Exploring the lifetime frontier with ATLAS

The first 15 minutes

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Science coffee, virtual Lund
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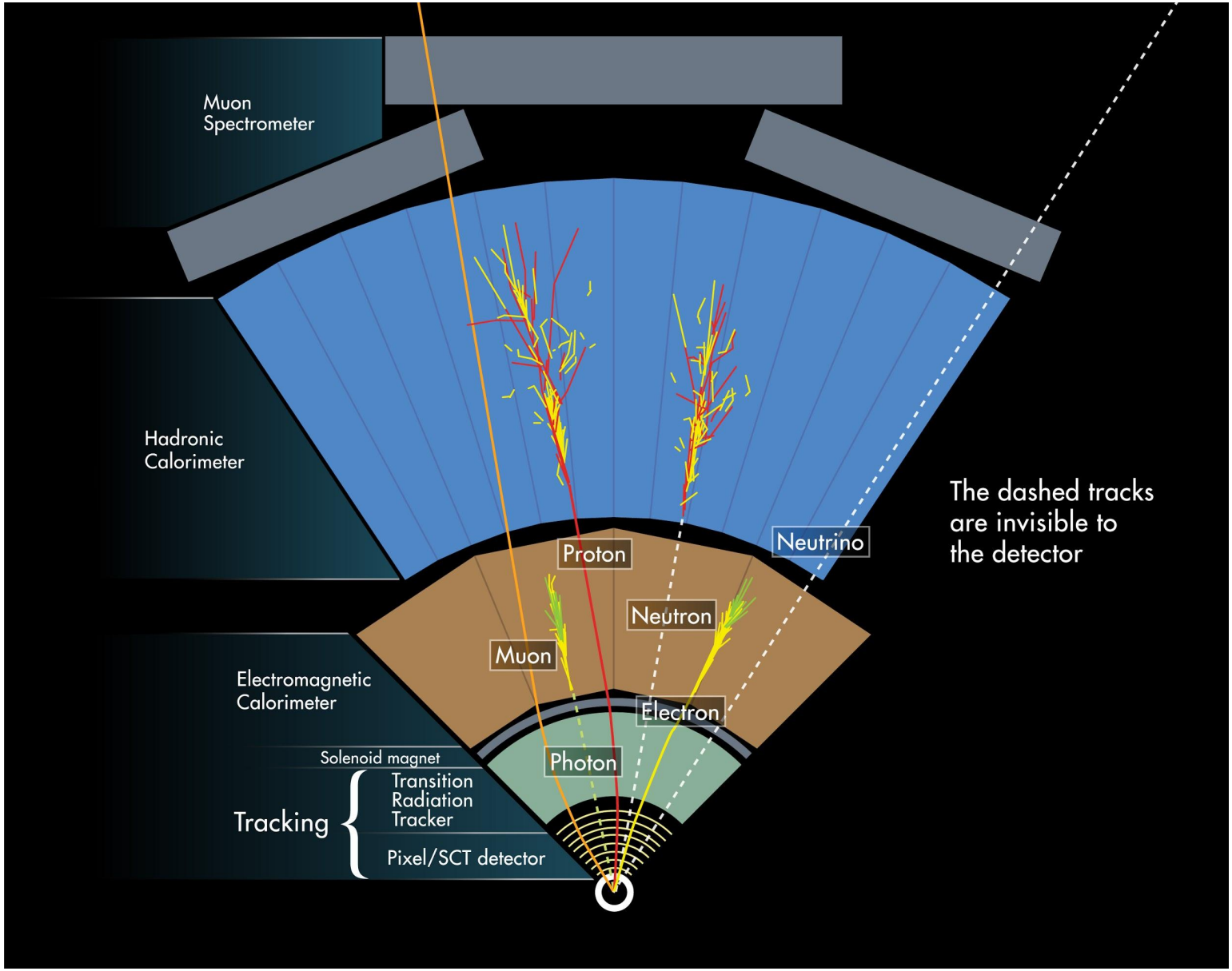
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

