Higgs Status
Experiments VS Theories

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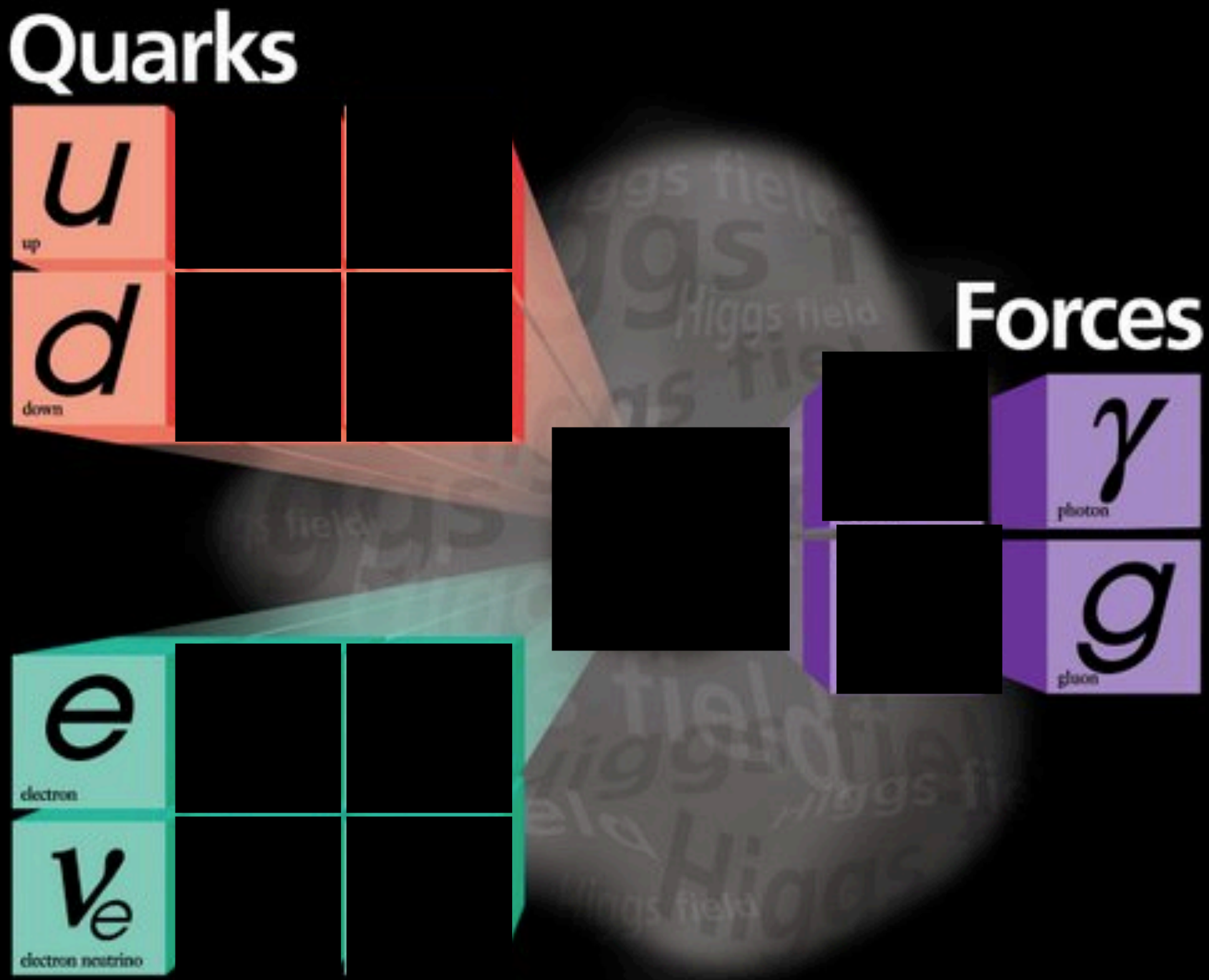
CP³ - Origins

