The Study of ZH->vvqq

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Tohoku University
Kohei Yoshida

Introduction

- **Target value : ΔBr(H->cc), ΔBr(H->bb)**
- $E_{C.M.}$: 250 GeV
- Integrated luminosity : 250 fb^{-1}
- Polarization : e^+(+30%), e^-(-80%)

- Signal : 2 jets in final states

$\nu_e\nu_e h$	$\nu_\mu\nu_\mu h$	$\nu_\tau\nu_\tau h$	Total
9.09E+03	5.14E+03	5.14E+03	1.94E+04

- Background : 4 fermion in final states

vvll	vlqq	qqqq	vvqq	llqq	llll	Total
1.11E+06	4.11E+06	4.05E+06	1.50E+05	3.94E+05	7.63E+05	1.06E+07

Analysis outline

1.Reconstruction as 2jets

2.Background rejection

- missing mass cut
- momentum cut (P_T, P_L, mom^{max})
- lepton ID cut (N_{lepton})
- y value cut (YPlus, YMinus)

3.Preparation of H->bb-sample, H->cc-sample

- flavor-tag (b-, c-, bc-tag)

4.Fitting of Higgs mass distribution

- estimation of N_{vvH} in bb-sample/cc-sample

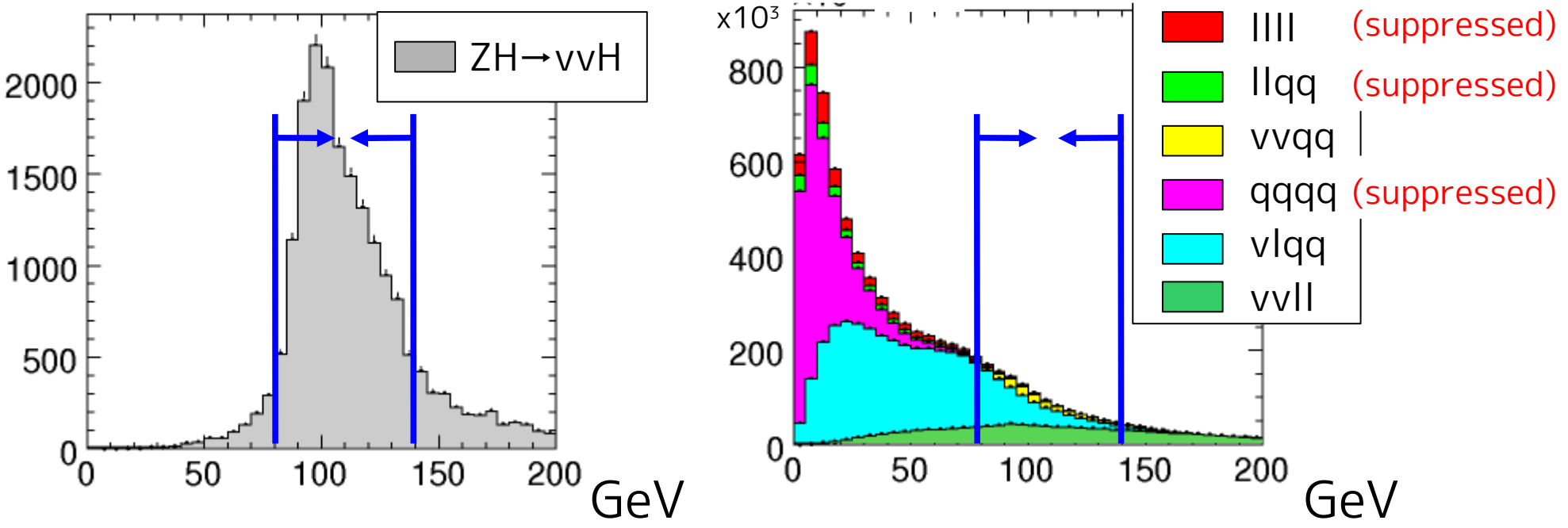
5.Estimation of measurement accuracy of branching ratio

Missing mass cut

To select Z->νν events, missing mass cut was applied.

