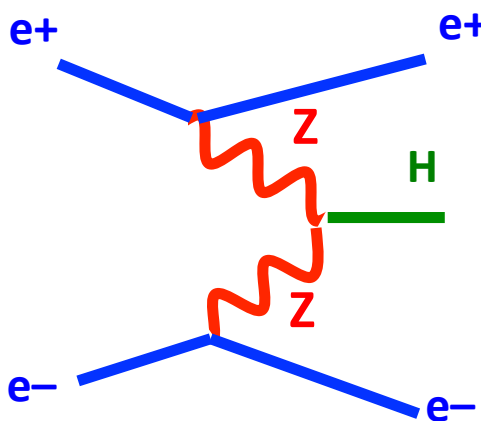


Higgs production in ZZ fusion at 1.4TeV: γ -induced backgrounds

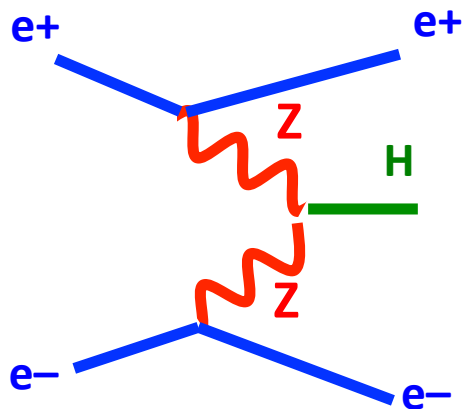


Aidan Robson
Dan Protopopescu

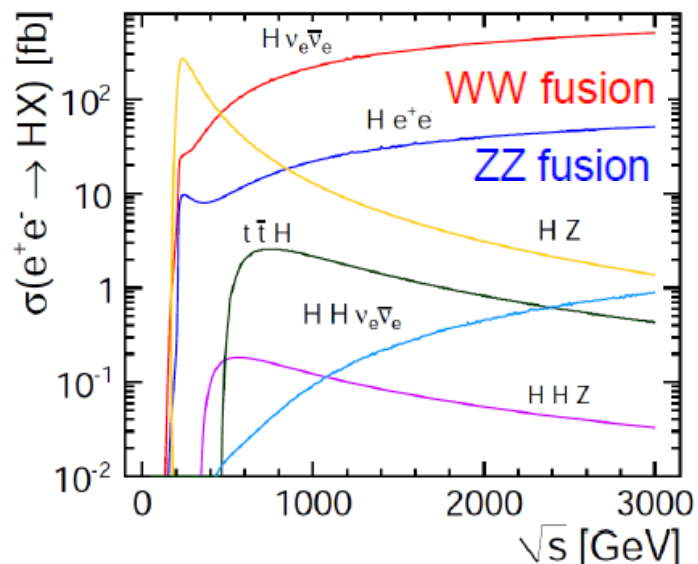
CLIC Workshop 2014
4 February 2014



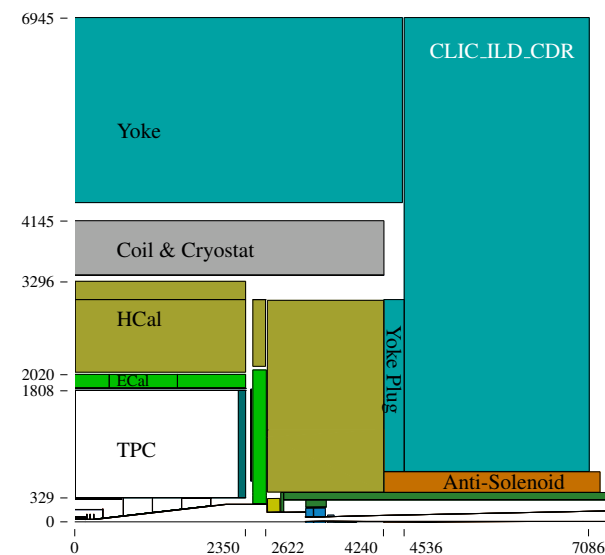
Introduction



- ◆ Fusion process $e^+e^- \rightarrow e^+e^-H$
Cross-section at 1.4TeV $\sim 24.5\text{fb}$
10% of leading production process
 $e^+e^- \rightarrow \nu\nu H$
but access to HZZ vertex



- ◆ Using CLIC-ILD detector (good forward coverage)



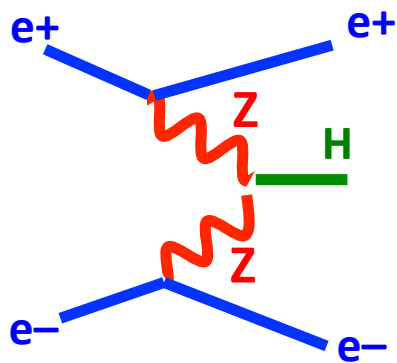
Today:

- ◆ (very) brief analysis reminder
- ◆ γ -induced background study

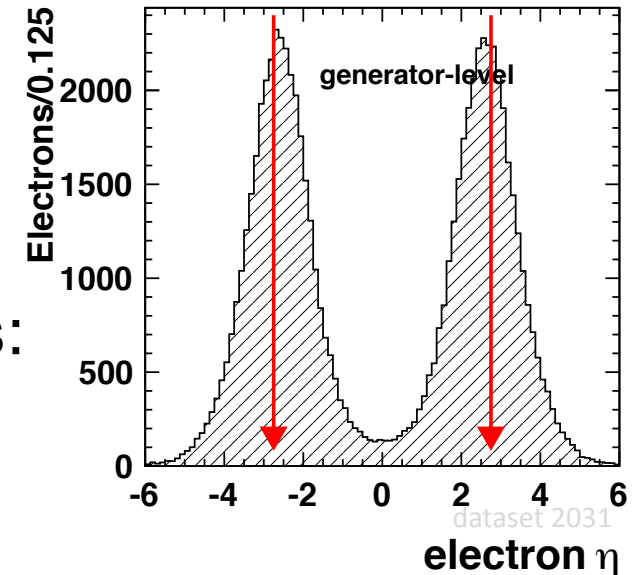
Characterising the signal



- Signature: 2 forward electrons, plus Higgs decay



Scattered beam electrons:



