Performance study -- BMR

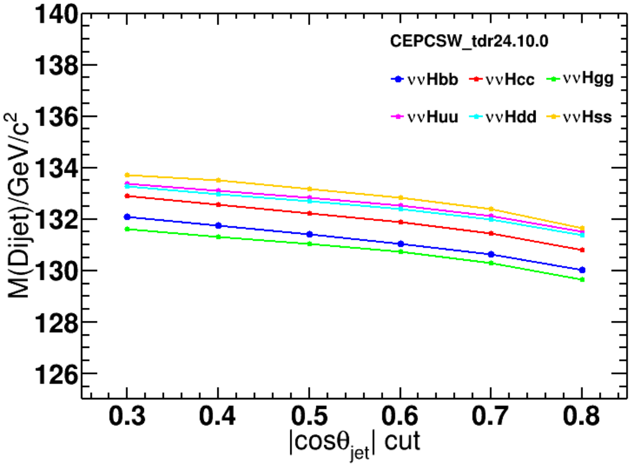
- Perform BMR study in $ZH \rightarrow \nu\nu + gg/bb/cc/uu/dd/ss$ with $\sqrt{s} = 240\text{GeV}/c^2$
- Comparisons without/with event cleaning under $|\cos\theta_{\text{jet}}| < 0.7$

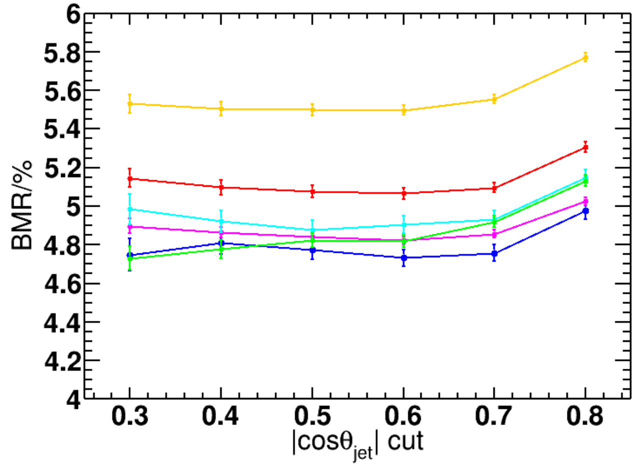
Case	process	$ZH \rightarrow \nu\nu gg$	$ZH \rightarrow \nu\nu bb$	$ZH \rightarrow \nu\nu cc$	$ZH \rightarrow \nu\nu uu$	$ZH \rightarrow \nu\nu dd$	$ZH \rightarrow \nu\nu ss$
Physical level	BMR/%	5.03 ± 0.03	6.44 ± 0.06	5.66 ± 0.04	4.87 ± 0.02	4.96 ± 0.04	5.58 ± 0.02
	Efficiency/%	59.2	57.7	58.0	58.4	58.2	58.0
Detector level	BMR/%	4.92 ± 0.03	4.76 ± 0.04	5.10 ± 0.03	4.86 ± 0.02	4.93 ± 0.04	5.56 ± 0.02
	Efficiency/%	52.9	21.7	38.0	55.3	55.1	54.9

  - Event cleaning: $\Sigma|Pt_{\text{ISR}}| < 1\text{GeV}/c \& \Sigma|Pt_{\nu}| < 1\text{GeV}/c$
  - Before event cleaning, BMR ranges from 4.87% to 6.44%
  - After event cleaning, BMR ranges from 4.76% to 5.56%
- Samples generated (see in backup) under CEPCSW_tdr24.10.0

