Thoughts on what we are doing here

Benjamin Grinstein

This is a workshop

Working groups?

Working groups!

more like

Brain droppings

(after George Carlin)

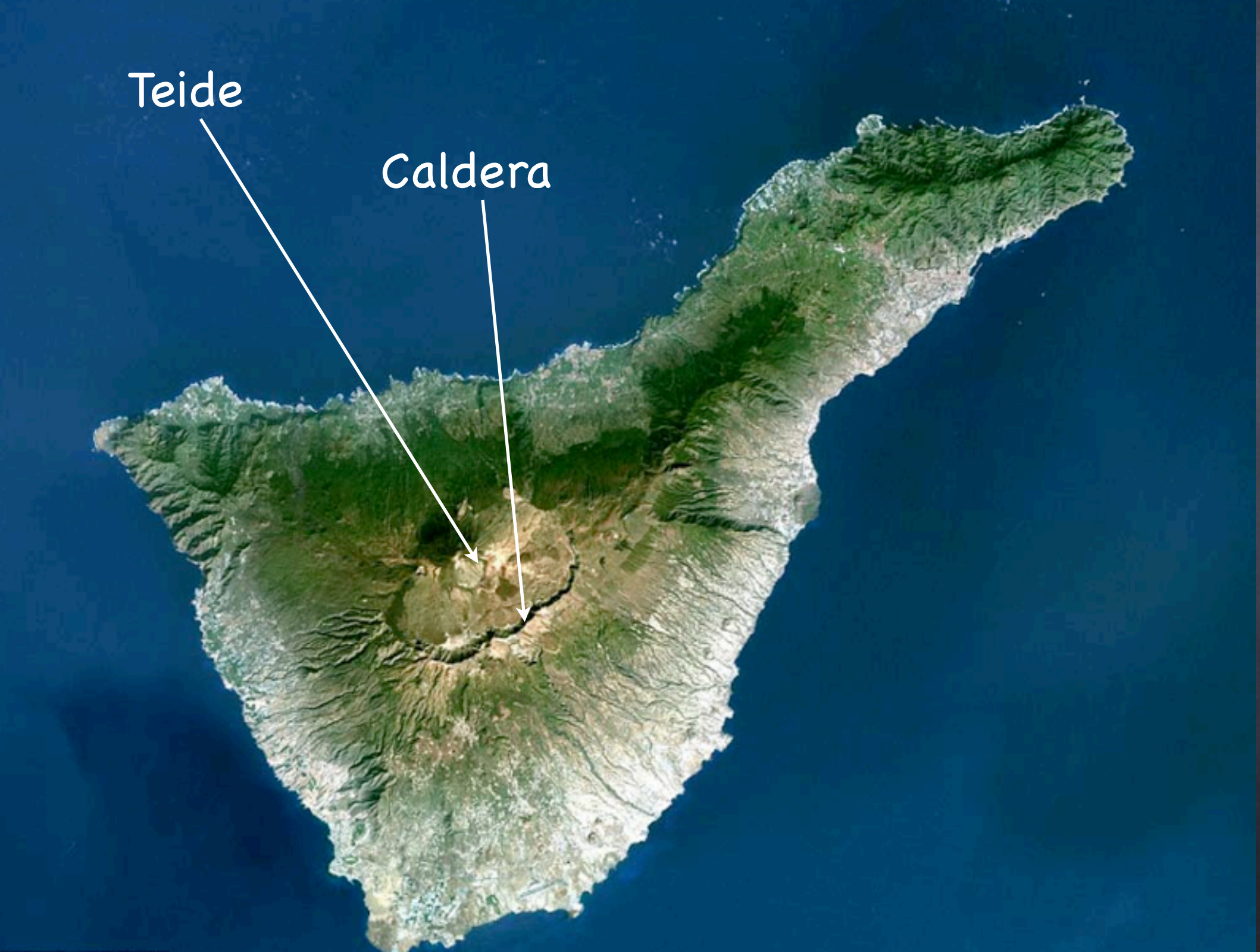
more like

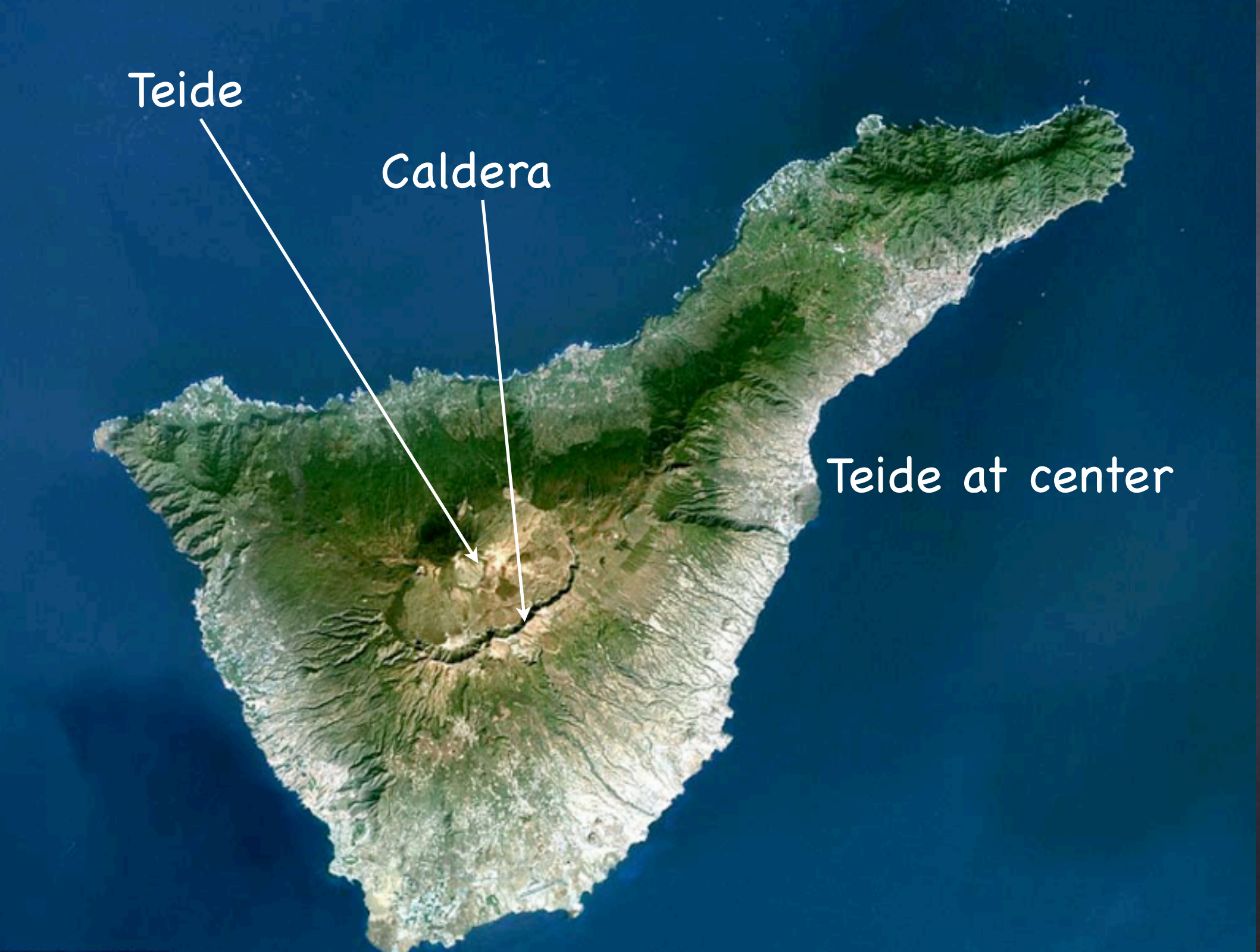
Brain droppings

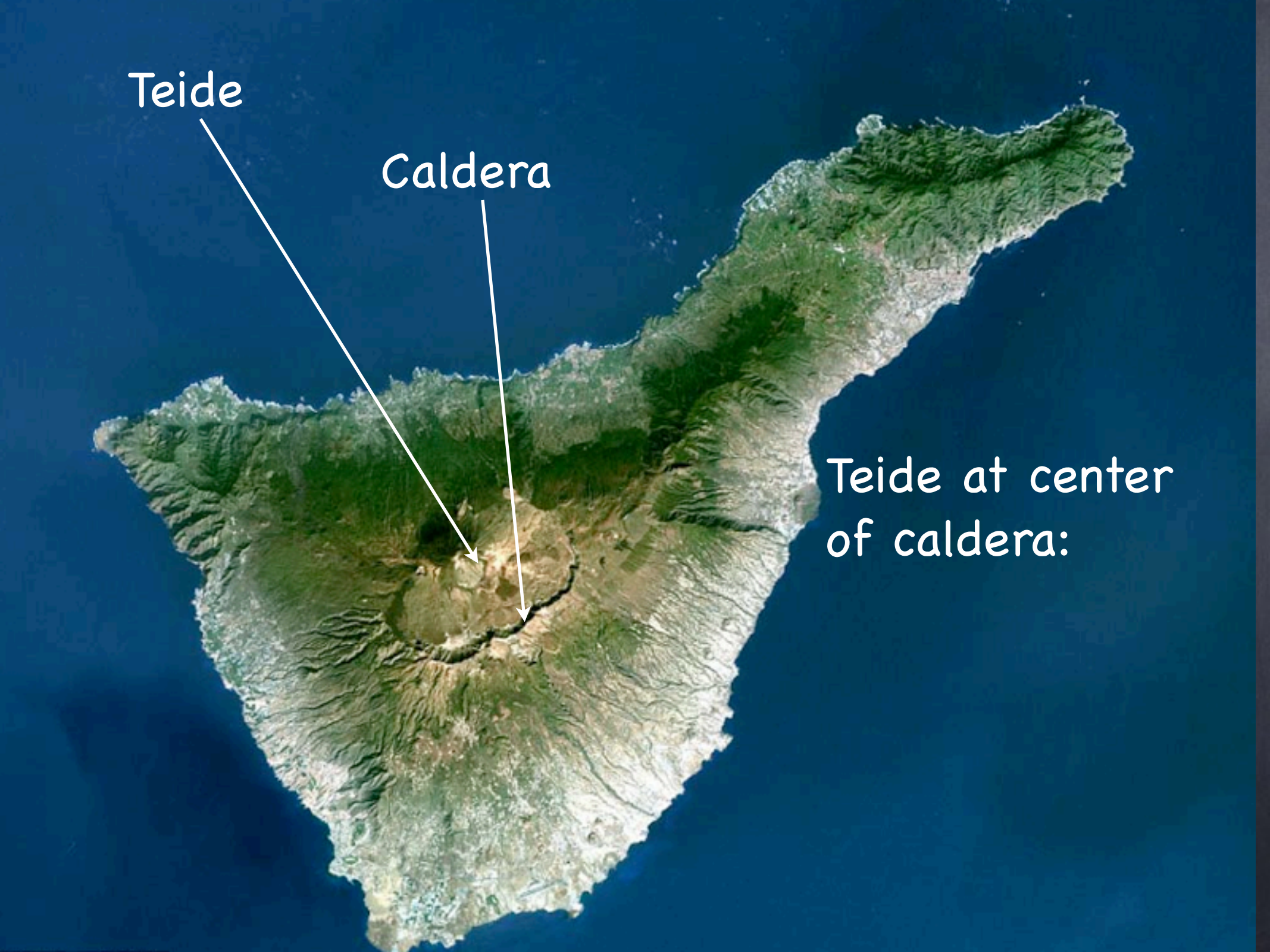
(after George Carlin)