Red arrows show detector acceptance

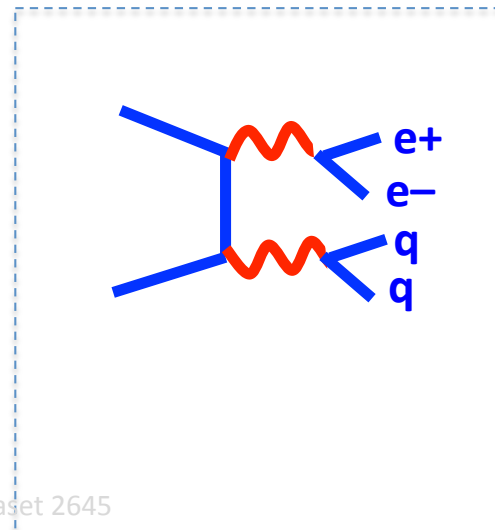
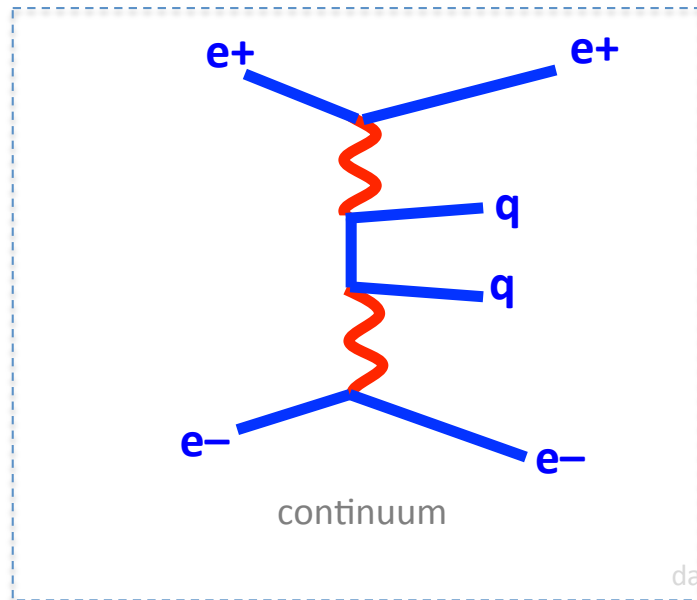
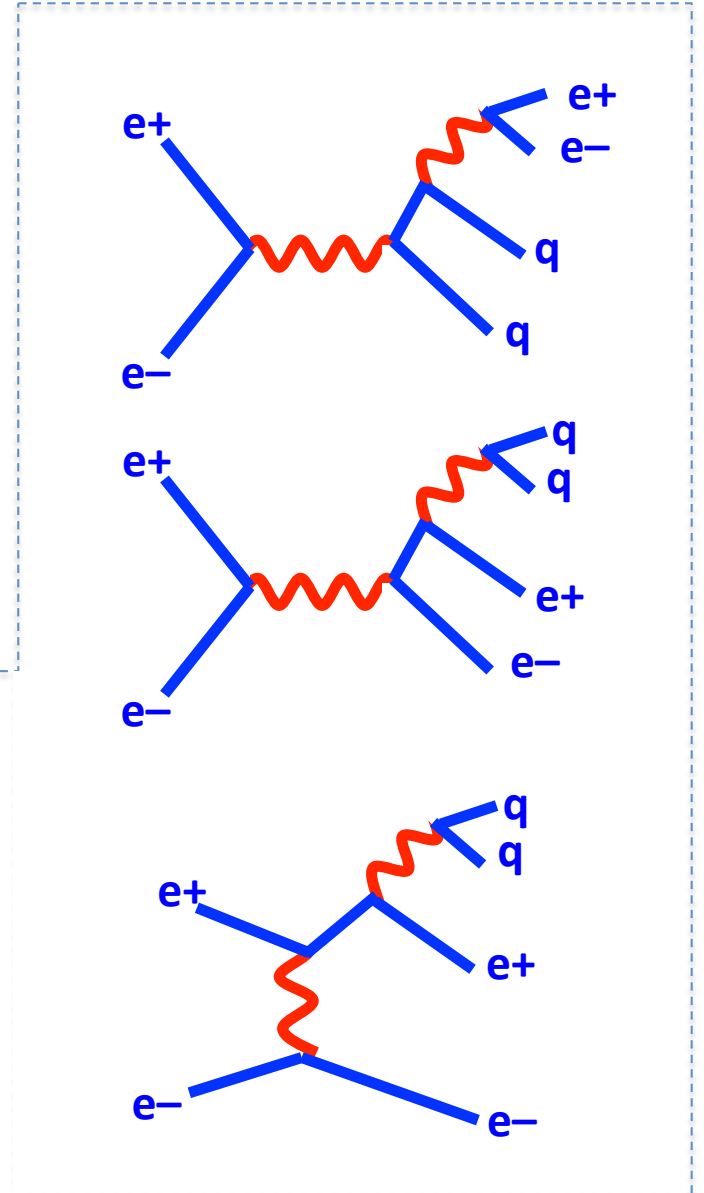
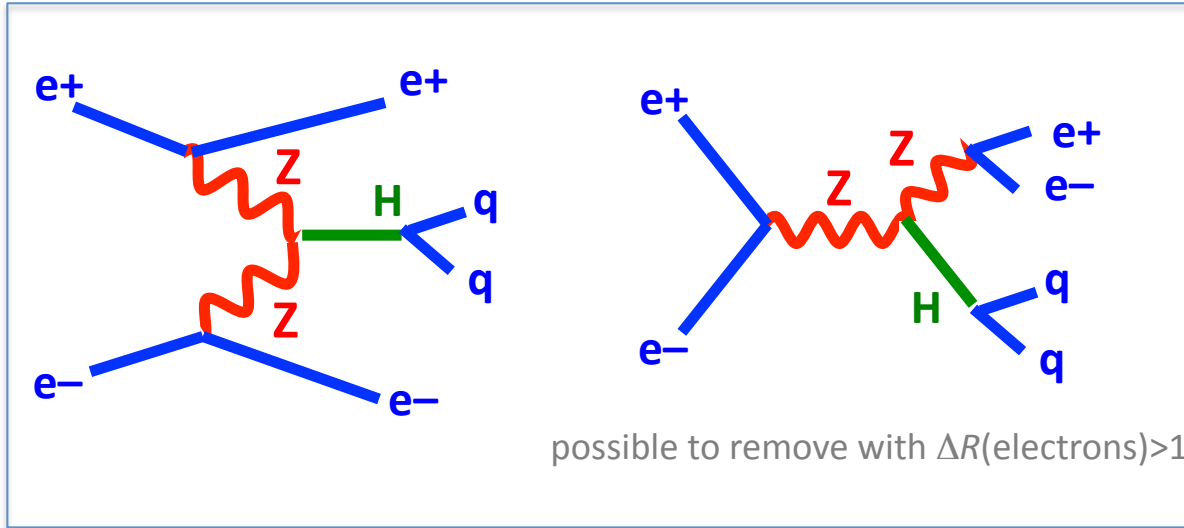
Initial kinematic selection:

2 opposite-charge electrons,
 $E > 100\text{GeV}$ and separated $\Delta\eta > 1$

Analysis strategy:

Multivariate likelihood analysis
(either looking at all visible decays,
or selecting $H \rightarrow b\bar{b}$)

Backgrounds



Leading background

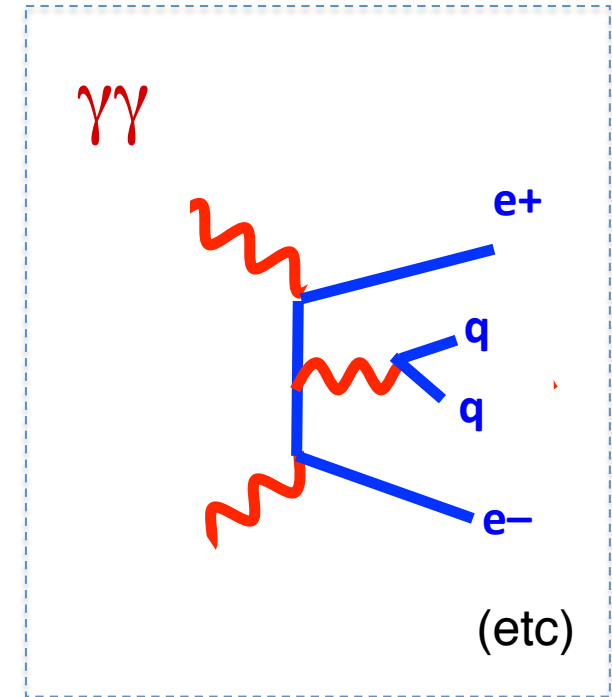
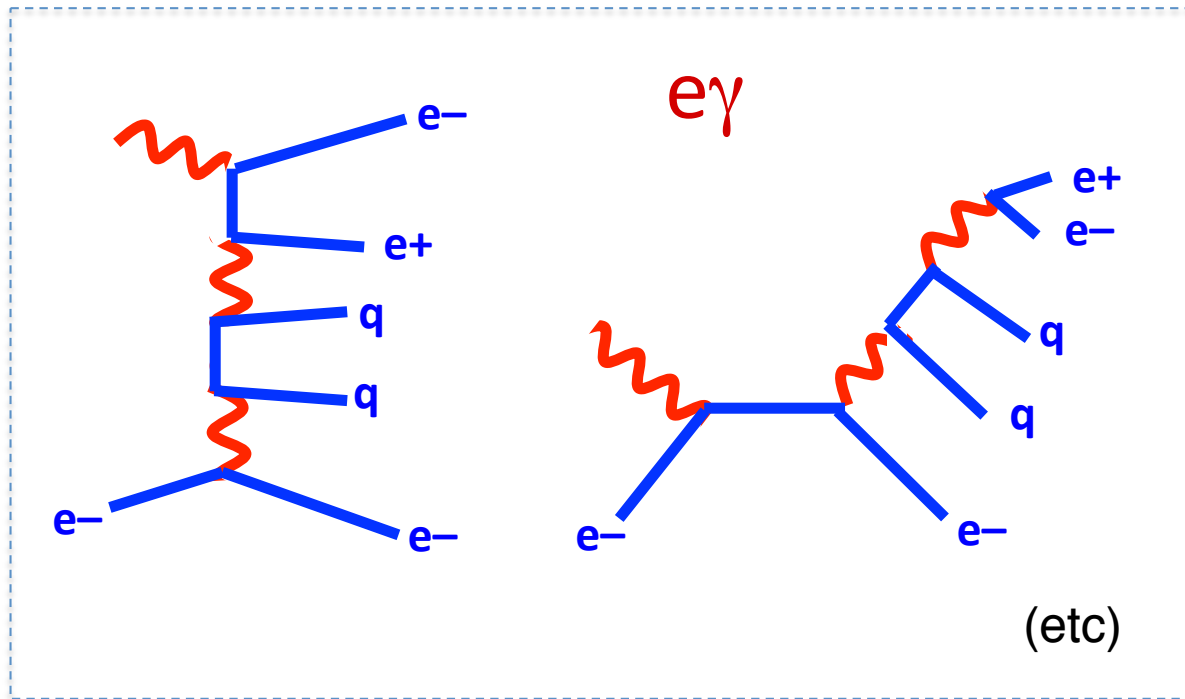


	eeH signal			qqll background		
	surviving (gen-lvl)	surviving (full sim)	dataset 2031 xs/fb	surviving (gen-lvl)	surviving (full sim)	dataset 2645 xs/fb
All events			24.47			2726.7
≥ 2 electron cands, $E > 100\text{GeV}$		29.2%	7.14		2.1%	58.02
$= 2$ electron cands, $E > 100\text{GeV}$		28.3%	6.93		2.1%	56.86
opposite charge	32%	27.7%	6.79	2.3%	2.0%	54.41
$\Delta\eta(\text{electrons}) > 1$	31%	26.5%	6.49	2.0%	1.8%	48.12

Generator-level numbers comparable
with full simulation

◆ qqll backgrounds well-suppressed – but still 8x signal

γ -induced backgrounds



dataset 2645

γ -induced backgrounds



Look at generator-level for $\gamma\gamma \rightarrow qqee$ and $e\gamma \rightarrow ellqq$

