Institute of Experimental Particle Physics

Karlsruher Institut für Technologie

JET TAGGER IMPLEMENTATION IN $H \to \tau\tau$

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CUTS

Explicit tau reconstruction

<table>
<tr><th>$Z \to \ell\ell$ Selection</th><th>$Z \to qq$ Selection</th><th>$Z \to \nu\nu$ Selection</th></tr>
<tr><td colspan="2">$100 < M_{collinear} < 150$ GeV</td><td rowspan="2">$E^{miss} > 100$ GeV</td></tr>
<tr><td colspan="2">$115 < M_{recoil} < 160$ GeV</td></tr>
<tr><td colspan="2">$E^{miss} > 10$ GeV</td><td rowspan="2">$|\Delta\phi_{\tau\tau}| < 3$</td></tr>
<tr><td>$70 < M_Z < 100$ GeV</td><td>$80 < M_Z < 95$ GeV</td></tr>
<tr><td colspan="3">$\Delta R_{\tau\tau} > 2$</td></tr>
<tr><td colspan="3">$\cos\theta_{\tau\tau} < 0$</td></tr>
<tr><td colspan="3">$|\cos\theta^{miss}| < 0.98$</td></tr>
</table>

CUTS

PNet tau reconstruction

$Z \to \ell\ell$ Selection	$Z \to qq$ Selection	$Z \to \nu\nu$ Selection
$100 < M_{collinear} < 150$ GeV		$E^{miss} > 100$ GeV
$115 < M_{recoil} < 160$ GeV		
$E^{miss} > 10$ GeV		$\lvert\Delta\phi_{\tau\tau}\rvert < 3$
$70 < M_Z < 100$ GeV	70 $< M_Z <$ 100 GeV	
$\Delta R_{\tau\tau} > 2$		
$\cos\theta_{\tau\tau} <$ -0.6		$\cos\theta_{\tau\tau} < -0.4$
$\lvert\cos\theta^{miss}\rvert < 0.98$		

now only for $H \to \tau_\ell\tau_\ell$ ➜

+ $Z_{1,2}$ τ score < 0.5
(for $Z \to qq$)

tau jet requirements: sum of constituents charge +-1, score>0.5, mass<3 GeV

LLHH - RECOIL

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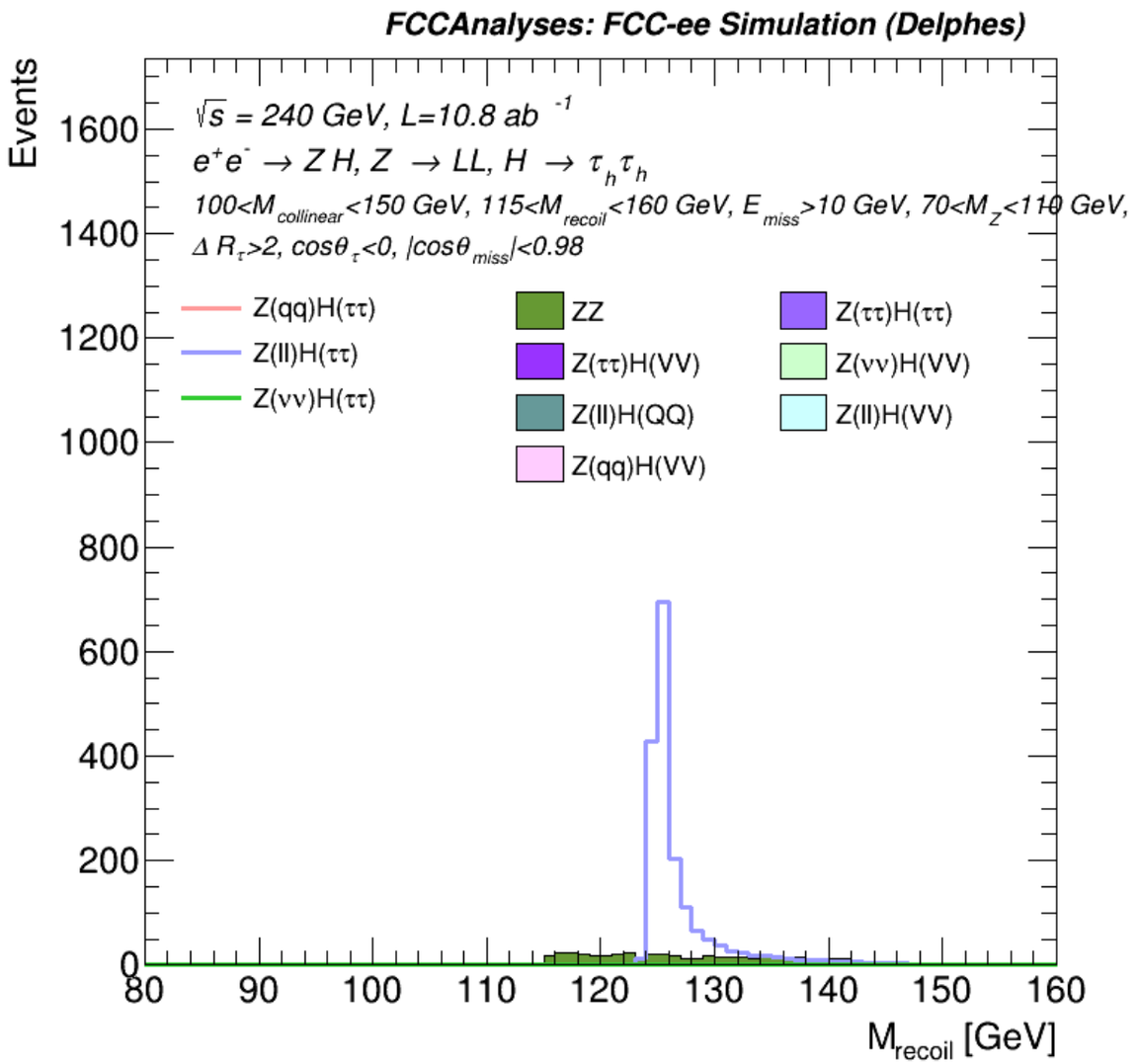
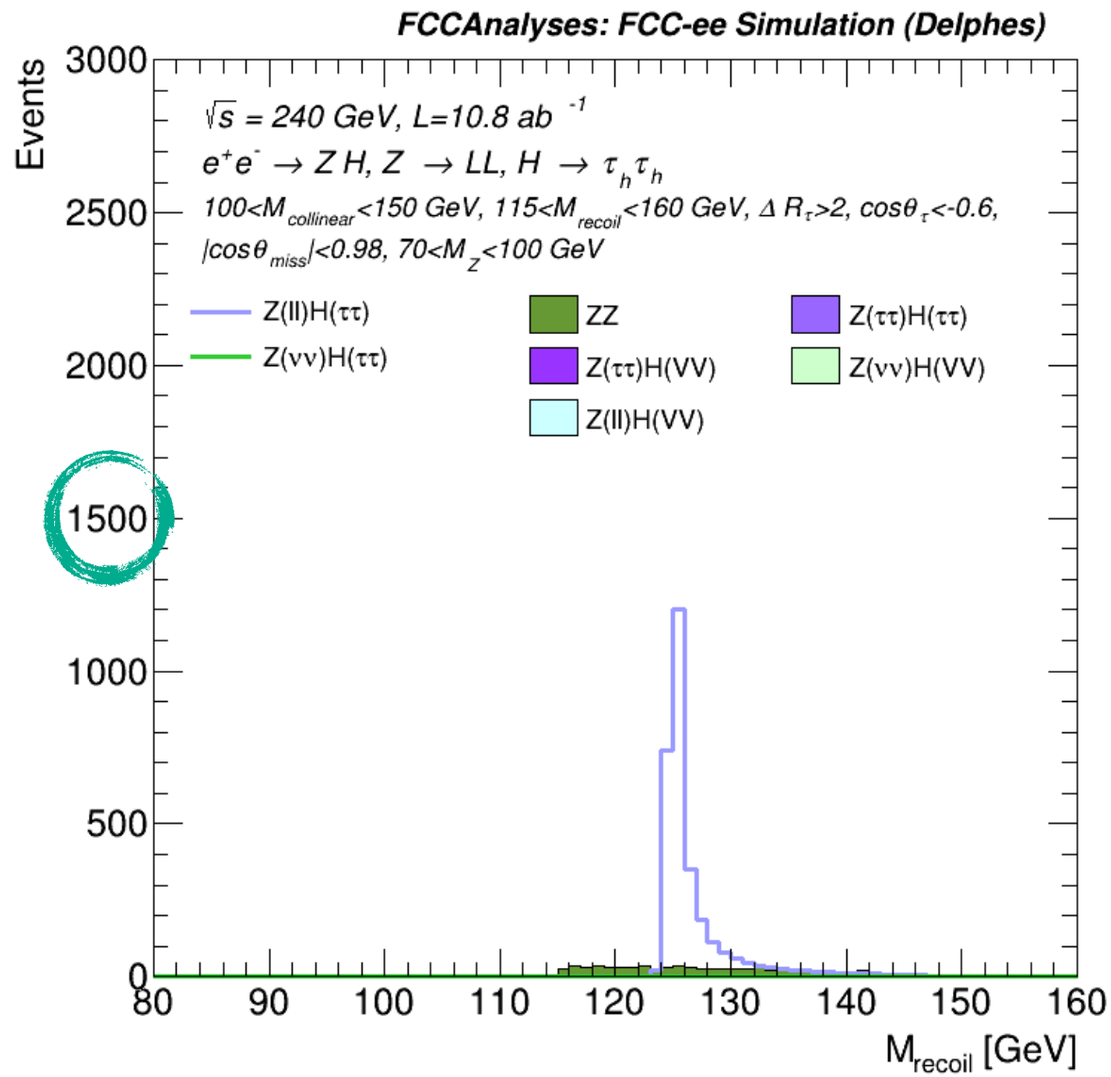
Explicit tau reconstruction



