What - in my personal opinion - should be the highest level conclusions of the Energy Frontier report?

Lian-Tao Wang

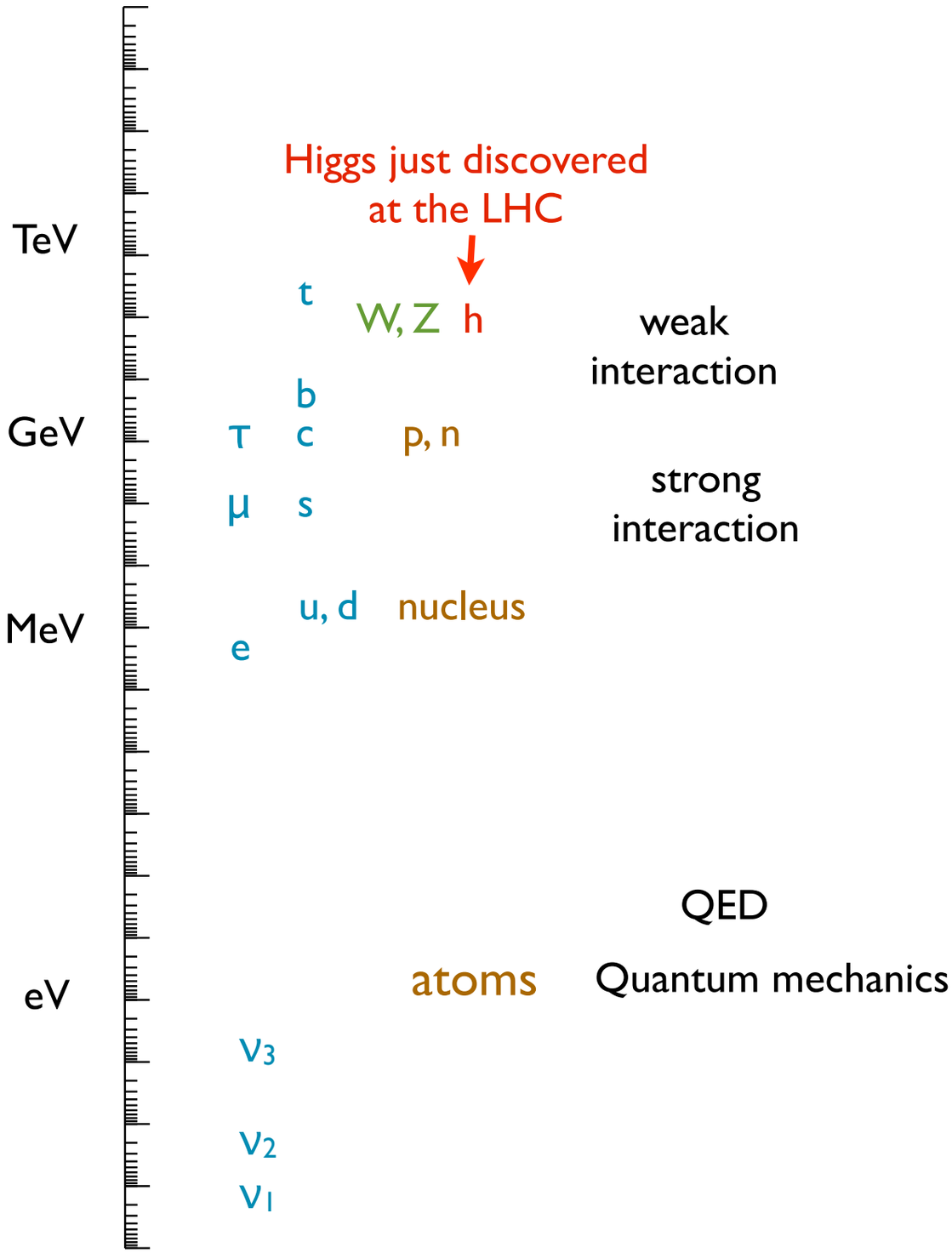
Seattle, July 2, 2013

Conclusions along the lines of

What's interesting?

