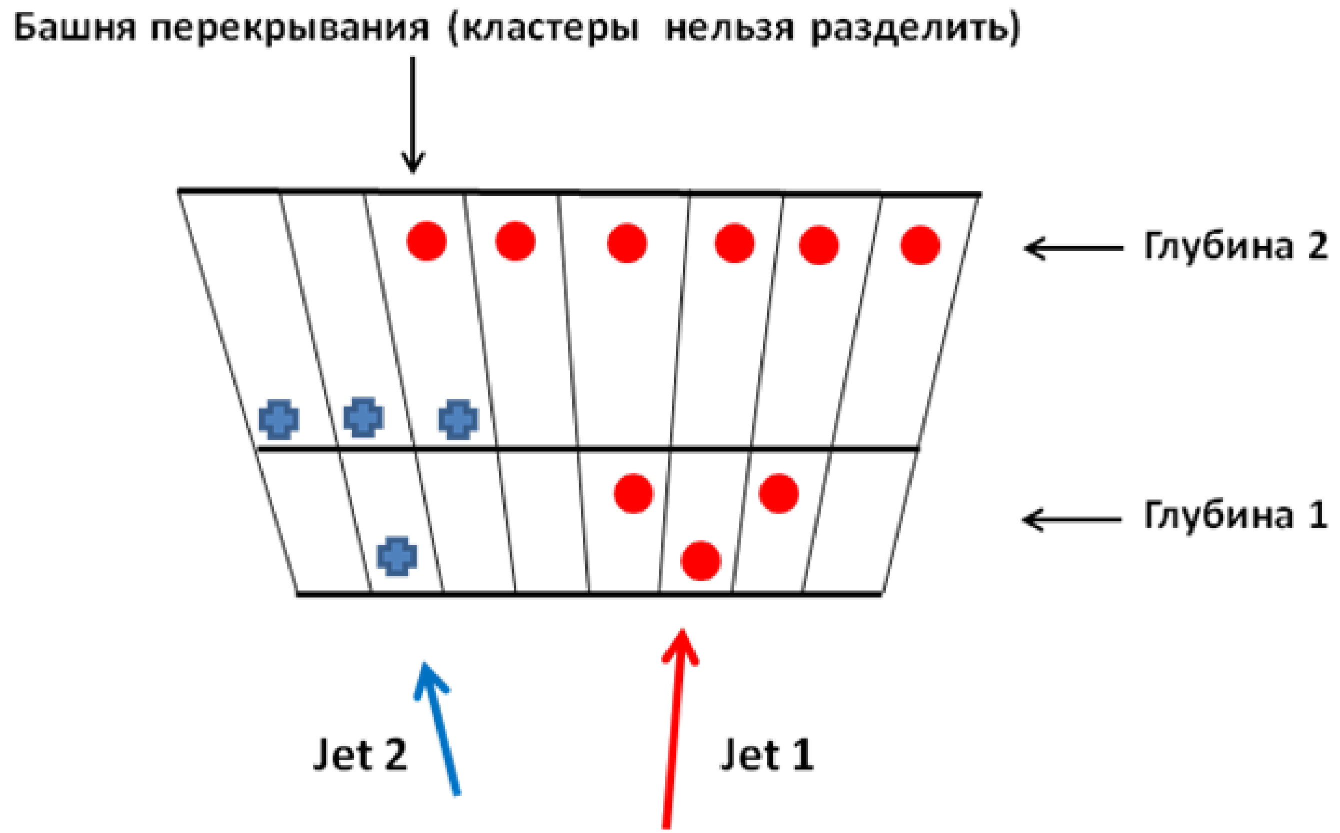
А. Тумасян
научный руководитель А. Сирунян

Jet algorithms development perspectives within HCAL upgrade

Old segmentation (HE)

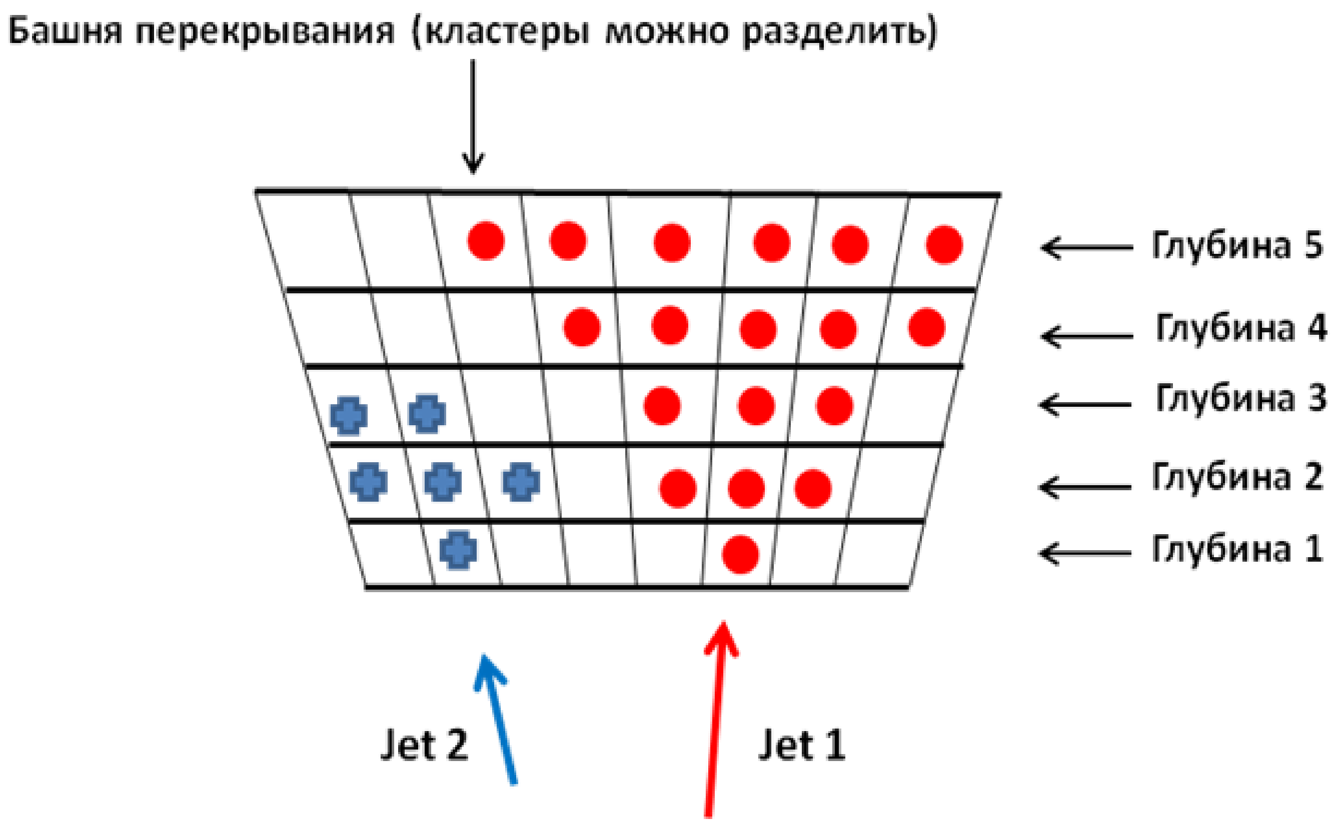
HPD (Hybride Photo-Diodes)



2 depth scheme

New segmentation (HE)

SiPM (Silicon Photomultipliers, Hamamatsu, Ketek, FBK)