PNet tau reconstruction



LLLH - RECOIL

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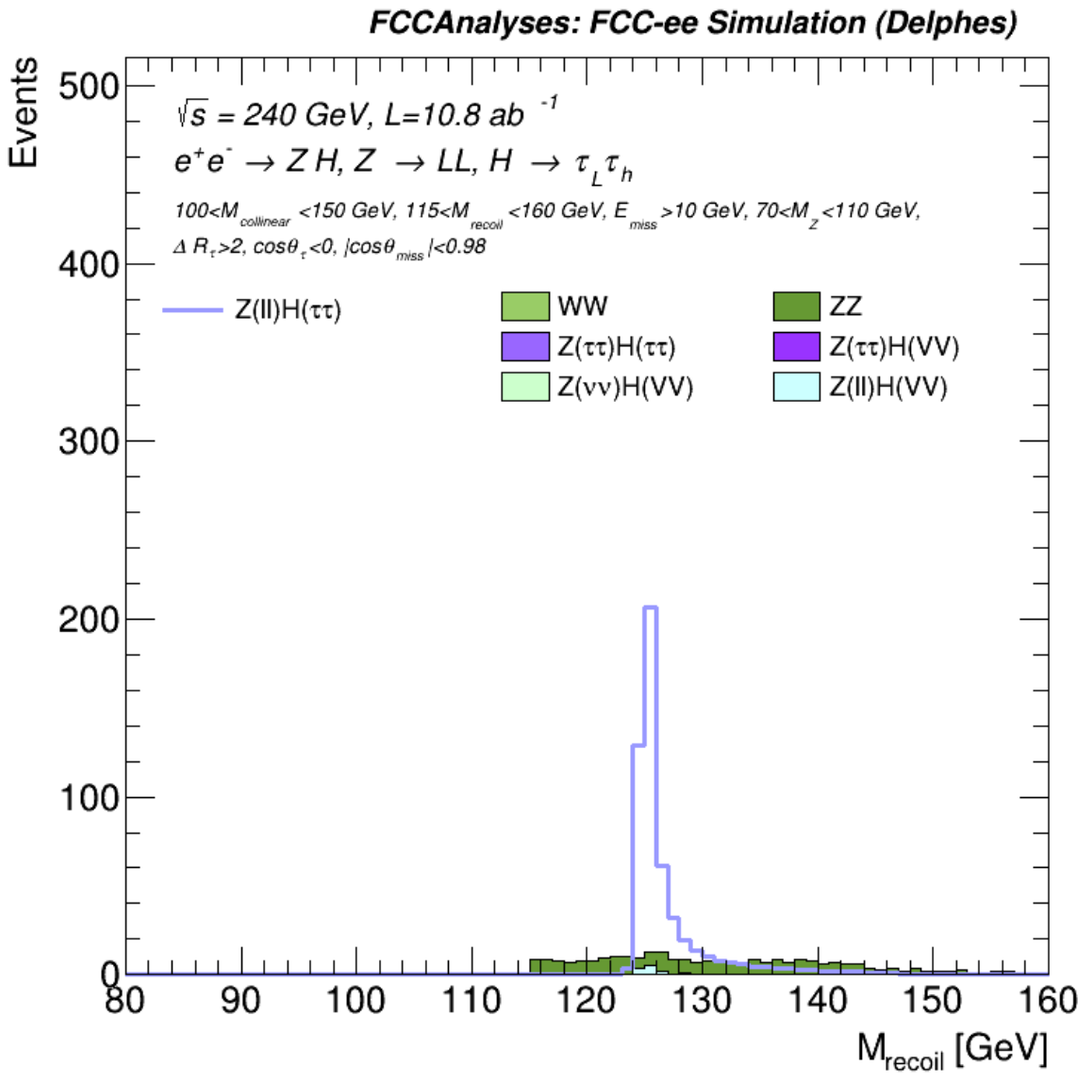
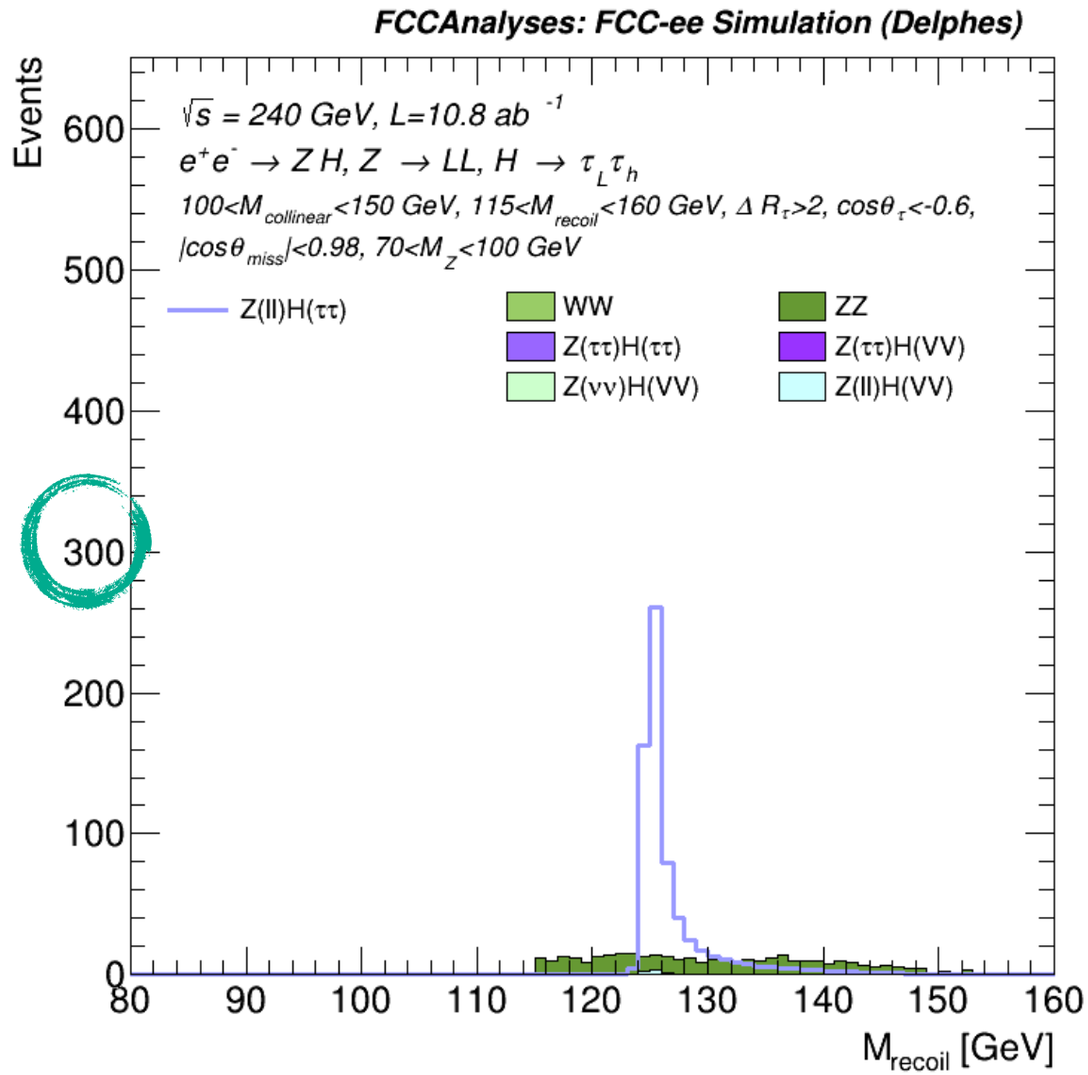
Explicit tau reconstruction



