Two Higgs Doublets Model — *physics setup*

$$\Phi_1 = \begin{pmatrix} -i(\cos\beta W_f^+ - \sin\beta H^+) \\ v_1 + \frac{1}{\sqrt{2}}((\cos\alpha H - \sin\alpha h) + i(\cos\beta Z_f - \sin\beta H_3)) \end{pmatrix}$$
$$\Phi_2 = \begin{pmatrix} -i(\sin\beta W_f^+ + \cos\beta H^+) \\ v_2 + \frac{1}{\sqrt{2}}((\sin\alpha H + \cos\alpha h) + i(\sin\beta Z_f + \cos\beta H_3)) \end{pmatrix}$$

$$\begin{aligned} V &= -\mu_1^2\Phi_1\Phi_1^* - \mu_2^2\Phi_2\Phi_2^* - \mu_{12}^2(\Phi_1^*\Phi_2 + \Phi_1\Phi_2^*) \\ &\quad +\lambda_1(\Phi_1\Phi_1^*)^2 + \lambda_2(\Phi_2\Phi_2^*)^2 \\ &\quad +\lambda_3(\Phi_1\Phi_1^*)(\Phi_2\Phi_2^*) + \lambda_4(\Phi_1\Phi_2^*)(\Phi_1^*\Phi_2) \\ &\quad +\lambda_5[(\Phi_1\Phi_2^*)(\Phi_1\Phi_2^*) + (\Phi_1^*\Phi_2)(\Phi_1^*\Phi_2)] \end{aligned}$$

$$\begin{aligned} \mu_1^2 &= -\mu_{12}^2\tan\beta + 2\lambda_1 v_1^2 + (\lambda_3+\lambda_4+\lambda_5)v_2^2 \\ \mu_2^2 &= -\mu_{12}^2\mathrm{ctn}\beta + 2\lambda_2 v_2^2 + (\lambda_3+\lambda_4+\lambda_5)v_1^2 \end{aligned}$$

$$\begin{aligned} \lambda_1 &= \frac{-\mu_{12}^2\tan\beta + M_h^2\sin^2\alpha + M_H^2\cos^2\beta}{4v_1^2} \\ \lambda_2 &= \frac{-\mu_{12}^2\mathrm{ctn}\beta + M_h^2\cos^2\alpha + M_H^2\sin^2\beta}{4v_2^2} \\ \lambda_3 &= -\frac{\mu_{12}^2}{2v_1v_2} + \frac{M_{H^\pm}^2}{v^2} + \frac{M_H^2 - M_h^2}{4v_1v_2} \\ \lambda_4 &= \frac{\mu_{12}^2}{2v_1v_2} + \frac{M_{H_3}^2 - 2M_{H^\pm}^2}{2v^2} \\ \lambda_5 &= \frac{\mu_{12}^2}{2v_1v_2} - \frac{M_{H_3}^2}{2v^2} \end{aligned}$$

Two Higgs Doublets Model — *LanHEP program*

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scalar h/h:     ('Light Higgs',   mass Mh = 160,  width wh = 1.461),
        H/H:     ('Heavy higgs',   mass MHH = 210, width wHh = 1.0),
        H3/H3:   ('3rd Higgs',     mass MH3 = 220, width wH3 =1.0),
       'H+'/'H-':('Charged Higgs', mass MHc = 205, width wHc = 1.0).

let     vvev=Sqrt2*MW*SW/EE.
parameter sb=0.8:'Sinus beta',   cb=Sqrt(1-sb**2):'Cosine beta'.
let     vev1=vvev*cb, vev2=vvev*sb.
parameter sa=-0.5:'Sinus alpha', ca=Sqrt(1-sa**2):'Cosine alpha'.

let ph1 = { -i*(cb*'W+.f'-sb*'H+'),
        vev(vev1)+((ca*H-sa*h)+i*(cb*'Z.f'-sb*H3))/Sqrt2 },
    Ph1 = {  i*(cb*'W-.f'-sb*'H-'),
        vev(vev1)+((ca*H-sa*h)-i*(cb*'Z.f'-sb*H3))/Sqrt2 }.

