Analysis of pp→ WH(bb) process with Neural Net

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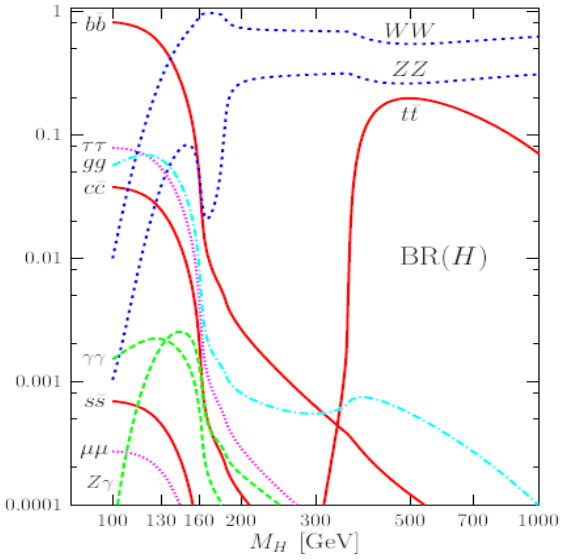
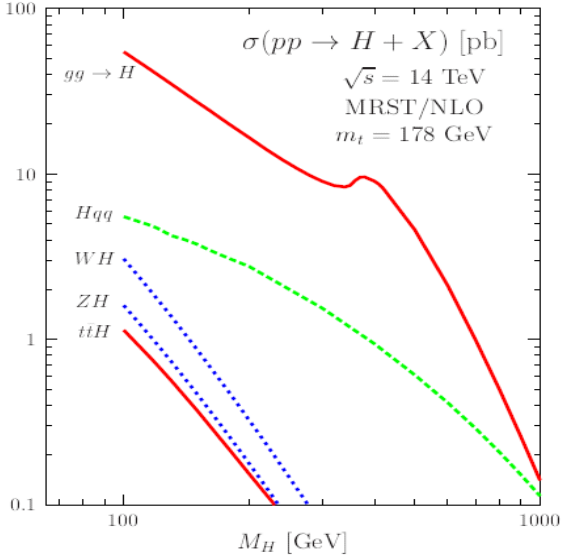
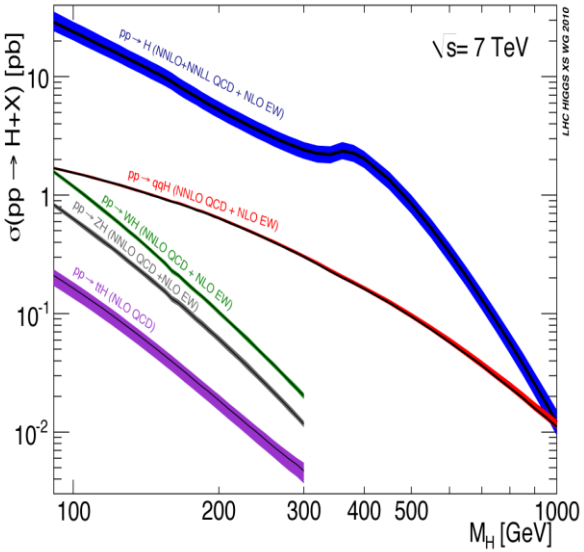
Outline

- *Introduction*
- *Relevant Variables*
- *Present situation*
- *Results from MC*
- *Next steps*

Higgs Boson production and BR

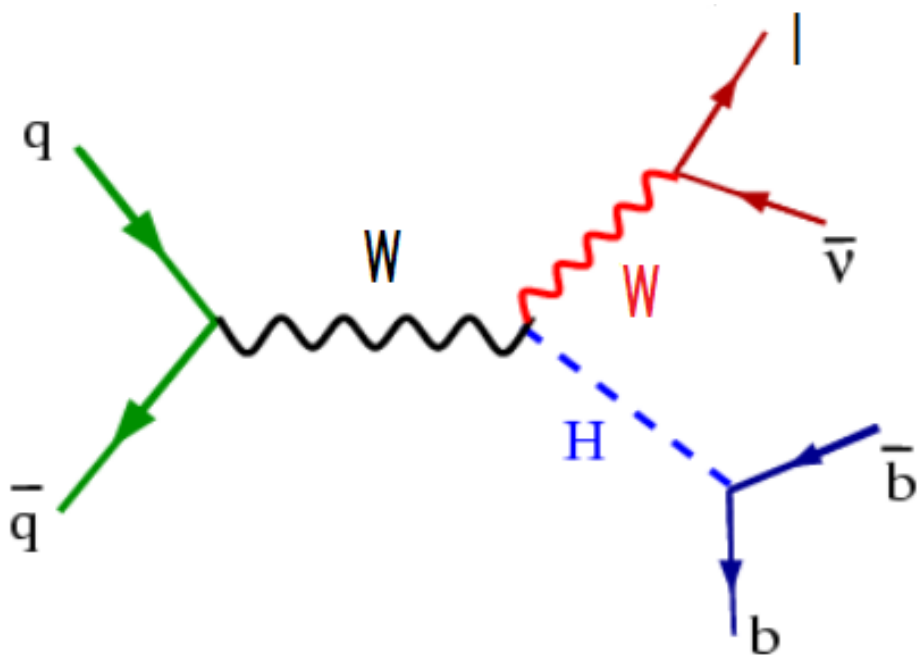






Higgs decay branching ratio (I), production channels at 14 TeV (II) and 7 TeV (III)

