Can LHC 2016 Data answer the question: Is Our Universe MetaStable ?

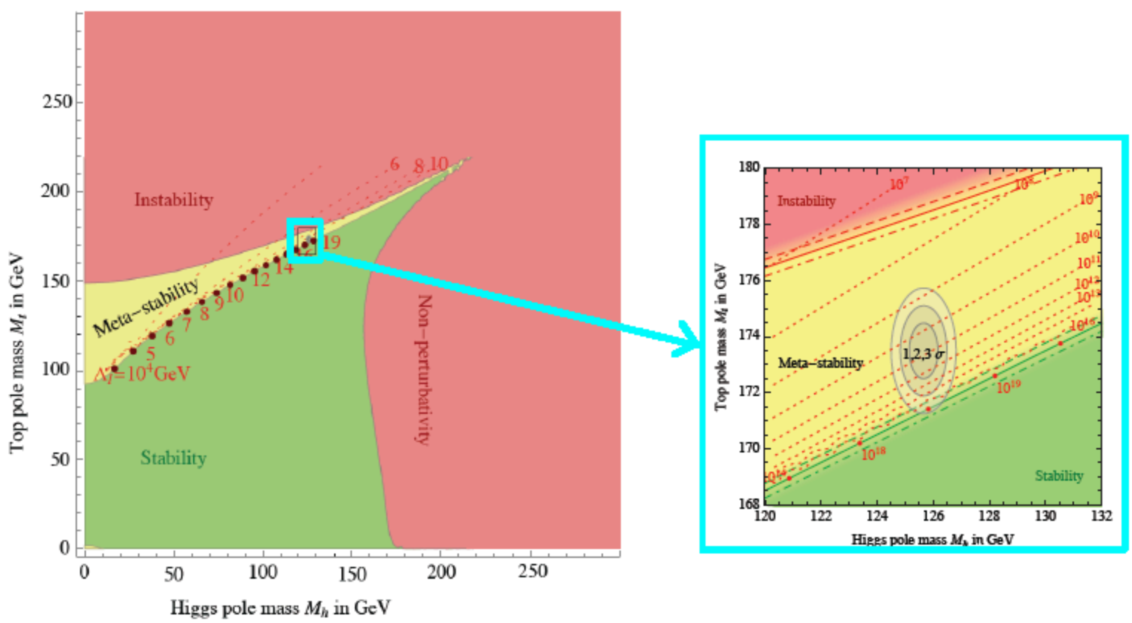
Frank Dodd (Tony) Smith, Jr. - 2013

In arXiv 1307.3536 Buttazzo, Degrassi, Giardino, Giudice, Sala, Salvio, and Strumia assume a Standard Model Higgs with a single 125.66 GeV Mass State and a Standard Model Tquark with a single 173.35 GeV Mass State and conclude that Our Universe is MetaStable with a possibility that its current ElectroWeak Vacuum could decay at any time (although its probable lifetime is at least around 10^400 years). However, the LHC has seen possible indications of at least two other Higgs Mass States (around 200 GeV and 250 GeV, with small cross sections about 20% of that of single SM Higgs) that are NOT in the MetaStable Vacuum Region. For the LHC to produce enough data beyond the 25/fb now available in 2013 to show whether or not the 200 GeV and 250 GeV Higgs Mass States are real, the upgrade of the long shutdown and the 2016 run data are necessary. Only the LHC 2016 Data can answer the question: Is Our Universe MetaStable?

Can LHC 2016 Data answer the question:
Is Our Universe MetaStable ?

Frank Dodd (Tony) Smith, Jr. - 2013

In arXiv 1307.3536 Buttazzo, Degrassi, Giardino, Giudice, Sala, Salvio, and Strumia say "... from data ... of the Higgs ... and the ... [Tquark] Yukawa coupling ... we extrapolate ... SM parameters up to large energies ... Then we study the phase diagram of the Standard Model in term of high-energy parameters, finding that
the measured Higgs mass roughly corresponds to ... **vacuum metastability** ...



