Unitarity Triangle fitting: 25 years and counting

Marcella Bona

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(QMUL)

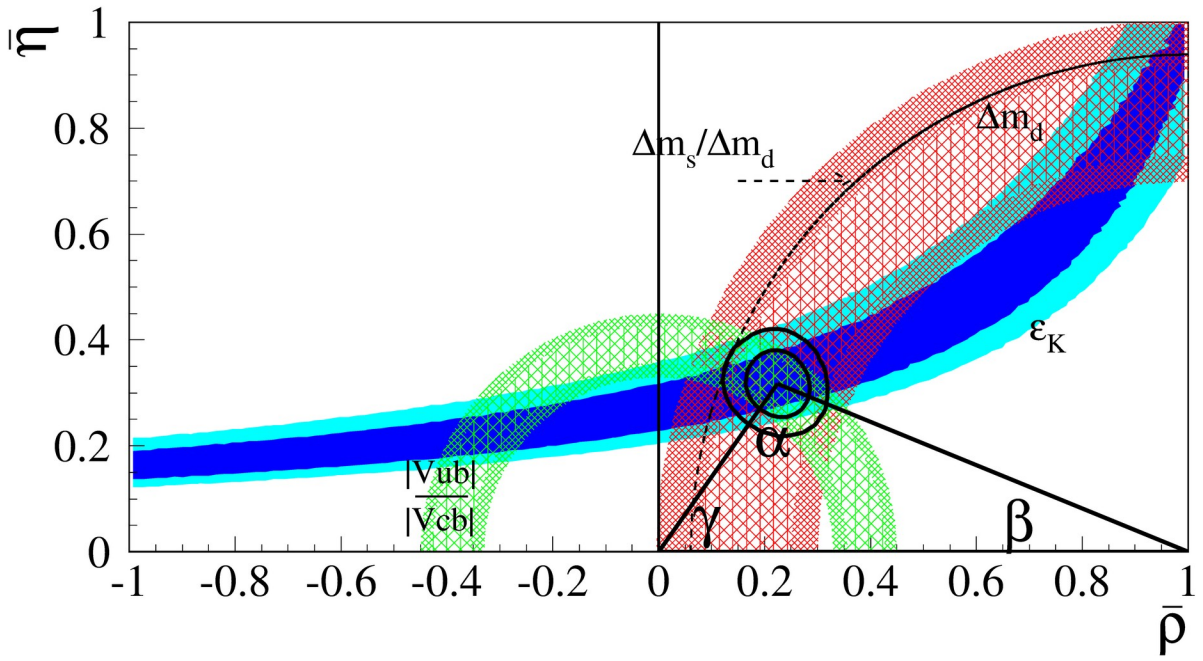
35 Years swinging in flavour physics: from $b \to s \ell \ell$ transitions to nonleptonic decays and back

17 May 2024

Everything began with Ciuchini et al…

- I'm sooooo young that I'm not really qualified to talk about this.. :)
- But that first seminal plot does appear in my PhD thesis...

Everything began with Ciuchini et al…



Everything began with Ciuchini et al…

- I'm sooooo young that I'm not really qualified to talk about this.. :)
- But that first seminal plot does appear in my PhD thesis…
- And in-fact.. this morning the "old guard" did point me to the 1995 seed..

1995

CERN-TH.7514/94
ROME prep. 94/1024

An Upgraded Analysis of ϵ'/ϵ at the Next-to-Leading Order

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[c] Theory Division, CERN, 1211 Geneva 23, Switzerland.
[d] Brookhaven National Laboratory, Physics Department, Upton, NY 11973
[e] Dip. di Fisica, Univ. di Roma "Tor Vergata" and INFN, Sezione di Roma II, Via della Ricerca Scientifica 1, I-00133 Rome, Italy.

Abstract

An upgraded analysis of ϵ, x_d and ϵ'/ϵ, using the latest determinations of the relevant experimental and theoretical parameters, is presented. Using the recent determination of the top quark mass, $m_t = (174 \pm 17)$ GeV, our best estimate is $\epsilon'/\epsilon = 3.1 \pm 2.5$, which lies in the range given by E731. We describe our determination of ϵ'/ϵ and make a comparison with other similar studies. A detailed discussion of the matching of the full theory to the effective Hamiltonian, written in terms of lattice operators, is also given.

Everything began with Ciuchini et al…

BUHEP-99-24
RM3-TH/99-9
ROME 99/1267

Combined analysis of the unitarity triangle and CP violation in the Standard Model

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[c] Department of Physics, Boston University, Boston, MA 02215 USA.