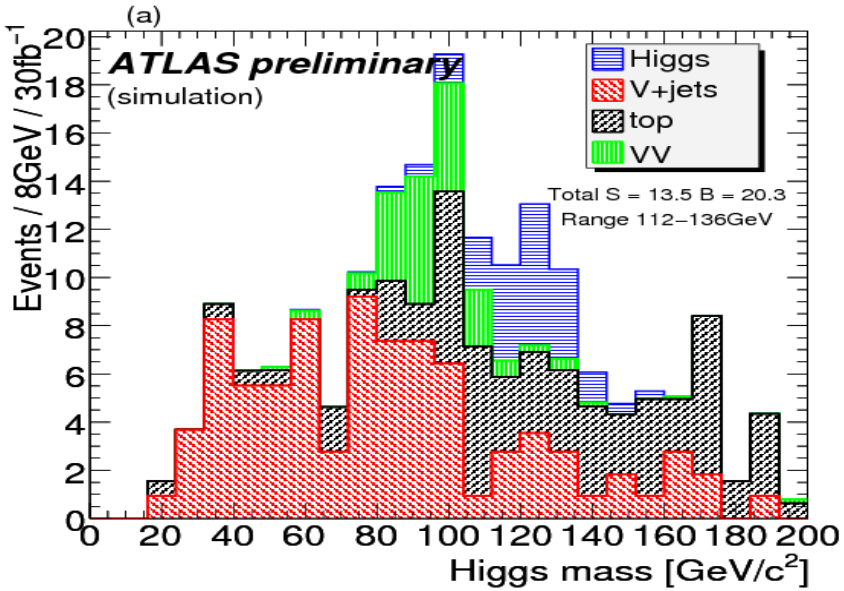
$pp \rightarrow WH(bb)$ process



Feynman diagram for associative production Higgs and W bosons

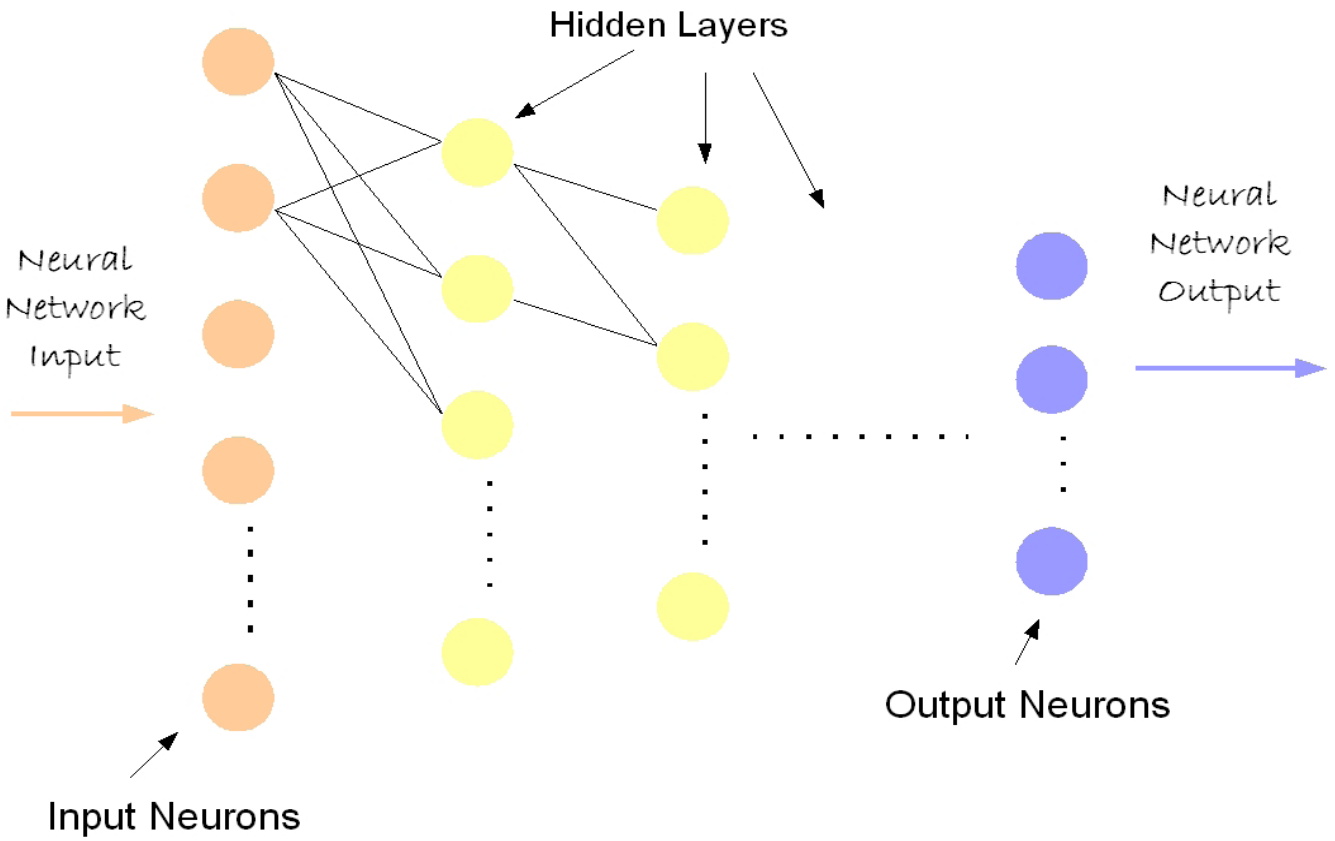
Background processes

- W+jets,
- WW,
- WZ,
- ttbar
- and single top



Distribution of the invariant mass of the Higgs candidate (ATL-PHYS-PUB-2009-088)

Neural Network architecture



Event selection and datasets

- **ATLFAST, cut-based analyses**:
  - Isolated (trigger) lepton & Two b-jets & Jet veto ($|\eta|<5$)
  - Loose cuts for NN:
    - other jets are allowed
    - the highest pT lepton is selected
    - b-jets selected with highest b-weight

- **Datasets** for signal and backgrounds were those used for the "fat jets" analysis (high jet pT cut of 200 GeV/c)

List of variables

From the new study:

- $\cos\theta_b^*$ - b-jet direction in H rest frame relative to H direction in c.m.s. of WH
- $\cos\theta^*_{H(W)}$ – H(W) direction in c.m.s. of WH
- $\sqrt{s}$ – sum of energies of W+H ($E_\nu+E_\ell+E_b+E_b$)

From our old (atlfast) paper:

- θ_{jj} - openning angle between two b-jets
- E_{jj} - sum of b-jet energies

From CDF:

- ΔR – distance between two b-jets in (η,ϕ)
- w_b, p_T^{jet} – b-weight and pT for each b-jet
- m_{jj} – invariant mass of two b-jets
- η_ℓ - lepton pseudorapidity
- p^ℓ_T - lepton pT
- E^{miss}_T- missing energy (MET_Calib)
- P^{WH}_T – vector sum of W and H pT's
- $N_{light\ jets}$ – number of light (non-b) jets

Using cuts in NN

For electrons:

Only one elec.
Pt > 20 GeV
$|\eta| < 2.5$
$\Delta R(\text{e-jet}) > 0.4$

For muons:

Only one muon
Pt > 20 GeV
$|\eta| < 2.5$
$\Delta R(\text{jet-}\mu) > 0.4$

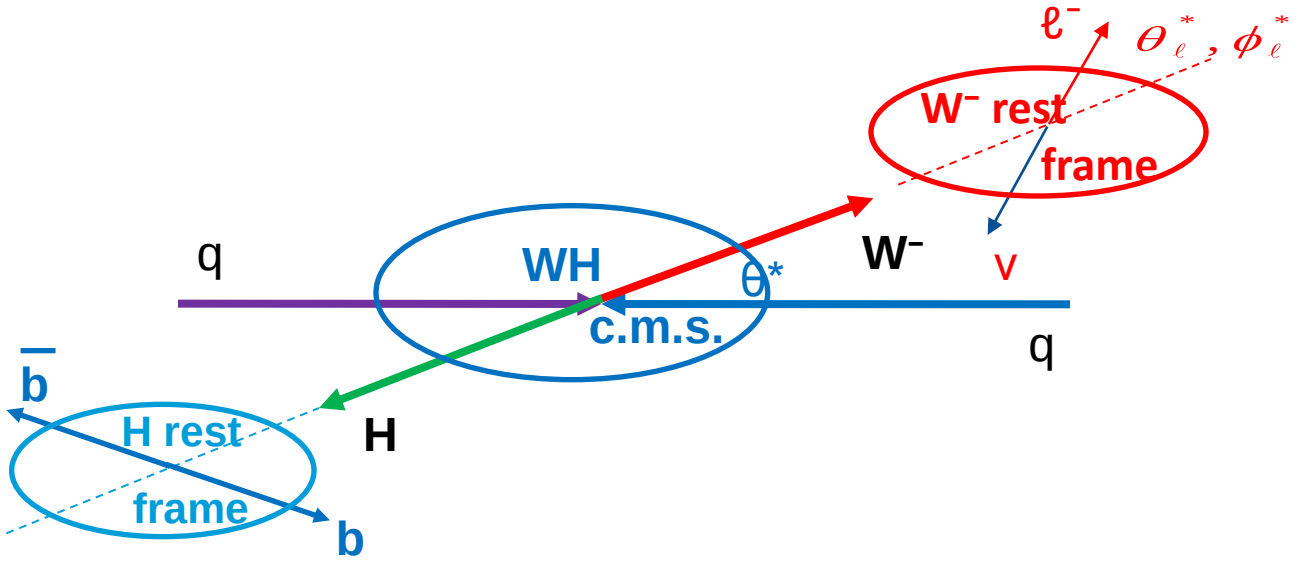
For jets:

Two b-jet tagged
Pt > 25 GeV
$w_{IP3DSV1} > 4$ for two b-jets
$w_{IP3DSV1} < 4$ for light jets
$\Delta Mjj = 25$ GeV

MET > 30 GeV

A "new" angular variables

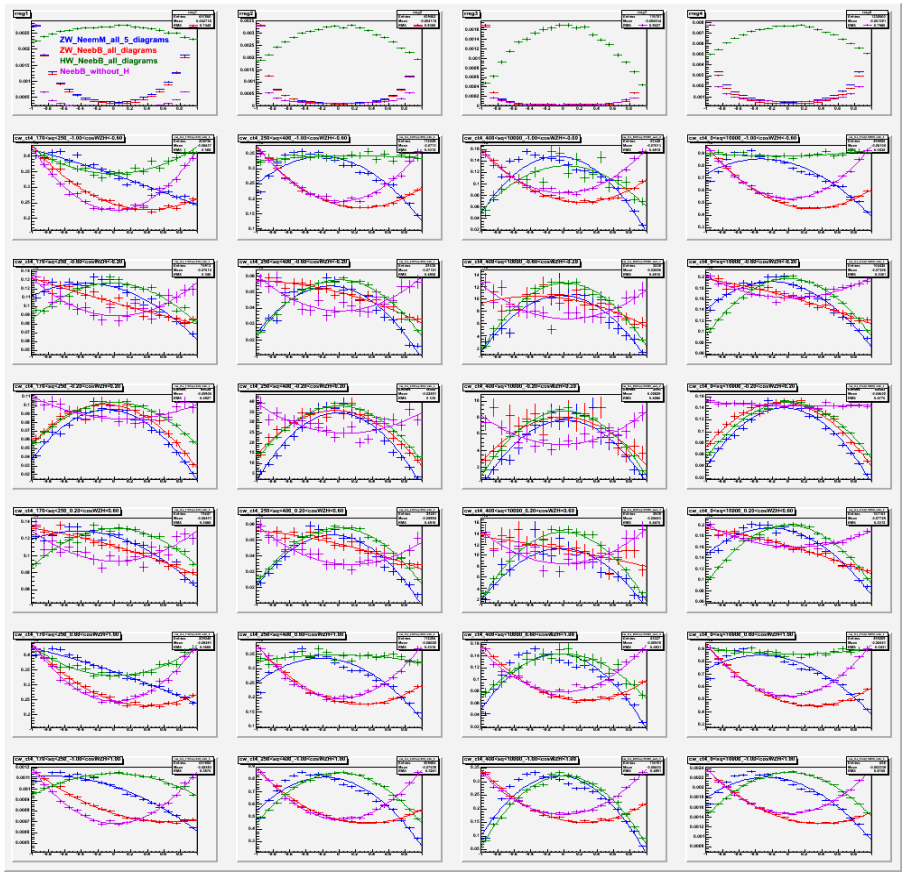
- *Spin effects: angular correlations*
- *WH:*



CompHep for WZ, WH, all bkgr's (1)

Plots of $\cos\theta_e^*$ *for processes:*

WZ(μμ) all diagrams
WZ(bB) all diagrams
WH(bB) all diagrams
and
WbB (without Higgs)



