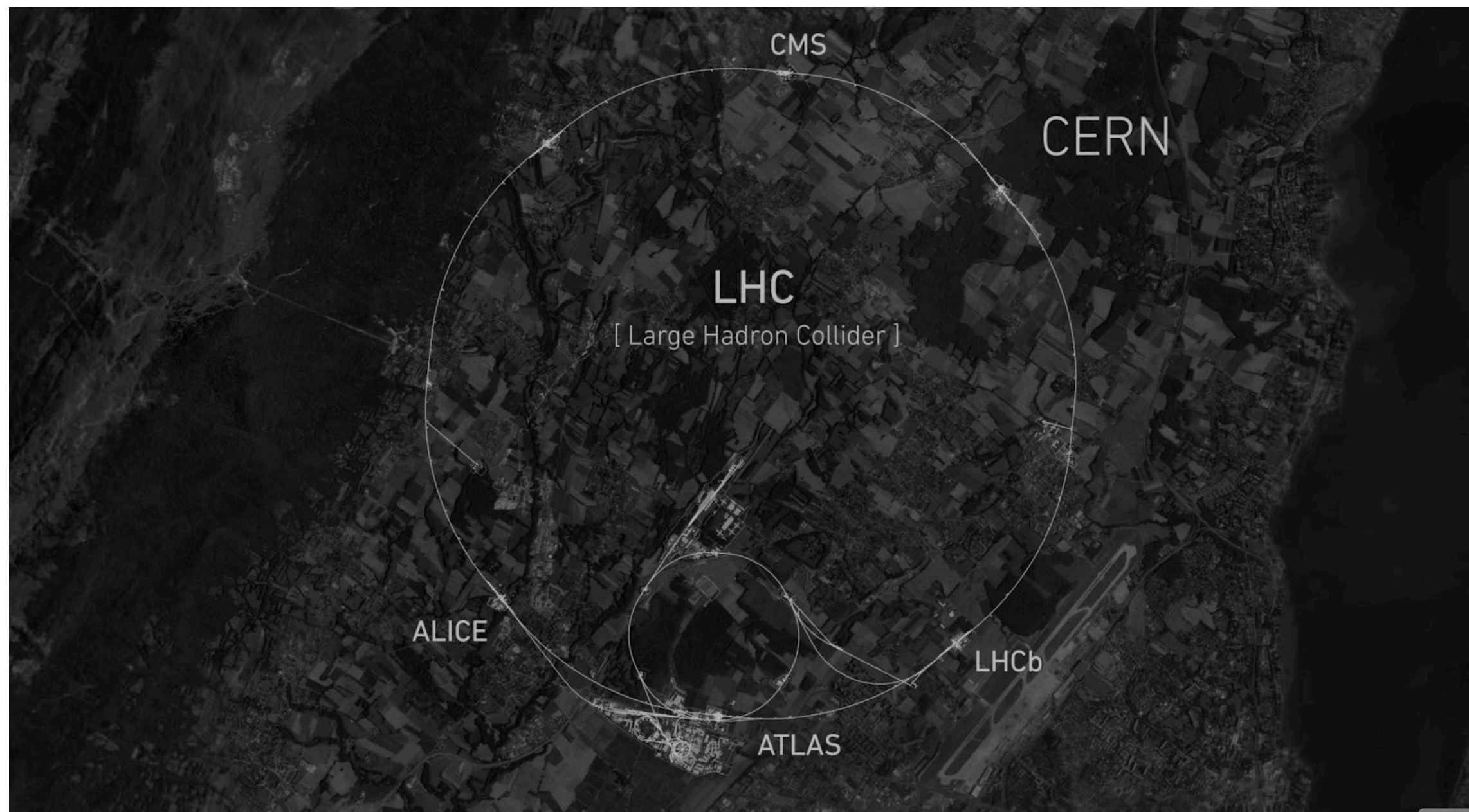


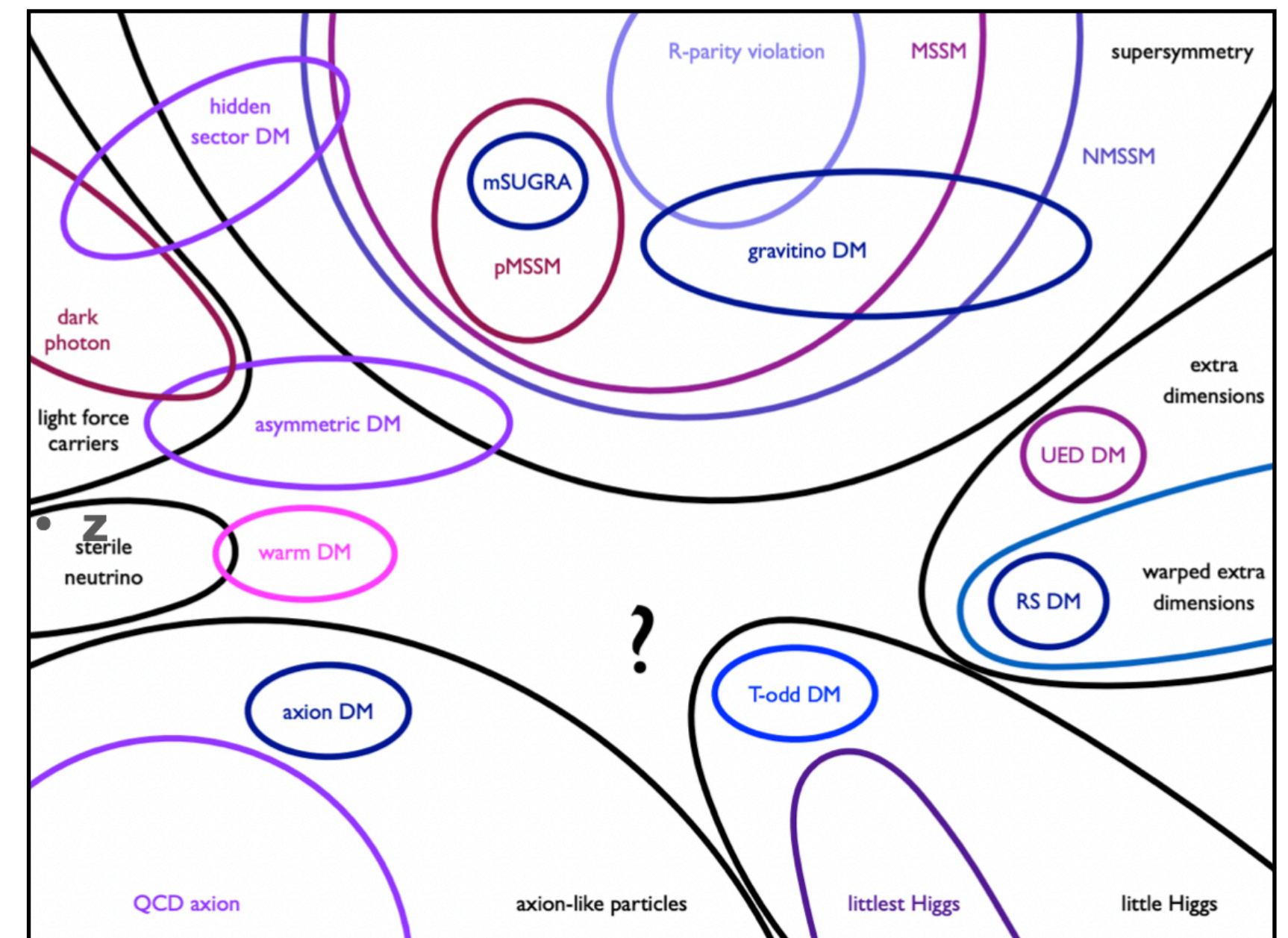
Pheno Interpretation at the LHC

Key Problem: Many variants of Physics beyond the Standard Model are proposed by theorists, but only a few experiments can check them