let ph2 = { -i*(sb*'W+.f'+cb*'H+'),
        vev(vev2)+((sa*H+ca*h)+i*(cb*H3+sb*'Z.f'))/Sqrt2 },
    Ph2 = {  i*(sb*'W-.f'+cb*'H-'),
        vev(vev2)+((sa*H+ca*h)-i*(cb*H3+sb*'Z.f'))/Sqrt2 }.

let l1 =-m12*sb/cb**3/4/vvev**2
           +(Mh**2*sa**2+MHH**2*ca**2)/vvev**2/cb**2/4.
let l2 =-m12*cb/sb**3/4/vvev**2
           +(Mh**2*ca**2+MHH**2*sa**2)/vvev**2/sb**2/4.
let l3 =-m12/cb/sb/vvev**2/2
           +MHc**2/vvev**2-sa*ca*(Mh**2-MHH**2)/vvev**2/cb/sb/2.
let l5 = m12/cb/sb/vvev**2/2-MH3**2/vvev**2/2.
let l4 = m12/cb/sb/vvev**2/2+(MH3**2-2*MHc**2)/vvev**2/2.
let m1=-m12*sb/cb+2*ll1*vev1**2+(l3+l4+l5)*vev2**2.
let m2=-m12*cb/sb+2*ll2*vev2**2+(l3+l4+l5)*vev1**2.

lterm  m1*Ph1*ph1+m2*Ph2*ph2+m12*(Ph1*ph2+ph1*Ph2).
lterm -l1*(Ph1*ph1)**2.
lterm -l2*(Ph2*ph2)**2.
lterm -l3*(Ph1*ph1*Ph2*ph2).
lterm -l4*(Ph1*ph2*Ph2*ph1).
lterm -l5*(Ph1*ph2*Ph1*ph2+Ph2*ph1*Ph2*ph1)/2.
```

Fields in the vertex	Variational derivative of Lagrangian by fields
$H \quad H \quad H$	$-3\frac{e}{M_W s_w {s_{2\beta}}^2}(({s_\beta {c_\alpha}^3 + c_\beta {s_\alpha}^3}) s_{2\beta} {M_H}^2 - 2 {s_{\alpha-\beta}}^2 s_{\beta+\alpha} \mu_{12}^2)$
$H \quad H \quad h$	$-\frac{1}{2}\frac{e s_{\alpha-\beta}}{M_W s_w {s_{2\beta}}^2}(2{M_H}^2 s_{2\alpha} s_{2\beta} + {M_h}^2 s_{2\alpha} s_{2\beta} - 12 c_\alpha \mu_{12}^2 s_\alpha - 4 c_\beta \mu_{12}^2 s_\beta)$
$H \quad H^+ \quad H^-$	$-\frac{e}{M_W s_w {s_{2\beta}}^2}(({s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3}) s_{2\beta} {M_H}^2 - 2 s_{\beta+\alpha} \mu_{12}^2 + c_{\beta-\alpha} {s_{2\beta}}^2 {M_{H^\pm}}^2)$
$H \quad H^+ \quad W_F^-$	$-\frac{1}{2}\frac{e s_{\alpha-\beta}}{M_W s_w}({M_H}^2 - {M_{H^\pm}}^2)$
$H \quad H^- \quad W_F^+$	$-\frac{1}{2}\frac{e s_{\alpha-\beta}}{M_W s_w}({M_H}^2 - {M_{H^\pm}}^2)$
$H \quad H_3 \quad H_3$	$-\frac{e}{M_W s_w {s_{2\beta}}^2}(({s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3}) s_{2\beta} {M_H}^2 - 2 s_{\beta+\alpha} \mu_{12}^2 + c_{\beta-\alpha} {s_{2\beta}}^2 {M_{H_3}}^2)$
$H \quad H_3 \quad Z_F$	$-\frac{1}{2}\frac{e s_{\alpha-\beta}}{M_W s_w}({M_H}^2 - {M_{H_3}}^2)$
$H \quad W_F^+ \quad W_F^-$	$-\frac{1}{2}\frac{e {M_H}^2 c_{\beta-\alpha}}{M_W s_w}$
$H \quad Z_F \quad Z_F$	$-\frac{1}{2}\frac{e {M_H}^2 c_{\beta-\alpha}}{M_W s_w}$
$H \quad h \quad h$	$-\frac{1}{2}\frac{e c_{\beta-\alpha}}{M_W s_w {s_{2\beta}}^2}({M_H}^2 s_{2\alpha} s_{2\beta} + 2{M_h}^2 s_{2\alpha} s_{2\beta} - 12 c_\alpha \mu_{12}^2 s_\alpha + 4 c_\beta \mu_{12}^2 s_\beta)$
$H^+ \quad H^- \quad h$	$-\frac{e}{M_W s_w {s_{2\beta}}^2}(({c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3}) s_{2\beta} {M_h}^2 - 2 c_{\beta+\alpha} \mu_{12}^2 - {s_{2\beta}}^2 s_{\alpha-\beta} {M_{H^\pm}}^2)$