$\cos\theta_W$

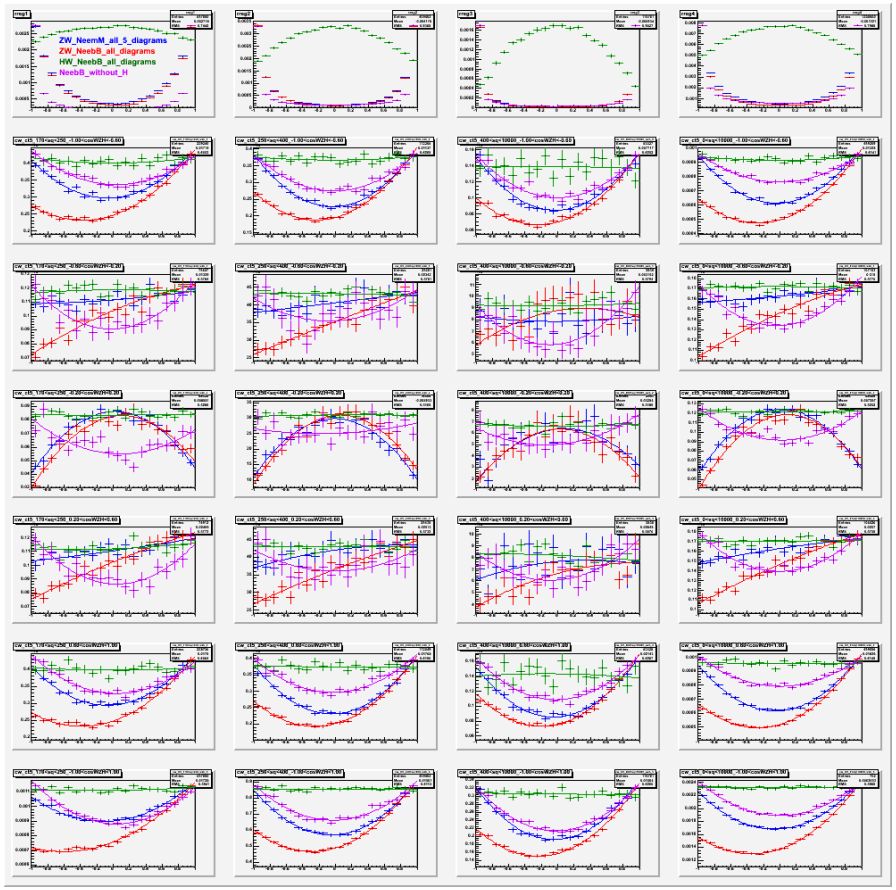
-1 <-- $\cos\theta_W$ --> +1

√s

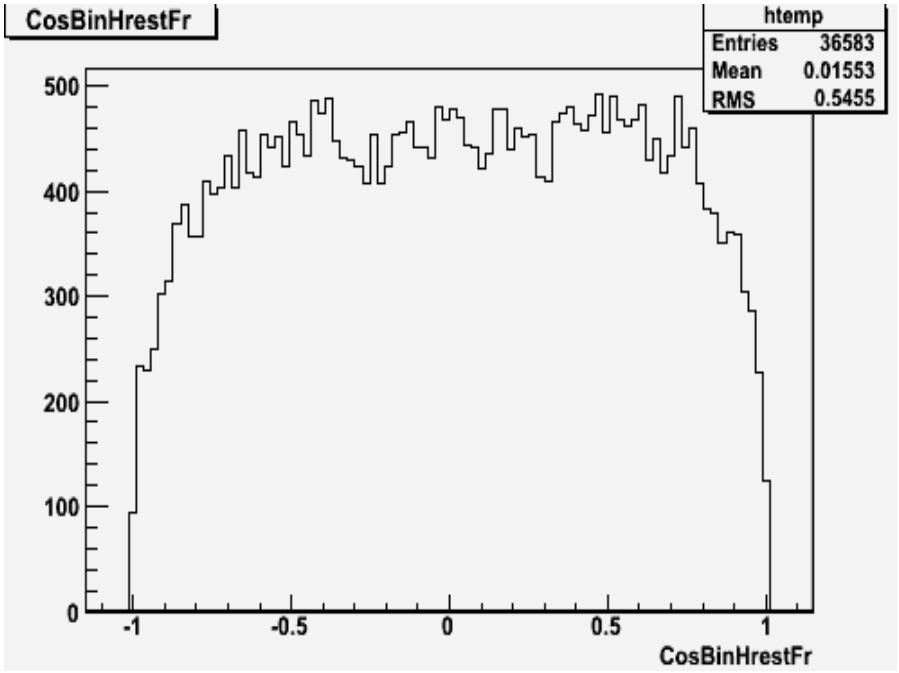
CompHep for WZ, WH, all bkgr's (2)

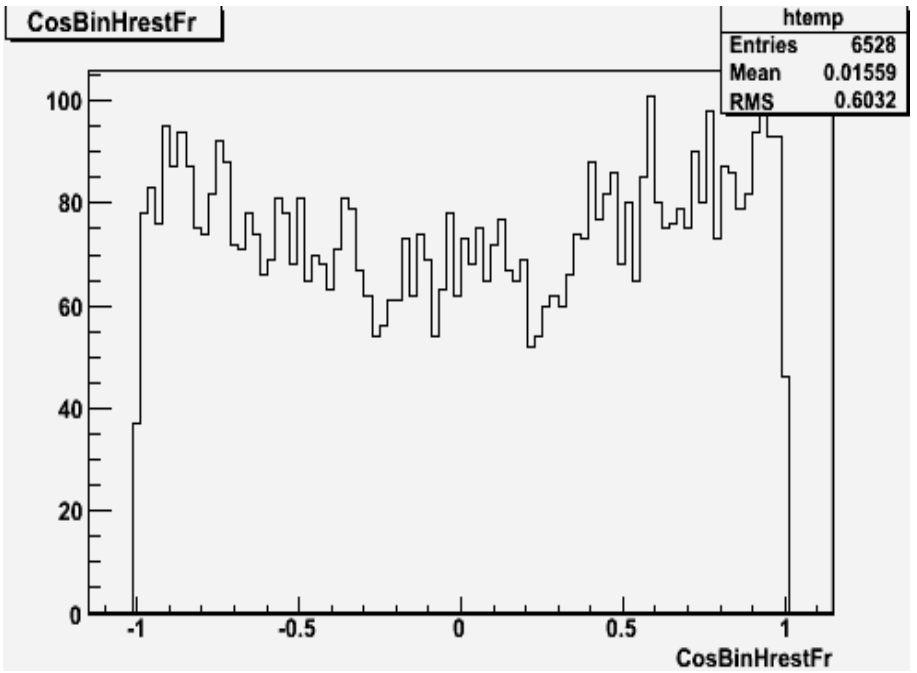
Plots of $\cos\theta_b^*$ *for processes:*

WZ(μμ) all diagrams
WZ(bB) all diagrams
WH(bB) all diagrams
and
WbB **(**without Higgs)



