Search for the Associated Production of Z and Higgs Bosons *in νν bb final state*

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On behalf of the D0 Collaboration

Outline

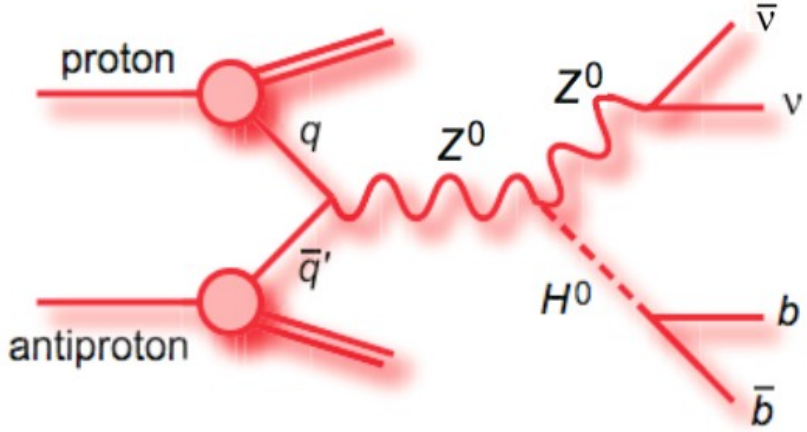
- *Introduction*
- *D0 Calorimeter*
- *Backgrounds*
- *Signal Selection*
- *B-tagging*
- *Multivariate Discriminant*
- *Limit*
- *Conclusion and Plans*

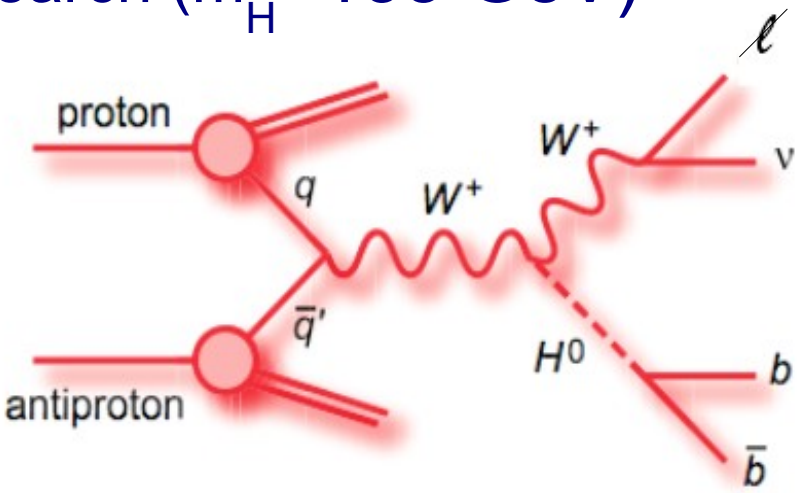
Introduction

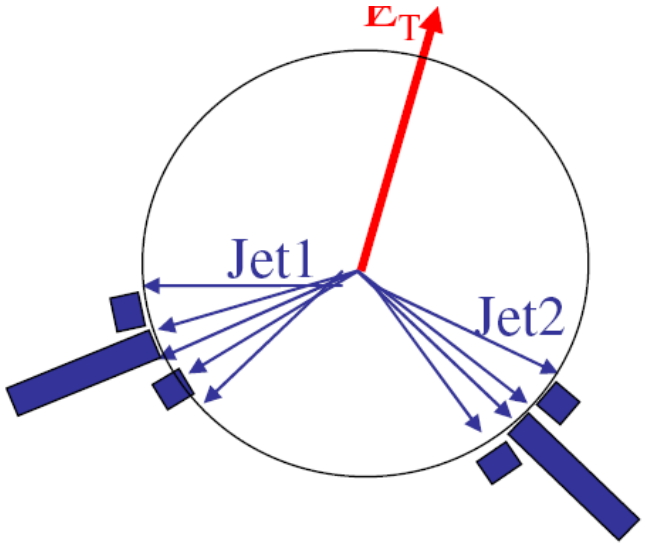
Motivation

High branching ratio for $Z \rightarrow \nu\bar{\nu}$

Most sensitive for low mass higgs search (m_H<135 GeV)



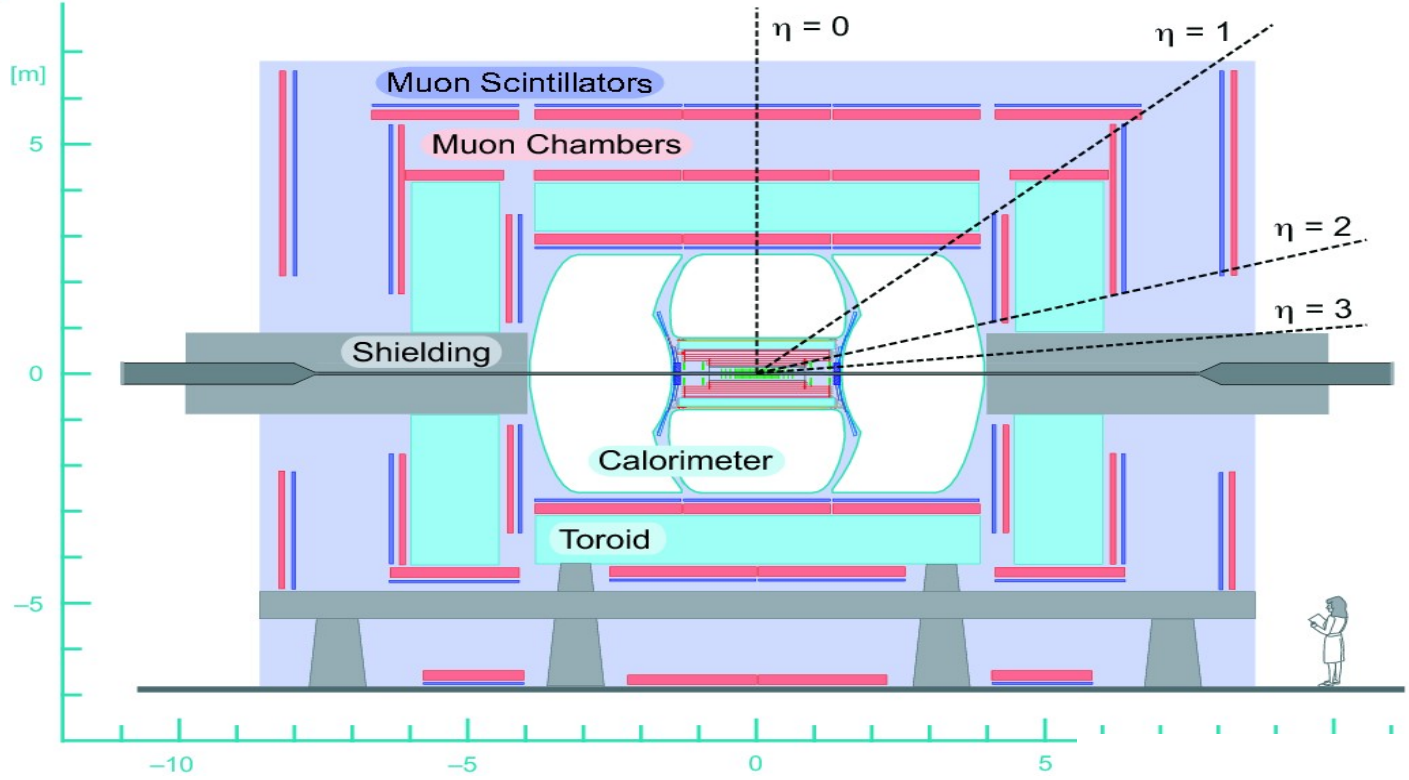




Characteristic signal

- Large Missing E_T from invisible Z decay
- Two boosted, high P_T b-tagged jets
- No identified lepton