How do we detect particles



The missing transverse momentum

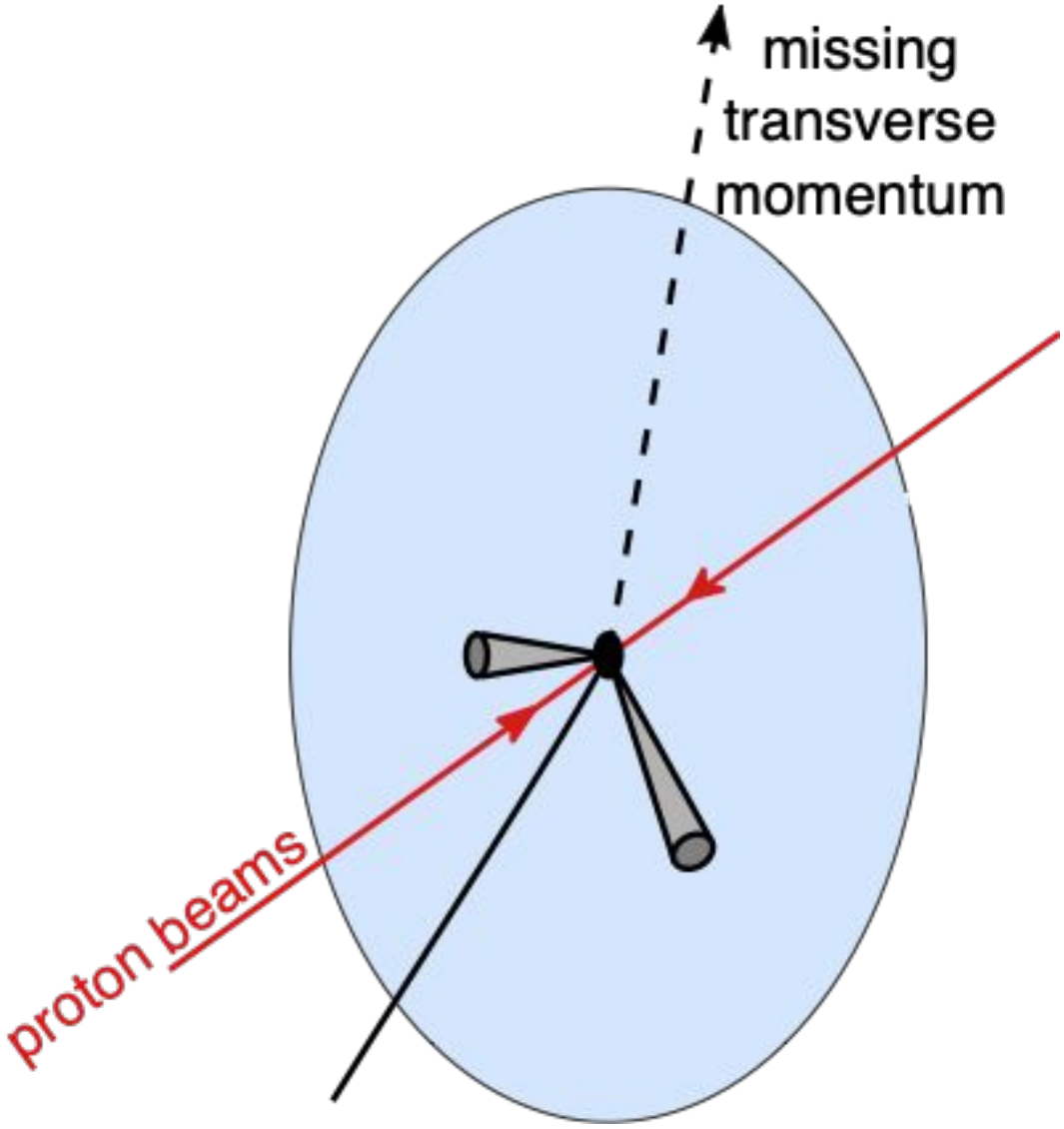


Image credit: C. Merlassino

Unstable particles

The probability that a particle survives for a given time before decaying follows an exponential distribution

$$P(t) = e^{-t/(\gamma\tau)}$$

Where:

- τ is the lifetime of the particle (at rest)
- ɣ is the Lorentz factor

A particle's lifetime and width are related:

$$\Gamma\tau = \hbar$$

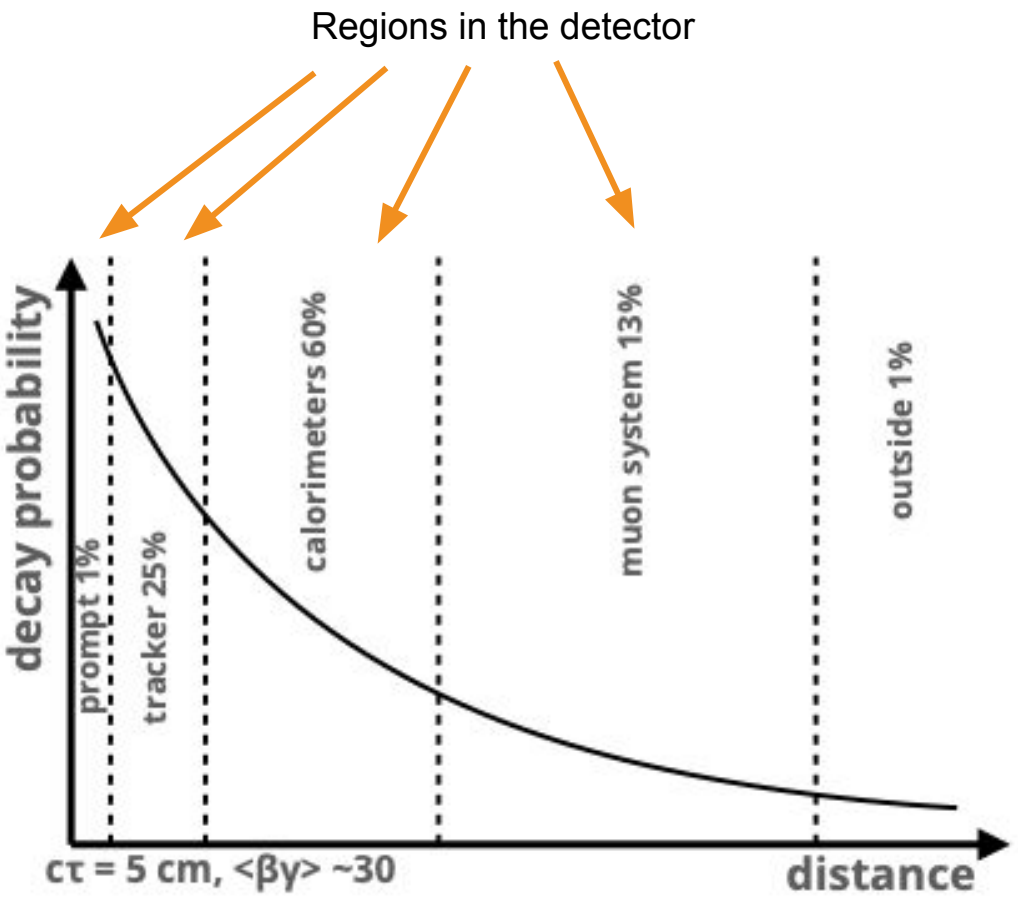
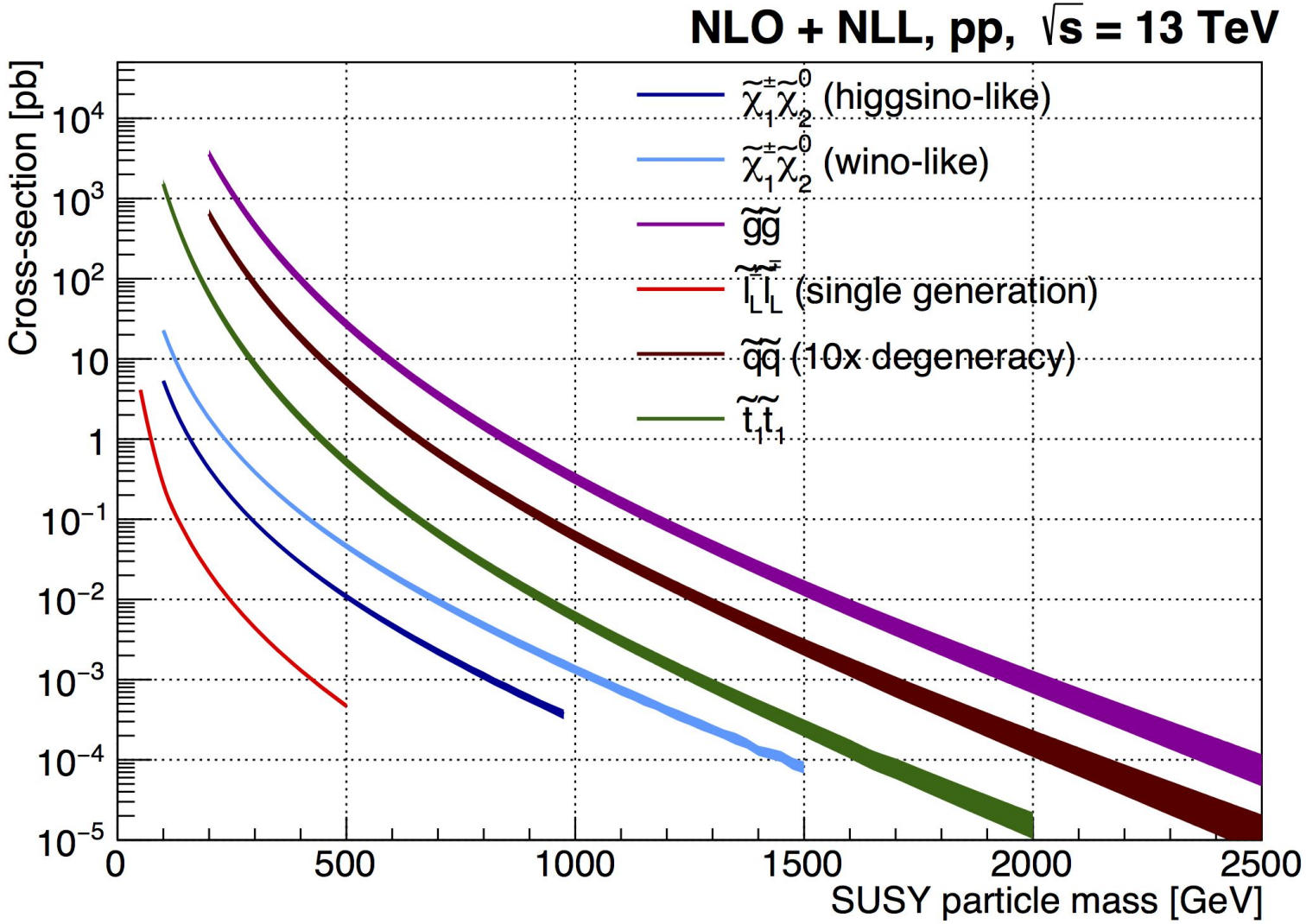


