

Publication of Statistical Models

1st hands-on workshop, 8-12 Nov 2021

Sabine Kraml — Workshop Opening

Publishing statistical models: Getting the most out of particle physics experiments

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September 9, 2021

Abstract

The statistical models used to derive the results of experimental analyses are of incredible scientific value and are essential information for analysis preservation and reuse. In this paper, we make the scientific case for systematically publishing the full statistical models and discuss the technical developments that make this practical. By means of a variety of physics cases — including parton distribution functions, Higgs boson measurements, effective field theory interpretations, direct searches for new physics, heavy flavor physics, direct dark matter detection, world averages, and beyond the Standard Model global fits — we illustrate how detailed information on the statistical modelling can enhance the short- and long-term impact of experimental results.

Motivation

white paper, arXiv:2109.04981

- Experimental results in particle physics are based on [statistical models](#).
- They [describe the probabilistic dependence](#) of the *observable* data on the parameters of interest and the nuisance parameters.
- [Essential information](#) for analysis **preservation** and **reuse**.
- In recent years, [a lot of progress](#) has been made regarding presentation of results, reinterpretation, Open Data, etc.
- [Publication of the full statistical models](#) is a logical step to maximise shelf life and scientific return; technical solutions exist to make this feasible.
- In 2109.04981, we advocate that publication of the full statistical models become [standard practice](#).

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A 20+ year journey

- **2000 First PHYSTAT workshop [CERN 2000-005]**

Unanimous [agreement](#) that particle physicists should [publish likelihood](#) functions, given their fundamental importance in extracting quantitative results from experimental data.

- **2012 Les Houches Recommendations for the Presentation of LHC Results [arXiv:1203.2489]**

Recommendation 3b: When feasible, [provide](#) a mathematical description of the final [likelihood function](#) in which experimental data and parameters are clearly distinguished, [...].

Recommendation 3c: Additionally [provide a digitized implementation](#) of the likelihood that is consistent with the mathematical description.

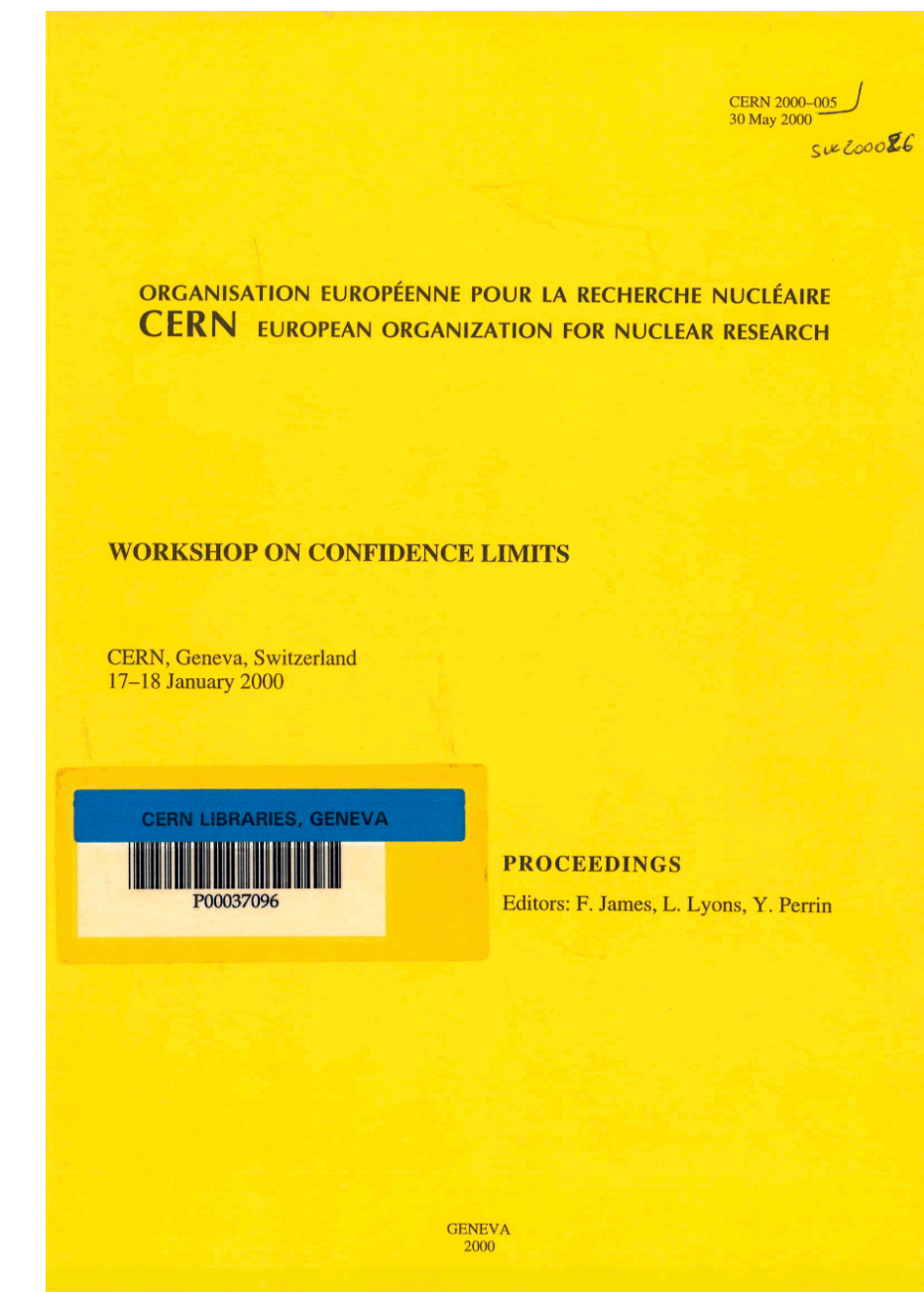
- **2013 Workshop on “Likelihoods for the LHC Searches”**

