France-Berkeley PHYSTAT

Unfolding Workshop

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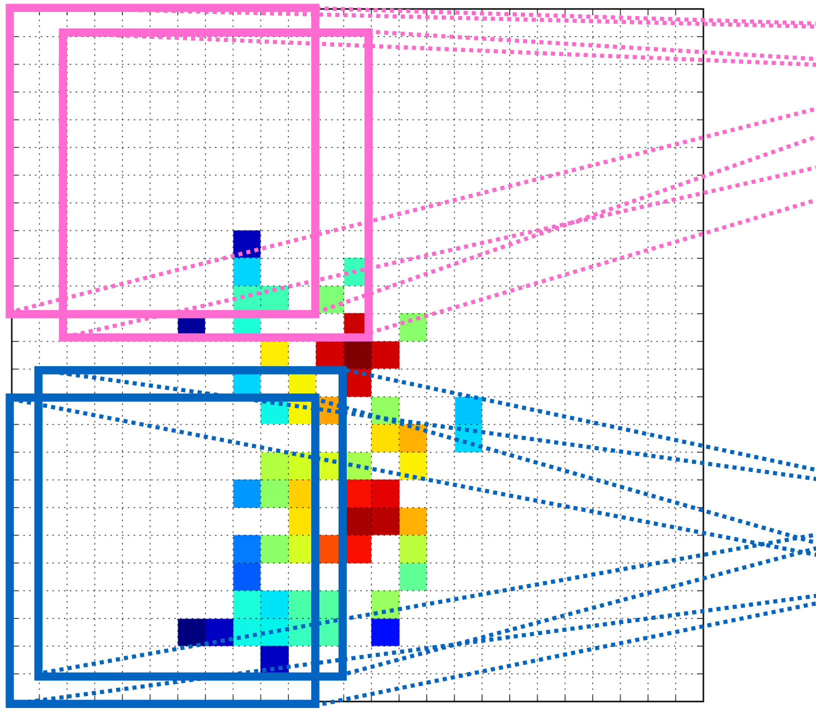

BERKELEY LAB

BIDS

BERKELEY INSTITUTE FOR DATA SCIENCE

June 2024

Methods!

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	TUnfold, SVD, IBU, QUnfold, NPU, … ~~TUnfold~~	Pick-your-favorite profile likelihood tool ~~Combine~~	OmniFold, cINN, VLD, cDDPM, …
Method	~~Least square minimisation~~	Maximum likelihood	
Speed	Linear algebra –> very fast	Numerical minimisation with Minuit and complex fit with nuisance parameters –> much slower	Not fast
Number of unfolded bins	Up to very large numbers	Complexity of the fit increases with the number of bins	Unbinned!
Regularisation	Possible	Possible	Implicit?
Background	Simple subtraction	Can do simultaneous binwise signal + background fit	Choose your own adventure
Systematic uncertainties	Vary externally and repeat unfolding	Simultaneous fit of nuisance parameters and profiling them	Repeat
Ideal application	High statistics, low background, precision analyses, e.g., inclusive jets, ttbar production	Anything, except cases with very large numbers of unfolded events	

Credits: O. Behnke, P. Gras, G. Kasieczka

+innovations still incoming (like moment unfolding, response matrix smoothing, posterior response, …)
(see papers on new unfolding methods just this year!)

Try them out!

12:10 - 13:30

Tutorials

Dr Carsten Burgard, Fernando Torales Acosta, Javier Mariño Villadamigo, Lydia Brenner, Nathan Hutsch, Vincent Alexander Croft

