

A wizard in a red robe and blue hat with a star on it, pointing a wand towards a bright star in a dark blue, starry night sky. The wizard is positioned on the left side of the frame, and the star is on the right. The background is a gradient of dark blue to black, filled with numerous small white stars and a few larger, brighter ones.

The LHC Higgs Cross Section Working Group

past, present and future

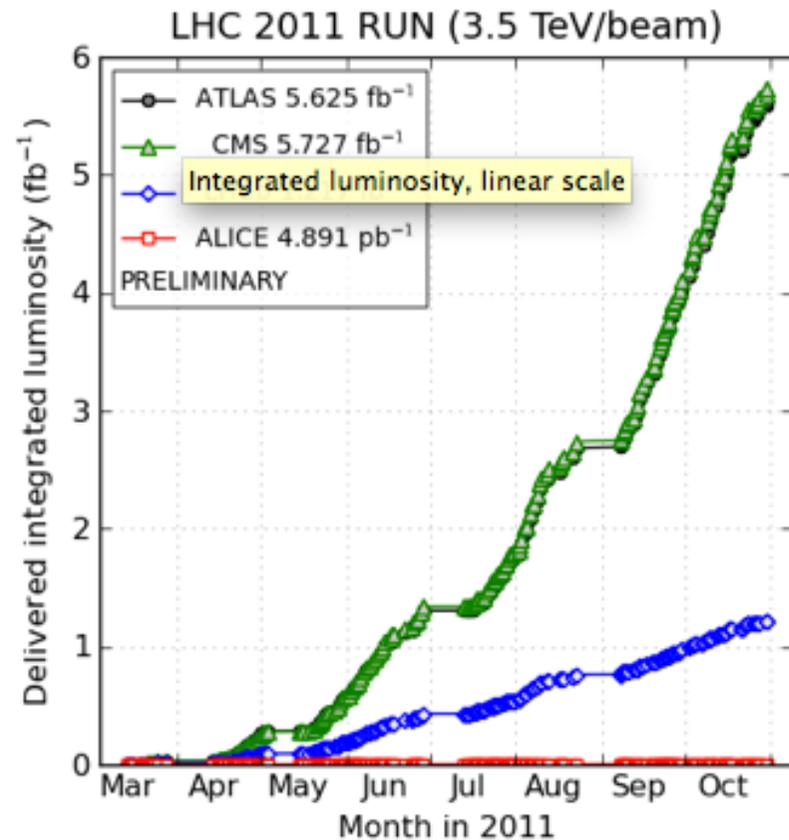
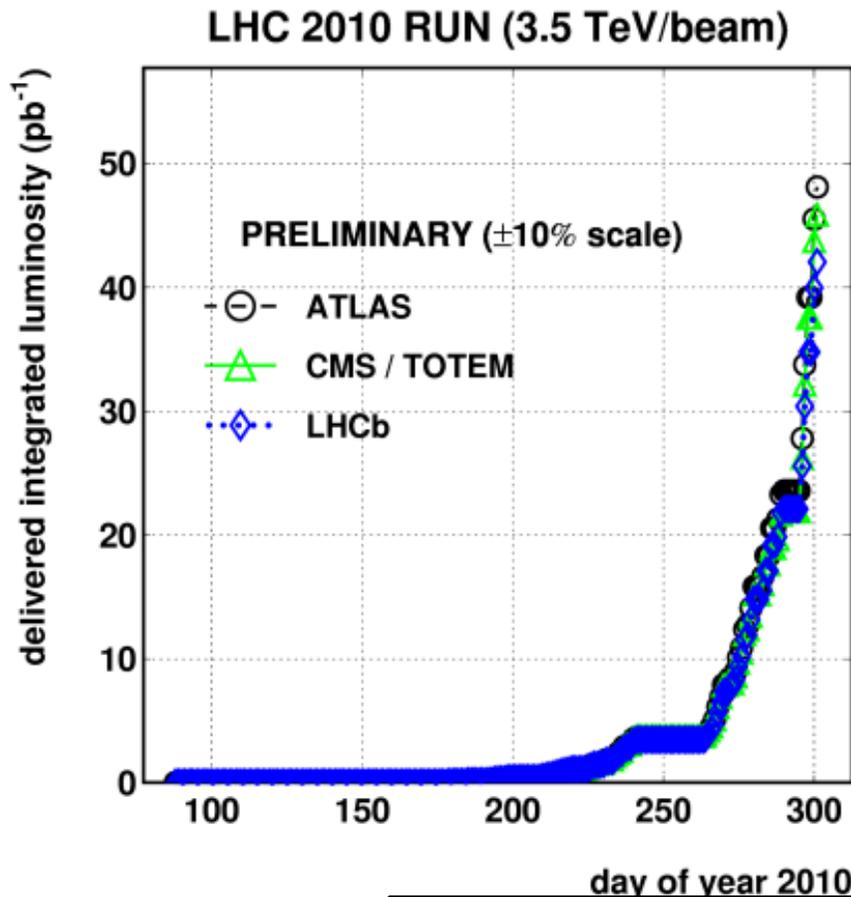
Outline

- **Almost exactly 2 years of work (since Torino 23-24 Nov 2009)**
- TH vs EXP: Love or war ?
- **What went ok**
- What did not work
- YR2: the scope of this workshop
-and beyond: Higgs or no Higgs ?

7 TeV Run 2010-2011

23- Nov – 2009 First collisions in Atlas and CMS at 900 GeV

2010/10/29 15.16



Recorded / usable by the Experiment is $\sim 10\% - 15\%$ less
i.e. a bit less than 5fb^{-1}

The results

- The YR1 is a “success”: 66 citations as of today and increasing every week
- The plots are shown in ALL the talks
- YR2 is awaited for and will be equally used.
- We EXP learned a lot from the TH community – hopefully viceversa!