organised by Kyle Cranmer, Harrison Prosper and Sezen Sekmen [indico]

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- **2000 Status and Recommendations after Run 2 [2003.07868]**

Report by the LHC Reinterpretation Forum [re-emphasises importance](#) of detailed information on likelihoods and statistical modelling.



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ATLAS PUB Note
ATL-PHYS-PUB-2019-029
21st October 2019



Reproducing searches for new physics with the ATLAS experiment through publication of full statistical likelihoods

The ATLAS Collaboration

The ATLAS Collaboration is starting to publicly provide likelihoods associated with statistical fits used in searches for new physics on HEPData. These likelihoods adhere to a specification first defined by the `HistFactory` p.d.f. template. This note introduces a JSON schema that fully describes the `HistFactory` statistical model and is sufficient to reproduce key results from published ATLAS analyses. This is per-se independent of its implementation in ROOT and it can be used to run statistical analysis outside of the ROOT and RooStats/RooFit framework. The first of these likelihoods published on HEPData is from a search for bottom-squark pair production. Using two independent implementations of the model, one in ROOT and one in pure Python, the limits on the bottom-squark mass are reproduced, underscoring the implementation independence and long-term viability of the archived data.



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New open release allows theorists to explore LHC data in a new way
The ATLAS collaboration releases full analysis likelihoods, a first for an LHC experiment
CERN News
9 JANUARY, 2020 | By Katarina Anthony

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New open release allows theorists to explore LHC data in a new way
The ATLAS collaboration has begun to publish likelihoods, a first for an LHC experiment

ATLAS releases 'full orchestra' of analysis instruments

01/14/21 | By Stephanie Melchor

The ATLAS collaboration has begun to publish likelihood functions, information that will allow researchers to better understand and use their experiment's data in future analyses.

Symmetry magazine

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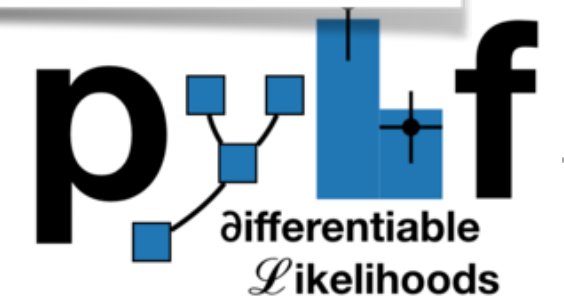
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Why this workshop

white paper, arXiv:2109.04981

- The available details on the statistical model may heavily affect the **short- and long-term impacts** of any measurement.
- See use cases; clear **call to action**.
- If adopted, will lead to more, and higher-quality, science. Huge impact.
- Significant change in standard publication practice; we recognize that **it will take time and effort** to establish new norms and conventions.
- Further developments are necessary to **enhance, facilitate, and streamline** both the publication and the usage of full statistical models. To be addressed in dedicated workshops (starting with this one)

<https://indico.cern.ch/event/1088121/>

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From the white paper summary

An immediate action that can be taken by the community:

- (i) publish all the associated RooWorkspaces or
- (ii) for binned statistical models based on the HistFactory specification, publish the models in the pyhf JSON format.

