Higgs to ss study

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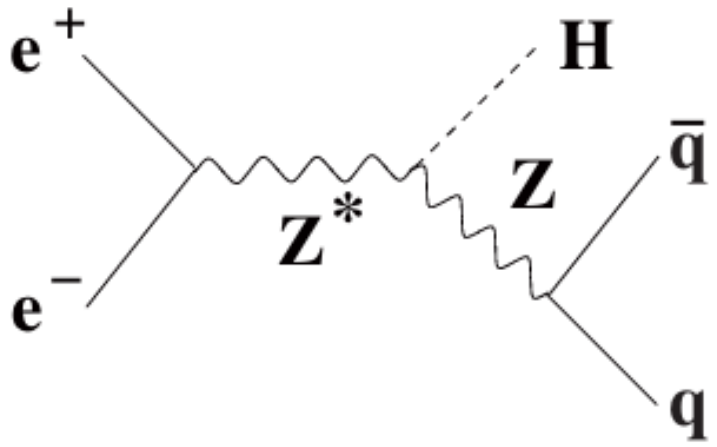
What I did

- Increase the number of events (polarization is only right)
- The backgrounds of 4-fermion and 2-fermion are analyzed in the same way.

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.

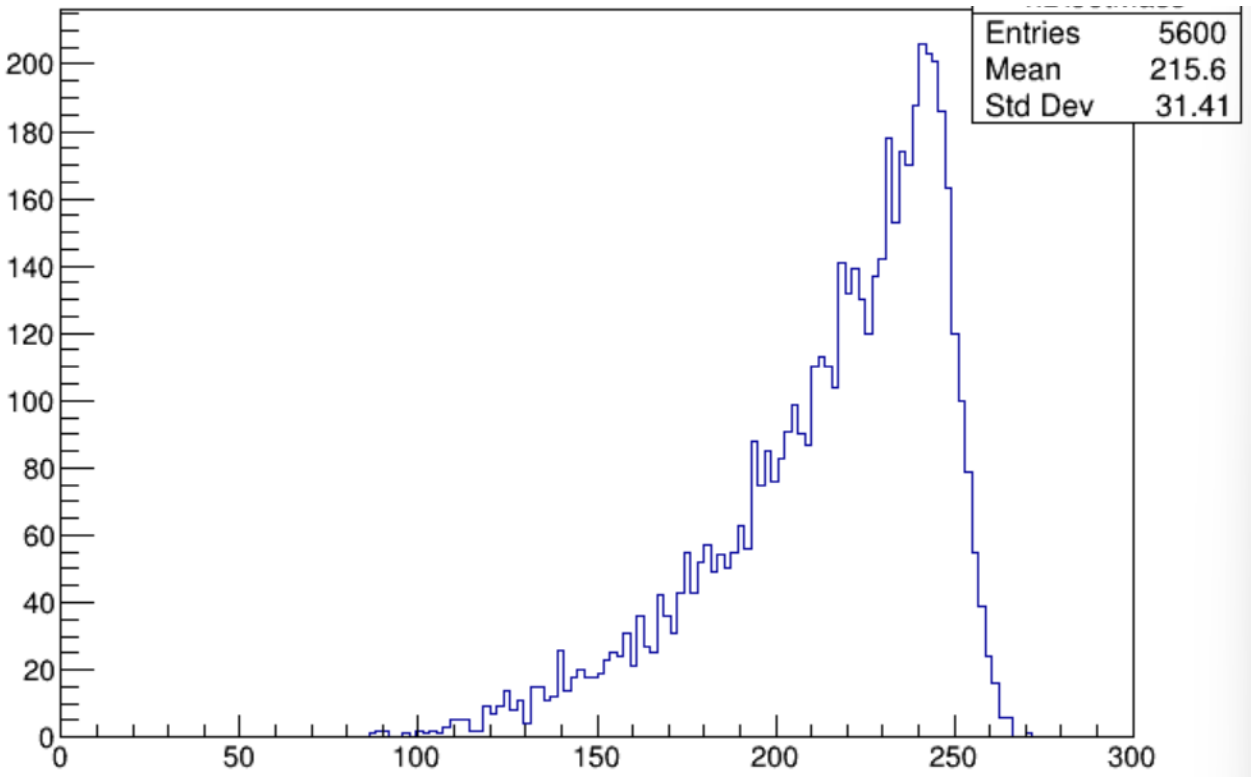
(3)Put data in a root file.

(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



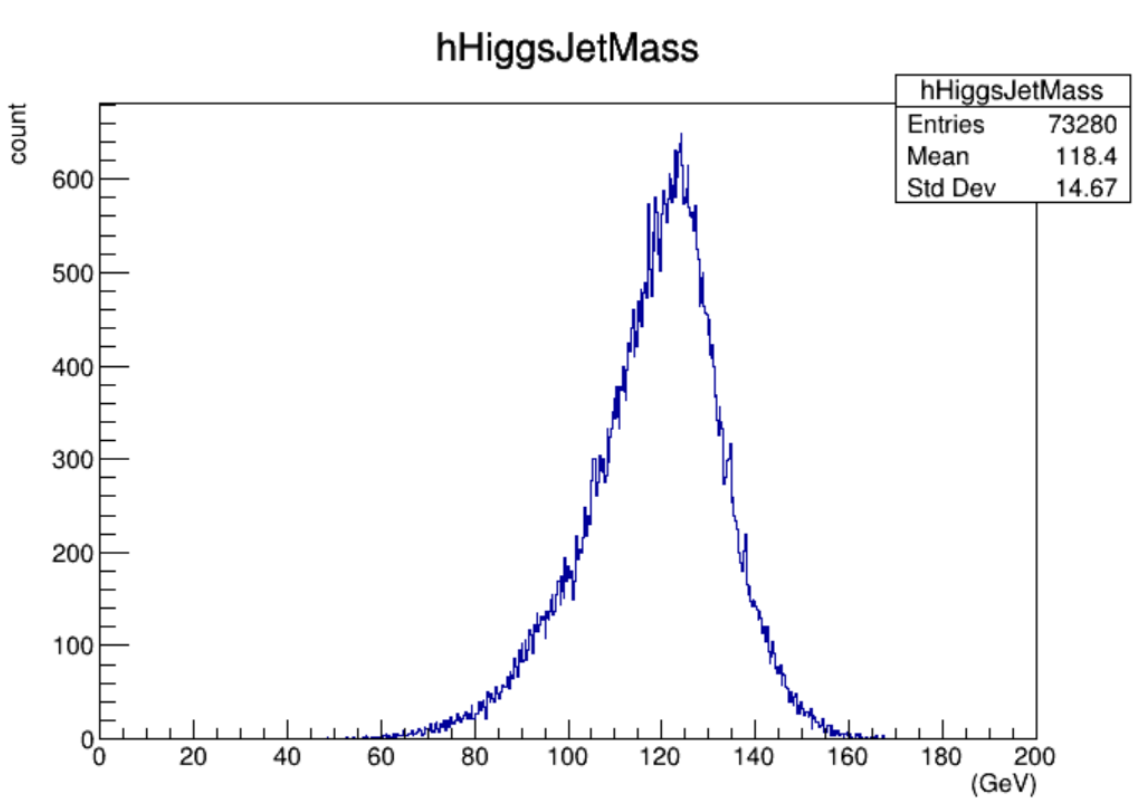
It is reconstructed with 4 jets,
so the peak is at 250 GeV.

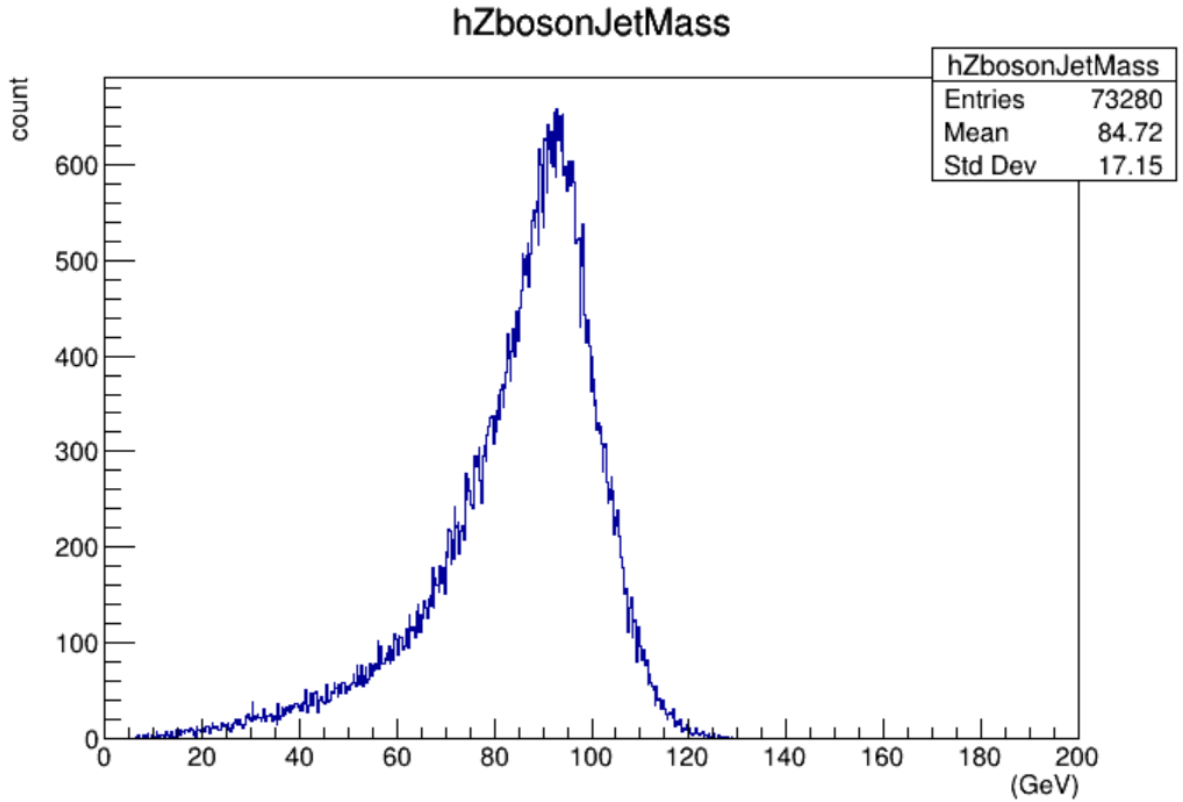
4-jet sorting(signal)

The jets were chosen so that χ^2 in this equation is the smallest.

