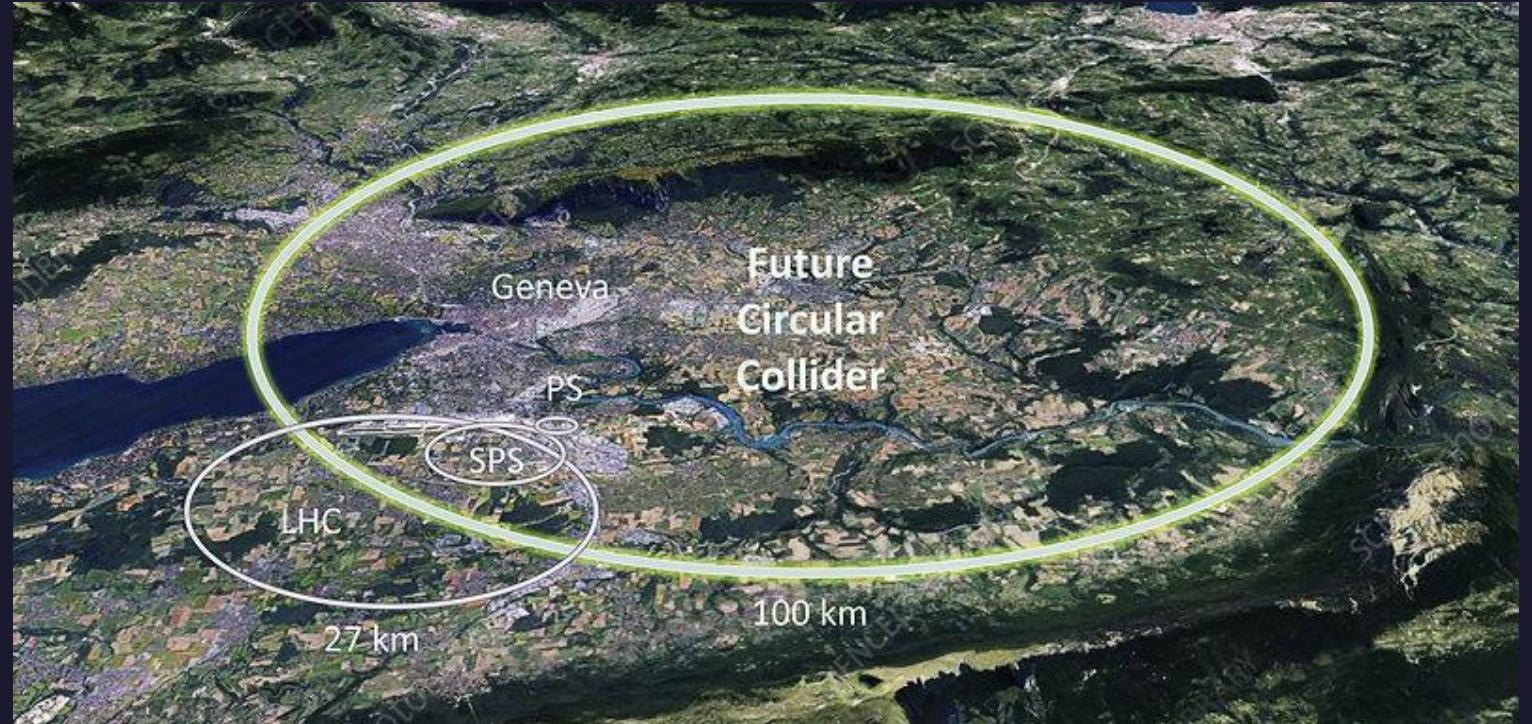


Long-lived axion-like particles at the FCC-ee

Weekly meeting with Juliette



Elnura Bakhishova

HELMHOLTZ

15.01.25



Comparing couplings

Generated samples (1 Mio each):

