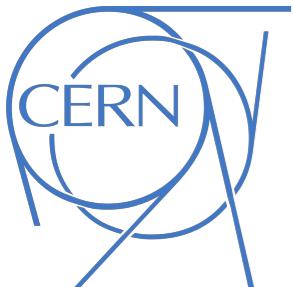


Observing the Higgs boson decaying into a pair of b-quarks

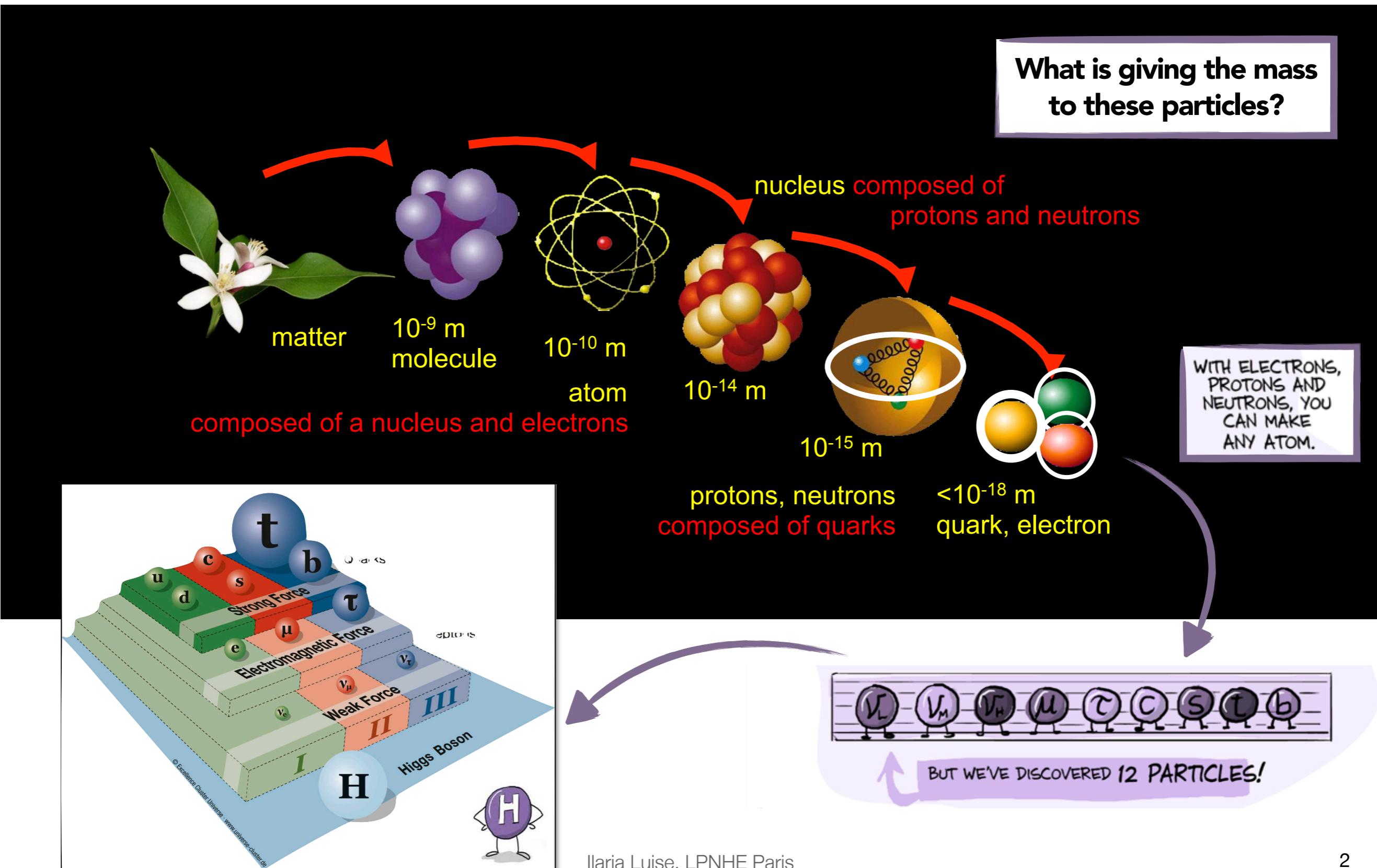


Ilaria Luise

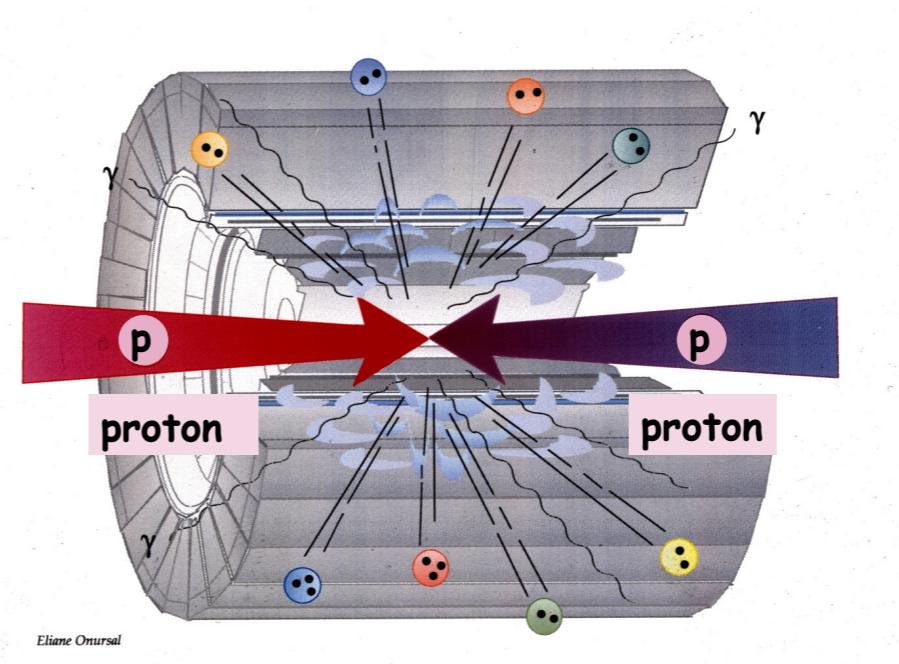
Biennale 17th April 2019



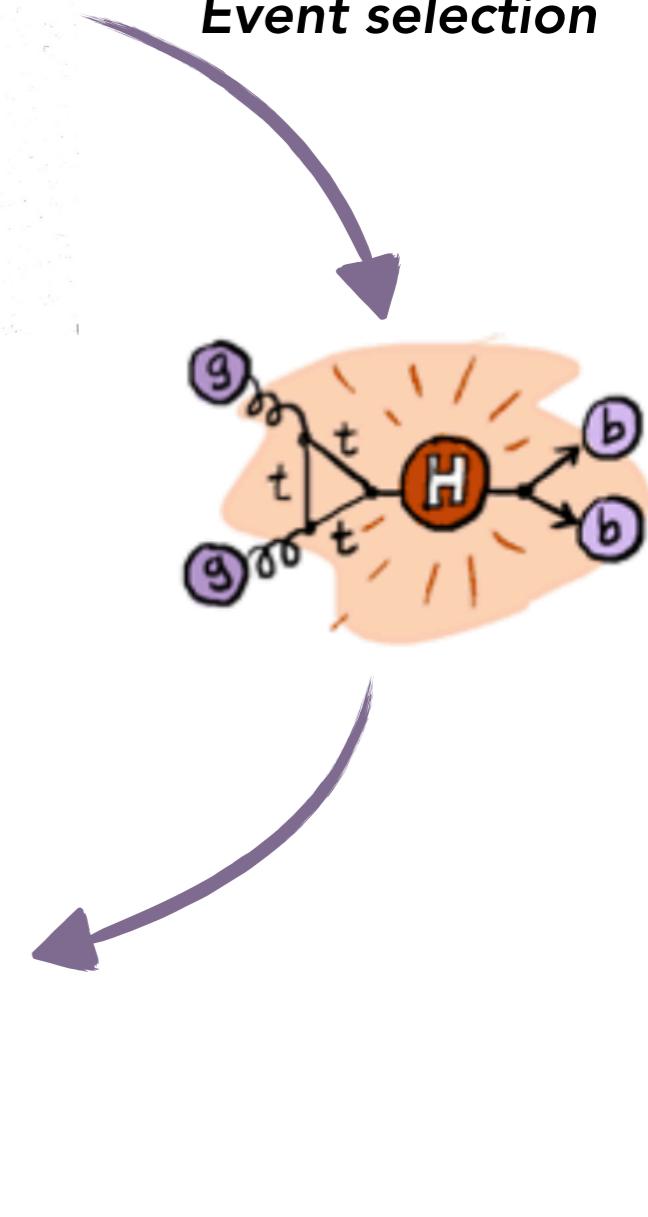
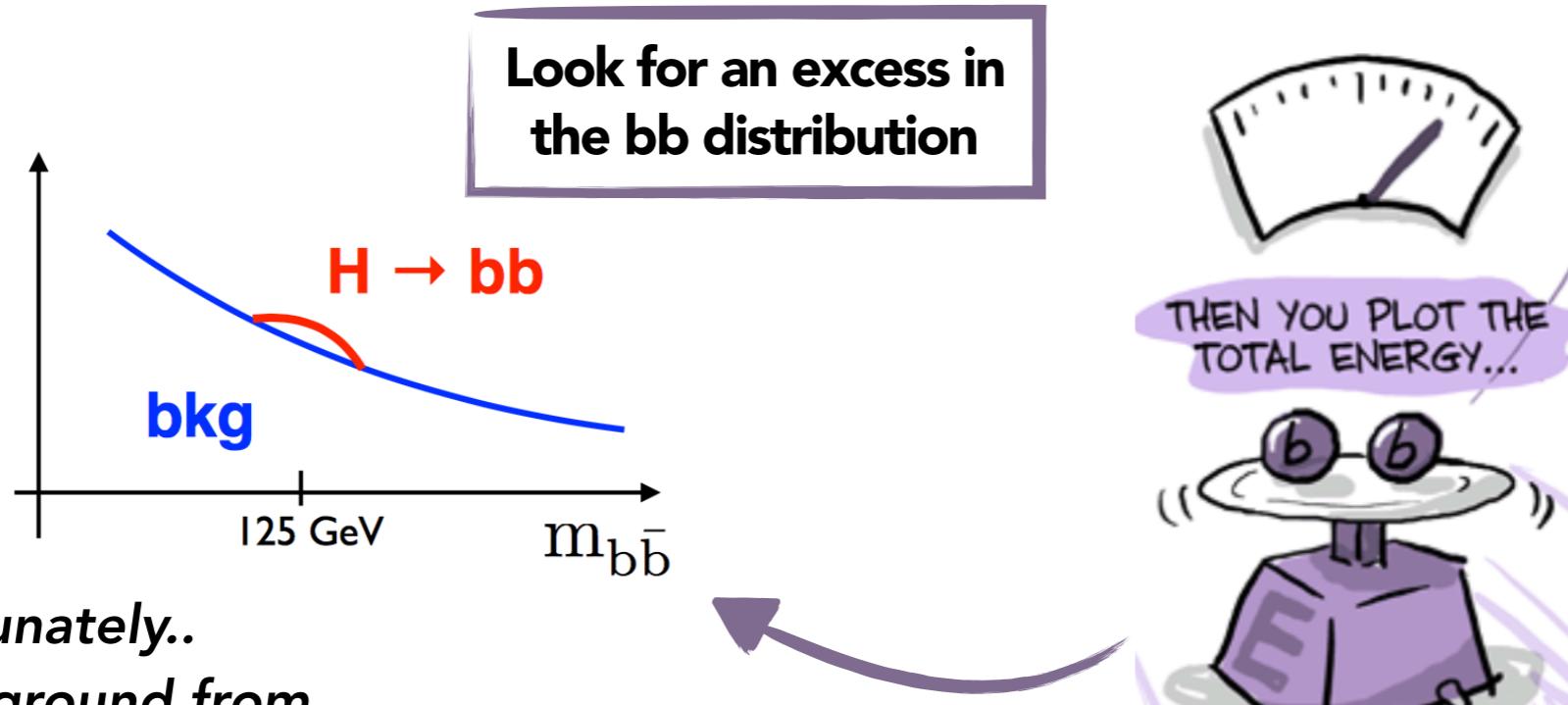