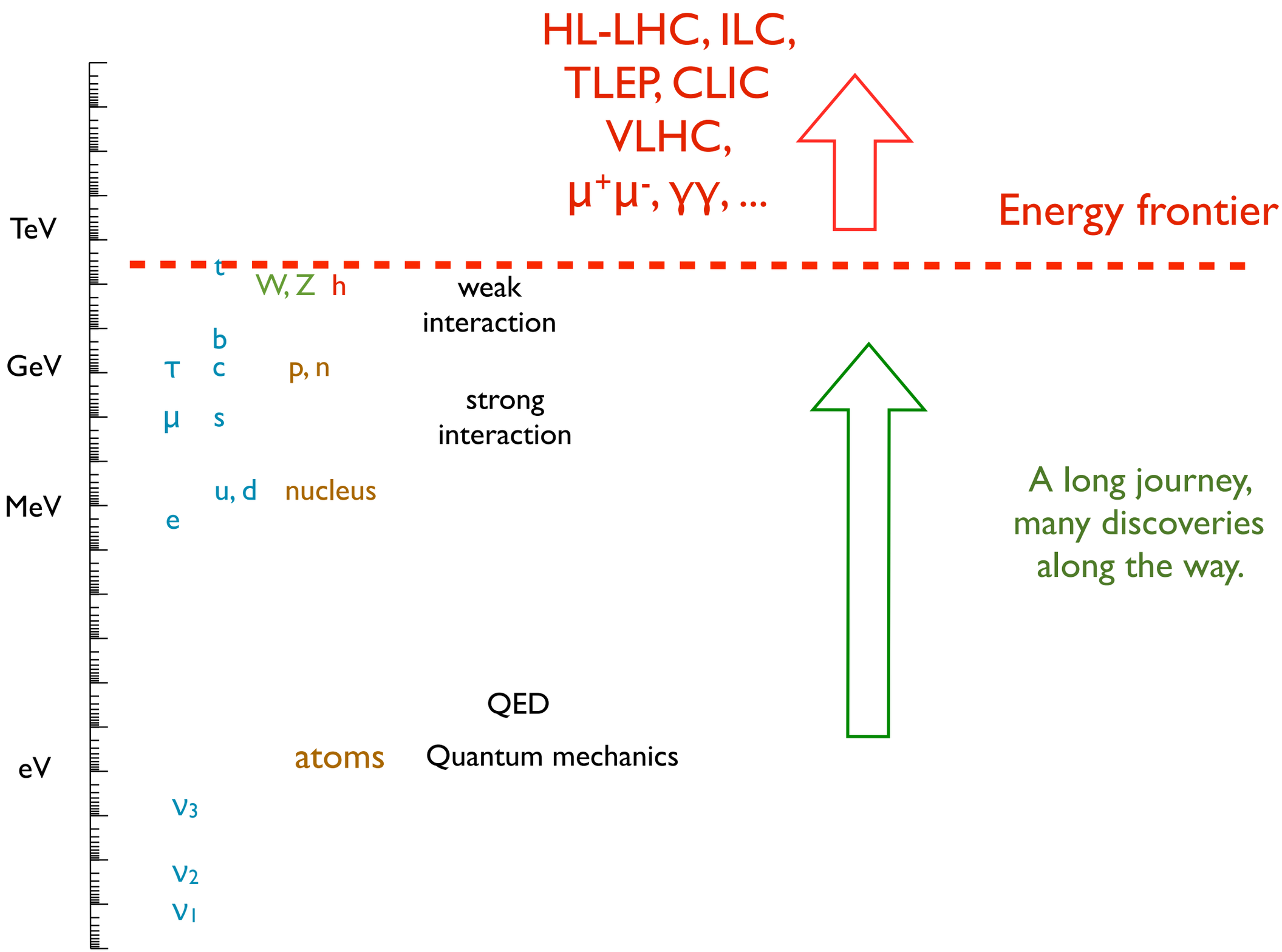
How can we get there?

EF: establishing new laws of physics



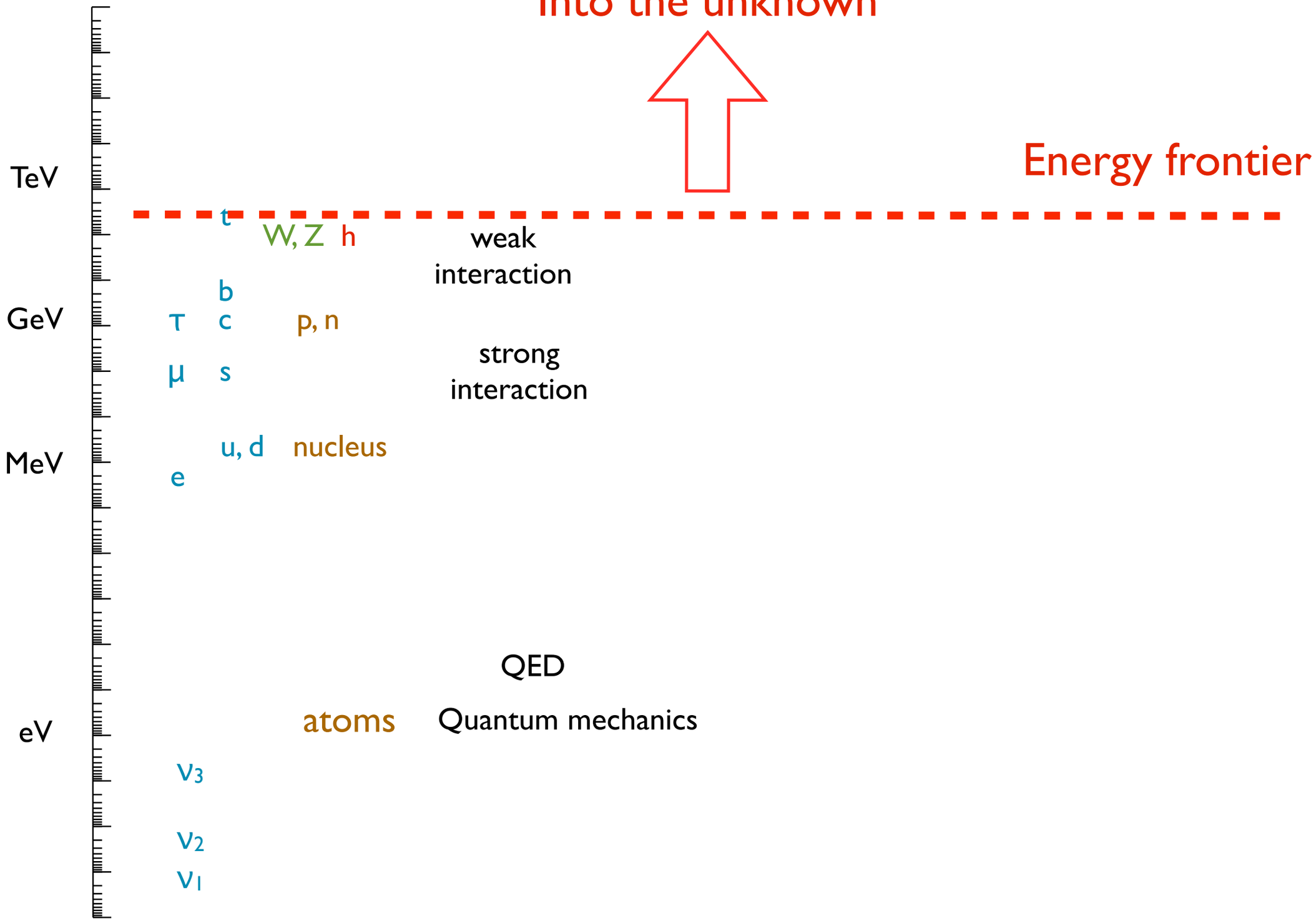
A long journey,
many discoveries
along the way.