ALP mass = 1 GeV

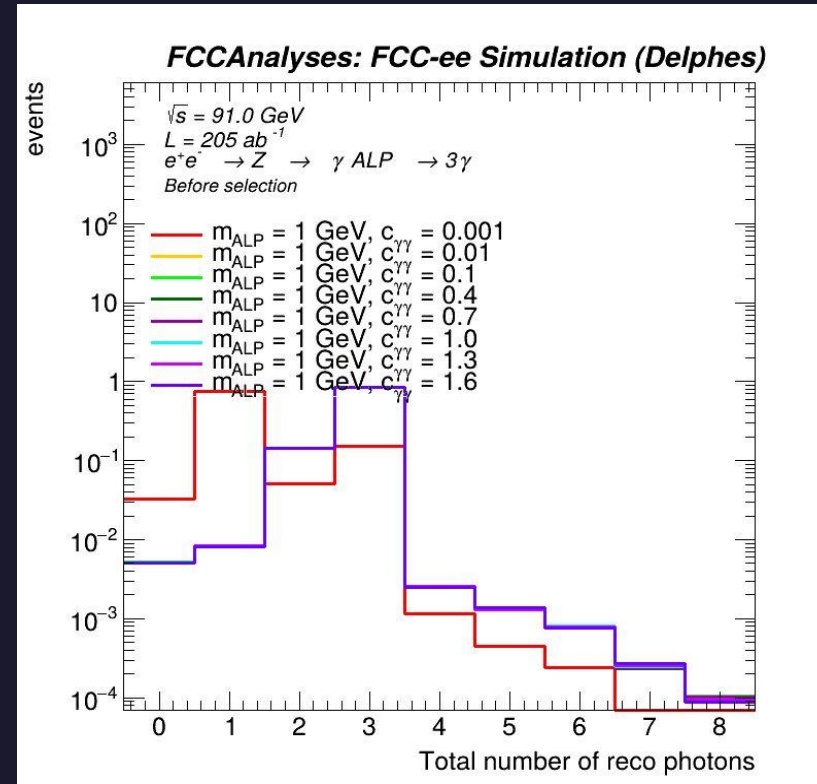
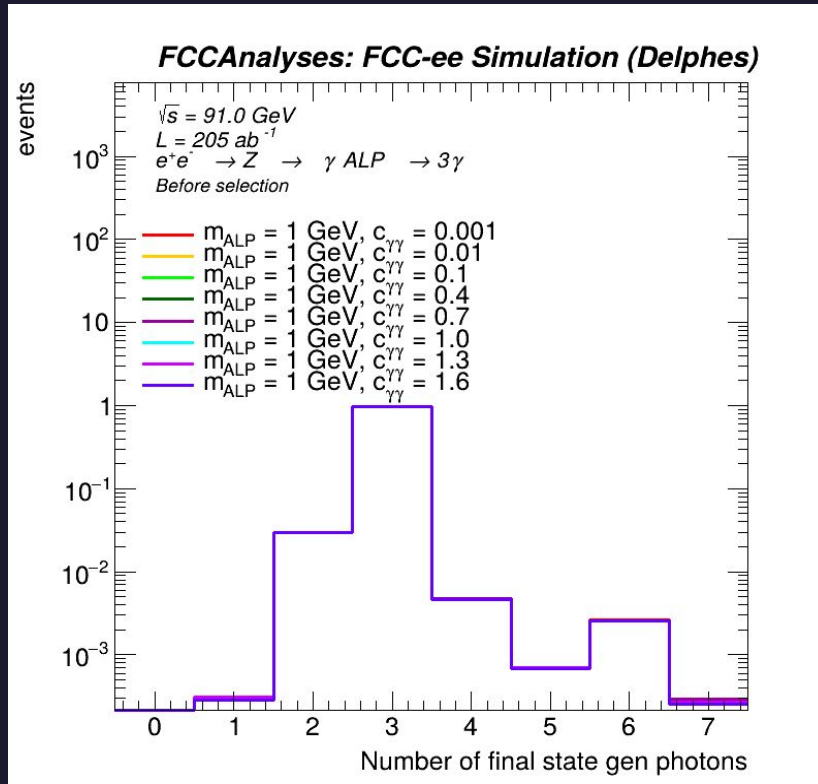
Coupling c_{YY}	Cross-section
0.001	2.739e-06
0.01	2.739e-04
0.1	0.02.739e-02
0.4	0.4382
0.7	1.342
1.0	2.739
1.3	4.629
1.6	7.011

Is putting all of those samples in one plot too much?

