This slide have all plots updated
However, signal yield is scaled down by 1/0.7,
problem fixed after 01.24.2022

All hadronic final states VVH events study

12.17.2021

Yanxi Gu

VBF Jet Selection methods

- **Method 1: max M_{jj}**
  - pick jet pairs with the largest M_{jj}, and their $M_{jj} > 500\text{GeV}$
- **Method2: max $\Delta\eta_{jj}$**
  - pick jet pairs with the largest $\Delta\eta_{jj}$
- **Method3: double side max energy**
  - pick jet1 with maximum energy
  - among the jets which have different η sign as jet1, pick max energy jet2
  - if there's no jets have different η sign with jet1, pick jet2 with the max Δη with jet 1

require $M_{jj} > 500\text{GeV}$, $\Delta\eta_{jj} > 3$

M_{jj} distributions for SSWWH

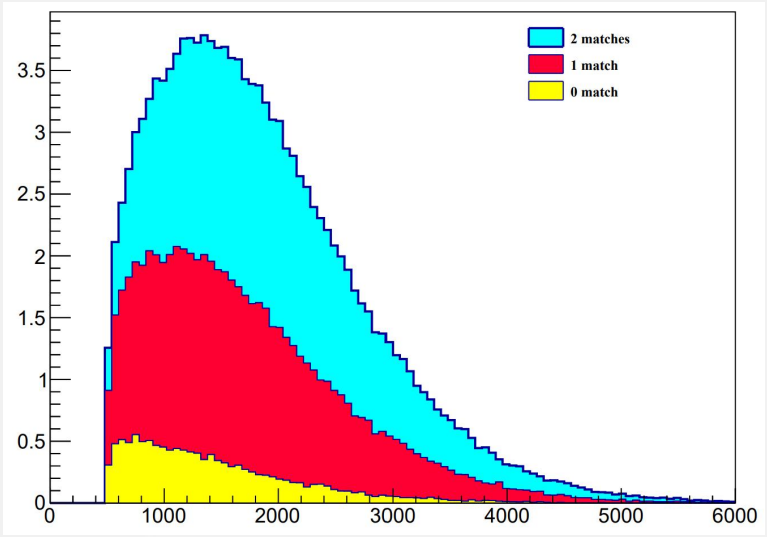

fig1.max Mjj method

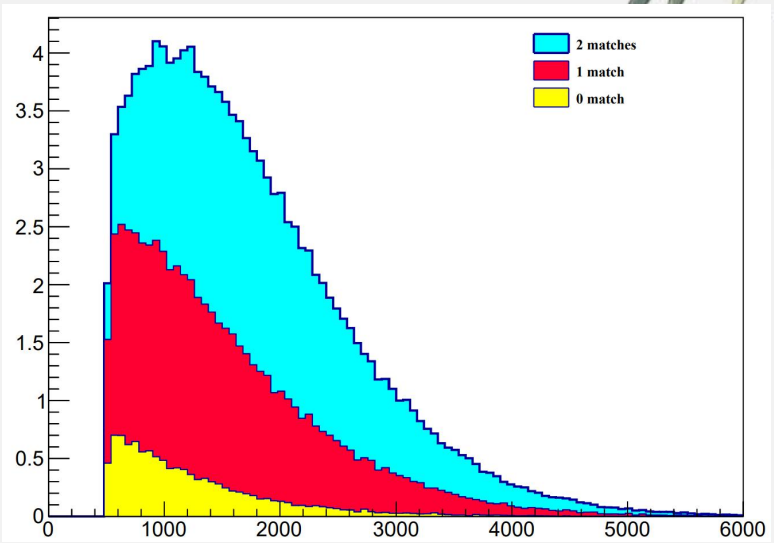

fig2.max Δη method

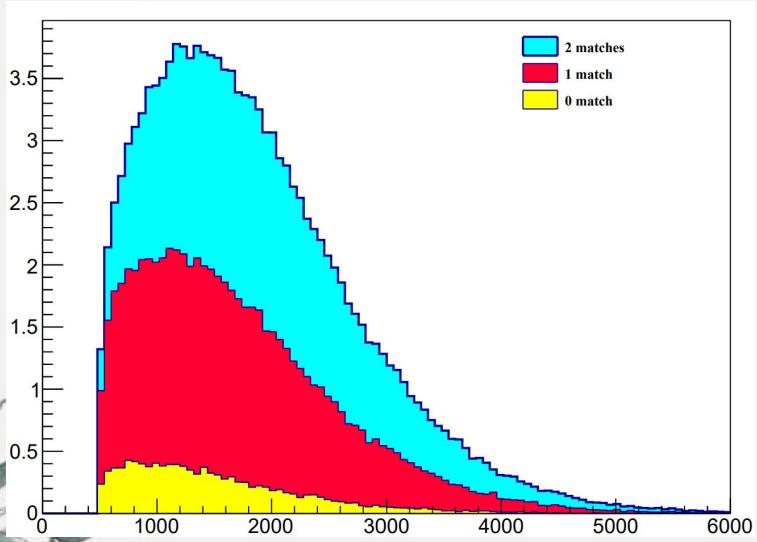

fig3. double side max energy method

M_{jj} distributions for OSWWH

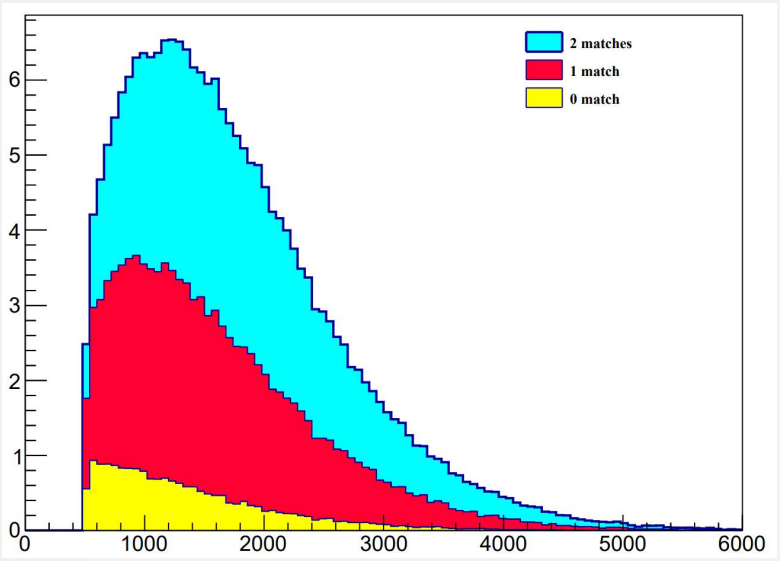

fig1.max Mjj method

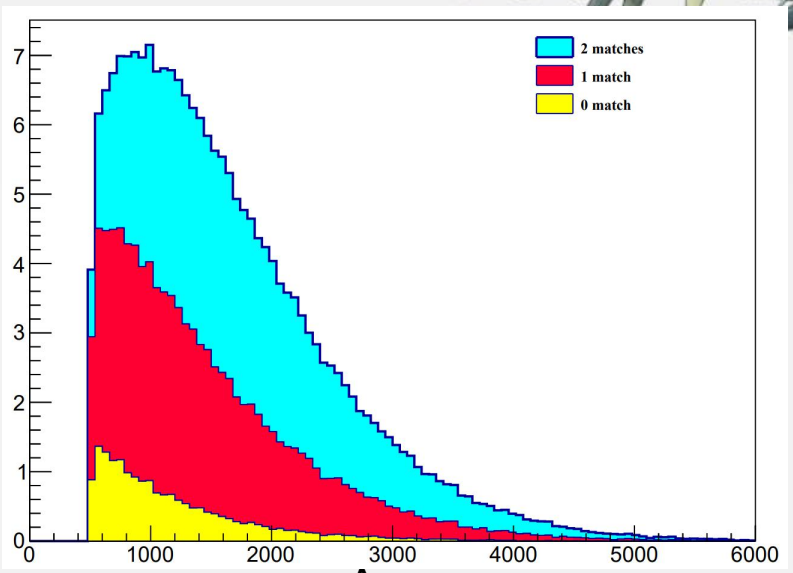

fig2.max Δη method

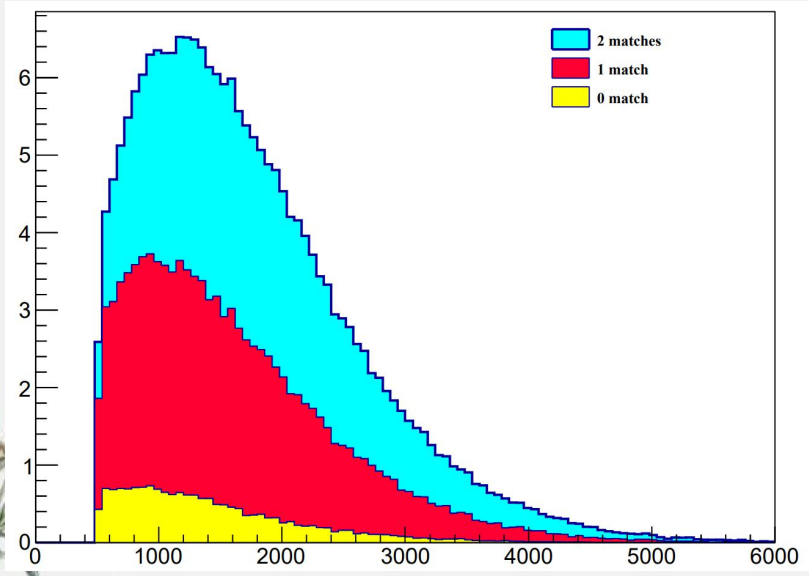