Image credit: S. Mehlhase

Cross sections

Producing heavy particles is exponentially hard



https://twiki.cern.ch/twiki/bin/view/LHCPhysics/SUSYCrossSections

Supersymmetry

The MSSM particle content

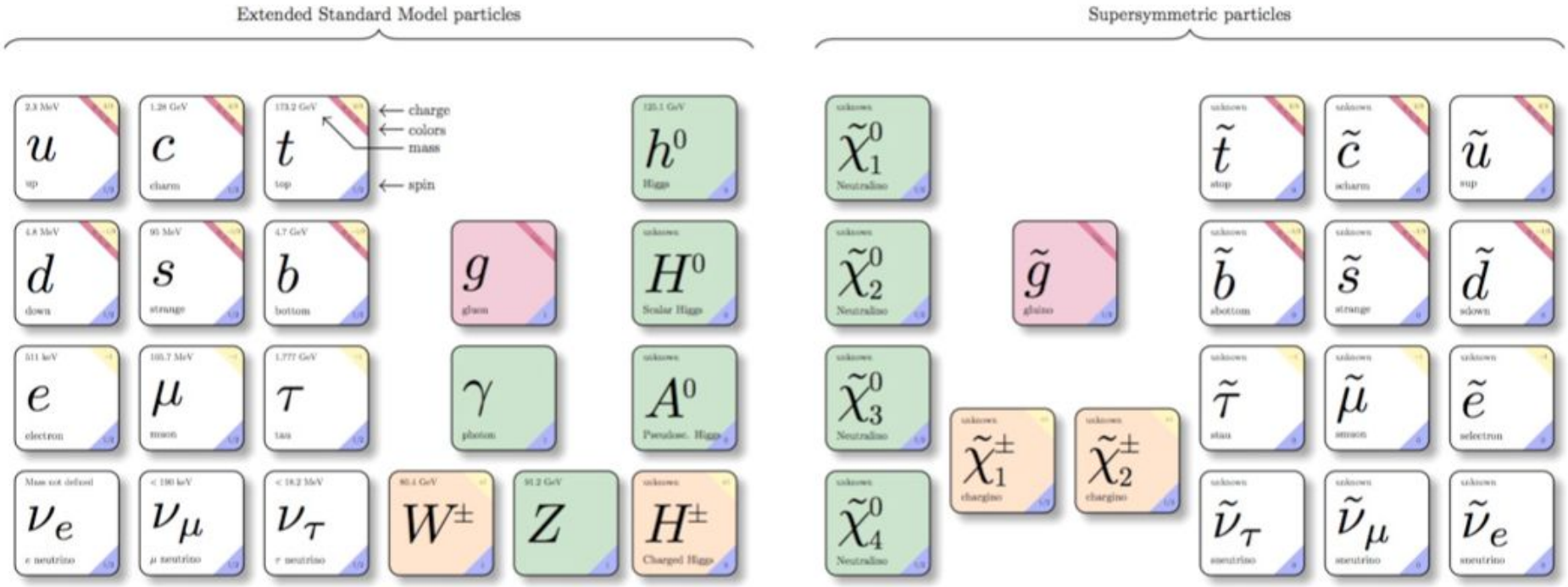
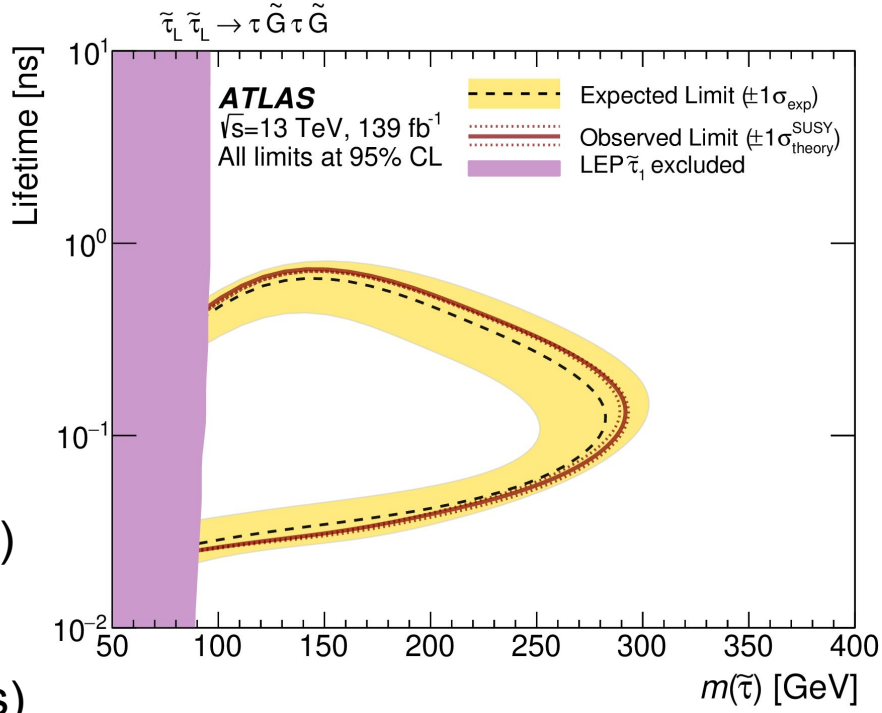


