

Global fit of BSM with CEPC using GAMBIT

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Our Plan

✓ Build the CEPC likelihood in GAMBIT

- Using present experimental central values

✓ Postprocess the published CMSSM / NUMH1 / NUHM2 / MSSM global results

- Experimental constraints in latest GAMBIT
- CEPC proposed results

✓ Analysis the results

▸ People: Peter Athron, Csaba Balazs, Andrew Fowlie, Wei Su, Yang Zhang **from GAMBIT**

Liangliang Su, Lei Wu **from Nanjing Normal University**

Working on this!

Besides the constraints, the calculation of observations are also improved.

Global fits

What? Why? How?

Using slides from

Investigating supersymmetry with GAMBIT

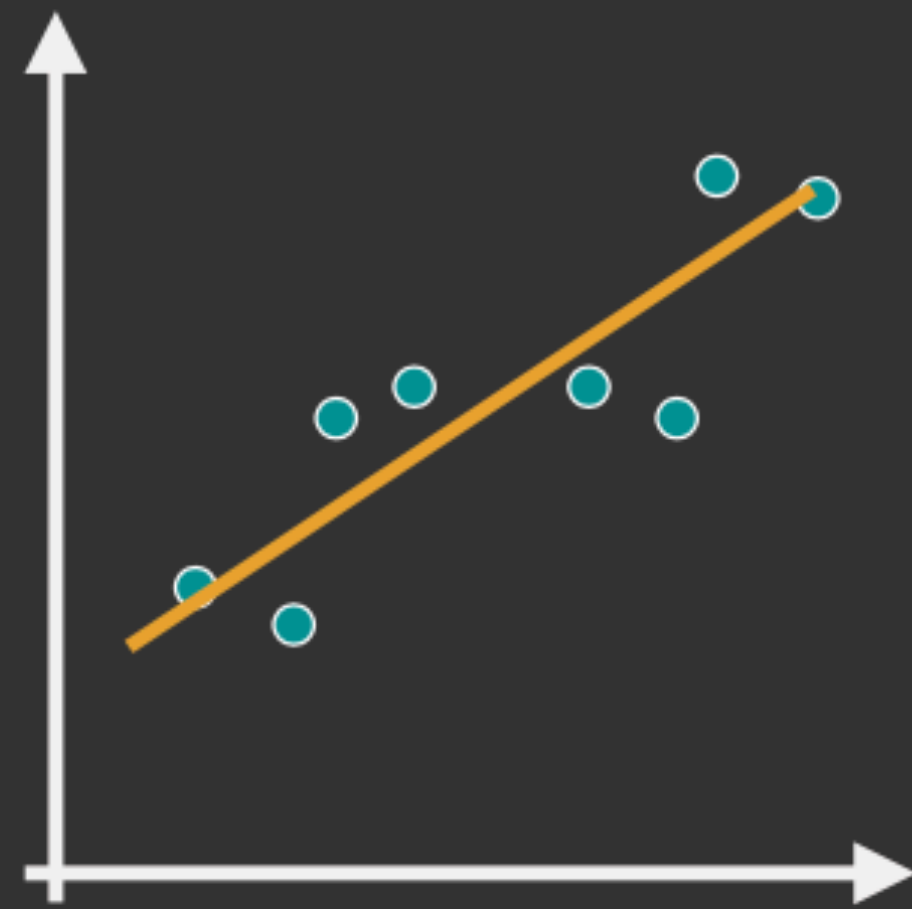
Anders Kvellestad, Imperial College London
on behalf of the GAMBIT Collaboration

