Reinterpretation of LHC results for new physics

9th general workshop of the BSM Reinterpretation Forum

25–28 Feb 2025, CERN

Chairs: Jon Butterworth • Martin Habedank • Sezen Sekmen • Sabine Kraml

https://indico.cern.ch/event/1466101/

Why reinterpretation?

- Searches for new physics at the LHC in a vast variety of channels; interpretations in specific target/simplified models.
- **The full understanding of the implications of these searches requires the interpretation of the experimental results in the context of all kinds of theoretical models** (incl. such not yet thought of!)**.**
- In addition, measurements primarily aimed at understanding SM processes can have a high degree of model independence and implicitly contain information about potential contributions from new physics.
- Again, this requires the (re)interpretation of the experimental results in the context of new models.
- Requires close theory-experiment interaction and **public tools**.

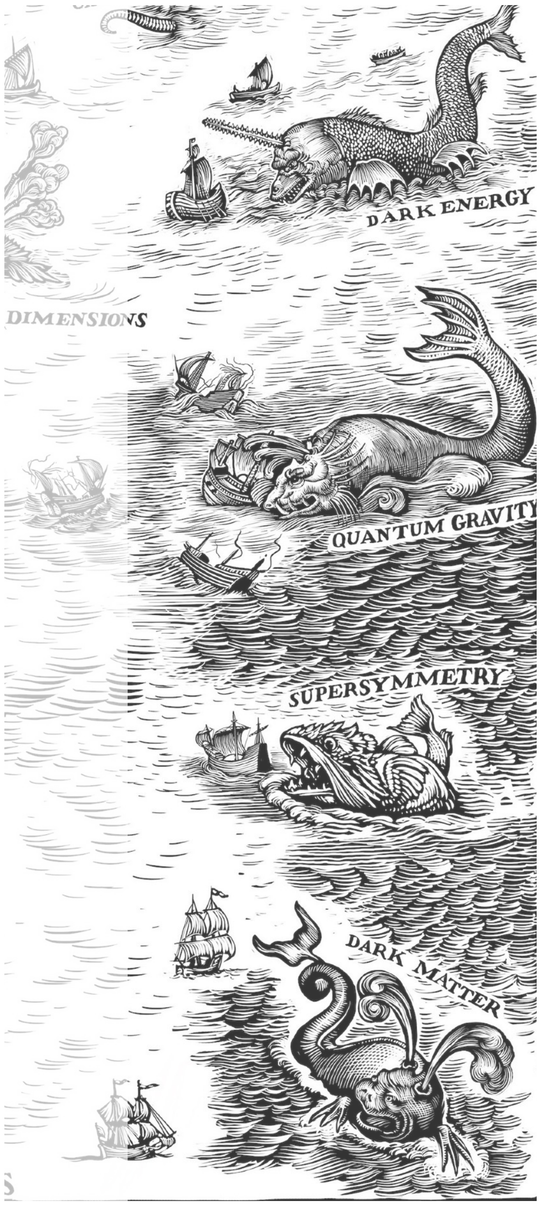

Illustration (c) C.Wormell from "A Map of the Invisible" by J.Butterworth

Experimental results vs. their interpretation

Empirical outcome, such as event counts or the measurement of some physical quantity

vs.

The act of comparing this empirical outcome to model predictions

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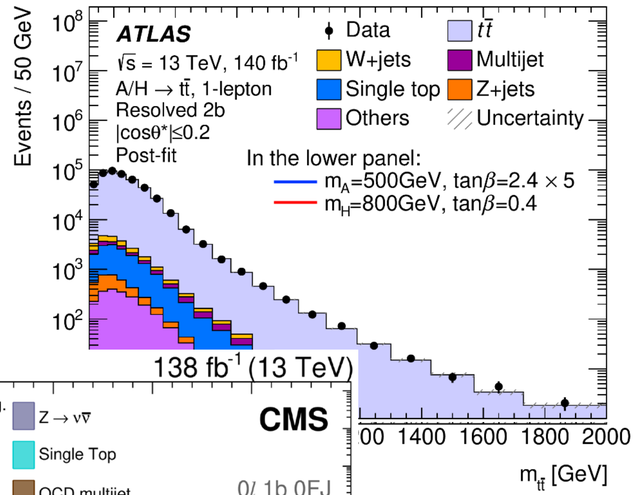