$H^+ \quad H_3 \quad W_F^-$	$-\frac{1}{2}\frac{ie}{M_W s_w}({M_{H^\pm}}^2 - {M_{H_3}}^2)$
$H^+ \quad W_F^- \quad h$	$-\frac{1}{2}\frac{e c_{\beta-\alpha}}{M_W s_w}({M_h}^2 - {M_{H^\pm}}^2)$
$H^- \quad H_3 \quad W_F^+$	$\frac{1}{2}\frac{ie}{M_W s_w}({M_{H^\pm}}^2 - {M_{H_3}}^2)$
$H^- \quad W_F^+ \quad h$	$-\frac{1}{2}\frac{e c_{\beta-\alpha}}{M_W s_w}({M_h}^2 - {M_{H^\pm}}^2)$
$H_3 \quad H_3 \quad h$	$-\frac{e}{M_W s_w {s_{2\beta}}^2}(({c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3}) s_{2\beta} {M_h}^2 - 2 c_{\beta+\alpha} \mu_{12}^2 - {s_{2\beta}}^2 s_{\alpha-\beta} {M_{H_3}}^2)$
$H_3 \quad Z_F \quad h$	$-\frac{1}{2}\frac{e c_{\beta-\alpha}}{M_W s_w}({M_h}^2 - {M_{H_3}}^2)$
$W_F^+ \quad W_F^- \quad h$	$\frac{1}{2}\frac{e {M_h}^2 s_{\alpha-\beta}}{M_W s_w}$
$Z_F \quad Z_F \quad h$	$\frac{1}{2}\frac{e {M_h}^2 s_{\alpha-\beta}}{M_W s_w}$
$h \quad h \quad h$	$-3\frac{e}{M_W s_w {s_{2\beta}}^2}(({c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3}) s_{2\beta} {M_h}^2 - 2 {c_{\beta-\alpha}}^2 c_{\beta+\alpha} \mu_{12}^2)$
$H \quad H \quad H \quad H$	$-\frac{3}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(4({s_\beta {c_\alpha}^3 + c_\beta {s_\alpha}^3})^2 s_{2\beta} {M_H}^2 + {s_{2\alpha}}^2 s_{2\beta} {s_{\alpha-\beta}}^2 {M_h}^2$ $-8 {s_{\alpha-\beta}}^2 {s_{\beta+\alpha}}^2 \mu_{12}^2)$
$H \quad H \quad H \quad h$	$-\frac{3}{4}\frac{e^2 s_{2\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(2({s_\beta {c_\alpha}^3 + c_\beta {s_\alpha}^3}) {M_H}^2 s_{2\beta} + {M_h}^2 c_{\beta-\alpha} s_{2\alpha} s_{2\beta}$ $-4\mu_{12}^2 s_{\beta+\alpha})$
$H \quad H \quad H^+ \quad H^-$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(s_{2\alpha} {s_{2\beta}}^2 {M_H}^2 + 3 s_{2\beta} {s_{\alpha-\beta}}^2 {s_{\beta+\alpha}}^2 {M_H}^2 + s_{2\beta} {s_{\alpha-\beta}}^4 {M_H}^2$ $+2({c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3}) s_{2\alpha} s_{2\beta} s_{\alpha-\beta} {M_h}^2 - 4 {c_{2\beta}}^2 {s_{\alpha-\beta}}^2 \mu_{12}^2 - 4 {s_{\beta+\alpha}}^2 \mu_{12}^2 + 2 {c_{\beta-\alpha}}^2 {s_{2\beta}}^3 {M_{H^\pm}}^2)$

Fields in the vertex	Variational derivative of Lagrangian by fields
$H \quad H \quad H^+ \quad W_F^-$	$-\frac{1}{4}\frac{e^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}(2({s_\beta}{c_\alpha}^3+{c_\beta}{s_\alpha}^3){M_H}^2 s_{2\beta}+{M_h}^2 c_{\beta-\alpha}s_{2\alpha}s_{2\beta}$ $-4c_{2\beta}\mu_{12}^2 s_{\alpha-\beta}-2{M_{H^\pm}}^2 c_{\beta-\alpha}{s_{2\beta}}^2)$
$H \quad H \quad H^- \quad W_F^+$	$-\frac{1}{4}\frac{e^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}(2({s_\beta}{c_\alpha}^3+{c_\beta}{s_\alpha}^3){M_H}^2 s_{2\beta}+{M_h}^2 c_{\beta-\alpha}s_{2\alpha}s_{2\beta}$ $-4c_{2\beta}\mu_{12}^2 s_{\alpha-\beta}-2{M_{H^\pm}}^2 c_{\beta-\alpha}{s_{2\beta}}^2)$
