Standard Model Higgs: 126, 200, 250 GeV

by Frank Dodd (Tony) Smith Jr.

Abstract:

In March 2013 at Moriond LHC announced results of data (about 25/fb)

from the LHC run ending at the long shutdown at the end of 2012.

As I see it, the ATLAS and CMS digamma channel data are consistent with

a Higgs Low Mass State at 126 GeV

and the ATLAS and CMS ZZ to 4l channel data are consistent with

a Higgs Low Mass State at 126 GeV

and a Higgs Mid Mass State around 200 GeV

and a Higgs High Mass State around 250 GeV.

This paper begins with description of 3-state Higgs/Tquark Condensate system,

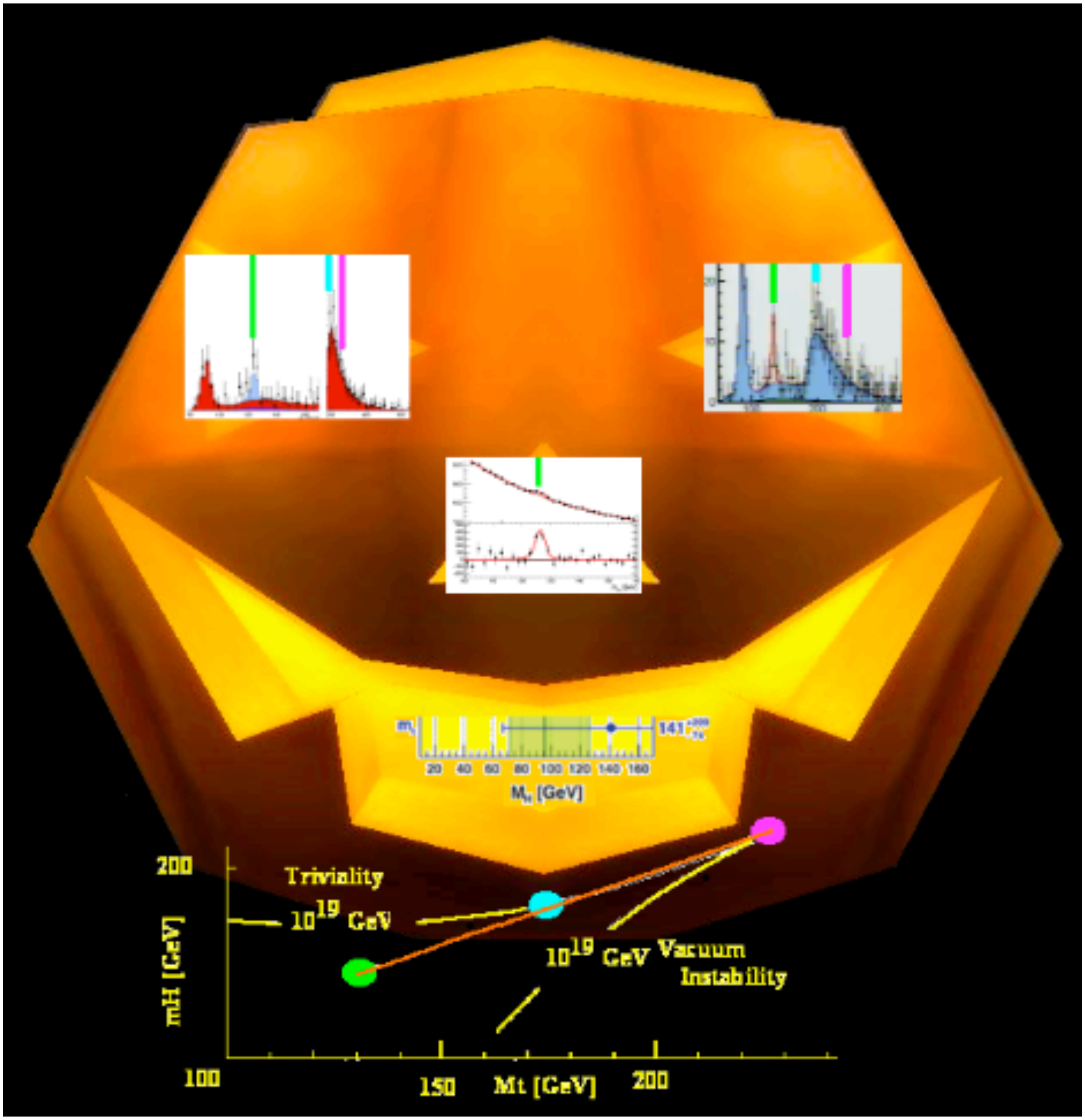
then calculation of Higgs mass,

then Tquark experimental results,

then Higgs experimental results through Moriond 2013,

and finally proposals for future physics experiments.

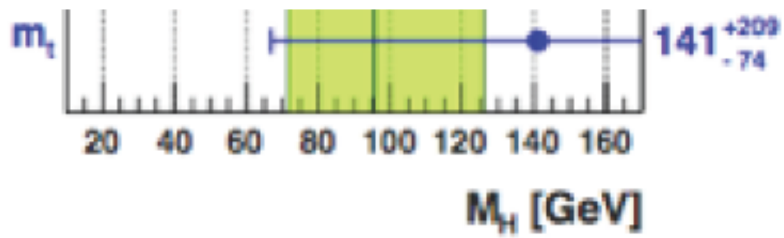
(References are included in the body of the paper and in linked material.)



LHC data (about 25/fb) from Halloween 2011 through Moriond 2013:

Using the ideas of - African IFA Divination; Clifford Algebra Cl(8)xCl(8) = Cl(16); Lie Algebra E8 ;
Hua Geometry of Bounded Complex Domains; Mayer Geometric Higgs Mechanism;
Batakis 8-dim Kaluza-Klein structure of hep-ph/0311165 by Hashimoto et al;
Segal Conformal Gravity version of the MacDowell-Mansouri Mechanism;
Real Clifford Algebra generalized Hyperfinite II1 von Neumannn factor AQFT; and
Joy Christian EPR Geometry - my E8 Physics model has been developed with a 3-state Higgs system
in which the Higgs is related to the Primitive Idempotents of the real Clifford Algebra Cl(8).

The Pumpkin Mouth Plot shows that the Electroweak Gfitter best fit for a floating Tquark mass as is required in my 3-State Higgs-Tquark System



is for a Higgs mass range that includes all three of its states: 126 GeV, around 200 GeV, and around 250 GeV.

Pumpkin Eye-Nose-Eye Plots are for LHC data (about 25/fb) up to the long shutdown at the end of 2012:

Left Eye: ATLAS Higgs ZZ-4l at Moriond 2013

Nose: ATLAS Higgs digamma at Moriond 2013

Right Eye: CMS Higgs ZZ-4l at Moriond 2013

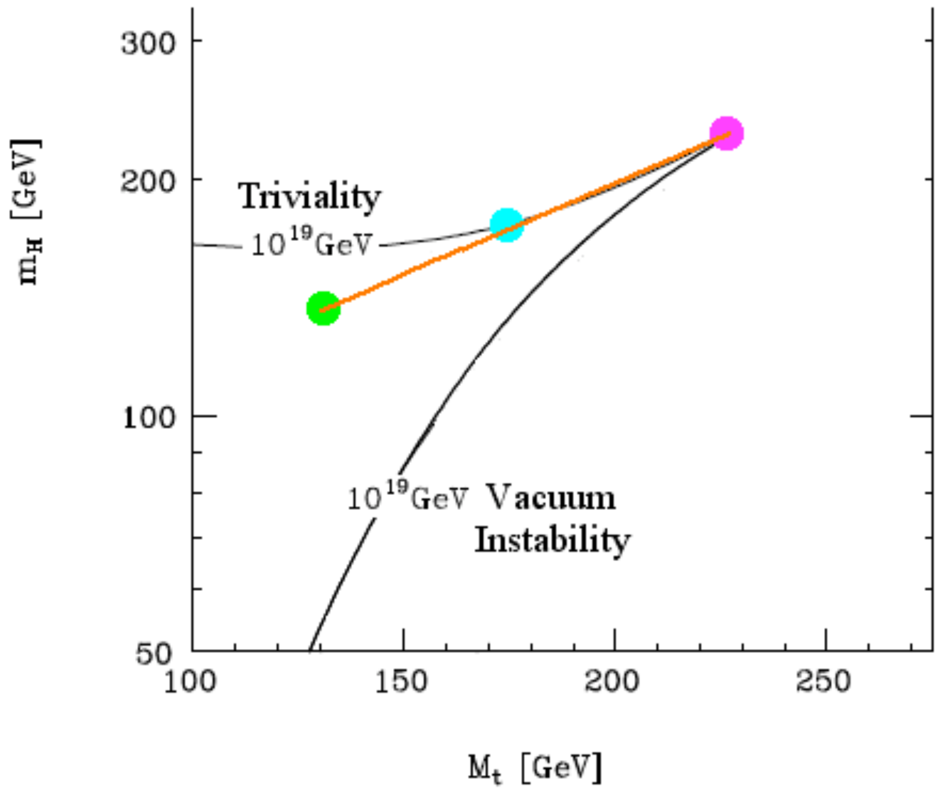
According to hep-ph/0307138 by C. D. Froggatt:
"... the top quark mass is the dominant term in the SM fermion mass matrix ... [so]... it is likely that its value will be understood dynamically ... the self-consistency of the pure SM up to some physical cut-off scale /\ imposes constraints on both the top quark and Higgs boson masses.

The first constraint is the so-called triviality bound: the running Higgs coupling constant lambda(mu) should not develop an Landau pole for mu < /\ .

The second is the vacuum stability bound: the running Higgs coupling constant lambda(mu) should not become negative leading to the instability of the usual SM vacuum.

These bounds are illustrated in Fig. 3 ... we shall be interested in the large cut-off scales /\ = 10^19 GeV, corresponding to the Planck scale [I have edited this sentence to restrict coverage to a Planck scale SM cut-off and have edited Fig. 3 and added material relevant to my E8 Physics model with 3 Higgs-Tquark states]
...
The upper part of ...[the]... curve corresponds to the triviality bound.

The lower part of ...[the]... curve coincides with the vacuum stability bound and the point in the top right-hand corner, where it meets the triviality bound curve, is the quasi-fixed infra-red fixed point for that value of /\ . ...



... Fig. 3: SM bounds in the (Mt , MH) plane ...".

The Magenta Dot is the high-mass state of a 220 GeV Truth Quark and a 240 GeV Higgs.
It is at the critical point of the Higgs-Tquark System with respect to Vacuum Instability and Triviality.
It corresponds to the description in hep-ph/9603293 by Koichi Yamawaki of the Bardeen-Hill-Lindner model
That high-mass Higgs is around 250 GeV in the range of the Higgs Vacuum Instability Boundary
which range includes the Higgs VEV.

The Gold Line leading down from the Critical Point roughly along the Triviality Boundary line is based on Renormalization Group calculations with the result that MH / MT = 1.1 as described by Koichi Yamawaki in hep-ph/9603293 .

The Cyan Dot where the Gold Line leaves the Triviality Boundary to go into our Ordinary Phase is the middle-mass state of a 174 GeV Truth Quark and Higgs around 200 GeV. It corresponds to the Higgs mass calculated by Hashimoto, Tanabashi, and Yamawaki in hep-ph/0311165 where they show that
for 8-dimensional Kaluza-Klein spacetime with the Higgs as a Truth Quark condensate
172 < MT < 175 GeV and 178 < MH < 188 GeV.
That mid-mass Higgs is around the 200 GeV range of the Higgs Triviality Boundary at which
the composite nature of the Higgs as T-Tbar condensate in (4+4)-dim Kaluza-Klein becomes manifest.

The Green Dot where the Gold Line terminates in our Ordinary Phase
is the low-mass state of a 130 GeV Truth Quark and a 126 GeV Higgs.

As to composite Higgs and the Triviality boundary, Pierre Ramond says in his book Journeys Beyond the Standard Model (Perseus Books 1999) at pages 175-176:

"... The Higgs quartic coupling has a complicated scale dependence. It evolves according to

d lambda / d t = (1 / 16 pi^2) beta_lambda

where the one loop contribution is given by

beta_lambda = 12 lambda^2 - ... - 4 H ...

The value of lambda at low energies is related [to] the physical value of the Higgs mass according to the tree level formula \

m_H = v sqrt(2 lambda)

while the vacuum value is determined by the Fermi constant

...

for a fixed vacuum value v, let us assume that the Higgs mass and therefore lambda is large. In that case, beta_lambda is dominated by the lambda^2 term, which drives the coupling towards its Landau pole at higher energies.

Hence the higher the Higgs mass, the higher lambda is and the close[r] the Landau pole to experimentally accessible regions.

This means that for a given (large) Higgs mass,
we expect the standard model to enter a strong coupling regime
at relatively low energies, losing in the process our ability to calculate.
This does not necessarily mean that the theory is incomplete,
only that we can no longer handle it ...
it is natural to think that this effect is caused by new strong interactions,
and that the Higgs actually is a composite ...
The resulting bound on lambda is sometimes called the **triviality bound**.
The reason for this unfortunate name (the theory is anything but trivial)
stems from lattice studies where the coupling is assumed to be finite everywhere;
in that case the coupling is driven to zero, yielding in fact a trivial theory.
In the standard model lambda is certainly not zero. ...".

Composite Higgs as Tquark condensate studies by Yamawaki et al have produced realistic models that are consistent with my E8 model with a 3-State System:

1 - My basic E8 Physic model state
with Tquark mass = 130 GeV and Higgs mass = 126 GeV

2 - Triviality boundary 8-dim Kaluza-Klein state described by Hashimoto, Tanabashi, and Yamawaki in hep-ph/0311165 where they say:
“... "... We perform the most attractive channel (MAC) analysis in the top mode standard model with TeV-scale extra dimensions, where the standard model gauge bosons and the third generation of quarks and leptons are put in D(=6,8,10,...) dimensions. In such a model, bulk gauge couplings rapidly grow in the ultraviolet region. In order to make the scenario viable, only the attractive force of the top condensate should exceed the critical coupling, while other channels such as the bottom and tau condensates should not. We then find that the top condensate can be the MAC for D=8 ... We predict masses of the top (m_t) and the Higgs (m_H) ... based on the renormalization group for the top Yukawa and Higgs quartic couplings with the compositeness conditions at the scale where the bulk top condenses ... for ...[Kaluza-Klein type]... dimension... D=8 ...
m_t = 172-175 GeV and m_H=176-188 GeV ...".