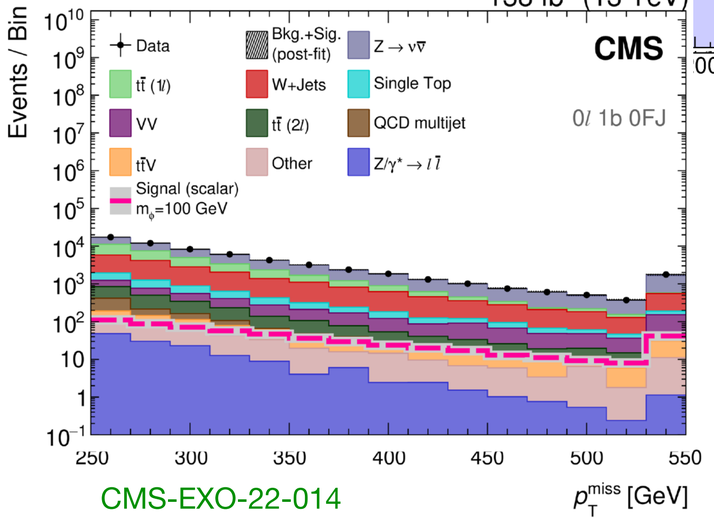

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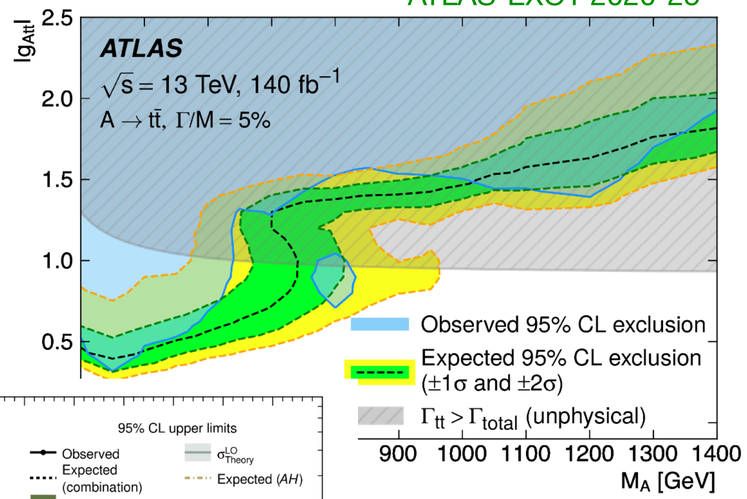
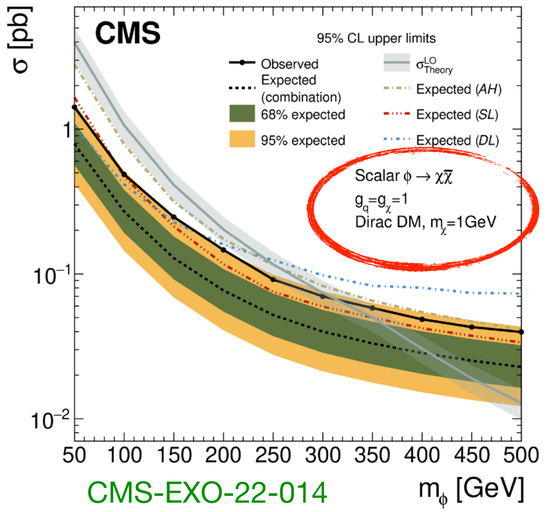
ATLAS-EXOT-2020-25





CMS-EXO-22-014

BSM Reinterpretation Forum (RiF)

2016 till now

Purpose: provide a platform for continued discussion of topics related to the BSM (re)interpretation of LHC data, including the development of the necessary public recasting tools and related infrastructure.

- **Community-driven effort**, >200 subscribers, ~100 active participants
- **Large steering group:** individual physicists, both TH and EXP, who are driving the reinterpretation efforts; a representative of each of the major public reinterpretation tools.