PRACEdays 2019, May 14 2019, Poznan

Imperial College
London

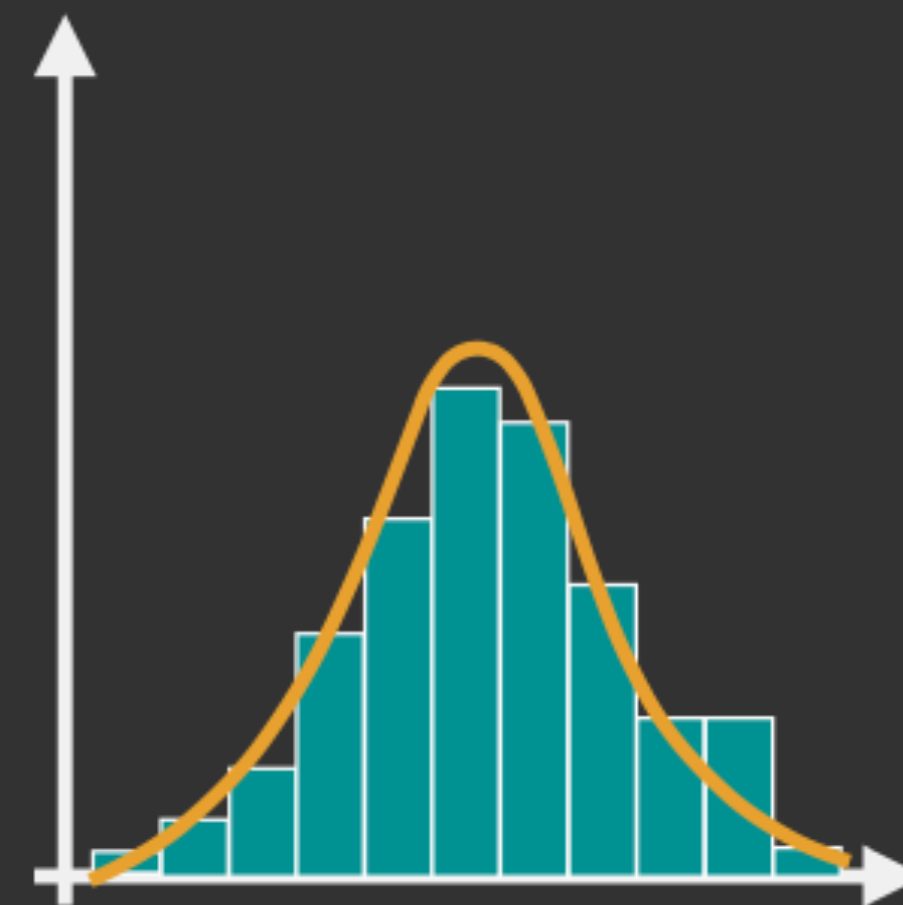


Statistical fits

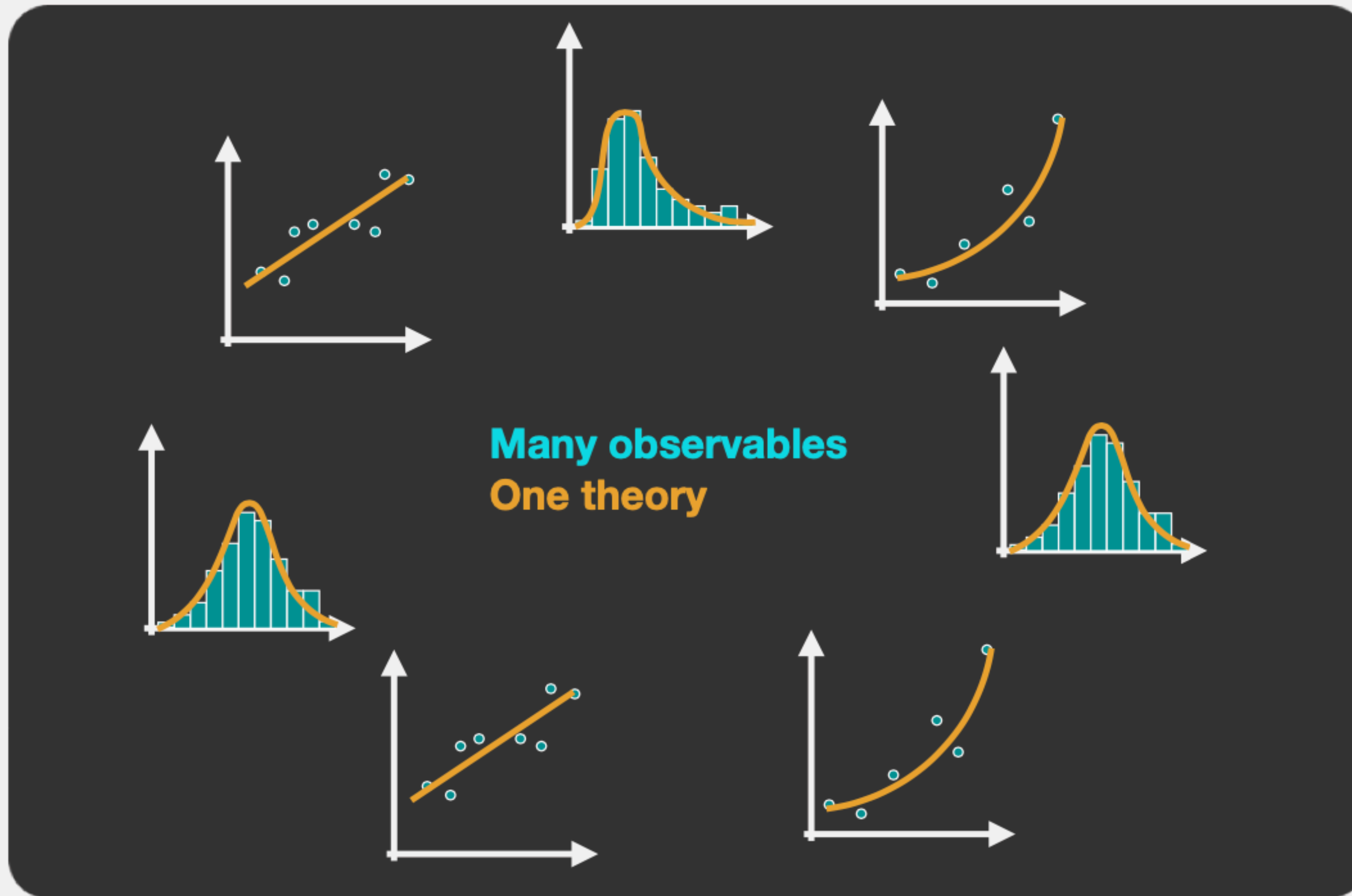


Some observable
Some model

Some other observable