80 GeV < missing mass < 140 GeV

The distributions of reconstructed missing mass

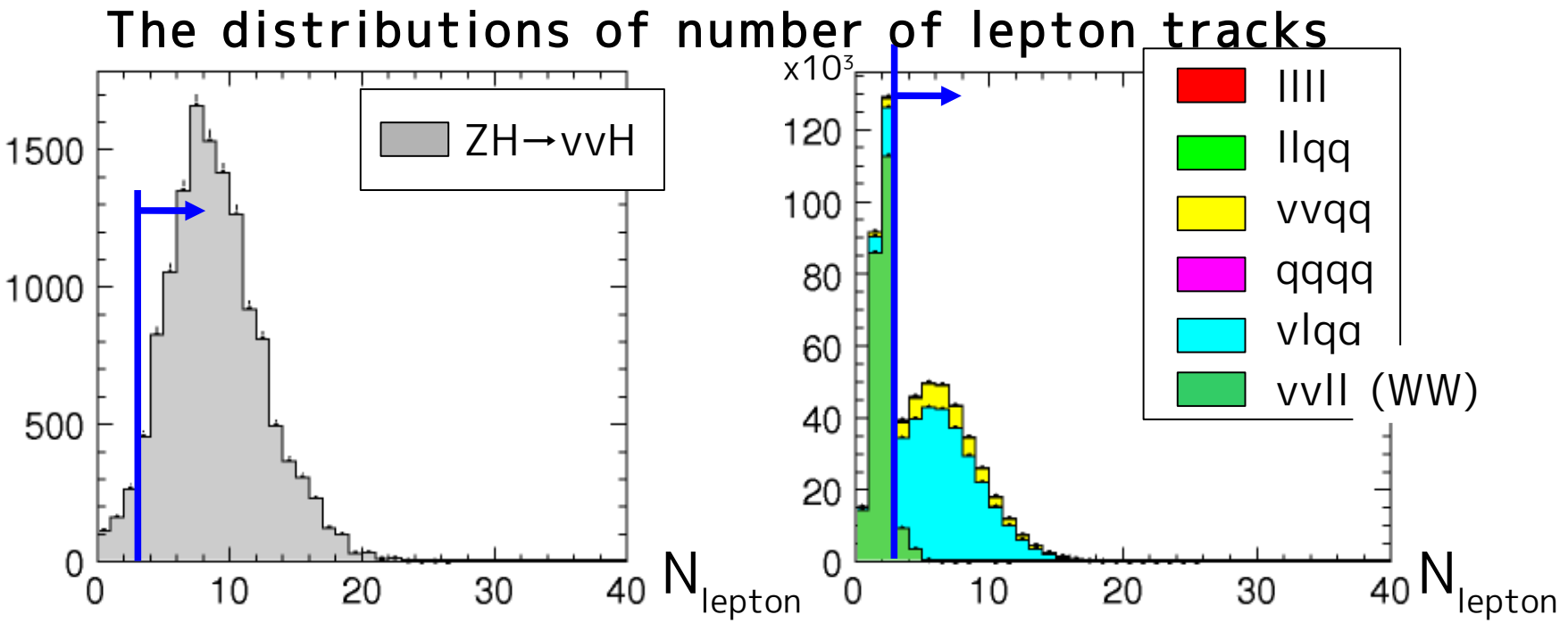


llll, llqq, and qqqq were suppressed.

N_{lepton} cut

To reject WW(W->vl) events,
the number of lepton tracks was checked.

-> We required $N_{lepton} > 3$.



WW(W->vl) events were suppressed.

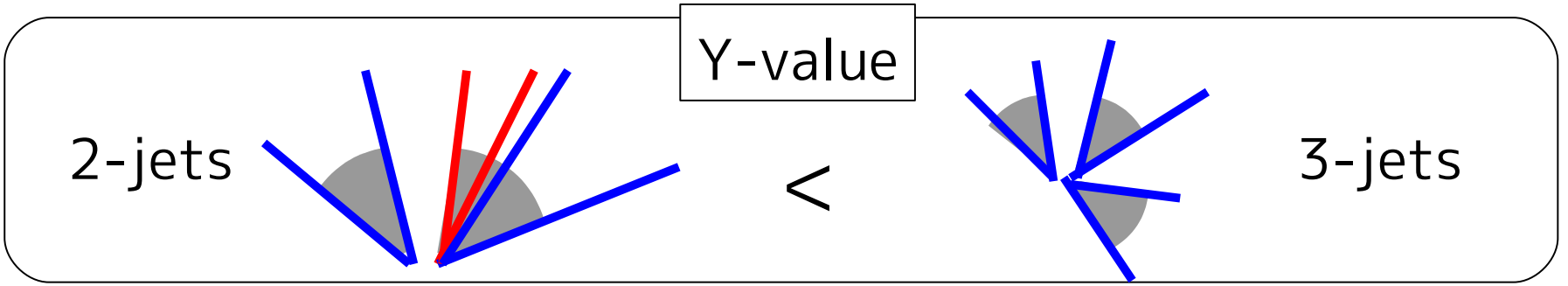
$\tau\nu_\tau qq$ events become main backgound.

YPlus Cut

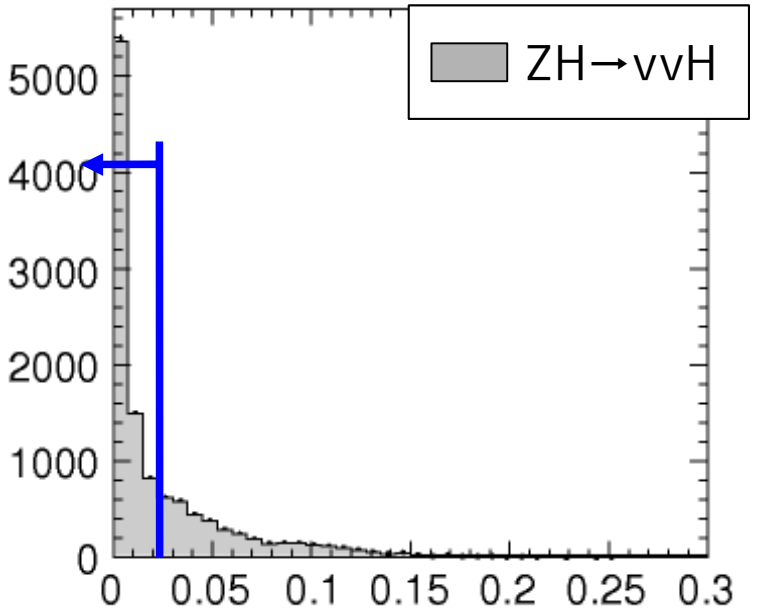
YPlus < 0.02 was selected to reject $\tau\nu_\tau qq$ events.

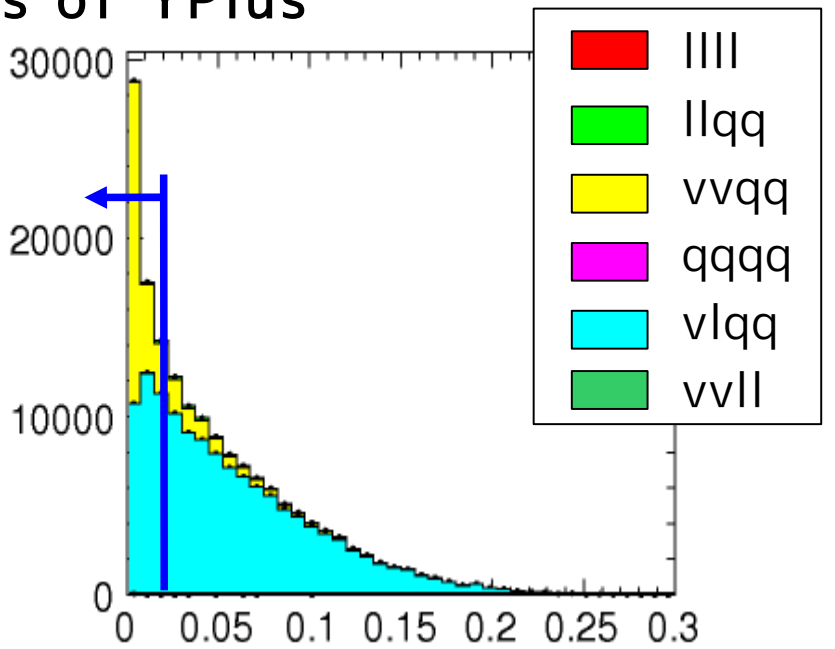
YPlus: y-value to reconstruct as 3(2+1)-jets

To reconstruct 2-jets as 3-jets, y-value should be small.