  Current: Jack Araz, Jon Butterworth, Andy Buckley, Carsten Burgard, Christopher Jackson Chang, Louie Dartmoor Corpe, Matthew Feickert, Lukas Heinrich, Sabine Kraml, Clemens Lange, (Michelangelo Mangano), Federico Redi, Krzysztof Rolbiecki, Sezen Sekmen, Markus Seidel, Nick Wardle.

  Previous members: Kyle Cranmer, Matthias Danninger, Nishita Desai, Matthew Dolan, Benjamin Fuks, Marie-Helene Genest, Tomas Gonzalo, Ahmed Ismail, Frank Krauss, Michael Krämer, Suchita Kulkarni, Nazila Mahmoudi, Stefano Moretti, Pat Scott, Jamie Tattersall, Wolfgang Waltenberger, Andreas Weiler.

- Supported by the LPCC, but **no official mandate**

Promote standards & good practice

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

RiF workshops

- Reports on recent reinterpretation studies; feedback to experiments
- Status and progress of public tools development
- Reviews from ATLAS/CMS/LHCb
  (new approaches, policies for providing auxiliary material, etc)
- Joint sessions with other groups:
  LLP, DM, EFT, …
- Open Data
- General best practices
  for reinterpretation/reuse of experimental results beyond the LHC: cross-talks w/ e.g. Astrophysics, Direct DM det., B-factories

- 15-17 June 2016 at **CERN** (kick-off)
- 12-14 Dec 2016 at **CERN**
- 16-18 Oct 2017 at **Fermilab**
- 14-16 May 2018 at **CERN**
- 2-4 April 2019 at **Imperial College**
- 15-19 Feb 2021 on **Zoom** (online only)
  - Apr-Sep 2021: mini-workshop series on open likelihoods (online)
- 12-15 Dec 2022 at **CERN**
- 29 Aug - 1 Sep 2023 at **IPPP Durham**
  - 17-20 June 2024 at LPSC Grenoble (mini-workshop)
- 25-28 Feb 2025 at **CERN**

↪ **transition from RiF to REI WG !**

LPCC
LHC Physics Centre at CERN

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LHC Beyond the Standard Model WG

Mandate: The LHC beyond the Standard Model (BSM) physics working group (LHC BSM WG) brings together theorists and experimentalists to define guidelines and recommendations for the benchmark models, interpretation, and characterisation of BSM searches at the LHC. As examples, the group develops and promotes well-defined signal models, specifying the assumptions behind them and describing the conditions under which they should be used. This would include both simplified models for specific signatures (experiment driven) and full models (theory driven). It works to improve the set of tools available to the experiments, such as higher-precision calculations of the backgrounds, where applicable working together with the other working groups. It also includes support to theorists for the reinterpretation of published LHC experimental results and discussions amongst experiments on common reconstruction developments.

https://lpcc.web.cern.ch/content/lhc-bsm-wg

BSM WG
- Dark Matter
- Long-lived particles
- Prompt BSM signatures
- Reinterpretation

EFT WG

Electroweak WG

Forward Physics WG

Heavy Flavour WG

Heavy Ions WG

Machine Learning WG

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LHC Physics Centre at CERN

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LHC REI WG: BSM re-interpretation of LHC results

This subgroup of the BSM WG builds on the experience of the long-established LHC re-interpretation forum (RIF), which will continue working under the umbrella of the BSM WG in continuity with its original scientific goals.

The REI WG provides a platform for continued discussion of topics related to the BSM (re)interpretation of LHC data, including the development of the necessary public Recasting Tools and related infrastructure.

Conveners:

- ATLAS: Martin Habedank
- CMS: Sezen Sekmen
- LHCb: Carlos Vazquez Sierra
- Theory: Sabine Kraml
- LPCC: Michelangelo Mangano

Contact us: lhc-reiwg-admin@cern.ch

https://lpcc.web.cern.ch/content/lhc-rei-wg

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LHC REI WG:
BSM re-interpretation of LHC results

- E-group: **lhc-reiwg@cern.ch** ← replaces info-lhc-reinterpretation@cern.ch
- Indico: https://indico.cern.ch/category/13649/
- Webpage: https://lpcc.web.cern.ch/content/lhc-rei-wg
- Twiki: https://twiki.cern.ch/twiki/bin/view/LHCPhysics/InterpretingLHCresults
- Documents: https://lpcc.web.cern.ch/content/reinterpretation-wg-documents