Image credit: M. Rimoldi

How to read 2D exclusion plots

A typical 2D exclusion plot

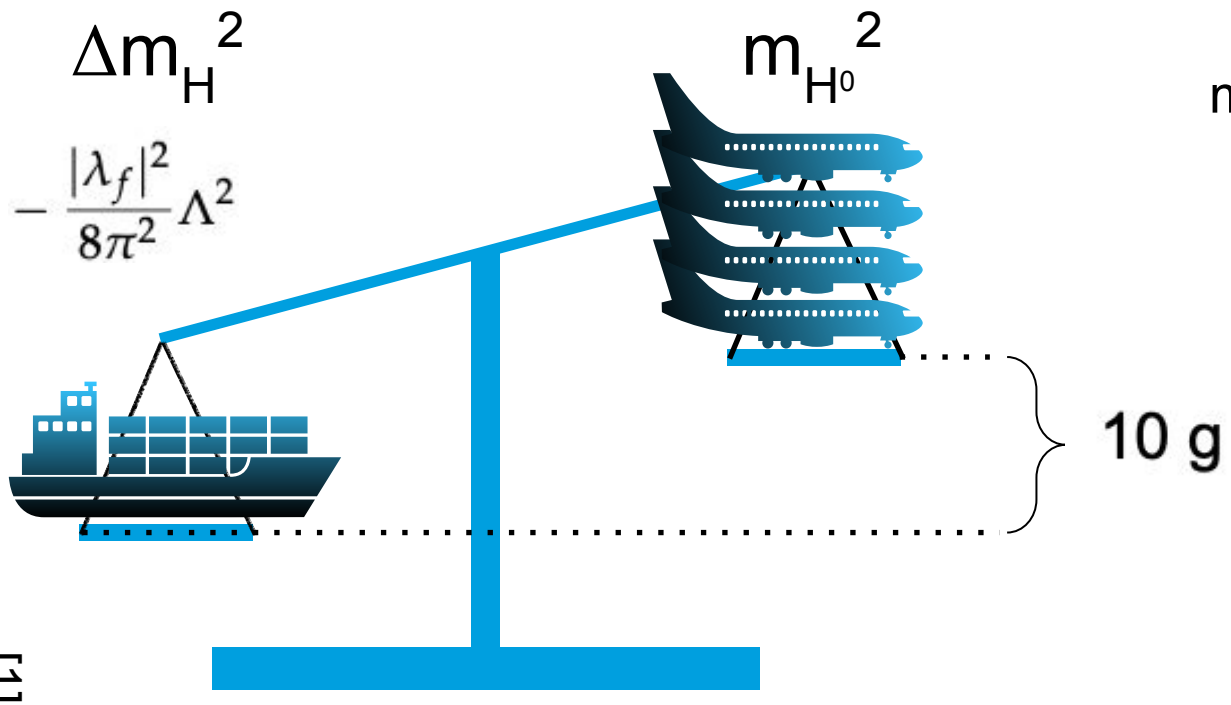
- The two axes represent two key parameters of the model sparticle masses
- Here, for every choice of parameters find the upper limit on the signal strength.
- The lines and bands show the contours of μ = 1 (or CLs = 0.05)
- The dashed curve is the median μ_{up}=1, with the yellow bands giving the ± 1σ regions (for SM uncertainties)
- Dashed red lines are the ± 1σ regions (for signal theory uncertainties)



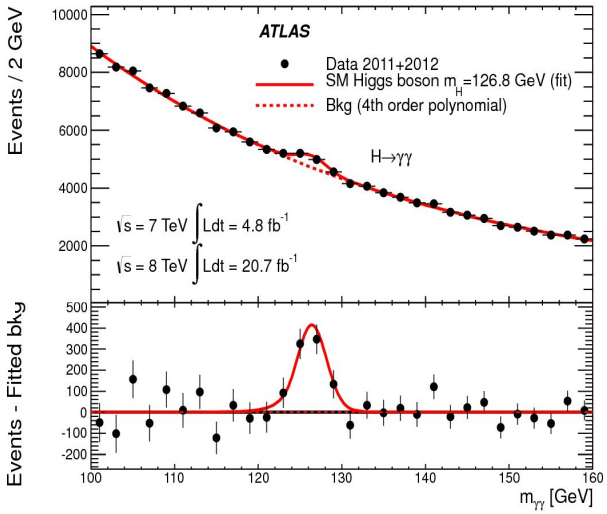
Extras

Hierarchy problem

Just a human bias?



m_H=124.97±0.24 GeV [1]



Similarly hard to believe!

[1] 1806.00242