# Higgs to ss study

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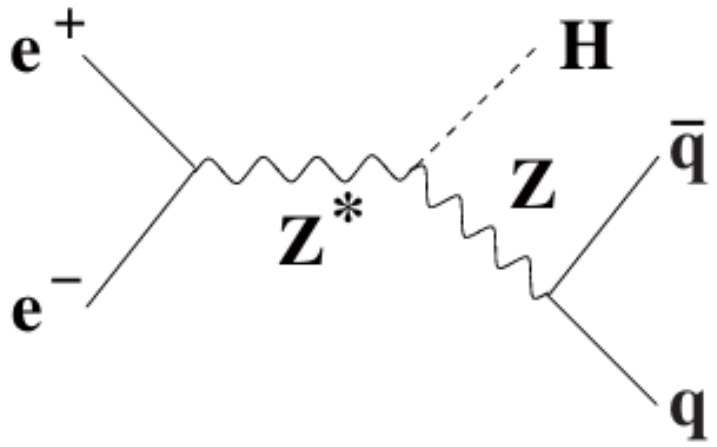
# Hadronic channel (qqH)




| 信号事象 | 反応断面積 $(fb^{-1})$ | 事象数 |
|---|---|---|
| $e^+e^- \to ZH \to q\bar{q}H$ | 210.028 | 52,507 |
| **背景事象** | **反応断面積 $(fb^{-1})$** | **事象数** |
| $e^+e^- \to \nu\bar{\nu}q\bar{q}$ | 600 | 149,979 |
| $e^+e^- \to q\bar{q}q\bar{q}$ | 16200 | 4,048,386 |
| $e^+e^- \to \nu\ell q\bar{q}$ | 16500 | 4,114,190 |
| $e^+e^- \to \ell^+\ell^- q\bar{q}$ | 1590 | 398,324 |
| $e^+e^- \to \nu\bar{\nu}\ell^+\ell^-$ | 4450 | 1,113,076 |
| $e^+e^- \to \ell^+\ell^-\ell^+\ell^-$ | 3050 | 762,973 |
| $e^+e^- \to q\bar{q}$ | 141000 | 35,353,277 |
| $e^+e^- \to gg$ | 34000 | 8,505,840 |

**This is the signal event**

Although the number of signal events is larger than in other processes, the number of background events is also larger, and efficient removal of background events is required.

There are four jets, two from the Higgs and two from the boson, and it is also important to correctly select the Higgs-decayed jet in the reconstruction.

reference document：東北大学大学院理学研究科 物理学専攻 吉田幸平「国際リニアコライダーにおける ヒッグス粒子の崩壊分岐比測定の研究」

# Hadronic channel Analysis Process (qqH)

(1)Thrust processor is used for signal events.

(2)Reconstruct with 4 jets.