EF: establishing new laws of physics



Each new step ≡ new territory

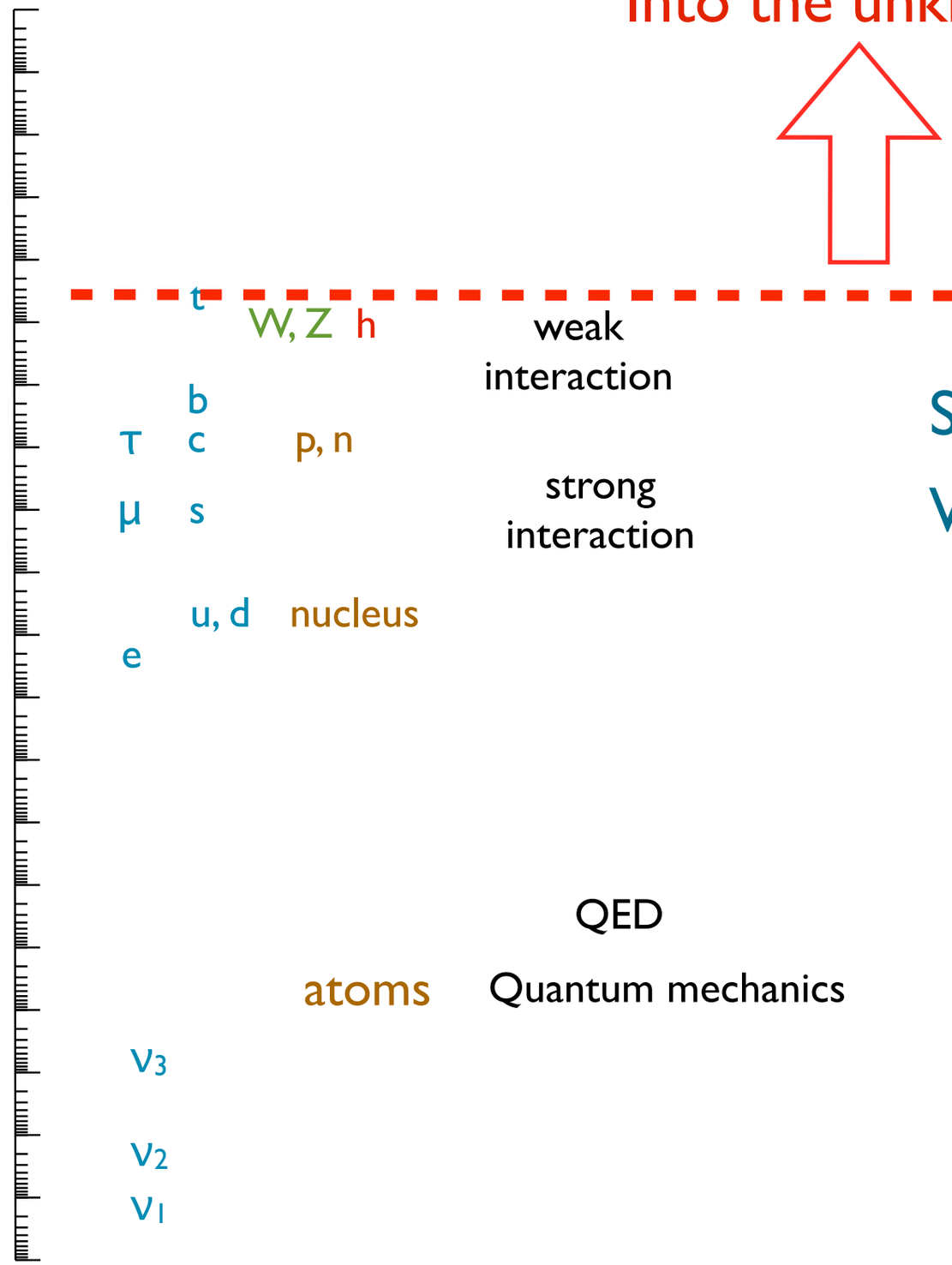
Into the unknown



Energy frontier

Each new step ≡ new territory

Into the unknown



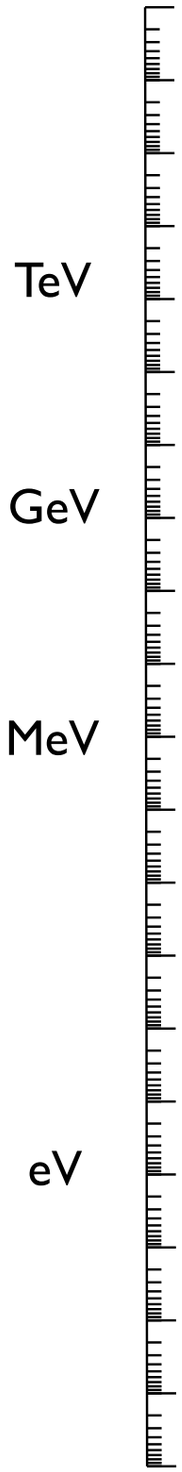
Energy frontier

SM "complete".