The goal of the group

<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections>

- Access the most advanced theory predictions for the Higgs Cross Section and Branching Ratio.
- Common and correlated theoretical inputs, like cross sections, PDF, SM inputs etc. are discussed in the group.
- Theoretical uncertainties.
- Experiments are/will coherently use the **COMMON INPUTS** based on the interaction with the TH community to facilitate the combination* of the individual results

*Higgs Combination Group

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Th vs Exp



Th vs Exp



TH vs EXP

- It is not always an easy collaboration
- We do not understand each other very often
- We have very different job, way of working, time-lines etc.
- The reality is that we are both necessary to reach a meaningful result.
- It is maybe not “love”, but we should avoid the “war” (well... sometime the war is more between TH vs TH...! Up to now never between Atlas and CMS!!)
- And... notice that combined marriage are the longer lasting!

TH to Exp

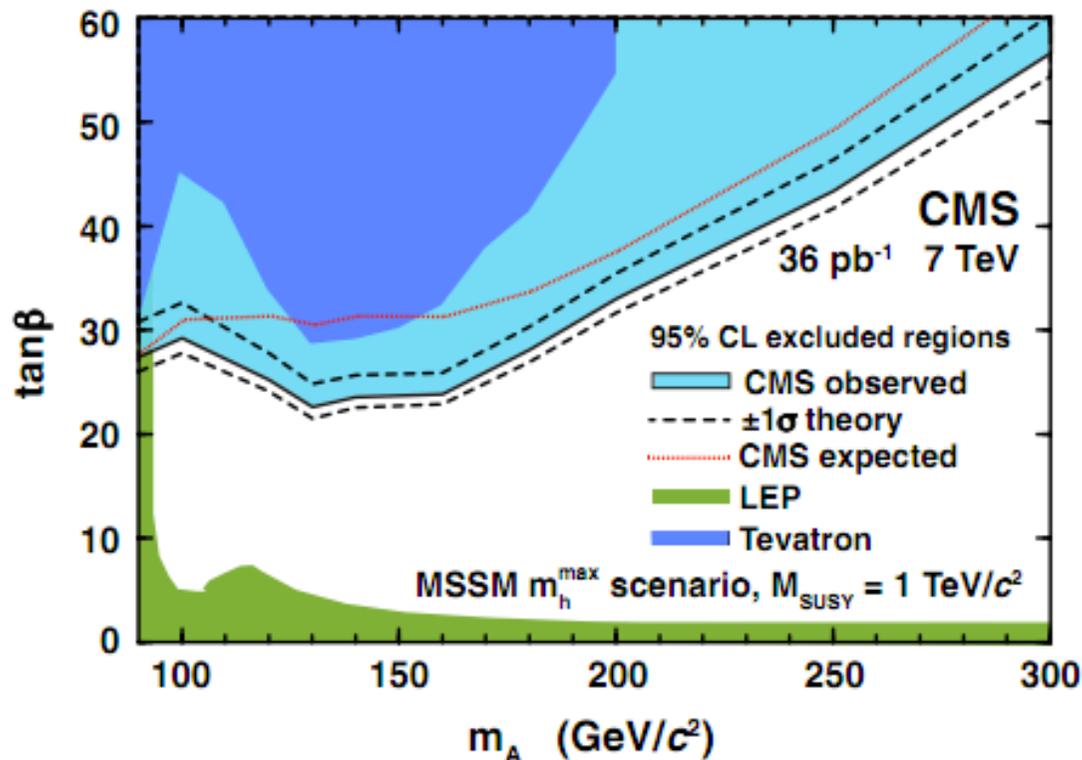
- All the tools TH developed have been used.
- Maybe it took us (exp) some time to learn, to change, to understand but the result is positive.
- All the most advanced theory predictions have been used.

→ THANKS !

- The papers (still very few) try to give you justice (references) → **Please help us in being correct.**

YR1 Jan 2011

- First result who used ALL the prescriptions from the LHC H XS wg:



ggH+bbH in MSSM neutral H

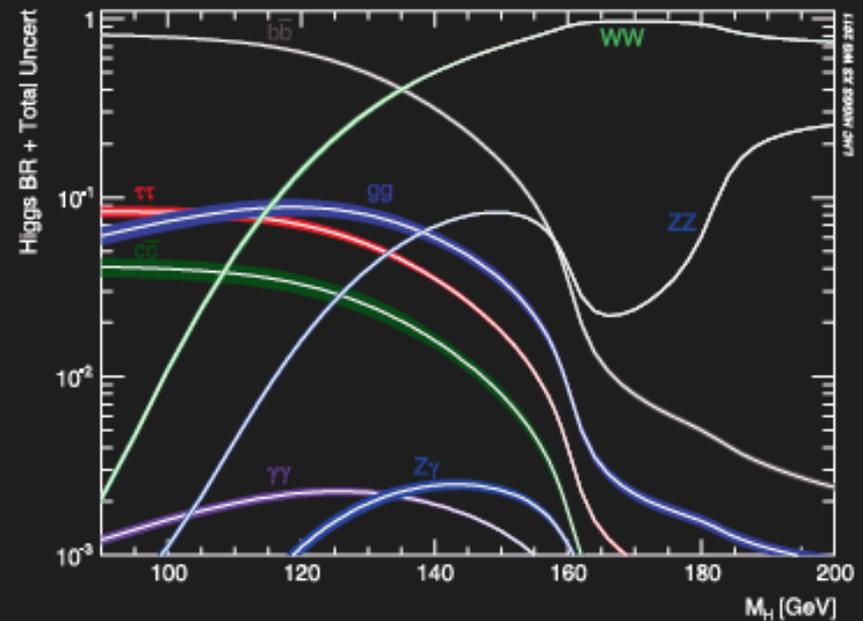
Total THU =
Envelope of the scale Unc +
sum in quadrature of PDF+ α_s Unc