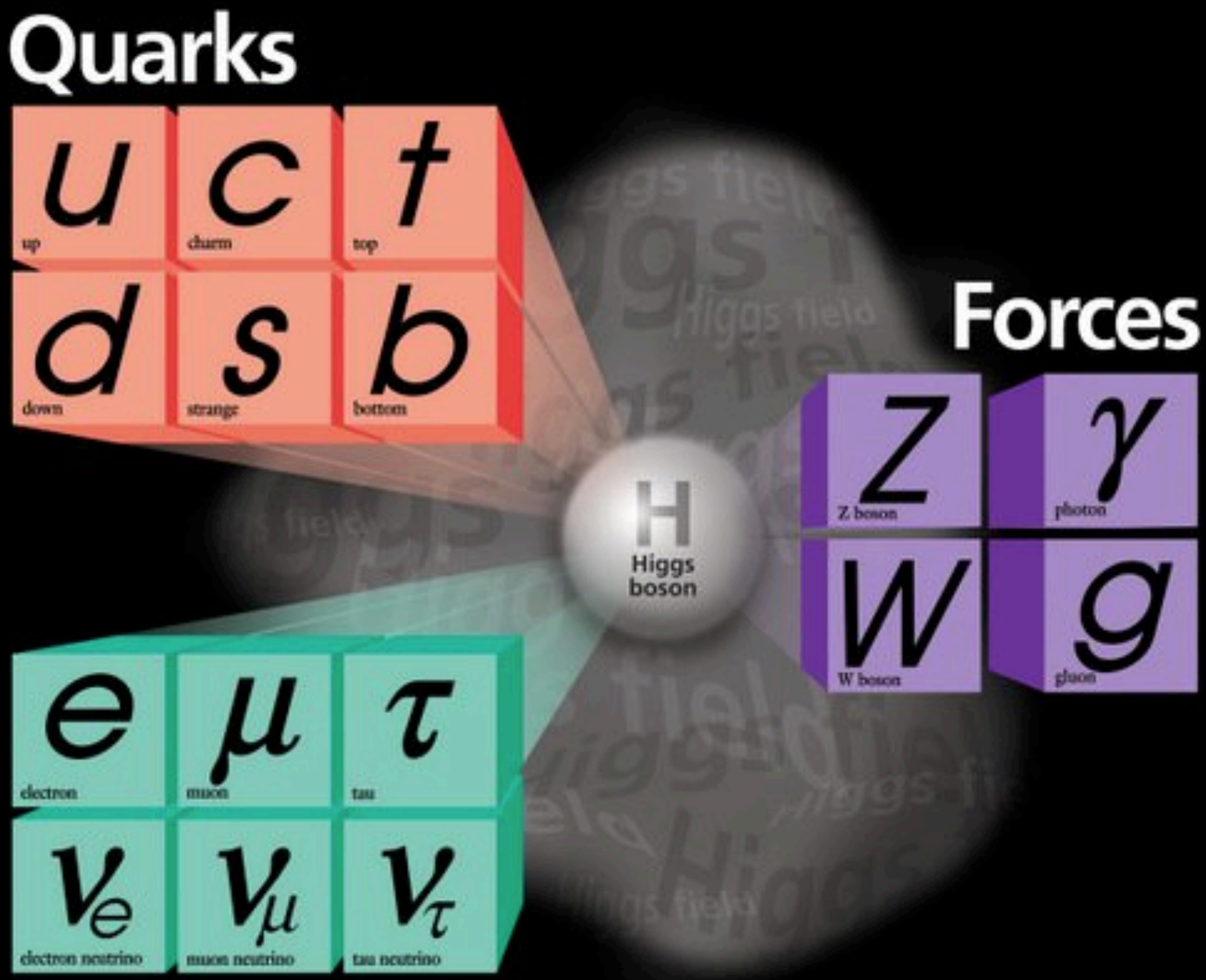
Particle Physics & Origin of Mass

17th January 2012

Matter


Quarks
u
up
d
down
Forces
γ
photon
g
gluon
e
electron
νe
electron neutrino
Leptons

