

GAUGE AND HIGGS BOSONS

γ (photon)

$$I(J^{PC}) = 0,1(1^{--})$$

Mass $m < 1 \times 10^{-18}$ eV
 Charge $q < 1 \times 10^{-46}$ e (mixed charge)
 Charge $q < 1 \times 10^{-35}$ e (single charge)
 Mean life τ = Stable

g (gluon)

$$I(J^P) = 0(1^-)$$

Mass $m = 0$ [a]
 SU(3) color octet

graviton

$$J = 2$$

Mass $m < 1.76 \times 10^{-23}$ eV

W

$$J = 1$$

Charge = ± 1 e
 Mass $m = 80.3692 \pm 0.0133$ GeV [b]
 W/Z mass ratio = 0.88136 ± 0.00015
 $m_Z - m_W = 10.818 \pm 0.013$ GeV
 $m_{W^+} - m_{W^-} = -0.029 \pm 0.028$ GeV
 Full width $\Gamma = 2.14 \pm 0.05$ GeV ($S = 1.7$)
 $\langle N_{\pi^\pm} \rangle = 15.70 \pm 0.35$
 $\langle N_{K^\pm} \rangle = 2.20 \pm 0.19$
 $\langle N_p \rangle = 0.92 \pm 0.14$
 $\langle N_{\text{charged}} \rangle = 19.39 \pm 0.08$

W^- modes are charge conjugates of the modes below.

W^+ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\ell^+ \nu$	[c] $(10.86 \pm 0.09) \%$		—
$e^+ \nu$	$(10.71 \pm 0.16) \%$		40185
$\mu^+ \nu$	$(10.63 \pm 0.15) \%$		40185
$\tau^+ \nu$	$(11.38 \pm 0.21) \%$		40165
hadrons	$(67.41 \pm 0.27) \%$		—
$\pi^+ \gamma$	< 1.9	$\times 10^{-6}$ 95%	40184
$\rho^+ \gamma$	< 5.2	$\times 10^{-6}$ 95%	40181
$K^+ \gamma$	< 1.7	$\times 10^{-6}$ 95%	40183
$D_s^+ \gamma$	< 6	$\times 10^{-4}$ 95%	40160
$c\bar{X}$	$(33.3 \pm 2.6) \%$		—
$c\bar{s}$	$(31^{+13}_{-11}) \%$		—
invisible	[d] $(1.4 \pm 2.8) \%$		—
$\pi^+ \pi^+ \pi^-$	< 1.01	$\times 10^{-6}$ 95%	40184

Z

$$J = 1$$

Charge = 0
 Mass $m = 91.1880 \pm 0.0020$ GeV [e]
 Full width $\Gamma = 2.4955 \pm 0.0023$ GeV
 $\Gamma(\ell^+ \ell^-) = 83.984 \pm 0.086$ MeV [c]
 $\Gamma(\text{invisible}) = 499.3 \pm 1.5$ MeV [f]
 $\Gamma(\text{hadrons}) = 1744.4 \pm 2.0$ MeV
 $\Gamma(\mu^+ \mu^-)/\Gamma(e^+ e^-) = 1.0001 \pm 0.0024$
 $\Gamma(\tau^+ \tau^-)/\Gamma(e^+ e^-) = 1.0020 \pm 0.0032$ [g]

NODE=GXXX005

NODE=S000

NODE=S000M;DTYPE=M

NODE=S000Q;DTYPE=Q;CLUMP=Q

NODE=S000QM;DTYPE=Q;CLUMP=Q;

OUR EVAL; → UNCHECKED ←

NODE=G021

NODE=G021M;DTYPE=M;OUR EVAL;
→ UNCHECKED ←

NODE=G033

NODE=G033M;DTYPE=M

NODE=S043

NODE=S043Q;DTYPE=q;OUR EVAL;