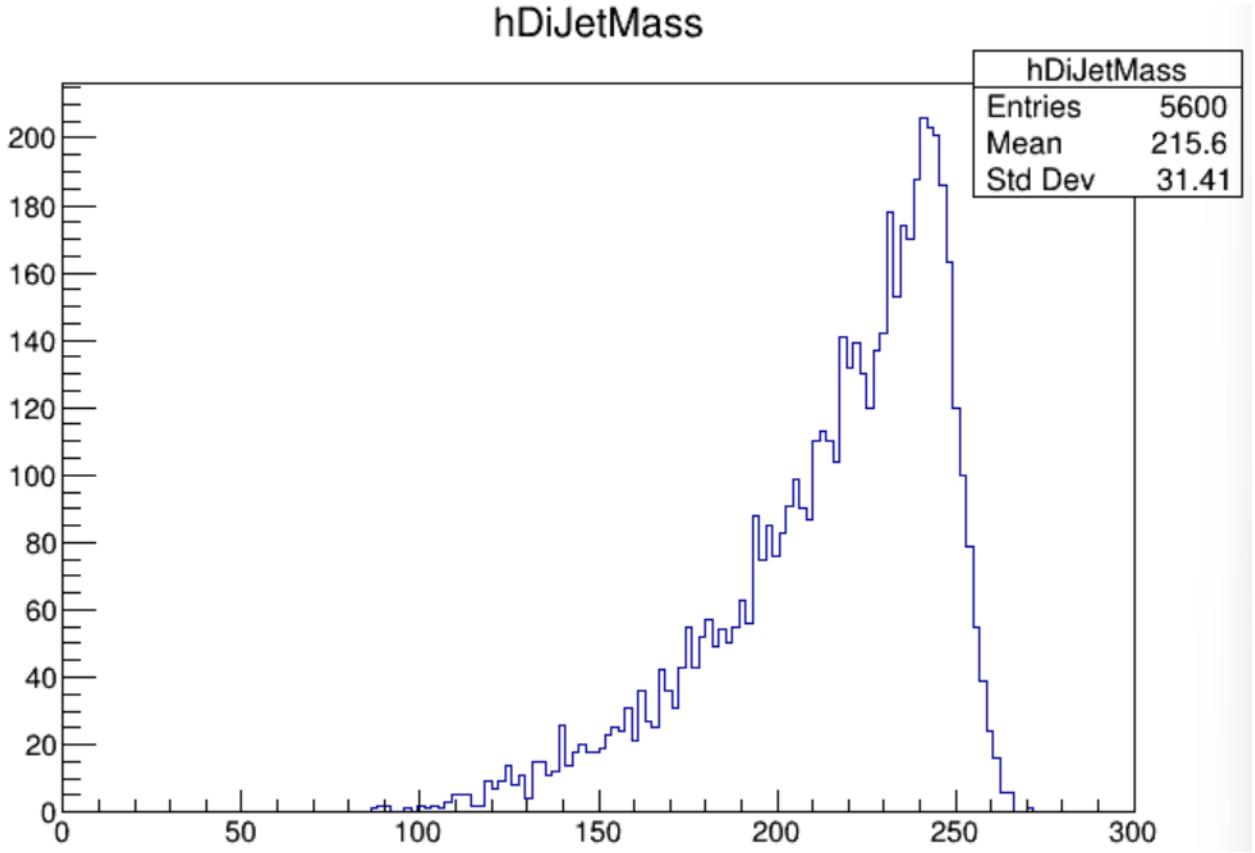
(3)Put data in a root file.

(4)Perform analysis on that root file.

(5)Analyze in the same way in the background.

# Hadronic channel (qqH)

Used Data:rv02-02.sv02-02.mILD_l5_o1_v02.E250-SetA.I402011.Pqqh.eL.pR.n000.d_dstm_15095_0.slcio



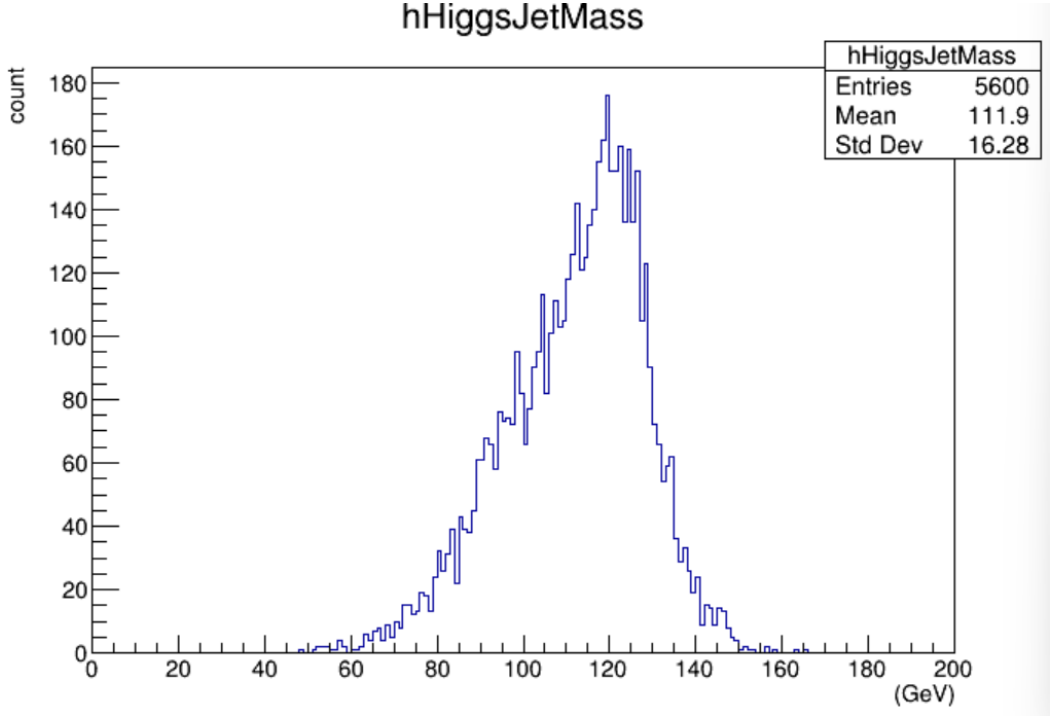

It is reconstructed with 4 jets, so the peak is at 250 GeV.