fig3. double side max energy method

M_{jj} distributions for WZH

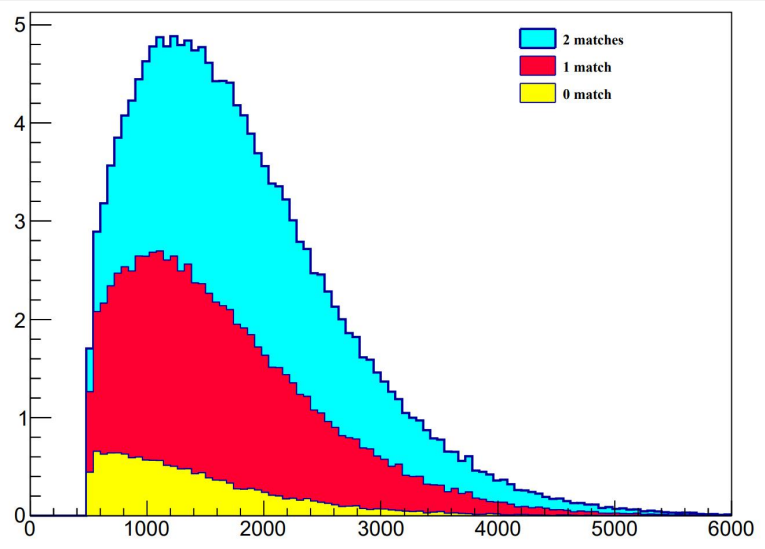

fig1.max Mjj method

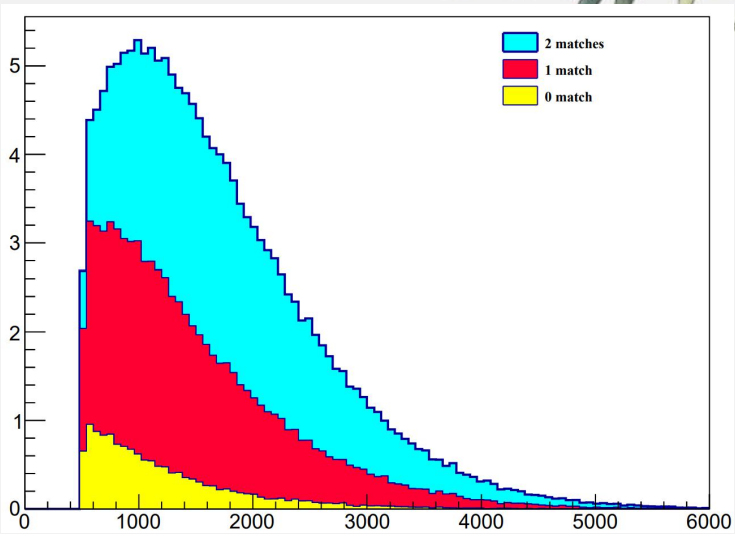

fig2.max Δη method

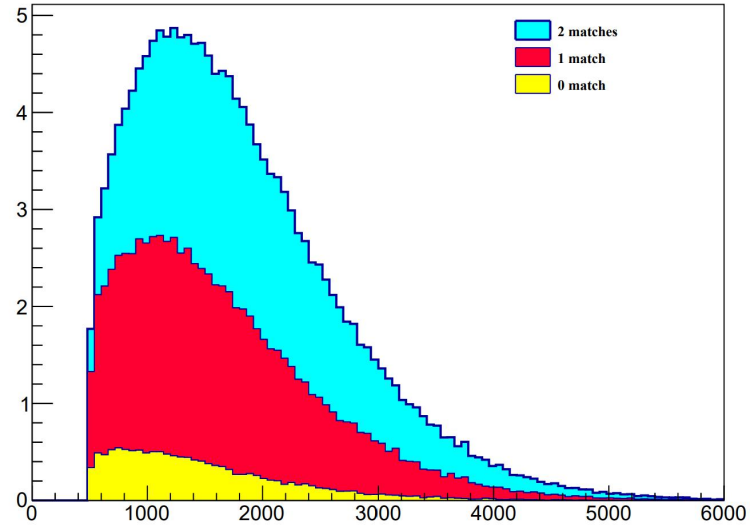

fig3. double side max energy method

M_{jj} distributions for ZZH

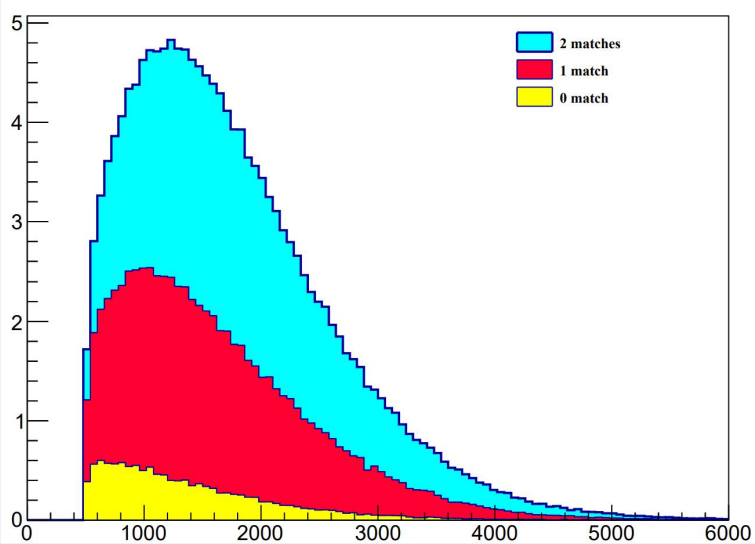

fig1.max Mjj method

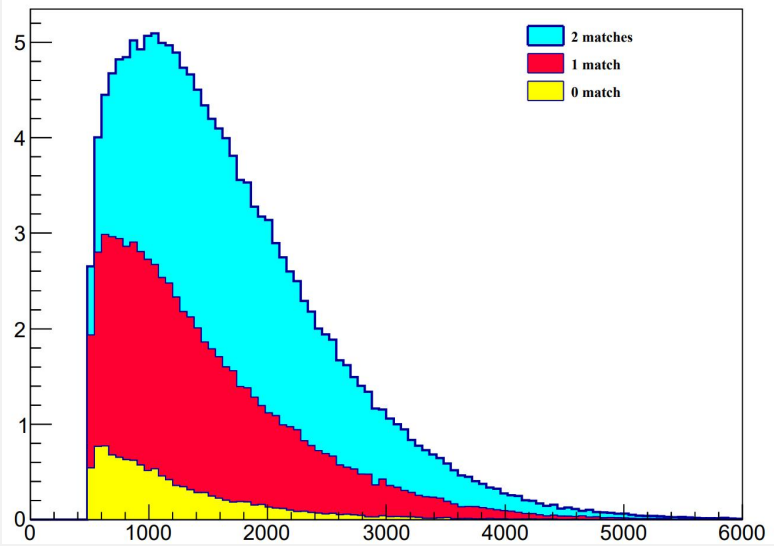

fig2.max Δη method

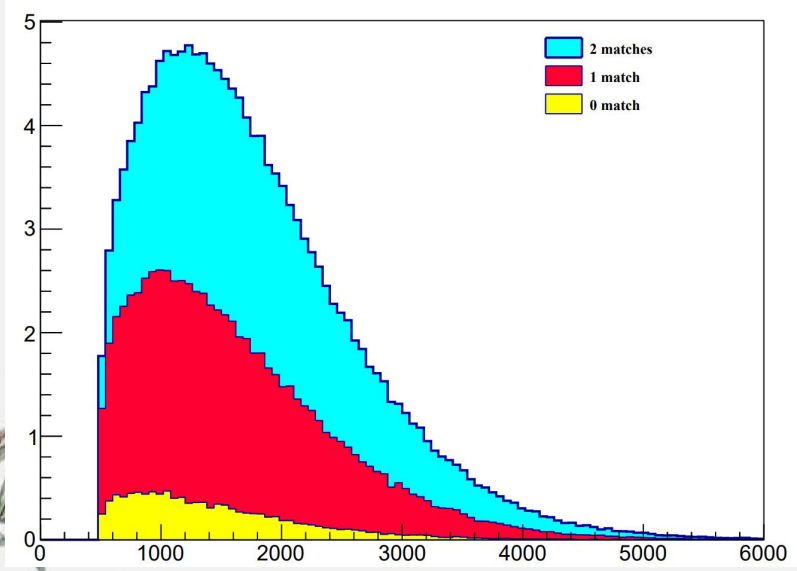

fig3. double side max energy method

Δ η distributions for SSWWH

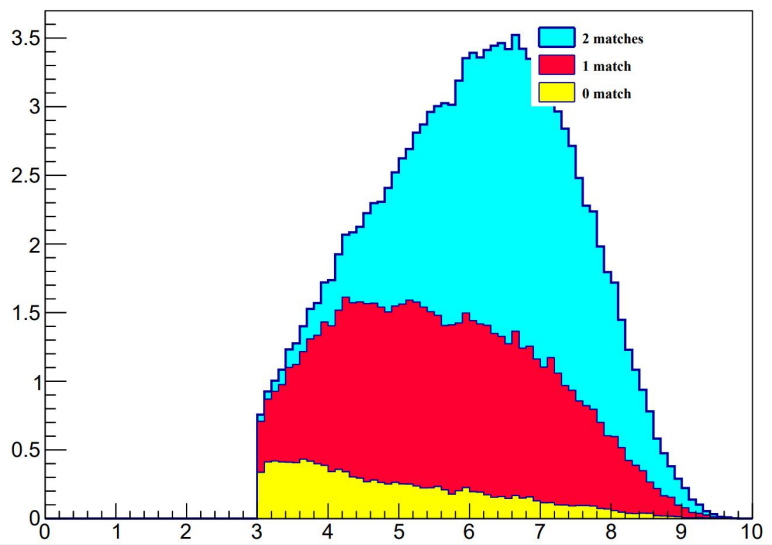