3 - Critical point BHL state
with Tquark mass = 218 +/- 3 GeV and Higgs mass = 239 +/- 3 GeV
As Yamawaki said in hep-ph/9603293: "... **the BHL formulation of the top quark condensate ... is based on the RG equation combined with the compositeness condition ... start[s] with the SM Lagrangian which includes explicit Higgs field at the Lagrangian level ... BHL is crucially based on the perturbative picture ...[which]... breaks down at high energy near the compositeness scale / \ ...[10^19 GeV]**... there must be a certain matching scale /_Matching such that the perturbative picture (BHL) is valid for mu < /_Matching, while only the nonperturbative picture (MTY) becomes consistent for mu > /_Matching ... However, **thanks to the presence of a quasi-infrared fixed point, BHL prediction is numerically quite stable against ambiguity at high energy region, namely, rather independent of whether this high energy region is replaced by MTY or something else**. ... Then we expect mt = mt(BHL) = ... = 1/(sqrt(2)) ybart v within 1-2%, where ybart is the quasi-infrared fixed point given by Beta(ybart) = 0 in ... the one-loop RG equation ... The composite Higgs loop changes ybart^2 by roughly the factor Nc/(Nc +3/2) = 2/3 compared with the MTY value, i.e., 250 GeV -> 250 x sqrt(2/3) = 204 GeV, while the electroweak gauge boson loop with opposite sign pulls it back a little bit to a higher value. **The BHL value is then**

given by mt = 218 +/- 3 GeV, at /\ = 10^19 GeV. The Higgs boson was predicted as a tbar-t bound state with a mass MH = 2mt based on the pure NJL model calculation1. Its mass was also calculated by BHL through the full RG equation ... the result being ... **MH / mt = 1.1) at /.\ = 10^19 GeV** ...".
... the top quark condensate proposed by Miransky, Tanabashi and Yamawaki (**MTY**) and by Nambu independently ... **entirely replaces the standard Higgs doublet by a composite one formed by a strongly coupled short range dynamics (four-fermion interaction) which triggers the top quark condensate**. The Higgs boson emerges as a tbar-t bound state and hence is deeply connected with the top quark itself. ... MTY introduced explicit four-fermion interactions responsible for the top quark condensate in addition to the standard gauge couplings. Based on the explicit solution of the ladder SD equation, MTY found that even if all the dimensionless four-fermion couplings are of O(1), only the coupling larger than the critical coupling yields non-zero (large) mass ... The model was further formulated in an elegant fashion by Bardeen, Hill and Lindner (BHL) in the SM language, based on the RG equation and the compositenes condition. BHL essentially incorporates 1/Nc sub-leading effects such as those of the composite Higgs loops and ... gauge boson loops which were disregarded by the MTY formulation. We can explicitly see that **BHL is in fact equivalent to MTY at 1/Nc-leading order**. Such effects turned out to reduce the above MTY value 250 GeV down to 220 GeV ...".

8-dim Kaluza-Klein spacetime physics as required by Hashimoto, Tanabashi, and Yamawaki for the Middle State of the 3-State System
was described by N. A. Batakis in Class. Quantum Grav. 3 (1986) L99-Ll05
in terms a M4xCP2 structure similar to that of my E8 Physics model.
Although spacetime and Standard Model gauge bosons worked well for Batakis,
he became discouraged by difficulties with fermions,
perhaps because he did not use Clifford Algebras with natural spinor structures
for fermions.

Higgs Mass Calculations:

Low-Mass State

The calculations produce ratios of masses, so that only one mass need be chosen to set the mass scale.
In the E8 model, the value of the fundamental mass scale vacuum expectation value v = <PHI> of the Higgs scalar field is set to be the sum of the physical masses of the weak bosons, W+, W-, and Z0,
such that, in accord with ratios calculated in the E8 model, the electron mass will be 0.5110 MeV.
Effectively, the electron mass of 0.5110 MeV is the only input into the calculated particle masses.

The relationship between the Higgs mass and v is given
by the Ginzburg-Landau term from the Mayer Mechanism as
(1/4) Tr ([PHI , PHI] - PHI)^2
or, in the notation of quant-ph/9806009 by Guang-jiong Ni
(1/4!) lambda PHI^4 - (1/2) sigma PHI^2
where the Higgs mass M_H = sqrt(2 sigma)Ni says:
"... the invariant meaning of the constant lambda in the Lagrangian is not the
coupling constant, the latter will change after quantization ... The invariant
meaning of lambda is nothing but the ratio of two mass scales:
lambda = 3 (M_H / PHI)^2 which remains unchanged irrespective of the order ...".

Since <PHI>^2 = v^2, and assuming that lambda = (cos(pi / 6))^2 = 0.866^2
(a value consistent with the Higgs-Tquark condensate model of Michio Hashimoto,
Masaharu Tanabashi, and Koichi Yamawaki in their paper at hep-ph/0311165)
we have
M_H^2 / v^2 = (cos(pi / 6))^2 / 3
In the E8 model, the fundamental mass scale vacuum expectation value v of the
Higgs scalar field is the fundamental mass parameter that is to be set to define all
other masses by the mass ratio formulas of the model and
v is set to be 252.514 GeV
so that
M_H = v cos(pi / 6) / sqrt(1 / 3) = 126.257 GeV

A Non-Condensate Higgs is represented by a Higgs at a point in M4
that is connected to a Higgs representation in CP2 ISS by a line whose length represents the Higgs mass

Higgs | Higgs in CP2 ISS
mass = 145 | Non-Condensate Higgs Mass = 145
Higgs | Higgs in M4 spacetime

and the value of lambda is 1 = 1^2
so that the Non-Condensate Higgs mass would be M_H = v /sqrt(3) = 145.789 GeV

However, in my E8 Physics model, the Higgs has beyond-tree-level structure due to a Tquark condensate

```
            mass = 145
        T ----------- Tbar           Effective Higgs in CP2 ISS
         \     |     /                     |
          \    |    /                      |
mass = 145 \   |   /   mass = 145          | Higgs Effective Mass =
            \  |  /                        | = 145 x cos(pi/6)= 145 x 0.866 = 126
             \ | /                         |
             Higgs                     Higgs in M4 spacetime
```

in which the Higgs at a point in M4 is connected to a T and Tbar in CP2 ISS
so that the vertices of the Higgs-T-Tbar system are connected by lines forming an equilateral triangle
composed of 2 right triangles (one from the CP2 origin to the T and to the M4 Higgs
and
another from the CP2 origin to the T and to the M4 Higgs).

In the T-quark condensate picture

lambda = 1^2 = lambda(T) + lambda(H) = (sin(pi/6))^2 + (cos(pi6))^2
and
lambda(H) = (cos(pi / 6))^2

Therefore:
The effective Higgs mass observed by experiments such as the LHC is:

Higgs Mass = 145.789 x cos(pi/6) = 126.257

Mid-Mass State

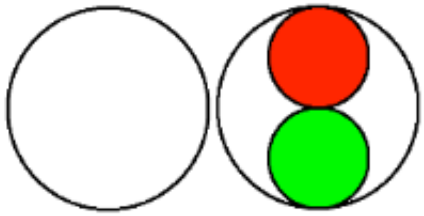
In my E8 Physics model, the Mid-Mass Higgs has structure is not restricted to Effective M4 Spacetime
as is the case with the Low-Mass Higgs Ground State
but extends to the full 4+4 = 8-dim structure of M4xCP2 Kaluza-Klein.

```
        T ----------- Tbar     in CP2 Internal Symmetry Space
         \           /
          \         /
           \       /
            \     /
             \   /
             Higgs             in M4 Physical Spacetime
```

Therefore the Mid-Mass Higgs looks like a 3-particle system of Higgs + T + Tbar.
The T and Tbar form a Pion-like state. Since Tquark Mid-Mass State is 174 GeV
the Mid-Mass T-Tbar that lives in the CP2 part of (4+4)-dim Kaluza-Klein
has mass (174+174) x (135 / (312+312) = 75 GeV.
The Higgs that lives in the M4 part of (4+4)-dim Kaluza-Klein
has, by itself, its Low-Mass Ground State Effective Mass of 125 GeV.

So, the total Mid-Mass Higgs lives in full 8-dim Kaluza-Klein with mass 75+125 = 200 GeV.
This is consistent with the Mid-Mass States of the Higgs and Tquark
being on the Triviality Boundary of the Higgs - Tquark System
and
with the 8-dim Kaluza-Klein model in hep-ph/0311165 by Hashimoto, Tanabashi, and Yamawaki.

