中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

Measurements of decay branching fractions of the Higgs boson to hadronic final states at the CEPC

[1]Yanping Huang, [1]Xiaotian Ma, [1,2]Zuofei Wu, [1]Shuo Han

[1]*Institute of High Energy Physics*

[2]*Nanjing University*

Status

- Measurements of decay branching fractions of the Higgs boson to hadronic final states at the CEPC
  - Use lepton cut and missing energy cut to separate hadronic Hzz and Hww events

Separate hadronic decays from inclusive Hzz and Hww

Z DECAY MODES

Γ_1	e^+e^-		(3.3632 ±0.0042) %
Γ_2	$\mu^+\mu^-$		(3.3662 ±0.0066) %
Γ_3	$\tau^+\tau^-$		(3.3696 ±0.0083) %
Γ_7	invisible		(20.000 ±0.055) %
Γ_8	hadrons		(69.911 ±0.056) %

W^+ DECAY MODES

Γ_2	$e^+\nu$		(10.71 ±0.16) %
Γ_3	$\mu^+\nu$		(10.63 ±0.15) %
Γ_4	$\tau^+\nu$		(11.38 ±0.21) %
Γ_5	hadrons		(67.41 ±0.27) %

τ^- DECAY MODES

Γ_3	$\mu^-\overline{\nu}_\mu\nu_\tau$	[1]	(17.39 ±0.04) %
Γ_4	$\mu^-\overline{\nu}_\mu\nu_\tau\gamma$	[2]	(3.67 ±0.08) $\times10^{-3}$
Γ_5	$e^-\overline{\nu}_e\nu_\tau$	[1]	(17.82 ±0.04) %
Γ_6	$e^-\overline{\nu}_e\nu_\tau\gamma$	[2]	(1.83 ±0.05) %
Γ_7	$h^- \geq 0K^0_L\,\nu_\tau$		(12.03 ±0.05) %
Γ_8	$h^-\nu_\tau$		(11.51 ±0.05) %
Γ_{12}	$h^- \geq 1\,\pi^0\nu_\tau$ (ex.K^0)		(36.50 ±0.09) %

For $H \to ZZ$:
Hadronic 48.9%
Semi-leptonic 42.0%
Leptonic 9.1%

For $H \to WW$:
Hadronic 45.4%
Semi-leptonic 44.0%
Leptonic 10.6%

For τ
~35% Leptonic

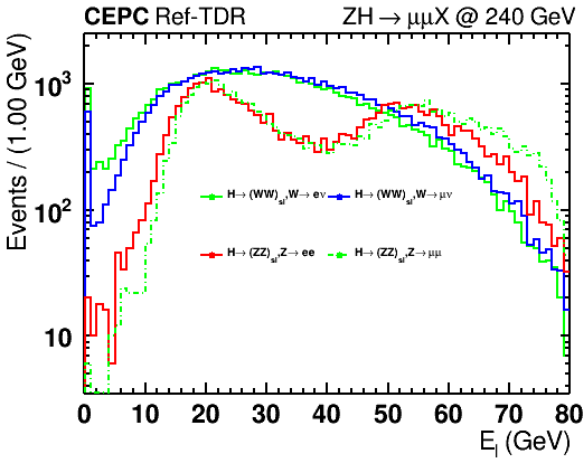
pdgLive

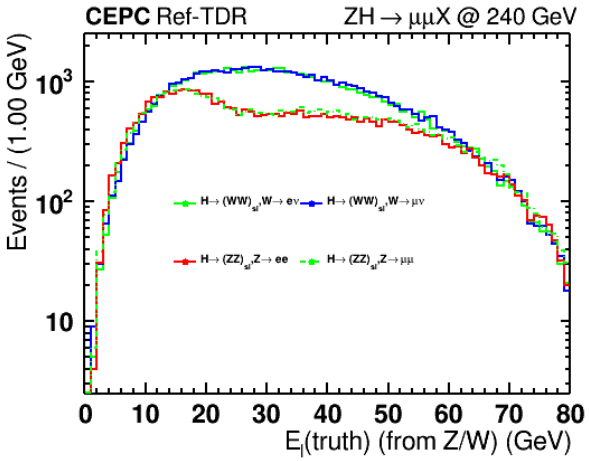
Process	$H \to WW^*$			$H \to ZZ^*$		
Final states	Hadronic	Semi-leptonic		Hadronic	Semi-leptonic	
		$e\nu$	$\mu\nu$		ee	$\mu\mu$
Simulated N	178264	56629	56801	185120	18221	17901
Muon pair & Z-mass	161636	51310	52175	167775	16526	17034
$E_l < 9.5\text{GeV}^*$	155453	3770	2418	155273	148	54
Total efficiency	87.2%	6.7%	4.3%	83.9%	0.8%	0.3%