Abstract

We perform a combined analysis of the unitarity triangle and of the CP violating parameter ε'/ε using the most recent determination of the relevant experimental data and, whenever possible, hadronic matrix elements from lattice QCD. We discuss the rôle of the main non-perturbative parameters and make a comparison with other recent analyses. We use lattice results for the matrix element of Q_8 obtained without reference to the strange quark mass. Since a reliable lattice determination of the matrix element of Q_6 is still missing, the theoretical predictions for ε'/ε suffer from large uncertainties. By evaluating this matrix element with the vacuum-saturation approximation, we typically find as central value $\varepsilon'/\varepsilon = (4 \div 7) \times 10^{-4}$. We conclude that the experimental data suggest large deviation of the value of the matrix element of Q_6 from the vacuum-saturation approximation, possibly due to penguin contractions.

October 1999

LAL 99-03
March 1999
DELPHI 99-27 CONF 226

Constraints on the parameters of the CKM matrix by End 1998

F. Parodi[(a)], P. Roudeau[(b)] and A. Stocchi[(b)]

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[(b)] **Laboratoire de l'Accélérateur Linéaire**
IN2P3-CNRS et Université de Paris-Sud, BP 34, F-91898 Orsay Cedex

1999

Everything began with Ciuchini et al…

LAL 00-77
ROME1-1307/00
RM3-TH/00-16

2000 CKM-TRIANGLE ANALYSIS

A Critical Review with Updated Experimental Inputs and Theoretical Parameters

M. Ciuchini[(a)], G. D'Agostini[(b)], E. Franco[(b)], V. Lubicz[(a)], G. Martinelli[(b)], F. Parodi[(c)], P. Roudeau[(d)] and A. Stocchi[(d)]

[(a)] **Università di Roma Tre and INFN, Sezione di Roma III,**
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[(b)] **Università "La Sapienza" and Sezione INFN di Roma,**
Piazzale A. Moro 2, 00185 Roma, Italy
[(c)] **Dipartimento di Fisica, Università di Genova and INFN**
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[(d)] **Laboratoire de l'Accélérateur Linéaire**
IN2P3-CNRS et Université de Paris-Sud, BP 34, F-91898 Orsay Cedex

2000

Abstract

Within the Standard Model, a review of the current determination of the sides and angles of the CKM unitarity triangle is presented, using experimental constraints from the measurements of $|\varepsilon_K|$, $|V_{ub}/V_{cb}|$, Δm_d and from the limit on Δm_s, available in September 2000. Results from the experimental search for $B_s^0 - \bar{B}_s^0$ oscillations are introduced in the present analysis using the likelihood. Special attention is devoted to the determination of the theoretical uncertainties. The purpose of the analysis is to infer regions where the parameters of interest lie with given probabilities. The BaBar "*95% C.L. scanning*" method is also commented.

And then came the 2nd CKM workshop

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- 2003: founding year of the UTfit collaboration

And I usurped Marco's first place…

2004

The 2004 UT*fit* Collaboration Report on the Status of the Unitarity Triangle in the Standard Model

UT*fit* Collaboration :

M. Bona[a], M. Ciuchini[b], E. Franco[c], V. Lubicz[b], G. Martinelli[c], F. Parodi[d], M. Pierini[e], P. Roudeau[e], C. Schiavi[d], L. Silvestrini[c], and A. Stocchi[e]

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[c] Dip. di Fisica, Università di Roma "La Sapienza" and INFN, Sezione di Roma
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And I usurped Marco's first place…

