Neutrino corrections to '12' terms

$$[C_{12}]^0_0 = [...] + \frac{f_\nu}{1575 b_1 s^2 t}\Bigg[-\frac{36}{7}s^2 t(-1+\mu^2)\left(15+10\beta_1+\beta_1^2(1+2\mu^2)\right) + 18 s^2\beta_1(5+\beta_1+2\beta_1\mu^2)\left(7\mu+7t^2\mu-2t(5+2\mu^2)\right)$$
$$+\frac{9}{7}\beta_1\left(7\mu+7t^2\mu-2t(3+4\mu^2)\right)\Big\{35+28\beta_1(2+\mu^2)+9\beta_1^2(1+4\mu^2)-2t\mu\left(35+84\beta_1+9\beta_1^2(3+2\mu^2)\right)$$
$$+t^2\left(35+28\beta_1(2+\mu^2)+9\beta_1^2(1+4\mu^2)\right)\Big\}+\frac{9}{49}t\beta_1\left(-34+49\left(\frac{1}{t}+t\right)\mu-64\mu^2\right)\Big\{35+14\beta_1(2+\mu^2)+3\beta_1^2(1+4\mu^2)$$
$$+t^2\left(35+14\beta_1(2+\mu^2)+3\beta_1^2(1+4\mu^2)\right)-2t\mu\left(35+42\beta_1+\beta_1^2(9+6\mu^2)\right)\Big\}+2s^2\beta_1\Bigg[-63t\gamma_2(5+\beta_1+2\beta_1\mu^2)$$
$$+3b_1\Big\{\mu\left(105+378\beta_1+20\beta_1^3(3+4\mu^2)+27\beta_1^2(11+4\mu^2)\right)+t^2\mu\left(105+378\beta_1+20\beta_1^3(3+4\mu^2)+27\beta_1^2(11+4\mu^2)\right)$$
$$-2t\left(105+81\beta_1^2(1+4\mu^2)+42\beta_1(5+4\mu^2)+4\beta_1^3(3+24\mu^2+8\mu^4)\right)\Big\}\Bigg]\Bigg] \tag{1}$$

$$[C_{12}]^0_2 = [..] + \frac{f_\nu\beta_1}{3465 b_1 s^2 t}\Bigg[-\frac{396}{49}s^2t(-1+\mu^2)(7+\beta_1+21\mu^2+11\beta_1\mu^2)+\frac{99}{7}\left(7\mu+7t^2\mu-2t(3+4\mu^2)\right)\Big\{14+3\beta_1^2(1+9\mu^2)$$
$$+\beta_1(26+22\mu^2)-2t\mu\left(14+6\beta_1(5+3\mu^2)+3\beta_1^2(3+7\mu^2)\right)+t^2\left(-7+21\mu^2+6\beta_1^2\mu^2(3+2\mu^2)+2\beta_1(-5+29\mu^2)\right)\Big\}$$
$$+\frac{99}{49}t\left(-34+49\left(\frac{1}{t}+t\right)\mu-64\mu^2\right)\Big\{14+\beta_1^2(1+9\mu^2)+\beta_1(13+11\mu^2)-2t\mu\left(14+3\beta_1(5+3\mu^2)+\beta_1^2(3+7\mu^2)\right)$$
$$+t^2\left(-7+21\mu^2+\beta_1(-5+29\mu^2)+\beta_1^2(6\mu^2+4\mu^4)\right)\Big\}+s^2\Bigg[\frac{99}{7}(7\mu+7t^2\mu-t(10+7\gamma_2+4\mu^2))(7+21\mu^2+\beta_1(2+22\mu^2))$$
$$+2b_1\Big\{6\mu\left(231+297\beta_1(3+\mu^2)+99\beta_1^2(8+7\mu^2)+10\beta_1^3(15+41\mu^2)\right)$$
$$+6t^2\mu\left(231+594\beta_1(1+\mu^2)+297\beta_1^2(1+4\mu^2)+20\beta_1^3(3+19\mu^2+6\mu^4)\right)$$
$$-3t\left(231(1+3\mu^2)+132\beta_1(5+31\mu^2)+297\beta_1^2(1+15\mu^2+4\mu^4)+16\beta_1^3(3+69\mu^2+68\mu^4)\right)\Big\}\Bigg]\Bigg] \tag{2}$$

$$[C_{12}]^1_2 = [...] + f_\nu\Bigg[\frac{\sqrt{\frac{2}{3}}\beta_1\sqrt{1-\mu^2}}{105 b_1 s^2}\Big\{\frac{36}{49}s^2(7+3\beta_1)\mu(-1+\mu^2)+\frac{3}{245}\left(-34+49\left(\frac{1}{t}+t\right)\mu-64\mu^2\right)\left(-5\beta_1(9+5\beta_1)\mu\right.$$
$$\left.+15t\left(7+6\beta_1(1+\mu^2)+\beta_1^2(1+4\mu^2)\right)-5t^2\mu\left(21+27\beta_1+\beta_1^2(6+4\mu^2)\right)\right)\Big\}+\frac{1}{1155 b_1 s^2 t}\sqrt{\frac{2}{3}}\beta_1\sqrt{1-\mu^2}\Big\{-3b_1 s^2\Big(231$$
$$+198\beta_1(3+2\mu^2)+60\beta_1^3(1+6\mu^2)+33\beta_1^2(11+24\mu^2)-2t\mu\left(231+1188\beta_1+80\beta_1^3(3+4\mu^2)+99\beta_1^2(11+4\mu^2)\right)$$
$$+t^2\left(231+363\beta_1^2(1+4\mu^2)+198\beta_1(3+4\mu^2)+20\beta_1^3(3+24\mu^2+8\mu^4)\right)\Big)$$
$$+11t\Big(9s^2(7+6\beta_1)\mu\left(\gamma_2+\frac{1}{7}\left(10-\frac{7\mu}{t}-7t\mu+4\mu^2\right)\right)+\frac{1}{7}\left(6-\frac{7\mu}{t}-7t\mu+8\mu^2\right)\Big(9\beta_1(6+5\beta_1)\mu$$
$$-9t\left(7+12\beta_1(1+\mu^2)+3\beta_1^2(1+4\mu^2)\right)+9t^2\mu\left(7+18\beta_1+\beta_1^2(6+4\mu^2)\right)\Big)\Big)\Big\}\Bigg] \tag{3}$$

$$[C_{12}]^2_2 = [...] + f_\nu\Bigg[\frac{\beta_1(-1+\mu^2)}{105\sqrt{6}b_1 s^2}\Big\{\frac{36}{49}s^2(7+\beta_1)(-1+\mu^2)$$
$$+\frac{3}{245}\left(-34+49\left(\frac{1}{t}+t\right)\mu-64\mu^2\right)\left(-5\beta_1(3+\beta_1)+30t\beta_1(3+\beta_1)\mu-5t^2\left(21+21\beta_1+\beta_1^2(2+4\mu^2)\right)\right)\Big\}$$
$$+\frac{1}{1155\sqrt{6}b_1 s^2 t}\beta_1(-1+\mu^2)\Big\{-2b_1 s^2\Big[18\beta_1(33+33\beta_1+10\beta_1^2)\mu+12t^2\beta_1\mu(99+132\beta_1+10\beta_1^2(3+2\mu^2))$$
$$-9t\left(77+220\beta_1+16\beta_1^3(1+4\mu^2)+33\beta_1^2(3+4\mu^2)\right)\Big]+11t\Big[9s^2(7+2\beta_1)\gamma_2+\frac{9}{7}s^2(7+2\beta_1)\left(10-\frac{7\mu}{t}-7t\mu+4\mu^2\right)$$
$$+\frac{1}{7}\left(6-\frac{7\mu}{t}-7t\mu+8\mu^2\right)\Big\{9\beta_1(2+\beta_1)-54t\beta_1(2+\beta_1)\mu+9t^2\left(7+14\beta_1+\beta_1^2(2+4\mu^2)\right)\Big\}\Big]\Big\}\Bigg] \tag{4}$$