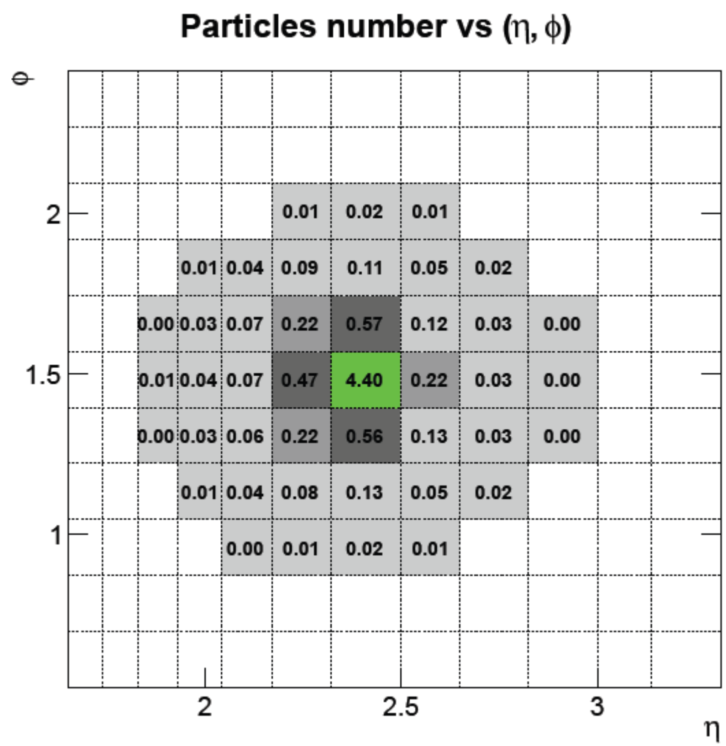


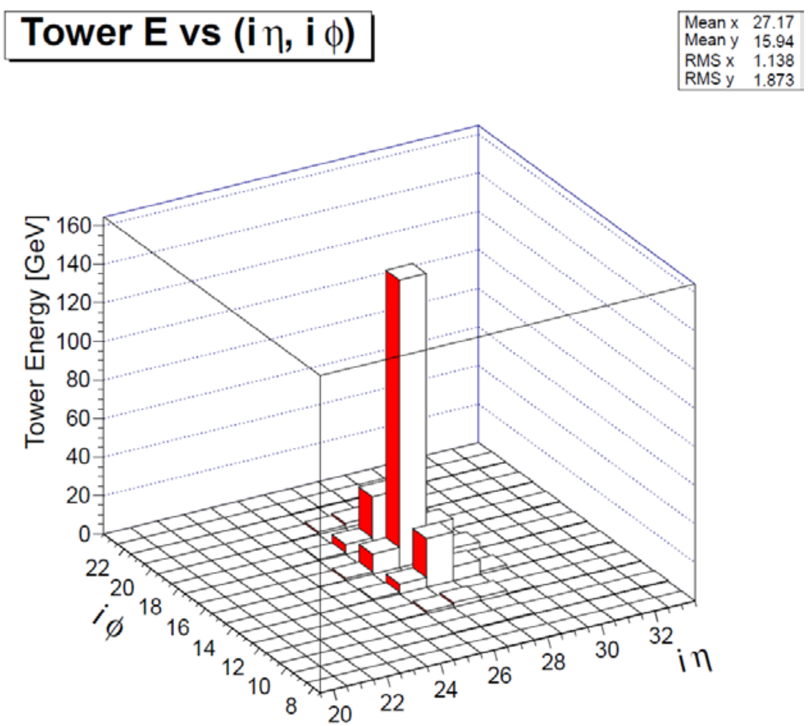
5 depth scheme

Suggested Algorithm

1. **Standard Reconstruction (identification of the main towers of energy)**
2. **Secondary Reconstruction (ReReconstruction) by towers depth.**

1. Identification of main towers





Light quark jet: E_T = 50 GeV; η = 2.4

2. ReReconstruction

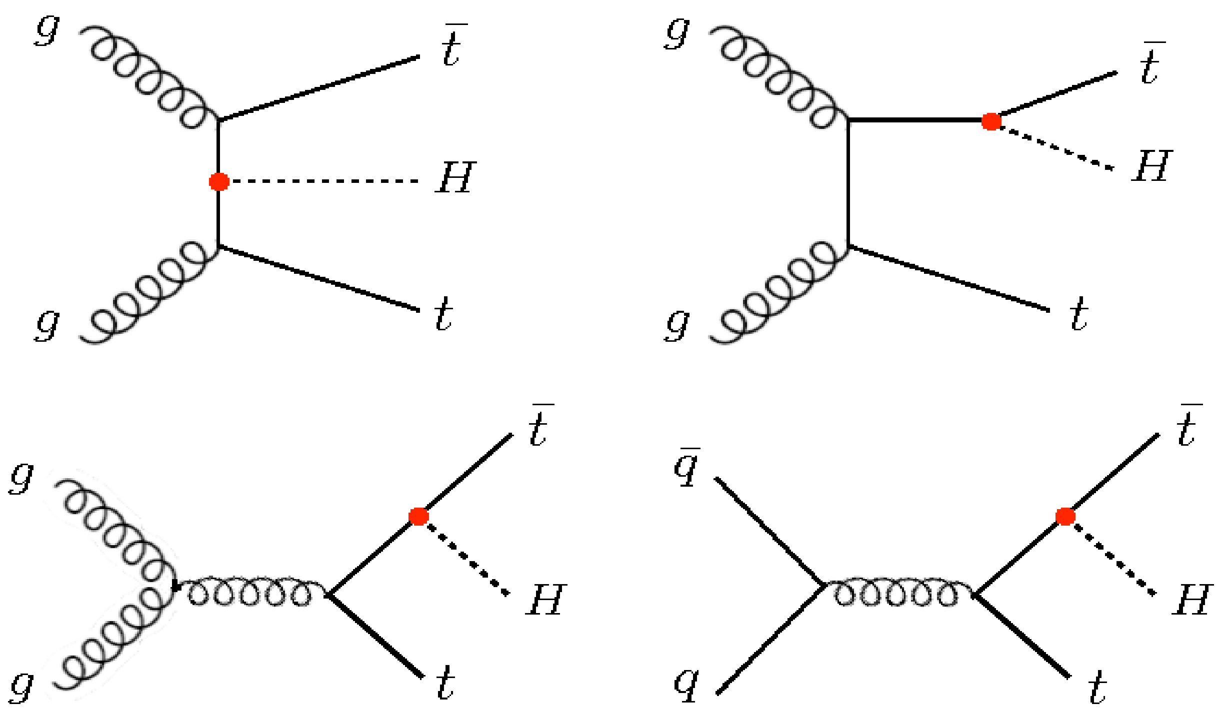
1. **Estimation of energy for each cell: $\mathbf{E}_{x,y,d}$**
2. **Looking for the path for cells from the last depth to the main towers:** **$\Delta d=0$ or $\Delta d=-1$; at only $\Delta d=0$ $E_{cell} < E_{neighboring\_cell}$**
3. **Checking for $\Delta R<R_0$ (preliminary estimated $R_0 = 0.175$ at $|\eta|<2.4$)**
4. **Selected cells combined for secondary reconstruction**

"Mini" tasks

1. **investigation and development of active cells selection (MC)**
2. **Investigation of EM and Hadron showers characteristics depending on the energy and the composite particles of jet (MC + BeamTest)**
3. **Investigation of Magnetic field influence with the new segmentation (MC)**
4. **Investigation of boundary effects influence on the showers with the new segmentation (MC + BeamTest) etc**