Looking at the constituents of our universe:



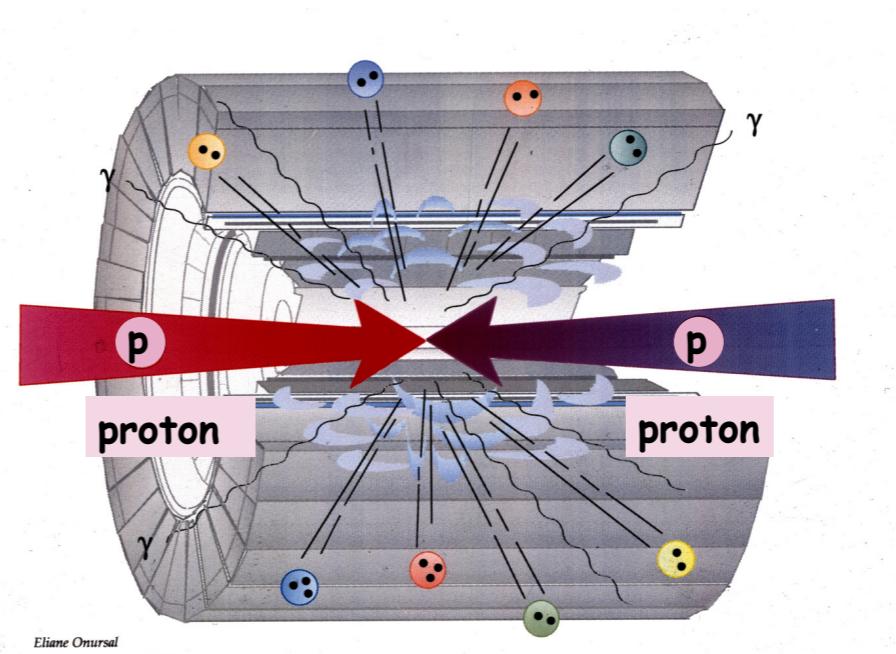
How to 'see' the Higgs boson?



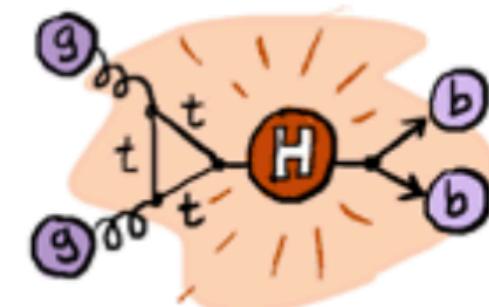
Process the data
+
Event selection



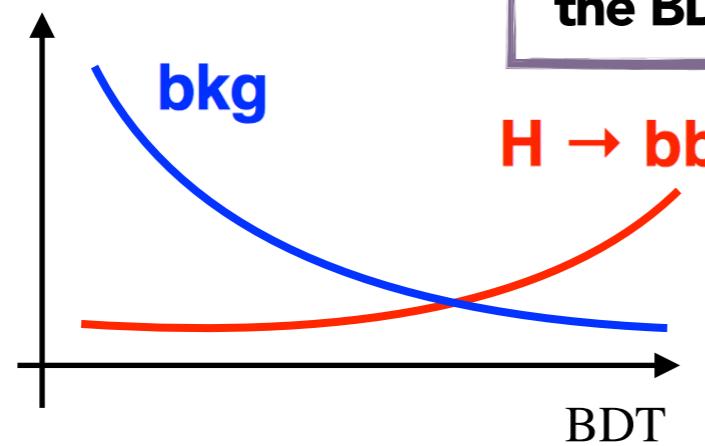
How to 'see' the Higgs boson?