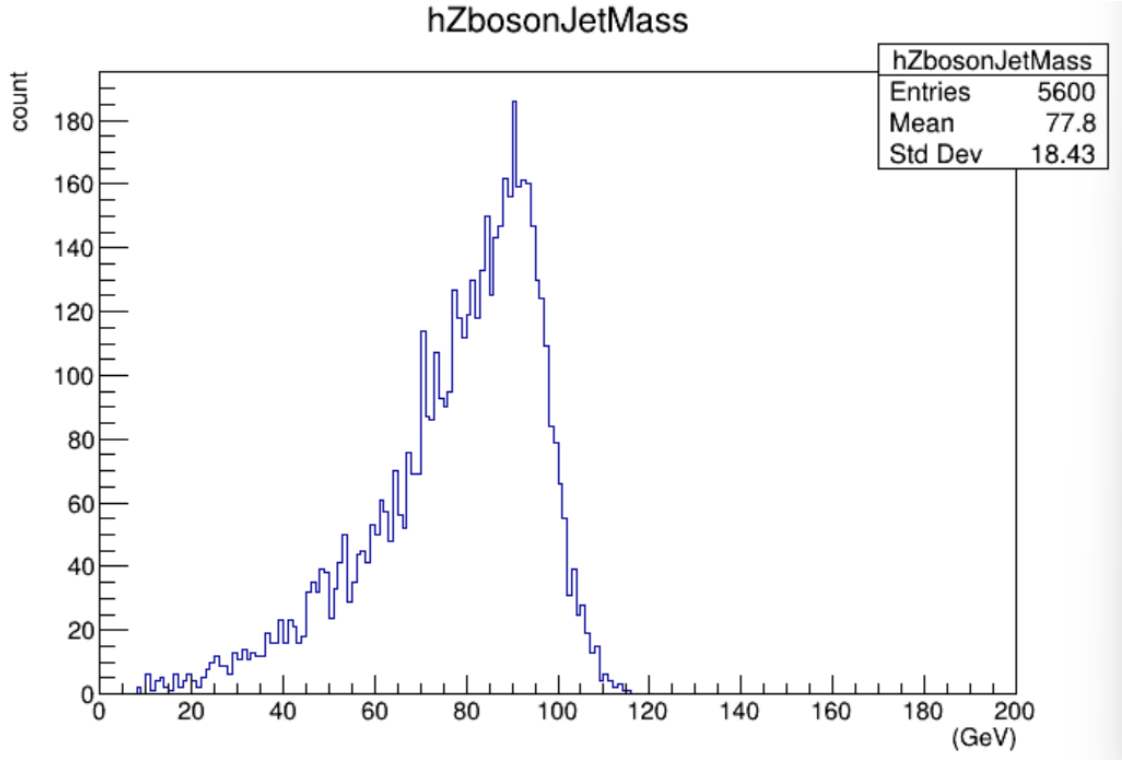
# 4-jet sorting

The jets were chosen so that $\chi^2$ in this equation is the smallest.

$$\chi^2 = \left(\frac{M_{j_1 j_2} - M_Z}{\sigma_Z}\right)^2 + \left(\frac{M_{j_3 j_4} - M_H}{\sigma_H}\right)^2,$$

※$M_Z = 91.2\ GeV$ , $M_H = 120\ GeV$
$\sigma_H = 4.4\ GeV$ $\sigma_Z = 4.7\ GeV$