14:00

15:00

16:00

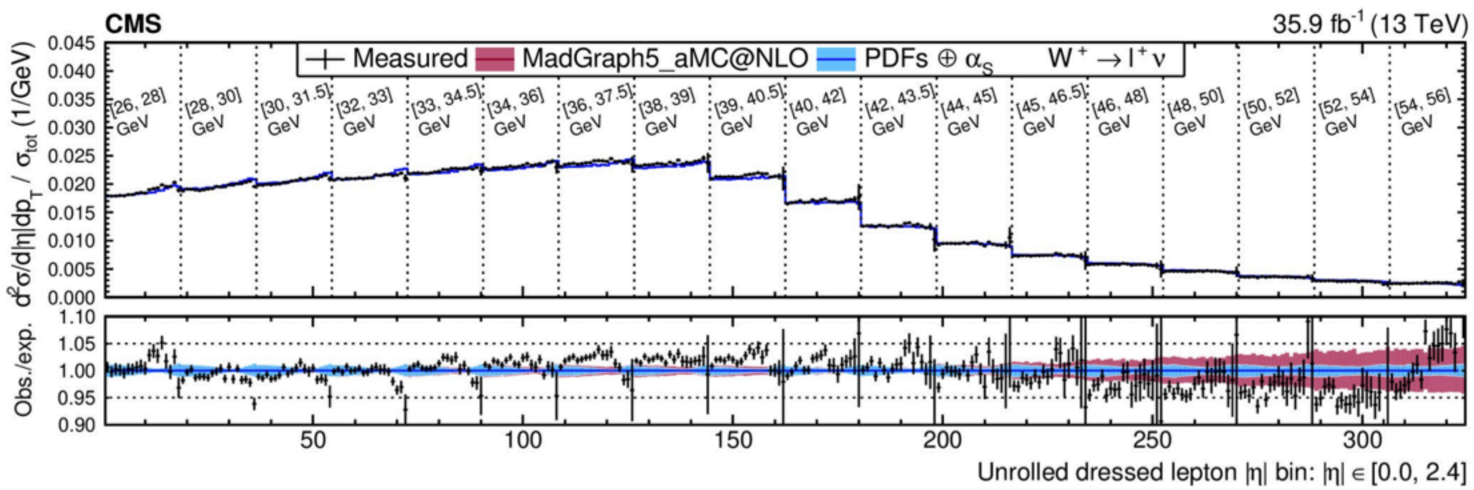
17:00

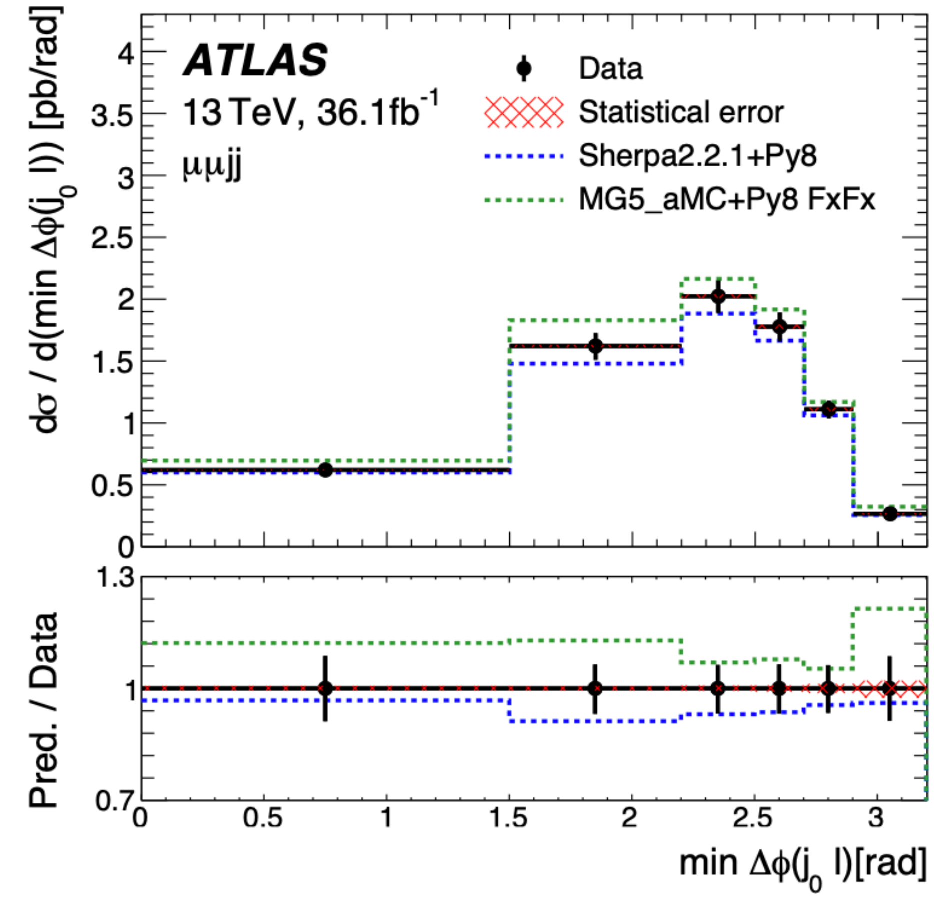
13:30 - 17:30