→ Cross-section proportional to c_{YY}^2

Comparing couplings

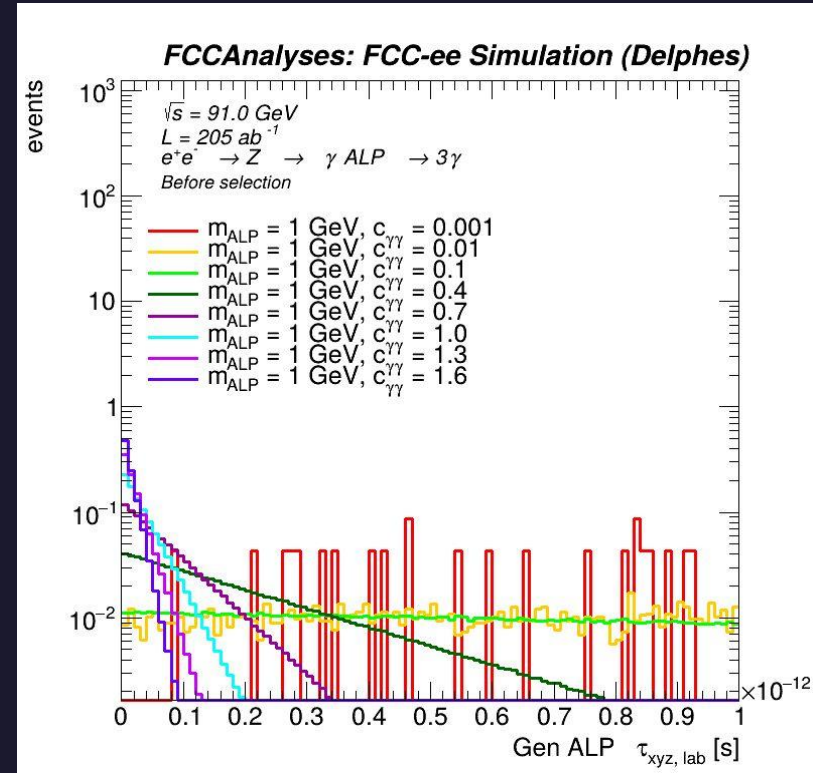
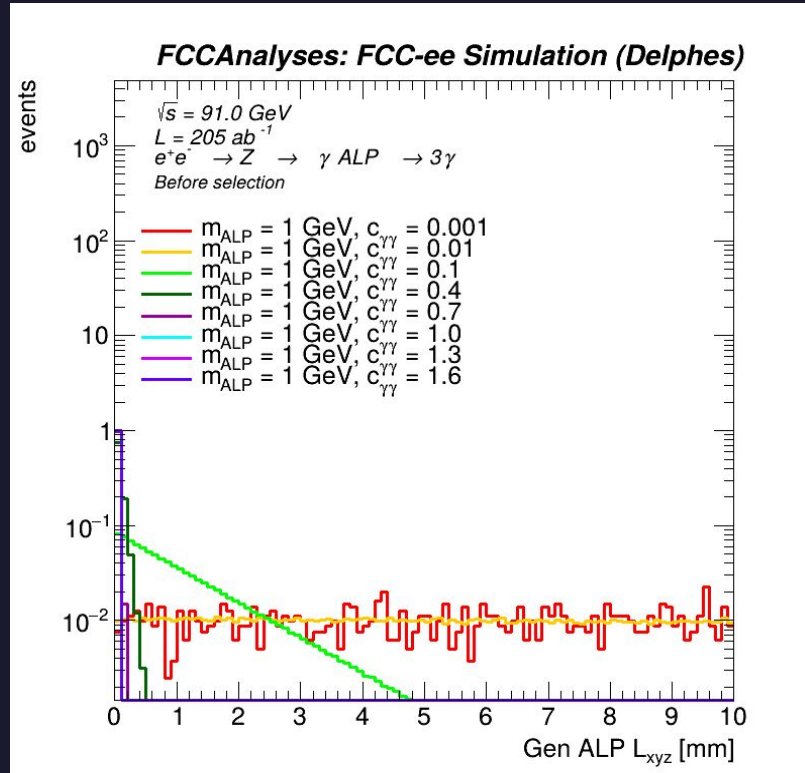
Final state photons



← For $c_{\gamma\gamma}=0.001$ in most cases only one photon is reconstructed: ALP is too long-lived and escapes the detector volume before decaying

