



Mjerenje svojstava Higgsovog bozona

Seminar doktoranada/postdoktoranada

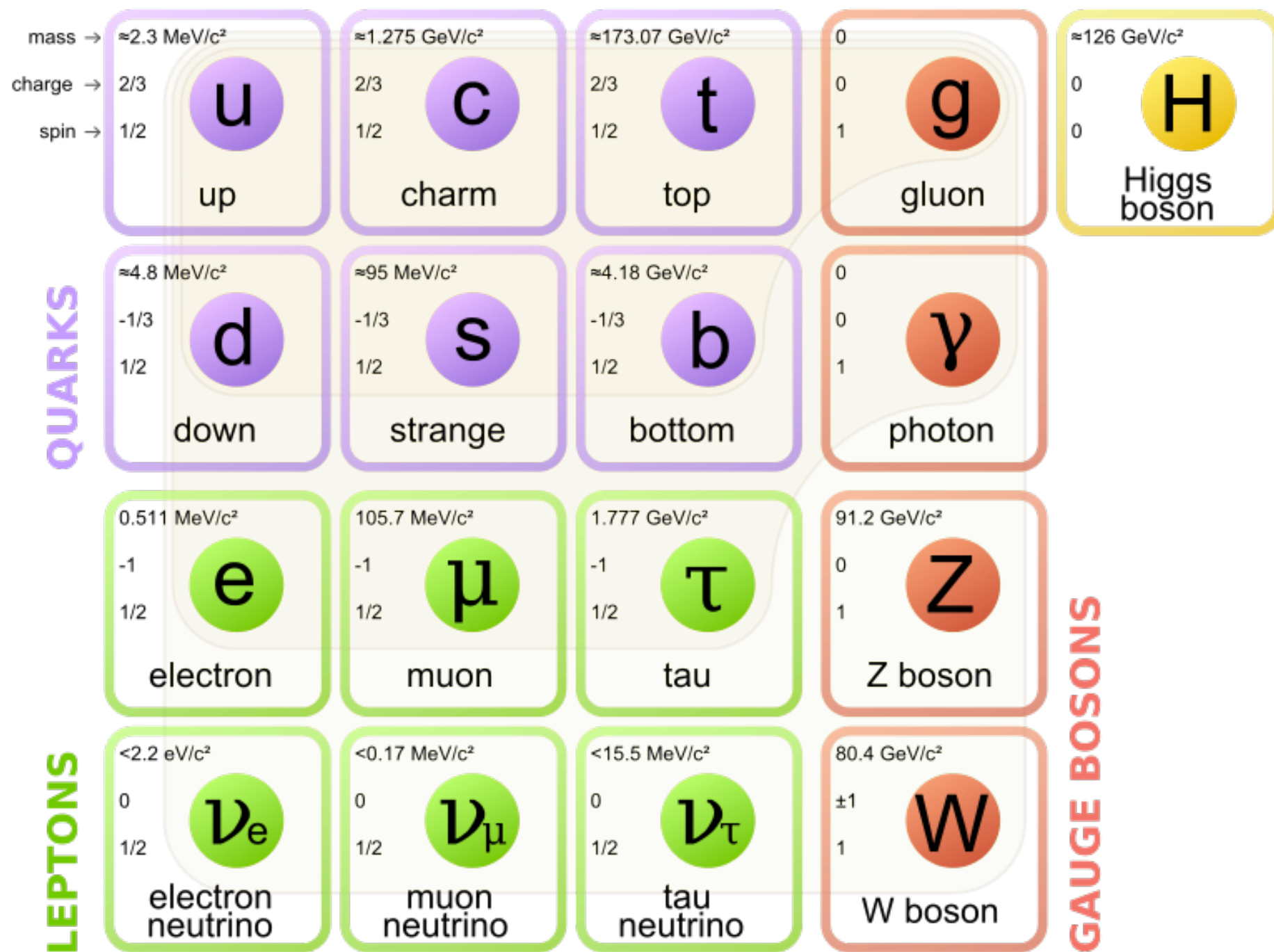
Marko Kovač

28.5.2014.

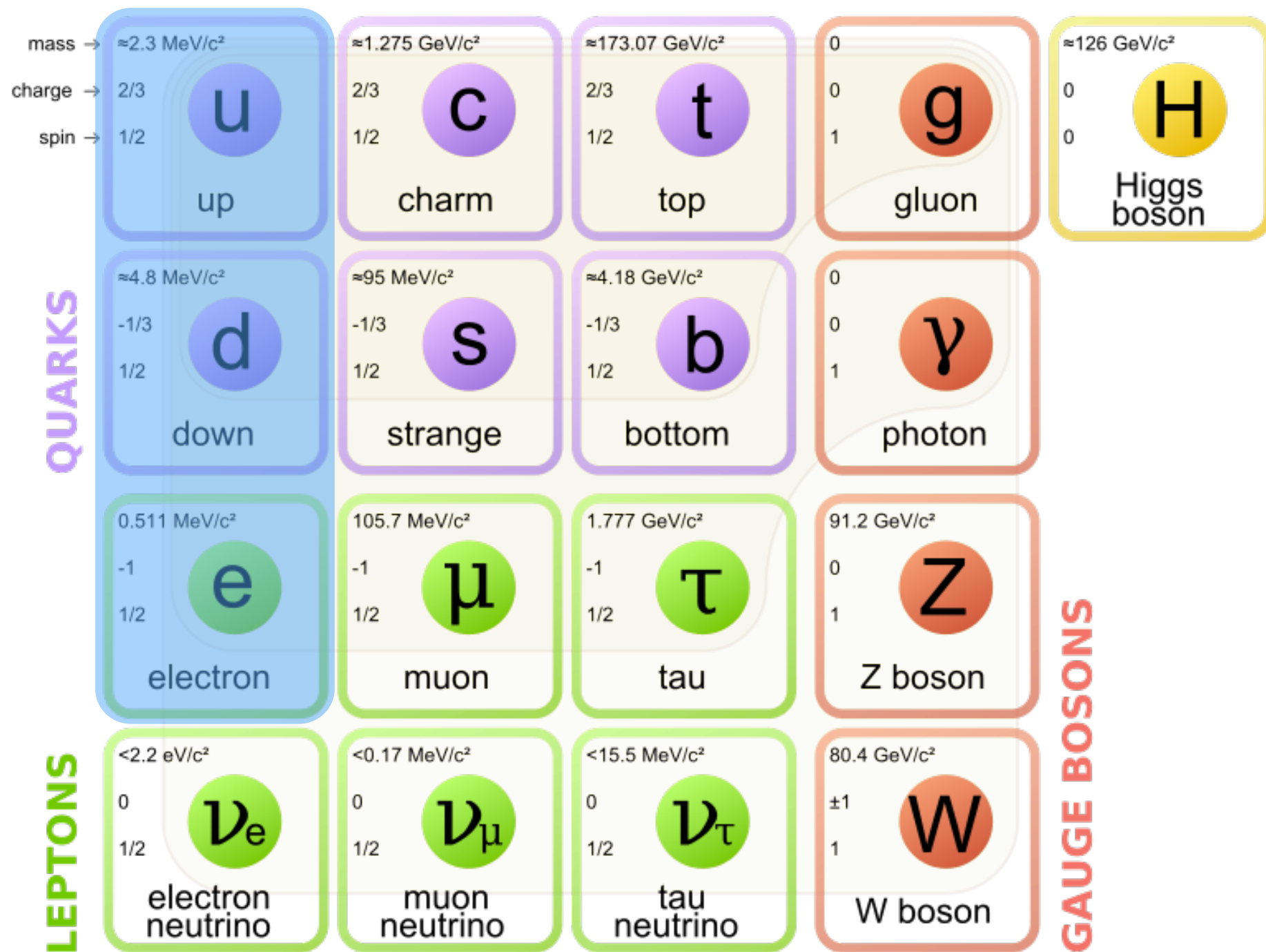
Sadržaj

- Standardni model (SM) elementarnih čestica
- CMS detektor
- Otkriće novog bozona
- Mjerenje spina novootkrivenog bozona
- Rezultati

