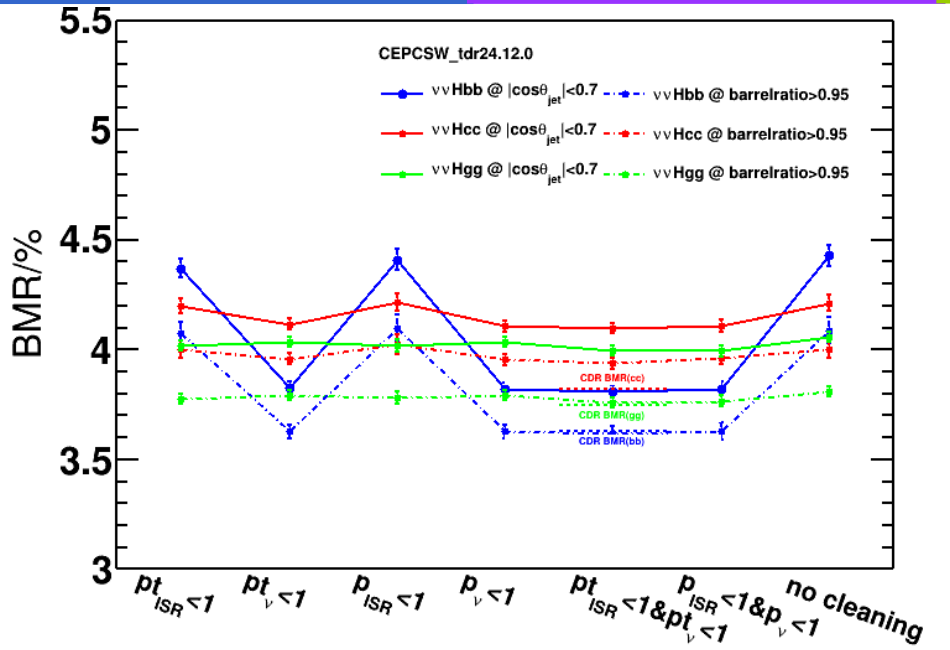
BMR -- Status

- BMR performance in $ZH \rightarrow \nu\nu + gg/bb/cc$ with $\sqrt{s} = 240\mathrm{GeV}/c^2$
- BMR performance with different event cleaning cuts
  - Barrelratio cut better than $\cos\theta_{\mathrm{jet}}$ in BMR with lower efficiency ($ZH \rightarrow \nu\nu gg$ is strange)
  - Barrelratio cut match with CDR BMRs except for $ZH \rightarrow \nu\nu cc$ which is 0.12% worse
  - p/pt cleaning cut in efficiency varies but almost the same in BMR
  - ISR influences slightly on BMR while ν influences a lot
- Comparison of different fitting methods
  - $ZH \rightarrow \nu\nu cc$ BMR improves from 3.94% to 3.89% (0.07% worse than CDR)
- Distributions of jets of different flavors
  - To understand the abnormal efficiency of barrelratio cut of $ZH \rightarrow \nu\nu gg$
- Samples generated under CEPCSW_tdr24.12.0 -- master

BMR -- performance



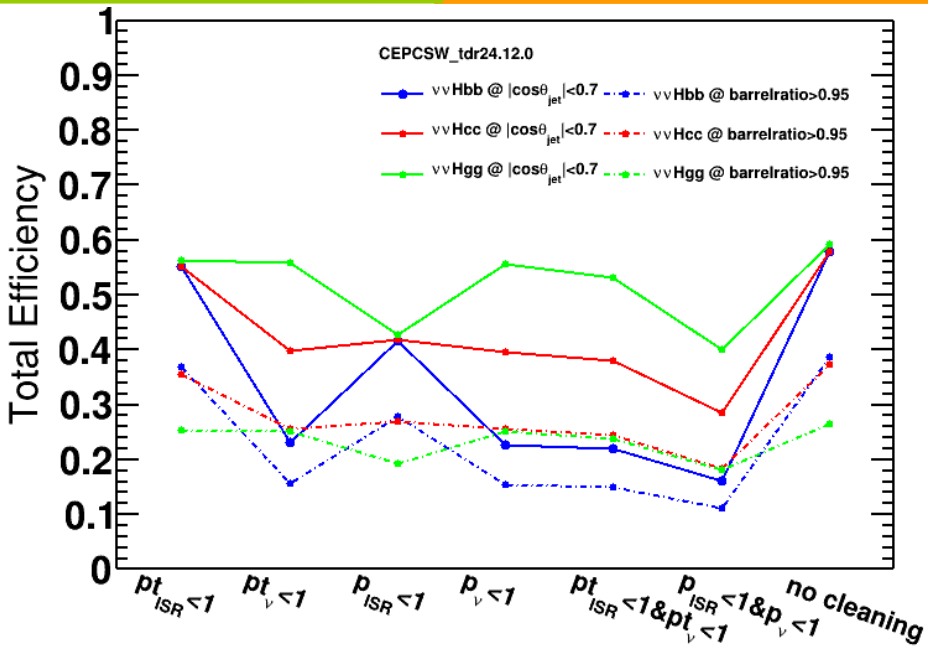


Table 1. Event cumulative efficiency for Higgs boson exclusive decay at the CEPC with $\sqrt{s} = 240$ GeV.