TTH process at 8 TeV

Associated *Higgs* production with *Top* quarks



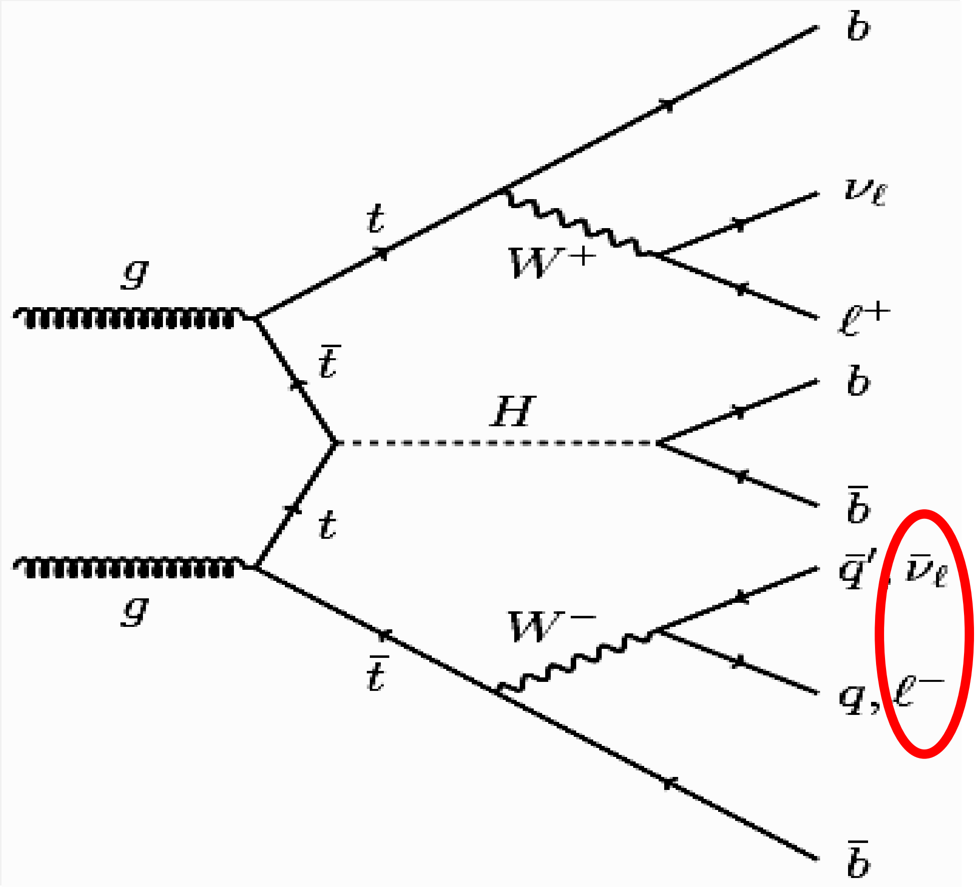
$\sigma \approx 0.12$ pb at 8 TeV

L=19.6 fb^{-1}

TTH dilepton channel

$H \to b\bar{b}$ branching **~ 68%**

$W \to l\,\nu$ branching **~ 21%** **(** $l = e,\mu$ **)**



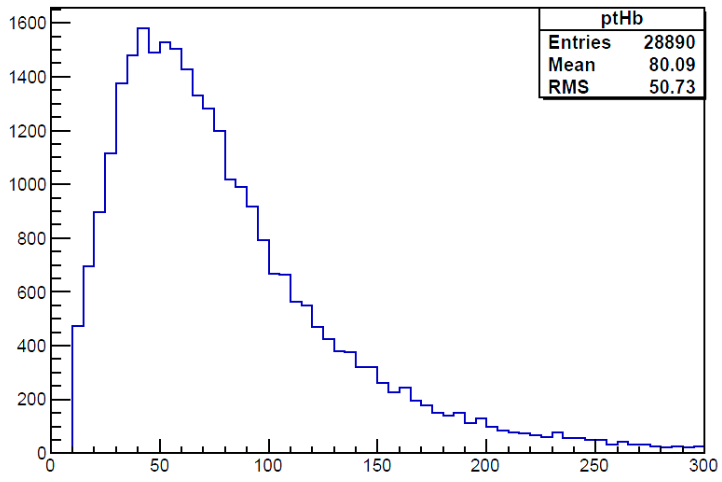
branching **~ 3 %**

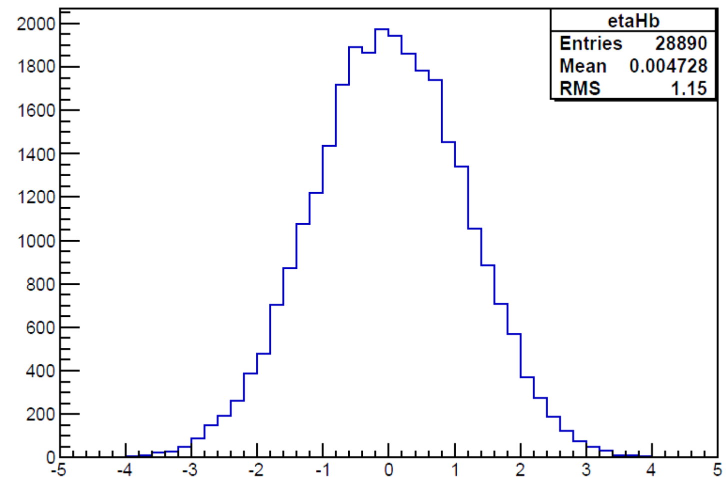
$\sigma \approx 3.5$ fb

~ 70 Events

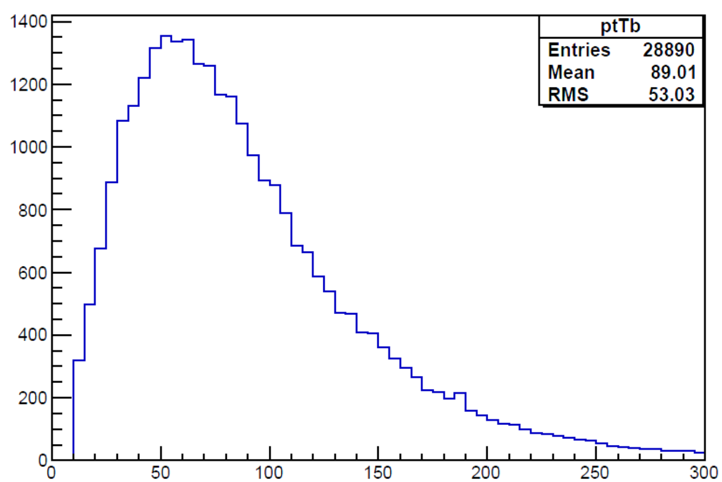
Kinematic Distributions of Objects

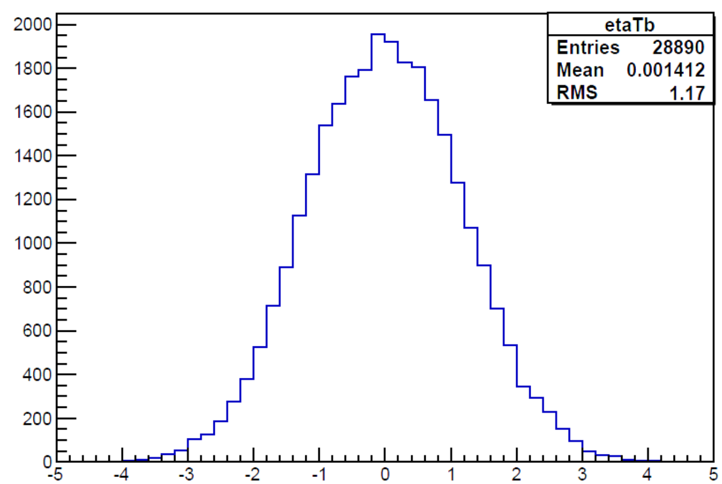
B-jets from H decay





B-jets from Top decay





Event Selection

Require:

- **A pair of oppositely charged, isolated, energetic leptons** (**2 electrons**, **2 muons** or **1 electron and 1 muon**)

$p_t L_1 > 20$ GeV, $p_t L_2 > 10$ GeV, $|\eta| < 2.5$ – For electrons,

$|\eta L_1| < 2.1$, $|\eta L_2| < 2.4$ – For muons

- **3 or more jets, with at least two of the jets being b-tagged:**

$p_t > 30$ GeV, $|\eta| < 2.5$ – anti-k_T algorithm (R=0.5)

b-jets identification – Combined Secondary Vertex (CSV) algorithm

CMS PAS HIG-13-019

CMS results as of 2013/07/26

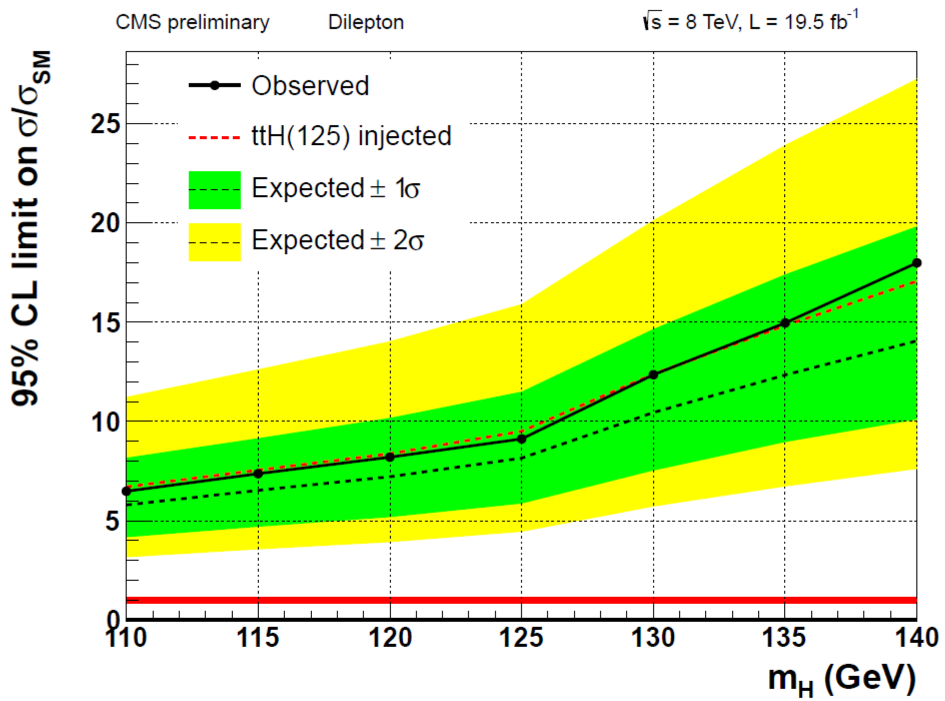


Figure 10: The observed and expected 95% CL upper limits on the signal strength parameter $\mu = \sigma/\sigma_{SM}$ for the dilepton channel using the 2012 dataset.

Conclusion

Combining the results from the lepton + jets, dilepton and tau channels, the observed and expected limits on the cross section for Higgs boson production in association with top-quark pairs for a Higgs boson mass of 125 GeV are 5.2 and 4.1 times the standard model expectation, respectively. The best-fit value for the signal strength μ is $0.85^{+2.47}_{-2.41}$ (68% CL).

CMS PAS HIG-13-019

Higgs mass reconstruction

LO scenario:

4 jets approximately similar by kinematic characteristics i.e. 6 possible combinations for jet-jet invariant mass.

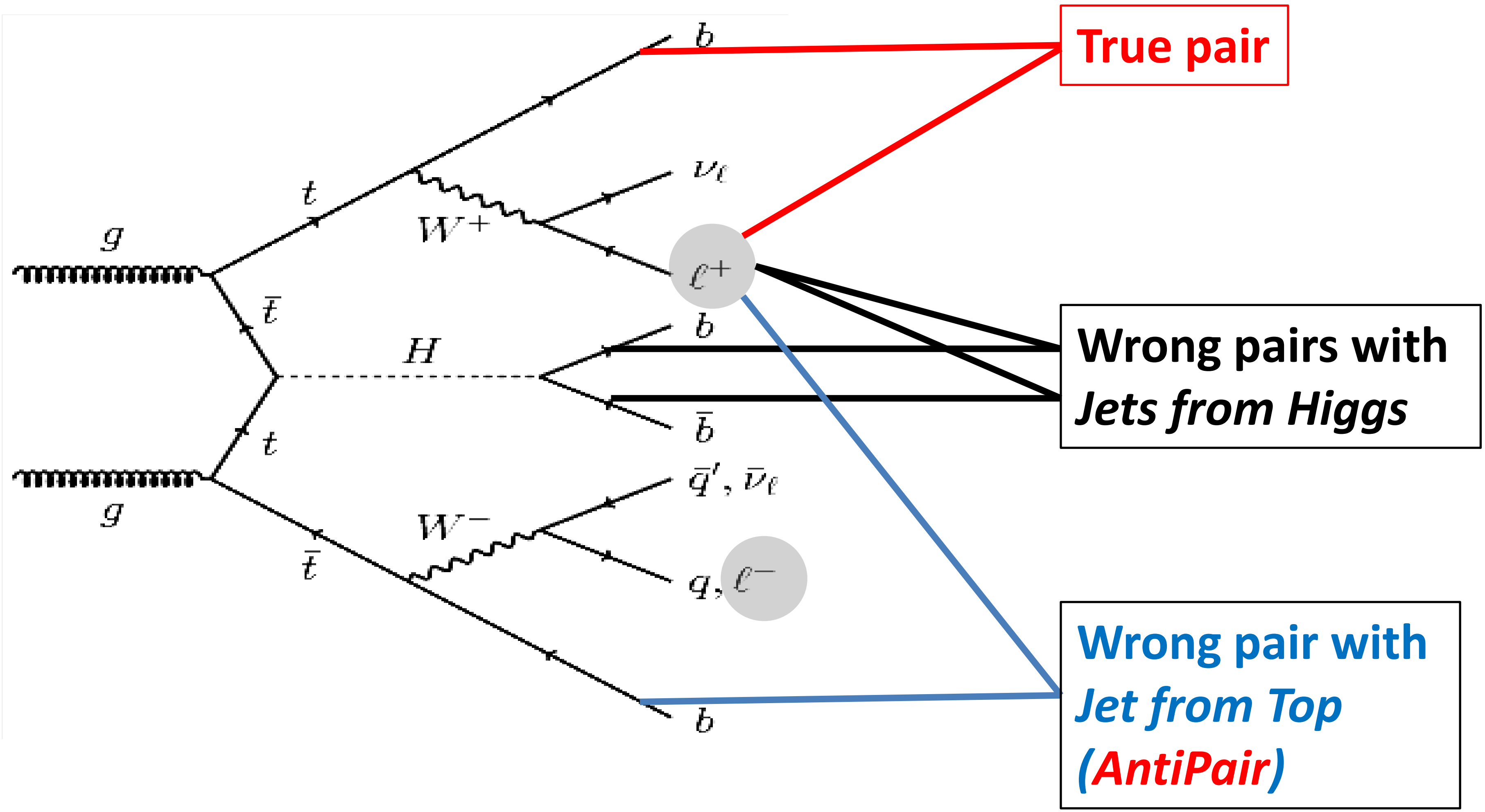
NLO scenario:

4 LO-jets + 1(2,3,…) additional jets i.e. 10(15,21,…) possible combinations for jet-jet invariant mass.

Needs additional conditions for identification of jets from *H* decay.