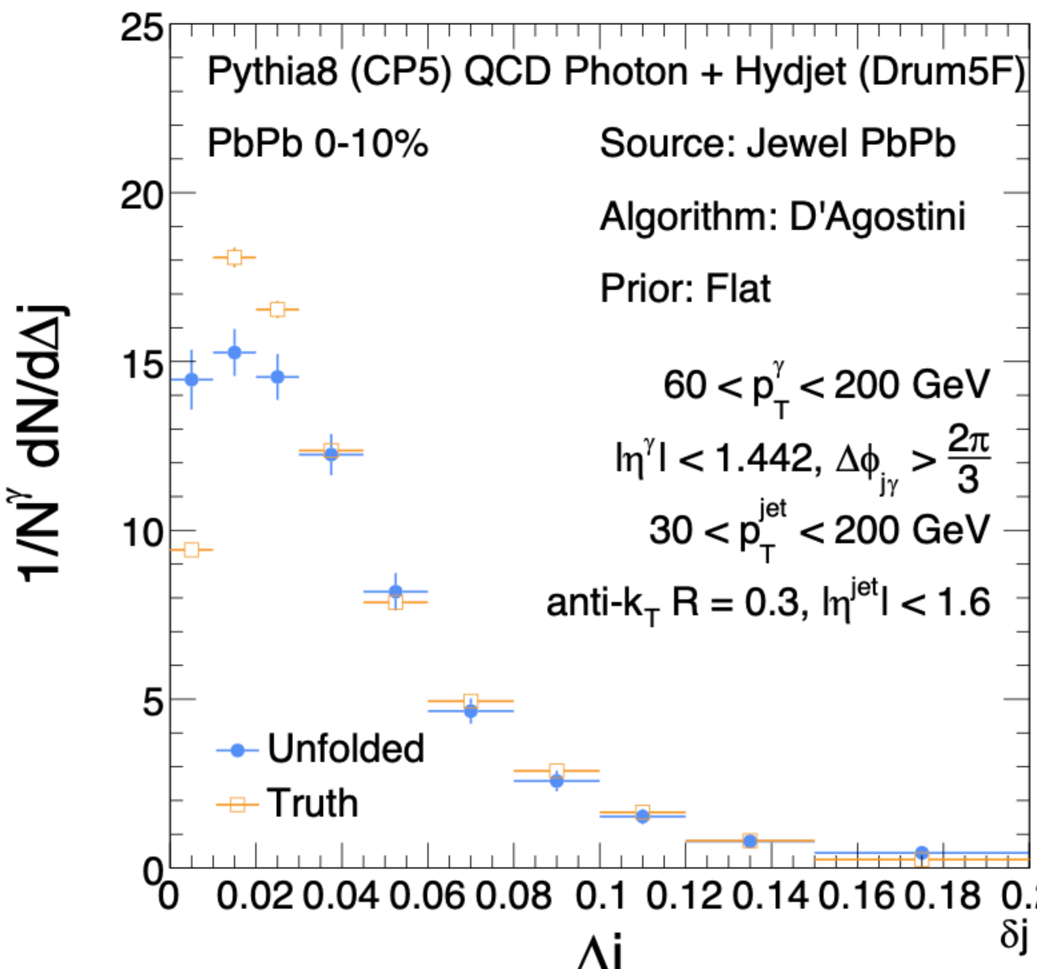
You can do the tutorials any time!
… and the people who prepared them are likely happy to answer your questions :)