Marcella Bona, INFN Torino

hep-ph/0408079

Unitarity Triangle *fit*: current status of the CKM matrix

www.utfit.org

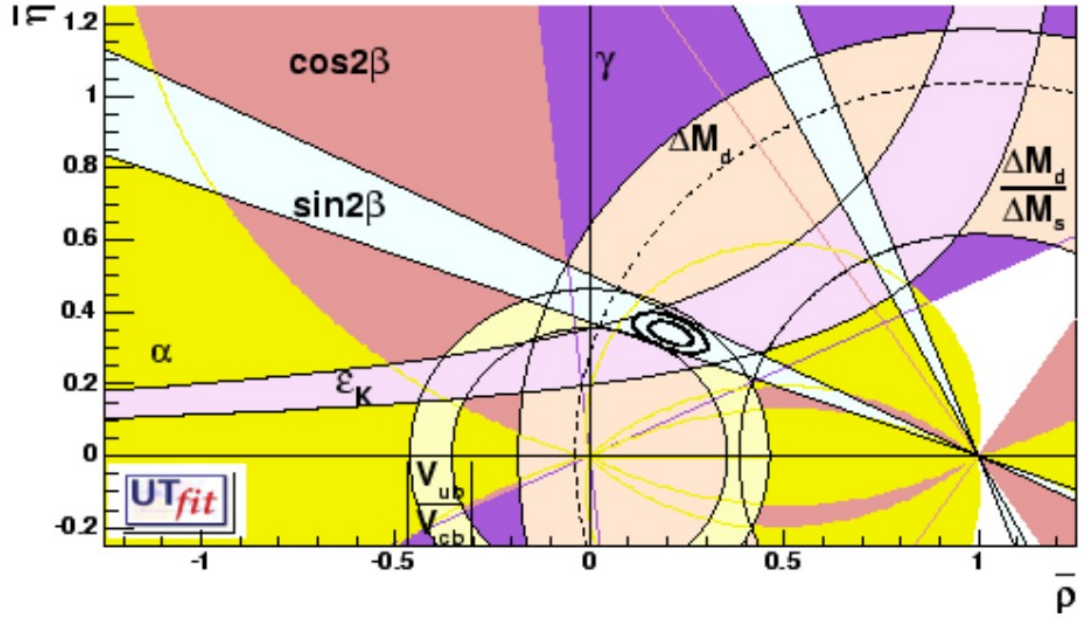
Marcella Bona
INFN and Università di Torino

on behalf of *UTfitters*
M.B., M. Ciuchini, G. D'Agostini, E. Franco, V. Lubicz,
G. Martinelli, F. Parodi, M. Pierini, P. Roudeau,
C. Schiavi, L. Silvestrini, A. Stocchi

32nd International Conference on High Energy Physics
Beijing, China, August 17th, 2004

ICHEP04, Beijing, China, August 17th, 2004 1

And we started our colour saga..



We quickly extended to beyond the SM

- With a speed that we can only dream now..

2005

The 2004 UT*fit* Collaboration Report on the Status of the Unitarity Triangle in the Standard Model

UT*fit* Collaboration :

M. Bona[a], M. Ciuchini[b], E. Franco[c], V. Lubicz[b], G. Martinelli[c], F. Parodi[d], M. Pierini[e], P. Roudeau[e], C. Schiavi[d], L. Silvestrini[c], and A. Stocchi[e]

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IN2P3-CNRS et Université de Paris-Sud, BP 34, F-91898 Orsay Cedex

We quickly extended to beyond the SM

- With a speed that we can only dream now.

2005

2006

Constraints on new physics from the quark mixing unitarity triangle

(**UT***fit* Collaboration)

M. Bona,[1] M. Ciuchini,[2] E. Franco,[3] V. Lubicz,[2] G. Martinelli,[3] F. Parodi,[4] M. Pierini,[5] P. Roudeau,[6] C. Schiavi,[4] L. Silvestrini,[3] A. Stocchi,[6] and V. Vagnoni[7]

[1] *Laboratoire d'Annecy-le-Vieux de Physique des Particules LAPP, IN2P3/CNRS, Université de Savoie*
[2] *Dip. di Fisica, Università di Roma Tre and INFN, Sez. di Roma Tre, I-00146 Roma, Italy*
[3] *Dip. di Fisica, Università di Roma "La Sapienza" and INFN, Sez. di Roma, I-00185 Roma, Italy*
[4] *Dip. di Fisica, Università di Genova and INFN, I-16146 Genova, Italy*
[5] *Department of Physics, University of Wisconsin, Madison, WI 53706, USA*
[6] *Laboratoire de l'Accélérateur Linéaire, IN2P3-CNRS et Université de Paris-Sud, BP 34, F-91898 Orsay Cedex, France*
[7] *INFN, Sez. di Bologna, I-40126 Bologna, Italy*

The status of the Unitarity Triangle beyond the Standard Model including the most recent results on Δm_s, on dilepton asymmetries and on width differences is presented. Even allowing for general New Physics loop contributions the Unitarity Triangle must be very close to the Standard Model result. With the new measurements from the Tevatron, we obtain for the first time a significant constraint on New Physics in the B_s sector. We present the allowed ranges of New Physics contributions to $\Delta F = 2$ processes, and of the time-dependent CP asymmetry in $B_s \to J/\Psi\phi$ decays.

The 2006 alpha battle..

- However we got a nice paper out of it (unlike others..)