PNet tau reconstruction



LLLL - RECOIL

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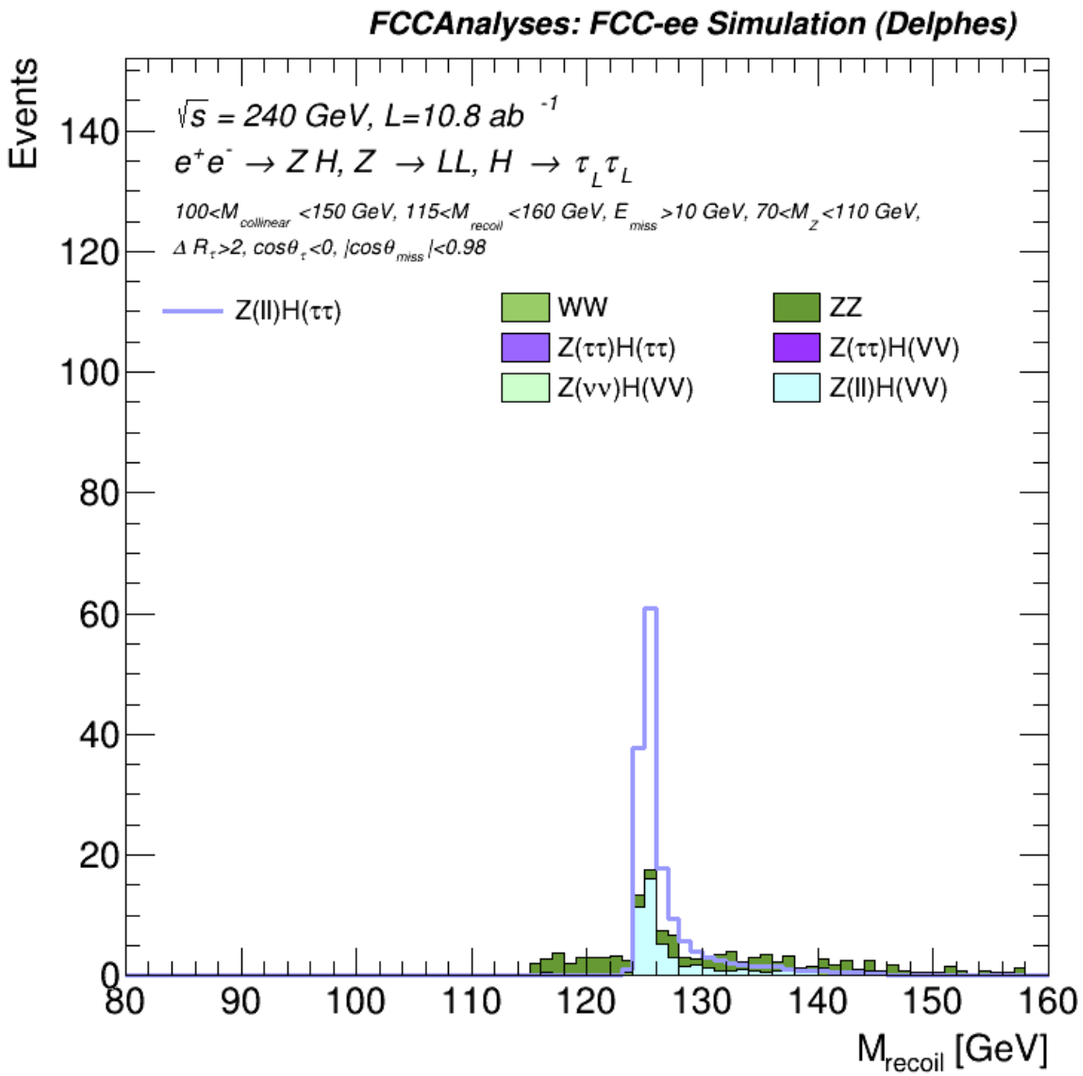
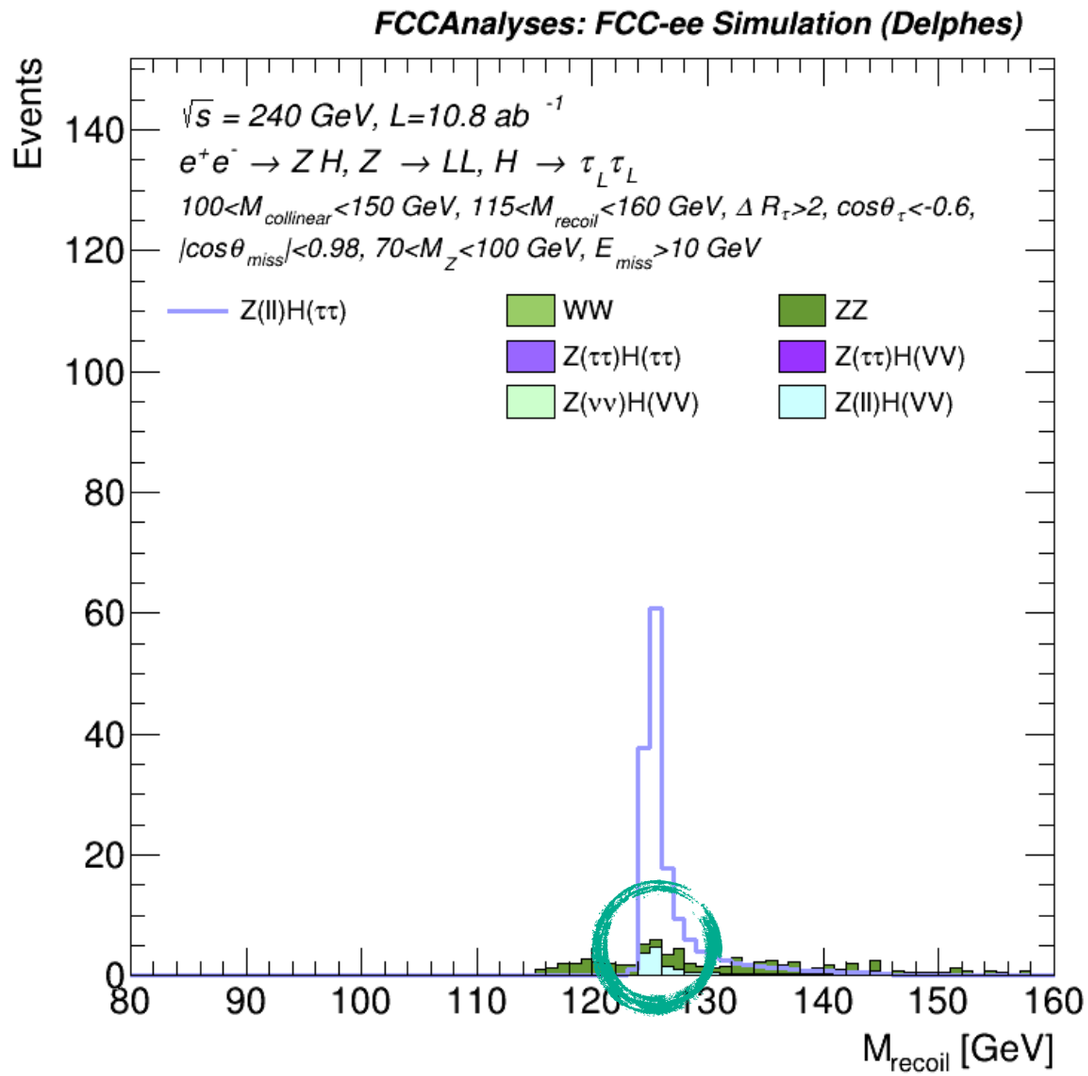
Explicit tau reconstruction



PNet tau reconstruction



$\nu\nu$HH - VISIBLE MASS

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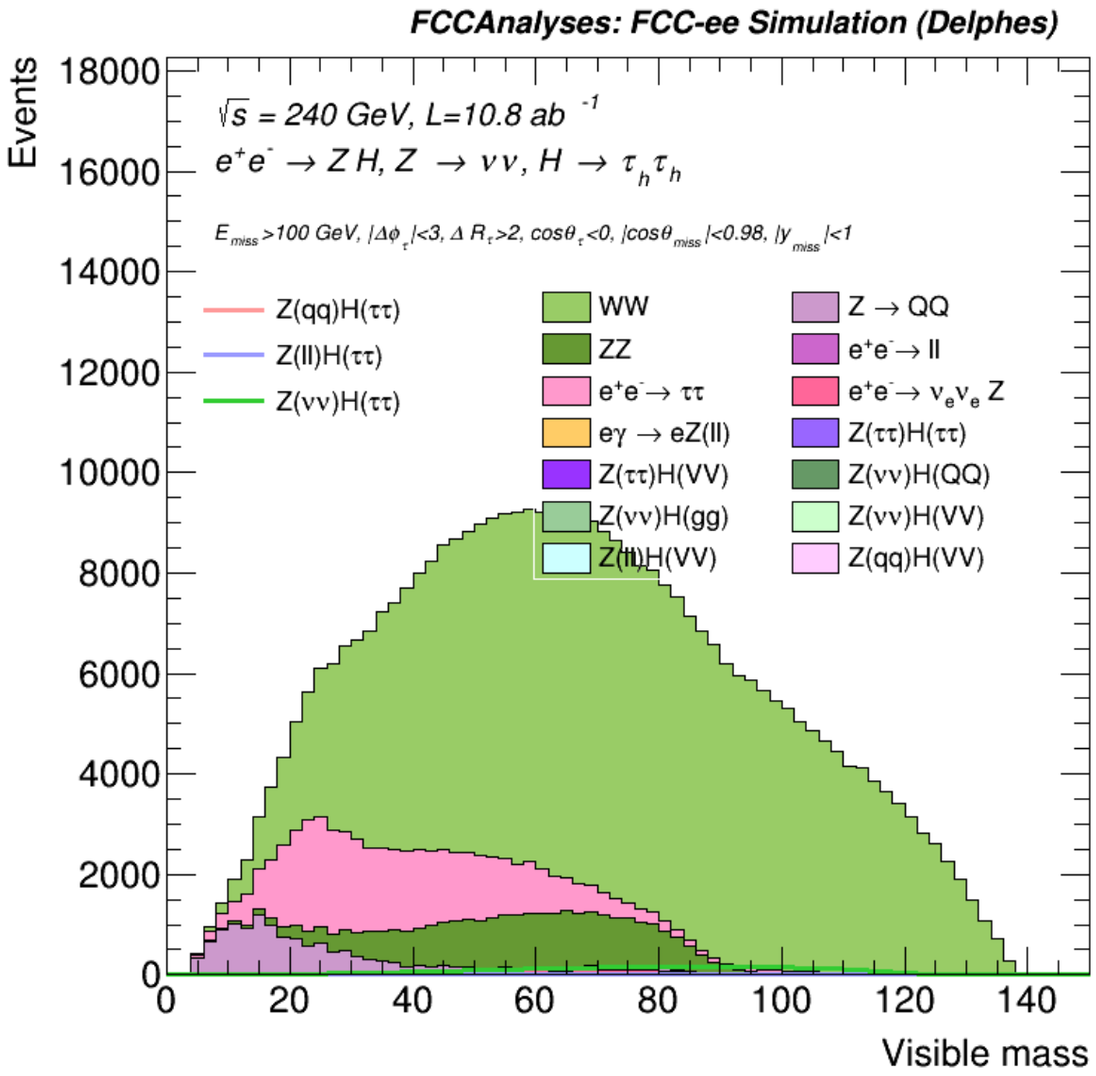
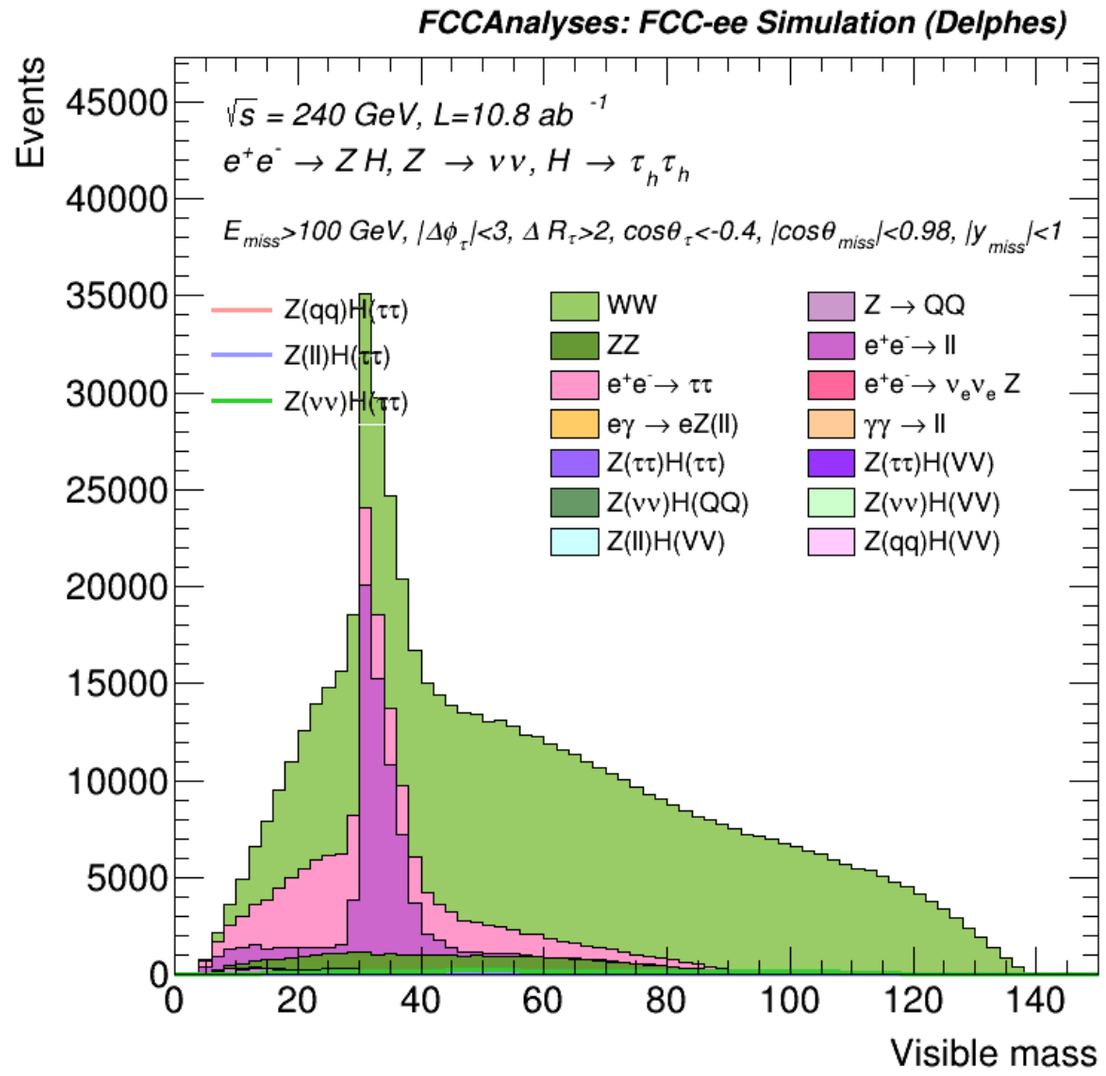
Explicit tau reconstruction