We don't know what's ahead.

Each new step ≡ new territory

Into the unknown



Energy frontier

SM "complete".

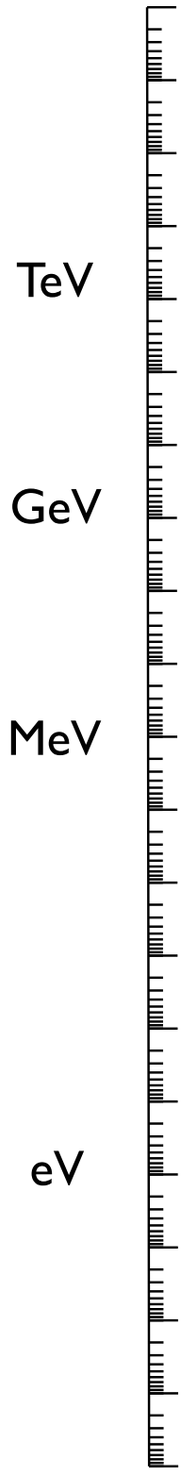
We don't know what's ahead.

Many big questions raised.

Many interesting ideas to test.

Expecting surprises.

Each new step ≡ new territory
Into the unknown



Energy frontier

t
W, Z h
weak interaction
b
τ c
p, n
μ s
strong interaction
u, d nucleus
e
QED
atoms
Quantum mechanics
ν_3
ν_2
ν_1

SM "complete".

We don't know what's ahead.

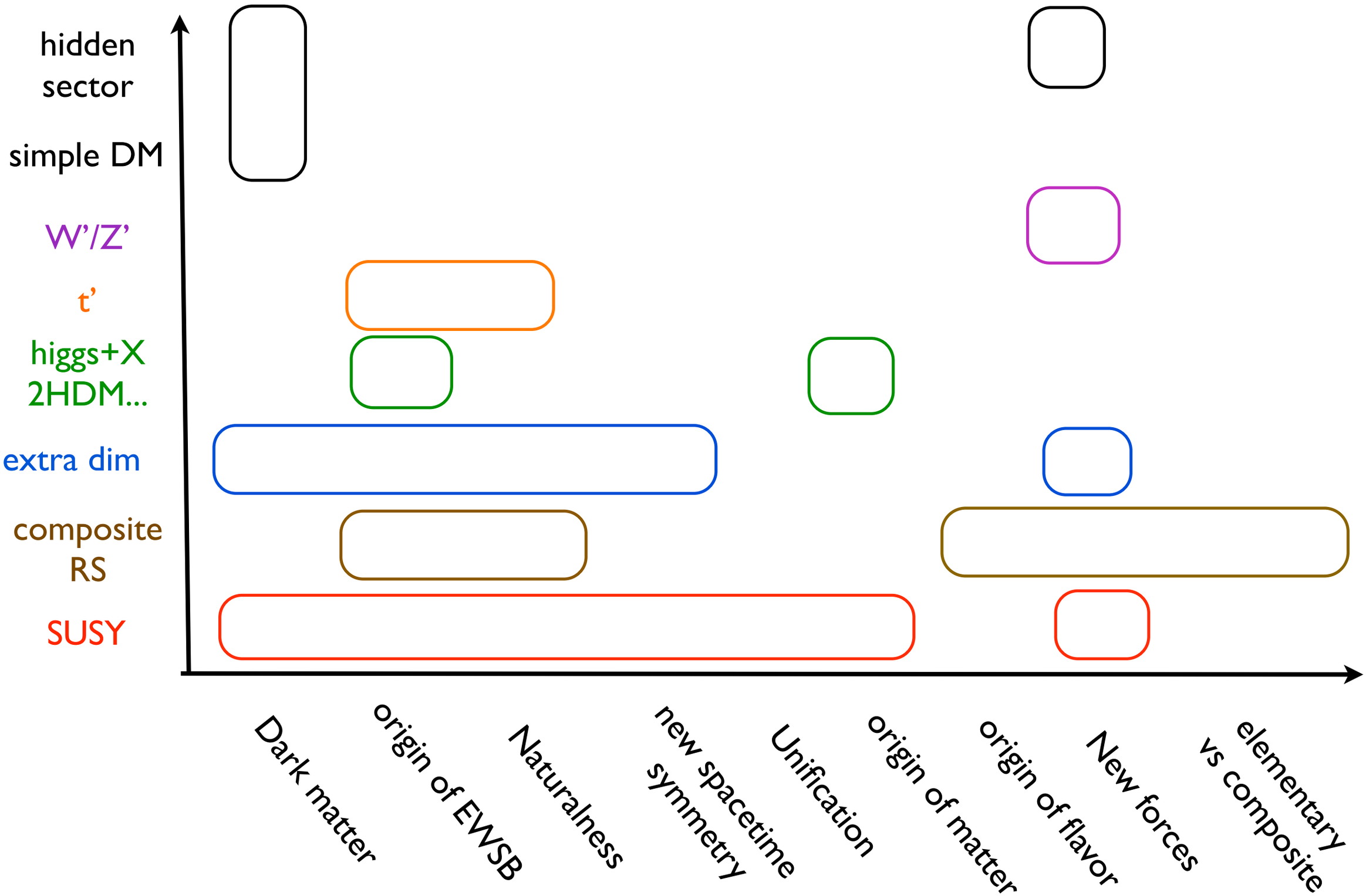
Many big questions raised.