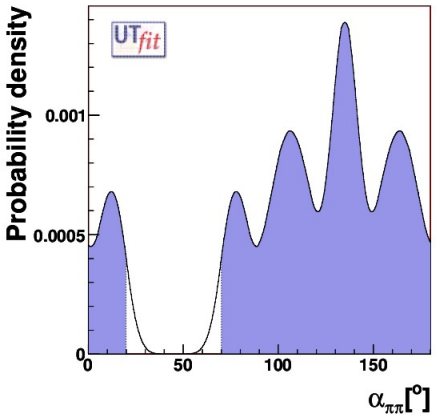
CERN-OPEN-2006-029
CPT-P56-2006
LAL 06-122
LAPP-2006-02

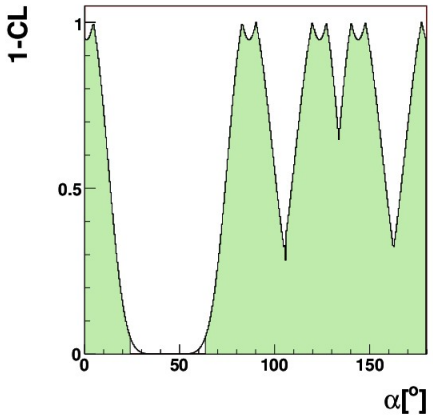
Bayesian Statistics at Work: the Troublesome Extraction of the CKM Phase α

J. Charles,[1] A. Höcker,[2] H. Lacker,[3] F.R. Le Diberder,[4] and S. T'Jampens[5]
[1] *CPT, Luminy Case 907, F-13288 Marseille Cedex 9, France*
[2] *CERN, CH-1211 Geneva 23, Switzerland*
[3] *TU Dresden, IKTP, D-01062 Dresden, Germany*
[4] *LAL, CNRS/IN2P3, Université Paris-Sud 11, Bât. 200, BP 34, F-91898 Orsay Cedex, France*
[5] *LAPP, CNRS/IN2P3, Université de Savoie, 9 Chemin de Bellevue, BP 110, F-74941 Annecy-le-Vieux Cedex, France*

(Dated: December 3, 2013)

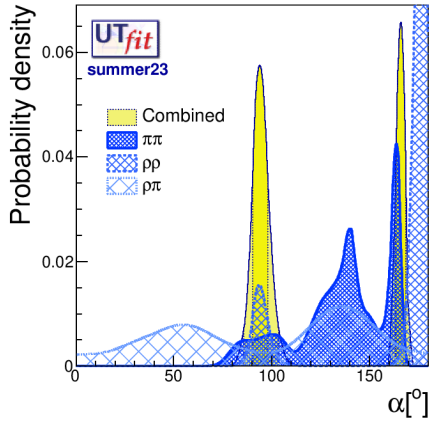
In Bayesian statistics, one's prior beliefs about underlying model parameters are revised with the information content of observed data from which, using Bayes' rule, a posterior belief is obtained. A non-trivial example taken from the isospin analysis of $B \to PP$ ($P = \pi$ or ρ) decays in heavy-flavor physics is chosen to illustrate the effect of the naive "objective" choice of flat priors in a multi-dimensional parameter space in presence of mirror solutions. It is demonstrated that the posterior distribution for the parameter of interest, the phase α, strongly depends on the choice of the parameterization in which the priors are uniform, and on the validity range in which the (un-normalizable) priors are truncated. We prove that the most probable values found by the Bayesian treatment do not coincide with the explicit analytical solutions, in contrast to the frequentist approach. It is also shown in the appendix that the $\alpha \to 0$ limit cannot be consistently treated in the Bayesian paradigm, because the latter violates the physical symmetries of the problem.

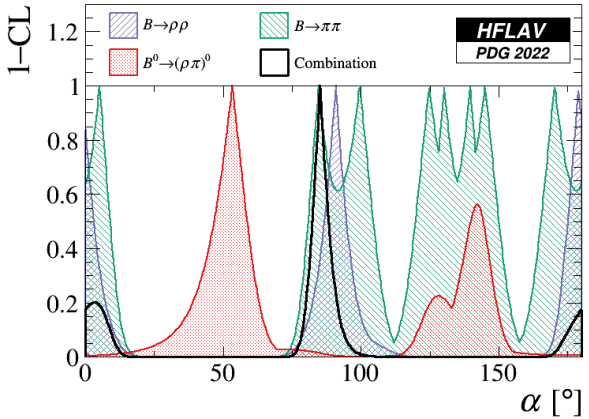




The 2006 alpha battle..

- And the alpha issue is not quite solved, we need LHCb and/or Belle to step up their games..