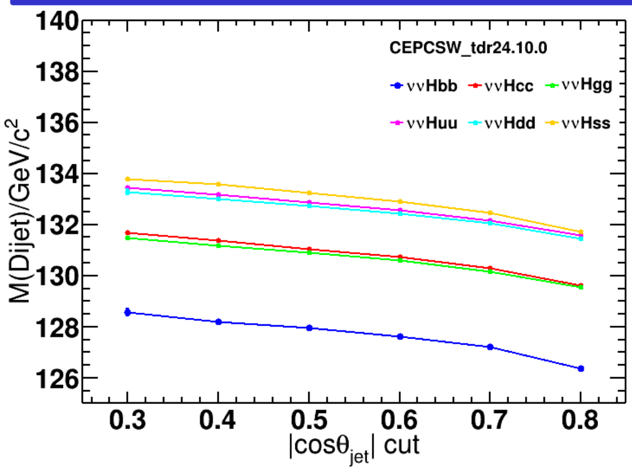
Performance study -- BMR

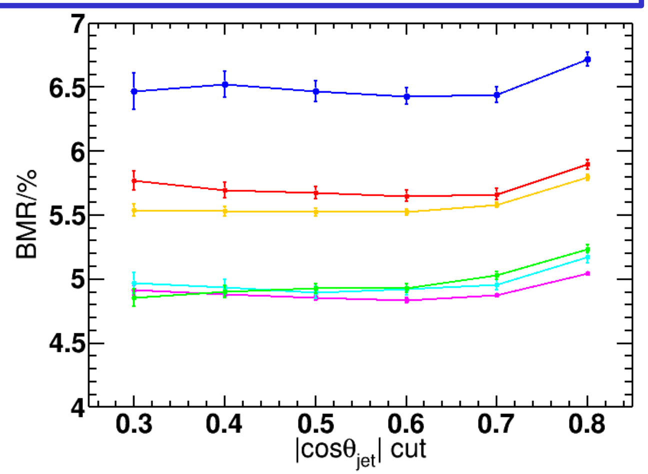
Higgs mass and BMR distributions according to $|\cos\theta_{\text{jet}}|$ cut -- event cleaning





Higgs mass and BMR distributions according to $|\cos\theta_{\text{jet}}|$ cut -- no cleaning





- Higgs mass larger than 130GeV/c^2 while truth M(Dijet) is 125GeV/c^2
- $|\cos\theta_{\text{jet}}|$ cut can't improve BMR too much

Performance study -- BMR

Table 1. Event cumulative efficiency for Higgs boson exclusive decay at the CEPC with $\sqrt{s} = 240$ GeV.

	gg(%)	bb(%)	cc(%)	WW^*(%)	ZZ^* (%)
Pt_ISR < 1 GeV	95.15	95.37	95.30	95.16	95.24
Pt_neutrino < 1 GeV	89.33	39.04	66.36	37.46	41.39
|Cos(Theta_Jet)| < 0.85	67.30	28.65	49.31	–	–

Table 3. Higgs boson mass resolution (sigma/Mean) for different decay modes with jets as final state particles, after event cleaning.