$$[C_{12}]_4^0 = [...] + \frac{3f_\nu\beta_1^2}{1226225b_1s^2t}\Bigg[1911t^4\mu\left(11(-1-18\mu^2+35\mu^4)+4\beta_1(-7-18\mu^2+65\mu^4)\right)$$
$$-26t^3\Big(12\beta_1(-140-1347\mu^2+3522\mu^4+1885\mu^6)+11(-59-1738\mu^2+3421\mu^4+3080\mu^6)\Big)$$
$$+196\mu\Big\{13(33+99\mu^2+8\beta_1(-2+17\mu^2))+s^2\Big(286(-1+3\mu^2)+4b_1\left(143(1+5\mu^2)+117\beta_1(1+14\mu^2)+30\beta_1^2(-3+31\mu^2)\right)\Big)\Big\}$$
$$+t^2\mu\Big\{143(-503+2430\mu^2+12185\mu^4)+52\beta_1(-5653+11890\mu^2+29043\mu^4)+98s^2\Big(572(-1+3\mu^2)$$
$$+b_1\left(2288(-2+5\mu^2)+60\beta_1^2(-37+34\mu^2+115\mu^4)+39\beta_1(-201+386\mu^2+175\mu^4)\right)\Big)\Big\}$$
$$-2t\Big\{832\beta_1(-20-6\mu^2+761\mu^4)+572(59+118\mu^2+999\mu^4)+s^2\Big(572(-1+3\mu^2)(68+49\gamma_2+30\mu^2)$$
$$+49b_1\left(286(-5+18\mu^2+35\mu^4)+117\beta_1(-37+82\mu^2+195\mu^4)+24\beta_1^2(-37-46\mu^2+643\mu^4)\right)\Big)\Big\}\Bigg] \tag{5}$$

$$[C_{12}]_4^1 = [...] + \frac{3f_\nu\beta_1^2\sqrt{1-\mu^2}}{245245\sqrt{5}b_1s^2t}\Bigg[-98b_1s^2\Big\{715(1+3\mu^2)+30\beta_1^2(5+79\mu^2)+39\beta_1(23+117\mu^2)$$
$$-2t\mu\left(286(5+7\mu^2)+120\beta_1^2(5+23\mu^2)+117\beta_1(23+37\mu^2)\right)+2t^2\Big(143(-1+15\mu^2)$$
$$+39\beta_1(-6+81\mu^2+35\mu^4)+30\beta_1^2(-1+27\mu^2+44\mu^4)\Big)\Big\}-13\Big\{196(33+22s^2+40\beta_1)\mu^2-t\mu\Big(6809 \tag{6}$$
$$+6988\beta_1+31999\mu^2+32212\beta_1\mu^2+88s^2(68+49\gamma_2+30\mu^2)\Big)+98t^4\mu^2\left(33(-1+7\mu^2)+4\beta_1(3+37\mu^2)\right)$$
$$+2t^2\left(649+308(40+7s^2)\mu^2+25839\mu^4+8\beta_1(30+1777\mu^2+2603\mu^4)\right)$$
$$-t^3\mu\left(11(-89+3505\mu^2+2464\mu^4)+4\beta_1(387+9041\mu^2+4292\mu^4)\right)\Big\}\Bigg]$$

$$[C_{12}]_4^2 = [...] + \frac{3\sqrt{2/5}f_\nu\beta_1^2(1-\mu^2)}{245245b_1s^2t}\Bigg[49\left(39(11+8\beta_1)+2s^2(143+6b_1(143+234\beta_1+90\beta_1^2))\right)\mu+637t^4\left(231\mu^3+4\beta_1\mu(5+31\mu^2)\right)$$
$$-52t^3\left(77\mu^2(61+44\mu^2)+2\beta_1(100+1647\mu^2+899\mu^4)\right)+t^2\mu\Big\{13\left(9405+7916\beta_1+22935\mu^2+14428\beta_1\mu^2\right)$$
$$+98s^2\Big(143+3b_1\left(572+20\beta_1^2(11+19\mu^2)+13\beta_1(61+35\mu^2)\right)\Big)\Big\}-2t\Big\{13\left(649+5819\mu^2+96\beta_1(5+44\mu^2)\right)$$
$$+s^2\left(143(68+49\gamma_2+30\mu^2)+49b_1\left(286(3+7\mu^2)+117\beta_1(11+31\mu^2)+24\beta_1^2(11+79\mu^2)\right)\right)\Big\}\Bigg] \tag{7}$$

$$[C_{12}]_4^3 = [...] + \frac{3f_\nu\beta_1^2(1-\mu^2)^{3/2}}{35035\sqrt{35}b_1s^2t}\Bigg[$$
$$-98b_1s^2\left(143+117\beta_1+30\beta_1^2-2t(286+351\beta_1+120\beta_1^2)\mu+t^2(286+60\beta_1^2(1+4\mu^2)+78\beta_1(4+5\mu^2))\right) \tag{8}$$
$$-13t(-1+2t\mu)\Big(147(11+4\beta_1)\mu+147t^2(11+4\beta_1)\mu-2t(649+968\mu^2+12\beta_1(20+29\mu^2))\Big)\Bigg]$$

$$[C_{12}]_4^4 = [...] + \frac{3f_\nu\beta_1^2(1-\mu^2)^2}{35035\sqrt{70}b_1s^2}\Big[98b_1s^2\left(-286+39\beta_1(-3+5t\mu)+12\beta_1^2(-2+5t\mu)\right) \tag{9}$$
$$+13t\left(49(33+4\beta_1)\mu+49t^2(33+4\beta_1)\mu-2t(649+80\beta_1+968\mu^2+116\beta_1\mu^2)\right)\Big]$$

$$[C_{12}]^0_6 = [...] + \frac{4f_\nu\beta_1^3}{282975b_1s^2t}\Bigg[1470t^4\mu(3-30\mu^2+35\mu^4) - 60t^3(60-1101\mu^2+810\mu^4+1015\mu^6)$$
$$+ 392\mu\left(-15+45\mu^2+b_1s^2(-90-78\beta_1+225\mu^2+190\beta_1\mu^2)\right) + t\Bigg\{ \tag{10}$$
$$- 960(-5-29\mu^2+83\mu^4) - 49b_1s^2\left[135(-1-18\mu^2+35\mu^4)+16\beta_1(-3-150\mu^2+265\mu^4)\right]\Bigg\}$$
$$+ t^2\mu\Bigg\{30(-1009-674\mu^2+4035\mu^4) + 49b_1s^2\left[135(-3-10\mu^2+21\mu^4)+8\beta_1(-15-230\mu^2+357\mu^4)\right]\Bigg\}\Bigg]$$

$$[C_{12}]^1_6 = [...] + +\frac{\sqrt{2/21}f_\nu\beta_1^3\sqrt{1-\mu^2}}{13475b_1s^2t}\Bigg[-40\Big(196\mu^2+98t^4\mu^2(-3+7\mu^2) - t\mu(13+967\mu^2) + 4t^2(-30+82\mu^2+389\mu^4)$$
$$+ t^3(387\mu-947\mu^3-812\mu^5)\Big) - 49b_1s^2\Big(12(5+4\beta_1)(-1+15\mu^2) - 8t\mu(-45-48\beta_1+315\mu^2+272\beta_1\mu^2) \tag{11}$$
$$+ 5t^2(-21-30\mu^2+315\mu^4+4\beta_1(-3-18\mu^2+77\mu^4))\Big)\Bigg]$$

$$[C_{12}]^2_6 = [...] - \frac{16f_\nu\beta_1^3(1-\mu^2)}{2695\sqrt{105}b_1s^2t}\Bigg[98(\mu+3b_1s^2(3+2\beta_1)\mu) + 98t^4\mu(-1+7\mu^2) - t\left(80+(704+147b_1s^2(21+16\beta_1))\mu^2\right)$$
$$- 4t^3(-20+258\mu^2+203\mu^4) + t^2\mu\left(480+1382\mu^2+49b_1s^2(3+5(9+8\beta_1)\mu^2)\right)\Bigg] \tag{12}$$

$$[C_{12}]^3_6 = [...] + \frac{f_\nu\beta_1^3(1-\mu^2)^{3/2}}{2695\sqrt{105}b_1s^2t}\Bigg[-49b_1s^2\Big(8(9+4\beta_1) - 16t(27+16\beta_1)\mu + t^2(27+20\beta_1)(1+15\mu^2)\Big) - 48t\Big(-49\mu+98t^3\mu^2$$
$$+ 4t(10+39\mu^2) - t^2\mu(129+116\mu^2)\Big)\Bigg] \tag{13}$$

$$[C_{12}]^4_6 = [...] + 2\sqrt{\frac{2}{7}}\frac{f_\nu\beta_1^3(1-\mu^2)^2}{13475b_1s^2}\Bigg[49b_1s^2(-45+75t\mu+8\beta_1(-2+5t\mu)) + 10t(49\mu+49t^2\mu-2t(20+29\mu^2))\Bigg] \tag{14}$$

$$[C_{12}]^5_6 = [...] - \frac{f_\nu t\beta_1^3(15+4\beta_1)(1-\mu^2)^{5/2}}{25\sqrt{77}} \tag{15}$$

$$[C_{12}]^0_8 = [...] + \frac{128f_\nu\beta_1^4}{10725t}\Big[4\mu(-3+5\mu^2) + t(-6+60\mu^2-70\mu^4) + t^2\mu(15-70\mu^2+63\mu^4)\Big] \tag{16}$$