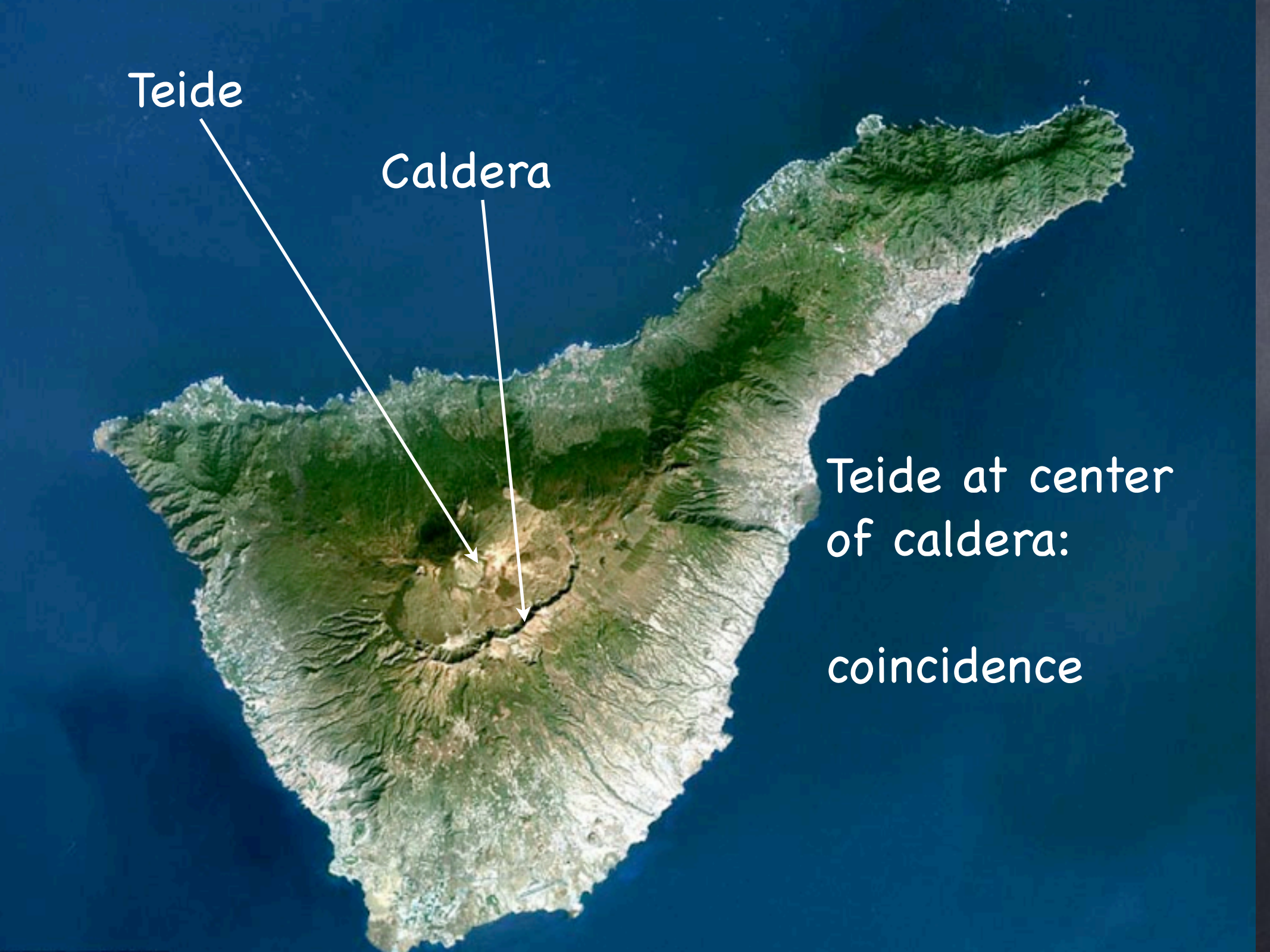
Provocative, not inspiring

Fine tuning


Teide
Caldera

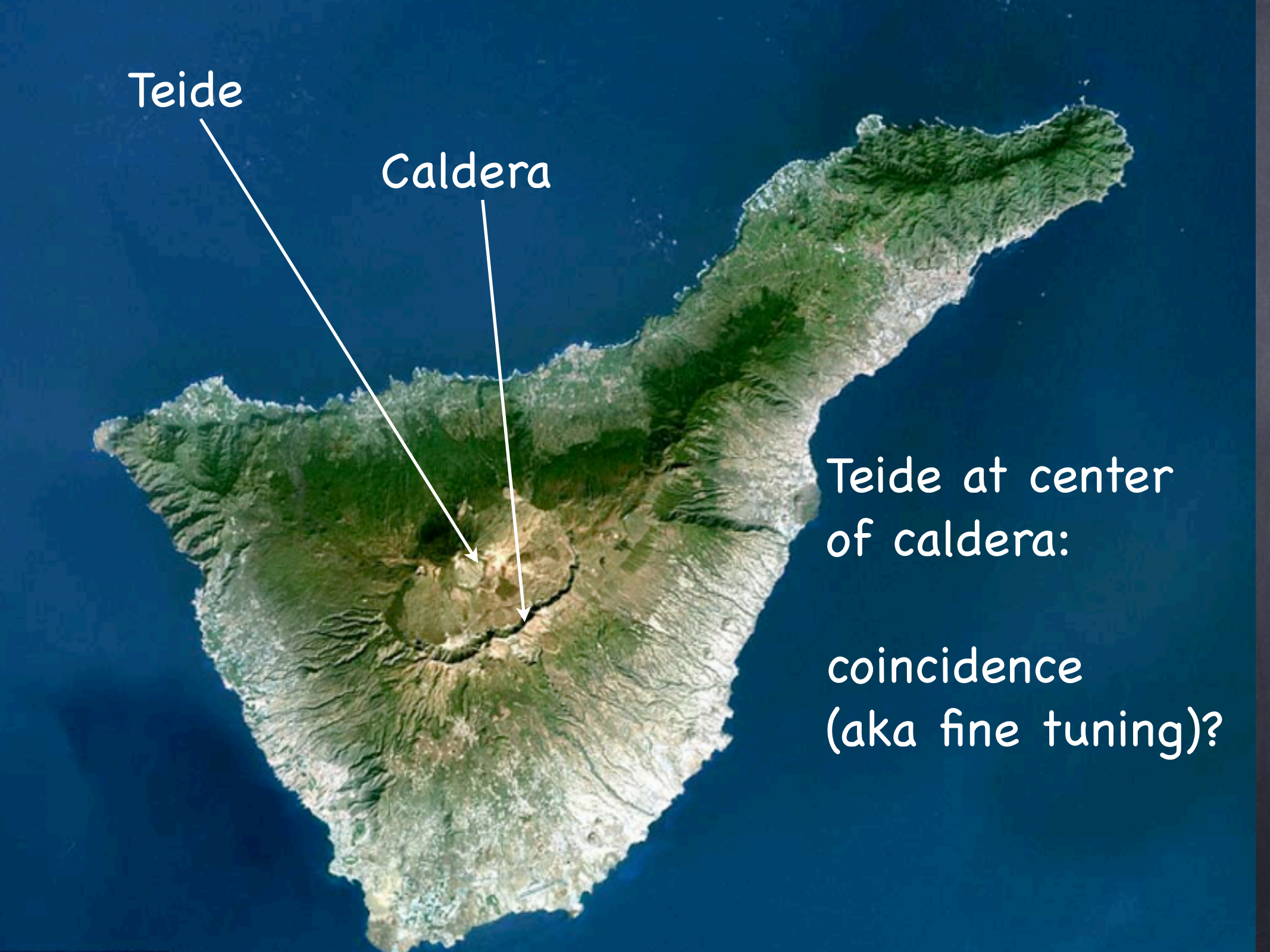

Teide
Caldera
Teide at center


Teide
Caldera
Teide at center
of caldera:



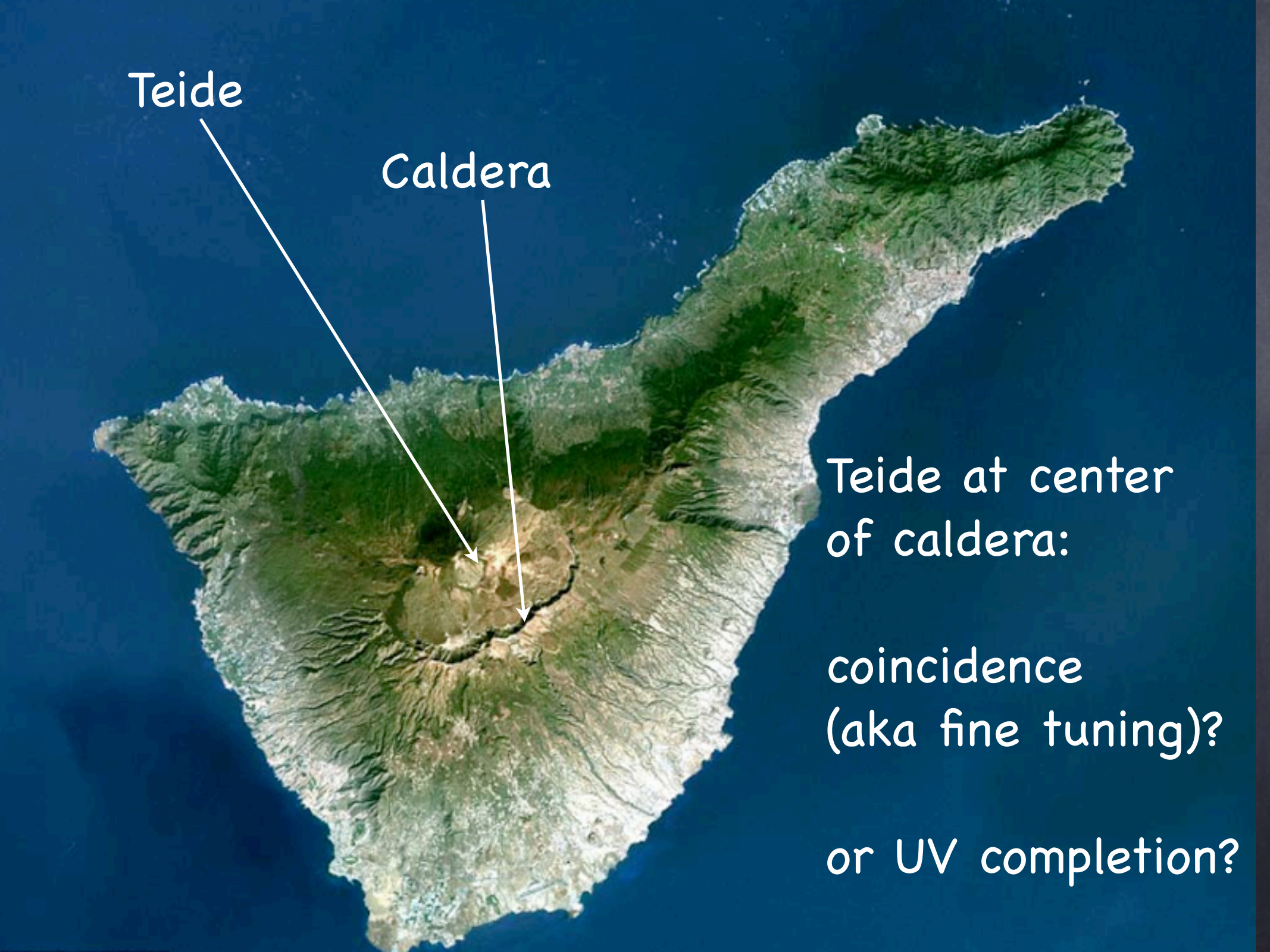
Teide at center of caldera:

coincidence



Teide at center of caldera:

coincidence (aka fine tuning)?



Teide at center of caldera:

coincidence (aka fine tuning)?

or UV completion?

The caldera was formed as a result of a geological landslide taking 40Ky about 180Ky ago

There was no Teide then

"Con el paso del tiempo, la gran depresión se fue rellenando hasta formar el Teide, que se convirtió en el pico más alto de España por "un caprichoso azar de la naturaleza", una erupción que "se pudo producir en el siglo XIV", pronostica el geofísico."

https://www.elmundo.es/elmundo/2012/04/12/ciencia/1334226413.html

(Actually, several eruptions, starting 120Ky ago, building up to present size)