Using samples that are available

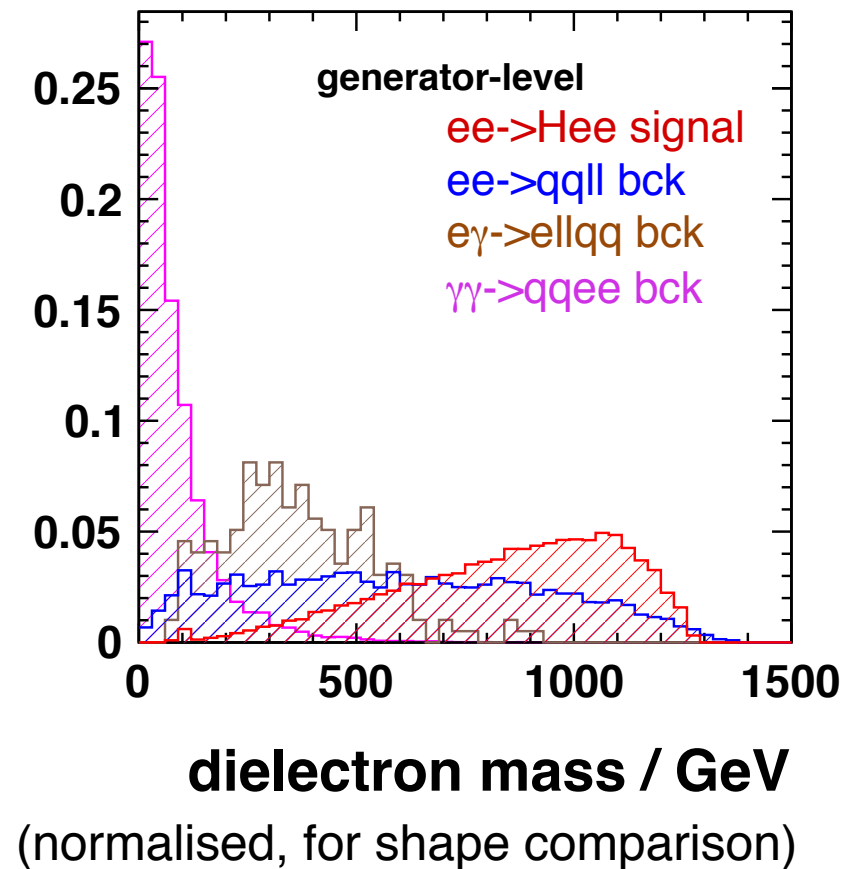
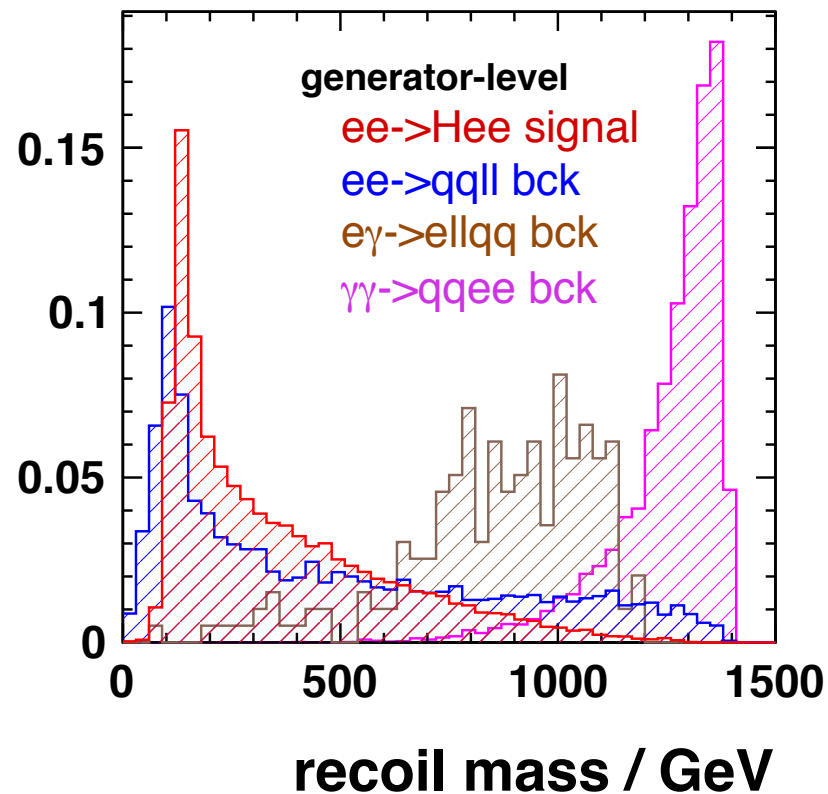
	qqll background dataset 2645		$\gamma\gamma \rightarrow qqee$ bck dataset 1980		$e\gamma \rightarrow ellqq$ bck dataset 2979	
	surviving (gen-lvl)	xs/fb	surviving (gen-lvl)	xs/fb	surviving (gen-lvl)	xs/fb
All events		2727		~12		?
≥ 2 electrons in detector acceptance, $E > 100\text{GeV}$		58			6.6%	
$= 2$ electrons in detector acceptance, $E > 100\text{GeV}$		57			5.7%	
opposite charge	2.3%	54	3.0%	0.4	2.7%	
$\Delta\eta(\text{electrons}) > 1$	2.0%	48	2.2%	0.3	1.4%	

- ◆ Looked at dataset 2979 for $e\gamma$: xs not listed
($e\gamma \rightarrow ell\nu\nu$ is $\sim 150\text{fb}$ at 3TeV)
- ◆ $e\gamma \rightarrow ellqq$ at 1.4TeV requested for $H \rightarrow Z\gamma$ analysis; will use that
- ◆ $\gamma\gamma \rightarrow qqee$ very small but need to check xs number and validity of dataset (1980=old; but also more requested for $H \rightarrow \tau\tau$ that could be used)

Separating signal and backgrounds



- ◆ Look at generator-level versions of event variables used for signal-background separation (for events with 2 electrons $> 100\text{GeV}$ and separated by $\Delta\eta > 1$)