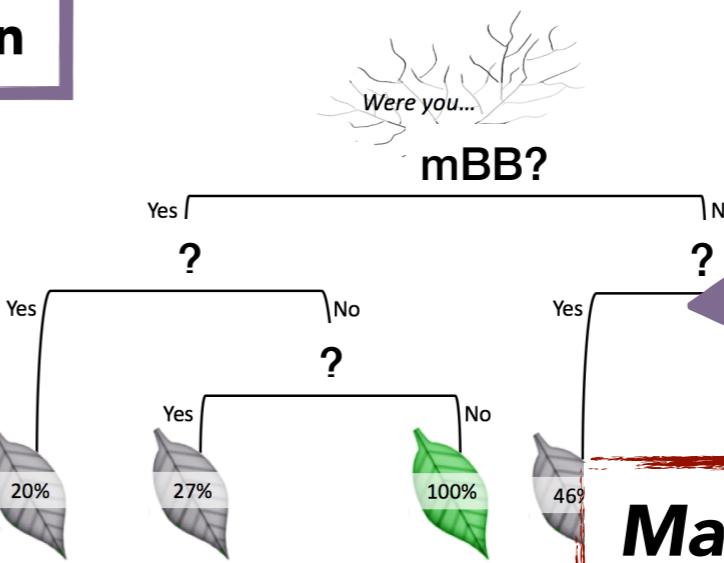
Process the data
+
Event selection



Look for an excess in
the BDT distribution

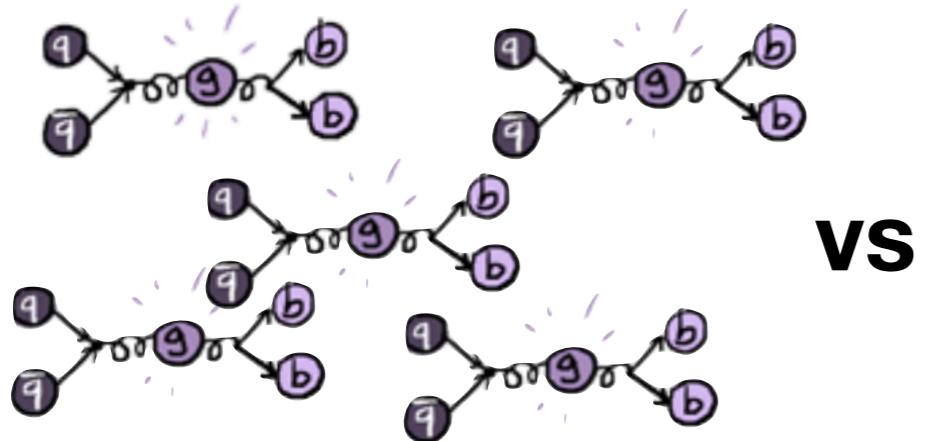


unfortunately..
Huge background from
same final state processes

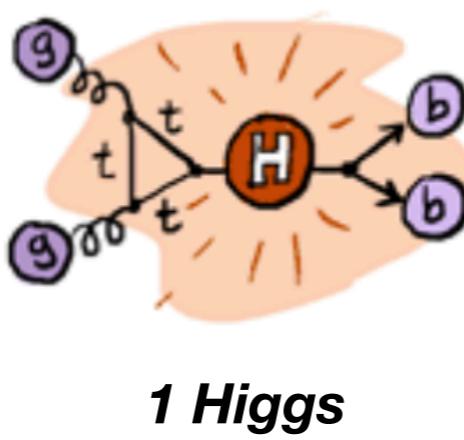


Machine learning!
(BDT)

How to disentangle from background?



VS

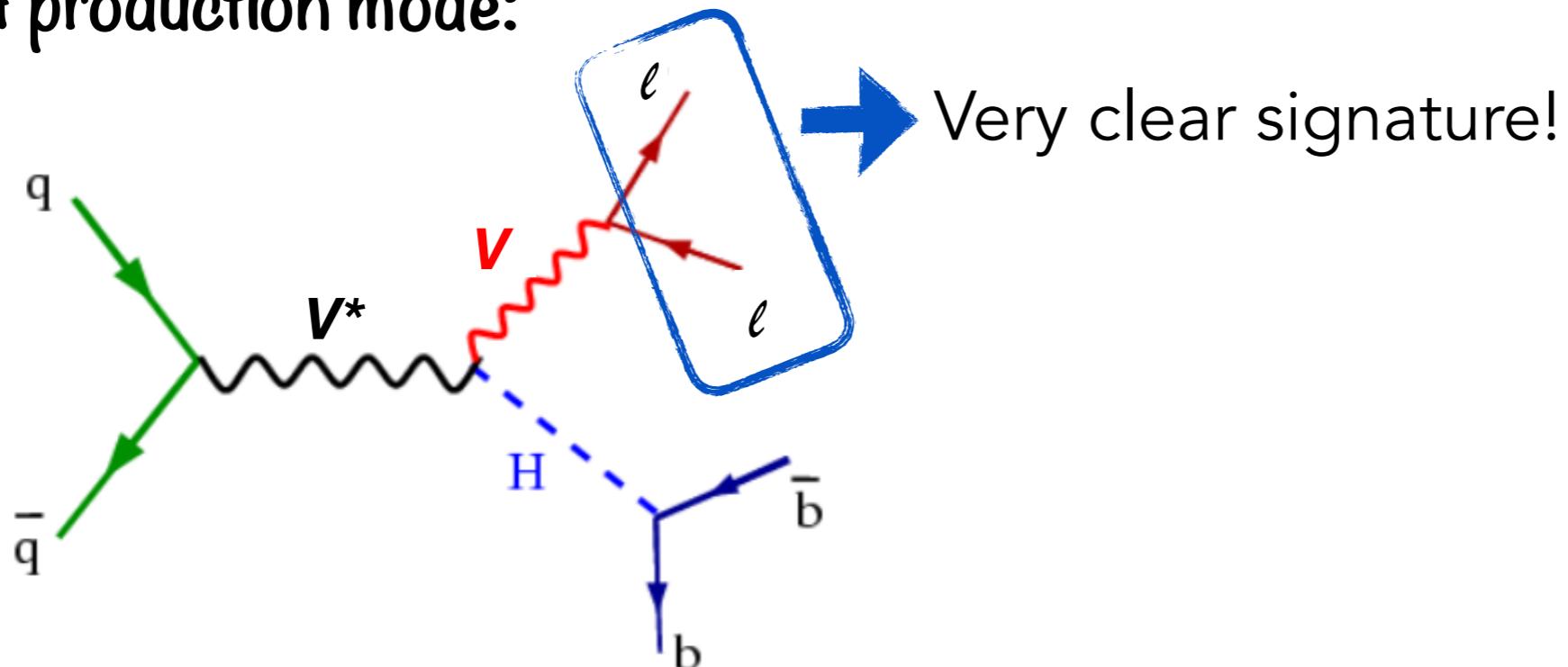


= ?

Idea!
Use just one specific **production mode** which has additional particles in the final state

10^8 background events produced

The VH production mode:



Very clear signature!