Answering “is my theory already excluded by the LHC” is difficult for outsiders



Experiment

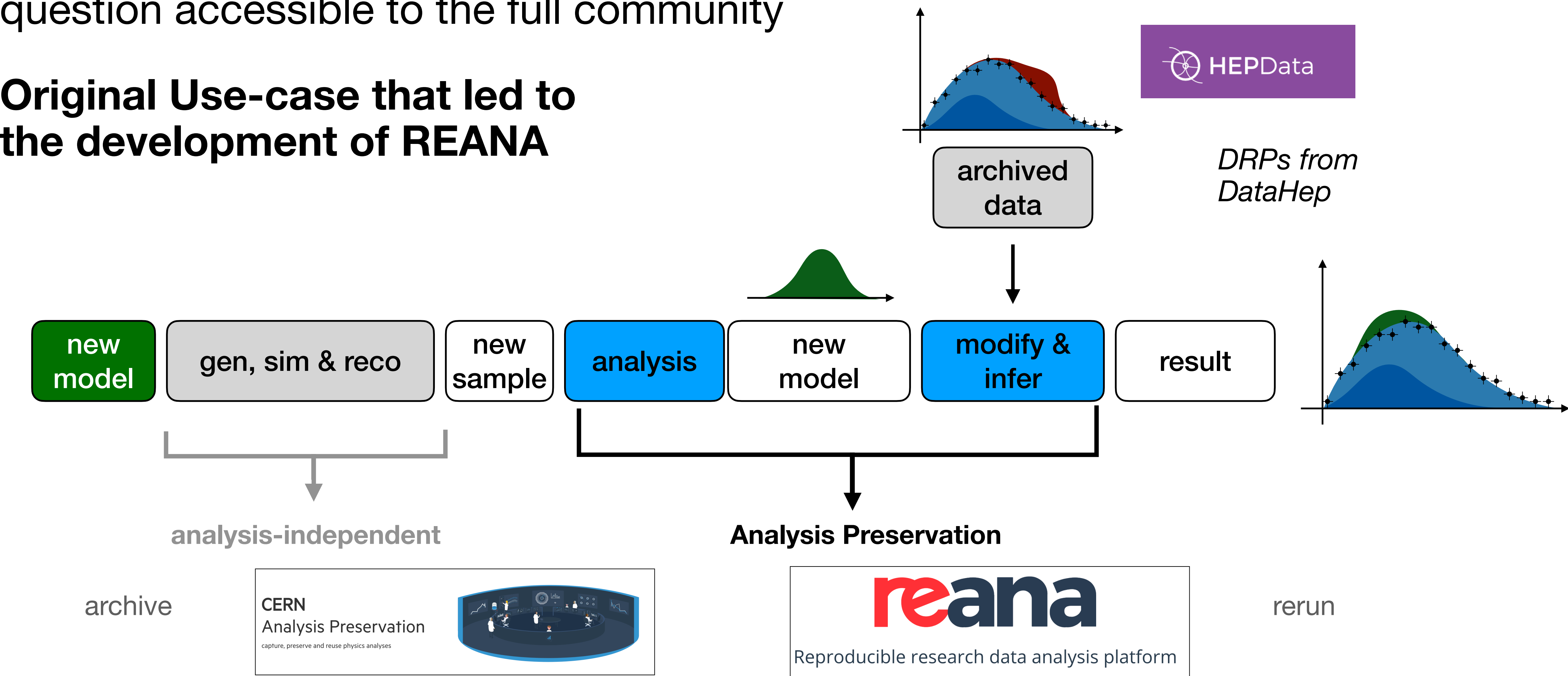


Theories

Reinterpretation

By preserving and reusing analysis pipelines, we can make answering this question accessible to the full community

Original Use-case that led to the development of REANA




Status Quo and Scaling Tests with REANA


Reinterpretation used successfully internally by LHC Experiments to explore high-dimensional theory parameter spaces. Execution of over O(10k) RANA workflows.

But so far no public infrastructure and interfaces exist to do this.
→ Opportunity for PUNCH to fill an important gap

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)