Comparing couplings

Decay length and observed lifetime

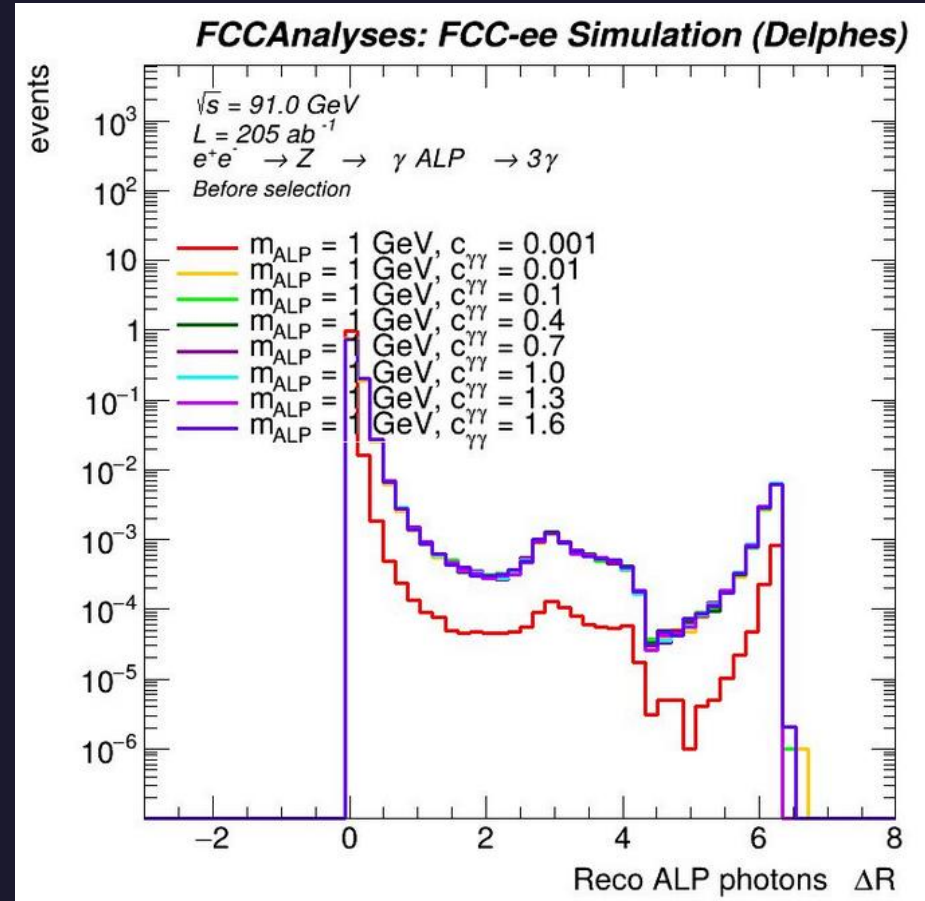
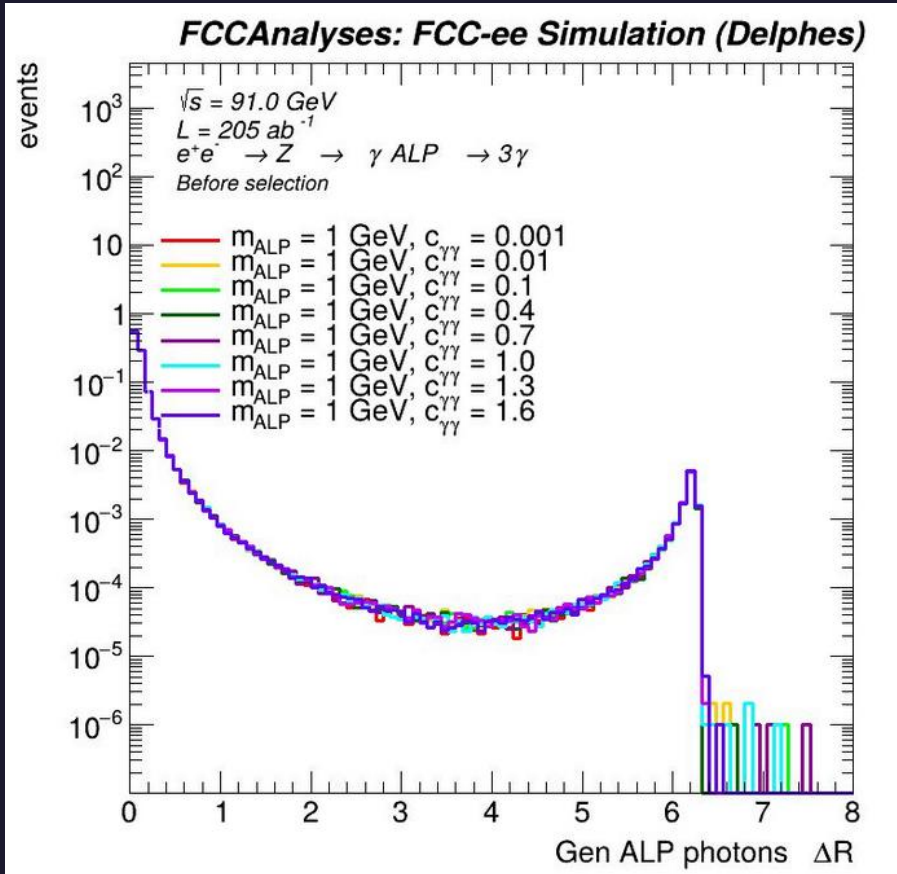


Keep $c_{\gamma\gamma} = 0.001$ & 0.01
in graphs or remove to see
clearer differences between
the couplings in the same
order of magnitude?