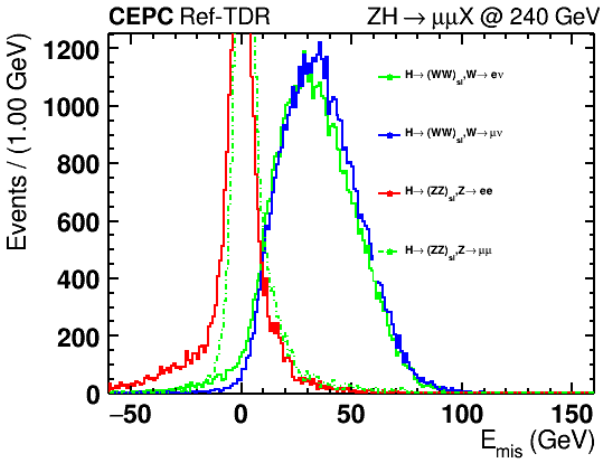
The cutflow

$*$: *lepton with the maximum energy (veto muons from Z)*

$**$: $E_{mis} = 240\text{GeV} - \Sigma E_{vis}$





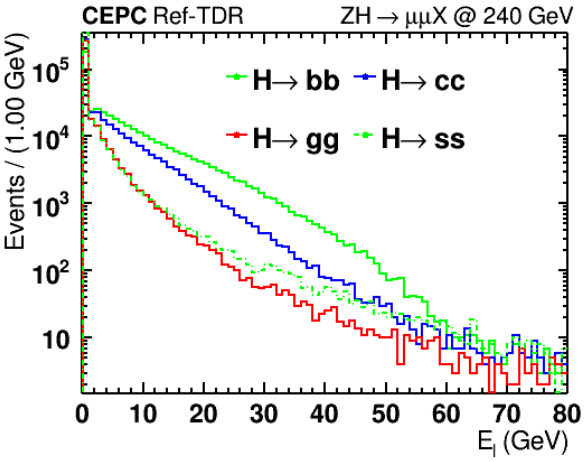


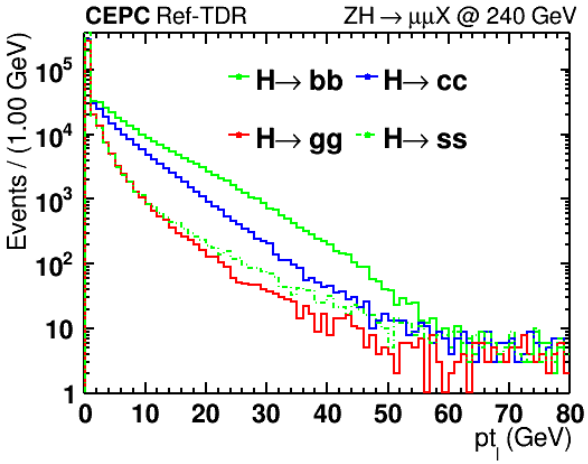
Process	$H \to bb$	$H \to cc$	$H \to gg$	$H \to ss$
Simulated N	495000	494500	371500	494250
Muon pair & Z-mass	449960	449169	337620	448584
$E_l < 9.5\text{GeV}^*$	341699	398559	328437	437095
Total efficiency	69.0%	80.6%	88.4%	88.4%