let's stop making up problems where there are none

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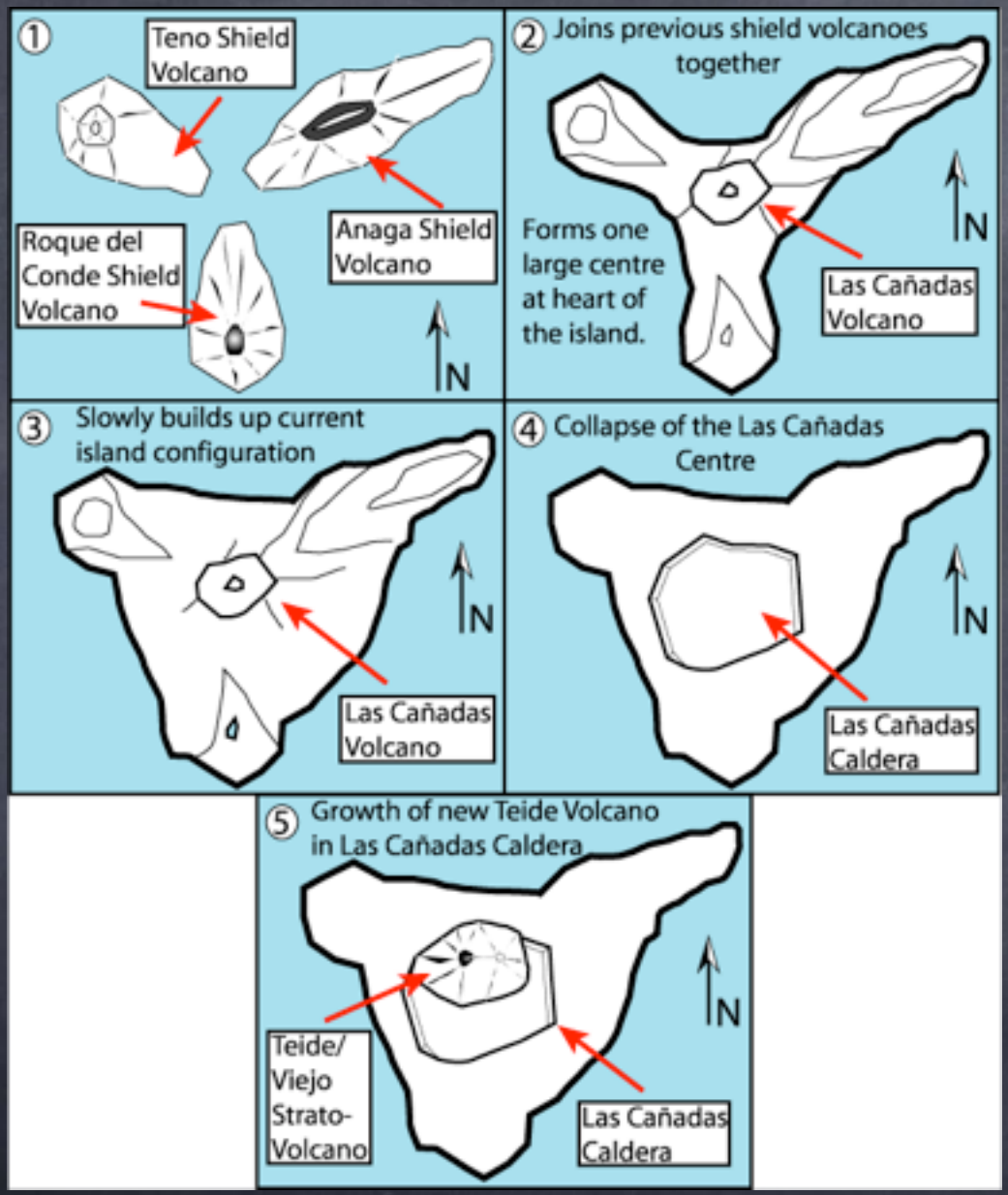

Flavor dishonesty

- Generic flavor speaker motivation slide
  - Explain origin of matter (ugh)
  - Why are there 3 generations
  - Why hierarchies of masses
  - Why texture of mixing matrices

Modeling flavor anomalies: shouldn't they answer the flavor questions?? How do we propose to ever address the "motivation" Qs?

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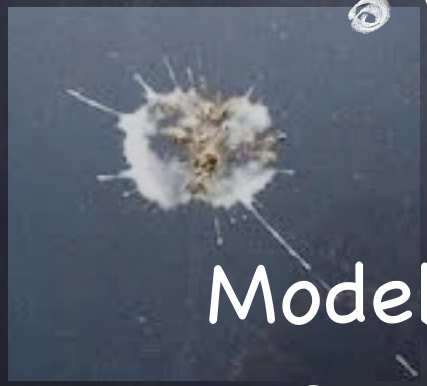

Modeling flavor anomalies: shouldn't they answer the flavor questions?? How do we propose to ever address the "motivation" Qs?

Glad to see some are starting to think about this, cf, talks by

Marzia Bordone (using Froggatt-Nielsen power counting in SMEFT coefficients)

Gino Isidori (proposing different gauge group representations to distinguish generations and hierarchical symmetry breaking to produce accidental U(2))

(I, with G Ross and S Pokorsky also tried)

Warning: this is not a summary talk

Do not expect to see your name quoted

Chances are if I did, it would not be kind

What do you say to

"We badly need LHC to see something"

?

This is same as this talk's title:
What are we doing here?

HC2NP: Can we ever be sure?

Can you trust there is NP in a 5σ deviation in $(g-2)_\mu$. In 7σ? 10σ?
How about in ε'/ε

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I feel more and more
irrelevant

Lattice will do it all

Homework: list all the problems in flavor physics that lattice will not do.

Grade: Look at it and ask:
should I change fields?

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Bare with me:
longish intro to my next dropping

How theory ends.

Peter Galison in How Experiments End asks

> How does a scientist decide at what point an experiment is completed and the results can be communicated to the scientific community?

Galison's thesis: sociological considerations matter in deciding when to stop looking for systematics

Two interesting proposals he gathers from particle physics

- Personal bias (historical) on methodology (often tied to type of instrumentation)
  - Example: golden event vs statistics Gargamelle vs HPWF ("alternating neutral currents")
  - Example: Even within Gargamelle,

"...several group members, particularly Perkins, found the single photograph of neutrino-electron scattering particularly important. For others, the difference in the spatial distribution between the observed neutral current candidates and the neutron background was decisive."

-Allan Frankin, Brit.]. Phil. Sci. 39 (1988). 411-414 (Review of Galison's)

Two interesting proposals he gathers from particle physics

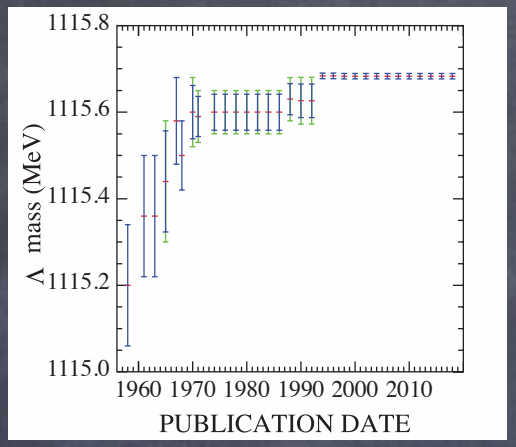
- Prejudice on expected result, provided by
  - previous experiments
  - theoretical expectations

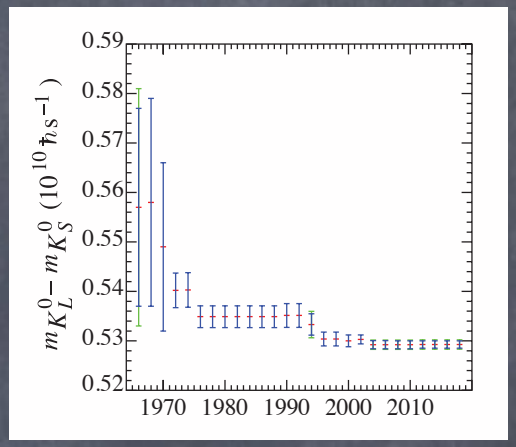
"A reasonable point at which to stop looking for [..] systematic effects is when the result agrees with previous measurements or when it agrees with existing theory."

-Allan Frankin, idem

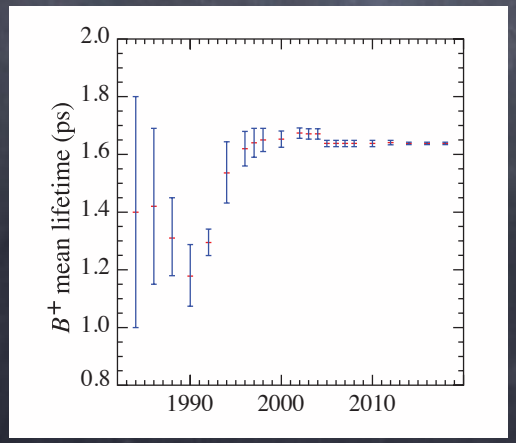
It is easy to find suggestions (evidence?) of prejudice due to previous measurements

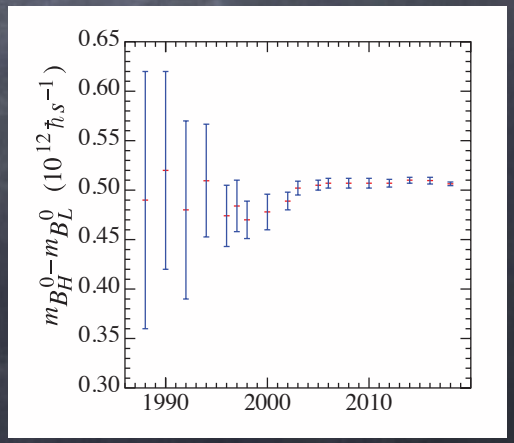
PDG Historical Plots





VS





Let's be clear

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Nobody is cheating

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systematic errors are hard to determine

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And it is difficult to insure all sources are included

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systematic errors are hard to determine

And it is difficult to insure all sources are included

The prejudice comes in deciding
when to stop trying

Prejudice from theoretical expectations

$$\boxed{g - 2 = -1}$$

"Their result for the ratio of the angular momentum of the sample to its magnetic moment (the authors called it) was very close (within 3%) to the expected value of $2m/e$. It was realized later that their result with the quoted uncertainty of 10% was not consistent with the correct value which is close to m/e. Apparently, the authors underestimated the experimental uncertainties."

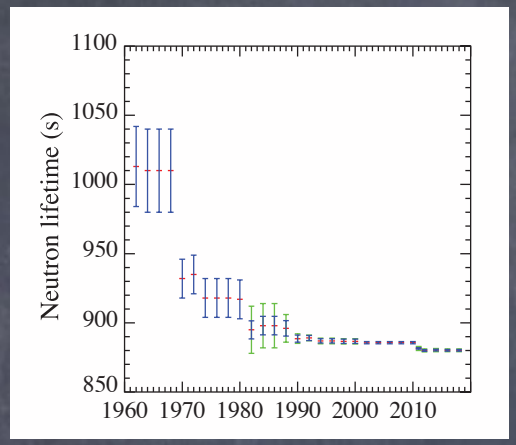
https://en.wikipedia.org/wiki/Einstein%E2%80%93de_Haas_effect

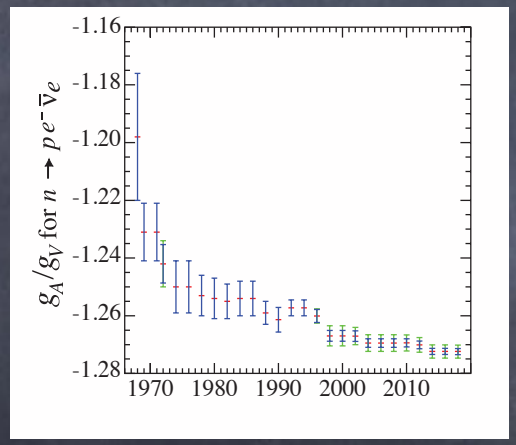
"Einstein and de Haas ended their search for systematic errors when their result for the gyromagnetic ratio, $g = 1$, agreed with their belief that magnetism was due to orbiting electrons."

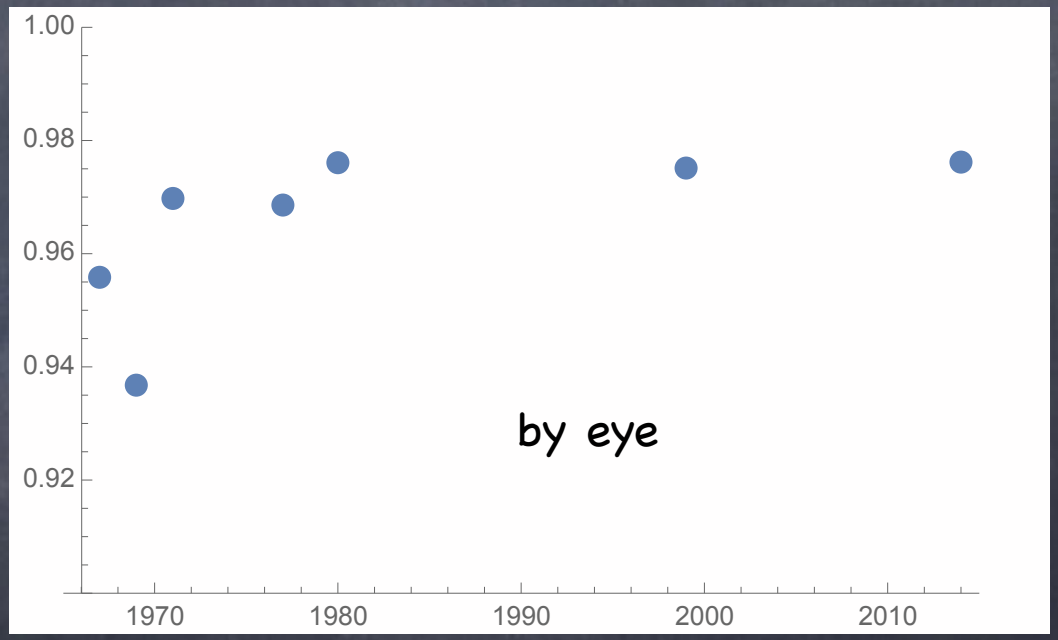
-Allan Frankin, idem

Correlated?

$$V_{ud} = \sqrt{\frac{4909\mathrm{s}}{\tau(1+3g_A^2)}}$$







if you do this year by year with error bars, please send me a copy

- Clearly experimentalists have learned to avoid this
- They have invented "blind analysis":
  - Do not look at signal in data until confident all systematics are down to the best you can do (or below statistical uncertainties)
  - Only then "open the box"
- Caveat: only, they do not do this if the result is unexpected (private communication, many experimenters that prefer to remain anonymous)

Theorists also allow prejudice to enter their "high precision" calculations

(Do) We also need theory
"blind analysis"(?)!