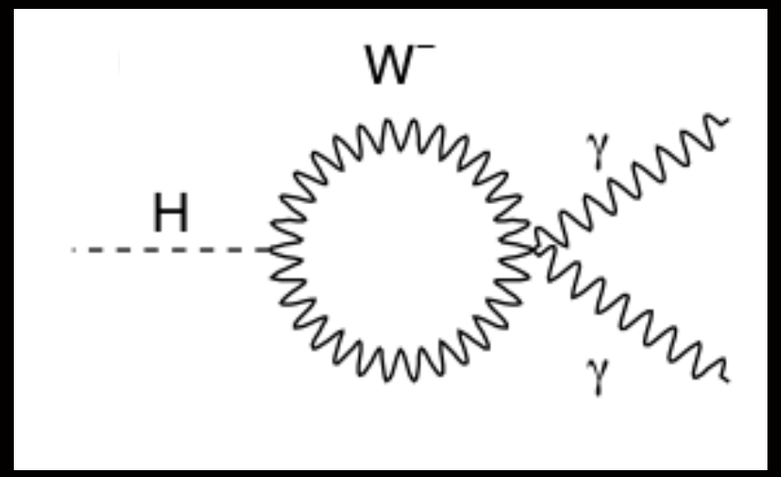
The Standard Model



Higgs at the Large Hadron Collider

- We are interested in processes like

$$pp \to H \to \gamma\gamma$$



$$\#\ \text{Events} = \sigma \cdot \mathcal{L} \cdot \Delta t$$

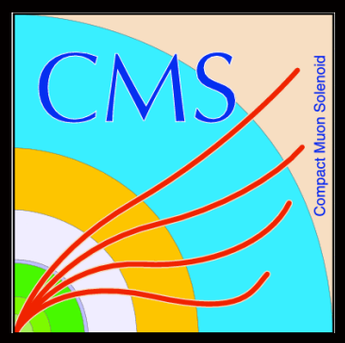
- Cross section σ: is the (differential) probability that the given process happen
  - Depends on the physics
- Luminosity $\mathcal{L}$: is related to the number of particle present in the beam
  - Depends on the experimental setup (LHC)
- Backgrounds: events with same final state of the signal events