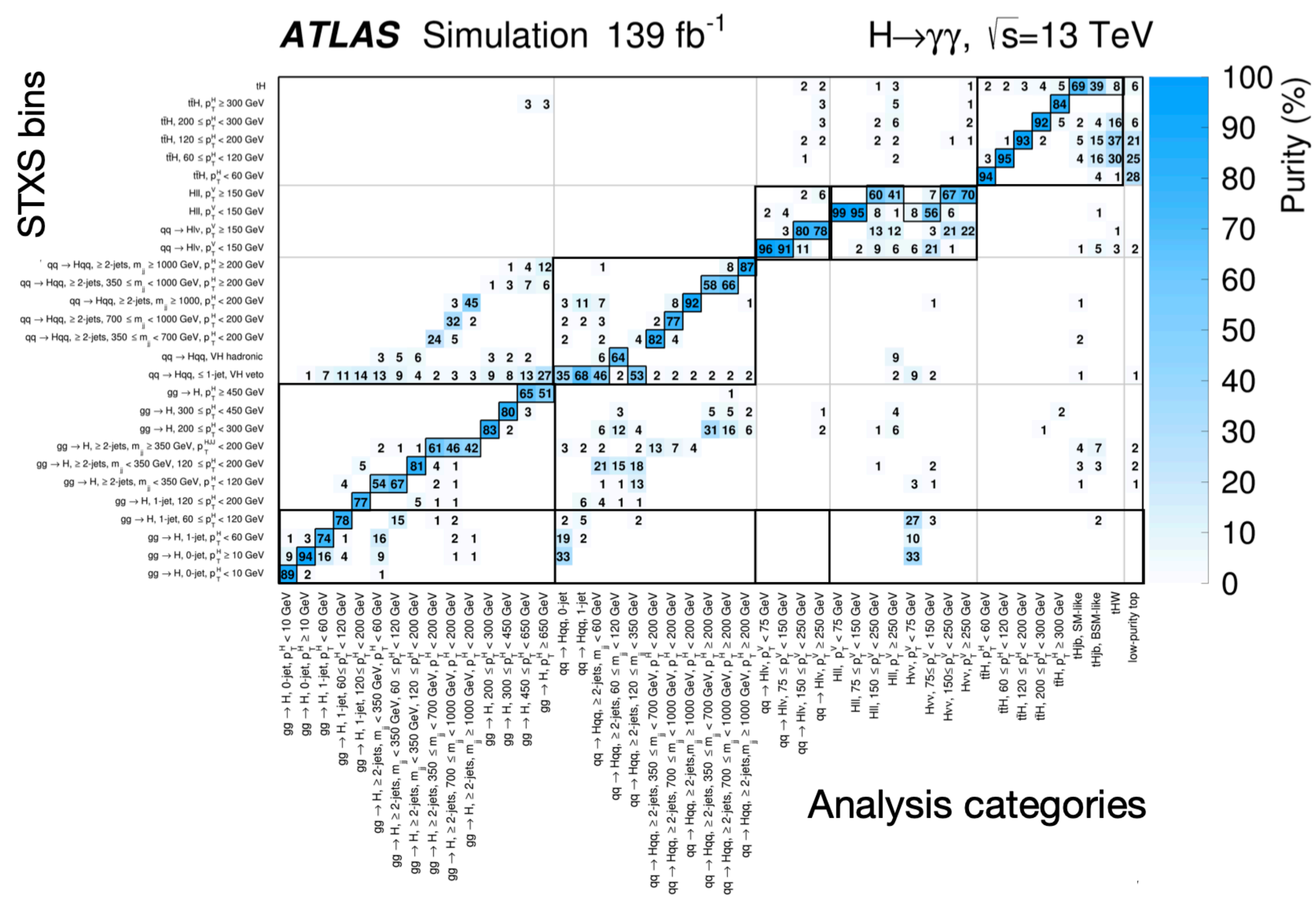
RooUnfold

See them in action!









See them in action!