My studies in the VHbb analysis:

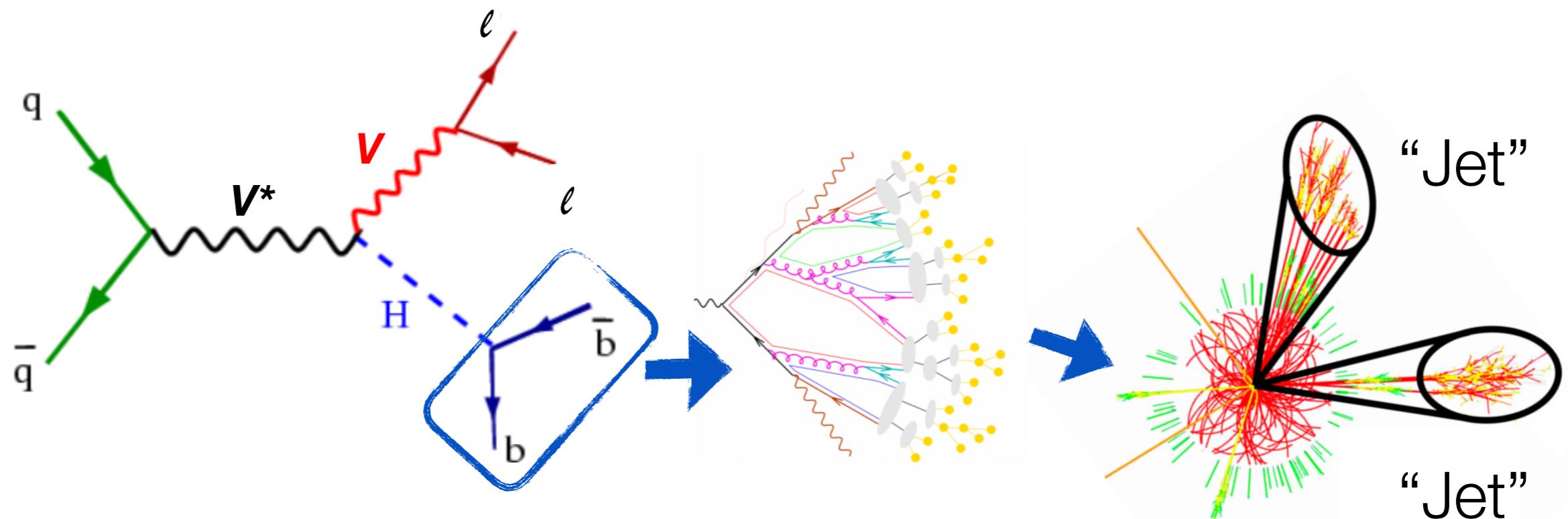
QUARKS	$\frac{2}{3}$ u up	c charm	t t bottom
	$-\frac{1}{3}$ d down	s strange	b bottom

B-tagging:

- We are just interested in b-jets, but there are many other flavor
- The algorithms we use to disentangle b-jets from other jets is the so called “b-tagging”.

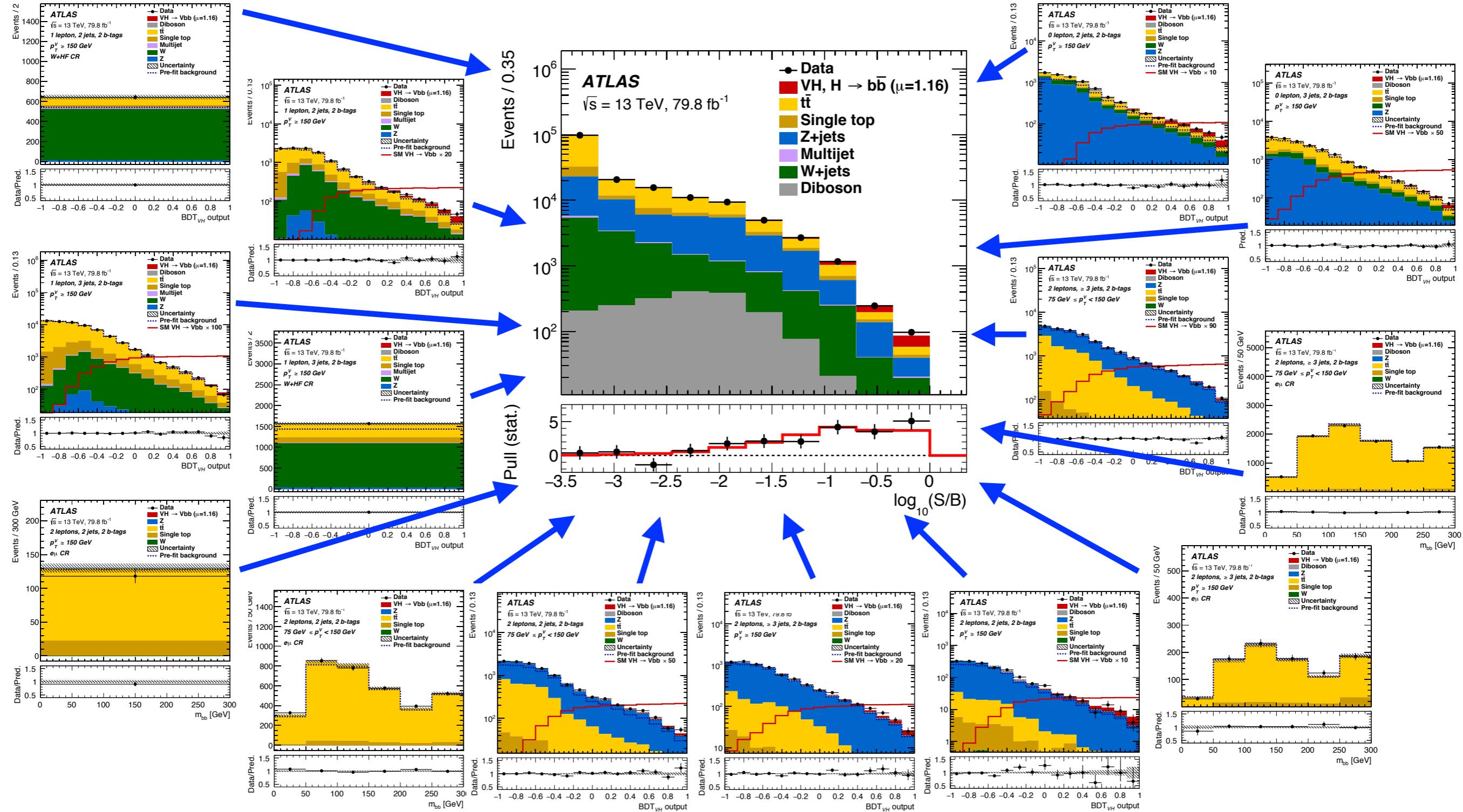
I am involved in various b-tagging activities in VHbb:

- New hybrid b-tagging techniques, statistical tagging, continuous tagging
- Include the b-tagging score in the BDT
- ... but also in the MVA and fitting activities