[image adapted from arXiv 1307.3536]

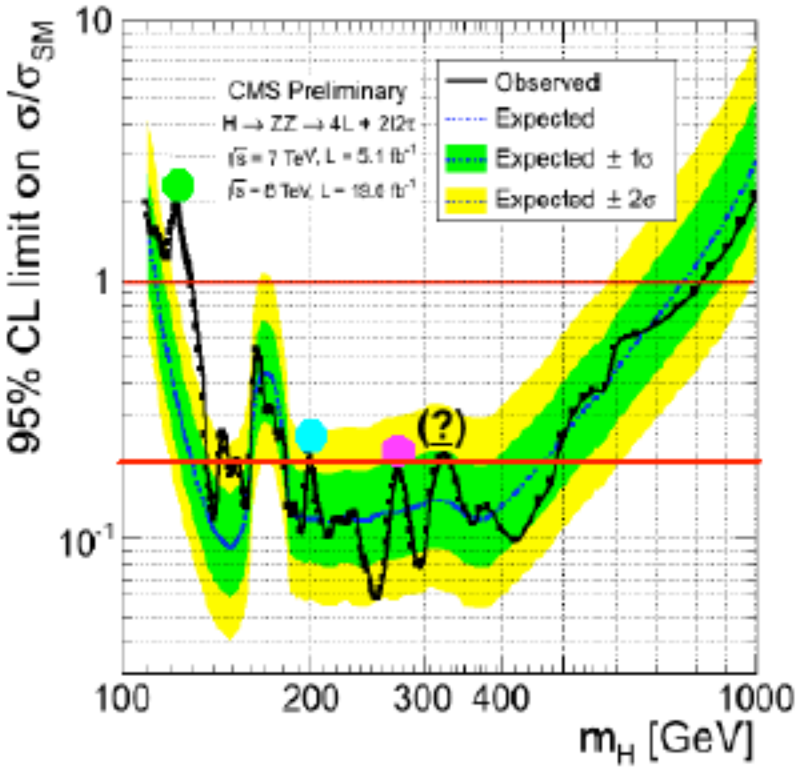
... The measured ...Higgs mass ... Mh = 125.66 +/- 0.34 GeV ... lies well within the ... window in which the SM can be extrapolated all the way up to the Planck mass Mpl
...
we adopt ... Pole mass of the [Tquark] Mt = 173.36 +/- 0.65 +/- 0.3 GeV
...
the ... values of Mh and Mt ... indicate that the SM Higgs vacuumis not the true vacuum ... and that our universe is potentially unstable ...
the instability scale ... above which the ... critical Higgs field ... potential becomes smaller than the value of the EW vacuum ... occurs at ... 10^10 - 10^12 GeV ...
suggesting that the instability is reached well below the Planck mass ...
The lifetime of the electroweak vacuum, with ... future cosmology ... dominated by the cosmological constant (/\CDM) ...[is at least about 10^400 years]..."

BUT

What if 125.66 GeV were not the only Higgs mass state ?
What if 173.35 GeV were not the only Tquark mass state ?