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DESY 21-130, ISSN 0418-9833

Measurement of lepton-jet correlation in deep-inelastic scattering with the H1 detector using machine learning for unfolding

(The H1 Collaboration)

arXiv:2108.12376v2 [hep-ex] 1 Apr 2022

Unbinned Deep Learning Jet Substructure Measurement in High Q^2 ep collisions at HERA

arXiv:2303.13620v2 [hep-ex] 8 May 2023

New last week!

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

Submitted to: Phys. Rev. Lett.

CERN-EP-2024-132
May 31, 2024

A simultaneous unbinned differential cross section measurement of twenty-four Z+jets kinematic observables with the ATLAS detector

The ATLAS Collaboration

arXiv [hep-ex] 30 May 2024

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

CERN-EP-2022-161
LHCb-PAPER-2022-013
August 25, 2022

Multidifferential study of identified charged hadron distributions in Z-tagged jets in proton-proton collisions at $\sqrt{s}$ =13 TeV

arXiv:2208.11691v1 [hep-ex] 24 Aug 2022

Abstract

Jet fragmentation functions are measured for the first time in proton-proton collisions for charged pions, kaons, and protons within jets recoiling against a Z boson. The charged-hadron distributions are studied longitudinally and transversely to the jet direction for jets with transverse momentum $20 < p_T < 100$ GeV and in the pseudorapidity range $2.5 < \eta < 4$. The data sample was collected with the LHCb experiment at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 1.64 fb^{-1}. Triple differential distributions as a function of the hadron longitudinal momentum fraction, hadron transverse momentum, and jet transverse momentum are also measured for the first time. This helps constrain transverse-momentum-dependent fragmentation functions. Differences in the shapes and magnitudes of the measured distributions for the different hadron species provide insights into the hadronization process for jets predominantly initiated by light quarks.

Submitted to Phys. Rev. D Letter

July 19, 2023

Measurement of CollinearDrop jet mass and its correlation with SoftDrop groomed jet substructure observables in $\sqrt{s} = 200$ GeV pp collisions by STAR

Youqi Song (Wright Laboratory, Yale University)

on behalf of the STAR Collaboration

arXiv:2307.07718v2 [nucl-ex] 18 Jul 2023

Jet substructure variables aim to reveal details of the parton fragmentation and hadronization processes that create a jet. By removing collinear radiation while maintaining the soft radiation components, one can construct CollinearDrop jet observables, which have enhanced sensitivity to the soft phase space within jets. We present a CollinearDrop jet measurement, corrected for detector effects with a machine learning method, MultiFold, and its correlation with groomed jet observables, in pp collisions at $\sqrt{s} = 200$ GeV at STAR. We demonstrate that the population of jets with a large non-perturbative contribution can be significantly enhanced by selecting on higher CollinearDrop jet mass fractions. In addition, we observe an anti-correlation between the amount of grooming and the angular scale of the first hard splitting of the jet.

PRESENTED AT

DIS2023: XXX International Workshop on Deep-Inelastic Scattering and Related Subjects,
Michigan State University, USA, 27-31 March 2023

Available on the CERN CDS information server

CMS PAS SMP-23-008

CMS Physics Analysis Summary

Contact: cms-pag-conveners-smp@cern.ch

2024/06/03

New last week!

Measurement of event shapes in minimum bias events from pp collisions at 13 TeV

The CMS Collaboration

Abstract

This note presents a measurement of event-shape variables using a data sample of low-pileup inelastic proton-proton collisions collected by the CMS detector at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 64 μb^{-1}. A number of observables related to the overall distribution of charged particles in the collisions is corrected for detector effects and compared to simulations. Inclusive event-shape distributions, as well as event shapes as a function of charged-particle multiplicity, are studied. None of the models investigated, including EPOS, one HERWIG7 tune, and several PYTHIA8 tunes, are able to satisfactorily describe the data. Moreover, there are significant trends in this misdescription that are common amongst all generator setups studied, particularly showing data being more isotropic than any of the simulations. Multidimensional unfolded distributions are provided, along with their correlations.

+CMS open data study

Challenges!

Which method(s)?

How to pick regularization?