$$pp \to X \to \gamma\gamma \qquad\qquad X \neq H$$

13th December 2011

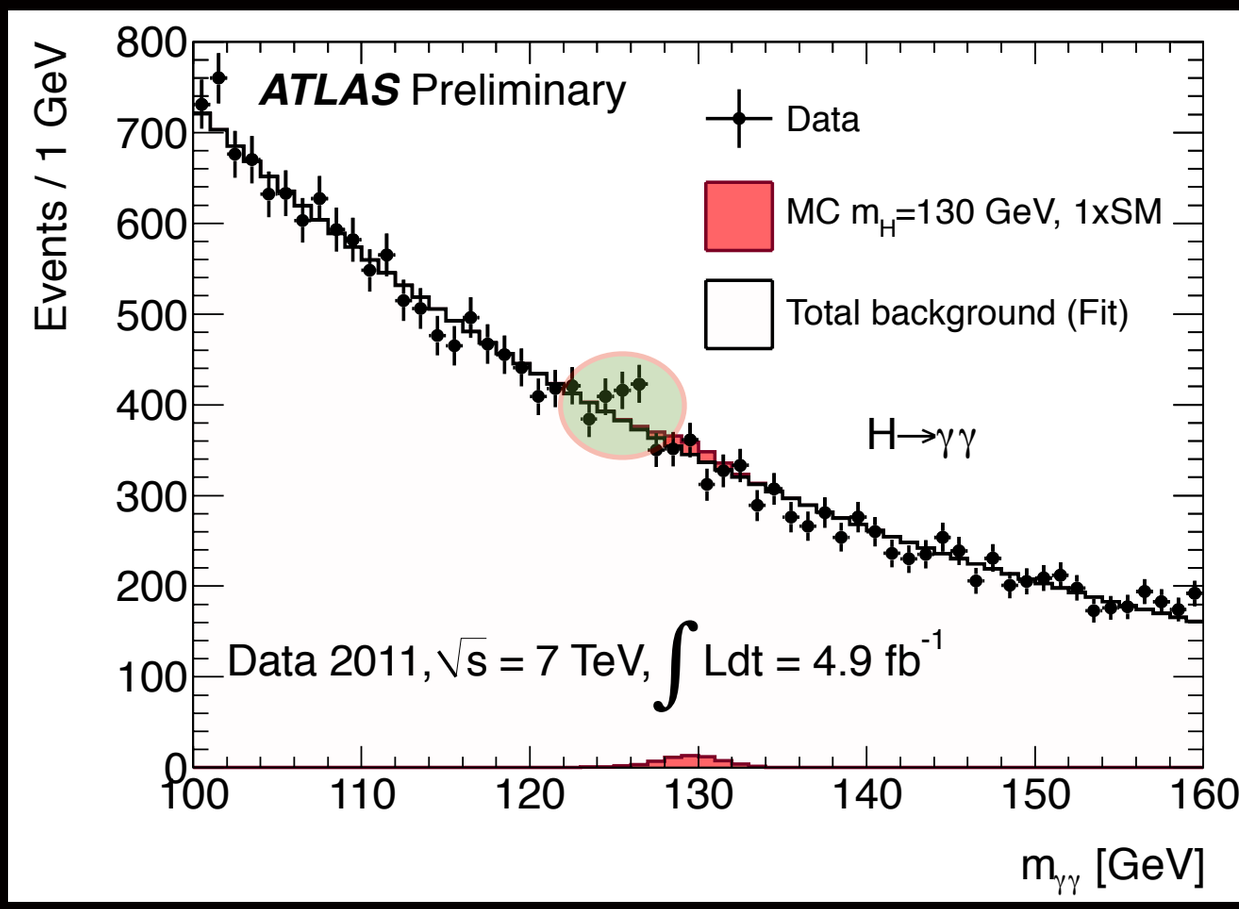
- $H \to \gamma\gamma$: 2.1 σ (3 events at 125 GeV)
- $H \to ZZ^* \to 4\ell$: 2.8 σ bump at 126 GeV
- $H \to W^+W^- \to (\ell^+\nu)(\ell^-\nu)$: 1.4 σ excess at 126 GeV

Combination: 3.6 σ excess at 126 GeV



- $H \to \gamma\gamma$: 2.34 σ bump at 123.5 GeV
- $H \to ZZ^* \to 4\ell$: 2 events at 126 GeV

Combination: 2.4 σ excess at 124 GeV



All the excesses are compatible with a Standard Model Higgs with mass of around 125 GeV

The Future of High Energy Physics

Did LHC discover a new particle in these channels?

Answer in 2012

Not yet! To claim a discovery of a new particle
we need more data (5 σ are needed)