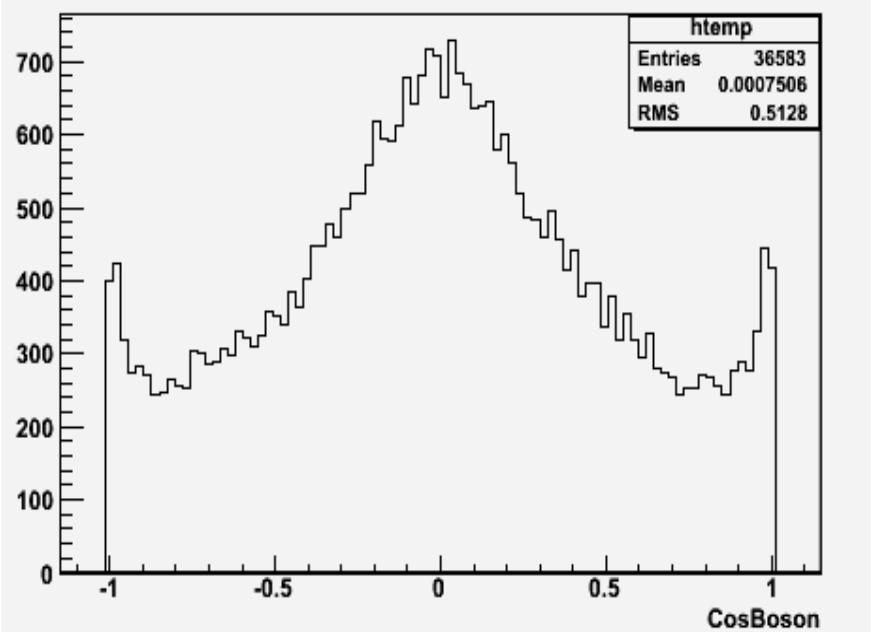
NN variables

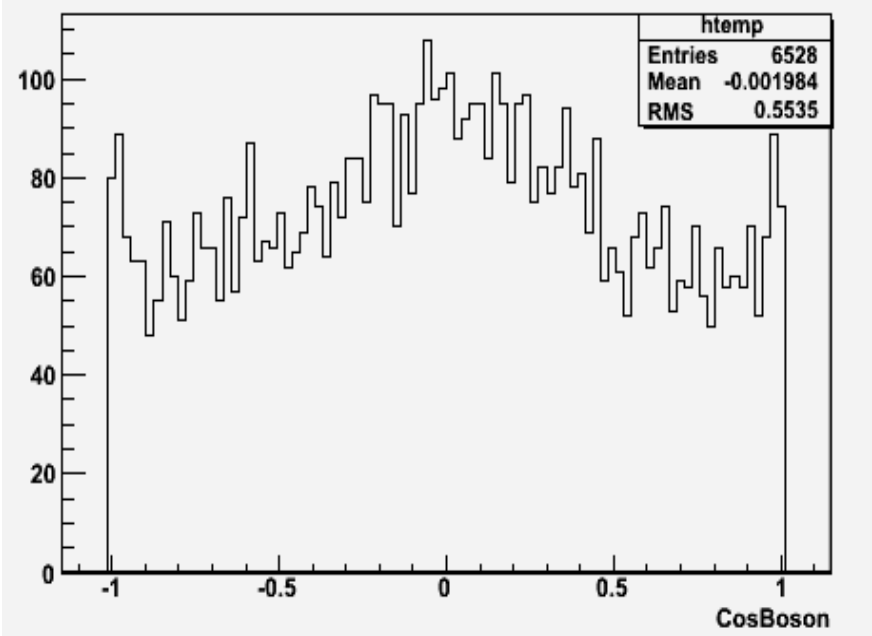




Cosine of angle between the directions of b-quark (in the rest frame of H-boson) and H-boson (in the WH c.m.s) for signal (left) and for bck. (right).

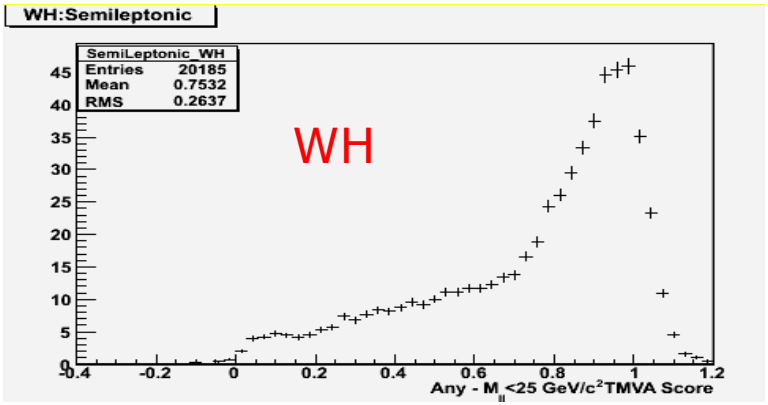
NN variables

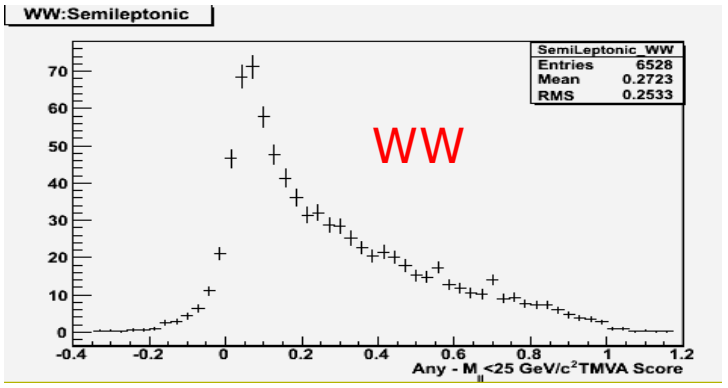


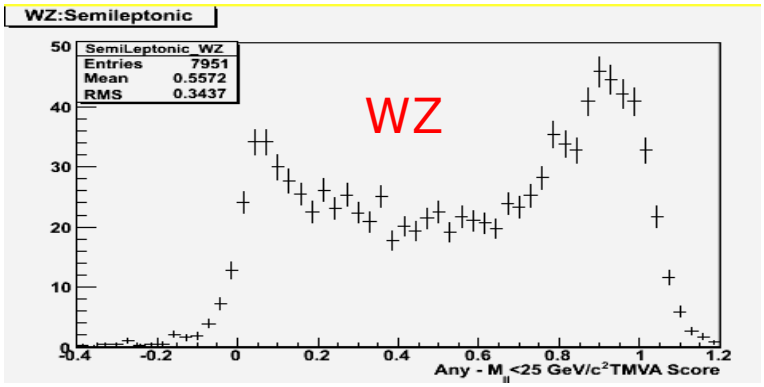


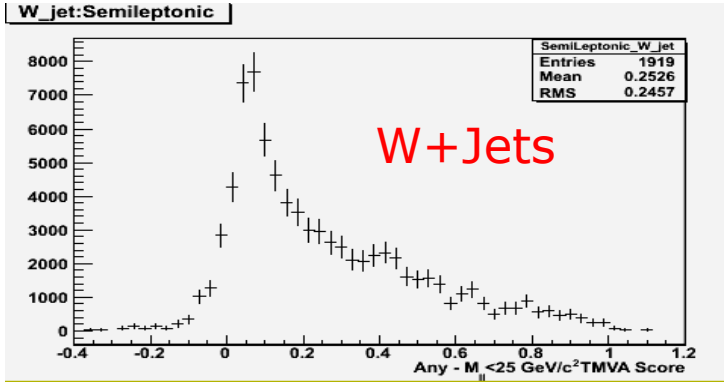
Cosine of angle between the directions of H-boson and initial quark in the c.m.s for signal (left) and for bck. (right).