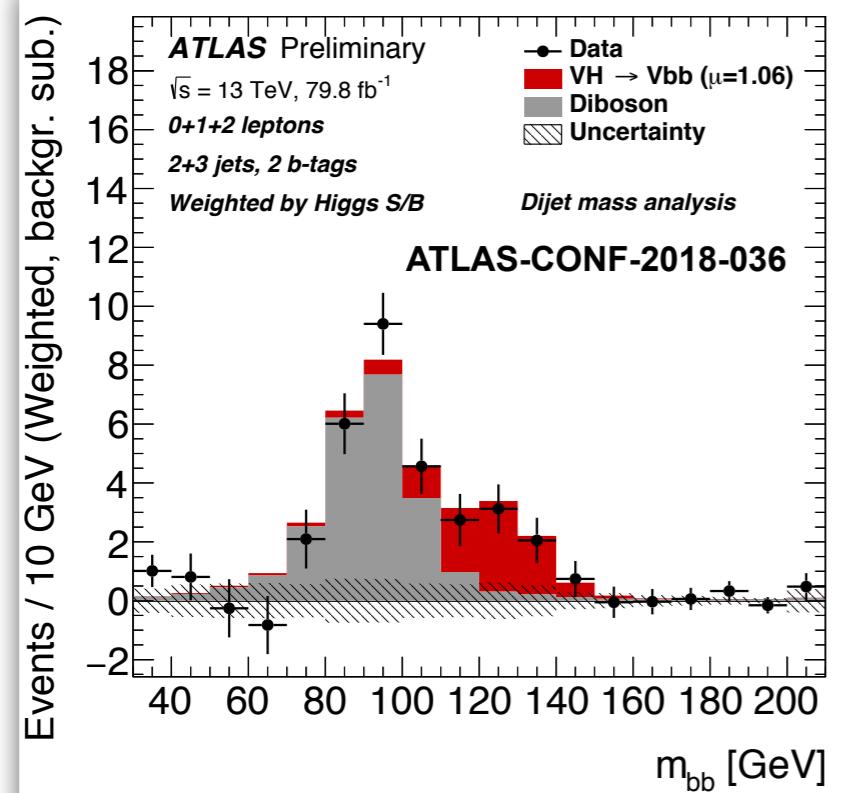
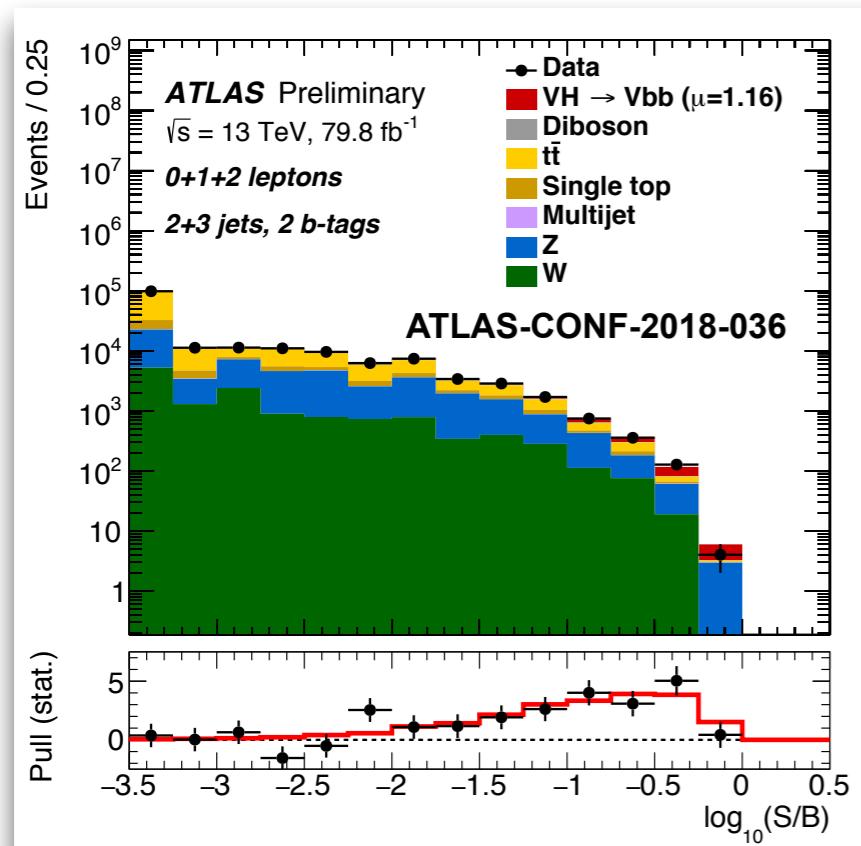


Full picture of the fit:

We do one **BDT** for each category of our analysis (lepton channel and other selections) and we combine them together with a **simultaneous fit**:

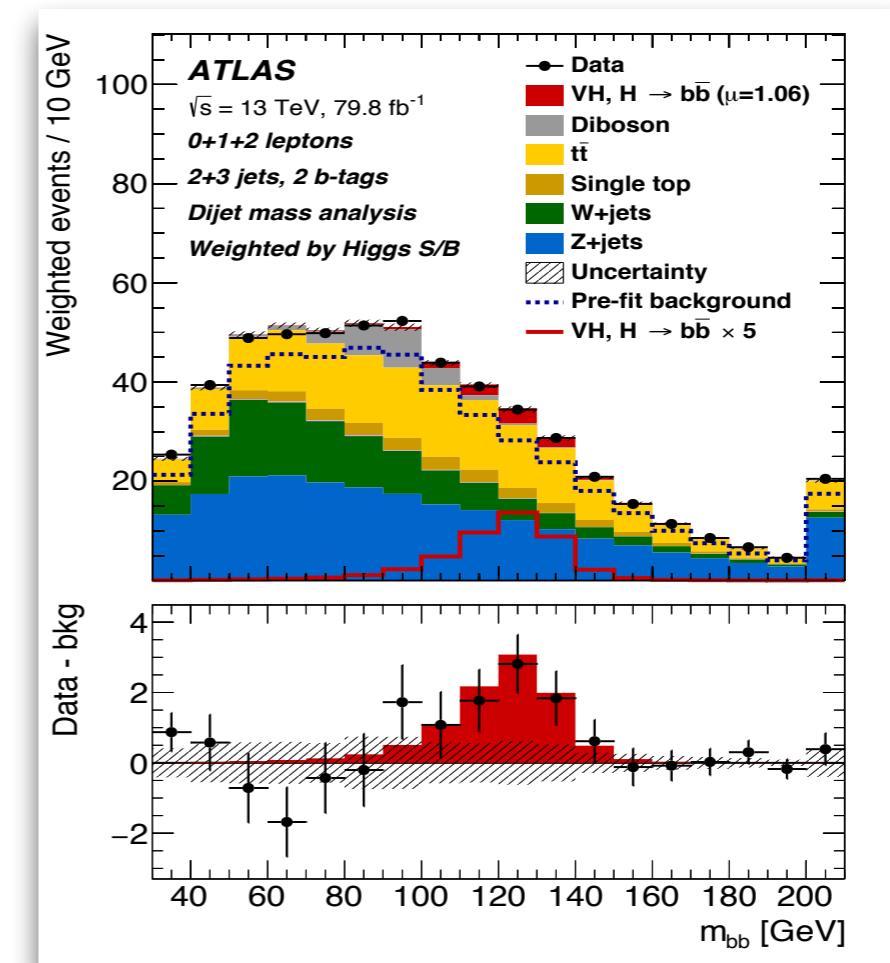


Results:



Many ways to plot the same thing..

The **excess in data (black points)** nicely **follows the expectations** in case of a simulated **Higgs signal (red)!**