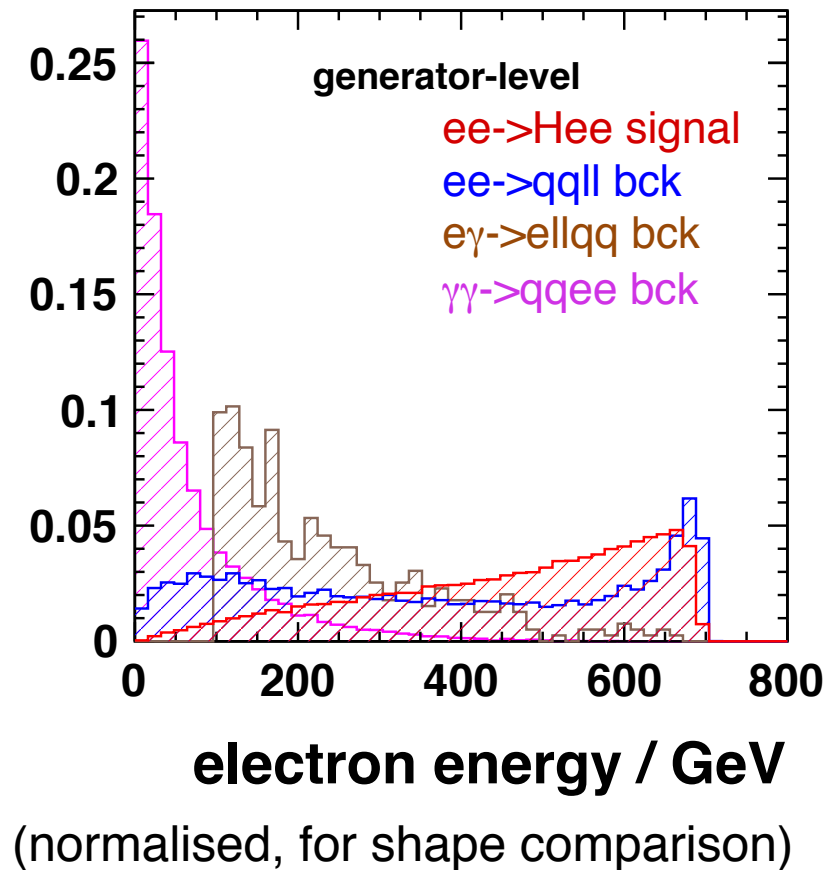
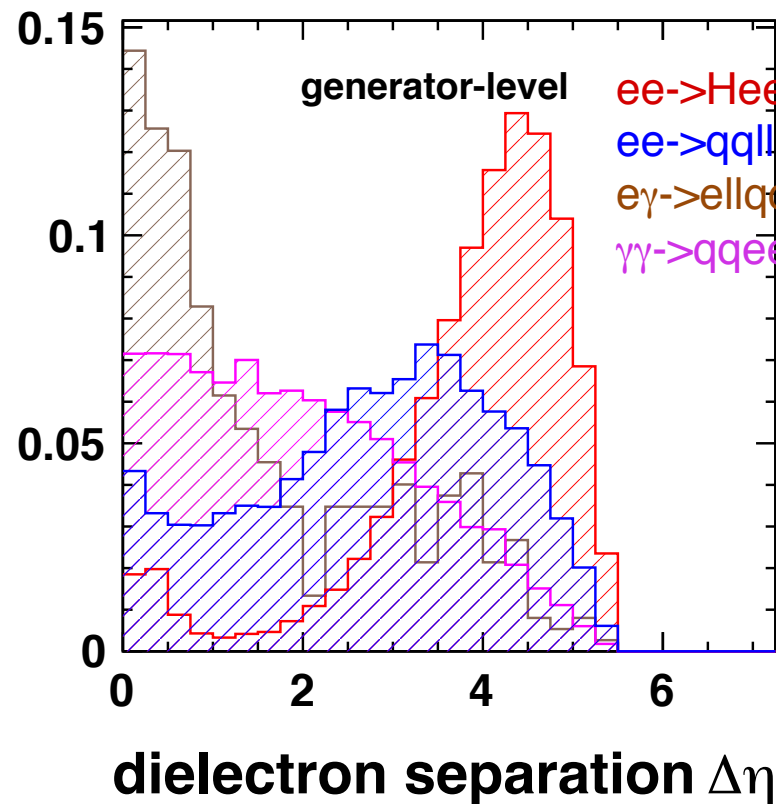


- ◆ eγ-induced bck well-separated from signal

Separating signal and backgrounds



- ◆ Look at generator-level versions of event variables used for signal-background separation (for events with 2 electrons $> 100\text{GeV}$ and separated by $\Delta\eta > 1$)



- ◆ e γ -induced bck well-separated from signal

Summary



- ◆ $e\gamma$ -induced background probably small and seems to be well-separated from signal
- ◆ waiting for new $e\gamma$ samples and cross-sections (from $H \rightarrow Z\gamma$ analysis) [or perhaps I could help?]
(also $\gamma\gamma$ samples from $H \rightarrow \tau\tau$ analysis)
- ◆ if it looks as though $e\gamma$ will be large, will request ILD reconstruction (currently SiD request) and put it into the likelihood discriminant