	$gg(\%)$	$bb(\%)$	$cc(\%)$	$WW^*(\%)$	$ZZ^*(\%)$
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	–	–

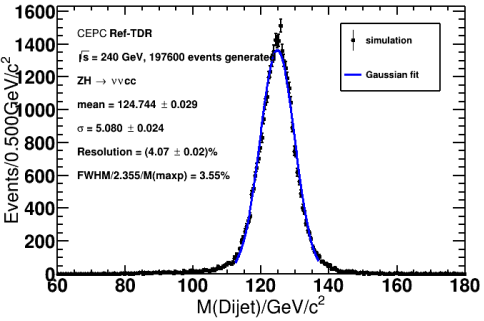
Table 3. Higgs boson mass resolution (sigma/Mean) for different decay modes with jets as final state particles, after event cleaning.

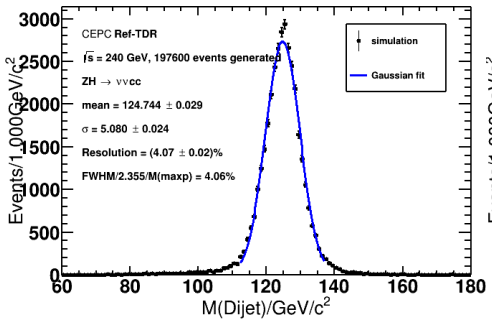
$H \to bb$	$H \to cc$	$H \to gg$	$H \to WW^*$	$H \to ZZ^*$
3.63%	3.82%	3.75%	3.81%	3.74%

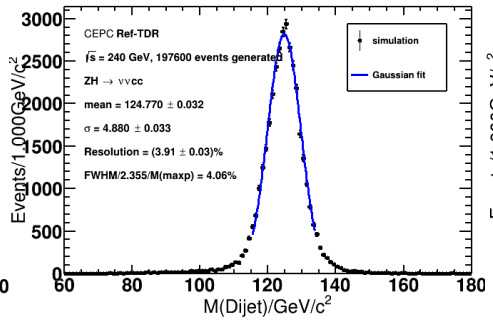
CDR reference

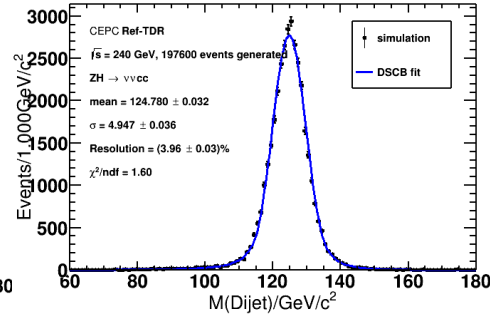
BMR -- fit with different methods

$ZH \to \nu\nu cc$ barrelratio > 0.95 With p event cleaning

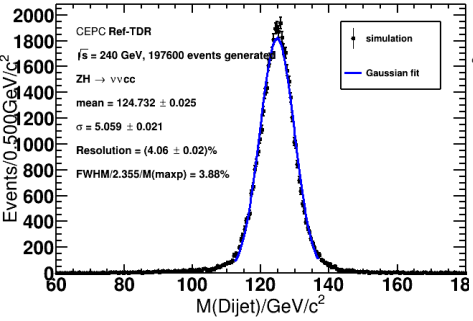


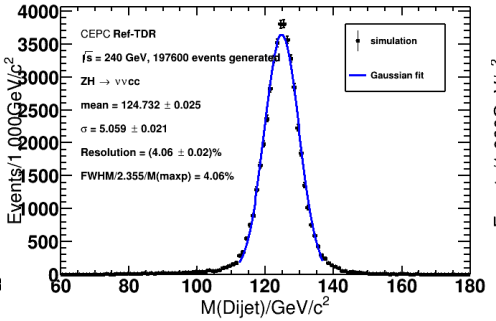


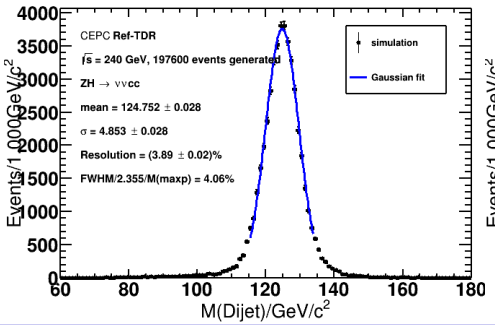


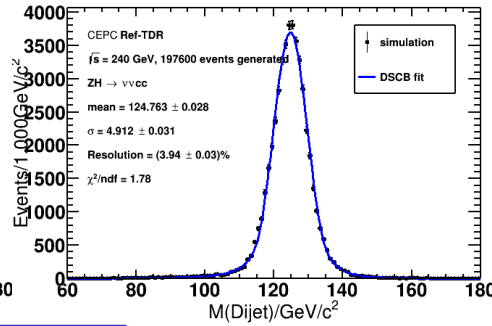


FWHM 0.5GeV/bin	FWHM 1GeV/bin Unbinned Gaussian fit	Unbinned Gaussian fit Shrink range	Unbinned DSCB fit (now)