(it has been checked that the sum in quadrature of the PDF+ α_s Unc error is a good approx of the PDF Unc. on the sum of the XS)

- After -> “Santander accord” to use the best from the 4FS and 5FS

BR

Numbers
used also
by Tevatron



Higgs branching ratios and their uncertainties for the low mass range.
From LHC Higgs Cross Section Working Group: Standard model Higgs-boson branching ratios with uncertainties

HqT , Powheg and more

- Rescaling $p_T(H)$ from Powheg with HqT done **BY ALL**
- Powheg for $ZZ^{(*)}$ promised in Bari and now used in Atlas and CMS !
- Jet-bin uncertainty :“BNL accord” used!
- Heavy Higgs Lineshape error uncertainty recommended and adopted in the EXPs results.
Next: correct Lineshape will be used.
- UE uncertainties quoted in most of the analyses

What did not work

- The conveners were not equally active and the burden was **on few**.
- The Theoretical Uncertainty was not used properly by the Higgs Combination Group:
 - the message did not pass clearly
 - there was un-understandable reluctance

→ **Total THU = Linear Sum of
{Scale Unc. + Parametric Unc.}**

- **Scale Uncertainties** have flat distributions: envelope method.
- All **Parametric Uncertainties** (PU), like PDF, α_s , ... will be added in quadrature (gaussian distr.)

Higgs Combination

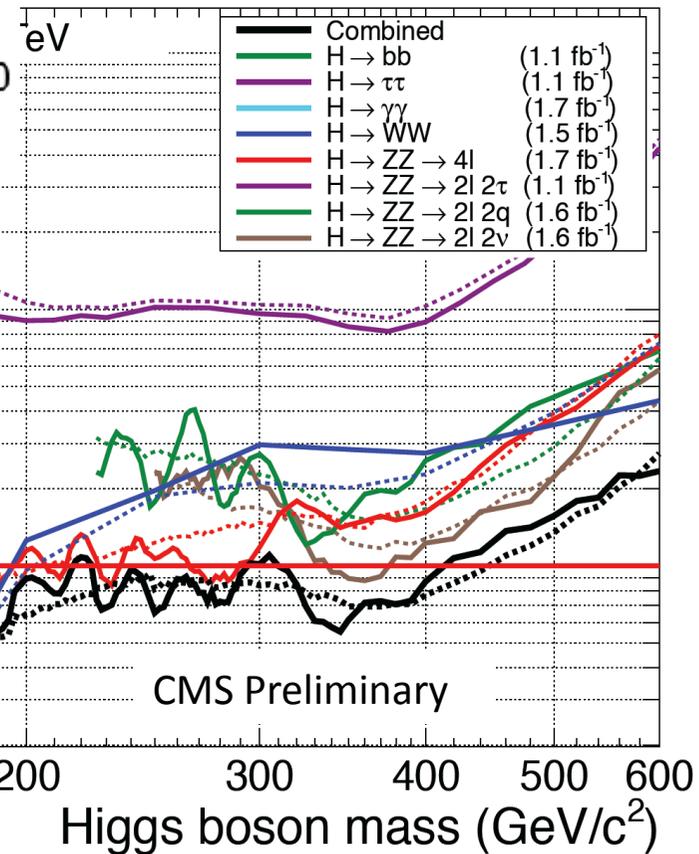
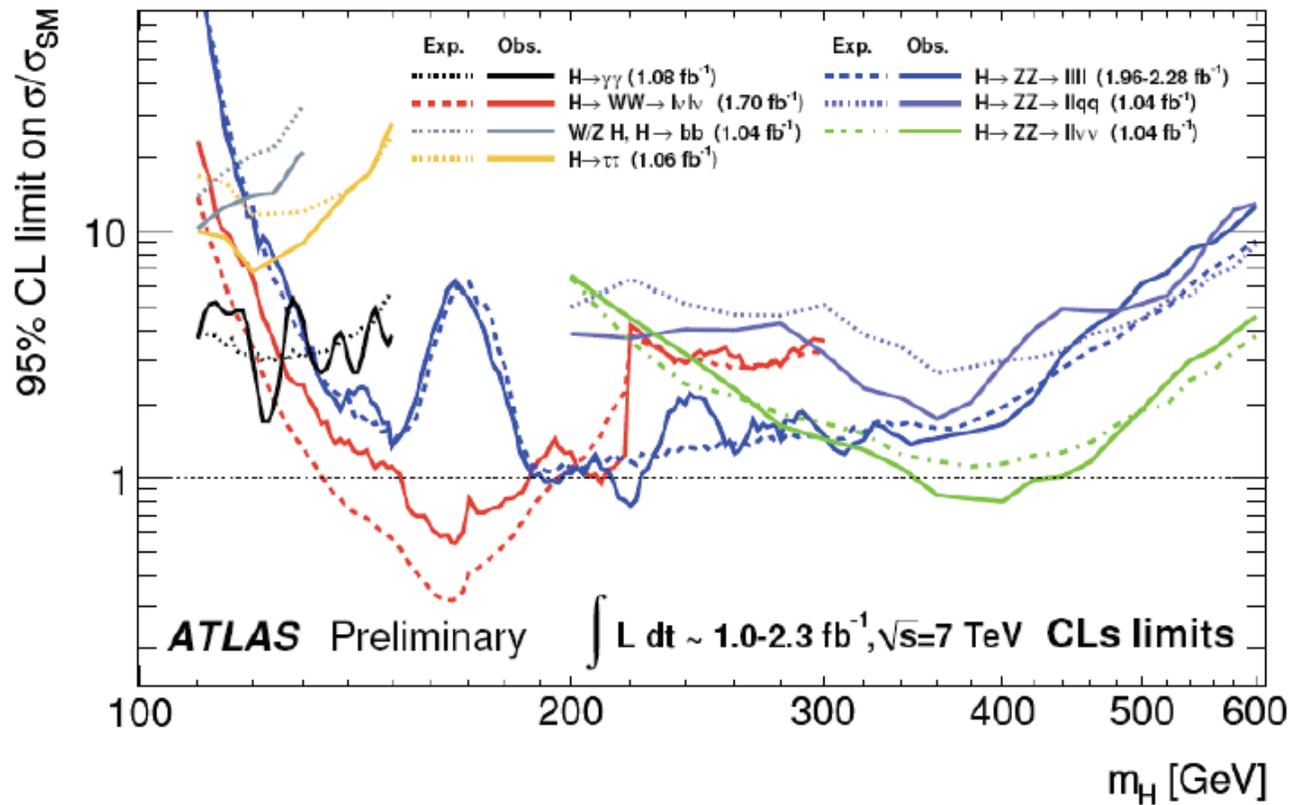