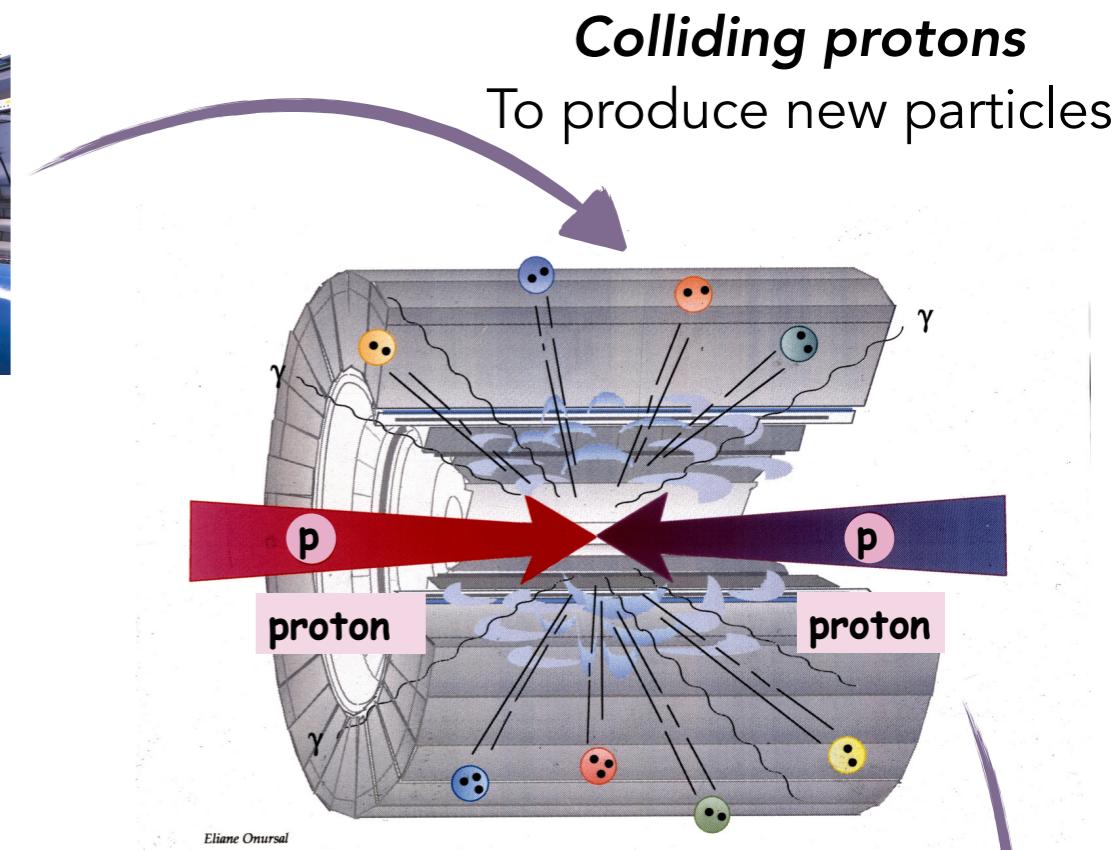
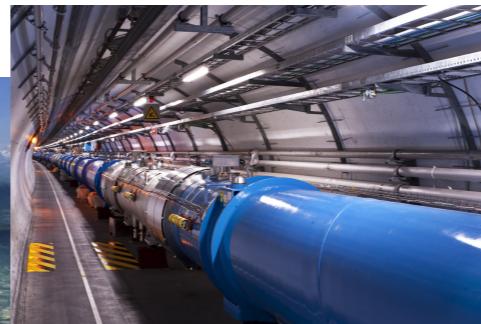
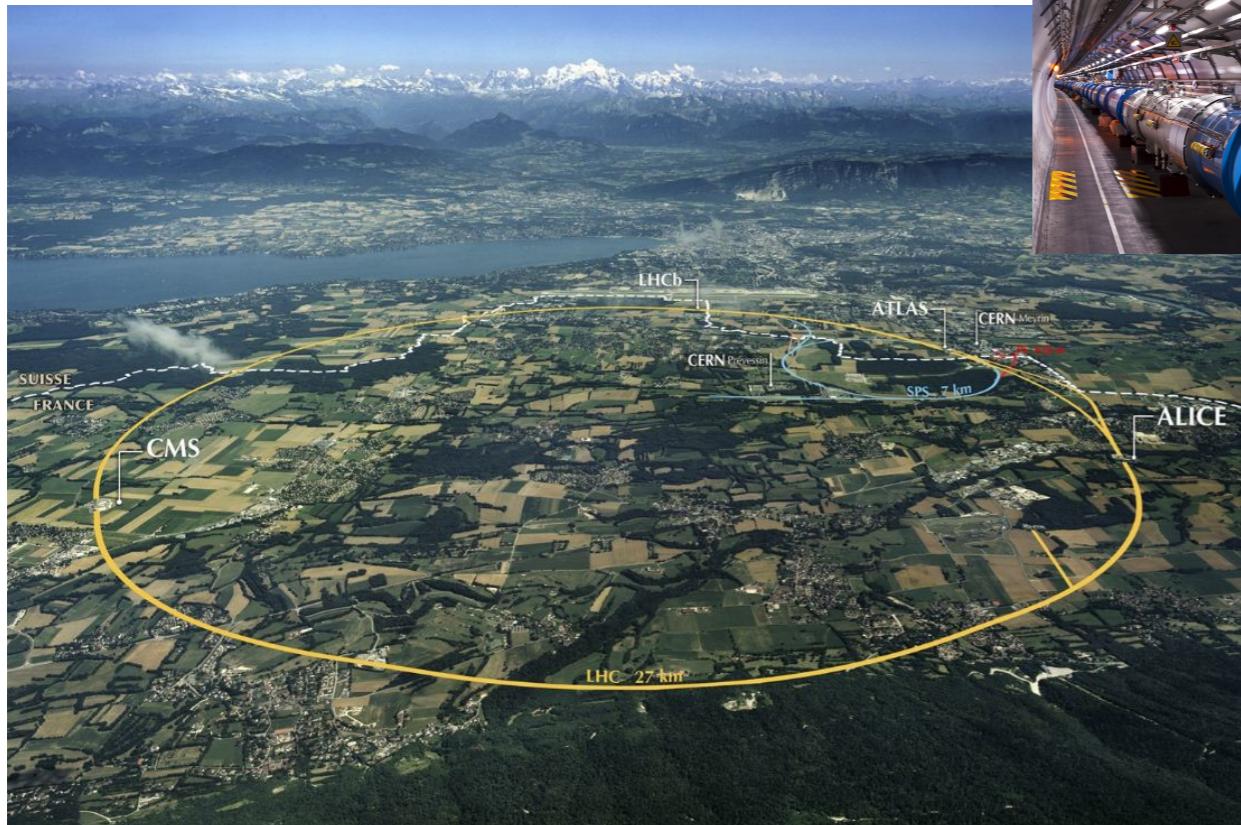
A lot of statistical analysis to understand if this is just due to a statistical fluctuation or not, but in the end..

We can claim the discovery!

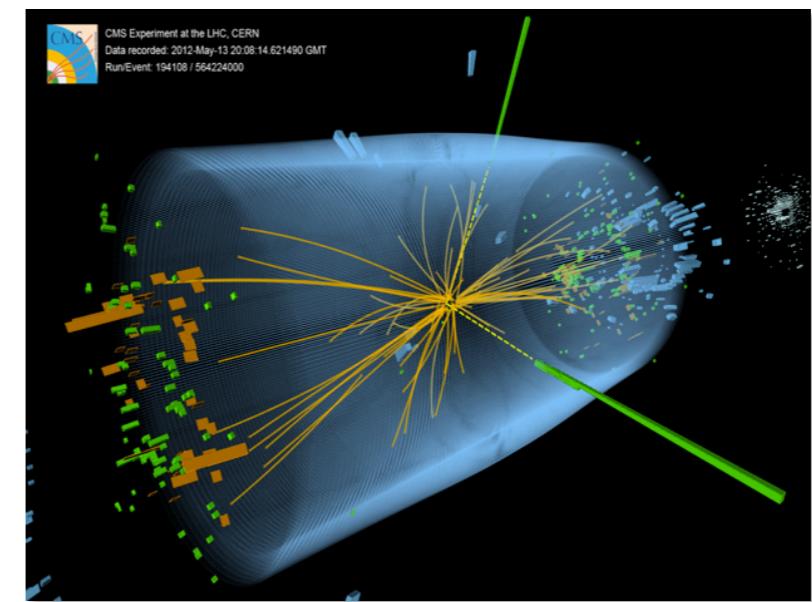
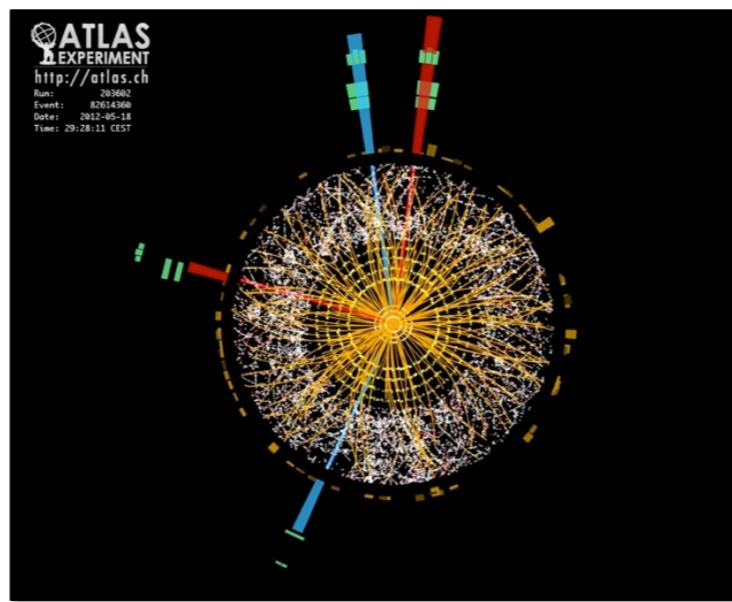
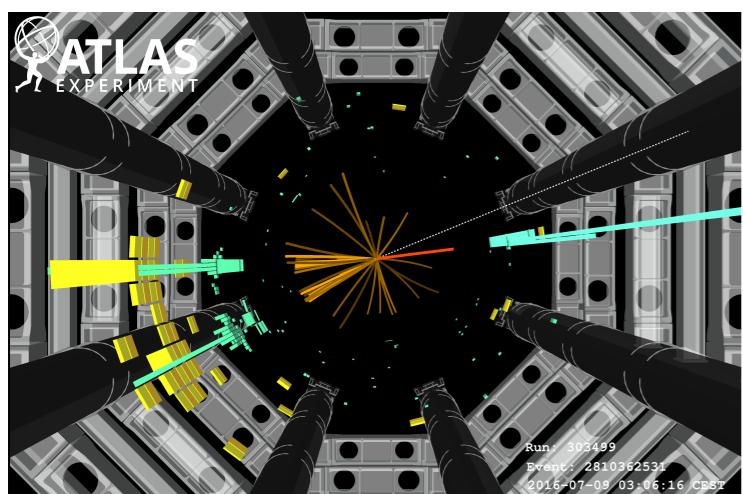
Thanks!