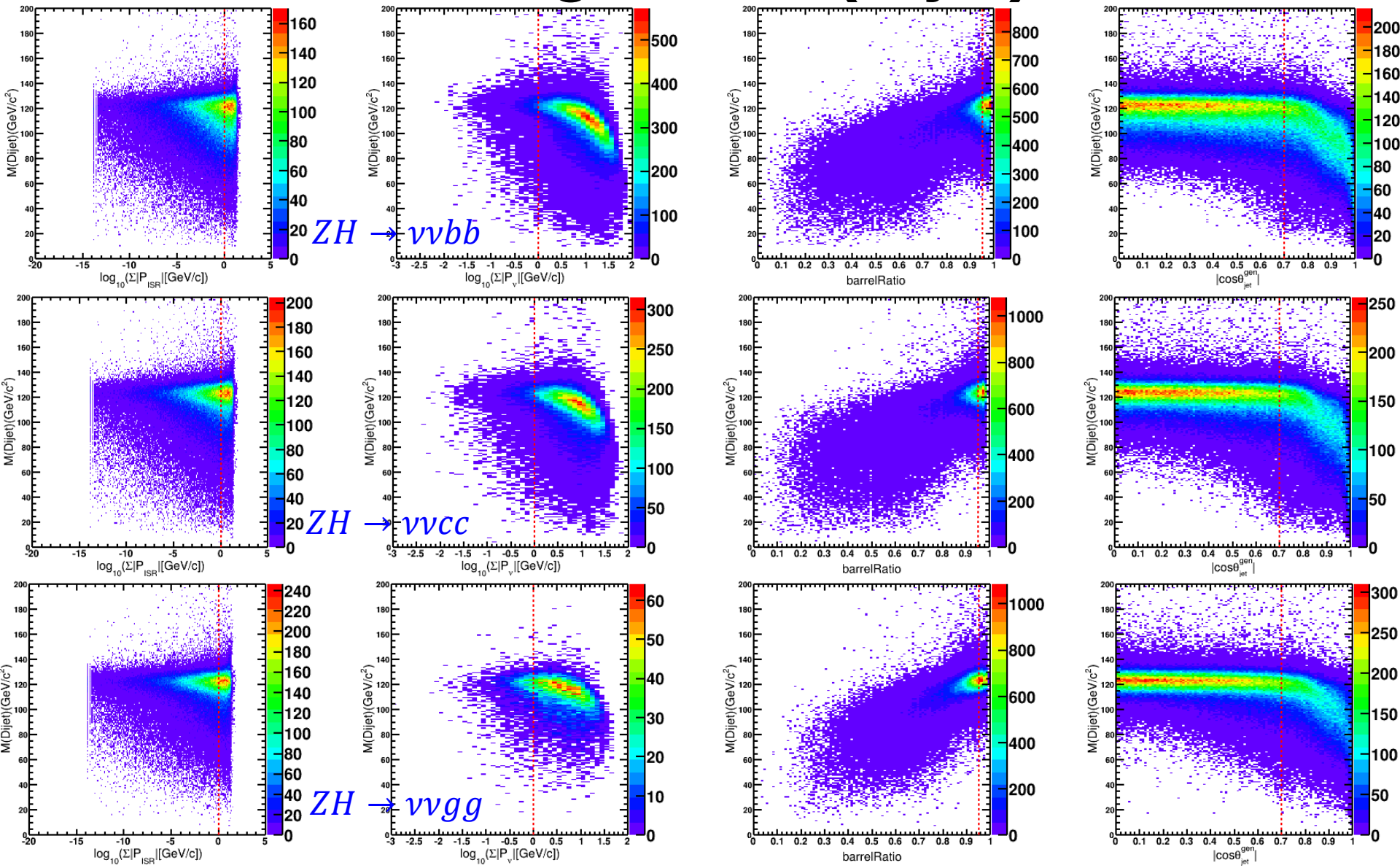




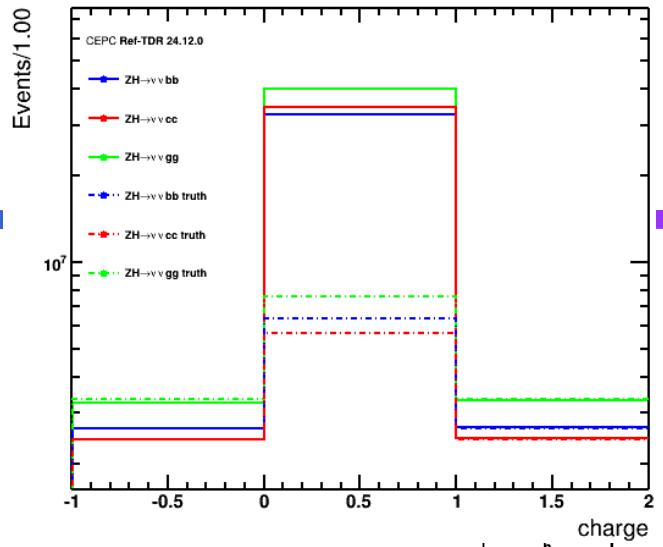
$ZH \to \nu\nu cc$ barrelratio > 0.95 With pt event cleaning

- **BMR improves from 3.96%/3.94% to 3.91%/3.89%**

Distributions against M(Dijet) and cuts

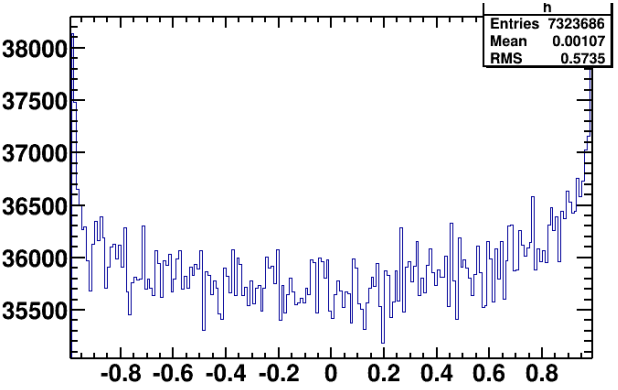


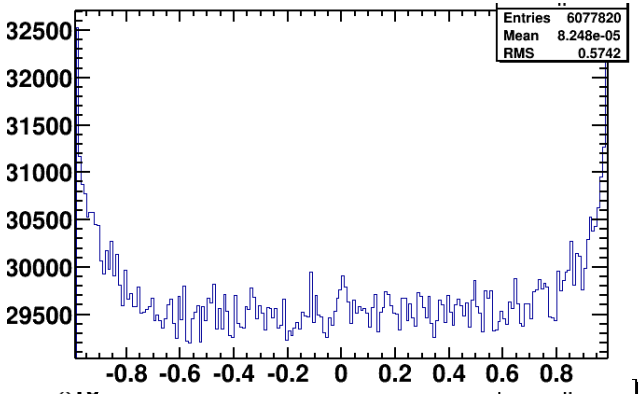