The distributions of YPlus



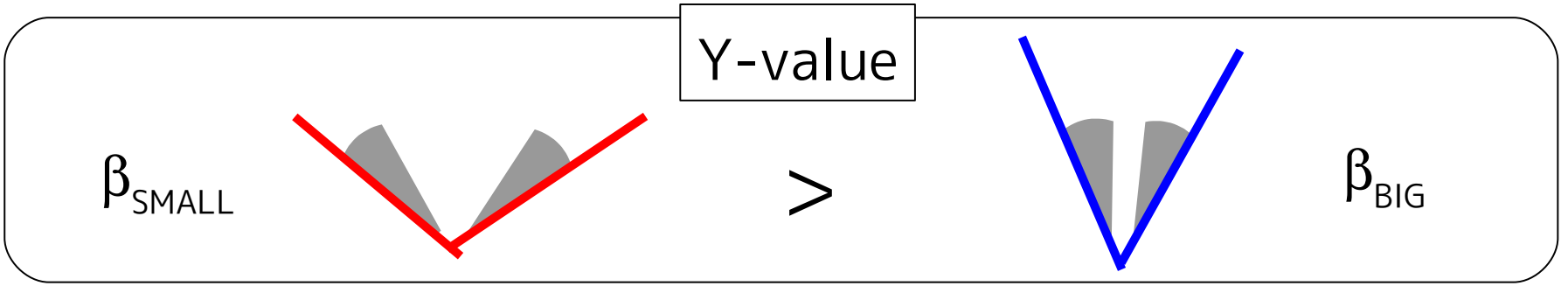


YMinus Cut

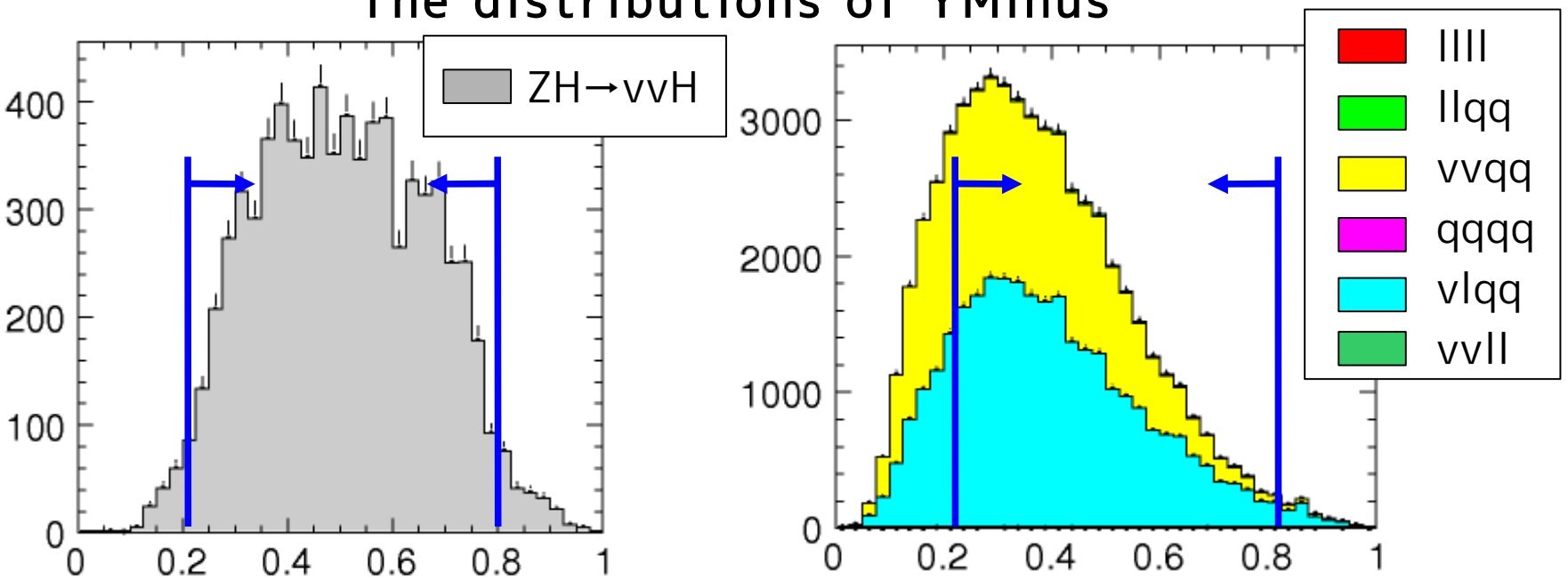
$\tau\nu_\tau qq$ events were rejected by requirement 0.2 < Yminus < 0.8.

Yminus: y-value to reconstruct as 1(2-1) jet

Y-value of Signal is bigger than that of WW, ZZ because of β.



The distributions of YMinus



Reduction summary

Background events were rejected efficiently by selection cuts.