$$[C_{12}]^1_8 = [...] - \frac{16f_\nu\beta_1^4\sqrt{2-2\mu^2}}{3575t}\Big[-6+30\mu^2-16t\mu(-3+7\mu^2)+5t^2(1-14\mu^2+21\mu^4)\Big] \tag{17}$$

$$[C_{12}]^2_8 = [...] - \frac{128f_\nu\beta_1^4(1-\mu^2)}{715\sqrt{35}t}\Big[3\mu+t(2-14\mu^2)+5t^2\mu(-1+3\mu^2)\Big] \tag{18}$$

$$[C_{12}]^3_8 = [...] - \frac{8\sqrt{\frac{2}{1155}}f_\nu\beta_1^4(1-\mu^2)^{3/2}}{65t}\left[4-32t\mu+5t^2(-1+9\mu^2)\right] \tag{19}$$

$$[C_{12}]^4_8 = [...] + \frac{32}{325}\sqrt{\frac{2}{77}}f_\nu\beta_1^4(-2+5t\mu)(1-\mu^2)^2 \tag{20}$$

$$[C_{12}]^5_8 = [...] - \frac{8}{25}\sqrt{\frac{2}{1001}}f_\nu t\beta_1^4(1-\mu^2)^{5/2} \tag{21}$$

Neutrino corrections to '23' terms

$$[C_{23}]_0^0 = [...] - \frac{f_\nu}{1575 b_1 s^4 t}\Bigg[63 s^2 t \beta_1 \gamma_2 \left(5+5s^2+2\beta_1+t^2(5+6\beta_1)-2t(5+6\beta_1)\mu+4\beta_1\mu^2\right)$$

$$+ 9\beta_1 \left(5+5s^2+2\beta_1+t^2(5+6\beta_1)-2t(5+6\beta_1)\mu+4\beta_1\mu^2\right)(7\mu+t(3-10\mu^2))$$

$$+ \frac{36}{7} t(-s^2+(t-\mu)^2)\left(5s^2(3+\beta_1)+\beta_1(5+\beta_1+t^2(5+3\beta_1)-2t(5+3\beta_1)\mu+2\beta_1\mu^2)\right)$$

$$- \frac{9}{49}\beta_1\left(s^2(15t-49\mu)+t(-15t^2+79t\mu-64\mu^2)\right)\Big\{7s^2(5+\beta_1+2\beta_1\mu^2)$$

$$+ \beta_1\left(-6t\mu(7+3\beta_1+2\beta_1\mu^2)+3(7+\beta_1+4\beta_1\mu^2)+t^2(7+3\beta_1+14\mu^2+12\beta_1\mu^2)\right)\Big\}$$

$$- \frac{9}{7}\beta_1(t-7\mu+6t\mu^2)\Big\{7s^2(5+\beta_1(2+4\mu^2))$$

$$+ \beta_1\left(42+9\beta_1+36\beta_1\mu^2-6t\mu(14+9\beta_1+6\beta_1\mu^2)+t^2(14+9\beta_1+28\mu^2+36\beta_1\mu^2)\right)\Big\}$$

$$+ 2b_1\beta_1\Big\{63s^4(5+6\beta_1)\mu+9s^2\left(5t^2(-7+9\beta_1^2)\mu-t\left(-35+28\beta_1(1+2\mu^2)+27\beta_1^2(1+4\mu^2)\right)+6\beta_1\mu\left(14+\beta_1(9+6\mu^2)\right)\right)$$

$$- 3\beta_1\Big[9t^4(14+15\beta_1)\mu-5\beta_1\mu\left(27+4\beta_1(3+4\mu^2)\right)-6t^2\mu\left(-63+10\beta_1^2(3+4\mu^2)\right)$$

$$+ 2t^3\left(-63(1+2\mu^2)-27\beta_1(1+4\mu^2)+10\beta_1^2(1+6\mu^2)\right)+6t\left(-21+9\beta_1(1+4\mu^2)+2\beta_1^2(3+24\mu^2+8\mu^4)\right)\Big]\Big\}\Bigg] \tag{22}$$

$$[C_{23}]_2^0 = [...] + \frac{f_\nu \beta_1}{169785 b_1 s^4 t}\Bigg[99 s^2(14+\beta_1+11\beta_1\mu^2)(s^2(15t-49\mu)+t(-15t^2+79t\mu-64\mu^2))$$

$$+ 396 t(s^2-(t-\mu)^2)\left(14+\beta_1+11\beta_1\mu^2+7s^2(-1+3\mu^2)+t^2(7+6\beta_1)(-1+3\mu^2)-2t\mu(14+3\beta_1+9\beta_1\mu^2)\right)$$

$$- 99\beta_1(s^2(-15t+49\mu)+t(15t^2-79t\mu+64\mu^2))\left(12+\beta_1+9\beta_1\mu^2+t^2(1+(11+6\beta_1)\mu^2+4\beta_1\mu^4)-2t\mu(12+\beta_1(3+7\mu^2))\right)$$

$$- 693\Big\{-2s^2(t-7\mu+6t\mu^2)(7+\beta_1+11\beta_1\mu^2)$$

$$+ 7s^2 t\gamma_2\left(7s^2(-1+3\mu^2)+t^2(7+12\beta_1)(-1+3\mu^2)-4t\mu(7+3\beta_1+9\beta_1\mu^2)+2(7+\beta_1+11\beta_1\mu^2)\right)$$

$$+ (7\mu+t(3-10\mu^2))\left(7s^2(-1+3\mu^2)+t^2(7+12\beta_1)(-1+3\mu^2)-4t\mu(7+3\beta_1+9\beta_1\mu^2)+2(7+\beta_1+11\beta_1\mu^2)\right)$$

$$- \beta_1(t-7\mu+6t\mu^2)\left(3(8+\beta_1+9\beta_1\mu^2)+2t^2(1+(11+9\beta_1)\mu^2+6\beta_1\mu^4)-6t\mu(8+\beta_1(3+7\mu^2))\right)\Big\}$$

$$- 98 b_1\Big\{198 s^4\mu(7+\beta_1(3+9\mu^2))$$

$$+ 66 s^2\left(3t^2\mu(-7+15\beta_1^2\mu^2)+9\beta_1\mu(8+\beta_1(3+7\mu^2))-3t(-7+9\beta_1^2\mu^2(3+2\mu^2)+\beta_1(2+22\mu^2))\right)$$

$$+ 6\beta_1\Big[-99t^4(\mu+(3+5\beta_1)\mu^3)+5\beta_1\mu(99+\beta_1(30+82\mu^2))+12t^2\mu(-99+5\beta_1^2(3+19\mu^2+6\mu^4))$$

$$+ t^3(198\beta_1\mu^2(3+2\mu^2)+99(1+11\mu^2)-10\beta_1^2(-1+21\mu^2+36\mu^4))-3t(-132+33\beta_1(1+9\mu^2)+4\beta_1^2(3+69\mu^2+68\mu^4))\Big]\Big\}\Bigg] \tag{23}$$

$$[C_{23}]^1_2 = [...] + \frac{\sqrt{2/3} f_\nu \beta_1 \sqrt{1-\mu^2}}{1155 b_1 s^4} \Bigg[$$
$$- \frac{11}{245t} \left(3\beta_1 \left(s^2(-15t+49\mu) + t(15t^2 - 79t\mu + 64\mu^2)\right) \left(-5(9s^2+5\beta_1)\mu + 15t(3+\beta_1+4\beta_1\mu^2) - 5t^2\mu(9+\beta_1(6+4\mu^2))\right)\right.$$
$$\left. - 36t(s^2-(t-\mu)^2)\left(-5(7s^2+3\beta_1)\mu - 5t^2(7+6\beta_1)\mu + 5t(7+\beta_1(3+6\mu^2))\right)\right) + \frac{1}{t}\Bigg\{ 99 b_1 s^4 (7 + 6\beta_1(1+2\mu^2))$$
$$+ 33 s^2 t \gamma_2 \left(3(7s^2+6\beta_1)\mu + 3t^2(7+12\beta_1)\mu - 3t(7+6\beta_1(1+2\mu^2))\right)$$
$$- \frac{99}{7}(-7\mu + t(-3+10\mu^2))\left((7s^2+6\beta_1)\mu + t^2(7+12\beta_1)\mu - t(7+6\beta_1(1+2\mu^2))\right)$$
$$- \frac{99}{7}\beta_1(t-7\mu+6t\mu^2)\left((6s^2+5\beta_1)\mu - 3t(2+\beta_1+4\beta_1\mu^2) + 2t^2\mu(3+\beta_1(3+2\mu^2))\right)$$
$$+ 99 b_1 s^2 \left(6\beta_1(2+\beta_1+4\beta_1\mu^2) - 12t\beta_1\mu(2+\beta_1(3+2\mu^2)) + t^2(-7+5\beta_1^2(1+4\mu^2))\right) + 9 b_1 \beta_1 \Big($$
$$- 11t^4(6+12\mu^2+5\beta_1(1+4\mu^2)) - 20t\beta_1\mu(11+4\beta_1(3+4\mu^2)) - 4t^3\mu(-99-22\beta_1(3+2\mu^2)+10\beta_1^2(3+4\mu^2))$$
$$\left. + 5\beta_1(11+4\beta_1(1+6\mu^2)) + 2t^2(-99+10\beta_1^2(3+24\mu^2+8\mu^4))\Big)\right\}\Bigg] \tag{24}$$

