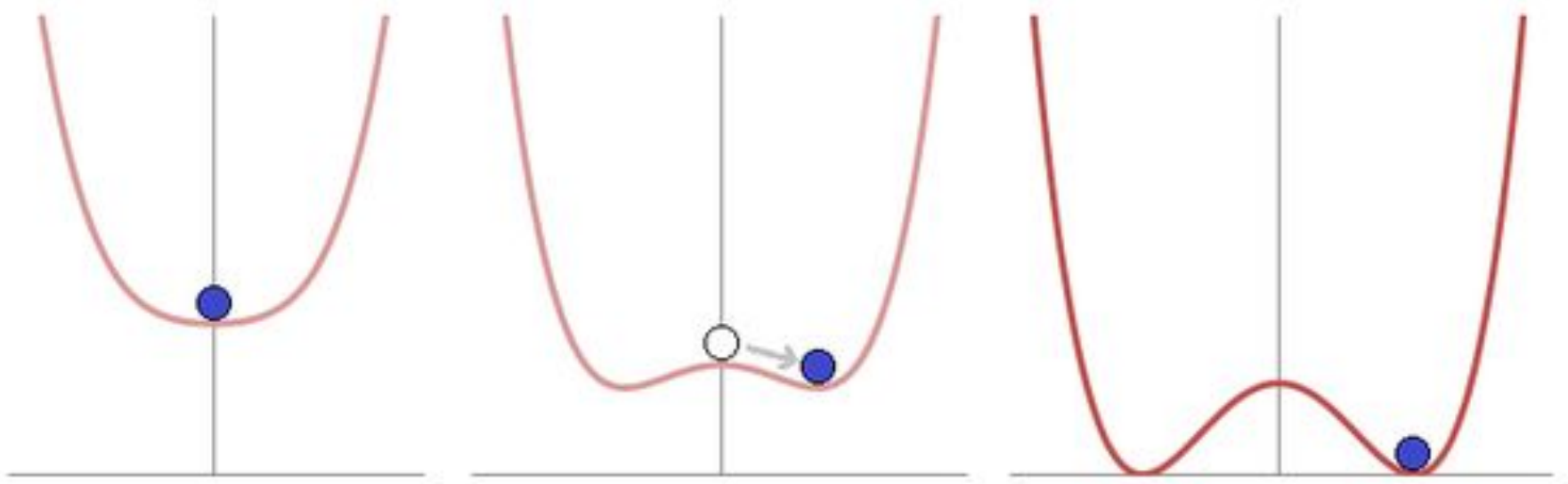
Higgs Physics at Future Colliders

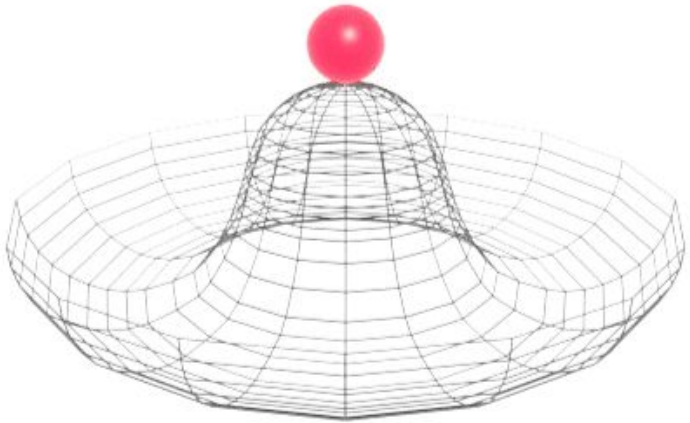
João Maria Santos; Maria Pessoa; Rafael Amado