Many interesting ideas to test.

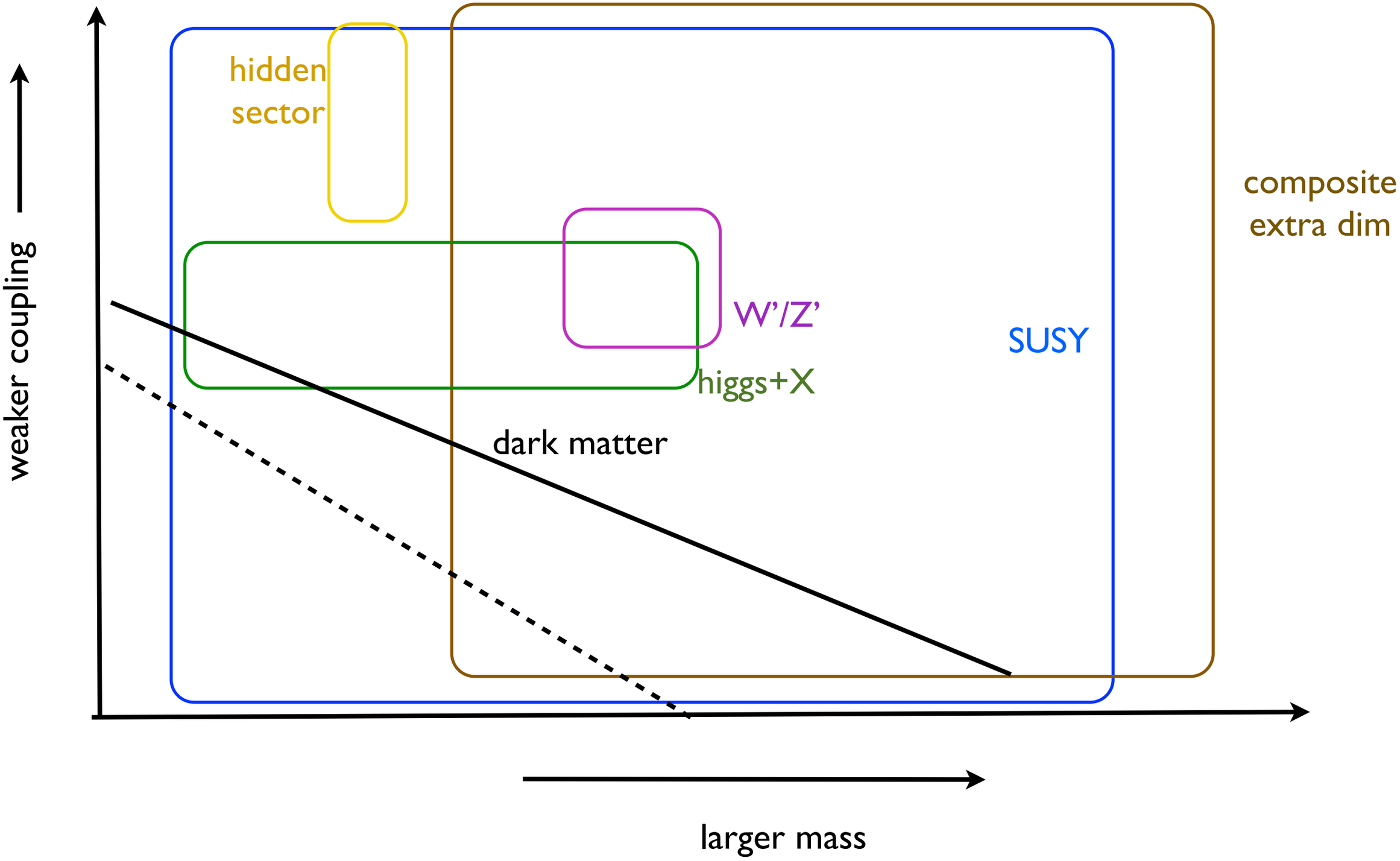
Expecting surprises.

Essential to make the next step!