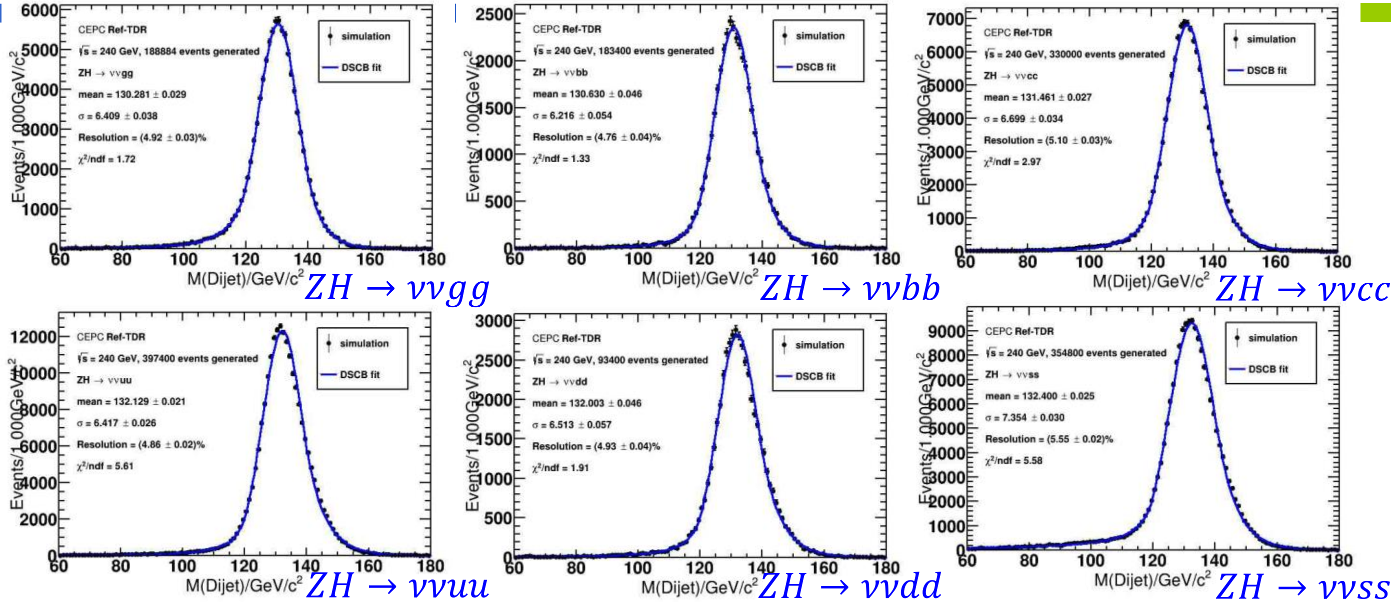
$H \to bb$	$H \to cc$	$H \to gg$	$H \to WW^*$	$H \to ZZ^*$
3.63%	3.82%	3.75%	3.81%	3.74%

CDR reference

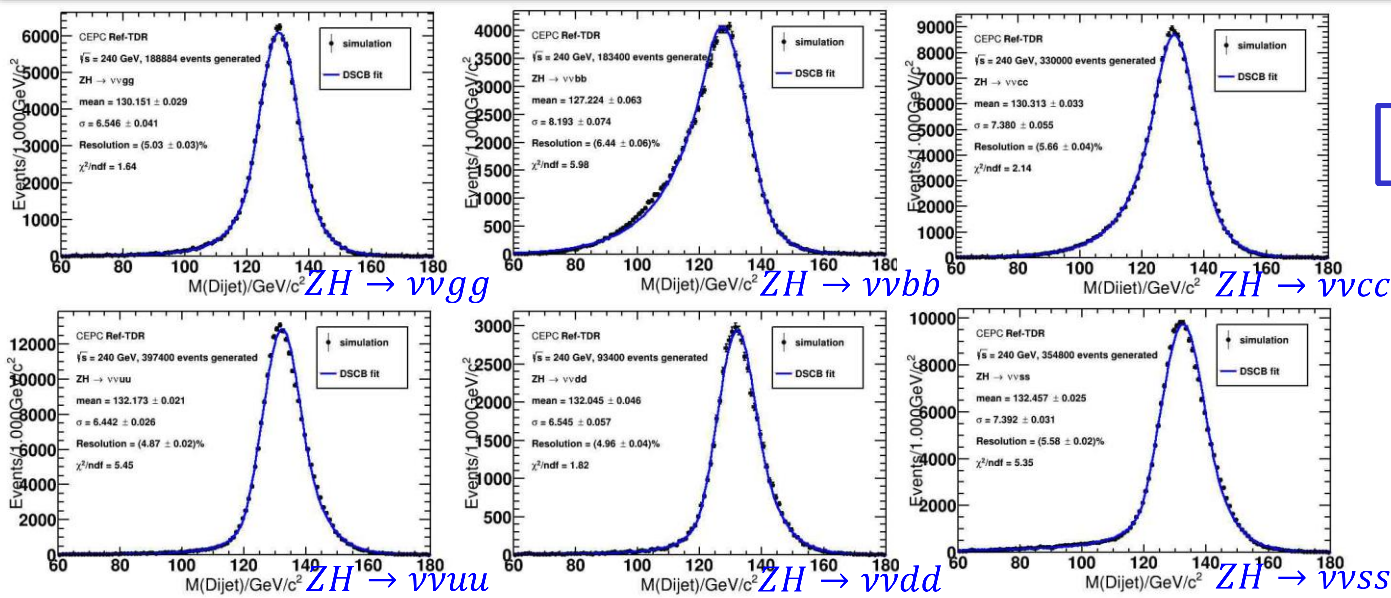
Process		$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$	$ZH \to \nu\nu uu$	$ZH \to \nu\nu dd$	$ZH \to \nu\nu ss$
Cumulative efficiency /%	$\Sigma\|Pt_{\text{ISR}}\| < 1\text{GeV}/c$	95.2	95.2	95.2	95.4	95.2	95.2
	$\Sigma\|Pt_{\nu}\| < 1\text{GeV}/c$	89.7	39.0	66.5	94.9	94.7	94.7
	$\|\cos\theta_{\text{jet}}\| < 0.7$	52.9	21.7	38.0	55.3	55.1	54.9
DSCB BMR/%		4.92 ± 0.03	4.76 ± 0.04	5.10 ± 0.03	4.86 ± 0.02	4.93 ± 0.04	5.56 ± 0.02