As to the cross-section of the Mid-Mass Higgs compared to that of the Low-Mass Ground State



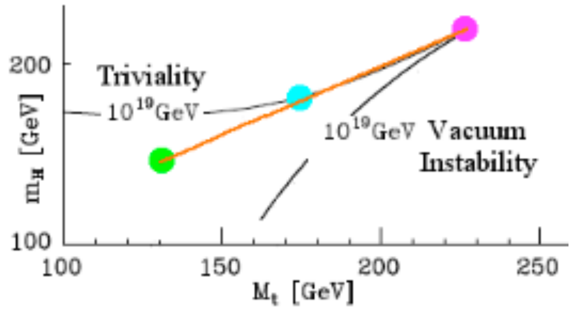
consider that the entire Ground State cross-section lives only in 4-dim M4 spacetime
(left white circle)
while for the Mid-Mass Higgs that cross-section lives in full 4+4 = 8-dim Kaluza-Klein spacetime
(right circle with red area only in CP2 ISS and white area partly in CP2 ISS
with only green area effectively living in 4-dim M4 spacetime)
so that our 4-dim M4 Physical Spacetime experiments only see for the Mid-Mass Higgs
a cross-section that is 25% of the full Ground State cross-section.
The 25% may also be visualized in terms of 8-dim coordinates {1,i,j,k,E,I,J,K}

	1	i	j	k	E	I	J	K
1	11	1i	1j	1k	1E	1I	1J	1K
i	i1	ii	ij	ik	iE	iI	iJ	iK
j	j1	ji	jj	jk	jE	jI	jJ	jK
k	k1	ki	kj	kk	kE	kI	kJ	kK
E	E1	Ei	Ej	Ek	EE	EI	EJ	EK
I	I1	Ii	Ij	Ik	IE	II	IJ	IK
J	J1	Ji	Jj	Jk	JE	JI	JJ	JK
K	K1	Ki	Kj	Kk	KE	KI	KJ	KK

in which {1,i,j,k} represent M4 and {E,I,J,K} represent CP2.

High-Mass State

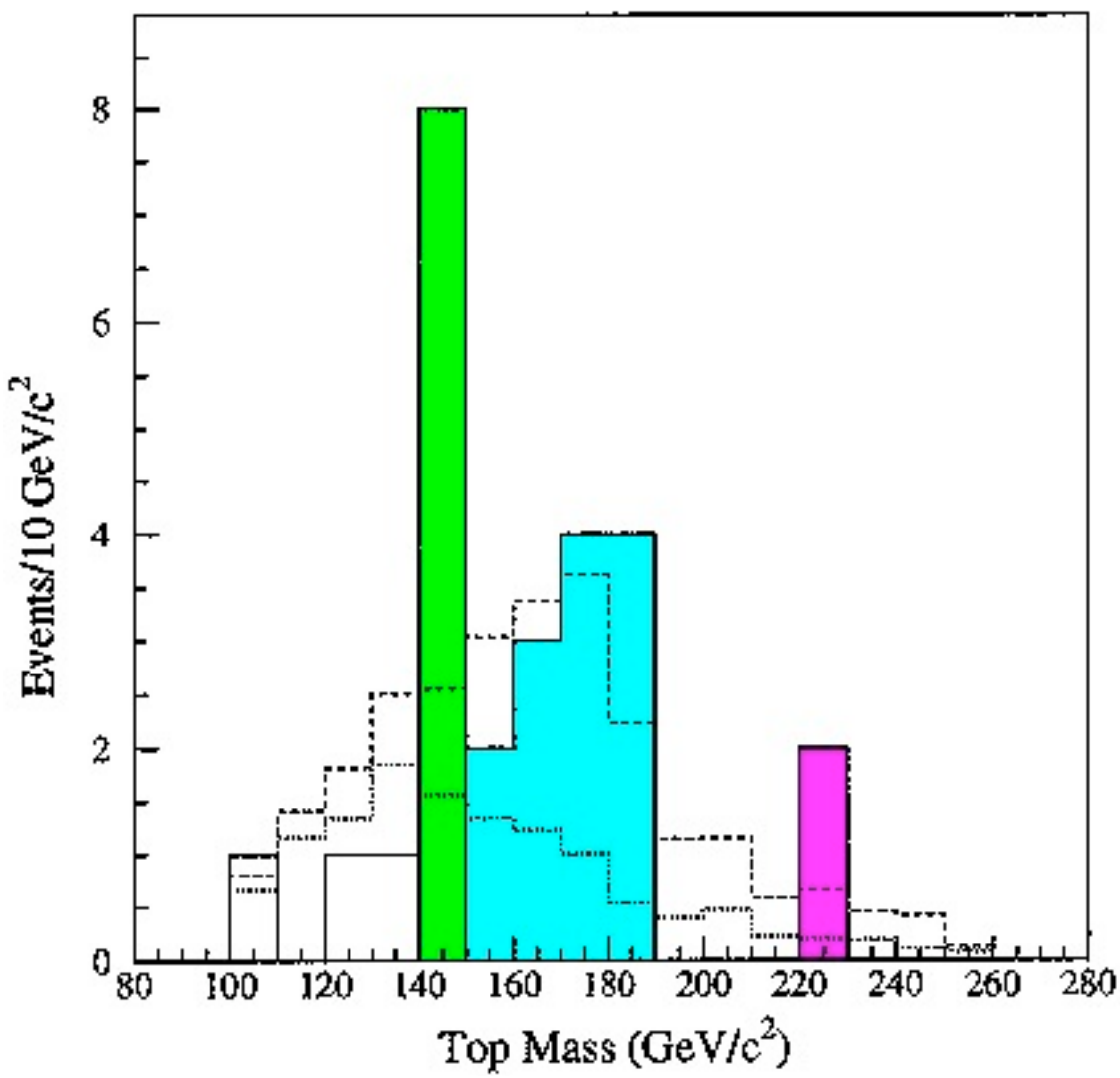
In my E8 Physics model, the High-Mass Higgs State is at the Critical Point of the Higgs-Tquark System



where the Triviality Boundary intersects the Vacuum Instability Boundary which is also at the Higgs Vacuum Expectation Value VEV around 250 GeV.

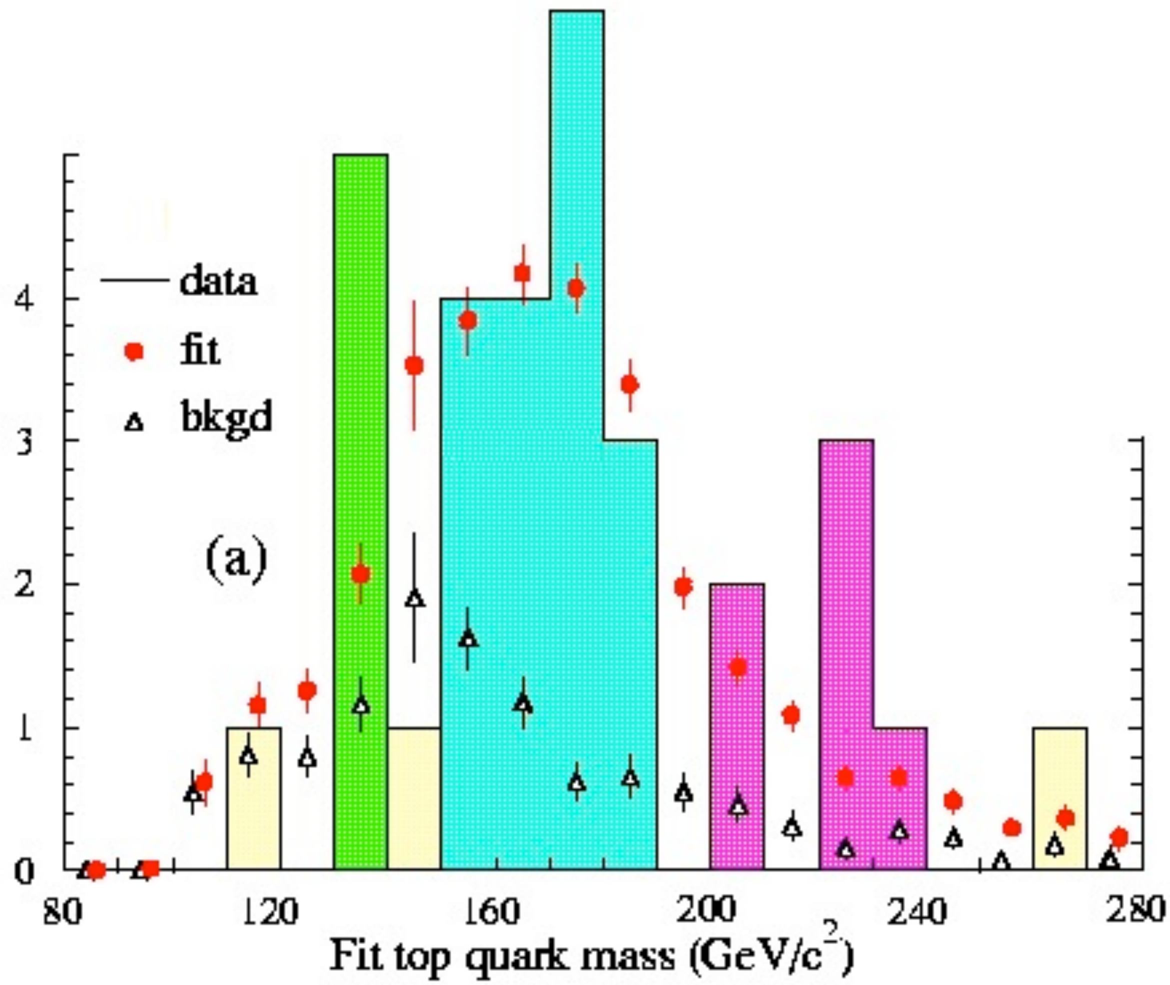
As with the Mid-Mass Higgs, the High-Mass Higgs lives in all 4+4 = 8 Kaluza-Klein dimensions and so has a cross-section that is 25% of the Higgs Ground State cross-section.