The D0 Calorimeter

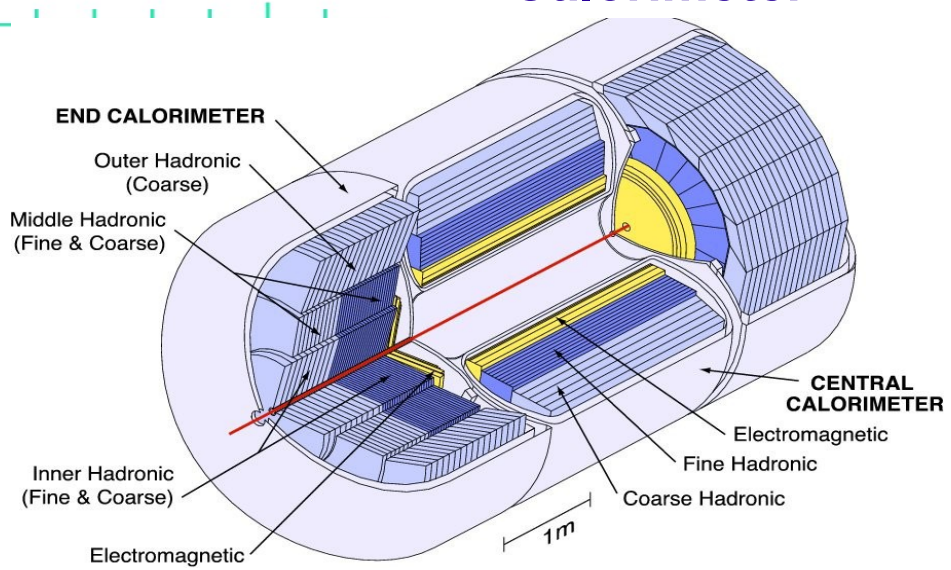


Tracking
Silicon Microstrip Tracker (SMT)
Central Fiber Tracker (CFT)

Surrounded by 2T Solenoid

Uranium/ Liquid-Argon Calorimeter

- Hermetic coverage $|\eta| < 4.2$.
- Online and offline monitoring.
- Algorithms to scan data from contaminated events.
- Daily pedestals performed.
- Stability ~99.8%.

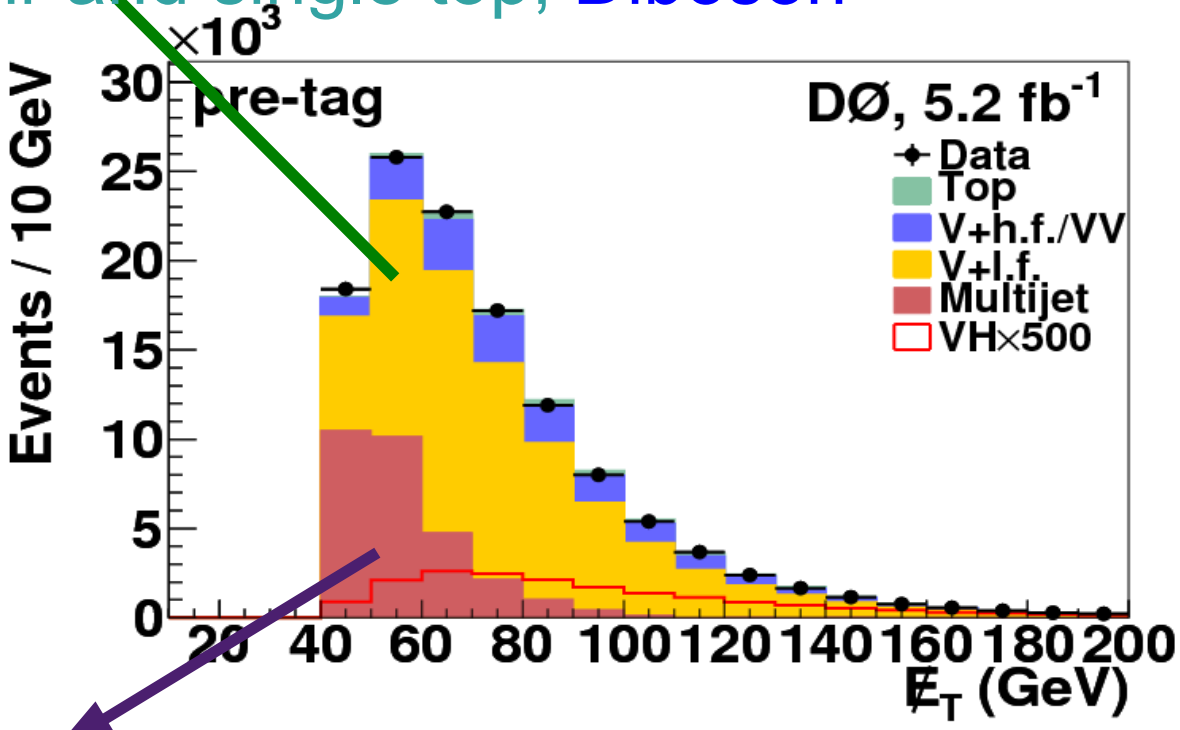


Backgrounds

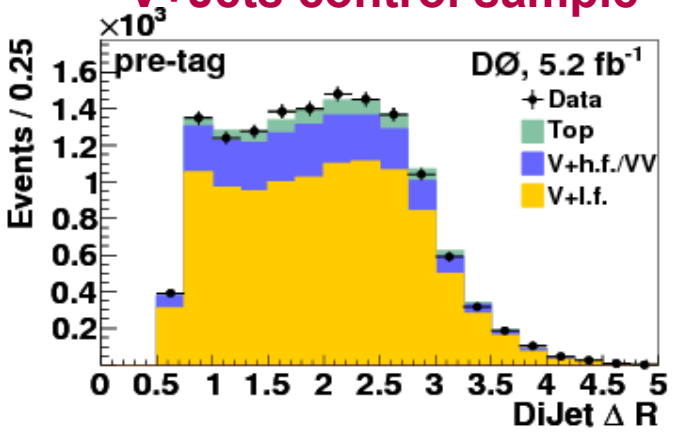
Physics Backgrounds (from MonteCarlo)