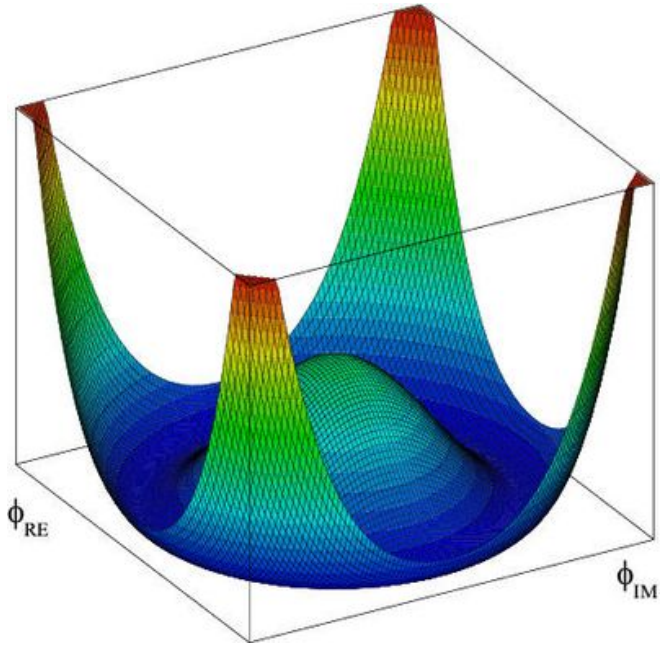
Introduction



Introduction

Breaking of eletro-weak symmetry





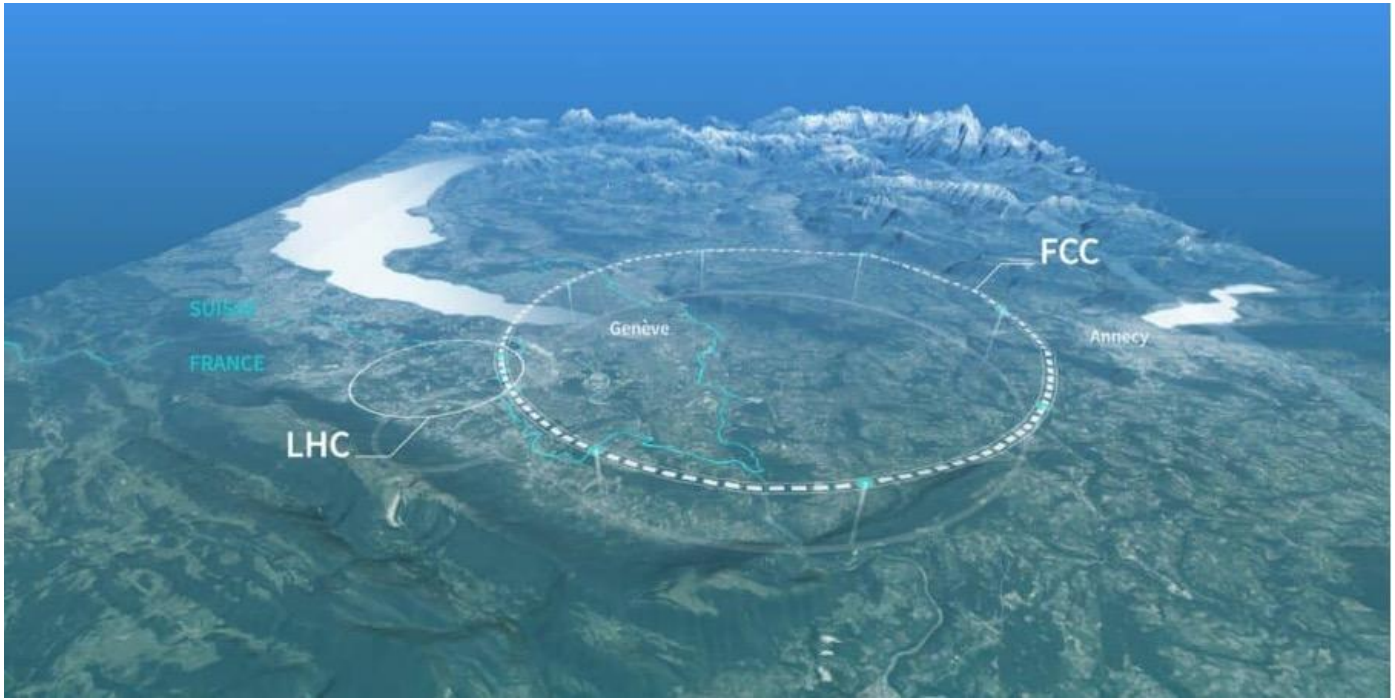
Introduction

$\mu^2 > 0$: parabolic potential (has only one position where the potential is minimal)