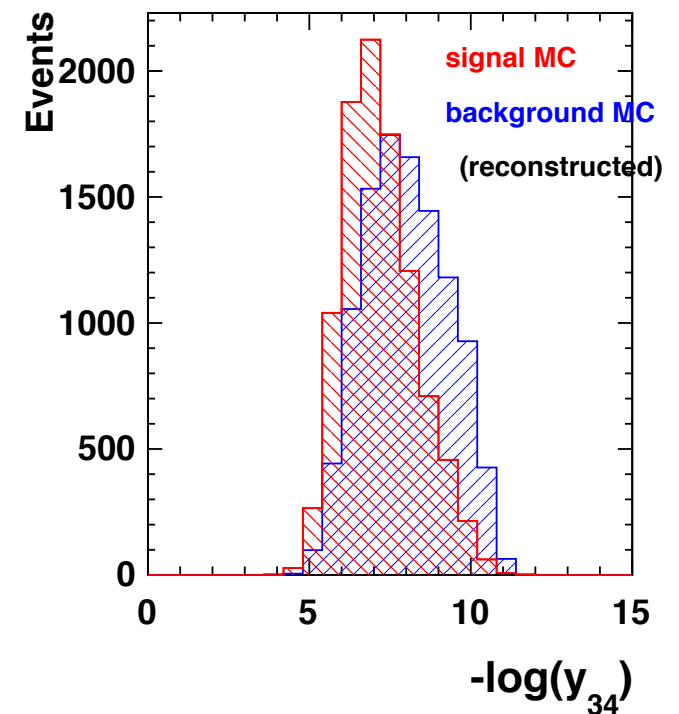
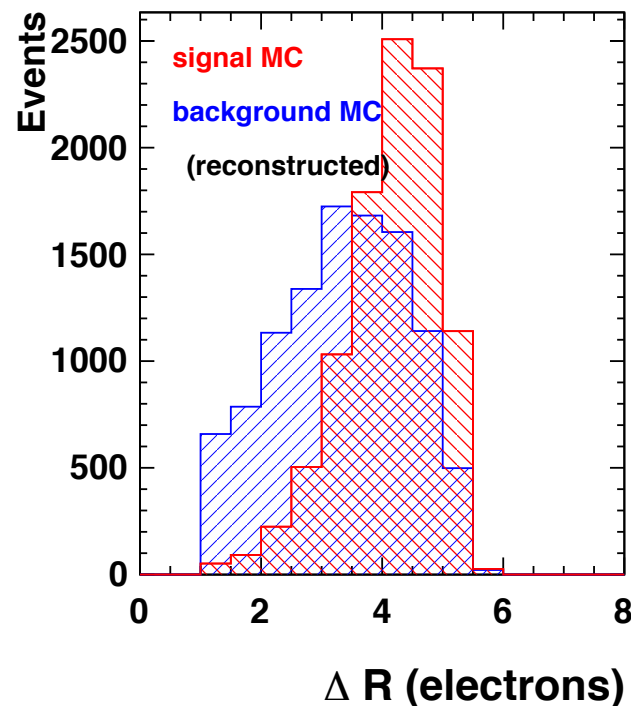
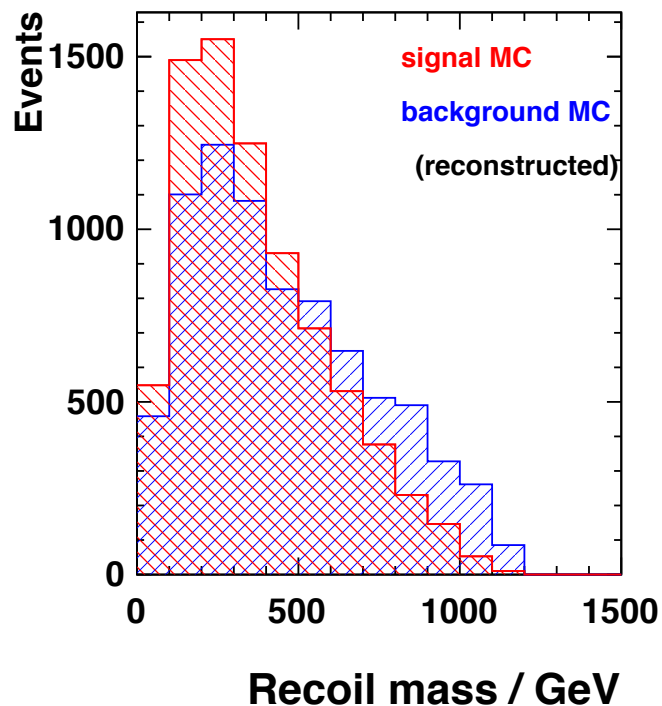