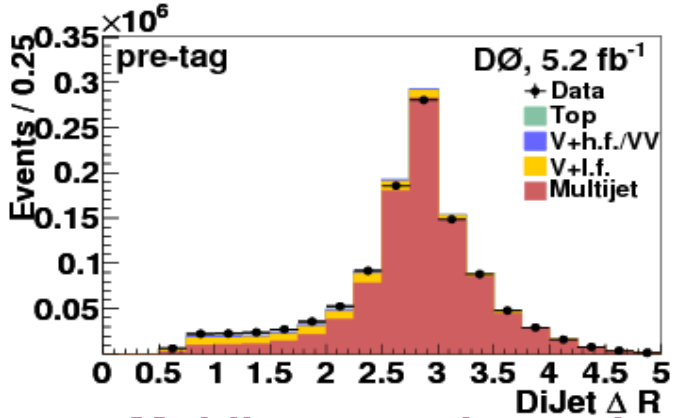
W/Z+heavy flavor jets W/Z+light flavor jets

Top pair and single top, Diboson



V+Jets control sample





Multijet control sample

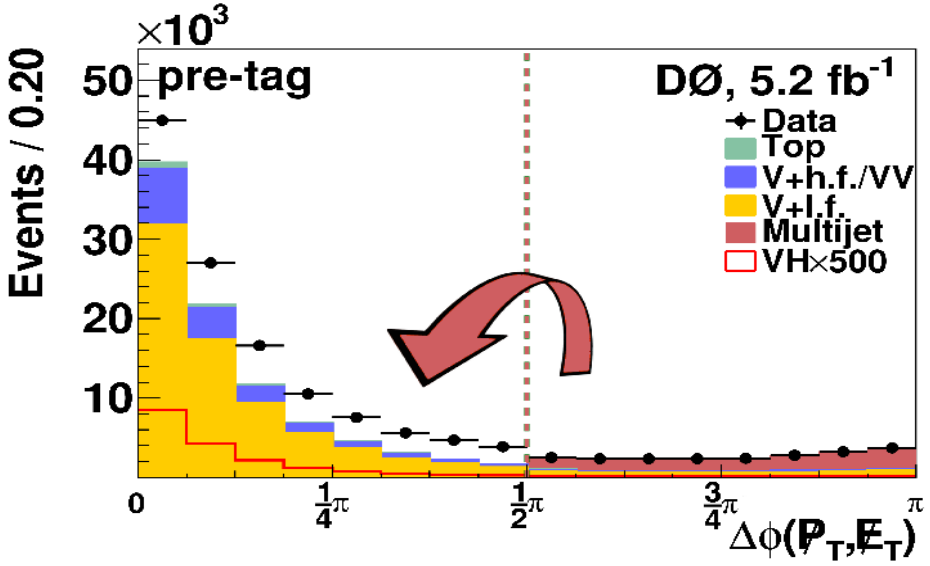
Instrumental Backgrounds (from Data)

Multijet events with mis-measured and fake MET

Validation of background modeling in control samples

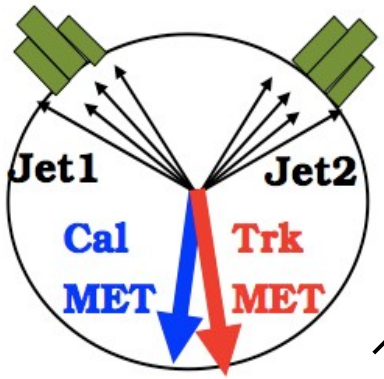
Multijet Modeling

Multijet modeling is done from the DATA sideband region where missing E_T from tracks and cal is not aligned.



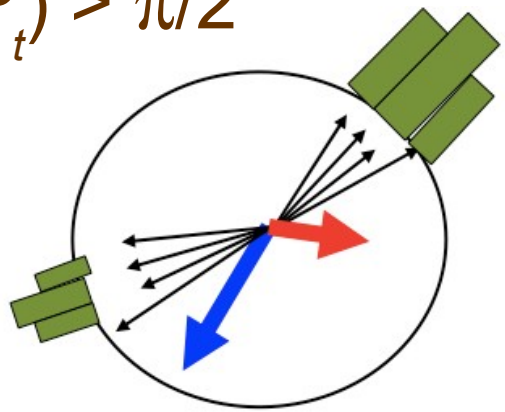
Define Signal Region

$\Delta\phi(\not{E}_T, \not{P}_t) < \pi/2$



Define Sideband Region

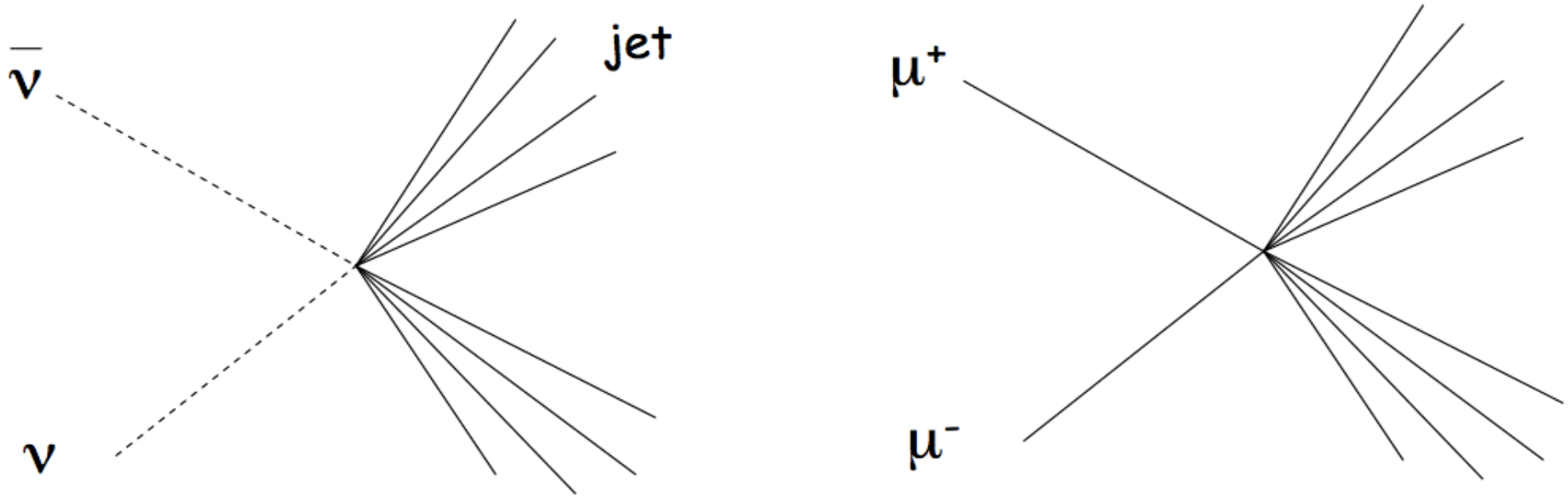
$\Delta\phi(\not{E}_T, \not{P}_t) > \pi/2$