fig1.max Mjj method

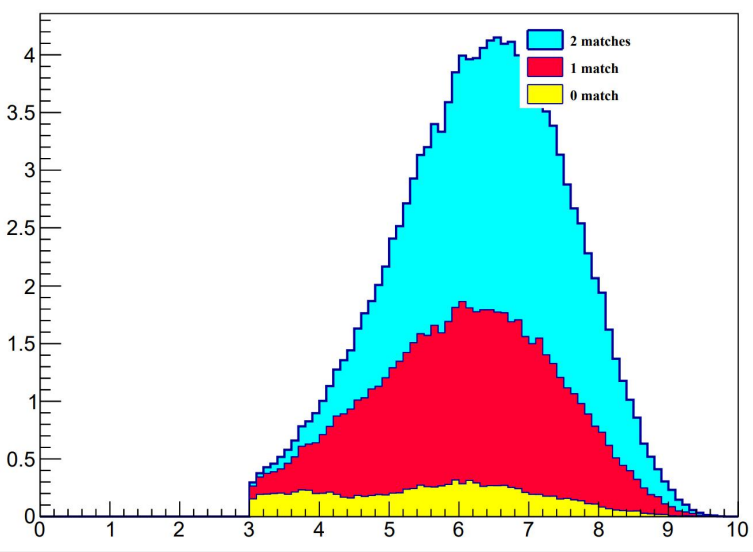

fig2.max Δη method

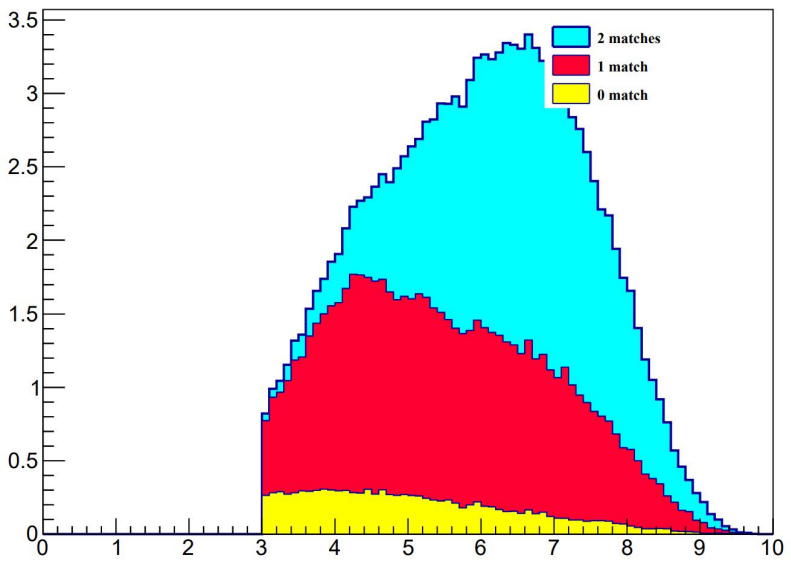

fig3. double side max energy method

Δ η distributions for OSWWH

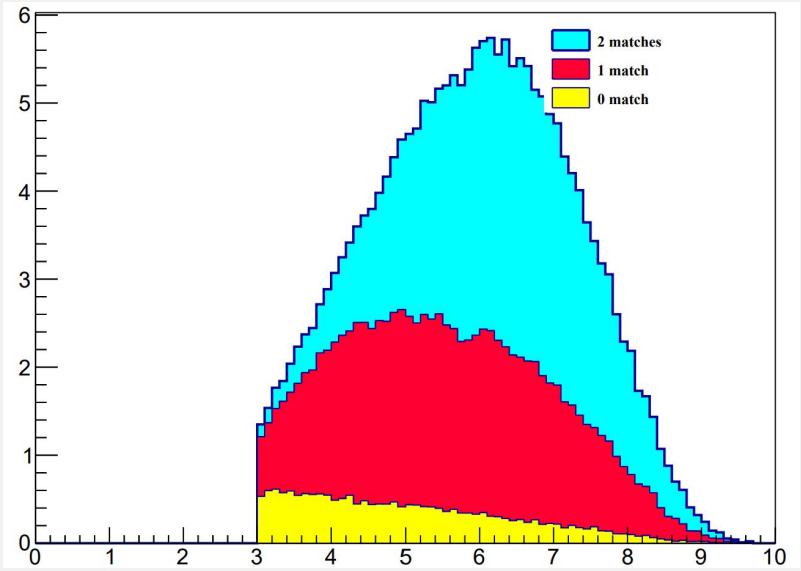

fig1.max Mjj method

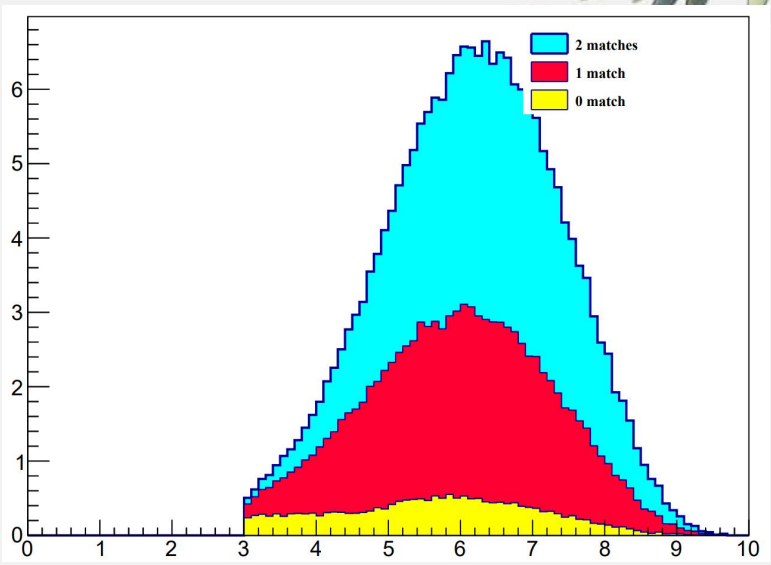

fig2.max Δη method

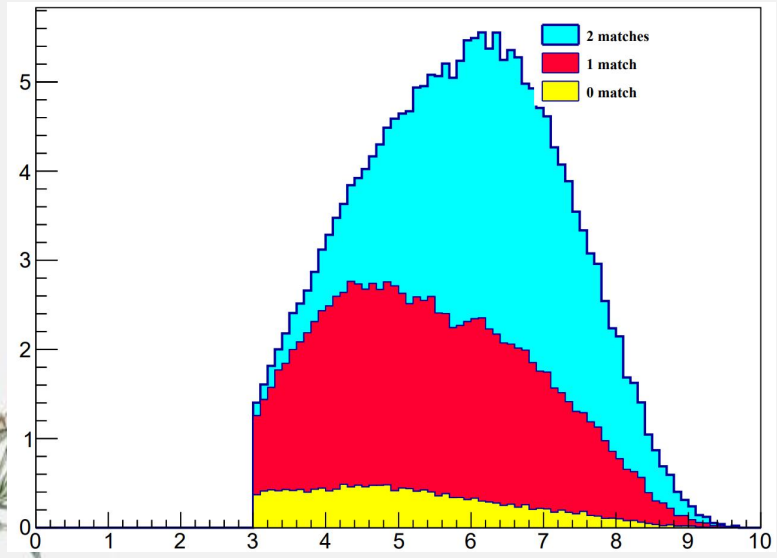

fig3. double side max energy method

Δ η distributions for WZH

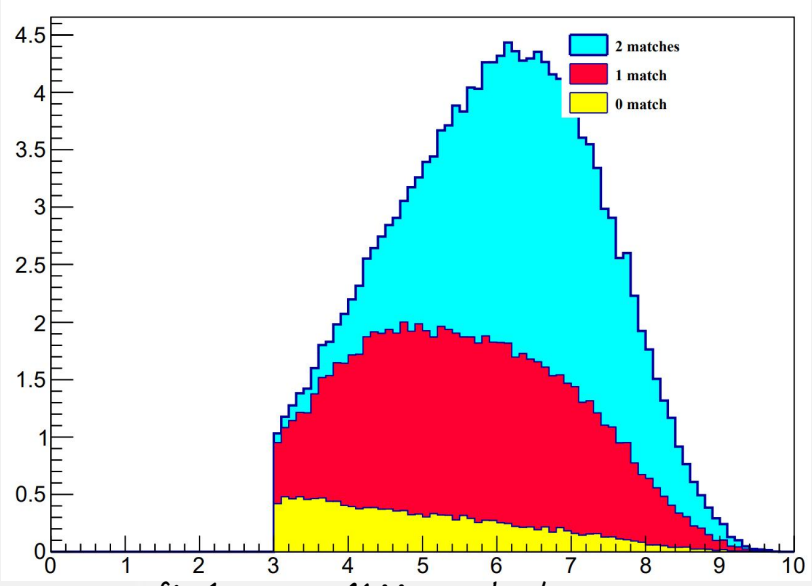

fig1.max Mjj method

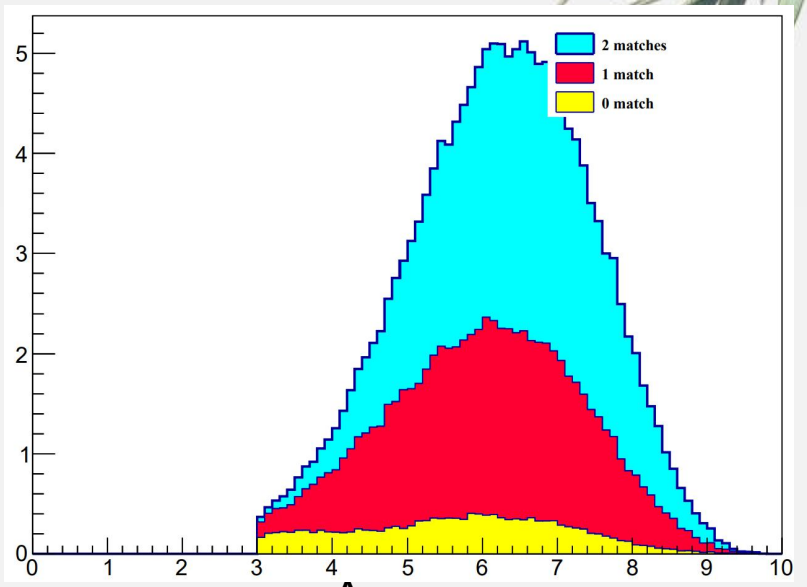

fig2.max Δη method