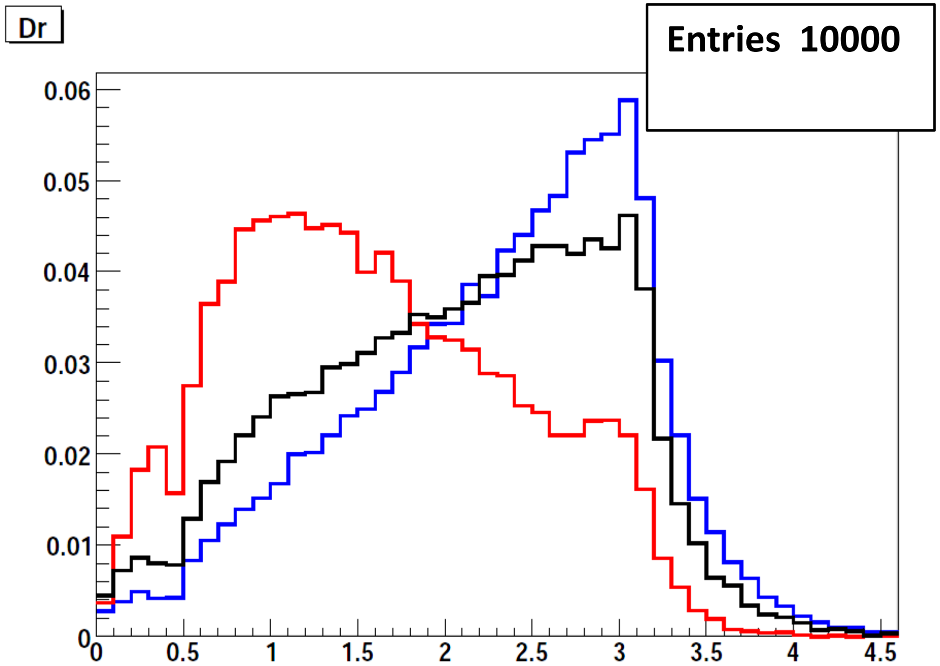
Additional Conditions

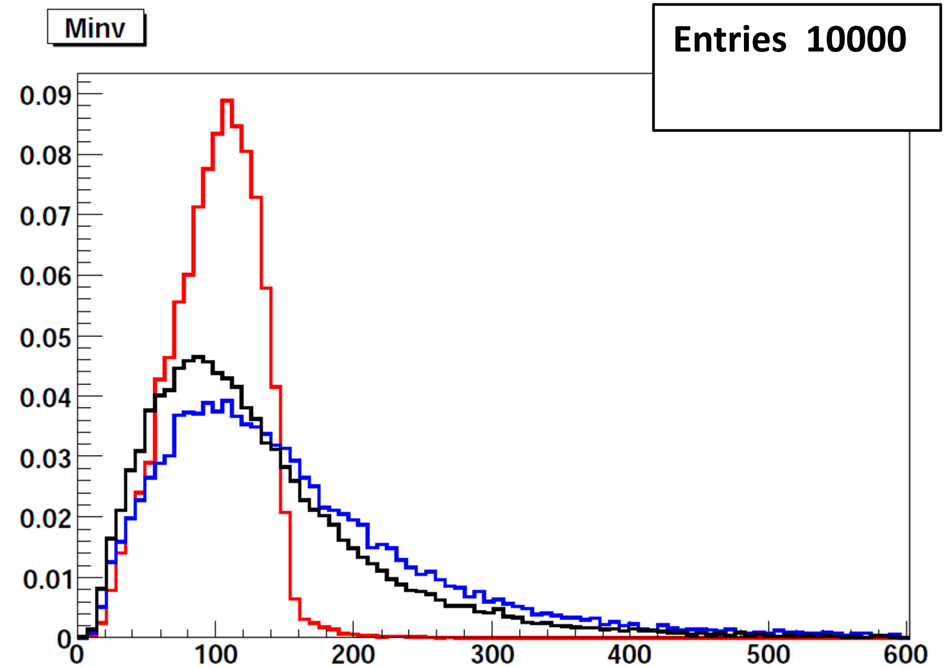
Lepton-Jet correlation:



Lepton-jet correlation

Normalized distributions:



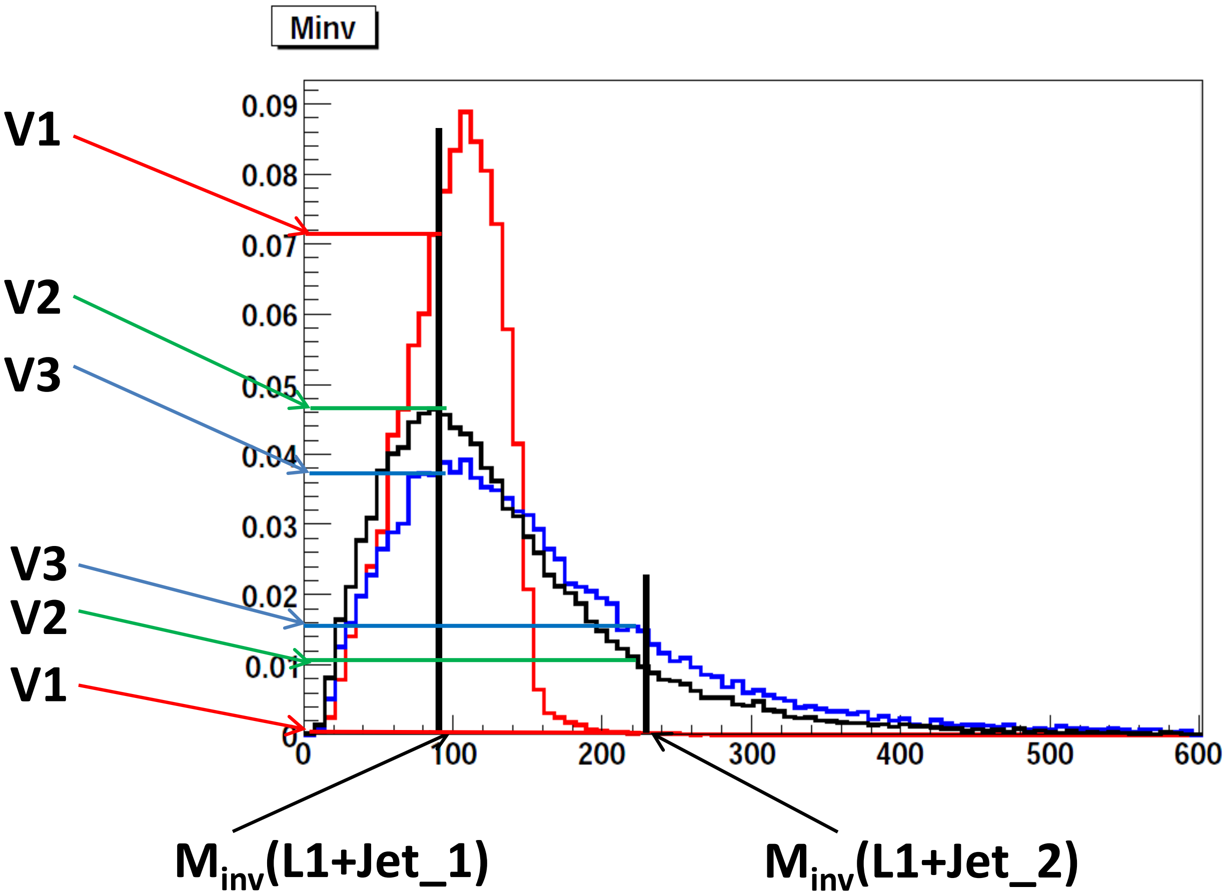


True pair

Wrong pairs with *Jet from Higgs*

Wrong pair with *Jet from Top (Antipair)*

Distribution functions



L1_pair $= \dfrac{V1}{V1+V2+2\times V3}$

L1_AntiPair $= \dfrac{V2}{V1+V2+2\times V3}$

L1_Higgs_b1 $= \dfrac{V3}{V1+V2+2\times V3}$

Jet_1 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *L1_Higgs_b2*}

Jet_2 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *L1_Higgs_b2*}

Jet_3 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *L1_Higgs_b2*}

Jet_4 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *L1_Higgs_b2*}

Distribution functions

First step:

Jet(i) {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *L1_Higgs_b2*} (i=1,2,3,4)

Where

L1_pair **=** ***L1_pair_Minv*** **x** ***L2_AntiPair_Minv*** **x** ***L1_pair_Dr*** **x** ***L2_AntiPair_Dr*** **x** $\frac{1}{S}$

L1_AntiPair **=** ***L1_AntiPair_Minv*** **x** ***L2_pair_Minv*** **x** ***L1_AntiPair_Dr*** **x** ***L2_pair_Dr*** **x** $\frac{1}{S}$

L1_Higgs_b1 **=** ***L1_Higgs_b1_Minv*** **x** ***L2_Higgs_b1_Minv*** **x** ***L1_AntiPair_Dr*** **x**

x ***L1_Higgs_b1_Dr*** **x** ***L2_Higgs_b1_Dr*** **x** $\frac{1}{S}$

L1_Higgs_b2 **=** ***L1_Higgs_b1***

S – normalizing factor for

L1_pair **+** ***L1_AntiPair*** **+** ***L1_Higgs_b1*** **+** ***L1_Higgs_b2*** **= 1**

Distribution functions: First Step

	Ideal scenario	Usual scenario
L1_pair	34.4155 32.1887 16.6979 16.6979	39.5351 22.4174 19.0238 19.0238
L2_pair	0 68.9314 15.5343 15.534	31.1602 19.8722 24.4838 24.4838
Higgs_b	0 0 50 50	37.5137 20.7938 20.8462 20.8462
Higgs_b	0 0 50 50	18.9374 23.1907 28.936 28.936

Identification of one of b-jets from H decay with accuracy 68 % (Jet with highest Higgs_b).

Possible increase to 74 %

Identification of pair of b-jets from H decay with accuracy 30 % (Tow Jets with highest Higgs_b factors).

Distribution functions: Second Step

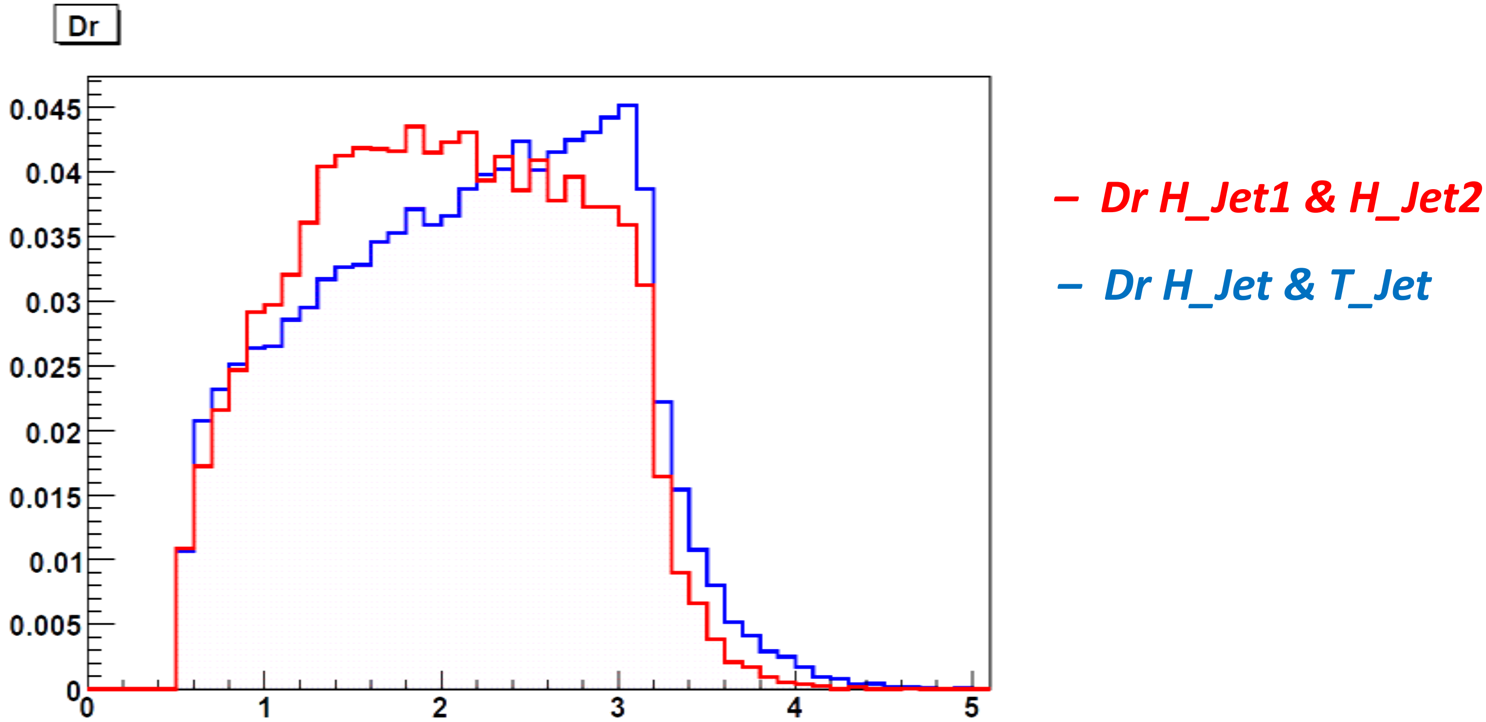
Remove founded jet from Higgs decay from the list of jets and than normalizing ather jets functions:

Jet_1 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *0*}

Jet_2 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *0*}

Jet_3 {*L1_pair*; *L1_AntiPair*; *L1_Higgs_b1*; *0*}

Jet_4 = 0



Distribution functions: Second Step

	Ideal scenario	Usual scenario 1	Usual scenario 2
L1_pair	82.1298 0 17.8702 0	46.6464 25.6945 27.6591 0	70.6968 0 29.3032 0
L2_pair	0 73.9892 26.0108 0	0 86.8776 13.1224 0	0. 42898 71.3389 28.2321 0
Higgs_b	0 0 100 0	43.6167 23.8449 32.5383 0	0.0407 89.083 10.8763 0

Identification of one of b-jets from Top decay with accuracy 82 %.