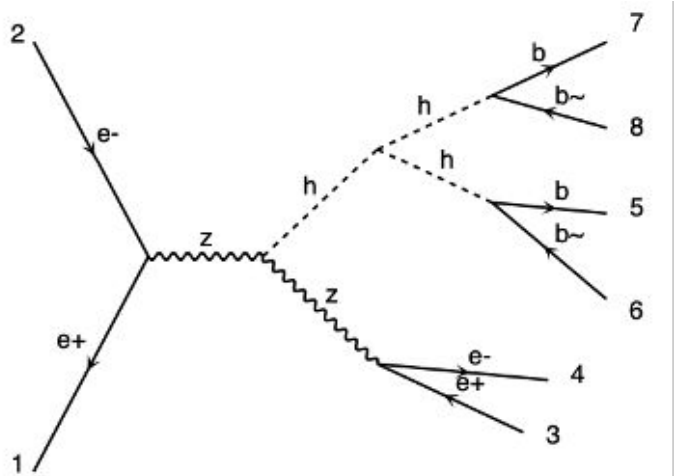
$\mu^2 < 0$: “mexican hat” potential (has various positions where the potential can have a minimal point)

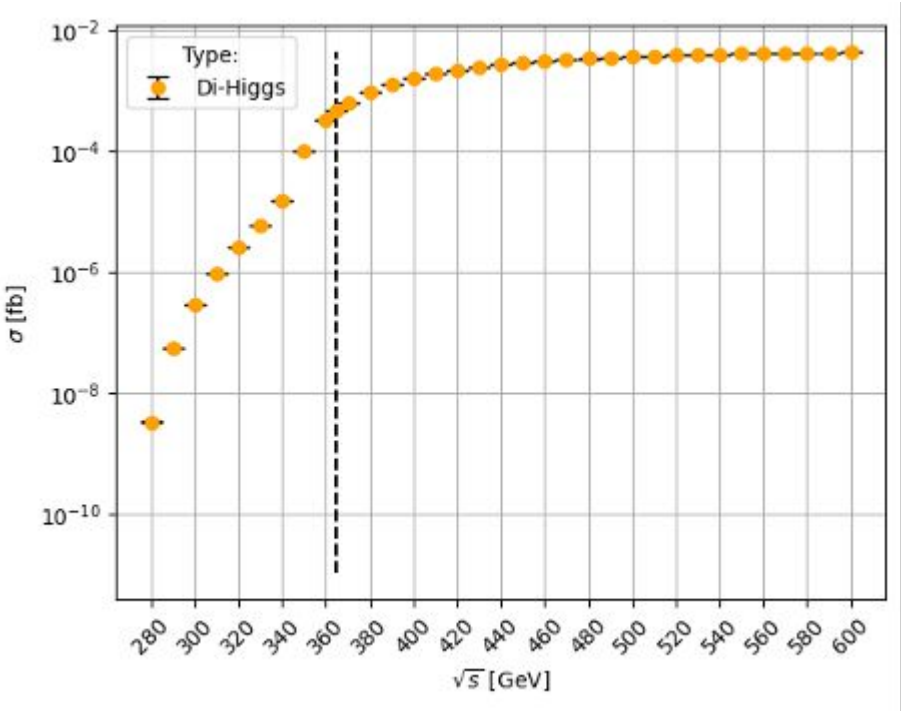
$$V(\phi) = \mu^2\phi^2 + \lambda\phi^4,$$

FCC - Future Circular Collider



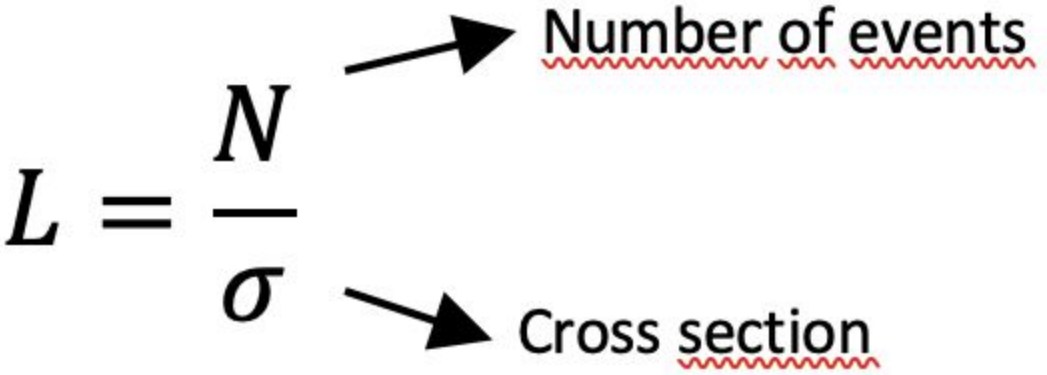
FCC - Future Circular Collider





[Credit: master's thesis of Francisco Casalinho, in preparation]