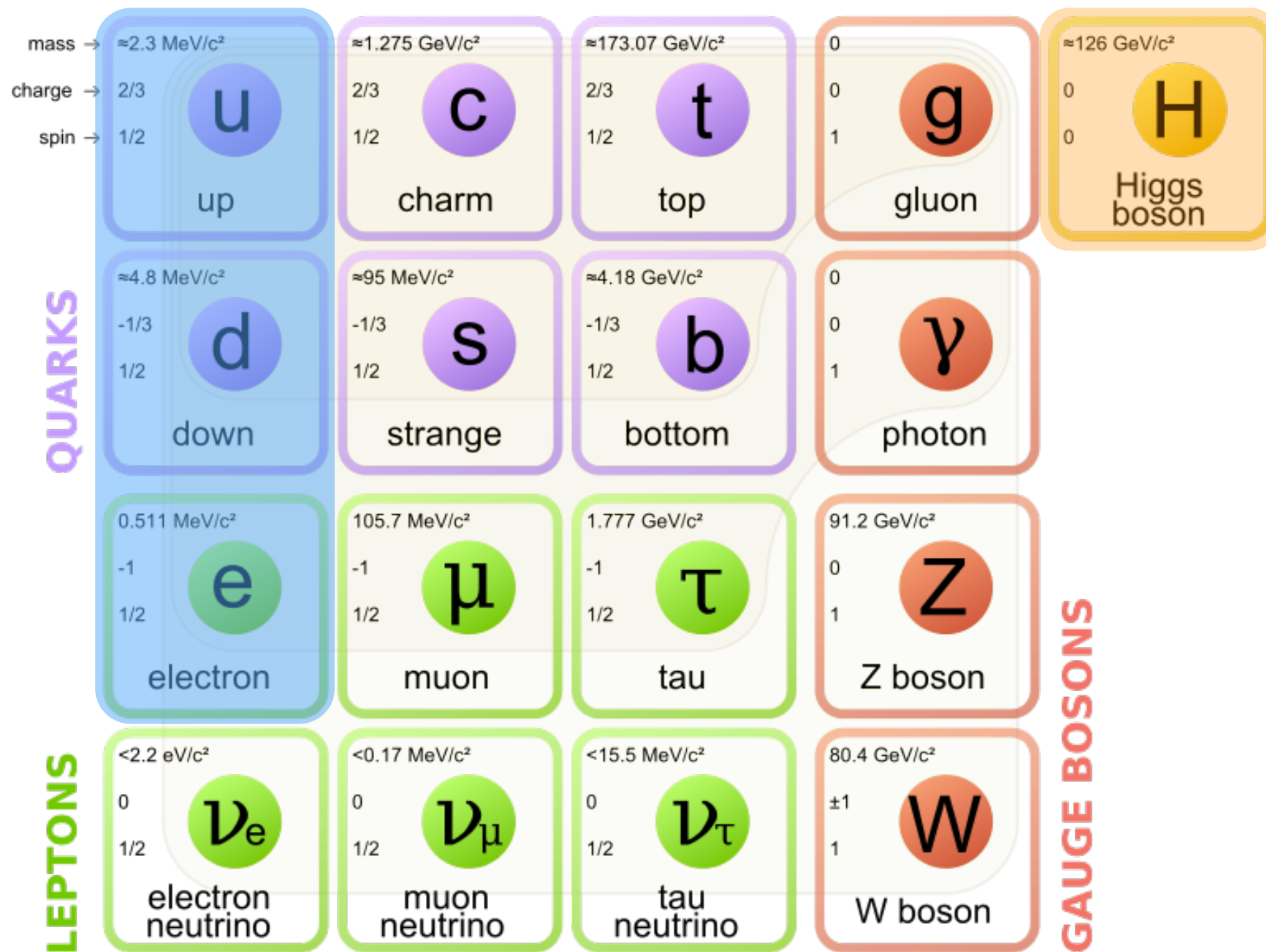
Standardni model elementarnih čestica



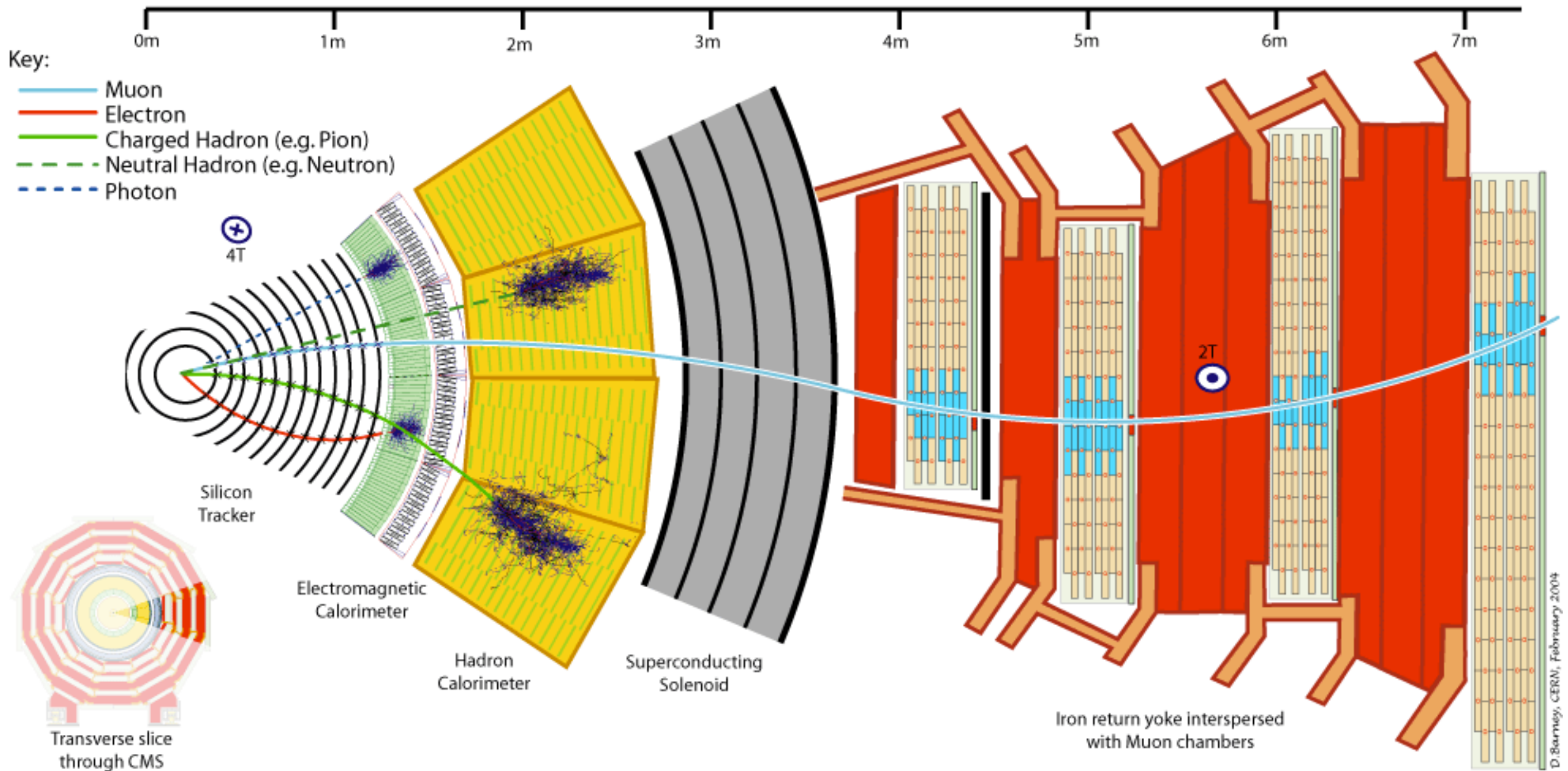
Standardni model elementarnih čestica



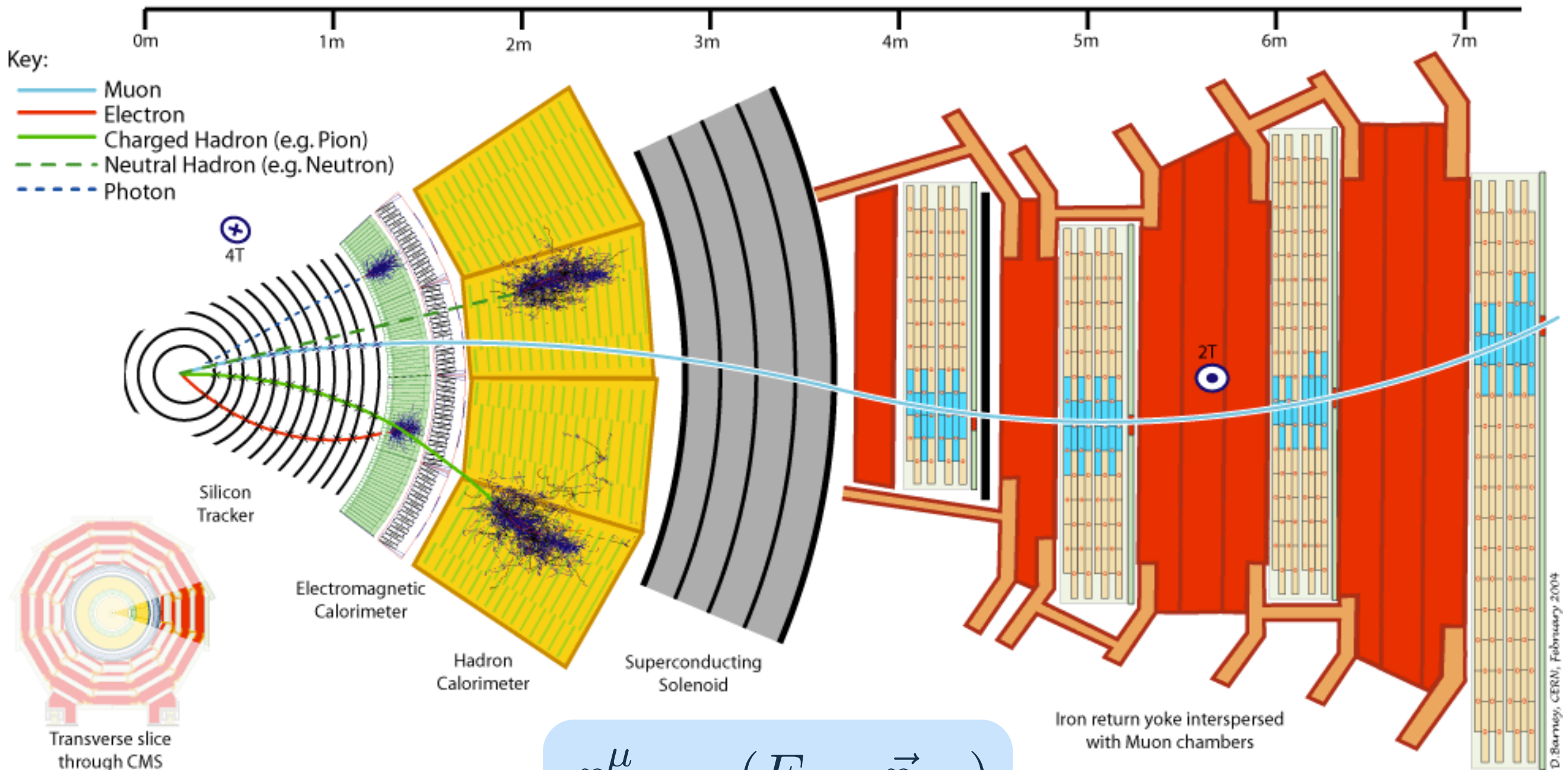