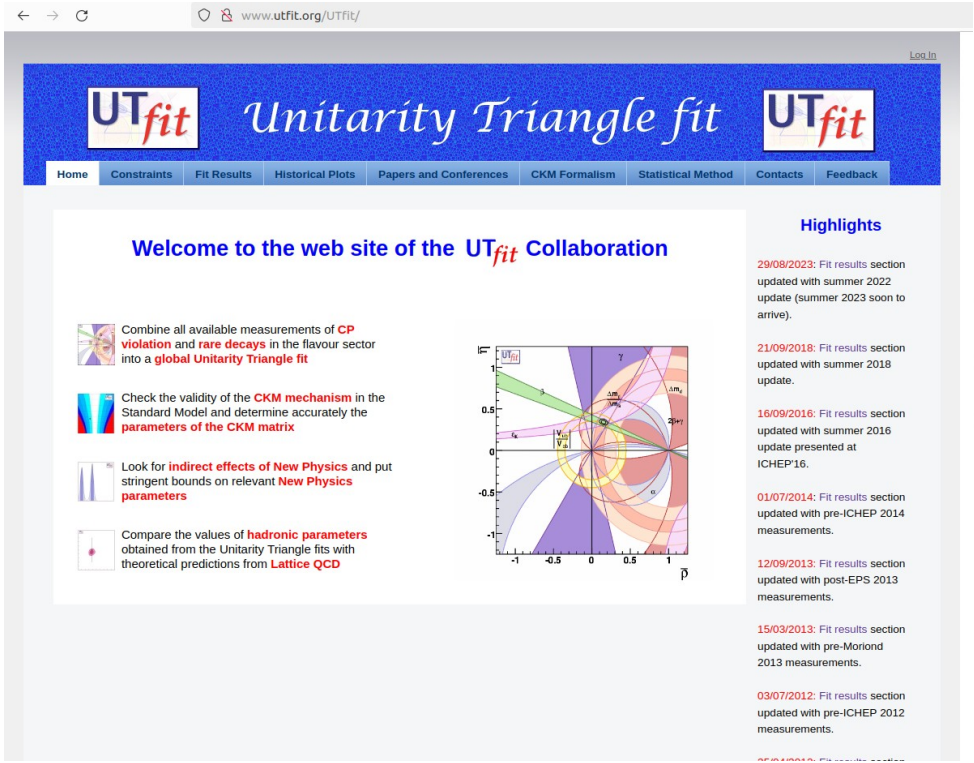




The 2006 CKM workshop in Nagoya:

In 2006 we also migrated the code:

- The first time..
- And in 2010 the webpage
- Although nobody has seriously dared to face the migration of the plotting macros in 20 years..
  - What are the new generations for?



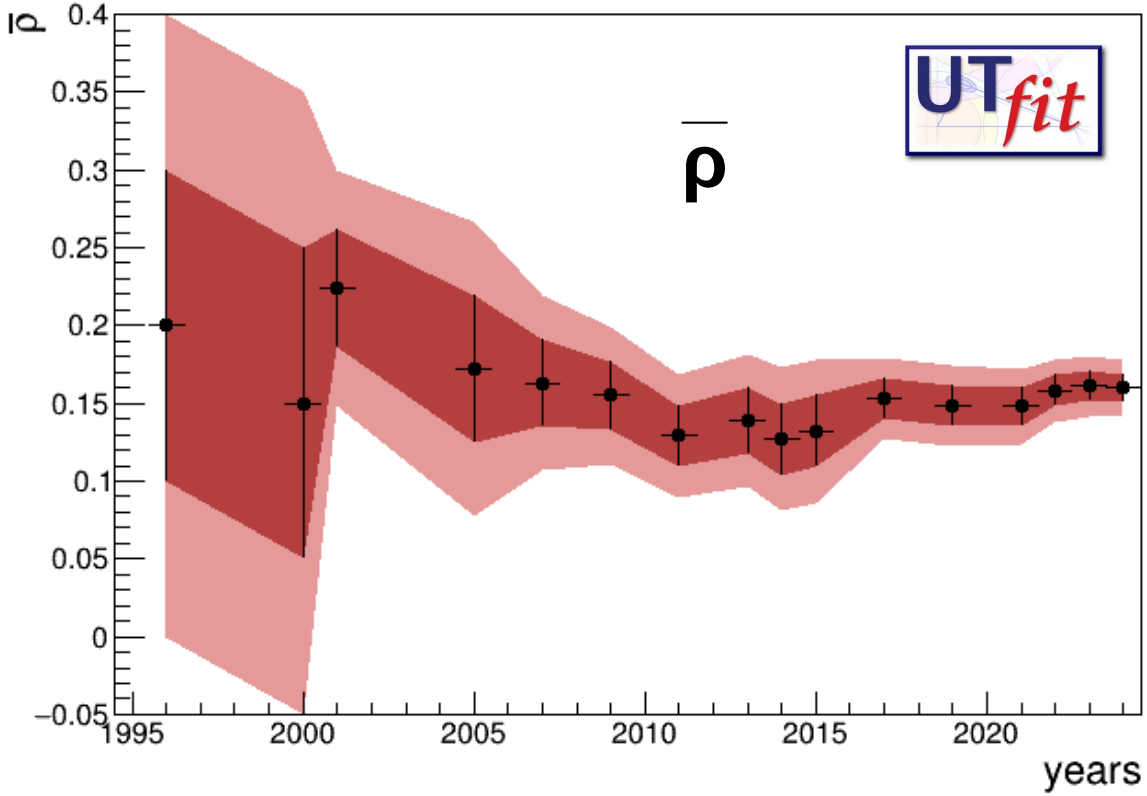
But the real migration has happened in the last two years to HEPfit code thanks to Luca's powerhouse, some new blood and Guido's drive..