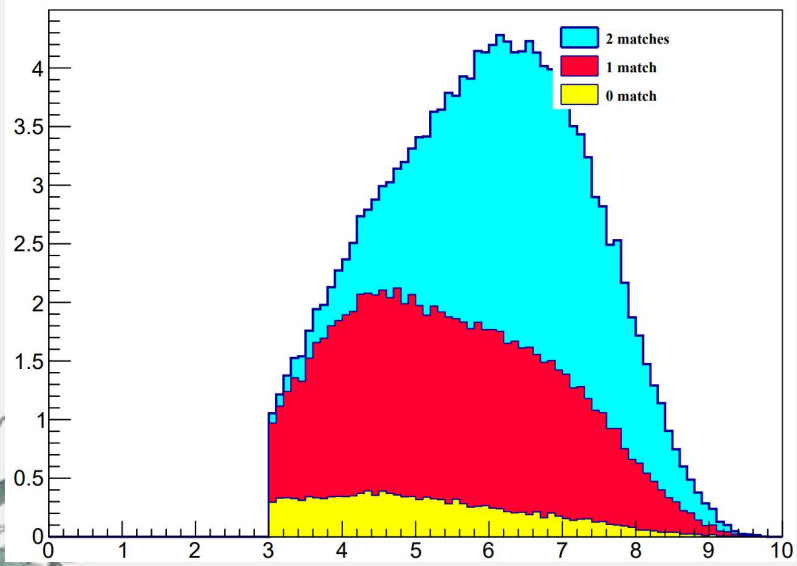

fig3. double side max energy method

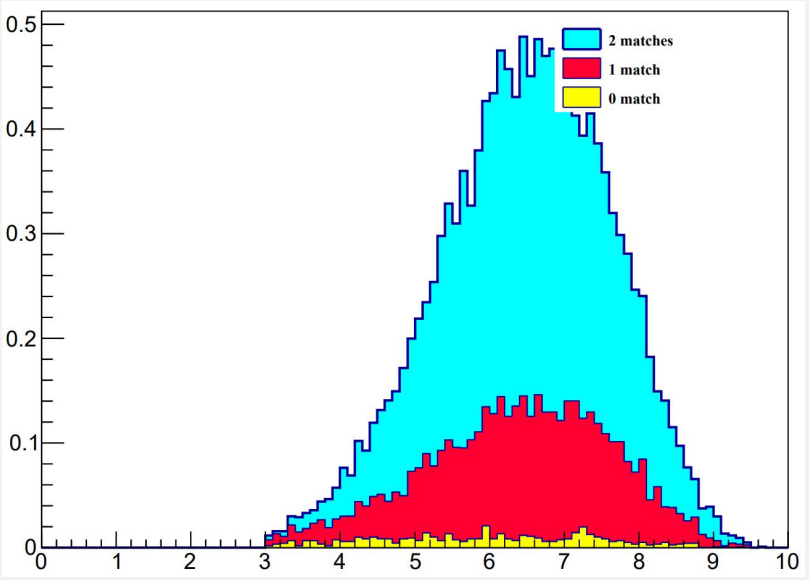

fig4.method4 especially 3+2 channel

Δ η distributions for ZZH

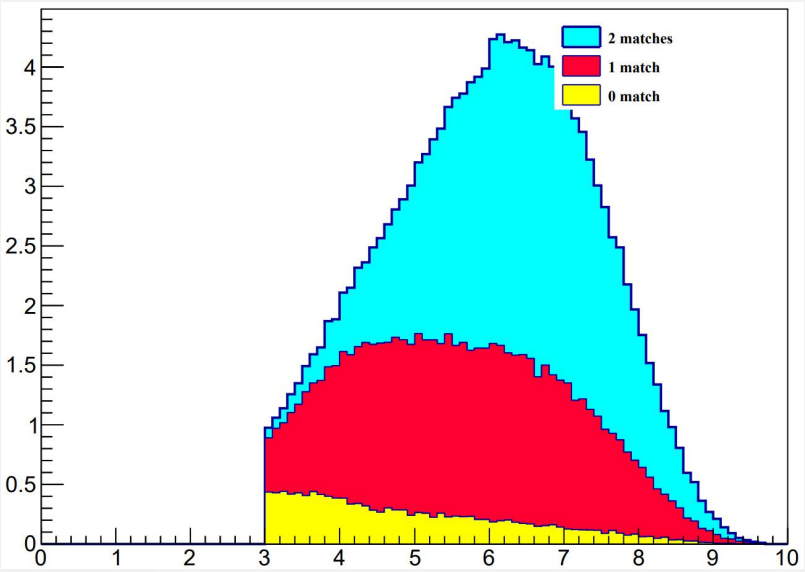

fig1.max Mjj method

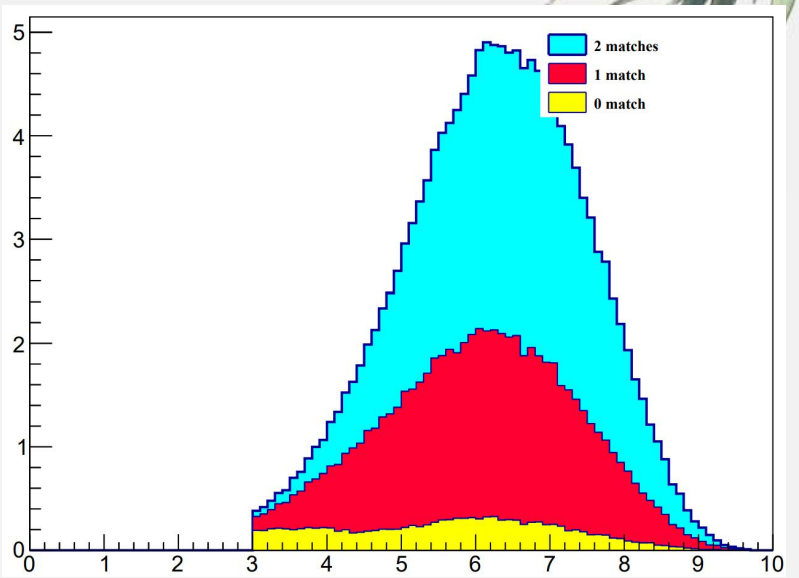

fig2.max Δη method

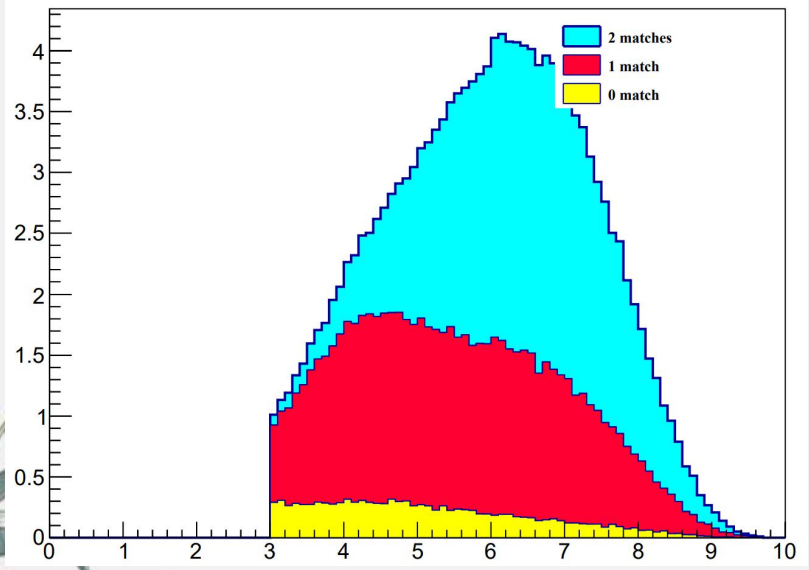

fig3. double side max energy method

Cut flow for VVH

cross section(fb^{-1})			SS WWH(5.19)	OS WWH(8.23)	WZH(5.37)	ZZH(4.24)
3+ fatjets	**3+ fatjets**		19.973	23.433	19.186	15.549
	2+ jets	2+ jets	16.493	19.567	15.935	12.740
		VBF cut1	14.762	17.124	14.114	11.253
		VBF cut2	14.684	17.017	14.046	11.185
		VBF cut3	14.754	17.114	14.099	11.244
	1 jet	1 jet	3.133	3.463	2.919	2.542
	0 jet	0 jet	0.347	0.403	0.333	0.267
2 fatjets	**2 fatjets**		60.865	86.896	67.764	63.922
	4+ jets	4+ jets	31.141	44.148	33.102	28.526
		VBF cut1	29.072	40.536	30.443	26.381
		VBF cut2	28.940	40.280	30.254	26.178
		VBF cut3	28.867	40.368	30.276	26.223
	3 jets	3 jets	18.945	26.772	19.878	18.344
		VBF cut1	15.909	22.292	16.472	15.307
		VBF cut2	15.751	22.072	16.339	15.113
		VBF cut3	15.716	20.078	16.305	15.157