Standardni model elementarnih čestica



CMS detektor



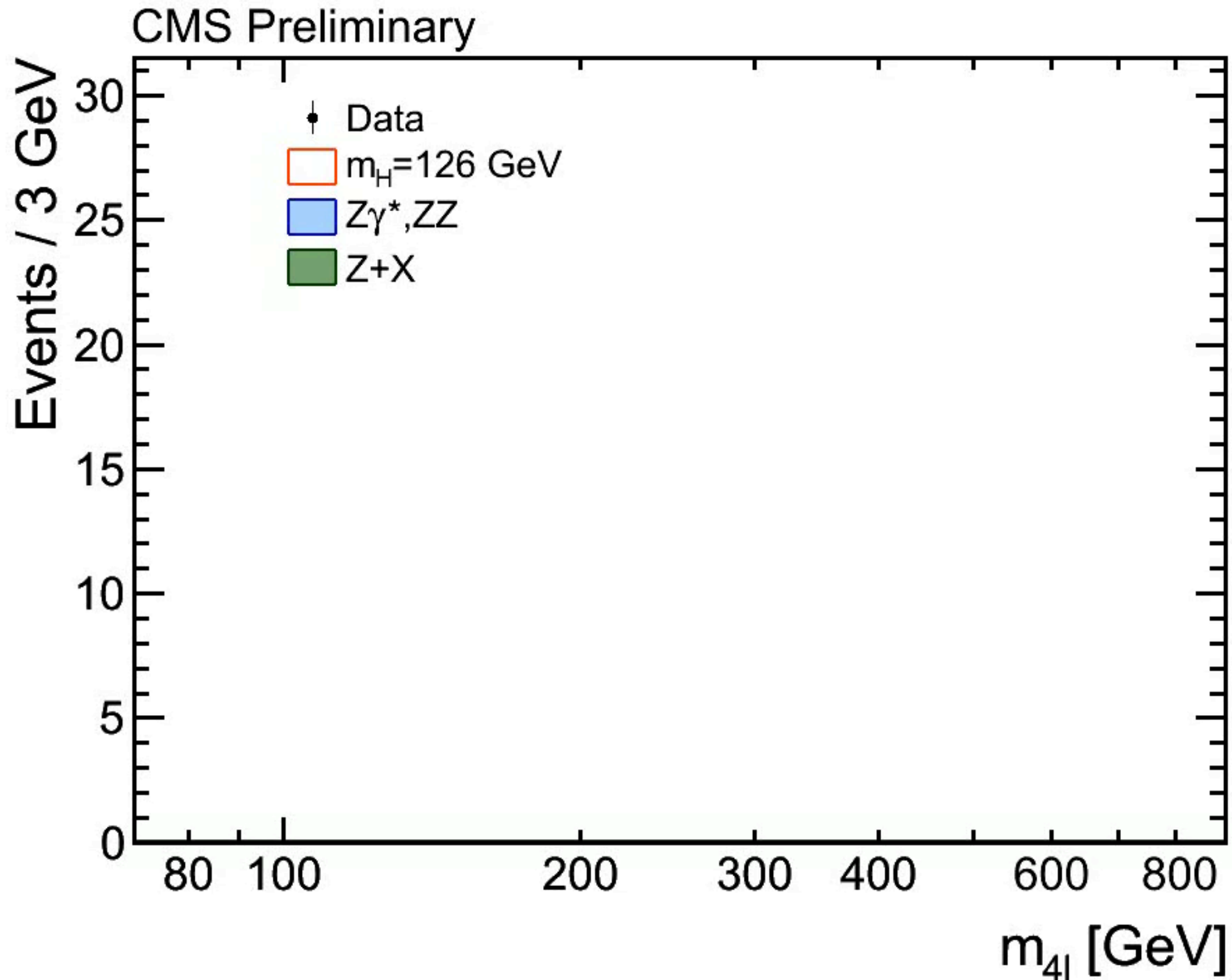
CMS detektor



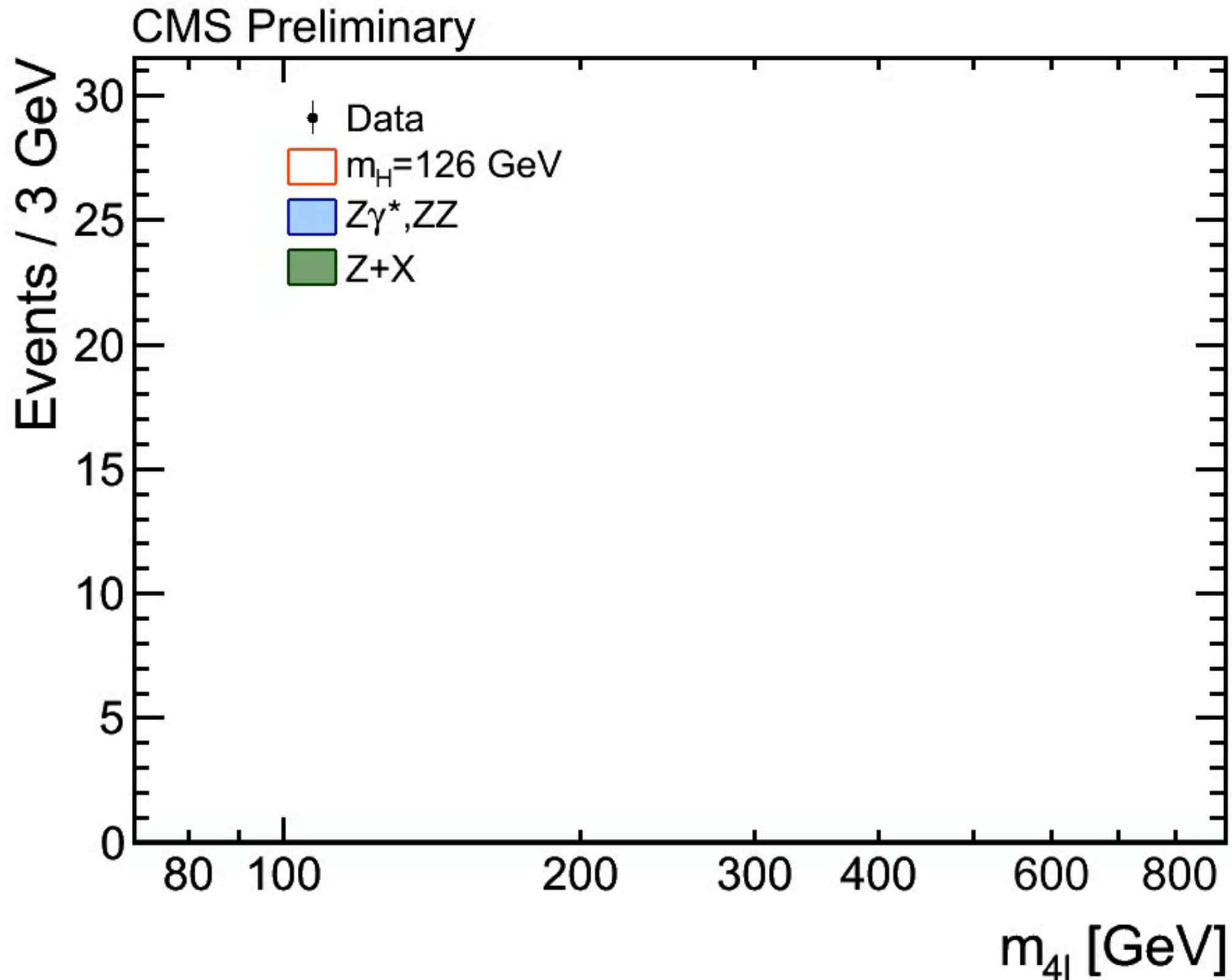
$$p_{e^+}^\mu = (E_{e^+}, \vec{p}_{e^+})$$