RELOADED

M.Bona, M. Ciuchini, D. Derkach, F. Ferrari,
E. Franco, V. Lubicz, G. Martinelli, D. Morgante,
M. Pierini, L. Silvestrini, S. Simula, A. Stocchi,
C. Tarantino, V. Vagnoni, M. Valli and L. Vittorio

Taking up this occasion to generate an historic view:

- Ciuchini et al and UTfit numbers:



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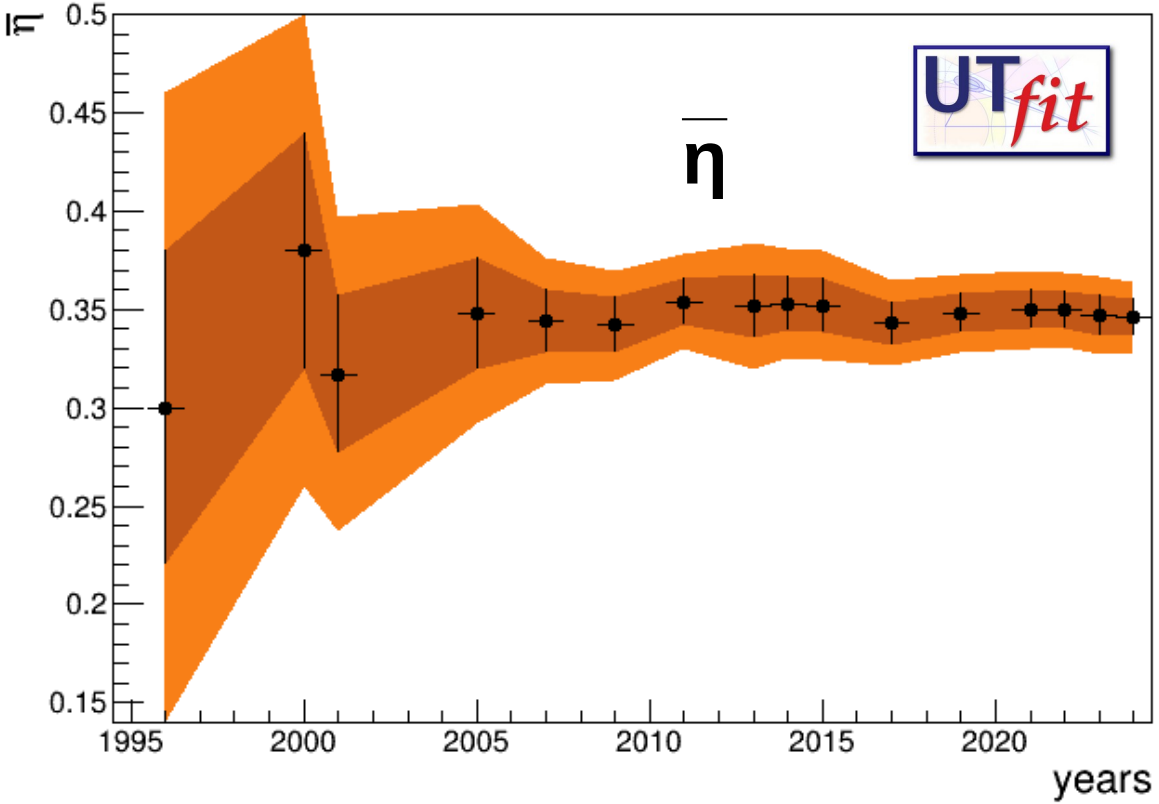