Theorists also allow prejudice to enter their "high precision" calculations

(Do) We also need theory "blind analysis"(?)!

Example

NB, examples abound, just pick one for fun

Superallowed what?

- V_{ud} is cleanly determined from super allowed beta decay
- CVC guarantees the exact normalization of the matrix element:

$$\langle 0^+|V^0|0^+\rangle = 1$$

  (ok, not=1, but the isospin charge of state)
- Hence PDG: $|V_{ud}| = 0.97420 \pm 0.00021$
  (in case you missed this, that's 0.02% accuracy)
- Hadronic complications averted!! No place in HC2NP program.

uh?

Exact isospin?

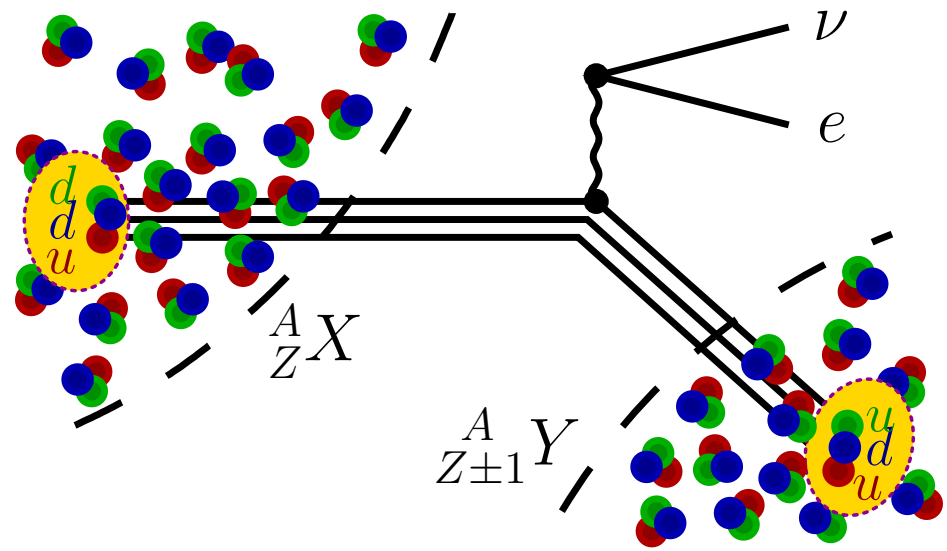
$m_u = m_d$? $e = 0$?

mmmhhhh...

Next few slides stolen from talk by Dan Melconian

The Corrected $\mathcal{F}t$ value

We must account for the fact that **the decay occurs within the nuclear medium**



$$\mathcal{F}t \equiv ft\left(1+\delta'_R\right)\left(1+\left(\delta_{\mathrm{NS}}-\delta_C\right)\right) = \frac{2915.6 \pm 1.1\ \mathrm{s}}{|V_{ud}|^2}$$

(*really* should be constant)

- δ'_R = $E_e^{\max}$ and Z dependent radiative correction
- δ_{NS} = nuclear structure dependent radiative correction
- δ_C = isospin symmetry-breaking correction
- Δ_R^V = transition independent radiative correction

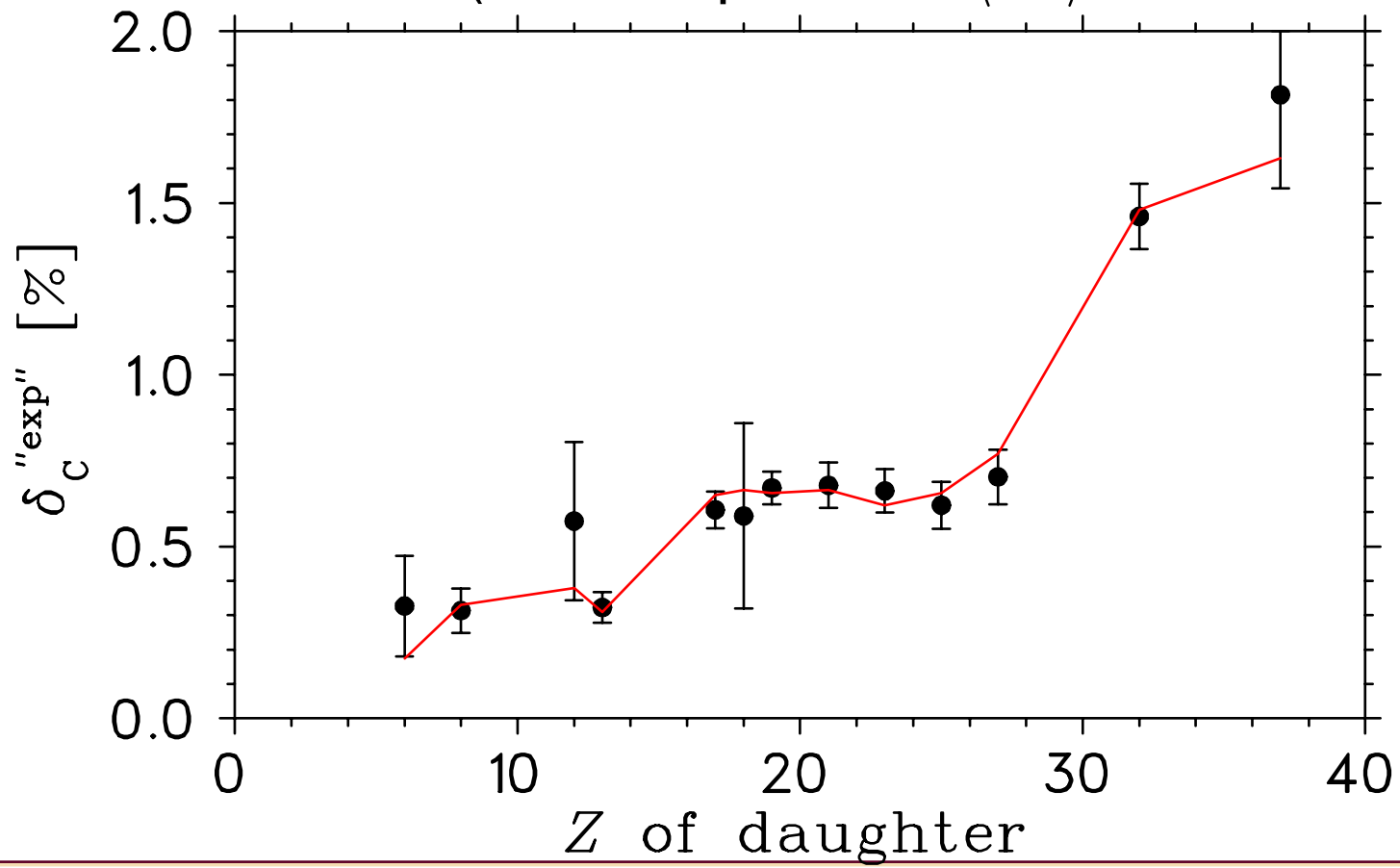
Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Define: $$\delta_C^{\text{“exp”}} \equiv 1 + \delta_{\text{NS}} - \frac{A}{ft(1+\delta'_R)}$$

and fit to the model-calculated δ_C's, with A a free parameter of the fit

(A corresponds to $\langle \mathcal{F}t \rangle$. . . **if** CVC holds!)



As you know

Vud is free from hadronic systematics

no nuclear modeling needed

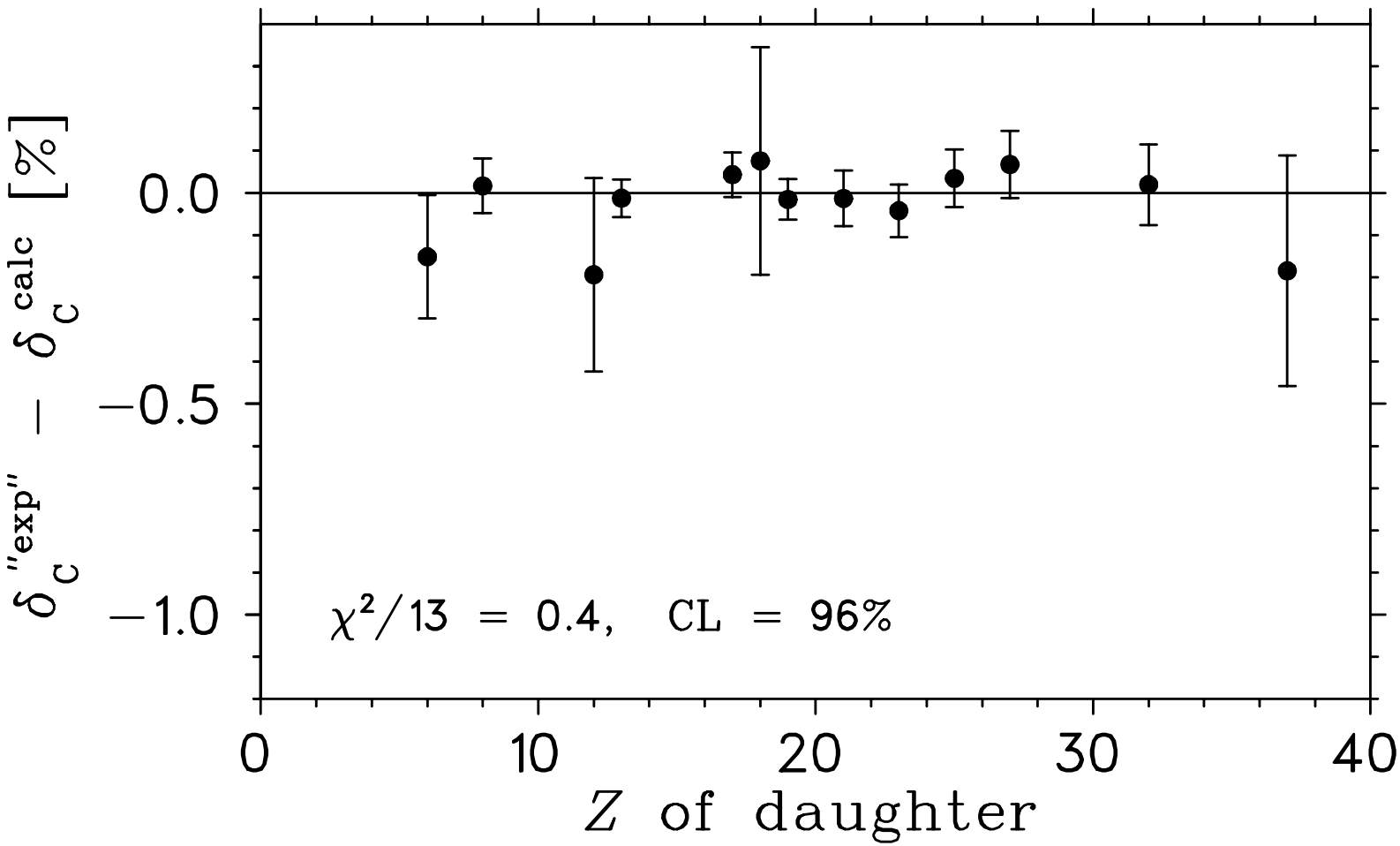
all thanks to CVC ...

Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Shell model with Woods-Saxon radial wavefunctions (TH):

best-fit $\langle \mathcal{F}t \rangle = 3072.0 \pm 0.6$ s



Excellent

Excellent

Too excellent

Excellent

Too excellent

CL =96%

Excellent

Too excellent

CL =96%

What do you think of elections

Excellent

Too excellent

CL =96%

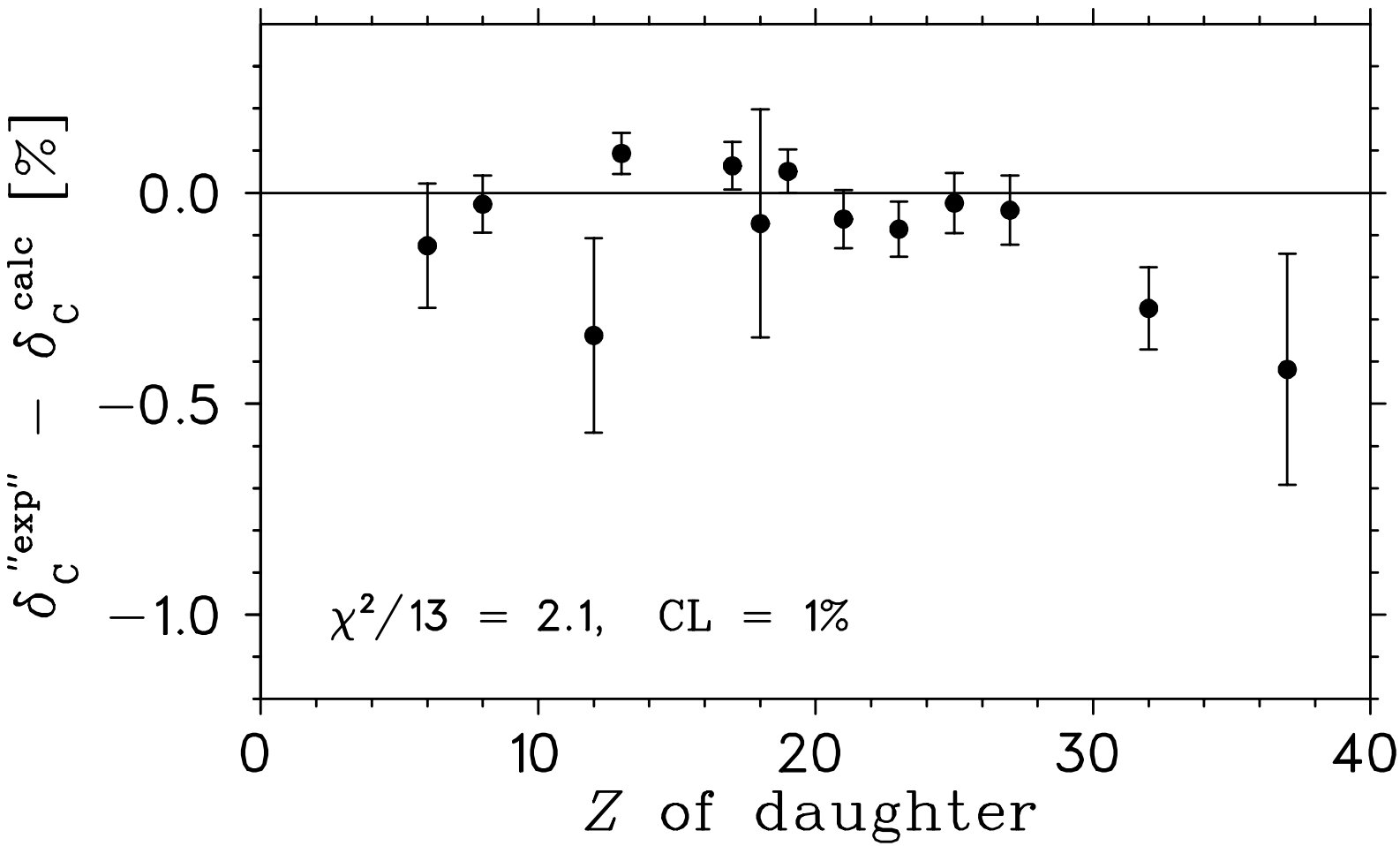
What do you think of elections won by 96% majority?

Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Shell model with Hartree-Fock radial wavefunctions (TH):

(would get $\langle \mathcal{F}t \rangle = 3071.3 \pm 0.8$ s)

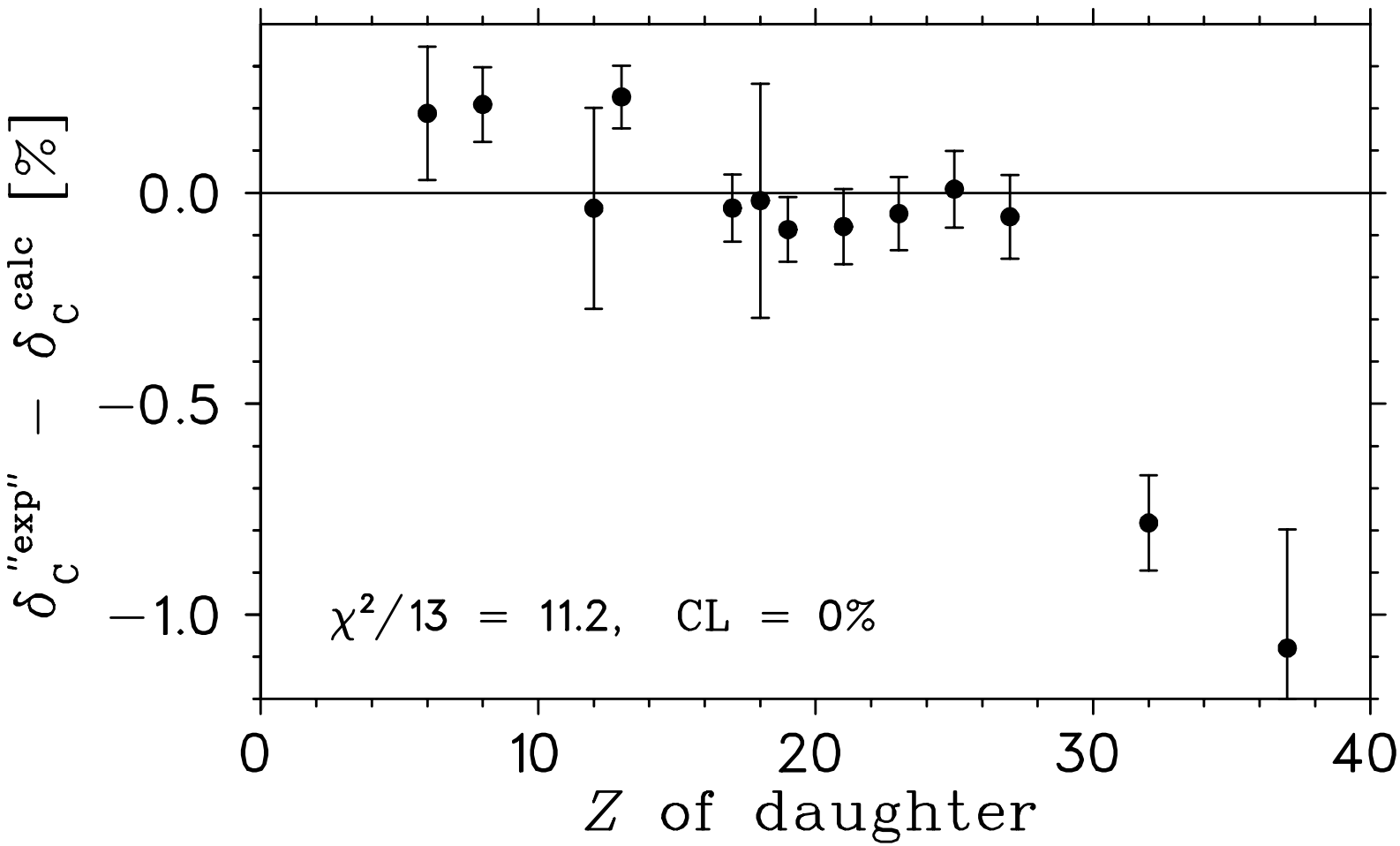


Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Isovector monopole resonance (Auerbach):

(would get $\langle \mathcal{F}t \rangle = 3087.7 \pm 1.9$ s)

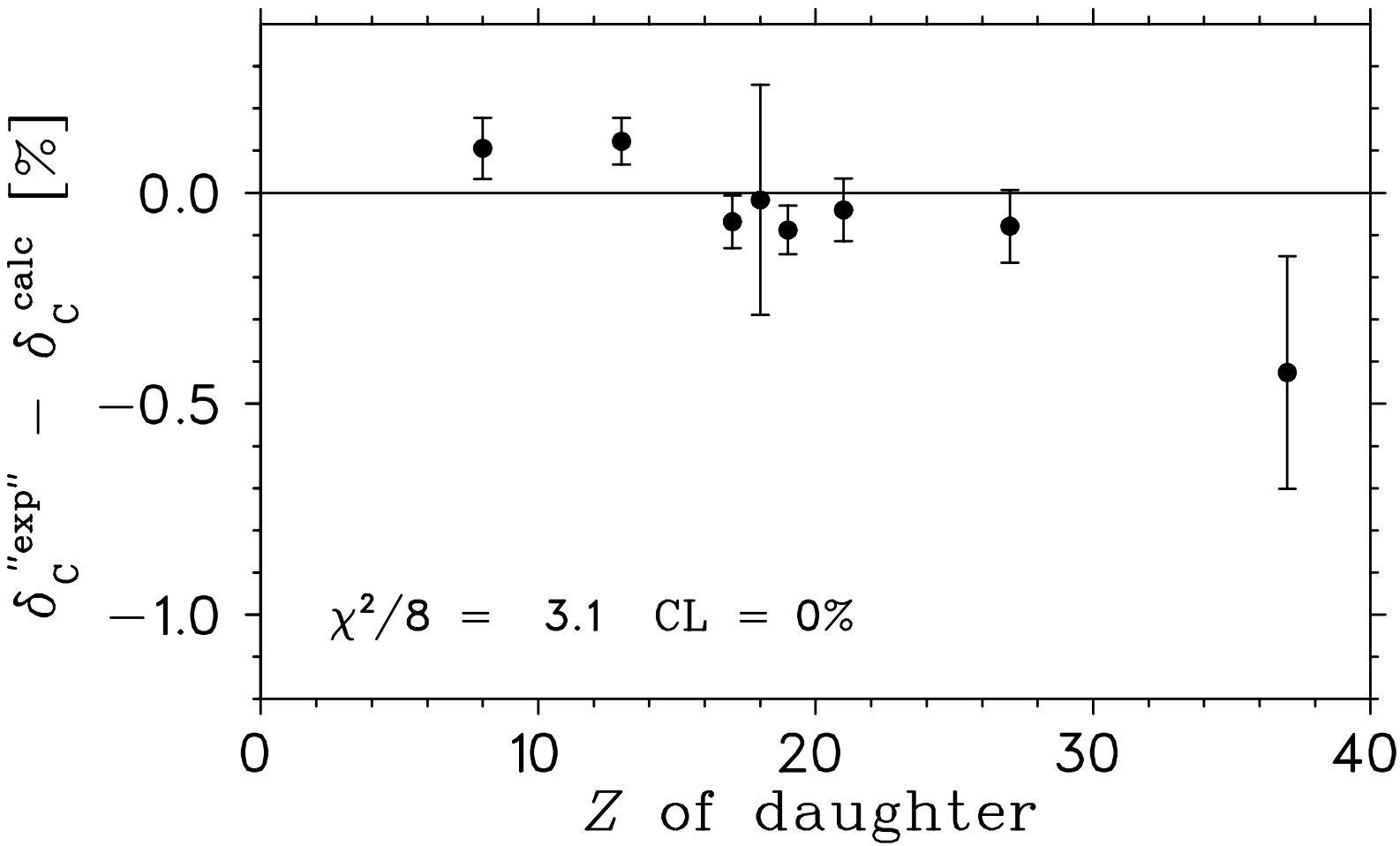


Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Relativistic RPA with PK01 eff. interaction (Liang):

(would get $\langle \mathcal{F}t \rangle = 3078.9 \pm 1.0$ s)

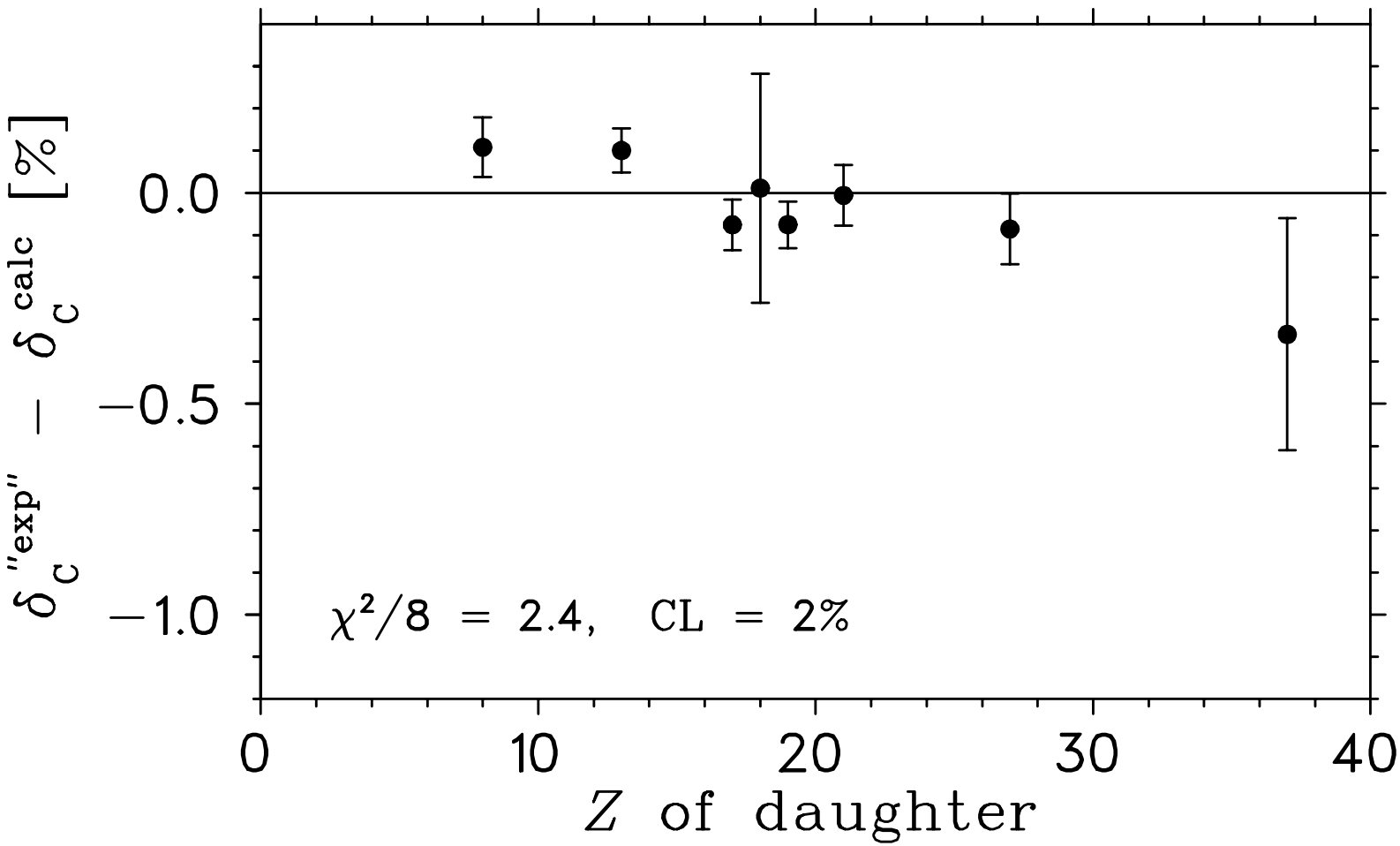


Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Relativistic RPA with DD-ME2 eff. interaction (Liang):