In 1994 a seimileptonic histogram from CDF



seems to me to show all three states of the T-quark.

In 1997 a semileptonic histogram from D0

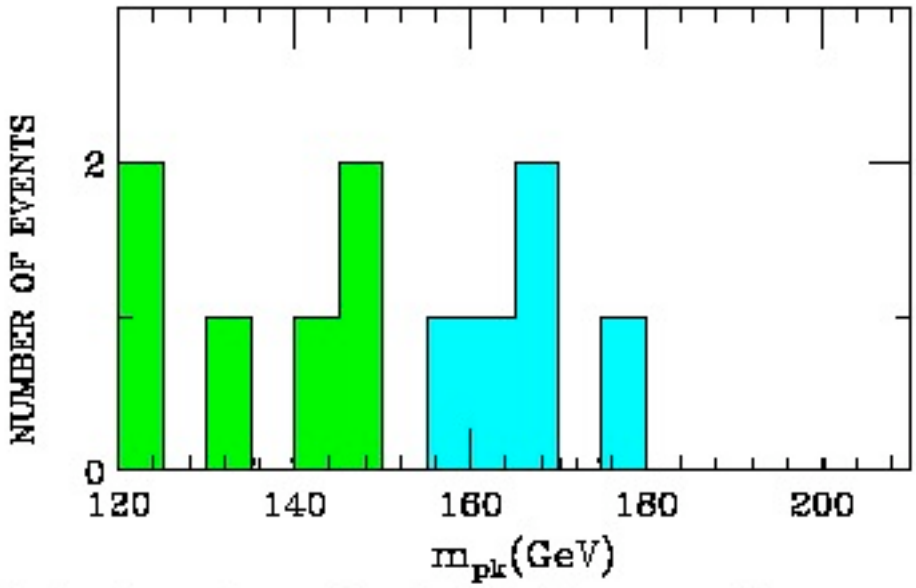


also seems to me to show all three states of the T-quark.

The fact that the low (green) state showed up in both independent detectors indicates
a significance of 4 sigma.

Some object that the low (green) state peak should be as wide as the peak for the middle (cyan) state,
but
my opinion is that the middle (cyan) state should be wide because it is on the Triviality boundary where the composite nature of the Higgs as T-Tbar condensate becomes manifest and
the low (cyan) state should be narrow because it is in the usual non-trivial region where the T-quark acts more nearly as a single individual particle.

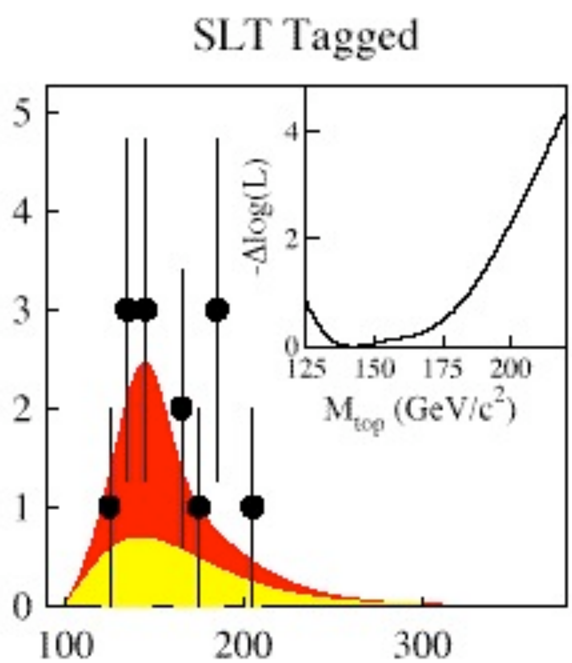
In 1998 a dilepton histogram from CDF



The distribution of m_{pk} values determined from 11 CDF dilepton events available empirically.

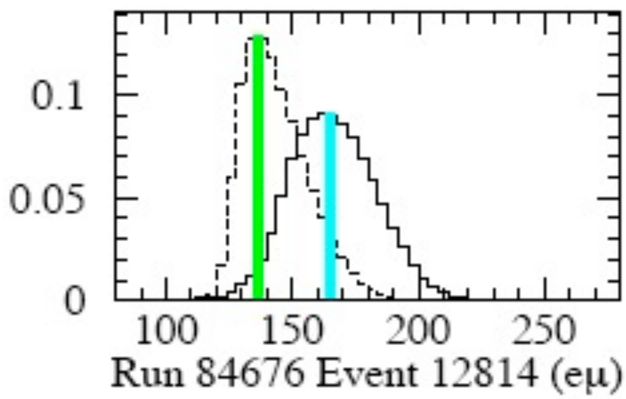
seems to me to show both the low (green) state and the middle (cyan) state of the T-quark.

In 1998 an analysis of 14 SLT tagged lepton + 4 jet events by CDF



showed a T-quark mass of 142 GeV (+33,-14) that seems to me to be consistent with the low (green) state of the T-quark.

In 1997 the Ph.D. thesis of Erich Ward Varnes (Varnes-fermilab-thesis-1997-28) at page 159 said:
"... distributions for the dilepton candidates. For events with more than two jets, the dashed curves show the results of considering only the two highest ET jets in the reconstruction ...



..." (colored bars added by me)

The event for all 3 jets (solid curve) seens to me to correspond to decay of a middle (cyan) T-quark state with one of the 3 jets corresponding to decay from the Triviality boundary down to the low (green) T-quark state, whose immediately subsequent decay is corresponds to the 2-jet (dashed curve) event at the low (green) energy level.
After 1998 until very recently Fermilab focussed its attention on detailed analysis of the middle (cyan) T-quark state, getting much valuable detailed information about it but **not producing much information about the low or high states**.

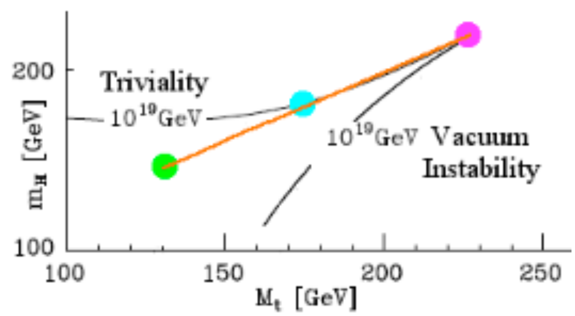
Standard Model Higgs: 126, 200, 250 GeV

Frank Dodd (Tony) Smith, Jr. - March 2013

This paper (viXra 1207.0028) is about LHC results announced through Moriond 2013
(it supercedes my earlier papers) - FermiLAT Higgs

In the 25/fb of data collected through the run ending with the long shutdown at the end of 2012, the LHC has observed a 126 GeV (about 133 proton masses) state of the Standard Model Higgs boson.