$\lg|\Sigma P_{\mathrm{ISR}}|$ | $\lg\Sigma|P_{\nu}|$ | barrelRatio | $\left|\cos\theta_{\mathrm{jet}}^{\mathrm{gen}}\right|$

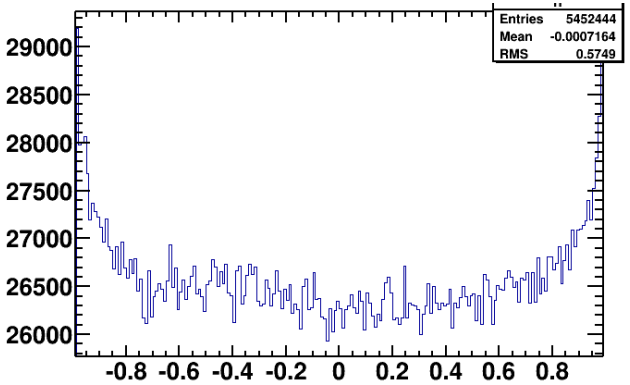


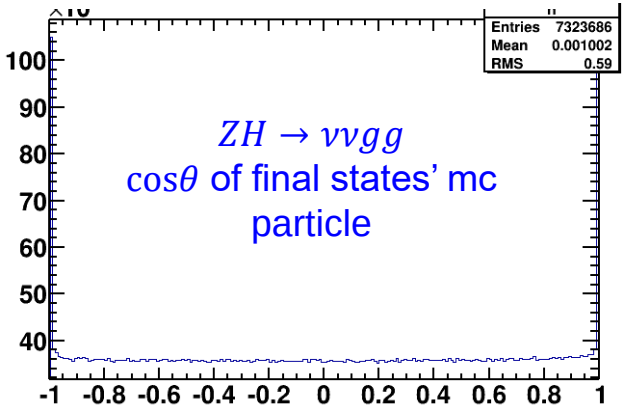
PFO particle numbers VS MCParticle numbers (generatorStatus==1 && veto neutrinos)

- Charged particles most reconstructed
- Neutral photons and hadrons reconstructed much more
- MCParticle numbers: gg > bb >cc