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

※$M_Z = 91.2\ GeV$, $M_H = 125\ GeV$
$\sigma_H = 4.4\ GeV$ $\sigma_Z = 4.7\ GeV$





Type of Cut

CM energy (GeV)	250		
Cut names	condition	Sig.	Bkg.
Generated		52507	45904900
χ^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%)	

H. Ono「Evaluation of measurement accuracies of the Higgs boson branching fractions in the International Linear Collider」

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

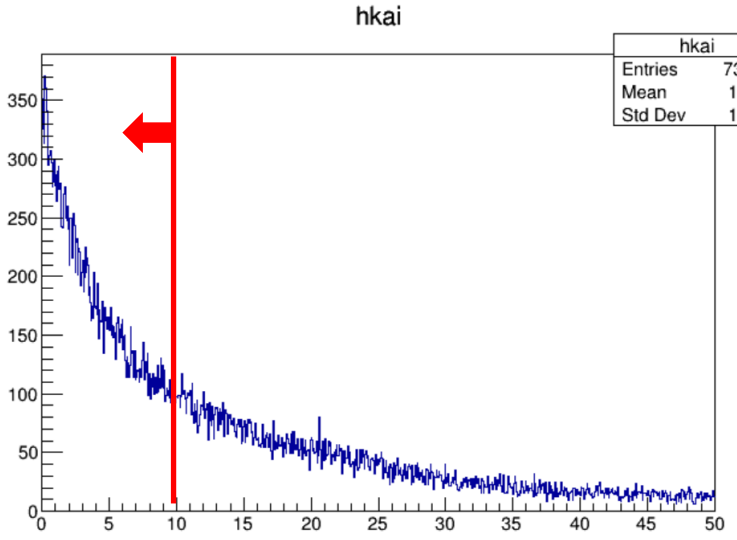
made the cut this time χ squared

$\chi^2 < 10$

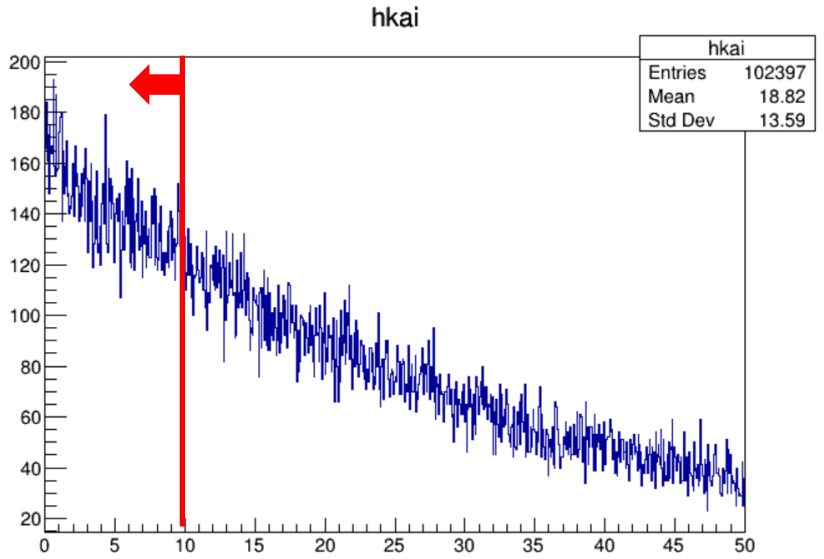
Cuts were made with a χ-square of this equation less than 10.

	reference	mydata
generated	52507	
χ^2 cut	32447	
decrease	38%	%

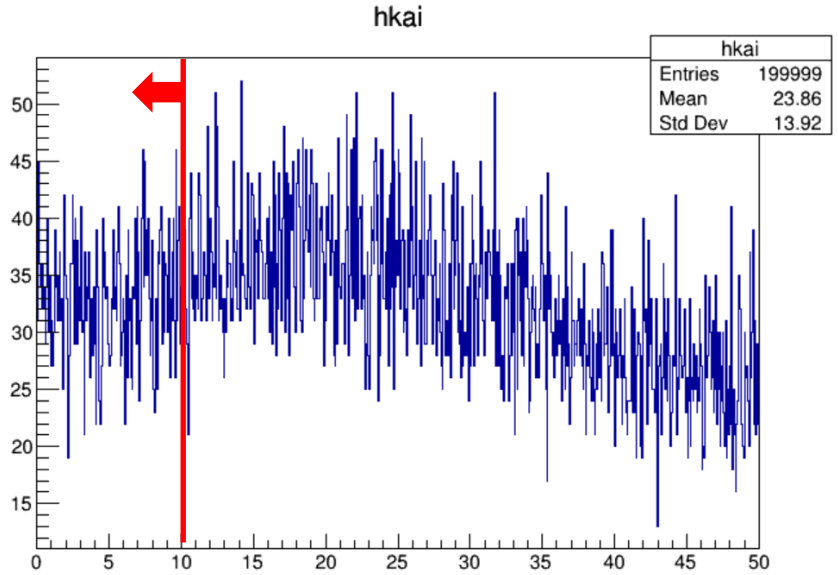
$$\chi^2 = \left(\frac{M_{j_1 j_2} - M_Z}{\sigma_Z}\right)^2 + \left(\frac{M_{j_3 j_4} - M_H}{\sigma_H}\right)^2,$$



Signal



4f



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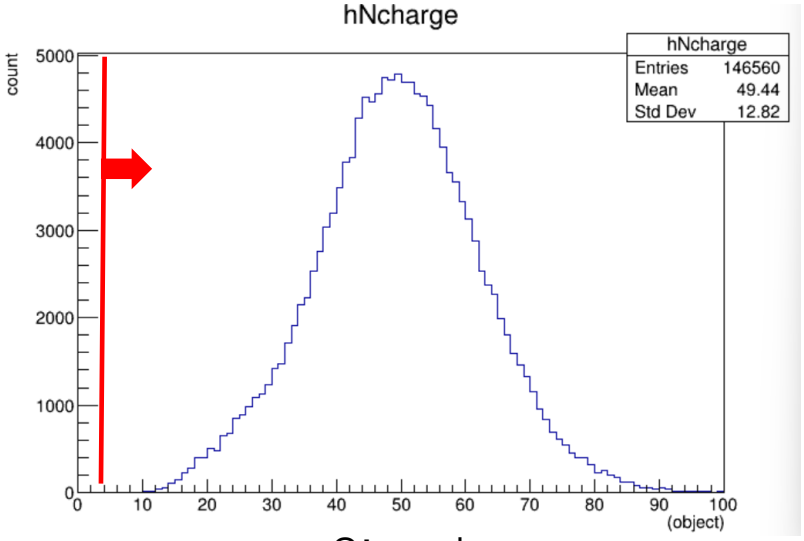
Ncharge > 4

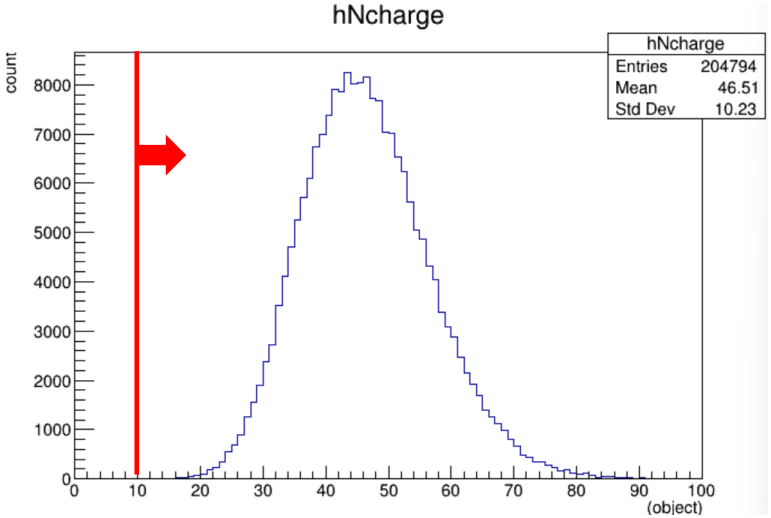


Signal

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

This graph shows the number of charge tracks for an event.

Ono’san made one cut per jet?