→ UNCHECKED ←

NODE=S043MR;DTYPE=f

NODE=S043MDZ;DTYPE=D

NODE=S043MD;DTYPE=D

NODE=S043W;DTYPE=G

NODE=S043PIC;DTYPE=K

NODE=S043KC;DTYPE=K

NODE=S043PRO;DTYPE=K

NODE=S043CHG;DTYPE=K

NODE=S043220;NODE=S043

DESIG=7

DESIG=1

DESIG=2

DESIG=5

DESIG=8

DESIG=6

DESIG=14

DESIG=15

DESIG=9

DESIG=12

DESIG=10

DESIG=11

DESIG=13

NODE=S044

NODE=S044Q;DTYPE=q;OUR EVAL;

→ UNCHECKED ←

NODE=S044M;DTYPE=M

NODE=S044W;DTYPE=G;OUR EVAL;

→ UNCHECKED ←

NODE=S044W4;DTYPE=w

NODE=S044W6;DTYPE=w

NODE=S044W5;DTYPE=w

NODE=S044R3;DTYPE=r

NODE=S044R19;DTYPE=r

Average charged multiplicity

$$\langle N_{\text{charged}} \rangle = 20.76 \pm 0.16 \quad (S = 2.1)$$

Couplings to quarks and leptons

$$g_V^\ell = -0.03783 \pm 0.00041$$

$$g_V^u = 0.266 \pm 0.034$$

$$g_V^d = -0.38^{+0.04}_{-0.05}$$

$$g_A^\ell = -0.50123 \pm 0.00026$$

$$g_A^u = 0.519^{+0.028}_{-0.033}$$

$$g_A^d = -0.527^{+0.040}_{-0.028}$$

$$g^{\nu\ell} = 0.5008 \pm 0.0008$$

$$g^{\nu e} = 0.53 \pm 0.09$$

$$g^{\nu\mu} = 0.502 \pm 0.017$$

Asymmetry parameters ^[h]