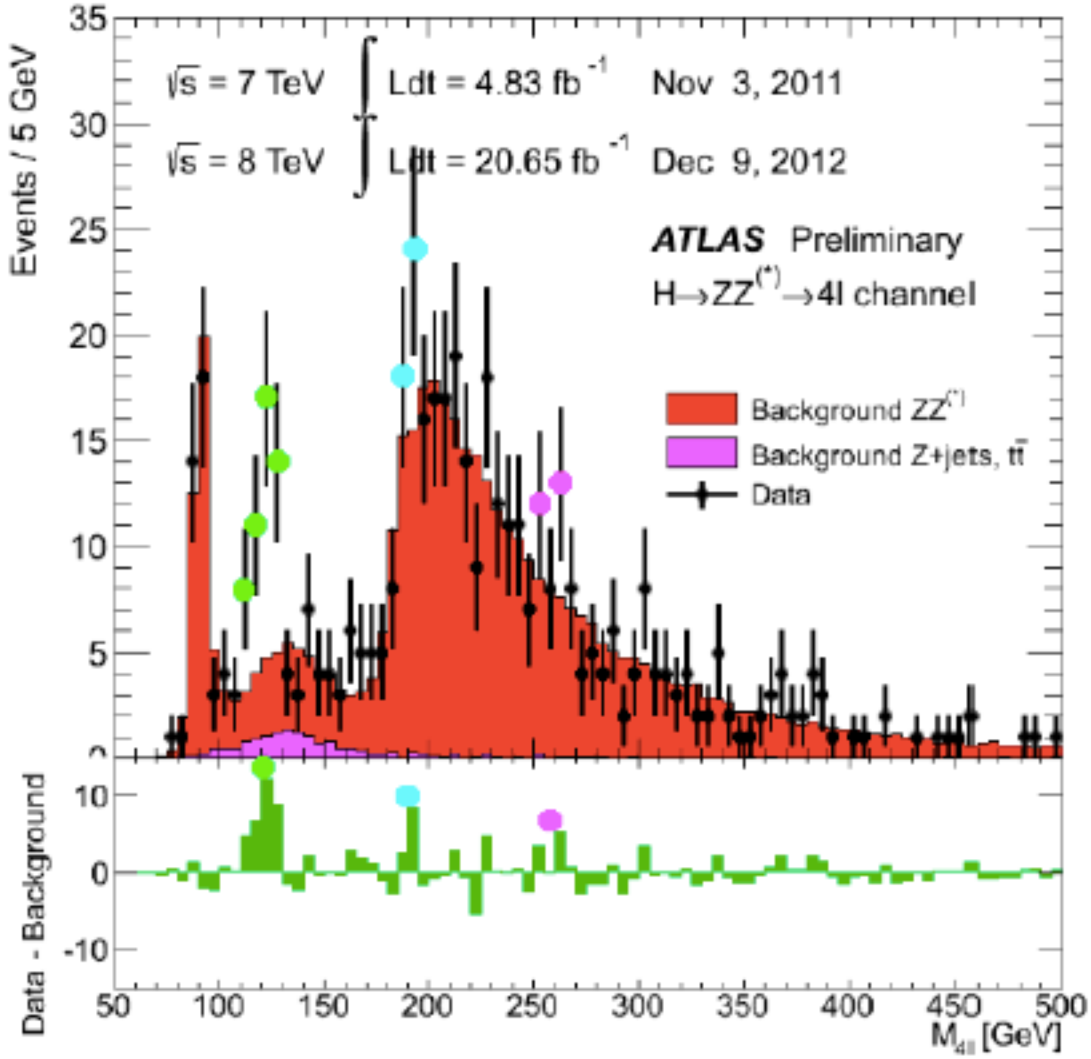
Has the LHC seen Higgs mass states beyond the 125.66 GeV state ?

The LHC has NOT seen any other Higgs mass state with cross section expected for a single SM Higgs, but in connection with Moriond 2013 CMS showed



a Brazil Band Plot for the High Mass Higgs to ZZ to 4l/2l2tau channel where:
top red line represents the expected cross section of a single Standard Model Higgs
lower red line represents about 20% of the expected Higgs SM cross section
green dot peak is at the 125.66 GeV Low Mass Higgs state with SM cross section
unmarked peaks around 160 and 180 GeV may represent WW and ZZ background
cyan dot peak around 200 (+/- 20 or so) GeV may represent a Mid Mass Higgs state with about 20% of the SM cross section
magenta dot peak around 250 (+/- 20 or so) GeV may represent a High Mass Higgs state with about 20% of the SM cross section.