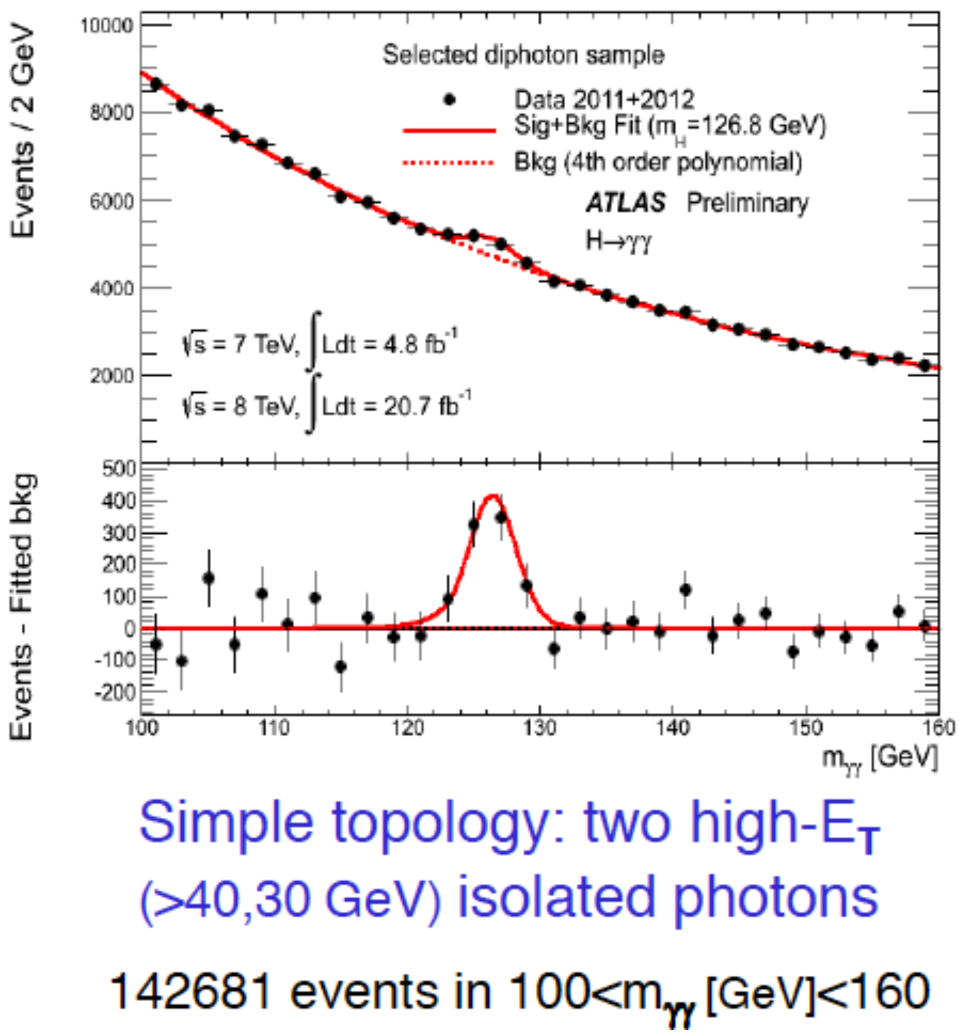
In my E8 Physics model the Higgs/Tquark system has 3 mass states



with the low-mass Higgs state calculated in my E8 Physics model to be 126.257 GeV.
The 3-state Higgs-Tquark system also has, near the Higgs Vacuum Expectation Value around 250 GeV, a high-mass state at a critical point with respect to Vacuum Instability and Triviality, as well as a mid-mass state around 200 GeV at which the system renormalization path enters conventional 4-dim Physical Spacetime, departing from the Triviality boundary at which an (4+4)-dim Klauza-Klein spacetime is manifested.

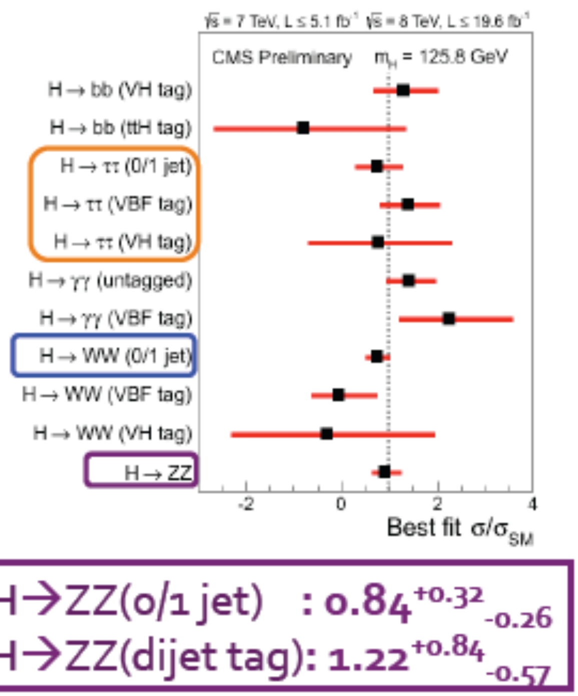
Here are some details about the LHC observation at 126 GeV and related results shown at Moriond 2013:

The digamma histogram for ATLAS



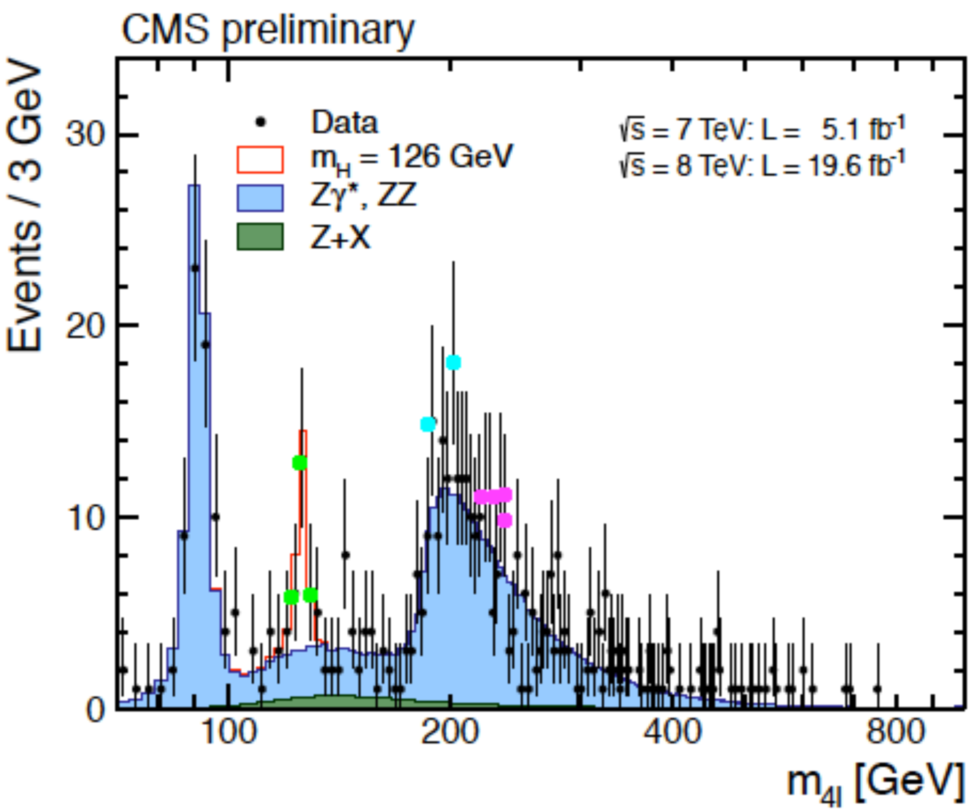
clearly shows only one peak below 160 GeV and it is around 126 GeV.