# Type of Cut

| CM energy (GeV) | 250 | | |
|---|---|---|---|
| Cut names | condition | Sig. | Bkg. |
| Generated | | 52507 | 45904900 |
| $\chi^2$ | $\chi^2 < 10$ | 32447 | 2608980 |
| # of charged tracks | $N_{chd} > 4$ | 25281 | 1120950 |
| $Y_{34}$ value | $-\log(Y_{34}) > 2.7$ | 25065 | 1002125 |
| thrust | thrust $< 0.9$ | 24688 | 935950 |
| thrust angle | $\lvert\cos\theta_{\text{thrust}}\rvert < 0.9$ | 21892 | 696201 |
| Higgs jets angle | $105^o < \theta_H < 160^o$ | 20062 | 622143 |
| $Z$ di-jet mass (GeV) | $80 < M_Z < 100$ | 16359 | 411863 |
| $H$ di-jet mass (GeV) | $105 < M_H < 130$ | 16359 | 411863 |
| Likelihood ratio | $LR > 0.375$ | 13726 | 166807 |
| Significance (Efficiency) | $S/\sqrt{S+B}$ | 32.3 (26.1%) | |

These are the cuts in this issue of the Hadron Channel.

made the cut this time $\chi$ squared

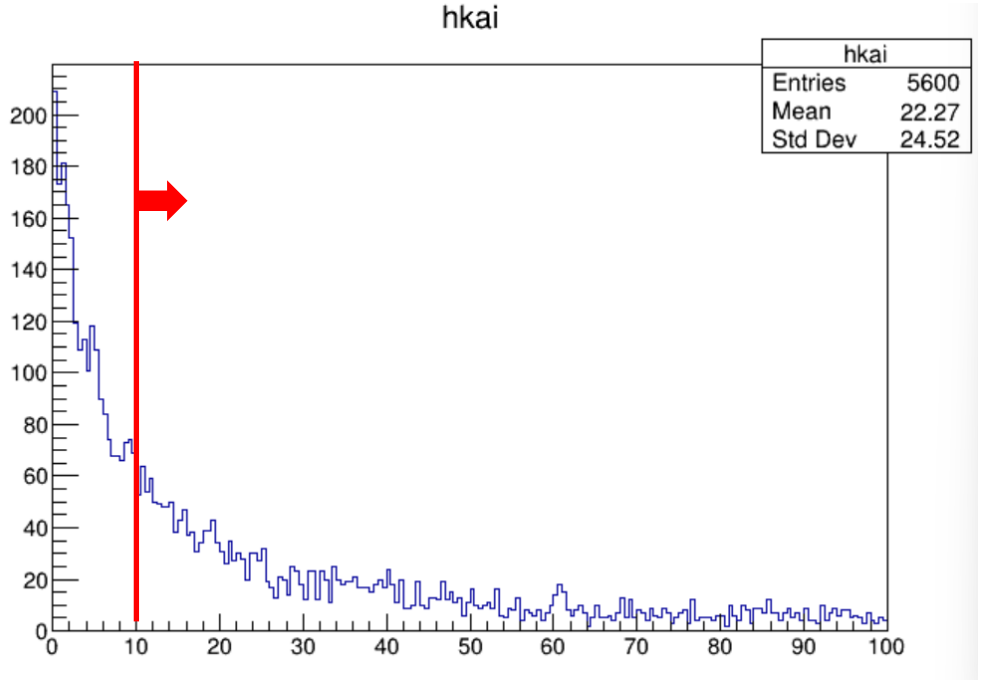
# $\chi^2 < 10$

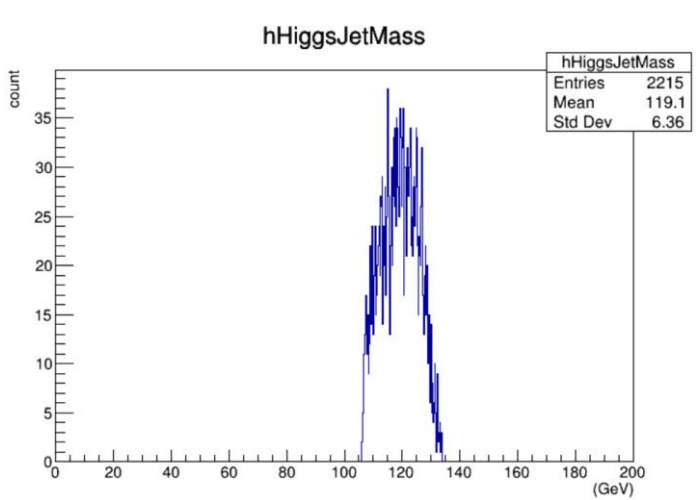
Cuts were made with a $\chi$-square of this equation less than 10.

