Fast Simulators for the LHC:
User Feedback

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CERN
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Who we are

Joint group of theorists and experimentalists of various institutes

What we do

Fit SUSY models (mainly CMSSM & NUHM1) to all kind of measurements:

- g-2
- B physics
- electroweak observables
- astrophysical observables
- Higgs mass limits
- SUSY searches at the LHC

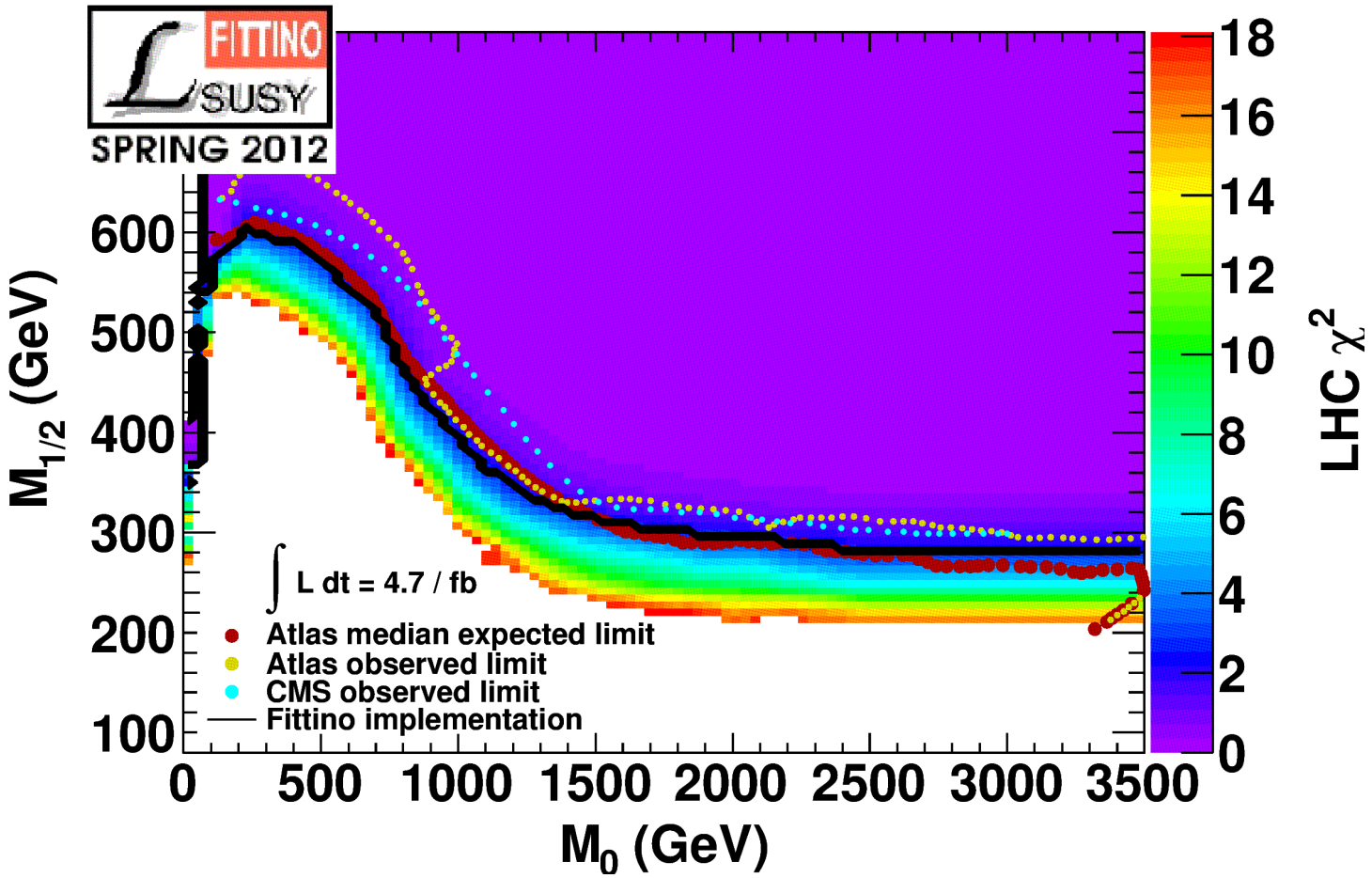
[1] arXiv:1102.4693, Phys. Rev. D84

[2] arXiv:1105.5398, Moriond 2011

[3] arXiv:1204.4199, accepted by JHEP

Why we use a fast detector simulation

1. We want to model the LHC χ^2 contribution correctly over the whole parameter range not only at the very position of the 95% CL exclusion.