$$[C_{23}]^2_2 = [...] + \frac{f_\nu \beta_1(-1+\mu^2)}{18865\sqrt{6} b_1 s^4 t}\Bigg[132t(-s^2+(t-\mu)^2)\left(7s^2+\beta_1+t^2(7+6\beta_1) - 6t\beta_1\mu\right)$$
$$+ 77\left(21s^2+6\beta_1+3t^2(7+12\beta_1) - 36t\beta_1\mu\right)\left(7\mu + t(3-10\mu^2)\right)$$
$$+ 11\beta_1\left(s^2(-15t+49\mu) + t(15t^2-79t\mu+64\mu^2)\right)\left(3s^2+\beta_1 - 6t\beta_1\mu + t^2(3+2\beta_1+4\beta_1\mu^2)\right)$$
$$+ 77\Big\{ 7s^2 t\gamma_2\left(21s^2+6\beta_1+3t^2(7+12\beta_1) - 36t\beta_1\mu\right) - 3\beta_1(t-7\mu+6t\mu^2)\left(2s^2+\beta_1-6t\beta_1\mu+2t^2(1+\beta_1+2\beta_1\mu^2)\right)\Big\}$$
$$+ 588 b_1\beta_1\Big\{ 33s^4\mu + 10\beta_1^2\mu - 11t^4(3+5\beta_1)\mu + 20t^2\beta_1^2\mu(3+2\mu^2) - t\beta_1\left(11+12\beta_1(1+4\mu^2)\right)$$
$$\left. + t^3\left(33+22\beta_1(1+2\mu^2) - 10\beta_1^2(1+4\mu^2)\right) + 11s^2\left(3\beta_1\mu + 5t^2\beta_1\mu - t(2+3\beta_1+6\beta_1\mu^2)\right)\Big\}\Bigg] \tag{25}$$

$$[C_{23}]^0_4 = [...] + \frac{3 f_\nu \beta_1^2}{1226225 b_1 s^4 t}\Bigg[- 572t\left(s^2-(t-\mu)^2\right)\left(4-12\mu^2+8t\mu(-3+5\mu^2) + t^2(-3+30\mu^2-35\mu^4)\right)$$
$$- 13\left(s^2(-15t+49\mu) + t(15t^2-79t\mu+64\mu^2)\right)\left(88 + 44s^2(-1+3\mu^2) + 8\beta_1(-2+17\mu^2) - 16t\mu(11+3\beta_1(-2+7\mu^2))\right.$$
$$\left. + t^2\left(44(-1+3\mu^2) + 3\beta_1(-7-18\mu^2+65\mu^4)\right)\right) + 91\Big\{ 154 s^2 t\gamma_2\left(4-12\mu^2+8t\mu(-3+5\mu^2) + t^2(-3+30\mu^2-35\mu^4)\right)$$
$$+ 22\left(7\mu + t(3-10\mu^2)\right)\left(4-12\mu^2+8t\mu(-3+5\mu^2) + t^2(-3+30\mu^2-35\mu^4)\right)$$
$$+ \left(t-7\mu+6t\mu^2\right)\left(88s^2(-1+3\mu^2) - 16t\mu\left(22+9\beta_1(-2+7\mu^2)\right) + 8\left(22+\beta_1(-6+51\mu^2)\right)\right.$$
$$\left. + t^2\left(88(-1+3\mu^2) + 9\beta_1(-7-18\mu^2+65\mu^4)\right)\right)\Big\} + 98 b_1\Big\{ 13t^4\mu\left(88(-3+5\mu^2) + 15\beta_1(-21+10\mu^2+35\mu^4)\right)$$
$$- 3t^2\mu\left(-2288 + 65s^2\beta_1(-21+10\mu^2+35\mu^4) + 60\beta_1^2(-37+34\mu^2+115\mu^4)\right)$$
$$+ 6t^3\left(572(1-3\mu^2) - 39\beta_1(-7-18\mu^2+65\mu^4) + 10\beta_1^2(-9-84\mu^2+135\mu^4+70\mu^6)\right)$$
$$- 8\mu\left(143s^4(-3+5\mu^2) + 26s^2\left(22+9\beta_1(-2+7\mu^2)\right) + 15\beta_1\left(39+\beta_1(-6+62\mu^2)\right)\right)$$
$$\left. + t\left(13s^2\left(176(-1+3\mu^2) + 27\beta_1(-7-18\mu^2+65\mu^4)\right) + 4\left(-572 + 156\beta_1(-2+17\mu^2) + 9\beta_1^2(-37-46\mu^2+643\mu^4)\right)\right)\Big\}\Bigg] \tag{26}$$

$$
\begin{aligned}
[C_{23}]^1_4 = [...] - \frac{1}{245245\sqrt{5}b_1 s^4 t} 3 f_\nu \beta_1^2 \sqrt{1-\mu^2} \Big[& -98 b_1 \Big\{ 429 s^4 (-1+5\mu^2) \\
& + 13 s^2 \left(88 - 176 t\mu + 3\beta_1 \left(3 + 117\mu^2 - 6t\mu(3+37\mu^2) + 5t^2(-3+9\mu^2+14\mu^4)\right)\right) \\
& - 3(40 t\beta_1\mu \left(26 + 3\beta_1(5+23\mu^2)\right) - 10\beta_1 \left(26 + \beta_1(5+79\mu^2)\right) + 13 t^4 \left(-11 + 55\mu^2 + 5\beta_1(-3+9\mu^2+14\mu^4)\right) \\
& + 4t^3 \mu \left(-286 - 13\beta_1(3+37\mu^2) + 10\beta_1^2(-3+31\mu^2+14\mu^4)\right) - 4t^2 \left(-143 + 15\beta_1^2(-1+27\mu^2+44\mu^4)\right) \Big\} + 13 \Big\{ \\
& - 196 \left(22 + 11 s^4 + 30\beta_1 + 2s^2(11+5\beta_1)\right)\mu^2 - 2t^5 \mu \left(198 + 45\beta_1 + 308\mu^2 + 555\beta_1\mu^2\right) \\
& + t^4 \left(88(6+41\mu^2+14\mu^4) + \beta_1(45 + 2229\mu^2 + 5846\mu^4)\right) + t^3 \mu \left(44\mu^2(-361+476\mu^2) + \beta_1(-711 - 7317\mu^2 + 4588\mu^4)\right) \\
& + 2s^2 \left(-22(-2+49\gamma_2)(-3+7\mu^2) + 15\beta_1(3+37\mu^2)\right) + t\mu \left(-770 + 660 s^4 + 22154\mu^2 + \beta_1(1281 + 19679\mu^2)\right) \\
& + s^2 \left(44(67 - 98\gamma_2 + 20\mu^2) + 9\beta_1(83 + 637\mu^2)\right) - t^2 \left(22(91 - 593\mu^2 + 1706\mu^4) + \beta_1(63 + 365\mu^2 + 18132\mu^4)\right) \\
& + s^2 \left(\beta_1(45 + 2049\mu^2 + 3626\mu^4) - 66(-8 + 10\mu^2 + 49\gamma_2(-1+5\mu^2))\right) \Big\} \Big]
\end{aligned} \tag{27}
$$