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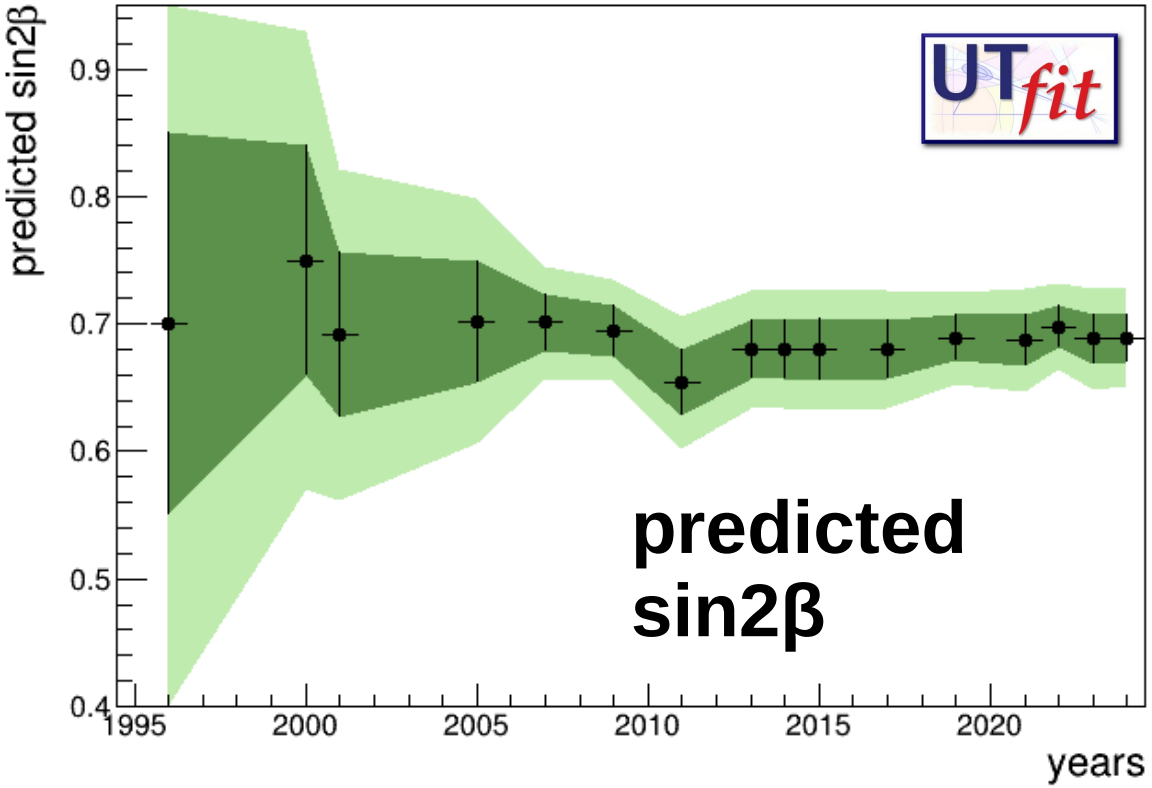