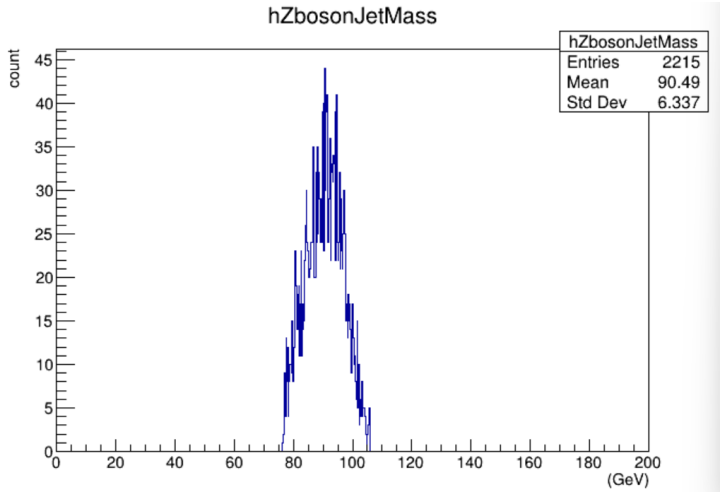
Mr.Ono data shows a 38% reduction with this cut,
whereas my data shows a reduction of about 60%.

| | reference | mydata |
|---|---|---|
| generated | 52507 | 5600 |
| $\chi^2$ cut | 32447 | 2215 |
| decrease | 38% | 60% |

$$\chi^2 = \left(\frac{M_{j_1 j_2} - M_Z}{\sigma_Z}\right)^2 + \left(\frac{M_{j_3 j_4} - M_H}{\sigma_H}\right)^2,$$

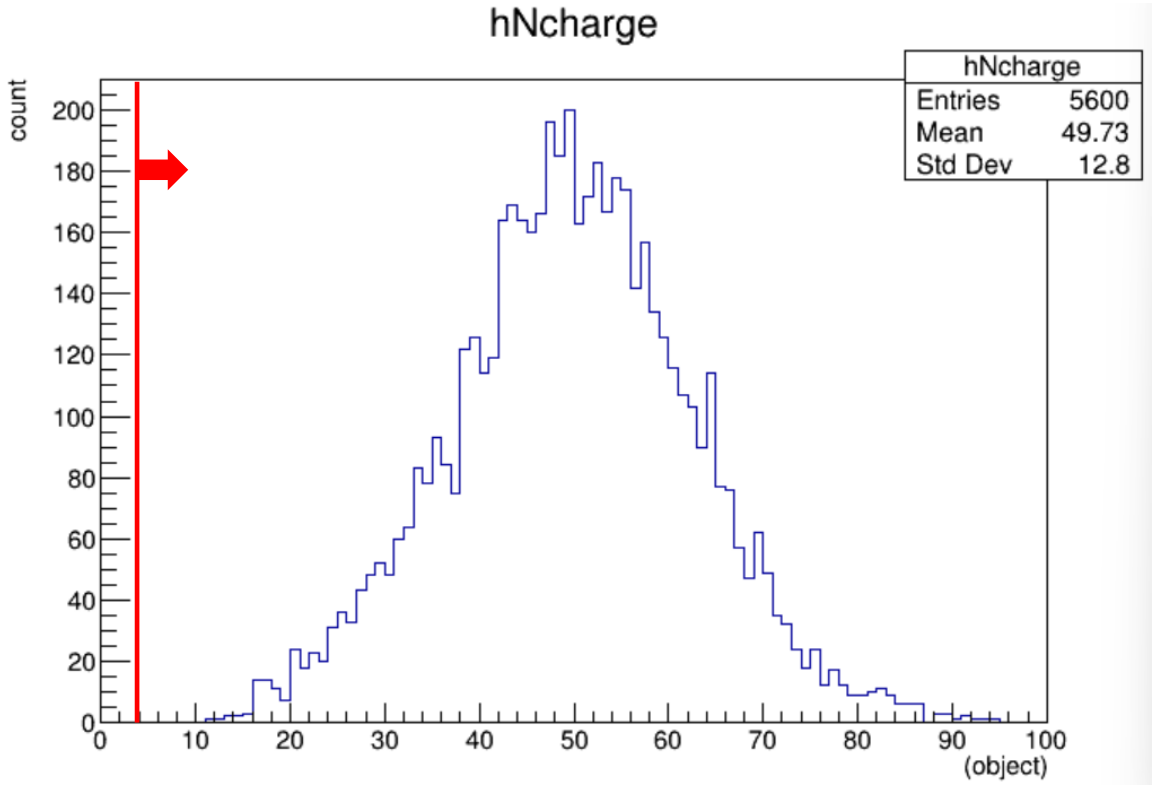


# Ncharge > 4

Used : MCParticleSkimmed MCPart charge
By requiring the number of charged tracks, the $llll, vvqq, gg$, events are eliminated.