Luminosity



Diagrams

e+ e- > z> e+ e- h WEIGHTED=6

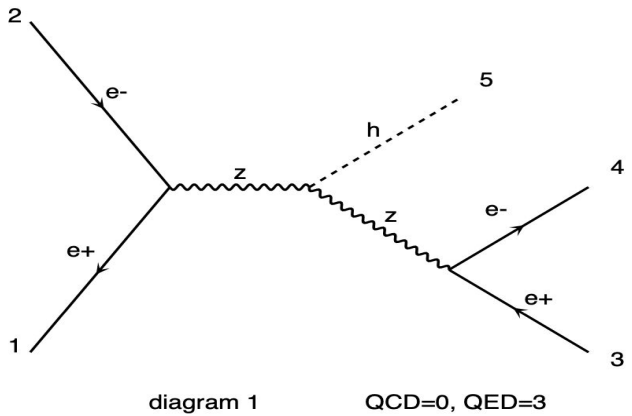


diagram 1 QCD=0, QED=3

e+ e- > e+ e- h WEIGHTED=6 $$ z

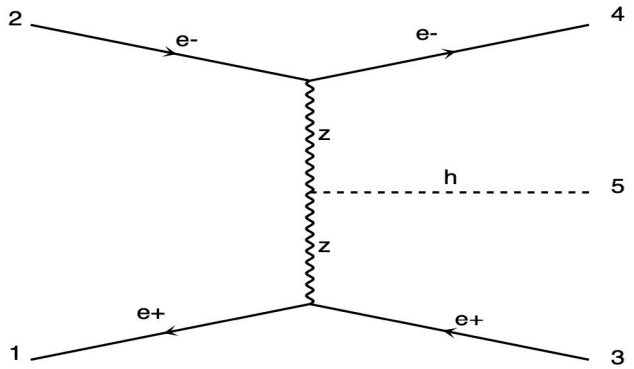
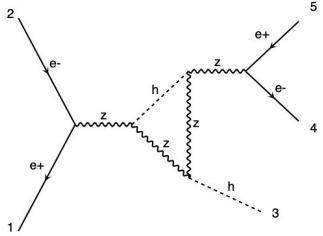
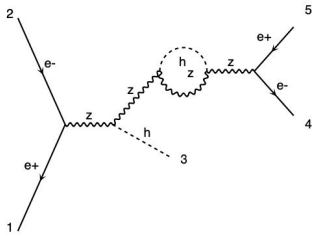