Some other model

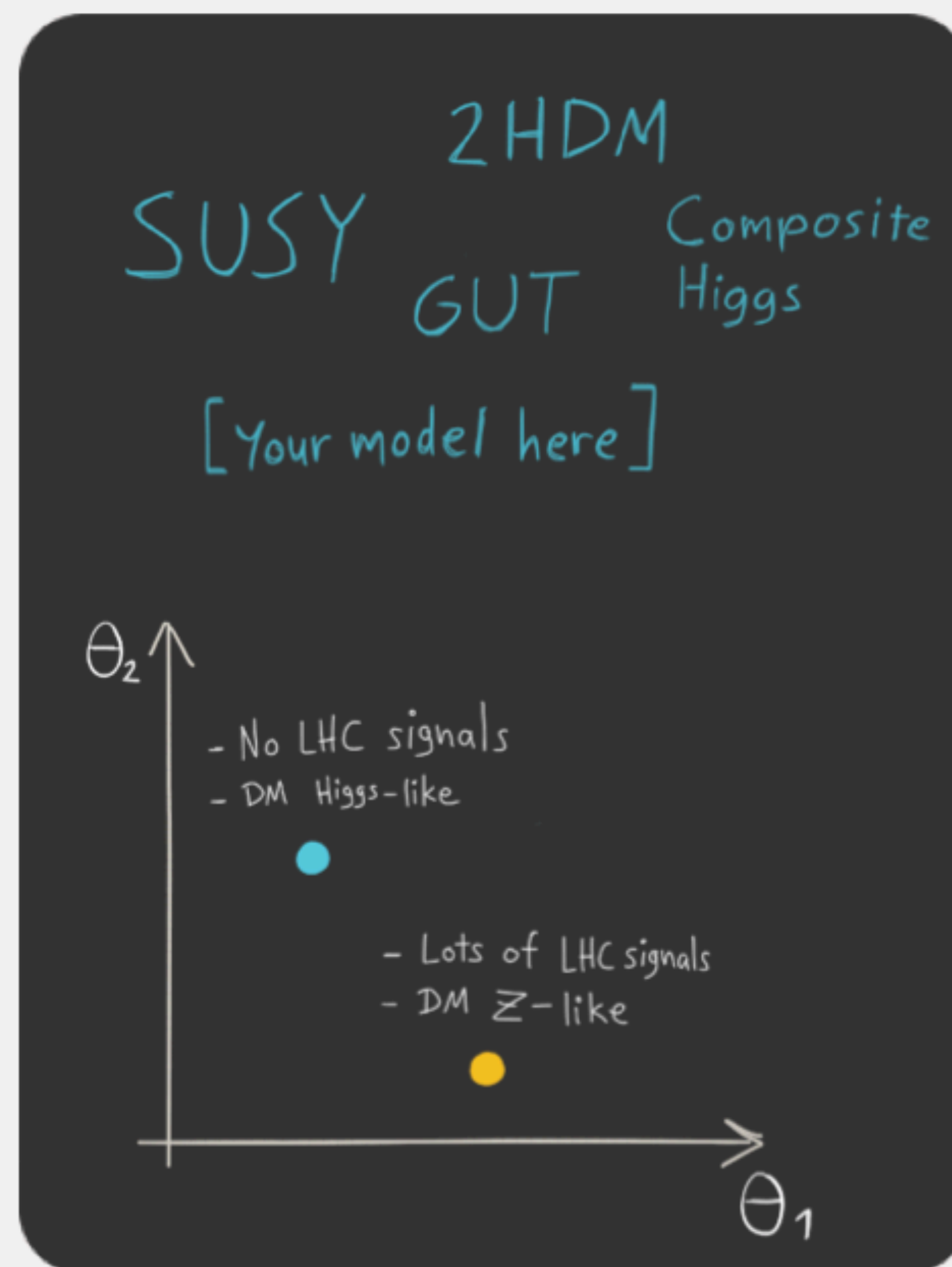


Global fits



Comparing new theories to data

- Lots of theories for physics beyond the Standard Model
- For each theory, a parameter space of varying phenomenology