$$A_e = 0.1515 \pm 0.0019$$

$$A_\mu = 0.142 \pm 0.015$$

$$A_\tau = 0.143 \pm 0.004$$

$$A_s = 0.90 \pm 0.09$$

$$A_c = 0.670 \pm 0.027$$

$$A_b = 0.923 \pm 0.020$$

Charge asymmetry (%) at Z pole

$$A_{FB}^{(0\ell)} = 1.71 \pm 0.10$$

$$A_{FB}^{(0u)} = 4 \pm 7$$

$$A_{FB}^{(0s)} = 9.8 \pm 1.1$$

$$A_{FB}^{(0c)} = 7.07 \pm 0.35$$

$$A_{FB}^{(0b)} = 9.92 \pm 0.16$$

$$\sin^2(\theta_{\text{eff}}) = 0.23148 \pm 0.00013$$

CLUMP=K

NODE=S044CHG;DTYPE=K;CLUMP=K

CLUMP=X

NODE=S044GLV;DTYPE=x;CLUMP=X

NODE=S044GUV;DTYPE=x;CLUMP=X

NODE=S044GDV;DTYPE=x;CLUMP=X

NODE=S044GLA;DTYPE=x;CLUMP=X

NODE=S044GUA;DTYPE=x;CLUMP=X

NODE=S044GDA;DTYPE=x;CLUMP=X

NODE=S044GNL;DTYPE=x;CLUMP=X

NODE=S044GNE;DTYPE=x;CLUMP=X

NODE=S044GNM;DTYPE=x;CLUMP=X

CLUMP=A

NODE=S044AE;DTYPE=A;CLUMP=A

NODE=S044AM;DTYPE=A;CLUMP=A

NODE=S044AT;DTYPE=A;CLUMP=A

NODE=S044AS;DTYPE=A;CLUMP=A

NODE=S044AC;DTYPE=A;CLUMP=A

NODE=S044AB;DTYPE=A;CLUMP=A

CLUMP=Z

NODE=S044Z0L;DTYPE=z;CLUMP=Z

NODE=S044Z0U;DTYPE=z;CLUMP=Z

NODE=S044Z0S;DTYPE=z;CLUMP=Z

NODE=S044Z0C;DTYPE=z;CLUMP=Z

NODE=S044Z0B;DTYPE=z;CLUMP=Z

NODE=S044SEF;DTYPE=a

Z DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)	
$e^+ e^-$	(3.3632 ± 0.0042) %		45594	NODE=S044215;DESIG=1
$\mu^+ \mu^-$	(3.3662 ± 0.0066) %		45594	DESIG=2
$\tau^+ \tau^-$	(3.3696 ± 0.0083) %		45559	DESIG=8
$\ell^+ \ell^-$	[c] (3.3658 ± 0.0023) %		—	DESIG=16
$\ell^+ \ell^- \ell^+ \ell^-$	[j] (4.55 ± 0.17) × 10 ⁻⁶		45594	DESIG=82
invisible	(20.000 ± 0.055) %		—	DESIG=9
hadrons	(69.911 ± 0.056) %		—	DESIG=7
($u\bar{u} + c\bar{c}$)/2	(11.6 ± 0.6) %		—	DESIG=21
($d\bar{d} + s\bar{s} + b\bar{b}$)/3	(15.6 ± 0.4) %		—	DESIG=22
$c\bar{c}$	(12.03 ± 0.21) %		—	DESIG=17
$b\bar{b}$	(15.12 ± 0.05) %		—	DESIG=6
$b\bar{b}b\bar{b}$	(3.6 ± 1.3) × 10 ⁻⁴		—	DESIG=73
$g g g$	< 1.1 %	CL=95%	—	DESIG=64
$\pi^0 \gamma$	< 2.01	× 10 ⁻⁵ CL=95%	45594	DESIG=10
$\eta \gamma$	< 5.1	× 10 ⁻⁵ CL=95%	45592	DESIG=11
$\rho^0 \gamma$	< 4.0	× 10 ⁻⁶ CL=95%	45591	DESIG=86
$\omega \gamma$	< 3.9	× 10 ⁻⁶ CL=95%	45591	DESIG=48
$\eta'(958) \gamma$	< 4.2	× 10 ⁻⁵ CL=95%	45589	DESIG=12
$\phi \gamma$	< 7	× 10 ⁻⁷ CL=95%	45588	DESIG=85
$\gamma \gamma$	< 1.46	× 10 ⁻⁵ CL=95%	45594	DESIG=13
$\pi^0 \pi^0$	< 1.52	× 10 ⁻⁵ CL=95%	45594	DESIG=83
$\gamma \gamma \gamma$	< 2.2	× 10 ⁻⁶ CL=95%	45594	DESIG=14
$\pi^\pm W^\mp$	[j] < 7	× 10 ⁻⁵ CL=95%	10176	DESIG=18
$\rho^\pm W^\mp$	[j] < 8.3	× 10 ⁻⁵ CL=95%	10151	DESIG=19
$J/\psi(1S) X$	(3.51 $^{+0.23}_{-0.25}$) × 10 ⁻³	S=1.1	—	DESIG=23