How to produce the Higgs:

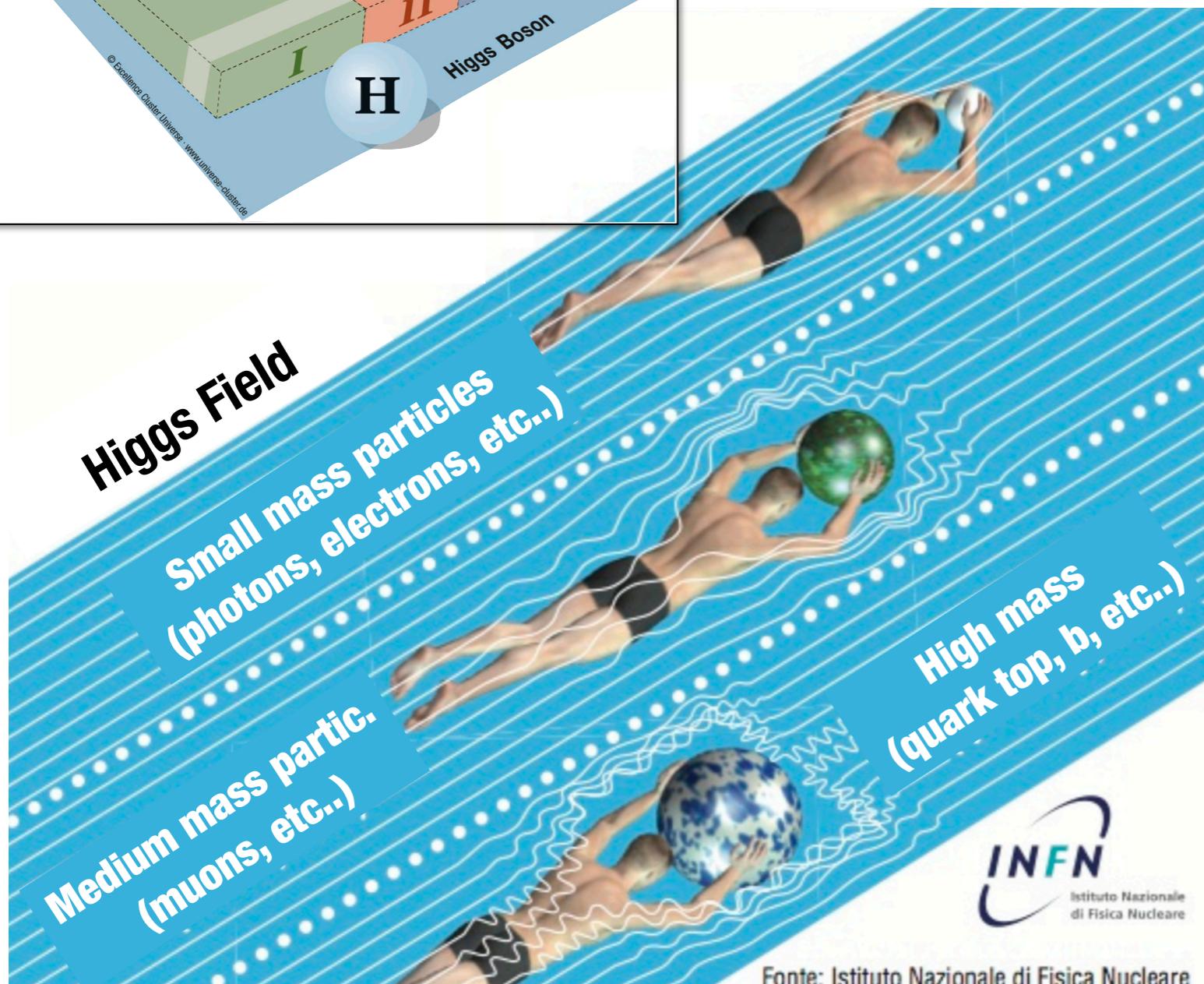
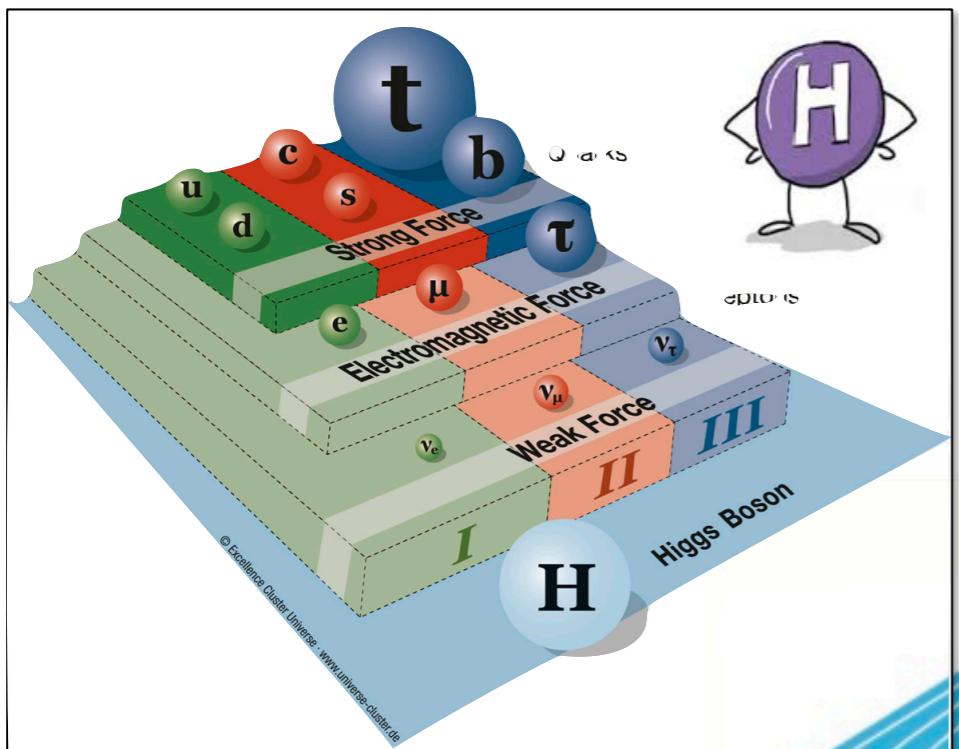
The LHC: 27km accelerator in Geneva



Among them also some Higgs bosons..



What is the mass of a particle?