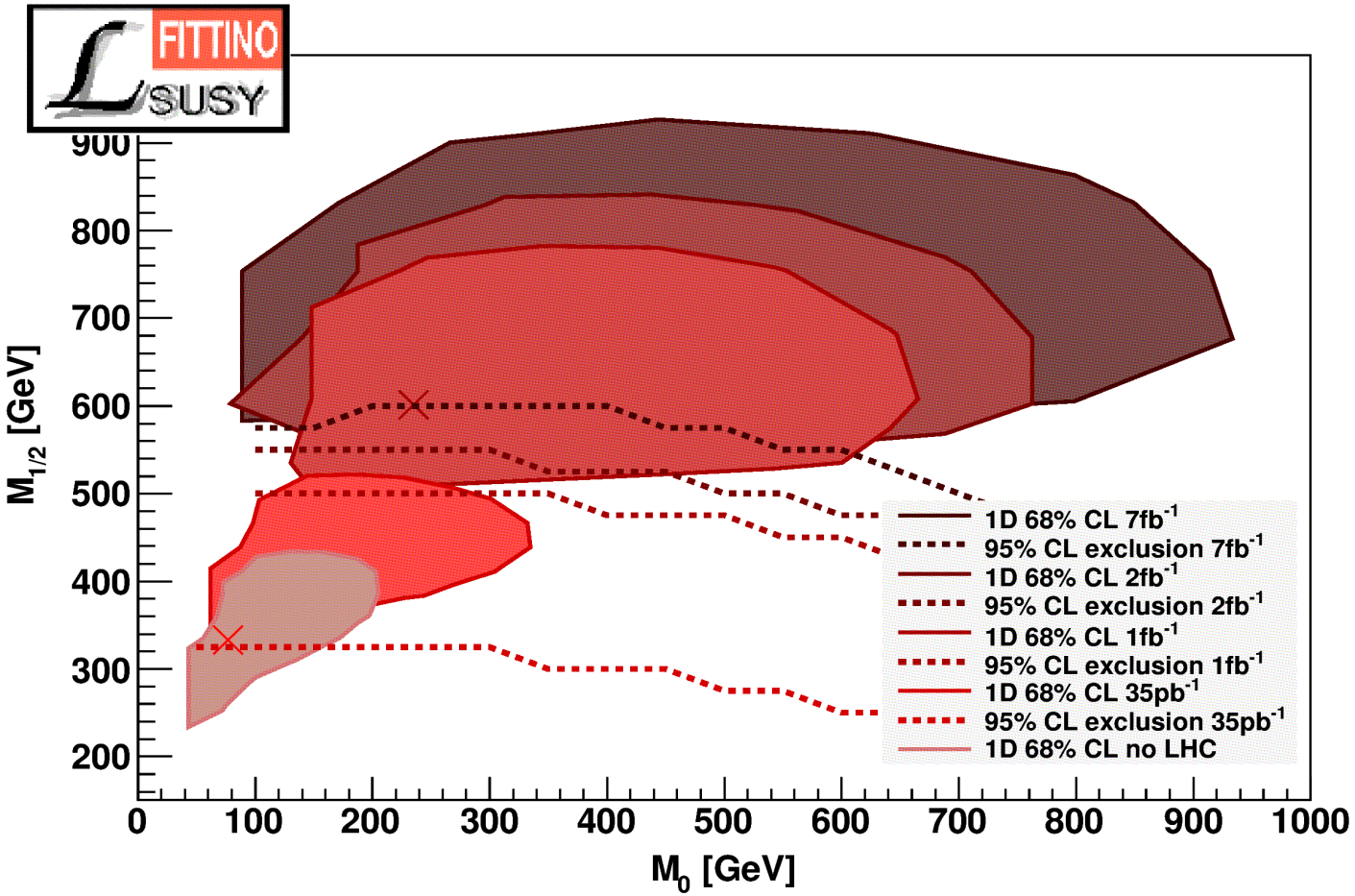


We take background numbers from ATLAS papers,
signal numbers from fast simulation which we use to redo the ATLAS analysis.

2. We want to be able to estimate the impact of possible future measurements.

From April 2011

[1], [2]



3. We want to be free to fit models not studied by ATLAS and CMS.

Use of simplified models could be an alternative.

Fittino's totally subjective Software Review:

How we test:

We look at

usability **I/O** **physics**

and assign  and  according to our

very personal impressions...

Unfortunately can't say anything about other fast simulators - sorry!

Fittino's totally subjective Software Review:

usability