diagram 1 QCD=0, QED=3

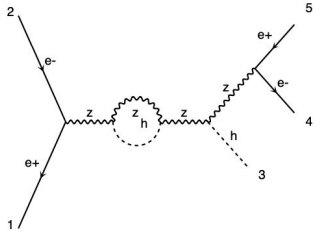
background: e+ e- > e+ e- b b~ / h



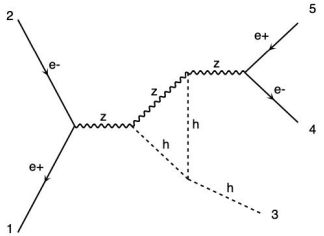
loop diagram 1 QCD=0, QED=5



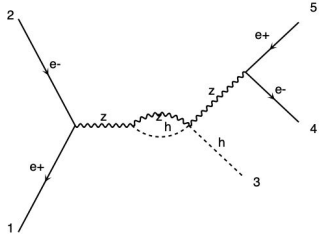
loop diagram 2 QCD=0, QED=5



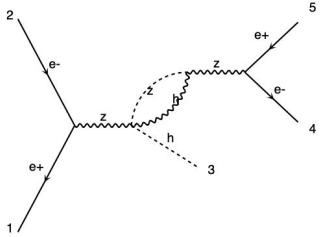
loop diagram 3 QCD=0, QED=5



loop diagram 4 QCD=0, QED=5

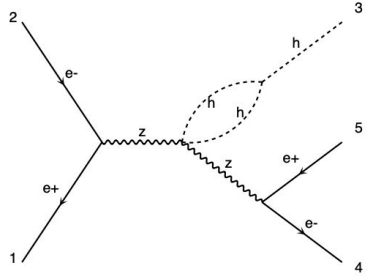


loop diagram 5 QCD=0, QED=5

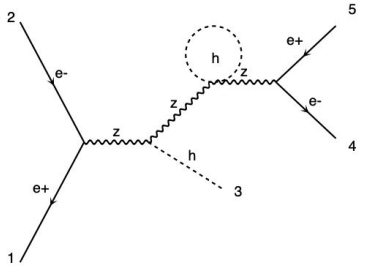


loop diagram 6 QCD=0, QED=5

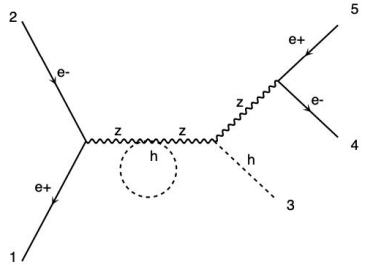
e+ e- > z> h e- e+ QED^2=8 QCD^2=0 [all= QCD QED] / g u c d s u c d s b b a e- mu- ve vm vt ta- t ghg gha g+ g0 g+ghgghz ghzghp ghwm w+



loop diagram 7 QCD=0, QED=5



loop diagram 8 QCD=0, QED=5



loop diagram 9 QCD=0, QED=5

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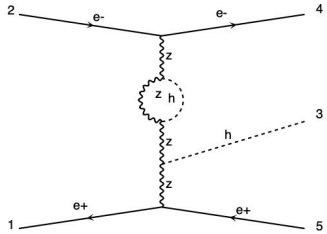

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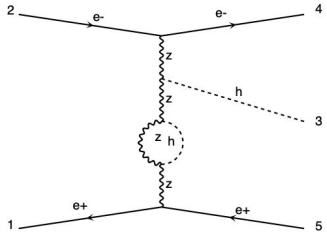

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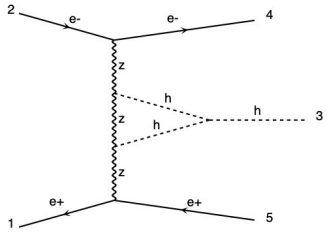

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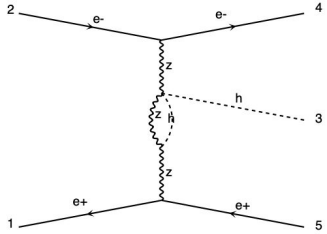

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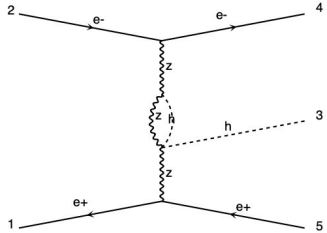

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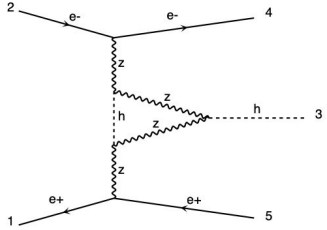

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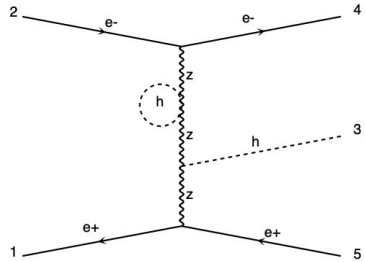

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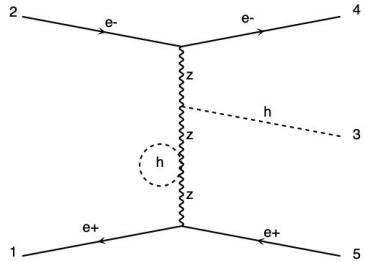