$J/\psi(1S)\gamma$	< 1.2	$\times 10^{-6}$	CL=95%	45541	DESIG=84
$\psi(2S)X$	(1.60 ± 0.29)	$\times 10^{-3}$		—	DESIG=60
$\psi(2S)\gamma$	< 2.4	$\times 10^{-6}$	CL=95%	45519	DESIG=87
$J/\psi(1S)J/\psi(1S)$	< 2.2	$\times 10^{-6}$	CL=95%	45489	DESIG=93
$\chi_{c1}(1P)X$	(2.9 ± 0.7)	$\times 10^{-3}$		—	DESIG=42
$\chi_{c2}(1P)X$	< 3.2	$\times 10^{-3}$	CL=90%	—	DESIG=65
$\Upsilon(1S)X + \Upsilon(2S)X$	(1.0 ± 0.5)	$\times 10^{-4}$		—	DESIG=69
$+ \Upsilon(3S)X$					
$\Upsilon(1S)X$	< 4.4	$\times 10^{-5}$	CL=95%	—	DESIG=66
$\Upsilon(1S)\gamma$	< 1.1	$\times 10^{-6}$	CL=95%	45103	DESIG=88
$\Upsilon(2S)X$	< 1.39	$\times 10^{-4}$	CL=95%	—	DESIG=67
$\Upsilon(2S)\gamma$	< 1.3	$\times 10^{-6}$	CL=95%	45043	DESIG=89
$\Upsilon(3S)X$	< 9.4	$\times 10^{-5}$	CL=95%	—	DESIG=68
$\Upsilon(3S)\gamma$	< 2.4	$\times 10^{-6}$	CL=95%	45006	DESIG=90
$\Upsilon(1, 2, 3S)\Upsilon(1, 2, 3S)$	< 1.5	$\times 10^{-6}$	CL=95%	—	DESIG=94
$K_S^0\gamma$	< 3.1	$\times 10^{-6}$	CL=95%	45593	DESIG=96
$D^0\gamma$	< 4.0	$\times 10^{-6}$	CL=95%	45575	DESIG=95
$(D^0/\bar{D}^0)X$	(20.7 ± 2.0)	%		—	DESIG=43
$D^\pm X$	(12.2 ± 1.7)	%		—	DESIG=44
$D^*(2010)^\pm X$	[j] (11.4 ± 1.3)	%		—	DESIG=24
$D_{s1}(2536)^\pm X$	(3.6 ± 0.8)	$\times 10^{-3}$		—	DESIG=75
$D_{sJ}(2573)^\pm X$	(5.8 ± 2.2)	$\times 10^{-3}$		—	DESIG=76
$D^{*'}(2629)^\pm X$	searched for			—	DESIG=74;OUR EVAL;→ UNCHECKED ←
B^+X	[k] (6.08 ± 0.13)	%		—	DESIG=77
B_s^0X	[k] (1.59 ± 0.13)	%		—	DESIG=49
B_c^+X	searched for			—	DESIG=70;OUR EVAL;→ UNCHECKED ←
Λ_c^+X	(1.54 ± 0.33)	%		—	DESIG=78
Ξ_c^0X	seen			—	DESIG=80;OUR EST;→ UNCHECKED ←
Ξ_b^0X	seen			—	DESIG=81;OUR EST;→ UNCHECKED ←
b -baryon X	[k] (1.38 ± 0.22)	%		—	DESIG=79
anomalous γ + hadrons	[l] < 3.2	$\times 10^{-3}$	CL=95%	—	DESIG=31
$e^+e^-\gamma$	[l] < 5.2	$\times 10^{-4}$	CL=95%	45594	DESIG=3
$\mu^+\mu^-\gamma$	[l] < 5.6	$\times 10^{-4}$	CL=95%	45594	DESIG=4
$\tau^+\tau^-\gamma$	[l] < 7.3	$\times 10^{-4}$	CL=95%	45559	DESIG=29
$\ell^+\ell^-\gamma\gamma$	[n] < 6.8	$\times 10^{-6}$	CL=95%	—	DESIG=45
$q\bar{q}\gamma\gamma$	[n] < 5.5	$\times 10^{-6}$	CL=95%	—	DESIG=46
$\nu\bar{\nu}\gamma\gamma$	[n] < 3.1	$\times 10^{-6}$	CL=95%	45594	DESIG=47
$e^\pm\mu^\mp$	LF [j] < 2.62	$\times 10^{-7}$	CL=95%	45594	DESIG=5
$e^\pm\tau^\mp$	LF [j] < 5.0	$\times 10^{-6}$	CL=95%	45577	DESIG=25
$\mu^\pm\tau^\mp$	LF [j] < 6.5	$\times 10^{-6}$	CL=95%	45577	DESIG=26
pe	L,B < 1.8	$\times 10^{-6}$	CL=95%	45589	DESIG=71
$p\mu$	L,B < 1.8	$\times 10^{-6}$	CL=95%	45589	DESIG=72