$\not{P}_t = |\Sigma P_T(\text{tracks})|$

Trigger Parametrization

Di-jet + MET Triggers

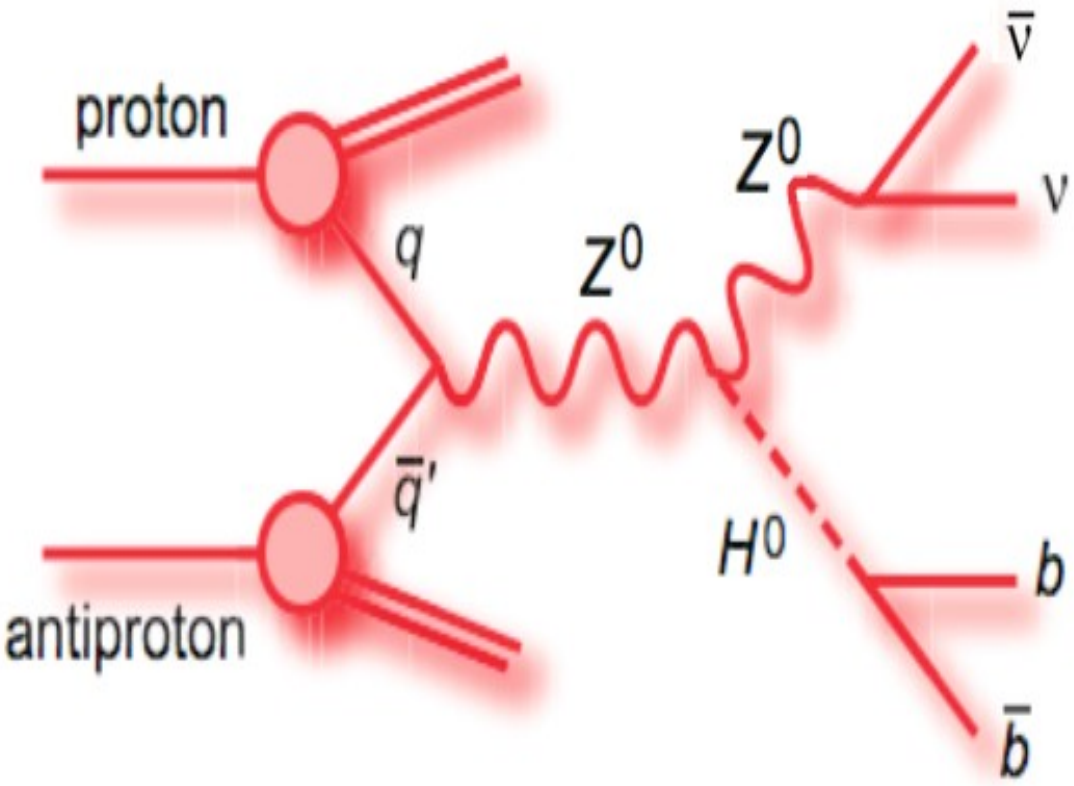


Parametrization done in $Z \rightarrow \mu^+\mu^-$ + *jets* events with same jets topology as the signal.

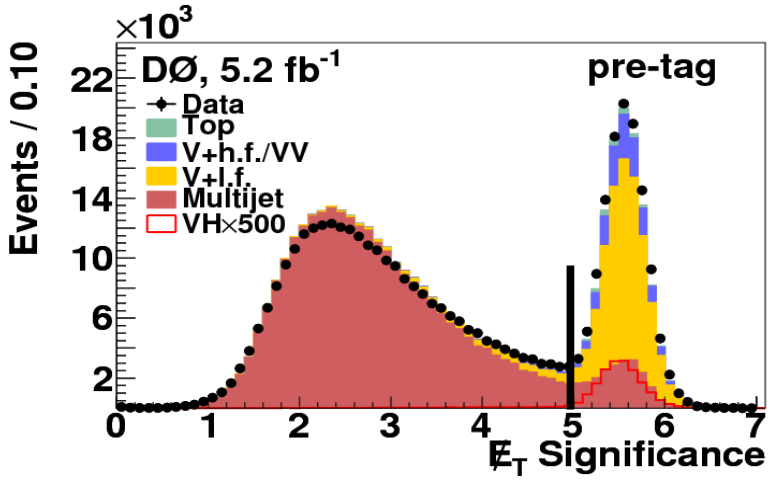
Validation performed in $W \rightarrow \mu\nu$ + *jets* events