Separating signal from backgrounds



- ◆ Look for event variables to characterise signal
 - ◆ separation between electrons ΔR
 - ◆ recoil mass
 - ◆ y_{34} to characterise final state shape

fairly independent of decay mode, for visible decays

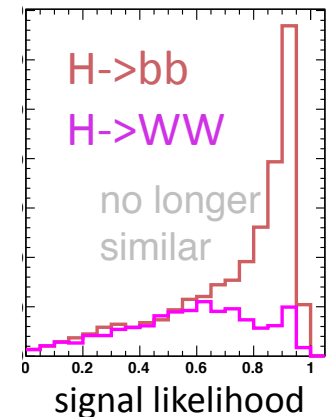
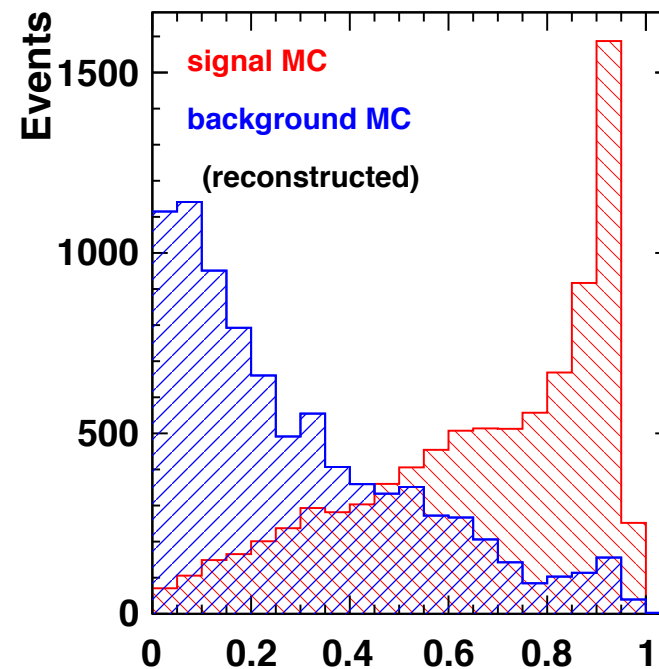
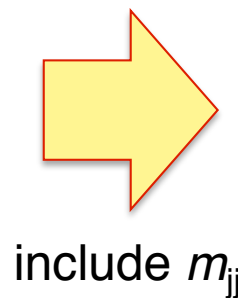
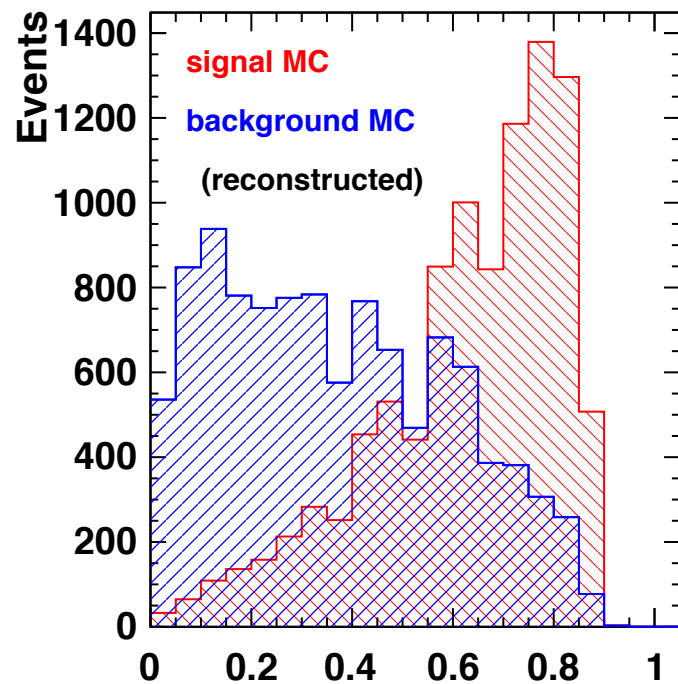


Background normalised to **signal** here

Likelihood incorporating final state jets



- ◆ Can include m_{jj} in likelihood and improve separation ... but then H->bb and H->WW look quite different



Signal likelihood

Signal likelihood

all events passing preselection

Background normalised to signal here
Background is actually ~ 8 x signal here

Final state with b-tag



	dataset 2031 eeH signal		dataset 2645 qqll background	
	surviving	xs/fb	surviving	xs/fb
All events		24.47		2726.7
>= 2electron candd, E>100GeV	29.2%	7.14	2.1%	58.02
==2 electron candd, E>100GeV	28.3%	6.93	2.1%	56.86
opposite charge	27.7%	6.79	2.0%	54.41
DeltaEta>1	26.5%	6.49	1.8%	48.12
4-jet topology has 2 jets matching electron candd	23.3%	5.70	1.4%	39.18
2 (truth) b-tags	12.5%	3.06	0.2%	6.26

ie, 4590 events in 1.5 ab^{-1}

Other backgrounds with two electrons, two jets, eg top:
– low dielectron mass and separation compared to signal