The mass is defined as the interaction of the particle with the so called Higgs Field. The more a particle is massive, the more it feels a sort of "friction" because of this field. This friction is what we call mass.

Summary:

The Higgs boson is the particle carrying the interaction with the Higgs field

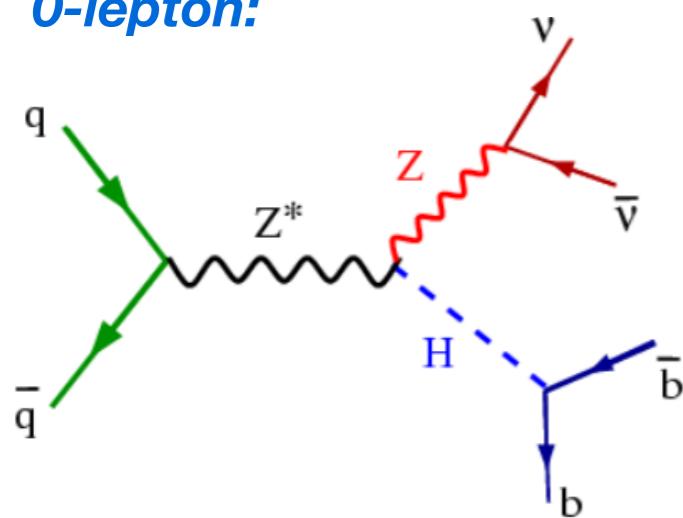
The Higgs has been predicted in the 60's by Peter Higgs

Finding this particle would confirm our understanding of the mechanism

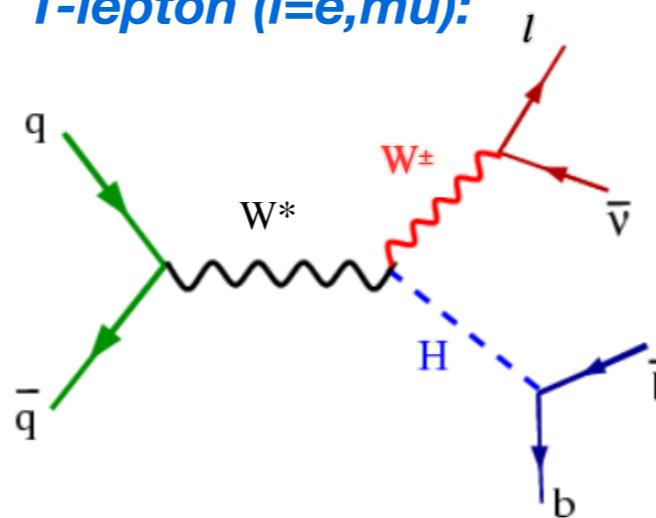
Analysis selection:

Signatures of $VH(H \rightarrow b\bar{b})$ events:

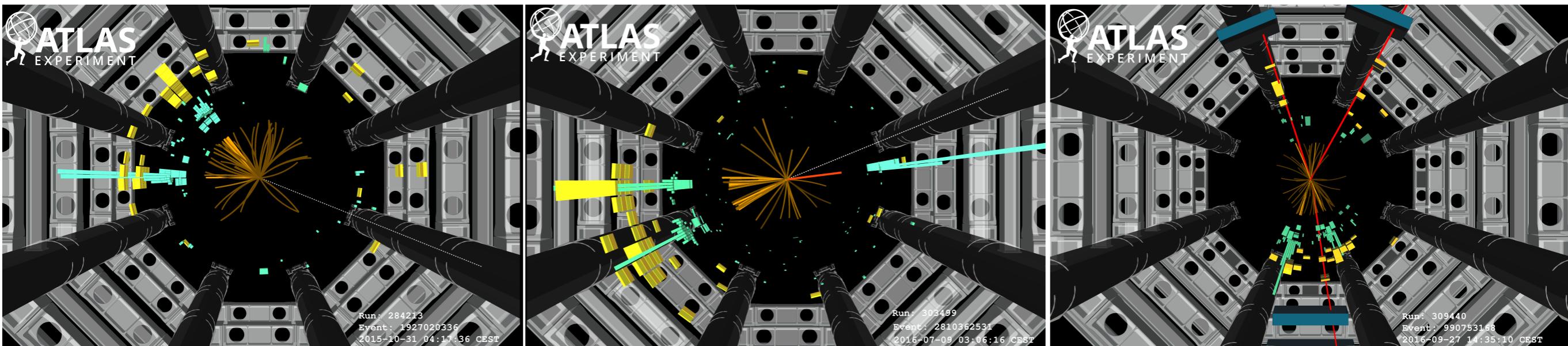
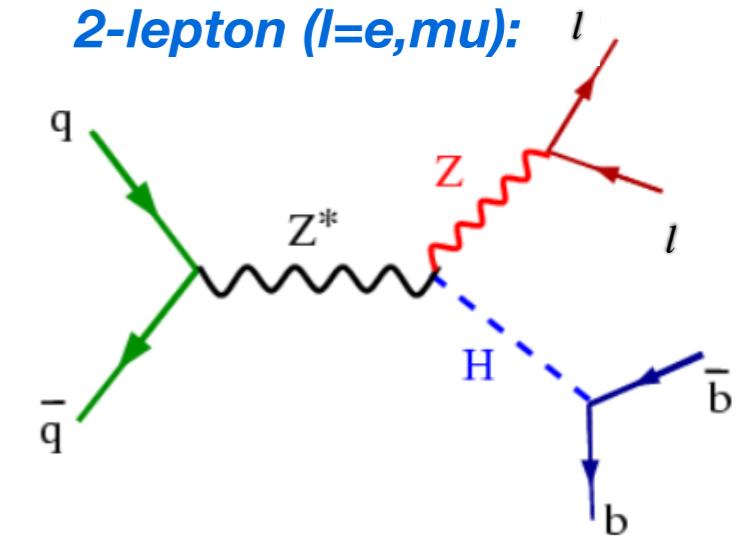
0-lepton:



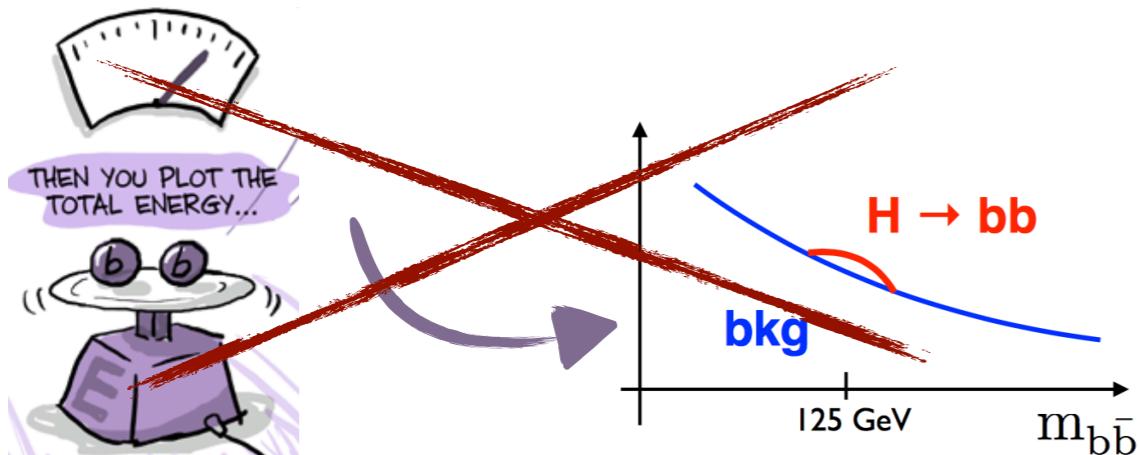
1-lepton ($l=e,\mu$):



2-lepton ($l=e,\mu$):



Use Multivariate Analysis to extract the signal:



Before I said we compute the mass of the final particles and we look for an excess in the mass distribution...
This is not entirely true!

Use Machine learning to combine many kinematic variables and enhance our power to reject the background

The MultiVariate Analysis (MVA):