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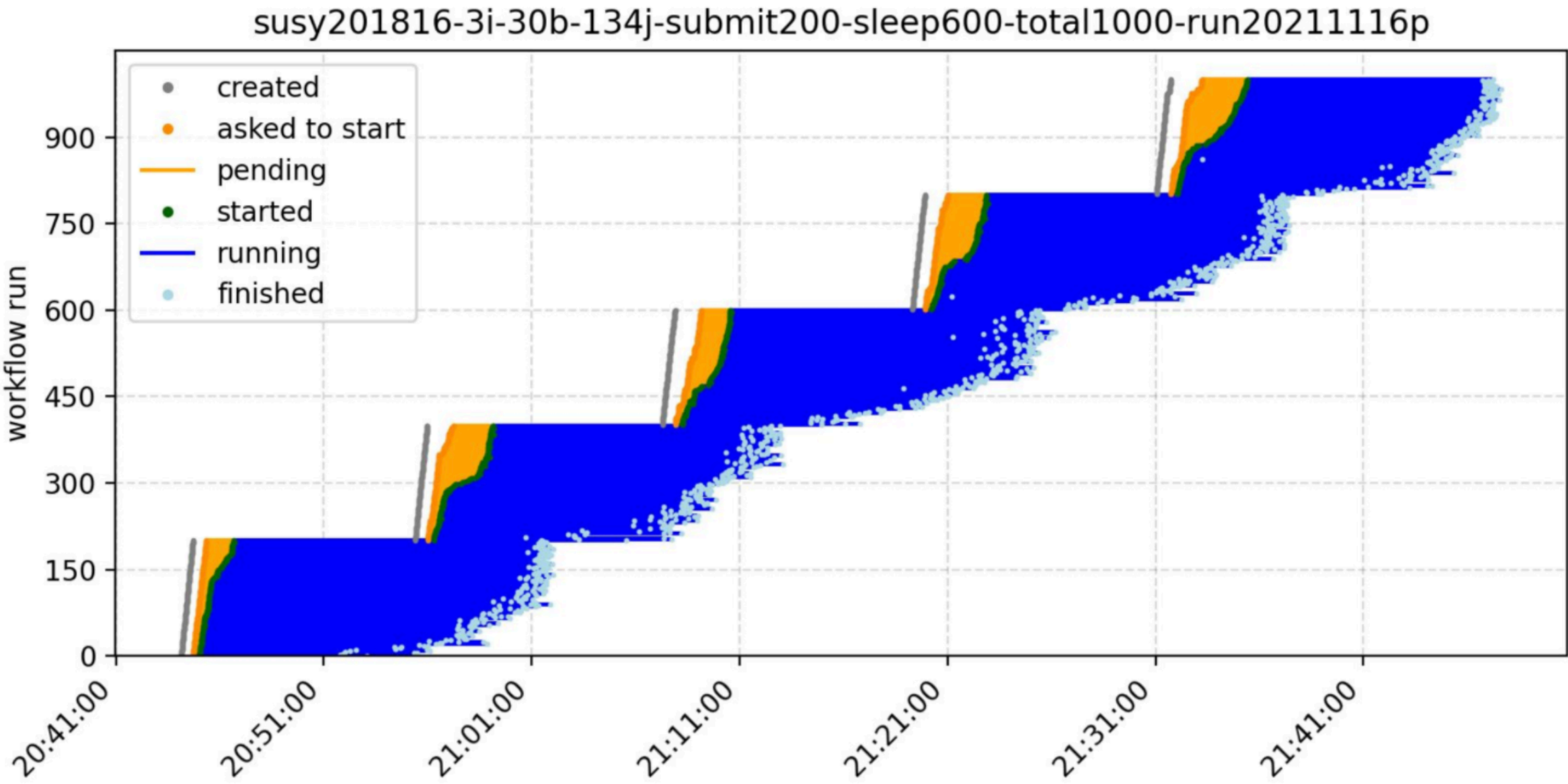
CERN-EP-2024-021
31st May 2024

392v2 [hep-ex] 30 May 2024

ATLAS Run 2 searches for electroweak production of supersymmetric particles interpreted within the pMSSM

The ATLAS Collaboration

A summary of the constraints from searches performed by the ATLAS Collaboration for the electroweak production of charginos and neutralinos is presented. Results from eight separate ATLAS searches are considered, each using 140 fb⁻¹ of proton–proton data at a centre-of-mass energy of $\sqrt{s} = 13$ TeV collected at the Large Hadron Collider during its second data-taking run. The results are interpreted in the context of the 19-parameter phenomenological minimal supersymmetric standard model, where *R*-parity conservation is assumed and the lightest



Questions

Which problems do they solve?

Enables the wider community to answer “is theory X excluded by the LHC” using production grade archived workflows from the experiment

Which gaps do they fill?

So far this has only been done inside of the experiments and not yet on Open Data or using Open Infrastructure

How could they be generalized / what is generic?

Creating a science-driven UI for re-use of data pipelines is a generic requirement. It serves as a example on how to capitalize on rich data products created by large-scale experiments

End-to-end FAIR use case?

This would be the first time we can demonstrate reinterpretation at the LHC using newly available Open Simulation and Open Data

Connection to DRP?

This uses a combination of open workflows (reana), open software (analysis code), open environemnts (docker images), open likelihoods (HepData)

Questions

How is the use case viewed from outside of PUNCH?

There is a broad interest in LHC interpretation (e.g. via the LHC Reinterpretation Working Group) and it's recognized need for the community (esp. given increasing use of AI in HEP). It's been the main driver for development of REANA etc. Also used in context of ESCAPE & EOSC

Define input – procedure – output? Specify workflow.

1. User can request new signal to be produced according to a theory specification (e.g. SUSY Model)
2. Computing Infrastructure runs simulation up to event reconstruction
3. User can select from a catalogue of preserved analyses for reinterpretation
4. Workflow is run on REANA using DRPs fetched from HepData and new simulation input
5. Result is presented to the user

Operation model? - what is required for the use case, and how to organize that?

Requires large-scale computing resources for simulation execution

Access to Open Data and Open Simulation (from CERN Open Data Portal)

Repository for preserved Workflows (either in PUNCH or e.g. CERN Analysis Preservation Portal)

Large-scale REANA instance for running preserved workflows

Web Services for User-Facing UI

Sustainability

The re-use of preserved pipelines minimized the amount of resources required to produce a new, gold-standard scientific result for a given set of theories, as only a new signal must be simulated and existing data and background estimates are re-used