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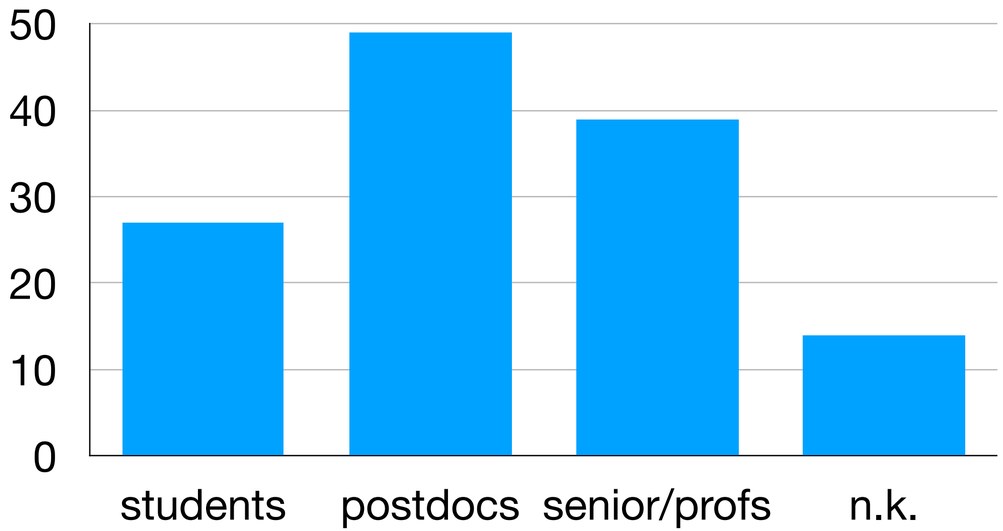
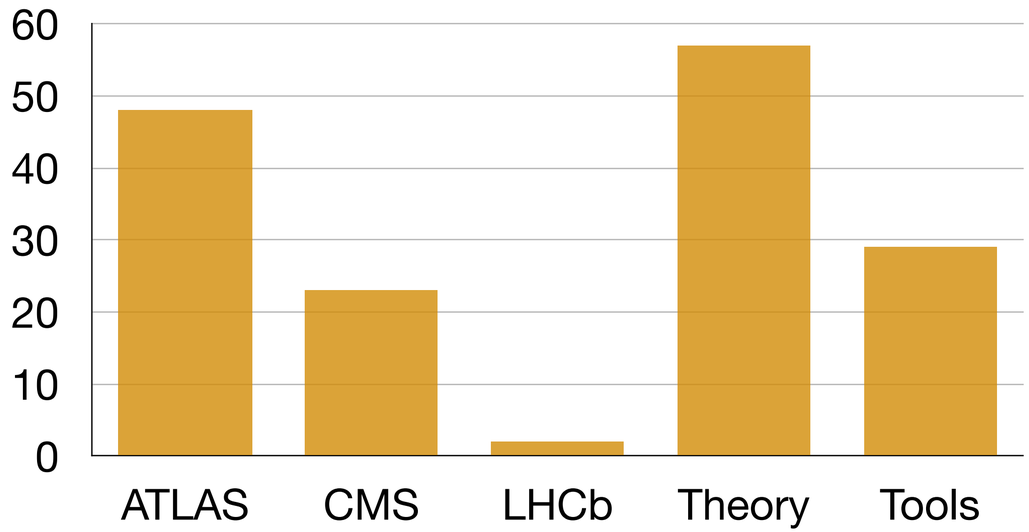
This workshop:
Total 129 participants from 29 countries, ~60 in person

Attendance stats





129 registered participants, ~ 60 to attend in person

status 25/02/25, 11 am

This workshop: programme overview

	Tuesday	Wednesday	Thursday	Friday
Morning		Open Data, Analysis Preserv.	(ML) Likelihoods	Pheno studies
		HEPData, HS3, BDT surrogates	Tools and related developments	Final discussion: ESPPU contribution, from RiF to REI, etc.
Afternoon	Pheno studies	free for project discussions (or TH seminar)	More on public reinterp. tools	
	CMS stat. models	ATLAS & CMS perspectives	ESPPU white paper discussion	