$$p_{e^-}^\mu = (E_{e^-}, \vec{p}_{e^-})$$

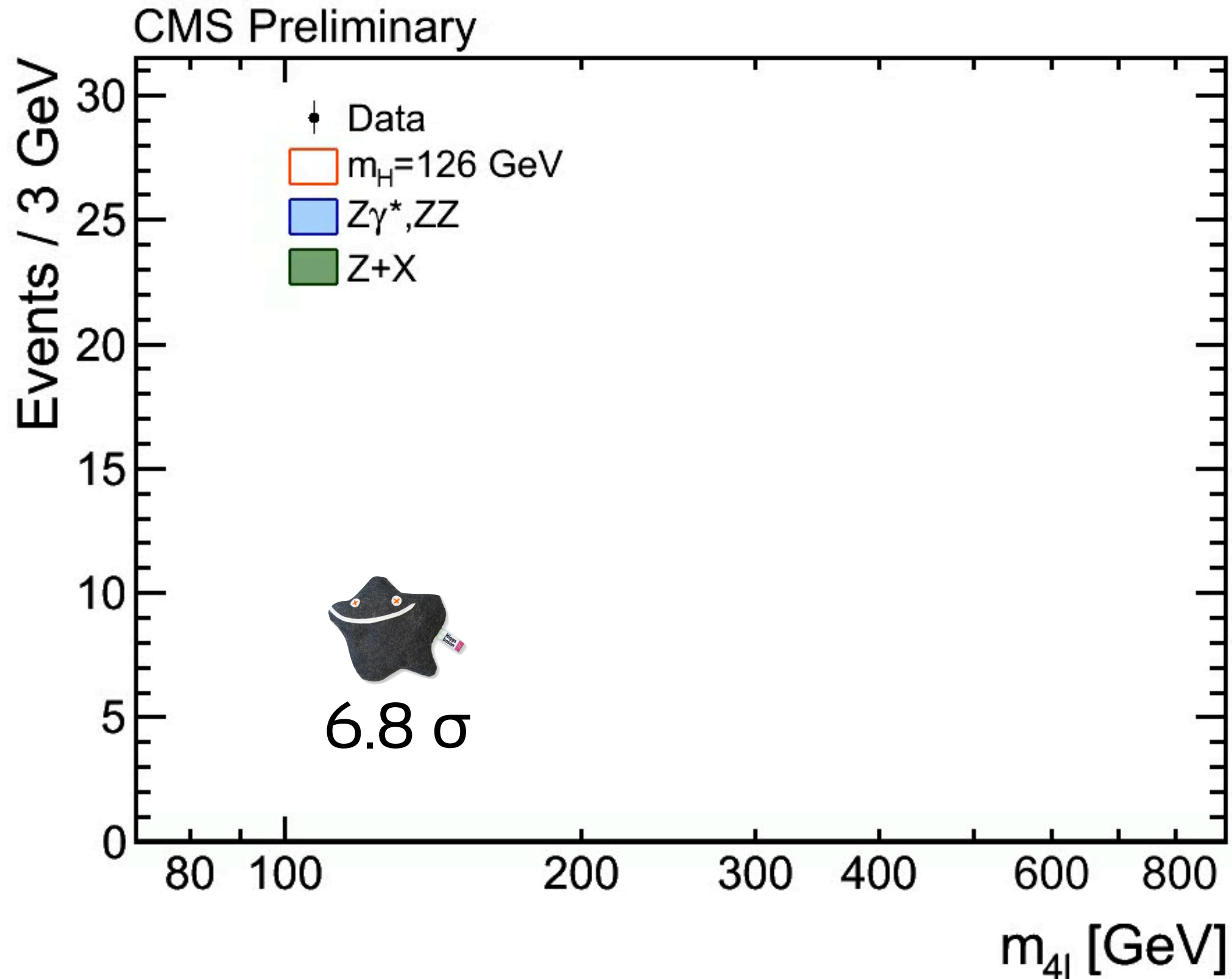
Otkriće novog bozona



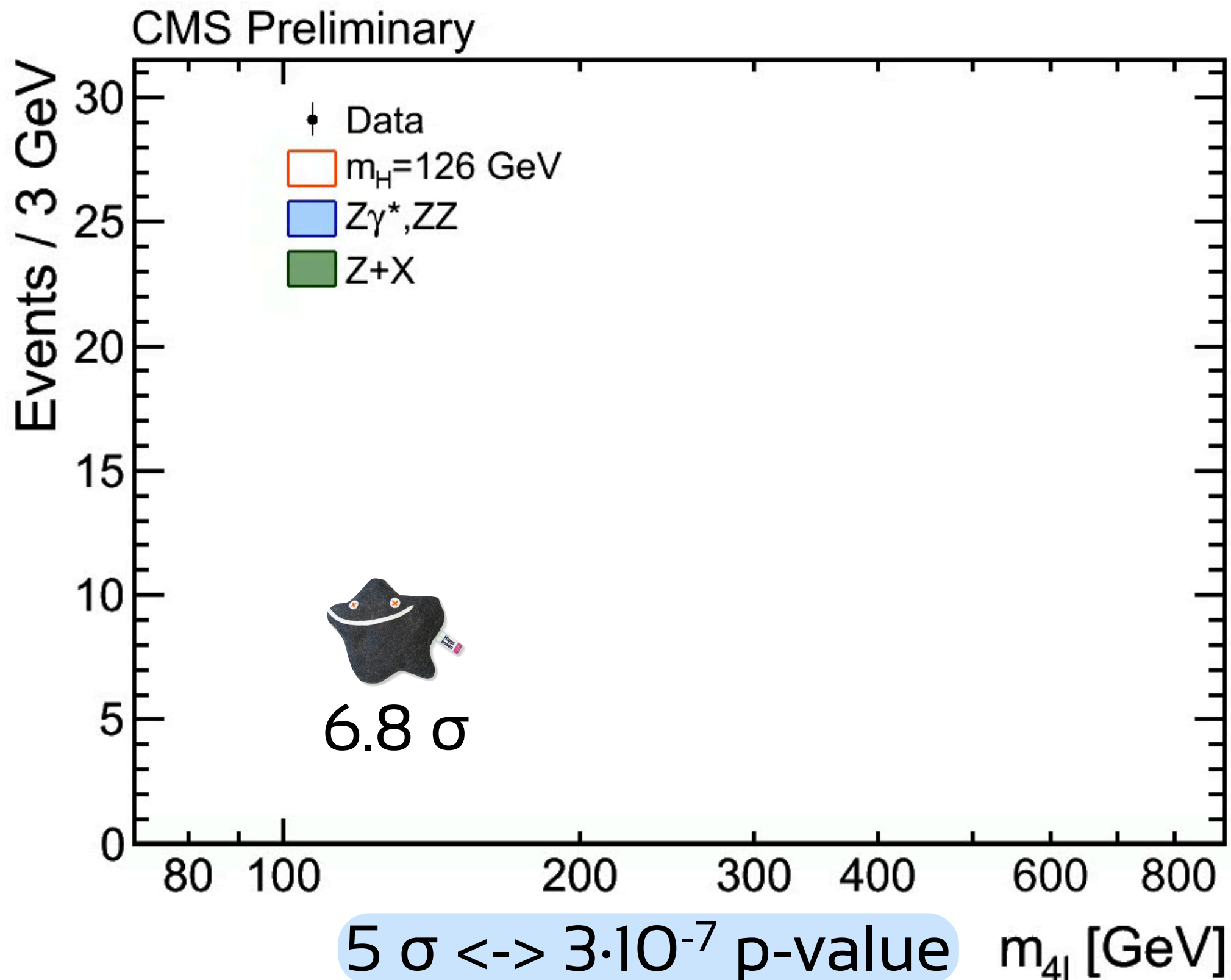
Otkriće novog bozona



Otkriće novog bozona



Otkriće novog bozona



Mjerenje spina novootkrivenog bozona

$$\begin{aligned}
 A(X \rightarrow V_1 V_2) = \Lambda^{-1} & \left[2g_1^{(2)} t_{\mu\nu} f^{*(1)\mu\alpha} f^{*(2)\nu\alpha} + 2g_2^{(2)} t_{\mu\nu} \frac{q_\alpha q_\beta}{\Lambda^2} f^{*(1)\mu\alpha} f^{*(2)\nu\beta} + g_3^{(2)} \frac{\tilde{q}^\beta \tilde{q}^\alpha}{\Lambda^2} t_{\beta\nu} \left(f^{*(1)\mu\nu} f_{\mu\alpha}^{*(2)} + f^{*(2)\mu\nu} f_{\mu\alpha}^{*(1)} \right) \right. \\
 & + g_4^{(2)} \frac{\tilde{q}^\nu \tilde{q}^\mu}{\Lambda^2} t_{\mu\nu} f^{*(1)\alpha\beta} f_{\alpha\beta}^{*(2)} + m_V^2 \left(2g_5^{(2)} t_{\mu\nu} \epsilon_1^{*\mu} \epsilon_2^{*\nu} + 2g_6^{(2)} \frac{\tilde{q}^\mu q_\alpha}{\Lambda^2} t_{\mu\nu} (\epsilon_1^{*\nu} \epsilon_2^{*\alpha} - \epsilon_1^{*\alpha} \epsilon_2^{*\nu}) + g_7^{(2)} \frac{\tilde{q}^\mu \tilde{q}^\nu}{\Lambda^2} t_{\mu\nu} \epsilon_1^* \epsilon_2^* \right) \\