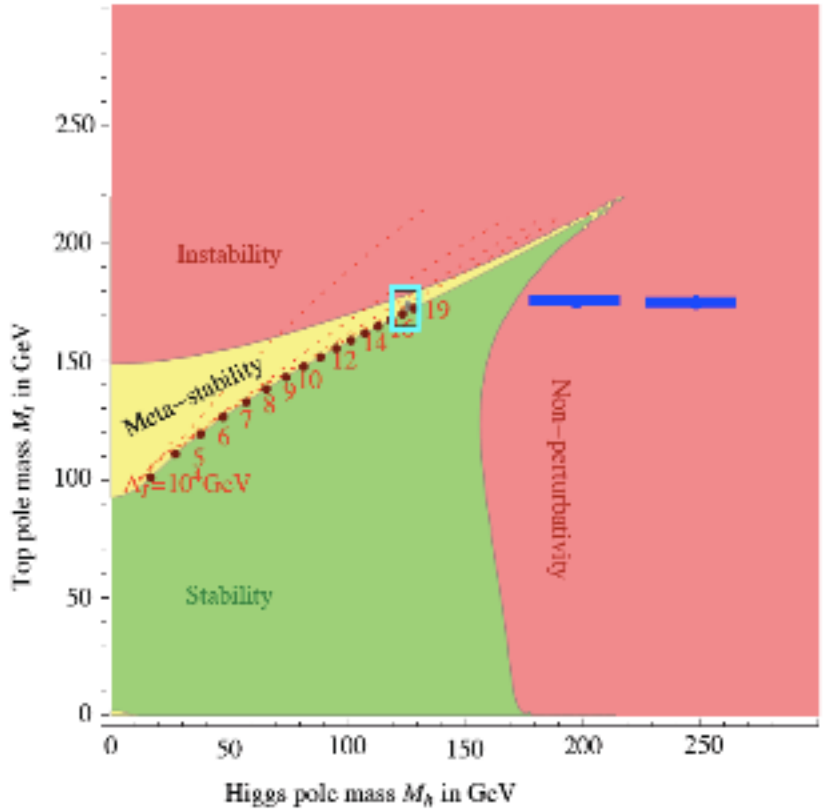
The (?) peak around 320 GeV may be a statistical fluctuation since it seems to have gone away in this ATLAS ZZ to 4l histogram



(between 300 and 350 GeV the two excess bins are adjacent to deficient bins).

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.

If the 200 GeV and 250 GeV Higgs Mid and High Mass states do prove to be real
and
if we continue to assume that the Tquark is a single mass state at 173.36 GeV



then we have both a MetaStable Vacuum and Non-perturbativity of Higgs.
Physically, Higgs Non-perturbativity indicates a composite Tquark condensate Higgs.
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)

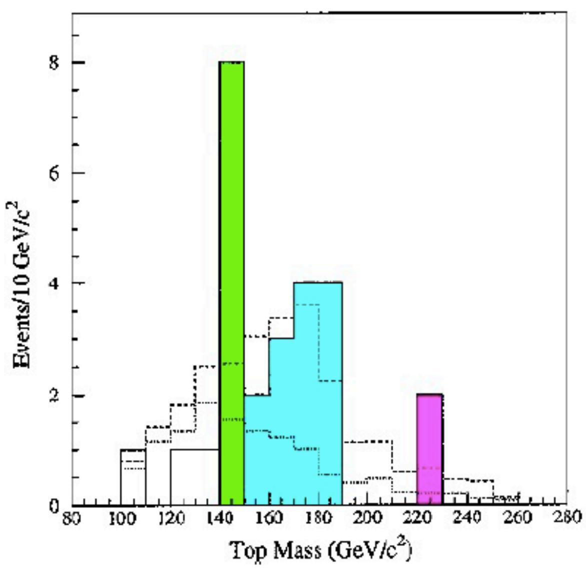
while the vacuum value is determined by the Fermi constant
...
for a fixed vacuum value v, let us assume that the Higgs mass and therefore lambda is large. In that case, beta_lambda is dominated by the lambda^2 term, which drives the coupling towards its Landau pole at higher energies. Hence the higher 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 ... it is natural to think that this effect is caused by new strong interactions, and that the Higgs actually is a composite ...".