(would get $\langle \mathcal{F}t \rangle = 3081.4 \pm 1.1$ s)

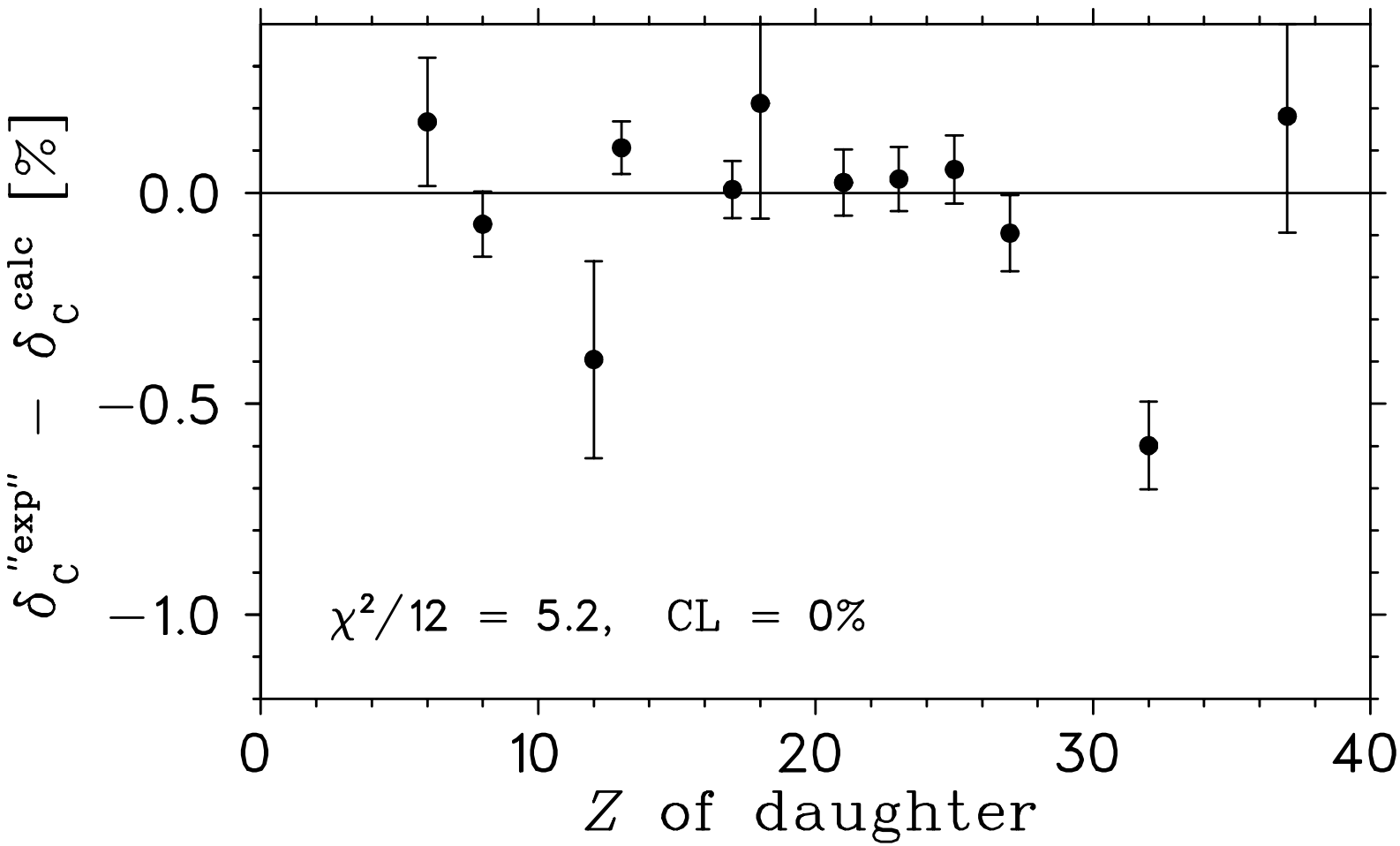


Testing calculations of ISB effects

How well does a model's calculated δ_C align the ft values?

Density functional theory (Satuła):

(would get $\langle \mathcal{F}t \rangle = 3070.0 \pm 1.4$ s)



and so on, ...

you get the idea

which brings me to ...

When being correct does not mean being correct

- Distinguish models from models
  - 1st kind: A mathematical model of reality
    - SM
  - 2nd kind: A mathematical model of what a mathematical model of reality predicts
    - hadronic models; examples abound:
      - ISGW
      - QCD sum rules
      - shell model with Woods-Saxon potential

2nd kind: it is what nonHE physics is all about
We do not do

- Nuclear physics from QCD
- Considensed matter from QED
- Biophysics from atomic physics

and so on

But the "NP" in "HC2NP" **demands** attention to the 1st kind

WAIT!!!!!

My favorite model (of the 2nd kind)
correctly describes areas of reality

(Translation: it agrees with experiment
when compared against a specific set
of observations for which it was designed,
and tuned over time)

I would hope you know why getting the correct pre/post-diction is not the same as getting the correct explanation

If I have to explain, I do it by analogy:

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If I have to explain, I do it by analogy:

$$\frac{16}{64}$$

I would hope you know why getting the correct pre/post-diction is not the same as getting the correct explanation

If I have to explain, I do it by analogy:

$$\frac{1\cancel{6}}{\cancel{6}4}$$

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$$\frac{1\cancel{6}}{\cancel{6}4} = \frac{1}{4}$$

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If I have to explain, I do it by analogy:

$$\frac{1\cancel{6}}{\cancel{6}4} = \frac{1}{4}$$

Wrong method, right answer

- close encounters of the 2nd kind

  - can it be used elsewhere?
  - do you learn anything from it?

- In HC2NP precision is key
- Hadronic models physically illuminating (sometimes)
- Not systematic expansions
- No reliable way to estimate systematic errors

Being popular does not mean being correct

- Not quite the same as previous
- But related. Citations:
  - ISGW: 1361
  - QCD sum rules: 5175

The incredible shrinking error

My model of time dependence of theoretical error:

$$\frac{d\Delta}{dt} = -\sum_i \epsilon_i \delta(t - t_i)$$

constrained by $\sum \epsilon_i < \Delta_0 \equiv \Delta(t \to -\infty)$

Empirically, often

$$\frac{d\Delta}{dt} = -\gamma\Delta - \sum_i \epsilon_i \delta(t - t_i)$$

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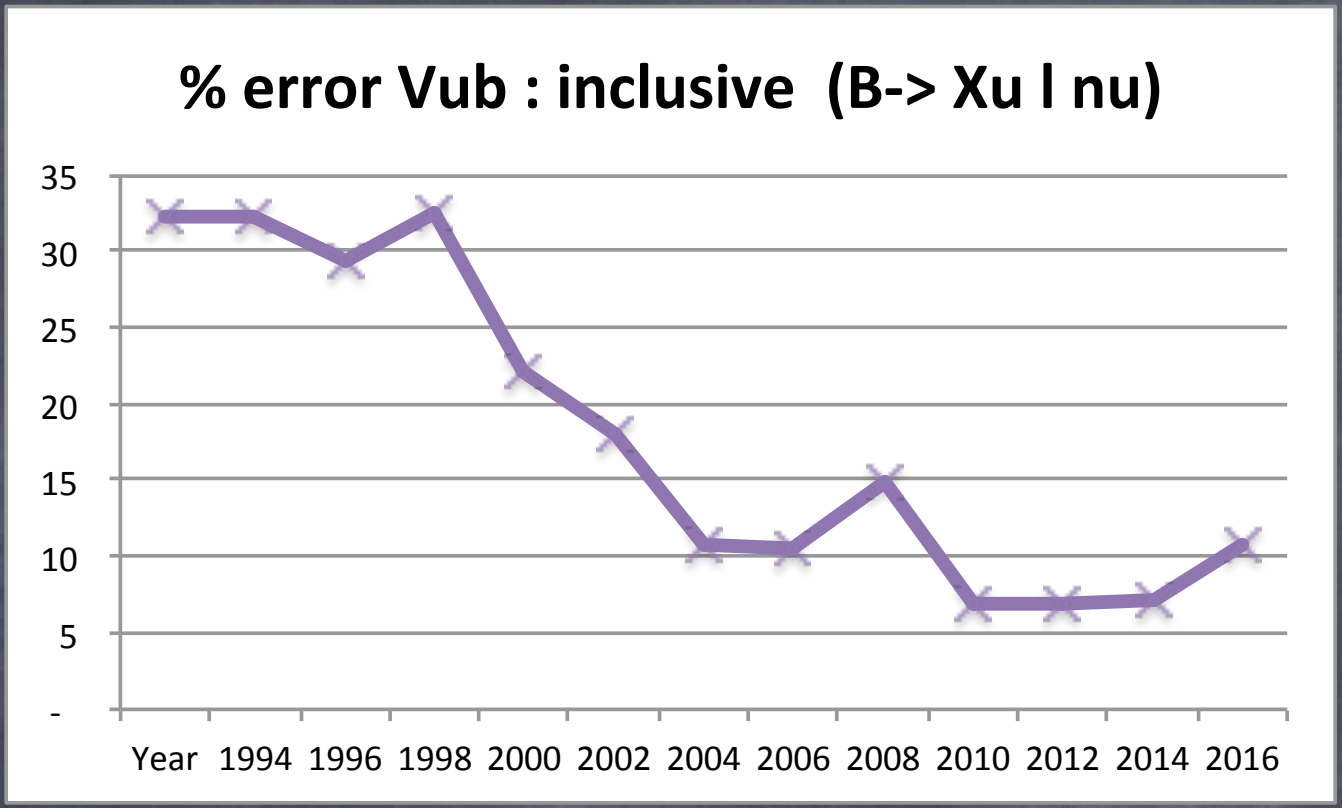
Empirically, often

$$\frac{d\Delta}{dt} = -\gamma\Delta - \sum_i \epsilon_i \delta(t - t_i)$$

- WE (meaning the HEP community, both HEPEXers and HEPTHers) **like** small errors
- We will use, cite, fund, invite to talk, invite to review, revere (ok, that's going too far) those who publish the smallest error
- Could this create an incentive to underestimate errors? Or an incentive to oversell methods and results?
  - COULD ERRORS SHRINK SANS JUSTIFICATION?