NN training output



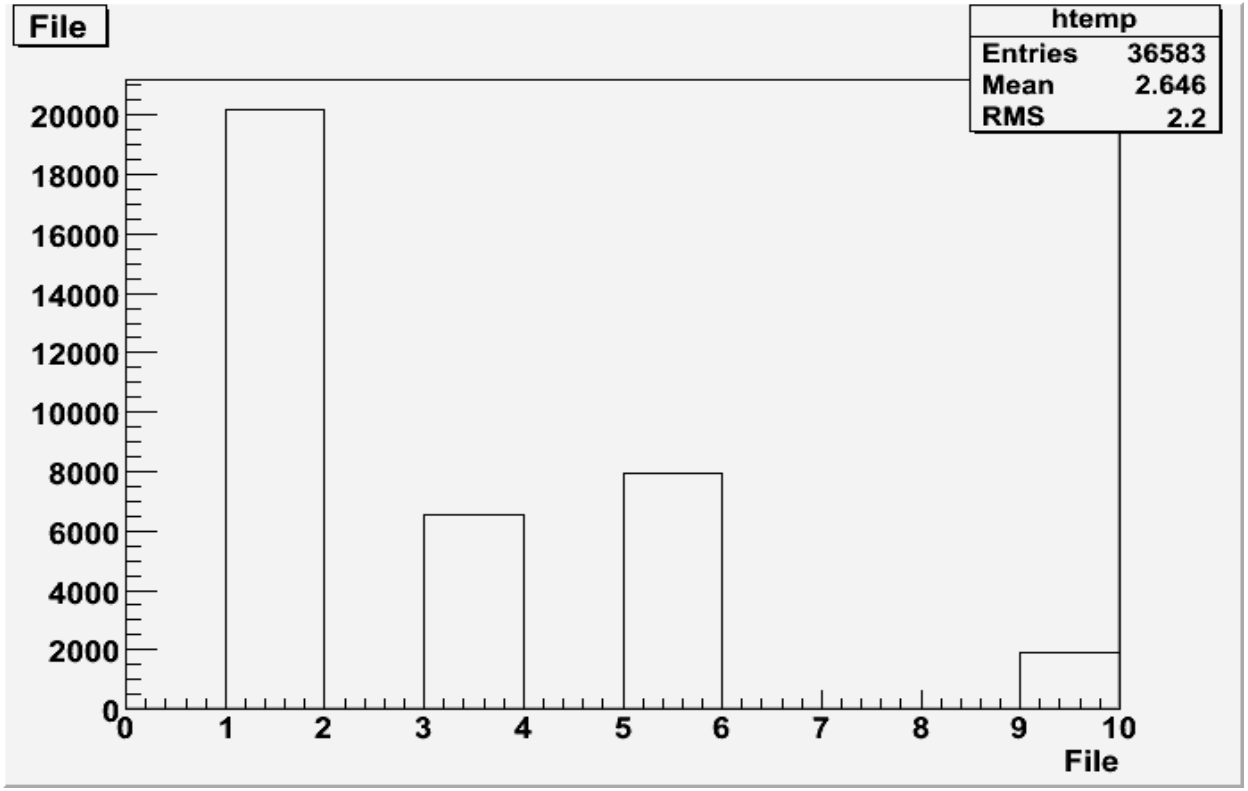






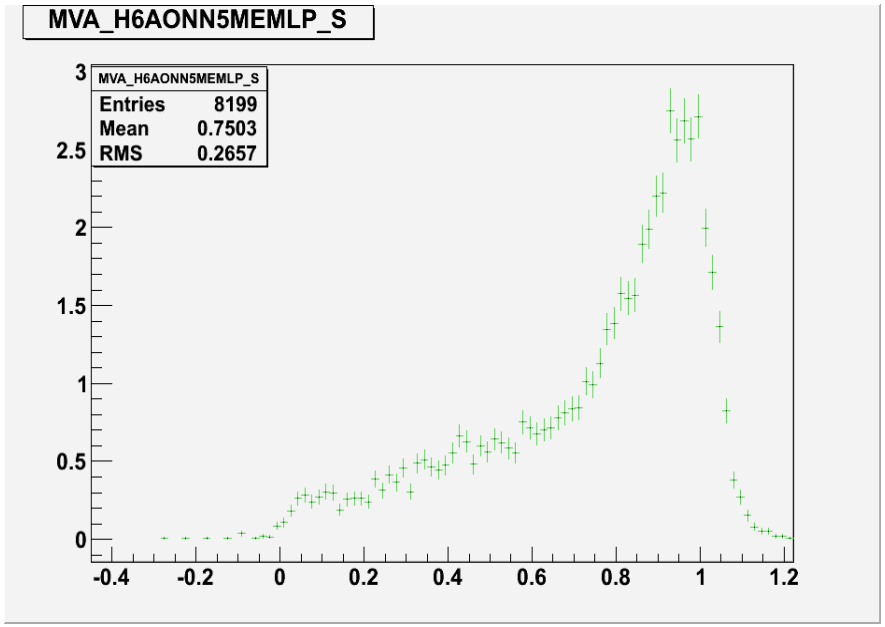
NN output for signal (first) and some background processes (the next three).

NN training (trees)