Distribution functions: Third Step

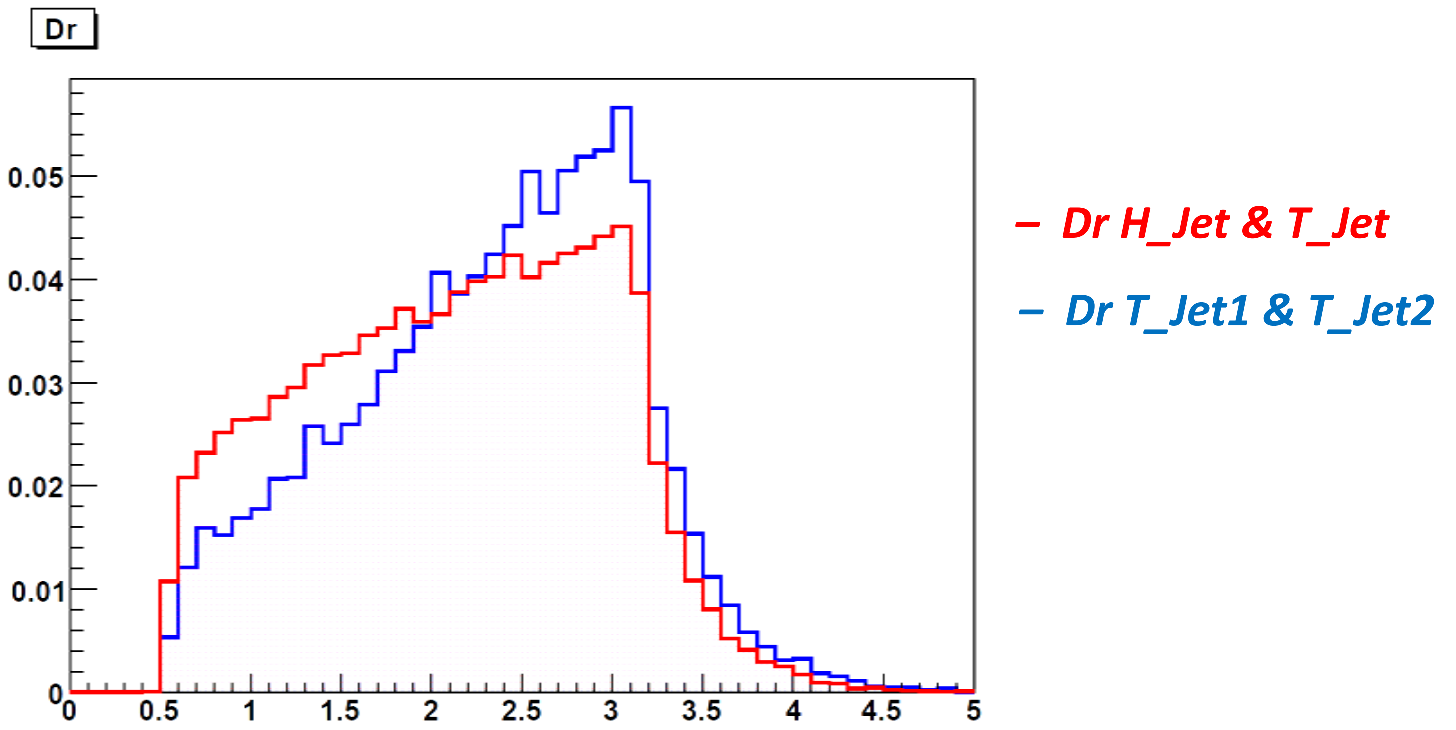
Remove founded jet from Top from the list of jets and than normalizing other jets functions:

Jet_1 = 0

Jet_2 {*0*; *L1_AntiPair*; *L1_Higgs_b1*; *0*}

Jet_3 {*0*; *L1_AntiPair*; *L1_Higgs_b1*; *0*}

Jet_4 = 0



Distribution functions: Third Step

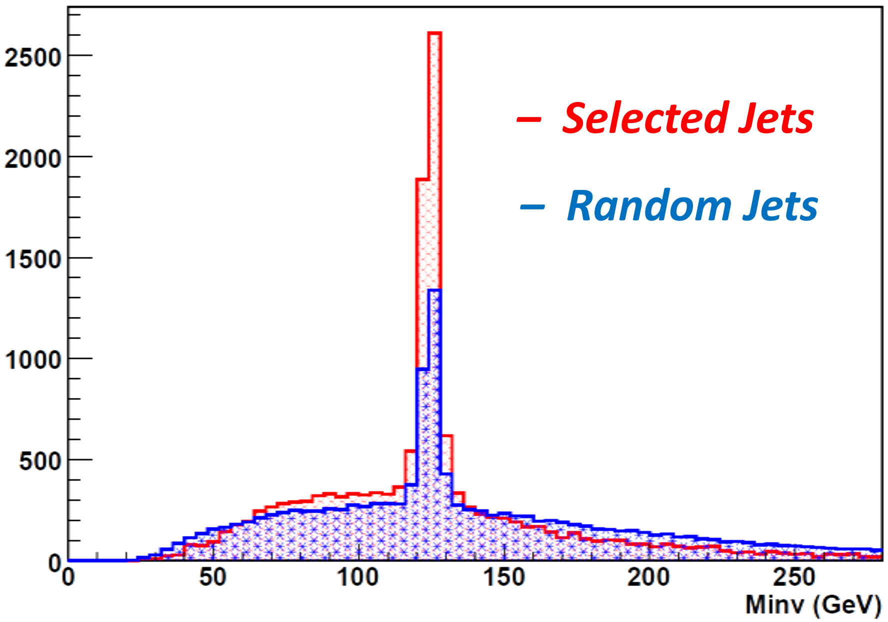
	Usual scenario
L2_pair	0 76.0673 23.9327 0
Higgs_b	0 51.8378 48.1622 0

Identification of second b-jets from H decay with accuracy 64 % (Jet with highest Higgs_b).

Total efficiency for selection of pair of jets from Higgs decay 36%.

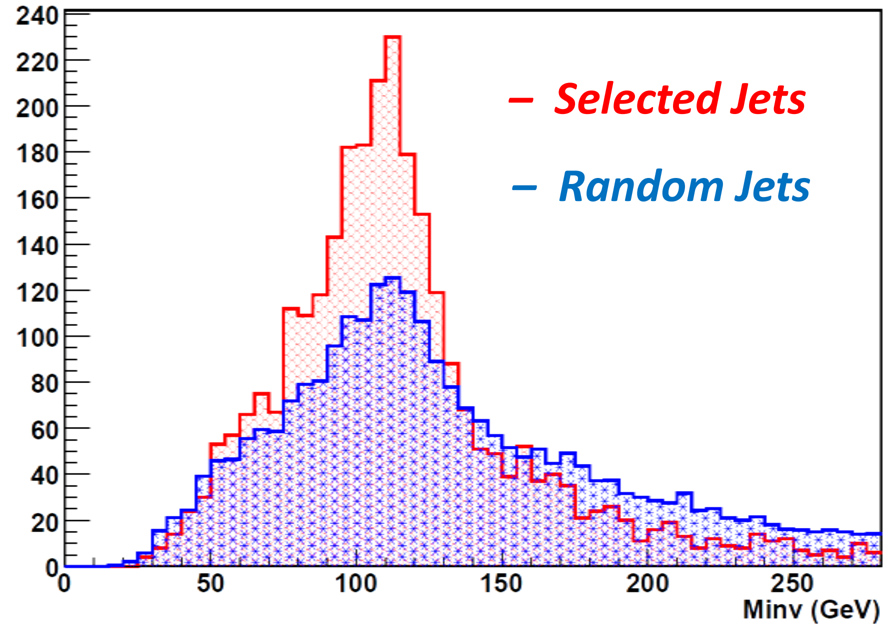
Possible increase to 40 %.