Gen ALP L_{xyz} : vertex of daughter photon

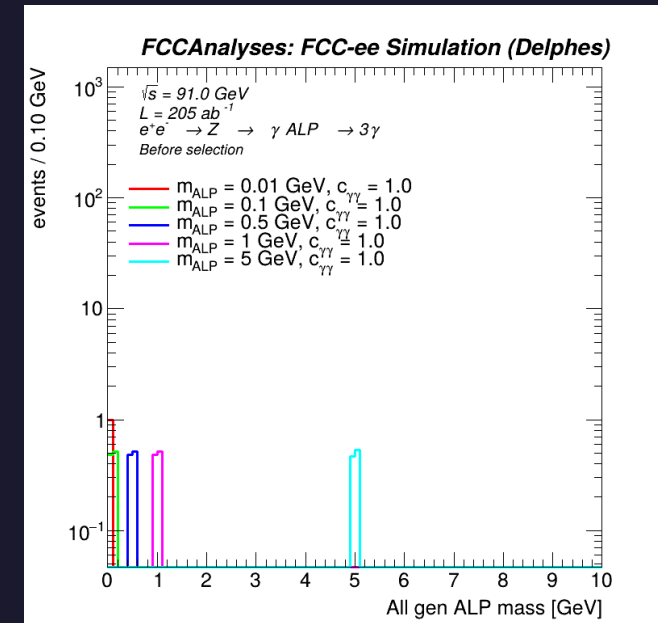
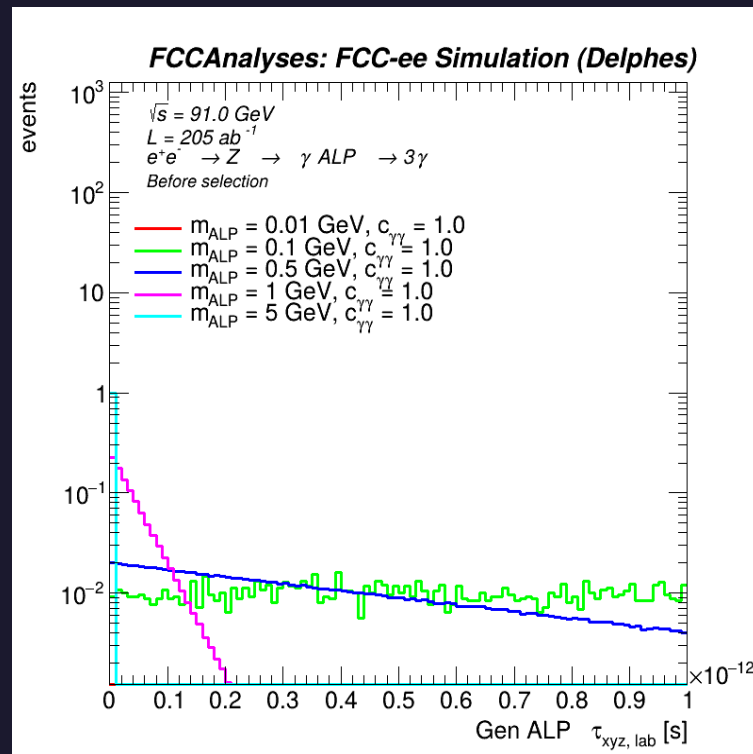
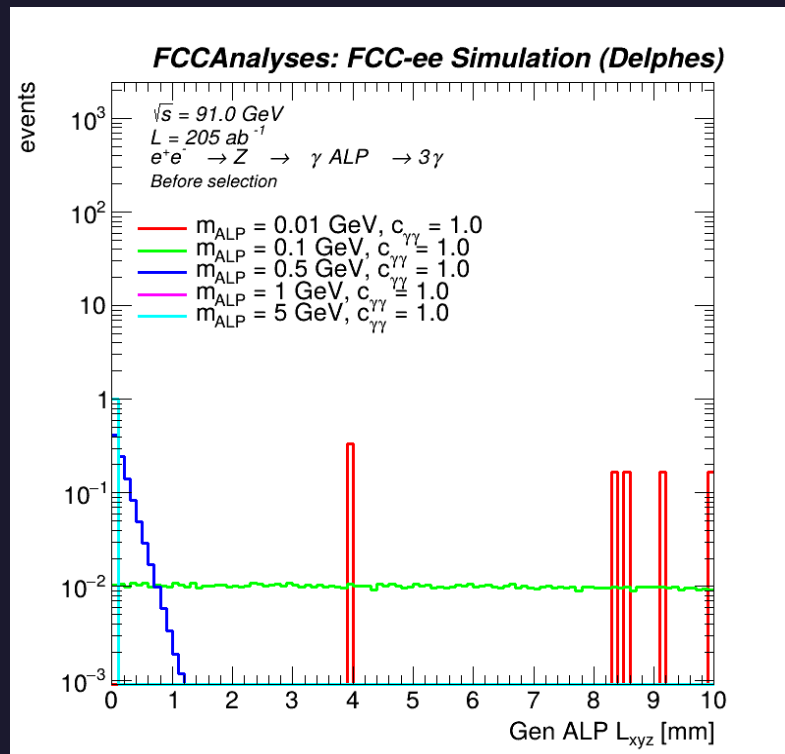
Comparing couplings

delta R gen and reco level



Comparing masses

Decay length and observed lifetime



GenALP L_{xyz} : vertex of daughter photon

Backgrounds

Created background samples (1Mio events each):

$ee \rightarrow aa$: $\rightarrow 1\,000\,000$ events
 57.32 ± 0.001178 pb

$ee \rightarrow aaa$: $\rightarrow 1\,000\,000$ events
 0.4624 ± 0.0001132 pb

$ee \rightarrow aaaa$: $\rightarrow 1\,000\,000$ events
 $0.001119 \pm 4.928e-07$ pb