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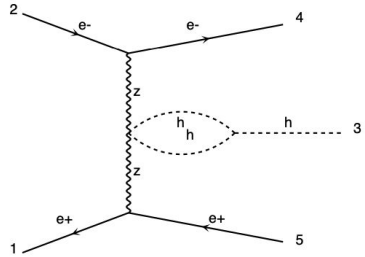
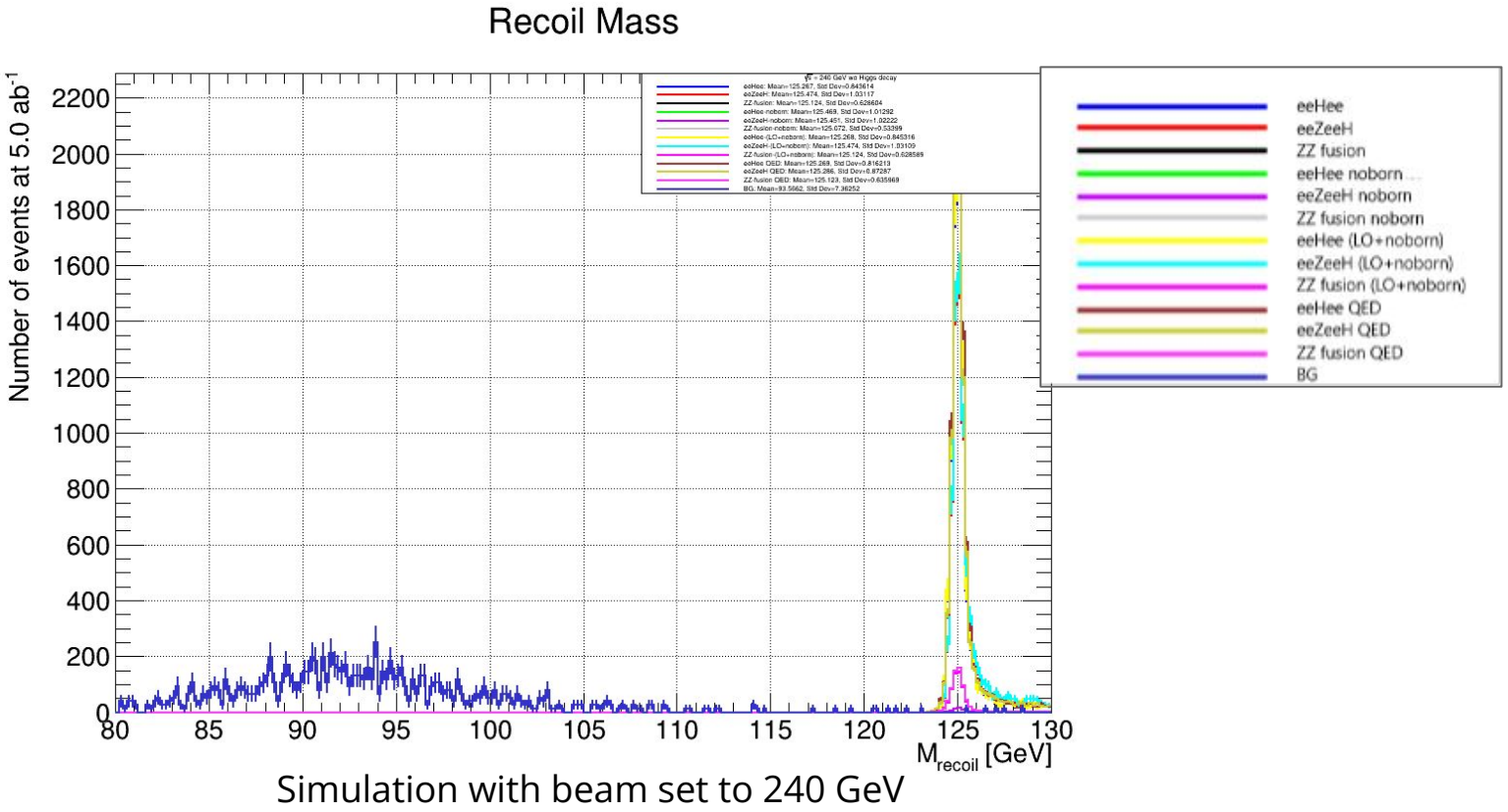