Signal Selection

✔ Trigger on Jets + MET



MET > 40 GeV
MET Significance > 5.0

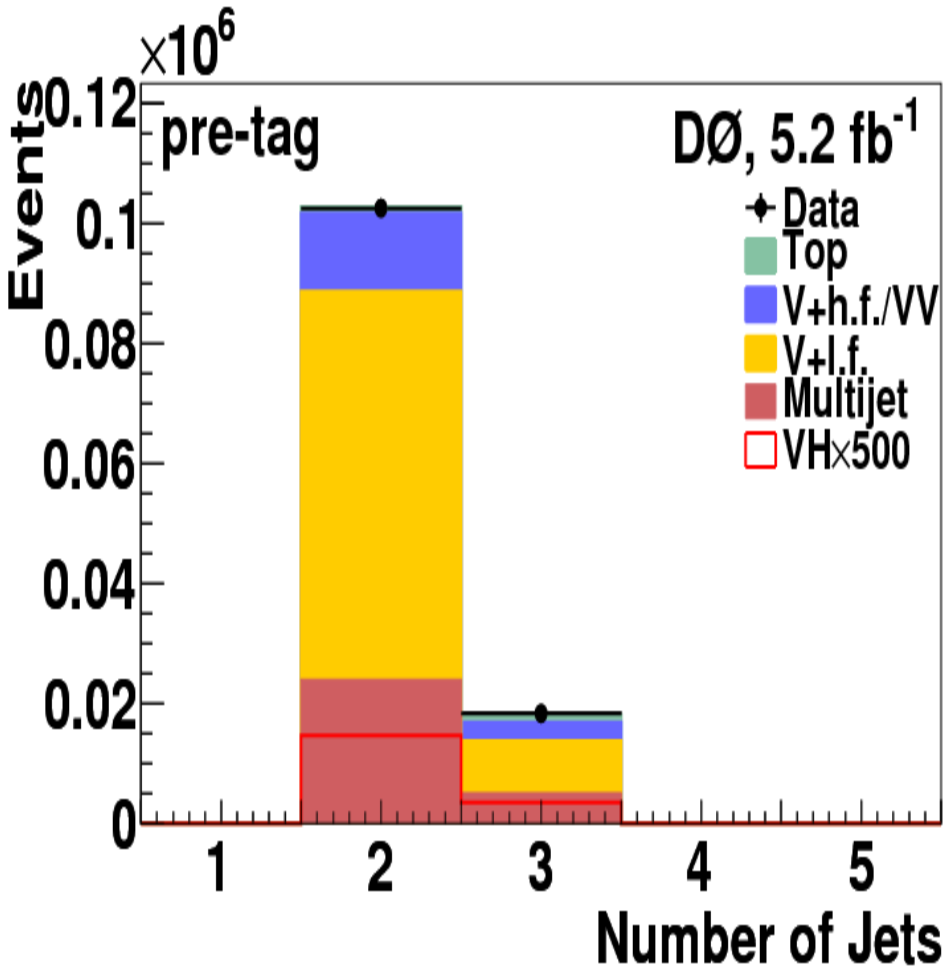


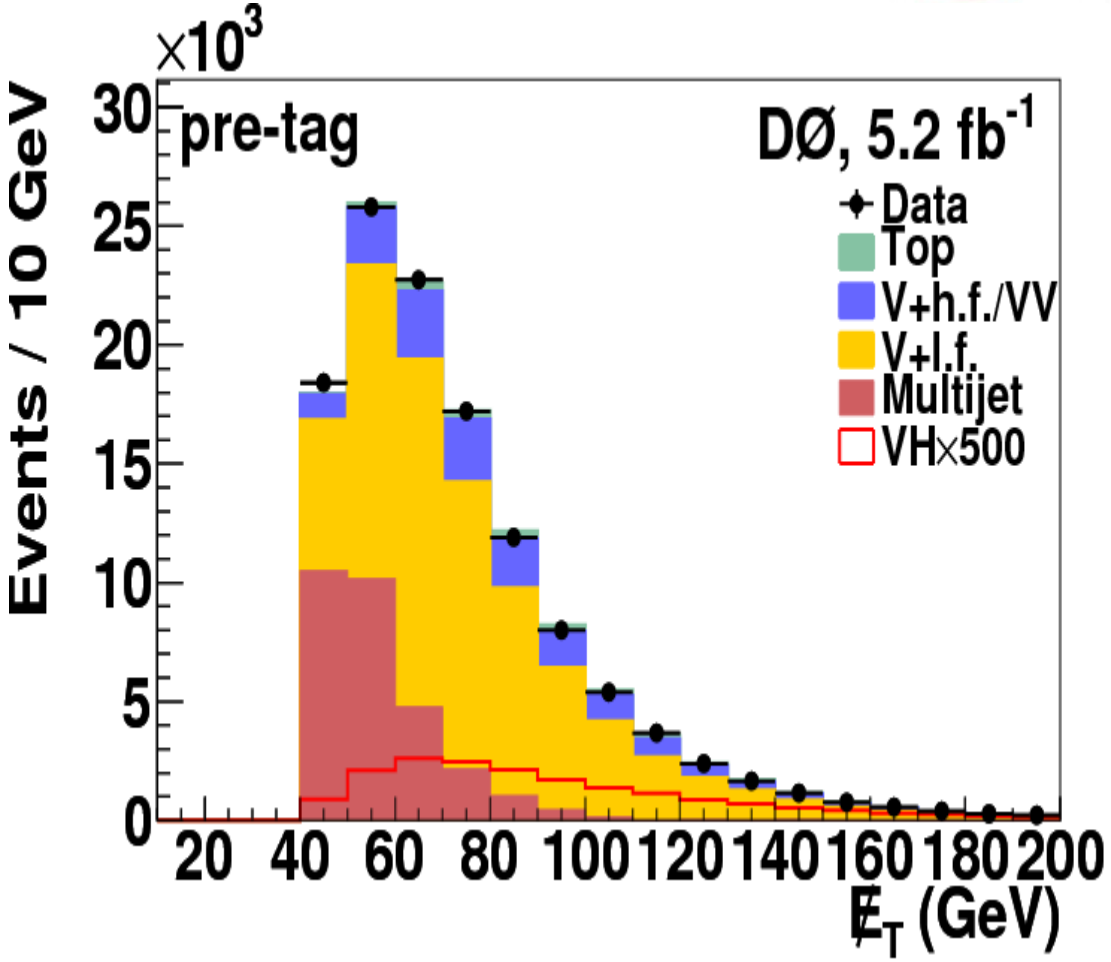
2 or 3 Jets
Boosted, $\Delta\phi$(leadingjets)<2.88

✔ Veto on identified leptons to ensure orthogonality to WH searches

✔ $\Delta\phi(\not\!\!E_T, \not\!\!P_t) < \pi/2$ (to reject multijet events)