Cut flow for VVH

			SS WWH	OS WWH	WZH	ZZH
2 fatjet	**2 fatjets**		60.865	86.896	67.764	63.922
	2 jets	2 jets	8.847	13.170	11.703	13.262
		VBF cut1	5.493	8.347	8.027	9.870
		VBF cut2	5.483	8.339	8.016	9.864
		VBF cut3	5.483	8.342	8.016	9.864
	<2 jets	<2 jets	1.932	2.807	3.081	3.790
1 fatjet	**1 fatjet**		45.615	73.563	62.040	64.026
	6+ jets	6+jets	17.266	28.599	20.530	17.791
		VBF cut1	15.847	26.069	18.725	16.346
		VBF cut2	15.971	26.107	18.807	16.403
		VBF cut3	15.743	25.923	18.567	16.192
	5 jets	5 jets	13.396	21.789	16.039	14.783
		VBF cut1	11.688	18.841	13.888	13.113
		VBF cut2	11.920	19.143	14.098	13.167
		VBF cut3	11.607	18.663	13.789	12.967
cross section			5.19 fb	8.23 fb	5.37 fb	4.24 fb

Cut flow for VVH

			SS WWH	OS WWH	WZH	ZZH
1 fatjet	**1 fatjet**		45.615	73.563	62.040	64.026
	4 jets	4 jets	10.100	15.792	14.561	15.755
		VBF cut1	8.108	12.518	11.979	13.481
		VBF cut2	8.369	12.853	12.209	13.565
		VBF cut3	8.062	12.441	11.938	13.387
	3 jets	5 jets	3.963	6.111	8.122	10.317
		VBF cut1	2.626	4.019	5.939	7.953
		VBF cut2	2.779	4.149	5.893	7.893
		VBF cut3	2.617	3.989	5.866	7.852
	2 jets	2 jets	0.806	1.150	2.411	4.418
		VBF cut1	0.359	0.475	1.248	2.934
		VBF cut2	0.357	0.470	1.249	2.929
		VBF cut3	0.357	0.470	1.248	2.930
	<2 jets		0.084	0.121	0.377	0.962
none of the above			35.709	75.536	52.918	47.187
cross section			5.19 fb	8.23 fb	5.37 fb	4.24 fb

*None of the above means, no fatjet

Jets matched to VBF quarks for WZH

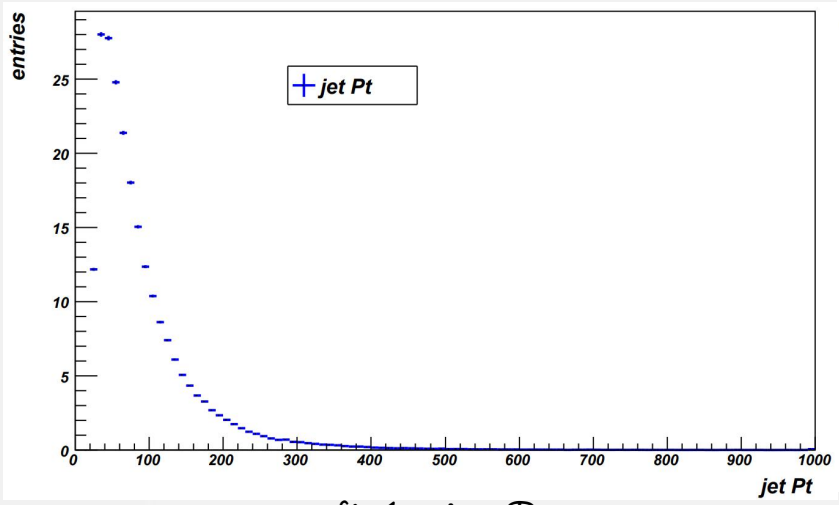

fig1. jet Pt

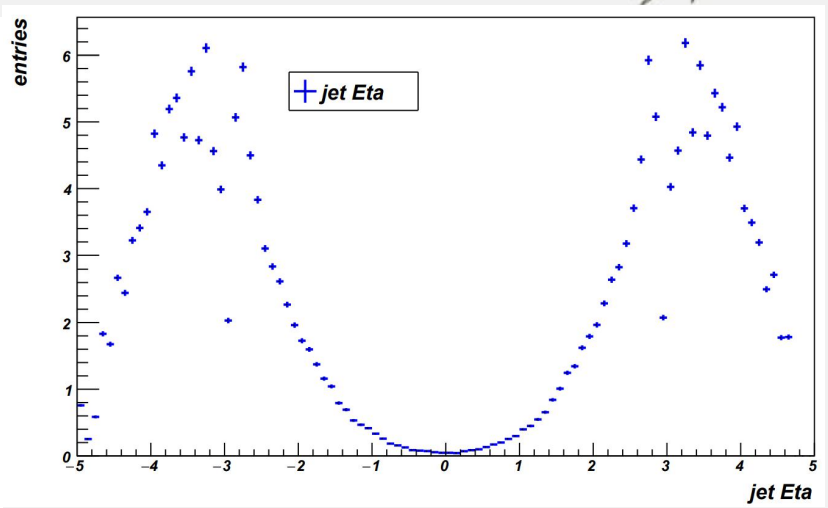

fig2. jet Eta

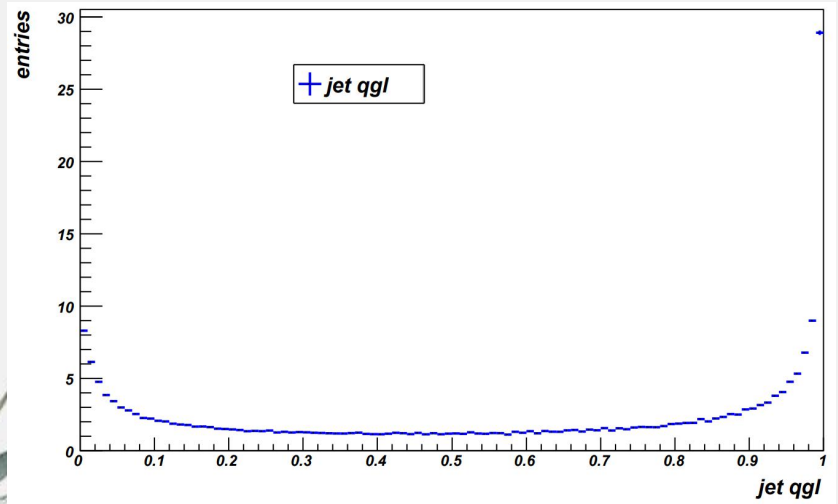

fig3. jet qgl

These are jets that matched to VBF quarks. (I plotted both of them together)