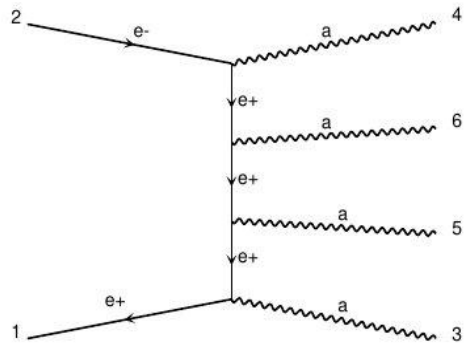


diagram 1 QCD=0, QED=4

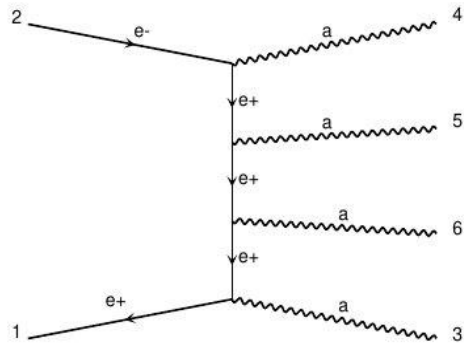


diagram 2 QCD=0, QED=4

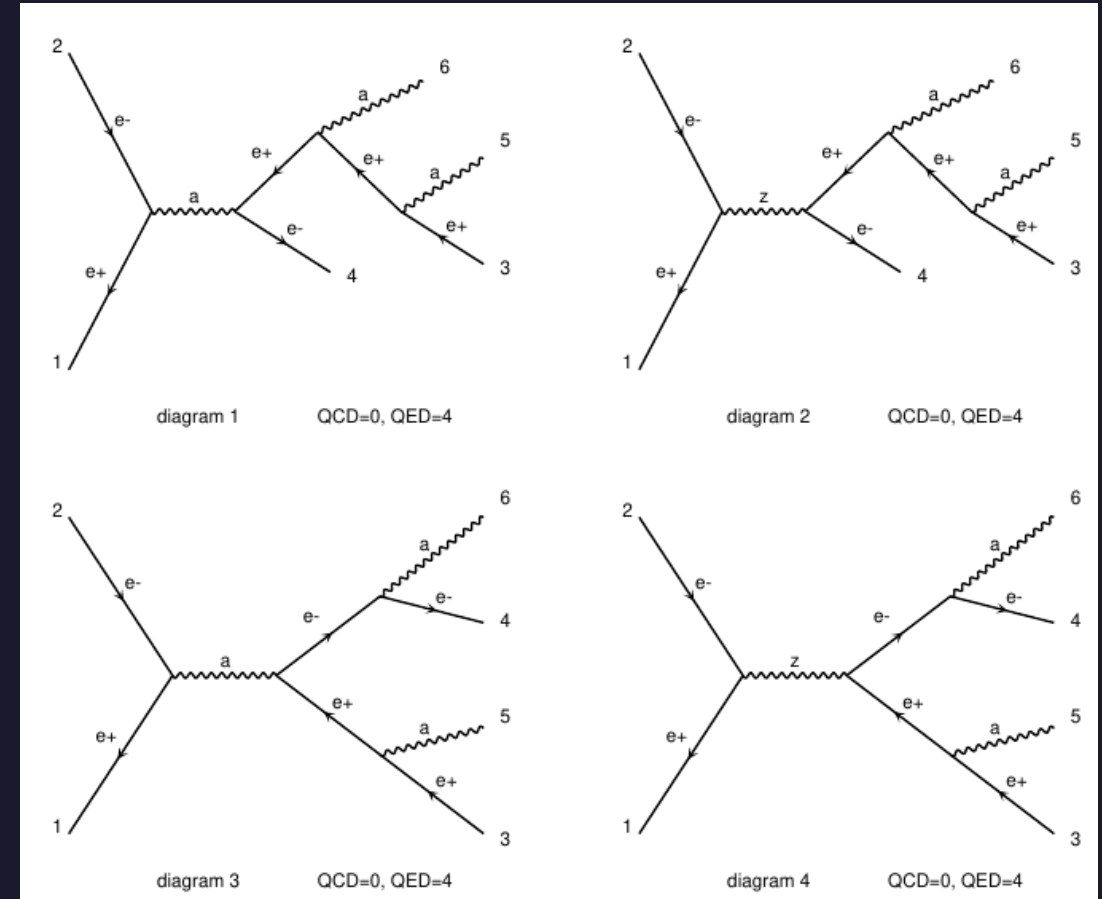
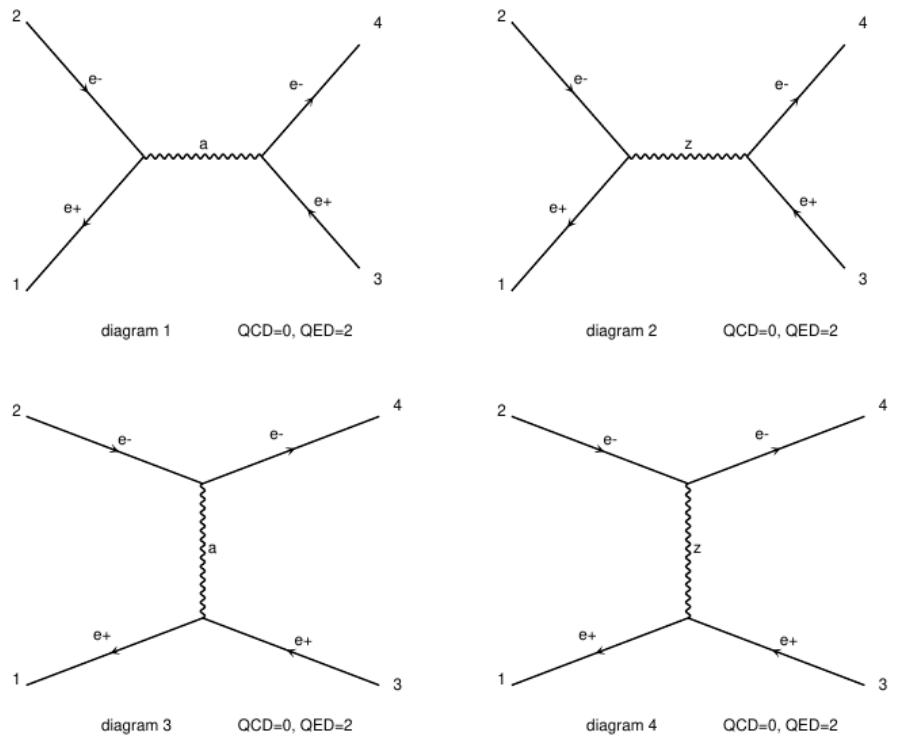
Backgrounds