$H \quad H \quad H_3 \quad H_3$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}({s_{2\alpha}}{s_{2\beta}}^2{M_H}^2+3{s_{2\beta}}{s_{\alpha-\beta}}^2{s_{\beta+\alpha}}^2{M_H}^2+{s_{2\beta}}{s_{\alpha-\beta}}^4{M_H}^2$ $+2({c_\alpha}{c_\beta}^3+{s_\alpha}{s_\beta}^3)s_{2\alpha}s_{2\beta}s_{\alpha-\beta}{M_h}^2-4{c_{2\beta}}^2{s_{\alpha-\beta}}^2\mu_{12}^2-4{s_{\beta+\alpha}}^2\mu_{12}^2+2{c_{\beta-\alpha}}^2{s_{2\beta}}^3{M_{H_3}}^2)$
$H \quad H \quad H_3 \quad Z_F$	$-\frac{1}{4}\frac{e^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}(2({s_\beta}{c_\alpha}^3+{c_\beta}{s_\alpha}^3){M_H}^2 s_{2\beta}+{M_h}^2 c_{\beta-\alpha}s_{2\alpha}s_{2\beta}$ $-4c_{2\beta}\mu_{12}^2 s_{\alpha-\beta}-2{M_{H_3}}^2 c_{\beta-\alpha}{s_{2\beta}}^2)$
$H \quad H \quad W_F^+ \quad W_F^-$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 s_{2\beta}}(2({s_\beta}{c_\alpha}^3+{c_\beta}{s_\alpha}^3)c_{\beta-\alpha}{M_H}^2-{s_{2\alpha}}{s_{\alpha-\beta}}^2{M_h}^2-4{s_{\alpha-\beta}}^2\mu_{12}^2$ $+2{s_{2\beta}}{s_{\alpha-\beta}}^2{M_{H^\pm}}^2)$
$H \quad H \quad Z_F \quad Z_F$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 s_{2\beta}}(2({s_\beta}{c_\alpha}^3+{c_\beta}{s_\alpha}^3)c_{\beta-\alpha}{M_H}^2-{s_{2\alpha}}{s_{\alpha-\beta}}^2{M_h}^2-4{s_{\alpha-\beta}}^2\mu_{12}^2$ $+2{s_{2\beta}}{s_{\alpha-\beta}}^2{M_{H_3}}^2)$
$H \quad H \quad h \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(3{s_{2\alpha}}^2{s_{2\beta}}{s_{\alpha-\beta}}^2{M_H}^2+{s_{2\alpha}}{s_{2\beta}}^2{M_H}^2-3{s_{2\alpha}}^2{s_{2\beta}}{s_{\alpha-\beta}}^2{M_h}^2$ $+4c_{\beta+\alpha}s_{2\alpha}s_{2\beta}s_{\alpha-\beta}{M_h}^2+2c_{\beta-\alpha}s_{2\alpha}s_{2\beta}s_{\beta+\alpha}{M_h}^2-24{c_\alpha}^2{s_\alpha}^2\mu_{12}^2$ $+8{c_\beta}^2{s_\beta}^2\mu_{12}^2)$
$H \quad H^+ \quad H^- \quad h$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(({s_\alpha}{c_\beta}^3+{c_\alpha}{s_\beta}^3)s_{2\alpha}s_{2\beta}s_{\alpha-\beta}{M_H}^2+({c_\alpha}{c_\beta}^3+{s_\alpha}{s_\beta}^3)c_{\beta-\alpha}s_{2\alpha}s_{2\beta}{M_h}^2$ $-4c_{2\beta}s_{2\alpha}\mu_{12}^2+2c_{\beta-\alpha}{s_{2\beta}}^2 s_{\alpha-\beta}\mu_{12}^2-c_{\beta-\alpha}{s_{2\beta}}^3 s_{\alpha-\beta}{M_{H^\pm}}^2)$
$H \quad H^+ \quad H_3 \quad W_F^-$	$-\frac{1}{4}\frac{ie^2 c_{\beta-\alpha}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2-{M_{H_3}}^2)$
$H \quad H^+ \quad W_F^- \quad Z_F$	$\frac{1}{4}\frac{ie^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2-{M_{H_3}}^2)$