- Comparison between CDR reference and current results
  - Efficiencies of event cleaning match for $ZH \to \nu\nu gg/\nu\nu bb/\nu\nu cc$
  - BMR for $ZH \to \nu\nu gg/\nu\nu bb/\nu\nu cc$ is worse by 1.17%/1.13%/1.28%

Performance study -- BMR

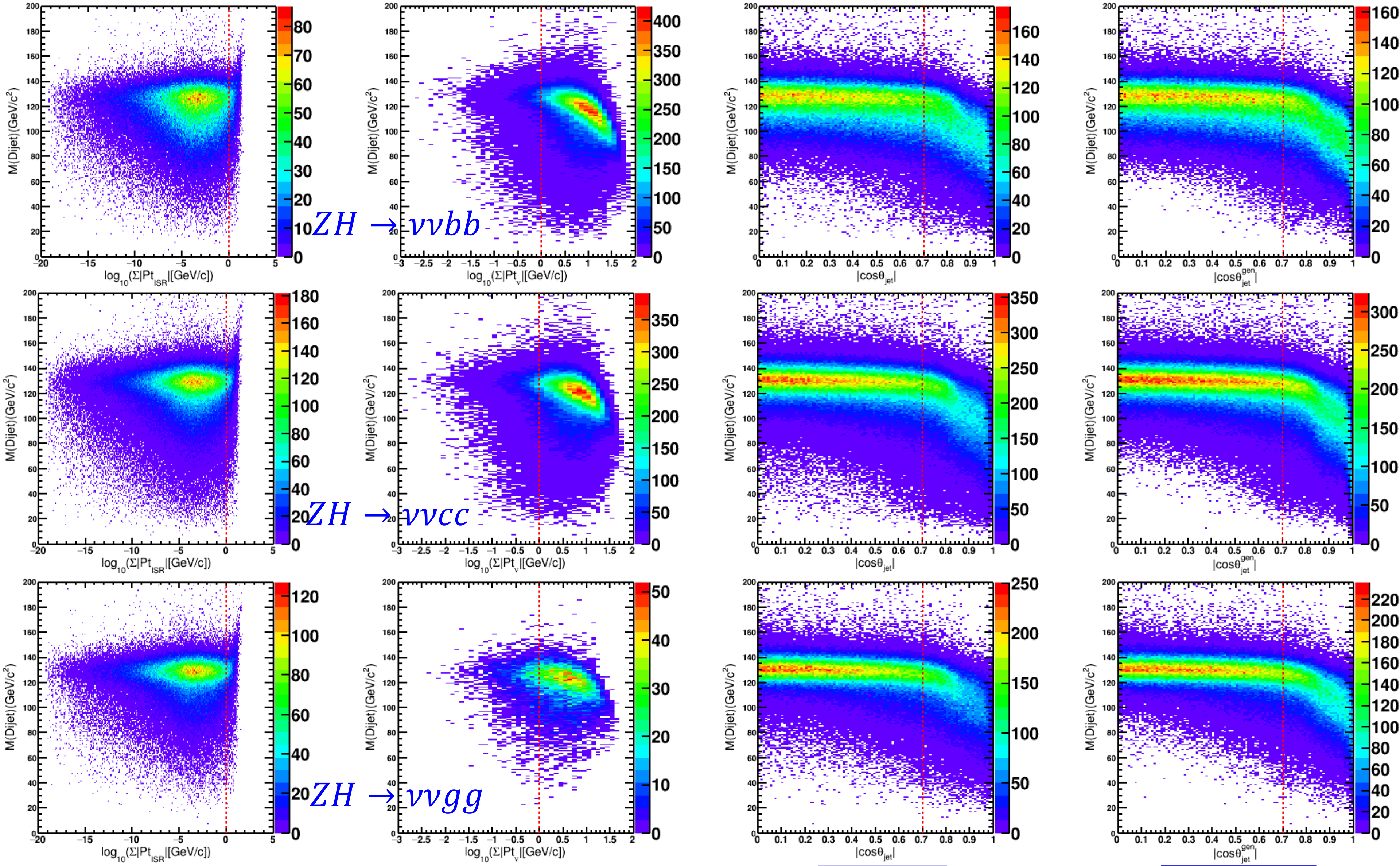


With event cleaning



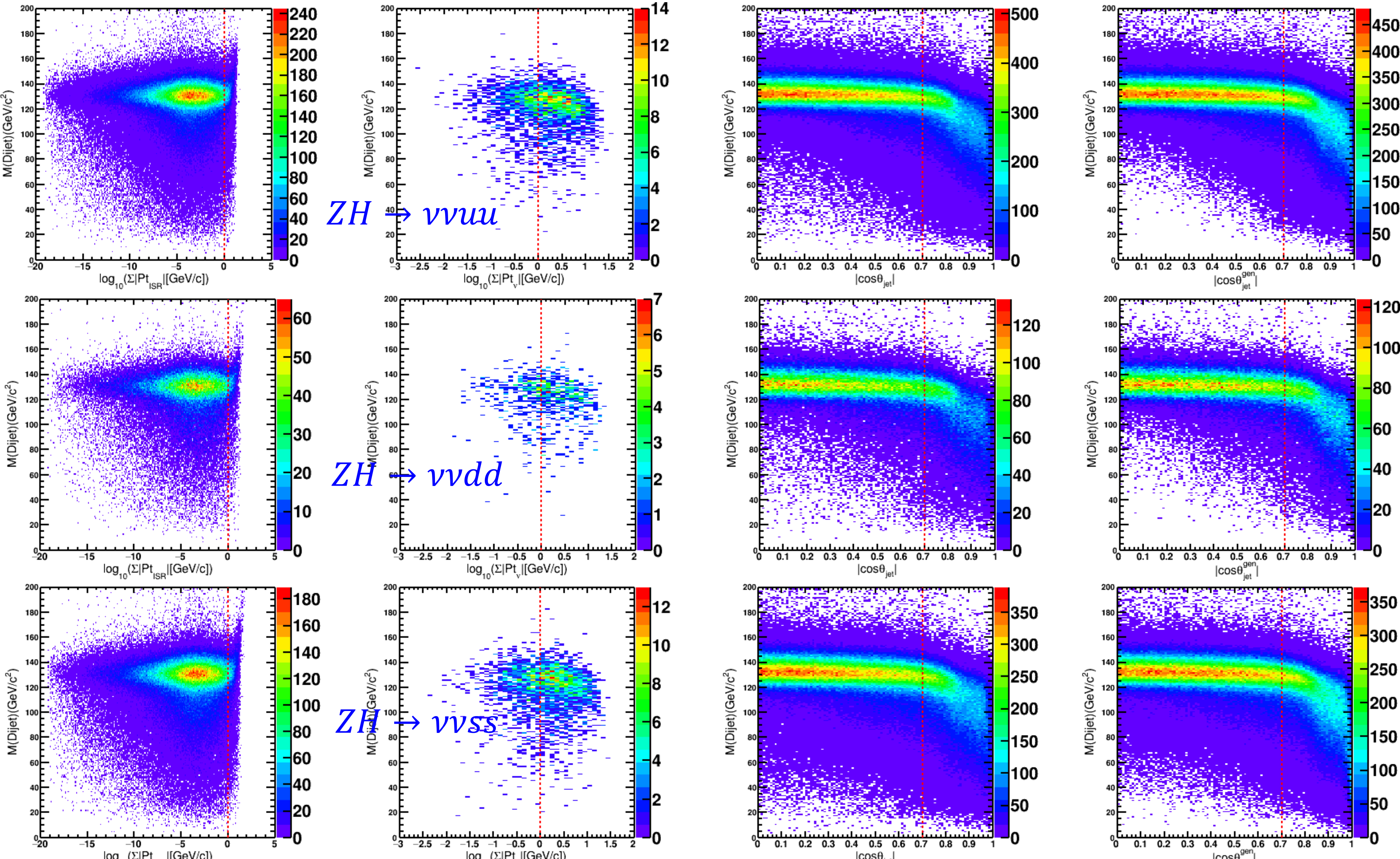
Without event cleaning

Distributions against M(Dijet) and cuts



$\lg|\Sigma Pt_{\mathrm{ISR}}|$ $\lg\Sigma|Pt_{\nu}|$ $|\cos\theta_{\mathrm{jet}}|$ $|\cos\theta_{\mathrm{jet}}^{\mathrm{gen}}|$

Distributions against M(Dijet) and cuts



$\lg|\Sigma Pt_{\text{ISR}}|$ $\lg\Sigma|Pt_{\nu}|$ $|\cos\theta_{\text{jet}}|$ $|\cos\theta_{\text{jet}}^{\text{gen}}|$