PNet tau reconstruction



$\nu\nu$LH - VISIBLE MASS

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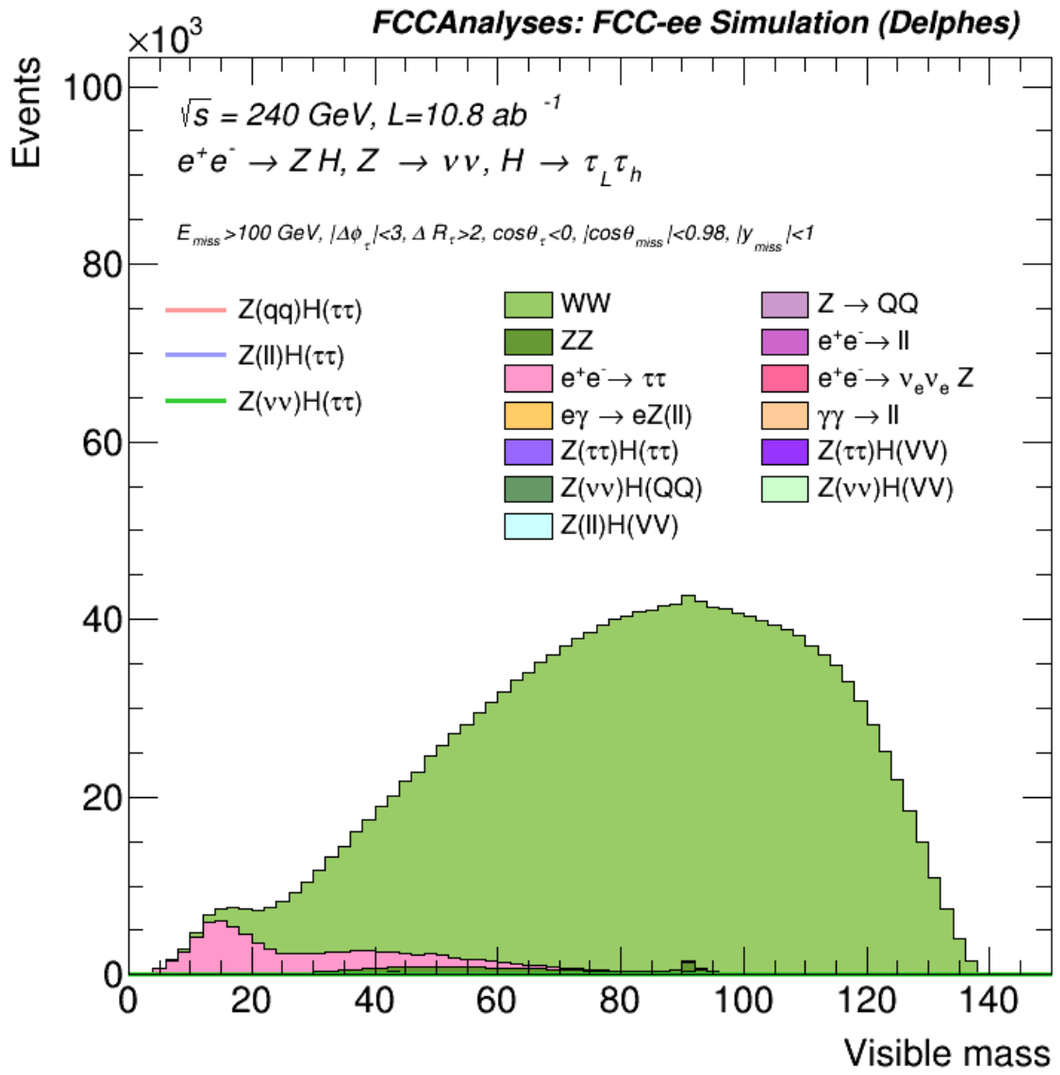
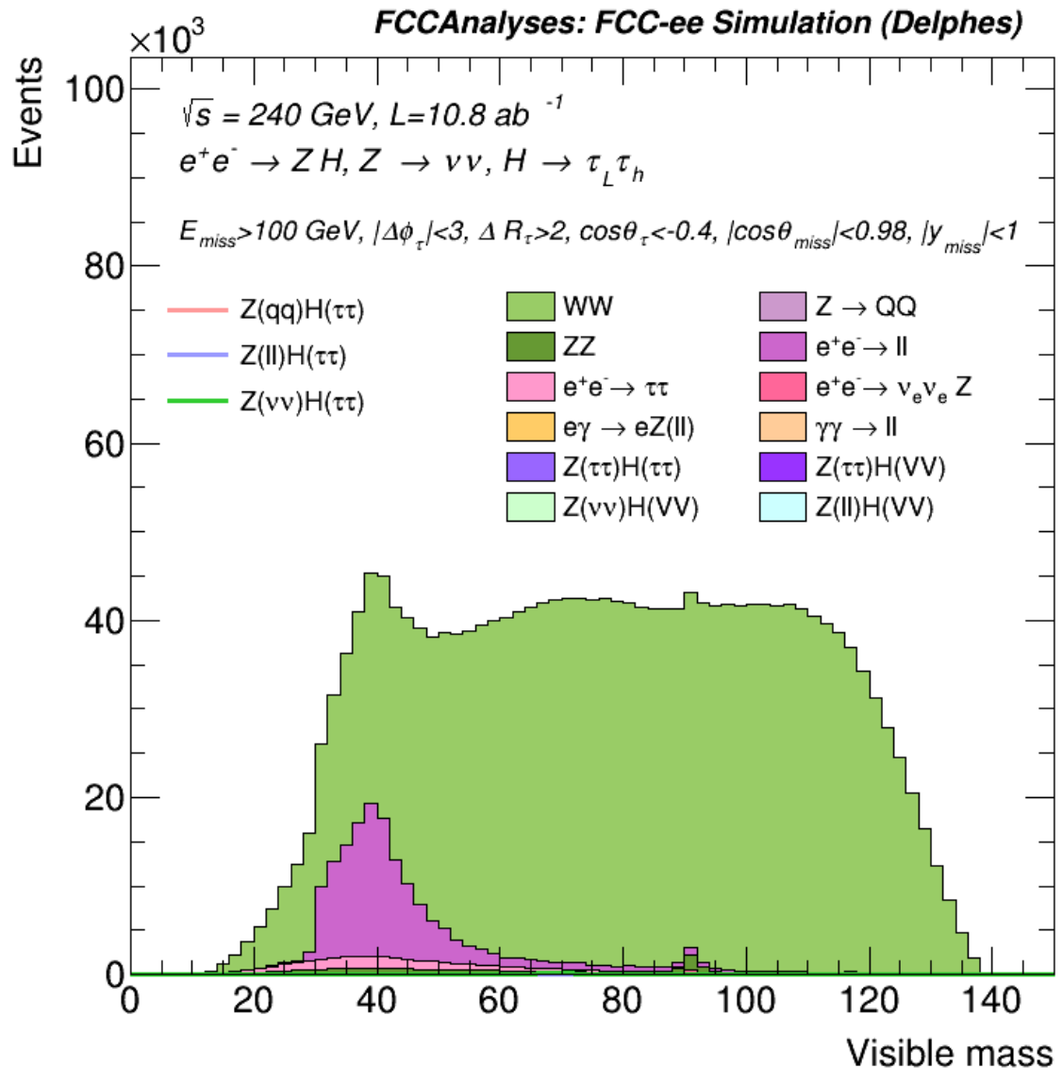
Explicit tau reconstruction