$H \quad H^+ \quad W_F^- \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}({s_{2\alpha}}{s_{2\beta}}{s_{\alpha-\beta}}^2{M_H}^2+{c_{\beta-\alpha}}^2{s_{2\alpha}}{s_{2\beta}}{M_h}^2-4c_{2\beta}c_{\beta-\alpha}s_{\alpha-\beta}\mu_{12}^2$ $-c_{2\alpha}c_{2\beta}{s_{2\beta}}^2{M_{H^\pm}}^2-4c_\alpha c_\beta {s_{2\beta}}^2 s_\alpha s_\beta {M_{H^\pm}}^2)$
$H \quad H^- \quad H_3 \quad W_F^+$	$\frac{1}{4}\frac{ie^2 c_{\beta-\alpha}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2-{M_{H_3}}^2)$
$H \quad H^- \quad W_F^+ \quad Z_F$	$-\frac{1}{4}\frac{ie^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2-{M_{H_3}}^2)$
$H \quad H^- \quad W_F^+ \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}({s_{2\alpha}}{s_{2\beta}}{s_{\alpha-\beta}}^2{M_H}^2+{c_{\beta-\alpha}}^2{s_{2\alpha}}{s_{2\beta}}{M_h}^2-4c_{2\beta}c_{\beta-\alpha}s_{\alpha-\beta}\mu_{12}^2$ $-c_{2\alpha}c_{2\beta}{s_{2\beta}}^2{M_{H^\pm}}^2-4c_\alpha c_\beta {s_{2\beta}}^2 s_\alpha s_\beta {M_{H^\pm}}^2)$

Fields in the vertex	Variational derivative of Lagrangian by fields
$H \quad H_3 \quad H_3 \quad h$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\alpha} s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\alpha} s_{2\beta} {M_h}^2$ $-4 c_{2\beta} s_{2\alpha} \mu_{12}^2 + 2 c_{\beta-\alpha} {s_{2\beta}}^2 s_{\alpha-\beta} \mu_{12}^2 - c_{\beta-\alpha} {s_{2\beta}}^3 s_{\alpha-\beta} {M_{H_3}}^2)$
$H \quad H_3 \quad Z_F \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}(s_{2\alpha} s_{2\beta} {s_{\alpha-\beta}}^2 {M_H}^2 + {c_{\beta-\alpha}}^2 s_{2\alpha} s_{2\beta} {M_h}^2 - 4 c_{2\beta} c_{\beta-\alpha} s_{\alpha-\beta} \mu_{12}^2$ $-c_{2\alpha} c_{2\beta} {s_{2\beta}}^2 {M_{H_3}}^2 - 4 c_\alpha c_\beta {s_{2\beta}}^2 s_\alpha s_\beta {M_{H_3}}^2)$
$H \quad W_F^+ \quad W_F^- \quad h$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2 s_{2\beta}}(M_H{}^2 s_{2\alpha} - {M_h}^2 s_{2\alpha} - 4\mu_{12}^2 + 2 {M_{H^\pm}}^2 s_{2\beta})$
$H \quad Z_F \quad Z_F \quad h$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2 s_{2\beta}}(M_H{}^2 s_{2\alpha} - {M_h}^2 s_{2\alpha} - 4\mu_{12}^2 + 2 {M_{H_3}}^2 s_{2\beta})$
$H \quad h \quad h \quad h$	$-\frac{3}{4}\frac{e^2 c_{\beta-\alpha} s_{2\alpha}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(M_H{}^2 s_{2\alpha} s_{2\beta} s_{\alpha-\beta} + 2(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3) {M_h}^2 s_{2\beta}$ $-4 c_{\beta+\alpha} \mu_{12}^2)$
$H^+ \quad H^+ \quad H^- \quad H^-$	$-2\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3)^2 s_{2\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3)^2 s_{2\beta} {M_h}^2$ $-2 {c_{2\beta}}^2 \mu_{12}^2)$
$H^+ \quad H^+ \quad H^- \quad W_F^-$	$-\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\beta} {M_h}^2$ $-2 c_{2\beta} \mu_{12}^2)$
