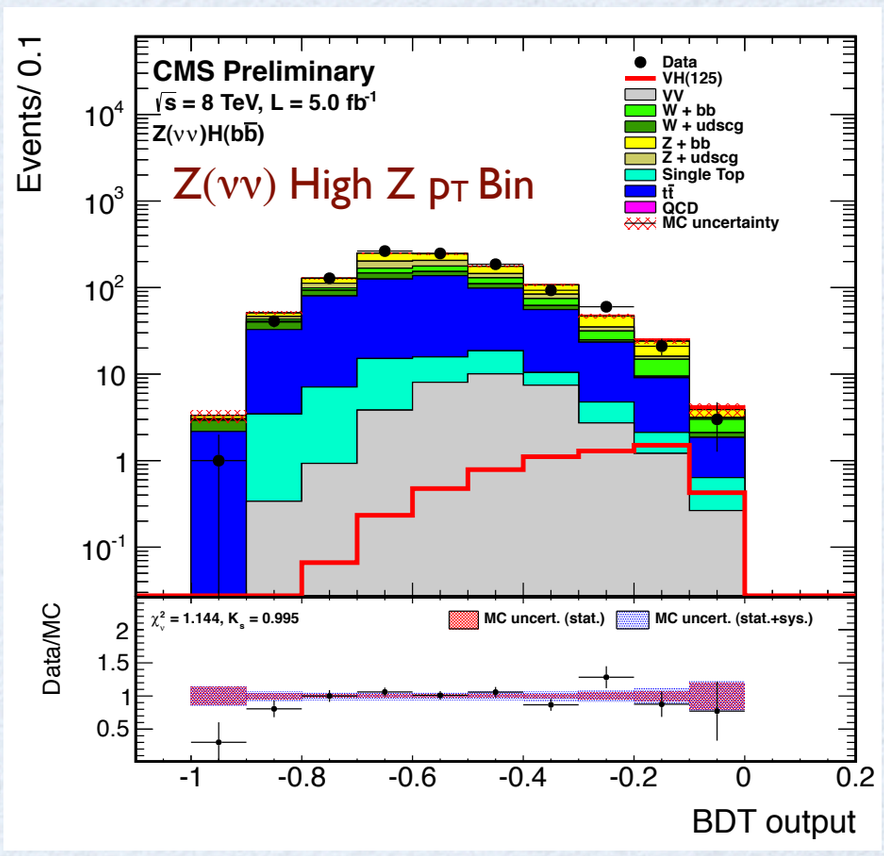
- p_{Tj}: transverse momentum of each Higgs daughter
- $M(jj)$: dijet invariant mass
- $p_T(jj)$: dijet transverse momentum
- $p_T(V)$: vector boson transverse momentum (or pfMET)
- CSV1: value of CSV for best b-tagged jet
- CSV2: value of CSV for second-best b-tagged jet
- $\Delta\phi(V,H)$: azimuthal angle between V (or pfMET) and dijet
- $\Delta\eta(J1,J2)$; difference in η between Higgs daughters
- $\Delta R(J1,J2)$; distance in η–ϕ between Higgs daughters
- N_{aj}: number of additional jets ($p_T > 30\,GeV$, $|\eta| < 4.5$)
- $\Delta\phi(pfMET,J)$(only for $Z(\nu\nu)H$)
- $\Delta\theta_{pull}$: color pull angle