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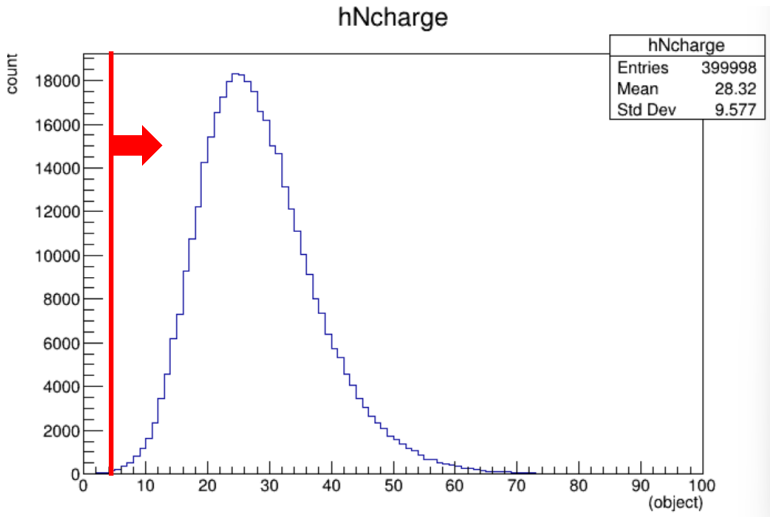
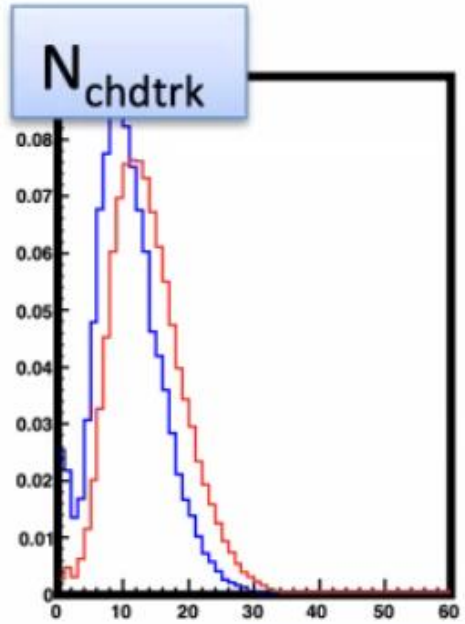


2f



Ono-san's data

The distribution of the number of charged tracks.

This is the number of cargo trucks per jet.

Y value < 2.7

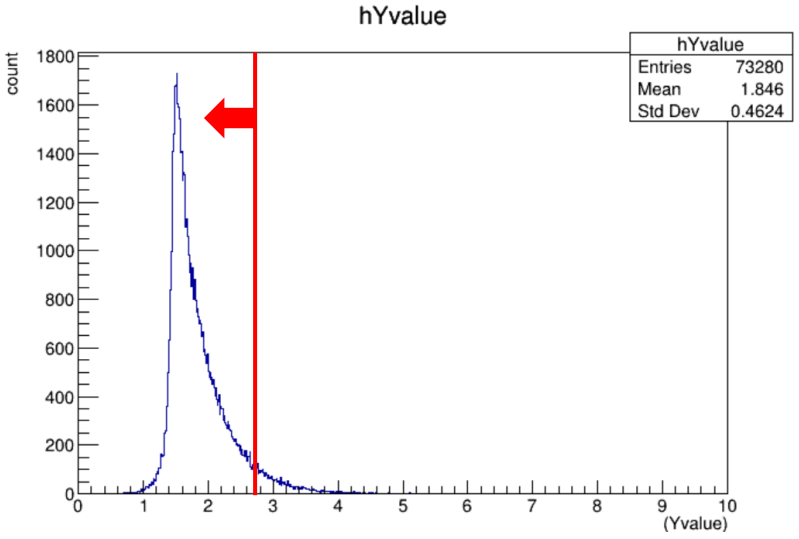
The Y value is used to determine how many jets are present.

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

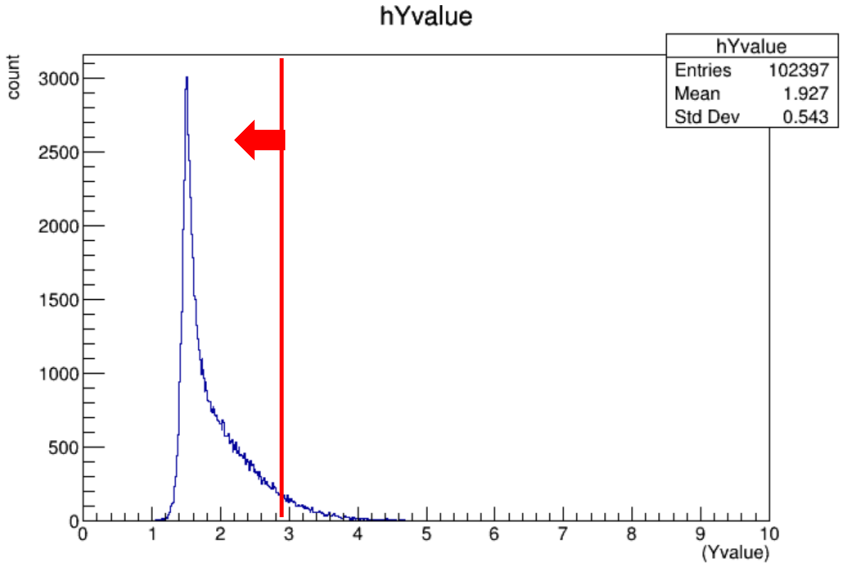
The Y value is expressed by this formula.

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

Background is not removed much.



Signal



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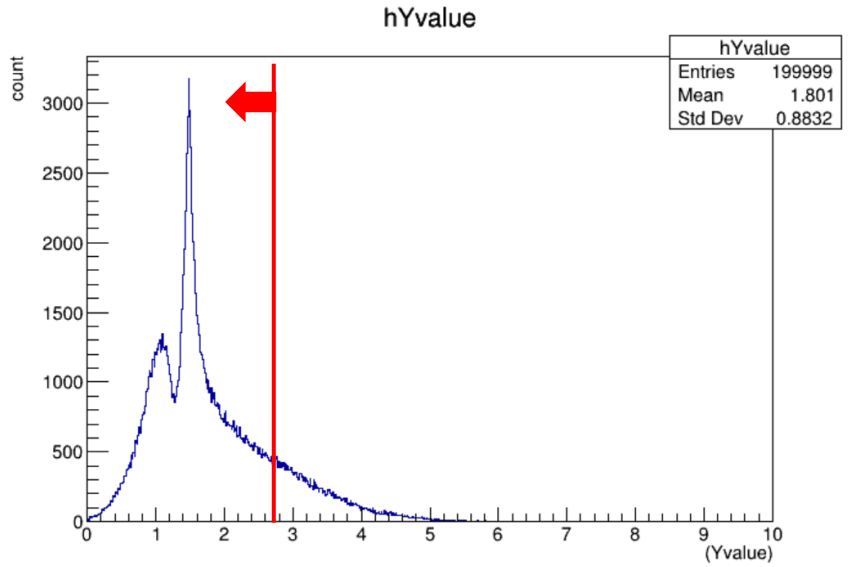

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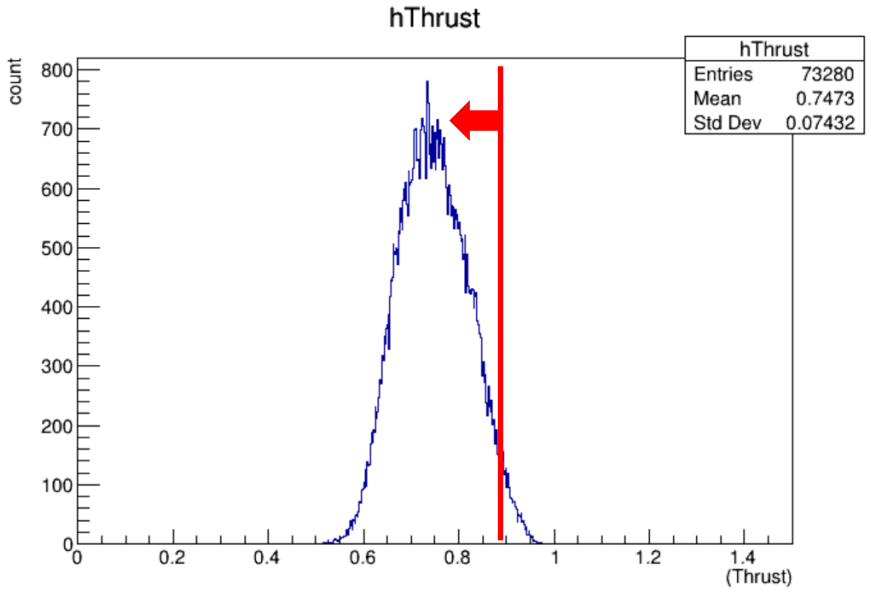
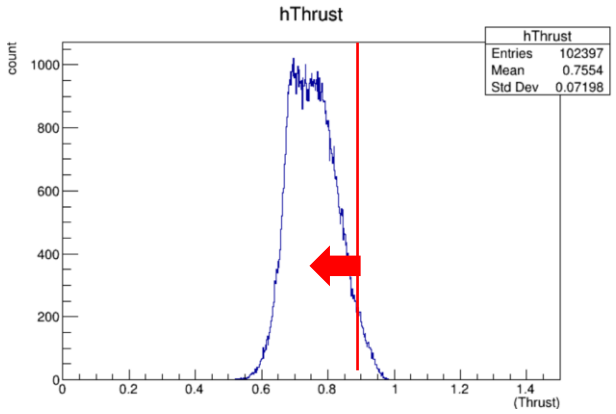
thrust < 0.9