<https://cdsweb.cern.ch/record/1399599>

<http://cdsweb.cern.ch/record/1399607>

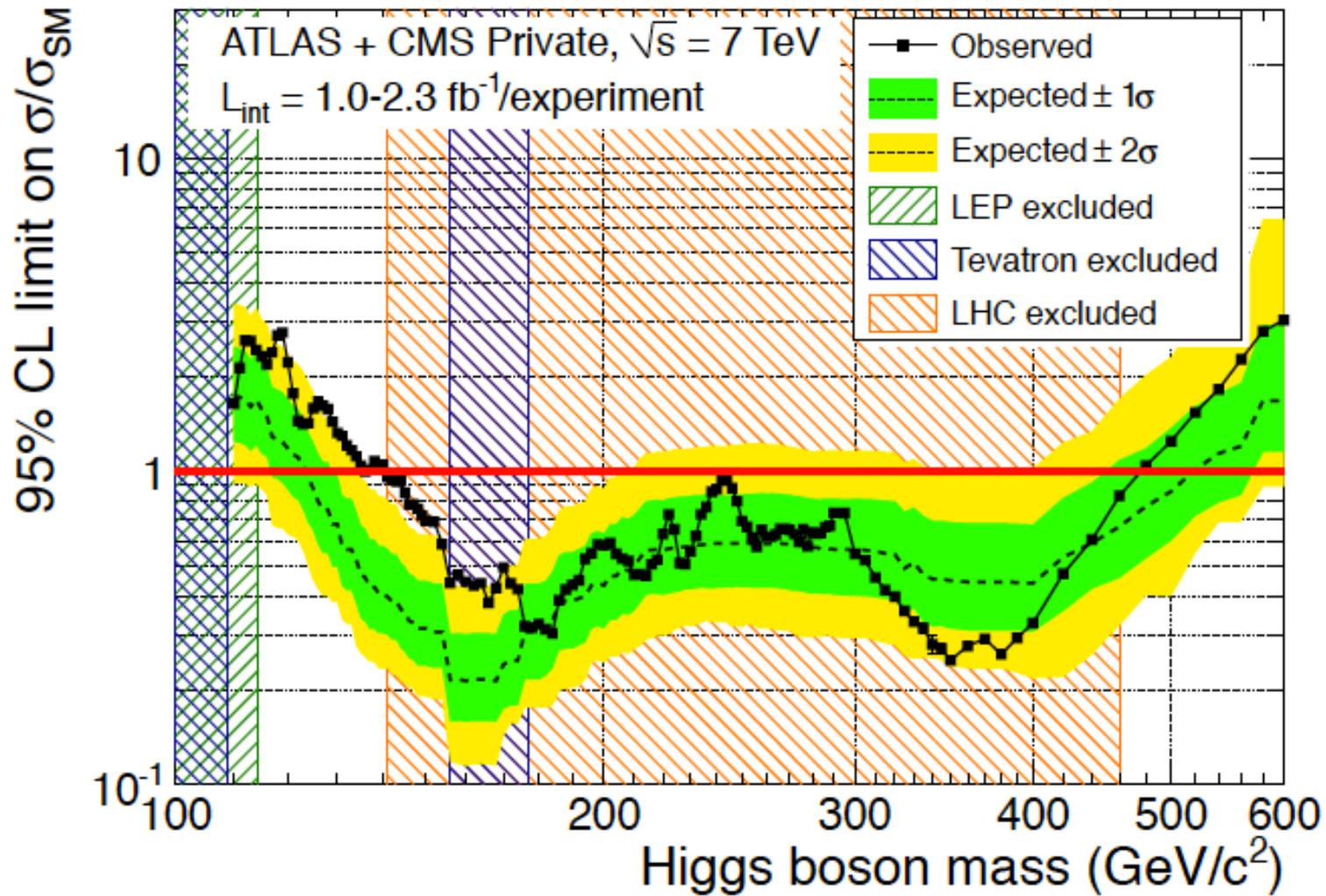
G. Petrucciani

Channel by channel



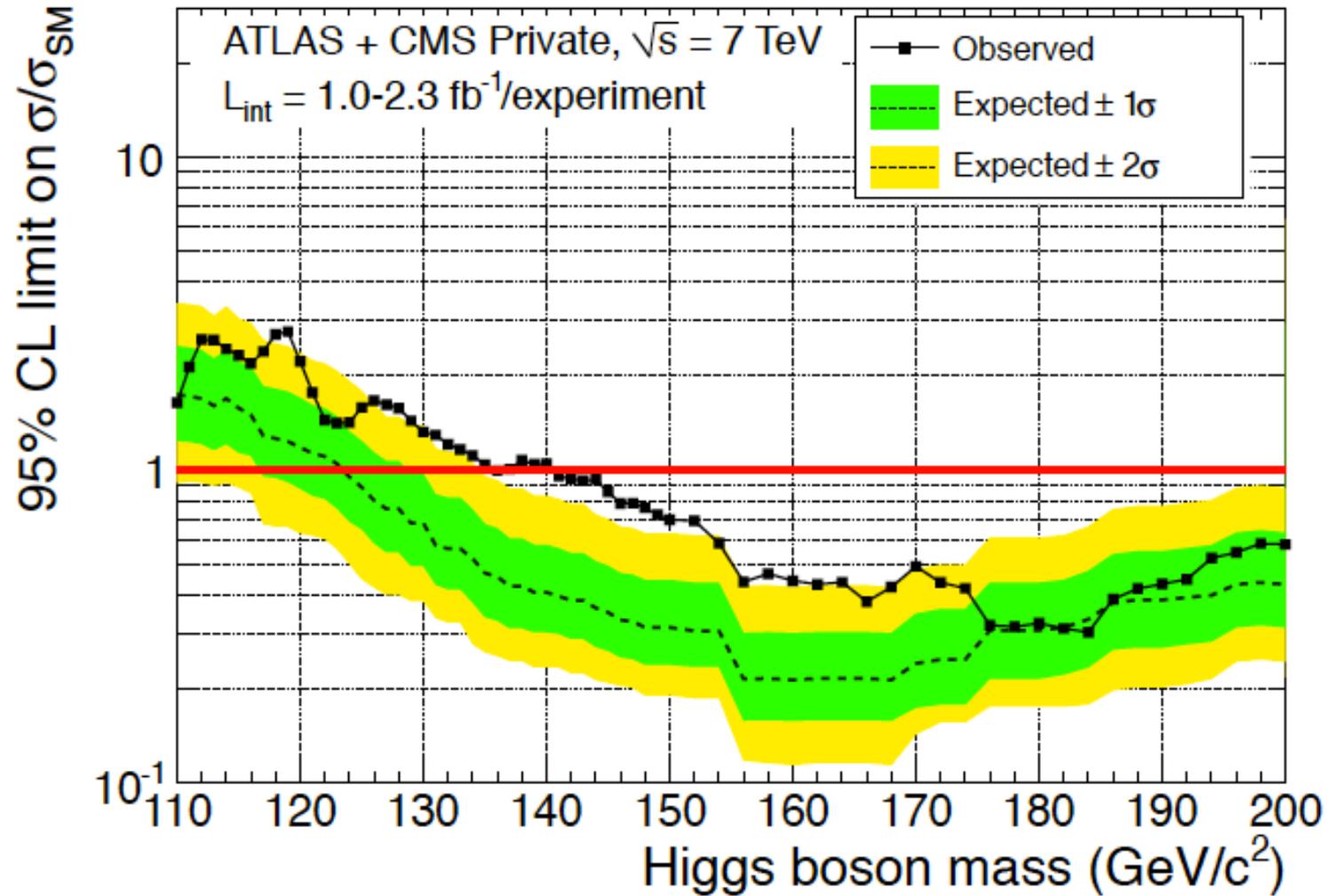