$H^+ \quad H^+ \quad W_F^- \quad W_F^-$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2}({s_{\alpha-\beta}}^2 {M_H}^2 + {c_{\beta-\alpha}}^2 {M_h}^2 - {M_{H_3}}^2)$
$H^+ \quad H^- \quad H^- \quad W_F^+$	$-\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\beta} {M_h}^2$ $-2 c_{2\beta} \mu_{12}^2)$
$H^+ \quad H^- \quad H_3 \quad H_3$	$-\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3)^2 s_{2\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3)^2 s_{2\beta} {M_h}^2$ $-2 {c_{2\beta}}^2 \mu_{12}^2)$
$H^+ \quad H^- \quad H_3 \quad Z_F$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\beta} {M_h}^2$ $-2 c_{2\beta} \mu_{12}^2)$
$H^+ \quad H^- \quad W_F^+ \quad W_F^-$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 s_{2\beta}}(s_{2\alpha} {M_H}^2 + 2 s_{2\beta} {s_{\alpha-\beta}}^2 {M_H}^2 - 2 {c_{2\beta}}^2 c_\alpha s_\alpha {M_h}^2 + 4 {c_\beta}^3 s_\beta {M_h}^2$ $-4 c_{2\beta} c_\beta {s_\alpha}^2 s_\beta {M_h}^2 - 4\mu_{12}^2 + s_{2\beta} {M_{H_3}}^2)$
$H^+ \quad H^- \quad Z_F \quad Z_F$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 s_{2\beta}}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) c_{\beta-\alpha} {M_H}^2 - (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) s_{\alpha-\beta} {M_h}^2$ $-2\mu_{12}^2 + s_{2\beta} {M_{H^\pm}}^2)$
$H^+ \quad H^- \quad h \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(2(s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\alpha} s_{2\beta} {M_H}^2 + 4 c_{2\alpha} c_{2\beta} s_{2\beta} {M_h}^2$ $+3 s_{2\beta} {s_{\alpha-\beta}}^2 {s_{\beta+\alpha}}^2 {M_h}^2 + s_{2\beta} {s_{\alpha-\beta}}^4 {M_h}^2 - 2 {s_{2\beta}}^2 {s_{\alpha-\beta}}^2 \mu_{12}^2 - 8(c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3)^2 \mu_{12}^2$ $+2 {s_{2\beta}}^3 {s_{\alpha-\beta}}^2 {M_{H^\pm}}^2)$

Fields in the vertex	Variational derivative of Lagrangian by fields
$H^+ \quad H_3 \quad H_3 \quad W_F^-$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\beta} {M_h}^2$ $-2 c_{2\beta} \mu_{12}^2)$
$H^+ \quad H_3 \quad W_F^- \quad Z_F$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2}({s_{\alpha-\beta}}^2 {M_H}^2 + {c_{\beta-\alpha}}^2 {M_h}^2 - {M_{H^\pm}}^2)$
$H^+ \quad H_3 \quad W_F^- \quad h$	$\frac{1}{4}\frac{ie^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2 - {M_{H_3}}^2)$
$H^+ \quad W_F^+ \quad W_F^- \quad W_F^-$	$-\frac{1}{2}\frac{e^2 c_{\beta-\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_H}^2 - {M_h}^2)$
$H^+ \quad W_F^- \quad Z_F \quad Z_F$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_H}^2 - {M_h}^2)$
$H^+ \quad W_F^- \quad Z_F \quad h$	$\frac{1}{4}\frac{ie^2 c_{\beta-\alpha}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2 - {M_{H_3}}^2)$