H

 $J = 0$

NODE=S126

was H^0

Mass $m = 125.20 \pm 0.11$ GeV (S = 1.4)
 Full width $\Gamma = 3.7^{+1.9}_{-1.4}$ MeV (assumes equal
 on-shell and off-shell effective couplings)

NODE=S126M;DTYPE=M

NODE=S126W;DTYPE=G

H Signal Strengths in Different Channels

Combined Final States = 1.03 ± 0.04
 $W W^* = 1.00 \pm 0.08$
 $Z Z^* = 1.02 \pm 0.08$
 $\gamma\gamma = 1.10 \pm 0.06$
 $c\bar{c}$ Final State < 14, CL = 95%
 $b\bar{b} = 0.99 \pm 0.12$
 $\mu^+ \mu^- = 1.21 \pm 0.35$
 $\tau^+ \tau^- = 0.91 \pm 0.09$
 $Z\gamma = 2.2 \pm 0.7$
 $\gamma^* \gamma$ Final State = 1.5 ± 0.5
 Fermion coupling (κ_F) = 0.94 ± 0.05
 Gauge boson coupling (κ_V) = 1.023 ± 0.026
 $t\bar{t}H$ Production = 1.10 ± 0.18
 $b\bar{b}H$ Production < 3.7, CL = 95%
 HH Production Cross Section in pp Collisions < 2.4, CL = 95%
 Higgs trilinear self coupling modifier $\kappa_\lambda = 3.8^{+2.1}_{-4.0}$
 Higgs-gauge boson quartic coupling modifier $\kappa_{2V} = 1.02 \pm 0.23$
 tH production = 6 ± 4
 H Production Cross Section in pp Collisions at $\sqrt{s} = 13$ TeV =
 56.8 ± 3.4 pb
 H Production Cross Section in pp Collisions at $\sqrt{s} = 13.6$ TeV
 = 58 ± 9 pb

CLUMP=A

NODE=S126SA;DTYPE=a;CLUMP=A
 NODE=S126SWW;DTYPE=a;CLUMP=A
 NODE=S126SZZ;DTYPE=a;CLUMP=A
 NODE=S126SGG;DTYPE=a;CLUMP=A
 NODE=S126SCC;DTYPE=a;CLUMP=A
 NODE=S126SBB;DTYPE=a;CLUMP=A
 NODE=S126SMU;DTYPE=a;CLUMP=A
 NODE=S126STT;DTYPE=a;CLUMP=A
 NODE=S126SZG;DTYPE=a;CLUMP=A
 NODE=S126A01;DTYPE=a;CLUMP=A
 NODE=S126KFC;DTYPE=c
 NODE=S126KVC;DTYPE=c
 NODE=S126STH;DTYPE=b;CLUMP=B
 NODE=S126SBH;DTYPE=b;CLUMP=B
 NODE=S126SHH;DTYPE=b
 NODE=S126KLA;DTYPE=b
 NODE=S126K2V;DTYPE=b
 NODE=S126PTH;DTYPE=b
 NODE=S126A02;DTYPE=b