Questions and ideas



Making the next step



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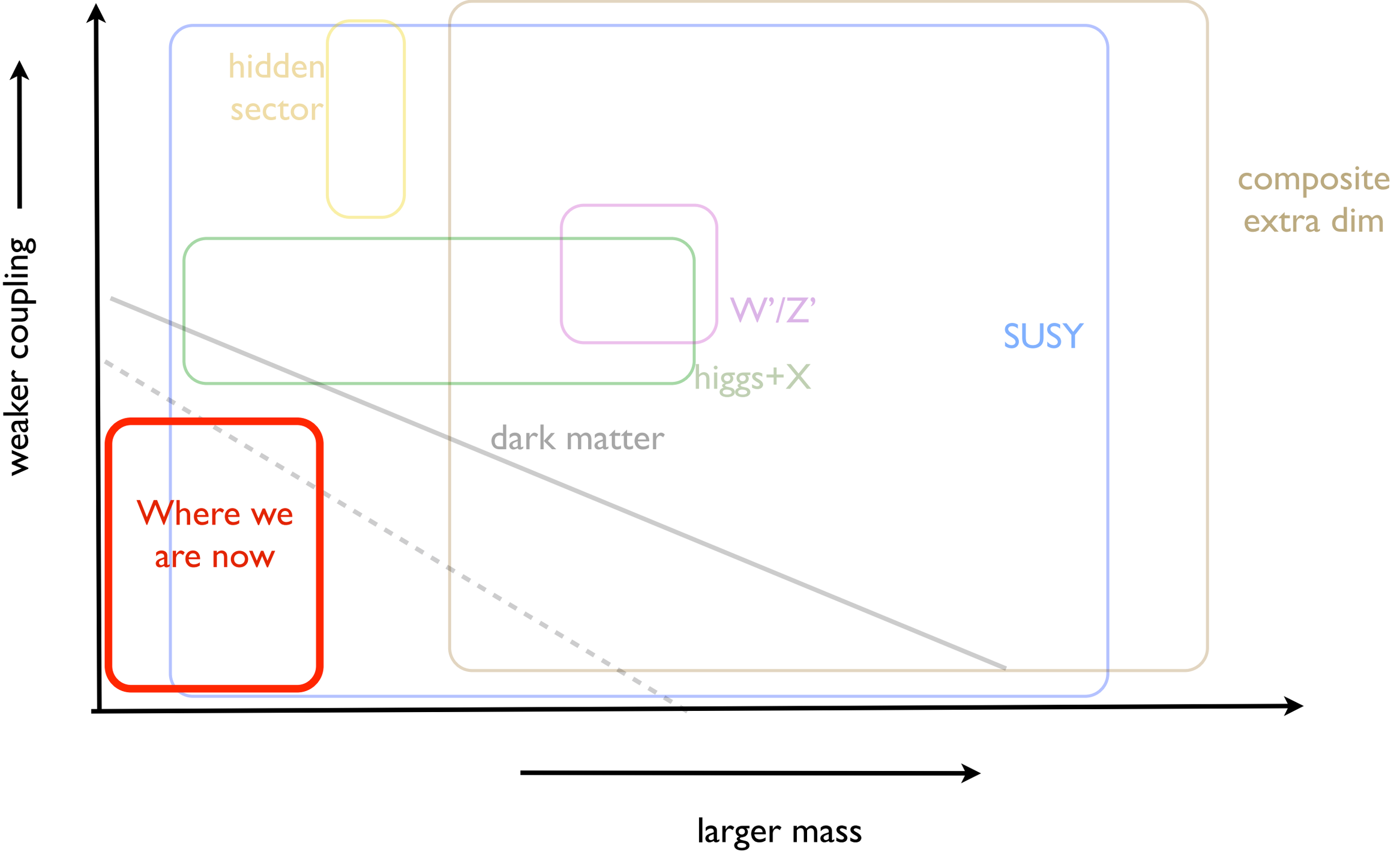
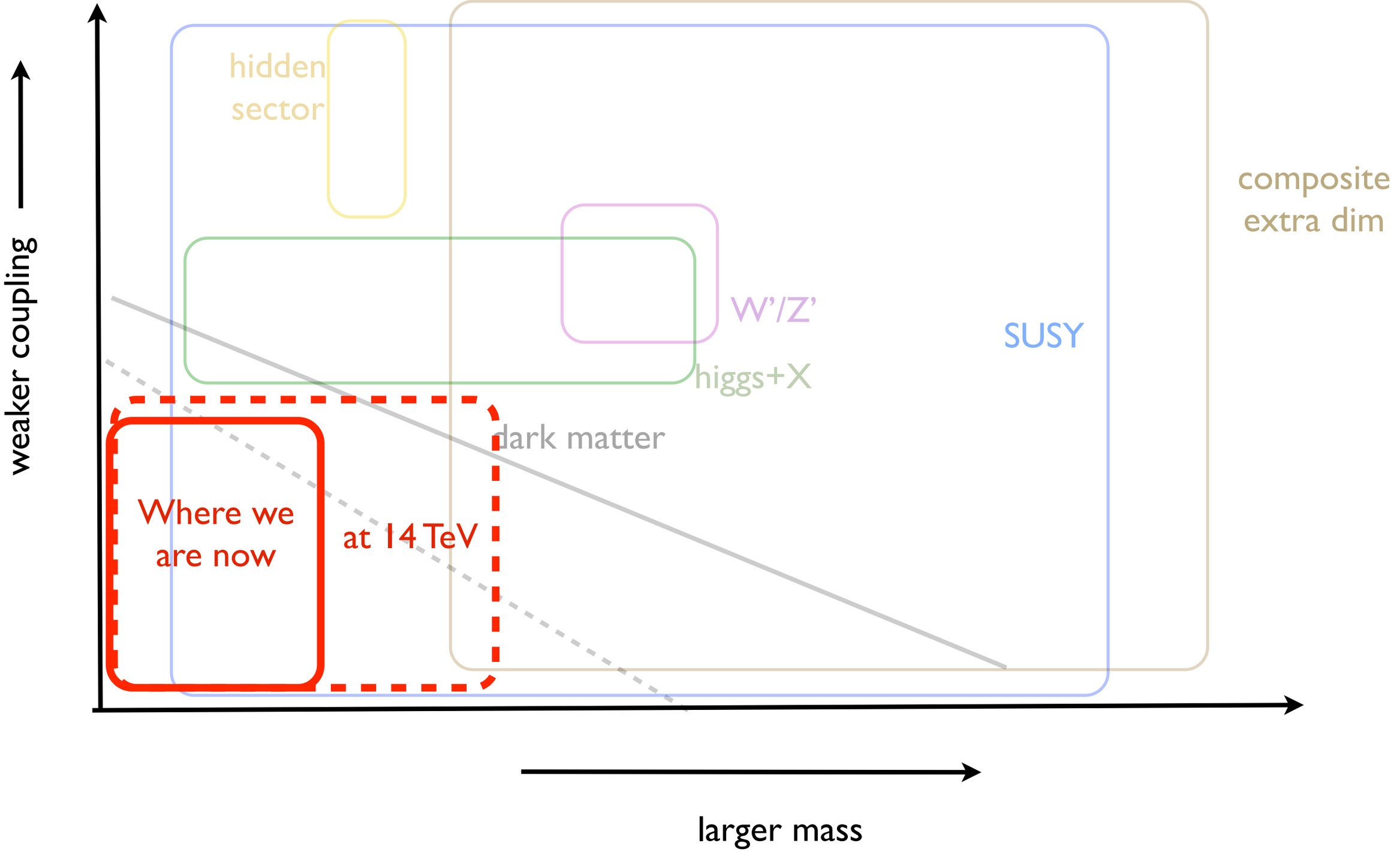
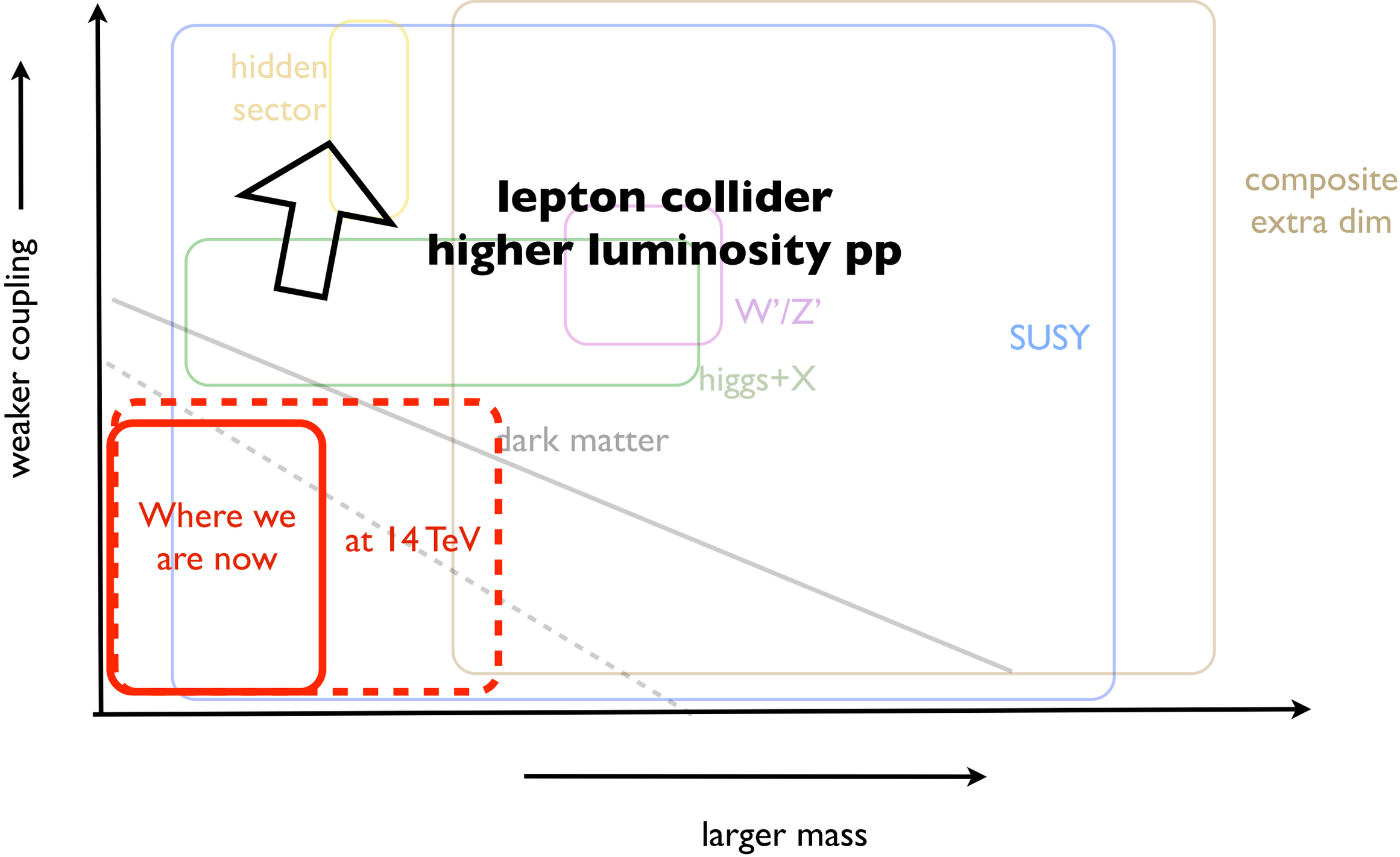