$H^+ \quad W_F^- \quad h \quad h$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}({M_H}^2 s_{2\alpha} s_{2\beta} s_{\alpha-\beta} + 2(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3) {M_h}^2 s_{2\beta}$ $-4 c_{2\beta} c_{\beta-\alpha} \mu_{12}^2 + 2 {M_{H^\pm}}^2 {s_{2\beta}}^2 s_{\alpha-\beta})$
$H^- \quad H^- \quad W_F^+ \quad W_F^+$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2}({s_{\alpha-\beta}}^2 {M_H}^2 + {c_{\beta-\alpha}}^2 {M_h}^2 - {M_{H_3}}^2)$
$H^- \quad H_3 \quad H_3 \quad W_F^+$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\beta} {M_h}^2$ $-2 c_{2\beta} \mu_{12}^2)$
$H^- \quad H_3 \quad W_F^+ \quad Z_F$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2}({s_{\alpha-\beta}}^2 {M_H}^2 + {c_{\beta-\alpha}}^2 {M_h}^2 - {M_{H^\pm}}^2)$
$H^- \quad H_3 \quad W_F^+ \quad h$	$-\frac{1}{4}\frac{ie^2 s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2 - {M_{H_3}}^2)$
$H^- \quad W_F^+ \quad W_F^+ \quad W_F^-$	$-\frac{1}{2}\frac{e^2 c_{\beta-\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_H}^2 - {M_h}^2)$
$H^- \quad W_F^+ \quad Z_F \quad Z_F$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha} s_{\alpha-\beta}}{{M_W}^2 {s_w}^2}({M_H}^2 - {M_h}^2)$
$H^- \quad W_F^+ \quad Z_F \quad h$	$-\frac{1}{4}\frac{ie^2 c_{\beta-\alpha}}{{M_W}^2 {s_w}^2}({M_{H^\pm}}^2 - {M_{H_3}}^2)$
$H^- \quad W_F^+ \quad h \quad h$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha}}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}({M_H}^2 s_{2\alpha} s_{2\beta} s_{\alpha-\beta} + 2(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3) {M_h}^2 s_{2\beta}$ $-4 c_{2\beta} c_{\beta-\alpha} \mu_{12}^2 + 2 {M_{H^\pm}}^2 {s_{2\beta}}^2 s_{\alpha-\beta})$
$H_3 \quad H_3 \quad H_3 \quad H_3$	$-3\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3)^2 s_{2\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3)^2 s_{2\beta} {M_h}^2$ $-2 {c_{2\beta}}^2 \mu_{12}^2)$
$H_3 \quad H_3 \quad H_3 \quad Z_F$	$-\frac{3}{2}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^2}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) s_{2\beta} s_{\alpha-\beta} {M_H}^2 + (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) c_{\beta-\alpha} s_{2\beta} {M_h}^2$ $-2 c_{2\beta} \mu_{12}^2)$
$H_3 \quad H_3 \quad W_F^+ \quad W_F^-$	$-\frac{1}{2}\frac{e^2}{{M_W}^2 {s_w}^2 s_{2\beta}}((s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3) c_{\beta-\alpha} {M_H}^2 - (c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3) s_{\alpha-\beta} {M_h}^2$ $-2\mu_{12}^2 + s_{2\beta} {M_{H^\pm}}^2)$

Fields in the vertex	Variational derivative of Lagrangian by fields