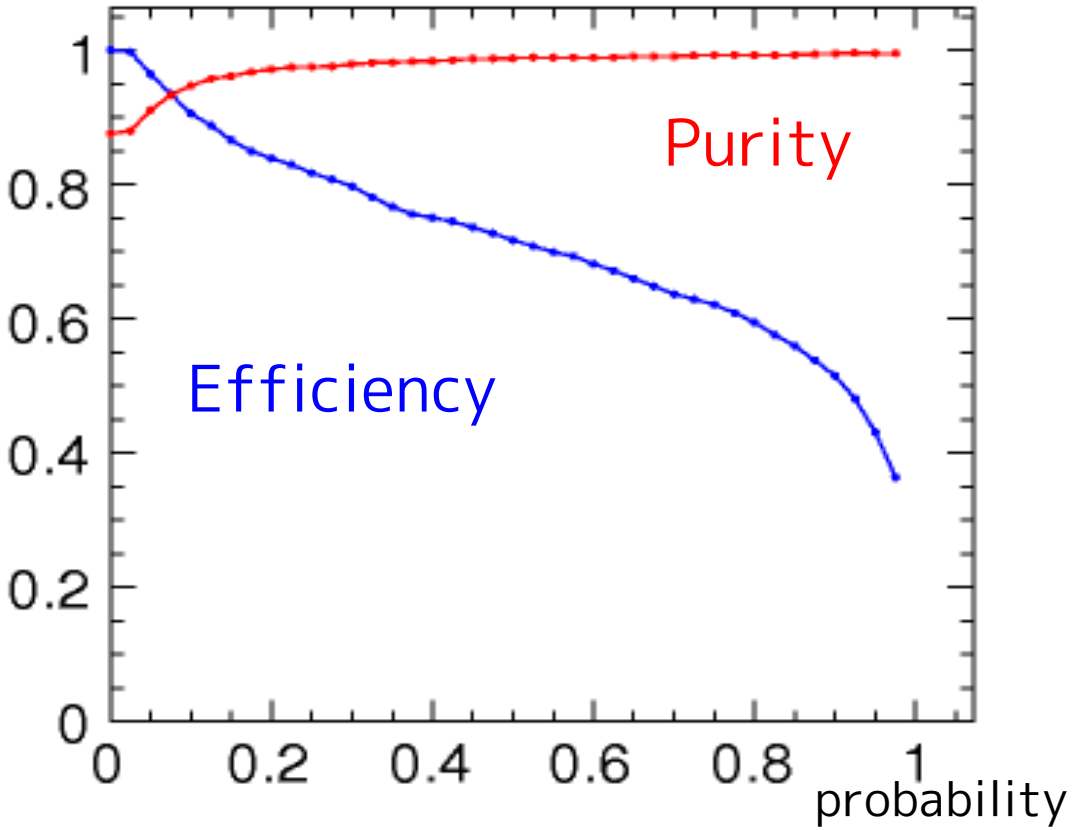
	$\nu\bar{\nu}H$	$\tau\nu_\tau qq$	$\mu\nu_\mu qq$	$e\nu_e qq$	$\nu_\tau\bar{\nu}_\tau qq$	$\nu_\mu\bar{\nu}_\mu qq$	$\nu_e\bar{\nu}_e qq$	other
nocut	19360	1326061	1327332	1460797	43446	43449	63085	6318190
M_Z	15684	386690	92360	81000	37936	37923	48985	491614
P_T	13918	268190	75143	67191	25545	25615	34614	337839
P_L	13534	200442	61715	61473	14062	14025	21658	266334
Nlepton	12540	167735	53994	27033	11698	11678	17936	6881
Mom^{max}	11502	114465	10382	5210	9499	9482	14893	2025
Yplus	7409	27228	2642	962	6989	6992	10980	435
Yminus	7054	23313	2188	845	5542	5544	9046	378
Efficiency	36.44%	1.76%	0.16%	0.06%	12.76%	12.76%	14.34%	0.01%

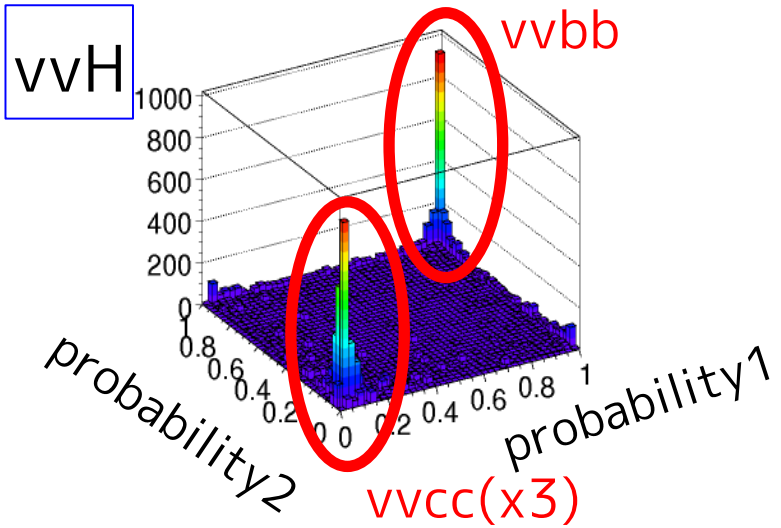
Efficiency

- Signal: 36.4%
- B.G.: 0.44%

Preparation of bb-sample with b-tag

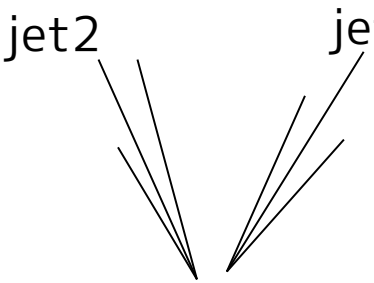
Efficiency and Purity of H->bb in ZH
for one jet after selection cuts