- Many different experiments can constrain each theory



Only a couple of parameters:

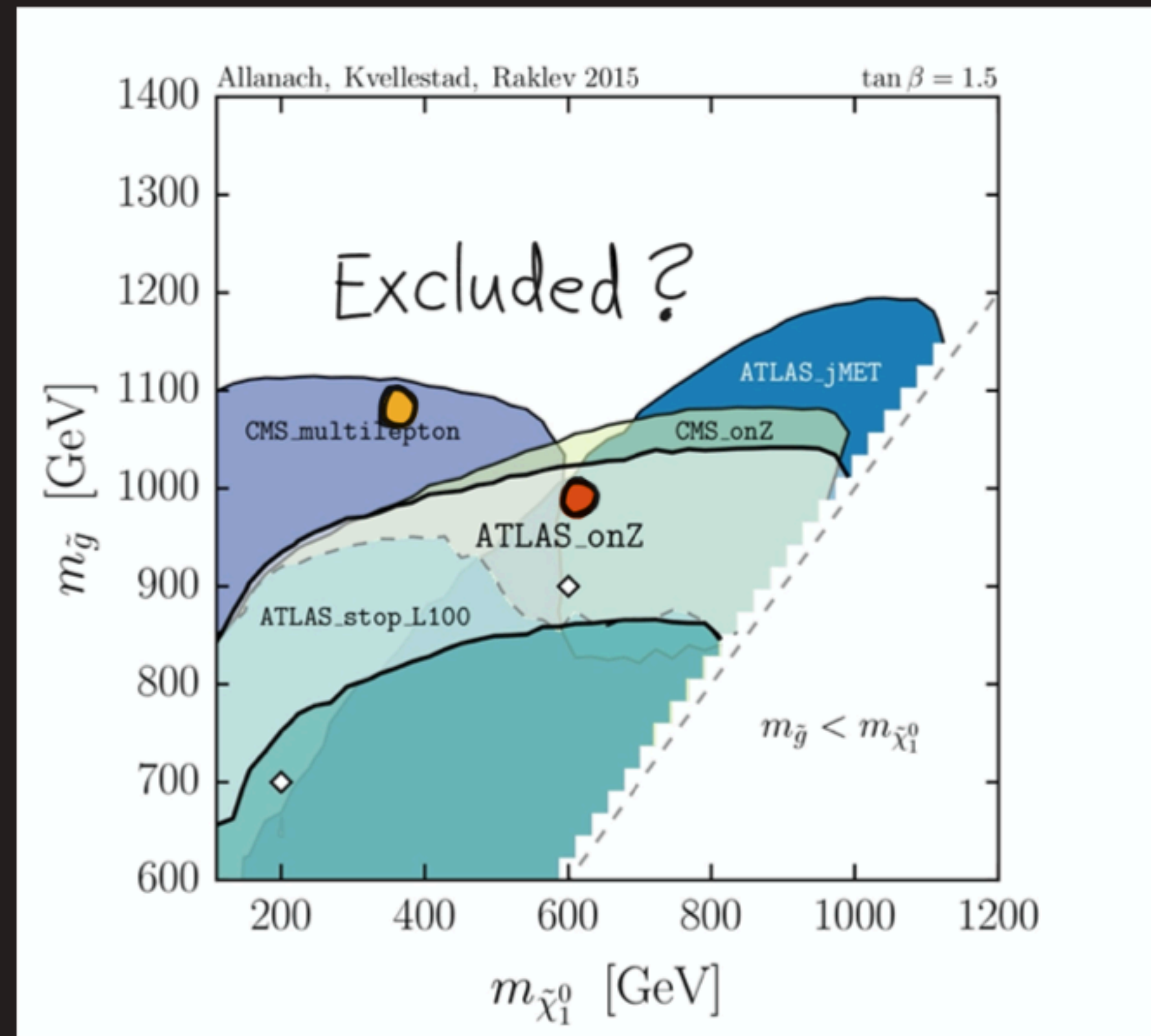
Compare preferred/excluded regions for different analyses