Compiles and runs out of the box. Easy to use. www.hebamme-sommer.de

Fittino's totally subjective Software Review:

I/O

Delphes

Input:

We used **HepMC Event Record** ASCII file output from Herwig++.

N.B.: This might not be the best choice – ASCII files become large and need time to read in.

Had big trouble with mother-daughter relationships and support of new HepMC version – both fixed now.

Output:

As experimentalist happy to get 'flat **ROOT** Ntuple.'

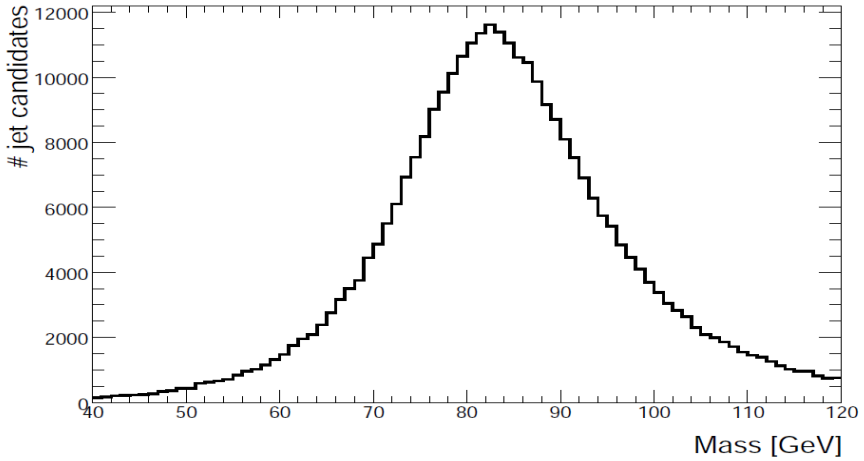
→ Appropriate for data storage.
→ Easy to merge.
→ Benefit from ROOT's analysis functionality.

MC truth information contained in additional TTree.

Fittino's totally subjective Software Review:

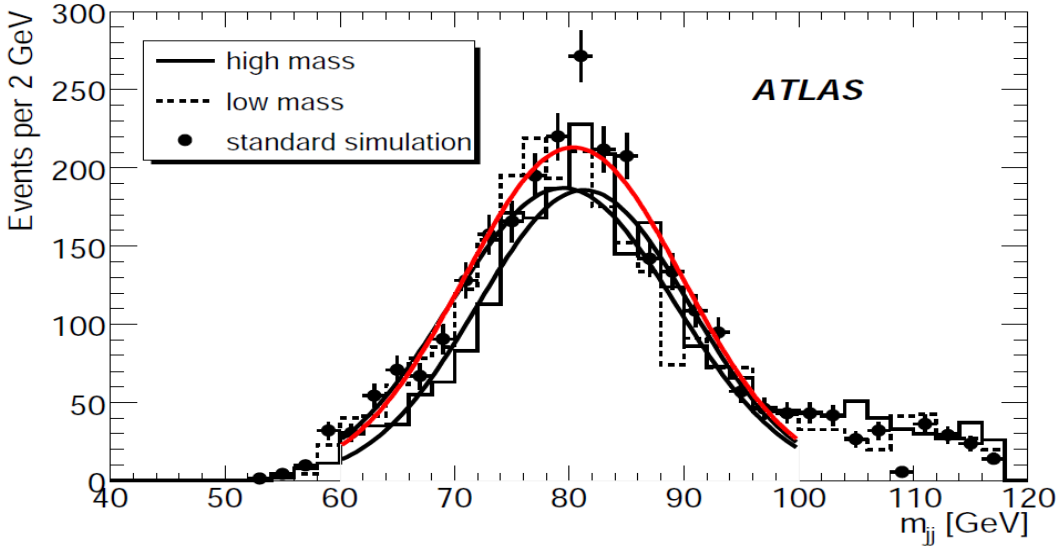
physics

jets



Delphes

(DESY-THESIS-2011-007, B. Gosdzik [4])



ATLAS

(arXiv:0901.0512)

reconstructed invariant mass for W → jj

Fittino's totally subjective Software Review:

physics

leptons:
no smearing of η & φ
100 % ID efficiency within detector & above p_T threshold
no fakes

But:

well documented:
what is done and also what is not done

possible to extend:
given the information in the Delphes root file things like that can easily be added in an 'afterburner' (if known from the experiments)

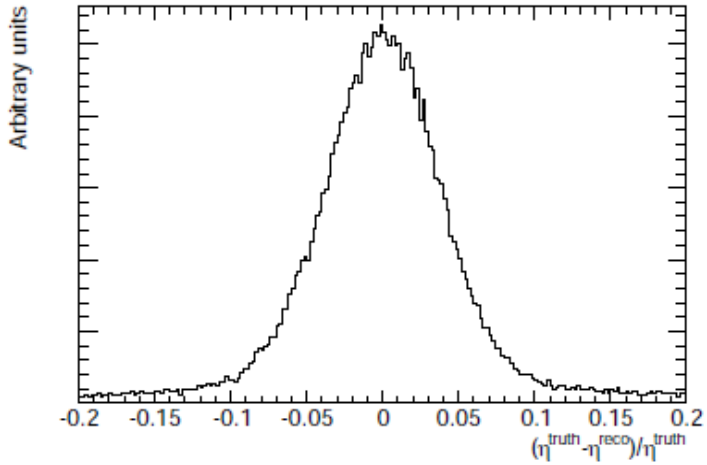
Fittino's totally subjective Software Review:

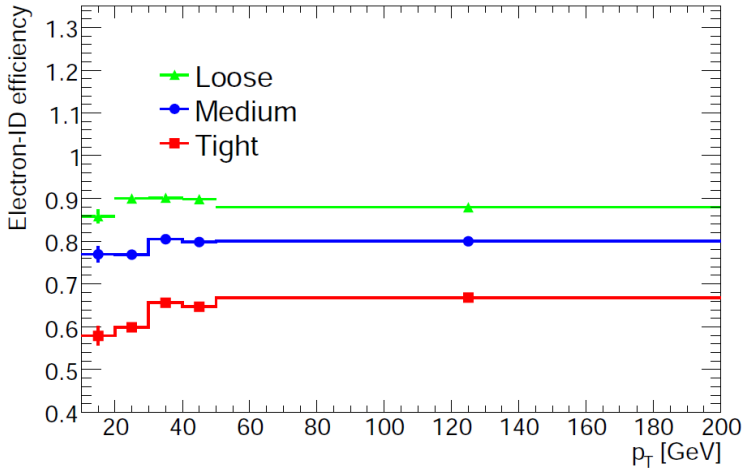
physics

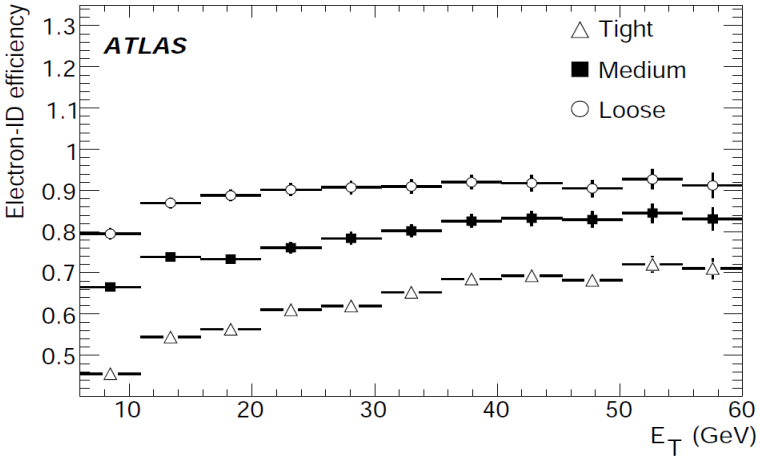
Delphes

Extensions of lepton reco simulation [4]:

- Add MC pions as fakes
- Smear η & φ depending on p_T
- Set p_T depending ID flags



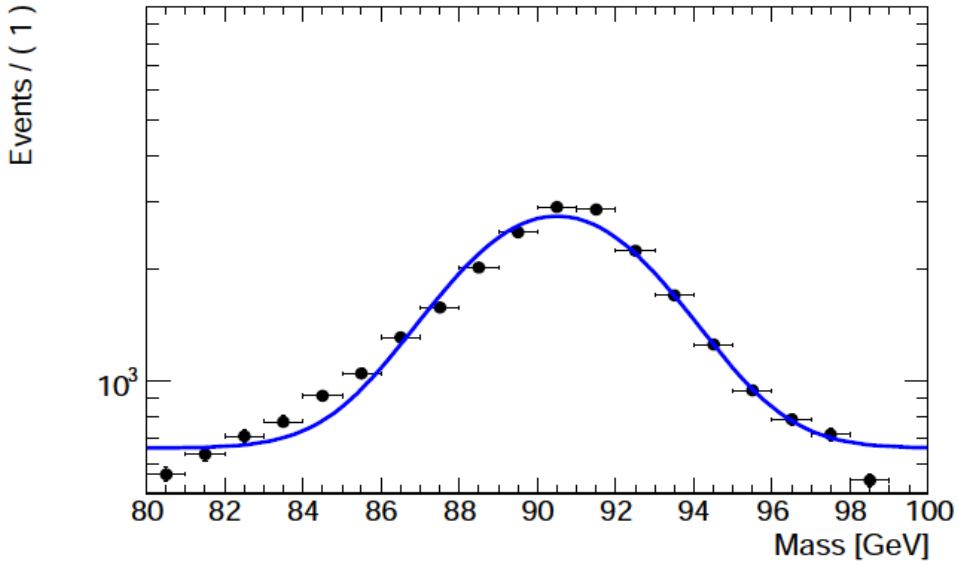




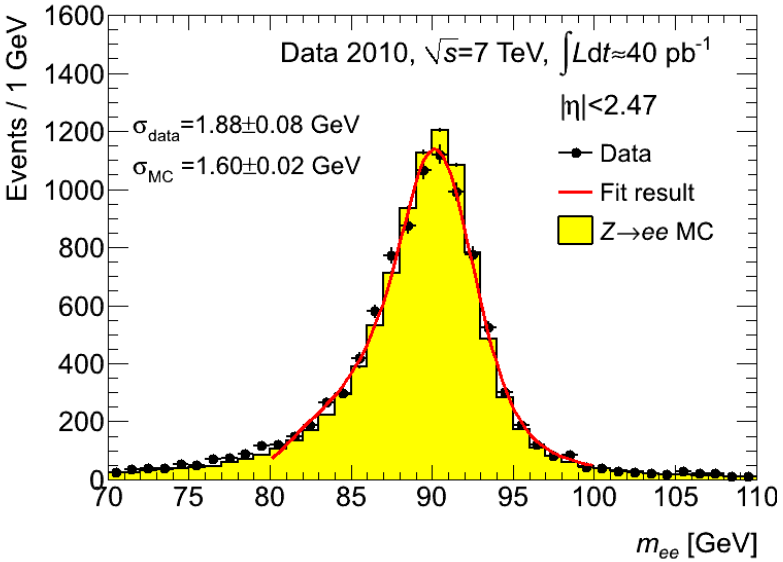
Fittino's totally subjective Software Review:

physics

Validation of lepton settings:



Delphes [4]



ATLAS

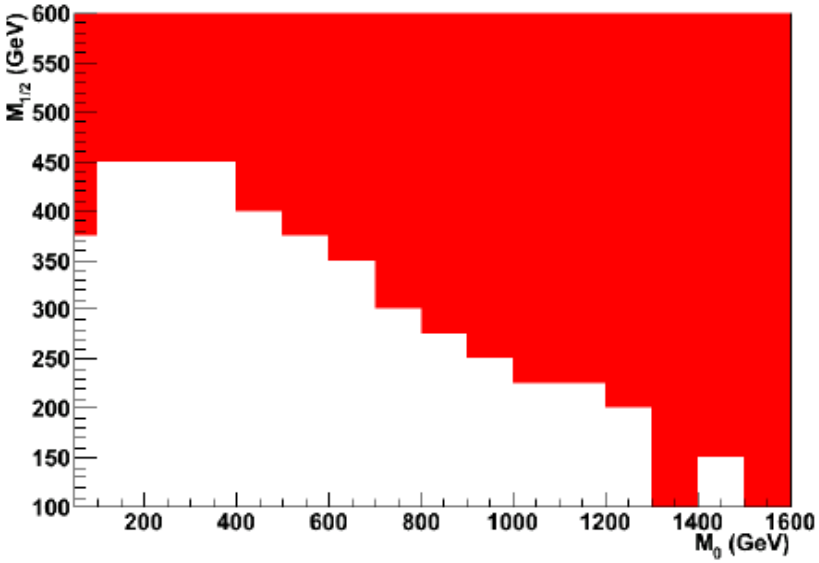
(ATL-COM-PHYS-2011-1637)

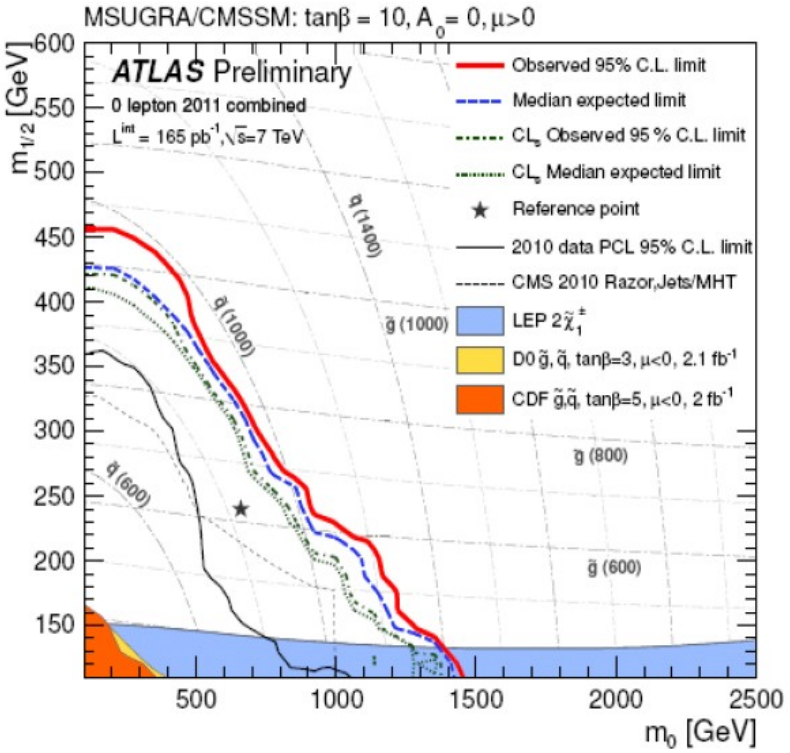
reconstructed invariant mass for Z → ee

Fittino's totally subjective Software Review:

physics

With these settings we reproduce ATLAS results out of the box:





verdict

Delphes proofs the power of having a public fast detector simulation.