Created background samples (1 Mio events each):

$ee \rightarrow ee$: $\rightarrow 1\,000\,000$ events
 4500 ± 0.2189 pb

$ee \rightarrow eeaa$: $\rightarrow 1\,000\,000$ events
 $0.09864 \pm 4.426e-05$ pb

$ee \rightarrow eeaaa$: $\rightarrow 1\,000\,000$ events
 $0.000111 \pm 4.238e-08$ pb



Backgrounds

...

How many signal samples to use when making the selections? 2 or 3?

--> $m = 1 \text{ GeV}$, $c_{YY} = ?$

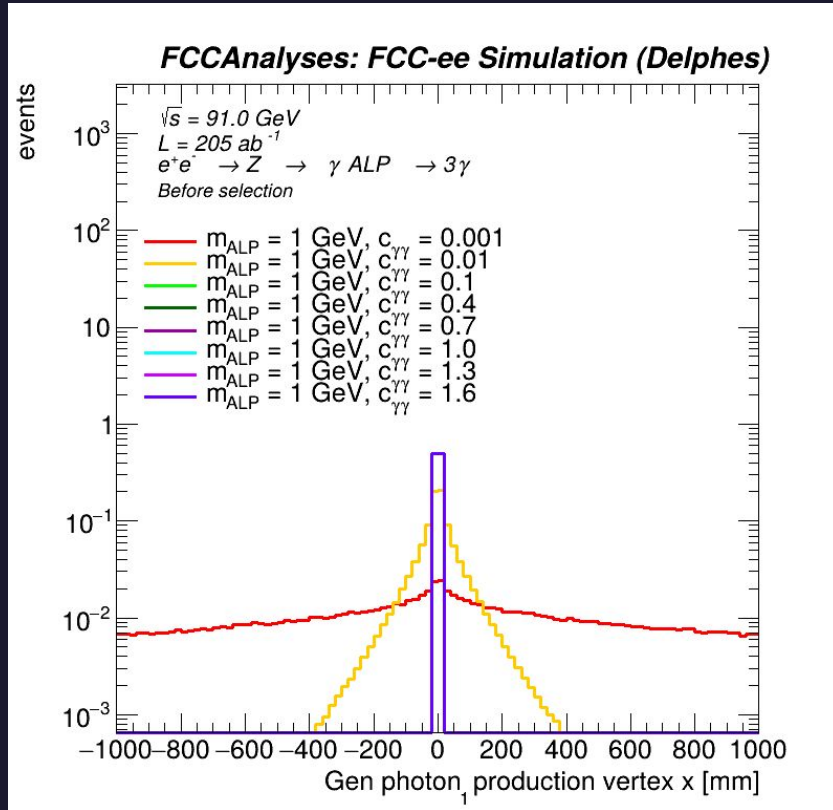
$m = 1 \text{ GeV}$, $c_{YY} = ?$

--> $m = ? \text{ GeV}$, $c_{YY} = 1.0$

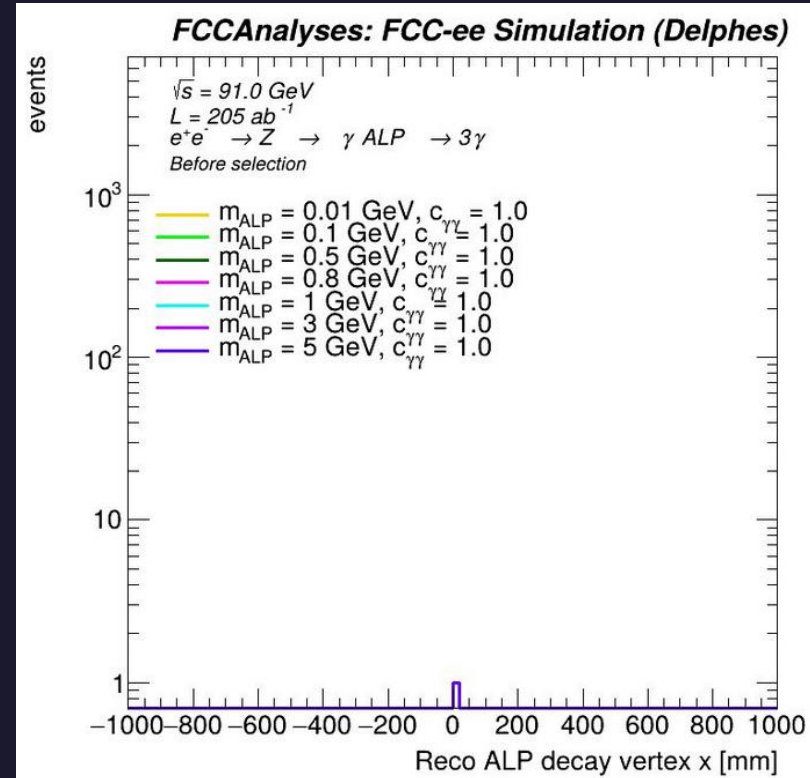