NODE=S126A03;DTYPE=b

H DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$W W^*$	(25.7 $\pm$ 2.5) %		—
$Z Z^*$	(2.80 $\pm$ 0.30) %		—
$\gamma\gamma$	(2.50 $\pm$ 0.20) $\times 10^{-3}$		62600
$b\bar{b}$	(53 $\pm$ 8) %		—
$e^+ e^-$	< 3.0 $\times 10^{-4}$	95%	62600
$\mu^+ \mu^-$	(2.6 $\pm$ 1.3) $\times 10^{-4}$		62600
$\tau^+ \tau^-$	(6.0 $^{+0.8}_{-0.7}$) %		62575
$Z\gamma$	(3.4 $\pm$ 1.1) $\times 10^{-3}$		29392
$Z\rho(770)$	< 1.21 %	95%	29384
$Z\phi(1020)$	< 3.6 $\times 10^{-3}$	95%	29378
ZJ/ψ	< 1.9 $\times 10^{-3}$	95%	29267
$Z\psi(2S)$	< 6.6 $\times 10^{-3}$	95%	29214
$J/\psi\gamma$	< 2.0 $\times 10^{-4}$	95%	62561
$J/\psi J/\psi$	< 3.8 $\times 10^{-4}$	95%	62523
$\psi(2S)\gamma$	< 1.05 $\times 10^{-3}$	95%	62546
$\psi(2S)J/\psi$	< 2.1 $\times 10^{-3}$	95%	62507
$\psi(2S)\psi(2S)$	< 3.0 $\times 10^{-3}$	95%	62491
$\Upsilon(1S)\gamma$	< 2.5 $\times 10^{-4}$	95%	62242
$\Upsilon(1S)\Upsilon(1S)$	< 1.7 $\times 10^{-3}$	95%	61881
$\Upsilon(2S)\gamma$	< 4.2 $\times 10^{-4}$	95%	62199
$\Upsilon(3S)\gamma$	< 3.4 $\times 10^{-4}$	95%	62172
$\Upsilon(nS)\Upsilon(mS)$	< 3.5 $\times 10^{-4}$	95%	—
$D^*\gamma$	< 1.0 $\times 10^{-3}$	95%	62584
$\rho(770)\gamma$	< 1.04 $\times 10^{-3}$	95%	62597
$\omega(782)\gamma$	< 5.5 $\times 10^{-4}$	95%	62597
$K^*(892)\gamma$	< 2.2 $\times 10^{-4}$	95%	62597
$\phi(1020)\gamma$	< 5 $\times 10^{-4}$	95%	62596
$e\mu$	LF < 4.4 $\times 10^{-5}$	95%	62600
$e\tau$	LF < 2.0 $\times 10^{-3}$	95%	62587
$\mu\tau$	LF < 1.5 $\times 10^{-3}$	95%	62587
invisible	< 10.7 %	95%	—
γ invisible	< 1.3 %	95%	—

NODE=S126220;DESIG=1

DESIG=2

DESIG=3

DESIG=4

DESIG=10

DESIG=8

DESIG=5

DESIG=6

DESIG=25

DESIG=26

DESIG=28

DESIG=29

DESIG=11

DESIG=22

DESIG=20

DESIG=30

DESIG=31

DESIG=12

DESIG=32

DESIG=13

DESIG=14

DESIG=23

DESIG=35

DESIG=19

DESIG=33

DESIG=34

DESIG=15

DESIG=17

DESIG=18

DESIG=9

DESIG=7

DESIG=24

Neutral Higgs Bosons, Searches for

NODE=S055

Mass limits for heavy neutral Higgs bosons (H_2^0, A^0) in the MSSM

The results have been obtained in the M_h^{125} benchmark scenario

$m > 1121$ GeV, CL = 95%	($\tan\beta = 10$)
$m > 1475$ GeV, CL = 95%	($\tan\beta = 20$)
$m > 1677$ GeV, CL = 95%	($\tan\beta = 30$)
$m > 1826$ GeV, CL = 95%	($\tan\beta = 40$)
$m > 1950$ GeV, CL = 95%	($\tan\beta = 50$)
$m > 2062$ GeV, CL = 95%	($\tan\beta = 60$)