$H_3 \quad H_3 \quad Z_F \quad Z_F$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 s_{2\beta}}(s_{2\alpha}{M_H}^2 + 3s_{2\beta}{s_{\alpha-\beta}}^2{M_H}^2 - 3s_{2\beta}{s_{\alpha-\beta}}^2{M_h}^2 - 4c_{\beta+\alpha}s_{\alpha-\beta}{M_h}^2$ $+2c_{\beta-\alpha}s_{\beta+\alpha}{M_h}^2 - 4\mu_{12}^2)$
$H_3 \quad H_3 \quad h \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2 {s_w}^2 {s_{2\beta}}^3}(2(s_\alpha {c_\beta}^3 + c_\alpha {s_\beta}^3)c_{\beta-\alpha}s_{2\alpha}s_{2\beta}{M_H}^2 + 4c_{2\alpha}c_{2\beta}s_{2\beta}{M_h}^2$ $+3s_{2\beta}{s_{\alpha-\beta}}^2{s_{\beta+\alpha}}^2{M_h}^2 + s_{2\beta}{s_{\alpha-\beta}}^4{M_h}^2 - 2{s_{2\beta}}^2{s_{\alpha-\beta}}^2\mu_{12}^2 - 8(c_\alpha {c_\beta}^3 + s_\alpha {s_\beta}^3)^2\mu_{12}^2$ $+2{s_{2\beta}}^3{s_{\alpha-\beta}}^2{M_{H_3}}^2)$
$H_3 \quad W_F^+ \quad W_F^- \quad Z_F$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha}s_{\alpha-\beta}}{{M_W}^2{s_w}^2}({M_H}^2 - {M_h}^2)$
$H_3 \quad Z_F \quad Z_F \quad Z_F$	$-\frac{3}{4}\frac{e^2 c_{\beta-\alpha}s_{\alpha-\beta}}{{M_W}^2{s_w}^2}({M_H}^2 - {M_h}^2)$
$H_3 \quad Z_F \quad h \quad h$	$-\frac{1}{4}\frac{e^2 c_{\beta-\alpha}}{{M_W}^2{s_w}^2{s_{2\beta}}^2}({M_H}^2 s_{2\alpha}s_{2\beta}s_{\alpha-\beta} + 2(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3){M_h}^2 s_{2\beta}$ $-4c_{2\beta}c_{\beta-\alpha}\mu_{12}^2 + 2{M_{H_3}}^2{s_{2\beta}}^2 s_{\alpha-\beta})$
$W_F^+ \quad W_F^+ \quad W_F^- \quad W_F^-$	$-\frac{1}{2}\frac{e^2}{{M_W}^2{s_w}^2}({c_{\beta-\alpha}}^2{M_H}^2 + {s_{\alpha-\beta}}^2{M_h}^2)$
$W_F^+ \quad W_F^- \quad Z_F \quad Z_F$	$-\frac{1}{4}\frac{e^2}{{M_W}^2{s_w}^2}({c_{\beta-\alpha}}^2{M_H}^2 + {s_{\alpha-\beta}}^2{M_h}^2)$
$W_F^+ \quad W_F^- \quad h \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2{s_w}^2 s_{2\beta}}({c_{\beta-\alpha}}^2 s_{2\alpha}{M_H}^2 - 2(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3)s_{\alpha-\beta}{M_h}^2 - 4{c_{\beta-\alpha}}^2\mu_{12}^2$ $+2{c_{\beta-\alpha}}^2 s_{2\beta}{M_{H^\pm}}^2)$
$Z_F \quad Z_F \quad Z_F \quad Z_F$	$-\frac{3}{4}\frac{e^2}{{M_W}^2{s_w}^2}({c_{\beta-\alpha}}^2{M_H}^2 + {s_{\alpha-\beta}}^2{M_h}^2)$
$Z_F \quad Z_F \quad h \quad h$	$-\frac{1}{4}\frac{e^2}{{M_W}^2{s_w}^2 s_{2\beta}}({c_{\beta-\alpha}}^2 s_{2\alpha}{M_H}^2 - 2(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3)s_{\alpha-\beta}{M_h}^2 - 4{c_{\beta-\alpha}}^2\mu_{12}^2$ $+2{c_{\beta-\alpha}}^2 s_{2\beta}{M_{H_3}}^2)$
$h \quad h \quad h \quad h$	$-\frac{3}{4}\frac{e^2}{{M_W}^2{s_w}^2{s_{2\beta}}^3}({c_{\beta-\alpha}}^2{s_{2\alpha}}^2 s_{2\beta}{M_H}^2 + 4(c_\beta {c_\alpha}^3 + s_\beta {s_\alpha}^3)^2 s_{2\beta}{M_h}^2$ $-8{c_{\beta-\alpha}}^2{c_{\beta+\alpha}}^2\mu_{12}^2)$