An example,

but again, they abound


% error Vub : inclusive (B-> Xu l nu)
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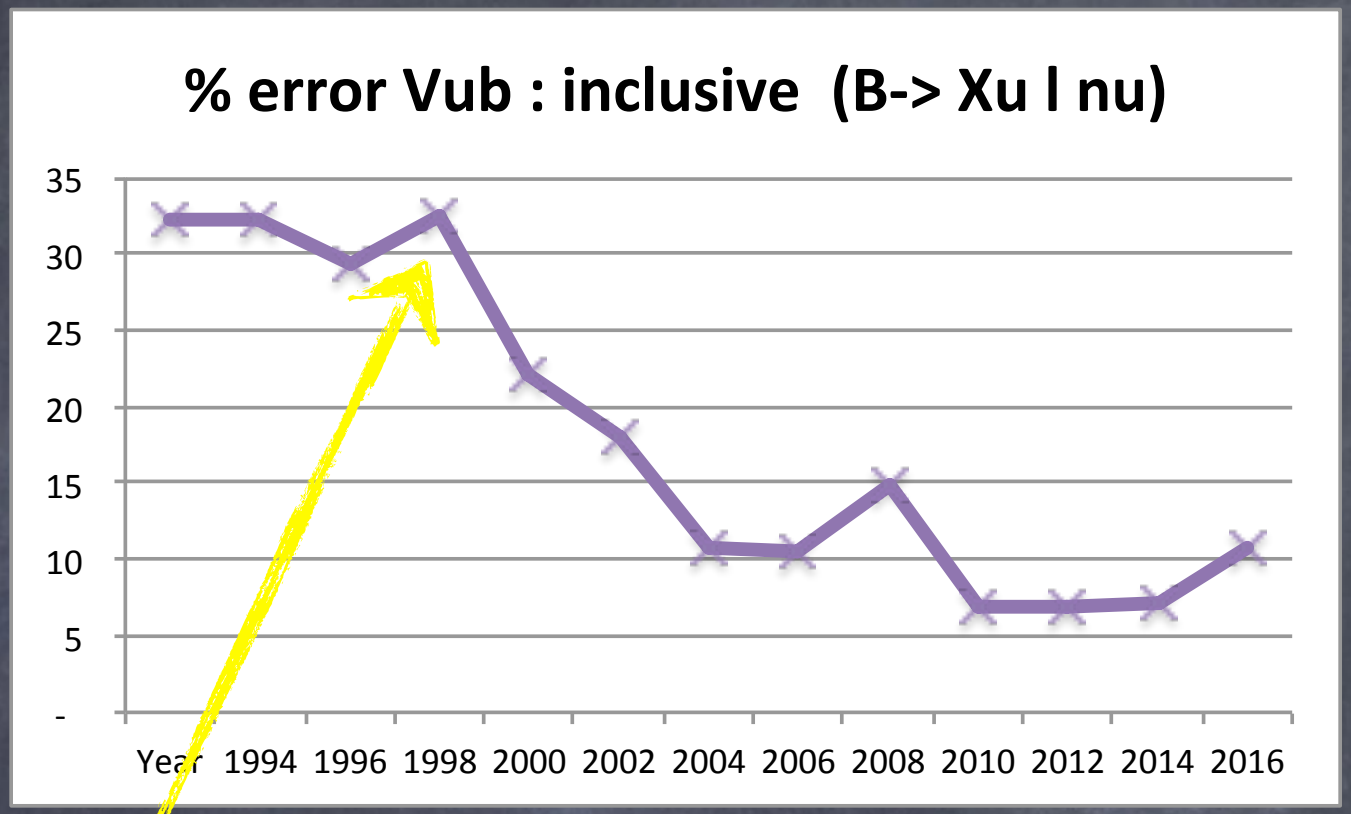

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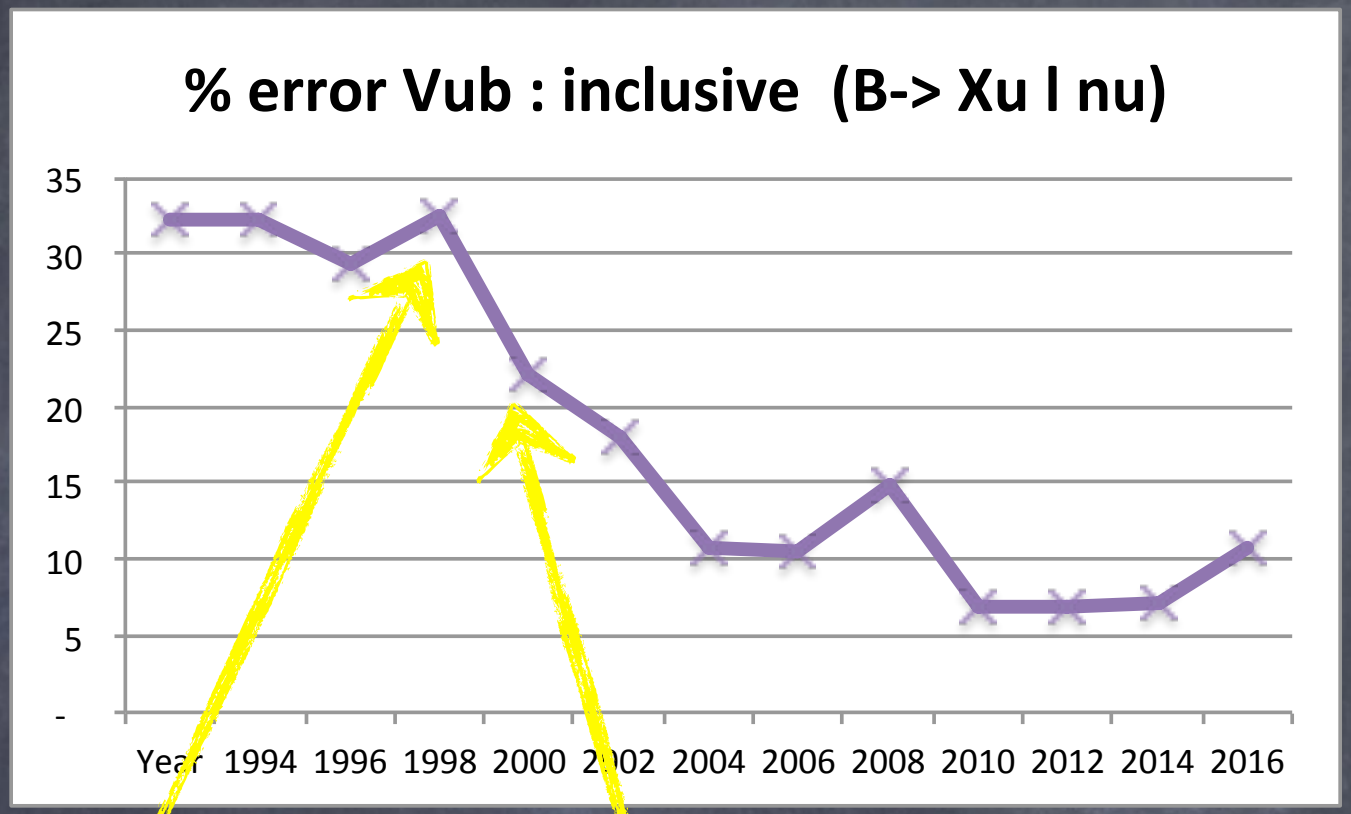

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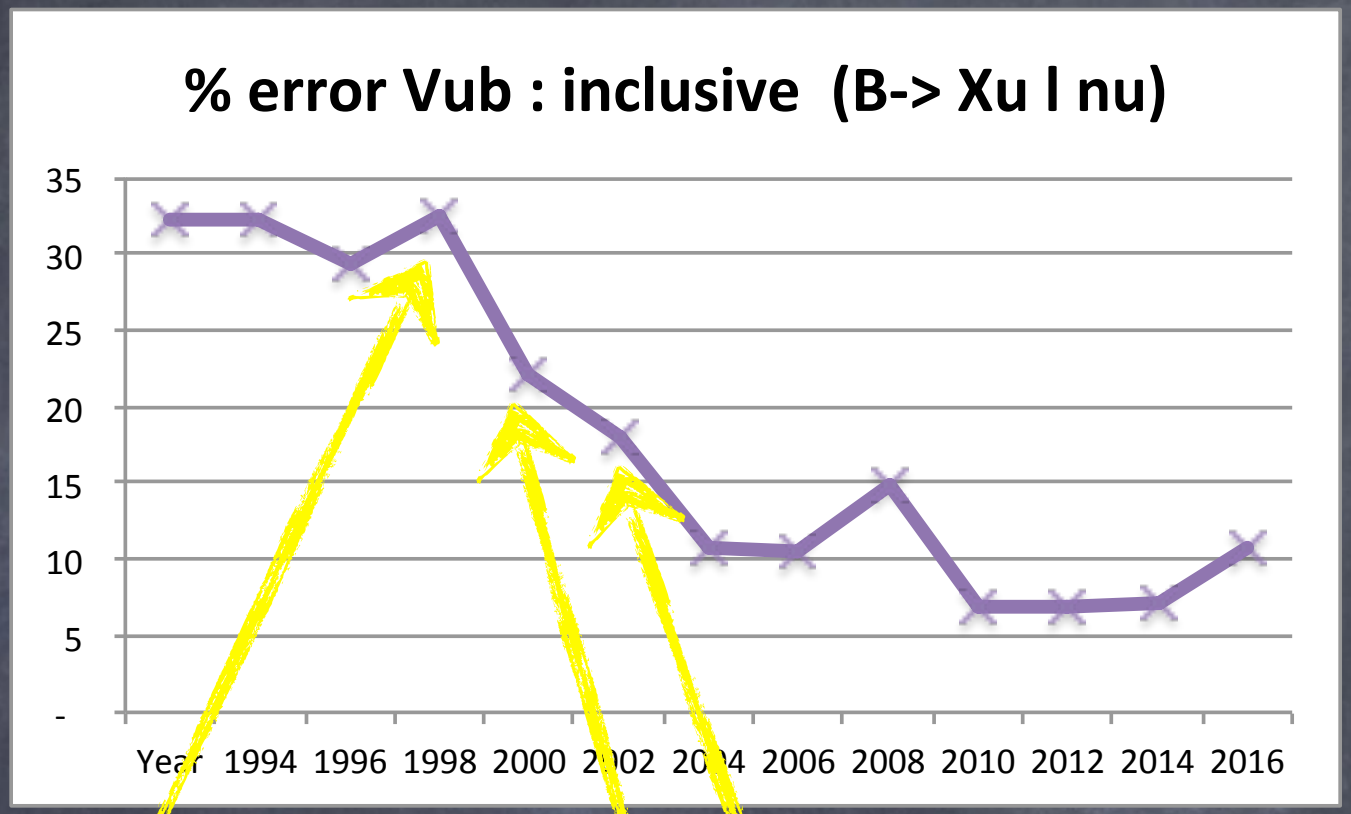
"a theoretical uncertainty within the 10%-15% window seems likely"



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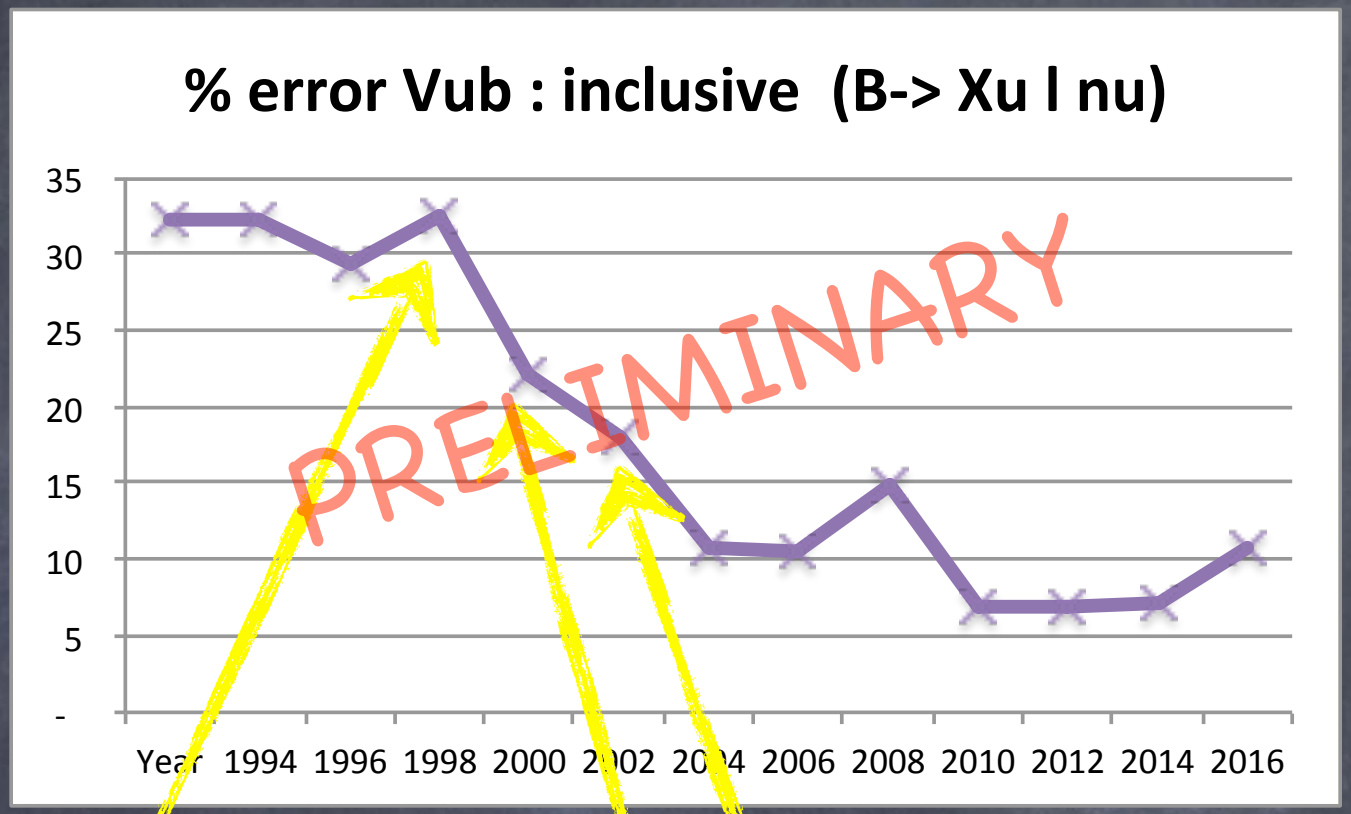