PNet tau reconstruction



$\nu\nu$LL - VISIBLE MASS

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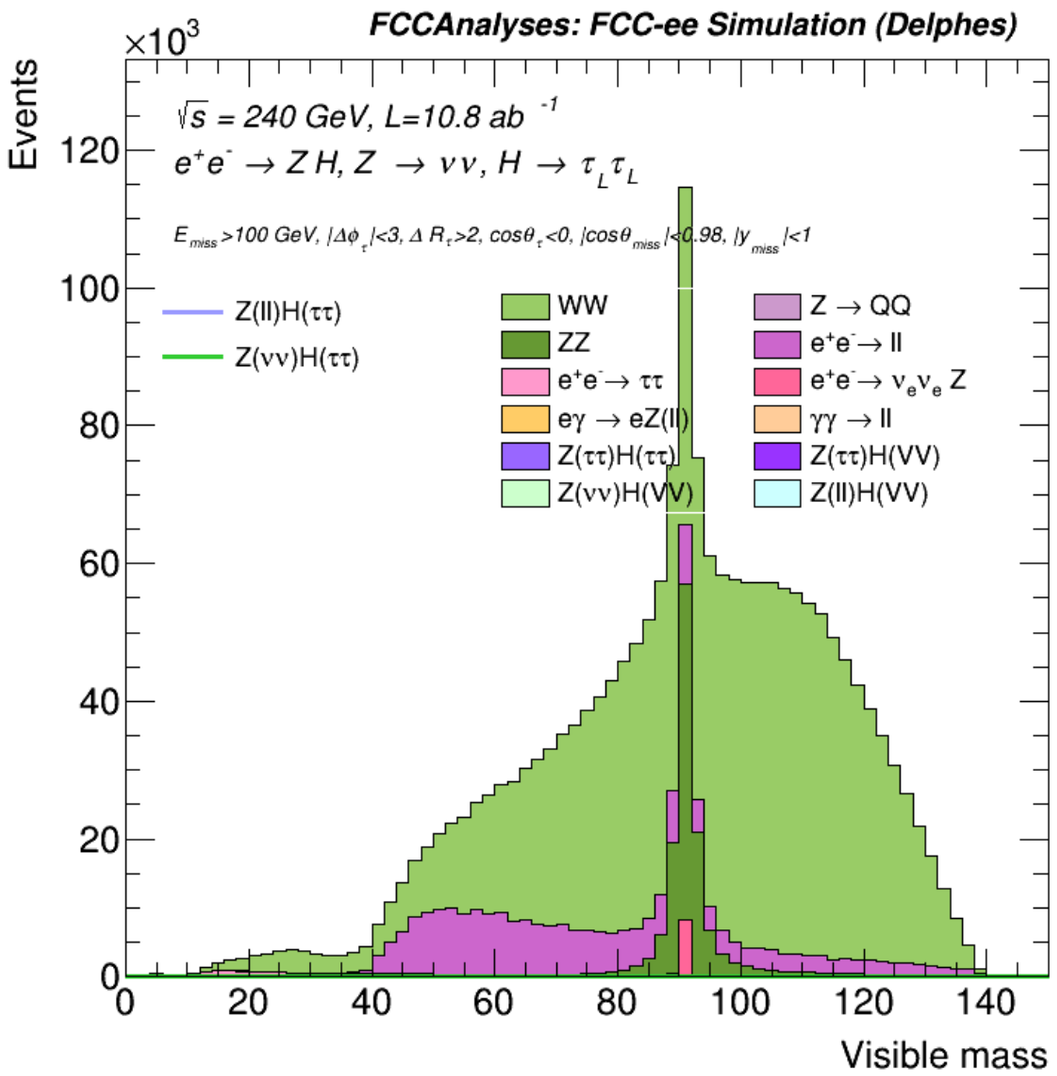
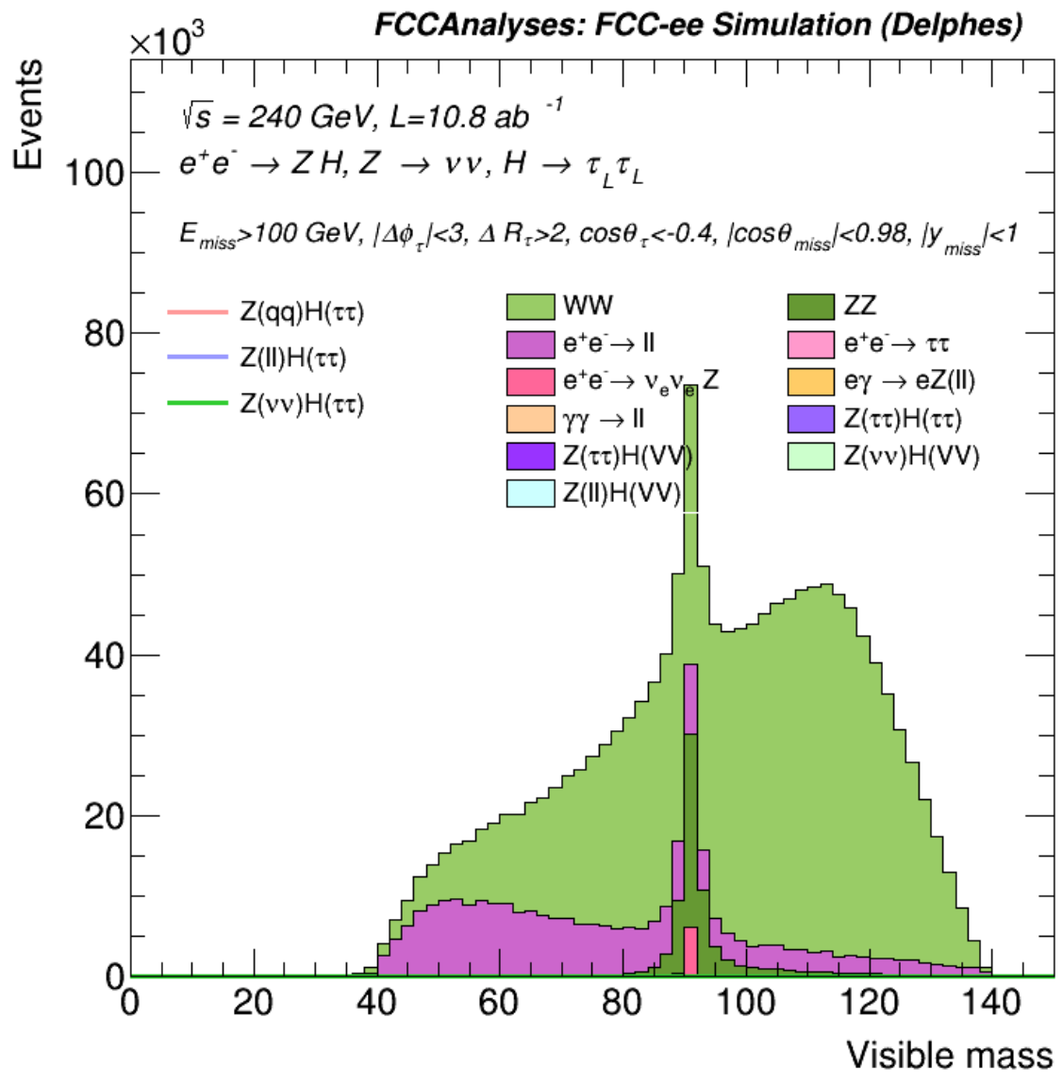
Explicit tau reconstruction