+ Simple to understand
(at a qualitative level)

÷ Per-point interpretation
is not straightforward

÷ Gets worse with
increasing number of
experimental analyses

Allanach, Kvellestad, Raklev: 1504.02752



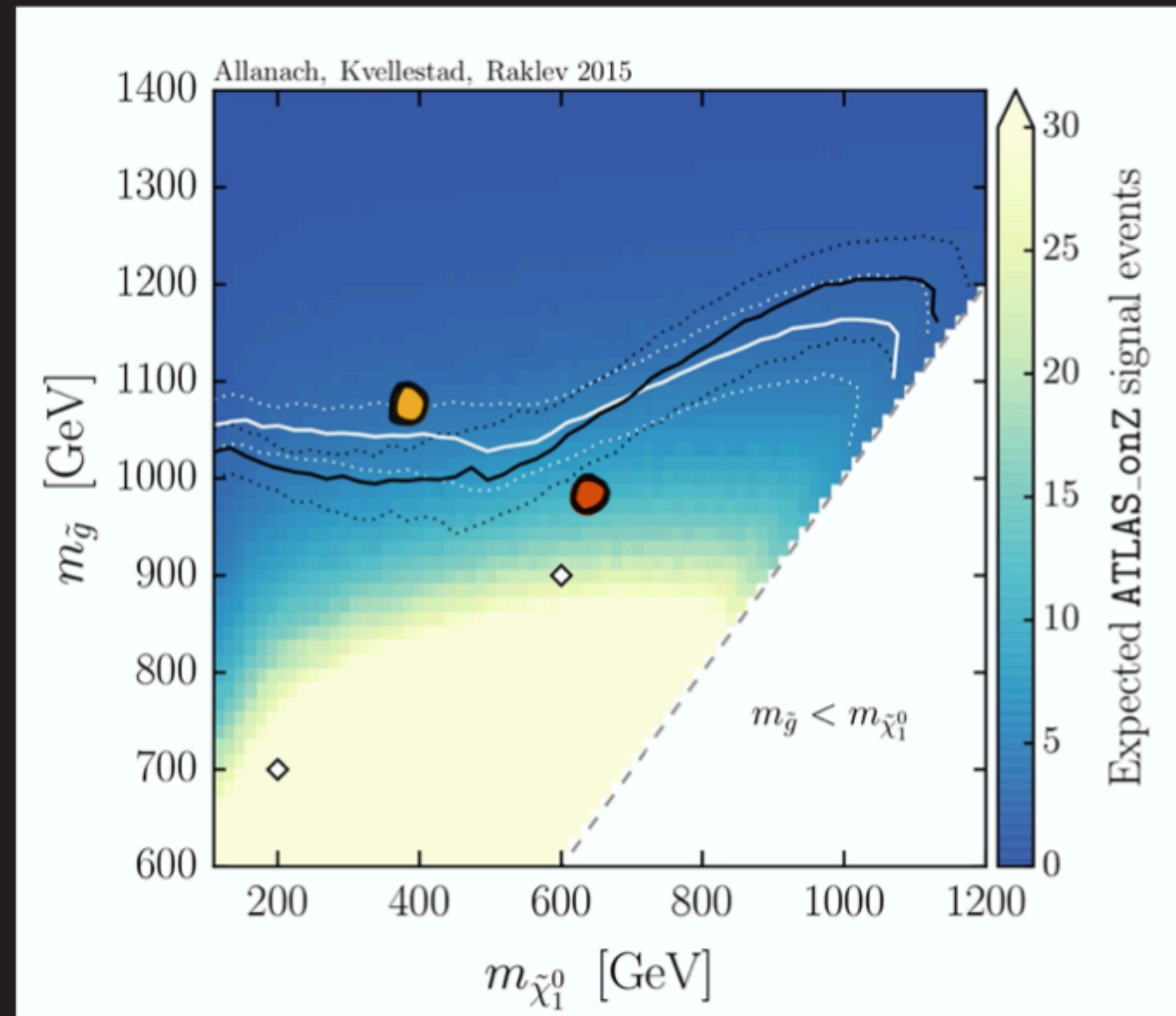
Many different searches:

Combine searches in a total likelihood function

+ Clear per-point interpretation

...but what if there are many parameters?

Allanach, Kvellestad, Raklev: 1504.02752



Many parameters and many constraints:

$$\text{Theory} \rightarrow f(x; \theta)$$

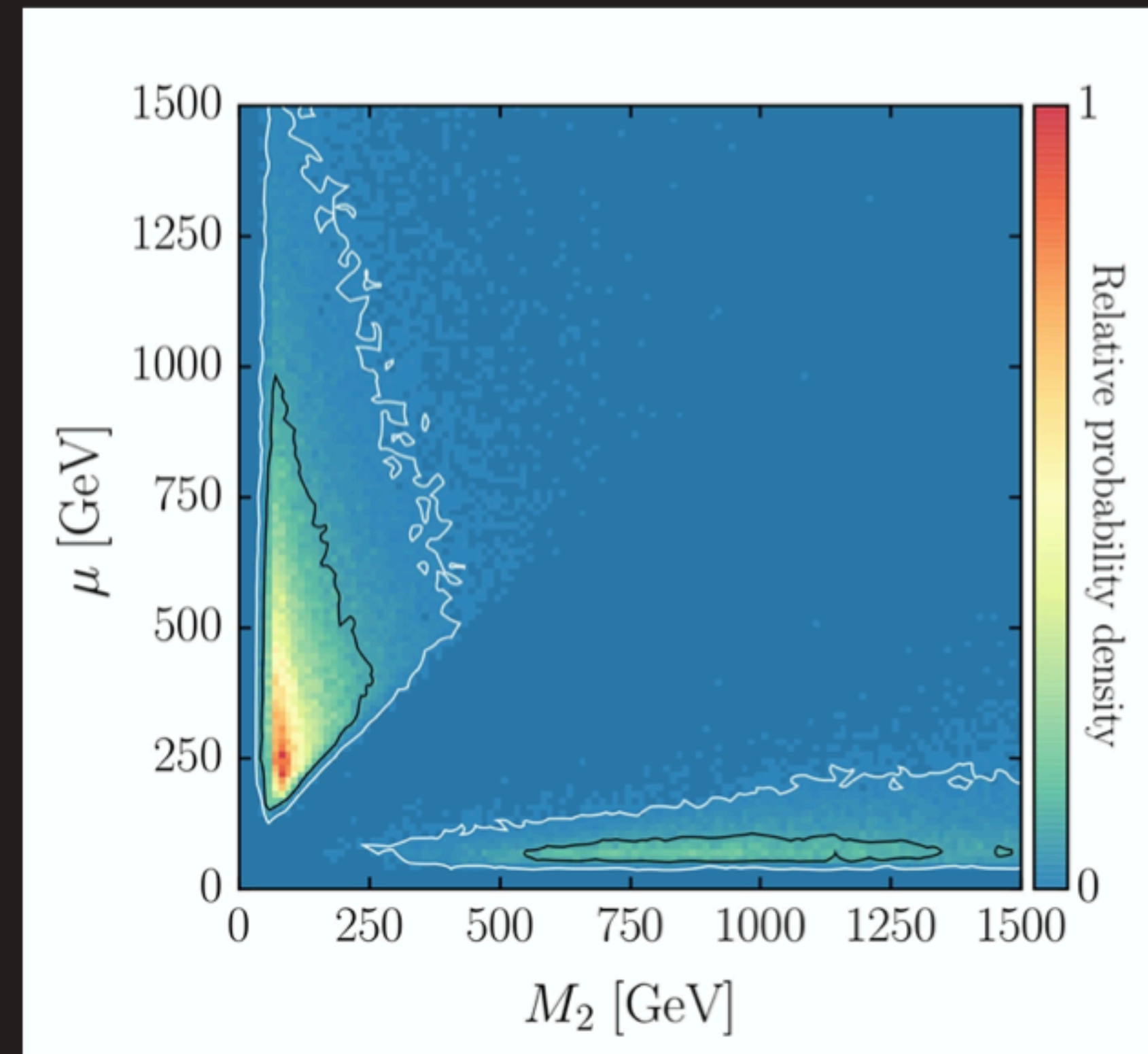
$$\text{Experiment} \rightarrow \mathcal{L}(\theta) = f(x_{\text{data}}; \theta)$$