 & \left. + g_8^{(2)} \frac{\tilde{q}_\mu \tilde{q}_\nu}{\Lambda^2} t_{\mu\nu} f^{*(1)\alpha\beta} \tilde{f}_{\alpha\beta}^{*(2)} + m_V^2 \left(g_9^{(2)} \frac{t_{\mu\alpha} \tilde{q}^\alpha}{\Lambda^2} \epsilon_{\mu\nu\rho\sigma} \epsilon_1^{*\nu} \epsilon_2^{*\rho} q^\sigma + \frac{g_{10}^{(2)} t_{\mu\alpha} \tilde{q}^\alpha}{\Lambda^4} \epsilon_{\mu\nu\rho\sigma} q^\rho \tilde{q}^\sigma (\epsilon_1^{*\nu} (q\epsilon_2^*) + \epsilon_2^{*\nu} (q\epsilon_1^*)) \right) \right]^{-1}
 \end{aligned}$$

Powheg Pythia
 MadGraph JHUGen Geant

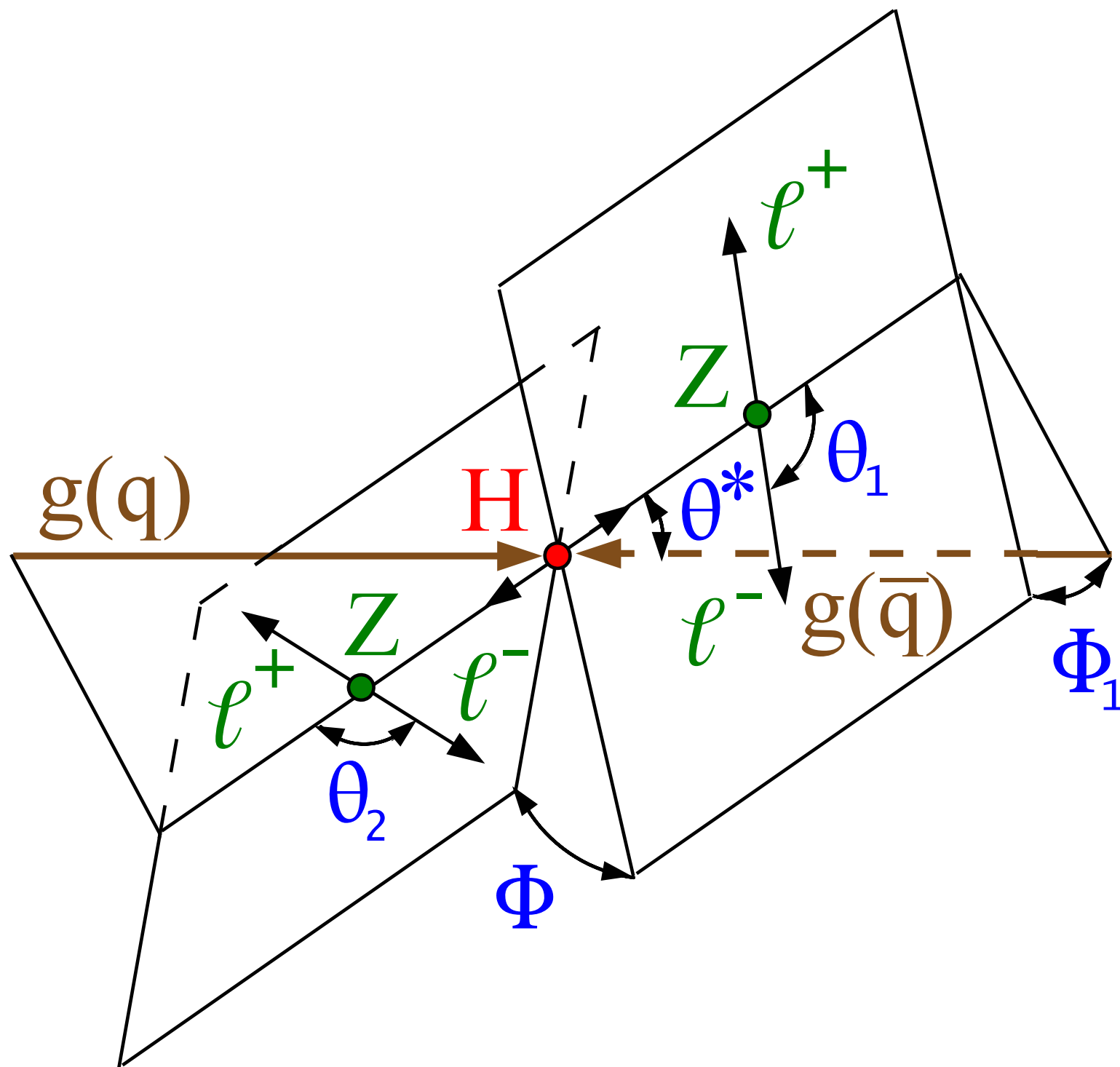
MC podaci

Mjerenje spina novootkrivenog bozona

Tijek analize:

- Simuliranje velikog broja događaja 0^+ modela (SM Higgs)
- Simuliranje velikog broja događaja alternativnih modela
 - Spin 0
 - Spin 1
 - Spin 2
- Analiza kinematike svakog događaja i konstruiranje diskriminanti potrebnih za statističku analizu
- Statistička analiza