Statistics and results presented this summer -> only these are combined

Atlas+CMS 1-2.3/fb



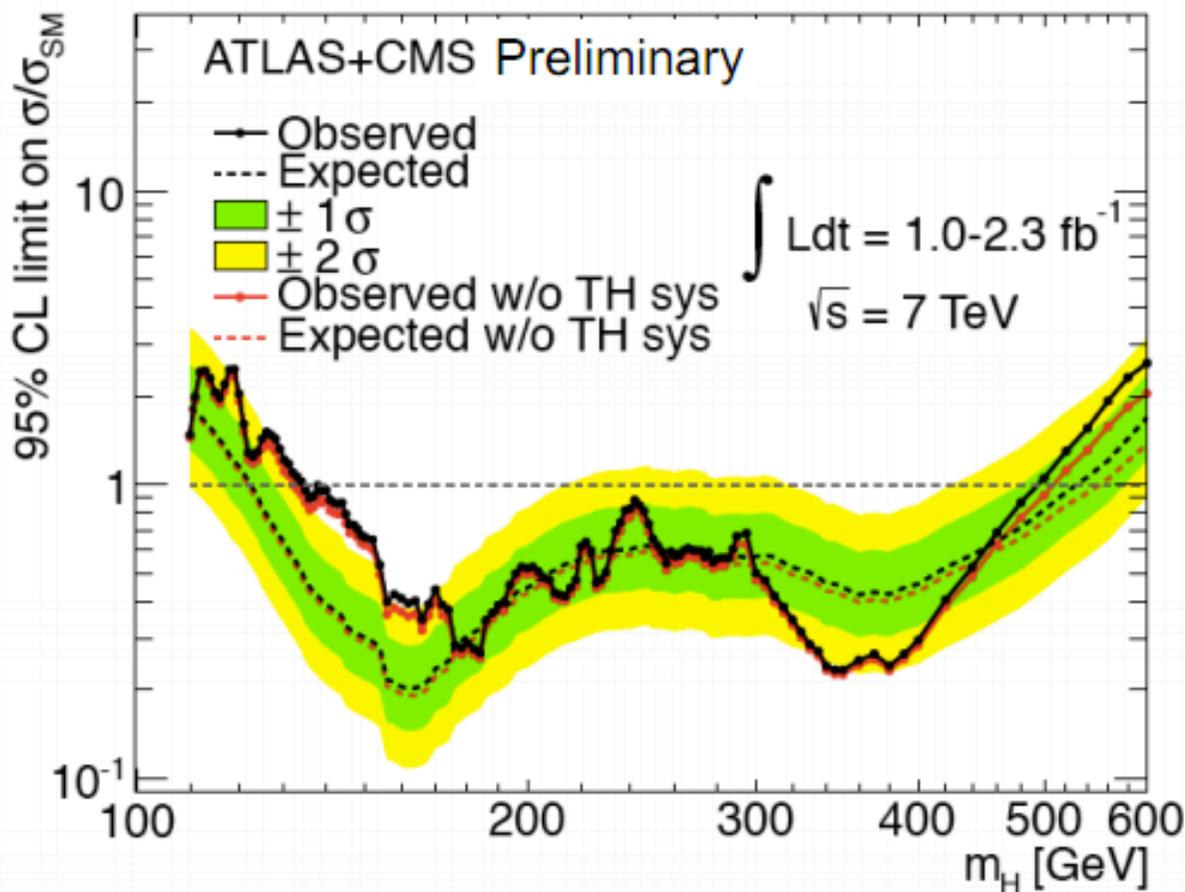
141 GeV < M(H) < 460 GeV excluded at 95%