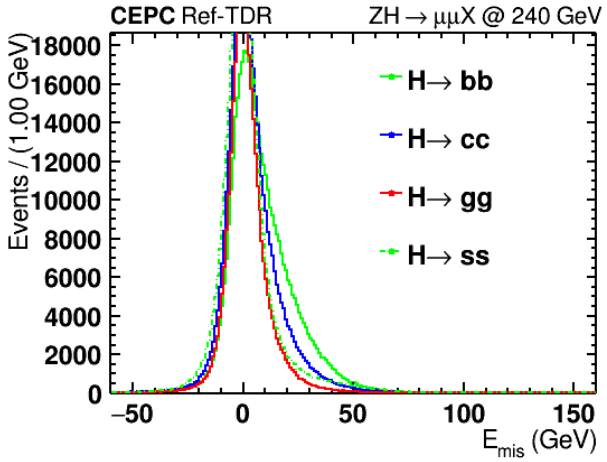
The cutflow

$*$: $lepton\ with\ the\ maximum\ energy\ (veto\ muons\ from\ Z)$

$**$: $E_{mis} = 240\text{GeV} - \Sigma E_{vis}$







An attempt with isolated lepton

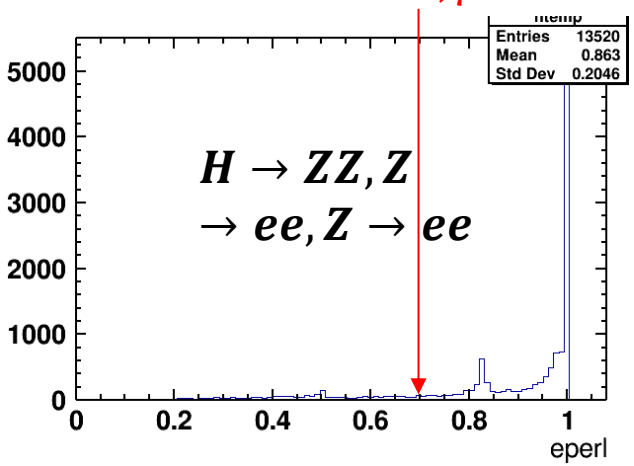
Process	$H \to WW^*$			$H \to ZZ^*$		
Final states	Hadronic	Semi-leptonic		Hadronic	Semi-leptonic	
		$e\nu$	$\mu\nu$		ee	$\mu\mu$
Simulated N	178264	56629	56801	185120	18221	17901
Muon pair & Z-mass	161636	51310	52175	167775	16526	17034
$N_{isol} == 0^*$	160996	11808	6892	165374	1882	750
Total efficiency	90.3%	20.9%	12.1%	89.3%	10.3%	4.2%

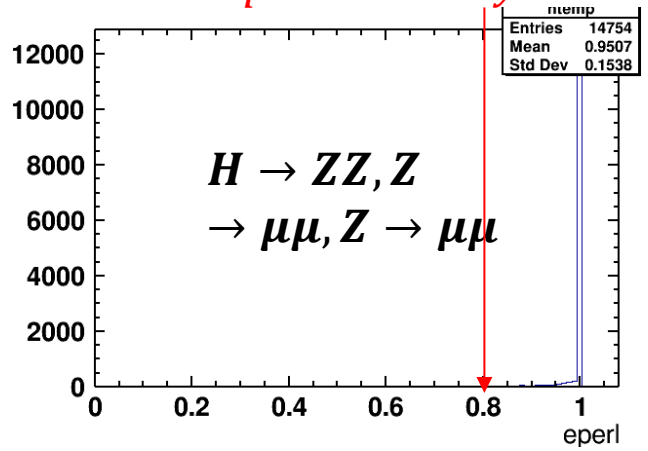
The cutflow

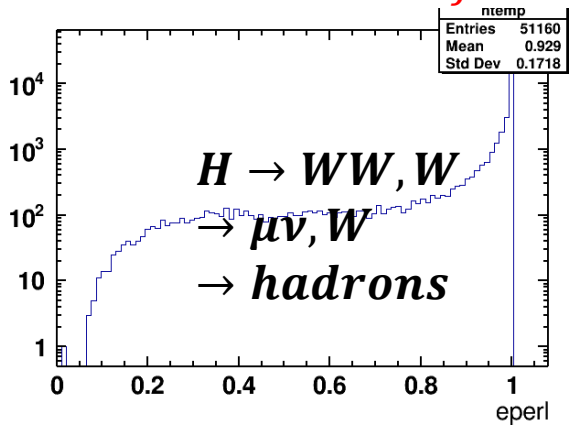
$*$: *leptons veto muons from* Z

($E > 5$GeV and in region($\Delta R < 0.4$): *energy deposit* $> 80\%/70\%$ *for isolated* μ/e)