It can be seen that there are no events with less than four charged tracks in the signal event.

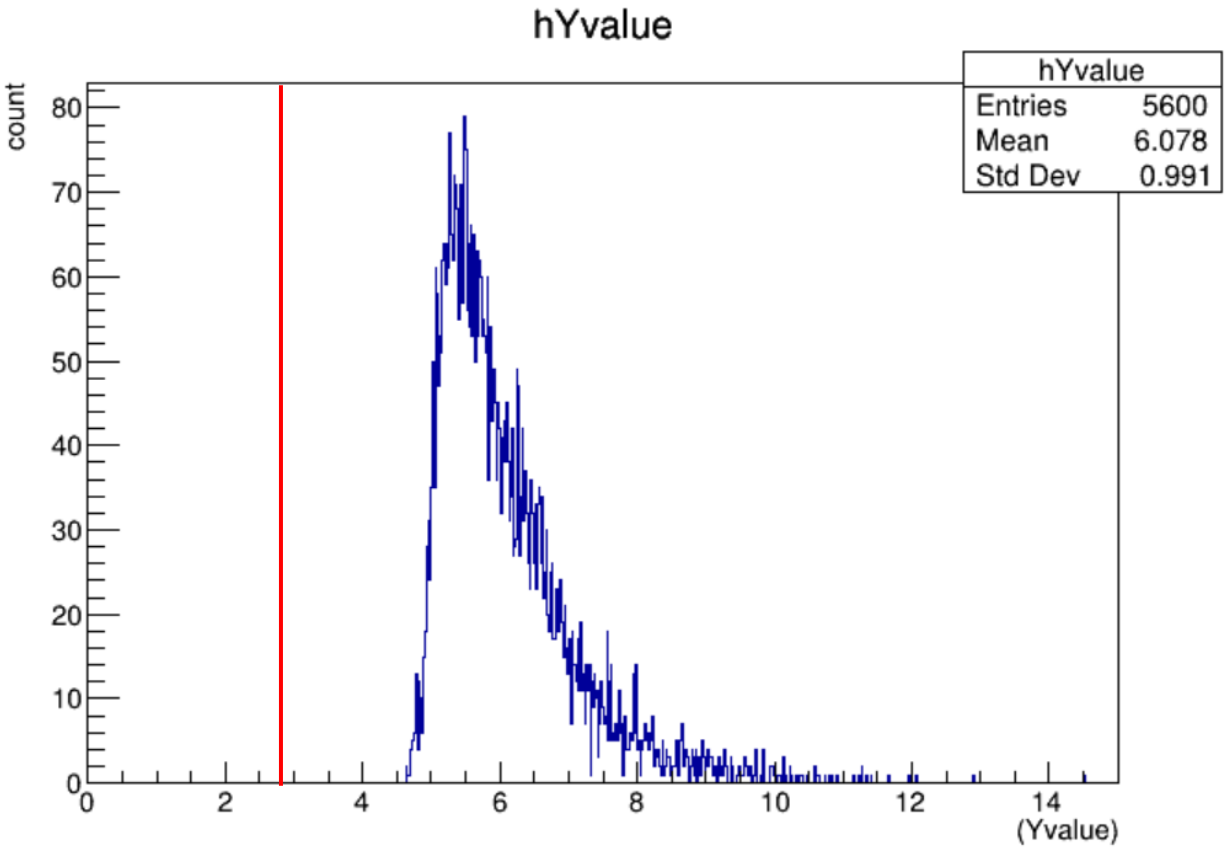
The distribution of the number of charged tracks.

# Y value > 2.7

The Y value is used to determine how many jets are present.