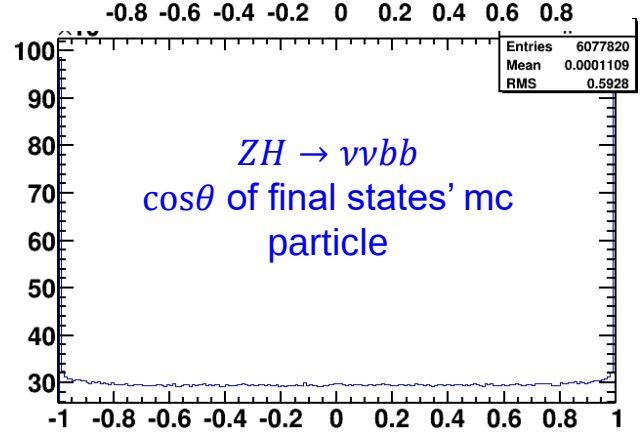




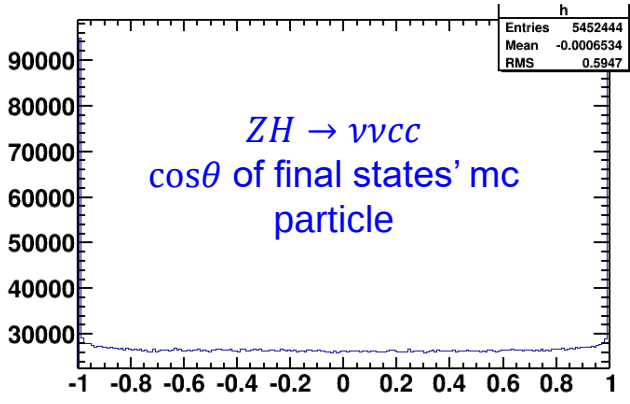




$ZH \rightarrow \nu\nu gg$
$\cos\theta$ of final states' mc particle

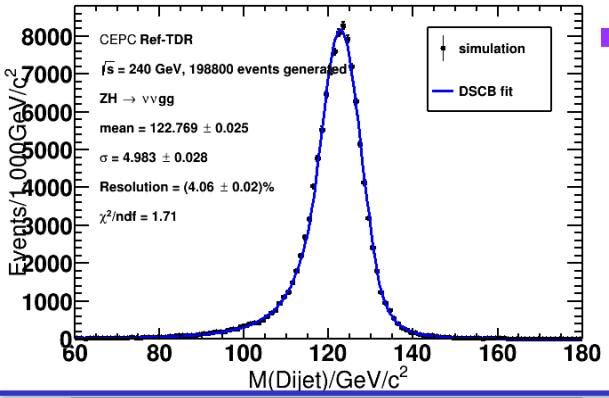


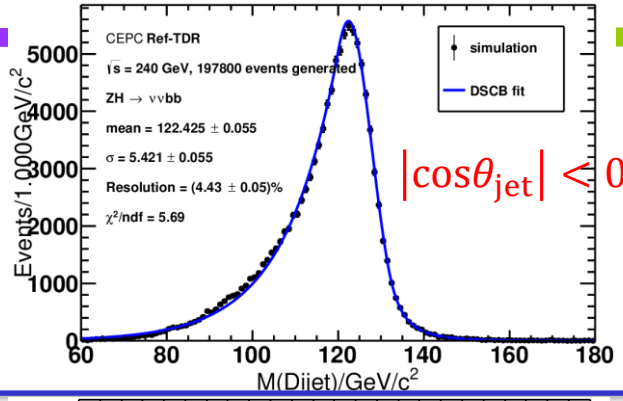
$ZH \rightarrow \nu\nu bb$
$\cos\theta$ of final states' mc particle



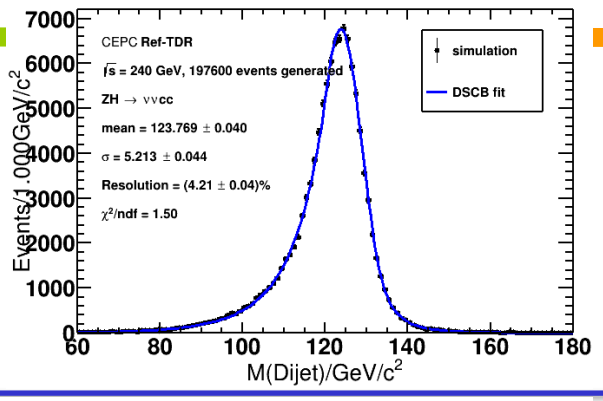
$ZH \rightarrow \nu\nu cc$
$\cos\theta$ of final states' mc particle