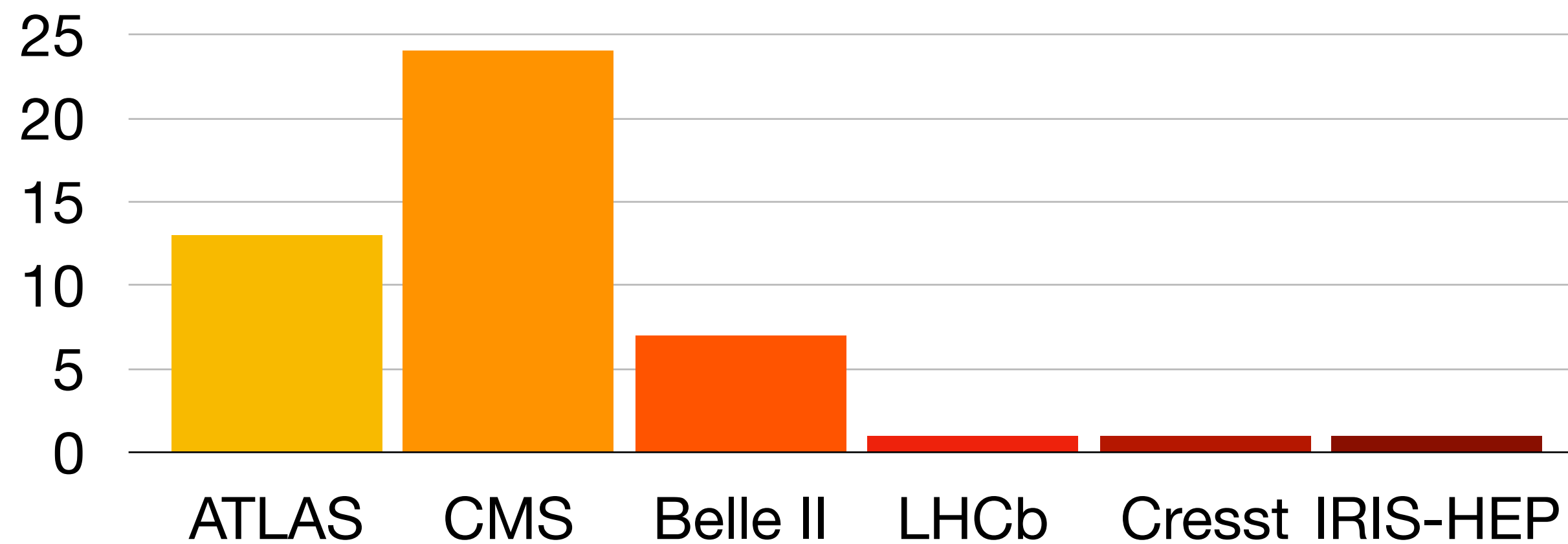
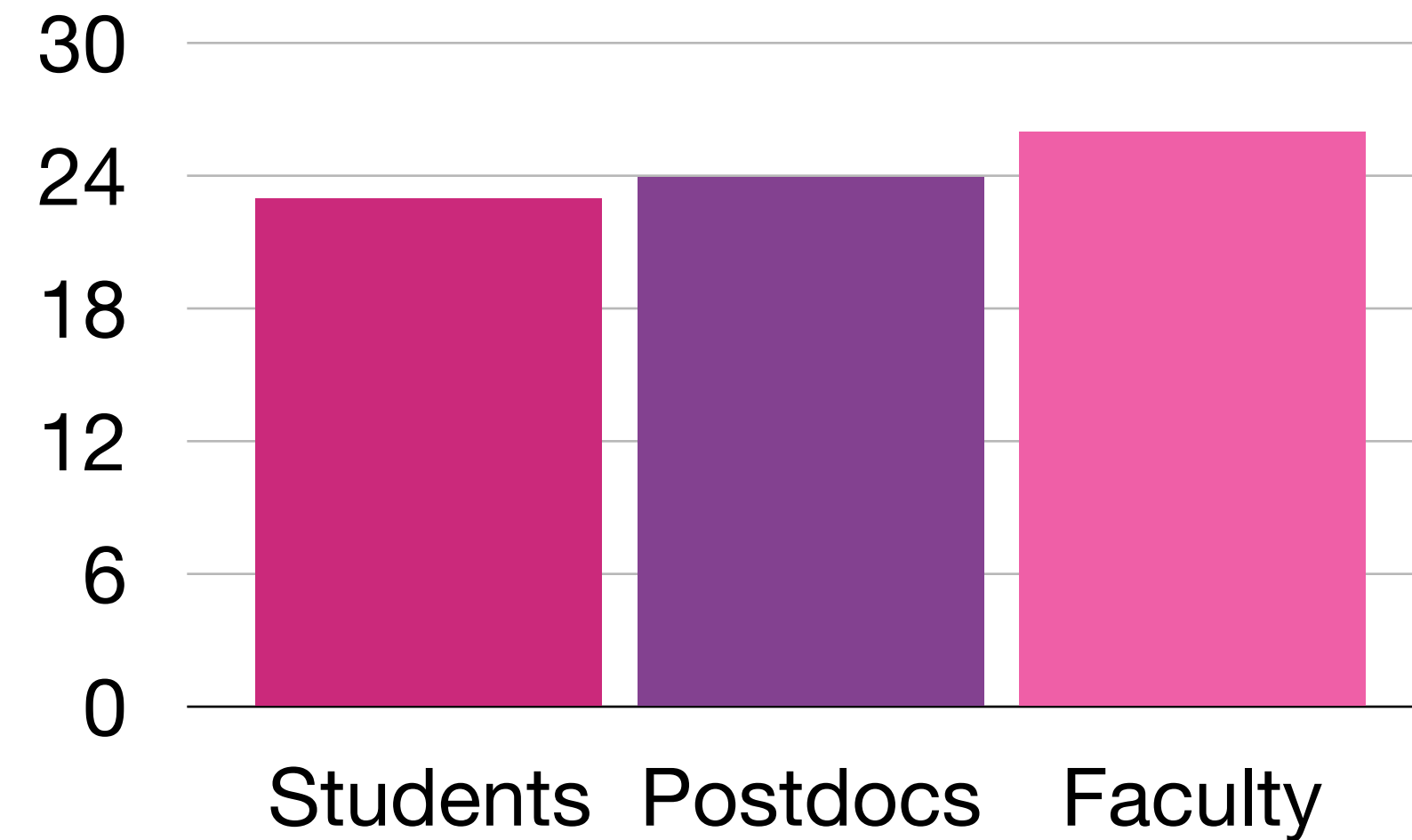
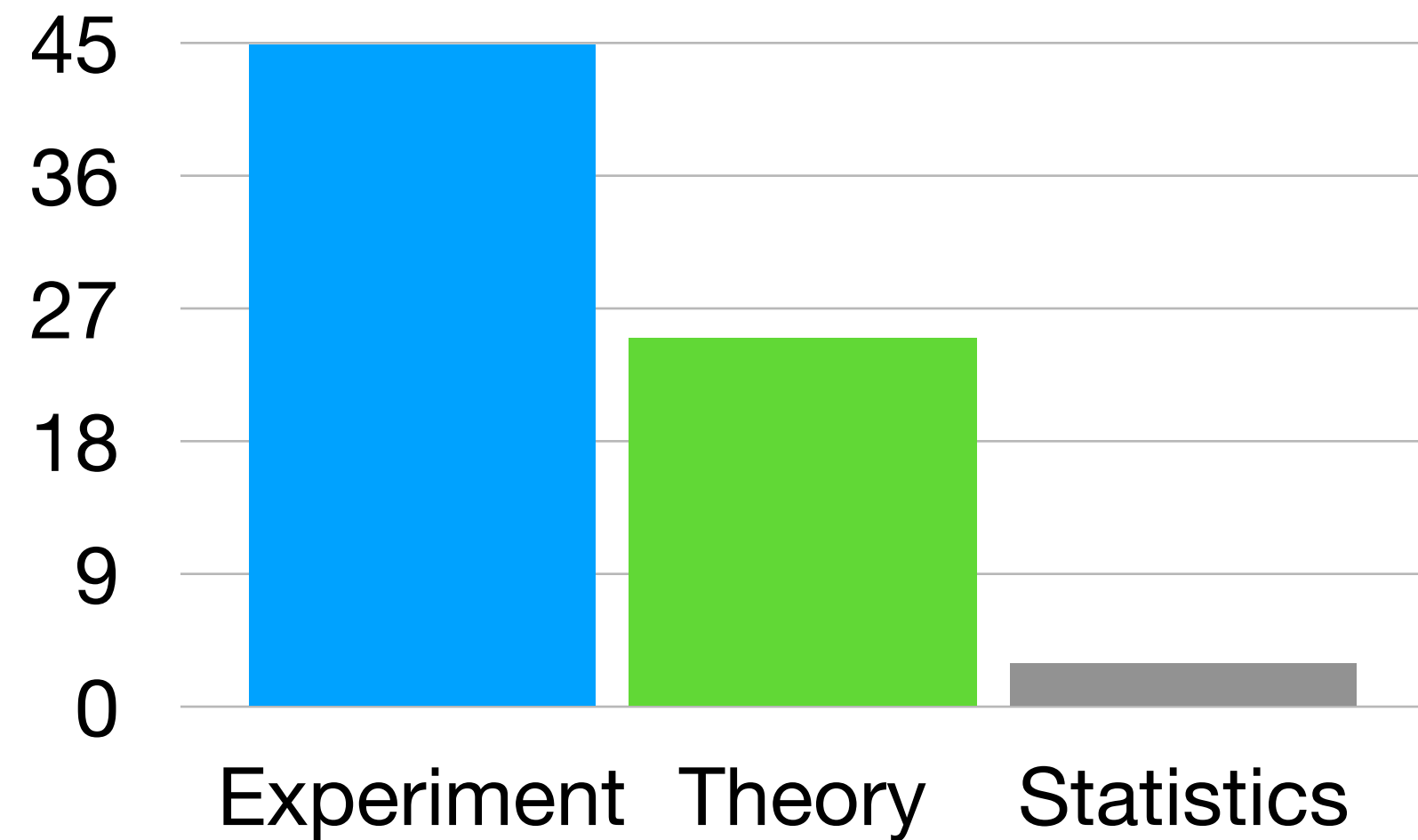
This would provide the impetus for the development of tools to make the use of the published models user-friendly, efficient, and effective.