We applied b-tagging after the selection cuts
with b-prob1 >0.9 & b-prob2>0.9

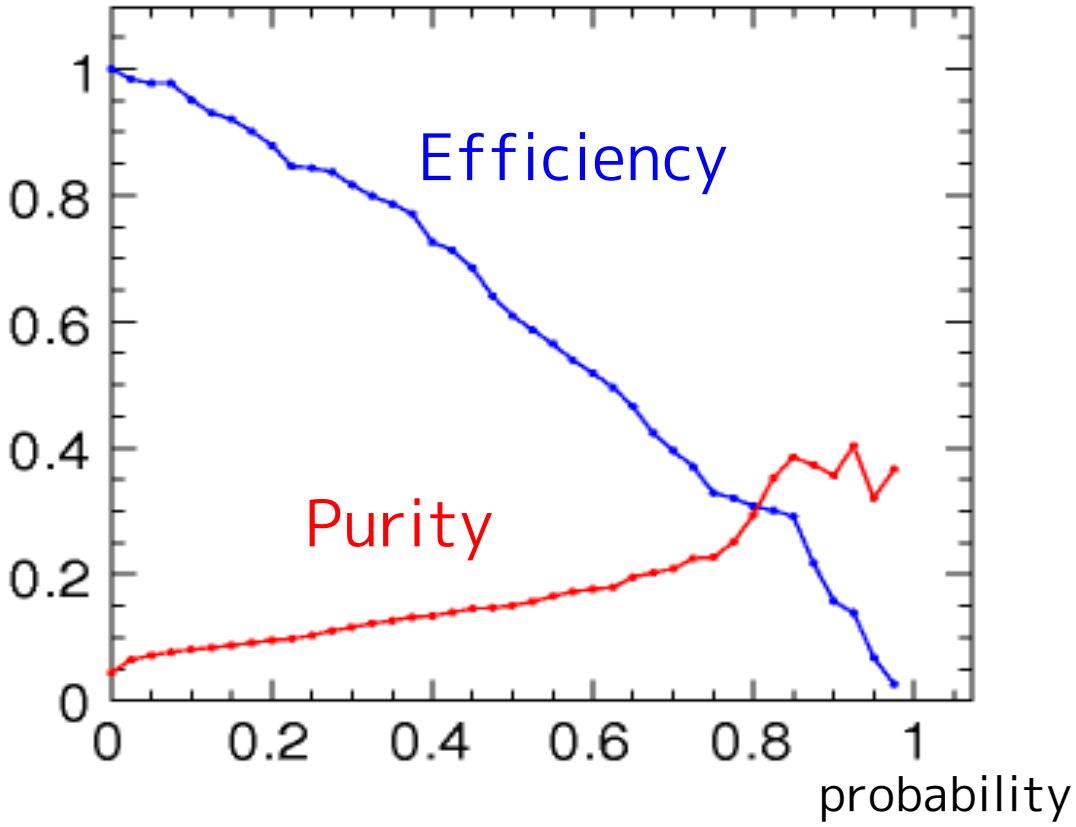
$\frac{N_{vvbb}}{N_{vvH}}$: 0.997

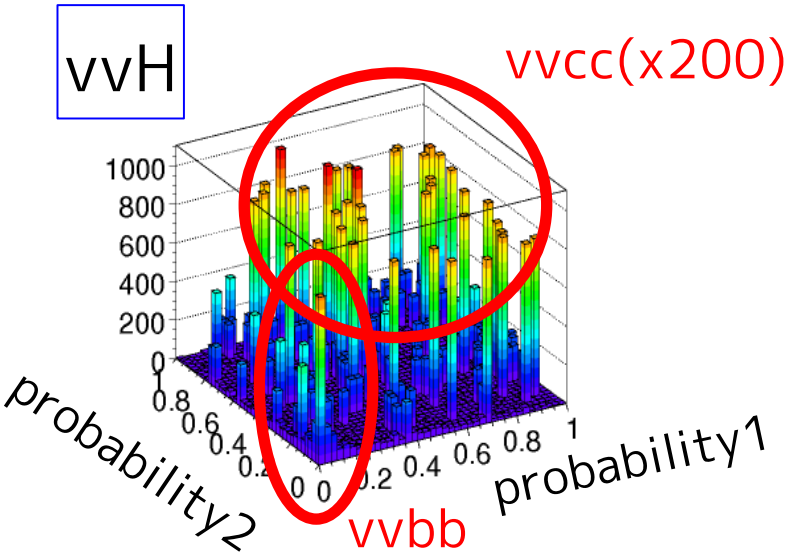


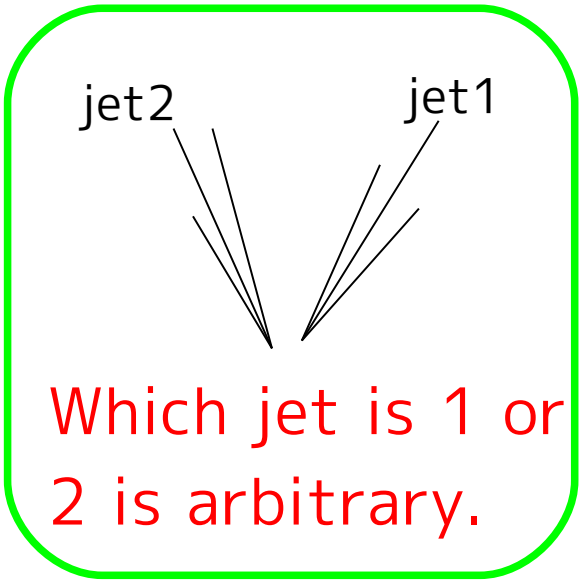
Which jet is 1 or 2 is arbitrary.