Invariant mass of selected jets



← ***Generation Level***

Reconstruction →



Plans

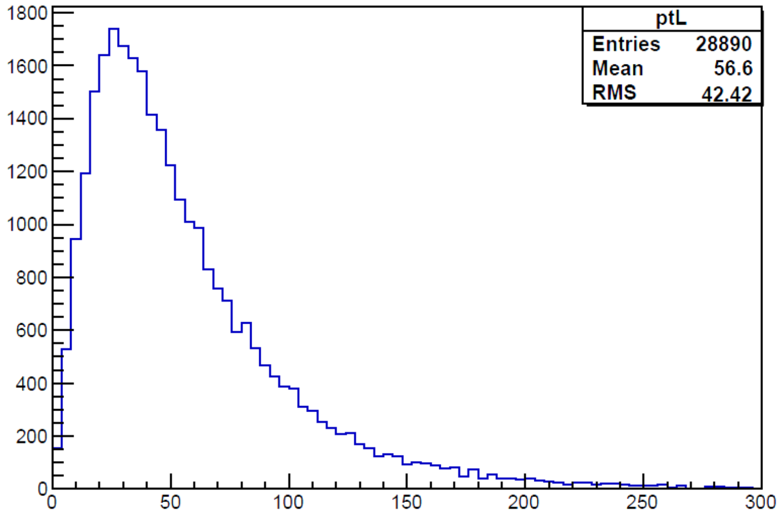
- **Check Algorithm on background process**
- **Check possibilities of Lepton – Jet charge correlation**
- **Check possibilities of NLO-Jet – LO-Jet correlation**

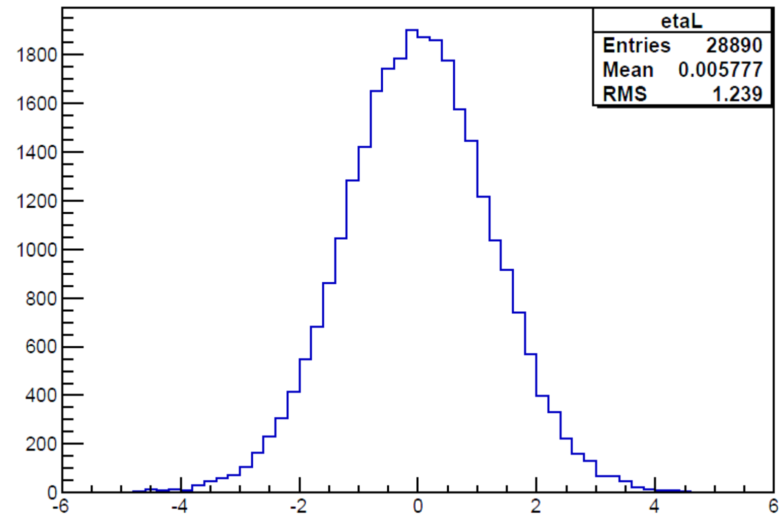
Work on MC with 14 TeV

Thank You

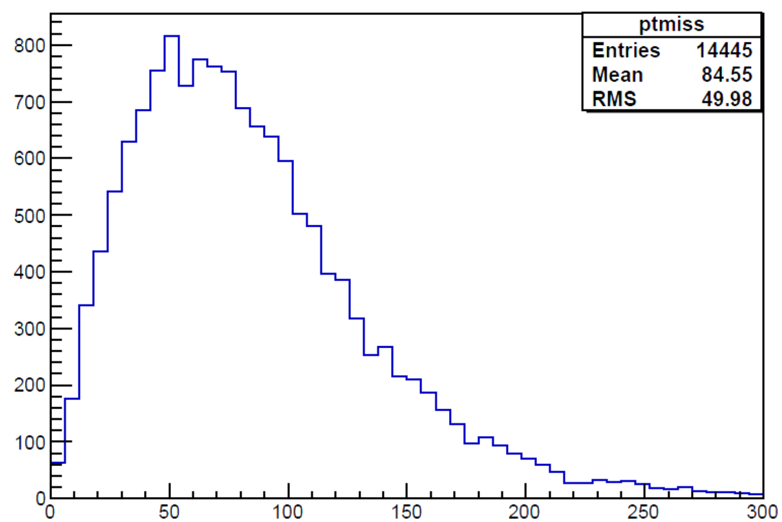
Kinematic Distributions of Objects

Charged Leptons (e, μ) form W decay



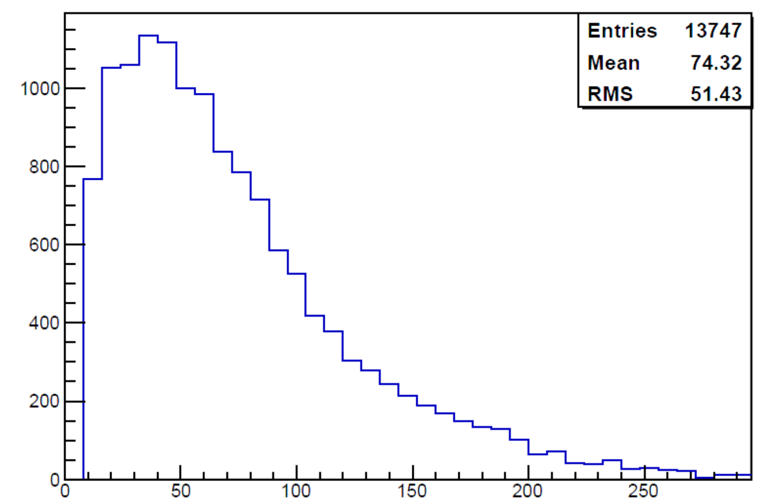


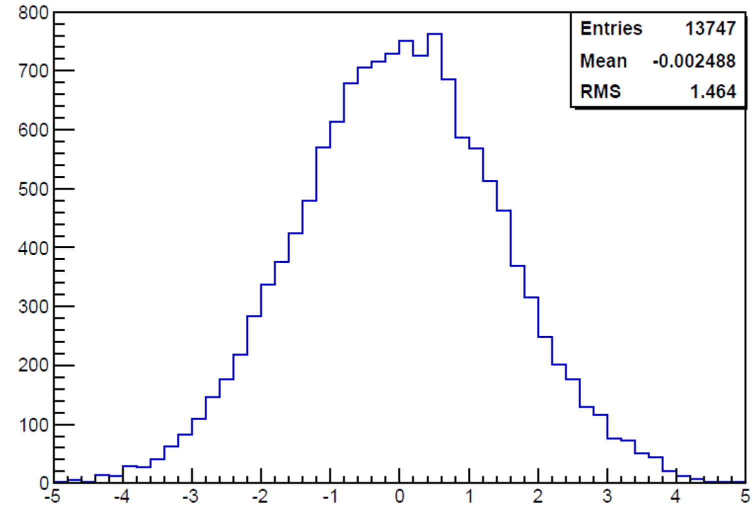
Total missing transverse momentum: $p_t(P_{\nu 1}+P_{\nu 1})$



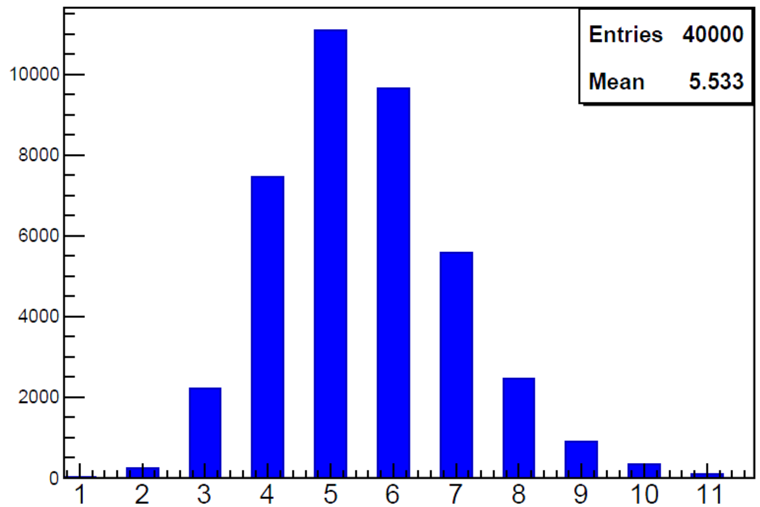
Kinematic Distributions of Objects

NLO jet wit highest transverse momentum





Number of jets with p_t>20 GeV/c



With ~ 63%, for NLO jet with highest p_t: p_t > 20 GeV, |η|<2.5, and p_t is higher than pt of one LO jet.

In general NLO jets produced from light quarks and gluons