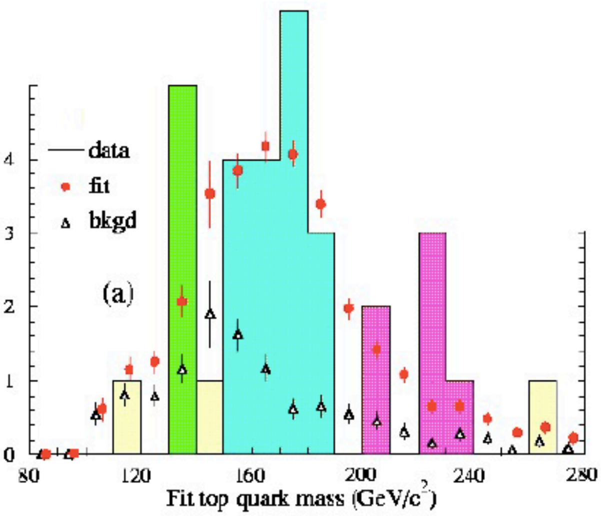
If the Higgs is really a 3-state Tquark condensate system (125.66 , 200 , 250 GeV)

then

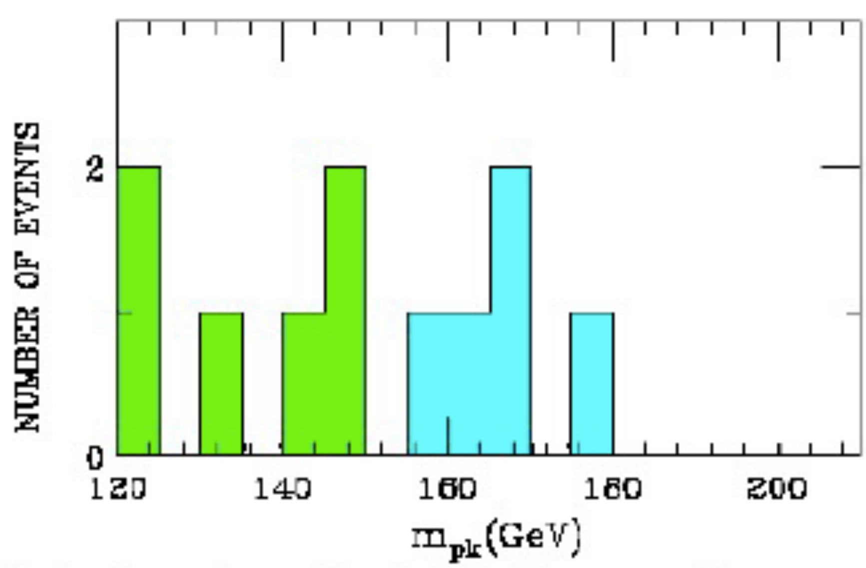
the Tquark may also have 3 mass states (130 , 173.35 , 220 GeV)