Perform a statistical fit to all available data — a *global fit*

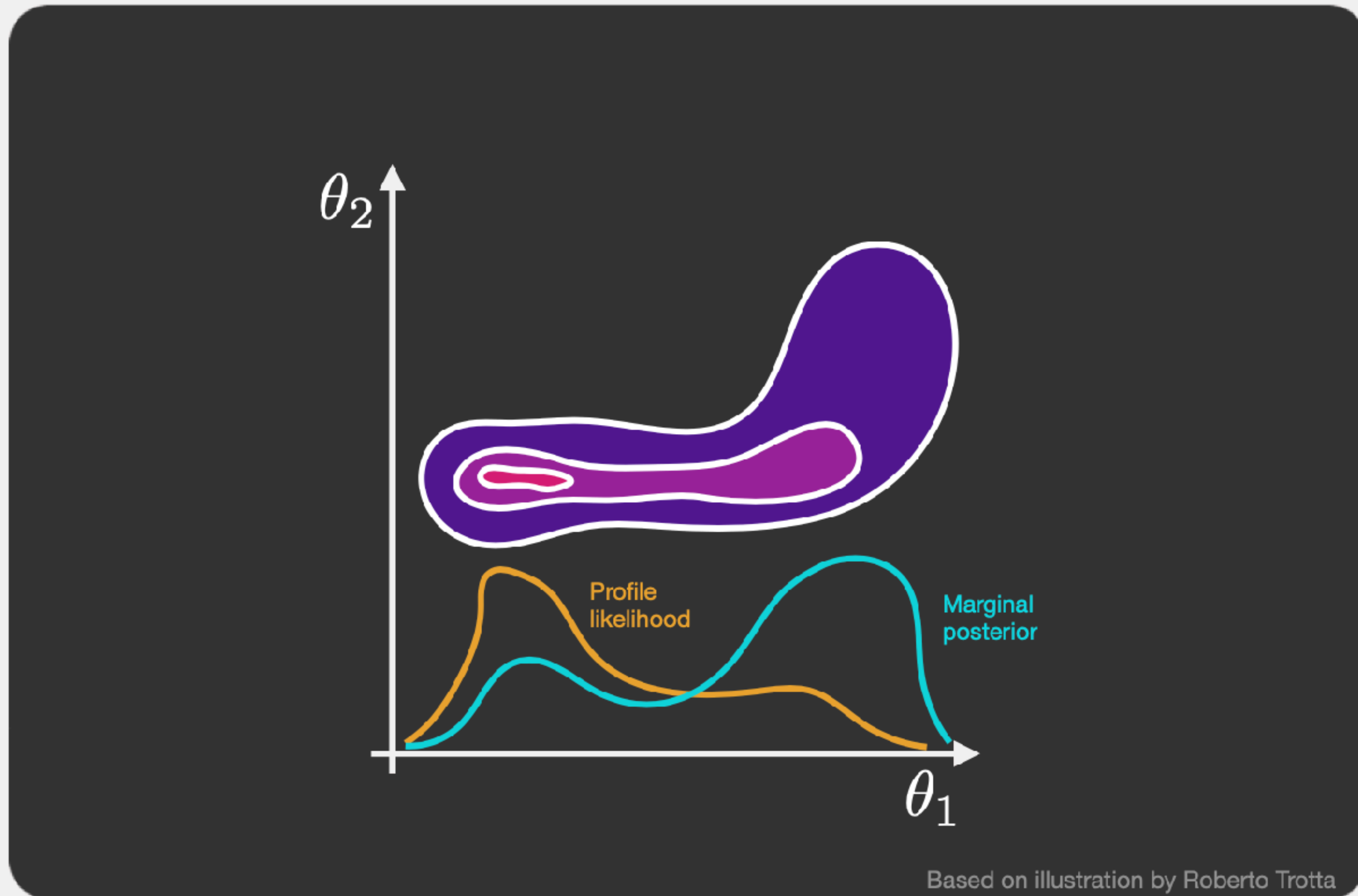
$$\mathcal{L} = \mathcal{L}_{\text{Collider}} \mathcal{L}_{\text{Higgs}} \mathcal{L}_{\text{DM}} \mathcal{L}_{\text{EWPO}} \mathcal{L}_{\text{Flavor}} \dots$$