Signal



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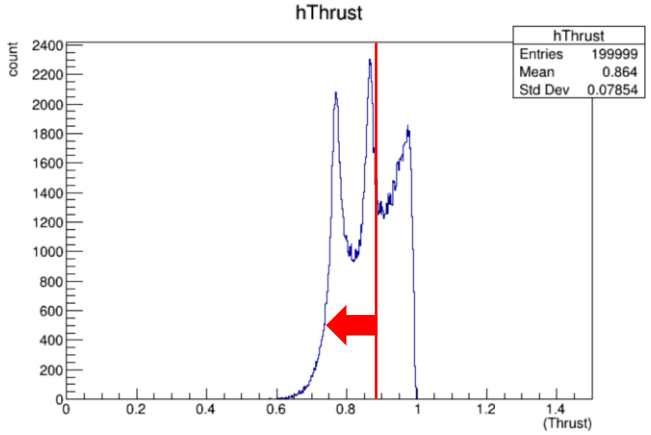


2f

Thrust Vector

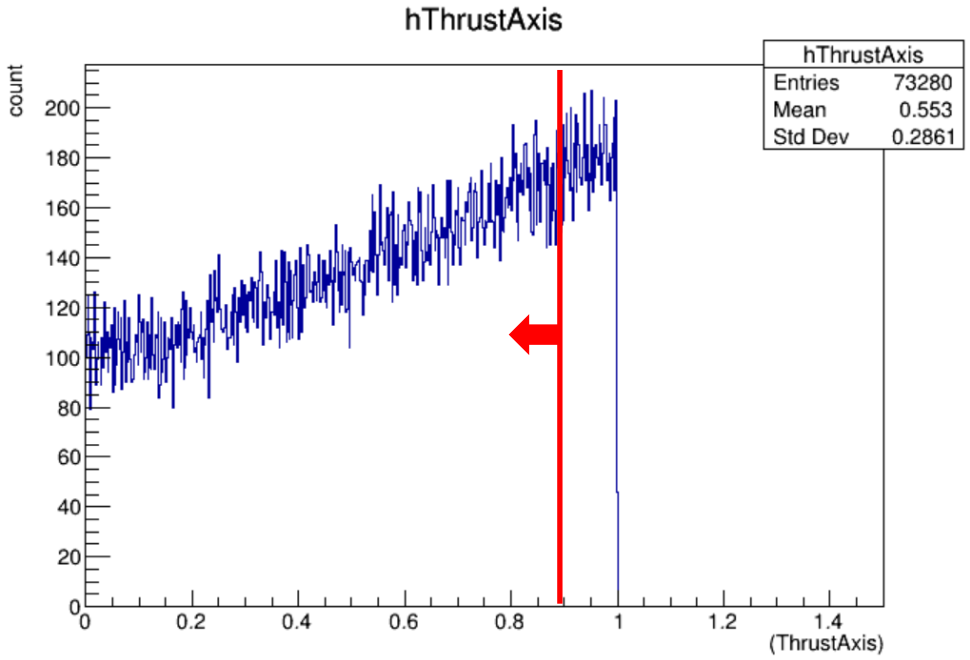
$$T = \frac{\sum |\overrightarrow{p_i} \cdot \vec{e}|}{\sum |\overrightarrow{p_i}|}$$

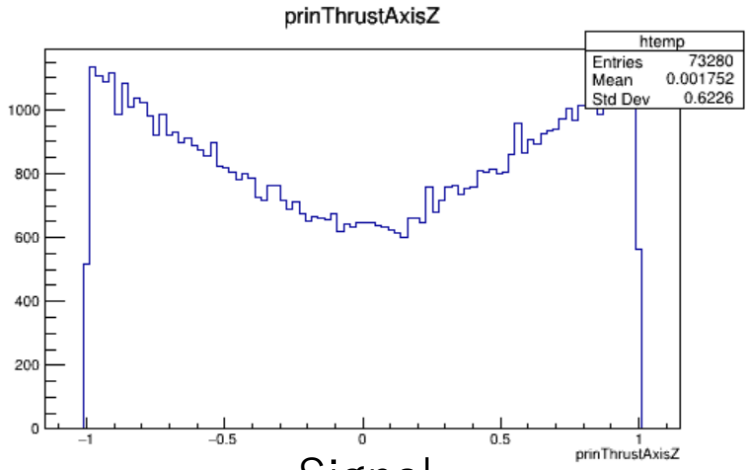
The vector T is called the thrust vector.
The vector whose magnitude is T is called the thrust vector.
→The direction in which the visible charged particle or photon loses the most momentum

	reference	mydata
generated	25065	
Thrust Cut	24688	
decrease	1.5%	%

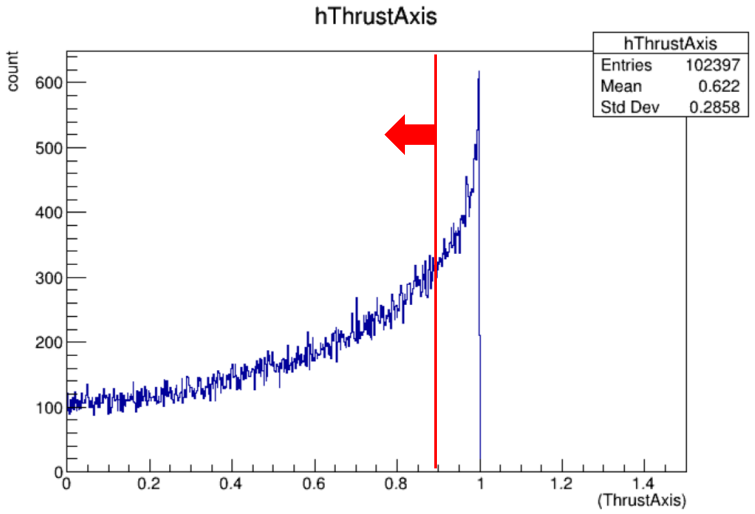
$\cos\theta_{thrust} < 0.9$

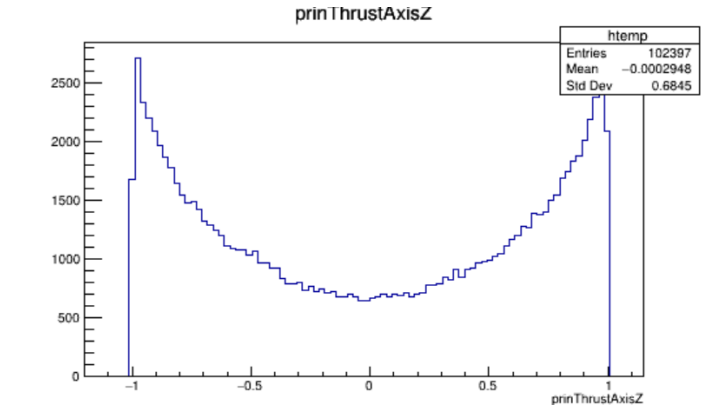
No significant differences were found between Mr. Ono's data and my data.
Can greatly reduce background





Signal





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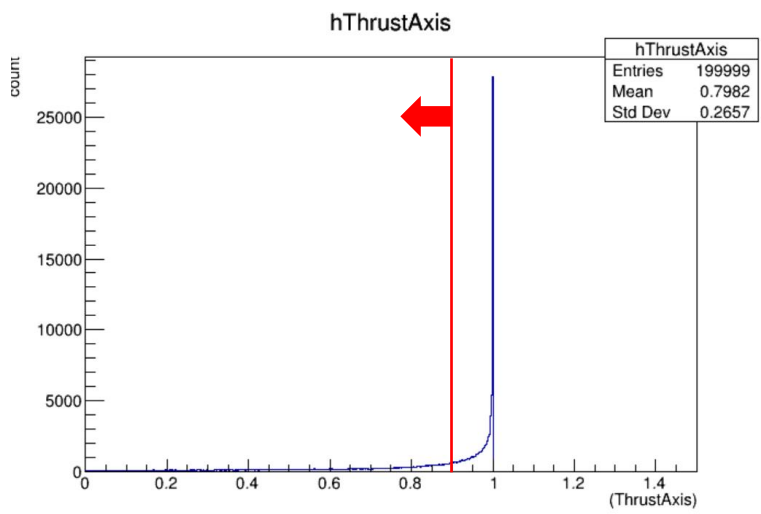
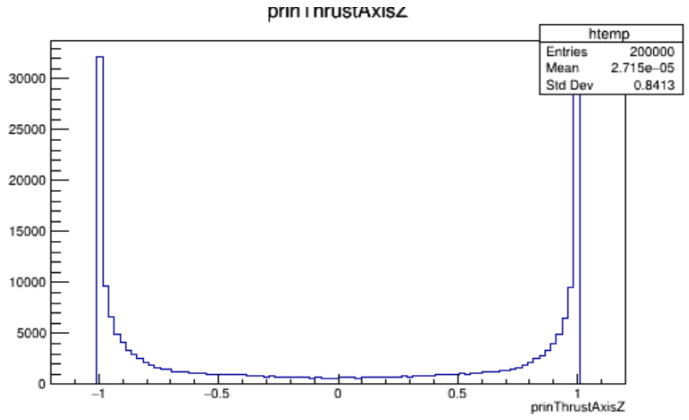




2f

result

The number of events is greatly reduced by the cut of χ squared and the cut of jet mass.