Longer-term developments are certainly needed to enhance, streamline, and facilitate the use of published statistical models. However, the publication of the currently available statistical models would already be a watershed development in the field, one we hope the community is ready to embrace.

Challenges and outstanding issues; cf. white paper sect. 5

- ▶ Systematic naming conventions for (nuisance) parameters
→ facilitate combinations
- ▶ Serialisation of statistical models beyond HistFactory
→ e.g., CMS Combine tool
- ▶ Strategies and public tools for pruning, simplification and/or partial profiling of the full model when runtime is an issue
→ model surveys, global fits
- ▶ Systematic use in theory community; extension of fitting procedures and tools that currently assume Gaussian error sources
→ e.g. PDF, EFT fits
- ▶ Errors on errors
- ▶ ...

73 registrants (status Sunday night)




Informal workshop; emphasis is on exchange of knowledge and ideas, and **discussion** !

And hopefully there will also be some coding done :-)

<https://indico.cern.ch/event/1088121/>

Publication of statistical models: hands-on workshop



8–12 Nov 2021
CERN (online only)
Europe/Zurich timezone

- Overview
- Scientific Programme
- Timetable
- Registration
- Participant List
- Videoconference**
- Resources

Videoconference

Publication of statistical models: hands-on workshop Event

 Breakout 1	Please log in and register 
 Publication of statistical models: hands-on workshop	Please log in and register 

↑
Main Zoom room for all sessions
(we are here now)

↖
Additional room(s) for discussions
in small groups - will create more if needed

Zoom rooms should be open and accessible 24/24 the whole week (registration needed)