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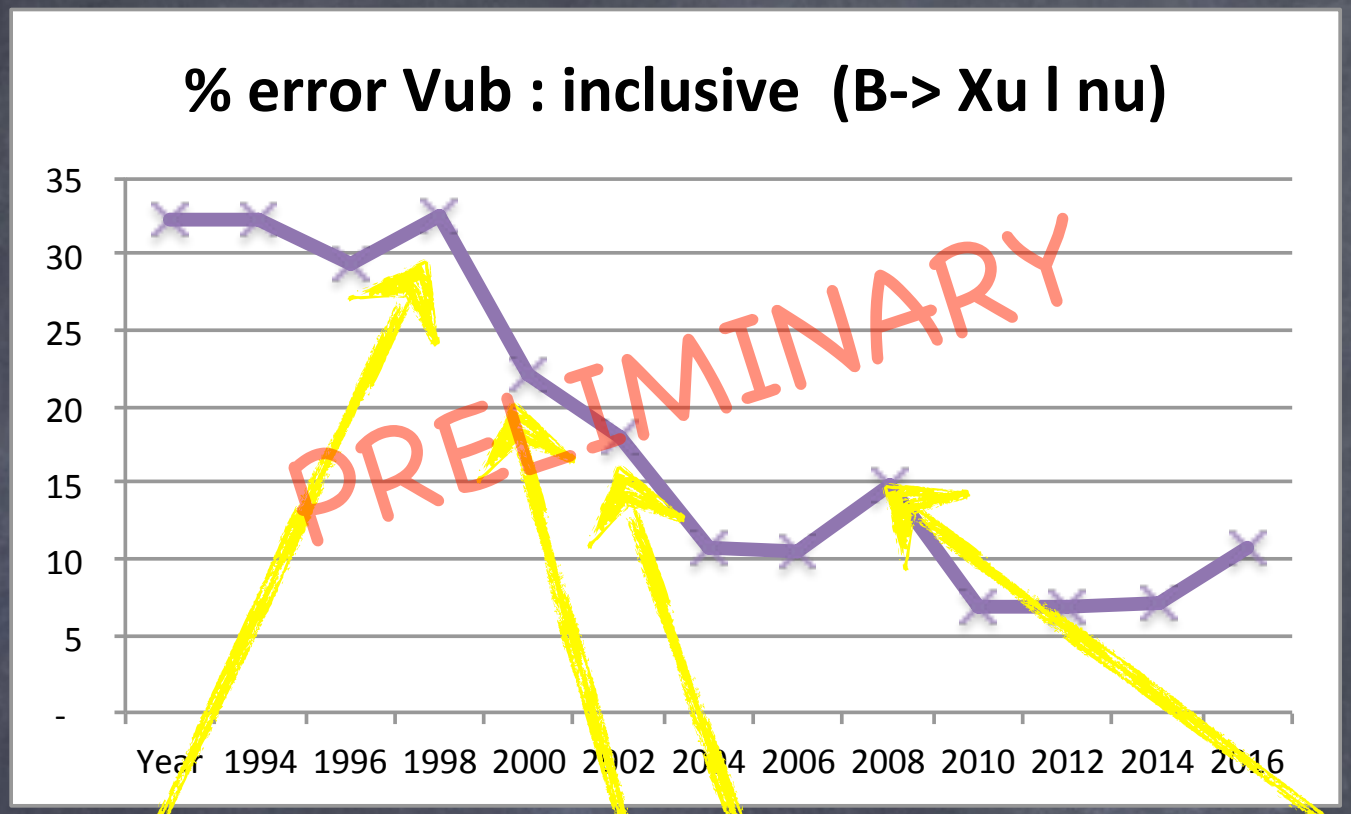

BLNP/GGOU/DGE

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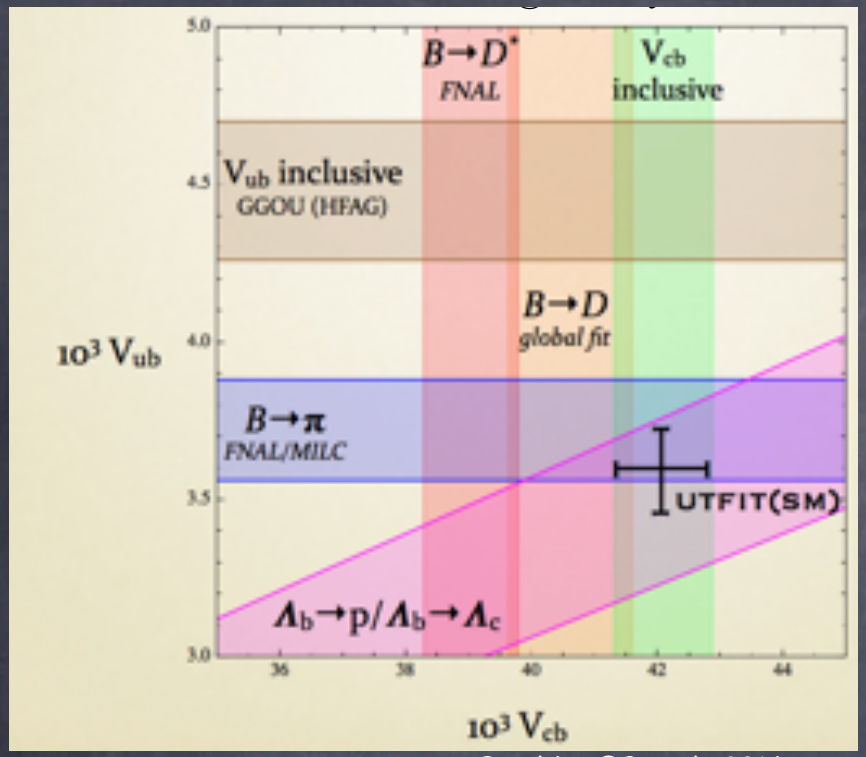
"a theoretical uncertainty within the 10%-15% window seems likely"

"for a total theory error of 15% and total precision of 18%."

and PDG conveniently ignores ADFR

QCD Calculation	Phase Space Region	$\Delta\Gamma_{\rm theory}$ (ps^{-1})	$\lvert V_{ub}\rvert(10^{-3})$
	$M_X \leq 1.55$ GeV	$39.3^{+4.7}_{-4.3}$	$4.17 \pm 0.15 \pm 0.12^{+0.24}_{-0.24}$
	$M_X \leq 1.70$ GeV	$46.1^{+5.0}_{-4.4}$	$3.97 \pm 0.17 \pm 0.14^{+0.20}_{-0.20}$
	$P_+ \leq 0.66$ GeV	$38.3^{+4.7}_{-4.3}$	$4.02 \pm 0.18 \pm 0.16^{+0.24}_{-0.23}$
BLNP	$M_X \leq 1.70$ GeV, $q^2 \geq 8$ GeV^2	$23.8^{+3.0}_{-2.4}$	$4.25 \pm 0.19 \pm 0.13^{+0.23}_{-0.25}$
	$M_X - q^2$, $p_\ell^* > 1.0$ GeV	$62.0^{+6.2}_{-5.0}$	$4.28 \pm 0.15 \pm 0.18^{+0.18}_{-0.20}$
	$p_\ell^* > 1.0$ GeV	$62.0^{+6.2}_{-5.0}$	$4.30 \pm 0.18 \pm 0.21^{+0.18}_{-0.20}$
	$p_\ell^* > 1.3$ GeV	$52.8^{+5.3}_{-4.3}$	$4.29 \pm 0.18 \pm 0.20^{+0.19}_{-0.20}$
	$M_X \leq 1.55$ GeV	$35.3^{+3.3}_{-3.5}$	$4.40 \pm 0.16 \pm 0.12^{+0.24}_{-0.19}$
	$M_X \leq 1.70$ GeV	$42.0^{+4.8}_{-4.8}$	$4.16 \pm 0.18 \pm 0.14^{+0.26}_{-0.22}$
	$P_+ \leq 0.66$ GeV	$36.9^{+5.5}_{-5.8}$	$4.10 \pm 0.19 \pm 0.17^{+0.37}_{-0.28}$
DGE	$M_X \leq 1.70$ GeV, $q^2 \geq 8$ GeV^2	$24.4^{+2.4}_{-2.0}$	$4.19 \pm 0.19 \pm 0.12^{+0.18}_{-0.19}$
	$M_X - q^2$, $p_\ell^* > 1.0$ GeV	$58.7^{+3.5}_{-3.2}$	$4.40 \pm 0.16 \pm 0.18^{+0.12}_{-0.13}$
	$p_\ell^* > 1.0$ GeV	$58.7^{+3.5}_{-3.2}$	$4.42 \pm 0.19 \pm 0.23^{+0.13}_{-0.13}$
	$p_\ell^* > 1.3$ GeV	$50.4^{+3.3}_{-3.0}$	$4.39 \pm 0.19 \pm 0.20^{+0.15}_{-0.14}$
	$M_X \leq 1.55$ GeV	$41.0^{+4.6}_{-3.8}$	$4.08 \pm 0.15 \pm 0.11^{+0.20}_{-0.21}$
	$M_X \leq 1.70$ GeV	$46.8^{+4.2}_{-3.6}$	$3.94 \pm 0.17 \pm 0.14^{+0.16}_{-0.17}$
	$P_+ \leq 0.66$ GeV	$44.0^{+8.6}_{-6.3}$	$3.75 \pm 0.17 \pm 0.15^{+0.30}_{-0.32}$
GGOU	$M_X \leq 1.70$ GeV, $q^2 \geq 8$ GeV^2	$24.7^{+3.2}_{-2.4}$	$4.17 \pm 0.18 \pm 0.12^{+0.22}_{-0.25}$
	$M_X - q^2$, $p_\ell^* > 1.0$ GeV	$60.2^{+3.0}_{-2.5}$	$4.35 \pm 0.16 \pm 0.18^{+0.09}_{-0.10}$
	$p_\ell^* > 1.0$ GeV	$60.2^{+3.0}_{-2.5}$	$4.36 \pm 0.19 \pm 0.23^{+0.09}_{-0.10}$
	$p_\ell^* > 1.3$ GeV	$51.8^{+2.8}_{-2.3}$	$4.33 \pm 0.18 \pm 0.20^{+0.10}_{-0.11}$
	$M_X \leq 1.55$ GeV	$47.1^{+5.2}_{-4.3}$	$3.81 \pm 0.14 \pm 0.11^{+0.18}_{-0.20}$
	$M_X \leq 1.70$ GeV	$52.3^{+5.4}_{-4.5}$	$3.73 \pm 0.16 \pm 0.13^{+0.17}_{-0.18}$
	$P_+ \leq 0.66$ GeV	$48.9^{+5.6}_{-4.6}$	$3.56 \pm 0.16 \pm 0.15^{+0.18}_{-0.19}$
ADFR	$M_X \leq 1.70$ GeV, $q^2 \geq 8$ GeV^2	$30.9^{+3.0}_{-2.5}$	$3.74 \pm 0.16 \pm 0.11^{+0.16}_{-0.17}$
	$M_X - q^2$, $p_\ell^* > 1.0$ GeV	$62.0^{+5.7}_{-5.0}$	$4.29 \pm 0.15 \pm 0.18^{+0.18}_{-0.19}$
	$p_\ell^* > 1.0$ GeV	$62.0^{+5.7}_{-5.0}$	$4.30 \pm 0.19 \pm 0.23^{+0.18}_{-0.19}$
	$p_\ell^* > 1.3$ GeV	$53.3^{+5.1}_{-4.4}$	$4.27 \pm 0.18 \pm 0.19^{+0.18}_{-0.19}$



Gambino@Beauty2016

Exclusive vs Inclusive problem?

V_{cb} from D* hare recent tortuous story

It changed between versions for Belle (2017 -> 2018)

Then it changed between versions for BaBar (2018 -> 2019)

and hence I do not bother citing them

Concluding remarks

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- But perhaps you found it thought provoking (and then I did not waste large T in preparing this)
- Even better, perhaps you are annoyed because you feel I have criticized your work: then I have done my work

I leave you with two RZ quotes:

"There is also an instanton model but I do not know if it can be trusted"

"I don't understand how these authors get 10% errors by combining two results, both with greater than 10% errors"

-priceless

Please join me in thanking organizers