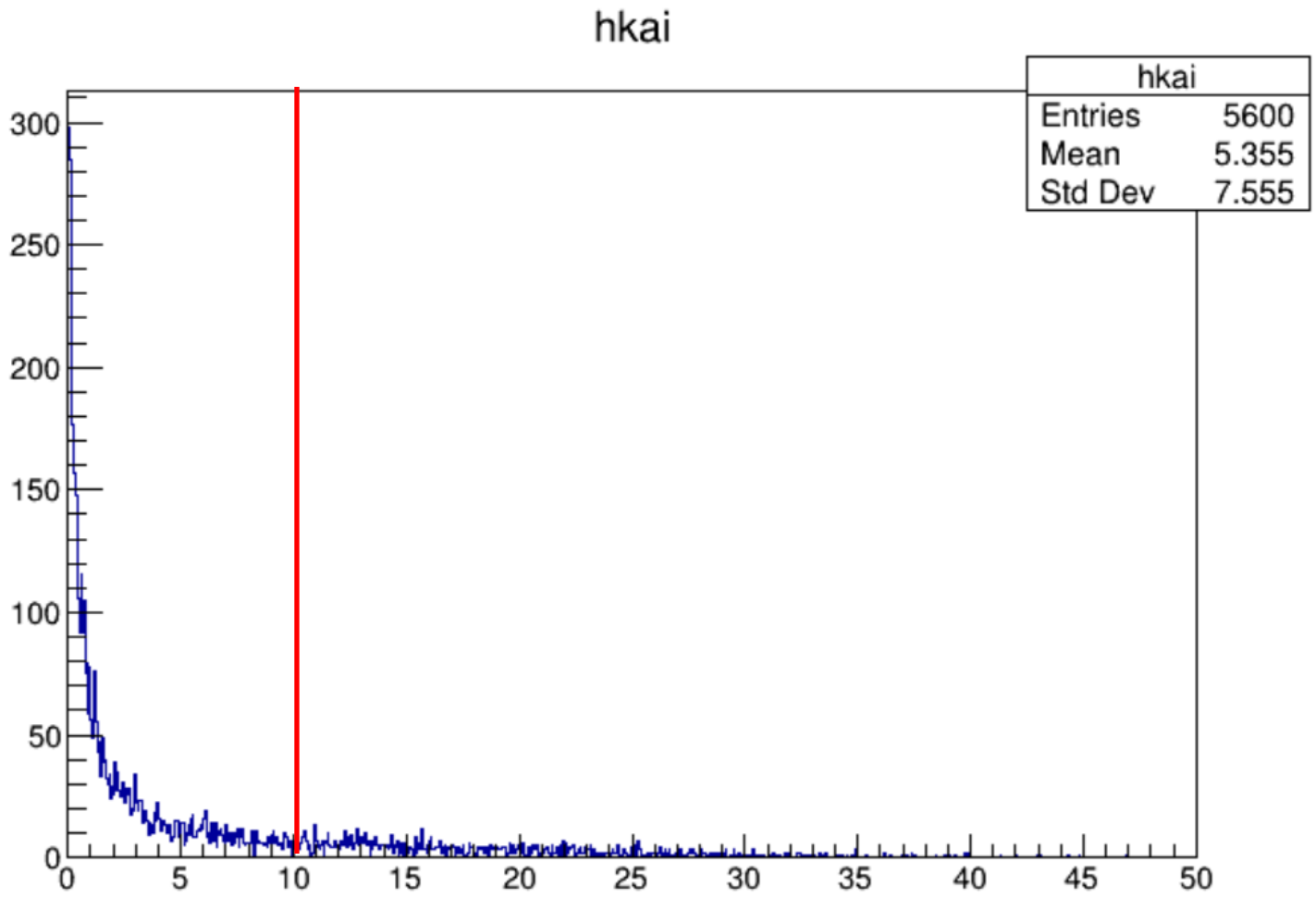
cut name	reference	%	my data	%
generated	52507	100	5600	100
$\chi 2$	32447	62	2215	40
charge tracks	25281	48	2215	40
Y value	25065	48	2126	38
thrust	24688	47	2096	37
thrust angle	21892	42	1892	34
Z di-jet mass	16359	31	1462	26
H di-jet mass	16359	31	1399	25

Next

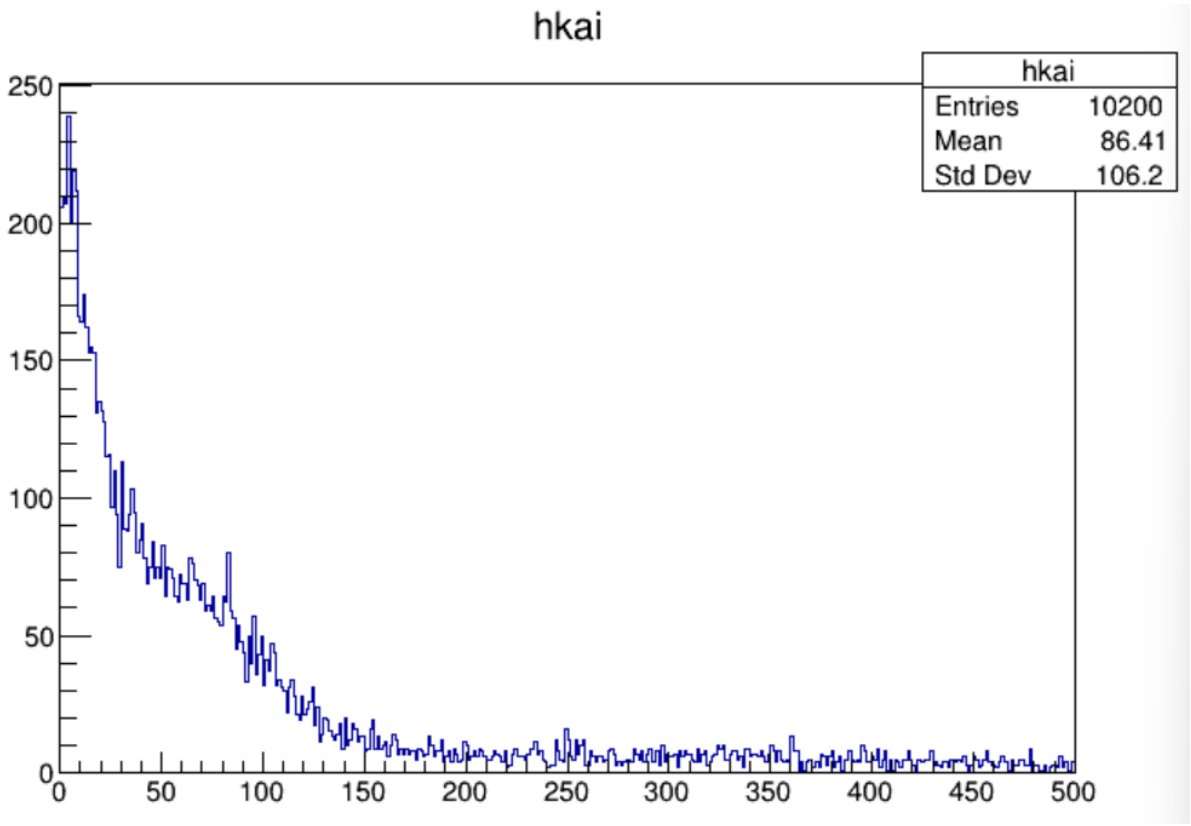
- Mixing polarization
- Adjustment of cut range