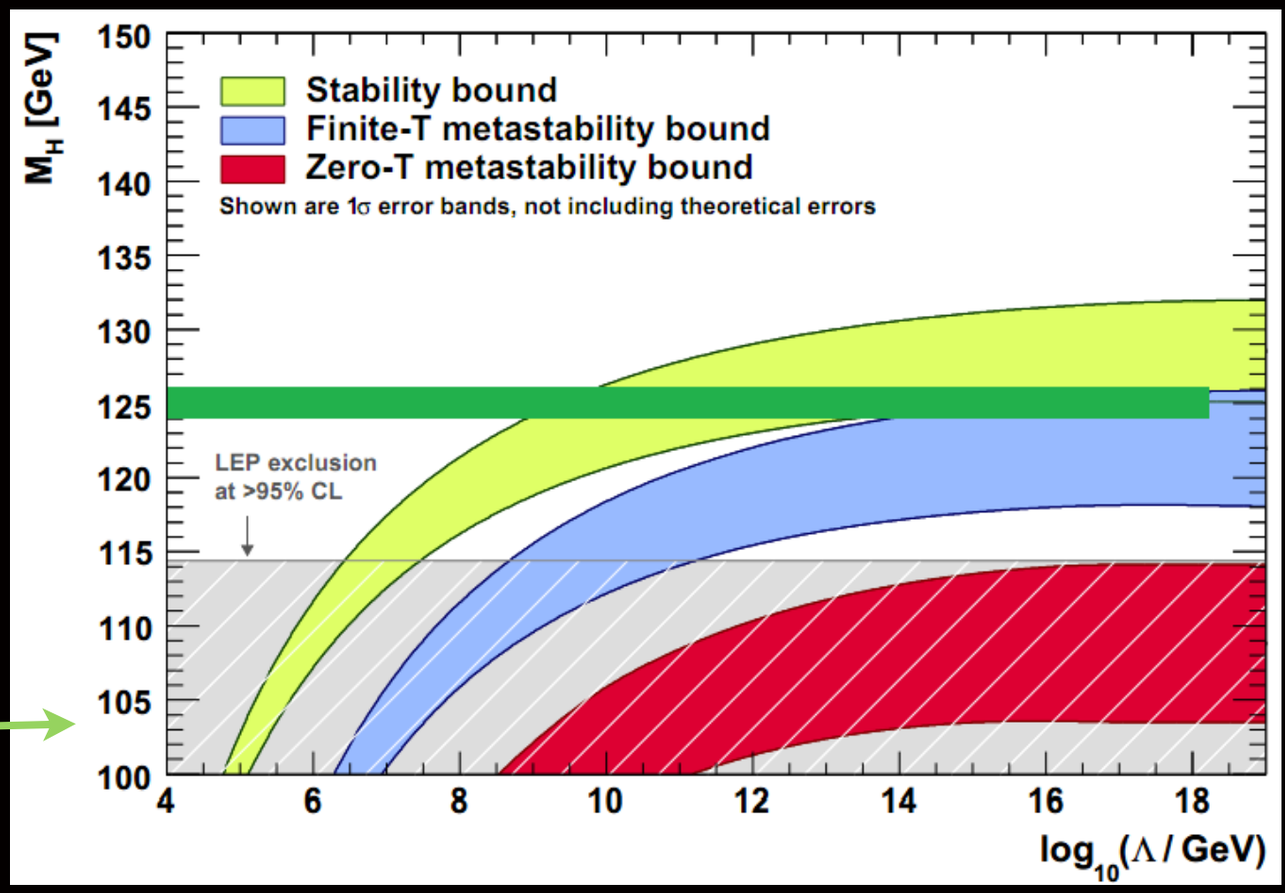
Is it really a Standard Model Higgs boson?

Answer in the next years

We need to verify that the new particle couples to
the others in the way predicted by the SM

Assuming a SM Higgs boson of 125 GeV, is this the end of High Energy Physics? NO!

- Gravity
- Neutrino masses
- Dark Matter
- Baryon Asymmetry in the Universe
- Stability of the potential
- ....



Beyond the Standard Model

Several extensions of the SM model can accommodate the LHC data, solving also several open problems in high energy physics:

Supersymmetric models @CP3 (Di Chiara, Sannino, MN)

- A boson with SM couplings is naturally present in the spectrum
- A lot of new particles

Strongly interacting models @CP3 (All of us)

- A light boson could emerge because of extra symmetry in the strong sector (dilaton or a Nambu-Goldstone boson) (next talk by Matin Mojaza)
- Several interesting phenomenological possibilities

2011 Summary

- January: CDF, new physics in the top sector?
- April: CDF, dijet bump at 150 GeV
- April: Xenon100, CoGENT puzzle on Dark Matter
- Summer: LHC into new territory (TeV physics)
- September: OPERA, superluminal neutrino
- November: LHCb, CP violation in charm
- December: ATLAS and CMS, Higgs progress

Thank you!