Atlas+CMS 1-2.3/fb: zoom





Theoretical systematic uncertainties



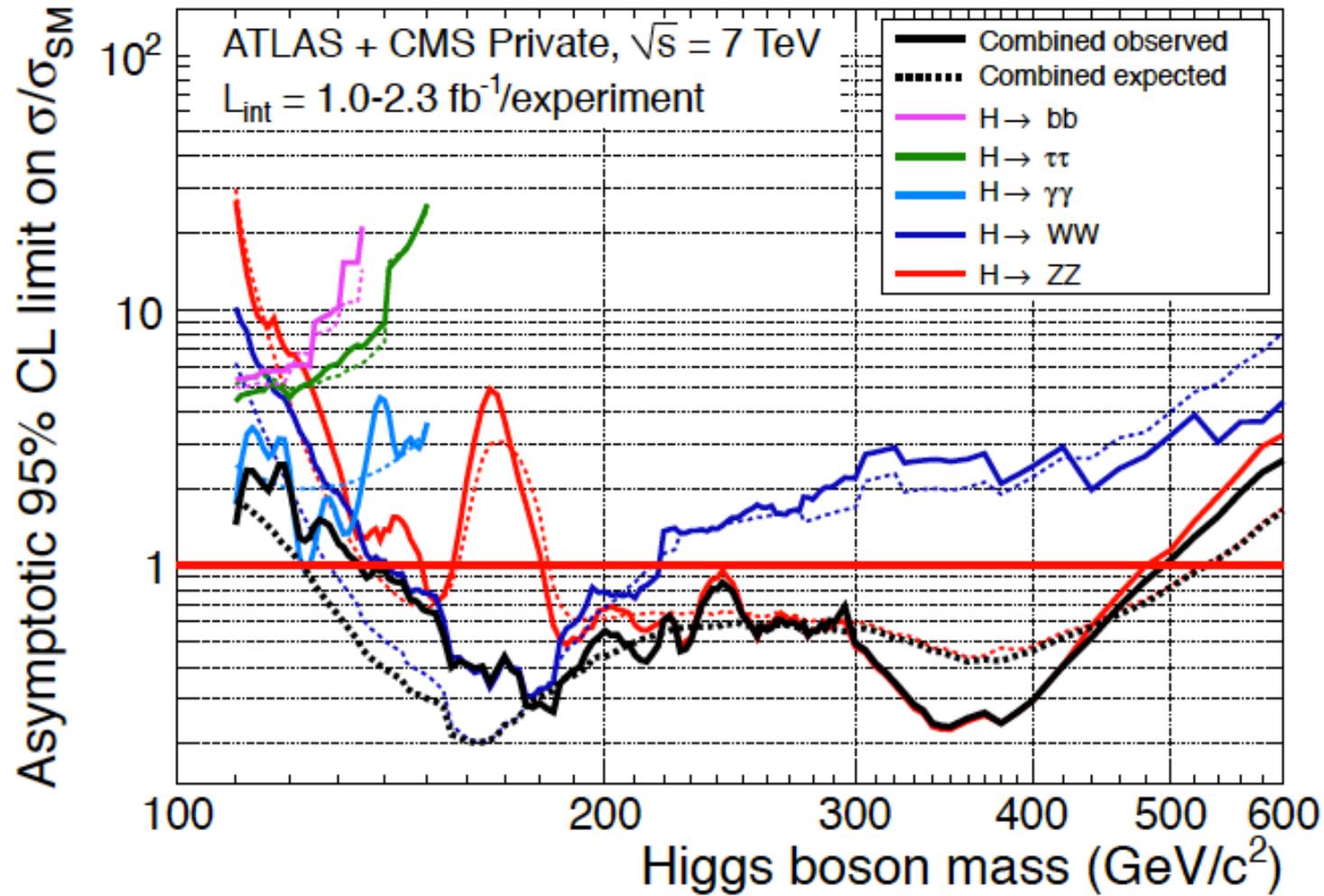
Expected exclusion changes by 1 GeV at low mass and 20 GeV at High mass



Thanks to the advances in theory and to LHC Higgs cross section group !