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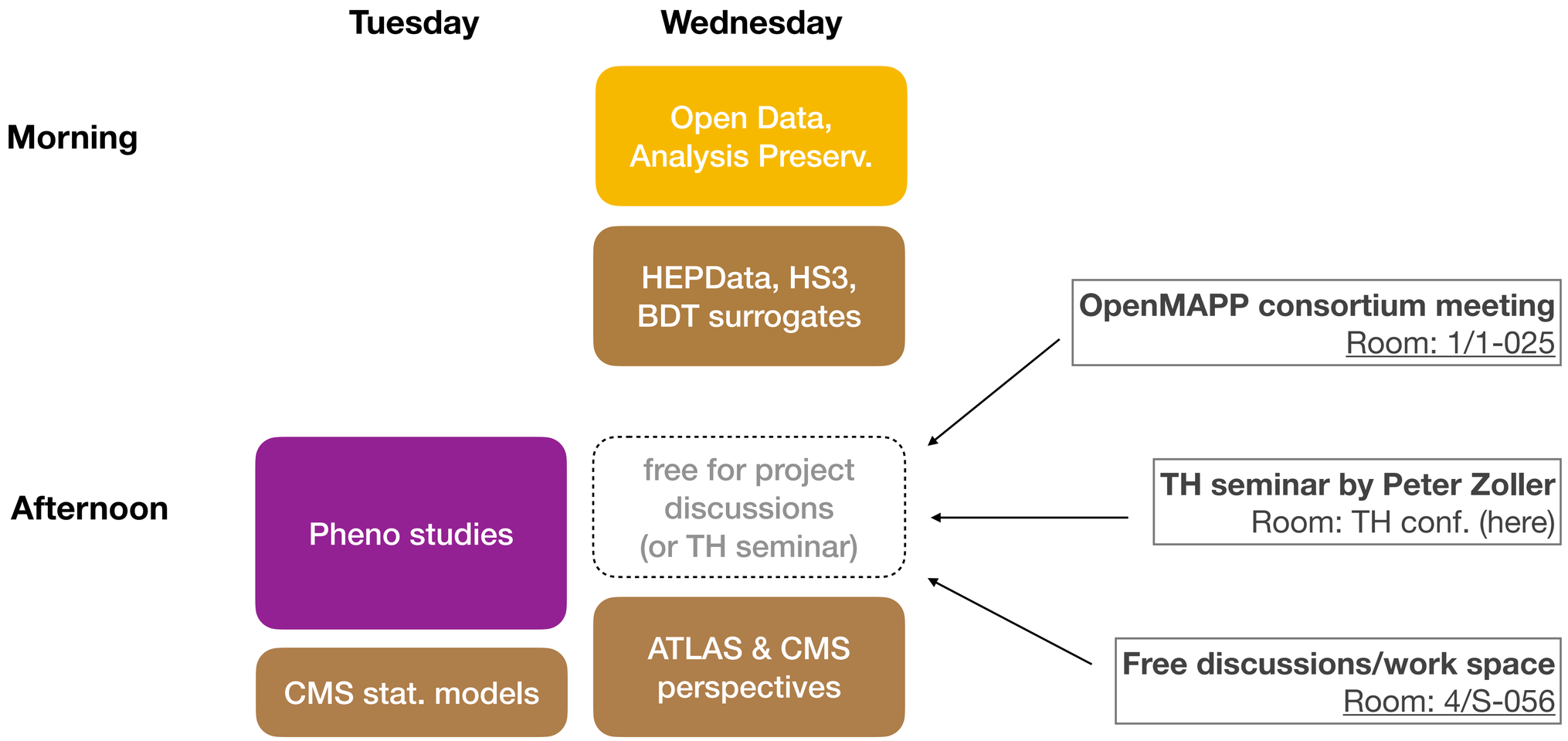

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Coffee breaks: 30 min

Downstairs in TH common room

REI WG — plans and action items

- Raise more awareness on why reinterpretability is crucial
- Highlight the specific information (aka auxiliary material) required
- Build a more coordinated effort within and across the collaborations in providing this information
- Highlight reinterpretations/usage of reinterpretation materials *in practise*
- Propagate new ideas/new developments that the community can benefit from
- Pinpoint possible and needed task forces for the REI WG

➳ final discussion on Friday

Enjoy the workshop !