Preparation of cc-sample with c-tag

Efficiency and Purity of H->cc in ZH
for one jet after selection cuts





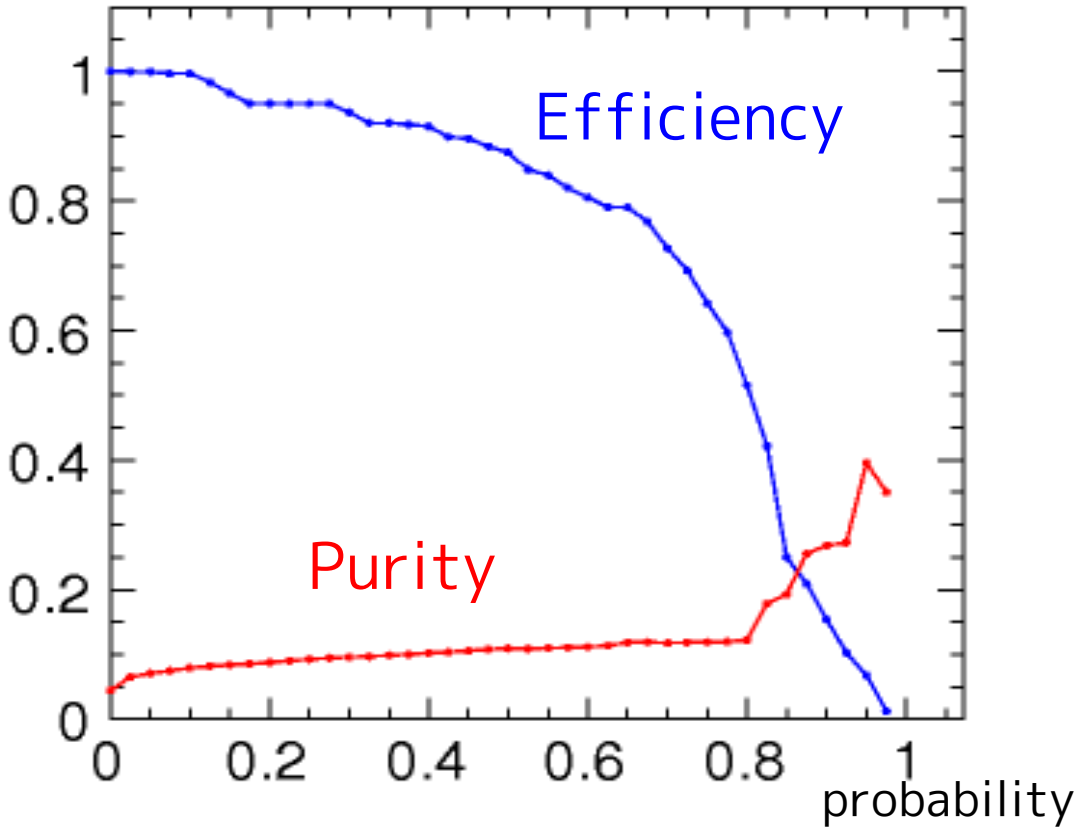


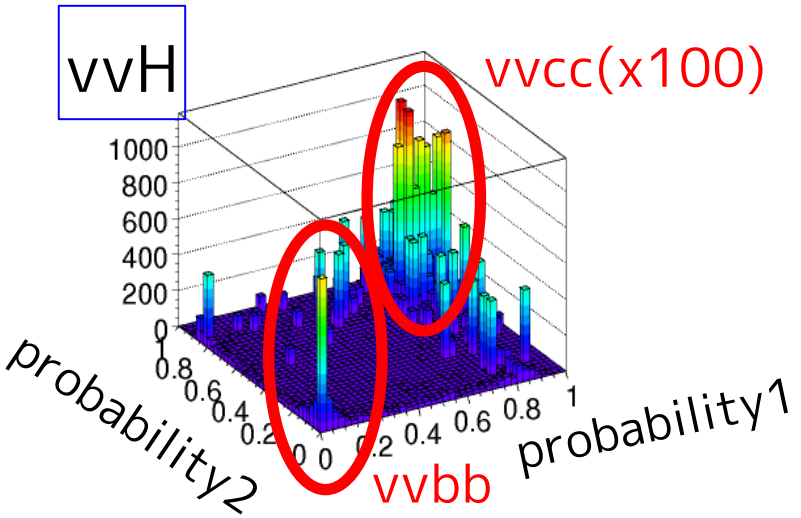
We applied c-tagging after the selection cuts with c-prob1 >0.8 OR c-prob2>0.8

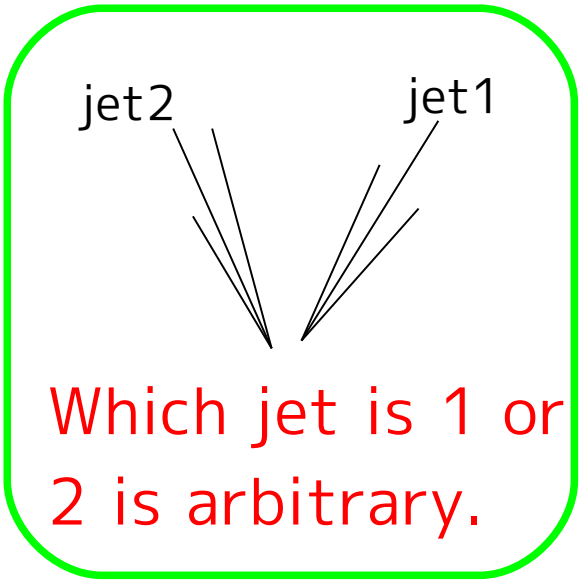
$\frac{N_{vvcc}}{N_{vvH}}$: 0.277

Preparation of cc-sample with bc-tag

Efficiency and Purity of H->cc in ZH
for one jet after selection cuts







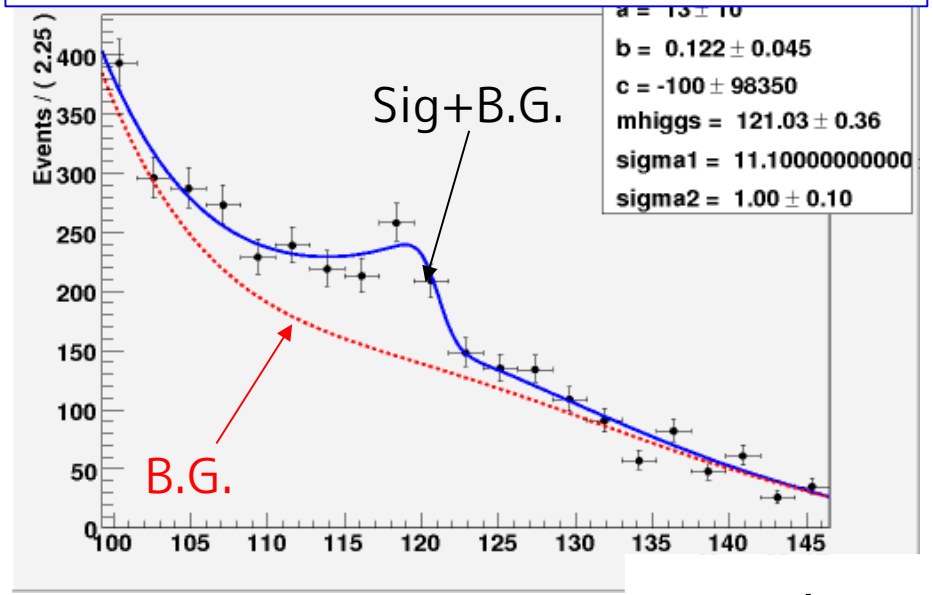
We applied bc-tagging after the selection cuts
with bc-prob1 >0.75 OR bc-prob2>0.75

$\frac{N_{vvcc}}{N_{vvH}}$: 0.11

Measurement accuracy of BR

- ΔN_{vvH}^{fit} and N_{vvH}^{fit} in cc-sample, bb-sample is estimated by fitting Sig+B.G.
  - ΔN_{vvH}^{fit}: statistical error of N_{vvH}^{fit}

Fitting result in cc-sample with c-tag



b-tagging

N_{vvH}^{fit} : 1792.5

ΔN_{vvH}^{fit} : 90.8

c-tagging

N_{vvH}^{fit} : 604

ΔN_{vvH}^{fit} : 195.2

bc-tagging

N_{vvH}^{fit} : 2494

ΔN_{vvH}^{fit} : 402.4

Measurement accuracy of BR

- The measurement accuracy of branching ratio of H→bb, H→cc are estimated by fitting result.