$$
\begin{aligned}
[C_{23}]^2_4 = [...] - \frac{1}{245245 b_1 s^4 t} 3\sqrt{\frac{2}{5}} f_\nu \beta_1^2 (-1+\mu^2) \Big[& -49 \Big(286 + 143(1+12b_1)s^4 + 234\beta_1 + 1080 b_1 \beta_1^2 + 26 s^2 (11 + 3(1+36b_1)\beta_1)\Big)\mu \\
& - 13 t^5 (121 + 308\mu^2 + 15\beta_1(5+31\mu^2)) + 13 t^4 \mu \Big(1045 + 935\beta_1 + 616\mu^2 + 2449\beta_1\mu^2 + 294 b_1(22 + 5\beta_1(5+7\mu^2))\Big) \\
& - t^2 \mu \Big\{ 17640 b_1 \beta_1^2 (11+19\mu^2) + 286(-130 + 751\mu^2) + 39\beta_1(339 + 2263\mu^2) + 13 s^2 \Big(-66(1+98\gamma_2) \\
& + \beta_1(785 + 1519\mu^2 + 1470 b_1(5+7\mu^2))\Big)\Big\} + t \Big\{ 2145 s^4 + 3528 b_1 \beta_1^2 (11+79\mu^2) + 286(-21+362\mu^2) \\
& + 78\beta_1(21 + 588 b_1 + 944\mu^2) + 26 s^2 (99 - 539\gamma_2 + 110\mu^2 + 9\beta_1(5+98\mu^2) + 49 b_1(44 + 9\beta_1(5+31\mu^2)))\Big\} \\
& + t^3 \Big\{ 588 b_1 \Big(-143 - 13\beta_1(5+31\mu^2) + 10\beta_1^2(2+29\mu^2+14\mu^4)\Big) + 13 \Big(22(26 - 229\mu^2 + 476\mu^4) \\
& + \beta_1(15 - 1883\mu^2 + 1922\mu^4) + s^2 \Big(-22(-2+49\gamma_2)(-1+7\mu^2) + 15\beta_1(5+31\mu^2)\Big)\Big)\Big\} \Big]
\end{aligned} \tag{28}
$$

$$
\begin{aligned}
[C_{23}]^3_4 = [...] - \frac{1}{35035\sqrt{35} b_1 s^4 t} 3 f_\nu \beta_1^2 (1-\mu^2)^{3/2} \Big[& -13 t(-1+2t\mu) \Big(t^3 (44 + 45\beta_1) - t^2 (88 + 237\beta_1)\mu + 49(22 + 3(3+s^2)\beta_1)\mu \\
& - t(-462 + 63\beta_1 + s^2(44 + 45\beta_1 - 1078\gamma_2) + 1496\mu^2 + 186\beta_1\mu^2)\Big) - 98 b_1 \Big(143 s^4 + 30\beta_1^2 - 360 t\beta_1^2\mu + 180 t^2 \beta_1^2 (1+4\mu^2) \\
& - 12 t^3 \beta_1 \mu(-39 + 30\beta_1 + 20\beta_1\mu^2) - 13 t^4 (11 + 15\beta_1 + 30\beta_1\mu^2) + 39 s^2 \beta_1 (3 - 18 t\mu + 5t^2(1+2\mu^2))\Big)\Big]
\end{aligned} \tag{29}
$$

$$
\begin{aligned}
[C_{23}]^4_4 = [...] + \frac{1}{35035\sqrt{70} b_1 s^4} 3 f_\nu \beta_1^2 (1-\mu^2)^2 \Big[& 882 b_1 \beta_1 (13 s^2 + 4\beta_1) - 13 t^4 (44 + 15\beta_1) \\
& + 13 t^3 \Big(88 + (79 + 1470 b_1)\beta_1\Big)\mu - 49 t \Big(286 + 13 \Big(3 + (1+30b_1)s^2\Big)\beta_1 + 360 b_1 \beta_1^2\Big)\mu \\
& + t^2 \Big(13 s^2 (44 + 15\beta_1 - 1078\gamma_2) + 286(-21 + 68\mu^2) + \beta_1(273 - 7644 b_1 + 806\mu^2) + 5880\beta_1^2 (b_1 + 2 b_1 \mu^2)\Big)\Big]
\end{aligned} \tag{30}
$$

$$
\begin{aligned}
[C_{23}]^0_6 = [...] + \frac{2 f_\nu \beta_1^3}{848925 b_1 s^4 t} \Big[& 945(t - 7\mu + 6t\mu^2) \left(-4 + 12\mu^2 - 8t\mu(-3+5\mu^2) + t^2(3 - 30\mu^2 + 35\mu^4)\right) \\
& + 45(s^2(15t - 49\mu) + t(-15t^2 + 79t\mu - 64\mu^2)) \left(-4 + 12\mu^2 - 8t\mu(-3+5\mu^2) + t^2(3 - 30\mu^2 + 35\mu^4)\right) \\
& + 294 b_1 \Big(45 t^4 \mu(15 - 70\mu^2 + 63\mu^4) - 8\mu(45 - 78\beta_1 + 190\beta_1\mu^2 + 45 s^2(-3+5\mu^2)) \\
& + t^2 \left(24\beta_1\mu(15 + 230\mu^2 - 357\mu^4) - 45 s^2 \mu(15 - 70\mu^2 + 63\mu^4)\right) \\
& + 2t^3 \left(-45(3 - 30\mu^2 + 35\mu^4) + \beta_1(85 - 435\mu^2 - 945\mu^4 + 1743\mu^6)\right) \\
& + 3t \left(45 s^2 (3 - 30\mu^2 + 35\mu^4) + 8(-15 + 45\mu^2 + \beta_1(-3 - 150\mu^2 + 265\mu^4))\right)\Big)\Big]
\end{aligned} \tag{31}
$$

$$[C_{23}]^1_6 = [...] - \frac{\sqrt{2/21} f_\nu \beta_1^3 \sqrt{1-\mu^2}}{13475 b_1 s^4 t}\Big[-10\left(4\mu + t(3-15\mu^2) + 2t^2\mu(-3+7\mu^2)\right)\left(15t^3 + 49(3+s^2)\mu - 79t^2\mu - t(21+15s^2+62\mu^2)\right)$$
$$- 147 b_1\Big(-25t^4(1-14\mu^2+21\mu^4) + 20t^2\beta_1(-3-18\mu^2+77\mu^4) + 8(5+\beta_1(-2+30\mu^2)) - 32t\mu(5+\beta_1(-6+34\mu^2))$$
$$+ 5s^2\left(-12+60\mu^2-24t\mu(-3+7\mu^2)+5t^2(1-14\mu^2+21\mu^4)\right) - 8t^3\mu\left(30-70\mu^2+\beta_1(-15-10\mu^2+81\mu^4)\right)\Big)\Big] \tag{32}$$

$$[C_{23}]^2_6 = [...] - \frac{4 f_\nu \beta_1^3 (1-\mu^2)}{2695\sqrt{105} b_1 s^4 t}\Big[-98\left(3+(1+36b_1)s^2+24b_1\beta_1\right)\mu - 30t^5(1-7\mu^2) + 2t^4\mu\left(11+553\mu^2+1470b_1(1-3\mu^2)\right)$$
$$- 2t^2\mu\left(-100+3(467+3920b_1\beta_1)\mu^2 + s^2(41+343\mu^2+1470b_1(1-3\mu^2))\right)$$
$$+ 2t\left(21+944\mu^2+3s^2(5+98\mu^2)+294b_1(2+24\beta_1\mu^2+3s^2(1-7\mu^2))\right)$$
$$+ t^3\left(-72-778\mu^2+868\mu^4+30s^2(1-7\mu^2)+147b_1\left(8-56\mu^2+5\beta_1(1-2\mu^2-15\mu^4)\right)\right)\Big] \tag{33}$$

$$[C_{23}]^3_6 = [...] - \frac{f_\nu \beta_1^3 (1-\mu^2)^{3/2}}{2695\sqrt{105} b_1 s^4 t}\Big[-12t(-1+2t\mu)\left(15t^3+49(3+s^2)\mu - 79t^2\mu - t(21+15s^2+62\mu^2)\right) \tag{34}$$
$$-49b_1\left(32\beta_1 - 384t\beta_1\mu - 45t^4(1-9\mu^2) + 60t^2(\beta_1+15\beta_1\mu^2) - 8t^3\mu(-36+15\beta_1+65\beta_1\mu^2) + 9s^2\left(8-48t\mu+5t^2(1-9\mu^2)\right)\right)\Big]$$

$$[C_{23}]^4_6 = [...] + \sqrt{\frac{2}{7}}\frac{f_\nu \beta_1^3 (1-\mu^2)^2}{13475 b_1 s^4}\Big[5t\left(-15t^3 - 49(3+s^2)\mu + 79t^2\mu + t(21+15s^2+62\mu^2)\right) \tag{35}$$
$$+ 294 b_1\left(8\beta_1 + 25t^3\mu - 40t\beta_1\mu - 5s^2(-3+5t\mu) + 2t^2(-5+3\beta_1+17\beta_1\mu^2)\right)\Big]$$

$$[C_{23}]^5_6 = [...] - \frac{3 f_\nu t \beta_1^3\left(-5s^2+5t^2-4\beta_1+8t\beta_1\mu\right)(1-\mu^2)^{5/2}}{25\sqrt{77} s^4} \tag{36}$$