PNet tau reconstruction



QQHH - RECOIL

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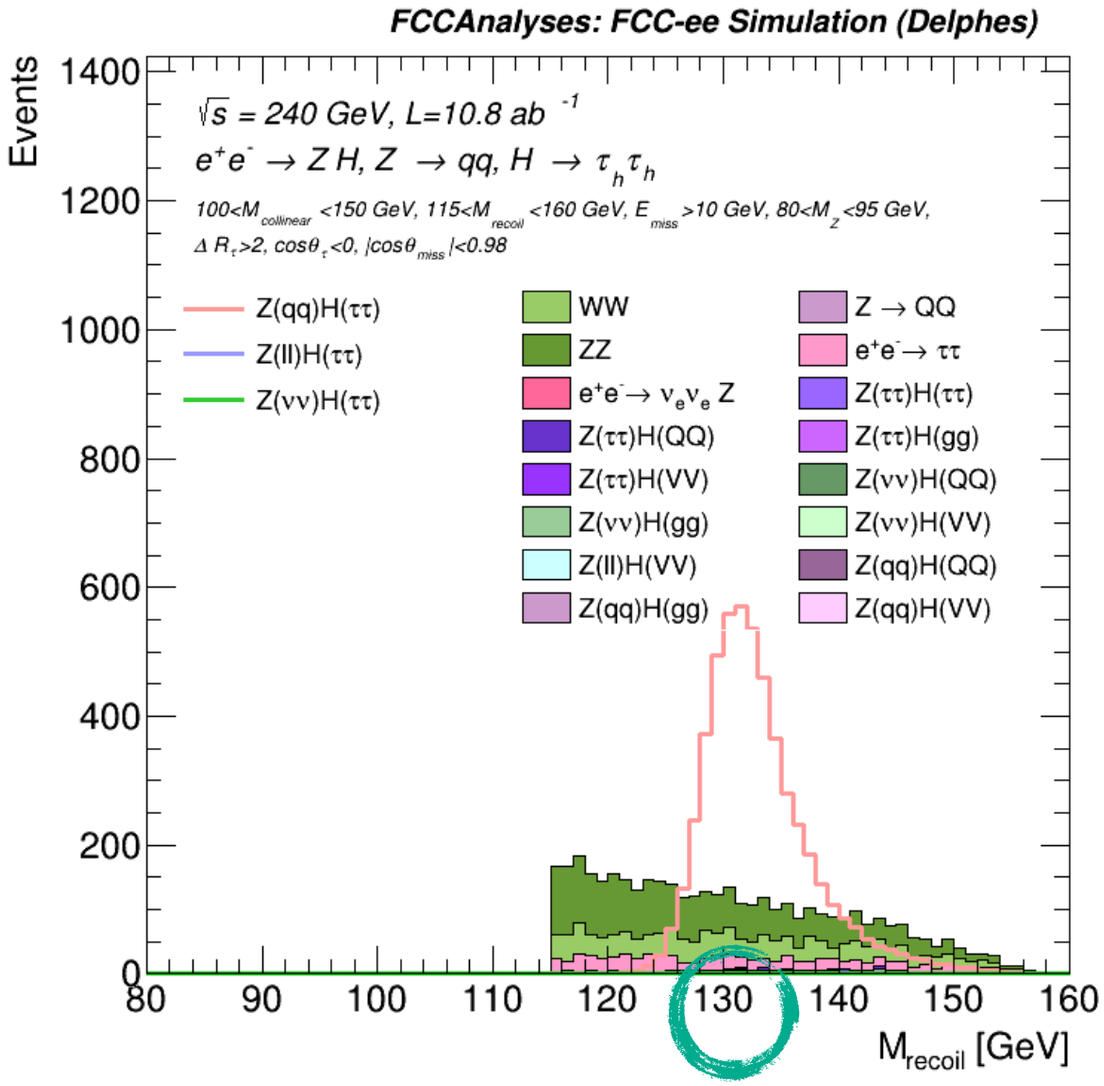
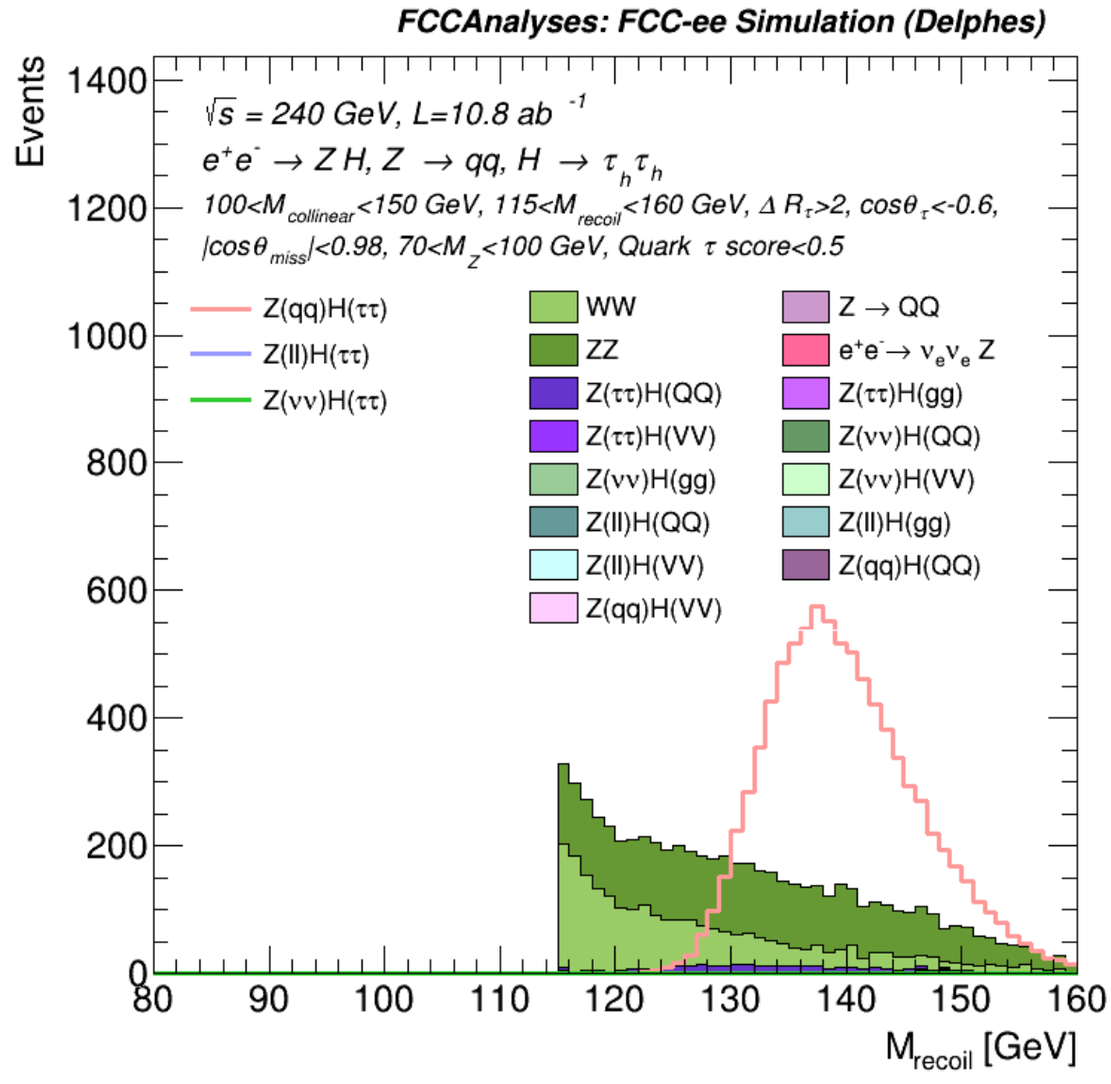
Explicit tau reconstruction



PNet tau reconstruction



no requirement for quark jet charges to match in either case (not radiation safe)

QQLH - RECOIL

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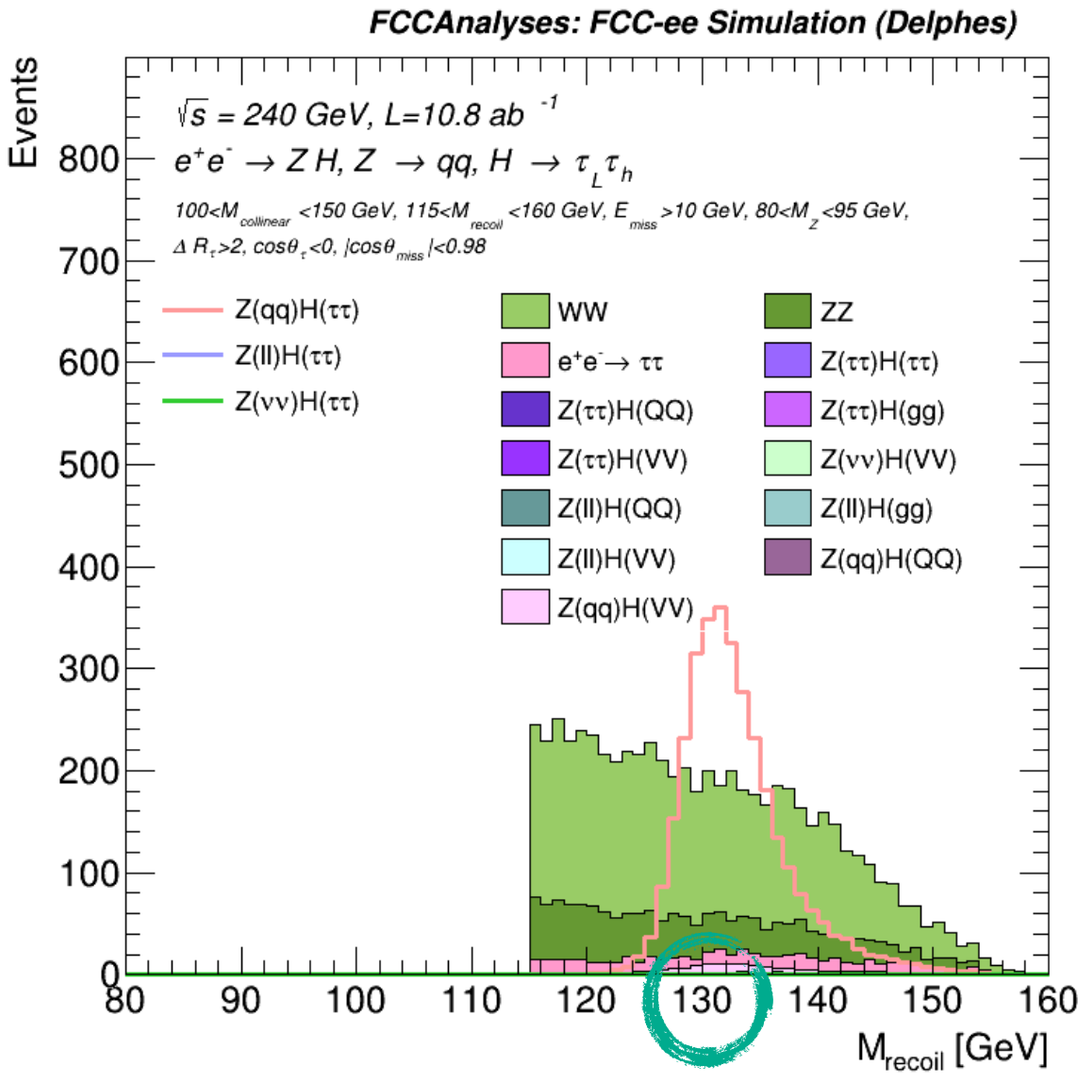
Explicit tau reconstruction



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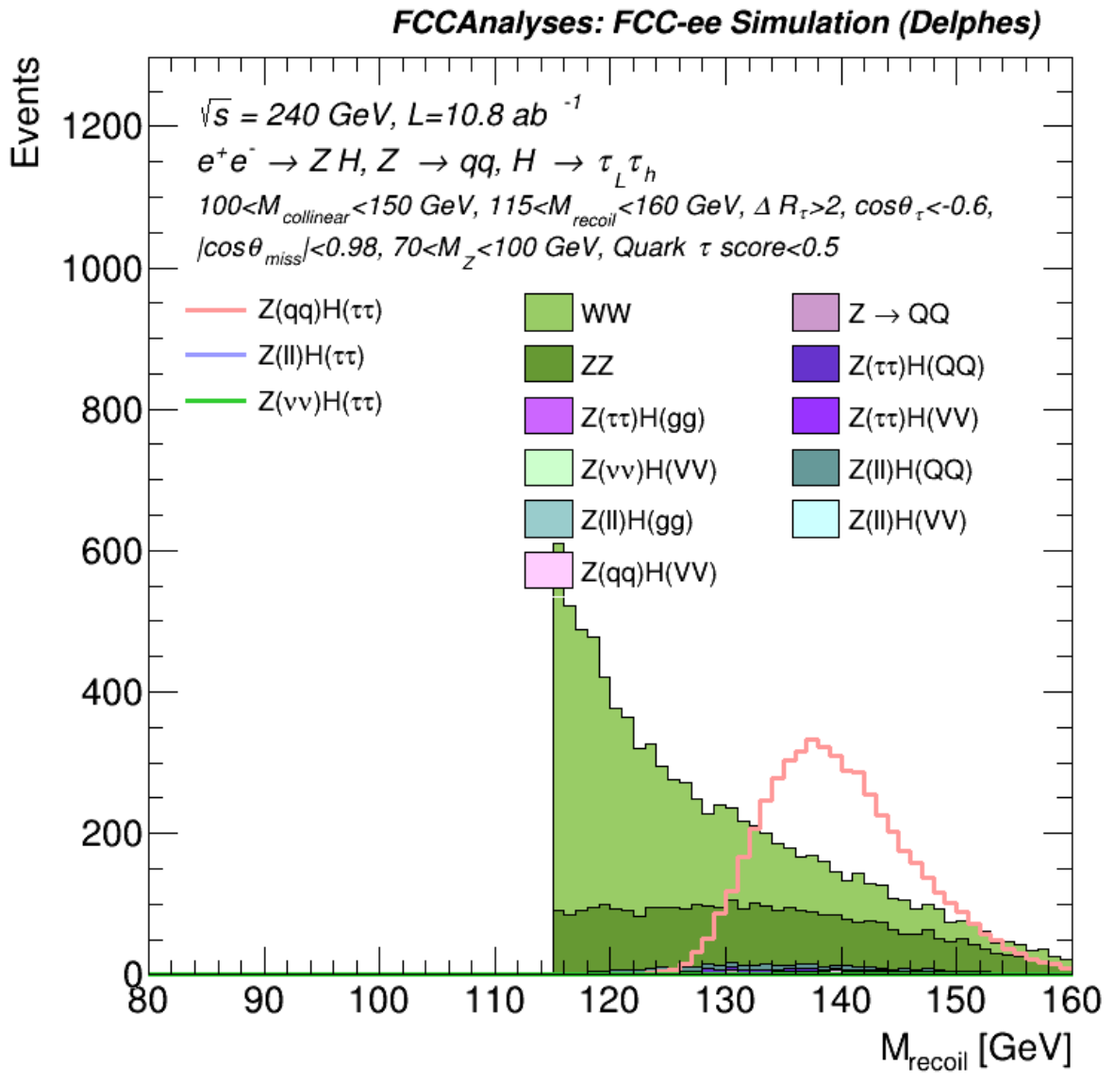