$$N'_{\nu\nu cc} = pN^{fit}_{\nu\nu H}$$

$$P: \frac{N_{\nu\nu cc}}{N_{\nu\nu H}}$$

Measurement accuracy

$$\frac{\Delta N'_{\nu\nu cc}}{N'_{\nu\nu cc}} = \frac{\sqrt{N^{fit2}_{\nu\nu H}\ \sigma^2_p + p^2 \Delta N^{fit2}_{\nu\nu H}}}{pN^{fit}_{\nu\nu H}}$$

ignored in this study

$$\frac{\Delta N'_{\nu\nu bb}}{N'_{\nu\nu bb}} = 5.1\% \text{ (b-tag)} \qquad \frac{\Delta N'_{\nu\nu cc}}{N'_{\nu\nu cc}} = 32.3\% \text{ (c-tag)}$$

$$= 16.1\% \text{ (bc-tag)}$$

Summary

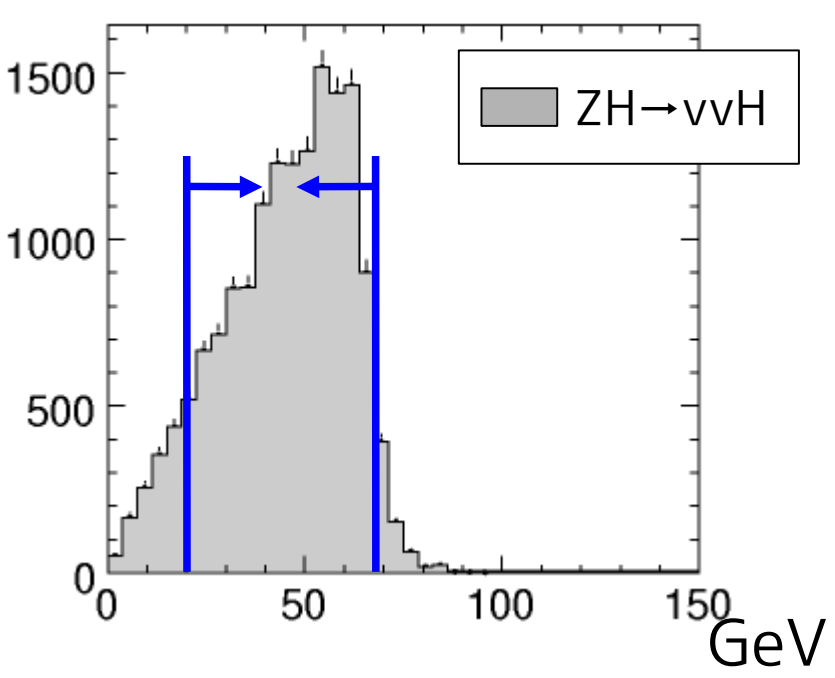
- The accuracy of the branching ratio of H→cc and H→bb were estimated by using ZH->vvqq.
  - ΔBr(H→bb) = 5.1 (b-tag)
  - ΔBr(H→cc) = 32.3% (c-tag)
  - ΔBr(H→cc) = 16.1 (bc-tag)

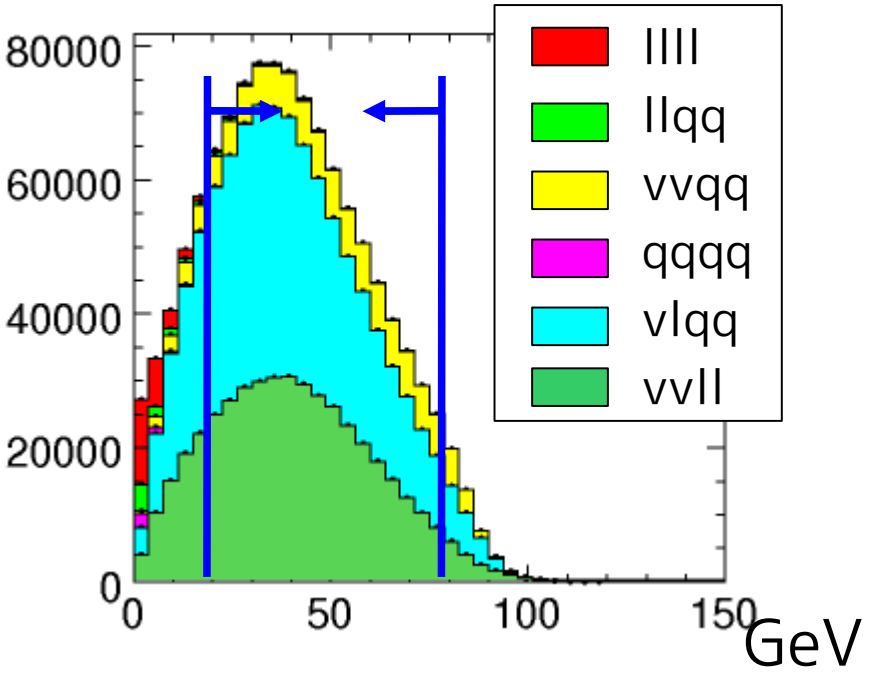
- The analysis note will be uploaded soon.