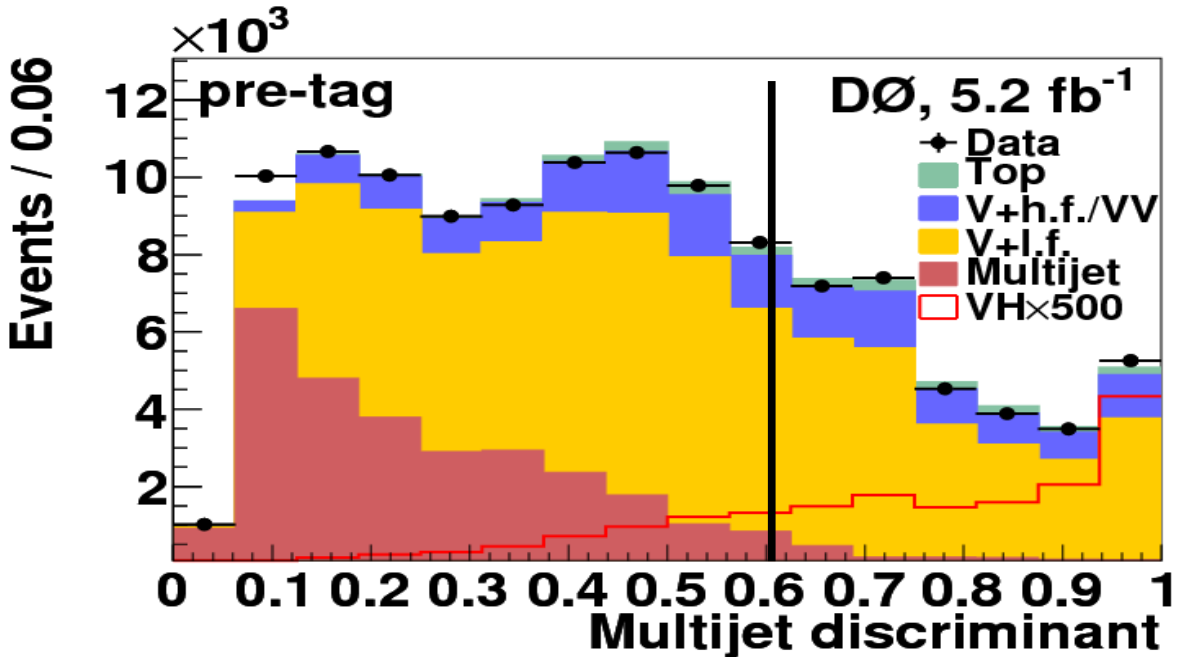
Before b-tagging



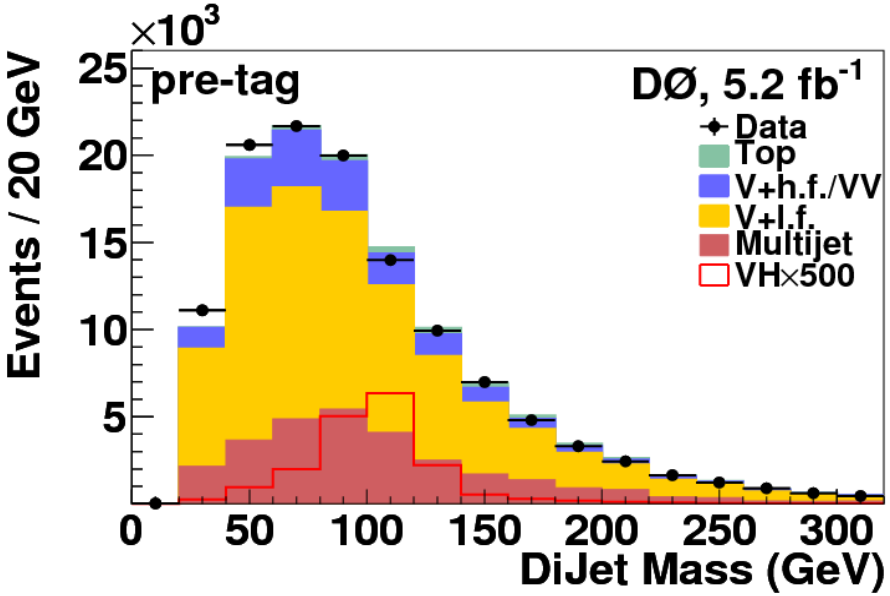


Excellent DATA/MC agreement

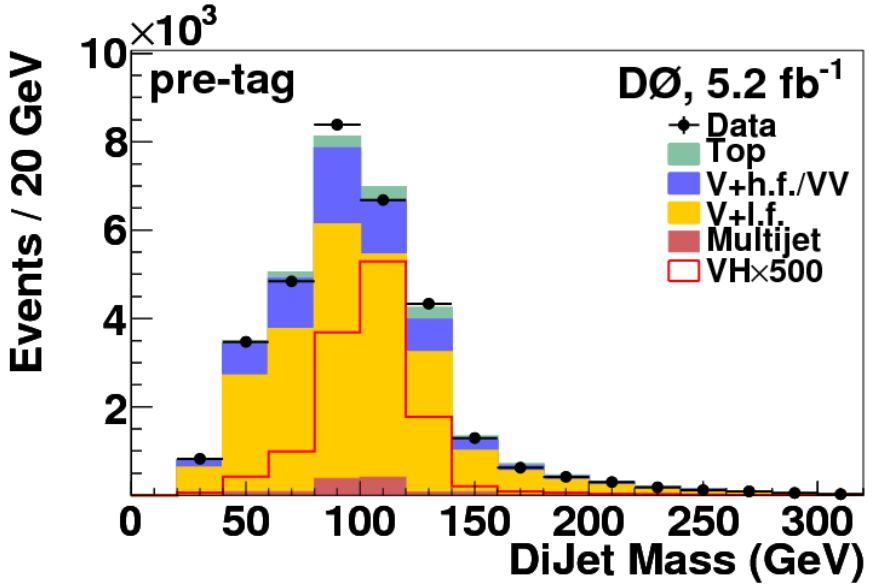
Multijet Removal



Train Boosted Decision Tree(BDT) using 23 variables to separate the signal from multijet background.
Optimized to remove 95% of MJ, retaining 70% of signal.