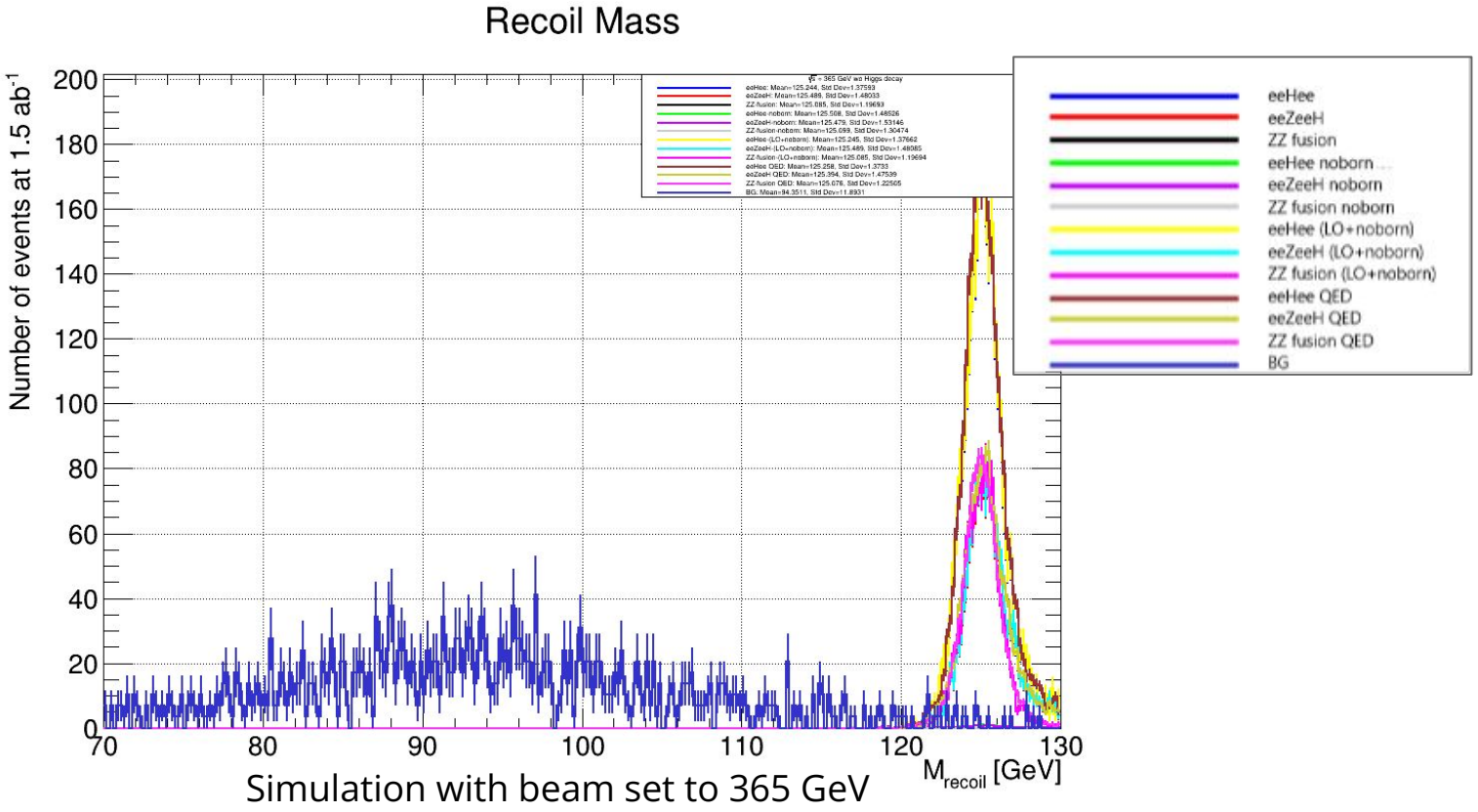
loop diagram 9 QCD=0, QED=5

Data Analysis



Simulation with beam set to 240 GeV

Data Analysis



Data Analysis

```
Lumi:
        eeHee LO: 1.27437e+06
        eeZeeH LO:1.34372e+06
        ZZ-fusion LO:2.02388e+07
        eeHee noborn: 1.48721e+08
        eeZeeH noborn:1.4892e+08
        ZZfusion noborn:1.24131e+11
        eeHee QED global: 5.88512e+06
        eeHee QED channel s: 6.27746e+06
        eeHee QED channel t: 8.59107e+07
        BG: 379651

Integral eeHee: 8290.36
Integral eeZeeH: 7397.35
Integral eeHee-z: 597.614
Integral eeHee_noborn: 67.6771
Integral eeZeeH_noborn: 68.9966
Integral eeeeH-z_noborn: 0.104043
Integral eeeeH_(LO+noborn): 8358.03
Integral eeZeeH_(LO+noborn): 7466.34
Integral eeeeH-z_(LO+noborn): 597.718
Integral eeeeH_QED: 9169.73
Integral eeZeeH_QED: 8534.5
Integral eeeeH-z_QED: 663.305
Integral BG: 10483.3

Integrals and errors:
        Signal
                eeHee LO: 9381.09 error: 191.851
                eeZeeH LO: 8997.38 error: 182.973
                eeHee-Z LO: 627.013 error: 12.446
                eeHee noborn: 82.5707 error: 1.66614
                eeZeeH noborn: 84.139 error: 1.68076
                eeHee-Z noborn: 0.105856 error: 0.00206491
                eeHee (LO+noborn): 9463.66 error: 191.858
                eeZeeH (LO+noborn): 9081.52 error: 182.981
                eeHee-Z (LO+noborn): 627.119 error: 12.446
                eeHee QED: 10282.7 error: 93.4676
                eeZeeH QED: 9636.06 error: 87.6078
                eeHee-Z QED: 696.887 error: 6.36858
                BG: 11220.8 error: 384.42
```

Beam energy of 240 GeV

```
Lumi:
        eeHee LO: 1.47929e+06
        eeZeeH LO:2.63227e+06
        ZZ-fusion LO:3.75094e+06
        eeHee noborn: 2.52143e+08
        eeZeeH noborn:2.54001e+08