$$[C_{23}]^6_6 = [...] - \frac{4 f_\nu t^2 \beta_1^4\left(1-\mu^2\right)^3}{25\sqrt{231} s^4} \tag{37}$$

$$[C_{23}]^0_8 = [...] + \frac{64 f_\nu \beta_1^4}{10725 s^4 t}\Big[8\mu(3-5\mu^2) + 6t(3-30\mu^2+35\mu^4) - 6t^2\mu(15-70\mu^2+63\mu^4) + t^3(-5+105\mu^2-315\mu^4+231\mu^6)\Big] \tag{38}$$

$$[C_{23}]^1_8 = [...] - \frac{48 f_\nu \beta_1^4(-1+2t\mu)\sqrt{2-2\mu^2}}{3575 s^4 t}\Big[-2+10\mu^2 - 4t\mu(-5+9\mu^2) + t^2(5-30\mu^2+33\mu^4)\Big] \tag{39}$$

$$[C_{23}]^2_8 = [...] - \frac{24 f_\nu \beta_1^4(1-\mu^2)}{715\sqrt{35} s^4 t}\Big[-16\mu + t\left(-16+112\mu^2+80t\mu(1-3\mu^2)+5t^2(1-18\mu^2+33\mu^4)\right)\Big] \tag{40}$$

$$[C_{23}]^3_8 = [...] - \frac{8\sqrt{\frac{2}{1155}} f_\nu \beta_1^4}{65 s^4 t}(-1+2t\mu)(1-\mu^2)^{3/2}\Big[4+5t\left(-8\mu+t(-3+11\mu^2)\right)\Big] \tag{41}$$

$$[C_{23}]^4_8 = [...] + \frac{48\sqrt{\frac{2}{77}} f_\nu \beta_1^4}{325 s^4}(1-\mu^2)^2\left(2-10t\mu+t^2(-1+11\mu^2)\right) \tag{42}$$

$$[C_{23}]^5_8 = [...] - \frac{24\sqrt{\frac{2}{1001}} f_\nu t \beta_1^4}{25 s^4}(-1+2t\mu)(1-\mu^2)^{5/2} \tag{43}$$

$$[C_{23}]^6_8 = [...] - \frac{8 f_\nu t^2 \beta_1^4 (1-\mu^2)^3}{25\sqrt{429} s^4} \tag{44}$$

Neutrino corrections to '31' terms

$$[C_{31}]^0_0 = [...] - \frac{f_\nu}{25725 b_1 s^4}\Bigg[21s^4\left(-60+5\beta_1(-19+49\gamma_2+49t(\mu+2b_1\mu))+\beta_1^2\left(-15(1+2\mu^2)+49t(\mu+12b_1\mu+2\mu^3)\right)\right)$$
$$+3s^2\Big\{420(-1+t\mu)^2+35\beta_1\left(15+49\gamma_2+98t^3\mu-t(79+98b_1+98\gamma_2)\mu+t^2(10+98b_1+49\gamma_2-44\mu^2)\right)+7\beta_1^2\Big[6(-2+49\gamma_2)$$
$$+49t^3\mu(5+24b_1+4\mu^2)-12t\mu(-7+49\gamma_2+5\mu^2)-t^2(63+350\mu^2+40\mu^4+392b_1(1+2\mu^2)-98\gamma_2(1+2\mu^2))\Big]+3\beta_1^3\Big[$$
$$-15(1+4\mu^2)+t\mu(139+1470b_1+256\mu^2)+49t^3(\mu+36b_1\mu+4(1+6b_1)\mu^3)-t^2(15+354\mu^2+196\mu^4+882b_1(1+4\mu^2))\Big]\Big\}$$
$$+\beta_1\Big\{420+567\beta_1+135\beta_1^2+630\beta_1\mu^2+540\beta_1^2\mu^2+49t^5\mu\left(105+84\beta_1(2+\mu^2)+40b_1\beta_1^3(3+4\mu^2)+27\beta_1^2(1+10b_1+4\mu^2)\right)$$
$$-3t\mu\Big[560+7\beta_1(217+588b_1+158\mu^2)+3\beta_1^2(169+1470b_1+376\mu^2)\Big]+3t^3\mu\Big[-35+4620\mu^2$$
$$-21\beta_1(7+588b_1-372\mu^2)+1960b_1\beta_1^3(3+4\mu^2)+6\beta_1^2(97+364\mu^2+124\mu^4)\Big]+t^2\Big[2625(1-2\mu^2)-1960\beta_1^3(b_1+6b_1\mu^2)$$
$$+21\beta_1(161+74\mu^2-40\mu^4+588b_1(1+2\mu^2))+18\beta_1^2(-3+194\mu^2+34\mu^4+294b_1(1+4\mu^2))\Big]-3t^4\Big[-735+5740\mu^2$$
$$+56\beta_1\mu^2(161+34\mu^2)+3\beta_1^2(21+1028\mu^2+836\mu^4)+196b_1\beta_1\left(-21+9\beta_1(1+4\mu^2)+2\beta_1^2(3+24\mu^2+8\mu^4)\right)\Big]\Big\}\Bigg] \tag{45}$$

$$[C_{31}]^0_2 = [...] - \frac{\beta_1 f_\nu}{56595 b_1 s^4}\Bigg[33\left(56+15\beta_1^2(1+9\mu^2)+3\beta_1(21+55\mu^2)\right)$$
$$-33t\mu\left(224+\beta_1^2(169+2940b_1+921\mu^2)+\beta_1(361+2352b_1+1139\mu^2)\right)+49t^5\mu\Big\{198\beta_1^2\mu^2(3+10b_1+2\mu^2)$$
$$+231(-1+3\mu^2)+66\beta_1(-5+29\mu^2)+80b_1\beta_1^3(3+19\mu^2+6\mu^4)\Big\}-3t^4\Big\{784b_1\beta_1^3(3+69\mu^2+68\mu^4)+77(21+67\mu^2+198\mu^4)$$
$$+22\beta_1^2\mu^2(504+1257\mu^2+124\mu^4+588b_1(3+2\mu^2))+22\beta_1(-63+1373\mu^2+1810\mu^4-588b_1(-1+3\mu^2))\Big\}$$
$$+3t^3\mu\Big\{1960b_1\beta_1^3(15+41\mu^2)+154(11+120\mu^2)+33\beta_1^2(91+505\mu^2+184\mu^4)+132\beta_1(68+267\mu^2+30\mu^4-147b_1(1+3\mu^2))\Big\}$$
$$+33s^4\Big(-15\beta_1(1+11\mu^2)+49t\beta_1(\mu+48b_1\mu+11\mu^3)+7\left(7+98\gamma_2-45\mu^2+49t\mu(-1+4b_1+3\mu^2)\right)\Big)$$
$$+t^2\Big\{462(19-44\mu^2)-1960b_1\beta_1^3(5+51\mu^2)+33\beta_1^2(-21+313\mu^2+608\mu^4+588b_1(1+9\mu^2))$$
$$+66\beta_1(202-413\mu^2+601\mu^4+294b_1(1+11\mu^2))\Big\}+33s^2\Big\{-105-48\beta_1-15\beta_1^2+686\gamma_2+1176\beta_1\gamma_2+315\mu^2$$
$$-135\beta_1^2\mu^2+t\mu\left(196b_1(-7+15\beta_1^2)-12\beta_1(-13+196\gamma_2+5\mu^2)-7(-79+196\gamma_2+237\mu^2)+\beta_1^2(139+651\mu^2)\right)\Big\}$$
$$+49t^3\mu\Big(7+21\mu^2+4\beta_1(-1+10\mu^2+6b_1(1+3\mu^2))+\beta_1^2(6\mu^2+4\mu^4+12b_1(3+7\mu^2))\Big)$$
$$-t^2\Big\{\beta_1^2(384\mu^2+746\mu^4)-7(53-187\mu^2+66\mu^4+49\gamma_2(-1+3\mu^2))$$
$$+2\beta_1(-36+391\mu^2+551\mu^4-49\gamma_2(1+11\mu^2))+98b_1(7-21\mu^2+9\beta_1^2(1+9\mu^2)+\beta_1(4+44\mu^2))\Big\}\Bigg] \tag{46}$$