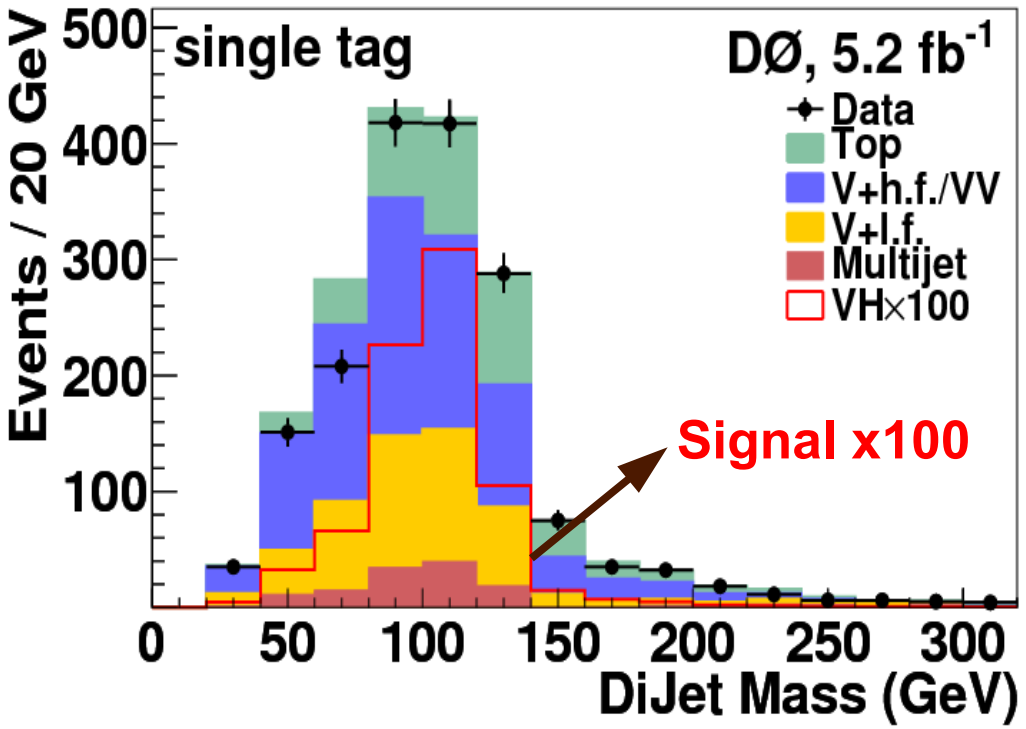
MJDT > 0.6

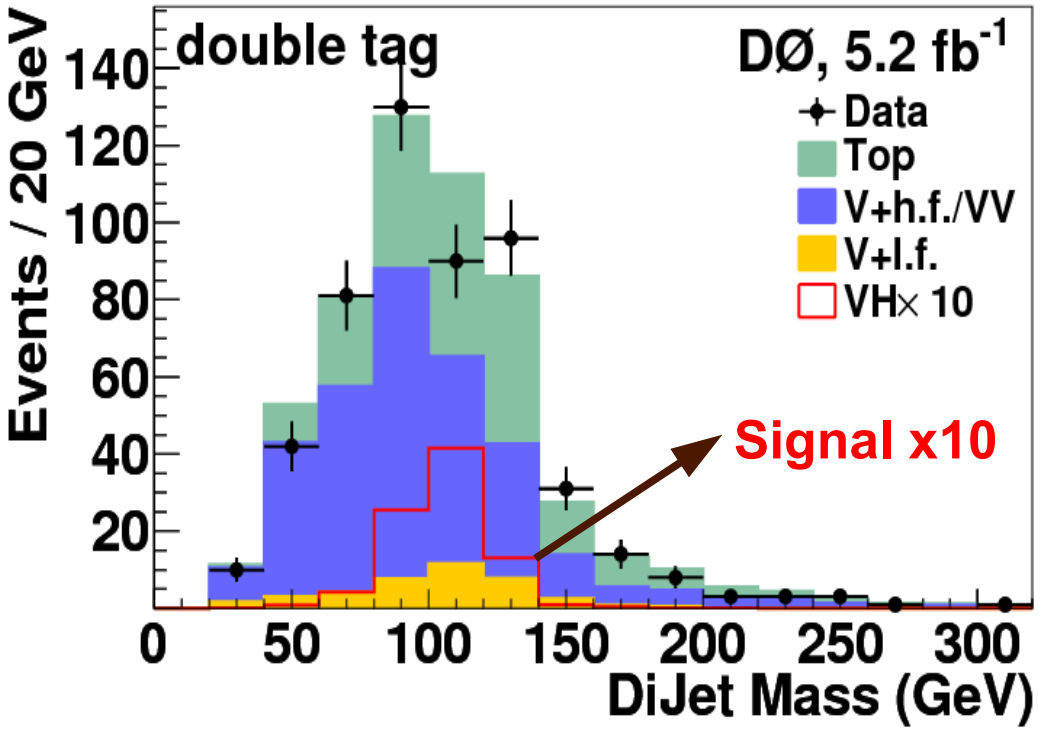


B-tagging

Used a Neural network b-tagging algorithm (uses tracking variables)

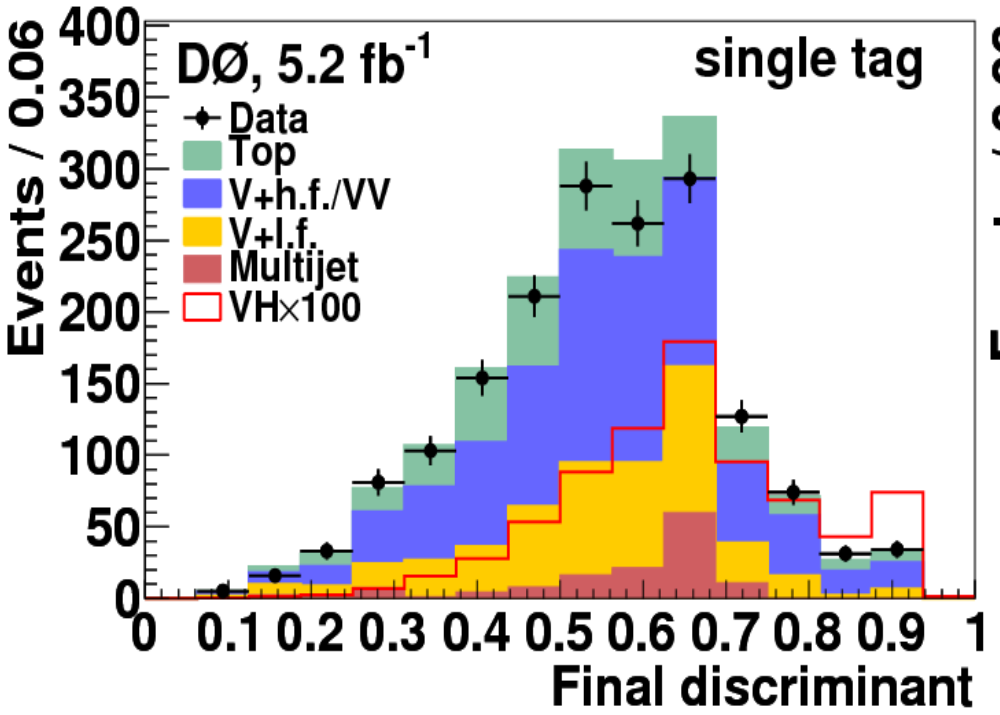
double tag : one tight tag and other loose tag – provides best sensitivity
single tag : one tight tag and no loose tag – enhances search sensitivity

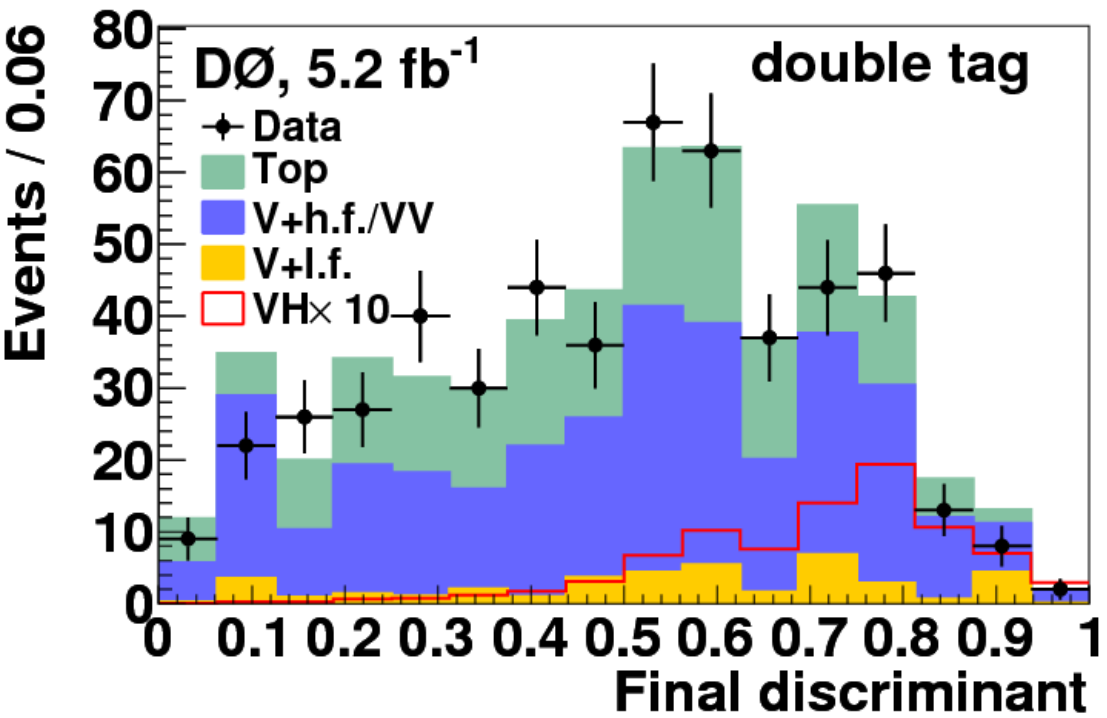




Final Discriminant

Trained BDT for final separation between signal and remaining SM backgrounds using same 23 variables, achieved good separation.