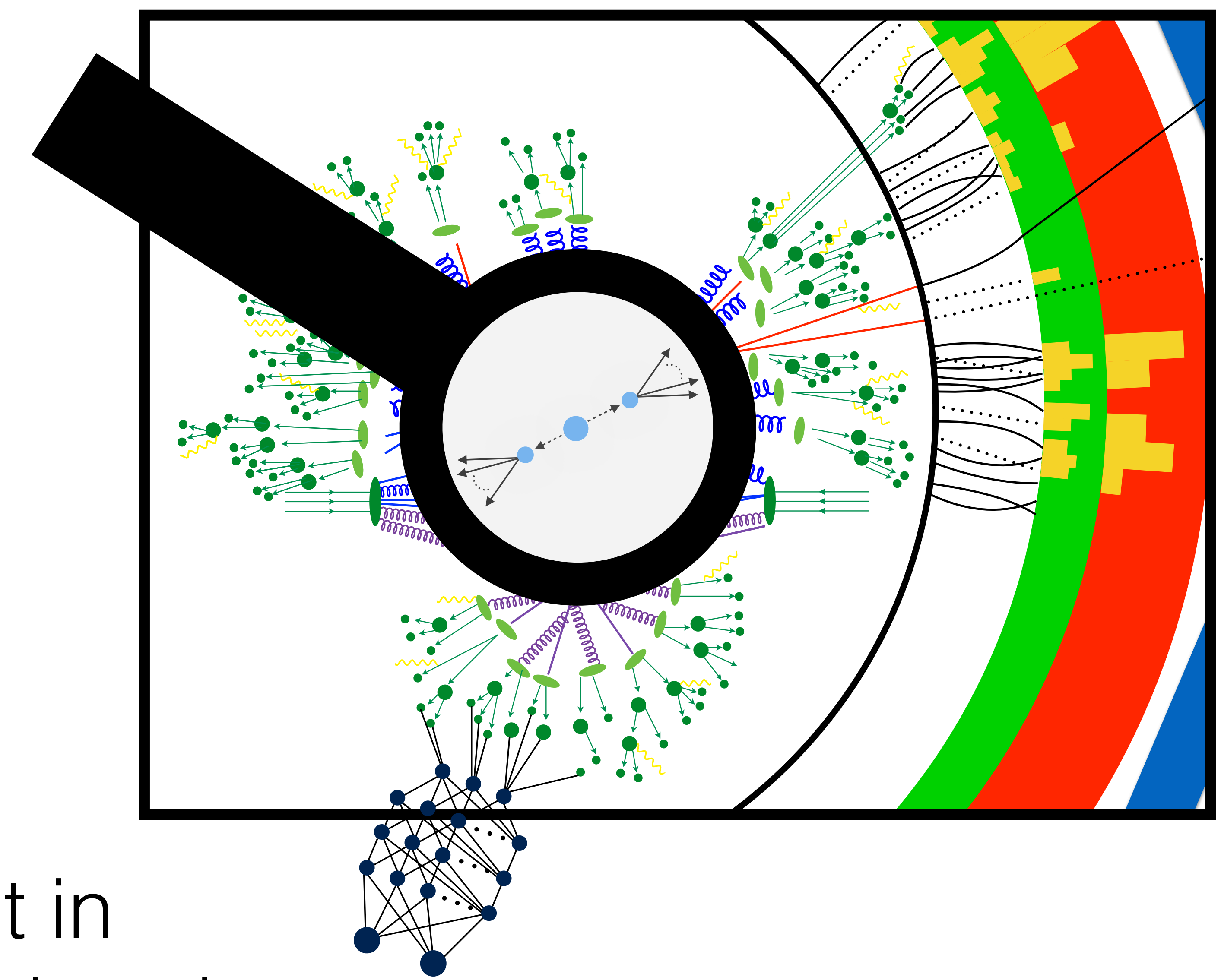
What/how uncertainties?

How to present results?

The conversation continues…

Unfolding is an active field !