Kinematika dogajaja



Opservable

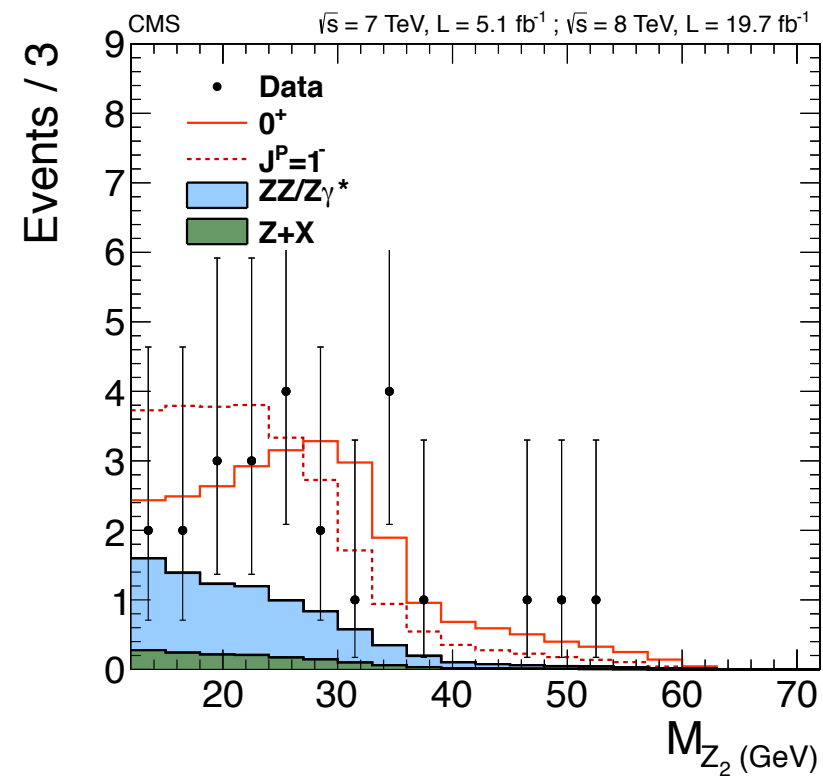
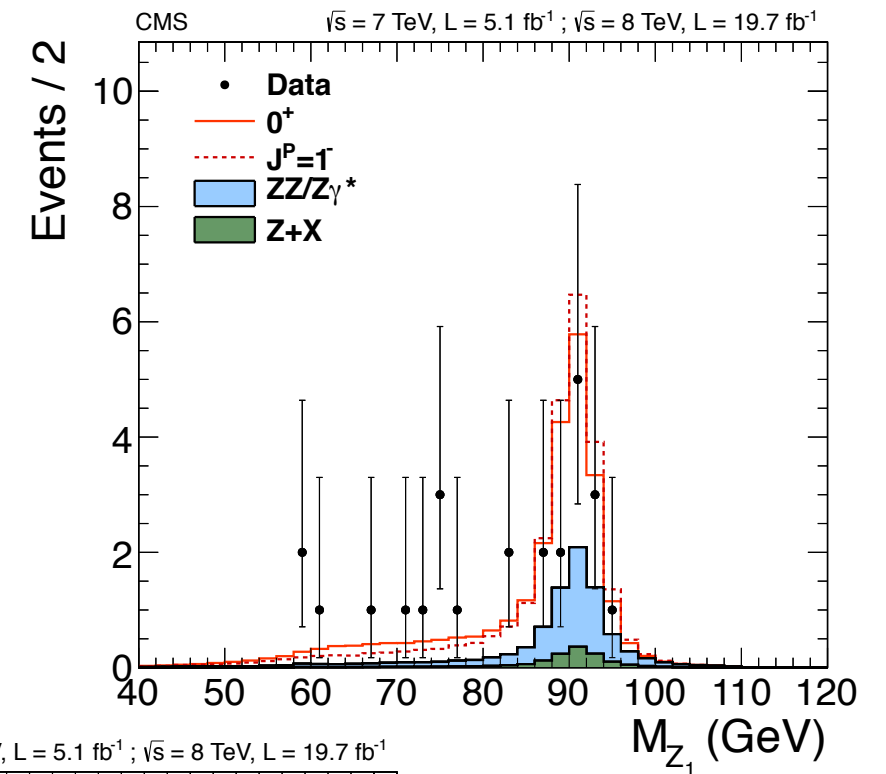
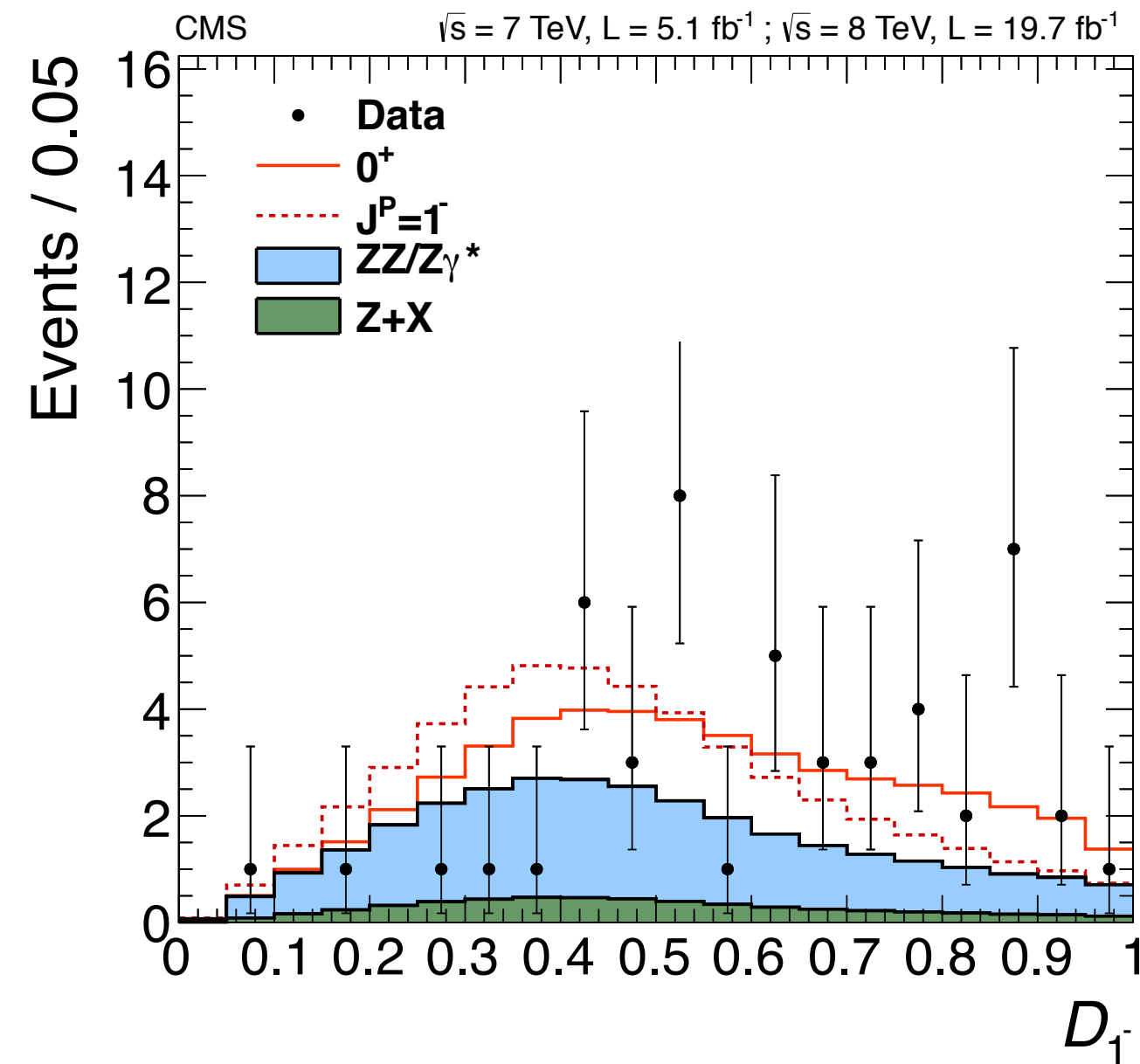