Back up

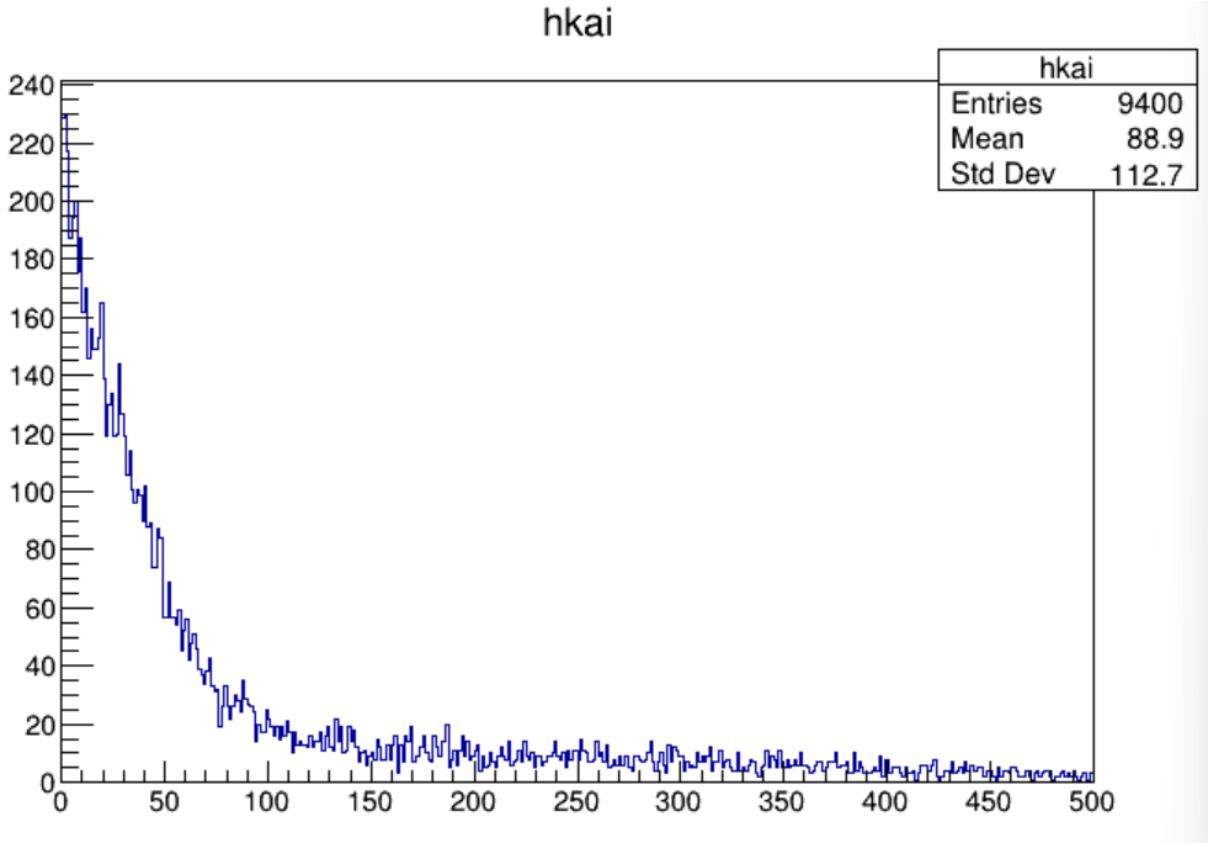
$\sigma_H = 16.28\,, \sigma_Z = 18.43$



BG_ $\chi^2 < 10$

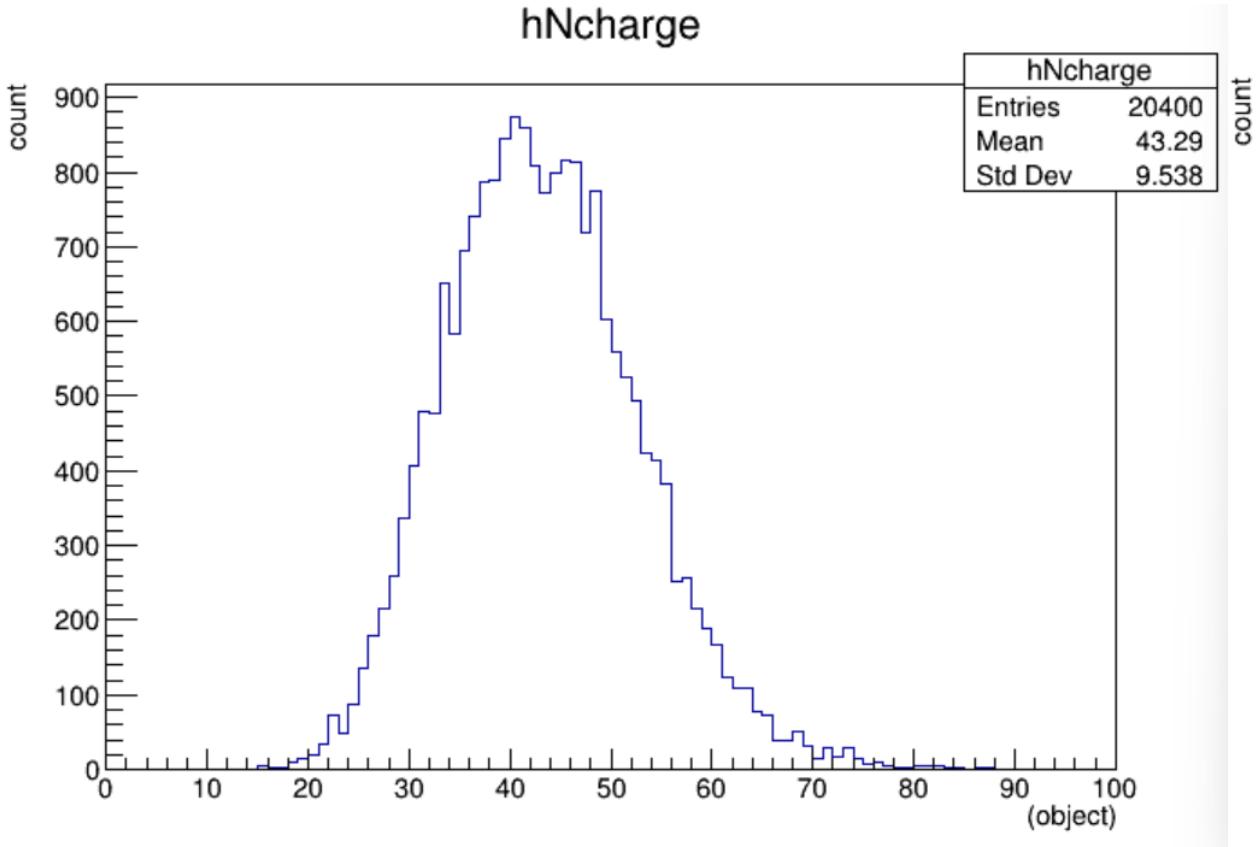


4f_WW_hadronic



4f_ZZ_hadronic

BG_Ncharge > 4



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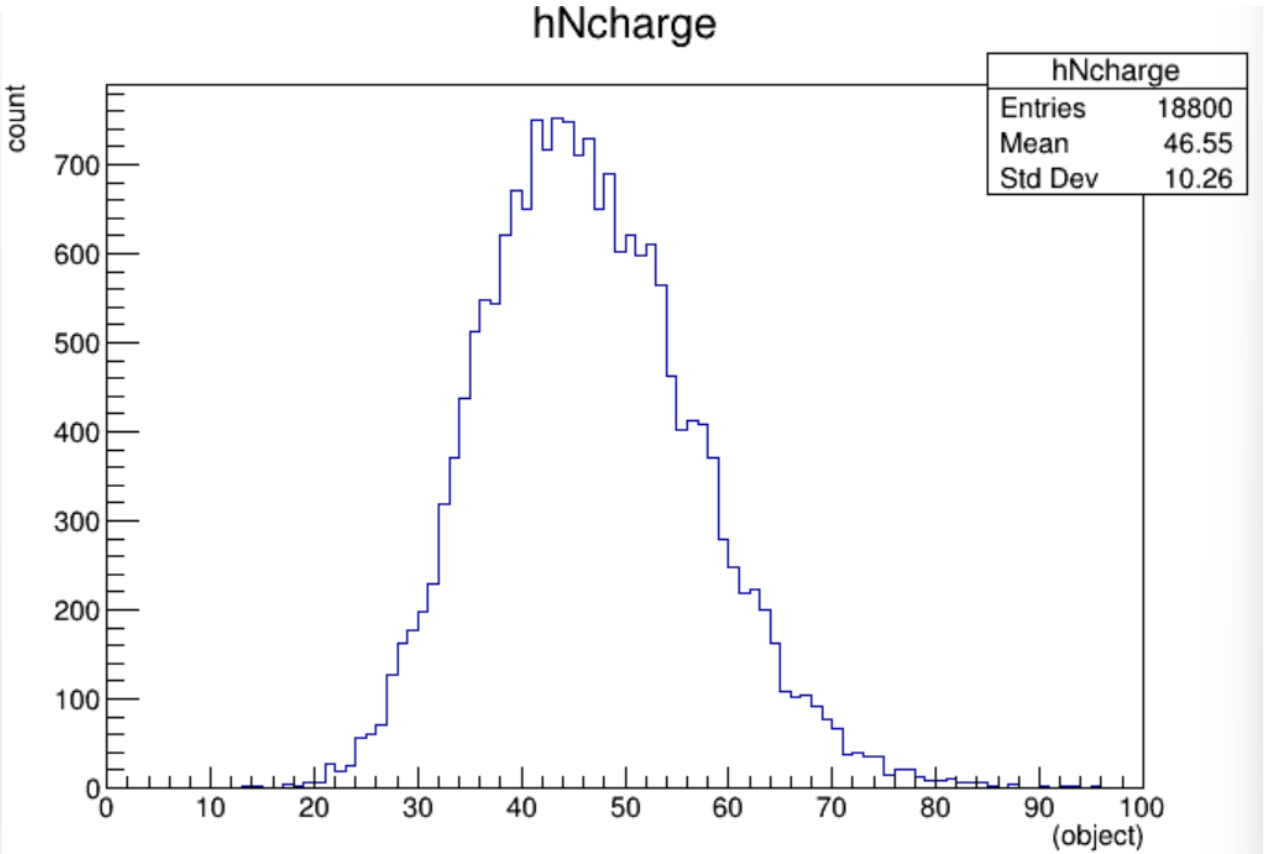
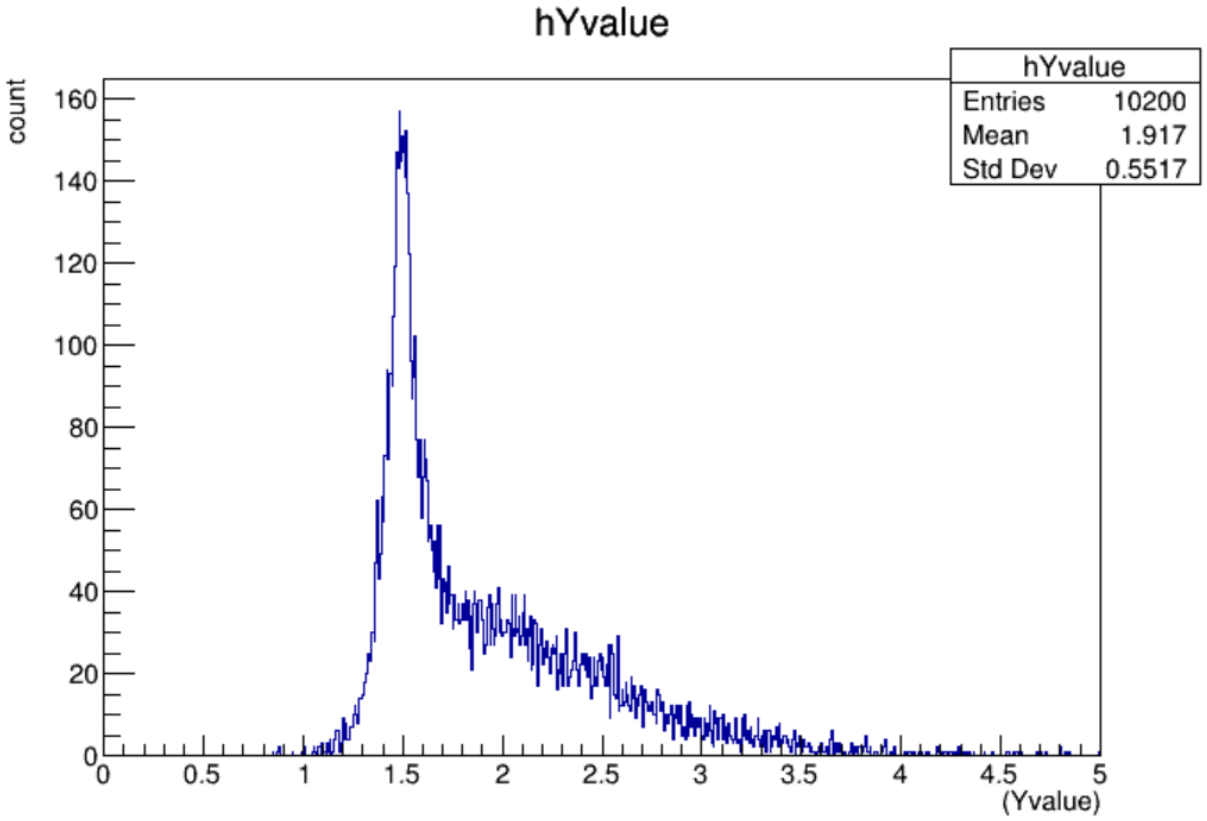