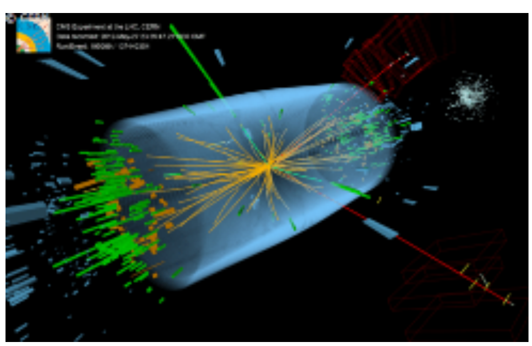
CMS shows the cross sections for Higgs at 125.8 GeV



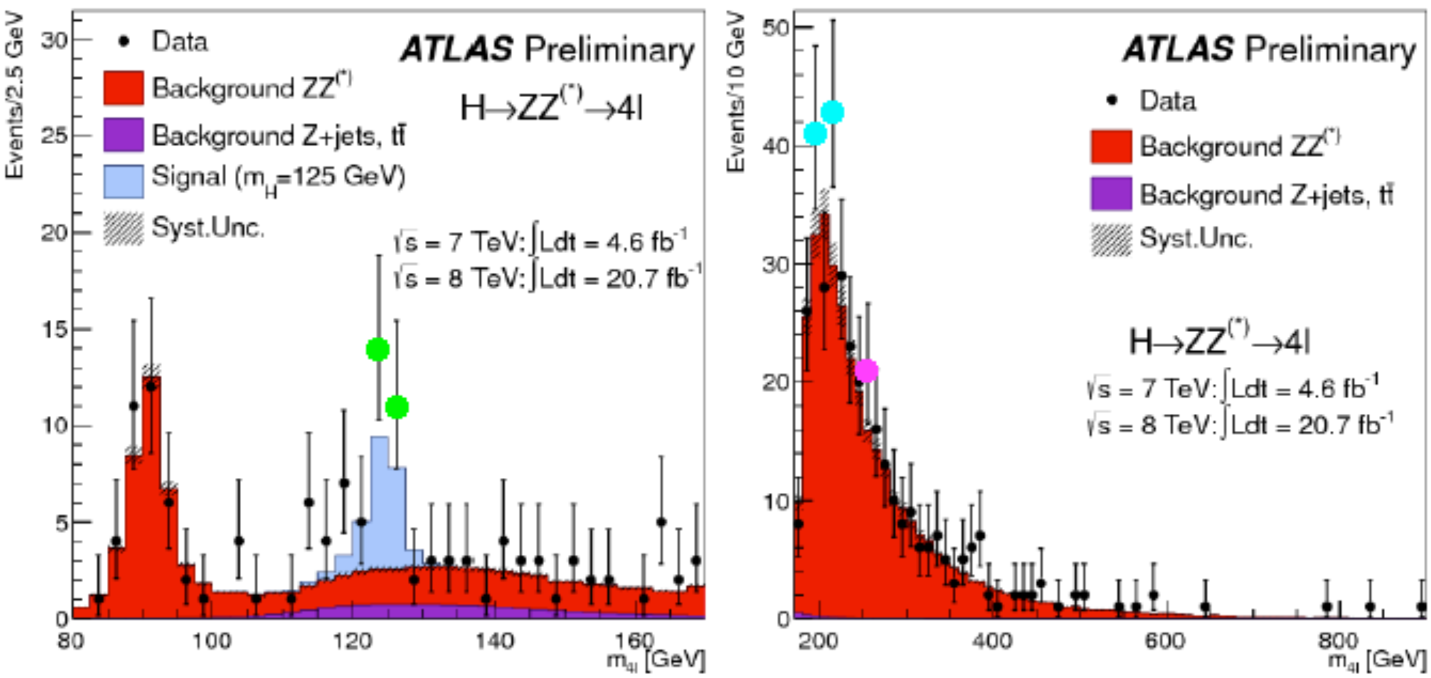
to be substantially consistent with the Standard Model for the WW and ZZ channels, a bit low for tau-tau and bb channels (but that is likely due to very low statistics there), and a bit high for the digamma channel (but that may be due to phenomena related to the Higgs as a Tquark condensate).

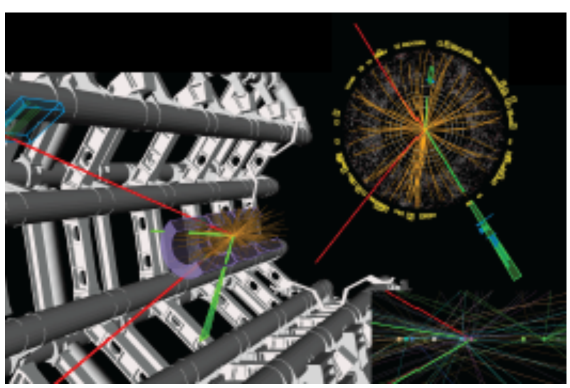
A CMS histogram (some colors added by me) for the Golden Channel Higgs to ZZ to 4l shows the peak around 126 GeV (green dots - lowHiggs mass state. The CMS histogram also indicates other excesses around 200 GeV (cyan dots - midHiggs mass state)
and around 250 GeV (magenta dots - highHiggs mass state).
An image of one of the events is shown below the histogram.



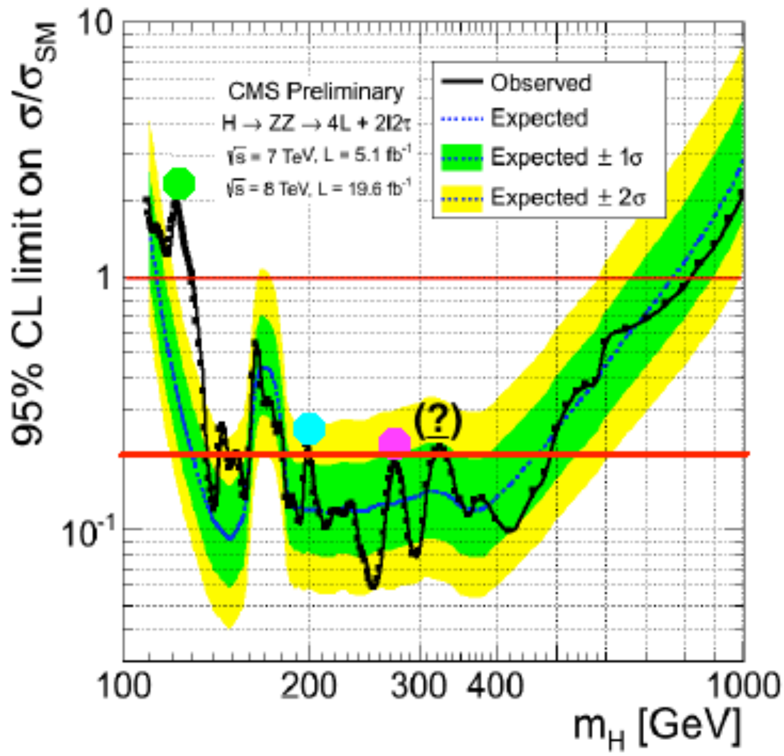


Some ATLAS ZZ to 4l histograms (some colors added by me) show the peak around 125 GeV (green dots - lowHiggs mass state. The ATLAS histograms also indicate other excesses around 200 GeV (cyan dots - midHiggs mass state)
and around 250 GeV (magenta dots - highHiggs mass state) . An image of one of the events is shown below the histograms.





CMS showed a Brazil Band Plot for the High Mass Higgs to ZZ to 4l/2l2tau channel
where the top red line represents the expected cross section of a single Standard Model Higgs
and the lower red line represents about 20% of the expected Higgs SM cross section.