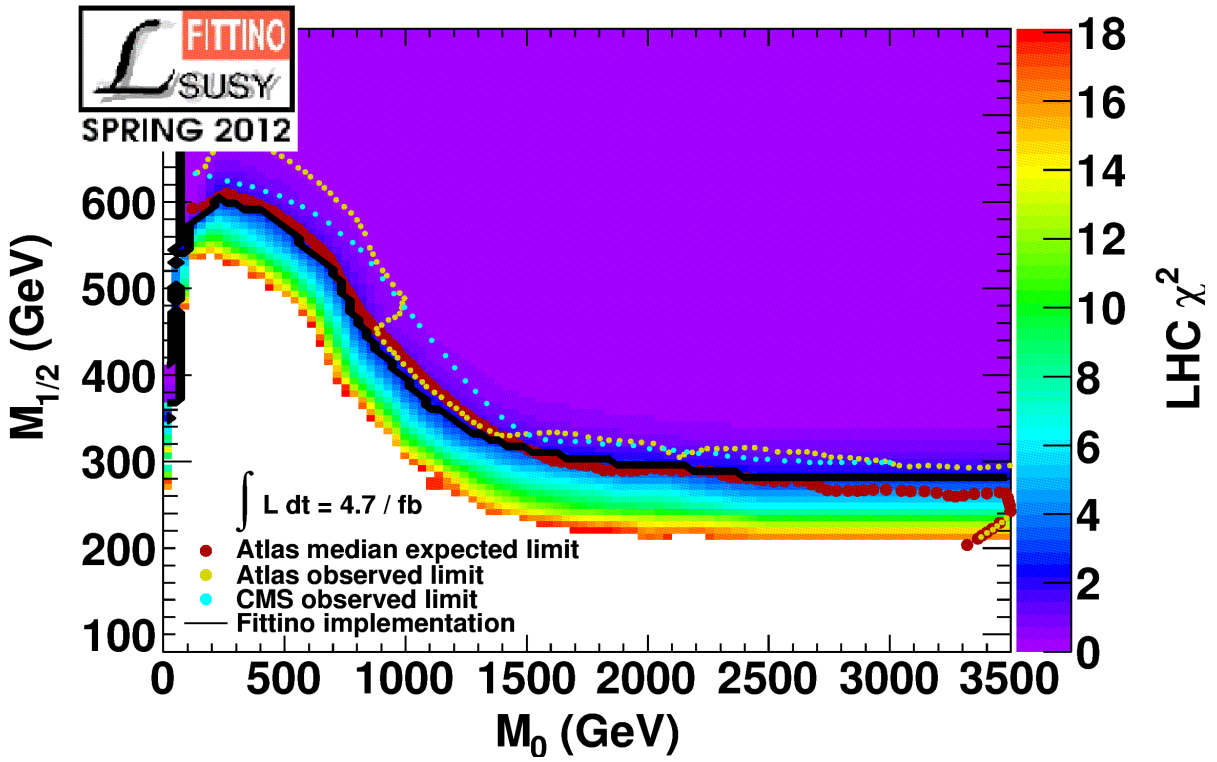
But: Even having a perfect fast simulator might not be enough.

The Analyses become more and more complex and maybe impossible to redo outside the experiments with a fast simulator.

E.g. the latest ATLAS 0 lepton search is using 11 SR,
55 CR and a profile likelihood technique to control background systematics.

In [3] we dealt with that by taking the 165pb-1 analysis,
reducing systematics and increasing efficiencies.

With these technique we are able to describe exclusion of the 5fb-1 Analysis within 1 σ.



Thank you for your attention!