Jets matched to VBF quarks for WZH

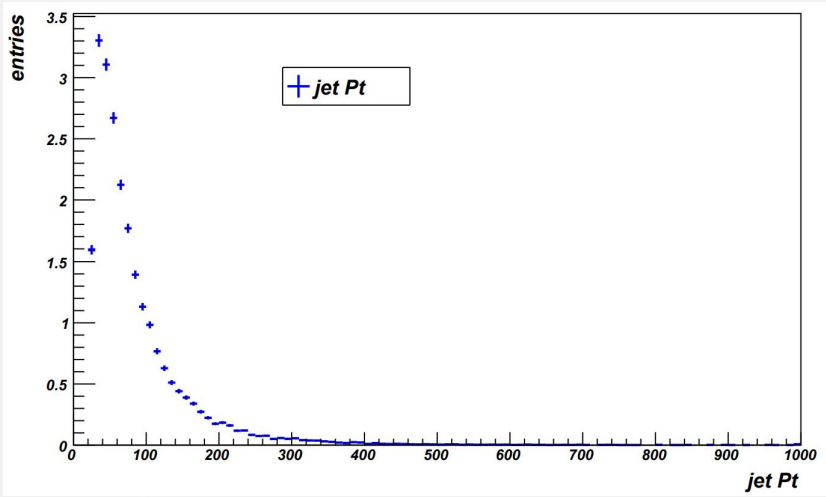

fig1. jet Pt

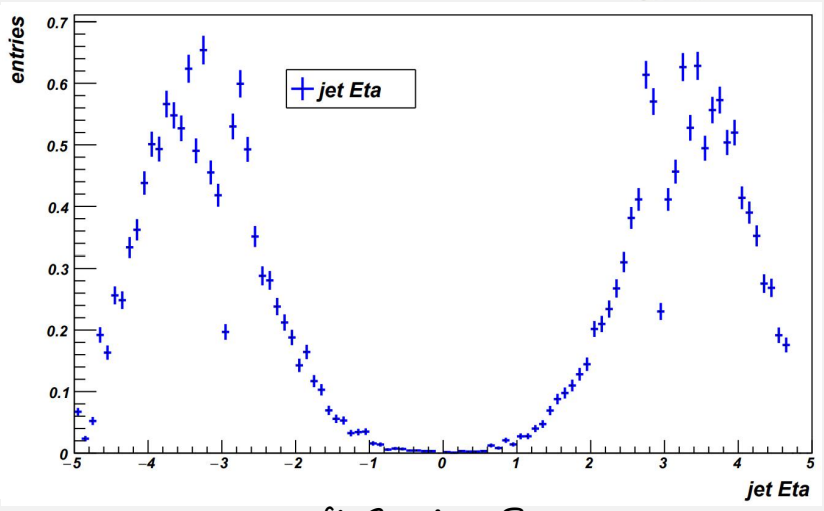

fig2. jet Eta

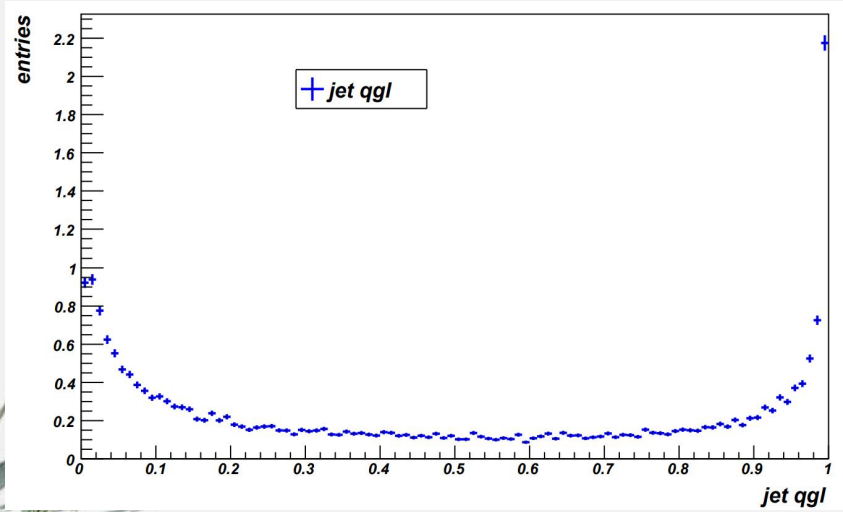

fig3. jet qgl

Only look at the 3 fatjets+2(+)jets category. This basically shows the few 2 matches jets and some events with 1 matched jets.

Back up

Jet/Fatjet Selection

- **Fatjet selectrion**
  - Fatjet $P_T > 250$GeV
  - Fatjet_jetId > 0
  - $|\eta_{fatjet}| < 2.5$
  - Fatjet_msoftdrop > 40GeV

- **Jet selectrion**
  - Jet $P_T > 25$GeV
  - $|\eta_{jet}| < 4.7$
  - $\Delta R(\text{fatjet, jet}) > 0.8$

- **VBF Jet requirement**
  - pick jet pairs with the largest M_{jj}, and their $M_{jj} > 500$GeV

Lepton Selection

- **Lepton loose Id selectrion (from ttH study)**

Electron

loose Id electrons:

- Electron $P_T > 7GeV$
- $|\eta_{\text{Electron}} + Electron\_deltaEtaSC| < 2.5$
- $|Electron\ d_{xy}|<0.05$
- $|\text{Electron } d_z|<0.1$
- $|\text{Electron sip3d}| <8$
- Electron_miniPFRelIso_all<0.4
- Electron_miniPFRelIso_all<=1
- Electron_mvaFall17V2noIso_WPL=true

Muon

loose Id muons:

- Muon $P_T > 5GeV$
- $|\eta_{\text{Muon}}| < 2.4$
- $|\text{Muon } d_{xy}|<0.05$
- $|\text{Muon } d_z|<0.1$
- $|\text{Muon sip3d}| <8$
- Muon_miniPFRelIso_all<0.4
- Muon_looseId=true

- **We require the number of leptons passing these selections should be 0**