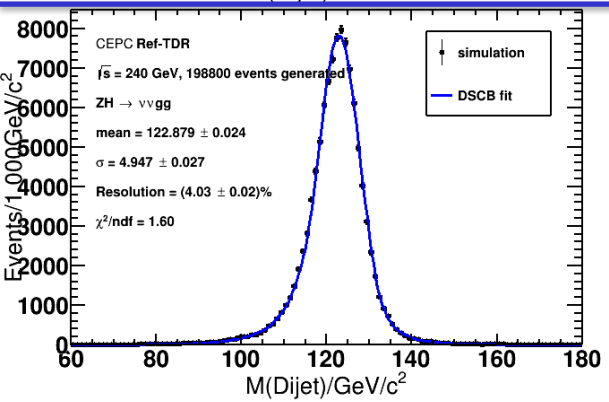
Backup -- BMR fitting results

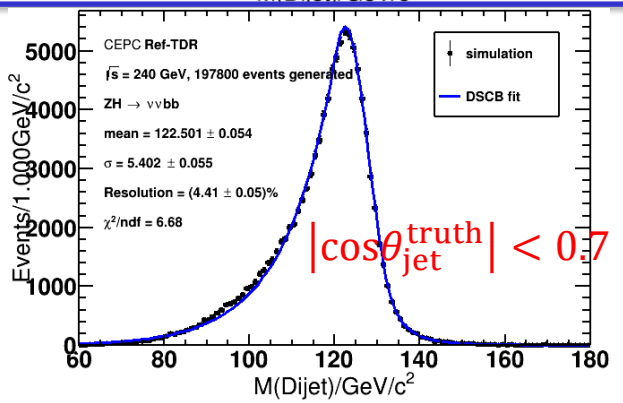




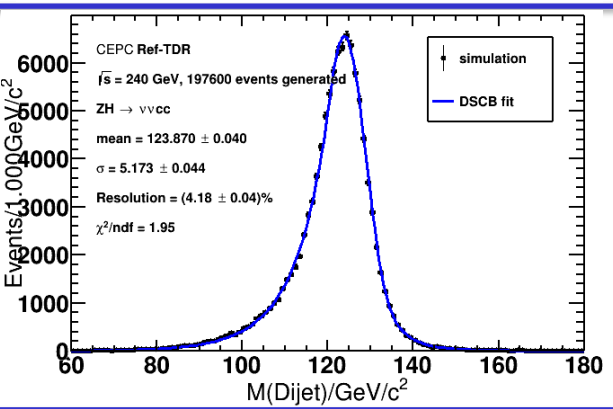
$|\cos\theta_{\text{jet}}| < 0.7$

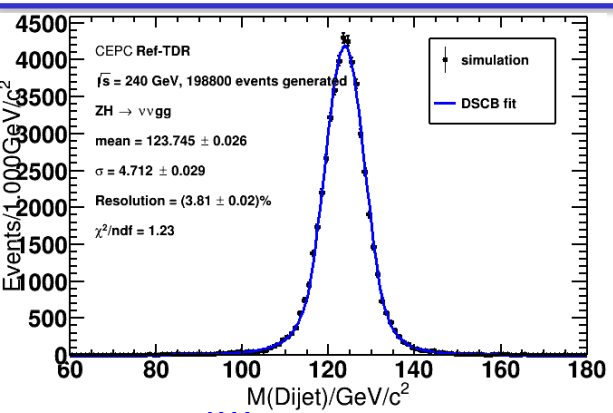




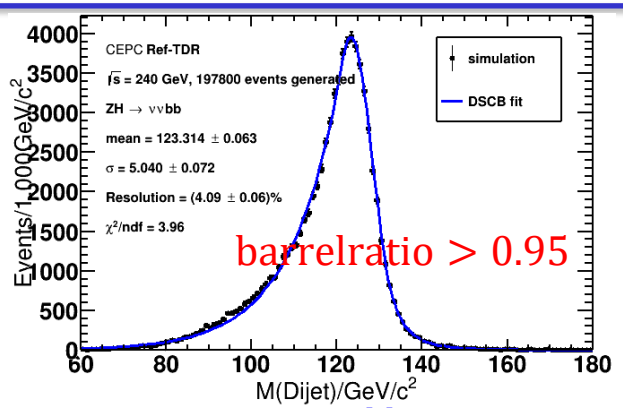


$|\cos\theta_{\text{jet}}^{\text{truth}}| < 0.7$



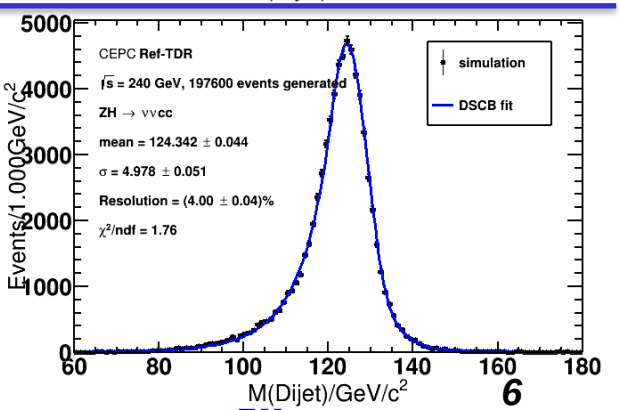


$ZH \to \nu\nu gg$



barrelratio > 0.95

$ZH \to \nu\nu bb$



$ZH \to \nu\nu cc$

BMR -- detector performance

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

Efficiency cutflow/%	$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
$\Sigma\|Pt_{\mathrm{ISR}}\| < 1\mathrm{GeV}/c$	95.3	95.4	95.4
$\Sigma\|Pt_{\nu}\| < 1\mathrm{GeV}/c$	89.8	39.3	66.6
$\|\cos\theta_{\mathrm{jet}}\| < 0.7$	53.1	22.0	38.0
BMR/%	3.99 ± 0.02	3.81 ± 0.03	4.10 ± 0.02
$\|\cos\theta_{\mathrm{jet}}^{\mathrm{truth}}\| < 0.7$	48.5	20.8	35.9
BMR/%	3.97 ± 0.02	3.76 ± 0.03	4.07 ± 0.02
barrelratio > 0.95	23.9	15.0	24.4
BMR/%	3.76 ± 0.02	3.62 ± 0.03	3.94 ± 0.03

Efficiency cutflow/%	$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
$\Sigma\|P_{\mathrm{ISR}}\| < 1\mathrm{GeV}/c$	72.5	72.5	72.7
$\Sigma\|P_{\nu}\| < 1\mathrm{GeV}/c$	68.0	28.1	49.6
$\|\cos\theta_{\mathrm{jet}}\| < 0.7$	40.0	16.2	28.5
BMR/%	3.99 ± 0.03	3.82 ± 0.03	4.11 ± 0.03
$\|\cos\theta_{\mathrm{jet}}^{\mathrm{truth}}\| < 0.7$	37.2	15.5	27.4
BMR/%	3.97 ± 0.02	3.77 ± 0.03	4.09 ± 0.03
barrelratio > 0.95	18.1	11.1	18.4
BMR/%	3.77 ± 0.03	3.63 ± 0.04	3.96 ± 0.03