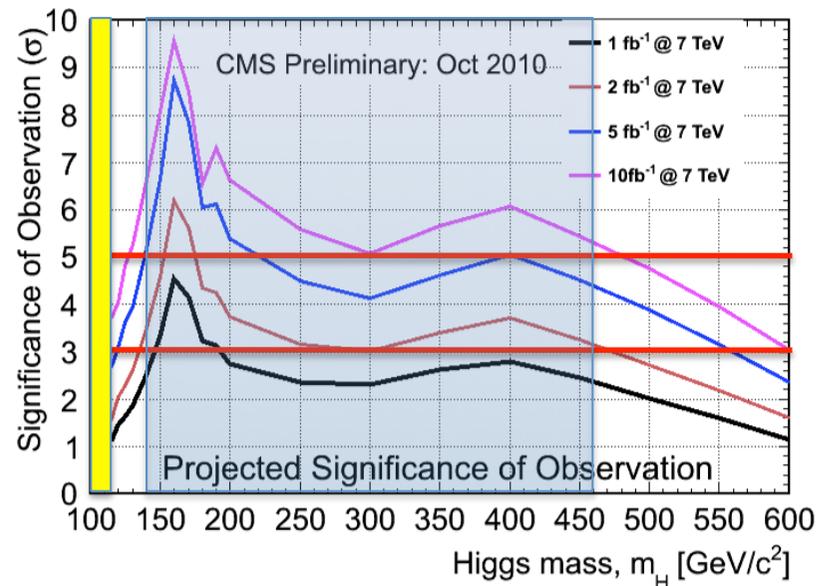
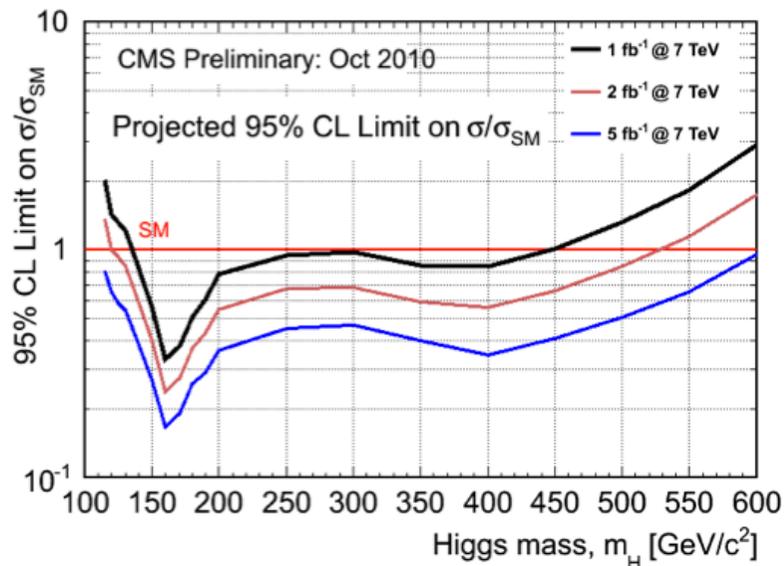
Gigi Rolandi, HCP

Channel by channel



Next year

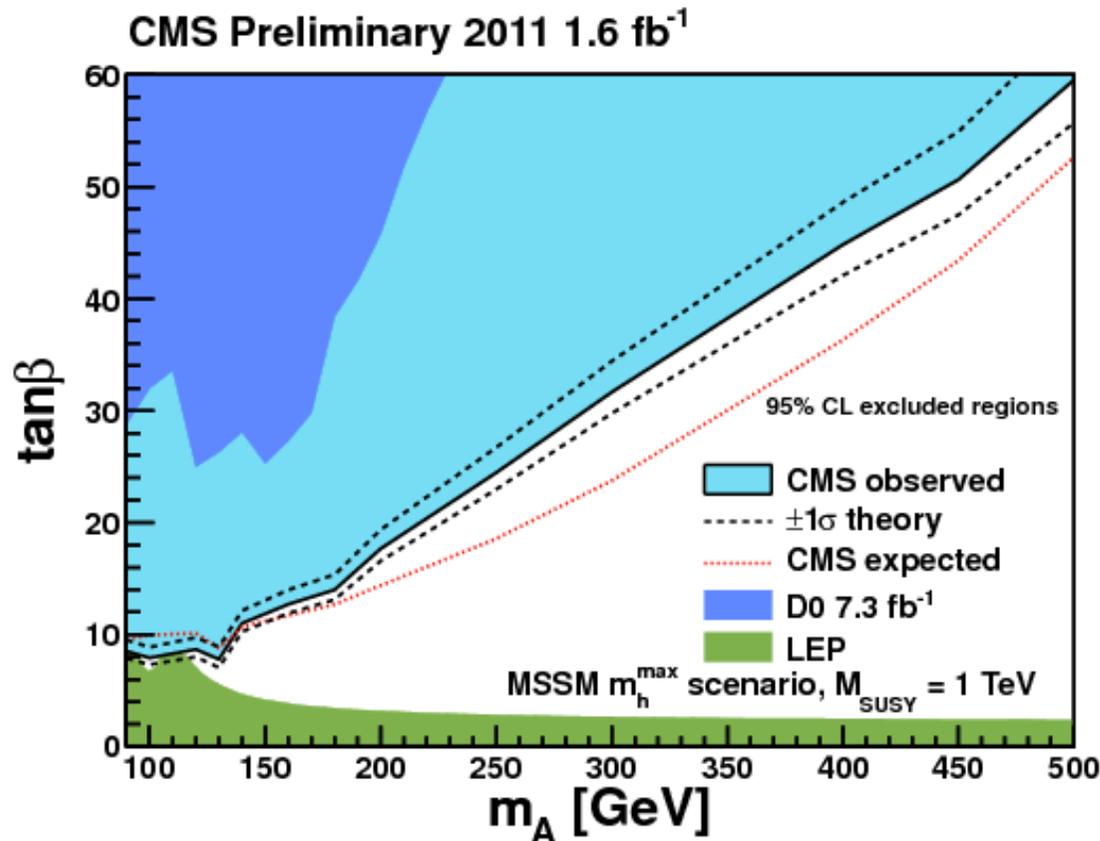
- By the end of the 7 TeV run, the luminosity collected will hopefully allow us to probe a wide range of Higgs-mass values



Excluded at 95%CL
Or nearly so

By the end of 2012 five sigma everywhere, maybe difficult at 115 GeV

MSSM ϕ



- Most sensitive channel for neutral Higgs searches in the context of SUSY models
 - Large portion of $\tan\beta$ - M_A plane excluded

2012 →

- Maybe next year we will even go to 8 TeV
- Then in 2013 and part of 2014 long shutdown to prepare the machine for 14 TeV.
- Restart in 2014 aiming at ~14 TeV
- 250-300 fb⁻¹ /year in the second half of the LHC life
- 3000 fb⁻¹ on tape by the end of the life of the LHC!