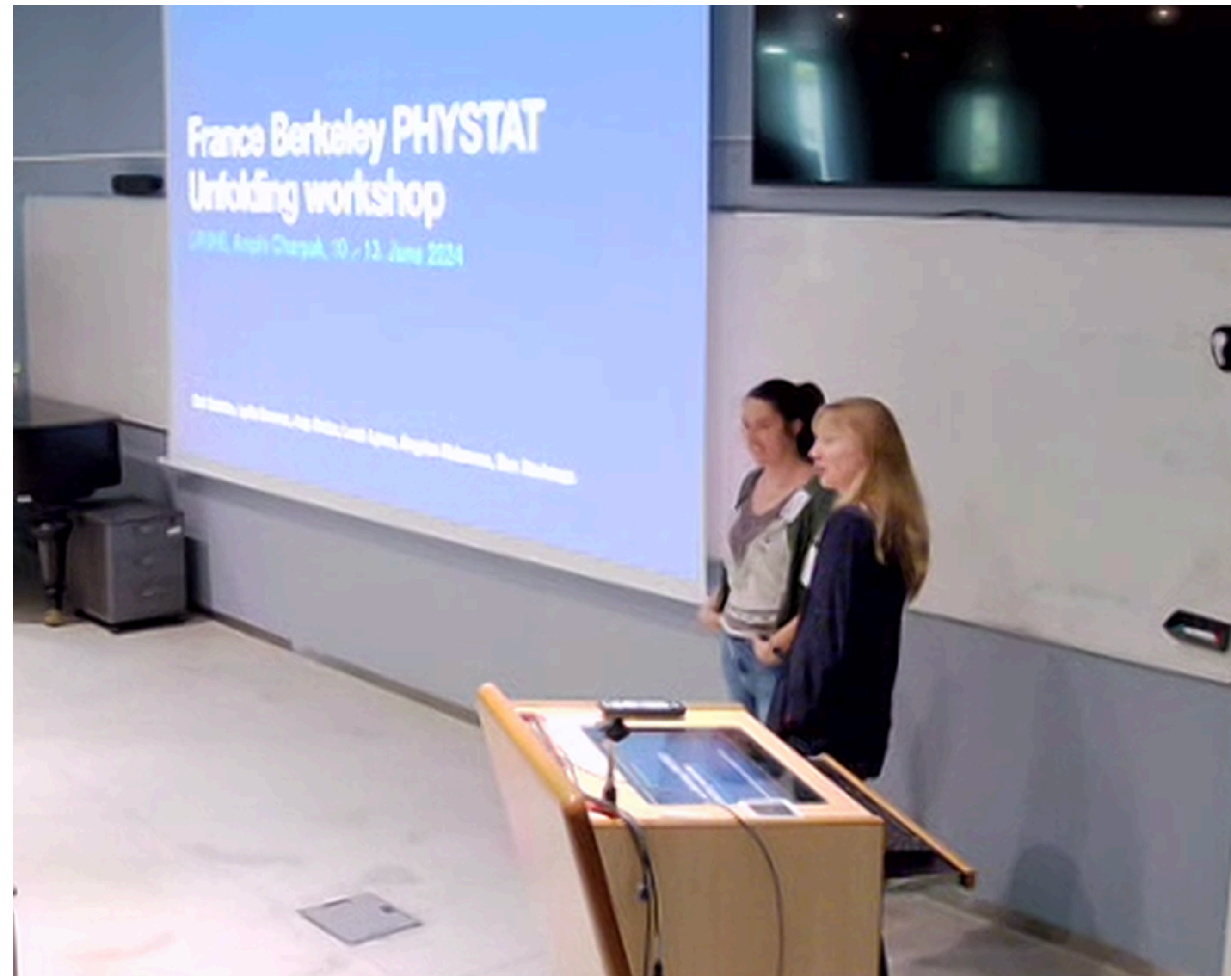
Interesting progress in both binned and unbinned approaches.



More R&D is required, but in parallel, new tools/ideas are already starting to **deliver science results**!

Thank you for the great discussions!

Thank you !!