- Little difference with p and pt using different selections

BMR -- detector performance

Efficiency cutflow/%	$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
$\Sigma\lvert Pt_{\mathrm{ISR}}\rvert < 1\mathrm{GeV}/c$	95.3	95.4	95.4
$\lvert\cos\theta_{\mathrm{jet}}\rvert < 0.7$	56.4	55.2	55.1
BMR/%	4.02 ± 0.02	4.37 ± 0.04	4.20 ± 0.04
$\lvert\cos\theta_{\mathrm{jet}}^{\mathrm{truth}}\rvert < 0.7$	51.5	52.1	52.1
BMR/%	3.99 ± 0.02	4.36 ± 0.04	4.17 ± 0.04
barrelratio > 0.95	25.3	36.9	35.6
BMR/%	3.78 ± 0.02	4.07 ± 0.05	4.00 ± 0.04

Efficiency cutflow/%	$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
$\Sigma\lvert P_{\mathrm{ISR}}\rvert < 1\mathrm{GeV}/c$	72.5	72.5	72.7
$\lvert\cos\theta_{\mathrm{jet}}\rvert < 0.7$	42.7	41.6	41.8
BMR/%	4.02 ± 0.03	4.41 ± 0.05	4.22 ± 0.04
$\lvert\cos\theta_{\mathrm{jet}}^{\mathrm{truth}}\rvert < 0.7$	39.6	39.9	40.1
BMR/%	3.99 ± 0.03	4.40 ± 0.05	4.18 ± 0.04
barrelratio > 0.95	19.2	27.9	27.0
BMR/%	3.78 ± 0.03	4.10 ± 0.06	4.03 ± 0.05

- Little difference with p and pt using different selections

BMR -- detector performance

Efficiency cutflow/%	$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
$\Sigma\lvert Pt_\nu\rvert < 1\mathrm{GeV}/c$	94.3	41.2	69.8
$\lvert\cos\theta_{\mathrm{jet}}\rvert < 0.7$	55.8	23.1	39.9
BMR/%	4.04 ± 0.02	3.83 ± 0.03	4.12 ± 0.03
$\lvert\cos\theta_{\mathrm{jet}}^{\mathrm{truth}}\rvert < 0.7$	50.9	21.8	37.7
BMR/%	4.01 ± 0.02	3.77 ± 0.03	4.09 ± 0.02
$\mathrm{barrelratio} > 0.95$	25.1	15.7	25.7
BMR/%	3.79 ± 0.02	3.63 ± 0.03	3.96 ± 0.03