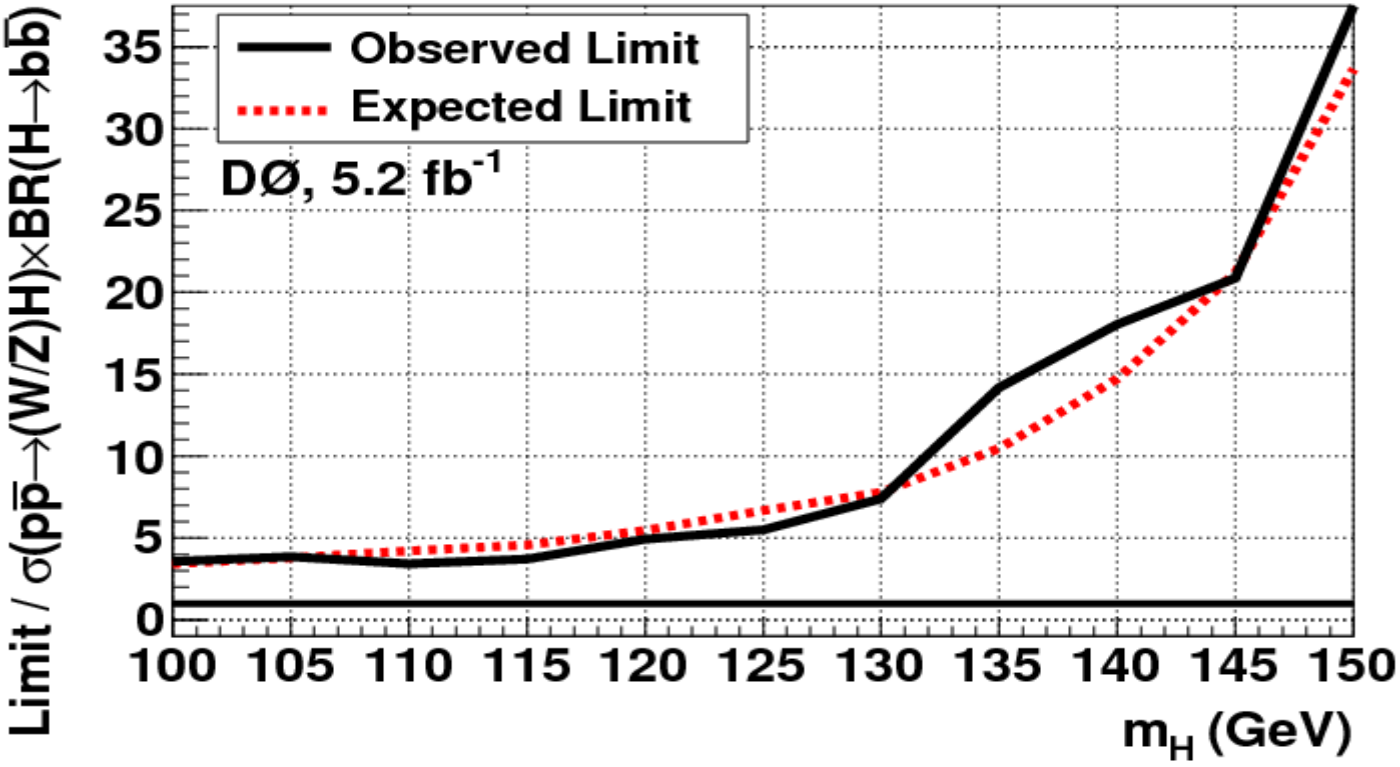




Main systematic uncertainties are from cross-sections(10%), luminosity(6%), b-tagging(8%) and V+hf jets modeling(10%)

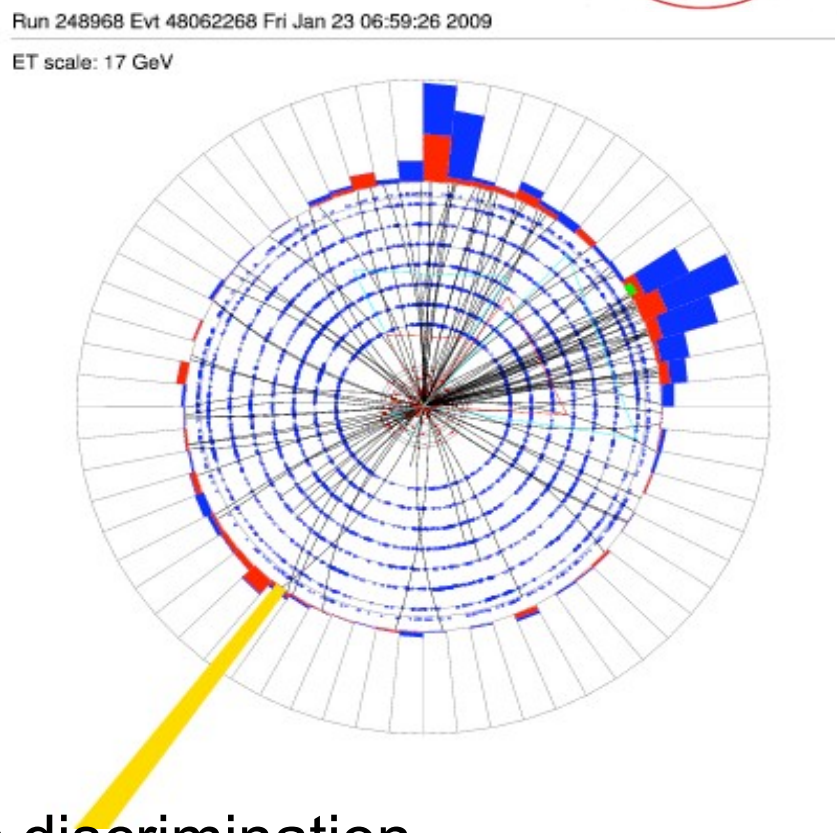
Limit

No deviation from the Standard Model expectation is observed.
Using BDT, set upper limit on the SM Higgs boson production "σ*BR(H→bb)" for ZH and WH processes (relative to SM value)



For m_H = 115 GeV limit is a factor 3.7 times the SM cross section.
(expected limit ~ 4.6)

Conclusions



- ✔ Result based on 5.2 fb-1 of data.
- ✔ Published in Physical Review Letters.
- ✔ 15% sensitivity improvement beyond luminosity gain from our previous result.

Plans:

- ✔ Switch to new b-tagger, better bb and bc discrimination.
- ✔ Improved jet energy resolution.
- ✔ Explore other multi variate techniques.

Stay tuned for exciting results.....