Charged Higgs Bosons ($H^\pm$ and $H^{\pm\pm}$), Searches for

Mass limits for $m_{H^\pm} < m(\text{top})$ in the MSSM

$m > 155$ GeV, CL = 95%

Mass limits for $m_{H^\pm} > m(\text{top})$ in the MSSM

The results have been obtained in the m_h^{mod-} benchmark scenario

$m > 181$ GeV, CL = 95%	($\tan\beta = 10$)
$m > 249$ GeV, CL = 95%	($\tan\beta = 20$)
$m > 390$ GeV, CL = 95%	($\tan\beta = 30$)
$m > 894$ GeV, CL = 95%	($\tan\beta = 40$)
$m > 1017$ GeV, CL = 95%	($\tan\beta = 50$)
$m > 1103$ GeV, CL = 95%	($\tan\beta = 60$)

New Heavy Bosons (W' , Z' , leptoquarks, etc.), Searches for

Additional W Bosons

W' with standard couplings

Mass $m > 6000$ GeV, CL = 95%	(pp direct search)
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W_R (Right-handed W Boson)

Mass $m > 715$ GeV, CL = 90%	(electroweak fit)
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Additional Z Bosons

Z'_{SM} with standard couplings

Mass $m > 5150$ GeV, CL = 95%	(pp direct search)
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Z_{LR} of $SU(2)_L \times SU(2)_R \times U(1)$ (with $g_L = g_R$)

Mass $m > 630$ GeV, CL = 95%	($p\bar{p}$ direct search)
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Mass $m > 1162$ GeV, CL = 95%	(electroweak fit)
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Z_χ of $SO(10) \rightarrow SU(5) \times U(1)_\chi$ (with $g_\chi = e/\cos\theta_W$)

Mass $m > 4800$ GeV, CL = 95%	(pp direct search)
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Z_ψ of $E_6 \rightarrow SO(10) \times U(1)_\psi$ (with $g_\psi = e/\cos\theta_W$)

Mass $m > 4560$ GeV, CL = 95%	(pp direct search)
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Z_η of $E_6 \rightarrow SU(3) \times SU(2) \times U(1) \times U(1)_\eta$ (with $g_\eta = e/\cos\theta_W$)

Mass $m > 3.900 \times 10^3$ GeV, CL = 95%	(pp direct search)
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Scalar Leptoquarks

$m > 1800$ GeV, CL = 95%	(1st gen., pair prod., $B(eq)=1$)
$m > 1755$ GeV, CL = 95%	(1st gen., single prod., $B(eq)=1$)
$m > 1700$ GeV, CL = 95%	(2nd gen., pair prod., $B(\mu q)=1$)
$m > 660$ GeV, CL = 95%	(2nd gen., single prod., $B(\mu q)=1$)
$m > 1520$ GeV, CL = 95%	(3rd gen., pair prod., $B(\tau t)=1$)
$m > 1280$ GeV, CL = 95%	(3rd gen., single prod., $B(\tau b)=1$)

(See the Particle Listings for assumptions on leptoquark quantum numbers and branching fractions.)

CLUMP=A

NODE=S055HM1;DTYPE=M;CLUMP=A
NODE=S055HM2;DTYPE=M;CLUMP=A
NODE=S055HM3;DTYPE=M;CLUMP=A
NODE=S055HM4;DTYPE=M;CLUMP=A
NODE=S055HM5;DTYPE=M;CLUMP=A
NODE=S055HM6;DTYPE=M;CLUMP=A

NODE=S064

CLUMP=A

NODE=S064HT0;DTYPE=M;CLUMP=A;
OUR EVAL;→ UNCHECKED ←

CLUMP=B

NODE=S064HT1;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←
NODE=S064HT2;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←
NODE=S064HT3;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←
NODE=S064HT4;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←
NODE=S064HT5;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←
NODE=S064HT6;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←