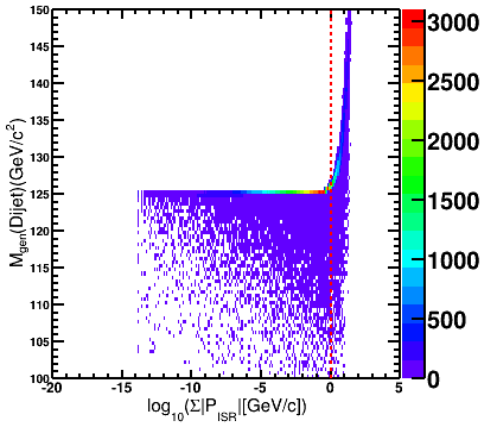
Efficiency cutflow/%	$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
$\Sigma\lvert P_\nu\rvert < 1\mathrm{GeV}/c$	93.8	38.9	68.2
$\lvert\cos\theta_{\mathrm{jet}}\rvert < 0.7$	55.6	22.6	39.6
BMR/%	4.04 ± 0.02	3.82 ± 0.03	4.11 ± 0.03
$\lvert\cos\theta_{\mathrm{jet}}^{\mathrm{truth}}\rvert < 0.7$	50.8	21.4	37.4
BMR/%	4.01 ± 0.02	3.77 ± 0.03	4.08 ± 0.02
$\mathrm{barrelratio} > 0.95$	25.1	15.5	25.5
BMR/%	3.79 ± 0.02	3.63 ± 0.04	3.96 ± 0.03

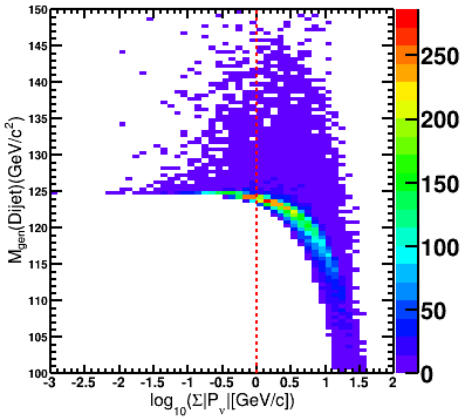
- Little difference with p and pt using different selections

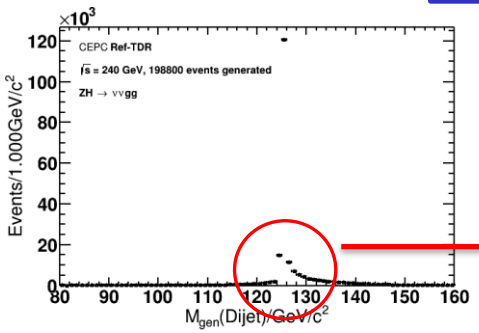
BMR -- tail in truth Higgs mass

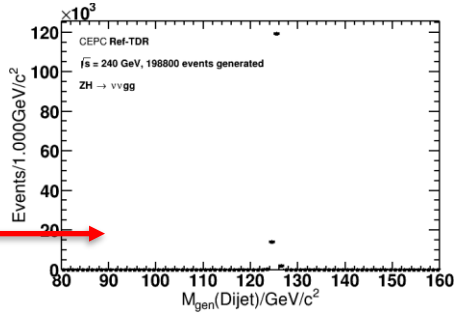
- Long tail of truth mass of Higgs in $ZH \rightarrow \nu\nu gg$
  - Strong correlations with $\Sigma P_{\mathrm{ISR}}/\Sigma P_{\nu}$ -> cut to remove tails

$\Sigma|P_{\mathrm{ISR}}| < 1\mathrm{GeV}/c$
$\&\Sigma|P_{\nu}| < 1\mathrm{GeV}/c$
Efficiency=0.725*0.938=68.0%

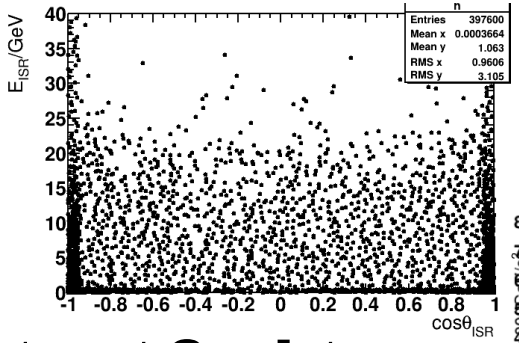


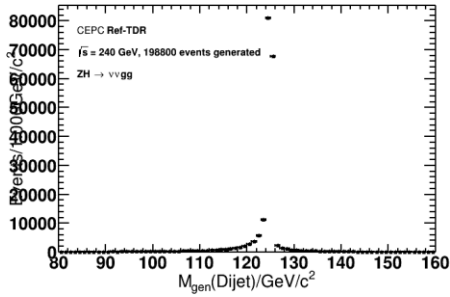






- ISR distribution
  - Ratio of ISR with energy > 1MeV: 42.85%
  - Ratio of ISR with energy > 1GeV: 14.47%
  - Ratio of ISR with cosθ > 0.99: 69.50%





- Veto truth particle whose $\cos\theta > 0.99$ to get GenJet
  - High mass tail better but low mass tail worse