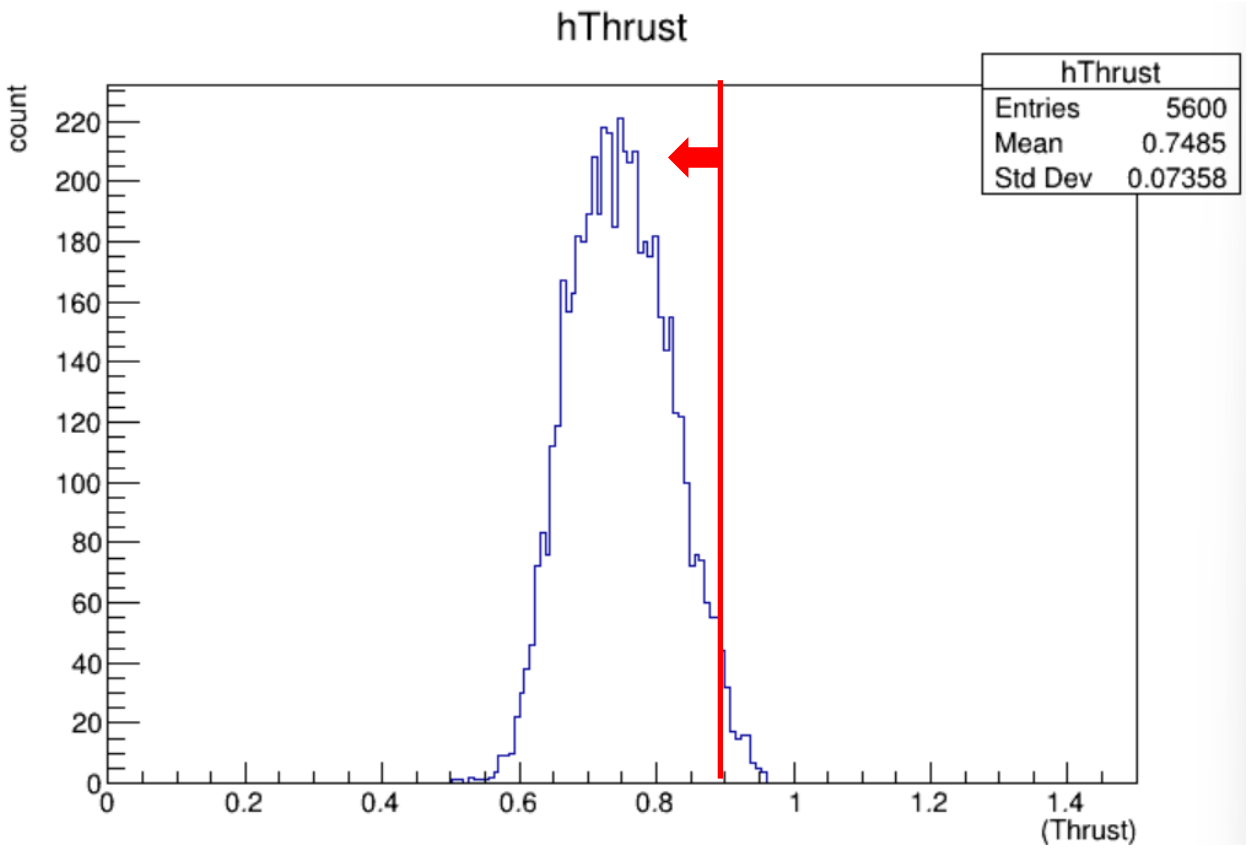
$$Y_{kl} = \frac{2\min(E_k, E_l)\,(1-\cos\theta)}{E_{vis}^2}$$

Reconstructed with 4 jets when $-logY$ is less than 2.7 Background is also removed.




It can be seen that there are no events with less than four charged tracks in the signal event.

# thrust




Thrust Vector

$$T = \frac{\sum |\overrightarrow{p_i} \cdot \vec{e}|}{\sum |\overrightarrow{p_i}|}$$

The vector T is called the thrust vector.The vector whose magnitude is T is called the thrust vector.
→The direction in which the visible charged particle or photon loses the most momentum

| | reference | mydata |
|---|---|---|
| generated | 25065 | 5600 |
| Thrust Cut | 24688 | 5488 |
| decrease | 1.5% | 2% |

# thrust angle

# Next

- Make thrust angle cuts.
- Make the cut by adding background.

# Back up

$\sigma_H = 16.28\,, \sigma_Z = 18.43$