4f_ZZ_hadronic

BG_Y value < 2.7



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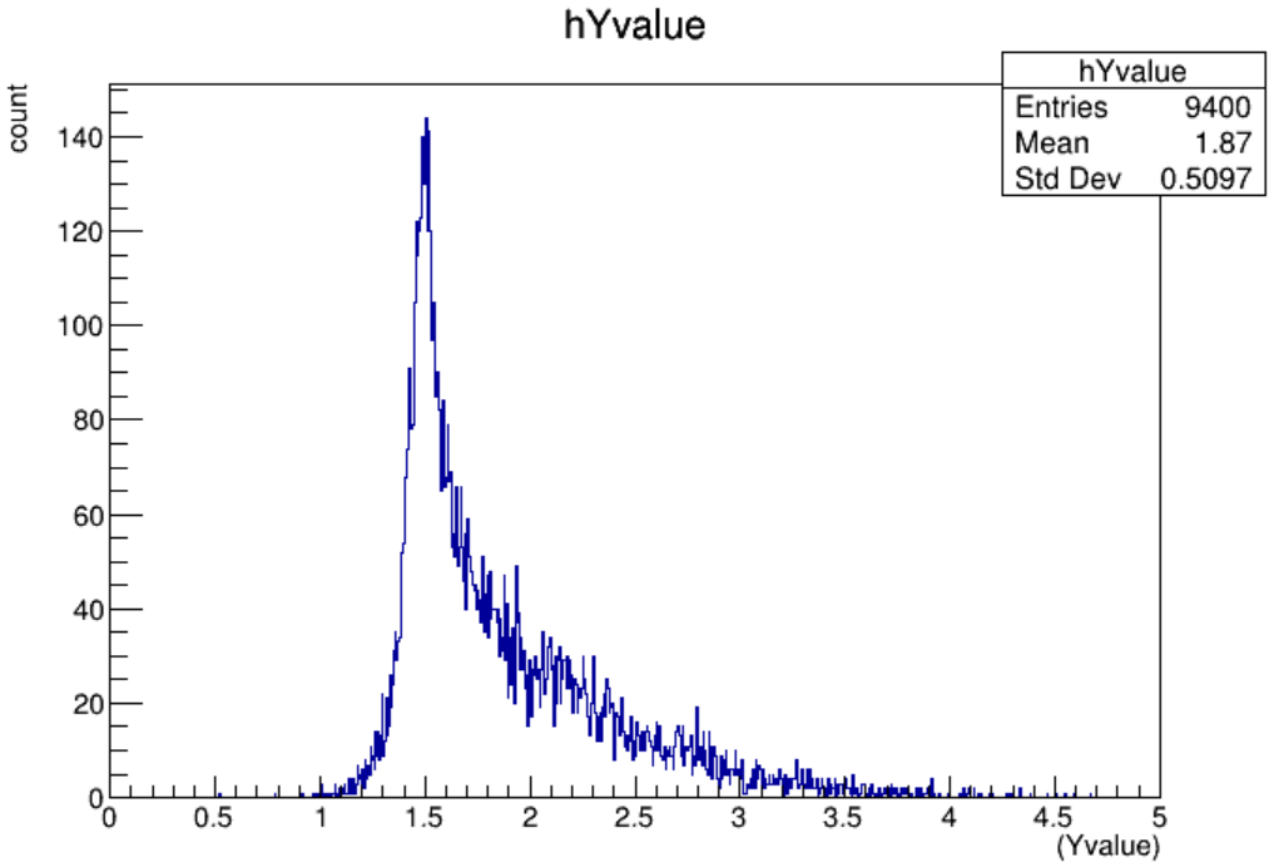
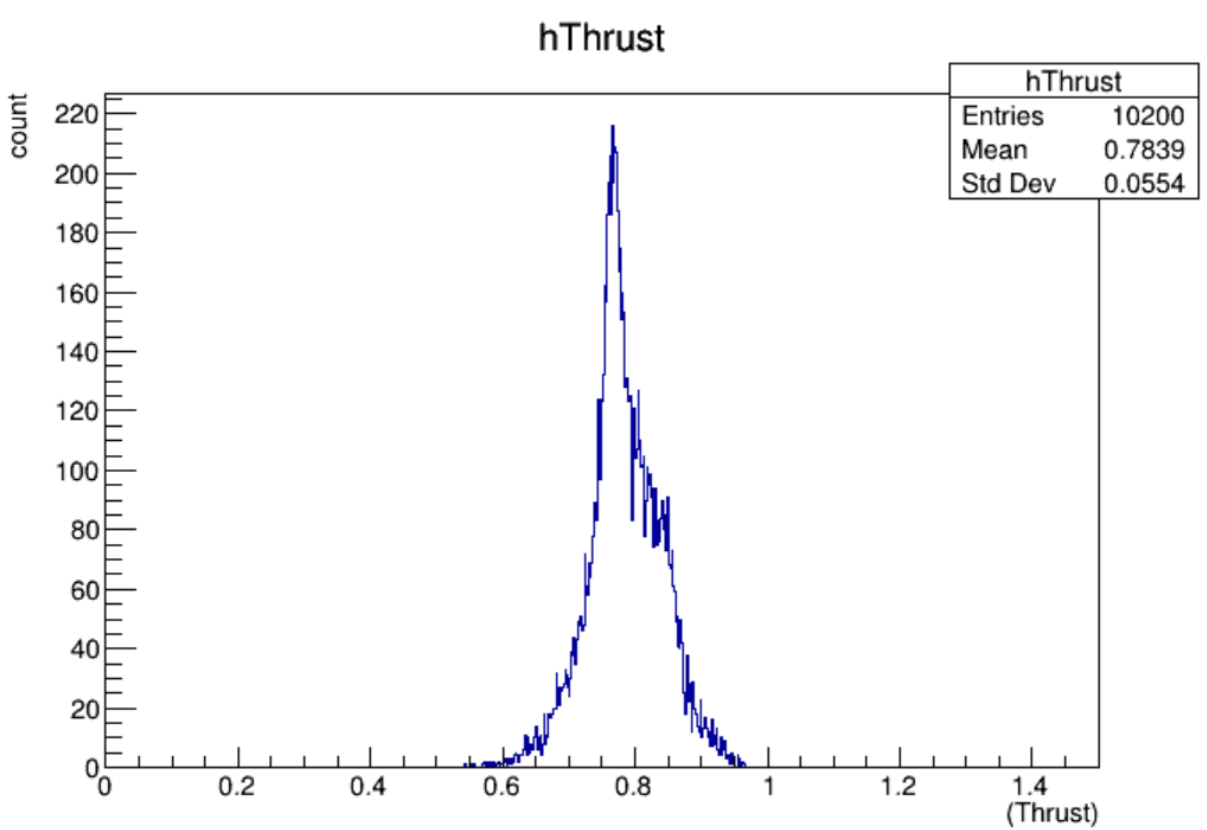
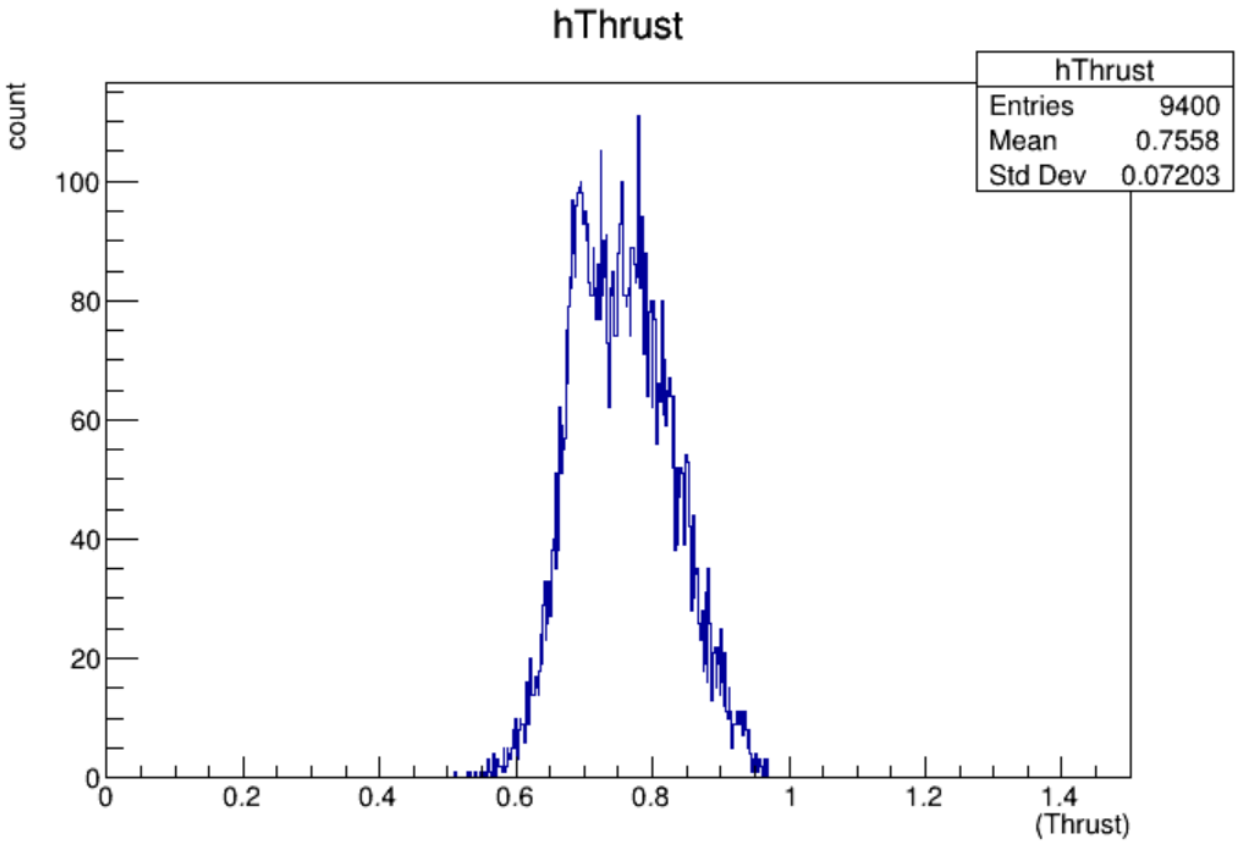