YR2: why we are here today

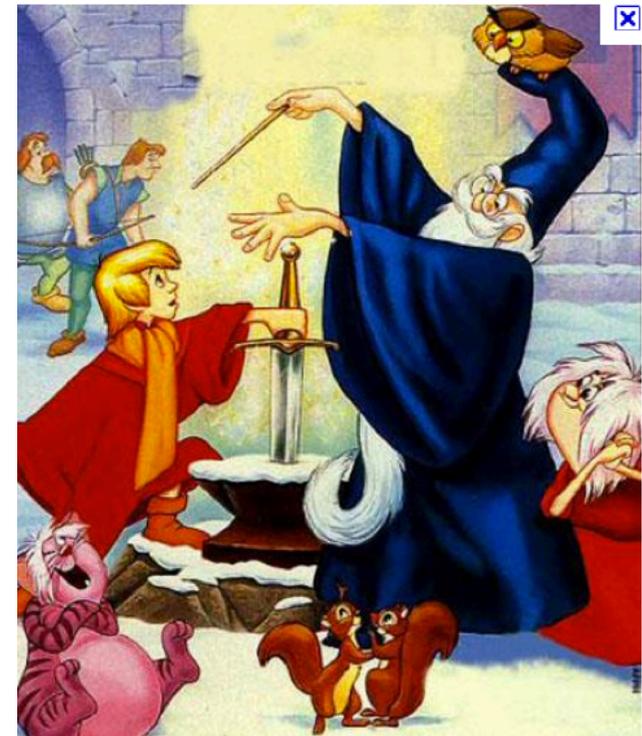
- **Presentation of the work done and that has been written for the YR2.**
- **No more changes after today! (we will close SVN)**
- **Thanks to all who did it on time !**
- **It was a hard work because it was at the same time with 5/fb of data! And all what we needed in the analyses is inside the YR2 – really interactive work.**

YR2 and beyond

- YR2: it is/will be used heavily by the experiments.
- What can be our future?
If Higgs exist:
 measurement of its properties

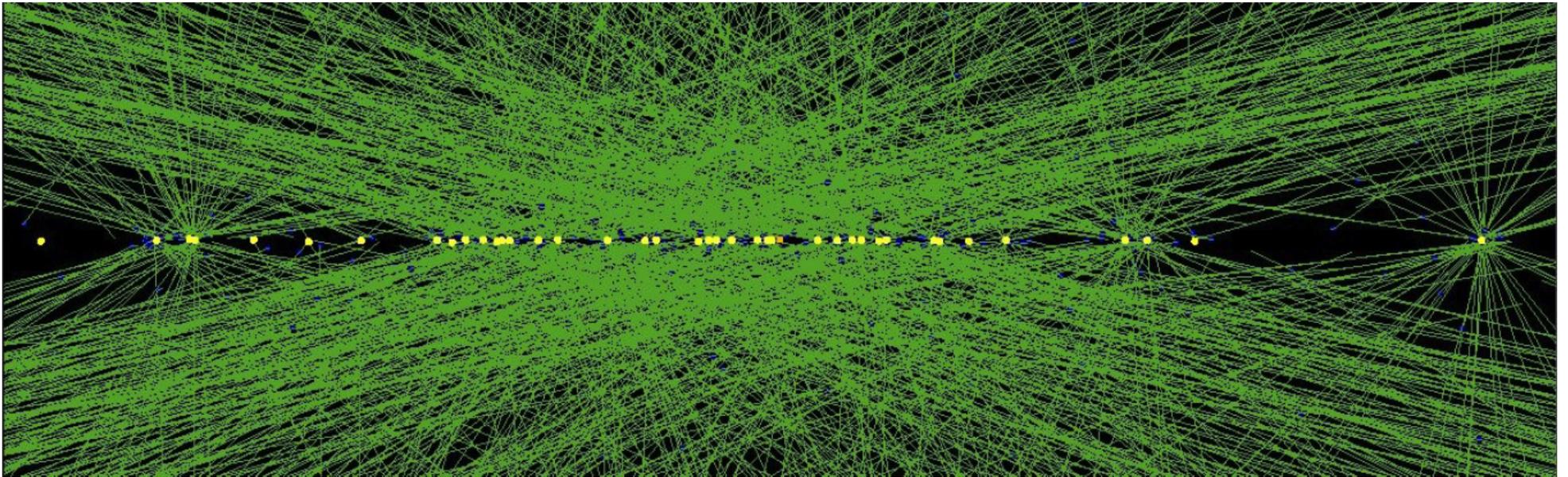
If SM Higgs is excluded:

- other models ?
- VV scattering ?



We should exist somehow as a reference of what has to be used and certified by the “competent” body

Not from a stone, but....



Event with 40 reconstructed vertices from a high PU fill

The future

- We “overall coordinators” are almost at the end of our mandate.
- We should re-structure the full group and for sure find more active people
- The new overall coordinators will take this responsibility!

Conclusion

- The YR1 is finally printed !!! After ~ 1 year
- Still a long way to go before publishing the YR2
- Next year will have a big impact on “us”

Thanks to all for this 2 years journey!