$m = ? \text{ GeV}$, $c_{YY} = 1.0$

Reco level photons?

Displaced vertex gen level and reco level



Coordinate of production of one of the ALP daughter photons

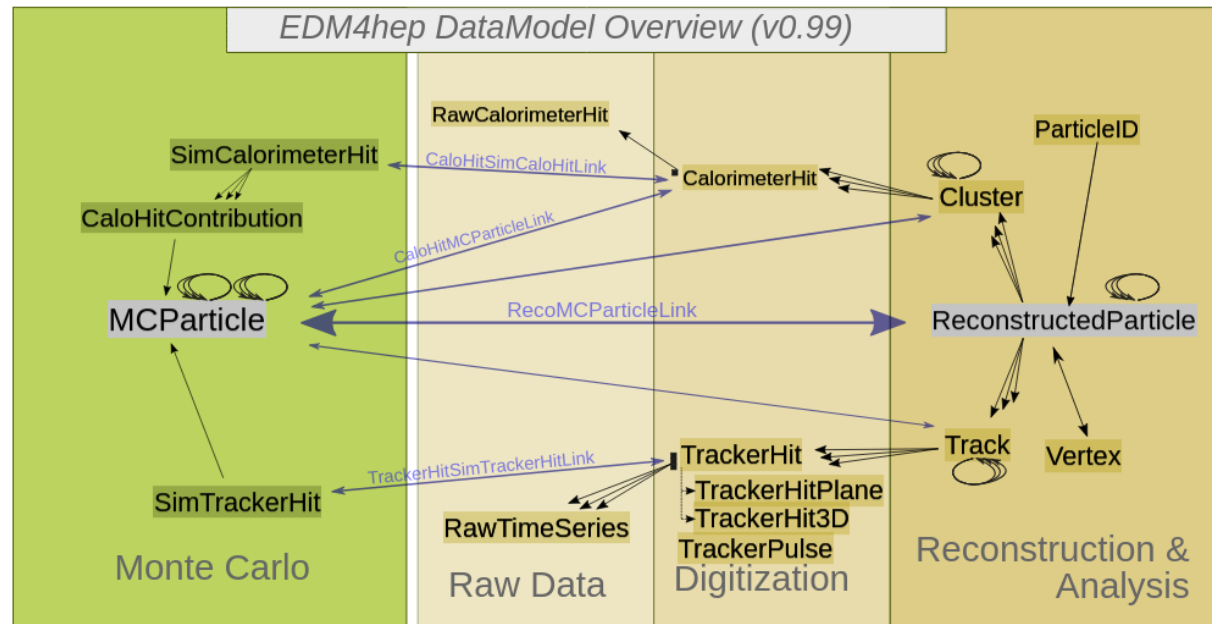


On reco level this is missing,
Photon reconstruction not possible (check cluster to MC link?)

Reco level photons?

EDM4hep

A generic event data model for future HEP collider experiments.



- No tracks
- Have to work with clusters

On reco level this is missing,
Photon reconstruction not possible (check cluster to MC link?)

Plots with background

Only test runs, scaling not fixed yet