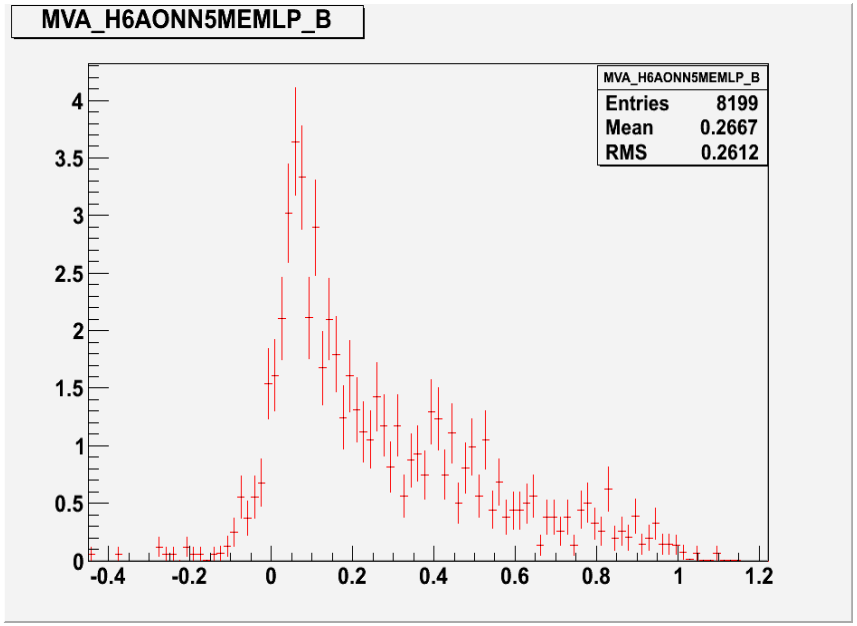


1-WH, 2-WW, 3-WZ and 4-W+jets

NN training output

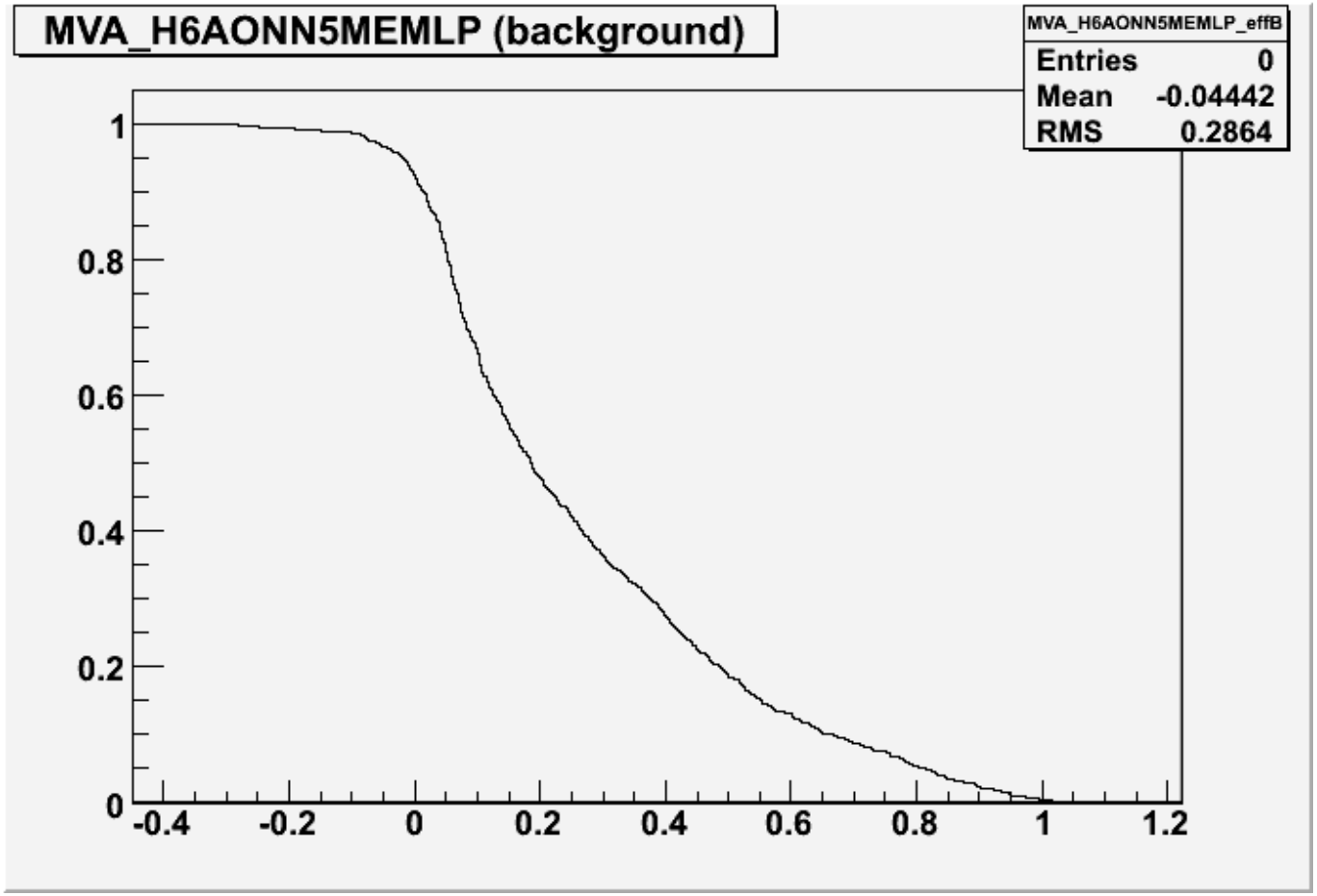


signal

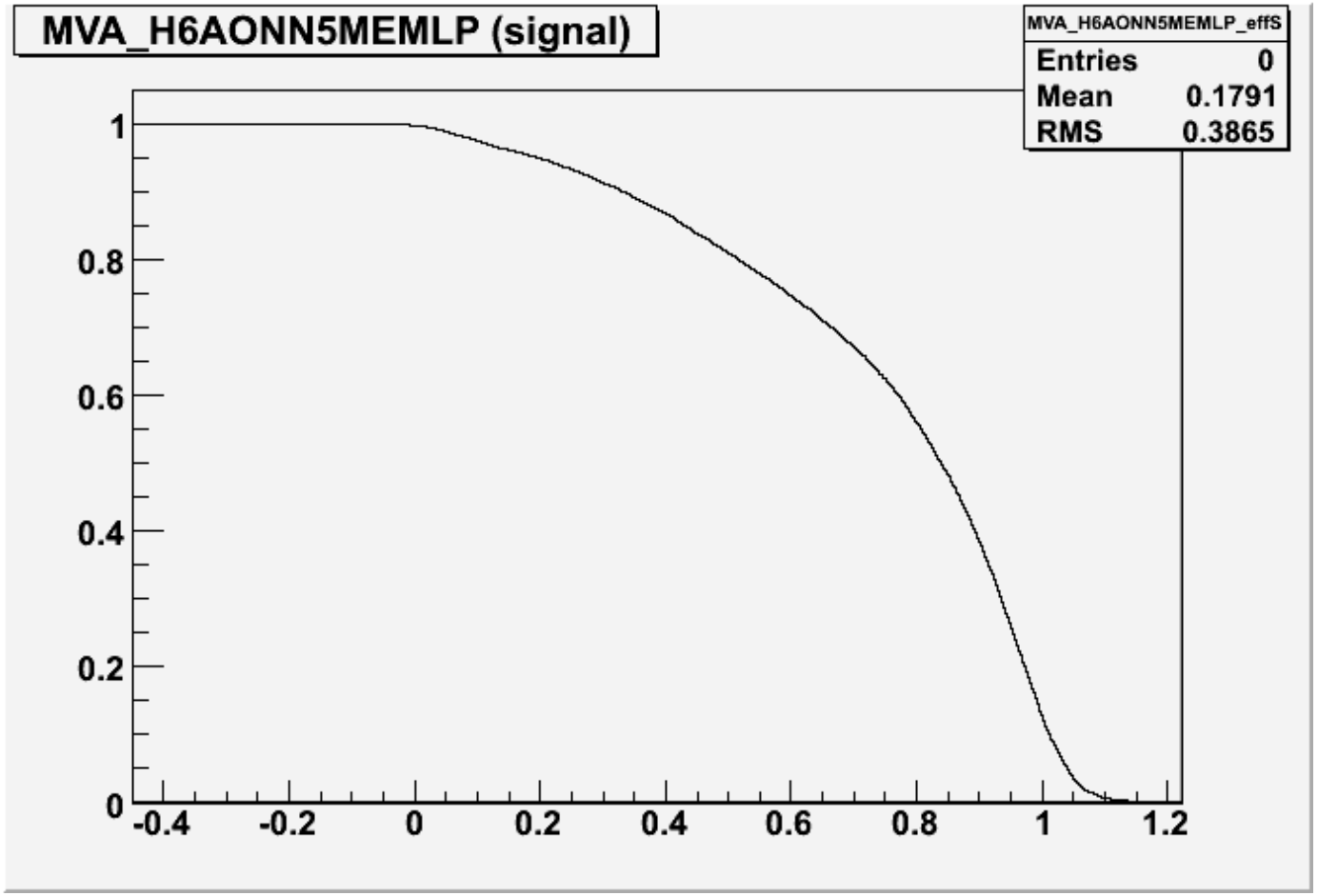


background

NN training (efficiency - backg)



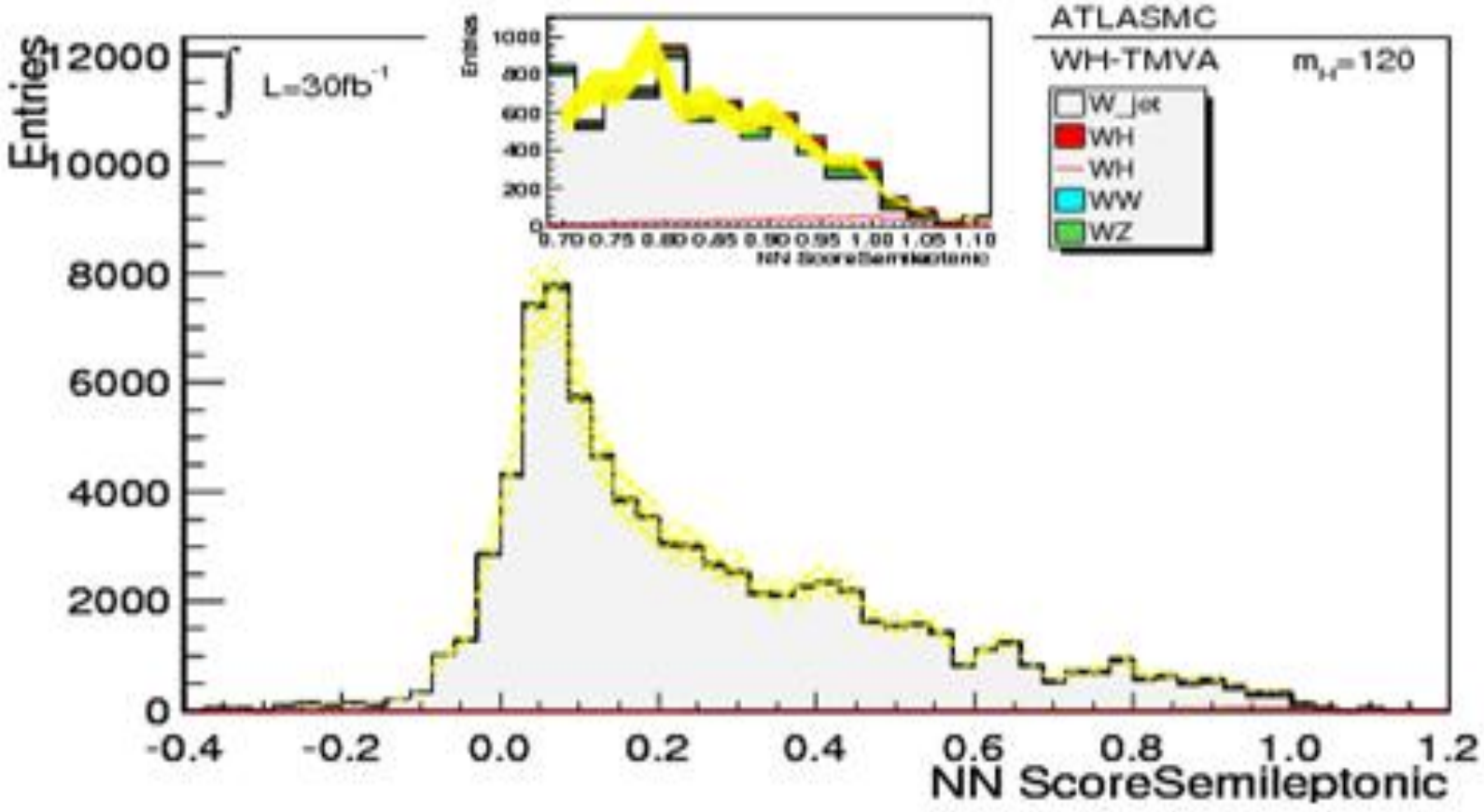
NN training (efficiency – signal)



NN training (systematics)

Parameter	Process			
	W+jet	WW	WZ	WH
Combine:Lumi	±0.06	±0.06	±0.06	±0.06
Combine:Trig	±0.015	±0.014	±0.013	±0.015
Combine:LepID	±0.003	±0.003	±0.003	±0.006
Met	±0.01	±0.01	±0.01	±0.01
nloAccep	±0.055	±0.10	±0.10	±0.10
x-sec	±0.10	±0.10	±0.10	±0.10
PDF	±0.019	±0.027	±0.027	±0.022

NN training output (summary)



Next steps

- Complete “fat jets” datasets analysis (document)
- Try another datasets with lower cut on jet pT (still small statistics for W+jets)
- Look around for other useful variables

  (e.g. from the top spin study)
- Try ATLAS data

Moscow river