- Explore likelihood across entire parameter space (smart sampling)
- Interpretation: frequentist/Bayesian
- Project down to 1 or 2 parameters (profile/marginalise)

Bomark, Kvellestad, Lola, Osland, Raklev: 1410.0921



Different questions, different answers



The basic steps of a global fit

- Choose your **model and parameterisation**
- Construct the **combined likelihood function** including observables from collider physics, dark matter, flavor physics, +++

$$\mathcal{L} = \mathcal{L}_{\text{collider}} \mathcal{L}_{\text{DM}} \mathcal{L}_{\text{flavor}} \mathcal{L}_{\text{EWPO}} \dots$$

- Use **sophisticated scanning techniques** to explore the likelihood function across the parameter space of the theory
- Test **parameter regions** in a statistically sensible way — not just single points (*parameter estimation*)
- Test **different theories the same way** (*model comparison*)

It's difficult...

[large number of observables]

×

[long calculation time per observable per parameter point]

×

[huge number of points required to explore parameter space]

≈

∞

GAMBIT

The **G**lobal **A**nd **M**odular **B**SM **I**nference **T**ool

- A **general** framework for BSM global fits
- Fully **open source**
- **Modular design:** can be extended with
 - new models
 - new likelihoods
 - new theory calculators
 - new scanning algorithms
- Use external codes (**backends**) as **runtime plugins**
 - Supported languages:
C, C++, Fortran, Python and Mathematica
- **Two-level parallelization** with MPI and OpenMP
- **Hierarchical** model database
- **Flexible output streams** (ASCII, HDF5, ...)
- Many **scanners** and **backends** already included



The screenshot shows the GAMBIT homepage layout. On the left is a navigation menu with a light green background, listing: Home, Results & Publications, Talks, Collaboration, Download, Source Code, Support (with sub-items: FAQ, Compiler matrix, Known issues, Documentation, Configuration examples, Report issue), Mailing list, Contact, and Internal pages (with sub-items: Wiki, Git repos: gambit (dev fork), gambit_internal, gambit_results). On the right is a large graphic of a fan of playing cards. The top cards are labeled G, A, M, B, I, T, and the bottom card is the Jack of Spades, which has 'GAMBIT' written on it. Below the cards, the text reads: 'GAMBIT The Global And Modular BSM Inference Tool'. A welcome message follows: 'Welcome to the GAMBIT homepage. GAMBIT is a global fitting code for generic Beyond the Standard Model theories, designed to allow fast and easy definition of new models, observables, likelihoods, scanners and backend physics codes.' Below that, it says: 'We have released GAMBIT to the public! Please check out the Source Code section and have fun with it!' and finally: 'You can read more about GAMBIT in this Physics World article.'

gambit.hepforge.org