P_T cut

20 GeV < P_T < 70 GeV

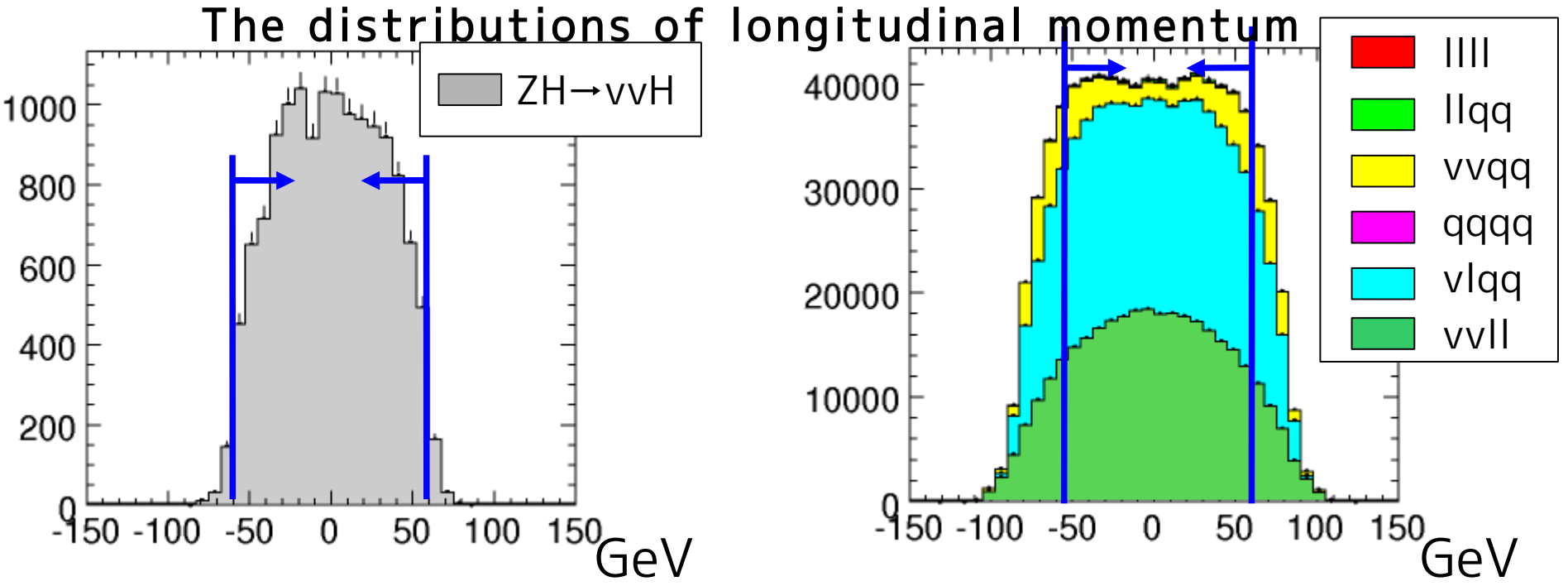
The distributions of transverse momentum





P_L cut

$-60\ \text{GeV} < P_L < 60\ \text{GeV}$

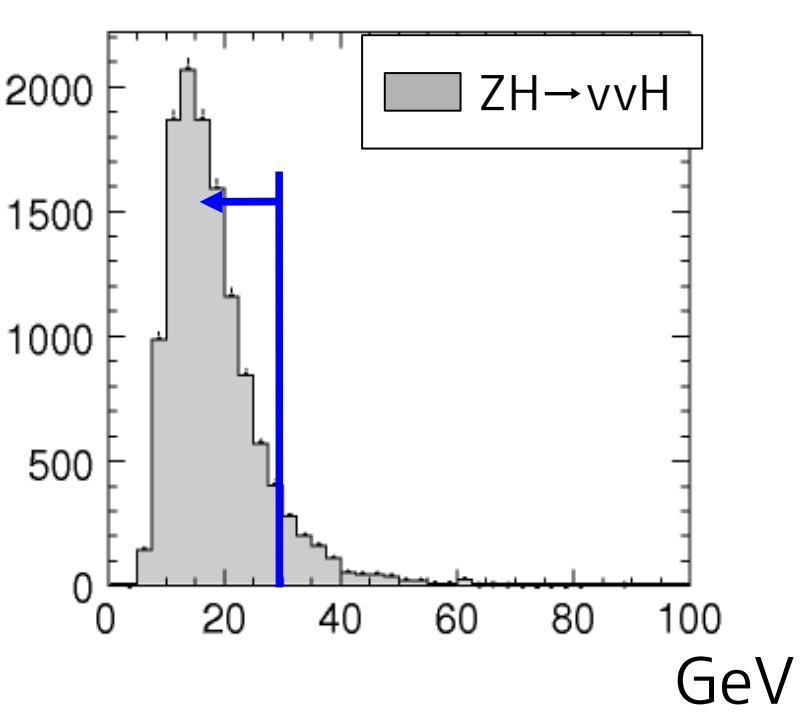


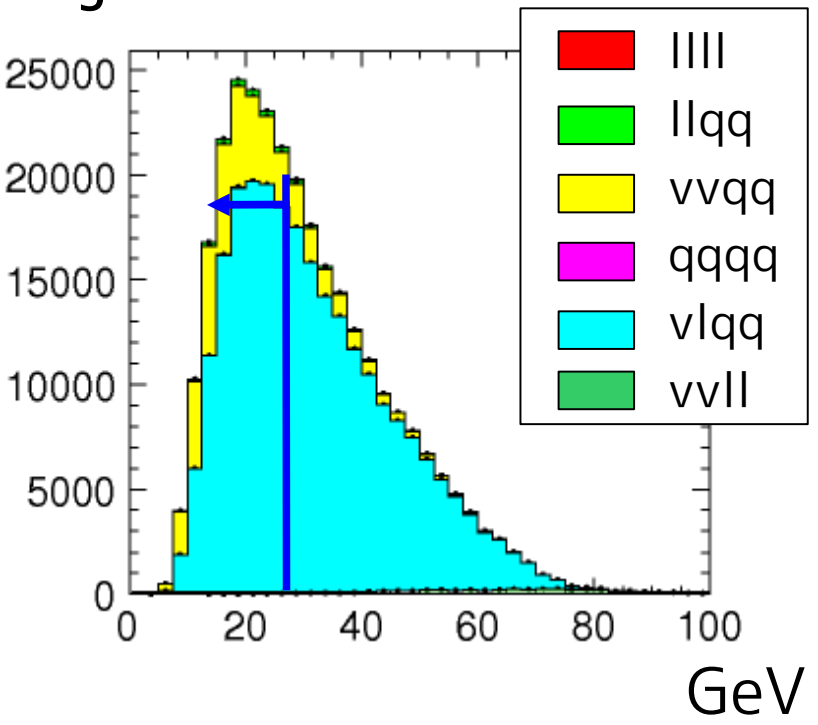
Momentum^{max} cut

Momentum^{max} is the highest momentum.

Momentum^{max} < 30GeV

The distributions of the highest momentum





Fit function

Signal

$$F(m) = N \int_{-m}^{M_H - m} dt (e^{B(m+t)} + C)(e^{-\frac{t^2}{2\sigma^2}} + Ae^{-\frac{t^2}{2\sigma'^2}})$$

Background

Chebychev polynomial