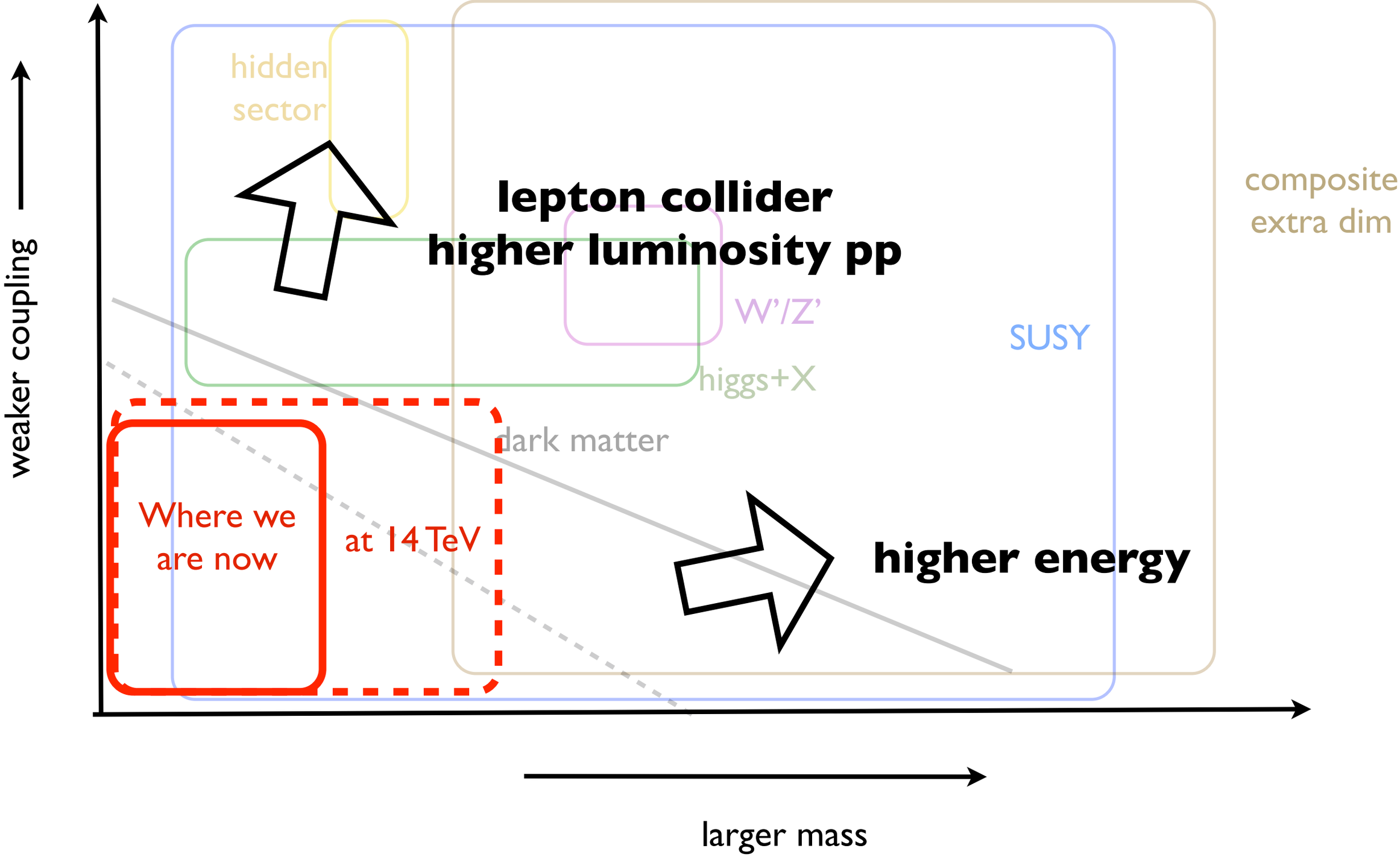
Making the next step



Making the next step



Making the next step



A few key cases

Careful Study of the Higgs need to be vigorously pursued.

- We have a new particle, but we don't understand it very well yet!
  - A new kind of particle: spin-0, key role in EWSB
- High luminosity LHC, ILC, Higgs factories, μμ...
  - shift of Higgs coupling $\delta \approx v^2/M^2_{NP}$,
    - e.g. $\delta \approx 5\%$ for $M_{NP} \approx$ TeV
    - If observed, sets the energy for the next collider!
  - Direct searches for extended Higgs sector (+VLHC)
- Possible surprises: exotic decays, connection to baryogenesis...

Investigate the WIMP dark matter: cover all the ground

- Dark matter is the only **known** new physics beyond the Standard Model.

LHC	VLHC 100 TeV	ILC/CLIC
M_{DM} ~10^2s GeV	M_{DM} ~TeV(s)	M_{DM} ~ 0.5 E_{cm} Spin, coupling Is it WIMP?

- Link to a possible dark sector.
- Strategy at EF strongly correlated with potential discovery at in direct/indirect detection.

Fully test the idea of naturalness

- 14 TeV LHC(HL) can push fine tuning limit to at least 10^{-2} , $\propto m^{-2}_{\text{top-partner, W/h partner}}$.
- 100 TeV VLHC can push this to about 10^{-4}.
- ILC/CLIC can discover and study Higgs/W partners very well.
- If a top partner is discovered, measure
  - spin. (SUSY or others).
  - Higgs coupling: addressing the naturalness?
  - higher luminosity pp, lepton collider with enough energy.

In addition

	HL-LHC	VLHC	HE-lepton collider	Higgs Factory
SUSY	electroweak-ino stau, ...	squark, gluino, stop	electroweak-ino stau, ...	
composite resonance/ extra dim	Higgs coupling	composite resonance	Higgs coupling	Higgs coupling
CP violation in NP	some?		good sensitivity	
Z'	good reach, some measurement	good reach, some measurement	good reach good measurement	
t'	TeV-ish	great reach	good for hidden, stealthy	
...				


LHC
H