$$[C_{31}]^1_2 = [...] + \frac{\sqrt{2/3}f_\nu\beta_1\sqrt{1-\mu^2}}{1155 b_1 s^4}\Bigg[\frac{11}{7}t\Big\{63s^2(7+6\beta_1)\gamma_2(-1+t\mu)+9t^2(7+6\beta_1)(-1+t\mu)(3+7t\mu-10\mu^2)$$
$$-9t(1-7t\mu+6\mu^2)\Big(\beta_1(6+5\beta_1)\mu+s^2(7+6\beta_1)\mu-3t\beta_1(2+\beta_1+4\mu^2+4\beta_1\mu^2)+2t^2\beta_1\mu(6+\beta_1(3+2\mu^2))\Big)\Big)\}$$
$$+\frac{33}{245}\Big\{60t(7+3\beta_1)(1-t\mu)(s^2-(-1+t\mu)^2)-5(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu))\Big($$
$$-(3s^2(7+3\beta_1)+\beta_1(9+5\beta_1))\mu+3t\beta_1(3+\beta_1+6\mu^2+4\beta_1\mu^2)-2t^2\beta_1\mu(9+\beta_1(3+2\mu^2))\Big)\Big\}$$
$$+b_1t\Big\{99s^4(7+6\beta_1)+99s^2\Big(-7+5\beta_1^2-2t(-7+12\beta_1+15\beta_1^2)\mu+6t^2\beta_1(2+\beta_1+4\mu^2+4\beta_1\mu^2)\Big)$$
$$+3\beta_1\Big[-33(6+5\beta_1)+4t(297+165\beta_1-70\beta_1^2)\mu-24t^3\mu(-33+11\beta_1(3+2\mu^2)+10\beta_1^2(3+4\mu^2))$$
$$+18t^2(-33(1+2\mu^2)+10\beta_1^2(1+6\mu^2))+5t^4\beta_1(33(1+4\mu^2)+4\beta_1(3+24\mu^2+8\mu^4))\Big]\Big\}\Bigg] \tag{47}$$

$$[C_{31}]^2_2 = [...] + \frac{f_\nu \beta_1 (1-\mu^2)}{1155\sqrt{6} b_1 s^4}\Bigg[\frac{396}{49}t^2(7+\beta_1)(-s^2+(-1+t\mu)^2)$$
$$+\frac{99}{7}t^2(1-7t\mu+6\mu^2)\Big(s^2(7+2\beta_1)+\beta_1(2+\beta_1-6t(2+\beta_1)\mu+2t^2(6+\beta_1+2\beta_1\mu^2))\Big)$$
$$+\frac{33}{49}(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu))\Big(3s^2(7+\beta_1)+\beta_1(3+\beta_1-6t(3+\beta_1)\mu+2t^2(9+\beta_1+2\beta_1\mu^2))\Big)$$
$$+t^2\Bigg\{\frac{99}{7}(7+2\beta_1)\left(7s^2\gamma_2+t^2(3+7t\mu-10\mu^2)\right)+2b_1\Big\{99s^2\left(7+4\beta_1(-1+3t\mu)+\beta_1^2(-3+6t\mu)\right)$$
$$+6\beta_1\left(99+33\beta_1-10\beta_1^2+9t(-33+10\beta_1^2)\mu+5t^3\beta_1\mu(33+4\beta_1(3+2\mu^2))-6t^2(-33+11\beta_1(1+2\mu^2)+6\beta_1^2(1+4\mu^2))\right)\Big\}\Bigg\}\Bigg] \tag{48}$$

$$[C_{31}]^0_4 = -\frac{3f_\nu\beta_1^2}{1226225 b_1 s^4}\Bigg[572s^4(15-45\mu^2+49t\mu(-1+8b_1+3\mu^2))+52(-77+495\mu^2+30\beta_1(-2+17\mu^2))$$
$$-52t\mu\left(-1507+196b_1(22+45\beta_1)+4257\mu^2+\beta_1(-676+3946\mu^2)\right)+49t^5\mu\Big\{286(-1-18\mu^2+35\mu^4)$$
$$+120b_1\beta_1^2(-37+34\mu^2+115\mu^4)+39\beta_1\left(10b_1(-21+10\mu^2+35\mu^4)+3(-7-18\mu^2+65\mu^4)\right)\Big\}$$
$$+t^3\mu\Big\{2352b_1\left(429-715\mu^2+30\beta_1^2(-3+31\mu^2)\right)+13\left(9\beta_1(-301+2818\mu^2+603\mu^4)-11(821-5706\mu^2+1965\mu^4)\right)\Big\}$$
$$+t^2\Big\{-2352b_1\left(143-429\mu^2+\beta_1(52-442\mu^2)+10\beta_1^2(-1+29\mu^2)\right)$$
$$+13\left(11(421-3346\mu^2+3445\mu^4)+\beta_1(21-10258\mu^2+21037\mu^4)\right)\Big\}+t^4\Big\{$$
$$-196b_1\left(-143(3-30\mu^2+35\mu^4)+117\beta_1(-7-18\mu^2+65\mu^4)+18\beta_1^2(-37-46\mu^2+643\mu^4)\right)$$
$$-13\left(22(105-1096\mu^2+2721\mu^4+350\mu^6)+3\beta_1(-147-5516\mu^2+16713\mu^4+4030\mu^6)\right)\Big\}$$
$$+13s^2\Bigg\{8(-44+30\beta_1+1078\gamma_2-255\beta_1\mu^2)+8t\mu\left(-22(11+98\gamma_2-15\mu^2)+\beta_1(-278+4410b_1+1463\mu^2)\right)$$
$$+49t^3\mu\Big(11(-5-6\mu^2+35\mu^4)+3\beta_1(-7-18\mu^2+65\mu^4)$$
$$+32b_1(-33+55\mu^2+9\beta_1(-2+7\mu^2))\Big)+t^2\Big(\beta_1(315+5514\mu^2-19389\mu^4)$$
$$+11(27+1490\mu^2-2725\mu^4+392\gamma_2(-1+3\mu^2))-784b_1(-22+66\mu^2+9\beta_1(-2+17\mu^2))\Big)\Bigg\}\Bigg] \tag{49}$$

$$[C_{31}]^1_4 = [...] + \frac{f_\nu\beta_1^2}{5005\sqrt{5}b_1 s^4}\sqrt{1-\mu^2}\Bigg[\frac{13}{7}t\Big\{1848s^2\gamma_2(-1+t\mu)+264t^2(-1+t\mu)(3+7t\mu-10\mu^2)$$
$$-t(1-7t\mu+6\mu^2)\Big(4(66+66s^2+90\beta_1)\mu+6t^2\mu(-66+9\beta_1+154\mu^2+111\beta_1\mu^2)-9t(-22+3\beta_1+110\mu^2+117\beta_1\mu^2)\Big)\Big\}$$
$$+6b_1t\Big\{572s^4-52(11+15\beta_1)-24t\mu(-143-130\beta_1+70\beta_1^2)-4t^3\mu\Big(143(3-7\mu^2)+90\beta_1^2(5+23\mu^2)$$
$$+39\beta_1(3+37\mu^2)\Big)+9t^2\Big(143-715\mu^2+10\beta_1^2(5+79\mu^2)\Big)+13s^2\Big(60\beta_1-8t\mu(22+45\beta_1)$$
$$+t^2(-66+9\beta_1+330\mu^2+351\beta_1\mu^2)\Big)+15t^4\beta_1\left(13(-3+9\mu^2+14\mu^4)+4\beta_1(-1+27\mu^2+44\mu^4)\right)\Big\}$$
$$+\frac{39}{245}\Big\{880t(1-t\mu)(s^2-(-1+t\mu)^2)+5\left(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu)\right)\Big(4(11+11s^2+10\beta_1)\mu$$
$$-3t(-11+\beta_1+55\mu^2+39\beta_1\mu^2)+2t^2\mu(-33+77\mu^2+\beta_1(3+37\mu^2))\Big)\Big\}\Bigg] \tag{50}$$

$$
\begin{aligned}
[C_{31}]^2_4 = [...] + \frac{f_\nu \beta_1^2}{5005 b_1 s^4}\sqrt{\frac{2}{5}}(1-\mu^2)\Bigg[& \frac{1716}{49}t^2\left(-s^2+(-1+t\mu)^2\right) \\
& + \frac{39}{49}\left(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu)\right)\left(11+11s^2+6\beta_1-6t(11+6\beta_1)\mu+t^2(-11+5\beta_1+77\mu^2+31\beta_1\mu^2)\right) \\
& + \frac{39}{7}t^2(-1+7t\mu-6\mu^2)\left(22+22s^2+18\beta_1-12t(11+9\beta_1)\mu+t^2(-22+15\beta_1+154\mu^2+93\beta_1\mu^2)\right) \\
& + t^2\Bigg\{\frac{858}{7}\left(7s^2\gamma_2+t^2(3+7t\mu-10\mu^2)\right)+6b_1\Big(858+468\beta_1-180\beta_1^2+18t(-143+90\beta_1^2)\mu \\
& + 26s^2(-22+66t\mu+27\beta_1(-1+2t\mu))+15t^3\beta_1\mu(65+91\mu^2+\beta_1(44+76\mu^2)) \\
& - 2t^2\left(143(1-7\mu^2)+39\beta_1(5+31\mu^2)+18\beta_1^2(11+79\mu^2)\right)\Big)\Bigg\}\Bigg]
\end{aligned}
\tag{51}
$$