e not isolated well, μ isolated well in leptonic decay but not so when mixed with jet







energy deposit

Back up

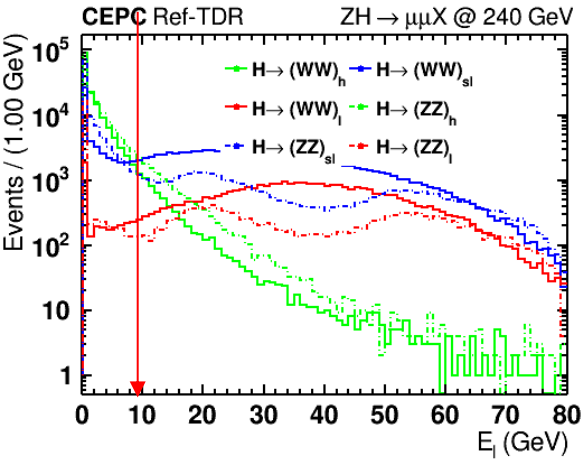
Separate hadronic decays from inclusive Hzz and Hww

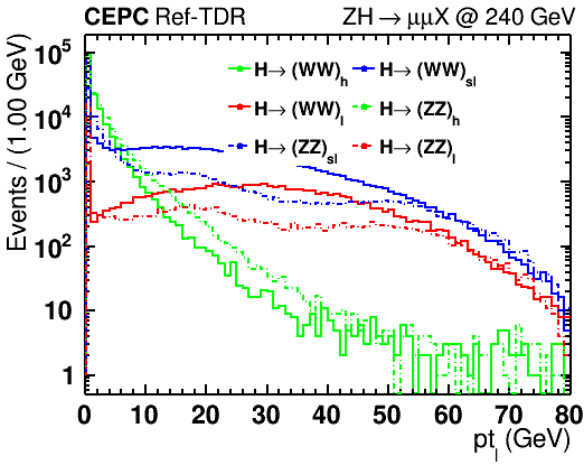
Process	$H \to WW^*$			$H \to ZZ^*$		
Final states	Hadronic	Semi-leptonic	Leptonic	Hadronic	Semi-leptonic	Leptonic
Simulated N	178264	169905	40831	185120	161172	35108
Muon pair & Z-mass	161636	154675	37437	167775	147049	32247
$E_l < 9.5\text{GeV}^*$	155453	46695	3491	155273	104557	17782
$E_{mis} < 15\text{GeV}^{**}$	143410	1789	3	138790	3850	11
Total efficiency	80.4%	1.1%	0.01%	75.0%	2.4%	0.03%

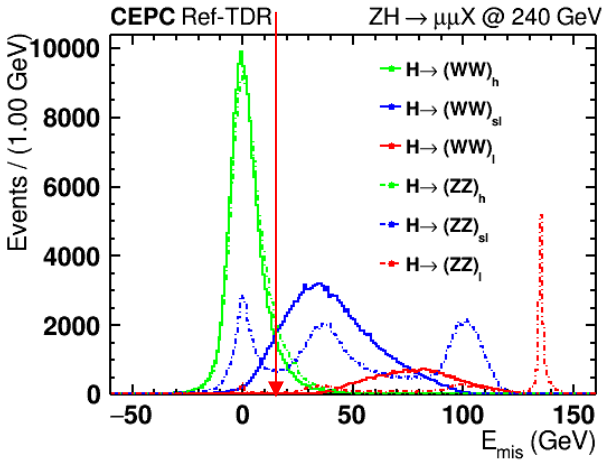
The cutflow

$*$: $lepton\ with\ the\ maximum\ energy\ (veto\ muons\ from\ Z)$

$**$: $E_{mis} = 240\text{GeV} - \Sigma E_{vis}$







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Simulated N	495000	494500	371500	494250
Muon pair & Z-mass	449960	449169	337620	448584
$E_l < 9.5\text{GeV}^*$	341699	398559	328437	437095
$E_{mis} < 15\text{GeV}^{**}$	270515	347792	303657	393647
Total efficiency	54.6%	70.3%	81.7%	79.6%

The cutflow

$*$: $lepton\ with\ the\ maximum\ energy\ (veto\ muons\ from\ Z)$

$**$: $E_{mis} = 240\text{GeV} - \Sigma E_{vis}$