4f_ZZ_hadronic

BG_Thrust > 0.9

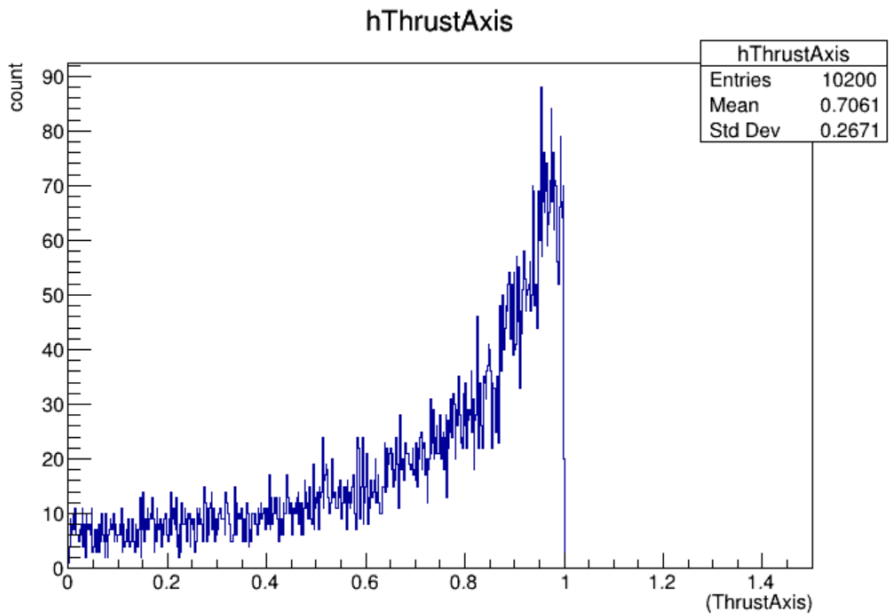


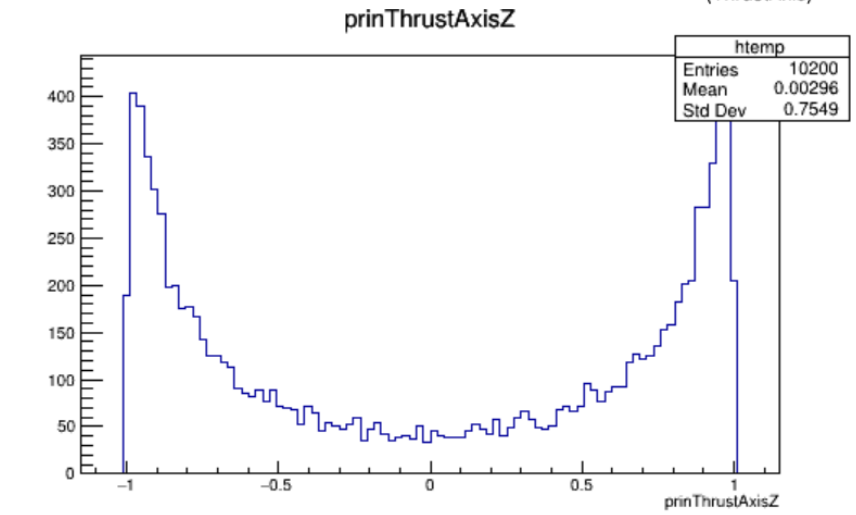
4f_WW_hadronic



4f_ZZ_hadronic

BG_ThrustAxis > 0.9





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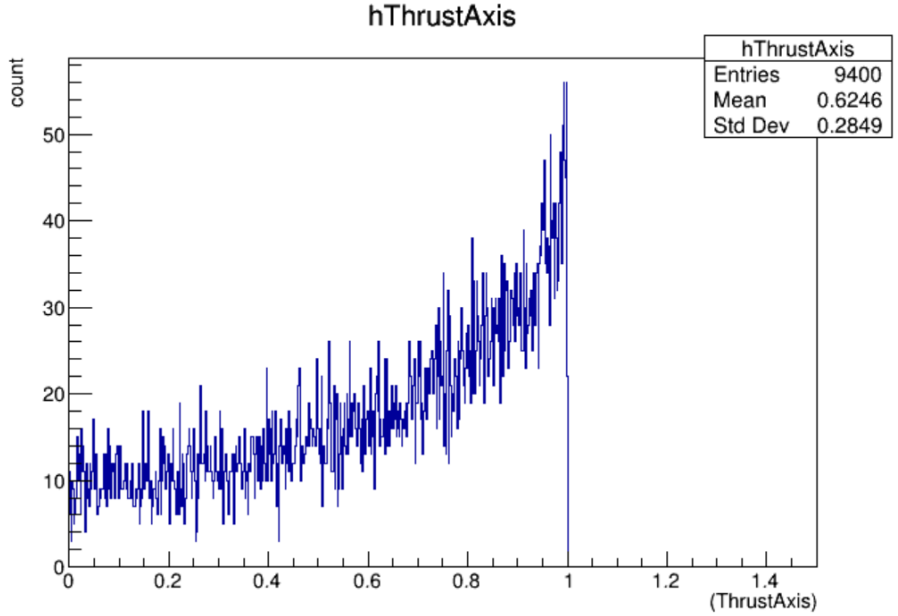

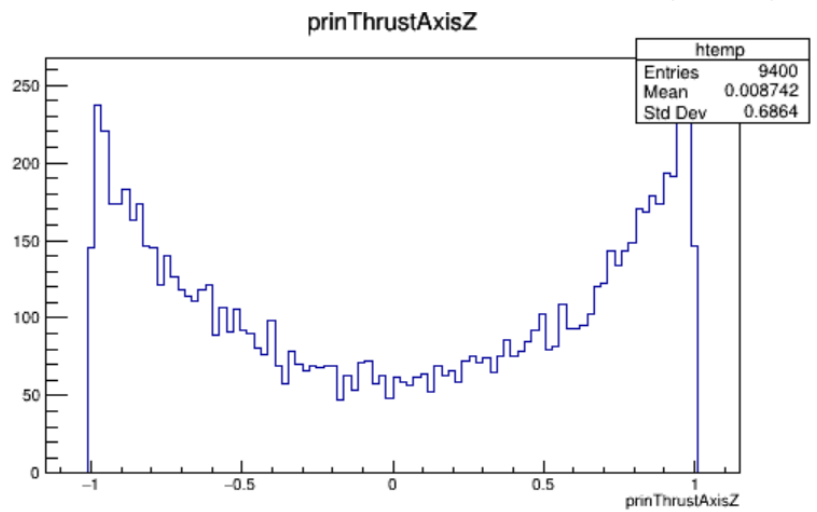

4f_ZZ_hadronic

BG_result

	WW_hadronic	%	ZZ_hadronic	%
generated	10200	10200	9400	9400
χ^2	1794	18	1874	20
charge tracks	1794	18	1874	20
Y value	1662	16	1745	19
thrust	1658	16	1726	18
thrust angle	1167	11	1420	15
Z di-jet mass	907	9	1092	12
H di-jet mass	850	8	1018	11