QQLL - RECOIL

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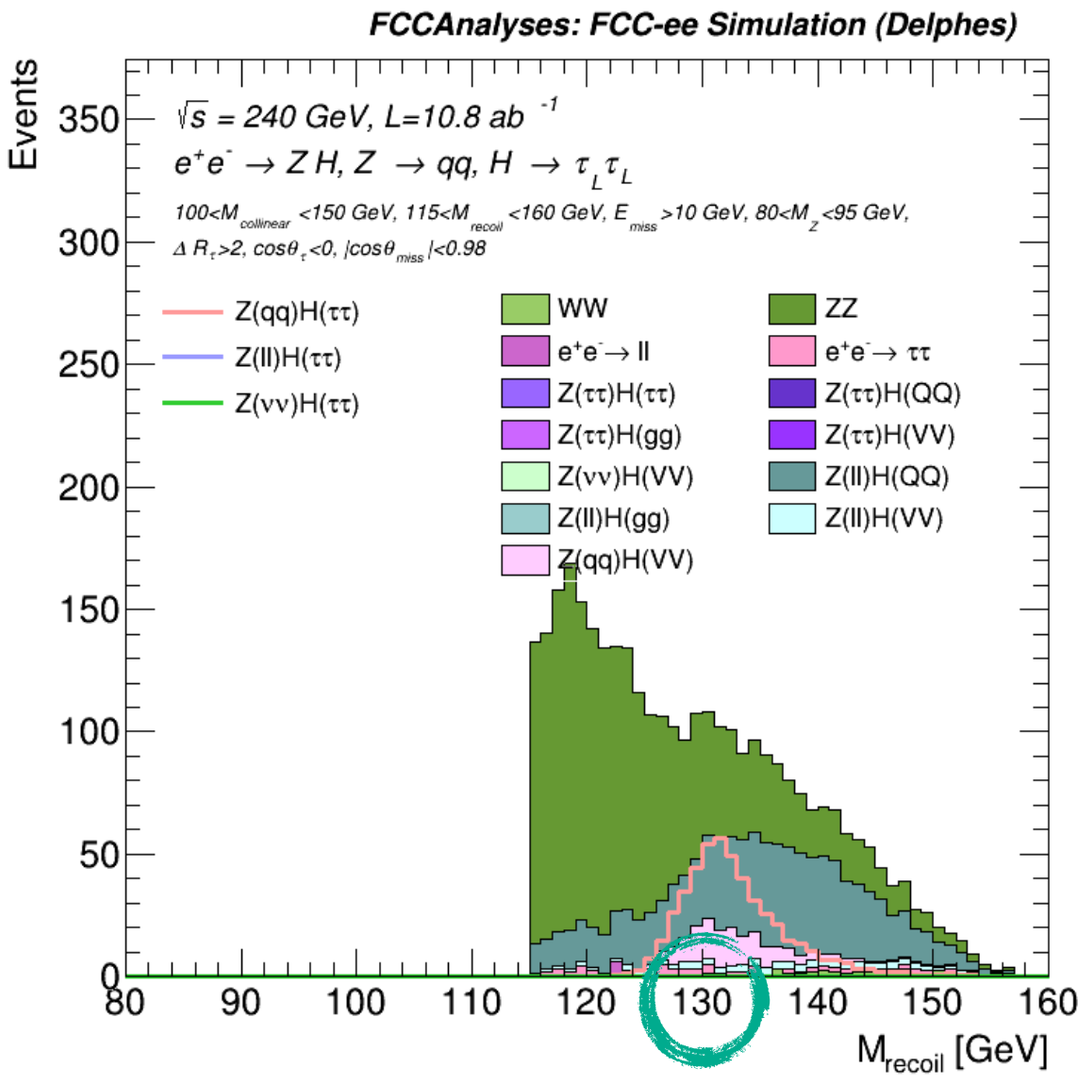
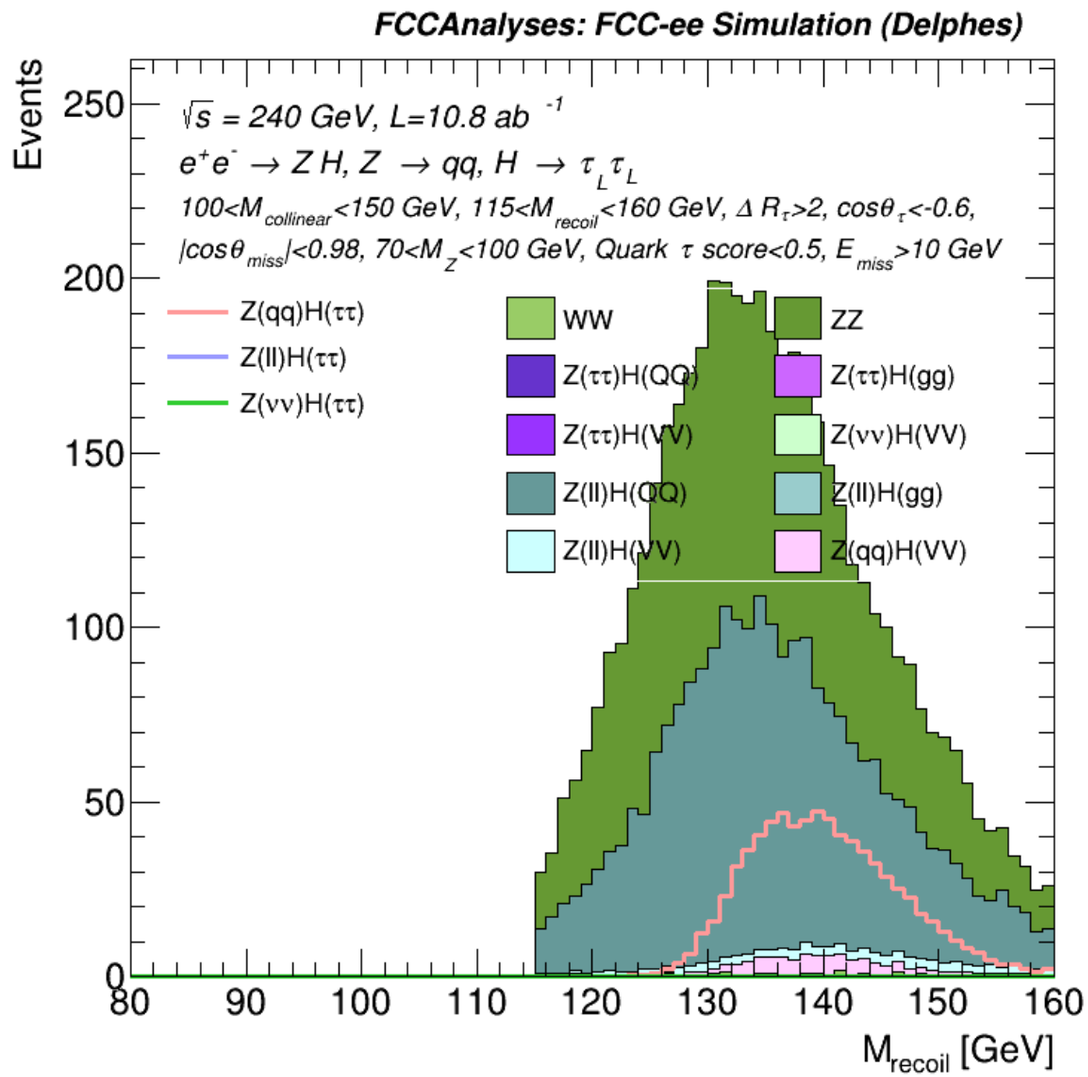
Explicit tau reconstruction



PNet tau reconstruction



RESULTS

- Relative uncertainty of $\pm 1.2\,\%$ with explicit reconstruction
- $\pm 0.94\,\%$ with jet tagger