8 TeV Data - 5 channels x 2 Bins = 10 such BDTs:





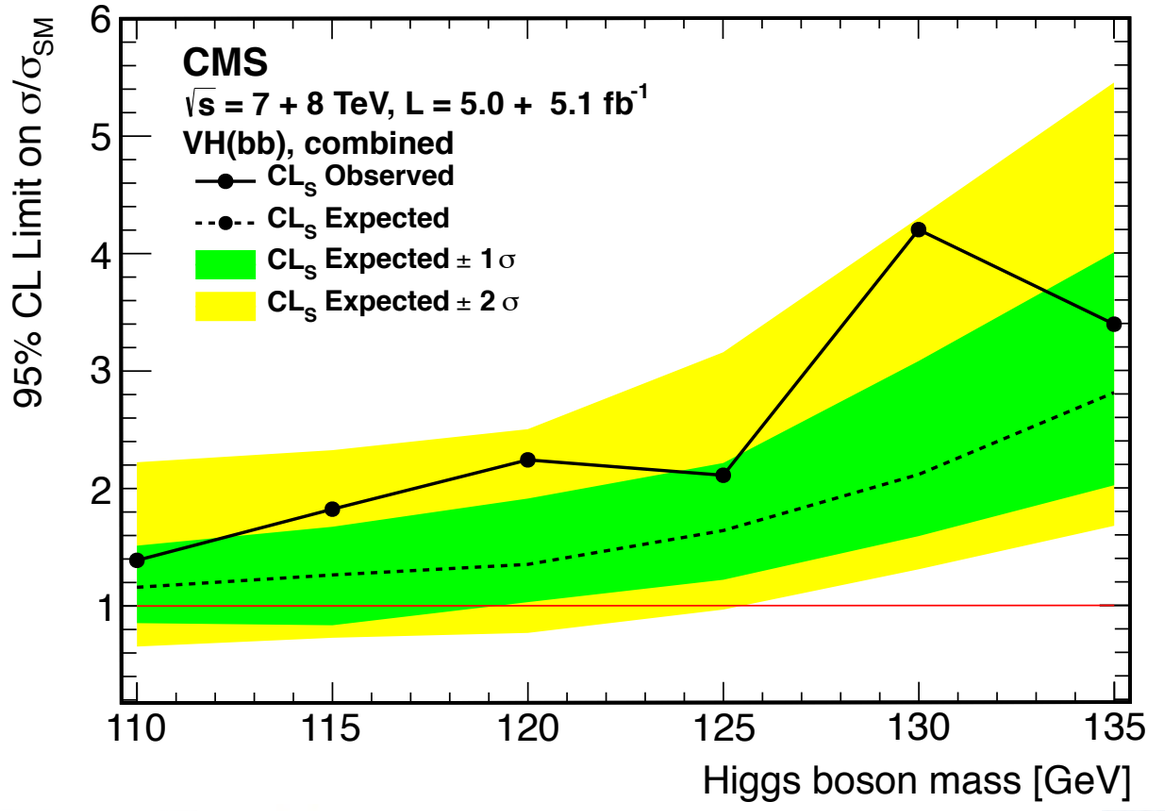


RESULTS

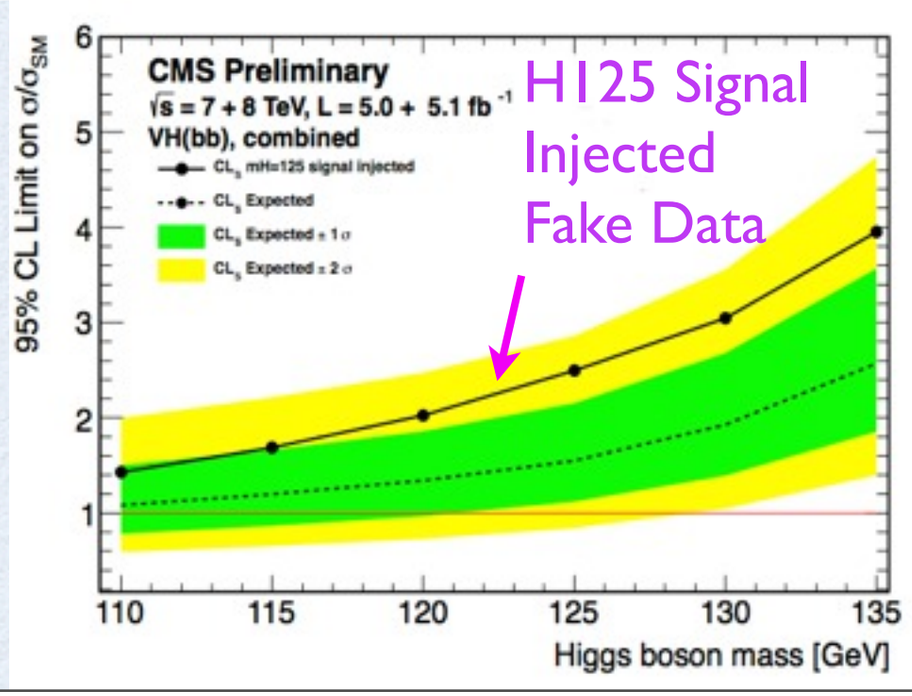
Systematic Uncertainty Sources:

Source	Range
Luminosity	2.2-4.4%
Lepton efficiency and trigger (per lepton)	3%
$Z(\nu\nu)H$ triggers	2%
Jet energy scale	2–3%
Jet energy resolution	3–6%
Missing transverse energy	3%
b-tagging	3–15%
Signal cross section (scale and PDF)	4%
Signal cross section (p_T boost, EWK/QCD)	5–10% / 10%
Signal Monte Carlo statistics	1-5%
Backgrounds (data estimate)	≈ 10%
Diboson and single-top (simulation estimate)	30%

7+8 TeV Final 5 Channel Combined Limit



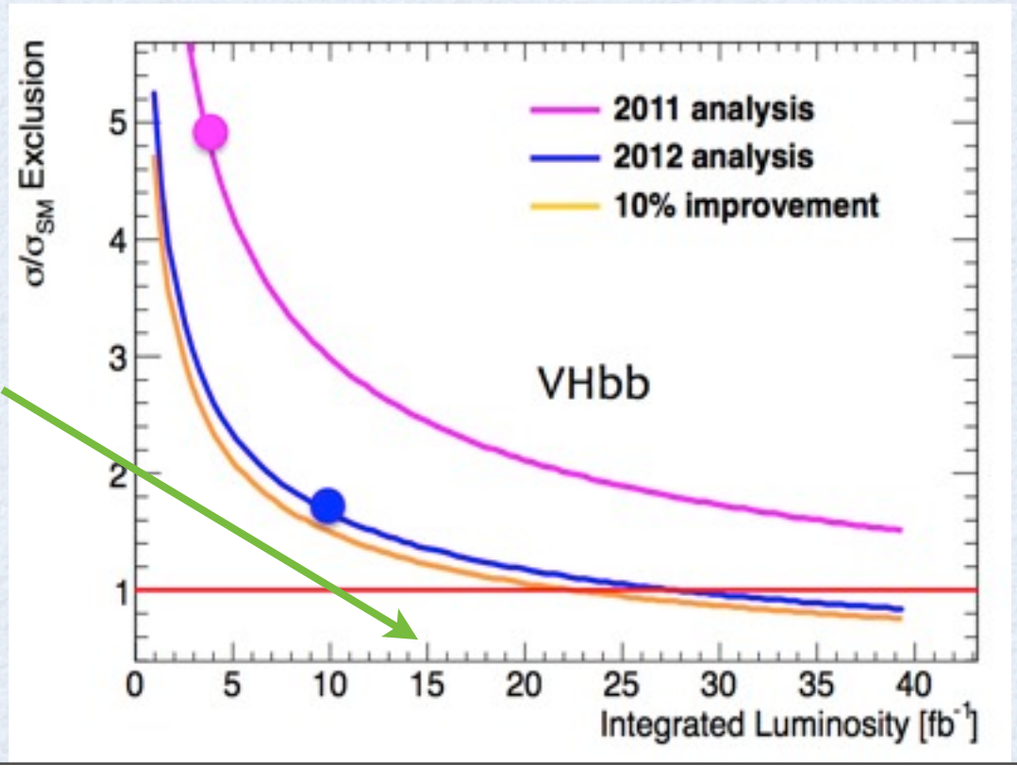
- Full Shape analysis performed on the BDTs
- Expected limit improves by ~50% since previous iteration (http://cdsweb.cern.ch/record/1406349)
- Slight excess (p-value~10^{-1}) is still consistent with background-only hypothesis



CONCLUSIONS

- Most recent approved results have been shown for VH → bb at CMS on 2011+2012 data
- A small excess is observed in the limit, but result still consistent with background-only hypothesis.
- With more data we are approaching Standard Model sensitivity.
- We are excited for HCP results, coming soon!

(~15 fb^{-1} for HCP)



THE END!