Back up

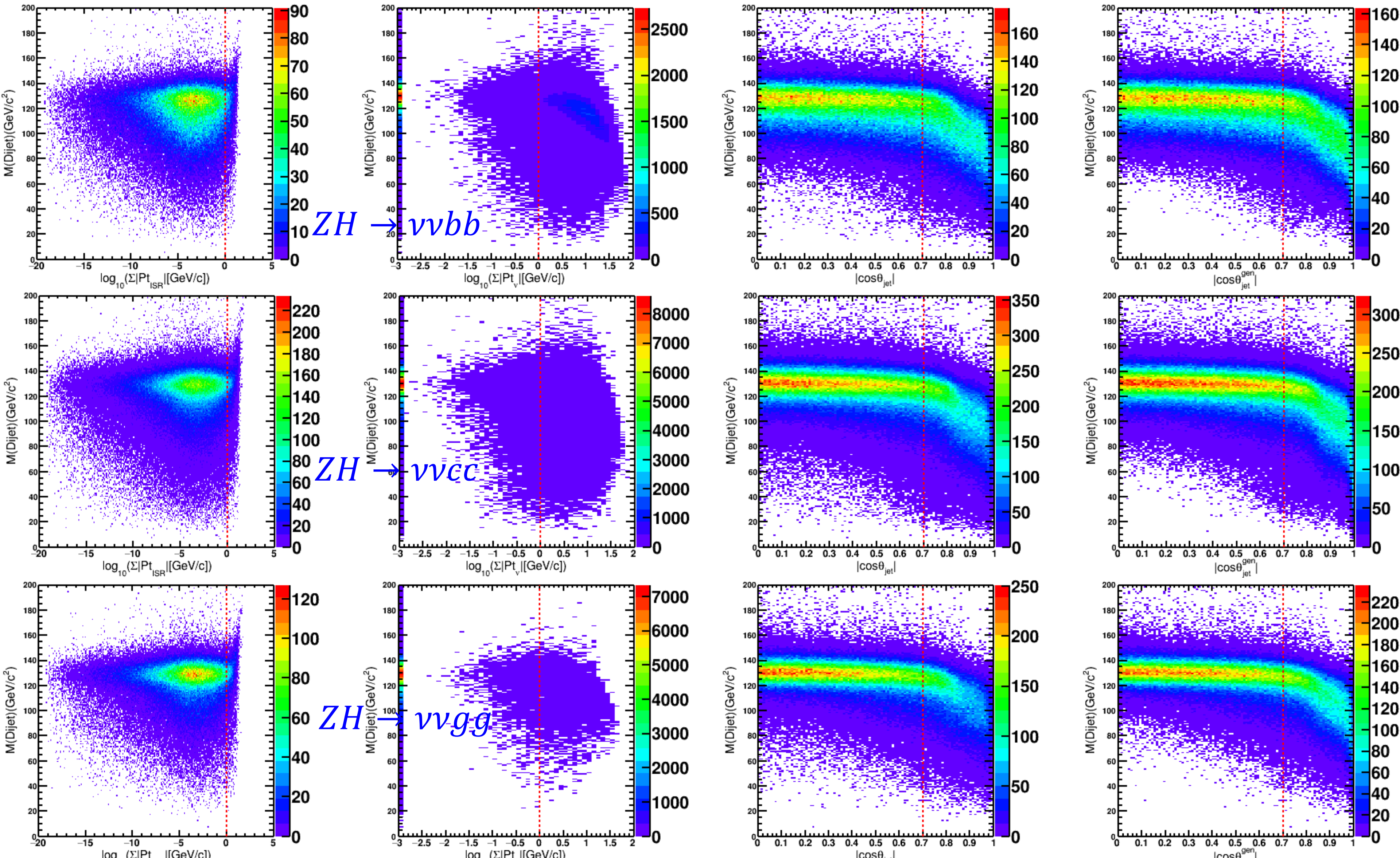
❖ Samples used：

- Generator1: /cefs/higgs/zhuyf/workspace/whizard360/WhizardAis/data/higgs/E240.Pn2n2h_uu.e0.p0.whizard195/
- Generator2: /cefs/data/stdhep/CEPC240/higgs/update_from_LiangHao_1M/data/E240.Pnnh_*/
- 24.9.1 samples: /cefs/higgs/maxiaotian/CEPCSW/sample/24.9.1/
  - gen_Rec_E240_nnHgg_5000.root, gen_Rec_E240_nnHbb_5000.root, gen_Rec_E240_nnHcc_5000.root
  - gen_Rec_E240_nnHuu_5000.root, gen_Rec_E240_nnHdd_5000.root, gen_Rec_E240_nnHss_5000.root
- 24.10.0 fit: /cefs/higgs/zhangkl/Production/
  - E240_nnHgg/ -> /cefs/higgs/maxiaotian/CEPCSW/sample/Jets_E240_nnHgg.root
  - E240_nnHbb_1105v2/ -> /cefs/higgs/maxiaotian/CEPCSW/sample/Jets_E240_nnHbb.root
  - E240_nnHcc/ -> /cefs/higgs/maxiaotian/CEPCSW/sample/Jets_E240_nnHcc.root
  - E240_nnHuu/ -> /cefs/higgs/maxiaotian/CEPCSW/sample/Jets_E240_nnHuu.root
  - E240_nnHddv2/ -> /cefs/higgs/maxiaotian/CEPCSW/sample/Jets_E240_nnHdd.root
  - E240_nnHss/ -> /cefs/higgs/maxiaotian/CEPCSW/sample/Jets_E240_nnHss.root
- 24.10.0 cleanfit: /cefs/higgs/maxiaotian/CEPCSW/sample/p_gamnu/
  - clean_E240_nnHbb.root, clean_E240_nnHcc.root, clean_E240_nnHdd.root