Explicit tau reconstruction			PNet tau reconstruction		
$Z \to qq, H \to \tau_\ell\tau_\ell$:	1.00002	-0.137676/+0.143218	$Z \to qq, H \to \tau_\ell\tau_\ell$:	1.00001	-0.164966/+0.171551
$Z \to qq, H \to \tau_\ell\tau_h$:	1.00004	-0.0476389/+0.04891	$Z \to qq, H \to \tau_\ell\tau_h$:	1	-0.0335816/+0.0342792
$Z \to qq, H \to \tau_h\tau_h$:	1.00003	-0.0397673/+0.0410996	$Z \to qq, H \to \tau_h\tau_h$:	1	-0.0312686/+0.0321034
$Z \to \ell\ell, H \to \tau_\ell\tau_\ell$:	1.00001	-0.219315/+0.271913	$Z \to \ell\ell, H \to \tau_\ell\tau_\ell$:	1	-0.211172/+0.271753
$Z \to \ell\ell, H \to \tau_\ell\tau_h$:	1.00001	-0.10732/+0.121276	$Z \to \ell\ell, H \to \tau_\ell\tau_h$:	1.00001	-0.0919025/+0.10183
$Z \to \ell\ell, H \to \tau_h\tau_h$:	1	-0.076209/+0.0836675	$Z \to \ell\ell, H \to \tau_h\tau_h$:	1.00001	-0.0610303/+0.0657535
$Z \to \nu\nu, H \to \tau_\ell\tau_\ell$:	1.00077	-3.00077/+3.20104	$Z \to \nu\nu, H \to \tau_\ell\tau_\ell$:	1.00049	-3.00049/+2.81221
$Z \to \nu\nu, H \to \tau_\ell\tau_h$:	0.999502	-0.803933/+0.806547	$Z \to \nu\nu, H \to \tau_\ell\tau_h$:	0.999359	-0.747994/+0.750728
$Z \to \nu\nu, H \to \tau_h\tau_h$:	1.00002	-0.261827/+0.26312	$Z \to \nu\nu, H \to \tau_h\tau_h$:	1.00002	-0.296557/+0.298062

NEXT STEPS

- looking at the efficiency of tau reconstruction without any requirement aside from score shows that this might give better performance (charge=1 so far)
  - tau jets would then be identified by having tau score>0.5 and the rest are quark jets
  - this recovers the loss in efficiency in the $Z \to qq$ samples compared to the explicit reconstruction (still lower but very close 77% vs. 79%, for other decays it's higher 95-98%)
  - needs more studies to be validated, especially to see if recoil mass will be closer to 125 GeV again with different cuts on the score or by relaxing the number of jets requested
- but there is the problem of the second peak in tau score either in taus or quark jets which need to be cleaned up (jets with one photon only, last week's meeting)
  - it can be done with very good results but
  - unfortunately, to do this properly we need to run stage1 ~5 days (started yesterday)

NEXT STEPS

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- next presentation at Higgs top performance meeting on Tuesday 12
  - will present the results discussed today with the tagger and say we’re still working on getting even better performance by addressing some issues found
  - we should (hopefully) instead have everything ready by the 18th for the final update of the FCC note

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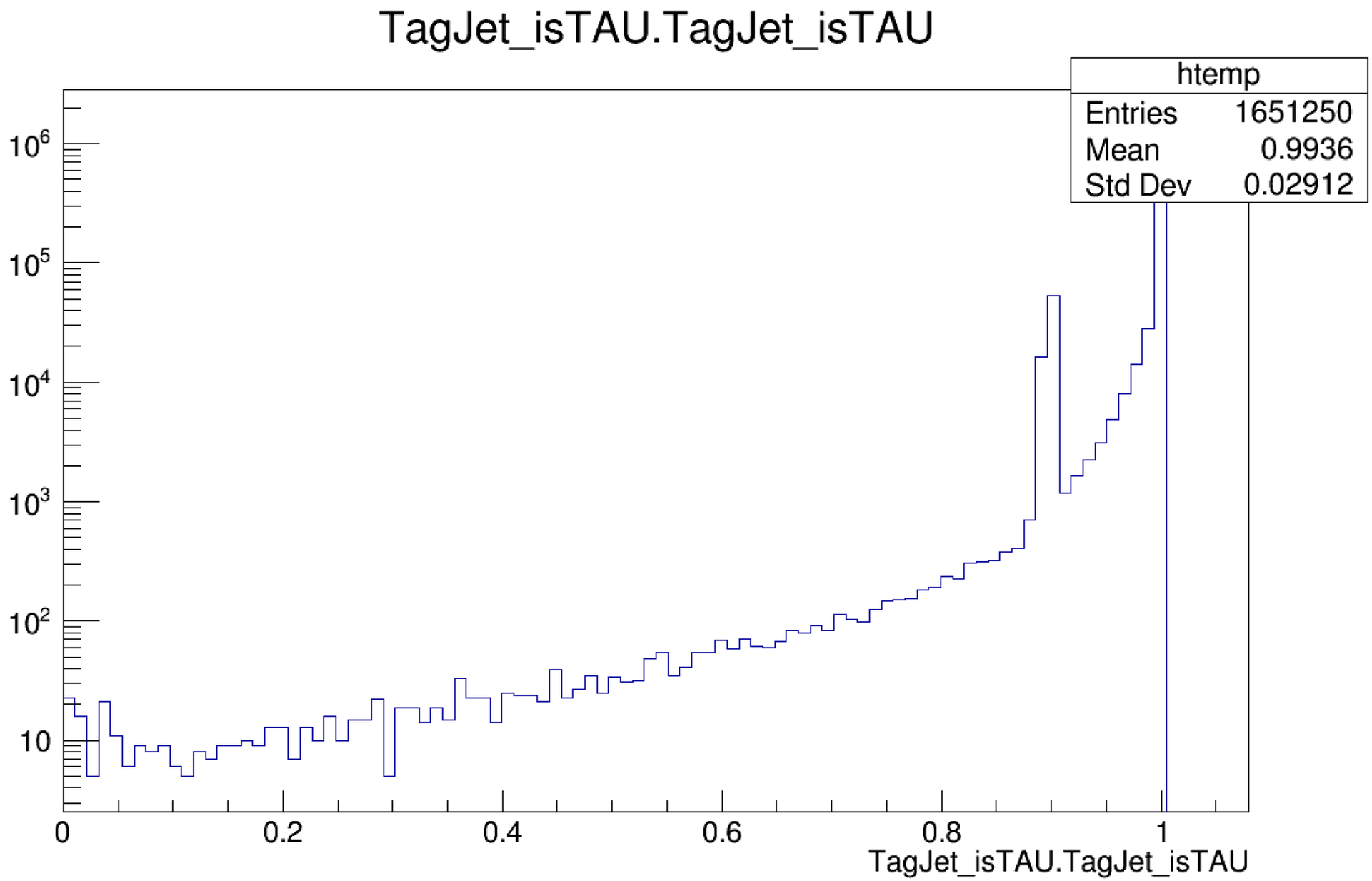
BACKUP

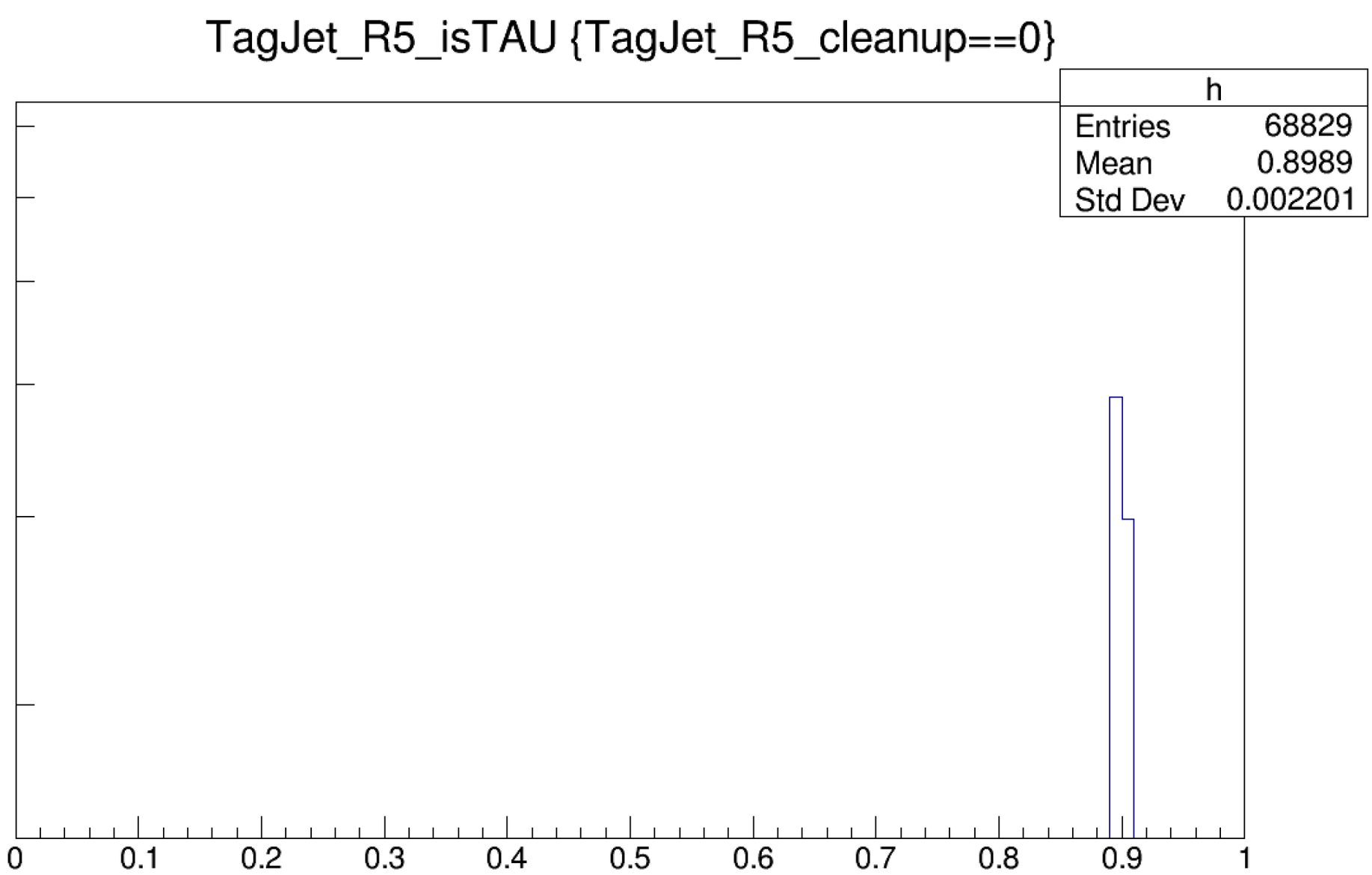
ISSUE WITH JET TAGGING



shown 1M events of $e^+e^- \to ZH, Z \to \nu\nu, H \to \tau\tau$

same behavior in backgrounds

PEAK CLEAN UP



excluding jets with only one photon

CLEANED JETS