NODE=S056

CLUMP=A

NODE=S056W1C;DTYPE=M;CLUMP=A;
OUR LIM;→ UNCHECKED ←

NODE=S056MR;DTYPE=M;CLUMP=A

CLUMP=B

NODE=S056Z1C;DTYPE=M;CLUMP=B;
OUR LIM;→ UNCHECKED ←

NODE=S056ZLR;DTYPE=M;CLUMP=B

NODE=S056ZL2;DTYPE=M;CLUMP=B;
OUR EVAL;→ UNCHECKED ←
NODE=S056ZCH;DTYPE=M;CLUMP=B;
OUR LIM;→ UNCHECKED ←

NODE=S056ZPS;DTYPE=M;CLUMP=B;
OUR LIM;→ UNCHECKED ←

NODE=S056ZET;DTYPE=M;CLUMP=B

CLUMP=C

NODE=S056EG1;DTYPE=M;CLUMP=C;
OUR EVAL;→ UNCHECKED ←
NODE=S056EG2;DTYPE=M;CLUMP=C;
OUR EVAL;→ UNCHECKED ←
NODE=S056EG3;DTYPE=M;CLUMP=C;
OUR EVAL;→ UNCHECKED ←
NODE=S056EG5;DTYPE=M;CLUMP=C;
OUR EVAL;→ UNCHECKED ←
NODE=S056EG4;DTYPE=M;CLUMP=C;
OUR EVAL;→ UNCHECKED ←
NODE=S056EG6;DTYPE=M;CLUMP=C;
OUR EVAL;→ UNCHECKED ←

Diquarks

Mass $m > 7200$ GeV, CL = 95% (E_6 diquark)

Axigluon

Mass $m > 6600$ GeV, CL = 95%

**Axions (A^0) and Other
Very Light Bosons, Searches for**

See the review on "Axions and other similar particles."

The best limit for the half-life of neutrinoless double beta decay with Majoron emission is $> 7.2 \times 10^{24}$ years (CL = 90%).

CLUMP=D

NODE=S056DQ;DTYPE=M;CLUMP=D;
OUR LIM;→ UNCHECKED ←
CLUMP=E

NODE=S056AXG;DTYPE=M;CLUMP=E;
OUR LIM;→ UNCHECKED ←

NODE=S029

NOTES

[a] Theoretical value. A mass as large as a few MeV may not be precluded.

[b] This value does not include the AALTONEN 22 measurement by CDF.
See the W mass section in the listings for details.

[c] ℓ indicates each type of lepton (e , μ , and τ), not sum over them.

[d] This represents the width for the decay of the W boson into a charged particle with momentum below detectability, $p < 200$ MeV.

[e] The Z -boson mass listed here corresponds to a Breit-Wigner resonance parameter. It lies approximately 34 MeV above the real part of the position of the pole (in the energy-squared plane) in the Z -boson propagator.

[f] This partial width takes into account Z decays into $\nu\bar{\nu}$ and any other possible undetected modes.

[g] This ratio has not been corrected for the τ mass.

[h] Here $A \equiv 2g_V g_A / (g_V^2 + g_A^2)$.

[i] Here ℓ indicates e or μ .

[j] The value is for the sum of the charge states or particle/antiparticle states indicated.

[k] This value is updated using the product of (i) the $Z \rightarrow b\bar{b}$ fraction from this listing and (ii) the b -hadron fraction in an unbiased sample of weakly decaying b -hadrons produced in Z -decays provided by the Heavy Flavor Averaging Group (HFLAV, <http://www.slac.stanford.edu/xorg/hflav/osc/PDG.2009/#FRACZ>).

[l] See the Z Particle Listings for the γ energy range used in this measurement.

[n] For $m_{\gamma\gamma} = (60 \pm 5)$ GeV.

LINKAGE=GSS

LINKAGE=SUM

LINKAGE=DXX

LINKAGE=WIN

LINKAGE=SZL

LINKAGE=ZZL

LINKAGE=TM

LINKAGE=ZA

LINKAGE=LEM

LINKAGE=SG

LINKAGE=HFF

LINKAGE=GDZ

LINKAGE=DYY