Matrični elementi

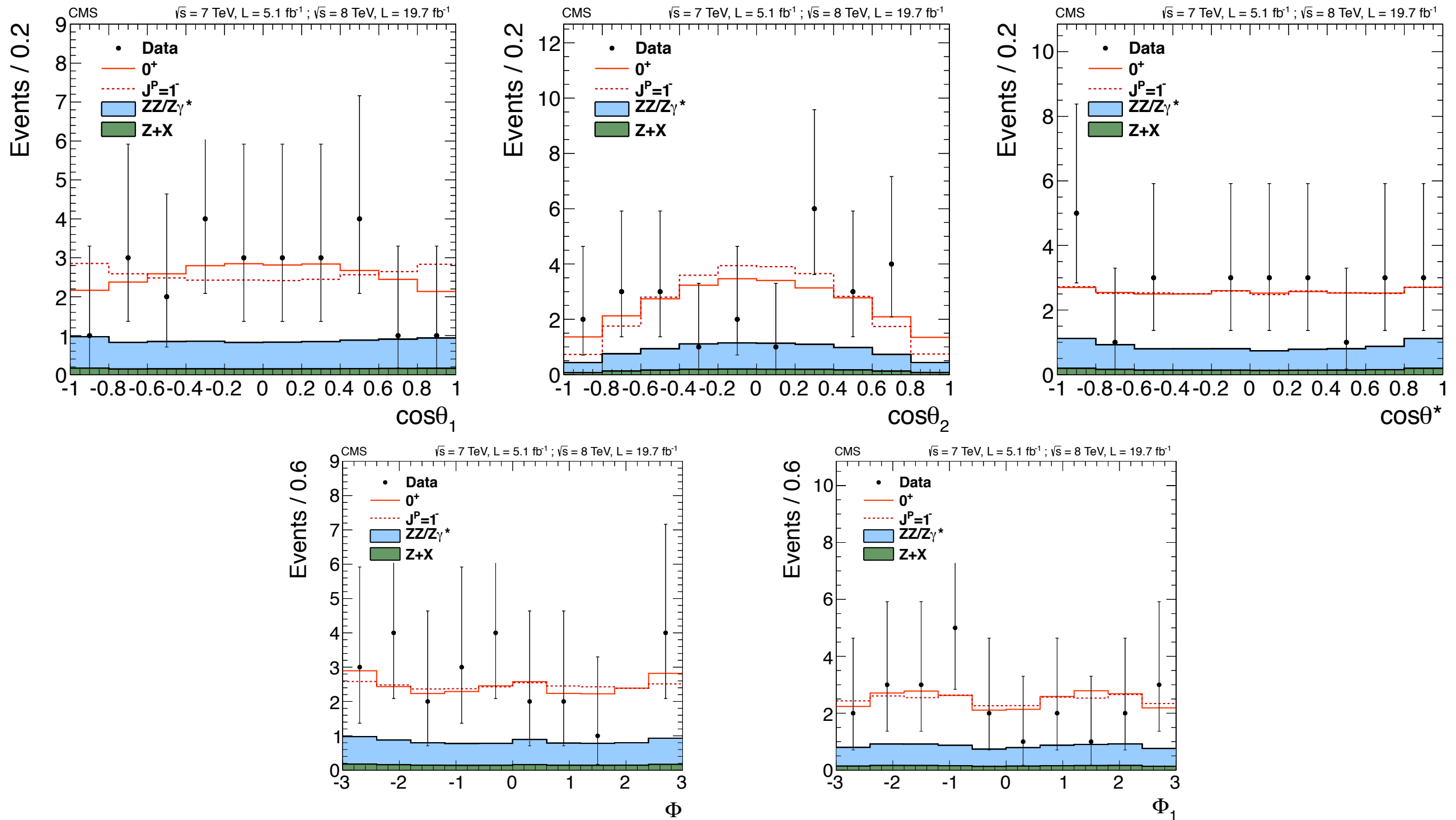


Diskriminante

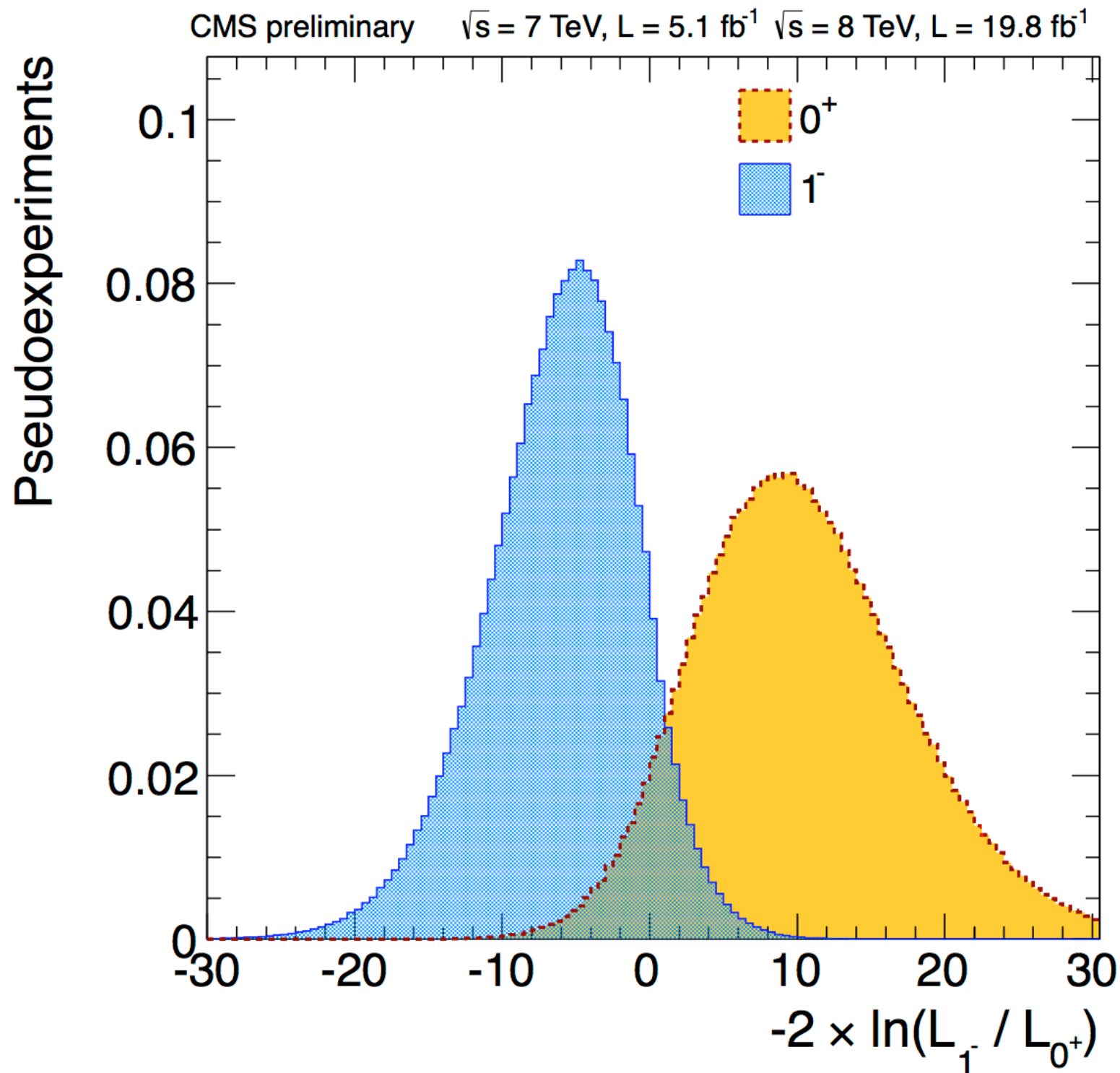
Kinematika događaja



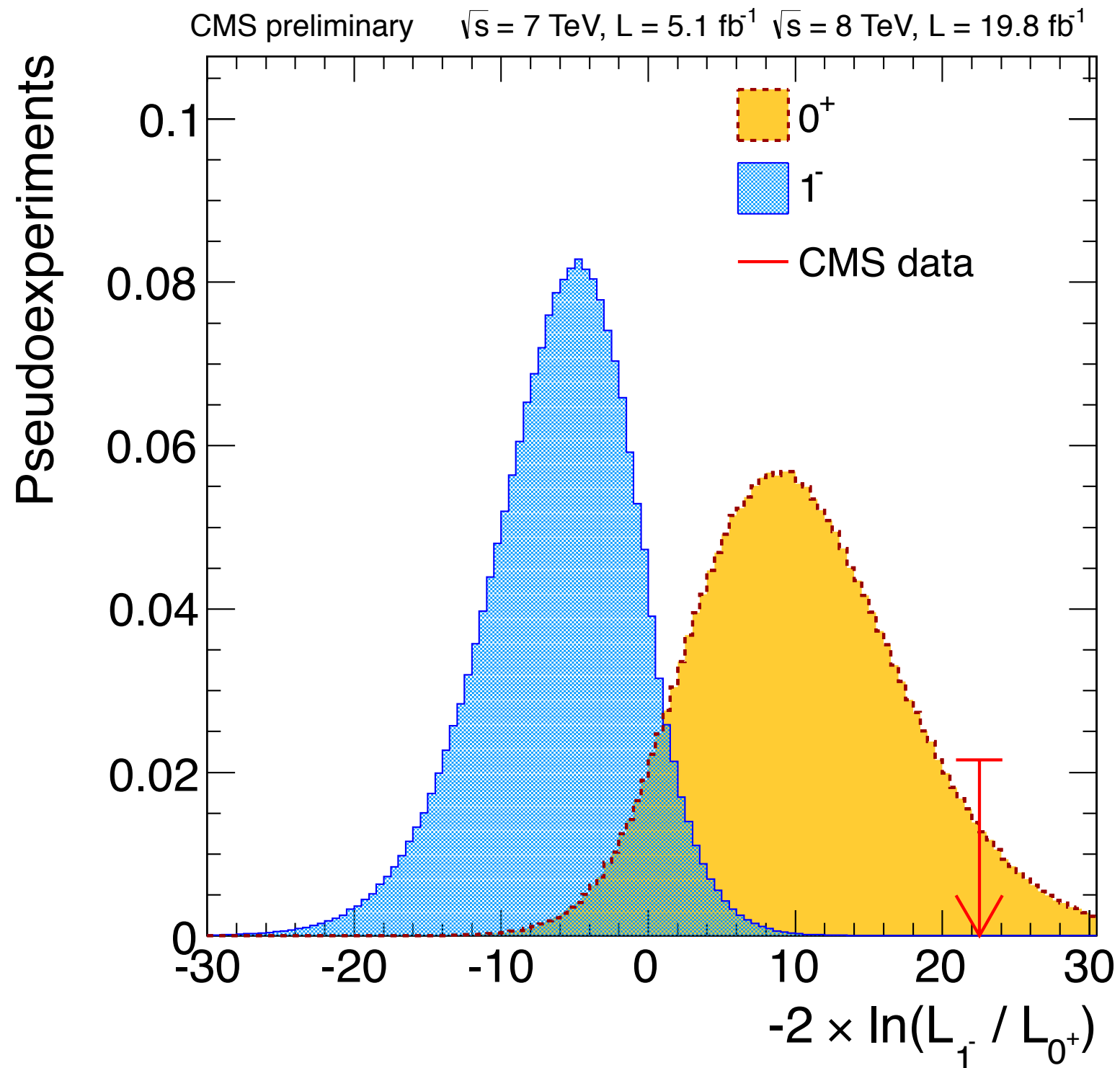
Kinematika događaja



Statistička analiza



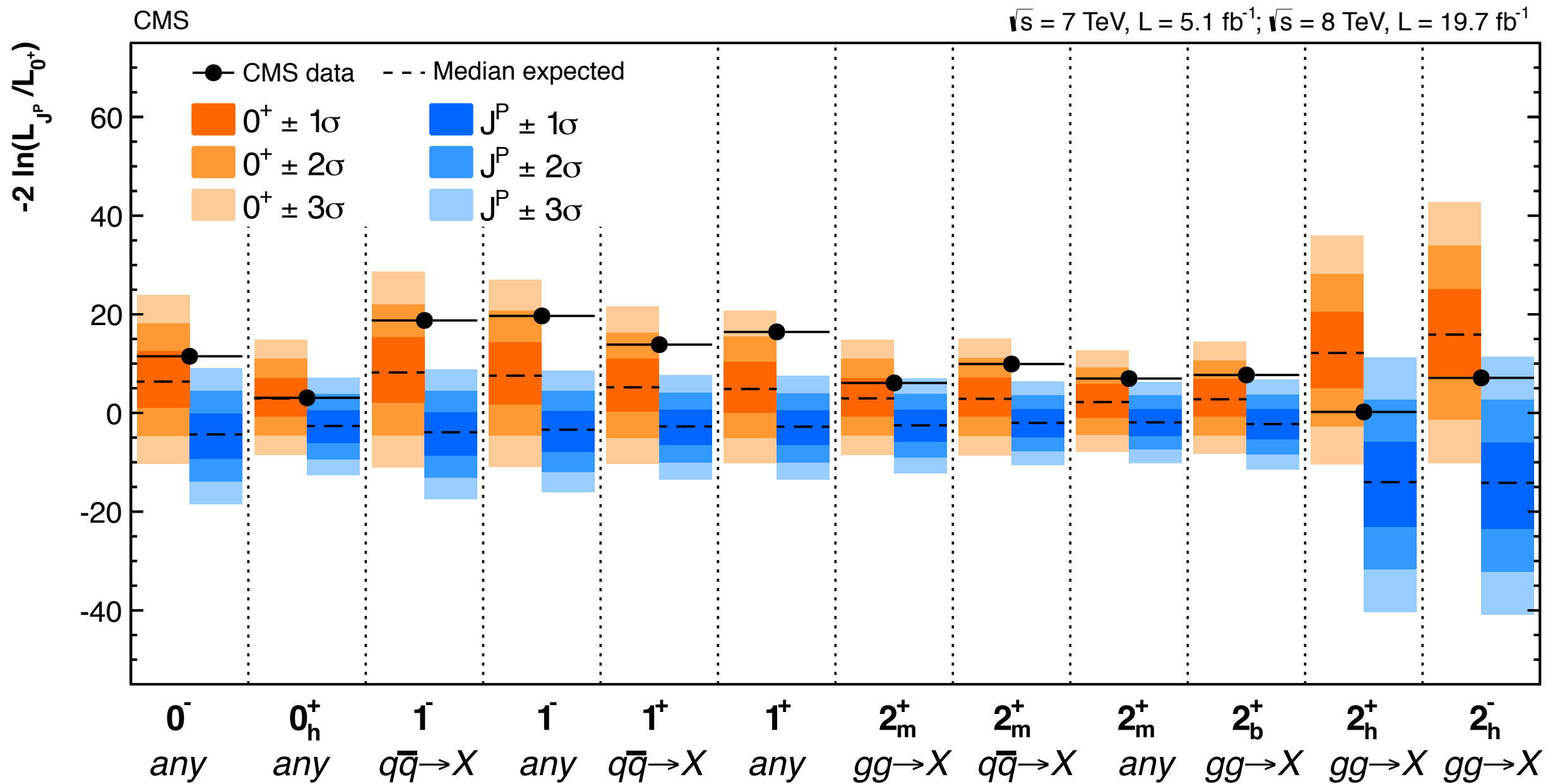
Statistička analiza



Rezultati

J^P model	J^P production	expected ($\mu=1$)	obs. 0^+	obs. J^P	CL _s
0^-	any	2.4σ (2.7σ)	-0.9σ	$+3.6\sigma$	0.09%
0_h^+	any	1.7σ (1.9σ)	-0.0σ	$+1.8\sigma$	7.1%
1^-	$q\bar{q} \rightarrow X$	2.6σ (2.7σ)	-1.4σ	$+4.8\sigma$	0.001%
1^-	any	2.6σ (2.6σ)	-1.7σ	$+4.9\sigma$	0.001%
1^+	$q\bar{q} \rightarrow X$	2.1σ (2.3σ)	-1.5σ	$+4.1\sigma$	0.03%
1^+	any	2.0σ (2.1σ)	-1.9σ	$+4.5\sigma$	0.01%
2_m^+	$gg \rightarrow X$	1.7σ (1.8σ)	-0.8σ	$+2.6\sigma$	1.9%
2_m^+	$q\bar{q} \rightarrow X$	1.6σ (1.7σ)	-1.6σ	$+3.6\sigma$	0.03%
2_m^+	any	1.5σ (1.5σ)	-1.3σ	$+3.0\sigma$	1.4%
2_b^+	$gg \rightarrow X$	1.6σ (1.8σ)	-1.2σ	$+3.1\sigma$	0.9%
2_h^+	$gg \rightarrow X$	3.7σ (4.0σ)	$+1.8\sigma$	$+1.9\sigma$	3.1%
2_h^-	$gg \rightarrow X$	4.0σ (4.5σ)	$+1.0\sigma$	$+3.0\sigma$	1.7%

Rezultati



Zaključak

Sva mjerenja izvršena do sada ukazuju na to da se radi o Standard Model Higgsovom bozonu!

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Sva mjerenja izvršena do sada ukazuju na to da se radi o Standard Model Higgsovom bozonu!