$$
\begin{aligned}
[C_{31}]^3_4 = [...] + \frac{f_\nu t\beta_1^2}{175175 b_1 s^4\sqrt{35}}(1-\mu^2)^{3/2}\Bigg[& 195(11+3\beta_1)(-1+2t\mu)(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu)) \\
& + 35t^2\Bigg\{39(22+9\beta_1)(-1+2t\mu)(-1+7t\mu-6\mu^2)+42b_1\Big(-429+90\beta_1^2+13s^2(22+9\beta_1)-4t(-143+117\beta_1+90\beta_1^2)\mu \\
& + 15t^2\beta_1(13+4\beta_1+26\mu^2+16\beta_1\mu^2)\Big)\Bigg\}\Bigg]
\end{aligned}
\tag{52}
$$

$$
\begin{aligned}
[C_{31}]^4_4 = [...] - \frac{3f_\nu t^2\beta_1^2}{35035 b_1 s^4\sqrt{70}}(1-\mu^2)^2\Big[& 195(11+\beta_1)-1027t(11+\beta_1)\mu+49t^3\mu\left(286+39(1+10b_1)\beta_1+120b_1\beta_1^2\right) \\
& + 13s^2(11+\beta_1)(-15+49t\mu)-t^2\left(196b_1(-143+39\beta_1+18\beta_1^2)+13(154+21\beta_1+220\mu^2+62\beta_1\mu^2)\right)\Big]
\end{aligned}
\tag{53}
$$

$$
\begin{aligned}
[C_{31}]^0_6 = [...] + \frac{2f_\nu\beta_1^3}{848925 b_1 s^4}\Bigg[& -45\left(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu)\right)\left(-4+12\mu^2-8t\mu(-3+5\mu^2)+t^2(3-30\mu^2+35\mu^4)\right) \\
& + 21t\Big\{-45t(-1+7t\mu-6\mu^2)\left(-4+12\mu^2-8t\mu(-3+5\mu^2)+t^2(3-30\mu^2+35\mu^4)\right)-14b_1\Big(360(-1+s^2)\mu \\
& - 4t\left(90-52\beta_1-270\mu^2+276\beta_1\mu^2+135s^2(-1+3\mu^2)\right)+24t^2\mu\left(15s^2(-3+5\mu^2)+2\beta_1(-39+95\mu^2)\right) \\
& - 6t^3\left(15(3-30\mu^2+35\mu^4)+4\beta_1(-3-150\mu^2+265\mu^4)\right)+t^4\mu\left(45(15-70\mu^2+63\mu^4)+8\beta_1(-15-230\mu^2+357\mu^4)\right)\Big)\Big\}\Bigg]
\end{aligned}
\tag{54}
$$

$$
\begin{aligned}
[C_{31}]^1_6 = [...] + \frac{\sqrt{2/21}f_\nu\beta_1^3\sqrt{1-\mu^2}}{40425 b_1 s^4}\Bigg[& 30\left(15-79t\mu+64t^2\mu^2+s^2(-15+49t\mu)\right)\left(4\mu+t(3-15\mu^2)+2t^2\mu(-3+7\mu^2)\right) \\
& + 21t\Big\{30t(-1+7t\mu-6\mu^2)\left(4\mu+t(3-15\mu^2)+2t^2\mu(-3+7\mu^2)\right)+7b_1\Big(-120+32t(15-14\beta_1)\mu+144t^2\beta_1(-1+15\mu^2) \\
& - 48t^3\mu(-15-12\beta_1+35\mu^2+68\beta_1\mu^2)+60s^2(2-12t\mu+3t^2(-1+5\mu^2)) \\
& + 5t^4\left(15(1-14\mu^2+21\mu^4)+4\beta_1(-3-18\mu^2+77\mu^4)\right)\Big)\Big\}\Bigg]
\end{aligned}
\tag{55}
$$

$$
\begin{aligned}
[C_{31}]^2_6 = & \frac{16\beta_1^3(1-\mu^2)}{165\sqrt{105}b_1 s^4}\Bigg[-\frac{5}{14}t^2(-1+7t\mu-6\mu^2)\left(1-6t\mu+t^2(-1+7\mu^2)\right) \\
& - 5b_1t^2\left(2-\beta_1+9t\beta_1\mu+s^2(-3+6t\mu)+5t^3\mu\left(-1+(3+2\beta_1)\mu^2\right)-2t^2\left(-1+(7+9\beta_1)\mu^2\right)\right)\Bigg] \\
& + \frac{8f_\nu\beta_1^3(1-\mu^2)}{2695\sqrt{105}b_1 s^4}\Bigg[15-169t\mu+t^3\mu\left(352+3528b_1\beta_1-181\mu^2\right)+t^2\left(-36-196b_1(-3+2\beta_1)+517\mu^2\right) \\
& + s^2\left(-15+139t\mu+49t^3\mu(-1+36b_1+7\mu^2)-3t^2(-5+294b_1+133\mu^2)\right) \\
& + 49t^5\mu\left(-3+21\mu^2+10b_1(-3+(9+8\beta_1)\mu^2)\right)-t^4\left(-21+967\mu^2+434\mu^4+588b_1(-1+(7+12\beta_1)\mu^2)\right)\Bigg]
\end{aligned}
\tag{56}
$$

$$[C_{31}]^3_6 = [...] - \frac{f_\nu t \beta_1^3 (1-\mu^2)^{3/2}}{2695\sqrt{105} b_1 s^4}\Big[180 - 1308 t\mu - 12t^2(21 + 392 b_1\beta_1 - 96\mu^2) + 12t^3\mu\left(189 + 392 b_1(3+4\beta_1) + 124\mu^2\right) \\ - 12 s^2\left(15 + 294 b_1 t^2 - 79 t\mu + 98 t^2\mu^2\right) - 49 t^4\left(72\mu^2 + 5b_1(-9 + 4\beta_1 + 81\mu^2 + 60\beta_1\mu^2)\right)\Big] \tag{57}$$

$$[C_{31}]^4_6 = [...] - \frac{\sqrt{2/7}}{13475 b_1 s^4} f_\nu t^2 \beta_1^3 (1-\mu^2)^2\Big[75 - 395 t\mu + 245 t^3\left(3 + 2b_1(15+8\beta_1)\right)\mu + 5s^2\left(-15 + 49 t\mu\right) \\ - t^2\left(588 b_1(5+4\beta_1) + 5\left(21 + 62\mu^2\right)\right)\Big] \tag{58}$$

$$[C_{31}]^5_6 = [...]\frac{f_\nu t^5 \beta_1^3 (15+4\beta_1)(1-\mu^2)^{5/2}}{25\sqrt{77} s^4} \tag{59}$$

$$[C_{31}]^0_8 = [...] - \frac{128 f_\nu t^2 \beta_1^4}{10725 s^4}\left[4 - 12\mu^2 + 12 t\mu(-3+5\mu^2) - 3t^2(3 - 30\mu^2 + 35\mu^4) + t^3\mu(15 - 70\mu^2 + 63\mu^4)\right] \tag{60}$$

$$[C_{31}]^1_8 = [...] + \frac{16 f_\nu t^2 \beta_1^4 \sqrt{2-2\mu^2}}{3575 s^4}\left[-16\mu + 18 t(-1+5\mu^2) - 24 t^2\mu(-3+7\mu^2) + 5t^3(1 - 14\mu^2 + 21\mu^4)\right] \tag{61}$$

$$[C_{31}]^2_8 = [...] + \frac{128 f_\nu t^2 \beta_1^4}{715\sqrt{35} s^4}(-1+\mu^2)\left[-1 + 9 t\mu + t^2(3 - 21\mu^2) + 5t^3\mu(-1+3\mu^2)\right] \tag{62}$$

$$[C_{31}]^3_8 = [...] + 8\sqrt{\frac{2}{1155}}\frac{f_\nu t^3 \beta_1^4}{65 s^4}(1-\mu^2)^{3/2}\left(12 - 48 t\mu + 5t^2(-1+9\mu^2)\right) \tag{63}$$

$$[C_{31}]^4_8 = [...] - 32\sqrt{\frac{2}{77}}\frac{f_\nu t^4 \beta_1^4}{325 s^4}(-3+5t\mu)(1-\mu^2)^2 \tag{64}$$

$$[C_{31}]^5_8 = [...] + 8\sqrt{\frac{2}{1001}}\frac{f_\nu t^5 \beta_1^4}{25 s^4}(1-\mu^2)^{5/2} \tag{65}$$