        ZZfusion noborn:3.07977e+10
        eeHee QED global: 6.54622e+06
        eeHee QED channel s: 1.24254e+07
        eeHee QED channel t: 1.52346e+07
        BG: 437828
Integral eeHee: 2448.81
Integral eeZeeH: 1194.41
Integral eeHee-z: 1074.93
Integral eeHee_noborn: 12.3323
Integral eeZeeH_noborn: 12.2421
Integral eeeeH-z_noborn: 0.128581
Integral eeeeH_(LO+noborn): 2461.14
Integral eeZeeH_(LO+noborn): 1206.65
Integral eeeeH-z_(LO+noborn): 1075.06
Integral eeeeH_QED: 2526.5
Integral eeZeeH_QED: 1296.17
Integral eeeeH-z_QED: 1116.73
Integral BG: 3059.42

Integrals and errors:
        Signal
                eeHee LO: 2860.49 error: 53.8567
                eeZeeH LO: 1629.77 error: 30.475
                eeHee-Z LO: 1115.32 error: 21.1191
                eeHee noborn: 16.8952 error: 0.317032
                eeZeeH noborn: 16.6004 error: 0.313103
                eeHee-Z noborn: 0.133695 error: 0.00255179
                eeHee (LO+noborn): 2877.39 error: 53.8576
                eeZeeH (LO+noborn): 1646.37 error: 30.4766
                eeHee-Z (LO+noborn): 1115.45 error: 21.1191
                eeHee QED: 2971.26 error: 26.0928
                eeZeeH QED: 1700.94 error: 14.3296
                eeHee-Z QED: 1158.97 error: 10.6823
                BG: 3504.8 error: 109.578
```

Beam energy of 365 GeV

Conclusion

$$contribuition = \frac{N^{(NLO)} - N^{(LO)}}{N^{(NLO)}} * 100$$

- for 240 GeV: contribution = 8.8 %
- for 365 GeV: contribution = 3.7 %

Conclusion

$$\Delta N = \sqrt{N} \Leftrightarrow \frac{\Delta N}{N} = \frac{1}{\sqrt{N}}$$

- for 240 GeV: $\sqrt{N} = \frac{1}{0.088} \Leftrightarrow N = 129$
- for 365 GeV: $\sqrt{N} = \frac{1}{0.037} \Leftrightarrow N = 730$

Conclusion

$$L = \frac{N}{\sigma}$$

Integrated Luminosity:

- for 240 GeV = 5.0 /ab
- for 365 GeV =1.5 /ab

Questions?