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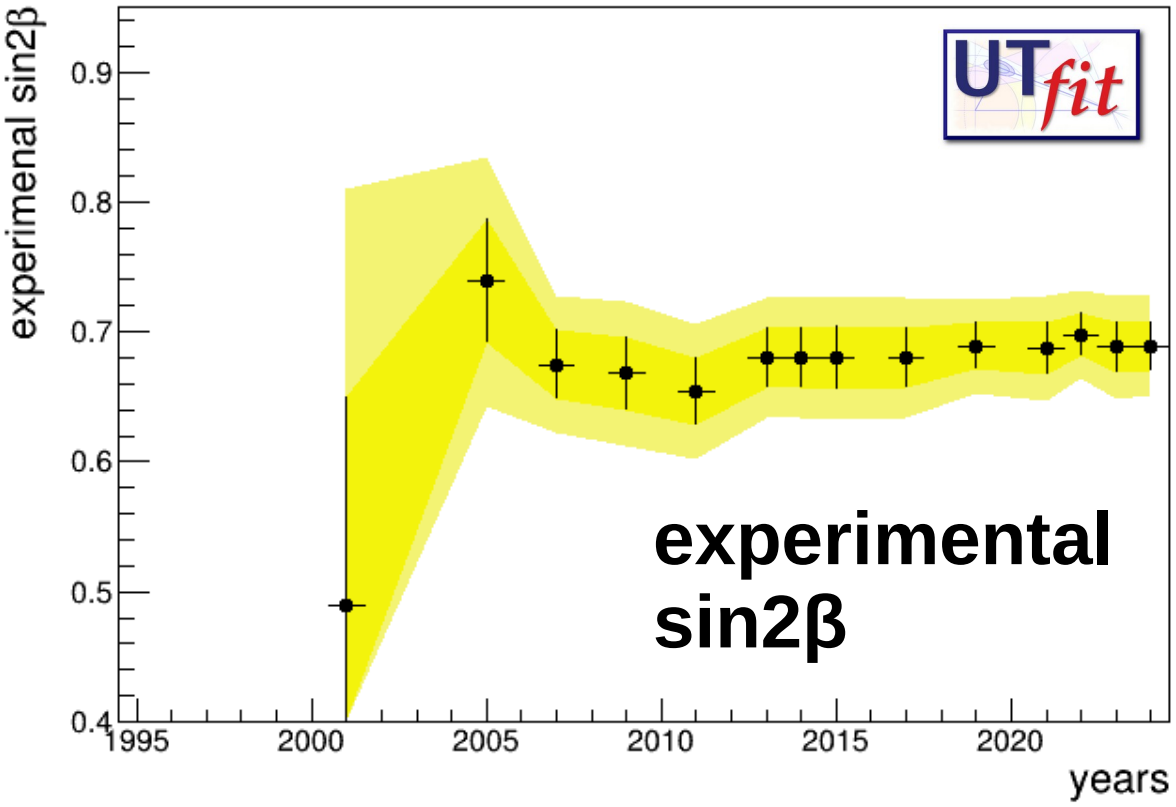
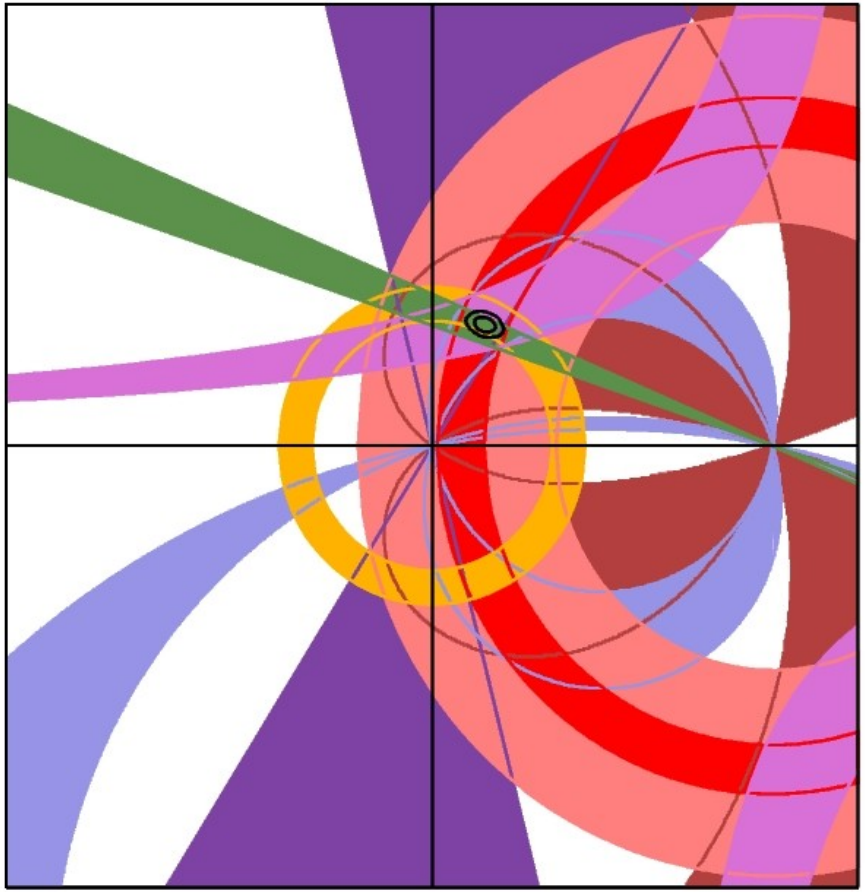


(personal) conclusions

- This UTfit adventure has changed my whole experience in particle physics
- I sleepwalked into taking side in a war..
- And I'm constantly aware that the first 2 lines of the emails need to contain all the information..



Back up slides