as indicated by these 1994 CDF and 1997 D0 semileptonic histograms

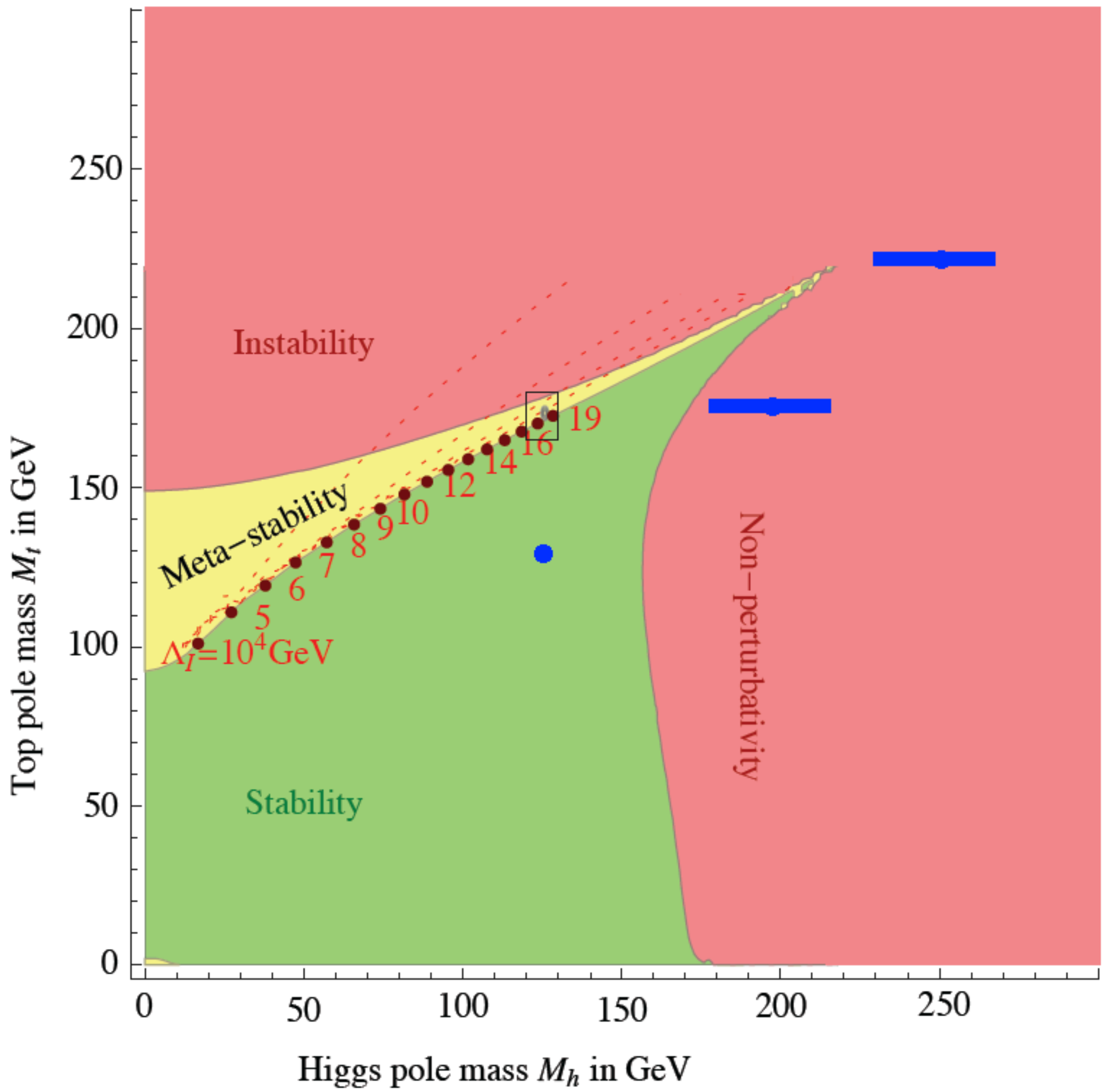




and this 1998 CDF dileptonic histogram



If you consider the Higgs-Tquark condensate system as having 3 mass states
and
if you match up the Low, Mid, and High mass states of the Higgs and Tquark
Low Mass = 125.66 GeV Higgs and 130 GeV Tquark
MId Mass = 200 GeV Higgs and 173.35 GeV Tquark
High Mass = 250 GeV Higgs and 220 GeV Tquark
then you have



No Vacuum Metastability or Instability.

A Low ground state (Mh = 125.66 Mt = 130 GeV) in the Stability Region.
A Mid state (Mh = 200 GeV Mt = 173.35 GeV) in the Non-perturbativity region.
A High state (Mh = 250 GeV Mt = 220 GeV) at the Critical Triple Point.