φ STAT

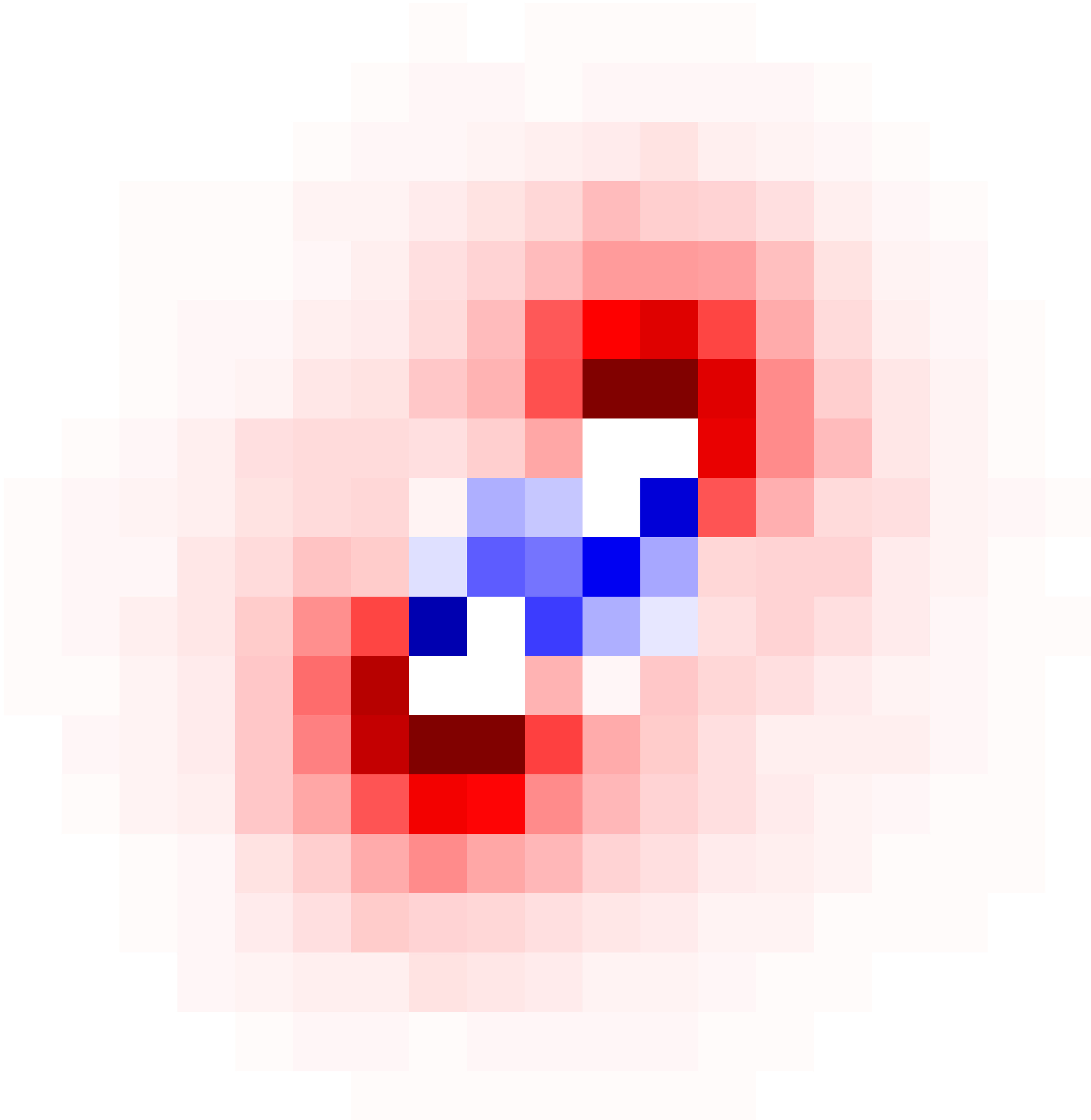
FRANCE-BERKELEY FUND
FONDS FRANCE-BERKELEY

Safe travels home !

Let's see how the future unfolds, for unfolding …

(not my pun!)

Dall E 2's take on "RooUnfold"



Fin.