  - clean_E240_nnHgg.root, clean_E240_nnHss.root, clean_E240_nnHuu.root

```
if (M.GetSize() >= 5) {
    double j[M.GetSize()];cnt=0;
    for(int i=0;i<M.GetSize();i++){
        if(S[i]==1){cnt++;j[cnt-1]=i;}
    }
    if(cnt >= 5){
        for(int i=0;i<2;i++){
        if(ID[j[i]]==22) {
            tot_p_ISR+=sqrt(pow(px[j[i]],2)+pow(py[j[i]],2)+pow(pz[j[i]],2));
            tot_pt_ISR+=sqrt(pow(px[j[i]],2)+pow(py[j[i]],2));}}
        for(int i=4;i<cnt;i++){
            int ii = j[i];
            p=sqrt(pow(px[ii],2)+pow(py[ii],2)+pow(pz[ii],2));
            pt=sqrt(pow(px[ii],2)+pow(py[ii],2));
            if(fabs(ID[ii])==12||fabs(ID[ii])==14||fabs(ID[ii])==16){
                tot_p_nu+=p;tot_pt_nu+=pt;}
```

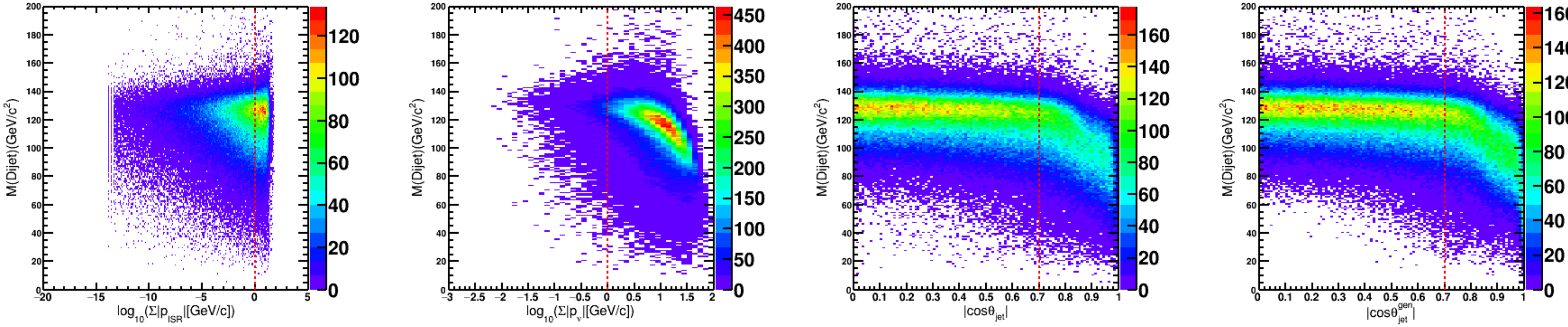
Pt_{ISR}: summing the transverse momentum of all ISR photons
Pt_{ν}: summing the transverse momentum of the neutrinos generated by Higgs boson decay products

Distributions (logx values add x=0 values) and cuts



$\lg|\Sigma Pt_{\text{ISR}}|$ | $\lg\Sigma|Pt_{\nu}|$ | $|\cos\theta_{\text{jet}}|$ | $|\cos\theta_{\text{jet}}^{\text{gen}}|$

|Pt| -> |P|



$ZH \rightarrow \nu\nu bb$