The green dot peak is at the 126 GeV Low Mass Higgs state with expected Standard Model cross section.

The cyan dot peak is around the 200 GeV Mid Mass Higgs state expected to have about 25% of the SM cross section.

The magenta dot peak is around the 250 (+/- 20 or so) GeV High Mass Higgs state expected to have about 25% of the SM cross section.

The **(?)** peak is around 320 GeV where I would not expect a Higgs Mass state.

It will probably be no earlier than 2016 (after the long shutdown) that the LHC will produce substantially more data than the 25/fb available at Moriond 2013 and therefore no earlier than 2016 for the green and yellow Brazil Bands to be pushed down (throughout the 170 GeV to 500 GeV region) below 10 per cent (the 10^(-1) line) of the SM cross section
as is needed to show whether or not the cyan dot , magenta dot, and/or **(?)** peaks are real or statistical fluctuations.

My guess (based on E8 Physics) is that the cyan dot and magenta dot peaks will prove to be real
and that the **(?)** peak will go away as a statistical fluctuation,
but
whatever the result,
it is now clear that Nature likes the plain vanilla Standard Model
(with or maybe without a couple of Little Brother Higgs states, where Little refers to cross section),
so:

With the Standard Model confirmed, what should physicists do in the future ?

Here are 4 things to think about:

1 - Since the Higgs came from Solid State Physics ideas of people like Anderson,
look closely at Solid State Nanostructures
(such as Nickel/Palladium that seems to be useful in Cold Fusion - vixra 1209.0007)
to see whether they can show new ways - vixra 1301.0150 -
to visualize the workings of High-Energy Physics of the Standard Model plus Gravity.

2 - If conventional 1-1 fermion-boson SuperSymmetry is not Nature's Way,
can we get the nice cancellations from a more Subtle SuperSymmetry ?
For that, my model uses a Triality-related symmetry between fermions and gauge bosons
based on its 8-dim Kaluza-Klein structure.

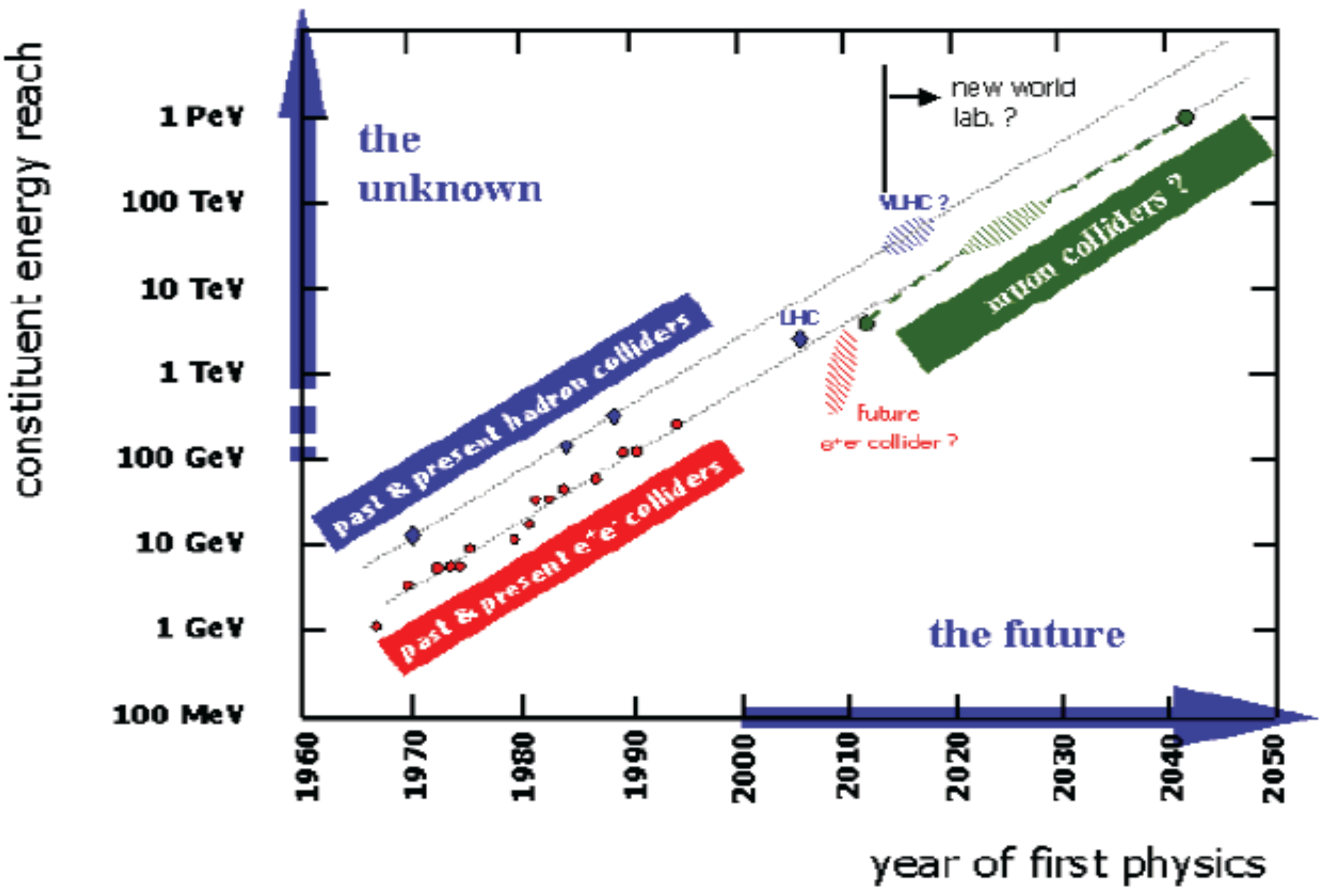
3 - What about Dark Matter and Dark Energy?
My model uses the Spin(2,4) = SU(2,2) Conformal Group of Irving Ezra Segal to account for both,
but it is experimental observation that counts.
An experimental approach to Dark Energy of Paul A. Warburton at University College London
uses terahertz frequency Josephson Junctions - vixra 1209.0109 -

Warburton said (IEEE Applied Superconductivity Conference, Chicago 2008):

"... We have fabricated intrinsic Josephson junction arrays ... and discuss ...
the application of intrinsic junctions as THz sources and qubits ...".

See also arXiv 1206.0516 by Xiao Hu, Shi-Zeng Lin, and Feng Liu entitled
"Optimal Condition for Strong Terahertz Radiation from Intrinsic Josephson Junctions"
and arXiv 0911.5371 by Xiao Hu andShi-Zeng Lin entitled
"Phase dynamics of inductively coupled intrinsic Josephson junctions
and terahertz electromagnetic radiation"

4 - What about the High Energy Massless Realm well above Electroweak Symmetry Breaking:
What happens to Kobayashi-Maskawa mixing in a Realm with no mass ?
How do you tell a muon from an electron if they are both massless ?
To find out, build a Muon Collider. In hep-ex00050008 Bruce King has a chart



and he gives a cost estimate of about $12 billion for a 1000 TeV (1 PeV) Linear Muon Collider with tunnel length about 1000 km. Marc Sher has noted that by now (late 2012 / early 2013) the cost estimate of $12 billion should be doubled or more.

My view is that even a cost of $100 billion is comparable
to the cost of the USA Navy construction program for 10 Gerald R. Ford - class aircraft carriers by 2040
and
is substantially less than the amount of money being printed up by USA Treasury/Fed Quantitative Easing which has since 2008 been giving Trillions of USA dollars to USA Big Banks every year.

Unlike Quantitative Easing giving money to Big Banks who keep it to themselves and their close friends
construction of Big Physics Machines could be effective in creating jobs,
encouraging people to understand Nature through Science,
and
being an example of peaceful cooperative development
as opposed to destructive military/economic competition.